GE Power Management

Numerical Single-Phase and Three-Phase Reclosing System

DRS

Instructions
GEK-106246A

Anything you can't find?

Anything not clear enough?

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1. PRODUCT DESCRIPTION AND APPLICATION

The DRS system is a numerical, microprocessor based multifunction recloser that uses a set of algorithms to implement several reclosing programs, both single phase and three phase, as described on chapter 2 on this instruction manual.

DRS system comes on a 19'' rack, 4 rack-units high. Figure 1 shows the panel drilling dimensions.

DRS system is applied on transmission lines of any voltage level, to perform circuit breaker reclosure after a protection trip, both single and three-phase. DRS may also be applied on complex bus-bar/line arrangements, as 1 1/2 circuit breaker, with master-slave logic and up to two reclosing attempts. This feature makes DRS applicable to any substation and voltage level, since it also includes voltage synchronism check and voltage logic (DBDL, DBLL, LBDL).

Registered data management and settings change may be done by using a personal computer connected to a serial port (RS232 or fiber optic) or using the human machine interface (HMI) built on the system, comprised of a 20-key keypad and a 2 row / 16 character display, located on the frontal plate of the relay.

a) Functions related to the Reclosure:

There are two operation modes incorporated in the DRS. The first one permits to control only one breaker, but with the possibility to be connected to a second DRS in a Master-Slave configuration, in order to be applied in a Breaker & Half Arrangement schemes. The second operation mode permits to control two breakers in a sequential mode. This second mode can be applied also in a Breaker & Half arrangement, but with the supervision limitations related to the fact that the two circuit breakers are considered as a single one (e.g. any lockout input caused by a problem in one breaker will block the reclose in both circuit breakers). Both operation modes can be selected in the relay by means of a setting.

For any operation mode and reclosing scheme, the DRS incorporates the following functions:

- 7 reclosing programs: high speed or time delayed reclosing and/or single phase and/or three phase reclosing.
- Manual closing for up to 2 breakers through the energization of inputs (pulse).
- Internal voltage synchrocheck function to supervise reclosing / closing.
- Undervoltage logic (DBDL, DBLL, LBDL) function to supervise reclosing / closing.
- Digital Inputs available to supervise reclosing / closing using external units.
- Blocking feature to disable the recloser if a maximum number of circuit breaker closings is exceeded.
- Blocking feature to disable the recloser if a maximum number of reclosing initiations in a defined time interval has been exceeded.
- Manual Blocking feature available.
- Recloser Remote Reset feature.
- Cumulative counters for each reclosing mode.
- Three-pole trip enable feature.
- Pole disagreement tripping function.
- Setting Group selection can be done using digital inputs.

b) Supervision and Monitoring Functions:

- Measurement of 4 voltage signals used for supervision.
- Circuit Breakers status.
- 17 target LEDs (16 user configurable using GE_INTRO PC software).
- Self-checking functions.

c) Analysis Functions:

- Event register (1 millisecond accuracy).
- Oscillography register.

d) Control Functions:

- 3 Groups of Settings.
- Time synchronization using serial communications or through an IRIG-B input for satellite GPS synchronization.
- Configurable Inputs and Outputs (GE_INTRO software).
- Internal user configurable Logic.

e) Communications Interfaces:

- Local and remote communications through three ports, one on the front and two on the rear.
- Human Machine interface (HMI) built on the relay, located on the frontal plate, comprised of keypad and display.
- Windows™ based Configuration PC Software (GE_INTRO) and Communication Software (GE_LOCAL). These programs are part of the GE-NESIS software package for complete Electrical Substation Management.

2. OPERATING PRINCIPLES

2.1 PROTECTION FUNCTIONS

2.1.1 CIRCUIT BREAKERS POLE DISAGREEMENT TRIP

The DRS includes an internal function to detect a pole disagreement situation. The DRS trips the breaker if such a condition is detected. This function consists on a timer associated to each circuit breaker pole status input, one per pole (phase). The internal logic of this function detects when one (or two) pole of the breaker is open (being the other pole (or poles) closed) for more than a set time.

2.1.2 RECLOSING / MANUAL CLOSING SUPERVISION.

DRS can be set to check if the circuit breaker can be reclosed / closed, by detecting if reclosing / closing conditions are met. Different conditions can be set to allow reclosing or manual closing for each circuit breaker. The DRS also includes separated time settings to perform voltage synchrocheck for reclosing and for closing. The following options are presented:

DEAD BUS - DEAD LINE CONDITION
DEAD BUS - LIVE LINE CONDITION
LIVE BUS - DEAD LINE CONDITION
INTERNAL SYNCHROCHECK
EXTERNAL INPUT
NO CONDITIONS

If several options are selected simultaneously, DRS will have permission to reclose / close the circuit breaker if any of them is met.

2.1.3 VOLTAGE SYNCHROCHECK UNITS

The DRS includes two voltage synchrocheck units. These units check if voltages at both sides of the circuit breaker meet the amplitude difference, angle difference and frequency difference condition set.

2.1.4 VOLTAGE DETECTOR UNITS

DRS includes 4 voltage detectors and 4 undervoltage detectors to detect if each side of each circuit breaker, Bus and Line sides, are Dead or Live.

2.1.5 RECLOSURE TIMERS AND COUNTERS

DRS system differentiates High Speed Single Pole Reclosures, High Speed Three Pole Reclosures and Time Delayed Three Pole Reclosures.

The DRS allows to set different time delays for each type of reclosure.

DRS relays include an accumulative counter for each different type of reclosure performed over each circuit breaker.

DRS also counts the total number of reclosures performed over each breaker, if the Blocking Function due to Excessive Closing / Reclosing operations is enabled.

2.1.6 BLOCKING FUNCTION DUE TO EXCESSIVE CLOSING / RECLOSING OPERATIONS

DRS allows to set the maximum number of closing / reclosing operations that each circuit breaker can withstand. If this limit is reached for one of the breakers, the recloser associated to that breaker is permanently blocked. To unblock this recloser it is necessary to reset the closures / reclosures counter or increase its limit. This function can be disabled. If disabled, DRS will not count the total number of closing / reclosing operations performed.

2.1.7 EXCESSIVE RECLOSING INITIATION BLOCKING FUNCTION

The DRS allows to set the maximum number of reclosing initiation orders allowed within a time interval. If this limit is reached, the recloser is temporarily blocked, until the reclosing initiation orders (within the time interval set) is lower than the setting. This function can be disabled.

2.1.8 RECLOSER INHIBIT, BLOCKING AND LOCKOUT STATUS

Depending on the Operation Mode selected, the Inhibition, blocking and lockout work in a different mode. If the Operation Mode corresponds to a DRS per circuit breaker, then the three status described above will be activated and act in a different operation mode than if one DRS is used for two breakers. If we are using one DRS per circuit breaker, then the following definitions are applicable:

Inhibition: The inhibition signal is normally a temporary signal that stops the recloser. When this signal disappears, the recloser continues with its setting program. If the duration of this signal is longer than the setting of the reset timer, the DRS changes to lockout. This feature is only active in the special operation mode.

Blocking: This is a situation that stops the operation of the DRS before the arrival of any reclose initiation order. In this situation, all the timers and internal status are in a reset stage, but the recloser can not operate. The only output that is active corresponds to the Three pole trip enable function. This status can be activated through the keypad and display or through a digital input. If the relay is in operation, this input becomes ineffective.

Lockout: This is an event that blocks the operation of the recloser independently of its status (recloser in service or recloser in progress). There are two Lockout status. The first one is the named Lockout. This is a status activated by a digital input. The effect is to stop any reclose action and maintain the recloser in that status until a manual reset signal is activated or until the associated circuit breaker is closed. The second lockout status is the named Lockout2. DRS reaches this status if any internal cause in the logic (during the reclosing cycle) originates a lockout. This second lockout status produces an output that normally is used to send to lockout a second recloser through a digital input.

If we are using a DRS for two breakers, then there are only two active statuses: The blocking, that operates in a similar way as described before and the lockout. In case of lockout status, there is only one status that activates by a digital input or by the internal logic. The reclosing over any of the circuit breakers can be manually blocked, independently, using the individual blocking inputs for each breaker, or using the general blocking input. If the reclosing is in progress, the blocking inputs do not stop the reclosing. The recloser can also be blocked/unblocked by means of the keypad and display in the relay front.

The recloser will leave the LOCKOUT status after a time delay following a circuit breaker closing or if a reset command is issued. (User can set the condition for the recloser to leave the lockout status)

There is other status that is possible to set. This is the 'OUT OF SERVICE'; for which the recloser is not operative.

2.1.9 THREE-POLE TRIP ENABLE

This is an instantaneous signal (except for single-pole recloser initiation) used to activate the associated protective relay (Currently a line protection relay) to trip as three-pole, even for single-phase to ground faults, if the recloser cannot reclose single-pole. For a single-pole reclose initiation, a settable timer is started that, when times-out, activates this signal.

2.1.10 RECLOSING FUNCTION (79)

DRS is a reclosing system that allows to command one or two circuit breakers (breakers are referred to as '1' and '2') following different schemes. If we select the normal operation mode the schemes that we can select are as follows:

1. Reclose the selected circuit breaker (79-1 or 79-2)
2. Reclose both circuit breakers simultaneously (79-1 and 79-2)
3. Recloser both circuit breakers sequentially. The sequence may be selected (79-12 or 79-21). The sequence may be selected using a digital input.

The Special Operation mode refers the possibility to control only one circuit breaker. In this case all the valid settings are referred to the 79-1 recloser. **Settings referred to 79-2 are not valid for this reclosing scheme.**

In the normal operation mode, the DRS runs 5 automatisms or states machine. There are two identical automatisms (79-1 Automatism and 79-2 Automatism) to command the simple reclosing of each circuit breaker (scheme 1) and the simultaneous reclosing (scheme 2) (Figure 7.2). There are two identical automatisms (79-12 Automatism and 79-21 Automatism) to command the sequential reclosures (scheme 3) (Figure 7.3). Finally there is a Main Automatism commanding the 4 automatisms mentioned above (Figure 7.1).

In the Special operation mode, the only valid automatisms are the Automatism corresponding to 79-1 and the Main Automatism in the portion of the 79-1.

The main states of the recloser are as follows:

RESET STATUS (Reset):
This is the initial state, ready to initiate a reclosing cycle. To be at this state, the associated circuit breaker is closed.

DEFINITIVE OPENING TIMER:
This is a transitional state on the way going to the Lock-Out status. If the circuit breaker is open and no reclose initiation has been received, the recloser moves or evolves towards the Lock-Out status. To avoid time coordination problems at the transition instant between the Reset Status and the Lock-Out Status, this transition is done through this status, which includes a time delay. If a reclose initiation signal is received while being at this status, the recloser moves to the Reset Status and starts a reclosing cycle.

RECLOSING TIMER:
This status is intended to delay the reclosing of the circuit breaker according to the requirements of the system. As this timer starts when the reclose initiation is received, when a high speed reclosing following a protective relay trip is selected, the user must take into account the circuit breaker opening time. The time delay setting should be long enough to allow the circuit breaker to open.

OPENING CHECKING (Circuit Breaker Open?):
At this status, the automatism checks if the circuit breaker is open before issuing a reclosing command.

DWELL TIMER:
This status is intended to let the circuit breaker complete the closing operation. The recloser stays at this status waiting for the circuit breaker to reclose, keeping the DRS reclosing outputs closed. If the set dwell time expires

and the circuit breaker is still open, the reclosing cycle is aborted and the recloser moves to the Lock-Out Status. Otherwise, the automatism moves to the Reset Time Status.

RESET TIMER:
After having reclosed the circuit breaker, and before considering it has been a successful restoration returning to the Reset Status, the recloser must wait the so called Reset Time. This delay is intended to determine if the fault has been completely cleared or if it is still there, and the protective relay trips again.

LOCKOUT:
The recloser moves to this status when the circuit breaker is open permanently or when there is the Lockout Input activated. The recloser is at this status until the circuit breaker is closed.

LOCKOUT2:
The recloser moves to this status when the circuit breaker is open permanently or when there is a failure during the reclosing cycle. The recloser is at this status until the circuit breaker is closed.

RECLAIM TIMER:
If the circuit breaker closes after having been permanently open, the recloser does not move immediately to the Reset Status. It evolves to this Status, where it remains waiting the so called Reclaim Time. The recloser leaves this status when this timer expires or if a Reset command is received, depending on the settings. This feature avoids reclosing on a permanent fault when the circuit breaker is manually closed.

HOLD TIMER:
For Three-pole reclosures, it is possible to check if the reclosing conditions are met before proceeding to reclose the circuit breaker. If the reclosing conditions are not met, the recloser waits the so called Hold Time before determining the reclosure is not feasible. If while counting this Hold Time, the reclosing conditions are met, the circuit breaker is reclosed and the recloser moves to the Dwell Time Status.

The Main Automatism is running all the time, and the other automatisms run depending on the Status of the Main Automatism. As an example, if only reclosing of circuit breaker number one (52-1) in the Normal Operation mode is required, or if the DRS is set in the Special Operation mode (and so set in the DRS), the reset status of the Main Automatism would be the '79-1 IN SERVICE' status, and then, only the 79-1 Automatism would be running.

The Main Automatism status can be accessed using the local HMI (keypad and Display) or through the GE_LOCAL communications software. As transitions between the different statuses are carried out so quickly by the automatisms during a real reclosing cycle (making it impossible to analyze a reclosure) DRS includes an oscillography recorder. GE has also available the *DRSTool* computer software, to analyze easily the performance of the DRS from an oscillography file. Using the communications software GE_LOCAL and retrieving a particular oscillography register, the user can easily analyze DRS performance running GE_OSC oscillography software and *DRSTool* analysis software. *DRSTool* allows to analyze all the internal digital signals (flags) of the recloser, the transitions between each statuses, times spent at each status, etc.

To explain how each automatism in the DRS system works, and due to the difficulty of writing, reading and understanding a detailed description of each reclosing automatism by using words, different reclosing situations are presented and explained.

We will start with the Normal Operation mode first and next we will continue with the Special Mode: The Normal Operation mode will be explained with a Boolean graphic and the Special mode with a Logic Graphic.

It is recommended to read chapter 3 (Settings Description) previously, to become familiarized with terms as: *reclosing scheme (X1.1), reclosing program (X1.2), reclosing permission (X4.5), Hold mode (X1.3), reclosing timers (X2.2, X2.3, X2.4), reset timer (X2.6), etc.*

2.1.11 NORMAL OPERATION MODE AUTOMATISM

2.1.11.1 Main Automatism: Figure 7.1

The starting status will be the 'OUT OF SERVICE' , with setting 'X1.1-RECLOSER SCHEME' set to 'out of service'.

1st case- Reclosings only on breaker#1, 52-1,

Set X1.1-RECLOSER SCHEME to 79-1. The Main Automatism will move to the 79-1 IN SERVICE, if there is no blocking signal.

As no reclose initiation signal has been received yet, 79-1 Automatism (figure 7.2) must be at its RESET status or its LOCKOUT status if the breaker is open.

If 79-1 is at its LOCKOUT status, the Main Automatism will move to the 'OUT OF SERVICE' status until the circuit breaker is closed. Then, 79-1 would move to its RESET status.

If 79-1 is at its IN SERVICE status and a permitted reclose initiation is received, the Main Automatism will move to the 79-1 RECLOSE IN PROGRESS status. Once at this status, the task of completing the reclosure is done by 79-1 Automatism. Either if the reclosure is successful or not, this automatism shall reach its RESET or LOCKOUT status (respectively). If it reaches its RESET status, the Main Automatism will return to its 79-1 IN SERVICE status. If 79-1 reaches its LOCKOUT status, the Main Automatism will move to its OUT OF SERVICE status.

2nd case - Simultaneous Reclosings on breakers#1 and #2.

Set X1.1-RECLOSER SCHEME to simultaneous reclosing. Main Automatism will move to its 79-1 AND 79-2 IN SERVICE, if no blocking signals exist and 79-1 and 79-2 are not at their LOCKOUT status. Breaker is closed.

If a permitted reclose initiation is received, the Main Automatism will move to its 79-1 AND 79-2 RECLOSE IN PROGRESS status, starting the 79-1 and 79-2 Simple Reclosing Automatisms to perform the reclosure. If both breakers are successfully reclosed, both automatisms will move to their RESET status and the Main Automatism will move to its 79-1 AND 79-2 IN SERVICE, going through the following statuses: 79-2 RECLOSE IN PROGRESS and 79-2 IN SERVICE or 79-1 RECLOSE IN PROGRESS and 79-1 IN SERVICE

3rd case -Sequential Reclosing, breaker#1 then #2. (79-12),

Set X1.1-RECLOSER SCHEME to sequential reclosing 1 then 2. The Main Automatism will move to its 79-1 AND 79-2 IN SERVICE, if no blocking signal exists and 79-1 and 79-2 Automatisms are not at LOCKOUT status. Breaker is closed.

If a permitted reclose initiation is received, the Main Automatism will move to its 79-12 RECLOSE IN PROGRESS status, starting the 79-12 Sequential Reclosing Automatism to perform the reclosure.

If both breakers are successfully reclosed, the Sequential Automatism will move to its RESET status and the Main Automatism will move to its 79-1 AND 79-2 IN SERVICE

If any of the reclosures fails and settings X1.6-FAILURE TO RECLOSE FIRST 52 and/or X1.6-FAILURE TO RECLOSE SECOND 52 are set to 'go to LOCKOUT', the Sequential Automatism will move to LOCKOUT and the Main Automatism will stay at its 79-12 RECLOSE IN PROGRESS status, until both breakers are closed; and then, the Sequential Automatism will move to its RESET status.

If any of the reclosures fails and settings X1.6-FAILURE TO RECLOSE FIRST 52 and/or X1.6-FAILURE TO RECLOSE SECOND 52 are set to 'continue', the Sequential Automatism will start the Simple Reclosing Automatisms (the Simple Reclosing Automatism of the failed reclosure would be at its LOCKOUT status) and the Main Automatism will move to its 79-1 RECLOSE IN PROGRESS or 79-2 RECLOSE IN PROGRESS status (depending of the 79 unit that remain active), going through the 79-1 AND 79-2 RECLOSE IN PROGRESS.

2.1.11.2 Simple Reclosing Automatism: Figure 7.2

High Speed Single-Pole Reclosing: R1

Starting from the RESET status (closed breaker), if a single-pole reclose initiation is received, the Automatism will move to its R1 RECLOSING TMP, if X1.2-RECLOSER PROGRAM is set to one of the following programs: 1, 3, 5, 6 or 7. *(keep in mind that a lockout input activation always blocks a reclose initiation)*.

If the DRS is waiting the X2.2-R1 RECLOSING TIME and a three-pole reclose initiation is received, the Automatism will move to its LOCKOUT status if X1.2-RECLOSING PROGRAM is set to 1 or 3. It will move to its R3 RECLOSING TIME if X1.2-RECLOSER PROGRAM is set to 5, 6 or 7. At this point, the importance of correctly set X2.8 THREE POLE TRIP ENABLE TIMER is noted.

When timer set to X2.2-R1 RECLOSING TIME expires, the automatism will move to its OPEN? R1 status. At this status, the DRS verifies that only one pole of the circuit breaker has been opened before moving to the R1 DWELL TIME status. Otherwise it would move to its LOCKOUT status.

DRS will wait, as maximum, 02.4-MAXIMUM TIME TO CLOSE 52 for the breaker to close before moving to its R1 RESET TIME. Otherwise it would move to its LOCKOUT status.

If timer set to X2.6-RESET TIME expires and there is no new reclose initiation, the fault is considered cleared, and the automatism moves to its RESET status.

High Speed Three-Pole Reclosing: R3

Starting from the RESET status (closed breaker), if a three-pole reclose initiation is received, the Automatism will move to its R3 RECLOSING TMP, if X1.2-RECLOSER PROGRAM is set to one of the following programs: 2, 4, 5, 6 or 7.

When timer set to X2.3-R3 RECLOSING TIME expires, the automatism will move to its OPEN? R3 status. At this point, the DRS verifies that the three poles of the circuit breaker have been open and permission to reclose exists before moving to the R3 DWELL TIME status. If there is no permission to reclose, but X1.3 HOLD MODE OPTIONS allows it, the automatism would move to its HOLD TIMER status. Otherwise it would move to its LOCKOUT status.

If DRS is set to wait for reclosing conditions (permission to reclose), the automatism will wait as a maximum the time set on X2.5 HOLD TIME for the reclosing conditions to be met. If so, it would move to its R3 DWELL TIME. Otherwise if would move to its LOCKOUT status.

DRS will wait, as maximum, 02.4-MAXIMUM TIME TO CLOSE 52 for the breaker to close before moving to its R3 RESET TIME. Otherwise it would move to its LOCKOUT status.

If timer set to X2.6-RESET TIME expires and there is no new reclose initiation, the fault is considered cleared, and the automatism moves to its RESET status.

Time Delayed Three-Pole Reclosing: T3

If being at R1 RESET TIME or R3 RESET TIME statuses a new reclose initiation is received (only three-pole reclose initiation is possible) and a second reclosing attempt is allowed, the automatism will move to its T3 RECLOSING TMP status.

The difference between this Time Delayed Three-pole Reclosing T3 and the High Speed Three-pole Reclosing R3 is that the RECLOSING TMP is X2.4- T3 RECLOSING TIME instead of X2.3- R3 RECLOSING TIME.

Being at the T3 RESET TIME status, DRS will not take a new reclose initiation signal. If such a signal is received, the fault would be considered as a permanent fault and the automatism would move to its LOCKOUT status.

2.1.11.3 Sequential Reclosing Automatism: Figure 7.3

High Speed Single-Pole Reclosing: R1

Starting from the RESET status (closed breaker), if a single-pole reclose initiation is received, the Automatism will move to its R1 RECLOSING TMP status, if X1.2-RECLOSING PROGRAM is set to one of the following programs: 1, 3, 5, 6 or 7. *(have in mind that a lockout input activation always blocks a reclose initiation)*.

If DRS is waiting the X2.2-R1 RECLOSING TIME and a three-pole reclose initiation is received, the Automatism will move to its LOCKOUT status, if X1.2-RECLOSER PROGRAM is set to 1 or 3. It will move to its R3 RECLOSING TIME if X1.2-RECLOSING PROGRAM is set to 5, 6 or 7.

When timer set to X2.2-R1 RECLOSING TIME expires, the automatism will move to its OPEN? 1R1 status. At this status, DRS verify that only one pole of the first circuit breaker has been opened before moving to the 1R1 DWELL TIME status. Otherwise it would move to its LOCKOUT status if X1.6 FAILURE TO RECLOSE 1ST 52 is set to 'move to LOCKOUT'. If X1.6 FAILURE TO RECLOSE 1ST 52 is set to 'continue', DRS will continue and try to reclose the second circuit breaker, then 79-12 Automatism will stop running. Main Automatism will move to 79-1 AND 79-2 RECLOSE IN PROGRESS status, 79-1 Automatism will move to its LOCKOUT status and 79-2 Automatism will move to its OPEN? R1 status.

DRS will wait, as maximum, 02.4-MAXIMUM TIME TO CLOSE 52 for the first breaker to close before moving to its 2R1 TRANSITION TIME. Otherwise, as in the previous case, it would move to its LOCKOUT status or try continuing and reclose the second circuit breaker.

The DRS waits X2.1-TRANSITION TIME before moving to its OPEN? 2R2, where it checks that only one pole of the second circuit breaker has been opened, before moving to its 2R1 DWELL TMP. Otherwise, it would move to its LOCKOUT status, if X1.7-FAILURE TO RECLOSE 2ND BREAKER is set to 'move to LOCKOUT'. If X1.6-FAILURE TO RECLOSE 2ND 52 is set to 'continue' then DRS gets ready to attempt a reclosure on the first breaker, if a new reclose initiation is received. For that, 79-12 Automatism stops running, Main Automatism moves to its 79-1 AND 79-2 RECLOSE IN PROGRESS, 79-2 Automatism moves to its LOCKOUT status and 79-1 Automatism moves to its R1 RESET TIME status.

DRS will wait, as maximum, 02.4-MAXIMUM TIME TO CLOSE 52 for the second breaker to close before moving to its 2R1 TRANSITION TIME status. Otherwise, if it does not close, as in the previous case, it would move to its LOCKOUT status or it will try continuing with new reclose initiation commands for the first circuit breaker.

The Automatism will stay at its 2R1 RESET TMP status a time equal to the difference between setting X2.6-RESET TIME and X2.1-TRANSITION TIME. If during this time, a new reclose initiation signal is not received, the fault is considered as cleared and the Automatism moves to its RESET status.

Otherwise, if a permitted three-pole reclose initiation signal is received whilst being at the 1R1 TRANSITION TIME status or at the 2R1 RESET TIME status, then it moves to 1T3 RECLOSING TIME status, to start a Time Delayed Three-pole Reclosing cycle.

High Speed Three-Pole Reclosing: R3

Starting from the RESET status (closed breaker), if a three-pole reclose initiation is received, the Automatism will move to its R3 RECLOSING TMP status, if X1.2-RECLOSER PROGRAM is set to one of the following programs: 2, 4, 5, 6 or 7.

When timer set to X2.3-R3 RECLOSING TIME expires, the automatism will move to its OPEN? 1R3 status. At this status, DRS verifies that the three poles of the first circuit breaker has been opened and reclosing conditions are met. After that DRS moves to the 1R3 DWELL TIME status. If there is no permission to reclose (reclosing conditions are not met), but X1.3 HOLD MODE is set to YES, then the automatism would move to its 1R3 HOLD TIMER status. Otherwise it would move to its LOCKOUT status if X1.6 FAILURE TO RECLOSE 1ST 52 is set to 'move to LOCKOUT'. If X1.6 FAILURE TO RECLOSE 1ST 52 is set to 'continue', DRS will continue and try to reclose the second circuit breaker, then 79-12 Automatism will stop running, Main Automatism will move to its 79-1 AND 79-2 RECLOSE IN PROGRESS status, 79-1 Automatism will move to its LOCKOUT status and 79-2 Automatism will move to its OPEN? R3 status.

If DRS is set to wait for reclosing conditions (permission to reclose), the automatism will wait, as maximum, the time set on X2.5 HOLD TIME for the reclosing conditions to be met, so it will move to its 1R3 DWELL TIME status. Otherwise it will move to its LOCKOUT status or continue and try to reclose the second circuit breaker.

The DRS waits X2.1-TRANSITION TIME before moving to its OPEN? 2R3 status, where it checks that the three poles of the second circuit breaker have been opened (before moving to its 2R3 DWELL TMP status). Otherwise, it will move to its LOCKOUT status, if X1.7-FAILURE TO RECLOSE 2ND 52 is set to 'move to LOCKOUT'. If X1.6-FAILURE TO RECLOSE 2ND 52 is set to 'continue' then DRS is ready to attempt a reclosure on the first breaker, if a new reclose initiation is received. For that, 79-12 Automatism stop running, Main Automatism moves to its 79-1 AND 79-2 RECLOSE IN PROGRESS status, 79-2 Automatism moves to its LOCKOUT status and 79-1 Automatism moves to its R3 RESET TIME status.

DRS will wait, as maximum, 02.4-MAXIMUM TIME TO CLOSE 52 for the second breaker to send a close signal before moving to its 2R3 TRANSITION TIME status. Otherwise, if it does not close, as in the previous case, it would move to its LOCKOUT status or it will try continuing with possible new reclose initiation commands for the first circuit breaker.

The Automatism will stay at its 2R3 RESET TMP status a time equal to the difference between setting X2.6-RESET TIME and X2.1-TRANSITION TIME. If during this time, a new reclose initiation signal is not received, the fault is considered as cleared and the Automatism moves to its RESET status.

Otherwise, if a permitted three-pole reclose initiation signal is received whilst being at the 1R3 TRANSITION TIME status or at the 2R3 RESET TIME status, then it moves to 1T3 RECLOSING TIME status, to start a Time Delayed Three-pole Reclosing cycle.

Time Delayed Three-Pole Reclosing: T3

The Time Delayed Three-Pole Reclosing cycle is similar to the High Speed Three-Pole Reclosing cycle. The only difference is that reclose initiation signals received whilst being at TRANSITION TIME status and RESET TIME status moves the automatism to its LOCKOUT status (fault not cleared).

2.1.12. SPECIAL OPERATION MODE AUTOMATISM

The operation mode is similar to the mode described on 2.1.11.1 and 2.1.11.2. differing in the part related to the lockout status. In this operation mode, we have included a second lockout status, in order to differentiate the lockout that activates an output contact from the output that does not activate an output contact. Also, the other difference, is the existence of an RT signal that is coming from other DRS if the DRS is working as an SLAVE relay. Finally, the treatment of the 2 pole open condition is also quite different to the normal operation mode, in order to match this requirement with the logic of three-phase tripping that arrives from the DBF when the Three pole trip enable function has been activated from the DRS.

In order to clarify the Boolean logic, we have included a logic drawing of this portion to bring a better explanation of the DRS operating in this mode.

2.1.12.1 General

DRS logic shown starts from the point that the recloser is “In service” status and we have activated only one recloser function (79-1)

The relay is able to operate as a Master or Slave in a Breaker & Half Arrangement, because the condition of Slave is only given by the activation of the inhibition inputs (RT1 or RT3).

2.1.12.2 Single Pole reclosing operation

The Reclosing Initiation 1P RI signal activates the central input of the gate AND1. If the reclose program 1, 3, 5, 6 or 7 is selected and no Block or Lockout input is present, the AND1 output activates a latched signal that start the TR1 (single pole reclosing timer). If no reset signal is present from the inputs RT1 or RT3 (Inhibition inputs from the Master recloser unit) a single pole reclose signal is send through the gates AND5 and OR6. The output of the gate AND16 check if the breaker has closed in checking time t1.

The output of the gate OR6 with the condition of the breaker closed activate the AND22 to initiate the TRE1 timer in order to give the 1P reset order. The output of AND22 activates also the second step of the recloser through AND27 and OR18 given a 3P reclose signal through the gate OR25 and AND35.

If after the first reclose signal appears a second reclose initiation a lockout output is given through the gates AND18 and OR11. This lockout signal is a condition that cause a signal output that normally is used to activate the lockout input in the DRS Slave.

We need to establish the difference between the Lockout condition and the Lockout 2.

The Lockout2 condition is caused by an abnormal operation of the DRS, or by the operation out of the established program (e.g. if we have programmed a single pole reclose with one shot only and there is a permanent fault, the DRS Master will go to Lockout2 producing an output that will send the Slave DRS to Lockout). If lockout is caused by an external situation (e.g. activation of the Lockout input because CB low pressure), the DRS Master goes to Lockout, but without any output signal activation. In that way, the Slave can follow the operation as a Master Unit, but without a possible lockout status caused by an external source.

2.1.12.3 Three Pole Reclose Operation

The Reclosing Initiation 3P RI signal activates the central input of the gate AND3. If the reclose program 2, 4, 5, 6 or 7 is selected and no Block or Lockout input is present the AND3 output activates a latched signal that starts the TR3 (Three pole reclosing timer). If no reset signal is present from the inputs RT1 or RT3 (Inhibition inputs from the Master recloser unit) a three pole reclose signal is send through the gates OR20 and AND35. The output from gate AND9 checks if the breaker has closed in checking time t4.

The output of the TR3 timer with the condition of the breaker closed activate the AND20 to initiate the TRE3 timer in order to give the 3P reset order. The output of AND20 activates also the second step of the recloser through AND30 and OR18 given a 3P reclose signal through the gate OR25 and AND35.

If after the first reclose signal appears a second reclose initiation a lockout output is given through the gates AND26 and OR14. This lockout signal is a condition that cause also a signal output that normally is used to activate the lockout input in the DRS Slave.

The Sync check input (internal or external one) is used only to give a 3P reclose permission through AND8 in the first reclose shot and through AND31 in the second reclose shot.

2.1.12.4 Three Pole Trip Enable Operation

Three pole trip enable is a function that is activated under the following circumstances:

1. A time delay (selectable) after the 1P reclosing initiation through OR9 and OR13
2. If DRS detects two or more phases open through OR10 and OR13.

2.1.12.5. Reclose in Progress Operation

Reclose in progress is activated by the 1P or 3P reclose initiation through OR16and it is stopped by the reset or lockout condition through OR17.

2.2 SUPERVISION AND RECORDING FUNCTIONS.

2.2.1 METERING

DRS system provides the measurement of the following magnitudes:

1. Module of the 4 voltages (line and Bus-bar).
2. Angle of the 4 voltages (line and Bus-bar).
3. Frequency of the 4 voltages (line and Bus-bar).

These measures can be read using the local HMI on the system (keypad and display) and also using the GE_LOCAL communications software.

2.2.2 LINE CIRCUIT BREAKER STATUS.

DRS system monitors the status of the three poles of the circuit breakers of the line, by reading the 52/a, 52/b, or both digital inputs (if DRS is set to monitor both contacts of the circuit breaker), or just 52/a or 52/b (if DRS is set to monitor only one contact). If set to monitor both contacts, then DRS can report about the following status: Unknown (1,1), Failure-to-Open (0,0) and Failure-to-Close (0,0) for each pole of the circuit breaker. The status of the circuit breaker can be seen using the local HMI on the system (keypad and display) and also using the GE_LOCAL communications software. GE_LOCAL also shows a real time line diagram (bay mimic). This graphical screen, as well as the measures screen can be configured by the user running GE_INTRO configuration software.

2.2.3 INTERNAL STATUS.

On the Internal Status, the system shows all the internal digital flags (inputs, pickups, alarms, etc.). There are 10 groups, with 16 flags each. Using the GE_INTRO software we can also combine the internal signals with OR and AND operators in order to build an external logic complementary of the built-in logic. The status of the AND outputs can be supervised also as internal flags, using the GE-LOCAL software.

Table 3. Internal States

0	0	PROGRAM INITIATE
0	1	SETTINGS CHANGE
0	2	COUNTER CHANGE
0	4	NEW EVENTS
0	5	LOCKOUT2 OUTPUT
0	6	OUT OF SERVICE
0	7	OSCILLOGRAPHY IN PROGRESS

1	0	PARALLEL EEPROM ALARM
1	1	SERIAL EEPROM ALARM
1	2	POWER SUPPLY ALARM
1	4	FACTORY SETTINGS ALARM
1	5	TABLE 1 DEFAULT SETTINGS
1	6	TABLE 2 DEFAULT SETTINGS
1	7	TABLE 3 DEFAULT SETTINGS

2	0	EXTERNAL TRIGGER
2	1	TABLE 1 ACTIVE
2	2	TABLE 2 ACTIVE
2	3	TABLE 3 ACTIVE
2	4	COMMUNICATIONS TRIGGER
2	5	LOCKOUT INPUT
2	6	1 POLE RECLOSE INITIATE
2	7	3 POLE RECLOSE INITIATE

3	0	L-1 DEAD LINE
3	1	B-1 DEAD BUS
3	2	L-2 DEAD LINE
3	3	B-2 DEAD BUS
3	4	L-1 LIVE LINE
3	5	B-1 LIVE BUS
3	6	L-2 LIVE LINE
3	7	B-2 LIVE BUS

4	0	79-1 EXTERNALLY ENABLED
4	1	52-1 EXTERNALLY ENABLED
4	2	79-1 INTERNALLY ENABLED
4	3	52-1 INTERNALLY ENABLED
4	4	52-1A STATUS
4	5	52-1A STATUS UNDEFINED
4	6	52-1A FAILED TO OPEN
4	7	52-1A FAILED TO CLOSE

5	0	52-1B STATUS
5	1	52-1B STATUS UNDEFINED
5	2	52-1B FAILED TO OPEN
5	3	52-1B FAILED TO CLOSE
5	4	52-1C STATUS
5	5	52-1C STATUS UNDEFINED
5	6	52-1C FAILED TO OPEN
5	7	52-1C FAILED TO CLOSE

6	0	79-2 EXTERNALLY ENABLED
6	1	52-2 EXTERNALLY ENABLED
6	2	79-1 INTERNALLY ENABLED
6	3	52-2 INTERNALLY ENABLED
6	4	52-2A STATUS
6	5	52-2A STATUS UNDEFINED
6	6	52-2A FAILED TO OPEN
6	7	52-2A FAILED TO CLOSE

7	0	52-2B STATUS
7	1	52-2B STATUS UNDEFINED
7	2	52-2B FAILED TO OPEN
7	3	52-2B FAILED TO CLOSE
7	4	52-2C STATUS
7	5	52-2C STATUS UNDEFINED
7	6	52-2C FAILED TO OPEN
7	7	52-2C FAILED TO CLOSE

8	0	52-1 POLE DISAGREEMENT
8	1	52-1 STATUS UNDEFINED
8	2	52-1 FAILED TO OPEN
8	3	52-1 FAILED TO CLOSE
8	4	52-1 3 POLES OPEN
8	5	52-1 2 POLES OPEN
8	6	52-1 1 POLE OPEN
8	7	52-1 3 POLES CLOSED

9	0	52-2 POLE DISAGREEMENT
9	1	52-2 STATUS UNDEFINED
9	2	52-2 FAILED TO OPEN
9	3	52-2 FAILED TO CLOSE
9	4	52-2 3 POLES OPEN
9	5	52-2 2 POLES OPEN
9	6	52-2 1 POLE OPEN
9	7	52-2 3 POLES CLOSED

10	0	DEAD LINE 52-1 DEAD BUS
10	1	LIVE LINE 52-1 DEAD BUS
10	2	DEAD LINE 52-1 LIVE BUS
10	3	LIVE LINE 52-1 LIVE BUS
10	4	52-1 SYNCHRONISM CHECK
10	5	52-1 SYNCHRONISM CHECK FOR RECLOSING
10	6	52-1 SYNCHRONISM CHECK FOR CLOSING
10	7	RT1 INPUT

11	0	DEAD LINE 52-2 DEAD BUS
11	1	LIVE LINE 52-2 DEAD BUS
11	2	DEAD LINE 52-2 LIVE BUS
11	3	LIVE LINE 52-2 LIVE BUS
11	4	52-2 SYNCHRONISM CHECK
11	5	52-2 SYNCHRONISM CHECK FOR RECLOSING
11	6	52-2 SYNCHRONISMM CHECK FOR CLOSING
11	7	RT3 INPUT

12	0	NO 79 READY
12	1	79-1 READY
12	2	79-2 READY
12	3	79-1 79-2 READY
12	4	79-1 RECLOSE IN PROGRESS
12	5	79-2 RECLOSE IN PROGRESS
12	6	1-2 SEQUENTIAL RECLOSE IN PROGRESS
12	7	2-1 SEQUENTIAL RECLOSE IN PROGRESS

13	0	SIMULTANEOUS RECLOSE IN PROGRESS
13	1	RECLOSE PROGRAM (*1)
13	2	RECLOSE PROGRAM (*2)
13	3	RECLOSE PROGRAM (*4)
13	5	LOCKOUT REPETITIVE TRIPPING
13	6	LOCKOUT 79-1 ACCUMULATED RECLOSURES
13	7	LOCKOUT 79-2 ACCUMULATED RECLOSURES

14	0	HIGH SPEED 1 POLE RECLOSE 79-1
14	1	HIGH SPEED 3 POLE RECLOSE 79-1
14	2	TIME DELAYED 3 POLE RECLOSE 79-1
14	3	CLOSE 52-1
14	4	HIGH SPEED 1 POLE RECLOSE 79-2
14	5	HIGH SPEED 3 POLE RECLOSE 79-2
14	6	TIME DELAYED POLE RECLOSE 79-2
14	7	CLOSE 52-2

15	0	LOCKOUT 79-1
15	1	LOCKOUT 79-2
15	2	LOCKOUT 79-12
15	3	LOCKOUT 79-21
15	4	79-1 RESET
15	5	79-2 RESET
15	6	3 POLE TRIP ENABLE 1
15	7	3 POLE TRIP ENABLE 2

16	0	RECLOSER CHANGE OF SEQUENCE
16	1	MANUAL CLOSE 52-1
16	2	MANUAL CLOSE 52-2
16	3	79-1 BLOCK
16	4	79-2 BLOCK
16	5	79 GENERAL BLOCK
16	6	LOCKOUT RESET

17	0	79-1 BLOCKED
17	1	79-2 BLOCKED

18	0	AND1:
18	1	AND2:
18	2	AND3:
18	3	AND4:
18	4	AND5:
18	5	AND6:
18	6	AND7:
18	7	AND8:

19	0	AND9:
19	1	AND10:
19	2	AND11:
19	3	AND12:
19	4	AND13:
19	5	AND14:
19	6	AND15:
19	7	AND16:

INTERNAL STATUSES DESCRIPTION

PROGRAM INITIATE

This signal becomes active when the DRS system has successfully passed all the internal Self-Tests and initializations. This signal can be useful to be assigned to an output with an alarm meaning, as it is, or inverted.

SETTINGS CHANGE

When a settings change is performed, this signal becomes active and it gets deactivated when the system generates the corresponding event.

COUNTER CHANGE

When a change on any counter is done, this signal becomes active, and it gets deactivated when the system generates the corresponding event.

NEW EVENTS

This signal becomes active when new events are generated, and gets deactivated when these new events are retrieved from a computer.

DATE/TIME LOST

This signal is active when the system is power-up (PROGRAM INITIATE) without having been time synchronized.

OUT OF SERVICE

This signal is active when the DRS system setting 1.1- RELAY STATUS is set to OUT OF SERVICE.

OSCILLOGRAPHY IN PROGRESS

This signal remains active whilst an oscillography record is being stored.

PARALLEL EEPROM ALARM

This signal becomes active when the system detects an error on the non-volatile RAM (PARALLEL EEPROM) where event list and counters are stored.

SERIAL EEPROM ALARM

This signal becomes active when the system detects an error on the non-volatile RAM (SERIAL EEPROM), where the settings are stored (duplicated)

POWER SUPPLY ALARM

This signal becomes active when an error on a power supply is detected. It is evident that this signal is only present on equipment with a redundant power supply module; if not, the system would shut down for a power supply failure situation.

FACTORY SETTINGS ALARM

If the General Settings have never been changed, the system has the factory default General Settings. This signal will report about this situation

TABLE 1 DEFAULT SETTINGS

If the settings on Table 1 have never been changed, the system has the factory default Table 1 settings. This signal will report about this situation

TABLE 2 DEFAULT SETTINGS

If the settings on Table 2 have never been changed, the system has the factory default Table 2 settings. This signal will report about this situation

TABLE 3 DEFAULT SETTINGS

If the settings on Table 3 have never been changed, the system has the factory default Table 3 settings. This signal will report about this situation

EXTERNAL TRIGGER

This signal becomes ON and OFF as the External Trigger Digital Input is energized and de-energized.

TABLE 1 ACTIVE
TABLE 2 ACTIVE

TABLE 3 ACTIVE

These three signals report which table is active at any moment. If the digital inputs intended to change tables are de-energized, then these signals would reflect the value set on setting 1.8-ACTIVE TABLE

COMMUNICATIONS TRIGGER

This signal becomes active when a trigger command is issued, either from the local HMI (keypad and display on the front plate) or from the GE_LOCAL communications software.

LOCKOUT INPUT

This signal becomes ON and OFF as the LOCKOUT Digital Input is energized and de-energized.

1 POLE RECLOSE INITIATE

This signal becomes ON and OFF as the Single-Pole Reclose Initiation Digital Input is energized and de-energized.

3 POLE RECLOSE INITIATE

This signal becomes ON and OFF as the Three-Pole Reclose Initiation Digital Input is energized and de-energized.

L-1 DEAD LINE

This signal reports if there is any voltage on Line-1. If voltage on Line-1 is lower than the threshold set on setting X3.1-L1 DEAD, then the signal will become active.

B-1 DEAD BUS

This signal reports if there is no voltage on Busbar-1. If voltage on Busbar-1 is lower than the threshold set on setting X3.3-B1 DEAD, then the signal will become active.

L-2 DEAD LINE

This signal reports if there is no voltage on Line-2. If voltage on Line-2 is lower than the threshold set on setting X3.5-L2 DEAD, then the signal will become active.

B-2 DEAD BUS

This signal reports if there is no voltage on Busbar-2. If voltage on Busbar-2 is lower than the threshold set on setting X3.7-B2 DEAD, then the signal will become active.

L-1 LIVE LINE

This signal reports if there is voltage on Line-1. If voltage on Line-1 is greater than the threshold set on setting X3.2-L1 LIVE, then the signal will become active.

B-1 LIVE BUS

This signal reports if there is voltage on Busbar-1. If voltage on Busbar-1 is greater than the threshold set on setting X3.4-B1 LIVE, then the signal will become active.

L-2 LIVE LINE

This signal reports if there is voltage on Line-2. If voltage on Line-2 is greater than the threshold set on setting X3.6-L2 LIVE, then the signal will become active.

B-2 LIVE BUS

This signal reports if there is voltage on Busbar-2. If voltage on Busbar-2 is greater than the threshold set on setting X3.8-B2 LIVE, then the signal will become active.

79-1 EXTERNALLY ENABLED

This signal becomes ON and OFF as the Permission to Reclose Circuit Breaker 1 Digital Input is energized and de-energized.

52-1 EXTERNALLY ENABLED

This signal becomes ON and OFF as the Permission to Close Circuit Breaker 1 Digital Input is energized and de-energized.

79-1 INTERNALLY ENABLED

This signal becomes active when the Reclosing Conditions set on setting X4.- SYNCHRONISM SETTINGS are met for circuit breaker 1.

52-1 INTERNALLY ENABLED

This signal becomes active when the Closing Conditions set on setting X6.- MANUAL CLOSE SETTINGS are met for circuit breaker 1.

52-1A STATUS

This signal reports the status of the Phase A pole of circuit breaker 1. When active means the pole is closed.

52-1A STATUS UNDEFINED

This signal becomes active if the status of the Phase A pole of circuit breaker number 1 is Unknown.

52-1A FAILED TO OPEN

If this signal is active, it is reporting a failure to open the Phase A pole of circuit breaker 1. This means that its transition from closed to open has taken more time than the specified on setting 2.3-MAXIMUM TIME TO OPEN 52.

52-1A FAILED TO CLOSE

If this signal is active, it is reporting a failure to close the Phase A pole of circuit breaker 1. This means that its transition from open to closed has taken more time than the specified on setting 2.4-MAXIMUM TIME TO CLOSE 52.

52-1B STATUS

This signal reports the status of the Phase B pole of circuit breaker 1. When active means the pole is closed.

52-1B STATUS UNDEFINED

This signal becomes active if the status of the Phase B pole of circuit breaker number 1 is Unknown.

52-1B FAILED TO OPEN

If this signal is active, it is reporting a failure to open the Phase B pole of circuit breaker 1. This means that its transition from closed to open has taken more time than the specified on setting 2.3-MAXIMUM TIME TO OPEN 52.

52-1B FAILED TO CLOSE

If this signal is active, it is reporting a failure to close the Phase B pole of circuit breaker 1. This means that its transition from open to closed has taken more time than the specified on setting 2.4-MAXIMUM TIME TO CLOSE 52.

52-1C STATUS

This signal reports the status of the Phase C pole of circuit breaker 1. When active means the pole is closed.

52-1C STATUS UNDEFINED

This signal becomes active if the status of the Phase C pole of circuit breaker number 1 is Unknown.

52-1C FAILED TO OPEN

If this signal is active, it is reporting a failure to open the Phase C pole of circuit breaker 1. This means that its transition from closed to open has taken more time than the specified on setting 2.3-MAXIMUM TIME TO OPEN 52.

52-1C FAILED TO CLOSE

If this signal is active, it is reporting a failure to close the Phase C pole of circuit breaker 1. This means that its transition from open to closed has taken more time than the specified on setting 2.4-MAXIMUM TIME TO CLOSE 52.

79-2 EXTERNALLY ENABLED

This signal becomes ON and OFF as the Permission to Reclose Circuit Breaker 2 Digital Input is energized and de-energized.

52-2 EXTERNALLY ENABLED

This signal becomes ON and OFF as the Permission to Close Circuit Breaker 2 Digital Input is energized and de-energized.

79-2 INTERNALLY ENABLED
This signal becomes active when the Reclosing Conditions set on setting X4.-SYNCHRONISM SETTINGS are met for circuit breaker 2.

52-2 INTERNALLY ENABLED
This signal becomes active when the Closing Conditions set on setting X6.- MANUAL CLOSE SETTINGS are met for circuit breaker 2.

52-2A STATUS
This signal reports the status of the Phase A pole of circuit breaker 2. When active means the pole is closed.

52-2A STATUS UNDEFINED
This signal becomes active if the status of the Phase A pole of circuit breaker number 2 is Unknown.

52-2A FAILED TO OPEN
If this signal is active, it is reporting a failure to open the Phase A pole of circuit breaker 2. This means that its transition from closed to open has taken more time than the specified on setting 2.3-MAXIMUM TIME TO OPEN 52.

52-2A FAILED TO CLOSE
If this signal is active, it is reporting a failure to close the Phase A pole of circuit breaker 2. This means that its transition from open to closed has taken more time than the specified on setting 2.4-MAXIMUM TIME TO CLOSE 52.

52-2B STATUS
This signal reports the status of the Phase B pole of circuit breaker 2. When active means the pole is closed.

52-2B STATUS UNDEFINED
This signal becomes active if the status of the Phase B pole of circuit breaker number 2 is Unknown.

52-2B FAILED TO OPEN
If this signal is active, it is reporting a failure to open the Phase B pole of circuit breaker 2. This means that its transition from closed to open has taken more time than the specified on setting 2.3-MAXIMUM TIME TO OPEN 52.

52-2B FAILED TO CLOSE
If this signal is active, it is reporting a failure to close the Phase B pole of circuit breaker 2. This means that its transition from open to closed has taken more time than the specified on setting 2.4-MAXIMUM TIME TO CLOSE 52.

52-2C STATUS
This signal reports the status of the Phase C pole of circuit breaker 2. When active means the pole is closed.

52-2C STATUS UNDEFINED
This signal becomes active if the status of the Phase C pole of circuit breaker number 2 is Unknown.

52-2C FAILED TO OPEN
If this signal is active, it is reporting a failure to open the Phase C pole of circuit breaker 2. This means that its transition from closed to open has taken more time than the specified on setting 2.3-MAXIMUM TIME TO OPEN 52.

52-2C FAILED TO CLOSE
If this signal is active, it is reporting a failure to close the Phase C pole of circuit breaker 2. This means that its transition from open to closed has taken more time than the specified on setting 2.4-MAXIMUM TIME TO CLOSE 52.

52-1 POLE DISAGREEMENT
This signal reports the status of the Pole Disagreement Tripping function for circuit breaker 1.

52-1 STATUS UNDEFINED
When this signal is active it reports that one of the poles of circuit breaker 1 has an unknown status.

52-1 FAILED TO OPEN
When this signal is active it reports that one of the poles of circuit breaker 1 has failed to open.

52-1 FAILED TO CLOSE
When this signal is active it reports that one of the poles of circuit breaker 1 has failed to close.

52-1 3 POLES OPEN
When this signal is active it reports that the three poles of circuit breaker 1 are open.

52-1 2 POLES OPEN
When this signal is active it reports that only two poles of circuit breaker 1 have opened.

52-1 1 POLE OPEN
When this signal is active it reports that only one pole of circuit breaker 1 has opened.

52-1 3 POLES CLOSED
When this signal is active it reports that the three poles of circuit breaker 1 are closed.

52-2 POLE DISAGREEMENT
This signal reports the status of the Pole Disagreement Tripping function for circuit breaker 2.

52-2 STATUS UNDEFINED
When this signal is active it reports that one of the poles of circuit breaker 2 has an unknown status.

52-2 FAILED TO OPEN
When this signal is active it reports that one of the poles of circuit breaker 2 has failed to open.

52-2 FAILED TO CLOSE
When this signal is active it reports that one of the poles of circuit breaker 2 has failed to close.

52-2 3 POLES OPEN
When this signal is active it reports that the three poles of circuit breaker 2 are open.

52-2 2 POLES OPEN
When this signal is active it reports that only two poles of circuit breaker 2 have opened.

52-2 1 POLE OPEN
When this signal is active it reports that only one pole of circuit breaker 2 has opened.

52-2 3 POLES CLOSED
When this signal is active it reports that the three poles of circuit breaker 2 are closed.

DEAD LINE 52-1 DEAD BUS
When this signal is active it reports that voltage at both sides of circuit breaker 1 is lower than settings X3.1-L1 DEAD and X3.3-B1 DEAD.

LIVE LINE 52-1 DEAD BUS
When this signal is active it reports that voltage on line side is greater than setting X3.2-L1 LIVE and voltage on Busbar side is lower than setting X3.3- B1 DEAD, for circuit breaker 1.

DEAD LINE 52-1 LIVE BUS
When this signal is active it reports that voltage on Busbar side is greater than setting X3.4-B1 LIVE and voltage on line side is lower than setting X3.1- L1 DEAD, for circuit breaker 1.

LIVE LINE 52-1 LIVE BUS
When this signal is active it reports that voltage at both sides of breaker 1 is greater that settings X3.2-L1 LIVE and X3.4-B1 LIVE.

52-1 SYNCHRONISM CHECK
When this signal is active it reports that module, phase and frequency differences between voltages at both sides of circuit breaker 1 are lower than settings X4.1-MODULE DIF, X4.2-PHASE DIF and X4.3-FREQUENCY DIF.

52-1 SYNCHRONISM CHECK FOR RECLOSING
This signal reports that 52-1 SYNCHRONISM CHECK signal has remain ON for a time longer than setting X4.4-SYNCHRONISM TIME FOR RECLOSING.

52-1 SYNCHRONISM CHECK FOR CLOSING
This signal reports that 52-1 SYNCHRONISM CHECK signal has remain ON for a time longer than setting X6.1-SYNCHRONISM TIME FOR CLOSING.

DEAD LINE 52-2 DEAD BUS
When this signal is active it reports that voltage at both sides of circuit breaker 2 is lower than settings X3.5-L2 DEAD and X3.7-B2 DEAD.

LIVE LINE 52-2 DEAD BUS
When this signal is active it reports that voltage on line side is greater than setting X3.6-L2 LIVE and voltage on Busbar side is lower than setting X3.7- B2 DEAD, for circuit breaker 2.

DEAD LINE 52-2 LIVE BUS
When this signal is active it reports that voltage on Busbar side is greater than setting X3.8-B2 LIVE and voltage on line side is lower than setting X3.5- L2 DEAD, for circuit breaker 2.

LIVE LINE 52-2 LIVE BUS
When this signal is active it reports that voltage at both sides of breaker 2 is greater that settings X3.6-L2 LIVE and X3.8-B2 LIVE.

52-2 SYNCHRONISM CHECK
When this signal is active it reports that module, phase and frequency differences between voltages at both sides of circuit breaker 2 are lower than settings X4.1-MODULE DIF, X4.2-PHASE DIF and X4.3-FREQUENCY DIF.

52-2 SYNCHRONISM CHECK FOR RECLOSING
This signal reports that 52-2 SYNCHRONISM CHECK signal has remain ON for a time longer than setting X4.4-SYNCHRONISM TIME FOR RECLOSING.

52-2 SYNCHRONISM CHECK FOR CLOSING
This signal reports that 52-2 SYNCHRONISM CHECK signal has remain ON for a time longer than setting X6.1-SYNCHRONISM TIME FOR CLOSING.

The following 9 signals reports the status of the Recloser Main Automatism. See Chapter 2.1.10.1 and figure 7.1:

NO 79 READY
This status reports that the Recloser cannot perform any reclosing cycle.

79-1 READY
This status reports that the Recloser is only ready to perform simple reclosing cycles on circuit breaker 1.

79-2 READY
This status reports that the Recloser is only ready to perform simple reclosing cycles on circuit breaker 2.

79-1 79-2 READY
This status reports that the Recloser is ready to perform simultaneous reclosings on both circuit breakers and also sequential reclosings.

79-1 RECLOSE IN PROGRESS
This status reports that a reclosing cycle on circuit breaker 1 is taking place.

79-2 RECLOSE IN PROGRESS
This status reports that a reclosing cycle on circuit breaker 2 is taking place.

1-2 SEQUENTIAL RECLOSE IN PROGRESS
This status reports that a sequential reclosing cycle on circuit breakers -1 then -2 is taking place.

2-1 SEQUENTIAL RECLOSE IN PROGRESS
This status reports that a sequential reclosing cycle on circuit breakers -2 then -1 is taking place.

SIMULTANEOUS RECLOSE IN PROGRESS
This status reports that a simultaneous reclosing cycle is taking place on both circuit breakers.

RECLOSE PROGRAM (*1)
RECLOSE PROGRAM (*2)
RECLOSE PROGRAM (*4)
These signals report (in a binary format) which reclosing program has been selected. As an example, if RECLOSE PROGRAM (*1) and RECLOSE PROGRAM (*4) signals were active, this would mean that program 5 has been selected.

These signals are given by the Reclosing Program Digital Inputs, or by setting X1.2-RECLOSER PROGRAM.

LOCKOUT REPETITIVE TRIPPING
This signal reports that the Recloser is blocked due to an excessive number of Reclose Initiation commands within a time interval. Settings used are 2.7-MAXIMUM RECLOSURES INITIATES NUMBER IN A TIME INTERVAL and 2.8-TIME INTERVAL FOR MAXIMUM RECLOSURES INITIATES NUMBER.

LOCKOUT 79-1 ACCUMULATED RECLOSURES
This signal reports that reclosures on circuit breaker 1 have been blocked, due number of closures over this circuit breaker have exceed the user setting.

LOCKOUT 79-2 ACCUMULATED RECLOSURES
This signal reports that reclosures on circuit breaker 1 have been blocked, due number of closures over this circuit breaker have exceed the user setting.

HIGH SPEED 1 POLE RECLOSE 79-1
This signal reports that a High Speed Single-Pole Reclosing Cycle is in progress over circuit breaker 1.

HIGH SPEED 3 POLE RECLOSE 79-1
This signal reports that a High Speed Three-Pole Reclosing Cycle is in progress over circuit breaker 1.

TIME DELAYED 3 POLE RECLOSE 79-1
This signal reports that a Time Delayed Three--Pole Reclosing Cycle is in progress over circuit breaker 1.

CLOSE 52-1
This signal reports a closing or reclosing command over circuit breaker 1. This is the signal to use to configure the outputs to close and reclose circuit breaker 1.

HIGH SPEED 1 POLE RECLOSE 79-2
This signal reports that a High Speed Single-Pole Reclosing Cycle is in progress over circuit breaker 2.

HIGH SPEED 3 POLE RECLOSE 79-2
This signal reports that a High Speed Three-Pole Reclosing Cycle is in progress over circuit breaker 2.

TIME DELAYED 3 POLE RECLOSE 79-2
This signal reports that a Time Delayed Three--Pole Reclosing Cycle is in progress over circuit breaker 2.

CLOSE 52-2
This signal reports a closing or reclosing command over circuit breaker 2. This is the signal to use to configure the outputs to close and reclose circuit breaker 2.

LOCKOUT 79-1
This signal reports that the Simple Reclosing Automatism over circuit breaker 1 is at its LOCKOUT status. See chapter 2.1.10.2 and figure 7.2.

LOCKOUT 79-2

This signal reports that the Simple Reclosing Automatism over circuit breaker 2 is at its LOCKOUT status. See chapter 2.1.10.2 and figure 7.2.

LOCKOUT 79-12

This signal reports that the '1 then 2' Sequential Reclosing Automatism is at its LOCKOUT status. See chapter 2.1.10.3 and figure 7.3.

LOCKOUT 79-21

This signal reports that the '2 then 1' Sequential Reclosing Automatism is at its LOCKOUT status. See chapter 2.1.10.3 and figure 7.3.

79-1 RESET

This signal reports that the Simple Reclosing Automatism over circuit breaker 1 is at its Reset Time Status. See chapter 2.1.10.2 and figure 7.2.

79-2 RESET

This signal reports that the Simple Reclosing Automatism over circuit breaker 2 is at its Reset Time Status. See chapter 2.1.10.2 and figure 7.2.

3 POLE TRIP ENABLE

This signal is use to make the line protection to trip three-pole if the fault persists and a new trip is needed.

RECLOSER CHANGE OF SEQUENCE

This signal becomes ON and OFF as the Sequence Change Digital Input is energized and de-energized.

MANUAL CLOSE 52-1

This signal becomes ON and OFF as the Manual Closing Command over circuit breaker 1 Digital Input is energized and de-energized.

MANUAL CLOSE 52-2

This signal becomes ON and OFF as the Manual Closing Command over circuit breaker 2 Digital Input is energized and de-energized.

79-1 BLOCK

This signal becomes ON and OFF as the Recloser Blocking Command over circuit breaker 1 Digital Input is energized and de-energized.

79-2 BLOCK

This signal becomes ON and OFF as the Recloser Blocking Command over circuit breaker 2 Digital Input is energized and de-energized.

79 GENERAL BLOCK

This signal becomes ON and OFF as the Recloser Blocking Command (for both breakers) Digital Input is energized and de-energized.

LOCKOUT RESET

This signal becomes ON and OFF as the Recloser Reset Command Digital Input is energized and de-energized.

79-1 BLOCKED

This signal reports that it is not possible to perform reclosures over circuit breaker 1.

79-2 BLOCKED

This signal reports that it is not possible to perform reclosures over circuit breaker 2.

2.2.4 TARGET LEDS

DRS includes 17 LEDs, one bicolor assigned to the Equipment Critical Alarm, and 16 red-color LEDs that are user configurable by using GE_INTRO configuration software. Any LED can be configured to light on (blinking or not, with memory or not), when an internal alarm becomes active or inactive. User can define up to 32 protection alarms (alarms related to and generated by the protection microprocessor) and up to 16 communications alarms (alarms related to and generated by the communications microprocessor). To define an alarm, the user has to name it, and select which internal flag or flags (OR gate) will turn it ON. As previously explained, internal flags are grouped in 10 sets of 16 signals each. Inputs to OR gates must belong to the same group of flags. AND gates are also available for one group, so the user can build logic circuits consisting of AND, OR and NOT gates with GE_INTRO.

The internal statuses represented by the 10 groups of 16 flags each, contain all the digital information of all the units (inputs, pick-ups, alarms, etc.).

Each LED can also be set to have memory or not, so if auxiliary power supply is turned off and then on, memorized LEDs will light on if they were on before removing the power supply. LEDs can also be set to blink.

There is a push button on the front plate to test the LEDs. Pushing this button, all the LEDs must light on. This button, labeled as TARGET RESET, is also used to reset the LEDs. It must be pushed for more than 3 seconds for the LEDs to reset.

DRS systems are shipped from our factory with the following LEDs configuration:

Table 1. *Default LED Configuration*

LED Nº	FUNCTION	COLOR
1	79-1 BLOCKED (blinking)	RED
2	79-2 BLOCKED (blinking)	RED
3	79-1 RECLOSE IN PROGRESS	RED
4	79-2 RECLOSE IN PROGRESS	RED
5	79-1 RECLOSURE R1 (with memory)	RED
6	79-1 RECLOSURE R3 (with memory)	RED
7	79-1 RECLOSURE T3 (with memory)	RED
8	79-2 RECLOSURE R1 (with memory)	RED
9	79-2 RECLOSURE R3 (with memory)	RED
10	79-2 RECLOSURE T3 (with memory)	RED
11	LOCKOUT 79-1 (blinking)	RED
12	LOCKOUT 79-2 (blinking)	RED
13	52-1 POLE DISAGREEMENT (with	RED
14	52-2 POLE DISAGREEMENT (with	RED
15	THREE POLE TRIP	RED
16	LOCAL COMMUNICATION (blinking)	RED

2.2.5 DRS SYSTEM SELF-CHECKING.

DRS system, thanks to its microprocessor-based technology, can incorporate self-checking functions, that guarantee the correct operation of the system, and that it will disable the unit if internal errors are detected.

These self-checking routines are performed at start-up and during operation. Self-checking includes tests on the internal power supply, working memory (RAM), oscillography memory (CAP-RAM) and settings, alarms, counters and calibrations memory (EEPROM).

There is also a hardware test for the target LEDs. All of them must light on if TARGET RESET push button is pushed. If it is pushed for more than 3 seconds, it will reset all memorized LEDs.

2.3 ANALYSIS FUNCTIONS.

DRS system includes an event register and an oscillography register with a time resolution of 1 millisecond. So as not to lose the date and time setting or the oscillography recorder information, the unit uses a capacitor as backup for the internal clock and register memory. This allows the information to be kept for at least 24 hours from the moment the power supply is lost.

2.3.1 EVENT RECORDER.

The DRS system keeps a record of the last 165 events and stores the following information: date and time (1 msec. resolution), the type of event, voltages measured at the time the event occurred, and the internal states matrix of the unit.

This event recorder is stored in a non-volatile memory and can be maintained indefinitely, even with no power supply.

The relay generates an event when any of the following signals changes its status:

Table 2. Causes generating events / logs

PROGRAM INITIATE
SETTINGS CHANGE
DATE / TIME LOST
OUT OF SERVICE
PARALLEL EEPROM ALARM
SERIAL EEPROM ALARM
POWER SUPPLY ALARM
FACTORY SETTINGS ALARM
TABLE 1 DEFAULT SETTINGS
TABLE 2 DEFAULT SETTINGS
TABLE 3 DEFAULT SETTINGS
EXTERNAL TRIGGER
TABLE 1 ACTIVE
TABLE 2 ACTIVE
TABLE 3 ACTIVE
COMMUNICATIONS TRIGGER
1 POLE RECLOSE INITIATE
3 POLE RECLOSE INITIATE
52-1 POLE DISAGREEMENT
52-1 UNDEFINED STATUS SIGNALLING
52-1 FAILED TO OPEN
52-1 FAILED TO CLOSE
52-1 CLOSE
52-2 POLE DISAGREEMENT
52-2 UNDEFINED STATUS SIGNALLING
52-2 FAILED TO OPEN
52-2 FAILED TO CLOSE
52-2 CLOSE
79-1 RECLOSE IN PROGRESS
79-2 RECLOSE IN PROGRESS

52-1 52-2 SEQUENTIAL RECLOSE IN PROGRESS
52-2 52-1 SEQUENTIAL RECLOSE IN PROGRESS
52 SIMULTANEOUS RECLOSE IN PROGRESS
REPETITIVE RECLOSURES
ACCUMULATED RECLOSURES 52-1
ACCUMULATED RECLOSURES 52-2
52-1 CLOSE
52-2 CLOSE
79-1 LOCKOUT
79-2 LOCKOUT
79-12 LOCKOUT
79-21 LOCKOUT
LOCKOUT INPUT ACTIVE
3 POLE TRIPPING ENABLED
RECLOSER CHANGE OF SEQUENCE
52-1 MANUAL CLOSE
52-2 MANUAL CLOSE
79-1 BLOCK OPERATION
79-2 BLOCK OPERATION
79 GENERAL BLOCK OPERATION
LOCKOUT RESET
79-1 BLOCKED
79-2 BLOCKED

2.3.2 OSCILLOGRAPHY RECORDER.

The DRS unit stores 4 oscillography registers, with a resolution of 4 samples per cycle. Each register has a maximum capacity of 264 cycles. The number of pre-fault cycles can be selected from 2 to 10 cycles. In this oscillography record, as a difference with the oscillography record of other protective relays, the interesting point is not to visualize the analog waves, but the digital signals (flags) and the status of the automatisms that command the performance of the DRS during a reclosing cycle.

GE provides a computer tool, called DRSTool, that allows the user to analyze the automatisms performance, the transitions between the internal statuses, times spent at each status, activation of internal flags, etc. happened during the reclosing cycle. DRSTool uses as source information, the oscillography record from the DRS.

Each oscillography record includes the following information:

- Automatisms evolution:
    - Main Automatism.
    - Simultaneous Reclosing Automatism.
    - Sequential Reclosing Automatism.

- Internal Digital Flags, as follows:

0	0	PROGRAM INITIATE
0	1	SETTINGS CHANGE
0	2	COUNTER CHANGE
0	4	NEW EVENTS
0	5	DATE/TIME LOST
0	6	OUT OF SERVICE
0	7	OSCILLOGRAPHY IN PROGRESS

2	0	EXTERNAL TRIGGER
2	1	TABLE 1 ACTIVE
2	2	TABLE 2 ACTIVE
2	3	TABLE 3 ACTIVE
2	4	COMMUNICATIONS TRIGGER
2	5	LOCKOUT INPUT
2	6	1 POLE RECLOSE INITIATE
2	7	3 POLE RECLOSE INITIATE

4	0	79-1 EXTERNALLY ENABLED
4	1	52-1 EXTERNALLY ENABLED
4	2	79-1 INTERNALLY ENABLED
4	3	52-1 INTERNALLY ENABLED
4	4	52-1A STATUS
4	5	52-1A STATUS UNDEFINED
4	6	52-1A FAILED TO OPEN
4	7	52-1A FAILED TO CLOSE

5	0	52-1B STATUS
5	1	52-1B UNDEFINED STATUS
5	2	52-1B FAILED TO OPEN
5	3	52-1B FAILED TO CLOSE
5	4	52-1C STATUS
5	5	52-1C UNDEFINED STATUS
5	6	52-1C FAILED TO OPEN
5	7	52-1C FAILED TO CLOSE

6	0	79-2 EXTERNALLY ENABLED
6	1	52-2 EXTERNALLY ENABLED
6	2	79-1 INTERNALLY ENABLED
6	3	52-2 INTERNALLY ENABLED
6	4	52-2A STATUS
6	5	52-2A STATUS UNDEFINED
6	6	52-2A FAILED TO OPEN
6	7	52-2A FAILED TO CLOSE

7	0	52-2B STATUS
7	1	52-2B STATUS UNDEFINED
7	2	52-2B FAILED TO OPEN
7	3	52-2B FAILED TO CLOSE
7	4	52-2C STATUS
7	5	52-2C STATUS UNDEFINED
7	6	52-2C FAILED TO OPEN
7	7	52-2C FAILED TO CLOSE

8	0	52-1 POLE DISAGREEMENT
8	1	52-1 STATUS UNDEFINED
8	2	52-1 FAILED TO OPEN
8	3	52-1 FAILED TO CLOSE
8	4	52-1 3 POLES OPEN
8	5	52-1 2 POLES OPEN
8	6	52-1 1 POLE OPEN
8	7	52-1 3 POLES CLOSED

9	0	52-2 POLE DISAGREEMENT
9	1	52-2 STATUS UNDEFINED
9	2	52-2 FAILED TO OPEN
9	3	52-2 FAILED TO CLOSE
9	4	52-2 3 POLES OPEN
9	5	52-2 2 POLES OPEN
9	6	52-2 1 POLE OPEN
9	7	52-2 3 POLES CLOSED

10	0	DEAD LINE 52-1 DEAD BUS
10	1	LIVE LINE 52-1 DEAD BUS
10	2	DEAD LINE 52-1 LIVE BUS
10	3	LIVE LINE 52-1 LIVE BUS
10	4	52-1 SYNCHRONISM CHECK
10	5	52-1 SYNCHRONISM CHECK FOR RECLOSING
10	6	52-1 SYCHRONISM CHECK FOR CLOSING

11	0	DEAD LINE 52-2 DEAD BUS
11	1	LIVE LINE 52-2 DEAD BUS
11	2	DEAD LINE 52-2 LIVE BUS
11	3	LIVE LINE 52-2 LIVE BUS
11	4	52-2 SYNCHRONISM CHECK
11	5	52-2 SYNCHRONISM CHECH FOR RECLOSING
11	6	52-2 SYNCHRONISM CHECK FOR CLOSING

12	0	NO 79 READY
12	1	79-1 READY
12	2	79-2 READY
12	3	79-1 79-2 READY
12	4	79-1 RECLOSE IN PROGRESS
12	5	79-2 RECLOSE IN PROGRESS
12	6	1-2 SEQUENTIAL RECLOSE IN PROGRESS
12	7	2-1 SEQUENTIAL RECLOSE IN PROGRESS

13	0	SIMULTANEOUS RECLOSE IN PROGRESS
13	1	RECLOSE PROGRAM (*1)
13	2	RECLOSE PROGRAM (*2)
13	3	RECLOSE PROGRAM (*4)
13	5	LOCKOUT REPETITIVE TRIPPING
13	6	LOCKOUT 79-1 ACCUMULATED RECLOSURES
13	7	LOCKOUT 79-2 ACCUMULATED RECLOSURES

14	0	HIGH SPEED 1 POLE RECLOSE 79-1
14	1	HIGH SPEED 3 POLE RECLOSE 79-1
14	2	TIME DELAYED 3 POLE RECLOSE 79-1
14	3	52-1 CLOSE
14	4	HIGH SPEED 1 POLE RECLOSE 79-2
14	5	HIGH SPEED 3 POLE RECLOSE 79-2
14	6	TIME DELAYED 3 POLE RECLOSE 79-2
14	7	52-2 CLOSE

15	0	LOCKOUT 79-1
15	1	LOCKOUT 79-2
15	2	LOCKOUT 79-12
15	3	LOCKOUT 79-21
15	4	79-1 RESET
15	5	79-2 RESET
15	6	3 POLE TRIP ENABLE

- Time and Date when the oscillography record was generated.
- Causes that trigger the oscillo. These may be one of the following:

  EXTERNAL TRIGGER.
  COMMUNICATION TRIGGER.
  SINGLE-POLE RECLOSE INITIATION.
  THREE-POLE RECLOSE INITIATION.

  There is an internal setting to define which functions or internal status may trigger the oscillo.

- General Settings and Settings Table active when the oscillo was triggered.

Oscillography records are stored following the International Standard format COMTRADE (IEEE C37.111-1991 Standard) using the GE_LOCAL communication software. They can be visualized using the GE-OSC program, or any other program that accepts the COMTRADE International Standard format or ASCII files (for example EXCEL™).

2.4 CONTROL

2.4.1 SETTINGS TABLES.

The DRS system has 3 independent setting tables, stored in non-volatile memory, so that information is kept even without auxiliary voltage. Only one setting table is active at a given time and this is the table that the system uses to run the different functions included in it.

Of all the settings which exist for the DRS unit, there are several groups (corresponding to General Settings, Breaker and Oscillography masks) which are generic and are therefore common to all the setting tables, while the rest of the settings are presented separately for each table.

There is an "ACTIVE TABLE" setting which determines the settings table which is active at a given moment.

The settings table can be changed by means of up to 2 digital inputs, referred to as "TABLE SELECTION-0" and "TABLE SELECTION-1" which allow up to 4 combinations from 0 to 3. To do this it is necessary to configure (using GE-INTRO software) two inputs. For applications that require fewer tables (up to 2) it is possible to use only one input.

The selected combination is obtained from the binary coding of the 2 inputs mentioned (see following table). The 0-0 means selecting the table indicated in the "ACTIVE TABLE" setting, and numbers 0-1 to 1-1 select tables 1 to 3 respectively

Table Selection INPUT-1	Table Selection INPUT-0	Active Table
0	0	Selected by setting
0	1	1
1	0	2
1	1	3

***NOTE**: if the inputs are programmed and used, energizing them, this selection has priority over the "ACTIVE TABLE" setting and the table which is in fact used is determined by the status of the digital inputs.*

Reclosing programs may also be selected by using digital inputs. Using three digital inputs, configurable with GE_INTRO, it is possible to select any of the 7 reclosing programs.

2.4.2 TIME SYNCHRONIZATION.

The DRS system includes an input for time synchronization. This input requires the connection of a device to supply a demodulated IRIG-B output. In this way coordinated universal time is measured to a high degree of accuracy, and this makes it possible to tag the events generated by the unit with a resolution of one millisecond.

The use of this input makes it possible to correlate data obtained from different units thanks to synchronization with GPS satellites. In this way it is possible to obtain very useful information for analysis, cross-referencing the information provided by different units for a given incident.

Alternatively, it is possible to synchronize units by means of communications, using the GE-LOCAL communications software, or manually by means of the HMI. If the IRIG-B input is used it has priority over time setting by communications, since the time read by IRIG-B is much more accurate.

2.4.3 CONFIGURABLE INPUTS AND OUTPUTS

2.4.3.1 Digital Inputs.

The DRS system has 42 digital inputs (6 groups of 7 inputs each with one common in each group). The inputs can be configured by the user by means of the GE-INTRO software.

One of the following meanings can be assigned to any input: (For more detail about the configuration of the inputs, see GE-INTRO Instruction Book).

Configurable digital inputs could be:

Active table select 0
Active table select 1
External trigger
521-A-a
521-A-b
521-B-a
521-B-b
521-C-a
521-C-b
522-A-a
522-A-b
522-B-a
522-B-b
522-C-a
522-C-b
Reclose sequence change

Lockout Input
1 pole reclose initiate
3 pole reclose initiate
521 manual close
522 manual close
521 reclose block (level)
522 reclose block (level)
General reclose block (level)
Lockout reset
521 reclose externally enabled.
522 reclose externally enabled
521 reclose inhibit
522 reclose inhibit
521 close externally enabled
522 close externally enabled

Elementary diagram on Figure 1 shows the factory default inputs configuration.

2.4.3.2 Outputs.

DRS includes 22 configurable isolated outputs.

The outputs are configured using the GE-INTRO configuration software.

The technical characteristics of the outputs are detailed in section 5.

The configurable outputs can be programmed using logic based on the internal protection states (pick-ups, trips, alarms, etc.). The DRS has 160 different internal states, and these can be used to carry out logical operations using NOT, AND and OR gates, giving the unit a great flexibility.

The configuration of the digital outputs and Output contacts assignment is done in different levels. At the first level it is possible to use AND gates of up to 16 signals. The output is incorporated into the states matrix so that it can in turn be used in next AND gates of up to 16 inputs. This process can continue until the 16 ANDs are used.

Once the AND gates have been configured it is possible to create a second level with OR gates of 16 inputs. All the inputs to an OR gate must belong to the same group of flags. The output of each OR gate is assigned to the DRS output selected by the user.

The default output configuration is included in the diagram of external connections in figure 1.

2.5 HUMAN MACHINE INTERFACE, HMI.

The DRS system includes as standard a 20-key keypad and a 2-line liquid crystal display (LCD) with 16 characters per line. This display has highly reliable LED diode back lighting (the screen brightness can be adjusted on the rear of the front board).

By means of this interface the user can change the settings, visualize measurements, carry out operations and access information stored in the unit. The functions of this local interface and how to use it are described in the section KEYBOARD AND DISPLAY.

2.6 REMOTE COMMUNICATIONS

The relay has 2 serial gates and three connectors. Gate 1 can be reached from the front of the relay in connector 1 (PORT 1) or from the back in connector 2 (PORT 2). The second gate can be reached from connector 3 (PORT 3), which is located on the rear.

There are different DRS models, each with a different physical connection for the PORT 3 connector (RS-232 or fiber-optic). In the "RS232" models the three connectors are RS232. In the "RS232 and fiber-optic" models the PORT1 and PORT2 connectors are RS232 while the PORT3 connector is replaced by a fiber-optic connector.

The PORT 1 connector has priority over the PORT 2 connector and is selected when the DCD (Data Carrier Detect) signal is activated. Figure 3 shows how to make the connections to a personal computer.

Communication driver 1 (PORT 1 and PORT 2 connectors) and Comm. driver 2 (PORT 3 connector) are independent and the unit can serve them simultaneously.

The communications protocol is the M-LINK for all the communication ports as standard. Optionally the PORT3 can be supplied with MODBUS RTU protocol. The M-LINK communication protocol requires the use of the GE-LOCAL software to communicate with the relay. The protocols are very reliable, and allow communication with different protection systems. They guarantee very efficient data transfer (especially for the oscillography and other large files) along with error detection and automatic communication recovery.

The status of the local/remote communication is indicated on the front of the unit by the LED indicator 16 (the last LED). Local communication refers to communication through the keypad/display, or through the communications PORTS 1 or 2, and remote communication refers to connection via the PORT 3).

Local and remote communications can exist at the same time, although in this particular situation, it is only possible to change settings and command operations using the PORT 1-2. This communication PORT has the priority (local communication) while the PORT 3 is limited only for accessing information. When the local communication is interrupted, either by the disconnection of PORT 1 connector or because the HMI is on the initial screen (a situation which can be caused intentionally, or automatically if no key has been pressed for 15 minutes), the PORT 3 recovers the ability to modify settings and carry out operations.

3. SETTINGS

This section describes the settings incorporated in the DRS, and the procedure for changing them. First, a complete list of the DRS settings is shown, with their limits, units and corresponding steps (column marked with Default indicates that this is the value of the setting when the relay leaves the factory). Individual comments for those settings that require more detailed explanation follow this table.

It is possible to see or to modify the settings manually, using the keypad and display, or by means of a computer connected to any of the serial ports. To modify the settings by means of the keyboard, go to section 8. KEYBOARD AND DISPLAY. To modify the settings using a computer follow these steps:

1. Make sure that the available connection cable coincides with the diagram in figure 3.
2. Connect the cable between the relay (or modem) and the serial port of the computer.
3. Install the DRS database supplied with the relay. This database will be installed automatically by default in the directory GE-NESIS\GE-LOCAL\WORKS (these directories are created when the GE-NESIS software is installed).
4. Run the GE_LOCAL software. For more details on the installation and use of the GE_LOCAL program see the instructions book GEK-105594.
5. Make sure that the program configuration communication parameters coincide with those of the DRS unit. More specially, these communication configuration parameters on the HMI are as follows:
    - COMMUNICATION BAUD RATE (for the relay, depending on which port is being used (local or remote))
    - STOP BITS (for the relay, depending on which port is being used (local or remote)).

To modify or view the unit's configuration parameters go to the configuration menu, corresponding to section "8. KEYBOARD AND DISPLAY".

When connecting to the relay, check that the relay number and password coincide with those that appear on the unit's configuration menu.

The DRS system has 3 settings tables stored in non-volatile memory, which can be selected by settings or configurable inputs. There is also a set of independent settings, common to all the tables. The following categories contain the settings common to the 3 tables:

GENERAL
BREAKER
OSCILLOGRAPHY MASK

The remaining categories, shown below, contain the settings which can be selected independently for each of the 3 tables:

- Recloser configuration
- Timers
- Voltage levels
- Reclose and synchronism permissions
- Pole disagreement
- Manual close permissions

It should be noted that in order to simplify setting the unit and for safety reasons, all settings related to the configuration of the unit (configurable inputs and outputs, alarms configuration and LEDs) have been removed from the keypad / display and communications software. To carry out these configuration settings changes the GE_INTRO configuration software must be run (please refer to the instruction book GEK-105594).

Unit Settings are shown in the following table:

TABLE 4 – DRS PROTECTION SETTINGS:

TEXT SHOWN ON RELAY	Index	Function	Limits	Default value
GENERAL SETTINGS	**01.0**	**General settings group**		
RELAY STATUS	01.1	Relay in service	0: out of service / 1: in service	In service
IDENTIFICATION	01.2	Relay identification	20 ASCII characters	No Id
FREQUENCY	01.3	Frequency	0:50Hz / 1:60Hz	60 Hz
LINE 1 VT RATIO	01.4	Line 1 VT ratio	1 - 4000	100
BUS 1 VT RATIO	01.5	Bus 1 VT ratio	1 - 4000	100
LINE 2 VT RATIO	01.6	Line 2 VT ratio	1 - 4000	100
BUS 2 VT RATIO	01.7	Bus 2 VT ratio	1 - 4000	100
ACTIVE TABLE	01.8	Number of the active settings table	1 -3	1
OPERATION MODE	01.9	Mode of Operation	Normal / Special	
BREAKER SETTINGS	**02.0**	**Breaker settings group**		
52-1 ID.	02.1	521 Identification	4 ASCII characters	52-1
52-2 ID.	02.2	522 Identification	4 ASCII characters	52-2
FAIL TO OPEN T.	02.3	Maximum time to open 52	0,05 - 1,00 s	0,50 s
FAIL TO CLOSE T.	02.4	Maximum time to close 52	0,05 - 5,00 s	0,50 s
52 CONTACTS	02.5	Number of breaker contacts (52/a, 52/a-52/b and 52/b	1-2-3	2: 52a and 52b contacts
MAX ACC CLOSES	02.6	Maximum accumulative number of closures + reclosures	0 - 65000	0: Out of service
MAX 79 INITIATES	02.7	Maximum reclosures initiates number in a time interval	0 - 60	0: Out of service
MAX 79 INIT TMP	02.8	Time interval for Maximum reclosures initiates number.	1 - 60 min	15 min
OSCILLOGRAPHY MASK	**03.0**	**Oscillography register settings**		
PREFAULT CYCLES	03.1	Prefault cycles	2-10	2
	03.2	*Oscillography trigger options:*		
EXTERNAL TRIGGER		External trigger input	Enable / Disable	Enable
COMM TRIGGER		Communications trigger	Enable / Disable	Enable
1P INITIATE		1 pole reclose initiate	Enable / Disable	Enable
3P INITIATE		3 pole reclose initiate	Enable / Disable	Enable

TEXT SHOWN ON RELAY	Index	Function	Limits	Default value
79 CFG. SETTINGS	**X1.0**	**79 Configuration settings group**		
79 SCHEME	X1.1	Recloser scheme		Out of service
OUT OF SERVICE			Out of service	
79-1			Reclose only 521	
79-2			Reclose only 522	
SIMULTANEOUS			Simultaneous reclose	
79-12			1-2 Sequential reclose	
79-21			2-1 Sequential reclose	
79 PROGRAM	X1.2	Recloser program		1: R1 → LO
PRG-1			1: R1 → LO	
PRG-2			2: R3 → LO	
PRG-3			3: R1 → T3 → LO	
PRG-4			4: R3 → T3 → LO	
PRG-5			5: R1 → LO + R3 → LO	
PRG-6			6: R1 → T3 → LO + R3 → T3 → LO	
PRG-7			7: R1 → T3 → LO + R3 → LO	
	X1.3	*Hold mode options:*		
WAIT 521 COND		Wait for 521 conditions	Enable / Disable	Disable
WAIT 522 COND		Wait for 522 conditions	Enable / Disable	Disable
LCKOUT EXIT MODE	X1.4	Lockout exit mode		Reclaim time
RECLAIM TIME			Reclaim time	
COMMAND			Command	
FIRST 52 FAILURE	X1.6	Failure to reclose first 52 (79 sequential)		Go to lockout
LOCKOUT			Go to lockout	
CONTINUE			Continue	
SCND 52 FAILURE	X1.7	Failure to reclose second 52 (79 sequential)		Go to lockout
LOCKOUT			Go to lockout	
CONTINUE			Continue only with first 52	
TMP 79 SETTINGS	**X2.0**	**79 timer settings group**		
TRANSITION TIME	X2.1	Transition time	0,01 - 60,00 s	0,50 s
R1 RECLOSING TIME	X2.2	R1 reclosing time	0,01 - 60,00 s	0,20 s
R3 RECLOSING TIME	X2.3	R3 reclosing time	0,01 - 60,00 s	0,20 s
T3 RECLOSING TIME	X2.4	T3 reclosing time	0,1 - 256,0 s	1,00 s
HOLD TIME	X2.5	Hold time	0,1 - 256,0 s	1,00 s
RESET TIME	X2.6	Reset time	0,1 - 256,0 s	1,00 s
DEF. OPEN TIME	X2.7	Time to definitive open	0,1 - 256,0 s	1,00 s
3P TRIP ENABLE T	X2.8	3 pole tripping enable time	0,01 - 60,00 s	0,12 s

TEXT SHOWN ON RELAY	Index	Function	Limits	Default value
VOLTAGE SETTINGS	**X3.0**	**Voltage level settings group**		
L1 DEAD	X3.1	Dead Line 1 pick-up voltage	10 - 180 V	10 V
L1 LIVE	X3.2	Live line 1 pick-up voltage	40 - 245 V	50 V
B1 DEAD	X3.3	Dead bus 1 pick-up voltage	10 - 180 V	10 V
B1 LIVE	X3.4	Live bus 1 pick-up voltage	40 - 245 V	50 V
L2 DEAD	X3.5	Dead line 2 pick-up voltage	10 - 180 V	10 V
L2 LIVE	X3.6	Live line 2 pick-up voltage	40 - 245 V	50 V
B2 DEAD	X3.7	Dead bus 2 pick-up voltage	10 - 180 V	10 V
B2 LIVE	X3.8	Live bus 2 pick-up voltage	40 - 245 V	50 V
SYNC. SETTINGS	**X4.0**	**Synchronism settings group**		
MODULE DIFF.	X4.1	Module difference	2 - 90 V	10 V
ANGLE DIFF.	X4.2	Angle difference	2º - 60º	10 º
FREQ. DIFF.	X4.3	Frequency difference	0,01 - 2,00 Hz	0,10 Hz
SYNCH. TIME	X4.4	Synchronism time to reclose	0,01 - 60,00 s	0,5 s
	X4.5	*Reclose 521 permission options:*		
DL-DB		Dead line – dead bus	Enable / Disable	Disable
LL-DB		Live line – dead bus	Enable / Disable	Disable
DL-LB		Dead line – live bus	Enable / Disable	Disable
SYNCHRO CHECK		SYNCHRO CHECK	Enable / Disable	Enable
EXTERNAL INPUT		External input	Enable / Disable	Disable
NO CONDITIONS		No conditions	Enable / Disable	Disable
	X4.6	*Reclose 522 permission options:*		
DL-DB		Dead line – dead bus	Enable / Disable	Disable
LL-DB		Live line – dead bus	Enable / Disable	Disable
DL-LB		Dead line – live bus	Enable / Disable	Disable
SYNCHRO CHECK		SYNCHRO CHECK	Enable / Disable	Enable
EXTERNAL INPUT		External input	Enable / Disable	Disable
NO CONDITIONS		No conditions	Enable / Disable	Disable
POLE DISAGREEMENT	**X5.0**	**Pole disagreement settings group**		
TRIPPING TIME	X5.1	Tripping time	0,1 - 256,0 s	1,00 s
	X5.2	*Trip permission options:*		
52-1 TRIP		521 trip allowed	Enable / Disable	Disable
52-2 TRIP		522 trip allowed	Enable / Disable	Disable

TEXT SHOWN ON RELAY	Index	Function	Limits	Default value
MANUAL CLOSE	**X6.0**	**Manual close settings group**		
SYNCH TIME	X6.1	Synchronism time to manual close	0,01 - 60,00 s	0,5 s
	X6.2	*521 close permissions options:*		
DL-DB		Dead line – dead bus	Enable / Disable	Disable
LL-DB		Line live – dead bus	Enable / Disable	Disable
DL-LB		Dead line – live bus	Enable / Disable	Disable
SYNCHRO CHECK		SYNCHRO CHECK	Enable / Disable	Enable
EXTERNAL INPUT		External input	Enable / Disable	Disable
NO CONDITIONS		No conditions	Enable / Disable	Disable
	X6.3	*522 close permissions options:*		
DL-DB		Dead line – dead bus	Enable / Disable	Disable
LL-DB		Line live – dead bus	Enable / Disable	Disable
DL-LB		Dead line – live bus	Enable / Disable	Disable
SYNCRO CHECK		SYNCRO CHECK	Enable / Disable	Enable
EXTERNAL OUTPUT		External input	Enable / Disable	Disable
NO CONDITIONS		No conditions	Enable / Disable	Disable

SETTINGS DESCRIPTION:

COMMON SETTINGS

1. GENERAL SETTINGS

1.1 RELAY STATUS:
This setting allows putting the system out or in service. If out of service, the system will never close any output, except the equipment alarm output, that will be continuously closed until the system is set to be in service. While out of service, the READY LED on the frontal plate will be red.

1.2 IDENTIFICATION:
This setting allows setting a 'name' or identification to the system (up to 20 characters). As this is an alphanumeric setting, it cannot be changed from the local numeric keypad on the frontal plate of the system.

1.3 FREQUENCY:
To set the frequency of the power system: 50 or 60 Hz.

1.4 LINE 1 VT RATIO:
This setting allow the user to visualize Line 1 voltage measures on primary values. It does not apply to measures for the event and oscillography record, since these are always secondary values.

1.5 BUS 1 VT RATIO:
This setting allow the user to visualize Busbar 1 voltage measures on primary values. It does not apply to measures for the event and oscillography record, since these are always secondary values.

1.6 LINE 2 VT RATIO:
This setting allow the user to visualize Line 2 voltage measures on primary values. It does not apply to measures for the event and oscillography record, since these are always secondary values.

1.7 BUS 2 VT RATIO:
This setting allow the user to visualize Busbar 2 voltage measures on primary values. It does not apply to measures for the event and oscillography record, since these are always secondary values.

1.8 ACTIVE SETTINGS TABLE:
This is to set which Setting Group is active (1, 2 or 3). If setting group selection digital inputs are energized, these have priority over setting 1.8. This means that it is possible to set 1.8 to Group 2 and have as active group 3, if it is selected using digital inputs.

1.9 OPERATION MODE:
This setting refers to the mode how we want to operate with the DRS. In the normal mode, we have the possibility to control up to two circuit breakers simultaneously or in sequence. In the special mode we can control only one circuit breaker, but also the DRS can control a second DRS in a Master-Slave configuration.

2. BREAKER SETTINGS

2.1 52-1 IDENTIFICATION:
This setting allows setting identification (up to 4 characters) for circuit breaker 1. As this is an alphanumeric setting, it cannot be changed from the local numeric keypad on the frontal plate of the system.

2.2 52-2 IDENTIFICATION:
This setting allows to set an identification (up to 4 characters) for circuit breaker 2. As this is an alphanumeric setting, it cannot be changed from the local numeric keypad on the frontal plate of the system.

2.3 MAXIMUM TIME TO OPEN 52:
If general setting 2.5 is set to 'two contacts, 52/a and 52/b', DRS checks if the close to open transition is done within the time set on this setting, 2.3.

2.4 MAXIMUM TIME TO CLOSE 52:
This setting is used to:
1. Set the time reclosing automatisms must wait for the breaker to close after having issued a closing command.

If this time is exceed, the automatisms will move to LOCKOUT (figures 7.2 and 7.3)

2. If general setting 2.5 is set to 'two contacts, 52/a and 52/b', DRS checks if the open to close transition is done within the time set on this setting, 2.4.

2.5 NUMBER OF 52 CONTACTS:

To set if DRS uses just 52/a, 52/b or 52/a and 52/b inputs to determine the circuit breakers status. If both contacts type are used, DRS will report additional information as 'Unknown Status', if both inputs are simultaneously energized, and 'Failure to Open' and 'Failure to Close' if both contacts are de-energized simultaneously for a time longer than set on settings 2.3 and 2.4 respectively.

If set to 2, and if breaker status is 'Unknown' neither open nor closed), functions where breaker status are used will not be active.

2.6 MAXIMUM ACCUMULATIVE NUMBER OF CLOSURES + RECLOSURES:

To set the maximum number of closures or reclosures allowed before reporting 'blocked due to maximum closures exceeded'. If set to 0, this function is disabled and closures counters for 52-1 and for 52-2 are not incremented, so no blocking is possible.

2.7 MAXIMUM RECLOSE INITIATE NUMBER IN A TIME INTERVAL:

2.8 TIME INTERVAL FOR MAXIMUM RECLOSE INITIATE NUMBER:

These two settings allow to set the maximum number of consecutive reclosures allowed within a time interval. If set to 0, this function is disabled.

3. OSCILLOGRAPHY MASK

3.1 NUMBER OF PREFAULT CYCLES

To set the number of pre-trigger cycles the user wants for his oscillography records. Pre-Trigger cycles refer to cycles before the oscillo was triggered, by any cause.

3.2 OSCILLOGRAPHY TRIGGER OPTIONS

This setting allows to set which causes may trig the oscillography recorder.

PARTICULAR SETTINGS

1. 79 CONFIGURATION SETTINGS

1.1 79 SCHEME:

This setting allows to define how reclosing will take place:

- Perform a simultaneous reclosing of both breakers.
- Perform a reclosing on just one breaker.
- Perform a sequential reclosing of breaker 1 and then breaker 2.
- Perform a sequential reclosing of breaker 2 and then breaker 1.
- Set the recloser OUT OF SERVICE.

1.2 79 PROGRAM:

To select a reclosing program among the following 7:
(R1 : Rapid or High Speed Single Pole Reclosing.
R3 : Rapid or High Speed Three Pole Reclosing.
T3 : Time Delayed Three Pole Reclosing.
LO : LOCKOUT.)

1. R1->LO: Just one High Speed Single Pole Reclosing.
2. R3->LO: Just one High Speed Three Pole Reclosing.
3. R1->T3->LO: One High Speed Single Pole Reclosing followed, if needed, by a Time Delayed Three Pole Reclosing.
4. R3->T3->LO: One High Speed Three Pole Reclosing followed, if needed, by a Time Delayed Three Pole Reclosing.

5. (R1+R3)->LO: Just one High Speed Reclosing, Single or Three Pole.
6. (R1+R3)->T3->LO: One High Speed Reclosing, Single or Three Pole followed, if needed, by a Time Delayed Three Pole Reclosing.
7. ((R1->T3)+R3)->LO: (One High Speed Single Pole Reclosing followed, if needed, by a Time Delayed Three Pole Reclosing) OR (Just one High Speed Three Pole Reclosing).

1.3 HOLD MODE:
This setting is used to make the automatism to wait the time set on X2.5-HOLD TIME if reclosing conditions are not met, before determining reclosing is not feasible. This only applies for three pole reclosures.

1.4 LOCKOUT EXIT MODE:
To set the reset action, in order to leave the LockOut status after having closed the circuit breaker. There are two reset possibilities:

- Wait for a reset command (digital input)
- Wait time set on X2.6-RESET TIME.

1.6 FAILURE TO RECLOSE FIRST 52:
For sequential reclosures, this setting is used to let (or not) the automatism to continue and try reclosing the second breaker after a failure to close the first one.

1.7 FAILURE TO RECLOSE SECOND 52:
For sequential reclosures, this setting is used to let (or not) the automatism to continue and try reclosing the first breaker (if a new Reclose initiation signal is received) after a failure to close the second one. This setting only applies if the reclosing program selected can perform more than one reclosing attempt.

2. 79 TIMER SETTINGS

2.1 TRANSITION TIME:
For sequential reclosures, this setting states the time delay after having closed the first breaker to issue the reclosing command for the second breaker.

2.2 R1 RECLOSING TIME:
To set the time delay between receiving a High Speed Single Pole Reclose initiation and issuing the closing command.

2.3 R3 RECLOSING TIME:
To set the time delay between receiving a High Speed Three Pole Reclose initiation and issuing the closing command.

2.4 T3 RECLOSING TIME:
To set the time delay between receiving a Time Delayed Three Pole Reclose initiation and issuing the closing command.

2.5 HOLD TIME:
To set the maximum time the automatisms wait for reclosing conditions to be met, if setting X1.3-HOLD MODE has been enabled. This only applies for three pole reclosings.

2.6 RESET TIME:
To set the following times:

1. Time before to end the LockOut status (if setting X1.4-LOCKOUT EXIT MODE has been set to 'RECLAIM TIME').
2. Time to consider a reclosure as successful (fault cleared) before returning to the Ready status.

2.7 TIME TO DEFINITIVE OPEN:
To set the minimum time a circuit breaker must remain open to consider it as a permanent opening. *(see figures 7.2 and 7.3).* If the breaker is at this status, open and steady, the recloser moves to LockOut.

2.8 3 POLE TRIPPING ENABLE TIME:
To set the time delay between receiving a single pole reclose initiation and activating the three-pole trip enable signal (see chapter 2.1.9)

3. VOLTAGE SETTINGS

3.1 DEAD LINE 1 PICK-UP VOLTAGE:
If Line 1 voltage is bellow the value set on this setting, it is considered DEAD, with no voltage.

3.2 LIVE LINE 1 PICK-UP VOLTAGE:
If Line 1 voltage is above the value set on this setting, it is considered LIVE, with voltage.

3.3 DEAD BUS 1 PICK-UP VOLTAGE:
If Busbar 1 voltage is bellow the value set on this setting, it is considered DEAD, with no voltage.

3.4 LIVE BUS 1 PICK-UP VOLTAGE:
If Busbar 1 voltage is above the value set on this setting, it is considered LIVE, with voltage.

3.5 DEAD LINE 2 PICK-UP VOLTAGE:
If Line 2 voltage is bellow the value set on this setting, it is considered DEAD, with no voltage.

3.6 LIVE LINE 2 PICK-UP VOLTAGE:
If Line 2 voltage is above the value set on this setting, it is considered LIVE, with voltage.

3.7 DEAD BUS 2 PICK-UP VOLTAGE:
If Busbar 2 voltage is bellow the value set on this setting, it is considered DEAD, with no voltage.

3.8 LIVE BUS 2 PICK-UP VOLTAGE:
If Busbar 2 voltage is above the value set on this setting, it is considered LIVE, with voltage.

4. SYNCHRONISM SETTINGS

4.1 MODULE DIFFERENCE:
To set the maximum module difference between voltages at both sides of a breaker to allow closures or reclosures.

4.2 ANGLE DIFFERENCE:
To set the maximum phase difference between voltages at both sides of a breaker to allow closures or reclosures.

4.3 FREQUENCY DIFFERENCE:
To set the maximum frequency difference between voltages at both sides of a breaker to allow closures or reclosures.

4.4 SYNCHRONISM TIME TO RECLOSE:
To set the minimum time conditions set on settings 4.1, 4.2 and 4.3 must be met to consider reclosures are feasible.

4.5 52-1 RECLOSE PERMISSIONS:
To set the reclosing conditions for circuit breaker 1. These can be: DL-DB, LL-DB, DL-LB , SYNCHRO-CHECK, External Permission, No Conditions.

4.6 52-2 RECLOSE PERMISSIONS:
To set the reclosing conditions for circuit breaker 1. These can be: DL-DB, LL-DB, DL-LB, SYNCHRO-CHECK, External Permission, No Conditions.

5. POLE DISAGREEMENT SETTINGS

5.1 TRIPPING TIME:
To set the time a pole disagreement situation must persist before issuing a Pole Disagreement trip.

5.2 TRIP PERMISSION:
To enable or disable Pole Disagreement trips.

6. MANUAL CLOSE SETTINGS

6.1 SYNCHRONISM TIME TO MANUAL CLOSE:

To set the minimum time conditions set on settings 4.1, 4.2 and 4.3 must be met to consider a manual closure is feasible.

6.2 52-1 CLOSE PERMISSIONS:

To set the closing conditions for circuit breaker 1. These can be: DL-DB, LL-DB, DL-LB, SYNCHRO-CHECK, External Permission, No Conditions.

6.3 52-2 CLOSE PERMISSIONS:

To set the closing conditions for circuit breaker 2. These can be: DL-DB, LL-DB, DL-LB , SYNCHRO-CHECK, External Permission, No Conditions.

4. TECNICAL CHARACTERISTICS

4.1 MODEL LIST

POSITION	DRS	1	-	0	0	-	C	0	-	0	0	1	A	-	DESCRIPTION
5															**Comm. Protocol**
			0												P1, P2: Mlink
			2												P1: Mlink ; P2: ModBus RTU
8															**Communications point to point**
						0									RS232
						1									1mm plastic F.O.
						2									62,5/125 glass F.O.
						3									RS-485
11															**Auxiliary Voltage**
															Single power supply
									G						48/125 Vdc
									H						110/250 Vdc.
15													**A**		**Revision Level**
16															**Language**
														-	Spanish
														I	English

4.2 TECHNICAL CHARACTERISTICS

MECHANICAL

- Metal casing 19 inches rack case 4 units high.
- IP51 protection grade (as per IEC 529).
- Local HMI with 2 LCD rows of 16 characters and a keypad of 20 keys.
- Rear connection by means of 104 strips of 12 terminals each.
- Dimensions: 437 x 200 x 176 mm.
- Weight: net 12 kg., shipping 13 kg

ELECTRICAL CHARACTERISTICS

- Frequency 50 or 60 Hz (selectable by setting)
- Nominal voltage: 90 to 220 Vac
- Auxiliary voltage: 48/125 Vdc or 100/250 Vdc (different models) ± 20%
- Thermal capacity:
  Voltage circuits
  - Permanent: 2 x Un
  - 1 min duration: 3.5 x Un
- Temperature ranges:
  - Operating: -20°C to +55°C
  - Storage: -40°C to +65°C
- Humidity: Up to 95% without condensation
- Tripping contacts:

- Rated voltage / Maximum opening voltage: 250/440 VAC
- Rated current / Closing current. 16/25 A
- Operating Power 4000 VA
- Mechanical life: 3 x 10E6 ops

- Burdens:
  - Voltage circuits: 0.2 VA to Un = 90 V
  - Consumption: 12 W (idle state)
  - For each digital input: 8 mA (1 W for Vaux = 125 Vdc)

COMMUNICATIONS

- Mode: Half duplex.
- Baud rates: 1200 to 19200 bps
- Type:

  - RS232 (ports 1,2)
  - Plastic fiber optic (optional port 2)
    Connector type: HFBR-4516
    Typical power output: -8dBm
    Receiver sensitivity: -39dBm
    Wave length: 660 nm
  - Glass fiber optic (optional port 2)
    Connector type: STA
    Typical power output: -17.5 dBm
    Receiver sensitivity: -24.5 dBm
    Wave length: 820 nm.
  - RS485 (optional port 2)

STANDARDS

The DRS system complies with the following standards, which include the GE insulation and electromagnetic standard and the standards required by European Community Directive 89/336 for the EC market, in line with European standards. It also complies with the European directive requirements for low voltage, and the environmental and operating requirements established in ANSI standards C37.90, IEC 255-5, IEC 255-6 and IEC 68.

Test	Standard	Class
• Insulation test voltage	IEC 255-5	600V, 2kV 50/60 Hz 1 min.
• Impulse voltage withstand	IEC 255-5	5 kV, 0.5 J
• 1 MHz interference	IEC 255-22-1	III
• Electrostatic discharge	IEC 255-22-2 EN 61000-4-2	IV 8 kV
• Immunity to radio interference	IEC 255-22-3	III
• Electromagnetic fields radiated with amplitude modulation	ENV 50140	10 V/m
• Electromagnetic fields radiated with amplitude modulation. Common mode	ENV 50141	10 V/m
• Electromagnetic fields radiated with frequency modulation	ENV 50204	10 V/m
• Fast transients	IEC 255-22-4 EN 61000-4-4	IV
• Magnetic fields at industrial frequency	EN 61000-4-8	30 Av/m
• RF emission	EN 55011	B

5. HARDWARE DESCRIPTION

CAUTION

The DRS relay contains electronic components that might be damaged by electrostatic discharge currents flowing through certain terminals. The main source of electrostatic discharge currents is the human body, especially under low humidity conditions, with carpet floors or isolating shoes. If such conditions are present, care should be taken while removing and handling DRS modules and PCB. Persons who hand these modules should make sure that their body are not charged, by either touching some surface at ground potential or by using an antistatic grounded wrist bracelet.

5.1 PHYSICAL DESCRIPTION

5.1.1 CASE

DRS case is an 19" standard rack four units high, manufactured in stainless steel and painted in gray epoxy resin. It consists of a backbone containing guides to support the different PCB and modules, and a rear plate in the same material containing the blocks of terminals. All the cases have a surge ground connection terminal in order to connect the relay to earth, essential not only in terms of personal security but also on behavior against electromagnetic disturbances.

All the modules are drawout, enabling easier maintenance and repairing of the relay.

DRS also incorporates a plastic sealed front cover. This cover keeps the relay sealed and provides a high protection against dust and water (IP51 index according to IEC529). A push-button allows access to the main functions without removing the cover.

In Figures 5 and 6, front and rear sides are shown.

5.1.2. ELECTRICAL CONNECTIONS.

DRS electrical connections: voltages, currents, digital inputs and output relays are done through drawout terminal boards with twelve terminal blocks each, located at the rear plate.

Additionally those terminal blocks, DRS relays include three communication ports. Two DB-9 ports for local connection, one on the rear plate and another on the front plate, and another one located at the rear plate used for remote point-to-point connection to the PC, or for network connection with other DDS system compatible relays. This third communication port may be, depending on the model list, an RS-232 with DB-9 connector, a fiber optic (glass or plastic) connector or finally an RS-485 connector.

Terminal blocks used for time synchronization through a demodulated IRIG-B input are also included in the rear plate.

5.1.3 INTERNAL CONSTRUCTION.

The internal architecture of DRS relays includes the following four units high drawout modules:

- 1 power supply module
- 1 magnetic module (VT inputs)
- 1 Protection CPU board
- 1 Communications CPU board
- 2 Digital inputs/outputs mixed boards

- 1 Digital outputs board

Each of these modules has a DIN type front connector used for the connection to the internal bus. Also, in case of having connections to the outside (inputs, outputs, and power supply) the male part of the terminal is incorporated. All these modules are inserted in the case perpendicularly to the rear plate.

Besides all these mentioned modules, other boards mounted parallel to the front plate are included. These modules are:

- Internal bus board.

This is a PCB board that makes the connection between the digital modules (inputs, outputs, CPU) and the auxiliary voltages from the power supply through their front DIN connectors.

- Front display board.

This is a PCB comprised of the alphanumeric display for protection management, and the configurable LEDs. Additionally, the board includes the front communication port and the bicolor LED indicating the equipment state.

The front module is solidly connected to the keypad board. A 12 pins flexible flat cable connects electrically these two modules.

The subgroup formed by these two boards is connected to the relay through another 40 pins flexible flat cable, connected itself to the front of the communications CPU.

- Front keypad board.

This is a printed circuit board, solidly joined to the front display board, as mentioned before, and supports the keypad (20 keys alphanumeric and functional keypad which acts on the alphanumeric display). This board also includes two transparent windows, one for the display and another one for the identification label with model, serial number and its more relevant technical characteristics.

The subgroup formed by both front boards is solidly joined to the case by means of 4 fixed screws placed at the four corners of the front plate. To get the access to the internal electronic modules the next steps must be followed (once the relay has been disconnected):

1. Remove the plastic cover.
2. Loose the fixed frontal screws till they are untied and only fixed by their fastening sleeve.
3. Let the front part fall softly till the flat cable, which is connected to the communication CPU, is accessible, and unfasten the extreme connected to this board.
4. Remove the frontal module.
5. Take out the internal bus, which connects the different modules.

If this process is followed, every relay module can be accessed in order to be taken out, maintained or replaced. Assembly procedure is the contrary, that is to say:

- Make sure that every drawout modules have been correctly inserted
- Assembly the internal bus that connects the different modules by pressing every connector from left to right in order to be sure of their right connection.
- Connect the front module with the communications board by using the flat cable.
- Place the frontal module at its position and screw it on the case by using the fixed screws
- Cover again the relay with its protective cover.

5.1.4 IDENTIFICATION.

Identification label of the relay is located at the right of the alphanumeric display in the frontal module. Model, serial number and more relevant nominal values are shown in this label.

Black color numbers serigraphy on the cover identifies terminal blocks placed at the rear plate. Each of the terminal blocks is identified by a letter placed at the upper border of the cover closed to the connector. This connector identifier is sequentially assigned to the different connectors, beginning by A which corresponds to the connector placed on the right extreme (looking at the relay from the back)

Each of the 12 terminals of each terminal block is identified from top to bottom by using a number between 1 to 12, which is labeled on the cover close to each connector. Synchronization connector terminals are identified by “IRIG-B” serigraphy, indicating its polarity by “+” and “-“.

For relays with fiber optic communication (glass or plastic), transmission and reception connectors terminals are identified by “TX” and “RX” labels respectively.

5.1.5 MAGNETIC MODULE.

Magnetic module takes voltage signals of the substation transformers, performing these two following operations:

- It gives galvanic isolation to external signals by means of relay internal transformers.
- It makes the external signals suitable (Accomplish) to the adequate levels for the internal electronic circuits.

Anti-aliasing filters are also included in the magnetic module. As this module is connected to external switchgear signals, it can be affected by electromagnetic disturbances. In order to avoid their effect, anti-noise filters have been included in the transformers’ primary (capacitors connected to chassis), as well as in the secondary (ferrite). This protection element act as a barrier, preventing possible disturbances generated in the relay to come out and affect the external equipment.

Last elements included in the magnetic module are load resistors. These resistors adequate the output levels of the transformers in order to be used by internal circuits.

5.1.6 PROTECTION CPU PROCESSING BOARD.

This is the main module of the protection part of the relay. The main functions are:

◊ Sampling of analog signals coming from magnetic module.
◊ Protection algorithm evaluation.
◊ Protection logic and auxiliary functions.
◊ Monitoring functions, events register, oscillography register, etc.
◊ Self-checking feature.
◊ Protection data communication to the communications CPU.

Module nucleus is a 16-bit microprocessor together with its auxiliary electronic circuits.

5.1.7 CPU COMMUNICATIONS MODULE.

Communications CPU nucleus, very similar to protection CPU module, consists of a 16-bit microprocessor together with its auxiliary electronic circuits.

Main function of the communications CPU module is to maintain and control the communications in the following channels:

◊ Internal communication with the protection and control CPU modules.
◊ Local mode communication with a PC through the front communications port.
◊ Remote mode communication through rear communication port.
◊ Man-machine interface by means of keypad and display.

5.1.8 DIGITAL INPUTS MODULE.

DRS design has been done for assuring the maximum number of inputs per board, maintaining at the same time the maximum reliability against electromagnetic disturbances.

Each of the inputs has a resistive reducer in order to adequate the external voltage battery levels (48 V, 125 V, ...) to the needs of the opto-coupler that gives galvanic insulation to each input. As the majority of these inputs come from elements connected to the substation switchgears, besides the resistive reducer one passive filter is provided in order to improve behavior against electromagnetic disturbances.

Digital inputs modules (as well as the output ones) provide one four bits selectable address, which allows including several modules in the same relay.

5.1.9 DIGITAL OUTPUTS MODULES.

Each of the DRS outputs boards includes 12 heavy-duty relays, (16 amperes continuously / 4000 VA breaking). These relays are type C (NC+NO). By means of a soldered jumper, each relay can be configured as NC or NO.

Contacts are free potential type, without common elements, and all of them have varistors between their terminals in order to protect them against overvoltages generated by the coils they are connected to, providing high immunity against electrical interference.

5.1.10 POWER SUPPLY

Power supply module includes the following functions:

- Generation, from the external battery voltage, of the necessary voltages for the operation of the DRS electronic circuitry, in this case 8 V (subsequently regulated to 5 V) for logic circuits and 24 V for trip contacts activation.
- Four configurable relays, with the same characteristic as the ones included in the outputs board.
- An auxiliary relay factory configured as system alarm.

Regarding power supply module we should emphasize that:

- One anti-noise filter is included in order to avoid possibly electromagnetic disturbances, and a current limiter is also included in order to protect the power supply against unintentional groundings.
- Configuration possibility of the output contacts provided a high versatility.
- Backup power supply possibility.

5.2 RECEPTION, HANDLING AND STORAGE.

DRS relays are supplied to the customer in a special package, protecting it adequately during transportation performed in normal conditions. Immediately after receiving the relay, it must be unpacked and customer should check whether it shows any signs of transportation damage. If it is apparent that inappropriate handling has damaged the relay, it must be immediately notified in writing to the carrier, and damage must be reported to the manufacturer.

When unpacking the relay, normal care should be taken in order not to lose the screws, documents and other auxiliary elements also supplied in the box.

If it is not intended to install the relay immediately, it is recommended to store it in its original package, and keep it in a dry, dust free and metal particles free place.

5.3 INSTALLATION.

DRS relays must be mounted on vertical planes allowing access to the front and the rear plates of the equipment. It is not necessary to have access to the lateral sides of the equipment mounted. Dimensions and panel drilling for DRS cases (19” rack 4 units high) are shown in Figure 5-4.

6. ACCEPTANCE TESTS

There follows a list of tests that can be used to check that the unit is fully operational.

6.1. CONNECTIONS AND NECESSARY EQUIPMENT

Necessary equipment:

- 4 AC voltage sources.
- One DC voltage power supply
- One multimeter
- 6 auxiliary relays to simulate the three poles of the 2 breakers.

The following connections shall be done:

- Wire the 4 AC voltage sources (to simulate VL1, VB1, VL2 and VB2) following the elementary diagram of the DRS (figure 1).
- Wire the 6 auxiliary relays that simulate the three poles of the breaker following the elementary diagram of the DRS (figure 1).

The DC power supply must be wired to terminals D11 (positive) and C11 (negative).

For safety reasons, the external protection earth terminal should be securely grounded.

6.2 VISUAL INSPECTION

Check that the relay has not suffered any kind of damage due to transport and handling.

Check that all the screws are sufficiently tight and that the terminal strips have not been damaged in any way.

Check that the information on the characteristics label coincide with those of the ordered model.

6.3 INSULATION TESTS

Progressively apply 2000 rms volts across all the terminals of a group (short-circuited one to each other) and the case, for one second.

Progressively apply 2000 rms volts between groups for one second.

6.4 POWER SUPPLY TEST

During the tests A12 terminal must be grounded for safety reasons

Apply nominal voltage to the DRS, and check that at its minimum (Vn - 20% Vn) and maximum (Vn + 20% Vn) voltage the system critical alarm is open. Check that with no voltage this contact closes.

Voltage Tests levels and typical consumption are as follows:

G Model		H Model	
Vdc	Typical Consumption (mA)	Vdc	Typical Consumption (mA)
39	550	80	550
125	227	250	227
150	205	300	205

6.5 VOLTAGE MEASUREMENT

Set the VT ratio to 1000 and system frequency to 50 Hz. (General Settings Group).

Apply the following voltages:

Magnitude	***1***	***2***	***3***	***4***	***5***
VL1 (V)	5@45º	10@0º	50@60º	100@150º	150@45º
VB1 (V)	5@0º	10@60º	50@150º	100@45º	150@0º
VL2 (V)	5@60º	10@150º	50@45º	100@0º	150@60º
VB2 (V)	5@150º	10@45º	50@0º	100@60	150@150º

Check that the system is measuring VL1, VL2, VB1 and VB2 with an accuracy better than 5%.

Change system frequency to 60 Hz. Change frequency on AC voltage sources and repeat the test.

6.6 DIGITAL INPUTS TEST

This test will be carried out applying minimum voltage (Vn - 20% Vn) and maximum voltage (Vn + 20% Vn).

Energize an input and check that the system detects its activation.
This can be done in two ways:

- Configuring an output to close when the input under test is energized.
- Configuring an LED to light on when the input under test is energized.

Remember that all these configuration changes must be done using GE_INTRO PC software.

Repeat this test for all DRS inputs.

6.7 OUTPUTS TEST.

6.7.1. OUTPUTS TEST.

All DRS outputs will be tests during the functional tests described on chapter 6.11.

6.7.2. CRITICAL ALARM OUTPUT TEST.

1. With no power supply, check that this output is closed.
2. Apply DC voltage to the DRS and check that there is no alarm signal ON, as for example 'DRS out of service', 'EEPROM Alarm' etc. If this is the case, then check that the critical alarm output is open.

6.8 COMMUNICATIONS PORTS TEST.

The test is to check that the 3 PORTS in the relay allow communication with the relay. To do this it is necessary to use a computer and a connector suitable to establish the connections between PC and relay as shown in figure 3.

The communication parameters that have to be set for the computer are DRS are as follows:

Relay number: 1
Remote port baud rate: 9600
Local port baud rate: 9600
Remote stop bits: 1
Local stop bits: 1

Using GE_LOCAL communications software, check that communications between relay and PC work properly using any of the 3 Ports. Repeat this test for different baud rates.

6.9 KEYPAD, DISPLAY AND LED TEST.

Push the TARGET RESET push button and check that all LEDs light on.

Press the following keys and check that the text on the display is the one shown on the right.

KEY	MESSAGE
< SET >	**VIEW PROTECTION SETTINGS**
< CLR >	**DRS GENERAL ELECTRIC**
< INF >	**STATUS**
< ENT >	**MODEL**
< ↑ >	**DATA BASE**
< ↓ >	**MODEL**
< CLR >	**STATUS**
< CLR >	**DRS GENERAL ELECTRIC**
< ACT >	**SET TIME/DATE**
< CLR >	**DRS GENERAL ELECTRIC**
<7169>	**NET BAUDRATE**
<↑>	**NET STOP BITS**

At this point, press one by one all the numbers (deleting them with the CLR key) and check that the pressed number appears on the display.

6.10 OPERATIONS

6.10.1. TIME SETTING.

Set the DRS with a date and time, and check on the INF menu that your inputs have been taken successfully by the DRS.

6.10.2. COMMUNICATIONS TRIGGER.

Using GE_LOCAL retrieve the header of the last oscillography record. Write down its number, date and time. Make sure that DRS settings allow you to perform a communications trigger. Perform a communications trigger.

Retrieve the header of the new oscillography record and check that it is a new one, and that it has been caused by your command. To check it is a new oscillo, just check oscillo number, date and time.

RECLOSER BLOCK

Block the recloser, and check that it does not work after a reclose initiate.

RECLOSER UNBLOCK

Unblock the recloser, and check that it works after a reclose initiate.

6.11 FUNCTIONAL TEST.

Use the factory default settings as follows:

Index	Function	Value
01.0	General settings group	
01.1	Relay status	In service
01.2	Relay identification	No id
01.3	Frequency	60 Hz
01.4	Line 1 VT ratio	100
01.5	Bus 1 VT ratio	100
01.6	Line 2 VT ratio	100
01.7	Bus 2 VT ratio	100
01.8	Active settings table	1
01.9	Operation Mode	Normal
02.0	**Breaker settings group**	
02.1	521 identification	52-1
02.2	522 identification	52-2
02.3	Maximum time to open 52	0,50 s
02.4	Maximum time to close 52	0,50 s
02.5	Number of 52 contacts	3: 52a and 52b contacts
02.6	Maximum accumulative number of closures + reclosures	0: Out of service
02.7	Maximum reclosures initiates number in a time interval	0: Out of service
02.8	Time interval for Maximum reclosures initiates number	15 min
03.0	**Oscillography register settings group**	
03.1	Prefault cycles	1
03.2	Oscillography trigger options	All enabled
X1.0	**79 Configuration settings group**	
X1.1	Recloser scheme	Out of service
X1.2	Recloser program	1: R1 → LO
X1.3	Hold mode options	All disabled
X1.4	Lockout exit mode	Reclaim time
X1.6	Failure to reclose first 52 (Sequential 79)	Go to lockout
X1.7	Failure to reclose second 52 (Sequential 79)	Go to lockout
X2.0	**79 timer settings group**	
X2.1	Transition time	0,50 s
X2.2	R1 Reclosing time	0,20 s
X2.3	R3 Reclosing time	0,20 s
X2.4	T3 Reclosing time	1,00 s
X2.5	Hold time	1,00 s
X2.6	Reset time	1,00 s
X2.7	Time to definitive open	1,00 s
X2.8	3 pole tripping enable time	0,12 s

Index	Function	Value
X3.0	**Voltage levels settings group**	
X3.1	Dead line 1 pick-up voltage	10 V
X3.2	Live line 1 pick-up voltage	50 V
X3.3	Dead bus 1 pick-up voltage	10 V
X3.4	Live bus 1 pick-up voltage	50 V
X3.5	Dead line 2 pick-up voltage	10 V
X3.6	Live line 2 pick-up voltage	50 V
X3.7	Dead bus 2 pick-up voltage	10 V
X3.8	Live bus 2 pick-up voltage	50 V
X4.0	**Synchronism settings group**	
X4.1	Module difference	10 V
X4.2	Angle difference	10 º
X4.3	Frequency difference	0,10 Hz
X4.4	Synchronism time to reclose	0,5 s
X4.5	521 reclose permission options	SYNCHRO CHECK
X4.6	522 reclose permission options	SYNCHRO CHECK
X5.0	**Pole disagreement settings group**	
X5.1	Tripping time	1,00 s
X5.2	Trip permission options	0: Both disable
X6.0	**Manual close settings group**	
X6.1	Synchronism time to manual close	0,5 s
X6.2	521 close permission options	SYNCHRO CHECK
X6.3	522 close permission options	SYNCHRO CHECK

6.11.1 POLE DISAGREEMENT FUNCTION.

1. Allow a trip caused by pole disagreement for 52-1 and 52-2 on settings group 1 (setting 1.5.2)
2. Set pole disagreement trip time to 1 sec. (setting 1.5.1)
3. Close all the poles of the auxiliary relays simulating the breaker.
4. Open just one pole of the 2 simulated breakers.
5. Check that DRS trips both breakers in 1-second time.

6.11.2 MANUAL CLOSURE, VOLTAGE DETECTORS AND SYNCHROCHECK.

1. Set the closing conditions for 52-1 and 52-2 (settings 16.2 and 16.3) to DL-DB and manually open all the poles simulating breakers.
2. Apply to the DRS the following voltages and energize the closing command inputs for 52-1 and 52-2 (R5-I8 and I5-I8). All poles will be close by the DRS.

VL1 (V)	9@9º
VB1 (V)	9@0º
VL2 (V)	9@9º
VB2 (V)	9@0º

1. Set the closing conditions for 52-1 and 52-2 (settings 16.2 and 16.3) to LL-DB and manually open all the poles simulating breakers.
2. Apply to the DRS the following voltages and energize the closing command inputs for 52-1 and 52-2 (R5-I8 and I5-I8). All poles will be close by the DRS.

VL1 (V)	59@9º
VB1 (V)	9@0º
VL2 (V)	59@9º
VB2 (V)	9@0º

1. Set the closing conditions for 52-1 and 52-2 (settings 16.2 and 16.3) to DL-LB and manually open all the poles simulating breakers.
2. Apply to the DRS the following voltages and energize the closing command inputs for 52-1 and 52-2 (R5-I8 and I5-I8). All poles will be close by the DRS.

VL1 (V)	9@9º
VB1 (V)	59@0º
VL2 (V)	9@9º
VB2 (V)	59@0º

1. Set the closing conditions for 52-1 and 52-2 (settings 16.2 and 16.3) to SYNCHRO-CHECK and manually open all the poles simulating breakers.
2. Apply to the DRS the following voltages and energize the closing command inputs for 52-1 and 52-2 (R5-I8 and I5-I8). All poles will be close by the DRS.

VL1 (V)	69@9º
VB1 (V)	60@0º
VL2 (V)	69@9º
VB2 (V)	60@0º

1. Set the closing conditions for 52-1 and 52-2 (settings 16.2 and 16.3) to EXTERNAL INPUT and manually open all the poles simulating breakers.
2. Energize the external permission inputs (R6-I8 and I6-I8) and the closing command inputs for 52-1 and 52-2 (R5-I8 and I5-I8). All poles will be close by the DRS.

1. Set the closing conditions for 52-1 and 52-2 (settings 16.2 and 16.3) to NO CONDITIONS and manually open all the poles simulating breakers.
2. Energize the closing command inputs for 52-1 and 52-2 (R5-I8 and I5-I8). All poles will be close by the DRS.

6.11.3 SIMULTANEOUS RECLOSINGS AND RECLOSING COUNTERS

1. Reset 1R1, 1R3, 1T3, 2R1, 2R3 and 2T3 reclosure counters.
2. Set:

02.0	**Breaker settings group**	
02.3	Maximum time to open 52	0,50 s
02.4	Maximum time to close 52	0,50 s
X1.0	**79 configuration settings group**	
X1.1	Recloser scheme	Simultaneous reclosures
X1.2	Recloser program	1: R1 → LO
X1.3	Hold mode	NO
X1.4	Lockout exit mode	Reclaim time
X1.6	Failure to reclose first 52 (79 sequential)	Go to lockout
X1.7	Failure to reclose second 52 (79 sequential)	Go to lockout
X2.0	**79 timer settings group**	
X2.1	Transition time	0,50 s
X2.2	Reclosing time R1	0,20 s
X2.3	Reclosing time R3	0,30 s
X2.4	Reclosing time T3	1,00 s
X2.5	Hold time	1,00 s
X2.6	Reset time	10,00 s
X2.7	Time to definitive open	1,00 s
X2.8	3 Pole tripping enable time	0,15 s

Recloser program-1: High speed single pole reclosing

1. Force a single pole fault situation (active the single pole initiate input with a 100ms pulse and open just one pole from each simulated breaker). Time to open of simulated breakers should be under R1 reclosing time value (0,200 s)
2. Check that DRS recloses these poles. In order to check the reclosing time values, the oscillography record generated must be downloaded to a PC with GE_LOCAL software and checked with the DRStool.
3. Check that 1R1 and 2R1 reclosures counters have been increased in one unit.

Recloser program-2: High speed three pole reclosing

1. Set X1.2- Recloser program = 2: R3 → LO.
2. Force a three pole fault situation (active the three pole initiate input with a 100ms pulse and open the three poles from each simulated breaker). Time to open of simulated breakers should be under R3 reclosing time value (0,300 s)
3. Check that DRS recloses these poles. In order to check the reclosing time values, the oscillography record generated must be downloaded to a PC with GE_LOCAL software and checked with the DRStool.
4. Check that 1R3 and 2R3 reclosures counters have been increased in one unit.

Recloser program-3: High speed single pole reclosing followed by Time Delayed three pole reclosing

1. Set X1.2-Recloser program = 3: R1→T3 → LO.
2. Set X4.5 521 Reclose permissions = No conditions
3. Set X4.6 522 Reclose permissions = No conditions
4. Force a single pole fault situation (active the single pole initiate input with a 100ms pulse and open just one pole from each simulated breaker). Time to open of simulated breakers should be under R1 reclosing time value (0,200 s)
5. Check that DRS recloses these poles.
6. Before Reset time expired (10 s) force a three pole fault situation (active the three pole initiate input with a 100ms pulse and open the three poles from each simulated breaker). Time to open of simulated breakers should be under T3 reclosing time value (1,00)
7. Check that DRS recloses these poles again.
8. Check that 1R1, 2R1, 1T3 y 2T3 reclosures counters have been increased in one unit.

6.11.4 LOCKOUT RECLOSE BY ACCUMULATED RECLOSES

1. Reset 1 and 2 closures counters.
2. Set:

02.0	**Breaker settings group**	
02.3	Maximum time to open 52	0,50 s
02.4	Maximum time to close 52	0,50 s
02.6	Maximum accumulative number of closures + reclosures	2
X1.0	**79 configuration settings group**	
X1.1	Recloser scheme	Simultaneous recloses
X1.2	Recloser program	1: R1 → LO
X1.3	Hold mode	No
X1.4	Lockout exit mode	Reclaim time
X1.6	Failure to reclose first 52 (79 sequential)	Go to lockout
X1.7	Failure to reclose second 52 (79 sequential)	Go to lockout
X2.0	**79 timer settings group**	
X2.1	Transition time	0,50 s
X2.2	R1 Reclosing time	0,20 s
X2.3	R3 Reclosing time	0,30 s
X2.4	T3 Reclosing time	1,00 s
X2.5	Hold time	1,00 s
X2.6	Reset time	10,00 s
X2.7	Time to definitive open	1,00 s

X2.8	3 pole tripping enable time	0,15 s

1. Force a single pole fault situation (active the single pole initiate input with a 100ms pulse and open just one pole from each simulated breaker) for three times. Time to open of simulated breakers should be under R1 reclosing time value (0,200 s)
2. Check that DRS only recloses for twice and 1 and 2 reclosures counters are equal to 2
3. Check that LOCKOUT 79-1 ACCUMULATED RECLOSURES internal status signal is active.

6.11.5 LOCKOUT RECLOSE BY REPETITIVE TRIPPING

1. Reset 1 and 2 closures counters.
2. Set:

02.0	**Breaker settings group**	
02.3	Maximum time to open 52	0,50 s
02.4	Maximum time to close 52	0,50 s
02.6	Maximum accumulative number of closures + reclosures	0
02.7	Maximum reclosures initiates number in a time interval	2
02.8	Time interval for Maximum reclosures initiates number	1 min
X1.0	**79 configuration settings group**	
X1.1	Recloser scheme	Simultaneous reclosures
X1.2	Recloser program	1: R1 → LO
X1.3	Hold mode options	All disabled
X1.4	Lockout exit mode	Reclaim time
X1.6	Failure to reclose first 52 (79 sequential)	Go to lockout
X1.7	Failure to reclose second 52 (79 sequential)	Go to lockout
X2.0	**79 timer settings group**	
X2.1	Transition time	0,50 s
X2.2	R1 Reclosing time	0,20 s
X2.3	R3 Reclosing time	0,30 s
X2.4	T3 Reclosing time	1,00 s
X2.5	Hold time	1,00 s
X2.6	Reset time	10,00 s
X2.7	Time to definitive open	1,00 s
X2.8	3 pole tripping enable time	0,15 s

1. Force a single pole fault situation (active the single pole initiate input with a 100ms pulse and open just one pole from each simulated breaker) for three times. Time to open of simulated breakers should be under R1 reclosing time value (0,200 s)
2. Check that DRS only recloses twice and 1 and 2 reclosures counters are equal to 2.
3. Check that LOCKOUT REPETITIVE TRIPPING internal status signal is active and it is deactivated before one-minute time.

6.11.6 THREE POLE TRIPPING ENABLE

Set:

X1.0	**79 configuration settings group**	
X1.1	Recloser scheme	Simultaneous reclosures
X1.2	Recloser program	1: R1 → LO

1. Check that 3 POLE TRIPPING ENABLE internal status signal and E6-F6 output are not activated.

Set:

X1.0	**79 configuration settings group**	
X1.1	Recloser scheme	Out of service
X1.2	Recloser program	1: R1 → LO

1. Check that 3 POLE TRIPPING ENABLE internal status signal and E6-F6 output are activated.

Set:

X1.0	**79 configuration settings group**	
X1.1	Recloser scheme	Simultaneous reclosures
X1.2	Recloser program	1: R3 → LO

1. Check that 3 POLE TRIPPING ENABLE internal status signal and E6-F6 output are activated.

6.11.7 SEQUENTIAL RECLOSE

1. Set:

02.0	**Breaker settings group**	
02.3	Maximum time to open 52	0,50 s
02.4	Maximum time to close 52	0,50 s
X1.0	**79 configuration settings group**	
X1.1	Recloser scheme	Sequential reclose 12
X1.2	Recloser program	1: R1 → LO
X1.3	Hold mode options	All disabled
X1.4	Lockout exit mode	Reclaim time
X1.6	Failure to reclose first 52 (79 sequential)	Go to lockout
X1.7	Failure to reclose second 52 (79 sequential)	Go to lockout
X2.0	**79 timer settings group**	
X2.1	Transition time	1,00 s
X2.2	R1 Reclosing time	0,20 s
X2.3	R3 Reclosing time	0,30 s
X2.4	T3 Reclosing time	1,00 s
X2.5	Hold time	1,00 s
X2.6	Reset time	10,00 s
X2.7	Time to definitive open	1,00 s
X2.8	3 Pole tripping enable time	0,15 s

Recloser program-1: High Speed single pole reclosing

1. Force a single pole fault situation (active the single pole initiate input with a 100ms pulse and open just one pole from each simulated breaker). Time to open of simulated breakers should be under R1 reclosing time value (0,200 s)
2. Check that DRS recloses these poles one second later. In order to check these reclosing times, oscillography record should be downloaded to a PC with the GE_LOCAL software and check it with the DRStool.
3. Check that time between SINGLE POLE RECLOSING INITIATE input activation and 52-1 CLOSE output activation is 0,02 s plus R1 Reclosing time = 0,200s.

Recloser program-2: High Speed Three pole reclosing

1. Set X1.2 - Recloser program = 2: R3 → LO.
2. Force a three pole fault situation (active the three pole initiate input with a 100ms pulse and open the three poles from each simulated breaker). Time to open of simulated breakers should be under R3 reclosing time value (0,300 s)
3. Check that DRS recloses these poles one second later. In order to check these reclosing times, oscillography record should be downloaded to a PC with the GE_LOCAL software and check it with the DRStool.
4. Check that time between THREE POLE RECLOSING INITIATE input activation and 52-1 CLOSE output activation is 0,02 s plus R3 Reclosing time = 0,300s.

Recloser program-3: High Speed Single Pole Reclosing → Time Delayed Three Pole Reclosing

1. Set X1.2-Recloser program=3: R1→T3 → LO.
2. Set X4.5 521 Recloser permissions = No conditions
3. Set X4.6 522 Recloser permissions = No conditions
4. Force a single pole fault situation (active the single pole initiate input with a 100ms pulse and open just one pole from each simulated breaker). Time to open of simulated breakers should be under R1 reclosing time value (0,200 s)
5. Check that DRS recloses these poles one second later.
6. Check that time between SINGLE POLE RECLOSING INITIATE input activation and 52-1 CLOSE output activation is 0,02 s plus R1 Reclosing time = 0,200s.
7. Before Reset time expired (10 s) force a three pole fault situation (active the three pole initiate input with a 100ms pulse and open the three poles from each simulated breaker). Time to open of simulated breakers should be under T3 Reclosing time value (1,00)
8. Check that DRS recloses these poles again one second later.
9. Check that time between THREE POLE RECLOSING INITIATE input activation and 52-1 CLOSE output activation is 0,02 s plus T3 Reclosing time = 1,00 s.

7. INSTALLATION AND MAINTENANCE

7.1 INSTALLATION.

The relay should be installed in a clean, dry and dust free place, with no vibrations. It should also be well lit to make easy inspection and testing.

It should be mounted on a vertical surface. Panel drilling diagram for panel mounting is shown in Figure 2.

Given that DRS design is based on high performance digital technology and manufacturing has been made with high precision instrumentation in a controlled process, recalibrate the relay it is not necessary. However, if the tests show that it is necessary to recalibrate the relay, it is recommended that the unit will be returned to manufacturer to have this done.

7.2 CONNECTION TO GROUND AND SUPPRESSION OF DISTURBANCES.

A12 terminal (see figure 6) should be connected to ground so that the disturbance suppression circuits included in the system work correctly. This connection should be as short as possible (25 cm or less preferably) to guarantee maximum protection. In this way, capacitors internally connected between the inputs and ground divert high frequency perturbances directly to ground without passing through the electronics circuitry, protected them perfectly.

This connection also guarantees physical security of personal who handles the relay, since the whole casing is connected to ground.

7.3 MAINTENANCE

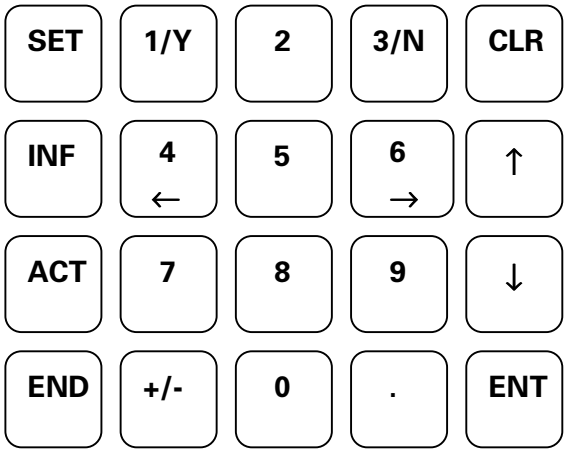
Given the important role played in the operation of any installation by the relays, a periodic program of tests is highly recommended. Testing the unit is recommended at intervals of 2 years or more. The unit incorporates built-in diagnostic functions in order to detect immediately some of the most likely circuit failures; customer can consult the results of this tests with the only aid of the keypad and display. Although these built in autodiagnosis does not reduce time between failures, it does increase the availability of the protection because it allows a drastic reduction in the average time involved in detecting and repairing the damage.

The set of tests that can be carried out to test all the features of the DRS functions are described in detail in ACCEPTANCE TESTS chapter.

Since most of the protection and communication functions are integrated in two separates programs, it is unlikely that faults will occur due to problems of wear or aging which are typical in electromechanical, analog or hybrid protection systems. Moreover, a failure in the communication processor does not affect protection functions, which are implemented by a dedicated processor.

8. KEYBOARD AND DISPLAY

The DRS has a 20 key keypad and a liquid crystal display with 32 characters, divided into two rows of 16 each. The appearance of the DRS keypad is shown in the following figure:



The keypad program uses menus to provide access to the different relay functions. These functions are divided in five large groups, each of them is accessed by means a different key. These groups are the following:

Information: Provides data about status relay. This menu is accessed using **INF** key.

Operations: It allows to synchronize date and time of the relay and to execute a communications trigger. This menu is accessed using **ACT** key.

Settings: Permits consulting and changing all the relay settings. This menu is accessed using **SET** key.

Configuration menu: Permits accessing to the system configuration, where passwords, access, communication speeds, etc. can be modified. This menu is accessed by keying in the code "**7169**" (GE in ASCII code). In order to access this mode, relay should be on the standby screen.

Single key menu: By pressing the ENT key the DRS can be operated in a simplified mode. It is not necessary to remove the methacrylate cover on the front of the relay to access this mode.

In standby mode, DRS shows the following on the display:

DRS
GENERAL ELECTRIC

From here, one of the last five groups mentioned before must be selected. In order to select a different group you must return to this screen and press the key that corresponds to that group.

Once inside a group, it is not possible to select a different group without leaving first and going back to the standby screen. Movement inside a group is carried out using the followings keys: ENT, CLR, ↑, ↓, ← y →. Their functions are as follows:

ENT: Accepts the option shown on the screen in that moment. It is equivalent to go down one level in the menu tree.

CLR: Abandons the option shown on the screen in that moment. It is equivalent to go up one level in the menu tree.

↑/↓: Change the option. It is equivalent to a horizontal movement inside a menu. When the required option appears on the display it can be selected by pressing the **ENT** key.

←/→: Show the different possibilities of a given setting. When the required option appears on the display it can be selected by pressing the **ENT** key.

8.1 MENU TREE.

The DRS has different menus divided into levels. Level 0 is the standby screen. Pressing the corresponding group key (SET, INF, etc.) accesses level 1 of the menus. Inside the level, movement is done using ↑/↓. To go down to levels 2 and 3, ENT key must be pressed. To go up a level inside the menu tree, CLR key must be pressed. Level 1 menu for each of the five groups is shown in the following table:

Group	Level 1	Description
SET	• VIEW PROTECTION SETTINGS • MODIFY PROTECTION SETTINGS	• View protection settings • Modify protection settings
INF	• STATUS	• Show the status of the relay
ACT	• SET DATE/TIME • COMM. TRIGGER	• Change date and time of the relay • Trigger oscillography by communication
ENT	• V1 • V2	• Show voltage 1 in kV referred to the primary • Show voltage 2 in kV referred to primary
	• V3 • V4	• Show voltage 3 in kV referred to primary • Show voltage 4 in kV referred to primary
	• FREQUENCY • PROTEC. STATUS • ACTIVE TABLE • DATE/TIME	• Show frequency in Hz. • Show the status of the protection system (in or out of service) • Show the active settings table number • Show date and time of the unit
7169	• NET. BAUDRATE • NET. STOP BITS • LOC. BAUDRATE • LOC. STOP BITS • LOCAL SETTINGS • REM SETTINGS • LOC. OPERATIONS • REM OPERATIONS • UNIT NUMBER • PASSWORD • t TIMEOUT	• Communications baud rate on remote network • Stop bits, remote network communications • Baud rate of local communication • Stop bits, local communications • Local settings changes allowed / not allowed • Remote settings changes allowed / not allowed • Local operations allowed / not allowed • Remote operations allowed / not allowed • Shows the unit number of the relay • Allows modification of the relay password • Maximum time of external synchronization in order to avoid timeout event

8.2 SETTINGS GROUP.

This group allows viewing and modifying of DRS settings. It is accessed by pressing SET key when DRS is in standby mode. When this key is pressed, the following message appears on the screen:

Pressing the up/down keys the following message will be displayed:

It is important to remember that in order to go down a level in the tree menu ENT key must be pressed and that to go up the CLR key should be pressed.

The DRS has a group of settings that is common for all the tables and others specific for each setting table.

The common settings are:

- General settings
- Breaker settings
- Oscillography mask options

The rest of the groups are applicable to each table independently, different groups being available for each table.

The steps to be taken in order to change any setting are as follows:

1. Press the SET key
2. Select the MODIFY SETTINGS option
3. Select the required setting inside the menu tree
4. Enter the value to be modified (or select the required value from the list of available values using $\leftarrow$ $\rightarrow$).
5. Press the ENT key. If any other setting in the same group is to be modified, steps 3 to 5 must be repeated.
6. Press the END key.

Relay will ask for confirmation of the change showing the following message on the display:

7. If you want to confirm the change press the 1/Y key (otherwise press 3/N key).

8. The DRS will then show the following message on the screen:

8. Press the CLR key repeatedly in order to return to the standby screen.

If the setting entered is outside the limits of the range for that setting, the relay will not accept the change and the following message will be displayed:

Some settings do not require to enter a value through the keypad. They are just a selection of an option among several possibilities. In this case the options can be visualized using the ←/→ keys.

8.3 INFORMATION GROUP.

This group provides information related to DRS internal status. Press the INF key in the main menu to access this group. If this key is pressed the following message will be displayed on the display:

Press the INF key in order to access to status menu. Inside this level we can move through the contents by using the ↑ and ↓ keys.

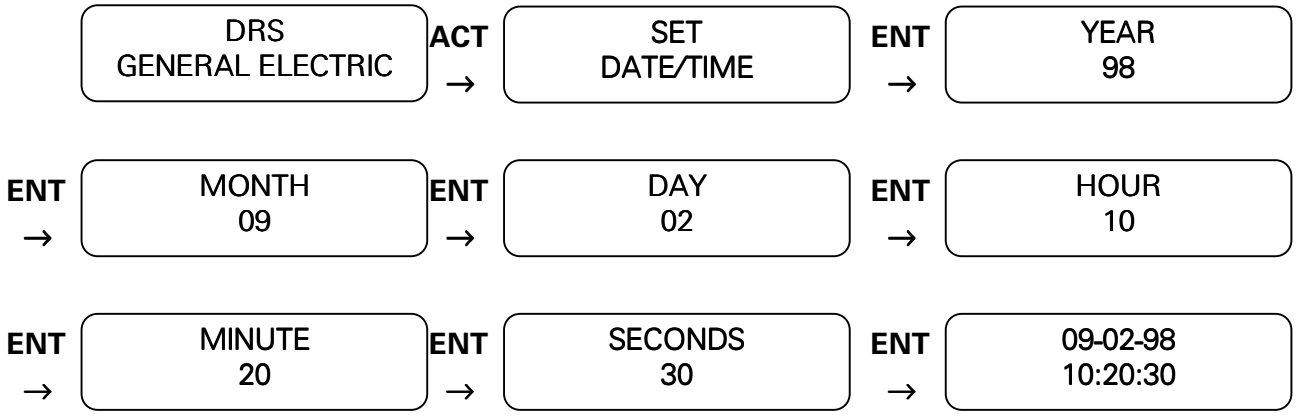
8.4 OPERATIONS GROUP.

This group allows to set date and time of the relay, and also to trigger an oscillography register.

To access the operations group press the ACT key when the relay is in standby mode. Possible Operations are the following:

- Set date and time
- Oscillography triggering.
- Recloser block
- Recloser unblock

To set the date and time, the following steps should be taken:



***NOTE** : If the default numerical value present must be changed, press the CLR key in order to delete it.*

Carrying out TRIGGER OSCILLOGRAPHY operation an oscillography register is started and stored when it finishes. GE_LOCAL software can be used in order to download the four last registers to a PC in COMTRADE format. To view these COMTRADE files GE_OSC program can be used.

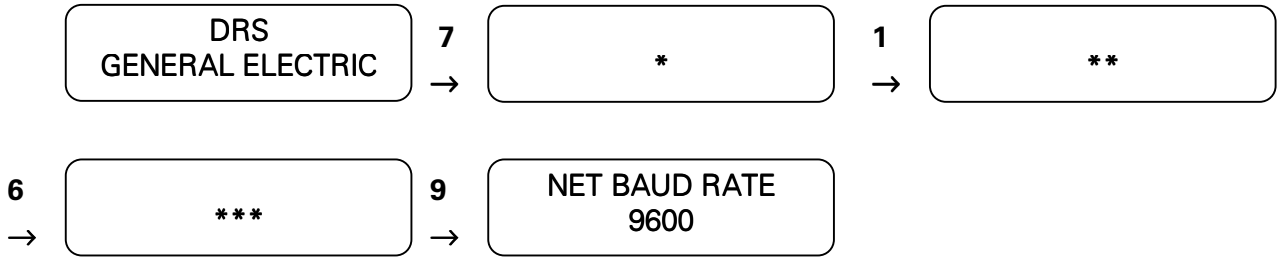
8.5 SINGLE KEY OPERATION.

The DRS has a simplified operation mode, which can be used by pressing the ENT key. This mode allows accessing to diverse information about the relay with no need to remove the external methacrylate cover. Operation of this mode is by pressing repeatedly the ENT key. This mode can be only accessed from the standby screen.

8.6 CONFIGURATION MENU

The DRS relay includes a configuration unit that can exclusively be accessed by means of the keypad. The aim is to select the way in which the DRS interacts with the exterior.

To enter the configuration menu, start from the standby screen and use the keypad to enter a four digit numerical code. If the code is correct, access to the configuration unit is permitted. If not the relay will return to the standby screen. The code is unique for all the DRS relays and it is not intended to be a password, but rather a simple safety measure to avoid accidental changes of the configuration. This code is **7169**, chosen because it coincides with the ASCII code for the GE initials. This is the way to enter the configuration unit from the standby screen:



The value and meaning of the settings are explained below. It is important to mention that movement between the options of this group is pressing the **up/down** keys.

- **NET. BAUDRATE**: It is the baud rate that DRS relay will use for serial communications through the remote port. The possible values for this setting are between 1200 and 19200 baud.
- **NET. STOP BITS**: It is the number of stop bits added to each byte transmitted on the serial line. It is treated as a binary logic setting selected by means of the logic key 1/Y as 1 and 3/N as 2.
- **LOC. BAUDRATE**: It is the baud rate that DRS relay will use for serial communications through the local port. The possible values for this setting are between 1200 and 19200 baud.
- **LOC. STOP BITS:** same as above but for local communications.
- **LOCAL SETTINGS**: Enables / disables setting changes by local communication.
- **REM SETTINGS**: Enables / disables setting changes by remote communications.
- **LOC OPERATIONS**: Enables / disables operations performed by local communications.
- **REM OPERATIONS**: Enables / disables operations performed by remote communications.
- **UNIT NUMBER**: Each DRS is identified by an unit number that serves to identify the messages directed to it when there are several devices connected to the same communication network. This number may be between 1 and 255, both included.
- **PASSWORD**: In order to prevent unauthorized persons from communicating remotely with the relay via GE_LOCAL program and changing the settings or performing operations, a password is provided by the relay. This password can only be seen on the relay display and takes the form of a number between 0 and 99999. The password introduced in GE_LOCAL should be identical to the relay password in order to permit the connection with it.

- **t TIMEOUT** : Set to 0 if the relay is not working in a DDS integrated system. Set to maximum time between two synchronism signals coming from the PC host when the relay is working in a DDS integrated system. If a new synchronism signal is not received in this time, the relay will report an error (“clock not set” alarm event).

FIGURES

LIST OF FIGURES

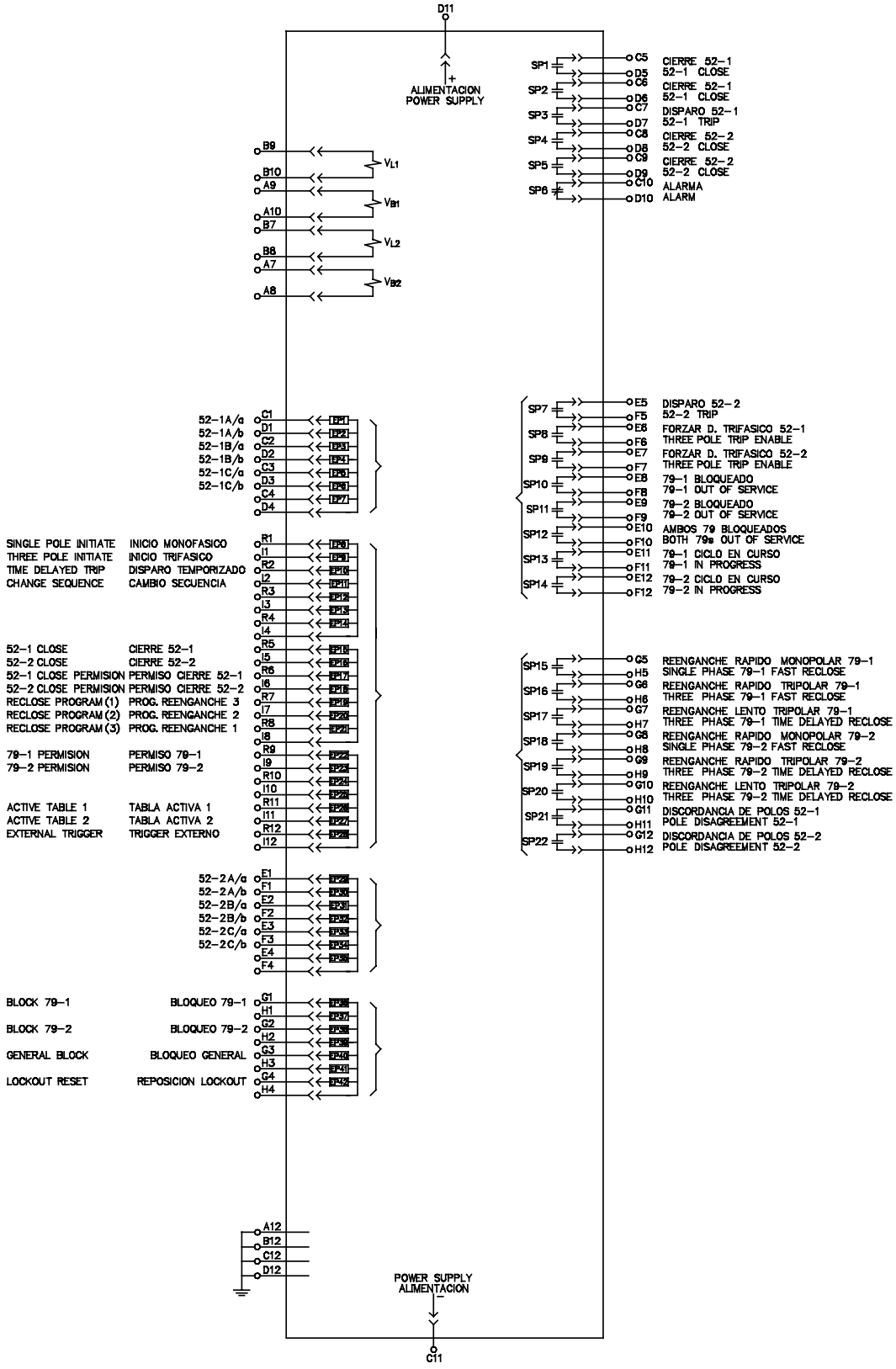


Figura 1 : *External Connections (189C40950202)*

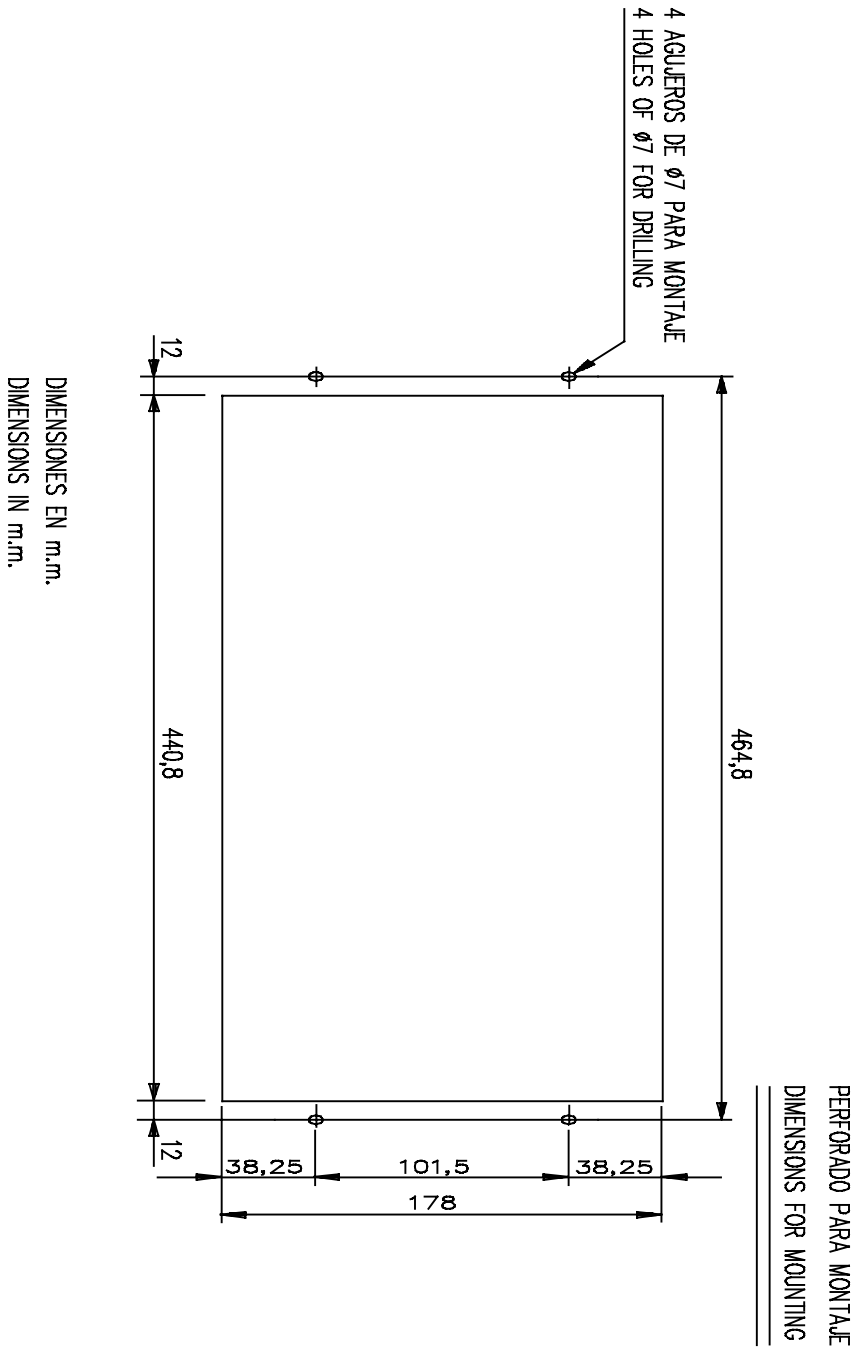
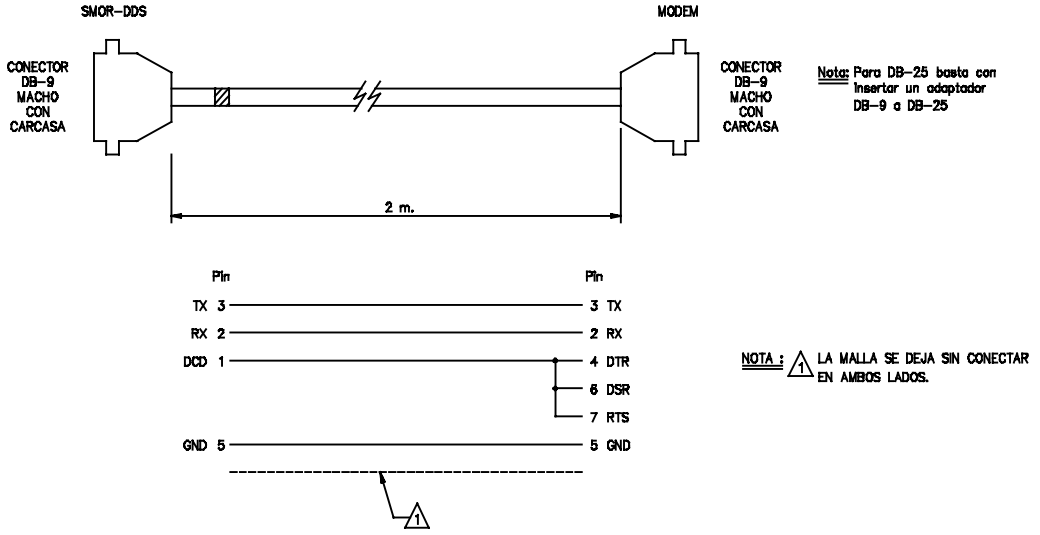


Figura 2 : *Panel drilling dimensions*



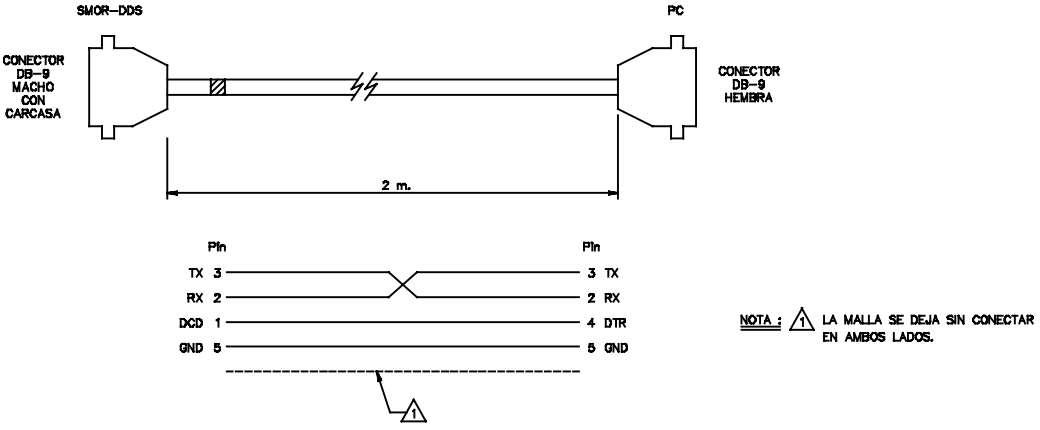


Figura 3. *RS-232 Connection*

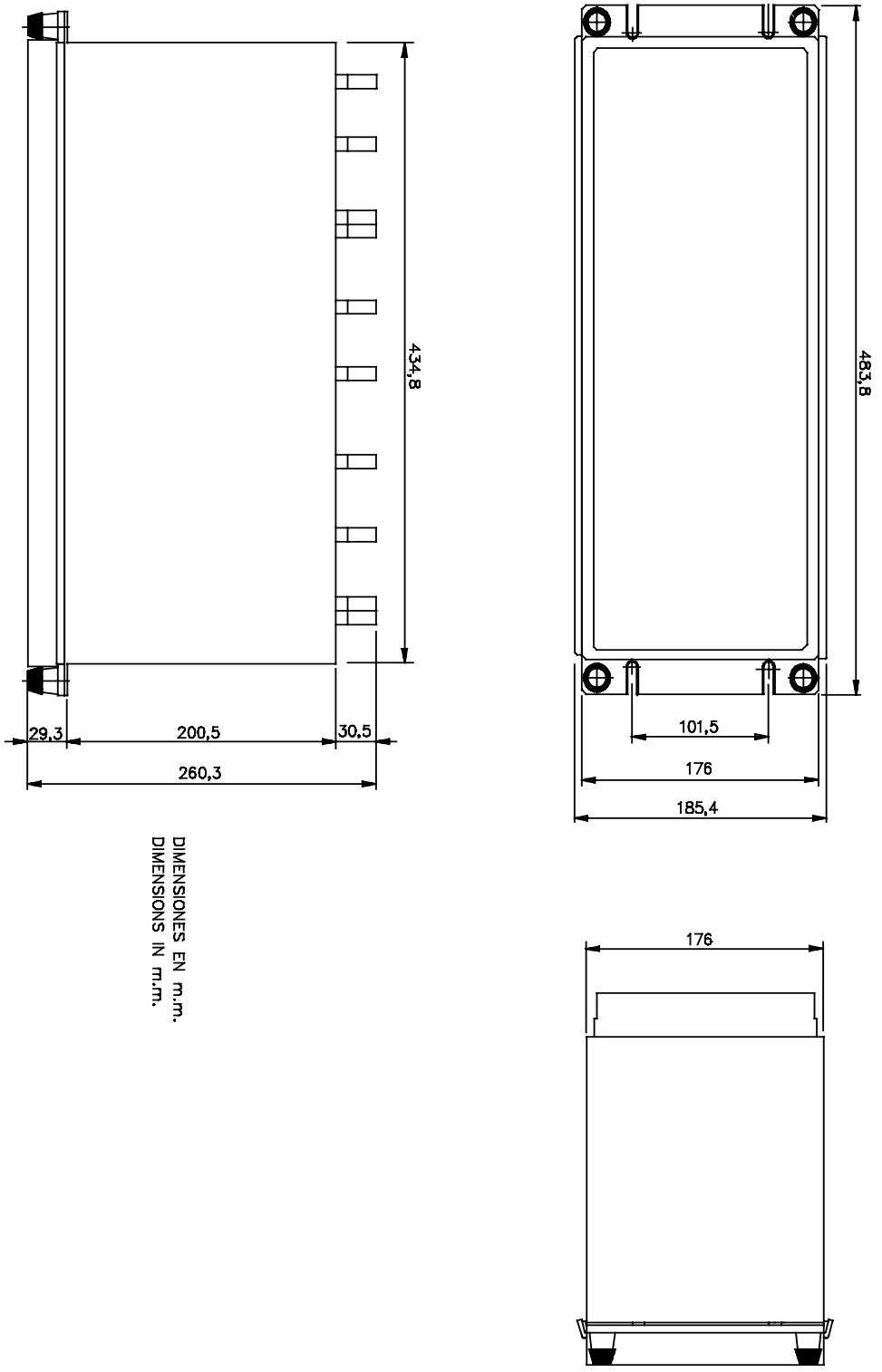


Figura 4 *: Dimensions diagram*

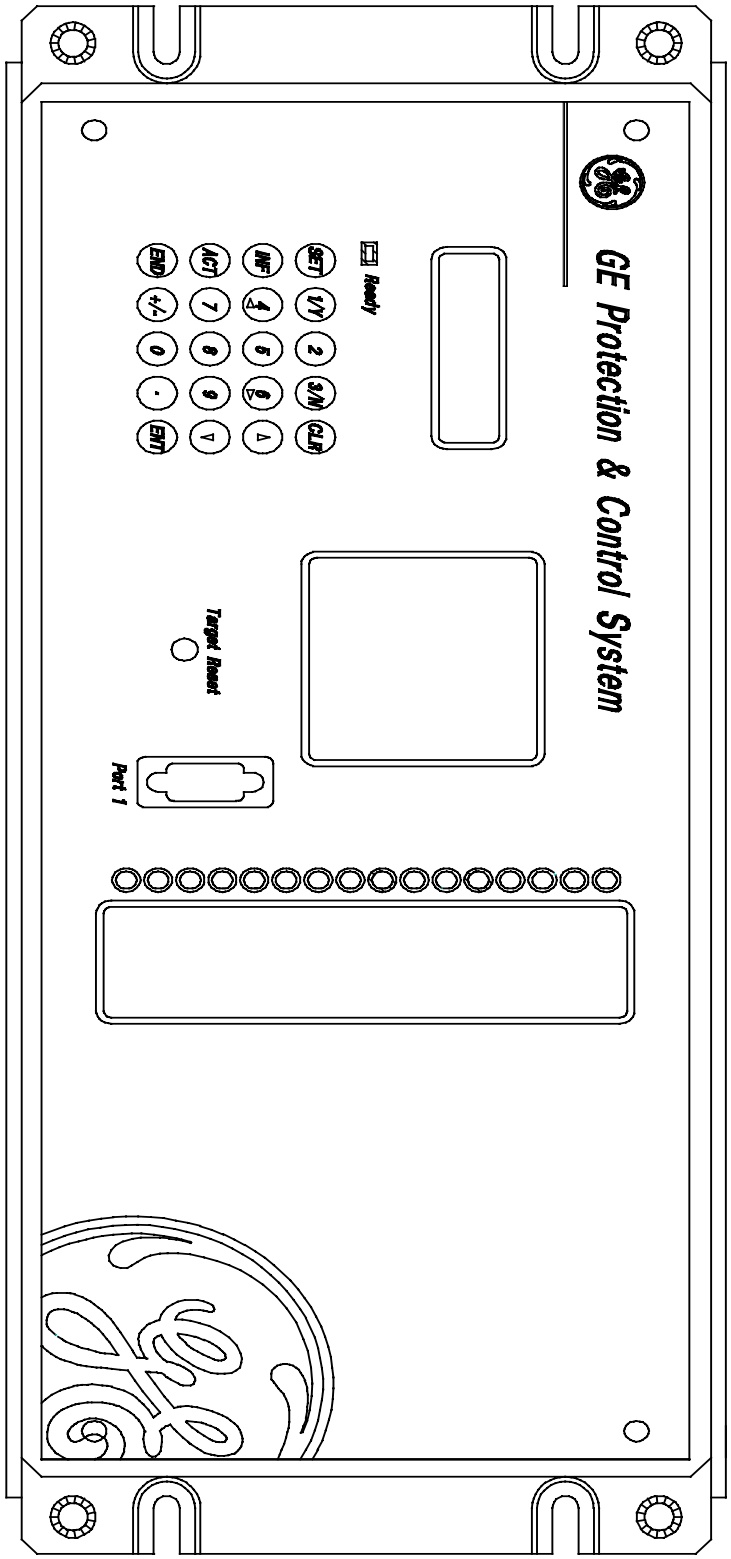


Figura 5 *: Front view*

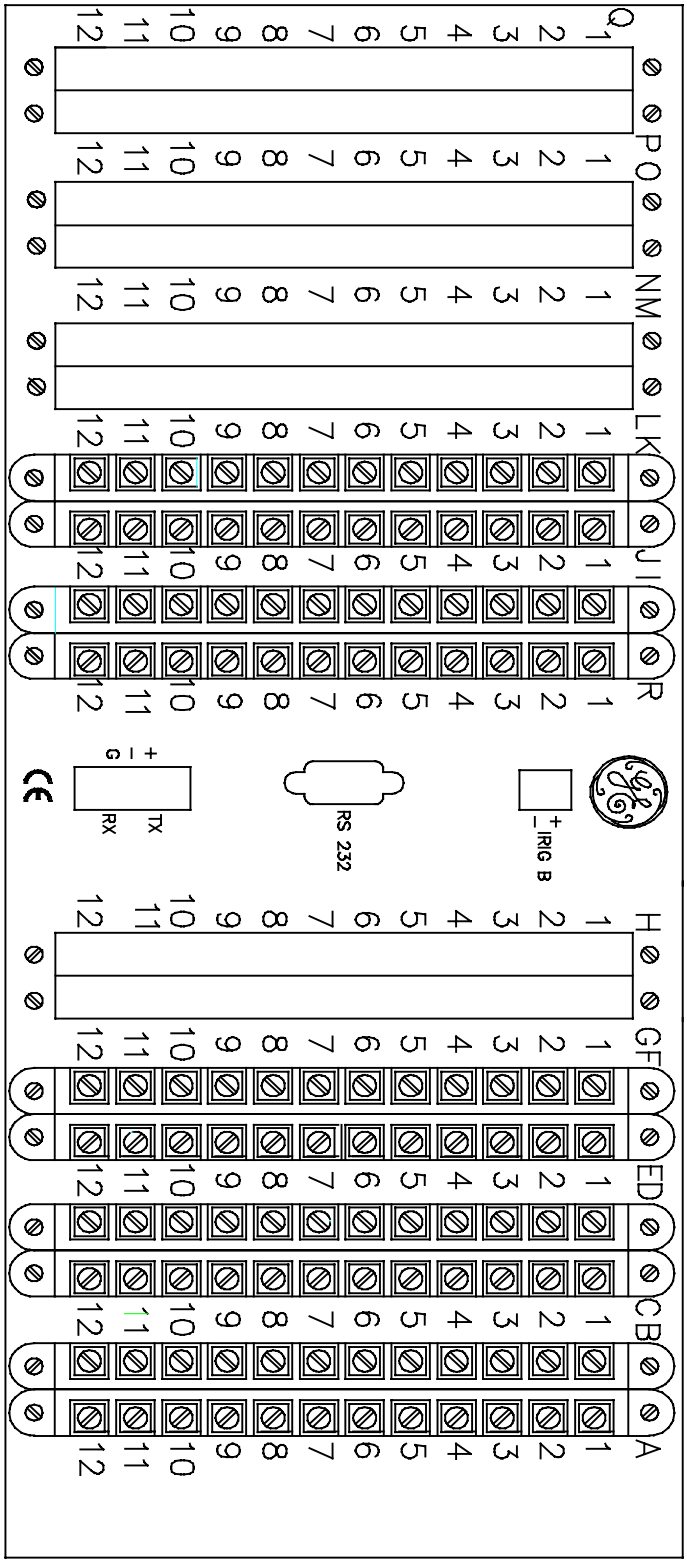


Figura 6 *: Rear View*

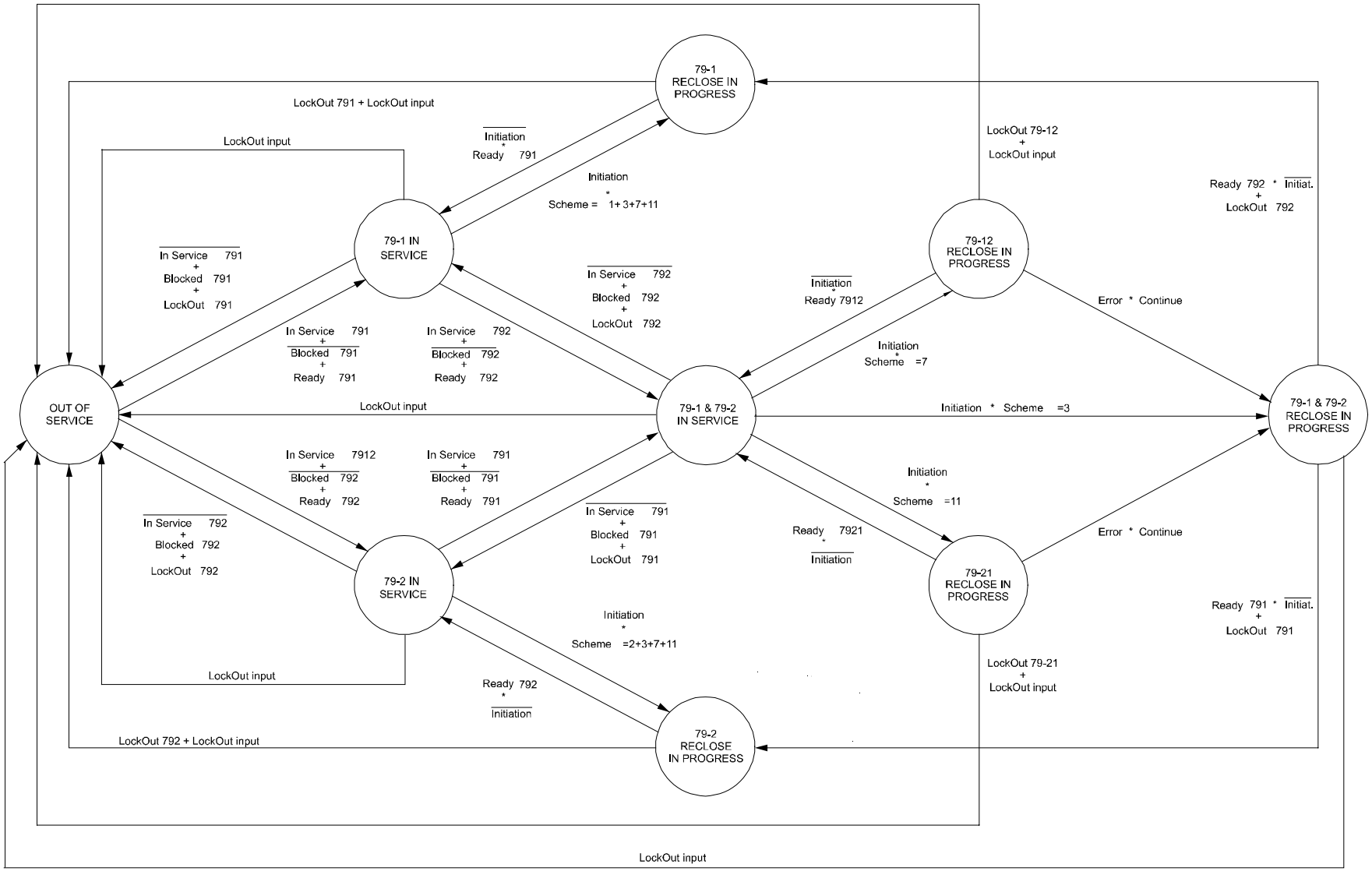


Figure 7.1. *General Automat (C4095F3)*

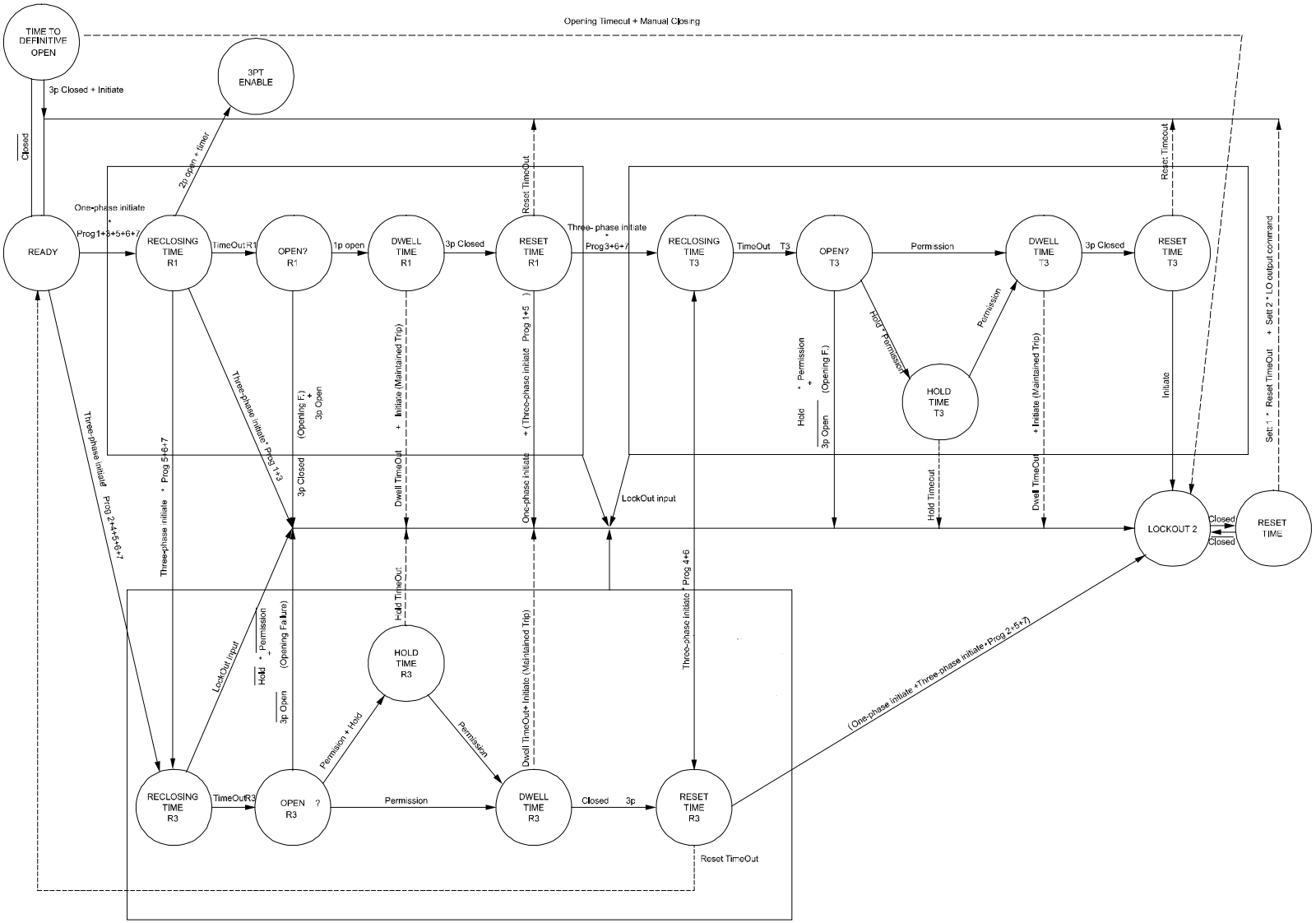


Figure 7.2.1. *Single reclose automat - Normal Operation (C40950401)*

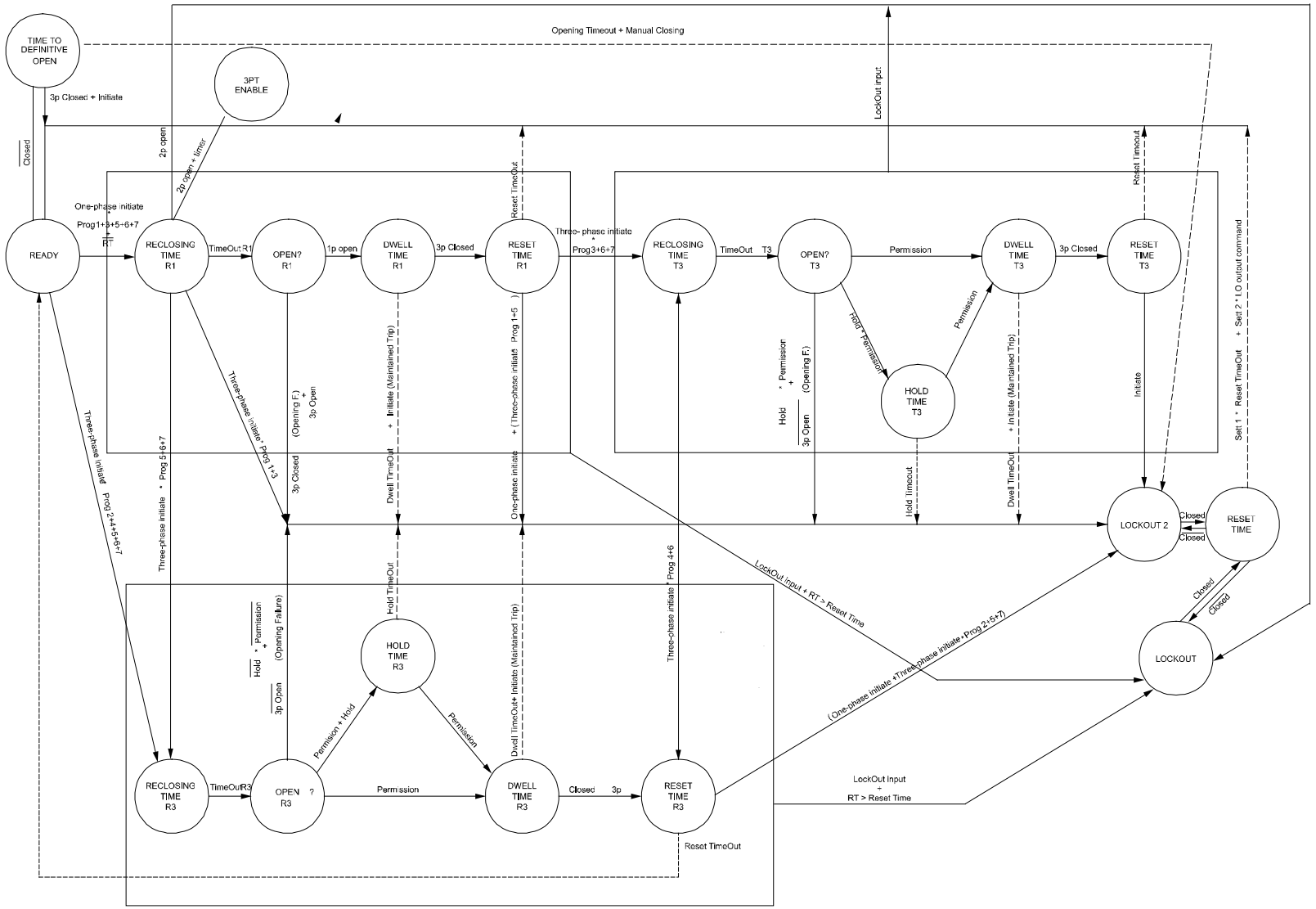


Figure 7.2.2. *Single reclose automat - Special Operation (C40950401)*

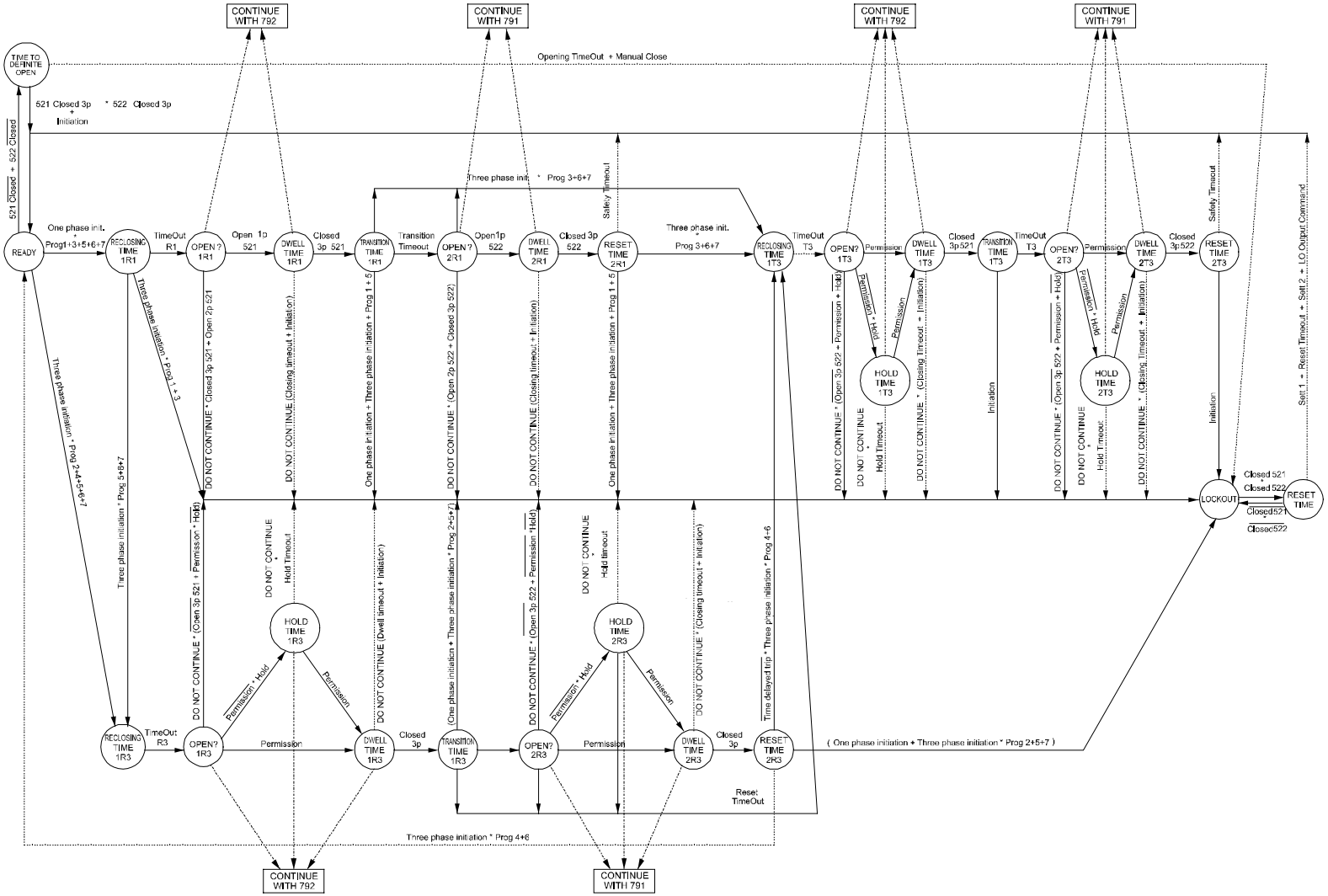


Figure 7.3. *Sequential Reclose Automat (C40950502)*