SEL-2020

COMMUNICATIONS PROCESSOR

INSTRUCTION MANUAL

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CAUTION: Never work on the SEL-2020 with the front or top cover removed, when the SEL-2020 is energized.

ATTENTION: Ne jamais travailler sur le SEL-2020 avec le panneau avant ou du dessus enlevé, quand le SEL-2020 est sous-tension.

CAUTION: There is danger of explosion if the battery is incorrectly replaced. Replace only with Ray-O-Vac® no. BR2335 or equivalent recommended by manufacturer. Dispose of used batteries according to the manufacturer's instructions.

ATTENTION: Il y a un danger d'explosion si la pile électrique n'est pas correctement remplacée. Utiliser exclusivement Ray-O-Vac® No. BR2335 ou un équivalent recommandé par le fabricant. Se débarrasser des piles usagées suivant les instructions du fabricant.

CAUTION: The SEL-2020 contains devices sensitive to electrostatic discharge (ESD). When working on the device with front or top cover removed, work surfaces and personnel must be properly grounded or equipment damage may result.

ATTENTION: Le SEL-2020 contient des composants sensibles aux décharges électrostatiques (DES). Quand on travaille sur l'appareil avec le panneau avant ou du dessus enlevé, les surfaces de travail et le personnel doivent être correctement mis à la terre pour éviter les dommages à l'équipement.

CAUTION: Frequent archive record clearing may exceed EEPROM capabilities. See the discussion in the Archive Data Region subsection of ***Section 9: Database***. If you completely clear an archive region that contains a large number of records (thousands of records), it may take a few minutes for the clearing to complete. During this time, most SEL-2020 automatic data collection will be suspended.

ATTENTION: De fréquentes suppressions d'archives pourraient dépasser la limite des EEPROM. Se référer à la discussion dans la sous-section Région des Données d'Archives de la ***Section 9: Banque de Données***. Si vous supprimez une zone d'archives qui contient un grand nombre d'enregistrements (par milliers), l'opération pourrait prendre quelques minutes. Pendant ce temps, la collecte automatique de données du SEL-2020 sera suspendue.

CAUTION: Frequent archive record clearing may exceed EEPROM capabilities. See the discussion in the Archive Data Region subsection of ***Section 9: Database***.

ATTENTION : Des suppressions fréquentes d'enregistrements d'archives peuvent dépasser la limite des EEPROM. Se référer à la discussion dans la sous-section Région des Données d'Archives de la ***Section 9: Banque de Données***.

CAUTION: Frequent archive record clearing may exceed EEPROM capabilities. Refer to the following paragraphs.

ATTENTION: Des suppressions fréquentes d'enregistrements d'archives peuvent dépasser la limite des EEPROM. Se référer aux paragraphes suivants.

WARNING: Do not rely upon pins 5 and 9 for safety grounding, because their current-carrying capacity is less than control power short circuit and protection levels.

AVERTISSEMENT: Ne pas se fier aux broches 5 et 9 pour une mise à la terre sécuritaire: leur limite de support en courant est inférieure au niveau de court-circuit assuré par la protection.

WARNING: This device is shipped with default passwords. Default passwords should be changed to private passwords at installation. Failure to change each default password to a private password may allow unauthorized access. SEL shall not be responsible for any damage resulting from unauthorized access.

AVERTISSEMENT: Cet appareil est expédié avec des mots de passe par défaut. A l'installation, les mots de passe par défaut devront être changés pour des mots de passe confidentiels. Dans le cas contraire, un accès non-autorisé à l'équipement peut être possible. SEL décline toute responsabilité pour tout dommage résultant de cet accès non-autorisé.

WARNING: Removal of this front panel exposes circuitry which may cause electrical shock that can result in injury or death.

AVERTISSEMENT: Le retrait du panneau avant expose à la circuiterie qui pourrait être la source de chocs électriques pouvant entraîner des blessures ou la mort.

DANGER: Contact with instrument terminals may cause electrical shock which can result in injury or death.

DANGER: Le contact avec les bornes de l' instrument peut causer un choc électrique pouvant entraîner des blessures ou la mort.

MANUAL CHANGE INFORMATION

The date code at the bottom of each page of this manual reflects the creation or revision date. Date codes are changed only on pages that have been revised and any following pages affected by the revisions (i.e., pagination). If significant revisions are made to a section, the date code on all pages of the section will be changed to reflect the revision date.

Each time revisions are made, both the main table of contents and the affected individual section table of contents are regenerated and the date code is changed to reflect the revision date.

Changes in this manual to date are summarized below (most recent revisions listed at top).

Revision Date	Summary of Revisions
The ***Manual Change Information*** section has been created to begin a record of revisions to this manual. All changes wll be recorded in this Summary of Revisions table.	
20010518	Reissued entire manual to reflect the following changes: Updated to new manual format Data Sheet, **Specifications** – Specified temperature range of external wires for CSA certification Appendix A, **Firmware Versions** – Additions
20010309	Inside Front Cover, Added Cautions, Warnings, and Dangers in English and French Data Sheet, Added new power supply option Section 2, Added new power supply option to page 2-21 (all pages reissued) Section 3, Additions (all pages reissued) Section 10, **Battery Replacement** – Caution Additions; clarifications throughout (all pages reissued)
20000512	Appendix B, **Optional Internal Modem Information** - Additions
20000427	Section 9, **Table 9.5** – Additions, format changes throughout (all pages reissued) Appendix I, **Table I.2** – Addition
20000221	Section 6, Corrections – (pages 1 - 42 reissued) Appendix A, **Firmware Versions** - Additions Appendix B, **Optional Internal Modem Information** - Changes
991222	Section 6, **Set M Examples** - Additions Section 6, **Set G – Global Settings** - Additions Section 6, **Table 6.17** - Additions Section 6, **Table 6.18** - Additions Appendix A, **Firmware Versions** - Additions Appendix I, **Internal Indication Object** - Additions

Revision Date	Summary of Revisions
	Appendix I, **Time Synchronization** - Additions
991021	Appendix A, **Firmware Versions** - Additions
990805	Section 5, **PORT n (Access Level 1)** - Additions Section 6, Additions (all pages reissued)
990319	Section 6, **Table 6.3** - Additions Section 6, **Table 6.4** - Additions Section 8, **Table 8.2** - Additions Section 9, **Table 9.5** - Additions Appendix G, Cross reference corrections Message Strings, Additions
981202	Section 4, Example 1 - Additions Appendix B, **Optional Internal Modem Information** - Additions
980724	Appendix A, **Firmware Versions -** Additions
980626	Section 3, **Table 3.2** - Clarifications
980515	Section 6, **Character String (Parse = 3)** - Additions and Clarifications Section 6, **Parsing Delays** - Additions Section 8, **Table 5.2** - Clarifications Section 9, **Figure 9.2** - Clarifications Section 9, **Port Status Register** - Additions Appendix A, **Firmware Versions -** Additions Appendix E, **Table E.1 & E.4** - Additions Appendix F, **SEL-2020 Compatibility** - Additions Appendix G, **Modbus Protocol** - Additions Appendix H, ***Fast Operate* Configuration** - Clarification Appendix I, **Table I.2** - Additions Appendix I, **Internal Indication Object** - Additions Appendix I, **Time Synchronization** - Additions
980116	Appendix A, **Firmware Versions -** Additions Appendix G, **Example #1** - Clarification
971103	Appendix A, **Firmware Versions -** Additions

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971029	Appendix A, **Firmware Versions -** Additions Appendix E, **Table E.1 & E.4 -** Additions Appendix F, **SEL-2020 Compatibility** - Additions Appendix G, **Modbus Protocol** - Additions
970825	Section 8, **Table 8.2** - Additions Section 8, **SEL-2020 Strings** - Additions Appendix E, **Table E.2** - Clarifications
970815	Section 4, **Example 1** - Clarifications in the "View 1:Global" screen capture and the "Set P 8" screen capture Section 4, **Example 9** - Additions in the "Set A 1" screen capture Section 7, **Processing Sequence** - Clarifications Section 8, **Table 8.2** - Additions Section 8, **SEL-2020 Strings** - Additions Section 9, **Table 9.2** - Additions and Deletions Appendix A, **Firmware Versions -** Additions Appendix H, - Formatting correction Appendix I, **Table I.3** - Clarifications and formatting corrections (pages I-1 to I-14 reissued)
970729	Appendix, B, **Optional Internal Modem Information** - Additions
970521	Appendix A, **Firmware Versions -** Additions
970514	Section 9, **Table 9.5** - Clarifications
970425	Section 1, Formatting Section 2, **Table 2.2** - Addition of new element Section 2, **Local Region** - Additions Section 6, **SET M - Math/Data Movement Settings** - Additions (pages 6-35 to 6-59 reissued) Section 6, **Worksheet SET M -** Clarifications Section 8, **Table 8.2** - Additions (all pages reissued) Section 8, **SEL-2020 Strings** - Additions Section 9, **Table 9.6** - Additions (pages 9-12 to 9-21 reissued) Section 9, **Local Elements** - Additions Section 9, **Table 9.7** - Additions Section 9, **Access by Bit** - Additions

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	Appendix A, **Firmware Versions -** Additions Appendix G, **Modbus Protocol** - Additions (all pages reissued)
970408	Section 2, **Receive Messages and Data** - Addition in Solicited Messages and Data Section 2, **Database Structure** - Additions in D1 to D8 Regions Section 2, **Data Parsing Options** - Additions in Non-"20" Message Response Section 2, **SET A - Auto Message Settings (Ports 1 - 16)** - Addition in DELAYn Section 3, **Alarm Contact Connection** - Clarification Section 4, **Figure 4.8** - Clarification Section 4, **Example 6, Operation** - Clarification Section 4, **Example 6, Set the SEL-2020, Step-By-Step** - Addition in 3b screen capture Section 4, **Example 9, Set the SEL-2020, Step-By-Step** - Clarification Section 5, **Table 5.1** - Add DEFRAG command Section 5, **AUTOn (Access Level 1)** - Additions Section 5, **DEFRAG (Access Level 2)** - Additions Section 5, **Help (Access Level 0)** - Additions Section 5, **SEL-2020 COMMAND SUMMARY -** Add DEFRAG command Section 6, **Table 6.3**, Add SETTLE1 and SETTLE2 settings Section 6, **Table 6.4**, Add SETTLE1 and SETTLE2 settings Section 6, **Data Parsing Options** - Additions Section 6, **Data Parsing Options** - Addition of Parse Option 5 Section 6, **Figure 6.6** - Additions Section 6, **Figure 6.7** - Additions Section 6, **Table 6.10 -** Additions Section 6, **Automated Control -** Additions Section 6, **Setting Sheets** - Additions Section 8, **Table 8.2** - Additions Section 8, **Message Sequences** - Addition of example Section 8, **SEL-2020 STRINGS Summary Sheet** - Additions Section 9, **Local Data Region (LOCAL)** - Additions Section 9, **Data Regions (D1-D8)** - Additions Appendix A, **Firmware Versions -** Additions

Revision Date	Summary of Revisions
	Appendix B, **Dial Strings -** Clarification Appendix E, **Table E.1 -** Addition of new relays Appendix E, **Table E.4 -** Addition of new relays Appendix F, **SEL-2020 Compatibility -** Addition of new relays Appendix G, **Hardware Connections and RTS Line Usage** - Additions Appendix G, **Message Framing -** Additions in Read Coil Status, Clarification in Force Single Coil Appendix G, **Table G.1 -** Clarification in SEL-279, Addition of new relays, Clarification in SEL-551 Appendix G, **Table G.2 -** Addition of new relays, Clarification in SEL-551 Appendix G, **Table G.3 -** Addition of new relays, Clarification in SEL-167/267, Clarification in SEL-167D/267D Appendix G, **Table G.4 -** Addition of new relays Appendix G, **Table G.5 -** Addition of new relays, Clarification in SEL-587 Appendix G, **Table G.6 -** Addition of new relays, Clarification in SEL-587 Appendix G, **Table G.7 -** Addition of new relays Appendix G, **Table G.8 -** Addition of new relays

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SECTION 1: INTRODUCTION

Section 1 provides you with a useful introduction to this manual and to the SEL-2020 Communications Processor. This section includes four parts: an Overview of the Manual; a List of Acronyms, Abbreviations, and Glossary Terms; Procedure for Initial Checkout; and an SEL-2020 Data Sheet with specifications.

We, the employee owners of Schweitzer Engineering Laboratories, Inc., are dedicated to making electric power safer, more reliable, and more economical. The SEL-2020 Communications Processor is designed to meet that goal.

We appreciate your interest in SEL products and we are dedicated to making sure you are satisfied. If you have any questions about the SEL-2020 or the manual, please contact us at :

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We guarantee prompt, courteous, and professional service.

We appreciate any comments and suggestions about new products or product improvements that would help us make your job easier.

Overview of the Manual

Background Information

This manual is designed to help you make the most effective use of the SEL-2020 Communications Processor, from the most basic to the most advanced applications. Each section begins with a detailed table of contents followed by a short paragraph summarizing the main areas of the section. The manual also includes the following helpful aids:

- Cross-references.
- Sample screens with notations
- Numbered steps for sequential instructions and diamond-shaped bullets for nonsequential instructions.
- Many explanatory figures, tables, and illustrations.
- Caution symbols to ensure your safety and the protection of the equipment.
- Pull-out lists on SEL-2020 commands and on special characters and pre-defined strings.

Section Highlights

The following list summarizes the main purpose of each section:

- ***Section 2: General Description***, describes the SEL-2020's special features and their benefits to the user.
- ***Section 3: Installation***, includes information and procedures you should be familiar with to install the SEL-2020 safely and effectively.
- ***Section 4: "Job Done" Examples***, describes SEL-2020 operations and user interface with nine examples that include a variety of common applications.
- ***Section 5: Commands***, describes the command set that you use to control, monitor, operate, and set the SEL-2020. This section also includes the rules governing the use of these commands. A list summarizing the commands appears at the end of this section and on a blue pull-out card at the back of the book.
- ***Section 6: Settings***, provides detailed information about the commands used to configure and control the SEL-2020 and explains how you should respond to the SEL-2020 settings prompts. The SEL-2020 setting sheets are included at the end of ***Section 6: Settings***.
- ***Section 7: SELOGIC® Control Equations***, covers SELOGIC Control Equation operation, inputs, syntax, and outputs.
- ***Section 8: Message Strings***, provides information about the characters, and pre-defined strings that you can use in a number of SEL-2020 settings. At the end of this section and also on a blue pull-out card at the end of the book is a summary list of special characters and pre-defined strings.
- ***Section 9: Database***, describes the structure of the SEL-2020 database and the various ways data within the database can be accessed.
- ***Section 10: Maintenance***, describes the minimal maintenance steps you should follow to keep the SEL-2020 operating properly. This section also includes a guide to troubleshooting and alarm diagnosis.

Appendices

The following appendices provide supplemental reference information:

- ***Appendix A: Firmware Versions***
- ***Appendix B: Optional Internal Modem Information***
- ***Appendix C: LMD Protocol***
- ***Appendix D: ASCII Reference Table***
- ***Appendix E: Planning Sheets***
- ***Appendix F: SEL-2020 Compatibility***
- ***Appendix G: Modbus® Protocol***
- ***Appendix H: Configuration and Fast Operate Commands***
- ***Appendix I: Distributed Network Protocol (DNP) V3.00***

List of Acronyms, Abbreviations, and Glossary Terms

Acronym/ Abbreviation	Definition
ASCII	American National Standard Code for Information Interchange
CPU	Central Processor Unit
CTS	Clear-To-Send
DNP	Distributed Network Protocol
EEPROM	Electronically Erasable Programmable Read-Only Memory
EIA	Electronic Industries Association
ESD	Electrostatic Discharge
FID	Firmware Identification
Flash Memory	Nonvolatile memory (retains data when power is removed)
GOES	Geostationary Operational Environmental Satellite
GPS	Global Positioning System
HMI	Human Machine Interface
IED	Intelligent Electronic Device
IRIG-B	Inter-Range Instrumentation Group (U.S. Government)
LMD	LMD Protocol
LPS	Linear Power Supply
LSB	Least Significant Bit
MOV	Metal Oxide Varistor
MSB	Most Significant Bit
Parse	To separate an item into its component parts and decide which parts to keep
PS	Power Supply
RTS	Request-To-Send
RTU	Remote Terminal Unit
RXD	Receive
SCADA	Supervisory Control and Data Acquisition
TTL	Transistor-Transistor Logic (0 Vdc to +5 Vdc)
TXD	Transmit
XON	Transmit ON character
XOFF	Transmit OFF character

Initial Checkout

Perform the following steps to ensure that the SEL-2020 communicates:

1. Visually inspect the SEL-2020 for loose or damaged parts.
2. Connect and apply power to the SEL-2020. (See the PWR SUP field on the rear-panel nameplate for power requirements.) If you do not have the proper voltage source available, use a power supply, like the SEL-LPS, to power the unit.
3. Press and hold the LED TEST button and confirm that all LEDs illuminate.
4. Connect a terminal (or computer equipped with terminal emulation software) to the front-panel connector Port F of the SEL-2020 using an SEL-C234A cable or equivalent.

5. Set the computer terminal or emulation software to operate at:
    - 2400 baud
    - 8 data bits
    - 1 stop bit
    - no parity
6. Press **<ENTER>** and verify that a "*" prompt is returned.
7. Type **ACCESS<ENTER>** to change to Access Level 1. Enter the factory-set password by typing **OTTER<ENTER>** at the password prompt. You will see a screen similar to the following:

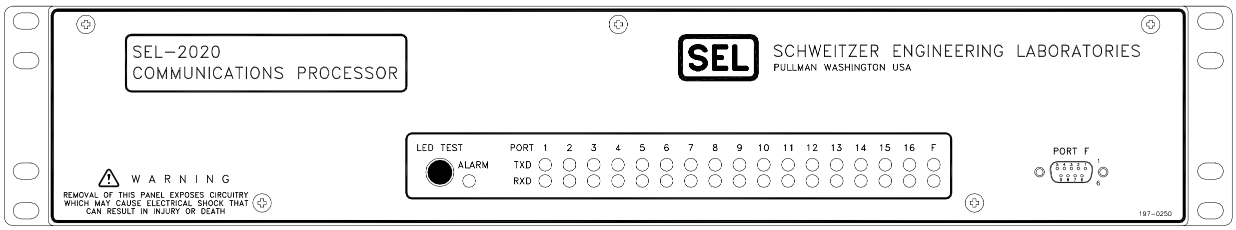
```
*ACCESS<ENTER>

Password: ? OTTER<ENTER>


EXAMPLE 2020 - S/N 94153001              Date: 01/02/90    Time: 06:54:03

Level 1

*>
```

8. Type **STATUS<ENTER>** and verify that a status report similar to the one below appears on your terminal. The RAM memory size should be 512 kb or 1024 kb. If you ordered optional Flash memory, verify that Flash reports 2048 kb. If you did not order optional Flash memory, Absent is reported as in the screen below. Confirm that IRIG-B input, I/O board, and modem configurations match your expectations. The status and communications statistics are shown for the 16 rear-panel ports and the front-panel port. Refer to the STATUS command explanation in ***Section 5: Commands*** for more detailed information.

```
*>>STATUS<ENTER>

COMMUNICATIONS PROCESSOR - S/N 95012004     Date: 03/02/95    Time: 15:32:24
FID=SEL-2020-R100-V0-D950324

SELF-TESTS

RAM       ROM       EEPROM    FLASH     P.S.      SET       BATTERY
512 kb    OK        OK        Absent    OK        OK        OK

IRIG-B Input: Present
I/O Board: Installed
Modem: Installed

Port   Status    Success Rate    SET M    Database Delays
1      Inactive                  None
2      Inactive                  None
3      Inactive                  None
4      Inactive                  None
5      Inactive                  None
6      Inactive                  None
7      Inactive                  None
8      Active                    None
9      Active                    None
10     Inactive                  None
11     Inactive                  None
12     Inactive                  None
13     Inactive                  None
14     Inactive                  None
15     Inactive                  None
16     Inactive                  None
F      Active       100%         None

*>>
```

Refer to the SEL-2020 Data Sheet in this section of the instruction manual, and ***Section 2: General Description*** for more information about the operation and features of the SEL-2020.

SEL-2020 Communications Processor



Data Sheet

General Description: The SEL-2020 Communications Processor is a breakthrough for substation communication and integration. It combines multiport communications, databases and processing, nonvolatile memory, timekeeping and synchronization, alarm monitoring, and auxiliary control into one compact, powerful, economical, easy-to-use, and rugged device.

- Automatically maintains databases for metering, events, and targets.
- Powerful 32-bit computer simultaneously supports 38400 baud on all master ports and 19200 baud on all other ports.
- SELOGIC® control equations coordinate commands, messages, and I/O.
- Auto-configuration features simplify application settings with SEL relays.
- Versatile data-processing power handles most relays, meters, and SCADA systems.
- One device integrates most small substations.
- Easily cascaded for economical large-station solutions.
- Communications processing reduces burden on SCADA and other equipment.
- Handles binary and ASCII communications for versatile application.
- Can be a Modbus® RTU or Distributed Network Protocol (DNP) V3.00 Level 2 slave to ease data collection and system control.

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Product Overview

SEL-2020 Description

The SEL-2020 Communications Processor (SEL-2020) provides many special features needed in today's substations for communicating with a variety of microprocessor-based devices, including digital fault recorders, sequential events recorders (SER), digital meters, and digital relays. The SEL-2020 can function as a simple, but intelligent, port switch. Or it can provide sophisticated communication and data handling capability required for advanced substation integration projects. Data are collected, processed, and stored in the SEL-2020 database, permitting quick distribution of selected data to an RTU (remote terminal unit) or other device. Figure 1 shows an example block diagram configuration of the SEL-2020 with various SEL relays and peripheral devices connected.

Enhanced/Intelligent Port Switching

Unlike conventional port switches, the SEL-2020 can support communications on all active ports — simultaneously — at baud rates up to 19200 or 38400 depending on port configuration. This means that you can communicate locally through the SEL-2020 with one connected intelligent electronic device (IED) at the same time that someone else is communicating remotely through the same SEL-2020 to another connected IED. Other intelligent features, like the SEL-2020 auto-configuration function, make setup and operation much easier than with simple port switches. In advanced applications, where the SEL-2020 is used to collect, store, and distribute information, the simultaneous communication function provides an uninterrupted flow of information from all active IEDs to an RTU or station integration computer; at the same time you can communicate through the SEL-2020, either locally or remotely, with one of the connected relays or IEDs.

Data Collection, Processing, Storage, Distribution

You can collect, store, process, and distribute target, meter, event, status, and other information — virtually all information available from an SEL relay and a variety of information available from other IEDs — with the SEL-2020, using a simple, but powerful, set of communication commands. Likewise, the SEL-2020 reduces the processing burden for these external devices by separating selected data from IEDs so that only the essential information is delivered and in the form and format required.

Substation Integration and Network Interface

Communication and information handling features make the SEL-2020 ideal for substation integration projects, eliminating the need for separate substation network architecture. On larger integration projects, the SEL-2020 reduces or eliminates the need for costly network interface devices, otherwise required for each IED. Inclusion of Modbus and DNP support eases integration with systems that support Modbus or DNP.

Time Synchronization

The SEL-2020 can synchronize the time clocks in attached devices, such as SEL relays, that accept a demodulated IRIG-B time signal. The demodulated IRIG-B signal is regenerated in the SEL-2020 from an external modulated or demodulated source, such as a GOES or GPS satellite clock receiver. If no IRIG-B source is available, the demodulated IRIG-B time signal is generated internally by the SEL-2020.

Optional Expanded Long-Term Information Storage

Long-term information storage, for such functions as alarms, event reports, and load profiles, can be accommodated using optional nonvolatile archive memory.

Optional Input/Output

Optional I/O, consisting of four programmable output contacts and 16 optoisolated inputs, is available for monitoring and control. You can use SELOGIC control equations, written in the SEL-2020 settings, to perform basic control functions such as consolidating alarms and switching adaptive relay setting groups. Jumper configure each output contact as form A or form B through soldered jumper connections. Jumper configure each input with board-level jumper connections, to accept one of three control input voltage ranges, 30-60 Vdc, 80-150 Vdc, or 150-300 Vdc.

Optional Internal Modem

An optional internal modem is also available for the SEL-2020 to reduce external wiring and connections. Whether external or internal, you can use any modem connected to the SEL-2020 to remotely communicate with or through the SEL-2020 to attached devices. Use any telecommunications software that supports ASCII dumb terminal emulation to communicate with and through the SEL-2020; no proprietary software is needed unless it is required by non-SEL IEDs. You can program each SEL-2020 port that is connected to a modem to dial out through the modem to deliver messages, event reports, and other information to computers at remote locations.

Compact Design

The SEL-2020 is available with two mounting styles; one is for mounting in panels and one is for mounting in racks. You can reverse the mounting ears on the rack-mount case for projection mounting. Figure 2 shows the SEL-2020 front and rear panels, both with and without the optional I/O board. Refer to Figure 5 for dimensions and rack-mount drill plan, and Figure 6 for panel-mount cutout and drill plan.

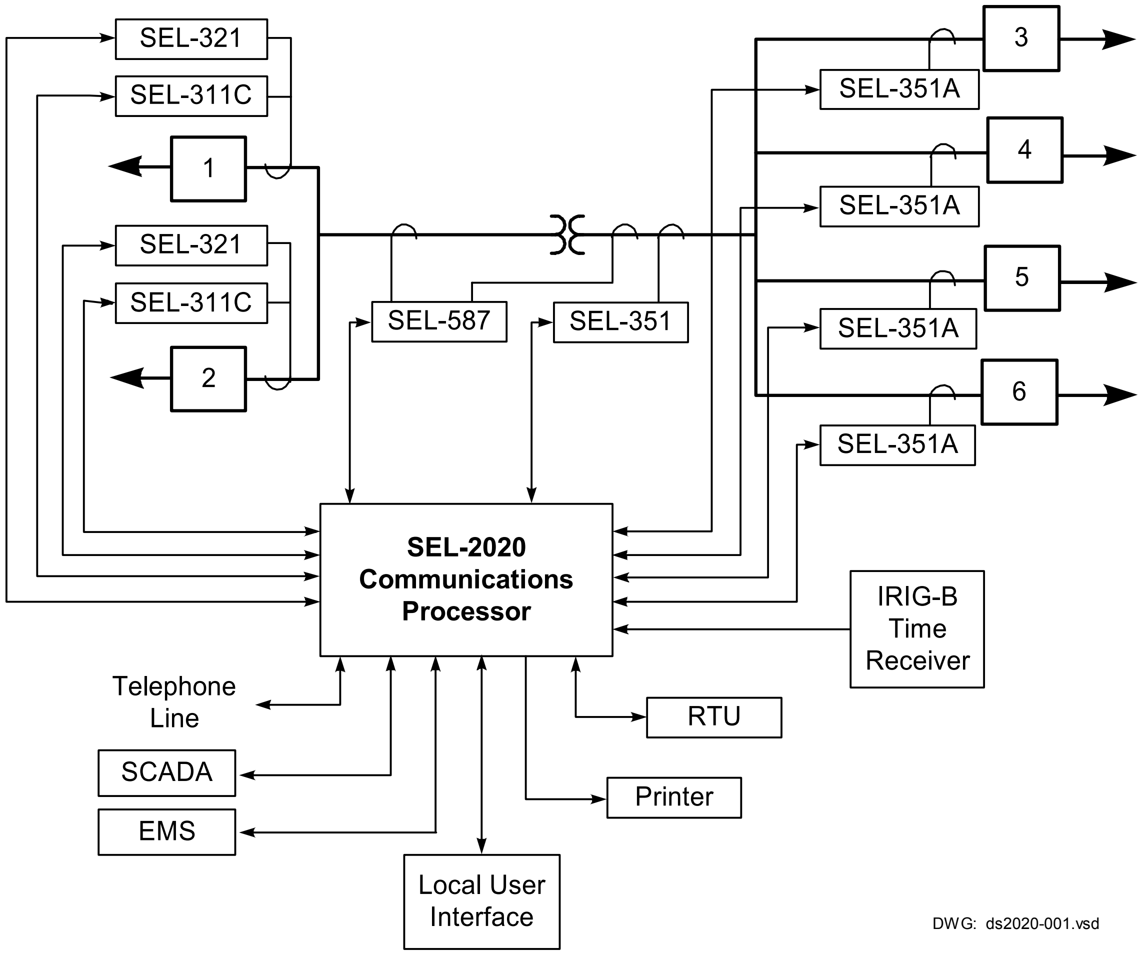


Figure 1: SEL-2020 Example Configuration Diagram

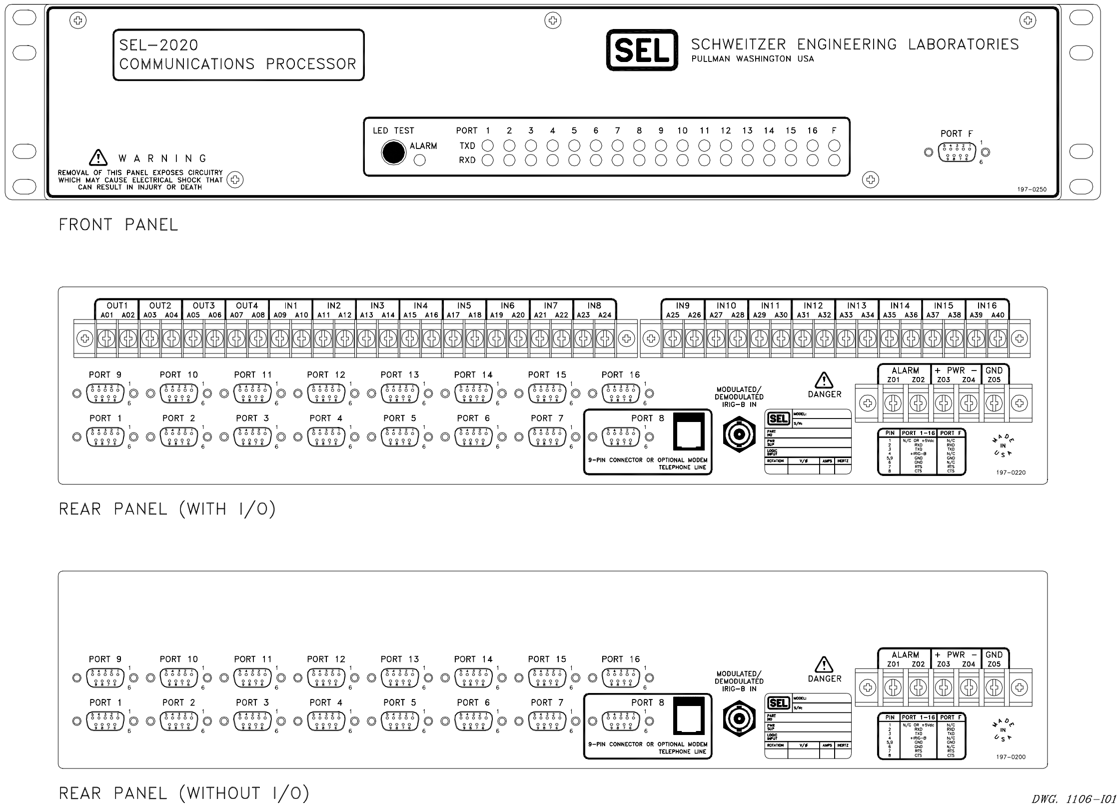


Figure 2: SEL-2020 Front and Rear Panels

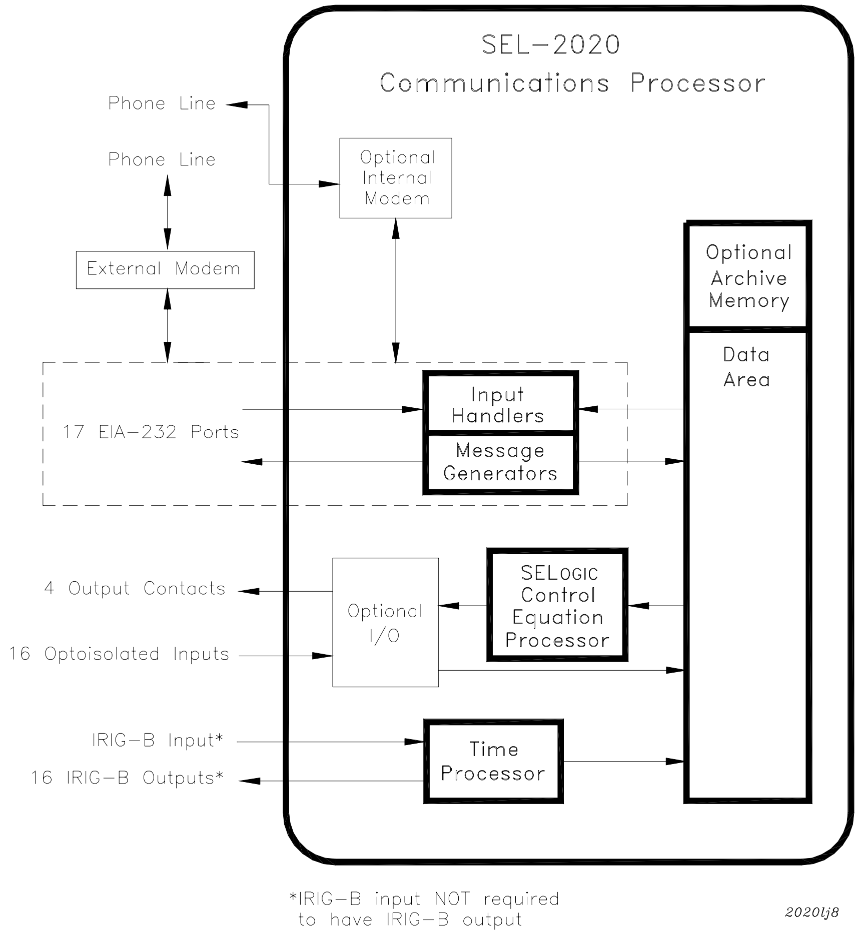


Figure 3: SEL-2020 Functional Model

Functional Model

Figure 3 shows a functional model of the SEL-2020 including the Input Handlers, Message Generators, Data Area, SELOGIC Control Equations Processor, Time Processor, optional I/O, optional nonvolatile archive memory and optional Internal Modem.

Input Handler/Message Generator

There is an Input Handler and Message Generator for each serial port. When you communicate with the SEL-2020 using the command set, the Input Handler separates the commands into their basic components. The Input Handler sends data to the Data Area and directs the Message Generator to make a response based on the SEL-2020 settings that you have defined.

When you use the SEL-2020 as a port switch, the Input Handler places collected data in the Data Area, and the Message Generator reads and outputs these data to a designated port. The Input Handler also stops communication when it recognizes the default termination condition or a termination condition you have defined in settings.

Messages are predefined responses that may include data, responses to special-purpose user-defined commands, and automatic messages that you have defined in settings and that are triggered by SELOGIC control equations. You can use relay automatic messages to initiate data collection by setting the SEL-2020 to collect and store data when an unsolicited message is received. For example, receiving a summary event report could trigger the SEL-2020 to send the EVENT command back to the relay. The relay would respond with the long event report, and the SEL-2020 could then save it. You can store the data in volatile RAM or in the optional nonvolatile archive memory.

Data Area With Automatic Database

The Data Area is divided into regions of volatile (RAM) and nonvolatile memory. The SEL-2020 stores settings in nonvolatile memory. The SEL-2020 is unique in its ability to receive, parse, store, and distribute data. The SEL-2020 automatically parses data from SEL relays, and has several parsing options for data from other devices. Additional nonvolatile archive memory is an option you can use for long-term data storage.

SELOGIC Control Equations Processor

The SELOGIC Control Equations Processor executes Boolean equations that you write to trigger transmission of messages. The Boolean values in the equations can be logic bits from the Data Area or comparisons against the present time. You can program the SEL-2020 to recognize user-defined commands and to set a bit in the Data Area when it receives one of these commands. The SELOGIC Control Equations Processor can then use this bit to initiate another operation, such as collecting data or transmitting a message. The SELOGIC Control Equations Processor also controls the optional I/O.

Arithmetic building blocks include addition, subtraction, multiplication, and division.

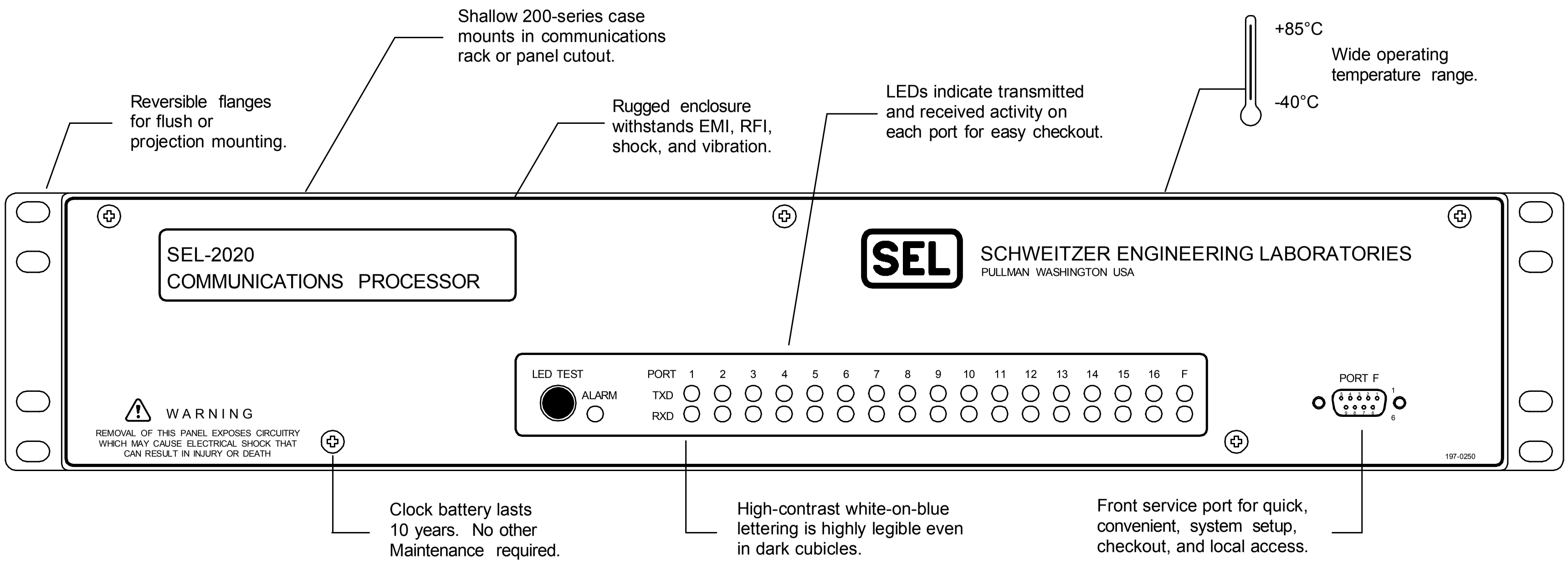
Time Processor

The Time Processor keeps the date and time, reads IRIG-B time input (if it is present), and broadcasts demodulated IRIG-B time code to all rear-panel serial ports. It also time-tags data stored in the Data Area and supplies time and day of the week input to the SELOGIC Control Equations Processor.

Optional I/O

If the optional I/O is installed, the inputs and outputs operate with the Data Area and the SELOGIC Control Equations Processor. Optoisolated inputs feed directly into the Data Area as logic bits, which you can view using SEL-2020 commands. You can program SELOGIC control equations to use the bits. The SELOGIC Control Equations Processor controls the output contacts on the I/O board. These output contacts can be programmed to operate based on Data Area bits or time comparisons. This powerful capability lets you build adaptive relay schemes, automate responses to alarms, and directly control power apparatus.

Integrate New and Existing Substations Today Using the SEL-2020 Communications Processor



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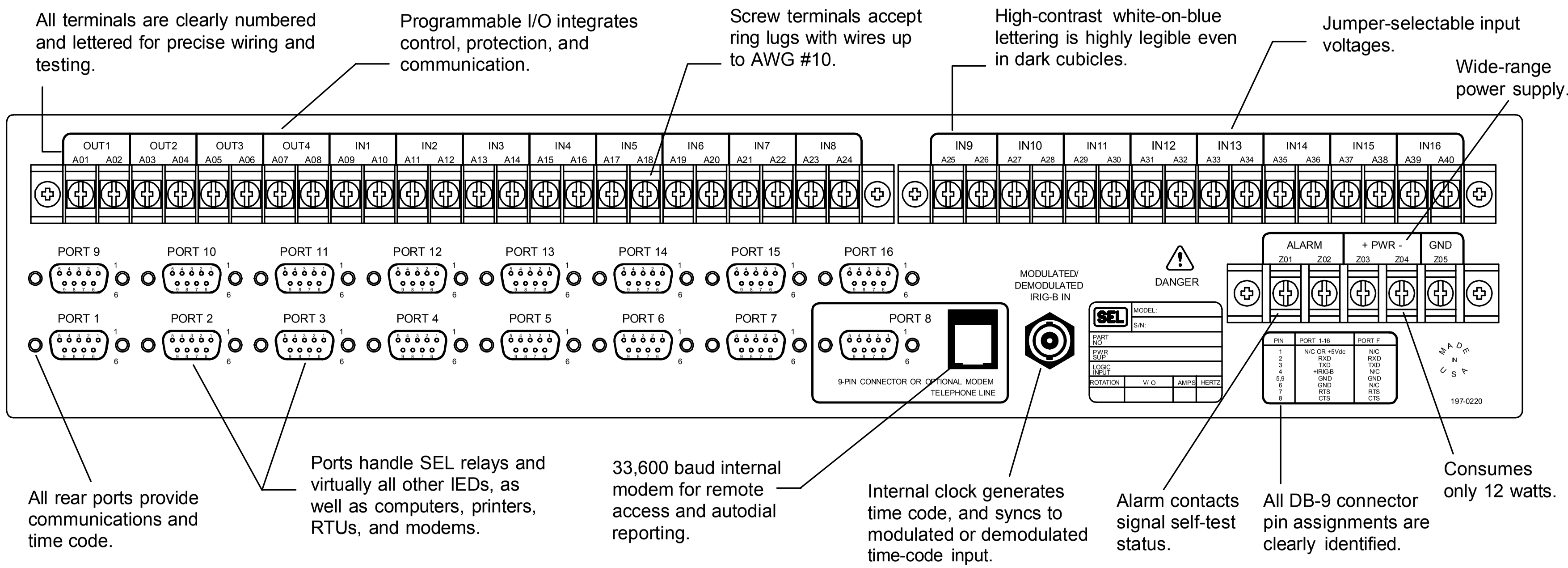

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SPECIFICATIONS

Output Contacts

Make: 30 A
Carry: 6 A continuous carry at 70°C, 4 A continuous carry at 85°C
One-second rating: 50 A
MOV protected: 270 Vac, 360 Vdc, 40 J
Pickup time: Less than 5 ms
Dropout time: Less than 5 ms, typical.

Breaking Capacity (10,000 operations):

24 V	0.75 A	L/R = 40 ms
48 V	0.50 A	L/R = 40 ms
125 V	0.30 A	L/R = 40 ms
250 V	0.20 A	L/R = 40 ms

Cyclic Capacity (2.5 cycles/second):

24 V	0.75 A	L/R = 40 ms
48 V	0.50 A	L/R = 40 ms
125 V	0.30 A	L/R = 40 ms
250 V	0.20 A	L/R = 40 ms

Note: Make per IEEE C37.90: 1989; Breaking and Cyclic Capacity per IEC 60255-23 [IEC 255-23]: 1994.

Optoisolated Input Ratings

The optoisolated inputs each draw 4 mA when nominal control voltage is applied.
Level-Sensitive Inputs (Six inputs total, basic version)

48 Vdc:	Operate (pickup) 38.4–60 Vdc;	Dropout 28.8 Vdc
125 Vdc:	Operate (pickup) 105–150 Vdc;	Dropout 75 Vdc
250 Vdc:	Operate (pickup) 200–300 Vdc;	Dropout 150 Vdc

Tightening Torque

Minimum: 7-in-lb (0.8 Nm)
Maximum: 12-in-lb (1.4 Nm)

Terminal Connections

Terminals or stranded copper wire. Ring terminals are recommended. Minimum temperature rating of 105°C.

Power Supply

Rated:	125/250 Vdc or Vac
Range:	85–350 Vdc or 85–264 Vac
Burden:	<25 W
Rated:	48/125 Vdc or 125 Vac
Range:	38–200 Vdc or 85–140 Vac
Burden:	<25 W
Rated:	24/48 Vdc
Range:	20–60 Vdc polarity dependent
Burden:	<25 W

Dielectric Strength

Power supply, logic inputs, and output contacts: 3000 Vdc for10 seconds.

Operating Temp.

–40° to +185°F (–40° to +85°C).
Optional Internal Modem: –40° to +158°F (–40° to +70°C).

Unit Weight

7 lb, 12 oz (3.50 kg).

Dimensions

3.47" H x 19.00" W x 9.00" D (8.81 cm x 48.26 cm x 22.86 cm).

Type Tests and Standards

IEEE C37.90.1 IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.
Logic inputs, output contacts, and power supply.

IEEE C37.90.2 IEEE Trial-Use Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.

5.5.2 (2)	Performed with 200 frequency steps per octave.
5.5.3	*Digital Equipment Modulation Test* not performed.
5.5.4	Test signal turned off between frequency steps to simulate keying.

IEC 68-2-30 Damp heat, cyclic (12 + 12-hour cycle).
Humidity, 95% between 25° and 55°C.

IEC 255-5 Impulse voltage test: 0.5 Joule, 5000 Volt.
Logic inputs, output contacts, and power supply.

IEC 255-21-1 Vibration test (sinusoidal).

IEC 255-21-2 Shock and bump tests.

IEC 255-22-1 Electrical disturbance tests for measuring relays and protection equipment, Part 1: 1 MHz burst disturbance tests.
Logic inputs, output contacts, and power supply.

IEC 801-2 Electrical discharge requirements.
Logic inputs, output contacts, time-code input, power supply, EIA-232 ports, and modem port.

IEC 801-4 Electrical fast transient/burst requirements.
Logic inputs, output contacts, power supply, and EIA-232 ports.

Serial Ports

1 front-panel/16 rear-panel ports, DB-9 connectors, MOV protected.
(Port 8 dedicated to EIA-232 or optional internal modem).

Real-Time Clock/ Calendar

Battery Type:	IEC No. BR2335 Lithium.
Battery Life:	10 years.
Clock Accuracy:	±20 min/yr @ 25°C (without power applied).
	±1 min/yr @ 25°C (with power applied).
	±1 ms with IRIG-B time-code input.

Baud Rates

300, 600, 1200, 2400, 4800, 9600, 19200, 38400.

Time-Code Input

Connector:	Female BNC.
Time Code:	Modulated IRIG-B 1000 Vdc isolation.
	Demodulated IRIG-B TTL-compatible.

Automatically sets SEL-2020 real-time clock/calendar.

Time-Code Output

Pinout: Pin 4 TTL-level signal.
Pin 6 Chassis ground reference.
Connectors: All 16 rear DB-9 port connectors.
Outputs are generated from IRIG-B input (when present) or generated by CPU from real-time clock/calendar.

Optional Memory

Base memory: 512 kB RAM, 32 kB EEPROM
Expanded RAM/settings: 1 MB of RAM, 64 kB EEPROM
Expanded RAM/settings, Archive (Flash): 1 MB of RAM, 64 kB EEPROM, 2 MB Flash

Optional Modem

Internally mounted, “AT” command set compatible; up to 33,600 baud. Complies with Part 68 FCC Rules and Regulations.

300 baud	CCITT V.21 and Bell 103
1200 baud	CCITT V.22 and Bell 212A
2400 baud	CCITT V.22bis
9600 baud	CCITT V.32
14400 baud	CCITT V.32bis
33600 baud	CCITT V.34

RJ-11C rear-panel connector.
May be configured for auto-dial or auto-answer.

APPLICATION EXAMPLES

Collect and Format Data from Relays and Other Devices

The operator can define strings to instruct the SEL-2020 to collect and format relay data for RTUs. Simple settings enable you to individually configure SEL-2020 ports to define their data retrieval and storage attributes. You can instruct the SEL-2020 to automatically interrogate connected devices for data collection. Built-in parsing and conversion capabilities help you retrieve data from many different devices. The SEL-2020 can also provide a uniform data interface to the RTU, so that the RTU software does not have to specifically accommodate each IED type.

Access Data Through Multiple Paths

Different departments in a utility may be interested in different data and different data rates. For example, a system operator may be interested in metering and contact data every five or ten seconds and fault location shortly after a fault. A protection engineer is usually interested in setting relays, and analyzing a full event report after a fault occurs. You can accommodate these needs by connecting one port on the SEL-2020 to a SCADA RTU for the operator and a telephone modem to another port for the protection engineer.

Program the SEL-2020 Database Functions

Use the SEL-2020 settings and SELOGIC control equations to build a database of load profiles and event reports and to store them in nonvolatile memory. Define commands so different devices can retrieve appropriately formatted data. Use arithmetic functions to sum current, power, or other data. Subtract sensed information from a threshold value and check the resulting sign to implement comparisons.

Synchronize All Relay Clocks Within a Substation

The SEL-2020 receives an IRIG-B time-code input from a single IRIG-B receiver or local clock and distributes it to the devices connected to any of the 16 serial ports. The SEL-2020 supports modulated or demodulated time-code input.

If there is no external signal, the SEL-2020 generates an IRIG-B signal using an internal clock so you can synchronize device clocks without an IRIG-B receiver or local clock.

Use Events to Switch Relay Setting Groups

Program the SEL-2020 to use the time of day, day of the week, or a specific event, such as a relay alarm output, to switch relay setting groups.

Monitor Relay Alarm Contacts

With the optional I/O installed, you can program the SEL-2020 to monitor relay alarm contacts. Instruct the SEL-2020 to send predetermined messages or initiate an action you designate, like closing an output contact based on these inputs.

Log Messages On a Local Printer

You can set the SEL-2020 to print selected messages, including control actions, diagnostic status messages, short event reports, and demand meter data.

Drive a Local Human-Machine Interface With Relay Data

Connect a computer to the SEL-2020 through the computer serial port. Using your own human-machine interface (HMI) software, you can build screens and specify the HMI data definition. You can create commands that instruct the SEL-2020 to send selected data to the standard serial port interface for the HMI package.

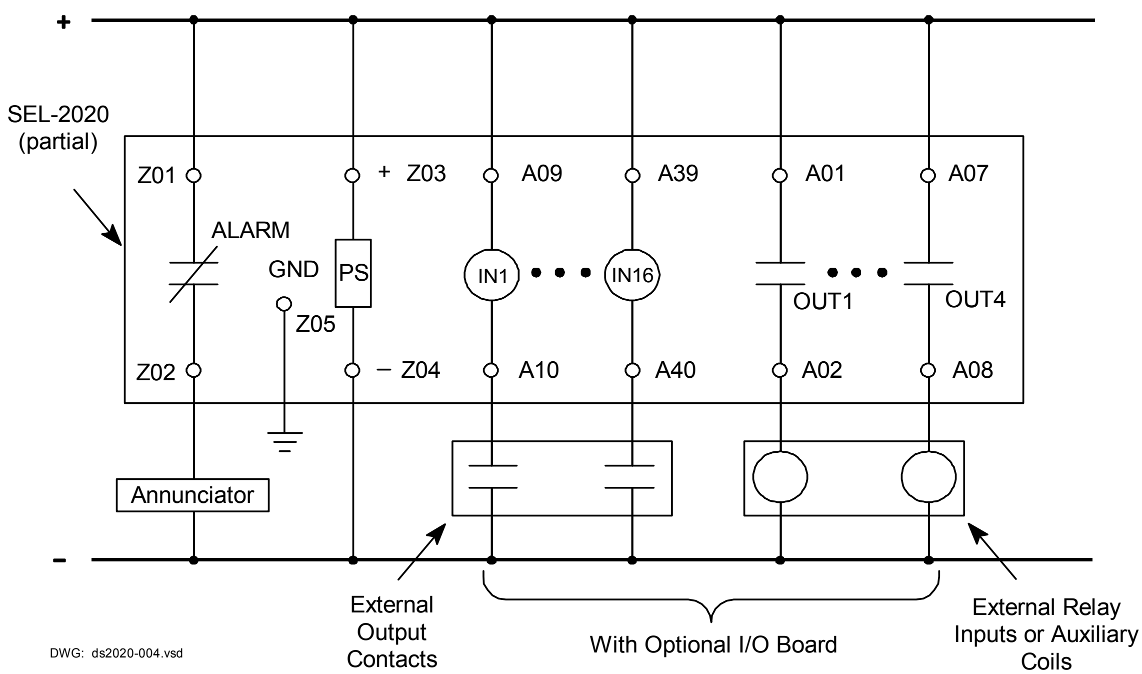

Figure 4: SEL-2020 Typical DC Wiring Diagram

SEL-5020 Settings Assistant Software for Learning, Setting, and Communicating With the SEL-2020

The SEL-5020 Settings Assistant is a graphical user interface that provides an intuitive Windows® environment for setting and communicating with the SEL-2020. The SEL-5020 helps the user create or edit settings and establish communications (using a serial connection) between the SEL-5020 on the PC and the SEL-2020. Complex strings and SELOGIC control equations are facilitated using String and Expression Builders in the SEL-5020. While special software is not required to communicate with and set the SEL-2020, the SEL-5020 can be a valuable tool, especially when programming multiple SEL-2020s.

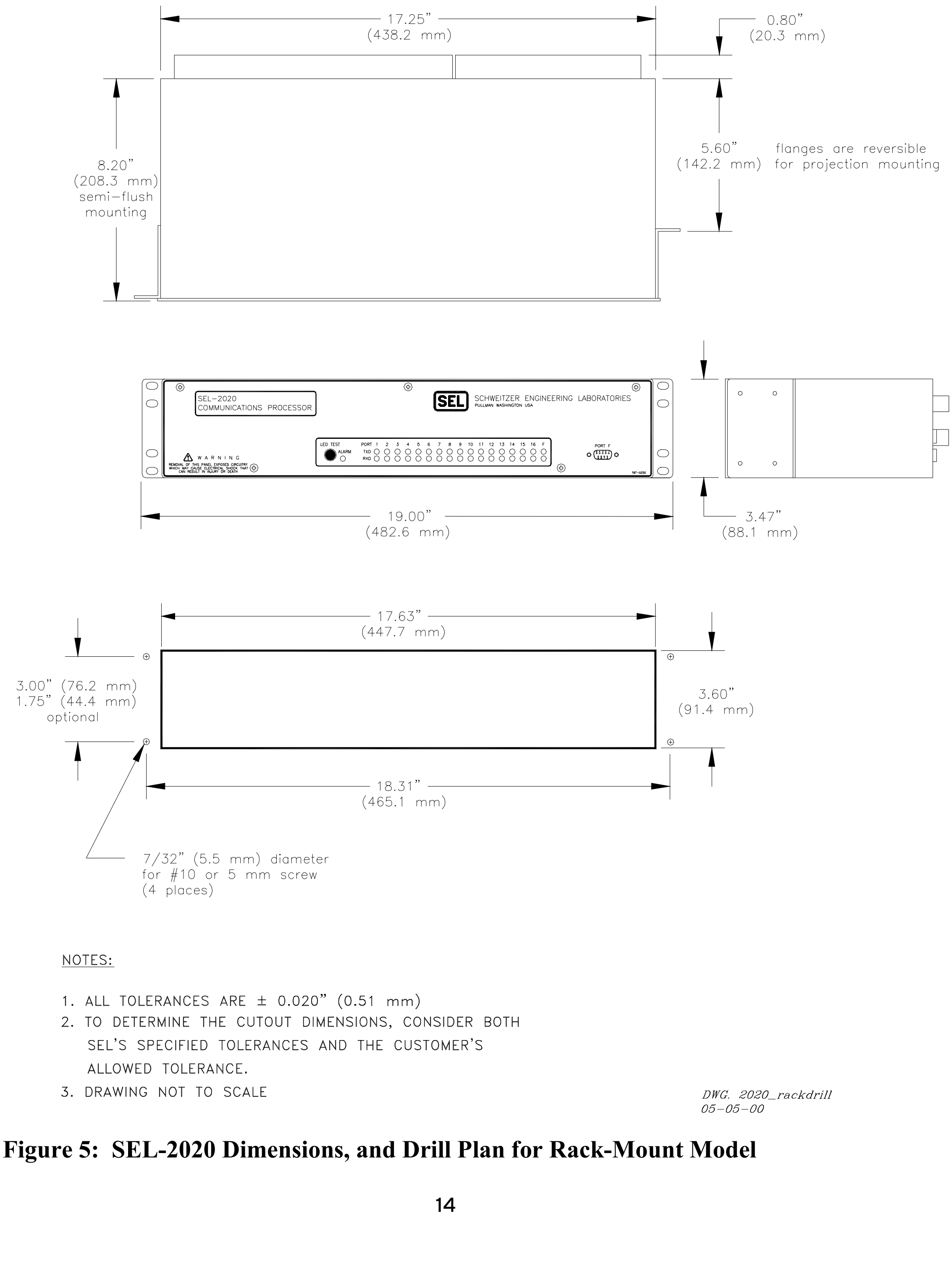

Figure 5: SEL-2020 Dimensions, and Drill Plan for Rack-Mount Model

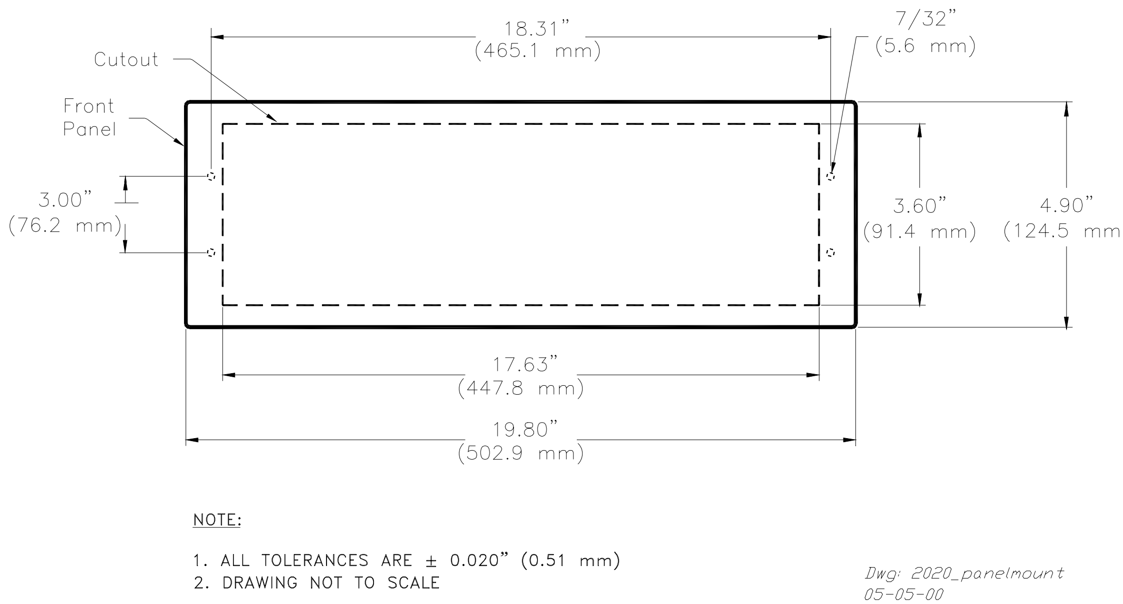

Figure 6: SEL-2020 Panel Cutout and Drill Plan for Panel-Mount Models

FACTORY ASSISTANCE

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We provide prompt, courteous, and professional service.

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SEL-2020 Communications Processor Data Sheet Date Code 20010518

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SECTION 2: GENERAL DESCRIPTION

INTRODUCTION

The SEL-2020 Communications Processor provides many special features needed in today's substations to communicate with a variety of microprocessor-based devices. The SEL-2020 can function as a simple, but intelligent, port switch. Or it can provide sophisticated communication and data handling capability required for advanced substation integration projects. The following pages describe the SEL-2020's features and their benefits to the user.

BASIC (BUT POWERFUL) FUNCTIONS

The SEL-2020's unique design and powerful features make it useful for a variety of functions. It can serve as an intelligent port switch, a synchronizing time source, a communications processor, a SELOGIC® Control Equations programmable controller, and an automatic database.

- **Intelligent Port Switch**: The SEL-2020, in its most basic role, is a port switch. Several features of the SEL-2020 improve significantly on that role, such as its multi-tasking/ multi-user capability, auto-configuration, wide range of settable baud rates (300 baud to 38400 baud), and complete selection of communication parameters (data bits, parity, stop bits, RTS/CTS, and XON/XOFF).
- **Synchronizing Time Source**: The SEL-2020 distributes a demodulated IRIG-B signal through Ports 1 to 16. This signal can be used by any attached device that recognizes the IRIG-B code simply by your connecting the proper cable to the SEL-2020. The signal can be distributed to SEL relays that accept IRIG-B input, simply by using a special cable designed for both communication and IRIG-B signals. The SEL-2020 internally generates the IRIG-B signal, unless you connect an external source of modulated or demodulated IRIG-B to the SEL-2020. If the connected device does not accept IRIG-B, you can program the SEL-2020 to send a date and time message to the device.
- **Communications Processor:** The SEL-2020 can send and receive message strings and codes in several different formats, permitting communication with a variety of devices, including SEL relays, PCs, modems, RTUs, printers, other IEDs, and other SEL-2020s. The built-in command set facilitates communication to and through the SEL-2020 using any communication software that supports ASCII "dumb terminal" emulation. You can also develop user-defined command strings to communicate to and from non-SEL devices. The SEL-2020 can also communicate as a slave on a Modbus RTU or DNP V3.00 network. This feature makes the SEL-2020 a convenient network device, which communicates to a master device through flexible connections such as point-to-point and daisy chain.
- **SELOGIC Control Equations Programmable Controller**: The SEL-2020 includes powerful SELOGIC Control Equations that can be used to trigger messages, commands, and control functions.
- **Automatic Database**: The SEL-2020 is unique in its ability to receive, parse, store, and distribute data. The SEL-2020 automatically parses data from SEL relays. Several parsing options are available to parse data from devices other than SEL relays. Selected portions of

the parsed data can be collected from each port's data region to reduce the processing burden for downstream devices.

Intelligent Port Switch

You can configure the SEL-2020 as a port switch simply by using the SET P command to activate and configure each port that has a device connected. Port F on the front and Port 8 on the rear panel are configured as Master ports at the factory, so you can connect your PC or terminal to either of these to communicate with the SEL-2020. The default communication parameters for Port F are 2400 baud, 8 data bits, 1 stop bit, and no parity. For Port 8, the default is 9600 baud, 8 data bits, 2 stop bits, and no parity.

Once you have configured each port using the SET P command, you can enter transparent communication with the device on any port using the PORT n command, where n is the number of the port. To quit transparent communication, simply use the default disconnect sequence, **<CTRL-D>**, by holding down the Control key and pressing D on your keyboard.

The following features make the SEL-2020 a very intelligent port switch.

Sixteen EIA-232 Rear Ports and One EIA-232 Front Port

Front and rear ports provide connection space for numerous types of devices, including SEL relays, other types of IEDs, PCs, printers, modems, and even other SEL-2020s. You can independently configure each port of the SEL-2020 to match the communication parameters of the attached device. All communication parameters are software settable. Baud rates can be set up to 38400 baud.

Multi-Tasking/Multi-User Operating System

The powerful SEL-2020 operating system allows operations to occur on all ports simultaneously. This capability allows multiple users to communicate with, or through, the SEL-2020 at the same time; other functions, like printing and modem dial-out, can also be occurring on different ports. In addition, on ports connected to SEL relays that support *Fast Meter* data collection, the SEL-2020 continues to collect meter data while the port is being used for normal ASCII operation: either ASCII data collection or transparent operation.

Who's Who Port Directory

The WHO command provides you with a list of all of the ports, the type of relay or device connected to each port, the current communication parameters, and a Port ID string that describes the device or application. The device type and Port ID string are entered automatically during the auto-configuration process when the connected device is an SEL relay.

Multi-Level Password Security

Passwords are required to gain access to the various communication levels of the SEL-2020. One level allows interrogation of settings and data only. Access to a second level is required to change settings.

Auto-Configuration

Setting the SEL-2020 communication parameters for a port is simplified through the SEL-2020's auto-configuration process. This process determines the proper baud to communicate with the connected device. The SEL-2020 also determines the startup string, relay type, *Fast Meter* capability, and relay ID for any SEL relay connected to its port. You should use the SET P command to activate and configure each port that has a connected device.

SYNCHRONIZING TIME SOURCE

You can synchronize the attached devices to an external time source or to the SEL-2020 built-in battery-backed clock.

Accepts External IRIG-B Input

The SEL-2020 accepts a modulated or demodulated IRIG-B signal through a rear-panel BNC connector. Three internal jumper settings are required to identify which type of signal, modulated or demodulated, will be applied to the SEL-2020. An internal database element asserts when the SEL-2020 receives an IRIG-B signal.

Generates IRIG-B Internally

If no external IRIG-B signal is applied, the SEL-2020 internal clock/calendar generates an IRIG-B signal. The SEL-2020 includes an internal battery-backed clock/calendar that maintains correct time with or without external power. The lithium-type battery has an expected life of ten years. The internal clock is accurate to within 1 minute per year with power applied. You can easily reset the clock and calendar using the SEL-2020 TIME and DATE commands.

Distributes IRIG-B through Ports 1-16

The SEL-2020 distributes a demodulated IRIG-B signal through all of its 16 rear ports. You can use this to synchronize any type of device, such as a relay, fault recorder, or meter, that can decode the IRIG-B signal. To use this feature, you need only to connect the device to the desired SEL-2020 port using a special cable designed for both communication and IRIG-B signal. For devices that do not have an IRIG-B port or cannot decode the IRIG-B signal, the SEL-2020 can send time and date messages on a periodic or time basis to keep their clocks synchronized.

COMMUNICATIONS PROCESSOR

The SEL-2020 has a distinct and significant advantage over simple port switches because of its sophisticated and powerful communication processing capabilities.

Send Messages Triggered by SELOGIC Control Equations

Messages sent from the SEL-2020 can be used to request data from other devices, or to control other devices. Use "20" messages, such as 20METER and 20TARGET, to request SEL relay data that are recognized by the SEL-2020 and are automatically parsed upon arrival. Use non

"20" messages for other data collection and control purposes. On SEL IED ports, you can also have relay operate commands (OPEN, CLOSE) sent automatically.

Receive Messages and Data

The SEL-2020 can receive, buffer, parse, store, and act upon solicited and unsolicited messages and data.

Unsolicited Messages

Unsolicited messages are strings that are sent to the SEL-2020 without being solicited by the SEL-2020. These messages include:

SEL-2020 Command Set. The SEL-2020 command set consists of predefined messages, 27 in all, that the SEL-2020 recognizes, understands, and responds to. You can send these commands, such as ACCESS, PORT and VIEW, from a dumb terminal or PC using any communication program that supports ASCII "dumb terminal" emulation. The SEL-2020 command set can be disabled on a port where user-defined commands are used.

IED Auto-Messages. IEDs may send data to the SEL-2020 without it being requested. These messages can be buffered and activities can be triggered based on specific messages. SEL relays send auto-messages to report specific activity or conditions. These include the SEL Event Report Summary issued through the SEL relay auto port when an event record is stored, the SEL Status Report issued to report a warning or failure, and the SEL Group Switch Report issued when a change in group settings occurs on a relay with multiple groups.

User-Defined Commands. You can define commands using the SET U command procedure. Receipt of one of these commands sets a command element that can be used in a SELOGIC Control Equation to initiate action defined in an associated message string. You can set the SEL-2020 to use these commands on IED ports to watch for unsolicited messages or on Master ports to supplement or replace the standard SEL-2020 command set. Use the SET U command to create User-Defined commands. SET U can also be used to instruct the SEL-2020 to watch for one, or more, of the standard SEL relay auto-messages. (See ***Section 6: Settings.***)

Modbus Protocol. You can select Ports 12, 14, and 16 of an SEL-2020 as Modbus ports. The network master (receiver) can access the database of all SEL-2020 ports through a Modbus port.

DNP Protocol. The SEL-2020 supports Distribution Network Protocol (DNP) V3.00 Level 2 on Port 16. It can be used for data access and for control.

Solicited Messages and Data

A message received in response to an SEL-2020 automatic message is called a solicited message. The SEL-2020 can recognize a solicited message response in two ways:

"20" Message Response. The "20" message responses are automatically parsed based on the SEL-2020's knowledge of the data format. The SEL-2020 uses these messages with SEL relays to collect relay data such as meter, target, event, and history. Meter and target data are transferred from the SEL relay to the SEL-2020 in binary format if the relay has *Fast Meter* capabilities.

These capabilities offer substantial advantages. *Fast Meter* data received from SEL relays consist of raw voltage and current samples. In many cases, the SEL-2020 calculates more output quantities from the raw data than the SEL relay that sampled the original data; these additional output quantities include current and voltage phasor angles, per-phase megawatts and megavars, and complete sequence components.

Fast Meter binary data are collected at a much higher speed than ASCII formatted data. Binary data transfer is not interrupted during transparent port communications, nor is it interrupted by ASCII data collection; ASCII data transfer is interrupted by transparent port communication. We highly recommend using relays with *Fast Meter* capability with the SEL-2020.

Non-"20" messages. Non-"20" responses can be ignored, or parsed using any one of five parsing options: ASCII Integer, ASCII Floating point, Character string, Integer string, and Integer string with XON/XOFF encoding. Non-"20" messages are primarily for use with devices other than SEL relays (see ***Section 8: Message Strings*** for more information).

You can use the SET A command to create SELOGIC Control Equations for message triggering and the associated message strings. Also use SET A to set the AUTOBUF switch that determines if unsolicited messages will be stored or ignored. (See ***Section 6: Settings.)***

SELOGIC CONTROL EQUATIONS PROGRAMMABLE CONTROLLER

You can trigger messages and control action with SELOGIC Control Equations.

The SEL-2020 issues messages when a user-defined condition for issuing the message is true. The condition is defined for each message by a SELOGIC Control Equation using:

- Time (Thh:mm:ss.s)
- Period (Phh:mm:ss.s with optional start and stop time)
- Internal trigger using any bit in the SEL-2020 Database, including:
  - Global elements: Day-of-week, intermediate logic elements (V, W, X, Y, Z, XT, YT, and ZT), remote bits, and external inputs (from optional I/O board)
  - Local elements: User-defined command elements, select-before-operate elements, database triggers, and relay operate elements
  - Relay elements: from SEL TARGET data

or any logical combination of the above.

SELOGIC Control Equations use OR (+), AND (*) and NOT(!) operations to combine terms. The SEL-2020 Global region includes intermediate variables V, W, X, Y, and Z, to provide additional SELOGIC Control Equation message capability. Intermediate variables X, Y, and Z have associated timers to provide even greater control capability and flexibility. (See ***Section 7: SELOGIC Control Equations**.)*

Twelve message groups are available per port. Messages 1 to 8 have associated data buffers to store responses. Four message groups, Messages 9 to 12, are for messages only, having no associated data buffer.

The SET A, automatic message setting command, establishes the message count, 0 to 12, of active triggering equations and message strings used on each port. You are then prompted to create the SELOGIC Control Equations for message triggering and associated messages within the framework of the SET A setting. (See ***Section 6: Settings.***)

AUTOMATIC DATABASE

Database Structure

The SEL-2020 Data Area includes a database structured as shown in Figure 2.1 consisting of the following defined regions: Global (GLOBAL), Local (LOCAL), Buffer (BUF), Data (D1-D8), Archive (A1-A3), and User (USER). For a more complete description of the database, see ***Section 9: Database***.

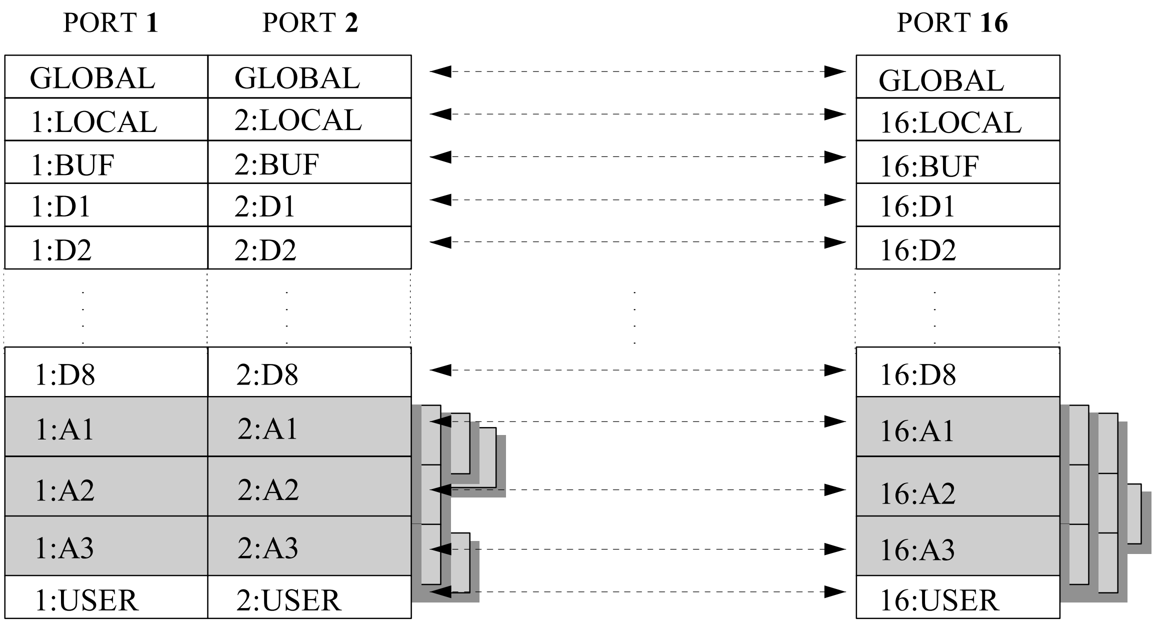

Figure 2.1: SEL-2020 Database Structure

Global Region

The Global region includes the following data which are common to all ports:

> SEL-2020 FID String, Status and Configuration information, Date and Time, Global elements, and Port F status.

Global elements are logical “1” when asserted or true, and “0” if not asserted or false. The Global elements, as the name implies, are stored in the Global data region, which is available for use by all ports. These elements can be used in any SELOGIC Control Equation to define a trigger condition. When the condition is true, the SEL-2020 sends the message associated with the SELOGIC Control Equation, such as requesting data or issuing a control command.

Table 2.1 lists the Global elements as they are stored in the Global data region. A brief description of these elements and their function follows the table.

Table 2.1: SEL-2020 Global Elements

Row	Global Elements							
0	SUN	MON	TUE	WED	THU	FRI	SAT	IRIG
1	V	W	X	XT	Y	YT	Z	ZT
2	R1	R2	R3	R4	R5	R6	R7	R8
3	PINAC	PCF	INAC	SDLY	*	*	*	SALARM
4	IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1
5	IN16	IN15	IN14	IN13	IN12	IN11	IN10	IN9
6	OUT1	OUT2	OUT3	OUT4	*	*	*	*

Row 0: Day-of-Week elements, SUN through SAT; one is asserted each day of the week; and external IRIG-B status element is asserted when the SEL-2020 detects the external IRIG-B signal.

Row 1: Intermediate Variable elements, V, W, X, Y, and Z, are asserted when the corresponding intermediate logic equation is true; and associated timer elements, XT, YT, and ZT, are asserted when the pickup timer times out until the dropout timer times out.

Row 2: Remote elements, R1 to R8, are set, cleared, or pulsed by the CONTROL command.

Row 3: SEL-2020 Status elements indicate a port is inactive pending auto-configuration (PINAC); a port has failed power-up auto-configuration (PCF); at least one port is inactive because it is not responding or not responding correctly (INAC); there has been at least one data collection missed since the last STATUS command (SDLY); and alarm pulse (SALARM).

Row 4: External Input elements, IN1 to IN8, are asserted when the associated external input is asserted (only available with optional I/O board).

Row 5: External Input elements, IN9 to IN16, are asserted when the associated external input is asserted (only available with optional I/O board).

Row 6: External Output elements, OUT1 to OUT4, are asserted when the associated external output contact operates (only available with optional I/O board). These elements are controlled by SELOGIC Control Equations.

All bit positions indicated with an * are reserved for future use.

Local Region

The Local region includes the following information which is unique to each port:

Status and Configuration, Archive Counter (nonvolatile Flash memory only), Local elements, Special Command Registers (SBO and CMD), FID String of attached device, and Port Identification String.

Local elements are logical "1" when asserted or true, and "0" if not asserted or false. The Local elements, as the name implies, reside in the Local data region on each port. These elements can be used in any SELOGIC Control Equation to define a trigger condition. When the condition is true, the SEL-2020 will send the message associated with the SELOGIC Control Equation, such as requesting data or issuing a control command.

Table 2.2 lists the SEL-2020 Local elements associated with each port. A brief description of these elements and their function follows the table.

Table 2.2: SEL-2020 Local Elements for Each Port

Row	Local Elements							
0	CMD1	CMD2	CMD3	CMD4	CMD5	CMD6	CMD7	CMD8
1	SBO1	SBO2	SBO3	SBO4	CTS	XOFF	INAC	UMB
2	D1	D2	D3	D4	D5	D6	D7	D8
3	D9	D10	D11	D12	ARCH1	ARCH2	ARCH3	MSET
4	DLY1	DLY2	DLY3	DLY4	DLY5	DLY6	DLY7	DLY8
5	DLY9	DLY10	DLY11	DLY12	DLYA1	DLYA2	DLYA3	DLY
6	BR1	BR2	BR3	BR4	BR5	BR6	BR7	BR8
7	BR9	BR10	BR11	BR12	BR13	BR14	BR15	BR16
8	RB1	RB2	RB3	RB4	RB5	RB6	RB7	RB8
9	RB9	RB10	RB11	RB12	RB13	RB14	RB15	RB16
10	SBR1	SBR2	SBR3	SBR4	SBR5	SBR6	SBR7	SBR8
11	SBR9	SBR10	SBR11	SBR12	SBR13	SBR14	SBR15	SBR16
12	SRB1	SRB2	SRB3	SRB4	SRB5	SRB6	SRB7	SRB8
13	SRB9	SRB10	SRB11	SRB12	SRB13	SRB14	SRB15	SRB16
14	CBR1	CBR2	CBR3	CBR4	CBR5	CBR6	CBR7	CBR8
15	CBR9	CBR10	CBR11	CBR12	CBR13	CBR14	CBR15	CBR16
16	CRB1	CRB2	CRB3	CRB4	CRB5	CRB6	CRB7	CRB8
17	CRB9	CRB10	CRB11	CRB12	CRB13	CRB14	CRB15	CRB16

Row 0: Command elements, CMD1 to CMD8, are each associated with one of the eight user-defined commands. The associated CMD bit is asserted when the SEL-2020 receives the user-defined command.

Row 1: Select-Before-Operate elements, SBO1 to SBO4, assert when two specific messages are sent in proper time sequence. Clear-To-Send element, CTS, is asserted when the CTS line is "up"; Transmit-OFF element, XOFF, is asserted when the SEL-2020 receives an XOFF signal from the attached device; the inactive element, INAC, is set when the port is inactive; and the Unsolicited-

Message-Buffer element, UMB, asserts when a message is stored in the port BUF region.

Row 2: Message trigger elements, D1 to D8, set when the associated trigger operation is pending or in progress.

Row 3: Message trigger elements, D9 to D12, and Archive region trigger elements, ARCH1 to ARCH3, set when the associated trigger operation is pending or in progress. M settings element, MSET, is asserted while the Math/Move equations for the port are executing.

Row 4: Message trigger delay elements, DLY1 to DLY8, assert when the associated message trigger element, D1 to D8, does not reset before the next trigger condition occurs, indicating a possible data collection delay or message error.

Row 5: Message trigger delay elements, DLY9 to DLY12 and DLYA1 to DLYA3, assert when the associated message trigger element, D9 to D12 or ARCH1 to ARCH3, does not reset before the next trigger condition occurs, indicating a possible data collection delay or message error.

Rows 6 - 7: Breaker bits (BR1 - BR16) may be associated with issuing breaker operate commands (OPEN/CLOSE) or may be used as latches for intermediate SELOGIC Control Equations. These bits are set by the SBR1 - SBR16 elements and cleared by the CBR1 - CBR16 elements.

Rows 8 - 9: Remote bits (RB1 - RB16) may be associated with issuing remote bit commands (CONTROL) or may be used as latches for intermediate SELOGIC Control Equations. These bits are set by the SRB1 - SRB16 elements and cleared by the CRB1 - CRB16 elements.

Rows 10 - 13: Set breaker (SBR1 - SBR16) and set remote bit (SRB1 - SRB16) elements set the corresponding breaker and remote bit elements, but may also be used as intermediate terms for SELOGIC Control Equations. These bits are controlled by logic equations (SET L) and by receipt of master port *Fast Operate* commands.

Rows 14 - 17: Clear breaker (CBR1 - CBR16) and clear remote bit (CRB1 - CRB16) elements clear the corresponding breaker and remote bit elements, but may also be used as intermediate terms for SELOGIC Control Equations. These bits are controlled by SELOGIC Control Equations (SET L) and by receipt of master port *Fast Operate* commands.

You can use the VIEW or TARGET command to show Local element status.

BUF Region

The BUF region contains buffered unsolicited messages from its associated port if you have set AUTOBUF to Yes. The buffer accumulates messages until it is full, at which point the newest message overwrites the oldest message. The buffer can be read and cleared in a number of ways both manually and automatically.

D1 to D8 Regions

For all ports, except the front port, the database includes data regions D1 to D8, allocated for data solicited by the SEL-2020. The first four registers of each region hold the date and time the data were collected. The remainder of each region is for the collected data. How the information is parsed, or separated into useful groups, will depend on the type of data and how it is collected. Each data region is associated with a message created using the SET A command. For example, the response from Message 1 will be captured in data region D1 and Message 2 response in data region D2. Responses from “20” messages, which include the following, are parsed automatically:

> 20METER, 20TARGET, 20DEMAND, 20HISTORY, 20STATUS, 20BREAKER, 20EVENT, 20EVENTS, and 20EVENTL.

Data received in response to non-“20” messages are parsed according to the parsing option you selected in the SET A automatic message settings. Non-“20” message parsing options include the following:

> Ignore, ASCII Integer, ASCII Floating-Point, Character String, Integer String, and Integer String with XON/XOFF encoding.

Each response is time-tagged by the SEL-2020 at the time it begins receiving the message. Data collected in regions D1 to D8 are held until the next data are received; the new data overwrites the old data. The SEL-2020 will assign a data label to each data region, depending on the message content and parsing method you choose. For example, if you set Message 1 on Port 1 to collect meter data from an SEL relay using the 20METER command, the region 1:D1 will be assigned a data label of METER. This label can be very helpful when you address the region to MAP or VIEW the data, or to retrieve specific data items from the data region.

A1 to A3 Regions

The archive data regions, A1 to A3, are only available if the SEL-2020 is equipped with optional nonvolatile Flash memory. These regions are designed for long-term storage of information, such as SEL relay long event reports and meter demand data. Each archive data region works on a First-In-First-Out (FIFO) basis, much like long event report storage in SEL relays. The number of records that can be stored in each region depends on the size of each record. Individual records can be viewed, retrieved, and cleared.

User Region

The User region is available on each port for any purpose you desire. You can write data to this area from a master device using the STORE command or the special user-defined data WRITE command. You can also copy data here from other regions for centralization and custom organization using the SET M command. Any port can then use data in this region to construct messages.

Database Tools

The SEL-2020 Command Set contains several commands to help you check that requested data are placed in the proper database location and to ensure that the data requests and responses are not overrunning each other, or interfering with each other.

AUTO

This SEL-2020 command provides a list of supported operate and "20" commands on auto-configured SEL IED ports. You can use this to confirm that the desired commands exist for the relay you are using.

MAP

This SEL-2020 command provides a method to look at the structure and addresses of a database region on a port-by-port basis, or at specific regions within each port's database. When this command is applied to a port, the SEL-2020 responds with a list of database regions, their data names, and the number of archive records. You can also use the MAP command to look at the database structure within a region. When this command is applied to a region, the SEL-2020 responds with a list of data item labels, their addresses, and the type and number of data.

VIEW

This SEL-2020 database tool enables you to look at the data that are being collected, parsed and stored in a database region on a specific port. Several variations of this command allow you to view all, part, or specific items within the data region.

TARGET

You can use the TARGET command to view the status of the SEL-2020 Global and Local elements and the status of any relay elements that are received from an SEL relay. The relay elements will appear to be appended to the Local elements. The TARGET command, like the SEL relay TARGET command, includes variations that permit you to request all elements or a selected row of elements, and to automatically repeat the request a specified number of times.

STATUS

The STATUS command provides you with an overview of the SEL-2020 performance and a port-by-port analysis of communication and database performance. Any problems with data collection or database delays occurring in any specific region will be identified on this report. This information will help you determine if data are being requested faster than can be accommodated by the attached device, or if multiple requests are interfering with each other. The status display also identifies ports in transparent communication.

MEM

The MEM command indicates the status of the RAM, EEPROM, and FLASH memory pools. You can use this to determine if you are in danger of running out of memory.

Data Parsing Options

The SEL-2020 database stores data that are parsed, or separated, into the smallest useful items. Parsing data in the SEL-2020 reduces communication and processing burdens for other devices or systems that use these data by permitting them to request and transfer only the specific data they need. The SEL-2020 performs the data parsing in several ways:

“20” Message Response

The SEL-2020 automatically parses data that are recognized. These data are requested using the “20” message format. The type of response will depend on the attached device's capability. If it has *Fast Meter* capability, the responses to 20METER messages are in binary format and the responses to 20DEMAND and 20TARGET messages may also be in a binary format.

Non-“20” Message Response

Message responses that are not recognized as SEL data can be ignored, or parsed by one of five techniques:

ASCII Integer (Parse = 1). Parses numbers only; every number separated by a space, comma, decimal, or any other character becomes a separate item.

ASCII Float (Parse = 2). Parses numbers only, but retains decimals as part of each number.

Character String (Parse = 3). Retains all numbers and characters in a character string.

Integer String (Parse = 4). Stores each pair of received bytes in a register, most-significant-byte first. This option is primarily useful for capturing data from devices that send data in binary words.

Integer String with XON/XOFF encoding (Parse = 5). Same as **Integer String** except special 2-byte encoding sequences used to represent XON (11h) and XOFF (13h) characters are translated back to the single byte codes for XON and XOFF. This option is necessary when capturing binary data while using XON/XOFF flow control.

SIMPLE SETTINGS

There are seven SET command variations you can use to configure and control the SEL-2020’s operation. These include SET G for global settings, SET P for port configuration and communication settings, SET A for automatic messages, SET U for user-defined commands, SET M for data movement and scaling, SET L for SELOGIC Control Equation settings, and SET C for calibration settings. See ***Section 6: Settings***, for more detailed information about this group of commands.

SET G - Global Settings

You use the SET G command to set global parameters that are used by all ports including the SEL-2020 ID string, intermediate logic variable settings, and the control equations for optional I/O board output contacts.

SET P - Port Configuration Choices (Ports F, 1-16)

You can use the SET P settings to establish each port’s configuration and communication parameters. The configuration options are designed to make the SEL-2020 compatible with almost any device that has an EIA-232 port. This is the only setting command required to use the SEL-2020 as a port switch.

You should use the SET P command to configure each port. The first prompt from the SEL-2020 requests you to identify the type of device connected to the port. Port F can only be configured as a Master port. The choices for Ports 1 to 16 include:

U (Unused)

The U response indicates that there is no device connected to the port. Accepting the setting with this choice deactivates the port.

S (SEL IED)

The S response indicates that an SEL relay or SEL-2020 is connected to the port (for other SEL devices, such as a PRTU, select O for Other IED). The SEL-2020 then asks you if the SEL-2020 should perform an auto-configuration with the relay on the port. If you respond YES, the SEL-2020 will automatically attempt to configure the port with information from the attached SEL relay. The SEL-2020 will determine the baud rate, relay type, relay ID, and if the SEL relay supports *Fast Meter* and *Fast Operate* data transfers. You will then be prompted for additional communication options and preferences.

O (Other IED)

The O response indicates there is an IED connected (possibly through a modem) to the port, but not an SEL relay. The SEL-2020 will ask you if the SEL-2020 should perform auto-baud with the device on the port. If selected, the auto-baud function will attempt to determine the correct baud rate needed to communicate with the attached IED. You will then be prompted for information about the device and other communication options and preferences.

P (Printer)

The P response indicates there is a serial printer attached to the SEL-2020. With this choice, you will be prompted for an ID string and several communication options and preferences.

M (Master)

The M response identifies the connected device as a master that can send messages to the SEL-2020 and receive messages from the SEL-2020. Master devices include PCs, RTUs, and modems. The SEL-2020 will prompt you with several configuration options and communication options and preferences.

SET A - Auto-Message Settings (Ports 1-16)

The first setting in the SET A group prompts you to determine if unsolicited messages should be stored in a buffer area associated with each port. After that, the setting group prompts you for the number of auto-messages desired on the port, the trigger condition for each message, and the message string that will be sent out of the SEL-2020 port. The setting also determines how a message response is treated by the SEL-2020. Messages and data received in response to standard SEL-2020 messages (“20” messages) are parsed automatically into the database. Alternate parsing options are available for nonstandard messages (non-“20” messages). If optional nonvolatile Flash memory is installed, the archive message control settings group is presented to you.

The Set A Command prompts you for the following settings that control messages and data on each port:

AUTOBUF

You can save unsolicited messages to the port's buffer with AUTOBUF = Y. If AUTOBUF=N, the SEL-2020 does not store unsolicited messages received on the port.

STARTUP

STARTUP sets the startup string (such as ACCESS command and password) that the SEL-2020 must send to the device in order to access the device on that port to retrieve data or issue commands.

SEND_OPER

Use this setting on SEL IED ports to associate available operate commands (OPEN, CLOSE, CONTROL), as determined during auto-configuration, with the breaker (BR1 - BR16) and remote bit (RB1 - RB16) elements.

MSG_CNT

With the MSG_CNT setting you enter a number from 0 to 12 to tell the SEL-2020 how many messages you plan on setting for a given port.

ISSUEn

You use the ISSUE setting to write a SELOGIC Control Equation that defines at what time, period, or other logical condition the message will be sent to the attached device.

MESGn

You use the MESGn setting to define the message string that will be sent when the ISSUEn message trigger condition is asserted or true.

PARSEn

For MESG1 through MESG8, the response from the attached device can be stored in a data region associated with the port. If the message requests data that the SEL-2020 can recognize, the data will be automatically parsed in that data region. If not, the SEL-2020 will ask you to select a parsing option using the PARSEn setting.

NUMn

If you choose to store the unrecognized data using one of the parsing options in the PARSEn setting, the SEL-2020 will prompt you to set a limit on the amount of data stored using the NUMn setting.

DELAYn

This setting is used with non-“20” messages to determine the method for detecting the end of the incoming message. In the default case, ON, the SEL-2020 will wait for a 15 second idle time before considering the message to be complete. The idle time is 5 seconds on other IED ports. When set OFF, the SEL-2020 will only wait until it has received the desired number of data items.

CHECKn

If the message being parsed contains a checksum, use this and the related settings that follow to enable the SEL-2020 to verify the message contents. This setting specifies the type of checksum that will be used to verify the message (8-bit, 16-bit, or CRC-16) as well as the checksum format (ASCII hexadecimal or binary). If the message does not contain a checksum or you do not care to verify it, this setting should be set to NONE.

ORDERn

If CHECKn is set for 16-bit checksum or CRC-16, this setting specifies the byte order of the checksum in the received message: high byte first or low byte first.

STARTn

This setting specifies a position in the received message where the checksum calculation begins. A numeric position in the string, or a specific character or character code, can be used to specify this setting.

STOPn

This setting specifies the position in the received message where the checksum calculation ends. Like the STARTn setting, this setting can be set using either a numeric position or a character code.

CHKPOSn

This setting specifies the checksum location in the received message. Either a character code or a numeric position in the string can be used to specify the location.

ACKn

This setting specifies the Acknowledge string to be sent when the checksum in the received message is valid.

NACKn

If the connected device watches for Acknowledge/Negative Acknowledge strings for message confirmation, use the NACKn setting to set the Negative Acknowledge string to be sent whenever the checksum verification fails.

ARCH_EN

The ARCH_EN setting prompt is only presented if optional nonvolatile Flash memory is available. Set ARCH_EN=Y to enable the use of the nonvolatile Flash memory for this port. Other prompts will then be presented to request ISSUEnA and MESGnA settings for the Archive data areas.

USER

You use the USER setting to establish the size of a message area for temporarily storing data. The STORE command is used separately to place the message string and other data in the USER data region of a particular port. Even if you do not set the USER setting, the SET M command will, if necessary, automatically increase the size of the message area to accommodate the SET M settings.

SET U - User-Defined Commands (Ports 1-16)

The SET U command allows you to create user-defined commands that other devices send to the SEL-2020. You can also use this setting to trigger action from selected SEL relay auto-messages (Event, Status, and Group). The user-defined commands can supplement or replace the preprogrammed SEL-2020 command set. This may be helpful if the device sending messages has some of the same commands as the SEL-2020, but different action is desired from the SEL-2020.

SET M - Data Movement (Ports 1-16)

The SET M command allows you to scale and move data to a User region. This allows you to customize data scaling and organization in a central location. This can significantly reduce data access time by reducing the number of requests necessary to get the data of interest. On port 16, the SET M command also defines what data is visible to DNP.

SET L - Logic (Ports 1-16)

The SET L command allows you to define control equations for all port-specific set and clear bits (SBR1 - SBR16, SRB1 - SRB16, CBR1 - CBR16, and CRB1 - CRB16).

SET C - Calibration

There is normally no need for you to calibrate the SEL-2020 because it is fully calibrated at the factory. Calibration checks are only needed if you change EPROMs to upgrade the SEL-2020 firmware, and even then it is unlikely that any changes will be needed.

“JOB DONE” EXAMPLE

To demonstrate the power and simplicity of the SEL-2020, set up the SEL-2020 to collect relay meter data from an SEL-251 Relay as follows:

1. Connect the SEL-251 Relay to an SEL-2020 port; this example uses Port 1. Use the SEL-C239 (Y type) cable because it handles both communication and IRIG-B. Connect the communication terminal at the Y end of the cable to Port 2R on the SEL-251 Relay because Port 2 on 200 series relays is capable of *Fast Meter* data transfer. Connect the IRIG-B terminal at the Y end to the relay’s AUX Input port. Connect the single connector end of the cable to Port 1 on the SEL-2020.

2. Access Level 2 on the SEL-2020 and issue the command **SET P 1** to configure Port 1. The SEL-2020 will prompt for the type of device connected to the port. Enter **S** for SEL IED, **Y** to auto-configure the port, and press the **<ENTER>** key to confirm the configuration prompts. The SEL-2020 will establish communication with the relay; determine the type of relay, relay ID, and communication baud rate; and determine if the relay is capable of *Fast Meter*. Enter **Y** to save port configuration changes at the final prompt.

3. Next, issue the command **SET A 1** to set an auto-message to collect relay meter data. Respond to prompts about saving unsolicited messages (AUTOBUF), the STARTUP string, and operate command enable (SENDOPER). Press **<ENTER>** to confirm the defaults for all of these. Enter **1** when prompted for the message count. At the ISSUE1 prompt, enter **P00:00:01** to set the message to trigger once every second. At the MESG1 prompt, enter **20METER** to send the request for meter data to the SEL relay. Press **<ENTER>** to accept the default for remaining settings and enter **Y** to save changes. As soon as the SEL-2020 accepts the setting change, the TXD and RXD Port 1 LEDs on the SEL-2020 will begin to flash as the SEL-2020 requests and receives meter data every second.

4. Verify connection, configuration, and data transfer using SEL-2020 commands WHO, MAP, VIEW, and STATUS as follows:

    a) Verify that the relay is connected to the desired port and configured properly by issuing the WHO command. The SEL-2020 responds to this command with some basic information about the SEL-2020 and a list of the devices and device identification strings associated with each port. In this case, the list shows that an SEL-151 device is connected to Port 1. The report lists the “151” and not “251” because the 151 firmware is used in both the 100 series and 200 series hardware packages.

```
*>>WHO<ENTER>

                                                Date: 03/06/95    Time: 09:05:20
FID=SEL-2020-R115-V0-D961020

Port #    Device     Protocol  Parameters  Identification
1         SEL-151    SEL       9600,8,2,N  Example 21.6 kV Feeder - S/N 93245011
2         SEL IED    SEL       9600,8,2,N
3         SEL IED    SEL       9600,8,2,N
4         SEL IED    SEL       9600,8,2,N
5         SEL IED    SEL       9600,8,2,N
6         SEL IED    SEL       9600,8,2,N
7         SEL IED    SEL       9600,8,2,N
8         Master     SEL       9600,8,2,N
9         Printer    Ascii     9600,8,2,N
10        SEL IED    SEL       9600,8,2,N
11        SEL IED    SEL       9600,8,2,N
12        SEL IED    SEL       9600,8,2,N
13        SEL IED    SEL       9600,8,2,N
14        SEL IED    SEL       9600,8,2,N
15        SEL IED    SEL       9600,8,2,N
16        SEL IED    SEL       9600,8,2,N
F*        Master     SEL       2400,8,2,N

*>>
```

The displayed response to the WHO command also identifies that Master port currently in use by an '*' next to its port number: Port F in the current example.

b) Verify the location and type of data being collected on Port 1 of the SEL-2020 by issuing the command string **MAP 1**. The SEL-2020 responds with a database map of the Port 1 data regions. This map shows that meter data are being collected in Port 1 region D1, which is associated with Port 1 Message 1. The B METER indicates that the SEL-2020 is receiving binary, or *Fast Meter*, data from the SEL-251 Relay. If the SEL-251 Relay did not have *Fast Meter* capability, there would be an “A” next to METER, indicating that the data are transferred in ASCII format.

```
*>>MAP 1<ENTER>
Port 1 Database Assignments
  Region    Data Type   # Records
  GLOBAL    --
  LOCAL     --
  BUF       --
  D1      B METER
  D2        Unused
  D3        Unused
  D4        Unused
  D5        Unused
  D6        Unused
  D7        Unused
  D8        Unused
  A1        Unused
  A2        Unused
  A3        Unused
  USER      Unused

*>>
```

You can refer to the specific data region by the region name, D1, or the data name, METER.

c) Verify the various metering quantities that are being collected and stored in the SEL-2020 by issuing the command string **MAP 1:METER** or **MAP 1:D1**. The SEL-2020 responds with a map of the specific data region, including a listing of the data item names, the starting address for each data item, and the type of data stored at each address.

```
*>>MAP 1:METER<ENTER>
Port 1,  Data Region METER  Map
Data Item    Starting Address   Type
_YEAR         2000h              int
DAY_OF_YEAR  2001h              int
TIME(ms)     2002h              int[2]
IA(A)        2004h              float[2]
IB(A)        2008h              float[2]
IC(A)        200Ch              float[2]
VA(V)        2010h              float[2]
VB(V)        2014h              float[2]
VC(V)        2018h              float[2]
IAB(A)       201Ch              float[2]
IBC(A)       2020h              float[2]
ICA(A)       2024h              float[2]
VAB(V)       2028h              float[2]
VBC(V)       202Ch              float[2]
VCA(V)       2030h              float[2]
PA(MW)       2034h              float
QA(MVAR)     2036h              float
PB(MW)       2038h              float
QB(MVAR)     203Ah              float
PC(MW)       203Ch              float
QC(MVAR)     203Eh              float
P(MW)        2040h              float
Q(MVAR)      2042h              float
I0(A)        2044h              float[2]
I1(A)        2048h              float[2]
I2(A)        204Ch              float[2]
V0(A)        2050h              float[2]
V1(A)        2054h              float[2]
V2(A)        2058h              float[2]


*>>
```

Notice in this case that all of the currents and voltages contain two floating-point numbers, one for magnitude, the other for phase angle. The magnitudes and phase angles are calculated from *Fast Meter* sample data. ASCII data includes only voltage and current magnitude.

d) View the data stored in the Port 1 METER data region by issuing the command string VIEW **1:METER** or **VIEW 1:D1**. The SEL-2020 responds with a data "dump" showing the data stored in the data region at the time of the request with the respective data item labels. In this example, the data in this data region are updated once each second.

```
*>>VIEW 1:METER <ENTER>

Port 1,  Data Region METER   Data

_YEAR = 1995  DAY_OF_YEAR = 1 (01/01)  TIME = 01:59:37.859
IA(A) =   2374.623,   102.078  IB(A) =   2353.747,   -17.810
IC(A) =   2369.258,  -137.949  VA(V) =  11278.516,   103.606
VB(V) =  11289.020,   -16.545  VC(V) =  11270.235,  -136.424
IAB(A) =   4092.593,   131.987  IBC(A) =   4093.101,    12.229
ICA(A) =   4107.771,  -107.898  VAB(V) =  19558.934,   133.546
VBC(V) =  19524.914,    13.488  VCA(V) =  19524.873,  -106.397
PA(MW) =     26.773  QA(MVAR) =      0.714  PB(MW) =     26.565
QB(MVAR) =      0.587  PC(MW) =     26.693  QC(MVAR) =      0.711
P(MW) =     80.030  Q(MVAR) =      2.012  IO(A) =      7.170,   135.000
  I1(A) =   2365.875,   102.106  I2(A) =      5.750,    40.418
VO(V) =      7.299,   -80.537  V1(V) =  11279.251,   103.546
V2(V) =     13.106,   163.608


*>>
```

Note that all current and voltages are reported in primary system quantities.

e) Check the communication and data retrieval performance by issuing the SEL-2020 **STATUS** command. The SEL-2020 responds with SEL-2020 general information, optional equipment information, and communication performance, including a listing of ports with their respective communication status, communication success rate, and database delays. In this example, the SEL-251 Relay is connected to the SEL-2020's Port 1, which is shown with active status and 100% communication success rate. If the relay is disconnected or turned off, the status changes to inactive. If database delays were encountered on this port, the specific region, or regions, affected would be listed under database delays. If these delays were a problem, you could adjust the data collection period or times to prevent overrunning data that can cause database delays.

```
*>>STATUS<ENTER>
COMMUNICATIONS PROCESSOR - S/N 95012004     Date: 03/06/95    Time: 13:46:43
FID=SEL-2020-R100-V0-D950324
SELF-TESTS
RAM       ROM       EEPROM    FLASH     P.S.      SET       BATTERY
512 kb    OK        OK        2048 kb   OK        OK        OK
IRIG-B Input: Present
I/O Board: Installed
Modem: Installed
Port   Status    Success Rate   SET M    Database Delays
1      Active       100%        None
2      Inactive                 None
3      Inactive                 None
4      Inactive                 None
5      Inactive                 None
6      Inactive                 None
7      Inactive                 None
8      Active                   None
9      Active                   None
10     Inactive                 None
11     Inactive                 None
12     Inactive                 None
13     Inactive                 None
14     Inactive                 None
15     Inactive                 None
16     Inactive                 None
F      Active      100%         None


*>>
```

"JOB DONE!"

Refer to ***Section 4: "Job Done" Examples*** for additional "Job Done" examples using the SEL-2020.

SEL-2020 ROBUST DESIGN

The SEL-2020 is designed to provide reliable service in a wide variety of electrical, physical and environmental conditions.

Wide Temperature Operating Range

The SEL-2020 is designed for operation with an ambient temperature between -40° and +85°C (-40° and +185°F). The SEL-2020 equipped with the optional internal model is designed for operation with an ambient temperature between -40° and +70°C (-40° and +158°F).

Wide Voltage Range Power Supply

Three power supply voltage ranges are available. The 125/250 volt power supply will operate with a voltage range of 85 to 300 Vdc, or 85 to 264 Vac. The 48/125 volt power supply will operate with a voltage range of 36 to 200 Vdc or 85 to 140 Vac. The 24/48 volt power supply will operate with a voltage range of 18 to 60 Vdc.

Meets Tough IEEE & IEC Standards

The SEL-2020 is designed to meet tough IEEE and IEC electrical, environmental, and vibration standards, making the SEL-2020 suitable for application in hostile environments such as substations and power plants, in relay and control houses, or in outdoor cabinets and enclosures.

User-Friendly Features

The SEL-2020 includes the following features that make it easy to use and apply with other devices.

Auto-Help

The SEL-2020 command set is forgiving, permitting you to enter some command strings in alternate sequences. However, if you make an entry that is not valid, the SEL-2020 automatically provides a list of acceptable commands. If part of your command is recognized, the SEL-2020 provides help by showing the proper command string format. Or you can type HELP for a complete list of the available commands. For the experienced user, Auto-Help can be disabled.

COPY Command

You can use the COPY command to copy settings from one port to another. This capability can speed the setting process where identical or very similar settings are used on multiple ports. The command has an option to copy settings from one port to all ports, but the SEL-2020 requests confirmation of the copy function for each port before performing the copy operation.

SWAP Command

You can use the SWAP command to swap settings between two ports. This capability may be handy when swapping port connections between two devices.

TOGGLE Command

You can use the TOGGLE command to toggle one of the Global or Local elements. This feature can be very helpful when testing SELOGIC Control Equation triggers, intermediate logic equations, or contact outputs.

Self-Testing

The SEL-2020 continually performs a number of self-test operations to ensure that it is functioning properly. You use the STATUS command to access results for the RAM, ROM, EEPROM, nonvolatile Flash memory, power supply, settings, and clock battery tests. The SEL-2020 is equipped with an alarm contact to provide an external indication of a failure.

5 Vdc on Rear Ports

An internal jumper for each port controls the availability of 5 Vdc to power an external device, such as an external modem. The default position of the jumper is open.

OPTIONS

Three options are available to meet additional customer needs:

Input/Output Board

Sixteen opto-isolated input terminals and four output contacts provide additional sensing and control capability to the SEL-2020. You can set the control input voltage for each input at 48 Vdc (30 - 60 V range), 125 Vdc (80 - 150 V range), or 250 Vdc (150 - 300 V range), according to the internal jumper you select. Output contacts are trip rated and can be individually configured as form A or form B using soldered board jumpers.

Internal Modem

The SEL-2020 internally mounted and powered modem is AT command set compatible and capable of up to 14400 baud communication. The modem uses the Port 8 communication line with access through an RJ11C modular connection jack on the rear panel. You can configure the modem for auto-dial or auto-answer.

Nonvolatile Flash Memory

Two megabytes of nonvolatile Flash memory are available with this option. This addition expands the capabilities of the SEL-2020 to permit long-term data storage without risk of losing the data if power to the SEL-2020 is turned off.

APPLICATIONS

The SEL-2020's features make it extremely versatile and powerful. The most obvious applications include:

Intelligent Port Switch

Flexible communications parameters make the SEL-2020 a great choice for almost any port switching application. The multi-tasking/multi-user capability and data handling capability make the SEL-2020 more of a self-contained network hub than a port switch, but it is still an economical choice for port switching applications. The time synchronization capabilities of the SEL-2020 add to its value in this application.

Substation Integrator

The SEL-2020's communication processing and database capability are designed to collect and store data from numerous devices, parse it into useful pieces, and distribute just the needed data to other devices or systems. This is the fundamental purpose of substation integration, making the SEL-2020 a natural choice for this application. Its networking capabilities allow it to be the communication network for small substation integration projects, or it can serve as a sub-network integrator with one or more ties to a larger substation network.

SCADA Interface

The SEL-2020 can be interfaced with a variety of devices, including RTUs. The SEL-2020 can serve as a data concentrator, to be polled by a local RTU, or it can be connected to a dedicated SCADA communication circuit and polled by a central device.

Conclusion

Whether the job is simply to set up a port switch to communicate with a few relays, or to integrate data and control for a substation integration project, the SEL-2020's numerous innovative features make it the quickest path to getting the JOB DONE!

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SECTION 3: INSTALLATION

INTRODUCTION

Planning should be the first step you take before installing any new device, and it is equally essential to ensure successful installation and operation of the SEL-2020 Communications Processor. This section of the SEL-2020 instruction manual includes information and procedures you should be familiar with to install the SEL-2020 safely and effectively. Safe and effective installation of the SEL-2020 requires proper mounting, connection, communications, and setup. The instructions in this section assume that you have successfully performed the initial checkout on the SEL-2020 and that you can install the SEL-2020 per the specifications, both as described in ***Section 1: Introduction.***

MOUNTING AND CONNECTIONS

This subsection provides details about the physical mounting and connection requirements for the SEL-2020 Communication Processor.

Mounting

The SEL-2020 Communications Processor is designed to be permanently mounted in a dry, indoor location. The SEL-2020 chassis includes reversible flanges that permit the unit to be flush mounted or projection mounted in a 19-inch relay rack or on a switchboard panel. The SEL-2020 can be mounted horizontally or vertically, although the front and rear panel stencils are designed to be read with the unit mounted horizontally. Use four #10 screws for mounting. Front and rear panel drawings, mounting dimensions, and drilling details are included in the SEL-2020 Data Sheet in ***Section 1: Introduction***.

Frame Ground Connection

You must connect the grounding terminal labeled “GND” on the rear panel to a frame ground for proper safety and performance. This terminal connects directly to the internal chassis ground of the instrument.

Power Connections

The terminals labeled “POWER” on the rear panel must be connected to a power source that matches the power supply (POW SUP) characteristics specified on the rear panel nameplate of your SEL-2020. If you provide a dc power source, you must connect the source with the proper polarity as indicated by the “+” and “–” labels on the power terminals. The SEL-2020 internal power supply has very low power consumption and a wide voltage tolerance. See the specifications in ***Section 1: Introduction*** for complete power supply information.

Alarm Contact Connection

The SEL-2020 includes an alarm output contact connected to terminals Z01 and Z02 labeled “ALARM” on the rear panel. At the factory, the alarm contact is configured to be closed for an alarm condition, and open for normal operation. This is a “Form B” contact because it is closed when there is no power. To invert the alarm output to close under normal conditions, change soldered jumper, JMP8, on the main board to select “Form A” contact usage. See Table 3.4 and Figure 3.2 for jumper settings.

The alarm contact asserts when no power is connected to the SEL-2020, the power supply fails, or self-test diagnostics detect a failure. Self-test diagnostic failures include memory failures, power supply failures, and invalid settings failures. See STATUS command subsection in ***Section 5: Commands*** for a discussion on these failures. If an I/O board is installed, the alarm contact is pulsed when Level 2 communication is accessed, or when an SEL-2020 setting change is accepted.

The ALARM LED will light whenever the alarm contact closes, unless there is a loss of power to the LED.

IRIG-B Input Connection

The SEL-2020 accepts a modulated or demodulated IRIG-B signal through a rear panel BNC connector labeled “MODULATED/DEMODULATED IRIG-B IN”. Three internal jumper settings are required to identify which type of signal, modulated or demodulated, will be applied to the SEL-2020. See Table 3.4 and Figure 3.2 for the main-board jumper positions to select the appropriate type of IRIG-B input signal. The factory default setting is demodulated IRIG-B time input.

Use a modulated IRIG-B signal for the input to the SEL-2020 if it is available. The modulated signal is isolated by a transformer, and the demodulator in the SEL-2020 includes automatic gain control. You can use a demodulated signal, but it may not be adequate if the cable to the source is too long. A maximum cable length of 50 ft (15 meters) is recommended to ensure satisfactory performance.

An internal element asserts in the SEL-2020 Global database region when an adequate IRIG-B input signal is received. If no external IRIG-B input signal is applied, the SEL-2020 generates an IRIG-B signal. The SEL-2020 includes an internal battery-backed clock/calendar that maintains correct time with or without external power.

IRIG-B Output Connection

The SEL-2020 distributes a demodulated IRIG-B output signal through all of its 16 rear ports. You can use this feature to synchronize any type of device, such as a relay, fault recorder, or meter that can decode the IRIG-B signal: you need only to connect the device to the desired SEL-2020 rear serial communication port using a special cable designed for both communication and IRIG-B signal. The IRIG-B signal is on pins 4 and 6 of the 9-pin, subminiature “D” connector (see Figure 3.1 and Table 3.1).

Where distance between the SEL-2020 and a device exceeds the cable length recommended for conventional EIA-232 metallic conductor cables, you can use modems to provide isolation and to establish communications to remote locations. Unfortunately, conventional short-haul, fiber optic, and telephone modems do not support IRIG-B signal transmission, so their use requires that you use some other method to synchronize the remote IED. Special fiber optic modems (like the SEL-2810) are available, however, that include a channel for the IRIG-B time code; these modems enable you to synchronize more precisely devices capable of receiving IRIG-B time code, even with a fiber optic communication link.

The IRIG-B signal includes code for day-of-year and time-of-day. It does not include a code to identify the year. To ensure the device calendar is set to the proper year, you need to set the date on each device receiving an IRIG-B signal. Most SEL relays store the year for the set date with the relay settings in nonvolatile memory, so once the date is properly set, the relay will maintain the proper year even if relay power is cycled off and on.

Communication Circuit Connections

The SEL-2020 Communications Processor is equipped with sixteen rear panel serial communication ports, labeled "PORT 1" through "PORT 16", and one front panel serial communication port, labeled "PORT F". The data connection for each SEL-2020 serial communication port uses EIA-232 standard signal levels in a 9-pin, subminiature "D" connector (see Figure 3.1 and Table 3.1). EIA-232 interfaces are supported by almost all modern relays, meters, computer, and communications devices.

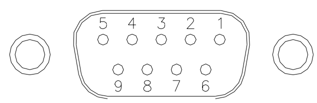

Figure 3.1: 9-Pin Connector Pin Number Convention (female chassis connector, as viewed from outside panel)

! WARNING

Do not rely upon pins 5 and 9 for safety grounding, because their current-carrying capacity is less than control power short circuit and protection levels.

The communication circuits are protected internally by low-energy, low-voltage MOVs and passive RC filters.

You should keep the length of the communication cables as short as possible to minimize communication circuit interference and also to minimize the magnitude of hazardous ground potential differences that can develop during abnormal power system conditions. See the next subsection, titled "Communication Cables" for additional details and restrictions.

Note: When an internal modem is installed, you must use the telephone connector on Port 8, not the 9-pin connector. Conversely, if the internal modem is not installed, you must use the 9-pin connector because the telephone connector on Port 8 will not be functional.

Table 3.1: Serial Port Connector Pin Definitions

Pin	Ports 1-16	Port F
1	+5 Vdc*	N/C
2	RXD	RXD
3	TXD	TXD
4	+IRIG-B	N/C
5,9	GND	GND
6	GND (-IRIG-B)	N/C
7	RTS	RTS
8	CTS	CTS

*When internal jumper is installed.

Communication Cables

Standard SEL communication cables available for your use with the SEL-2020 are listed in Table 3.2. Using an improper cable can cause numerous problems, so you must be sure to specify the proper cable for the application. Please call the SEL factory if you have any questions about cables and cable connections.

Never use standard null-modem cables with the SEL-2020. Using any non-SEL cable can cause severe power and ground problems involving pins 1, 4, and 6 on the SEL-2020 communication ports.

Table 3.2: Communication Cables for Devices Attached to SEL-2020

SEL Cable #	Connect SEL-2020 to:	Remote Connector (on cable)	Port Type	RTS/CTS Supported	IRIG-B Included
C157A	Existing SEL-PRTU Relay Cable retrofit	9-pin Con-X-All (female)		no	no
C222	25-pin DCE devices: Standard modem, ABB 25-pin PONI module	DB-25P	DCE	no	no
C223A	25-pin DTE Devices: Beckwith M0420 (25-pin) Black Box COS Port Switch GE 90-70 & 90-30 PCM (PLC), GEC Optimho Relay, GE DLP/DFM	DB-25P	DTE	no	no
C225	9-pin DCE devices: 9-pin modem	DB-9P	DCE	no	no
C227A	25-pin DTE devices: Standard 25-pin computer	DB-25S	DTE	no	no
C234A	9-pin DTE devices: Standard computer	DB-9S	DTE	no	no
C239	9-pin DTE devices w/ IRIG-B: SEL-200/321 Series Relays	DB-9P, DB-9P	DTE/ IRIG-B	yes	yes
C241	25-pin DCE devices: ABB SADI, Black Box COS Port Switch (DCE), Baytech Port Switch	DB-25P	DCE	no	no
C245A	9-pin DCE devices: RFL-9660 Digital Port Switch	DB-9S	DCE	yes	no
C246A	9-pin DCE devices: Rochester Instrument Sys, CIU, Basler 9-pin DCE	DB-9P	DCE	no	no
C247	25-pin DTE devices Systems Northwest RTU	DB-25P	DTE	no	no
C255	Quantum Meter	DB-25P	N/A	no	no
C272A	9-pin DTE devices: ABB DPU2000R	DB-9P	DTE	no	no
C273A	9-pin DTE devices w/ IRIG: SEL-500 Series, SEL-300 Series except SEL-321	DB-9P	DTE/ IRIG-B	yes	yes
C276	9-pin DTE device w/ IRIG: SEL-2020 EIA-232 & IRIG-B	DB-9P, BNC	DTE/ IRIG-B	yes	yes
C277	9-pin DTE devices: MODICON 9-pin DTE	DB-9P	DTE	no	no
C278	Scientific Columbus JEM-10 Meter w/ Curo Style Connector	No connector (tinned wires)	N/A	no	no
C279	25-pin DTE device w/ IRIG: GE-DLP EIA-232 & IRIG-B	DB-25P, BNC	DTE/ IRIG-B	no	yes
C280	Harris WESDAC D20M RFL-9300	DB-9S	DTE	no	no
C281	9-pin DTE devices: Standard computer, RFL-9745, ABB 9-pin PONI Module (DTE), Beckwith M0420 (9-pin)	DB-9S	DTE	yes	no

Table 3.2: Communication Cables for Devices Attached to SEL-2020 (continued)

SEL Cable #	Connect SEL-2020 to:	Remote Connector (on cable)	Port Type	RTS/CTS Supported	IRIG-B Included
C282	9-pin DTE devices: Tasnet 9-pin DTE, Beckwith M3430 Dranetz SER	DB-9P	DTE	yes	no
C285	9-pin DCE with flow control: ABB 9-pin PONI Module (DCE), ABB FOCUS Data Module	DB-9P	DCE	yes	no
C339	9-pin Round Con-X-All devices w/ IRIG: SEL-100 Series Relays/SEL-PRTU	9-pin Con-X-ALL (male), 9-pin Con-X-ALL (male)	N/A	yes	yes

The following list provides additional rules and practices you should follow to ensure successful communication using EIA-232 serial communication devices and cables:

- You should keep the length of the communication cables as short as possible to minimize communication circuit interference and also to minimize the magnitude of hazardous ground potential differences that can develop during abnormal power system conditions.
- EIA-232 communication cable lengths should never exceed 50 feet, and you should always use shielded cables for communication circuit lengths greater than 10 feet.
- Modems are required for communications over long distances and to provide isolation from ground potential differences between device locations.
- Route communication cables well away from power and control circuits. Switching spikes and surges in power and control circuits can cause noise in the communications circuits if not adequately separated.
- Lower baud rate communication is less susceptible to interference and will transmit greater distances over the same medium than with higher baud rates. You should use the lowest baud rate that provides adequate data transfer speed.

Communications

This subsection describes how you can optimize the communications interface between the SEL-2020 and other devices it will communicate with.

Modems

If electrical interference is a problem, consider using point-to-point fiber-optic modems to provide electrical isolation and noise immunity. We recommend the SEL-2810 Fiber-Optic Modem for these applications. The connection between the SEL-2020 and the modem is EIA-232. The connection between the remote modem and the remote device is also EIA-232. Optical fibers connect the two modems.

For sites where the main issue is cable length, you can use short-haul modems connected by wire. This alternative is a compromise between the low cost and short cable for direct EIA-232 connections and the isolation and noise immunity of higher-cost fiber-optic links.

You must provide power to any modem that you install between the SEL-2020 and another device. You can use the SEL-2020 to power some types of modems connected to its rear-panel ports. With the proper jumper connections, the EIA-232 outputs of the SEL-2020 will support modems which accept +5 Vdc power. The total current drawn by all of the external modems powered by one SEL-2020 should not exceed 0.5 amp. See Table 3.4 and Figure 3.2 for the +5 Vdc power jumper settings for each port. None of these jumpers are installed at the factory. Some modems power themselves from the control and data lines. These modems do not require connection to the +5 Vdc power.

Telephone Line Communications

A telephone dial-up link is one option for off-site communications with an SEL-2020. Use a modem to convert from the audio telephone line to an EIA-232 interface on the SEL-2020. You can use the optional SEL internal modem to connect a telephone line to Port 8 of the SEL-2020. Or you can use an external modem connected to any of the rear-panel ports. You can set the SEL-2020 to answer the phone and to initiate calls based on conditions that you select.

You should use telephone line protection equipment where the line enters the building, to ensure personnel safety and reduce damage to equipment from ground-potential rise and other hazardous conditions. Connect the line protection equipment to the modem following standard commercial telephone wiring standards.

If you use one telephone line for both voice and SEL-2020 communications, set the SEL-2020 modem port to ignore a specified number of rings before answering, so that personnel at the site can answer the phone before the modem answers. You can also provide a hook-switch in the phone line, so on-site personnel can disconnect the telephone line from the modem; however, you may want to use some type of timer instead to disconnect the line to prevent them from leaving the modem disconnected.

If you have one telephone line to communicate with a mix of telephones and modems in a site, you typically use a telephone port switch. Connect the protection equipment to the telephone port switch, and the telephone port switch to the SEL-2020 modem and other devices with standard telephone wiring.

Data Flow Control

All SEL devices, including the SEL-2020, support XON/XOFF software data flow control. You should select this option, or accept the XON/XOFF = Y default for any communication setting where the SEL-2020 is connected to another SEL device. Set RTS/CTS = N to connect an SEL-2020 to any SEL device.

The SEL-2020 also supports RTS/CTS hardware data flow control. You should select the RTS/CTS option only if the connected device uses RTS/CTS, and does not use XON/XOFF flow control. Consult the instruction manual or contact the device vendor to determine the proper flow control technique for each non-SEL device. If you select RTS/CTS hardware data flow control, make sure that the cable you are using to connect the device to the SEL-2020 has conductors for RTS/CTS.

Baud Rate

The default baud rate for the SEL-2020 front port, Port F, is 2400 baud. You can change the Port F baud rate, and the other Port F communication parameters using the SET P command. You can force the Port F baud rate to 2400 baud by hardware jumper selection (see Table 3.4).

The default baud rate for all rear panel communication ports is 9600 baud. You can change the baud rate for each of these ports and the associated communication parameters with the SET P setting command. With an SEL relay attached to one of the rear ports, the SEL-2020 will automatically set the baud rate to match the relay baud rate when you request the SEL-2020 to perform auto-configuration. With other IEDs attached to the ports, the SEL-2020 baud rate is automatically set to match the attached IED baud rate when you request the SEL-2020 to perform the auto-baud function.

To change the communication baud rate with a device, you should change the baud rate on the device first, either by baud rate jumper, dip switch or software setting, then you should change the baud rate setting on the associated SEL-2020 port using the SET P command. (See ***Section 6: Settings*** for more information on making settings changes.)

Master Device to SEL-2020 Communication

Some Master devices, such as RTUs, cannot accept unsolicited messages, requiring that they only receive a response to a request they send. When you interface the SEL-2020 with such a device, you must make sure that the SEL-2020 does not send any auto-messages to the device unless the SEL-2020 first receives a request. Use the SET U command to create user-defined commands that will trigger the appropriate auto-message response.

You must use the same precaution when you interface the SEL-2020 with a master device using the LMD protocol.

Passwords

Factory-set passwords are:

Level 1 = OTTER

Level 2 = TAIL

You can set your own passwords with the PASSWORD command, or you can disable the password protection with jumper selection (see Table 3.4). (See ***Section 5: Commands*** for more information on access levels and password control.)

Data Collection Periods

You can set the SEL-2020 Communications Processor to collect data from attached devices on an exception basis, i.e., only when an event occurs, and you can set the SEL-2020 to collect data on a regular, periodic basis. Each SEL-2020 port collects data independently, based on your settings, and you can set each port to collect data in different ways using separate message trigger conditions and data request messages. Likewise, each SEL-2020 port responds to requests for data independently, based on your settings. In either case, the SEL-2020 will not issue or respond to another request for data on the same port until the previous request has been satisfied. If the data response has not been completed before the same message trigger condition occurs again, the second trigger will be missed completely. The SEL-2020 will acknowledge this missed trigger by setting a delay bit in the port register, which is reported in the SEL-2020 status report.

Although both exception and periodic data collection can encounter this type of delay, you can control the periodic collection period, and thereby minimize the possibility of collection delays, and missed triggers. You should consider first, if the attached device is capable of transferring data in binary format, or only in ASCII character format, and second, the type of data you plan to request, i.e., meter, target, demand, or another type.

Table 3.3 presents some general guidelines regarding minimum data collection periods you should use to collect various types of data from SEL relays in binary or ASCII format. The guidelines in this table assume the relay is using a baud rate of 2400 or above and is not busy processing events or communicating on more than one port. As this table shows, there is a dramatic difference between the minimum collection period for a relay that has *Fast Meter* (binary data transfer) capability, and one that can transfer data only in ASCII format.

When connecting to SEL 100 and 200 series relays that have *Fast Meter* binary data capability, always connect to Port 2 on the relay. Binary data transfer is not supported on Port 1 of these relays.

Table 3.3: SEL-2020 Minimum Data Collection Period (in Seconds)

Command	**Binary Data Format** (*Fast Meter*)	**ASCII Data Format** (no *Fast Meter*)
20METER	1	10
20DEMAND	1	10
20TARGET	1	20[1]
20STATUS	N/A	10
20BREAKER	N/A	10
20HISTORY	N/A	20[2]
20EVENT	N/A	120
20EVENTS	N/A	120
20EVENTL[3]	N/A	300

Notes: [1] SEL-321 Relay requires one minute.

[2] SEL-321 Relay requires 30 seconds. The SEL-BFR and SEL-2BFR Relays require 40 seconds.

[3] Only supported on SEL relays that support 16 sample/cycle event reports.

JUMPER SETTINGS

This subsection describes the hardware jumper selections available on the SEL-2020 Communcations Processor, and the recommended procedures for making the jumper setting changes.

Main Board Jumpers

Set the main board jumpers to meet your requirements. See Table 3.4 for jumper functions and positions. See Figure 3.2 for jumper locations on the main board.

Table 3.4: Main Board Jumper Positions

Function	Install Jumpers At:
IRIG-B Input Modulated Demodulated (factory setting)	 JMP**2** 2-3, JMP**7** 2-3(remove JMP**1**) JMP**1**, JMP**2** 1-2, JMP**7** 1-2
Connect +5 Vdc to pin 1 on: Port 1/ /Port 2 Port 3/ /Port 4 Port 5/ /Port 6 Port 7/ /Port 8 Port 9/ /Port 10 Port 11/ /Port 12 Port 13/ /Port 14 Port 15/ /Port 16 (factory setting = all off)	 JMP**6,** Position **A/** /JMP**6,** Position **C** JMP**5,** Position **A/** /JMP**5,** Position **C** JMP**4,** Position **A/** /JMP**4,** Position **C** JMP**3,** Position **B/** /JMP**3,** Position **C** JMP**6,** Position **B/** /JMP**6,** Position **D** JMP**5,** Position **B/** /JMP**5,** Position **D** JMP**4,** Position **B/** /JMP**4,** Position **D** JMP**3,** Position **A/** /JMP**3**, Position **D**
Alarm Contact Form Form A Form B (factory setting)	JMP**8** (20 AWG wire) **A** to Common (20 AWG wire) **B** to Common
Port F Baud Rate 2,400 baud, RTS/CTS = N, XON/XOFF = Y Selected by SET P settings.(factory setting)	(This jumper is read on power-up.) JMP**9** **A** Installed JMP**9** **A** Removed
Password Disable Password Enable (factory setting)	JMP**9** **B** Installed JMP**9** **B** Removed
Unused	JMP**9** **C**
Reserved - Do not install	JMP**9** **D**

Input/Output Connections

If your SEL-2020 is equipped with the optional I/O board, it has a terminal strip that extends nearly the full width of the SEL-2020, near the top of the rear panel.

Configure the Inputs for 48 V, 125 V or 250 V

You may reconfigure the inputs by changing jumpers on the edge of the board near the inputs and outputs. Table 3.5 and Figure 3.3 show the jumper positions required to configure the inputs for 30-60 Vdc, 80-150 Vdc, or 150-300 Vdc. If your device has a 125-250 V power supply, the default jumper setting is 80-150 Vdc. If your device has a 24-48 V power supply, the default jumper setting is 30-60 Vdc.

Table 3.5: Optional I/O Board Control Input Voltage Selection Jumper Positions

Terminal	Jumpers	30 - 60 Vdc	80 - 150 Vdc	150 - 300 Vdc
IN1	JMP31, JMP32	both in	31 out, 32 in	both out
IN2	JMP29, JMP30	both in	29 out, 30 in	both out
IN3	JMP27, JMP28	both in	27 out, 28 in	both out
IN4	JMP25, JMP26	both in	25 out, 26 in	both out
IN5	JMP23, JMP24	both in	23 out, 24 in	both out
IN6	JMP21, JMP22	both in	21 out, 22 in	both out
IN7	JMP19, JMP20	both in	19 out, 20 in	both out
IN8	JMP17, JMP18	both in	17 out, 18 in	both out
IN9	JMP15, JMP16	both in	15 out, 16 in	both out
IN10	JMP13, JMP14	both in	13 out, 14 in	both out
IN11	JMP11, JMP12	both in	11 out, 12 in	both out
IN12	JMP9, JMP10	both in	9 out, 10 in	both out
IN13	JMP7, JMP8	both in	7 out, 8 in	both out
IN14	JMP5, JMP6	both in	5 out, 6 in	both out
IN15	JMP3, JMP4	both in	3 out, 4 in	both out
IN16	JMP1, JMP2	both in	1 out, 2 in	both out

Configure the Output Contact Form

The SEL-2020 I/O board is shipped from the factory with form A output contacts. You may reconfigure the contacts by desoldering and then resoldering the 20 AWG jumper wire for each contact. Table 3.6 and Figure 3.3 show the jumper positions required to configure the contacts.

Table 3.6: Optional I/O Board Contact Form Jumper Positions

Output Contact	Jumper	Jumper Setting Form A contact	 Form B contact
OUT1 OUT2 OUT3 OUT4	JMP36 JMP35 JMP34 JMP33	Connect A to Common with 20 AWG wire (factory setting)	Connect B to Common with 20 AWG wire

Open the SEL-2020 to Access Internal Jumpers

After you have decided on the appropriate SEL-2020 hardware configuration, you are ready to reconfigure the SEL-2020 if the default configuration does not meet your needs. Perform the following steps to gain access to internal jumpers:

1. De-energize the SEL-2020.

⚠ CAUTION	Never work on the SEL-2020 with the front or top cover removed, when the SEL-2020 is energized.

2. Remove the screws attaching the front panel and top cover and remove the front panel and top cover.

⚠ CAUTION	The SEL-2020 contains devices sensitive to electrostatic discharge (ESD). When working on the device with front or top cover removed, work surfaces and personnel must be properly grounded or equipment damage may result.

3. If the optional I/O board is installed, disconnect any cables joining the I/O board to the main board.

4. Remove the I/O board temporarily by sliding it forward and out.

Set Jumpers

See Figure 3.2 for main board jumper locations. Configure the following main board jumpers according to the selections you have made:

- Modulated or demodulated IRIG-B input.
- Alarm contact form: A or B.
- Serial port +5 Vdc power output for each rear port.
- Port F baud rate jumper.
- Password disable jumper.

See Figure 3.3 for I/O board jumper locations. While the I/O board is removed, configure the following jumpers according to the selections you have made:

- Configure I/O board inputs for 48 Vdc, 125 Vdc, or 250 Vdc.
- Select output contact form: A or B.

Reassemble the SEL-2020

After configuring jumpers, reassemble the SEL-2020 as follows:

1. If you removed an optional I/O board, replace it.

2. Reconnect any cables that were disconnected between the I/O board and the main board.

3. Replace the top cover and top-cover screws and tighten them securely.

4. Replace the front panel and front-panel screws and tighten them securely.

INSTALLATION

Before you install the SEL-2020, you should perform the initial checkout procedure found in ***Section 1: Introduction***, and set the configuration jumpers according to your installation requirements per the instructions outlined earlier in this section. Install the SEL-2020 according to the following step-by-step instructions:

1. Mount the SEL-2020 in the desired panel location. Mounting information, including chassis, cutout and drilling dimensions are shown in the data sheet included in ***Section 1: Introduction***.

2. Connect the devices you desire to the SEL-2020 rear-panel DB-9 communication ports using SEL cables, or their equivalents. Cable information is located near the beginning of this section.

3. Connect power and ground, alarm, IRIG-B, and optional I/O on the rear panel.

4. Connect a terminal (or computer equipped with terminal emulation software) to the front-panel connector Port F of the SEL-2020 using an SEL-C234A cable or equivalent.

5. Set the computer terminal or emulation software to operate at:

   - 2,400 baud, 8 data bits, 1 stop bit, no parity

6. Press **<ENTER>** and verify that a “*” prompt is returned.

7. Type **ACCESS<ENTER>** to change to Access Level 1. Enter the factory-set password by typing **OTTER<ENTER>** at the password prompt. You will see a screen similar to the following:

```
*ACCESS<ENTER>

Password: ? OTTER<ENTER>


COMMUNICATIONS PROCESSOR - S/N 95012004     Date: 03/02/95    Time: 14:33:52

Level 1
*>
```

8. Type **STATUS<ENTER>** and verify that a status report similar to the one below appears on your terminal. The RAM memory size should be 512 kb or 1024 kb. If you ordered optional nonvolatile Flash memory, verify that Flash reports 2048 kb. If you did not order optional nonvolatile Flash memory, Absent is reported as in the screen below. Confirm that IRIG-B input, I/O board, and modem configurations match your expectations. This step completes installation of the SEL-2020.

```
*>>STATUS<ENTER>

COMMUNICATIONS PROCESSOR - S/N 95012004     Date: 03/02/95    Time: 15:32:24
FID=SEL-2020-R100-V0-D950324

SELF-TESTS

RAM       ROM       EEPROM    FLASH     P.S.      SET       BATTERY
512 kb    OK        OK        Absent    OK        OK        OK

IRIG-B Input: Present
I/O Board: Installed
Modem: Installed

Port   Status    Success Rate    SET M    Database Delays
1      Inactive                  None
2      Inactive                  None
3      Inactive                  None
4      Inactive                  None
5      Inactive                  None
6      Inactive                  None
7      Inactive                  None
8      Active                    None
9      Active                    None
10     Inactive                  None
11     Inactive                  None
12     Inactive                  None
13     Inactive                  None
14     Inactive                  None
15     Inactive                  None
16     Inactive                  None
F      Active           100%     None


*>
```

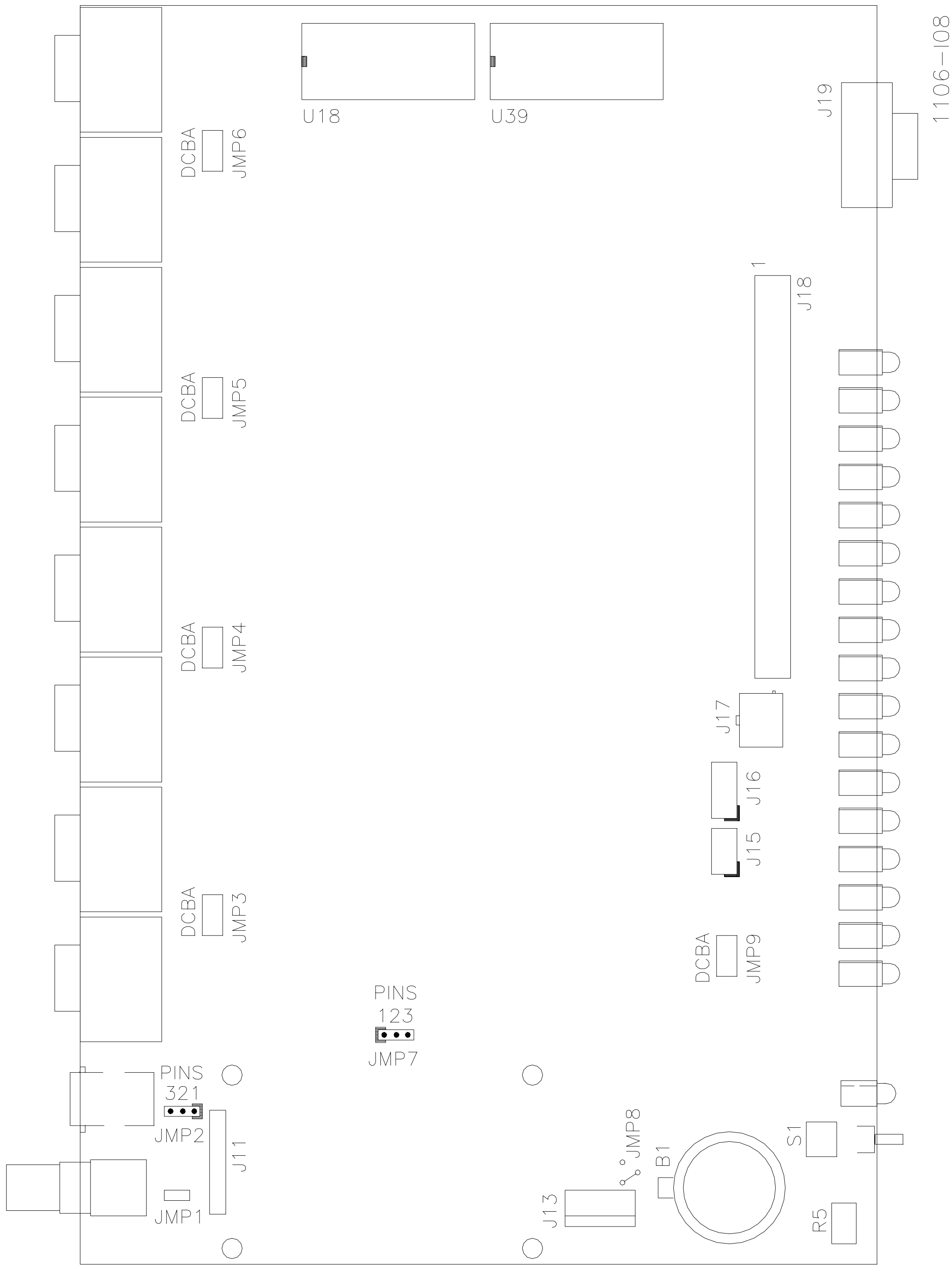

Figure 3.2: SEL-2020 Main Board Jumper Location

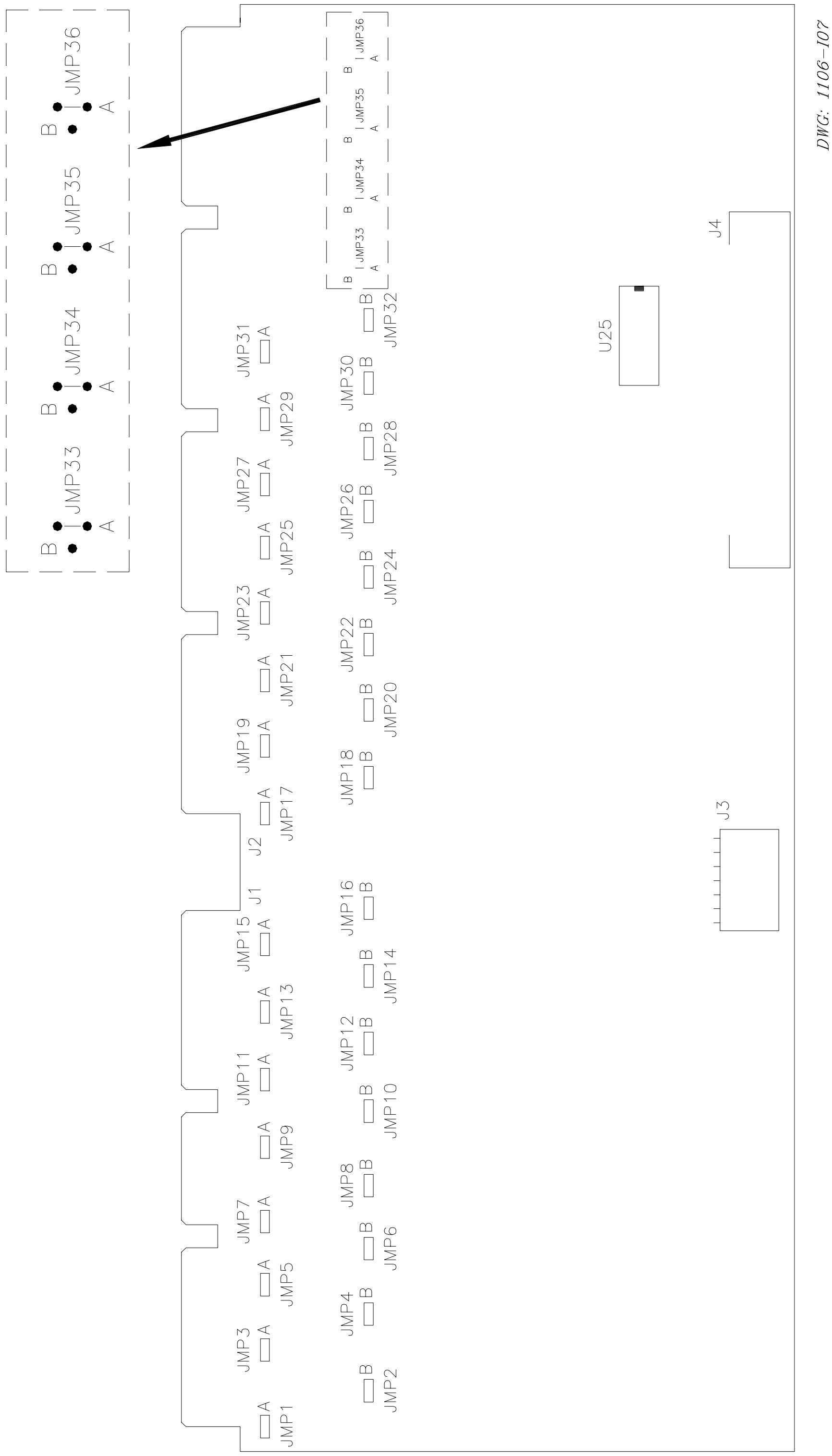

Figure 3.3: SEL-2020 Optional I/O Board Jumper Location

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FIGURES

SECTION 4: "JOB DONE" EXAMPLES

INTRODUCTION

This section describes SEL-2020 operations and user interface with eight examples that include a variety of common applications. In this manual, commands you type appear in bold/uppercase: **OTTER**. Keys you press appear in bold/uppercase/brackets: **<ENTER>**. SEL-2020 output screen images appear boxed and in the following format:

```
COMMUNICATIONS PROCESSOR - S/N 95012004     Date: 03/02/95    Time: 15:38:33          1
```

1 Explanatory notes: Explanatory notes associated with the SEL-2020 screen images are provided below each screen image.

Each example assumes you have successfully performed the Initial Checkout described in ***Section 1: Introduction***, and you have configured the SEL-2020 hardware by placing jumpers according to the instructions in the Installation subsection in ***Section 3: Installation***. The examples include an introduction to the problem or task, identification of the problem, overview or definition of the solution, and the step-by-step procedure you should follow to accomplish the solution with the SEL-2020.

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EXAMPLE 1: USING THE SEL-2020 AS A PORT SWITCH

INTRODUCTION

This example assumes your substation has an SEL-2020, seven SEL-251 Relays, an IRIG-B source, and a telephone line. Also, you have SEL-C239 cables of the appropriate length to connect the SEL-2020 to each relay. You have a PC or terminal and an SEL-234A cable to communicate with the SEL-2020. You will connect all of these as shown in Figure 4.1, below.

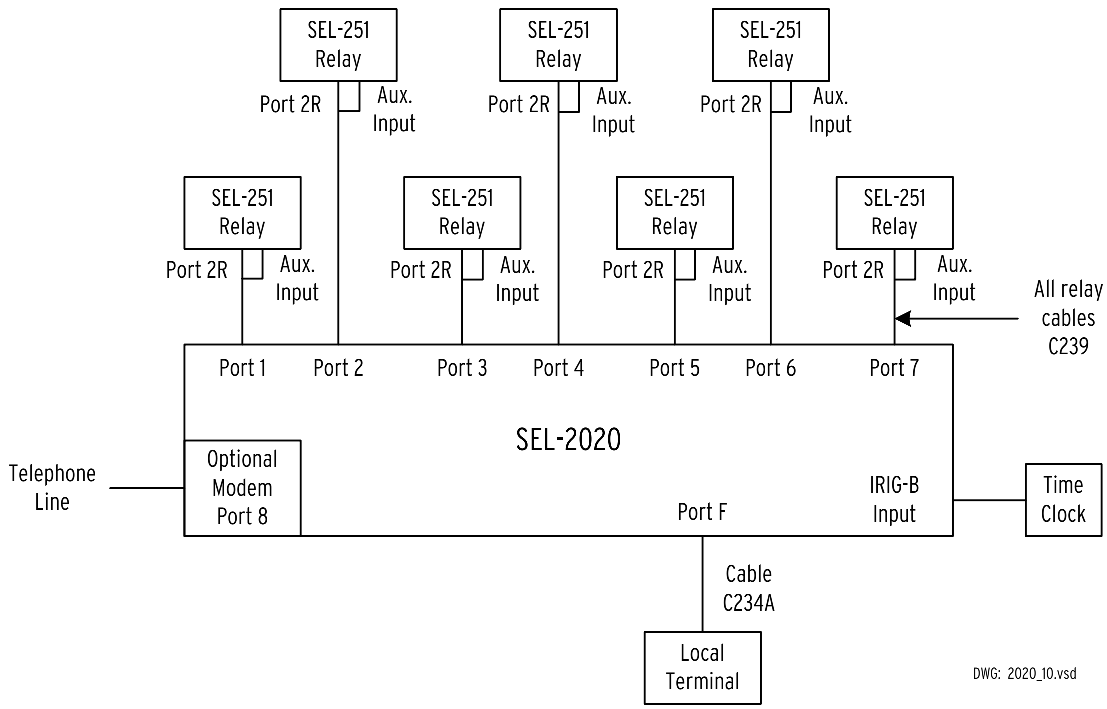

Figure 4.1: SEL-2020 Configured with Seven SEL-251 Relays, Optional Modem, and IRIG-B Source

IDENTIFYING THE PROBLEM

Your objective in Example 1 is to accomplish the following tasks:

- You want the SEL-2020 to time synchronize all IEDs with the IRIG-B source.
- You want to send date messages to the relays even though they receive IRIG-B time code, so if power is cycled on a relay, the appropriate date (including year) is available as a reference.
- You want to access information in all the IEDs through the telephone port.

Defining the Solution

Complete Hardware Connections

1. Connect each SEL-251 Relay as follows:
    a. On the relay, install cable SEL-C239 connectors to Port 2R and AUX INPUT.
    b. Plug the other end of cable SEL-C239 into the desired SEL-2020 serial port.
2. Connect the IRIG-B time source to the SEL-2020 IRIG-B input. (You need to know if the time source has a modulated or demodulated IRIG-B signal. Set the IRIG-B jumpers in the SEL-2020 to match the type of signal.)
3. Connect a telephone line to the phone line connector at Port 8.
4. Connect your computer's serial port to the SEL-2020's Port F with an SEL-C234A cable.

Note: You do not need to modify the baud rate of Port 2 at the relay; the SEL-2020 will match the baud rate during auto-configuration.

Set the SEL-2020

1. Issue the ACCESS and 2ACCESS commands and associated passwords to go to Access Level 2.
2. Use SET P F to set Port F parameters.
3. Set Port 1 configuration communications options using the SET P 1 command.
4. Use SET A 1 to define a timed trigger condition in the form of (Thh:mm:ss) to send a date message at a specific time once each day to the relay connected to Port 1.
5. Use the COPY 1 ALL command to copy Port 1 settings to the other ports (2, 3, 4, 5, 6, and 7) with devices attached.
6. Use SET P 8 to set Port 8 as a modem port.

Verify and Test All Communication Paths

1. Use the STATUS command to check that IRIG-B signal is present and devices are connected to ports as expected.
2. Check transparent communication with each port. Use PORT n command to enter transparent communication with Port n, where n is any port number (1-16); use **<CTRL-D>** to end transparent communication.
3. Check that all SEL relays are receiving proper IRIG-B signal from the SEL-2020, that all relays have their Port 2 set to issue auto-messages, and that the relay Port 2 time-out is OFF.
    - Enter Transparent Communication with each port, Access Level 1, and issue the IRIG command.
    - Issue the SHO command to check the relay's AUTO and TIME settings.
    - Exit transparent communication using the default disconnect sequence, **<CTRL-D>.**

4. Check that the SEL-2020 issues the correct date code to each relay. Change the relay date to the wrong year; use the TOGGLE command to issue the SEL-2020 date message.

5. Check Modem Communication. Have someone call; the SEL-2020 modem should answer by the fourth ring. The remote caller can enter transparent communication, and you can watch the communication using front panel LEDs and the STATUS command.

SET THE SEL-2020, STEP-BY-STEP

1. Issue the ACCESS and 2ACCESS commands and associated passwords to go to Access Level 2.

2. Use SET P F to set Port F parameters.

   You should have the following screen:

```
*>>SET P F<ENTER>

Port communications settings for Port F


Port Identification String
PORTID  =""                                                                    1
 ? Service port<ENTER>


Modem Settings

Modem Control (Y/N)                          MODEM   = N     ? <ENTER>


Communications Settings

Baud Rate (300, 600, 1200, 2400, 4800, 9600) BAUD    = 2400  ? <ENTER>

Parity (N,O,E)                               PARITY  = N     ? <ENTER>

Enable RTS/CTS handshaking (Y/N)             RTS_CTS = N     ? <ENTER>

Enable XON/XOFF flow control (Y/N)           XON_XOFF= Y     ? <ENTER>

Port Timeout in minutes (0.0-30.0)           TIMEOUT = OFF  ? <ENTER>

Automatic help messages enabled (Y/N)        AUTO_HELP= Y    ? <ENTER>


Transparent Communications Termination Sequence

First delay time (0-600 seconds)             TERTIME1= 1   ?<ENTER>

Termination string
TERSTRING="\004"                                                               2
 ? <ENTER>

Second delay time (0-600 seconds)            TERTIME2= OFF   ? <ENTER>

PORT:F
PORTID  ="Service port"
MODEM   = N
BAUD    = 2400
PARITY  = N
RTS_CTS = N    XON_XOFF=                                                       3
TIMEOUT = OFF
AUTO_HELP= Y
TERTIME1= 1
TERSTRING="\004"
TERTIME2= OFF

Save changes (Y/N) ? Y<ENTER>

Port F Setting Changed

*>>
```

Notes:

1 Enter a Port ID just for fun.

2 Default TERSTRING = “\004” is ASCII hexadecimal code for keystroke **<CTRL-D>**. Use **<CTRL-D>** to end or quit transparent communication with a port.

3 Review all settings and accept the changes by typing **Y<ENTER>**.

3. Set Port 1 communications options using the SET P command.

   You should have the following screen:

```
*>>SET P 1<ENTER>

Port communications settings for Port 1


Device Type (U=Unused, S=SEL IED, O=Other IED,
             P=Printer, M=Master)             DEVICE  = S     ? <ENTER>

Auto-configure port (Y/N)                   CONFIG  = N     ? Y<ENTER>          1

Attempting auto-configuration...

FID:      FID=SEL-151-R412-V656rp1rqys-D941208-E2
DEVICE ID: Example 21.6 kV Line
BAUD RATE: 9600
OPERATE SUPPORT:  ASCII (1 Breakers, 0 Remote Bits)
LEVEL 1 PASSWORD:  OTTER
LEVEL 2 PASSWORD:  TAIL
COMMANDS SUPPORTED:
  B 20METER
  A 20TARGET
  A 20HISTORY
  A 20STATUS
  A 20EVENT
  A 20EVENTS

Port Identification String
PORTID  ="Example 21.6 kV Line"
 ? <ENTER>


Communications Settings

Baud Rate (300, 600, 1200, 2400, 4800, 9600,
           19200)                           BAUD    = 9600  ? <ENTER>

Number data bits (7,8)                      DATABIT = 8     ? <ENTER>

Stop Bits (1,2)                             STOPBIT = 2     ? <ENTER>

Parity (N,O,E,1,0)                          PARITY  = N     ? <ENTER>

Enable RTS/CTS handshaking (Y/N)            RTS_CTS = N     ? <ENTER>

Port Timeout in minutes (0.0-30.0)          TIMEOUT = OFF   ? 30<ENTER>         2

PORT:1
DEVICE  = S
CONFIG  = Y

PORTID  ="Example 21.6 kV Line"
BAUD    = 9600
DATABIT = 8    STOPBIT = 2    PARITY  = N
RTS_CTS = N
TIMEOUT = 30.0

Save changes (Y/N) ? Y<ENTER>                                                   3

Port 1 Settings Changed

*>>
```

Notes:

1 Type **Y<ENTER>** to auto-configure the port.

2 Set port time-out to 30 minutes to automatically disconnect transparent communication.

3 Accept new settings by typing **Y <ENTER>** to save changes.

4. Use SET A to define a timed trigger condition in the form of (Thh:mm:ss) to send a date message at a specific time once each day to the relay connected to Port 1.

   This setting sequence uses the SET A command to set a message trigger and a message in Port 1 of the SEL-2020. This example sets the SEL-2020 to issue the date command to the relay attached to Port 1 once each day. Even though you supply IRIG-B time to the relays, if a relay is powered down for any reason it may need this date information to establish the current year because the year is not supplied by IRIG-B. The date is retrieved from the SEL-2020 Global data region and formatted in a message string that the relay will recognize.

   The SEL-2020 maintains date and time information in the Global data region. You can access this information using the VIEW command. Use the labels displayed by the VIEW command when you define the date message sequence with the SET A command. For an interpretation of the labels shown in the VIEW screen, see Table 9.2 and the description of the Global data region in ***Section 9: Database***.

   To see the Global data format, type **VIEW 1:GLOBAL <ENTER>** to display Global database information.

   Your screen should look like this:

```
*>>VIEW 1:GLOBAL<ENTER>

Port 1,  Data Region GLOBAL   Data

FID = FID=SEL-2020-R115-VO-D961020
STATUS = 0100h  CONFIG = 0CA0h  __YEAR = 1995  DAY_OF_YEAR = 62 (03/03)
MONTH = 3  DATE = 3  TIME = 14:12:03.598
ELEMENTS = 04h,00h,00h,20h,FFh,FFh,00h
REMOTE_BIT_REG = 0000h  REMOTE_BITS = 00h  _YEARS = 95
_HOURS = 14  _MINS = 12  _SECS = 3  PORT_STATUS = 0004h
ALT_PORT = 255  NUM_MESGS = 20  BAD_MESGS = 0

*>>
```

   Now, type **SET A 1** to define a timed trigger condition and a message to send the date message to the relay connected to Port 1 at a specific time once each day. Enter the information and follow the prompts as shown in the following screen image. Your screen should look like this:

```
*>>SET A 1<ENTER>

Automatic message settings for Port 1

Save Unsolicited Messages (Y/N)             AUTOBUF = Y    ? <ENTER>                    1

Port Startup String
STARTUP ="ACC\nOTTER\n2AC\nTAIL\n"
 ? <ENTER>
                                                                                         2
Send Operate command on Logic bit transition (Y/N) SEND_OPER=N    ? <ENTER>

Auto-message Settings
                                                                                         3
How many auto-message sequences (0-12)      MSG_CNT = 0     ? 1<ENTER>

Item 1 trigger D1
ISSUE1  = NA
 ? T1:00<ENTER>                                                                          4

Item 1 message
MESG1   = ""
 ? DATE \RI;1:GLOBAL:MONTH//\RI;1:GLOBAL:DATE//\RI;1:GLOBAL:_YEAR/\N<ENTER>              5

Item 1 response parsing method (0=IGNORE,
 1=ASCII_INT, 2=ASCII_FLOAT, 3=CHAR_STRING, 4=INT_STRING)PARSE1  = 0     ? <ENTER>

Time delay to allow response to complete (OFF, ON)DELAY1  = ON      ? <ENTER>            6

Archive Settings

Enable use of archive data items (Y/N)      ARCH_EN = N      ? <ENTER>

Size of user-defined data space in registers USER    = 0     ? <ENTER>

AUTOBUF = Y
STARTUP ="ACC\nOTTER\n2AC\nTAIL\n"
SEND_OPER=N
MSG_CNT = 1

ISSUE1  = T01:00:00.0
MESG1   = "DATE \RI;01:GLOBAL:MONTH//\RI;01:GLOBAL:DATE//\RI;01:GLOBAL:_YEAR/\
n"
PARSE1  = 0
DELAY1 = ON

ARCH_EN = N
USER    = 0

Save changes (Y/N) ? Y<ENTER>

Port 1 Settings Changed

*>>
```

Notes:

1. Set AUTOBUF=Yes to permit the SEL-2020 to collect and store unsolicited messages from the relay, like summary event reports and group switch reports.
2. Leave automatic operate control disabled for this example.
3. Set MSG_CNT=1 so SEL-2020 prompts for one message trigger and message.
4. Set ISSUE1=T01:00 to trigger MESG1 at 1:00 a.m. every day.
5. Set MESG1=(as shown) to send the date command to the relay with the current date, i.e., DATE MM/DD/YYYY <CR>.
6. Leave DELAY1=ON so response to DATE message will not be interpreted as a response to a following message request.

5. Use the COPY command to copy Port 1 settings to the other ports (2, 3, 4, 5, 6, and 7) with devices attached.

   The above step results in the following screen. Port settings were not copied beyond Port 7. If you know that all SEL IEDs are identical, you may type **N<ENTER>** when asked for auto-configuration and simply enter the Port ID for each port since auto-configuration information will be the same. Sometimes settings are lost during copying because of device incompatibilities. Therefore, whenever you use the COPY command you should check all settings using the SHOWSET command on each port (e.g., SHO 2).

```
*>>COPY 1 ALL<ENTER>                                                    [1]

Copy settings from Port 1 to Port 2 (Y/N) ? Y<ENTER>
Perform auto-configuration on Port 2 (Y/N) ? Y<ENTER>
Attempting auto-configuration...Done.
Port 2 Settings Changed

Copy settings from Port 1 to Port 3 (Y/N) ? Y<ENTER>
Perform auto-configuration on Port 3 (Y/N) ? Y<ENTER>
Attempting auto-configuration...Done.
Port 3 Settings Changed

Copy settings from Port 1 to Port 4 (Y/N) ? Y<ENTER>
Perform auto-configuration on Port 4 (Y/N) ? Y<ENTER>
Attempting auto-configuration...Done.
Port 4 Settings Changed

Copy settings from Port 1 to Port 5 (Y/N) ? Y<ENTER>
Perform auto-configuration on Port 5 (Y/N) ? Y<ENTER>
Attempting auto-configuration...Done.
Port 5 Settings Changed

Copy settings from Port 1 to Port 6 (Y/N) ? Y<ENTER>
Perform auto-configuration on Port 6 (Y/N) ? Y<ENTER>
Attempting auto-configuration...Done.
Port 6 Settings Changed

Copy settings from Port 1 to Port 7 (Y/N) ? Y<ENTER>
Perform auto-configuration on Port 7 (Y/N) ? Y<ENTER>
Attempting auto-configuration...Done.
Port 7 Settings Changed

Unable to write settings to Port 8:  Internal Modem Installed

Copy settings from Port 1 to Port 9 (Y/N) ? N<ENTER>
Copy settings from Port 1 to Port 10 (Y/N) ? N<ENTER>
Copy settings from Port 1 to Port 11 (Y/N) ? N<ENTER>
Copy settings from Port 1 to Port 12 (Y/N) ? N<ENTER>
Copy settings from Port 1 to Port 13 (Y/N) ? N<ENTER>
Copy settings from Port 1 to Port 14 (Y/N) ? N<ENTER>
Copy settings from Port 1 to Port 15 (Y/N) ? N<ENTER>
Copy settings from Port 1 to Port 16 (Y/N) ? N<ENTER>

*>>
```

Note: 1 Use the COPY 1 ALL as a shortcut to copy settings on Port 1 to all other ports. Port 8 is not permitted as a destination because it has an internal modem in this example.

6. Use SET P to set Port 8 as a modem port.

   Your screen should appear similar to the following:

```
*>>SET P 8<ENTER>

Port communications settings for Port 8


Device Type (U=Unused, S=SEL IED, O=Other IED,
             P=Printer, M=Master)              Device  = M     ? <ENTER>

Communications Type (S=SEL, L=LMD)           PROTOCOL = S     ? <ENTER>

Enable Fast Operate commands on this port (Y/N)FAST_OP = N       ? <ENTER>          [1]

Port Identification String
PORTID  =""
 ? MODEM<ENTER>                                                                     [2]


Modem Settings

Start-up String
MSTR    ="ATX0E0&D0%E1S0=4"
 ? <ENTER>                                                                          [3]


Communications Settings

Baud Rate (300, 600, 1200, 2400, 4800, 9600,
           19200, 38400)                   BAUD    = 9600  ? 38400<ENTER>          [4]

Number data bits (7,8)                     DATABIT = 8     ? <ENTER>

Stop Bits (1,2)                            STOPBIT = 2     ? <ENTER>

Parity (N,O,E,1,0)                         PARITY  = N     ? <ENTER>

Enable RTS/CTS handshaking (Y/N)           RTS_CTS = N     ? <ENTER>

Enable XON/XOFF flow control (Y/N)         XON_XOFF= Y     ? <ENTER>

Port Timeout in minutes (0.0-30.0)         TIMEOUT = 5.0   ? 30 <ENTER>

                                    (continued on next page)
```

Notes:

1. Leave *Fast Operate* commands disabled for this example. See ***Appendix H: SEL-2020 Configuration and Fast Operate Commands*** for a complete discussion of these commands.
2. Enter “MODEM” or some other description to identify the port as a modem port.
3. Accept the default modem startup initialization string for the SEL-2020 internal modem. See ***Appendix B: Optional Internal Modem Information*** for a complete description of modem settings.
4. The default baud rate for all rear ports is 9600. Set the baud rate to 38400 baud to take full advantage of the internal modem’s 14400 maximum baud rate. When you call the substation from a remote location, the modem on your PC and the SEL-2020 internal modem will negotiate the highest possible baud rate, up to the 14400 baud maximum rate of the SEL-2020 internal modem if your PC has a modem capable of the same or higher baud rate.

```
(SET P 8 continued from previous page)

Echo received characters (Y/N)              ECHO    = Y     ? <ENTER>

Automatic help messages enabled (Y/N)       AUTO_HELP= Y     ? <ENTER>

Transparent Communications Termination Sequence

First delay time (0-600 seconds)            TERTIME1= 1   ? <ENTER>

Termination string
TERSTRING="\004"
 ? <ENTER>

Second delay time (0-600 seconds)           TERTIME2= OFF   ? <ENTER>

PORT:8
DEVICE  = M
PROTOCOL= S
FAST_OP = Y
PORTID  ="MODEM"
MSTR    ="ATX0E0&D0%E1S0=4"
BAUD    = 38400
DATABIT = 8     STOPBIT = 2    PARITY  = N
RTS_CTS = N     XON_XOFF= Y
TIMEOUT = 30.0  ECHO    = Y
AUTO_HELP= Y
TERTIME1= 1
TERSTRING="\004"
TERTIME2= OFF
                                                                         5
Save changes (Y/N) ? Y<ENTER>

Port 8 Settings Changed

*>>
```

Note: 5 Type **Y<ENTER>** to accept port setting changes.

VERIFY AND TEST ALL COMMUNICATION PATHS

The remainder of this example verifies proper communication with the SEL-251 Relays attached to each port of the SEL-2020.

1. Issue the STATUS command to check that IRIG-B signal is present and devices are connected as expected. Your screen should look similar to the following:

```
*>>STATUS<ENTER>

COMMUNICATIONS PROCESSOR - S/N 95012004     Date: 03/06/95    Time: 13:46:43
FID=SEL-2020-R100-V0-D950324

SELF-TESTS

RAM       ROM       EEPROM    FLASH     P.S.      SET       BATTERY
512 kb    OK        OK        2048 kb   OK        OK        OK

IRIG-B Input: Present
I/O Board: Installed
Modem: Installed

Port   Status   Success Rate    SET M    Database Delays
1      Active                   None
2      Active                   None
3      Active                   None
4      Active                   None
5      Active                   None
6      Active                   None
7      Active                   None
8      Active                   None
9      Active                   None
10     Inactive                 None
11     Inactive                 None
12     Inactive                 None
13     Inactive                 None
14     Inactive                 None
15     Inactive                 None
16     InActive                 None
F      Active      100%         None


*>>
```

2. Initiate transparent communications to the relay on Port 1 by typing **PORT 1<ENTER>**. Press **<ENTER>** a second time to receive the relay system prompt. You will see the following screen:

```
*>>PORT 1<ENTER>
Transparent Communications to Port 1 established

<ENTER>

=
```

You should communicate with the relay attached to Port 1 as though your terminal were directly connected to the relay. The relay should be at Access Level 0, as indicated by the "=" prompt. If you do not see the "Transparent Communication Established" message or the relay prompt, check the cable connection and the relay status. See the Troubleshooting subsection of ***Section 10: Maintenance*** for more detailed information.

3. Use the ACCESS command and relay password to get to Access Level 1. At the "=>" relay prompt, issue the IRIG command. IRIG directs the relay to read the demodulated IRIG-B time-code input on the AUX input power panel port. If the relay reads the time code successfully, the relay updates the internal clock/calendar time and date and transmits a message with relay ID string, date, and time. If no IRIG-B signal is present, or the code cannot be read successfully, the relay sends the error message "IRIG B DATA ERROR". If you receive an error message, check the cable connection between the SEL-2020 and the relay AUX input port and consult the Troubleshooting Subsection in ***Section 10: Maintenance*** of this manual.

   Issue the SHOWSET command (SHO for short) to view the relay settings. You should see relay setting information similar to the following:

```
=>SHO<ENTER>
Settings for group 1

Example 21.6 kV Feeder - S/N 93245011
CTR  =120.00  PTR  =180.00
R1   =0.58    X1   =1.50    R0   =1.44    X0   =4.56
RS   =0.00    XS   =0.00    LL   =2.42
DATC =15      PDEM =12.00   QDEM =12.00   NDEM =0.99
79OI1=60      79OI2=600     79OI3=900     79OI4=0
79RST=1800    M79SH=00000
50C  =99.99   27L  =0.00    27H  =0.00    27C  =2       TCI  =0
50Q  =99.99   50QT =0
51QP =6.00    51QTD=15.00   51QC =3       51QRS=N
50NL =20.01   50NLT=2       50NH =99.99
51NP =1.50    51NTD=2.00    51NC =3       51NRS=N
50L  =99.99   50LT =0       50H  =39.99
51P  =6.00    51TD =6.00    51C  =3       51RS =N
52APU=1200    52ADO=0       TSPU =0       TSDO =0
TKPU =0       TKDO =0       TZPU =0       TZDO =0

PRESS RETURN ? <ENTER>

SELogic Equations

S(123)  =
A(12)   =
B(12)   =50NLT
C(12)   =50NL
D(12)   =
E(34)   =79RS+79CY+52AT
F(34)   =IN6
G(34)   =
H(34)   =
J(1234) =
K(1234) =
L(1234) =
A1(1234)=TF
A2(1234)=NDEM

PRESS RETURN ? <ENTER>

V(56)   =B*E*F
W(56)   =C*E*F
X(56)   =
Y(56)   =
Z(56)   =
A3(1346)=79CY
A4(2346)=

                          (continued on next page)
```

```
                                    (SHO continued from previous page)

TR(1246)=50H+51T+51NT+V
RC(1246)=50H+TF
ER(1246)=51P+51QP+51NP+TF+W
SEQ(1)  =
ETC(1)  =
ITC(1)  =

Global settings
DEMR =Y       CFT  =60      TDUR =4       TFT  =30      TGR  =180  ITT  =5       TIME1=15
TIME2=0       AUTO =2       RINGS=3    IN1  =SS1     IN2  =DT      IN3  =RE      IN4  =
IN5  =52A     IN6  =

=>
```

While you have the relay global settings on the screen, verify that:

TIME2=0

AUTO=2 or 3 (setting 2 is for Port 2 and setting 3 is for both Ports 1 and 2)

These settings allow the SEL-2020 to continue to receive automatic messages from the relay without the port timing out. If these two settings are not as shown above, go to Access Level 2 and use the relay SET command to change them.

Return the relay to Access Level 0 and quit transparent communication using the default disconnect sequence or key stroke **<CTRL-D>**.

Note: After transparent communications with the relay, the SEL-2020 will reissue the STARTUP string to the relay to return it to the access level needed for proper operation. If you change a relay password, modify the port's startup string to match. If you use an SEL-501 Relay and change one of the relay type settings, re-configure afterwards so that the SEL-2020 maintains a correct target list.

You should see the following:

```
=>>QUIT<ENTER>

Example 21.6 kV Feeder - S/N 93245011      Date: 3/5/92      Time: 10:01:36

=<CTRL-D>

Transparent Communications to Port 1 terminated

*>>
```

4. Use the TOGGLE command, as shown in the following screen image, to send the date message previously defined as MESG1 in the SEL-2020 As shown here, you toggle the state of the D1 element to trigger the associated message MESG1. The SELOGIC Control Equation in ISSUE1 normally does this, but the TOGGLE command lets you test the process without waiting for the SELOGIC Control Equation condition to become true.

```
*>>TOGGLE 1:D1<ENTER>

Bit toggled

*>>
```

Re-establish transparent communications with the relay and verify that the date matches the date in the SEL-2020. Use the DATE command to change the date and year in the relay (DATE MM/DD/YY); exit transparent communication and issue the TOGGLE command again. Enter transparent communication and again verify that the date matches the date in the SEL-2020. If the date does not match, exit transparent communication and double-check the SEL-2020 MESG1 setting to make sure that the message string exactly matches the string in the SET A example shown earlier.

5. Check modem communication.

   Have someone call the phone number of the telephone line connected to the SEL-2020 modem. The modem should answer by the fourth ring. The caller's communication program should be set for an 8-bit word, no parity, and 2 stop bits. Any baud rate can be used, up to the maximum baud rate of the caller's modem or 14400 baud, whichever is greater.

   The remote caller can enter transparent communication with any of the relays attached to the SEL-2020 using the PORT command, just as you did earlier. You can monitor the communication using the LEDs on the SEL-2020 front panel and using the STATUS command. The STATUS screen shows the ports that are in transparent communication and the port number they are in transparent communication with. For instance, if Port 8 is in transparent communication with Port 1, the status of Port 8 will show TRANS1, and the status of Port 1 will show TRANS8.

   The remote caller should use the same procedure to quit transparent communication as he or she did earlier. If, for some reason, remote communication is cut off before the remote caller quits transparent communication, the TIMEOUT on the SEL-2020 modem port will disconnect transparent communication automatically in 30 minutes.

EXAMPLE 2: PRINT RELAY MESSAGES

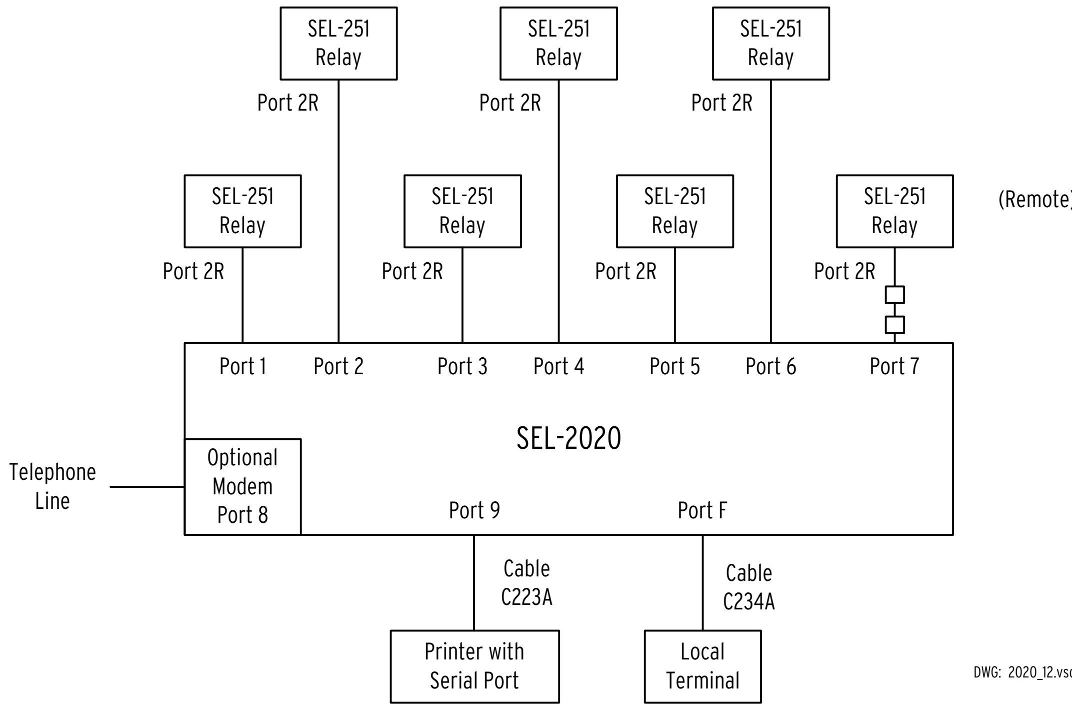

Figure 4.2: SEL-2020 with Relays and Printers

INTRODUCTION

Example 2 is similar to Example 1, but minor changes and additions have been made to demonstrate additional SEL-2020 features and capabilities. The cable for the relay connected to the SEL-2020 Port 7 is replaced with a short-haul modem that supports communication, but not IRIG-B signal, and a serial printer is added to SEL-2020 Port 9.

IDENTIFYING THE PROBLEM

Your objective in Example 2 is to accomplish the following tasks:

- You want the SEL-2020 to print all unsolicited messages (e.g., summary event reports, power-up messages) that are generated by the relays connected to the SEL-2020.
- You want to time-synchronize the clock/calendars on all of the connected relays, including one that cannot accept IRIG-B because it is remotely connected through short-haul modems.

DEFINING THE SOLUTION

Complete Hardware Connections

1. Configure each SEL-251 Relay as in Example 1, except for the following:
    - The SEL-251 on Port 7 is now connected through short-haul modems. Consequently, there is no IRIG-B connection and we must supply the time using an ASCII command.
2. The computer connected to Port F and the configuration of Port F remain as in Example 1.
3. Connect a serial port printer to SEL-2020 Port 9 using an SEL-C223A cable or equivalent.

Ports 1 through 8 of the SEL-2020 remain configured as in Example 1.

Set the SEL-2020

1. Set SEL-2020 Port 7 to send a time and date command to the relay.
2. Use the SET P command to configure Port 9 as a printer port.
3. Use the SET A command to enable printing of unsolicited messages on Port 9 and clear the buffers after printing.

Verify and Test All Communication Paths

1. Use the STATUS command to check that IRIG-B signal is present and devices are connected to ports as expected. Also use the WHO command to see a list of connected devices.
2. Test the connection with each port using the PORT command to enter transparent communication. Check the connection with the printer by sending a message to Port 9. Use the default disconnect sequence **<CTRL-D>** to terminate transparent communication.
3. Use the TOGGLE command to issue the time and date command to the relay on Port 7.

SET THE SEL-2020 STEP-BY-STEP

1. Set Port 7 to send a time command to the relay as shown on the following screen image:

```
*>>SET A 7<ENTER>

Automatic message settings for Port 7


Save Unsolicited Messages (Y/N)             AUTOBUF = Y     ? <ENTER>

Port Startup String
STARTUP ="ACC\nOTTER\N2AC\nTAIL\N"
 ? <ENTER>

Send operate command on logic bit transition (Y/N) SEND_OPER=N ? <ENTER>

Auto-message Settings

How many auto-message sequences (0-12)      MSG_CNT = 1     ? <ENTER>

Item 1 trigger D1
ISSUE1  = T01:00:00.0
 ? <ENTER>

Item 1 message
MESG1   = "DATE \RI;07:GLOBAL:MONTH//\RI;07:GLOBAL:DATE//\RI;07:GLOBAL:_YEAR/\n"
 ? TIME 1:00:01\N DATE \RI;7:GLOBAL:MONTH//\<ENTER>                       1  2  3

 ? \RI;7:GLOBAL:DATE//\RI;7:GLOBAL:_YEAR/\N<ENTER>

Item 1 response parsing method (0=IGNORE,
 1=ASCII_INT, 2=ASCII_FLOAT, 3=CHAR_STRING, 4=INT_STRING)PARSE1  = 0     ? <ENTER>

Time delay to allow response to complete (OFF,ON)  DELAY1  = ON     ? <ENTER>


Archive Settings

Enable use of archive data items (Y/N)      ARCH_EN = N     ? <ENTER>

Size of user-defined data space in registers USER    = 0    ? <ENTER>

AUTOBUF = Y
STARTUP ="ACC\nOTTER\n2AC\nTAIL\n"
SEND_OPER=N

MSG_CNT = 1


ISSUE1  = T01:00:00.0
MESG1   = "TIME 1:00:01\n DATE \RI;07:GLOBAL:MONTH//\RI;07:GLOBAL:DATE//\RI;07
:GLOBAL:_YEAR/\n"
PARSE1  = 0
DELAY1  = ON

ARCH_EN = N
USER    = 0

Save changes (Y/N) ? Y<ENTER>

Port 7 Settings Changed

*>>
```

Notes:

1. Combine the TIME and DATE command in the same message as shown in this example, or separate the two commands into separate messages.

2. The time entered in the command string, TIME 1:00:01, is set one second later than the ISSUE1 SELOGIC Control Equation time to account for an expected one second delay in command transmission.

3 Use the \<ENTER> special character sequence at the end of a line to continue on a second line.

2. Use the SET P command to configure Port 9 as a printer port.

```
*>>SET P 9<ENTER>

Port communications settings for Port 9


Device Type (U=Unused, S=SEL IED, O=Other IED,
             P=Printer, M=Master)             DEVICE  = P     ? <ENTER>          1

Port Identification String
PORTID  =""
 ? Line Printer<ENTER>                                                            2


Communications Settings

Baud Rate (300, 600, 1200, 2400, 4800, 9600,
           19200)                           BAUD    = 9600  ? <ENTER>

Number data bits (7,8)                      DATABIT = 8     ? <ENTER>

Stop Bits (1,2)                             STOPBIT = 2     ? <ENTER>

Parity (N,O,E,1,0)                          PARITY  = N     ? <ENTER>            3

Enable RTS/CTS handshaking (Y/N)            RTS_CTS = N     ? <ENTER>

Enable XON/XOFF flow control (Y/N)          XON_XOFF= Y     ? <ENTER>

Port Timeout in minutes (0.0-30.0)          TIMEOUT = OFF   ? 30 <ENTER>

PORT:9
DEVICE  = P
PORTID  ="Line Printer"
BAUD    = 9600
DATABIT = 8    STOPBIT = 2    PARITY  = N
RTS_CTS = N    XON_XOFF= Y
TIMEOUT = 30.0


Save changes (Y/N) ? Y<ENTER>

Port 9 Settings Changed

*>>
```

Notes: 1 Enter **P** to identify the device type as a printer.

2 Enter an identification for the SEL-2020 port directory.

3 Enter communication parameters compatible with the printer.

3. Use the SET A command to enable printing of unsolicited messages on Port 9 and to clear the buffers after printing.

   You should see the following screen:

```
*>>SET A 9<ENTER>

Automatic message settings for Port 9


Port Startup String
STARTUP =""
 ? <ENTER>


Auto-message Settings

How many auto-message sequences (0-12)       MSG_CNT = 0     ? 1<ENTER>

Print all buffered unsolicited messages (Y/N)PRINT_ALL= N     ? Y<ENTER>

Clear unsolicited message buffer after print (Y/N)CLEAR_BUF= N     ? Y<ENTER>

Size of user-defined data space in registers USER    = 0     ? <ENTER>

STARTUP =""

MSG_CNT = 1

PRINT_ALL= Y
CLEAR_BUF= Y
USER    = 0

Save changes (Y/N) ? Y<ENTER>

Port 9 Settings Changed


*>>
```

Notes:

1. Your printer may require a power-up initialization. If it does, you enter it as a startup string. The startup string is issued to the printer when you power up the SEL-2020.
2. You enable printing unsolicited messages and set the SEL-2020 to clear the unsolicited message buffers as the messages are printed. The PRINT_ALL setting automatically gives the printer access to unsolicited messages received and stored on all ports.

VERIFY AND TEST ALL COMMUNICATION PATHS

1. Issue the STATUS command to check that IRIG-B signal is present and devices are connected to ports as expected. This command was used in Example 1. You can also use the WHO command to see a list of all devices connected to SEL-2020 ports. The SEL-2020 response to the WHO command should look similar to the following screen image:

```
*>>WHO<ENTER>

                                                Date: 03/03/95    Time: 14:21:05
FID=SEL-2020-R115-V0-D961020

Port #    Device     Protocol  Parameters   Identification
1         SEL-151   SEL       9600,8,2,N   Example 21.6 kV Line - S/N 93245011
2         SEL-151   SEL       9600,8,2,N   Example 21.6 kV feeder - S/N 94292025
3         SEL-151   SEL       9600,8,2,N   Example 21.6 kV Feeder - S/N 94265010
4         SEL-151   SEL       9600,8,2,N   Example 21.6 kV Feeder - S/N 94266022
5         SEL-151   SEL       9600,8,2,N   Example 21.6 kV feeder - S/N 95010024
6         SEL-151   SEL       9600,8,2,N   Example 21.6 kV feeder - S/N 95011020
7         SEL-151   SEL       9600,8,2,N   Example 21.6 kV Feeder. -S/N 95011596
8         Master     SEL       38400,8,2,N  MODEM
9         Printer    Ascii     9600,8,2,N   Line Printer
10        SEL IED    SEL       9600,8,2,N
11        SEL IED    SEL       9600,8,2,N
12        SEL IED    SEL       9600,8,2,N
13        SEL IED    SEL       9600,8,2,N
14        SEL IED    SEL       9600,8,2,N
15        SEL IED    SEL       9600,8,2,N
16        SEL IED    SEL       9600,8,2,N
F*        Master     SEL       2400,8,2,N   Service port


*>>
```

2. Once you have established the port settings for the printer, test the connection by using the PORT command and issuing a message as follows:

```
*>>PORT 9 E<ENTER>

Transparent Communications to Port 9 established

This is a test <ENTER>
This is the second line.<ENTER>

<CTRL-L><CTRL-D>

Transparent Communications to Port 9 terminated

*>>
```

This example prints the following two lines of text on the printer and then form feeds the printer.

This is a test.
This is the second line.

Some printers print as they receive each character, some print only when they receive a complete line, and some do not print until they receive an entire page. This example should result in output on any of these types of printers. The **<CTRL-L>** is the form feed from most keyboards.

3. Use the TOGGLE command to issue the time and date command stored in MESG1 on Port 7 to the relay on Port 7.

```
*>>TOGGLE 7:D1<ENTER>

Bit Toggled

*>>
```

Note the time you toggled the bit. Enter transparent communication with the relay on Port 7 and check the time on the relay. The relay time should be 01:00:00 plus the number of seconds since you toggled the message trigger bit. This synchronization technique is not as accurate as with IRIG-B. You can expect the time on the relay to be synchronized within three seconds of the SEL-2020 clock.

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EXAMPLE 3: SEL-2020 APPLIED TO SCADA RTU DATA ACCESS

INTRODUCTION

Example 3 is similar to Examples 1 and 2, except an RTU is added in this example to demonstrate the database and data transfer capabilities of the SEL-2020.

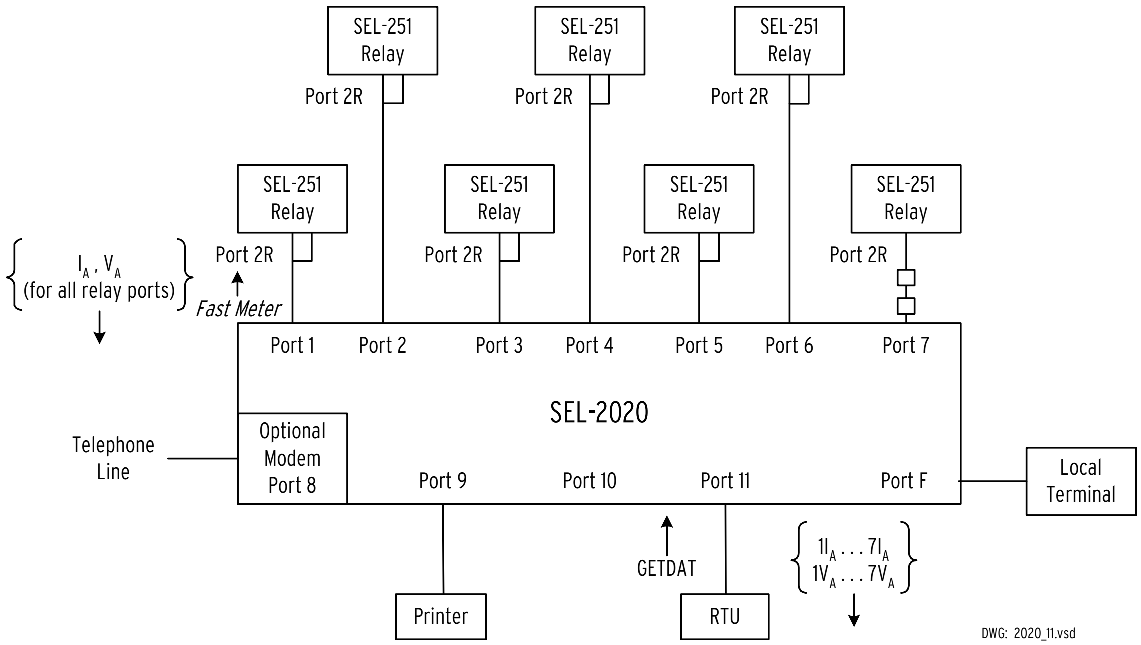


Figure 4.3: SCADA RTU Configuration Diagram

IDENTIFYING THE PROBLEM

Your objective in Example 3 is to collect A-phase voltage and current information from the substation feeders for the SCADA system. After evaluating several options, you decide that the most cost-effective method is to use the SEL-2020 to collect metering data from the seven substation relays. You want the SEL-2020 to collect data every second to avoid data latency when the RTU requests data at 1.5 second intervals.

DEFINING THE SOLUTION

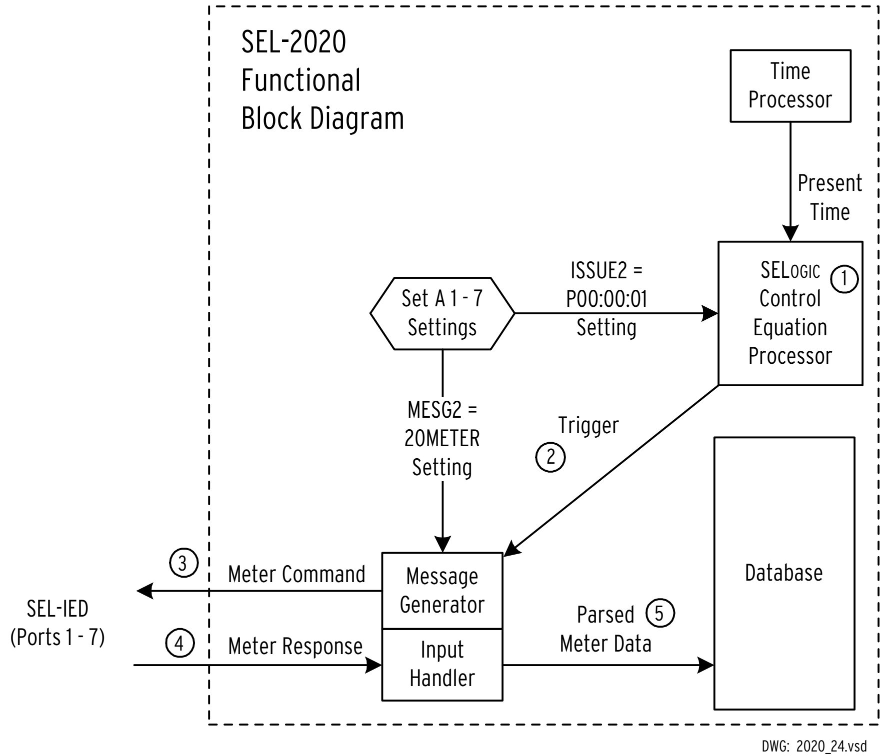
The solution is to use the automatic database features of the SEL-2020. Figure 4.3 shows the SEL-2020 installation, with the RTU connected to Port 11.

Complete Hardware Connections

1. The SEL-251 Relays remain configured as in the previous example.
2. Connect the EIA-232 port on the RTU to Port 11 of the SEL-2020 with a proper communication cable.
3. Retain the configuration for SEL-2020 Ports 1 through 9 from previous examples.

Set the SEL-2020

1. Use the SET P command to configure Port 11 as a Master port for the RTU.
2. Use the SET A command to define a trigger condition (P00:00:01.0) on Port 1 that periodically triggers a message (see Figure 4.4). Create a message to send a meter command (using 20METER setting) to relays when the trigger condition exists.



① The SELOGIC Control Equation Processor compares the Time Processor input to the timed issue condition set for Ports 1 through 7. You previously set the timed issue condition to ISSUE2 = P00:00:01 using the SET A command.

② When the SELOGIC Control Equation Processor detects a match between the time and the issue condition (once each second in the example) it sets the D2 trigger bit.

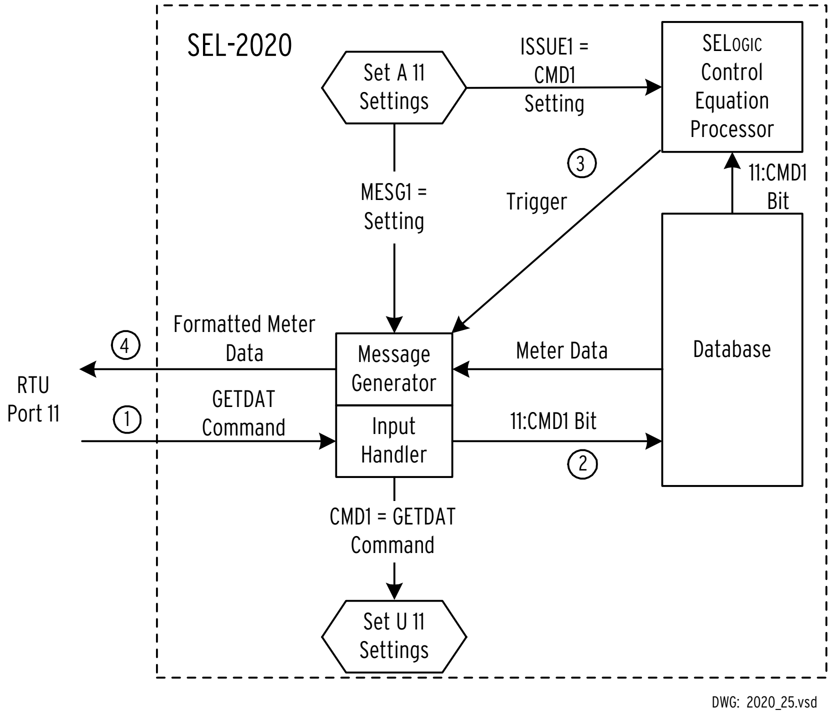
③ The Message Generator detects the D2 bit set and issues MESG2. You previously set MESG2 = 20METER using the SET A command. The SEL-2020 is programmed to send the METER command appropriate for the connected SEL relay.

④ The relay sends meter data to the SEL-2020.

⑤ Because you auto-configured this port (in a previous example), the SEL-2020 is programmed to parse the response. The SEL-2020 parses the response and stores it in the port database.

Figure 4.4: Trigger P00:00:01 and 20METER Setting in SET A

3. Use the COPY 1 ALL command to copy settings from Port 1 to Ports 2 through 6. You cannot copy the settings to Port 7, because Port 7 has the additional date and time message. Repeat Step 2 on Port 7 to define the trigger and message on that port.



① An RTU attached to Port 11 sends the GETDAT command to the SEL-2020. You previously defined this command (CMD1="GETDAT") using the SET U command.

② The Input Handler detects GETDAT and asserts the 11:CMD1 bit in the database.

③ The SELOGIC Control Equation Processor detects the 11:CMD1 bit and asserts the D1 trigger because you previously set ISSUE1=11:CMD1 using the SET A command for Port 11.

④ The Message Generator detects D1 bit set and issues MESG1. MESG1 instructs the SEL-2020 to retrieve A-phase current and voltage data from Ports 1 through 7 databases and transmit these data through Port 11. You previously defined MESG1=\Rf;01:METER:IA/,\Rf;01:METER:VA/...\Rf;07:METER:IA/,\Rf;07:METER:VA/ using the SET A command

Figure 4.5: Define CMD1="GETDAT" in SET U

4. Define a command (GETDAT) that the RTU will send to the SEL-2020 to request meter data (see Figure 4.5). Use SET U to define this user-defined command on Port 11 (CMD1="GETDAT").
5. Use the SET A command to define a trigger condition (CMD1 is asserted) and a message it triggers on Port 11. The message (MESG1) is a string you build that requests current and voltage meter data from the Port 1 through 7 databases.

Verify and Test All Communication Paths

1. Verify that the SEL-2020 is requesting meter data from each relay every second and receiving meter data in response to that request.
2. Verify that the relay meter data is parsed and stored in the SEL-2020 database.
3. Verify that the SEL-2020 will respond to the user-defined "GETDAT" command with the proper meter data from all seven relay port databases.

SET THE SEL-2020, STEP-BY-STEP

Use the SET P command to configure Port 11 as a Master port for the RTU.

You should have the following screen:

```
*>>SET P 11<ENTER>

Port communications settings for Port 11


Device Type (U=Unused, S=SEL IED, O=Other IED,
             P=Printer, M=Master)             DEVICE  = S     ? M<ENTER>                1

Communications Type (S=SEL, L=LMD)          PROTOCOL= S     ? <ENTER>

Enable Fast Operate Commands on this port (Y/N) FAST_OP=N      ? <ENTER>

Port Identification String
PORTID  =""
 ? RTU<ENTER>                                                                           2


Modem Settings

Modem Control (Y/N)                         MODEM   = N     ? <ENTER>


Communications Settings

Baud Rate (300, 600, 1200, 2400, 4800, 9600,
           19200, 38400)                    BAUD    = 9600  ? <ENTER>                   3

Number data bits (7,8)                      DATABIT = 8     ? <ENTER>

Stop Bits (1,2)                             STOPBIT = 2     ? <ENTER>

Parity (N,O,E,1,0)                          PARITY  = N     ? END<ENTER>

PORT:11
DEVICE  = M
PROTOCOL= S
FAST_OP = N
PORTID  ="RTU"
MODEM   = N
BAUD    = 9600
DATABIT = 8    STOPBIT = 2    PARITY  = N
RTS_CTS = N    XON_XOFF= Y
TIMEOUT = OFF  ECHO    = Y
AUTO_HELP= Y
TERTIME1= 1
TERSTRING="\004"
TERTIME2= OFF

Save changes (Y/N) ? Y<ENTER>

Port 11 Settings Changed

*>>
```

Notes:

1 Set the device type to Master.

2 Enter an ID to indicate this port is connected to an RTU.

3 Accept the default baud rate and associated communication parameters if they are compatible with the RTU. If these parameters are not compatible, make changes as necessary.

2. Define automatic message settings for Port 1 with the SET A command.

Your screen should look like this:

```
*>>SET A 1<ENTER>

Automatic message settings for Port 1


Save Unsolicited Messages (Y/N)             AUTOBUF = Y      ? <ENTER>

Port Startup String
STARTUP ="ACC\nOTTER\n2AC\nTAIL\n"
 ? <ENTER>

Send operate command on logic bit transition (Y/N) SEND_OPER = N     ? <ENTER>

Auto-message Settings

How many auto-message sequences (0-12)      MSG_CNT = 1     ? 2<ENTER>                    1

Item 1 trigger D1
ISSUE1  = T01:00:00.0
 ? <ENTER>

Item 1 message
MESG1   = "DATE \RI;01:GLOBAL:MONTH//\RI;01:GLOBAL:DATE//\RI;01:GLOBAL:_YEAR/\n"
 ? <ENTER>

Item 1 response parsing method (0=IGNORE,
 1=ASCII_INT, 2=ASCII_FLOAT, 3=CHAR_STRING, 4=INT_STRING)PARSE1  = 0     ? <ENTER>

Time delay to allow response to complete (OFF,ON) DELAY1  = ON      ? <ENTER>

Item 2 trigger D2
ISSUE2  = NA
 ? P00:00:01<ENTER>                                                                         2

Item 2 message
MESG2   = ""                                                                                3
 ? 20METER<ENTER>

Archive Settings

Enable use of archive data items (Y/N)      ARCH_EN = N     ? <ENTER>

Size of user-defined data space in registers USER    = 0     ? <ENTER>

AUTOBUF = Y
STARTUP ="ACC\nOTTER\n2AC\nTAIL\n"
SEND_OPER=N

MSG_CNT = 2

ISSUE1  = T01:00:00.0
MESG1   = "DATE \RI;01:GLOBAL:MONTH//\RI;01:GLOBAL:DATE//\RI;01:GLOBAL:_YEAR/\n"
PARSE1  = 0
DELAY1  = ON

ISSUE2  = P00:00:01.0
MESG2   = 20METER

ARCH_EN = N
USER    = 0

Save changes (Y/N) ? Y<ENTER>

Port 1 Settings Changed

*>>
```

Notes: 1 Change the message count from 1 to 2 to add a trigger and message setting on this port.

2 Set the trigger condition to issue the message periodically (P) every second (00 hrs:00 minutes:01 seconds).

3 Set the message to request meter data from the relay. The 20METER message is a special "20" message for SEL relays.

3. Use the COPY 1 ALL command to copy settings from Port 1 to Ports 2 through 6. In Example 3, you do not copy to Port 7 because it has a long string message that you do not want to re-enter. Use the SET A command to define a trigger condition (P00:00:01.0) on Port 7 that periodically triggers a message to send a meter command (using 20METER setting) to relays when the trigger condition exists, just like Ports 1 through 6.

You should see a screen similar to the following when you use the COPY command:

```
*>>COPY 1 ALL<ENTER>

Copy settings from Port 1 to Port 2 (Y/N) ? Y<ENTER>

Perform auto-configuration on Port 2 (Y/N) ? N<ENTER>
Port 2 Settings Changed                                              1

Copy settings from Port 1 to Port 3 (Y/N) ? Y<ENTER>

Perform auto-configuration on Port 3 (Y/N) ? N<ENTER>
Port 3 Settings Changed

Copy settings from Port 1 to Port 4 (Y/N) ? Y<ENTER>

Perform auto-configuration on Port 4 (Y/N) ? N<ENTER>
Port 4 Settings Changed

Copy settings from Port 1 to Port 5 (Y/N) ? Y<ENTER>

Perform auto-configuration on Port 5 (Y/N) ? N<ENTER>
Port 5 Settings Changed

Copy settings from Port 1 to Port 6 (Y/N) ? Y<ENTER>

Perform auto-configuration on Port 6 (Y/N) ? N<ENTER>
Port 6 Settings Changed

Copy settings from Port 1 to Port 7 (Y/N) ? N<ENTER>

Unable to write settings to Port 8:  Internal Modem Installed

Copy settings from Port 1 to Port 9 (Y/N) ? N<ENTER>

Copy settings from Port 1 to Port 10 (Y/N) ? N<ENTER>

Copy settings from Port 1 to Port 11 (Y/N) ? N<ENTER>

Copy settings from Port 1 to Port 12 (Y/N) ? N<ENTER>

Copy settings from Port 1 to Port 13 (Y/N) ? N<ENTER>

Copy settings from Port 1 to Port 14 (Y/N) ? N<ENTER>

Copy settings from Port 1 to Port 15 (Y/N) ? N<ENTER>

Copy settings from Port 1 to Port 16 (Y/N) ? N<ENTER>

*>>
```

Note: 1 You do not need to perform auto-configuration if all port devices are identical. However, you may need to reset port IDs on all ports that settings are copied to, if port IDs were different on each port.

4. Define a command (GETDAT) that the RTU will send to the SEL-2020 to request meter data (see Figure 4.5). Use SET U to define this user-defined command (CMD1="GETDAT").

   Your screen should show the following:

```
*>>SET U 11<ENTER>

User settings for Port 11

Warning:  setting CMD_EN=N will disable SEL-2020 commmands on this port

Enable SEL-2020 Commands (Y/N)              CMD_EN  = Y     ? N<ENTER>        1

Command termination character               CMD_CH  = \00D  ? <ENTER>         2


General-Purpose User-Defined Input Commands                                   3

Number of general purpose commands (0-8)    CMD_CNT = 0     ? 1<ENTER>

Command String 1
CMD1    = ""
 ? GETDAT<ENTER>                                                              4


Special-Purpose User-Defined Input Commands

Enable use of special purpose commands (Y/N) STR_EN  = N     ? <ENTER>        5

CMD_EN  = N    CMD_CH  = \00D
CMD_CNT = 1
CMD1    = "GETDAT"
STR_EN  = N

Save changes (Y/N) ? Y<ENTER>

Port 11 Settings Changed
*>>
```

Notes:

1 Disable the SEL-2020 command set on this port because you don't want the SEL-2020 to recognize any message from the RTU, other than the "GETDAT" command you defined.

2 When you disable the SEL-2020 command set, the SEL-2020 prompts you for a command termination character. The default is "\00D", which is the ASCII string for carriage return (**<CR>**).

3 Enter CMD_CNT=1 to set one user-defined command.

4 Set CMD1=GETDAT; the user-defined command the RTU will send to the SEL-2020.

5 The SEL-2020 prompts you to enable special purpose commands TRANS, WRITE, and READ. No special purpose commands are used in this example.

5. Use the SET A 11 command to define a trigger condition (CMD1 is asserted) and a message the SEL-2020 sends to the RTU on Port 11. The message (MESG1) is a string you build that extracts current and voltage meter data from Ports 1 through 7.

   Your screen should look similar to the following:

```
*>>SET A 11<ENTER>

Automatic message settings for Port 11


Auto-message Settings

How many auto-message sequences (0-12)      MSG_CNT = 0     ? 1<ENTER>                     1

Item 1 trigger D1
ISSUE1  = NA
 ? CMD1<ENTER>                                                                              2

Item 1 message
MESG1   = ""
 ? \Rf;1:METER:IA/,\Rf;1:METER:VA/,\Rf;2:METER:IA/,\Rf;2:METER:VA/,\<ENTER>

 ? \Rf;3:METER:IA/,\Rf;3:METER:VA/,\Rf;4:METER:IA/,\Rf;4:METER:VA/,\<ENTER>                 3

 ? \Rf;5:METER:IA/,\Rf;5:METER:VA/,\Rf;6:METER:IA/,\Rf;6:METER:VA/,\<ENTER>

 ? \Rf;7:METER:IA/,\Rf;7:METER:VA/\n<ENTER>

Archive Settings

Enable use of archive data items (Y/N)      ARCH_EN = N     ? <ENTER>

Size of user-defined data space in registers USER    = 0     ? <ENTER>

MSG_CNT = 1


ISSUE1  = 11:CMD1
MESG1   ="\RF;01:METER:IA/,\RF;01:METER:VA/,\RF;02:METER:IA/,\RF;02:METER:VA/
,\RF;03:METER:IA/,\RF;03:METER:VA/,\RF;04:METER:IA/,\RF;04:METER:VA/
,\RF;05:METER:IA/,\RF;05:METER:VA/,\RF;06:METER:IA/,\RF;06:METER:VA/,
\RF;07:METER:IA/,\RF;07:METER:VA/\n"

ARCH_EN = N
USER    = 0

Save changes (Y/N) ? Y<ENTER>

Port 11 Settings Changed

*>>
```

Notes:

1. Enter 1 because you want to define one message trigger and one message.
2. Set ISSUE1=CMD1 to trigger MESG1 when the SEL-2020 CMD1 element asserts.
3. Set MESG1 as shown in the above screen to retrieve the A-phase current and voltage data stored in the database on each of the SEL relay ports, 1 through 7. Data are defined with a string format of \Rf;(Port number):(Data region label):(Data item label)/, where \Rf:...../ requests the data in floating-point format.

VERIFY AND TEST ALL COMMUNICATION PATHS

1. Verify that the SEL-2020 is requesting meter data from each relay every second and receiving meter data in response to that request.

   - Visually check the front panel Light Emitting Diodes (LEDs); the green transmit (TXD) LEDs should illuminate once every second on Ports 1 through 7 to indicate that the SEL-2020 is sending a message to the relay at that rate; the red receive (RXD) LEDs should illuminate at the same rate, but with a slight delay following illumination of the green LED. This indicates that the SEL relay is responding to the message sent by the SEL-2020.
   - Use the STATUS command to see how each port is operating:

     Success Rate column should show 100% for each port. If not, the SEL-2020 is getting unexpected responses. Database Delays should not show any region labels (e.g., D2, A1). Each designator shows a request for data with a previous request pending. Some reasons for database delays are given in the STATUS Command subsection of ***Section 5: Commands***.

   You should see a screen similar to the following:

```
*>>STATUS<ENTER>

COMMUNICATIONS PROCESSOR - S/N 95012004     Date: 03/06/95    Time: 13:46:43
FID=SEL-2020-R100-V0-D950324

SELF-TESTS

RAM       ROM       EEPROM    FLASH     P.S.      SET       BATTERY
512 kb    OK        OK        2048 kb   OK        OK        OK

IRIG-B Input: Present
I/O Board: Installed
Modem: Installed

Port   Status   Success Rate   SET M    Database Delays
1      Active       100%       None
2      Active       100%       None
3      Active       100%       None
4      Active       100%       None
5      Active       100%       None
6      Active       100%       None
7      Active       100%       None
8      Active                  None
9      Active                  None
10     Inactive                None
11     Active                  None
12     Inactive                None
13     Inactive                None
14     Inactive                None
15     Inactive                None
16     InActive                None
F      Active       100%       None


*>>
```

   - Use the MAP 1 command to view the Port 1 database. B METER indicates binary or *Fast Meter* data collection. A METER would indicate ASCII or conventional meter data collection.

```
*>>MAP 1<ENTER>

Port 1 Database Assignments

  Region    Data Type   # Records

  GLOBAL    --
  LOCAL     --
  BUF       --
  D1        Unused
  D2      B METER
  D3        Unused
  D4        Unused
  D5        Unused
  D6        Unused
  D7        Unused
  D8        Unused
  A1        Unused
  A2        Unused
  A3        Unused
  USER      Unused


*>>
```

2. Verify that the relay meter data is parsed and stored in the SEL-2020 database. Determine how data are stored within the data region with the MAP 1:METER command.

   You should see a screen similar to the following:

```
*>>MAP 1:METER <ENTER>

Port 1,  Data Region METER  Map

Data Item    Starting Address   Type

_YEAR        2000h              int
DAY_OF_YEAR  2001h              int
TIME(ms)     2002h              int[2]
IA(A)        2004h              float[2]
IB(A)        2008h              float[2]
IC(A)        200Ch              float[2]
VA(V)        2010h              float[2]
VB(V)        2014h              float[2]
VC(V)        2018h              float[2]
IAB(A)       201Ch              float[2]
IBC(A)       2020h              float[2]
ICA(A)       2024h              float[2]
VAB(V)       2028h              float[2]
VBC(V)       202Ch              float[2]
VCA(V)       2030h              float[2]
PA(MW)       2034h              float
QA(MVAR)     2036h              float
PB(MW)       2038h              float
QB(MVAR)     203Ah              float
PC(MW)       203Ch              float
QC(MVAR)     203Eh              float
P(MW)        2040h              float
Q(MVAR)      2042h              float
I0(A)        2044h              float[2]
I1(A)        2048h              float[2]
```

(continued on next page)

```
                            (MAP1:METER continued from previous page)

I2(A)        204Ch             float[2]
V0(V)        2050h             float[2]
V1(V)        2054h             float[2]
V2(V)        2058h             float[2]

*>>
```

Examine collected meter data using the VIEW command.

You should see a screen similar to the following:

```
*>>VIEW 1:METER <ENTER>

Port 1,  Data Region METER   Data

_YEAR = 1995  DAY_OF_YEAR = 1 (01/01)  TIME = 01:59:37.859
IA(A) =   2374.623,   102.078  IB(A) =   2353.747,   -17.810
IC(A) =   2369.258,  -137.949  VA(V) =  11278.516,   103.606
VB(V) =  11289.020,   -16.545  VC(V) =  11270.235,  -136.424
IAB(A) =   4092.593,   131.987  IBC(A) =   4093.101,    12.229
ICA(A) =   4107.771,  -107.898  VAB(V) =  19558.934,   133.546
VBC(V) =  19524.914,    13.488  VCA(V) =  19524.873,  -106.397
PA(MW) =     26.773  QA(MVAR) =      0.714  PB(MW) =     26.565
QB(MVAR) =      0.587  PC(MW) =     26.693  QC(MVAR) =      0.711
P(MW) =     80.030  Q(MVAR) =      2.012  I0(A) =      7.170,   135.000
  I1(A) =   2365.875,   102.106  I2(A) =      5.750,    40.418
V0(V) =      7.299,   -80.537  V1(V) =  11279.251,   103.546
V2(V) =     13.106,   163.608


*>>
```

3. Verify that the SEL-2020 will respond to the user-defined “GETDAT” command with the proper meter data from all seven ports. Use a terminal to send the GETDAT messages to Port 11 on the SEL-2020.

```
*>>GETDAT<ENTER>

*>>593.91,12013.22,598.34,12111.33,587.96,12131.22,597.65,12045.34,601.43,12011.34,596.12,12102.33,5
95.11,12045.52

*>>
```

In the screen above, the GETDAT response is a message consisting of an ASCII string of 14 numbers. The first number is the A-phase Amps for Port 1, the second the A-phase Volts for Port 1. Similarly, there are six more pairs of readings for the other six relays.

Now, you must program the RTU to send the GETDAT command whenever it wants an update of the meter information and to interpret the comma-delimited data stream it receives in response. This example shows the user-defined command and the response string as ASCII messages. You may also define binary user-defined commands. See ***Section 8: Message Strings*** for more detailed information about requesting other data formats.

EXAMPLE 4: ARCHIVE EVENT REPORTS TO NONVOLATILE FLASH MEMORY

INTRODUCTION

This example assumes you have SEL relays connected to several of the SEL-2020 ports, as in the previous examples, and also that the SEL-2020 is equipped with optional nonvolatile Flash memory. The nonvolatile Flash memory is required for long-term data storage capable of archiving multiple records. This example demonstrates another unique feature of the SEL-2020: the ability to count the number of summary event reports received from an SEL relay, and then retrieve that number of long event reports to store in the SEL-2020 database.

IDENTIFYING THE PROBLEM

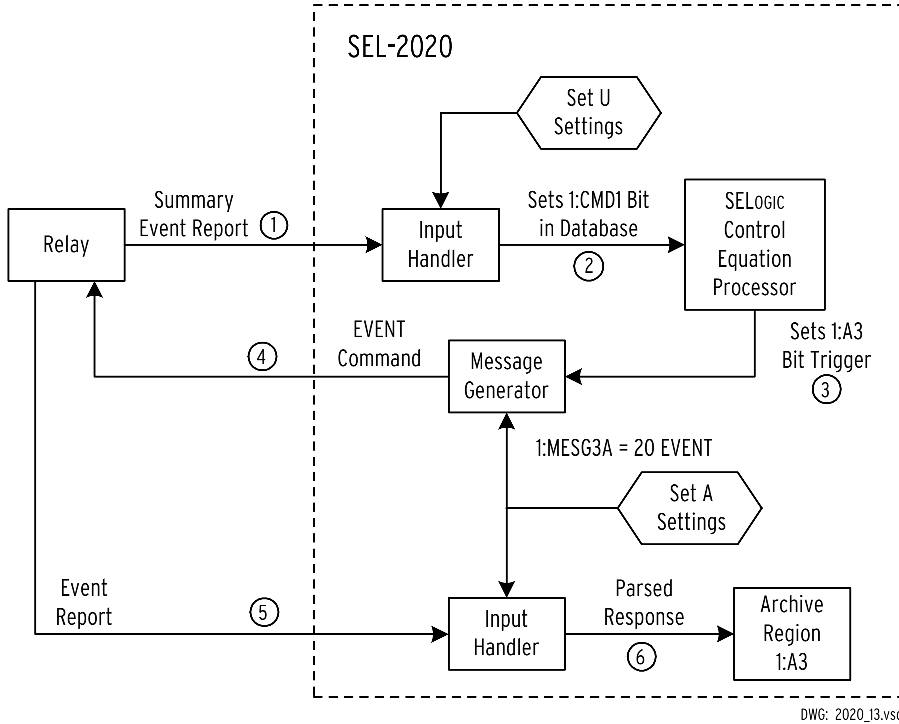
In response to summary event reports, you want the SEL-2020 to request long event reports from all attached relays and archive them as unique records in nonvolatile memory.

DEFINING THE SOLUTION

Set the SEL-2020

Figure 4.6 is a functional model showing how long event reports can be archived in SEL-2020 memory. To accomplish this function, follow these steps:

1. Use the SET U command to enable the pre-defined user-defined command 20EVENT on Port 1. 20EVENT is a pre-defined string for user-defined commands that asserts the corresponding CMDx bit when the SEL-2020 receives a summary event report. See ***Section 8: Message Strings*** for a list of pre-defined strings and more detailed information about strings.
2. On Port 1, use the SET A command to enable archiving of data, and to define the issue condition CMD1 to trigger event report collection (using the 20EVENT setting).
3. Use the COPY ALL command, as in previous examples, to copy these settings to all ports where you want event report data collected. If connected IEDs are not identical, auto-configure the ports. If they are identical, adjust port IDs and check all settings.



① The SEL relay on Port 1 sends a summary event report to the SEL-2020. You must ensure that the relay port is set to "AUTO" to send summary event reports to the SEL-2020.

② The SEL-2020 recognizes this event report because you set CMD1=20EVENT using the SET U command. The Input Handler therefore sets the CMD1 bit in the Port 1 database.

③ The SELOGIC Control Equation Processor reads the 1:CMD1 bit set and sets the 1:A3 bit, which triggers the message generator to send a pre-set message. You defined the 1:A3 trigger condition as ISSUE3A=CMD1 using the SET A command.

④ The Message Generator requests an event report from the relay. You defined this message as: MESG3A=20EVENT using the SET A command. The command the SEL-2020 sends is the EVENT command appropriate to that relay.

⑤ The relay responds by sending the long event report to the SEL-2020.

⑥ Because Port 1 was auto-configured from a previous example, the SEL-2020 is programmed to parse the response from the relay. The SEL-2020 parses the response and stores the report in Archive Region 1:A3.

Figure 4.6: Functional Model of Message Archive Function for Port 1

Test the Operation

1. Use the MAP command to see the general database structure including the number of archive records stored.
2. Force an event on a relay and wait a couple of minutes for it to be retrieved.
3. View the contents of each port archive data region individually using the VIEW command.

SET THE SEL-2020, STEP-BY-STEP

Set all SEL-2020 ports that you want to collect event reports using the following steps:

1. Use the SET U command to enable the pre-defined user-defined command 20EVENT on Port 1. 20EVENT is a pre-defined string for user-defined commands that asserts the corresponding CMD bit when the SEL-2020 receives a summary event report. See ***Section 8: Message Strings*** for a list of pre-defined strings.

   You should see the following screen:

```
*>>SET U 1<ENTER>

User settings for Port 1



General-Purpose User-Defined Input Commands

Number of general purpose commands (0-4)     CMD_CNT = 0     ? 1<ENTER>          1

Command String 1
CMD1    = ""
 ? 20EVENT<ENTER>                                                                 2

CMD_CNT = 1
CMD1    = 20EVENT

Save changes (Y/N) ? Y<ENTER>

Port 1 Settings Changed


*>>
```

Notes:

1. Set CMD_CNT to 1 to open one user-defined command setting. Because this port was configured as an SEL IED port in the previous examples, only four commands can be set. Master ports have eight (8) command settings available.

2. Set CMD1=20EVENT. This settings tells the SEL-2020 to look for summary event reports. When it receives a summary report, the CMD1 element on this port is asserted.

2. On Port 1, use the SET A command to enable archiving of data, and to define the issue condition CMD1 to trigger event report collection (using the 20EVENT setting).

   You should see the following screen:

```
*>>SET A 1<ENTER>

Automatic message settings for Port 1


Save Unsolicited Messages (Y/N)             AUTOBUF = Y     ? <ENTER>

Port Startup String
STARTUP ="ACC\nOTTER\n2AC\nTAIL\n"
 ? <ENTER>

Send Operate command on Logic bit transition (Y/N) SEND_OPER=N     ?<ENTER>


Auto-message Settings

How many auto-message sequences (0-12)      MSG_CNT = 2      ? <ENTER>

Item 1 trigger D1
ISSUE1  = T01:00:00.0
 ? <ENTER>

Item 1 message
MESG1 = "DATE \RI;01:GLOBAL:MONTH//\RI;01:GLOBAL:DATE//\RI;01:GLOBAL:_YEAR/\n
 ? <ENTER>

Item 1 response parsing method (0=IGNORE,
 1=ASCII_INT, 2=ASCII_FLOAT, 3=CHAR_STRING, 4=INT_STRING)PARSE1  = 0     ? <ENTER>

Time delay to allow response to complete (OFF, ON) DELAY1   = ON    ? <ENTER>

Item 2 trigger D2
ISSUE2  = P00:00:01.0
? <ENTER>

Item 2 message
MESG2   = 20METER
 ? <ENTER>


Archive Settings

Enable use of archive data items (Y/N)       ARCH_EN = N     ? Y<ENTER>          1

Archive 1 trigger ARCH1
ISSUE1A = NA
 ? <ENTER>

Archive 2 trigger ARCH2
ISSUE2a = NA
 ? <ENTER>

Archive 3 trigger ARCH3
ISSUE3A = NA
 ? CMD1<ENTER>                                                                   2

Archive 3 message
MESG3A  = ""
 ? 20EVENT<ENTER>                                                                3

Size of user-defined data space in registers  USER    = 0     ? <ENTER>
```

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```
(SET A1 continued from previous page)

AUTOBUF = Y
STARTUP ="ACC\nOTTER\n2AC\nTAIL\n"
SEND_OPER= N

MSG_CNT = 2


ISSUE1  = T01:00:00.0
MESG1   = "DATE \RI;01:GLOBAL:MONTH//\RI;01:GLOBAL:DATE//\RI;01:GLOBAL:_YEAR/\n"
PARSE1  = 0
DELAY1  = ON

ISSUE2  = P00:00:01.0

MESG2   = 20METER

ARCH_EN = Y

ISSUE1A = NA

Press RETURN to continue<ENTER>

ISSUE2A = NA

ISSUE3A = 1:CMD1
MESG3A  = 20EVENT
USER    = 0

Save changes (Y/N) ? Y<ENTER>

Port 1 Settings Changed


*>>
```

Notes:

1. Enable use of the archival data regions by setting ARCH_EN=Y.
2. Set ISSUE 3A=CMD1 to initiate MESG3A when the CMD1 element asserts on this port.
3. Set MESG3A=20EVENT to collect a long event report from the SEL relay on this port when the CMD1 element asserts. MESG3A is used in preference to MESG1A and MESG2A because data region A3 is the only archive data region large enough to hold a record the length of a standard event report. Alternately, you could use the pre-defined string 20EVENTS to collect a literal event report. Use 20EVENTS if you use an external program which requires the event report format provided by the relay.

3. Use the COPY ALL command, as in previous examples, to copy these settings to all ports where you want event report data collected. If connected IEDs are not identical, auto-configure the ports. If they are identical, adjust port IDs and check all settings.

   If the SEL-2020 receives multiple SEL relay summary event reports on the same port in rapid succession, the SEL-2020 will retrieve one long event report every five minutes until all of the long event reports have been collected.

   In the above procedure, you use Archive 3 because it is the only archive region large enough to hold a long event report. Other archive regions consist of 2048 registers; Archive region 3 contains 30720 registers.

You must read and remove reports from the archive occasionally to avoid overflowing the archive. If the archive memory becomes full, the SEL-2020 will not collect any new reports until some old ones are removed.

Test the Operation

1. Use the MAP command to see the general database structure including the number of archive records stored.

```
*>>MAP 1<ENTER>

Port 1 Database Assignments

  Region    Data Type   # Records

  GLOBAL    --
  LOCAL     --
  BUF       --
  D1        Unused
  D2      B METER
  D3        Unused
  D4        Unused
  D5        Unused
  D6        Unused
  D7        Unused
  D8        Unused
  A1        Unused
  A2        Unused
  A3      A EVENT       1
  USER      Unused


*>>
```

2. Force an event on a relay and wait a couple of minutes for it to be retrieved.

3. View the contents of each port archive data region individually using the VIEW command. Clear the entire contents of each archive data region with the CLEAR command, or add C to the end of the VIEW command to clear an individual record (e.g., VIEW 1:A3 C).

   The following screen shows an actual event report captured on Port 1 and then displayed using the VIEW command. The first date and time are SEL-2020 date and time stamp; the second row of date and time are relay-supplied information. The main body of the report includes sampled analog and digital status data. Fault type and fault location are included at the end of the report.

   20EVENT report data are parsed automatically for the SEL-2020's database. You can collect the complete literal event report with complete header, footer, and setting data by setting MESGA3 to 20EVENTS for a 4 sample/cycle report or 20EVENTL for a 16 sample/cycle report.

```
*>>VIEW 1:EVENT C<ENTER>

Port 1,  Data Region EVENT   Data

_YEAR = 1995  DAY_OF_YEAR = 137 (05/17)  TIME = 3:20:16.886
MONTH = 5  DAY = 17  YEAR = 95  HOUR = 3  MIN = 19  SECONDS =     36.862

IR(A) IA(A) IB(A) IC(A)     VA(V)     VB(V)     VC(V) Digital status
    0   219   375  -594   4233.00   7794.00 -12164.00 .... .. ... . L. .... ...
    5  -555   467    92 -11255.00   9222.00   2199.00 .... .. ... . L. .... ...
    0  -219  -375   594  -4233.00  -7802.00  12164.00 .... .. ... . L. .... ...
   -5   555  -467   -92  11263.00  -9215.00  -2206.00 .... .. ... . L. .... ...

    0   219   375  -596   4218.00   7802.00 -12157.00 .... .. ... . L. .... ...
    2  -555   467    95 -11263.00   9215.00   2206.00 .... .. ... . L. .... ...
    2  -219  -375   596  -4211.00  -7802.00  12157.00 .... .. ... . L. .... ...
   -2   555  -467   -95  11263.00  -9215.00  -2206.00 .... .. ... . L. .... ...

   -2   219   375  -596   4211.00   7809.00 -12157.00 .... .. ... . L. .... ...
    2  -555   467    95 -11263.00   9208.00   2214.00 .... .. ... . L. .... ...
    2  -219  -375   596  -4211.00  -7816.00  12157.00 .... .. ... . L. .... ...
   -2   555  -467   -95  11270.00  -9201.00  -2221.00 .... .. ... . L. .... ...

   -2   216   375  -596   4204.00   7816.00 -12157.00 .... .. ... . L. .... ...
    5  -555   467    95 -11277.00   9201.00   2221.00 .... .. ... . L. .... ...
    0  -214  -375   596  -4196.00  -7816.00  12157.00 .... .. ... . L. .... ...
   -5   555  -467   -95  11277.00  -9201.00  -2228.00 .... .. ... . L. .... ...

    0   216   375  -596   4196.00   7823.00 -12157.00 .... .. ... . L. .... ...
    2  -557   467    95 -11277.00   9193.00   2235.00 .... .. ... . L. .... ...
    2  -216  -375   596  -4196.00  -7831.00  12157.00 .... .. ... . L. .... ...
   -2   557  -467   -95  11277.00  -9186.00  -2235.00 .... .. ... . L. .... ...

   -2   214   375  -596   4189.00   7831.00 -12157.00 .... .. ... . L. .... ...
    5  -555   467    95 -11277.00   9186.00   2242.00 .... .. ... . L. .... ...
    0  -214  -377   596  -4175.00  -7831.00  12150.00 .... .. ... . L. .... ...
   -2   555  -465   -97  11277.00  -9186.00  -2250.00 .... .. ... . L. .... ...

   -2   216   377  -594   4168.00   7831.00 -12142.00 .... .. ... . L. .... ...
    2  -557   465    97 -11277.00   9186.00   2250.00 .... .. ... . L. .... ...
    2  -216  -377   594  -4168.00  -7838.00  12150.00 .... .. ... . L. .... ...
   -5   557  -465   -97  11284.00  -9179.00  -2257.00 .... .. ... . L. .... ...

    0   214   377  -594   4160.00   7845.00 -12157.00 .... .. ... . L. .... ...
    5  -555   465    97 -11292.00   9172.00   2264.00 .... .. ... . L. .... ...
    0  -214  -377   594  -4153.00  -7845.00  12157.00 .... .. ... . L. .... ...
   -5   557  -465   -97  11292.00  -9172.00  -2271.00 .... .. ... . L. .... ...

    0   212   377  -594   4153.00   7845.00 -12150.00 .... .. ... . L. .... ...
    5  -557   465    97 -11292.00   9172.00   2278.00 .... .. ... . L. .... ...
    0  -212  -377   594  -4153.00  -7852.00  12142.00 .... .. ... . L. .... ...
   -5   557  -465   -97  11292.00  -9164.00  -2278.00 .... .. ... . L. .... ...

    0   212   379  -594   4153.00   7859.00 -12142.00 .... .. ... . L. .... ...
    5  -557   462    97 -11292.00   9157.00   2278.00 .... .. ... . L. .... ...
    0  -212  -379   594  -4153.00  -7859.00  12150.00 .... .. ... . L. .... ...
   -5   557  -462   -97  11299.00  -9157.00  -2286.00 .... .. ... . L. .... ...

    0   212   379  -594   4139.00   7859.00 -12150.00 .... .. ... . L. .... ...
    5  -557   462    97 -11299.00   9157.00   2293.00 .... .. ... . L. .... ...
    0  -212  -379   594  -4124.00  -7867.00  12142.00 .... .. ... . L. .... ...
   -2   557  -462   -97  11292.00  -9150.00  -2300.00 .... .. ... . L. .... ...

TYPE = TRIG
FAULT LOC = $$$$$$$$$$

*>>
```

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EXAMPLE 5: PRINT ARCHIVED EVENT REPORTS

INTRODUCTION

Example 5 assumes you have an SEL-2020 with relays and printer connected and configured as in Example 2, and that you have collected long event reports from the SEL relay connected to SEL-2020 Port 1, as described in Example 4. Example 5 shows yet another way you can control data with the SEL-2020 Communications Processor.

IDENTIFYING THE PROBLEM

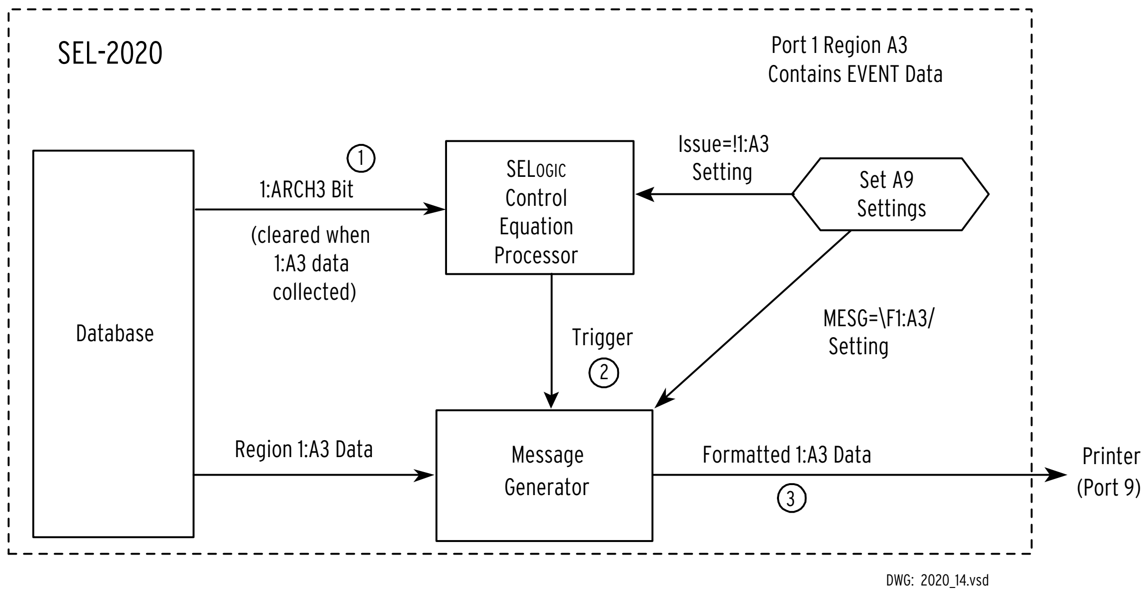
You want to print the long event reports collected from the SEL relay on your SEL-2020 Port 1 and stored in the A3 Archive data region of the SEL-2020 Port 1 database.

DEFINING THE SOLUTION

Set the SEL-2020

1. For the printer on Port 9, use SET A 9 to control printing of the long event report.

   In Example 4, we set Ports 1 through 7 to collect a long event report whenever the SEL-2020 received an unsolicited summary event report from the SEL relays on those ports. In this example, we print the collected reports using a control sequence diagrammed and described in Figure 4.7.



① An event report is collected and archived to 1:A3 database. The 1:ARCH3 bit is asserted each time a long event record is received. After the event report is received, the SEL-2020 clears the 1:ARCH3 bit.

② The SELOGIC Control Equation Processor detects the !1:ARCH3 condition and sets the D2 bit. You previously defined this issue condition as ISSUE2=!1:ARCH3 using the SET A command for Port 9.

③ The Message Generator detects the D2 bit is set and issues MESG2. This message retrieves data from Archive Region A3 and sends it to the printer on Port 9, then clears the A3 region. You previously defined MESG2 as MESG2=\F1:A3;C/ using the SET A command for Port 9.

Figure 4.7: Functional Model of Printing Archived Reports

SET THE SEL-2020, STEP-BY-STEP

For the printer on Port 9, use SET A 9 to output the long event report.

You should see the following screen:

```
*>>SET A 9<ENTER>

Automatic message settings for Port 9


Port Start-Up String
STARTUP =""
 ? <ENTER>


Auto Message Settings

How many auto-message sequences (0-12)        MSG_CNT = 1     ? 2<ENTER>          1

Print all buffered unsolicited messages (Y/N)  PRINT_ALL= Y     ? <ENTER>

Clear unsolicited message buffer after print (Y/N)CLEAR_BUF= Y     ? <ENTER>

Item 2 trigger D2
ISSUE2  =NA                                                                        2
 ? !1:ARCH3<ENTER>

Item 2 message
MESG2   =""                                                                        3
 ? \F1:A3;C/<ENTER>

Size of user-defined data space in registers   USER    = 0     ? <ENTER>

STARTUP =""

MSG_CNT = 2
PRINT_ALL= Y
CLEAR_BUF= Y


ISSUE2  =!1:ARCH3
MESG2   ="\F01:A3;C/"
USER    = 0

Save changes (Y/N) ? Y<ENTER>

Port 9 Settings Changed


*>>
```

Notes:

1 Set MESG_CNT=2 to add a new message trigger and message on Port 9.

2 Set ISSUE2=!1:ARCH3 to trigger MESG2 when the A3 data region bit, ARCH3, on Port 1 deasserts at the conclusion of a long event report storage sequence.

3 Set MESG2=\F1:A3;C/ to send the formatted output from the Port 1, A3 data region to the printer. When this transfer is complete, clear the Port 1, A3 data region. Depending on your printer, you may want to issue a form feed after the printing process is completed. You can do this simply by adding the ASCII form feed character sequence (\00C) to the end of the MESG2 message string.

To print long event reports from all seven Port A3 archive data regions, you set Port 9 ISSUE 2=:

!1:ARCH3*!2:ARCH3*!3:ARCH3*!4:ARCH3*!5:ARCH3*!6:ARCH3*!7:ARCH3

for the SELOGIC Control Equation defining the trigger condition, and set Port 9 MESG2=:

\F1:A3;C/\F2:A3;C/\F3:A3;C/\F4:A3;C/\F5:A3;C/\F6:A3;C/\F7:A3;C/

for the message definition.

EXAMPLE 6: COLLECT EVENT REPORTS BY MODEM

INTRODUCTION

Example 6 expands on the SEL-2020 data and communication processing capabilities developed and described in the previous examples. This example demonstrates the ability to transfer data via a modem and telephone link to a remote computer at specified times and days of the week.

IDENTIFYING THE PROBLEM

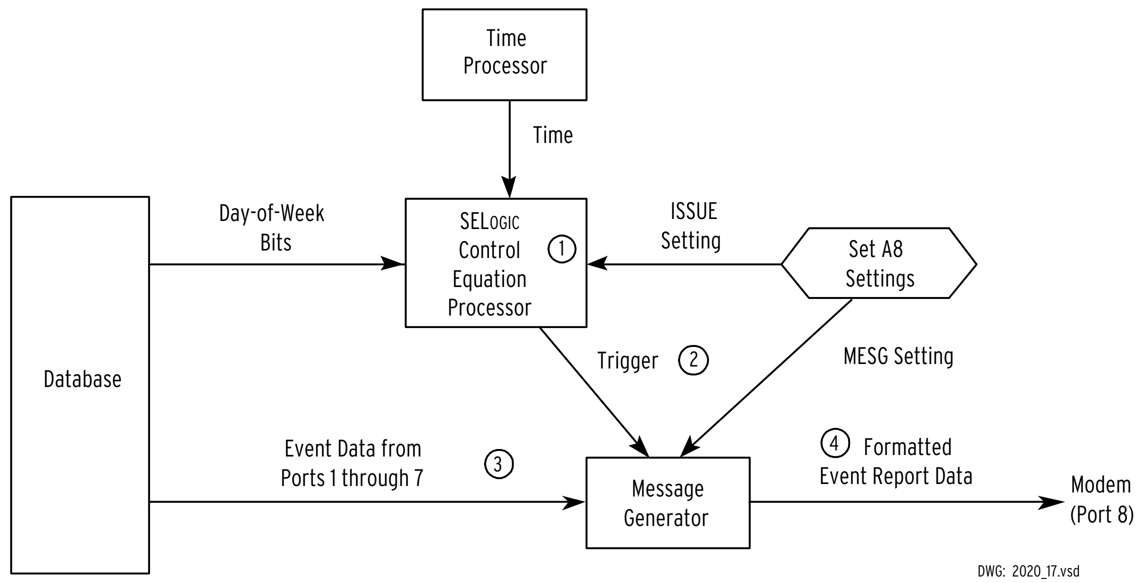
In this example, you must transfer the SEL relay long event reports to a remote computer at a specified time each weekday. You will continue to collect, store, and locally print the long event reports as you did in Example 5, except you will not clear the long event report records from the archive data region as the records are printed.

DEFINING THE SOLUTION

Maintain the SEL-2020 settings to collect long event reports as shown in Examples 4 and 5.

Set the SEL-2020

1. Use SET A 8 to supply Port 8 with the timed trigger condition and the message to retrieve contents of the A3 Data Region on Ports 1 through 7.
2. Change the printer settings made in Example 5 so event report records are not cleared after printing.



① The SELOGIC Control Equation Processor compares time from the Time Processor and Day-of-Week elements from the database to the issue conditions. In Example 4, you set the SEL-2020 to collect event reports. You defined the message trigger condition (ISSUE1) using the SET A command for Port 8.

② When message trigger conditions in item ① above are met, the SELOGIC Control Equation Processor sets the D1 trigger bit.

③ The Message Generator detects the D1 bit set and issues MESG1, which instructs the SEL-2020 to dial the modem using the number specified in the \I string.

④ The SEL-2020 sends formatted event data to the device attached to Port 8.

Figure 4.8: Functional Model of Collection by Modem

SET THE SEL-2020, STEP-BY-STEP

Use SET A 8 to supply Port 8 with the timed trigger condition and the message to retrieve contents of the A3 Data Region on Ports 1 through 7.

You should see the following screen:

```
*>>SET A 8<ENTER>

Automatic message settings for Port 8


Auto-message Settings

How many auto-message sequences (0-12)       MSG_CNT = 0     ? 1<ENTER>                    1

Item 1 trigger D1
ISSUE1  = NA
 ? T7:00 * MON + T7:00 * TUE + T07:00 * WED + T07:00 * THU + T07:00 * FRI<ENTER>           2

Item 1 message
MESG1   = ""
 ? \IATDT3321890/\F1:A3;CA/\F2:A3;CA/\F3:A3;CA/\F4:A3;CA/\F5:A3;CA/\<ENTER                 3
 ? \F6:A3;CA/F7:A3;CA/<ENTER>

Archive Settings

Enable use of archive data items (Y/N)      ARCH_EN = N       ? <ENTER>

Size of user-defined data space in registers USER  = 0     ? <ENTER>

MSG_CNT = 1


ISSUE1  = T07:00:00.0 * MON + T07:00:00.0 * TUE + T07:00:00.0 *
WED + T07:00:00.0 * THU + T07:00:00.0 * FRI
MESG1   = "\IATDT3321890/\F01:A3;CA/\F02:A3;CA/\F03:A3;CA/\F04:A3;CA/\F05:A3;CA/\F06:A3;CA
/\F07:A3;CA/"

ARCH_EN = N
USER    = 0

Save changes (Y/N) ? Y<ENTER>

Port 8 Settings Changed


*>>
```

Notes:

1. Set MESG_CNT=1 to add a new message trigger and message on Port 8.
2. Set ISSUE 1 as shown to trigger MESG1 every weekday morning, Monday through Friday, at 7:00 a.m.
3. Set MESG1 as shown to initiate a phone call to a remote computer, and send the formatted long event report records stored in the A3 archive data region on Ports 1 through 7, clearing the archive region records as the records are read and sent. The \I character string initiates the phone call using the given number. The records in each of the A3 archive data regions on Ports 1 through 7 are read and cleared using the \F.../ string that outputs formatted data. The ;CA appended to the Port #:A3 address instructs the SEL-2020 to read all records in the queue and clear them as they are read.

2. Change the printer settings made in Example 5 so event report records are no longer cleared after printing. The records will remain in the archive data region until they are sent to the modem every weekday morning.

   You should see the following screen:

```
*>>SET A 9 <ENTER>

Automatic message settings for Port 9


Port Startup String
STARTUP =""
 ? <ENTER>

Auto-message Settings

How many auto-message sequences (0-12)       MSG_CNT = 2     ? <ENTER>

Print all buffered unsolicited messages (Y/N)PRINT_ALL= Y     ? <ENTER>

Clear unsolicited message buffer after print (Y/N)CLEAR_BUF= Y     ? <ENTER>

Item 2 trigger D2
ISSUE2  = !1:ARCH3 * !2:ARCH3 * !3:ARCH3 * !4:ARCH3 * !5:ARCH3 *
!6:ARCH3 * !7:ARCH3
 ? <ENTER>

Item 2 message
MESG2   = "\F01:A3;C/\F02:A3;C/\F03:A3;C/\F04:A3;C/\F05:A3;C/\F06:A3;C/\F07:A3;C/"          1
 ? \F01:A3/\F02:A3/\F03:A3/\F04:A3/\F05:A3/\F06:A3/\F07:A3/ <ENTER>

Size of user-defined data space in registers USER    = 0     ? <ENTER>

STARTUP =""

MSG_CNT = 2

PRINT_ALL= Y
CLEAR_BUF= Y

ISSUE2  = !1:ARCH3 * !2:ARCH3 * !3:ARCH3 * !4:ARCH3 * !5:ARCH3 *
!6:ARCH3 * !7:ARCH3
MESG2   = "\F01:A3/\F02:A3/\F03:A3/\F04:A3/\F05:A3/\F06:A3/\F07:A3/"
USER    = 0

Save changes (Y/N) ? Y <ENTER>

Port 9 Settings Changed

*>>
```

Note: 1 Change the \F:.../ string so it no longer clears the record queue when the records are sent to the printer.

OPERATION

On each day (Monday through Friday) at 7:00 a.m., the SEL-2020 dials the number specified with the \I string in the MESG1 setting, transfers event reports stored in the database on Ports 1 through 7, and then deletes the reports from the database.

After initiating the dial string, the SEL-2020 internal modem waits 60 seconds for a connection. If a connection is not established in 60 seconds, the SEL-2020 hangs up the modem and tries the call again in two minutes.

EXAMPLE 7: SWITCH GROUP SETTINGS ON ALL RELAYS

Example 7 demonstrates the SEL-2020's ability to send commands to other devices, in this case other SEL relays, using a command string that you store in the User data region on one port. This example uses the SEL relay GROUP command to change group settings on several SEL-251 Relays attached to the SEL-2020, all at the same time with a single command. You could change group settings on individual ports with separate command and message combinations, each combination issuing one change. But the method shown here allows you to switch between any number of group settings on all relays by creating just one command and one message.

This example, like the previous examples, assumes that you have an SEL-2020 with seven SEL-251 Relays attached to Ports 1 through 7, as shown below in Figure 4.9.

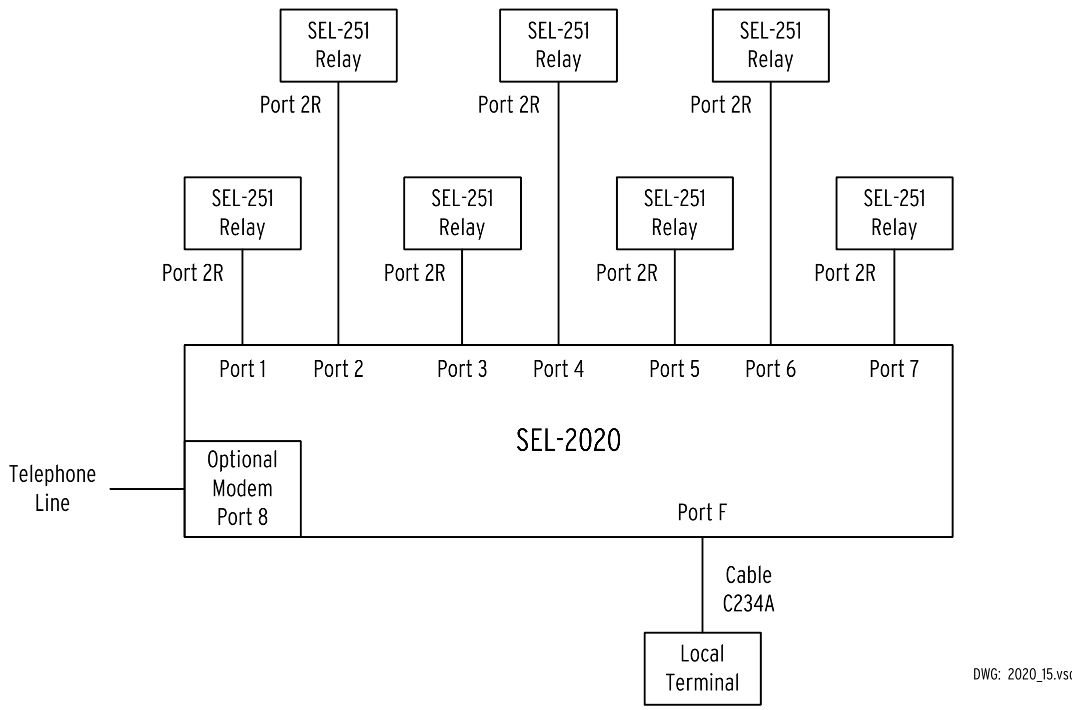


Figure 4.9: Group Switch Configuration Diagram

IDENTIFYING THE PROBLEM

Your objective in this example is to switch settings from Group 2 to Group 3 on all SEL-251 relays attached to the SEL-2020. Later, you must switch the settings from Group 3 back to Group 2, again, on all SEL-251 Relays attached to the SEL-2020.

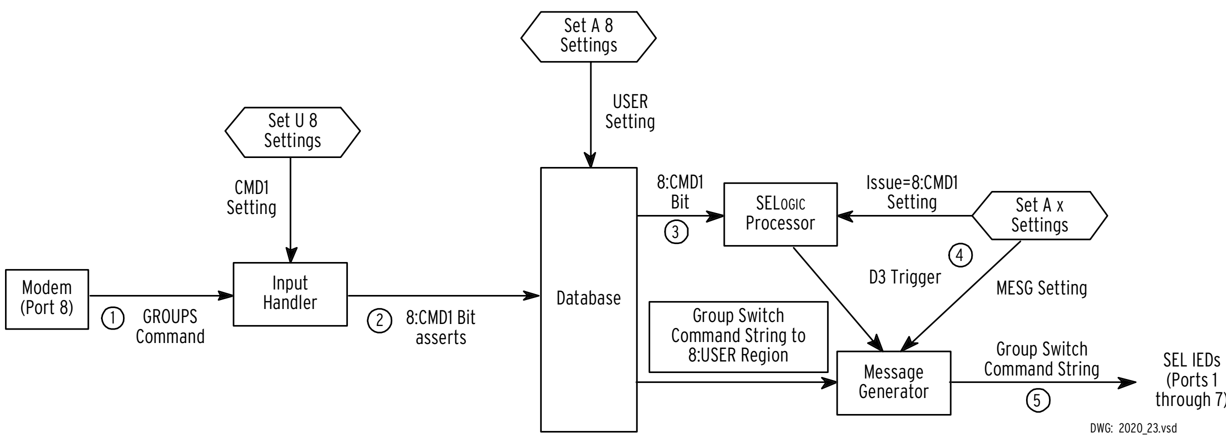
DEFINING THE SOLUTION

Set the SEL-2020

1. Reserve memory in the User region of Port 8 with the SET A command. This space will be used for a message you will create.
2. Also for Port 8, use the SET U command to tell the SEL-2020 to watch for the GROUPS command.
3. Create the automatic message that is sent in response to the user-defined command.
4. Use the COPY ALL command to copy these settings to Ports 2 through 7 as in previous example.

Operation

1. Establish remote communication with the SEL-2020 through the internal modem on Port 8.
2. Use the STORE command to store a group switch command in the Port 8 User region.
3. Send the GROUPS command that you defined to trigger the SEL-2020 to send the group switch command to Ports 1 through 7.



① You send the GROUPS command. You defined the GROUPS command string (CMD1="GROUPS") using the SET U command for Port 8.

② The Input Handler sets the 8:CMD1 bit.

③ The SELOGIC Control Equation Processor reads the 8:CMD1 bit. You set the ISSUE3 condition to be 8:CMD1 using the SET A command for Port 1. You then copied these settings to Ports 2 through 7 using the COPY ALL command.

④ The SELOGIC Control Equation Processor sets the D3 trigger bit on Ports 1 through 7 in response to the 8:CMD1 bit.

⑤ The Message Generator is triggered by the D3 bit and sends MESG3 instructing the Message Generator to fetch the string from Port 8 User Region that sends the stored GROUP switch command to the relays on Ports 1 through 7.

Figure 4.10: Group Switch Functional Diagram

SET THE SEL-2020, STEP-BY-STEP

1. Use the SET A command to reserve memory in the User data region of Port 8 for a message you will create.

   Your screen should look like this:

```
*>>SET A 8<ENTER>

Automatic message settings for Port 8


Auto-message Settings

How many auto-message sequences (0-12)       MSG_CNT = 1     ? <ENTER>

Item 1 trigger D1
ISSUE1  = T07:00:00.0 * MON + T07:00:00.0 * TUE + T07:00:00.0 *
WED + T07:00:00.0 * THU + T07:00:00.0 * FRI
 ? <ENTER> >

Item 1 message
MESG1   = "\IATDT3321890/\F01:A3;CA/\F02:A3;CA/\F03:A3;CA/\F04:A3;CA/\F05:A3;CA/\F06:A3;CA
/\F07:A3;CA/"
 ? <ENTER>


Archive Settings

Enable use of archive data items (Y/N        ARCH_EN = N       ? <ENTER>

Size of user-defined data space in registers  USER    = 0       ? 40<ENTER>          1

MSG_CNT = 1

ISSUE1  = T07:00:00.0 * MON + T07:00:00.0 * TUE + T07:00:00.0 *
WED + T07:00:00.0 * THU + T07:00:00.0 * FRI
MESG1   = "\IATDT3321890/\F01:A3;CA/\F02:A3;CA/\F03:A3;CA/\F04:A3;CA/\F05:A3;CA/\F06:A3;CA
/\F07:A3;CA/"


ARCH_EN = N
USER    = 40

Save changes (Y/N) ? Y<ENTER>

Port 8 Settings Changed

*>>
```

Note: 1 Reserve space for 40 characters in the User data region on Port 8. You will later store the command string that the SEL-2020 will issue to change group settings in this region on the attached SEL relays.

2. Also for Port 8, use the SET U command to tell the SEL-2020 to watch for the GROUPS command.

   You should see the following screen:

```
*>>SET U 8<ENTER>

User settings for Port 8

Warning:  setting CMD_EN=N will disable SEL-2020 commands on this Port

Enable SEL-2020 Commands (Y/N)              CMD_EN  = Y     ? <ENTER>


General-Purpose User-Defined Input Commands

Number of general purpose commands (0-8)    CMD_CNT = 0     ? 1<ENTER>            1

Command String 1
CMD1    = ""
 ? GROUPS<ENTER>                                                                   2


Special-Purpose User-Defined Input Commands

Enable use of special purpose commands (Y/N) STR_EN  = N     ? <ENTER>

CMD_EN  = Y
CMD_CNT = 1
CMD1    = "GROUPS"
STR_EN  = N

Save changes (Y/N) ? Y<ENTER>

Port 8 Settings Changed


*>>
```

Notes: 1 Set CMD_CNT=1 to add a new general-purpose user-defined command.

2 Set CMD1 = GROUPS to establish a command you will send to the SEL-2020 to change group settings on all attached relays.

3a. Create the command string you will use to perform the group switch. To execute the group switch you must cause the relay to:

- Go to Access Level 2.
- Issue and confirm the group switch command.
- Return to Access Level 1.

Assuming the Level 2 password is TAIL, and x is the group number, the complete command string is:

"2AC\nTAIL\nGROUP x\nY\nACC\n"

Since each \n encodes one character, the total length of the string is 23 characters.

3b. Use the SET A command to create the automatic message on Port 1 that is sent in response to the user-defined command.

Your screen should look like this:

```
*>>SET A 1<ENTER>

Automatic message settings for Port 1

Save Unsolicited Messages (Y/N)             AUTOBUF = Y     ? <ENTER>

Port Startup String
STARTUP ="ACC\nOTTER\n2AC\nTAIL\n"
 ? <ENTER>

Send Operate command on Logic bit transition (Y/N)SEND_OPER=N      ? <ENTER>

Auto-message Settings

How many auto-message sequences (0-12)      MSG_CNT = 2     ? 3 <ENTER>          1

Item 1 trigger D1
ISSUE1  = T01:00:00.0
 ? <ENTER>

Item 1 message
MESG1 = "DATE \RI;01:GLOBAL:MONTH//\RI;01:GLOBAL:DATE//\RI;01:GLOBAL:_YEAR/\n"
 ? <ENTER>

Item 1 response parsing method (0=IGNORE,
 1=ASCII_INT, 2=ASCII_FLOAT, 3=CHAR_STRING, 4=INT_STRING)PARSE1  = 0     ? <ENTER>

Time delay to allow response to complete (OFF, ON) DELAY1  = ON      ? <ENTER>

Item 2 trigger D2
ISSUE2  = P00:00:01.0
 ? <ENTER>

Item 2 message
MESG2   = 20METER
 ? <ENTER>

Item 3 trigger D3
ISSUE3 = NA
 ? 8:CMD1<ENTER>                                                                 2

Item 3 message
MESG3  = ""
? \RC;8:USER:0;23/<ENTER>                                                        3


                              (continued on next page)
```

Notes:

1 Set MESG_CNT=3 to add a 3rd message.

2 Set ISSUE 3=8:CMD1 to initiate MESG3 when the CMD1 element on Port 8 asserts. This element is asserted when the “GROUPS” command is received on Port 8.

3 Set MESG3A=\Rc;08:USER:0;23/ to send the message stored in the Port 8 User data region when the ISSUE 3 message trigger condition asserts. The format of the message is \Rc;(port number):(data region):(starting address);(number of characters)/, where the \Rc;..../ string requests the register data from that address.

```
                              (SET A 1 continued from previous page)

Item 3 response parsing method (0=IGNORE,
 1=ASCII_INT, 2 =ASCII_FLOAT, 3=CHAR_STRING, 4=INT_STRING)PARSE3  = 0       ? <ENTER>

Time delay to allow response to complete (OFF, ON) DELAY3  = ON       ? <ENTER>

Archive Settings

Warning:  Setting ARCH_EN = N will result in the loss of all Archive data and Archive settings for
          this port.

Enable use of archive data items (Y/N)       ARCH_EN = Y     ? <ENTER>

Archive 1 trigger ARCH1
ISSUE1A = NA
 ? <ENTER>

Archive 2 trigger ARCH2
ISSUE2A = NA
 ? <ENTER>

Archive 3 trigger ARCH3
ISSUE3A = 1:LOCAL:CMD1
 ? <ENTER>

Archive 3 message
MESG3A  = 20EVENT
 ? <ENTER>

Size of user-defined data space in registers USER    = 0     ? <ENTER>

AUTOBUF = Y
STARTUP ="ACC\nOTTER\n2AC\nTAIL\n"
SEND_OPER= N

MSG_CNT = 3


ISSUE1  = T01:00:00
MESG1   = "DATE \RI;01:GLOBAL:MONTH//\RI;01:GLOBAL:DATE//\RI;01:GLOBAL:_YEAR/\n"
PARSE1  = 0
DELAY1  = ON

ISSUE2  = P00:00:01.0
MESG2   = 20METER

ISSUE3  = 8:CMD1
MESG  = "\RC;08:USER:0000h;23/"
PARSE3  = 0
DELAY3  = ON


Press RETURN to continue <ENTER>

ARCH_EN = Y

ISSUE1A = NA

ISSUE2A = NA

ISSUE3A = 1:CMD1
MESG3A  = 20EVENT
USER    = 0

Save changes (Y/N) ? Y<ENTER>

Port 1 Settings Changed

*>>
```

4. Use the COPY ALL command to copy these settings to Ports 2 through 7 as in previous examples.

OPERATION

To make the group switch to Group 3, send the following two commands to the SEL-2020 from a connected modem:

STORE 8:USER:0 "2AC\nTAIL\nGROUP 3\nY\nACC\n"<ENTER>
GROUPS<ENTER>

To switch back to setting Group 2, send the following two commands to the SEL-2020 from a connected modem:

STORE 8:USER:0 "2AC\nTAIL\nGROUP 2\nY\n\ACC\n"<ENTER>
GROUPS<ENTER>

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EXAMPLE 8: GETTING DATA FROM A NON-SEL IED

Example 8 demonstrates the SEL-2020's ability to communicate with non-SEL IEDs using the nearly universal EIA-232 communications interface. The EIA-232 interface is a standard with specified electrical signal parameters that ensures compatibility between two devices. For devices that use this standard, you must know how to make the proper electrical connection between the two devices to permit communication. Additionally, each of these devices must recognize the "language" that the other "speaks;" therefore, you need the "dictionary," or command set, that defines each language.

In this example, the SEL-2020 communicates with a DGH 1000 RTD Interface Module. This example assumes that you have connected the DGH 1000 to Port 12 on the SEL-2020, as shown in Figure 4.11, using the proper cable, and that you know the communication parameters (baud rate, data bits, parity, stop bits, and flow control) required by the DGH 1000. The example also assumes that you have the command set, or "dictionary" of terms, for each device. In this case you know that when you send the message string "$1RD" to the DGH 1000, the device returns the temperature as an ASCII floating-point number.

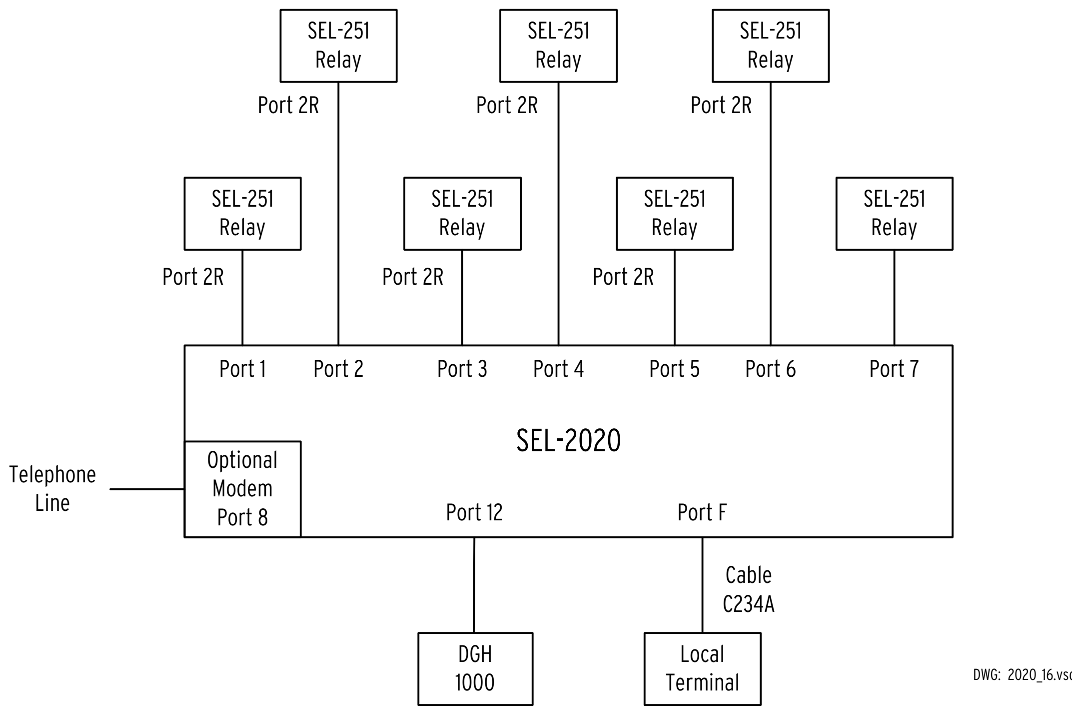

Figure 4.11: Non-SEL IED Attached to Port 12

IDENTIFYING THE PROBLEM

Your objective in this example is to use the SEL-2020 to retrieve temperature data from a remote thermal device (RTD) interface module called the DGH 1000. The DGH 1000 is connected to the SEL-2020's Port 12 and you want to collect these data every 30 seconds.

DEFINING THE SOLUTION

Set the SEL-2020

1. Use SET P 12 to configure Port 12 as an "Other IED" port with the DGH 1000 communication parameters. Use the SET A 12 command to make the following settings:
   - Set AUTOBUF=N so Port 12 does not store unsolicited messages.
   - Define message trigger ISSUE1 to send a message every 30 seconds.
   - Create a message, $1RD\00D, that is sent to the DGH 1000 when triggered.
   - Set PARSE and NUM to accept one floating-point number.

Test the Operation

1. Use the TOGGLE command to force data collection and the VIEW command to view the collected data.

SET THE SEL-2020, STEP-BY-STEP

1. Use SET P 12 to configure Port 12 as an “Other IED” port with the DGH 1000 communication parameters.

   You should have the following screen:

```
*>>SET P 12<ENTER>

Port communications settings for Port 12


Device Type (U=Unused, S=SEL IED, O=Other IED,
             P=Printer, M=Master)              DEVICE  = S     ? O<ENTER>        [1]

Modem Settings

Modem Control (Y/N)                          MODEM    = N      ? <ENTER>

Attempt to detect port baud rate (Y/N)       AUTO_BAUD= N      ? <ENTER>

Communications Type (A=ASCII, B=Binary)      PROTOCOL= INVALID ? A<ENTER>        [2]

Port Identification String
PORTID  =""                                                                      [3]
 ? DGH1000<ENTER>


Communications Settings

Baud Rate (300, 600, 1200, 2400, 4800, 9600,
           19200)                            BAUD    = 9600  ? 300<ENTER>

Number data bits (7,8)                       DATABIT = 8     ? <ENTER>

Stop Bits (1,2)                              STOPBIT = 2     ? 1<ENTER>

Parity (N,O,E,1,0)                           PARITY  = N     ? <ENTER>           [4]

Enable RTS/CTS handshaking (Y/N)             RTS_CTS = N     ? <ENTER>

Enable XON/XOFF flow control (Y/N)           XON_XOFF= Y     ? N<ENTER>

Port Timeout in minutes (0.0-30.0)           TIMEOUT = OFF   ? <ENTER>

PORT:12
DEVICE  = O
MODEM   = N
AUTO_BAUD= N
PROTOCOL= A
PORTID  ="DGH1000"
BAUD    = 300
DATABIT = 8    STOPBIT = 1    PARITY  = N
RTS_CTS = N    XON_XOFF= N
TIMEOUT = OFF


Save changes (Y/N) ? Y<ENTER>

Port 12 Settings Changed

*>>
```

Notes:

1. Set DEVICE=O to reconfigure the port device type as “Other IED”.
2. Set PROTOCOL=A to allow ASCII and binary communications.
3. Enter the name of the device for port identification.
4. Enter communication parameters compatible with the DGH 1000.

2. Set the SEL-2020 with the SET A 12 command to collect data from the DGH 1000 every 30 seconds.

   You should see the following screen:

```
*>>SET A 12<ENTER>

Automatic message settings for Port 12


Save Unsolicited Messages (Y/N)              AUTOBUF = N     ? <ENTER>

Port Startup String
STARTUP =""
 ? <ENTER>


Auto-message Settings

How many auto-message sequences (0-12)       MSG_CNT = 0     ? 1<ENTER>                        1

Item 1 trigger D1
ISSUE1  = NA
 ? P00:00:30<ENTER>                                                                             2

Item 1 message
MESG1   = ""
 ? $1RD\00D<ENTER>                                                                              3

Item 1 response parsing method (0=IGNORE,
 1=ASCII_INT, 2=ASCII_FLOAT, 3=CHAR_STRING, 4=INT_STRING)PARSE1  = 0     ? 2<ENTER>             4

Item 1 number of data items                  NUM1    = 1     ? <ENTER>                          5

Time delay to allow response to complete (OFF, ON) DELAY1  = ON     ? <ENTER>                   6


Archive Settings

Enable use of archive data items (Y/N)       ARCH_EN = N     ? <ENTER>

Size of user-defined data space in registers USER    = 0     ? <ENTER>

AUTOBUF = N
STARTUP =""

MSG_CNT = 1


ISSUE1  = P00:00:30.0
MESG1   = "$1RD\00D"
PARSE1  = 2
NUM1    = 1
DELAY1  = ON

ARCH_EN = N
USER    = 0

Save changes (Y/N) ? Y<ENTER>

Port 12 Settings Changed


*>>
```

Notes: 1 Set MSG_CNT=1 to add a new message trigger and message.

2 Set ISSUE1=P00:00:30 to periodically trigger MESG1 every 30 seconds.

3 Set MESG1=$1RD\00D to send the command $1RD to request temperature data from the DGH 1000. The carriage return, \00D, is required to complete the command sequence.

4 Select PARSE=2 to select the ASCII_FLOAT parsing method because you know the temperature is in floating-point format.

5 Set NUM1=1 to accept one item because you know only one number is returned from the DGH1000.

6 Since we know only one data item is coming in, we could set DELAY1 to OFF. If we wanted to collect data more often than every 5 seconds, we would need to set it OFF to avoid the idle time check. Since we are only collecting the data every 30 seconds, the value of the setting does not matter.

TEST THE OPERATION

1. Test the operation by forcing a data collection and viewing the results.

```
*>>TOGGLE 12:D1<ENTER>                                                     1

Bit toggled

*>>VIEW 12:D1<ENTER>                                                       2

Port 12,  Data Region FLOAT   Data

_YEAR = 1995  DAY_OF_YEAR = 65 (03/06)  TIME = 18:53:18.857
FLOAT =      27.000


*>>
```

Notes: 1 Use the TOGGLE command to assert the D1 bit on Port 12. The D1 message (MESG1) is sent when the D1 bit is asserted. This should result in one data collection operation.

2 Use the VIEW command to view the data collected from the DGH 1000. The data are parsed and stored in the D1 data region on Port 12 in floating-point format. The data are time-tagged at the time the SEL-2020 begins to receive the data.

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EXAMPLE 9: SEL-2020 APPLIED TO SCADA RTU CONTROL

INTRODUCTION

Example 9 is similar to the previous examples, but we add the capability to open and close breakers by commanding the SEL-251 relays through the SCADA system.

IDENTIFYING THE PROBLEM

Your objective in this example is to be able to rapidly open and close breakers via SCADA RTU command.

DEFINING THE SOLUTION

The solution is to use the built-in operate support of the SEL-2020. To get the best response from the relay, we will use SEL-251-1 relays because they support *Fast Operate* commands. *Fast Operate* commands are short binary commands that cause the SEL-251-1 to open or close within 16 milliseconds of receiving the message. If we used conventional SEL-251 relays, the SEL-2020 would have to issue ASCII OPEN and CLOSE commands, which can take many seconds to function.

The following steps will have to be taken:

1. Make sure *Fast Operate* commands are enabled in the SEL-251.
2. Enable operate control of the SEL-251 relays using the SET A command on each SEL-251 port.
3. Establish SELOGIC for opening and closing using SET L on each SEL-251 port.
4. Verify connection by sending various operate commands to relays.

SET THE SEL-2020 STEP-BY-STEP

Verify that the operate jumper on the relay is in the operate enable position. On some relays, such as the SEL-321-1, you will also need to confirm that the *Fast Operate* enable setting is set to yes.

Once you have confirmed that the relay is configured to support *Fast Operate*, use the SET A command on Port 1 to enable direct operate control:

```
*>>SET A 1<ENTER>

Automatic message settings for Port 1


Save Unsolicited Messages (Y/N)             AUTOBUF = Y     ? <ENTER>

Port Startup String
STARTUP ="ACC\nOTTER\n2AC\nTAIL\n"
 ? <ENTER>

Send Operate command on Logic bit transition (Y/N)SEND_OPER= N     ? Y<ENTER>                  1


Auto-message Settings

How many auto-message sequences (0-12)      MSG_CNT = 3     ? END<ENTER>

AUTOBUF = Y
STARTUP ="ACC\nOTTER\n2AC\nTAIL\n"
SEND_OPER= Y

MSG_CNT = 3


ISSUE1  = T01:00:00.0
MESG1   = "DATE \RI;01:GLOBAL:MONTH//\RI;01:GLOBAL:DATE//\RI;01:GLOBAL:_YEAR/\n"
PARSE1  = 0
DELAY1  = ON

ISSUE2  = P00:00:01.0
MESG2   = 20METER

ISSUE3  = 8:CMD1
MESG3   = "\RC;08:USER:0000h;23/"
PARSE3  = 0
DELAY3  = ON

Press RETURN to continue<ENTER>


ARCH_EN = Y

ISSUE1A = NA

ISSUE2A = NA

ISSUE3A = 1:CMD1
MESG3A  = 20EVENT
USER    = 0

Save changes (Y/N) ? Y<ENTER>

Port 1 Settings Changed


*>>
```

Notes: 1 Set SEND_OPER=Y to enable direct operate control via logic bits.

Repeat this process for Ports 2-7.

This operation will associate the port BR1 bit with the relay breaker. Whenever the SBR1 bit asserts, the SEL-2020 will issue an OPEN command to the relay. Whenever the CBR1 bit asserts, the SEL-2020 will issue a CLOSE command. These two bits can be controlled by SELOGIC or by master port *Fast Operate* commands. For this example, we will use CMD bits to control the SBR1 and CBR1 bits. See ***Appendix H: Configuration and Fast Operate Commands*** for more information on using *Fast Operate* commands to trigger these operations.

Using the following steps to set the SELOGIC for Port 1:

```
*>>SET L 1<ENTER>

Logic settings for Port 1



SBR1    = NA
 ? CMD1<ENTER>


CBR1    = NA
 ? CMD2<ENTER>


SBR2    = NA
 ? END<ENTER>

SBR1    = CMD1
CBR1    = CMD2

Save changes (Y/N) ? Y<ENTER>

Port 1 Settings Changed


*>>
```

Repeat this process on Ports 2-7. The system should now be ready for operation.

TEST THE OPERATION

To test the operation, we can trigger various CMD bits and confirm that the relay properly closes its TRIP or CLOSE contact. The ASCII command to open a breaker will be:

STORE 1:081Dh 1 sets 1:CMD1

and to close a breaker will be:

STORE 1:081Dh 2 sets 1:CMD2

The commands for the other ports will be similar.

Use a terminal or your RTU to issue one of these commands while monitoring the trip and close contacts of the relay being operated. Confirm that the operations take place as expected.

If you are controlling the SEL-2020 from the RTU using Modbus, you can operate the SBR1 and CBR1 bits directly. See ***Appendix G: Modbus Protocol*** for more information.

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SECTION 5: COMMANDS

INTRODUCTION

You control, monitor, operate, and set the SEL-2020 with the command set described in this section. This section also includes the rules governing the use of these commands. A list summarizing the commands appears at the end of this section and on a blue pull-out card at the back of the book.

COMMAND OPERATION

Command/response protocol refers to the command structure and syntax that you must use to communicate with the SEL-2020. Access levels determine the levels at which you can interrogate the SEL-2020. Higher levels of access are required to set and operate the device.

Command/Response Protocol

The built-in SEL-2020 command set operates according to the following command/response protocol:

- All commands accepted by the SEL-2020 are of the form:

  <command><CR> or <command><CR><LF>

- The SEL-2020 recognizes both full commands or commands abbreviated to the first three characters: SHOWSET 1 equals SHO 1.
- You may use upper and lower case characters without distinction, except in passwords.
- Arguments are separated from commands by spaces, commas, semicolons, colons, or slashes.

Note: The ENTER key on most keyboards is configured to send the ASCII character 13 (^M) for a carriage return. This manual instructs you to press the **<ENTER>** key after commands, which should send the proper ASCII code to the SEL-2020.

- The SEL-2020 transmits all noninteractive messages in the following format:

```
<STX><MESSAGE LINE 1><CR><LF>
    <MESSAGE LINE 2><CR><LF>
     .
     .
     .
<LAST MESSAGE LINE><CR><LF>
<ETX><STX> <PROMPT><ETX>
```

Each message begins with the start-of-transmission character STX (ASCII character 02) and ends with the end-of-transmission character ETX (ASCII character 03). Each line of the message ends with a carriage return and line feed.

- The CAN character (ASCII character 24) aborts a pending transmission. This capability is useful in terminating an unwanted transmission.
- You can send control characters from most keyboards with the following keystrokes:

  XON: <CTRL-Q> (hold down the Control key and press Q)

  XOFF: <CTRL-S> (hold down the Control key and press S)

  CAN: <CTRL-X> (hold down the Control key and press X)

Command Access Levels

A multilevel password system with three access levels provides security against unauthorized access. This system allows you to give personnel access only to those functions they require. The password system is disabled when the password jumper is inserted on the main board of the SEL-2020. (See ***Section 3: Installation*** for information on using this jumper.)

Each level has an associated screen prompt that indicates the active level. Table 5.1 shows the access levels of the prompts as well as the commands available from each access level.

Table 5.1: Access Level Characteristics

Access Level	0	1	2
Prompt	*	*>	*>>
Available Commands		2ACCESS	2ACCESS
	ACCESS	ACCESS	ACCESS
		AUTO	AUTO
		BROADCAST	BROADCAST
		CLEAR	CLEAR
			CONTROL
			COPY
		DATE	DATE
			DEFRAG
		DNPMAP	DNPMAP
	HELP	HELP	HELP
	ID	ID	ID
		IRIG	IRIG
		MAP	MAP
		MEM	MEM
			PASSWORD
		PORT	PORT
	QUIT	QUIT	QUIT
			SET
		SHOWSET	SHOWSET
		STATUS	STATUS
			STORE
			SWAP
		TARGET	TARGET
		TIME	TIME
			TOGGLE
		VIEW	VIEW
		WHO	WHO

Changing Access Levels

The SEL-2020 always reverts to Access Level 0 at power-up, after time-out, and when you issue the QUIT command at the end of a communication session. To access Level 1, you should type **ACCESS<ENTER>** at the "*" prompt and then enter the password. The default password is OTTER. To enter Access Level 2 from Access Level 1, use the 2ACCESS command and the Access Level 2 password. The default password is TAIL. If JMP9 B is installed on the SEL-2020 main board, a password is not required to change access levels. (See ***Section 3: Installation*** for information on installing jumpers.)

To return to Access Level 0, use the QUIT command. The port automatically returns to Access Level 0 after no activity has occurred on the port for the specified time-out interval.

See the following paragraphs for the details of using the ACCESS, 2ACCESS, and QUIT commands.

SEL-2020 Command Set

This section describes all SEL-2020 commands in alphabetical order. The minimum access level for each command is indicated in parentheses after the command name. See Table 5.1 for a complete summary of command access levels.

2ACCESS (Access Level 1)

Use the 2ACCESS command to enter Access Level 2. You need a password unless jumper JMP9 B is installed. The default password at this level is TAIL. Use the PASSWORD command at Level 2 to change passwords.

The following display exemplifies successful access:

```
*>2ACCESS<ENTER>

Password: ? TAIL<ENTER>

COMMUNICATIONS PROCESSOR - S/N 95012004     Date: 03/07/95    Time: 08:38:10

Level 2

*>>
```

You may use any command from the "*>>" prompt. The SALARM bit will go to 1 for one second for a successful Level 2 access and for three successive bad passwords. In SEL-2020 Communication Processors with I/O boards, you can assign an output contact to SALARM to allow an external system to monitor for invalid access. In SEL-2020 units without an I/O board, the SALARM bit is automatically routed to the ALARM contact, causing it to pulse, unless it is already in an alarm condition.

ACCESS (Access Level 0)

Use the ACCESS command to enter Access Level 1. You need a password unless jumper JMP9 B is installed. The default password at this level is OTTER. From Access Level 2, you can use the PASSWORD command to change this password.

The following display exemplifies successful access:

```
*ACCESS<ENTER>

Password: ? OTTER<ENTER>


COMMUNICATIONS PROCESSOR - S/N 95012004     Date: 03/07/95    Time: 08:45:43

Level 1
*>
```

If you enter wrong passwords during three consecutive attempts, the SEL-2020 pulses the SALARM bit for one second. In SEL-2020 Communication Processors with I/O boards, you can assign an output contact to SALARM to allow an external system to monitor for invalid access. In SEL-2020 units without an I/O board, the SALARM bit is automatically routed to the ALARM contact, causing it to pulse, unless it is already in an alarm condition.

AUTO n (Access Level 1)

The AUTO command displays the results of auto-configuration on a port. The response message shows the device FID string, the device ID string, the baud rate, the supported operate commands, and a list of supported “20” commands. The operate command support indicates whether ASCII or binary operate messages are supported, the number of breakers and remote bits supported, and the type of remote bit operations supported (set, clear, pulse). Each “20” command is preceded by an A or B to indicate whether the data will be collected using an ASCII or binary *Fast Meter* format. The following screen shows an example of a typical AUTO command response.

```
*>>AUTO 1 <ENTER>

FID:       FID=SEL-151-R412-V656rp1rqys-D940901-E2
DEVICE ID: Example 21.6 kV Line
BAUD RATE: 9600
OPERATE SUPPORT:ASCII (1 Breakers, 0 Remote Bits)
COMMANDS SUPPORTED:
  B 20METER
  A 20DEMAND
  B 20TARGET
  A 20HISTORY
  A 20STATUS
  A 20BREAKER
  A 20EVENT
  A 20EVENTS

*>>
```

BROADCAST (Access Level 1)

The BROADCAST command allows you to communicate from one master port to all IED ports simultaneously. When you issue the BROADCAST command, the SEL-2020 will indicate the connected ports. From then on, anything you enter will be sent to all connected ports.

Any messages from any of the connected IED ports will be sent to the single master port, as long as they are framed with the <STX>/<ETX> characters. To transfer binary messages, add an AAh byte after the <STX> character and then a message length as the next byte. The SEL-2020 will use the message length to determine the end of the message, instead of checking for an <ETX> character.

Use the BROADCAST command with an R parameter to enter broadcast communications in a receive only mode. In this mode, master port messages are used for connection termination only.

Exit broadcast mode by entering the transparent termination sequence defined in the SEL-2020 master port settings. (See ***Section 6: Settings*** for additional discussion on termination sequences.) You will need to allow an extra second for TERTIME1 due to some additional broadcast command delays.

CLEAR m:n (Access Level 1)

The CLEAR command clears data from the unsolicited message queue or from the archive data region of an intelligent electronic device (IED) port. Parameter m specifies which port (1 through 16). Parameter n may be BUF for the unsolicited message queue or A1, A2, or A3 for the appropriate archive. Alternatively, for the archive regions, you may use the data label for the region (see MAP command). Clearing the unsolicited message queue clears all received messages from the buffer. Clearing an archive entry removes the oldest item from that archive queue; subsequent entries will remain. To completely clear an archive queue, add the parameter A. For example, use: **CLEAR 4:A2 A** to clear Port 4, Archive 2, all entries.

! CAUTION

Frequent archive record clearing may exceed EEPROM capabilities. See the discussion in the Archive Data Region subsection of ***Section 9: Database***. If you completely clear an archive region that contains a large number of records (thousands of records), it may take a few minutes for the clearing to complete. During this time, most SEL-2020 automatic data collection will be suspended.

CONTROL m (Access Level 2)

You can use the CONTROL command to set (assert), clear (deassert), and pulse (assert and deassert) global element bits R1 through R8. These bits exist in the Global region of the SEL-2020 database. In the example below, executing the CONTROL command controls the global element bit R5. When you enter the CONTROL command with parameter m to identify the bit number you want to control, the SEL-2020 asks for an operation; enter: SRB to set the specified bit, CRB to clear the specified bit, and PRB to pulse the specified bit. Those are the only acceptable operations. You must again specify the bit you want to control (1 through 8) following the operation. If you intend to pulse the bit, you can supply a time parameter or a 1 second time is the default. The example below pulses R5 for 3 seconds.

```
*>>CONTROL 5<ENTER>

Control RB5:  PRB 5 3<ENTER>

*>>
```

COPY m n (Access Level 2)

The COPY command copies port-specific settings port (P), automatic message (A), data movement (M), user-defined command (U), and logic (L) settings) from Port m to Port n (m and n equal any combination of 1 through 16). You would type **COPY 1 ALL<ENTER>** to copy Port 1 settings to all other rear-panel ports.

Use SET to modify copied settings. Settings cannot be copied to any port that is actively involved in transparent communications.

The SEL-2020 makes the following confirmations for each port to which settings are copied:

```
*>>COPY 1 5<ENTER>

Copy settings from Port 1 to Port 5 (Y/N) ? Y<ENTER>

Perform auto-configuration on Port 5 (Y/N) ? N<ENTER>
Port 5 Settings Changed

*>>
```

If you copy to multiple ports using the ALL parameter, the confirmation is repeated for each port.

If you copy settings having CONFIG=Y, the SEL-2020 asks if you want to auto-configure the destination port. If you answer N (No), the SEL-2020 assumes the devices connected to the two ports are identical. If you answer Y (Yes), you may lose some auto-message settings on the destination port if the connected device is not the same type as the device connected to the source port.

When you use the COPY command, the SEL-2020 will make changes to port numbers used in strings and in SELOGIC Control Equations within the copied settings based on the following rules: for the command format "COPY n m", any reference to Port n will change to m, and any reference to a port other than n will remain unchanged. Always use the SHOWSET command to verify settings following a copy. Use the SET command to make required adjustments to settings.

The SALARM bit asserts for one second after a successful copy to indicate that the settings have changed. If there is no I/O board installed, the alarm contact will also close for one second..

If you copy settings to the current port, change your terminal's communication parameters to match once you accept the changes.

DATE (Access Level 1)

The DATE command, without parameters, displays the date stored by the internal calendar/clock. Use the date command with a date parameter to change the date: DATE mm/dd/yy. For example, set the date to March 20, 1994, by entering:

```
*>>DATE 03/20/94<ENTER>

03/20/94
*>>
```

If you use IRIG-B, the day of the year determined from IRIG-B overrides the date settings.

DEFRAG (Access Level 2)

The DEFRAG command defragments EEPROM. The SEL-2020 settings are stored in EEPROM. After multiple settings changes, the available portion of EEPROM may become fragmented (available bytes exist as several small blocks as opposed to a single larger block). The DEFRAG command may be necessary in order to allow further settings changes to be successfully saved.

```
*>>DEFRAG<ENTER>

Performing EEPROM defragmentation will suspend most SEL-2020 activities.

Perform EEPROM defragmentation (Y/N)? Y<ENTER>

Defragmenting ... complete.

*>>
```

Executing the DEFRAG command will momentarily suspend many of the SEL-2020 database and communications activities while the SEL-2020 concentrates the available EEPROM into a single block. Use the MEM command to check EEPROM fragmentation.

DNPMAP (Access Level 1)

The DNPMAP command displays a map of the data available to DNP, including object type, index, and default variation. This map is based on the port and math settings on port 16. Event objects will not be displayed; event objects will have the same indexes as their corresponding static object. See ***Appendix I: Distributed Network Protocol (DNP)V3.00*** for more information.

```
*>>DNPMAP<ENTER>

                                             Date: 03/03/95    Time: 15:06:06

DNP Address:  0000h

Object Type     Index      Default Variation      Label
     01          0-47           02                1:TARGET:TARGET
     20          0-2            06                1:LOCAL:ARCHIVE_CNTRS
     30          0              03                1:METER:IA(A)
     30          1              03                1:METER:IB(A)
     30          2              03                1:METER:IC(A)
     30          3              03                1:METER:VA(V)
     30          4              03                1:METER:VB(V)
     30          5              03                1:METER:VC(V)

*>>
```

HELP (Access Level 0)

The HELP command lists all commands available at the current access level with a one-line description of each, as shown in the display below. Use the HELP command with another command as its parameter and it will provide the syntax and a brief description of the command. If you use the HELP command with an invalid command parameter, the SEL-2020 responds with an error message.

```
*HELP<ENTER>
Commands available at current access level:

- ACCESS - Change access level to Access Level 1
- HELP - Provide information on available commands
- ID - Display SEL-2020 identification information
- QUIT - Change access level to Access Level 0

*
```

ID (Access Level 0)

The SEL-2020 responds to the ID command with its current ID string, as set in the global settings described later in this section, and its firmware identification string (FID string). The command response is as follows:

```
*ID<ENTER>
"FID=SEL-2020-R100-V0-D950306","06D2"
"COMMUNICATIONS PROCESSOR - S/N 95012004","0A6B"

*
```

The four digits at the end of each line are the 16-bit checksum in ASCII-hexadecimal for the preceding string. This checksum is calculated by summing the character codes starting with the first quote and going through the comma separating the string and checksum.

Normally, you use the WHO or STATUS command to determine this same information. The ID command provides consistency between the SEL-2020 and newer SEL relays.

Add a port number to the ID command (ID n, where n is any valid port number 1 to 16) to obtain the FID and ID of the device connected to that port of the SEL-2020.

IRIG (Access Level 1)

The IRIG command directs the SEL-2020 to read the IRIG-B time-code input at the IRIG-B port on the back panel.

If it reads the time code successfully, it updates the internal clock/calendar time and date. The SEL-2020 then sends its ID, date, and time to the terminal.

```
*>IRIG<ENTER>

COMMUNICATIONS PROCESSOR - S/N 95012004     Date: 03/07/95    Time: 09:06:33

*>
```

If the IRIG-B signal is not present or cannot be read, the SEL-2020 sends the error message “IRIG-B DATA ERROR.”

> **Note:** Normally, using this command is unnecessary because the SEL-2020 automatically synchronizes every few minutes; however, you can use the IRIG command to avoid waiting for automatic synchronization during testing and installation checkout.

MAP m (Access Level 1)

You should use the MAP command to see the organization of data stored in a port database. Parameter m specifies the port number. Data are listed by association with each region if only the port number parameter is given. If you add a region parameter, text and numeric references are shown for data stored in the region, e.g., MAP 2:TARGET. (See access methods discussion in ***Section 9: Database*** for a complete description of database access methods.)

To observe the use of the Port 1 database, type **MAP 1<ENTER>**. You will see a screen with the following format:

```
*>>MAP 1<ENTER>

Port 1 Database Assignments

  Region    Data Type   # Records

  GLOBAL    --
  LOCAL     --
  BUF       --
  D1          Unused
  D2        B METER
  D3          Unused
  D4        B TARGET
  D5        A STATUS
  D6          Unused
  D7          Unused
  D8          Unused
  A1          Unused
  A2          Unused
  A3        A EVENT        0
  USER        Unused


*>>
```

In the above example, every region in the database is listed by its label. GLOBAL, LOCAL and BUF contain data pertinent to the SEL-2020, and the other regions contain data collected for Port 1. The type of data stored in each region is listed. The letter just to the left of the data name in the Data Type column indicates the data transfer format: A for ASCII, B for Binary. The # Records column lists records queued in the A1 through A3 archive data regions.

Use the MAP command with a region specifier to see the labels, addresses, and types of data stored in that region:

```
>>MAP 1:D2<ENTER>

Port 1,  Data Region METER  Map

Data Item    Starting Address   Type

_YEAR        2800h              int
DAY_OF_YEAR  2801h              int
TIME(ms)     2802h              int[2]
IA(A)        2804h              float[2]
IB(A)        2808h              float[2]
IC(A)        280Ch              float[2]
VA(V)        2810h              float[2]
VB(V)        2814h              float[2]
VC(V)        2818h              float[2]
IAB(A)       281Ch              float[2]
IBC(A)       2820h              float[2]
ICA(A)       2824h              float[2]
VAB(V)       2828h              float[2]
VBC(V)       282Ch              float[2]
VCA(V)       2830h              float[2]
PA(MW)       2834h              float
QA(MVAR)     2836h              float
PB(MW)       2838h              float
QB(MVAR)     283Ah              float
PC(MW)       283Ch              float
QC(MVAR)     283Eh              float
P(MW)        2840h              float
Q(MVAR)      2842h              float
I0(A)        2844h              float[2]
I1(A)        2848h              float[2]
I2(A)        284Ch              float[2]
V0(V)        2850h              float[2]
V1(V)        2854h              float[2]
V2(V)        2858h              float[2]

*>>
```

Each item within a data region has a label, a numeric address (given in hexadecimal), and a type. The types are “char” for character data, “int” for integer data, and “float” for floating point data. If an item consists of an array of these entries, the number of items is indicated in brackets after the type specifier, i.e., int[2] means there are two integers stored.

Add the BL parameter to the **MAP** command to receive bit label information if it is available. The following example illustrates the BL parameter:

```
*>>MAP 2:TARGET BL<ENTER>

Port 2,  Data Region TARGET  Map

Data Item    Starting Address   Type   Bit Labels

_YEAR        4800h              int
DAY_OF_YEAR  4801h              int
TIME(ms)     4802h              int[2]
TARGET       4804h              char[9]
             4804h              INST  A     B     C     Q     N     RS    LO
             4805h              51P   50L   50H   51QP  50Q   51NP  50NL  50NH
             4806h              51T   50LT  50C   51QT  50QT  51NT  50NLT 27
             4807h              79RS  79CY  79LO  79SH  52AT  52BT  IN6   IN5
             4808h              PDEM  QDEM  NDEM  TF    CF    TCMA  ST    TRIP
             4809h              A     B     C     D     E     F     G     H
             480Ah              J     KT    L     V     W     X     Y     ZT
             480Bh              *     *     IN6   IN5   IN4   IN3   IN2   IN1
             480Ch              *     TRIP  CLOSE A1    A2    A3    A4    ALRM


*>>
```

The bit labels are listed in most-significant to least-significant bit order, the same as in SEL relays. Bit labels are available in the GLOBAL, LOCAL, and TARGET (if not in archive) regions.

MEM (Access Level 1)

The MEM command shows the status of all dynamically-allocated memory. This includes RAM, where the database is stored; EEPROM, where string and SELOGIC Control Equation settings are stored; and non-volatile Flash, where archive data are stored. The report indicates the number of bytes of dynamic memory, the number of free (unused) bytes, the number of free blocks (contiguous segments of unused memory), and the size of the largest free block. The following screen shows a typical MEM report.

```
*>>MEM <ENTER>

Memory       Total        Bytes       Blocks    Largest block
type         bytes        free         free       available

RAM          334618       155490          2        151890
EEPROM        18308        14018         20         11516
FLASH       2097152      1081344        584        146176

*>>
```

You can use the free bytes and largest available block to determine if you are running out of memory. The number of free blocks indicates how badly the memory is fragmented. The more free blocks there are, the less efficiently the SEL-2020 can use the available free memory.

PASSWORD (Access Level 2)

Use the PASSWORD command to inspect or change existing passwords. To inspect passwords, type **PASSWORD<ENTER>**. The passwords for Level 1 and Level 2 are displayed.

```
*>>PASSWORD<ENTER>

1:OTTER
2:TAIL
*>>
```

To change the password for Access Level 1 to BIKE, enter the following:

```
*>>PASSWORD 1 BIKE<ENTER>

Set
*>>
```

To disable passwords at a specific level, enter the keyword DISABLE instead of a password when setting the password:

```
*>>PASS 1 DISABLE<ENTER>

Disabled

*>>PASS<ENTER>

1:PASSWORD DISABLED
2:TAIL

*>>
```

The SEL-2020 sets the password, closes the ALARM contact for approximately one second, and transmits the response "Set". After entering new passwords, type **PASSWORD<ENTER>** to inspect them. Make sure they are what you intended, and record the new passwords.

When you change passwords, the SALARM bit will assert for one second. If there is no I/O board installed in the SEL-2020, the alarm contact will close for one second.

Passwords are any length up to six numbers, letters, or other printable characters except delimiters (space, comma, semicolon, colon, and slash). Upper and lower case letters are treated as different characters. Examples of valid, distinct passwords include:

OTTER otter Ot3456 +TAIL+ !@#$%^ 123456 12345. 12345

Note: Do not select characters that have been selected for LMD prefixes. See Appendix C for an explanation of LMD prefixes.

If the passwords are lost or you wish to operate the SEL-2020 without password protection, install the Password Jumper (JMP9 B) on the main board (see ***Section 3: Planning*** for jumper location). With no password protection, you may gain access without knowing the passwords and view or change active passwords and settings.

PORT n (Access Level 1)

The PORT command connects the master port issuing the command to the designated port, permitting transparent communication between the two ports. To terminate transparent communications and return to SEL-2020 command operation, use the disconnect sequence set for your port. You cannot connect to a port that is already communicating transparently.

The following example illustrates using the PORT command to enter and exit transparent communications:

```
*>>PORT 9<ENTER>

Transparent Communications to Port 9 established
<CTRL-D>
Transparent Communications to Port 9 terminated

*>>
```

This example uses the default termination character <CTRL-D> to exit transparent communications. You can set the termination string on the master port using the TERSTRING setting within the SET P command.

When connecting to a printer port, you may add an E parameter to enable echoing from the SEL-2020 (e.g., PORT 5 E). Using this parameter, you can see what you are sending to the printer, but you will not see any messages sent to you by the printer.

To select the Direct Transparent mode, add the D parameter to the Port command (Port n D, where n selects the port number). The Direct Transparent mode passes characters through rapidly, without significant buffering delays.

See ***Section 6: Settings*** for a more complete discussion of transparent communications.

QUIT (Access Level 0)

The QUIT command causes the SEL-2020 to return control to Access Level 0 from Level 1 or Level 2. The command displays the SEL-2020 ID, date, and time of QUIT command execution.

Use this command when you finish communicating with the SEL-2020 to prevent unauthorized access. Control returns to Access Level 0 automatically after a settable interval with no activity (see TIMEOUT setting in the SET P subsection of ***Section 6: Settings***). If the port you are communicating with is using Limited-Multidrop Protocol, the connection is dropped when you issue the QUIT command. If you are connected to the port through a dial-up modem, the SEL-2020 will hang up the modem when it receives a QUIT command.

SET Commands (Access Level 2)

Use the seven SET command variations to configure the SEL-2020. These seven SET command variations are listed in Table 5.2 with their parameters, formats, and uses. Table 5.3 lists the editing keys used with all SET commands. SET M has some additional editing features which are described in ***Section 6: Settings***.

The SET command always requires a class parameter (G, C, P, A, M, L, or U). If the setting is port specific, the class will be P, A, M, L, or U, and you must supply the port (1 through 16 or F). You may also specify the setting to start with. You can give these parameters in any order.

Table 5.2: Variations on the SET Command

Command	Sets	Format	Application
SET G	Enter SEL-2020 ID. Define intermediate SELOGIC Control Equations. Define contact output functions.	SET G SET G ID	Set global settings Set global settings starting at ID
SET C	Oscillator frequency.	SET C	Set calibration setting
SET P n	Enter port ID. Set all port configuration and communication parameters.	SET P SET P 1 SET P 2 PARITY	Set current port Set Port 1 Set Port 2 starting at entry PARITY
SET A n	Define automatic message and trigger sequences. Determine response handling for messages.	SET A SET A 4 SET A 3 ISSUE1A	Set current port Set Port 4 Set Port 3 starting with ISSUE1A
SET U n	Create user-defined commands.	SET U SET U 4 SET U 12 READ	Set current port Set Port 4 Set Port 12 starting with READ setting
SET M n	Define data scaling and movement equations.	SET M SET M 7	Set current port Set Port 7
SET L n	Defines logic equations.	SEL L SEL L 6 SET L 6 SBR3	Set current port Set Port 6 Set Port 6 starting with the SBR3 setting

Note 1: The SET A, SET M, and SET L commands are not available on the front-panel port (Port F).

Note 2: The SET U command is not available on the front-panel port (Port F), or when the port device type is set to Printer. (You select the port device type using SET P).

Note 3: If you use SET P to change settings on a modem port and there is an active connection, the connection will be hung up when you accept the settings.

Table 5.3: Editing Keys for SET Commands

Press Key(s)	Results
∧ <ENTER>	Moves to the previous entry prompt.
< <ENTER>	Moves to the first entry prompt in the previous settings category.
> <ENTER>	Moves to the first entry prompt in the next settings category.
<ENTER>	Accepts setting, then moves to next entry prompt.
END<ENTER>	Exits editing session and displays all settings. Prompts: "Accept settings (Y/N)?". Type **Y<ENTER>** to save changes and exit, **N<ENTER>** to exit without saving.
<CTRL-X>	Aborts editing session without saving changes.
OFF<ENTER>	Flags a setting as not applicable.

Section 6: Settings explains all of the settings, including their applicability to various connected device types. Refer to that section for complete reference information.

The SEL-2020 checks each entry to ensure that it is a valid choice. If it is not, the SEL-2020 generates an "Out of Range" message, and prompts for the setting.

When you finish a setting, it is not necessary to scroll through the remaining settings. Type **END<ENTER>** after your last change to display the new settings and acceptance prompt.

After you enter all data, the SEL-2020 displays the new settings and asks to enable them. Type **Y<ENTER>** to approve the new settings or **N<ENTER>** to abort setting changes. If you type **Y<ENTER>** and have a setting violation, an error message is displayed, and the settings prompt moves to the first setting that affects the failure. If settings are acceptable, the SEL-2020 saves them. While the active settings are updated, the SEL-2020 port being modified is disabled and the SALARM bit asserts for one second. If there is no I/O board in the SEL-2020, the alarm contact will close for one second.

When the settings change on a port, that port is reset. If you change the settings on the current port, the settings become effective after being accepted. If you change the baud rate, you also must change the baud rate on your terminal to match in order to resume communicating with the SEL-2020. You may not change the settings on a port that is currently communicating transparently with another port.

Use the COPY or SWAP commands to move settings between ports.

SHOWSET t (Access Level 1)

You use the SHOWSET command to display settings. SHOWSET works with all settings classes: P, A, M, U, L, G, and C. The P, A, U, M, and L classes require a port number parameter (1 through 16 or F). For example, enter the command **SHOWSET P F** to examine the front-panel port settings, and enter the command **SHOWSET G** to examine the global settings. You can display P, A, M, U, and L settings for a port by giving the port number as the only parameter to SHOWSET. (For example, use SHOWSET 5 to view all Port 5 settings.) Enter parameters following the SHOWSET command in any order.

You cannot enter or modify settings with this command. Change settings with the SET command.

STATUS (Access Level 1)

Use the STATUS command to inspect self-test status, the configuration of this unit, and the status of each port. The SEL-2020 automatically sends the STATUS command response message to Port F whenever the self-test software enters a warning or failure state. Add a repeat count parameter to cause the STATUS command to repeat a given number of times. For example, type **STATUS 4** to view the status information four times.

The STATUS report format appears as follows:

```
*>>STATUS<ENTER>

COMMUNICATIONS PROCESSOR - S/N 95012004     Date: 03/07/95    Time: 10:12:06
FID=SEL-2020-R100-V0-D950324

SELF-TESTS

RAM       ROM       EEPROM    FLASH     P.S.      SET       BATTERY
512 kb    OK        OK        2048 kb   OK        OK        OK

IRIG-B Input: Present
I/O Board: Installed
Modem: Installed

Port   Status   Success Rate   SET M       Database Delays
1      Active       100%       Running     D2 D4 D5 D6 D7
2      Active        80%       None        D2 D3 D4 D5 D6 D7
3      Trans F      100%       None
4      Active       100%       Disabled    D2 D3 D4 D5
5      Active       100%       None
6      Active        66%       None
7      Active       100%       None        D2 D3 D4 D5
8      Active                  None
9      Active                  None
10     Inactive                None
11     Active                  None
12     Active                  None
13     Inactive                None
14     Inactive                None
15     Inactive                None
16     Active        66%       None
F      Trans 3                 None


*>>
```

Table 5.4 describes the STATUS report self-test and configuration fields.

The configuration information (RAM size, nonvolatile Flash memory size, IRIG-B input, I/O board presence, and modem presence) reported in the status message is determined at system power-up. A configuration item not reported as expected may indicate a problem in accessing that item. If a failure occurs, the SEL-2020 will attempt to continue operating, but invalid data may be reported.

Table 5.4: Status Report Description

Parameter	Status Displayed	Explanation
RAM	xxxx kb Uxx	Installed RAM size; self-test OK. Self-test failure in specified RAM device.
ROM	OK Uxx	ROM self-test successful. Self-test failure in specified device.
EEPROM	OK FAIL	EEPROM self-test successful. Self-test failure.
FLASH	xxxx kb Absent FAIL	Installed nonvolatile Flash memory size; self-test successful. No nonvolatile Flash memory installed. Self-test failure.
PS	OK FAIL	Power supply voltages are acceptable. A power supply voltage is out-of-tolerance.
SET	OK FAIL	Settings are OK. Settings are not valid.
BATTERY	OK FAIL	Battery-backed clock battery was OK on last power-up. Bad date or time reported by battery-backed clock on last power-up. This is probably due to a low battery.
IRIG-B Input	Absent Present	No IRIG-B input signal is detected. IRIG-B input signal is present.
I/O Board	Absent Installed	No I/O board is installed. I/O board is installed.
Modem	Absent Installed	No internal modem is installed. An internal modem is installed.

The SEL-2020 settings become invalid when the SEL-2020 copies ROM default settings into EEPROM. This problem occurs when new ROMs are installed in the SEL-2020. You use the SET C command to change the settings to VALID. For any unexpected self-test failure, you should contact the factory immediately to get the unit repaired.

Port Status Information

Status. The Port Status Column of the report indicates, for each port, whether the port is Unused, Active (in a normal active state), Inactive (not responding), pInactive (in an inactive state with a power-up auto-configuration pending), ConfigFail (in a power-up auto-configuration failure state), Trans n (communicating transparently with some other port, e.g., Trans 7), or Broadcast (communicating to all IED ports simultaneously).

Success Rate. The Success Rate column indicates the percentage of error-free messages received; errors could be due to checksum failure or unexpected data items. The Success Rate is reset when you issue a STATUS command, or you issue a SET P command for a port.

SET M. The SET M column indicates the state of SET M settings. ‘None’ indicates that there are not SET M settings on the port or that the SEL-2020 is still doing power-up initialization and the settings have not yet compiled. 'Running' indicates that SET M settings exist and are running on the designated port. 'Disabled' indicates that SET M settings exist but are not running on the designated port; this is typically due to insufficient RAM. See ***Section 6: Settings*** for a complete discussion of SET M settings.

Database Delays. The Database Delays column indicates in which database regions (e.g., D1 A1) data have not been collected at the desired rate since the last STATUS command was issued. Any entry in this column indicates a request for data with a previous request pending. These delays will occur: a) in transparent mode because the SEL-2020 cannot perform its data collection operation, b) if the data collection rate is set too high for the IED response time, or c) if the SEL-2020 is so busy that it cannot process data requests at the set rates.

STORE m:n d (Access Level 2)

Use the STORE command to store data directly into a database. Parameter m specifies the port number (1 through 16); parameter n specifies the starting database address; and parameter d is a data stream with each item consisting of data as characters, decimal integers, hexadecimal integers, or single-precision floating-point numbers. You identify the data as character data by placing the character(s) in single quotes (i.e., "F"), null-terminated string data by placing the character(s) in double quotes (i.e., "G"). Decimal integer data are the default. Hexadecimal integer data are indicated when the last character is an "h." Floating-point data are indicated by the presence of a decimal point (.) within the number.

Use the STORE command to force data into the database for test purposes. The database address being accessed must be a valid database address for writing. You cannot write to read-only addresses in the Global and Local Data Regions. You can write to any allocated User Data Region. You set up the User Data Region for each port as a portion of the auto-message settings (SET A). Use the VIEW command to confirm that data are stored as you expected.

The following example illustrates how you use the STORE command to store various types of data and how you use the VIEW command to see the stored response:

```
*>>STORE 3:F800h 'F' 123 123h 123.<ENTER>

*>>VIEW 3:F800h NR 5<ENTER>

3:F800h

0046h 007Bh 0123h 42F6h 0000h

*>>
```

SWAP n m (Access Level 2)

The SWAP command switches all port-specific settings (P, A, M, U, and L settings) between two ports. The SEL-2020 requests confirmation, as for the COPY command. This command can only be performed if neither of the two ports is currently communicating transparently. Before performing the SWAP, the SEL-2020 requests confirmation. If you answer yes, the alarm contact is pulsed and the involved ports are reset. Neither of the selected ports may be the current port or Port F.

```
*>>SWAP 4 6<ENTER>

Swap Port 6 settings with Port 4 settings (Y/N) ? Y<ENTER>

Port 6 Settings Changed
Port 4 Settings Changed

*>>
```

When you use the SWAP command, the SEL-2020 makes changes to port numbers used in strings and in SELOGIC Control Equations within the settings on all ports, based on the following rules: for the command format "SWAP n m", any reference to port n will change to m, and any reference to port m will change to n; any reference to a port other than n or m will remain unchanged. You should always use SHOWSET after a swap to make sure all settings and port references are as desired.

TARGET n m (Access Level 1)

The TARGET command displays global or port-specific element information. You enter G for parameter n to display global elements or 1 through 16 for port-specific elements (Port F has no elements). Port-specific elements include elements from the LOCAL region and from the TARGET region (if it exists as a data region). For parameter m, enter the element row number you want displayed or enter ALL to show all of the elements. You may add a repeat count as a third parameter to repeat the displayed response the specified number of times. You can always abort the display using the <CAN> character (<CTRL-X>).

Because many of the SEL-2020 elements will assert (logical 1) for only a few milliseconds, the SEL-2020 elements displayed by the TARGET command are the logical OR of each element's status during the last one second period. If an element is asserted at any point within the last second, the element status is displayed as asserted. When displaying repeatedly, each update will be one second apart, so each will show the element status since the previous row's display. The TARGET display of the SEL IED elements will simply show the result of the most recent sample from the device. See ***Section 7: SELOGIC Control Equations:*** for a description of all local and global elements.

TIME (Access Level 1)

The TIME command displays and sets the internal clock. To set the clock, type **TIME** and the desired setting, then press **<ENTER>**. To set the clock to 23:30:00, enter:

```
*>TIME 23:30:00<ENTER>

23:30:00
*>
```

A quartz crystal oscillator provides the time base for the internal clock. You can also set the time clock automatically through the SEL-2020 time-code input using a source of modulated or demodulated IRIG-B time code. The SEL-2020 contains a battery-backed real-time clock, so the time and date will be maintained through a loss of power.

TOGGLE m (Access Level 2)

The TOGGLE command toggles the specified element (parameter m) for test purposes. You may specify global elements simply by giving their name. Local elements must have the port number preceding the element label (i.e., 4:D2). If that element can trigger an operation, then that operation will occur. Use this command to test your data collection and data access functions without having to force some external condition.

Normally, the toggled element will automatically toggle back as a result of subsequent SELOGIC Control Equation calculations. However, if the specified bit has an unused SELOGIC Control Equation, it will remain in the new state until you use the TOGGLE command to return it to the original state. The TOGGLE command is intended for test purposes only; you should use the CONTROL command if you want operational control of some bits.

VIEW (Access Level 1)

Use the VIEW command to look at data stored in a port's database. The data are displayed as formatted data if accessed by data region, as hexadecimal words if accessed by address, or as binary value if accessed by bit. Supply the following parameters after the VIEW command in the order listed:

data reference — Use any valid data region (port number, region label, or data type label), register address, or bit access method to specify the data to be viewed. Examples:

VIEW 1:D1	(port #:region label)
VIEW 1:METER	(port #:data type label)
VIEW 1:0807h	(port #:register address)
VIEW 1:0807h:4	(port #:register address:bit number)

C — Add the clear flag after a BUF or archive region reference to clear that region as you view it.
Example: VIEW 1:BUF C

⚠ CAUTION Frequent archive record clearing may exceed EEPROM capabilities. See the discussion in the Archive Data Region subsection of ***Section 9: Database***.

BL — Add the bit label flag after a region reference to see any elements in that region displayed as bits with their labels. Such elements exist in the GLOBAL, LOCAL, and TARGET (if not in archive) regions.
Example: VIEW 1:GLOBAL BL

/n — Add a number "n" after an archive region reference to see that record number within the archive record queue. Number 1 is the oldest record, higher numbers reference newer records.
Example: VIEW 1:A3/4

Note: You cannot use the clear parameter C with /n, i.e., you can only clear the oldest record.

NR n — Add an NR followed by a count parameter "n" after a register reference to see "n" registers of data.
Example: VIEW 1:0807h NR 4

WHO (Access Level 1)

You can use the WHO command to obtain a list of devices connected to the SEL-2020. The SEL-2020 responds with a table showing device type, protocol, baud rate, data bits, stop bits, parity, and a device identification string for the device on each port. The screen below shows a sample response.

```
*>WHO<ENTER>

                                          Date: 03/07/95    Time: 11:06:56
FID=SEL-2020-R100-V0-D950324

Port #    Device      Protocol  Parameters   Identification
1         SEL-151     SEL       9600,8,2,N   Example 21.6 kV Line
2         SEL-151     SEL       9600,8,2,N   Example 21.6 kV Line
3         SEL-151     SEL       9600,8,2,N   Example 21.6 kV Line
4         SEL-151     SEL       9600,8,2,N   Example 21.6 kV Line
5         SEL-151     SEL       9600,8,2,N   Example 21.6 kV Line
6         SEL-151     SEL       9600,8,2,N   Example 21.6 kV Line
7         SEL-151     SEL       9600,8,2,N   Example 21.6 kV Line
8         Master      SEL       38400,8,2,N  MODEM
9         Printer     Ascii     9600,8,2,N   Line Printer
10        SEL IED     SEL       9600,8,2,N
11        Master      SEL       9600,8,2,N   RTU
12        Other IED   Ascii     300,8,1,N    DGH1000
13        SEL IED     SEL       9600,8,2,N
14        SEL IED     SEL       9600,8,2,N
15        SEL IED     SEL       9600,8,2,N
16        Master      DNP       9600,8,2,N
F*        Master      SEL       2500,8,2,N

*>
```

Note the "*" just to the right of the F in the Port # column on the above screen. This "*" indicates the port you are connected to.

SEL-2020 COMMAND SUMMARY

Access Level 0

ACCESS	Use this command to enter Access Level 1. Access Level 1 provides you with interrogate, read-only capability. You will be prompted for the Level 1 Password if the SEL-2020 password disable jumper is removed.
HELP	Lists all commands available at the current access level. Use with a command as its parameter and it will provide the syntax and a brief description of the command.
ID	Displays SEL-2020 current ID, as set in the global settings, and the firmware identification string (FID string). (See also WHO and STATUS commands.)
QUIT	Causes the SEL-2020 to return control to Access Level 0 from Level 1 or 2. The command displays the SEL-2020 ID, date, and time of QUIT command execution.

Access Level 1

2ACCESS	Use to enter Access Level 2. Access Level 2 provides you with the ability to change SEL-2020 settings. You will be prompted for the Level 2 Password if the SEL-2020 password disable jumper is removed.
AUTO n	Displays the results of auto-configuration on selected port.
BROADCAST	Establish direct communications with all IED ports simultaneously. To terminate communications and return to command operation, use the termination sequence set for your port. (<CTRL-D> is the default termination sequence.)
CLEAR m:n	Clears data from the unsolicited message queue or from the archive data regions of an intelligent electronic device (IED) port. Parameter m specifies which port (1-16). Parameter n may be BUF for the unsolicited message queue or A1, A2, or A3 for the archive data regions. CLEAR m:BUF clears all messages stored in the Port m buffer. Clearing an archive entry removes the oldest item from that queue; subsequent entries remain. To completely clear an archive queue, add the parameter A (CLEAR 4:A2 A).
DATE	Displays the date stored by the internal calendar/clock. Use a date parameter to change the date: DATE mm/dd/yy.
DNPMAP	Displays map of data available on DNP port.
IRIG	Directs the SEL-2020 to read IRIG-B time-code input at the IRIG-B port. It updates the internal clock/calendar time and date to the time code.
MAP m:n	Displays the data structure and format for data stored in a port database. Parameter m = port number (1-16). Parameter n = data region (GLOBAL, LOCAL, BUF, D1-D8, or A1-A3). Gives port data structure and format if only port number is given. With both parameters, shows data region structure and data address format.
MEM	Displays the status of memory usage.
PORT n	Establishes transparent communication between the master port issuing the command and the designated printer or IED port. To terminate communications and return to command operation, use the termination sequence set for your port. (<CTRL-D> is the default termination sequence.)
SHOWSET n	Displays settings for the specified class or port number. Settings cannot be entered or modified with this command. Change settings with the SET command in Access Level 2.
STATUS	Shows SEL-2020 self-test status and the configuration, communication, and data performance of each port. Type STATUS 4 to view the status information four times.
TARGET n m	Displays global element or port-specific element information. Enter G for parameter n to display global elements or enter 1-16 to display port-specific elements (the front-panel port has no elements). For parameter m, enter the element row number you want displayed or enter ALL to show all of the elements. You may add a repeat count as the third parameter.

TIME	Displays and sets time for the internal clock. To set the clock, type TIME and the desired setting, then press <ENTER>. Separate the hours, minutes, and seconds with colons, semicolons, spaces, commas, or slashes.
VIEW m:n	Shows data stored in a port's database. Parameter m specifies which port (1-16). Parameter n specifies what data to view: an address range in decimal or hex; a specific region of the database; GLOBAL for global data region, LOCAL for local data region, BUF for auto-message buffer, D1-D8 for automatic data collection regions, or A1-A3 for archived data regions; or you can specify the data type directly, i.e., METER, TARGER, HISTORY, etc); or an element. If you are viewing a region, you can add BL to the command strings to request the SEL-2020 to display element bits with their bit labels.
WHO	Shows what is connected to each port. Gives a table showing, for each port, the connected device type (specific relay type if it is an SEL relay port, otherwise simply the port device type), protocol, baud rate, data bits, stop bits, parity, and a device identification.

Access Level 2

CONTROL m	Parameter m specifies the global elements, R1 through R8, you will operate. You are then prompted to enter one of three control operations: SRB sets a specified bit; CRB clears a specified bit; and PRB pulses a specified bit. You specify the bit (1-8) following the operation. To pulse, supply a time as a second parameter or a 1 second time is the default.
COPY m n	Copies port-specific settings (classes P, A, M, U, and L) from Port m to Port n (m and n equal any combination of 1-16). Type COPY m ALL<ENTER> if you wish to copy the Port m settings to all other rear-panel port.
DEFRAG	Defragments EEPROM.
PASSWORD	Shows or sets passwords. PASSWORD 1 BIKE<ENTER> changes Level 1 password to BIKE. The ALARM contact closes for approximately one second and transmits the response "Set".
SET n	Parameter n specifies the specific class: SET G enters global settings; SET C enters calibration settings; SET A enters automatic message settings; SET U enters user-defined command settings; SET P enters port settings, SET M enters data movement settings, and SET L enters logic settings. SET A, SET U, SET P, SET M, and SET L must have an additional parameter to designate the Port (1-16, F).
STORE m:n d	Stores data directly into a database. Parameter m specifies the port number (Port F is not a valid option); parameter n specifies the starting database address; and parameter d is a data stream with each item consisting of data as characters, strings, decimal integers, hexadecimal integers, or single-precision floating point numbers.
SWAP n m	Switches all port-specific settings (P, A, M, U, and L settings) between two ports. Confirmation is requested. The involved ports are reset.
TOGGLE m	Toggles a specified element bit, m. You specify global elements by their name. Port-specific elements need the port number preceding the element label (i.e., 4:D2).

Note: All commands accepted by the SEL-2020 are of the form <command><CR> or <command><CR><LF> (<command><ENTER>) where <command> consists of:

- Commands truncated to the first three characters (SHO 1 = SHOWSET 1)
- Upper and lower case characters, without distinction, except in passwords
- Arguments separated from commands by spaces, commas, semicolons, colons, or slashes

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SECTION 6: SETTINGS

INTRODUCTION

This section provides detailed information about the commands used to configure and control the SEL-2020 and explains how you should respond to the SEL-2020 settings prompts. The SEL-2020 setting sheets are included at the end of ***Section 6: Settings***.

SET COMMANDS

There are seven SET command variations used to configure and control the SEL-2020's operation. These commands correspond to the seven different classes of settings shown in Figure 6.1 and listed in Table 6.1, namely SET P, SET A, SET U, SET M, SET L, SET G, and SET C. Figure 6.1 shows how the SET commands relate to specific ports. Table 6.1 lists the SET commands: their parameters, formats, and uses. Table 6.2 lists the user-friendly editing keys used with all SET commands.

The SET command always requires a class parameter (P, A, U, M, L, G, or C). If the setting is port specific, the class is P, A, M, L, or U, and you must supply the port position (1 through 16 or F). You can give these parameters in any order, for example, SET 1 A or SET A 1. You may also specify the setting to start with, i.e., SET 1 A ISSUE1, to jump directly to that setting.

Basic, but intelligent, port switching capabilities of the SEL-2020 are established with the SET P command. You apply the SEL-2020's advanced communication, control, and database features with the SET A, SET U, SET M, SET L, and SET G commands. The settings classes used in this section, and how they apply, are outlined below.

SET Function	Port 1	Port 2	. . .	Port 16	Port F
Port Configuration	SET P 1	SET P 2	. . .	SET P 16	SET P F
Automatic Messages	SET A 1	SET A 2	. . .	SET A 16	------
User-Defined Commands	SET U 1 (not printer ports)	SET U 2 (not printer ports)	. . .	SET U 16 (not printer ports)	------
Data Movement Equations	SET M 1	SET M 2		SET M 16	------
Logic Equations	SET L 1	SET L 2		SET L 16	------
Global Settings	SET G (not port specific)				
Calibration Settings	SET C (not port specific)				

Figure 6.1: SET P, SET A, SET U, SET M, SET L, SET G, and SET C as they Apply to SEL-2020 Ports

Table 6.1: Variations on the SET Command

Command	Sets	Format	Application
SET P n	- Port ID. - All port communication parameters.	SET P SET P 1 SET P 2 PARITY	Set current port. Set Port 1. Set Port 2 starting at entry PARITY.
SET A n	- Unsolicited message control. - Automatic messages and trigger conditions. - Data parsing.	SET A SET A 4 SET A 3 ISSUE1A	Set current port. Set Port 4. Set Port 3 starting with ISSUE1A.
SET U n	- SEL-2020 command set control. - User-defined commands.	SET U SET U 4 SET U 12 READ	Set current port. Set Port 4. Set Port 12 starting with READ setting.
SET M n	- Define data scaling and movement equations	SET M SET M 7	Set current port Set Port 7
SET L n	- Logic equations	SET L SET L 6 SET L 12 CBR2	Set current port Set Port 6 Set Port 12 starting with CBR2 setting
SET G	- SEL-2020 ID. - Intermediate SELOGIC Control Equation Elements. - Contact output functions.	SET G SET G ID	Set global settings. Set global settings starting at ID.
SET C	- Clock oscillator frequency. - Settings valid.	SET C	Clock calibration, validate settings after ROM change.

Note: The SET A, SET M, and SET L commands are not available on Port F. SET A and SET M are not available if the port device type is set to Unused. The SET U command is not available on Port F or if the port device type is set to Unused or Printer. You establish the device type in the port communications settings (SET P).

Table 6.2: Editing Keys for SET Commands

Press Key(s)	Results
^ <ENTER>	Moves to previous entry in a setting category until you get to the first entry in the category and then it moves to previous category.
< <ENTER>	Moves to previous settings category.
> <ENTER>	Moves to next settings category.
<ENTER>	Accepts setting, then moves to next entry.
END<ENTER>	Exits editing session and displays all settings. Prompts: "Accept settings (Y/N)?". Type Y<ENTER> to save changes and exit, N<ENTER> to exit without saving. Lower case letters (end, y, n) are also accepted.
<CTRL-X>	Aborts editing session without saving changes.
OFF<ENTER>	Flags a setting as not applicable. Lower case letters (off) are also accepted.

The SEL-2020 checks each entry to ensure that it is a valid choice. If it is not, an "Out of Range" message is generated, and the SEL-2020 prompts for the setting.

After you enter all data, the SEL-2020 displays the new settings and asks to enable them. Answer **Y<ENTER>** to approve the new settings. If you violate a rule for setting relationships, an error message is displayed, and the settings prompt moves to the first setting that affects the failure. If settings are acceptable, the SEL-2020 saves them. While the active settings are updated, the SEL-2020 port being modified is disabled. On a settings change, the SEL-2020 pulses the SALARM bit to 1 for one second. On SEL-2020 Communications Processors without an optional I/O board, the alarm contact will also close for one second.

When the settings change on a port, that port is reset. If you change the settings on the current port, the settings become effective after being accepted. If you change the baud rate, you will have to change the baud rate on your terminal to match in order to resume communicating with the SEL-2020. You may not change the settings on a port that is currently communicating transparently with another port. Also, only one setting session is permitted at one time; you will receive a message that the SET command is not available if someone else is using one of the SET commands at the time you send a SET command.

Use the COPY or SWAP commands to copy and move settings between ports. Always use the SHOWSET command on ports you copied or swapped settings on to verify that all port references and messages are correct.

SET P - Port Configuration and Communication Settings

Use the SET P command to:

- Configure each port you connect to a new device.
- Reconfigure a port you connect to a different device.
- Reconfigure a port connected to a device that has upgraded firmware.

SET P Settings

When you issue the SET P command the SEL-2020 will prompt you for configuration and communication parameters according to Table 6.3 for ports 1 through 16 and for port F. A description of each prompt and a discussion about the appropriate responses to each prompt follows these tables.

Table 6.3: SET P Prompts

"SET P n" Port Communications Setting Prompts for ports n = 1 through 16								SET P F Prompts
DEVICE (**U**, **S**, **O**, **P**, **M**)								
U(nused)	**S**(EL IED)	**O**(ther IED)	**P**(rinter)	**M**(aster)				
	CONFIG (Y/N)	MODEM (Y/N)		PROTOCOL (**L**, **S**, **M**, **D**)				
		N(O): AUTO_BAUD / Y(ES): MSTR, CD_CTS		**L**(MD)	**S**(EL)	**M**(odbus)	**D**(NP)	
		PROTOCOL (A/B)		ADDRESS	FAST_OP	MAP_TYPE	ADDRESS	
		A(SCII) / B(inary)		PREFIX		START_ID	CLASS	
				SETTLE		SETTLE1	0 / 1-3	
						SETTLE2	16BIT	
						ADDRESS	SO_TIMEOUT	
						1-16	DL_CONFIRM	
							0 / 1-15: DL_TIMEOUT	
							MIN_DELAY	
							MAX_DELAY	
							SETTLE1	
							SETTLE2	
							REPORT_ON	
							UNSOL_REP	
							N(O) / Y(ES): UNSOL_POW, REP_ADDR, NUM_EVENT, AGE_TX	
							CONFIRM_TO	
	PORTID	PORTID	PORTID	PORTID				PORTID
					MODEM (Y/N)			MODEM (Y/N)
					N(O) / Y(ES): MSTR, CD_CTS			N(O) / Y(ES): MSTR, CD_CTS
	BAUD	BAUD	BAUD	BAUD				BAUD
	DATABIT	DATABIT	DATABIT	DATABIT				
	STOPBIT	STOPBIT	STOPBIT	STOPBIT				
	PARITY	PARITY	PARITY	PARITY				PARITY
	RTS_CTS (Y/N)	RTS_CTS (Y/N)*	RTS_CTS (Y/N)		RTS_CTS (Y/N)*			RTS_CTS (Y/N)*
		XON/XOFF (Y/N)	XON/XOFF (Y/N)	XON/XOFF (Y/N)				XON/XOFF (Y/N)
	TIMEOUT	TIMEOUT	TIMEOUT	TIMEOUT				TIMEOUT
				ECHO (Y/N)				
				AUTOHELP (Y/N)				AUTOHELP (Y/N)
				TERTIME1				TERTIME1
				TERSTRING				TERSTRING
				TERTIME2				TERTIME2
Save changes (Y/N)								
Y(ES) Port n Settings Changed				**N**(O) Settings aborted				

*If CD_CTS=Y, RTS_CTS will not be available

Table 6.4 includes detailed information about the SET P settings.

Table 6.4: SET P Port Communications Settings Information

Setting	Comment
DEVICE	**Prompt**. Device Type (Unused, SEL IED, Other IED, Printer, Master). **Description**. You select the device type attached to this port: Unused if no device is connected. SEL IED if an SEL relay is connected. Other IED if another type of SEL device or other vendor's IED is connected. Printer if a serial printer is connected. Master if an RTU, PC, PLC, NIM or ASCII dumb terminal is connected.
CONFIG	**Prompt**. Auto-configure port (Y/N). **Description**. If you say yes, the SEL-2020 determines relay type, model number, metering capability, port ID, baud rate, passwords, relay elements, and other information necessary for the SEL-2020 to automatically communicate with SEL relays. The SEL-2020 reports the results of the auto-configuration once it successfully completes.
Note:	If auto-configuration fails, it may indicate that the connected device is not recognized, that there is a communication problem between the devices, or that the connected device was slow to respond. Check for any obvious problems with the connection, then re-attempt auto-configuration. If auto-configuration still fails, attempt to gain transparent communications with the device using PORT n. If this does not succeed, there is a communication problem. If you can connect transparently, but auto-configuration still fails, there is a probably an incompatibility between the connected device and the SEL-2020. If this happens, contact the factory for further assistance.
AUTO_BAUD	**Prompt:** Attempt to detect port baud rate (Y/N). **Description:** The SEL-2020 depends on the IED returning a <CR> or <LF> character in response to a <CR><LF> for baud rate determination to work.
PROTOCOL	**Prompt**. Communications Type (SEL/LMD/Modbus/DNP for Master, or ASCII/BINARY for Other IED). **Description**. This setting identifies special port communication parameters. For Other IEDs you may choose between ASCII and BINARY; selecting ASCII allows the normal ASCII and binary communication; selecting BINARY automatically disables XON/XOFF handshaking. If Port 16 DEVICE is set to master, the choices are SEL, LMD, Modbus, and DNP. If Port 12 or 14 DEVICE is master, then the choices are SEL, LMD, and Modbus. For any other port with DEVICE set to master, the choices are SEL and LMD. Selecting SEL allows the normal ASCII and binary communications, selecting LMD adds the SEL LMD Protocol, selecting Modbus disables normal communications and enables Modbus communications on the selected port, and selecting DNP disables normal communications and enables DNP communications on the selected port. If you choose LMD, you must select an address and prefix character and set the settle time. (See ***Appendix C: LMD Protocol*** for an explanation of LMD protocol.) If you choose Modbus, you must select the address for each port with Modbus data. (See ***Appendix G: Modbus Protocol*** for reference information on Modbus.) If you choose DNP, there are a number of additional settings to configure the DNP operation. (See ***Appendix I: DNP V3.00*** for reference information on DNP.)

Table 6.4: SET P Port Communications Settings Information (continued)

Setting	Comment
ADDRESS	**Prompt**. First LMD Port Address (1 through 81). **Description**. You supply a port address only if you selected LMD as the PROTOCOL. The LMD address is the first of seventeen used by the SEL-2020; the defined address is for SEL-2020 communications and the next 16 are for transparent communications to the respective ports. (See ***Appendix C: LMD Protocol*** for an explanation of LMD protocol.)
PREFIX	**Prompt**. LMD Address Prefix Character (@#$%&). **Description**. You supply LMD prefix character only if LMD was selected as the PROTOCOL. The prefix setting is the character the SEL-2020 watches for when using LMD protocol. (See ***Appendix C: LMD Protocol*** for an explanation of LMD protocol.)
SETTLE	**Prompt**. LMD Port Settle Time (0-30 seconds). **Description**. You supply a LMD port settle time only if LMD was selected as the PROTOCOL. (See ***Appendix C: LMD Protocol*** for an explanation of LMD protocol.)
MAP_TYPE	**Prompt.** Modbus Map Type (F=Float, I=Integer). **Description.** Selection for Modbus map style. See ***Appendix G: Modbus Protocol*** for an explanation of the two map styles.
START_ID	**Prompt.** Starting Code for ID List (0-255). **Description.** Used to offset Modbus device ID list. (See ***Appendix G: Modbus Protocol*** for reference information on Modbus.
SETTLE1	**Prompt.** Transmission delay from RTS assertion (0-30000 ms). **Description.** Delay between RTS assertion and start of transmission. (See ***Appendix G: Modbus Protocol*** for reference information on Modbus. See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
SETTLE2	**Prompt.** Posttransmit RTS deassertion delay (0-30000 ms). **Description.** Delay between end of transmission and RTS deassertion. (See ***Appendix G: Modbus Protocol*** for reference information on Modbus. See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
ADDRESS1	**Prompt.** Address of Port 1 (1-247). **Description**. Modbus device address 1-247, or OFF if no Modbus access desired. Similarly for ADDRESS2-16. (See ***Appendix G: Modbus Protocol*** for reference information on Modbus.)
ADDRESS	**Prompt**. DNP Address (0-65534 or 0000h-FFFEh). **Description**. Address of the SEL-2020. It must be unique from all other DNP addresses on the connection. (See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
CLASS	**Prompt**. Class for event data (0 for no event data, 1, 2, 3). **Description**. Enter the DNP class, 1-3, to reference SEL-2020 event data under. Enter 0 if you do not want any event data. (See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
16BIT	**Prompt**. Use 16 or 32-bit default variations for analog inputs (16/32). **Description**. DNP analog input objects can use default variations 16 or 32-bits in size. Set this to 16 or 32-bit, based on which default you prefer. Generally 32-bit is preferable, because you get a better range, but if your master does not support 32-bit analog inputs, you must use 16-bit. (See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)

Table 6.4: SET P Port Communications Settings Information (continued)

Setting	Comment
SO_TIMEOUT	**Prompt**. Select/Operate time-out interval, seconds (0.0-30). **Description**. Enter the maximum allowable time between DNP function codes for Select and Operate. If an Operate command follows the Select command by more than this time-out, the operation will not occur. Set based on worst-case timing of your master. (See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
DL_CONFIRM	**Prompt**. Number of data-link retries (0 for no confirmation, 1-15). **Description**. Set to 0 to disable DNP data-link confirmation. Otherwise, set to the number of retries you want the DNP data-link to use. (See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
DL_TIMEOUT	**Prompt**. Data Link Time-out (0-5000 milliseconds). **Description**. Set to the worst-case DNP data-link acknowledge time of your master. When using DNP data-link confirmation, this is the time the SEL-2020 will wait before assuming there is no confirmation and resending the message. (See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
MIN_DELAY	**Prompt**. Minimum Delay from DCD to transmission (0-1000 msec). **Description**. This is the minimum delay the SEL-2020 will wait from DCD going away or from the last character being received before initiating data transmission. (***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
MAX_DELAY	**Prompt**. Maximum Delay from DCD to transmission (0-1000 msec). **Description**. This is the maximum delay the SEL-2020 will wait from DCD going away or from the last character being received before initiating data transmission, if there is a transmission pending. Set this to something bigger than MIN_DELAY to cause some randomness in the time at which it attempts to transmit again. In a system with unsolicited messaging, this will help reduce the likelihood of repeated collisions. (***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
REPORT_ON	**Prompt**. Percent of Full-Scale Change to Report on (0-100%). **Description**. This setting determines at what point counter and analog input events are declared. Set this to the percent of the full-scale that you want events reported on. (See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
UNSOL_REP	**Prompt**. Allow Unsolicited Reporting (Y/N). **Description**. Set to Yes to enable unsolicted DNP event reporting or No to disable such reporting. (***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
UNSOL_POW	**Prompt**. Enable unsolicited messages on power-up (Y/N). **Description**. Set based on whether or not you want DNP unsolicited reporting enabled on power-up. If your master supports the unsolicted message enable function code, set this to No and let your master enable it to reduce bus contention on power-up. Otherwise, set it to Yes. (See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)

Table 6.4: SET P Port Communications Settings Information (continued)

Setting	Comment
REP_ADDR	**Prompt**. Address of master to Report to (0-65534 or 0000h-FFFEh). **Description**. Set this to the address of the master on your DNP network. This is the address the SEL-2020 will send unsolicited responses to. (See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
NUM_EVENT	**Prompt**. Number of events to transmit on (1-200). **Description**. Set this to the number of events you want to have accumulate before the SEL-2020 sends the data in a DNP unsolicited response. (See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
AGE_TX	**Prompt**. Age of oldest event to force transmit on (1.0-60.0 sec). **Description**. Set this to the maximum age you want your event data to get to before sending it in a DNP unsolicited response, even if the minimum number of events have not yet accumulated. (See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
CONFIRM_TO	**Prompt**. Time-out for Acknowledge of Event Data (50-50000 msec). **Description**. Set this to the maximum time it should take your master to issue a DNP application layer confirm to an unsolicited or event data response. When sending DNP unsolicited responses or event data, this is the delay the SEL-2020 will wait before considering the data transmission unsuccessful. (See ***Appendix I: Distributed Network Protocol (DNP) V3.00*** for an explanation of the DNP protocol.)
FAST_OP	**Prompt:** Enable Fast Operate commands on this port (Y/N). **Description:** Use this setting to enable (Y) or disable (N) fast operate support on this master port. Fast operate commands can be used to rapidly change the various set and clear logic bits. See ***Appendix H: SEL-2020 Configuration and Fast Operate Commands*** for more information.
PORTID	**Prompt**. Port Identification String. **Description**. Provides a convenient means to label or identify the connected device. Auto-configuration automatically sets the Port ID to the relay ID on SEL IED ports. Used by the WHO command to identify the port. Maximum 40 characters.
MODEM	**Prompt**. Modem Control (Y/N). **Description**. You set to Y (Yes) if using an external dial-up modem. MODEM setting is forced to Y (Yes) if a built-in modem is installed on that port. This setting is only available for master and other IED ports.
MSTR	**Prompt**. Modem Startup String. **Description**. If you use a modem, you must enter a modem startup string to initialize the modem. The default string sets the modem to answer on four rings. You may set this number to match the needs of your modem and application, but, to match SEL-2020 expectations, there are a few modem settings that should not be modified: • The escape character must be "+" • The modem must be in verbal mode • The echo must be disabled • The X0 code set should be selected • The escape code guard time should be one second (See ***Appendix B: Optional Internal Modem Information*** for details on internal modem. See your modem instruction manual for details on your modem.)

Table 6.4: SET P Port Communications Settings Information (continued)

Setting	Comment
CD_CTS	**Prompt.** Modem Carrier Detect connected to CTS input (Y/N). **Description.** If you are using an external modem which has its Carrier Detect (CD) output connected to the SEL-2020 CTS input (such as with SEL-C222 cable), set this to Y. Otherwise, set it to N.
BAUD	**Prompt**. Baud Rate (300, 600, 1200, 2400, 4800, 9600, 19200, 38400). **Description**. You enter the baud rate this port will communicate at. Port F limits are 300 to 9600 baud. Only ports designated masters may use 38400 baud. Automatically set if auto-configured.
DATABIT	**Prompt**. Number data bits (7,8). **Description**. You enter the number of data bits this port requires for communication. Port F is fixed at 8 data bits with no parity or 7 bits with parity. Figure 6.2 illustrates how this setting influences the EIA-232 character format.
STOPBIT	**Prompt**. Stop bits (1, 2). **Description**. You enter the stop bits this port requires for communication. Port F is fixed at 1 stop bit. Figure 6.2 illustrates how this setting influences the EIA-232 character format
PARITY	**Prompt**. Parity (N, O, E, 1, 0). **Description**. You enter the parity this port will use in communicating. Port F limited to parity options N (No), O (Odd), and E (Even). Figure 6.2 illustrates how this setting influences the EIA-232 character format
RTS_CTS	**Prompt**. Enable RTS/CTS handshaking (Y/N). **Description**. You set to Y (Yes) to enable RTS/CTS handshaking. If LMD Protocol or Modbus is used, RTS/CTS control is not available. Instead, RTS is driven to control any external transceiver. (For a definition of RTS/CTS, see Data Flow Control subsection following this table.) With Modem set to Y (Yes) and CD_CTS set to Y (Yes), RTS_CTS control is not available.
XON_XOFF	**Prompt**. Enable XON/XOFF flow control (Y/N). **Description**. You set to Y (Yes) to enable XON/XOFF flow control. If PROTOCOL is set to binary, XON/XOFF flow control is forced to N (No). (For a definition of XON/XOFF, see Data Flow Control subsection following this table.)
TIMEOUT	**Prompt**. Port Timeout in minutes (0-30). **Description**. The time-out setting is used for two different functions. After a set amount of idle time expires with the port in transparent mode, transparent mode is automatically terminated. On Master ports, if this time expires with the port idling, any in-process command is terminated and the access level is reduced to Level 0. Time-out action will also disconnect LMD communications and hang up the modem if it is connected. A value of 0 disables time-out. **WARNING:** Use a non-zero timeout value for modem ports. If the modem connection is unintentionally interrupted, you can call and successfully reconnect TIMEOUT minutes later.
ECHO	**Prompt**. Echo received characters (Y/N). **Description**. Master Port only - The echo option allows you to decide whether or not you wish the SEL-2020 to provide character echo to a master device (only printable characters are echoed). ECHO is always Y (Yes) for Port F.

Table 6.4: SET P Port Communications Settings Information (continued)

Setting	Comment
AUTO_HELP	**Prompt.** Automatic help messages enabled (Y/N). **Description:** Default setting is AUTO_HELP=Y. You can disable Auto-Help on a port by setting AUTO_HELP=N. Auto-Help provides correct commands and command syntax messages when you enter an incorrect command or command syntax. If you disable Auto-Help on a Master port, you can request help with the HELP command.
TERTIME1	**Prompt**. First delay time (0 to 600 seconds). **Description**. You enter a time that a port must be idle before checking for the termination string. For a description of transparent communications, see the Transparent Communications subsection following this table.
TERSTRING	**Prompt**. Termination string. **Description**. You enter a string that will terminate transparent communications. The default is \004, the code for <Ctrl-D>. For a description of transparent communications, see the Transparent Communications subsection following this table.
TERTIME2	**Prompt**. Second delay time (0 to 600 seconds). **Description**. You enter a time the port must be idle, after receiving the termination string, before terminating transparent communications. For a description of transparent communications, see the Transparent Communications subsection following this table.

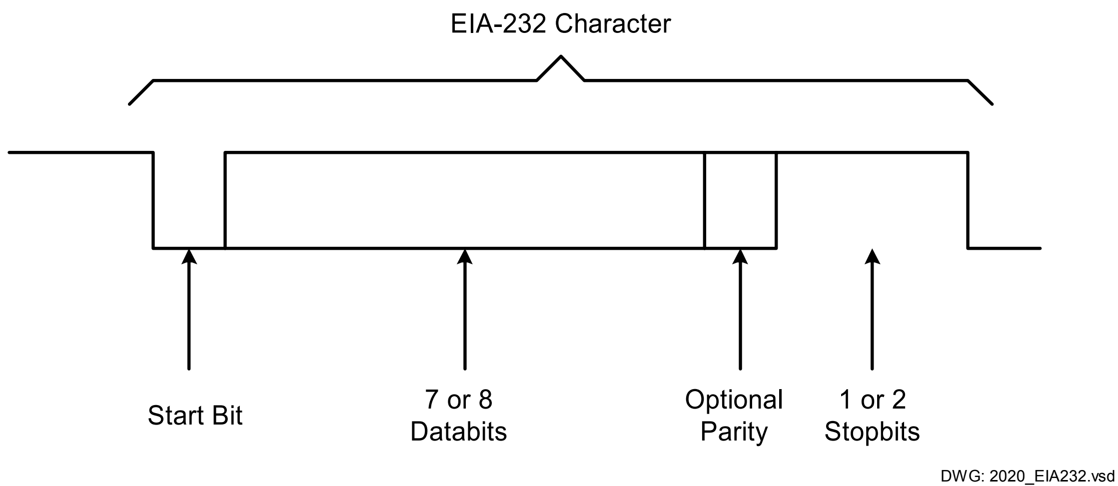

Figure 6.2: EIA-232 Character Format

Transparent Communications

Transparent communications allow a master device to communicate directly with an IED or printer through the SEL-2020. You enter the transparent communications mode using the PORT command from the SEL-2020 command set or using a special user-defined command string you set with the TRANS setting (see SET U subsection in this section).

Broadcast communications are similar to transparent communications, except that a master port communicates with multiple IEDs simultaneously. Broadcast communications can only be entered using the BROADCAST command.

While you are transparently communicating through the SEL-2020, *Fast Meter* binary data will continue to be collected and *Fast Operate* control operations will continue to be sent. If you attempt a *Fast Meter* or *Fast Operate* request via the transparent connection, your request and the automatic request may collide, leading to neither taking place. If you plan to use *Fast Meter* or *Fast Operate* commands while transparently connected, you should disable any automatic *Fast Meter* collection and *Fast Operate* control to avoid these collisions.

The SEL-2020 requires a three-step procedure to terminate transparent communications. This three-step procedure helps ensure that transparent mode is not accidentally terminated by normal data communications. The three-step process includes an initial channel idle time (set with TERTIME1), a termination character sequence (set with TERSTRING), and a second channel idle time (set with TERTIME2). All of these items are user-definable and can be set such that they are not used when less security is required. The SEL-2020 default termination sequence has the first time delay set to 1 second, the termination character set to <EOT> (end of transmission character, ASCII character 4, <CTRL-D> on most keyboards), and the second time delay set to 0.

Direct Transparent Mode

The SEL-2030 normally uses data buffering when transferring data through transparently connected ports. Some non-SEL IED protocols are intolerant of this data buffering since the buffering introduces random inter-character time delays into the data stream. The SEL-2030 includes a Direct Transparent mode that eliminates these inter-character delays while maintaining the buffering effectiveness. The Direct Transparent mode inter-character delay is typically less than 1 millisecond and never exceeds 2 milliseconds. The Direct Transparent mode is available on any rear-panel Master port, however is not available on the front Master port.

To select the Direct Transparent mode, add the D parameter to the Port command (Port n D, where n selects the port number). The SEL-2030 passes characters through rapidly, without significant buffering delays. Therefore no handshaking is required if the Master and Slave port baud rates match. Hardware handshaking may be required if the Master and Slave port baud rates do not match. Software handshaking (XON/XOFF) is not supported by the SEL-2030 in Direct Transparent mode, regardless of the XON_XOFF port setting. However, XON/XOFF characters pass through the transparent port connection, allowing the connected devices to use software handshaking independent of the SEL-2030.

The Direct Transparent mode (D parameter) typically should not be used when transparently connecting to SEL devices. SEL interleaved binary messages (binary 20METER, 20TARGET, etc.) are not supported during Direct Transparent mode connections.

Data Flow Control

All SEL devices, including the SEL-2020, support XON/XOFF software data flow control. The SEL-2020 also supports RTS/CTS hardware data flow control. If the device connected to an SEL-2020 port has XON/XOFF software data flow control capability, you should enable this flow control method on both the SEL-2020 and the connected device. You should use RTS/CTS hardware data flow control only if the connected device has RTS/CTS capability and does not have XON/XOFF capability. In either case, both the SEL-2020 and the connected device must have the same data flow control method enabled.

You can enable XON/XOFF data flow control on an SEL-2020 port with the SET P command by setting XON_XOFF = Y. With XON/XOFF data flow control enabled, the SEL-2020 monitors the volume of data in its received data buffer on that port and transmits an XON (hexadecimal code 11) character when that port's buffer drops below one-quarter (25%) full. The SEL-2020 transmits an XOFF (hexadecimal code 13) character when that port's buffer is over three-fourths (75%) full. A device connected to the SEL-2020 port with XON/XOFF software data flow control enabled should terminate message transmission at the end of the message in progress when an XOFF character is received from the SEL-2020 and should resume transmission when an XON character is received.

Likewise, you can use XON/XOFF to control the SEL-2020 message and data transmission. When the SEL-2020 receives an XOFF character when it is transmitting a message, the SEL-2020 pauses transmission until it receives an XON character. If the SEL-2020 is not sending a message or data when it receives XOFF, the SEL-2020 does not send any new transmission until it receives an XON character from the other device.

Set RTS_CTS = N for any SEL-2020 to SEL device connection. If RTS_CTS = N, the SEL-2020 RTS output will always be asserted, and the CTS input status will have no effect on communication.

Consult the instruction manual or contact the device vendor to determine the proper flow control technique for each non-SEL device. If you select RTS/CTS hardware data flow control, make sure that the cable you are using to connect the device to the SEL-2020 is wired for RTS/CTS.

When RTS/CTS hardware flow control is required, use SET P to set RTS_CTS = Y. Automatic communication sources with RTS/CTS hardware data flow control enabled must stop message transmission immediately when the SEL-2020 deasserts RTS so they do not overwrite the SEL-2020 buffer on that port. Likewise, if RTS_CTS = Y, the SEL-2020 does not send message or data characters until the CTS input is asserted.

Modem Operation

There are a number of issues to consider if you are using a modem. In particular, flow control and disconnect sequences need to be considered.

When a modem connection is made, it is possible for the phone line connection to be at a lower baud rate than the modem to SEL-2020 connection. This can lead to a loss of characters during large data transfers, because the SEL-2020 can overrun the modem. This can be prevented by setting the SEL-2020 to the lowest likely connection rate, typically 2400 baud. Alternatively, you can enable RTS/CTS or XON/XOFF flow control between the SEL-2020 and the modem.

To use hardware flow control, set RTS_CTS = Y on the modem port. Only use this setting if the RTS and CTS control lines are wired between the SEL-2020 and the modem. (For the internal modem, this connection is already made.) The modem should default to use hardware flow control.

Alternatively, to use software flow control, set XON_XOFF=Y on the modem port and modify the MSTR setting to enable XON/XOFF handshaking within the modem. You will need to look in your modem data sheet to determine the appropriate code for your modem.

Another thing to consider when using modems is how you will terminate the connection. If you simply hang up, the SEL-2020 will be left in whatever state you were in. This could be a state which you cannot call back into. To avoid this, you should do two things.

When a modem is on a master port, always exit transparent connections and issue the QUIT command to terminate the connection. This way, you will always leave the SEL-2020 in a known state. Secondly, set the port TIMEOUT setting to something other than 0. If you do leave the SEL-2020 in a bad state, it will go back to a basic Access Level 0 state after the TIMEOUT time, as if a QUIT command had been issued.

SET A - Automatic Message Settings

Use the SET A command to set the SEL-2020 to:

- Automatically buffer unsolicited messages the SEL-2020 receives.
- Automatically print those unsolicited messages, and clear the buffer after printing if you desire.
- Automatically issue operate messages based on operatic elements.
- Define startup strings for connected devices so the SEL-2020 can automatically communicate with those devices.
- Create messages to send to other devices and define conditions that trigger those messages (messages are commands, data, or both).
- Define data parsing methods you want used on responses received.
- Define conditions where data are archived in optional nonvolatile memory.

You can create up to 12 automatic messages per port with the standard SEL-2020 configuration. Eight of these message functions have an associated data area to store responses, and the other four are for messages only. Three additional message functions are available with the nonvolatile Flash memory option, for a total of 15 possible message functions per port.

Automatic Message Operation

The messaging process is diagrammed in Figure 6.3.

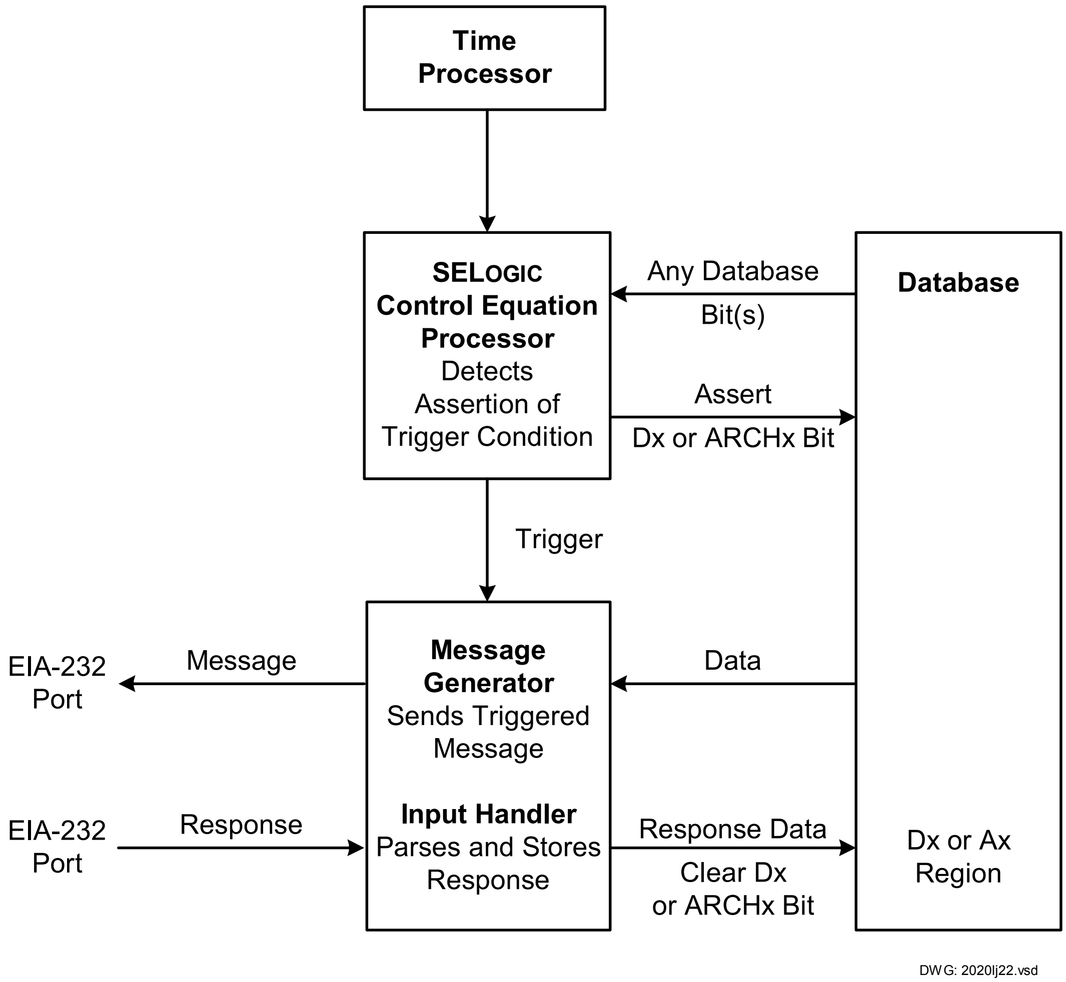

Figure 6.3: Automatic Message Operation Functional Block Diagram

The SELOGIC Control Equation Processor (Figure 6.3) detects the true or false status of the trigger condition as defined in a SELOGIC Control Equation (using the ISSUEx setting). When the condition becomes true, SELOGIC Control Equation Processor sets the Dx or ARCHx bit (depending on whether it is a data or archive region of the database involved) and causes the Message Generator to issue the message that you have defined with the auto-message setting. See ***Section 7: SELOGIC Control Equations*** for more details about triggering.

The message issued may elicit a response. With the settings, you tell the SEL-2020 what data to expect (including meter, ASCII floating point, and integer) and how to parse, validate, and store the data. The data are then stored in the appropriate region of the database and the Dx or ARCHx bit is cleared. If a response is not expected, the Dx or ARCHx bit is cleared upon issue of the triggered message. See ***Section 8: Message Strings*** for details on strings.

Data Collection Periods

You can set the SEL-2020 Communications Processor to collect data from attached devices on an exception basis, i.e., only when an event occurs, and you can set the SEL-2020 to collect data on a regular, periodic basis. Each SEL-2020 port collects data independently, based on your settings, and you can set each port to collect data in different ways using separate message trigger conditions and data request messages. Likewise, each SEL-2020 port responds to requests for data independently, based on your settings. In either case, the SEL-2020 will not issue or respond to another request for data on the same port until the previous request has been satisfied. If the data response has not been completed before the same message trigger condition occurs again, the second trigger will be missed completely. The SEL-2020 will acknowledge this missed trigger by setting a delay bit in the port register, which is reported in the SEL-2020 status report.

Although both exception and periodic data collection can encounter this type of delay, you can control the periodic collection period, and thereby minimize the possibility of collection delays and missed triggers. You should consider first, if the attached device is capable of transferring data in binary format, or only in ASCII character format, and second, the type of data you plan to request, i.e., meter, target, demand, or another type.

Table 6.5 presents some general guidelines regarding minimum data collection periods you should use to collect various types of data from SEL relays in binary or ASCII format. The guidelines in this table assume the relay is using a baud rate of 2400 or above and is not busy processing events or communicating on more than one port. As this table shows, there is a dramatic difference between the minimum collection period for a relay that has *Fast Meter* (binary data transfer) capability, and one that can transfer data only in ASCII format.

Table 6.5: SEL-2020 Minimum Data Collection Period (in Seconds)

Command	Binary Data Format (*Fast Meter*)	ASCII Data Format (no *Fast Meter*)
20METER	1	10
20DEMAND	1	10
20TARGET	1	20[1]
20STATUS	N/A	10
20BREAKER	N/A	10
20HISTORY	N/A	20[2]
20EVENT	N/A	120
20EVENTS	N/A	120
20EVENTL[3]	N/A	300

Notes: [1] SEL-321 Relay requires one minute.
[2] SEL -321 Relay requires 30 seconds. The SEL-BFR and SEL-2BFR Relays require 40 seconds.
[3] Only supported on SEL relays that support 16 sample/cycle event reports.

When connecting to SEL 100 and 200 series relays that have *Fast Meter* binary data capability, always connect to Port 2 on the relay. Binary data transfer is not supported on Port 1 of these relays.

Collection periods for non-"20" message-based collections are dependent on the device response speed and the value of the DELAY setting. As a minimum, the collection period will always contain the time required to send a request and receive the response. If DELAY is set ON, there will be an additional delay while the SEL-2020 waits for the port to be idle for 15 seconds on SEL-IED ports and 5 seconds on all other ports.

Data Parsing Options

The SEL-2020 database stores data that are parsed, or separated, into the smallest useful element or bit size. Parsing data in the SEL-2020 reduces the communication and processing burden for other devices or systems that use these data by permitting them to request and transfer only the specific data they need.

The SEL-2020 automatically parses data that are recognized from SEL relays. You request these data using the "20" message format. The type of response will depend on the SEL relay's capability. If the relay has *Fast Meter* capability, the response to the 20METER message is in a binary format. Some relays also respond to 20TARGET and 20DEMAND messages with a binary data format. Binary data are transferred faster than ASCII data and allow simultaneous ASCII dialogue, making *Fast Meter* binary data transfer the preferred choice whenever possible.

The SEL-2020 also automatically calculates additional metering parameters from the binary data. For example, ASCII meter data provide current and voltage magnitude, but the binary meter data results include magnitude and angle. Binary meter data also include calculated per-phase watts and vars, in addition to the three-phase watts and vars.

You can parse message responses that are not recognized SEL data in several ways. You can set the SEL-2020 to ignore the data by setting PARSEx = 0. Or you can set the SEL-2020 to accept the data and parse it according to one of the five techniques listed below. If DEVICE is set to SEL and the connected device echoes the request message, parsing begins after the echoed request is received.

ASCII Integer (Parse = 1)

This technique parses numbers only; every number separated by a space, comma, decimal, or any other nonnumeric character is stored as a separate item. For example, if you selected the ASCII Integer option, and set the number of responses (NUMx) to 7, the following message is parsed as shown below:

Message: "This is a 2020 message with numbers 10, -6.2, and 2,459.884"

Parsed result: "2020, 10, -6, 2, 2, 459, 884"

If you set the number of responses less than 7, the parsed result will be truncated; if you set the number of responses greater than 7, the result will include trailing 0s, i.e. "..., 884, 0, 0, 0".

ASCII Float (Parse = 2)

This technique also parses numbers only, but retains decimals as part of each number. All other nonnumeric characters are parsing characters. For example, if you selected the ASCII Float option and set the number of responses (NUMx) to 5, the following message is parsed as shown below:

Message: "This is a 2020 message with numbers 10, -6.2, and 2,459.884"

Parsed result: "2020, 10, -6.2, 2, 459.884"

If you set the number of responses less than 5, the parsed result will be truncated; if you set the number of responses greater than 4, the result will include trailing 0s, i.e. "..., 459.884, 0, 0, 0".

Character String (Parse = 3)

This technique retains all numbers and characters in a character string. For example, if you selected the Character String option and set the number of responses (NUMx) to 60, the example message is parsed as follows:

Message: "This is a 2020 message with numbers 10, -6.2, and 2,459.884"

Parsed response: "This is a 2020 message with numbers 10, -6.2, and 2,459.884"

For this parsing method, the SEL-2020 always appends a NULL character (00h) to the end of the parsed response before storing it to the database. This means that the NUMx setting must be set to a value one greater than the expected number of response items. The above string is actually 59 characters in length, yet the NUMx setting was set to 60.

If you set the number of responses less than 60, the parsed result will be truncated; if you set the number of responses greater than 60, the result will include extra trailing nulls, which are non-printing characters, so you will not see any difference when using default data viewing methods, i.e., "...d 2,459.884."

Integer String (Parse = 4)

This technique stores each pair of received bytes in a register, most-significant-byte first. The Integer String option is primarily useful for capturing data from devices that send data in binary words. Because this parsing option uses both upper and lower bytes of each register, it stores data in fewer registers (less space) than the Character String option. You can retrieve data from these registers using the special strings designed to work with a data word. See ***Section 8: Message Strings*** for more detailed information.

Integer String with XON/XOFF Encoding (Parse = 5)

This technique works just like Integer String, except each pair of received bytes is compared to a set of special codes that are used to encode the XON (11h) and XOFF (13h) characters. If one of the special codes is encountered, the appropriate 11h or 13h character is stored. The encodings used are as follows: a 99h followed by a 01h represents XON (11h), a 99h followed by a 02h represents a XOFF (13h), a 99h followed by a 03h represents a 99h. Since 99h is always encoded, any 99h that is received and is not followed by 01h, 02h, or 03h is ignored. For example, if you set the parse option to Integer String with XON/XOFF encoding and set the number of items (NUMn) to 4, the following message is parsed as shown below (all data shown as hexadecimal character codes):

Message: 019902109903249915FF9934C80B

Parsed result: 011310992415FF34

Notice that the NUMn setting applies to the number of “parsed” items, not to the number of received items. This parsing method is useful when binary data are being received while XON/XOFF flow control is enabled. When communicating with another SEL-2020, the \Rx.../ and \Ry.../ strings can be used in the downstream SEL-2020 to encode the data before sending it to the upstream 2020. See ***Section 8: Message Strings*** for more detailed information.

Parsing Delays

When any of the above “generic” parsing methods is used (Parse = 1,2,3,4,5), the SEL-2020 uses the NUMx setting to determine when to stop collecting data items. If the SEL-2020 has not received the specified number of items, it will continue to wait for them until a predetermined amount of time has passed without receipt of a new item. This time delay is 5 seconds for ports with DEVICE set to Other-IED and 15 seconds for ports with DEVICE set to SEL-IED. Once this amount of time passes, the SEL-2020 takes the data items that it has received and continues to the next step in the parsing process, either performing checksum validation or simply storing the data to the database.

If the SEL-2020 receives the number of items specified by the NUMx setting, the next task is determined by the DELAYx setting. If the DELAYx setting is set to “ON”, then the SEL-2020 will execute the same type of delay as described above, ignoring any received items until no more items are received for a fixed time interval. It then moves on to the next step in the parsing process. If the DELAYx setting is set to “OFF’, then the SEL-2020 will immediately move on to the next step in the parsing process. Any characters received beyond the number of expected data items may end up in the Unsolicited Message Buffer or may even be captured by a subsequent data collection process. Setting the DELAYx setting to “ON” helps to ensure that excess characters in a device response will not be treated as part of a subsequent request-response sequence. This introduces time delays in the parsing process, preventing rapid successive data collections. When it is known that the responding device will send a fixed number of items without any excess trailing characters, setting DELAYx to “OFF” may be preferable because this enables the parsing process to complete quickly, allowing for rapid successive data collections.

Checksum Validation

If you choose a parse type of Character String (PARSEn=3), Integer String (PARSEn=4), or Integer String with XON/XOFF encoding (PARSEn=5), you can set the SEL-2020 to perform checksum validation on the parsed response. The CHECKn setting specifies the type of checksum being used (CRC-16, 8-bit checksum, or 16-bit checksum) and the format of the checksum (ASCII hexadecimal or binary). The ORDERn setting specifies the byte ordering of the checksum for CRC-16 and 16-bit checksums. The STARTn, STOPn, and CHKPOSn settings specify the locations of the data to be validated and the checksum in the received data stream. Three methods are available for specifying these position settings: 1) specify a byte index in the received data stream, where byte index 1 is the first position, 2) specify a character or character code, where a trailing ‘i’ can be appended to indicate that the character itself is included, 3) specify the number of bytes that follow the item being specified. To specify a byte index, you enter a positive integer. To specify a character you can enter the character or, if the character is non-printable, the ASCII character code. Add the trailing ‘i’ to specify inclusion of the character itself. You must quote any numeric character so that it is not treated as a byte index (e.g., enter ‘9’ or “9” to indicate the character 9 as opposed to byte 9). The examples in Table 6.6 demonstrate the use of each method.

Table 6.6: Example Position Settings

Example Setting	Meaning
START1=1	start calculating checksum at first received byte
START1=#	start calculating checksum at the first byte following the character ‘#’
START1=#i	start calculating checksum at the ‘#’ character (‘#’ is included in checksum).
START1 = E10	start calculating checksum 10 bytes before the end of the message
STOP1 = 20	stop checksum calculation at 20th byte (byte 20 is the last byte of data)
STOP1 = \003	stop checksum calculation at ETX character (03 character code)
STOP1 = \003i	stop checksum calculation after ETX (ETX character is included in checksum)
STOP1=E4	stop calculating checksum 4 bytes before the end of the message
CHKPOS1 = 40	the checksum starts at the 40th byte of the received data.
CHKPOS1=\001	the checksum starts after the SOH character (01 character code).
CHKPOS1=E2	the checksum is located 2 bytes from the end of the message

Suppose the string below will be sent to the SEL-2020 and you wish to verify that there are no transmission errors. Assume that the checksum is calculated on the data within the quotes. In this case the checksum is a 16-bit checksum in ASCII hexadecimal format with the high byte first. There are many different ways that you could specify the locations of the data and checksum. Four examples are given.

received data: “This is data”,044E

settings:

CHECK = 16A,
ORDER = H,

method 1:	START = 2,	STOP = 13,	CHKPOS = 16
method 2:	START = E18,	STOP = E6,	CHKPOS = E4
method 3:	START = “,	STOP = “,	CHKPOS = ‘ ,’
method 4:	START = 2,	STOP = “,	CHKPOS = E4

The method you choose for each of the position settings will depend on the format of the received data. These position settings apply only to the data to be stored. This means that the NUMn setting must be large enough to contain all of the data and the checksum. Otherwise the checksum verification will consistently fail. The position settings must be sequential in the received data: the STARTn position must be on or before the STOPn position and the STOPn position must precede the CHKPOSn position.

The ACKn and NACKn settings allow you to set strings to be sent following successful or failed checksum validation, respectively. The content of these strings is limited to characters and character codes. None of the special SEL-2020 strings are allowed.

When the SEL-2020 is set to do checksum verification, data are only stored to the database when the checksum verification is successful. If the checksum verification fails, the SEL-2020 will re-request the data by sending the NACKn string if one is set. If no NACKn string is set, the MESGn string will be sent again. The SEL-2020 will then parse the data and attempt checksum verification again. If this verification fails again, one final attempt (for a total of three) will be made. If the NACKn string was sent previously and resulted in no response at all, the final re-request will be made using the MESGn string. If the checksum verification is successful, the data are stored to the database (including the checksum) and the ACKn string is sent to the connected device.

SET A Prompts and Settings

When you issue the SET A command for a specific port, the SEL-2020 prompts you for responses based on the type of device connected to that port. There are four device types as outlined below.

- SEL-IED device port (Table 6.7)
- Other IED device port (Table 6.8)
- Printer device port (Table 6.9)
- Master device port (Table 6.10)

Detailed descriptions of the SET A Auto-Message Settings are described in Table 6.11.

Table 6.7: SET A Auto-Message Settings Prompts for SEL IED Device

AUTOBUF (Y/N)						
STARTUP						
SEND_OPER*						
MSG_CNT (0-12)						
0	**1-8**					**9-12**
	ISSUE1-8					ISSUE9-12
	MESG1-8					MESG9-12
	“20” msg.	non “20” msg.				
		PARSE1-8 (0-5)				
		0	**1-5**			
			NUM1-8			
		DELAY1-8				DELAY9-12
		CHECK1-8				
		N	8A,8B	16A,16B, CA,CB		
				ORDER1-8		
			START1-8			
			STOP1-8			
			CHKPOS1-8			
			ACK1-8			
			NACK1-8			
ARCH_EN (Y/N)						only available with optional nonvolatile Flash memory
Y(ES)					**N**(O)	
ISSUE1A-3A						
MESG1A-3A						
“20” msg.	non “20” msg.					
	PARSE1A-3A (0-5)					
	0	**1-5**				
		NUM1A-3A				
	DELAY1A-3A					
	CHECK1A-3A					
	N	8A,8B	16A,16B,CA,CB			
			ORDER1A-3A			
		START1A-3A				
		STOP1A-3A				
		CHKPOS1A-3A				
		ACK1A-3A				
		NACK1A-3A				
USER	USER				USER	
Save changes (Y/N)						
Y(ES) Port n Settings Changed	**N**(O) Settings aborted					

* Only available if port configured for SEL relay with breaker and/or remote bit operations.

Table 6.8: SET A Auto-Message Prompts for OTHER IED Device

AUTOBUF (Y/N)

STARTUP

MSG_CNT (0-12)

- **0**
- **1-8**
  - ISSUE1-8
  - MESG1-8
  - PARSE1-8 (0-5)
    - **0**
    - **1-5**
      - NUM1-8
  - DELAY1-8
  - CHECK1-8
    - N
    - 8A,8B
    - 16A,16B,CA,CB
      - ORDER1-8
    - START1-8
    - STOP1-8
    - CHKPOS1-8
    - ACK1-8
    - NACK1-8
- **9-12**
  - ISSUE9-12
  - MESG9-12
  - DELAY9-12

ARCH_EN (Y/N) — only available with optional nonvolatile Flash memory

- **Y**(ES)
  - ISSUE1A-3A
  - MESG1A-3A
  - PARSE1A-3A (0-5)
    - **0**
    - **1-5**
      - NUM1A-3A
  - DELAY1A-3A
  - CHECK1A-3A
    - N
    - 8A,8B
    - 16A,16B,CA,CB
      - ORDER1A-3A
    - START1A-3A
    - STOP1A-3A
    - CHKPOS1A-3A
    - ACK1A-3A
    - NACK1A-3A
- **N**(O)

1-4

NUM1A-3A

- **Y**(ES) Port n Settings Changed
- **N**(O) Settings aborted

Table 6.9: SET A Auto-Message Setting Prompts for PRINTER Device

<table>
<tr><td colspan="4">STARTUP</td></tr>
<tr><td colspan="4">MSG_CNT (0-12)</td></tr>
<tr><td rowspan="5">0</td><td colspan="2">1</td><td rowspan="3">2-12</td></tr>
<tr><td colspan="2">PRINT_ALL (Y/N)</td></tr>
<tr><td>Y(ES)</td><td>N(O)</td></tr>
<tr><td rowspan="2">CLEAR_BUF (Y/N)</td><td>ISSUE1</td><td>ISSUE2-12</td></tr>
<tr><td>MESG1</td><td>MESG2-12</td></tr>
<tr><td colspan="4">USER</td></tr>
<tr><td colspan="4">Save changes (Y/N)</td></tr>
<tr><td colspan="2">Y(ES)
Port n Settings Changed</td><td colspan="2">N(O)
Settings aborted</td></tr>
</table>

Table 6.10: SET A Auto-Message Settings Prompts for MASTER Device

<table>
<tr><td colspan="2">PROTOCOL = SEL or LMD</td><td colspan="2">PROTOCOL = MODBUS or DNP</td><td rowspan="5"></td></tr>
<tr><td colspan="2">MSG_CNT (0-12)</td><td colspan="2">MSG_CNT (1-1)</td></tr>
<tr><td rowspan="3">0</td><td>1-12</td><td rowspan="3">0</td><td>1</td></tr>
<tr><td>ISSUE1-12</td><td>ISSUE1</td></tr>
<tr><td>MESG1-12</td><td>MESG1</td></tr>
<tr><td colspan="2">ARCH_EN (Y/N)</td><td colspan="2">ARCH_EN(Y/N)</td><td rowspan="4">only available
with optional
nonvolatile
Flash memory</td></tr>
<tr><td>Y(ES)</td><td rowspan="3">N(O)</td><td>Y(ES)</td><td rowspan="3">N(O)</td></tr>
<tr><td>ISSUE1A</td><td>ISSUE1A</td></tr>
<tr><td>MESG1A</td><td>MESG1A</td></tr>
<tr><td colspan="2">USER</td><td colspan="2">USER</td><td rowspan="3"></td></tr>
<tr><td colspan="2">Save changes (Y/N)</td><td colspan="2">Save Changes (Y/N)</td></tr>
<tr><td>Y(ES)
Port n Settings
changed</td><td>N(O)
Settings aborted</td><td>Y(ES)
Port n Settings
changed</td><td>N(O)
Settings aborted</td></tr>
</table>

Table 6.11: SET A Automatic Message Settings Information

Setting	Comment
AUTOBUF	**Prompt**. Save unsolicited messages (Y/N). **Description**. You enter Y (Yes) to save unsolicited messages received by the SEL-2020. Ports configured for IEDs can buffer unsolicited messages. User-defined commands will work regardless of this setting. Not available for Master or Printer.
STARTUP	**Prompt**. Port startup string. **Description**. You enter a startup string for the device attached to this port. The startup string supports devices that need some initialization on power-up. When the SEL-2020 is powered-up, these startup messages will be transmitted. Typically, this string is used on SEL relays that need to be at Access Level 1 or Access Level 2 for automatic data collection by the SEL-2020. Not available for Master ports. The startup string is sent: • When you accept setting changes after the SWAP or COPY commands. • At power-up. • When an inactive port becomes active. • When you accept SET A setting changes.
SEND_OPER	**Prompt:** Send operate command on logic bit transition (Y/N/YP). **Description:** Use this setting to enable automated control of the attached SEL device. The YP selection indicates that Remote Bits should always be pulsed. See the following subsection, ***Automated Control***, for more information.
MSG_CNT	**Prompt**. How many auto-message sequences (0-12). **Description**. You enter the number of the auto-message(s) you wish to use. Messages 1 to 8 have an associated data area to store responses, messages 9 to 12 are for messages only.
PRINT_ALL	**Prompt**. Print all unsolicited messages (Y/N). **Description**. You set to Y (Yes) to print all unsolicited messages received by the SEL-2020 to a Printer port. Only those messages received on ports that have AUTOBUF=Y will be printed. The PRINT_ALL prompt only appears on ports with a DEVICE = P for printer. This setting occupies the Message 1 position. You can create more selective printing functions using SELOGIC Control Equations and message strings on other message functions.
CLEAR_BUF	**Prompt**. Clear unsolicited message buffer after print (Y/N). **Description**. You set to Y (Yes) to clear the unsolicited message buffer after printing. Only applies to Printer ports.
Note: Up to twelve auto-messages may be defined using the ISSUEx and MESGx settings. The first eight may have their responses parsed using the PARSEx setting.	
ISSUE1-12	**Prompt**. Item 1-12 trigger. **Description**. You enter the trigger condition as a SELOGIC Control Equation that triggers the associated message. ISSUE1 triggers MESG1, ISSUE2 triggers MESG2, etc. See ***Section 7: SELOGIC Control Equations*** for instructions on developing these trigger conditions. There is a 200 character per equation limit for a single equation and a 50 term (element names and time functions) limit per equation.

Table 6.11: SET A Automatic Message Settings Information (continued)

Setting	Comment
MESG1-12	**Prompt**. Item 1-12 message. **Description**. You enter the message string to be sent when the associated ISSUE condition is met. Each message is limited to 1000 characters. Use the \ symbol at the end of a line and press **<ENTER>** to continue on the next line.
PARSE1-8	**Prompt**. Item 1-8 response parsing method (0=IGNORE, 1=ASCII_INT, 2=ASCII_FLOAT, 3=CHAR_STRING, 4=INT_STRING, 5=INT_STRX). **Description**. You select the parsing option to be used for the message response. For Masters and Printers, the parsing option is always forced to IGNORE. Parsing is automatically set for SEL relays if the message string is a recognized "20" command.
NUM1-8	**Prompt**. Item 1-8 number of data items. **Description**. You enter the maximum number of items the SEL-2020 may store from the response. The limit is determined by the type of data and the size of the associated region. See ***Section 9: Database*** for more information on region sizes.
DELAY1-12	**Prompt.** Item 1-12 time delay to allow response to complete (OFF, ON). **Description.** If you know you are collecting the entire response, use the OFF setting to avoid unnecessary delays. Otherwise, use the ON setting so the response does not confuse subsequent data collections.
CHECK1-8	**Prompt.** Checksum verification (N=NONE, 8A=8BIT ASCII, 8B=8BIT Binary, 16A=16BIT ASCII, 16B=16BIT Binary, CA=CRC16 ASCII, CB=CRC16 Binary). **Description.** You select the verification method you wish to use to confirm that the data was accurately transmitted over the data channel. The data must contain a validation code of this same type and format. Otherwise, select NONE.
ORDER1-8	**Prompt.** Checksum byte order(H=High byte first, L=Low byte first) **Description.** You enter the ordering of the bytes in the received validation code. Does not apply to 8-bit (single-byte) checksums.
START1-8	**Prompt.** Position or character where verification will start. **Description.** You enter the position in the received data where the checksum validation should begin. This position can be an index from the start, an index from the end, or a specific character.
STOP1-8	**Prompt.** Position or character where verification will stop. **Description.** You enter the position in the received data where the checksum validation should end. This position can be an index from the start, an index from the end, or a specific character.
CHKPOS1-8	**Prompt.** Position or character where checksum located. **Description.** You enter the position in the received data where the validation code will be located. This position can be an index from the start, an index from the end, or a specific character.
ACK1-8	**Prompt.** Acknowledge string. **Description.** You define the string to send to the connected device when the data received from it passes the checksum verification. This string is limited to 10 characters.
NACK1-8	**Prompt.** Negative Acknowledge string. **Description.** You define the string to send to the connected device when the data received from it does not pass the checksum verification. This string is limited to 10 characters.

Table 6.11: SET A Automatic Message Settings Information (continued)

Setting	Comment
ARCH_EN	**Prompt**. Enable use of archive data items (Y/N). **Description**. You enter Y (Yes) to enable use of nonvolatile memory. ARCH_EN is forced to N (No) if nonvolatile Flash memory is not installed. Not available for printer ports.
ISSUE1A-3A	**Prompt**. Archive 1 to 3 trigger. **Description**. You define the trigger condition as a SELOGIC Control Equation that initiates a message. This setting available only if ARCH_EN is set to Y (Yes).
MESG1A-3A	**Prompt**. Archive 1 to 3 message. **Description**. You enter the message to send in response to the associated trigger condition. This setting available only if ARCH_EN is set to Y (Yes).
PARSE1A-3A	**Prompt**. Archive 1 to 3 response parsing method (0=IGNORE, 1=ASCII_INT, 2=ASCII_FLOAT, 3=CHAR_STRING, 4=INT_STRING, 5=INT_STRX). **Description**. You select the parsing option to be used for the message response. This setting available only if ARCH_EN is set to Y (Yes). Parsing is automatically set for SEL IEDs if string is a recognized "20" command.
NUM1A-3A	**Prompt**. Archive 1 to 3 number of data items. **Description**. You enter the maximum number of data items the SEL-2020 may store from the response.
DELAY1A-3A	**Prompt:** Archive 1 to 3 time delay to allow response to complete (OFF, ON). **Description.** If you know you are collecting the entire response, use the OFF setting to avoid unnecessary delays. Otherwise, use the ON setting so the response does not confuse subsequent data collections.
CHECK1A-3A	**Prompt.** Checksum verification (N=NONE, 8A=8BIT ASCII, 8B=8BIT Binary, 16A=16BIT ASCII, 16B=16BIT Binary, CA=CRC16 ASCII, CB=CRC16 Binary). **Description.** You select the verification method you wish to use to confirm that the data was accurately transmitted over the data channel. The data must contain a validation code of this same type and format. Otherwise, select NONE.
ORDER1A-3A	**Prompt.** Checksum byte order(H=High byte first, L=Low byte first) **Description.** You enter the ordering of the bytes in the received validation code. Does not apply to 8-bit (single-byte) checksums.
START1A-3A	**Prompt.** Position or character where verification will start. **Description.** You enter the position in the received data where the checksum validation should begin. This position can be an index from the start, an index from the end, or a specific character.
STOP1A-3A	**Prompt.** Position or character where verification will stop. **Description.** You enter the position in the received data where the checksum validation should end. This position can be an index from the start, an index from the end, or a specific character.
CHKPOS1A-3A	**Prompt.** Position or character where checksum located. **Description.** You enter the position in the received data where the validation code will be located. This position can be an index from the start, an index from the end, or a specific character.

Table 6.11: SET A Automatic Message Settings Information (continued)

Setting	Comment
ACK1A-3A	**Prompt.** Acknowledge string. **Description.** You define the string to send to the connected device when the data received from it passes the checksum verification. This string is limited to 10 characters.
NACK1A-3A	**Prompt.** Negative Acknowledge string. **Description.** You define the string to send to the connected device when the data received from it does not pass the checksum verification. This string is limited to 10 characters.
USER	**Prompt**. Size of user-defined data space in registers. **Description**. You enter the number of registers you need to use for data storage in the User region of memory. This may be automatically increased during SET M operations.

Automated Control

You can associate SELOGIC elements with specific SEL IED operations by enabling the SEND_OPER setting. Changes in these elements can then cause the SEL-2020 to directly issue operate commands to the attached SEL IED.

To find out what will be associated, use the AUTO n command to determine the number of supported breakers and remote bits for operate control. For every breaker supported, one BRn bit will be associated with an SEL IED breaker. For every remote bit supported, one RBn bit will be associated with an SEL IED remote bit. Setting and clearing of BRn bits corresponds to issuing OPEN and CLOSE commands, respectively. When SEND_OPER=Y, setting and clearing of RBn bits corresponds to issuing remote bit set and clear commands, respectively. When SEND_OPER=YP, setting RBn bits corresponds to issuing remote bit pulse commands and clearing RBn bits has no direct effect.

If the attached SEL IED is an SEL-2020, the sixteen breakers correspond to the BR1 bits on each port. Similarly, the sixteen remote bits correspond to the RB1 bits on each port. For example, if you set BR5 in the local SEL-2020 on a port auto-configured with an SEL-2020 attached, the command to set Port 5 BR1 will be issued to the attached SEL-2020.

The SEL-2020 can issue these commands in one of two ways: ASCII or binary. The AUTO command will tell you which is supported. When ASCII commands are used, the SEL-2020 will have to wait for any ASCII communications in process to complete before issuing the command. If binary commands are used, the SEL-2020 will issue the command to the attached SEL IED within 100 milliseconds.

The operate commands will be issued on the rising edge of the set and clear bits, unless they both rise simultaneously. Consequently, the breaker and remote bits will track the value of the last operation the SEL-2020 performed. The relay may operate breakers or have its remote bits changed independent of the SEL-2020, so you cannot depend on the state of the breaker and remote bits to indicate the state of the relay.

If you wish to block the operation of one of these bits, assign both the set and clear equations to a blocking element. For instance, if you use X to block breaker one operations, you would set the equations to:

SBR1 = X
CBR1 = X

With both the set and clear elements asserted, there can be no rising edges to trigger operate commands.

SET U - USER-DEFINED COMMANDS

Use the SET U command to:

- Create user-defined commands that the SEL-2020 will obey.
- Enable handling of a recognized, but unsolicited, SEL relay auto-message.
- Control the SEL-2020 command set.

User-defined commands allow the SEL-2020 to recognize unsolicited inputs. You can create up to eleven user-defined commands for any Master port, including eight general-purpose and three special-purpose commands. You can create up to four general-purpose user-defined commands on SEL IED and other IED ports.

The SEL-2020 has a pre-defined command set (e.g., SHOW, VIEW, SET) that allows you to control, interrogate, and set the SEL-2020 functions from your computer. If a port is connected to an unattended device (e.g., an RTU or substation computer), the SEL-2020 pre-defined command set may be supplemented or replaced by user-defined commands that are appropriate for the device and function. They are called user-defined because you define the command string and the action performed by the SEL-2020 when the command is received by the SEL-2020. These commands are available at all access levels.

On IED ports, the SEL-2020 recognizes unsolicited messages from the IED based on user-defined message strings you define with the SET U command (e.g., a summary event report from an SEL relay).

On a Master port, commands are normally terminated with a carriage return (<CR>). The carriage return is typically sent from a terminal or PC by depressing the Enter key. User-defined commands on a Master port will similarly be recognized upon receipt of a <CR>. If you disable the SEL-2020 command set to use only user-defined commands on that port (using the CMD_EN setting), you may select an alternate command termination character (using the CMD_CH setting).

General-Purpose Commands

You can set the SEL-2020 so that receipt of a command you defined sets an SEL-2020 database bit. You can then use that bit in a SELOGIC Control Equation to trigger a control action or message response.

When the SEL-2020 receives a general-purpose user-defined command, it pulses the associated local element command (CMDx) bit. You may create up to eight general-purpose commands per port to control the local elements CMD1 through CMD8.

For SEL relays, there are pre-defined auto-messages that you can set the SEL-2020 to recognize, such as status, summary event reports, and group switch reports. For example, if you define the first general-purpose command on an SEL IED port to be 20EVENT, the SEL-2020 element CMD1 on that port pulses when the SEL-2020 receives a summary event report. You use the

CMD1 bit within a SELOGIC Control Equation to trigger a message or a control action in response. See Example 4 in ***Section 4: Job Done Examples*** for an application example.

Similarly, on a Master port, you could define "XYZ" to be a user-defined command (CMD1="XYZ"). When the SEL-2020 receives "XYZ" on the Master port, it will pulse the CMD1 bit as shown in Figure 6.4, which you may use to trigger a response. See Examples 3 and 7 in ***Section 4: Job Done Examples*** for some application examples. See ***Section 8: Message Strings*** for definitions of valid message strings.

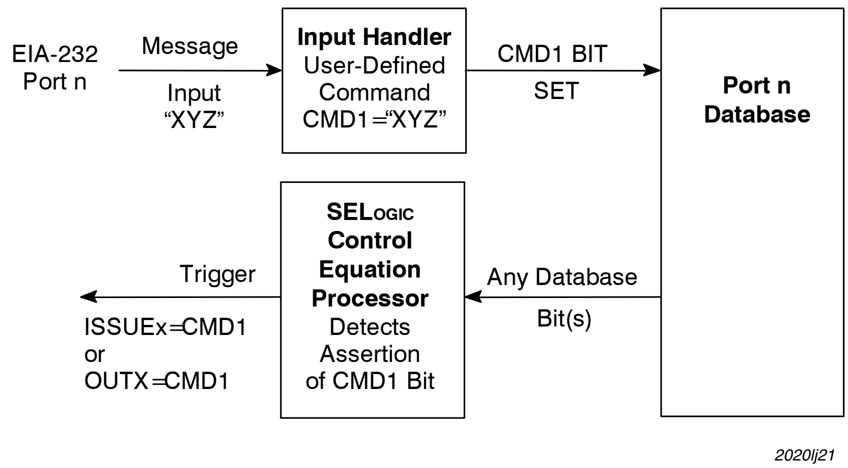

Figure 6.4: SET U Example CMD1 Message Detection

Special-Purpose Commands

There are three commands whose syntax and response messages you may define using the settings READ, WRITE, and TRANS (transparent connect). These commands read data items, write data items, and enter transparent communications. These commands are similar to the VIEW, STORE, and PORT commands available in the SEL-2020 Command Set. The READ, WRITE, and TRANS special purpose commands may be useful with master devices that you can program to automatically communicate with the SEL-2020.

To build these commands, you must specify the position and format of the port number, address, and data, as applicable, within the message. You then specify how the SEL-2020 should respond to each of these commands for both successful and unsuccessful operations.

For example, assume you have made the following settings. See ***Section 8: Message Strings*** for an explanation of the special characters used in these settings.

TRANS = "TR\Pa/" TRANSACK = "\006" TRANSNACK = "\015"	To enter transparent mode with another SEL-2020 port, use the message format you defined with the TRANS command. For example, to enter transparent mode with Port 5 with these settings, issue the command TR05<ENTER>. If the transparent connection is successful, the SEL-2020 will respond with 06h (ASCII ACK) and you will be transparently connected. To terminate the transparent connection, use the transparent disconnect sequence you set using SET P. If the transparent connection could not be established, the SEL-2020 will respond with 15h (ASCII NACK).
READ = "RD\Pa/@\Aa/" READACK = "RP\Dh/" READNACK = ""	To read data from the SEL-2020 database, use the message format you defined with the READ command. To read from Port 7's database at address 1001h with these settings, send the command RD07@1001<ENTER>. The SEL-2020 will respond with the data if the read is successful (e.g., RP0013). If the read cannot be performed, the SEL-2020 will not respond, because there is no response defined (READNACK) in these settings.
WRITE = "WR\Pa/@\Aa/=\Dh/" WRITEACK = "OK" WRITENACK = "FAIL"	To write data to the SEL-2020 database, use the message format you have defined with the WRITE command. To write 0036h to Port 11's database at address D007h with these settings, send the message WR0B@D007=0036<ENTER> to the SEL-2020. The SEL-2020 will respond "OK" if successful, or "FAIL" if the write could not be performed.

This example uses ASCII commands, but these commands could also have been built as binary commands.

SET U Settings

The SET U command will prompt you for user-defined strings and the command you want to use to trigger a response on Master, SEL IED, and other IED ports. SET U is not applicable to printer ports. You can also use the SET U command to disable the SEL-2020 command set on Master ports. Table 6.12 and

Table 6.13 show the prompts you will see with the SET U command. includes detailed information about the SET U settings.

Table 6.12: SET U User-Defined Setting Prompts for MASTER Device

CMD_EN (Y/N)			
Y(ES)	N(O)		
	CMD_CH		
CMD_CNT (0 - 8)			
0	1-8		
	CMD1 to CMD8		
STR_EN (Y/N)			
N(O)	Y(ES)		
	TRANS		
		“”	“x”
			TRANSACK
			TRANSNACK
	READ		
		“”	“x”
			READACK
			READNACK
	WRITE		
		“”	“x”
			WRITEACK
			WRITENACK
Save changes (Y/N)			
Y(ES) Port n Settings Changed	**N**(O) Settings aborted		

Table 6.13: SET U User-Defined Setting Prompts for SEL IED Device and Other IED Device

CMD_CNT (0-4)	
0	**1-4**
	CMD1 to CMD4
Save changes (Y/N)	
Y(ES) Port n Settings Changed	**N**(O) Settings aborted

Table 6.14: Set U User-Defined Command Settings

Setting	Comment
CMD_EN	**Prompt**. Enable SEL-2020 Commands (Y/N). **Description**. You enter N (No) to disable the SEL-2020 command set. This setting is only available for Master ports.
CMD_CH	**Prompt**. Command termination character. **Description**. You may define the command termination character with this entry. This setting is only available if CMD_EN is set to N (No); it is forced to <CR> otherwise. Changing this character from <CR> will disable prompting on this port.
CMD_CNT	**Prompt**. Number of general-purpose commands (0-8). **Description**. You enter a number (0-8) to enable command strings (CMD1 through CMD8). (0-4) on SEL IED and other IED ports.
Note: You may define up to eight command strings: CMD1 through CMD8.	
CMD1 - 8 or CMD1 - 4	**Prompt**. Command String 1 - 8 (see Table 6.12) or Command String 1 - 4 (see Table 6.13). **Description**. You enter the string that the SEL-2020 watches for to control the associated CMD bit. Each string is limited to 40 characters.
STR_EN	**Prompt**. Enable use of special-purpose commands (Y/N). **Description**. You set to Y (Yes) to enable use of the special-purpose user-defined commands. For Master ports only.
TRANS	**Prompt**. Initiate transparent mode sequence. **Description**. You define a character sequence which the SEL-2020 watches for to initiate transparent communications. This setting is only available if STR_EN is set to Y (Yes). Must include \P.../ port number string. This string is limited to 40 characters.
TRANSACK	**Prompt**. Transparent mode acknowledge. **Description**. You define the response string the SEL-2020 uses if an entry into transparent mode is successful. This setting is only available if STR_EN is set to Y (Yes). This response string is limited to 1000 characters.
TRANSNACK	**Prompt**. Transparent mode denial. **Description**. You define the response string the SEL-2020 uses if an entry into transparent mode is unsuccessful. This setting is only available if STR_EN is set to Y (Yes). This response string is limited to 1000 characters.
READ	**Prompt**. Read data. **Description**. You define the character sequence the SEL-2020 watches for to perform a data read operation. You must include \P../ and \A../ strings. This setting is only available if STR_EN is set to Y (Yes). This string is limited to 40 characters.
READACK	**Prompt**. Read data normal response. **Description**. You define the response string the SEL-2020 uses if a read operation is successful. Must include \D.../ string. This setting is only available if STR_EN is set to Y (Yes). This response string is limited to 1000 characters.

Table 6.14: Set U User-Defined Command Settings (continued)

Setting	Comment
READNACK	**Prompt**. Read data error response. **Description**. You define the response string the SEL-2020 uses if a read operation is not successful. This setting is only available if STR_EN is set to Y (Yes). This response string is limited to 1000 characters.
WRITE	**Prompt**. Write data. **Description**. You define the character sequence the SEL-2020 watches for to perform a data write operation. Must include \P.../, \A.../ and \D.../ strings. This setting is only available if STR_EN is set to Y (Yes). This string is limited to 40 characters.
WRITEACK	**Prompt**. Write data success response. **Description**. You define the response the SEL-2020 uses if a write operation is successful. This setting is only available if STR_EN is set to Y (Yes). This response string is limited to 1000 characters.
WRITENACK	**Prompt**. Write data error response. **Description**. You define the response the SEL-2020 uses if a write operation is unsuccessful. This setting is only available if STR_EN is set to Y (Yes). This response string is limited to 1000 characters.

Note: If CMD_CH is set to <CR>, the SEL-2020 will ignore non-printing characters entered on the port. Therefore, you should not use non-printing characters in user-defined commands unless you change the termination character.

SET L - LOGIC SETTINGS

Use the SET L command to establish the SELOGIC Control Equations that control the intermediate breaker and remote bit logic. There are a total of 64 bits that can be directly controlled by these equations. These elements act as inputs to 32 S-R latches, whose outputs are also available for use in SELOGIC. On SEL IED ports, these bits can be associated with IED breaker and remote bit operation, as discussed earlier in this section. The operation of these latches is more fully described in ***Section 7: SELOGIC Control Equations***.

Table 6.15 fully describes these settings.

Table 6.15: SET L Logic Settings and Definitions

Setting	Comment
SBR1-SBR16	**Prompt**. SBR*n*=. **Description**. You enter a SELOGIC Control Equation definition for this set breaker logic element.
CBR1-CBR16	**Prompt**. CBR*n*=. **Description**. You enter a SELOGIC Control Equation definition for this clear breaker logic element.
SRB1-SRB16	**Prompt**. SRB*n*=. **Description**. You enter a SELOGIC Control Equation definition for this set remote bit logic element.
CRB1-CRB16	**Prompt**. CRB*n*=. **Description**. You enter a SELOGIC Control Equation definition for this clear remote bit logic element.

SET M - MATH/DATA MOVEMENT SETTINGS

You use the SET M n command to create a macro that automatically copies specific data from any designated SEL-2020 port database to the SEL-2020 port “n” database User region. This permits you to concentrate selected data from one or more port databases into a single port database User region for quick and easy data retrieval. You can also scale each selected data item by multiplying or dividing by a scaling constant. The SET M n command permits you to create up to 250 lines of equations and operations for each of the sixteen SEL-2020 port databases.

This settings class is unique from all others. There are no settings labels and prompts. Instead, you enter equations and operations as lines within the settings. Because of this, the edit control keys and commands are slightly different. Table 6.16 lists the available editing keys and commands.

Table 6.16: Editing Keys and Commands for SET M

Command	Function
<ENTER>	Go to next line; if on empty line at end of settings, exit settings.
END<ENTER>	Exit settings.
<CTRL-X>	Abort settings (lose all changes).
^<ENTER>	Go back to previous line.
<<ENTER>	Go back to first line.
><ENTER>	Go to blank line following the last line.
***n*<ENTER>**	Go to line *n*.
DELETE [n]<ENTER>	Delete the current line. If *n* is included, delete *n* lines, starting with the current line.
INSERT<ENTER>	Insert a blank line at the current location; current line and all following lines shift down one line.

Each line within the SET M entry may contain either an equation, operation, or a comment.

Equations define how to move data into the port User region. They have the following syntax, where brackets [ ] indicate optional items, and vertical bar | is used to separate mutually exclusive options:

dest[*,type*][;[*atype*][*;label*]][+|-|*|/]=*source*[*,type*][*scaling*][*;repeat_count*]

or

dest[*,type*] [;[*atype*][*;label*]][+|-|*|/]=*constant*[*;repeat_count*]

or

dest:*bit*[;[*atype*][;*label*]][+|*]=[!]*source_bit*

or

dest:*bit*[;[*atype*][;*label*]][+|*]=*bit_const*

where:

type is the data type for the location: f - float (IEEE single-precision), i - signed integer (16-bit 2's complement), p-pack character data LSB first (available on left side only), c-pack character data MSB first (available on left-side only), H1L - read low byte as ASCII-hex value (available on right-side only), H1H - read high byte as ASCII-hex value (available on right-side only); *dest* will default to integer; *source* will default to location data type; *constant* will default to float if a decimal point is present, to integer otherwise;
atype is the access type: B to treat as 16 binary items (default if type is P or equation is a bit assignment), I to treat as 16-bit signed integer (default if type is I), L to treat as 32-bit signed integer, F to treat as floating point number (default if type is F), C to treat as 16-bit counter, S to treat as packed ASCII string (default if type is C);
label is an ASCII text label of up to 19 characters;
[+|-|*|/] specifies (for register operations) mathematical operator, add, subtract, multiply, divide;
source is a source address using any valid register addressing method;
scaling is either */constant* or **constant*; this is simply a mathematical operation;
dest is the destination address as an offset into the user region in decimal or hexadecimal;
repeat_count is how many times to repeat this for subsequent addresses;
constant is a numeric, decimal (integer or floating-point) constant;
bit is a bit number 0-15
\+ used (in bit operations) in front of = to form "+=" indicates that the source bit will be ORed into the destination bit.
* used (in bit operations) in front of = to form "*=" indicates that the source bit will be ANDed into the destination bit.
! indicates that the source bit value should be inverted (complemented);
source_bit is a bit from an SEL-2020/2030 database (see ***Section 6: Database*** for more information on bit access methods); and
bit_const is the constant 0 or 1, indicating the state of a bit.

SET M EXAMPLES

0 = 1:METER:IA	Store the port 1 IA value to the first location in the User region; if the value is stored as a floating-point value, it will be converted to integer.
1 = 1:METER:VA/100	Divide the port 1 VA value by 100 and store it to the second location in the User region; if the value is stored as a floating-point value, it will be converted to an integer after the division.
2,f = 2:2800h,f;6	Starting from the port 2 address 2800h, copy 6 values to the User region, starting at the third register; treat both the source and destination values as floating-point values, so each copy will move two registers.
14 = 123H	Store the value 123h (291) in the fifteenth register of the User region.
15,C = 1:GLOBAL:0;40	Copy FID string into a packed character format.
55;C;DEAD_COUNTER=5	Store a 5 in the 56th register of the User region and treat it as a counter with the label "DEAD_COUNTER".
60:0 = X	Store the value of Global Element X to bit 0 of the 61st register in the User region.
60:0;;GLOBALS += Y	Use Logical OR to OR the value of Global bit Y with the current value of bit 0 in the 61st User region register. Store the result to bit 0 in the 61st User region register and give that register the label "GLOBALS".
122:14 = 1	Set bit 14 of the 123rd register in the User region to 1.
97:4;I;TAR_WRD = !3:52A	Store the inverted value of the Port 3 relay 52A element to bit 4 of the 98th User region register and treat it as a 16-bit signed integer with the label "TAR_WRD".
1 += 1:METER:VB	Add the Port 1 VB value to the value in the second register of the User region and store the result in the second register of the User region.

ASCII HEXADECIMAL DATA CONVERSION EXAMPLE

Assume that region D1 on port 1 contains the string "A5F0" in registers 4 and 5. A VIEW command displays the following:

VIEW 1:D1:4 NR 2

4135h   4630h

The objective is to convert to the integer value A5F0 (42,480). Use the SET M functions described above to convert as illustrated below:

```
0 = 1:D1:5,H1L          # convert and store first half of low byte
0 += 1:D1:5,H1H*16   # convert, shift, and add second half of low byte
0 += 1:D1:4,H1L*256  #convert, shift, add low 4 bits of upper byte
0 += 1:D1:4,H1H*4096  #convert, shift, and add upper 4 bits
```

If the data were parsed using Character String parsing (parse type 3), the VIEW command display appears as follows:

VIEW 1:D1:4 NR 4

0041h   0035h   0046h   0030h

The objective is to convert to the integer value A5F0 (42,480). Use the SET M functions to convert as illustrated below:

```
0 = 1:D1:7,H1L          # convert and store first half of low byte
0 += 1:D1:6,H1L*16   # convert, shift, and add second half of low byte
0 += 1:D1:5,H1L*256  #convert, shift, add low 4 bits of upper byte
0 += 1:D1:4,H1L*4096  #convert, shift, and add upper 4 bits
```

SET M Data Type Considerations

You may need to give special consideration to data types within your equations. When working with analog quantities, the meaning of integer and floating-point quantities is straightforward. However, when accessing other types of data (e.g., status, strings, targets) you will want to be more careful. These types of items are stored as character or integer data. Generally, you will simply want to copy them using default data types with no scaling. This will result in no change in their representation.

When multiple equations are used to manipulate the same register, the access type and label from the last reference to that register will be used to define its final access type and label.

Another thing to consider is reasonable limits to the repeat count. Generally, you should only copy one type of data with a single equation. This is because the SEL-2020 will do its type determinations based on the first item only. Thus, if your repeat count tries to copy data of multiple types, the data of types that differ from the initial type will be misinterpreted.

Two types of operations are allowed:

FREEZE *n*
RELEASE *n*

where *n* is a port number. The FREEZE operation prevents the specified port's database from changing until the corresponding RELEASE operation has been performed. Use these operations to maintain data coherency while moving multiple data items from a specific port database. If you do not use these, it is possible that data may be updated in the midst of copying a block of data. For every FREEZE operation, a corresponding RELEASE operation is required. Only one port database may be frozen at a time.

You may also add comments. Comments start with a '#' character and continue to the end of the line. Comments may exist as stand-alone lines or following equations or operations.

On any type of entry, comment, equation, or operation you may continue the entry to a second line by placing a backslash (\) as the last character on the line. Whether you make an entry all on one line, or use multiple lines, the total length of the entry may not exceed 80 characters.

When you exit settings, you will be prompted for settings acceptance, just like in all other settings classes. If the User region allocation (USER settings in SET A) is insufficient for the given SET M settings, the SEL-2020 will automatically increase it as necessary. If there is insufficient memory for the increased User region, you will be warned and the STATUS command will show the SET M status on the port to be disabled.

Once these settings have been accepted, the SEL-2020 will process them every half second, on the half second.

SET G - GLOBAL SETTINGS

Use the SET G command to:

- Create a device identification string.
- Select a time synchronization source.
- Define intermediate logic using SELOGIC Control Equations.
- Define SELOGIC Control Equations that control optional I/O board output contacts.

Table 6.17: SET G Global Setting Prompts

DEVICE ID		
TIME_SRC		
LOG_EN (Y/N)		
N(O)	**Y**(ES)	
	V	
	W	
	X	
	Y	
	Z	
	XPICKUP	
	XDROPOOUT	
	YPICKUP	
	YDROPOUT	
	ZPICKUP	
	ZDROPOUT	
OUT1		Only with optional I/O Board
OUT2		
OUT3		
OUT4		
Save changes (Y/N)		
Y(ES)	**N**(O)	
	Settings aborted	

Global settings include primarily the intermediate logic and optional output contact logic available in the SEL-2020. Table 6.18 lists all Global settings and their description strings. You should use SET G to modify and SHO G to view these settings.

Of the five intermediate logic variables (V, W, X, Y, and Z) described in Table 6.18, X, Y, and Z have generic pickup/dropout timers associated with them. For the output of a timer to be asserted, its input must first be asserted for the pickup time. Once a timer is asserted, for its output to be deasserted, its input must be deasserted for the dropout time. If an I/O board is installed, you may define conditions that assert outputs on the board.

You define the logic elements using SELOGIC Control Equations and set their timers using the SET G command. For a complete discussion of these equations, see ***Section 7: SELOGIC Control Equations.***

Table 6.18 includes a complete description of the SET G settings.

Table 6.18: SET G Global Settings and Definitions

Setting	Comment
ID	**Prompt**. Device Identification. **Description**. Any string of up to 40 characters that you wish to use to identify this device.
TIME_SRC	**Prompt**. SEL-2020 Time Synchronization source (IRIG, DNP, OFF). **Description**. Select the source used by the SEL-2020 to time-synchronize itself.
LOG_EN	**Prompt**. Enable use of intermediate logic (Y/N). **Description**. There are five intermediate logic variables, three of which have associated timers. You set this setting to Y (Yes) to enable their use, or set it to N (No) if you do not plan to use them.
V	**Prompt**. V=. **Description**. You enter a SELOGIC Control Equation definition for the intermediate logic element V.
W	**Prompt**. W=. **Description**. You enter a SELOGIC Control Equation definition for the intermediate logic element W.
X	**Prompt**. X=. **Description**. You enter a SELOGIC Control Equation definition for the intermediate logic element X.
Y	**Prompt**. Y=. **Description**. You enter a SELOGIC Control Equation definition for the intermediate logic element Y.
Z	**Prompt**. Z=. **Description**. You enter a SELOGIC Control Equation definition for the intermediate logic element Z.
XPICKUP	**Prompt**. X Timer Pickup time (seconds). **Description**. The range is 0.0-86400.0 seconds in 0.1 second increments.
XDROPOUT	**Prompt**. X Timer Dropout time (seconds). **Description**. The range is 0.0-86400.0 seconds in 0.1 second increments.
YPICKUP	**Prompt**. Y Timer Pickup time (seconds). **Description**. The range is 0.0-86400.0 seconds in 0.1 second increments.
YDROPOUT	**Prompt**. Y Timer Dropout time (seconds). **Description**. The range is 0.0-86400.0 seconds in 0.1 second increments.

Table 6.18: SET G Global Settings and Definitions (continued)

Setting	Comment
ZPICKUP	**Prompt**. Z Timer Pickup time (seconds). **Description**. The range is 0.0-86400.0 seconds in 0.1 second increments.
ZDROPOUT	**Prompt**. Z Timer Dropout time (seconds). **Description**. The range is 0.0-86400.0 seconds in 0.1 second increments.
OUT1	**Prompt**. Output contact 1 assignment. **Description**. You enter a SELOGIC Control Equation definition for contact OUT1. This setting is available only if the optional I/O board is installed.
OUT2	**Prompt**. Output contact 2 assignment. **Description**. You enter a SELOGIC Control Equation definition for contact OUT2. This setting is available only if the optional I/O board is installed.
OUT3	**Prompt**. Output contact 3 assignment. **Description**. You enter a SELOGIC Control Equation definition for contact OUT3. This setting is available only if the optional I/O board is installed.
OUT4	**Prompt**. Output contact 4 assignment. **Description**. You enter a SELOGIC Control Equation definition for contact OUT4. This setting is available only if the optional I/O board is installed.

SET C - CALIBRATION COMMAND

Use the SET C command to:

- Recalibrate the SEL-2020 internal clock frequency.
- Change the settings to VALID after replacing ROMs.

The SEL-2020 clock frequency is calibrated at the factory and normally needs no calibration. If you must install new ROMs, check and note the clock frequency before you remove the old ROM chips, and again after you install the new chips using the SHO C command. The example following Table 6.19 illustrates how you change the SEL-2020 clock frequency in the unlikely event that it is necessary. This example also illustrates how to change the settings to VALID, which is the common step required after replacing ROMs.

Table 6.19: Calibration Settings

Setting	Comment
OSCFREQ	**Prompt**. Oscillator Frequency (kHz). **Description**. Enter the measured or recorded oscillator frequency. Used to correct the real-time clock for the difference between actual and ideal oscillator frequency. (See the example below.)
CVALID	**Prompt**. Calibration Settings Valid (Y/N). **Description**. Set to Y (Yes) to validate the settings. This will clear a SET failure as reported by the STATUS command. You are prompted for this setting only if it is currently set to N (No).

Type **SHO C<ENTER>** and record the OSCFREQ setting so it can be re-entered after the ROMs are changed. The OSCFREQ setting used in the following example is used only to show the setting process.

After changing ROMs, use the SET C command to enter the recorded frequency and set the settings to VALID as shown in the example below:

```
*>>SET C<ENTER>

Calibration settings

Oscillator Frequency (kHz)                 OSCFREQ =16777.217  ?16780.110<ENTER>

Calibration Settings Valid (Y/N)           CVALID  = N     ?Y<ENTER>

OSCFREQ = 16780.110

Save changes (Y/N) ?Y<ENTER>

*>>
```

WORKSHEET SET G

Date ____________
Approved by ____________
SEL-2020 S/N ____________

Device Identification = ____

Enable use of intermediate logic (Y/N) = ________________________________

V = ____

W = ____

X = ____

Y = ____

Z = ____

X Timer Pickup time (seconds) = ____________________________________

X Timer Dropout time (seconds) = ___________________________________

Y Timer Pickup time (seconds) = ____________________________________

Y (Timer Dropout time (seconds) = __________________________________

Z Timer Pickup time (seconds) = ____________________________________

Z Timer Dropout time (seconds) = ___________________________________

OUT1 = ____

OUT2 = ____

OUT3 = ____

OUT4 = ____

SETTINGS SHEET - SEL IED - SET P and SET A

Date ______________
Approved by ______________
SEL-2020 S/N ______________

Port ( )

SET P

DEVICE	(U=Unused, S=SEL IED, O=Other IED, P=Printer, M=Master)	S
CONFIG	Auto-configure port (Y/N)	______________
PORTID*	Port identification string	______________
BAUD*	(300,600,1200,2400,4800,9600,19200)	______________
DATABIT	Number data bits (7, 8)	______________
STOPBIT	Stop bits (1, 2)	______________
PARITY	(N, O, E, 1, 0)	______________
RTS_CTS	Enable RTS_CTS handshaking (Y/N)	______________
TIMEOUT	Port timeout (0.0-30.0 minutes)	______________

SET A

AUTOBUF	Save Unsolicited messages (Y/N)	______________
STARTUP*	Port Startup String	______________
SEND_OPER	Send operate command automatically (Y/N/YP)	______________
MSG_CNT	How many auto-message sequences (0-12)	______________
ISSUE1-12	Items 1-12 triggers D1-D12 =	See Worksheet SET A
MESG1-12	Items 1-12 messages =	See Worksheet SET A
PARSE1-8	Items 1-8 response parsing methods	See Worksheet SET A
NUM1-8	Items 1-8 number of data items	See Worksheet SET A
DELAY1-12	Items 1-12 time delay to allow response to complete (OFF,ON)	See Worksheet SET A
CHECK1-8	Items 1-8 message validation	See Worksheet SET A
ORDER1-8	Items 1-8 validation byte order	See Worksheet SET A
START1-8	Items 1-8 validation start	See Worksheet SET A
STOP1-8	Items 1-8 validation stop	See Worksheet SET A
CHKPOS1-8	Items 1-8 validation position	See Worksheet SET A
ACK1-8	Items 1-8 acknowledge string	See Worksheet SET A
NACK1-8	Items 1-8 negative acknowledge string	See Worksheet SET A

Archive Settings

ARCH_EN	Enable use of archive data items (Y/N)	______________
ISSUE1A-3A	Archive 1-3 triggers A1-A3 =	See Worksheet SET A
MESG1A-3A	Archive 1-3 messages	See Worksheet SET A
PARSE1A-3A	Archive 1-3 response parsing methods	See Worksheet SET A
NUM1A-3A	Archive 1-3 number of data items	See Worksheet SET A
DELAY1A-3A	Archive 1-3 time delay to allow response to complete (OFF,ON)	See Worksheet SET A
CHECK1A-3A	Archive 1-3 message validation	See Worksheet SET A
ORDER1A-3A	Archive 1-3 validation byte order	See Worksheet SET A
START1A-3A	Archive 1-3 validation start	See Worksheet SET A
STOP1A-3A	Archive 1-3 validation stop	See Worksheet SET A
CHKPOS1A-3A	Archive 1-3 validation position	See Worksheet SET A

ACK1A-3A	Archive 1-3 acknowledge string	See Worksheet SET A
NACK1A-3A	Archive 1-3 negative acknowledge string	See Worksheet SET A
USER	Size of user-defined data space in registers	____________________

SET U	See Worksheet SET U

*Set automatically if auto-configuration is performed.

SETTINGS SHEET - OTHER IED - SET P and SET A

Date ________________
Approved by ________________
SEL-2020 S/N ________________

Port ( )

SET P

DEVICE	U=Unused, S=SEL IED, O=Other IED, P=Printer, M=Master)	O
MODEM	Modem control (Y/N)	________
MSTR	Startup string (only if MODEM is Y)	________
CD_CTS	Modem CD connected to CTS input (Y/N) (only if MODEM is Y)	________
AUTO_BAUD	(Y/N)	________
PROTOCOL	(A=ASCII , B=BINARY)	________
PORTID	Port identification string	________
BAUD*	(300,600,1200,2400,4800,9600,19200)	________
DATABIT	Number data bits (7, 8)	________
STOPBIT	Stop bits (1, 2)	________
PARITY	(N, O, E, 1, 0)	________
RTS_CTS	Enable RTS_CTS handshaking (Y/N)	________
XON_XOFF	Enable XON_XOFF flow control (Y/N)	________
TIMEOUT	Port timeout (0.0-30.0 minutes)	________

SET A

AUTOBUF	Save Unsolicited messages (Y/N)	________
STARTUP	Port Startup String	________
MSG_CNT	How many auto-message sequences (0-12)	________
ISSUE1-12	Items 1-12 triggers D1-D12 =	See Worksheet SET A
MESG1-12	Items 1-12 message	See Worksheet SET A
PARSE1-8	Items 1-8 response parsing methods	See Worksheet SET A
NUM1-8	Items 1-8 number of data items	See Worksheet SET A
DELAY1-12	Items 1-12 time delay to allow response to complete (OFF,ON)	See Worksheet SET A
CHECK1-8	Items 1-8 message validation	See Worksheet SET A
ORDER1-8	Items 1-8 validation byte order	See Worksheet SET A
START1-8	Items 1-8 validation start	See Worksheet SET A
STOP1-8	Items 1-8 validation stop	See Worksheet SET A
CHKPOS1-8	Items 1-8 validation position	See Worksheet SET A
ACK1-8	Items 1-8 acknowledge string	See Worksheet SET A
NACK1-8	Items 1-8 negative acknowledge string	See Worksheet SET A
ARCH_EN	Enable use of archive data items (Y/N)	________
ISSUE1A-3A	Archive 1-3 trigger A1-A3 =	See Worksheet SET A
MESG1A-3A	Archive 1-3 messages	See Worksheet SET A
PARSE1A-3A	Archive 1-3 response parsing methods	See Worksheet SET A
NUM1A-3A	Archive 1-3 number of data items	See Worksheet SET A
DELAY1A-3A	Archive 1-3 time delay to allow response to complete (OFF,ON)	See Worksheet SET A
CHECK1A-3A	Archive 1-3 message validation	See Worksheet SET A
ORDER1A-3A	Archive 1-3 validation byte order	See Worksheet SET A
START1A-3A	Archive 1-3 validation start	See Worksheet SET A

STOP1A-3A	Archive 1-3 validation stop	See Worksheet SET A
CHKPOS1A-3A	Archive 1-3 validation position	See Worksheet SET A
ACK1A-3A	Archive 1-3 acknowledge string	See Worksheet SET A
NACK1A-3A	Archive 1-3 negative acknowledge string	See Worksheet SET A
USER	Size of user-defined data space in registers	____________________

SET U See Worksheet SET U

*Set automatically if auto-baud is performed.

SETTINGS SHEET - MASTER PORT (SEL or LMD protocol) - SET P and SET A

Date ______________
Approved by ______________
SEL-2020 S/N ______________

Port ( )

SET P

DEVICE	(U=Unused, S=SEL IED, O=Other IED, P=Printer, M=Master)	M
PROTOCOL**	(S=SEL, L=LMD, M=Modbus, D=DNP)	______
ADDRESS*	First LMD port address (1-8)	______
PREFIX*	LMD address prefix character (@, #, $, %, &)	______
SETTLE*	LMD port settle time (0-30 seconds)	______
FAST_OP***	Enable *Fast Operate* commands (Y/N)	______
PORTID	Port identification string	______
MODEM	Modem control (Automatically Y if modem installed, automatically N if LMD protocol is selected) (Y/N)	______
MSTR	Startup string (only if MODEM is Y)	______
CD_CTS	Modem CD connected to CTS input (Y/N) (only if MODEM is Y)	______
BAUD**	(300,600,1200,2400,4800,9600,19200, 38400)	______
DATABIT**	Number data bits (7, 8)	______
STOPBIT**	Stop bits (1, 2)	______
PARITY**	(N, O, E, 1, 0)	______
RTS_CTS	Enable RTS_CTS handshaking (Y/N)	______
XON_XOFF	Enable XON_XOFF flow control (Y/N)	______
TIMEOUT	Port timeout (0.0-30.0 minutes)	______
ECHO**	Echo received characters (Y/N)	______
AUTOHELP	Automatic help messages enabled (Y/N)	______
TERTIME1	First delay time (0-600 seconds)	______
TERSTRING1	Termination string	______
TERTIME2	Second delay time (0-600 seconds)	______

SET A

MSG_CNT	How many auto-message sequences (0-12)	______
ISSUE1-12	Items 1-12 triggers D1-D12 =	See Worksheet SET A
MESG1-12	Items 1-12 messages	See Worksheet SET A
USER	Size of user-defined data space in registers	______

SET U See Worksheet SET U

* Applies if PROTOCOL set to LMD.
** Port F is limited to baud rates from 300-9600, 8 data bits (including parity), 1 stop bit, SEL protocol, echo enabled, and parity options N, 0, and E.
*** Applies if Protocol set to SEL.

SETTINGS SHEET - MASTER Modbus PORT - SET P

Date ______________
Approved by ______________
SEL-2020 S/N ______________

Port ( )

SET P

DEVICE	(U=Unused, S=SEL IED, O=Other IED, P=Printer, M=Master)	M
PROTOCOL	(S=SEL, L=LMD, M=Modbus, D=DNP)	M
MAP_TYPE	(F=Float, I=Integer)	
START_ID	Starting Code for ID list (0-255)	
SETTLE1	Transmission delay from RTS assertion, ms	
SETTLE2	Post-transmit RTS deassertion delay, ms	
ADDRESS1	Address of Port 1 (1-247)	
ADDRESS2	Address of Port 2 (1-247)	
ADDRESS3	Address of Port 3 (1-247)	
ADDRESS4	Address of Port 4 (1-247)	
ADDRESS5	Address of Port 5 (1-247)	
ADDRESS6	Address of Port 6 (1-247)	
ADDRESS7	Address of Port 7 (1-247)	
ADDRESS8	Address of Port 8 (1-247)	
ADDRESS9	Address of Port 9 (1-247)	
ADDRESS10	Address of Port 10 (1-247)	
ADDRESS11	Address of Port 11 (1-247)	
ADDRESS12	Address of Port 12 (1-247)	
ADDRESS13	Address of Port 13 (1-247)	
ADDRESS14	Address of Port 14 (1-247)	
ADDRESS15	Address of Port 15 (1-247)	
ADDRESS16	Address of Port 16 (1-247)	
PORT ID	Port identification string	
BAUD	(300,600,1200,2400,4800,9600,19200,38400)	
PARITY	(N,O,E)	

SET A

MSG_CNT	How many auto-message sequences (0-1)	
ISSUE1	Item 1 trigger D1=	
MESG1	Item 1 message	20USER
ARCH_EN	Enable use of archive data items (Y/N)	
ISSUE1A	Item 1A trigger ARCH1=	
MESG1A	Item 1A message	20USER
USER	Size of user-defined data space in registers	

SET U

Not available.

SETTINGS SHEET - MASTER DNP PORT - SET P

Date ______________
Approved by ______________
SEL-2020 S/N ______________

Port ( )

SET P

DEVICE	(U=Unused, S=SEL IED, O=Other IED, P=Printer, M=Master)	M
PROTOCOL	(S=SEL, L=LMD, M=Modbus, D=DNP)	D
ADDRESS	DNP Address (0-65534 or 0000h-FFFEh)	
CLASS	Class for event data (0 for no event, 1-3)	
16BIT	Use 16 or 32-bit default variations for analog inputs	
SO_TIMEOUT	Select/Operate time-out interval, seconds (0.0-30.0)	
DL_CONFIRM	Number of data-link retries (0 for no confirm, 1-15)	
DL_TIMEOUT	Data Link Time-out interval, seconds (0.0-30.0)	
MIN_DELAY	Minimum Delay from DCD to transmission, ms	
MAX_DELAY	Maximum Delay from DCD to transmission, ms	
SETTLE1	Transmission delay from RTS assertion, ms	
SETTLE2	Post-transmit RTS deassertion delay, ms	
REPORT_ON	Percent of Full-Scale Change to Report on (0-100%)	
UNSOL_REP	Alow Unsolicited Reporting (Y/N)	
UNSOL_POW	Enable unsolicited messages on power-up (Y/N)	
REP_ADDR	Address of master to Report to (0-65534 or 0000h-FFFEh)	
NUM_EVENT	Number of events to transmit on (1-200)	
AGE_TX	Age of oldest event to force transmit on, sec (1.0-60.0)	
CONFIRM_TO	Time-out for confirmation of unsolicited message, ms	
PORT ID	Port identification string	
BAUD	(300,600,1200,2400,4800,9600,19200,38400)	
PARITY	(N,O,E)	

SET A

MSG_CNT	How many auto-message sequences (0-1)	
ISSUE1	Item 1 trigger, D1 =	
MESG1	Item 1 message	20USER
ARCH_EN	Enable use of archive data items (Y/N)	
ISSUE1A	Item 1A trigger, ARCH1 =	
MESG1A	Item 1A message	20USER
USER	Size of user-defined data space	

SET U

Not available.

SETTINGS SHEET - PRINTER - SET P and SET A

Date ______________
Approved by ______________
SEL-2020 S/N ______________

Port ( )

SET P

DEVICE	(U=Unused, S=SEL IED, O=Other IED, P=Printer, M=Master)	P
PORTID	Port identification string	______
BAUD	(300,600,1200,2400,4800,9600,19200)	______
DATABIT	Number data bits (7, 8)	______
STOPBIT	Stop bits (1, 2)	______
PARITY	(N, O, E, 1, 0)	______
RTS_CTS	Enable RTS_CTS handshaking (Y/N)	______
XON_XOFF	Enable XON_XOFF flow control (Y/N)	______
TIMEOUT	Port timeout (0.0-30.0 minutes)	______

SET A

STARTUP	Port Startup String	______
MSG_CNT	How many auto-message sequences (0-12)	______
PRINT_ALL	Print all buffered unsolicited messages (Y/N)	______
CLEAR_BUF	Clear unsolicited message buffer after print (Y/N)	______
ISSUE2-12	Items 2-12 trigger D2-D12 =	See Worksheet SET A
MESG2-12	Items 2-12 messages	See Worksheet SET A
USER	Size of user-defined data space in registers	______

SET U

Not available.

WORKSHEET SET A

Date ______________
Approved by ______________
SEL-2020 S/N ______________

D1

ISSUE1:				
MESG1:				
PARSE1:		NUM1:		DELAY1:
CHECK1:	ORDER1:	START1:	STOP1:	CHKPOS1:
ACK1:		NACK1:		

D2

ISSUE2:				
MESG2:				
PARSE2:		NUM2:		DELAY2:
CHECK2:	ORDER2:	START2:	STOP2:	CHKPOS2:
ACK2:		NACK2:		

D3

ISSUE3:				
MESG3:				
PARSE3:		NUM3:		DELAY3:
CHECK3:	ORDER3:	START3:	STOP3:	CHKPOS3:
ACK3:		NACK3:		

WORKSHEET SET A (continued)

Date ______________
Approved by ______________
SEL-2020 S/N ______________

D4

ISSUE4:				
MESG4:				
PARSE4:		NUM4:		DELAY4:
CHECK4:	ORDER4:	START4:	STOP4:	CHKPOS4:
ACK4:		NACK4:		

D5

ISSUE5:				
MESG5:				
PARSE5:		NUM5:		DELAY5:
CHECK5:	ORDER5:	START5:	STOP5:	CHKPOS5:
ACK5:		NACK5:		

D6

ISSUE6:				
MESG6:				
PARSE6:		NUM6:		DELAY6:
CHECK6:	ORDER6:	START6:	STOP6:	CHKPOS6:
ACK6:		NACK6:		

WORKSHEET SET A (continued)

Date _______________
Approved by _______________
SEL-2020 S/N _______________

D7

ISSUE7:				
MESG7:				
PARSE7:		NUM7:		DELAY7:
CHECK7:	ORDER7:	START7:	STOP7:	CHKPOS7:
ACK7:		NACK7:		

D8

ISSUE8:				
MESG8:				
PARSE8:		NUM8:		DELAY8:
CHECK8:	ORDER8:	START8:	STOP8:	CHKPOS8:
ACK8:		NACK8:		

WORKSHEET SET A (continued)

Date ______________
Approved by ______________
SEL-2020 S/N ______________

D9	ISSUE9:
	MESG9:
	DELAY9:
D10	ISSUE10:
	MESG10:
	DELAY10:
D11	ISSUE11:
	MESG11:
	DELAY11:
D12	ISSUE12:
	MESG12:
	DELAY12:

WORKSHEET SET A (continued)

Date ______________
Approved by ______________
SEL-2020 S/N ______________

A1

ISSUE1A:				
MESG1A:				
PARSE1A:		NUM1A:		DELAY1A:
CHECK1A:	ORDER1A:	START1A:	STOP1A:	CHKPOS1A:
ACK1A:		NACK1A:		

A2

ISSUE2A:				
MESG2A:				
PARSE2A:		NUM2A:		DELAY2A:
CHECK2A:	ORDER2A:	START2A:	STOP2A:	CHKPOS2A:
ACK2A:		NACK2A:		

A3

ISSUE3A:				
MESG3A:				
PARSE3A:		NUM3A:		DELAY3A:
CHECK3A:	ORDER3A:	START3A:	STOP3A:	CHKPOS3A:
ACK3A:		NACK3A:		

WORKSHEET SET U

Date _______________
Approved by _______________
SEL-2020 S/N _______________

CMD_EN*	Enable SEL-2020 commands (Y/N)	
CMD_CH*	Command termination character	
CMD_CNT	Number of general-purpose commands (0-8)	
CMD1	Command String 1 =	
CMD2	Command String 2 =	
CMD3	Command String 3 =	
CMD4	Command String 4 =	
CMD5*	Command String 5 =	
CMD6*	Command String 6 =	
CMD7*	Command String 7 =	
CMD8*	Command String 8 =	
STR_EN*	Enable use of special-purpose commands (Y/N)	
TRANS*	Initiate transparent mode sequence	
TRANSACK*	Transparent mode acknowledge	
TRANSNACK*	Transparent mode denial	
READ*	Read data	
READACK*	Read data normal response	
READNACK*	Read data error response	
WRITE*	Write data	
WRITEACK*	Write data success response	
WRITENACK*	Write data error response	

*Only available on Master ports

WORKSHEET SET L

Date: ________________
Approved by: ________________
SEL-2020 S/N: ________________

Port #____

SBR1 = ____

SBR2 = ____

SBR3 = ____

SBR4 = ____

SBR5 = ____

SBR6 = ____

SBR7 = ____

SBR8 = ____

SBR9 = ____

SBR10 = ____

SBR11 = ____

SBR12 = ____

SBR13 = ____

SBR14 = ____

SBR15 = ____

SBR16 = ____

CBR1 = ____

CBR2 = ____

CBR3 = ____

CBR4 = ____

CBR5 = ____

CBR6 = ____

CBR7 = ____

CBR8 = ____

CBR9 = ____

CBR10 = ____

CBR11 = ____

CBR12 = ____

CBR13 = ____

CBR14 = ____

CBR15 = ____

CBR16 = ____

SRB1 = ____

SRB2 = ____

SRB3 = ____

SRB4 = ____

SRB5 = ____

SRB6 = ____

SRB7 = ____

SRB8 = ____

SRB9 = ____

SRB10 = ____

SRB11 = ____

SRB12 = ____

SRB13 = ____

SRB14 = ____

SRB15 = ____

SRB16 = ____

CRB1 = ______________________________

CRB2 = ______________________________

CRB3 = ______________________________

CRB4 = ______________________________

CRB5 = ______________________________

CRB6 = ______________________________

CRB7 = ______________________________

CRB8 = ______________________________

CRB9 = ______________________________

CRB10 = ______________________________

CRB11 = ______________________________

CRB12 = ______________________________

CRB13 = ______________________________

CRB14 = ______________________________

CRB15 = ______________________________

CRB16 = ______________________________

WORKSHEET SET M

Date _____________
Approved by _____________
SEL-2020 S/N _____________

Data Source			Data Destination				Equation	Comments
Register or Bit Address, or Constant	Type	Scaling	Register or Bit Reference	Type	Access Type	Label		

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SECTION 7: SELOGIC® CONTROL EQUATIONS

INTRODUCTION

This section covers SELOGIC® Control Equation operation, inputs, syntax, and outputs.

SELOGIC Control Equations are central to many of the functions of the SEL-2020. They are defined within the global (SET G), auto-message (SET A), and logic (SET L) settings described in ***Section 6: Settings***.

OPERATION

SELOGIC Control Equations are at the heart of the more advanced functions of the SEL-2020 because they define when operations are to take place, and they control contact outputs on the optional I/O board. Many conditions detected by the device are represented by Boolean values or bits that are used in these equations. You can assign the value of one bit to an output bit, which has some pre-defined use. You can also use Boolean equations to combine multiple input bits to drive a specified output. You will find examples of these equations later in this section. Figure 7.1 illustrates the SELOGIC Control Equation data flow.

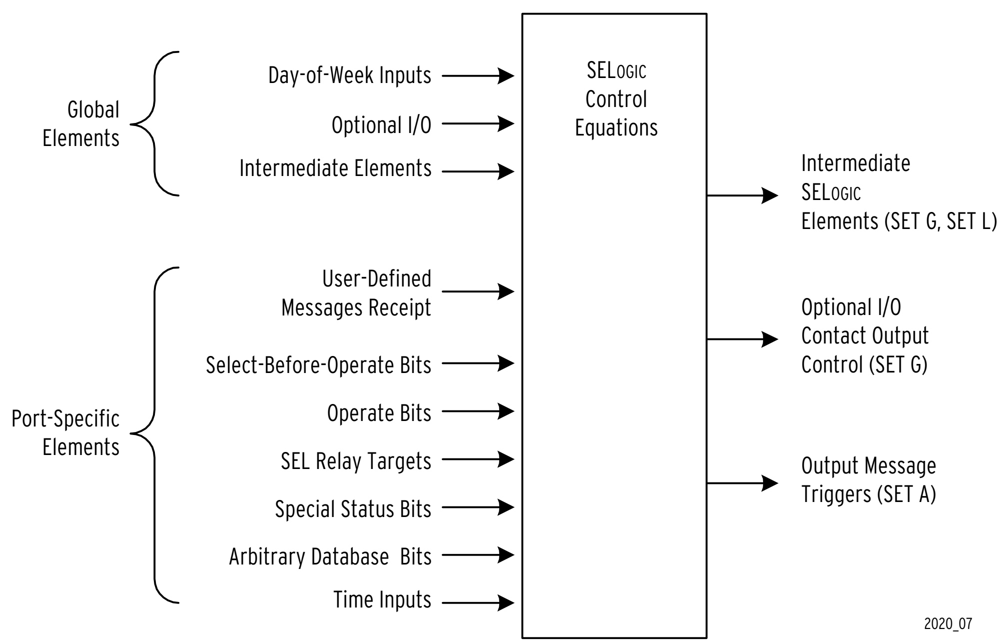


Figure 7.1: SELOGIC Control Equations Inputs and Outputs

SELOGIC Control Equation inputs include the current time, global elements (as seen by executing the TAR G command), local elements (as seen by executing the TAR n command), and arbitrary database bits.

Messages are triggered by the rising edge (or assertion) of the trigger condition bit. You can use output messages for the following tasks:

- Request data from an IED.
- Send a command to an IED (to change setting groups, for example).
- Send data you want stored to a printer or master device.

In addition to inputs and outputs, there are five intermediate logic variables. You can use these variables to write equations, the results of which may be used in output equations. Three intermediate elements have pickup and dropout delay timers associated with them.

INPUTS

As shown in Figure 7.1, there are a number of different types of SELOGIC Control Equation inputs. These include global elements, local elements, relay elements, relay status information, arbitrary database bits, and timed conditions.

Global Elements

Global elements exist within the Global data region that is common to all Port databases. Items within this region include the day of the week, remote bits, intermediate SELOGIC Control Equation terms, and I/O board inputs and outputs. These elements are defined in ***Section 9: Database***. Global elements are referenced in SELOGIC Control Equations by their element names. For example, you would enter the Sunday day-of-week element in a SELOGIC Control Equation as SUN.

Local Elements

Local elements exist within the Local data region of each port's database. Some of these elements are asserted by user-defined command receipt, some by select-before-operate registers, some by SELOGIC Control Equations, and others by data collection operation. These elements are defined in ***Section 9: Database***. To use a local element in a logic equation, you must give both its Port number and label. For example, to access element D1 on Port 3, the element label to use is 3:D1. If the SELOGIC Control Equation you are writing is port-specific, the Port for elements on that Port need not be specified.

Relay Elements

SEL relay elements are available on any SEL relay port that is collecting element data (uses 20TARGET data collection). Each element may be specified by its element label, preceded by the Port number. For example, to access relay element 51NT on Port 4, you use 4:51NT. If the element name matches a local or global element, you must specify the region to identify the proper element (e.g., 4:TARGET:IN1). If you write a port-specific equation, the Port for the desired relay element is in the local port, and the relay element label is unique from any local and global elements, then you do not need to specify the Port number. You can view the relay element labels by using the TAR n ALL, MAP n TARGET BL, or VIEW n TARGET BL commands.

Note: Because the SEL-2020 can only sample relay elements, you should only use elements you are confident will be asserted when a sample occurs. Elements that are only asserted momentarily will probably not be seen by the SEL-2020 in their asserted state.

Status Information

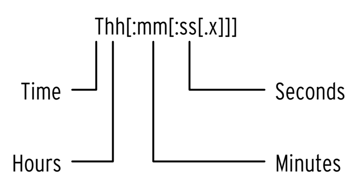
Along with their meter information, some SEL relays provide status information, which includes bits for self-test failures and new events. These bits are stored in the SEL-2020 as part of the relay element data. Use the TARGET command once a Port is configured to see what SEL relay special elements are available. These items are selected the same way as SEL relay elements.

Database Bits as Elements

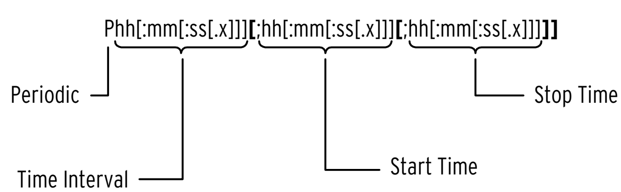
Arbitrary database bit references allow any bit of any register within any database region to be referenced as a SELOGIC Control Equation term. To specify an element of this type, you must select the Port number, register number, and bit number. For example, to access bit 11 of register 800Fh on Port 12, use the element label: 12:800Fh:Bh. If the register does not exist when you select it, you will be warned, but the term will be accepted. If it does not exist when SELOGIC Control Equations run, it will be treated as false (logic 0).

Timed Conditions

For controlling operations that must occur at specified times or periodically, you may use time-of-day or periodic items. Time-of-day equation entries have the following syntax:



This portion of an equation is true when the specified time-of-day occurs. The minutes, seconds, and tenths-of-seconds fields are optional, as indicated by the square brackets. To make something occur periodically, use a periodic item:



This item specifies the interval, optional start time, and optional stop time. The minutes, seconds, and tenths-of-seconds fields for all three time fields are optional, as indicated by the square brackets. For all three time fields The interval specifies how often to perform an operation. The start time specifies the time-of-day to start the interval. If the start time is not included, it will default to 00:00:00.0. The stop time specifies the time-of-day to stop the periodic samples. It defaults to 24:00:00.0. Both of these timed conditions will be true for approximately 100 milliseconds. If a start time is specified with a smaller time increment than the periodic time interval, the start time will act as an offset. This may be useful to prevent simultaneous operation of multiple messages that could result in database delays.

EQUATION SYNTAX

You create SELOGIC Control Equations by combining terms (inputs described above) in logical equations. This section describes the syntax of these equations. The simplest equation consists of directly entering a single element. More complex equations require the use of logical operators.

Operators

You can create SELOGIC Control Equations that use multiple SEL-2020 elements with logical AND (*), OR (+), and inversion (!) operators in a single equation. The following list defines the use of these operators.

*	AND	Requires that elements on both sides of the * symbol be asserted before the logic condition is true. For example, in the equation OUT1=IN1*IN2 the terms IN1 and IN2 must both be true for OUT1 to be true.
+	OR	Requires that one element on either side of the + symbol be asserted before the logical condition is true. The equation OUT1=IN1+IN2 requires either IN1 or IN2 to be true for OUT1 to be true.
!	Invert	Inverts the value of the element immediately following the ! symbol. For example, the equation OUT1=IN1*!IN2 requires IN1 to be true and IN2 to be false for OUT1 to be true.

Insert a backslash (\) symbol at the end of the line of a SELOGIC Control Equation (just before pressing <ENTER>) to continue the same equation on a subsequent line. Otherwise, the equation may only be one line. There is a 200 characters per equation limit for a single equation and a 50 term (element names and time functions) limit per equation.

Operator Precedence

When the SEL-2020 processes the SELOGIC Control Equations, the ! is applied first, followed by AND (*) functions, and finally by OR (+) functions. The *, +, and ! functions may be used in any combination. For example, consider the equation:

OUT4=X*Y+Z*V

This logic says that the AND function (*) is performed on assigned values for intermediate elements X and Y, Z and V before they are ORed (+) to determine the state of output 4 (OUT4=(X*Y)+(Z*V)). This is typically referred to as a minterm or sum-of-products equation.

Limitations

Table 7.1 lists unacceptable combinations of SELOGIC Control Equation operators:

Table 7.1: Unacceptable SELOGIC Control Equation Operator Combinations

*+	**	!*	!+
+*	++	!!	

Equation Disabling

Programming an equation to NA disables that function, i.e., OUT4 = NA..

OUTPUTS

You use SELOGIC Control Equations to control contact outputs, intermediate logic, and auto-message triggers.

Contact Outputs

Four contact outputs on the optional I/O board are controlled by SELOGIC Control Equations. The contact output equations are processed every 3.9 milliseconds. An output contact will be asserted (closed for a type A contact) when its corresponding SELOGIC Control Equation is true; it will be de-asserted when its corresponding SELOGIC Control Equation is false. Contact output SELOGIC Control Equations are established in the global settings.

Global Intermediate Logic

Five intermediate logic elements (V, W, X, Y, Z) may be used to hold intermediate results. Three elements (X, Y, Z) also have associated pickup/dropout timers which the SEL-2020 may use for various timing functions. These elements are processed every 15.6 milliseconds.

The timers operate as standard pickup/dropout timers. For a timer output (XT, YT, or ZT) to assert, the corresponding input must be true for the pickup time. Similarly, for a timer output to de-assert once it has asserted, the corresponding input must be false for the dropout time. Pickup and dropout times can be set to zero to disable them.

Intermediate logic SELOGIC Control Equations and timer values are established in the global settings.

Local Intermediate Logic

There are 96 intermediate logic elements associated with each port. These elements operate together to form 32 S-R latches where 32 elements are set elements, 32 are clear elements, and 32 are the latch outputs. The set and clear elements are driven by SELOGIC Control Equations (SET L), by master port *Fast Operate* commands, and by Modbus and DNP operations. (See ***Appendix G: Modbus Protocol, Appendix H: SEL-2020 Configuration and Fast Operate Commands,*** and ***Appendix I: Distribution Network Protocol (DNP) V3.00***.) Figure 7.2 illustrates the relationship of these elements.

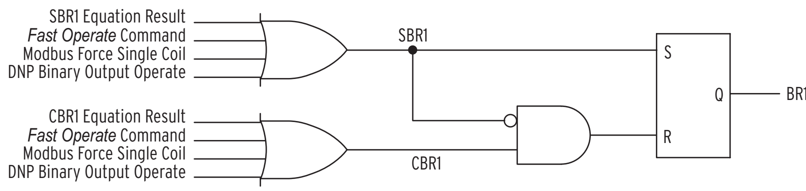


Figure 7.2: Example of Latch Operation

Message Triggers

On all used ports, you can set the Port to send a message based on a trigger condition. These trigger conditions, which are defined using SELOGIC Control Equations, are processed every 15.6 milliseconds.

Whenever the SEL-2020 detects a rising edge (_⌐) of a trigger condition (ISSUEx setting), it sets the corresponding Dx or ARCHx element. Once the message has been issued and any corresponding data collection is completed, the Dx or ARCHx is cleared. If a rising edge of a trigger condition is detected but the corresponding Dx or ARCHx element is already set, then the corresponding DLYx or DLYAx bit will be set to indicate that an auto-message operation has been missed. You can clear DLYx and DLYAx bits by executing a STATUS command. Figure 7.3 illustrates this logic.

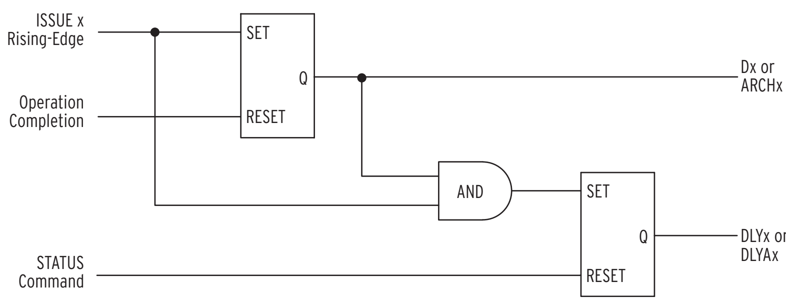


Figure 7.3: Message Triggering Logic

A typical trigger sequence starts with a trigger condition being satisfied. For example, consider the SELOGIC Control Equation ISSUE1 = P00:00:10.0. This trigger condition will have a rising edge every 10 seconds. Figure 7.4 illustrates the relative timing of this issue condition and its corresponding message element (D1).

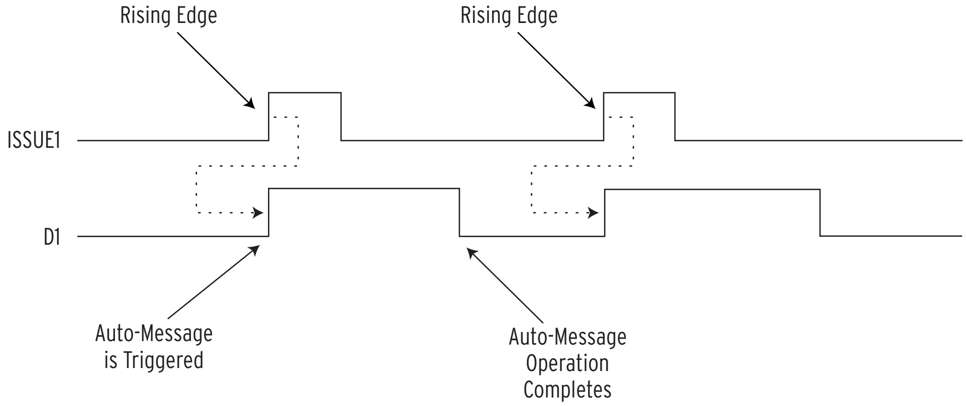


Figure 7.4: Normal Auto-Message Trigger

If the auto-message is not completely processed before the next trigger occurs (for this example, longer than 10 seconds), then the DLYx bit will be set, as shown in Figure 7.5.

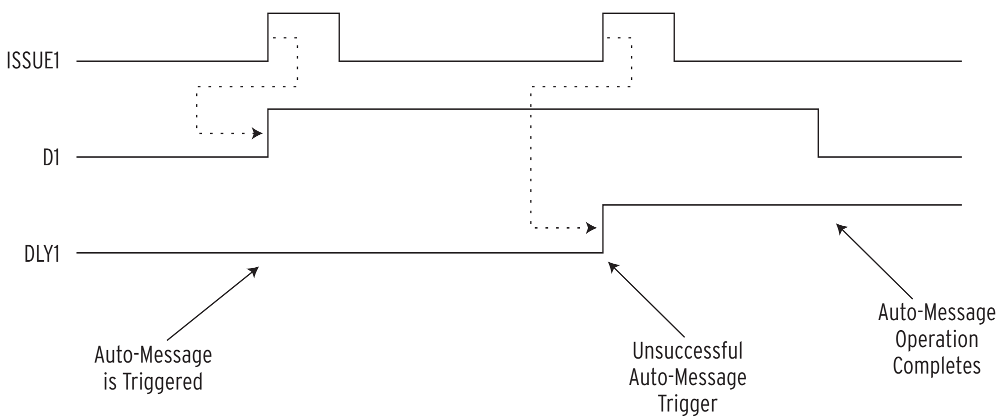


Figure 7.5: Unsuccessful Auto-Message Trigger

The database delay region of the STATUS command response indicates which auto-messages are unsuccessful. You may need to increase the ISSUE period to eliminate repeated unsuccessful auto-message triggers.

Another interesting case to consider is when SELOGIC Control Equations contain elements that are cleared by the triggered auto-message. If such an element is set again before the auto-message processing is complete, further triggering may be disabled. For example, consider the following trigger and message settings:

ISSUE2 = 1:UMB+2:UMB
MESG2 = \DAC1/\DAC2/

These settings are meant to output any unsolicited messages received on Ports 1 and 2. However, 1:UMB can become set while \DAC2/ is being processed, leaving the trigger condition in a set state and precluding any further rising edges; the trigger condition has become disabled. Figure 7.6 illustrates this problem.

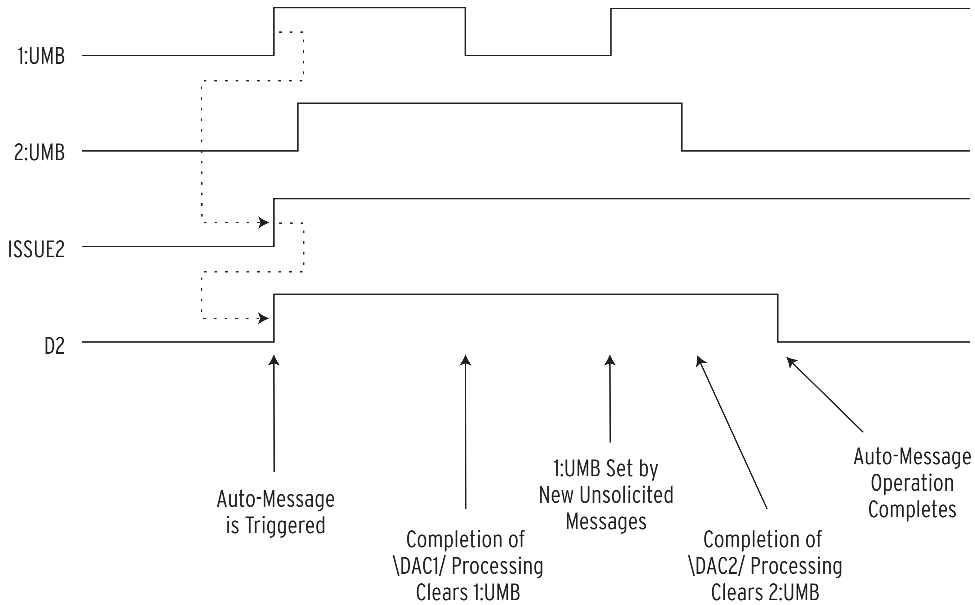


Figure 7.6: Trigger Lock-Out Problem

You can prevent this problem by writing a SELOGIC Control Equation that forces the trigger condition to reset itself immediately.

The following SELOGIC Control Equation adds !D2 to the previous equation:

ISSUE2 = 1:UMB*!D2+2:UMB*!D2

Now, as shown by Figure 7.7, the trigger condition will only be true momentarily; then it will retrigger upon completion of the message processing.

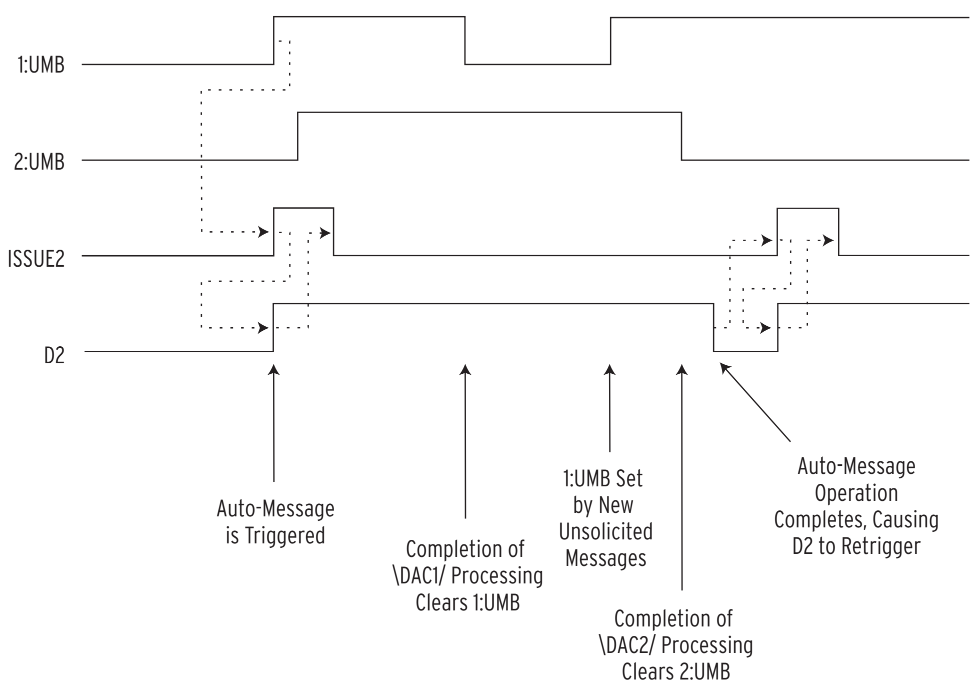


Figure 7.7: Forcing Re-triggering Avoids Trigger Lock-Out

Processing Sequence

You may need to consider the order in which SELOGIC Control Equations are processed to fully understand their operation and thereby ensure the desired result. When a SELOGIC Control Equation contains, as one of its terms, the result of another SELOGIC Control Equation, the order in which the equations are processed may affect the result. For example, consider three SELOGIC Control Equations, A, B, and C, that are processed in alphabetic order. It takes 1 µs to process each equation, and the group is processed every 15 ms. If SELOGIC Control Equation B contains the results of equation A, the results of B will be current (within 1 µs) because A was processed as part of the current process cycle. However, if equation B contains the results of equation C, the results of B will not be current because the results of C are from the previous process cycle, which is now 15 ms old.

The SEL-2020 processes SELOGIC Control Equation in the following order and frequency (see Figure 7.8 for an illustration of this processing sequence):

Symbol	Period	Description	Order
0	3.9 ms	Output SELOGIC Control Equations	OUT1 to OUT4
I	15.6 ms	Intermediate Logic	V,W,X,XT,Y,YT,Z,ZT
1-16	15.6 ms	Port Logic (e.g. 3 = Port 3 Logic)	SBR1, SBR2, …, SBR16, CBR1, CBR2, …, CBR16 SRB1, SRB2, …, SRB16, CRB1, CRB2, …, CRB16, ISSUE1 to ISSUE12, ISSUE1A to ISSUE3A, BR1, BR2, …, BR16, RB1, RB2, …, RB16

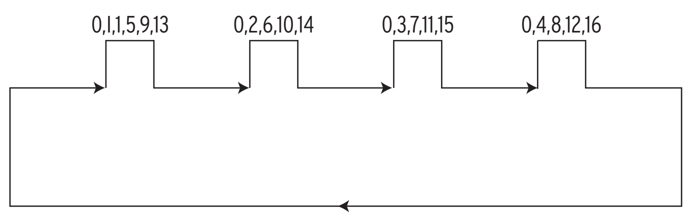


Figure 7.8: Processing Sequence Illustration

To illustrate the effects of the processing sequence, consider the following equations:

W=V	Equation 1
V=W	Equation 2
ISSUE1=1:UMB*!D1	Equation 3

In Equation 1, V is processed before W, so W will always exactly match V in value. However, in Equation 2, V will always lag W by 15.6 milliseconds because V is processed before W; V is being assigned the value W was set to during the last processing interval. In Equation 3, the issue condition will be true for one processing interval, because D1 is found based on the ISSUE1 value; so the D1 used in the equation will be the result of the previous processing interval's computations.

TABLE OF CONTENTS

TABLES

SECTION 8: MESSAGE STRINGS

INTRODUCTION

This section provides information about the characters, special sequences of characters, and pre-defined strings that you can use in a number of SEL-2020 settings. At the end of this section and also on a blue pull-out card at the end of the book is a summary list of special characters and pre-defined strings.

OVERVIEW

A string is a sequence of characters that make up part, or all, of a message command or identifier label. Each character may be an ASCII printable character or any 8-bit code that represents a nonprintable character. You use these strings in the following ways:

- Device and Port IDs, termination strings, and modem startup strings in Port configuration using the SET P command.
- Startup sequence for an IED and message strings in auto-messages using the SET A command.
- User-defined commands and responses using the SET U command.

Note: You should avoid using LMD prefix characters in Master port user-defined commands. For an explanation of LMD and a list of LMD prefix characters see ***Appendix C: LMD Protocol.***

Message strings consist of literal characters, special sequences, and pre-defined strings. Literal characters include both ASCII printable and non-printable characters. Special sequences are strings that are interpreted to have a special meaning when they are used, such as dial a particular phone number, or output a specified set of database data. Pre-defined strings are used with SEL IEDs to represent certain predefined operations, such as 20METER means collect meter data in best method available for attached device. The following sections further describe these types of message sequences.

LITERAL CHARACTERS

Message strings typically contain some literal characters. These consist of both ASCII printable characters and non-printable characters. Printable characters (except '\') are entered into a string by directly entering the character (depressing the key for that character on your keyboard). You can also enter any character based on its 8-bit code. To enter a non-printable character (or special sequence strings) using printable characters, you must use a special sequence to indicate that you are entering something other than a printable character. These sequences always begin with a backslash ('\'). Table 8.1 shows the format of the various special character sequences available.

The following are examples of simple strings:

“Another device”	A literal string for “Another device”
“TRIG\nY\n”	String for TRIG<ENTER>Y<ENTER>
“\002HI\\BOB\003”	String for <STX>HI\BOB<ETX>

You can use the quote character to define the beginning and end of a string. If you don’t, the SEL-2020 will put the string in quotes anyway. The only exception is for pre-defined strings discussed later in this section.

Table 8.1: Special Characters for Use in Strings

Character	Comments
\”	The SEL-2020 interprets this as a quote character in a string, as distinguished from quotes at the beginning and end of a string.
\\	The SEL-2020 interprets this as a backslash character in a string.
\n	ENTER sequence (CR/LF combination, just CR on SEL IED ports).
\0xx	The SEL-2020 interprets this as an 8-bit character, where xx = an ASCII character value in hexadecimal; (e.g., \004 is ASCII End-of-Text, EOT, character). See ***Appendix D: ASCII Reference Table*** for conversion table.
\ <ENTER>	Use to continue a string to the next line.

SPECIAL SEQUENCES

The SEL-2020 is pre-programmed to interpret special sequences of characters for special purposes. You can use these special character sequences in auto-messages or user-defined commands to control the data that are referenced by the message and to control the response initiated by the message. These special sequences are particularly well suited for use with non-SEL IEDs and devices.

Message Sequences

You may use the special character sequences listed in Table 8.2 in automatic messages, configured with SET A, and special-purpose user-defined command responses, configured with SET U.

Table 8.2: Special Message Sequences for Strings

Character	Comments
\CSx/	Begin checksum calculation. x specifies checksum type. c=CRC-16. Based on the polynomial $X^{16} + X^{15} + X^{2} + 1$ b=8-bit checksum. Sum all bytes and take least significant byte. w=16-bit checksum. Sum all bytes and take two-byte result.
\CE/	Stop checksum calculation.
\COyz/	Output checksum. y specifies format. a=ASCII-hexadecimal. b=binary. x=binary with XON/XOFF encoding z specifies byte order. h=high byte first. l=low byte first.
\DA[C][P]n/	Output unsolicited message queue data for Port n. C= if included, clear the queue after the read. P= if included, only read characters that have been added to the unsolicited message queue since the last time the message queue was read. P and C options are mutually exclusive.
\Dt/	Data item output for READACK setting (SET U). t specifies the data format. b=binary word (2 bytes). h=ASCII-hexadecimal word (4 digits). c=binary bytes (1 byte). g=ASCII-hexadecimal byte (2 digits).
\Fp:r[;C[A]]/	Output formatted region data. p=the port number. r=the data region. ;C=clear archive item after it is read. ;CA= read the entire queue of records from an archive region and clear them as they are read. **CAUTION** Frequent archive record clearing may exceed EEPROM capabilities. See the discussion in the Archive Data Region subsection of ***Section 9: Database***. If you completely clear an archive region that contains a large number of records (thousands of records), it may take a few minutes for the clearing to complete. During this time, most SEL-2020 automatic data collection will be suspended.

Table 8.2: Special Message Sequences for Strings (continued)

Character	Comments
\Idstr[:h]/	Initiate a phone call using the given dial string. Only applies to modem ports. dstr= a dial string of up to 40 characters. Typically consisits of ATDT and phone number. See ***Appendix B: Optional Internal Modem Information*** or your modem user's manual for more information on dial strings. h= hang up flag. Set to Y to automatically hang up modem at end of string. Set to N to leave modem connected. You will need to send a separate message later to disconnect the modem (i.e., "\MATH"). (If not included, the default is Y.)
\M	Modem Escape String. Sends modem escape sequence to force a modem into command mode. (The modem escape sequence is a 2-second pause, issuance of the string "+++", and another 2-second pause.) Only available on modem ports. Literal characters in a string after this sequence will be output, even if the carrier detect input is low.
\Rt;saddr[;n]/	Output register contents. t specifies the data format. b=binary word (2 bytes). c=binary byte (1 byte). h=ASCII-hexadecimal word (4 digits). g=ASCII-hexadecimal byte (2 digits). f=float in ASCII. i=integer in ASCII. u=unsigned integer in ASCII. x=binary byte with XON/XOFF encoding. y=binary word with XON/XOFF encoding saddr= register address, using any valid register access method. (See ***Section 9: Database***.) n= specifies how many registers to read. Data items are delimited by spaces for all but b and c formats. One (1) is assumed if you do not specify.
\SP/	Suppress prompt (on Master port). Do not display new prompt after message contents.
\Td/	Time delay; use this code to place a delay within string output. d= time in seconds and may be specified as decimal fraction. (This time delay will be rounded to the nearest 1/32 of a second.) Time must be in the range of 0.03 - 2047.

Table 8.2: Special Message Sequences for Strings (continued)

Character	Comments
\W;saddr;n,daddr/	Unsolicited database write. Applies only to ports where DEVICE=MASTER or SEL, and PROTOCOL=SEL. Unsolicited Write messages have a binary format and are interleaved within ascii message exchanges. saddr= Source register starting address, using any valid register access method. The source address range may be any database region other than the Archive region (A1-A3). (See ***Section 9: Database***.) n= Specifies how many registers to write. Number of registers must not exceed 115. daddr= Destination SEL-2020/2030 User region address, using any valid User region address (F800h-FFFFh). (See ***Section 9: Database***.) Note: Since the destination starting address refers to allocated memory within a separate SEL-2020/2030, there is no verification that the destination User region memory exists. Use the SET A command to adjust the User region memory size of a destination SEL-2020/2030. (See ***Section 6: Settings***.)

The following are examples of using special message sequences in strings:

MESG1="\F1:METER/"

Output the formatted meter data from Port 1. The screen below shows a sample response to this message.

```
Port 1,  Data Region METER   Data

_YEAR = 1995  DAY_OF_YEAR = 1 (01/01)  TIME = 01:59:37.859
IA(A) =   2374.623,   102.078  IB(A) =   2353.747,   -17.810
IC(A) =   2369.258,  -137.949  VA(V) =  11278.516,   103.606
VB(V) =  11289.020,   -16.545  VC(V) =  11270.235,  -136.424
IAB(A) =   4092.593,   131.987  IBC(A) =   4093.101,    12.229
ICA(A) =   4107.771,  -107.898  VAB(V) =  19558.934,   133.546
VBC(V) =  19524.914,    13.488  VCA(V) =  19524.873,  -106.397
PA(MW) =     26.773  QA(MVAR) =      0.714  PB(MW) =     26.565
QB(MVAR) =      0.587  PC(MW) =     26.693  QC(MVAR) =      0.711
P(MW) =     80.030  Q(MVAR) =      2.012  I0(A) =      7.170,   135.000
  I1(A) =   2365.875,   102.106  I2(A) =      5.750,    40.418
V0(V) =      7.299,   -80.537  V1(V) =  11279.251,   103.546
V2(V) =     13.106,   163.608
```

MESG2="DATE \Ri;1:GLOBAL:MONTH//\
\Ri;1:GLOBAL:DATE//\Ri;1:GLOBAL:_YEAR/\n"

Output SEL IED date command, with date being read from global region of Port 1's database. Example output from this:
DATE 5/2/1995<CR><LF>.

MESG3="\IATDT15093321890/\T5/\DAC7/"	Initiate a phone call by issuing embedded dial string and waiting for connect indication from modem, wait 5 seconds after connection, output unsolicited message data from Port 7, and clear Port 7's unsolicited message buffer. The phone call will be placed, even if there is no data to send (the unsolicited message buffer is empty). The connection will be dropped once the transfer is complete.
MESG4="\CSC/\002\RH;12:USER:0;100/\003\CE/,\COah/\n"	Output <STX> followed by Port 12 User Region data and <ETX>, followed by comma and CRC-16 checksum displayed in ASCII hexadecimal format and then <CR><LF>. The \CSc/ and \CE/ strings indicate that the CRC-16 checksum is calculated on all of the data output from the <STX> through the <ETX>.

Parsing Sequences

You use the SET U command to create basic and complex user-defined message strings that the SEL-2020 will recognize. Basic user-defined commands have a fixed character sequence. The SEL-2020 will recognize a basic message from an attached device only if that message matches the user-defined message character sequence exactly, in both form and content.

For more advanced applications, you can use parsing sequence characters to develop a user-defined message that permits the message sent from the attached device to vary in content, provided it matches the message format exactly. You can also use parsing sequences to construct a single user-defined message string. This string format can recognize messages having a partially fixed character sequence with a "wildcard" format. Refer to Table 8.3 for parsing sequence characters you can use with the SEL-2020.

Table 8.3: Special Parsing Sequences for Strings

Character	Comments
\At/	Register address. For READ and WRITE settings only. t specifies the address format. b=binary (2 bytes). a=ASCII-hexadecimal (4 digits).
\Dt/	Data item. For WRITE setting only. t specifies the data format. b=binary word (2 bytes). h=ASCII-hexadecimal word (4 digits). c=binary bytes (1 byte). g=ASCII-hexadecimal byte (2 digits).
\Pt/	Port number. For TRANS, READ, and WRITE settings only. t specifies the Port number format. b=binary (1 byte). a=ASCII-hexadecimal (2 digits).
\X[X]/	Ignore character. \X/ indicates ignore one character. \XX/ indicates ignore all characters following until the next defined character is encountered.

The following are examples of using special parsing sequences in strings:

CMD1="In the\XX/"	The CMD1 bit will assert whenever a string that begins with "In the" is received at the SEL-2020 Port set with this user-defined message.
WRITE="W\Pa/@\Aa/=\Dh/"	Creates a write command that the SEL-2020 uses to recognize data in a special format. In this example, the string containing the data must begin with a W, followed by a Port number, an @ symbol, a database address, an = character, and finally the data. For instance, to write 0 (zero) to Port 8, address F800h, you would have to send the string "W08@F800=0000" to the SEL-2020.

PRE-DEFINED STRINGS

When working with SEL relays, the SEL-2020 includes some pre-defined strings you can use in SET A auto-messages to collect data. The SEL-2020 also includes four pre-defined strings you can enter as SET U user-defined commands to recognize automatic messages sent from an SEL relay. Table 8.4 lists the pre-defined strings you can use on auto-configured SEL IED ports for data collection (SET A MESGx settings). Table 8.5 lists other pre-defined strings that are available regardless of the port type. Table 8.6 lists pre-defined strings you can use on SEL IED ports to watch for unsolicited messages (relay auto-messages).

Table 8.4: Pre-Defined Strings for Auto-Messages with Auto-Configured SEL IEDs

String	Comment
20METER	Send ASCII meter or *Fast Meter* command, as appropriate.
20DEMAND	Send ASCII demand meter or fast demand meter command, as appropriate.
20TARGET	Send ASCII target command sequence or *Fast Meter*, as appropriate. **Note**: When the SEL-2020 collects target data from relays that do not have *Fast Meter* capability, the TARGET commands sent by the SEL-2020 may momentarily modify the front-panel targets on the relays—just as if you were sending the target command to the relay without the SEL-2020.
20HISTORY	Send ASCII history command.
20STATUS	Send ASCII status command.
20BREAKER	Send ASCII breaker command.
20EVENT	Send ASCII request for standard (4 sample/cycle) event report. Stored in a parsed format. (Refer to the following subsection for some additional features.)
20EVENTS	Send ASCII request for standard (4 sample/cycle) event report. Stored in a literal format. (Refer to the following subsection for some additional features.)
20EVENTL	Send ASCII request for long (16 sample/cycle) event report. Stored in a literal format. (Refer to the following subsection for some additional features.)

Table 8.5: Other Pre-Defined Strings for Auto-Messages

String	Comment
20USER	No message is sent, but data from User Region is copied to this region.

Table 8.6: Pre-Defined Strings for General-Purpose User-Defined Commands with SEL IEDs

String	Comment
20EVENT	Recognize summary event reports received from SEL relays and trigger with delay. Will continue to re-trigger until all reports are collected.
20EVENTQ	Recognize summary event reports received from SEL relays and trigger immediately.
20STATUS	Recognize status messages received from SEL relays.
20GROUP	Recognize group switch messages from SEL relays.

20EVENT Features

Because SEL relays may trigger multiple event reports in rapid succession, the SEL-2020 has special features based on these triggers to facilitate collecting event reports. To take advantage of these special features, you must set 20EVENT as a user-defined command with SET U. The SEL-2020 then keeps track of the number of summary event reports received from the SEL relay on that port. You must then set MESG3 or MESG3A to 20EVENT, 20EVENTS, or 20EVENTL. The SEL-2020 will then collect the oldest unread event report from the SEL relay. The CMDx bit corresponding to the 20EVENT command will continue to retrigger every 5 minutes as long as there are uncollected event reports. (To have the CMDx bit trigger immediately on each unsolicited summary event report, use the user-defined command 20EVENTQ.) The number of reports left to read is visible in the Local region of the port database.

These features can be used to collect and process event reports in a number of ways. Examples 4, 5, and 6 in ***Section 4: Job Done Examples*** illustrate using these features to collect event reports into archive memory, to print them, and, once a day, to call out to a remote computer to upload the event reports. The following example illustrates collecting event reports and calling them out when you do not have archive memory installed. Consider a relay on Port 1 and modem on Port 8 with the following settings:

```
SET U 1

    CMD1=20EVENT

SET A 1

    ISSUE3=CMD1*!8:D1
    MESG3=20EVENT

SET A 8

    ISSUE1=!1:D3
    MESG1="\IATDT15093321890/\F1:D3/"
```

Consider what happens when the relay triggers three event reports in rapid succession. The 1:CMD1 bit triggers collection of an event report. Because the SEL-2020 received three summary event reports, the SEL-2020 collects the third event report. After the SEL-2020 finishes collecting this event report, the modem initiates a phone call and uploads the event report. Every 5 minutes, the SEL-2020 retriggers the 1:CMD1 causing the next event report to be collected and transferred via modem, until all three event reports have been collected and transferred.

If the modem port is unsuccessful at initiating a phone call when the next 1:CMD1 trigger occurs, the !8:D1 term in the event report collection trigger equation prevents a new event report from being read until the event report has been successfully transferred. The 1:CMD1 bit will continue to retrigger every 5 minutes until all unread event reports are collected.

MODEM DIAL-OUT PROCESS

The SEL-2020 can dial out to a remote PC, terminal, or IED through an attached or internal modem. This feature is useful to automatically transfer data from the SEL-2020 database to a remote location or to acquire data from a remote device. With the SET A command, set an ISSUEn message trigger to define the condition that initiates the dial-out process, and set a MESGn to define the message content and data.

The ISSUEn trigger condition can be based on time and/or day-of-week, or any logic condition using global and local elements in the SEL-2020 database collected from attached devices. The MESGn message string must begin with a \I.../ special string sequence, followed by the data (or data request) and/or data output strings, \R.../ or \F.../, that define the message to be sent.

The \I special string sequence initiates the dial-out process through the modem using the provided dial string. For example \IATDT15093321890/ would dial the SEL factory. The SEL-2020 will wait up to 60 seconds for a carrier signal from the remote modem, which indicates the call has been completed. If a carrier signal is not detected in 60 seconds, the SEL-2020 will hang-up and wait 2 minutes before initiating a subsequent dial-out attempt. (Only two attempts are made before the SEL-2020 gives up on the message.) You must, therefore, set the remote modem to answer a call in less than 60 seconds. The SEL-2020 data are transferred when a successful connection is made.

SEL-2020 STRINGS

Special Characters for Use in Strings

Character	Use	Comment
\"	A	Quote character. Use to insert a quote character in a string.
\\	A	Backslash character. Insert a backslash character in a string.
\n	A	New line character (CR/LF combination, just CR on SEL IED ports).
\0xx	A	Insert any 8-bit character. xx = A character value in hex; (e.g., \004 is ASCII EOT character. See ***Appendix D: ASCII Reference Table*** for ASCII conversion table.)
\<ENTER>	A	Use this sequence to continue a string to the next line.
\At/	I*	Register address. t= specifies the address format: b=binary (2 bytes) a=ASCII-hex (4 digits)
\Csx/	O	Begin checksum calculation x specifies checksum type c=CRC-16 b=8-bit checksum w=16-bit checksum
\CE/	O	Stop checksum calculation
\COyz/	O	Output checksum y specifies format a=ASCII-hexadecimal b=binary x=binary with XON/XOFF encoding z specifies byte order h=high byte first l=low byte first
\DA[C][P]n/	O	DA=output unsolicited message queue data for Port n; C= if included, clear the queue after the read; the data are handled as set of characters. P= only output characters not previously output; mutually exclusive with C parameter.
\Dt/	I* or READACK	D=data item t=specifies the data format: b=binary word (2 bytes), c=binary bytes (1 byte), h=ASCII-hex word (4 digits), g=ASCII-hex byte (2 digits).
\Fp:r[;C[A]]/	O	F=Output formatted region data. p= the port number. r= the data region. ;C= clear archive item after it is read; CA=read the entire queue of records from an archive region and clear them as they are read.
\Idstr[:h]/	O	Initiate a phone call using the given dial string. Only applies to modem ports. dstr= a dial string of up to 40 characters. Typically consists of ATDT and phone number. h= hang up flag. Y to hang up at end of message, N to stay on-line.
\M	O	Issue modem escape sequence. Only applies to modem ports.
\Pt/	I*	P=Port number t=specifies the port number format: b=binary (1 byte), a=ASCII-hex (2 digits)

Character	Use	Comment
\Rt;saddr[;n]/	O	R=Output register contents t=specifies the data format: b=binary word (2 bytes), c=binary byte (1 byte) g=ASCII-hex byte (2 digits), h=ASCII-hex word (4 digits) f=float in ASCII i=integer in ASCII u=unsigned integer in ASCII x=binary byte with XON/XOFF encoding y=binary word with XON/XOFF encoding saddr=register address, using any valid register access method. n= specifies how many items to read. Data items are delimited by spaces for all except b and c formats. One is assumed if you do not specify.
\SP/	O	Suppress prompt (on Master port). Do not display new prompt after message contents.
\Td/	O	Time delay; use this code to place a delay within string output; d=time in seconds and may be specified as decimal fraction. Time must be in the range of 0.03 to 2047.
\W;saddr;n,daddr/	O	Unsolicited database write. Applies only to ports where DEVICE=MASTER or SEL, and PROTOCOL=SEL. saddr= Source register starting address, using any valid register access method. The source address range may be any database region other than the Archive regions (A1-A3). n= Specifies how many registers to write. Number of registers must not exceed 115. daddr= Destination SEL-2020/2030 User region address, using any valid User region address (F800h-FFFFh).
\X[X]/	I	X= Ignore character. \X/ indicates ignore one character. \XX/ indicates ignore all characters following until the next defined character is encountered.

Use code:
A=All messages I=Input messages O=Output messages
*Only usable in special-purpose user-defined commands.

Pre-Defined Strings for Auto-Messages with Auto-Configured SEL Relays

String	Comment
20METER	Send ASCII meter or fast meter command, as appropriate.
20DEMAND	Send ASCII demand meter or fast demand meter command, as appropriate.
20TARGET	Send ASCII target command sequence or fast meter, as appropriate.

Note: When the SEL-2020 collects target data from relays that do not have fast meter capability, the TARGET commands sent by the SEL-2020 may modify the front-panel targets on the relays--just as if you were sending the target command to the relay without the SEL-2020.

String	Comment
20HISTORY	Send ASCII history command.
20STATUS	Send ASCII status command.
20BREAKER	Send ASCII breaker command.
20EVENT	Send ASCII event command. Store in parsed format.
20EVENTS	Send ASCII event command. Store in literal format.
20EVENTL	Send ASCII long event command. Store in literal format.

Pre-Defined Strings for Auto-Messages

String	Comment
20USER	Copy user region data to this region.

Pre-Defined Strings for General-Purpose User-Defined Commands with SEL Relays

String	Comment
20EVENT	Recognize summary event reports received from SEL IEDs (delay between triggers).
20EVENTQ	Recognize summary event reports received from SEL IEDs (trigger immediately).
20STATUS	Recognize status messages received from SEL IEDs.
20GROUP	Recognize group switch commands from SEL IEDs.

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SECTION 9: DATABASE

INTRODUCTION

The SEL-2020 database contains status information and data collected from devices attached to the 16 rear communication ports. This section describes the structure of the database and the various ways data within the database can be accessed.

DATABASE STRUCTURE

The SEL-2020 data area includes a database for each of the 16 rear communication ports. Each port database consists of up to 15 regions, including Global (GLOBAL), Local (LOCAL), Unsolicited Message Buffer (BUF), eight Data regions (D1 to D8), three Archive regions (A1 to A3), and a User data region (USER). Global, Local, and User regions are available on all used ports. The unsolicited message buffer (BUF) and Data regions are available on ports with SEL IED and other IED device types. The Archive data regions are available on IED ports if the SEL-2020 is equipped with optional nonvolatile Flash memory. The first data region (D1) and Archive data region (A1) are available on Master ports for use with the 20USER setting (see ***Section 8: Message Strings*** for more information). Figure 9.1 illustrates the overall database structure.

Table 9.1 provides detailed information about each port's database. More detailed information about each region is located in this section under Region Descriptions.

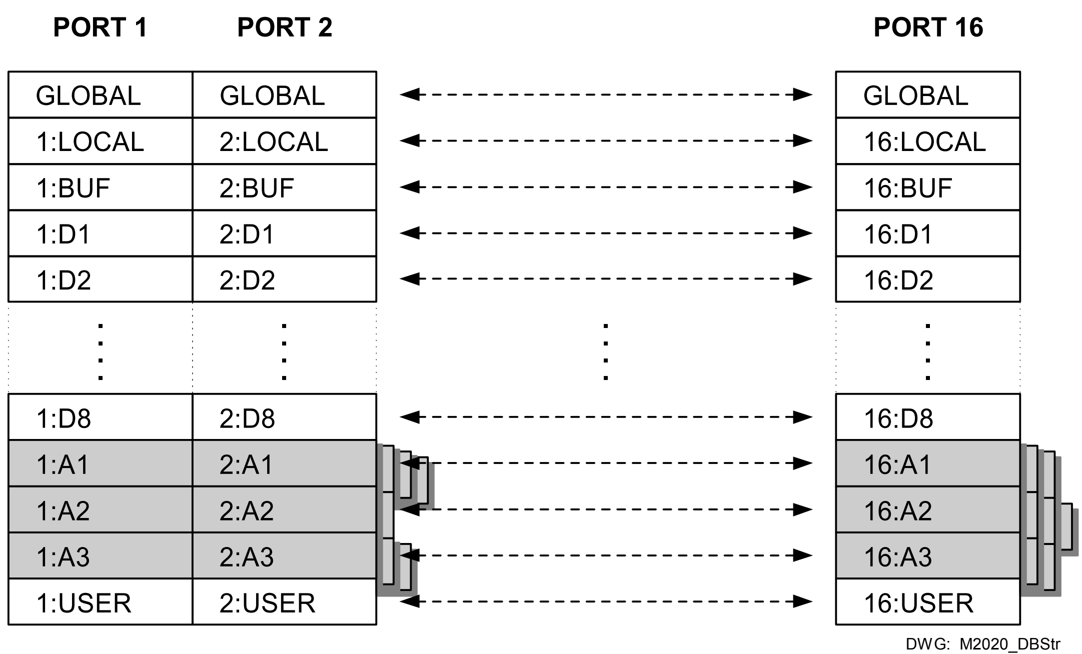

Figure 9.1: Overall Database Structure

The region sizes shown in Table 9.1 indicate the maximum amount of data that can be stored in each region. The actual data stored in each region of each port depends on the settings you apply using the SET A command.

If you set AUTOBUF=Y on a port, unsolicited messages are stored in the BUF region until the region is cleared, or until the region is completely filled. When the BUF region is filled, the newest data will overwrite the oldest data as they are received.

The data regions D1 to D8 store data solicited by messages you create with the ISSUEx and MESGx settings. The data you solicit using "20" messages are parsed automatically in the associated data region. All of the "20" message responses will fit in any of the data regions, except the response to the 20EVENT, 20EVENTS, and 20EVENTL messages. These messages elicit an event report from an SEL relay. Only the D3 and A3 data regions are large enough to hold an entire 20EVENT or 20EVENTS event report response and only the A3 region is large enough to hold a 20EVENTL event report response.

You control the size of the data solicited with non-"20" messages based on the parsing method you choose and the size of the message response you define with the NUMx setting. If you specify a size larger than the region size, the SEL-2020 will respond immediately with an "Out of Range" message.

You can only reference those portions of regions that have data assigned. If you reference an address that is not assigned, the SEL-2020 will respond with a message that the data address does not exist.

You allocate all, or a portion, of the User data region with the SET A command, or the SET M command automatically allocates the User data region. You must use the STORE command, user-defined write command, or Modbus write function code to put the data into this area. You may also use SET M to establish automatic storage of data into the User region.

Archive regions are unique from other regions. Where all other regions contain only a single record, the archive regions contain a queue of records. From a data access point of view, the archive regions appear to only contain the oldest record. But, as soon as it is cleared, the next oldest record will appear. The number of archive records that can be stored is only limited by the amount of nonvolatile Flash memory.

Table 9.1: Database Regions for a Single Port

Region	Address From	Address To	Register Size
Global Data	0000h	07FFh	2 k
Local Data	0800h	0FFFh	2 k
BUF (Unsolicited Message Queue)	1000h	1FFFh	4 k
Data Region 1	2000h	27FFh	2 k
Data Region 2	2800h	2FFFh	2 k
Data Region 3	3000h	47FFh	6 k
Data Region 4	4800h	4FFFh	2 k
Data Region 5	5000h	57FFh	2 k
Data Region 6	5800h	5FFFh	2 k
Data Region 7	6000h	67FFh	2 k
Data Region 8	6800h	6FFFh	2 k
Archive Data Region 1	7000h	77FFh	2 k
Archive Data Region 2	7800h	7FFFh	2 k
Archive Data Region 3	8000h	F7FFh	30 k
User-Defined Data Region	F800h	FFFFh	2 k

Archive regions are only available if the SEL-2020 is equipped with optional nonvolatile Flash memory. The nonvolatile nature of these data regions, combined with the unique capability to contain multiple records, make them ideally suited to long-term data collection and storage. You can use the VIEW command to view the data associated with any record in the Archive region queue; all other commands read only the oldest record. See the memory calculation procedure in ***Appendix E: Planning Sheets*** for more information.

The SEL-2020 assigns Data and Archive regions alternate labels or names based on the data stored in them. For instance, if you use the 20METER message to collect and store SEL relay meter data in Data region D1, that region is assigned the alternate label “METER”. Use the MAP command to view a list of regions on a port and any alternate labels associated with some of the regions.

You can also use the MAP command to show the detailed structure of any region.

DATA STORAGE FORMATS

Data are contained within the SEL-2020 database in various formats. Character items and strings are stored with each character requiring one register but only using the lower byte of the register; the high byte is always zero. Any unused characters in a string are set to a value of zero. Integer items require a complete register. Real numbers are stored in IEEE single-precision floating-point format in two registers with the most-significant word stored in the lower-addressed register of the two. (See Figure 9.2 for an illustration of how these data types map into the registers.) You can use the VIEW and MAP commands to identify the data storage format and see the stored data. You can use message strings in an auto-message to transfer the data from the SEL-2020 to another device in virtually any format. See ***Section 8: Message Strings*** for more detailed information.

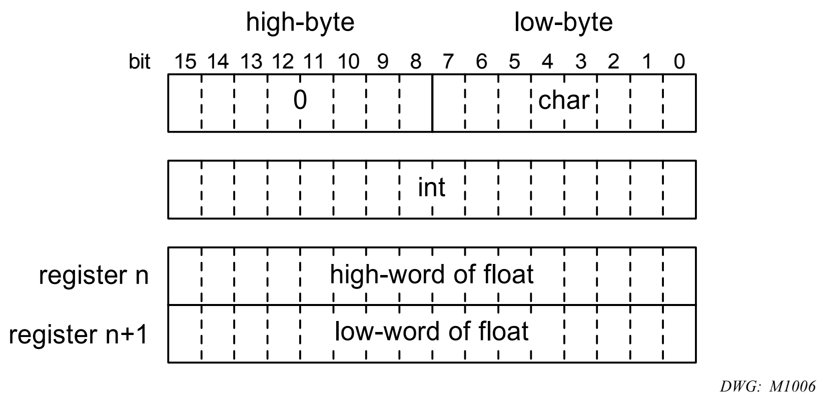

Figure 9.2: Register Usage for Different Data Types

REGION DESCRIPTIONS

Global Data Region (GLOBAL)

The Global data region includes the following data that are common to all ports: SEL-2020 FID string, status and configuration information, date and time, global element bits, and Port F status (see Table 9.2, Table 9.3, and Table 9.4). Each port database contains the same information in this region (e.g., 1:GLOBAL is the same as 2:GLOBAL).

Table 9.2: Global Data Region

Starting Address	Data Item Label	Data Type	Notes
0000h	FID	char[40]	Read-only.
0028h	STATUS	int	Bit for each type of failure; read-only. See Global Status Register subsection following this table.
0029h	CONFIG	int	Indicates SEL-2020 hardware configuration; read-only. See Configuration Register subsection following this table.
002Ah	_YEAR	int	i.e., 1994.
002Bh	DAY_OF_YEAR	int	1 through 365.
002Ch	MONTH	int	1 through 12.

Table 9.2: Global Data Region (continued)

Starting Address	Data Item Label	Data Type	Notes
002Dh	DATE	int	1 through 31.
002Eh	TIME(ms)	int[2]	Append two registers to get 32-bit time; register 2Eh has high-word, 2Fh has low-word; 0-86,399,999.
0030h	ELEMENTS	char[7]	Eight-bit character for each row. See Global Elements subsection following this table.
0037h	REMOTE_BIT_REG	int	See Remote Bit Control Register subsection following this table.
0038h	REMOTE_BITS	int	Directly operate all 8 remote bits. Lower byte corresponds to bits: bit 0 is R8, bit 1 is R7, … bit 7 is R1. The upper byte must be the complement of the lower byte for command to be accepted.
0039h	_YEARS	int	Years in the century. 0 through 99.
003Ah	_HOURS	int	Hours in the day. 0 through 23.
003Bh	_MINS	int	Minutes in the hour. 0 through 59.
003Ch	_SECS	int	Seconds in the minute. 0 through 59.
0400h	PORT_STATUS	int	Read-only. See Port F Status Register subsection following this table.
0401h	ALT_PORT	int	Port number Port F is in transparent communications with; 255 if not transparently connected; read-only.
0402h	NUM_MESGS	int	PORT F #Messages Received. Reset when port reset, or count exceeds 32767; read-only.
0403h	BAD_MESGS	int	PORT F #Bad Messages Received. Reset when previous field reset; read-only.
0404h	Unused		

Global Status Register

```
0000000  0 0 0 0 0 0 0 0 0
                         +15 V power supply failure
                         -15 V power supply failure
                         Unused
                         RAM failure
                         ROM failure
                         EEPROM failure
                         Flash failure
                         Set failure
                         Battery failure
                         Unused
```

See STATUS command for complete discussion of failure types.

Configuration Register

```
0000  0  000  10  10  000  1
                           1 = Modem
                           0 = No Modem

                           100 = I/O Board
                           000 = No I/O Board

                           01 = 256 k RAM
                           10 = 512 k RAM
                           11 = 1 Mb RAM

                           01 = 16 k EEPROM
                           10 = 32 k EEPROM
                           11 = 64 k EEPROM

                           000 = 0 k Flash
                           001 = 256 k Flash
                           010 = 1 Mb Flash
                           011 = 1.28 Mb Flash
                           100 = 2 Mb Flash

                           0 = 16 MHz CPU
                           1 = 20 MHz CPU

                           Not Used
```

Global Elements

Table 9.3 shows global elements. Table 9.4 lists definitions for global elements.

Table 9.3: Global Elements

Row	Global Elements							
0	SUN	MON	TUE	WED	THU	FRI	SAT	IRIG
1	V	W	X	XT	Y	YT	Z	ZT
2	R1	R2	R3	R4	R5	R6	R7	R8
3	PINAC	PCF	INAC	SDLY	*	*	*	SALARM
4	IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1
5	IN16	IN15	IN14	IN13	IN12	IN11	IN10	IN9
6	OUT1	OUT2	OUT3	OUT4	*	*	*	*

Row 0: Day-of-Week elements, SUN through SAT; one is asserted each day of the week; and the external IRIG-B status element (IRIG) is asserted when the SEL-2020 detects the external IRIG-B signal.

Row 1: Intermediate Variable elements, V, W, X, Y, and Z, are asserted when the corresponding intermediate logic equation is true; and associated timer bits, XT, YT, and ZT, are asserted when the pickup timer times out until the dropout timer times out.

Row 2: Remote elements, R1 to R8, are set, cleared, or pulsed by the CONTROL command.

Row 3: SEL-2020 Status elements indicate a port is inactive pending auto-configuration (PINAC); a port has failed power-up auto-configuration (PCF); at least one port is inactive because it is not responding or not responding correctly (INAC); and there has been at least one data collection missed since the last STATUS command (SDLY). The SALARM bit asserts for one second whenever there is a settings change, Access Level 2 is gained, a password is entered incorrectly on three successive attempts, or a password is changed.

Row 4: External Input elements, IN1 to IN8, are asserted when the associated external input is asserted (only available with optional I/O board).

Row 5: External Input elements, IN9 to IN16, are asserted when the associated external input is asserted (only available with optional I/O board).

Row 6: External Output elements, OUT1 to OUT4, are asserted when the associated external output contact operates (only available with optional I/O board).

All bit positions with an * are reserved for future use.

Table 9.4: Global Element Definitions

Element	Definition
SUN	Sunday Flag
MON	Monday Flag
TUE	Tuesday Flag
WED	Wednesday Flag
THU	Thursday Flag
FRI	Friday Flag
SAT	Saturday Flag
IRIG	IRIG-B Input Present Flag is set when IRIG-B input is sensed.
V	Intermediate Element V
W	Intermediate Element W
X	Intermediate Element Y
XT	X Element Timer Output
Y	Intermediate Element Y
YT	Y Element Timer Output
Z	Intermediate Element Z
ZT	Z Element Timer Output
R1	Remote Bit 1
R2	Remote Bit 2
.	.
.	.
.	.
R8	Remote Bit 8
PINAC	A port is in a Power-Up Inactive State
PCF	A port is in a Power-Up Configuration Failure State
INAC	A port is in an Inactive State
SDLY	A SELOGIC Control Equation automatic message operation has been missed on a port.
*	Unused
SALARM	Settings Change Alarm
IN8	Input Eight Element
IN7	Input Seven Element
.	.
.	.
.	.
IN1	Input One Element
IN16	Input Sixteen Element
IN15	Input Fifteen Element
.	.
.	.
.	.
IN9	Input Nine Element
OUT1	Output One Element
OUT2	Output Two Element
OUT3	Output Three Element
OUT4	Output Four Element
*	Unused

Available with Optional I/O Board

Remote Bit Control Register

```
00000000000   00   000

                        Bit Number
                        000 = R8
                        001 = R1
                        010 = R2
                        011 = R3
                        100 = R4
                        101 = R5
                        110 = R6
                        111 = R7

                        Operation
                        01 = set
                        10 = clear
                        11 = pulse

                            Time
               00000000001 = 1 sec
               00000000011 = 3 sec
                     .
                     .
                     .
example:

writing 0000000001111011 or 007Bh to register 0037h pulses remote
bit R3 for 3 seconds.
```

Port F Status Register

```
00000000  0  000  0  100

                            Device Type
                            100 = Master Port

                            1 = Transparent Mode
                            0 = Not Transparent Mode

                            Unused

                            1 = Modem Connected Remotely
                            0 = No Modem or Modem Disconnected

                            Unused
```

Local Data Region (LOCAL)

The Local Data Region contains information specific to the local port. This information includes port status, local elements (intermediate logic, general command receipt, select-before-operate flags), database status, select-before-operate registers, archive queue counters, device FID (for auto-configured SEL IED ports), and port ID setting. (See Table 9.5, Table 9.6, and Table 9.7 for detailed information).

The Local Data Region also contains the most recent fault location and type. These registers are only used if 20EVENT or 20EVENTQ is set as a user-defined command so that the SEL-2020 is watching for unsolicited summary event reports. Once the fault location and type are updated, the SEL-2020 will not update them again until 30 seconds elapse during which no unsolicited event reports are received. This allows the database to maintain the type and location of the initial fault.

Table 9.5: Local Data Region

Starting Address	Data Item Label	Data Type	Notes
0800h	PORT_STATUS	int	Read-only. See Port Status Register subsection following this table.
0801h	ALT_PORT	int	Port number this port is in transparent communications with; 255 if not transparently connected; read-only.
0802h	NUM_MESGS	int	#Messages Received. Reset when port reset, port inactive, or count exceeds 32767; read-only.
0803h	BAD_MESGS	int	#Bad Messages Received. Reset when previous item reset; read-only.
0804h	ARCHIVE_CNTRS	int[3]	Number of records in each archive region; read-only.
0807h	ELEMENTS	char[18]	Read-only. See Local Elements subsection following this table.
0819h	SBO_REGS	char[4]	Must write AAh then 55h to this register within 1 second to pulse SELOGIC Control Equations bit (SB01 through SB04 Table 9.7).
081Dh	COMMAND_REG	char	Number (1 through 8) of command bit (CMDx) to set; write-only.
081Eh	CLR_ARCH_REG	int	Write FE01h, FD02h, or FC03h to clear record in archive regions 1-3, respectively.
	⚠ CAUTION	Frequent archive record clearing may exceed EEPROM capabilities. See the discussion in the Archive Data Region subsection of ***Section 9: Database***.	
081Fh	FID	char[80]	FID string of attached SEL IED.
086Fh	PORTID	char[41]	Port ID setting.
0898h	EVENT_COUNT	char	Number of unread event reports. See 20EVENT Features subsection in ***Section 8: Message Strings*** for more information.
0899h	FAULT_LOC	float	Most recent fault location. Applies only when User-Defined Commands (SET U) include CMDn = 20EVENT or CMDn = 20EVENTQ.

Table 9.5: Local Data Region (continued)

Starting Address	Data Item Label	Data Type	Notes
089Bh	FAULT_TYPE	char[10]	ASCII string describing most recent fault type. Applies only when User-Defined Commands (SET U) include CMDn = 20EVENT or CMDn = 20EVENTQ.
08A5h	UNSOL_WRT	int	Number of Unsolicited Write messages received since last reset. Resets when count exceeds 65535, port reset, Status command execution or UW_TIME reset; read-only.
08A6h	UW_FAIL	int	Number of failed Unsolicited Write messages received since last reset. Resets when UNSOL_WRT or UW_TIME resets; read-only. Note: The UW_FAIL register represents the total number of message failures. Additional detail is reported when the UW_FAIL register is read using the default SEL-2020/2030 VIEW command (VIEW n LOCAL, where n represents port number). Failure counts are itemized and reported based on the following categories: • CRC Fail • Address Fail • Insufficient Memory • Busy • General Data Error
08A7h	UW_TIME(ms)	int[2]	Time period since last Unsolicited Write statistics reset. Use this value to calculate message success/failure rates. Append two registers to get 32-bit time; register 08A7h is high-word, 08A8h is low-word. Resets when count exceeds 4,294,967,296 (about 50 days) or UNSOL_WRT reset; read-only.
08A9h	UW_MAXTIME(ms)	int[2]	Maximum time between received Unsolicited Write messages. Append two registers to get 32-bit time; register 08A9h is high-word, 08AAh is low-word. Resets when UNSOL_WRT or UW_TIME resets.

Port Status Register

```
000000  0 0 0 0 0 0 0  000

Device Type
000 = Unused Port
001 = Printer Port
010 = Other IED Port
011 = SEL IED Port
100 = Master Port

0 = Not Transparently Connected
1 = Transparently Connected

0 = Port Active
1 = Port Inactive

0 = Auto-Configuration OK, if
    applicable
1 = Failed Power-Up Auto-
    Configuration

0 = Connected on Power-Up
1 = Inactive on Power-Up; Auto-
    Configuration Pending

0 = No Modem or Modem is
    Disconnected
1 = Modem is Remotely Connected

0 = M Settings Running
1 = M Settings Disabled

0 = Port Communications OK
1 = Unable to Communicate with
    Connected Device

Unused
```

The “Port Inactive” bit indicates a communications problem. Once the SEL-2020 has completed its power-up initialization, this bit sets whenever the connected device fails to respond correctly during the data collection process. The bit is cleared as soon as the SEL-2020 communicates successfully again with the device. The “Port Inactive” bit may be set and cleared regularly if the communications link is noisy.

The “Unable to Communicate with Connected Device” bit is set only when the SEL-2020 fails on 10 consecutive attempts to communicate with the connected device. The bit is cleared as soon as the SEL-2020 communicates successfully with the device. This bit generally indicates a major communications problem, as opposed to an intermittent problem.

See the STATUS command description for a more complete discussion of the various port status possibilities.

Local Elements

Table 9.6 shows local elements. Table 9.7 lists the definitions for all port-specific elements.

Table 9.6: Local Elements

Row	Local Elements							
0	CMD1	CMD2	CMD3	CMD4	CMD5	CMD6	CMD7	CMD8
1	SBO1	SBO2	SBO3	SBO4	CTS	XOFF	INAC	UMB
2	D1	D2	D3	D4	D5	D6	D7	D8
3	D9	D10	D11	D12	ARCH1	ARCH2	ARCH3	MSET
4	DLY1	DLY2	DLY3	DLY4	DLY5	DLY6	DLY7	DLY8
5	DLY9	DLY10	DLY11	DLY12	DLYA1	DLYA2	DLYA3	DLY
6	BR1	BR2	BR3	BR4	BR5	BR6	BR7	BR8
7	BR9	BR10	BR11	BR12	BR13	BR14	BR15	BR16
8	RB1	RB2	RB3	RB4	RB5	RB6	RB7	RB8
9	RB9	RB10	RB11	RB12	RB13	RB14	RB15	RB16
10	SBR1	SBR2	SBR3	SBR4	SBR5	SBR6	SBR7	SBR8
11	SBR9	SBR10	SBR11	SBR12	SBR13	SBR14	SBR15	SBR16
12	SRB1	SRB2	SRB3	SRB4	SRB5	SRB6	SRB7	SRB8
13	SRB9	SRB10	SRB11	SRB12	SRB13	SRB14	SRB15	SRB16
14	CBR1	CBR2	CBR3	CBR4	CBR5	CBR6	CBR7	CBR8
15	CBR9	CBR10	CBR11	CBR12	CBR13	CBR14	CBR15	CBR16
16	CRB1	CRB2	CRB3	CRB4	CRB5	CRB6	CRB7	CRB8
17	CRB9	CRB10	CRB11	CRB12	CRB13	CRB14	CRB15	CRB16

Row 0: Command elements, CMD1 to CMD8, are each associated with one of the eight user-defined commands. The associated CMD bit is asserted when the SEL-2020 receives the user-defined command.

Row 1: Select-Before-Operate elements, SBO1 to SBO4, assert when two specific messages are sent in proper time sequence. Clear-To-Send element, CTS, is asserted when the CTS line is "up"; Transmit-OFF element, XOFF, is asserted when the SEL-2020 receives an XOFF signal from the attached device; the inactive element, INAC, is set when the port is inactive; and the Unsolicited-Message-Buffer element, UMB, asserts when a message is stored in the port BUF region.

Row 2: Message trigger elements, D1 to D8, set when the associated trigger operation is pending or in progress.

Row 3: Message trigger elements, D9 to D12, and Archive region trigger elements, ARCH1 to ARCH3, set when the associated trigger operation is pending or in progress. M settings element, MSET, is asserted while the Math/Move equations for the port are executing.

Row 4: Message trigger delay elements, DLY1 to DLY8, assert when the associated message trigger element, D1 to D8, does not reset before the next trigger condition occurs, indicating a possible data collection delay or message error.

Row 5: Message trigger delay elements, DLY9 to DLY12 and DLYA1 to DLYA3, assert when the associated message trigger element, D9 to D12 or ARCH1 to ARCH3, does not reset before the next trigger condition occurs, indicating a possible data collection delay or message error.

Rows 6 - 7: Breaker bits (BR1 - BR16) may be associated with issuing breaker operate commands (OPEN/CLOSE) or may be used as latches for intermediate SELOGIC Control Equations. These bits are set by the SBR1 - SBR16 elements and cleared by the CBR1 - CBR16 elements.

Rows 8 - 9: Remote bits (RB1 - RB16) may be associated with issuing remote bit commands (CONTROL) or may be used as latches for intermediate SELOGIC Control Equations. These bits are set by the SRB1 - SRB16 elements and cleared by the CRB1 - CRB16 elements.

Rows 10 - 13: Set breaker (SBR1 - SBR16) and set remote bit (SRB1 - SRB16) set the corresponding breaker and remote bit elements, but may also be used as intermediate terms for SELOGIC Control Equations. These bits are controlled by logic equations (SET L) and by receipt of master port *Fast Operate* commands.

Rows 14 - 17: Clear breaker (CBR1 - CBR16) and clear remote bit (CRB1 - CRB16) clear the corresponding breaker and remote bit elements, but may also be used as intermediate terms for SELOGIC Control Equations. These bits are controlled by SELOGIC Control Equations (SET L) and by receipt of master port *Fast Operate* commands.

You can use the VIEW or TARGET command to show Local element status. The SEL-2020 TARGET command response will also display the status of relay elements received from an attached SEL relay in rows 18 and up, as if they were appended to the Local elements.

Table 9.7: Local Element Definitions

Element	Description
CMD1	User-defined command number one received flag.
CMD2	User-defined command number two received flag.
.	.
.	.
.	.
CMD8	User-defined command number eight received flag.
SBO1	Select-before-operate register one flag. Pulsed by writing AAh then 55h to register 0819h within 1.0 second of each other.
SBO2	Select-before-operate register two flag. Controlled by register 081Ah.
SBO3	Select-before-operate register three flag. Controlled by register 081Bh.
SBO4	Select-before-operate register four flag. Controlled by register 081Ch.
CTS	Follows the state of CTS input.
XOFF	Set when port has been disabled by remote device using XOFF character.
INAC	Set when port is inactive.
UMB	Data present in unsolicited message buffer flag.
D1	Auto-message one trigger.
D2	Auto-message two trigger.
.	.
.	.
.	.
D12	Auto-message twelve trigger.
ARCH1	Archive one auto-message trigger.
ARCH2	Archive two auto-message trigger.
ARCH3	Archive three auto-message trigger.
MSET	Set while Math/Move equations executing.
DLY1	Auto-message one trigger overrun flag.
DLY2	Auto-message two trigger overrun flag.
.	.
.	.
.	.
DLY12	Auto-message twelve trigger overrun flag.
DLYA1	Archive one auto-message trigger overrun flag.
DLYA2	Archive two auto-message trigger overrun flag.
DLYA3	Archive three trigger overrun flag.
DLY	Logical OR of DLY1-12 and DLYA1-3.
BR1	Local latch result which may be associated with Breaker 1.
BR2	Local latch result which may be associated with Breaker 2.
.	.
.	.
.	.
BR16	Local latch result which may be associated with Breaker 16.

Table 9.7: Local Element Definitions (continued)

Element	Description
RB1	Local latch result which may be associated with Remote Bit 1.
RB2	Local latch result which may be associated with Remote Bit 2.
.	.
.	.
.	.
RB16	Local latch result which may be associated with Remote Bit 16.
SBR1	Intermediate result which sets element BR1.
SBR2	Intermediate result which sets element BR2.
.	.
.	.
.	.
SBR16	Intermediate result which sets element BR16.
SRB1	Intermediate result which sets element RB1.
SRB2	Intermediate result which sets element RB2.
.	.
.	.
.	.
SRB16	Intermediate result which sets element RB16.
CBR1	Intermediate result which clears element BR1.
CBR2	Intermediate result which clears element BR2.
.	.
.	.
.	.
CBR16	Intermediate result which clears element BR16.
CRB1	Intermediate result which clears element RB1.
CRB2	Intermediate result which clears element RB2.
.	.
.	.
.	.
CRB16	Intermediate result which clears element RB16.

Unsolicited Message Queue (BUF)

The unsolicited message queue contains all unsolicited messages received from an IED. You must set AUTOBUF=Y with the SET A command for unsolicited messages to be stored here. Use the CLEAR m:BUF or VIEW m:BUF C commands periodically to clear the message queue so data are not overwritten. Alternatively, a \DACn/ string can clear these buffers.

At the top of the BUF region are two registers, Start Index and End Index (see Table 9.8), that contain register offsets. The Start and End Indices reference the beginning address of the circular buffer (1002h) to determine the address of the start and end of data. The first offset points to the address of the beginning of unread data. The second offset points to the address just beyond the last unread data. The SEL-2020 maintains the second offset. If you reference these data by region with VIEW, CLEAR, or \DAC string, the SEL-2020 maintains the first index for you. If you are directly reading the data (using VIEW by address, or user-defined READ command) you must maintain the first offset as data are read.

The remainder of the region acts as a circular character buffer beginning at address 1002h. Each register in the circular buffer contains one character. When the end of the buffer is reached, it wraps around to the beginning of the circular buffer (address 1002h) and continues. If the buffer gets full (end index catches up to start index), the oldest data will be overwritten.

Table 9.8: BUF (Unsolicited Message Queue) Organization

Starting Address	Data Item Label	Data Type	Notes
1000h	START_OFFSET	int	Offset from 1002h to first active character in buffer (0-4093).
1001h	END_OFFSET	int	Offset from 1002h to next available character location in buffer (0-4093); read-only.
1002h	BUFFER	char[4094]	Circular buffer of characters; Start and End indices indicate where nonerased information exists; read-only.

Data Regions (D1 - D8)

The Data regions hold data collected by the SEL-2020. The first four registers of each Data region hold the date and time the data were collected. The remainder of the Data region is for the collected data. Using the SET A command, you specify a parsing method for data. There are parsing methods defined specific to SEL relays for the following types of data:

- Demand meter
- Meter
- History
- Status
- Elements
- Breaker
- Event

The following parsing options are valid for any IED data:

- Extract and store integers.
- Extract and store floating points.
- Store response as character string.
- Store response as integer string.
- Store response as integer string while decoding XON/XOFF encodings.
- Ignore response.

The format of the data stored in a Data region depends on the parsing method and the type of device connected. Once you have set a Data region to collect a specific type of data, use the MAP command to determine how the data are organized and formatted. Refer to ***Section 6: Settings***, under SET A for more detailed information about parsing options.

Archive Data Regions (A1 - A3)

These regions are very similar to the data regions. However, in these regions, the data are stored in nonvolatile Flash memory. Each region acts as a queue, buffering multiple responses. Each record can be as large as the region. The only limit on the number of records you can store in an archive region is the amount of available non-volatile Flash memory. These data regions are only usable if optional nonvolatile Flash memory is installed in the SEL-2020. (Confirm the presence of nonvolatile Flash memory using the STATUS command.)

In the LOCAL Data Region of the database, counters are maintained for each Archive data region indicating the number of records currently queued up. You can view the archived data records with the VIEW command, or you can read the archived data records with an auto-message using the \F.../ formatted read message string. You can remove archived data records using the CLEAR or VIEW C commands, you can include the ;C or ;CA modifiers in a \F.../ string, or you can use the Clear Archive Register in the Local Data region.

!	CAUTION	Frequent archive record clearing may exceed EEPROM capabilities. Refer to the following paragraphs.

Carefully consider the method used for archive record clearing to ensure the SEL-2020 EEPROM does not experience premature failure. Every time an archive record(s) is cleared, a register corresponding to that port and region is updated. The EEPROM is guaranteed to support 100,000 writes; therefore, select a clearing method that will not clear any specific region more than 100,000 times.

The best way to minimize clearing operations is to use the CLEAR A command or the \F...;CA/ string to clear archive records on a periodic basis. These methods only cause one EEPROM update, while clearing a potentially large number of records. Use ***Appendix E: Planning Sheets*** to determine memory usage and necessary clearing frequency.

If the archive memory becomes full, the SEL-2020 will not store any new records until enough archive memory is freed up. Use the MEMORY command to check how full the memory is. You can use the planning guides in ***Appendix E: Planning Sheets*** to determine how much data will fit in the archive and plan your clearing method accordingly.

User-Defined Data (USER)

You can use this data region for whatever purpose you desire. When you are using DNP communications this is where the data is read from (see ***Appendix I: Distributed Network Protocol (DNP) V 3.00*** for more information). Data can be put in this data region by writing from a master device using either the STORE command or the user-defined data WRITE command. Data can also be stored in this data region automatically using the SET M command. Any port may then use this data in constructing messages. Use SET A to enable this region. SET M will also enable this region if it was not previously set using SET A.

ACCESS METHODS

You can access data contained within the database by function, region, register, or bit.

Access by Function

You can access much of the data within the database based on its function; you do not need to know where it is in the database to reference it. The following commands access database information by function:

CONTROL	Affects Global elements in Global region.
DATE	Accesses date information in Global region.
ID	Reads FID string from Global or Local region.
STATUS	Reads various Global and Local region items.
TARGET	Reads Global, Local, and Relay elements contained in Global, Local, and Dx regions.
TIME	Accesses time within Global region.

Access by Region

Access data by region when working with groups of associated data. To access by region, specify a port number and a region label. The region label may be the generic label or the data type, as given by the MAP command.

Table 9.9: Data Access by Region Labels

Generic Labels	Example Data Type Labels
GLOBAL	METER
LOCAL	DEMAND
BUF	TARGET
D1 through D8	STATUS
A1 through A3	FLOAT
USER	CHAR

The following commands use region access methods:

CLEAR

MAP

VIEW

The special message string \F.../ also uses region access.

Some examples of accessing data by region are:

VIEW 2:METER	Displays meter data from the Port 2 database.
MESG1="\F8:DEMAND/"	Defines the contents of MESG1 as formatted demand data from the Port 8 database.
CLEAR 7:A1	Clear the oldest record from region A1 of Port 7's database.

Access by Register

When you view a port database by register you are viewing a contiguous space of 64k registers. You reference a register in one of three ways:

Port Number:Address

Port Number:Region Label:Address Offset

Port Number:Region Label:Data Item Label

The STORE and VIEW commands support address accesses, as does the \R.../ special message string.

Consider accessing the year within the Global region. It can be referenced any of the following ways (the port number is arbitrary when you are accessing the Global region):

1:002Ah

1:GLOBAL:2Ah

1:GLOBAL:_YEAR

Some other examples are:

VIEW 5:1234h	An SEL-2020 command typed from the command line that displays the contents of Port 5, hexadecimal address 1234.
MESG1="\Rb;5:1234h/"	The same register and port number as above in a message string that defines the contents of Message 1 as register data found in that address in binary format.
MESG1="\Rf;5:METER:IA/"	Defines the contents of Message 1 as the IA data item of the meter data found in the Port 5 database in floating-point format.
STORE 8:USER:0 "Data"	Stores the string "Data" starting at first address of User data region on Port 8.

Often, you will wish to access multiple adjacent registers at once. The STORE command allows this by letting you store a set of data, starting at the specified address. Add the parameters NR and a count after the address in a VIEW command to display multiple registers. Add a semicolon and a count after the address within a \R.../ special message string to read multiple registers. The following examples illustrate multiple register access:

STORE 8:USER:0 5,7,9,11	Store integers 5,7,9, and 11 in first four registers of User region.
VIEW 5:LOCAL:ELEMENTS NR 6	View 6 registers, starting with first element register in Port 5's Local region.
MESG2= "\Rf;5:METER:IA;6/"	Read 6 registers (3 floats), starting with the IA register in the meter region of Port 5.

Access by Bit

Individual bits within the database can also be accessed. Five bit access methods are available:

Bit Label
Port Number:Bit Label
Port Number:Region Label:Bit Label
Port Number:Address:Bit Number
Port Number:Region Label:Address Offset:Bit Number

The first two access methods are short hand notations for the third method. When only a bit label is specified, the SEL-2020 searches the Global, then Local, and then TARGET regions for the bit. When only a port number and bit label are specified, the SEL-2020 searches the Local, then TARGET regions on the specified port for the bit.

The last two access methods use bit numbers. Bit numbers must be in the range 0 to 15 where 0 is the least-significant bit and 15 is the most-significant bit.

Bit access is primarily used within SELOGIC Control Equations but can also be used within SETM equations and by the VIEW and TOGGLE commands. Bits within archive regions may not be used in SELOGIC Control Equations nor by the TOGGLE command. They can still be examined using the VIEW command. You can view the bit labels using the TAR, MAP region BL, and VIEW region BL commands.

Consider accessing the local element CMD4 on Port 5 from the Port 5 settings. This bit can be referenced the following ways:

CMD4	Bit Label
5:CMD4	Port Number:Bit Label
5:LOCAL:CMD4	Port Number:Region Label:Bit Label
5:0807h:4	Port Number:Address:Bit Number
5:LOCAL:7:4	Port Number:Region Label:Address Offset:Bit Number

Some other examples are:

	ISSUE1=IN1	References Global IN1 element if the I/O board is installed; otherwise references IN1 bit in TARGET region, if it exists.
	VIEW 1:27L	View status of 27L bit on Port 1 within the TARGET region
or	VIEW 1:TARGET:27L	(27L does not exist in Local region).
	OUT2=5:TARGET:LOP	Causes OUT2 to follow the state of the LOP element in Port 5's TARGET region.
	OUT3=7:1234h:7	Causes OUT3 to follow the state of bit 7 (high bit of low byte) of register 1234h within the Port 7 database.
	X=9:D2:13h:Ah	Causes X to follow the state of bit 10 within the 19th register of Port 9's D2 region.

Within a SELOGIC Control Equation setting, if you reference a bit by address that does not exist, the SEL-2020 will respond with a warning message, but it will accept the setting.

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SECTION 10: MAINTENANCE

INTRODUCTION

This section describes the minimal maintenance steps you should follow to keep the SEL-2020 operating properly. This section also includes a guide to troubleshooting and alarm diagnosis.

CALIBRATION

Schweitzer Engineering Laboratories (SEL) performs a calibration of the SEL-2020 clock at the factory. You do not need to periodically calibrate the clock.

BATTERY REPLACEMENT

A battery maintains the clock (date and time) if the external DC source is lost or removed. The battery is a 3 V Lithium Carbon Monofluoride coin cell, IEC No. BR2335 or equivalent. At room temperature (25°C) the battery will discharge for 10 years at rated load.

The battery experiences a low self-discharge rate when the SEL-2020 is powered from an external source. If the source is lost or disconnected, the battery discharges to keep the internal clock going. The battery cannot be recharged.

⚠ CAUTION	There is danger of explosion if the battery is incorrectly replaced. Replace only with Ray-O-Vac® no. BR2335 or equivalent recommended by manufacturer. Dispose of used batteries according to the manufacturer's instructions.

Perform the battery replacement procedure if the SEL-2020 reports a battery failure. You will also notice that the time and date are incorrect. To change the battery, perform the following steps:

1. Remove power from the SEL-2020.
2. Remove any cables connected to Port F of the SEL-2020.
3. Remove the front-panel screws and front panel.

⚠ CAUTION	The SEL-2020 contains devices sensitive to electrostatic discharge (ESD). When working on the device with front or top cover removed, work surfaces and personnel must be properly grounded or equipment damage may result.

4. Locate the battery on the front left-hand side of the main board.

5. Remove the battery from beneath the clip and install a new one. The positive side (+) of the battery faces up.
6. Replace the front panel and front-panel screws and tighten securely.
7. Replace any cables removed from the SEL-2020.
8. Apply power to the SEL-2020, and set the date and time again. A battery failure will be reported the first time you power-up with a new battery because the date and time reported by the battery-backed clock will not be valid.

Alarm Conditions

The SEL-2020 will assert the ALARM contact for a variety of conditions. It will also assert the SALARM bit for a number of conditions. In SEL-2020 Communications Processors without I/O boards, the ALARM contact will assert whenever the SALARM bit asserts. In units with I/O boards, you will need to assign SALARM to an output contact, using SET G, if you want to monitor these conditions. Table 10.1 lists the various conditions that cause ALARM contact and SALARM operations.

Table 10.1: Alarm Conditions

Command or Condition	Asserts ALARM Contact	Asserts SALARM Bit	Comment
2ACCESS	if no I/O board	Yes	One second pulse when entering Access Level 2 and if password is entered incorrectly on three successive attempts.
ACCESS	if no I/O board	Yes	One second pulse if password is entered incorrectly on three successive attempts.
PASSWORD	if no I/O board	Yes	One second pulse when password is changed.
SET	if no I/O board	Yes	One second pulse on settings change.
COPY	if no I/O board	Yes	One second pulse on settings change.
SWAP	if no I/O board	Yes	One second pulse on settings change.
Self-Test Failure	Yes	No	Latches if SEL-2020 fails a self-test (contact the factory).
Invalid Settings	Yes	No	CVALID setting is set to No. Clear alarm by setting CVALID to Yes using SET C.

SELF-TESTS

The SEL-2020 continually runs the following self-tests. Any test failure causes an alarm to be latched and the status report to be issued on Port F.

- **RAM.** The SEL-2020 continually performs read-write test of RAM.
- **ROM.** The SEL-2020 continually computes and checks a checksum of ROM.
- **EEPROM/Flash.** The SEL-2020 continually validates data blocks using checksums.
- **Power supply.** Threshold comparators (+/- 15 V) are continually checked for tolerance.

TROUBLESHOOTING

Power System Problems

Table 10.2 describes typical SEL-2020 power system problems and solutions.

Table 10.2: Power System Problems

Symptom	Probable Cause	Corrective Action
All front-panel LEDs remain dark when LED TEST button is pressed.	No power to rear-panel power terminals.	Supply power to rear-panel power terminals.
	Internal power supply defective.	Remove power and contact the factory.
+5 Vdc not supplied to pin 1 of rear-panel communication port(s).	Jumper(s) not installed on main board.	See the jumper settings in ***Section 3: Installation***.

Communications Problems

Refer to Table 10.3 for some troubleshooting for typical communications problems.

Table 10.3: Communications Problems

Symptom	Probable Cause	Corrective Action
SEL-2020 does not communicate with PC.	Serial cable damaged or wrong cable connected.	Inspect the cabling for damage and proper connection.
	SEL-2020 baud rate default jumper installed.	1. Set the PC terminal to 2400 baud to communicate with the SEL-2020. 2. Using the SET command, set the SEL-2020 baud rate. 3. Access the main board using steps 1 through 4 in Battery Replacement section. 4. Remove jumper JMP9 A (see Figure 3.2). Place the jumper on one pin of the connector for safe keeping. 5. Set the baud rate of the PC terminal to match the SEL-2020. 6. Cycle SEL-2020 power and reconnect.
	Port and baud rate settings of PC may be incorrect.	Set the port and baud rate settings of the PC terminal to match the SEL-2020. If you do not know what the settings are, install the baud rate jumper and then make the settings.
SEL-2020 does not communicate with connected IED.	Serial cable damaged or wrong cable connected.	Inspect the cabling for damage and proper connection. Make sure appropriate cable is connected (see Table 3.2).
	Port settings do not match the IED settings.	Using the SET command, set the port settings to match those of the IED connected to the port.
	Port may be locked up due to hardware handshaking.	Reset IED and/or reset port settings using SET P and accepting settings.
	Component failure. Port F LED(s) illuminates but others do not illuminate when port is addressed.	Remove power and contact the factory.

SEL-2020 Firmware Upgrades

SEL may occasionally offer upgrades to improve the performance of this device. To install firmware upgrades, refer to the instructions supplied with the firmware upgrades.

Relay Firmware Upgrades

When you upgrade the firmware within an SEL relay attached to the SEL-2020, you will need to re-auto-configure the SEL-2020 so it will recognize the upgraded relay. When performing a relay firmware upgrade, go through these steps to insure continued proper operation:

1. Take the relay out of service. The SEL-2020 will show this port's status as Inactive and will no longer collect data.
2. Upgrade the relay according to its upgrade instructions.
3. Apply power to relay and re-set its settings, as necessary.
4. Perform any relay testing that your practices require.
5. Re-connect the relay to the SEL-2020, if necessary.
6. Connect a terminal to the SEL-2020 and go to Access Level 2.
7. Execute a SET P command on the relay port and re-auto-configure the port. Save these settings.
8. Confirm that the SEL-2020 is now communicating as before.
9. Place relay back in service.

Factory Assistance

The employee-owners of Schweitzer Engineering Laboratories, Inc., are dedicated to making electric power safer, more reliable, and more economical.

We appreciate your interest in SEL products, and we are committed to making sure you are satisfied. If you have any questions, please contact us at:

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We guarantee prompt, courteous, and professional service.

We appreciate receiving any comments and suggestions about new products or product improvements that would help us make your job easier.

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APPENDIX A: FIRMWARE VERSIONS

This manual covers SEL-2020 Communications Processors that contain firmware bearing the following part numbers and revision numbers (most recent firmware listed at top):

Firmware Part/Revision No.	Description of Firmware
SEL-2020-R132-V0-Z000000-D20010518	Add support for SEL-400 series relays. Correct problem causing inaccurate calculation of certain phase angles in 20METER data. Correct problem causing power-up auto-configuration of older relays to fail.
SEL-2020-R131-V0-D000221	Improve performance of SET M operations. Performance was decreased by enhancements made in version R130. Correct Unsolicited Write statistics in the Local database region so that failure categories are updated correctly instead of remaining 0.
SEL-2020-R130-V0-D991222	Add TIME_SRC setting for selection of time synchronization source. Correct problem that caused inaccuracy in DNP time synchronization (problem in versions R108 and R109 only)

To find the firmware revision number in your Communications Processor, use the ID command. The first line is an FID number. The following is an example FID with the Part/Revision number in bold:

FID=**SEL-2020-R132-**V0-Z000000-D20010518

The following table shows firmware that does not precisely match this manual:

Firmware Part/Revision No.	Description of Firmware
SEL-2020-R129-V0-D991021	Correct problem with ASCII-Hexadecimal-to-Integer conversions (H1L and H1H data types within SET M).
SEL-2020-R128-V0	Add math operators (add, subtract, multiply, divide) and ASCII hexadecimal data types to SET M syntax. Support Direct Transparent mode (PORT n D).

Firmware Part/Revision No.	Description of Firmware
SEL-2020-R127-V0	Add Unsolicited Write message string (\W;saddr;n,daddr/). Add new registers in Local database region for Unsolicited Write statistics. Improve efficiency of *Fast Meter* calculations so that SEL-2020 performs better when collecting *Fast Meter* data from several relays. Change DNP settings so CONFIRM_TO setting is accessible as long as CLASS is not set to 0. Previously, CONFIRM_TO was hidden unless UNSOL_REP was set to YES. Also changed lower limit on CONFIRM_TO setting from 0 to 50 milliseconds. On power-up auto-configuration, allow for a single auto-configuration retry in the case where the port begins to auto-configure for the relay but then fails (ConfigFail status). Fix problem where DNP port would not function at all if Master was polling it during power-up initialization. Fix problem that could cause the wrong (inverted) value of the SEL-321-1 Alarm bit (!ALRM) to be moved to the User region via SET M. This was correctable using the FREEZE and RELEASE operations. It is no longer an issue, so FREEZE/RELEASE are not necessary. Address memory loss caused by failed modem dial-out messages (\Idstr/).
SEL-2020-R126-V0	Fix problem with clearing Archive data via the Automatic Message string \Fp:An;C/.
SEL-2020-R125-V0	Add DNP time synchronization. Enhance Fast Meter collection to reduce the number of Modbus “busy” responses in units with Flash RAM (archive).
SEL-2020-R124-V0	Fix problem with Modbus bit reads from Target region.
SEL-2020-R324-V2 SEL-2020-R123-V0	Fix problem with Modbus bit reads from Target region. Make Port F baud rate jumper force flow control so that RTS/CTS=N, XON/XOFF=Y. Fix problem that under rare circumstances, would result in failed *Fast Meter* collection.
SEL-2020-R323-V2	Supports alternate main board.

Firmware Part/Revision No.	Description of Firmware
SEL-2020-R122-V0	Change SET M equation processing of ",P" and ",C" data types so they work correctly when source data is undefined. Fix Modbus problem related to attempted bit reads at address FFFFh. Process SET M equations and SET L logic for ports with status of pInactive or Config Fail. Make sure auto-configuration process does not alter the STARTUP string such that it attains a lower Access Level. Add _YEARS, _HOURS, _MINS, _SECS to Global Database Region.
SEL-2020-R121-V0	Fix problem with SEL-187V/287V Meter collection. Allow access to more EEPROM in units with 64k of EEPROM.
SEL-2020-R120-V0	Add bit manipulation to SET M. Add MSET bit to elements in Local database region. Add \SP/ string for prompt suppression.
SEL-2020-R119-V0	Support checksums in Automatic Messages and parsed responses. Support XON/XOFF encoding for binary data transfers. Do not respond to DNP or Modbus requests until power-up initialization is complete. No longer attempt to ignore echoed request when parsing data on Other-IED port with ASCII protocol.
SEL-2020-R118-V0	Allow Modbus access to bits in User Region of database. Support automatic Remote Bit pulsing with SEL relays.
SEL-2020-R117-V0	Fixed problem where having more than 255 DNP objects caused lockup.
SEL-2020-R116-V0	Speeds some data collection. Adds operate control of SEL IEDs. Adds *Fast Operate* commands to master ports. Enhances BROADCAST command. Expands WHO command report. Allows individual passwords to be disabled. Adds capability to copy USER region data to an archive region. Expands SET M data types. Adds DNP V3.00 slave support.
SEL-2020-R115-V0	Modifies alarm handling in units with I/O boards.
SEL-2020-R114-V0	Corrects problem with message sending on Inactive Other-IED port.
SEL-2020-R113-V0	Improves performance. Adds Modbus bit access capability. Extracts fault location and type from unsolicited messages.
SEL-2020-R111-V0	Improves reliability of communication with SEL relays.
SEL-2020-R110-V0	Allows OTHER IED to have a modem. Allows RTS/CTS handshaking on modem ports. Adds BROADCAST commands. Adds SET M for data movement. Adds event report counter to local data region.

Firmware Part/Revision No.	Description of Firmware
SEL-2020-R108-V0	Reduces likelihood of premature EEPROM failure.
SEL-2020-R107-V0	Adds improved support for SEL-587. Adds CD_CTS setting for external modems. Expands Modbus to allow direct database reads and writes and to get device IDs. Improves Modbus response time.
SEL-2020-R106-V0	Adds support for GUI settings aid. Adds AUTO and MEM commands. Adds sequence data to binary "fast meter" calculations. Adds alternate integer-only data map to Modbus protocol support.
SEL-2020-R105-V0	Adds Modbus RTU protocol support for accessing collected demand meter, history, target, and breaker data. Adds clear archive records through Modbus.
SEL-2020-R104-V0	Fix RTS/CTS data flow control.
SEL-2020-R103-V0	Adds Archive memory support, multiple phone number support, and two new ways to collect event reports.
SEL-2020-R102-V0	Adds Modbus RTU protocol support for accessing collected meter data. Fixed problems in master port timout while transparently connected and in simultaneous setting and transparent communication with a master port.
SEL-2020-R101-V0	Same as below except supports 32 kb EEPROM configuration.
SEL-2020-R100-V0	This firmware does not support the nonvolatile Flash memory option.

APPENDIX B: OPTIONAL INTERNAL MODEM INFORMATION

DESCRIPTION

The SEL-2020 optional internal modem contains all of the circuitry required for complete modem operation, allowing direct connection to the Public Switched Telephone Network (PSTN). This modem complies with CCITT V.21 (International 300 baud), V.22 (International 1200 baud), V.22bis (2400 baud), V.32 (9600 baud), V.32bis (14400 baud), V.34 (33600 baud) and Bell 103 (North American 300 baud) and 212A (North American 1200 baud) protocols. The modem is "AT" command set compatible.

FCC COMPLIANCE

The SEL-2020 optional internal modem complies with Part 68 of the FCC Rules and Regulations. The SEL-2020 has a label which contains the FCC Registration Number and Ringer Equivalence Number (REN) of the modem. You must, upon request, provide this information to your telephone company.

The REN is useful to determine the quantity of devices you may connect to a telephone line and still have all of these devices ring when the number is called. In most areas, the sum of the RENs of all devices connected to one line should not exceed five. To determine the number of devices you may connect to the line, contact your local telephone company to find the maximum REN for your calling area.

If your system causes harm to the telephone network, the telephone company may discontinue service temporarily. If possible, they will notify you in advance. If advance notification is not practical, you will be notified as soon as possible.

Your telephone company may make changes in its facilities, equipment, operations, or procedures that could affect proper functioning of your equipment. If they do, they should notify you in advance to give you an opportunity to maintain uninterrupted telephone service.

You may not under any circumstances attempt any service, adjustments, or repairs on the modem. It must be returned to the factory for any such work.

MODEM IDENTIFICATION

To determine the SEL-2020 internal modem part number, refer to the modem identification sticker located on the SEL-2020 rear panel. Tables B.1 - B.4 illustrate the command set information for the different modem types.

DEFAULT FACTORY SETTINGS

The SEL-2020 optional internal modem is shipped to you with user profile 0 active. This profile contains modem factory default settings, except for the following items:

- Command characters are not echoed (E0).
- Basic result codes are enabled (X0).
- Modem ignores DTR (&D0).
- Modem will answer on 4 rings (S0=4).

THE MODEM COMMAND SET

In general, all commands except the A/ (repeat the previous command line) command, and the Escape sequence +++ have the syntax:

AT<CR>

where AT is the attention command alerting the modem that a command follows and <CR> (carriage return) signifies the end of the command line. The modem recognizes all upper case or all lower case characters, i.e., AT or at, but not mixed cases, i.e., At or aT. The command may be a single command:

ATS0=1<CR>

or a sequence:

ATS0=1&D2&W<CR>

The modem examines the command line prefix to determine the communications settings of your computer (bps and parity) and adopts these settings automatically. They remain in effect until the modem receives another AT command, you issue a command to change them, or the modem is turned off.

THE S REGISTERS

Software registers (S registers) contain information that controls the operation of your modem. The S registers and a description of their functions follow the AT Command Set tables.

Table B.1: AT Command Set Description – Radicom Part # 336MM-T-SEL

Basic Commands	Function
A	Automatically answer call
A/	Repeat previous command
B0	Operate under CCITT communication standard
B1	Operate under Bell communication standard*
E0	Command characters not echoed
E1	Command characters are echoed*
H0	On hook (hang up)*
H1	Off hook (busy line)
I0	Reports product code
I3	Reports firmware version
L0	Lowest speaker volume
L1	Low speaker volume
L2	Moderate speaker volume*
L3	High speaker volume
N0	Handshake only at DTE rate
N1	Initiate handshaking at DTE rate; fallback if unsuccessful*
O0	Go on line*
O1	Initiate retrain returning On Line
Q0	Enable result codes
Q1	Disable result codes
Sr?	Read S register
Sr=n	Write n to S register
V0	Send numeric result codes
V1	Send word result codes*
W0	Modem reports DTE speed*
W1	Modem reports DTE speed and error correction protocol
W2	Modem reports the DCE speed
* Modem factory default settings	

Table B.1 AT Command Set Description – Radicom Part # 336MM-T-SEL (continued)

Basic Commands	Function
X0	Basic response set, blind dialing
X1	Extended response set, blind dialing
X2	Extended response set, dial tone detection
X3	Extended response set, blind dialing & busy signal detection
X4	Extended response set, dial tone & busy signal detection*
Y0	Disable long space disconnect*
Y1	Enable long space disconnect
Z0	Reset to user profile 0*
Z1	Reset to user profile 1
Ampersand Commands	**Function**
&C0	DCD always on
&C1	DCD on only in presence of the carrier signal*
&D0	Ignore DTR signal
&D1	Return to command mode after losing DTR
&D2	Hang up, turn off auto-answer, and go to command mode after losing DTR*
&D3	Reset after losing DTR
&F	Restore factory configuration
&G0	No guard tone*
&G1	550 Hz guard tone
&G2	1800 Hz guard tone
&K0	Disable flow control
&K3	RTS/CTS flow control
&K4	XON/OFF flow control
&K5	Transparent XON/XOFF flow control
&K6	RTS/CTS and XON/XOFF flow control
&L0	Dial-up operation*
&L1	Leased line operation
* Modem factory default settings	

Table B.1 AT Command Set Description – Radicom Part # 336MM-T-SEL (continued)

Ampersand Commands	Function
&P0	Pulse dial make/break ratio of 39/61 @ 10 PPS*
&P1	Pulse dial make/break ratio of 33/67 @ 10 PPS
&P2	Pulse dial make/break ratio of 39/61 @ 20 PPS
&P 3	Pulse dial make/break ratio of 33/67 @ 20 PPS
&S0	DSR always active*
&S1	DSR in accordance with V.25
&T0	Terminate test in progress*
&T1	Begin local analog loop-back test
&T3	Begin local digital loop-back test
&T4	Accept a request from a remote modem for remote digital loop-back test
&T5	Reject a request from a remote modem for remote digital loop-back test
&T6	Begin a remote digital loop-back test
&T7	Begin a remote digital loop-back test with self-test
&T8	Begin a remote analog loop-back test with self-test
&V	View modem settings
&W0	Store active profile as user profile 0*
&W1	Store active profile as user profile 1
&Zn=x	Store telephone number x in memory location n
Other Commands	**Function**
%E0	Disable line quality monitor/auto retrain
%E1	Enable line quality monitor/auto retrain
%E2	Enable line quality and fallback/fall forward*
%L	Read received line signal level
%Q	Read line signal quality
\A0	Set maximum MNP block size to 64 characters
\A1	Set maximum MNP block size to 128 characters
\A2	Set maximum MNP block size to 192 characters
\A3	Set maximum MNP block size to 256 characters*
* Modem factory default settings	

Table B.1 AT Command Set Description – Radicom Part # 336MM-T-SEL (continued)

Other Commands	Function
\Bn	Transmit break of n x 100 ms.
\F0	Sets modem to Answer mode
\F1	Sets modem to Originate mode
\G0	Disable modem port flow control*
\G1	XON/XOFF modem port flow control
\Kn	Break control
	Break received from host with Reliable link: n=0,2,4 Enter on-line command mode; do not transmit break n=1 Purge buffers, immediately transmit break n=5 Send break in sequence with buffered data*
	Break received from host with Direct link: n=0,4 Immediately transmit break, then enter on-line command mode n=1,3,5 Immediately send break* n=2 Enter command mode, but do not transmit break signal
	Break received from host with Normal link: n=0,1 Purge buffers, immediately send break to the host n=2,3,5 Immediately send break to the host* n=4 Send break to the host in sequence with data
	Host initiates break (AT\B); Reliable link: n=0,1,3 Purge buffers; immediately transmit break n=2 Immediately transmit break n=4,5 Transmit break in sequence with data*
\N0	Normal mode, disable error correction
\N1	Direct mode, no buffering, no error correction
\N2	Reliable mode, LAPM or MNP required to make a connection
\N3	V.42 Auto-reliable mode, accept either an error controlled or non-error controlled link*
\N4	V.42 Reliable mode, LAPM required
\N5	MNP Reliable mode, MNP required to make a connection
)M0	Disable cellular power level adjustment during MNP10 link negotiations
)M1	Enable cellular power level adjustment during MNP10 link negotiations
* Modem factory default settings	

Table B.1 AT Command Set Description – Radicom Part # 336MM-T-SEL (continued)

Other Commands	Function
*H0	MNP10 link negotiations occur at the highest supported speed
*H1	MNP10 link negotiations occur at 1200 bps
*H2	MNP10 link negotiations occur at 4800 bps
-K0	Disable LAPM to MNP10 conversion
-K1	Enable LAPM to MNP10 conversion*
-K2	Enable LAPM to MNP10 conversion, but no initiation of MNP Extended Service during V.42 LAPM answer mode detection
-Q0	Fallback enabled only to 4800 bps
-Q1	Fallback to 2400 bps or 1200 bps*
@M0	Initial cellular transmit level @ -26 dBm*
@M1	Initial cellular transmit level @ -30 dBm
@M2-@M10	Initial cellular transmit level @ -10 dBm
@M11	Initial cellular transmit level @ -11 dBm
@M12	Initial cellular transmit level @ -12 dBm
@M30	Initial cellular transmit level @ -30 dBm
@M31	Initial cellular transmit level @ -31 dBm
:E0	Disable the compromise equalizer
:E1	Enable the compromise equalizer
+MS = 0	Force V.21 modulation @ 300 baud
+MS = 1	Force V.22 modulation @ 1200 baud
+MS = 2	Force V.22bis modulation @ 1200 or 2400 baud
+MS = 3	Force V.23 modulation @ 1200 baud
+MS = 9	Force V.32 modulation @ 4800 or 9600 baud
+MS = 10	Force V.32bis modulation @ 4800, 7200, 9600, 12,000, or 14,400 baud
+MS = 11	Force V.34 modulation @ 2400, 4800, 7200, 9600, 12,000, 14,400, 16,800, 19,200, 21,600, 24,000, 26,400, 28,800, 31,200, 33,600
+MS = 64	Force Bell 103 modulation @300 baud
+MS = 69	Force Bell 212 modulation @ 1200 baud
* Modem factory default settings	

Table B.1 AT Command Set Description – Radicom Part # 336MM-T-SEL (continued)

Dialing Command	Function
D	Dial telephone number
Dialing Modifiers	**Function**
P	Pulse dial
T	Touch-tone dial
R	Originate call in answer mode
W	Wait for dial tone
,	Pause for the duration of S8
;	Return to command mode after dialing
!	Hook flash
@	Wait for silence
* Modem factory default settings	

Table B.2: S Register Information - Radicom Part # 336MM-T-SEL

Register	Parameter (default)	Function
S0	0-255 rings (0)	Auto-answer. Specifies the ring on which the modem answers an incoming call.
S1	0-255 rings (0)	Ring counter. Counts number of rings that have occurred on incoming call.
S2	0-127 ASCII (43)	Escape code character. The decimal value (ASCII) of character that indicates ESC during transmission.
S3	0-127 ASCII (13)	Carriage return character. The decimal value (ASCII) of the character that indicates carriage return (CR) during data transmission.
S4	0-127 ASCII (10)	Line feed character. The decimal value (ASCII) of character that indicates line feed (LF) during data transmission. The default is LF.
S5	0-32, 127 ASCII (8)	Backspace character. The decimal value (ASCII) that indicates backspace during transmission.

Table B.2: S Register Information - Radicom Part # 336MM-T-SEL (continued)

Register	Parameter (default)	Function
S6	2-255 seconds (2)	Dial tone wait. Number of seconds the modem will wait for dial tone before dialing. If no dial tone detected during this time, it responds "NO DIAL TONE".
S7	1-60 seconds (60)	Carrier signal wait. Number of seconds modem will wait for carrier signal after dialing or answering. If no carrier detected during this time, it responds with "NO CARRIER".
S8	0-255 seconds (2)	Pause time for comma. Number of seconds modem will pause for each comma placed in a dial command string.
S9	1-255/0.1 seconds (6)	Carrier detect response time. Number of seconds the responding carrier signal must be present for the modem to recognize it. Default means listen for 0.6 seconds. Increasing the time reduces the chance the modem will mistake noise, such as a voice or a busy signal, as a carrier signal.
S10	1-255/0.1 seconds (14)	Carrier loss time. Length of time a signal from remote modem may be lost before modem hangs up.
S11	50-255 milliseconds (90)	DTMF tone. Sets duration and spacing of tones when using touch tone dialing. Higher setting means slower dialing rate.
S12	20-255/0.02 seconds (50)	Escape code guard time. Length of quiet time required before and after you enter Escape command. Set the guard time large enough so the escape can be recognized, given the rate at which you are transmitting. S12=0 allows recognition of any successive +++ with no guard time.
S18	1-255 seconds (0)	Test timer. Sets duration of a modem diagnostic test before it automatically cancels.
S30	0-255/0.01 second (0)	Duration of inactivity on TXD and RXD before automatic disconnect.

Table B.3: AT Command Set Description - Part # XE1414A

Basic Commands	Function
A	Automatically answer call
B0	Operate under CCITT communication standard
B1	Operate under Bell communication standard*
E0	Command characters not echoed
E1	Command characters are echoed*
F0	Auto baud detect*
F1	300 bps (V.21 or Bel 103)
F3	V.23
F4	1200 bps (V.22 or Bel 212 A)
F5	2400 bps (V.22 bis)
F6	4800 bps (V.32/B.32 bis)
F7	7200 bps (V.32 bis)
F8	9600 bps (V.32/V.32 bis)
F9	12,000 bps (V.32 bis)
F10	14,000 bps (V.32 bis)
H0	On hook (hang up)*
H1	Off hook (busy line)
L0	Lowest speaker volume
L1	Low speaker volume
L2	Moderate speaker volume*
L3	High speaker volume
M0	Speaker off
M1	Speaker on until carrier received*
M2	Speaker remains on
M3	Speaker on after dialing until carrier is detected
N0	Handshake only at DTE rate
N1	Initiate handshaking at DTE rate; fallback if unsuccessful*
* Modem factory default settings	

Table B.3: AT Command Set Description - Part # XE1414A (continued)

Basic Commands	Function
O0	Go on line*
O1	Initiate retrain returning On Line
Q0	Enable result codes
Q1	Disable result codes
Sr?	Read S register
Sr=n	Write n to S register
V0	Send numeric result codes
V1	Send word result codes*
X0	Basic response set, blind dialing
X1	Extended response set, blind dialing
X2	Extended response set, dial tone detection
X3	Extended response set, blind dialing & busy signal detection
X4	Extended response set, dial tone & busy signal detection*
Y0	Disable long space disconnect*
Y1	Enable long space disconnect
Z0	Reset to user profile 0*
Z1	Reset to user profile 1
Ampersand Commands	**Function**
&C0	DCD always on
&C1	DCD on only in presence of the carrier signal*
&D0	Ignore DTR signal
&D1	Return to command mode after losing DTR
&D2	Hang up, turn off auto-answer, and go to command mode after losing DTR*
&D3	Reset after losing DTR
&F	Restore factory configuration
&G0	No guard tone*
&G1	550 Hz guard tone
&G2	1800 Hz guard tone
* Modem factory default settings	

Table B.3: AT Command Set Description - Part # XE1414A (continued)

Ampersand Commands	Function
&K0	Disable flow control
&K3	RTS/CTS flow control
&K4	XON/OFF flow control
&K5	Transparent XON/XOFF flow control
&K6	RTS/CTS and XON/XOFF flow control
&P0	Pulse dial make/break ratio of 39/61 @ 10 PPS*
&P1	Pulse dial make/break ratio of 33/67 @ 10 PPS
&P2	Pulse dial make/break ratio of 39/61 @ 20 PPS
&P 3	Pulse dial make/break ratio of 33/67 @ 20 PPS
&S0	DSR always active*
&S1	DSR in accordance with V.25
&T0	Terminate test in progress*
&T1	Begin local analog loop-back test
&T3	Begin local digital loop-back test
&T4	Accept a request from a remote modem for remote digital loop-back test
&T5	Reject a request from a remote modem for remote digital loop-back test
&T6	Begin a remote digital loop-back test
&T7	Begin a remote digital loop-back test with self-test
&T8	Begin a remote analog loop-back test with self-test
&V0	View active profile and user profile 0*
&V1	View active profile and user profile 1
&W0	Store active profile as user profile 0*
&W1	Store active profile as user profile 1
&Zn=x	Store telephone number x in memory location n
* Modem factory default settings	

Table B.3: AT Command Set Description - Part # XE1414A (continued)

Other Commands	Function
%E0	Disable line quality monitor/auto retrain
%E1	Enable line quality monitor/auto retrain
%E2	Enable line quality and fallback/fall forward*
%L	Read received line signal level
%Q	Read line signal quality
\A0	Set maximum MNP block size to 64 characters
\A1	Set maximum MNP block size to 128 characters
\A2	Set maximum MNP block size to 192 characters
\A3	Set maximum MNP block size to 256 characters*
\Bn	Transmit break of n x 100 ms.
\G0	Disable modem port flow control*
\G1	XON/XOFF modem port flow control
\J0	Serial port speed independent of link speed
\J1	Serial port speed automatically set to link speed*
\Kn	Break control Break received from host with Reliable link: n=0,2,4 Enter on-line command mode; do not transmit break n=1 Purge buffers, immediately transmit break n=5 Send break in sequence with buffered data* Break received from host with Direct link: n=0,4 Immediately transmit break, then enter on-line command mode n=1,3,5 Immediately send break* n=2 Enter command mode, but do not transmit break signal Break received from host with Normal link: n=0,1 Purge buffers, immediately send break to the host n=2,3,5 Immediately send break to the host* n=4 Send break to the host in sequence with data Host initiates break (AT\B); Reliable link: n=0,1,3 Purge buffers; immediately transmit break n=2 Immediately transmit break n=4,5 Transmit break in sequence with data*
* Modem factory default settings	

Table B.3: AT Command Set Description - Part # XE1414A (continued)

Other Commands	Function
\N0	Normal mode, disable error correction
\N1	Direct mode, no buffering, no error correction
\N2	Reliable mode, LAPM or MNP required to make a connection
\N3	V.42 Auto-reliable mode, accept either an error controlled or non-error controlled link*
\N4	V.42 Reliable mode, LAPM required
\N5	MNP Reliable mode, MNP required to make a connection
)M0	Disable cellular power level adjustment during MNP10 link negotiations
)M1	Enable cellular power level adjustment during MNP10 link negotiations
*H0	MNP10 link negotiations occur at the highest supported speed
*H1	MNP10 link negotiations occur at 1200 bps
*H2	MNP10 link negotiations occur at 4800 bps
-K0	Disable LAPM to MNP10 conversion
-K1	Enable LAPM to MNP10 conversion*
-K2	Enable LAPM to MNP10 conversion, but no initiation of MNP Extended Service during V.42 LAPM answer mode detection
-Q0	Fallback enabled only to 4800 bps
-Q1	Fallback to 2400 bps or 1200 bps*
@M0	Initial cellular transmit level @ -26 dBm*
@M1	Initial cellular transmit level @ -30 dBm
@M2-@M10	Initial cellular transmit level @ -10 dBm
@M11	Initial cellular transmit level @ -11 dBm
@M12	Initial cellular transmit level @ -12 dBm
@M30	Initial cellular transmit level @ -30 dBm
@M31	Initial cellular transmit level @ -31 dBm
:E0	Disable the compromise equalizer
:E1	Enable the compromise equalizer
* Modem factory default settings	

Table B.3: AT Command Set Description - Part # XE1414A (continued)

Dialing Command	Function
D	Dial telephone number
Dialing Modifiers	**Function**
P	Pulse dial
T	Touch-tone dial
R	Originate call in answer mode
W	Wait for dial tone
,	Pause for the duration of S8
;	Return to command mode after dialing
!	Hook flash
@	Wait for silence
* Modem factory default settings	

Table B.4: S Register Information - Part # XE1414A

Register	Parameter (default)	Function
S0	0-255 rings (0)	Auto-answer. Specifies the ring on which the modem answers an incoming call.
S1	0-255 rings (0)	Ring counter. Counts number of rings that have occurred on incoming call.
S2	0-127 ASCII (43)	Escape code character. The decimal value (ASCII) of character that indicates ESC during transmission.
S3	0-127 ASCII (13)	Carriage return character. The decimal value (ASCII) of the character that indicates carriage return (CR) during data transmission.
S4	0-127 ASCII (10)	Line feed character. The decimal value (ASCII) of character that indicates line feed (LF) during data transmission. The default is LF.
S5	0-32, 127 ASCII (8)	Backspace character. The decimal value (ASCII) that indicates backspace during transmission.

Table B.4: S Register Information - Part # XE1414A - (continued)

Register	Parameter (default)	Function
S6	2-255 seconds (2)	Dial tone wait. Number of seconds the modem will wait for dial tone before dialing. If no dial tone detected during this time, it responds "NO DIAL TONE".
S7	1-60 seconds (60)	Carrier signal wait. Number of seconds modem will wait for carrier signal after dialing or answering. If no carrier detected during this time, it responds with "NO CARRIER".
S8	0-255 seconds (2)	Pause time for comma. Number of seconds modem will pause for each comma placed in a dial command string.
S9	1-255/0.1 seconds (6)	Carrier detect response time. Number of seconds the responding carrier signal must be present for the modem to recognize it. Default means listen for 0.6 seconds. Increasing the time reduces the chance the modem will mistake noise, such as a voice or a busy signal, as a carrier signal.
S10	1-255/0.1 seconds (14)	Carrier loss time. Length of time a signal from remote modem may be lost before modem hangs up.
S11	50-255 milliseconds (90)	DTMF tone. Sets duration and spacing of tones when using touch tone dialing. Higher setting means slower dialing rate.
S12	20-255/0.02 seconds (50)	Escape code guard time. Length of quiet time required before and after you enter Escape command. Set the guard time large enough so the escape can be recognized, given the rate at which you are transmitting. S12=0 allows recognition of any successive +++ with no guard time.
S18	1-255 seconds (0)	Test timer. Sets duration of a modem diagnostic test before it automatically cancels.
S30	0-255/0.01 second (0)	Duration of inactivity on TXD and RXD before automatic disconnect.

Table B.5: AT Command Set Description - Part # XE1414V

Basic Commands	Function
A	Automatically answer call
B0	Operate under CCITT communication standard
B1	Operate under Bell communication standard*
E0	Command characters not echoed
E1	Command characters are echoed*
H0	On hook (hang up)*
H1	Off hook (busy line)
L0	Lowest speaker volume
L1	Low speaker volume
L2	Moderate speaker volume*
L3	High speaker volume
M0	Speaker off
M1	Speaker on until carrier received*
M2	Speaker remains on
M3	Speaker on after dialing until carrier is detected
N0	Handshake only at DTE rate
N1	Initiate handshaking at DTE rate; fallback if unsuccessful*
O0	Go on line*
O1	Initiate retrain returning On Line
Q0	Enable result codes
Q1	Disable result codes
Sr?	Read S register
Sr=n	Write n to S register
V0	Send numeric result codes
V1	Send word result codes*
X0	Basic response set, blind dialing
X1	Extended response set, blind dialing
* Modem factory default settings	

Table B.5: AT Command Set Description - Part # XE1414V (continued)

Basic Commands	Function
X2	Extended response set, dial tone detection
X3	Extended response set, blind dialing & busy signal detection
X4	Extended response set, dial tone & busy signal detection*
Y0	Disable long space disconnect*
Y1	Enable long space disconnect
Z0	Reset to user profile 0*
Z1	Reset to user profile 1
Ampersand Commands	**Function**
&C0	DCD always on
&C1	DCD on only in presence of the carrier signal*
&D0	Ignore DTR signal
&D1	Return to command mode after losing DTR
&D2	Hang up, turn off auto-answer, and go to command mode after losing DTR*
&D3	Reset after losing DTR
&F	Restore factory configuration
&G0	No guard tone*
&G1	550 Hz guard tone
&G2	1800 Hz guard tone
&P0	Pulse dial make/break ratio of 39/61 (USA/Canada)*
&P1	Pulse dial make/break ratio of 33/67 (Europe/Hong Kong)
&S0	DSR always active*
&S1	DSR in accordance with V.25
&T0	Terminate test in progress*
&T1	Begin local analog loop-back test
&T3	Begin local digital loop-back test
&T4	Accept a request from a remote modem for remote digital loop-back test
&T5	Reject a request from a remote modem for remote digital loop-back test
&T6	Begin a remote digital loop-back test
* Modem factory default settings	

Table B.5: AT Command Set Description - Part # XE1414V (continued)

Ampersand Commands	Function
&T7	Begin a remote digital loop-back test with self-test
&T8	Begin a remote analog loop-back test with self-test
&U0	V.32 uses Trellis Coding with QAM backup*
&U1	V.32 uses QAM only
&V0	View active profile and user profile 0*
&V1	View active profile and user profile 1
&W0	Store active profile as user profile 0*
&W1	Store active profile as user profile 1
&Zn=x	Store telephone number x in memory location n
Other Commands	**Function**
-C0	Calling tone disabled*
-C1	Transmit 1300 Hz calling tone
-J0	V.42 detect uses LAPM only
-J1	V.42 detect uses MNP or LAPM
“H0	V.42bis compression disabled
“H1	V.42bis compression only when transmitting
“H2	V.42bis compression only when receiving
“H3	V.42bis compression when transmitting and receiving*
%A	Set auto-reliable fallback character
%C0	No MNP5 data compression
%C1	MNP5 data compression*
%Q	Read line signal quality
\A0	Maximum 64 characters in MNP block
\A1	Maximum 128 characters in MNP block
\A2	Maximum 192 characters in MNP block
\A3	Maximum 256 characters in MNP block*
\B0	Transmit break
* Modem factory default settings	

Table B.5: AT Command Set Description - Part # XE1414V (continued)

Other Commands	Function
\G0	Disable modem port flow control*
\G1	XON/XOFF modem port flow control
\J0	Serial port speed independent of link speed*
\J1	Serial port rate automatically changed to link speek
\N0	Normal mode, no error correction
\N1	Direct mode, no buffering, no error correction
\N2	MNP reliable mode, MNP connection required
\N3	V.42 auto-reliable mode, accept either an error controlled or non-error controlled link*
\N4	V.42 reliable mode, LAPM required
\Q0	Flow control disabled
\Q1	XON/XOFF flow control
\Q2	CTS flow control
\Q3	RTS/CTS flow control*
\U	Select auto-reliable link
\V0	Normal result codes
\V1	MNP result codes
\V2	V.42 result codes*
\X0	Process flow control characters*
\X1	Process XON/XOFF and pass them down the link
\Y	Switch to reliable link
\Z	Switch to normal mode
Dialing Command	**Function**
D	Dial telephone number
* Modem factory default settings	

Table B.5: AT Command Set Description - Part # XE1414V (continued)

Dialing Modifiers	Function
P	Pulse dial
T	Touch-tone dial
R	Originate call in answer mode
W	Wait for dial tone
,	Pause for the duration of S8
;	Return to command mode after dialing
!	Hook flash
@	Wait for silence
* Modem factory default settings	

Table B.6: S Register Information - Part # XE1414V

Register	Parameter (default)	Function
S0	0-255 rings (0)	Auto-answer. Specifies the ring on which the modem answers an incoming call.
S1	0-255 rings (0)	Ring counter. Counts number of rings that have occurred on incoming call.
S2	0-127 ASCII (43)	Escape code character. The decimal value (ASCII) of character that indicates ESC during transmission.
S3	0-127 ASCII (13)	Carriage return character. The decimal value (ASCII) of the character that indicates carriage return (CR) during data transmission.
S4	0-127 ASCII (10)	Line feed character. The decimal value (ASCII) of character that indicates line feed (LF) during data transmission. The default is LF.
S5	0-32, 127 ASCII (8)	Backspace character. The decimal value (ASCII) that indicates backspace during transmission.
S6	2-255 seconds (2)	Dial tone wait. Number of seconds the modem will wait for dial tone before dialing. If no dial tone detected during this time, it responds "NO DIAL TONE".

Table B.6: S Register Information - Part # XE1414V (continued)

Register	Parameter (default)	Function
S7	1-60 seconds (60)	Carrier signal wait. Number of seconds modem will wait for carrier signal after dialing or answering. If no carrier detected during this time, it responds with "NO CARRIER".
S8	0-255 seconds (2)	Pause time for comma. Number of seconds modem will pause for each comma placed in a dial command string.
S9	1-255/0.1 seconds (6)	Carrier detect response time. Number of seconds the responding carrier signal must be present for the modem to recognize it. Default means listen for 0.6 seconds. Increasing the time reduces the chance the modem will mistake noise, such as a voice or a busy signal, as a carrier signal.
S10	1-255/0.1 seconds (14)	Carrier loss time. Length of time a signal from remote modem may be lost before modem hangs up.
S11	50-255 milliseconds (90)	DTMF tone. Sets duration and spacing of tones when using touch tone dialing. Higher setting means slower dialing rate.
S12	20-255/0.02 seconds (50)	Escape code guard time. Length of quiet time required before and after you enter Escape command. Set the guard time large enough so the escape can be recognized, given the rate at which you are transmitting. S12=0 allows recognition of any successive +++ with no guard time.
S18	1-255 seconds (0)	Test timer. Sets duration of a modem diagnostic test before it automatically cancels.

Using Modem Commands

Dial Strings

Dial strings are initiated with the *attention code* (AT) followed by the appropriate parameters (see ***AT Command Set Description***). For example, the dial string ATDT3321890 instructs the modem to dial (D) a number using touch tone dialing (T), ATDP instructs the modem to dial using pulse dialing (P). The phone number (3321890) always follows the dialing command and its modifiers.

You can include some characters in the phone number to affect the dialing process: adding a comma (,) pauses the modem for a time period set in the modem's S8 register (see ***S Register Information***). Adding an exclamation character (!) causes the modem to execute a hook flash (hang up for a half second, then release the switch hook for a half second) before continuing to dial. The hook flash is needed with some phone systems to transfer to an extension.

Dial strings are entered using a \I string in a MESG setting from the SET A command for a port, which has a modem attached. Example 6 in ***Section 4: Job Done Examples*** illustrates the dial string setting for Port 8.

Startup Strings

Example 1 in ***Section 4: Job Done Examples*** show the MSTR setting establishing modem operating parameters on startup with the startup string: ATX0E0&D0%E1S0=4.

In the above string:

AT: Attention code.

X0: Basic response setting, blind dialing.

E0: Characters not echoed to the terminal.

&D0: Ignore the DTR signal.

%E1: Enable line quality monitor/auto retrain, disable fallback/fall forward.

S0=4: Set the S0 register to 4 (answer on the fourth ring).

If your modem is not operating properly, you can reinitialize it with the factory settings by setting MSTR=AT&FX0E0&D0S0=4&W using the SET P command. The modem is reinitialized when you save the setting changes. After this is done, you can remove the &F and &W from the MSTR setting using the SET P command again.

APPENDIX C: LMD PROTOCOL

This protocol permits multiple SEL devices to share a common communications channel. It is appropriate for low-cost, low-speed port switching applications where updating a real-time database is not a requirement.

SETTINGS

Use the SET P command to activate the multidrop protocol. Change the PROTOCOL port setting from the default SEL to LMD to reveal the following settings:

ADDRESS:	Two character ASCII address. The range is "01" to "99". The default is "01".
PREFIX:	One character to precede the address. This should be a character which does not occur in the course of other communications with the relay. Valid choices are one of the following: "@" "#" "$" "%" "&". The default is "@".
SETTLE TIME:	Time in seconds that transmission is delayed after the request to send (RTS line) asserts. This delay accommodates transmitters with a slow rise time.

OPERATION

1. The device ignores all input from this port until it detects the prefix character and the two-byte address.
2. The device then asserts the RTS line, which you can use to key a serial data transmitter. The port enables echo and message transmission. If the port has received an XOFF character, the device performs as if it received an XON.
3. Wait until you receive a prompt before entering commands to avoid losing echoed characters while the external transmitter is warming up.
4. Until the device connection terminates, you can use the standard commands that are available when PROTOCOL is set to SEL.
5. The QUIT command terminates the connection. If no data are sent to the device before the port timeup period, it automatically terminates the connection.
6. Enter the sequence CTRL-X QUIT <CR> before entering the prefix character if all devices in the multidrop network do not have the same prefix setting.

Note: You can use the SET P command to change the port settings to return to SEL protocol.

APPENDIX D: ASCII REFERENCE TABLE

Table D.1: ASCII Reference Table

Decimal Code	Hexadecimal Code	Character	Keystroke
0	00	NUL	
1	01	SOH	CTRL-A
2	02	STX	CTRL-B
3	03	ETX	CTRL-C
4	04	EOT	CTRL-D
5	05	ENQ	CTRL-E
6	06	ACK	CTRL-F
7	07	BEL	CTRL-G
8	08	BS	CTRL-H
9	09	HT	CTRL-I
10	0A	LF	CTRL-J
11	0B	VT	CTRL-K
12	0C	FF	CTRL-L
13	0D	CR	CTRL-M
14	0E	SO	CTRL-N
15	0F	SI	CTRL-O
16	10	DLE	CTRL-P
17	11	DC1 (XON)	CTRL-Q
18	12	DC2	CTRL-R
19	13	DC3 (XOFF)	CTRL-S
20	14	DC4	CTRL-T
21	15	NAK	CTRL-U
22	16	SYN	CTRL-V

Table D.1: ASCII Reference Table (continued)

Decimal Code	Hexadecimal Code	Character	Keystroke
23	17	ETB	CTRL-W
24	18	CAN	CTRL-X
25	19	EM	CTRL-Y
26	1A	SUB	CTRL-Z
27	1B	ESC	ESC
28	1C	FS	
29	1D	GS	
30	1E	RS	
31	1F	US	
32	20	SP	SPACE
33	21	!	!
34	22	"	"
35	23	#	#
36	24	$	$
37	25	%	%
38	26	&	&
39	27	'	'
40	28	(	(
41	29	)	)
42	2A	*	*
43	2B	+	+
44	2C	,	,
45	2D	-	-
46	2E	.	.
47	2F	/	/
48	30	0	0

Table D.1: ASCII Reference Table (continued)

Decimal Code	Hexadecimal Code	Character	Keystroke
49	31	1	1
50	32	2	2
51	33	3	3
52	34	4	4
53	35	5	5
54	36	6	6
55	37	7	7
56	38	8	8
57	39	9	9
58	3A	:	:
59	3B	;	;
60	3C	<	<
61	3D	=	=
62	3E	>	>
63	3F	?	?
64	40	@	@
65	41	A	A
66	42	B	B
67	43	C	C
68	44	D	D
69	45	E	E
70	46	F	F
71	47	G	G
72	48	H	H
73	49	I	I
74	4A	J	J
75	4B	K	K

Table D.1: ASCII Reference Table (continued)

Decimal Code	Hexadecimal Code	Character	Keystroke
76	4C	L	L
77	4D	M	M
78	4E	N	N
79	4F	O	O
80	50	P	P
81	51	Q	Q
82	52	R	R
83	53	S	S
84	54	T	T
85	55	U	U
86	56	V	V
87	57	W	W
88	58	X	X
89	59	Y	Y
90	5A	Z	Z
91	5B	[	[
92	5C	\	\
93	5D	]	]
94	5E	_	_
95	5F	_	_
96	60	`	`
97	61	a	a
98	62	b	b
99	63	c	c
100	64	d	d
101	65	e	e
102	66	f	f

Table D.1: ASCII Reference Table (continued)

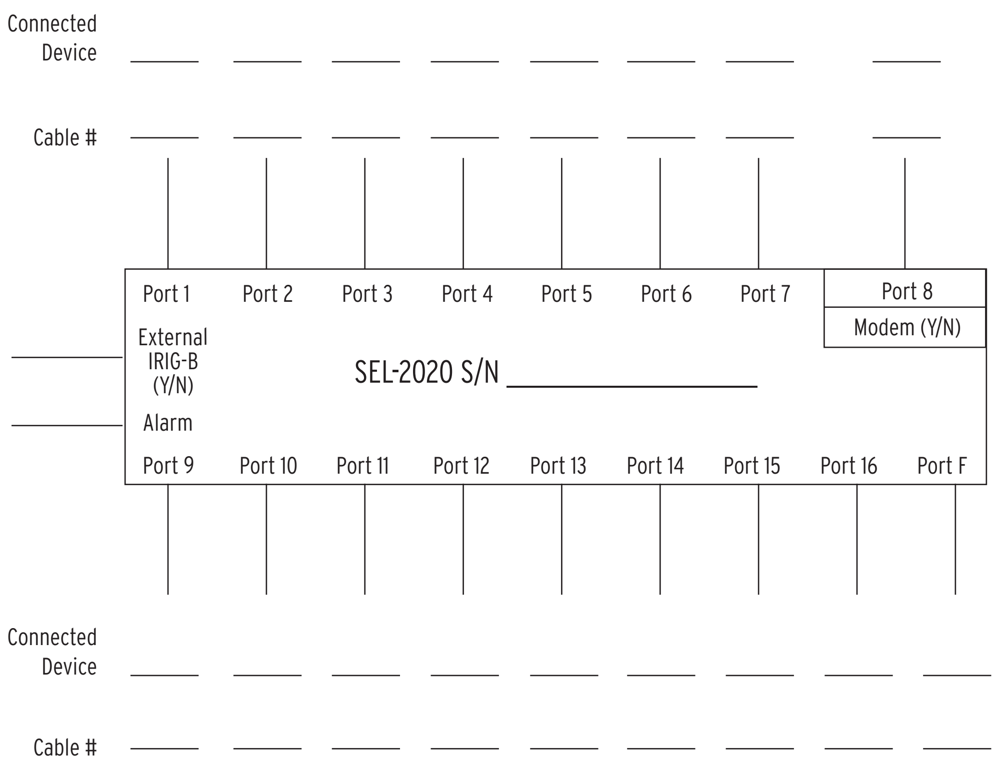
<table>
<tr><th>Decimal Code</th><th>Hexadecimal Code</th><th>Character</th><th>Keystroke</th></tr>
<tr><td>103</td><td>67</td><td>g</td><td>g</td></tr>
<tr><td>104</td><td>68</td><td>h</td><td>h</td></tr>
<tr><td>105</td><td>69</td><td>i</td><td>i</td></tr>
<tr><td>106</td><td>6A</td><td>j</td><td>j</td></tr>
<tr><td>107</td><td>6B</td><td>k</td><td>k</td></tr>
<tr><td>108</td><td>6C</td><td>l</td><td>l</td></tr>
<tr><td>109</td><td>6D</td><td>m</td><td>m</td></tr>
<tr><td>110</td><td>6E</td><td>n</td><td>n</td></tr>
<tr><td>111</td><td>6F</td><td>o</td><td>o</td></tr>
<tr><td>112</td><td>70</td><td>p</td><td>p</td></tr>
<tr><td>113</td><td>71</td><td>q</td><td>q</td></tr>
<tr><td>114</td><td>72</td><td>r</td><td>r</td></tr>
<tr><td>115</td><td>73</td><td>s</td><td>s</td></tr>
<tr><td>116</td><td>74</td><td>t</td><td>t</td></tr>
<tr><td>117</td><td>75</td><td>u</td><td>u</td></tr>
<tr><td>118</td><td>76</td><td>v</td><td>v</td></tr>
<tr><td>119</td><td>77</td><td>w</td><td>w</td></tr>
<tr><td>120</td><td>78</td><td>x</td><td>x</td></tr>
<tr><td>121</td><td>79</td><td>y</td><td>y</td></tr>
<tr><td>122</td><td>7A</td><td>z</td><td>z</td></tr>
<tr><td>123</td><td>7B</td><td>{</td><td>{</td></tr>
<tr><td>124</td><td>7C</td><td>|</td><td>|</td></tr>
<tr><td>125</td><td>7D</td><td>}</td><td>}</td></tr>
<tr><td>126</td><td>7E</td><td>~</td><td>~</td></tr>
<tr><td>127</td><td>7F</td><td>DEL</td><td>DEL</td></tr>
</table>

APPENDIX E: PLANNING SHEETS

Date ____________________

Approved by ____________________

SEL-2020 Location ____________________



Optional I/O

	Description		Description
OUT1		IN7	
OUT2		IN8	
OUT3		IN9	
OUT4		IN10	
IN1		IN11	
IN2		IN12	
IN3		1N13	
IN4		IN14	
IN5		IN15	
IN6		IN16	

2020_20

Figure E.1: SEL-2020 Device Connection Plan

CALCULATE MEMORY USAGE

Nonvolatile Flash Memory Usage Estimation

The total nonvolatile Flash memory available for archive storage is 8192 blocks. (A block is 256 bytes.) Table E.1 shows the memory requirements for various types of data. Each item requires one to five blocks of overhead, plus 1/7 to 240 blocks per record stored, as indicated in the table.

Table E.1: “20” Message Archive Requirements in Blocks

Relay	Meter	Fast Meter	Demand	Target	Status	Breaker	History	EVENT	EVENTS	EVENT L
49	$\frac{1}{3}n+2$	---	---	---	2n+1	---	n+2	11n+3	25n+1	---
121	$\frac{1}{3}n+2$	---	---	$\frac{1}{6}n+1$	2n+1	---	2n+2	11n+3	25n+1	---
121-10	$\frac{1}{3}n+2$	n+4	---	$\frac{1}{7}n+1$	2n+1	---	2n+2	11n+3	25n+1	---
121B	$\frac{1}{3}n+2$	n+4	---	$\frac{1}{7}n+1$	2n+1	---	2n+2	11n+3	25n+1	---
121C	$\frac{1}{3}n+2$	n+4	---	$\frac{1}{7}n+1$	2n+1	---	2n+2	11n+3	25n+1	---
121D	$\frac{1}{4}n+2$	---	---	$\frac{1}{7}n+1$	2n+1	---	2n+2	11n+3	25n+1	---
121F	$\frac{1}{3}n+3$	n+4	---	$\frac{1}{7}n+1$	2n+1	---	2n+2	11n+3	25n+1	---
121G	$\frac{1}{3}n+2$	n+4	---	$\frac{1}{7}n+1$	2n+1	---	2n+2	11n+3	25n+1	---
121H	$\frac{1}{3}n+2$	n+4	---	$\frac{1}{7}n+1$	2n+1	---	2n+2	11n+3	25n+1	---
121S	$\frac{1}{3}n+2$	n+4	---	$\frac{1}{7}n+1$	2n+1	---	2n+2	11n+3	25n+1	---
151	$\frac{1}{3}n+3$	n+4	$\frac{1}{3}n+2$	$\frac{1}{6}n+1$	2n+1	$\frac{1}{2}n+3$	3n+2	11n+3	25n+1	---
151C	$\frac{1}{3}n+3$	n+4	$\frac{1}{3}n+2$	$\frac{1}{6}n+1$	2n+1	$\frac{1}{2}n+3$	3n+2	11n+3	25n+1	---
151CD	$\frac{1}{4}n+2$	n+3	$\frac{1}{3}n+2$	$\frac{1}{6}n+1$	2n+1	$\frac{1}{2}n+3$	3n+2	11n+3	25n+1	---
151D	$\frac{1}{4}n+2$	n+3	$\frac{1}{3}n+2$	$\frac{1}{6}n+1$	2n+1	$\frac{1}{2}n+3$	3n+2	11n+3	25n+1	---
167	$\frac{1}{3}n+3$	---	$\frac{1}{3}n+3$	$\frac{1}{7}n+1$	2n+1	---	3n+2	11n+3	25n+1	---
167D	$\frac{1}{3}n+2$	n+3	$\frac{1}{3}n+2$	$\frac{1}{7}n+1$	2n+1	---	3n+2	11n+3	25n+1	---
187V	$\frac{1}{3}n+2$	---	---	$\frac{1}{6}n+1$	2n+1	---	3n+2	12n+3	25n+1	---
279	$\frac{1}{3}n+2$	---	---	$\frac{1}{7}n+1$	2n+1	$\frac{1}{4}n+2$	---	---	---	---
279H	$\frac{1}{3}n+2$	---	---	$\frac{1}{6}n+1$	2n+1	---	3n+2	13n+3	25n+1	---
BFR	$\frac{1}{3}n+2$	---	---	$\frac{1}{7}n+1$	2n+1	---	14n+2	16n+3	48n+1	---
300G	---	n+5	$\frac{1}{2}n+4$	$\frac{1}{4}n+1$	2n+4	---	11n+1	31n+4	48n+1	240n+1
PG10	$\frac{1}{3}n+2$	n+4	---	$\frac{1}{7}n+1$	2n+1	---	2n+2	11n+3	25n+1	---
321	$\frac{1}{3}n+2$	n+5	---	$\frac{1}{3}n+1$	2n+1	---	10n+2	11n+3	48n+1	240n+1
321-1*	---	n+3	---	$\frac{1}{3}n+1$	n+3	---	12n+2	9n+2	48n+1	240n+1
351	---	n+6	n+5	$\frac{1}{3}n+1$	2n+4	---	5n+4	31n+5	48n+1	240n+1
351R	---	n+5	$\frac{1}{2}n+4$	$\frac{1}{3}n+1$	2n+5	---	7n+3	36n+5	48n+1	240n+1
352	---	2n+6	---	$\frac{1}{2}n+1$	2n+4	2n+3	5n+3	16n+4	48n+1	240n+1
387	---	n+4	n+3	$\frac{1}{4}n+1$	2n+5	$\frac{1}{2}n+4$	32n+3	22n+4	48n+1	240n+1
501	$\frac{1}{5}n+2$	n+3***	$\frac{1}{5}n+2$	$\frac{1}{6}n+1$	2n+1	$\frac{1}{3}n+3$	4n+2	14n+3	48n+1	---
551	---	$\frac{1}{3}n+2$	---	$\frac{1}{7}n+1$	n+3	---	5n+2	17n+3	48n+1	---
587	---	n+4	$\frac{1}{3}n+2$	$\frac{1}{6}n+1$	n+4**	---	4n+2**	23n+5**	48n+1**	---

* Only applies to SEL-321-1 relays with a date code later than 950907. Older SEL-321-1 relays have same sizes as SEL-321 relays.
** Only available in SEL-587 relays with a date code later than 950907.
*** Only applies to SEL-501 relays with a date code later than 960101.

To determine the Flash memory required, perform the following steps, using Table E.3 as a planning sheet:

1. Estimate the desired maximum number of records (n) of each type on each port.
2. For "20" message archive regions, determine the memory requirements using the records estimated as "n" in Table E.1. For regions in which you use generic parsing, follow the process in Table E.2 to find the archive requirements.
3. Calculate the blocks required per region (rounding all fractions up to the nearest integer) and enter in Table E.3. Sum to determine total requirement.
4. If total requirement exceeds 8192 blocks, you must use more than one SEL-2020, or reduce the amount of data you archive.

Table E.2: Generic Parsing Archive Requirements

a)	If you are using CHAR_STRING parsing, each record will require S=28+NUM bytes where NUM is your size setting for the region. If you are using INT_STRING or ASCII_INT parsing, each record will require S=28+2·NUM bytes. If you are using ASCII_FLOAT parsing, each record will require S=28+4·NUM.
b)	If the size determined in bytes is greater than 254, the number of blocks required per record is the record size in bytes plus 2 divided by 256 and rounded up: $A = \left\lceil \frac{S+2}{256} \right\rceil$
c)	If the size determined in bytes is less than 128, the number of records that will fit in a block is 254 divided by the record size and rounded down: $A = \frac{1}{\left\lfloor \frac{254}{S} \right\rfloor}$
d)	If the size determined is greater than 128 bytes and less than 254, you will get one record per block: $A = 1$
e)	The archive memory requirements are: $An+1$

Table E.3: Archive Memory Usage Estimation

Port	Archive 1 No. Of Records	Archive 1 Record Size	Archive 1 No. Of Blocks	Archive 2 No. Of Records	Archive 2 Record Size	Archive 2 No. Of Blocks	Archive 3 No. Of Records	Archive 3 Record Size	Archive 3 No. Of Blocks
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									

Total A1 Blocks ________ Total A2 Blocks ________ Total A3 Blocks ________

A1 Blocks + A2 Blocks + A3 Blocks = ________

(Max. available: 8192 blocks)

For example, consider the case where you want to collect demand meter data from an SEL-151 Relay every 15 minutes and want the SEL-2020 to store up to 10 days worth of this data. This yields a total desired number of records of 960. From Table E.1, the memory requirement for 151 demand meter data is $\frac{1}{3}n + 2$. Thus, the total number of blocks is $\frac{1}{3}(960) + 2 = 322$.

RAM Usage Estimation

Of the 512 kbytes of RAM in the SEL-2020, approximately 250,000 bytes are available for database operations in units without nonvolatile Flash memory; approximately 120,000 bytes are available in units with nonvolatile Flash memory. To determine the memory used by your planned functions, sum the memory used for auto-configuration, User region, and Data regions on each port.

Auto-Configuration Memory Overhead

There is a memory overhead for auto-configuration. In RAM, each configured relay requires:

- Approximately 200 bytes for all relays in Table E.4, except SEL-321-1 and SEL-500 series relays
- Approximately 5000 bytes for newer relays (e.g., SEL-321-1 and SEL-500 series relays)

User Region Memory

Memory requirements for the User region are 30 bytes + twice the USER setting you enter with the SET A command. (Be aware that the USER setting may automatically increase when you use the SET M command). If you are using SET M, there will be an additional memory requirement of 30 bytes per line in your SET M settings.

Data Region Usage

To estimate Data Region (D1 through D8) memory usage for “20” data collection, use the record sizes directly from Table E.4. For non “20” data collection, you determine the record sizes from the PARSE and NUM settings:

S=128+NUM	if PARSE=CHAR_STRING
S=128+2·NUM	if PARSE=INT_STRING or PARSE=ASCII_INT
S=128+4·NUM	if PARSE=ASCII_FLOAT

Table E.4: Data Record Sizes (Bytes) by Relay and Record Type

SEL Relay	Record Type: Fast Meter	Meter	Demand	Target	Status	Breaker	History	EVENT	EVENTS
49		52			408		138	2682	6148
121		52		427	408		392	2682	6148
121-10	1054	52		361	408		392	2672	6148
121B	1054	52		328	408		428	2770	6148
121C	1054	52		361	408		416	2770	6148
121D		34		361	408		392	2770	6148
121F	1092	58		361	408		392	2770	6148
121G	1054	52		361	408		392	2770	6148
121H	1054	52		361	408		392	2770	6148
121S	1054	52		361	408		392	2772	6148
151	1054	58	44	427	408	60	632	2672	6148
151C	1054	58	44	427	408	60	560	2668	6148
151CD	850	38	44	427	408	60	560	2668	6148
151D	850	38	44	427	408	60	632	2672	6148
167		64	64	361	408		656	2770	6148
167D	850	46	46	361	408		656	2770	6148
187V		44		427	408		512	2864	6148
279		44		394	408	36			
279H		52		427	408		512	3120	6148
BFR		52		394	408		3408	3868	12400
PG1O	1054	52		262	408		392	2770	6148
300G	1472		980	1794	1360		3248	8728	12288
321*	1282	52		1902	488/906		2328/ 3296	2672/ 2764	12400
351	1514		1242	1884	1206		1946	8738	12400
351R	1368		980	2638	1548		2310	10172	12288
352	1582			3186	1310	948	1720	4720	12400
387	1010		778	2014	1428	1008	8638	6506	12400
501	782***	28	28/438***	460	488	64	888	3414	12400
551	364			694	962		1498	4612	12400
587	1100		438	660	1082**		1390**	6838**	12400**

* For columns with two numbers, the first number applies to the 321 and to 321-1 relays with a date code earlier than 950907. The second number applies to newer 321-1 relays.

** Only available in 587 relays with a date code later than 950907.

*** Only applies to 501 relays with a date code later than 960101.

APPENDIX F: SEL-2020 COMPATIBILITY

The SEL-2020 is designed to work with and was tested with SEL relays listed in the table below, plus all SEL relays released after December 1994. It should work with most older relay firmware versions, but some firmware will not be compatible. If you have an old version of relay firmware and experience difficulties using it with the SEL-2020, you should upgrade the relay firmware to the current version. The date code is a part of the FID string found at the top of each long event report.

Relays	Date Codes
49	881007
49E*	881007
121, -1, -2, -2A, -3, -4, -6, -8	920522
121-10, -16, -17	930420
121B/221B, -1	940722
121C-1/221C, -1	930708
121D/221D	931102
121F/221F, -1, -2, -3, -8	930420
121G/221G, -3, -4, -5, -6, -7, -8, -9	941021
121H/221H, -3	940126
121S/221S	921102
151/251, -1, -2, -3	940901
151C/251C, -1, -2, -3	940901
251CD, -1, -3	940901
151D/251D, -1, -3	940901
167/267, -2, -4, -5	931026
167D/267D, -3	940830
187V/287V, -1	940820
279	941110
279H, -1,. -2	941107
BFR/2BFR, -1	940125
PG10/2PG10, -7, -8	930830
300G	All
321	940927
321-1	941114
321-5	960807
351	All
351R	All
352	All
387	All
501,-2	941108
551	All
587	950510

* Only works at baud rates of 2400 or below.

APPENDIX G: MODBUS PROTOCOL

OVERVIEW

The SEL-2020 Communications Processor supports the Modbus RTU protocol on ports 12, 14, and 16 for data access from any SEL-2020 port. The SEL-2020 is always a Modbus slave. All data within the SEL-2020 database can be read using Modbus. Basic control functions can be performed using Modbus.

You can set the SEL-2020 for up to 16 Modbus slave addresses; set a unique slave address for each port that has data you want to collect through a Modbus port. The Modbus master views the SEL-2020 as a group of individual devices, each with a unique Modbus slave address.

Modbus protocol compatibility facilitates connection to many Remote Terminal Units (RTU), and to most Programmable Logic Controllers (PLC) and PLC Networks.

SETTINGS

From Port F or another master port, use the SET P 12, SET P 14, or SET P 16 command to set the device type to "MASTER" and the protocol to "MODBUS". The SEL-2020 will prompt for the map style, device ID offset, and Modbus slave address for each of 16 ports. With the map type setting, you select between the default map which contains floating-point data and the integer-only map. With the device ID offset setting, you can select an offset for the device ID table, which is discussed later in this appendix. You must also provide the slave device address(es) for Modbus access to data from the desired port(s).

For each SEL-2020 port connected to an IED with data you want to access by Modbus, you must use the following SET commands (refer to ***Section 6: Settings***):

- Use the SET P command to set and autoconfigure the SEL IED Port.
- For function code 04 access, use the SET A command to specify 20METER, 20DEMAND, 20HISTORY, 20TARGET, and 20BREAKER data retrieval as desired. The region selected for the data collection does not matter; Modbus will access the first data region of that type on the port. You can also access user region data using this function code.
- For function code 03 access, set the collections as desired and use the MAP command to determine the data addresses.
- For custom data access, use SET M to organize and scale data as desired.

HARDWARE CONNECTIONS AND RTS LINE USAGE

An EIA-232 Connection is the most common connection between an SEL-2020 Communications Processor and a Remote Terminal Unit. When Modbus is used in a dedicated link, the RTU should ignore the RTS output from the SEL-2020. To accomplish this, you may need to connect the Clear-To-Send (CTS) pin to +12 Vdc in the cable connector at the RTU.

If you use the SEL-2020 as a slave in a multidrop Modbus configuration, use the Request-To-Send (RTS) output as your “push-to-talk” signal to “key on” the slave transmitter. Devices that typically utilize RTS keying include EIA-232 to 4-wire EIA-485 converters and modems bridged to a shared audio line. The SEL-2020 asserts the RTS line prior to transmitting, executes the delay established by the SETTLE1 setting, transmits a message, executes the delay established by the SETTLE2 setting, and deasserts the RTS line. While the SETTLE2 (posttransmit) delay is executing, the RTS line remains asserted. So, a transmission that occurs during the SETTLE2 delay will be sent without executing the SETTLE1 (pretransmit) delay.

DATA ACCESS CONSIDERATIONS

When you program the Modbus master device to read data, you may access all data in one read message, or you may access selected data with separate read messages. If you read all data, the data you read will all correspond to a single data sample from the attached relay. However, if you read the data in pieces, subsequent reads will not necessarily be from the same data sample. You can avoid this by using the 05 function code to freeze a copy of the data for reading. This is discussed in detail later in this appendix.

Data can be stored in either an archive region or a normal database region. If the data are stored in a normal database region, the data retrieved through Modbus protocol are the newest collected data from the relays. If the data are stored in an archive region, the data retrieved through Modbus protocol are the oldest collected data from the relays.

To clear the oldest collected data in an archive region, send the “clear” message (using function code 05h). After the oldest record is cleared, the next record can be read. The “clear” only works for data in an archive region. If the data are not stored in an archive region, the SEL-2020 will respond to the “clear” with an exception message containing error code “Illegal Data Address (02h).”

TIMING

The SEL-2020 will respond to all Modbus requests, if it is going to respond at all, within 0.5 seconds of receiving the request (1.0 seconds if reading from an archive region). To determine the minimum sampling interval, you must add the maximum time for request and response messages and for master processing to this response time. If the SEL-2020 receives a Modbus request before it has finished processing the previous request, it will ignore the new request and respond to the original one.

The SEL-2020 monitors the elapsed time between receipt of characters. If 3-½ character times elapse without a new character, then the SEL-2020 ends the message and starts listening for a new transmission. All messages received by the SEL-2020 must be separated by at least 3-½ character times plus 2.0 ms to ensure there is no confusion between messages. (3-½ character times is 4.0 ms at 9600 baud.)

FUNCTION CODES

Message Framing

All Modbus data requests consist of an address, a function code, some data, and a checksum. For the SEL-2020 to respond, the address must match one of those established in the settings and the checksum must be valid. This frame format can be viewed as:

1 byte	Slave Address (must match an ADDRESSn setting)
1 byte	Function Code (see below for supported function codes)
n bytes	Information specific to function code
2 bytes	CRC-16 code for message

For successful operations, the response message will have the same format as the request message. For error responses, the message format will be as follows:

1 byte	Slave Address (echo of received)
1 byte	Exception Function Code (function code with high-bit set)
1 byte	Exception Code (see below)
2 bytes	CRC-16 code for message

Whenever multiple-byte values are sent over Modbus, they are sent most significant byte first.

The function codes supported by the SEL-2020 are:

01h	Read Coil Status
02h	Read Input Status
03h	Read Holding Register
04h	Read Input Register
05h	Force Single Coil
06h	Preset Single Register
10h	Preset Multiple Registers
11h	Report Slave ID

Read Coil Status (Function Code 01h)

The SEL-2020 uses function code 01h to read the status of various bits. You may read up to 1000 bits at once.

The master request must have the following format:

1 byte	Slave Address
1 byte	Function Code (01h)
2 bytes	Starting Bit Address
2 bytes	Number of Bits to Read
2 bytes	CRC-16 for Message

A successful SEL-2020 response will have the following format:

1 byte	Slave Address
1 byte	Function Code (01h)
1 byte	Byte Count
n bytes	Data
2 bytes	CRC-16 for Message

The data response contains 8 bits per data byte, with the LSB of the first byte corresponding to the addressed bit.

The following table lists the supported bit addresses:

Bit Addresses	Corresponding Database Register
1000h - 100Fh	Global Status Register
1010h - 101Fh	Global Configuration Register
1020h - 1057h	7 Global Element Registers (low-byte only)
1058h - 105Fh	Reserved - Always 0
1060h - 106Fh	Local Status Register
1070h - 10FFh	18 Local Element Registers (low-byte only)
1100h - 15FFh	Target Region Targets (low-bytes only)
1600h-	User Region Registers

In all cases, bit numbering starts with the LSB of each register. See ***Section 9: Database*** for a description of these registers. To access relay target data, you must set a region to collect the target data. Then, using the command MAP n TARGET BL, you can determine how many bytes of target data exist and what each bit is. The first target element is accessible at 1100h.

When referencing the data from most masters, you will need to set the coil number one greater than the listed bit address.

Read Input Status (Function Code 02h)

Function code 02h is used in a manner identical to function code 01h, as discussed above. Most masters use 1X references with this function code. To find the 1X reference with 5-digit addressing, add 10001 to the bit address specified above.

Read Holding Register (Function Code 03h)

The SEL-2020 uses function code 03h for reading from the database directly. Chapter 9 discusses this database. Use the MAP command to determine the details of the register maps based on your settings. You may read a maximum of 125 registers at once with this function code. Most masters use 4X references with this function code. To find the 4X reference with 5-digit addressing, add 40001 to the database addresses.

From a Modbus Master, reading registers in the database with addresses above 9999 (270Fh), requires 6-digit addressing to avoid corrupting the type identifier digit 4. For example, the first register in the user region is at address F800h which translates to 463489 in 6-digit addressing.

To read the user region with 5-digit addressing, access registers as 3X using function code 04.

The master request must have the following format:

1 byte	Slave Address
1 byte	Function code (03h)
2 bytes	Starting database address
2 bytes	Number of registers to read
2 bytes	CRC-16 for message

A successful SEL-2020 response will have the format:

1 byte	Slave Address
1 byte	Function code (03h)
1 byte	Byte count (should be twice number of registers read)
n bytes	Byte Count Bytes of Data
2 bytes	CRC-16 for Message

Read Input Register (Function Code 04h)

The SEL-2020 uses function code 04h for reading from a Modbus specific map. This map has various kinds of data at specific addresses, independent of user settings. You must merely collect the data in some region, and it will be visible in this register map. In this map, you can also select whether to use the standard-style, which includes floating-point data, or an integer-only map, based on a setting. You may read a maximum of 125 registers at once with this function code.

The master request must have the following format:

1 byte	Slave Address
1 byte	Function Code (04h)
2 bytes	Starting database address
2 bytes	Number of registers to read
2 bytes	CRC-16 for message

A successful SEL-2020 response will have the format:

1 byte	Slave Address
1 byte	Function Code (04h)
1 byte	Byte Count (should be twice number of registers read)
n bytes	Byte count bytes of data
2 bytes	CRC-16 for message

Tables G.1 through G.10 contain register maps for meter data, demand meter data, history data, target data, and breaker data from various SEL relays for 04h accesses. You can use these maps to identify the registers that contain the data you want to collect through the Modbus port. These maps contain the same data available in database regions, but it is arranged differently. Most masters use 3x references when accessing input registers. To use this reference method with 5-digit addressing, simply add 30001 to the address in the tables. Floating-point items are transferred most-significant word first. Make sure your master can accept floating-point data in this format before using it.

User region registers can be accessed using 5-digit addressing starting at 32401 and following.

Force Single Coil (Function Code 05h)

The SEL-2020 uses this function code for a variety of data control purposes. Specifically, you can use it to clear archive records, hold copies of data records, release copies of data records, and operate breaker and remote bit elements.

The master request must have the following format:

1 byte	Slave Address
1 byte	Function Code (05h)
2 bytes	Coil Reference
2 bytes	Operation Code
2 bytes	CRC-16 for Message

A successful SEL-2020 response will be an echo of the request message.

There are six special purpose coil references:

0000h	Clear archive record using function code 04h addressing
0003h	Copy a region using function code 04h addressing
0004h	Release a region copy using function code 04h addressing
0010h	Clear archive record using function code 03h addressing
0013h	Copy a region using function code 03h addressing
0014h	Release a region copy using function code 03h addressing

Coil references 0000h and 0010h are for clearing archive records. The operation code must be the starting address of the record to clear. Once you clear an archive record, subsequent reads from that region will return data from the next record stored in that region.

! CAUTION

Frequent archive record clearing may exceed EEPROM capabilities. See the discussion in the Archive Data Region subsection of ***Section 9: Database***.

Coil references 0003h and 0013h cause a copy of the specified region to be made. Subsequent reads from this region will read from your copy. This allows you to read data regions that are larger than 125 registers without the data changing between accesses. Specify the region to copy by giving its starting address as the operation address. Use coil references 0004h and 0014h to release the region copy once you are done with it. If there is insufficient memory to make the requested copy, the SEL-2020 will respond with a BUSY exception code.

For coil references 0000h, 0003h, and 0004h, the operation code must correspond to a modified map address (map function code 04h uses). For operation code 0010h, 0013h, and 0014h, this starting address must correspond to a true database address.

Coil references 10AOh through 10BFh correspond to the port breaker and remote bit elements:

10A0h - 10A7h	correspond to BR8 - BR1
10A8h - 10Afh	correspond to BR16 - BR9
10B0h - 10B7h	correspond to RB8 - RB1
10B8h - 10BFh	correspond to RB16 - RB9

Send a coil ON (operation code FF00h) to set the bit and OFF (operation code 0000h) to clear the bit.

When referencing coils from most masters, you will need to set the coil number one greater than the specified coil reference.

Preset Single Register (Function Code 06h)

The SEL-2020 uses this function to allow a Modbus master to write directly to a database register. ***Section 9: Database*** shows which registers are writeable and defines their operation. If you are accustomed to 4X references with this function code, for 6-digit addressing simply add 400001 to the standard database addresses.

The master request must have the following format:

1 byte	Slave Address
1 byte	Function Code (06h)
2 bytes	Register Address
2 bytes	Data
2 bytes	CRC-16 for message

A successful SEL-2020 response will be an echo of the request message.

Preset Multiple Registers (Function Code 10h)

This function code works much like code 06h, except that it allows you to write multiple registers at once, up to 120 per operation. Normally, this function code will only be used in the USER region. If you are accustomed to 4X references with the function code, for 6-digit addressing simply add 400001 to the standard database addresses.

The master request must have the following format:

1 byte	Slave Address
1 byte	Function Code (10h)
2 bytes	Starting Address
2 bytes	Number of registers to write
1 byte	Byte count (should be twice number of registers)
n bytes	Byte count bytes of data
2 bytes	CRC-16 for Message

A successful response will have the format:

1 byte	Slave Address
1 byte	Function Code (10h)
2 bytes	Starting Address
2 bytes	Number of Registers
2 bytes	CRC-16 for Message

Report Slave ID (Function Code 11h)

The SEL-2020 identifies the port device type when it receives this request. It also provides information on how data is being collected from an SEL relay so the specific map to use can be determined.

The master request must have the following format:

1 byte	Slave Address
1 byte	Function Code (11h)
2 bytes	CRC-16 for Message

A successful SEL-2020 response will have the following format:

1 byte	Slave Address
1 byte	Function Code (11h)
1 byte	Byte Count (7)
1 byte	Slave ID (see following table)
1 byte	Run Status
1 byte	*Fast Meter* status
4 bytes	Reserved (always 0)
2 bytes	CRC-16 for Message

The reported slave ID is simply the sum (modulo-256) of the START_ID setting and the device ID from the following table:

Slave ID	00	Unused	Slave ID	18	SEL-151D/251D
	01	Printer		19	SEL-167/267
	02	Other IED		20	SEL-167D/267D
	03	Unknown SEL IED		21	SEL-187V/287V
	04	Master Port		22	SEL-279
	05	SEL-49		23	SEL-279H
	06	SEL-121		24	SEL-321
	07	SEL-121-10		25	SEL-501
	08	SEL-121B/221B		26	SEL-BFR/2BFR
	09	SEL-121C/221C		27	SEL-PG10/2PG10
	10	SEL-121D/221D		28	SEL-587
	11	SEL-121F/221F		29	SEL-551
	12	SEL-121G/221G		30	SEL-351
	13	SEL-121H/221H		31	SEL-352
	14	SEL-121S/221S		32	SEL-387
	15	SEL-151/251		33	SEL-300G
	16	SEL-151C/251C		34	SEL-351R
	17	SEL-151CD/251CD			

You would normally only offset this table, using START_ID, if you need the values to be unique from the IDs of other devices on your Modbus network. The reported run status will be FFh if the port is Active, 00h otherwise. The *Fast Meter* status indicates what data is being collected using binary data collection. Possible values are:

0	No *Fast Meter*
1	Meter data only
3	Meter and Target data
7	Meter, Target, and Demand data

Error Handling

There are a number of errors that an SEL-2020 Modbus port can detect and handle. Framing errors (message did not have a correct slave address or length) and CRC mismatches will prevent an SEL-2020 response to the message. If a legitimate message is received, but cannot be processed, the SEL-2020 will respond with an error response, as indicated in the Message Framing subsection above. The following is a list of possible exception codes:

01 - ILLEGAL FUNCTION	The received function code is not supported.
02 - ILLEGAL DATA ADDRESS	Some portion of requested registers is undefined or invalid. For data writes, this may mean that the address is read-only. For force single coil operations, the address is not the beginning of a valid region.
03 - ILLEGAL DATA VALUE	The referenced data value in a force single coil operation is not valid for the given coil.
04 - FAILURE IN ASSOCIATED DEVICE	The port accessed is not currently collecting the desired data because of improper settings or because the port is inactive or read from an empty region.
06 - BUSY, REJECTED MESSAGE	The SEL-2020 is unable to respond in a timely fashion due to internal data access conflicts. Also, used to indicate insufficient memory for requested operation.

Master Device Configuration Considerations

Modbus masters are capable of block requesting registers. Block requests of data can be a problem, as described in the following example. You want 5 registers starting at address 105, and another 5 registers starting at address 205, and your Modbus master can request up to 125 registers. It will request 105 registers starting at address 105. The SEL-2020 may not have data defined for all addresses between 100 and 200, and will declare the request invalid. To get these 10 registers, you must alter the maximum registers that your Modbus master can request, or move the registers to a contiguous area of a user region (using the SET M procedure) and request them at this new address.

"Job Done" Examples For Modbus

Example #1: Simple Meter Data Access

This example demonstrates the ability of the SEL-2020 to provide data to a Modbus master device. Set up the SEL-2020, an SEL-321-1 Relay, and a Modbus Master as follows:

1. Connect the SEL-321-1 Relay to an SEL-2020 port (this example uses Port 2). Use the SEL-C239 (Y type) cable because it handles both communication and IRIG-B. Connect the communication terminal at the Y end of the cable to a port on the SEL-321-1 Relay.

Connect the IRIG-B terminal at the Y end to the relay's AUX input port. Connect the single connector end of the cable to Port 2 on the SEL-2020.

2. Connect a Modbus master device to an SEL-2020 Modbus port; this example uses Port 16.

3. Change the SEL-2020 access level to Access Level 2 on the SEL-2020 and issue the command SET P 16 to configure Port 16. The SEL-2020 will prompt for the type of device connected to the port. Enter **M** for Master, enter **M** a second time for Modbus protocol. Select the default floating-point map and set the start ID to 0. Assign an address to Port 2 and enter OFF for other port addresses. See the following example:

```
*>>SET P 16<ENTER>

Port communications settings for Port 16

Device Type (U=Unused, S=SEL IED, O=Other IED,
             P=Printer, M=Master)            DEVICE  = S     ? M<ENTER>

Communications Type (S=SEL, L=LMD, M=MODBUS)  PROTOCOL= S     ? M<ENTER>

Modbus Map Type (F=Float, I=Integer)          MAP_TYPE= F     ? <ENTER>

Starting Code for ID List (0-255)            START_ID= 0     ? <ENTER>

Transmission delay from RTS assertion (0-30000 milliseconds) SETTLE1=0 ? <ENTER>

Post-transmit RTS de-assertion delay (0-30000 milliseconds) SETTLE2=0 ? <ENTER>

Address of Port 1 (1-247)                    ADDRESS1= OFF   ? <ENTER>

Address of Port 2 (1-247)                    ADDRESS2= OFF   ? 6<ENTER>

Address of Port 3 (1-247)                    ADDRESS3= OFF   ? END<ENTER>

PORT:16
DEVICE  = M
PROTOCOL= M
MAP_TYPE= F
START_ID= 0
SETTLE1 = 0
SETTLE2 = 0
ADDRESS1= OFF  ADDRESS2= 6    ADDRESS3= OFF  ADDRESS4= OFF
ADDRESS5= OFF  ADDRESS6= OFF  ADDRESS7= OFF  ADDRESS8= OFF
ADDRESS9= OFF  ADDRESS10= OFF  ADDRESS11= OFF  ADDRESS12= OFF
ADDRESS13= OFF  ADDRESS14= OFF  ADDRESS15= OFF  ADDRESS16= OFF
PORTID  =""
BAUD    = 9600
PARITY  = N

Save changes (Y/N) ? Y<ENTER>

Port 16 Settings Changed

*>>
```

4. Issue the command SET P 2 to configure Port 2. The SEL-2020 will prompt for the type of device connected to the port. Enter **S** for SEL IED, enter **Y** to auto-configure the port, and press **<ENTER>** to confirm the configuration prompts. The SEL-2020 will establish communication with the relay, relay ID, and communication baud rate and determine if the relay is capable of *Fast Meter*. Enter **Y** to save port configuration changes at the final prompt.

5. Next, issue the command SET A 2 to set an auto-message to collect relay meter data. Respond to prompts about saving unsolicited messages (AUTOBUF) and the STARTUP string. Press **<ENTER>** to confirm the defaults for both prompts. Enter 1 when prompted for the message count. At the ISSUE1 prompt, enter **P00:00:01** to set the message to trigger once every second. At the MESG1 prompt, enter **20METER** to send the request for meter data to the SEL relay. Press **<ENTER>** to accept the default for remaining settings and enter Y to save changes. As soon as the SEL-2020 accepts the setting change, the TXD and RXD Port 2 LEDs on the SEL-2020 will begin to flash as the SEL-2020 requests and receives meter data every second.

6. Confirm that the meter data are collected in binary format by issuing a MAP 2 command. The D1 region should show a "B" preceding the METER data type, indicating binary collection.

7. View the data stored in the Port 2 METER data region by issuing the command VIEW 2:METER or VIEW 2:D1. The SEL-2020 responds with a data "dump" showing the data stored in the region at the time of the request with the respective data item labels. In this example, the data are updated once each second.

8. Cause the Modbus master to send a "read PORT 2 METER region" message. In the message, the slave address field is the Port 2 address set in Step 3. The Register Address field is METER (100). The Register Count is the meter data length for SEL-321-1. (See Table G.1 for the register map.) The returned METER data are the same as the data displayed by the VIEW command if the data have not been updated since issuing the VIEW command. The following shows a typical exchange:

   Received message:

06	to address 6
04	function code 4
00 64	starting register address 100
00 60	read 96 registers
xx xx	CRC-16 code

Response message:

06	from address 6
04	successful function code 4 response
C0	192 bytes of data following
00 05	first register
00 02	second register
...	
yy yy yy yy	last two registers (IEEE float)
xx xx	CRC-16 code

Example #2: Accessing Centralized Data

This example demonstrates the ability of the SEL-2020 to centralize data to reduce the number of Modbus accesses necessary to collect data. This example uses an SEL-121F and an SEL-501 on Ports 3 and 4 of the SEL-2020, respectively. The objective is to read the current and voltage magnitudes from the relays with a single Modbus access. The following procedure explains how to set the SEL-2020 and collect the data.

1. Connect the two relays to Ports 3 and 4 of the SEL-2020. Establish basic communications settings to the first relay by auto-configuring using SET P 3. Use SET A 3 to set meter data collection. Copy these settings to Port 4 using COPY 3 4. Auto-configure Port 4 while copying.

2. Set Port 16 to be a Modbus port, as shown below:

```
*>>SET P 16<ENTER>

Port communications settings for Port 16

Device Type (U=Unused, S=SEL IED, O=Other IED,
             P=Printer, M=Master)           DEVICE  = U     ? M<ENTER>

Communications Type (S=SEL, L=LMD, M=MODBUS) PROTOCOL= S     ? M<ENTER>

Modbus Map Type (F=Float, I=Integer)        MAP_TYPE= F     ? <ENTER>

Starting Code for ID List (0-255)           START_ID= 0     ? <ENTER>

Transmission delay from RTS assertion (0-30000 milliseconds) SETTLE1=0 ? <ENTER>

Post-transmit RTS de-assertion delay (0-30000 milliseconds) SETTLE2=0 ? <ENTER>

                                    (continued on next page)
```

```
                              (continued from previous page)

Address of Port 1 (1-247)              ADDRESS1= OFF   ? <ENTER>

Address of Port 2 (1-247)              ADDRESS2= OFF   ? <ENTER>

Address of Port 3 (1-247)              ADDRESS3= OFF   ? 15<ENTER>

Address of Port 4 (1-247)              ADDRESS4= OFF   ? 16<ENTER>

Address of Port 5 (1-247)              ADDRESS5= OFF   ? <ENTER>

Address of Port 6 (1-247)              ADDRESS6= OFF   ? <ENTER>

Address of Port 7 (1-247)              ADDRESS7= OFF   ? <ENTER>

Address of Port 8 (1-247)              ADDRESS8= OFF   ? <ENTER>

Address of Port 9 (1-247)              ADDRESS9= OFF   ? <ENTER>

Address of Port 10 (1-247)             ADDRESS10= OFF   ? <ENTER>

Address of Port 11 (1-247)             ADDRESS11= OFF   ? <ENTER>

Address of Port 12 (1-247)             ADDRESS12= OFF   ? <ENTER>

Address of Port 13 (1-247)             ADDRESS13= OFF   ? <ENTER>

Address of Port 14 (1-247)             ADDRESS14= OFF   ? <ENTER>

Address of Port 15 (1-247)             ADDRESS15= OFF   ? <ENTER>

Address of Port 16 (1-247)             ADDRESS16= OFF   ? 17<ENTER>

Port Identification String
PORTID  =""
 ? Modbus Port<ENTER>

Communications Settings

Baud Rate (300, 600, 1200, 2400, 4800, 9600,
           19200, 38400)               BAUD    = 9600  ? <ENTER>

Parity (N,O,E)                         PARITY  = N     ? <ENTER>

PORT:16
DEVICE  = M
PROTOCOL= M
MAP_TYPE= F
START_ID= 0
SETTLE1 = 0
SETTLE2 = 0
ADDRESS1= OFF  ADDRESS2= OFF  ADDRESS3= 15   ADDRESS4= 16
ADDRESS5= OFF  ADDRESS6= OFF  ADDRESS7= OFF  ADDRESS8= OFF
ADDRESS9= OFF  ADDRESS10= OFF  ADDRESS11= OFF  ADDRESS12= OFF
ADDRESS13= OFF  ADDRESS14= OFF  ADDRESS15= OFF  ADDRESS16= 17
PORTID  ="Modbus Port"
BAUD    = 9600
PARITY  = N

Save changes (Y/N) ? Y<ENTER>

Port 16 Settings Changed

*>>
```

3. Determine where the data of interest is located using the commands MAP 3:METER and MAP 4:METER:

```
*>>MAP 3:METER<ENTER>

Port 3,  Data Region METER  Map

Data Item    Starting Address   Type

_YEAR         2000h              int
DAY_OF_YEAR  2001h              int
TIME(ms)     2002h              int[2]
IA(A)        2004h              float[2]
IB(A)        2008h              float[2]
IC(A)        200Ch              float[2]
VA(V)        2010h              float[2]
VB(V)        2014h              float[2]
VC(V)        2018h              float[2]
VS(V)        201Ch              float[2]
IAB(A)       2020h              float[2]
IBC(A)       2024h              float[2]
ICA(A)       2028h              float[2]
VAB(V)       202Ch              float[2]
VBC(V)       2030h              float[2]
VCA(V)       2034h              float[2]
PA(MW)       2038h              float
QA(MVAR)     203Ah              float
PB(MW)       203Ch              float
QB(MVAR)     203Eh              float
PC(MW)       2040h              float
QC(MVAR)     2042h              float
P(MW)        2044h              float
Q(MVAR)      2046h              float
I0(A)        2048h              float[2]
I1(A)        204Ch              float[2]
I2(A)        2050h              float[2]
V0(V)        2054h              float[2]
V1(V)        2058h              float[2]
V2(V)        205Ch              float[2]

*>>
```

```
*>>MAP 4:METER<ENTER>

Port 4,  Data Region METER  Map

Data Item    Starting Address   Type

_YEAR         2000h              int
DAY_OF_YEAR  2001h              int
TIME(ms)     2002h              int[2]
IAX(A)       2004h              int
IBX(A)       2005h              int
ICX(A)       2006h              int
IAY(A)       2007h              int
IBY(A)       2008h              int
ICY(A)       2009h              int
3I2X(A)      200Ah              int
IRX(A)       200Bh              int
3I2Y(A)      200Ch              int
IRY(A)       200Dh              int

*>>
```

4. Set-up the Port 16 user region to hold the currents and voltages of interest using the command SET M 16:

```
*>>SET M 16<ENTER>

Mathematical/move equation settings for Port 16

  1
 ? 0=3:METER:IA<ENTER>
  2
 ? 1=3:METER:IB<ENTER>
  3
 ? 2=3:METER:IC<ENTER>
  4
 ? 3=3:METER:VA<ENTER>
  5
 ? 4=3:METER:VB<ENTER>
  6
 ? 5=3:METER:VC<ENTER>
  7
 ? 6=4:METER:IAX<ENTER>
  8
 ? 7=4:METER:IBX<ENTER>
9
 ? 8=4:METER:ICX<ENTER>
 10
 ? 9=4:METER:IAY<ENTER>
11
 ? 10=4:METER:IBY<ENTER>
 12
 ? 11=4:METER:ICY<ENTER>
 13
 ? <ENTER>

  1 000h = 3:METER:IA(A)
  2 001h = 3:METER:IB(A)
  3 002h = 3:METER:IC(A)
  4 003h = 3:METER:VA(V)
  5 004h = 3:METER:VB(V)
  6 005h = 3:METER:VC(V)
  7 006h = 4:METER:IAX(A)
  8 007h = 4:METER:IBX(A)
  9 008h = 4:METER:ICX(A)
 10 009h = 4:METER:IAY(A)
 11 00Ah = 4:METER:IBY(A)
 12 00Bh = 4:METER:ICY(A)

Save changes (Y/N) ? Y<ENTER>

USER database region too small: Current size = 0  Size needed = 12
Attempting to allocate larger USER region... Done.

Port 16 Settings Changed

*>>
```

5. The SEL-2020 is now collecting meter data from the two relays. The items of interest are being copied to the Port 16 user region every half second. You can now access this data via Modbus. For this example, we will read the data using function code 03 from address F800h. (***Section 9: Database*** shows that the User region starts at address F800h.) The data could also be read using function code 04 from address 2400 (0960h). To read the data, send the following message:

Received message:

11	—	address 17
03	—	function code 3
F8 00	├	starting register address F800h
00 0C	├	read 12 registers
xx xx	├	CRC-16 code

Response message:

11	—	from address 17
03	—	successful function code 3 response
18	—	24 bytes of data following
00 14	├	SEL-121F IA data
00 15	├	SEL-121F IB data
...		
xx xx	├	SEL-501 ICY data
xx xx	├	CRC-16 code

Table G.1: Register Maps for Meter Data, Floating-Point Type

The METER command provides up-to-date meter information. However, for different SEL relays, the meter data have different formats. Therefore, the register map will depend on the type of relay. The meter data will always start at register address 100.

The first eight registers of Modbus meter data are the date and time stamp. This is the closest time known to the SEL-2020; for all SEL-300 and SEL-500 series relays that use *Fast Meter*, it is the time to the nearest millisecond that the data were sampled. For other relays, it is the time the SEL-2020 received the meter data. The data types of currents, voltages, and power are IEEE single-precision floating-point numbers; all other data are integers. All of these registers are read-only, as indicated by the (R) following the register addresses. The following are meter maps for all current SEL relays: Group I for ASCII meter data format and Group II for binary meter data format.

The meter data the SEL-2020 retrieves may be in ASCII or binary format. Use the MAP n command to determine the data types on a port. It will show an A for ASCII or a B for binary data preceding the meter data type. The meter data retrieved with ASCII message format are shown in the "ASCII Meter" MAP; the meter data retrieved with the binary meter format are shown as "Binary Fast Meter" in this table.

Reg.#	Description	Units	Range

I. Data from Relays with ASCII Meter Format.

SEL-49; SEL-121/221,-1,-2,-2A,-3,-4,-5,-6,-8; SEL-121/221,-10,-16,-17; SEL-121B/221B,-1; SEL-121C/ 221C,-1; SEL-121G/221G,-3,-4,-5,-6,-7,-8,-9; SEL-121H/221H; SEL-121S/221S; SEL-BFR/2BFR,-1, SEL-PG10/ 2PG10,-7,-8; SEL-321:

Reg.#	Description	Units	Range
100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current IA	A, primary	IEEE float
110-111(R)	Phase Current IB	A, primary	IEEE float
112-113(R)	Phase Current IC	A, primary	IEEE float
114-115(R)	Difference Current IAB	A, primary	IEEE float
116-117(R)	Difference Current IBC	A, primary	IEEE float
118-119(R)	Difference Current ICA	A, primary	IEEE float
120-121(R)	Phase Voltage VA	kV, primary	IEEE float
122-123(R)	Phase Voltage VB	kV, primary	IEEE float
124-125(R)	Phase Voltage VC	kV, primary	IEEE float
126-127(R)	Difference Voltage VAB	kV, primary	IEEE float
128-129(R)	Difference Voltage VBC	kV, primary	IEEE float
130-131(R)	Difference Voltage VCA	kV, primary	IEEE float
132-133(R)	Real Power P	MW, primary	IEEE float
134-135(R)	Reactive Power Q	MVAR, primary	IEEE float

SEL-121D/221D:

Reg.#	Description	Units	Range
100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current IA	A, primary	IEEE float
110-111(R)	Phase Current IB	A, primary	IEEE float
112-113(R)	Phase Current IC	A, primary	IEEE float
114-115(R)	Difference Voltage VAB	kV, primary	IEEE float
116-117(R)	Difference Voltage VBC	kV, primary	IEEE float
118-119(R)	Difference Voltage VCA	kV, primary	IEEE float
120-121(R)	Real Power P	MW, primary	IEEE float
122-123(R)	Reactive Power Q	MVAR, primary	IEEE float

SEL-121F/221F,-1,-2,-3,-8:

Reg.#	Description	Units	Range
100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current IA	A, primary	IEEE float
110-111(R)	Phase Current IB	A, primary	IEEE float
112-113(R)	Phase Current IC	A, primary	IEEE float
114-115(R)	Difference Current IAB	A, primary	IEEE float

116-117(R)	Difference Current IBC	A, primary	IEEE float
118-119(R)	Difference Current ICA	A, primary	IEEE float
120-121(R)	Residual Current IR	A, primary	IEEE float
122-123(R)	Phase Voltage VA	kV, primary	IEEE float
124-125(R)	Phase Voltage VB	kV, primary	IEEE float
126-127(R)	Phase Voltage VC	kV, primary	IEEE float
128-129(R)	Difference VAB	kV, primary	IEEE float
130-131(R)	Difference VBC	kV, primary	IEEE float
132-133(R)	Difference VCA	kV, primary	IEEE float
134-135(R)	Synchronizing Voltage VS	kV, primary	IEEE float
136-137(R)	Real Power P	MW, primary	IEEE float
138-139(R)	Reactive Power Q	MVAR, primary	IEEE float

SEL-151/251,-1,-2,-3; SEL-151C/251C,-1,-2,-3:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current IA	A, primary	IEEE float
110-111(R)	Phase Current IB	A, primary	IEEE float
112-113(R)	Phase Current IC	A, primary	IEEE float
114-115(R)	Residual Current IR	A, primary	IEEE float
116-117(R)	Negative-Sequence Current 3I2	A, primary	IEEE float
118-119(R)	Real Power P	MW, primary	IEEE float
120-121(R)	Reactive Power Q	MVAR, primary	IEEE float
122-123(R)	Phase Voltage VA	V, primary	IEEE float
124-125(R)	Phase Voltage VB	V, primary	IEEE float
126-127(R)	Phase Voltage VC	V, primary	IEEE float
128-129(R)	Zero-Sequence Voltage 3V0	V, primary	IEEE float
130-131(R)	Difference Voltage VAB	V, primary	IEEE float
132-133(R)	Difference Voltage VBC	V, primary	IEEE float
134-135(R)	Difference Voltage VCA	V, primary	IEEE float
136-137(R)	Negative-Sequence Voltage 3V2	V, primary	IEEE float

FOR SEL-151D/251D,-1,-3; SEL-151CD/251CD,-1,-3:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current IA	A, primary	IEEE float
110-111(R)	Phase Current IB	A, primary	IEEE float
112-113(R)	Phase Current IC	A, primary	IEEE float
114-115(R)	Residual Current IR	A, primary	IEEE float
116-117(R)	Negative-Sequence Current 3I2	A, primary	IEEE float
118-119(R)	Real Power P	MW, primary	IEEE float
120-121(R)	Reactive Power Q	MVAR, primary	IEEE float
122-123(R)	Difference Voltage VAB	V, primary	IEEE float
124-125(R)	Difference Voltage VBC	V, primary	IEEE float
126-127(R)	Difference Voltage VCA	V, primary	IEEE float

SEL-167/267,-2,-4,-5:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59

106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current IA	A, primary	IEEE float
110-111(R)	Phase Current IB	A, primary	IEEE float
112-113(R)	Phase Current IC	A, primary	IEEE float
114-115(R)	Difference Current IAB	A, primary	IEEE float
116-117(R)	Difference Current IBC	A, primary	IEEE float
118-119(R)	Difference Current ICA	A, primary	IEEE float
120-121(R)	Demand Phase Current IAD	A, primary	IEEE float
122-123(R)	Demand Phase Current IBD	A, primary	IEEE float
124-125(R)	Demand Phase Current ICD	A, primary	IEEE float
126-127(R)	Peak-Demand Phase Current IAP	A, primary	IEEE float
128-129(R)	Peak-Demand Phase Current IBP	A, primary	IEEE float
130-131(R)	Peak-Demand Phase Current ICP	A, primary	IEEE float
132-133(R)	Phase Voltage VA	kV, primary	IEEE float
134-135(R)	Phase Voltage VB	kV, primary	IEEE float
136-137(R)	Phase Voltage VC	kV, primary	IEEE float
138-139(R)	Difference Voltage VAB	kV, primary	IEEE float
140-141(R)	Difference Voltage VBC	kV, primary	IEEE float
142-143(R)	Difference Voltage VCA	kV, primary	IEEE float
144-145(R)	Real Power P	MW, primary	IEEE float
146-147(R)	Reactive Power Q	MVAR, primary	IEEE float

SEL-167D/267D:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current IA	A, primary	IEEE float
110-111(R)	Phase Current IB	A, primary	IEEE float
112-113(R)	Phase Current IC	A, primary	IEEE float
114-115(R)	Demand Phase Current IAD	A, primary	IEEE float
116-117(R)	Demand Phase Current IBD	A, primary	IEEE float
118-119(R)	Demand Phase Current ICD	A, primary	IEEE float
120-121(R)	Peak-Demand Phase Current IAP	A, primary	IEEE float
122-123(R)	Peak-Demand Phase Current IBP	A, primary	IEEE float
124-125(R)	Peak-Demand Phase Current ICP	A, primary	IEEE float
126-127(R)	Difference Voltage VAB	kV, primary	IEEE float
128-129(R)	Difference Voltage VBC	kV, primary	IEEE float
130-131(R)	Difference Voltage VCA	kV, primary	IEEE float
132-133(R)	Real Power P	MW, primary	IEEE float
134-135(R)	Reactive Power Q	MVAR, primary	IEEE float

SEL-187V/287V:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Voltage VAX	V, secondary	IEEE float
110-111(R)	Phase Voltage VBX	V, secondary	IEEE float
112-113(R)	Phase Voltage VCX	V, secondary	IEEE float
114-115(R)	Phase Voltage VAY	V, secondary	IEEE float
116-117(R)	Phase Voltage VBY	V, secondary	IEEE float
118-119(R)	Phase Voltage VCY	V, secondary	IEEE float
120-121(R)	Differential Voltage VAD	V, secondary	IEEE float
122-123(R)	Differential Voltage VBD	V, secondary	IEEE float
124-125(R)	Differential Voltage VCD	V, secondary	IEEE float

SEL-279:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Voltage V1	V, secondary	IEEE float
110-111(R)	Phase Voltage V3	V, secondary	IEEE float
112-113(R)	Phase Voltage V5	V, secondary	IEEE float
114-115(R)	Phase Voltage V2	V, secondary	IEEE float
116-117(R)	Phase Voltage V4	V, secondary	IEEE float
118-119(R)	Phase Voltage V6	V, secondary	IEEE float
120-121(R)	Differential Voltage V12D	V, secondary	IEEE float
122-123(R)	Differential Voltage V34D	V, secondary	IEEE float
124-125(R)	Differential Voltage V56D	V, secondary	IEEE float

SEL-279H,-1,-2:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Bus Positive Sequence Voltage VPB	V, secondary	IEEE float
110-111(R)	Phase Voltage V1	V, secondary	IEEE float
112-113(R)	Phase Voltage V3	V, secondary	IEEE float
114-115(R)	Phase Voltage V5	V, secondary	IEEE float
116-117(R)	Line Positive Sequence Voltage VPL	V, secondary	IEEE float
118-119(R)	Phase Voltage V2	V, secondary	IEEE float
120-121(R)	Phase Voltage V4	V, secondary	IEEE float
122-123(R)	Phase Voltage V6	V, secondary	IEEE float
124-125(R)	Differential Voltage V12D	V, secondary	IEEE float
126-127(R)	Differential Voltage V34D	V, secondary	IEEE float
128-129(R)	Differential Voltage V56D	V, secondary	IEEE float

SEL-501:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current IAX	A, primary	IEEE float
110-111(R)	Phase Current IBX	A, primary	IEEE float
112-113(R)	Phase Current ICX	A, primary	IEEE float
114-115(R)	Phase Current IAY	A, primary	IEEE float
116-117(R)	Phase Current IBY	A, primary	IEEE float
118-119(R)	Phase Current ICY	A, primary	IEEE float
120-121(R)	Negative-Sequence Current 3I2X	A, primary	IEEE float
122-123(R)	Residual Current IRX	A, primary	IEEE float
124-125(R)	Negative-Sequence Current 3I2Y	A, primary	IEEE float
126-127(R)	Residual Current IRY	A, primary	IEEE float

II. Data from Relays with Binary Fast Meter Format

SEL-121/221,-10,-16,-17; SEL-121B/221B,-1; SEL-121C/221C,-1; SEL-121G/221G,-3,-4,-5,-6,-7,-8,-9; SEL-121H/221H; SEL-121S/221S; SEL-PG10/2PG10,-7,-8; SEL-151/251,-1,-2,-3; SEL-151C/251C,-1,-2,-3; SEL-321-1, -2 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current Magnitude IA	A, primary	IEEE float
110-111(R)	Phase Current Angle	Degrees	IEEE float
112-113(R)	Phase Current Magnitude IB	A, primary	IEEE float
114-115(R)	Phase Current Angle	Degrees	IEEE float
116-117(R)	Phase Current Magnitude IC	A, primary	IEEE float
118-119(R)	Phase Current Angle	Degrees	IEEE float
120-121(R)	Phase Voltage Magnitude VA	V, primary	IEEE float
122-123(R)	Phase Voltage Angle	Degrees	IEEE float
124-125(R)	Phase Voltage Magnitude VB	V, primary	IEEE float
126-127(R)	Phase Voltage Angle	Degrees	IEEE float
128-129(R)	Phase Voltage Magnitude VC	V, primary	IEEE float
130-131(R)	Phase Voltage Angle	Degrees	IEEE float
132-133(R)	Difference Current Magnitude IAB	A, primary	IEEE float
134-135(R)	Difference Current Angle	Degrees	IEEE float
136-137(R)	Difference Current Magnitude IBC	A, primary	IEEE float
138-139(R)	Difference Current Angle	Degrees	IEEE float
140-141(R)	Difference Current Magnitude ICA	A, primary	IEEE float
142-143(R)	Difference Current Angle	Degrees	IEEE float
144-145(R)	Difference Voltage Magnitude VAB	V, primary	IEEE float
146-147(R)	Difference Voltage Angle	Degrees	IEEE float
148-149(R)	Difference Voltage Magnitude VBC	V, primary	IEEE float
150-151(R)	Difference Voltage Angle	Degrees	IEEE float
152-153(R)	Difference Voltage Magnitude VCA	V, primary	IEEE float
154-155(R)	Difference Voltage Angle	Degrees	IEEE float
156-157(R)	Phase Real Power PA	MW, primary	IEEE float
158-159(R)	Phase Reactive Power QA	MVAR, primary	IEEE float
160-161(R)	Phase Real Power PB	MW, primary	IEEE float
162-63(R)	Phase Reactive Power QB	MVAR, primary	IEEE float
164-165(R)	Phase Real Power PC	MW, primary	IEEE float
166-167(R)	Phase Reactive Power QC	MVAR, primary	IEEE float
168-169(R)	Three Phase Real Power P	MW, primary	IEEE float
170-171(R)	Three Phase Reactive Power Q	MVAR, primary	IEEE float
172-173(R)	Zero-Sequence Current Magnitude I0	A, primary	IEEE float
174-175(R)	Zero-Sequence Current Angle	Degrees	IEEE float
176-177(R)	Positive-Sequence Current Magnitude I1	A, primary	IEEE float
178-179(R)	Positive-Sequence Current Angle	Degrees	IEEE float
180-181(R)	Negative-Sequence Current Magnitude I2	A, primary	IEEE float
182-183(R)	Negative-Sequence Current Angle	Degrees	IEEE float
184-185(R)	Zero-Sequence Voltage Magnitude V0	V, primary	IEEE float
186-187(R)	Zero-Sequence Voltage Angle	Degrees	IEEE float
188-189(R)	Positive-Sequence Voltage Magnitude V1	V, primary	IEEE float
190-191(R)	Positive-Sequence Voltage Angle	Degrees	IEEE float
192-193(R)	Negative-Sequence Voltage Magnitude V2	V, primary	IEEE float
194-195(R)	Negative-Sequence Voltage Angle	Degrees	IEEE float

SEL-121F/221F,-1,-2,-3,-8 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999

107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current Magnitude IA	A, primary	IEEE float
110-111(R)	Phase Current Angle	Degrees	IEEE float
112-113(R)	Phase Current Magnitude IB	A, primary	IEEE float
114-115(R)	Phase Current Angle	Degrees	IEEE float
116-117(R)	Phase Current Magnitude IC	A, primary	IEEE float
118-119(R)	Phase Current Angle	Degrees	IEEE float
120-121(R)	Phase Voltage Magnitude VA	V, primary	IEEE float
122-123(R)	Phase Voltage Angle	Degrees	IEEE float
124-125(R)	Phase Voltage Magnitude VB	V, primary	IEEE float
126-127(R)	Phase Voltage Angle	Degrees	IEEE float
128-129(R)	Phase Voltage Magnitude VC	V, primary	IEEE float
130-131(R)	Phase Voltage Angle	Degrees	IEEE float
132-133(R)	Synchronizing Voltage Magnitude VS	V, primary	IEEE float
134-135(R)	Synchronizing Voltage Angle	Degrees	IEEE float
136-137(R)	Difference Current Magnitude IAB	A, primary	IEEE float
138-139(R)	Difference Current Angle	Degrees	IEEE float
140-141(R)	Difference Current Magnitude IBC	A, primary	IEEE float
142-143(R)	Difference Current Angle	Degrees	IEEE float
144-145(R)	Difference Current Magnitude ICA	A, primary	IEEE float
146-147(R)	Difference Current Angle	Degrees	IEEE float
148-149(R)	Difference Voltage Magnitude VAB	V, primary	IEEE float
150-151(R)	Difference Voltage Angle	Degrees	IEEE float
152-153(R)	Difference Voltage Magnitude VBC	V, primary	IEEE float
154-155(R)	Difference Voltage Angle	Degrees	IEEE float
156-157(R)	Difference Voltage Magnitude VCA	V, primary	IEEE float
158-159(R)	Difference Voltage Angle	Degrees	IEEE float
160-161(R)	Phase Real Power PA	MW, primary	IEEE float
162-163(R)	Phase Reactive Power QA	MVAR, primary	IEEE float
164-165(R)	Phase Real Power PB	MW, primary	IEEE float
166-167(R)	Phase Reactive Power QB	MVAR, primary	IEEE float
168-169(R)	Phase Real Power PC	MW, primary	IEEE float
170-171(R)	Phase Reactive Power QC	MVAR, primary	IEEE float
172-173(R)	Three Phase Real Power P	MW, primary	IEEE float
174-175(R)	Three Phase Reactive Power Q	MVAR, primary	IEEE float
176-177(R)	Zero-Sequence Current Magnitude I0	A, primary	IEEE float
178-179(R)	Zero-Sequence Current Angle	Degrees	IEEE float
180-181(R)	Positive-Sequence Current Magnitude I1	A, primary	IEEE float
182-183(R)	Positive-Sequence Current Angle	Degrees	IEEE float
184-185(R)	Negative-Sequence Current Magnitude I2	A, primary	IEEE float
186-187(R)	Negative-Sequence Current Angle	Degrees	IEEE float
188-189(R)	Zero-Sequence Voltage Magnitude V0	V, primary	IEEE float
190-191(R)	Zero-Sequence Voltage Angle	Degrees	IEEE float
192-193(R)	Positive-Sequence Voltage Magnitude V1	V, primary	IEEE float
194-195(R)	Positive-Sequence Voltage Angle	Degrees	IEEE float
196-197(R)	Negative-Sequence Voltage Magnitude V2	V, primary	IEEE float
198-199(R)	Negative-Sequence Voltage Angle	Degrees	IEEE float

SEL-151D/251D,-1,-3; SEL-151CD/251CD,-1,-3; SEL-167D/267D Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current Magnitude IA	A, primary	IEEE float
110-111(R)	Phase Current Angle	Degrees	IEEE float
112-113(R)	Phase Current Magnitude IB	A, primary	IEEE float
114-115(R)	Phase Current Angle	Degrees	IEEE float
116-117(R)	Phase Current Magnitude IC	A, primary	IEEE float
118-119(R)	Phase Current Angle	Degrees	IEEE float
120-121(R)	Difference Voltage Magnitude VAB	V, primary	IEEE float
122-123(R)	Difference Voltage Angle	Degrees	IEEE float
124-125(R)	Difference Voltage Magnitude VBC	V, primary	IEEE float
126-127(R)	Difference Voltage Angle	Degrees	IEEE float

128-129(R)	Difference Voltage Magnitude VCA	V, primary	IEEE float
130-131(R)	Difference Voltage Angle	Degrees	IEEE float
132-133(R)	Difference Current Magnitude IAB	A, primary	IEEE float
134-135(R)	Difference Current Angle	Degrees	IEEE float
136-137(R)	Difference Current Magnitude IBC	A, primary	IEEE float
138-139(R)	Difference Current Angle	Degrees	IEEE float
140-141(R)	Difference Current Magnitude ICA	A, primary	IEEE float
142-143(R)	Difference Current Angle	Degrees	IEEE float
144-145(R)	Three Phase Real Power P	MW, primary	IEEE float
146-147(R)	Three Phase Reactive Power Q	MVAR, primary	IEEE float
148-149(R)	Zero-Sequence Current Magnitude I0	A, primary	IEEE float
150-151(R)	Zero-Sequence Current Angle	Degrees	IEEE float
152-153(R)	Positive-Sequence Current Magnitude I1	A, primary	IEEE float
154-155(R)	Positive-Sequence Angle	Degrees	IEEE float
156-157(R)	Negative-Sequence Current Magnitude I2	A, primary	IEEE float
158-159(R)	Negative-Sequence Angle	Degrees	IEEE float
160-161(R)	Zero-Sequence Voltage Magnitude V0	V, primary	IEEE float
162-163(R)	Zero-Sequence Voltage Angle	Degrees	IEEE float
164-165(R)	Positive-Sequence Voltage Magnitude V1	V, primary	IEEE float
166-167(R)	Positive-Sequence Voltage Angle	Degrees	IEEE float
168-169(R)	Negative-Sequence Voltage Magnitude V2	V, primary	IEEE float
170-171(R)	Negative-Sequence Voltage Angle	Degrees	IEEE float

SEL-300G0 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current Magnitude IA	Amps, primary	IEEE float
110-111(R)	Phase Current Angle	Degrees	IEEE float
112-113(R)	Phase Current Magnitude IB	Amps, primary	IEEE float
114-115(R)	Phase Current Angle	Degrees	IEEE float
116-117(R)	Phase Current Magnitude IC	Amps, primary	IEEE float
118-119(R)	Phase Current Angle	Degrees	IEEE float
120-121(R)	Neutral Current Magnitude IN	A, primary	IEEE float
122-123(R)	Neutral Current Angle	Degrees	IEEE float
124-125(R)	Phase Voltage Magnitude VA	V, primary	IEEE float
126-127(R)	Phase Voltage Angle	Degrees	IEEE float
128-129(R)	Phase Voltage Magnitude VB	V, primary	IEEE float
130-131(R)	Phase Voltage Angle	Degrees	IEEE float
132-133(R)	Phase Voltage Magnitude VC	V, primary	IEEE float
134-135(R)	Phase Voltage Angle	Degrees	IEEE float
136-137(R)	Neutral Voltage Magnitude VN	V, primary	IEEE float
138-139(R)	Neutral Voltage Angle	Degrees	IEEE float
140-141(R)	Frequency Magnitude	Hertz	IEEE float
142-143(R)	Frequency Angle	Degrees	IEEE float (0.0)
144-145(R)	Battery Voltage Magnitude VBAT	V, primary	IEEE float
146-147(R)	Battery Voltage Angle	Degrees	IEEE float (0.0)
148-149(R)	Line Current Magnitude IAB	Amps, primary	IEEE float
150-151(R)	Line Current Angle	Degrees	IEEE float
152-153(R)	Line Current Magnitude IBC	Amps, primary	IEEE float
154-155(R)	Line Current Angle	Degrees	IEEE float
156-157(R)	Line Current Magnitude ICA	Amps, primary	IEEE float
158-159(R)	Line Current Angle	Degrees	IEEE float
160-161(R)	Line Voltage Magnitude VAB	V, primary	IEEE float
162-163(R)	Line Voltage Angle	Degrees	IEEE float
164-165(R)	Line Voltage Magnitude VBC	V, primary	IEEE float
166-167(R)	Line Voltage Angle	Degrees	IEEE float
168-169(R)	Line Voltage Magnitude VCA	V, primary	IEEE float
170-171(R)	Line Voltage Angle	Degrees	IEEE float
172-173(R)	Phase Real Power PA	MW, primary	IEEE float
174-175(R)	Phase Reactive Power QA	MVAR, primary	IEEE float
176-177(R)	Phase Real Power PB	MW, primary	IEEE float

178-179(R)	Phase Reactive Power QB	MVAR, primary	IEEE float
180-181(R)	Phase Real Power PC	MW, primary	IEEE float
182-183(R)	Phase Reactive Power QC	MVAR, primary	IEEE float
184-185(R)	Three Phase Real Power PMW	MW, primary	IEEE float
186-187(R)	Three Phase Reactive Power QMVAR	MVAR, primary	IEEE float
188-189(R)	Zero-Sequence Current Magnitude I0	A, primary	IEEE float
190-191(R)	Zero-Sequence Current Angle	Degrees	IEEE float
192-193(R)	Positive-Sequence Current Magnitude I1	A, primary	IEEE float
194-195(R)	Positive-Sequence Current Angle	Degrees	IEEE float
196-197(R)	Negative-Sequence Current Magnitude I2	A, primary	IEEE float
198-199(R)	Negative-Sequence Current Angle	Degrees	IEEE float

(Remaining data can not be accessed through this Modbus map.)

SEL-300G1 (Differential Option) Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current Magnitude IA	Amps, primary	IEEE float
110-111(R)	Phase Current Angle	Degrees	IEEE float
112-113(R)	Phase Current Magnitude IB	Amps, primary	IEEE float
114-115(R)	Phase Current Angle	Degrees	IEEE float
116-117(R)	Phase Current Magnitude IC	Amps, primary	IEEE float
118-119(R)	Phase Current Angle	Degrees	IEEE float
120-121(R)	Neutral Current Magnitude IN	Amps, primary	IEEE float
122-123(R)	Neutral Current Angle	Degrees	IEEE float
124-125(R)	Phase Voltage Magnitude VA	V, primary	IEEE float
126-127(R)	Phase Voltage Angle	Degrees	IEEE float
128-129(R)	Phase Voltage Magnitude VB	V, primary	IEEE float
130-131(R)	Phase Voltage Angle	Degrees	IEEE float
132-133(R)	Phase Voltage Magnitude VC	V, primary	IEEE float
134-135(R)	Phase Voltage Angle	Degrees	IEEE float
136-137(R)	Neutral Voltage Magnitude VN	V, primary	IEEE float
138-139(R)	Neutral Voltage Angle	Degrees	IEEE float
140-141(R)	Diff. Current Magnitude IA87	Amps, primary	IEEE float
142-143(R)	Diff. Current Angle	Degrees	IEEE float
144-145(R)	Diff. Current Magnitude IB87	Amps, primary	IEEE float
146-147(R)	Diff. Current Angle	Degrees	IEEE float
148-149(R)	Diff. Current Magnitude IC87	Amps, primary	IEEE float
150-151(R)	Diff. Current Angle	Degrees	IEEE float
152-153(R)	Frequency Magnitude	Hertz	IEEE float
154-155(R)	Frequency Angle	Degrees	IEEE float (0.0)
156-157(R)	Battery Voltage Magnitude VBAT	V, primary	IEEE float
158-159(R)	Battery Voltage Angle	Degrees	IEEE float (0.0)
160-161(R)	Line Current Magnitude IAB	Amps, primary	IEEE float
162-163(R)	Line Current Angle	Degrees	IEEE float
164-165(R)	Line Current Magnitude IBC	Amps, primary	IEEE float
166-167(R)	Line Current Angle	Degrees	IEEE float
168-169(R)	Line Current Magnitude ICA	Amps, primary	IEEE float
170-171(R)	Line Current Angle	Degrees	IEEE float
172-173(R)	Line Voltage Magnitude VAB	V, primary	IEEE float
174-175(R)	Line Voltage Angle	Degrees	IEEE float
176-177(R)	Line Voltage Magnitude VBC	V, primary	IEEE float
178-179(R)	Line Voltage Angle	Degrees	IEEE float
180-181(R)	Line Voltage Magnitude VCA	V, primary	IEEE float
182-183(R)	Line Voltage Angle	Degrees	IEEE float
184-185(R)	Phase Real Power PA	MW, primary	IEEE float
186-187(R)	Phase Reactive Power QA	MVAR, primary	IEEE float
188-189(R)	Phase Real Power PB	MW, primary	IEEE float
190-191(R)	Phase Reactive Power QB	MVAR, primary	IEEE float
192-193(R)	Phase Real Power PC	MW, primary	IEEE float
194-195(R)	Phase Reactive Power QC	MVAR, primary	IEEE float
196-197(R)	Three Phase Real Power PMW	MW, primary	IEEE float

198-199(R)	Three Phase Reactive Power QMVAR	MVAR, primary	IEEE float

(Remaining data can not be accessed through this Modbus map.)

SEL-351; SEL-351R Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
108-109(R)	Phase Current Magnitude IA	Amps, primary	IEEE float
110-111(R)	Phase Current Angle	Degrees	IEEE float
112-113(R)	Phase Current Magnitude IB	Amps, primary	IEEE float
114-115(R)	Phase Current Angle	Degrees	IEEE float
116-117(R)	Phase Current Magnitude IC	Amps, primary	IEEE float
118-119(R)	Phase Current Angle	Degrees	IEEE float
120-121(R)	Neutral Current Magnitude IN	A, primary	IEEE float
122-123(R)	Neutral Current Angle	Degrees	IEEE float
124-125(R)	Phase Voltage Magnitude VA	V, primary	IEEE float
126-127(R)	Phase Voltage Angle	Degrees	IEEE float
128-129(R)	Phase Voltage Magnitude VB	V, primary	IEEE float
130-131(R)	Phase Voltage Angle	Degrees	IEEE float
132-133(R)	Phase Voltage Magnitude VC	V, primary	IEEE float
134-135(R)	Phase Voltage Angle	Degrees	IEEE float
136-137(R)	Synchronizing Voltage Magnitude VS	V, primary	IEEE float
138-139(R)	Synchronizing Voltage Angle	Degrees	IEEE float
140-141(R)	Frequency Magnitude	Hertz	IEEE float
142-143(R)	Frequency Angle	Degrees	IEEE float (0.0)
144-145(R)	Battery Voltage Magnitude VBAT	V, primary	IEEE float
146-147(R)	Battery Voltage Angle	Degrees	IEEE float (0.0)
148-149(R)	Line Current Magnitude IAB	Amps, primary	IEEE float
150-151(R)	Line Current Angle	Degrees	IEEE float
152-153(R)	Line Current Magnitude IBC	Amps, primary	IEEE float
154-155(R)	Line Current Angle	Degrees	IEEE float
156-157(R)	Line Current Magnitude ICA	Amps, primary	IEEE float
158-159(R)	Line Current Angle	Degrees	IEEE float
160-161(R)	Line Voltage Magnitude VAB	V, primary	IEEE float
162-163(R)	Line Voltage Angle	Degrees	IEEE float
164-165(R)	Line Voltage Magnitude VBC	V, primary	IEEE float
166-167(R)	Line Voltage Angle	Degrees	IEEE float
168-169(R)	Line Voltage Magnitude VCA	V, primary	IEEE float
170-171(R)	Line Voltage Angle	Degrees	IEEE float
172-173(R)	Phase Real Power PA	MW, primary	IEEE float
174-175(R)	Phase Reactive Power QA	MVAR, primary	IEEE float
176-177(R)	Phase Real Power PB	MW, primary	IEEE float
178-179(R)	Phase Reactive Power QB	MVAR, primary	IEEE float
180-181(R)	Phase Real Power PC	MW, primary	IEEE float
182-183(R)	Phase Reactive Power QC	MVAR, primary	IEEE float
184-185(R)	Three Phase Real Power PMW	MW, primary	IEEE float
186-187(R)	Three Phase Reactive Power QMVAR	MVAR, primary	IEEE float
188-189(R)	Zero-Sequence Current Magnitude I0	A, primary	IEEE float
190-191(R)	Zero-Sequence Current Angle	Degrees	IEEE float
192-193(R)	Positive-Sequence Current Magnitude I1	A, primary	IEEE float
194-195(R)	Positive-Sequence Current Angle	Degrees	IEEE float
196-197(R)	Negative-Sequence Current Magnitude I2	A, primary	IEEE float
198-199(R)	Negative-Sequence Current Angle	Degrees	IEEE float

(Remaining data can not be accessed through this Modbus map.)

SEL-352 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23

104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Voltage Magnitude VAX	V, primary	IEEE float
110-111(R)	Phase Voltage Angle	Degrees	IEEE float
112-113(R)	Phase Current Magnitude IA	A, primary	IEEE float
114-115(R)	Phase Current Angle	Degrees	IEEE float
116-117(R)	Phase Voltage Magnitude VAY	V, primary	IEEE float
118-119(R)	Phase Voltage Angle	Degrees	IEEE float
120-121(R)	Phase Voltage Magnitude VBX	V, primary	IEEE float
122-123(R)	Phase Voltage Angle	Degrees	IEEE float
124-125(R)	Phase Current Magnitude IB	A, primary	IEEE float
126-127(R)	Phase Current Angle	Degrees	IEEE float
128-129(R)	Phase Voltage Magnitude VBY	V, primary	IEEE float
130-131(R)	Phase Voltage Angle	Degrees	IEEE float
132-133(R)	Phase Voltage Magnitude VCX	V, primary	IEEE float
134-135(R)	Phase Voltage Angle	Degrees	IEEE float
136-137(R)	Phase Current Magnitude IC	A, primary	IEEE float
138-139(R)	Phase Current Angle	Degrees	IEEE float
140-141(R)	Phase Voltage Magnitude VCY	V, primary	IEEE float
142-143(R)	Phase Voltage Angle	Degrees	IEEE float
144-145(R)	Difference Current Magnitude IAB	Amps, primary	IEEE float
146-147(R)	Difference Current Angle	Degrees	IEEE float
148-149(R)	Difference Current Magnitude IBC	Amps, primary	IEEE float
150-151(R)	Difference Current Angle	Degrees	IEEE float
152-153(R)	Difference Current Magnitude ICA	Amps, primary	IEEE float
154-155(R)	Difference Current Angle	Degrees	IEEE float
156-157(R)	Difference Voltage Magnitude VAB1	V, primary	IEEE float
158-159(R)	Difference Voltage Angle	Degrees	IEEE float
160-161(R)	Difference Voltage Magnitude VBC1	V, primary	IEEE float
162-163(R)	Difference Voltage Angle	Degrees	IEEE float
164-165(R)	Difference Voltage Magnitude VCA1	V, primary	IEEE float
166-167(R)	Difference Voltage Angle	Degrees	IEEE float
168-169(R)	Phase Real Power PA	MW, primary	IEEE float
170-171(R)	Phase Reactive Power QA	MVAR, primary	IEEE float
172-173(R)	Phase Real Power PB	MW, primary	IEEE float
174-175(R)	Phase Reactive Power QB	MVAR, primary	IEEE float
176-177(R)	Phase Real Power PC	MW, primary	IEEE float
178-179(R)	Phase Reactive Power QC	MVAR, primary	IEEE float
180-181(R)	Three Phase Real Power P	MW, primary	IEEE float
182-183(R)	Three Phase Reactive Power Q	MVAR, primary	IEEE float
184-185(R)	Difference Voltage Magnitude VAB2	V, primary	IEEE float
186-187(R)	Difference Voltage Angle	Degrees	IEEE float
188-189(R)	Difference Voltage Magnitude VBC2	V, primary	IEEE float
190-191(R)	Difference Voltage Angle	Degrees	IEEE float
192-193(R)	Difference Voltage Magnitude VCA2	V, primary	IEEE float
194-195(R)	Difference Voltage Angle	Degrees	IEEE float
196-197(R)	Zero-Sequence Current Magnitude I0	A, primary	IEEE float
198-199(R)	Zero-Sequence Current Angle	Degrees	IEEE float

(Remaining data cannot be accessed through this Modbus map.)

SEL-387 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current Magnitude IAW1	A, primary	IEEE float
110-111(R)	Phase Current Angle	Degrees	IEEE float
112-113(R)	Phase Current Magnitude IBW1	A, primary	IEEE float
114-115(R)	Phase Current Angle	Degrees	IEEE float
116-117(R)	Phase Current Magnitude ICW1	A, primary	IEEE float
118-119(R)	Phase Current Angle	Degrees	IEEE float

120-121(R)	Phase Current Magnitude IAW2	A, primary	IEEE float
122-123(R)	Phase Current Angle	Degrees	IEEE float
124-125(R)	Phase Current Magnitude IBW2	A, primary	IEEE float
126-127(R)	Phase Current Angle	Degrees	IEEE float
128-129(R)	Phase Current Magnitude ICW2	A, primary	IEEE float
130-131(R)	Phase Current Angle	Degrees	IEEE float
132-133(R)	Phase Current Magnitude IAW3	A, primary	IEEE float
134-135(R)	Phase Current Angle	Degrees	IEEE float
136-137(R)	Phase Current Magnitude IBW3	A, primary	IEEE float
138-139(R)	Phase Current Angle	Degrees	IEEE float
140-141(R)	Phase Current Magnitude ICW3	A, primary	IEEE float
142-143(R)	Phase Current Angle	Degrees	IEEE float
144-145(R)	Phase Current Magnitude IAW4	A, primary	IEEE float
146-147(R)	Phase Current Angle	Degrees	IEEE float
148-149(R)	Phase Current Magnitude IBW4	A, primary	IEEE float
150-151(R)	Phase Current Angle	Degrees	IEEE float
152-153(R)	Phase Current Magnitude ICW4	A, primary	IEEE float
154-155(R)	Phase Current Angle	Degrees	IEEE float
156-157(R)	Zero-Sequence Current Magnitude I0W1	A, primary	IEEE float
158-159(R)	Zero-Sequence Current Angle	Degrees	IEEE float
160-161(R)	Positive-Sequence Current Magnitude I1W1	A, primary	IEEE float
162-163(R)	Positive-Sequence Current Angle	Degrees	IEEE float
164-165(R)	Negative-Sequence Current Magnitude I2W1	A, primary	IEEE float
166-167(R)	Negative-Sequence Current Angle	Degrees	IEEE float
168-169(R)	Zero-Sequence Current Magnitude I0W2	A, primary	IEEE float
170-171(R)	Zero-Sequence Current Angle	Degrees	IEEE float
172-173(R)	Positive-Sequence Current Magnitude I1W2	A, primary	IEEE float
174-175(R)	Positive-Sequence Current Angle	Degrees	IEEE float
176-177(R)	Negative-Sequence Current Magnitude I2W2	A, primary	IEEE float
178-179(R)	Negative-Sequence Current Angle	Degrees	IEEE float
180-181(R)	Zero-Sequence Current Magnitude I0W3	A, primary	IEEE float
182-183(R)	Zero-Sequence Current Angle	Degrees	IEEE float
184-185(R)	Positive-Sequence Current Magnitude I1W3	A, primary	IEEE float
186-187(R)	Positive-Sequence Current Angle	Degrees	IEEE float
188-189(R)	Negative-Sequence Current Magnitude I2W3	A, primary	IEEE float
190-191(R)	Negative-Sequence Current Angle	Degrees	IEEE float
192-193(R)	Zero-Sequence Current Magnitude I0W4	A, primary	IEEE float
194-195(R)	Zero-Sequence Current Angle	Degrees	IEEE float
196-197(R)	Positive-Sequence Current Magnitude I1W4	A, primary	IEEE float
198-199(R)	Positive-Sequence Current Angle	Degrees	IEEE float

(Remaining data cannot be accessed through this Modbus map.)

SEL-501,-1,-2 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current Magnitude IAX	A, primary	IEEE float
110-111(R)	Phase Current Angle	Degrees	IEEE float
112-113(R)	Phase Current Magnitude IBX	A, primary	IEEE float
114-115(R)	Phase Current Angle	Degrees	IEEE float
116-117(R)	Phase Current Magnitude ICX	A, primary	IEEE float
118-119(R)	Phase Current Angle	Degrees	IEEE float
120-121(R)	Phase Current Magnitude IAY	A, primary	IEEE float
122-123(R)	Phase Current Angle	Degrees	IEEE float
124-125(R)	Phase Current Magnitude IBY	A, primary	IEEE float
126-127(R)	Phase Current Angle	Degrees	IEEE float
128-129(R)	Phase Current Magnitude ICY	A, primary	IEEE float
130-131(R)	Phase Current Angle	Degrees	IEEE float
132-133(R)	Difference Current Magnitude IABX	A, primary	IEEE float
134-135(R)	Difference Current Angle	Degrees	IEEE float
137-137(R)	Difference Current Magnitude IBCX	A, primary	IEEE float
138-139(R)	Difference Current Angle	Degrees	IEEE float

140-141(R)	Difference Current Magnitude ICAX	A, primary	IEEE float
142-143(R)	Difference Current Angle	Degrees	IEEE float
144-145(R)	Difference Current Magnitude IABY	A, primary	IEEE float
146-147(R)	Difference Current Angle	Degrees	IEEE float
148-149(R)	Difference Current Magnitude IBCY	A, primary	IEEE float
150-151(R)	Difference Current Angle	Degrees	IEEE float
152-153(R)	Difference Current Magnitude ICAY	A, primary	IEEE float
154-155(R)	Difference Current Angle	Degrees	IEEE float
156-157(R)	Zero-Sequence Current Magnitude I0X	A, primary	IEEE float
158-159(R)	Zero-Sequence Current Angle	Degrees	IEEE float
160-161(R)	Positive-Sequence Current Magnitude I1X	A, primary	IEEE float
162-163(R)	Positive-Sequence Current Angle	Degrees	IEEE float
164-165(R)	Negative-Sequence Current Magnitude I2X	A, primary	IEEE float
166-167(R)	Negative-Sequence Current Angle	Degrees	IEEE float
168-169(R)	Zero-Sequence Current Magnitude I0Y	A, primary	IEEE float
170-171(R)	Zero-Sequence Current Angle	Degrees	IEEE float
172-173(R)	Positive-Sequence Current Magnitude I1Y	A, primary	IEEE float
174-175(R)	Positive-Sequence Current Angle	Degrees	IEEE float
176-177(R)	Negative-Sequence Current Magnitude I2Y	A, primary	IEEE float
178-179(R)	Negative-Sequence Current Angle	Degrees	IEEE float

SEL-551 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current Magnitude IA	A, primary	IEEE float
110-111(R)	Phase Current Angle	Degrees	IEEE float
112-113(R)	Phase Current Magnitude IB	A, primary	IEEE float
114-115(R)	Phase Current Angle	Degrees	IEEE float
116-117(R)	Phase Current Magnitude IC	A, primary	IEEE float
118-119(R)	Phase Current Angle	Degrees	IEEE float
120-121(R)	Neutral Current Magnitude IN	A, primary	IEEE float
122-123(R)	Neutral Current Angle	Degrees	IEEE float
124-125(R)	Difference Current Magnitude IAB	A, primary	IEEE float
126-127(R)	Difference Current Angle	Degrees	IEEE float
128-129(R)	Difference Current Magnitude IBC	A, primary	IEEE float
130-131(R)	Difference Current Angle	Degrees	IEEE float
132-133(R)	Difference Current Magnitude ICA	A, primary	IEEE float
134-135(R)	Difference Current Angle	Degrees	IEEE float

SEL-587 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108-109(R)	Phase Current Magnitude IAW1	A, primary	IEEE float
110-111(R)	Phase Current Angle	Degrees	IEEE float
112-113(R)	Phase Current Magnitude IBW1	A, primary	IEEE float
114-115(R)	Phase Current Angle	Degrees	IEEE float
116-117(R)	Phase Current Magnitude ICW1	A, primary	IEEE float
118-119(R)	Phase Current Angle	Degrees	IEEE float
120-121(R)	Phase Current Magnitude IAW2	A, primary	IEEE float
122-123(R)	Phase Current Angle	Degrees	IEEE float
124-125(R)	Phase Current Magnitude IBW2	A, primary	IEEE float
126-127(R)	Phase Current Angle	Degrees	IEEE float
128-129(R)	Phase Current Magnitude ICW2	A, primary	IEEE float
130-131(R)	Phase Current Angle	Degrees	IEEE float

132-133(R)	Difference Current Magnitude IAB	A, primary	IEEE float
134-135(R)	Difference Current Angle	Degrees	IEEE float
136-137(R)	Difference Current Magnitude IBC	A, primary	IEEE float
138-139(R)	Difference Current Angle	Degrees	IEEE float
140-141(R)	Difference Current Magnitude ICA	A, primary	IEEE float
142-143(R)	Difference Current Angle	Degrees	IEEE float
144-145(R)	Difference Current Magnitude IAB	A, primary	IEEE float
146-147(R)	Difference Current Angle	Degrees	IEEE float
148-149(R)	Difference Current Magnitude IBC	A, primary	IEEE float
150-151(R)	Difference Current Angle	Degrees	IEEE float
152-153(R)	Difference Current Magnitude ICA	A, primary	IEEE float
154-155(R)	Difference Current Angle	Degrees	IEEE float
156-157(R)	Zero-Sequence Current Magnitude I0W1	A, primary	IEEE float
158-159(R)	Zero-Sequence Current Angle	Degrees	IEEE float
160-161(R)	Positive-Sequence Current Magnitude I1W1	A, primary	IEEE float
162-163(R)	Positive-Sequence Current Angle	Degrees	IEEE float
164-165(R)	Negative-Sequence Current Magnitude I2W1	A, primary	IEEE float
166-167(R)	Negative-Sequence Current Angle	Degrees	IEEE float
168-169(R)	Zero-Sequence Current Magnitude I0W2	A, primary	IEEE float
170-171(R)	Zero-Sequence Current Angle	Degrees	IEEE float
172-173(R)	Positive-Sequence Current Magnitude I1W2	A, primary	IEEE float
174-175(R)	Positive-Sequence Current Angle	Degrees	IEEE float
176-177(R)	Negative-Sequence Current Magnitude I2W2	A, primary	IEEE float
178-179(R)	Negative-Sequence Current Angle	Degrees	IEEE float

Table G.2: Register Maps for Meter Data, Integer Type

This set of maps is the same as those presented in Table G.1 except that all floating-point data is given in an integer format. If a value ever exceeds the range of an integer, the maximum allowed value will be given. Be sure to carefully check the units to make sure you scale the data appropriately.

Reg.# | **Description** | **Units** | **Range**

I. Data from Relays with ASCII Meter Format.

SEL-49; SEL-121/221,-1,-2,-2A,-3,-4,-5,-6,-8; SEL-121/221,-10,-16,-17; SEL-121B/221B,-1; SEL-121C/ 221C,-1; SEL-121G/221G,-3,-4,-5,-6,-7,-8,-9; SEL-121H/221H; SEL-121S/221S; SEL-BFR/2BFR,-1, SEL-PG10/ 2PG10,-7,-8; SEL-321:

Reg.#	Description	Units	Range
100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Current IA	A, primary	0-32767 A, pri
109(R)	Phase Current IB	A, primary	0-32767 A, pri
110(R)	Phase Current IC	A, primary	0-32767 A, pri
111(R)	Difference Current IAB	A, primary	0-32767 A, pri
112(R)	Difference Current IBC	A, primary	0-32767 A, pri
113(R)	Difference Current ICA	A, primary	0-32767 A, pri
114(R)	Phase Voltage VA	kV/10, primary	0.0-3276.7 kV, pri
115(R)	Phase Voltage VB	kV/10, primary	0.0-3276.7 kV, pri
116(R)	Phase Voltage VC	kV/10, primary	0.0-3276.7 kV, pri
117(R)	Difference Voltage VAB	kV/10, primary	0.0-3276.7 kV, pri
118(R)	Difference Voltage VBC	kV/10, primary	0.0-3276.7 kV, pri
119(R)	Difference Voltage VCA	kV/10, primary	0.0-3276.7 kV, pri
120(R)	Real Power P	MW/10, primary	±3276.7 MW, pri
121(R)	Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri

SEL-121D/221D:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Current IA	A, primary	0-32767 A, pri
109(R)	Phase Current IB	A, primary	0-32767 A, pri
110(R)	Phase Current IC	A, primary	0-32767 A, pri
111(R)	Difference Voltage VAB	kV/10, primary	0.0-3276.7 kV, pri
112(R)	Difference Voltage VBC	kV/10, primary	0.0-3276.7 kV, pri
113(R)	Difference Voltage VCA	kV/10, primary	0.0-3276.7 kV, pri
114(R)	Real Power P	MW/10, primary	±3276.7 MW, pri
115(R)	Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri

SEL-121F/221F,-1,-2,-3,-8:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Current IA	A, primary	0-32767 A, pri
109(R)	Phase Current IB	A, primary	0-32767 A, pri
110(R)	Phase Current IC	A, primary	0-32767 A, pri
111(R)	Difference Current IAB	A, primary	0-32767 A, pri
112(R)	Difference Current IBC	A, primary	0-32767 A, pri
113(R)	Difference Current ICA	A, primary	0-32767 A, pri
114(R)	Residual Current IR	A, primary	0-32767 A, pri
115(R)	Phase Voltage VA	kV/10, primary	0.0-3276.7 kV, pri
116(R)	Phase Voltage VB	kV/10, primary	0.0-3276.7 kV, pri
117(R)	Phase Voltage VC	kV/10, primary	0.0-3276.7 kV, pri
118(R)	Difference Voltage VAB	kV/10, primary	0.0-3276.7 kV, pri
119(R)	Difference Voltage VBC	kV/10, primary	0.0-3276.7 kV, pri
120(R)	Difference Voltage VCA	kV/10, primary	0.0-3276.7 kV, pri
121(R)	Synchronizing Voltage VS	kV/10, primary	0.0-3276.7 kV, pri
122(R)	Real Power P	MW/10, primary	±3276.7 MW, pri
123(R)	Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri

SEL-151/251,-1,-2,-3; SEL-151C/251C,-1,-2,-3:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Current IA	A, primary	0-32767 A, pri
109(R)	Phase Current IB	A, primary	0-32767 A, pri
110(R)	Phase Current IC	A, primary	0-32767 A, pri
111(R)	Residual Current IR	A, primary	0-32767 A, pri
112(R)	Negative-Sequence Current 3I2	A, primary	0-32767 A, pri
113(R)	Real Power P	MW/10, primary	±3276.7 MW, pri
114(R)	Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri
115(R)	Phase Voltage VA	kV/10, primary	0.0-3276.7 kV, pri
116(R)	Phase Voltage VB	kV/10, primary	0.0-3276.7 kV, pri
117(R)	Phase Voltage VC	kV/10, primary	0.0-3276.7 kV, pri
118(R)	Zero-Sequence Voltage 3V0	kV/10, primary	0.0-3276.7 kV, pri
119(R)	Difference Voltage VAB	kV/10, primary	0.0-3276.7 kV, pri

120(R)	Difference Voltage VBC	kV/10, primary	0.0-3276.7 kV, pri
121(R)	Difference Voltage VCA	kV/10, primary	0.0-3276.7 kV, pri
122(R)	Negative-Sequence Voltage 3V2	kV/10, primary	0.0-3276.7 kV, pri

FOR SEL-151D/251D,-1,-3; SEL-151CD/251CD,-1,-3:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
108(R)	Phase Current IA	A, primary	0-32767 A, pri
109(R)	Phase Current IB	A, primary	0-32767 A, pri
110(R)	Phase Current IC	A, primary	0-32767 A, pri
111(R)	Residual Current IR	A, primary	0-32767 A, pri
112(R)	Negative-Sequence Current 3I2	A, primary	0-32767 A, pri
113(R)	Real Power P	MW/10, primary	±3276.7 MW, pri
114(R)	Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri
115(R)	Difference Voltage VAB	kV/10, primary	0.0-3276.7 kV, pri
116(R)	Difference Voltage VBC	kV/10, primary	0.0-3276.7 kV, pri
117(R)	Difference Voltage VCA	kV/10, primary	0.0-3276.7 kV, pri

SEL-167/267,-2,-4,-5:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
108(R)	Phase Current IA	A, primary	0-32767 A, pri
109(R)	Phase Current IB	A, primary	0-32767 A, pri
110(R)	Phase Current IC	A, primary	0-32767 A, pri
111(R)	Difference Current IAB	A, primary	0-32767 A, pri
112(R)	Difference Current IBC	A, primary	0-32767 A, pri
113(R)	Difference Current ICA	A, primary	0-32767 A, pri
114(R)	Demand Phase Current IAD	A, primary	0-32767 A, pri
115(R)	Demand Phase Current IBD	A, primary	0-32767 A, pri
116(R)	Demand Phase Current ICD	A, primary	0-32767 A, pri
117(R)	Peak-Demand Phase Current IAP	A, primary	0-32767 A, pri
118(R)	Peak-Demand Phase Current IBP	A, primary	0-32767 A, pri
119(R)	Peak-Demand Phase Current ICP	A, primary	0-32767 A, pri
120(R)	Phase Voltage VA	kV/10, primary	0.0-3276.7 kV, pri
121(R)	Phase Voltage VB	kV/10, primary	0.0-3276.7 kV, pri
122(R)	Phase Voltage VC	kV/10, primary	0.0-3276.7 kV, pri
123(R)	Difference Voltage VAB	kV/10, primary	0.0-3276.7 kV, pri
124(R)	Difference Voltage VBC	kV/10, primary	0.0-3276.7 kV, pri
125(R)	Difference Voltage VCA	kV/10, primary	0.0-3276.7 kV, pri
126(R)	Real Power P	MW/10, primary	±3276.7 MW, pri
127(R)	Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri

SEL-167D/267D:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
108(R)	Phase Current IA	A, primary	0-32767 A, pri
109(R)	Phase Current IB	A, primary	0-32767 A, pri

110(R)	Phase Current IC	A, primary	0-32767 A, pri
111(R)	Demand Phase Current IAD	A, primary	0-32767 A, pri
112(R)	Demand Phase Current IBD	A, primary	0-32767 A, pri
113(R)	Demand Phase Current ICD	A, primary	0-32767 A, pri
114(R)	Peak-Demand Phase Current IAP	A, primary	0-32767 A, pri
115(R)	Peak-Demand Phase Current IBP	A, primary	0-32767 A, pri
116(R)	Peak-Demand Phase Current ICP	A, primary	0-32767 A, pri
117(R)	Difference Voltage VAB	kV/10, primary	0.0-3276.7 kV, pri
118(R)	Difference Voltage VBC	kV/10, primary	0.0-3276.7 kV, pri
119(R)	Difference Voltage VCA	kV/10, primary	0.0-3276.7 kV, pri
120(R)	Real Power P	MW/10, primary	±3276.7 MW, pri
121(R)	Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri

SEL-187V/287V:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Voltage VAX	V/100, secondary	0.00-327.67 V, sec
109(R)	Phase Voltage VBX	V/100, secondary	0.00-327.67 V, sec
110(R)	Phase Voltage VCX	V/100, secondary	0.00-327.67 V, sec
111(R)	Phase Voltage VAY	V/100, secondary	0.00-327.67 V, sec
112(R)	Phase Voltage VBY	V/100, secondary	0.00-327.67 V, sec
113(R)	Phase Voltage VCY	V/100, secondary	0.00-327.67 V, sec
114(R)	Differential Voltage VAD	V/100, secondary	0.00-327.67 V, sec
115(R)	Differential Voltage VBD	V/100, secondary	0.00-327.67 V, sec
116(R)	Differential Voltage VCD	V/100, secondary	0.00-327.67 V, sec

SEL-279:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Voltage V1	V/100, secondary	0.00-327.67 V, sec
109(R)	Phase Voltage V3	V/100, secondary	0.00-327.67 V, sec
110(R)	Phase Voltage V5	V/100, secondary	0.00-327.67 V, sec
111(R)	Phase Voltage V2	V/100, secondary	0.00-327.67 V, sec
112(R)	Phase Voltage V4	V/100, secondary	0.00-327.67 V, sec
113(R)	Phase Voltage V6	V/100, secondary	0.00-327.67 V, sec
114(R)	Differential Voltage V12D	V/100, secondary	0.00-327.67 V, sec
115(R)	Differential Voltage V32D	V/100, secondary	0.00-327.67 V, sec
116(R)	Differential Voltage V56D	V/100, secondary	0.00-327.67 V, sec

SEL-279H,-1,-2:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Bus Positive Sequence Voltage VPB	V/100, secondary	0.00-327.67 V, sec
109(R)	Phase Voltage V1	V/100, secondary	0.00-327.67 V, sec
110(R)	Phase Voltage V3	V/100, secondary	0.00-327.67 V, sec
111(R)	Phase Voltage V5	V/100, secondary	0.00-327.67 V, sec
112(R)	Line Positive Sequence Voltage VPL	V/100, secondary	0.00-327.67 V, sec

113(R)	Phase Voltage V2	V/100, secondary	0.00-327.67 V, sec
114(R)	Phase Voltage V4	V/100, secondary	0.00-327.67 V, sec
115(R)	Phase Voltage V6	V/100, secondary	0.00-327.67 V, sec
116(R)	Differential Voltage V12D	V/100, secondary	0.00-327.67 V, sec
117(R)	Differential Voltage V34D	V/100, secondary	0.00-327.67 V, sec
118(R)	Differential Voltage V56D	V/100, secondary	0.00-327.67 V, sec

SEL-501:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
108(R)	Phase Current IAX	A, primary	0-32767 A, pri
109(R)	Phase Current IBX	A, primary	0-32767 A, pri
110(R)	Phase Current ICX	A, primary	0-32767 A, pri
111(R)	Phase Current IAY	A, primary	0-32767 A, pri
112(R)	Phase Current IBY	A, primary	0-32767 A, pri
113(R)	Phase Current ICY	A, primary	0-32767 A, pri
114(R)	Negative-Sequence Current 3I2X	A, primary	0-32767 A, pri
115(R)	Residual Current IRX	A, primary	0-32767 A, pri
116(R)	Negative-Sequence Current 3I2Y	A, primary	0-32767 A, pri
117(R)	Residual Current IRY	A, primary	0-32767 A, pri

II. Data from Relays with Binary Fast Meter Format

SEL-121/221,-10,-16,-17; SEL-121B/221B,-1; SEL-121C/221C,-1; SEL-121G/221G,-3,-4,-5,-6,-7,-8,-9; SEL-121H/221H; SEL-121S/221S; SEL-PG10/2PG10,-7,-8; SEL-151/251,-1,-2,-3; SEL-151C/251C,-1,-2,-3; SEL-321-1, -2 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
108(R)	Phase Current Magnitude IA	A, primary	0-32767 A, pri
109(R)	Phase Current Angle	Degrees/10	±180.0°
110(R)	Phase Current Magnitude IB	A, primary	0-32767 A, pri
111(R)	Phase Current Angle	Degrees/10	±180.0°
112(R)	Phase Current Magnitude IC	A, primary	0-32767 A, pri
113(R)	Phase Current Angle	Degrees/10	±180.0°
114(R)	Phase Voltage Magnitude VA	kV/10, primary	0.0-3276.7 kV, pri
115(R)	Phase Voltage Angle	Degrees/10	±180.0°
116(R)	Phase Voltage Magnitude VB	kV/10, primary	0.0-3276.7 kV, pri
117(R)	Phase Voltage Angle	Degrees/10	±180.0°
118(R)	Phase Voltage Magnitude VC	kV/10, primary	0.0-3276.7 kV, pri
119(R)	Phase Voltage Angle	Degrees/10	±180.0°
120(R)	Difference Current Magnitude IAB	A, primary	0-32767 A, pri
121(R)	Difference Current Angle	Degrees/10	±180.0°
122(R)	Difference Current Magnitude IBC	A, primary	0-32767 A, pri
123(R)	Difference Current Angle	Degrees/10	±180.0°
124(R)	Difference Current Magnitude ICA	A, primary	0-32767 A, pri
125(R)	Difference Current Angle	Degrees/10	±180.0°
126(R)	Difference Voltage Magnitude VAB	kV/10, primary	0.0-3276.7 kV, pri
127(R)	Difference Voltage Angle	Degrees/10	±180.0°
128(R)	Difference Voltage Magnitude VBC	kV/10, primary	0.0-3276.7 kV, pri
129(R)	Difference Voltage Angle	Degrees/10	±180.0°
130(R)	Difference Voltage Magnitude VCA	kV/10, primary	0.0-3276.7 kV, pri
131(R)	Difference Voltage Angle	Degrees/10	±180.0°
132(R)	Phase Real Power PA	MW/10, primary	±3276.7 MW, pri
133(R)	Phase Reactive Power QA	MVAR/10, primary	±3276.7 MVAR, pri

134(R)	Phase Real Power PB	MW/10, primary	±3276.7 MW, pri
135(R)	Phase Reactive Power QB	MVAR/10, primary	±3276.7 MVAR, pri
136(R)	Phase Real Power PC	MW/10, primary	±3276.7 MW, pri
137(R)	Phase Reactive Power QC	MVAR/10, primary	±3276.7 MVAR, pri
138(R)	Three Phase Real Power P	MW/10, primary	±3276.7 MW, pri
139(R)	Three Phase Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri
140(R)	Zero-Sequence Current Magnitude I0	A, primary	0-32767 A, pri
141(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
142(R)	Positive-Sequence Current Magnitude I1	A, primary	0-32767 A, pri
143(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
144(R)	Negative-Sequence Current Magnitude I2	A, primary	0-32767 A, pri
145(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°
146(R)	Zero-Sequence Voltage Magnitude V0	kV/10, primary	0.0-3276.7 kV, pri
147(R)	Zero-Sequence Voltage Angle	Degrees/10	±180.0°
148(R)	Positive-Sequence Voltage Magnitude V1	kV/10, primary	0.0-3276.7 kV, pri
149(R)	Positive-Sequence Voltage Angle	Degrees/10	±180.0°
150(R)	Negative-Sequence Voltage Magnitude V2	kV/10, primary	0.0-3276.7 kV, pri
151(R)	Negative-Sequence Voltage Angle	Degrees/10	±180.0°

SEL-121F/221F,-1,-2,-3,-8 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Current Magnitude IA	A, primary	0-32767 A, pri
109(R)	Phase Current Angle	Degrees/10	±180.0°
110(R)	Phase Current Magnitude IB	A, primary	0-32767 A, pri
111(R)	Phase Current Angle	Degrees/10	±180.0°
112(R)	Phase Current Magnitude IC	A, primary	0-32767 A, pri
113(R)	Phase Current Angle	Degrees/10	±180.0°
114(R)	Phase Voltage Magnitude VA	kV/10, primary	0.0-3276.7 kV, pri
115(R)	Phase Voltage Angle	Degrees/10	±180.0°
116(R)	Phase Voltage Magnitude VB	kV/10, primary	0.0-3276.7 kV, pri
117(R)	Phase Voltage Angle	Degrees/10	±180.0°
118(R)	Phase Voltage Magnitude VC	kV/10, primary	0.0-3276.7 kV, pri
119(R)	Phase Voltage Angle	Degrees/10	±180.0°
120(R)	Synchronizing Voltage Magnitude VS	kV/10, primary	0.0-3276.7 kV, pri
121(R)	Synchronizing Voltage Angle	Degrees/10	±180.0°
122(R)	Difference Current Magnitude IAB	A, primary	0-32767 A, pri
123(R)	Difference Current Angle	Degrees/10	±180.0°
124(R)	Difference Current Magnitude IBC	A, primary	0-32767 A, pri
125(R)	Difference Current Angle	Degrees/10	±180.0°
126(R)	Difference Current Magnitude ICA	A, primary	0-32767 A, pri
127(R)	Difference Current Angle	Degrees/10	±180.0°
128(R)	Difference Voltage Magnitude VAB	kV/10, primary	0.0-3276.7 kV, pri
129(R)	Difference Voltage Angle	Degrees/10	±180.0°
130(R)	Difference Voltage Magnitude VBC	kV/10, primary	0.0-3276.7 kV, pri
131(R)	Difference Voltage Angle	Degrees/10	±180.0°
132(R)	Difference Voltage Magnitude VCA	kV/10, primary	0.0-3276.7 kV, pri
133(R)	Difference Voltage Angle	Degrees/10	±180.0°
134(R)	Phase Real Power PA	MW/10, primary	±3276.7 MW, pri
135(R)	Phase Reactive Power QA	MVAR/10, primary	±3276.7 MVAR, pri
136(R)	Phase Real Power PB	MW/10, primary	±3276.7 MW, pri
137(R)	Phase Reactive Power QB	MVAR/10, primary	±3276.7 MVAR, pri
138(R)	Phase Real Power PC	MW/10, primary	±3276.7 MW, pri
139(R)	Phase Reactive Power QC	MVAR/10, primary	±3276.7 MVAR, pri
140(R)	Three Phase Real Power P	MW/10, primary	±3276.7 MW, pri
141(R)	Three Phase Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri
142(R)	Zero-Sequence Current Magnitude I0	A, primary	0-32767 A, pri
143(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
144(R)	Positive-Sequence Current Magnitude I1	A, primary	0-32767 A, pri
145(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
146(R)	Negative-Sequence Current Magnitude I2	A, primary	0-32767 A, pri

147(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°
148(R)	Zero-Sequence Voltage Magnitude V0	kV/10, primary	0.0-3276.7 kV, pri
149(R)	Zero-Sequence Voltage Angle	Degrees/10	±180.0°
150(R)	Positive-Sequence Voltage Magnitude V1	kV/10, primary	0.0-3276.7 kV, pri
151(R)	Positive-Sequence Voltage Angle	Degrees/10	±180.0°
152(R)	Negative-Sequence Voltage Magnitude V2	kV/10, primary	0.0-3276.7 kV, pri
153(R)	Negative-Sequence Voltage Angle	Degrees/10	±180.0°

SEL-151D/251D,-1,-3; SEL-151CD/251CD,-1,-3; SEL-167D/267D Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Current Magnitude IA	A, primary	0-32767 A, pri
109(R)	Phase Current Angle	Degrees/10	±180.0°
110(R)	Phase Current Magnitude IB	A, primary	0-32767 A, pri
111(R)	Phase Current Angle	Degrees/10	±180.0°
112(R)	Phase Current Magnitude IC	A, primary	0-32767 A, pri
113(R)	Phase Current Angle	Degrees/10	±180.0°
114(R)	Difference Voltage Magnitude VAB	kV/10, primary	0.0-3276.7 kV, pri
115(R)	Difference Voltage Angle	Degrees/10	±180.0°
116(R)	Difference Voltage Magnitude VBC	kV/10, primary	0.0-3276.7 kV, pri
117(R)	Difference Voltage Angle	Degrees/10	±180.0°
118(R)	Difference Voltage Magnitude VCA	kV/10, primary	0.0-3276.7 kV, pri
119(R)	Difference Voltage Angle	Degrees/10	±180.0°
120(R)	Difference Current Magnitude IAB	A, primary	0-32767 A, pri
121(R)	Difference Current Angle	Degrees/10	±180.0°
122(R)	Difference Current Magnitude IBC	A, primary	0-32767 A, pri
123(R)	Difference Current Angle	Degrees/10	±180.0°
124(R)	Difference Current Magnitude ICA	A, primary	0-32767 A, pri
125(R)	Difference Current Angle	Degrees/10	±180.0°
126(R)	Three Phase Real Power P	MW/10, primary	±3276.7 MW, pri
127(R)	Three Phase Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri
128(R)	Zero-Sequence Current Magnitude I0	A, primary	0-32767 A, pri
129(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
130(R)	Positive-Sequence Current Magnitude I1	A, primary	0-32767 A, pri
131(R)	Positive-Sequence Angle	Degrees/10	±180.0°
132(R)	Negative-Sequence Current Magnitude I2	A, primary	0-32767 A, pri
133(R)	Negative-Sequence Angle	Degrees/10	±180.0°
134(R)	Zero-Sequence Voltage Magnitude V0	kV/10, primary	0 kV, pri
135(R)	Zero-Sequence Voltage Angle	Degrees/10	±180.0°
136(R)	Positive-Sequence Voltage Magnitude V1	kV/10, primary	0.0-3276.7 kV, pri
137(R)	Positive-Sequence Voltage Angle	Degrees/10	±180.0°
138(R)	Negative-Sequence Voltage Magnitude V2	kV/10, primary	0.0-3276.7 kV, pri
139(R)	Negative-Sequence Voltage Angle	Degrees/10	±180.0°

SEL-300GO Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Current Magnitude IA	Amps, primary	0-32767 A, pri
109(R)	Phase Current Angle	Degrees/10	±180.0°
110(R)	Phase Current Magnitude IB	Amps, primary	0-32767 A, pri
111(R)	Phase Current Angle	Degrees/10	±180.0°
112(R)	Phase Current Magnitude IC	Amps, primary	0-32767 A, pri
113(R)	Phase Current Angle	Degrees/10	±180.0°
114(R)	Neutral Current Magnitude IN	Amps, primary	0-32767 A, pri

115(R)	Neutral Current Angle	Degrees/10	±180.0°
116(R)	Phase Voltage Magnitude VA	kV/10, primary	0-3276.7 kV, pri
117(R)	Phase Voltage Angle	Degrees/10	±180.0°
118(R)	Phase Voltage Magnitude VB	kV/10, primary	0-3276.7 kV, pri
119(R)	Phase Voltage Angle	Degrees/10	±180.0°
120(R)	Phase Voltage Magnitude VC	kV/10, primary	0-3276.7 kV, pri
121(R)	Phase Voltage Angle	Degrees/10	±180.0°
122(R)	Neutral Voltage Magnitude VN	kV/10, primary	0-3276.7 kV, pri
123(R)	Neutral Voltage Angle	Degrees/10	±180.0°
124(R)	Frequency Magnitude	Hertz/10	0-3276.7 Hz
125(R)	Frequency Angle	Degrees	±180.0° (0.0)
126(R)	Battery Voltage Magnitude VBAT	kV/10, primary	0-3276.7 kV, pri
127(R)	Battery Voltage Angle	Degrees/10	±180.0° (0.0)
128(R)	Line Current Magnitude IAB	Amps, primary	0-32767 A, pri
129(R)	Line Current Angle	Degrees/10	±180.0°
130(R)	Line Current Magnitude IBC	Amps, primary	0-32767 A, pri
131(R)	Line Current Angle	Degrees/10	±180.0°
132(R)	Line Current Magnitude ICA	Amps, primary	0-32767 A, pri
133(R)	Line Current Angle	Degrees/10	±180.0°
134(R)	Line Voltage Magnitude VAB	kV/10, primary	0-3276.7 kV, pri
135(R)	Line Voltage Angle	Degrees/10	±180.0°
136(R)	Line Voltage Magnitude VBC	kV/10, primary	0-3276.7 kV, pri
137(R)	Line Voltage Angle	Degrees/10	±180.0°
138(R)	Line Voltage Magnitude VCA	kV/10, primary	0-3276.7 kV, pri
139(R)	Line Voltage Angle	Degrees/10	±180.0°
140(R)	Phase Real Power PA	MW/10, primary	±3276.7 MW
141(R)	Phase Reactive Power QA	MVAR/10, primary	±3276.7 MVAR
142(R)	Phase Real Power PB	MW/10, primary	±3276.7 MW
143(R)	Phase Reactive Power QB	MVAR/10, primary	±3276.7 MVAR
144(R)	Phase Real Power PC	MW/10, primary	±3276.7 MW
145(R)	Phase Reactive Power QC	MVAR/10, primary	±3276.7 MVAR
146(R)	Three Phase Real Power PMW	MW/10, primary	±3276.7 MW
147(R)	Three Phase Reactive Power QMVAR	MVAR/10, primary	±3276.7 MVAR
148(R)	Zero-Sequence Current Magnitude I0	A, primary	0-32767 A, pri
149(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
150(R)	Positive-Sequence Current Magnitude I1	A, primary	0-32767 A, pri
151(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
152(R)	Negative-Sequence Current Magnitude I2	A, primary	0-32767 A, pri
153(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°
154(R)	Zero-Sequence Voltage Magnitude V0	kV/10, primary	0-3276.7 kV, pri
155(R)	Zero-Sequence Voltage Angle	Degrees/10	±180.0°
156(R)	Positive-Sequence Voltage Magnitude V1	kV/10, primary	0-3276.7 kV, pri
157(R)	Positive-Sequence Voltage Angle	Degrees/10	±180.0°
158(R)	Negative-Sequence Voltage Magnitude V2	kV/10, primary	0-3276.7 kV, pri
159(R)	Negative-Sequence Voltage Angle	Degrees/10	±180.0°

SEL-300G1 (Differential Option) Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Current Magnitude IA	Amps, primary	0-32767 A, pri
109(R)	Phase Current Angle	Degrees/10	±180.0°
110(R)	Phase Current Magnitude IB	Amps, primary	0-32767 A, pri
111(R)	Phase Current Angle	Degrees/10	±180.0°
112(R)	Phase Current Magnitude IC	Amps, primary	0-32767 A, pri
113(R)	Phase Current Angle	Degrees/10	±180.0°
114(R)	Neutral Current Magnitude IN	Amps, primary	0-32767 A, pri
115(R)	Neutral Current Angle	Degrees/10	±180.0°
116(R)	Phase Voltage Magnitude VA	kV/10, primary	0-3276.7 kV, pri

117(R)	Phase Voltage Angle	Degrees/10	±180.0°
118(R)	Phase Voltage Magnitude VB	kV/10, primary	0-3276.7 kV, pri
119(R)	Phase Voltage Angle	Degrees/10	±180.0°
120(R)	Phase Voltage Magnitude VC	kV/10, primary	0-3276.7 kV, pri
121(R)	Phase Voltage Angle	Degrees/10	±180.0°
122(R)	Neutral Voltage Magnitude VN	kV/10, primary	0-3276.7 kV, pri
123(R)	Neutral Voltage Angle	Degrees/10	±180.0°
124(R)	Diff. Current Magnitude IA87	Amps, primary	0-32767 A, pri
125(R)	Diff. Current Angle	Degrees/10	±180.0°
126(R)	Diff. Current Magnitude IB87	Amps, primary	0-32767 A, pri
127(R)	Diff. Current Angle	Degrees/10	±180.0°
128(R)	Diff. Current Magnitude IC87	Amps, primary	0-32767 A, pri
129(R)	Diff. Current Angle	Degrees/10	±180.0°
130(R)	Frequency Magnitude	Hertz/10	0-3276.7 Hz
131(R)	Frequency Angle	Degrees	±180.0° (0.0)
132(R)	Battery Voltage Magnitude VBAT	kV/10, primary	0-3276.7 kV, pri
133(R)	Battery Voltage Angle	Degrees/10	±180.0° (0.0)
134(R)	Line Current Magnitude IAB	Amps, primary	0-32767 A, pri
135(R)	Line Current Angle	Degrees/10	±180.0°
136(R)	Line Current Magnitude IBC	Amps, primary	0-32767 A, pri
137(R)	Line Current Angle	Degrees/10	±180.0°
138(R)	Line Current Magnitude ICA	Amps, primary	0-32767 A, pri
139(R)	Line Current Angle	Degrees/10	±180.0°
140(R)	Line Voltage Magnitude VAB	kV/10, primary	0-3276.7 kV, pri
141(R)	Line Voltage Angle	Degrees/10	±180.0°
142(R)	Line Voltage Magnitude VBC	kV/10, primary	0-3276.7 kV, pri
143(R)	Line Voltage Angle	Degrees/10	±180.0°
144(R)	Line Voltage Magnitude VCA	kV/10, primary	0-3276.7 kV, pri
145(R)	Line Voltage Angle	Degrees/10	±180.0°
146(R)	Phase Real Power PA	MW/10, primary	±3276.7 MW
147(R)	Phase Reactive Power QA	MVAR/10, primary	±3276.7 MVAR
148(R)	Phase Real Power PB	MW/10, primary	±3276.7 MW
149(R)	Phase Reactive Power QB	MVAR/10, primary	±3276.7 MVAR
150(R)	Phase Real Power PC	MW/10, primary	±3276.7 MW
151(R)	Phase Reactive Power QC	MVAR/10, primary	±3276.7 MVAR
152(R)	Three Phase Real Power PMW	MW/10, primary	±3276.7 MW
153(R)	Three Phase Reactive Power QMVAR	MVAR/10, primary	±3276.7 MVAR
154(R)	Zero-Sequence Current Magnitude I0	A, primary	0-32767 A, pri
155(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
156(R)	Positive-Sequence Current Magnitude I1	A, primary	0-32767 A, pri
157(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
158(R)	Negative-Sequence Current Magnitude I2	A, primary	0-32767 A, pri
159(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°
160(R)	Zero-Sequence Voltage Magnitude V0	kV/10, primary	0-3276.7 kV, pri
161(R)	Zero-Sequence Voltage Angle	Degrees/10	±180.0°
162(R)	Positive-Sequence Voltage Magnitude V1	kV/10, primary	0-3276.7 kV, pri
163(R)	Positive-Sequence Voltage Angle	Degrees/10	±180.0°
164(R)	Negative-Sequence Voltage Magnitude V2	kV/10, primary	0-3276.7 kV, pri
165(R)	Negative-Sequence Voltage Angle	Degrees/10	±180.0°

SEL-351; SEL-351R Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Current Magnitude IA	Amps, primary	0-32767 A, pri
109(R)	Phase Current Angle	Degrees/10	±180.0°
110(R)	Phase Current Magnitude IB	Amps, primary	0-32767 A, pri
111(R)	Phase Current Angle	Degrees/10	±180.0°
112(R)	Phase Current Magnitude IC	Amps, primary	0-32767 A, pri

113(R)	Phase Current Angle	Degrees/10	±180.0°
114(R)	Neutral Current Magnitude IN	A, primary	0-32767 A, pri
115(R)	Neutral Current Angle	Degrees/10	±180.0°
116(R)	Phase Voltage Magnitude VA	kV/10, primary	0-3276.7 kV, pri
117(R)	Phase Voltage Angle	Degrees/10	±180.0°
118(R)	Phase Voltage Magnitude VB	kV/10, primary	0-3276.7 kV, pri
119(R)	Phase Voltage Angle	Degrees/10	±180.0°
120(R)	Phase Voltage Magnitude VC	kV/10, primary	0-3276.7 kV, pri
121(R)	Phase Voltage Angle	Degrees/10	±180.0°
122(R)	Synchronizing Voltage Magnitude VS	kV/10, primary	0-3276.7 kV, pri
123(R)	Synchronizing Voltage Angle	Degrees/10	±180.0°
124(R)	Frequency Magnitude	Hertz/10	0-3276.7 Hz
125(R)	Frequency Angle	Degrees	±180.0° (0.0)
126(R)	Battery Voltage Magnitude VBAT	kV/10, primary	0-3276.7 kV, pri
127(R)	Battery Voltage Angle	Degrees/10	±180.0° (0.0)
128(R)	Line Current Magnitude IAB	Amps, primary	0-32767 A, pri
129(R)	Line Current Angle	Degrees/10	±180.0°
130(R)	Line Current Magnitude IBC	Amps, primary	0-32767 A, pri
131(R)	Line Current Angle	Degrees/10	±180.0°
132(R)	Line Current Magnitude ICA	Amps, primary	0-32767 A, pri
133(R)	Line Current Angle	Degrees/10	±180.0°
134(R)	Line Voltage Magnitude VAB	kV/10, primary	0-3276.7 kV, pri
135(R)	Line Voltage Angle	Degrees/10	±180.0°
136(R)	Line Voltage Magnitude VBC	kV/10, primary	0-3276.7 kV, pri
137(R)	Line Voltage Angle	Degrees/10	±180.0°
138(R)	Line Voltage Magnitude VCA	kV/10, primary	0-3276.7 kV, pri
139(R)	Line Voltage Angle	Degrees/10	±180.0°
140(R)	Phase Real Power PA	MW/10, primary	±3276.7 MW
141(R)	Phase Reactive Power QA	MVAR/10, primary	±3276.7 MVAR
142(R)	Phase Real Power PB	MW/10, primary	±3276.7 MW
143(R)	Phase Reactive Power QB	MVAR/10, primary	±3276.7 MVAR
144(R)	Phase Real Power PC	MW/10, primary	±3276.7 MW
145(R)	Phase Reactive Power QC	MVAR/10, primary	±3276.7 MVAR
146(R)	Three Phase Real Power PMW	MW/10, primary	±3276.7 MW
147(R)	Three Phase Reactive Power QMVAR	MVAR/10, primary	±3276.7 MVAR
148(R)	Zero-Sequence Current Magnitude I0	A, primary	0-32767 A, pri
149(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
150(R)	Positive-Sequence Current Magnitude I1	A, primary	0-32767 A, pri
151(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
152(R)	Negative-Sequence Current Magnitude I2	A, primary	0-32767 A, pri
153(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°
154(R)	Zero-Sequence Voltage Magnitude V0	kV/10, primary	0-3276.7 kV, pri
155(R)	Zero-Sequence Voltage Angle	Degrees/10	±180.0°
156(R)	Positive-Sequence Voltage Magnitude V1	kV/10, primary	0-3276.7 kV, pri
157(R)	Positive-Sequence Voltage Angle	Degrees/10	±180.0°
158(R)	Negative-Sequence Voltage Magnitude V2	kV/10, primary	0-3276.7 kV, pri
159(R)	Negative-Sequence Voltage Angle	Degrees/10	±180.0°

SEL-352 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Voltage Magnitude VA1	kV/10, primary	0-3276.7 kV, pri
109(R)	Phase Voltage Angle	Degrees/10	±180.0°
110(R)	Phase Current Magnitude IA	A, primary	0-32767 A, pri
111(R)	Phase Current Angle	Degrees/10	±180.0°
112(R)	Phase Voltage Magnitude VA2	KV/10, primary	0-3276.7 kV, pri
113(R)	Phase Voltage Angle	Degrees/10	±180.0°
114(R)	Phase Voltage Magnitude VB1	V, primary	0-3276.7 kV, pri

115(R)	Phase Voltage Angle	Degrees/10	±180.0°
116(R)	Phase Current Magnitude IB	A, primary	0-32767 A, pri
117(R)	Phase Current Angle	Degrees/10	±180.0°
118(R)	Phase Voltage Magnitude VB2	KV/10, primary	0-3276.7 kV, pri
119(R)	Phase Voltage Angle	Degrees/10	±180.0°
120(R)	Phase Voltage Magnitude VC1	KV/10, primary	0-3276.7 kV, pri
121(R)	Phase Voltage Angle	Degrees/10	±180.0°
122(R)	Phase Current Magnitude IC	A, primary	0-32767 A, pri
123(R)	Phase Current Angle	Degrees/10	±180.0°
124(R)	Phase Voltage Magnitude VC2	KV/10, primary	0-3276.7 kV, pri
125(R)	Phase Voltage Angle	Degrees/10	±180.0°
126(R)	Difference Current Magnitude IAB	Amps, primary	0-32767 A, pri
127(R)	Difference Current Angle	Degrees/10	±180.0°
128(R)	Difference Current Magnitude IBC	Amps, primary	0-32767 A, pri
129(R)	Difference Current Angle	Degrees/10	±180.0°
130(R)	Difference Current Magnitude ICA	Amps, primary	0-32767 A, pri
131(R)	Difference Current Angle	Degrees/10	±180.0°
132(R)	Difference Voltage Magnitude VAB1	KV/10, primary	0-3276.7 kV, pri
133(R)	Difference Voltage Angle	Degrees/10	±180.0°
134(R)	Difference Voltage Magnitude VBC1	KV/10, primary	0-3276.7 kV, pri
135(R)	Difference Voltage Angle	Degrees/10	±180.0°
136(R)	Difference Voltage Magnitude VCA1	KV/10, primary	0-3276.7 kV, pri
137(R)	Difference Voltage Angle	Degrees/10	±180.0°
138(R)	Phase Real Power PA	MW/10, primary	±3276.7 MW
139(R)	Phase Reactive Power QA	MVAR/10, primary	±3276.7 MVAR
140(R)	Phase Real Power PB	MW/10, primary	±3276.7 MW
141(R)	Phase Reactive Power QB	MVAR/10, primary	±3276.7 MVAR
142(R)	Phase Real Power PC	MW/10, primary	±3276.7 MW
143(R)	Phase Reactive Power QC	MVAR/10, primary	±3276.7 MVAR
144(R)	Three Phase Real Power P	MW/10, primary	±3276.7 MW
145(R)	Three Phase Reactive Power Q	MVAR/10, primary	±3276.7 MVAR
146(R)	Difference Voltage Magnitude VAB2	KV/10, primary	0-3276.7 kV, pri
147(R)	Difference Voltage Angle	Degrees/10	±180.0°
148(R)	Difference Voltage Magnitude VBC2	KV/10, primary	0-3276.7 kV, pri
149(R)	Difference Voltage Angle	Degrees/10	±180.0°
150(R)	Difference Voltage Magnitude VCA2	KV/10, primary	0-3276.7 kV, pri
151(R)	Difference Voltage Angle	Degrees/10	±180.0°
152(R)	Zero-Sequence Current Magnitude I0	A, primary	0-32767 A, pri
153(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
154(R)	Positive-Sequence Current Magnitude I1	A, primary	0-32767 A, pri
155(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
156(R)	Negative-Sequence Current Magnitude I2	A, primary	0-32767 A, pri
157(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°
158(R)	Zero-Sequence Voltage Magnitude V01	KV/10, primary	0-3276.7 kV, pri
159(R)	Zero-Sequence Voltage Angle	Degrees/10	±180.0°
160(R)	Positive-Sequence Voltage Magnitude V11	KV/10, primary	0-3276.7 kV, pri
161(R)	Positive-Sequence Voltage Angle	Degrees/10	±180.0°
162(R)	Negative-Sequence Voltage Magnitude V21	KV/10, primary	0-3276.7 kV, pri
163(R)	Negative-Sequence Voltage Angle	Degrees/10	±180.0°
164(R)	Zero-Sequence Voltage Magnitude V02	KV/10, primary	0-3276.7 kV, pri
165(R)	Zero-Sequence Voltage Angle	Degrees/10	±180.0°
166(R)	Positive-Sequence Voltage Magnitude V12	KV/10, primary	0-3276.7 kV, pri
167(R)	Positive-Sequence Voltage Angle	Degrees/10	±180.0°
168(R)	Negative-Sequence Voltage Magnitude V22	KV/10, primary	0-3276.7 kV, pri
169(R)	Negative-Sequence Voltage Angle	Degrees/10	±180.0°

SEL-387 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999

107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Current Magnitude IAW1	A, primary	0-32767 A, pri
109(R)	Phase Current Angle	Degrees/10	±180.0°
110(R)	Phase Current Magnitude IBW1	A, primary	0-32767 A, pri
111(R)	Phase Current Angle	Degrees/10	±180.0°
112(R)	Phase Current Magnitude ICW1	A, primary	0-32767 A, pri
113(R)	Phase Current Angle	Degrees/10	±180.0°
114(R)	Phase Current Magnitude IAW2	A, primary	0-32767 A, pri
115(R)	Phase Current Angle	Degrees/10	±180.0°
116(R)	Phase Current Magnitude IBW2	A, primary	0-32767 A, pri
117(R)	Phase Current Angle	Degrees/10	±180.0°
118(R)	Phase Current Magnitude ICW2	A, primary	0-32767 A, pri
119(R)	Phase Current Angle	Degrees/10	±180.0°
120(R)	Phase Current Magnitude IAW3	A, primary	0-32767 A, pri
121(R)	Phase Current Angle	Degrees/10	±180.0°
122(R)	Phase Current Magnitude IBW3	A, primary	0-32767 A, pri
123(R)	Phase Current Angle	Degrees/10	±180.0°
124(R)	Phase Current Magnitude ICW3	A, primary	0-32767 A, pri
125(R)	Phase Current Angle	Degrees/10	±180.0°
126(R)	Phase Current Magnitude IAW4	A, primary	0-32767 A, pri
127(R)	Phase Current Angle	Degrees/10	±180.0°
128(R)	Phase Current Magnitude IBW4	A, primary	0-32767 A, pri
129(R)	Phase Current Angle	Degrees/10	±180.0°
130(R)	Phase Current Magnitude ICW4	A, primary	0-32767 A, pri
131(R)	Phase Current Angle	Degrees/10	±180.0°
132(R)	Zero-Sequence Current Magnitude IOW1	A, primary	0-32767 A, pri
133(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
134(R)	Positive-Sequence Current Magnitude I1W1	A, primary	0-32767 A, pri
135(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
136(R)	Negative-Sequence Current Magnitude I2W1	A, primary	0-32767 A, pri
137(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°
138(R)	Zero-Sequence Current Magnitude IOW2	A, primary	0-32767 A, pri
139(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
140(R)	Positive-Sequence Current Magnitude I1W2	A, primary	0-32767 A, pri
141(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
142(R)	Negative-Sequence Current Magnitude I2W2	A, primary	0-32767 A, pri
143(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°
144(R)	Zero-Sequence Current Magnitude IOW3	A, primary	0-32767 A, pri
145(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
146(R)	Positive-Sequence Current Magnitude I1W3	A, primary	0-32767 A, pri
147(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
148(R)	Negative-Sequence Current Magnitude I2W3	A, primary	0-32767 A, pri
149(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°
150(R)	Zero-Sequence Current Magnitude IOW4	A, primary	0-32767 A, pri
151(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
152(R)	Positive-Sequence Current Magnitude I1W4	A, primary	0-32767 A, pri
153(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
154(R)	Negative-Sequence Current Magnitude I2W4	A, primary	0-32767 A, pri
155(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°

SEL-501,-1,-2 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Current Magnitude IAX	A, primary	0-32767 A, pri
109(R)	Phase Current Angle	Degrees/10	±180.0°
110(R)	Phase Current Magnitude IBX	A, primary	0-32767 A, pri
111(R)	Phase Current Angle	Degrees/10	±180.0°
112(R)	Phase Current Magnitude ICX	A, primary	0-32767 A, pri
113(R)	Phase Current Angle	Degrees/10	±180.0°
114(R)	Phase Current Magnitude IAY	A, primary	0-32767 A, pri
115(R)	Phase Current Angle	Degrees/10	±180.0°

116(R)	Phase Current Magnitude IBY	A, primary	0-32767 A, pri
117(R)	Phase Current Angle	Degrees/10	±180.0°
118(R)	Phase Current Magnitude ICY	A, primary	0-32767 A, pri
119(R)	Phase Current Angle	Degrees/10	±180.0°
120(R)	Difference Current Magnitude IABX	A, primary	0-32767 A, pri
121(R)	Difference Current Angle	Degrees/10	±180.0°
122(R)	Difference Current Magnitude IBCX	A, primary	0-32767 A, pri
123(R)	Difference Current Angle	Degrees/10	±180.0°
124(R)	Difference Current Magnitude ICAX	A, primary	0-32767 A, pri
125(R)	Difference Current Angle	Degrees/10	±180.0°
126(R)	Difference Current Magnitude IABY	A, primary	0-32767 A, pri
127(R)	Difference Current Angle	Degrees/10	±180.0°
128(R)	Difference Current Magnitude IBCY	A, primary	0-32767 A, pri
129(R)	Difference Current Angle	Degrees/10	±180.0°
130(R)	Difference Current Magnitude ICAY	A, primary	0-32767 A, pri
131(R)	Difference Current Angle	Degrees/10	±180.0°
132(R)	Zero-Sequence Current Magnitude I0X	A, primary	0-32767 A, pri
133(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
134(R)	Positive-Sequence Current Magnitude I1X	A, primary	0-32767 A, pri
135(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
136(R)	Negative-Sequence Current Magnitude I2X	A, primary	0-32767 A, pri
137(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°
138(R)	Zero-Sequence Current Magnitude I0Y	A, primary	0-32767 A, pri
139(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
140(R)	Positive-Sequence Current Magnitude I1Y	A, primary	0-32767 A, pri
141(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
142(R)	Negative-Sequence Current Magnitude I2Y	A, primary	0-32767 A, pri
143(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°

SEL-551 Binary Fast Meter Format:

100(R)	Meter Date Stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108 (R)	Phase Current Magnitude IA	A, primary	0-32767A, pri
109(R)	Phase Current Angle	Degrees	±180.0°
110(R)	Phase Current Magnitude IB	A, primary	0-32767A, pri
111(R)	Phase Current Angle	Degrees	±180.0°
112(R)	Phase Current Magnitude IC	A, primary	0-32767A, pri
113(R)	Phase Current Angle	Degrees	±180.0°
114(R)	Neutral Current Magnitude IN	A, primary	0-32767A, pri
115(R)	Neutral Current Angle	Degrees	±180.0°
116(R)	Difference Current Magnitude IAB	A, primary	0-32767A, pri
117(R)	Difference Current Angle	Degrees	±180.0°
118(R)	Difference Current Magnitude IBC	A, primary	0-32767A, pri
119(R)	Difference Current Angle	Degrees	±180.0°
120(R)	Difference Current Magnitude ICA	A, primary	0-32767A, pri
121(R)	Difference Current Angle	Degrees	±180.0°

SEL-587 Binary Fast Meter Format:

100(R)	Meter Date stamp	Month	1-12
101(R)	Meter Date stamp	Day of the Month	1-31
102(R)	Meter Date stamp	Year	0-99
103(R)	Meter Time stamp	Hours	0-23
104(R)	Meter Time stamp	Minutes	0-59
105(R)	Meter Time stamp	Seconds	0-59
106(R)	Meter Time stamp	Milliseconds	0-999
107(R)	Meter Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
108(R)	Phase Current Magnitude IAW1	A, primary	0-32767 A, pri
109(R)	Phase Current Angle	Degrees/10	±180.0°
110(R)	Phase Current Magnitude IBW1	A, primary	0-32767 A, pri
111(R)	Phase Current Angle	Degrees/10	±180.0°

112(R)	Phase Current Magnitude ICW1	A, primary	0-32767 A, pri
113(R)	Phase Current Angle	Degrees/10	±180.0°
114(R)	Phase Current Magnitude IAW2	A, primary	0-32767 A, pri
115(R)	Phase Current Angle	Degrees/10	±180.0°
116(R)	Phase Current Magnitude IBW2	A, primary	0-32767 A, pri
117(R)	Phase Current Angle	Degrees/10	±180.0°
118(R)	Phase Current Magnitude ICW2	A, primary	0-32767 A, pri
119(R)	Phase Current Angle	Degrees/10	±180.0°
120(R)	Difference Current Magnitude IAB	A, primary	0-32767 A, pri
121(R)	Difference Current Angle	Degrees/10	±180.0°
122(R)	Difference Current Magnitude IBC	A, primary	0-32767 A, pri
123(R)	Difference Current Angle	Degrees/10	±180.0°
124(R)	Difference Current Magnitude ICA	A, primary	0-32767 A, pri
125(R)	Difference Current Angle	Degrees/10	±180.0°
126(R)	Difference Current Magnitude IAB	A, primary	0-32767 A, pri
127(R)	Difference Current Angle	Degrees/10	±180.0°
128(R)	Difference Current Magnitude IBC	A, primary	0-32767 A, pri
129(R)	Difference Current Angle	Degrees/10	±180.0°
130(R)	Difference Current Magnitude ICA	A, primary	0-32767 A, pri
131(R)	Difference Current Angle	Degrees/10	±180.0°
132(R)	Zero-Sequence Current Magnitude IOW1	A, primary	0-32767 A, pri
133(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
134(R)	Positive-Sequence Current Magnitude I1W1	A, primary	0-32767 A, pri
135(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
136(R)	Negative-Sequence Current Magnitude I2W1	A, primary	0-32767 A, pri
137(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°
138(R)	Zero-Sequence Current Magnitude IOW2	A, primary	0-32767 A, pri
139(R)	Zero-Sequence Current Angle	Degrees/10	±180.0°
140(R)	Positive-Sequence Current Magnitude I1W2	A, primary	0-32767 A, pri
141(R)	Positive-Sequence Current Angle	Degrees/10	±180.0°
142(R)	Negative-Sequence Current Magnitude I2W2	A, primary	0-32767 A, pri
143(R)	Negative-Sequence Current Angle	Degrees/10	±180.0°

Table G.3: Register Maps for Demand Meter Data, Floating-Point Type

The first eight registers of Modbus demand meter data are the collection date and time stamp. This is the time the SEL-2020 received the demand data.

Reg.#	Description	Units	Range
For SEL-151/251,-1,-2,-3; SEL-151C/251C,-1,-2,-3; SEL-151CD/251CD,-1,-3; SEL-151D/251D,-1,-3:			
2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2308(R)	Phase Current IA	A, primary	Integer
2309(R)	Phase Current IB	A, primary	Integer
2310(R)	Phase Current IC	A, primary	Integer
2311(R)	Residual Current IR	A, primary	Integer
2312(R)	Negative Sequence 3I2	A, primary	Integer
2313-2314(R)	Real Power P	MW, primary	IEEE float
2315-2316(R)	Reactive Power Q	MVAR, primary	IEEE float
2317(R)	Peak Demand Phase Current IA	A, primary	Integer
2318(R)	Peak Demand Phase Current IB	A, primary	Integer
2319(R)	Peak Demand Phase Current IC	A, primary	Integer
2320(R)	Peak Demand Residual Current IR	A, primary	Integer
2321(R)	Peak Demand Negative Sequence 3I2	A, primary	Integer
2322-2323(R)	Peak Demand Real Power P	MW, primary	IEEE float
2324-2325(R)	Peak Demand Reactive Power Q	MVAR, primary	IEEE float

SEL-167/267,-2,-4,-5:

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2308(R)	Phase Current IA	A, primary	Integer
2309(R)	Phase Current IB	A, primary	Integer
2310(R)	Phase Current IC	A, primary	Integer
2311(R)	Difference Current IAB	A, primary	Integer
2312(R)	Difference Current IBC	A, primary	Integer
2313(R)	Difference Current ICA	A, primary	Integer
2314(R)	Demand Phase Current IA	A, primary	Integer
2315(R)	Demand Phase Current IB	A, primary	Integer
2316(R)	Demand Phase Current IC	A, primary	Integer
2317(R)	Peak Phase Current IA	A, primary	Integer
2318(R)	Peak Phase Current IB	A, primary	Integer
2319(R)	Peak Phase Current IC	A, primary	Integer
2320-2321(R)	Phase Voltage VA	kV, primary	IEEE float
2322-2323(R)	Phase Voltage VB	kV, primary	IEEE float
2324-2325(R)	Phase Voltage VC	kV, primary	IEEE float
2326-2327(R)	Difference Voltage VAB	kV, primary	IEEE float
2328-2329(R)	Difference Voltage VBC	kV, primary	IEEE float
2330-2331(R)	Difference Voltage VCA	kV, primary	IEEE float
2332-2333(R)	Real Power P	MW, primary	IEEE float
2334-2335(R)	Reactive Power Q	MVAR, primary	IEEE float

SEL-167D/267D:

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2308(R)	Phase Current IA	A, primary	Integer
2309(R)	Phase Current IB	A, primary	Integer
2310(R)	Phase Current IC	A, primary	Integer
2311(R)	Demand Phase Current IA	A, primary	Integer
2312(R)	Demand Phase Current IB	A, primary	Integer
2313(R)	Demand Phase Current IC	A, primary	Integer
2314(R)	Peak Phase Current IA	A, primary	Integer
2315(R)	Peak Phase Current IB	A, primary	Integer
2316(R)	Peak Phase Current IC	A, primary	Integer
2317-2318(R)	Phase Voltage VA	kV, primary	IEEE float
2319-2320(R)	Phase Voltage VB	kV, primary	IEEE float
2321-2322(R)	Phase Voltage VC	kV, primary	IEEE float
2323-2324(R)	Real Power P	MW, primary	IEEE float
2325-2326(R)	Reactive Power Q	MVAR, primary	IEEE float

For 300G; SEL-351; SEL-351R:

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2308-2309(R)	Phase Current IA	A, primary	IEEE float
2310-2311(R)	Phase Current IB	A, primary	IEEE float

2312-2313(R)	Phase Current IC	A, primary	IEEE float
2314-2315(R)	Neutral Current IN	A, primary	IEEE float
2316-2317(R)	Ground Current IG	A, primary	IEEE float
2318-2319(R)	Negative Sequence 3I2	A, primary	IEEE float
2320-2321(R)	Phase Real Power Input PA+	MW, primary	IEEE float
2322-2323(R)	Phase Real Power Input PB+	MW, primary	IEEE float
2324-2325(R)	Phase Real Power Input PC+	MW, primary	IEEE float
2326-2327(R)	3-Phase Real Power Input P3+	MW, primary	IEEE float
2328-2329(R)	Phase Reactive Power Input QA+	MVAR, primary	IEEE float
2330-2331(R)	Phase Reactive Power Input QB+	MVAR, primary	IEEE float
2332-2333(R)	Phase Reactive Power Input QC+	MVAR, primary	IEEE float
2334-2335(R)	3-Phase Reactive Power Input Q3+	MVAR, primary	IEEE float
2336-2337(R)	Phase Real Power Output PA-	MW, primary	IEEE float
2338-2339(R)	Phase Real Power Output PB-	MW, primary	IEEE float
2340-2341(R)	Phase Real Power Output PC-	MW, primary	IEEE float
2342-2343(R)	3-Phase Real Power Output P3-	MW, primary	IEEE float
2344-2345(R)	Phase Reactive Power Output QA-	MVAR, primary	IEEE float
2346-2347(R)	Phase Reactive Power Output QB-	MVAR, primary	IEEE float
2348-2349(R)	Phase Reactive Power Output QC-	MVAR, primary	IEEE float
2350-2351(R)	3-Phase Reactive Power Output Q3-	MVAR, primary	IEEE float

For SEL-387:

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2308-2309(R)	Phase Current IAW1	A, primary	IEEE float
2310-2311(R)	Phase Current IBW1	A, primary	IEEE float
2312-2313(R)	Phase Current ICW1	A, primary	IEEE float
2314-2315(R)	Negative-Sequence 3I2W1	A, primary	IEEE float
2316-2317(R)	Residual Current IRW1	A, primary	IEEE float
2318-2319(R)	Phase Current IAW2	A, primary	IEEE float
2320-2321(R)	Phase Current IBW2	A, primary	IEEE float
2322-2323(R)	Phase Current ICW2	A, primary	IEEE float
2324-2325(R)	Negative-Sequence 3I2W2	A, primary	IEEE float
2326-2327(R)	Residual Current IRW2	A, primary	IEEE float
2328-2329(R)	Phase Current IAW3	A, primary	IEEE float
2330-2331(R)	Phase Current IBW3	A, primary	IEEE float
2332-2333(R)	Phase Current ICW3	A, primary	IEEE float
2334-2335(R)	Negative-Sequence 3I2W3	A, primary	IEEE float
2336-2337(R)	Residual Current IRW3	A, primary	IEEE float
2338-2339(R)	Phase Current IAW4	A, primary	IEEE float
2340-2341(R)	Phase Current IBW4	A, primary	IEEE float
2342-2343(R)	Phase Current ICW4	A, primary	IEEE float
2344-2345(R)	Negative-Sequence 3I2W4	A, primary	IEEE float
2346-2347(R)	Residual Current IRW4	A, primary	IEEE float

For SEL-501 (ASCII Collection):

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2308(R)	Phase Current IAX	A, primary	Integer
2309(R)	Phase Current IBX	A, primary	Integer
2310(R)	Phase Current ICX	A, primary	Integer
2311(R)	Phase Current IAY	A, primary	Integer
2312(R)	Phase Current IBY	A, primary	Integer
2313(R)	Phase Current ICY	A, primary	Integer

2314(R)	Negative Sequence Current 3I2X	A, primary	Integer
2315(R)	Residual Current IRX	A, primary	Integer
2316(R)	Negative Sequence Current 3I2Y	A, primary	Integer
2317(R)	Residual Current IRY	A, primary	Integer

For SEL-501,-1,-2 (Binary Format):

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2308-2309(R)	Phase Current IAX	A, primary	IEEE float
2310-2311(R)	Phase Current IBX	A, primary	IEEE float
2312-2313(R)	Phase Current ICX	A, primary	IEEE float
2314-2315(R)	Negative-Sequence Current 3I2X	A, primary	IEEE float
2316-2317(R)	Residual Current IRX	A, primary	IEEE float
2318-2319(R)	Phase Current IAY	A, primary	IEEE float
2320-2321(R)	Phase Current IBY	A, primary	IEEE float
2322-2323(R)	Phase Current ICY	A, primary	IEEE float
2324-2325(R)	Negative-Sequence Current 3I2Y	A, primary	IEEE float
2326-2327(R)	Residual Current IRY	A, primary	IEEE float

For SEL-587:

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2308-2309(R)	Phase Current IAW1	A, primary	IEEE float
2310-2311(R)	Phase Current IBW1	A, primary	IEEE float
2312-2313(R)	Phase Current ICW1	A, primary	IEEE float
2314-2315(R)	Negative Sequence Current 3I2W1	A, primary	IEEE float
2316-2317(R)	Residual Current IRW1	A, primary	IEEE float
2318-2319(R)	Phase Current IAW2	A, primary	IEEE float
2320-2321(R)	Phase Current IBW2	A, primary	IEEE float
2322-2323(R)	Phase Current ICW2	A, primary	IEEE float
2324-2325(R)	Negative Sequence Current 3I2W2	A, primary	IEEE float
2326-2327(R)	Residual Current IRW2	A, primary	IEEE float

Table G.4: Register Maps for Demand Meter Data, Integer Type

The first eight registers of Modbus demand meter data are the collection date and time stamp. This is the time the SEL-2020 received the demand data.

Reg.#	Description	Units	Range
For SEL-151/251,-1,-2,-3; SEL-151C/251C,-1,-2,-3; SEL-151CD/251CD,-1,-3; SEL-151D/251D,-1,-3:			
2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2308(R)	Phase Current IA	A, primary	Integer

2309(R)	Phase Current IB	A, primary	Integer
2310(R)	Phase Current IC	A, primary	Integer
2311(R)	Residual Current IR	A, primary	Integer
2312(R)	Negative Sequence 3I2	A, primary	Integer
2313(R)	Real Power P	MW/10, primary	±3276.7 MW, pri
2314(R)	Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri
2315(R)	Peak Demand Phase Current IA	A, primary	Integer
2316(R)	Peak Demand Phase Current IB	A, primary	Integer
2317(R)	Peak Demand Phase Current IC	A, primary	Integer
2318(R)	Peak Demand Residual Current IR	A, primary	Integer
2319(R)	Peak Demand Negative Sequence 3I2	A, primary	Integer
2320(R)	Peak Demand Real Power P	MW/10, primary	±3276.7 MW, pri
2321(R)	Peak Demand Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri

SEL-167/267,-2,-4,-5:

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2308(R)	Phase Current IA	A, primary	Integer
2309(R)	Phase Current IB	A, primary	Integer
2310(R)	Phase Current IC	A, primary	Integer
2311(R)	Difference Current IAB	A, primary	Integer
2312(R)	Difference Current IBC	A, primary	Integer
2313(R)	Difference Current ICA	A, primary	Integer
2314(R)	Demand Phase Current IA	A, primary	Integer
2315(R)	Demand Phase Current IB	A, primary	Integer
2316(R)	Demand Phase Current IC	A, primary	Integer
2317(R)	Peak Phase Current IA	A, primary	Integer
2318(R)	Peak Phase Current IB	A, primary	Integer
2319(R)	Peak Phase Current IC	A, primary	Integer
2320(R)	Phase Voltage VA	kV/10, primary	0.0-3276.7 kV, pri
2321(R)	Phase Voltage VB	kV/10, primary	0.0-3276.7 kV, pri
2322(R)	Phase Voltage VC	kV/10, primary	0.0-3276.7 kV, pri
2323(R)	Difference Voltage VAB	kV/10, primary	0.0-3276.7 kV, pri
2324(R)	Difference Voltage VBC	kV/10, primary	0.0-3276.7 kV, pri
2325(R)	Difference Voltage VCA	kV/10, primary	0.0-3276.7 kV, pri
2326(R)	Peak Demand Real Power P	MW/10, primary	±3276.7 MW, pri
2327(R)	Peak Demand Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri

SEL-167D/267D:

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2308(R)	Phase Current IA	A, primary	Integer
2309(R)	Phase Current IB	A, primary	Integer
2310(R)	Phase Current IC	A, primary	Integer
2311(R)	Demand Phase Current IA	A, primary	Integer
2312(R)	Demand Phase Current IB	A, primary	Integer
2313(R)	Demand Phase Current IC	A, primary	Integer
2314(R)	Peak Phase Current IA	A, primary	Integer
2315(R)	Peak Phase Current IB	A, primary	Integer
2316(R)	Peak Phase Current IC	A, primary	Integer
2317(R)	Phase Voltage VA	kV/10, primary	0.0-3276.7 kV, pri
2318(R)	Phase Voltage VB	kV/10, primary	0.0-3276.7 kV, pri
2319(R)	Phase Voltage VC	kV/10, primary	0.0-3276.7 kV, pri
2320(R)	Peak Demand Real Power P	MW/10, primary	±3276.7 MW, pri

2321(R)	Peak Demand Reactive Power Q	MVAR/10, primary	±3276.7 MVAR, pri

For SEL-300G; SEL-351; SEL-351R:

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2308(R)	Phase Current IA	A, primary	0-32767 A, pri
2309(R)	Phase Current IB	A, primary	0-32767 A, pri
2310(R)	Phase Current IC	A, primary	0-32767 A, pri
2311(R)	Neutral Current IN	A, primary	0-32767 A, pri
2312(R)	Ground Current IG	A, primary	0-32767 A, pri
2313(R)	Negative Sequence 3I2	A, primary	0-32767 A, pri
2314(R)	Phase Real Power Input PA+	MW/10, primary	±3276.7 MW
2315(R)	Phase Real Power Input PB+	MW/10, primary	±3276.7 MW
2316(R)	Phase Real Power Input PC+	MW/10, primary	±3276.7 MW
2317(R)	3-Phase Real Power Input P3+	MW/10, primary	±3276.7 MW
2318(R)	Phase Reactive Power Input QA+	MVAR/10, primary	±3276.7 MVAR
2319(R)	Phase Reactive Power Input QB+	MVAR/10, primary	±3276.7 MVAR
2320(R)	Phase Reactive Power Input QC+	MVAR/10, primary	±3276.7 MVAR
2321(R)	3-Phase Reactive Power Input Q3+	MVAR/10, primary	±3276.7 MVAR
2322(R)	Phase Real Power Output PA-	MW/10, primary	±3276.7 MW
2323(R)	Phase Real Power Output PB-	MW/10, primary	±3276.7 MW
2324(R)	Phase Real Power Output PC-	MW/10, primary	±3276.7 MW
2325(R)	3-Phase Real Power Output P3-	MW/10, primary	±3276.7 MW
2326(R)	Phase Reactive Power Output QA-	MVAR/10, primary	±3276.7 MVAR
2327(R)	Phase Reactive Power Output QB-	MVAR/10, primary	±3276.7 MVAR
2328(R)	Phase Reactive Power Output QC-	MVAR/10, primary	±3276.7 MVAR
2329(R)	3-Phase Reactive Power Output Q3-	MVAR/10, primary	±3276.7 MVAR

For SEL-387:

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2308(R)	Phase Current IAW1	A, primary	0-32767 A, pri
2309(R)	Phase Current IBW1	A, primary	0-32767 A, pri
2310(R)	Phase Current ICW1	A, primary	0-32767 A, pri
2311(R)	Negative-Sequence 3I2W1	A, primary	0-32767 A, pri
2312(R)	Residual Current IRW1	A, primary	0-32767 A, pri
2313(R)	Phase Current IAW2	A, primary	0-32767 A, pri
2314(R)	Phase Current IBW2	A, primary	0-32767 A, pri
2315(R)	Phase Current ICW2	A, primary	0-32767 A, pri
2316(R)	Negative-Sequence 3I2W2	A, primary	0-32767 A, pri
2317(R)	Residual Current IRW2	A, primary	0-32767 A, pri
2318(R)	Phase Current IAW3	A, primary	0-32767 A, pri
2319(R)	Phase Current IBW3	A, primary	0-32767 A, pri
2320(R)	Phase Current ICW3	A, primary	0-32767 A, pri
2321(R)	Negative-Sequence 3I2W3	A, primary	0-32767 A, pri
2322(R)	Residual Current IRW3	A, primary	0-32767 A, pri
2323(R)	Phase Current IAW4	A, primary	0-32767 A, pri
2324(R)	Phase Current IBW4	A, primary	0-32767 A, pri
2325(R)	Phase Current ICW4	A, primary	0-32767 A, pri
2326(R)	Negative-Sequence 3I2W4	A, primary	0-32767 A, pri
2327(R)	Residual Current IRW4	A, primary	0-32767 A, pri

For SEL-501 (ASCII Format):

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2308(R)	Phase Current IAX	A, primary	Integer
2309(R)	Phase Current IBX	A, primary	Integer
2310(R)	Phase Current ICX	A, primary	Integer
2311(R)	Phase Current IAY	A, primary	Integer
2312(R)	Phase Current IBY	A, primary	Integer
2313(R)	Phase Current ICY	A, primary	Integer
2314(R)	Negative Sequence Current 3I2X	A, primary	Integer
2315(R)	Residual Current IRX	A, primary	Integer
2316(R)	Negative Sequence Current 3I2Y	A, primary	Integer
2317(R)	Residual Current IRY	A, primary	Integer

For SEL-501,-1,-2 (Binary Format):

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2308(R)	Phase Current IAX	A, primary	0-32767 A, pri
2309(R)	Phase Current IBX	A, primary	0-32767 A, pri
2310(R)	Phase Current ICX	A, primary	0-32767 A, pri
2311(R)	Negative-Sequence Current 3I2X	A, primary	0-32767 A, pri
2312(R)	Residual Current IRX	A, primary	0-32767 A, pri
2313(R)	Phase Current IAY	A, primary	0-32767 A, pri
2314(R)	Phase Current IBY	A, primary	0-32767 A, pri
2315(R)	Phase Current ICY	A, primary	0-32767 A, pri
2316(R)	Negative-Sequence Current 3I2Y	A, primary	0-32767 A, pri
2317(R)	Residual Current IRY	A, primary	0-32767 A, pri

For SEL-587:

2300(R)	Demand Date stamp	Month	1-12
2301(R)	Demand Date stamp	Day of the Month	1-31
2302(R)	Demand Date stamp	Year	0-99
2303(R)	Demand Time stamp	Hours	0-23
2304(R)	Demand Time stamp	Minutes	0-59
2305(R)	Demand Time stamp	Seconds	0-59
2306(R)	Demand Time stamp	Milliseconds	0-999
2307(R)	Demand Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2308(R)	Phase Current IAW1	A, primary	0-32767 A, pri
2309(R)	Phase Current IBW1	A, primary	0-32767 A, pri
2310(R)	Phase Current ICW1	A, primary	0-32767 A, pri
2311(R)	Negative Sequence Current 3I2W1	A, primary	0-32767 A, pri
2312(R)	Residual Current IRW1	A, primary	0-32767 A, pri
2313(R)	Phase Current IAW2	A, primary	0-32767 A, pri
2314(R)	Phase Current IBW2	A, primary	0-32767 A, pri
2315(R)	Phase Current ICW2	A, primary	0-32767 A, pri
2316(R)	Negative Sequence Current 3I2W2	A, primary	0-32767 A, pri
2317(R)	Residual Current IRW2	A, primary	0-32767 A, pri

Table G.5: Register Maps for History Data, Floating-Point Type

The first eight registers of the Modbus history data are the collection date and time stamp. This is the time the SEL-2020 received the history data. The data following the collection date and time stamp are a series of history records, from most recent to oldest. The number of history records for each relay are also indicated.

History Map for SEL-49 (Total history records are 5):

Reg.#	Description	Units	Range
200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-5
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219-220(R)	1st Fault Location	Miles or Kilometers	IEEE Float
221(R)	2nd History Record Number	None	1-5
.	.	.	.
.	.	.	.
.	.	.	.
271-272(R)	5th Fault Location	Miles or Kilometers	IEEE Float

History Map for SEL-121/221,-1,-2,-2A,-3,-4,-5,-6,-8,-10,-16,-17; SEL-121D/221D; SEl-121F/221F,-1,-2, -3,-8; SEL-121G/221G,-3,-4,-5,-6,-7,-8,-9; SEL-121H/221H; SEL-121S/221S; SEL-PG10/2PG10,-7,-8 (Total history records are 12):

Reg.#	Description	Units	Range
200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219-220(R)	1st Fault Location	Miles or Kilometers	IEEE Float
221-222(R)	1st Fault Duration	Cycles	IEEE Float
223(R)	1st Fault Current	A	Integer
224(R)	2nd History Record Number	None	1-12
.	.	.	.
.	.	.	.
.	.	.	.
399(R)	12th Fault Current	A	Integer

History Map for SEL-121B/221B,-1 (Total history records are 12):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219(R)	1st Group	None	Integer
220-221(R)	1st Fault Location	Miles or Kilometers	IEEE Float
222-223(R)	1st Fault Duration	Cycles	IEEE Float
224(R)	1st Fault Current	A	Integer
225(R)	2nd History Record Number	None	1-12
.	.	.	.
.	.	.	.
.	.	.	.
411(R)	12th Fault Current	None	Integer

History Map for SEL-121C/221C,-1 (Total history records are 12):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219-220(R)	1st Fault Location	Miles or Kilometers	IEEE Float
221-222(R)	1st Fault Duration	Cycles	IEEE Float
223(R)	1st Fault Current	A	Integer
224(R)	1st Shot	None	Integer
225(R)	2nd History Record Number	None	1-12
.	.	.	.
.	.	.	.
.	.	.	.
411(R)	12th Shot	None	Integer

History Map for SEL-151/251,-1,-2,-3; SEL-151D/251D,-1,-3 (Total history records are 12):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6

208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219-220(R)	1st Fault Location	None	IEEE Float
221(R)	1st Shot	None	Integer
222(R)	1st Fault Current	A	Integer
223(R)	1st Group	None	Integer
224-233(R)	1st Target	None	20 Char
234(R)	2nd History Record Number	None	1-12
.	.	.	.
.	.	.	.
.	.	.	.
510-519(R)	12th Target	None	20 Char

History Map for SEL-151C/251C,-1,-2,-3; SEL-151CD/251CD,-1,-3 (Total history records are 12):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219(R)	1st Fault Current	A	Integer
220(R)	1st Group	None	Integer
221-230(R)	1st Target	None	20 Char
231(R)	2nd History Record Number	None	1-12
.	.	.	.
.	.	.	.
.	.	.	.
474-483(R)	12th Target	None	20 Char

History Map for SEL-167/267,-2,-4,-5; SEL-167D/267D (Total history records are 12):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219-220(R)	1st Fault Location	Miles or Kilometers	IEEE Float

221-222(R)	1st Fault Duration	Cycles	IEEE Float
223-224(R)	1st Fault Current	A	IEEE Float
225-234(R)	1st Target	None	20 Char
235(R)	2nd History Record Number	None	1-12
.	.	.	.
.	.	.	.
.	.	.	.
522-531(R)	12th Target	None	20 Char

History Map for SEL-187V/287V,-1; SEL-279H,-1,-2 (Total history records are 12):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219-228(R)	1st Target	None	20 Char
229(R)	2nd History Record Number	None	1-12
.	.	.	.
.	.	.	.
.	.	.	.
450-459(R)	12th Target	None	20 Char

History Map for SEL-BFR/2BFR,-1 (total history records are 100):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-100
209-211(R)	1st Type	None	6 Char
212-213(R)	1st 52A	Cycles	IEEE Float
214-215(R)	1st IV-Time	Cycles	IEEE Float
216-217(R)	1st Energy	MJ	IEEE Float
218(R)	1st History Date Stamp	Month	1-12
219(R)	1st History Date Stamp	Day	1-31
220(R)	1st History Date Stamp	Year	0-99
221(R)	1st History Time Stamp	Hours	0-23
222(R)	1st History Time Stamp	Minutes	0-59
223(R)	1st History Time Stamp	Seconds	0-59
224(R)	1st History Time Stamp	Milliseconds	0-999
225(R)	2nd History Record Number	None	1-100
.	.	.	.
.	.	.	.
.	.	.	.
1906-1907(R)	100th History Time Stamp	Seconds	IEEE Float

History Map for SEL-300G:

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99

203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-30
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 char
220(R)	1st Fault Current	A, primary	0-32767A, pri
221-222(R)	1st Fault Frequency	Hertz	IEEE float
223(R)	1st Group	None	Integer
224-252(R)	1st Targets	None	58 char
253(R)	2nd History Record Number	None	1-30
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
1529-1557(R)	30th Targets	None	58 char

History Map for SEL-321-1 (pre 950907) (Total history records are 40):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-40
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219-220(R)	1st Fault Location	None	IEEE Float
221(R)	1st Group	None	Integer
222-236(R)	1st Target	None	30 Char
237(R)	2nd History Record Number	None	1-40
.	.	.	.
.	.	.	.
.	.	.	.
1353-1367(R)	40th Target	None	30 Char

History Map for SEL-321-1, -2 (post 950907) (Total history records are 40):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-40
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23

213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 Char
220-221(R)	1st Fault Location	None	IEEE Float
222(R)	1st Group	None	Integer
223-245(R)	1st Target	None	46 Char
246(R)	2nd History Record Number	None	1-40
.	.	.	.
.	.	.	.
.	.	.	.
1705-1727(R)	40th Target	None	46 Char

History Map for SEL-351:

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-16
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 char
220-221(R)	1st Fault Location	Miles or Kilometers	IEEE float
222(R)	1st Fault Current	A, primary	0-32767A, pri
223-224(R)	1st Fault Frequency	Hertz	IEEE float
225(R)	1st Group	None	Integer
226(R)	1st Shot Number	None	
227-238(R)	1st Targets	None	24 char
239(R)	2nd History Record Number	None	1-40
.	.	.	.
.	.	.	.
.	.	.	.
691-702(R)	16th Targets	None	24 char

History Map for SEL-351R:

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-29
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 char
220-221(R)	1st Fault Location	Miles or Kilometers	IEEE float
222(R)	1st Fault Current	A, primary	0-32767A, pri
223-224(R)	1st Fault Frequency	Hertz	IEEE float
225(R)	1st Group	None	Integer
226(R)	1st Shot Number	None	

227-235(R)	1st Targets	None	18 char
236(R)	2nd History Record Number	None	1-29
.	.	.	.
.	.	.	.
.	.	.	.
1011-1019(R)	29th Targets	None	18 char

History Map for SEL-352:

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-40
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 char
220(R)	1st Group	None	Integer
221(R)	2nd History Record Number	None	1-40
.	.	.	.
.	.	.	.
.	.	.	.
727(R)	40th Group	None	Integer

History Map for SEL-387 (Total history records are 99):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208-225(R)	Device FID	None	36 char
226(R)	History Month	Month	1-12
227(R)	History Day of Month	Day of the Month	1-31
228(R)	History Year	Year	1980-2080
229(R)	History Time	Hours	0-23
230(R)	History Time	Minutes	0-59
231(R)	History Time	Seconds	0-59
232(R)	History Time	Milliseconds	0-999
233(R)	1st History Record Number	None	1-99
234(R)	1st History Date Stamp	Month	1-12
235(R)	1st History Date Stamp	Day	1-31
236(R)	1st History Date Stamp	Year	1980-2080
237(R)	1st History Time Stamp	Hours	0-23
238(R)	1st History Time Stamp	Minutes	0-59
239(R)	1st History Time Stamp	Seconds	0-59
240(R)	1st History Time Stamp	Milliseconds	0-999
241-244(R)	1st History Event Type	None	8 char
245(R)	1st History Group Number	None	1-6
246-272(R)	1st History Targets	None	54 char
273(R)	2nd History Record Number	None	1-99
.	.	.	.
.	.	.	.
.	.	.	.
2085(R)	47th History Group Number	None	1-6

(Remaining data cannot be accessed through this Modbus map.)

History Map for SEL-501,-1,-2 (Total history records are 20):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-20
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-3
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 Char
220-229(R)	1st Target	None	20 Char
230(R)	2nd History Record Number	None	1-20
.	.	.	.
.	.	.	.
.	.	.	.
638-647(R)	20th Target	None	20 Char

History Map for SEL-551 (Total history records are 20):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-20
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 Char
220(R)	1st Shot Number	None	0-4 or -32768
221(R)	1st Fault Current	A, primary	0-32767A, pri
222-233(R)	1st Targets	None	24 Char
234(R)	2nd History Record Number	None	1-20
.	.	.	.
.	.	.	.
.	.	.	.
716-727(R)	20th Targets	None	24 Char

History Map for SEL-587 (Total history records are 20):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-20
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31

211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Event	None	8 Char
220-229(R)	1st Target	None	20 Char
230(R)	2nd History Record Number	None	1-20
.	.	.	.
.	.	.	.
.	.	.	.
638-647(R)	20th Target	None	20 Char

Table G.6: Register Maps for History Data, Integer Type

The first eight registers of the Modbus history data are the collection date and time stamp. This is the time the SEL-2020 received the history data. The data following the collection date and time stamp are a series of history records, from most recent to oldest. The number of history records for each relay are also indicated.

History Map for SEL-49 (Total history records are 5):

Reg.#	Description	Units	Range
200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-5
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219(R)	1st Fault Location	Miles/10 or Kilometers/10	±3276.7
220(R)	2nd History Record Number	None	1-5
.	.	.	.
.	.	.	.
.	.	.	.
267(R)	5th Fault Location	Miles/10 or Kilometers/10	±3276.7

History Map for SEL-121/221,-1,-2,-2A,-3,-4,-5,-6,-8,-10,-16,-17; SEL-121D/221D; SEl-121F/221F,-1,-2,-3,-8; SEL-121G/221G,-3,-4,-5,-6,-7,-8,-9; SEL-121H/221H; SEL-121S/221S; SEL-PG10/2PG10,-7,-8 (Total history records are 12):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99

212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219(R)	1st Fault Location	Miles/10 or Kilometers/10	±3276.7
220(R)	1st Fault Duration	Cycles/10	0.0-3276.7 Cycles
221(R)	1st Fault Current	A, primary	Integer
222(R)	2nd History Record Number	None	1-12
.	.	.	.
.	.	.	.
.	.	.	.
375(R)	12th Fault Current	A	Integer

History Map for SEL-121B/221B,-1 (Total history records are 12):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219(R)	1st Group	None	Integer
220(R)	1st Fault Location	Miles/10 or Kilometers/10	±3276.7
221(R)	1st Fault Duration	Cycles/10	0.0-3276.7 Cycles
222(R)	1st Fault Current	A, primary	Integer
223(R)	2nd History Record Number	None	1-12
.	.	.	.
.	.	.	.
.	.	.	.
387(R)	12th Fault Current	None	Integer

History Map for SEL-121C/221C,-1 (Total history records are 12):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219(R)	1st Fault Location	Miles/10 or Kilometers/10	±3276.7
220(R)	1st Fault Duration	Cycles/10	0.0-3276.7 Cycles
221(R)	1st Fault Current	A, primary	Integer
222(R)	1st Shot	None	Integer
223(R)	2nd History Record Number	None	1-12
.	.	.	.

.	.	.	.
.	.	.	.
387(R)	12th Shot	None	Integer

History Map for SEL-151/251,-1,-2,-3; SEL-151D/251D,-1,-3 (Total history records are 12):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219(R)	1st Fault Location	Per Unit/10	±3276.7
220(R)	1st Shot	None	Integer
221(R)	1st Fault Current	A, primary	Integer
222(R)	1st Group	None	Integer
223-232(R)	1st Target	None	20 Char
233(R)	2nd History Record Number	None	1-12
.	.	.	.
.	.	.	.
.	.	.	.
498-507(R)	12th Target	None	20 Char

History Map for SEL-151C/251C,-1,-2,-3; SEL-151CD/251CD,-1,-3 (Total history records are 12):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219(R)	1st Fault Current	A, primary	Integer
220(R)	1st Group	None	Integer
221-230(R)	1st Target	None	20 Char
231(R)	2nd History Record Number	None	1-12
.	.	.	.
.	.	.	.
.	.	.	.
474-483(R)	12th Target	None	20 Char

History Map for SEL-167/267,-2,-4,-5; SEL-167D/267D (Total history records are 12):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23

204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219(R)	1st Fault Location	Miles/10 or Kilometers/10	±3276.7
220(R)	1st Fault Duration	Cycles/10	0.0-3276.7 Cycles
221(R)	1st Fault Current	A, primary	0-32767 A, pri
222-231(R)	1st Target	None	20 Char
232(R)	2nd History Record Number	None	1-12
.	.	.	.
.	.	.	.
.	.	.	.
486-495(R)	12th Target	None	20 Char

History Map for SEL-187V/287V,-1; SEL-279H,-1,-2 (Total history records are 12):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-12
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219-228(R)	1st Target	None	20 Char
229(R)	2nd History Record Number	None	1-12
.	.	.	.
.	.	.	.
.	.	.	.
450-459(R)	12th Target	None	20 Char

History Map for SEL-BFR/2BFR,-1 (total history records are 100):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-100
209-211(R)	1st Type	None	6 Char
212(R)	1st 52A	Cycles/10	0.0-3276.7 Cycles
213(R)	1st IV-Time	Cycles/10	0.0-3276.7 Cycles
214(R)	1st Energy	MJ/100	0.00-327.67 MJ
215(R)	1st History Date Stamp	Month	1-12
216(R)	1st History Date Stamp	Day	1-31
217(R)	1st History Date Stamp	Year	0-99
218(R)	1st History Time Stamp	Hours	0-23

219(R)	1st History Time Stamp	Minutes	0-59
220(R)	1st History Time Stamp	Seconds	0-59
221(R)	1st History Time Stamp	Milliseconds	0-999
222(R)	2nd History Record Number	None	1-100
.	.	.	.
.	.	.	.
.	.	.	.
1607(R)	100th History Time Stamp	Milliseconds	0-999

History Map for SEL-300G:

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-30
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 char
220(R)	1st Fault Current	A, primary	0-32767A, pri
221(R)	1st Fault Frequency	Hertz/10	Integer
222(R)	1st Group	None	Integer
223-251(R)	1st Targets	None	58 char
252(R)	2nd History Record Number	None	1-30
.	.	.	.
.	.	.	.
.	.	.	.
1499-1527(R)	30th Targets	None	58 char

History Map for SEL-321-1 (pre 950907) (Total history records are 40):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-40
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-218(R)	1st Fault Type	None	6 Char
219(R)	1st Fault Location	Per Unit/10	±3276.7
220(R)	1st Group	None	Integer
221-235(R)	1st Target	None	30 Char
236(R)	2nd History Record Number	None	1-40
.	.	.	.
.	.	.	.
.	.	.	.
1313-1327(R)	40th Target	None	30 Char

History Map for SEL-321-1, -2 (post 950907) (Total history records are 40):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-40
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 Char
220(R)	1st Fault Location	Per Unit/10	±3276.7
221(R)	1st Group	None	Integer
222-244(R)	1st Target	None	46 Char
245(R)	2nd History Record Number	None	1-40
.	.	.	.
.	.	.	.
.	.	.	.
1465-1487(R)	40th Target	None	46 Char

History Map for SEL-351:

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-16
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 char
220(R)	1st Fault Location	Mi/10 or Km/10	Integer
221(R)	1st Fault Current	A, primary	0-32767A, pri
222(R)	1st Fault Frequency	Hertz/10	Integer
223(R)	1st Group	None	Integer
224(R)	1st Shot Number	None	
225-236(R)	1st Targets	None	24 char
237(R)	2nd History Record Number	None	1-16
.	.	.	.
.	.	.	.
.	.	.	.
660-671(R)	16th Targets	None	24 char

History Map for SEL-351R:

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999

207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-29
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 char
220(R)	1st Fault Location	Mi/10 or Km/10	Integer
221(R)	1st Fault Current	A, primary	0-32767A, pri
222(R)	1st Fault Frequency	Hertz/10	Integer
223(R)	1st Group	None	Integer
224(R)	1st Shot Number	None	
225-233(R)	1st Targets	None	18 char
234(R)	2nd History Record Number	None	1-29
.	.	.	.
.	.	.	.
.	.	.	.
953-961(R)	29th Targets	None	18 char

History Map for SEL-352:

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-40
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 char
220(R)	1st Group	None	Integer
221(R)	2nd History Record Number	None	1-40
.	.	.	.
.	.	.	.
.	.	.	.
727(R)	40th Group	None	Integer

History Map for SEL-387 (Total history records are 99):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208-225(R)	Device FID	None	36 char
226(R)	History Month	Month	1-12
227(R)	History Day of Month	Day of the Month	1-31
228(R)	History Year	Year	1980-2080
229(R)	History Time	Hours	0-23
230(R)	History Time	Minutes	0-59
231(R)	History Time	Seconds	0-59
232(R)	History Time	Milliseconds	0-999
233(R)	1st History Record Number	None	1-99
234(R)	1st History Date Stamp	Month	1-12

235(R)	1st History Date Stamp	Day	1-31
236(R)	1st History Date Stamp	Year	1980-2080
237(R)	1st History Time Stamp	Hours	0-23
238(R)	1st History Time Stamp	Minutes	0-59
239(R)	1st History Time Stamp	Seconds	0-59
240(R)	1st History Time Stamp	Milliseconds	0-999
241-244(R)	1st History Event Type	None	8 char
245(R)	1st History Group Number	None	1-6
246-272(R)	1st History Targets	None	54 char
273(R)	2nd History Record Number	None	1-99
.	.	.	.
.	.	.	.
.	.	.	.
2085(R)	47th History Group Number	None	1-6

(Remaining data cannot be accessed through this Modbus map.)

History Map for SEL-501,-1,-2 (Total history records are 20):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-20
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-3
211(R)	1st History Date Stamp	Year	0-99
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 Char
220-229(R)	1st Target	None	20 Char
230(R)	2nd History Record Number	None	1-20
.	.	.	.
.	.	.	.
.	.	.	.
638-647(R)	20th Target	None	20 Char

History Map for SEL-551 (Total history records are 20):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-20
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Fault Type	None	8 Char
220(R)	1st Shot Number	None	0-4 or -32768
221(R)	1st Fault Current	A, primary	0-32676A, pri
222-233(R)	1st Targets	None	24 Char
234(R)	2nd History Record Number	None	1-20

.	.	.	.
.	.	.	.
.	.	.	.
716-727(R)	20th Targets	None	24 Char

History Map for SEL-587 (Total history records are 20):

200(R)	History Date stamp	Month	1-12
201(R)	History Date stamp	Day of the Month	1-31
202(R)	History Date stamp	Year	0-99
203(R)	History Time stamp	Hours	0-23
204(R)	History Time stamp	Minutes	0-59
205(R)	History Time stamp	Seconds	0-59
206(R)	History Time stamp	Milliseconds	0-999
207(R)	History Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
208(R)	1st History Record Number	None	1-20
209(R)	1st History Date Stamp	Month	1-12
210(R)	1st History Date Stamp	Day	1-31
211(R)	1st History Date Stamp	Year	1980-2080
212(R)	1st History Time Stamp	Hours	0-23
213(R)	1st History Time Stamp	Minutes	0-59
214(R)	1st History Time Stamp	Seconds	0-59
215(R)	1st History Time Stamp	Milliseconds	0-999
216-219(R)	1st Event	None	8 Char
220-229(R)	1st Target	None	20 Char
230(R)	2nd History Record Number	None	1-20
.	.	.	.
.	.	.	.
.	.	.	.
638-647(R)	20th Target	None	20 Char

Table G.7: Register Maps for Relay Target Data, Both Types

The first eight registers of Modbus target data are the collection date and time stamp. Following the date and time stamp is the target string. The bit labels for the target string are also shown in MSB to LSB order. You can obtain these bit labels by typing **MAP n BL,** where **n** is the port number.

These maps apply to both the floating-point and integer only map types.

Reg.#	**Description**	**Units**	**Range**
SEL-121/221,-1,-2,-2A,-3,-5,-6:			
2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

EN	A	B	C	G	1	2	3	*	*	CA1	BC1	AB1	C1	B1	A1
*	*	CA2	BC2	AB2	C2	B2	A2	*	*	CA3	BC3	AB3	C3	B3	A3
*	46P	46PH	47P	46Q	47Q	47QH	32Q	*	TRIP	CLOSE	TTI	A	B	C	ALARM
*	*	ET	52A	DC	BT	TT	DT	Z3FT	Z3F	Z2FT	Z2F	Z1F	BPF	GS	GD
ABC	*	21P3	21G3	21P2	21G2	21P1	21G1	*	*	*	*	*	*	*	*

SEL-121/221,-4,-8:

```
2100(R)      Target Date stamp                        Month                     1-12
2101(R)      Target Date stamp                        Day of the Month          1-31
2102(R)      Target Date stamp                        Year                      0-99
2103(R)      Target Time stamp                        Hours                     0-23
2104(R)      Target Time stamp                        Minutes                   0-59
2105(R)      Target Time stamp                        Seconds                   0-59
2106(R)      Target Time stamp                        Milliseconds              0-999
2107(R)      Target Date stamp                        Day of the week (Sunday-0, Monday-1, ...) 0-6
2108-2112(R) Target                                   None

EN      A      B      C      G      1      2      3      *      *      CA1    BC1    AB1    C1     B1     A1
*       *      CA2    BC2    AB2    C2     B2     A2     *      *      CA3    BC3    AB3    C3     B3     A3
*       46P    46PH   47P    46Q    47Q    47QH   32Q    *      TRIP   CLOSE  TTI    Z1     Z2     Z3     ALARM
*       *      ET     52A    DC     BT     TT     DT     Z3FT   Z3F    Z2FT   Z2F    Z1F    BPF    GS     GD
ABC     *      21P3   21G3   21P2   21G2   21P1   21G1   *      *      *      *      *      *      *      *
```

SEL-121/221,-10,-16,-17:

```
2100(R)      Target Date stamp                        Month                     1-12
2101(R)      Target Date stamp                        Day of the Month          1-31
2102(R)      Target Date stamp                        Year                      0-99
2103(R)      Target Time stamp                        Hours                     0-23
2104(R)      Target Time stamp                        Minutes                   0-59
2105(R)      Target Time stamp                        Seconds                   0-59
2106(R)      Target Time stamp                        Milliseconds              0-999
2107(R)      Target Date stamp                        Day of the week (Sunday-0, Monday-1, ...) 0-6
2108-2111(R) Target                                   None

EN      PH1    G1     PH2    G2     PH3    G3     51N    Z1P    Z1G    Z2PT   Z2GT   Z3     Z3T    3P21   32Q
67N     51NP   51NT   50NG   50P    50H    IN1    REJO   LOP    TRIP   *      *      *      *      *      *
50G     50N    *      *      Z3G    Z3P    RC     RI     *      *      ET     52A    DC     BT     PT     IN1
*       TRIP   CLOS   A1     A2     A3     A4     ALRM   *      *      *      *      *      *      *      *
```

SEL-121B/221B,-1:

```
2100(R)      Target Date stamp                        Month                     1-12
2101(R)      Target Date stamp                        Day of the Month          1-31
2102(R)      Target Date stamp                        Year                      0-99
2103(R)      Target Time stamp                        Hours                     0-23
2104(R)      Target Time stamp                        Minutes                   0-59
2105(R)      Target Time stamp                        Seconds                   0-59
2106(R)      Target Time stamp                        Milliseconds              0-999
2107(R)      Target Date stamp                        Day of the week (Sunday-0, Monday-1, ...) 0-6
2108-2110(R) Target                                   None

EN      PH1    G1     PH2    G2     PH3    G3     51N    1ABC   2ABC   3ABC   LOP    50H    50M    50MF   50L
51NT    67N1   67N2   67N3   51NP   Z1P    Z2P    Z3P    Z2PT   Z3PT   Z2GT   Z3GT   ALRM   TRIP   TC     DF
52AT    *      52A    S5     S4     S3     S2     S1     *      TRIP   CLOS   A1     A2     A3     A4     ALRM
```

SEL-121C/221C:

```
2100(R)      Target Date stamp                        Month                     1-12
2101(R)      Target Date stamp                        Day of the Month          1-31
2102(R)      Target Date stamp                        Year                      0-99
2103(R)      Target Time stamp                        Hours                     0-23
2104(R)      Target Time stamp                        Minutes                   0-59
2105(R)      Target Time stamp                        Seconds                   0-59
2106(R)      Target Time stamp                        Milliseconds              0-999
2107(R)      Target Date stamp                        Day of the week (Sunday-0, Monday-1, ...) 0-6
2108-2111(R) Target                                   None

EN      PH1    G1     PH2    G2     PH3    G3     51N    51PT   1ABC   2ABC   3ABC   51PP   50H    50L    LOP
51NT    67N1   67N2   67N3   51NP   Z1P    Z2P    Z3P    DF     DR     Z2GT   Z3GT   50MF   RC     RI     Z3PT
50M     TRIP   TC     DT     52BT   59N    *      *      52AT   *      ET     52A    DC     BT     PT     DT
*       TRIP   CLOS   A1     A2     A3     A4     ALRM   *      *      *      *      *      *      *      *
```

SEL-121C/221C,-1:

```
2100(R)      Target Date stamp                          Month                     1-12
2101(R)      Target Date stamp                          Day of the Month          1-31
2102(R)      Target Date stamp                          Year                      0-99
2103(R)      Target Time stamp                          Hours                     0-23
2104(R)      Target Time stamp                          Minutes                   0-59
2105(R)      Target Time stamp                          Seconds                   0-59
2106(R)      Target Time stamp                          Milliseconds              0-999
2107(R)      Target Date stamp                          Day of the week (Sunday-0, Monday-1, ...) 0-6
2108-2111(R) Target                                     None

EN       PH1    G1     PH2    G2     PH3    G3     51N    51PT   1ABC   2ABC   3ABC   51PP   50H    50L    LOP
51NT     67N1   67N2   67N3   51NP   Z1P    Z2P    Z3P    DF     DR     Z2GT   Z3GT   50MF   RC     RI     Z3PT
50M      TRIP   TC     DT     52BT   59N    47XL   47XD   52AT   *      ET     52A    DC     BT     PT     DT
*        TRIP   CLOS   A1     A2     A3     A4     ALRM   *      *      *      *      *      *      *      *
```

SEL-121D/221D:

```
2100(R)      Target Date stamp                          Month                     1-12
2101(R)      Target Date stamp                          Day of the Month          1-31
2102(R)      Target Date stamp                          Year                      0-99
2103(R)      Target Time stamp                          Hours                     0-23
2104(R)      Target Time stamp                          Minutes                   0-59
2105(R)      Target Time stamp                          Seconds                   0-59
2106(R)      Target Time stamp                          Milliseconds              0-999
2107(R)      Target Date stamp                          Day of the week (Sunday-0, Monday-1, ...) 0-6
2108-2111(R) Target                                     None

EN       PH1    G1     PH2    G2     PH3    G3     51N    1ABC   2ABC   3ABC   REJO   LOP    50H    50M    50L
51NT     67N1   67N2   67N3   51NP   Z1P    Z2P    Z3P    Z2PT   Z3PT   50G    3P50   50MF   RC     RI     DF
ALRM     TRIP   TC     DT     52BT   52AT   Z2GT   Z3GT   52AT   *      ET     52A    DC     BT     PT     DT
*        TRIP   CLOSE  A1     A2     A3     A4     ALRM   *      *      *      *      *      *      *      *
```

SEL-121F/221F,-1,-8:

```
2100(R)      Target Date stamp                          Month                     1-12
2101(R)      Target Date stamp                          Day of the Month          1-31
2102(R)      Target Date stamp                          Year                      0-99
2103(R)      Target Time stamp                          Hours                     0-23
2104(R)      Target Time stamp                          Minutes                   0-59
2105(R)      Target Time stamp                          Seconds                   0-59
2106(R)      Target Time stamp                          Milliseconds              0-999
2107(R)      Target Date stamp                          Day of the week (Sunday-0, Monday-1, ...) 0-6
2108-2111(R) Target                                     None

EN       PH1    G1     PH2    G2     PH3    G3     51N    Z1P    Z1G    Z2PT   Z2GT   Z3     Z3T    3P21   32Q
67N      51NP   51NT   50NG   50P    50H    IN1    REJO   LOP    52BT   27S    27P    59S    59P    SSC    VSC
50G      50N    59PH   25     Z3G    Z3P    RC     RI     *      *      ET     52A    DC     BT     PT     IN1
*        TRIP   CLOS   A1     A2     A3     A4     ALRM   *      *      *      *      *      *      *      *
```

SEL-121F/221F,-2:

```
2100(R)      Target Date stamp                          Month                     1-12
2101(R)      Target Date stamp                          Day of the Month          1-31
2102(R)      Target Date stamp                          Year                      0-99
2103(R)      Target Time stamp                          Hours                     0-23
2104(R)      Target Time stamp                          Minutes                   0-59
2105(R)      Target Time stamp                          Seconds                   0-59
2106(R)      Target Time stamp                          Milliseconds              0-999
2107(R)      Target Date stamp                          Day of the week (Sunday-0, Monday-1, ...) 0-6
2108-2111(R) Target                                     None

EN       PH1    G1     PH2    G2     PH3    G3     51N    Z1P    Z1G    Z2PT   Z2GT   Z3     Z3T    3P21   32Q
67N      51NP   51NT   50NG   50P    50H    IN1    REJO   LOP    TRIP   27S    27P    59S    59P    SSC    VSC
50G      50N    59PH   25     Z3G    Z3P    RC     RI     *      *      ET     52A    DC     BT     PT     IN1
*        TRIP   CLOS   A1     A2     A3     A4     ALRM   *      *      *      *      *      *      *      *
```

SEL-121F/221F,-3:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2111(R)	Target	None	

EN	PH1	G1	PH2	G2	PH3	G3	51N	Z1P	Z1G	Z2PT	Z2GT	Z3	Z3T	3P21	32Q
67N	51NP	51NT	50NG	50P	50H	IN1	REJO	LOP	BFT	27S	27P	59S	59P	SSC	VSC
50G	50N	59PH	25	Z3G	Z3P	RC	RI	*	*	ET	52A	DC	BT	PT	IN1
*	TRIP	CLOS	A1	A2	A3	A4	ALRM	*	*	*	*	*	*	*	*

SEL-121G/221G,-3,-4:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2111(R)	Target	None	

EN	PH1	G1	PH2	G2	PH3	G3	51N	1ABC	2ABC	3ABC	4ABC	LOP	50H	50M	50L
51NT	67N1	67N2	67N3	51NP	Z1P	Z2P	Z3P	Z2PT	Z3PT	OSB	3P50	50MF	RC	RI	DF
ALRM	TRIP	TC	DT	52BT	52AT	Z2GT	Z3GT	52AT	*	ET	52A	DC	BT	PT	DT
*	TRIP	CLOS	A1	A2	A3	A4	ALRM	*	*	*	*	*	*	*	*

SEL-121G/221G,-5,-8,-9:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2111(R)	Target	None	

EN	PH1	G1	PH2	G2	PH3	G3	51N	1ABC	2ABC	3ABC	4ABC	LOP	50H	50M	50L
51NT	67N1	67N2	67N3	51NP	Z1P	Z2P	Z3P	Z2PT	Z3PT	OSB	3P50	50MF	RC	RI	STOP
50N3	TRIP	TC	DT	52BT	Z3X	Z2GT	Z3GT	52AT	*	ET	52A	DC	BT	PT	DT
*	TRIP	CLOS	A1	A2	A3	A4	ALRM	*	*	*	*	*	*	*	*

SEL-121G/221G,-6,-7:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2111(R)	Target	None	

EN	PH1	G1	PH2	G2	PH3	G3	51N	1ABC	2ABC	3ABC	4ABC	LOP	50H	50M	50L
51NT	67N1	67N2	67N3	51NP	Z1P	Z2P	Z3P	Z2PT	Z3PT	50L3	3P50	50MF	RC	RI	STOP
50N3	TRIP	TC	DT	52BT	Z3X	Z2GT	Z3GT	52AT	*	ET	52A	DC	BT	PT	DT
*	TRIP	CLOS	A1	A2	A3	A4	ALRM	*	*	*	*	*	*	*	*

SEL-121H/221H:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2111(R)	Target	None	

EN	PH1	G1	PH2	G2	PH3	G3	51N	1ABC	2ABC	3ABC	4ABC	LOP	50H	50M	50L
51NT	67N1	67N2	67N3	51NP	Z1P	Z2P	Z3P	Z2PT	Z3PT	Z3RB	KEY	50MF	PTEE	ECTT	DF
ALRM	TRIP	TC	DT	52BT	WFC	Z2GT	Z3GT	52AT	*	ET	52A	DC	BT	PT	DT
*	TRIP	CLOS	A1	A2	A3	A4	ALRM	*	*	*	*	*	*	*	*

SEL-121S/221S:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2111(R)	Target	None	

EN	A	B	C	G	Z1	Z2	Z3	Z1P	Z1G	Z2PT	Z2GT	Z3P	Z3G	Z3T	50H
67NP	67NT	51NP	51NT	50NG	50P	50G	32Q	FDS	3P21	LOP	52BT	IN1	PO	3PT	*
50N	Z3CG	Z3BG	Z3AG	RC	RI	52A3	52B3	*	*	ET	52AC	52AB	52AA	PT	IN1
*	TRIP	CLOS	A1	TRPA	TRPB	TRPC	ALRM	*	*	*	*	*	*	*	*

SEL-151/251,-2,-3; SEL-151D/251D,-3:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

INST	A	B	C	Q	N	RS	LO	51P	50L	50H	51QP	50Q	51NP	50NL	50NH
51T	50LT	50C	51QT	50QT	51NT	50NLT	27	79RS	79CY	79LO	79SH	52AT	52BT	IN6	IN5
PDEM	QDEM	NDEM	TF	CF	TCMA	ST	TRIP	A	B	C	D	E	F	G	H
J	KT	L	V	W	X	Y	ZT	*	*	IN6	IN5	IN4	IN3	IN2	IN1
*	TRIP	CLOS	A1	A2	A3	A4	ALRM	*	*	*	*	*	*	*	*

SEL-151/251-1; SEL-151D/251D-1:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

INST	A	B	C	G	RS	CY	LO	51P	50L	50H	51GP	50G	51NP	50NL	50NH
51T	50LT	50C	51GT	50GT	51NT	50NLT	27	79RS	79CY	79LO	79SH	52AT	52BT	IN6	IN5
PDEM	CLOS	NDEM	TF	CF	TCMA	ST	TRIP	A	B	C	D	E	F	G	H
J	KT	L	V	W	X	Y	ZT	*	*	IN6	IN5	IN4	IN3	IN2	IN1

*	TRIP	CLOSE	A1	A2	A3	A4	ALRM	*	*	*	*	*	*	*	*

SEL-151C/251C,-2,-3; SEL-151CD/251CD,-3:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2112(R)	Target	None	

INST	A	B	C	Q	N	EN	ALRM	51P	50L	50M	51QP	50Q	51NP	50NL	50NH
51T	50LT	50MT	51QT	50QT	51NT	50NLT	50H	21P	50C	27	*	52AT	52BT	IN6	IN5
PDEM	QDEM	NDEM	TF	CF	TCMA	ST	TRIP	A	B	C	D	E	F	G	H
J	KT	L	V	W	X	Y	ZT	*	*	IN6	IN5	IN4	IN3	IN2	IN1
*	TRIP	CLOSE	A1	A2	A3	A4	ALRM	*	*	*	*	*	*	*	*

SEL-151C/251C-1; SEL-151CD/251CD-1:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2112(R)	Target	None	

INST	A	B	C	G	BKR	EN	ALRM	51P	50L	50M	*	*	51NP	50NL	50NH
51T	50LT	50MT	*	*	51NT	50NLT	50H	21P	50C	27	*	52AT	52BT	IN6	IN5
PDEM	CLOS	NDEM	TF	CF	TCMA	ST	TRIP	A	B	C	D	E	F	G	H
J	KT	L	V	W	X	Y	ZT	*	*	IN6	IN5	IN4	IN3	IN2	IN1
*	TRIP	CLOSE	A1	A2	A3	A4	ALRM	*	*	*	*	*	*	*	*

SEL-167/267,-2; SEL-167D/267D:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2111(R)	Target	None	

PH1	G1	PH2	G2	PH3	G3	51P	51N	51NP	50N1	50N2	50N3	51PP	50P1	50P2	50P3
DFP	67N1	67N2	67N3	DFG	67P1	67P2	67P3	51NT	Z1GT	Z2GT	Z3GT	51PT	Z1PT	Z2PT	Z3PT
ALRM	TRIP	TC	DT	52BT	SH1	TOCP	DCTH	52AT	*	ET	52A	DC	BT	PT	DT
*	TRIP	CLOS	A1	A2	A3	A4	ALRM	*	*	*	*	*	*	*	*

SEL-167/267,-4,-5:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2111(R)	Target	None	

EN	INST	TIME	A	B	C	G	LO	51NP	50N1	50N2	50N3	51PP	50P1	50P2	50P3
DFP	67N1	67N2	67N3	DFG	67P1	67P2	67P3	51NT	Z1GT	Z2GT	Z3GT	51PT	Z1PT	Z2PT	Z3PT
LOP	TRIP	TC	DT	52BT	SH1	50MF	DCTH	52AT	*	ET	52A	DC	BT	PT	DT
*	TRIP	CLOS	A1	A2	A3	A4	ALRM	*	*	*	*	*	*	*	*

SEL-187V/287V,-1:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

EN	87A	87B	87C	X59T	Y59T	X59I	Y59I	X59A	X59B	X59C	3Y59	Y59A	Y59B	Y59C	3Y59D
X27A	X27B	X27C	LTCH	Y27A	Y27B	Y27C	3Y27	X59P	X59T	Y59P	Y59T	59P1	27P1	59P2	27P2
VH1	VL1	VH2	VL2	VHD1	VLD1	VHD2	VLD2	87H	87HD	LOP	LOPD	VCI1	VCI2	87T	87A
87AT	87AA	87BT	87BA	87CT	87CA	87TD	87AD	*	*	ET2	ET1	LE2	RE2	LE1	RE1
*	TRIP	A1	A2	A3	A4	A5	ALRM	*	*	*	*	*	*	*	*

SEL-279:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2111(R)	Target	None	

HS	HLDB	DLHB	HLHB	RS	CY	LO	DLDB	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB
HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2
CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT
DH1	HD2	HD1	EMT	DTL	HSRB	HSRI	52	ALRM	OUT3	OUT2	OUT1	CLOS	DLDB	HLHB	DH2

SEL-279H:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2111(R)	Target	None	

52A1	52A2	RC1	RC2	RS	CY	LO	CLOS	27B	27L	59B	59L	25T1	25T2	CLS1	CLS2
SPC1	SPC2	3PC1	3PC2	RSET	CYCL	LOCK	OTT	52A1	52A2	52BT1	52BT2	79OIT	3PRI	79RST	79SH
LTCH	A	B	C	D	E	ST	L	G	H	I	M	W	X	Y	ZT
SPRI	IN7	IN6	IN5	IN4	IN3	IN2	IN1	ALRM	OUT4	OUT3	OUT2	OUT1	DTL	RE	3PRI

SEL-279H,-1:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2111(R)	Target	None	

52A1	52A2	RC1	RC2	RS	CY	LO	CLOS	27B	27L	59B	59L	25T1	25T2	CLS1	CLS2
SPC1	SPC2	3PC1	3PC2	RSET	CYCL	LOCK	OTT	52A1	52A2	52BT1	52BT2	79OIT	3PRI	SPRI	79SH
LTCH	A	B	C	D	E	ST	L	G	H	I	M	W	X	Y	ZT
RE	IN7	IN6	IN5	IN4	IN3	IN2	IN1	ALRM	OUT4	OUT3	OUT2	OUT1	DTL	RE	3PRI

SEL-279H,-2:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2112(R)	Target	None	

52A1	52A2	RC1	RC2	RS	CY	LO	CLOS	27B	27L	59B	59L	25T1	25T2	CLS1	CLS2
SPC1	SPC2	3PC1	3PC2	RSET	CYCL	LOCK	OTT	52A1	52A2	52BT1	52BT2	79OIT	3PRI	SPRI	79SH
LTCH	A	B	C	D	E	ST	L	G	H	I	M	W	X	Y	ZT
27B3	27L4	59B3	59L4	25T3	25T4	CF1	CF2	RE	IN7	IN6	IN5	IN4	IN3	IN2	IN1
ALRM	OUT4	OUT3	OUT2	OUT1	DTL	RE	3PRI	*	*	*	*	*	*	*	*

SEL-BFR/2BFR:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2111(R)	Target	None	

EN	AL	PF	A	B	C	52A	MOD	FBF	LBF	LPF	50FT	50LD	50MD	52BV	TTF
FOBF	FOPF	59FO	59H	ALRM	TC	TB	TA	PDBF	PDPF	87UA	87UB	87UC	86RS	MTD	CTF
CRFA	CRPA	TRFA	TRPA	CRFB	CRPB	TRFB	TRPB	CRFC	CRPC	TRFC	TRPC	DOPA	DOPB	DOPC	47Q
X	86BF	A1	A2	A3	A4	A5	ALARM	X	X	CLOS	MOD	52A	TPC	TPB	TPA

SEL-BFR/2BFR-1:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2111(R)	Target	None	

EN	AL	PF	A	B	C	52A	MOD	FBF	FPF	BFI	50FT	50LD	50MD	50BV	TTF
FOBF	FOPF	59FO	59H	ALRM	TC	TB	TA	PDBF	PDPF	87UA	87UB	87UC	86RS	MTD	CTF
CRFA	CRPA	TRFA	TRPA	CRFB	CRPB	TRFB	TRPB	CRFC	CRPC	TRFC	TRPC	DOPA	DOPB	DOPC	47Q
*	86BF	A1	A2	A3	A4	A5	ALARM	*	*	CLOS	MOD	52A	TPC	TPB	TPA

SEL-PG10/2PG10,-7,-8:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2109(R)	Target	None	

EN	ALRM	50L	67N	3PH	2PH	INST	TIME	50L	ZABC	ZP	ZPT	67NP	67NT	67NI	67DT
*	*	52A	E3	E2	E1	EXT2	EXT1	*	TRIP	A1	A2	A3	A4	A5	ALRM

SEL-300G0:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2131(R)	Target	None	

*	*	*	STSET	*	*	*	*	EN	BKR	LOP	TRIP	51V	50	51	N
24	27/59	32	40	46	64G	81	87	24TC	24D1	24D1T	24C2	24C2T	24CR	SS1	SS2
27P1	27P2	27PP	27V1	59P1	59P2	59G1	59G2	32PTC	32P1	32P1T	32P2	32P2T	59V1	59Q	59PP
40ZTC	40Z1	40Z1T	40Z2	40Z2T	*	SG1	SG2	46QTC	46Q1	46Q1T	46Q2	46Q2T	46Q2R	INAD	INADT
51PTC	51P	51PT	51PR	51CTC	51C	51CT	51CR	51GTC	51G	51GT	51GR	51NTC	51N	51NT	51NR
51VTC	51V	51VT	51VR	PDEM	QDEM	GDEM	NDEM	50P1	50P1T	50P2	50P2T	50G1	50G1T	50G2	50G2T
50N1	50N1T	50N2	50N2T	CC	CL	CLOSE	ULCL	64GTC	64G1	64G1T	64G2	64G2T	*	60LOP	CLEN
BKMON	BCW	BCWA	BCWB	BCWC	FAULT	DCLO	DCHI	81D1	81D2	81D3	81D4	81D5	81D6	3PO	52A
81D1T	81D2T	81D3T	81D4T	81D5T	81D6T	27B81	50L	ONLINE	BND1A	BND1T	BND2A	BND2T	BND3A	BND3T	BNDA
TRGTR	BND4A	BND4T	BND5A	BND5T	BND6A	BND6T	BNDT	TRIP	TRIP1	TRIP2	TRIP3	TRIP4	OC1	OC2	OC3
TR1	TR2	TR3	TR4	ULTR1	ULTR2	ULTR3	ULTR4	LB1	LB2	LB3	LB4	LB5	LB6	LB7	LB8
RB1	RB2	RB3	RB4	RB5	RB6	RB7	RB8	SET1	SET2	SET3	SET4	SET5	SET6	SET7	SET8
RST1	RST2	RST3	RST4	RST5	RST6	RST7	RST8	LT1	LT2	LT3	LT4	LT5	LT6	LT7	LT8
SV1	SV2	SV3	SV4	SV1T	SV2T	SV3T	SV4T	SV5	SV6	SV7	SV8	SV5T	SV6T	SV7T	SV8T
SV9	SV10	SV11	SV12	SV9T	SV10T	SV11T	SV12T	SV13	SV14	SV15	SV16	SV13T	SV14T	SV15T	SV16T
DP8	DP7	DP6	DP5	DP4	DP3	DP2	DP1	*	*	*	*	*	*	*	*
ER	*	IN106	IN105	IN104	IN103	IN102	IN101	ALARM	OUT107	OUT106	OUT105	OUT104	OUT103	OUT102	OUT101
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

SEL-300G1 (Differential Option):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2131(R)	Target	None	

*	*	*	STSET	*	*	*	*	EN	BKR	LOP	TRIP	51V	50	51	N
24	27/59	32	40	46	64G	81	87	24TC	24D1	24D1T	24C2	24C2T	24CR	SS1	SS2
27P1	27P2	27PP	27V1	59P1	59P2	59G1	59G2	32PTC	32P1	32P1T	32P2	32P2T	59V1	59Q	59PP
40ZTC	40Z1	40Z1T	40Z2	40Z2T	*	SG1	SG2	46QTC	46Q1	46Q1T	46Q2	46Q2T	46Q2R	INAD	INADT
51PTC	51P	51PT	51PR	51CTC	51C	51CT	51CR	51GTC	51G	51GT	51GR	51NTC	51N	51NT	51NR
51VTC	51V	51VT	51VR	PDEM	QDEM	GDEM	NDEM	50P1	50P1T	50P2	50P2T	50G1	50G1T	50G2	50G2T
50N1	50N1T	50N2	50N2T	CC	CL	CLOSE	ULCL	64GTC	64G1	64G1T	64G2	64G2T	*	60LOP	CLEN
BKMON	BCW	BCWA	BCWB	BCWC	FAULT	DCLO	DCHI	81D1	81D2	81D3	81D4	81D5	81D6	3PO	52A
81D1T	81D2T	81D3T	81D4T	81D5T	81D6T	27B81	50L	ONLINE	BND1A	BND1T	BND2A	BND2T	BND3A	BND3T	BNDA
TRGTR	BND4A	BND4T	BND5A	BND5T	BND6A	BND6T	BNDT	TRIP	TRIP1	TRIP2	TRIP3	TRIP4	OC1	OC2	OC3
TR1	TR2	TR3	TR4	ULTR1	ULTR2	ULTR3	ULTR4	LB1	LB2	LB3	LB4	LB5	LB6	LB7	LB8
RB1	RB2	RB3	RB4	RB5	RB6	RB7	RB8	SET1	SET2	SET3	SET4	SET5	SET6	SET7	SET8
RST1	RST2	RST3	RST4	RST5	RST6	RST7	RST8	LT1	LT2	LT3	LT4	LT5	LT6	LT7	LT8
SV1	SV2	SV3	SV4	SV1T	SV2T	SV3T	SV4T	SV5	SV6	SV7	SV8	SV5T	SV6T	SV7T	SV8T
SV9	SV10	SV11	SV12	SV9T	SV10T	SV11T	SV12T	SV13	SV14	SV15	SV16	SV13T	SV14T	SV15T	SV16T

DP8	DP7	DP6	DP5	DP4	DP3	DP2	DP1	*	*	*	*	*	*	*	*
ER	*	IN106	IN105	IN104	IN103	IN102	IN101	ALARM	OUT107	OUT106	OUT105	OUT104	OUT103	OUT102	OUT101
87B	87BL1	87BL2	87BL3	87R	87R1	87R2	87R3	87U	87U1	87U2	87U3	50H1	50H1T	50H2	50H2T
50Q1	50Q1T	50Q2	50Q2T	50R1	50R1T	50R2	50R2T	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

SEL-321: (Model 32101)

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2128(R)	Target	None	

INST	TIME	COMM	SOTF	ZONE1	ZONE2	ZONE2	ZONE4	EN	A	B	C	G	Q	51	50
Z4G	Z3G	Z2G	Z1G	M4P	M3P	M2P	M1P	Z4GT	Z3GT	Z2GT	LOP	M4PT	M3PT	M2PT	OPA
67Q4	67Q3	67Q2	67Q1	67N4	67N3	67N2	67N1	67Q4T	67Q3T	67Q2T	OST	67N4T	67N3T	67N2T	OSB
PD1	3P27	27L	50H	50MF	51NT	51QT	51PT	ZLOAD	SOTFE	TCM	*	3PO	SPO	REJO	PD2
3P50R	51NP	51QP	51PP	50G	50PP	50M	50L	50Q4	50Q3	50Q2	50Q1	50N4	50N3	50N2	50N1
50ABC	X6ABC	X5ABC	3PT	TPC	TPB	TPA	32QF	3P59	59L	59N	59PR	59PB	59QL	59PL	50Q
BTX	*	STOP	START	FIDEN	FSC	FSB	FSA	32QR	Z1X	CC	EKEY	Z3RB	ATB	ECTT	KEY
XAG4	XAG3	XAG2	XAG1	MAG4	MAG3	MAG2	MAG1	XBG4	XBG3	XBG2	XBG1	MBG4	MBG3	MBG2	MBG1
XCG4	XCG3	XCG2	XCG1	MCG4	MCG3	MCG2	MCG1	MBC4	MBC3	MBC2	MBC1	MAB4	MAB3	MAB2	MAB1
SPOC	SPOB	SPOA	*	MCA4	MCA3	MCA2	MCA1	50HH	OSTI	50CA	50BC	50AB	*	*	*
*	*	*	*	*	*	*	TOP	LP1	SS3	SS2	SS1	EXT	DT	BT	PT
EXTUL	PARC	PARB	PARA	SPTE	PTXFR	LP2	LOG	LP3	CLOSE	52AC2	52AC1	52AB2	52AB1	52AA2	52AA1
LP5	LP4	TCMC2	TCMC1	TCMB2	TCMB1	TCMA2	TCMA1	DTA	DTB	DTC	LP6	LP7	LP8	LP9	LP10
ZT	Z	YT	Y	XT	X	W	V	RAG4	RAG3	RAG2	RAG1	MER	MTO	MTU	MTCS
RCG4	RCG3	RCG2	RCG1	RBG4	RBG3	RBG2	RBG1	50AL4	50AL3	50AL2	50AL1	VPOLV	N3PT	L3PT	PTRX
50CL4	50CL3	50CL2	50CL1	50BL4	50BL3	50BL2	50BL1	50G4	50G3	50G2	50G1	50CL	50BL	50AL	*
OSB4	OSB3	OSB2	OSB1	50PP4	50PP3	50PP2	50PP1	TS	TC	TB	TA	*	*	ILOP	50P
SPT_EN	*	*	*	*	52AC	52AB	52AA	50AB4	50AB3	50AB2	50AB1	ATPC	ATPB	ATPA	50PPL
50CA4	50CA3	50CA2	50CA1	50BC4	50BC3	50BC2	50BC1	*	51NR	51QR	51PR	*	*	*	*
OUT1	OUT2	OUT3	OUT4	OUT5	OUT6	OUT7	OUT8	OUT9	OUT10	OUT11	OUT12	OUT13	OUT14	OUT15	!ALARM
IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1	*	*	*	*	*	*	*	*

SEL-321: (Model 32102)

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2129(R)	Target	None	

INST	TIME	COMM	SOTF	ZONE1	ZONE2	ZONE2	ZONE4	EN	A	B	C	G	Q	51	50
Z4G	Z3G	Z2G	Z1G	M4P	M3P	M2P	M1P	Z4GT	Z3GT	Z2GT	LOP	M4PT	M3PT	M2PT	OPA
67Q4	67Q3	67Q2	67Q1	67N4	67N3	67N2	67N1	67Q4T	67Q3T	67Q2T	OST	67N4T	67N3T	67N2T	OSB
PD1	3P27	27L	50H	50MF	51NT	51QT	51PT	ZLOAD	SOTFE	TCM	*	3PO	SPO	REJO	PD2
3P50R	51NP	51QP	51PP	50G	50PP	50M	50L	50Q4	50Q3	50Q2	50Q1	50N4	50N3	50N2	50N1
50ABC	X6ABC	X5ABC	3PT	TPC	TPB	TPA	32QF	3P59	59L	59N	59PR	59PB	59QL	59PL	50Q
BTX	*	STOP	START	FIDEN	FSC	FSB	FSA	32QR	Z1X	CC	EKEY	Z3RB	ATB	ECTT	KEY
XAG4	XAG3	XAG2	XAG1	MAG4	MAG3	MAG2	MAG1	XBG4	XBG3	XBG2	XBG1	MBG4	MBG3	MBG2	MBG1
XCG4	XCG3	XCG2	XCG1	MCG4	MCG3	MCG2	MCG1	MBC4	MBC3	MBC2	MBC1	MAB4	MAB3	MAB2	MAB1
SPOC	SPOB	SPOA	*	MCA4	MCA3	MCA2	MCA1	50HH	OSTI	50CA	50BC	50AB	*	*	*
*	*	*	*	*	*	*	TOP	LP1	SS3	SS2	SS1	EXT	DT	BT	PT
EXTUL	PARC	PARB	PARA	SPTE	PTXFR	LP2	LOG	LP3	CLOSE	52AC2	52AC1	52AB2	52AB1	52AA2	52AA1

LP5	LP4	TCMC2	TCMC1	TCMB2	TCMB1	TCMA2	TCMA1	DTA	DTB	DTC	LP6	LP7	LP8	LP9	LP10
ZT	Z	YT	Y	XT	X	W	V	RAG4	RAG3	RAG2	RAG1	MER	MTO	MTU	MTCS
RCG4	RCG3	RCG2	RCG1	RBG4	RBG3	RBG2	RBG1	50AL4	50AL3	50AL2	50AL1	VPOLV	N3PT	L3PT	PTRX
50CL4	50CL3	50CL2	50CL1	50BL4	50BL3	50BL2	50BL1	50G4	50G3	50G2	50G1	50CL	50BL	50AL	*
OSB4	OSB3	OSB2	OSB1	50PP4	50PP3	50PP2	50PP1	TS	TC	TB	TA	*	*	ILOP	50P
SPT_EN	*	*	*	*	52AC	52AB	52AA	50AB4	50AB3	50AB2	50AB1	ATPC	ATPB	ATPA	50PPL
50CA4	50CA3	50CA2	50CA1	50BC4	50BC3	50BC2	50BC1	*	51NR	51QR	51PR	*	*	*	*
OUT1	OUT2	OUT3	OUT4	OUT5	OUT6	OUT7	OUT8	OUT9	OUT10	OUT11	OUT12	OUT13	OUT14	OUT15	!ALARM
OUT17	OUT18	OUT19	OUT20	OUT21	OUT22	OUT23	OUT24	OUT25	OUT26	OUT27	OUT28	OUT29	OUT30	OUT31	OUT32
IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1	IN16	IN15	IN14	IN13	IN12	IN11	IN10	IN9

SEL-321-1: (Model 32111) (pre 951201):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2120(R)	Target	None	

*	*	*	STSET	STFAIL	STWARN	STEVE	STP	INST	TIME	COMM	SOTF	ZONE1	ZONE2	ZONE3	ZONE4
EN	A	B	C	G	Q	51	50	Z4G	Z3G	Z2G	Z1G	M4P	M3P	M2P	M1P
Z4GT	Z3GT	Z2GT	LOP	M4PT	M3PT	M2PT	OPA	67Q4	67Q3	67Q2	67Q1	67N4	67N3	67N2	67N1
67Q4T	67Q3T	67Q2T	OST	67N4T	67N3T	67N2T	OSB	PD1	3P27	27L	50H	50MF	51NT	51QT	51PT
ZLOAD	SOTFE	TCM	*	3PO	SPO	REJO	PD2	3P50R	51NP	51QP	51PP	50G	50PP	50M	50L
50Q4	50Q3	50Q2	50Q1	50N4	50N3	50N2	50N1	50ABC	X6ABC	X5ABC	3PT	TPC	TPB	TPA	32QF
3P59	59L	59N	59PR	59PB	59QL	59PL	50Q	BTX	*	STOP	START	FIDEN	FSC	FSB	FSA
32QR	Z1X	CC	EKEY	Z3RB	ATB	ECTT	KEY	XAG4	XAG3	XAG2	XAG1	MAG4	MAG3	MAG2	MAG1
XBG4	XBG3	XBG2	XBG1	MBG4	MBG3	MBG2	MBG1	XCG4	XCG3	XCG2	XCG1	MCG4	MCG3	MCG2	MCG1
MBC4	MBC3	MBC2	MBC1	MAB4	MAB3	MAB2	MAB1	SPOC	SPOB	SPOA	*	MCA4	MCA3	MCA2	MCA1
50HH	OSTI	50CA	50BC	50AB	*	*	*	RB8	RB7	RB6	RB5	RB4	RB3	RB2	RB1
RB16	RB15	RB14	RB13	RB12	RB11	RB10	RB9	OUT1	OUT2	OUT3	OUT4	OUT5	OUT6	OUT7	OUT8
OUT9	OUT10	OUT11	OUT12	OUT13	OUT14	OUT15	!ALARM	IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1

SEL-321-1: (Model 32111) (post 951201):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2121(R)	Target	None	

*	*	*	STSET	STFAIL	STWARN	STEVE	STP	INST	TIME	COMM	SOTF	ZONE1	ZONE2	ZONE3	ZONE4
EN	A	B	C	G	Q	51	50	Z4G	Z3G	Z2G	Z1G	M4P	M3P	M2P	M1P
Z4GT	Z3GT	Z2GT	LOP	M4PT	M3PT	M2PT	OPA	67Q4	67Q3	67Q2	67Q1	67N4	67N3	67N2	67N1
67Q4T	67Q3T	67Q2T	OST	67N4T	67N3T	67N2T	OSB	PD1	3P27	27L	50H	50MF	51NT	51QT	51PT
ZLOAD	SOTFE	TCM	*	3PO	SPO	REJO	PD2	3P50R	51NP	51QP	51PP	50G	50PP	50M	50L
50Q4	50Q3	50Q2	50Q1	50N4	50N3	50N2	50N1	50ABC	X6ABC	X5ABC	3PT	TPC	TPB	TPA	32QF
3P59	59L	59N	59PR	59PB	59QL	59PL	50Q	BTX	*	STOP	START	FIDEN	FSC	FSB	FSA
32QR	Z1X	CC	EKEY	Z3RB	ATB	ECTT	KEY	XAG4	XAG3	XAG2	XAG1	MAG4	MAG3	MAG2	MAG1
XBG4	XBG3	XBG2	XBG1	MBG4	MBG3	MBG2	MBG1	XCG4	XCG3	XCG2	XCG1	MCG4	MCG3	MCG2	MCG1
MBC4	MBC3	MBC2	MBC1	MAB4	MAB3	MAB2	MAB1	SPOC	SPOB	SPOA	*	MCA4	MCA3	MCA2	MCA1
50HH	OSTI	50CA	50BC	50AB	*	*	*	RB8	RB7	RB6	RB5	RB4	RB3	RB2	RB1
RB16	RB15	RB14	RB13	RB12	RB11	RB10	RB9	OUT1	OUT2	OUT3	OUT4	OUT5	OUT6	OUT7	OUT8
OUT9	OUT10	OUT11	OUT12	OUT13	OUT14	OUT15	!ALARM	TMB8	TMB7	TMB6	TMB5	TMB4	TMB3	TMB2	TMB1
IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1	RMB8	RMB7	RMB6	RMB5	RMB4	RMB3	RMB2	RMB1

SEL-321-1: (Model 32112) (pre 951201):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31

2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2122(R)	Target	None	

*	*	*	STSET	STFAIL	STWARN	STEVE	STP	INST	TIME	COMM	SOTF	ZONE1	ZONE2	ZONE3	ZONE4
EN	A	B	C	G	Q	51	50	Z4G	Z3G	Z2G	Z1G	M4P	M3P	M2P	M1P
Z4GT	Z3GT	Z2GT	LOP	M4PT	M3PT	M2PT	OPA	67Q4	67Q3	67Q2	67Q1	67N4	67N3	67N2	67N1
67Q4T	67Q3T	67Q2T	OST	67N4T	67N3T	67N2T	OSB	PD1	3P27	27L	50H	50MF	51NT	51QT	51PT
ZLOAD	SOTFE	TCM	*	3PO	SPO	REJO	PD2	3P50R	51NP	51QP	51PP	50G	50PP	50M	50L
50Q4	50Q3	50Q2	50Q1	50N4	50N3	50N2	50N1	50ABC	X6ABC	X5ABC	3PT	TPC	TPB	TPA	32QF
3P59	59L	59N	59PR	59PB	59QL	59PL	50Q	BTX	*	STOP	START	FIDEN	FSC	FSB	FSA
32QR	Z1X	CC	EKEY	Z3RB	ATB	ECTT	KEY	XAG4	XAG3	XAG2	XAG1	MAG4	MAG3	MAG2	MAG1
XBG4	XBG3	XBG2	XBG1	MBG4	MBG3	MBG2	MBG1	XCG4	XCG3	XCG2	XCG1	MCG4	MCG3	MCG2	MCG1
MBC4	MBC3	MBC2	MBC1	MAB4	MAB3	MAB2	MAB1	SPOC	SPOB	SPOA	*	MCA4	MCA3	MCA2	MCA1
50HH	OSTI	50CA	50BC	50AB	*	*	*	RB8	RB7	RB6	RB5	RB4	RB3	RB2	RB1
RB16	RB15	RB14	RB13	RB12	RB11	RB10	RB9	OUT1	OUT2	OUT3	OUT4	OUT5	OUT6	OUT7	OUT8
OUT9	OUT10	OUT11	OUT12	OUT13	OUT14	OUT15	!ALARM	OUT17	OUT18	OUT19	OUT20	OUT21	OUT22	OUT23	OUT24
OUT25	OUT26	OUT27	OUT28	OUT29	OUT30	OUT31	OUT32	IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1
IN16	IN15	IN14	IN13	IN12	IN11	IN10	IN9	*	*	*	*	*	*	*	*

SEL-321-1: (Model 32112) (post 951201):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2123(R)	Target	None	

*	*	*	STSET	STFAIL	STWARN	STEVE	STPWR	INST	TIME	COMM	SOTF	ZONE1	ZONE2	ZONE3	ZONE4
EN	A	B	C	G	Q	51	50	Z4G	Z3G	Z2G	Z1G	M4P	M3P	M2P	M1P
Z4GT	Z3GT	Z2GT	LOP	M4PT	M3PT	M2PT	OPA	67Q4	67Q3	67Q2	67Q1	67N4	67N3	67N2	67N1
67Q4T	67Q3T	67Q2T	OST	67N4T	67N3T	67N2T	OSB	PD1	3P27	27L	50H	50MF	51NT	51QT	51PT
ZLOAD	SOTFE	TCM	*	3PO	SPO	REJO	PD2	3P50R	51NP	51QP	51PP	50G	50PP	50M	50L
50Q4	50Q3	50Q2	50Q1	50N4	50N3	50N2	50N1	50ABC	X6ABC	X5ABC	3PT	TPC	TPB	TPA	32QF
3P59	59L	59N	59PR	59PB	59QL	59PL	50Q	BTX	*	STOP	START	FIDEN	FSC	FSB	FSA
32QR	Z1X	CC	EKEY	Z3RB	ATB	ECTT	KEY	XAG4	XAG3	XAG2	XAG1	MAG4	MAG3	MAG2	MAG1
XBG4	XBG3	XBG2	XBG1	MBG4	MBG3	MBG2	MBG1	XCG4	XCG3	XCG2	XCG1	MCG4	MCG3	MCG2	MCG1
MBC4	MBC3	MBC2	MBC1	MAB4	MAB3	MAB2	MAB1	SPOC	SPOB	SPOA	*	MCA4	MCA3	MCA2	MCA1
50HH	OSTI	50CA	50BC	50AB	*	*	*	RB8	RB7	RB6	RB5	RB4	RB3	RB2	RB1
RB16	RB15	RB14	RB13	RB12	RB11	RB10	RB9	OUT1	OUT2	OUT3	OUT4	OUT5	OUT6	OUT7	OUT8
OUT9	OUT10	OUT11	OUT12	OUT13	OUT14	OUT15	ALARM	OUT17	OUT18	OUT19	OUT20	OUT21	OUT22	OUT23	OUT24
OUT25	OUT26	OUT27	OUT28	OUT29	OUT30	OUT31	OUT32	TMB8	TMB7	TMB6	TMB5	TMB4	TMB3	TMB2	TMB1
IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1	IN16	IN15	IN14	IN13	IN12	IN11	IN10	IN9
RMB8	RMB7	RMB6	RMB5	RMB4	RMB3	RMB2	RMB1	*	*	*	*	*	*	*	

SEL-351:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2131(R)	Target	None	

*	*	*	STSET	*	*	*	*	EN	TRIP	INST	COMM	SOTF	50	51	81
A	B	C	G	N	RS	CY	LO	50A1	50B1	50C1	50A2	50B2	50C2	50A3	50B3
50C3	50A4	50B4	50C4	50AB1	50BC1	50CA1	50AB2	50BC2	50CA2	50AB3	50BC3	50CA3	50AB4	50BC4	50CA4

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50A    50B    50C    51A    51AT   51AR   51B    51BT   51BR   51C    51CT   51CR   51P    51PT   51PR   51N
51NT   51NR   51G    51GT   51GR   51Q    51QT   51QR   50P1   50P2   50P3   50P4   50N1   50N2   50N3   50N4
67P1   67P2   67P3   67P4   67N1   67N2   67N3   67N4   67P1T  67P2T  67P3T  67P4T  67N1T  67N2T  67N3T  67N4T
50G1   50G2   50G3   50G4   50Q1   50Q2   50Q3   50Q4   67G1   67G2   67G3   67G4   67Q1   67Q2   67Q3   67Q4
67G1T  67G2T  67G3T  67G4T  67Q1T  67Q2T  67Q3T  67Q4T  50P5   50P6   50N5   50N6   50G5   50G6   50Q5   50Q6
50QF   50QR   50GF   50GR   32VE   32QGE  32IE   32QE   F32P   R32P   F32Q   R32Q   F32QG  R32QG  F32V   R32V
F32I   R32I   32PF   32PR   32QF   32QR   32GF   32GR   27A1   27B1   27C1   27A2   27B2   27C2   59A1   59B1
59C1   59A2   59B2   59C2   27AB   27BC   27CA   59AB   59BC   59CA   59N1   59N2   59Q    59V1   27S    59S1
59S2   59VP   59VS   SF     25A1   25A2   3P27   3P59   81D1   81D2   81D3   81D4   81D5   81D6   27B81  50L
81D1T  81D2T  81D3T  81D4T  81D5T  81D6T  VPOLV  LOP    IN8    IN7    IN6    IN5    IN4    IN3    IN2    IN1
LB1    LB2    LB3    LB4    LB5    LB6    LB7    LB8    RB1    RB2    RB3    RB4    RB5    RB6    RB7    RB8
LT1    LT2    LT3    LT4    LT5    LT6    LT7    LT8    SV1    SV2    SV3    SV4    SV1T   SV2T   SV3T   SV4T
SV5    SV6    SV7    SV8    SV5T   SV6T   SV7T   SV8T   SV9    SV10   SV11   SV12   SV9T   SV10T  SV11T  SV12T
SV13   SV14   SV15   SV16   SV13T  SV14T  SV15T  SV16T  79RS   79CY   79LO   SH0    SH1    SH2    SH3    SH4
CLOSE  CF     RCSF   OPTMN  RSTMN  FSA    FSB    FSC    SG1    SG2    SG3    SG4    SG5    SG6    ZLOUT  ZLIN
BCW    50P32  *      *      *      *      *      *      ZLOAD  BCWA   BCWB   BCWC   ALARM  OUT11  OUT10  OUT9
OUT8   OUT7   OUT6   OUT5   OUT4   OUT3   OUT2   OUT1   3PO    SOTFE  Z3RB   KEY    EKEY   ECTT   WFC    PT
PTRX2  PTRX   PTRX1  UBB1   UBB2   UBB    Z3XT   DSTRT  NSTRT  STOP   BTX    TRIP   OC     CC     DCHI   DCLO
67P2S  67N2S  67G2S  67Q2S  PDEM   NDEM   GDEM   QDEM   *      *      *      *      *      *      *      *
*      *      *      *      *      *      *      *      *      *      *      *      *      *      *      *
*      *      *      *      *      *      *      *      *      *      *      *      *      *      *      *
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For SEL-351R:

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2100(R)       Target Date stamp                          Month                     1-12
2101(R)       Target Date stamp                          Day of the Month          1-31
2102(R)       Target Date stamp                          Year                      0-99
2103(R)       Target Time stamp                          Hours                     0-23
2104(R)       Target Time stamp                          Minutes                   0-59
2105(R)       Target Time stamp                          Seconds                   0-59
2106(R)       Target Time stamp                          Milliseconds              0-999
2107(R)       Target Date stamp                          Day of the week (Sunday-0, Monday-1, ...) 0-6
2108-2138(R)  Target                                     None
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*      *      *      STSET  *      *      *      *      LED10  LED11  LED12  LED13  LED14  LED15  LED16  LED17
LED18  LED19  LED20  LED21  LED22  LED23  LED24  LED25  50A1   50B1   50C1   50A2   50B2   50C2   50A3   50B3
50C3   50A4   50B4   50C4   50AB1  50BC1  50CA1  50AB2  50BC2  50CA2  50AB3  50BC3  50CA3  50AB4  50BC4  50CA4
50A    50B    50C    51P1   51P1T  51P1R  51N1   51N1T  51N1R  51G1   51G1T  51G1R  51P2   51P2T  51P2R  51N2
51N2T  51N2R  51G2   51G2T  51G2R  51Q    51QT   51QR   50P1   50P2   50P3   50P4   50N1   50N2   50N3   50N4
67P1   67P2   67P3   67P4   67N1   67N2   67N3   67N4   67P1T  67P2T  67P3T  67P4T  67N1T  67N2T  67N3T  67N4T
50G1   50G2   50G3   50G4   50Q1   50Q2   50Q3   50Q4   67G1   67G2   67G3   67G4   67Q1   67Q2   67Q3   67Q4
67G1T  67G2T  67G3T  67G4T  67Q1T  67Q2T  67Q3T  67Q4T  50P5   50P6   50N5   50N6   50G5   50G6   50Q5   50Q6
50QF   50QR   50GF   50GR   32VE   32QGE  32IE   32QE   F32P   R32P   F32Q   R32Q   F32QG  R32QG  F32V   R32V
F32I   R32I   32PF   32PR   32QF   32QR   32GF   32GR   27A1   27B1   27C1   27A2   27B2   27C2   59A1   59B1
59C1   59A2   59B2   59C2   27AB   27BC   27CA   59AB   59BC   59CA   59N1   59N2   59Q    59V1   27S    59S1
59S2   59VP   59VS   SF     25A1   25A2   3P27   3P59   81D1   81D2   81D3   81D4   81D5   81D6   27B81  50L
81D1T  81D2T  81D3T  81D4T  81D5T  81D6T  VPOLV  LOP    RCTR   RCCL   IN106  IN105  IN104  IN103  IN102  IN101
LB1    LB2    LB3    LB4    LB5    LB6    LB7    LB8    RB1    RB2    RB3    RB4    RB5    RB6    RB7    RB8
LT1    LT2    LT3    LT4    LT5    LT6    LT7    LT8    SV1    SV2    SV3    SV4    SV1T   SV2T   SV3T   SV4T
SV5    SV6    SV7    SV8    SV5T   SV6T   SV7T   SV8T   SV9    SV10   SV11   SV12   SV9T   SV10T  SV11T  SV12T
SV13   SV14   SV15   SV16   SV13T  SV14T  SV15T  SV16T  79RS   79CY   79LO   SH0    SH1    SH2    SH3    SH4
CLOSE  CF     RCSF   OPTMN  RSTMN  FSA    FSB    FSC    BCW    50P32  NOBATT 59VA   TRGTR  52A    COMMT  CHRGG
SG1    SG2    SG3    SG4    SG5    SG6    ZLOUT  ZLIN   ZLOAD  BCWA   BCWB   BCWC   BCBOK  TOSLP  DISTST DTFAIL
ALARM  OUT107 OUT106 OUT105 OUT104 OUT103 OUT102 OUT101 3PO    SOTFE  Z3RB   KEY    EKEY   ECTT   WFC    PT
PTRX2  PTRX   PTRX1  UBB1   UBB2   UBB    Z3XT   DSTRT  NSTRT  STOP   BTX    TRIP   OC     CC     CLG    NOMSG
67P2S  67N2S  67G2S  67Q2S  PDEM   NDEM   GDEM   QDEM   PB1    PB2    PB3    PB4    PB5    PB6    PB7    PB8
PB9    PINBD  PINC   PINE   PINF   SW1    DISCHG LED9   LED1   LED2   LED3   LED4   LED5   LED6   LED7   LED8
OCP    OCG    OLP    OLG    OLS    HTP    HTG    HLP    HLG    CLP    RPP    RPG    RPS    SEQC   3PHV   GTP
RMB8A  RMB7A  RMB6A  RMB5A  RMB4A  RMB3A  RMB2A  RMB1A  TMB8A  TMB7A  TMB6A  TMB5A  TMB4A  TMB3A  TMB2A  TMB1A
RMB8B  RMB7B  RMB6B  RMB5B  RMB4B  RMB3B  RMB2B  RMB1B  TMB8B  TMB7B  TMB6B  TMB5B  TMB4B  TMB3B  TMB2B  TMB1B
LBOKB  CBADB  RBADB  ROKB   LBOKA  CBADA  RBADA  ROKA   OUT201 OUT202 OUT203 OUT204 OUT205 OUT206 OUT207 OUT208
OUT209 OUT210 OUT211 OUT212 OUT213 OUT214 OUT215 OUT216 IN208  IN207  IN206  IN205  IN204  IN203  IN202  IN201
*      *      *      *      *      *      *      *      *      *      *      *      *      *      *      *
*      *      *      *      *      *      *      *      *      *      *      *      *      *      *      *
*      *      *      *      *      *      *      *      *      *      *      *      *      *      *      *
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For SEL-352:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2147(R)	Target	None	

*	*	*	STSET	STFAIL	STWARN	*	*	EN	PF	86BFT	86RS	TRIP	CLOSE	52A	MOD
FAULT	LOAD	UBAL	FLASH	THERM	A	B	C	Y59L3	X59L3	50LDC	50LDB	50LDA	50FTC	50FTB	50FTA
87THA	87FOA	Y27D3	X27D3	50N	50MDC	50MDB	50MDA	47Q	37OP	25T	46P	87THC	87FOC	87THB	87FOB
X59LC	X59HC	X27DB	X59LB	X59HB	X27DA	X59LA	X59HA	ZERO	Y27DC	Y59LC	Y27DB	Y59LB	Y27DA	Y59LA	X27DC
ONE	50MNC	50MNB	50MNA	87F	87H	87TH	X59H	25M	25C	46C	46B	46A	50MD	50LD	50FT
Y47Q	X47Q	37OPC	37OPB	37OPA	87HC	87HB	87HA	CCMD	TCMD	XNTC	XPTC	XNTB	XPTB	XNTA	XPTA
*	*	YNTC	YPTC	YNTB	YPTB	YNTA	YPTA	D86BF	D7Q	D6Q	D5Q	D4Q	D3Q	D2Q	D1Q
RB8	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB16	RB15	RB14	RB13	RB12	RB11	RB10	RB9
*	*	IN106	IN105	IN104	IN103	IN102	IN101	IN208	IN207	IN206	IN205	IN204	IN203	IN202	IN201
IN216	IN215	IN214	IN213	IN212	IN211	IN210	IN209	IN308	IN307	IN306	IN305	IN304	IN303	IN302	IN301
IN316	IN315	IN314	IN313	IN312	IN311	IN310	IN309	MCLOSE	CLOSE	TRIP3	TRIPC	TRIPB	TRIPA	SS2	SS1
*	LODCT	LOD2	LOD1	MODST	52AC	52AB	52AA	L1CR	L1CS	L1BQ	L1BR	L1BS	L1AQ	L1AR	L1AS
*	T1CD	T1C	T1BD	T1B	T1AD	T1A	L1CQ	*	*	*	*	*	SAC	SAB	SAA
LFAR	LFAS	TTCD	TTC	TTBD	TTB	TTAD	TTA	*	LFCQ	LFCR	LFCS	LFBQ	LFBR	LFBS	LFAQ
*	*	FCCD	FCC	FCBD	FCB	FCAD	FCA	LLBS	LLAQ	LLAR	LLAS	D52Q	DLCQ	DLBQ	DLAQ
LPB	LPAD	LPA	LLCQ	LLCR	LLCS	LLBQ	LLBR	LDC	LDBD	LDB	LDAD	LDA	LPCD	LPC	LPBD
*	APD	AP	L52Q	L52R	L52S	D52	LDCD	*	*	*	DLC	DLB	DLA	AFD	AF
LTAR	LTAS	OPCD	OPC	OPBD	OPB	OPAD	OPA	*	LTCQ	LTCR	LTCS	LTBQ	LTBR	LTBS	LTAQ
*	*	CRMEC	CRMEB	CRMEA	TRMEC	TRMEB	TRMEA	*	KTRK	26TFC	26TFB	26TFA	26CFC	26CFB	26CFA
*	*	26TPC	26TPB	26TPA	26CPC	26CPB	26CPA	F2AD	F2A	F1CD	F1C	F1BD	F1B	F1AD	F1A
F3BD	F3B	F3AD	F3A	F2CD	F2C	F2BD	F2B	LHBQ	LHBR	LHBS	LHAQ	LHAR	LHAS	F3CD	F3C
LVBR	LVBS	LVAQ	LVAR	LVAS	LHCQ	LHCR	LHCS	FPBD	FPB	FPAD	FPA	LVCQ	LVCR	LVCS	LVBQ
FFCD	FFC	FFBD	FFB	FFAD	FFA	FPCD	FPC	*	UPAD	UPA	LUQ	LUR	LUS	UCD	UC
UFBD	UFB	UFAD	UFA	UPCD	UPC	UPBD	UPB	*	*	*	*	*	*	UFCD	UFC
*	*	LT3D	LT3	LT2D	LT2	LT1D	LT1	MCT	RCCD	RCC	RCBD	RCB	RCAD	RCA	RCLS
PCPA	SCTD	SCT	SYNCTD	SYNCT	CCTD	CCT	MCTD	ZCPB	ZCNA	ZCPA	PCNC	PCPC	PCNB	PCPB	PCNA
*	SYNCEN	CTCD	CTBD	CTAD	ZCNC	ZCPC	ZCNB	CAMT	BPF	BDNC	TWO	CWO	52ACV	FCRS	FTRS
*	*	*	BALRM	PTD	SC	ST	MCC	LRTCR	LRTCS	LRTBQ	LRTBR	LRTBS	LRTAQ	LRTAR	LRTAS
*	RT3D	RT3	RT2D	RT2	RT1D	RT1	LRTCQ	L4CR	L4CS	L4BQ	L4BR	L4BS	L4AQ	L4AR	L4AS
L5AS	T3CD	T3C	T3BD	T3B	T3AD	T3A	L4CQ	L5CQ	L5CR	L5CS	L5BQ	L5BR	L5BS	L5AQ	L5AR
L6AR	L6AS	T4CD	T4C	T4BD	T4B	T4AD	T4A	*	L6CQ	L6CR	L6CS	L6BQ	L6BR	L6BS	L6AQ
*	*	*	*	*	SBC	SBB	SBA	UBBF	UBPF	FOBF	FOPF	CTF	TTF	LBF	LPF
RTC	RTB	RTA	CCC	CCB	CCA	LODBF	LODPF	*	*	*	*	*	DCC	DCB	DCA
*	*	*	*	*	*	*	FBF	L1MQ	L1MR	L1MS	M1D	M1	D2MQ	D1MQ	M86T
L3MS	M3D	M3	L2MQ	L2MR	L2MS	M2D	M2	*	*	D2M	D1M	M4D	M4	L3MQ	L3MR
*	*	*	MER	86BFT	86RS	MDT	*	*	D7	D6	D5	D4	D3	D2	D1
*	*	*	*	*	CTC	CTB	CTA	*	*	*	*	*	*	*	*
ALARM	OUT107	OUT106	OUT105	OUT104	OUT103	OUT102	OUT101	OUT201	OUT202	OUT203	OUT204	OUT205	OUT206	OUT207	OUT208
OUT209	OUT210	OUT211	OUT212	OUT213	OUT214	OUT215	OUT216	OUT301	OUT302	OUT303	OUT304	OUT305	OUT306	OUT307	OUT308
OUT309	OUT310	OUT311	OUT312	OUT313	OUT314	OUT315	OUT316	*	*	*	*	*	*	*	*

For SEL-387:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2130(R)	Target	None	

EN	TRIP	INST	87-1	87-2	87-3	50	51	A	B	C	N	W1	W2	W3	W4
50P11	50P11T	50P12	51P1	51P1T	51P1R	PDEM1	OCA	50A13	50B13	50C13	50P13	50A14	50B14	50C14	50P14
50N11	50N11T	50N12	51N1	51N1T	51N1R	NDEM1	OC1	50Q11	50Q11T	50Q12	51Q1	51Q1T	51Q1R	QDEM1	CC1

50P21	50P21T	50P22	51P2	51P2T	51P2R	PDEM2	OCB	50A23	50B23	50C23	50P23	50A24	50B24	50C24	50P24
50N21	50N21T	50N22	51N2	51N2T	51N2R	NDEM2	OC2	50Q21	50Q21T	50Q22	51Q2	51Q2T	51Q2R	QDEM2	CC2
50P31	50P31T	50P32	51P3	51P3T	51P3R	PDEM3	OCC	50A33	50B33	50C33	50P33	50A34	50B34	50C34	50P34
50N31	50N31T	50N32	51N3	51N3T	51N3R	NDEM3	OC3	50Q31	50Q31T	50Q32	51Q3	51Q3T	51Q3R	QDEM3	CC3
50P41	50P41T	50P42	51P4	51P4T	51P4R	PDEM4	*	50A43	50B43	50C43	50P43	50A44	50B44	50C44	50P44
50N41	50N41T	50N42	51N4	51N4T	51N4R	NDEM4	OC4	50Q41	50Q41T	50Q42	51Q4	51Q4T	51Q4R	QDEM4	CC4
87U1	87U2	87U3	87U	87R1	87R2	87R3	87R	2HB1	2HB2	2HB3	5HB1	5HB2	5HB3	TH5	TH5T
87BL1	87BL2	87BL3	87BL	87E1	87E2	87E3	32IE	8701	8702	8703	50GC	50G4	32IR	32IF	REFP
51PC1	51PC1T	51PC1R	51NC1	51NC1T	51NC1R	DC1	DC2	51PC2	51PC2T	51PC2R	51NC2	51NC2T	51NC2R	DC3	DC4
RB1	RB2	RB3	RB4	RB5	RB6	RB7	RB8	RB9	RB10	RB11	RB12	RB13	RB14	RB15	RB16
SG1	SG2	SG3	SG4	SG5	SG6	CHSG	*	*	*	IN106	IN105	IN104	IN103	IN102	IN101
IN208	IN207	IN206	IN205	IN204	IN203	IN202	IN201	IN216	IN215	IN214	IN213	IN212	IN211	IN210	IN209
IN308	IN307	IN306	IN305	IN304	IN303	IN302	IN301	IN316	IN315	IN314	IN313	IN312	IN311	IN310	IN309
S1V1	S1V2	S1V3	S1V4	S1V1T	S1V2T	S1V3T	S1V4T	S1LT1	S1LT2	S1LT3	S1LT4	S2LT1	S2LT2	S2LT3	S2LT4
S2V1	S2V2	S2V3	S2V4	S2V1T	S2V2T	S2V3T	S2V4T	S3V1	S3V2	S3V3	S3V4	S3V5	S3V6	S3V7	S3V8
S3V1T	S3V2T	S3V3T	S3V4T	S3V5T	S3V6T	S3V7T	S3V8T	BCWA1	BCWB1	BCWC1	BCW1	BCWA2	BCWB2	BCWC2	BCW2
BCWA3	BCWB3	BCWC3	BCW3	BCWA4	BCWB4	BCWC4	BCW4	TRIP1	TRIP2	TRIP3	TRIP4	TRIP5	TRIPL	*	TRGTR
CLS1	CLS2	CLS3	CLS4	CF1T	CF2T	CF3T	CF4T	!ALARM	OUT107	OUT106	OUT105	OUT104	OUT103	OUT102	OUT101
OUT201	OUT202	OUT203	OUT204	OUT205	OUT206	OUT207	OUT208	OUT209	OUT210	OUT211	OUT212	OUT213	OUT214	OUT215	OUT216
OUT301	OUT302	OUT303	OUT304	OUT305	OUT306	OUT307	OUT308	OUT309	OUT310	OUT311	OUT312	OUT313	OUT314	OUT315	OUT316

For SEL-501 (APP X=FDR/OC1; Y=FDR/OC1) (ASCII Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
X51PT	X51QT	X51NT	X50PT	X50H	X50QT	X50NT	X50NH	X51PP	X51QP	X51NP	X50PP	*	X50QP	X50NP	*
X51PR	X51QR	X51NR	*	*	*	*	*	YX	YY	YINST	YA	YB	YC	YQ	YN
*	YXIN	YYIN	YALARM	YXOUT1	YXOUT2	YYOUT1	YYOUT2	Y51PT	Y51QT	Y51NT	Y50PT	Y50H	Y50QT	Y50NT	Y50NH
Y51PP	Y51QP	Y51NP	Y50PP	*	Y50QP	Y50NP	*	Y51PR	Y51QR	Y51NR	*	*	*	*	*

For SEL-501 (APP X=FDR/OC1; Y=MOT) (ASCII Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
X51PT	X51QT	X51NT	X50PT	X50H	X50QT	X50NT	X50NH	X51PP	X51QP	X51NP	X50PP	*	X50QP	X50NP	*
X51PR	X51QR	X51NR	*	*	*	*	*	YX	YY	YINST	YA	YB	YC	YX	YN
*	YXIN	YYIN	YALARM	YXOUT1	YXOUT2	YYOUT1	YYOUT2	Y49	*	YSTL	Y50PT	Y50H	Y50QT	Y50NT	Y50NH
Y49A	Y50L	Y50ST	Y50PP	YLLOSS	Y50QP	Y50NP	YLJAM	*	*	*	*	*	*	*	*

For SEL-501 (APP X=FDR/OC1; Y=BFR) (ASCII Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
X51PT	X51QT	X51NT	X50PT	X50H	X50QT	X50NT	X50NH	X51PP	X51QP	X51NP	X50PP	*	X50QP	X50NP	*
X51PR	X51QR	X51NR	*	*	*	*	*	YX	YY	YINST	YA	YB	YC	YQ	YN
*	YXIN	YYIN	YALARM	YXOUT1	YXOUT2	YYOUT1	YYOUT2	Y86TR	YRTRP	Y62T	Y50PP	*	*	Y50NP	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

For SEL-501 (APP X=FDR/OC1; Y=TMR/OFF) (ASCII Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
X51PT	X51QT	X51NT	X50PT	X50H	X50QT	X50NT	X50NH	X51PP	X51QP	X51NP	X50PP	*	X50QP	X50NP	*
X51PR	X51QR	X51NR	*	*	*	*	*	YX	YY	YINST	YA	YB	YC	YQ	YN
*	YXIN	YYIN	YALARM	YXOUT1	YXOUT2	YYOUT1	YYOUT2	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

For SEL-501 (APP X=MOT; Y=MOT) (ASCII Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
X49	*	XSTL	X50PT	X50H	X50QT	X50NT	X50NH	X49A	X50L	X50ST	X50PP	XLLOSS	X50QP	X50NP	XLJAM
*	*	*	*	*	*	*	*	YX	YY	YINST	YA	YB	YC	YQ	YN
*	YXIN	YYIN	YALARM	YXOUT1	YXOUT2	YYOUT1	YYOUT2	Y49	*	YSTL	Y50PT	Y50H	Y50QT	Y50NT	Y50NH
Y49A	Y50L	Y50ST	Y50PP	YLLOSS	Y50QP	YTPNP	YLJAM	*	*	*	*	*	*	*	*

For SEL-501 (APP X=MOT; Y=BFR) (ASCII Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
X49	*	XSTL	X50PT	X50H	X50QT	X50NT	X50NH	X49A	X50L	X50ST	X50PP	XLLOSS	X50QP	X50NP	XLJAM
*	*	*	*	*	*	*	*	YX	YY	YINST	YA	YB	YC	YQ	YN
*	YXIN	YYIN	YALARM	YYOUT1	YYOUT2	YYOUT1	YYOUT2	Y86TR	YRTRP	Y62T	Y50PP	*	*	Y50NP	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

For SEL-501 (APP X=MOT; Y=TMR/OFF) (ASCII Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59

2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
X49	*	XSTL	X50PT	X50H	X50QT	X50NT	X50NH	X49A	X50L	X50ST	X50PP	XLLOSS	X50QP	X50NP	XLJAM
*	*	*	*	*	*	*	*	YX	YY	YINST	YA	YB	YC	YQ	YN
*	YXIN	YYIN	YALARM	YXOUT1	YXOUT2	YYOUT1	YYOUT2	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

For SEL-501 (APP X=MOT; Y=FDR/OC1) (ASCII Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
X49	*	XSTL	X50PT	X50H	X50QT	X50NT	X50NH	X49A	X50L	X50ST	X50PP	XLLOSS	X50QP	X50NP	XLJAM
*	*	*	*	*	*	*	*	YX	YY	YINST	YA	YB	YC	YQ	YN
*	YXIN	YYIN	YALARM	YXOUT1	YXOUT2	YYOUT1	YYOUT2	Y51PT	Y51QT	Y51NT	Y50PT	Y50H	Y50QT	Y50NT	Y50NH
Y51PP	Y51QP	Y51NP	Y50PP	*	Y50QP	Y50NP	*	Y51PR	Y51QR	Y51NR	*	*	*	*	*

For SEL-501 (APP X=BFR; Y=MOT) (ASCII| Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
X86TR	XRTRP	X62T	X50PP	*	*	X50NP	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	YX	YY	YINST	YA	YB	YC	YQ	YN
*	YXIN	YYIN	YALARM	YXOUT1	YXOUT2	YYOUT1	YYOUT2	Y49	*	YSTL	Y50PT	Y50H	Y50QT	Y50NT	Y50NH
Y49A	Y50L	Y50ST	Y50PP	YLLOSS	Y50QP	YTPNP	YLJAM	*	*	*	*	*	*	*	*

For SEL-501 (APP X=BFR; Y=FDR/OC1) (ASCII Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
X86TR	XRTRP	X62T	X50PP	*	*	X50NP	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	YX	YY	YINST	YA	YB	YC	YQ	YN
*	YXIN	YYIN	YALARM	YXOUT1	YXOUT2	YYOUT1	YYOUT2	Y50PT	Y51QT	Y51NT	Y50PT	Y50H	Y50QT	Y50NT	Y50NH
Y50PP	Y51QP	Y51NP	Y50PP	*	Y50QP	Y50NP	*	Y50PR	Y51QR	Y51NR	*	*	*	*	*

For SEL-501 (APP X=BFR; Y=BFR) (ASCII Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
X86TR	XRTRP	X62T	X50PP	*	*	X50NP	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	YX	YY	YINST	YA	YB	YC	YQ	YN
*	YXIN	YYIN	YALARM	YXOUT1	YXOUT2	YYOUT1	YYOUT2	Y86TR	YRTRP	Y62T	Y50PP	*	*	Y50NP	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

For SEL-501 (APP X=BFR; Y=TMR/OFF) (ASCII Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
X86TR	XRTRP	X62T	X50PP	*	*	X50NP	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	YX	YY	YINST	YA	YB	YC	YQ	YN
*	YXIN	YYIN	YALARM	YXOUT1	YXOUT2	YYOUT1	YYOUT2	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

For SEL-501 (APP X=TMR/OFF; Y=FDR/OC1) (ASCII Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	YX	YY	YINST	YA	YB	YC	YQ	YN
*	YXIN	YYIN	YALARM	YXOUT1	YXOUT2	YYOUT1	YYOUT2	Y51PT	Y51QT	Y51NT	Y50PT	Y50H	Y50QT	Y50NT	Y50NH
Y51PP	Y51QP	Y51NP	Y50PP	*	Y50QP	Y50NP	*	Y51PR	Y51QR	Y51NR	*	*	*	*	*

For SEL-501 (APP X=TMR/OFF; Y=MOT) (ASCII Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2112(R)	Target	None	

XX	XY	XINST	XA	XB	XC	XQ	XN	*	XXIN	XYIN	XALARM	XXOUT1	XXOUT2	XYOUT1	XYOUT2
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

```
*        *      *     *       *      *      *      *      YX     YY     YINST YA      YB     YC     YQ     YN
*        YXIN   YYIN  YALARM  YXOUT1 YXOUT2 YYOUT1 YYOUT2 Y49    *      YSTL  Y50PT   Y50H   Y50QT  Y50NT  Y50NH
Y59A     Y50L   Y50ST Y50PP   YLLOSS Y50QP  Y50NP  YLJAM  *      *      *     *       *      *      *      *
```

For SEL-501 (APP X=TMR/OFF; Y=BFR) (ASCII Format):

```
2100(R)      Target Date stamp                          Month                      1-12
2101(R)      Target Date stamp                          Day of the Month           1-31
2102(R)      Target Date stamp                          Year                       0-99
2103(R)      Target Time stamp                          Hours                      0-23
2104(R)      Target Time stamp                          Minutes                    0-59
2105(R)      Target Time stamp                          Seconds                    0-59
2106(R)      Target Time stamp                          Milliseconds               0-999
2107(R)      Target Date stamp                          Day of the week (Sunday-0, Monday-1, ...) 0-6
2108-2112(R) Target                                     None
```

```
XX       XY     XINST XA      XB     XC     XQ     XN     *      XXIN   XYIN  XALARM  XXOUT1 XXOUT2 XYOUT1 XYOUT2
*        *      *     *       *      *      *      *      *      *      *     *       *      *      *      *
*        *      *     *       *      *      *      *      YX     YY     YINST YA      YB     YC     YQ     YN
*        YXIN   YYIN  YALARM  YXOUT1 YXOUT2 YYOUT1 YYOUT2 Y86TR  YRTRP  Y62T  Y50PP   *      *      Y50NP  *
*        *      *     *       *      *      *      *      *      *      *     *       *      *      *      *
```

For SEL-501 (APP X=TMR/OFF; Y=TMR/OFF) (ASCII Format):

```
2100(R)      Target Date stamp                          Month                      1-12
2101(R)      Target Date stamp                          Day of the Month           1-31
2102(R)      Target Date stamp                          Year                       0-99
2103(R)      Target Time stamp                          Hours                      0-23
2104(R)      Target Time stamp                          Minutes                    0-59
2105(R)      Target Time stamp                          Seconds                    0-59
2106(R)      Target Time stamp                          Milliseconds               0-999
2107(R)      Target Date stamp                          Day of the week (Sunday-0, Monday-1, ...) 0-6
2108-2112(R) Target                                     None
```

```
XX       XY     XINST XA      XB     XC     XQ     XN     *      XXIN   XYIN  XALARM  XXOUT1 XXOUT2 XYOUT1 XYOUT2
*        *      *     *       *      *      *      *      *      *      *     *       *      *      *      *
*        *      *     *       *      *      *      *      YX     YY     YINST YA      YB     YC     YQ     YN
*        YXIN   YYIN  YALARM  YXOUT1 YXOUT2 YYOUT1 YYOUT2 *      *      *     *       *      *      *      *
*        *      *     *       *      *      *      *      *      *      *     *       *      *      *      *
```

For SEL-501 (APP X=FDR/OC1; Y=FDR/OC1); SEL-501-1,-2 (Binary Format):

```
2100(R)      Target Date stamp                          Month                      1-12
2101(R)      Target Date stamp                          Day of the Month           1-31
2102(R)      Target Date stamp                          Year                       0-99
2103(R)      Target Time stamp                          Hours                      0-23
2104(R)      Target Time stamp                          Minutes                    0-59
2105(R)      Target Time stamp                          Seconds                    0-59
2106(R)      Target Time stamp                          Milliseconds               0-999
2107(R)      Target Date stamp                          Day of the week (Sunday-0, Monday-1, ...) 0-6
2108-2112(R) Target                                     None
```

```
*        *      *      STSET  *      *      *      *      X      *      INST   A      B      C      Q      N
X51PT    X51QT  X51NT  X50PT  X50H   X50QT  X50NT  X50NH  X51PP  X51QP  X51NP  X50PP  *      X50QP  X50NP  *
X51PR    X51QR  X51NR  *      *      *      *      *      *      Y      INST   A      B      C      Q      N
Y51PT    Y51QT  Y51NT  Y50PT  Y50H   Y50QT  Y50NT  Y50NH* Y51PP  Y51QP  Y51NP  Y50PP  *      Y50QP  Y50NP  *
Y51PR    Y51QR  Y51NR  *      *      *      *      *      *      XIN    YIN    ALARM  XOUT1  XOUT2  YOUT1  YOUT2
```

For SEL-501 (APP X=FDR/OC1; Y=MOT) (Binary Format):

```
2100(R)      Target Date stamp                          Month                      1-12
2101(R)      Target Date stamp                          Day of the Month           1-31
2102(R)      Target Date stamp                          Year                       0-99
2103(R)      Target Time stamp                          Hours                      0-23
2104(R)      Target Time stamp                          Minutes                    0-59
2105(R)      Target Time stamp                          Seconds                    0-59
2106(R)      Target Time stamp                          Milliseconds               0-999
2107(R)      Target Date stamp                          Day of the week (Sunday-0, Monday-1, ...) 0-6
```

2108-2112(R)	Target	None

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
X51PT	X51QT	X51NT	X50PT	X50H	X50QT	X50NT	X50NH	X51PP	X51QP	X51NP	X50PP	*	X50QP	X50NP	*
X51PR	X51QR	X51NR	*	*	*	*	*	*	Y	INST	A	B	C	Q	N
Y49	*	YSTL	Y50PT	Y50H	Y50QT	Y50NT	Y50NH	Y49A	Y50L	Y50ST	Y50PP	YLLOSS	Y50QP	Y50NP	YLJAM
*	*	*	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=FDR/OC1; Y=BFR) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Date Time stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
X1PT	X51QT	X51NT	X50PT	X50H	X50QT	X50NT	X50NH	X51PP	X51QP	X51NP	X50PP	*	X50QP	X50NP	*
X51PR	X51QR	X51NR	*	*	*	*	*	*	Y	INST	A	B	C	Q	N
Y86TR	YRTRP	Y62T	Y50PP	*	*	Y50NP	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=FDR/OC1; Y=TMR/OFF) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
X51PT	X51QT	X51NT	X50PT	X50H	X50QT	X50NT	X50NH	X51PP	X51QP	X51NP	X50PP	*	X50QP	X50NP	*
X51PR	X51QR	X51NR	*	*	*	*	*	*	Y	INST	A	B	C	Q	N
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=MOT; Y=MOT) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
X49	*	XSTL	X50PT	X50H	X50QT	X50NT	X50NH	X49A	X50L	X50ST	X50PP	XLLOSS	X50QP	X50NP	XLJAM
*	*	*	*	*	*	*	*	*	Y	INST	A	B	C	Q	N
Y49	*	YSTL	Y50PT	Y50H	Y50QT	Y50NT	Y50NH	Y49A	Y50L	Y50ST	Y50PP	YLLOSS	Y50QP	YTPNP	YLJAM
*	*	*	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=MOT; Y=BFR) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23

2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
X49	*	XSTL	X50PT	X50H	X50QT	X50NT	X50NH	X49A	X50L	X50ST	X50PP	XLLOSS	X50QP	X50NP	XLJAM
*	*	*	*	*	*	*		*	Y	INST	A	B	C	Q	N
Y86TR	YRTRP	Y62T	Y50PP	*	*	Y50NP	Y*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=MOT; Y=TMR/OFF) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
X49	*	XSTL	X50PT	X50H	X50QT	X50NT	X50NH	X49A	X50L	X50ST	X50PP	XLLOSS	X50QP	X50NP	XLJAM
*	*	*	*	*	*	*		*	Y	INST	A	B	C	Q	N
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=MOT; Y=FDR/OC1) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
X49	*	XSTL	X50PT	X50H	X50QT	X50NT	X50NH	X49A	X50L	X50ST	X50PP	XLLOSS	X50QP	X50NP	XLJAM
*	*	*	*	*	*	*		*	Y	INST	A	B	C	Q	N
Y51PT	Y51QT	Y51NT	Y50PT	Y50H	Y50QT	Y50NT	Y50NH	Y51PP	Y51QP	Y51NP	Y50PP	*	Y50QP	Y50NP	*
Y51PR	Y51QR	Y51NR	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=BFR; Y=MOT) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
X86TR	XRTRP	X62T	X50PP	*	*	X50NP	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	Y	INST	A	B	C	Q	N
Y49	*	YSTL	Y50PT	Y50H	Y50QT	Y50NT	Y50NH	Y49A	Y50L	Y50ST	Y50PP	YLLOSS	Y50QP	YTPNP	YLJAM
*	*	*	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=BFR; Y=FDR/OC1) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
X86TR	XRTRP	X62T	X50PP	*	*	X50NP	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*		*	Y	INST	A	B	C	Q	N
Y50PT	Y51QT	Y51NT	Y50PT	Y50H	Y50QT	Y50NT	Y50NH	Y50PP	Y51QP	Y51NP	Y50PP	*	Y50QP	Y50NP	*
Y50PR	Y51QR	Y51NR	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=BFR; Y=BFR) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
X86TR	XRTRP	X62T	X50PP	*	*	X50NP	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	Y	INST	A	B	C	Q	N
Y86TR	YRTRP	Y62T	Y50PP	*	*	Y50NP	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=BFR; Y=TMR/OFF) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
X86TR	XRTRP	X62T	X50PP	*	*	X50NP	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	Y	INST	A	B	C	Q	N
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=TMR/OFF; Y=FDR/OC1) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	Y	INST	A	B	C	Q	N
Y51PT	Y51QT	Y51NT	Y50PT	Y50H	Y50QT	Y50NT	Y50NH	Y51PP	Y51QP	Y51NP	Y50PP	*	Y50QP	Y50NP	*
Y51PR	Y51QR	Y51NR	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=TMR/OFF; Y=MOT) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	Y	INST	A	B	C	Q	N
Y49	*	YSTL	Y50PT	Y50H	Y50QT	Y50NT	Y50NH	Y59A	Y50L	Y50ST	Y50PP	YLLOSS	Y50QP	Y50NP	YLJAM
*	*	*	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=TMR/OFF; Y=BFR) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	Y	INST	A	B	C	Q	N
Y86TR	YRTRP	Y62T	Y50PP	*	*	Y50NP	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-501 (APP X=TMR/OFF; Y=TMR/OFF) (Binary Format):

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2112(R)	Target	None	

*	*	*	STSET	*	*	*	*	X	*	INST	A	B	C	Q	N
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	Y	INST	A	B	C	Q	N
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	XIN	YIN	ALARM	XOUT1	XOUT2	YOUT1	YOUT2

For SEL-551:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59

2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2114(R)	Target	None	

*	*	*	STSET	*	*	*	*	EN	INST	A	B	C	N	RS	LO
51P1	51P2	51N1	51G1	51P1T	51P2T	51N1T	51GIT	51Q1	51Q2	51Q1T	51Q2T	50P1	50P2	50P3	50P4
50P5	50P6	50N1	50N2	50G1	50G2	50Q1	50Q2	50A	50B	50C	IN1	IN2	OC	CC	CF
LB1	LB2	LB3	LB4	LB5	LB6	LB7	LB8	RB1	RB2	RB3	RB4	RB5	RB6	RB7	RB8
SV1	SV2	SV3	SV4	SV5	SV6	SV7	SV8	SV9	SV10	SV11	SV12	SV13	SV14	*	*
79RS	79CY	79LO	SH0	SH1	SH2	SH3	SH4	TRIP	CLOSE	51P1R	51P2R	51N1R	51G1R	51Q1R	51Q2R
SV5T	SV6T	SF7T	SV8T	SV9T	SV10T	SV11T	SV12T	SV13T	SV14T	*	ALARM	OUT1	OUT2	OUT3	OUT4

For SEL-587:

2100(R)	Target Date stamp	Month	1-12
2101(R)	Target Date stamp	Day of the Month	1-31
2102(R)	Target Date stamp	Year	0-99
2103(R)	Target Time stamp	Hours	0-23
2104(R)	Target Time stamp	Minutes	0-59
2105(R)	Target Time stamp	Seconds	0-59
2106(R)	Target Time stamp	Milliseconds	0-999
2107(R)	Target Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2108-2114(R)	Target	None	

*	*	*	STSET	STFAIL	STWARN	STEVE	STP	EN	87	50	51	A	B	C	N
51P1P	51Q1P	51N1P	51P1T	51Q1T	51N1T	*	RB1	50P1P	50Q1P	50N1P	50P1T	50Q1T	50N1T	50P1H	50N1H
51P2P	51Q2P	51N2P	51P2T	51Q2T	51N2T	*	RB2	50P2P	50Q2P	50N2P	50P2T	50Q2T	50N2T	50P2H	50N2H
87U1	87U2	87U3	87U	87R1	87R2	87R3	87R	2HB1	2HB2	2HB3	5HB1	5HB2	5HB3	87BL	RB3
TH5P	TH5T	PDEM	NDEM	QDEM	TRP1	TRP2	TRP3	OC1	OC2	CC1	CC2	IN1	IN2	52A1	52A2
MTU3	MTU2	MTU1	MER	YT	Y	XT	X	51P1R	51Q1R	51N1R	51P2R	51Q2R	51N2R	*	RB4
*	*	*	ALARM	OUT1	OUT2	OUT3	OUT4	*	*	*	*	*	*	*	*

Table G.8: Register Maps for Breaker Data, Floating-Point Type

The first eight registers of Modbus breaker data are the collection date and time stamp.

Reg.#	Description	Units	Range
For SEL-151/251,-1,-2,-3; SEL-151C/251C,-1,-2,-3; SEL-151CD/251CD,-1,-3; SEL-151D/251D,-1,-3:			
2200(R)	Breaker Date stamp	Month	1-12
2201(R)	Breaker Date stamp	Day of the Month	1-31
2202(R)	Breaker Date stamp	Year	0-99
2203(R)	Breaker Time stamp	Hours	0-23
2204(R)	Breaker Time stamp	Minutes	0-59
2205(R)	Breaker Time stamp	Seconds	0-59
2206(R)	Breaker Time stamp	Milliseconds	0-999
2207(R)	Breaker Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2208(R)	Rly Trips	None	Integer
2209(R)	Breaker Last reset Date stamp	Month	1-12
2210(R)	Breaker Last reset Date stamp	Day of the Month	1-31
2211(R)	Breaker Last reset Date stamp	Year	0-99
2212(R)	Breaker Last reset Time stamp	Hours	0-23
2213(R)	Breaker Last reset Time stamp	Minutes	0-59
2214(R)	Breaker Last reset Time stamp	Seconds	0-59
2215-2216(R)	IA	kA	IEEE Float
2217-2218(R)	IB	kA	IEEE Float
2219-2220(R)	IC	kA	IEEE Float
2221(R)	Ext Trips	None	Integer
2222(R)	Breaker Last reset Date stamp	Month	1-12
2223(R)	Breaker Last reset Date stamp	Day of the Month	1-31
2224(R)	Breaker Last reset Date stamp	Year	0-99
2225(R)	Breaker Last reset Time stamp	Hours	0-23
2226(R)	Breaker Last reset Time stamp	Minutes	0-59
2227(R)	Breaker Last reset Time stamp	Seconds	0-59
2228-2229(R)	IA	kA	IEEE Float

2230-2231(R)	IB	kA	IEEE Float
2232-2233(R)	IC	kA	IEEE Float

For SEL-279:

2200(R)	Breaker Date stamp	Month	1-12
2201(R)	Breaker Date stamp	Day of the Month	1-31
2202(R)	Breaker Date stamp	Year	0-99
2203(R)	Breaker Time stamp	Hours	0-23
2204(R)	Breaker Time stamp	Minutes	0-59
2205(R)	Breaker Time stamp	Seconds	0-59
2206(R)	Breaker Time stamp	Milliseconds	0-999
2207(R)	Breaker Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2208(R)	Rly Closures	None	Integer
2209(R)	Breaker Last reset Date stamp	Month	1-12
2210(R)	Breaker Last reset Date stamp	Day of the Month	1-31
2211(R)	Breaker Last reset Date stamp	Year	0-99
2212(R)	Breaker Last reset Time stamp	Hours	0-23
2213(R)	Breaker Last reset Time stamp	Minutes	0-59
2214(R)	Breaker Last reset Time stamp	Seconds	0-59
2215(R)	Ext Closures	None	Integer
2216(R)	Breaker Last reset Date stamp	Month	1-12
2217(R)	Breaker Last reset Date stamp	Day of the Month	1-31
2218(R)	Breaker Last reset Date stamp	Year	0-99
2219(R)	Breaker Last reset Time stamp	Hours	0-23
2220(R)	Breaker Last reset Time stamp	Minutes	0-59
2221(R)	Breaker Last reset Time stamp	Seconds	0-59

For SEL-352:

2200(R)	Breaker 2020 Date stamp	Month	1-12
2201(R)	Breaker 2020 Date stamp	Day of the Month	1-31
2202(R)	Breaker 2020 Date stamp	Year	0-99
2203(R)	Breaker 2020 Time stamp	Hours	0-23
2204(R)	Breaker 2020 Time stamp	Minutes	0-59
2205(R)	Breaker 2020 Time stamp	Seconds	0-59
2206(R)	Breaker 2020 Time stamp	Milliseconds	0-999
2207(R)	Breaker 2020 Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2208-2225(R)	FID String	None	36 char
2226(R)	Breaker Date stamp	Month	1-12
2227(R)	Breaker Date stamp	Day of the Month	1-31
2228(R)	Breaker Date stamp	Year	0-99
2229(R)	Breaker Time stamp	Hours	0-23
2230(R)	Breaker Time stamp	Minutes	0-59
2231(R)	Breaker Time stamp	Seconds	0-59
2232(R)	Breaker Time stamp	Milliseconds	0-999
2233(R)	Breaker Monitor Cleared Date stamp	Month	1-12
2234(R)	Breaker Monitor Cleared Date stamp	Day of the Month	1-31
2235(R)	Breaker Monitor Cleared Date stamp	Year	0-99
2236-2237(R)	Trip A Number of Operations	None	IEEE float
2238-2239(R)	Trip A Average Electrical Time	Milliseconds	IEEE float
2240-2241(R)	Trip A Average Mechanical Time	Milliseconds	IEEE float
2242-2243(R)	Trip A Last Electrical Time	Milliseconds	IEEE float
2244-2245(R)	Trip A Last Mechanical Time	Milliseconds	IEEE float
2246-2247(R)	Trip A Total Energy	MJoules	IEEE float
2248-2249(R)	Trip A Total Current	Amps	IEEE float
2250-2251(R)	Trip B Number of Operations	None	IEEE float
.	.	.	.
.	.	.	.
.	.	.	.
2276-2277(R)	Trip C Total Current	Amps	IEEE float
2278-2279(R)	Close A Number of Operations	None	IEEE float
2280-2281(R)	Close A Average Electrical Time	Milliseconds	IEEE float
2282-2283(R)	Close A Average Mechanical Time	Milliseconds	IEEE float
2284-2285(R)	Close A Last Electrical Time	Milliseconds	IEEE float
2286-2287(R)	Close A Last Mechanical Time	Milliseconds	IEEE float
2288-2289(R)	Close A Total Energy	MJoules	IEEE float
2290-2291(R)	Close A Total Current	Amps	IEEE float

2292-2293(R)	Close B Number of Operations	None	IEEE float
2294-2295(R)	Close B Average Electrical Time	Milliseconds	IEEE float
2296-2297(R)	Close B Average Mechanical Time	Milliseconds	IEEE float
2298-2299(R)	Close B Last Electrical Time	Milliseconds	IEEE float

(Remaining data cannot be accessed through Modbus using Float map.)

For SEL-387:

2200(R)	Breaker Date stamp	Month	1-12
2201(R)	Breaker Date stamp	Day of the Month	1-31
2202(R)	Breaker Date stamp	Year	0-99
2203(R)	Breaker Time stamp	Hours	0-23
2204(R)	Breaker Time stamp	Minutes	0-59
2205(R)	Breaker Time stamp	Seconds	0-59
2206(R)	Breaker Time stamp	Milliseconds	0-999
2207(R)	Breaker Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2208-2225(R)	Relay FID	None	36 char
2226(R)	Breaker Date stamp	Month	1-12
2227(R)	Breaker Date stamp	Day of the Month	1-31
2228(R)	Breaker Date stamp	Year	1980-2080
2229(R)	Breaker Time stamp	Hours	0-23
2230(R)	Breaker Time stamp	Minutes	0-59
2231(R)	Breaker Time stamp	Seconds	0-59
2232(R)	Breaker Time stamp	Milliseconds	0-999
2233(R)	Breaker Number	None	1-4
2234(R)	Internal Trip Count	None	0-32767
2235-2236(R)	IA Internal	kA, primary	IEEE float
2237-2238(R)	IB Internal	kA, primary	IEEE float
2239-2240(R)	IC Internal	kA, primary	IEEE float
2241(R)	External Trip Count	None	0-32767
2242-2243(R)	IA External	kA, primary	IEEE float
2244-2245(R)	IB External	kA, primary	IEEE float
2246-2247(R)	IC External	kA, primary	IEEE float
2248(R)	Pole1 Wear	percent	0-100
2249(R)	Pole2 Wear	percent	0-100
2250(R)	Pole3 Wear	percent	0-100
2251(R)	Last Reset Date Stamp	Month	1-12
2252(R)	Last Reset Date Stamp	Day of the Month	1-31
2253(R)	Last Reset Date Stamp	Year	1980-2080
2254(R)	Last Reset Time Stamp	Hours	0-23
2255(R)	Last Reset Time Stamp	Minutes	0-59
2256(R)	Last Reset Time Stamp	Seconds	0-59
2257(R)	Last Reset Time Stamp	Milliseconds	0-999

For SEL-501,-1,-2:

2200(R)	Breaker Date stamp	Month	1-12
2201(R)	Breaker Date stamp	Day of the Month	1-31
2202(R)	Breaker Date stamp	Year	0-99
2203(R)	Breaker Time stamp	Hours	0-23
2204(R)	Breaker Time stamp	Minutes	0-59
2205(R)	Breaker Time stamp	Seconds	0-59
2206(R)	Breaker Time stamp	Milliseconds	0-999
2207(R)	Breaker Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2208(R)	Internal Trips X	None	Integer
2209-2210(R)	IA	kA	IEEE float
2211-2212(R)	IB	kA	IEEE float
2213-2214(R)	IC	kA	IEEE float
2215(R)	External Trips X	None	Integer
2216-2217(R)	IA	kA	IEEE float
2218-2219(R)	IB	kA	IEEE float
2220-2221(R)	IC	kA	IEEE float
2222(R)	Internal Trips Y	None	Integer
2223-2224(R)	IA	kA	IEEE float
2225-2226(R)	IB	kA	IEEE float
2227-2228(R)	IC	kA	IEEE float
2229(R)	External Trips Y	None	Integer
2230-2231(R)	IA	kA	IEEE float

2232-2233(R)	IB	kA	IEEE float
2234-2235(R)	IC	kA	IEEE float

Table G.9: Register Maps for Breaker Data, Integer Type

The first eight registers of Modbus breaker data are the collection date and time stamp.

Reg.#	Description	Units	Range
For SEL-151/251,-1,-2,-3; SEL-151C/251C,-1,-2,-3; SEL-151CD/251CD,-1,-3; SEL-151D/251D,-1,-3:			
2200(R)	Breaker Date stamp	Month	1-12
2201(R)	Breaker Date stamp	Day of the Month	1-31
2202(R)	Breaker Date stamp	Year	0-99
2203(R)	Breaker Time stamp	Hours	0-23
2204(R)	Breaker Time stamp	Minutes	0-59
2205(R)	Breaker Time stamp	Seconds	0-59
2206(R)	Breaker Time stamp	Milliseconds	0-999
2207(R)	Breaker Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2208(R)	Rly Trips	None	Integer
2209(R)	Breaker Last reset Date stamp	Month	1-12
2210(R)	Breaker Last reset Date stamp	Day of the Month	1-31
2211(R)	Breaker Last reset Date stamp	Year	0-99
2212(R)	Breaker Last reset Time stamp	Hours	0-23
2213(R)	Breaker Last reset Time stamp	Minutes	0-59
2214(R)	Breaker Last reset Time stamp	Seconds	0-59
2215(R)	IA	kA/10, primary	0.00-3276.7 kA, pri
2216(R)	IB	kA/10, primary	0.00-3276.7 kA, pri
2217(R)	IC	kA/10, primary	0.00-3276.7 kA, pri
2218(R)	Ext Trips	None	Integer
2219(R)	Breaker Last reset Date stamp	Month	1-12
2220(R)	Breaker Last reset Date stamp	Day of the Month	1-31
2221(R)	Breaker Last reset Date stamp	Year	0-99
2222(R)	Breaker Last reset Time stamp	Hours	0-23
2223(R)	Breaker Last reset Time stamp	Minutes	0-59
2224(R)	Breaker Last reset Time stamp	Seconds	0-59
2225(R)	IA	kA/10, primary	0.00-3276.7 kA, pri
2226(R)	IB	kA/10, primary	0.00-3276.7 kA, pri
2227(R)	IC	kA/10, primary	0.00-3276.7 kA, pri
For SEL-279:			
2200(R)	Breaker Date stamp	Month	1-12
2201(R)	Breaker Date stamp	Day of the Month	1-31
2202(R)	Breaker Date stamp	Year	0-99
2203(R)	Breaker Time stamp	Hours	0-23
2204(R)	Breaker Time stamp	Minutes	0-59
2205(R)	Breaker Time stamp	Seconds	0-59
2206(R)	Breaker Time stamp	Milliseconds	0-999
2207(R)	Breaker Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2208(R)	Rly Closures	None	Integer
2209(R)	Breaker Last reset Date stamp	Month	1-12
2210(R)	Breaker Last reset Date stamp	Day of the Month	1-31
2211(R)	Breaker Last reset Date stamp	Year	0-99
2212(R)	Breaker Last reset Time stamp	Hours	0-23
2213(R)	Breaker Last reset Time stamp	Minutes	0-59
2214(R)	Breaker Last reset Time stamp	Seconds	0-59
2215(R)	Ext Closures	None	Integer
2216(R)	Breaker Last reset Date stamp	Month	1-12
2217(R)	Breaker Last reset Date stamp	Day of the Month	1-31
2218(R)	Breaker Last reset Date stamp	Year	0-99
2219(R)	Breaker Last reset Time stamp	Hours	0-23
2220(R)	Breaker Last reset Time stamp	Minutes	0-59
2221(R)	Breaker Last reset Time stamp	Seconds	0-59

For SEL-352:

2200(R)	Breaker 2020 Date stamp	Month	1-12
2201(R)	Breaker 2020 Date stamp	Day of the Month	1-31
2202(R)	Breaker 2020 Date stamp	Year	0-99
2203(R)	Breaker 2020 Time stamp	Hours	0-23
2204(R)	Breaker 2020 Time stamp	Minutes	0-59
2205(R)	Breaker 2020 Time stamp	Seconds	0-59
2206(R)	Breaker 2020 Time stamp	Milliseconds	0-999
2207(R)	Breaker 2020 Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2208-2225(R)	FID String	None	36 char
2226(R)	Breaker Date stamp	Month	1-12
2227(R)	Breaker Date stamp	Day of the Month	1-31
2228(R)	Breaker Date stamp	Year	0-99
2229(R)	Breaker Time stamp	Hours	0-23
2230(R)	Breaker Time stamp	Minutes	0-59
2231(R)	Breaker Time stamp	Seconds	0-59
2232(R)	Breaker Time stamp	Milliseconds	0-999
2233(R)	Breaker Monitor Cleared Date stamp	Month	1-12
2234(R)	Breaker Monitor Cleared Date stamp	Day of the Month	1-31
2235(R)	Breaker Monitor Cleared Date stamp	Year	0-99
2236(R)	Trip A Number of Operations	None	Integer
2237(R)	Trip A Average Electrical Time	Milliseconds	Integer
2238(R)	Trip A Average Mechanical Time	Milliseconds	Integer
2239(R)	Trip A Last Electrical Time	Milliseconds	Integer
2240(R)	Trip A Last Mechanical Time	Milliseconds	Integer
2241(R)	Trip A Total Energy	MJoules	0-32767 MJ
2242(R)	Trip A Total Current	Amps	0-32767 A, pri
2243(R)	Trip B Number of Operations	None	Integer
.	.	.	.
.	.	.	.
.	.	.	.
2256(R)	Trip C Total Current	Amps	0-32767 A, pri
2257(R)	Close A Number of Operations	None	Integer
2258(R)	Close A Average Electrical Time	Milliseconds	Integer
2259(R)	Close A Average Mechanical Time	Milliseconds	Integer
2260(R)	Close A Last Electrical Time	Milliseconds	Integer
2261(R)	Close A Last Mechanical Time	Milliseconds	Integer
2262(R)	Close A Total Energy	MJoules	0-32767 MJ
2263(R)	Close A Total Current	Amps	0-32767 A, pri
2264(R)	Close B Number of Operations	None	Integer
.	.	.	.
.	.	.	.
.	.	.	.
2277(R)	Close C Total Current	Amps	0-32767 A, pri
2278-2283(R)	Number of Operations Label	None	12 char
2284-2289(R)	Avg Electrical Time Label	None	12 char
2290-2295(R)	Avg Mechanical Time Label	None	12 char
2296-2299(R)	Last Electrical Time Label	None	12 char

(Remaining data cannot be accessed through Modbus.)

For SEL-387:

2200(R)	Breaker Date stamp	Month	1-12
2201(R)	Breaker Date stamp	Day of the Month	1-31
2202(R)	Breaker Date stamp	Year	0-99
2203(R)	Breaker Time stamp	Hours	0-23
2204(R)	Breaker Time stamp	Minutes	0-59
2205(R)	Breaker Time stamp	Seconds	0-59
2206(R)	Breaker Time stamp	Milliseconds	0-999
2207(R)	Breaker Date stamp	Day of the week (Sunday-0, Monday-1, ...)	0-6
2208-2225(R)	Relay FID	None	36 char
2226(R)	Breaker Date stamp	Month	1-12
2227(R)	Breaker Date stamp	Day of the Month	1-31
2228(R)	Breaker Date stamp	Year	1980-2080
2229(R)	Breaker Time stamp	Hours	0-23
2230(R)	Breaker Time stamp	Minutes	0-59
2231(R)	Breaker Time stamp	Seconds	0-59

2232(R)	Breaker Time stamp	Milliseconds	0-999
2233(R)	Breaker Number	None	1-4
2234(R)	Internal Trip Count	None	0-32767
2235(R)	IA Internal	kA/10, primary	0-3276.7 kA, pri
2236(R)	IB Internal	kA/10, primary	0-3276.7 kA, pri
2237(R)	IC Internal	kA/10, primary	0-3276.7 kA, pri
2238(R)	External Trip Count	None	0-32767
2239(R)	IA External	kA/10, primary	0-3276.7 kA, pri
2240(R)	IB External	kA/10, primary	0-3276.7 kA, pri
2241(R)	IC External	kA/10, primary	0-3276.7 kA, pri
2242(R)	Pole1 Wear	percent	0-100
2243(R)	Pole2 Wear	percent	0-100
2244(R)	Pole3 Wear	percent	0-100
2245(R)	Last Reset Date Stamp	Month	1-12
2246(R)	Last Reset Date Stamp	Day of the Month	1-31
2247(R)	Last Reset Date Stamp	Year	1980-2080
2248(R)	Last Reset Time Stamp	Hours	0-23
2249(R)	Last Reset Time Stamp	Minutes	0-59
2250(R)	Last Reset Time Stamp	Seconds	0-59
2251(R)	Last Reset Time Stamp	Milliseconds	0-999

For SEL-501,-1,-2:

2200(R)	Breaker Date stamp	Month	1-12
2201(R)	Breaker Date stamp	Day of the Month	1-31
2202(R)	Breaker Date stamp	Year	0-99
2203(R)	Breaker Time stamp	Hours	0-23
2204(R)	Breaker Time stamp	Minutes	0-59
2205(R)	Breaker Time stamp	Seconds	0-59
2206(R)	Breaker Time stamp	Milliseconds	0-999
2207(R)	Breaker Time stamp	Day of the week (Sunday-0, Monday-1, ...) 0-6	
2208(R)	Internal Trips X	None	Integer
2209(R)	IA	kA/10, primary	0.00-3276.7 kA, pri
2210(R)	IB	kA/10, primary	0.00-3276.7 kA, pri
2211(R)	IC	kA/10, primary	0.00-3276.7 kA, pri
2212(R)	External Trips X	None	Integer
2213(R)	IA	kA/10, primary	0.00-3276.7 kA, pri
2214(R)	IB	kA/10, primary	0.00-3276.7 kA, pri
2215(R)	IC	kA/10, primary	0.00-3276.7 kA, pri
2216(R)	Internal Trips Y	None	Integer
2217(R)	IA	kA/10, primary	0.00-3276.7 kA, pri
2218(R)	IB	kA/10, primary	0.00-3276.7 kA, pri
2219(R)	IC	kA/10, primary	0.00-3276.7 kA, pri
2220(R)	External Trips Y	None	Integer
2221(R)	IA	kA/10, primary	0.00-3276.7 kA, pri
2222(R)	IB	kA/10, primary	0.00-3276.7 kA, pri
2223(R)	IC	kA/10, primary	0.00-3276.7 kA, pri

Table G.10: Register Map for User Data

Reg.#	Description	Units	Range
2400(R)	First User Register	---	---
.	.	.	.
.	.	.	.
.	.	.	.
4446(R)	Last User Register	---	---

Note: The actual number of user region registers available depends on the SET A USER setting on the port.

APPENDIX H: SEL-2020 CONFIGURATION AND *FAST OPERATE* COMMANDS

OVERVIEW

This appendix describes the binary commands supported on SEL-2020 master ports using SEL protocol with FAST_OP=Y. There are three types of commands supported: device definition, *Fast Operate* configuration, and *Fast Operate* commands. See *Application Guide AG95-10: Configuration and Fast Meter Messages* to see how these commands relate to the general SEL binary command definitions.

DEVICE DEFINITION

The device definition can be found in response to the A5C0h command. It will have the following format:

A5C0	Command
0E	Message length (14 bytes)
03	Support three protocols
00	Does not support *Fast Meter* messages
00	Does not support status flag commands
0100	Supports SEL protocol with *Fast Operate* commands
0001	Supports LMD protocol without *Fast Operate* commands
0002	Supports Modbus protocol
00	Pad byte
xx	Checksum

FAST OPERATE CONFIGURATION

The *Fast Operate* Configuration information is returned in response to the A5CFh command. It has the following format:

A5CF	Command
0C	Message length (12 bytes)
10	16 ports in SEL-2020
10	16 breakers per port supported
10	16 remote bits per port supported
A5E5	*Fast Operate* command to open a breaker
A5E6	*Fast Operate* command to close a breaker
A5E8	*Fast Operate* command to clear a remote bit
A5E7	*Fast Operate* command to set a remote bit
00	Pad byte
xx	Checksum

FAST OPERATE COMMANDS

Using the SEL-2020 *Fast Operate* commands, you can set or clear any of the 256 breaker and 256 remote bits within the SEL-2020. The impact of these bits depends on whether or not they are used in SELOGIC and whether or not they are used to trigger issuing of operate commands. See ***Section 6: Settings*** for more information.

Upon receipt of a *Fast Operate* message, the SEL-2020 will set the appropriate bit within 100 milliseconds.

All SEL-2020 *Fast Operate* commands have the following format:

Bytes	Usage
2	Command (one of A5E5, A5E6, A5E7, A5E8)
1	Message length - always 8
2	Operate Code - upper byte is port number (1-16); lower byte is bit number (1-16)
2	Operation Validation Code: (4 * Operate Code) + 1
1	Checksum

APPENDIX I: DISTRIBUTED NETWORK PROTOCOL (DNP) V3.00

OVERVIEW

The SEL-2020 supports DNP V3.00 Level 2 protocol on Port 16. It can be used for data access and for control. For a complete description of this protocol refer to the *DNP Basic Four Documentation Set* and the *DNP V3.00 Subset Definition*, both of which are available from the DNP User's Group.

INSTALLATION

If you are using the SEL-2020 in a point-to-point DNP connection, simply connect Port 16 to your DNP master. If you are using the SEL-2020 in a multi-drop configuration, you will need to connect a transceiver to Port 16. If the transceiver has a Carrier Detect signal, connect it to Port 16's CTS input. Otherwise connect RTS to CTS at Port 16. If the transceiver requires a signal to enable its transmitter, the RTS output on Port 16 can be used for that function.

CONFIGURATION

Section 6: Settings lists all of the DNP related settings and their functions. In order to optimally configure the SEL-2020 for DNP operation, you will need to understand the basics of DNP and the capabilities of your DNP master.

Data-Link Operation

There are two important decisions you need to make about your data-link layer operation. One is how you want to handle data-link confirmation. The other is how you want to handle data-link access.

If you have a highly reliable communication link, you can disable data-link confirmation altogether, which significantly reduces communications overhead. Otherwise, you will need to enable confirmation, determine how many retries you want to allow, and what the data-link timeout should be. The noisier your communications channel is, the more likely it is that a message will be corrupted. Thus, you should set your number of retries higher on noisy channels. Set the data-link timeout long enough to allow for the worst-case response of your master plus transmission time.

When the SEL-2020 decides to transmit on the DNP link, it has to wait if the physical connection is in use. The SEL-2020 monitors physical connections by using both its CTS input (treated as a carrier detect) and by monitoring character receipt. Once the physical link goes idle, as indicated by CTS being deasserted and no characters being received, the SEL-2020 will wait a configurable amount of time before beginning a transmission. This hold-off time will be a random time between the MIN_DELAY and MAX_DELAY setting values. This hold-off is random so multiple devices waiting to communicate on the network will not continually collide.

Data Access Method

Based on the capabilities of your system, you will need to determine how you want to retrieve data on your DNP connection. The following table summarizes the main options, from least to most efficient, and indicates the key related settings.

Table I.1: Data Access Methods

Data Retrieval Method	Description	Relevant SEL-2020 Settings
Polled Static	The master polls for static (Class 0) data only.	Set CLASS = 0, Set UNSOL_REP = N.
Polled Report-by-Exception	The master polls frequently for event data and occasionally for static data.	Set CLASS to a non-zero value, Set UNSOL_REP = N.
Unsolicited Report-by-Exception	The slave devices send unsolicited event data to the master and the master occasionally sends integrity polls for static data.	Set CLASS to a non-zero value, Set UNSOL_REP = Y, Set NUM_EVENT and AGE_TX according to how often you want messages sent.
Quiescent	The master never polls and relies on unsolicited reports only.	Set CLASS to a non-zero value, Set UNSOL_REP = Y, Set NUM_EVENT and AGE_TX according to how often you want messages sent.

DEVICE PROFILE

Device Profile Document

As required by the *DNP V3.00 Subset Definitions* document, below is the device profile.

DNP V3.00 **DEVICE PROFILE DOCUMENT** This document must be accompanied by a table having the following headings: Object Group / Request Function Codes / Response Function Codes Object Variation / Request Qualifiers / Response Qualifiers Object Name (optional)
Vendor Name: **Schweitzer Engineering Laboratories, Inc.**
Device Name: **SEL-2020 Communications Processor**

Highest DNP Level Supported: For Requests **Level 2** For Responses **Level 2**	Device Function: ☐ Master ☑ Slave
Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table): <u>Supports enabling and disabling of unsolicited reports on a class basis</u>	
Maximum Data Link Frame Size (octets): Transmitted <u>292</u> Received (must be 292)	Maximum Application Fragment Size (octets): Transmitted <u>2048</u> (if >2048, must be configurable) Received <u>2048</u> (must be >= 249)
Maximum Data Link Re-tries: ☐ None ☐ Fixed at ______ ☑ Configurable, range <u>0</u> to <u>15</u>	Maximum Application Layer Re-tries: ☑ None ☐ Configurable, range _____ to (Fixed is not permitted)
Requires Data Link Layer Confirmation: ☐ Never ☐ Always ☐ Sometimes If 'Sometimes', when? ______ ☑ Configurable If 'Configurable', how? <u>by settings; see ***Section 6: Settings***</u>	
Requires Application Layer Confirmation: ☐ Never ☐ Always (not recommended) ☑ When reporting Event Data (Slave devices only) ☐ When sending multi-fragment responses (Slave devices only) ☐ Sometimes If 'Sometimes', when? ______ ☐ Configurable If 'Configurable', how? ______	

Timeouts while waiting for:

Data Link Confirm	☐ None	☐ Fixed at ______	☐ Variable	☑ Configurable
Complete Appl. Fragment	☑ None	☐ Fixed at ______	☐ Variable	☐ Configurable
Application Confirm	☐ None	☐ Fixed at ______	☐ Variable	☑ Configurable
Complete Appl. Response	☑ None	☐ Fixed at ______	☐ Variable	☐ Configurable

Others ______

Attach explanation if 'Variable' or 'Configurable' was checked for any timeout

Sends/Executes Control Operations:

WRITE Binary Outputs	☐ Never	☑ Always	☐ Sometimes	☐ Configurable
SELECT/OPERATE	☐ Never	☑ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE	☐ Never	☑ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE - NO ACK	☐ Never	☑ Always	☐ Sometimes	☐ Configurable
Count > 1	☑ Never	☐ Always	☐ Sometimes	☐ Configurable
Pulse On	☐ Never	☑ Always	☐ Sometimes	☐ Configurable
Pulse Off	☐ Never	☑ Always	☐ Sometimes	☐ Configurable
Latch On	☐ Never	☑ Always	☐ Sometimes	☐ Configurable
Latch Off	☐ Never	☑ Always	☐ Sometimes	☐ Configurable
Queue	☑ Never	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☑ Never	☐ Always	☐ Sometimes	☐ Configurable

Attach explanation if 'Sometimes' or 'Configurable' was checked for any operation.

FILL OUT THE FOLLOWING ITEM FOR MASTER DEVICES ONLY:

Expects Binary Input Change Events:

- ☐ Either time-tagged or non-time-tagged for a single event
- ☐ Both time-tagged and non-time-tagged for a single event
- ☐ Configurable (attach explanation)

FILL OUT THE FOLLOWING ITEMS FOR SLAVE DEVICES ONLY

Reports Binary Input Change Events when no specific variation requested:

- ☐ Never
- ☐ Only time-tagged
- ☑ Only non-time-tagged
- ☐ Configurable to send both, one or the other (attach explanation)

Reports time-tagged Binary Input Change Events when no specific variation requested:

- ☑ Never
- ☐ Binary Input Change With Time
- ☐ Binary Input Change With Relative Time
- ☐ Configurable (attach explanation)

Sends Unsolicited Responses:

- ☐ Never
- ☑ Configurable (attach explanation)
- ☐ Only certain objects
- ☐ Sometimes (attach explanation)
- ☑ ENABLE/DISABLE UNSOLICITED

Function codes supported

Sends Static Data in Unsolicited Responses:

- ☑ Never
- ☐ When Device Restarts
- ☐ When Status Flags Change

No other options are permitted.

Default Counter Object/Variation:

- ☐ No Counters Reported
- ☐ Configurable (attach explanation)
- ☑ Default Object 20
- ☐ Default Variation 6
- ☐ Point-by-point list attached

Counters Roll Over at:

- ☐ No Counters Reported
- ☐ Configurable (attach explanation)
- ☑ 16 Bits
- ☐ 32 Bits
- ☐ Other Value ______________
- ☐ Point-by-point list attached

Sends Multi-Fragment Responses: ☐ Yes ☑ No

In all cases within the device profile that an item is configurable, it is controlled by the SEL-2020 settings. See the previous subsection and ***Section 6: Settings*** for more information.

OBJECT TABLE

Unsolicited DNP messages always format the data objects for the default variation. Default variations are indicated in the table by an asterisk (*).

Table I.2: Object Table

OBJECT			REQUEST (supported)		RESPONSE (may generate)	
Obj	**Var** *def	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**
1	0	Binary Input - All Variations	1	6		
1	1	Binary Input	1	0,1,6,7,8	129	0,1,7,8
1	2*	Binary Input with Status	1	0,1,6,7,8	129	0,1,7,8
2	0	Binary Input Change - All Variations	1	6,7,8		
2	1*	Binary Input Change without Time	1	6,7,8	129,130	17,28
2	2	Binary Input Change with Time	1	6,7,8	129	17,28
2	3	Binary Input Change with Relative Time	1	6,7,8	129	17,28
10	0	Binary Output - All Variations	1	6		
10	1	Binary Output				
10	2*	Binary Output Status	1	0,1,6	129	0,1
12	0	Control Block - All Variations				
12	1	Control Relay Output Block	3,4,5,6	17, 28	129	echo of request
12	2	Pattern Control Block				
12	3	Pattern Mask				
20	0	Binary Counter - All Variations	1	6		
20	1	32-Bit Binary Counter				
20	2	16-Bit Binary Counter				
20	3	32-Bit Delta Counter				
20	4	16-Bit Delta Counter				
20	5	32-Bit Binary Counter without Flag	1	0,1,6,7,8	129	0,1,7,8
20	6*	16-Bit Binary Counter without Flag	1	0,1,6,7,8	129	0,1,7,8
20	7	32-Bit Delta Counter without Flag				
20	8	16-Bit Delta Counter without Flag				
21	0	Frozen Counter - All Variations				
21	1	32-Bit Frozen Counter				
21	2	16-Bit Frozen Counter				
21	3	32-Bit Frozen Delta Counter				
21	4	16-Bit Frozen Delta Counter				
21	5	32-Bit Frozen Counter with Time of Freeze				
21	6	16-Bit Frozen Counter with Time of Freeze				

OBJECT			REQUEST (supported)		RESPONSE (may generate)	
Obj	Var *def	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes (dec)	Qual Codes (hex)
21	7	32-Bit Frozen Delta Counter with Time of Freeze				
21	8	16-Bit Frozen Delta Counter with Time of Freeze				
21	9	32-Bit Frozen Counter without Flag				
21	10	16-Bit Frozen Counter without Flag				
21	11	32-Bit Frozen Delta Counter without Flag				
21	12	16-Bit Frozen Delta Counter without Flag				
22	0	Counter Change Event - All Variations	1	6		
22	1	32-Bit Counter Change Event without Time	1	6,7,8	129	17,28
22	2*	16-Bit Counter Change Event without Time	1	6,7,8	129,130	17,28
22	3	32-Bit Delta Counter Change Event without Time				
22	4	16-Bit Delta Counter Change Event without Time				
22	5	32-Bit Counter Change Event with Time	1	6,7,8	129	17,28
22	6	16-Bit Counter Change Event with Time	1	6,7,8	129	17,28
22	7	32-Bit Delta Counter Change Event with Time				
22	8	16-Bit Delta Counter Change Event with Time				
23	0	Frozen Counter Event - All Variations				
23	1	32-Bit Frozen Counter Event without Time				
23	2	16-Bit Frozen Counter Event without Time				
23	3	32-Bit Frozen Delta Counter Event without Time				
23	4	16-Bit Frozen Delta Counter Event without Time				
23	5	32-Bit Frozen Counter Event with Time				
23	6	16-Bit Frozen Counter Event with Time				
23	7	32-Bit Frozen Delta Counter Event with Time				
23	8	16-Bit Frozen Delta Counter Event with Time				
30	0	Analog Input - All Variations	1	6		
30	1	32-Bit Analog Input	1	0,1,6,7,8	129	0,1,7,8
30	2	16-Bit Analog Input	1	0,1,6,7,8	129	0,1,7,8
30	3*	32-Bit Analog Input without Flag	1	0,1,6,7,8	129	0,1,7,8
30	4*	16-Bit Analog Input without Flag	1	0,1,6,7,8	129	0,1,7,8
31	0	Frozen Analog Input - All Variations				
31	1	32-Bit Frozen Analog Input				
31	2	16-Bit Frozen Analog Input				
31	3	32-Bit Frozen Analog Input with Time of Freeze				

OBJECT			REQUEST (supported)		RESPONSE (may generate)	
Obj	**Var** *def	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**
31	4	16-Bit Frozen Analog Input with Time of Freeze				
31	5	32-Bit Frozen Analog Input without Flag				
31	6	16-Bit Frozen Analog Input without Flag				
32	0	Analog Change Event - All Variations	1	6,7,8		
32	1*	32-Bit Analog Change Event without Time	1	6,7,8	129,130	17,28
32	2*	16-Bit Analog Change Event without Time	1	6,7,8	129,130	17,28
32	3	32-Bit Analog Change Event with Time	1	6,7,8	129	17,28
32	4	16-Bit Analog Change Event with Time	1	6,7,8	129	17,28
33	0	Frozen Analog Event - All Variations				
33	1	32-Bit Frozen Analog Event without Time				
33	2	16-Bit Frozen Analog Event without Time				
33	3	32-Bit Frozen Analog Event with Time				
33	4	16-Bit Frozen Analog Event with Time				
40	0	Analog Output Status - All Variations	1	0,1,6		
40	1	32-Bit Analog Output Status	1	0,1,6,7,8	129	0,1,7,8
40	2*	16-Bit Analog Output Status	1	0,1,6,7,8	129	0,1,7,8
41	0	Analog Output Block - All Variations				
41	1	32-Bit Analog Output Block				
41	2	16-Bit Analog Output Block	3,4,5,6	17,28	129	echo of request
50	0	Time and Date - All Variations				
50	1	Time and Date	2	07, quan-tity=1		
			1	07, quan-tity=1	129	07, quan-tity=1
50	2	Time and Date with Interval				
51	0	Time and Date CTO - All Variations				
51	1	Time and Date CTO				
51	2	Unsynchronized Time and Date CTO				07, quan-tity=1
52	0	Time Delay - All Variations				
52	1	Time Delay Coarse				
52	2	Time Delay Fine			129	07, quan-tity=1
60	0					
60	1	Class 0 Data	1	06		
60	2	Class 1 Data	1,20,21	06,07,08		
60	3	Class 2 Data	1,20,21	06,07,08		
60	4	Class 3 Data	1,20,21	06,07,08		
70	1	File Identifier				

OBJECT			REQUEST (supported)		RESPONSE (may generate)	
Obj	**Var** *def	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes (dec)**	**Qual Codes (hex)**
80	1	Internal Indications	2	00, index=7		
81	1	Storage Object				
82	1	Device Profile				
83	1	Private Registration Object				
83	2	Private Registration Object Descriptor				
90	1	Application Identifier				
100	1	Short Floating Point				
100	2	Long Floating Point				
100	3	Extended Floating Point				
101	1	Small Packed Binary-Coded Decimal				
101	2	Medium Packed Binary-Coded Decimal				
101	3	Large Packed Binary-Coded Decimal				
		No object	13,14			

OBJECT DEFINITIONS

Input Objects

Binary input, counter, and analog input objects are fully configurable by the user. To make data visible to DNP, it must be moved to the User region on port 16 using the SET M process to establish what data is moved and how it is to be treated. ***See Section 6: Settings*** for more information on using SET M. To determine the DNP map once these settings are in place, use the DNPMAP command. ***See Section 5: Commands*** for more information on this command.

Since the only data visible to DNP is that moved by SET M, the event time stamps associated with changed data are the timestamps of when the data changed within the User region. This may be significantly delayed from when the data item changed within the IED. Therefore, event timestamps should not be used for precise sequence-of-events purposes, but it may be used for approximate timing.

Output Objects

There are 1300 binary output objects supported, of which only the first 84 are readable. Within the control relay output block used to control the binary outputs, only the code field within the control code byte is used; all other fields are ignored. The Latch On/Off and Pulse On/Off codes can be used with each binary output object, however their meaning is specific to the item, as shown in Table I.3. For more information on these bits, see ***Section 9: Database***. The first 8 bits are in the Global region and the remaining ones are in the Local region.

Table I.3: Binary Output Object Operations

Relative Index	Bit Label	Operation Code			
		Latch On	Latch Off	Pulse On	Pulse Off
0-7	R1-R8	Set	Clear	Set	Clear
0-7	CMD1-CMD8	Set	Do nothing	Set	Do nothing
8-11	SBO1-SBO4	Set	Do nothing	Set	Do nothing
12-27	SBR1-SBR16	Set	Do nothing	Set	Do nothing
28-43	SRB1-SRB16	Set	Do nothing	Set	Do nothing
44-59	CBR1-CBR16	Set	Do nothing	Set	Do nothing
60-75	CRB1-CRB16	Set	Do nothing	Set	Do nothing

Table I.4 lists the complete output object references. Use the relative indexes from Table I.3 to determine specific bit locations. Objects 8-83 are unique from other objects because the actual port being mapped to is determined by the analog output object. This yields two ways in which binary output objects can be operated: directly using indexes 0-7 and 84-1299 or by reference by writing to analog output object 0 and binary output object 8-83 at the same time. The bits can only be read using the analog output object to select the data to read.

Table I.4: Binary Output Objects

Index Range	Applicable Port	Covered Bits
0-7	N/A	R1-R8
8-83	Selected by Analog Object Index 0	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
84-159	Port 1	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
160-235	Port 2	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
236-311	Port 3	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
312-387	Port 4	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
388-463	Port 5	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
464-539	Port 6	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
540-615	Port 7	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
616-691	Port 8	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
692-767	Port 9	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
768-843	Port 10	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
844-919	Port 11	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
920-995	Port 12	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
996-1071	Port 13	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
1072-1147	Port 14	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
1148-1223	Port 15	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16
1224-1299	Port 16	CMD1-CMD8, SBO1-SBO4, SBR1-SBR16, SRB1-SRB16, CBR1-CBR16, CRB1-CRB16

Internal Indication Object

Within the Internal Indications (IIN) object, the bits are used as specified within the DNP standard. When TIME_SRC=DNP within the Global settings, the SEL-2020 requests time synchronization every 15 minutes. Bit 4 within the IIN object will be set and remain set until the SEL-2020 receives a time synchronization. If the SEL-2020 receives a time synchronization, it will clear the bit and then set it again 15 minutes later. The SEL-2020 does not have local/remote states, so the local/remote bit indicates whether or not SELOGIC is running. If SELOGIC is not running, the status is indicated as local since the DNP data will not be updated by SET M while SELOGIC is not running.

TIMING

Maximum data-link response time (without confirmation): 150 milliseconds.
Maximum class 0 request response time (without confirmation): 300 milliseconds.
Maximum data-link confirm time: 150 milliseconds.
Maximum application confirm time (without data-link confirmation): 150 milliseconds.

TIME SYNCHRONIZATION

When TIME_SRC=DNP within the Global settings, you can perform Time Synchronization via DNP by executing a write to the Date/Time object (object 50). The DNP protocol assumes that the time value sent by the master device is the time at which the first bit of the first byte of the write request is received by the slave (SEL-2020). It is the responsibility of the master to account for transmission delay between sending the request and the SEL-2020 receipt of the request. In many systems this transmission delay will be 0. For example, in a simple point-to-point connection, the moment the first bit is transmitted by the master, it is received by the slave device. In configurations where the communication link may introduce delays, the master may perform a Delay Measurement command and then calculate the transmission delay based on the result of the Delay Measurement. The master can then add this calculated transmission delay time to the time value that it sends to the SEL-2020 when it writes the time. When time synchronization is performed, the SEL-2020 will synchronize itself to within 5 milliseconds (+3/-2) of the given time. When the Delay Measurement command is performed, the value reported by the SEL-2020 is accurate to 10 milliseconds (+5/-5). So, disregarding errors external to the SEL-2020, a time synchronization that uses a Delay Measurement calculation is accurate to within 15 milliseconds (+8/-7).

"JOB DONE" EXAMPLE

This example demonstrates how to configure the SEL-2020 to provide data to a DNP master. For this example we will have two SEL-121F relays connected to the SEL-2020, on ports 1 and 2. The following procedure explains how to set the SEL-2020 and collect data.

1. Connect the two relays to ports 1 and 2 of the SEL-2020. Establish basic communications settings to the first relay by auto-configuring it using the SET P 1 command. Use SET A 1 to enable operate control and to collect meter and target data. Use COPY 1 2 with auto-configuration to establish settings with the second relay.

2. Determine how you want to operate the DNP connection and configure it using SET P 1. For this example we will assume polled static operation only.

```
*>>SET P 16<ENTER>

Port communications settings for Port 16


Device Type (U=Unused, S=SEL IED, O=Other IED,
             P=Printer, M=Master)              DEVICE  = S     ? M<ENTER>

Communications Type (S=SEL, L=LMD, M=MODBUS, D=DNP)PROTOCOL= S     ? D<ENTER>

DNP Address (0-65534 or 0-FFFEh)             ADDRESS = 0     ? 5<ENTER>

Class for event data (0 for no event data,1,2,3)CLASS   = 2     ? 0<ENTER>             1

Use 16 or 32-bit default variations for analog inputs (16/32)16BIT   = 32    ? 16<ENTER>      2

Select/Operate time-out interval, seconds (0.0-30.0)SO_TIMEOUT= 1.0   ? <ENTER>         3

Number of data-link retries (0 for no confirmation, 1-15)DL_CONFIRM= 3     ? 0<ENTER>

Minimum Delay from DCD to transmission (0-1000 msec)MIN_DELAY= 50    ? <ENTER>

Maximum Delay from DCD to transmission (0-1000 msec)MAX_DELAY= 100   ? <ENTER>

Transmission delay from RTS assertion (0-30000 milliseconds) SETTLE1=0 ? <ENTER>

Post-transmit RTS de-assertion delay (0-30000 milliseconds) SETTLE2=0 ? <ENTER>

Allow Unsolicited Reporting (Y/N)            UNSOL_REP= N     ? <ENTER>

Port Identification String
PORTID  =""
 ? DNP port<ENTER>


Communications Settings

Baud Rate (300, 600, 1200, 2400, 4800, 9600,
           19200, 38400)                     BAUD    = 9600  ? <ENTER>


Transparent Communications Termination Sequence

PORT:16
DEVICE  = M
PROTOCOL= D
ADDRESS = 5
CLASS   = OFF
16BIT   = 16
SO_TIMEOUT= 1.0
DL_CONFIRM= 0
MIN_DELAY= 50
MAX_DELAY= 100
SETTLE1  = 0
SETTLE2  = 0
UNSOL_REP= N
PORTID  ="DNP port"
BAUD    = 9600

Save changes (Y/N) ? Y<ENTER>

Port 16 Settings Changed

*>>
```

Notes:

1. Set CLASS to 0 because we want to operate in polled-static mode. If we wanted to have event data available, we would have set this to the class we wanted event data available in.
2. Set default variation to 16 in case master device does not support 32-bit variations.
3. Set DL_CONFIRM to 0 because we assume a high reliability link. If we thought errors were probable, we would set this to a non-zero value and specify a data-link time-out using the DL_TIMEOUT setting.

3. Move meter and target data of interest to the port 16 User region using the SET M 16 command:

```
*>>SET M 16<ENTER>

Mathematical/move equation settings for Port 16

  1
 ? 0=1:METER:IA<ENTER>
  2
 ? 1=1:METER:IB<ENTER>
  3
 ? 2=1:METER:IC<ENTER>
  4
 ? 3=1:METER:VA/100<ENTER>
  5
 ? 4=1:METER:VB/100<ENTER>
  6
 ? 5=1:METER:VC/100<ENTER>
  7
 ? 6,P=1:TARGET:TARGET;7<ENTER>
  8
 ? 10=2:METER:IA<ENTER>
  9
 ? 11=2:METER:IB<ENTER>
 10
 ? 12=2:METER:IC<ENTER>
 11
 ? 13=2:METER:VA/100<ENTER>
 12
 ? 14=2:METER:VB/100<ENTER>
 13
 ? 15=2:METER:VC/100<ENTER>
 14
 ? 16,P=2:TARGET:TARGET;7<ENTER>
 15
 ? <ENTER>

  1 000h = 1:METER:IA(A)
  2 001h = 1:METER:IB(A)
  3 002h = 1:METER:IC(A)
  4 003h = 1:METER:VA(V)/100
  5 004h = 1:METER:VB(V)/100
  6 005h = 1:METER:VC(V)/100
  7 006h,P = 1:TARGET:TARGET;7
  8 00Ah = 2:METER:IA(A)
  9 00Bh = 2:METER:IB(A)
 10 00Ch = 2:METER:IC(A)
 11 00Dh = 2:METER:VA(V)/100
 12 00Eh = 2:METER:VB(V)/100
 13 00Fh = 2:METER:VC(V)/100
 14 010h,P = 2:TARGET:TARGET;7

Save changes (Y/N) ? Y<ENTER>
```

(continued on next page)

```
                          (continued from previous page)

USER database region too small: Current size = 0  Size needed = 20
Attempting to allocate larger USER region... Done.

Port 16 Settings Changed


*>>
```

Notice that we divided the voltage data by 100, so the read value will be in tenths of kilovolts.

4. Use the DNPMAP command to determine the object types and indexes of the binary input, counter, and analog input objects you have selected:

```
*>>DNPMAP<ENTER>

                                   Date: 01/01/95    Time: 00:22:03

DNP Address:  0005h

Object Type     Index      Default Variation      Label
     01          0-63           02                1:TARGET:TARGET
     01         64-127          02                2:TARGET:TARGET
     30          0              04                1:METER:IA(A)
     30          1              04                1:METER:IB(A)
     30          2              04                1:METER:IC(A)
     30          3              04                1:METER:VA(V)
     30          4              04                1:METER:VB(V)
     30          5              04                1:METER:VC(V)
     30          6              04                2:METER:IA(A)
     30          7              04                2:METER:IB(A)
     30          8              04                2:METER:IC(A)
     30          9              04                2:METER:VA(V)
     30         10              04                2:METER:VB(V)
     30         11              04                2:METER:VC(V)

*>>
```

5. The data are now ready to be read. Configure your master to perform Class 0 polls to read all of the static data. You can also selectively read data. Use the map obtained above with the DNPMAP command to interpret the data.

6. You can also perform control using this interface by writing to binary outputs. The binary outputs are not configurable; they are listed in tables I.3 and I.4 above. Thus, to cause the relay on port 1 to open its breaker, you need to pulse the 1:SBR1 bit by performing a latch on or pulse on operation (direct operate or select-before-operate) to the binary output object 96. Similarly, to cause the relay on port 1 to close its breaker, you need to pulse the 1:CBR1 bit by operating the binary output object 128.

SEL-2020 COMMAND SUMMARY

Access Level 0

ACCESS	Use this command to enter Access Level 1. Access Level 1 provides you with interrogate, read-only capability. You will be prompted for the Level 1 Password if the SEL-2020 password disable jumper is removed.
HELP	Lists all commands available at the current access level. Use with a command as its parameter and it will provide the syntax and a brief description of the command.
ID	Displays SEL-2020 current ID, as set in the global settings, and the firmware identification string (FID string). (See also WHO and STATUS commands.)
QUIT	Causes the SEL-2020 to return control to Access Level 0 from Level 1 or 2. The command displays the SEL-2020 ID, date, and time of QUIT command execution.

Access Level 1

2ACCESS	Use to enter Access Level 2. Access Level 2 provides you with the ability to change SEL-2020 settings. You will be prompted for the Level 2 Password if the SEL-2020 password disable jumper is removed.
AUTO n	Displays the results of auto-configuration on selected port.
BROADCAST	Establish direct communications with all IED ports simultaneously. To terminate communications and return to command operation, use the termination sequence set for your port. (<CTRL-D> is the default termination sequence.)
CLEAR m:n	Clears data from the unsolicited message queue or from the archive data regions of an intelligent electronic device (IED) port. Parameter m specifies which port (1-16). Parameter n may be BUF for the unsolicited message queue or A1, A2, or A3 for the archive data regions. CLEAR m:BUF clears all messages stored in the Port m buffer. Clearing an archive entry removes the oldest item from that queue; subsequent entries remain. To completely clear an archive queue, add the parameter A (CLEAR 4:A2 A).
DATE	Displays the date stored by the internal calendar/clock. Use a date parameter to change the date: DATE mm/dd/yy.
DNPMAP	Displays map of data available on DNP port.
IRIG	Directs the SEL-2020 to read IRIG-B time-code input at the IRIG-B port. It updates the internal clock/calendar time and date to the time code.
MAP m:n	Displays the data structure and format for data stored in a port database. Parameter m = port number (1-16). Parameter n = data region (GLOBAL, LOCAL, BUF, D1-D8, or A1-A3). Gives port data structure and format if only port number is given. With both parameters, shows data region structure and data address format.
MEM	Displays the status of memory usage.
PORT n	Establishes transparent communication between the master port issuing the command and the designated printer or IED port. To terminate communications and return to command operation, use the termination sequence set for your port. (<CTRL-D> is the default termination sequence.)
SHOWSET n	Displays settings for the specified class or port number. Settings cannot be entered or modified with this command. Change settings with the SET command in Access Level 2.
STATUS	Shows SEL-2020 self-test status and the configuration, communication, and data performance of each port. Type STATUS 4 to view the status information four times.
TARGET n m	Displays global element or port-specific element information. Enter G for parameter n to display global elements or enter 1-16 to display port-specific elements (the front-panel port has no elements). For parameter m, enter the element row number you want displayed or enter ALL to show all of the elements. You may add a repeat count as the third parameter.

TIME Displays and sets time for the internal clock. To set the clock, type TIME and the desired setting, then press <ENTER>. Separate the hours, minutes, and seconds with colons, semicolons, spaces, commas, or slashes.

VIEW m:n Shows data stored in a port's database. Parameter m specifies which port (1-16). Parameter n specifies what data to view: an address range in decimal or hex; a specific region of the database; GLOBAL for global data region, LOCAL for local data region, BUF for auto-message buffer, D1-D8 for automatic data collection regions, or A1-A3 for archived data regions; or you can specify the data type directly, i.e., METER, TARGER, HISTORY, etc); or an element. If you are viewing a region, you can add BL to the command strings to request the SEL-2020 to display element bits with their bit labels.

WHO Shows what is connected to each port. Gives a table showing, for each port, the connected device type (specific relay type if it is an SEL relay port, otherwise simply the port device type), protocol, baud rate, data bits, stop bits, parity, and a device identification.

Access Level 2

CONTROL m Parameter m specifies the global elements, R1 through R8, you will operate. You are then prompted to enter one of three control operations: SRB sets a specified bit; CRB clears a specified bit; and PRB pulses a specified bit. You specify the bit (1-8) following the operation. To pulse, supply a time as a second parameter or a 1 second time is the default.

COPY m n Copies port-specific settings (classes P, A, M, U, and L) from Port m to Port n (m and n equal any combination of 1-16). Type COPY m ALL<ENTER> if you wish to copy the Port m settings to all other rear-panel port.

DEFRAG Defragments EEPROM.

PASSWORD Shows or sets passwords. PASSWORD 1 BIKE<ENTER> changes Level 1 password to BIKE. The ALARM contact closes for approximately one second and transmits the response "Set".

SET n Parameter n specifies the specific class: SET G enters global settings; SET C enters calibration settings; SET A enters automatic message settings; SET U enters user-defined command settings; SET P enters port settings, SET M enters data movement settings, and SET L enters logic settings. SET A, SET U, SET P, SET M, and SET L must have an additional parameter to designate the Port (1-16, F).

STORE m:n d Stores data directly into a database. Parameter m specifies the port number (Port F is not a valid option); parameter n specifies the starting database address; and parameter d is a data stream with each item consisting of data as characters, strings, decimal integers, hexadecimal integers, or single-precision floating point numbers.

SWAP n m Switches all port-specific settings (P, A, M, U, and L settings) between two ports. Confirmation is requested. The involved ports are reset.

TOGGLE m Toggles a specified element bit, m. You specify global elements by their name. Port-specific elements need the port number preceding the element label (i.e., 4:D2).

Note: All commands accepted by the SEL-2020 are of the form <command><CR> or <command><CR><LF> (<command><ENTER>) where <command> consists of:

- Commands truncated to the first three characters (SHO 1 = SHOWSET 1)
- Upper and lower case characters, without distinction, except in passwords
- Arguments separated from commands by spaces, commas, semicolons, colons, or slashes

SEL-2020 COMMAND SUMMARY

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HELP	Lists all commands available at the current access level. Use with a command as its parameter and it will provide the syntax and a brief description of the command.
ID	Displays SEL-2020 current ID, as set in the global settings, and the firmware identification string (FID string). (See also WHO and STATUS commands.)
QUIT	Causes the SEL-2020 to return control to Access Level 0 from Level 1 or 2. The command displays the SEL-2020 ID, date, and time of QUIT command execution.

Access Level 1

2ACCESS	Use to enter Access Level 2. Access Level 2 provides you with the ability to change SEL-2020 settings. You will be prompted for the Level 2 Password if the SEL-2020 password disable jumper is removed.
AUTO n	Displays the results of auto-configuration on selected port.
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CLEAR m:n	Clears data from the unsolicited message queue or from the archive data regions of an intelligent electronic device (IED) port. Parameter m specifies which port (1-16). Parameter n may be BUF for the unsolicited message queue or A1, A2, or A3 for the archive data regions. CLEAR m:BUF clears all messages stored in the Port m buffer. Clearing an archive entry removes the oldest item from that queue; subsequent entries remain. To completely clear an archive queue, add the parameter A (CLEAR 4:A2 A).
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DNPMAP	Displays map of data available on DNP port.
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MAP m:n	Displays the data structure and format for data stored in a port database. Parameter m = port number (1-16). Parameter n = data region (GLOBAL, LOCAL, BUF, D1-D8, or A1-A3). Gives port data structure and format if only port number is given. With both parameters, shows data region structure and data address format.
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PORT n	Establishes transparent communication between the master port issuing the command and the designated printer or IED port. To terminate communications and return to command operation, use the termination sequence set for your port. (<CTRL-D> is the default termination sequence.)
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TIME	Displays and sets time for the internal clock. To set the clock, type TIME and the desired setting, then press <ENTER>. Separate the hours, minutes, and seconds with colons, semicolons, spaces, commas, or slashes.
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WHO	Shows what is connected to each port. Gives a table showing, for each port, the connected device type (specific relay type if it is an SEL relay port, otherwise simply the port device type), protocol, baud rate, data bits, stop bits, parity, and a device identification.

Access Level 2

CONTROL m	Parameter m specifies the global elements, R1 through R8, you will operate. You are then prompted to enter one of three control operations: SRB sets a specified bit; CRB clears a specified bit; and PRB pulses a specified bit. You specify the bit (1-8) following the operation. To pulse, supply a time as a second parameter or a 1 second time is the default.
COPY m n	Copies port-specific settings (classes P, A, M, U, and L) from Port m to Port n (m and n equal any combination of 1-16). Type COPY m ALL<ENTER> if you wish to copy the Port m settings to all other rear-panel port.
DEFRAG	Defragments EEPROM.
PASSWORD	Shows or sets passwords. PASSWORD 1 BIKE<ENTER> changes Level 1 password to BIKE. The ALARM contact closes for approximately one second and transmits the response "Set".
SET n	Parameter n specifies the specific class: SET G enters global settings; SET C enters calibration settings; SET A enters automatic message settings; SET U enters user-defined command settings; SET P enters port settings, SET M enters data movement settings, and SET L enters logic settings. SET A, SET U, SET P, SET M, and SET L must have an additional parameter to designate the Port (1-16, F).
STORE m:n d	Stores data directly into a database. Parameter m specifies the port number (Port F is not a valid option); parameter n specifies the starting database address; and parameter d is a data stream with each item consisting of data as characters, strings, decimal integers, hexadecimal integers, or single-precision floating point numbers.
SWAP n m	Switches all port-specific settings (P, A, M, U, and L settings) between two ports. Confirmation is requested. The involved ports are reset.
TOGGLE m	Toggles a specified element bit, m. You specify global elements by their name. Port-specific elements need the port number preceding the element label (i.e., 4:D2).

Note: All commands accepted by the SEL-2020 are of the form <command><CR> or <command><CR><LF> (<command><ENTER>) where <command> consists of:

- Commands truncated to the first three characters (SHO 1 = SHOWSET 1)
- Upper and lower case characters, without distinction, except in passwords
- Arguments separated from commands by spaces, commas, semicolons, colons, or slashes

SEL-2020 STRINGS

Special Characters for Use in Strings

Character	Use	Comment
\"	A	Quote character. Use to insert a quote character in a string.
\\	A	Backslash character. Insert a backslash character in a string.
\n	A	New line character (CR/LF combination, just CR on SEL IED ports).
\0xx	A	Insert any 8-bit character. xx = A character value in hex; (e.g., \004 is ASCII EOT character. See ***Appendix D: ASCII Reference Table*** for ASCII conversion table.)
\<ENTER>	A	Use this sequence to continue a string to the next line.
\At/	I*	Register address. t= specifies the address format: b=binary (2 bytes) a=ASCII-hex (4 digits)
\Csx/	O	Begin checksum calculation x specifies checksum type c=CRC-16 b=8-bit checksum w=16-bit checksum
\CE/	O	Stop checksum calculation
\COyz/	O	Output checksum y specifies format a=ASCII-hexadecimal b=binary x=binary with XON/XOFF encoding z specifies byte order h=high byte first l=low byte first
\DA[C][P]n/	O	DA=output unsolicited message queue data for Port n; C= if included, clear the queue after the read; the data are handled as set of characters. P= only output characters not previously output; mutually exclusive with C parameter.
\Dt/	I* or READACK	D=data item t=specifies the data format: b=binary word (2 bytes), c=binary bytes (1 byte), h=ASCII-hex word (4 digits), g=ASCII-hex byte (2 digits).
\Fp:r[;C[A]]/	O	F=Output formatted region data. p= the port number. r= the data region. ;C= clear archive item after it is read; CA=read the entire queue of records from an archive region and clear them as they are read.
\Idstr[:h]/	O	Initiate a phone call using the given dial string. Only applies to modem ports. dstr= a dial string of up to 40 characters. Typically consists of ATDT and phone number. h= hang up flag. Y to hang up at end of message, N to stay on-line.
\M	O	Issue modem escape sequence. Only applies to modem ports.
\Pt/	I*	P=Port number t=specifies the port number format: b=binary (1 byte), a=ASCII-hex (2 digits)

Character	Use	Comment
\Rt;saddr[;n]/	O	R=Output register contents t=specifies the data format: b=binary word (2 bytes), c=binary byte (1 byte) g=ASCII-hex byte (2 digits), h=ASCII-hex word (4 digits) f=float in ASCII i=integer in ASCII u=unsigned integer in ASCII x=binary byte with XON/XOFF encoding y=binary word with XON/XOFF encoding saddr=register address, using any valid register access method. n= specifies how many items to read. Data items are delimited by spaces for all except b and c formats. One is assumed if you do not specify.
\SP/	O	Suppress prompt (on Master port). Do not display new prompt after message contents.
\Td/	O	Time delay; use this code to place a delay within string output; d=time in seconds and may be specified as decimal fraction. Time must be in the range of 0.03 to 2047.
\W;saddr;n,daddr/	O	Unsolicited database write. Applies only to ports where DEVICE=MASTER or SEL, and PROTOCOL=SEL. saddr= Source register starting address, using any valid register access method. The source address range may be any database region other than the Archive regions (A1-A3). n= Specifies how many registers to write. Number of registers must not exceed 115. daddr= Destination SEL-2020/2030 User region address, using any valid User region address (F800h-FFFFh).
\X[X]/	I	X= Ignore character. \X/ indicates ignore one character. \XX/ indicates ignore all characters following until the next defined character is encountered.

Use code:
A=All messages I=Input messages O=Output messages
*Only usable in special-purpose user-defined commands.

Pre-Defined Strings for Auto-Messages with Auto-Configured SEL Relays

String	Comment
20METER	Send ASCII meter or fast meter command, as appropriate.
20DEMAND	Send ASCII demand meter or fast demand meter command, as appropriate.
20TARGET	Send ASCII target command sequence or fast meter, as appropriate.

Note: When the SEL-2020 collects target data from relays that do not have fast meter capability, the TARGET commands sent by the SEL-2020 may modify the front-panel targets on the relays--just as if you were sending the target command to the relay without the SEL-2020.

String	Comment
20HISTORY	Send ASCII history command.
20STATUS	Send ASCII status command.
20BREAKER	Send ASCII breaker command.
20EVENT	Send ASCII event command. Store in parsed format.
20EVENTS	Send ASCII event command. Store in literal format.
20EVENTL	Send ASCII long event command. Store in literal format.

Pre-Defined Strings for Auto-Messages

String	Comment
20USER	Copy user region data to this region.

Pre-Defined Strings for General-Purpose User-Defined Commands with SEL Relays

String	Comment
20EVENT	Recognize summary event reports received from SEL IEDs (delay between triggers).
20EVENTQ	Recognize summary event reports received from SEL IEDs (trigger immediately).
20STATUS	Recognize status messages received from SEL IEDs.
20GROUP	Recognize group switch commands from SEL IEDs.