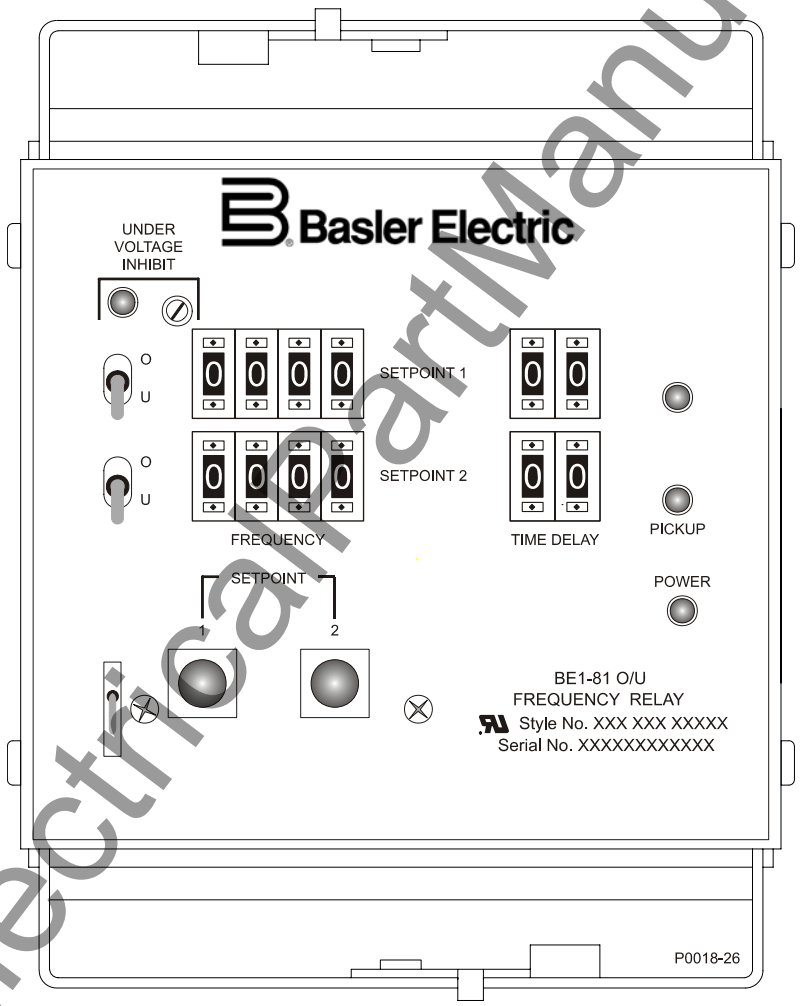
INSTRUCTION MANUAL

FOR

DIGITAL FREQUENCY RELAY

BE1-81O/U



Basler Electric

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INTRODUCTION

This instruction manual provides information about the operation and installation of the BE1-81O/U Digital Frequency Relay. To accomplish this, the following information is provided:

- General Information and Specifications
- Controls and Indicators
- Functional Description
- Installation
- Testing

WARNING!

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

NOTE

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

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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.

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REVISION HISTORY

The following information provides a historical summary of the changes made to the BE1-81O/U instruction manual (9137300990). Revisions are listed in reverse chronological order.

Manual Revision and Date	Change
J, 10/07	• Added manual part number and revision to all footers. • Updated power supply burden data in Section 1. • Updated output contact ratings in Section 1. • Updated front panel drawings to show LED targets. • Updated target description in Section 3.
H, 09/03	• Removed references to timing option D1. • Made various minor corrections throughout manual.
G, 06/99	• Revised style chart to reflect changes to the E1 and E2 timing options. • Changed dielectric test specification listed in Sections 1 and 4. • Figures 2-3 and 3-3 were updated to show the three-position Selector Switch S7. • All case drawings were updated to show revised case covers. • Definite time delay options test procedures (Section 5) were modified to accommodate the new E1 and E2 timing options.
F, 04/98	• Revised paragraph styles. • Section 1: Changed frequency sensing limits to 30 and 80 Hz and deleted paragraphs concerning revision levels. Modified power supply ranges. Changed pickup accuracy from ±0.008 Hz to ±0.01 Hz. New statement was added to Isolation, 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). • Section 3: Added wide-range power supply data and deleted Figure 3-5. • Section 4: Extracted testing and adjustment information and created new Section 5, *Tests and Adjustments.* Incremented remaining section numbers as required. Inserted additional installation diagrams to cover all relay styles.
E, 03/93	• Various relay changes were incorporated into the manual.

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SECTION 1 • GENERAL INFORMATION

INTRODUCTION

The BE1-81O/U Digital Frequency Relay monitors the frequency of a single-phase, ac voltage and provides accurate frequency protection for a distribution system or generator operating at 50 or 60 hertz.

The BE1-81O/U initiates removal of a load from a distribution system when the system frequency decreases below the relay's adjustable setpoint. When the system frequency returns to normal (as defined by another setpoint), the BE1-81O/U permits restoration of the load. The BE1-81O/U may be tailored to the operating frequency/time characteristic of a generator to permit removal of the generator from service if the generator frequency (or system frequency) exceeds a setpoint. This scheme also permits restoration to service when the generator (or system) frequency returns to normal.

FEATURES

The BE1-81O/U can be specified with up to four independently adjustable frequency setpoints and time delays with associated output relays and target indicators.

Frequency Setpoints

Each frequency setpoint has a setting range of 40 to 70 hertz and can be switch selected to detect over-frequency or underfrequency. BE1-81O/U relays with one or two setpoints are supplied in an S1 case. Relays with three or four setpoints are supplied in an M1 case.

Time Delays

Each definite time delay setting can be adjusted for a delay of three cycles to 990 seconds.

Undervoltage Inhibit

An undervoltage inhibit feature prevents relay operation if the sensed voltage decreases below the adjustable front panel setting.

Targets

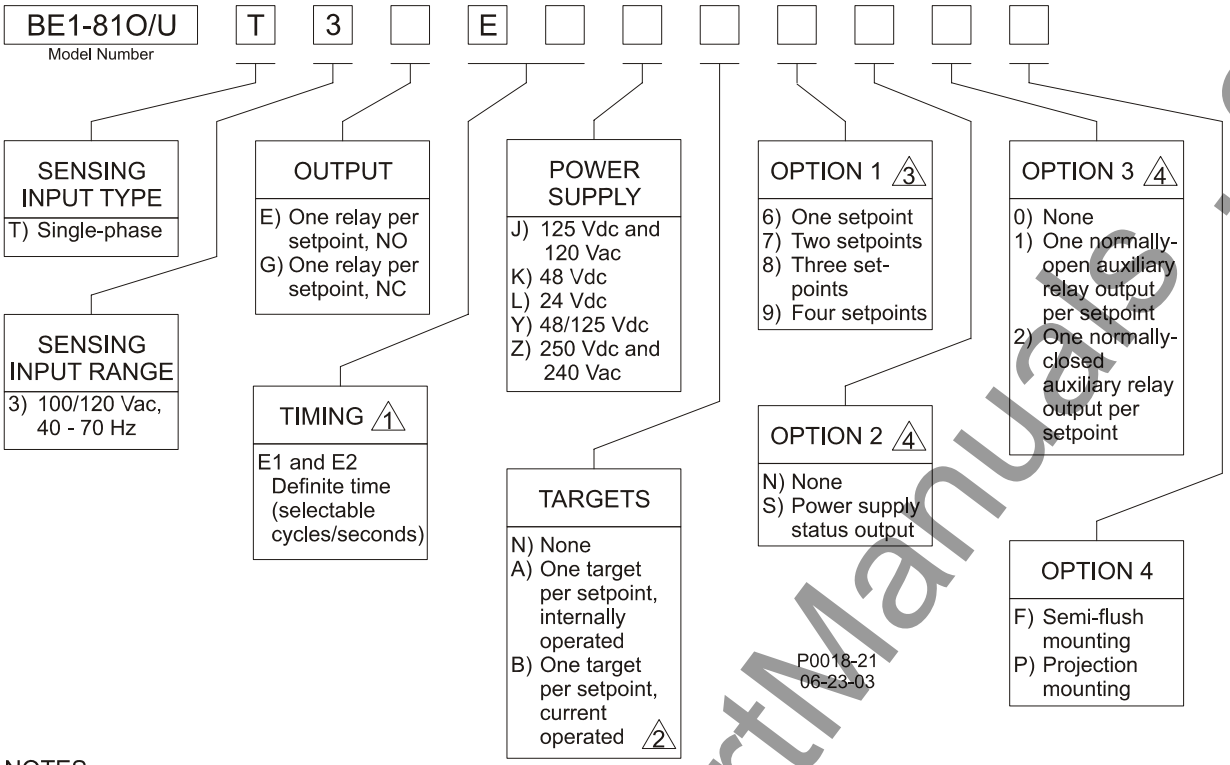
Either internally-operated or current-operated target indicators are available for each setpoint.

OPERATION

When the sensed frequency passes through a setpoint in the selected direction, a three-cycle timer begins timing. If the condition persists for the duration of the three-cycle timer, the Pickup LED indicator lights and the definite time delay is triggered. If the pickup condition persists for the duration of the time delay setting, the corresponding output relay energizes, operates the appropriate output contacts, and trips the setpoint's target indicator.

STYLE NUMBER

BE1-81O/U electrical characteristics and operating features are defined by a combination of letters and numbers that make up the relay style number. The style number describes the features and options of a particular relay and appears on the front panel, draw-out cradle assembly, and the relay case. The style number identification chart shown in Figure 1-1 illustrates the features and options for the BE1-81O/U relay.



NOTES

1. BE1-81O/U relays with hardware version M and higher, with Timing Option E1 or E2, have an extended timing range. The new range for both timing options is identical at 3 cycles to 990 seconds (16.5 minutes).

   Earlier relays with Timing Option E1 had a timing range of 3 cycles to 99 cycles and did not include range selection switches. Earlier relays with Timing Option E2 had a timing range of 3 to 99 seconds.

   To provide rearward compatibility for users of the BE1-81O/U with Timing Option E1, new units are shipped with the timing range switches set in default positions to emulate the E1 timing range.

2. Target B should be selected only if Output E is specified.
3. If Option 1 is 6 or 7, an S1 case is required. If Option 1 is 8 or 9, an M1 case is required.
4. If Option 1 is 9 and Option 2 is S, the auxiliary relay (Option 3 is 1 or 2) associated with setpoint 4 is omitted.

Figure 1-1. Style Number Identification Chart

For example, if the BE1-81O/U style number was **T3E E1J A9N2F**, the relay would have the following features and options.

T----------Single-phase sensing input
3----------100/120 Vac, 40 to 70 Hz nominal sensing range
E ----------One normally-open output relay per setpoint
E1----------Definite time delay, selectable for cycles or seconds
J----------125 Vdc or 120 Vac relay operating power
A ----------One internally-operated target for each setpoint
9----------Four frequency setpoints
N ----------No power supply status output
2----------One normally-closed, auxiliary relay output for each setpoint
F----------Semi-flush case mounting

SPECIFICATIONS

BE1-81O/U electrical and physical specifications are listed in the following paragraphs.

Sensing Input

Voltage Range: 40 to 132 Vac

Frequency

Detection Range: 30 to 80 Hz (Revision D and subsequent)
35 to 80 Hz (Revision C and previous)

Computation Range: 40 to 70 Hz

Burden: 2 VA maximum

Operating Power Input

Relay operating power may be obtained from a wide variety of external voltage sources. When ordering, any one of five internal power supply types may be selected to match the operating power voltage level available at your site. Available power supply types are listed in Table 1-1.

Table 1-1. Power Supply Types

Type	Input Voltage		Burden at Nominal
	Nominal	Range	
K (midrange)	48 Vdc	24 to 150 Vdc	3.6 W
J (midrange)	125 Vdc 120 Vac	24 to 150 Vdc 90 to 132 Vac	3.9 W 16.0 VA
L (low range)	24 Vdc	12 to 32 Vdc *	3.7 W
Y (mid range)	48 Vdc 125 Vdc	24 to 150 Vdc 24 to 150 Vdc	3.6 W 3.9 W
Z (high range)	250 Vdc 240 Vac	68 to 280 Vdc 90 to 270 Vac	3.9 W 24.6 VA

* The type L power supply initially requires 14 Vdc to begin operating. Once operating, the voltage may be reduced to 12 Vdc and operation will continue.

Relay Outputs

One relay output is provided for each setpoint. Relay outputs can be specified as normally open or normally closed. One normally open or normally closed auxiliary relay output per setpoint is also available as an option.

Output Contacts

Resistive Ratings

120 Vac: Make, break, and carry 7 Aac continuously
250 Vdc: Make and carry 30 Adc for 0.2 s, carry 7 Adc continuously, and break 0.3 Adc
500 Vdc: Make and carry 15 Adc for 0.2 s, carry 7 Adc continuously, and break 0.3 Adc

Inductive Ratings

120 Vac, 125 Vdc, 250 Vdc: Break 0.3 A (L/R = 0.04)

Target Indicators (optional)

Electronically latching, manually reset targets indicate that a setpoint contact has energized. Either internally operated or current operated targets may be specified.

Current operated targets require a minimum trip circuit current of 200 milliamperes and have a continuous rating of 3 amperes, a two-minute rating of 7 amperes, and a one-second rating of 30 amperes.

Internally operated targets should be selected if the relay has normally-closed output contacts.

Frequency Setpoint

Range:	40 to 70 Hz
Increment:	0.01 Hz
Accuracy:	±0.01 Hz of the setpoint setting

Time Delay

Definite Time (E1 & E2)

Setting Range

Cycles (of applied freq.):	3 to 99 cycles in 1 cycle increments 10 to 990 cycles in 10 cycle increments 100 to 9900 cycles in 100 cycle increments
Seconds:	0.1 to 9.9 seconds in 0.1 second increments 1.0 to 99 seconds in 1 second increments 10 to 990 seconds in 10 second increments

Accuracy

Cycles:	±1.0 cycle
Seconds:	±2% of the setting or ±25 ms, whichever is greater

Inverse Time (D1) (Option no longer available)

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.)

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

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.

Undervoltage Inhibit

Setting Range:	40 to 120 Vac
Accuracy:	±5% of the setting at 25°C for nominal frequency input

Type Tests

Dielectric Strength:	Meets IEC 60255-5 and exceeds IEEE C37.90 one-minute dielectric tests as follows: All circuits to ground: 2828 Vdc Input to output circuits: 2000 Vac or 2828 Vdc
Surge Withstand Capability:	Qualified to IEEE C37.90.1-1989
Fast Transient:	Qualified to IEEE C37.90.-11989
Impulse:	Qualified to IEC 60255-5
Radio Frequency Interference:	Maintains proper operation when tested in accordance with IEEE C37.90-1989 Field tested using a 5-watt, hand-held transceiver operating at random frequencies centered around 144 MHz and 440 MHz, with the antenna located 6 inches (152 millimeters) from the relay in both horizontal and vertical planes.
Shock:	Withstands 15 G in each of three mutually perpendicular axes
Vibration:	Withstands 2 G in each of three mutually perpendicular axes swept over the range of 10 to 500 Hz for a total of six sweeps, 15 minutes each sweep.

Temperature Ratings

Operating:	–40°C to 70°C (–40°F to 158°F)
Storage:	–65°C to 100°C (–85°F to 212°F)

UL Recognized

UL recognized per Standard 508, UL File No. E97033. Note: Output contacts are not UL recognized for voltages greater than 250 volts and input power supply voltages greater than 150 volts.

GOST-R

Gost-R certified No. POCC US.ME05.B03391; complies with the relevant standards of Gosstandart of Russia. Issued by accredited certification body POCC RU.0001.11ME05.

Case Size

One or Two Setpoints:	S1 (See Section 4, *Installation* for case dimensions.)
Three or Four Setpoints:	M1 (See Section 4, *Installation* for case dimensions.)

Weight

S1 Case:	13 lb (5.90 kg) net
M1 Case:	18 lb (8.16 kg) net

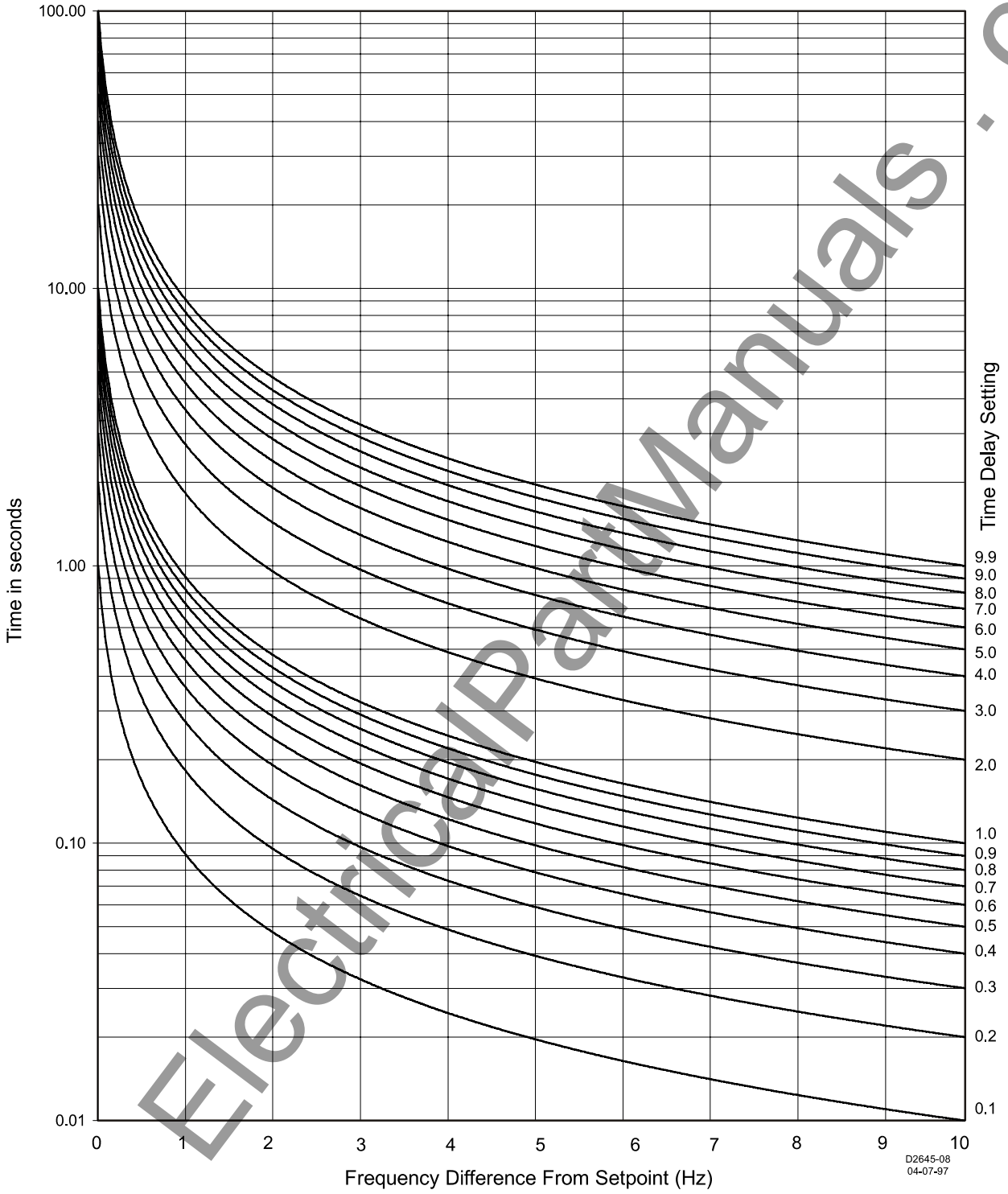


Figure 1-2. Inverse Time Overfrequency Characteristic Curves

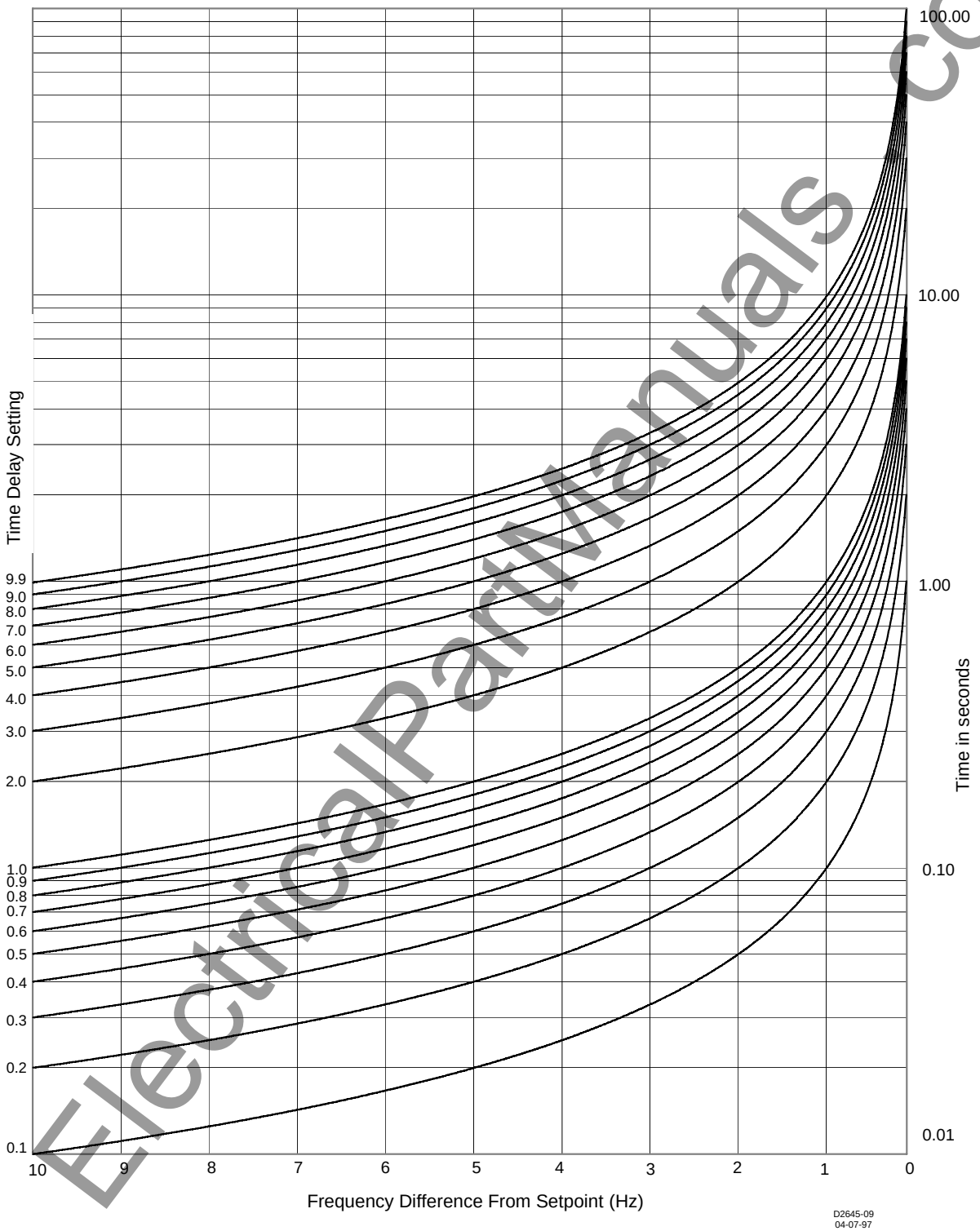


Figure 1-3. Inverse Time Underfrequency Characteristic Curves

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SECTION 2 • CONTROLS AND INDICATORS

INTRODUCTION

BE1-81O/U controls and indicators are located on the front panel and circuit boards.

FRONT PANEL

The front panel controls and indicators are shown in Figure 2-1 and described in Table 2-1.

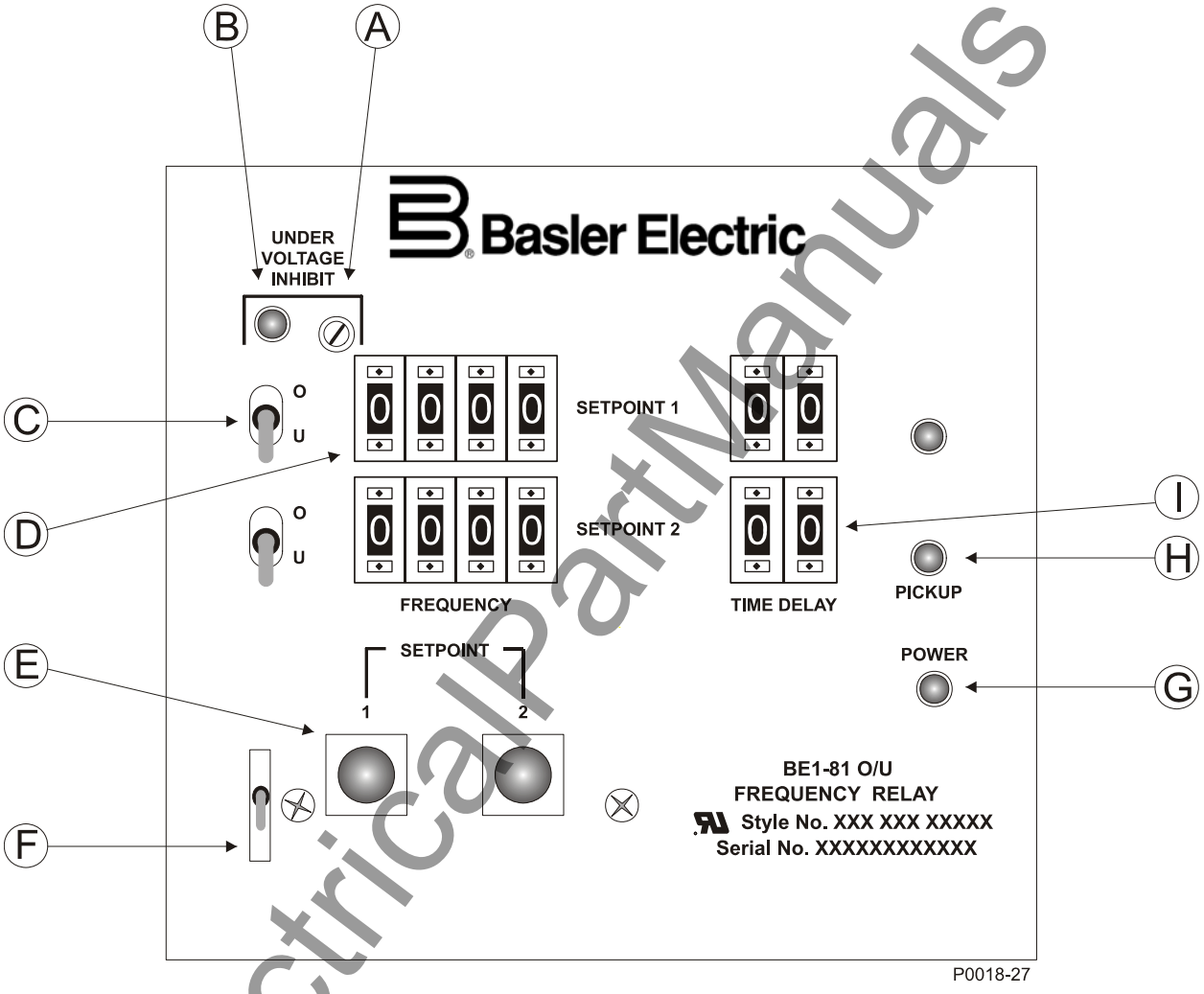

Figure 2-1. Front Panel Controls and Indicators

Table 2-1. Front Panel Controls and indicators

Locator	Function
A	*Undervoltage Inhibit Control.* Relay operation is inhibited when the sensed voltage decreases below the setting of this multi-turn potentiometer. The Undervoltage Inhibit Control has a setting range of 40 to 120 Vac. The BE1-81O/U is delivered with the control set at 80 Vac.
B	*Undervoltage Inhibit Indicator.* This light emitting diode (LED) lights when the sensed voltage decreases below the setting of the Undervoltage Inhibit Control. Relay operation is inhibited when this LED is on.
C	*Over/Under Selector Switch.* A two-position toggle switch configures the corresponding frequency setting (locator D) as an overfrequency (O) or underfrequency (U) setpoint. One selector switch is provided for each frequency setpoint of the relay.

Locator	Function
D	*Frequency Selector Switches.* A set of four thumbwheel switches adjusts the setpoint frequency in 0.01 hertz increments over an allowable range of 40 to 70 hertz. One set of four thumbwheel switches is provided for each frequency setpoint of the relay. Note that selecting a setting outside the 40 to 70 hertz range will result in a loss of frequency protection.
E	*Target Indicators.* Electronically-latching red target indicators illuminate when the associated setpoint output relay energizes. When the optional targets are specified, a target indicator is provided for each frequency setpoint of the relay. To ensure proper operation of current-operated targets, the trip circuit current must be greater than 200 milliamperes.
F	*Target Reset Switch.* Operating this switch resets all of the target indicators.
G	*Power Indicator.* This LED lights when operating power is applied to the relay.
H	*Pickup Indicator.* When an underfrequency or overfrequency condition is detected, the corresponding pickup indicator lights and stays lit until the frequency returns to a non-trip level.
I	*Time Delay Selector Switches.* A set of two thumbwheel switches sets the time delay between the corresponding frequency setpoint (locator D) pickup and output relay reaction. The time delay obtained by these switches is affected by the setting of Selector Switch S7. See *Circuit Board* for details about configuring S7. One set of two thumbwheel switches is provided for each frequency setpoint of the relay.

CIRCUIT BOARD

A single control, Selector Switch S7, is located on the Definite Time circuit boards. (The number of Definite Time circuit boards corresponds to the number of setpoints specified by the relay style number.) S7 configures the Time Delay Selector Switches (Table 2-1, locator I) to adjust the definite time delay in seconds or cycles and have a multiplier of times 1, 10, or 100.

With the cradle assembly withdrawn from the case, the three-section Selector Switches are accessed at the right side of the cradle assembly. Figure 2-2 illustrates the location of S7 on a BE1-81O/U relay with two setpoints.

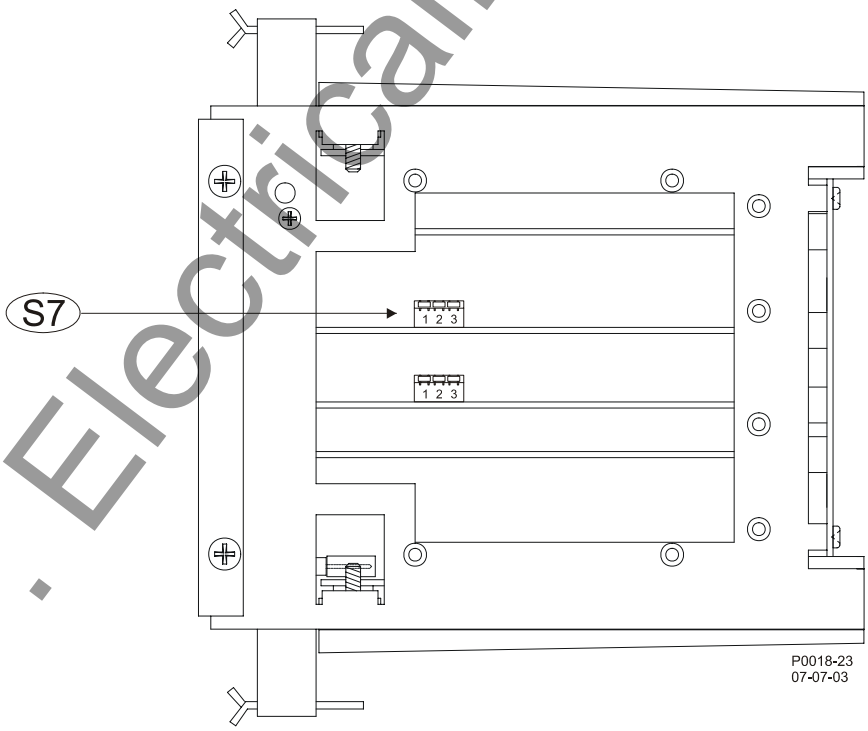

Figure 2-2. Location of Selector Switch S7

Multiplier Settings

Sections S7-1 and S7-2 configure the multiplier used with the Time Delay Selector Switches.

For a times one (X1) multiplier, S7-1 and S7-2 are placed in the down position.

For a times 10 (X10) multiplier, S7-1 is placed in the up position and S7-2 is placed in the down position. A times 10 multiplier is also obtained when S7-1 is placed in the down position and S7-2 is placed in the up position.

For a times 100 (X100) multiplier, S7-1 and S7-2 are placed in the up position.

Cycles/Seconds Settings

S7-3 either selects cycles or seconds as the unit of measure for the definite time delay. S7-3 is placed in the up position to select cycles. The down position of S7-3 selects seconds.

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SECTION 3 • FUNCTIONAL DESCRIPTION

INTRODUCTION

The Digital Frequency Relay, BE1-81O/U, has one to four frequency setpoints for protecting an ac source from underfrequency and overfrequency conditions within the limits of 40 to 70 hertz. When the BE1-81O/U senses an underfrequency or overfrequency condition, an output relay energizes after a selectable time delay. Relay operation is disabled if the sensed voltage decreases below an adjustable undervoltage inhibit setting.

FUNCTIONAL DESCRIPTION

BE1-81O/U functions are illustrated in the block diagram of Figure 3-1 and described in the following paragraphs.

Input Signal

Because input signal 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 3-2 shows the attenuation, in decibels, for input frequencies of 12 to 200 Hz.

A single-phase voltage is applied to an input signal conditioning circuit that consists of a transformer and band-pass filter. The sensed input signal is applied to the zero-crossing logic and undervoltage detection circuits.

Undervoltage Inhibit

This circuit prevents the output relays from energizing during an undervoltage condition associated with equipment startup. The circuit prevents operation of the zero-cross logic and time delay logic, and lights the Undervoltage Inhibit Indicator when the level of the sensed voltage decreases below the setting. A potentiometer, accessed through the front panel, is used to adjust the undervoltage inhibit level from 40 to 120 Vac. BE1-81O/U relays are delivered with an undervoltage inhibit setting of 80 Vac.

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 supplies 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 2 MHz period clock pulses to the minimum period difference logic circuit.

Minimum Period Difference Logic

Each zero-cross pulse causes this logic to count 24580 2 MHz clock pulses, which is the period of the 80 Hz maximum detectable frequency limit. When the sensed frequency is less than the limit, an end-of-period reference (EOPR) pulse is generated to initiate the maximum period difference and measurement logic.

However, if the sensed frequency equals or exceeds the 80 Hz maximum frequency limit (zero-cross pulses interrupt the counts) for three consecutive cycles, the maximum period difference logic is bypassed. The measured-frequency converter then computes the frequency at this maximum frequency limit. The definite time delay is not affected by the frequency limit being exceeded.

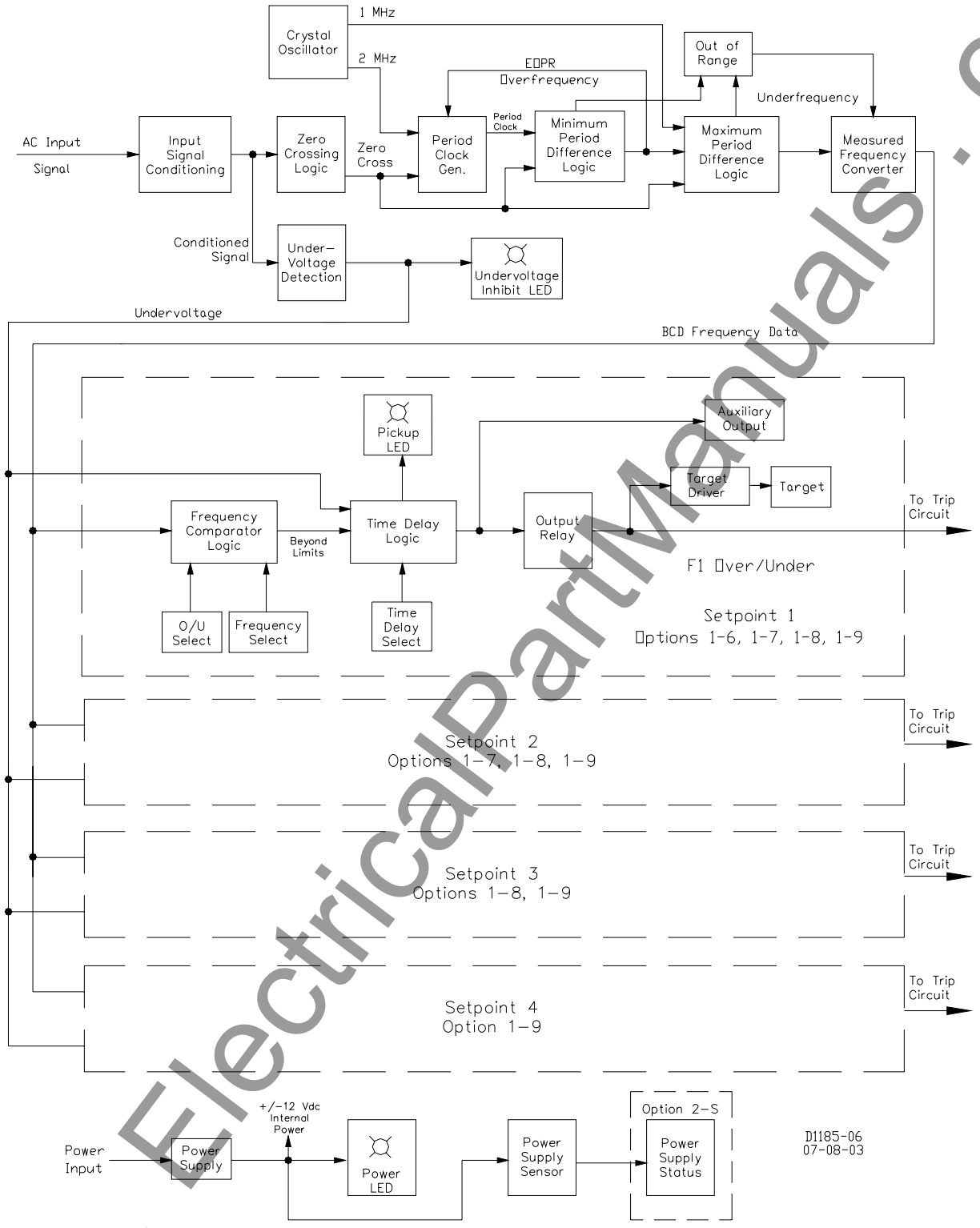

Figure 3-1. BE1-81O/U Functional Block Diagram

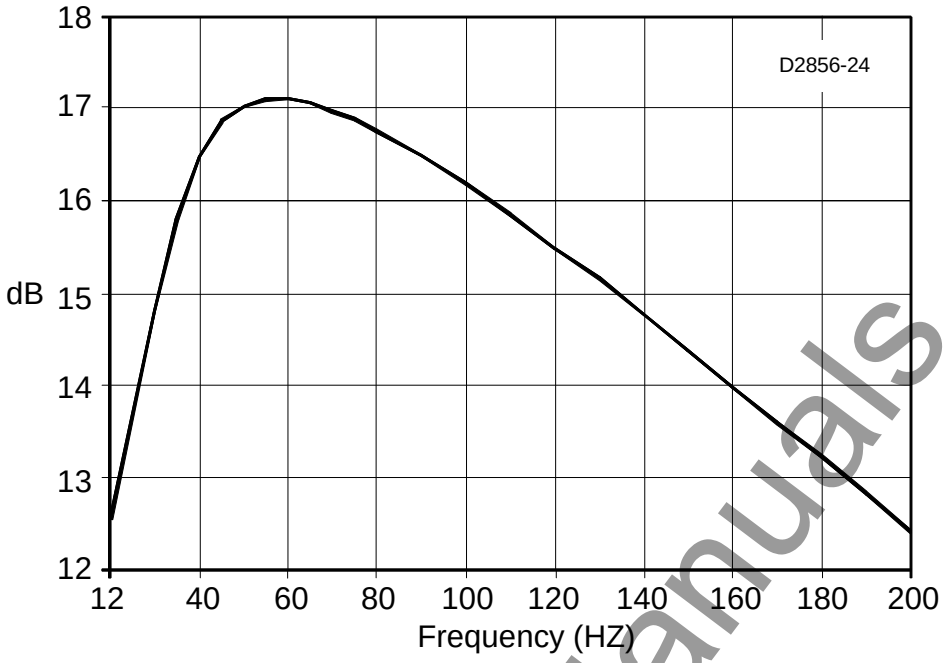

Figure 3-2. Band-Pass Filter Characteristics

Maximum Period Difference Logic

This logic includes an address resister and programmable, read-only memory (PROM). Following the EOPR pulse from the minimum period difference logic, the address register counts 1 MHz clock pulses to address 4096 data words stored inn the PROM. Completion of the count represents the period of the 30 Hz 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 Hz 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. The definite time delay is not affected by the frequency limit being exceeded.

Measured Frequency Converter

The measured frequency converter changes 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 0.01 Hz) within the 30 to 80 Hz 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 Frequency Selector Switch setting on the front panel. An output is triggered when the sensed frequency decreases below the setpoint (Over/Under Selector Switch set to U), or when the sensed frequency increases above the setpoint (Over/Under Selector Switch set to O). The resultant output consists of an enabling level that starts a count-up timer and lights the front panel Pickup Indicator.

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 setting, the definite time delay logic lights the Pickup Indicator. When the front panel Time Delay Selector Switch setting is reached, the logic energizes the setpoint output relay. The total time delay, with seconds-type timing selected, is the Time Delay Selector Switch setting plus one cycle of the sensed input plus 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 and output relay reset.

When delay is set in cycles, the relay calculates delay using a zero-cross counter. Hence, the measured delay will vary with incoming frequency. The time delay may be calculated as follows.

$$\text{delay (seconds)} = \frac{\text{delay setting in cycles}}{\text{applied frequency in hertz}} (\pm \text{spec. accuracy})$$

If 00, 01, or 02 is set as the time delay, the relay response will vary according to the revision level of the relay. The revision-dependent response of the relay may include a block of relay tripping, a trip as fast as two cycles, or a trip in three or more cycles.

NOTE

A delay setting of 00, 01, or 02 cycles should not be used unless the relay response to the setting is tested and found acceptable.

When delay is set in seconds, the relay calculates delay using an internal clock. This gives a time delay that will not change as the sensed frequency changes.

Time Delay Selection

Time delay selection is controlled by Selector Switch S7 on the definite time circuit board. S7 is a user-settable, three-section switch for selecting definite timing in seconds or cycles and a multiplier of times 1, 10, or 100.

NOTE

Earlier BE1-81O/U relays with timing option E1 had a timing range of 3 to 99 cycles and did not include Selector Switch S7. Earlier relays with timing option E2 had a timing range of 3 to 99 cycles.

To provide rearward compatibility for users of earlier BE1-81O/U relays with timing option E1, relays are delivered with S7 set to emulate the E1 timing range.

Sections S7-1 and S7-2 configure the multiplier used with the Time Delay Selector Switches. For a times one (X1) multiplier, S7-1 and S7-2 are placed in the down position. For a times 10 (X10) multiplier, S7-1 is placed in the up position and S7-2 is placed in the down position. A times 10 multiplier is also obtained when S7-1 is placed in the down position and S7-2 is placed in the up position. For a times 100 (X100) multiplier, S7-1 and S7-2 are placed in the up position.

Section S7-3 either selects cycles or seconds as the unit of measure for the definite time delay. S7-3 is placed in the up position to select cycles. The down position of S7-3 selects seconds.

Table 3-1 lists some time delay setting examples.

Table 3-1. Time Delay Setting Examples

Time Delay Selector Switch	Selector Switch S7		Time Delay
	S7-1, 2	S7-3	
25	X1	cycles	25 cycles
	X10	cycles	250 cycles
	X100	cycles	2500 cycles
	X1	seconds	2.5 seconds
	X10	seconds	25 seconds
	X100	seconds	250 seconds

Relay Outputs

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 Outputs

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 is included for each setpoint and is the same contact type for all setpoints within a relay.

Power Supply

BE1-81O/U internal circuitry is powered by one of three wide-range power supplies. Power supply voltage ratings are listed in Table 1-1.

Relay operating power is developed by the wide range, isolated, low burden, flyback switching power supply. Input power (source voltage) for the power supply is not polarity sensitive. The front panel Power Indicator lights to indicate that the power supply is functioning properly.

Power Supply Status Output

The optional power supply status output relay (option 2-S) has a set of normally closed contacts that are energized open during normal operation. If the power supply output fails (or operating power is removed from the relay), the power supply status output relay de-energizes and the contacts close.

Target Indicators

Target indicators are optional components selected when a relay is ordered. The electronically latched and reset targets consist of red LED indicators located on the relay front panel. A latched target is reset by operating the target reset switch on the front panel. If relay operating power is lost, any illuminated (latched) targets are extinguished. When relay operating power is restored, the previously latched targets are restored to their latched state.

A relay can be equipped with either internally operated targets or current operated targets.

Internally Operated Targets

The relay trip outputs are directly applied to drive the appropriate target indicator. Each indicator is illuminated regardless of the current level in the trip circuit.

Current Operated Targets

A current operated target is triggered by closure of the corresponding output contact and the presence of at least 200 milliamperes of current flowing in the trip circuit.

NOTE

Prior to October 2007, BE1-81O/U target indicators consisted of magnetically latched, disc indicators. These mechanically latched target indicators have been replaced by the electronically latched LED targets in use today.

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SECTION 4 • INSTALLATION

INTRODUCTION

BE1-81O/U relays are shipped in sturdy cartons to prevent damage during transit. Upon receipt of a relay, check the model and style number against the requisition and packing list to confirm that they agree. Inspect the relay for shipping damage. If there is evidence of damage, file a claim with the carrier and notify Basler Electric.

If the relay will not be installed immediately, place the relay in its original shipping carton and store in a moisture- and dust-free environment.

OPERATING PRECAUTIONS

Before installing the relay, note the following precautions.

- A minimum of 200 milliamperes in the output contact circuit is required to ensure reliable operation of current operated targets.
- When the connecting plugs are removed, the relay is disconnected from the operating circuit and will not provide system protection. Always be sure that external operating conditions are stable before removing a relay from service. Also, ensure that connecting plugs are installed before replacing the case cover.

NOTE

Be sure that the relay 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 devices, it is recommended to use a separate lead to the ground bus from each device.

MOUNTING

Because the BE1-81O/U relay is of solid-state design, it may be mounted at any convenient angle.

The BE1-81O/U relay is supplied in an S1 or M1 case. Relays with one setpoint (option 1-6) or two setpoints (option 1-7) are supplied in an S1 case. Relays with three setpoints (option 1-8) or four setpoints (option 1-9) are supplied in an M1 case.

S1 and M1 cases are configured for semi-flush mounting (option 4-F) or projection mounting (option 4-P).

S1 dimension drawings and panel cutting diagrams are provided in Figures 4-1 through 4-6. M1 dimension drawings and panel cutting diagrams are provided in Figures 4-7 through 4-13.

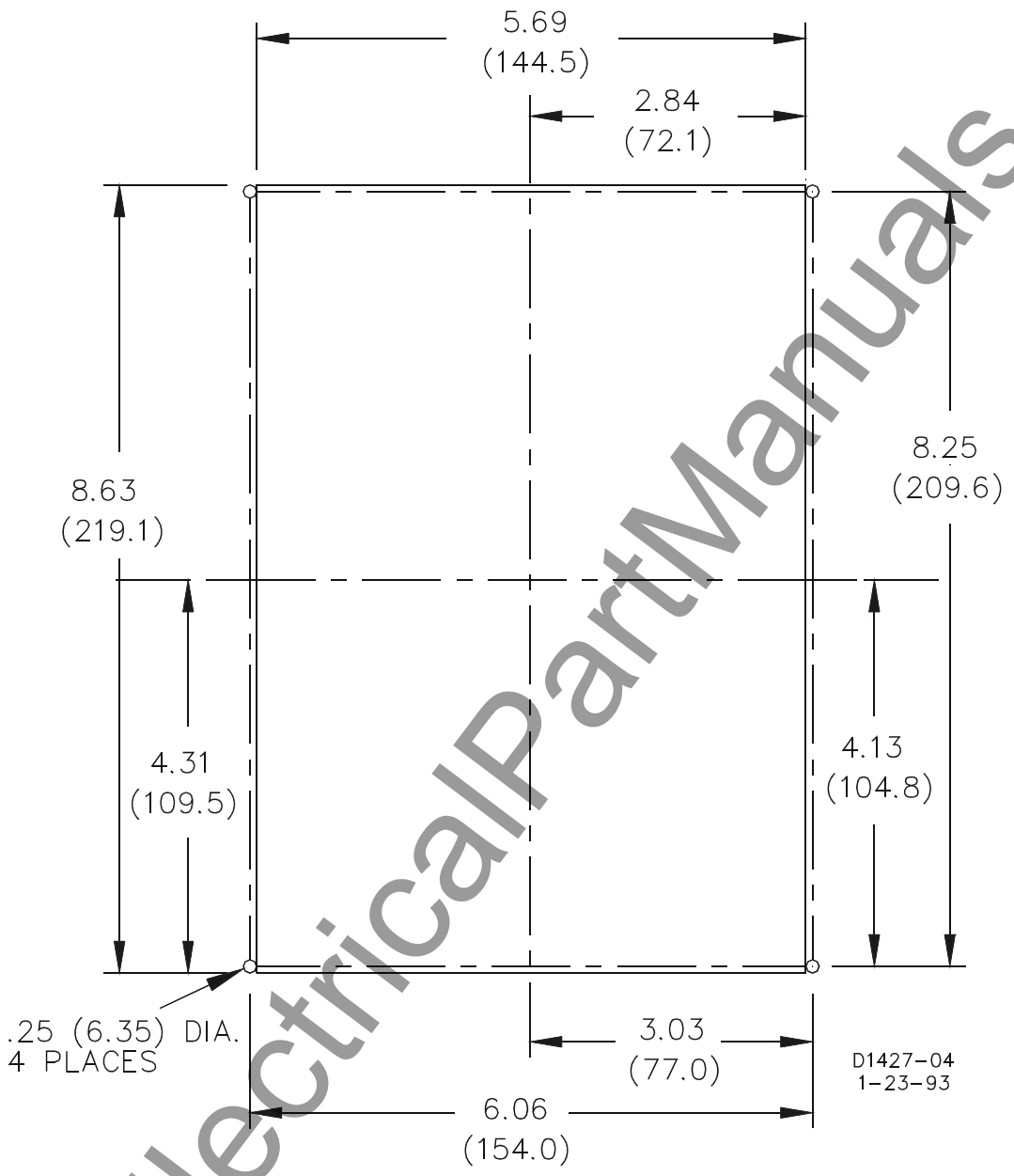

Figure 4-1. S1 Case, Panel Cutting Diagram, Semi-Flush Mounting

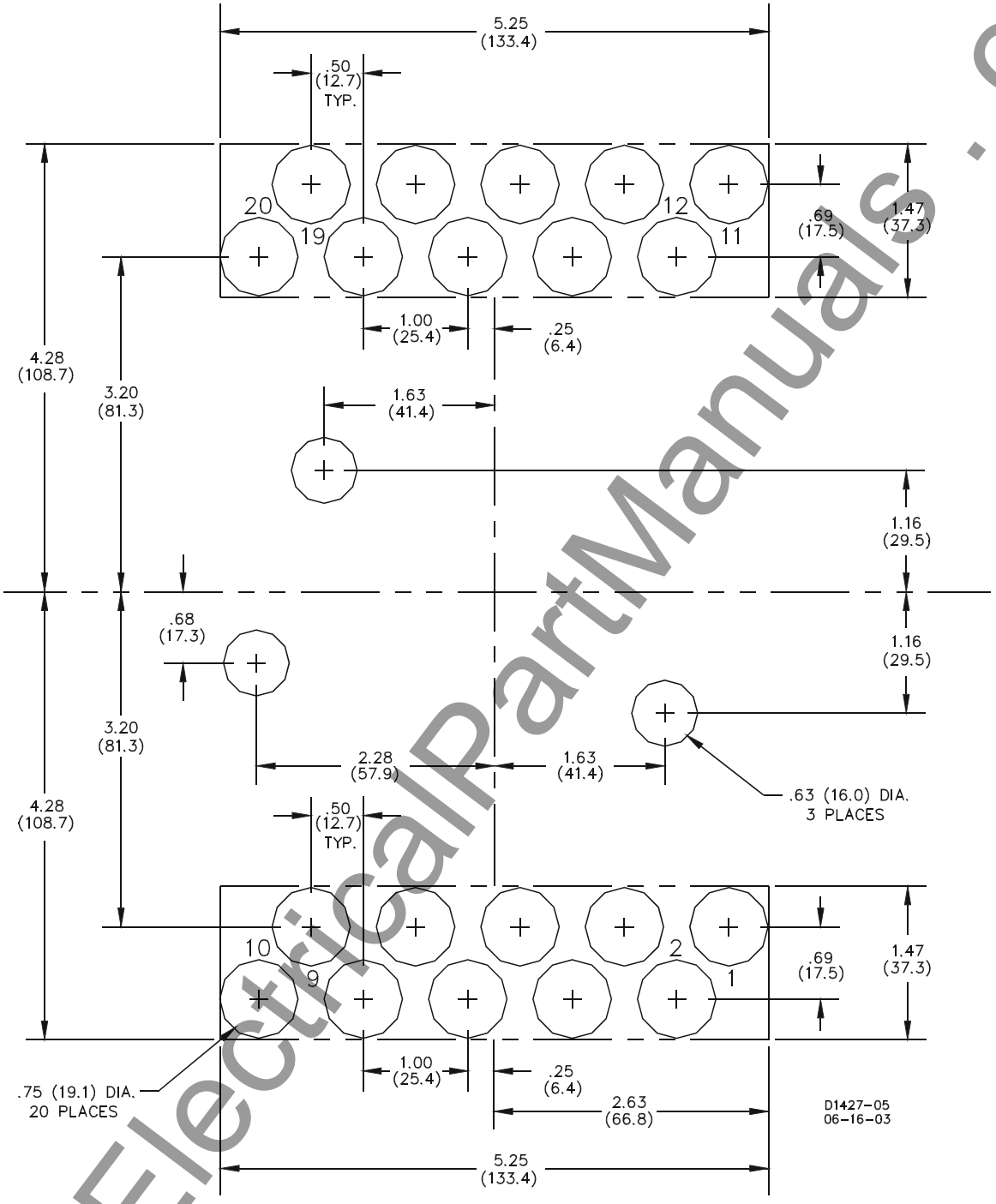

Figure 4-2. S1 Case, Panel Cutting/Drilling Diagram, Projection Mounting, Rear View

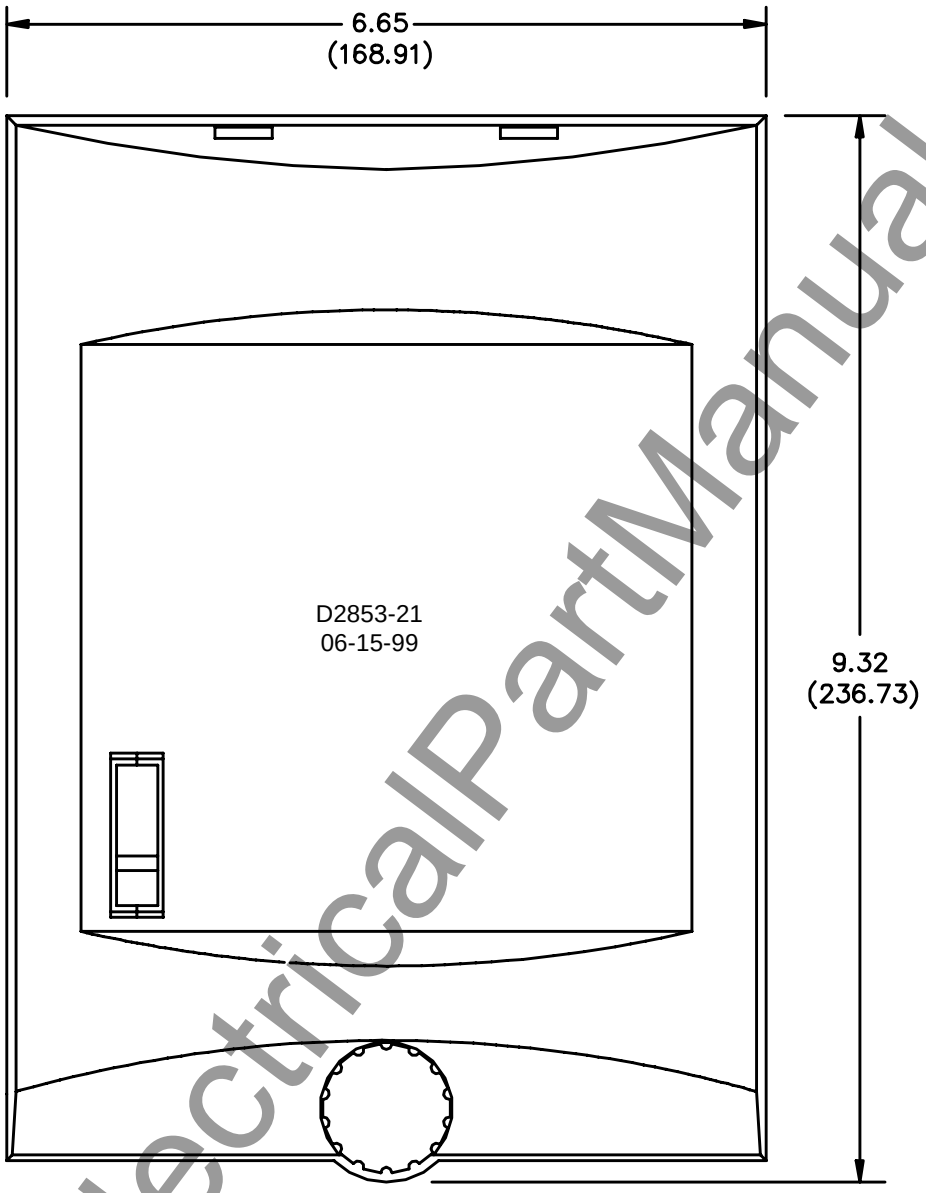

Figure 4-3. S1 Case (Cover) Dimensions, Front View

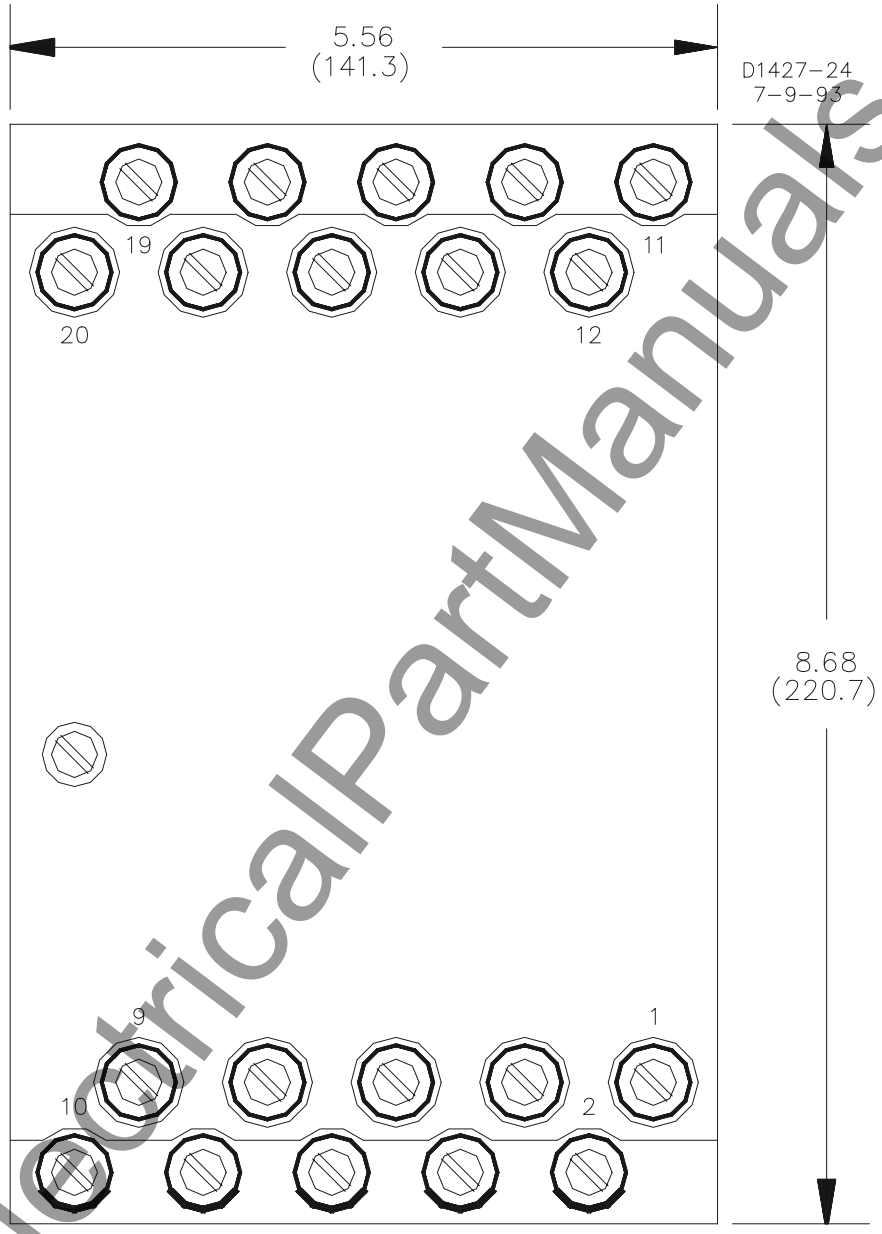

Figure 4-4. S1 Case Dimensions, Rear View

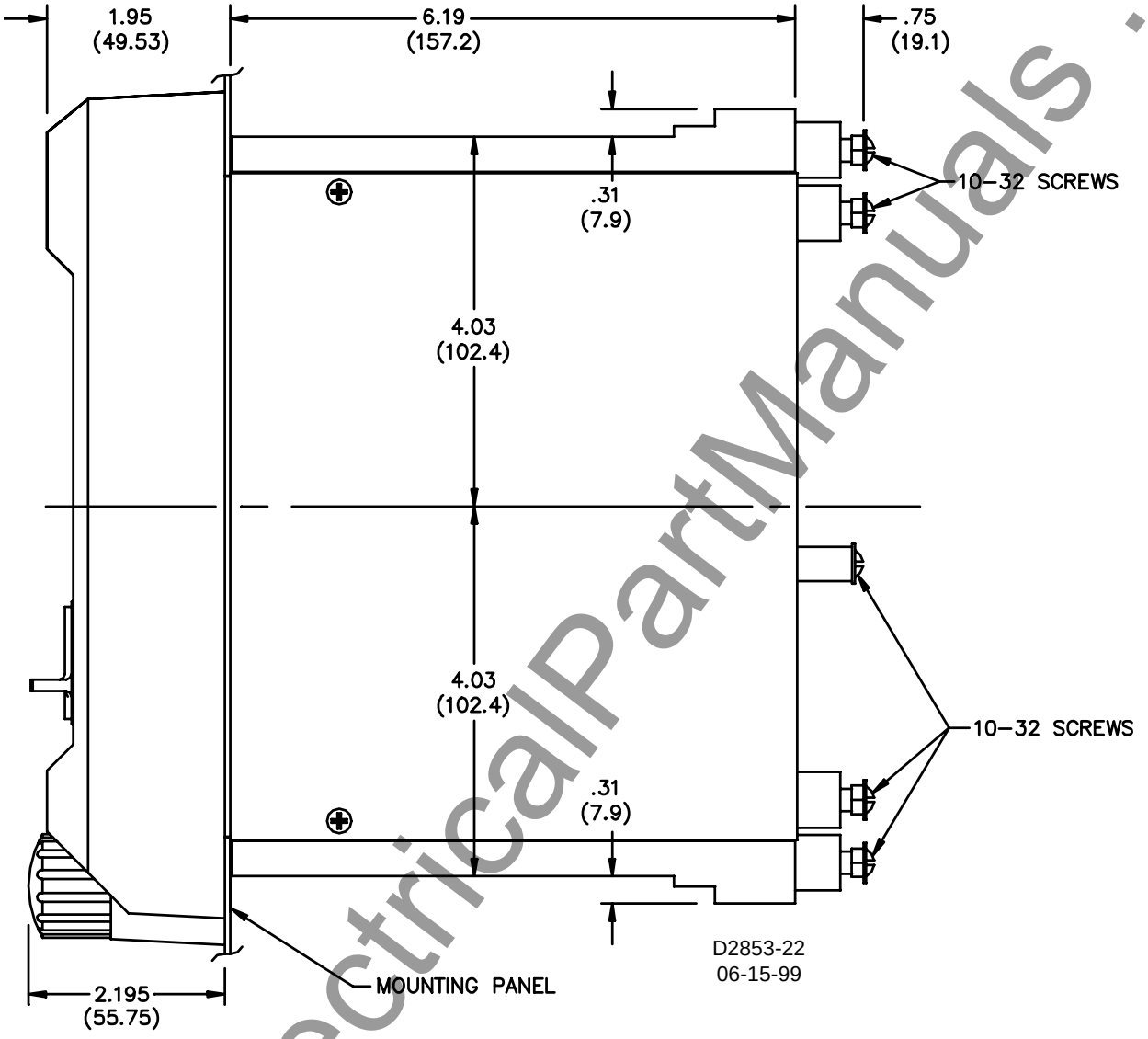

Figure 4-5. S1 Case Dimensions, Semi-Flush Mounting, Side View

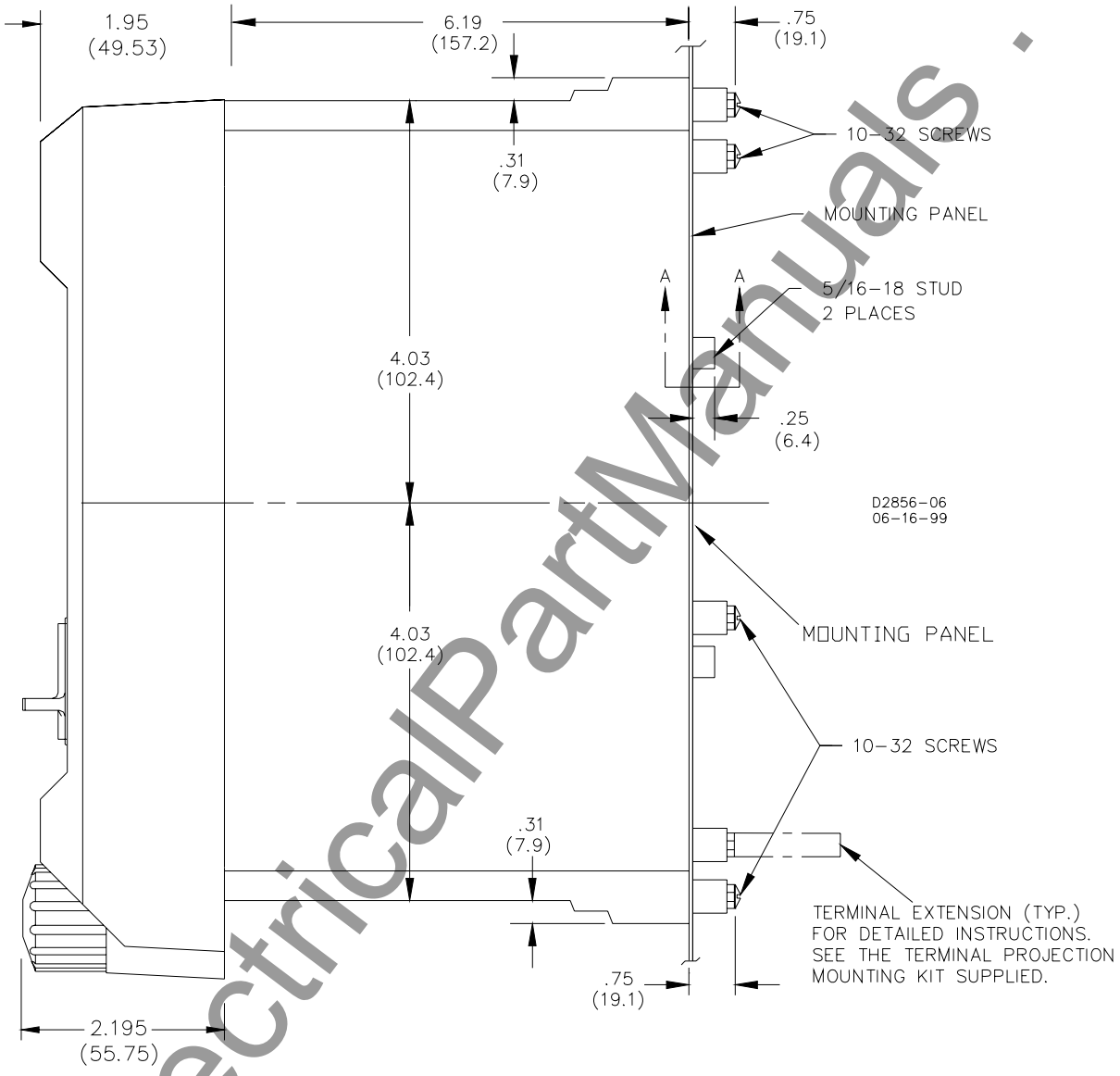

Figure 4-6. S1 Case Dimensions, Projection Mounting, Side View

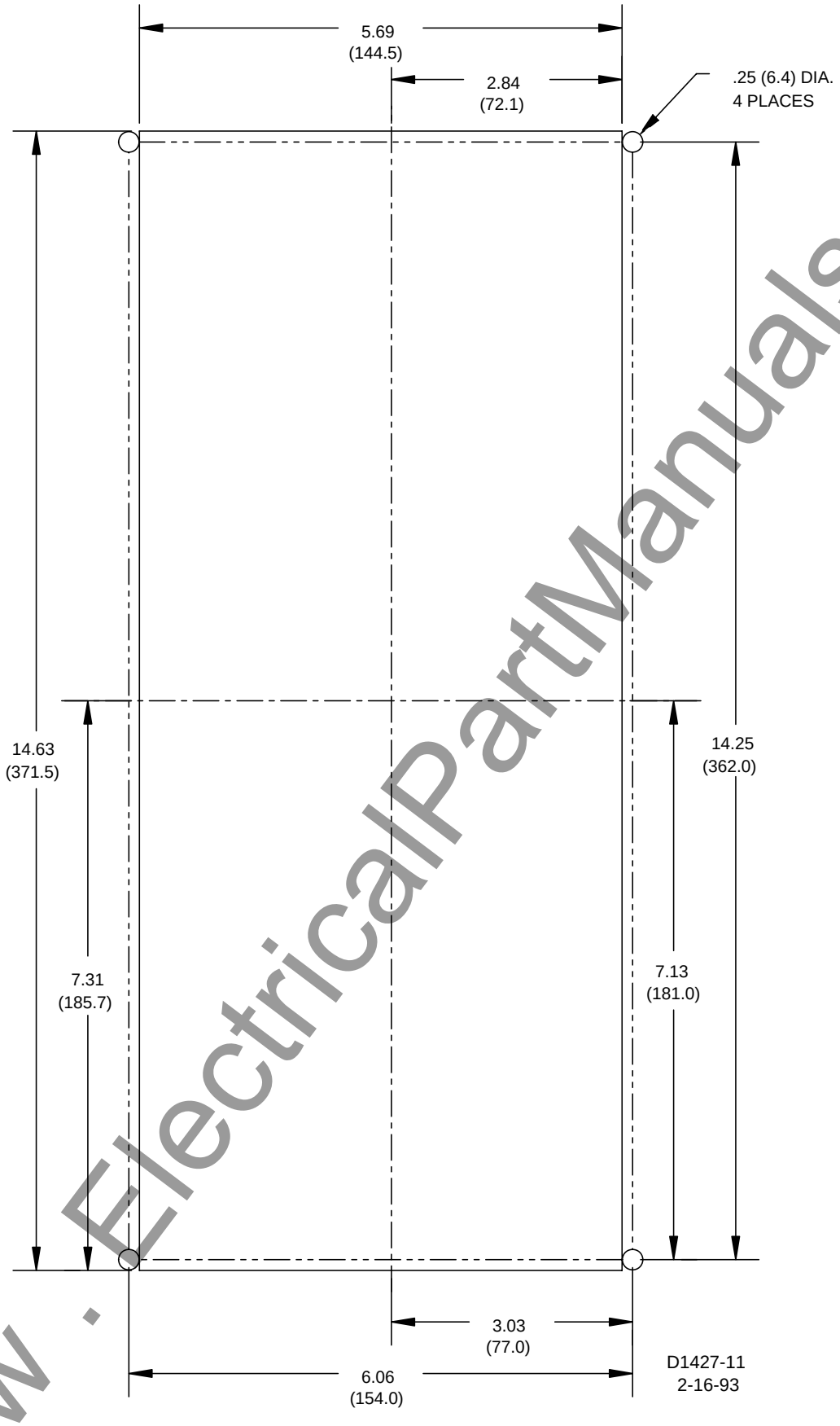

Figure 4-7. M1 Case, Panel Cutting Diagram, Semi-Flush Mounting

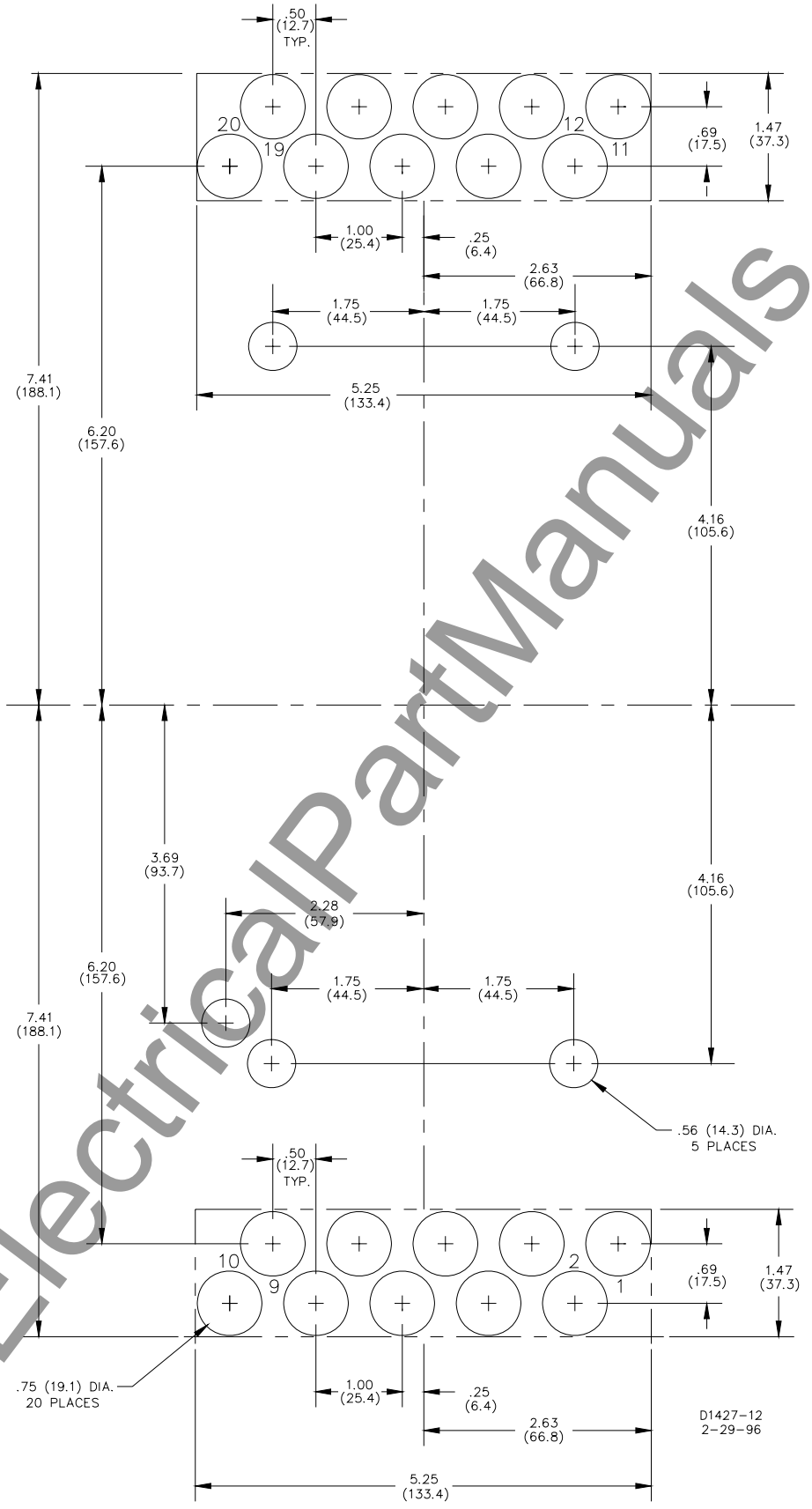

Figure 4-8. M1 Case, Panel Cutting/Drilling Diagram, Projection Mounting, Double-Ended, Rear View

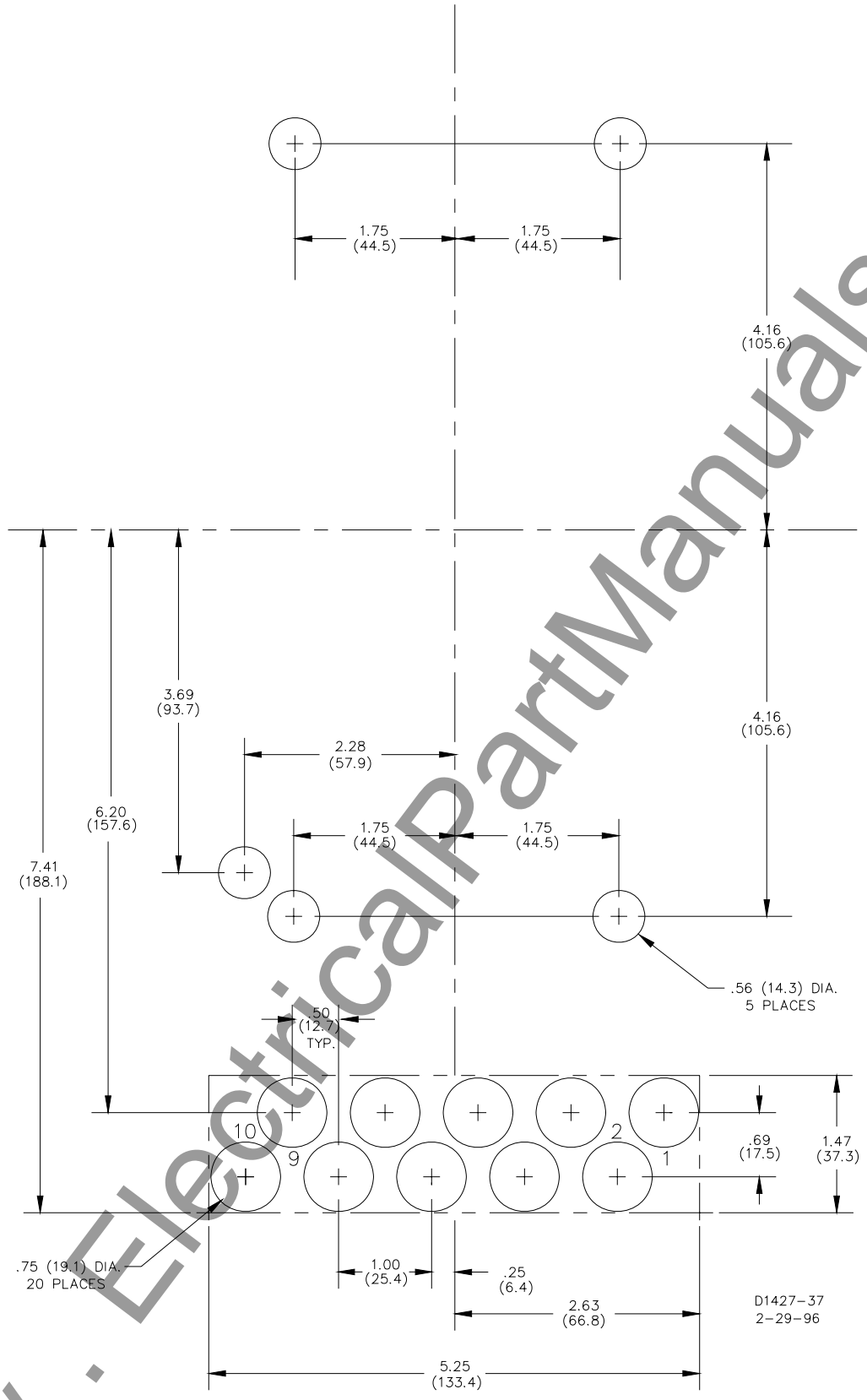

Figure 4-9. M1 Case, Cutting/Drilling Diagram, Projection Mounting, Single-Ended, Rear View

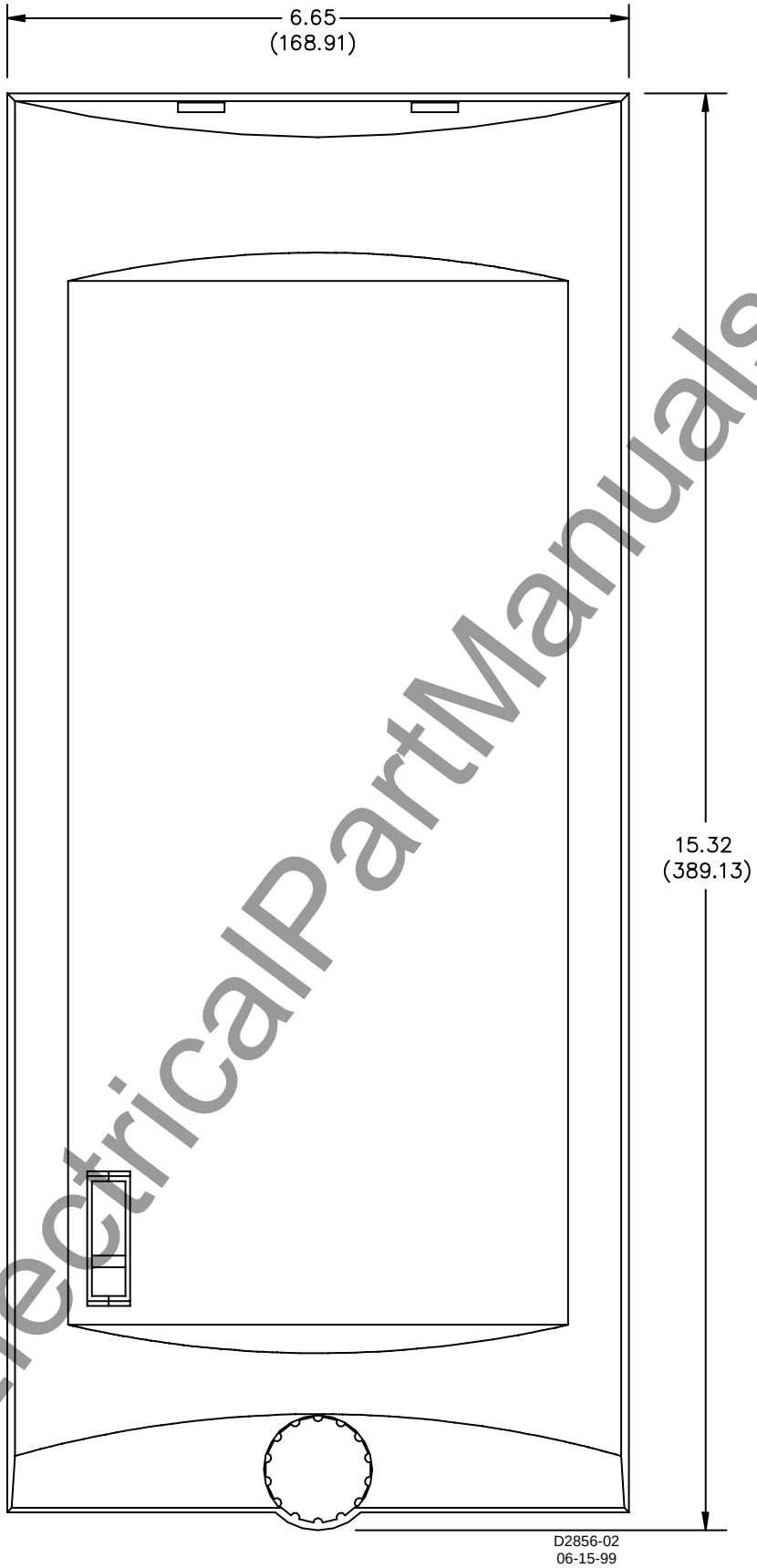

Figure 4-10. M1 Case (Cover) Dimensions, Front View

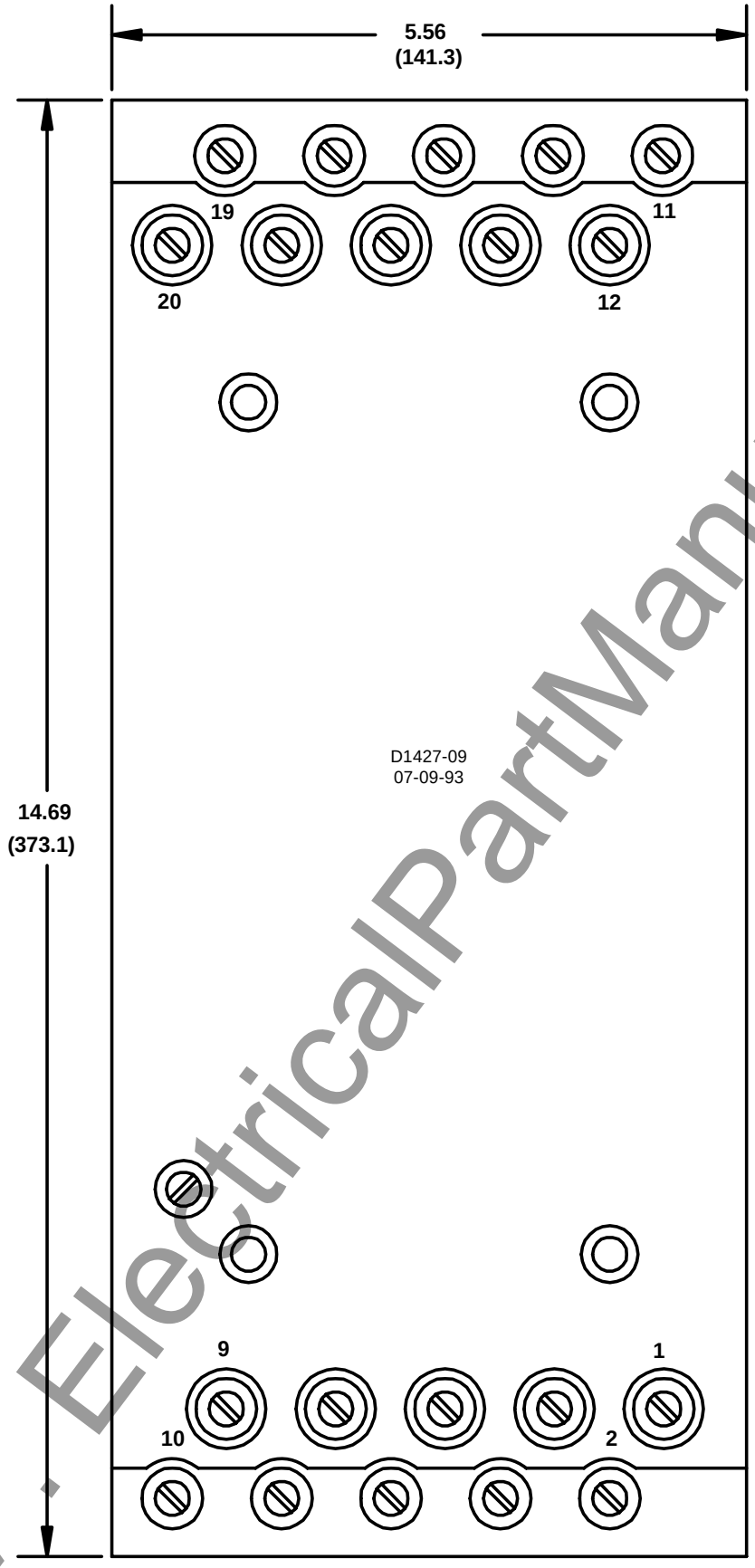

Figure 4-11. M1 Case Dimensions, Rear View

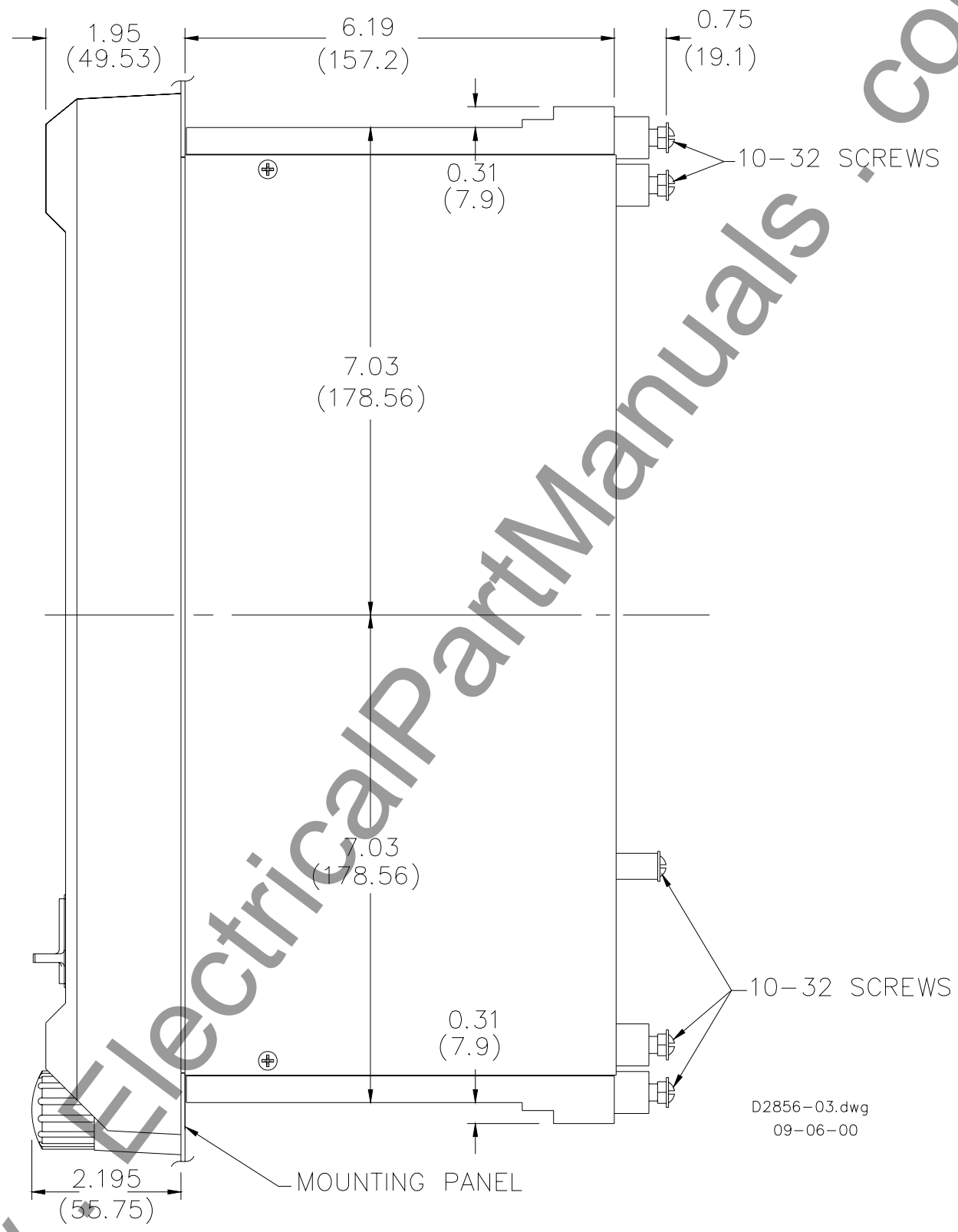

Figure 4-12. M1 Case Dimensions, Semi-Flush Mounting, Side View

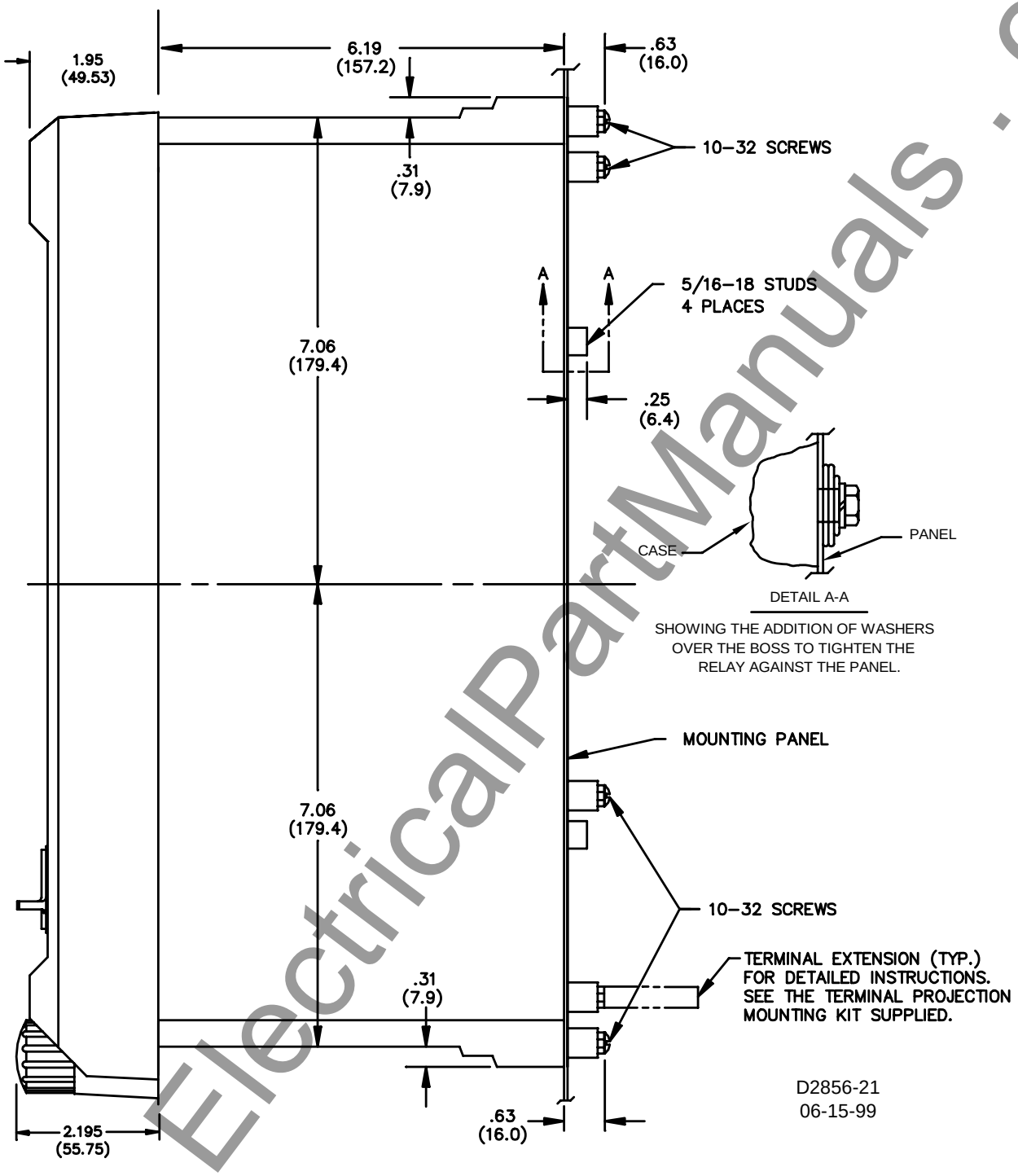

Figure 4-13. M1 Case Dimensions, Projection Mounting, Side View

CONNECTIONS

Relay circuitry connects to the case terminals through removable connection plugs (one plug for 10-terminal cases and two plugs for 20-terminal cases). Removal of the connection plugs opens the normally-open trip contact circuits and short-circuits the normally-closed trip contact circuits before opening the power and sensing circuits.

Incorrect wiring may result in damage to the relay. Except for the ground wire, connections should be made with wire no smaller than 14 AWG. Typical internal connections are shown in Figure 4-14. External connections are shown in Figures 4-15 and 4-16.

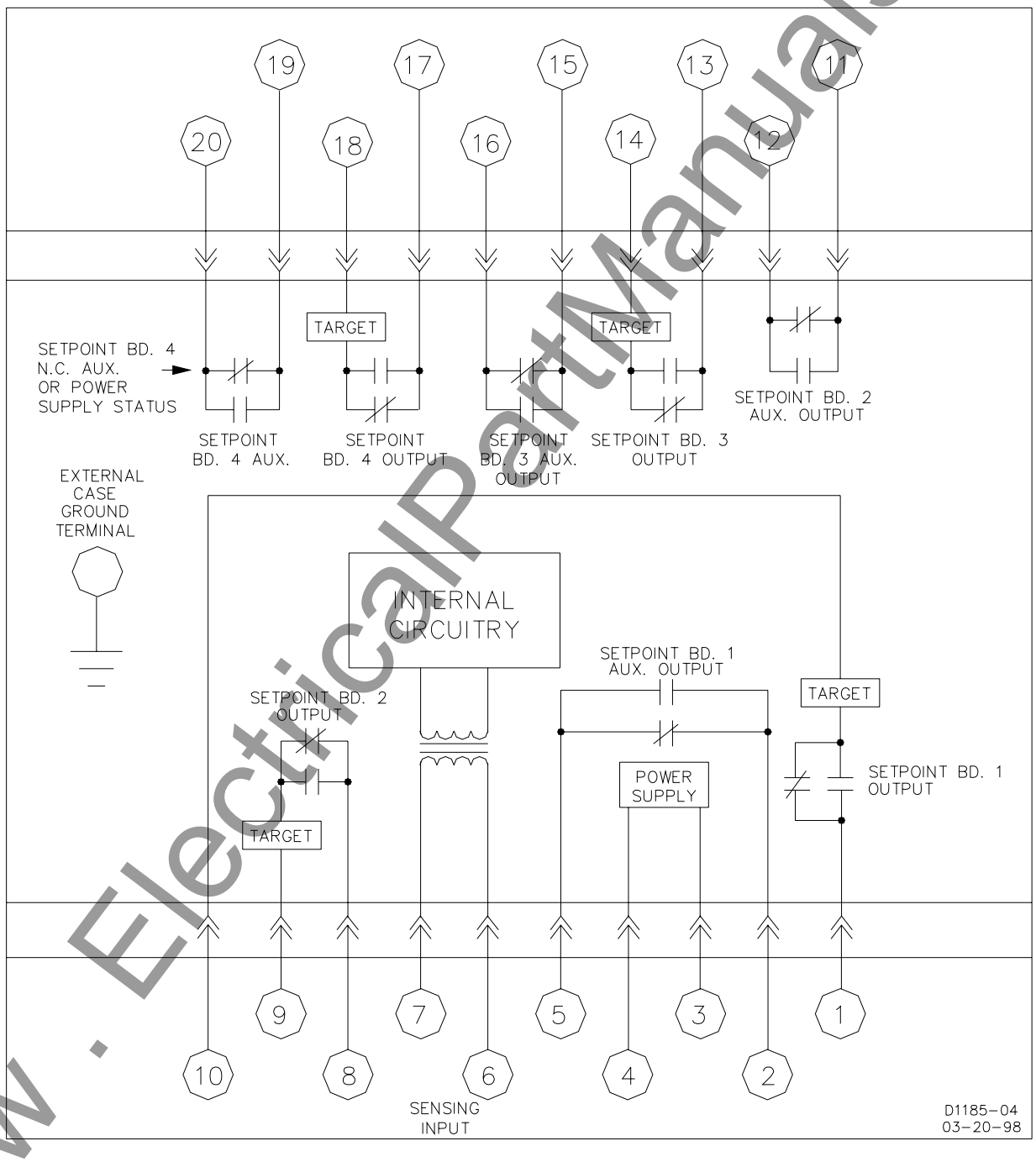

Figure 4-14. Internal Relay Connections

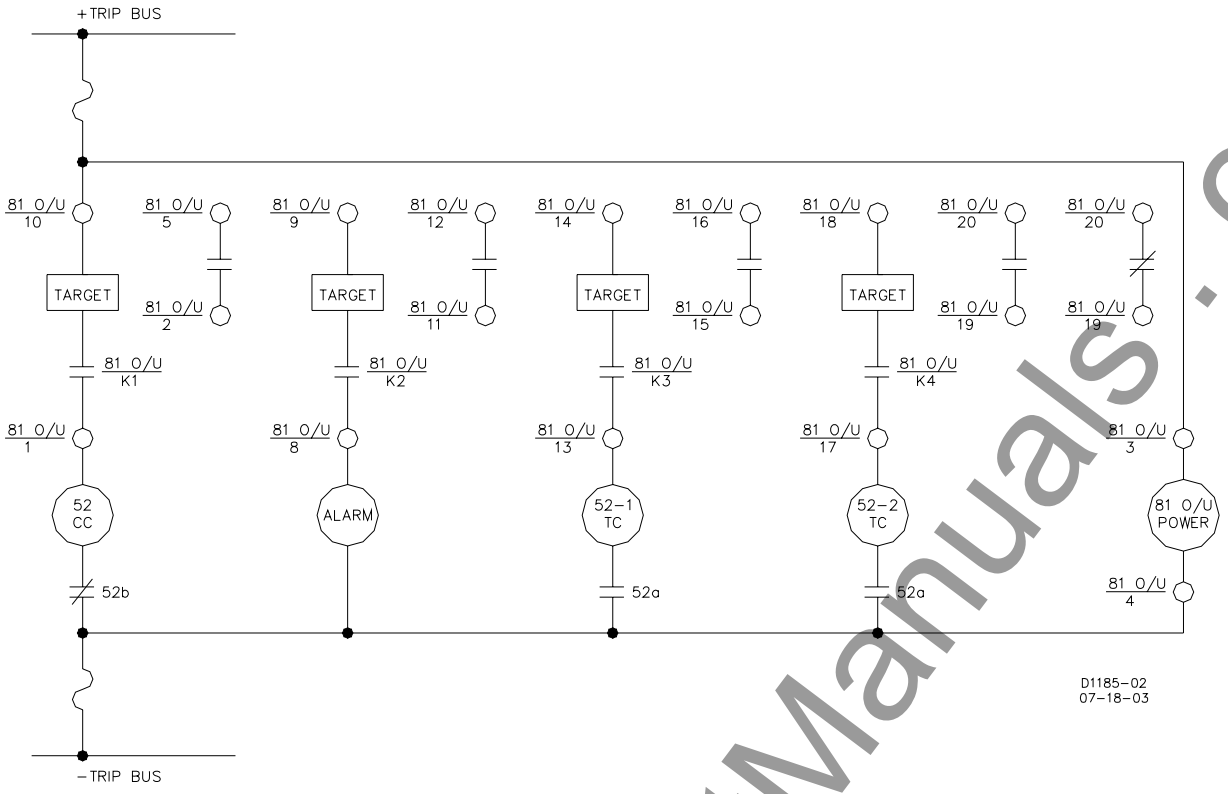

Figure 4-15. Typical DC Connections

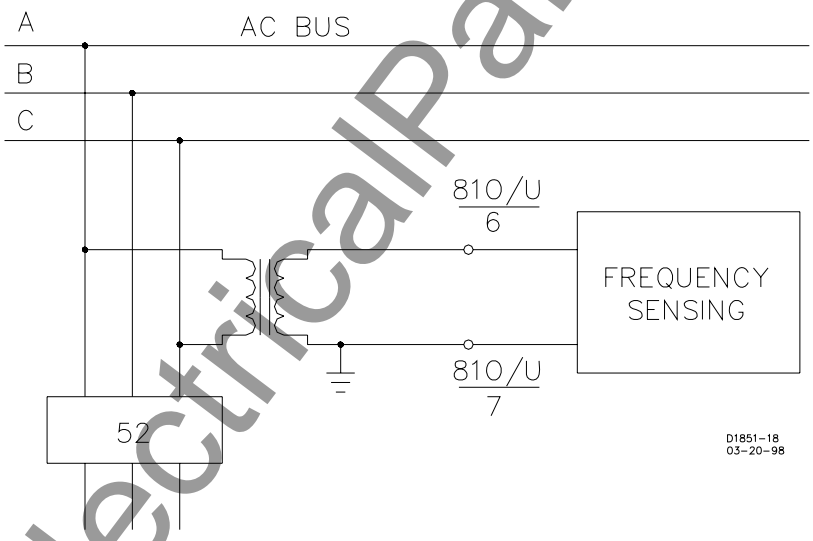

Figure 4-16. Typical AC Sensing Connections

MAINTENANCE

BE1-81O/U relays require no preventative maintenance other than a periodic operational check. If the relay fails to function properly, contact Technical Sales Support at Basler Electric to coordinate repairs.

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 (104°F). Typically, the life expectancy of a 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 30 minutes.

SECTION 5 • TESTING

INTRODUCTION

Procedures in this section are used for testing and adjusting a BE1-81O/U relay for the desired operation in a protective scheme. If a relay fails a test, or an adjustment discloses a faulty relay, refer to Section 6.

TEST EQUIPMENT

Minimum test equipment requirements are listed below. Test connections are shown in Figure 5-1.

NOTE

One of the commercially available frequency relay test set may be used to test the relay. These test sets have electronic switching and frequency and time generating accuracies that exceed the accuracy of the BE1-81O/U relay.

- ac or dc power source for relay operating power
- ac source for relay frequency sensing ∗
- Hardware (battery and lamp, multimeter, etc.) or method of determining when the relay output contacts close

∗ A source with frequency stability of 0.00002 hertz must exhibit phase noise of less than 90 decibels 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.

OPERATIONAL TEST

Operational testing is divided into testing of frequency pickup settings, selector settings, time delays, and the undervoltage inhibit function.

High and Low Frequency Pickup

1. Connect the relay as shown in Figure 5-1.
2. Adjust Selector Switch S7 for setpoint 1, located on the definite time circuit board controlling setpoint 1, to obtain a time delay in cycles with a x1 multiplier (S7-1 down, S7-2 down, and S7-3 up).
3. Adjust the front panel, setpoint 1 controls to the following settings.

   Over/Under Selector Switch: Over (O) position
   Frequency Selector Switch: 70.00
   Time Delay Selector Switch: 25
4. Apply operating power to the relay.
5. Apply 60 Hz voltage to the relay sensing input. The level of voltage must exceed the setting of the adjustable, front panel Undervoltage Inhibit control.
6. Slowly increase the sensing input frequency until the setpoint 1 Pickup indicator just lights. The sensing input frequency should be 70 Hz, ±0.01 Hz.
7. Adjust the front panel, setpoint 1 controls to the following settings.

   Over/Under Selector Switch: Under (U) position
   Frequency Selector Switch: 50.00
8. Slowly decrease the sensing input frequency until the setpoint 1 Pickup indicator just lights. The sensing input frequency should be 50 Hz, ±0.01 Hz.

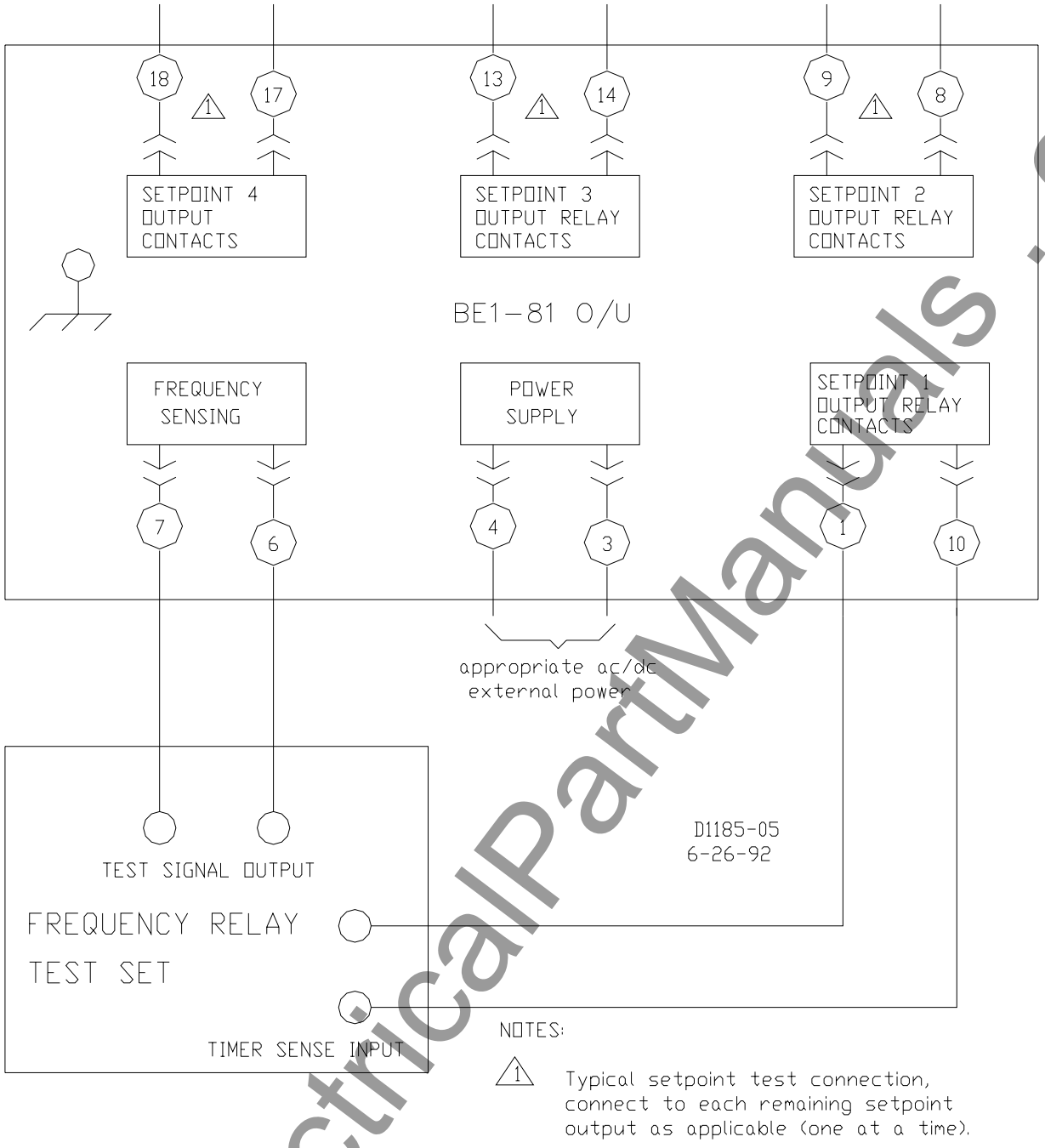

Figure 5-1. BE1-81O/U Test Setup

Frequency Selector Settings

1. Connect the relay as shown in Figure 5-1.
2. Adjust the front panel, setpoint 1 controls to the following settings.

   Over/Under Selector Switch: Under (U) position
   Frequency Selector Switch: 51.11
3. Apply operating power to the relay.
4. Apply 60 Hz voltage to the relay sensing input. The level of voltage must exceed the setting of the adjustable, front panel Undervoltage Inhibit control.
5. Slowly decrease the sensing input frequency until the setpoint 1 Pickup indicator just lights. The sensing input frequency should be 51.11 Hz, ±0.01 Hz.
6. Repeat steps 4 and 5 for Frequency Selector Switch settings of 52.22, 54.44, and 58.88.

Definite Time Delay – Cycles

1. Connect the relay as shown in Figure 5-1.
2. Adjust Selector Switch S7 for setpoint 1, located on the definite time circuit board controlling setpoint 1, to obtain a time delay in cycles with a x1 multiplier (S7-1 down, S7-2 down, and S7-3 up).
3. Adjust the front panel, setpoint 1 controls to the following settings.

   Over/Under Selector Switch: Under (U) position
   Frequency Selector Switch: 55.00
   Time Delay Selector Switch: 11
4. Apply operating power to the relay.
5. Apply 60 Hz voltage to the relay sensing input. The level of voltage must exceed the setting of the adjustable, front panel Undervoltage Inhibit control.
6. Ensure that the target indicators are reset.
7. Step the sensing input frequency down from 60 Hz to 53 Hz. The setpoint 1 Pickup indicator lights and the test set timer begins counting. When the time delay ends, the setpoint 1 output relay and target trips, and the test set timer stops counting. The timer should indicate 0.208 seconds (11 cycles x 1/53, ±1.0 Hz).
8. Restore the sensing input frequency to 60 Hz and reset the targets.
9. Repeat steps 7 and 8 for Time Delay Selector Switch settings of 22, 44, and 88.
10. If desired, the above steps may be performed with Selector Switch S7 configured for a time delay multiplier of x10 (S7-1 up and S7-2 down) or x100 (S7-1 up and S7-2 up).

Definite Time Delay – Seconds

1. Connect the relay as shown in Figure 5-1.
2. Adjust Selector Switch S7 for setpoint 1, located on the definite time circuit board controlling setpoint 1, to obtain a time delay in seconds with a x1 multiplier (S7-1 down, S7-2 down, and S7-3 down).
3. Adjust the front panel, setpoint 1 controls to the following settings.

   Over/Under Selector Switch: Under (U) position
   Frequency Selector Switch: 55.00
   Time Delay Selector Switch: 25
4. Apply operating power to the relay.
5. Apply 60 Hz voltage to the relay sensing input. The level of voltage must exceed the setting of the adjustable, front panel Undervoltage Inhibit control.
6. Ensure that the target indicators are reset.
7. Step the sensing input frequency down from 60 Hz to 53 Hz. The setpoint 1 Pickup indicator lights and the test set timer begins counting. When the time delay ends, the setpoint 1 output relay and target trips, and the test set timer stops counting. The timer should indicate 2.5 seconds, ±0.05 seconds.
8. Restore the sensing input frequency to 60 Hz and reset the targets.
9. Repeat steps 7 and 8 for Time Delay Selector Switch settings of 22, 44, and 88.
10. If desired, the above steps may be performed with Selector Switch S7 configured for a time delay multiplier of x10 (S7-1 up and S7-2 down) or x100 (S7-1 up and S7-2 up).

Undervoltage Inhibit

1. Connect the relay as shown in Figure 5-1.
2. Adjust the front panel, setpoint 1 controls to the following settings.

   Over/Under Selector Switch: Under (U) position
   Frequency Selector Switch: 60.00
   Time Delay Selector Switch: 25
3. Apply operating power to the relay.
4. Apply 60 Hz voltage to the relay sensing input. The level of voltage must exceed the setting of the adjustable, front panel Undervoltage Inhibit control.

5. Decrease the level of the sensing input voltage until it is considerably less than the Undervoltage Inhibit control setting. (BE1-81O/U relays are delivered with an undervoltage inhibit setting of 80 Vac.) The Undervoltage Inhibit indicator should light.
6. Decrease the frequency of the sensing input voltage to 59 Hz. The setpoint 1 Pickup indicator should not light and the setpoint 1 output relay should not trip.
7. Increase the level of the sensing input voltage until it exceeds the level of the undervoltage inhibit setting. The Undervoltage Inhibit indicator should turn off, the setpoint 1 Pickup indicator should light, and the setpoint 1 output relay should trip after the Time Delay Selector switch setting expires.

Setpoint 2, 3, and 4 Testing

Where applicable, the preceding tests can be performed for setpoints 2, 3, and 4 by reconnecting the output connections for each setpoint and substituting the appropriate setpoint numbers in the test steps.

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