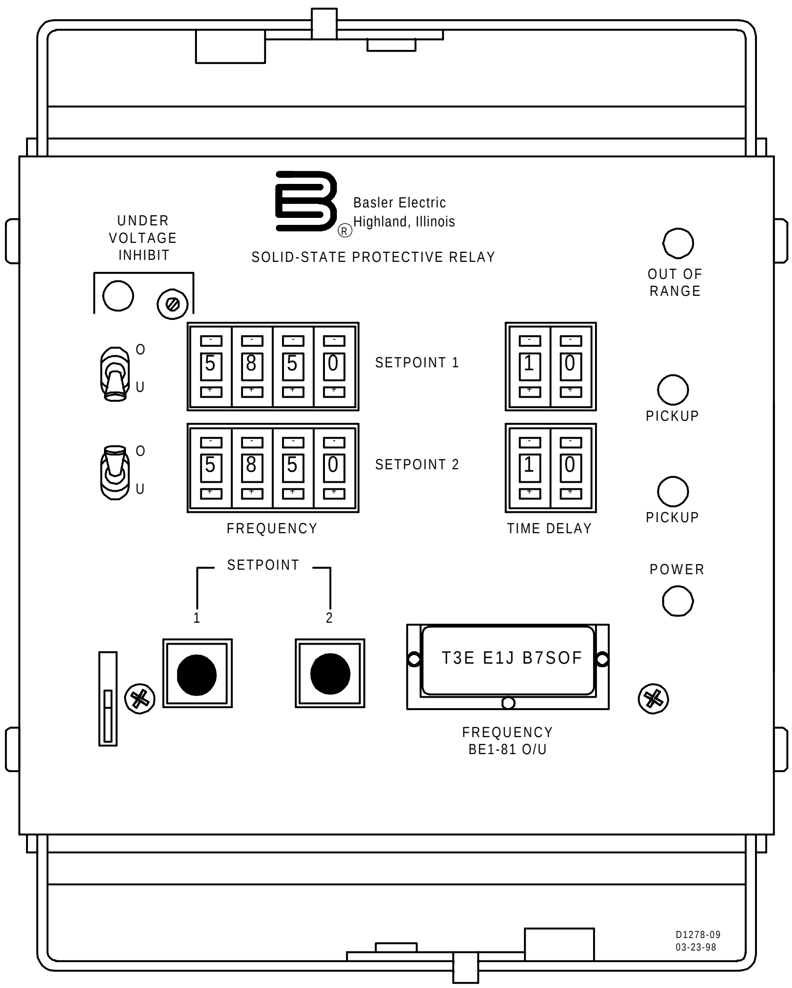
INSTRUCTION MANUAL

FOR
DIGITAL FREQUENCY RELAY
BE1-81O/U



Basler Electric

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INTRODUCTION

This Instruction Manual provides information concerning the operation and installation of BE1-81O/U Digital Frequency Relays. Unit Revision E and M to the relay incorporated design changes that are backward compatible with previous versions of the relay. To accomplish this, the following is provided.

- **Specifications**
- **Functional Description**
- **Mounting Information**
- **Operational Tests**

W A R N I N G !

To avoid personal injury or equipment damage, only qualified personnel should perform the procedures presented in this manual.

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It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. Should further information be required, contact Basler Electric Company, Highland, Illinois.

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SECTION 1 • GENERAL INFORMATION

DESCRIPTION

Digital Frequency Relay, BE1-81 O/U, is a solid-state protective device that monitors the frequency of a single-phase ac voltage to provide accurate frequency protection for distribution systems and generators. The protected system operating frequency can be 50 hertz or 60 hertz.

The relay is designed to permit removal of a load from a distribution system when the system frequency falls below a setpoint. The relay will permit restoration of the load when the system frequency returns to normal as defined by another setpoint. Also, the relay may be tailored to the operating frequency/time characteristic of a generator to permit the removal of the generator from service if the generator output frequency (or system frequency) exceeds a setpoint. This scheme also permits restoration to service when the generator (or system) frequency returns to normal.

APPLICATIONS

BE1-81 O/U Digital Frequency Relays sense frequency between the limits of 30 and 80 hertz. The relays provide up to four independently adjustable frequency/time delay setpoints with corresponding output relays. Each setpoint may be set to recognize either overfrequency or underfrequency. When the sensed frequency passes through a setpoint in the selected direction, timing begins. If the condition continues for three cycles, the PICKUP LED lights. After the selected time delay times out, the associated setpoint output relay energizes. When the frequency returns through the setpoint and remains there for three cycles, the output relay resets.

Each FREQUENCY selector provides setpoint selection over the range of 40 to 70 hertz. TIME DELAY is available with either definite time or inverse time characteristics. Refer to Figure 1-1 for style selections.

Inverse time delay (option D1) is inversely proportional to the magnitude of the difference between the detected frequency and the setpoint frequency. This relationship may be tailored to the application by means of the characteristic response curves.

Definite time delay (option E1) setpoints are selectable over the range of three to 99 cycles.

Definite time delay (option E2) setpoints are field selectable for time delays in seconds or cycles. Each setpoint is selectable over the range of three to 990 cycles or 0.1 to 99 seconds.

The FREQUENCY and TIME DELAY selectors for the setpoints are accessible at the front panel. Each FREQUENCY setpoint includes an O/U switch for selecting whether the setpoint will respond to either an overfrequency (O) or underfrequency (U).

An undervoltage inhibit circuit prevents relay operation if the sensed voltage falls below the setting (factory set at 80 Vac, but is front panel-adjustable over the range of 40-120 Vac). If inverse time delay is installed and either maximum frequency measurement limit is exceeded, the magnitude of the delay will remain at the value determined at the frequency limit. Targets, either internally operated or operated by current in the output circuit, are available for all of the setpoints in the relay.

When one or two setpoints are specified, the relay is supplied in an S1 style case. When three or four setpoints are specified, the relay is supplied in an M1 style case.

The relay assembly is mounted in a drawout cradle. Test points and circuit components are accessible by removing the individual printed circuit boards from the cradle and using an extender board (Basler part number 9 1655 00 100) to test or troubleshoot. An available test plug (Basler part number 10095 or G.E. part number 12XLA12A1) enables the relay to be tested in place without distributing external control circuit wiring.

MODEL AND STYLE NUMBER

The electrical characteristic and operational features included in a specific relay are defined by a combination of letters and numbers that make up the relay style number. The style number together with the model number describe the features and options in a particular unit and appear on the front panel, drawout cradle, and inside the case assembly. The model number BE1-81 O/U designates the relay as a Basler electric, Class 100, Digital Frequency Relay.

Style Number Example

The style number identification chart shown in Figure 1-1 illustrates the features and options for BE1-81 O/U relays. For example, if the style number were BE1-81 O/U T3E E1J A9N2F, the unit would have the following features.

BE1-81 O/U	Model number
T	Single-phase sensing type
3	100/120 Vac, 40-70 hertz nominal sensing range
E	One normally open output relay per setpoint
E1	Definite time delay
J	Operating power derived from 125 Vdc or 120 Vac source
A	One internally operated target for each setpoint
9	Four setpoints
N	No power supply status output
2	One normally closed auxiliary relay output for each setpoint
F	Semi-flush mounting

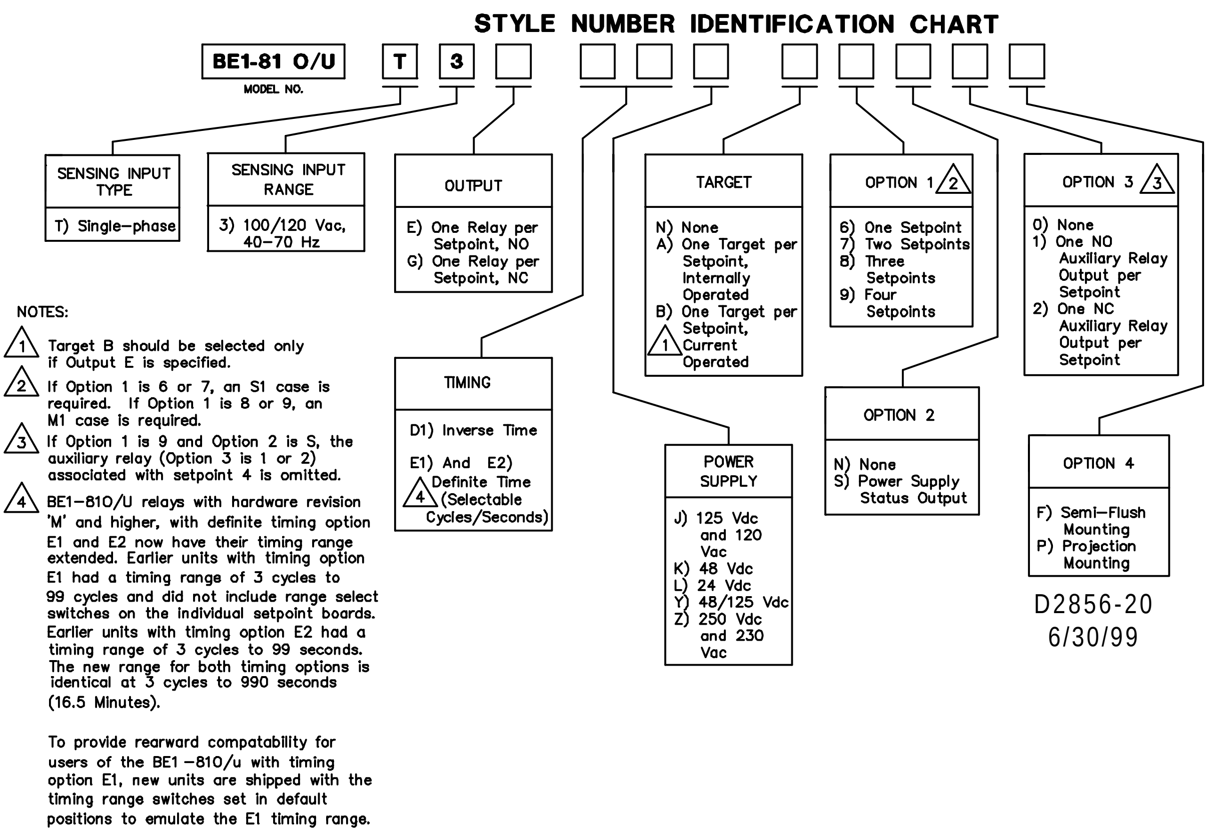

Figure 1-1. Style Number Identification Chart

SPECIFICATIONS

BE1-81 O/U Digital Frequency Relays have the following features and capabilities.

Sensing Input

The frequency sensing input is rated for 132 Vac maximum continuous at 50/60 hertz at a maximum burden of 2 VA. Input voltage can vary between 40 and 132 Vac. The input frequency is detectable between the limits of 30 and 80 hertz (relays unit revision D and subsequent). For relays revision C and previous, the input frequency is detectable between the limits of 35 and 80 hertz. Accurate computation occurs between the nominal limits of 40 and 70 hertz.

Output Circuits

One relay output is provided for each setpoint. Relay outputs are normally open or normally closed as specified. One normally open or normally closed auxiliary relay output per setpoint is also provided, if ordered.

Output Contacts

Output contacts are rated as follows:

Resistive

120/240 Vac - Make 30 A for 0.2 seconds, carry 7 A continuously, and break 7 A.

125/250 Vdc - Make and carry 30 A for 0.2 seconds, carry 7 A continuously, break 0.3 A.

Inductive

120/240 Vac, - 125/250 Vdc Make and carry 30 A for 0.2 seconds, carry 7 A continuously, break 0.3 A. (L/R = 0.04).

Power Input

Internal relay operating power may be obtained from a wide variety of external voltage sources. When ordering, any one of five internal power supplies may be selected to match operating power input voltage level to available external voltage sources. Available power supplies are shown in Table 1-1.

Table 1-1. Power Supply Options

Type	Nominal Input Voltage	Input Voltage Range	Burden at Nominal
K (Mid Range)	48 Vdc	24 to 150 Vdc	4.4 W
J (Mid Range)	125 Vdc 120 Vac	24 to 150 Vdc 90 to 132 Vac	4.4 W 10.1 VA
†L (Low Range)	24 Vdc	12 to 32 Vdc	4.5 W
Y (Mid Range)	48 Vdc 125 Vdc	24 to 150 Vdc 24 to 150 Vdc	4.4 W 4.4 W
Z (High Range)	250 Vdc 230 Vac	68 to 280 Vdc 90 to 270 Vac	5.5 W 14.0 VA

† Type L power supply may require 14 Vdc to begin operating. Once operating, the voltage may be reduced to 12 Vdc.

Target Indicators

Target indicators may be either internally operated or current operated (operated by a minimum of 0.2 A through the output trip circuit). When the target is current operated, the trip output circuit current must be limited to 30 A for 1 second, 7 A for 2 minutes, and 3 A continuously.

Setpoint Frequency Selectors

Thumbwheel switches provide frequency pickup settings in increments of 0.01 hertz.

Pickup

±0.01 hertz of the set value.

Time Delay Adjustability

Definite Time Option E1 & E2

Field selectable range is 3 to 99 cycles in 1 cycle increments, 10 to 990 cycles in 10 cycle increments, 0.1 to 9.9 seconds in 0.1 second increments, or 1 to 99 seconds in 1 second increments. Settings 00, 01, or 02 cycles operate the same as 03 cycles because the timing circuits require 3 cycle continuous excursion through the setpoint before tripping the output circuit.

Inverse Time Option

TIME DELAY setting is 0.1 to 9.9 (99 curve settings). The characteristic curve plot points shown in Figures 1-2 and 1-3 are calculated from the following equation. (All possible curves are **NOT** shown on the graphs.)

$$Curve\ Plot\ Point = \frac{TIME\ DELAY\ (Curve)\ Setting}{Frequency\ Difference\ From\ Setpoint}$$

Curve plot point range (time delay in seconds) is 0.1 to 100 seconds for a frequency difference of 0 to 10 hertz from the FREQUENCY setpoint. Actual time delay is the sum of the elapsed time for three cycles of the input frequency (timing circuits require three cycle continuous excursion through the setpoint) plus the time for the plotted point on the curve.

Time Delay Accuracy

Definite Time Options E1, E2

±1.0 cycle for delay settings in cycles. For delay settings in seconds, ±2% of the setting or 25 milliseconds whichever is greater.

Inverse Time Option D1

Within 5% of the selected characteristic curve plus 3 cycles of the sensed frequency for a given step change in frequency, over a sensing range of 40 to 132 Vac at 25° C.

Undervoltage Inhibit Accuracy

Within ±5% of the setting at 25° C for nominal frequency input.

UL Recognized

UL Recognized per Standard 508, UL File No. E97033. Note: Relay is not UL Recognized for output contact voltages greater than 250 volts and input power supply voltages greater than 150 volts.

Isolation

Meets IEC 255-5 and exceeds ANSI/IEEE C37.90 one-minute dielectric tests as follows:

All circuits to ground:	2828 Vdc.
Input to output circuits:	2000 Vac or 2828 Vdc

Radio Frequency Interference (RFI)

Field Tested using a five watt, hand-held transceiver operating at random frequencies centered around 144 MHz and 440 MHz, with the antenna located six inches from the relay in both horizontal and vertical planes.

Maintains proper operation when tested for interference in accordance with IEC C37.90-1989, Trial-Use Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.

Surge Withstand Capability

Qualified to ANSI/IEEE C37.90.1-1989 *Standard Surge Withstand*

Capability (SWC) Tests for Protective Relays and Relay Systems.

Fast Transient	Qualified to ANSI/IEEE C37.90.1-1989.
Impulse Test	Qualified to IEC 255-5.
Shock	15 g in each of three mutually perpendicular axes.
Vibration	2 g in each of three mutually perpendicular axes swept over the range of 10 to 500 hertz for a total of 6 sweeps, 15 minutes each sweep.
Temperature	
Operating Range	-40°C (-40°F) to 70°C (158°F)
Storage Range	-40°C (-40°F) to 85°C (185°F)
Weight	Approximately 18 pounds (M1 case) or 13 pounds (S1 case) net.
Case Size	M1 (three or four setpoints) or S1 (one or two setpoints).

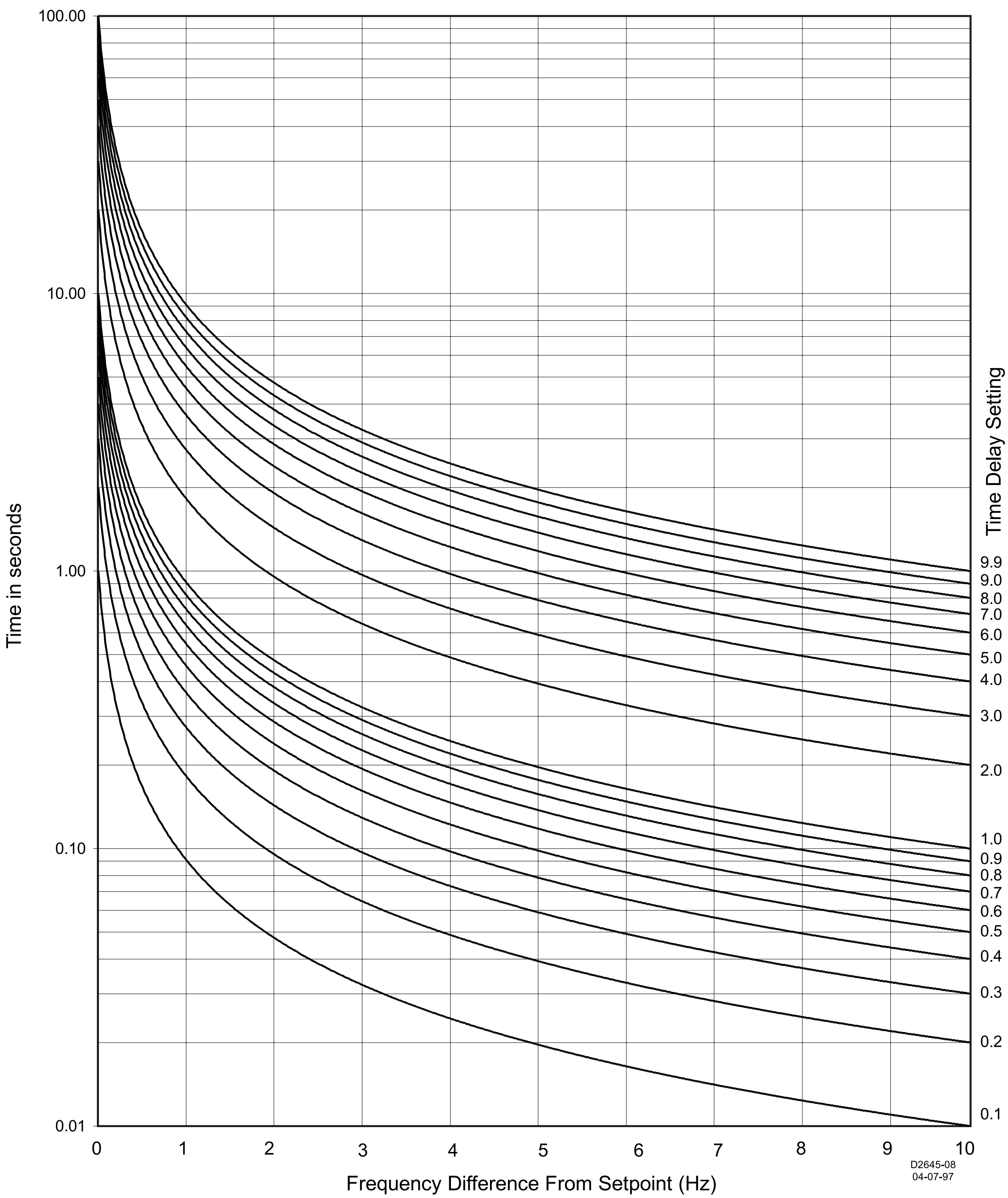

Figure 1-2. Inverse Time Overfrequency Characteristic Curves

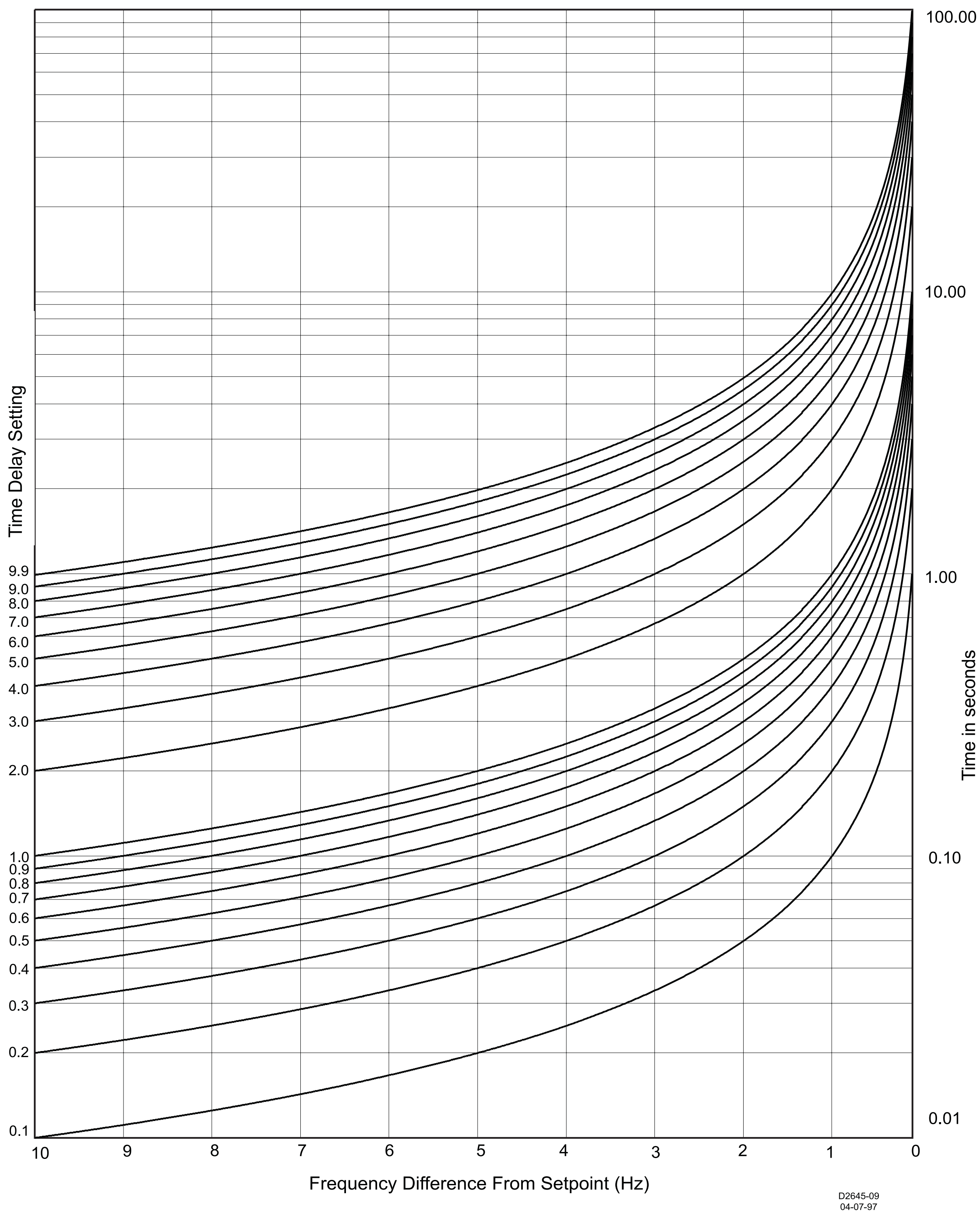

Figure 1-3. Inverse Time Underfrequency Characteristic Curves

SECTION 2 • HUMAN MACHINE INTERFACE

(Controls And Indicators)

DESCRIPTION

Table 2-1 lists and briefly describes the operator controls and indicators of the BE1-81O/U Digital Frequency Relay. Reference the call-out letters to Figures 2-1, 2-2, and 2-3.

Table 2-1. BE1-81 O/U Controls and Indicators

Locator	Control or Indicator	Function
A	**TIME DELAY** Selector	A set of two thumb-wheel switches selects the time delay between setpoint pickup and output relay reaction. There is one set of switches per setpoint.
B	**PICKUP** LED	Red LED is ON when sensed frequency exceeds the setpoint. The LED remains ON until the sensed frequency is less than the setpoint. One LED per setpoint.
C	**Power** LED	LED is ON when the relay power supply is supplying a nominal ±12 Vdc to the internal circuitry.
D	**Target Reset** Lever	Linkage extends through bottom of front cover to reset all magnetically latched target indicators.
E	**SETPOINT** Targets	Black target indicator trips to red and is magnetically latched when the associated output relay is energized. One for each SETPOINT.
F	**O/U** Selector	Two-position toggle switch allows selection of an overfrequency (O) or underfrequency (U) function of the corresponding frequency selector. One for each SETPOINT.
G	**FREQUENCY** Selector	A set of four thumbwheel switches, selects the setpoint frequency in increments of 0.01 Hz over an allowable range of 40 to 70 Hz. One for each SETPOINT.
H	**UNDER VOLTAGE INHIBIT** LED	Red LED is ON when the sensed input drops below the UNDER VOLTAGE INHIBIT adjustment level.
I	**UNDER VOLTAGE INHIBIT** Adjustment	Adjusts the undervoltage inhibit level between 40 and 120 Vac. Relay operation is inhibited if the sensed voltage falls below the setting. The nominal factory setting is 80 Vac. Adjustment is by a small screwdriver through the front panel.

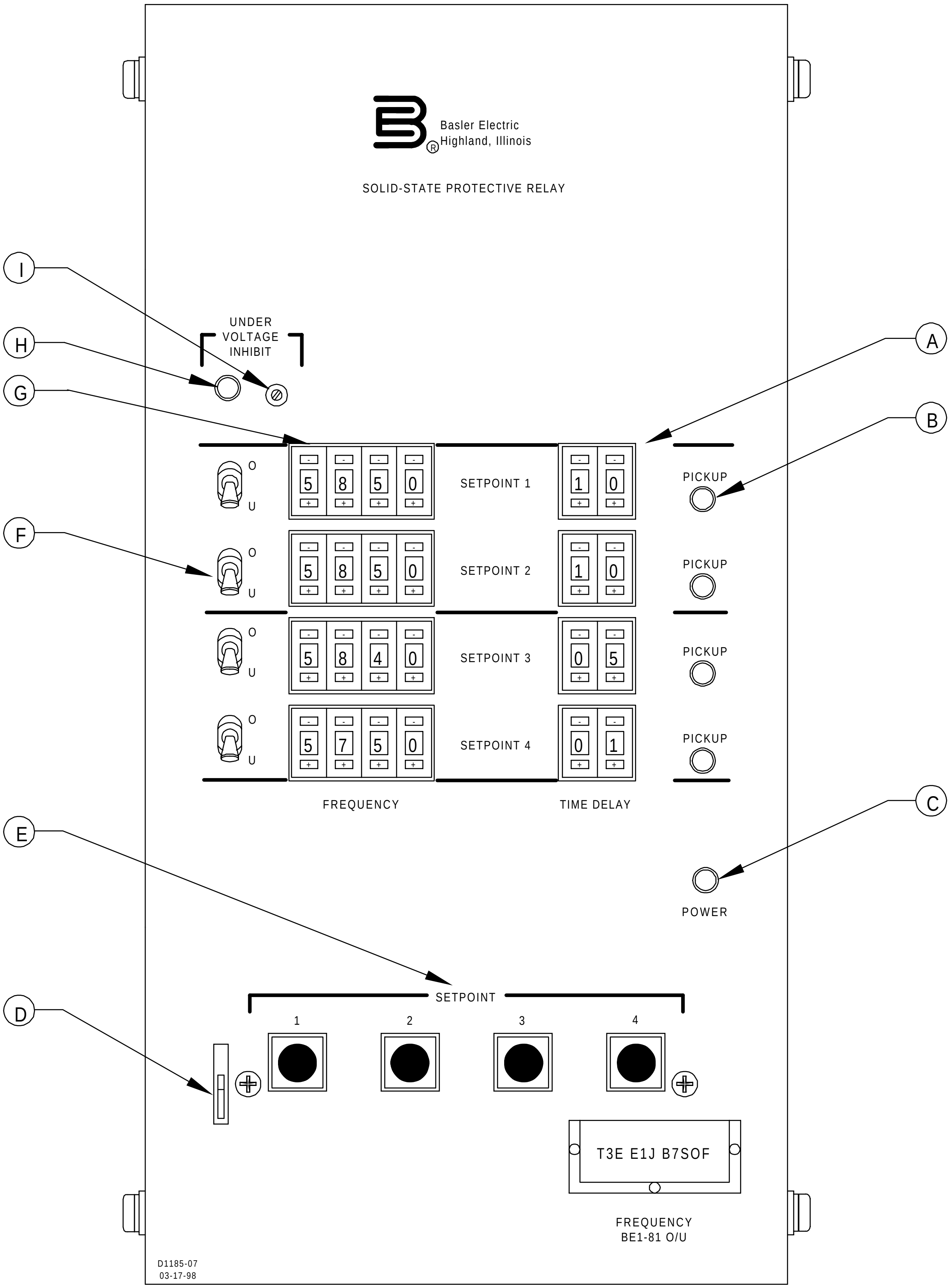

Figure 2-1. Location of Controls and Indicators

Table 2-1. BE1-81 O/U Controls and Indicators - Continued

Locator	Control or Indicator	Function
J	**OUT OF RANGE** LED	LED is ON when the sensed frequency is outside the sensing range of 35 to 80 Hz.
K	**Selector Switch S7** (Definite Time Option E1 and E2)	Field selectable, three section switch for selecting definite time delay in seconds or cycles and a multiplier of X1, X10 or X100. S7-1and S7-2 select the multiplier. Down selects X1 and up selects X10. Section 1 and section 2 are marked on the switch, and the multiplier positions are marked on the circuit board. Either switch can be used to select X10 multiplier. For X100, both switches must be set for X10. S7-3 selects seconds (S) or cycles (C). Down selects seconds and up selects cycles. Section 3 is also marked on the switch; S and C are marked on the circuit board.

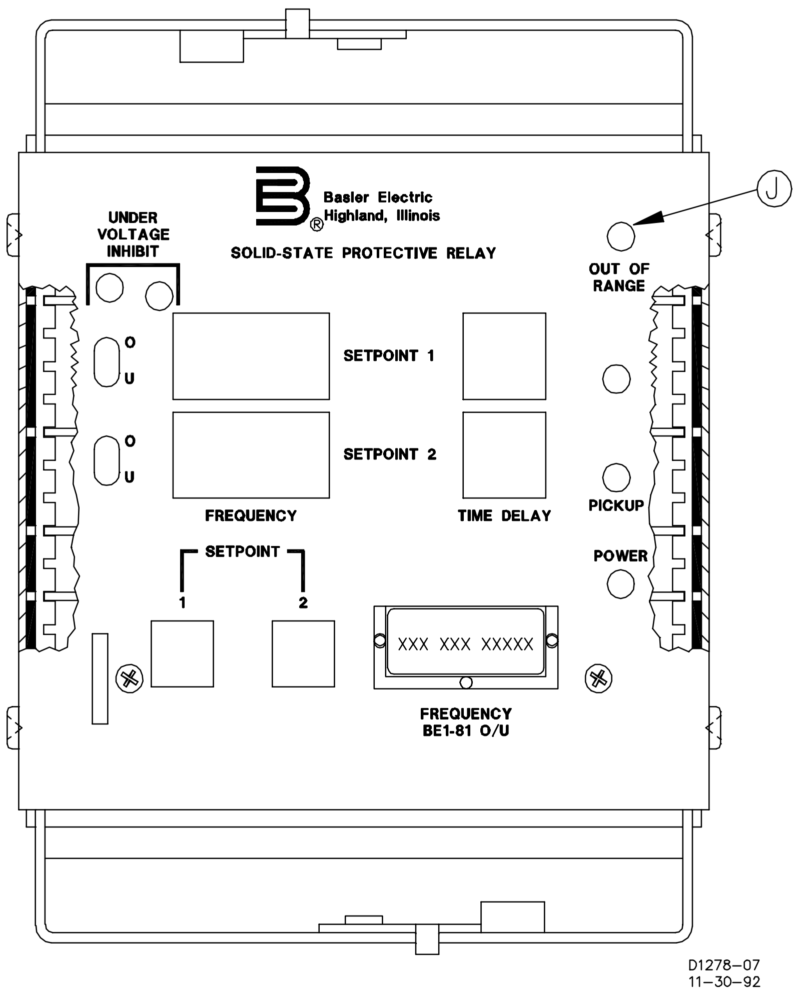

Figure 2-2. Location of Controls and Indicators S1 Case (Relays Revision C and Previous)

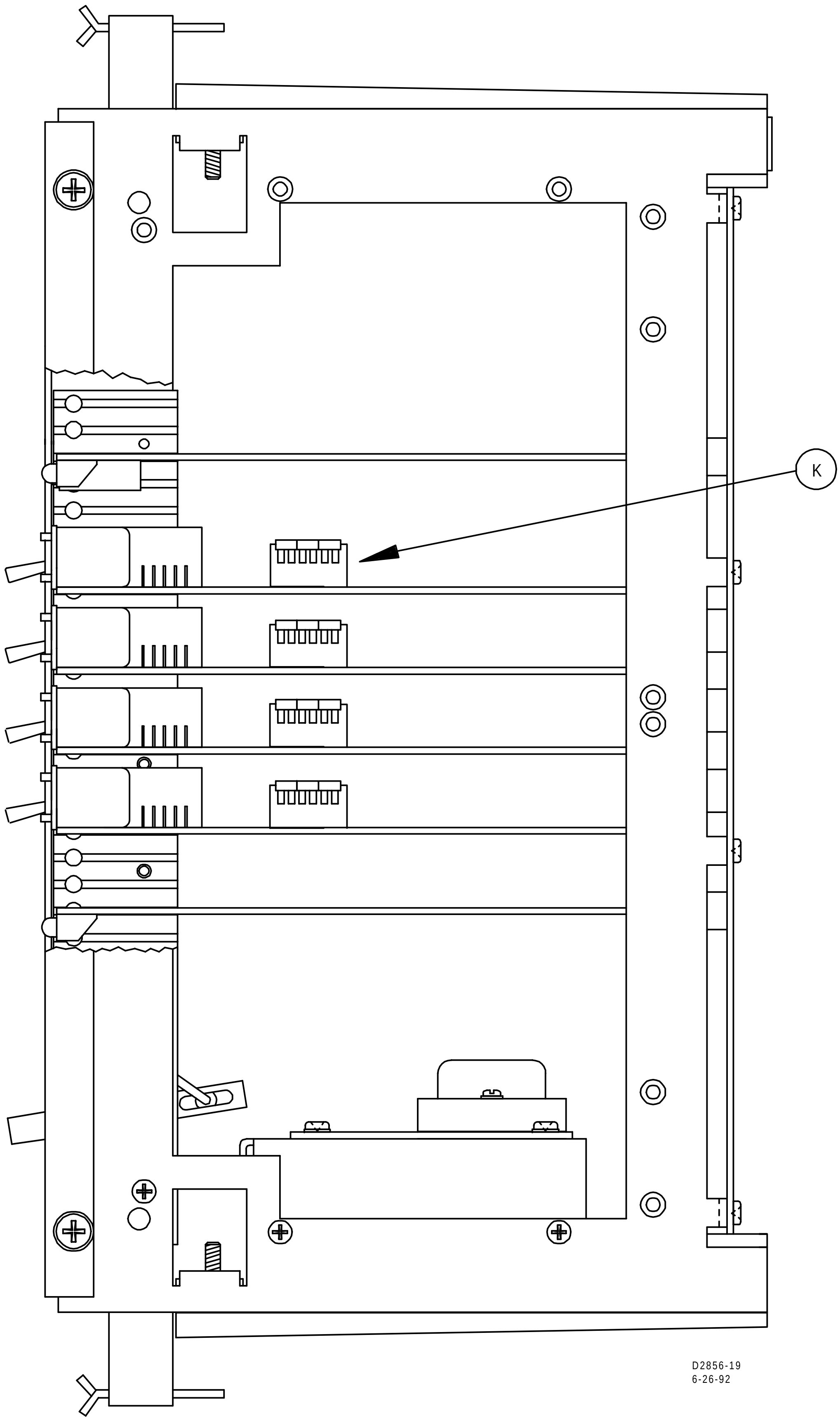

Figure 2-3. Definite Time Board Switch S7 (Definite Time Option E1 or E2)

SECTION 3 • FUNCTIONAL DESCRIPTION

GENERAL

Digital Frequency Relays, BE1-81 O/U provide one to four frequency setpoints for monitoring under and overfrequency conditions of an ac source within the nominal limits of 40 hertz to 70 hertz. When the relay senses that a setpoint is exceeded, an output relay is energized after a selectable time delay. The undervoltage inhibit circuit prevents relay operation if the sensed ac source voltage decreases below this limit.

FUNCTIONAL DESCRIPTION

The following paragraphs describe the functional operation of the relay.

Sensing Input

Because input signal zero crossings are used to measure the input frequency, it is necessary to filter unwanted harmonics and transients. Some attenuation of the input signal results. Figure 3-1 illustrates this attenuation in dB for input frequencies.

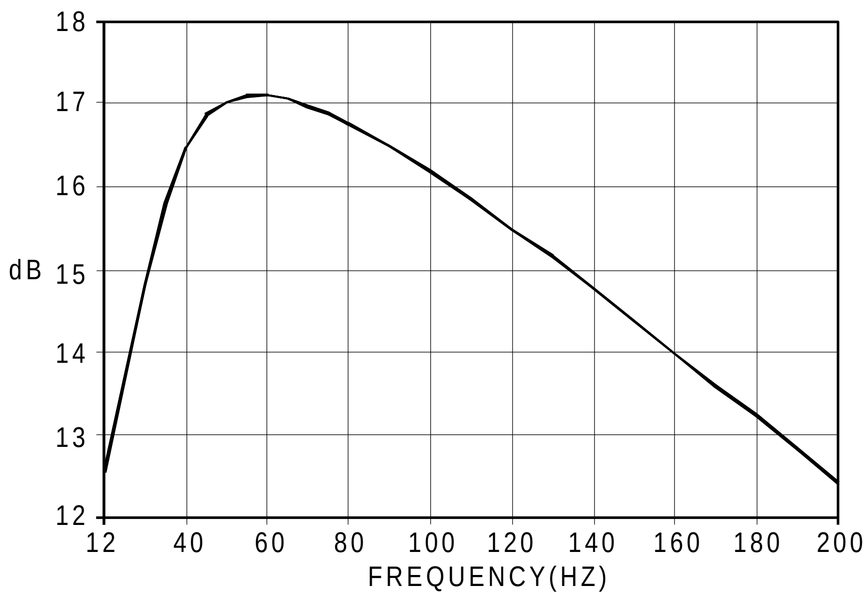

Figure 3-1. Bandpass Filter Characteristics

A single-phase voltage is applied to an input signal conditioning circuit (transformer and bandpass filter, Figure 3-2). The sensed input signal is applied to the zero crossing logic and undervoltage detect circuits. Refer to Figures 3-3 and 3-4 for the location of assemblies.

Undervoltage Inhibit

This circuit prevents the output relay(s) from energizing during an undervoltage condition associated with equipment startup. The circuit prevents operation of the zero cross logic and the time delay logic, and lights the UNDER VOLTAGE INHIBIT LED when the level of the sensed voltage is less than the setting. The inhibit level is factory set to 80 Vac (nominal), but may be adjusted between 40 and 120 Vac.

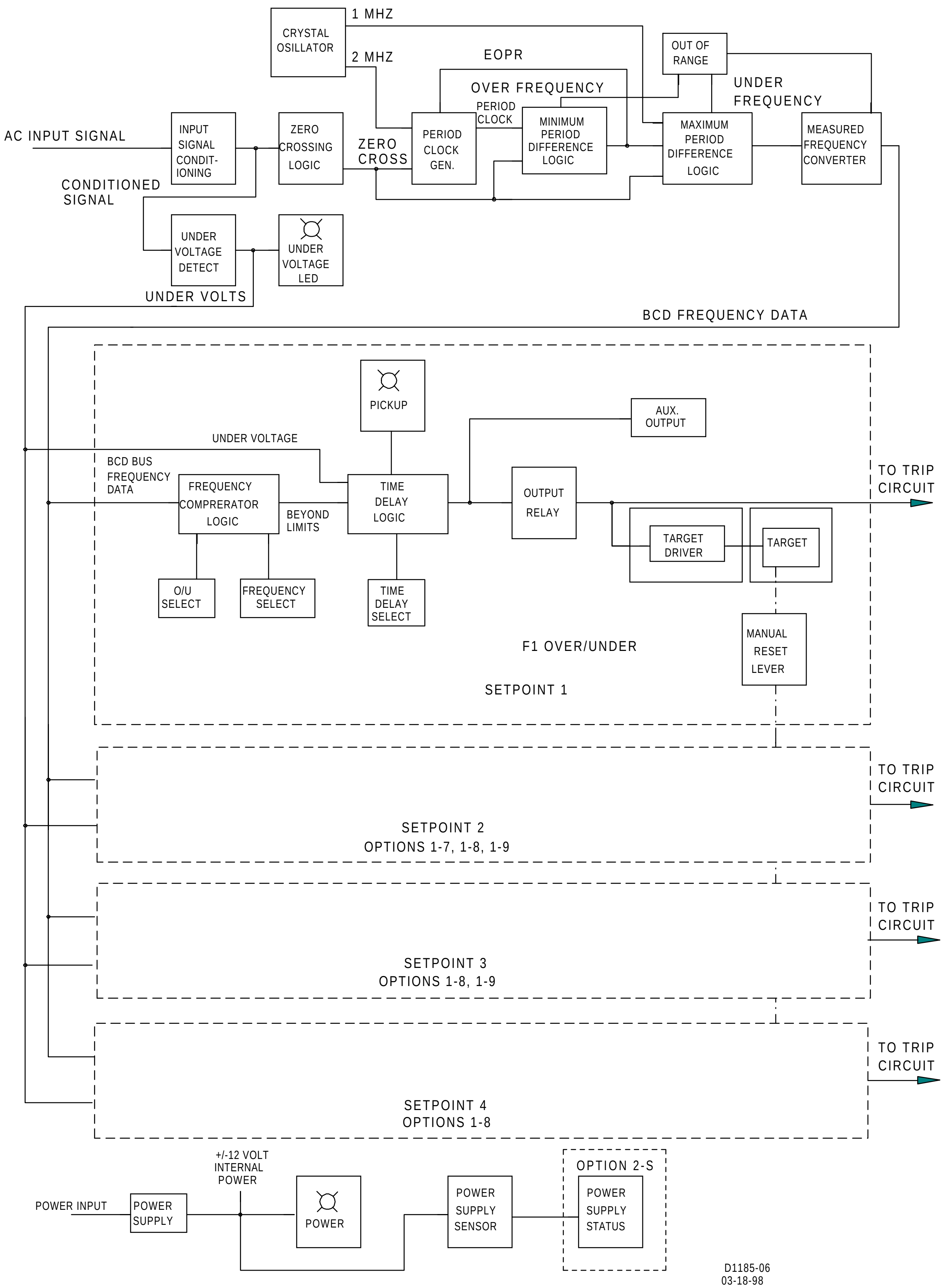

Figure 3-2. BE1-81O/U Functional Block Diagram

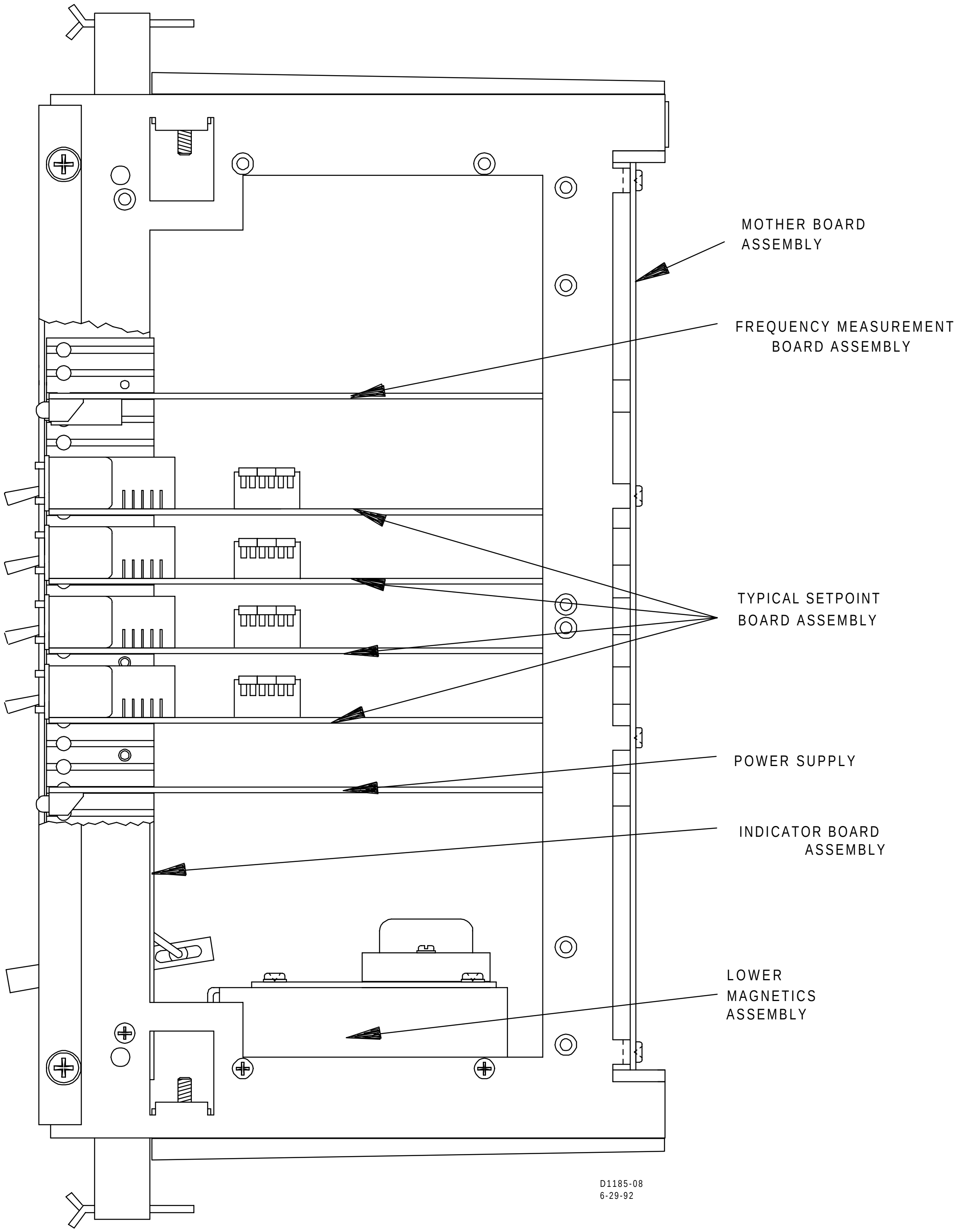

Figure 3-3. Location of Assemblies (Typical M1 Case)

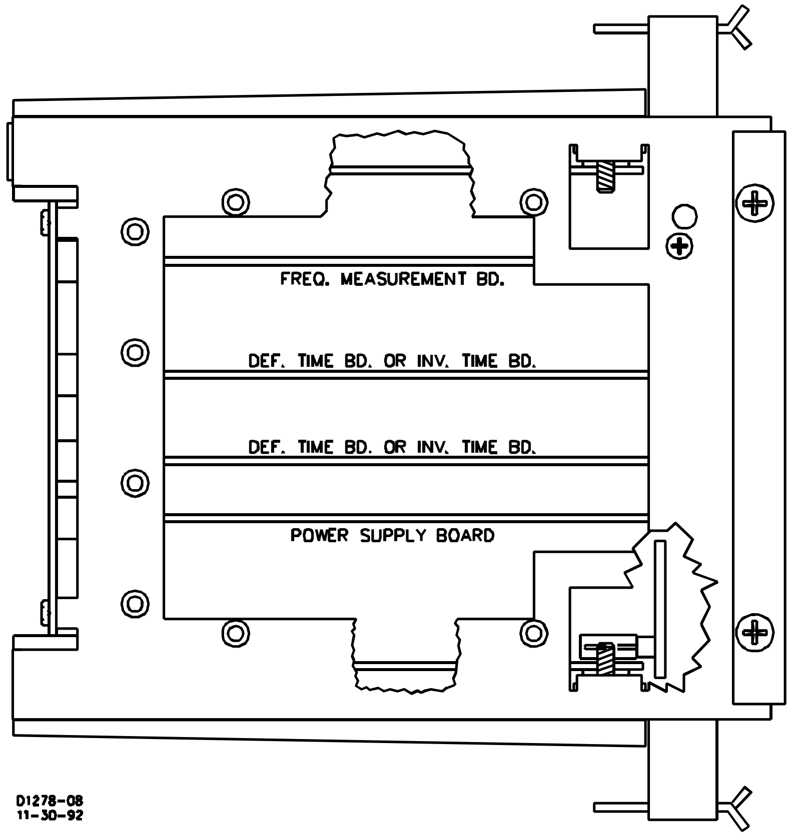

Figure 3-4. Location of Assemblies (Typical S1 Case)

Zero Crossing Logic

The zero crossing logic circuit converts the sensed frequency to pulses synchronized to each positive-going zero crossing of the waveform. The pulse frequency represents the period of the waveform and is applied to the period clock generator, minimum period difference logic, and maximum period difference logic circuits.

Crystal Oscillator

The crystal-controlled oscillator provides accurate 1 MHZ and 2 MHZ timing signals for the clock logic.

Period Clock Generator

A frequency comparison is made for each cycle of sensed frequency. The period clock generator generates a reference signal that is synchronized with the beginning of each cycle of the sensed frequency. At each zero crossing pulse, the clock gates the two megahertz period clock pulses to the minimum period difference logic circuit.

Minimum Period Difference Logic

Each zero cross pulse causes this logic to count 24580 two-megahertz clock pulses which is the period of the 80 hertz maximum detectable frequency limit. When the sensed frequency is less than the limit, an EOPR (end of period reference) pulse is generated to initiate the maximum period difference and measurement logic.

However, if the sensed frequency equals or exceeds the 80 hertz maximum frequency limit (zero cross pulses interrupt the counts) for three consecutive cycles, the maximum period difference logic is bypassed. On relays revision C and previous, the OUT OF RANGE LED lights. The measured frequency converter then computes the frequency at this maximum frequency limit. If inverse time delay is present in the relay, the time delay is determined as though the frequency were at the maximum frequency limit. The definite time delay, if present, is not affected by the frequency limit being exceeded.

Maximum Period Difference Logic

This logic includes an address register and a programmable read-only memory (PROM). Following the EOPR pulse from the minimum period difference logic, the address register counts 1 megahertz clock pulses to address 4096 data words stored in the PROM. Completion of the count represents the period of the 30 hertz minimum detectable frequency limit. If zero cross pulses have properly occurred before the count ends, the measured frequency converter computes the actual frequency within the frequency limits utilizing the corresponding data words stored in the PROM.

If sensed frequency decreases to less than the 30 hertz minimum frequency limit (zero cross pulses occur after the counts are completed) for three consecutive cycles, the measured frequency converter computes the frequency at the minimum frequency limit. On relays revision C and previous, the OUT OF RANGE LED lights. If inverse time delay is present in the relay, the time delay is determined as though the frequency were at the minimum frequency limit. The definite time delay, if present, is not affected by the frequency limit being exceeded.

Measured Frequency Converter

The measured frequency converter converts the data word from the maximum period difference logic to a four digit binary coded decimal (BCD) number that represents the actual sensed frequency (with an accuracy of .01 hertz) within the 30 hertz to 80 hertz limits. The BCD frequency data bus passes this data to the frequency comparator logic of each setpoint.

Frequency Comparator Logic

This logic compares the BCD number representing the actual sensed frequency with the setpoint frequency selected on the front panel thumbwheel selectors. An output is provided when the sensed frequency is less than the setpoint (if the O/U toggle switch is set to U), or when the frequency exceeds the setpoint (if the O/U toggle switch is set to O). The resultant output consists of an enabling level that starts a count-up timer and turns ON the PICKUP LED.

Definite Time Delay Logic

The enable signal (representing a detected over or underfrequency condition) from the frequency comparator logic initiates the count of zero cross pulses. After three consecutive cycles exceed the pickup point, the definite time delay logic causes the PICKUP LED to lite. When the TIME DELAY selector setting is reached, the logic energizes the setpoint output relay. The total time delay with seconds type timing selected is the TIME DELAY setting + one cycle of the sensed input + 0.008 seconds (output relay delay). The PICKUP LED remains lit until the frequency condition is corrected. When the sensed frequency returns to normal for three cycles, the PICKUP LED extinguishes and the output relay resets.

On definite time delay option E1 and E2, time delay selection is controlled by switch S7 on the definite time board assembly. Switch S7 is a field selectable, three section switch for selecting definite timing in seconds or cycles and a multiplier of X1, X10 or X100. S7-1 and S7-2 selects the multiplier. (Down selects X1 and up selects X10.) X100 is selectable by setting both S7-1 and S7-2 to X10. Section 1 and Section 2 are marked on the switch, and the multiplier positions are marked on the circuit board. S7-3 selects seconds (S) or cycles (C). (Down selects seconds and up selects cycles.) Section 3 is also marked on the switch; S and C are marked on the circuit board. With seconds and X1 selected on switch S7 and 25 on the TIME DELAY thumbwheels, a 2.5 second time delay is selected. With cycles and X1 selected, and 25 on the thumbwheels, a 25 cycle time delay is selected. With seconds and X10 selected on switch S7 and 25 on the TIME DELAY thumbwheels, a 25 second time delay is selected. With cycles and X10 selected, and 25 on the thumbwheels, a 250 cycle time delay is selected. With seconds and X100 selected on switch S7 and 25 on the TIME DELAY thumbwheels, a 250 second time delay is selected. With cycles and X100 selected, and 25 on the thumbwheels, a 2,500 cycle time delay is selected.

Inverse Time Delay Logic

In the inverse time delay logic, the digital input provided by the TIME DELAY selector is entered into a down counter. When three consecutive cycles have occurred after initiation, the PICKUP LED is lit, and the gated pulse trains from the frequency comparator causes the counter to count down. Since the number of pulses is proportional to the sensed frequency difference, the count ends sooner for greater frequency differences and vice versa, creating the inverse time characteristic. If the sensed frequency drops below the 30 hertz limit, or exceeds the 80 hertz limit, the count proceeds as determined by the limit. When the count ends, the setpoint output relay is energized.

The PICKUP LED remains lit and the output relay remains energized until the input frequency returns to normal. When the sensed frequency passes back through the setpoint, the relay is reset. At that time, the output relay de-energizes and the PICKUP LED extinguishes. There is no intentional time delay for reset with inverse time delay logic.

Relay Output

The time delay logic output for each setpoint energizes an associated output relay that is normally open (output type E) or normally closed (output type G). The relay output type specified is the same for each setpoint included in the relay.

Auxiliary Relay Output

An auxiliary relay may be specified that is energized simultaneously with the output relay. The relay contacts are either normally open (option 3-1) or normally closed (option 3-2). When specified, this option will be included for each setpoint and is the same contact type for all setpoints within a relay.

Target

A target indicator is included for each setpoint. Targets are either internally operated (type A) or current operated (type B) and will be the same for all setpoints. The internally operated target trips when the time delay circuit energizes the output relay. The current operated target trips when a minimum of 0.2 A. flows through the closed contacts of the energized output relay.

Each target is identified on the front panel as SETPOINT 1, SETPOINT 2, SETPOINT 3, or SETPOINT 4. When tripped, each target goes from black to red and is magnetically latched. All targets are reset manually by a single lever.

Power Supply

Basler Electric enhanced the power supply design for unit case relays. This new design created three, wide range power supplies that replace the five previous power supplies. Style number identifiers for these power supplies have not been changed so that customers may order the same style numbers that they ordered previously. The first newly designed power supplies were installed in unit case relays with EIA date codes 9638 (third week of September 1996). A benefit of this new design increases the power supply operating ranges such that the 48/125 volt selector is no longer necessary. Specific voltage ranges for the three new power supplies and a cross reference to the style number identifiers are shown in Table 3-1.

Table 3-1. Wide Range Power Supply Voltage Ranges

Power Supply	Style Chart Identifier	Nominal Voltage	Voltage Range
Low Range	L	24 Vdc	12 to 32 Vdc
Mid Range	K, J, Y	48 , 125 Vdc, 125 Vac	24 to 150 Vdc, 90 to 132 Vac
High Range	Z	250 Vdc, 230 Vac	62 to 280 Vdc, 90 to 270 Vac

Relay operating power is developed by the wide range, isolated, low burden, flyback switching design, solid-state power supply. A nominal positive and negative twelve volts dc is delivered to the internal circuitry. Input (source voltage) for the power supply is not polarity sensitive. A red LED turns ON to indicate that the power supply is functioning properly.

Power Supply Status Output

The power supply status output relay has a set of normally closed contacts that are energized open during power-up. If either or both of the power supply output legs (+12 Vdc or -12 Vdc) fails, the power supply status output relay is de-energized and the contacts close.

SECTION 4 • INSTALLATION

GENERAL

When not shipped as part of a control or switchgear panel, the relays are shipped in sturdy cartons to prevent damage during transit. Immediately upon receipt of a relay, check the model and style number against the requisition and packing list to see that they agree. Visually inspect the relay for damage that may have occurred during shipment. If there is evidence of damage, immediately file a claim with the carrier and notify the Regional Sales Office, or contact the Sales Representative at Basler Electric, Highland, Illinois.

In the event the relay is not to be installed immediately, store the relay in its original shipping carton in a moisture and dust free environment. When relay is to be placed in service, it is recommended that the operational test procedure (Section 5) be performed prior to installation.

RELAY OPERATING PRECAUTIONS

Before installation or operation of the relay, note the following precautions:

1. A minimum of 0.2 A in the output circuit is required to ensure operation of current operated targets.
2. Always reset targets by use of the target reset lever.
3. The relay is a solid-state device. If a wiring insulation test is required, remove the connection plugs and withdraw the cradle from its case.
4. When the connection plugs are removed, the relay is disconnected from the operating circuit and will not provide system protection. Always be sure that external operating (monitored) conditions are stable before removing a relay for inspection, test, or service.
5. Be sure the relay case is hard wired to earth ground using the ground terminal on the rear of the unit. It is recommended to use a separate ground lead to the ground bus for each relay.

DIELECTRIC TEST

In accordance with IEC 255-5 and ANSI/IEEE C37.90-1978, one-minute dielectric (high potential) tests may be performed using up to 2000 Vac (45-65 hertz). This device employs decoupling capacitors to ground from terminals 1, 2, 3, 4, 5, and 10. At 2000 Vac, a leakage current of up to 5 milliamperes per terminal is to be expected. Because of the leakage current, it is recommended that dielectric tests be performed using dc voltages equivalent to the peak ac value (2,828 Vdc).

MOUNTING

Because the relay is of solid state design, it does not have to be mounted vertically. Any convenient mounting angle may be chosen. Relay outline dimensions and panel drilling diagrams are shown in Figures 4-1 through 4-17.

CONNECTIONS

Incorrect wiring may result in damage to the relay. Except for the ground wire (see following note), connections should be made with minimum wire size of 14 AWG. Typical internal connections are shown in Figure 4-18. External connections are shown in Figures 4-19 and 4-20.

> **NOTE**
> Be sure the relay case is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear of the relay case. When the relay is configured in a system with other protective devices, it is recommended to use a separate lead to the ground bus from each relay.

Relay circuitry is connected to the case terminals by removable connection plugs (1 plug for 10-terminal cases and 2 plugs for 20-terminal cases). Removal of the connection plug(s) opens the normally open trip contact circuits and shorts the normally closed trip contact circuits before opening the power and sensing circuits.

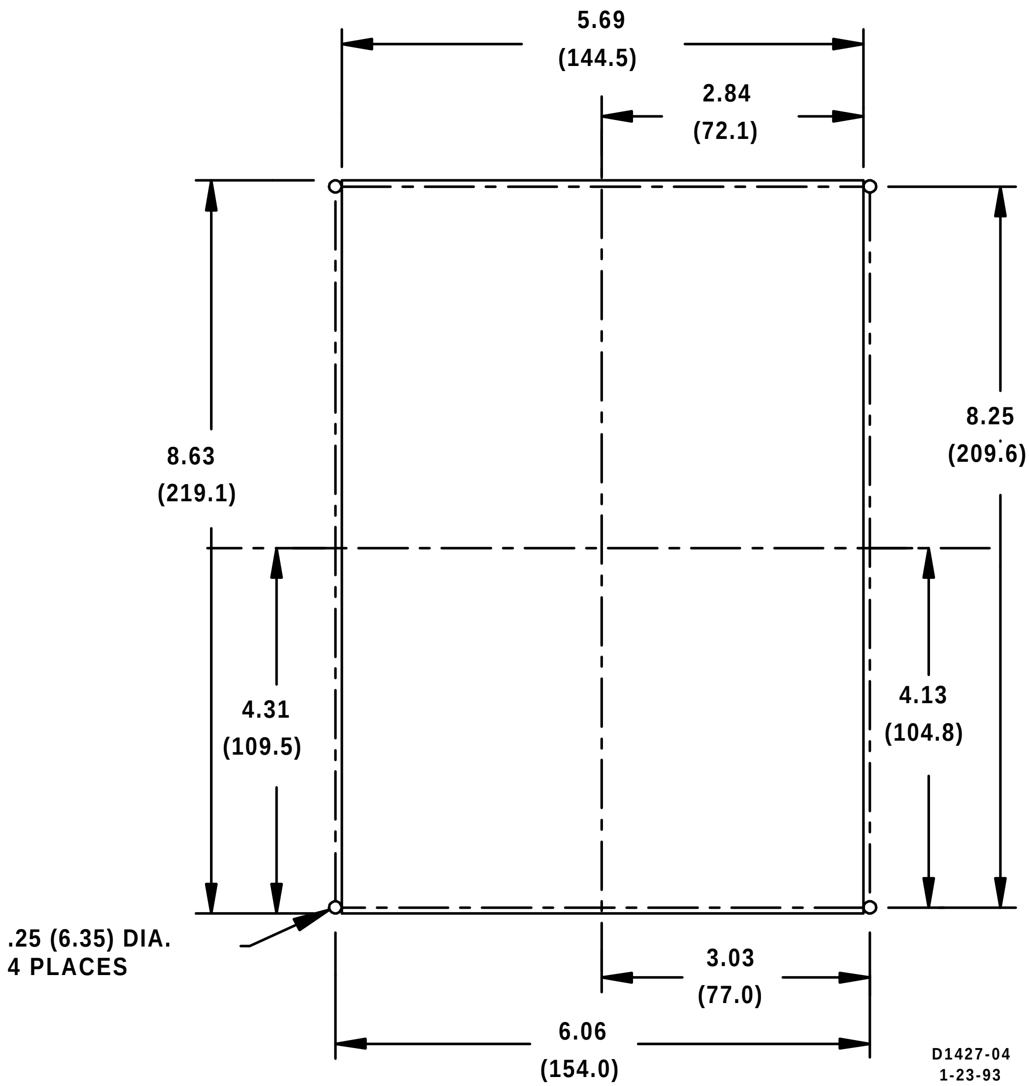

Figure 4-1. S1 Case, Panel Drilling Diagram, Semi-Flush Mounting

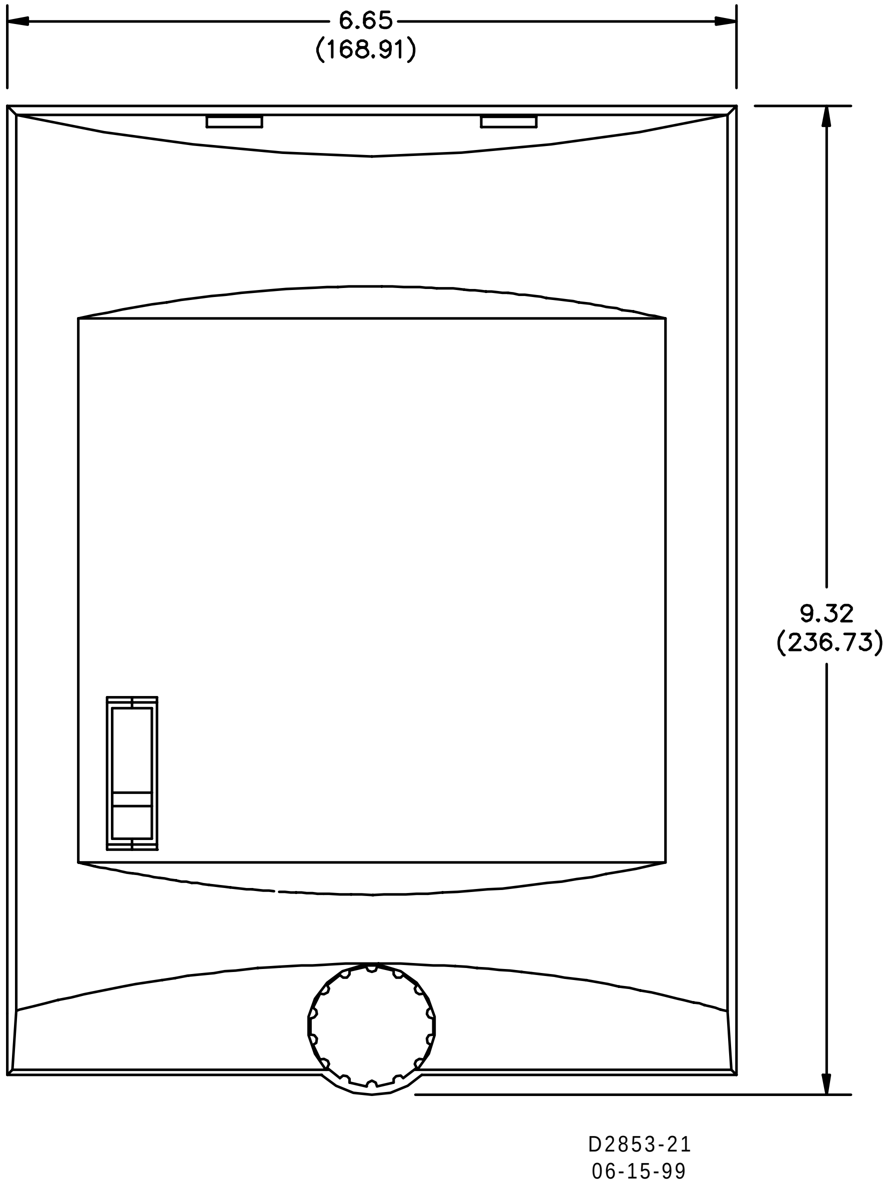

Figure 4-2. S1 Case, Outline Dimensions, Front View

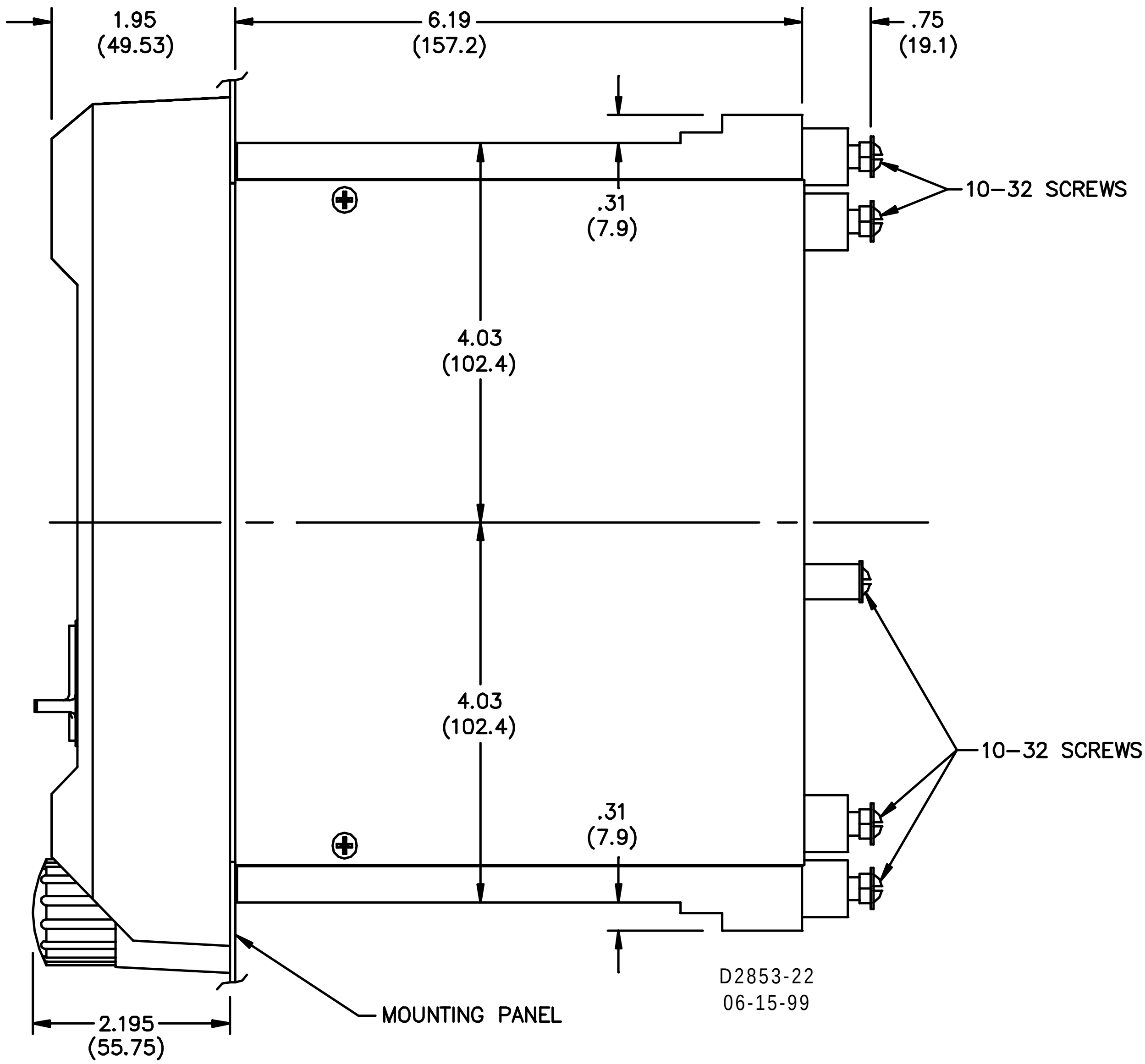

Figure 4-3. S1 Case, Double-Ended, Semi-Flush Mounting, Side View

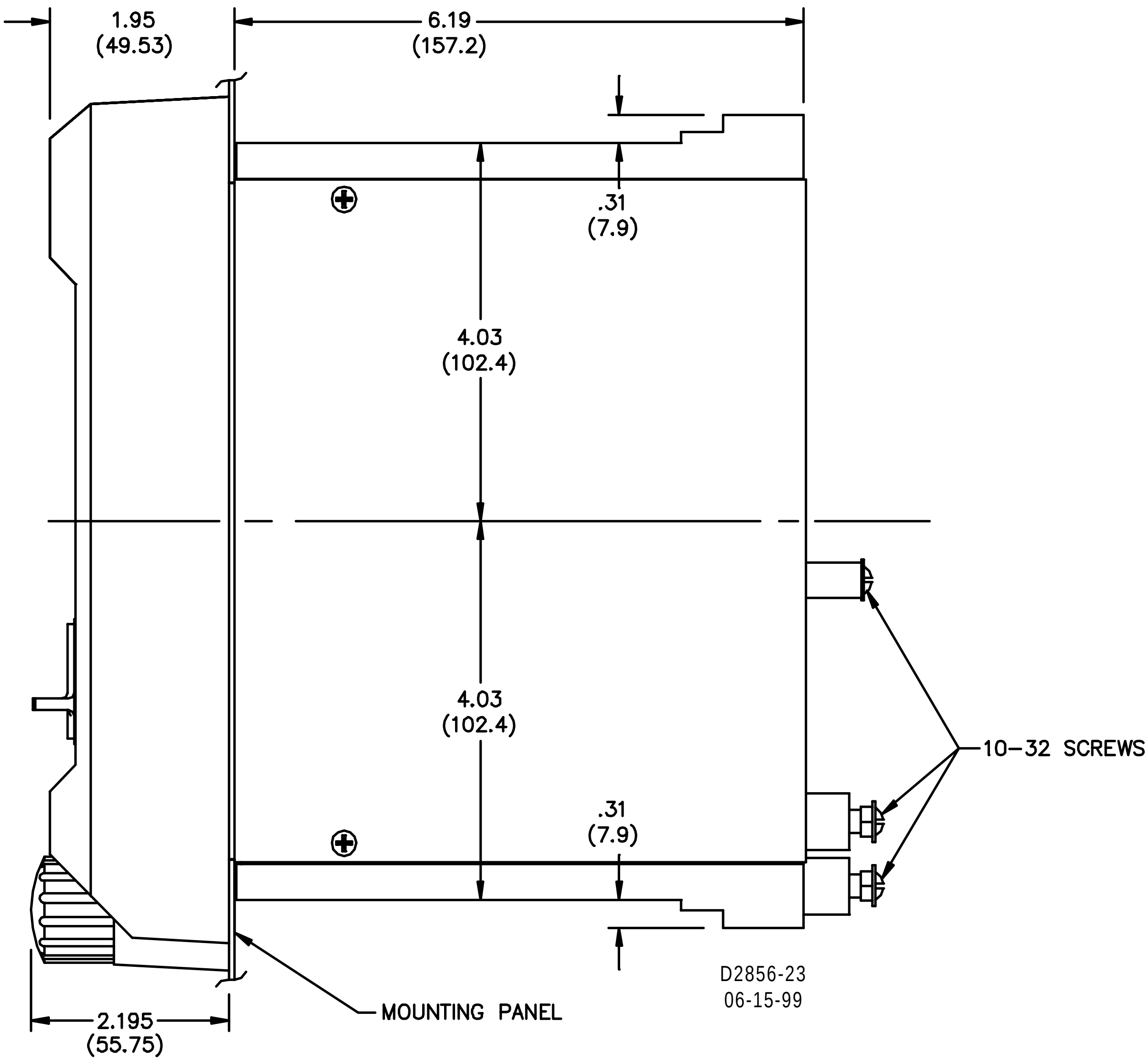

Figure 4-4. S1 Case, Single-Ended, Semi-Flush Mounting, Side View

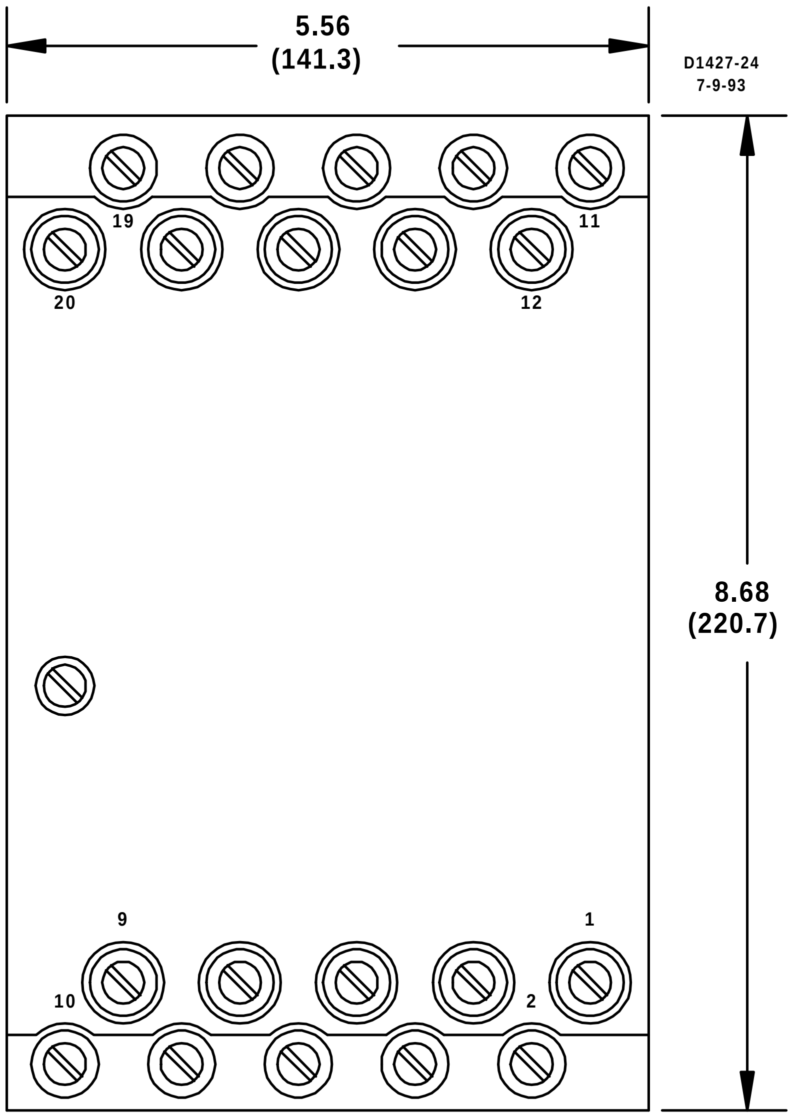

Figure 4-5. S1 Case, Double-Ended, Semi-Flush Mounting, Outline Dimensions, Rear View

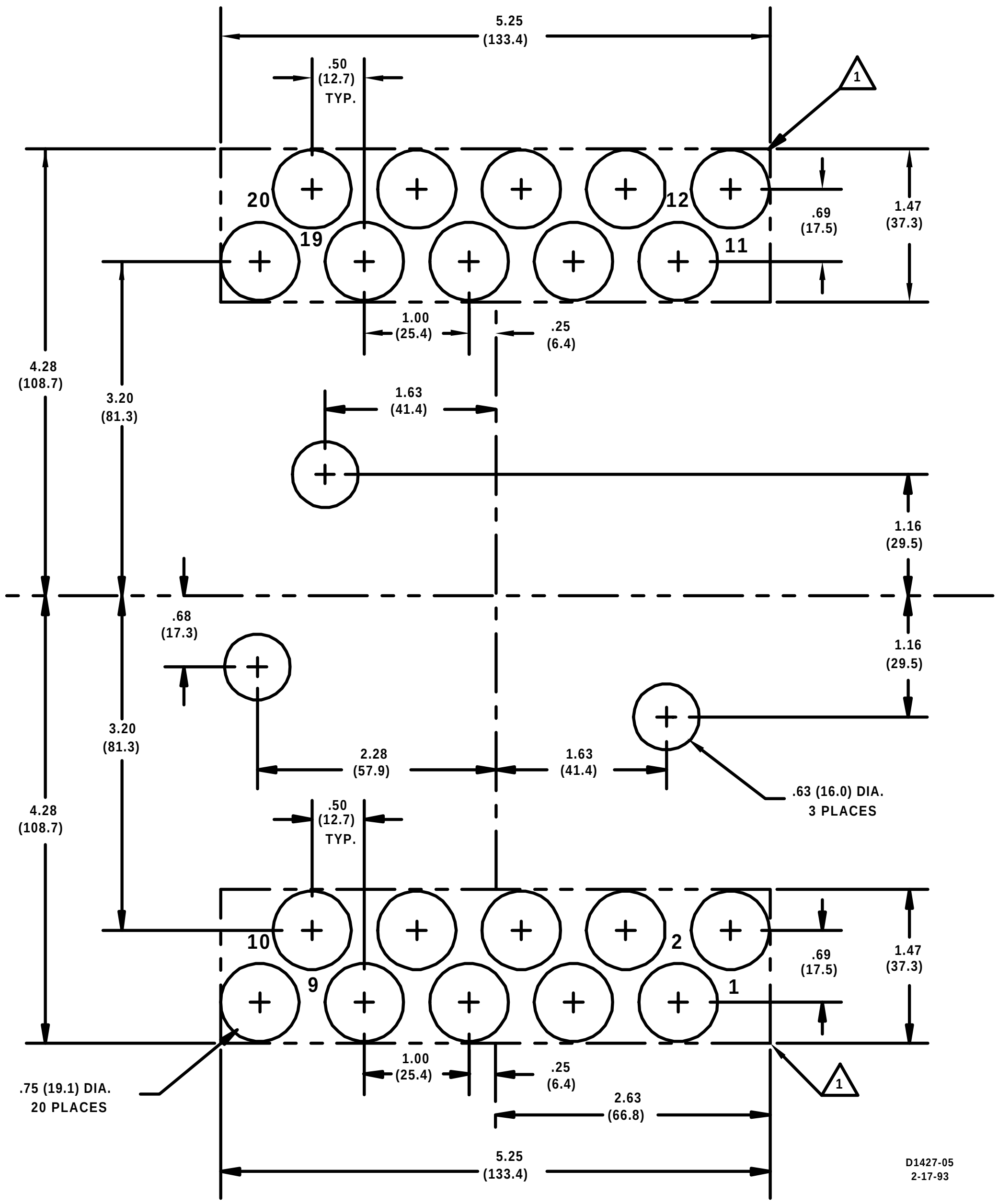

Figure 4-6. S1 Case, Double-Ended, Projection Mounting, Panel Drilling Diagram, Rear View

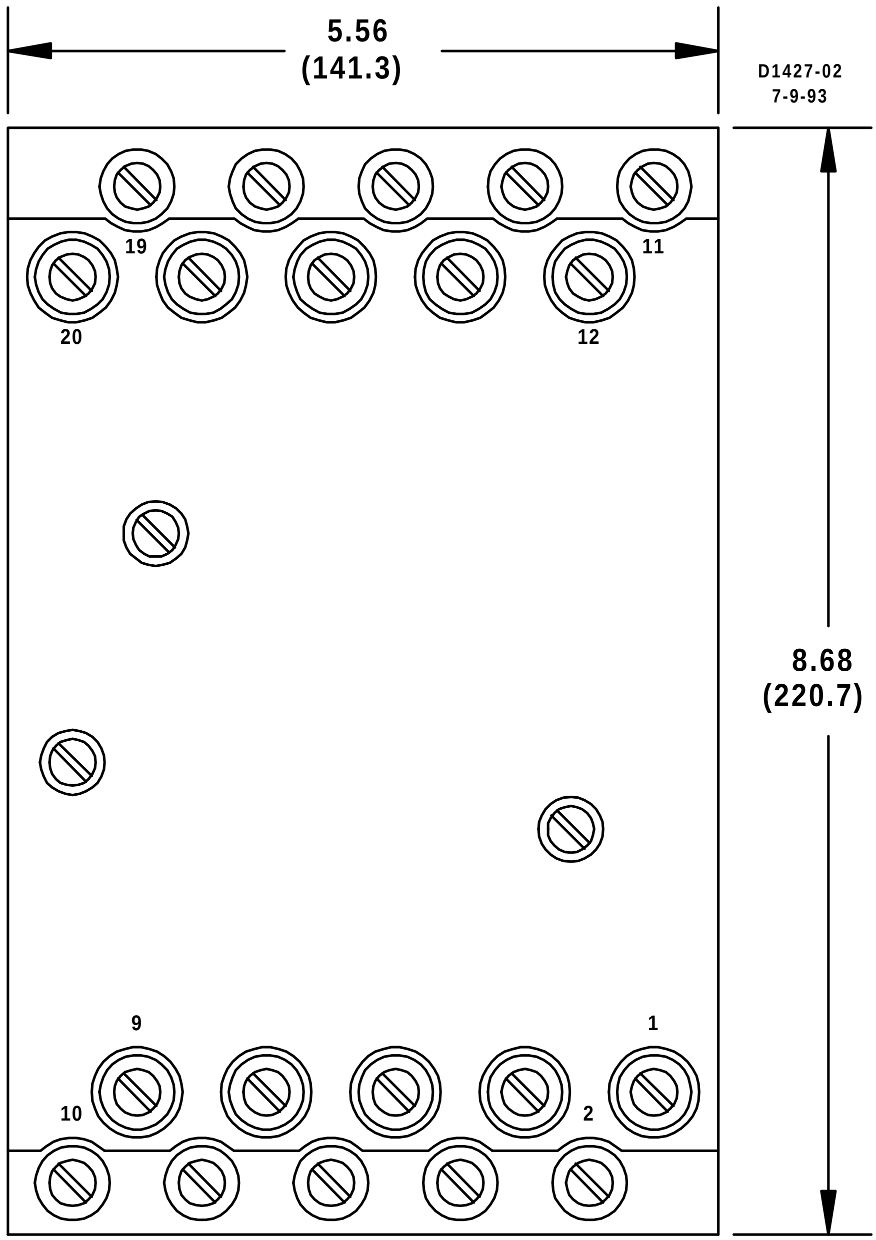

Figure 4-7. S1 Case, Double-Ended, Projection Mounting, Rear View

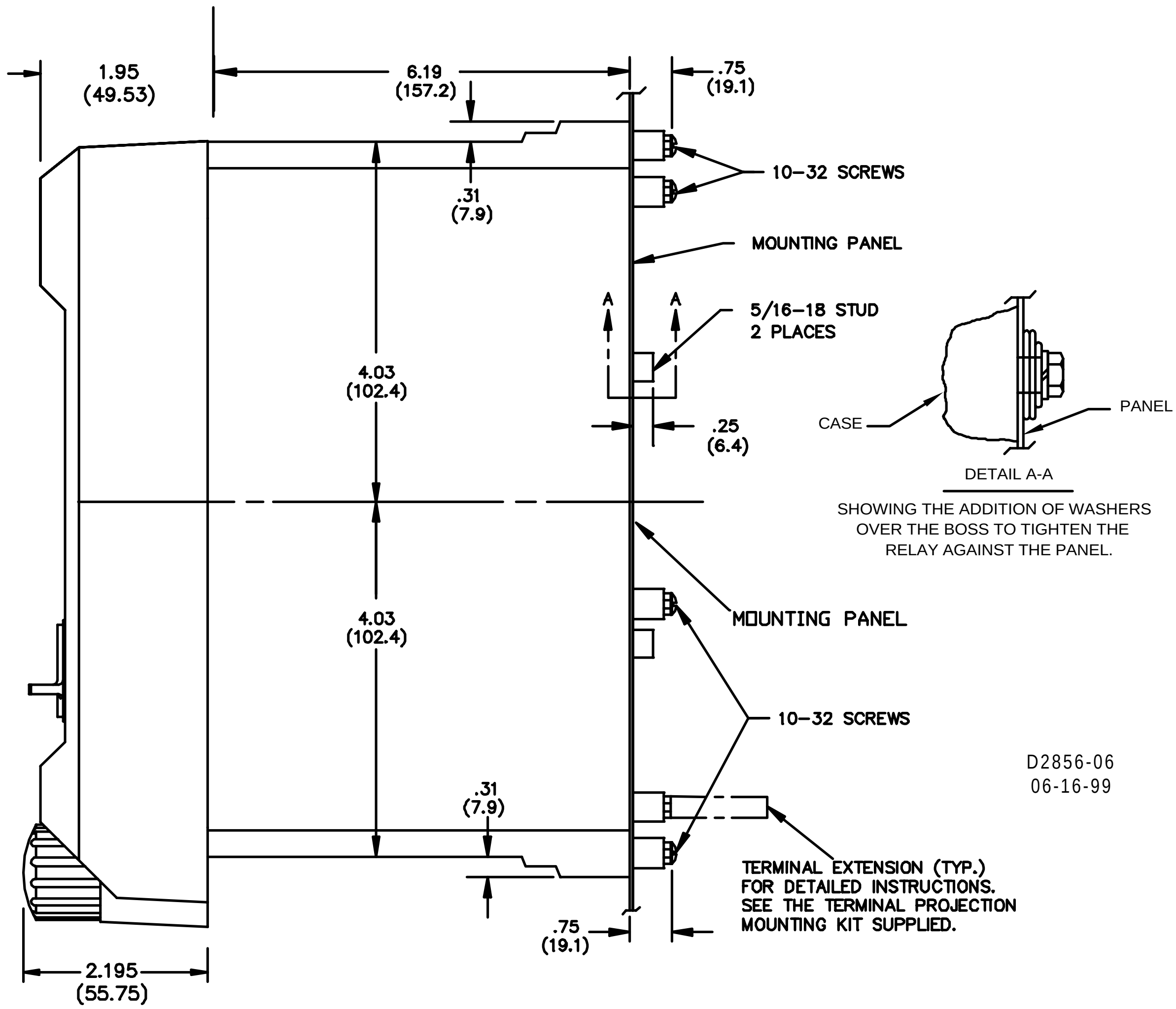

Figure 4-8. S1 Case, Double-Ended, Projection Mounting, Side View

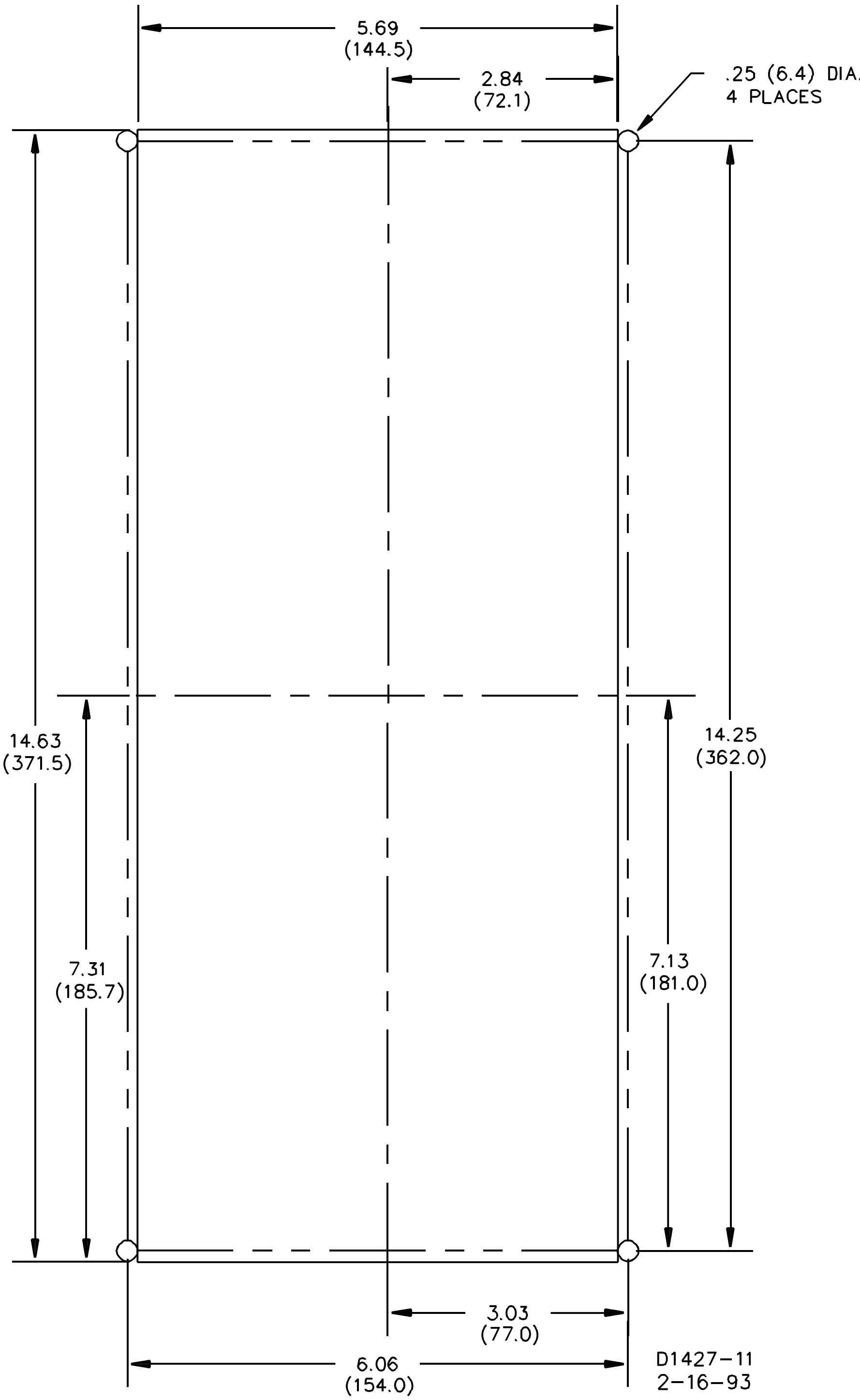

Figure 4-9. M1 Case, Semi-Flush Mounting, Panel Drilling Diagram

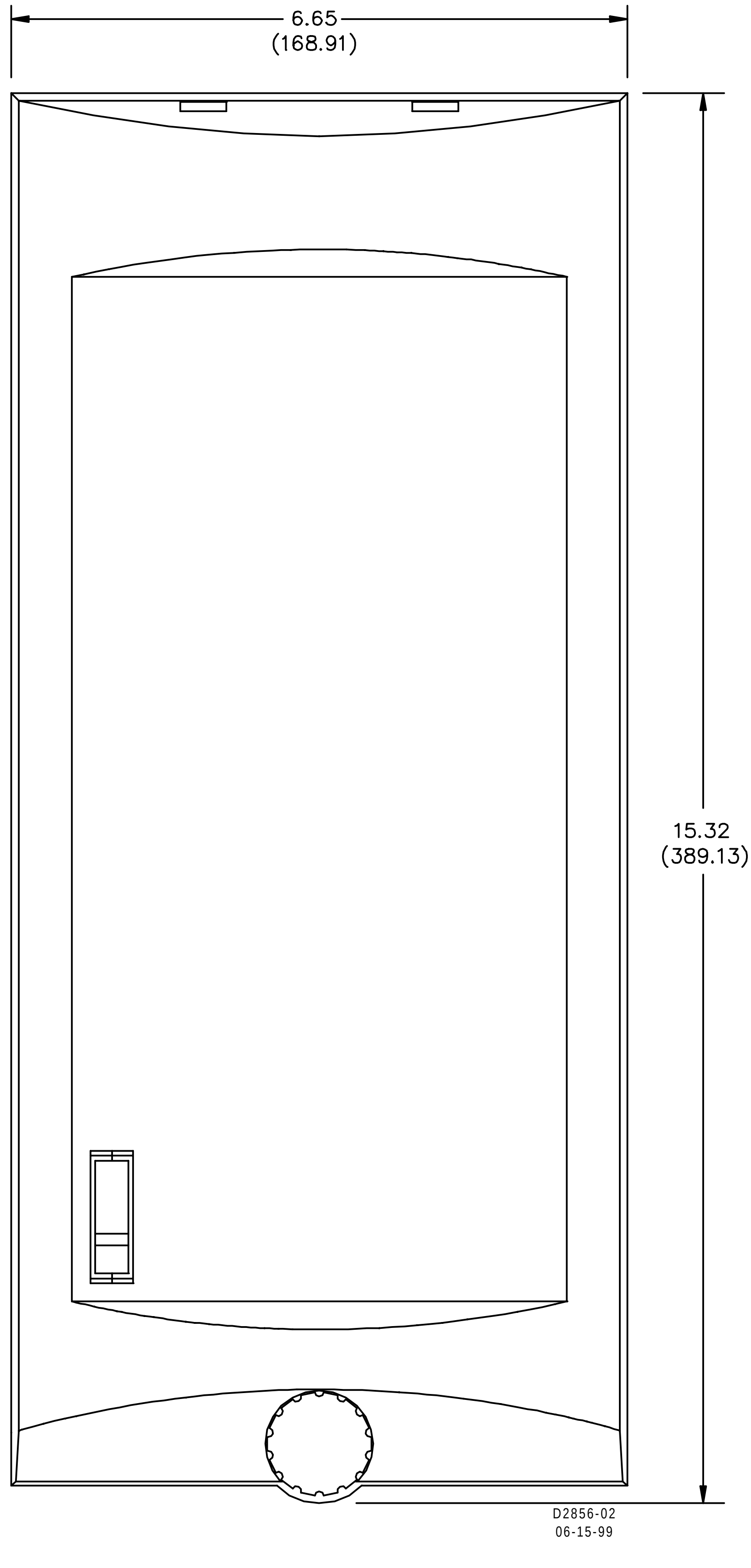

Figure 4-10. M1 Case, Outline Dimensions, Front View

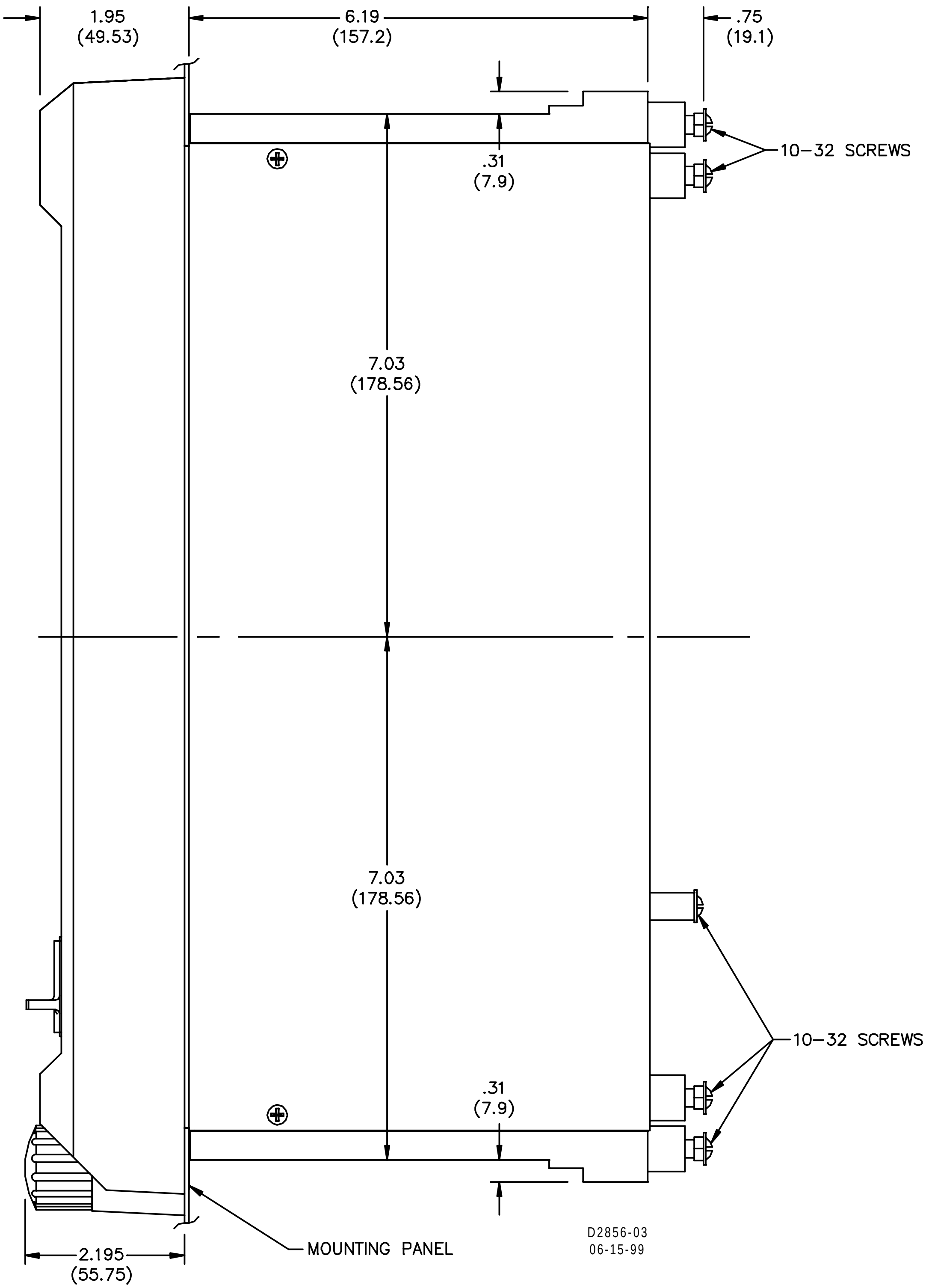

Figure 4-11. M1 Case, Double-Ended, Semi-Flush Mounting, Side View

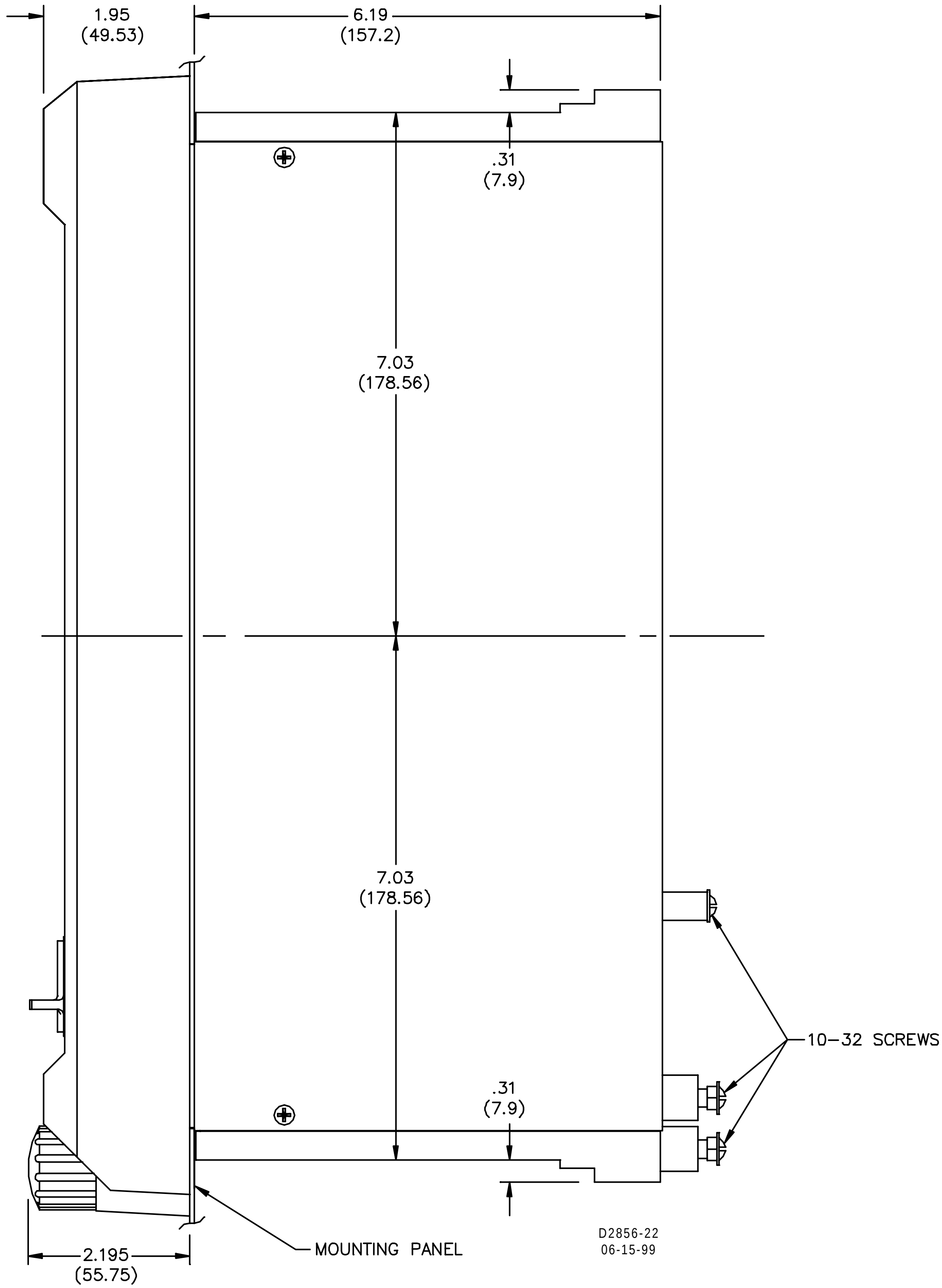

Figure 4-12. M1 Case, Single-Ended, Semi-Flush Mounting, SideView

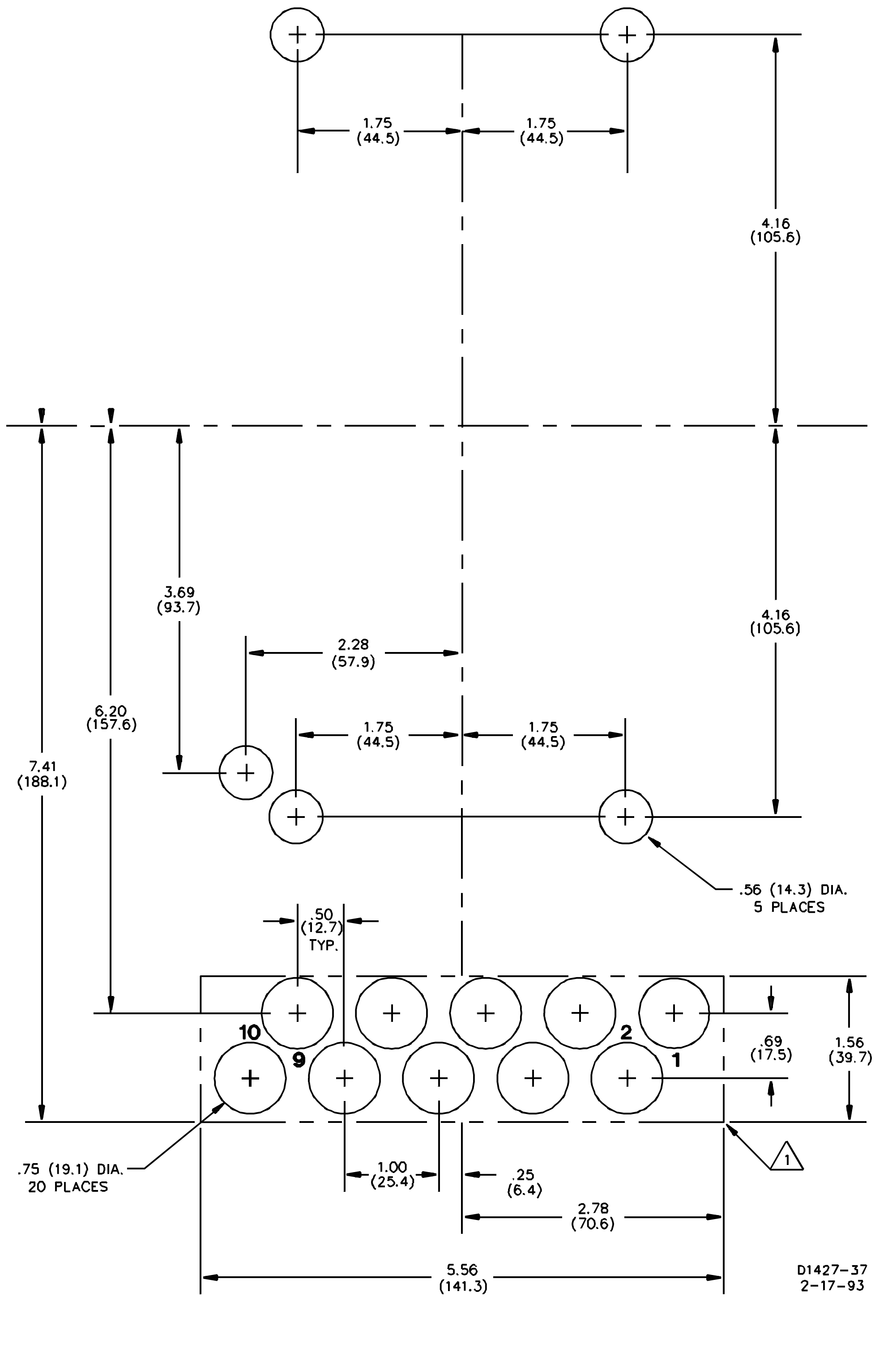

Figure 4-13. M1 Case, Single-Ended, Projection Mounting, Panel Drilling Diagram, RearView

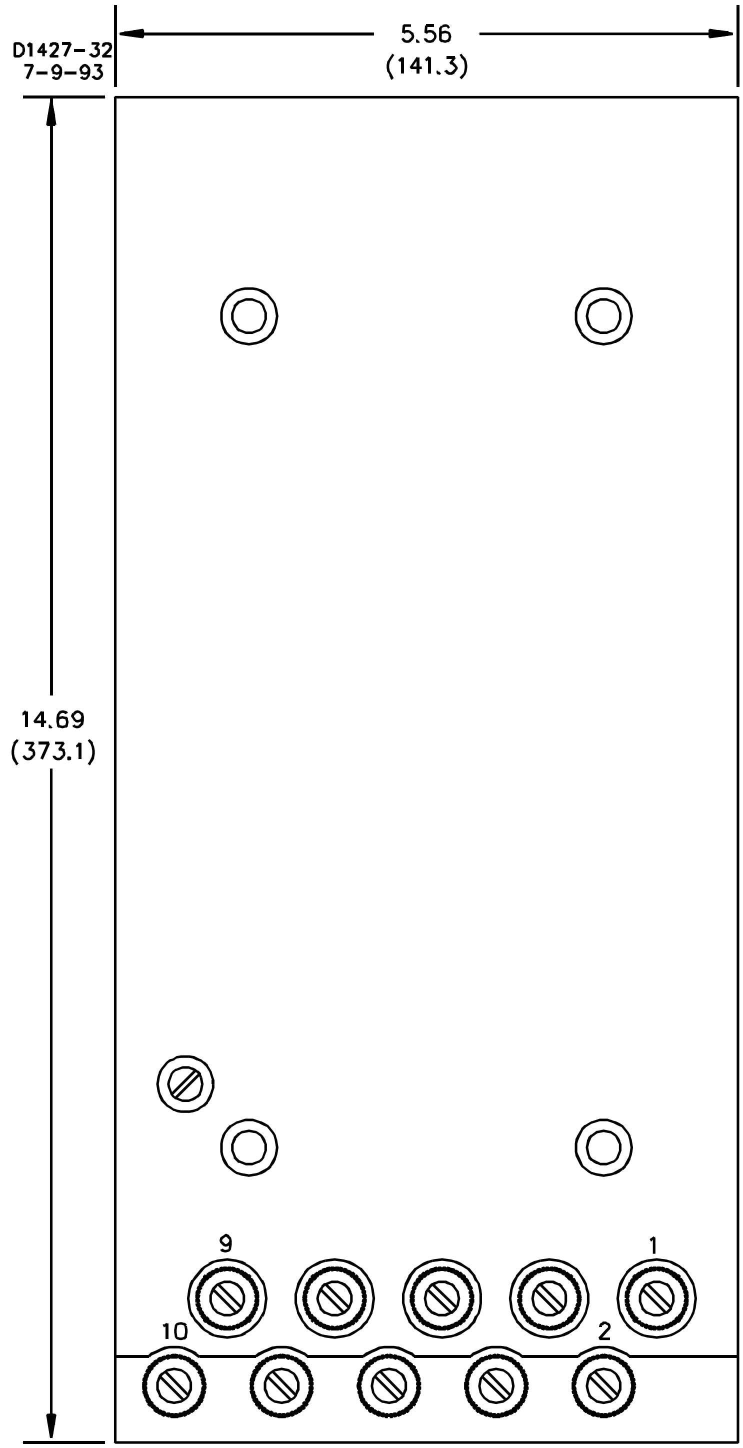

Figure 4-14. M1 Case, Single-Ended, Projection Mount, Outline Dimensions, Rear View

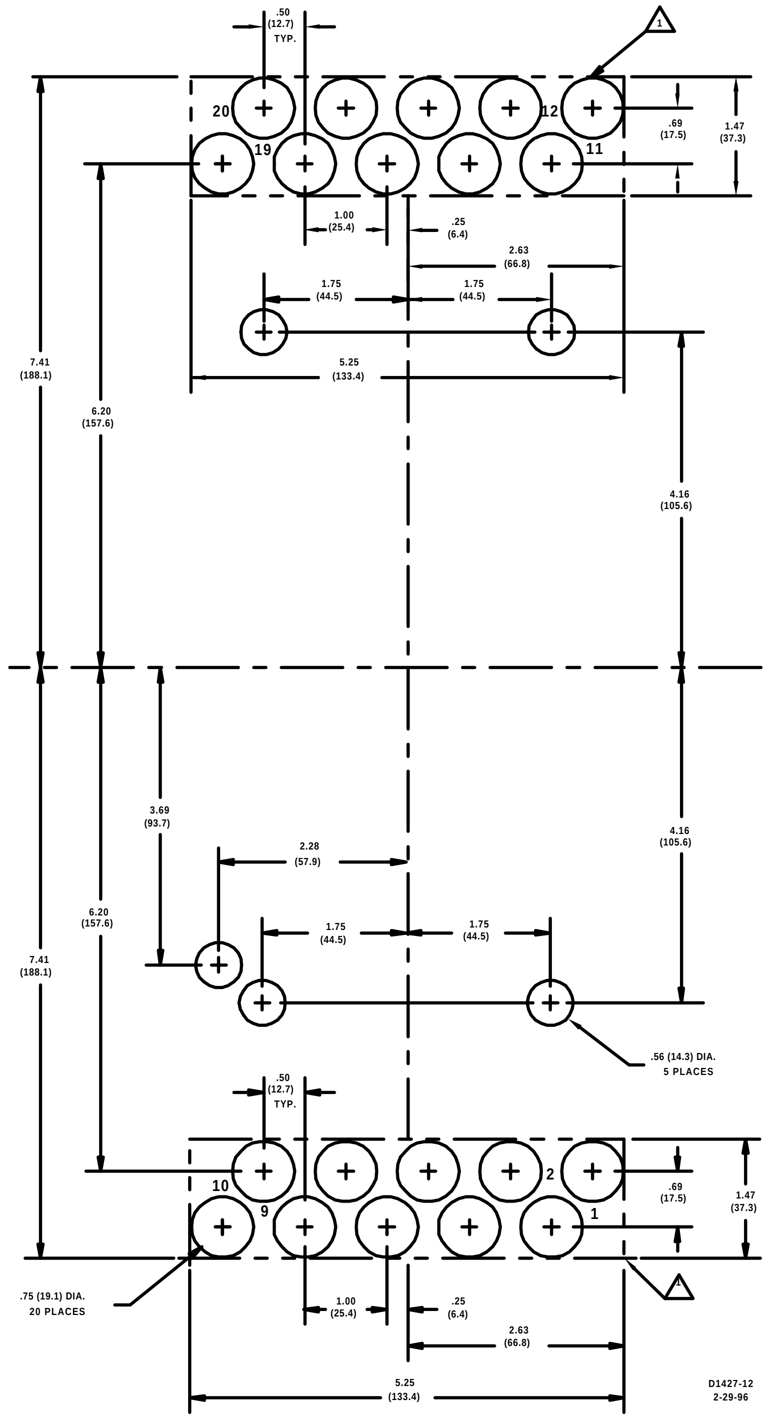

Figure 4-15. M1 Case, Double-Ended, Projection Mounting, Panel Drilling Diagram

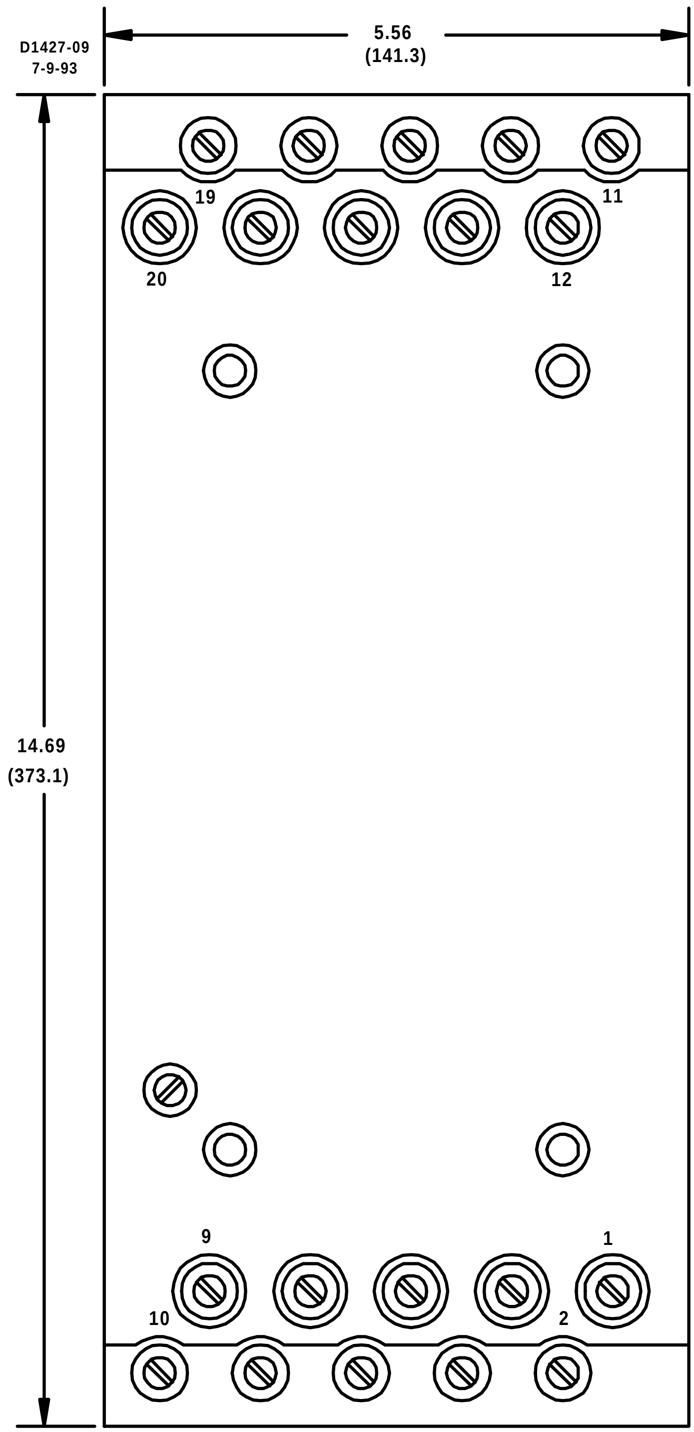

Figure 4-16. M1 Case, Double-Ended, Projection Mounting, Outline Dimensions

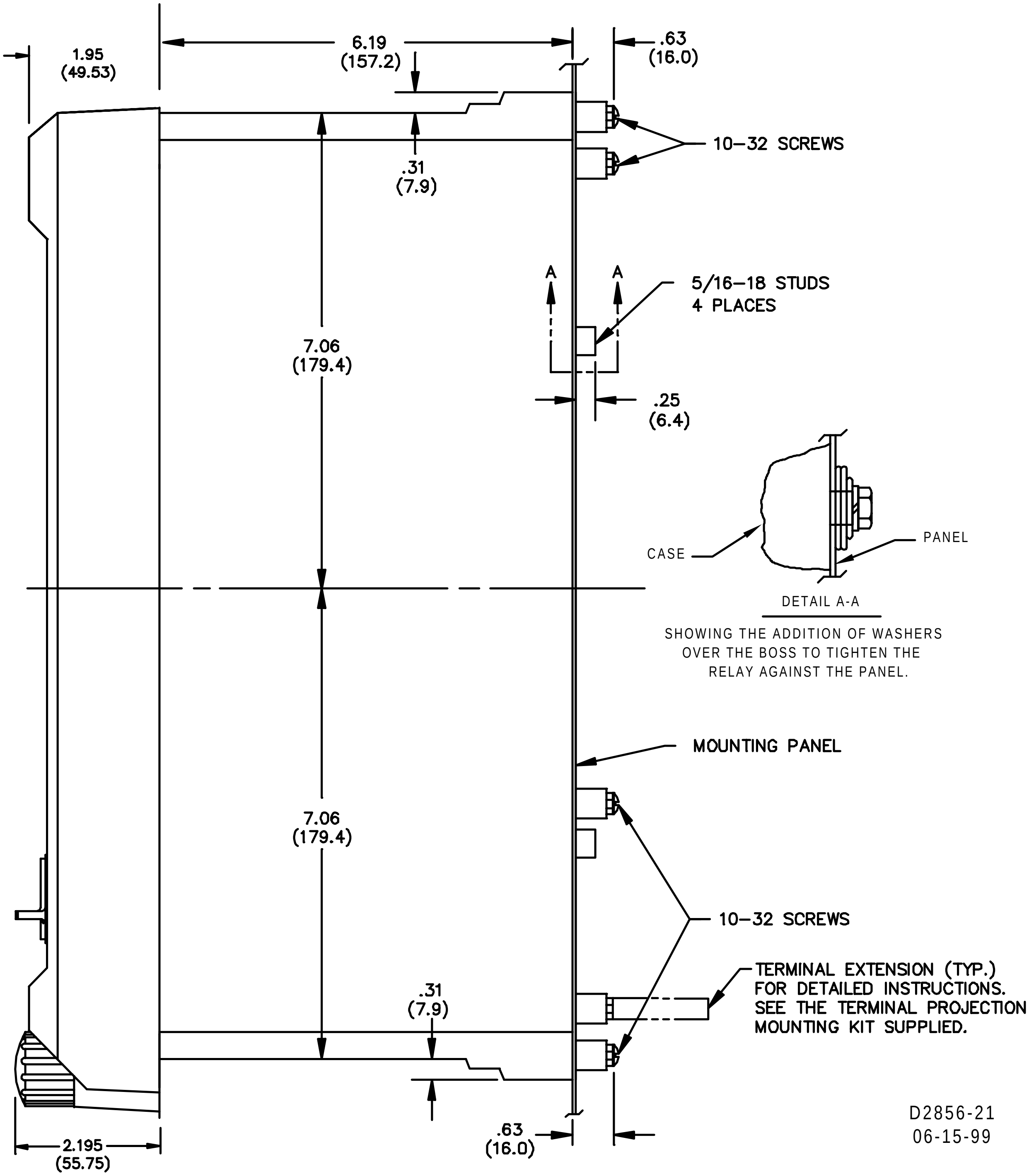

Figure 4-17. M1 Case, Double-Ended, Projection Mounting, Side View

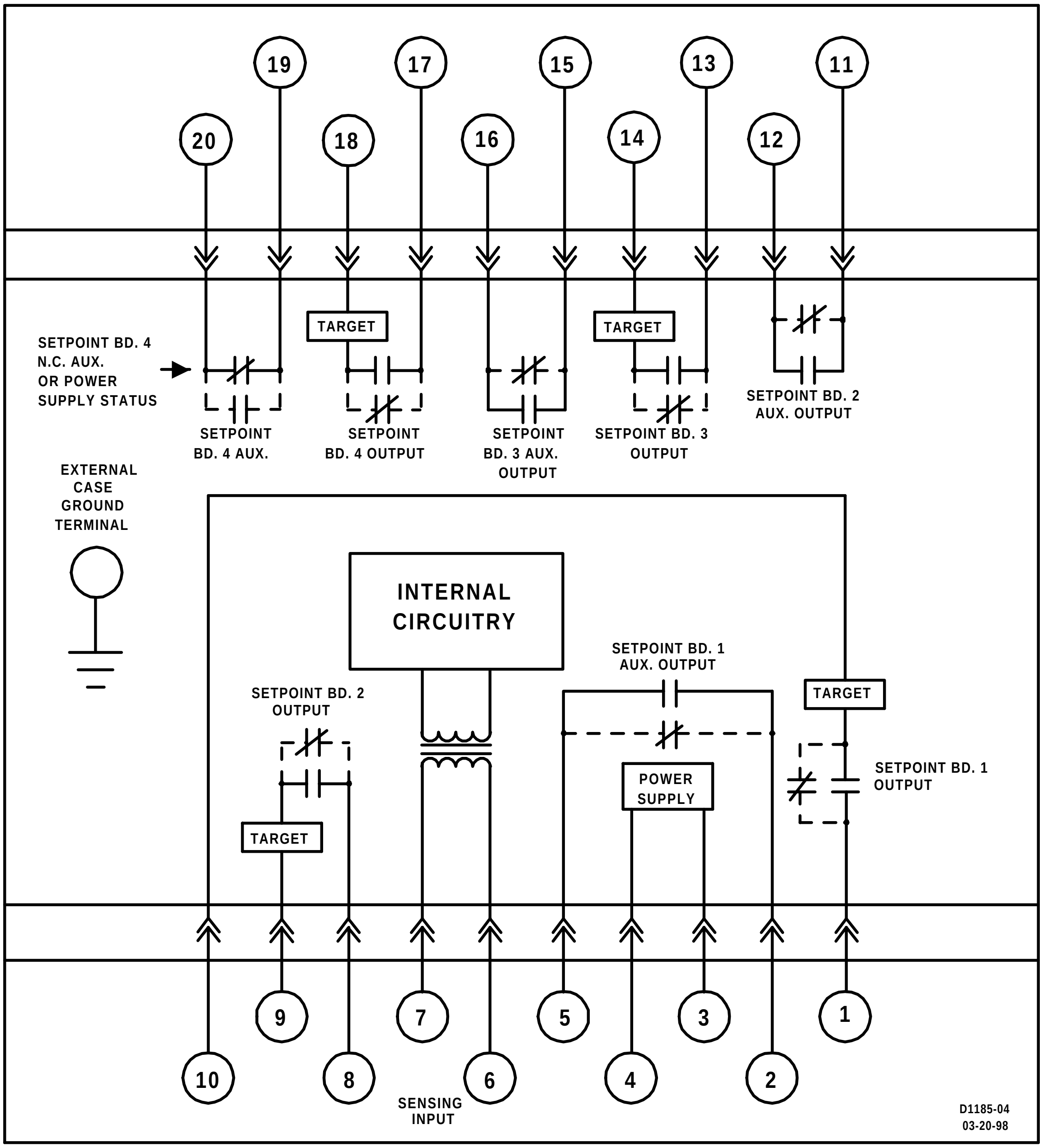

Figure 4-18. Internal Connections

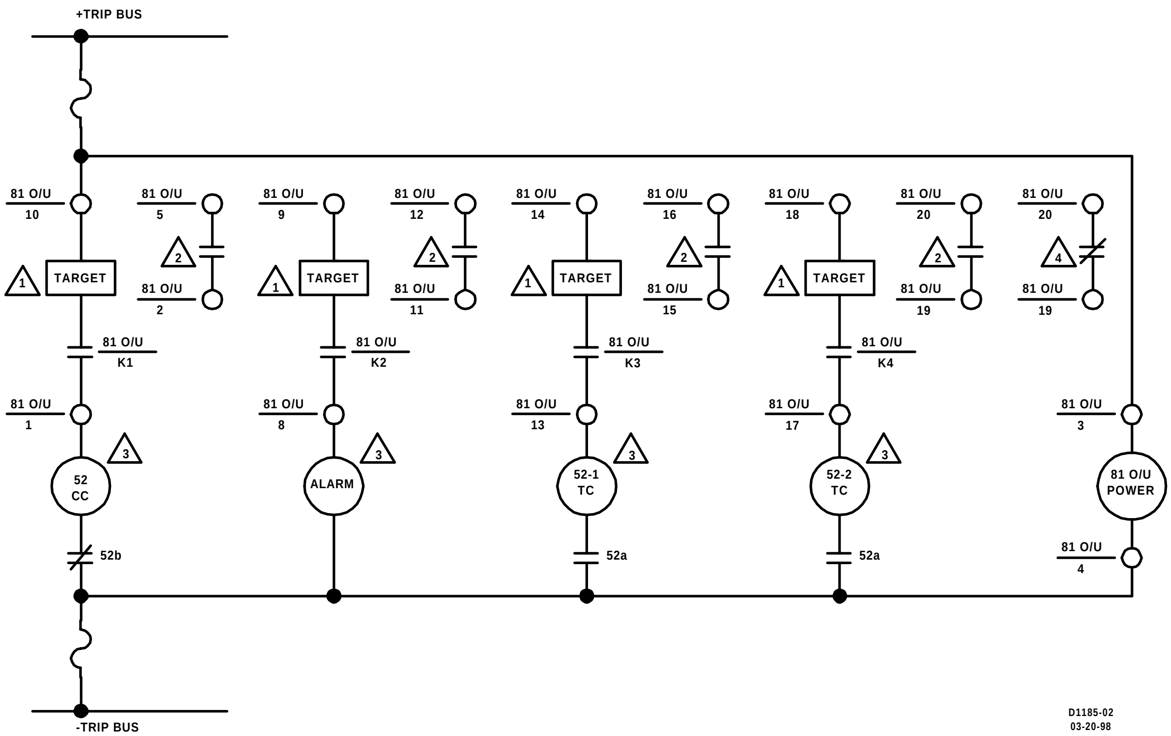

Figure 4-19. DC Connections

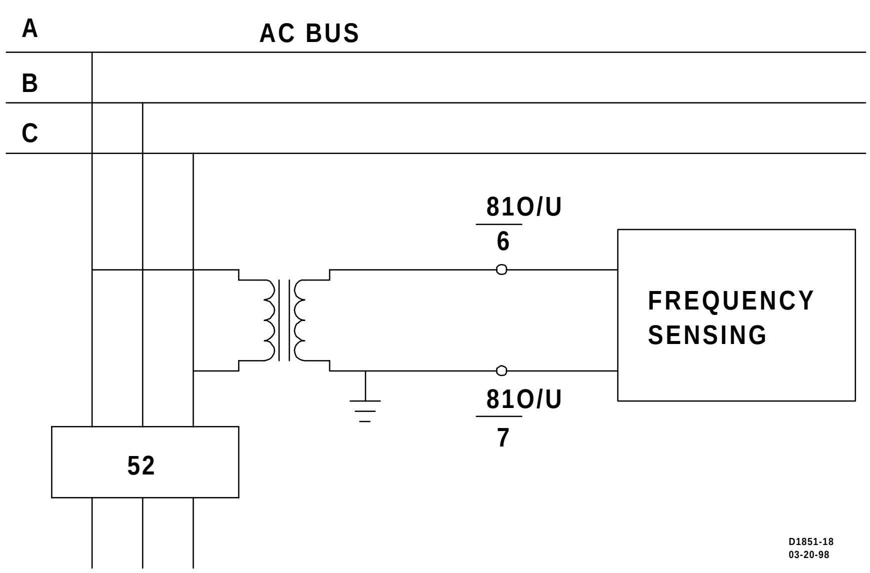

Figure 4-20. AC Sensing Connections

SECTION 5 • TESTS AND ADJUSTMENTS

GENERAL

Procedures in this section are for use in testing and adjusting a relay for the desired operation in a protective scheme. If a relay fails an operational test, or if an adjustment discloses a faulty relay, refer to Section 6.

REQUIRED TEST EQUIPMENT

Minimum test equipment required for relay testing and adjustment is listed below. Refer to Figure 5-1 for the test setup.

> NOTE
> Commercially available frequency relay test sets with frequency and time generating accuracies exceeding those of the relay, and including electronic switching, may be used.

a. Appropriate ac or dc power source for relay operation.
b. Appropriate ac source for frequency sensing. (A source with frequency stability of 0.00002 Hz must exhibit phase noise of less than 90 db for accurate measurement. The accuracy and stability of this source is necessary as the relay precisely measures the period between positive going zero-crossings of the applied waveform and responds instantaneously to the sensed condition.)
c. Hardware (battery and lamp, multimeter, etc.) or method of determining that the output contacts close.

OPERATIONAL TEST

High and Low Frequency Pickup

Step 1. Connect the relay as shown in Figure 4-1.

Step 2. Apply power to the relay.

Step 3. Adjust the input voltage to exceed the level of the (adjustable) UNDER VOLTAGE INHIBIT control (nominal 80 Vac).

Step 4. Position SETPOINT 1 O/U switch to O, FREQUENCY selector to 70.00 Hz, and TIME DELAY selector to 25 (cycles).

Step 5. Apply 60 Hz from the variable frequency source to the relay frequency sensing input

Step 6. Slowly increase the input frequency until the SETPOINT 1 PICKUP LED just lights.

RESULT: The input frequency is within 70.00 ±0.01 Hz.

Step 7. Set the SETPOINT 1 O/U switch to U and FREQUENCY selector to 50.00 Hz.

Step 8. Slowly decrease the input frequency until the SETPOINT 1 PICKUP LED just lights.

RESULT: The input frequency is within ±0.01 Hz of the FREQUENCY selector setting of 50 Hz.

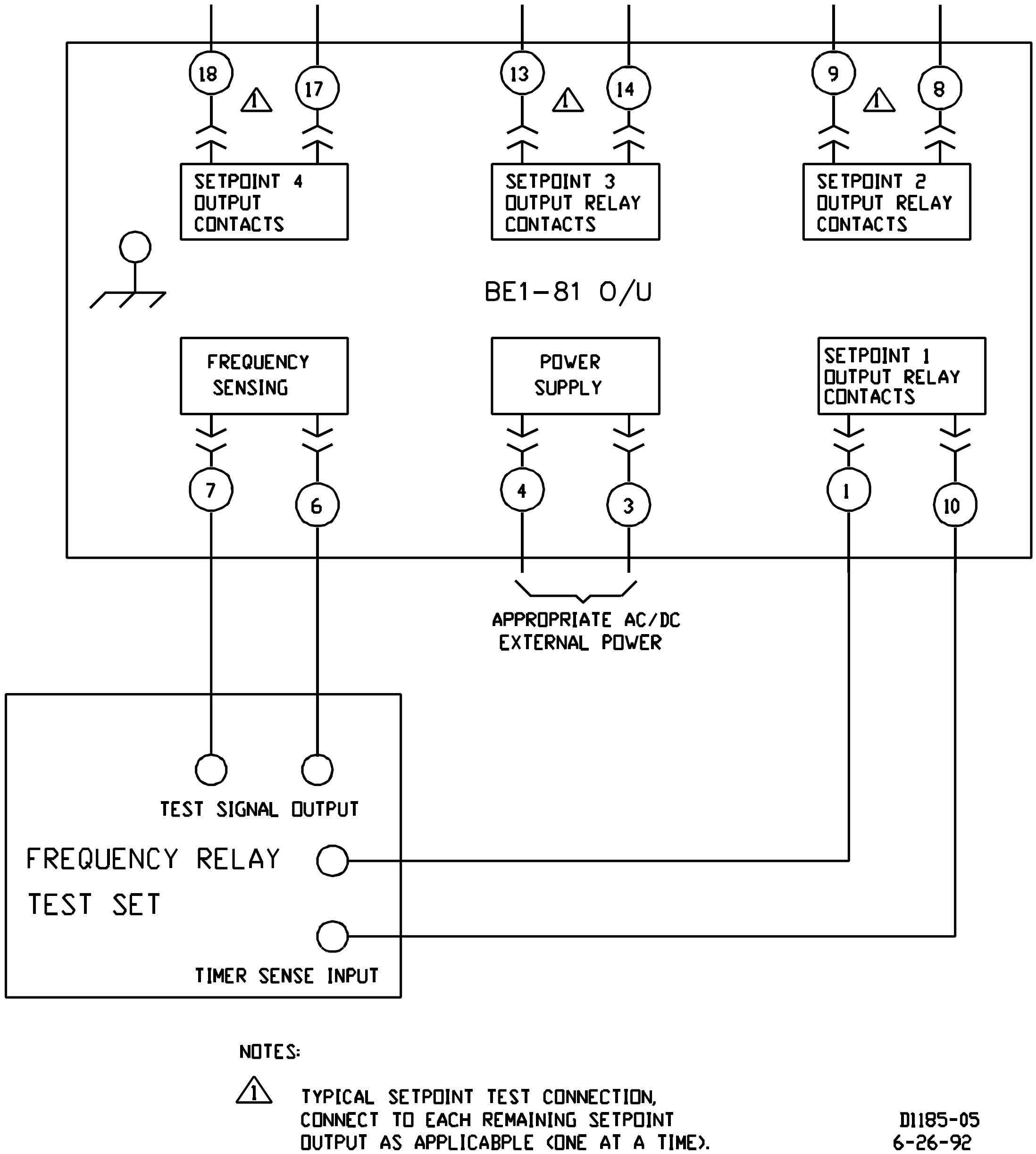

Figure 5-1. Test Setup Diagram

Frequency Selector Settings

Step 1. Connect the relay as shown in Figure 5-1.

Step 2. Apply power to the relay.

Step 3. Adjust the input voltage to exceed the level of the (adjustable) UNDER VOLTAGE INHIBIT control (nominal 80 Vac).

Step 4. Set the SETPOINT 1 O/U selector switch to U.

Step 5. Set the FREQUENCY selector to 51.11 Hz.

Step 6. Starting at a frequency above the setpoint frequency, slowly decrease the input frequency until the SETPOINT 1 PICKUP LED just lights.

RESULT: The input frequency is within ±0.01 Hz of the FREQUENCY selector setting of 51.11 Hz.

Step 7. Repeat STEPS 4 and 5 for FREQUENCY selector settings of 52.22 Hz, 54.44 Hz and 58.88 Hz.

Definite TIME DELAY (Option E1: S7-1 = X1, S7-2 = X1, S7-3 = C)

Step 1. Connect the relay as shown in Figure 5-1.

Step 2. Apply power to the relay.

Step 3. Adjust the input voltage to exceed the level of the (adjustable) UNDER VOLTAGE INHIBIT control (nominal 80 Vac).

Step 4. Set the SETPOINT 1 O/U selector switch to U, the FREQUENCY selector to 55 Hz, and the TIME DELAY selector to 11.

Step 5. Ensure that the targets are reset.

Step 6. Apply a step change (from 60 Hz to 53 Hz) from the variable frequency source to the relay frequency sensing input.

RESULT: (1) The SETPOINT 1 PICKUP LED lights.
(2) The test setup counter is initiated.

Step 7. When the time delay ends, the output relay is tripped.

RESULT: (1) The test setup counter stops (record count for use in Step 8).
(2) The target trips.

Step 8. The counter reading recorded in Step 7 should equal 0.208 seconds (11 cycles ÷ 53 Hz ±1.0 Hz).

Step 9. Restore the variable frequency source to 60 Hz.

RESULT: The relay resets, de-energizing the setpoint 1 output relay.

Step 10. Reset target.

Step 11. Repeat STEPS 4 through 10 for TIME DELAY selector settings 22, 44, and 88.

Definite TIME DELAY (Option E2)

Step 1. Connect the relay as shown in Figure 5-1.

Step 2. Apply power to the relay.

Step 3. Adjust the input voltage to exceed the level of the (adjustable) UNDER VOLTAGE INHIBIT control (nominal 80 Vac).

Step 4. Set the SETPOINT 1 O/U selector switch to U, the FREQUENCY selector to 55 Hz, and the TIME DELAY selector to 25 (seconds - X1, 25 = 2.5 seconds).

Step 5. Ensure that the targets are reset.

Step 6. Apply a step change (from 60 Hz to 53 Hz) from the variable frequency source to the relay frequency sensing input.

RESULT: (1) The SETPOINT 1 PICKUP LED lights.
(2) The test setup counter is initiated.

Step 7. When the time delay ends, the output relay is tripped.

RESULT: (1) The test setup counter stops (record count for use in Step 8).
(2) The target trips.

Step 8. The counter reading recorded in Step 7 should equal 2.5 seconds ±0.05 seconds.

Step 9. Restore the variable frequency source to 60 Hz.

RESULT: The relay resets, de-energizing the setpoint 1 output relay.

Step 10. Reset target.

Step 11. Repeat STEPS 4 through 10 for TIME DELAY selector settings (seconds - X1) of 22, 44, and 88.

Step 12. Repeat STEPS 4 through 10 for TIME DELAY selector settings (seconds - X10) of 22, 44, 88.

Inverse Time Delay (Option D1)

Step 1. Connect the relay as shown in Figure 5-1.

Step 2. Apply power to the relay.

Step 3. Adjust the input voltage to exceed the level of the (adjustable) UNDER VOLTAGE INHIBIT control (nominal 80 Vac).

Step 4. Set the SETPOINT 1 O/U selector switch to U, the FREQUENCY selector to 55 Hz, and the TIME DELAY selector to 2.5.

Step 5. Insure that the targets are reset.

Step 6. Apply a step change (from 60 Hz to 53 Hz) from the variable frequency source to the relay frequency sensing input.

RESULT: (1) The SETPOINT 1 PICKUP LED lights.
(2) The test setup counter is initiated.

Step 7. When the time delay ends, the output relay is tripped.

RESULT: (1) The test setup counter stops (record count for use in Step 8).
(2) The target trips.

Step 8. The counter reading recorded in Step 7 should equal 1.3 seconds ±5% + 3 cycles of the sensed frequency.

Step 9. Restore the variable frequency source to 60 Hz.

RESULT: The relay resets, de-energizing the setpoint 1 output relay.

Step 10. Reset target.

Step 11. Repeat STEPS 4 through 10 for TIME DELAY selector settings of 2.2, 4.4, and 8.8.

Other points can be checked by using the graph in Section 1. All possible curves are not shown on the graphs.

Undervoltage Inhibit

Step 1. Connect the relay as shown in Figure 5-1.

Step 2. Apply power to the relay.

Step 3. Set the SETPOINT 1 O/U selector switch to U, the FREQUENCY selector to 60 Hz, and the TIME DELAY selector to 25.

Step 3. Adjust the 60 Hz input voltage until it is considerably less than the level of the UNDER VOLTAGE INHIBIT control (nominal 80 Vac).

RESULT: UNDER VOLTAGE INHIBIT LED lights.

Step 4. Adjust the relay frequency sensing input to 59 Hz.

RESULT: The SETPOINT 1 PICKUP LED does **NOT** light and the SETPOINT 1 output relay does **NOT** trip.

Step 5. Adjust the voltage until the voltage exceeds the level of the UNDER VOLTAGE INHIBIT control (nominal 80 Vac).

RESULT: (1) UNDER VOLTAGE INHIBIT LED extinguishes.
(2) SETPOINT 1 PICKUP LED lights.
(3) SETPOINT 1 output trips after the time delay expires.

SETPOINT 2, 3, and 4 Performance Tests

Repeat the preceding tests for SETPOINT 2, 3, and 4, by reconnecting the setpoint output connections for each setpoint and substituting the appropriate setpoint number(s) in the test text.

This concludes the operational test procedure.

SECTION 6 • MAINTENANCE

GENERAL

BE1-81O/U Digital Frequency Relays require no preventive maintenance other than a periodic operational test (refer to Section 5 for operational test procedures). If factory repair is desired, contact the Customer Service Department of the Power Systems Group, Basler Electric, for a return authorization number prior to shipping.

IN-HOUSE REPAIR

In-house replacement of individual components may be difficult and should not be attempted unless appropriate equipment and qualified personnel are available.

> **CAUTION**
> Substitution of printed circuit boards or individual components does not necessarily mean the relay will operate properly. Always test the relay before placing it in operation.

If in-house repair is to be attempted, the quality of replacement parts must be at least equal to that of the original components. When complete boards or assemblies are needed, the following information is required.

1. Relay model and style number
2. Relay serial number
3. Board or assembly
   a) Part number
   b) Serial number
   c) Revision letter
4. The name of the board or assembly.

STORAGE

This protective relay contains aluminum electrolytic capacitors which generally have a life expectancy in excess of 10 years at storage temperatures less than 40°C. Typically, the life expectancy of the capacitor is cut in half for every 10°C rise in temperature. Storage life can be extended if, at one-year intervals, power is applied to the relay for a period of thirty minutes.

TEST PLUG

Test plugs (Basler part number 10095 or G.E. part number XLA12A1) provide a quick, easy method of testing relays without removing them from their case. Test plugs are simply substituted for the connection plugs. This provides access to the external stud connections as well as to the internal circuitry.

Test plugs consist of black and red phenolic moldings with twenty electrically separated contact fingers connected to ten coaxial binding posts. Fingers on the black side are connected to the inner binding posts (black thumb nuts) and tap into the relay internal circuitry. Fingers on the red side of the test plug are connected to the outer binding posts (red thumb nuts) and also connect to the relay case terminals.

When testing circuits connected to the bottom set of case terminals, the test plug is inserted with the numbers 1 through 10 facing up. Similarly, when using the test plug in the upper part of the relay, the numbers 11 through 20 are faceup. It is impossible, due to the construction of the test plug, to insert it with the wrong orientation.

SECTION 7 • MANUAL CHANGE INFORMATION

GENERAL

Substantive changes in this manual to date are summarized in Table 7-1.

Revision	Summary of Changes	ECA/DATE
D	Manual changed to match style and format of new manuals, and incorporate changes to relay, Revision D.	12709/07-23-92
E	Manual changed to incorporate changes to relay, Revision E, and to make the manual backwards compatible with previous relay revisions.	12998/03-10-93
F	Changed paragraph styles to new manual design. Changed Section 1, frequency sensing limits to 30 and 80 hertz, and deleted paragraphs on Revision Levels. Changed Specifications: *Power Supply* - ranges; *Pickup* - from ±0.008 hertz to ±0.01 hertz; *Isolation* - new statement; *RFI* - added IEEE qualification statement; added *UL Recognition*; corrected M1 case weight; and corrected *Inverse Time Over/Underfrequency Characteristic Curve Diagrams* (Figures 1-2 and 1-3). Added wide range power supply data to Section 3 and deleted Figure 3-5. Divided old Section 4, *Installation,* into new Section 4, *Installation* and Section 5, *Tests And Adjustments*, and bumped all remaining sections. Added additional installation diagrams to cover all relay styles.	16660/04-08-98
G	Changed style chart to reflect change to E1 and E2 option. Also changed dielectric spec. of section 1 and section 4. Figures 2-3 and 3-3 were updated to show the modified 3 position switch. All case drawings in section 4 were updated to reflect the new covers for M1 and S1 style cases. Definite time delay options test procedures in section 5 have been modified to reflect the new E1 and E2 styles.	5111/06-30-99