SEL-279H-1 Relay

Two-Breaker Reclosing Relay
Voltage Relay
Synchronism Check Relay

Instruction Manual

20071030

SCHWEITZER ENGINEERING LABORATORIES, INC.

WARNING: This device is shipped with default passwords. Default passwords should be changed to private passwords at installation. Failure to change each default password to a private password may allow unauthorized access. SEL shall not be responsible for any damage resulting from unauthorized access.

AVERTISSEMENT: Cet équipement est expédié avec des mots de passe par défaut. A l'installation, les mots de passe par défaut devront être changés pour des mots de passe confidentiels. Dans le cas contraire, un accès non-autorisé à l'équipement pourrait être possible. SEL décline toute responsabilité pour tout dommage résultant de cet accès non-autorisé.

PM279H-02

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SECTION 1: INTRODUCTION

GETTING STARTED

If you are not familiar with this relay, we suggest that you read this introduction, then perform the ***Initial Checkout Procedure*** in ***Section 7: Maintenance and Testing***.

OVERVIEW

The SEL-279H-1 Relay:

- Controls one or two breakers for delayed and high-speed reclosures
- Includes all logic and elements required for restoration, test, and synchronism check to:
  - Restore dead bus from hot line (hot line/dead bus)
  - Test dead line from hot bus (dead line/hot bus)
  - Connect two hot systems (hot line/hot bus/synchronism)
  - Open breaker status only (no voltage checks)
- Separate timers per breaker for single-pole and three-pole reclosures
- SELOGIC® control equations allow custom reclosing, alarm, and control schemes
- Event reports show reclosing sequences and timing
- Accepts three-phase wye, delta, or single-phase voltage inputs
- Makes an ideal reclosing relay for retrofits or new installations
- Includes:

Serial communications ports	Automatic self-testing
Metering	Horizontal or vertical mounting

GENERAL DESCRIPTION

The relay includes all logic and voltage elements needed to control reclosing sequences and perform synchronism check functions for up to two line breakers. Applications include:

- Single, ring-bus, or breaker-and-a-half installations
- Single-pole or three-pole tripping schemes

Metering and sequence-of-event recording capabilities enhance the basic package. SELOGIC control equations for programming the output contacts and assigning the logic input functions gives this unit unparalleled flexibility.

Time-Delayed and High-Speed Reclosing Restore Normal Power System Operation

The SEL-279H-1 Relay provides both time-delayed and high-speed reclose functions.

Use these reclosing functions to:

- Test a dead line from a hot bus
- Energize a dead bus from a hot line
- Connect two hot systems with instantaneous or delayed synchronism supervision, or
- Connect two systems, regardless of voltage conditions

The relay provides up to two reclose attempts for these and other conditions. Internal under- and overvoltage and synchronism check elements may be enabled to supervise reclosing.

Automatically Transfer Breaker Reclose Logic when Removing One Breaker from Service

In some two-breaker applications, one breaker is primary (or first to close) and the remaining breaker is designated secondary. When the primary breaker is removed from service, the relay can automatically transfer the primary breaker reclose timing and logic (including synch-check) to the secondary breaker. This allows the secondary breaker to close as if it were the primary breaker without operator intervention.

Analyze Reclosing Sequences Using Event Reports

The relay stores voltage, relay element, input, and output contact information in a sequence-of-event type format as an event report. You select which conditions generate event reports. The information in each full report is 48 cycles long with cycle resolution. The twelve latest reports are stored. Event reporting economically provides valuable engineering and operating information, eliminating the need for event recorders and oscillographs in most applications.

Access Relay Information with Local and Remote Communications

Two EIA-232 serial communications ports (Port 1 and Port 2) allow local or remote communications with the relay. Baud rates are separately settable for these ports.

Voltage Metering on Both Sides of the Line Breaker(s)

The relay meters per-phase voltages on both sides of the line breaker(s). Per-phase voltage-magnitude differences and positive-sequence voltage are also metered.

Automatic Self-Testing Enhances Relay Reliability and Availability

The relay runs a variety of self-tests. The ALARM OUT contact closes for a self-test failure or loss-of-power, immediately alerting maintenance personnel of relay service needs.

Sample Applications

The bus/line arrangements shown in Figure 1.1 illustrate a sampling of installations where the SEL-279H-1 Relay is applicable.

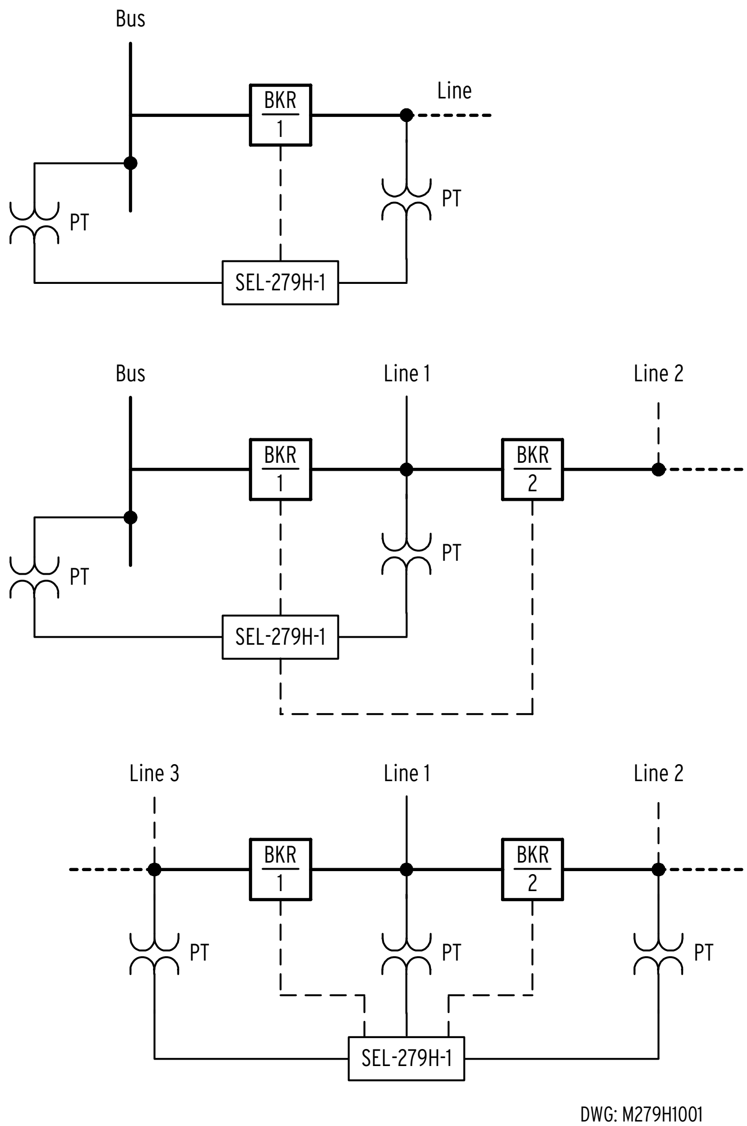

Figure 1.1: Example SEL-279H-1 Relay Bus/Line Applications

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SECTION 2: SPECIFICATIONS

GENERAL SPECIFICATIONS

AC Input Voltages	270 V rms for each voltage input V1, V3, V5, V2, V4, and V6
Limiting Short-Time Thermal Withstand	Voltage Inputs 365 Vac for 10 seconds
Output Contacts	Using the simplified method of assessment (IEC 255-0-20:1974, 5.2.2)

Making Capacity (per IEC 255-0-20:1974, 5.1.1)

30 Amps (dc)

Breaking Capacity (per IEC 255-0-20:1974, 5.1.2) L/R = 40 ms

48 V	0.5 Amps (dc)	10,000 operations
125 V	0.3 Amps (dc)	10,000 operations
250 V	0.2 Amps (dc)	10,000 operations

Cyclic Capacity (per IEC 255-0-20:1974, 5.1.3)

48 V	0.5 Amps (dc)	2.5 cycles per second
125 V	0.3 Amps (dc)	2.5 cycles per second
250 V	0.2 Amps (dc)	2.5 cycles per second

Continuous Capacity (per IEC 255-0-20:1974, 5.1.4)

6 Amps (dc)

Short Time Capacity (per IEC 255-0-20:1974, 5.1.5)

100 Amps (dc) for one second

Optoisolated Inputs

24 Vdc:	15–30 Vdc
48 Vdc:	30–60 Vdc
250 Vdc:	150–300 Vdc

Current = 4 mA at nominal voltage

Fixed "Level-Sensitive" inputs are provided on relays with 125 Vdc optoisolated inputs. The 125 Vdc optoisolated inputs each draw 6 mA when nominal control voltage is applied.

125 Vdc: on for 100–150 Vdc; off below 75 Vdc

Communications Two EIA-232 serial communications ports (Ports 1 and 2) with separately settable baud rates. Port 2 has front and rear panel connectors. The ports use standard, 9-pin subminiature "D" connectors.

Frequency	50 or 60 Hz (specified when ordered)
Power Supply	24/48 V: 20–60 Vdc; 125/250 V: 85–350 Vdc or 85–264 Vac 10 W nominal, 14 W max. (all output relays energized)
Rated Burden	Voltage Inputs 0.3 VA @ 270 V 0.45 VA @ 365 V
Timer Accuracy	Pickup: ±1 cycle Dropout: ±1 cycle
Relay Dimensions	Refer to Figure 6.3
Mounting	Available in horizontal and vertical mounting configurations
Dielectric Strength	2500 Vac for 10 seconds on analog inputs (per IEC 255-5:1977) 3100 Vdc for 10 seconds on power supply, logic inputs, and contact outputs (per IEC 255-5:1977)
Operating Temp.	–40° to 158°F (–40° to 70°C)
Unit Weight	16 pounds (7.3 kg)
Shipping Weight	Approximately 23 pounds (10.4 kg), including two instruction manuals

Type Tests and Standards

IEEE C37.90.1 IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.

IEEE C37.90.2 IEEE Trial-Use Standard, Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.

Exceptions:

5.5.2 (2)	Performed with 200 frequency steps per octave
5.5.3	*Digital Equipment Modulation Test* not performed
5.5.4	Test signal turned off between frequency steps to simulate keying

IEC 68-2-30 Basic environmental testing procedures, Part 2: Tests, Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle).
Humidity, 95% between 25°C and 55°C.

IEC 255-5 Electrical relays, Part 5: Insulation tests for electrical relays.
Impulse voltage test, 0.5 Joule, 5000 volt.

IEC 255-21-1 Electrical relays, Part 21: Vibration, shock, bump, and seismic tests on measuring relays and protection equipment, Section One - Vibration test (sinusoidal).
Severity Level: 1

IEC 255-21-2 Electrical relays, Part 21: Vibration, shock, bump, and seismic tests on measuring relays and protection equipment, Section Two - Shock and bump tests.
Severity Level: 1

IEC 801-2 Electromagnetic compatibility for industrial-process measurement and control equipment, Part 2: Electrostatic discharge requirements.
Severity Level: 4

IEC 801-4 Electromagnetic compatibility for industrial-process measurement and control equipment, Part 4: Electrical fast transient/burst requirements.
Severity Level: 4

Voltage Element Accuracy 0 to 230 Volts rms, ±1 Volts rms ±3% of setting.

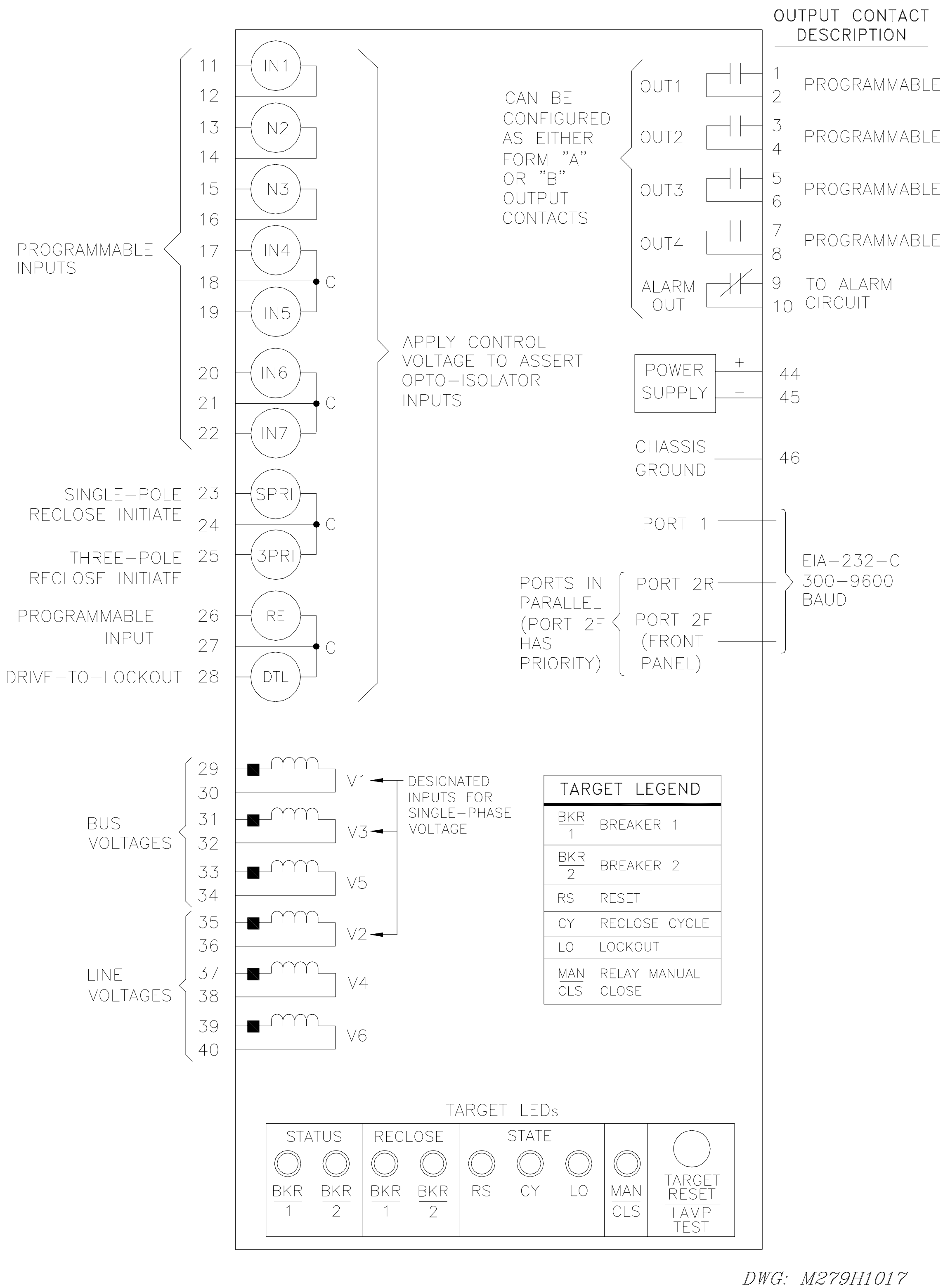

Figure 2.1: SEL-279H-1 Relay Input, Output, and Target Diagram

BASIC FUNCTIONAL OVERVIEW

Inputs (see Figure 2.1)

The relay ac voltage inputs are taken from one, two, or three voltage sources (refer to ***Section 6: Installation*** for connection examples). These voltages are used for dead bus or line (27B or 27L), hot bus or line (59B or 59L), and synchronism checking elements. The status of these voltage elements, inputs, and recloser status (reset, cycle, or lockout) are available for programming reclose control, alarm, and control scheme needs.

The relay has eleven optically isolated inputs: eight are assignable, three have fixed function assignments. Energize these optically isolated inputs from line breaker status contact(s), external contacts and switches. These logic inputs read the circuit breaker position, initiate or block reclosures, and enable or disable reclosing functions.

SELOGIC Control Equations for Programmable Logic (see Figure 2.2)

SELOGIC® control equations include ANDing, ORing, inverting functions, timing, and programmable inputs and outputs. SELOGIC control equations add power and flexibility while simplifying programming.

Use this programmable logic to assign conditions for:

- Starting and completing reclose timing
- Canceling reclose
- Reclose reset timing
- Event report triggering

Output Contacts (see Figure 2.1)

The relay has four programmable output contacts labeled OUT1 through OUT4. Each output contact is rated for close duty. SELOGIC control equations allow programming the output contacts with logic conditions, relay element status, or combinations of these to close breakers, generate status or alarm conditions. The ALARM OUT contact closes in response to any self-test failure or loss-of-power.

Relay Word

Each Relay Word bit has two states: logical 1 when asserted, logical 0 when not asserted.

Table 2.1: Relay Word

Row 1	**27B**	**27L**	**59B**	**59L**	**25T1**	**25T2**	**CLS1**	**CLS2**
Row 2	**SPC1**	**SPC2**	**3PC1**	**3PC2**	**RSET**	**CYCL**	**LOCK**	**OTT**
Row 3	**52A1**	**52A2**	**52BT1**	**52BT2**	**79OIT**	**3PRI**	**SPRI**	**79SH**
Row 4	**LTCH**	**A**	**B**	**C**	**D**	**E**	**ST**	**!L**
Row 5	**G**	**H**	**I**	**!M**	**W**	**X**	**Y**	**ZT**
Row 6	**RE**	**IN7**	**IN6**	**IN5**	**IN4**	**IN3**	**IN2**	**IN1**

Table 2.2 defines the Relay Word bits displayed in Table 2.1. Figure 2.2 shows how the Relay Word bits are used in SELOGIC control equations. The following ***Relay Settings and Logic*** portion in this section provides more settings details.

Table 2.2: Relay Word Bit Definitions

Bit	Definition
27B	Dead bus voltage element–asserts for bus voltage below setting 27B (see Figure 2.5)
27L	Dead line voltage element–asserts for line voltage below setting 27L (see Figure 2.6)
59B	Hot bus voltage element–asserts for bus voltage above setting 59B (see Figure 2.7)
59L	Hot line voltage element–asserts for line voltage above setting 59L (see Figure 2.8)
25T1	Breaker 1 time delayed synchronism check element (see Figure 2.9)
25T2	Breaker 2 time delayed synchronism check element (see Figure 2.10)
CLS1	Breaker 1 close logic output–asserts for auto reclose or manual close (see Figure 2.20)
CLS2	Breaker 2 close logic output–asserts for auto reclose or manual close (see Figure 2.21)
SPC1	Breaker 1 single-pole reclose output to Breaker 1 close logic (see Figure 2.11)
SPC2	Breaker 2 single-pole reclose output to Breaker 2 close logic (see Figure 2.13)
3PC1	Breaker 1 three-pole reclose output to Breaker 1 close logic (see Figure 2.12)
3PC2	Breaker 2 three-pole reclose output to Breaker 2 close logic (see Figure 2.14)
RSET	Reset State (see Figure 2.17)
CYCL	Reclose Cycle State (see Figure 2.17)
LOCK	Lockout State (see Figure 2.17)
OTT	Overall timer time-out (see Figure 2.18)
52BT2	Breaker 2 out-of-service (see Figure 2.4)
79OIT	Asserts for any reclose open interval timer timing, Breaker 1 or Breaker 2
3PRI	Input 3PRI bit, asserts for control voltage applied to input 3PRI
SPRI	Input SPRI bit, asserts for control voltage applied to input SPRI
79SH	Shot bit; asserts for shots selected by the M79SH setting

Bit	Definition
B	Select any OR-combination of elements in Rows 1, 2, 3, and 6
C	Select any OR-combination of elements in Rows 1, 2, 3, and 6
D	Select any OR-combination of elements in Rows 1, 2, 3, and 6
E	Select any OR-combination of elements in Rows 1, 2, 3, and 6
ST	Output of timer TS, driven by any selected OR-combination of elements in Rows 1, 2, 3, and 6 to setting S
!L	Output from inverter, driven by any select OR-combination of elements in Rows 1, 2, 3, and 6 to setting L
G	Select any AND-combination of elements in Rows 1, 2, 3, and 4
H	Select any AND-combination of elements in Rows 1, 2, 3, and 4
I	Select any AND-combination of elements in Rows 1, 2, 3, and 4
!M	Output from inverter, driven by any select AND-combination of elements in Rows 1, 2, 3, and 4 to setting M
W	Select any AND-combination of elements in Row 4
X	Select any AND-combination of elements in Row 4
Y	Select any AND-combination of elements in Row 4
ZT	Output of timer TZ, driven by any selected AND-combination of elements in Row 4 to setting Z
RE	Input RE bit, asserts for control voltage applied to input RE
IN7	Input IN7 bit, asserts for control voltage applied to input IN7
IN6	Input IN6 bit, asserts for control voltage applied to input IN6
IN5	Input IN5 bit, asserts for control voltage applied to input IN5
IN4	Input IN4 bit, asserts for control voltage applied to input IN4
IN3	Input IN3 bit, asserts for control voltage applied to input IN3
IN2	Input IN2 bit, asserts for control voltage applied to input IN2
IN1	Input IN1 bit, asserts for control voltage applied to input IN1

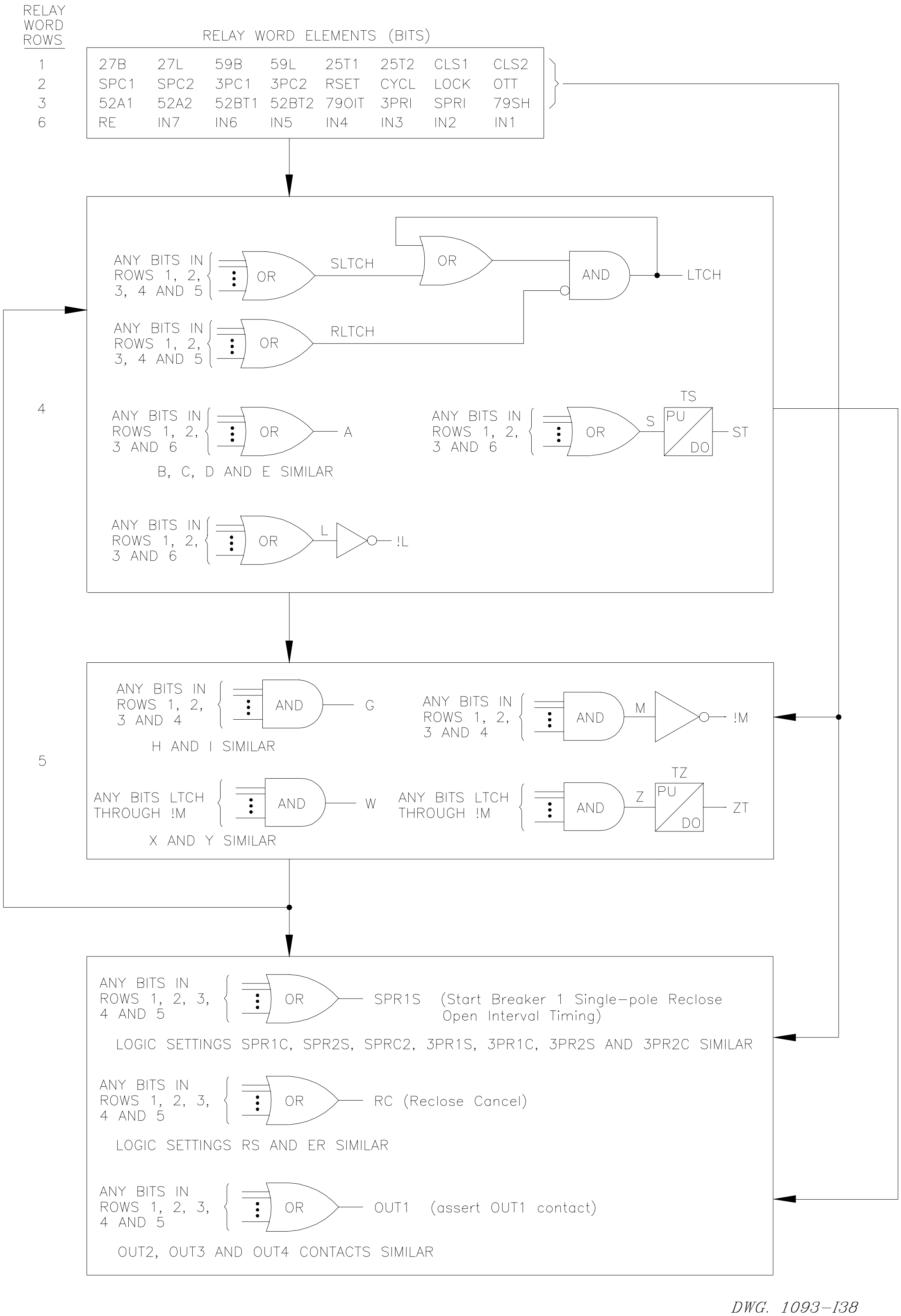

Figure 2.2: SEL-279H-1 Relay SELOGIC Control Equations Block Diagram

Relay Settings and Logic

The SEL-279H-1 Relay uses a variety of settings to define breaker control and voltage measurement. These settings are:

- BKRC Breaker Control setting
- VSRC Voltage Input Source setting
- LNM Line Voltage Measurement setting
- BSM Bus Voltage Measurement setting

Other settings (e.g., voltage element and timer settings) are explained as they are used in the following logic explanations. They are also listed in the **SET** command explanation in ***Section 3: Communications***.

Programmable input options are listed in the **INPUT** command explanation in ***Section 3: Communications***.

SELOGIC control equations settings are explained as they are used in the following logic explanations. They are also listed in the **LOGIC** command explanation in ***Section 3: Communications***.

Breaker Control Setting (BKRC)

The choices for the Breaker Control setting are BKRC = 0, 1, or 2.

BKRC = 0

The relay controls two breakers with independent reclosing logic.

BKRC = 1

The relay controls one breaker designated as Breaker 1. This setting allows Breaker 1 to also use the Breaker 2 reclose logic.

BKRC = 2

The relay controls two breakers with Breaker 1 as the primary breaker (first to close) and Breaker 2 as the secondary breaker (follows the primary breaker). However, if the primary breaker is taken out-of-service, then the primary breaker reclose timing and logic transfer to the secondary breaker.

Voltage Input Source Setting (VSRC)

The choices for the Voltage Input Source setting are VSRC = 0, 2, or 3.

VSRC = 0

If no line or bus voltage is connected to the relay, set VSRC = 0 and the voltage and synchronism check elements are inoperative. The dead bus and line voltage elements are always asserted. The hot bus and line voltage elements are always deasserted.

VSRC = 2

If only one voltage source is connected to the relay (e.g., the line voltage) or the voltages on the line and bus side of one breaker are connected to the relay, set VSRC = 2.

Setting VSRC = 2 does not preclude having two breaker control (setting BKRC = 0 or 2). Voltages are brought in from both sides of designated Breaker 1.

If only one voltage source is connected, it can be wired to either the line or bus voltage inputs. The voltage source can be either single-phase or three-phase.

If both the line and bus voltage are connected to the relay, the voltage sources can be either single-phase or three-phase.

For single-phase voltage:

Connect single-phase bus voltage to voltage input V1.

Connect single-phase line voltage to voltage input V2.

VSRC = 3

If two breakers are to be controlled (setting BKRC = 0 or 2) and it is desired to monitor voltage from all three sides of the two controlled breakers (refer to Figure 6.6 in ***Section 6: Installation***), set VSRC = 3. Only single-phase voltage can be brought in from the bus-sides of both breakers:

Connect single-phase voltage from the bus-side of Breaker 1 to voltage input V1.

Connect single-phase voltage from the bus-side of Breaker 2 to voltage input V3.

The line-side voltage, common to both breakers, can be three-phase (use voltage inputs V2, V4, and V6) or single-phase (use voltage input V2).

Line Voltage Measurement Setting (LNM)

The choices for the Line Voltage Measurement setting are LNM = 0, 1, 3, or P. This setting determines the nature of the hot and dead line voltage elements.

LNM = 0

If no line voltage is connected to the relay, set LNM = 0 and the line voltage elements are inoperative (the dead line voltage element is always asserted).

LNM = 1

If single-phase line voltage is connected to the relay, set LNM = 1 and the line voltage elements operate as single-phase elements (connect single-phase line voltage to voltage input V2).

LNM = 3, or P

If three-phase line voltage is connected to the relay:

Set LNM = 3 and the line voltage elements operate as three-phase elements

or

Set LNM = P and the line voltage elements operate from positive-sequence voltage.

Bus Voltage Measurement Setting (BSM)

The choices for the Bus Voltage Measurement setting are BSM = 0, 1, 3, or P. This setting determines the nature of the hot and dead bus voltage elements.

If voltage is monitored from all three sides of two controlled breakers, setting VSRC = 3 and the BSM setting is ignored.

BSM = 0

If no bus voltage is connected to the relay, set BSM = 0 and the bus voltage elements are inoperative (the dead bus voltage element is always asserted).

BSM = 1

If single-phase bus voltage is connected to the relay, set BSM = 1 and the bus voltage elements operate as single-phase elements (connect single-phase bus voltage to voltage input V1).

BSM = 3, or P

If three-phase bus voltage is connected to the relay:

Set BSM = 3 and the bus voltage elements operate as three-phase elements

or

Set BSM = P and the bus voltage elements operate from positive-sequence voltage.

Breaker Status and Out-of-Service Logic (see Figure 2.4)

Breaker Status

Breaker status can be provided by 52a or 52b breaker status contacts. The breaker status input assignments of:

Breaker 1 (primary breaker)

Breaker 2 (secondary breaker)

are made separately to any programmable input. For example, if programmable input IN1 is to be the breaker status input for a 52b contact from Breaker 1, the following setting is made:

IN1 = !52A1

All relay logic operates on "52a" type breaker status, so 52b inputs are inverted to provide **52A1** and **52A2** for Breaker 1 and Breaker 2 status, respectively.

Out-of-Service

The out-of-service timers qualify a breaker as being open for a set period of time:

52PU1 (Breaker 1 Out-of-service Pickup Delay setting)

52PU2 (Breaker 2 Out-of-service Pickup Delay setting)

The out-of-service timers begin timing when the breaker is open and the recloser is not in the cycle state. If the timer is timing to an out-of-service condition and the recloser enters the cycle state, timing is stalled until the recloser is not in the cycle state.

Once qualified, the breaker is deemed “out-of-service”—it cannot be automatically reclosed. If the breaker control setting BKRC = 2, then Breaker 1 reclose timing and logic is automatically transferred to Breaker 2.

An example of being “out-of-service” is opening Breaker 1 manually so it operates as a “normally open” breaker on the system. Once time 52PU1 has timed out for Breaker 1, it is deemed “out-of-service” (**52BT1** = logical 1).

An “out-of service” breaker can only be put back into service by manually closing the breaker and qualifying it as being closed for a set period of time:

52DO1 (Breaker 1 Out-of-service Dropout Delay setting)

52DO2 (Breaker 2 Out-of-service Dropout Delay setting)

Once qualified, the breaker is deemed “in-service”—it can be automatically reclosed.

Continuing with the example, if “out-of-service” Breaker 1 is manually closed, then dropout time 52DO1 starts timing. When 52DO1 times out, Breaker 1 is back “in-service” (**52BT1** = logical 0).

Dead Bus Voltage Logic (see Figure 2.5)

The dead bus voltage element, **27B,** indicates a dead bus voltage condition (**27B** = logical 1). The **27B** element monitors voltage based upon the BSM setting (explanation follows) and the VSRC setting.

When VSRC = 3, a single-phase voltage is connected from all sides of the two breakers. A total of three separate single-phase voltages may be connected (the line side may use three-phase voltages connected to voltage inputs V2, V4, and V6):

V1 for Breaker 1 bus-side voltage.

V3 for Breaker 2 bus-side voltage.

V2 for the line-side voltage between Breakers 1 and 2.

V1 and V3 are used as follows:

Breaker 1 is in-service (**52BT1** = logical 0), then V1 is monitored for the dead bus voltage condition.

or

Breaker 1 is out-of-service (**52BT1** = logical 1) and Breaker 2 is in-service (**52BT2** = logical 0), then V3 is monitored for the dead bus voltage condition.

When VSRC = 2, the nature of the dead bus voltage element (**27B**) changes depending on the Bus Voltage Measurement setting BSM:

BSM = P, positive-sequence bus voltage (VPB) is monitored (VPB is derived from three-phase bus voltage V1, V3, and V5).

BSM = 1, single-phase bus voltage V1, is monitored.

BSM = 3, three-phase bus voltage V1, V3, and V5 is monitored.

Dead Line Voltage Logic (see Figure 2.6)

The dead line voltage element, **27L**, indicates a dead line voltage condition (**27L** = logical 1). The nature of the dead line voltage element (**27L**) changes depending on the Line Voltage Measurement setting LNM:

LNM = P, positive-sequence line voltage (VPL) is monitored (VPL is derived from three-phase line voltage V2, V4, and V6).

LNM = 1, single-phase line voltage V2, is monitored.

LNM = 3, three-phase line voltage V2, V4, and V6 is monitored.

Hot Bus Voltage Logic (see Figure 2.7)

The hot bus voltage element, **59B**, indicates a hot bus voltage condition (**59B** = logical 1). The **59B** element monitors voltage based upon the BSM setting (explanation follows) and the VSRC setting.

When VSRC = 3, a single-phase voltage is connected from all sides of the two breakers. A total of three separate single-phase voltages may be connected (the line side may use three-phase input voltages connected to voltage inputs V2, V4, and V6):

V1 for Breaker 1 bus-side voltage

V3 for Breaker 2 bus-side voltage

V2 for the line-side voltage between Breakers 1 and 2

V1 and V3 are used as follows:

Breaker 1 is in-service (**52BT1** = logical 0), then V1 is monitored for the bus over-voltage condition.

or

Breaker 1 is out-of-service (**52BT1** = logical 1) and Breaker 2 is in-service (**52BT2** = logical 0), then V3 is monitored for the hot bus voltage condition.

When VSRC = 2, the nature of the hot bus voltage element (**59B**) changes depending on the Bus Voltage Measurement setting BSM:

BSM = P, positive-sequence bus voltage (VPB) is monitored (VPB is derived from three-phase bus voltage V1, V3, and V5).

BSM = 1, single-phase bus voltage V1, is monitored.

BSM = 3, three-phase bus voltage V1, V3, and V5 is monitored.

Hot Line Voltage Logic (see Figure 2.8)

The hot line voltage element, **59L**, indicates a hot line voltage condition (**59L** = logical 1). The nature of the hot line voltage element (**59L**) changes depending on the Line Voltage Measurement setting LNM:

LNM = P, positive-sequence line voltage (VPL) is monitored (VPL is derived from three-phase line voltage V2, V4, and V6).

LNM = 1, single-phase line voltage V2, is monitored.

LNM = 3, three-phase line voltage V2, V4, and V6 is monitored.

Synchronism Check Element Operation

Synchronism check elements **25T1** and **25T2**, control synchronism checking for Breaker 1 (**25T1**) and Breaker 2 (**25T2**).

The following example demonstrates how to make these settings. The example uses single-phase voltage across Breaker 1 (V1 for the bus, V2 for the line).

Example Synchronism Check Difference Voltage Setting (25DV)

In Figure 2.3, ϕ is the maximum phase angle across the circuit breaker allowed for synchronism check reclosing. No phase angle setting is made in the SEL-279H-1 Relay. A Synchronism Check Difference Voltage setting (25DV) is made instead.

In this setting example, the Hot Bus Voltage Threshold (59B) and Hot Line Voltage Threshold (59L) are set the same. Voltage V1 and V2 are equal in magnitude in Figure 2.3. Knowing the desired maximum phase angle ϕ, the 25DV setting is derived as follows:

$$\sin(\phi/2) = (25DV/2)/(59B)$$

Solving for setting 25DV:

$$25DV = 2(59B)[\sin(\phi/2)]$$

For a desired maximum phase angle ϕ = 17° and 59B = 56 V, secondary:

$$\begin{aligned} 25DV &= 2(56 \text{ V, secondary})[\sin(17°/2)] \\ &= 17 \text{ V, secondary} \end{aligned}$$

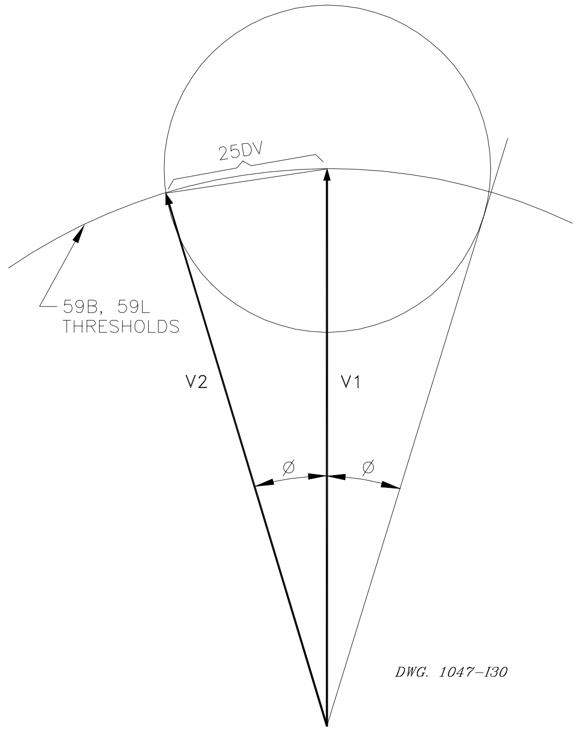

Figure 2.3: SEL-279H-1 Relay Synchronism Check

Example Synchronism Check Delay Setting (25D)

The Synchronism Check Delay setting 25D provides time qualification for the synchronism check elements and is related to the maximum slip frequency as follows (setting 25D set in cycles):

max. slip freq. = [2ϕ/(360°/slip cycle)] [(1/25D)(60 cycles/second)]

{ϕ/[3(25D)]}[(slip cycle • cycles)/(degrees • second)]

The maximum slip frequency is the maximum frequency difference between voltages V1 and V2 that can be tolerated for synchronism check reclosing (see Figure 2.3). Solving for setting 25D:

25D = {ϕ/[3(max. slip freq.)]}[(slip cycle • cycles)/(degrees • second)]

For a desired maximum phase angle ϕ = 17° and maximum slip frequency = 0.0472 Hz (Hz in terms of slip cycles/second):

25D = {17°/[3(0.0472 slip cycles/second)]}[(slip cycle • cycles)/(degrees • second)]

= 120 cycles

Breaker 1 Synchronism Check Logic (see Figure 2.9)

The Breaker 1 time-delayed synchronism check element, **25T1**, provides time-qualified synchronism checking for Breaker 1 (primary breaker).

Two-Breaker Control (General)

When two breakers are being controlled by the SEL-279H-1 Relay:

Breaker 1 (primary breaker)

Breaker 2 (secondary breaker)

Single-phase voltage is connected on all sides of the breakers. A total of three separate single-phase voltages are connected (Voltage Input Source setting VSRC = 3 is required):

V1 for Breaker 1 bus-side voltage

V3 for Breaker 2 bus-side voltage

V2 for the line-side voltage between Breakers 1 and 2

Single-phase synchronism checking is performed across Breaker 1, using voltages V1 and V2.

Two-Breaker Control (Independent; BKRC = 0)

If Breaker Control setting BKRC = 0, synchronism check 1 logic is always enabled for Breaker 1. No automatic transfer takes place. Synchronism checking for Breakers 1 and 2 operates independently.

Two-Breaker Control (Automatic Transfer; BKRC = 2)

Automatic transfer is the Breaker 1 reclose timing and logic transferring to Breaker 2 if Breaker 1 is out-of-service. Breaker Control setting BKRC = 2 has to be made.

In this operating mode, Breaker 1 synchronism check logic is enabled, unless both the following conditions are true:

Breaker 1 is out-of-service (Breaker 1 open for greater than setting time 52PU1; **52BT1** = logical 1).

Breaker 2 is in-service (**52BT2** = logical 0).

Breaker 1 synchronism check logic is then disabled and Breaker 2 synchronism check logic is enabled. In effect, synchronism checking "transfers" from Breaker 1 to Breaker 2.

Single-Breaker Control

If voltage is brought in from the bus- and line-sides of Breaker 1, Voltage Input Source setting VSRC = 2 is required.

For single-phase synchronism check across Breaker 1 the following connections are made:

V1 for Breaker 1 bus-side voltage

V2 for Breaker 1 line-side voltage

For three-phase synchronism check across Breaker 1 the following connections are made:

V1, V3, and V5 for Breaker 1 bus-side voltage

V2, V4, and V6 for Breaker 1 line-side voltage

Breaker 2 Synchronism Check Logic (see Figure 2.10)

The Breaker 2 time-delayed synchronism check element, **25T2**, provides time-qualified synchronism checking for Breaker 2 (secondary breaker).

Two-Breaker Control (General)

When two breakers are being controlled by the SEL-279H-1 Relay:

Breaker 1 (primary breaker)

Breaker 2 (secondary breaker)

Single-phase voltage is brought in from all sides of the breakers. A total of three separate single-phase voltages are connected (Voltage Input Source setting VSRC = 3 is required):

V1 for Breaker 1 bus-side voltage

V3 for Breaker 2 bus-side voltage

V2 for the line-side voltage between Breakers 1 and 2

Single-phase synchronism checking is performed across Breaker 2, using voltages V2 and V3.

Two-Breaker Control (Independent; BKRC = 0)

If Breaker Control setting BKRC = 0, synchronism check 2 logic is always enabled for Breaker 2. No automatic transfer takes place. Synchronism checking for breakers 1 and 2 operates independently.

Two-Breaker Control (Automatic Transfer; BKRC = 2)

Automatic transfer is the Breaker 1 reclose timing and logic transferring to Breaker 2 if Breaker 1 is out-of-service. Breaker Control setting BKRC = 2 has to be made.

In this operating mode, Breaker 2 synchronism check logic is:

Disabled if Breaker 1 is in-service (**52BT1** = logical 0).

Enabled if Breaker 1 is out-of-service (**52BT1** = logical 1). In effect, synchronism checking "transfers" from Breaker 1 to Breaker 2.

Single-Breaker Control (BKRC = 1)

If single-breaker control is selected (Breaker Control setting BKRC = 1), only Breaker 1 (primary breaker) is controlled by the SEL-279H-1 Relay. Breaker 2 is not controlled at all by the SEL-279H-1 Relay and thus Breaker 2 synchronism check logic is disabled.

Breaker 1 Single-Pole Reclose Logic (see Figure 2.11)

Single-Pole Reclose Initiation

Single-pole reclose initiation for Breaker 1 occurs when all the following conditions are true:

The SEL-279H-1 Relay is in the reset state (**RSET** = logical 1).

The Breaker 1 Single-pole Reclose Open Interval setting SOI1 ≠ 0. Setting SOI1 = 0 defeats the Breaker 1 Single-pole Reclose logic.

Breaker 1 is closed (**52A1** = logical 1).

Breaker 1 is not out-of-service (**52BT1** = logical 0).

The SPRE input is asserted (if SPRE is assigned to an input).

The SEL-279H-1 Relay detects the rising-edge of the assertion of the single-pole reclose initiate input (SPRI).

If automatic transfer is enabled by Breaker Control setting BKRC = 2, Breaker 1 single-pole reclose logic transfers to Breaker 2 if:

Breaker 1 is out-of-service (**52BT1** = logical 1)

Breaker 2 is in-service (**52BT2** = logical 0)

Then if Breaker 2 is closed (**52A2** = logical 1) and the SEL-279H-1 Relay detects the rising-edge of the assertion of input SPRI, single-pole reclosing is initiated for Breaker 2, with the Breaker 1 Single-pole Reclose Open Interval setting SOI1.

Single-Pole Reclose Open Interval Timing

Breaker 1 single-pole reclose open interval timer starts timing (setting SOI1) if the supervising SPR1S condition is true or not set (SPR1S = NA) and the single-pole reclose initiate condition is true. SPR1S is the programmable Start Breaker 1 Single-pole Reclose Open Interval Timing logic setting.

Single-pole open interval timing can be stalled if a programmable input is assigned the SRT1 function (stall Breaker 1 reclose timing) and this input is asserted.

Single-pole open interval timing is completely shut down and disabled if any of the following occur:

Input 3PRI (three-pole reclose initiate) is asserted–most likely from a fault evolving to involve multiple phases.

The relay has been driven to last shot.

The CLS1 Relay Word bit asserts. CLS1 is the output of the final Breaker 1 close logic. CLS1 is assigned to a programmable output contact to close Breaker 1.

Automatic transfer control has been selected (Breaker Control setting BKRC = 2), Breaker 1 is out-of-service (52BT1 = logical 1), and the CLS2 Relay Word bit asserts. CLS2 is the output of the final Breaker 2 close logic. CLS2 is assigned to a programmable output contact to close Breaker 2. (Automatic transfer is the Breaker 1 reclose timing and logic transferring to Breaker 2 if Breaker 1 is out-of-service.)

Single-Pole Reclose Output

When the Breaker 1 single-pole reclose open interval timer times out, the SPC1 Relay Word bit asserts if the supervising SPR1C condition is true or not set (SPR1C = NA). SPR1C is the programmable Complete Breaker 1 Single-pole Reclose logic setting.

Relay Word bit SPC1 runs into the Breaker 1 close logic for the final logic step to reclosing Breaker 1.

Breaker 1 Three-Pole Reclose Logic (see Figure 2.12)

Three-Pole Reclose Initiation

Three-pole reclose initiation for Breaker 1 occurs when all the following conditions are true:

The Breaker 1 Three-pole Reclose Open Interval setting 3OI1 ≠ 0. Setting 3OI1 = 0 defeats the Breaker 1 Three-pole Reclose logic.

Breaker 1 is closed (**52A1** = logical 1).

Breaker 1 is not out-of-service (**52BT1** = logical 0).

The 3PRE input is energized (if 3PRE is assigned to an input).

The SEL-279H-1 Relay detects the rising-edge of the assertion of the three-pole reclose initiate input (3PRI).

If automatic transfer is enabled by Breaker Control setting BKRC = 2, Breaker 1 three-pole reclose logic transfers to Breaker 2 if:

Breaker 1 is out-of-service (**52BT1** = logical 1).

Breaker 2 is in-service (**52BT2** = logical 0).

Then if Breaker 2 is closed (**52A2** = logical 1) and the SEL-279H-1 Relay detects the rising-edge of the assertion of input 3PRI, three-pole reclose is initiated for Breaker 2, with the Breaker 1 Three-pole Reclose Open Interval setting 3OI1.

If a single-pole reclose initiation has already occurred, the relay is in the reclose cycle state (**CYCL** = logical 1) and Breakers 1 and 2 are open (**52A1** = logical 0 and **52A2** = logical 0). If the fault evolves to involve multiple phases, input 3PRI will then assert. Single-pole reclose open interval timing shuts-down and three-pole reclose open interval timing begins.

Three-Pole Reclose Open Interval Timing

Breaker 1 three-pole reclose open interval timer starts timing (setting 3OI1) if the supervising 3PR1S condition is true or not set (3PR1S = NA) and the three-pole reclose initiate condition is true. 3PR1S is the programmable Start Breaker 1 Three-pole Reclose Open Interval Timing logic setting.

Three-pole open interval timing can be stalled if a programmable input is assigned the SRT1 function (stall Breaker 1 reclose timing) and this input is asserted.

Three-pole open interval timing is completely shut down and disabled if any of the following occur:

The relay is in the lockout state (**LOCK** = logical 1).

The relay has been driven to last shot, but is not in the lockout state (**LOCK** = logical 0), and attempted a manually initiated breaker close.

The CLS1 Relay Word bit asserts. CLS1 is the output of the final Breaker 1 close logic. CLS1 is assigned to a programmable output contact to close Breaker 1.

Automatic transfer control has been selected (Breaker Control setting BKRC = 2), Breaker 1 is out-of-service (**52BT1** = logical 1), and the CLS2 Relay Word bit asserts. CLS2 is the output of the final Breaker 2 close logic. CLS2 is assigned to a programmable output contact to close Breaker 2. (Automatic transfer is the Breaker 1 reclose timing and logic transferring to Breaker 2 if Breaker 1 is out-of-service).

Three-Pole Reclose Output

When the Breaker 1 three-pole reclose open interval timer times out, the 3PC1 Relay Word bit asserts if the supervising 3PR1C condition is true or not set (3PR1C = NA). 3PR1C is the programmable Complete Breaker 1 Three-pole Reclose logic setting.

Relay Word bit 3PC1 runs into the Breaker 1 close logic for the final logic step to reclosing Breaker 1.

Breaker 2 Single-Pole Reclose Logic (see Figure 2.13)

Single-Pole Reclose Initiation

Single-pole reclose initiation for Breaker 2 occurs when all the following conditions are true:

The SEL-279H-1 Relay is in the reset state (**RSET** = logical 1).

The Breaker 2 Single-pole Reclose Open Interval setting SOI2 ≠ 0. Setting SOI2 = 0 defeats the Breaker 2 Single-pole Reclose logic.

Breaker 2 is closed (**52A2** = logical 1).

Breaker 2 is not out-of-service (**52BT2** = logical 0).

The SPRE input is energized (if the SPRE is assigned to an input).

The SEL-279H-1 Relay detects the rising-edge of the assertion of the single-pole reclose initiate input (SPRI).

If automatic transfer is enabled by Breaker Control setting BKRC = 2, Breaker 2 single-pole reclose logic is shut down if either Breaker 1 or Breaker 2 is out-of-service (**52BT1** = logical 1 or **52BT2** = logical 1). Breaker 1 single-pole reclose logic transfers to Breaker 2 if:

Breaker 1 is out-of-service (**52BT1** = logical 1).

Breaker 2 is in-service (**52BT2** = logical 0; see Breaker 1 Single-Pole Reclose Logic).

If only Breaker 1 is being controlled by the relay (BKRC = 1), the Breaker 2 single-pole reclose logic can be used by Breaker 1.

With BKRC = 0, Breaker 1 and Breaker 2 reclose logic operate independently.

Single-Pole Reclose Open Interval Timing

Breaker 2 single-pole reclose open interval timer starts timing (setting SOI2) if the supervising SPR2S condition is true or not set (SPR2S = NA) and the single-pole reclose initiate condition is true. SPR2S is the programmable Start Breaker 2 Single-pole Reclose Open Interval Timing logic setting.

Single-pole open interval timing can be stalled if a programmable input is assigned the SRT2 function (stall Breaker 2 reclose timing) and this input is asserted. Timing can also be stalled if BKRC = 1 and a programmable input is assigned the SRT1 function (stall Breaker 1 reclose timing) and this input is asserted.

Single-pole open interval timing is completely shut down and disabled if any of the following occur:

Input 3PRI (three-pole reclose initiate) is asserted—most likely from a fault evolving to involve multiple phases.

The CLS2 Relay Word bit asserts. CLS2 is the output of the final Breaker 2 close logic. CLS2 is assigned to a programmable output contact to close Breaker 2.

The relay has been driven to last shot.

The CLS1 Relay Word bit asserts and BKRC = 1.

Single-Pole Reclose Output

When the Breaker 2 single-pole reclose open interval timer times out, the SPC2 Relay Word bit asserts if the supervising SPR2C condition is true or not set (SPR2C = NA). SPR2C is the programmable Complete Breaker 2 Single-pole Reclose Open Interval Timing logic setting.

Relay Word bit SPC2 runs into the Breaker 2 close logic for the final logic step to reclosing Breaker 2.

Breaker 2 Three-Pole Reclose Logic (see Figure 2.14)

Three-Pole Reclose Initiation

Three-pole reclose initiation for Breaker 2 occurs when all the following conditions are true:

The Breaker 2 Three-pole Reclose Open Interval setting 3OI2 $\neq$ 0. Setting 3OI2 = 0 defeats the Breaker 2 Three-pole Reclose logic.

Breaker 2 is closed (**52A2** = logical 1).

Breaker 2 is not out-of-service (**52BT2** = logical 0).

The 3PRE input is energized (if the 3PRE is assigned to an input).

The SEL-279H-1 Relay detects the rising-edge of the three-pole reclose initiate input (3PRI) being asserted.

If automatic transfer is enabled by Breaker Control setting BKRC = 2, Breaker 2 three-pole reclose logic is shut down if either Breaker 1 or Breaker 2 is out-of-service (**52BT1** = logical 1 or **52BT2** = logical 1). Breaker 1 three-pole reclose logic transfers to Breaker 2 if:

Breaker 1 is out-of-service (**52BT1** = logical 1).

Breaker 2 is in-service (**52BT2** = logical 0; see Breaker 1 Three-Pole Reclose Logic).

If only Breaker 1 is being controlled by the relay (BKRC = 1), the Breaker 2 three-pole reclose logic can be used by Breaker 1.

With BKRC = 0, Breaker 1 and Breaker 2 reclose logic operate independently.

If a single-pole reclose initiation has already occurred, the relay is in the reclose cycle state (**CYCL** = logical 1) and Breakers 1 and 2 are open (**52A1** = logical 0 and **52A2** = logical 0). If the fault evolves to involve multiple phases, input 3PRI will then assert. Single-pole reclose open interval timing shuts down and three-pole reclose open interval timing begins.

Three-Pole Reclose Open Interval Timing

Breaker 2 three-pole reclose open interval timer starts timing (setting 3OI2) if the supervising 3PR2S condition is true or not set (3PR2S = NA) and the three-pole reclose initiate condition is true. 3PR2S is the programmable Start Breaker 2 Three-pole Reclose Open Interval Timing logic setting.

Three-pole open interval timing can be stalled if a programmable input is assigned the SRT2 function (stall Breaker 2 reclose timing) and this input is asserted. Timing can also be stalled if BKRC = 1 and a programmable input is assigned the SRT1 function (stall Breaker 1 reclose timing) and this input is asserted.

Three-pole open interval timing is completely shut down and disabled if any of the following occur:

The CLS2 Relay Word bit asserts. CLS2 is the output of the final Breaker 2 close logic. CLS2 is assigned to a programmable output contact to close Breaker 2.

The relay is in the lockout state (**LOCK** = logical 1).

The relay has been driven to last shot, but is not in the lockout state (**LOCK** = logical 0), and attempted a manually initiated breaker close.

The CLS1 Relay Word bit asserts and BKRC = 1.

Three-Pole Reclose Output

When the Breaker 2 three-pole reclose open interval timer times out, the 3PC2 Relay Word bit asserts if the supervising 3PR2C condition is true or not set (3PR2C = NA). 3PR2C is the programmable Complete Breaker 2 Three-pole Reclose Open Interval Timing logic setting.

Relay Word bit 3PC2 runs into the Breaker 2 close logic for the final logic step to reclosing Breaker 2.

Lockout Initiate Logic (see Figure 2.15)

The Lockout Initiate condition comes true if any of the following occur:

Either of the two following conditions is considered to be a Recloser Out-of-Service condition:

1. Input SPRE is deasserted (if SPRE is assigned to an input) and input 3PRE is deasserted (if 3PRE is assigned to an input).
2. Input RE (Reclose Enable) is deasserted (if RE is assigned to an input).

Input SPRE is asserted, input 3PRE is not asserted (if 3PRE is assigned to an input), and the three-pole reclose initiate input asserts.

Input DTL (Drive-To-Lockout) is asserted.

The Overall Timer times out (**OTT** = logical 1).

The relay has been driven to last shot and the Single-pole Reclose Initiate (SPRI) input or Three-pole Reclose Initiate (3PRI) input asserts.

The relay is in the reset state or lockout state (not in the reclose cycle state; **CYCL** = logical 0) and *both* Breaker 1 and Breaker 2 open up.

Reset Condition Logic (see Figure 2.16)

Prerequisite Conditions

Some prerequisite conditions are needed before the Reset Timer (setting 79RS) can begin timing:

The supervising RS condition is true or not set (RS = NA). RS is the programmable Reset Timing Condition logic setting.

The relay is not in the reset state (**RSET** = logical 0) and either:

Both breakers at a previous time were *both* open (this condition seals-in) or

Previously at least one of the breakers was closed, the relay was in the lockout state (**LOCK** = logical 1), input RE (Reclose Enable) was asserted, and input DTL (Drive-To-Lockout) was deasserted (this condition seals-in).

Reset Condition Timing

With these prerequisite conditions true, the Reset Timer (setting 79RS) begins timing if any of the following occur:

Single-breaker control (breaker control setting BKRC = 1)

Breaker 1 is in-service (**52BT1** = logical 0), and Breaker 1 is closed (**52A1** = logical 1).

Two-breaker control (breaker control setting BKRC ≠ 1)

Breaker 1 is in-service (**52BT1** = logical 0), Breaker 2 is in-service (**52BT2** = logical 0), and *both* Breaker 1 and Breaker 2 are closed (**52A1** = logical 1 and **52A2** = logical 1).

Breaker 1 is in-service (**52BT1** = logical 0), Breaker 2 is out-of-service (**52BT2** = logical 1), and Breaker 1 is closed (**52A1** = logical 1).

Breaker 1 is out-of-service (**52BT1** = logical 1), Breaker 2 is in-service (**52BT2** = logical 0), and Breaker 2 is closed (**52A2** = logical 1).

Reset timing is stalled if any of the following occur:

Breaker 1 is closed (**52A1** = logical 1) and a programmable input assigned to the SRT1 function (stall Breaker 1 reclose timing) is asserted.

Breaker 2 is closed (**52A2** = logical 1) and a programmable input assigned to the SRT2 function (stall Breaker 2 reclose timing) is asserted.

Recloser Enable (RE) input is deasserted.

Drive-to-Lockout (DTL) input is asserted.

Relay State Logic (see Figure 2.17)

The relay is always in one of three states:

Reset	(Relay Word bit **RSET**)
Reclose Cycle	(Relay Word bit **CYCL**)
Lockout	(Relay Word bit **LOCK**)

The Lockout Initiate condition takes priority over any other condition. Thus any time the Lockout Initiate condition comes true, the relay immediately goes to the lockout state, regardless of any other conditions. For operational safety, the relay powers up in the lockout state.

If the 79RS (Reset Condition; see Figure 2.16) comes true and the relay is not in the reset state and Lockout Initiate is not asserted, the relay goes to the reset state.

If the relay is in the reset state, Lockout Initiate is not asserted, Breaker 1 or Breaker 2 is closed (**52A1** = logical 1 or **52A2** = logical 1), and either input SPRI (Single-pole Reclose Initiate) or input 3PRI (Three-pole Reclose Initiate), the relay goes into the reclose cycle state.

Overall Timer Logic (see Figure 2.18)

The Overall Timer limits the amount of time (setting OTD) the relay can spend in the reclose cycle state. If the Overall Timer times out, **OTT** = logical 1 and the relay goes to the lockout state (see Lockout Initiate Logic). It also unlatches standing close conditions (see Breaker 1 Close Logic and Breaker 2 Close Logic).

Shot Counter Logic (see Figure 2.19)

Increment Shot Counter

The shot counter increments if Relay Word bit CLS1 or CLS2 asserts and all the following conditions are true:

Both Breaker 1 and Breaker 2 are open (**52A1** = logical 0 and **52A2** = logical 0).

The relay is in the reclose cycle state (**CYCL** = logical 1).

The relay is not at the last shot (shot = 2).

Relay Word bits **CLS1** and **CLS2** are the final close logic outputs for Breaker 1 and Breaker 2, respectively. **CLS1** and **CLS2** are typically assigned to separate programmable output contacts to close Breaker 1 and Breaker 2, respectively.

The relay cannot increment beyond the last shot. Once the relay goes to the reset state, the shot counter reverts back to shot = 0.

Drive to Last Shot

The relay is driven to last shot if either of the following occur:

The relay goes to the lockout state (**LOCK** = logical 1).

The relay is in the reclose cycle state and a manual close occurs for Breaker 1 or Breaker 2.

A manual close can be any of the following:

<u>Breaker closed external to relay</u>.

Breaker 1 closes (**52A1** = logical 1) and Relay Word bit **CLS1** is not asserted (**CLS1** = logical 0).

Breaker 2 closes (**52A2** = logical 1) and Relay Word bit **CLS2** is not asserted (**CLS2** = logical 0).

<u>Manual close via relay</u>

The **CLOSE 1** command is executed for Breaker 1 (CC1 = logical 1) and the supervising **MC1S** condition is true or not set (**MC1S** = NA).

The **CLOSE 2** command is executed for Breaker 2 (CC2 = logical 1) and the supervising **MC2S** condition is true or not set (**MC2S** = NA).

The Breaker 1 Manual Close function (CL1) is assigned and asserted, the Manual Close Enable function (CLSEN) is assigned and asserted (or not asserted for !CLSEN input assignment) and the supervising **MC1S** conditions are true or **MC1S** is not set (**MC1S** = NA).

The Breaker 2 Manual Close function (CL2) is assigned and asserted, the Manual Close Enable function (CLSEN) is assigned and asserted (or not asserted for !CLSEN input assignment) and the supervising **MC2S** conditions are true or **MC2S** is not set (**MC2S** = NA).

<u>Breaker 1 Close Logic (see Figure 2.20)</u>

Close Conditions

Relay Word bit **CLS1** is the output of the Breaker 1 close logic. **CLS1** is assigned to a programmable output contact to close Breaker 1. **CLS1** asserts (**CLS1** = logical 1) if any of the following close conditions occur:

Breaker 1 is in-service (**52BT1** = logical 0) and either the Breaker 1 single-pole reclose open interval timer or the Breaker 1 three-pole reclose open interval timer successfully time-out (Relay Word bit **SPC1** or **3PC1** asserts).

Breaker 1 is in-service (**52BT1** = logical 0), BKRC = 1, the Breaker 2 single-pole reclose open interval timer or the Breaker 2 three-pole reclose open interval timer successfully time-out (Relay Word bit **SPC2** or **3PC2** asserts).

The Breaker 1 Manual Close function (CL1) is assigned and asserted, the Manual Close Enable function (CLSEN) is assigned and asserted (or not asserted for !CLSEN input assignment) and the supervising **MC1S** conditions are true or **MC1S** is not set (**MC1S** = NA).

The **CLOSE 1** command is executed for Breaker 1 (CC1 = logical 1), the Manual Close Enable function (CLSEN) is assigned and asserted (or not asserted for !CLSEN input assignment) and the supervising **MC1S** conditions are true or **MC1S** is not set (**MC1S** = NA).

Close Unlatch Conditions

CLS1 deasserts (**CLS1** = logical 0) if any of the following conditions occur (if **CLS1** is assigned to a programmable output contact, unlatches):

Breaker 1 closes (**52A1** = logical 1).

The Overall Timer times out (the relay has been in the reclose cycle state too long; **OTT** = logical 1).

The TARGET RESET button is pushed.

Close Dropout Delay

The Close Dropout Delay (CDOD) delays dropout of the close signal to the breaker. This ensures that the breaker close coil is no longer drawing close current in case there is miscoordination between the 52A (or 52B) input and the actual breaker close path.

Breaker 2 Close Logic (see Figure 2.21)

Close Conditions

Relay Word bit **CLS2** is the output of the Breaker 2 close logic. **CLS2** is assigned to a programmable output contact to close Breaker 2. **CLS2** asserts (**CLS2** = logical 1) if any of the following close conditions occur:

The Breaker 2 single-pole reclose open interval timer successfully times out (Relay Word bit **SPC2** asserts) or the Breaker 2 three-pole reclose open interval timer successfully times out (Relay Word bit **3PC2** asserts) and Breaker 2 is in-service (**52BT2** = logical 0).

The Breaker 2 Manual Close function (CL2) is assigned and asserted, the Manual Close Enable function (CLSEN) is assigned and asserted (or not asserted for !CLSEN input assignment) and the supervising **MC2S** conditions are true or **MC2S** is not set (**MC2S** = NA).

The **CLOSE 2** command is executed for Breaker 2 (CC2 = logical 1), the Manual Close Enable function (CLSEN) is assigned and asserted (or not asserted for !CLSEN input assignment) and the supervising **MC2S** conditions are true or **MC2S** is not set (**MC2S** = NA).

CLS2 also asserts if all the following conditions are true:

Breaker control setting BKRC = 2 (selects two breaker control with automatic transfer of Breaker 1 reclose timing and logic to Breaker 2 if Breaker 1 is out-of-service).

Breaker 1 is out-of-service (**52BT1** = logical 1).

Breaker 1 single-pole open interval timer or the Breaker 1 three-pole open interval timer successfully times out (Relay Word bit **SPC1** or **3PC1** asserts).

Close Unlatch Conditions

CLS2 deasserts (**CLS2** = logical 0) if any of the following conditions occur (if **CLS2** is assigned to a programmable output contact, unlatches):

Breaker 2 closes (**52A2** = logical 1).

The Overall Timer times out (the relay has been in the reclose cycle state too long; **OTT** = logical 1).

The TARGET RESET button is pushed.

Close Dropout Delay

The Close Dropout Delay (CDOD) delays dropout of the close signal to the breaker. This ensures that the breaker close coil is no longer drawing close current in case there is miscoordination between the 52A (or 52B) input and the actual breaker close path.

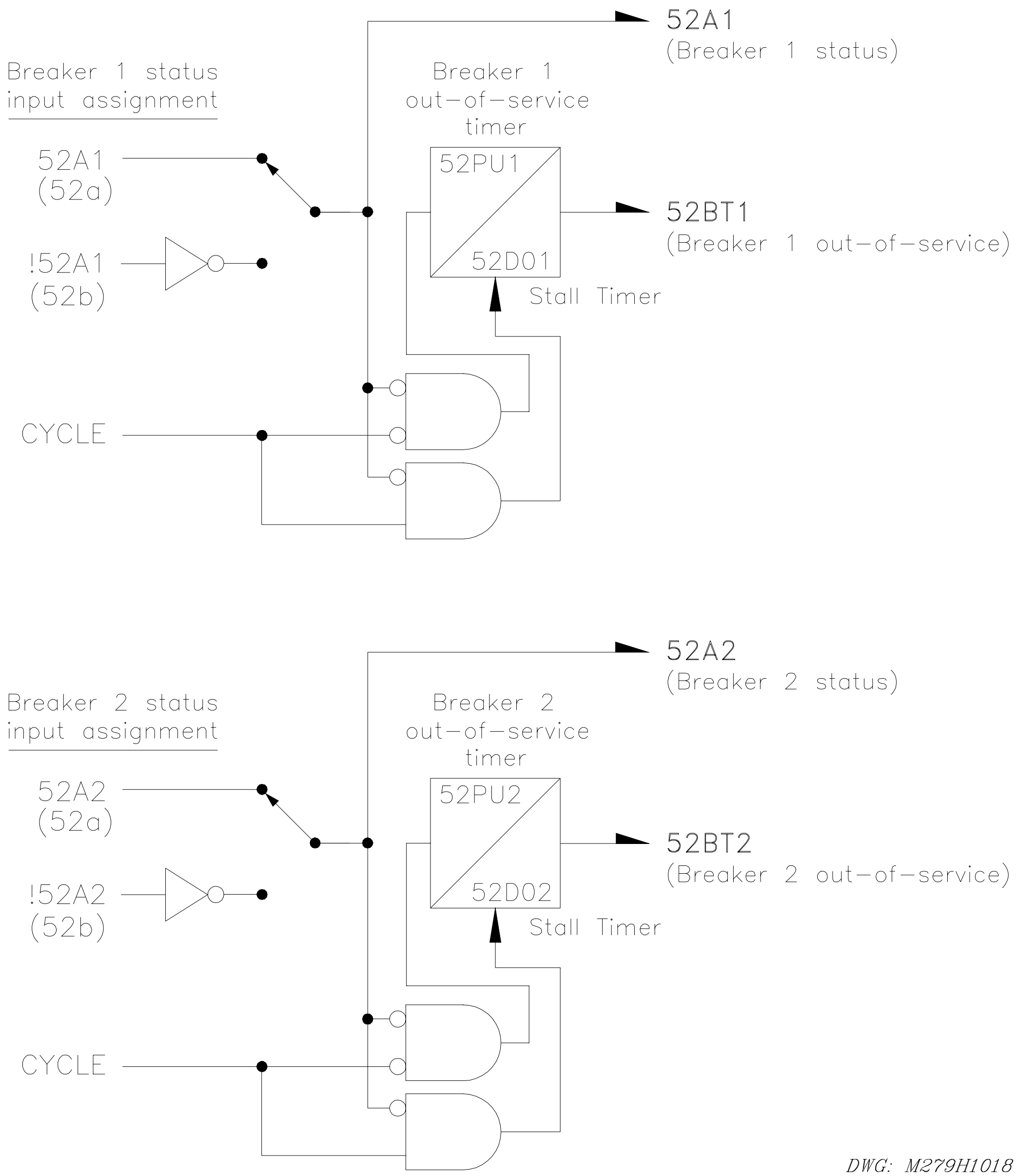

Figure 2.4: Breaker Status and Out-of-Service Logic

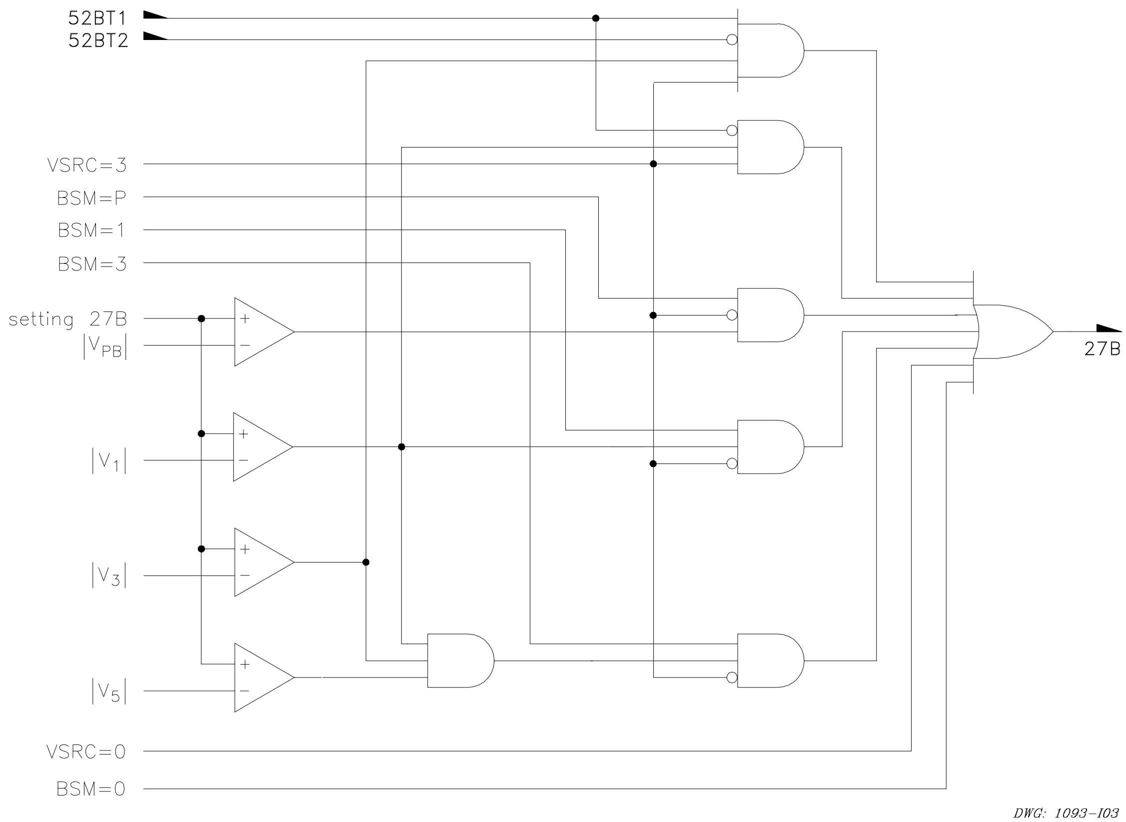

Figure 2.5: Dead Bus Voltage Logic

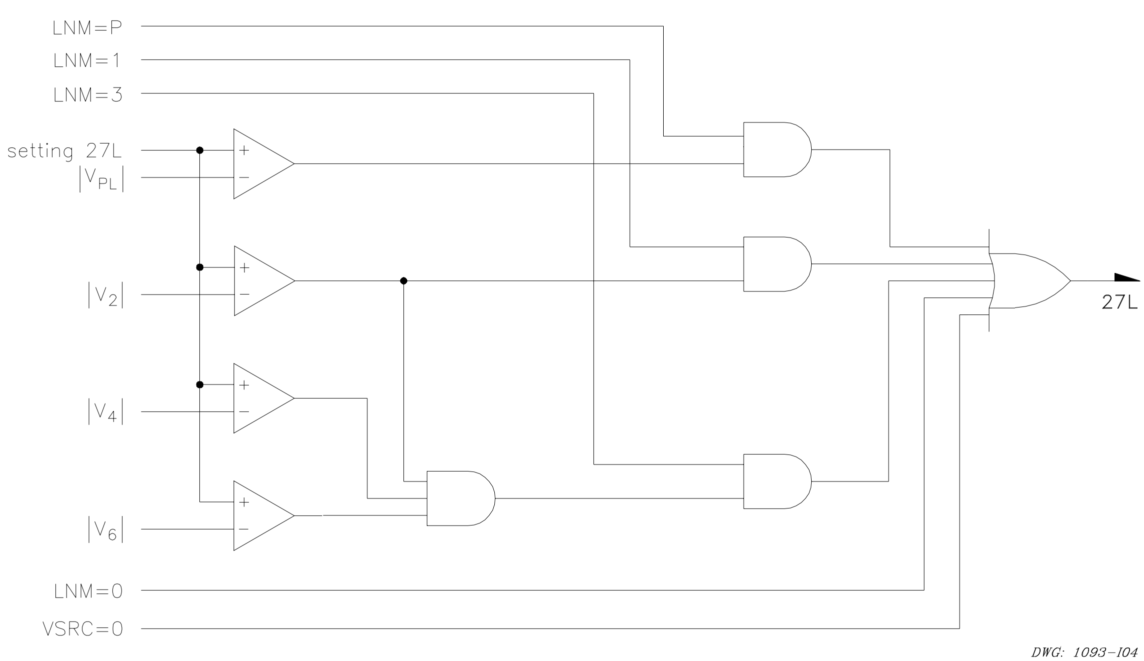

Figure 2.6: Dead Line Voltage Logic

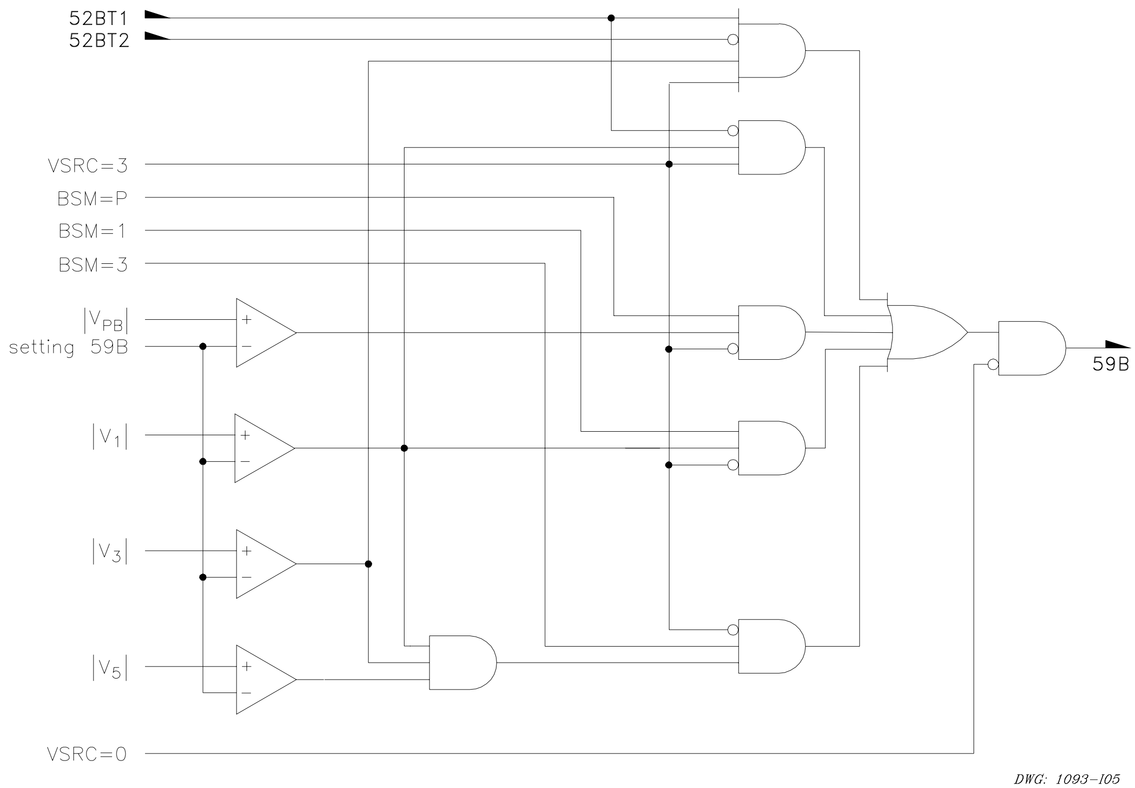

Figure 2.7: Hot Bus Voltage Logic

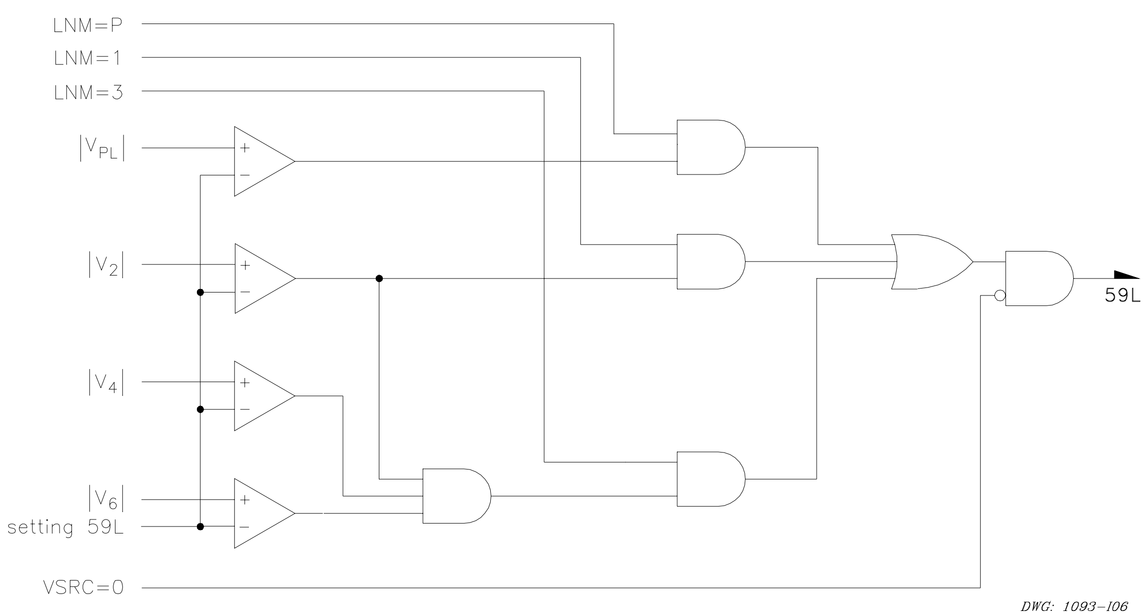

Figure 2.8: Hot Line Voltage Logic

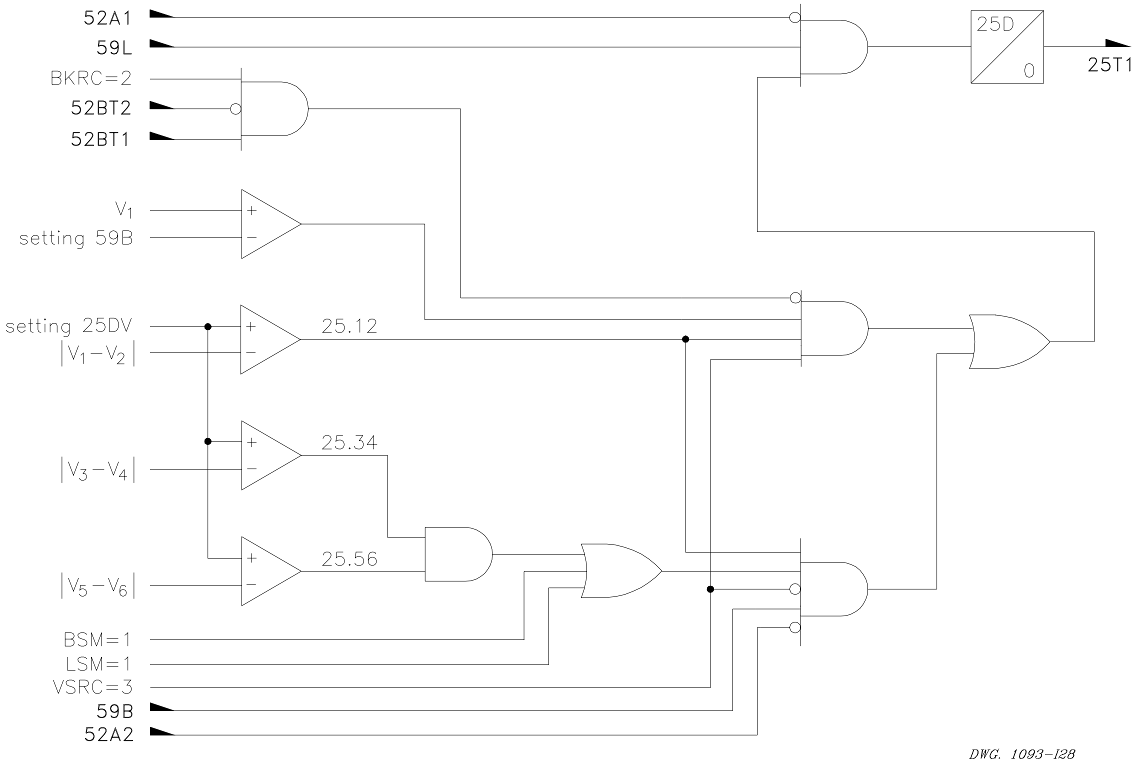

Figure 2.9: Breaker 1 Synchronism Check Logic

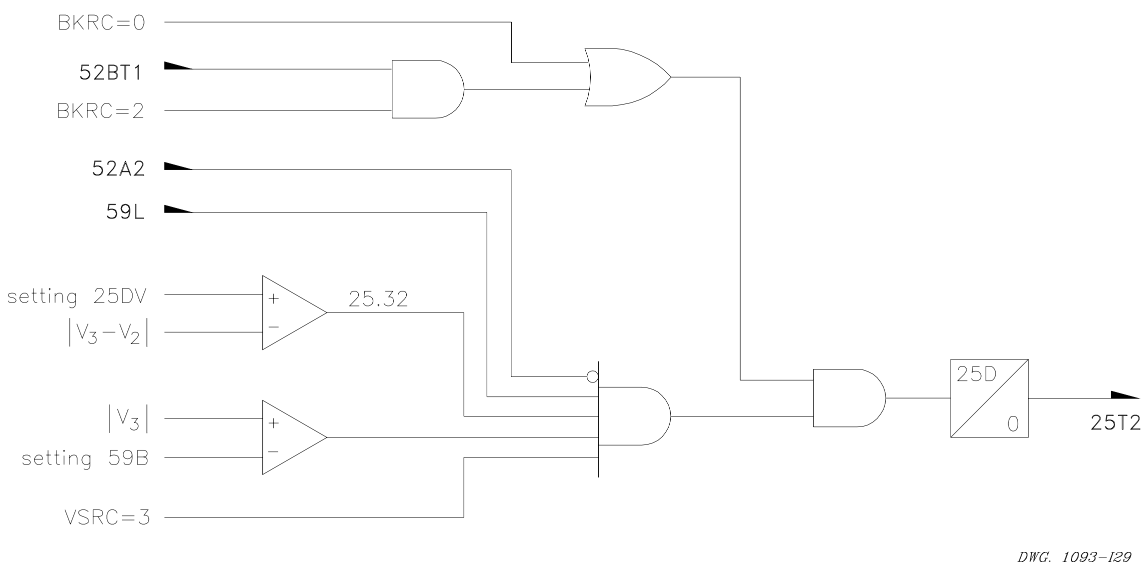

Figure 2.10: Breaker 2 Synchronism Check Logic

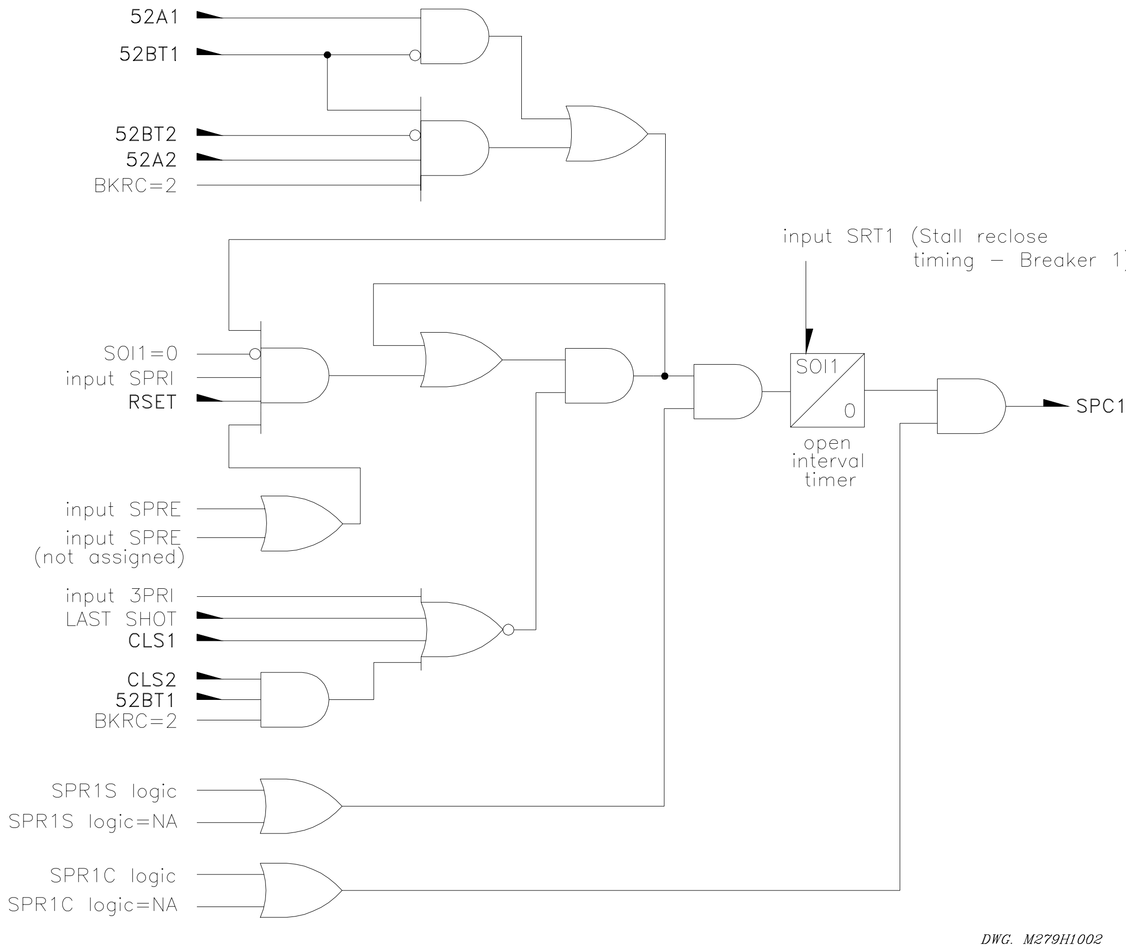

Figure 2.11: Breaker 1 Single-Pole Reclose Logic

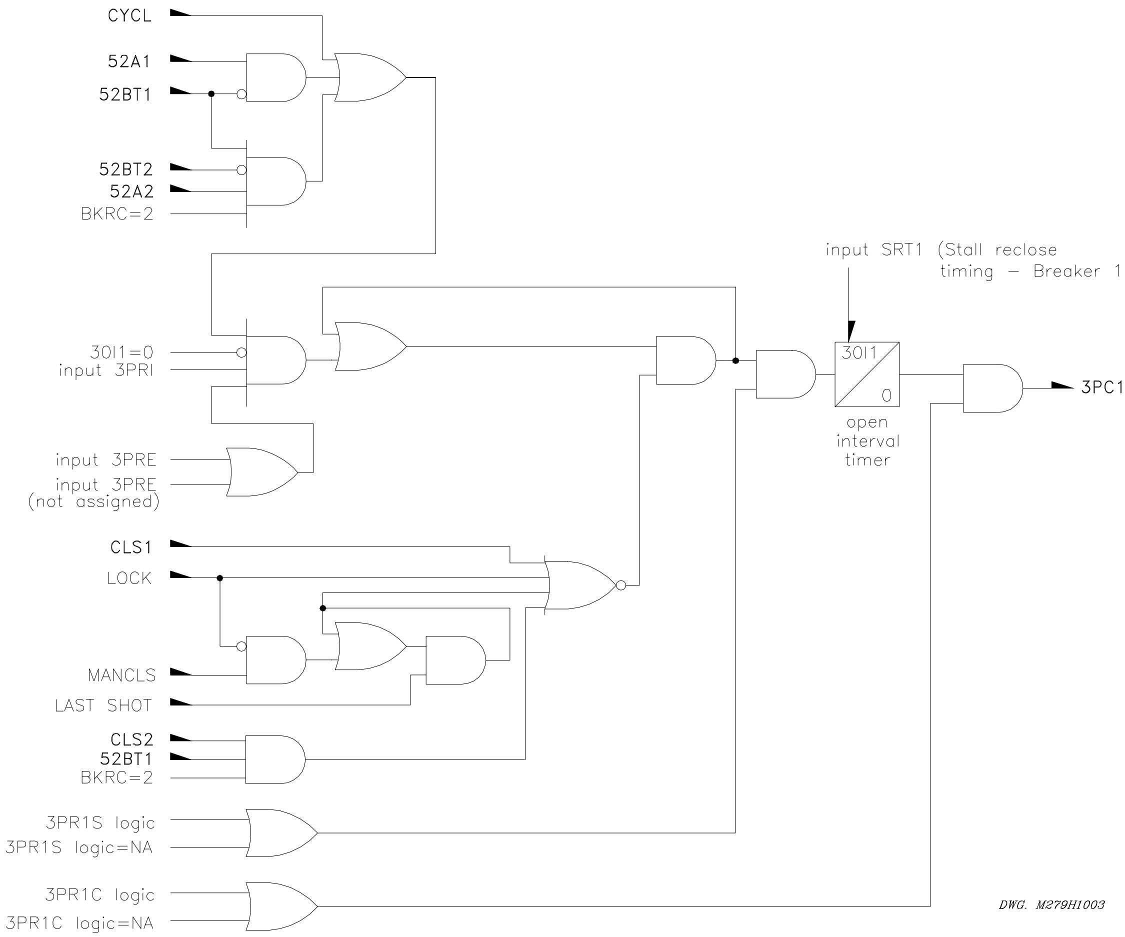

Figure 2.12: Breaker 1 Three-Pole Reclose Logic

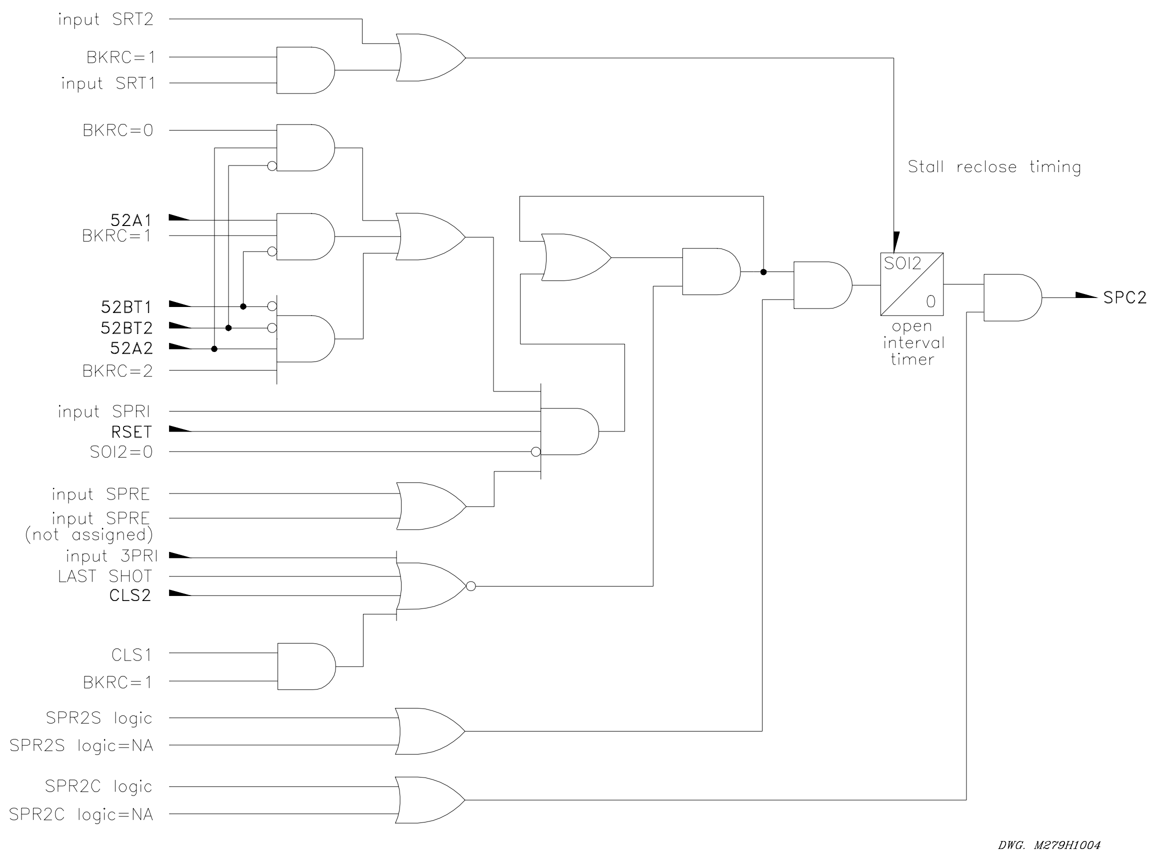

Figure 2.13: Breaker 2 Single-Pole Reclose Logic

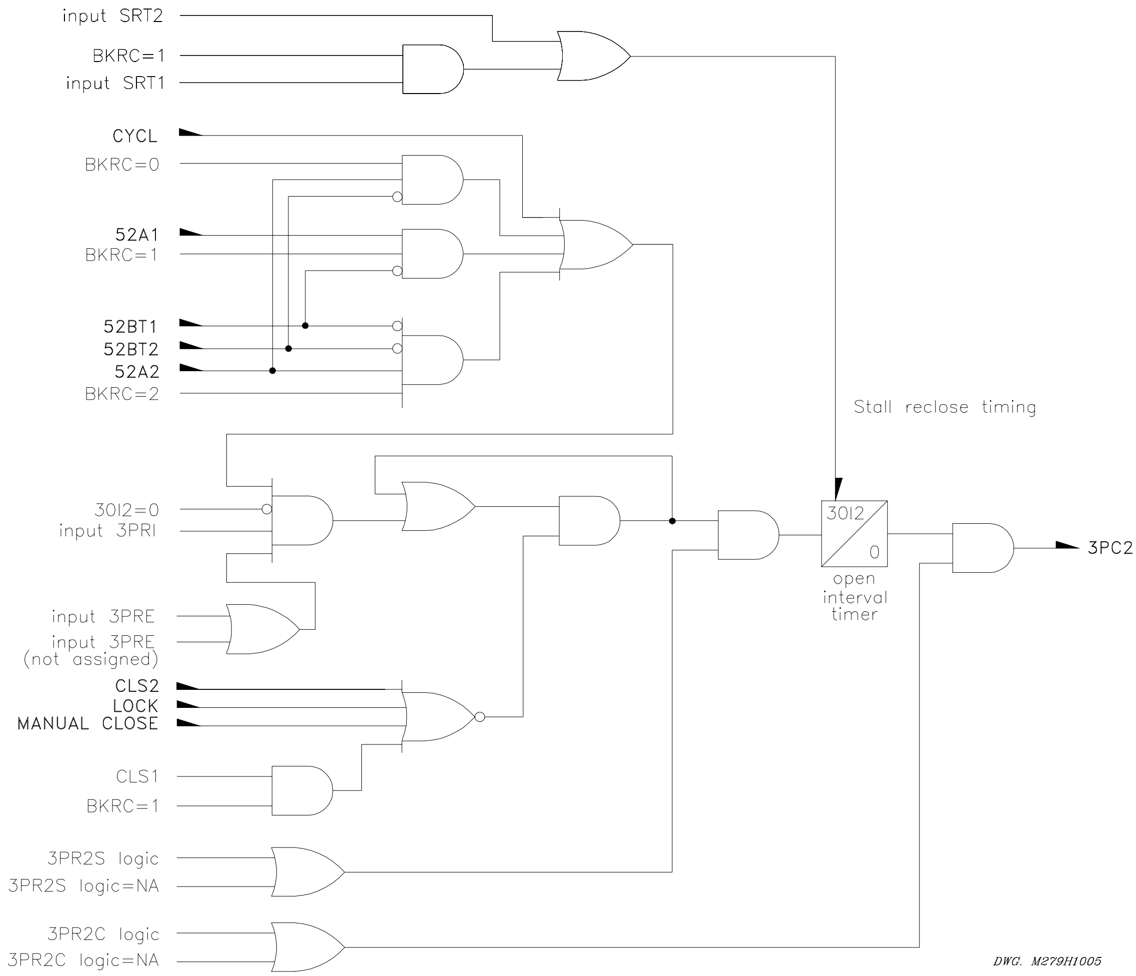

Figure 2.14: Breaker 2 Three-Pole Reclose Logic

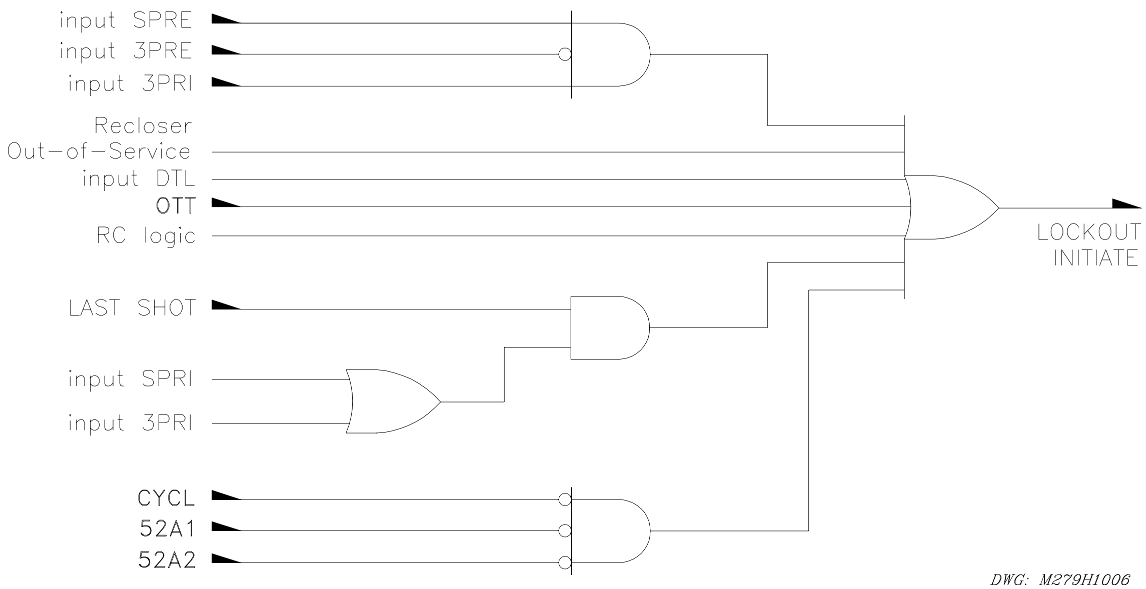

Figure 2.15: Lockout Initiate Logic

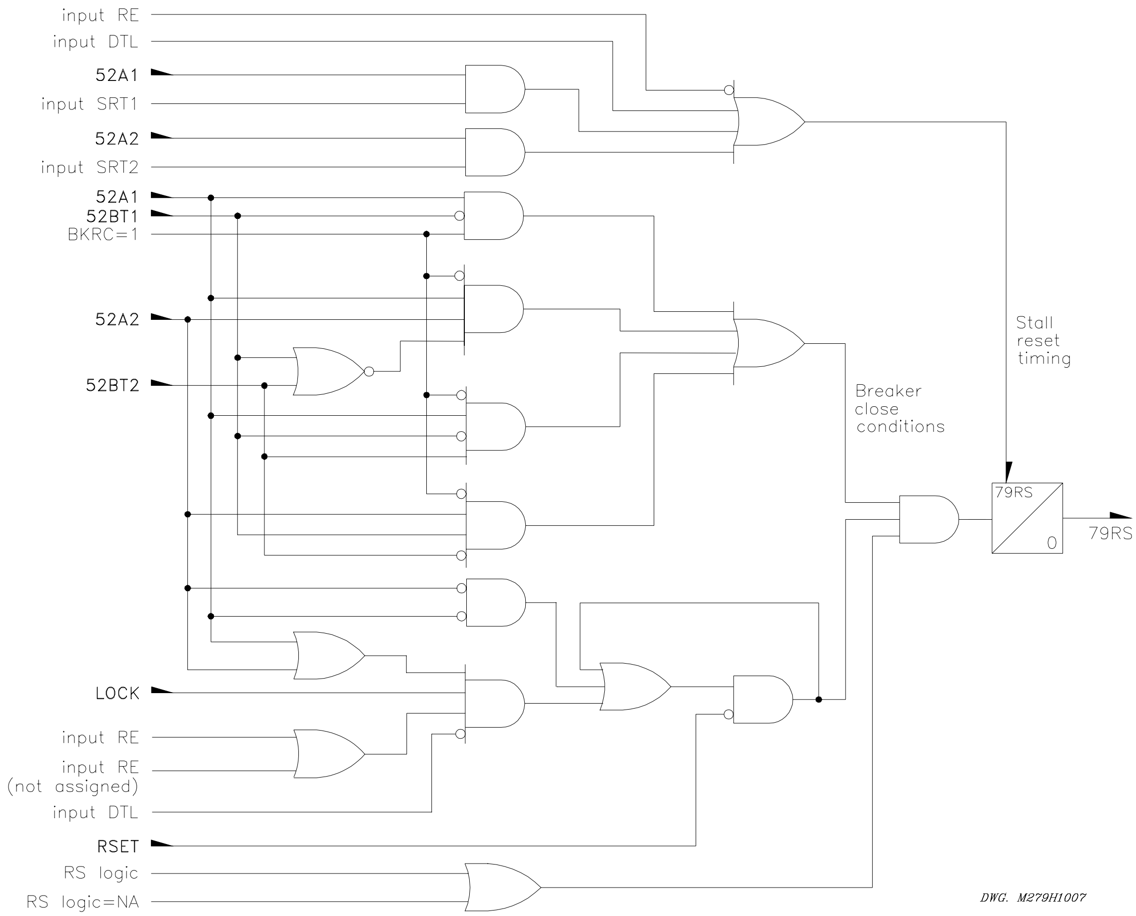

Figure 2.16: Reset Condition Logic

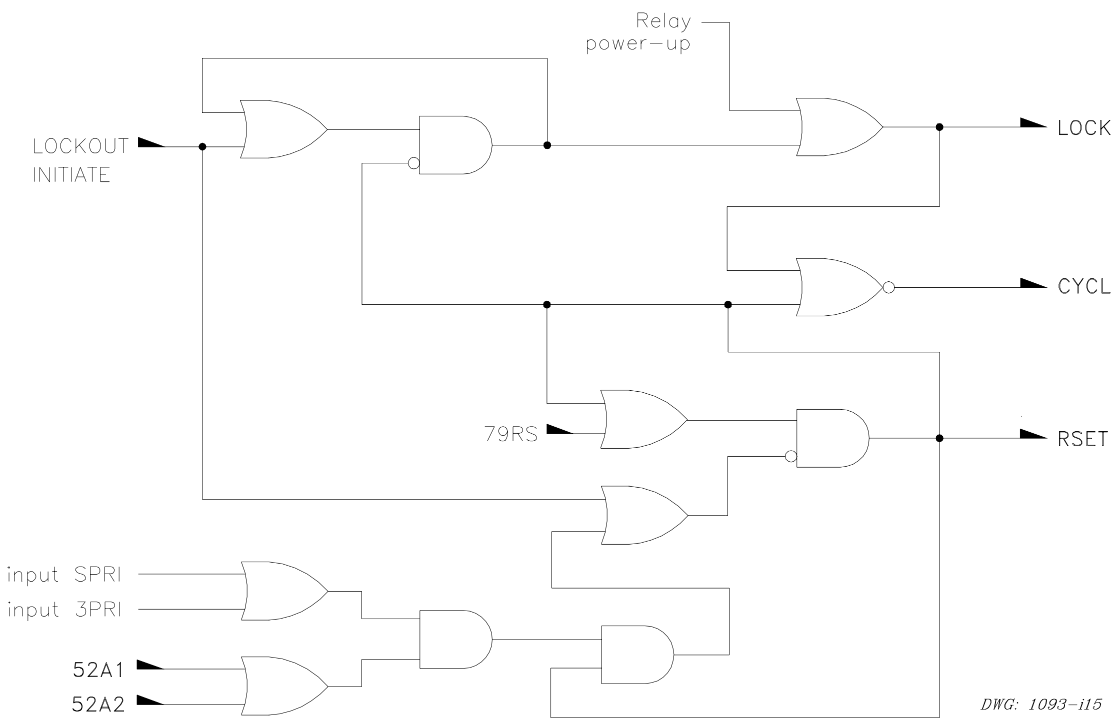

Figure 2.17: Relay State Logic

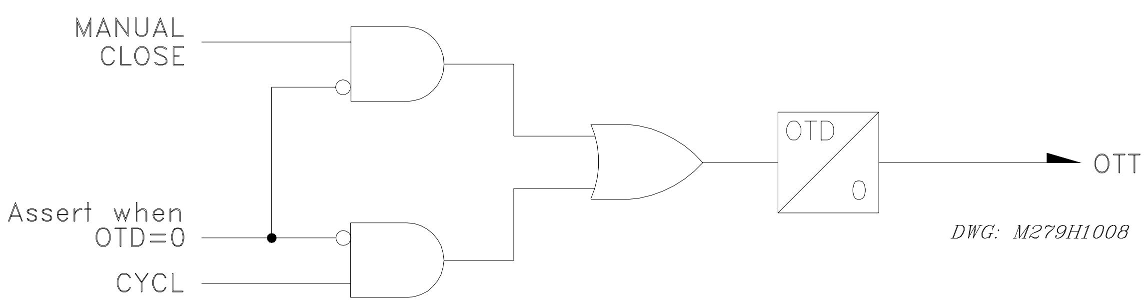

Figure 2.18: Overall Timer Logic

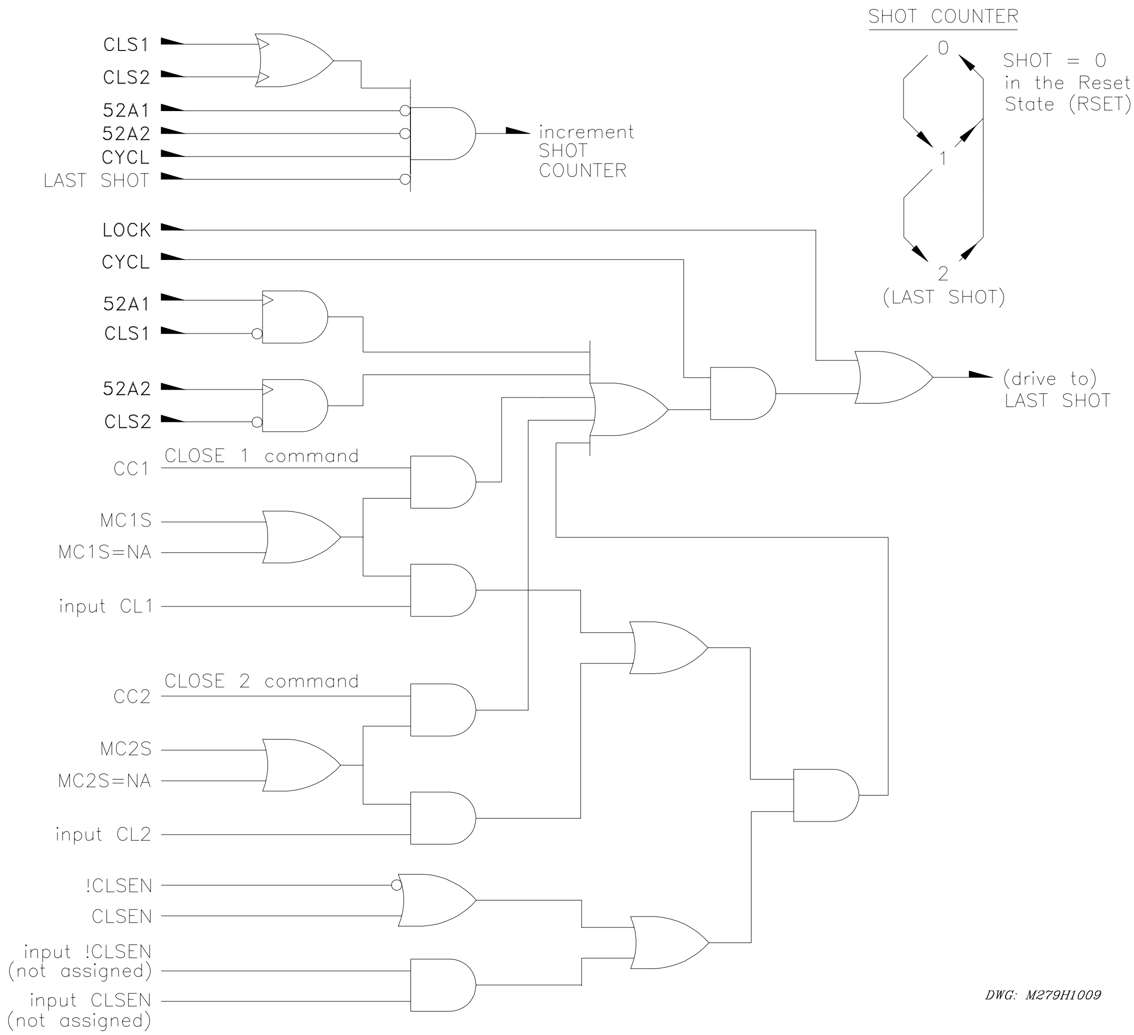

Figure 2.19: Shot Counter Logic

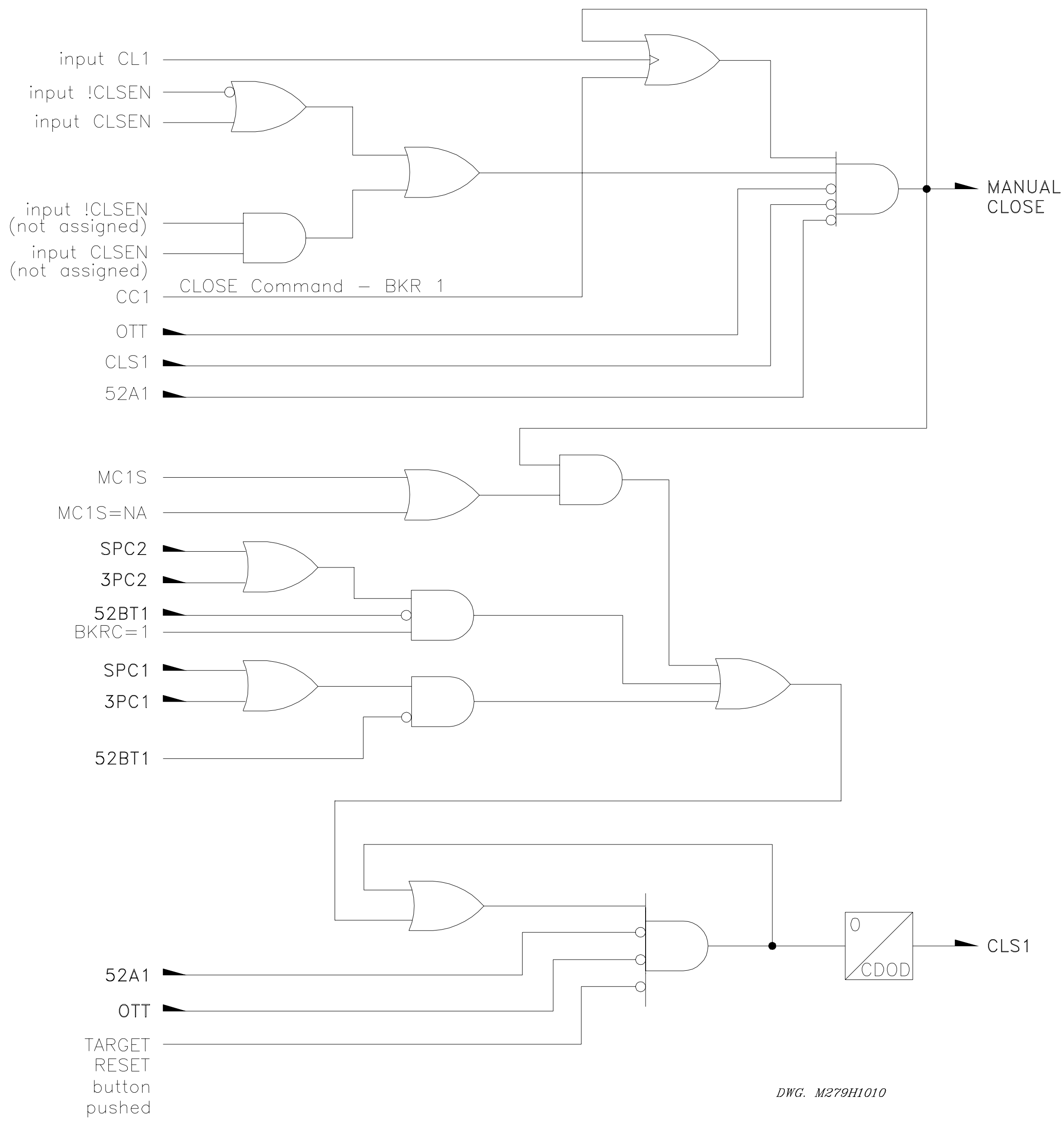

Figure 2.20: Breaker 1 Close Logic

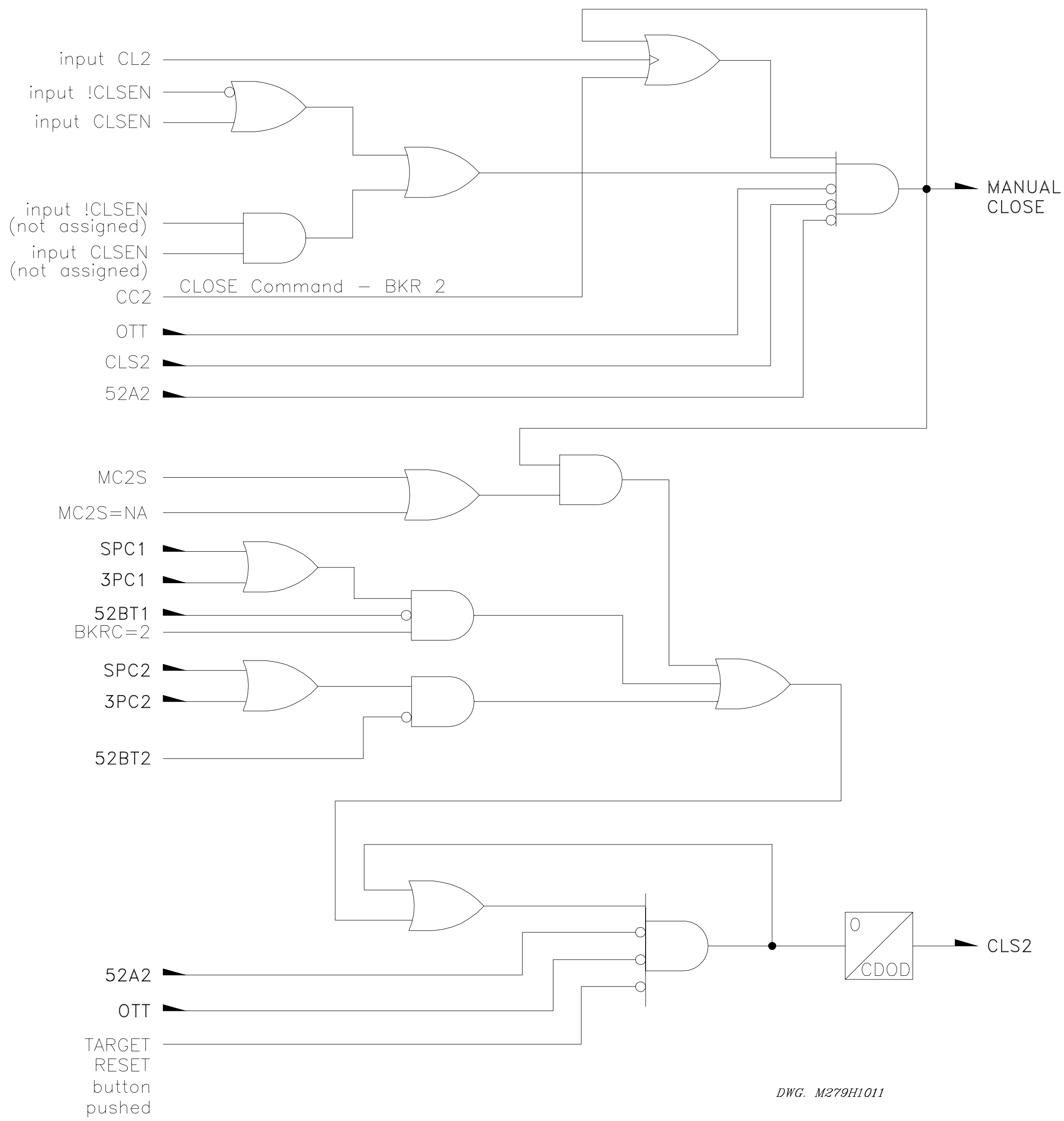

Figure 2.21: Breaker 2 Close Logic

TARGETS

Read targeting information by inspecting the LEDs or remotely with the **TARGET** command and event reports. The **TARGET** command can access other information as well.

See Figure 2.22.

The STATUS targets indicate circuit breaker status (illuminated for closed breaker):

BKR/1 asserts if a circuit breaker status input is assigned for Breaker 1 and Breaker 1 is closed—follows Relay Word bit **52A1**. This target lists as 52A1 in the **TARGET** command and in the event reports.

BKR/2 asserts if a circuit breaker status input is assigned for Breaker 2 and Breaker 2 is closed—follows Relay Word bit **52A2**. This target lists as 52A2 in the **TARGET** command and in the event reports.

The RECLOSE targets indicate the reclosed circuit breaker:

BKR/1 asserts if a reclose is attempted for Breaker 1. This targets lists as RC1 in the **TARGET** command and in the event reports.

BKR/2 asserts if a reclose is attempted for Breaker 2. This target lists as RC2 in the **TARGET** command and in the event reports.

The STATE targets indicate the state of the relay:

RS asserts if the relay is in the Reset State—follows Relay Word bit **RSET**. This target lists as RS in the **TARGET** command and in the event reports.

CY asserts if the relay is in the Reclose Cycle State—follows Relay Word bit **CYCL**. This target lists as CY in the **TARGET** command and in the event reports.

LO asserts if the relay is in the Lockout State—follows Relay Word bit **LOCK**. This target lists as LO in the **TARGET** command and in the event reports.

The MAN/CLS target asserts if a manual close attempt of either Breaker 1 or Breaker 2 is made via the SEL-279H-1 Relay. This target lists as CLOS in the **TARGET** command and in the event reports.

Refer to Table 3.2 in ***Section 3: Communications*** to see how the front panel targets list in the **TARGET** command and in the event reports.

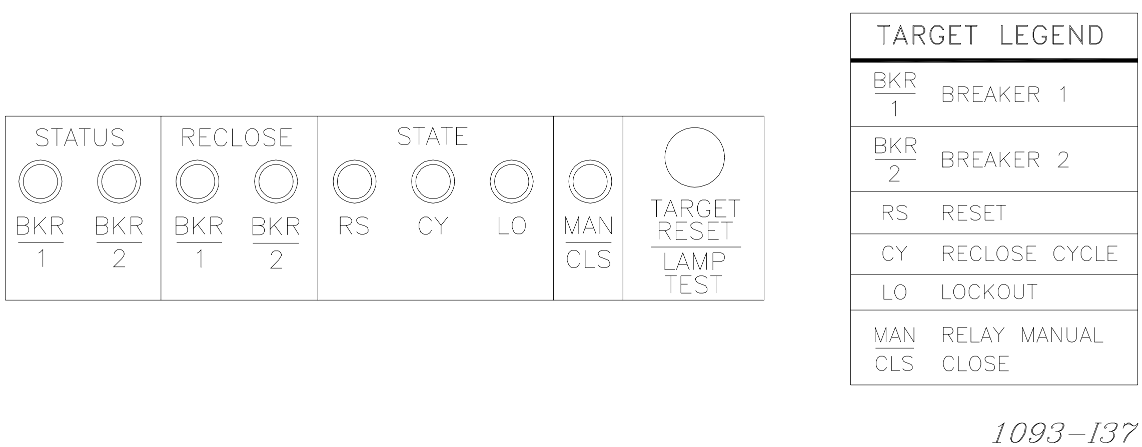

Figure 2.22: SEL-279H-1 Relay Front Panel Targets and Legend

The RECLOSE and MAN/CLS targets unlatch if any of the following occur:

- a new reclosing event occurs
- the TARGET RESET/LAMP TEST button is pushed
- the **TARGET R** (target reset) command is executed
- a relay, input, or logic setting change is made with the **SET**, **INPUT**, or **LOGIC** commands

When an operator presses the TARGET RESET/LAMP TEST BUTTON, all eight LEDs illuminate for a one-second lamp test and to indicate that the relay is operational.

The various cited commands are described in ***Section 3: Communications***.

METERING

The SEL-279H-1 Relay provides voltage metering. See the **METER** command in ***Section 3: Communications*** for more information.

SELF-TESTS

The relay runs a variety of self-tests. Some tests have warning and failure states, others only have failure states. The relay generates a status report after any change in self-test status.

The relay closes the ALARM OUT contact after any self-test fails. When it detects certain failures, the relay disables the breaker control functions and places its output driver port in an input mode. No outputs may be asserted when the instrument is in this configuration. The relay runs all self-tests on power up and before enabling new settings. During normal operation, it performs self-tests every few minutes.

Offset

The relay measures the offset voltage of each analog input channel and compares the value against fixed limits. It issues a warning when offset is greater than 50 millivolts in any channel and declares a failure when offset exceeds 75 millivolts. The offset levels of all channels appear in the **STATUS** command format (see ***Section 3: Communications***).

Power Supply

Power supply voltages are limit-checked. The table below summarizes voltage limits.

Table 2.3: Power Supply Self-Test Limits

Supply	Warning Thresholds		Failure Thresholds	
+5 V	+5.3 V	+4.7 V	+5.4 V	+4.6 V
+15 V	+15.8 V	+14.2 V	+16.2 V	+13.8 V
–15 V	–15.8 V	–14.2 V	–16.2 V	–13.8 V

The relay transmits a STATUS message for any self-test failure or warning. A +5 volt supply failure de-energizes all output relays and blocks their operation. A ±15 volt supply failure disables protective relay functions while control functions remain intact. The ALARM OUT contact remains closed after a power supply failure.

Random-Access Memory

The relay checks random-access memory (RAM) to ensure that each byte can be written to and read from. There is no warning state for this test. If the relay detects a problem, it transmits a STATUS message with the socket designation of the affected RAM IC. A RAM failure disables protective and control functions and closes the ALARM OUT contact.

Read-Only Memory

The relay checks read-only memory (ROM) by computing a checksum. If the computed value does not agree with the stored value, the relay declares a ROM failure. It transmits a STATUS message with the socket designation of the affected ROM IC. A ROM failure disables protective and control functions and closes the ALARM OUT contact.

Analog-to-Digital Converter

The analog-to-digital converter (ADC) changes voltage signals derived from power system voltages and currents into numbers for processing by the microcomputer. The ADC test verifies converter function by checking conversion time. The test fails if conversion time is excessive or a conversion starts and never finishes. There is no warning state for this test. While an ADC failure disables protective functions, control functions remain intact. The relay transmits a STATUS message and closes the ALARM OUT contact.

Master Offset

The master offset (MOF) test checks offset in the multiplexer/analog to digital converter circuit. A grounded input is selected and sampled for dc offset. The warning threshold is 50 mV; failure threshold is 75 mV. A failure pulses the ALARM OUT contact closed for one second. The relay transmits a STATUS message for both warning and failure conditions.

Settings

The relay stores two images of the system settings in nonvolatile memory. The test compares them when the relay is initially set and periodically thereafter. If the images disagree, the setting test fails and the relay disables all protective and control functions. It transmits the STATUS message to indicate a failed test. The ALARM OUT contact remains closed after a setting failure.

Table 2.4 shows relay actions for any self-test condition: warning (W) or failure (F).

Table 2.4: Self-Test Summary

Self-Test	Limits	Status Message	Relay Elements & Reclosing Disabled	Control Disabled	ALARM OUT Contact
RAM	----	F	YES	YES	permanent contact assertion
ROM	----	F	YES	YES	permanent contact assertion
SETTINGS	----	F	YES	YES	permanent contact assertion
A/D	----	F	YES	NO	permanent contact assertion
+5 V	±0.3 V	W	NO	NO	no contact assertion
	±0.4 V	F	YES	YES	permanent contact assertion
±15 V	±0.8 V	W	NO	NO	no contact assertion
	±1.2 V	F	YES	NO	permanent contact assertion
CHANNEL	50 mV	W	NO	NO	no contact assertion
OFFSETS	75 mV	F	NO	NO	one second contact pulse
MASTER	50 mV	W	NO	NO	no contact assertion
OFFSET	75 mV	F	NO	NO	one second contact pulse

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SECTION 3: COMMUNICATIONS

INTRODUCTION

The relay is set and operated via serial communications interfaces connected to a computer terminal and/or modem or the SEL-PRTU. Communication serves these purposes:

1. The relay responds to commands spanning all functions, e.g., setting, metering, and control operations.
2. The relay generates an event record for an event triggering command, or for pickup of any relay element that triggers an event record.
3. The relay transmits messages in response to changes in system status, e.g., self-test warning.

It is impossible to disable any relaying or control functions via communications, unless a user enters erroneous or improper settings or logic with the INPUT, LOGIC, or SET commands.

Note: In this manual, commands to type appear in bold/upper case: **OTTER**. Keys to press appear in bold/ brackets: **<Enter>**.

Relay output appears boxed and in the following format:

```
Example SEL-279H-1 Relay            Date: 4/7/95   Time: 01:01:01
```

SERIAL PORT CONNECTIONS AND CONFIGURATIONS

Port 1 and Port 2 are EIA-232 serial data interfaces.

Port 1 is located on the rear panel and is generally used for remote communications via a modem or the SEL-PRTU.

Port 2 has connectors on both the front and rear panels, designated Port 2F and Port 2R, respectively. Port 2F has priority over Port 2R. These ports are generally used for local communications. Port 2R is typically connected to a printer. Port 2F is typically used for temporary communications via a portable terminal.

When a device is plugged into Port 2F, the relay automatically begins addressing Port 2F and discontinues communications with Port 2R. When a device is unplugged from Port 2F, the relay automatically resumes communications with the device connected to Port 2R.

The baud rate of each port is set by jumpers near the front of the main board. You can access these jumpers by removing either the top cover or front panel. Available baud rates are 300, 600, 1200, 2400, 4800, or 9600.

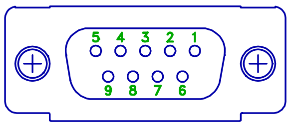
! CAUTION Do not select two baud rates for the same port as this can damage the relay baud rate generator. The relay is shipped with Port 1 set to 300 baud and Port 2F/2R set to 2400 baud.

The serial data format is:

- Eight data bits
- Two stop bits (-E2 model) or one stop bit (-E1 model)
- No parity

This format may not be changed.

Figure 3.1 shows the pin number convention for the EIA-232 data ports.



(female chassis connector, as viewed from outside panel)

Figure 3.1: 9-Pin Connector Pin Number Convention

Table 3.1 lists port pin assignments and signal definitions.

Table 3.1: SEL-279H-1 Relay Serial Port Connector Pin Assignments

Pin	Port 1, Port 2R	Port 2F	Description
1	+5 Vdc	N/C	+5 Vdc available if JMP8 installed
2	RXD	RXD	Receive data input.
3	TXD	TXD	Transmit data output.
4	+12 Vdc	N/C	+12 Vdc available if JMP10 installed
5	GND	GND	
6	–12 Vdc	N/C	–12 Vdc available if JMP9 installed
7	RTS	RTS	The relay asserts this line under normal conditions. When its received-data buffer is full, the line is deasserted, and asserts again when the buffer has sufficient room to receive more data. Connected devices should monitor RTS (usually with their CTS input) and stop transmission whenever the line deasserts. If transmission continues, data may be lost.
8	CTS	CTS	The relay monitors CTS, and transmits characters only if CTS is asserted.
9	GND	GND	Ground for ground wires and shields

COMMUNICATIONS PROTOCOL

Communications protocol consists of hardware and software features. Hardware protocol includes the control line functions described above. The following software protocol is designed for manual and automatic communications.

1. All commands received by the relay must be of the form:

   <command><CR>   or   <command><CRLF>

Thus, a command transmitted to the relay should consist of the command followed by either a carriage return or a carriage return and line feed. You may truncate commands to the first three characters. Thus, **EVENT 1 <Enter>** would become **EVE 1 <Enter>**. Upper and lower case characters may be used without distinction, except in passwords.

Note: The **<Enter>** key on most keyboards is configured to send the ASCII character 13 (^M) for a carriage return. This manual instructs you to press the ENTER key after commands, which should send the proper ASCII code to the relay.

2. The relay transmits all messages in the following format:

   <STX> <MESSAGE LINE 1> <CRLF>
   <MESSAGE LINE 2> <CRLF>
   •
   •
   •
   <LAST MESSAGE LINE> <CRLF> <PROMPT> <ETX>

Each message begins with the start-of-transmission character (ASCII 02) and ends with the end-of-transmission character (ASCII 03). Each line of the message ends with a carriage return and line feed.

3. The relay indicates the volume of data in its received data buffer through an XON/XOFF protocol.

The relay transmits XON (ASCII hex 11) and asserts the RTS output when the buffer drops below one-quarter full.

The relay transmits XOFF (ASCII hex 13) when the buffer is over three-fourths full. The relay deasserts the RTS output when the buffer is approximately 95 percent full. Automatic transmission sources should monitor for the XOFF character so they do not overwrite the buffer. Transmission should terminate at the end of the message in progress when XOFF is received and may resume when the relay sends XON.

4. You can use an XON/XOFF procedure to control the relay during data transmission. When the relay receives XOFF during transmission, it pauses until it receives an XON character. If there is no message in progress when the relay receives XOFF, it blocks transmission of any message presented to its buffer. Messages will be accepted after the relay receives XON.

The CAN character (ASCII hex 18) aborts a pending transmission. This is useful in terminating an unwanted transmission.

5. Control characters can be sent from most keyboards with the following keystrokes:

   XON: **<Ctrl+Q>** (hold down the Control key and press Q)

   XOFF: **<Ctrl+S>** (hold down the Control key and press S)

   CAN: **<Ctrl+X>** (hold down the Control key and press X)

6. The relay input buffer is limited to 128 characters. If the buffer is over 75 percent full, the relay will send an XOFF to the terminal to terminate transmission. This should be avoided, as the relay may never send an XON if there are no termination characters (carriage returns) within the buffered text.

COMMAND CHARACTERISTICS

The relay responds to commands sent to either serial communications interface. A two-level password system provides security against unauthorized access.

When the power is first turned on, the relay is in Access Level 0 and honors only the **ACCESS** command. It responds "Invalid command" or "Invalid access level" to any other entry.

You may enter Access Level 1 with the **ACCESS** command and first password. The Level 1 password is factory-set to OTTER and may be changed with the **PASSWORD** command in Access Level 2. Most commands may be used in Access Level 1.

Critical commands such as **SET** operate only in Access Level 2. You may enter Access Level 2 with the **2ACCESS** command and second password. The Level 2 password is factory-set to TAIL and may be changed with the **PASSWORD** command.

Startup

Immediately after power is applied, the relay transmits the following message to the port(s) designated automatic:

```
Example SEL-279H-1 Relay         Date: 1/1/94       Time: 01:01:01
SEL-279H-1
=
```

The ALARM OUT contact should pull in.

The = represents the Access Level 0 prompt.

The relays are shipped with Port 2 designated automatic; you may use the **SET** command to change this designation (see **SET** command, AUTO setting). This allows you to select Port 1, Port 2, or both ports to transmit automatic responses from the relay.

To enter Level 1, type the following on a terminal connected to Port 2:

```
=ACCESS <Enter>
```

The response is:

```
Password: ? @@@@@@
```

Enter the Level 1 password **OTTER** and press **<Enter>**. The response is:

```
Example  SEL-279H-1 Relay       Date: 1/1/94      Time: 01:01:44
Level 1
=>
```

The Access Level 1 prompt is =>. Now you can execute any Level 1 command.

Use a similar procedure to enter Access Level 2:

Type **2ACCESS <Enter>**. The relay pulses the ALARM OUT contact closed for approximately one second in response to your access attempt. Enter the password **TAIL** when prompted. After you enter the second password, the relay opens access to Level 2, as indicated by the following message and Level 2 prompt (=>>):

```
=>2ACCESS <Enter>
Password:   TAIL <Enter>


Example SEL-279H-1 Relay            Date: 1/1/94   Time: 01:03:32

Level 2
=>>
```

You can enter any command at this prompt.

Command Format

Commands consist of three or more characters; only the first three characters of any command are required. You may use upper or lower case characters without distinction, except in passwords.

You must separate arguments from the command by spaces, commas, semicolons, colons, or slashes.

You can enter commands any time after the terminal displays an appropriate prompt.

In this manual, commands to type appear in bold/upper case: **OTTER**. Keys to press appear in bold/brackets: **<Enter>**. Some commands have optional parameters; these appear after the command in bold/lower case.

COMMAND DESCRIPTIONS

Access Level 0 Command

ACCESS

ACCESS allows you to enter Access Level 1. The password is required unless you install jumper JMP103. The first password is set to OTTER at the factory; use the Level 2 command **PASSWORD** to change passwords.

The following display indicates successful access:

```
=ACCESS <Enter>
Password:  OTTER <Enter>


Example SEL-279H-1 Relay            Date: 1/1/94   Time: 14:03:57

Level 1
=>
```

The => prompt indicates Access Level 1.

If you enter incorrect passwords during three consecutive attempts, the relay pulses the ALARM OUT contact closed for one second. This feature can alert personnel to an unauthorized access attempt if the ALARM OUT contact is connected to a monitoring system.

Access Level 1 Commands

2ACCESS

2ACCESS allows you to enter Access Level 2. The password is required unless you install jumper JMP103. The second password is set to TAIL at the factory; use the Level 2 command **PASSWORD** to change passwords.

The following display indicates successful access:

```
=>2ACCESS <Enter>
Password:  TAIL <Enter>


Example SEL-279H-1 Relay            Date: 1/1/94   Time: 14:12:01

Level 2
=>>
```

You may use any command from the =>> prompt. The relay pulses the ALARM OUT contact closed for one second after any Level 2 access attempt (unless an alarm condition exists). If access is denied, the ALARM OUT contact pulses again.

DATE mm/dd/yy

DATE displays the date stored by the internal calendar/clock. To set the date, type **DATE mm/dd/yy <Enter>**.

To set the date to April 7, 1995, enter:

```
=>DATE 4/7/95 <Enter>
4/7/95
=>

=>DATE <Enter>
4/7/95
=>
```

The relay sets the date, pulses the ALARM relay closed as it stores the year in EEPROM (if the year input differs from the year stored), and displays the new date.

EVENT *n*

EVENT displays an event report. Type **EVENT *n* <Enter>** to display an event report for the nth event. The parameter *n* ranges from 1 for the newest event through 12 for the oldest event stored in relay memory. If *n* is not specified, the default value is 1 and the relay displays the newest event report.

You can control transmissions from the relay with the following keystrokes:

- **<Ctrl+S>** Pause transmission
- **<Ctrl+Q>** Continue transmission
- **<Ctrl+X>** Terminate transmission

The following incidents clear the event buffers:

- Control power interruption
- Changing any relay setting via the **INPUT**, **LOGIC**, or **SET** commands

All event data are lost when event buffers are cleared. If an event buffer is empty when you request an event, the relay returns an error message:

```
=>EVENT 12 <Enter>
Invalid event
=>
```

Section 4: Event Reporting explains the generation and analysis of event reports.

HISTORY

HISTORY displays the date, time, event type, Master Timer position, and targets for each of the last twelve events. The full sixty-cycle event reports also include this information (**EVENT *n*** to display).

```
=>HISTORY <Enter>

Example SEL-279H-1 Relay       Date: 4/8/95       Time: 11:15:12

#   DATE               TIME           EVENT          TARGETS
1  4/7/95         05:02:48.625       CLS1           RC1 CY
2  4/1/95         08:07:40.129       TRIG           52A1  52A2  RS
3
 ⋮                  ⋮
11
12

=>
```

Note that only two events have occurred since the relay was set or powered on.

The time is saved to the nearest cycle (16.7 ms) and referenced to the sixth row of data in the report. All reports trigger at row 6.

The EVENT column provides an abbreviated indication of the event type.

TRIG:	**TRIGGER** command execution
Programmable Condition:	event report generated by a condition programmed with the Event Report triggering condition logic setting (ER) picking up. The condition is then listed as the event type (e.g., **CLS1**)

The TARGETS column lists the front panel targets illuminated at event report initiation. Refer to Table 3.2 in this section (TARGET 0, Front Panel Targets).

If the event buffers are cleared, the event summaries listed by the **HISTORY** command are lost (see **EVENT** in this section).

METER *n*

METER displays **present** values of the following in V rms, secondary:

- VPB: bus positive-sequence voltage (derived from V1, V3, and V5 voltages)
- V1: voltage at V1 terminal inputs
- V3: voltage at V3 terminal inputs
- V5: voltage at V5 terminal inputs
- VPL: line positive-sequence voltage (derived from V2, V4, and V6 voltages)
- V2: voltage at V2 terminal inputs
- V4: voltage at V4 terminal inputs
- V6: voltage at V6 terminal inputs
- d12: magnitude of phasor voltage difference between V1 and V2

- d34: magnitude of phasor voltage difference between V3 and V4
- d56: magnitude of phasor voltage difference between V5 and V6

```
=>METER <Enter>

Example SEL-279H-1 Relay         Date: 4/8/95       Time: 11:15:12

VPB=67    V1=67    V3=67    V5=67    VPL=67    V2=67    V4=67    V6=67

d12=0    d34=0    d56=0

=>
```

The optional parameter *n* selects the number of times the relay displays meter data. To display a series of eight meter readings, type **METER 8 <Enter>**.

QUIT

QUIT returns control to Access Level 0 from Level 1 or 2 and resets targets to the Relay Targets (TAR 0). The command displays the relay I.D., date, and time of **QUIT** command execution.

Use this command when you finish communicating with the relay to prevent unauthorized access. Control returns to Access Level 0 automatically after a settable interval of no activity (see the TIME1 and TIME2 settings of the **SET** command).

```
=>QUIT <Enter>

Example SEL-279H-1 Relay          Date: 4/8/95      Time: 12:45:40

=
```

SHOWSET

SHOWSET displays the relay, logic, and input settings. You cannot enter or modify settings with this command. The **SET** command description provides complete information about changing settings. The **LOGIC** command description provides complete information about changing SELOGIC® control equations. The **INPUT** command description provides complete information about changing programmable input assignments. *Settings ranges and explanations are found in* ***Section 2: Specifications*** *(Relay Settings and Logic) and in* ***Section 5: Applications***.

```
=>>SHOWSET <Enter>

Settings for: Example SEL-279H-1 Relay


VSRC  =2        LNM   =3        BSM   =0        BKRC  =2
27B   =0        27L   =0        59B   =100      59L   =55
25DV  =0        25D   =0
SOI1  =57       SOI2  =30       3OI1  =27       3OI2  =30
79RS  =60       M79SH =011      CDOD  =0
52PU1 =600      52DO1 =600      52PU2 =600      52DO2 =600      OTD   =900
TSPU  =0        TSDO  =0        TZPU  =0        TZDO  =0
TIME1 =5        TIME2 =0        AUTO  =2
```

```
SELogic Control Equations

A(1236)        = 3PRI+SPRI
B(1236)        =
C(1236)        =
D(1236)        =
E(1236)        =
S(1236)        =
L(1236)        =
G(1234)        = CYCL*79SH*A
H(1234)        =
I(1234)        =
M(1234)        =
W(45)          =
X(45)          =
Y(45)          =
Z(45)          =
SPR1S(12345)   =
SPR1C(12345)   =
3PR1S(12345)   =
3PR1C(12345)   = 59L
SPR2S(12345)   = 52A1
SPR2C(12345)   =
3PR2S(12345)   = 52A1
3PR2C(12345)   =
RLTCH(12345)   =
SLTCH(12345)   =
RC(12345)      = G
RS(12345)      =
MC1S(12345)    =
MC2S(12345)    =
ER(12345)      = CLS1+CLS2+A
OUT1(12345)    = CLS1
OUT2(12345)    = CLS2
OUT3(12345)    = LOCK
OUT4(12345)    =

Input Assignments:

IN1 = 52A1   IN2 = 52A2   IN3 =        IN4 =
IN5 =        IN6 =        IN7 =        RE  = RE
=>>
```

STATUS

STATUS allows inspection of self-test status. The relay automatically executes the **STATUS** command whenever a self-test enters a warning or failure state. If this occurs, the relay transmits a STATUS report from the port(s) designated automatic (see **SET** command, AUTO setting).

The STATUS report format appears below.

```
=>STATUS <Enter>

W-Warn F=Fail
       V1    V3    V5    V2    V4    V6
OS     2     1     2     0     1     1

PS      4.95        15.01       -14.94

RAM     ROM     A/D     MOF     SET
OK      OK      OK      OK      OK

=>
```

The OS row indicates measured dc offset voltages in millivolts for the six analog channels. An out-of-tolerance offset is indicated by a W (warning) or F (failure) following the displayed offset value.

The PS row indicates power supply voltages in volts for the three power supply outputs.

If a RAM or ROM test fails, the IC socket code of the defective part replaces OK.

The A/D self-test checks analog-to-digital conversion time.

The MOF test checks dc offset in the MUX-PGA-A/D circuit.

The SET self-test calculates a checksum of the settings stored in nonvolatile memory and compares it to the checksum calculated when the settings were last changed.

Section 2: Specifications provides full definitions of the self-tests, warning and failure limits, and warning and failure results.

TARGET *n k*

TARGET selects the information to be displayed on the target LEDs and to be communicated by this command.

When relay power is first turned on, the LED display indicates the functions marked on the front panel.

Using the **TARGET** command, you may select any one of the following eight sets of data to display on the LEDs.

Table 3.2: Target LED Assignment

LED:	1	2	3	4	5	6	7	8	
N									
0	52A1	52A2	RC1	RC2	RS	CY	LO	CLOS	Front Panel Targets
1	27B	27L	59B	59L	25T1	25T2	CLS1	CLS2	Relay Word row 1
2	SPC1	SPC2	3PC1	3PC2	RSET	CYCL	LOCK	OTT	Relay Word row 2
3	52A1	52A2	52BT1	52BT2	79OIT	3PRI	SPRI	79SH	Relay Word row 3
4	LTCH	A	B	C	D	E	ST	!L	Relay Word row 4
5	G	H	I	!M	W	X	Y	ZT	Relay Word row 5

LED:	1	2	3	4	5	6	7	8	
6	RE	IN7	IN6	IN5	IN4	IN3	IN2	IN1	Relay Word row 6
7	ALRM	OUT4	OUT3	OUT2	OUT1	DTL	RE	3PRI	Output contacts/ Inputs

See Figure 2.22 and Table 2.2 in ***Section 2: Specifications*** for explanation of front panel target and Relay Word information in Table 3.2.

These selections are useful in testing, checking contact states, and reading targets remotely. “1” indicates an asserted element; “0” indicates a deasserted element.

The optional command parameter *k* selects the number of times the relay displays target data for parameter *n*. The example below shows a series of ten target readings for Relay Word row 2. Target headings repeat every eight rows. You cannot use parameter *k* without parameter *n*.

```
=>TARGET 2 10 <Enter>

SPC1  SPC2  3PC1  3PC2  RSET  CYCL  LOCK  OTT
0     0     0     0     1     0     0     0
0     0     0     0     1     0     0     0
0     0     0     0     1     0     0     0
0     0     0     0     1     0     0     0
0     0     0     0     1     0     0     0
0     0     0     0     1     0     0     0
0     0     0     0     1     0     0     0
0     0     0     0     1     0     0     0

SPC1  SPC2  3PC1  3PC2  RSET  CYCL  LOCK  OTT
0     0     0     0     1     0     0     0
0     0     0     0     1     0     0     0

=>
```

When you are finished, type **TAR 0 <Enter>** to return to the functions marked on the front panel so field personnel do not misinterpret displayed data.

When a serial port times out (see TIME1, TIME2 settings) and an automatic message is sent to that port, the relay automatically clears the targets and displays the TAR 0 data.

Press the front panel TARGET RESET button to clear the TAR 0 data and illuminate all target LEDs for a one second lamp test.

If you place the relay in service with a target level other than Level 0, it automatically returns to target Level 0 when the auto port times out. While this feature prevents confusion among station operators and readers, it can be inconvenient if the relay tester requires targets to remain on another level. Targets remain in the specified level if you assign the AUTO setting to a port with zero time-out or set both TIME1 and TIME2 to zero. This halts automatic port time-out.

TARGET R

You can reset front panel targets to TAR 0 and clear them remotely or locally with the **TARGET R** command. Type **TARGET R <Enter>** to reset and clear the targets as shown in the following example.

```
=>TARGET R <Enter>
Targets reset

52A1  52A2  RC1   RC2   RS    CY    LO    CLOS
1     1     0     0     1     0     0     0

=>
```

TIME hh:mm:ss

TIME displays the internal clock. To set the clock, type **TIME** and the desired setting, then press **<Enter>**. Separate the hours, minutes, and seconds with colons, semicolons, spaces, commas, or slashes. To set the clock to 23:30:00, enter:

```
=>TIME  23:30:00 <Enter>
23:30:00
=>
```

A quartz crystal oscillator provides the time base for the internal clock.

TRIGGER

TRIGGER generates an event record. After command entry, the relay responds "Triggered" and displays a record summary.

```
=>TRIGGER <Enter>
Triggered

=>

Example SEL-279H-1 Relay           Date: 4/7/95     Time: 09:25:20

Event: TRIG            Targets: 52A1  52A2  RS

=>
```

Table 4.1 in ***Section 4: Event Reporting*** lists the ways event reports can be generated.

Access Level 2 Commands

While all commands are available from Access Level 2, the commands below are available only from Access Level 2. Remember, the relay pulses the ALARM contacts closed for one second after any Level 2 access attempt.

CLOSE *n*

The **CLOSE *n*** (*n* = 1 or 2) command asserts the respective CLS1 or CLS2 Relay Word Bits when jumper JMP104 is installed on the main board and the respective circuit breaker status input indicates an open circuit breaker. The CLS1 or CLS2 bit then remains asserted until the respective circuit breaker status input indicates that the circuit breaker has closed or until the overall timer (setting OTT) expires.

To close the primary circuit breaker with this command, type **CLOSE 1 <Enter>**. The relay responds with the message: "Close BREAKER 1 (Y/N) ?" **Y <Enter>** yields a second prompting string: "Are you sure (Y/N) ?" Type **Y <Enter>** to assert the CLS1 bit. If the CLS1 bit is assigned to an output contact, the output contact asserts when the CLS1 bit asserts. The relay transmits the message "Breaker CLOSED" when the breaker closes or if it is already closed (as determined by circuit breaker status input state). Typing **N <Enter>** after either of the above messages aborts the closing operation with the message "Aborted."

```
=>>CLOSE 1 <Enter>
Close BREAKER 1 (Y/N) ? Y <Enter>
Are you sure (Y/N) ? Y <Enter>
Breaker 1 CLOSED
=>>

Example SEL-279H-1 Relay         Date: 4/7/95      Time: 09:25:20

Event: CLS1           Targets: LO

=>>
```

After **CLOSE 1** command execution, if the response is "Breaker 1 OPEN" instead of "Breaker 1 CLOSED," the primary circuit breaker status input did not indicate primary circuit breaker closure.

INPUT *n*

The **INPUT** command programs the eight programmable optoisolated inputs IN1 through IN7 and RE. Available input assignments are:

- 52A1 Breaker 1 status (52A contact input)
- 52A2 Breaker 2 status (52A contact input)
- !52A1 Breaker 1 status (52B contact input)
- !52A2 Breaker 2 status (52B contact input)
- SRT1 Stall recloser timing for breaker 1
- SRT2 Stall recloser timing for breaker 2
- CLSEN Manual close input enable
- !CLSEN Inverted manual close input enable
- CL1 Breaker 1 manual close input
- CL2 Breaker 2 manual close input
- RE Reclose enable input

- 3PRE Three-pole reclose enable input
- SPRE Single-pole reclose enable input

The input programming procedure requires you to enter changes at the prompt (?) or press **<Enter>** to indicate no change. Enter **NA** to clear settings. You can jump to a specific setting by entering the setting name as a parameter *n*.

When you finish entering input setting changes, you need not scroll through the remaining logic settings. Type **END <Enter>** after your last change to display the new input settings and enable prompt.

When all the input settings are entered, the relay displays the new input settings and prompts for approval to enable the relay with them. **Y <Enter>** enters the new data, pulses the ALARM OUT contact closed momentarily, and clears the event buffers. **N <Enter>** retains the old settings.

The programmable inputs, whether assigned a function or not, can be used in the SELOGIC control equations (see **LOGIC** command). The states of programmable inputs IN1 through IN7, RE, and fixed inputs SPRI and 3PRI (asserted or deasserted) are found in rows 7 and 3 of the Relay Word (see Table 2.1 in the ***Section 2: Specifications***).

```
=>>INP IN1 <Enter>

Input Definitions.

IN1  = 52A1 ?
IN2  = 52A2 ?
IN3  =    ?
IN4  =    ?
IN5  =    ? SRT1 <Enter>
IN6  =    ?
IN7  =    ?
RE   = RE

New Input Assignments:
IN1 = 52A1   IN2 = 52A2   IN3 =        IN4 =
IN5 = SRT1   IN6 =        IN7 =        RE = RE
OK (Y/N) ? n


=>>
```

LOGIC *n*

The **LOGIC** command programs the SELOGIC control equations which control the reclosing process, programmable output contacts, and event report generation.

The logic programming procedure requires you to enter changes at the prompt (?) or press **<Enter>** to indicate no change. Enter **NA** to clear settings. You can jump to a specific setting by entering the setting name as parameter *n*. You do not need to include the parenthetical [e.g., just B, not B(1236)].

When you finish entering logic setting changes, you need not scroll through the remaining logic settings. Type **END <Enter>** after your last change to display the new logic settings and enable prompt.

When all logic settings are entered, the relay displays the new logic settings and prompts for approval to enable the relay with them. **Y <Enter>** enters the new data, pulses the ALARM OUT contact closed momentarily, and clears the event buffers. **N <Enter>** retains the old settings.

Logic settings explanations are found in ***Section 2: Specifications*** *(Relay Settings and Logic) and in* ***Section 5: Applications****.*

```
=>>LOGIC B <Enter>

SELogic Control Equations:

B(1236)       =  ?
C(1236)       =  ?
D(1236)       =  ?
E(1236)       =  ?
S(1236)       =  ?
L(1236)       =  ?
G(1234)       = CYCL*79SH*A ?
H(1234)       =  ?
I(1234)       =  ?
M(1234)       =  ?
W(45)         =  ?
X(45)         =  ?
Y(45)         =  ?
Z(45)         =  ?
SPR1S(12345)  =  ?
SPR1C(12345)  =  ?
3PR1S(12345)  =  ?
3PR1C(12345)  = 59L ?
SPR2S(12345)  = 52A1 ?
SPR2C(12345)  =  ?
3PR2S(12345)  = 52A1 ?
3PR2C(12345)  =  ?
RLTCH(12345)  =  ?
SLTCH(12345)  =  ?
RC(12345)     = G ?
RS(12345)     =  ?
MC1S(12345)   =
MC2S(12345)   =
ER(12345)     = SPRI+3PRI ?
OUT1(12345)   = CLS1 ?
OUT2(12345)   = CLS2 ?
OUT3(12345)   = LOCK ?
OUT4(12345)   =  ?

New SELogic Control Equations:

A(1236)       = 3PRI+SPRI
B(1236)       =
C(1236)       =
D(1236)       =
E(1236)       =
S(1236)       =
L(1236)       =
G(1234)       = CYCL*79SH*A
H(1234)       =
I(1234)       =
M(1234)       =
W(45)         =
X(45)         =
Y(45)         =
Z(45)         =
SPR1S(12345)  =
SPR1C(12345)  =
3PR1S(12345)  =
3PR1C(12345)  = 59L
SPR2S(12345)  = 52A1
SPR2C(12345)  =
3PR2S(12345)  = 52A1
3PR2C(12345)  =
RLTCH(12345)  =
```

```
SLTCH(12345)  =
RC(12345)     = G
RS(12345)     =
MC1S(12345)   =
MC2S(12345)   =
ER(12345)     = CLS1+CLS2+A
OUT1(12345)   = CLS1
OUT2(12345)   = CLS2
OUT3(12345)   = LOCK
OUT4(12345)   =

OK (Y/N) ? N <Enter>


=>>
```

Note: You must set each programmable logic equation properly for your application.

PASSWORD (1 or 2) Password

PASSWORD allows you to inspect or change existing passwords. To inspect passwords, type **PASSWORD <Enter>** as the following example shows:

```
=>>PASSWORD <Enter>
1: OTTER
2: TAIL
=>>
```

To change the password for Access Level 1 to BIKE enter the following:

```
=>>PASSWORD 1 BIKE <Enter>
Set
=>>
```

The relay sets the password, pulses the ALARM relay closed, and transmits the response "Set."

After entering new passwords, type **PASSWORD <Enter>** to inspect them. Make sure they are what you intended and record the new passwords.

Passwords can be any length up to six numbers, letters, or any other printable characters except delimiters (space, comma, semicolon, colon, slash). Upper and lower case letters are treated as different characters. Examples of valid, distinct passwords include:

- OTTER
- Otter
- Ot3456
- +TAIL+
- !@#$%^
- 123456
- 12345.
- 12345

If the passwords are lost or you wish to operate the relay without password protection, install JMP103 on the main board. With no password protection, you may gain access without knowing the passwords and view or change current passwords and settings.

SET *n*

SET allows entry of relay settings and logic. At the setting procedure prompts (?), enter new data or press **<Enter>** to retain existing settings. You can jump to a specific setting by entering the setting name as parameter *n*.

The relay prompts you for each setting and checks the new setting against established limits. If a setting falls within its setting range, the relay prompts you for the next setting. If a setting is outside its established limits, an "Out of range" or "Invalid" error message results. You have another chance to enter the setting. If you want to retain the old setting, press <**Enter**> and proceed to the next setting.

When you finish entering setting changes, you need not scroll through the remaining settings. Type **END <Enter>** after your last change to display the new settings and enable prompt. Do not use the END statement at the Relay ID setting; use **<Ctrl+X>** to abort the SET procedure from this point.

After you enter all data, the relay displays the new settings and prompts for approval to enable new group settings. Answer **Y <Enter>** to approve the new settings; the relay enables them and clears the event buffer; the ALARM OUT contact pulses closed.

A list of relay settings follows. *Settings ranges and explanations are found in* ***Section 2: Specifications*** *(Relay Settings and Logic) and in* ***Section 5: Applications***.

```
=>>SET <ENTER>


SET clears events. CTRL-X cancels.
Enter data, or RETURN for no change

ID   : Example SEL-279H-1 Relay

VSRC : Volt Sources 0,2,3...... = 2        ?
LNM  : Line conn 0,1,3,P....... = 3        ?
BSM  : Bus conn 0,1,3,P........ = 0        ?
BKRC : Bkr control 0,1,2....... = 2        ?

27B  : Bus dead, V sec......... = 0        ?
27L  : Line.................... = 0        ?
59B  : Bus hot, V sec.......... = 100      ?
59L  : Line.................... = 55       ?

25DV : Synch chk diff, V sec... = 0        ?
25D  : Synch chk dly, cyc...... = 0        ?

SOI1 : Bkr1 sngl pole delay.... = 57       ?
SOI2 : Bkr2.................... = 30       ?
3OI1 : Bkr1 3 pole delay....... = 27       ?
3OI2 : Bkr2.................... = 30       ?

79RS : Reclose rst dly, cyc.... = 60       ?
M79SH: Shot Mask............... = 011      ?
CDOD : Close do dly, cyc....... = 0        ?

52PU1: Bkr1 pu dly, cyc........ = 600      ?
52DO1: Bkr1 do dly, cyc........ = 600      ?
52PU2: Bkr2 pu dly, cyc........ = 600      ?
52DO2: Bkr2 do dly, cyc........ = 600      ?
```

```
OTD  : Overall tmr dly, cyc.... = 900      ?

TSPU : TS timer pu dly, cyc.... = 0        ?
TSDO : TS timer do dly, cyc.... = 0        ?
TZPU : TZ timer pu dly, cyc.... = 0        ?
TZDO : TZ timer do dly, cyc.... = 0        ?

TIME1: Port 1 timeout, min..... = 5        ?
TIME2: ........................ = 0        ?
AUTO : Auto port 1,2,3......... = 2        ?

New settings for: Example SEL-279H-1 Relay

VSRC  =2        LNM   =3        BSM   =0        BKRC  =2
27B   =0        27L   =0        59B   =100      59L   =55
25DV  =0        25D   =0
SOI1  =57       SOI2  =30       3OI1  =27       3OI2  =30
79RS  =60       M79SH =011      CDOD  =0
52PU1 =600      52DO1 =600      52PU2 =600      52DO2 =600      OTD   =900
TSPU  =0        TSDO  =0        TZPU  =0        TZDO  =0
TIME1 =5        TIME2 =0        AUTO  =2
OK (Y/N) ? N <Enter>


=>>
```

Be sure the settings you choose result in relay performance appropriate to your application.

SEL-279H-1 RELAY COMMAND SUMMARY

Access Level 0 Command

ACCESS	Answer password prompt (if password protection is enabled) to enter Access Level 1. Third unsuccessful attempt pulses ALARM OUT contact closed for one second.

Access Level 1 Commands

2ACCESS	Answer password prompt (if password protection is enabled) to enter Access Level 2. This command always pulses the ALARM OUT contact closed for one second.
DATE m/d/y	Sets or displays date. **DAT 4/5/93** sets date to April 5, 1993. **DATE** pulses ALARM contacts when year entered differs from year stored. To display the date only, enter **DATE**.
EVENT *n*	Shows event record. **EVE** or **EVE 1** shows newest event; **EVE 12** shows oldest (*n* = 1, 2, 3, . . . 11, or 12).
HISTORY	Shows Date, Time, Event, and Targets, for the last twelve events.
METER *n*	Displays present terminal, positive-sequence, and difference voltage values. Optional *n* displays METER data *n* times.
QUIT	Returns control to Access Level 0; return target display to Relay Targets.
SHOWSET	Displays relay, logic, and input settings without affecting them.
STATUS	Shows self-test status.
TARGET *n k*	Shows data and sets target LEDs as follows (*n* = 0, 1, 2, . . . 6, or 7): **TAR 0**: Front Panel Targets — **TAR 1**: Relay Word row 1 **TAR 2**: Relay Word row 2 — **TAR 3**: Relay Word row 3 **TAR 4**: Relay Word row 4 — **TAR 5**: Relay Word row 5 **TAR 6**: Input States — **TAR 7**: Output Contact/Input States Optional *k* displays target data *k* times.
TARGET R	Clears targets and returns to TAR 0
TIME h/m/s	Sets or displays time. **TIM 13/32/00** sets clock to 1:32:00 PM. To display the time only, enter TIME.
TRIGGER	Triggers and saves an event record (event type is TRIG).

Access Level 2 Commands

CLOSE *n*	(*n* = 1 or 2) Asserts Relay Word bits CLS1 or CLS2 if allowed by jumper JMP104 setting.
INPUT *n*	Shows or sets the programmable inputs. Command pulses ALARM OUT contact closed for one second and clears event buffers when new programmable input settings are stored.
LOGIC *n*	Shows or sets SELOGIC control equations. Command pulses ALARM OUT contact closed for one second and clears event buffers when new settings are stored.
PASSWORD	Shows or sets passwords. ALARM OUT contact pulses closed after password entry. **PAS 1 OTTER** sets Level 1 password to OTTER. **PAS 2 TAIL** sets Level 2 password to TAIL.
SET *n*	Initiates setting procedure. Option *n* directs the relay to begin the setting procedure at setting n (e.g., if *n* = 27B, the setting procedure starts at setting 27B, bypassing all settings before 27B). If no optional *n* is entered, the setting procedure starts at the beginning. The relay clears event buffers when new settings are stored and the ALARM OUT contact pulses closed.

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SECTION 4: EVENT REPORTING

EVENT REPORT GENERATION

The relay generates a summary and full event report in response to the actions listed in Table 4.1. The summary event report allows a quick review of the information necessary to determine the event type. The full event report displays 48 cycles of information for analyzing system and reclosing scheme performance. Triggering is recorded to the nearest cycle and referenced to the 6th row of data in the event report.

Table 4.1: Event Report Triggering Actions

- **TRIGGER** command execution
- Programmable Event Report triggering condition logic setting (ER) asserts

SUMMARY EVENT REPORT

The summary event report is automatically transmitted from port(s) designated by the AUTO setting regardless of access level, as long as the designated port has not timed out. If automatic transmissions are monitored by a dedicated channel or printed on a dedicated printer, enter zero for the timeout setting (TIME1 or TIME2) of the appropriate port. Review the stored summary event reports with the **HISTORY** command.

The summary event report includes:

- Relay terminal identifier
- Date and time
- Event type
- Front panel targets

The following is an example summary event report.

```
Example SEL-279H-1 Relay       Date: 1/1/94     Time: 01:05:29

Event: CLS1           Targets: RC1 CY

=>>
```

The latest twelve event reports are stored in volatile memory. The relay clears the event report and history buffer for the following conditions:

- Loss of control power
- Entry of new setting via the **INPUT**, **LOGIC**, or **SET** commands

FULL EVENT REPORT

The full event report contains 48 cycles of voltage (magnitudes only) and relay information. The report also includes settings active during the event. This information is useful in reviewing reclosing action, relay element response, and breaker reaction time. Use the **EVENT** command to display a full event report (see Figure 4.1).

The CYC column numbers the consecutive rows of the event report.

The VP columns under the Bus and Line Voltage headings list the magnitude of the positive-sequence voltage present on the bus and line. These positive-sequence voltage values only have meaning if three-phase voltage is connected to the relay.

The voltage difference columns d12, d34, and d56 list the magnitude of the phasor voltage difference between V1 and V2, V3 and V4, and V5 and V6. These voltage difference values only have meaning if they measure voltage across a circuit breaker (the same voltage values a synchronism check element measures). Thus V1 and V2 would have to be connected to the same phase on both sides of the circuit breaker and likewise for the other voltage values.

Relay elements, inputs, and output contact states appear in the right-hand columns of the event report. The corresponding symbol given in Table 4.2 indicates assertion; "." indicates deassertion.

Table 4.2: Event Report Column Definitions

Column	Definition/Element	Symbol
Elements	Voltage type	
27B	Dead Bus	*
	27B Relay Word bit	
27L	Dead Line	*
	27L Relay Word bit	
59B	Hot Bus	*
	59B Relay Word bit	
59L	Hot Line	*
	59L Relay Word bit	
25T	Time Delayed Synchronism Check	
	25T1 Relay Word bit	1
	25T2 Relay Word bit	2
	Both	B

Column	Definition/Element	Symbol
Timing	Timers timing/states	
79	Relay state	
	Reset state	R
	RSET Relay Word bit	
	Reclose cycle state	C
	CYCL Relay Word bit	
	Lockout state	L
	LOCK Relay Word bit	
SPR	Single-pole reclose open interval timer timing	
	Breaker 1	1
	Breaker 2	2
	Both	B
3PR	Three-pole reclose open interval timer timing	
	Breaker 1	1
	Breaker 2	2
	Both	B
52B	Out-of-service timer timing or timed out	
	Breaker 1	1
	Breaker 2	2
	Both	B
Out	Output contacts	
1	OUT1	*
2	OUT2	*
3	OUT3	*
4	OUT4	*
ALR	ALARM OUT	*

Column	Definition/Element	Symbol
Inputs	Optically isolated inputs	
1&2	IN1	1
	IN2	2
	Both	B
3&4	IN3	3
	IN4	4
	Both	B
5&6	IN5	5
	IN6	6
	Both	B
7	IN7	*
RI	Reclose Initiate	
	Single-pole (SPRI)	1
	Three-pole (3PRI)	3
	Both	B
RE	Reclose Enable	*
DTL	Drive-to-lockout	*

```
EXAMPLE SEL-279H-1 RELAY                    Date:  10/1/95     Time: 12:59:53.491

          FID=SEL-279H-1-R400-V6-D951003-E2

                          Voltages (V sec.)                 Elements  Timing  Out  Inputs

           C       Bus              Line         Difference   22 55 2   7S35   1234A 1357RRD
           Y                                                  77 99 5   9PP2       L &&& IET
           C  VP  V1  V3  V5   VP  V2  V4  V6   d12 d34 d56   BL BL T    RRB       R 246   L

           1  63  63  63  63   63  63  63  63     0   0   0   B. .B ..  R...   ..... B....*.
           2  63  63  64  63   63  62  64  63     0   0   0   B. .B ..  R...   ..... B....*.
           3  62  62  60  64   62  62  59  64     0   0   0   B. .B ..  R...   ..... B....*.
           4  53  59  37  63   53  59  37  63     0   0   0   B. .. ..  R...   ..... B....*.
           5  53  58  37  63   53  58  38  63     0   0   0   B. .. ..  R...   ..... B...3*.
           6  59  61  58  61   41  55  30  57     6  28   4   B. .. ..  C.B.   ..... B...3*.

           7  63  63  61  63   12  10  15  12    51  49  51   B. .. ..  C.B.   ..... B...3*.
           8  64  63  64  64    0   0   0   0    63  64  64   B. .. ..  C.B.   ..... ....3*.
           9  65  64  64  64    0   0   0   0    64  64  64   B. .. ..  C.1.   ..... ....3*.
          10  65  64  64  65    0   0   0   0    64  64  65   B. .. ..  C.1.   ..... ....3*.
          11  65  65  64  64    0   0   0   0    65  64  64   B. .. ..  C.1.   ..... ....3*.
          12  65  63  64  64    0   0   0   0    63  64  64   B. .. ..  C.1.   ..... ....3*.

          13  64  63  63  63    0   0   0   0    63  63  63   B. .. ..  C.1.   ..... ....3*.
          14  64  64  63  63    0   0   0   0    64  63  63   B. .. ..  C.1.   ..... .....*.
          15  64  64  63  63    0   0   0   0    64  63  63   B. .. ..  C.1.   ..... .....*.
          16  64  63  63  63    0   0   0   0    63  63  63   B. .. ..  C.1.   ..... .....*.
          17  64  64  63  63    0   0   0   0    64  63  63   B. .. ..  C.1.   ..... .....*.
          18  64  64  63  63    0   0   0   0    64  63  63   B. .. ..  C.1.   ..... .....*.

          19  63  63  61  63    0   0   0   0    63  61  63   B. .. ..  C.1.   ..... .....*.
          20  64  63  64  64    0   0   0   0    63  64  64   B. .. ..  C.1.   ..... .....*.
          21  65  64  64  64    0   0   0   0    64  64  64   B. .. ..  C.1.   ..... .....*.
          22  65  64  64  65    0   0   0   0    64  64  65   B. .. ..  C.1.   ..... .....*.
          23  65  65  64  64    0   0   0   0    65  64  64   B. .. ..  C.1.   ..... .....*.
          24  65  63  64  64    0   0   0   0    63  64  64   B. .. ..  C.1.   ..... .....*.

          25  64  63  63  63    0   0   0   0    63  63  63   B. .. ..  C.1.   ..... .....*.
          26  64  64  63  63    0   0   0   0    64  63  63   B. .. ..  C.1.   ..... .....*.
          27  64  64  63  63    0   0   0   0    64  63  63   B. .. ..  C.1.   ..... .....*.
          28  64  63  63  63    0   0   0   0    63  63  63   B. .. ..  C.1.   ..... .....*.
          29  64  64  63  63   34  58  33  44     6  30  19   B. .. ..  C.1.   ..... .....*.
          30  64  64  63  63   35  50  22  63    14  41   0   B. .. ..  C.1.   ..... .....*.

          31  64  65  63  63   64  65  61  60     0   2   3   B. .B ..  C.1.   ..... .....*.
          32  64  65  64  64   64  65  64  64     0   0   0   B. .B ..  C.1.   ..... .....*.
          33  65  64  64  64   65  64  64  64     0   0   0   B. .B ..  C...   *.... .....*.
          34  65  65  64  65   65  64  64  65     0   0   0   B. .B ..  C...   *.... .....*.
          35  65  65  64  64   65  65  64  64     0   0   0   B. .B ..  C...   *.... .....*.
          36  65  65  64  64   65  64  64  64     0   0   0   B. .B ..  C...   *.... .....*.

          37  64  63  63  63   63  63  63  63     1   0   0   B. .B ..  C...   *.... 1....*.
          38  64  64  63  63   64  63  63  63     0   0   0   B. .B ..  C.2.   ..... 1....*.
          39  64  64  63  63   64  64  63  63     0   0   0   B. .B ..  C.2.   ..... 1....*.
          40  64  63  63  63   64  63  63  63     0   0   0   B. .B ..  C.2.   ..... 1....*.
          41  64  64  63  63   64  64  64  63     0   0   0   B. .B ..  C.2.   ..... 1....*.
          42  64  64  63  63   64  63  63  63     0   0   0   B. .B ..  C.2.   ..... 1....*.

          43  64  63  63  63   63  63  63  63     1   0   0   B. .B ..  C.2.   ..... 1....*.
          44  64  64  63  63   64  65  63  63     0   0   0   B. .B ..  C.2.   ..... 1....*.
          45  64  64  63  63   64  64  63  63     0   0   0   B. .B ..  C.2.   ..... 1....*.
          46  64  63  63  63   64  63  63  63     0   0   0   B. .B ..  C.2.   ..... 1....*.
          47  64  64  63  63   64  64  64  63     0   0   0   B. .B ..  C.2.   ..... 1....*.
          48  64  64  63  63   64  63  63  63     0   0   0   B. .B ..  C.2.   ..... 1....*.

          Event: A              Targets:    52A1 52A2 CY

          VSRC  =2        LNM   =3        BSM   =0        BKRC  =2
          27B   =0        27L   =0        59B   =100      59L   =55
          25DV  =0        25D   =0
          SOI1  =57       SOI2  =30       30I1  =27       30I2  =30
          79RS  =60       M79SH =011      CDOD  =0
          52PU1 =600      52DO1 =600      52PU2 =600      52DO2 =600      OTD   =900
          TSPU  =0        TSDO  =0        TZPU  =0        TZDO  =0
          TIME1 =5        TIME2 =0        AUTO  =2
```

48 cycles of data

Hot line (59L=B)

Reset State (79=R)

Recloser Enabled (RE=*)

3-Pole Reclose Timing (3PR=B; Both Breakers)

3-Pole Reclose Initiate (RI=3)

3-Pole Reclose Timing (3PR=1; Breaker 1; Setting 30I1=27 cycles)

Cycle State (79=C)

IN1 and IN2 Deasserted (Inputs 1 & 2= “.”; Both Breakers Open)

Line re-energized from remote end (59L=B).

Breaker 1 Close (OUT1=*)

Breaker 1 Closes (Inputs 1 & 2=1)

3-Pole Reclose Timing (3PR=2; Breaker 2)

```
SELogic Control Equations

A(1236)      = 3PRI+SPRI
B(1236)      =
C(1236)      =
D(1236)      =
E(1236)      =
S(1236)      =
L(1236)      =
G(1234)      = CYCL*79SH*A
H(1234)      =
I(1234)      =
M(1234)      =
W(45)        =
X(45)        =
Y(45)        =
Z(45)        =
SPR1S(12345) =
SPR1C(12345) =
3PR1S(12345) =
3PR1C(12345) = 59L        Hot line check (line re-energized from remote end)
SPR2S(12345) = 52A1
SPR2C(12345) =
3PR2S(12345) = 52A1       Breaker 2 starts Timing to Reclose after Breaker 1
                          is closed
3PR2C(12345) =
RLTCH(12345) =
SLTCH(12345) =
RC(12345)    = G          Internal Reclose Cancel Condition
RS(12345)    =
MC1S(12345)  =
MC2S(12345)  =
ER(12345)    = CLS1+CLS2+A   Programmable Event Report Generation Conditions
OUT1(12345)  = CLS1       Breaker 1 Close Output Contact
OUT2(12345)  = CLS2       Breaker 2 Close Output Contact
OUT3(12345)  = LOCK       Lockout Alarm
OUT4(12345)  =

Input Assignments:

IN1 = 52A1  IN2 = 52A2  IN3 =       IN4 =
IN5 =       IN6 =       IN7 =       RE  = RE
=>>                                 52a connected to Inputs IN1 & IN2
```

Figure 4.1: Example Event Report

FIRMWARE IDENTIFICATION

The SEL-279H-1 Relay provides a means of interpreting Firmware Identification Data (FID). The FID string is included near the top of each long event report. The string format is as follows:

FID = [PN] - R[RN] - V[VS] - D[RD] - E[ER],

where:

[PN] = Product Name (e.g., SEL-279H-1)

[RN] = Revision Number (e.g., 400)

[VS] = Version Specifications (e.g., 6ps)

[RD] = Release Date (e.g., YYMMDD = 931027)

[ER] = Version Specification: EEPROM

For the SEL-279H-1 Relay, version specifications are interpreted as follows: V[VS] = V[A].

Option	Specifier	Specifier Meaning	Option Description
A	5, 6	50 Hz, 60 Hz	Power System Frequency
B	P	none	Programmable RE input
C	S	none	Voltage Elements

EEPROM version specifications are interpreted as follows: E[ER] = E[Z].

Option	Specifier	Specifier Meaning	Option Description
Z	1, 2	1 stop bit, 2 stop bits	Communications Protocol Stop Bits

Please contact Schweitzer Engineering Laboratories for information concerning available versions of the SEL-279H-1 Relay. Version specifications provided above are not intended for ordering purposes but to aid in identification of the software installed in a relay.

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SECTION 5: APPLICATIONS

RECLOSING FOR VARIED BREAKER ARRANGEMENTS

The SEL-279H-1 Relay includes all logic and voltage elements needed to control reclosing sequences and perform synchronism check functions for up to two line breakers. Applications include:

Single, ring-bus, or breaker-and-a-half installations.

Single-pole or three-pole tripping schemes.

An SEL-279H-1 Relay example application for a breaker-and-a-half installation is detailed.

OVERVIEW OF EXAMPLE APPLICATION

In Figure 5.1 an SEL-279H-1 Relay controls Breakers 1 and 2 (BKR/1 and BKR/2) in a breaker-and-a-half installation. These two breakers serve Line 1. Single-shot, three-pole reclosing is the normal operating mode. Under certain system operating conditions, single-shot, single-pole reclosing is used.

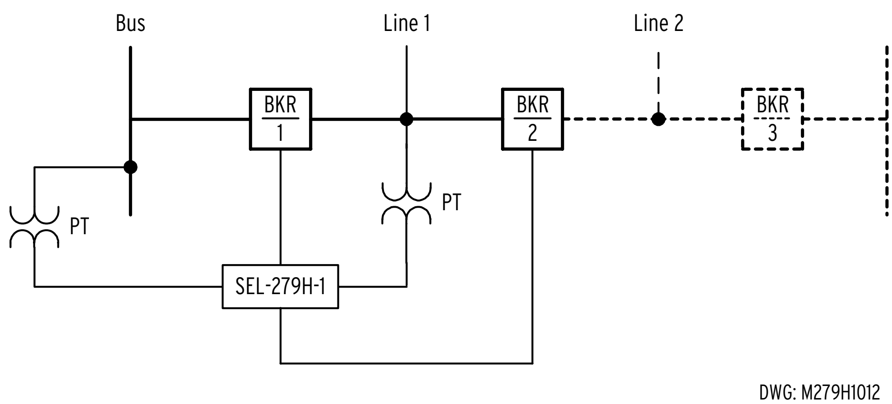

Figure 5.1: SEL-279H-1 Relay Applied to a Breaker-and-a-Half Installation

Reclose Scenario

A fault on Line 1 causes both Breakers 1 and 2 to trip open. Line 1 is re-energized from the remote-end. The SEL-279H-1 Relay makes a "hot line check" (did the remote-end successfully re-energize Line 1?).

If Line 1 is "hot", the SEL-279H-1 Relay recloses Breaker 1 first, followed by Breaker 2. Only a single reclose attempt is made (single-shot). If the breakers trip open again, the SEL-279H-1 Relay goes to the lockout state.

Settings Required

The required settings for the above reclose scenario are the default settings that come with the SEL-279H-1 Relay and are listed in Figure 4.1 in ***Section 4: Event Reporting***. General settings explanations and ranges are found in ***Section 2: Specifications*** (Relay Settings and Logic). The **SET**, **LOGIC**, and **INPUT** commands are used to set the relay (see ***Section 3: Communications***).

Remember, the following settings are just for one example application. Many varied reclosing schemes can be implemented with the SEL-279H-1 Relay.

Settings for Example Application (Made with the SET Command)

Identifier (ID)

The SEL-279H-1 Relay tags its event reports with a label at the top. This allows you to match event reports to relays. This label comes from the identifier (ID) setting (limited to 39 characters). Typical identifiers include an abbreviation of the line terminal and substation name.

ID = Example SEL-279H-1 Relay

Voltage Input Source (VSRC)

In Figure 5.1 voltages from both (two) sides of Breaker 1 are connected to the SEL-279H-1 Relay.

VSRC = 2

Line Voltage Measurement (LNM)

Three-phase voltage from Line 1 is connected to the relay.

LNM = 3

The dead and hot line voltage elements (**27L** and **59L**) then operate as three-phase elements.

Bus Voltage Measurement (BSM)

Three-phase voltage from the bus-side of Breaker 1 is connected to the relay for metering purposes only. The dead and hot bus voltage elements (**27B** and **59B**) are not being used.

BSM = 0

This setting causes the dead bus voltage elements (**27B**) to be asserted all the time.

Breaker Control (BKRC)

Two breakers are being controlled by the SEL-279H-1 Relay.

BKRC = 2

Breaker 1 is the primary breaker and Breaker 2 is the secondary breaker.

Dead Bus Voltage Threshold (27B)

The dead bus voltage element (**27B**) is not being used. Previous setting BSM = 0 causes them to be asserted all the time. The Dead Bus Voltage Threshold setting is thus inconsequential–set it to zero.

27B = 0

The setting range is 0 to 270 volts secondary in 1 volt secondary increments.

Dead Line Voltage Threshold (27L)

The dead line voltage element (**27L**) is not being used. To make them inoperative make the Dead Line Voltage Threshold setting:

27L = 0

The setting range is 0 to 270 volts secondary in 1 volt secondary increments.

Hot Bus Voltage Threshold (59B)

The hot bus voltage element (**59B**) is not being used. With BSM = 0 the **59B** element can never operate. The Hot Bus Voltage Threshold setting is thus inconsequential. Set it at a high value, for example, 100 volts.

59B = 100

The setting range is 0 to 270 volts secondary in 1 volt secondary increments.

Hot Line Voltage Threshold (59L)

The hot line voltage element (**59L**) is used for a "hot line check" (did the remote-end successfully re-energize Line 1?). Nominal line-to-neutral line voltage connected to the relay is 67 volts secondary.

59L = 55

Three-phase line voltage above 55 volts secondary causes the hot line voltage elements (**59L** and **59L4**) to assert–indicating healthy line voltage.

The setting range is 0 to 270 volts secondary in 1 volt secondary increments.

Synchronism Check Difference Voltage (25DV)

The synchronism check feature is not being used.

25DV = 0

The setting range is 0 to 270 volts secondary in 1 volt secondary increments.

Synchronism Check Delay (25D and 25D1)

The synchronism check feature is not being used.

25D = 0

The setting range is 0 to 32767 cycles in 1-cycle increments.

Breaker 1 Single-Pole Open Interval (SOI1)

If single-pole reclosing is initiated via input SPRI, Breaker 1 should reclose 57 cycles later:

SOI1 = 57

The setting range is 0 to 32767 cycles in 1-cycle increments (SOI1 = 0 defeats the setting).

Breaker 2 Single-Pole Open Interval (SOI2)

If single-pole reclosing is initiated via input SPRI, Breaker 2 should reclose 30 cycles after Breaker 1 recloses:

SOI2 = 30

SELOGIC® control equations that follow are programmed to allow Breaker 2 to reclose 30 cycles after Breaker 1 recloses.

The setting range is 0 to 32767 cycles in 1-cycle increments (SOI2 = 0 defeats the setting).

Breaker 1 Three-Pole Open Interval (3OI1)

If three-pole reclosing is initiated via input 3PRI, Breaker 1 should reclose 27 cycles later:

3OI1 = 27

The setting range is 0 to 32767 cycles in 1-cycle increments (3OI1 = 0 defeats the setting).

Breaker 2 Three-Pole Open Interval (3OI2)

If three-pole reclosing is initiated via input 3PRI, Breaker 2 should reclose 30 cycles after Breaker 1 recloses:

3OI2 = 30

SELOGIC control equations that follow are programmed to allow Breaker 2 to reclose 30 cycles after Breaker 1 recloses.

The setting range is 0 to 32767 cycles in 1-cycle increments (3OI2 = 0 defeats the setting).

Reset Time (79RS)

After both breakers are reclosed in an automatic reclose cycle or manually closed from the Lockout State, a one second (60 cycle) reset time qualifies a successful closure and then takes the relay to the Reset State.

79RS = 60

If one or the other breaker is out-of-service, the reset time just qualifies the in-service breaker.

The setting range is 30 to 32767 cycles in 1-cycle increments.

Shot Mask (M79SH)

Relay Word bit **79SH** is controlled by Shot Mask setting M79SH. For this application:

M79SH = 011

The digits of the M79SH setting (from left to right) correspond to shot 0, 1, and 2. The shot counter increments when the relay issues a close (it only increments for the first breaker to close). The shot is 0 when the breakers are closed and the relay is in the Reset State.

Setting the digits to 0 or 1 for setting M79SH determines whether Relay Word bit **79SH** asserts or not (= logical 1 or = logical 0) for the given shot. For the above M79SH setting:

Shot	79SH
0	0
1	1
2	1

Relay Word bit **79SH** is used in the following SELOGIC control equations to limit the reclose shots to one shot.

Close Dropout Delay (CDOD)

The Close Dropout Delay is not used in this application.

CDOD = 0 (inoperative)

With CDOD = 0, when the CLS1 or CLS2 Relay Word bit asserts for a breaker closure, it remains asserted until the 52A1 or 52A2 input, respectively, indicates that the circuit breaker(s) is closed (see Figure 2.4).

Setting Limit Check

0 to 32767 cycles, 1-cycle steps

Breaker 1 Out-of-Service Pickup Delay (52PU1)

If Breaker 1 is open for more than ten seconds (600 cycles), Breaker 1 is deemed "out-of-service"—it cannot be automatically reclosed.

52PU1 = 600

The setting range is 30 to 32767 cycles in 1-cycle increments.

Breaker 1 Out-of-Service Dropout Delay (52DO1)

If Breaker 1 is "out-of-service", it can only be put back "in-service" and available for automatic reclosing if the breaker is manually closed and it is qualified as being closed for 10 seconds (600 cycles).

52DO1 = 600

The setting range is 0 to 32767 cycles in 1-cycle increments.

Breaker 2 Out-of-Service Pickup Delay (52PU2)

If Breaker 2 is open for more than ten seconds (600 cycles), Breaker 2 is deemed "out-of-service"—it cannot be automatically reclosed.

52PU2 = 600

The setting range is 30 to 32767 cycles in 1-cycle increments.

Breaker 2 Out-of-Service Dropout Delay (52DO2)

If Breaker 2 is "out-of-service", it can only be put back "in-service" and available for automatic reclosing if the breaker is manually closed and it is qualified as being closed for 10 seconds (600 cycles).

52DO2 = 600

The setting range is 0 to 32767 cycles in 1-cycle increments.

Overall Timer Delay (OTD)

If the total automatic reclosing cycle takes more than 15 seconds (900 cycles), the relay is driven to the Lockout State.

OTD = 900

Note that the Overall Timer setting time is much longer than any accumulation of Breaker 2 open interval time settings. The Overall Timer times when the relay is in the Reclose Cycle State.

For example, this prevents the relay from indefinitely stalling with a standing close because a breaker status back to the relay does not work correctly. When time OTD times out, the close output contacts unlatch and the relay goes to the Lockout State. The same happens for any other stall condition when the relay is in the Reclose Cycle State.

The setting range is 0 to 32767 cycles in 1-cycle increments; setting OTD = 0 disables the overall timer logic.

SELOGIC Control Equations Timers, Pickup and Dropout Times (TSPU, TSDO, TZPU, TZDO)

These programmable timers are not used in this application.

SELOGIC control equations setting S(1236) is the input to timer TS, with pickup time TSPU and dropout time TSDO. The output of timer TS is Relay Word bit **ST**.

SELOGIC control equations setting Z(45) is the input to timer TZ, with pickup time TZPU and dropout time TZDO. The output of timer TZ is Relay Word bit **ZT**.

The setting range is 0 to 32767 cycles in 1-cycle increments.

Port Time-Outs (TIME1, TIME2)

If communication is taking place through Port 1 and Port 1 has no activity for five minutes, Port 1 is turned off.

TIME1 = 5

Port 2 is designated to transmit automatic messages (e.g., summary event reports, status messages). The time-out feature is defeated by a setting of zero (Port 2 is always ready to transmit automatic messages).

TIME2 = 0

The setting range is 0 to 30 minutes in one-minute increments.

Autoport (AUTO)

Port 2 is designated to transmit automatic messages (e.g., summary event reports, status messages).

AUTO = 2

The setting range is:

AUTO	Port(s) designated for automatic messages
1	1
2	2
3	1 and 2

SELOGIC CONTROL EQUATIONS SETTINGS FOR EXAMPLE APPLICATION (MADE WITH THE LOGIC COMMAND)

See Figure 2.2 in ***Section 2: Specifications*** for an overview of SELOGIC control equations settings.

ORing Variables

Only the A(1236) setting is used. The numbers in parentheses indicate the Relay Word rows accessible by the setting. This setting drives Relay Word bit **A**.

A(1236) = **3PRI**+**SPRI**

Relay Word bit **A** asserts (= logical 1) if the 3PRI (Three-pole Reclose Initiate) input OR SPRI (Single-pole Reclose Initiate) input is asserted. Relay Word bit **A** is used in the logic that follows.

Other ORing variables are available (see Figure 2.2 in ***Section 2: Specifications***). One of these ORing variables is the input into a timer and another is an input into a logic inverter.

ANDing Variables

Only the G(1234) setting is used. The numbers in parentheses indicate the Relay Word rows accessible by the setting. This setting drives Relay Word bit **G**.

G(1234) = **CYCL** * **79SH** * **A**

Relay Word bit **G** asserts (= logical 1) if all the following programmed conditions are true:

CYCL	=	logical 1	(the relay is in the Reclose Cycle State)
79SH	=	logical 1	(the shot counter is at shot = 1 or shot = 2, per setting M79SH which controls Relay Word bit **79SH**)
A	=	logical 1	[3PRI (Three-pole Reclose Initiate) input OR SPRI (Single-pole Reclose Initiate) input is asserted]

Relay Word bit **G** is used in logic that follows.

Other ANDing variables are available (see Figure 2.2 in ***Section 2: Specifications***). One of these ANDing variables is the input into a timer and another is an input into a logic inverter.

Reclose and Timing Supervision Logic Settings

The following logic settings are made that supervise open interval timing and reclosing (the numbers in parentheses indicate the Relay Word rows accessible by the setting):

3PR1C(12345) =	**59L**	[3PR1C is the Complete Breaker 1 Three-pole Reclose logic setting that supervises the Breaker 1 reclosing after the Three-pole Reclose Open Interval setting 3OI1 times out. The relay cannot reclose Breaker 1 unless Line 1 is "hot" (**59L** = logical 1). This indicates that the remote-end successfully re-energized Line 1.]

SPR2S(12345)	=	**52A1**	[SPR2S is the Start Breaker 2 Single-pole Reclose Open Interval Timing logic setting that supervises the Breaker 2 Single-pole Reclose Open Interval timer (setting SOI2). SOI2 cannot time for Breaker 2 unless Breaker 1 is already closed (**52A1** = logical 1).]
3PR2S(12345)	=	**52A1**	[3PR2S is the Start Breaker 2 Three-pole Reclose Open Interval Timing logic setting that supervises the Breaker 2 Three-pole Reclose Open Interval timer (setting 3OI2). 3OI2 cannot time for Breaker 2 unless Breaker 1 is already closed (**52A1** = logical 1).]

Other similar reclose and timing supervision settings are available (see Figure 2.2 in ***Section 2: Specifications***).

Latching Variable Settings

Latching variable logic settings are not used in this example. The logic settings are (the numbers in parentheses indicate the Relay Word rows accessible by the setting):

RLTCH(12345) = [Reset the Relay Word bit **LTCH** (drive **LTCH** to logical 0)]

SLTCH(12345) = [Set the Relay Word bit **LTCH** (**LTCH** = logical 1)]

Logic setting RLTCH(12345) has priority over logic setting SLTCH(12345) in controlling the latching Relay Word bit **LTCH** (see Figure 2.2 in ***Section 2: Specifications***).

Reclose Cancel Setting

The reclose cancel setting drives the relay to the Lockout State if the programmed condition comes true (the numbers in parentheses indicate the Relay Word rows accessible by the setting):

RC(12345) = **G** = **CYCL** * **79SH** * **A**, effectively

Relay Word bits **CYCL**, **79SH**, and **A** were previously defined:

CYCL	= logical 1	(the relay is in the Reclose Cycle State)
79SH	= logical 1	(the shot counter is at shot = 1 or shot = 2, per setting M79SH which controls Relay Word bit **79SH**)
A	= logical 1	[3PRI (Three-pole Reclose Initiate) input <u>OR</u> SPRI (Single-pole Reclose Initiate) input is asserted]

This logic effectively cancels reclosing if a trip occurs after the first reclosure. Trip contacts from the protective relays are wired to the 3PRI (Three-pole Reclose Initiate) and/or SPRI (Single-pole Reclose Initiate) inputs (see Figure 6.8 in ***Section 6: Installation***). The shot counter is at shot = 1 for the first reclosure and after. Thus reclosing is limited to a single reclose attempt (single-shot).

Reset Timing Condition Setting

The Reset Timing Condition setting puts additional conditions on the reset timer other than just closed breakers (the numbers in parentheses indicate the Relay Word rows accessible by the setting):

RS(12345) =

This setting is not used in this example.

Manual Close Setting

The manual close (MC1S and MC2S) settings are used to supervise a manual close order issued through the SEL-279H-1 Relay. The MC1S and MC2S SELOGIC control equations supervise the **CLOSE** command and the CL1 and the CL2 logic inputs. The numbers in parentheses indicate the Relay Word rows accessible by the setting.

MC1S(12345) =

MC2S(12345) =

This setting is not used in this example.

Event Report Triggering Condition Setting

The Event Report Triggering Condition setting selects conditions to generate 48-cycle event reports (the numbers in parentheses indicate the Relay Word rows accessible by the setting):

ER(12345) = **CLS1**+**CLS2**+**A**

Relay Word bits **CLS1**, **CLS2**, and **A** are defined as:

CLS1	= logical 1	(close Breaker 1)
CLS2	= logical 1	(close Breaker 2)
A	= logical 1	[3PRI (Three-pole Reclose Initiate) input OR SPRI (Single-pole Reclose Initiate) input is asserted]

Each listed element is monitored individually. If a selected condition asserts (e.g., a reclose is issued to Breaker 2—**CLS2** asserts; **CLS2** is assigned also to an output contact) and an event report is not presently being generated, an event report is generated.

Output Contact Settings

The output contact functions are programmable (the numbers in parentheses indicate the Relay Word rows accessible by the setting):

OUT1(12345) = **CLS1**	(close Breaker 1)
OUT2(12345) = **CLS2**	(close Breaker 2)
OUT3(12345) = **LOCK**	(lockout alarm)
OUT4(12345) =	(output contact OUT4 not used)

Input Settings for Example Application (Made with the INPUT Command)

Input Settings

The optoisolated input functions are programmable:

IN1 = 52A1	(Breaker 1 52a contact)
IN2 = 52A2	(Breaker 2 52a contact)
RE = RE	(Reclose Enable)

The other inputs IN3 through IN7 are not used.

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SECTION 6: INSTALLATION

INSTALLATION

Mounting

The SEL-279H-1 Relay is designed for mounting by its front vertical flanges in a 19" vertical relay rack. It may also be mounted semi-flush in a switchboard panel. Use four #10 screws for mounting. See Figure 6.4.

Frame Ground Connection

Terminal 46 on the rear panel must be connected to frame ground for safety and performance. These terminals connect directly to the chassis ground of the instrument.

Power Connections

Terminals 44 and 45 on the rear panel must be connected to a source of control voltage. Control power passes through these terminals to the fuse(s) and a toggle switch, if installed. The power continues through a surge filter and connects to the switching power supply. The control power circuitry is isolated from the frame ground.

Secondary Circuits

The relay presents a very low burden to the secondary potential circuits.

Control Circuits

The control inputs are dry. For example, to assert input IN5, you must apply control voltage to input IN5 terminals 18 and 19.

Inputs IN1, IN2, and IN3 are individually isolated and a terminal pair is brought out for each input. There are no internal connections between these control inputs.

Inputs IN4, IN5, IN6, IN7, SPRI, 3PRI, RE, and DTL are paired, two inputs to a common terminal. See Figure 6.2 and Figure 6.8.

Control outputs are dry relay contacts rated for closing duty. A metal-oxide varistor protects each contact.

Communications Circuits

Connections to the two EIA-232 serial communications ports are made via the two 9-pin connectors labeled PORT 1 and PORT 2R on the rear panel and PORT 2F on the front panel. Pins 5 and 9 connect directly to frame (chassis) ground. See Table 3.1 for pin assignment.

⚠ WARNING Do not rely upon pins 5 and 9 for safety grounding, because their current carrying capacity is less than control power short circuit and protection levels.

The communications circuits are protected by low-energy, low-voltage MOVs and passive RC filters. You can minimize communications-circuit difficulties by keeping the length of the EIA-232 cables as short as possible. Lengths of 12 feet or less are recommended, and the cable length should never exceed 100 feet. Use shielded communications cable for lengths greater than 10 feet. Modems are required for communications over long distances.

Route the communications cables well away from the secondary and control circuits. Do not bundle the communications wiring with secondary or control circuit wiring. If these wires are bundled, switching spikes and surges can cause noise in the communications wiring. This noise may exceed the communications logic thresholds and introduce errors.

Jumper Selection

Jumpers J103, J104, and J5 are on the front edge of the main board. They are easily accessed by removing the top cover or front panel. Soldered wire jumpers JMP3 through JMP7 are toward the back of the main board and are accessed by removing the top cover.

EIA-232 Jumpers

J5 provides EIA-232 baud rate selection. Available baud rates are 300, 600, 1200, 2400, 4800, and 9600. To select a baud rate for a particular port, place the jumper so it connects a pin labeled with the desired port to a pin labeled with the desired baud rate.

⚠ CAUTION Do not select two baud rates for the same port. This can damage the baud rate generator.

Password Protection Jumper

Put JMP103 in place to disable password protection. This feature is useful if passwords are not required or when passwords are forgotten.

CLOSE Command Enable Jumper

With jumper JMP104 in place, the **CLOSE** command is enabled. If you remove jumper JMP104, **CLOSE** command execution results in the message: "Aborted."

Output Contact Soldered Wire Jumpers

All the output contacts can be configured as “a” or “b” contacts with soldered wire jumpers JMP3 through JMP7 (each jumper has positions A and B). The output contact/soldered wire jumper correspondence is as follows:

Output Contact	Jumper
OUT1	JMP7
OUT2	JMP6
OUT3	JMP5
OUT4	JMP4
ALARM OUT	JMP3

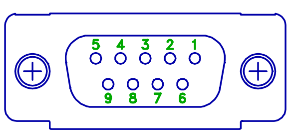
Communications Port External Power Jumpers

DC power is available from Port 1 and Port 2R to power external devices. Jumpers must be selected to route dc power to the rear panel connectors. The internal jumpers are near Port 1 and are labeled as follows: JMP8 = +5 V; JMP9 = –12 V; JMP10 = +12 V. Use caution to ensure the dc current requirement of the external equipment does not exceed the relay power supply specifications. Only route dc power to the rear ports if required for your application.

EIA-232 Installation

The following information contains specific details regarding communications port pinouts.

A pin definition of the 9-pin port connectors and cabling information for the EIA-232 ports appears in Figure 6.1. The following cable listings show several types of EIA-232 cables. These and other cables are available from SEL. Cable configuration sheets are also available at no charge for a large number of devices. Contact the factory for more information.



(female chassis connector, as viewed from outside panel)

Figure 6.1: 9-Pin Connector Pin Number Convention

EIA-232 Cables

Cable C234

SEL-279H-1 Relay			9-Pin *DTE Device	
GND	5		5	GND
TXD	3		2	RXD
RXD	2		3	TXD
RTS	7	Jumper		
CTS	8			
		Jumper	1	DCD
			4	DTR
			6	DSR
			8	CTS
			9	RI

Cable C222

SEL-279H-1		**DCE Device	
GND	5	7	GND
TXD	3	2	RXD
RTS	7	20	DTR
RXD	2	3	TXD
CTS	8	8	CD
GND	9	1	GND

Cable C231

SEL-PRTU		SEL-279H-1 Relay	
GND	1	5	GND
TXD	2	2	RXD
RXD	4	3	TXD
CTS	5	7	RTS
+12	7	8	CTS
GND	9	9	GND

* DTE = Data Terminal Equipment (Computer, Terminal, Printer, etc.)

** DCE = Data Communications Equipment (Modem, etc.)

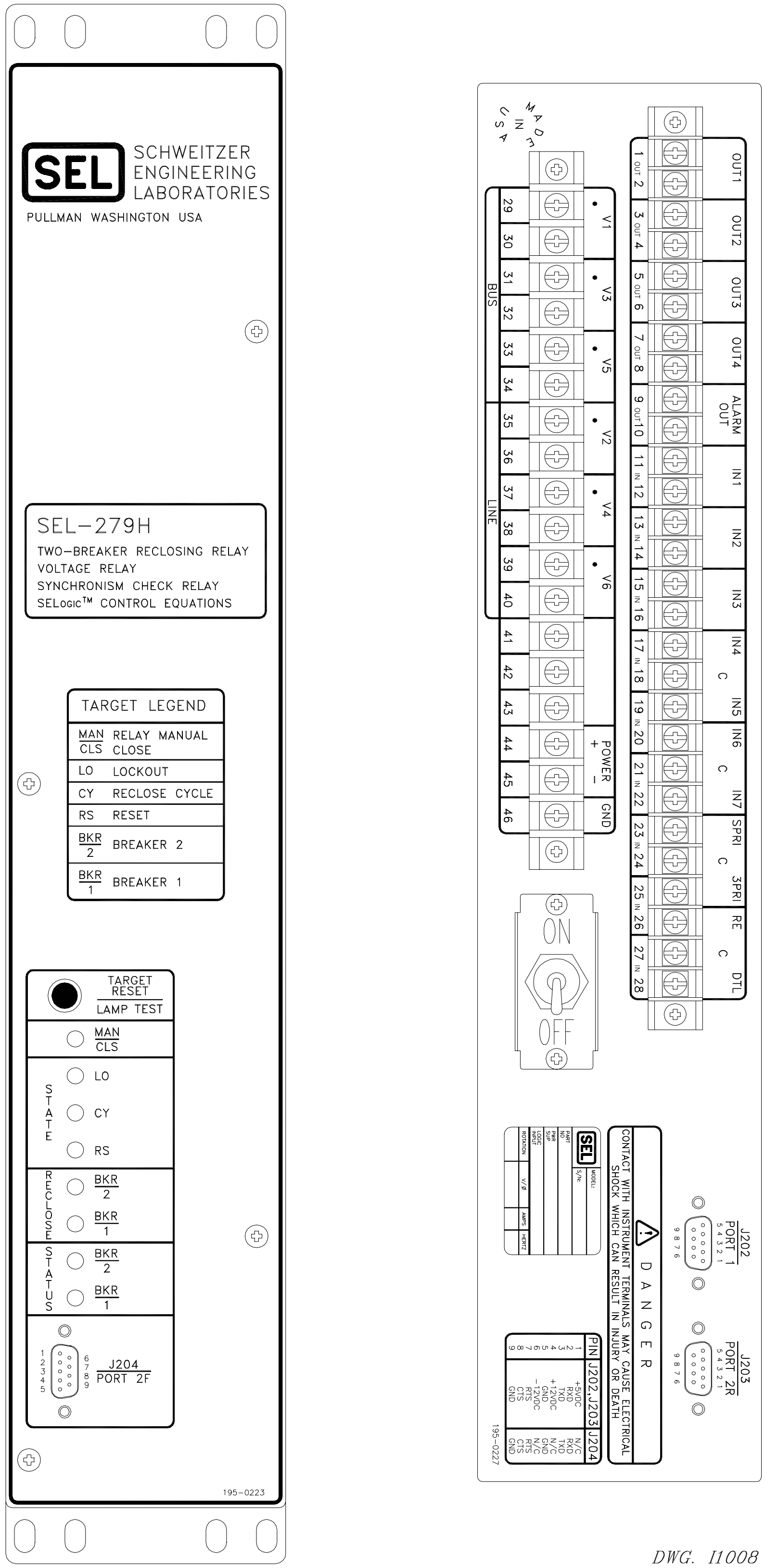


Figure 6.2: SEL-279H-1 Relay Vertical Front and Rear Panel Drawings

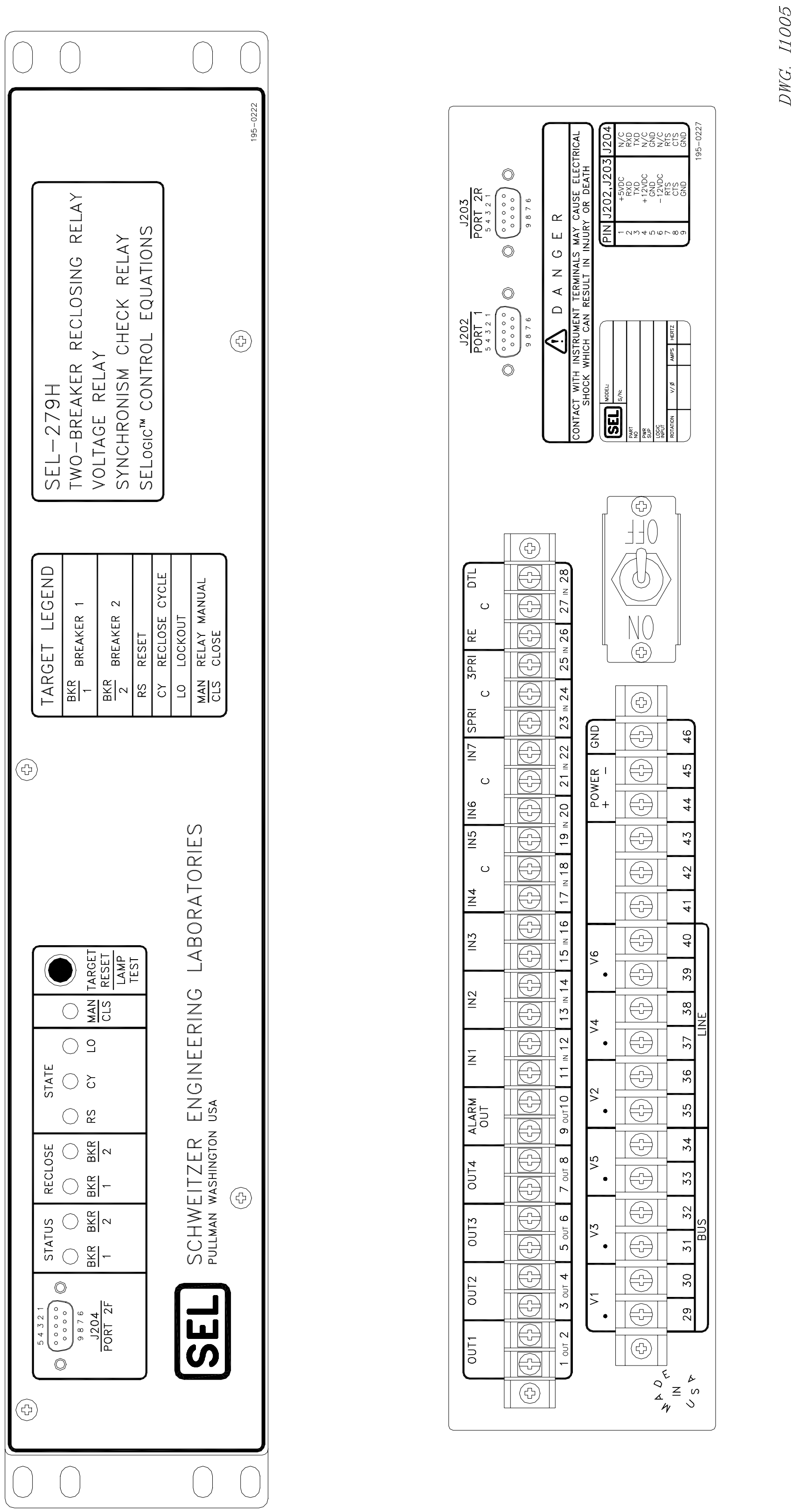


Figure 6.3: SEL-279H-1 Relay Horizontal Front and Rear Panel Drawings

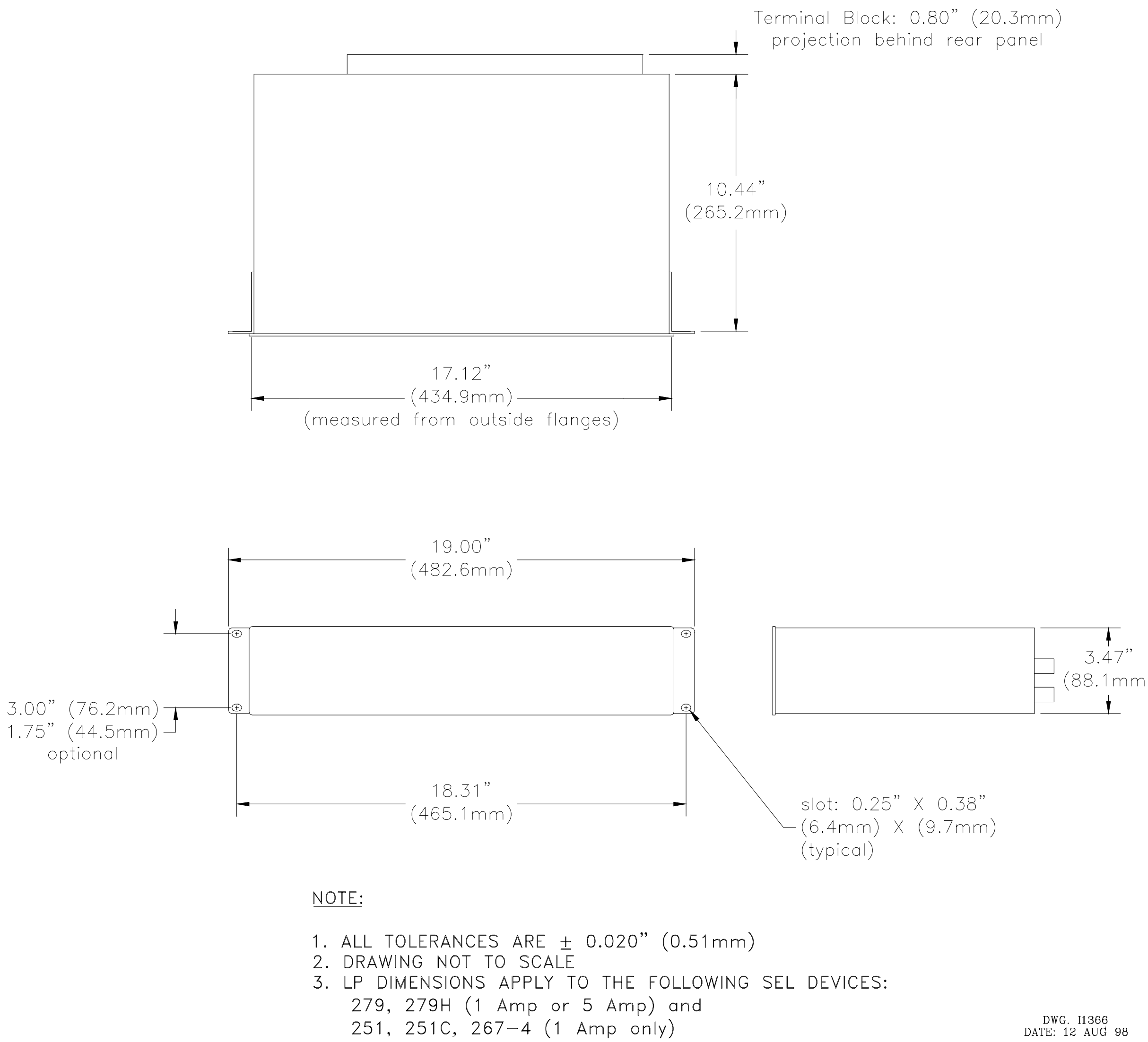


Figure 6.4: Relay Dimensions and Drill Plan

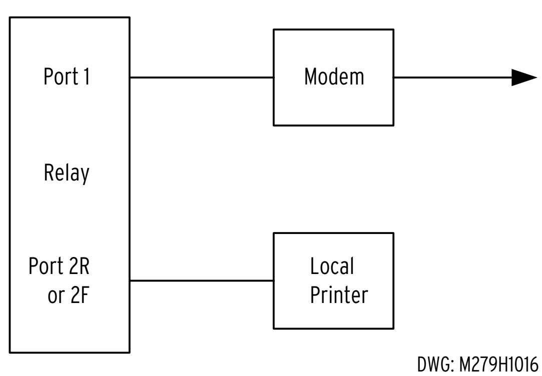


Figure 6.5: Communications—One Unit at One Location

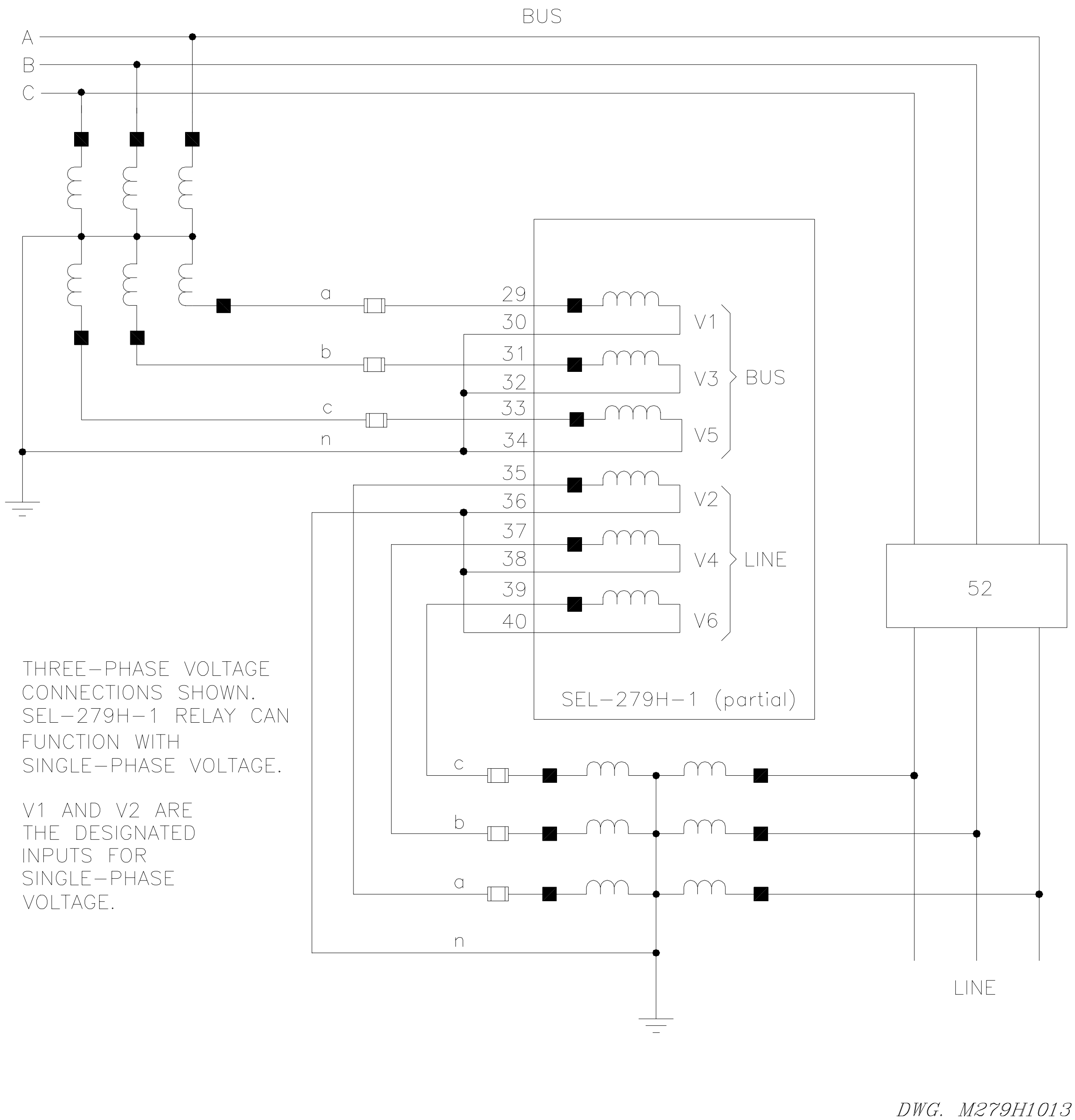


Figure 6.6: SEL-279H-1 Relay Typical AC External Wye-Connected Voltages (Single-Breaker, Six-Voltage Connection Shown; Set VSRC = 2)

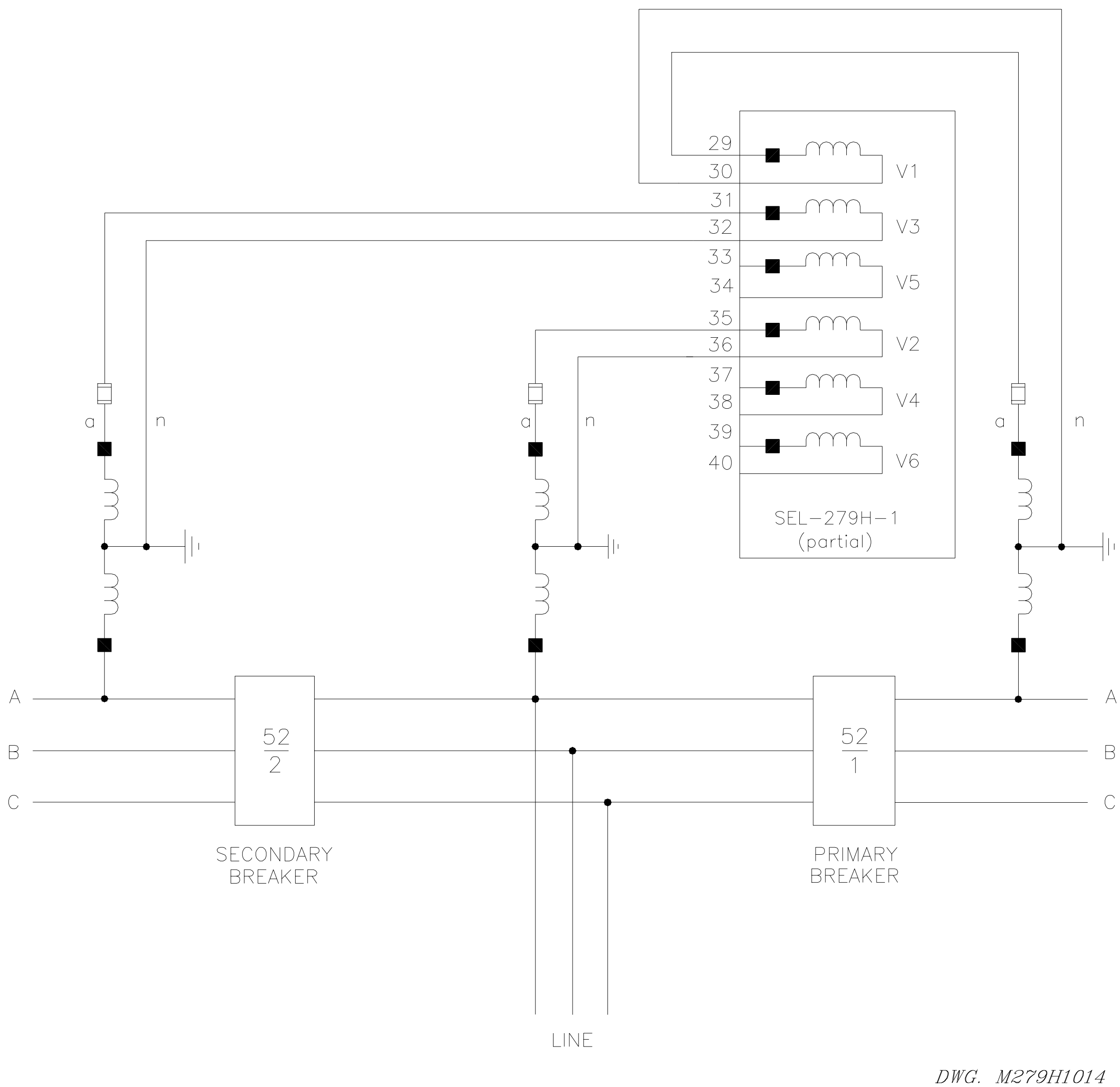
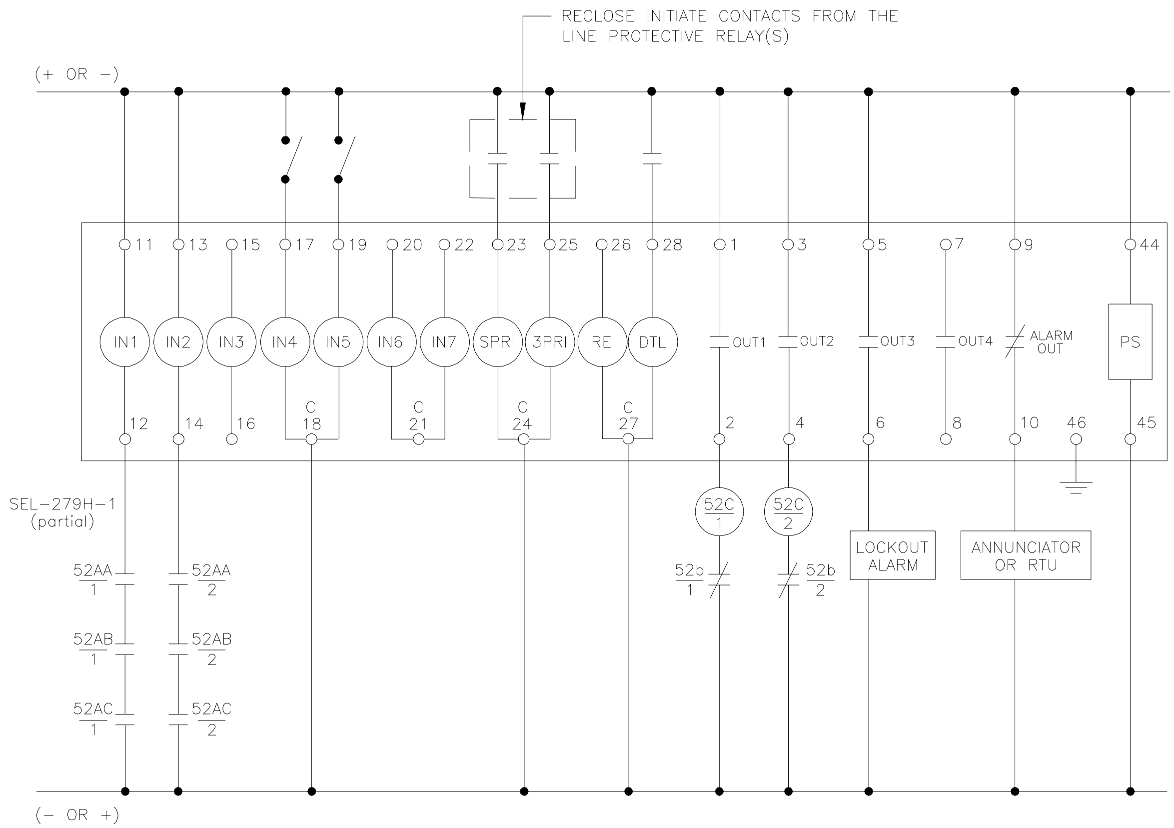


Figure 6.7: SEL-279H-1 Relay Typical AC External Wye-Connected Voltage (Two-Breaker, Three-Voltage Connection Shown; Set VSRC = 3)



Programmable Inputs

IN1 = 52A1 (status of primary breaker 52/1)

IN2 = 52A2 (status of secondary breaker 52/2)

IN4 = SPRE (single−pole reclose enable)

IN5 = 3PRE (Three−pole reclose enable)

IN3, IN6, IN7, and RE are optional

Dedicated Inputs

SPRI Single−Pole Reclose Initiate

3PRI Three−Pole Reclose Initiate

DTL Drive−to−Lockout

Programmable Output Contacts

OUT1 = CLS1 (close for primary breaker 52/1)

OUT2 = CLS2 (close for secondary breaker 52/2)

OUT3 = LOCK (lockout alarm)

OUT4 (optional)

DWG. M279H1015

Figure 6.8: SEL-279H-1 Relay Typical DC External Wye-Connections (Two-Breaker Application Shown)

TABLE OF CONTENTS

TABLES

FIGURES

SECTION 7: MAINTENANCE AND TESTING

TEST PROCEDURES

Test Aids Provided by the Relay

The following features assist you during relay testing and calibration:

METER
Command

The **METER** command shows the voltages presented to the relay in secondary values. These quantities are useful for comparing relay calibration against other meters of known accuracy. See ***Section 3: Communications*** for more information about the **TARGET** command.

When testing the relay, first verify relay calibration. Consider all tests invalid if you determine that the relay is out of calibration. Each relay is calibrated at the factory prior to shipment and should not require further adjustment. If calibration is necessary, refer to ***Calibration*** in this section.

TARGET
Command

The relay allows you to reassign front panel targets to indicate elements and intermediate logic results in the Relay Word as well as input and output contact status. Use the **TARGET** command to reassign the front panel LEDs. Once target LEDs are reassigned from the default targets, the front panel targets are no longer latching. This means the targets follow the pickup and dropout condition in much the same manner as an output contact. See ***Section 3: Communications*** for more information about the **TARGET** command.

By employing the target LEDs for testing, you need not change the relay settings for testing purposes.

Event
Reporting

The relay generates a 48-cycle event report in response to user selection conditions. Each event report contains voltage information, relay element states, and input/output contact information in cycle resolution. If you question the relay response or your test method, use the event report for assistance.

Each event report is date and time tagged relative to the 6th cycle of the event report. Each report is triggered upon assertion of designated relay elements or contact outputs. See ***Section 4: Event Reporting*** for more information about event reports.

Test Methods

There are two means of determining the pickup and dropout of relay elements: target lamp illumination and output contact closure.

Testing Via Target LED Illumination

During testing you can use target lamp illumination to determine relay element status. Using the **TARGET** command, set the front panel targets to display the element under test. For example, the hot and dead bus and line elements appear in Relay Word row 1. When you type the command **TARGET 1 <Enter>**, the LEDs display the status of the elements in Relay Word row 1. Thus, with Target 1 displayed, if the dead bus element (**27B**) asserts, the leftmost LED illuminates. Using LED illumination as an indicator, you can measure the element operating characteristics.

When the **TARGET** command sets target LED output to a level other than 0 (Relay Targets), the front panel target markings no longer correspond to illuminated LEDs and the LEDs do not latch.

If you place the relay in service with a target level other than Level 0, it automatically returns to Level 0 when the automatic port times out. While this feature prevents confusion among station operators and readers, it can be inconvenient if the relay tester does not want targets to revert to Level 0.

To simplify testing using targets, set the relay AUTO setting equal to the port which you intend to use. Also, set that port TIME setting equal to zero. This prevents target reset when the auto port times out. Remember to reset these settings and the target level before returning the relay to service following tests.

Testing Via Output Contact Assertion

To test using this method, set one programmable output contact to assert when the element under test picks up. With the **LOGIC** command, set an output contact equal to the element under test.

For an "a" contact, when the condition asserts, the output contact closes; when the condition deasserts, the output contact opens.

For a "b" contact, when the condition asserts, the output contact opens. When the condition deasserts, the output contact closes. Programmable contacts can be specified at the factory as "a" or "b." Using contact operation as an indicator, you can measure element operating characteristics, stop timers, etc.

Tests in this section use the output contact method and assume an "a" output contact.

Using a Breaker Simulator

Because much of the relay logic depends on whether the breaker is open or closed, it is important to use a breaker simulator. The following logic depends on the state of the circuit breaker status input:

- Reclosing Relay Logic
- Close Function Logic

We recommend testing the SEL-279H-1 Relay with a latching relay to simulate line breaker auxiliary contact action. This ensures proper assertion and deassertion of the circuit breaker status function assigned to an input on the back panel.

INITIAL CHECKOUT

The initial checkout procedure should familiarize you with the relay and ensure that all functions are operational. Study Functional Specification and Description in ***Section 2: Specifications***, command descriptions in ***Section 3: Communications***, and ***Section 4: Event Reporting*** for a complete understanding of the relay capabilities.

Equipment Required

The following equipment is necessary for initial checkout.

1. Terminal with EIA-232 serial interface
2. Interconnecting cable between terminal and relay
3. Source of control power
4. Source of single-phase voltage
5. Ohmmeter or contact opening/closing sensing device

Checkout Procedure

In the procedure below, you will use several relay commands. ***Section 3: Communications*** provides a full explanation of all commands. The following information should allow you to complete the checkout without referring to the detailed descriptions.

Note: In this manual, commands to type appear in bold/upper case: **OTTER**. Keys to press appear in bold/ brackets: **<Enter>**.

Relay output appears in the following format:

```
Example SEL-279H-1 Relay                Date: 10/5/93   Time: 01:01:01
```

Step 1

Purpose: Be sure you received the relay in satisfactory condition.

Method: Inspect the instrument for physical damage such as dents or rattles.

Step 2

Purpose: Verify the requirements for the relay logic inputs, control power voltage level, and voltage and current inputs.

Method: Refer to the information sticker on the rear panel of the relay. Figure 7.1 provides an example. Please read the information on this sticker before applying power to the relay or starting tests. Be sure your dc supply is correctly adjusted for the control and logic input requirements.

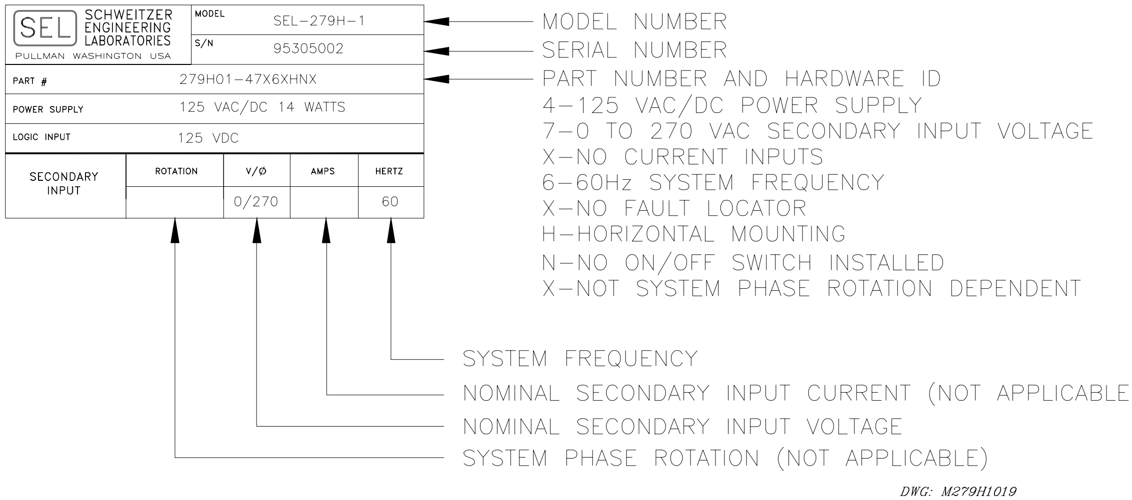


Figure 7.1: Relay Part Number and Hardware Identification Sticker

Step 3

Purpose: Verify the communications interface setup.

Method: Connect a computer terminal to Port 2F on the relay front panel. The terminal should be configured to 2400 baud, eight data bits, two stop bits, and no parity. The relay is shipped from the factory with Port 2 set to 2400 baud and Port 1 set to 300 baud. ***Section 3: Communications*** provides additional details on port configuration. Baud rate selection is described under ***Jumper Selection*** in ***Section 6: Installation***. Figure 7.2 shows the typical communications interface setup for testing purposes.

At some time later (perhaps after the completion of this checkout procedure) connect the computer terminal to the other ports (2R and 1) to verify operation. Keep in mind the baud rates.

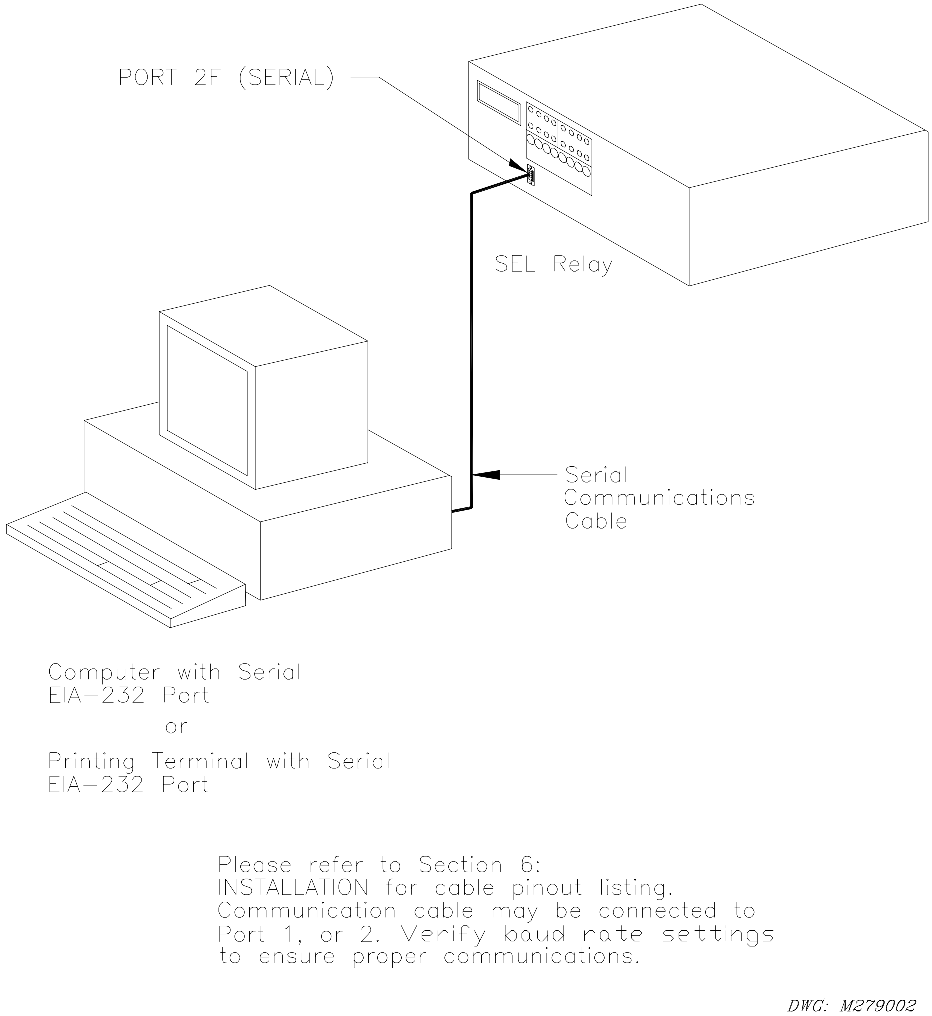


Figure 7.2: Communications Interface Setup

Step 4

Purpose: Establish control power connections.

Method: Connect a frame ground to terminal 46 on the rear panel and connect rated control power to terminals 44 and 45. Polarity is unimportant. Relays supplied with 125 or 250 V power supplies may be powered from a 115 Vac wall receptacle for testing. In the final installation, we recommend that the relay receive control power from the station dc battery to avoid losing events stored in volatile memory if station service is lost.

Step 5

Purpose: Apply control voltage to the relay and start Access Level 0 communications.

Method: Turn on the relay power. All front panel targets should illuminate when you press the TARGET RESET button. If not, be sure that power is present and check the fuse or fuses. The following message should appear on the terminal:

```
Example SEL-279H-1 Relay                    Date: 10/5/93   Time: 01:01:01

SEL-279H-1
=
```

The ALARM OUT relay should pull in, holding its "b" contacts (terminals 9, 10) open. If the relay pulls in but no message is received, check the terminal configuration. If neither occurs, turn off the power and refer to Troubleshooting later in this section.

The = prompt indicates that communications with the relay are at Access Level 0, the first of three levels. The only command accepted at this level is **ACCESS**, which opens communications on Access Level 1.

Note: If you are using a battery simulator, be sure the simulator voltage level is stabilized before turning the relay on.

Step 6

Purpose: Establish Access Level 1 communications.

Method: Type **ACCESS** and press **<Enter>**. At the prompt, enter the Access Level 1 password **OTTER** and press **<Enter>**. The => prompt should appear, indicating that you have established communications at Access Level 1.

Step 7

Purpose: Verify relay self-test status.

Method: Type **STATUS** and press **<Enter>**. The following display should appear on the terminal:

```
=>STATUS <Enter>

W-Warn F=Fail
       V1    V3    V5    V2    V4    V6
OS     2     1     2     0     1     1

PS      4.95        15.01       -14.94

RAM     ROM     A/D     MOF     SET
OK      OK      OK      OK      OK

=>
```

Step 8

Purpose: View the demonstration settings entered before shipment.

Method: The relay is shipped with demonstration settings; type **SHOWSET <Enter>** to view them. The terminal should display the following:

```
VSRC  =2        LNM   =3        BSM   =0        BKRC  =2
27B   =0        27L   =0        59B   =100      59L   =55
25DV  =0        25D   =0
SOI1  =57       SOI2  =30       3OI1  =27       3OI2  =30
79RS  =60       M79SH =011      CDOD  =0
52PU1 =600      52DO1 =600      52PU2 =600      52DO2 =600      OTD   =900
TSPU  =0        TSDO  =0        TZPU  =0        TZDO  =0
TIME1 =5        TIME2 =0        AUTO  =2

SELogic Control Equations

A(1236)      = 3PRI+SPRI
B(1236)      =
C(1236)      =
D(1236)      =
E(1236)      =
S(1236)      =
L(1236)      =
G(1234)      = CYCL*79SH*A
H(1234)      =
I(1234)      =
M(1234)      =
W(45)        =
X(45)        =
Y(45)        =
Z(45)        =
SPR1S(12345) =
SPR1C(12345) =
3PR1S(12345) =
3PR1C(12345) = 59L
SPR2S(12345) = 52A1
SPR2C(12345) =
3PR2S(12345) = 52A1
3PR2C(12345) =
RLTCH(12345) =
SLTCH(12345) =
RC(12345)    = G
RS(12345)    =
MC1S(12345)  =
MC2S(12345)  =
ER(12345)    = CLS1+CLS2+A
OUT1(12345)  = CLS1
OUT2(12345)  = CLS2
OUT3(12345)  = LOCK
OUT4(12345)  =

Input Assignments:

IN1 = 52A1   IN2 = 52A2   IN3 =        IN4 =
IN5 =        IN6 =        IN7 =        RE  = RE
=>>
```

Section 5: Applications includes a complete explanation of the settings.

Step 9

Purpose: Connect voltage source to the relay.

Method: Turn power off and connect the sources of voltage to the rear panel terminals of the relay as shown in Figure 7.3. Apply 67 V rms and turn power back on.

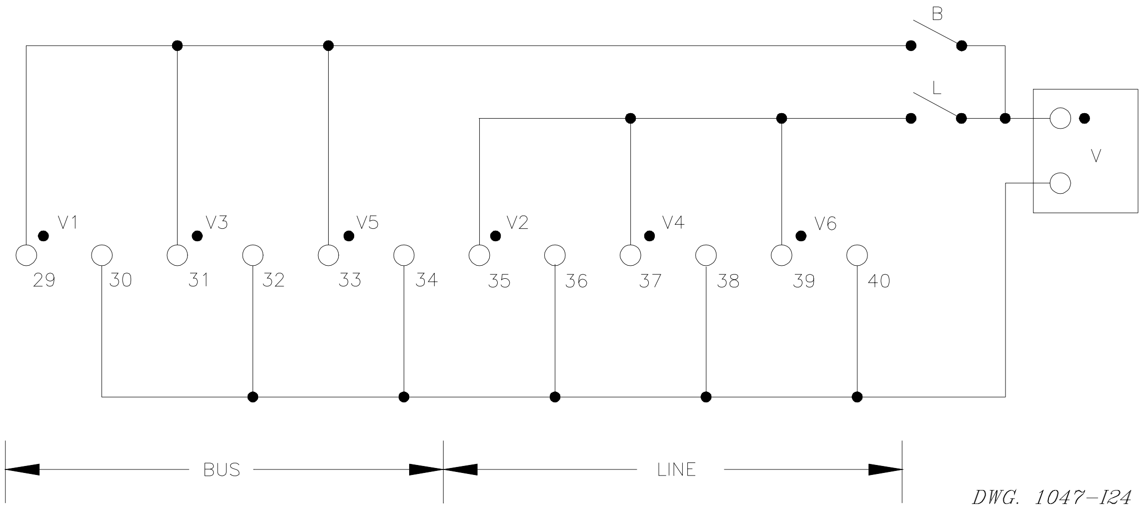


Figure 7.3: SEL-279H-1 Relay Voltage Test Connections

Step 10

Purpose: Verify correct voltage connections and levels.

Method: Use the **METER** command to measure the voltages applied in Step 9. The **METER** command explanation in ***Section 3: Communications*** defines the displayed metering quantities. Refer to Figure 7.3.

1. Open switch B and close switch L. Metering should appear as:

```
=>METER <Enter>

Example SEL-279H-1 Relay        Date: 10/15/93       Time: 11:15:12

VPB=0    V1=0    V3=0    V5=0    VPL=0    V2=67    V4=67    V6=67
d12=67    d34=67    d56=67

=>
```

2. Close switch B and open switch L. Metering should appear as:

```
=>METER <Enter>

Example SEL-279H-1 Relay        Date: 04/15/93       Time: 11:15:12

VPB=0    V1=67    V3=67    V5=67    VPL=0    V2=0    V4=0    V6=0
d12=67    d34=67    d56=67

=>
```

3. Close both switches B and L. Metering should appear as:

```
=>METER <Enter>

Example SEL-279H-1 Relay           Date: 10/15/93       Time: 11:15:12

VPB=0    V1=67    V3=67    V5=67    VPL=0    V2=67    V4=67    V6=67
d12=0    d34=0    d56=0

=>
```

Step 11

Purpose: Verify that the optically isolated inputs assert when you apply control voltage across respective terminal pairs. Some of the inputs share a common terminal. See Figure 6.2 and Figure 6.8 in ***Section 6: Installation***.

Method:

1. Set the target LEDs to display the first eight optically isolated inputs by typing **TAR 6 <Enter>**. The front panel LEDs should now follow the inputs as listed in Table 7.1.

Table 7.1: LED/Input Correspondence for TAR 6 Command

Front Panel LEDs	BKR 1	BKR 2	BKR 1	BKR 2	RS	CY	LO	MAN CLS
TAR 6	RE	IN7	IN6	IN5	IN4	IN3	IN2	IN1
Terminal Numbers	26,27	21,22	20,21	18,19	17,18	15,16	13,14	11,12

2. Apply control voltage to each input and make sure the corresponding target LED turns on.

3. Set the target LEDs to display the last three optically isolated inputs by typing **TAR 7 <Enter>**. The front panel LEDs should now follow the inputs as follows (you are only concerned with the last three LEDs):

Table 7.2: LED/Input Correspondence for TAR 7 Command

Front Panel LEDs	BKR 1	BKR 2	BKR 1	BKR 2	RS	CY	LO	MAN CLS
TAR 7	ALRM	OUT4	OUT3	OUT2	OUT1	DTL	RE	3PRI
Terminal Numbers						27,28	26,27	24,25

4. Apply control voltage to these last three inputs and make sure the corresponding target LED turns on. After the testing is finished, type **TAR R <Enter>** to revert the target LEDs back to their normal display mode.

Step 12

Purpose: Establish Access Level 2 communications.

Method: Type **2ACCESS** and press **<Enter>**. At the prompt, enter the Access Level 2 password **TAIL** and press **<Enter>**. The =>> prompt should appear, indicating that you have established communications at Access Level 2.

This checkout procedure demonstrates only a few relay features. For a complete understanding of relay capabilities, study ***Functional Description*** in ***Section 2: Specifications***, the command descriptions in ***Section 3: Communications***, and ***Section 4: Event Reporting***. For more test procedures, see the following ***Reclosing Function Test***.

Step 13

Purpose: Verify that the output contacts operate. This discussion assumes:

- output contacts OUT1, OUT2, OUT3, and OUT4 are "a" seals,
- output contact ALARM OUT is a "b" seal.

If some of the output contacts are other than above, just keep in mind to look for the opposite operation (output contact opening instead of closing).

Method: Use the **LOGIC** command to program output contact OUT1 with the **CLS1** Relay Word bit and "blank out" the other programmable output contacts OUT2, OUT3, and OUT4 (enter "NA"). The **LOGIC** command is explained in ***Section 3: Communications***.

When this new logic setting is enabled, the ALARM OUT contact pulses closed (monitor the ALARM OUT contact to verify that it does assert).

Execute the **SHOWSET** command to verify that one of the programmable inputs (IN1 through IN7 and RE) is assigned to the 52A1 function (Breaker 1 status – 52a contact). Make this setting with the **INPUT** command if it does not exist. Do not connect anything to this input (relay will think the breaker is open).

Execute the **CLOSE 1** command and monitor output contact OUT1 to see that it closes. Push the TARGET RESET button if OUT1 needs to be unlatched.

Repeat this for output contact OUT2 [program output contact OUT2 with the **CLS1** Relay Word bit and "blank out" the other programmable output contacts OUT1, OUT3, and OUT4 (enter "NA")] and so forth for output contact OUT3 and then output contact OUT4.

Before continuing with the following ***Reclose Function and Timing Tests***, set the settings back to the default settings (as shown in Figure 4.1 in ***Section 4: Event Reporting***).

Reclose Function and Timing Tests

Purpose: Test the general reclose function and timing of the relay. These tests use the default settings shown in Figure 4.1 in ***Section 4: Event Reporting***. The explanation for these settings is in ***Section 5: Applications***.

Equipment Required

The following equipment is necessary to complete a reclosing functional test:

1. Terminal with EIA-232 serial interface
2. Interconnecting cable between terminal and relay
3. Source of relay control power
4. Source of single-phase voltage
5. Timer with contact inputs for start and stop
6. Two breaker simulators

Set up the equipment as shown in Figure 7.4 and Figure 7.5. Note that one breaker simulator is designated primary breaker 52/1 simulator and the other is designated secondary breaker 52/2 simulator.

Note: For all of the following tests, set the input RE to NA (RE = NA) using the **LOGIC** command.

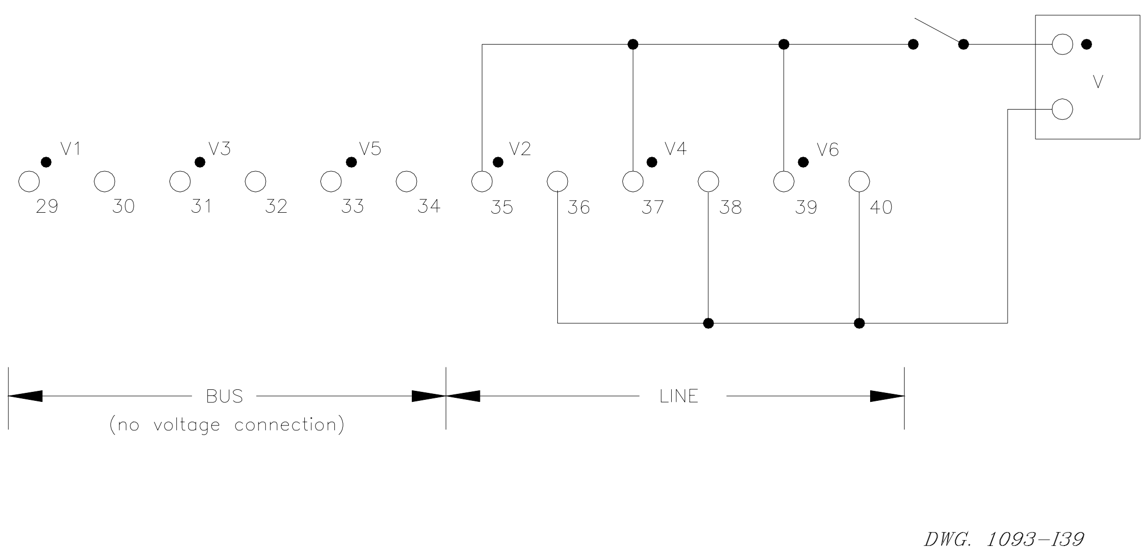


Figure 7.4: SEL-279H-1 Relay Reclose Function Test–AC Connections

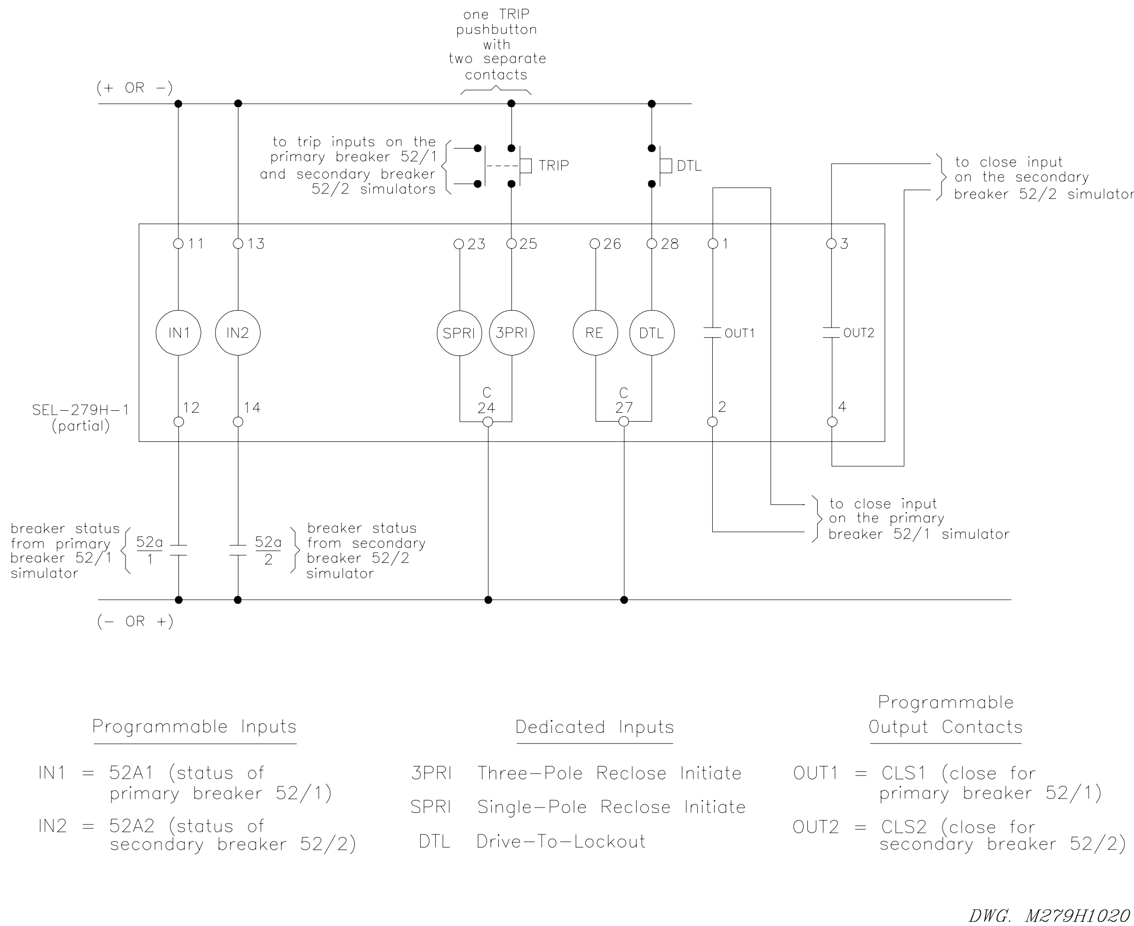


Figure 7.5: SEL-279H-1 Relay Reclose Function Test–DC Connections

Step 1

Purpose: General reclose function test to observe reclosing and front panel target LED information.

Method:

1. Close both breaker simulators. The relay STATUS LEDs BKR/1 and BKR/2 illuminate, indicating the breaker simulators are closed.
2. After 79RS time the RS (Reset) LED illuminates.
3. Close the Line voltage switch (see Figure 7.4). This is a reclose supervising condition explained later in item 9.
4. Push the TRIP pushbutton (see Figure 7.5). Push it fast–**do not** hold it down. Notice the RS (Reset) LED extinguishes and the CY (Reclose Cycle) LED illuminates.
5. About a half second after pushing the TRIP pushbutton, the primary breaker simulator recloses (corresponding to Breaker 1 Three-pole Reclose Open Interval setting 3OI1 = 27 cycles) , followed by the secondary breaker simulator reclosing about a half second later (corresponding to Breaker 2 Three-pole Reclose Open Interval setting 3OI2 = 30 cycles). The relay RECLOSE LEDs BKR/1 and BKR/2 illuminate, indicating the breaker simulators reclosed.

One second after the secondary breaker simulator recloses, the CY (Reclose Cycle) LED extinguishes and the RS (Reset) LED illuminates (corresponding to Reset Time setting 79RS = 60 cycles). The relay is back in the Reset State again.

6. Push and hold the DTL pushbutton. The RS (Reset) LED extinguishes and the LO (Lockout) LED illuminates. The relay is in the Lockout State. Push the TRIP pushbutton again to try to initiate reclosing. Notice that no reclosing takes place–the relay remains in the Lockout State. Release the DTL pushbutton.

   Leave the breaker simulators open for more than ten seconds and the breaker simulators are deemed "out-of service" and cannot be automatically reclosed (corresponding to Breaker 1 Out-of-Service Pickup Delay setting 52PU1 = 600 cycles and Breaker 2 Out-of-Service Pickup Delay setting 52PU2 = 600 cycles). The Relay Word bits **52BT1** and **52BT2** indicate "out-of-service" for the primary breaker and the secondary breaker, respectively.

7. Close the breaker simulators. After another ten seconds, the breaker simulators are deemed "in service" (corresponding to Breaker 1 Out-of-Service Dropout Delay setting 52DO1 = 600 cycles and Breaker 2 Out-of-Service Dropout Delay setting 52DO2 = 600 cycles).

   Then the Reset Time setting 79RS = 60 cycles times out and the relay is back in the Reset State again. The LO (Lockout) LED extinguishes and the RS (Reset) LED illuminates. Push the TRIP pushbutton again and notice that reclosing is initiated as before.

8. With both breakers closed and the relay in the Reset State again, push the TRIP pushbutton and then push the DTL pushbutton right after (if the DTL input is connected up). The relay immediately goes to the Lockout State (the LO LED illuminates).

9. Close both breaker simulators and open the Line voltage (see Figure 7.4). With both breaker simulators closed and the relay in the Reset State again (RS LED illuminated), push the TRIP pushbutton and notice that no reclosing takes place. Healthy line voltage is needed to supervise the reclose of the primary breaker simulator (corresponding to the Complete Breaker 1 Three-pole Reclose logic setting 3PR1C = **59L**).

   The reclosing scheme implemented assumes that a remote breaker restores the line first. If healthy voltage is not present, the remote end must not have successfully restored the line.

   The relay stays in the Reclose Cycle State (CY LED illuminated) for 15 seconds (corresponding to Overall Timer Delay setting OTT = 900 cycles). The healthy line voltage reclose supervising condition for the primary breaker simulator is not present and the relay "waits" for healthy line voltage to appear. If the Overall Timer times out before healthy line voltage appears, the relay goes to the Lockout State (CY LED extinguishes and the LO LED illuminates).

Step 2

Purpose: Time testing the primary breaker (Breaker 1) open interval timer

Method:

1. In Figure 7.5, the simulated trip (TRIP pushbutton) is asserting input 3PRI (Three-pole Reclose Initiate). Thus the relay times on three-pole reclose open interval settings. The primary breaker three-pole reclose open interval setting is Breaker 1 Three-pole Reclose Open Interval setting:

   3OI1 = 27 cycles

2. To prepare to test time setting 3OI1, make the following settings:

30I2	= 0 cycles	=	defeat Breaker 2 Three-pole Reclose Open Interval setting
OUT3(12345)	= **79OIT**	=	open interval 3OI1 timing (operating condition for OUT3 contact)
OUT4(12345)	= **CLS1**	=	output of Breaker 1 close logic (operating condition for OUT4 contact)

   Relay Word bit **79OIT** asserts any time a single- or three-pole open interval timer is timing for Breaker 1 or Breaker 2 (primary or secondary breaker). When setting 3OI1 times out, Relay Word **CLS1** asserts (output of Breaker 1 close logic).

3. Wire OUT3 contact to the “start” input of the timer. OUT3 contact asserts when Breaker 1 Three-pole Reclose Open Interval setting 3OI1 starts timing.

4. Wire OUT4 contact to the “stop” input of the timer. OUT4 contact asserts when Breaker 1 Three-pole Reclose Open Interval setting 3OI1 times out (Breaker 1 close logic output **CLS1** asserts).

5. Close both breaker simulators.

6. After 79RS time the RS (Reset) LED illuminates.

7. Close the Line voltage switch (see Figure 7.4). This is a reclose supervising condition explained in the previous Step 1, General reclose function test.

8. Push the TRIP pushbutton (see Figure 7.5). Push it fast—**do not** hold it down. The primary breaker simulator will reclose.

9. Read and then reset the timer. Compare the reading to Breaker 1 Three-pole Reclose Open Interval setting:

   3OI1 = 27 cycles

Step 3

Purpose: Time testing the secondary breaker (Breaker 2) open interval timer

Method:

1. In Figure 7.5, the simulated trip (TRIP pushbutton) is asserting input 3PRI (Three-pole Reclose Initiate). Thus the relay times on three-pole reclose open interval settings. The secondary breaker three-pole reclose open interval setting is Breaker 2 Three-pole Reclose Open Interval setting:

   3OI2 = 30 cycles

2. To prepare to test time setting 3OI2, make the following logic settings:

3OI1	= 0 cycles	=	defeat Breaker 1 Three-pole Reclose Open Interval setting
OUT3(12345)	= **79OIT**	=	open interval 3OI2 timing (operating condition for OUT3 contact)
OUT4(12345)	= **CLS2**	=	output of Breaker 2 close logic (operating condition for OUT4 contact)

   Relay Word bit **79OIT** asserts any time a single- or three-pole open interval timer is timing for Breaker 1 or Breaker 2 (primary or secondary breaker). When setting 3OI2 times out, Relay Word **CLS2** asserts (output of Breaker 2 close logic).

3. Wire OUT3 contact to the "start" input of the timer. OUT3 contact asserts when Breaker 2 Three-pole Reclose Open Interval setting 3OI2 starts timing.

4. Wire OUT4 contact to the "stop" input of the timer. OUT4 contact asserts when Breaker 2 Three-pole Reclose Open Interval setting 3OI2 times out (Breaker 2 close logic output **CLS2** asserts).

5. Close both breaker simulators.

6. After 79RS time the RS (Reset) LED illuminates.

7. Push the TRIP pushbutton (see Figure 7.5). Push it fast—**do not** hold it down. The secondary breaker simulator will reclose.

8. Read and then reset the timer. Compare the reading to Breaker 2 Three-pole Reclose Open Interval setting:

   3OI2 = 30 cycles

Calibration

When testing this relay, first verify relay calibration. Consider all tests invalid if you determine that the relay is out of calibration. System calibration requires trimming analog channel gains and offsets.

Each SEL relay is fully tested and calibrated before it leaves the factory. Although periodic calibration is unnecessary, you should consider calibrating the relay for the conditions listed below:

1. Replacement of any analog components in the system, such as operational amplifiers, the A/D converter, or sample/hold amplifiers.
2. Replacement of input transformers.
3. Out-of-tolerance indication of analog voltages (**STATUS** command).

Equipment Required

1. Calibrated ac digital voltmeter
2. One calibrated voltage source
3. Computer terminal

Calibration Procedures

Offset Adjustments

1. Be sure voltage inputs are zero at the rear panel and remove the front panel and top cover of the relay.
2. Turn the system power on.
3. Execute the **STATUS** command to observe the offsets while adjusting potentiometers R102, R104, R106, R108, R110, and R112 for indications of 5 mV or less (clockwise rotation results in positive offset). Note that the **STATUS** command is updated approximately every 30 seconds. One full revolution will change measurement by approximately 1 to 2 mV.

Gain Adjustments

The procedure below uses an ac voltage at the relay voltage inputs. This allows gain adjustments to accommodate ratio error in the input transformers.

1. Connect a 50 V, 60 Hz source to all six voltage inputs.
2. Turn on the system power.
3. Type **METER 222 <Enter>** to repeat the **METER** command and display 222 times (you may cancel any command using the **<Ctrl+X>** key sequence).
4. Adjust R122–R127 for correct indication (counterclockwise increases gain).
5. Replace the relay cover.

TROUBLESHOOTING

Inspection Procedure

Complete the following procedure before disturbing the system. After you finish the inspection, proceed to the Troubleshooting Table.

1. Measure and record control power voltage at terminals 44 and 45.
2. Check to see that the power is on, but do not turn system off if it is on.
3. Measure and record the voltage at all control inputs.
4. Measure and record the state of all output relays.
5. Inspect the cabling to the serial communications ports and be sure a communications device is connected to at least one communications port.

Troubleshooting Table

All Front Panel LEDs Dark

1. Power is off.
2. Blown power supply fuse.
3. Input power not present.
4. Self-test failure.
5. **TARGET** command improperly set.

Note: For 1, 2, 3, and 4 the ALARM OUT contact should be closed.

System Does Not Respond to Commands

1. Communications device not connected to system.
2. Relay or communications device at incorrect baud rate or other communication parameter incompatibility, including cabling error.
3. System is processing event record. Wait several seconds.
4. System is attempting to transmit information, but cannot due to handshake line conflict. Check communications cabling.
5. System is in the XOFF state, halting communications. Type **<Ctrl+Q>** to put system in XON state.

No Prompting Message Issued to Terminal Upon Power-Up

1. Terminal not connected to system.
2. Wrong baud rate.
3. Terminal improperly connected to system.
4. Other port designated AUTO in the relay settings.
5. Port time-out interval set to a value other than zero.
6. Board failure.

Terminal Displays Meaningless Characters

Baud rate set incorrectly. Check terminal configuration. See ***Section 3: Communications***.

Self-Test Failure: +5 Volts

1. Power supply +5 volt output out of tolerance. See **STATUS** command.
2. A/D converter failure.

Self-Test Failure: +15 Volts

1. Power supply +15 volt output out of tolerance. See **STATUS** command.
2. A/D converter failure.

Self-Test Failure: -15 Volts

1. Power supply -15 volt output out of tolerance. See **STATUS** command.
2. A/D converter failure.

Self-Test Failure: Offset

1. Offset drift. Adjust offsets.
2. A/D converter drift.

Self-Test Failure: ROM Checksum

EPROM failure. Replace EPROM(s).

Self-Test Failure: RAM

Static RAM IC failure. Replace RAM(s).

Self-Test Failure: A/D Converter

1. A/D converter failure.
2. RAM error not detected by RAM test.

Alarm Contact Closed

1. Power is off.
2. Blown power supply fuse.
3. Power supply failure.
4. Improper EPROMs or EPROM failure.
5. Board failure.

Firmware Upgrade Instructions

SEL may occasionally offer firmware upgrades to improve the performance of your relay. These instructions explain how to remove the relay drawout assembly to install new firmware.

The modifications require that you power down the relay, remove the relay front panel, pull out the drawout unit, exchange several integrated circuit chips, and reassemble the relay. If you do not wish to perform the modifications yourself, we can assist you. Simply return the relay and integrated circuit chips to us. We will install the new chips and return the unit to you within a few days.

⚠ WARNING This procedure requires that you handle electrostatic discharge sensitive components. If your facility is not equipped to work with these components, we recommend that you return the relay to SEL for firmware installation.

Upgrade Instructions

1. If the relay is in service, disable its control functions. Turn off control power to the relay. Disconnect all communication cables from the rear panel of the relay.
2. Remove the relay front panel by unscrewing the five front panel screws. With the front panel removed, you can see the aluminum drawout chassis. The main board is attached to the top of the drawout chassis. The power supply and transformer assembly are attached to the bottom of the relay chassis.
3. Disconnect the power supply and transformer secondary cables from the underside of the drawout assembly.
4. Remove the drawout assembly by pulling the spacers on the bottom of the drawout chassis. You should be able to remove the assembly with your fingers. If the drawout assembly does not come free, check to make sure all communications cables are disconnected from the relay rear panel. Because steps five and six involve handling electrostatic discharge (ESD)

sensitive devices and assemblies, perform these steps at an ESD safe work station. This will help prevent possible damage by electrostatic discharge.

5. Note the orientation of the ICs to be replaced. Use a small screwdriver to pry the indicated ICs free from their sockets. Be careful not to bend the IC pins or damage adjacent components.
6. Carefully place the new ICs in the appropriate sockets. Check the orientation of the ICs. Be sure that each IC is in its corresponding socket. Look for IC pins that bent under or did not enter a socket hole.
7. Slide the drawout assembly into the relay chassis. Using your fingers, push the assembly in until the front of the assembly is flush with the front of the relay chassis. Reconnect the power supply and transformer secondary cables to the receivers on the underside of the drawout assembly. Replace the relay front panel.
8. With breaker control disabled, turn relay power on and enter your settings. Execute the **STATUS**, **METER**, and **TRIGGER** commands to ensure that all functions are operational. Set and record your Access Level 1 and 2 passwords and the date and time. The relay is now ready to resume protective functions.

Factory Assistance

We appreciate your interest in SEL products. If you have questions or comments, please contact us at:

Schweitzer Engineering Laboratories
2350 NE Hopkins Court
Pullman, WA 99163-5603 USA
Tel: +1.509.332.1890
Fax: +1.509.332.7990
Internet: http://www.selinc.com

TABLE OF CONTENTS

TABLES

APPENDIX A: FIRMWARE AND MANUAL VERSIONS

FIRMWARE

This manual covers SEL relays that contain firmware bearing the following part numbers and revision numbers:

Table A.1: Firmware Revision History

Firmware Part/ Revision No.	Description of Firmware
This firmware differs from the previous version as follows:	
	– Supervise manual close logic with 52A.
SEL-279H-1-R404-D981110	60 Hz Version
SEL-279H-1-R454-D981110	50 Hz Version
This firmware differs from the previous version as follows:	
	– Corrected close input edge detect logic in closing logic.
SEL-279H-1-R403	60 Hz Version
SEL-279H-1-R453	50 Hz Version
This firmware differs from the previous version as follows:	
	– Corrected operation of SELOGIC® control equation variables ST and ZT dropout timers.
SEL-279H-1-R402	60 Hz Version
SEL-279H-1-R452	50 Hz Version
This firmware differs from the previous version as follows:	
	– Corrected 52b breaker status contact input debounce problem.
SEL-279H-1-R401	60 Hz Version
SEL-279H-1-R451	50 Hz Version
SEL-279H-1-R400	60 Hz Version
SEL-279H-1-R450	50 Hz Version

To find the firmware revision number in your relay, obtain an event report (which identifies the firmware) using the **EVENT** command. This is an FID number with the Part/Revision number in bold:

FID=**SEL-279H-1-R400**-V6ps-D951003-E2

For a detailed explanation of the FID refer to ***Section 4: Event Reporting***.

INSTRUCTION MANUAL

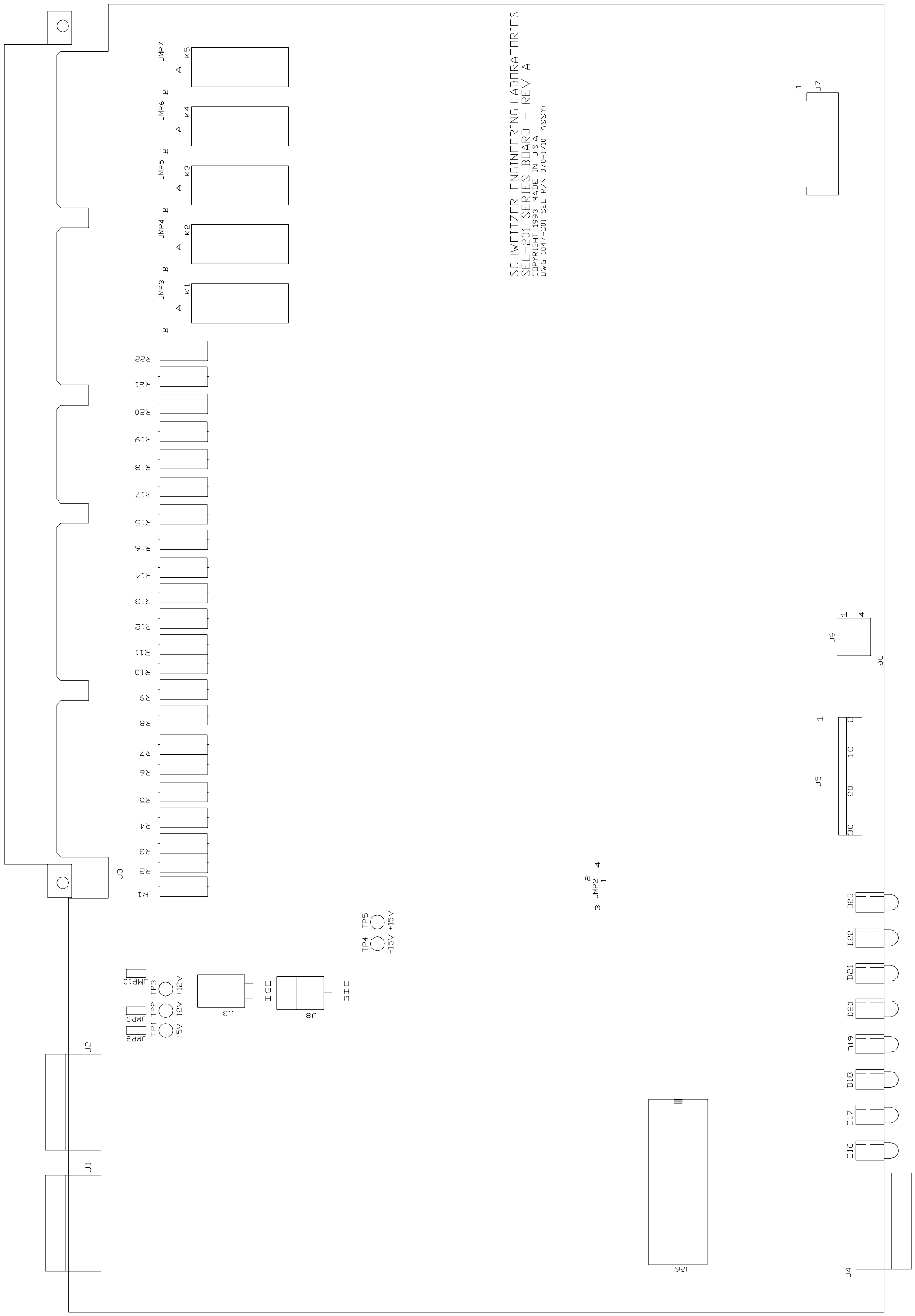
The date code at the bottom of each page of this manual reflects the creation or revision date.

Table A.2 lists the instruction manual release dates and a description of modifications. The most recent instruction manual revisions are listed at the top.

Table A.2: Manual Revision History

Revision Date	Summary of Revisions
This manual differs from the previous version as follows:	
20071030	– Moved Manual Change Information to Appendix A.
This manual differs from the previous version as follows:	
20000425	– Incorporated information from “SEL-200 Series Relay Addendum” (new optoisolated logic input rating) in ***Section 2: Specifications***. – Added Rising Edge Detection to inputs CL1 and CL2 in Figures 2.20 and 2.21, respectively.
This manual differs from the previous version as follows:	
981117	– Updated ***Figure 2.21: Breaker 2 Close Logic*** in ***Section 2: Specifications***. – ***Appendix A, Page A-1*** – added new firmware versions.
This manual differs from the previous version as follows:	
981026	– Incorporated information from “SEL-279 Series Specifications Addendum” into ***Section 2: Specifications*** – Updated ***Figure 6.4: Relay Dimensions, Panel Cutout, and Drill Diagrams*** in ***Section 6: Installation***. The figure caption now reads ***Relay Dimensions and Drill Plan***. – Updated Appendix A (supervise manual close logic with 52A).
This manual differs from the previous version as follows:	
980407	– Updated Appendix A (corrected close input edge detect logic in closing logic).
This manual differs from the previous version as follows:	
970827	– ***Appendix A, Page A-1*** – added new firmware versions.
This manual differs from the previous version as follows:	
970501	The ***Manual Change Information*** section has been created to begin a record of revisions to this manual. All changes which occur following this revision date code will be recorded in this Summary of Revisions Table. – ***Appendix A, Page A-1*** – added new firmware versions

APPENDIX B: SEL-279H-1 RELAY MAIN BOARD JUMPER CONNECTOR AND SOCKET LOCATIONS



DWG: MAINBORD

SEL-279H-1 RELAY COMMAND SUMMARY

Access Level 0 Command	
ACCESS	Answer password prompt (if password protection is enabled) to enter Access Level 1. Third unsuccessful attempt pulses ALARM OUT contact closed for one second.

Access Level 1 Commands	
2ACCESS	Answer password prompt (if password protection is enabled) to enter Access Level 2. This command always pulses the ALARM OUT contact closed for one second.
DATE m/d/y	Sets or displays date. **DAT 4/5/93** sets date to April 5, 1993. **DATE** pulses ALARM contacts when year entered differs from year stored. To display the date only, enter **DATE**.
EVENT *n*	Shows event record. **EVE** or **EVE 1** shows newest event; **EVE 12** shows oldest (n = 1, 2, 3, . . . 11, or 12).
HISTORY	Shows Date, Time, Event, and Targets, for the last twelve events.
METER *n*	Displays present terminal, positive-sequence, and difference voltage values. Optional n displays METER data n times.
QUIT	Returns control to Access Level 0; return target display to Relay Targets.
SHOWSET	Displays relay, logic, and input settings without affecting them.
STATUS	Shows self-test status.
TARGET *n k*	Shows data and sets target LEDs as follows (n = 0, 1, 2, . . . 6, or 7): **TAR 0**: Front Panel Targets — **TAR 1**: Relay Word row 1 **TAR 2**: Relay Word row 2 — **TAR 3**: Relay Word row 3 **TAR 4**: Relay Word row 4 — **TAR 5**: Relay Word row 5 **TAR 6**: Input States — **TAR 7**: Output Contact/Input States Optional k displays target data k times.
TARGET R	Clears targets and returns to TAR 0
TIME h/m/s	Sets or displays time. **TIM 13/32/00** sets clock to 1:32:00 PM. To display the time only, enter TIME.
TRIGGER	Triggers and saves an event record (event type is TRIG).

Access Level 2 Commands	
CLOSE *n*	(n = 1 or 2) Asserts Relay Word bits CLS1 or CLS2 if allowed by jumper JMP104 setting.
INPUT *n*	Shows or sets the programmable inputs. Command pulses ALARM OUT contact closed for one second and clears event buffers when new programmable input settings are stored.
LOGIC *n*	Shows or sets SELOGIC control equations. Command pulses ALARM OUT contact closed for one second and clears event buffers when new settings are stored.
PASSWORD	Shows or sets passwords. ALARM OUT contact pulses closed after password entry. **PAS 1 OTTER** sets Level 1 password to OTTER. **PAS 2 TAIL** sets Level 2 password to TAIL.
SET *n*	Initiates setting procedure. Option n directs the relay to begin the setting procedure at setting n (e.g., if n = 27B, the setting procedure starts at setting 27B, bypassing all settings before 27B). If no optional n is entered, the setting procedure starts at the beginning. The relay clears event buffers when new settings are stored and the ALARM OUT contact pulses closed.

SEL-279H-1 RELAY COMMAND SUMMARY

Access Level 0 Command

ACCESS	Answer password prompt (if password protection is enabled) to enter Access Level 1. Third unsuccessful attempt pulses ALARM OUT contact closed for one second.

Access Level 1 Commands

2ACCESS	Answer password prompt (if password protection is enabled) to enter Access Level 2. This command always pulses the ALARM OUT contact closed for one second.
DATE m/d/y	Sets or displays date. **DAT 4/5/93** sets date to April 5, 1993. **DATE** pulses ALARM contacts when year entered differs from year stored. To display the date only, enter **DATE**.
EVENT *n*	Shows event record. **EVE** or **EVE 1** shows newest event; **EVE 12** shows oldest (n = 1, 2, 3, . . . 11, or 12).
HISTORY	Shows Date, Time, Event, and Targets, for the last twelve events.
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PASSWORD	Shows or sets passwords. ALARM OUT contact pulses closed after password entry. **PAS 1 OTTER** sets Level 1 password to OTTER. **PAS 2 TAIL** sets Level 2 password to TAIL.
SET *n*	Initiates setting procedure. Option n directs the relay to begin the setting procedure at setting n (e.g., if n = 27B, the setting procedure starts at setting 27B, bypassing all settings before 27B). If no optional n is entered, the setting procedure starts at the beginning. The relay clears event buffers when new settings are stored and the ALARM OUT contact pulses closed.