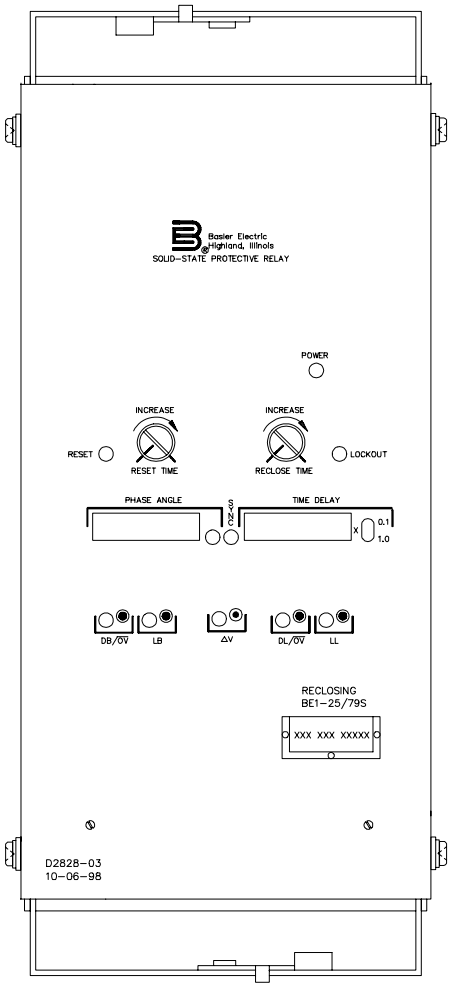
INSTRUCTION MANUAL

FOR

SYNC-CHECK/SINGLE SHOT RECLOSING RELAY BE1-25/79S



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INTRODUCTION

This Instruction Manual provides information concerning the operation and installation of BE1-25/79S Sync-Check/Single Shot Reclosing Relay. To accomplish this, the following is provided.

Specifications

Installation

Operational Tests

Mounting Information

WARNING

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

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

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CONTENTS

CONTENTS-Continued

SECTION 1 • GENERAL INFORMATION

PURPOSE

The BE1-25/79S Sync-Check/Single Shot Reclosing Relay is a solid-state, digital electronic device used to automatically reclose a circuit breaker that has been tripped by a control and protection system. Reclose initiate and reclose cancel signals from the control and protection system are monitored, and line and bus voltage levels and phasing are verified, before breaker reclosure is permitted. An optional timer limits the reclosing attempt time, and optional voltage monitoring and vector voltage difference logic provide additional verification of proper system conditions for safe reclosing.

DESCRIPTION

The Basler Sync-Check/Single Shot Reclosing Relay, after first receiving a reclose initiate (RI) signal from the control and protection system, senses the opening of the circuit breaker as signified by the closing of a Form B auxiliary contact (52b) of the breaker. Simultaneously, line and bus voltages are monitored, and if either or both voltages are below a minimum voltage limit, a reclose timer is initiated; after the reclose timer completes a preselected period, a reclose output relay is energized to close the breaker. However, if the monitored line and bus voltages are both above the minimum voltage limit, (live-line/live-bus condition) the reclose timer is inhibited and sync-check operation is enabled. The sync-check function verifies that the line and bus phase angle is within a preselected phase limit for the duration of a preselected sync-check timer interval before the reclose output relay is energized. The sync-check function also energizes a "sync" output relay simultaneously with the reclose output relay. During either timer period, the control and protection system can generate a reclose cancel (RC) signal to inhibit closing of the reclose relay.

The monitored minimum voltage limit is fixed at 80 Vac, maximum. The sync-check phase angle limit is selectable with two front panel-mounted PHASE ANGLE thumbwheel selectors over a range of 1° to 99°. The sync-check time delay period is established by two front panel-mounted TIME DELAY thumbwheel selectors and a X0.1/X1.0 multiplier over a period of 0.1 to 99 seconds. The reclose timer delay period is adjustable with a front panel-mounted RECLOSE TIME control over the optional ranges of 0.1 to 2 seconds, 1 to 20 seconds, or 5 to 60 seconds.

The reclosing of the tripped circuit breaker requires an RI signal to be generated by the control and protection system as a contact closure and received by the relay before the breaker open (52b) signal occurs as another contact closure. The RI signal allows the relay to distinguish between protective trips for which reclosing is required and those breaker operations for which reclosing is not desirable. When the 52b signal is received, the RI signal can be removed. An RC signal may be applied to the relay to inhibit the reclosing operation, so that when a breaker trip occurs, the reclose output relay is not energized. Following receipt of RC, the breaker must be closed by other means.

When the circuit breaker is closed by the relay (or if closed by other means before the relay attempts reclosure), a reset timer in the relay defines a preselected time period. If the breaker is still closed at the end of the time period, the relay resets and is ready for the next reclosing attempt. If the breaker trips before the reset interval ends, the relay will not attempt another reclosure. In this case, the relay will then reset only when the breaker is closed by other means and has remained closed for the reset timer interval.

The reset timer interval is adjustable with a front panel-mounted RESET TIME control over the range of 5 to 60 seconds.

An optional reclose fail timer limits the period that the reclose output relay is energized, so that if the reclosure attempt fails, the reclose relay does not remain energized. Two optional ranges are available: 2 to 3 seconds and 5 to 6 seconds.

A voltage difference option verifies that the vector difference between the line and bus voltages is less than a preselected limit (ΔV) before the sync-check operation is permitted.

The voltage difference option limit is adjustable on a front panel-mounted control over a range of 1-135 Vac.

A voltage monitor option allows the minimum live voltage limit for sync-check operation to be adjustable between 80 and 135 Vac. This option also provides additional verifications that must be satisfied before the reclose timer is allowed to reclose the breaker. These verifications consist of the active monitoring of a single phase of the line and bus voltage for preselected live-line/dead-bus, dead-line/live-bus, and dead-line/dead-bus voltage conditions. If these voltage conditions are satisfied within a fixed time period, as determined by a maximum trial timer, the reclose timer is initiated. An overvoltage limit (OV) mode is also selectable, allowing an upper voltage limit to be placed on the "live" voltage conditions, so that when the limit is exceeded, reclosing is not permitted.

The voltage conditions and the OV mode are preselected using circuit board-mounted selector switches, and the voltage levels are adjustable over the range of 10 to 135 Vac using front panel-accessible DB/OV, LB, DL/OV and LL screwdriver controls.

All Sync-Check/Single Shot Reclosing Relays are equipped with a "J1/J2 shorting plug" that, when removed from the normal position, allows independent and simultaneous operation of the reclose timer and the sync-check function. When the plug is removed, only the reclose timer energizes the reclose relay, and the sync-check function energizes only the sync relay.

The relay assembly is mounted in a drawout cradle and enclosed in a standard, utility style, case available with either semi-flush or projection mounting. An Ml case is used when the voltage monitor and/or voltage difference option is specified. All other configurations use the S1 case. Test points and circuit components are accessible by removal of the individual printed circuit boards from the relay cradle and using an extender board (Basler part number 9 1129 30 101) to test or troubleshoot. An available test plug (Basler part number 10095) permits the relay to be tested in place without disturbing external control circuit wiring.

MODEL AND STYLE NUMBER

The electrical characteristics and optional features included in a particular style BE1-25/79S Sync-Check/Single Shot Reclosing Relay are defined by a combination of letters and numbers that make up its style number. The model number, BE1-25/79S together with the style number, describing the options included in the specific device, appear on the front panel, drawout cradle, and inside the case assembly. Upon receipt of a Sync-Check/Single Shot Reclosing Relay, be sure to check the style number against the requisition and packing list to see that they agree.

Style Number Example

The Style Number Identification Chart (Figure 1-1) defines the electrical characteristics and operational features included in BE1-25/79S relays. For example, if the Style Number were **B1N A4C B5R0F**, the device would have the following:

(B) Single shot reclosing with reclose initiate and reclose cancel;

(1) Lockout and reset circuits;

(N) Instantaneous trip enable not available;

(A4) Reclosure time delay range of 5 to 60 seconds;

(C) Internal relay operating power to be obtained from a 125 Vdc or 100/120 Vac source;

(B) Reset timer that is continuously adjustable from 5 to 60 seconds; together with a 95 second limit for the voltage monitor to accept line or bus conditions;

(5) Isolated contact sensing input,

(R) Voltage monitor and voltage difference (M1 case);

(0) Continuous reclose signal;

(F) Semi-flush mounting.

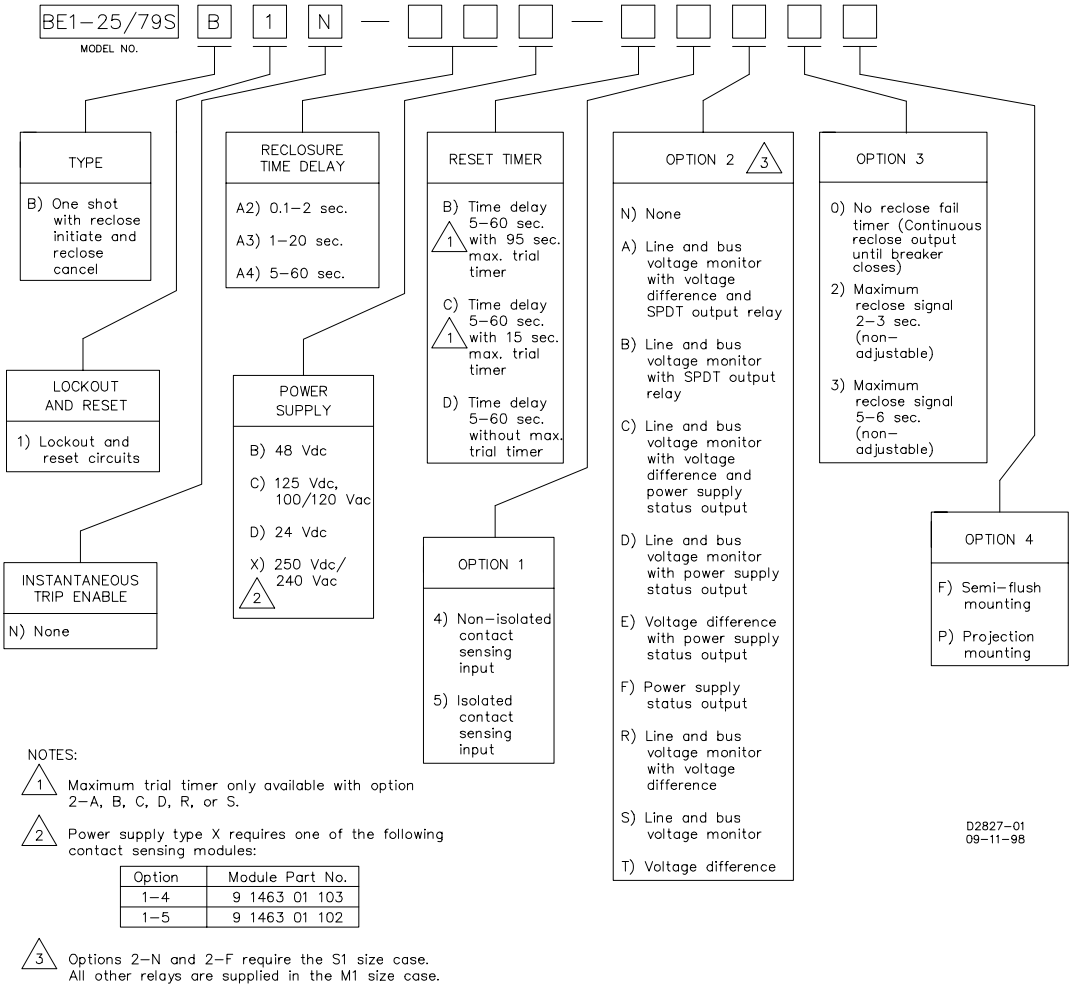


Figure 1-1. Style Identification Chart

SPECIFICATIONS

Power Input

In order to satisfy the various external voltage sources that may be available, and depending on relay application, one of the four types of power supplies listed in Table 1-1 may be optionally selected to provide internal relay operating power. If power supply Type X is used, an external sensing input module is required.

Table 1-1. Power Supply Types And Specifications

Type	Nominal Input Voltage	Input Voltage Range	Burden at Nominal
B (Mid Range)	48 Vdc	24 to 150 Vdc	4.0 W
C (Mid Range)	125 Vdc 120 Vac	24 to 150 Vdc 90 to 132 Vac	4.0 W 10.0 VA
D(Low Range)	24 Vdc	12 † to 32 Vdc	4.0 W
X (High Range)	250 Vdc 240 Vac	62 to 280 Vdc 90 to 270 Vac	5.0 W 14.0 VA

† Type D power supply initially requires 14 Vdc to begin operating. Once operating, the voltage may be reduced to 12 Vdc and operation will continue.

Contact Sensing Inputs

All contact sensing inputs recognize a change in contact status within 8 milliseconds.

Reclose Initiate (RI) Input

Either isolated contact sensing or non-isolated contact sensing is available and will be the same for all inputs in a specific relay.

When isolated contact sensing is provided, a dedicated Form A dry contact rated 0.05 amp at 250 Vdc is required to complete the sensing circuit.

When non-isolated contact sensing is provided, the input is polarity sensitive and requires 24 - 60 Vdc at an additional burden of 3.5 W for a Type B power supply, 61-150 Vdc at 4.5 W for a Type C power supply, 12-32 Vdc at 2.0 W for a Type D power supply, and 140 - 280 Vdc at 7.5 W for a Type X power supply.

The RI input, when closed prior to the closure of the breaker sensing contact (52b), initiates the relay to respond to the change of state of the breaker sensing input.

Breaker Sensing Input (52b)

When isolated contact sensing is provided, a dedicated Form B dry contact rated 0.05 amp at 250 Vdc is required to complete the sensing circuit.

When non-isolated contact sensing is provided, input requirements are the same as the reclose initiate (RI) input.

The breaker sensing input, when closed or when control voltage is supplied, signifies that the controlled breaker is open.

Reclose Cancel (RC) Input

Input requirements are the same as the reclose initiate (RI) input.

The reclose cancel input, when closed, terminates the reclose timer operation and cancels the breaker reclosure attempt.

Voltage Sensing Input

The voltage sensing input is rated for 150 Vac continuously at 50/60 Hertz $\pm$ 10 Hertz, at a maximum burden of 1 VA.

Minimum Voltage

Voltage of a single phase each of line and bus must exceed a nominal minimum of 80 Vac to enable sync-check logic operation. Due to manufacturing tolerances, the minimum voltage may be significantly less than 80 Vac.

Sync-Check (Phase Difference)	The sync-check sensing inputs of a single phase of line and of bus voltages must fall within a pre-selected phase difference limit to enable sync-check logic operation.
Voltage Difference Sensing (Options 2-A, 2-R, and 2-T)	The vector voltage difference between line and bus voltages of a single phase must fall within a pre-selected vector voltage difference (ΔV) limit to enable sync-check logic operation.
Voltage Monitor Sensing Input (Options 2-A, 2-B, 2-R and 2-S)	The voltage monitor senses a single phase each of line and bus voltages, and when these voltages are within pre-selected levels, the voltage monitor logic allows operation of either the sync-check logic or the reclose timer (as predetermined by the minimum voltage input); also (for options 2A and 2B) an SPDT voltage monitor relay is energized.
Output Contacts	
Resistive	
120/240 Vac	Make 30 A for 0.2 seconds, carry 7 A continuously, and break 7 A.
125/250 Vdc	Make 30 A for 0.2 seconds, carry 7 A continuously, and break 0.3 A.
Inductive	
120/240 Vac, 125/250 Vdc	Make 30 A for 0.2 seconds, carry 7 A continuously, and break 0.3 A (L/R = 0.04).
Phase Angle Selection Range	Adjustable in 1° increments over the range of 1-99°.
Phase Angle Accuracy	From a reference measurement made at a nominal input frequency of 50/60 Hz, input voltage of 80 to 135 Vac at 25°C the phase measurement error shall be less than ±0.5° or ±5% (whichever is greater) over the input frequency range of 45-65 Hertz, input voltage range of 80 to 135 Vac over the specified operating temperature range.
Vector Voltage Difference Range (Options 2-A, 2-R, and 2-T)	Continuously adjustable over the range of 1 to 135 Vac.
Vector Voltage Difference Accuracy (Options 2-A, 2-R, and 2-T)	From a setpoint made at a nominal input frequency of 50/60 Hz, input voltage of 80 to 135 Vac and at 25°C, the voltage difference measurement error shall be less than ±0.5 Vac or ±5% (whichever is greater) over the input frequency range of 45-65 Hz, input voltage range of 80 to 135 Vac, and over the specified operating temperature range (and ±3% from 25°C over a limited temperature range of +15° to +40°C).
Voltage Monitor Range (Options 2-A, 2-B, 2-R and 2-S)	Continuously adjustable over the range of 10 to 135 Vac.
Voltage Monitor Accuracy (Options 2-A, 2-B, 2-R, and 2-S)	From a setpoint made at a nominal input frequency of 50/60 Hz, input voltage of 10 to 135 Vac and at 25°C, the voltage level measurement error shall be less than ±3% over the input frequency range of 45-65 Hz, input voltage range of 0 to 150 Vac, and over the specified operating temperature range (and ±1% from 25°C over a limited temperature range of +15° to +40°C).

Sync-Check Time Delay Accuracy at 25°C	25 msec or ±5% (whichever is greater) of the selected value over the range of 0.1 to 99 seconds at 25°C.
Sync-Check Time Delay Accuracy Overall	From a setpoint made at a nominal input frequency of 50/60 Hz, input voltage of 10 to 135 Vac and at 25°C, the sync-check timer delay error shall be less than ±10 msec or ±2% (whichever is greater) over the input frequency range of 45-65 Hz, the input voltage range of 10 to 135 Vac, and the specified operating temperature range.
Reclose Timer Range	Continuously adjustable over the range of 0.1 to 2 seconds (Option A2), 1 to 20 seconds (Option A3), or 5 to 60 seconds (Option A4).
Reclose Timer Accuracy	From a setpoint made at a nominal input frequency of 50/60 Hz, input voltage of 10 to 135 Vac and at 25°C, the reclose timer delay error shall be less than ±50 msec or ±5% (whichever is greater) over the input frequency range of 45-65 Hz, input voltage range of 10 to 135 Vac, and over the specified operating temperature range.
Reset Timer Range	Continuously adjustable over the range of 5 to 60 seconds.
Reset Timer Accuracy	From a setpoint made at a nominal input frequency of 50/60 Hz, input voltage of 10 to 135 Vac and at 25°C, the reset time delay error shall be less than ±5% over the input frequency range of 45-65 Hz, input voltage range of 10 to 135 Vac, and over the specified operating temperature range.
Reclose Fail Timer Accuracy	Repeatability within ±5% over the range of 2 to 3 seconds (Option 3-2) or 5 to 6 seconds (Option 3-3) for a nominal frequency of 50/60 Hz at 25°C.
Maximum Trial Timer (Optional with Voltage Monitor)	Either 95 ±10.0 seconds (with Reset Timer B) or 15 ±2.0 seconds (with Reset Timer C), for a nominal input frequency of 50/60 Hz at 25°C.
Slip Frequency	See Figure 1-2 for sync-check maximum slip frequency versus TIME DELAY and PHASE ANGLE selectors settings.
Reclose Signal	*Option 3-0*: Continuous until the breaker closes. *Option 3-2*: 2-3 seconds or until the breaker closes, whichever occurs first. *Option 3-3*: 5-6 seconds or until the breaker closes, whichever occurs first.
Temperature	
Operating	-40°C (-40°F) to +70°C (+158°F).
Storage	-65°C (-85°F) to +100°C (+212°F).
Shock	In standard tests, the relay has withstood 15g is each of three mutually perpendicular planes without structural damage or degradation of performance.

Vibration	In standard tests, the relay has withstood 2g in each of three mutually perpendicular planes, swept over the range of 10 to 500 Hz for a total of six sweeps, 15 minutes each sweep, without structural damage or degradation of performance.
Isolation	In accordance with IEC 255-5 and ANSI/IEEE C37.90, one minute dielectric (high potential) tests as follows: All circuits to ground: 2121 Vdc Input to output circuits: 1500 Vac or 2121 Vdc
Radio Frequency Interference (RFI)	Maintains proper operation when tested for interference in accordance with IECC C37.90-1989, *Trial-Use Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.*
Surge Withstand Capability	Qualified to ANSI/IEEE C37.90.1-1989 Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.
Weight	13.6 pounds net (S1 Case) 18.0 pounds net (M1 Case)
Case Size	S1 (double ended) if Option 2 is N; M1 otherwise.

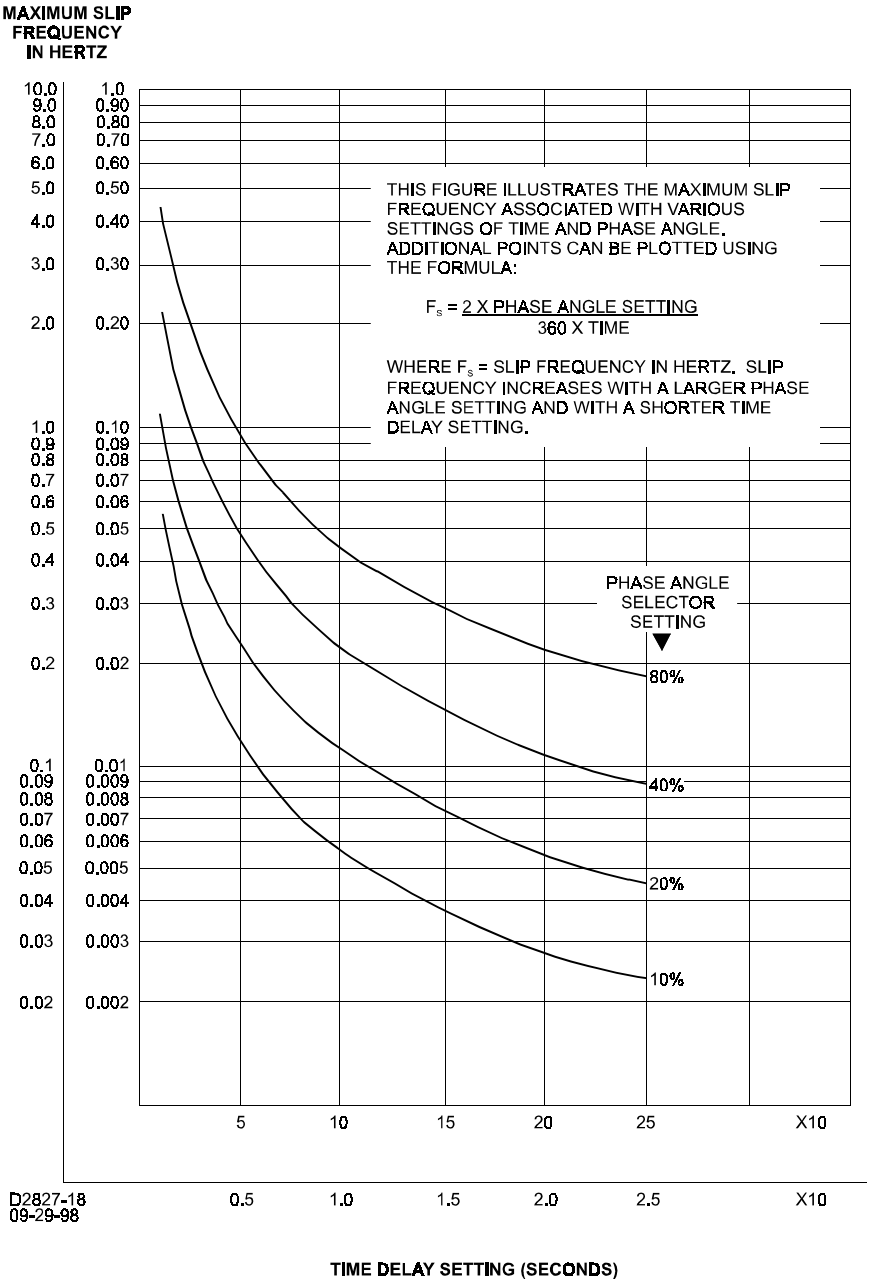


Figure 1-2. Sync-Check Maximum Slip Frequency Versus Time Delay and Phase Angle Selectors Settings

SECTION 2 • CIRCUITS

GENERAL

This section describes the circuit operation of the basic BE1-25/79S Sync-Check/Single Shot Reclosing Relay and the available options.

The BE1-25/79S Sync-Check/Single Shot Reclosing Relay is functionally shown in Figure 2-1. The timing relationships of the sequence of events that occur after the initiation of a reclosing attempt are represented by the timing diagrams of Figures 2-2 and 2-3. These diagrams are included for reference and as an aid in the understanding of the operation of the relay.

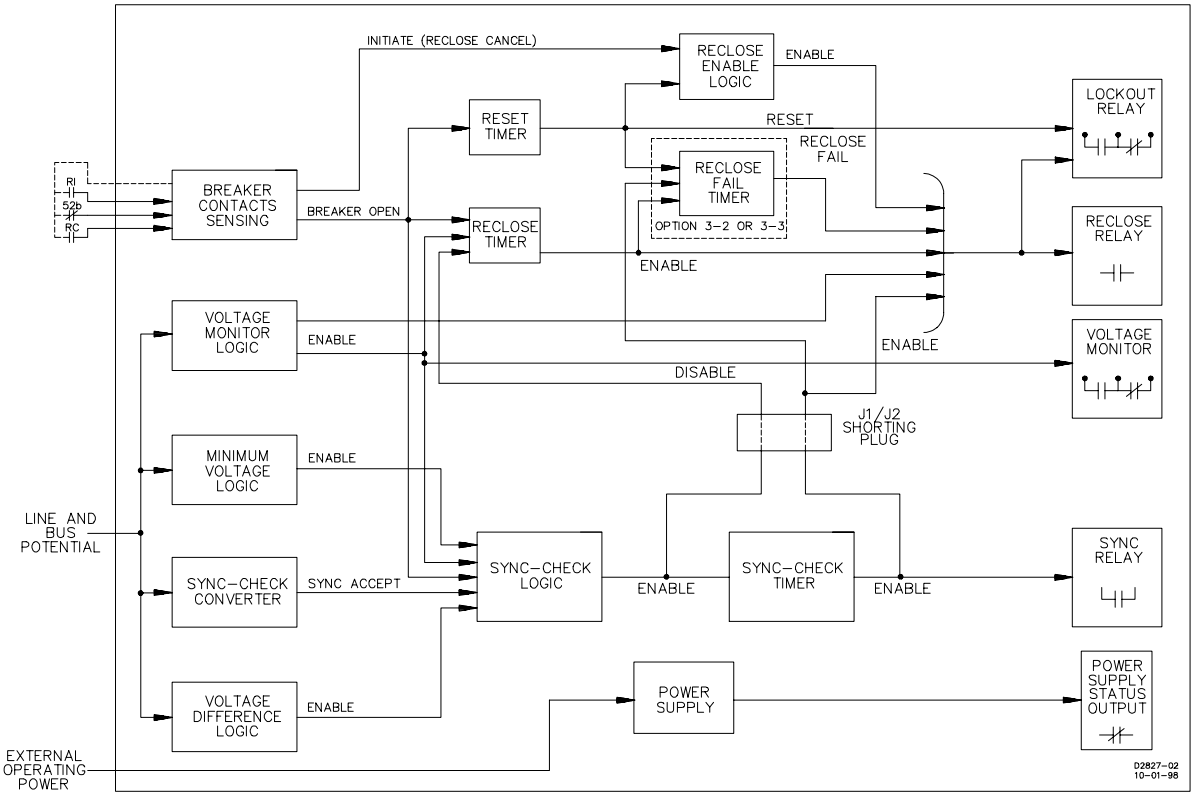


Figure 2-1. Relay Simplified Block Diagram

The relay provides automatic reclosing of a circuit breaker that has been tripped by a protective relay. The relay senses a Form B auxiliary contact of the circuit breaker to detect the position of the breaker. A reclose initiate (RI) signal must be received from the protective system prior to the closure of the breaker auxiliary contact. Receipt of this signal indicates that automatic reclosing is to be permitted.

A reclose cancel (RC) signal may be generated by the protective system. The RC signal must be present at least 8 milliseconds before it is recognized by the relay. When RC is recognized, the relay inhibits automatic reclosing of the controlled breaker. Following an RC signal, the controlled breaker must be closed by other means.

Upon opening of the breaker, the RESET indicator goes out, and the sensed line and bus voltages are compared against a minimum voltage limit of 80 Vac, maximum.

When either or both voltages are below the minimum voltage limit, a preselected reclose timer period is initiated. If the breaker is still open and the RC signal is absent at the end of this time period, the reclose

timer energizes the reclose relay to close the breaker.

When the line and bus voltages are both above the minimum voltage limit, the reclose timer is inhibited and the sync-check logic is enabled. The sync-check logic senses the phase difference between the two voltages and verifies the difference is less than a preselected phase angle limit before allowing automatic breaker reclosure. For the basic relay (voltage monitor option not installed) an unlimited time period is provided for this to occur. When the phase difference falls within the limit, a sync-check timer initiates a pre-selected time delay period, and if the phase difference is still within the limit at the end of the period, and if the breaker is still open and the RC signal is still absent, the reclose output relay is energized.

When the reclose output relay is energized, either by the reclose timer or the sync-check logic, a lockout relay is energized and a LOCKOUT indicator lights. If the sync-check logic initiated the reclosing, a "sync" output relay is simultaneously energized and a SYNC indicator lights.

When the breaker recloses, the reclose relay and the sync relay are de-energized, the SYNC indicator goes out, and a reset timer begins a preselected time interval. If the breaker is still closed by the end of the time interval, the lockout relay is de-energized, the LOCKOUT indicator goes out and the RESET indicator lights; the relay is now ready for another reclosing operation. This process occurs whether the relay caused the breaker closure or closure was effected by other means before the relay attempted reclosure.

If the breaker did not reclose, or opens before the time interval ends, the lockout relay remains energized and the LOCKOUT indicator remains lit; the breaker must then be reclosed by other means and remain closed for the reset period.

An optional reclose fail timer initiates a short time period when the reclose relay is energized, and if the breaker fails to reclose during this period, the reclose relay is de-energized; if the reclose fail timer is not present, the reclose relay is de-energized only when the breaker is reclosed.

An optional vector voltage difference circuit (Options 2-A, 2-R, and 2-T) provides additional verification before allowing sync-check operation; the vector voltage difference between the line and bus must be within a preselected limit before breaker reclosure is permitted.

An optional voltage monitor circuit (Options 2-A, 2-B, 2-R, and 2-S) allows individual adjustment of the live-line and live-bus minimum voltage limit between 80 Vac and 135 Vac. An overvoltage limit ($\overline{\text{OV}}$) mode is provided that allows an adjustable upper limit to be placed on the line and/or bus voltages. When the voltages fall within these limits during a time period determined by a maximum trial timer, the sync-check logic is permitted to operate. Synchronization must then occur during the remainder of the time period to allow energizing of the reclose relay. For the instances of the line and/or bus voltage(s) being below the minimum voltage limit (sync-check logic inhibited, reclose timer enabled) this option includes three selectable line and bus voltage conditions - live-line/dead-bus, dead-line/live-bus, and dead-line/dead-bus - which will allow the reclose timer to operate if the selected condition(s) are met during the time period provided by the maximum trial timer. An optional voltage monitor output relay is also available.

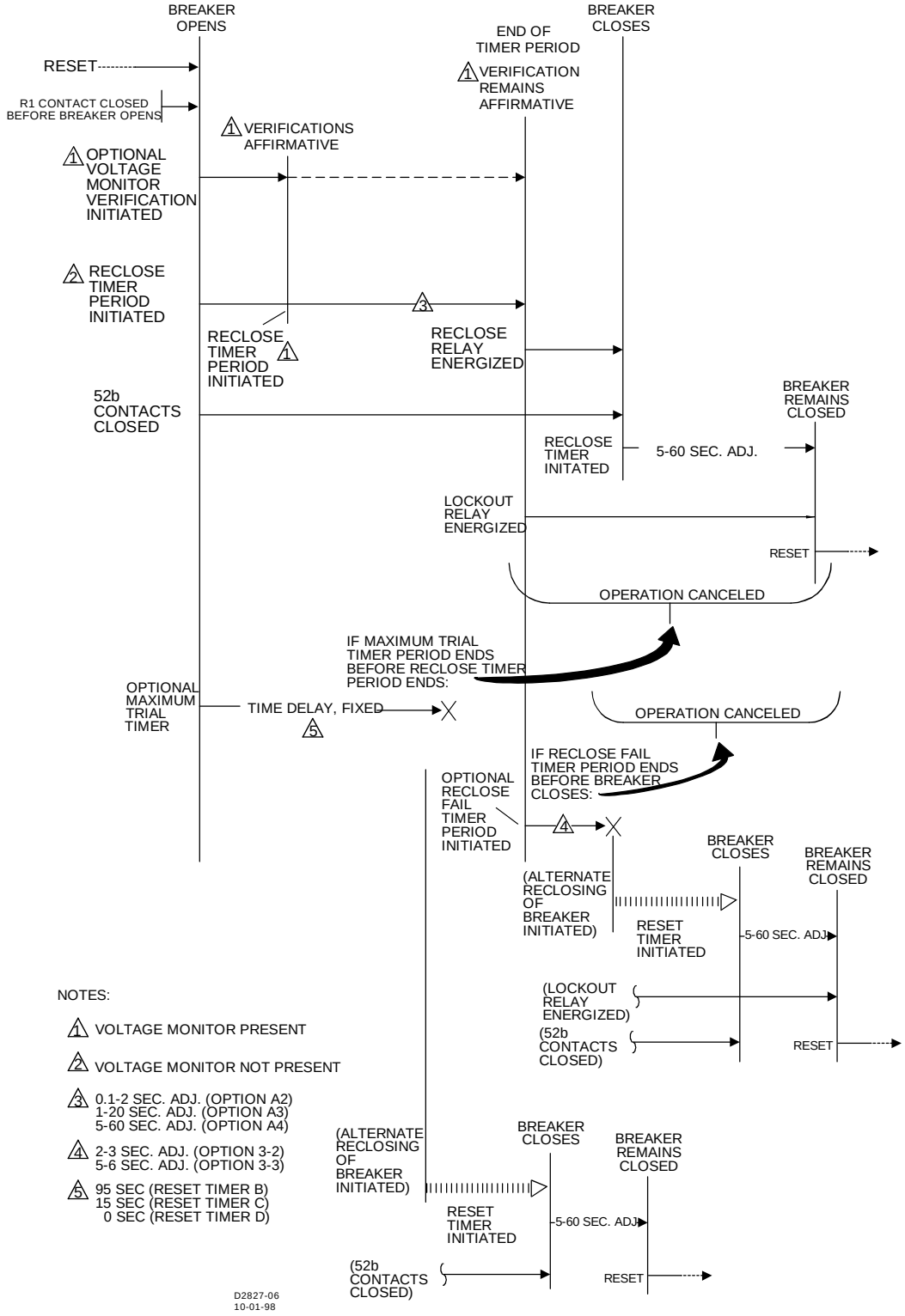


Figure 2-2. Timing Diagram - Reclose Timer Reclosing

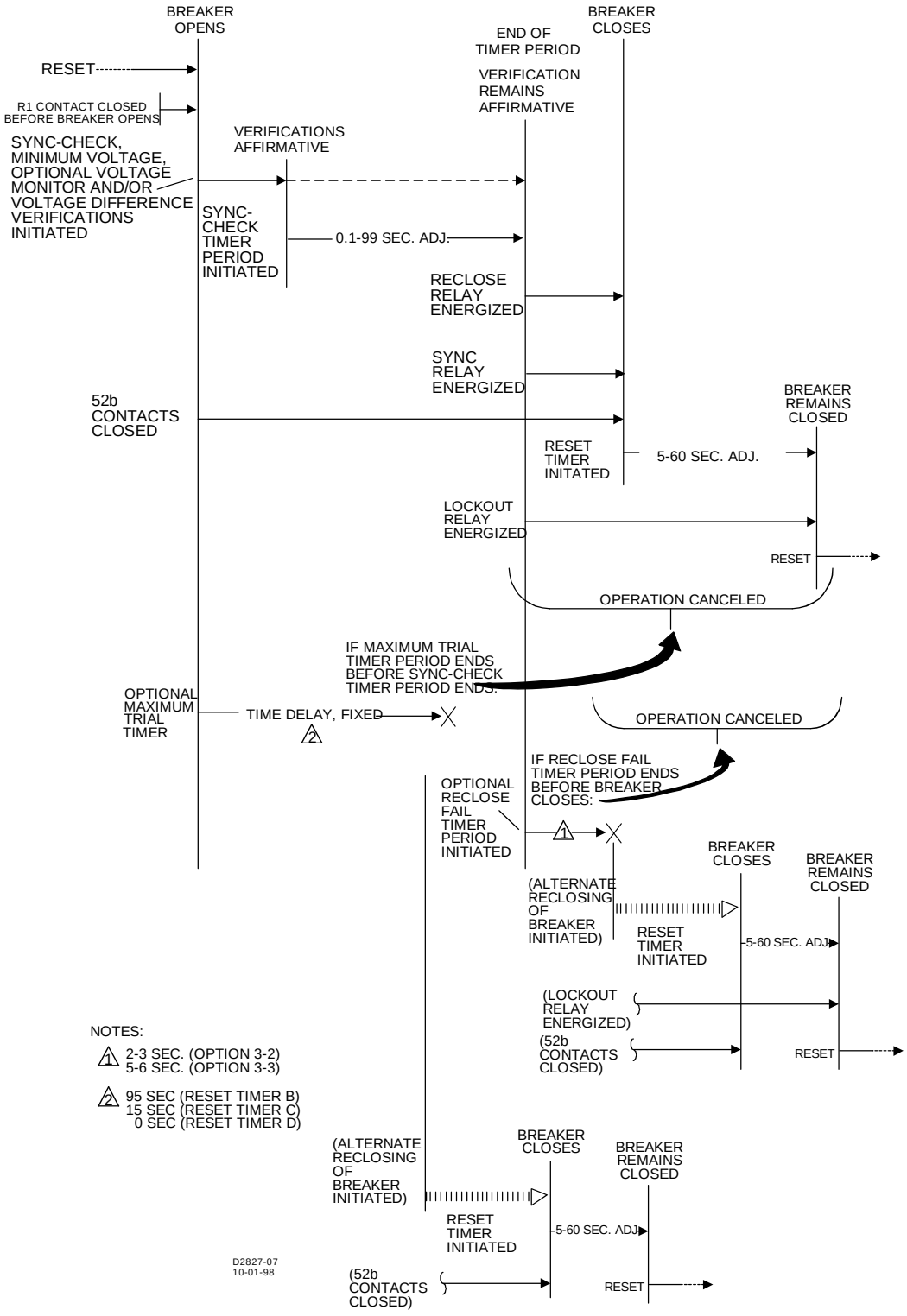


Figure 2-3. Timing Diagram - Sync-Check Reclosing

BASIC RECLOSING RELAY

The following is a functional description of the basic Sync-Check/Single Shot Reclosing Relay. Figure 2-4 is a detailed block diagram of the basic Sync-Check/Single Shot Reclosing Relay with options enclosed by dashed lines.

Power Supply

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

Table 2-1. Wide Range Power Supply Voltage Ranges

Power Supply	Style Chart Identifiers	Nominal Voltage	Voltage Range
Low Range	D	24 Vdc	12† to 32 Vdc
Mid Range	B, C	48, 125 Vdc, 120 Vac	24 to 150 Vdc, 90 to 132 Vac
High Range	X	125, 250 Vdc, 120, 240 Vac	62 to 280 Vdc, 90 to 270 Vac

† 14 Vdc is required to start the power supply.

Relay operating power is developed by the wide range, isolated, low burden, flyback switching, solid state power supply. Nominal ±12 Vdc is delivered to the relay internal circuitry. Input (source voltage) for the power supply is not polarity sensitive. A red LED turns ON to indicate that the power supply is functioning properly.

Reclose Initiate Contact Sensing (RI)

Reclose initiate contact sensing is provided in one of two basic configurations, and must be the same for all of the sensing contacts within a specific relay; one configuration is used when isolated input contact sensing Option 1-5 is specified, and the other is used when non-isolated input contact sensing Option 1-4 is specified (See Figure 4-15). These configurations must be modified to accommodate an essential external sensing input module for relays containing the Type X (250 Vdc, 240 Vac) power supply. When isolated sensing is provided, the relay supplies current to an isolated Form A contact in the protective system. When non-isolated sensing is specified, the relay receives a voltage through a contact from the protective system. If the RECLOSE INITIATE (RI) signal has been present prior to the closing of the 52b contact, an INITIATE signal is generated that enables operation of the reclose enable logic. Once this has occurred, the RI signal may be removed.

When the RI feature is not required, the relay input terminal 12 (input module terminal RI with Type X power supply) may be connected to the system battery positive lead for Option 1-4, or a jumper installed between relay terminals 12 and 15 (relay terminal 12 and input module terminal RI with Type X power supply) for Option 1-5, to provide a permanent enable.

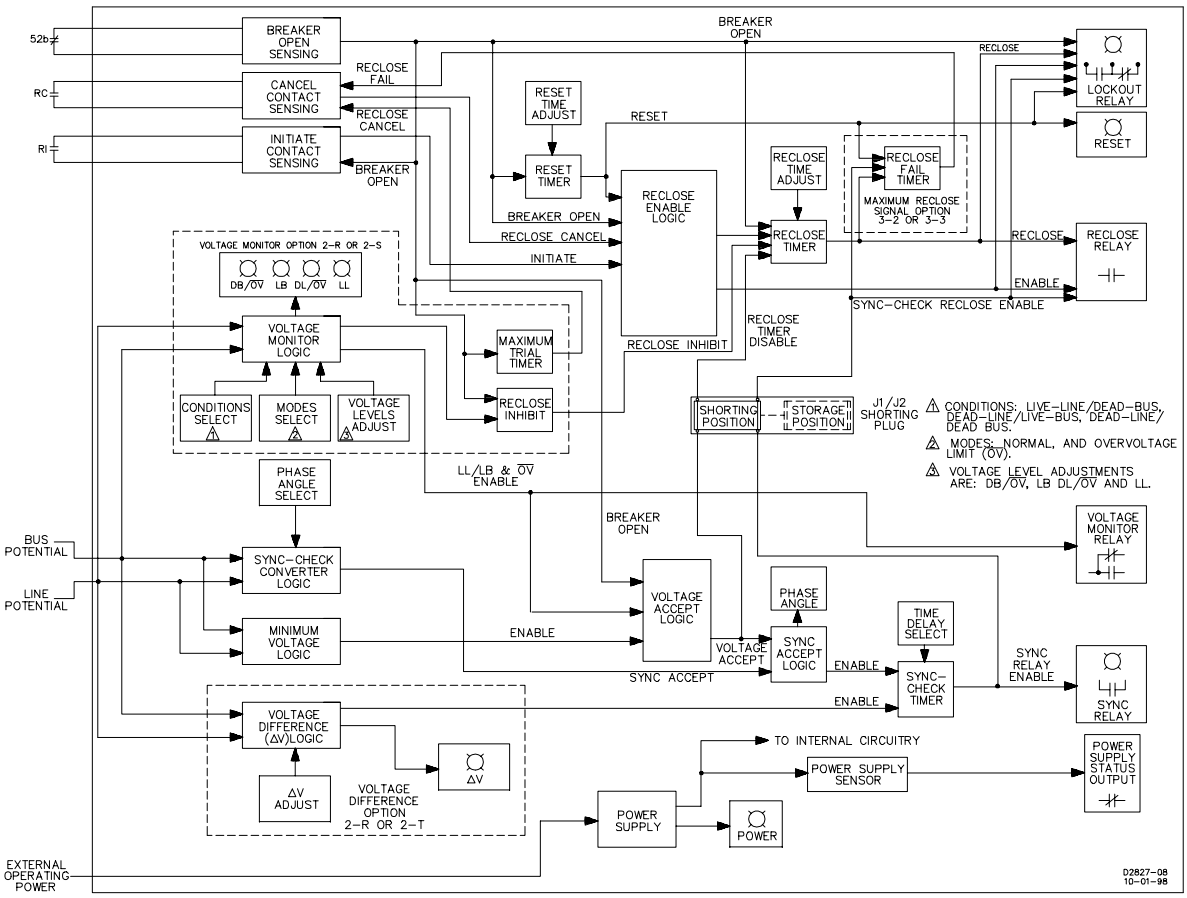


Figure 2-4. Relay Detailed Functional Block Diagram

Breaker Open Sensing (52b)

The breaker open sensing is provided in one of two basic configurations. When isolated sensing is provided, the relay supplies current to an isolated Form B contact in the protective system. When non-isolated sensing is specified, the relay receives a voltage through a contact from the protective system. The breaker open sensing circuit detects the breaker position. If the breaker opens (52b closes), and if the RI signal has been present prior to the closing of 52b, a BREAKER OPEN signal is generated as an input to the reclosing enable logic, to the sync accept logic and to the maximum trial timer if the voltage monitor (Options 2-A, 2-B, 2-R and 2-S) is installed.

When the breaker closes, the BREAKER OPEN signal is terminated. This occurs regardless of the state of the other inputs to the relay. Termination of the BREAKER OPEN signal disables the reclose enable logic and sync-check logic, stops the reclose timer, stops the maximum trial timer (if installed) initiates the reset timer, and de-energizes the reclose relay and sync relay.

Reclose Cancel Contact Sensing (RC)

The reclose cancel contact sensing is provided in the same two configurations as the reclose initiate contact sensing. When the RC contact sensing circuit detects a signal from the protective system, it generates a RECLOSE CANCEL (RC) signal which inhibits the operation of the reclose enable logic .

Minimum Voltage Sensing

The minimum voltage logic establishes a nominal minimum voltage limit of 80 Vac for the line and bus, creating "live" voltage zones above this level. This ensures that the line and bus voltages are of sufficient

amplitude to allow accurate phase angle measurement. If the voltages are within the "live" zones, an ENABLE signal is provided to the sync-check (voltage accept) logic. Before performing the sync-check function this circuit generates a RECLOSE TIMER DISABLE signal that prevents the reclose timer from energizing the reclose relay.

If the line and/or bus voltages are not within the “live” zones, the sync-check logic is disabled and the reclose timer is permitted to operate. (Due to production tolerances, the actual minimum voltage may be significantly less than 80 Vac, but never more.)

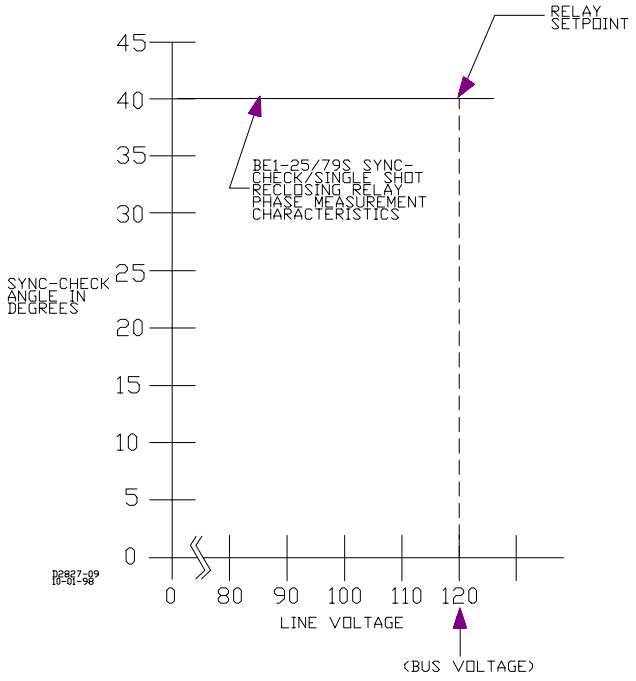


Figure 2-5. BE1-25/79S Sync-Check/Single Shot Reclosing Relay Phase Measurement Characteristics Curve

Sync-Check Line and Bus Phase Difference Sensing

The sync-check converter logic converts a single phase of the line and bus ac voltages to digital information and compares the phase difference of these two phases against a pre-selected phase difference limit selected on the front panel PHASE ANGLE selector. If the detected phase angle difference is within this limit a SYNC ACCEPT signal is provided to the sync-check (sync accept) logic.

The PHASE ANGLE selector permits selection of the allowable limit of phase difference between the line and bus voltages in 1° increments over a range of 1° to 99°.

The digitized direct phase comparison circuitry in the sync-check converter provides a flat phase comparison curve as input voltages vary, so that an input voltage fluctuation will not affect phase measurements. Figure 2-5 shows the characteristic curve of the BE1-25/79S Sync-Check/Single Shot Reclosing Relay for a phase angle setting of 40°, when the bus voltage is at 120 Vac and the line voltage fluctuates over a range of 120 Vac to the fixed minimum voltage level of 80 Vac.

Reclose Enable Logic

The reclose enable logic generates an ENABLE signal for the reclose relay, allowing either the reclose timer or sync-check logic to then energize the relay (as determined by the minimum voltage logic). The ENABLE signal is present when the INITIATE and BREAKER OPEN signals have arrived in the proper sequence and are present, the RECLOSE CANCEL signal is not present, and the RECLOSE INHIBIT signal from the

(Options 2-R and 2-S) voltage monitor logic is not present.

The reclose enable logic also starts and stops the reclose timer in response to the enable and inhibit signals.

Reclose Timer

The reclose timer is started by the reclose enable logic and measures an interval controlled by the front panel RECLOSE TIME control. At the completion of the programmed interval, if RECLOSE CANCEL is not generated by the RC contact sensing circuit and BREAKER OPEN is still present, the reclose timer generates RECLOSE to energize the reclose relay (closing the breaker) and the lockout relay. RECLOSE is terminated when the BREAKER OPEN ends due to the breaker closing or when the RECLOSE CANCEL signal is generated.

The reclose timer is prevented from operating by a RECLOSE TIMER DISABLE signal from the sync-check (voltage accept) logic when the sync-check logic is operating.

If the monitored voltages become incorrect, the reclose timer will reset and begin the timed interval over when the voltages are correct. This must occur within the time limit established by the Maximum Trial timer. The time limit depends upon the style letter of the reset timer: B = 95 $\pm$10.0 seconds; C = 15 $\pm$2.0 seconds; D has no time limit.

Voltage Accept Logic (Sync-Check)

The voltage accept logic provides a VOLTAGE ACCEPT signal for the sync accept logic when the BREAKER OPEN signal from the breaker open sensing circuit is present, the ENABLE signal from the minimum voltage logic is present, and the ENABLE (LL/LB CONDITION) signal from the (Options 2-A, 2-B, 2-R and 2-S) voltage monitor logic is present. The VOLTAGE ACCEPT signal is also applied to the reclose timer as the RECLOSE TIMER DISABLE signal, preventing the reclose timer from energizing the reclose relay.

Sync Accept Logic

Operation of the sync accept logic is initiated by the combined presence of the SYNC ACCEPT signal from the sync-check converter, and the VOLTAGE ACCEPT signal from the voltage accept logic. When these signals are present, the PHASE ANGLE indicator lights and the sync-check timer is started. Removal of any signals from the voltage accept logic and sync accept logic extinguishes the PHASE ANGLE indicator.

Sync-Check Timer

CAUTION

Selection of 0 seconds time delay is not recommended since this causes spontaneous energizing of the sync relay and generation of a false SYNC-CHECK RECLOSE ENABLE signal.

Sync-check timer action starts when all required signals are present at the input to the voltage accept and sync accept logic, causing the logic to pass an enabling signal to the timer, and when an ENABLE signal is present from the (Options 2-A, 2-R, and 2-T) voltage difference logic.

Time delay is pre-selected by the TIME DELAY selector and X0.1/X1.0 multiplier over the range of 0.1 to 99 seconds.

If all appropriate measured inputs to the sync-check logic have remained within the selected and fixed limits by the end of the selected time delay period, the timer generates a SYNC-CHECK RECLOSE ENABLE signal. The signal energizes the sync relay and lights the SYNC indicator, and if the RI signal was present at the correct time and the RC signal is not present, energizes the reclose relay and lockout relay and lights the LOCKOUT indicator.

If during the delay period one of the inputs to the sensing circuits exceeds the limit, the timer is reset and starts the delay cycle over when all sensing inputs are again within the correct limits.

Closure of the circuit breaker (52b contact open) removes the BREAKER OPEN signal from the voltage accept logic, removing the enabling signal from the timer and de-energizing the reclose relay and sync relay, extinguishing the SYNC indicator, and initiating the reset timer time period.

Reset Timer

The reset timer provides an automatic reset for the relay when the breaker has remained closed for the duration of the preselected reset time interval. The reset timer initiates a time interval of between 5 and 60 seconds as determined by the setting of the RESET TIME control on the front panel.

When the controlled breaker closes (either due to automatic reclosure by the relay or by other means before the relay initiates reclosure), removing the BREAKER OPEN signal, the reset timer is initiated. If the breaker is still closed at the end of the selected period, the timer generates the RESET signal, which lights the RESET indicator, de-energizes the SPDT lockout relay and extinguishes the LOCKOUT indicator. The RESET signal also resets the reclose enable logic (if previously initiated) so that it is ready to respond to a subsequent protective trip of the breaker. This sequence of events occurring after breaker closure also forms a "supervisory" function in that the relay also registers closing attempts made by external means, in addition to relay initiated reclosing.

The reset condition, with RESET indicator lit, is the normal state for the relay as it waits for a protective trip of the breaker.

If a breaker trip occurs before the reset interval has expired, the RESET signal is not generated, the internal lockout relay is energized (if not previously energized by close command), the LOCKOUT indicator is lit and the relay will not attempt to close the breaker or to reset itself. Resetting of the relay requires closing the controlled breaker by other means and its remaining closed for the duration of the reset interval.

RELAY OPTIONS

The following paragraphs describe the options available for the Sync-Check/Single Shot Reclosing Relay.

Reclose Fail Timer (Options 3-2 and 3-3)

When the reclose relay is energized, the reclose fail timer begins to time the maximum allowable reclose interval for which the reclose relay will be energized. This interval is 2 to 3 seconds (Option 3-2) or 5 to 6 seconds (Option 3-3).

When a 2 to 3 or 5 to 6 second reclosing signal option is provided, a RECLOSE FAIL signal is generated by the reclose fail timer if the reclose command from the relay has not caused the controlled breaker to close in the pre-set time. The RECLOSE FAIL signal is internally applied to the cancel contact sensing circuit and has an effect similar to receiving RC from the protective system. RECLOSE CANCEL generated in response to RECLOSE FAIL inhibits the reclose enable logic and causes the reclose relay to de-energize.

For relays with Option 3-0, the reclose fail timer is not present and the relay will output a continuous RECLOSE signal until the breaker is closed.

Voltage Difference (ΔV) Sensing (Options 2-A, 2-R, and 2-T)

When the voltage difference option is included, the BE1-25/79S Sync-Check/Single Shot Reclosing Relay will be supplied in an M1 case.

The voltage difference logic converts a single phase of line and bus ac voltages to a vector difference voltage, and compares the voltage against a preselected voltage difference limit selected on the front panel ΔV control. If the detected difference is less than the limit, an ENABLE signal is passed to the sync-check timer and the front panel ΔV indicator is lit.

The ΔV control permits continuous adjustment of the allowable limit of voltage difference between the line and bus voltages over a range of 1-135 Vac.

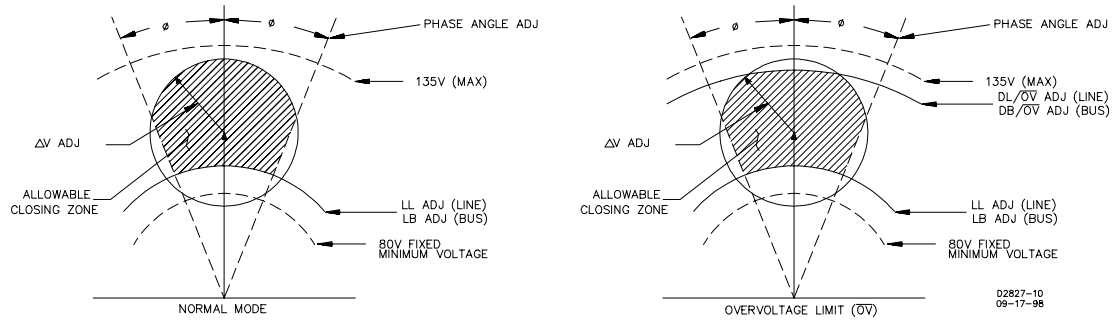


Figure 2-6. Sync-Check and Voltage Monitor with Vector Voltage

Difference Allowable Closing Zones

Figure 2-6 is a graph depicting the vector voltage difference of the line and bus voltages superimposed over the phase angle limit and optional voltage monitor line and bus live/dead voltage limits. The resulting allowable closing zone is shown on the graph for both modes.

Voltage Monitor Sensing (Options 2-A, 2-B, 2-R, and 2-S)

When the voltage monitor option is included, the BE1-25/79S Sync-Check/Single Shot Reclosing Relay will be supplied in an M1 case.

The voltage monitor provides additional selectable voltage conditions that must be met before breaker closure is permitted. This option provides selector switches and adjustment controls that allow tailoring the operation of the relay to a wide range of line and bus voltage conditions. Options 2-A and 2-B also supply separate output contacts for the voltage monitor.

The voltage monitor option expands the minimum voltage function by providing individual front panel controls that allow the reference level to be precisely selectable between the minimum voltage level of 80 Vac and 135 Vac. These controls are the LB control for the live-bus, and the LL control for the live-line. If the detected voltages are within the "live" zones - above the pre-selected voltage levels the sync-check logic is enabled, the voltage monitor relay (if present) is energized, and the reclose timer is disabled. But if either or both voltages are below the levels, the reclose timer is enabled and the sync-check logic is disabled. (See Figure 2-2 for timing sequences involving the voltage monitor during reclose timer operation. See Figure 2-3 for timing sequences occurring during a sync-check reclosing.)

Operation of the reclose timer is also modified by the voltage monitor with the addition of three circuit board-mounted switches consisting of CONDITION switches no. 3, 4 and 5. These switches allow selection of any combination of three permissible line and bus voltage conditions that must be met before the reclose timer is permitted to operate: dead-line/live-bus, live-line/dead-bus, and dead-line/dead-bus (see Figure 2-7).

Two additional front panel controls consisting of the DB/$\overline{\text{OV}}$ control for the dead-bus and the DL/$\overline{\text{OV}}$ control for the dead-line, together with the LB and LL controls, provide independent determination of the live and dead voltage levels for the line and bus conditions over the range of 10 to 135 Vac during the "normal" mode (the $\overline{\text{OV}}$ function in the switch nomenclature does not pertain at this time and, together with "normal" and "$\overline{\text{OV}}$" modes, is explained later). This scheme establishes “dead" voltage zones, in addition to the "live" zones, for which breaker reclosing can occur, and provides a precise means of pre-selecting line and bus voltage levels so that the "live" zone is above the monitored live level and the "dead" zone is below the monitored dead level established by the controls.

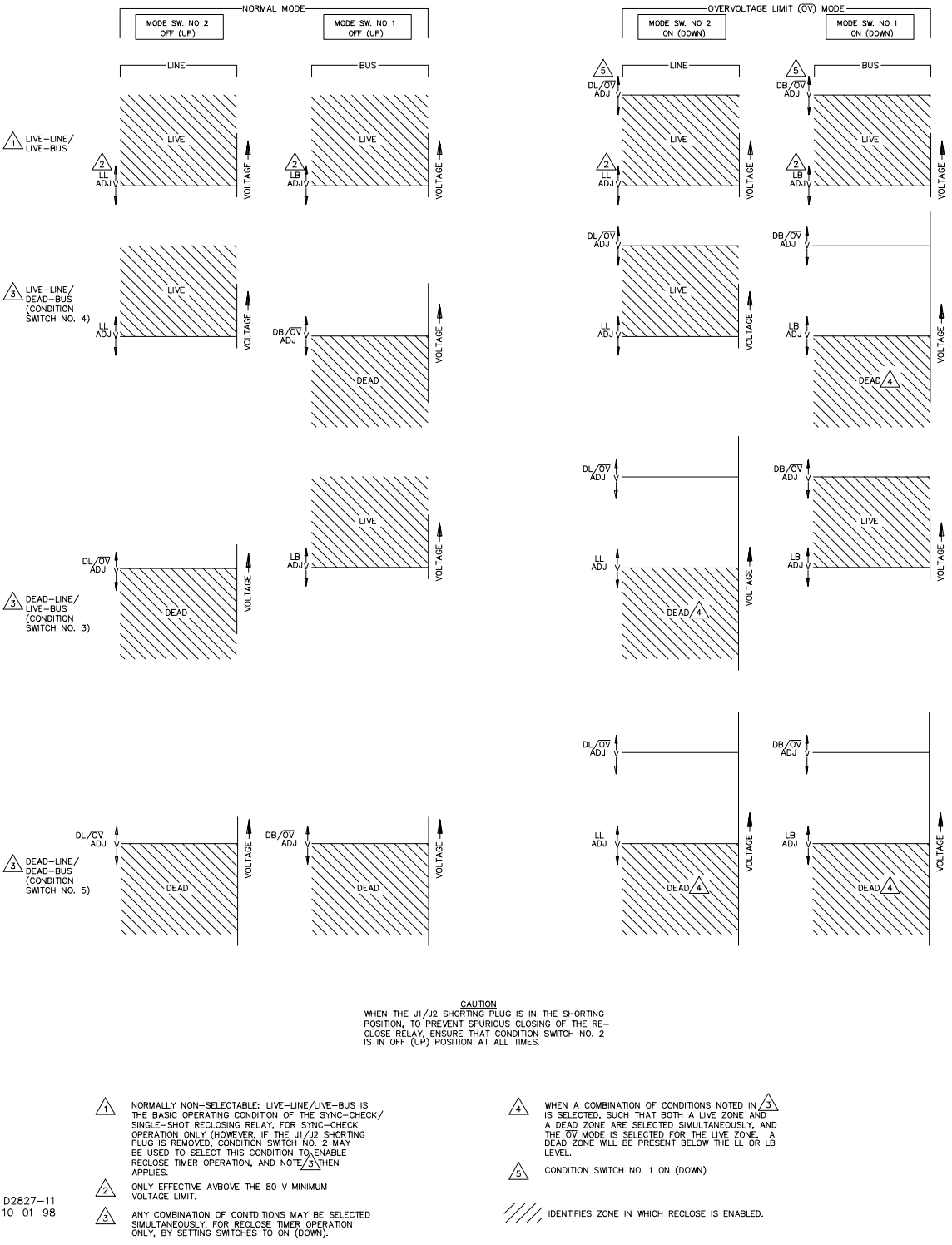


Figure 2-7. Voltage Monitor Conditions, Modes, and Voltage Levels Diagram

(Options 2-A, 2-B, 2-R, and 2-S Only)

As an example, the relay may be programmed for the DEAD-LINE/LIVE-BUS condition, in addition to the basic LIVE-LINE/LIVE-BUS condition, with the individual controls set for LIVE-LINE, above 100 volts; DEAD-LINE, below 40 volts; and LIVE-BUS, above 35 volts (Figure 2-8).

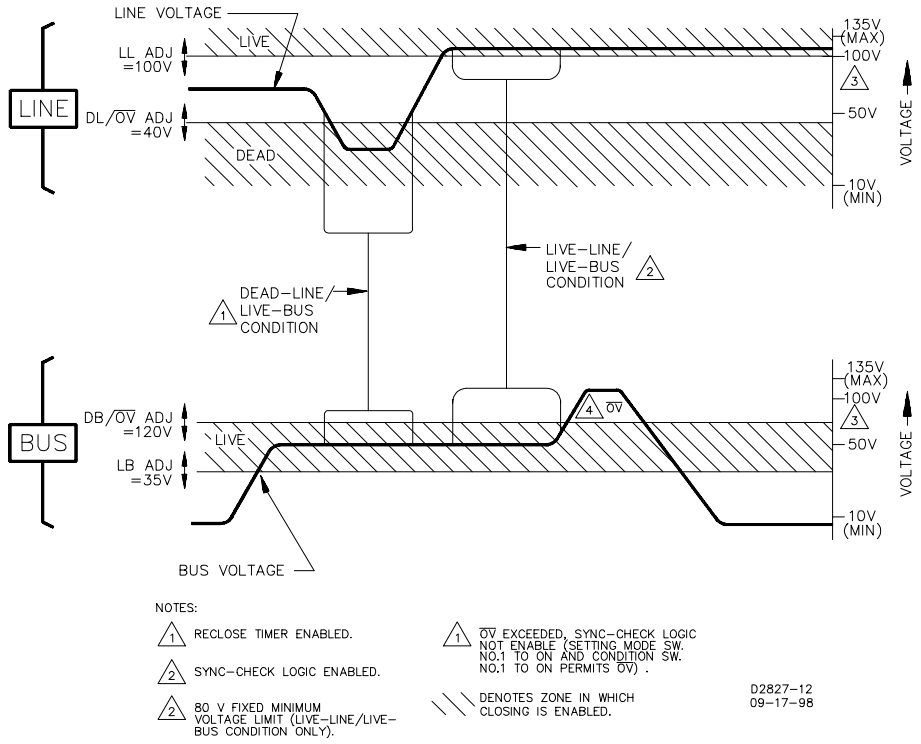


Figure 2-8. Example of Optional Voltage Monitor Live-Line/Live-Bus Closing, and Dead-Line/Live-Bus Closing with Live-Bus Overvoltage Limit ($\overline{OV}$)

In this case sync-check logic operation would be permitted only when the line and bus voltages satisfy the front panel settings for the LIVE-LINE/LIVE-BUS condition. If this condition is not satisfied, the sync-check logic is inhibited, and if the voltages do satisfy the settings for the DEAD-LINE/LIVE-BUS condition, the reclose timer is permitted to operate. If none of the selected conditions are met the voltage monitor prevents reclosing from occurring.

NOTE

For proper operation of the voltage monitor logic, the "live" controls, when not used, must be adjusted above the "dead" control levels, **but** below 80 Vac. Unused "dead" controls must be adjusted fully CCW, then backed off one turn.

Note in Figure 2-8 that the LB control setting of 35 volts for the live-bus is only effective for the DEAD-LINE/LIVE-BUS condition (reclose timer operation); for the basic LIVE-LINE/LIVE-BUS condition (sync-check operation), the 80 volt minimum voltage limit prevails over the LB control setting.

Circuit board-mounted MODE switches allow selection of either a "normal" mode or an overvoltage limit ($\overline{OV}$) mode ("normal" mode denotes non-operation of the $\overline{OV}$ mode). MODE switch no. 1 for the dead-line/live-bus condition, and MODE switch no. 2 for the live-line/dead-bus condition, allow independent selection of an adjustable overvoltage limit ($\overline{OV}$) level that defines a live voltage band for permissible reclosing (see Figure 2-7). In this mode, live-line or live-bus closing will be permitted if the appropriate monitored voltage(s) is

within the permissible band.

As shown in Figure 2-8, reclosing will not be permitted if the monitored bus voltage is above the selected $\overline{OV}$ setting of 120 volts or below the live setting of 35 volts. Adjustments of the $\overline{OV}$ limits for the live-line and live-bus are provided by the dual-function front panel controls, DL/$\overline{OV}$ and DB/$\overline{OV}$.

When the situation occurs in which both a live zone and a dead zone are selected for the line or bus, with $\overline{OV}$ also selected for the live zone, positioning the DL/$\overline{OV}$ or DB/$\overline{OV}$ control above the LL or LB control setting causes the dead zone to occupy the area below the LL or LB level instead of immediately below the DL/$\overline{OV}$ or DB/$\overline{OV}$ level (see the $\overline{OV}$ MODE column of Figure 2-7, using the combined live-line/dead-bus and dead-line/live-bus conditions as examples.

If $\overline{OV}$ is selected for live-line/dead-bus (mode switch no. 2) or dead-line/live-bus (mode switch no. 1) conditions, $\overline{OV}$ during the sync-check live-line/live-bus condition can be prevented from occurring by setting CONDITION switch no. 1 to the off (up) position. Setting the switch to the on (down) position will allow $\overline{OV}$ during the live-line/live-bus condition, if $\overline{OV}$ was previously selected for live-line/dead-bus or dead-line/live-bus conditions.

Figure 2-9 provides further examples of the selection of line and bus live/dead zones using the selection diagram of Figure 2-7.

In some units (those with Reset Timer B or C) there is a Maximum Trial Timer on the voltage monitor board that limits the opportunity for reclosing to either 95 or 15 seconds (for B and C respectively) after an open breaker is sensed at the 52b input. If the required line and/or bus voltages have not been detected during the specified time, the relay is inhibited from issuing a reclosing signal. The inhibit remains in effect until the breaker is closed by other means, thereby circumventing the precarious situation that could arise from a relay poised to issue a reclose signal long after the instigating event has passed.

Power Supply Status Output (Options 2-C thru 2-F)

The power supply status output relay is energized and its NC output contact is opened when power is applied to the relay. Normal internal relay operating voltage maintains the power supply status output relay continuously energized with its output contact open. If the power supply output voltage falls below the requirements of proper operation, the power supply output relay is deenergized, closing the NC output contact.

SPECIAL FIELD MODIFICATION OF BASIC RELAY - J1/J2 SHORTING PLUG

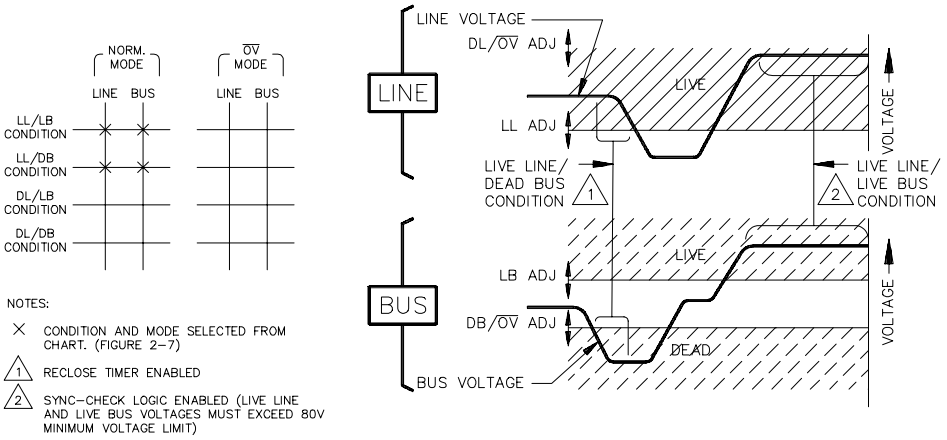
Removal of the J1/J2 shorting plug from the SHORTING position separates the sync-check logic from the remainder of the relay logic, allowing only the reclose timer to reclose the breaker. The sync-check logic still functions to energize only the sync relay when normal input conditions are satisfied.

As shown in Figure 2-4, with the J1/J2 shorting plug removed, the RECLOSE TIMER DISABLE signal from the sync-check logic cannot prevent the reclose timer from energizing the reclose relay, and the SYNC-CHECK RECLOSE ENABLE signal is removed from the reclose relay.

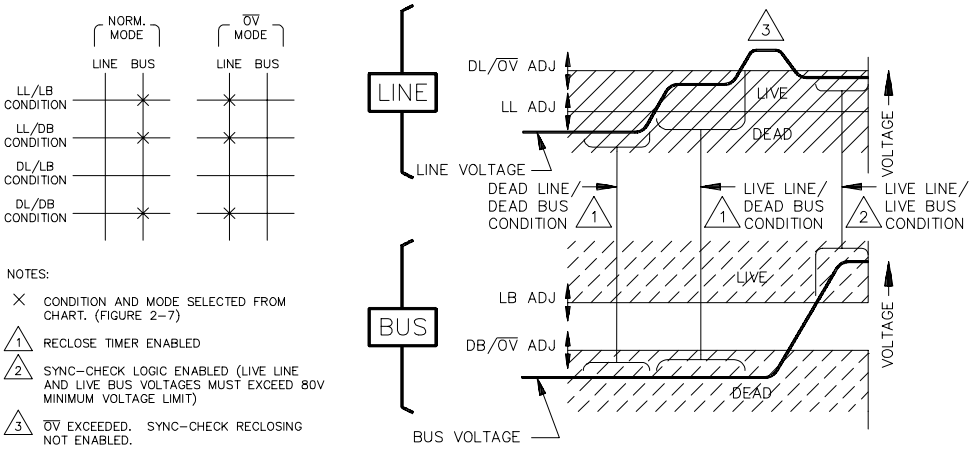
The minimum voltage logic, therefore, no longer prevents the reclose timer from closing the circuit breaker when the line and bus voltages are both above the 80 Vac minimum. This allows the reclose timer to operate under all line and bus voltage conditions (if the voltage monitor option is not installed).

If the voltage monitor option is installed, the additional selectable live-line/live-bus condition, using CONDITION switch no. 2 on the voltage monitor circuit board, is now available for the reclose timer.

When the J1/J2 shorting plug is removed, the plug is placed in a STORAGE position adjacent to the SHORTING position (see Figures 3-4 and 3-5).



LIVE LINE/LIVE BUS CONDITION, WITH SELECTED LIVE LINE/DEAD BUS CONDITION



LIVE LINE/LIVE BUS CONDITION, WITH SELECTED LIVE LINE/DEAD BUS AND DEAD LINE/DEAD BUS CONDITIONS AND OV FOR THE LIVE LINE.

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Figure 2-9. Examples of Optional Voltage Monitor Live and Dead Zones Selection

SECTION 3 • HUMAN-MACHINE INTERFACE

CONTROLS AND INDICATORS

The following table describes the controls and indicators of the BE1-25/79S Sync-Check/Single Shot Reclosing Relay. Figures 3-1 and 3-2 refer to the locator in the table.

Table 3-1. Location of Controls and Indicators

Locator	Control or Indicator	Function
A	POWER Indicator (LED)	This red light emitting diode lights when the relay power supply is supplying a nominal ±12 Vdc to the relay internal circuitry.
B	RESET TIME Control	This control provides continuous adjustment of the reset time interval over a range of 5 to 60 seconds.
C	RESET Indicator	This red LED is lit when the controlled circuit breaker has remained closed for the duration of the preprogrammed reset time. The indicator goes out when the breaker opens (52b closes). The indicator is normally lit.
D	PHASE ANGLE Selector	This sync-check logic dual thumbwheel selector provides selection, in 1° increments over a range of 1° to 99°, of the phase difference limit between the line and bus voltages. Refer to Figure 1-2 for slip frequency chart that provides appropriate PHASE ANGLE and TIME DELAY selectors settings for various slip frequencies.
E	PHASE ANGLE Indicator	This red LED lights when the following conditions are met: phase angle difference between the line and bus voltages is less than the PHASE ANGLE selector setting; line and bus sensing voltages are greater than the 80 Vac fixed minimum; the breaker sensing input (52b) is closed, signifying the breaker is open, and (Options 2-R and 2-S only) a live-line and live-bus condition is present as defined by the voltage monitor logic.
F	SYNC Indicator	This red LED lights when the sync-check timer energizes the sync output relay and goes out when the breaker sensing input (52b) opens, signifying breaker closure.

Locator	Control or Indicator	Function
G	TIME DELAY Selector	This sync-check logic dual thumbwheel selector allows selection of the time delay between the sensing of desired line and bus phase and voltage conditions and closing of the sync relay, reclose relay and lockout relay contacts. Time delay is selectable in 0.1 second increments over a range of 0.1 to 9.9 seconds (X0.1 selected on X0.1/X1.0 multiplier) and 1 second increments over a range of 01 to 99 seconds (X1.0 selected on X0.1/X1.0 multiplier). Refer to Figure 1-2 for slip frequency chart that provides appropriate PHASE ANGLE and TIME DELAY selectors settings for various slip frequencies. **CAUTION** SELECTION OF 0 SECONDS TIME DELAY IS NOT RECOMMENDED SINCE THIS CAUSES SPONTANEOUS ENERGIZING OF THE SYNC RELAY AND GENERATION OF A FALSE SYNC-CHECK RECLOSE ENABLE SIGNAL.
H	X0.1/X/1.0 Multiplier	This multiplier allows selection of a 0.1 to 9.9 seconds range (X0.1) or a 01 to 99 seconds range (X1.0) on the TIME DELAY selector.
I	RECLOSE TIME Control	This reclose timer control provides continuous adjustment of the time delay between the opening of the breaker sensing input (52b) and closing of the reclose relay and lockout relay, over three optional ranges: 0.1 to 2 seconds, (Option A2), 1 to 20 seconds (Option A3), or 5 to 60 seconds (Option A4).
J	LOCKOUT Indicator	This red LED lights when the relay generates a reclose command or if the breaker reopens before the reset timer has expired. The indicator goes out when the breaker is closed and the reset time interval expires.

The remaining controls and indicators are only present when the Voltage Monitor and/or the Voltage Difference options are present. Refer to Figure 3-2 for reference to callouts.

Table 3-2. Location of Controls and Indicators

Locator	Indicator or Control	Function
1	LL Indicator	This red LED lights when the line voltage is greater than the live-line setting.

Locator	Indicator or Control	Function
2	DL/$\overline{OV}$ Indicator	This red LED lights when the line voltage is less than the dead-line (DL) setting when operating in the normal mode, or less than the overvoltage limit ($\overline{OV}$) setting when operating in the overvoltage limit ($\overline{OV}$) mode.
3	ΔV Indicator	This red LED lights when the bus and line voltage difference is less than the limit selected on the ΔV control.
4	LB Indicator	This red LED lights when the bus voltage is greater than the live-bus setting.
5	DB/$\overline{OV}$ Indicator	This red light emitting diode is lit when the line voltage is less than the dead-line setting during the normal mode, or less than the overvoltage limit setting during the overvoltage limit mode.
6	DB/$\overline{OV}$ Control	This multi-turn control provides continuous adjustment over a range of 10 to 135 Vac, of the dead bus (DB) voltage monitoring level when operating in the normal mode, or the overvoltage limit ($\overline{OV}$) for the live-bus voltage monitoring level when operating in the overvoltage limit ($\overline{OV}$) mode. Adjustment is by a small screwdriver through the front panel. Minimum voltage is fully CCW. When unused, this control must be adjusted fully CCW, then backed off one turn.
7	LB Control	This multi-turn control provides continuous adjustment, over a range of 80 to 135 Vac during sync-check logic operation or over a range of 10 to 135 Vac during reclose timer operation, of the live-bus voltage monitoring level. Adjustment is by a small screwdriver through the front panel. Minimum voltage is fully CCW. This control must always be set higher than the DB control, whether or not the LB function is used. When not in use, be sure (additionally) that it is set lower than 80 Vac.
8	ΔV Control	This multi-turn control provides continuous adjustment, over a range of 1-135 Vac, of the allowable limit of voltage difference between the line and bus voltages. Adjustment is by small screwdriver through the front panel. Minimum voltage difference is fully CCW.
9	DL/$\overline{OV}$ Control	This multi-turn control provides continuous adjustment, over a range of 10 to 135 volts, of the dead-line (DL) voltage monitoring level when operating in the normal mode. When operating in the overvoltage limit ($\overline{OV}$) mode, provides the overvoltage limit ($\overline{OV}$) for the live-line voltage monitoring level. Adjustment is by a small screwdriver through the front panel. Minimum voltage is fully CCW. When unused, this control must be adjusted fully CCW, then backed off one turn.

Locator	Indicator or Control	Function
10	LL Control	This multi-turn control provides continuous adjustment over a range of 80 to 135 Vac during sync-check logic operation, or over a range of 10 to 135 Vac during reclose timer operation, of the live-line voltage monitoring level. Adjustment is by small screwdriver thru the front panel. Minimum voltage is fully CCW. This control must always be set higher than the DL control, whether or not the LL function is used. When not used, be sure (additionally) that it is set lower than 80 Vac.

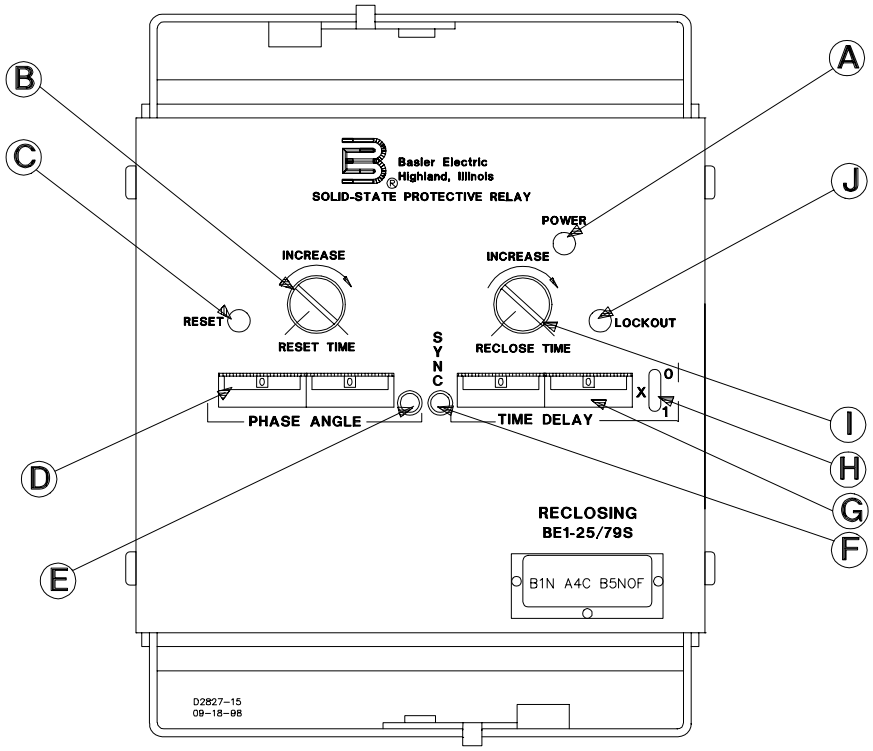

Figure 3-1. Location of Controls and Indicators for S1 Case

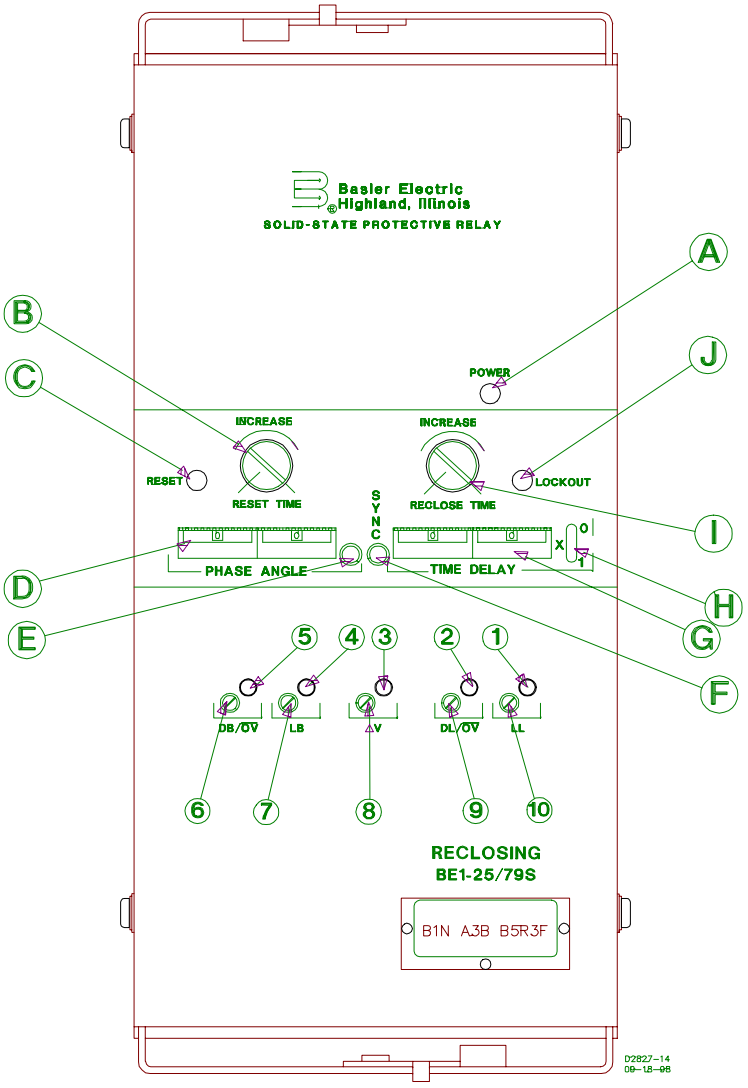

Figure 3-2. Location of Controls and Indicators for M1 Case

SWITCHES

CONDITION Switches

These switches are present only when the Voltage Monitor option is supplied. (Reference Figure 3-3.) Note that setting CONDITION Switches 3 through 5 to off (up) prevents operation of the reclose timer. This is also true of CONDITION Switch 2 if the J1/J2 plug is removed from the shorting position.

Table 3-3. Condition Switches

CONDITION Switch No. 1 (Affects sync-check operation only.)	Off (up) position: prevents the overvoltage limit ($\overline{OV}$) mode of operation during the live-line/ live-bus condition. On (down) position: allows the $\overline{OV}$ mode of operation to occur during the live-line/live-bus condition if the $\overline{OV}$ mode has been previously selected on MODE switch no. 1 or no. 2.
CONDITION Switch No. 2	Not used when the J1/J2 shorting plug is in the normal SHORTING position. **CAUTION** TO PREVENT SPURIOUS CLOSING OF THE RECLOSE RELAY WHEN THE J1/J2 SHORTING PLUG IS IN THE NORMAL SHORTING POSITION, ENSURE THAT CONDITION SWITCH NO. 2 IS IN THE OFF (UP) POSITION AT ALL TIMES. **NOTE** If the J1/J2 shorting plug is removed from the SHORTING position and placed in the STORAGE position to allow independent sync-check logic operation and reclose timer operation, this switch performs the following functions: Off (up) position: prevents reclose timer operation during the LIVE-LINE/LIVE-BUS condition. On (down) position: allows reclose timer operation during the LIVE-LINE/LIVE-BUS condition.
CONDITION Switch No. 3	Off (up) position: prevents reclose enable logic operation during the DEAD-LINE/LIVE-BUS condition. On (down) position: allows reclose enable logic operation during the DEAD-LINE/LIVE-BUS condition.
CONDITION Switch No. 4	Off (up) position: prevents reclose enable logic operation during the LIVE-LINE/DEAD-BUS condition. On (down) position: allows reclose enable logic operation during the LIVE-LINE/DEAD-BUS condition.

CONDITION Switch No. 5	Off (up) position: prevents reclose enable logic operation during the DEAD-LINE/DEAD-BUS condition. On (down) position: allows reclose enable logic operation during the DEAD-LINE/DEAD-BUS condition.

MODE Switches

Like the CONDITION switches above, these switches are present only when the Voltage Monitor option is supplied (Figure 3-3).

Table 3-4. Mode Switches

MODE Switch No. 1	Normal (up) position: prevents the overvoltage limit ($\overline{OV}$) mode of operation from occurring during all live-bus conditions. (See Figure 2-7.) Overvoltage Limit ($\overline{OV}$) (down) position:allows the $\overline{OV}$ mode of operation to occur during all live-bus conditions (to also allow $\overline{OV}$ during the live-bus condition for the sync-check logic, CONDITION switch no. 1 must also be set to on (down)). (See Figure 2-7.)
MODE Switch No. 2	Analogous to MODE switch no. 1 for all live-line conditions.

J1/J2 Shorting Plug

Shorting (Normal) Position: allows the sync-check logic to energize both the sync relay and the reclose relay, or the reclose timer to energize the reclose relay (depending on normal sensed line and bus voltage conditions). If the voltage monitor option (Options 2-A, 2-B, 2-R, and 2-S) is installed, CONDITION switch no. 2, live-line/live-bus selection, is not used.

Storage Position: allows independent and simultaneous sync-check logic energizing of the sync relay only, and reclose timer energizing of the reclose relay only. If the voltage monitor option is installed, CONDITION switch no. 2 may be used to select the live-line/live-bus condition for reclose timer operation. For location of shorting plug see Figure 3-4 (for S1 case), or Figure 3-5 (M1 case).

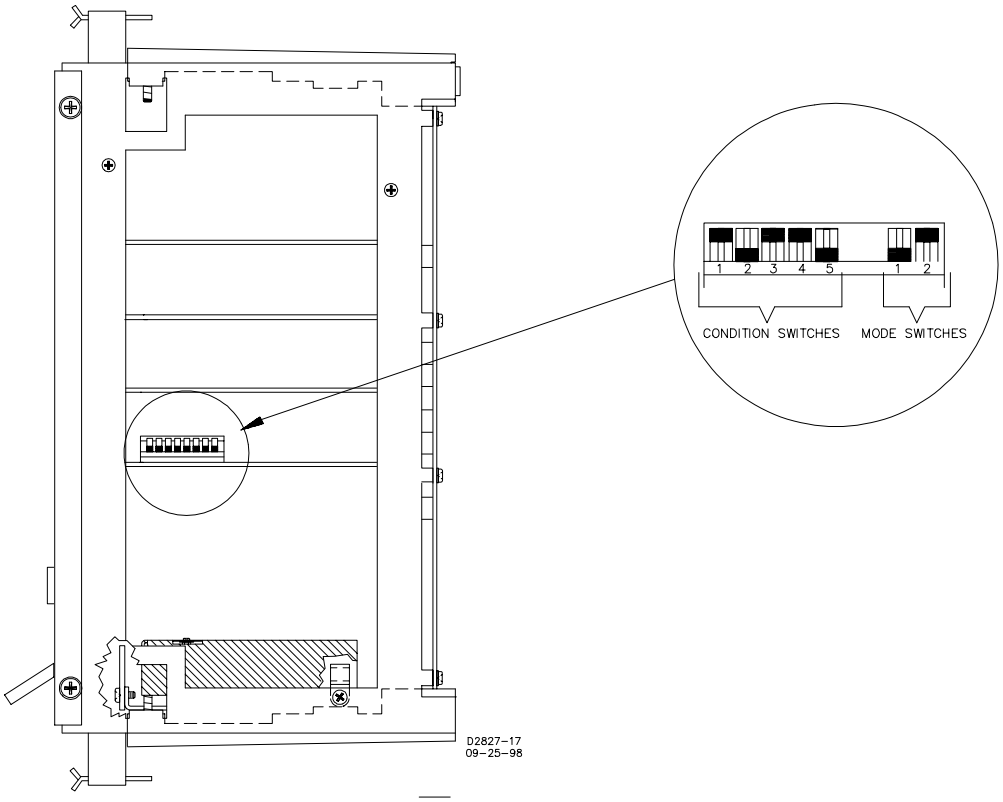

Figure 3-3. Optional Voltage Monitor Board CONDITION and MODE Switches Location (M1 Case Only)

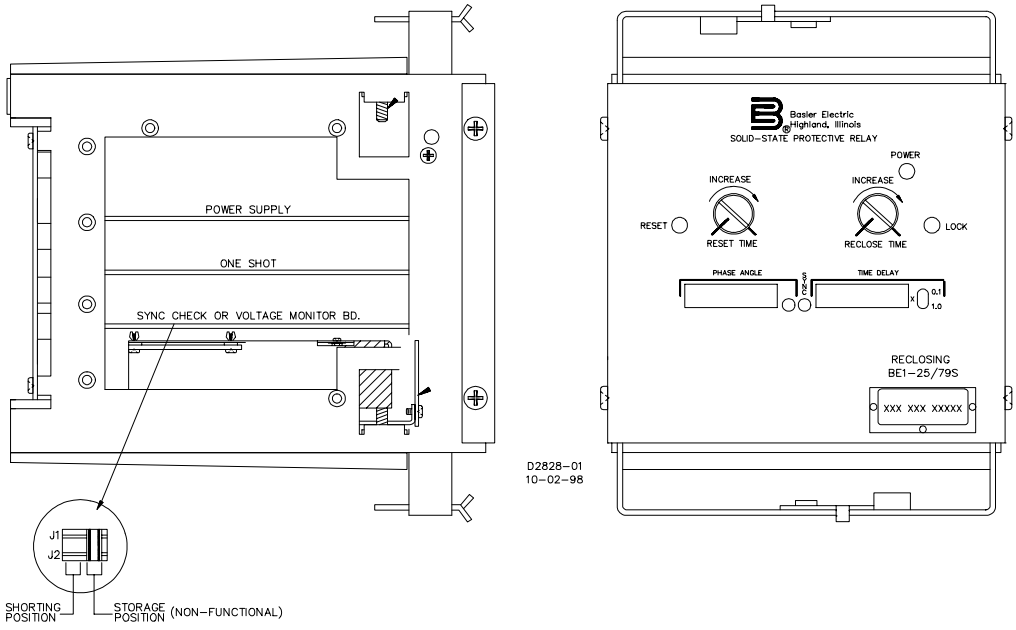

Figure 3-4. Sync-Check Board Shorting Plug Location, S1 Case

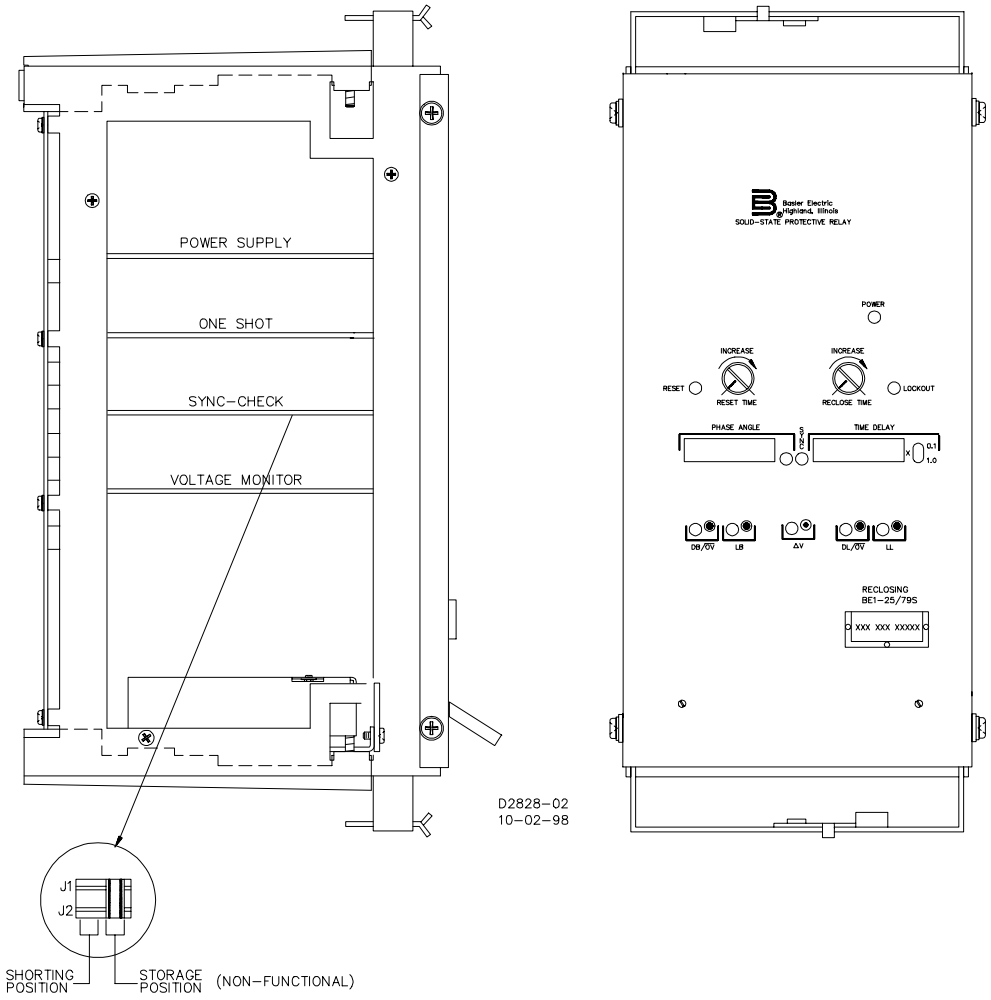

Figure 3-5. Sync-Check Board Shorting Plug Location, M1 Case

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SECTION 4 • INSTALLATION

UNPACKING

When not shipped as part of a control or switchgear panel, the relays are shipped in sturdy cartons to prevent damage during transit. Reasonable care should be exercised when unpacking the relay to prevent damage or disturbing of adjustments.

INSPECTING

Visually inspect the relay for damage that may have been incurred during shipment. If there is evidence of damage, immediately file a claim with the carrier and notify either the Regional Sales Office or Basler Electric Company's main office in Highland, Illinois.

Be sure also to check the relay model and style number against the requisition and packing list to see that they agree.

MOUNTING

The relay is intended to be vertically mounted in a location relatively free of moisture, dust, and excessive vibration. Relay outline dimension and panel drilling diagrams for S1 and M1 cases are shown in Figures 4-1 through 4-12.

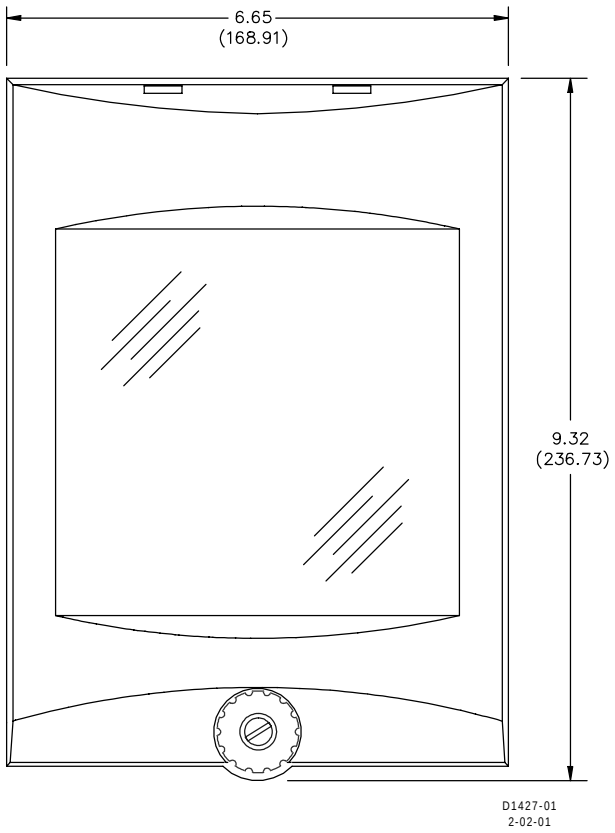

Figure 4-1 . S1 Case, Outline Dimensions, Front View

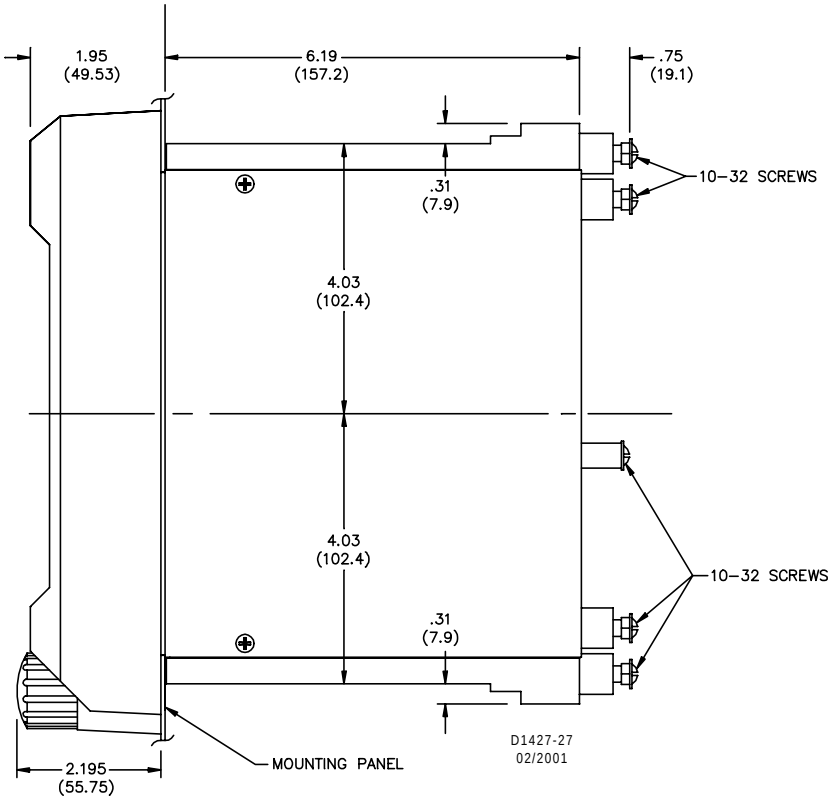

Figure 4-2 . S1 Case, Double-Ended, Semi-Flush Mounting, Outline Dimensions, Side View

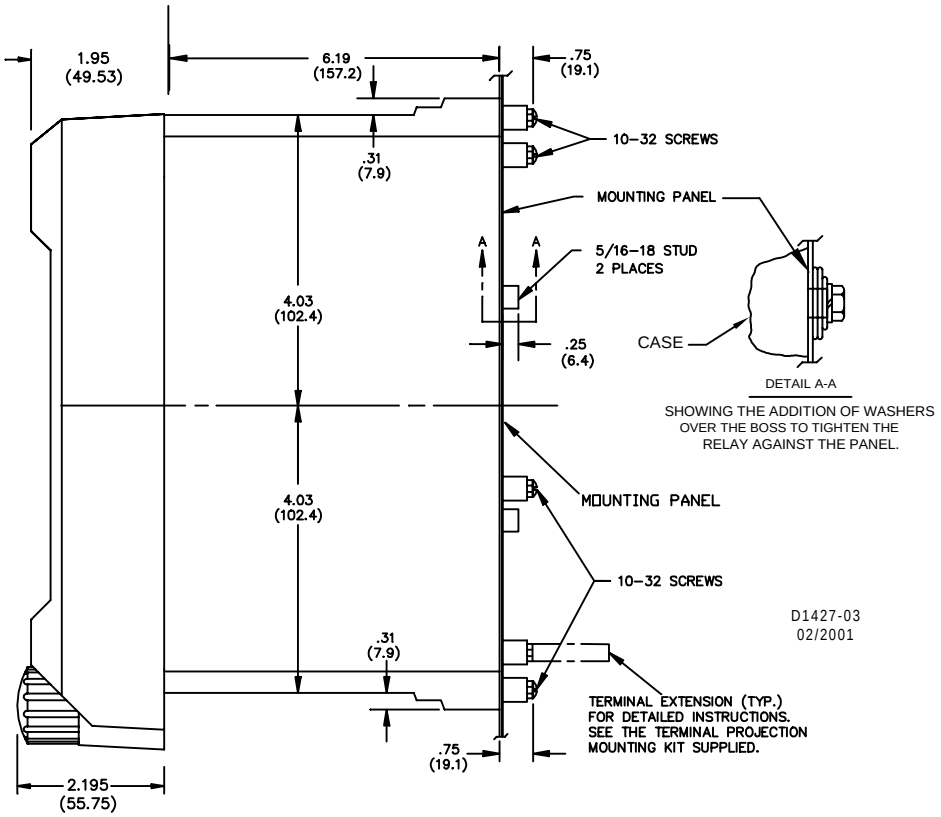

Figure 4-3 . S1 Case, Double-Ended, Projection Mount, Outline Dimensions, Side View

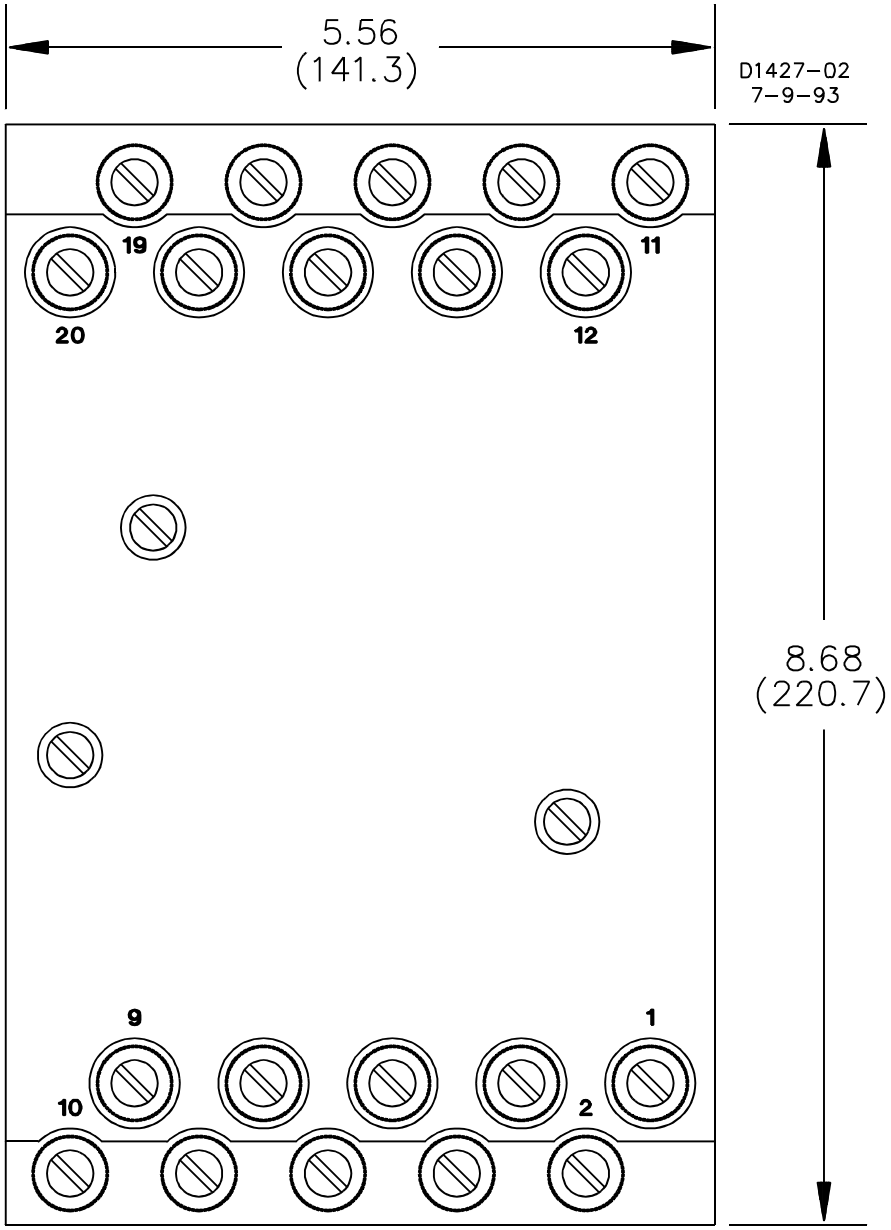

Figure 4-4 . S1 Case, Double-Ended, Projection Mount, Outline Dimensions, Rear View

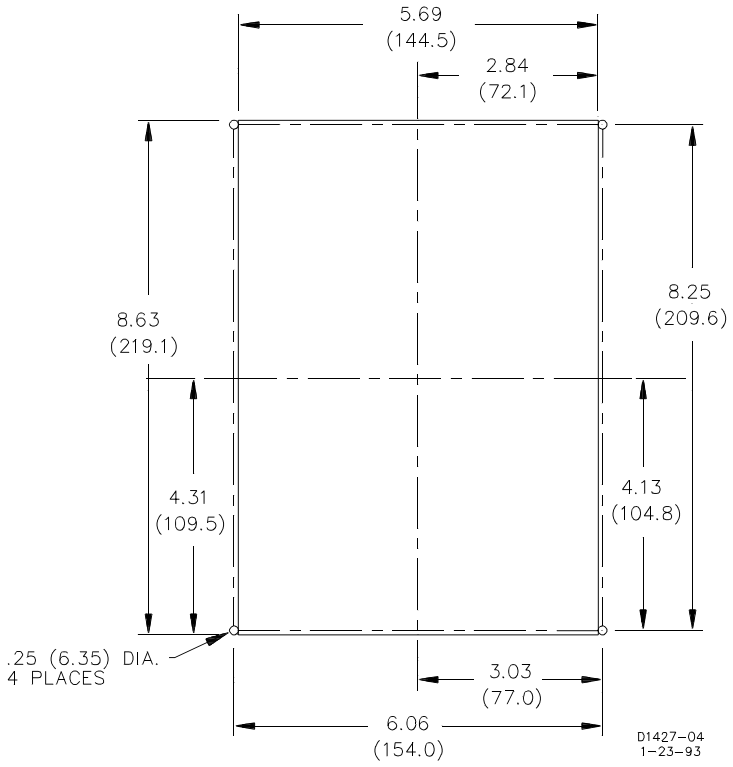

Figure 4-5 . S1 Case, Panel Drilling Diagram, Semi-Flush Mounting

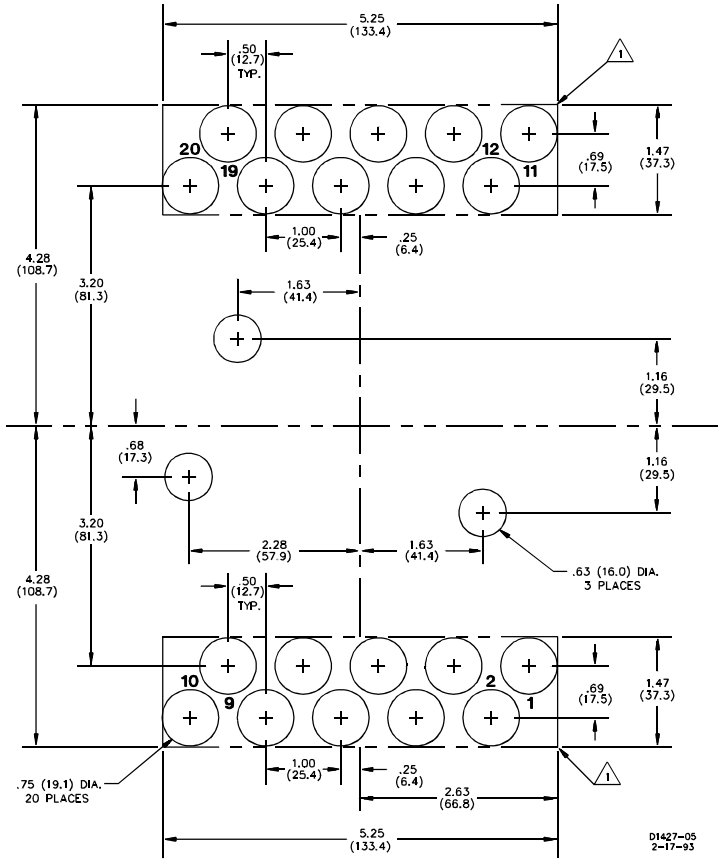

Figure 4-6 . S1 Case, Double-Ended, Projection Mounting, Panel Drilling Diagram, Rear View

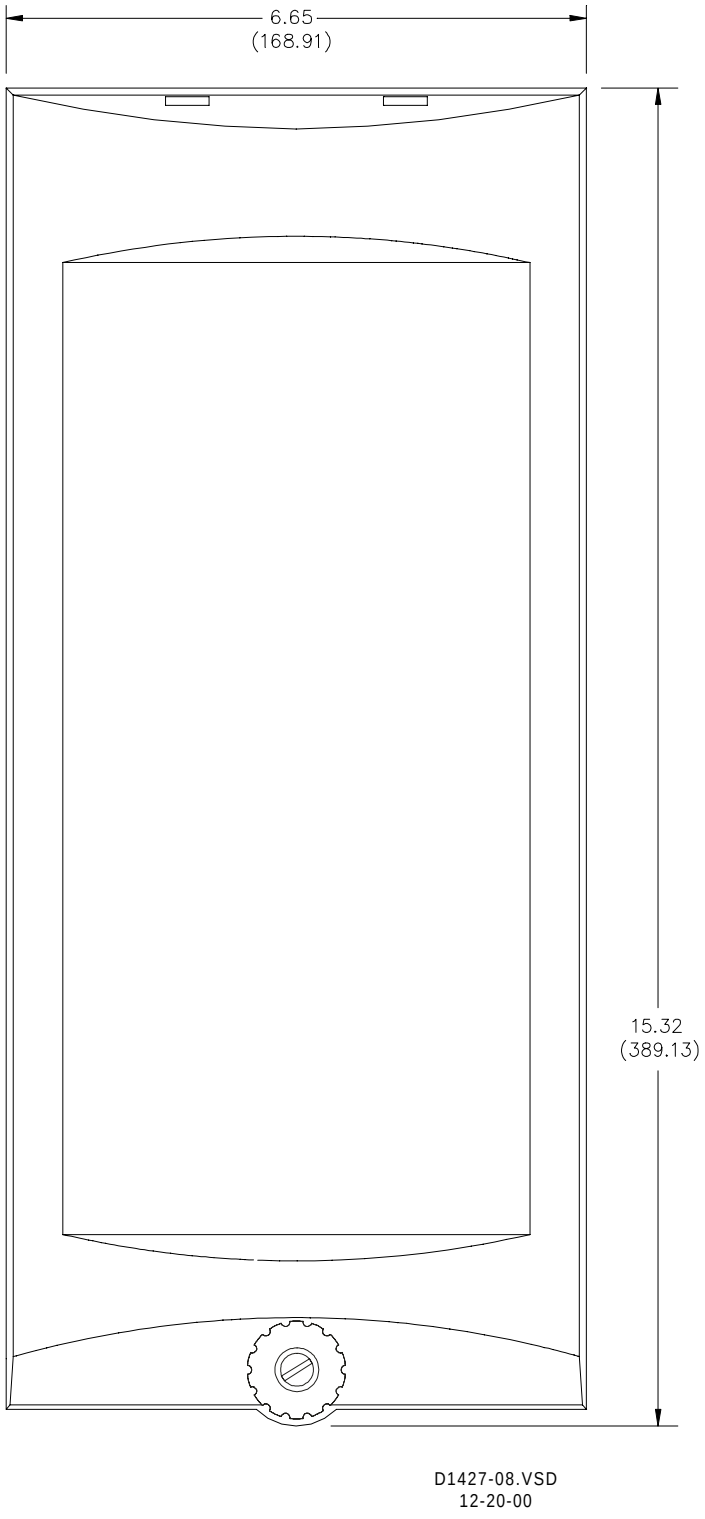

Figure 4-7. M1 Case, Outline Dimensions, Front View

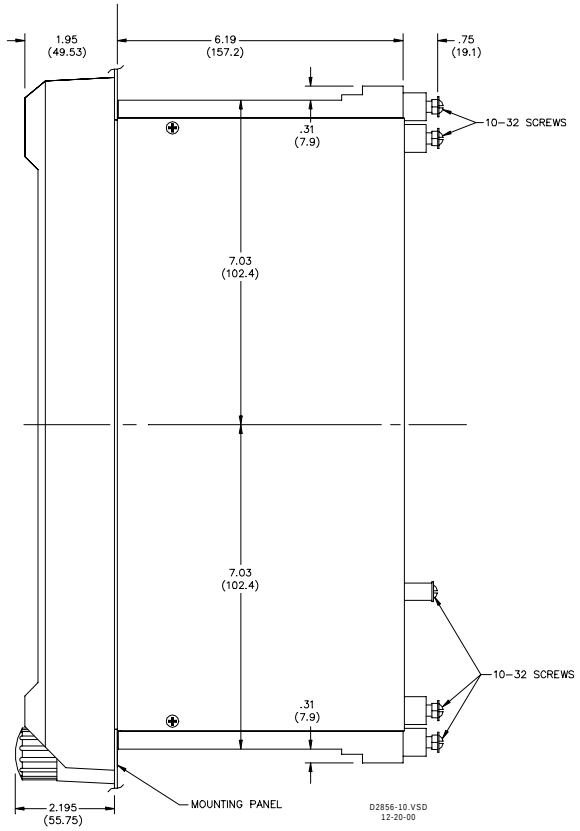

Figure 4-8. M1 Case, Double-Ended, Semi-Flush Mounting, Outline Dimensions, Side View

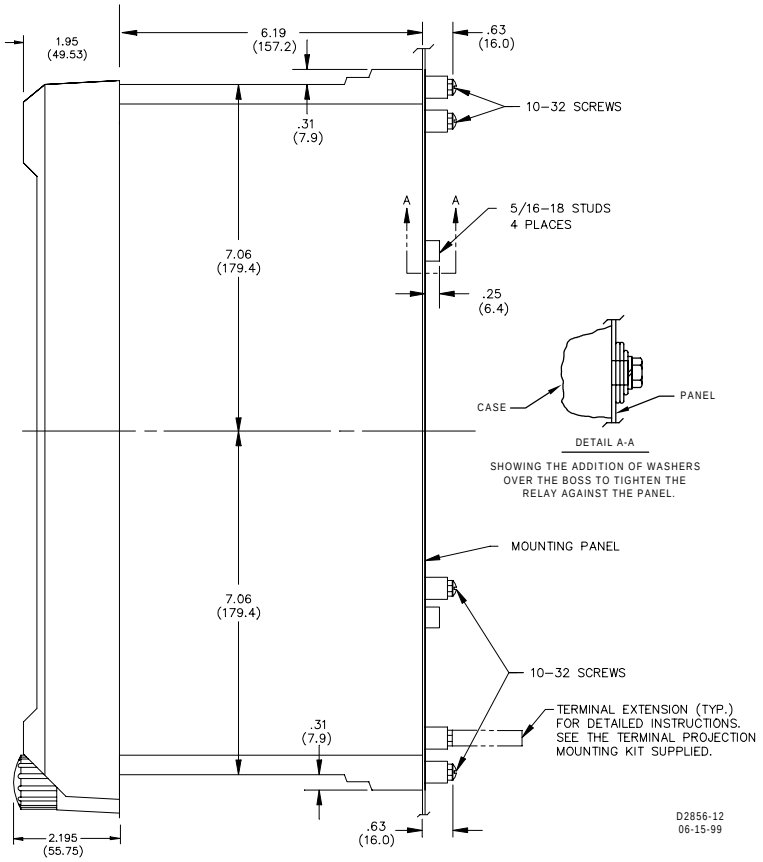

Figure 4-9. M1 Case, Double-Ended, Projection Mounting, Outline Dimensions, Side View

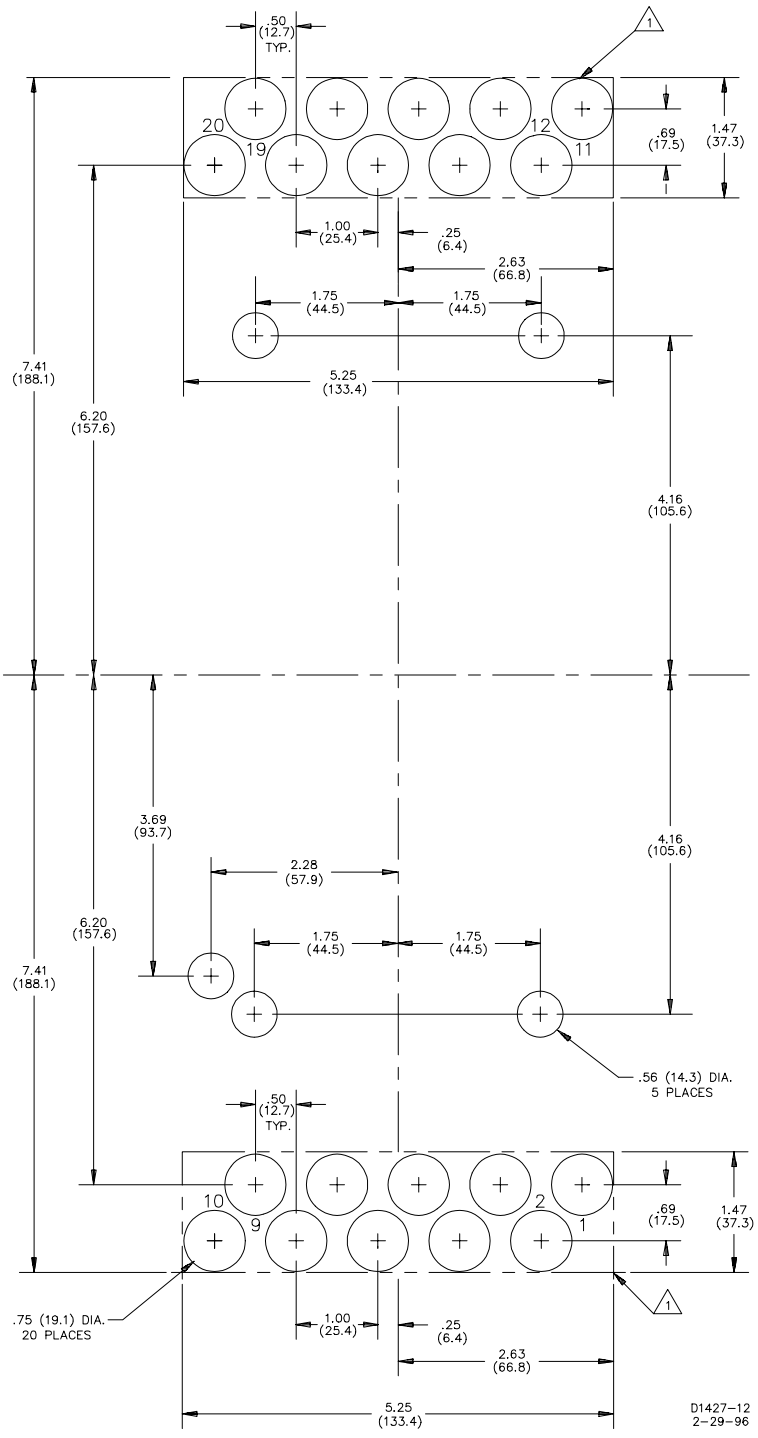

Figure 4-10. M1 Case, Double-Ended, Panel Drilling Diagram, Rear View

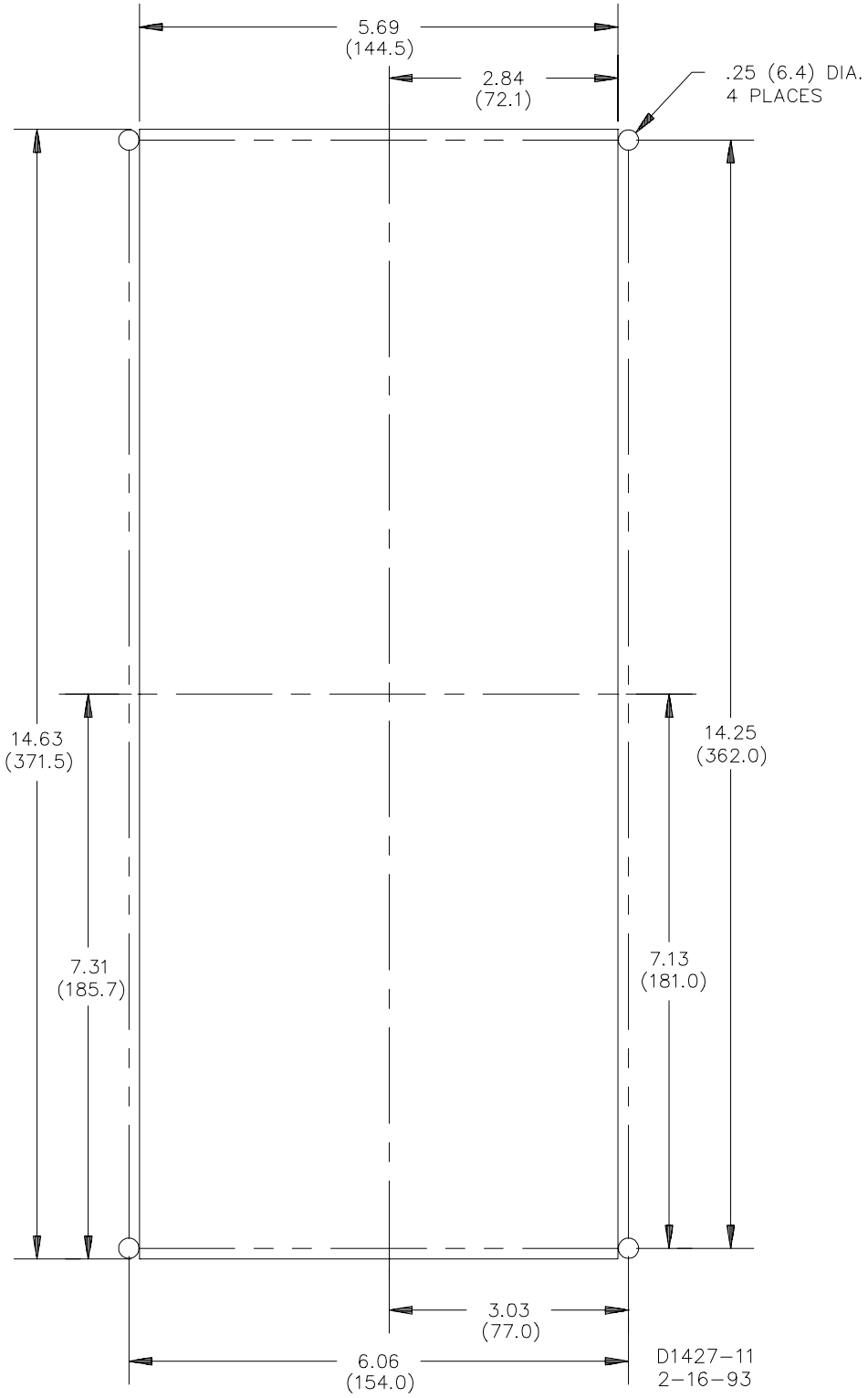

Figure 4-11. M1 Case, Panel Drilling Diagram

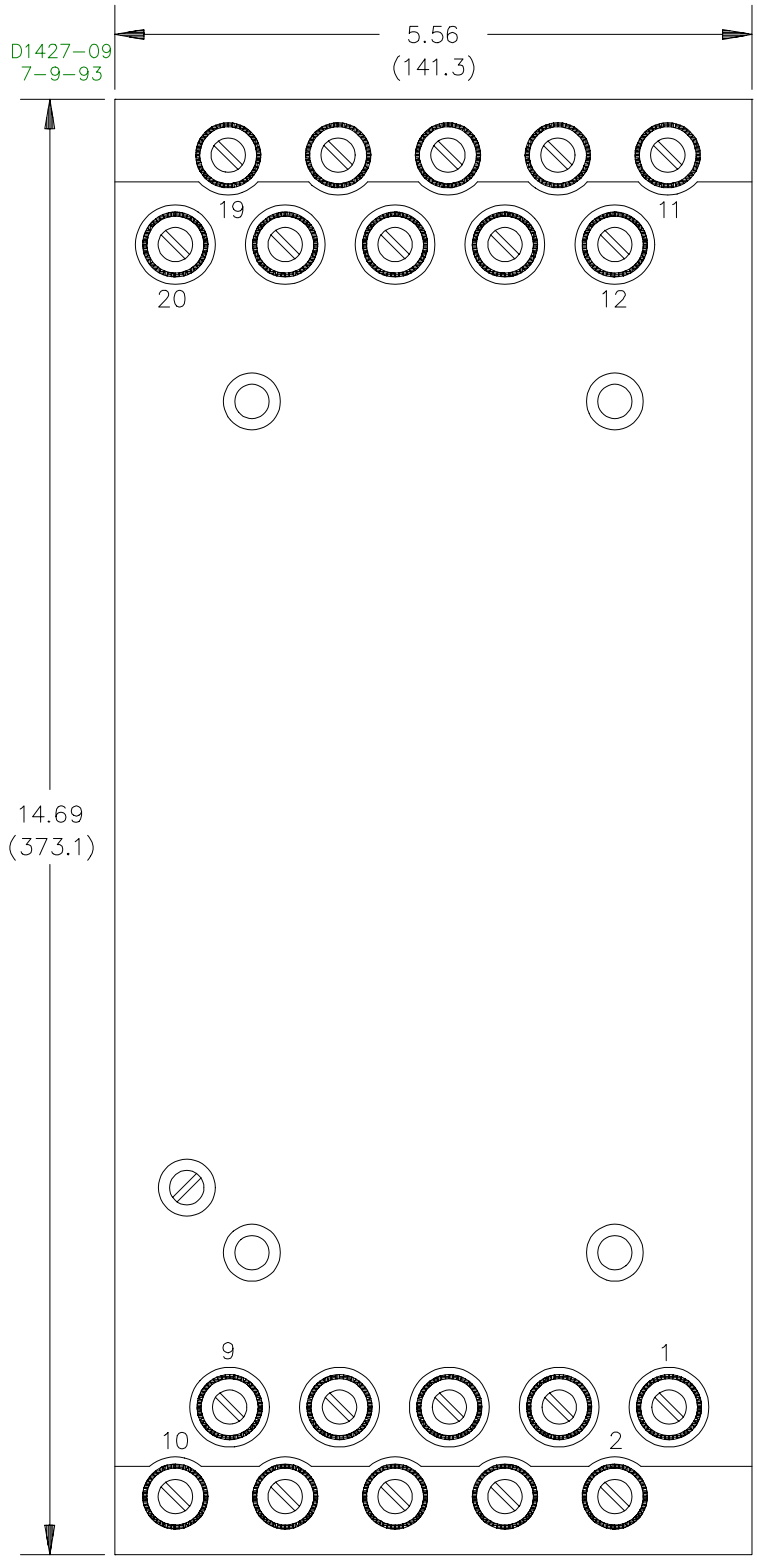

Figure 4-12. M1 Case, Projection Mounting, Outline Dimensions, Rear View

CONNECTIONS

CAUTION

THIS IS A SOLID-STATE DEVICE. MEGGER AND HIGH POTENTIAL TEST EQUIPMENT MUST NOT BE USED. IF A WIRING INSULATION TEST IS REQUIRED, REMOVE THE CONNECTING PLUG AND WITHDRAW THE RELAY FROM ITS CASE.

External connections to the relay are made at the rear of the case. Typical external connections are shown in Figures 4-13 and 4-15. Incorrect wiring may result in damage to the relay. Typical internal connections are shown in Figures 4-16 and 4-17. Be sure to check model and style number against the options described in Section 1 before interconnecting and energizing a particular relay. Interconnections should be made with minimum 14 AWG stranded wire.

NOTE

Be sure that the relay case is hardwired to earth ground using the ground terminal on the rear of the relay case with not less than 12 AWG copper wire. Do not "daisy chain" ground connections. Always use a separate ground lead to the ground bus for each relay.

T h e
output contacts should be interrupted by a breaker auxiliary form B contact to de-energize the output circuit and prevent arcing.

Non-isolated sensing inputs are polarity sensitive. Relay case terminals 12, 13, and 14 are positive with respect to terminal 15.

Terminals 3 and 4 are external relay power supply voltage inputs and are not polarity sensitive.

Relays containing the Type X (250 Vdc, 240 Vac) power supply require an external sensing input module. Connections for this module are shown in Figure 4-15.

Removal of the connecting plugs opens the trip contact before opening the sensing and power circuits.

STORING

In the event that the relay is not to be installed immediately, or has been taken out of service, store the relay in its original shipping carton in a moisture and dust free area.

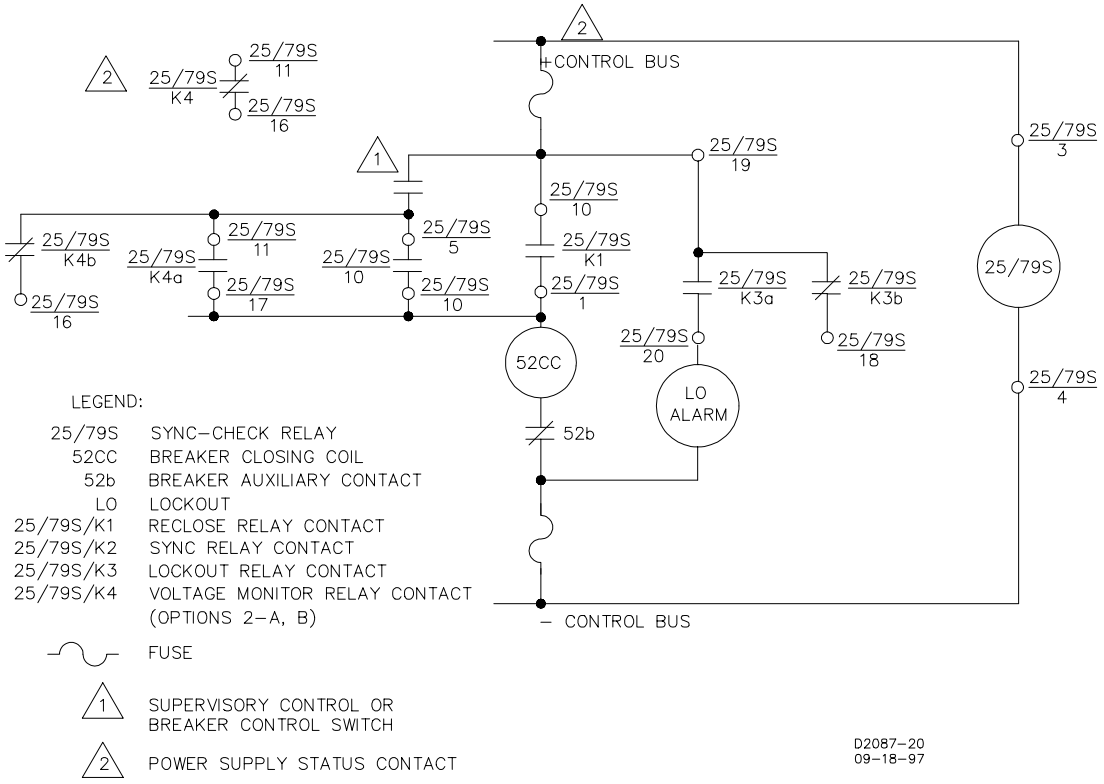

Figure 4-13. Control Circuit Connections

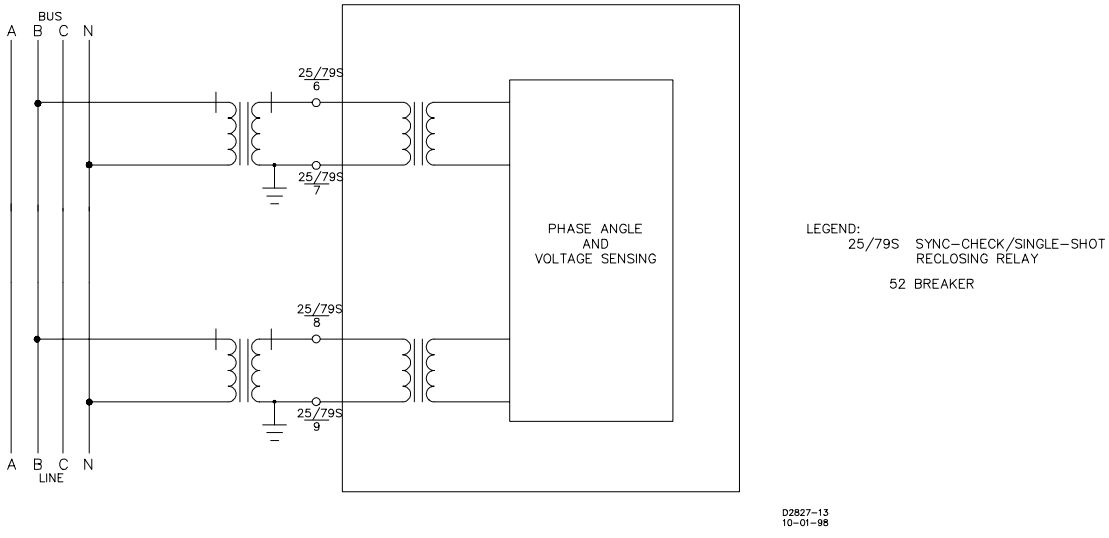

Figure 4-14. Voltage Sensing Connections

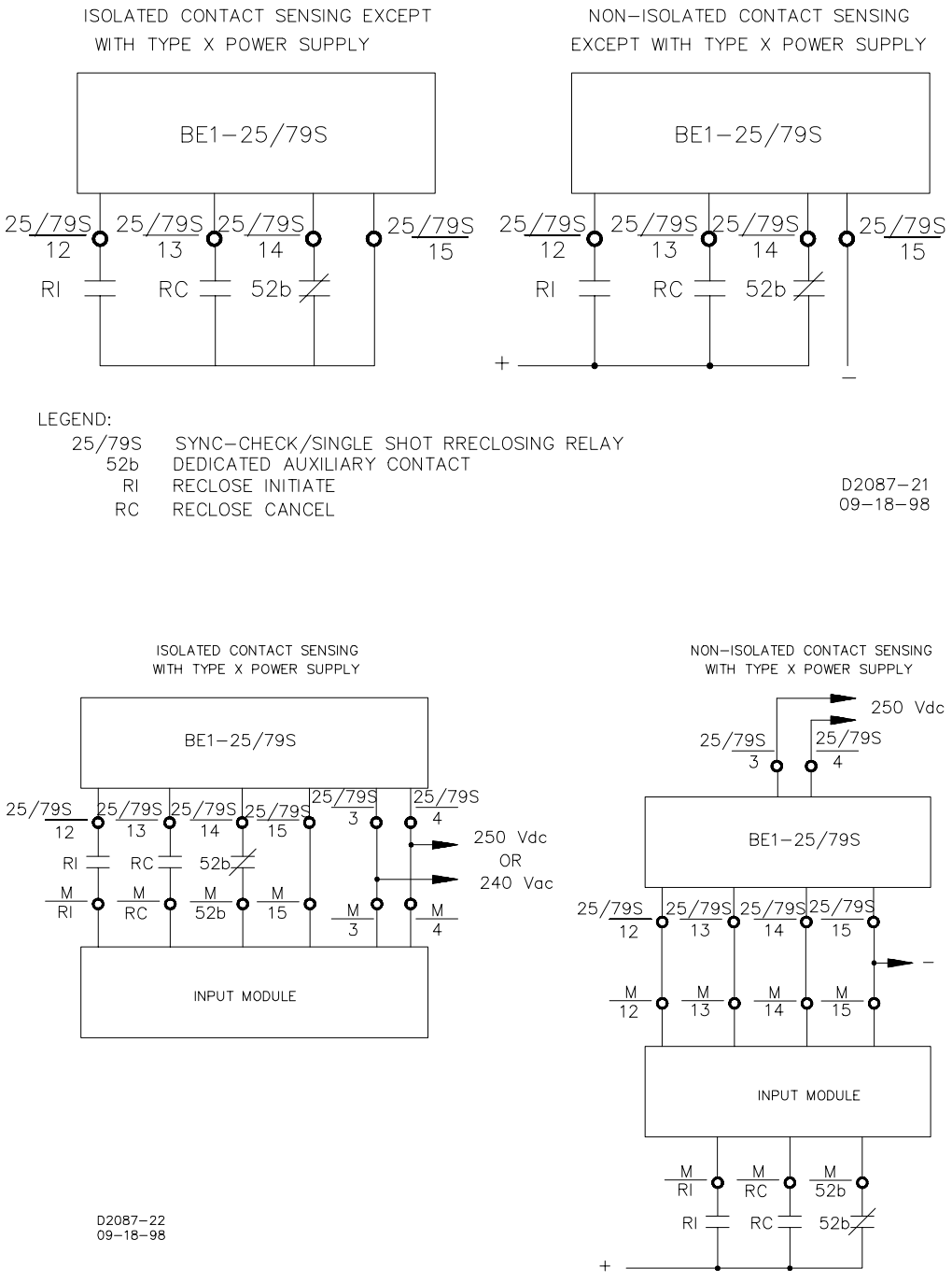

Figure 4-15. Contact Sensing Connections

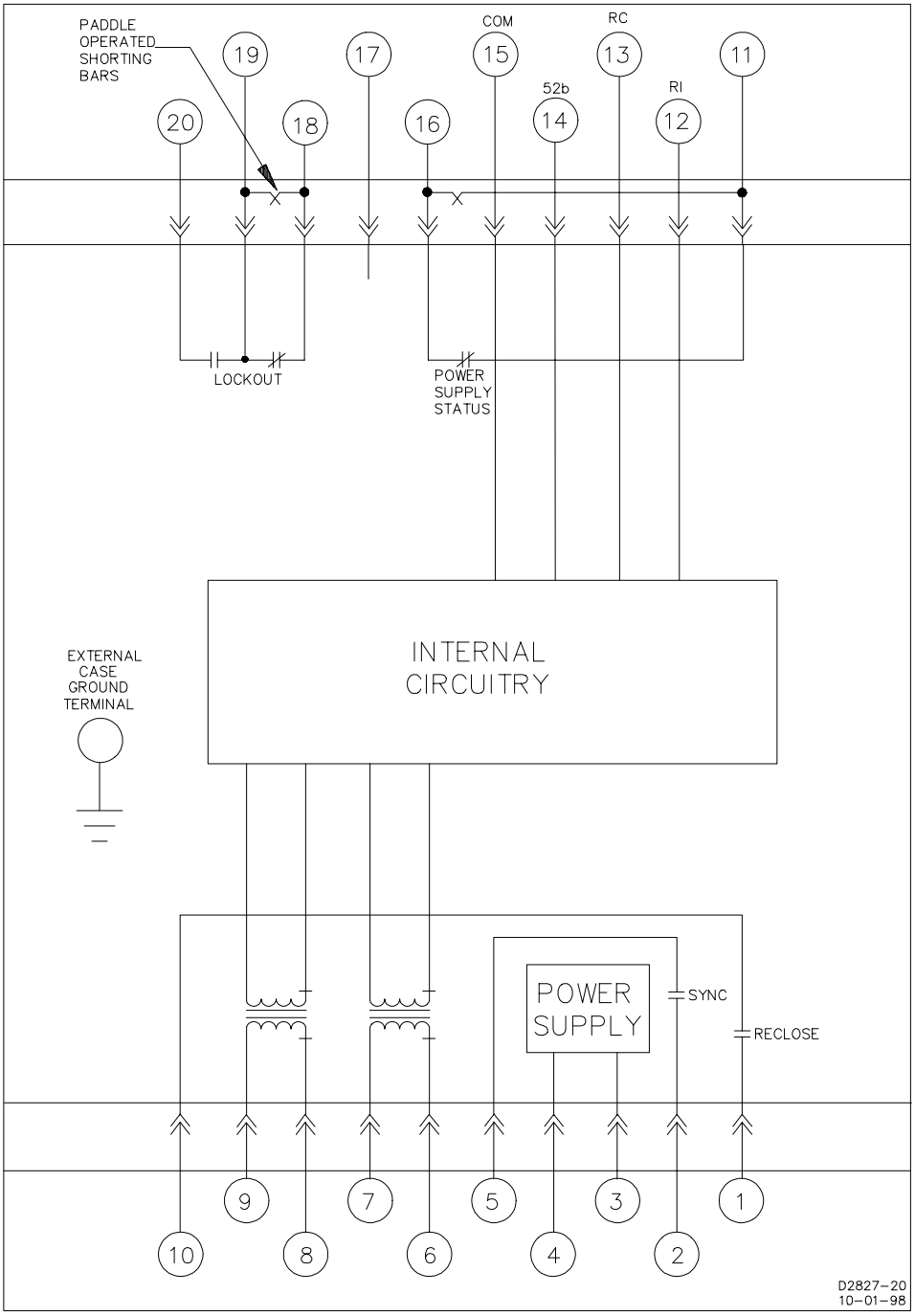

Figure 4-16. Typical Internal Connections with Power Supply Status

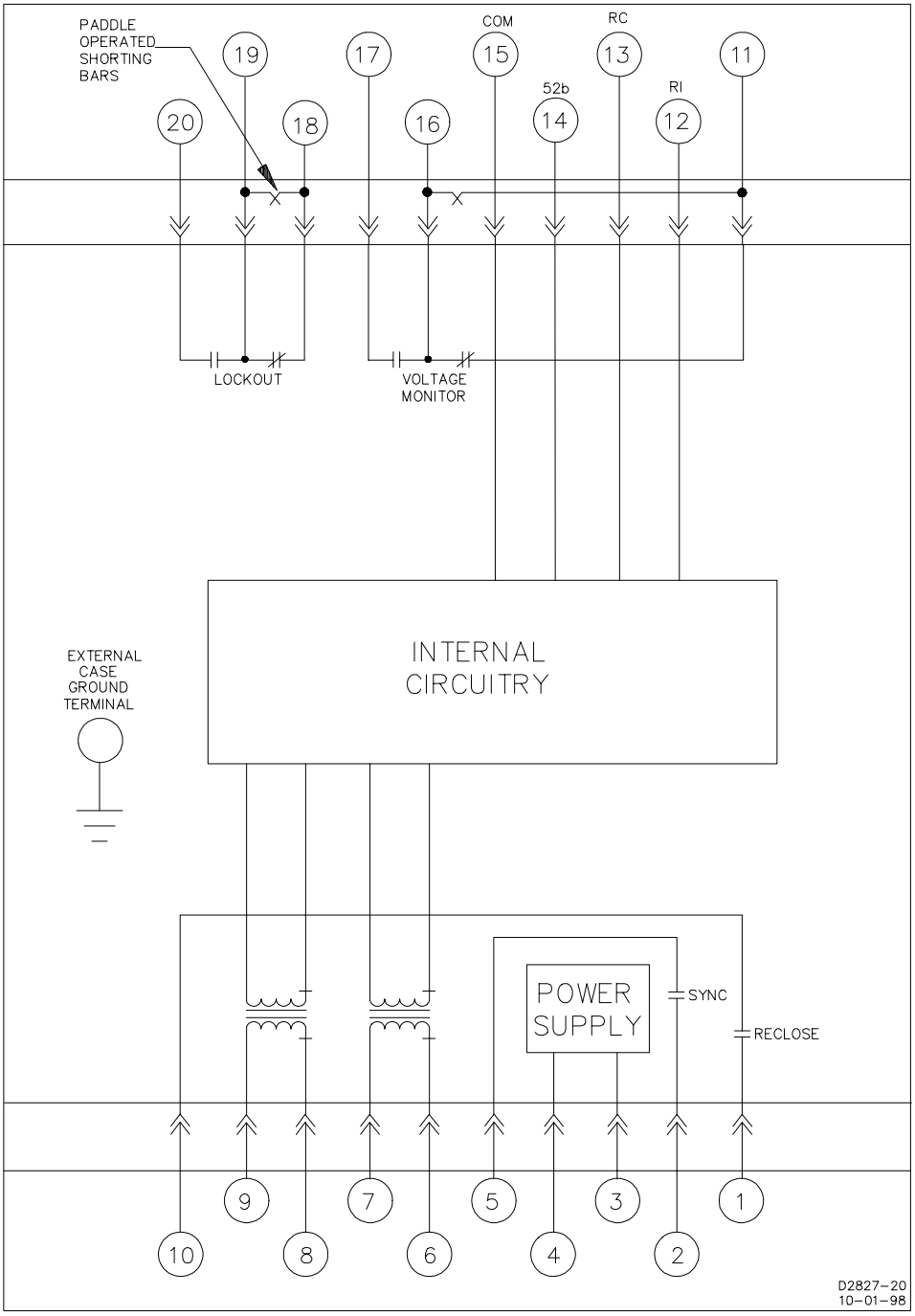

Figure 4-17. Typical Internal Connections with Option 2A or 2B

SECTION 5 • OPERATIONAL TEST

GENERAL

The procedures in this section are suggested for use in testing the relay; also for selecting the reset and reclose time settings, the sync-check line and bus phase difference setting and time delay, the line and bus voltage monitoring levels, and the line and bus voltage difference level.

If a relay fails an operational test, or if the various selection procedures disclose a faulty relay, refer to Section 6.

The minimum recommended test equipment required for relay testing and selection procedures are listed below. Refer to Figure 5-1 for test setup diagram.

1. Two single-phase ac voltage sources.
2. Two transformers, variable over the range of 0 to 135 Vac with an output capable of 5 VA.
3. Two voltmeters indicating over the range of 0 to 150 Vac.
4. Phase shifter variable over the range of 0 to 45° phase shift and with a wattage compatible with variable transformer.
5. Appropriate ac or dc external power source for relay operation.
6. Dc external power source for test lamps DS1 and DS2.
7. Dc external power source for test lamp DS3.
8. Dc external power source (if non-isolated input Option 1.4 is installed) for breaker input sensing.
9. Press-to-make switches (S1 and S3).
10. Press-to-break switch (S2).
11. Single throw switch (S4).
12. Relay (K1) with one normally open contact and one normally closed contact.
13. Counter/timer.
14. Test lamps (DS1), (DS2), and (DS3).

SYNC-CHECK/SINGLE SHOT RECLOSING RELAY OPERATIONAL TEST

STEP 1. Connect the relay as shown in Figure 5-1. If equipped with Power Supply Status Output (Options 2-C through 2-F), and with the unit in a powered-up condition, verify that the power supply status output contact is energized open (terminals 11 and 16). Remove input power and verify that the status output contact closes. Restore input power.

NOTE

Ensure J1/J2 shorting plug is in shorting position. See Figure 3-2 or 3-2A.

If the optional voltage monitor (Options 2-A, 2-B, 2-C, 2-D, 2-R, or 2-S) is installed in the relay, perform steps 2 through 22. If not, proceed to the note which follows step 22.

STEP 2. To gain access to the voltage monitor board CONDITION and MODE switches, remove the connecting plugs and remove the cradle assembly from the relay.

STEP 3. Ensure that all CONDITION and MODE switches on the voltage monitor board are set to normal

(up) or off (up) (see Figure 3-3).

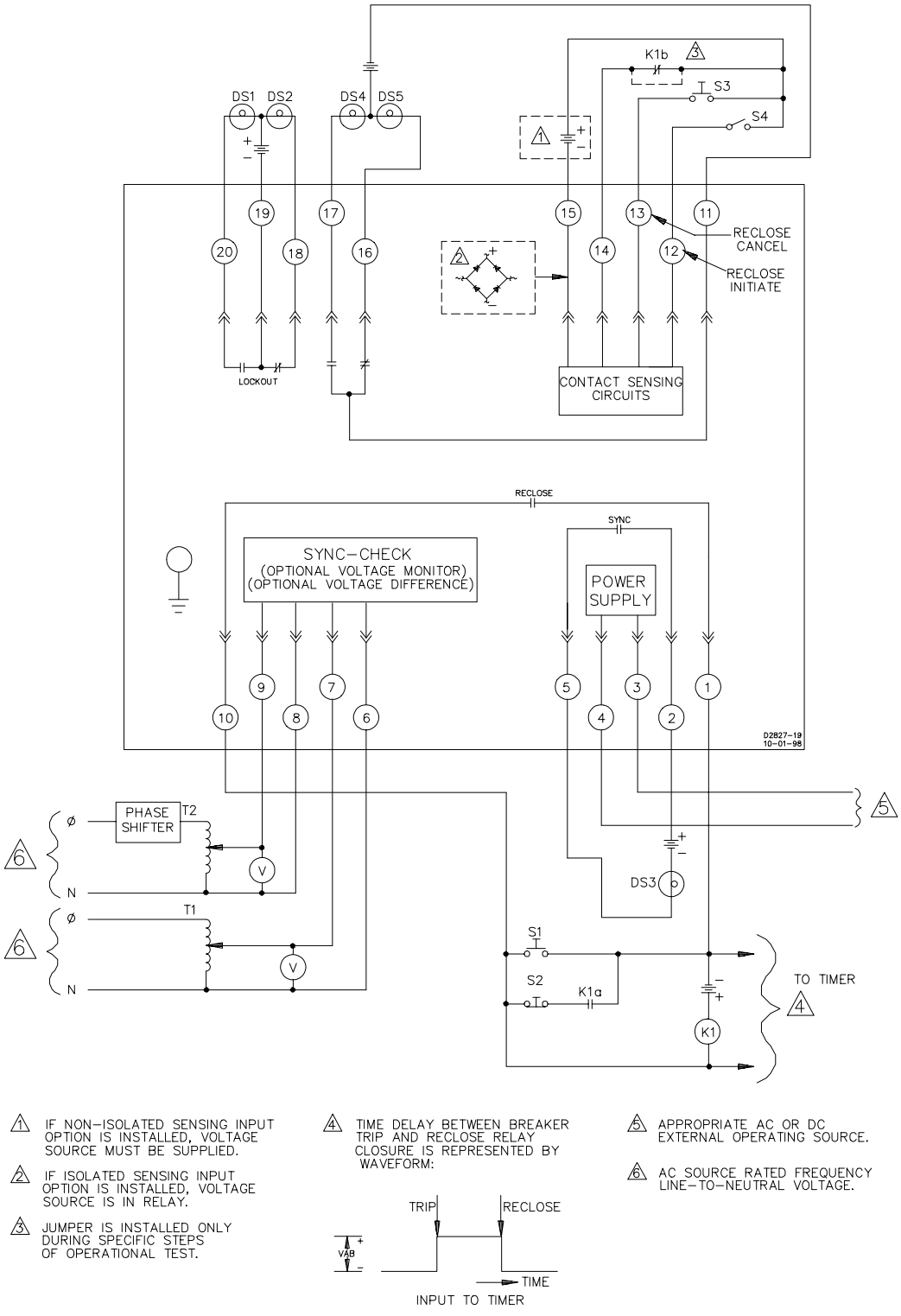

Figure 5-1. Test Setup Diagram (Typical)

STEP 4. Re-install the cradle in the relay and install plugs.

NOTE

The front panel LL, LB, DL/$\overline{OV}$ and DB/$\overline{OV}$ controls are multiturn controls requiring insertion of a small screwdriver for adjustment. Use care when near limits of travel of controls to prevent excessive torqueing of controls and subsequent damage to the stops.

STEP 5. On the front panel, adjust the LL and LB controls fully CW, and the DL/$\overline{OV}$ and DB/$\overline{OV}$ controls fully CCW.

NOTE

Steps 6 through 9 verify operation of maximum and minimum voltage monitor settings for live-line and live-bus.

STEP 6. Adjust the T1 (bus) and T2 (line) output voltages to 135 Vac.

STEP 7. Adjust the LL and LB controls until the LL and LB indicators light. Both adjustments should require only a few turns from the maximum (fully CW) position.

STEP 8. Adjust the T1 (bus) and T2 (line) output voltages to 10 Vac, extinguishing both indicators.

STEP 9. Adjust the LL and LB controls until the LL and LB indicators light. Both adjustments should be near their maximum turn limits.

NOTE

Steps 10 through 12 verify the operation of the maximum and minimum voltage monitor settings for dead-line and dead-bus.

STEP 10. With input voltages remaining at 10 Vac, adjust the DL/$\overline{OV}$ and DB/$\overline{OV}$ controls until the DL/$\overline{OV}$ and DB/$\overline{OV}$ indicators light. Both adjustments should require only a few turns from the minimum (fully CCW) position.

STEP 11. Adjust the T1 (bus) and T2 (line) voltages to 135 Vac, extinguishing both indicators.

STEP 12. Adjust the DL/$\overline{OV}$ and DB/$\overline{OV}$ controls until the DL/$\overline{OV}$ and DB/$\overline{OV}$ indicators light. Both adjustments should be near their maximum turn limits.

NOTE

Steps 13 through 22 set up the voltage monitor circuitry to prevent generation of the RECLOSE INHIBIT signal, allowing the reclose enable logic to operate.

STEP 13. On the front panel, adjust the LL and LB controls fully CW, and the DL/$\overline{OV}$ and DB/$\overline{OV}$ controls fully CCW.

STEP 14. To gain access to the voltage monitor board CONDITION and MODE switches, remove the connecting plugs and remove the cradle assembly from the relay.

STEP 15. Select the live-line/dead-bus condition by setting CONDITION switch no. 4 to on (down).

STEP 16. Select the $\overline{OV}$ mode for the live-line by setting MODE switch no. 2 to $\overline{OV}$ (down).

STEP 17. Re-install the cradle in the relay and install the plugs.

STEP 18. Adjust the T1 (bus) output to 20 Vac and the T2 (line) output to 40 Vac.

STEP 19. Slowly adjust the DB/$\overline{\text{OV}}$ control until the DB/$\overline{\text{OV}}$ indicator lights, establishing the reclose enable zone for the dead-bus at below the 20 Vac level.

STEP 20. Slowly adjust the LL control until the LL indicator lights, establishing the reclose relay enable zone for the live-line at above the 40 Vac level.

STEP 21. To set up an overvoltage limit ($\overline{\text{OV}}$) for the live-line, adjust the T2 output voltage to 100 Vac and adjust the DL/$\overline{\text{OV}}$ control fully CCW. Slowly adjust the DL/$\overline{\text{OV}}$ control CW until the DL/$\overline{\text{OV}}$ indicator lights, establishing the $\overline{\text{OV}}$ level at 100 Vac.

STEP 22. Adjust the T1 output voltage to 10 Vac, placing the dead-bus voltage within the dead-bus reclosing zone and lighting the DB/$\overline{\text{OV}}$ indicator; adjust the T2 output voltage to 70 Vac, placing the live-line voltage below the $\overline{\text{OV}}$ limit and within the live-line reclosing zone, and lighting the LL indicator. At this time the (optional) voltage monitor relay should be energized.

Table 5-1. Reclose Time Substitution Chart

STEP	RECLOSE TIME CONTROL OPTIONAL RANGES		
	A2	**A3**	**A4**
25	0.1 second	1 second	5 seconds
29	100 ±50 msec (0.10 ±0.05 seconds)	1000 ±50 msec (1.0 ±0.05 seconds)	5000 ±250 msec (5.0 ±0.25 seconds)
31	2 seconds	20 seconds	60 seconds
33	2 seconds or more	20 seconds or more	60 seconds or more

NOTE

The following steps test the reclose enable logic and reclose timer in a relay with a reclose time delay range of 0.1 to 2 seconds (Option A2). If your relay has a different time delay option, refer to Table 5-1 for the step values to substitute in the test procedure.

STEP 23. With the relay connected as shown in Figure 5-1, indicators DS1 and DS2 are slaved to the LOCKOUT indicator. When the indicator is lit, DS1 is on and DS2 is off; and vice versa.

STEP 24. To inhibit the sync-check logic and enable the reclose timer, ensure that T1 and T2 are positioned as given in step 22.

STEP 25. Set the RECLOSE TIME control fully CCW (0.1 second) and RESET TIME to maximum (fully CW) to test minimum reclose time operation. (Refer to Table 5-1.)

STEP 26. Close switch S4 to supply RI signal to relay.

STEP 27. Press and release S1 to reset K1. Allow relay to reset.

NOTE

To obtain an accurate reading in step 28, switch S2 should be pressed and released in less time than the RECLOSE TIME setting.

STEP 28. Press and release momentary contact switch S2 to simulate a breaker trip.

STEP 29. Observe RESET indicator goes out, K1 is energized, and LOCKOUT indicator lights. Timer displays 100 ± 50 milliseconds. (Refer to Table 5-1.)

STEP 30. Approximately one minute after S2 was pressed, LOCKOUT indicator goes out and RESET indicator lights.

STEP 31. Set RECLOSE TIME fully CW (2 seconds) to test maximum reclose time operation. (Refer to Table 5-1.)

STEP 32. Press and release momentary contact switch S2 to simulate a breaker trip.

STEP 33. Observe RESET indicator goes out. LOCKOUT indicator lights and K1 is energized after two seconds. Timer displays 2000 milliseconds or more. (Refer to Table 5-1.)

STEP 34. Observe RESET indicator lights and LOCKOUT indicator goes out about one minute after LOCKOUT indicator lights.

STEP 35. Open switch S4. Press and release momentary contact switch S2 to simulate a breaker trip when RI is not present.

STEP 36. Observe RESET indicator goes out, LOCKOUT indicator does not light. Reclosure does not occur.

STEP 37. Press and release S1 to simulate closing the breaker by other means. Within 5 seconds, press and release S2 to simulate a breaker trip before the reset interval has expired.

STEP 38. Observe that LOCKOUT indicator lights.

STEP 39. Press and release switch S1 to simulate closing the breaker by other means.

STEP 40. Observe that RESET indicator lights after about one minute.

STEP 41. Close switch S4 to supply the RI signal to the relay.

STEP 42. Press and hold switch S2.

STEP 43. Connect a jumper across relay contact K1b on test setup to simulate a breaker trip that will not be cleared by a reclose signal.

NOTE

Input to timer in step 44 is reverse of that shown in Figure 5-1. Voltage goes low on trip and returns to high when reclose signal terminates.

STEP 44. Observe RESET indicator goes out and LOCKOUT indicator lights and remains lit. If relay is provided with Option 3-0 (continuous reclose signal), the timer is started and not stopped. If relay is provided with Option 3-2, the timer will indicate between 2 and 3 seconds. If relay is provided with Option 3-3, the timer will indicate between 5 and 6 seconds.

STEP 45. Release switch S2, remove jumper installed in step 43. Press and release switch S1 to simulate closing the breaker by other means.

STEP 46. Observe after 60 seconds LOCKOUT indicator goes out and RESET indicator lights.

STEP 47. Press and hold S3 and press and release switch S2 to simulate a breaker trip while RC signal is present.

STEP 48. Observe RESET indicator goes out. No reclosure occurs. (Release S3).

STEP 49. Press and release switch S1 to simulate closing the breaker by other means.

STEP 50. Observe after 60 seconds RESET indicator lights.

NOTE

If the optional voltage monitor is installed in the relay, perform the remainder of the following tests. If not, proceed to step 63.

The following steps simulate a breaker trip with a live-line overvoltage condition such that the line voltage is higher than the $\overline{OV}$ setting established in step 22. The voltage monitor timer that prevents reclosing is then checked.

STEP 51. Ensure K1 is energized by pressing and releasing S1.

STEP 52. Adjust the T2 output voltage to 120 Vac, so that the live-line voltage is above the $\overline{OV}$ level of 100 Vac.

STEP 53. Press and release S2 to simulate a breaker trip.

STEP 54. Observe RESET indicator goes out. No reclosure occurs.

STEP 55. When the timer indicates 'X' seconds, rapidly (within 2 seconds) adjust the T2 output voltage to 70 Vac.

X = 80 seconds for units with Reset Timer B.

X = 10 seconds for units with Reset Timer C.

For units with Reset Timer D there is no time limit for the voltage monitor. In this case, the response to the 70 Vac of T2 should be checked without regard to a time limit.

STEP 56. Observe RESET indicator goes out and K1 is energized after two seconds.

NOTE

If equipped with Reset Timer D, omit steps 57 through 61.

STEP 57. Repeat steps 51 through 54.

STEP 58. When the timer indicates 'Y' seconds, rapidly (within 2 seconds) adjust the T2 output voltage to 70 Vac.

Y = 110 seconds for units with Reset Timer B.

Y = 20 seconds for units with Reset Timer C.

STEP 59. Observe RESET indicator remains out. No reclosure occurs.

STEP 60. Press and release switch S1 to simulate closing the breaker by other means.

STEP 61. Observe that after 60 seconds RESET indicator lights.

STEP 62. Using T1 (bus) and T2 (line) adjust the DB/$\overline{OV}$ and DL/$\overline{OV}$ controls to the 10 Vac level, and the LB and LL control s to the 20 Vac level .

NOTE

The front panel ΔV control is a multiturn control requiring insertion of a small screwdriver for adjustment. Use care when near limits of travel of control to prevent excessive torqueing of control and subsequent damage to the stops.

STEP 63. If the voltage difference option (Option 2-R, 2-T, or 2-A) is installed, adjust the ΔV control fully CW to the maximum setting.

STEP 64. Adjust the T1 (bus) and T2 (line) output voltages to 95 Vac.

STEP 65. Adjust the line phase shifter to 0°.

NOTE

Steps 67 through 77 verify sync-check operation at selected phase angle detection limits and verify the sync-check timer minimum and maximum settings. These steps also verify operation of the voltage difference logic if installed.

STEP 66. Ensure S4 is closed to supply the RI signal to the relay, and that K1 is energized.

STEP 67. Set the front panel PHASE ANGLE selector to 2°.

STEP 68. Set the TIME DELAY selector to 99 and the X0.1/X1.0 multiplier to 1.0 for a time delay of 99 seconds.

STEP 69. Press and release switch S2, simulating a breaker trip. The PHASE ANGLE indicator should light, signifying that the phase difference between the line and the bus is less than the PHASE ANGLE selector setting of 2°.

After the timer registers a time delay of 99 ±4.95 seconds, the SYNC indicator and test indicator DS3 should briefly light, then go out together with the PHASE ANGLE indicator, signifying that K1 has been re-energized by the reclose relay. Simultaneously, the LOCKOUT indicator should light, remaining lit until the reset period (60 seconds) ends, at which time, the LOCKOUT indicator goes out and the RESET indicator lights.

STEP 70. Adjust the phase shifter to 5°.

STEP 71. Press and release switch S2, simulating a breaker trip. The PHASE ANGLE indicator should not light, signifying that the phase difference between the line and the bus is greater than the PHASE ANGLE selector setting of 2° (time delay will not be initiated, the SYNC and LOCKOUT indicators and DS3 will not light, and the sync relay contacts will not close. K1 remains de-energized).

STEP 72. Set the front panel PHASE ANGLE selector to 45° then quickly perform step 73 before the sync-check timer can energize K1 and prematurely extinguish the PHASE ANGLE indicator.

STEP 73. Adjust the line phase shift until the PHASE ANGLE indicator goes out signifying that the line phase shift has exceeded 45°.

STEP 74. Adjust the line phase shift until the PHASE ANGLE indicator again lights, signifying that the line phase shift is slightly less than the PHASE ANGLE selector setting of 45°.

STEP 75. Set the TIME DELAY selector to 1.0 and the X0.1/X1.0 multiplier to 0.1 for a time delay of 0.1 seconds.

STEP 76. Momentarily press switch S1 to energize relay K1.

STEP 77. Repeat step 69 for a phase angle difference of less than 45° and time delay of 0.1 second.

NOTE

Steps 78 through 83 check the minimum voltage logic of 80 Vac, maximum.

STEP 78. Adjust the T2 (line) output voltage to 30 Vac.

STEP 79. Press and release switch S2, simulating a breaker trip. The PHASE ANGLE indicator should not light, signifying that the line voltage is less than the minimum acceptable voltage of 80 Vac, maximum.

STEP 80. Set the TIME DELAY selector to 99 and the X0.1/X1.0 multiplier to 1.0 for a time delay of 99 seconds.

STEP 81. Slowly adjust the T2 (line) output voltage until the PHASE ANGLE indicator lights. The minimum voltage point should be 80 Vac, maximum.

STEP 82. Adjust the T2 (line) output voltage to 95 Vac and the T1 (bus) output voltage to 30 Vac.

STEP 83. Press and release switch S2, then repeat steps 81 and 82 using the T1 (bus) output voltage.

NOTE

If the optional voltage monitor (Options 2-A, 2-B, 2-R, or 2-5) is installed in the relay, perform steps 84 through 96. If not, proceed to step 97.

Steps 84 through 96 verify the operation of the sync-check logic live-line/live-bus condition with the voltage monitor option added. The $\overline{\text{OV}}$ mode is also checked.

STEP 84. Adjust the T1 (bus) and T2 (line) outputs to 90 Vac.

STEP 85. Slowly adjust the LL and LB controls until the LL and LB indicators just go out, establishing the reclose relay closing enable zones for both the live-line and live-bus at above the 90 Vac level (overriding the minimum voltage logic level of 80 Vac, maximum, of the basic relay).

STEP 86. To set up an overvoltage limit ($\overline{\text{OV}}$) for the live-line, adjust the T2 output voltage to 100 Vac and adjust the DL/$\overline{\text{OV}}$ control fully CCW. Slowly adjust the DL/$\overline{\text{OV}}$ control CW until the DL/$\overline{\text{OV}}$ indicator lights, establishing the $\overline{\text{OV}}$ level at 100 Vac.

STEP 87. Adjust the T1 (bus) output to 100 Vac, placing the output within the closing zone.

STEP 88. Adjust the T2 (line) output to 120 Vac, placing the output above the 100 Vac $\overline{\text{OV}}$ level established in step 86. Press and release switch S1, simulating breaker closure.

STEP 89. Press and release switch S2, simulating a breaker trip. K1 should de-energize, then re-energize. This verifies that the $\overline{\text{OV}}$ mode will not operate during the live-line/live-bus condition if CONDITION switch no. 1 is in the off (up) position.

STEP 90. To gain access to the voltage monitor board CONDITION switch no. 1, remove the connecting plugs and remove the cradle assembly from the relay case.

STEP 91. Set CONDITION switch no. 1 to on (down), permitting $\overline{\text{OV}}$ during the live-line/live-bus condition.

STEP 92. Re-install the cradle in the relay case and install the plugs.

STEP 93. Press and release switch S1, simulating breaker closure.

STEP 94. Press and release switch S2, simulating a breaker trip. K1 should remain de-energized, verifying that the $\overline{\text{OV}}$ mode for the live-line is functioning during the live-line/live-bus condition.

STEP 95. Remove the connecting plugs and remove the cradle assembly from the relay case.

STEP 96. Set all MODE and CONDITION switches on the voltage monitor board to off (up) or normal (up).

NOTE

If equipped with the voltage difference option, check the ΔV control minimum and maximum settings by performing steps 97 through 105.

If not, the test ends here.

STEP 97. Adjust the ΔV control fully CCW to the minimum setting.

STEP 98. Adjust the T1 (bus) output to 120 Vac and the T2 (line) output to 121 Vac.

STEP 99. Adjust the ΔV control CW until the ΔV indicator lights. The adjustment should require only a few turns from the minimum setting.

STEP 100. Adjust the T2 (line) output voltage to 135 Vac, extinguishing the ΔV indicator.

STEP 101. Adjust the ΔV control CW until the ΔV indicator lights. The ΔV control should be near its maximum turn limit.

STEP 102. Adjust the T1 (bus) output voltage to 85 Vac.

STEP 103. Adjust the ΔV control CCW until the ΔV indicator goes out.

STEP 104. Press switch S1 to energize relay K1, opening the K1b contacts.

STEP 105. Press and release switch S2, simulating a breaker trip. K1 should remain de-energized, verifying that the voltage difference logic will prevent reclose relay closure if the line and bus voltage difference is greater than the ΔV control setting limit.

NOTE

Steps 106 through 110 provide a means of calibrating the Maximum Trial timer. This timer is only present when Reset Timer Option B or C is installed. For all other relays the operational test is concluded.

STEP 106. Set Condition Switches 1 and 2 down, 3 through 5 up.

STEP 107. Set Mode Switches 1 down, 2 up.

STEP 108. Place a voltmeter between pin 39 of Voltage Monitor board and ground. (Should read 0 volts.)

STEP 109. Apply a high (tripping) signal to relay terminal 14 (52b) and note the time it takes until terminal 39 goes high. Time should be as follows.

For Reset Option B: 95 $\pm$10 seconds.

For Reset Option C: 15 $\pm$2 seconds.

STEP 110. If time period falls outside of the specified tolerance, adjust potentiometer R60 as required.

NOTE

This concludes the Sync-Check/Single Shot Reclosing Relay Operational Test.

RECLOSE TIME AND RESET TIME SELECTION

NOTE

If the voltage monitor option is installed, perform steps 1-4. If not, proceed to step 5.

STEP 1. To gain access to the voltage monitor board CONDITION and MODE switches, remove the connecting plugs and remove the cradle assembly from the relay.

STEP 2. Insure that all the CONDITION and MODE switches are set to the off (up) or normal (up) positions.

STEP 3. Set CONDITION switch no. 5 to on (down) for a dead-line/dead-bus condition to allow

reclose timer operation with the simplified set-up configuration of step 5.

STEP 4. Re-install the cradle in the relay and install plugs.

STEP 5. Connect the relay as shown in Figure 5-1 (for simplicity, the phase shifter, T1, T2, and the two voltmeters may be excluded).

STEP 6. Close switch S4 to supply RI signal to relay.

STEP 7. Press and release S1 to reset K1, simulating breaker closure. Allow relay to reset.

STEP 8. Set the RECLOSE TIME control fully CCW and the RESET TIME control fully CCW.

STEP 9. Press and release momentary contact switch S2 to simulate a breaker trip. RESET indicator goes out and LOCKOUT indicator lights. Timer should display (RECLOSE TIME) 0.10 $\pm$ 0.05 seconds (A2 option), or 1 +0, -0.05 seconds (A3 option), or 5.0 (+0, -0.25) seconds (A4 option).

STEP 10. Approximately 5 seconds (RESET TIME) after K1 re-energizes, the LOCKOUT indicator goes out, and the RESET INDICATOR LIGHTS.

STEP 11. Repeat steps 9, 10, and 11 , adjusting the RECLOSE TIME control (step 9) and RESET TIME control (step 10) until the relay is programmed to the desired RECLOSE TIME and RESET TIME intervals. Refer to Table 5-2 for the RECLOSE TIME control range that applies to the relay.

Table 5-2. Reclose Time

	RECLOSE TIME CONTROL OPTIONAL RANGES		
OPTION	A2	A3	A4
RANGE	0.10 $\pm$ 0.05 to 2 + seconds	1.0 (+0, -0.05) to 20 + seconds	5.0 (+0, -0.25) to 60 + seconds

SYNC-CHECK PHASE ANGLE AND TIME DELAY SELECTION

CAUTION

SELECTION OF 0 SECONDS TIME DELAY IS NOT RECOMMENDED SINCE THIS CAUSES SPONTANEOUS ENERGIZING OF THE SYNC RELAY, AND GENERATION OF A FALSE SYNC-CHECK RECLOSE ENABLE SIGNAL.

NOTE

Selection consists of entering the desired maximum phase angle limit and time delay on the relay front panel PHASE ANGLE and TIME DELAY thumbwheel selectors. Refer to Figure 1-2 for slip frequency chart that provides appropriate PHASE ANGLE and TIME DELAY selectors settings for various slip frequencies.

VOLTAGE MONITOR CONDITIONS

STEP 1. To gain access to the voltage monitor board CONDITION and MODE switches, remove the connecting plugs and remove the cradle assembly from the relay.

STEP 2. Insure that all the CONDITION and MODE switches are set to the off (up) or normal (up) positions.

NOTE

The selection of line and bus live/dead conditions in the following steps apply only to the reclose timer. (The sync check logic always operates only in the live-line/live-bus condition.)

STEP 3. (Reclose timer only)

To select condition(s), perform any or all of the following (see Figures 2-7 and 3-3):

a) (Step a may be performed only if the J1/J2 shorting plug is in the storage position. Refer to Section 2) For the LIVE-LINE/LIVE-BUS condition: set CONDITION switch No. 2 to the on (down) position.

b) For the LIVE-LINE/DEAD-BUS condition: set CONDITION switch No. 4 to the on (down) position.

c) For the DEAD-LINE/LIVE-BUS condition: set CONDITION switch No. 3 to the on (down) position.

d) For the DEAD-LINE/DEAD-BUS condition: set CONDITION switch No. 5 to the on (down) position.

STEP 4. (Reclose timer only) To select the overvoltage limit ($\overline{OV}$) mode for the live-line and/or live-bus conditions selected in step 3, perform one or both of the following (see Figure 2-7).

a. For $\overline{OV}$ during the LIVE-LINE/DEAD-BUS condition: set MODE switch No. 2 to on (down).

b. For $\overline{OV}$ during the DEAD-LINE/LIVE-BUS condition: set MODE switch No. 1 to on (down).

STEP 5. (Sync-check logic only) To select the overvoltage limit ($\overline{OV}$) mode for the sync-check logic LIVE-LINE/LIVE-BUS condition, perform the following (see Figure 3-3).

NOTE

a. For this selection to be effective, MODE switch No. 1 or No. 2 must be set to on (down).

b. For $\overline{OV}$ during the live-line/live-bus condition: perform step 4a and/or 4b and set CONDITION switch No. 1 to on (down).

STEP 6. Re-install the cradle in the relay and install plugs.

STEP 7. Connect relay as shown in Figure 5-1.

STEP 8. Adjust the LL and LB controls on the front panel fully CW. Adjust the DL/$\overline{OV}$ and DB/$\overline{OV}$ controls fully CCW, then back off 1 turn.

STEP 9. (Reclose timer only) To select the desired voltage levels for the previously selected conditions of step 3, perform the following (see Figure 2-3):

NOTE

Steps a and c will affect the LL and LB control settings established for the sync-check logic. Refer to step 10.

a) If the live-line condition is selected (step 3a or 3b), adjust the T2 (line) output to the

voltage level, above which, reclosing is desired. Slowly adjust the LL control until the LL indicator just lights.

b) If the dead-line condition is selected (step 3c or 3d), adjust the T2 (line) output to the voltage level, below which, reclosing is desired. Slowly adjust the DL/$\overline{\text{OV}}$ control until the DL/$\overline{\text{OV}}$ indicator just lights.

c) If the live-bus condition is selected (step 3a or 3b), adjust the T1 (bus) output to the voltage level, above which, reclosing is desired. Slowly adjust the DB/$\overline{\text{OV}}$ control until the DB/$\overline{\text{OV}}$ indicator just lights.

d) If the dead-bus condition is selected (Step 3c or 3d), adjust the T1 (bus) output to the voltage level, below which, reclosing is desired. Slowly adjust the DB/$\overline{\text{OV}}$ control until the DB/$\overline{\text{OV}}$ indicator just lights.

NOTE

The voltage monitor is now set to allow the reclose timer to energize the reclose relay when the line and bus voltage conditions established in step 9 are encountered in the power control system.

STEP 10. (Sync-check logic only). To select the desired voltage levels for sync-check logic operation, perform the following:

NOTE

These steps will affect the LL and LB control settings established for the reclose timer. Refer to steps 9a and 9c.

a) For the line voltage level, adjust the T2 (line) output to the voltage level, above which, sync-check logic operation is desired. (If it is not desired to override the 80 Vac limit, and if the DL/$\overline{\text{OV}}$ control was adjusted in step 9b, adjust T2 below the limit and above the DL/$\overline{\text{OV}}$ setting.) Slowly adjust the LL control until the LL indicator just lights.

b) For the bus voltage level, adjust the T1 (bus) output to the voltage level above which, sync-check logic operation is desired. (If it is not desired to override the 80 Vac limit, and if the DB/$\overline{\text{OV}}$ control was adjusted in step 9d, adjust T1 below the limit and above the DB/$\overline{\text{OV}}$ setting.) Slowly adjust the LB control until the LL indicator just lights.

NOTE

The voltage monitor is now set to allow the sync-check logic to energize the reclose relay when the line and bus voltage conditions established in step 10 are encountered in the power control system.

STEP 11. If $\overline{\text{OV}}$ was selected (step 4 or 5) adjust the T1 (bus) and/or T2 (line) output voltages to the desired higher voltage level that represents the overvoltage limit level.

STEP 12. Slowly adjust the $\overline{\text{OV}}$ voltage level adjustments (DL/$\overline{\text{OV}}$ and DB/$\overline{\text{OV}}$) until the associated indicator just lights.

NOTE

The voltage monitor is now set to inhibit reclose timer operation and/or sync-check logic operation when the overvoltage conditions established in steps 11 and/or 12 are encountered in the power control system.

To check the operation of the relay with the resulting set-up, perform the following steps:

STEP 13. Momentarily press switch S1 to energize relay K1.

STEP 14. Close switch S4 to supply RI signal to relay.

STEP 15. Ensure that the RECLOSE TIME and RESET TIME controls are adjusted to the desired periods.

STEP 16. To ensure that the sync-check logic is inhibited from operation, set the phase shifter so that the phase difference between the line and bus is greater than the limit set up.

NOTE

Step 17, 18, and 19 check reclose timer operation.

STEP 17. To check reclose timer energization of the reclose relay, adjust the T1 (bus) and T2 (line) outputs to within the reclose enable zones established in steps 9 and 11 for the reclose timer.

STEP 18. Press and release switch S2. K1 should de-energize, then energize at the end of the period adjusted on the RECLOSE TIME control.

STEP 19. If the $\overline{\text{OV}}$ mode was selected, adjust the appropriate input voltage (T1 and/or T2) until the voltage exceeds the $\overline{\text{OV}}$ level. With K1 energized, press and release switch S2. Relay K1 should de-energize but not re-energize (verifying the inhibiting of reclose timer operation when an overvoltage condition exists).

NOTE

Steps 20-24 check sync-check logic operation.

STEP 20. To ensure that the sync-check logic is enabled, set the phase shifter to within the line and bus phase difference limit set up. Ensure that the TIME DELAY selector is adjusted to the desired period.

STEP 21. If the voltage difference option (Option 2-A, 2-R, or 2-T) is present, ensure that the T1 and T2 output voltages are within the limit established in *Voltage Difference ΔV Selection* when performing the next step.

STEP 22. To check the sync-check logic energization of the reclose relay, adjust the T1 (bus) and T2 (line) outputs to within the reclose enable zones established in steps 10 and 11 for the sync-check logic.

STEP 23. Press and release switch S2. K1 should de-energize, then energize at the end of the period selected on the TIME DELAY selector.

STEP 24. If the $\overline{\text{OV}}$ mode was selected, adjust the appropriate input voltage (T1 or T2) until the voltage exceeds the $\overline{\text{OV}}$ level. With K1 energized, press and release switch S2. Relay K1 should de-energize but not re-energize (verifying the inhibiting of sync-check logic operation when an overvoltage condition exists).

NOTE

The voltage monitor is now verified to operate in accordance with previous selections.

VOLTAGE DIFFERENCE ΔV SELECTION (OPTIONS 2-A, 2-R, AND 2-T ONLY)

STEP 1. Connect only T1, T2, and the voltmeters to relay terminals 6, 7, 8 and 9 as shown in Figure 5-1.

STEP 2. Adjust the ΔV control fully CCW.

STEP 3. Adjust the T1 (bus) and T2 (line) outputs to the desired maximum differential voltage.

STEP 4. Slowly adjust the ΔV control CW until the ΔV indicator just lights.

NOTE

The voltage difference circuitry is now set to allow sync-check logic operation when the line and bus voltage differential is within the limit established in step 4.

PREVENTING SYNC-CHECK CLOSING OF THE RECLOSE RELAY - UTILIZING THE J1/J2 SHORTING PLUG

NOTE

This set-up procedure includes an operational verification of the resulting set-up.

Removal of the J1/J2 shorting plug prevents sync check closing of the reclose relay. This effectively separates the operation of the reclose timer and the sync-check logic so that under all conditions only the reclose timer closes the reclose relay and only the sync-check logic closes the sync relay.

CAUTION

NEVER REMOVE OR INSTALL A PRINTED CIRCUIT BOARD WITH POWER APPLIED TO THE RELAY.

STEP 1. Remove all power from the relay.

STEP 2. Remove the front cover from the relay case.

STEP 3. Remove the three Phillips head screws from both sides of each applicable front cover plate. See Figure 3-4 (S1 case) or 3-5 (M1 case).

CAUTION

BE SURE TO OBSERVE THE PRINTED CIRCUIT BOARD HANDLING PRECAUTION PROCEDURES OUTLINED IN THE FRONT OF THIS MANUAL WHEN HANDLING PC BOARDS.

STEP 4. Remove the sync-check printed circuit board from the relay case by pulling straight out. See Figure 3-4 (S1 case) or Figure 3-5 (M1 case) for the location of the sync-check board.

STEP 5. Remove the J1/J2 shorting plug from the shorting position on the sync-check board and place on the storage position. See Figure 3-4 (S1 case) or Figure 3-5 (M1 case).

STEP 6. Installation of the sync-check board is the reverse of removal.

STEP 7. Connect the relay as shown in Figure 5-1.

STEP 8. Ensure that the RESET TIME control is adjusted to a suitable setting. Adjust the RECLOSE TIME control fully CW (maximum).

STEP 9. Ensure that the sync-check logic PHASE ANGLE control is adjusted to allow sync-check operation. Adjust the sync-check TIME DELAY selector to 01 and the X0.1/X1.0 multiplier to 0.1 for a time delay of 0.1 second.

STEP 10. If the voltage monitor option is installed in the relay, ensure that only CONDITION switch no. 2 is set to on (down), allowing live-line/live-bus operation only. Ensure the LL, LB, DL/$\overline{\text{OV}}$ and DB/$\overline{\text{OV}}$ controls are adjusted to allow live-line/live-bus operation.

STEP 11. If the voltage difference option is installed in the relay, ensure that the ΔV control is adjusted to allow sync-check logic operation.

STEP 12. Press and release switch S1, simulating breaker closure.

STEP 13. Close the R1 switch, S4.

STEP 14. Press and release switch S2, simulating a breaker trip. After the sync-check timer time delay of 0.1 second, the sync relay should close, lighting DS3. (The RESET indicator remains lit the LOCKOUT indicator remains out, and K1 remains de-energized, verifying that the sync-check logic no longer controls the reclose relay during the live-line/live-bus condition.)

After the reclose time of 2 seconds expires, the reclose relay closes, re-energizing K1 and removing the breaker open input, DS3 then goes out, the LOCKOUT indicator lights and the RESET indicator goes out (this verifies that the reclose timer now controls the reclose relay during the live-line/live-bus condition, in addition to the other conditions).

SECTION 6 • MAINTENANCE

GENERAL

The relay is a solid-state device and requires no preventive maintenance other than a periodic operational check. The procedures in Section 5 of this manual provide an adequate check to verify proper operation of the relay. If the relay fails to function, and factory repair is desired, contact the Customer Service Department of the Power Systems Group, Basler Electric, for a return authorization number prior to shipping.

Due to the fact that most components are on conformally coated printed circuit boards, in-house replacement of individual components may be difficult and should not be attempted unless appropriate equipment and adequately trained personnel are available.

NOTE

Is is recommended that the relay be returned to the factory for repair and recalibration due to the availability of factory or production quality test and calibration equipment as well as parts. If returned, as a minimum, the entire relay cradle should be shipped as an assembly, preferably in a case.

DISASSEMBLY

The following is a general description of the process required to disassemble Basler Protective Relays. It is not intended to apply to any specific relay. Therefore, in actual disassembly, care should be taken by watching for connecting cables and ribbons. Disconnect power before disassembly.

1. Remove the protective case front cover by first removing the thumbscrew located at bottom center.
2. Pull out the connecting plug(s) located above and below the drawout cradle. To aid withdrawal, a side-to-side motion, while pulling, is recommended.
3. Release top and bottom swivel latches.
4. Carefully slide the drawout cradle out of the case.
5. Remove the Phillips screws from the cradle front panel and pull panel off. Panel may be in sections.
6. To remove printed circuit boards, pull straight out. (Attempting printed circuit board component replacement is not recommended.)

The relay may be reassembled by reversing the procedure.

IN-HOUSE REPAIR

CAUTION

Removal and direct substitution of printed circuit boards or individual components does not necessarily mean the relay will operate properly without further calibration or verfication. Always check/calibrate the relay prior to replacing relay into the operating system.

When complete boards or assemblies are needed, the following information is required.

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

SECTION 7 • MANUAL CHANGE INFORMATION

CHANGES

This section contains information concerning the previous editions of the manual. The substantive changes to date are summarized in the Table 7-1.

Table 7-1. Changes

Revision	Summary of Changes	ECO/Date
A	Deleted all references to Service Manual, 9 1410 00 621. Deleted Style Number Block Diagram. Updated Style Number Identification Chart by changing Power Supply X from "230 Vac" to "240 Vac" and Option 3 from "(0) None" to "(0) No reclose fail timer (continuous reclose output until breaker closes)." Added new power supply information and updated isolation information to Specifications and Section 3 starting with "Basler Electric enhanced the power supply design..." Added RFI to *Specifications*. Added Figures to Section 3 to identify Controls and Indicators. Added new dimension diagrams to include all options available (S1 and M1 Cases, Double-Ended, both mounting positions) and added internal connection diagrams to Section 4. Added independent grounds to *Voltage Sensing Connections*. Added new Section 7 "Manual Change Information." Changed the format of the manual.	641/10-02-98
B	Updated the drawings of the S1 and M1 cases in section 4 to the latest drawings.	12244/02-08-01

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