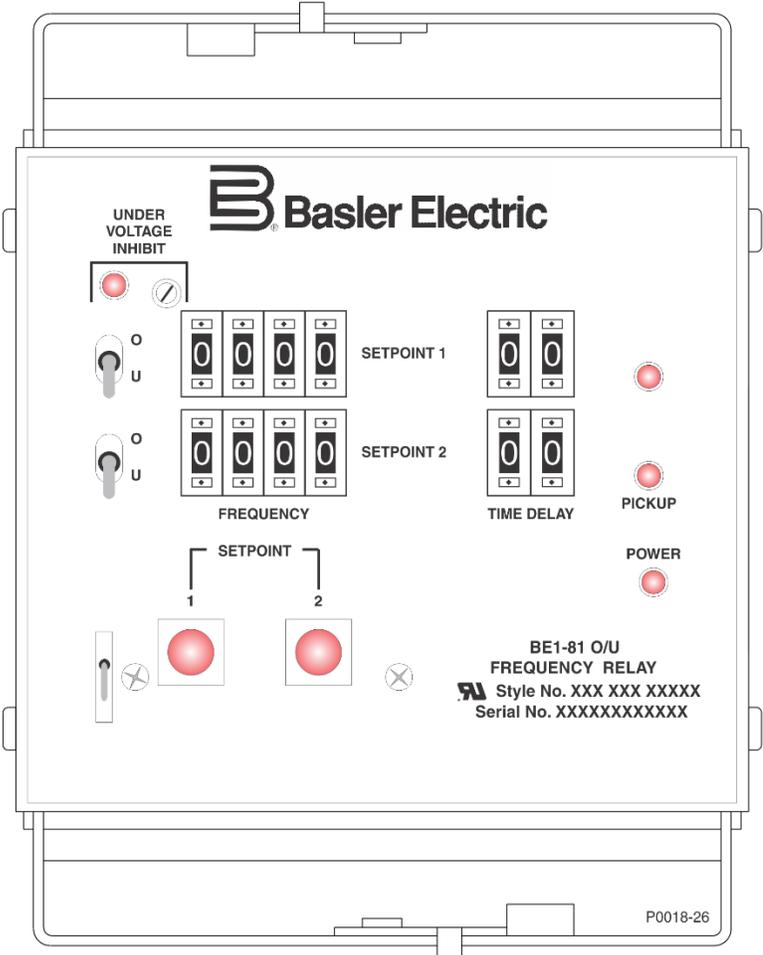




BE1-810/U

Digital Frequency Relay

Instruction Manual



 **WARNING:** California's Proposition 65 requires special warnings for products that may contain chemicals known to the state of California to cause cancer, birth defects or other reproductive harm. Please note that by posting this Proposition 65 warning, we are notifying you that one or more of the Proposition 65 listed chemicals may be present in products we sell to you. For more information about the specific chemicals found in this product, please visit <https://www.basler.com/Prop65>.

Preface

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

- Controls and indicators
- Functional description
- Mounting and connections
- Testing
- Specifications

Conventions Used in this Manual

Important safety and procedural information is emphasized and presented in this manual through warning, caution, and note boxes. Each type is illustrated and defined as follows.

Warning!

Warning boxes call attention to conditions or actions that may cause personal injury or death.

Caution

Caution boxes call attention to operating conditions that may lead to equipment or property damage.

Note

Note boxes emphasize important information pertaining to installation or operation.



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Warning!

READ THIS MANUAL. Read this manual before installing, operating, or maintaining this equipment. Note all warnings, cautions, and notes in this manual as well as on the product. Keep this manual with the product for reference. Only qualified personnel should install, operate, or service this system. Failure to follow warning and cautionary labels may result in personal injury or property damage. Exercise caution at all times.

Basler Electric does not assume any responsibility to compliance or noncompliance with national code, local code, or any other applicable code. This manual serves as reference material that must be well understood prior to installation, operation, or maintenance.

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This publication contains confidential information of Basler Electric Company, an Illinois corporation. It is loaned for confidential use, subject to return on request, and with the mutual understanding that it will not be used in any manner detrimental to the interests of Basler Electric Company and used strictly for the purpose intended.

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. Over time, improvements and revisions may be made to this publication. Before performing any of the following procedures, contact Basler Electric for the latest revision of this manual.

The English-language version of this manual serves as the only approved manual version.

Revision History

A historical summary of the changes made to this instruction manual is provided below. Revisions are listed in reverse chronological order.

Instruction Manual Revision History

Manual Revision and Date	Change
S, Jul 2022	<ul style="list-style-type: none"> Added a note about EMI suppression in the <i>Installation</i> section
R, Dec 2021	<ul style="list-style-type: none"> Adjusted style chart to reflect obsolescence of current operated targets Relocated <i>Revision History</i> information to the manual preface Added chapter numbers and adjusted page, figure, and table numbers to restart at the beginning of each chapter
Q	<ul style="list-style-type: none"> This revision letter not used
P2, Apr 2019	<ul style="list-style-type: none"> Adjusted wording of California Proposition 65 warning statement
P1, Dec 2018	<ul style="list-style-type: none"> Added California Proposition 65 warning statement
P, Aug 2015	<ul style="list-style-type: none"> Corrected truncated lines in the style chart Changed the storage temperature listed in the <i>Specifications</i> chapter Minor enhancements to Figures 3, 25, 26, and 28
O	<ul style="list-style-type: none"> This revision letter not used
N, Jun 2014	<ul style="list-style-type: none"> Corrected truncated boxes in style chart
M, Feb 2013	<ul style="list-style-type: none"> Updated case and cover drawings
L, Sep 2011	<ul style="list-style-type: none"> Added Figures 4-3, 4-6, 4-7, 4-10, and 4-11 for single-ended cases Removed Figure 4-9 for M1 single-ended case
K, Sep 2010	<ul style="list-style-type: none"> Updated time delay accuracy Updated GOST-R certification statement Updated rear case drawings Updated storage statement in the <i>Installation</i> chapter
J, Oct 2007	<ul style="list-style-type: none"> Added manual part number and revision letter to all page footers Updated power supply burden data Updated the output contact ratings Updated the front-panel drawings to show LED targets Updated the target description
I	<ul style="list-style-type: none"> This revision letter not used
H, Sep 2003	<ul style="list-style-type: none"> Removed references to timing option D1
G, Jun 2009	<ul style="list-style-type: none"> Revised style chart to reflect changes to the E1 and E2 timing options Changed dielectric test specification listed in chapters 1 and 4 Updated Figures 2-3 and 3-3 to show the three-position Selector Switch (S7) All case drawings were updated to show revised case covers Definite time delay options test procedures were modified to accommodate the new E1 and E2 timing options

Manual Revision and Date	Change
F, Apr 1998	<ul style="list-style-type: none"> • 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 • Added IEEE qualification statement and UL recognition • Corrected M1 case weight • Corrected Figures 1-2 and 1-3 (inverse time over/underfrequency characteristic curve diagrams) • Added wide-range power supply data and deleted Figure 3-5 • Extracted testing and adjustment information from chapter 4 and created new chapter 5, <i>Test and Adjustments</i>. • Inserted additional installation diagrams to cover all relay styles
E, Mar 1993	<ul style="list-style-type: none"> • Various relay changes were incorporated into the manual
D, C, B, A and —	<ul style="list-style-type: none"> • Revision information not available for these manual versions

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1 • 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

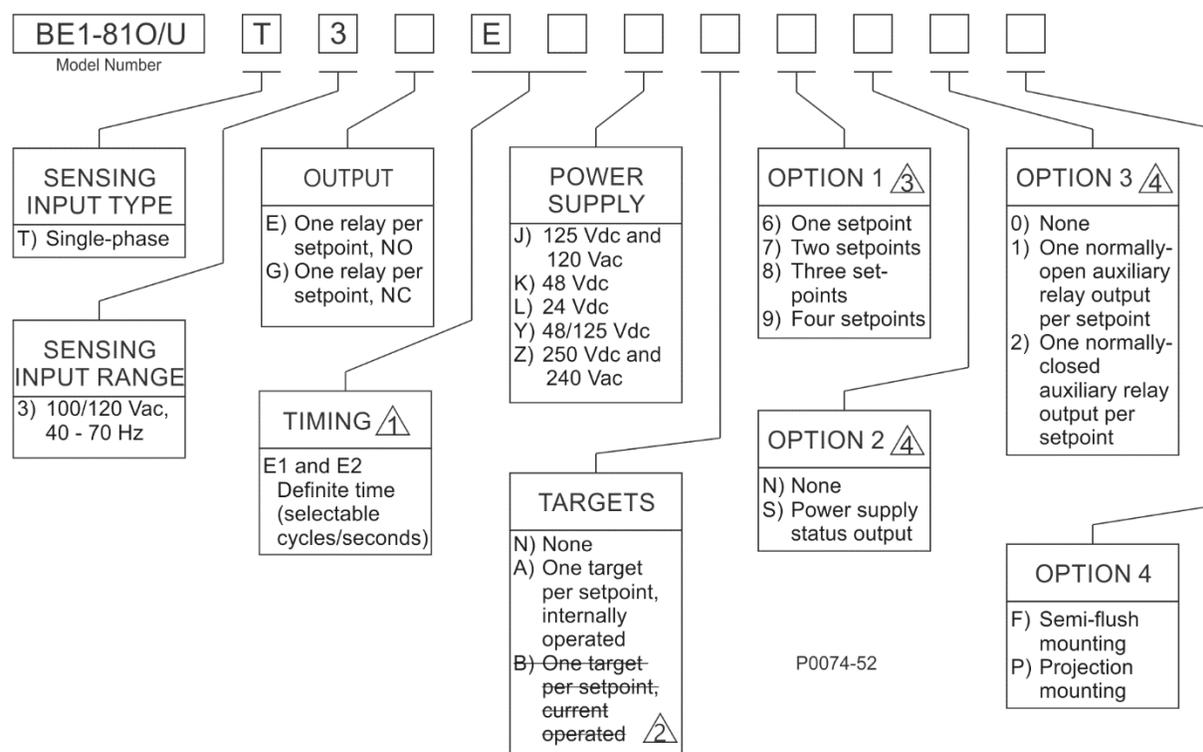
Either internally-operated or current-operated target indicators are available for each setpoint.

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 and operates the appropriate output contacts, and the target indicator is lit.

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 illustrates the features and options for the BE1-81O/U relay.



NOTES

- 1 BE1-810/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 BE1-810/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. Current operated targets are no longer available.
- 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. BE1-810/U Style Chart

2 • Controls and Indicators

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.

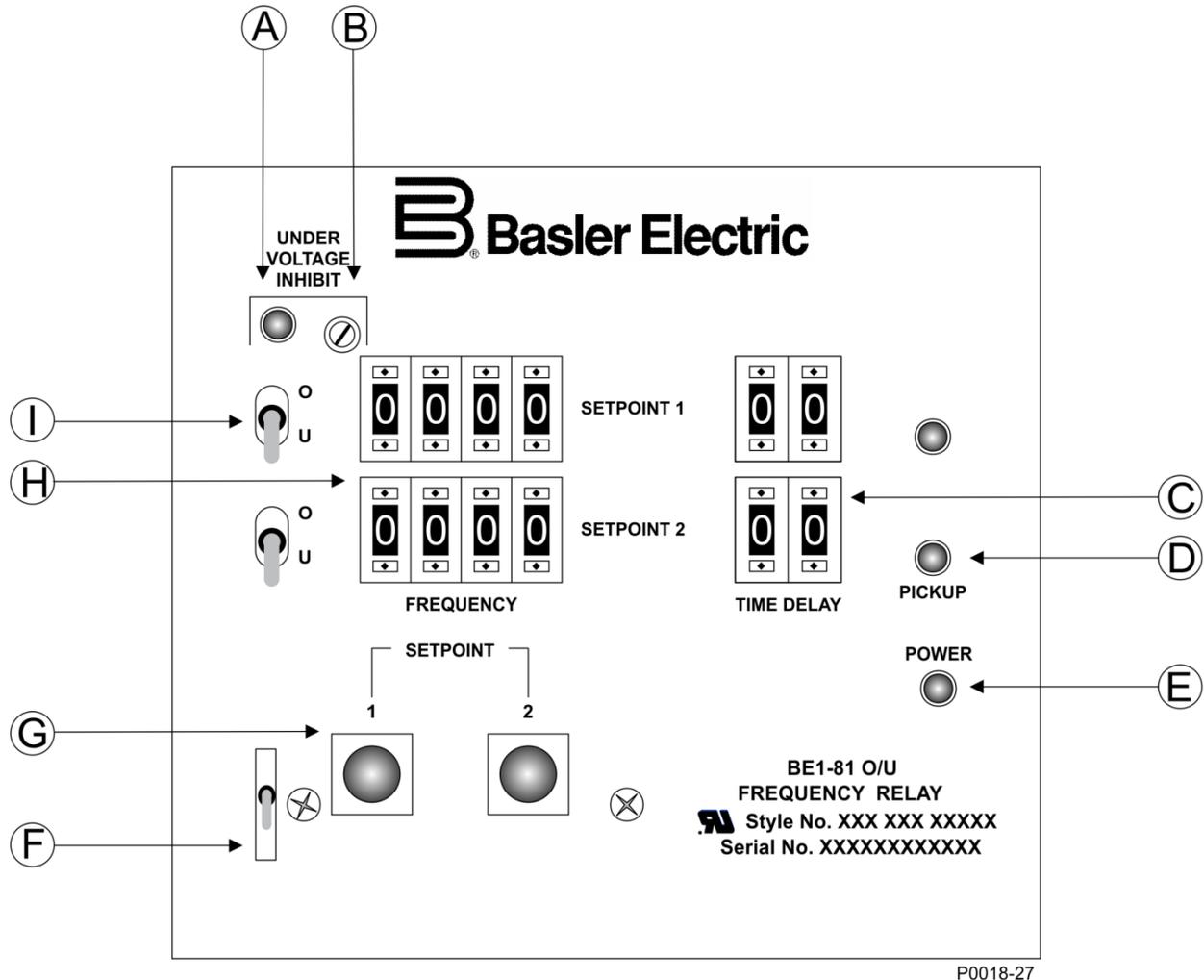


Figure 2-1. Front-Panel Controls and Indicators

Table 2-1. Front Panel Control and Indicator Descriptions

Locator	Function
A	<i>Undervoltage Inhibit Indicator.</i> 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.
B	<i>Undervoltage Inhibit Control.</i> 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.

Locator	Function
C	<i>Time Delay Selector Switches.</i> A set of two thumbwheel switches sets the time delay between the corresponding frequency setpoint (locator H) 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.
D	<i>Pickup Indicator.</i> 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.
E	<i>Power Indicator.</i> This LED lights when operating power is applied to the relay.
F	<i>Target Reset Switch.</i> Operating this switch resets all of the target indicators.
G	<i>Target Indicators.</i> 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.
H	<i>Frequency Selector Switches.</i> 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.
I	<i>Over/Under Selector Switch.</i> A two-position toggle switch configures the corresponding frequency setting (locator H) as an overfrequency (O) or underfrequency (U) setpoint. One selector switch 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 C) 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.

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.

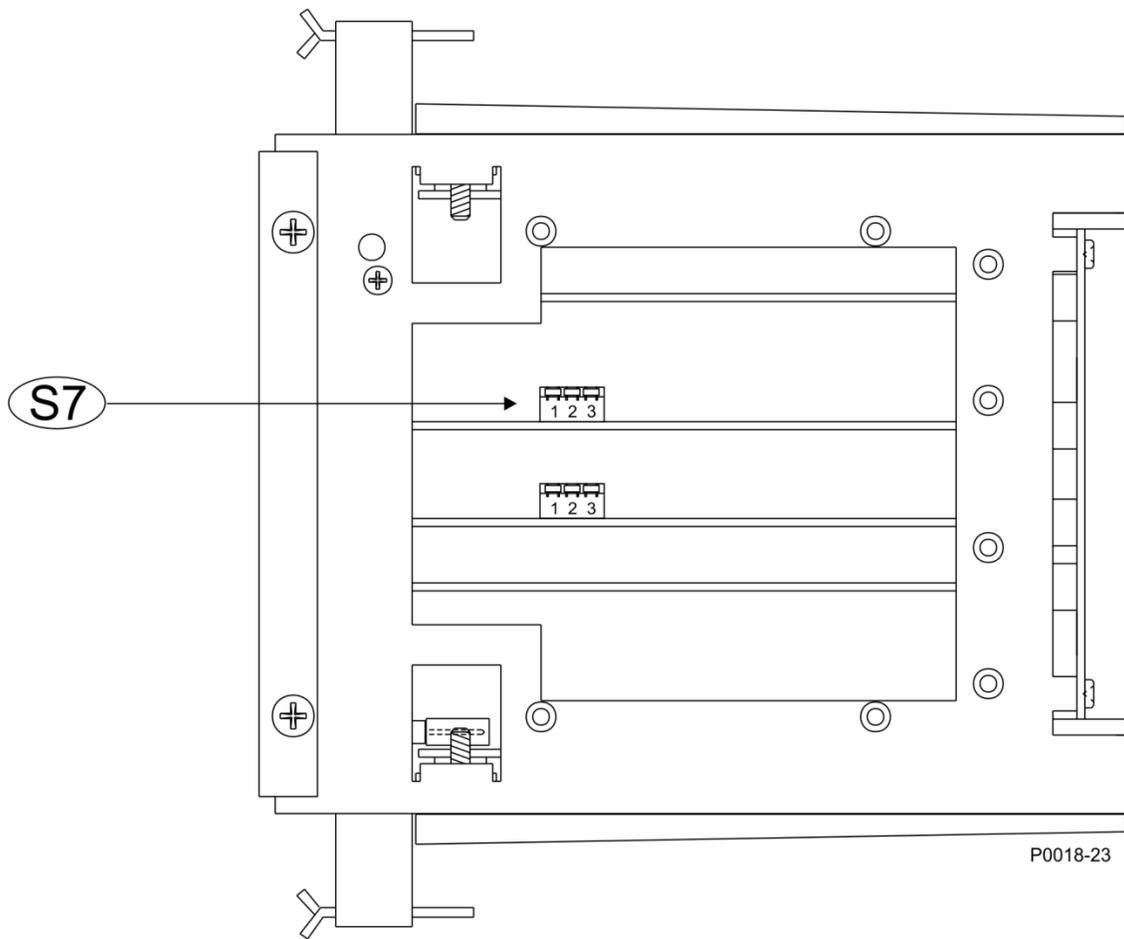


Figure 2-2. Location of Selector Switch S7



3 • Functional Description

The 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.

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 24,580 2 MHz clock pulses, which is the period of the 80 hertz 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 hertz 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.

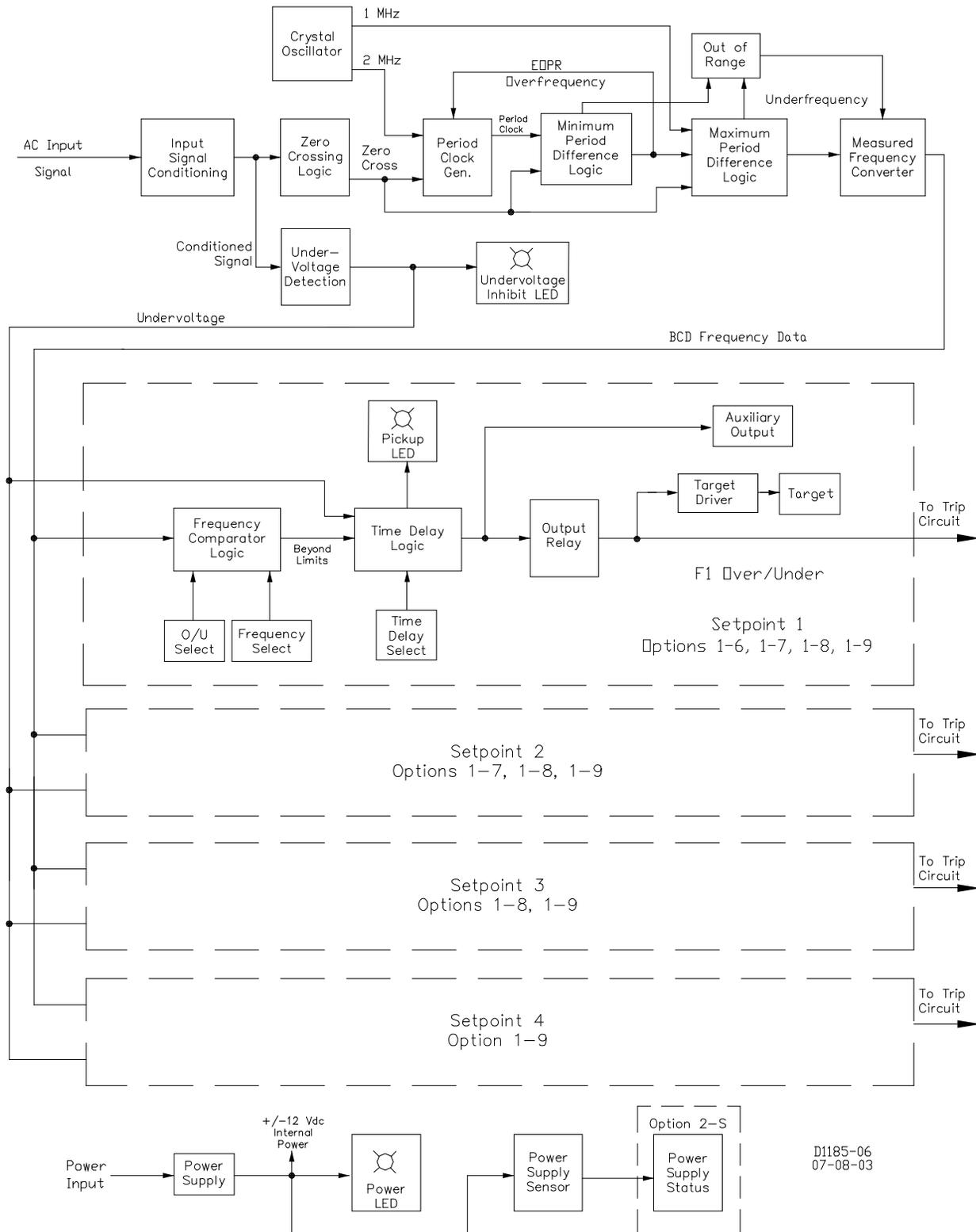


Figure 3-1. BE1-810/U Functional Block Diagram

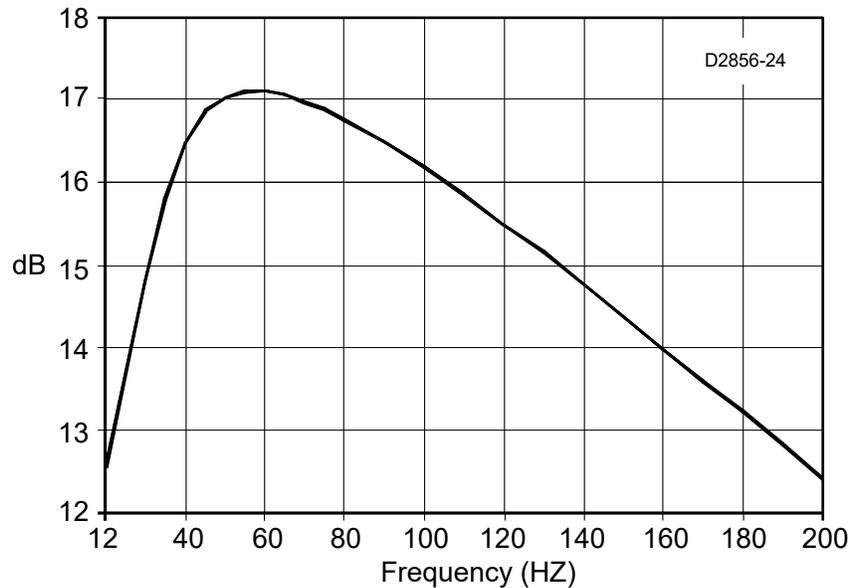


Figure 3-2. Band-Pass Filter Characteristics

Maximum Period Difference Logic

This logic includes an address register 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 4,096 data words stored in 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.

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

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 BE1-810/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 BE1-810/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	2,500 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 the *Specifications* chapter.

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.



4 • Installation

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 connection 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 connection plugs are installed before replacing the case cover.

Notes

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.

It is recommended in all applications where contact outputs drive relay coils that a reverse biased diode be implemented in parallel with the relay coil for EMI suppression.

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 illustrated in Figures 4-1 through 4-19.

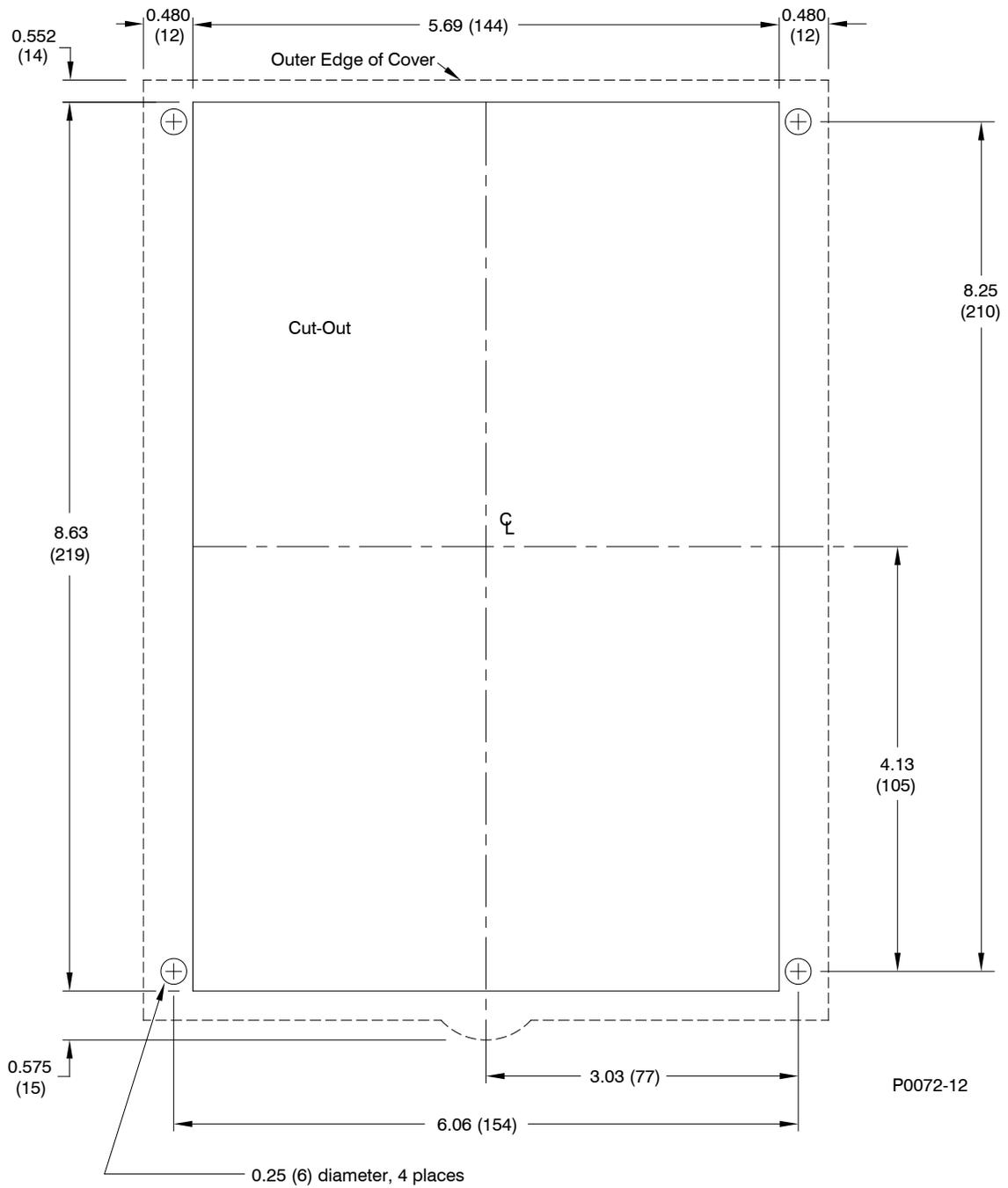


Figure 4-1. Panel Cutting/Drilling, Semi-Flush, S1 Case

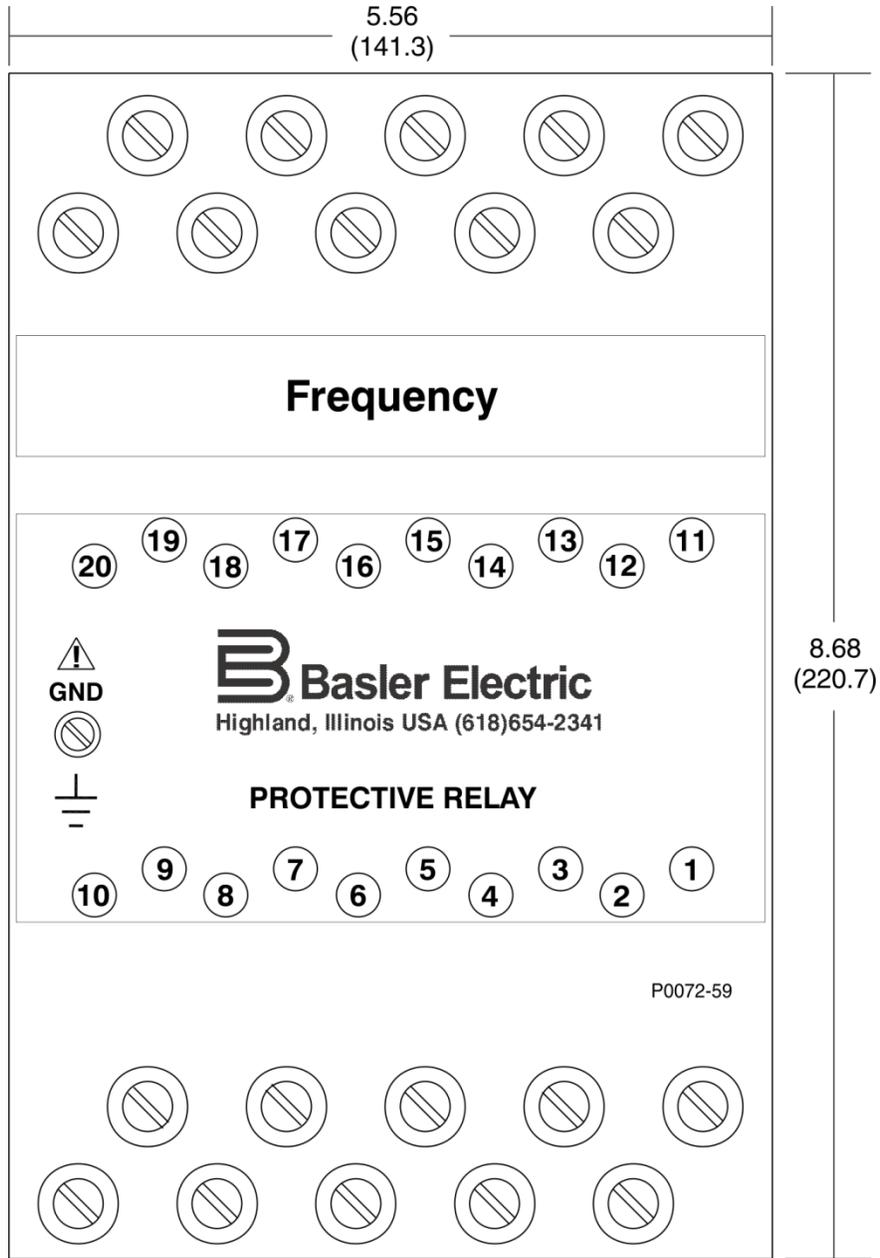


Figure 4-2. S1 Case Dimensions, Rear View, Double Ended, Semi-Flush Mount

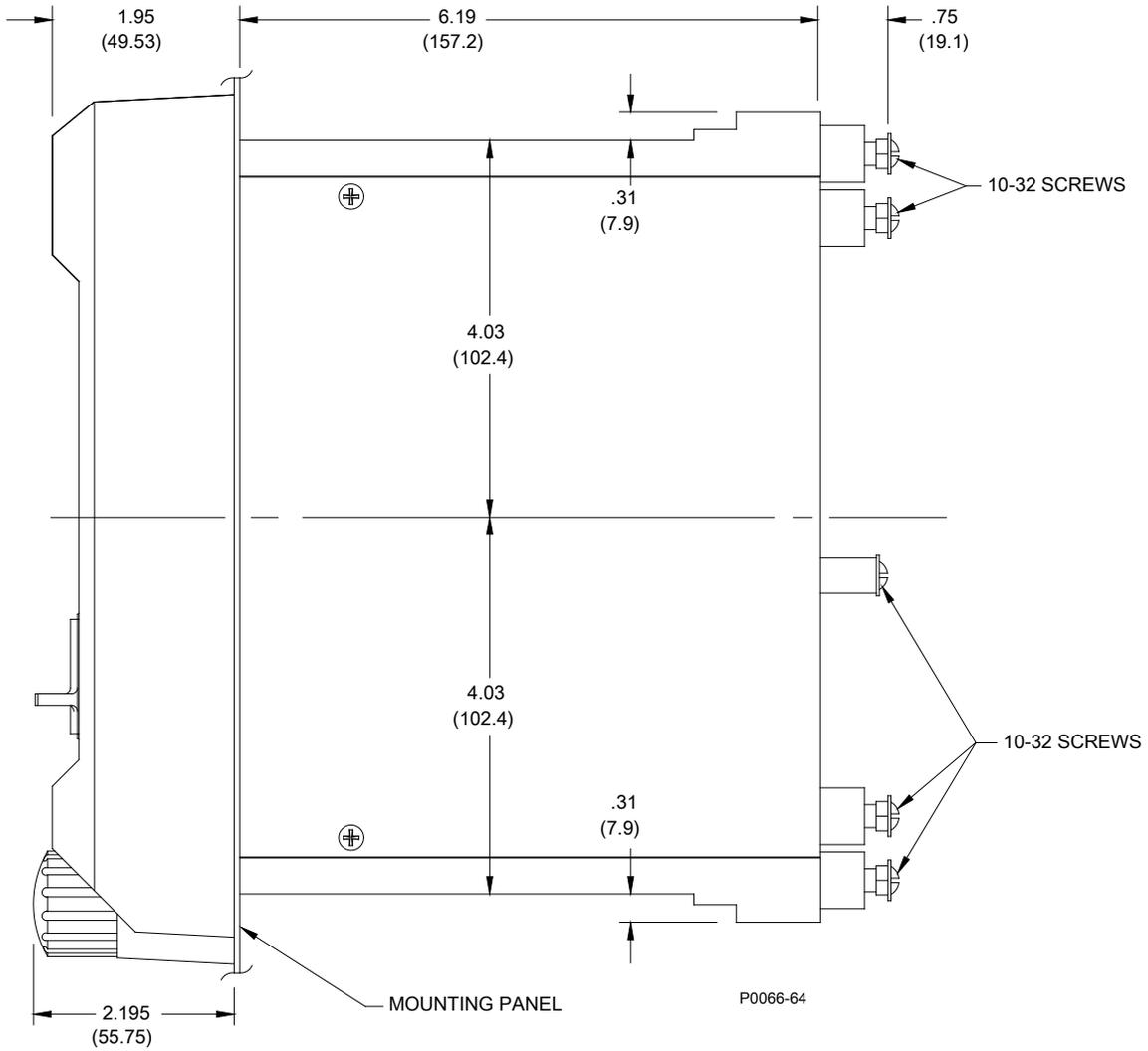


Figure 4-3. S1 Case Dimensions, Side View, Double Ended, Semi-Flush Mount

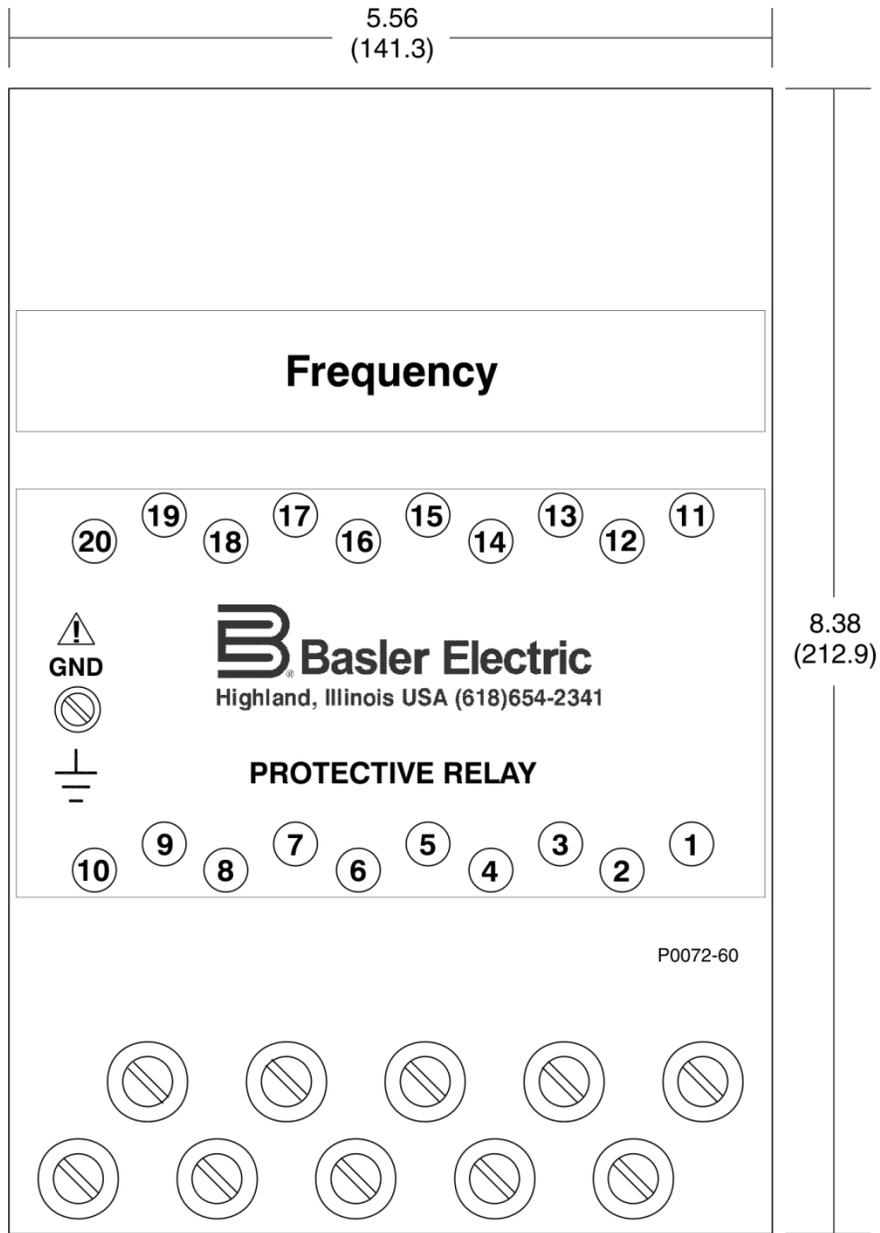


Figure 4-4. S1 Case Dimensions, Rear View, Single Ended, Semi-Flush Mount

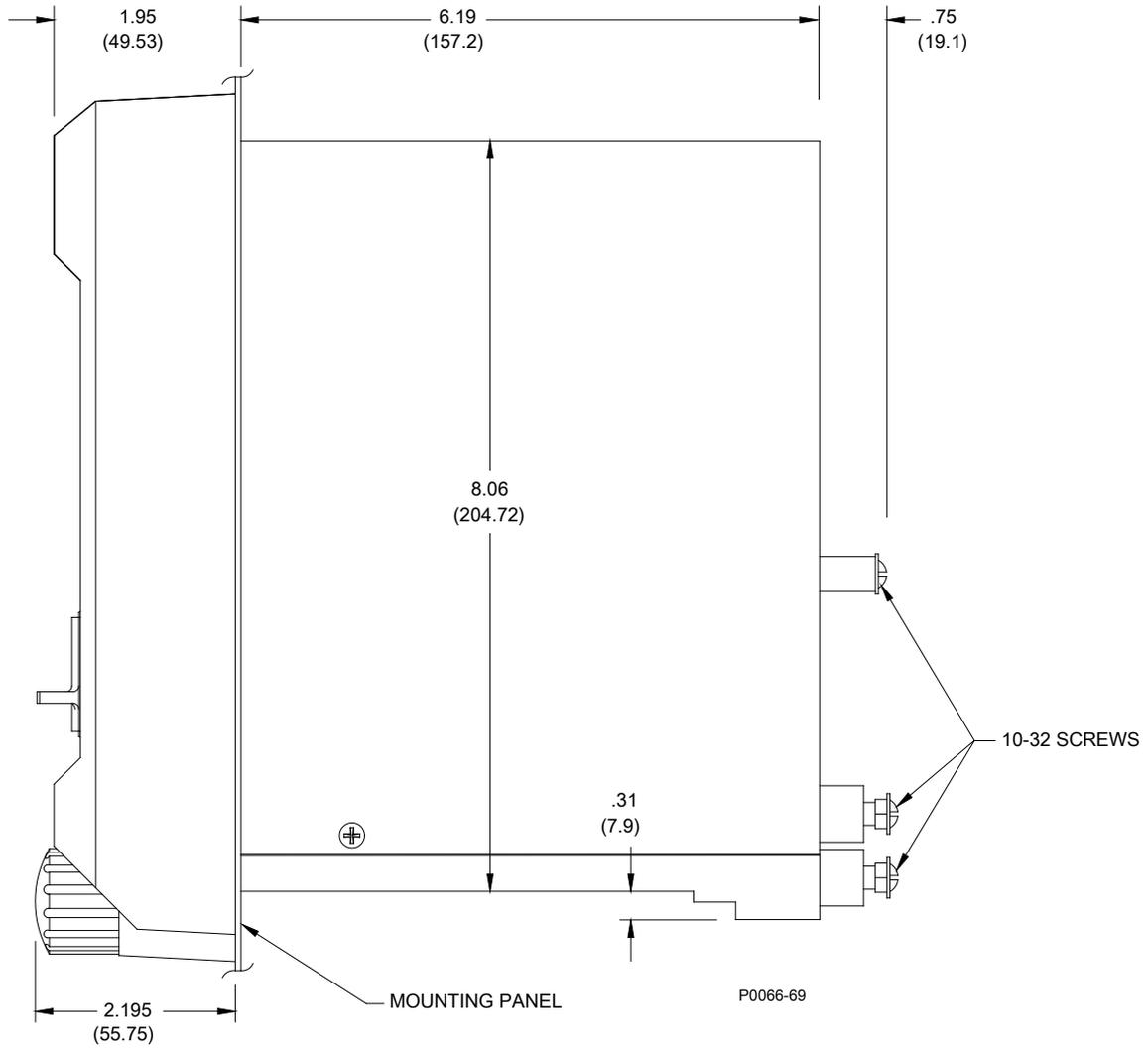


Figure 4-5. S1 Case Dimensions, Side View, Single Ended, Semi-Flush Mount

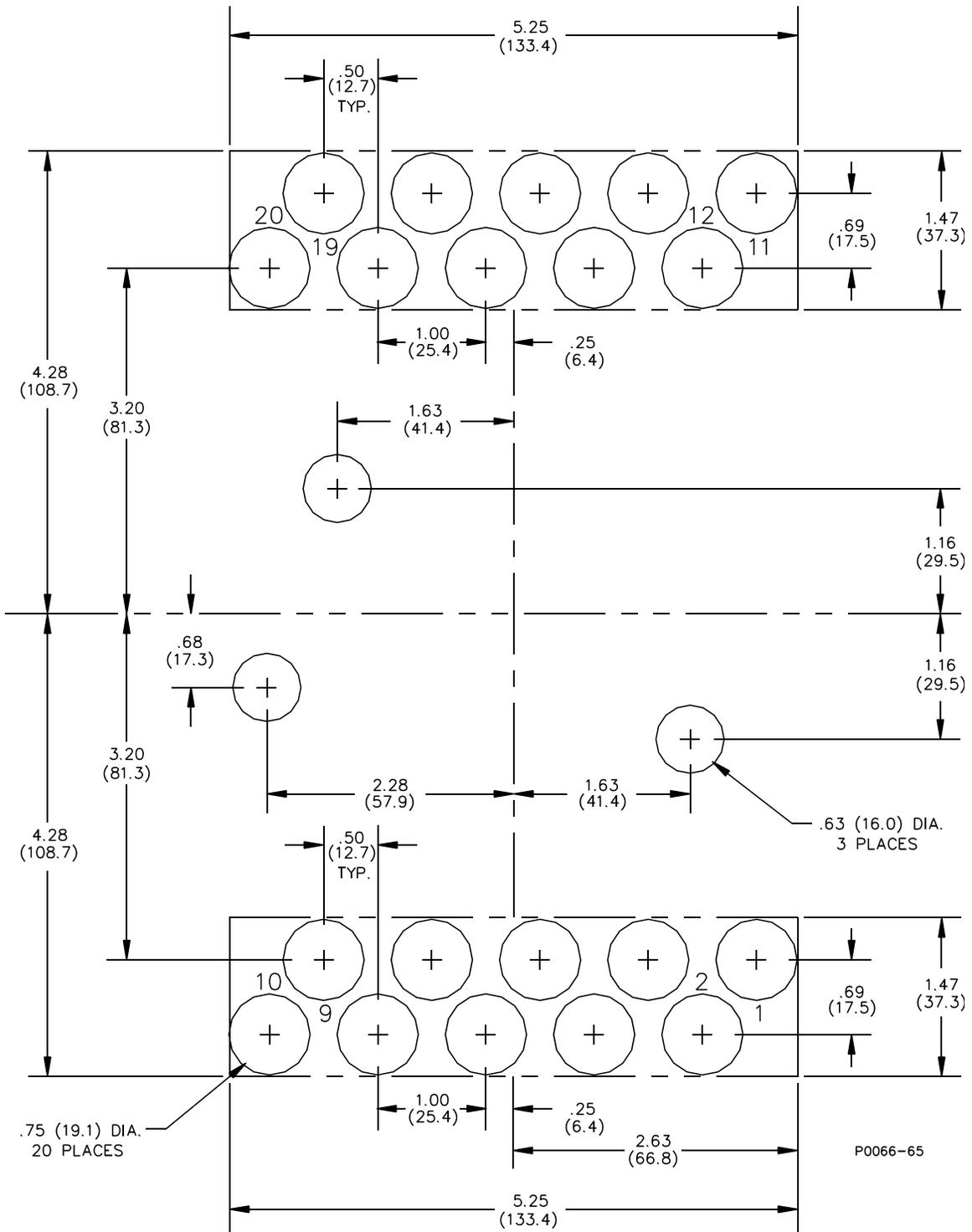


Figure 4-6. Panel Cutting/Drilling, Double Ended, Projection Mount, S1 Case

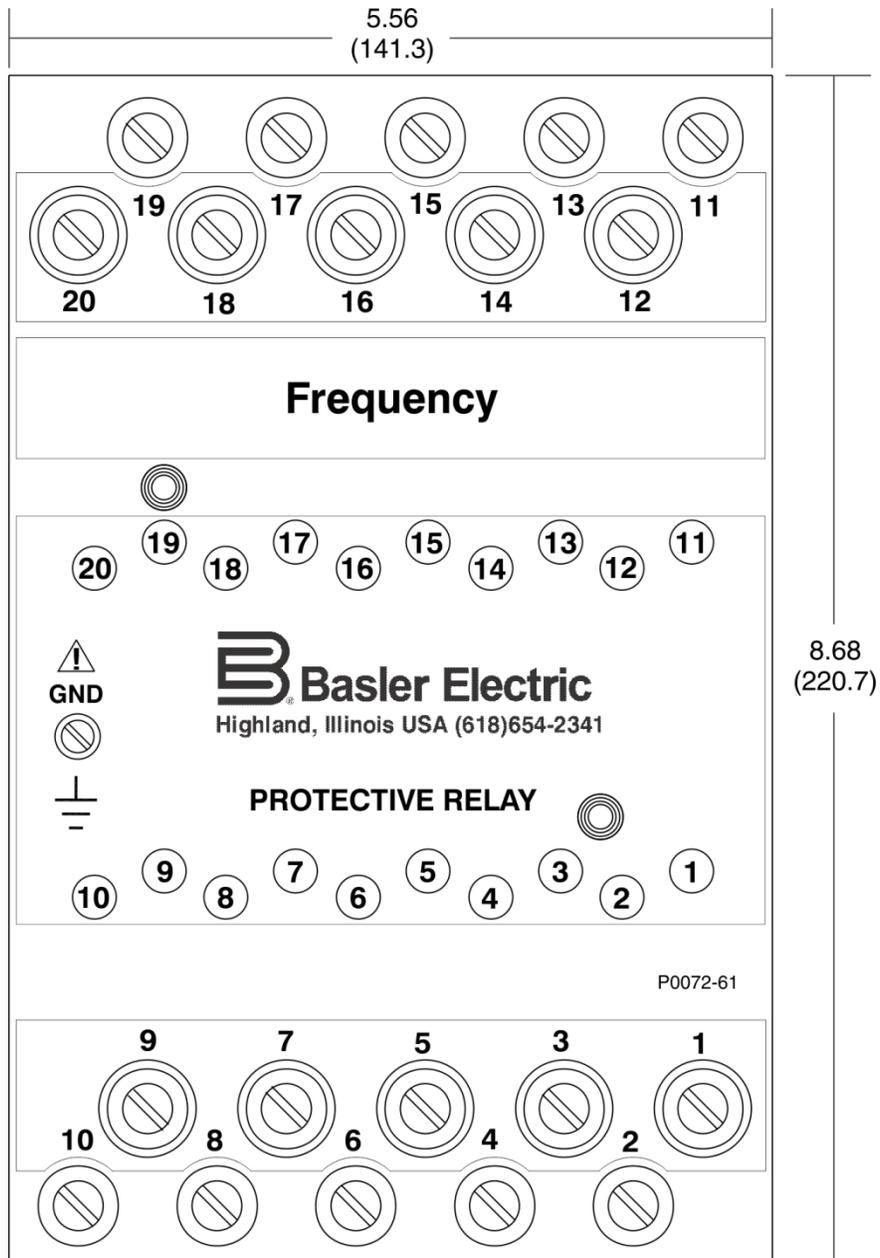


Figure 4-7. S1 Case Dimensions, Rear View, Double Ended, Projection Mount

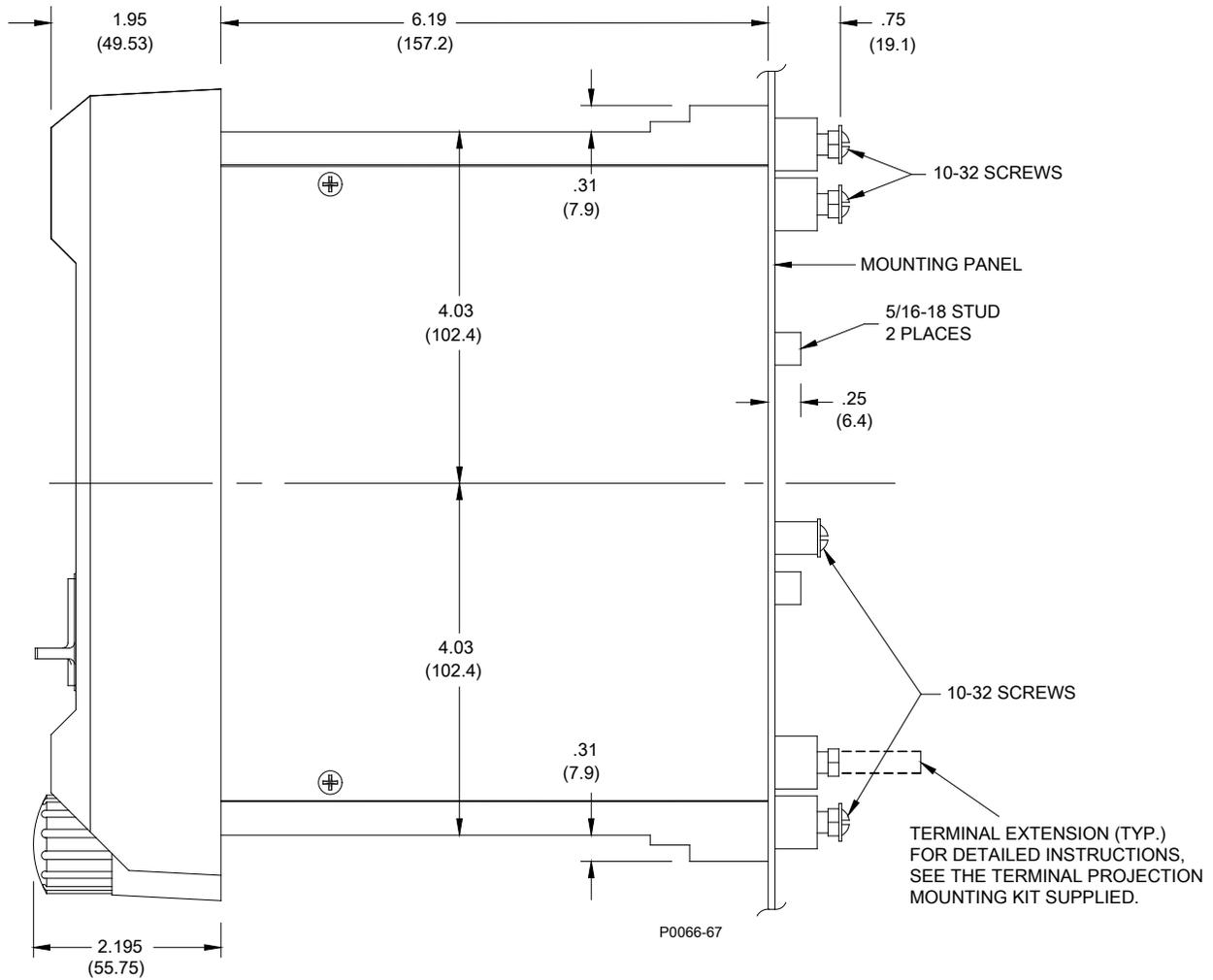


Figure 4-8. S1 Case Dimensions, Side View, Double Ended, Projection Mount

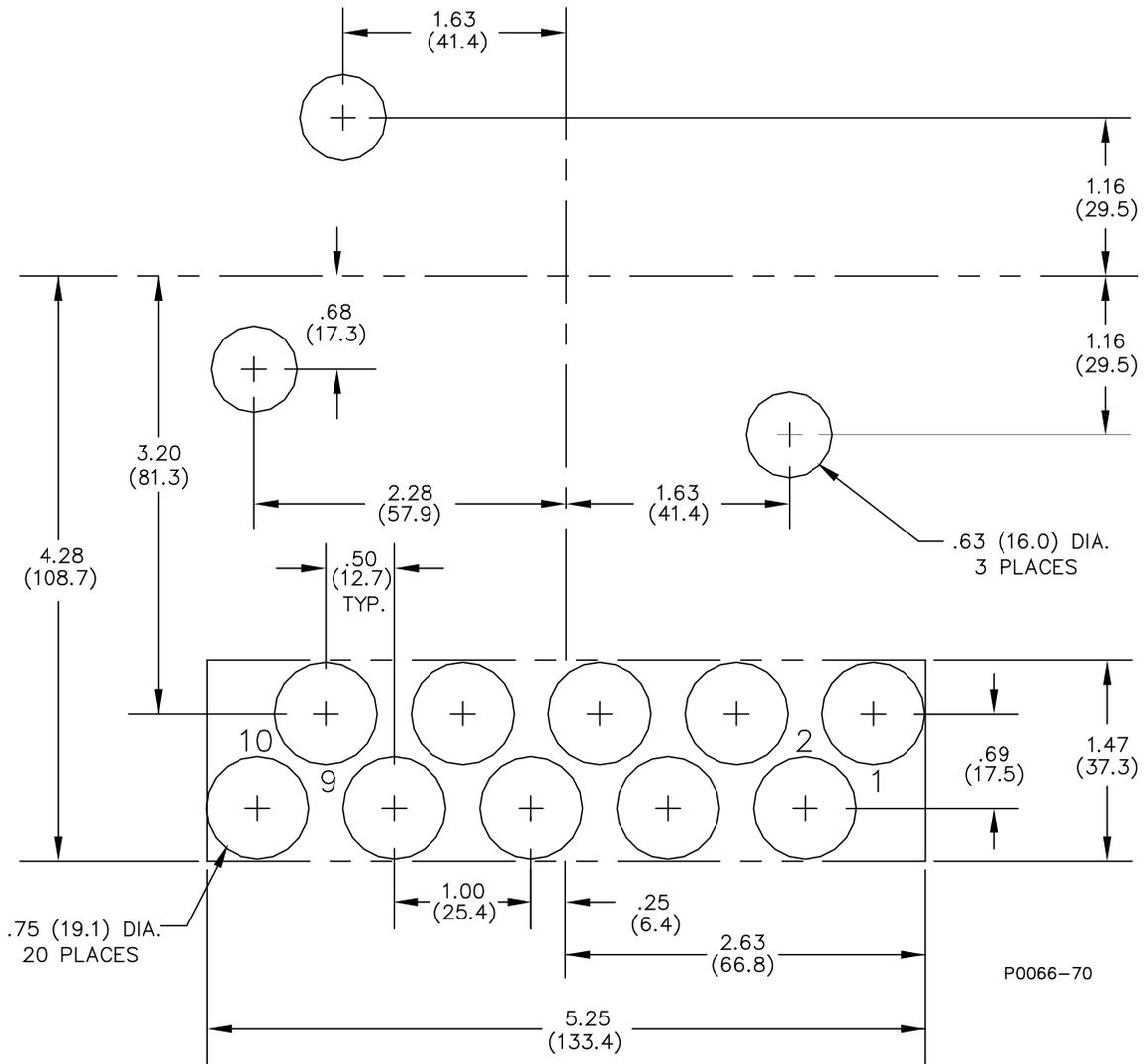


Figure 4-9. Panel Cutting/Drilling, Single Ended, Projection Mount, S1 Case

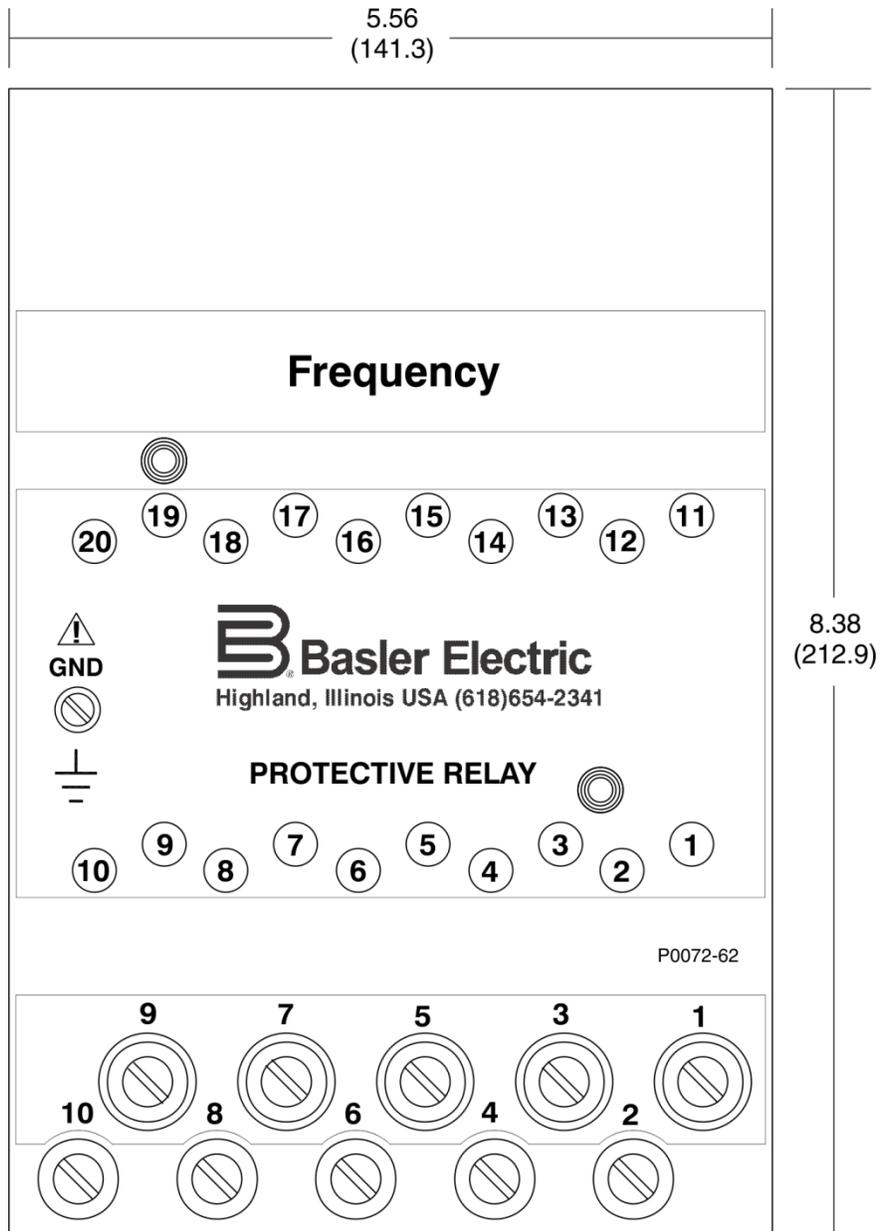


Figure 4-10. S1 Case Dimensions, Rear View, Single Ended, Projection Mount

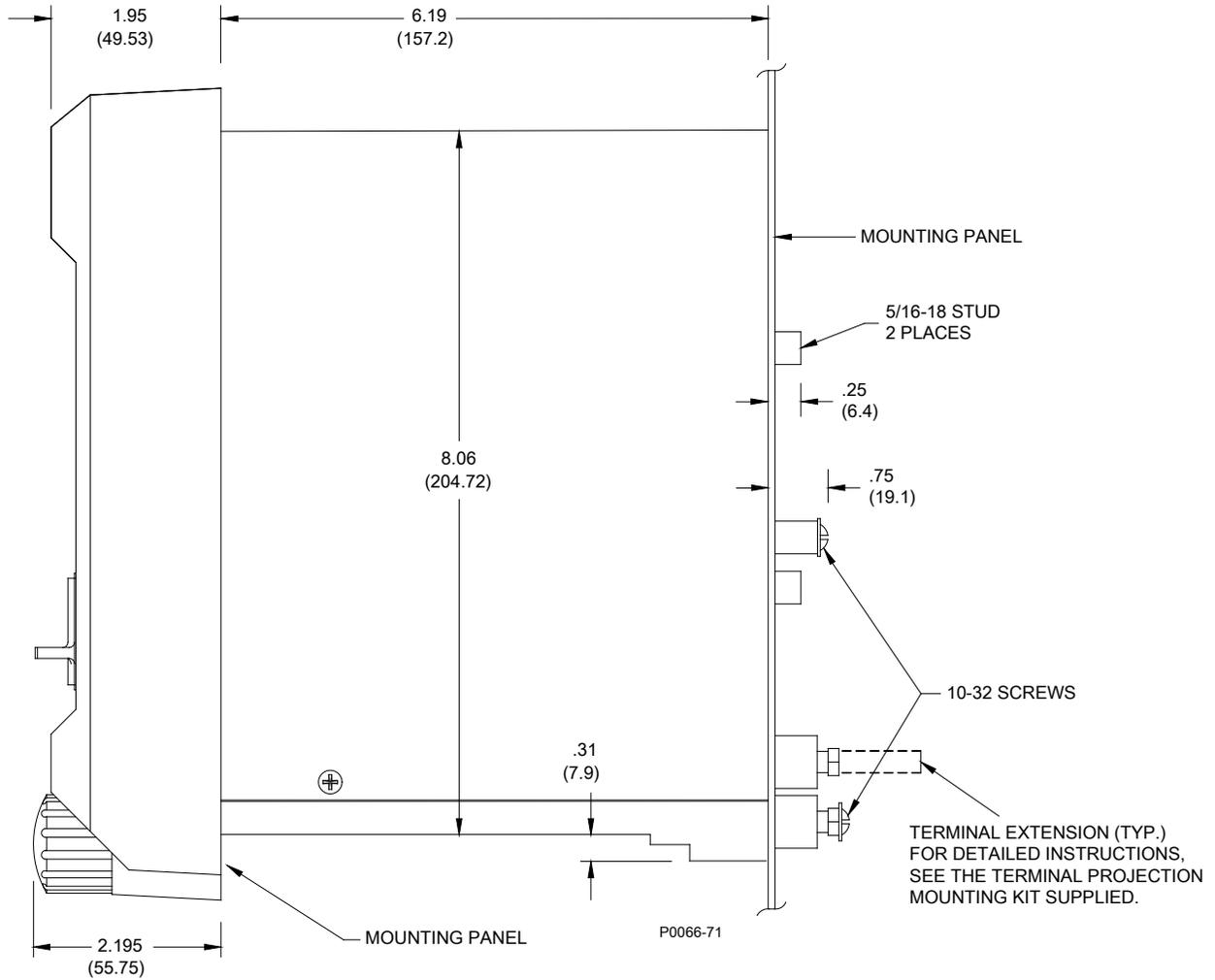


Figure 4-11. S1 Case Dimensions, Side View, Single Ended, Projection Mount

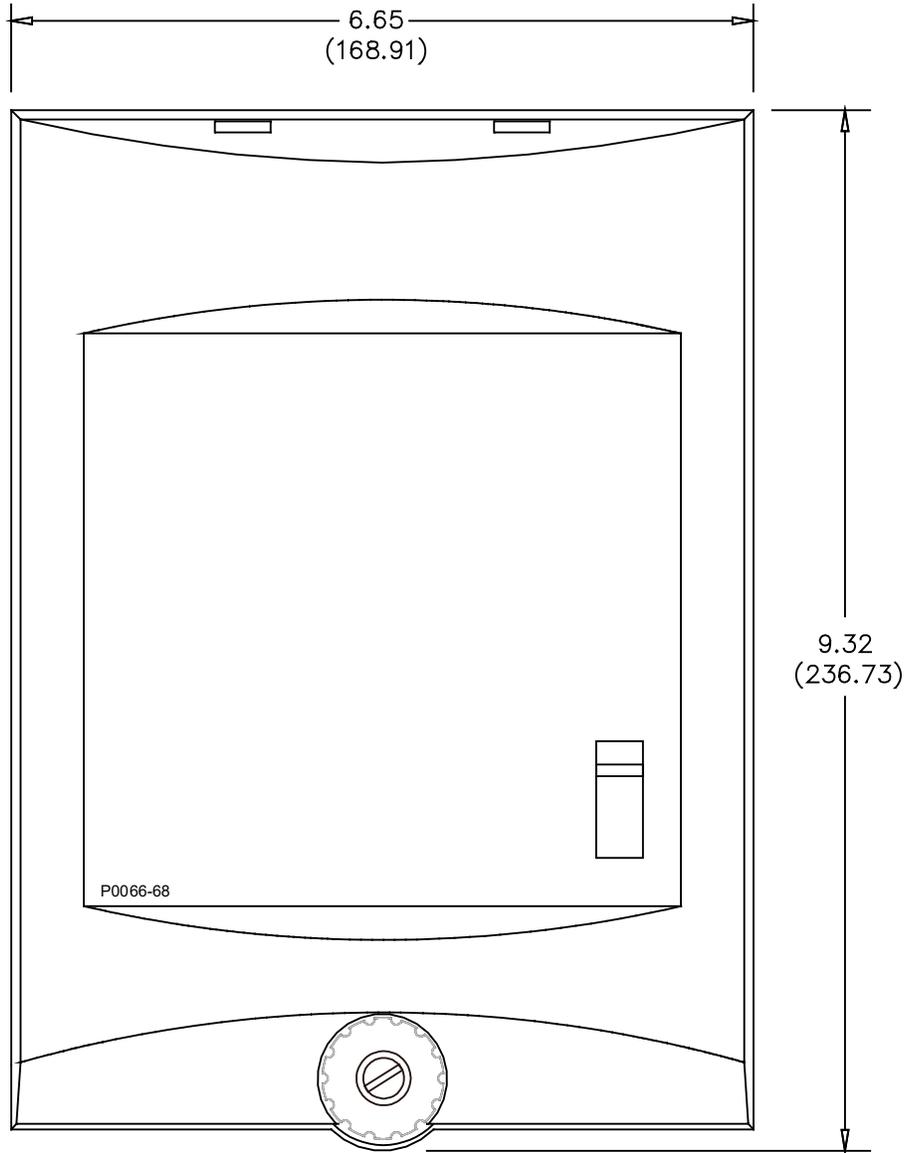


Figure 4-12. S1 Case Cover Dimensions, Front View

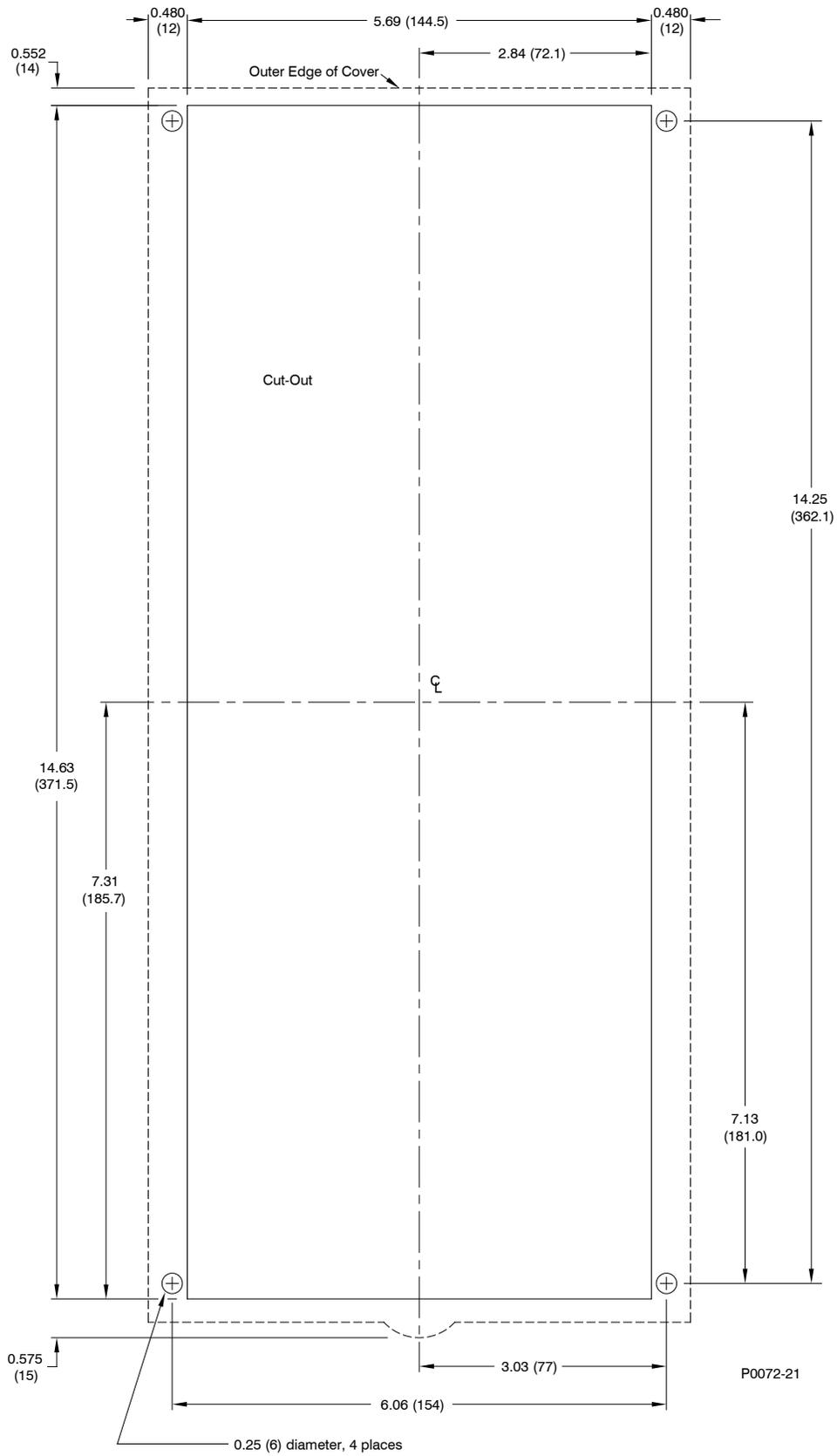


Figure 4-13. Panel Cutting/Drilling, Semi-Flush, M1 Case

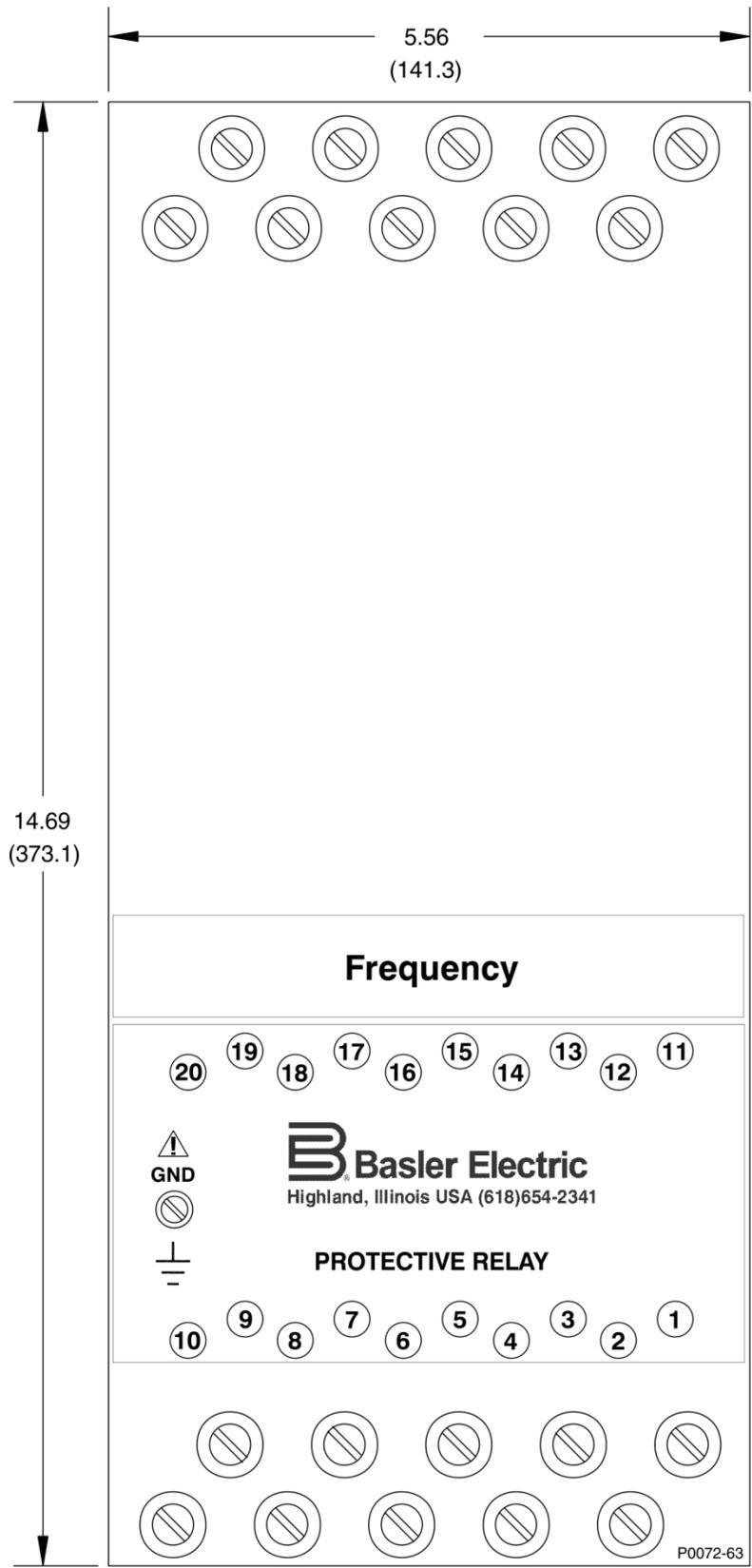


Figure 4-14. M1 Case Dimensions, Rear View, Double Ended, Semi-Flush Mount

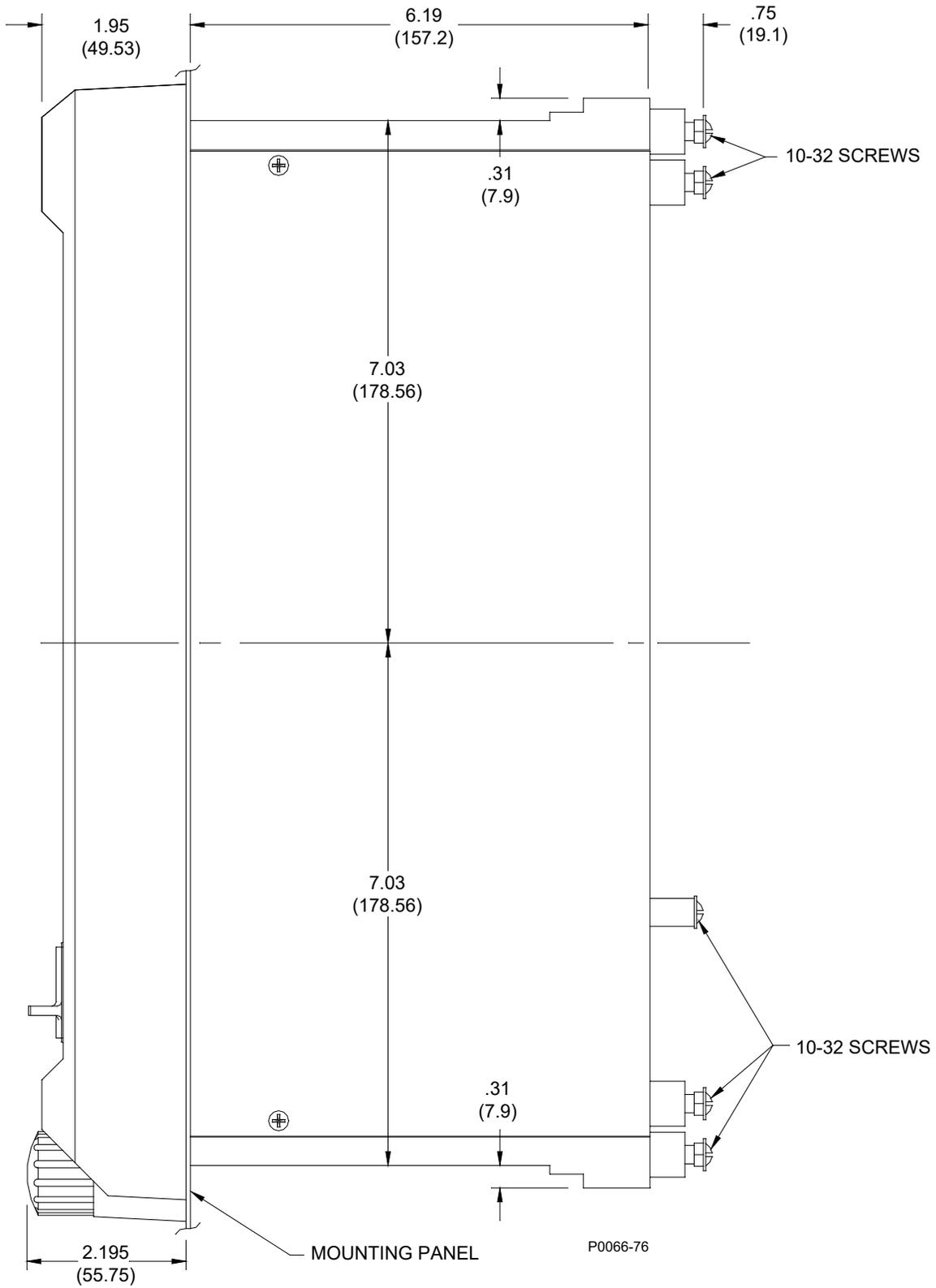


Figure 4-15. M1 Case Dimensions, Side View, Double Ended, Semi-Flush Mount

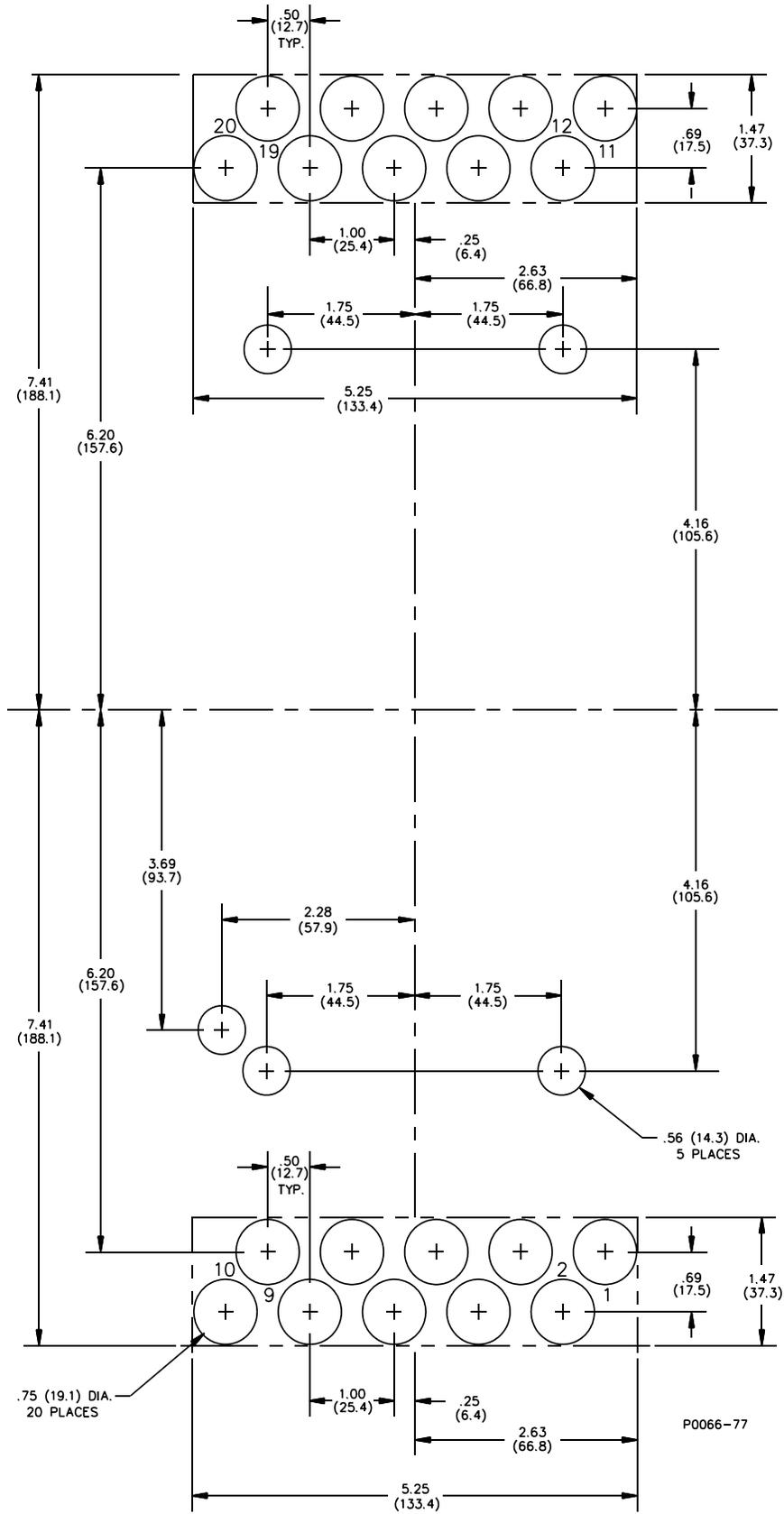


Figure 4-16. Panel Cutting/Drilling, Double Ended, Projection Mount Case

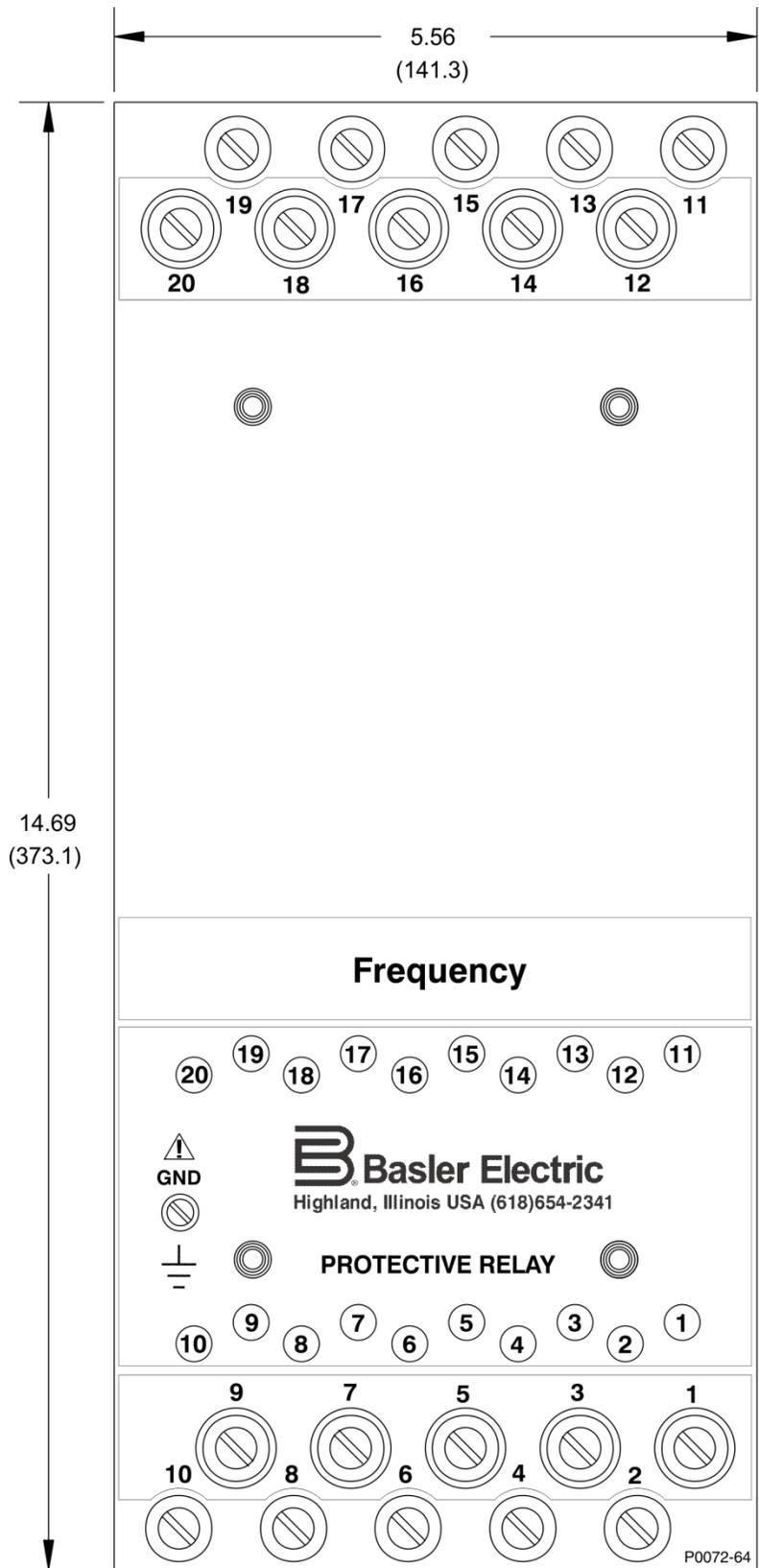


Figure 4-17. M1 Case Dimensions, Rear View, Double Ended, Projection Mount

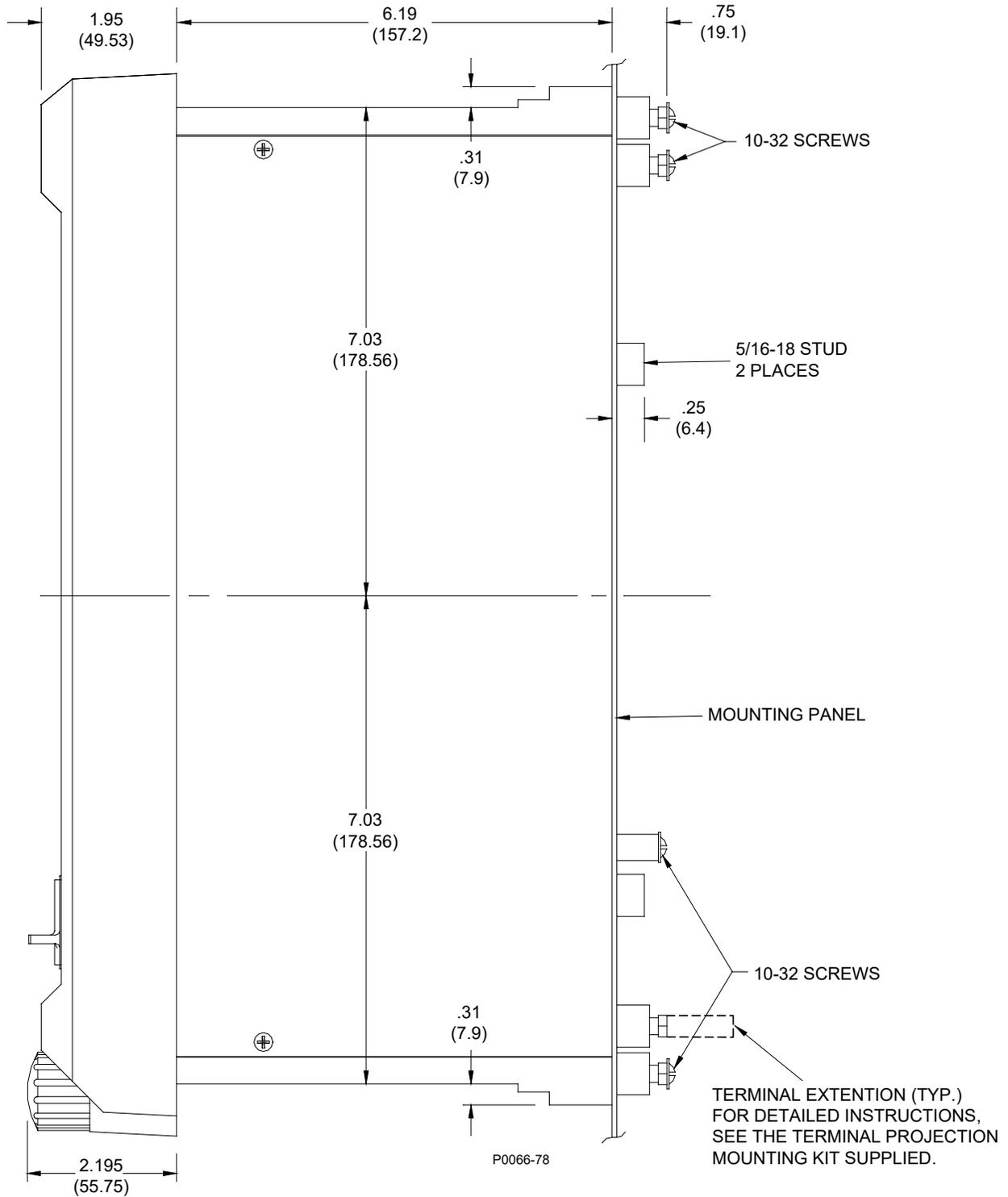


Figure 4-18. M1 Case Dimensions, Side View, Double Ended, Projection Mount

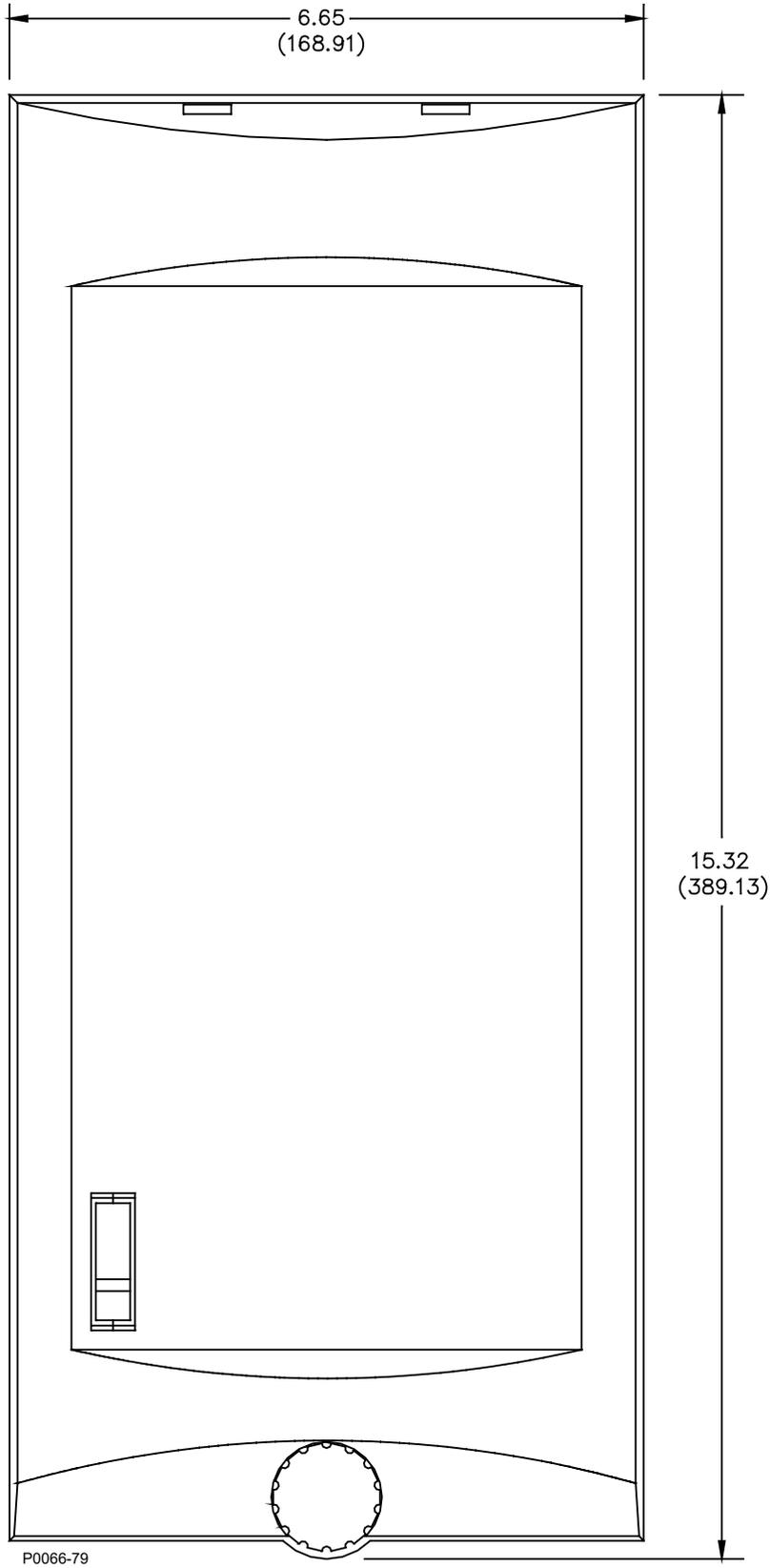


Figure 4-19. M1 Case Cover Dimensions, Front View

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 4-20. External connections are shown in Figures 4-21 and 4-22.

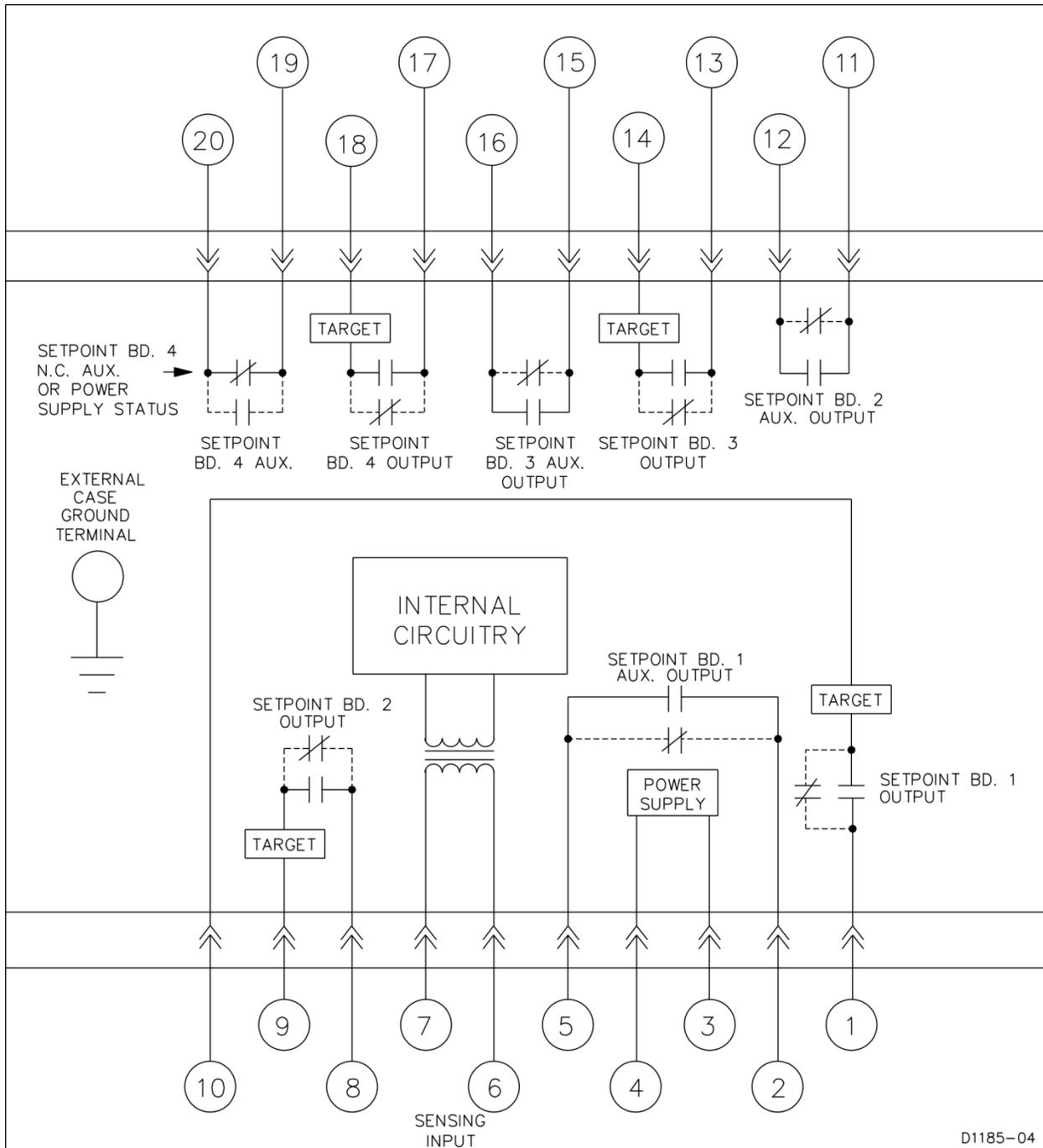


Figure 4-20. Internal Relay Connections

D1185-04

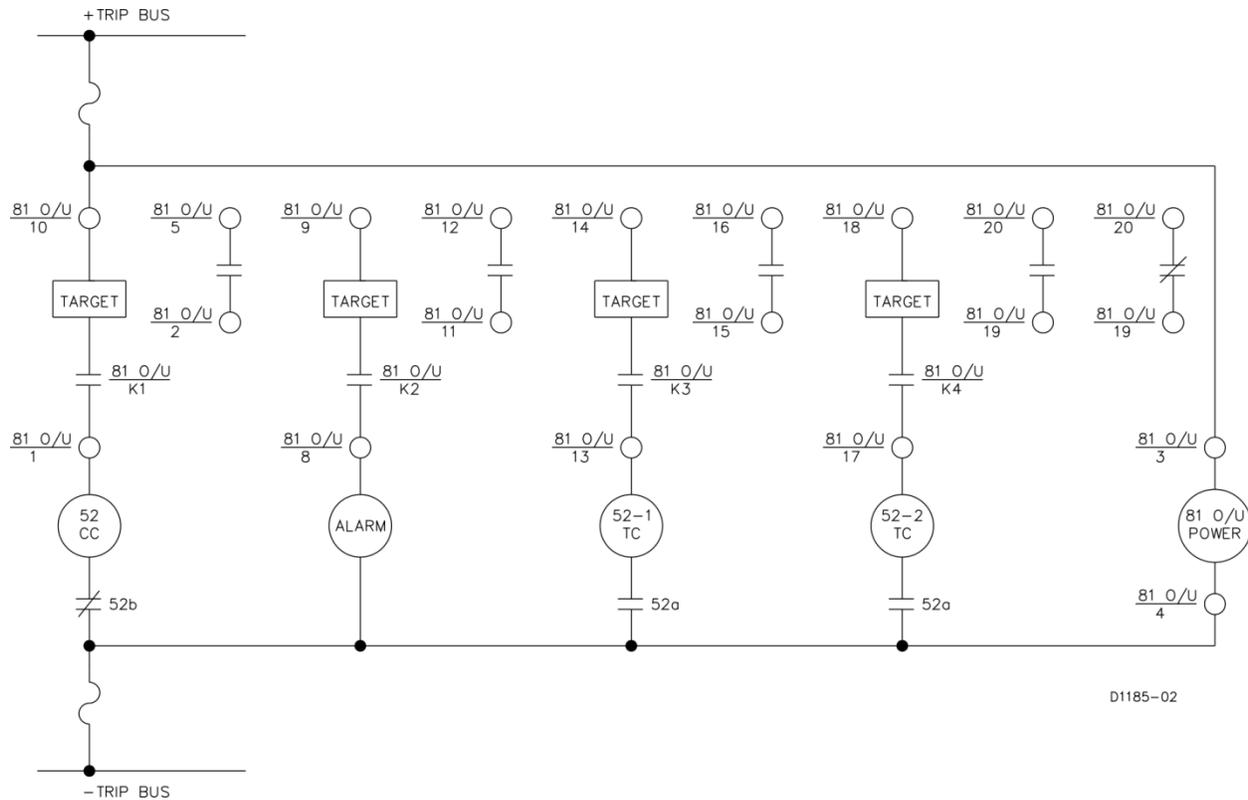


Figure 4-21. Typical DC Connections

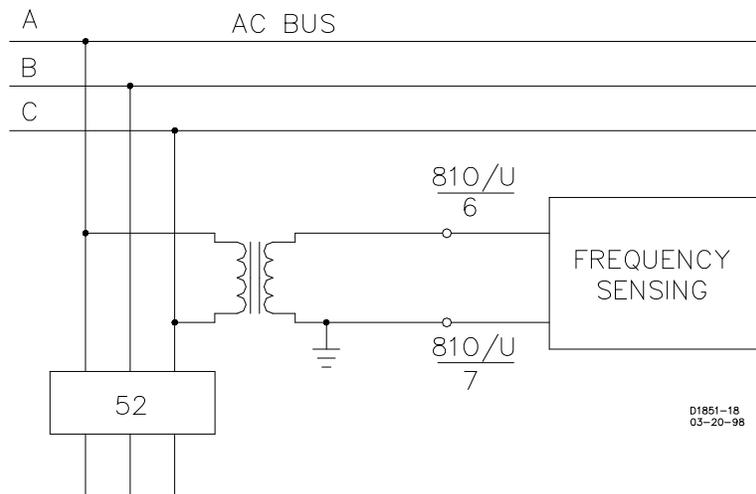


Figure 4-22. Typical AC Sensing Connections

Maintenance

BE1-810/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 device contains long-life aluminum electrolytic capacitors. For devices that are not in service (spares in storage), the life of these capacitors can be maximized by energizing the device for 30 minutes once per year.



5 • Testing

Procedures in this section are used for testing and adjusting a BE1-81O/U relay for the desired operation in a protective scheme.

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-hertz 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.

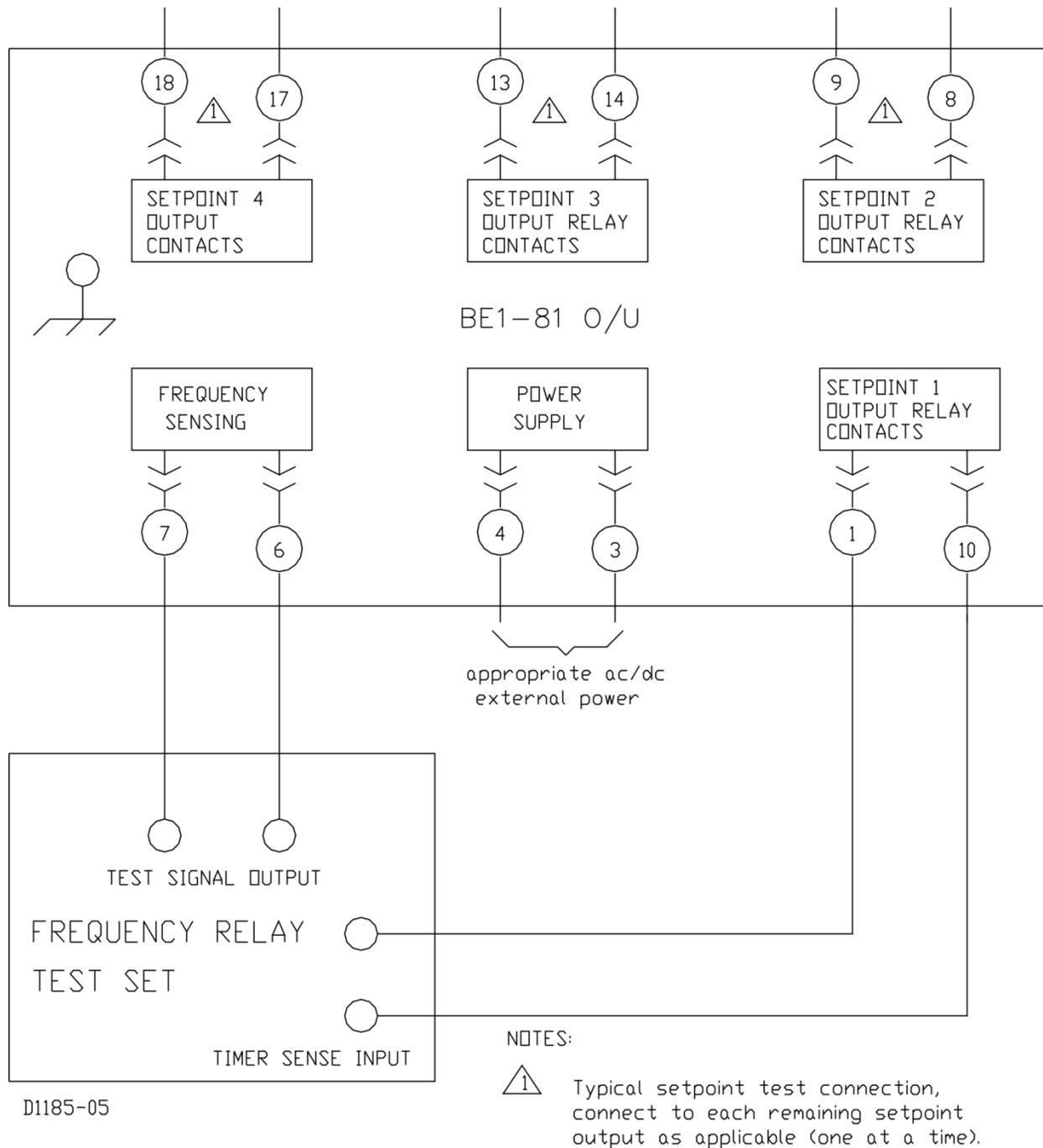


Figure 5-1. BE1-81O/U Test Connections

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-hertz 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-hertz 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 cycles).
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-hertz 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 starts 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-hertz 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. (BE1-810/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.

6 • Specifications

BE1-81O/U relays have the following features and capabilities.

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 6-1.

Table 6-1. Power Supply Types

Type	Input Voltage		Burden at Nominal
	Nominal	Range	
K (mid-range)	48 Vdc	24 to 150 Vdc	3.6 W
J (mid-range)	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 VacMake, break, and carry 7 Aac continuously

250 VdcMake and carry 30 Adc for 0.2 seconds, carry 7 Adc continuously, and break 0.3 Adc

500 VdcMake and carry 15 Adc for 0.2 seconds, 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

Setting Range

Cycles (of applied frequency).....	3 to 99 cycles in 1 cycle increments
	10 to 990 cycles in 10 cycle increments
	100 to 9,900 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.....	+2 cycles or –1 cycle for 0.02 Hz to 1 Hz frequency variation from setpoint setting
	±1 cycle for frequency variation greater than 1 Hz from setpoint setting
Seconds	±2% of the setting or ±50 ms, whichever is greater for 0.02 Hz to 1 Hz frequency variation from setpoint setting
	±2% of the setting or ±25 ms, whichever is greater for frequency variation greater than 1 Hz from setpoint setting

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.....	2,828 Vdc
Input to output circuits	2,000 Vac or 2,828 Vdc

Surge Withstand Capability

Qualified to IEEE C37.90.1-1989

Fast Transient

Qualified to IEEE C37.90.1-1989

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.....-40°C to 85°C (-40°F to 185°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.

Case Size

One or Two Setpoints S1*

Three or Four Setpoints M1*

* See the *Installation* chapter for case dimensions.

Weight

S1 Case..... 13 lb (5.90 kg)

M1 Case 18 lb (8.16 kg)



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