SEL-279

Reclosing Relay
Voltage Relay
Synchronism Check

Instruction Manual

20000425

SEL SCHWEITZER ENGINEERING LABORATORIES, INC.

⚠CAUTION

Equipment components are sensitive to electrostatic discharge (ESD). Undetectable permanent damage can result if you do not use proper ESD procedures. Ground yourself, your work surface, and this equipment before removing any cover from this equipment. If your facility is not equipped to work with these components, contact SEL about returning this device and related SEL equipment for service.

⚠WARNING

Have only qualified personnel service this equipment. If you are not qualified to service this equipment, you can injure yourself or others, or cause equipment damage.

⚠WARNING

Use of this equipment in a manner other than specified in this manual can impair operator safety safeguards provided by this equipment.

⚠DANGER

Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.

⚠DANGER

Contact with instrument terminals can cause electrical shock that can result in injury or death.

⚠ATTENTION

Les composants de cet équipement sont sensibles aux décharges électrostatiques (DES). Des dommages permanents non-décelables peuvent résulter de l'absence de précautions contre les DES. Raccordez-vous correctement à la terre, ainsi que la surface de travail et l'appareil avant d'en retirer un panneau. Si vous n'êtes pas équipés pour travailler avec ce type de composants, contacter SEL afin de retourner l'appareil pour un service en usine.

⚠AVERTISSEMENT

Seules des personnes qualifiées peuvent travailler sur cet appareil. Si vous n'êtes pas qualifiés pour ce travail, vous pourriez vous blesser avec d'autres personnes ou endommager l'équipement.

⚠AVERTISSEMENT

L'utilisation de cet appareil suivant des procédures différentes de celles indiquées dans ce manuel peut désarmer les dispositifs de protection d'opérateur normalement actifs sur cet équipement.

⚠DANGER

Débrancher tous les raccordements externes avant d'ouvrir cet appareil. Tout contact avec des tensions ou courants internes à l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.

⚠DANGER

Tout contact avec les bornes de l'appareil peut causer un choc électrique pouvant entraîner des blessuers ou la mort.

PM279-01

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.

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.

20001120

INSTRUCTION MANUAL ADDENDUM

50 Hz Options

This manual is written for relays operating at a nominal system frequency of 60 Hz. For relays which specify a nominal frequency of 50 Hz, substitute 50 Hz for each reference to 60 Hz.

References made to a sampling time of 1/240 seconds should be replaced with a time of 1/200 seconds.

MANUAL CHANGE INFORMATION

The date code at the bottom of each page of this manual reflects the creation or revision date. Date codes are changed only on pages that have been revised and any following pages affected by the revisions (i.e., pagination). If significant revisions are made to a section, the date code on all pages of the section will be changed to reflect the revision date.

Each time revisions are made, both the main table of contents and the affected individual section table of contents are regenerated and the date code is changed to reflect the revision date.

Changes in this manual to date are summarized below (most recent revisions listed at top).

Revision Date	Summary of Revisions
20000425	Replaced Figure 6.2 to show correct SEL-279 front panel.
981130	Incorporated information from ***"SEL-279 Series Specifications Addendum"*** into ***Section 2: Specifications***. Updated ***Figure 6.3: Relay Dimensions, Panel Cutout, and Drill Diagrams*** in ***Section 6: Installation***. The figure caption now reads ***Relay Dimensions and Drill Plan***. ***Section 5: Applications*** –.Added DL/DB input information to page 5-8. Added Settings Sheets to end of section.

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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 & TESTING.

OVERVIEW

The SEL-279 Relay:

- Includes all logic and elements for restoration, test, and synchronism check:

  - 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)

- Controls a breaker or switching device for delayed and high speed reclosures
- Dead line/dead bus/trip scheme isolates bus sections for test and restoration
- Event reports show reclosing sequences and timing
- Accepts three-phase wye, delta, or single-phase voltage inputs
- User can program custom reclosing, alarm, and control schemes
- Ideal reclosing relay for retrofits
- Includes:

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

GENERAL DESCRIPTION

The primary function of the SEL-279 Relay is to control reclosing sequences. The relay includes all logic and voltage elements needed to control reclosing sequences, perform synchronism check and isolation functions for switching devices at all voltage levels.

All traditional reclose functions are combined in a single device. Metering, sequence-of-event recording capabilities, and programmable output contacts enhance the basic package.

Time Delayed and High Speed Reclosing Restore Normal Power System Operation

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

Use the time delayed reclosing functions to:

- Energize a dead bus from a hot line
- Test a dead line from a hot bus
- Connect two hot systems with synchronism supervision
- Connect two systems, regardless of voltage conditions (voltage unavailable)

The relay provides up to eight time delayed reclose attempts for these and other conditions. Each reclose attempt time is a setpoint on a timer which emulates a motor driven timer with eight timing lobes. This timer is labeled the Master Timer. Programmable aspects are:

- Master Timer run conditions
- Individual Master Timer setpoint time reclose conditions

High speed reclose timing is independent of the Master Timer. Use the high speed reclose function to energize a line following a fault. Internal voltage and instantaneous synchronism check elements may be enabled to supervise high speed reclosing.

Dead Line/Dead Bus/Trip Scheme Sectionalizes Dead Power Systems

The Dead Line/Dead Bus/Trip scheme logic trips circuit switching devices when the voltages are dead on both sides of the closed switching device. This feature permits an orderly restoration of your system following an outage of multiple line or bus sections.

Analyze Reclosing Sequences Using Event Reports

The SEL-279 Relay stores voltage, relay element, input, and output contact information in an event report. You select between two formats for the event reports (see Section 4: EVENT REPORTING). The relay stores the latest twelve event reports. 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 RS-232-C 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 Circuit Switching Device

The relay meters per phase voltages on both sides of the circuit switching device. Voltage magnitude differences across the switching device are also metered for each phase.

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 illustrate a sampling of installations where the SEL-279 Relay is applicable. A single SEL-279 Relay controls one circuit switching device. The reclose timing between adjacent SEL-279 Relay installations can be coordinated for orderly system restoration.

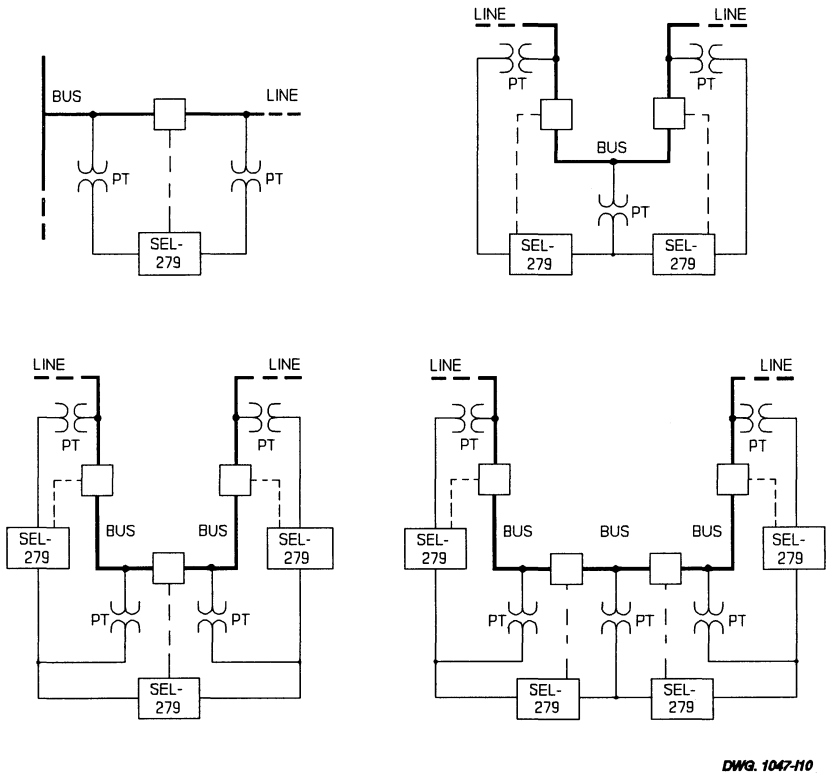

Figure 1.1: Example SEL-279 Relay Bus/Line Applications

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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
125 Vdc: 80 - 150 Vdc
250 Vdc: 150 - 300 Vdc
Current = 4 mA at nominal voltage

Communications

Two EIA RS-232-C 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)
Environment	IEC 68-2-30 Temperature/Humidity Cycle Test - six day (type tested)
Interference Tests	IEEE C37.90 SWC Test (type tested); IEC 255-6 Interference Test (type tested) IEC 801-4 Electrical Fast Transient/Burst (type tested)
Impulse Tests	IEC 255-5 0.5 joule, 5000 Volt Test (type tested)
RFI Tests	IEEE C37.90.2-199X (draft) Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
Vibration and Shock Test	IEC 255-21-1 & -2, Class 1 Test (type tested)
ESD Test	IEC 801-2 Electrostatic Discharge Test (type tested)
Unit Weight	16 pounds (7.3 kg)
Shipping Weight	Approximately 23 pounds (10.4 kg), including two instruction manuals

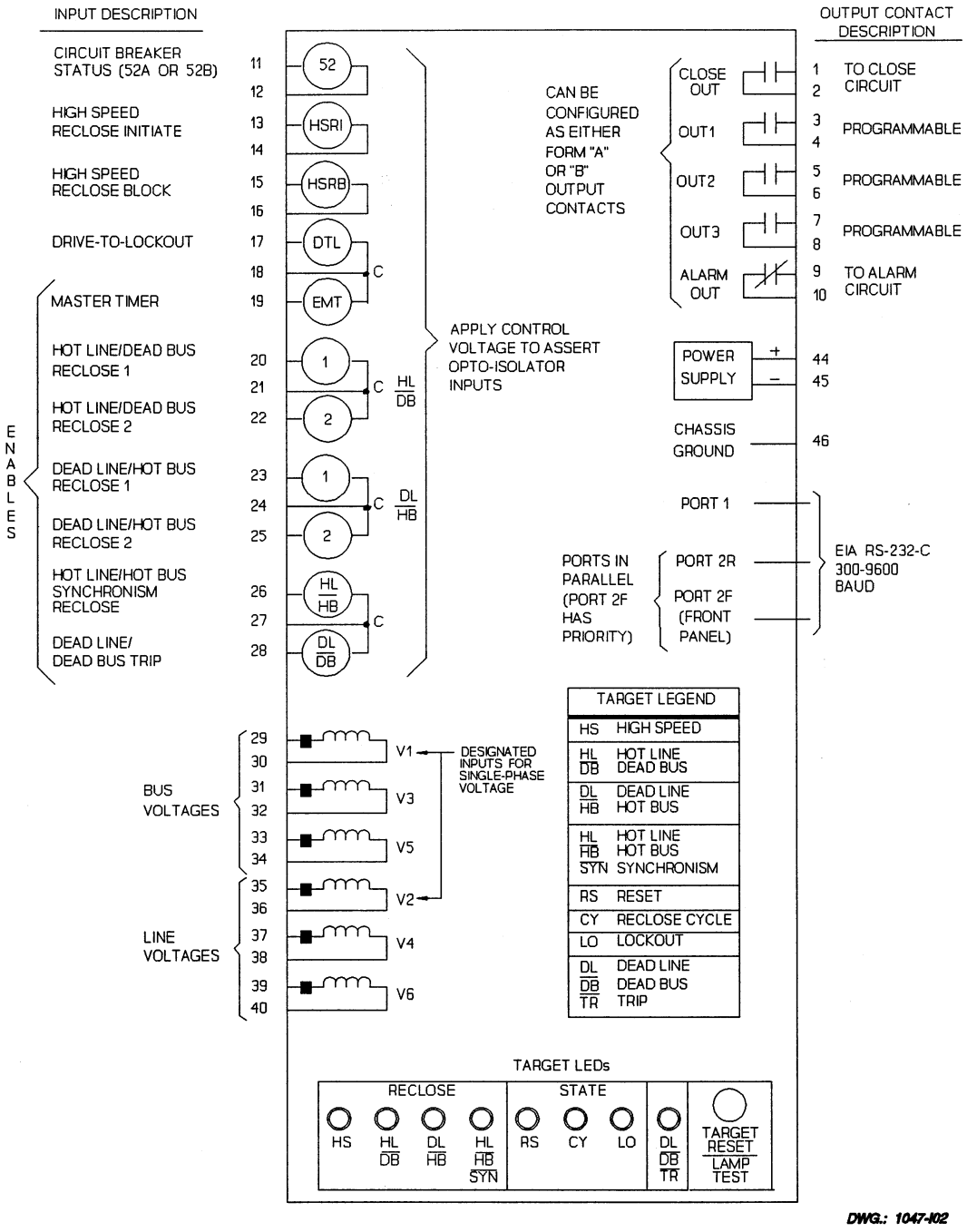


Figure 2.1: SEL-279 Relay Input, Output, and Target Diagram

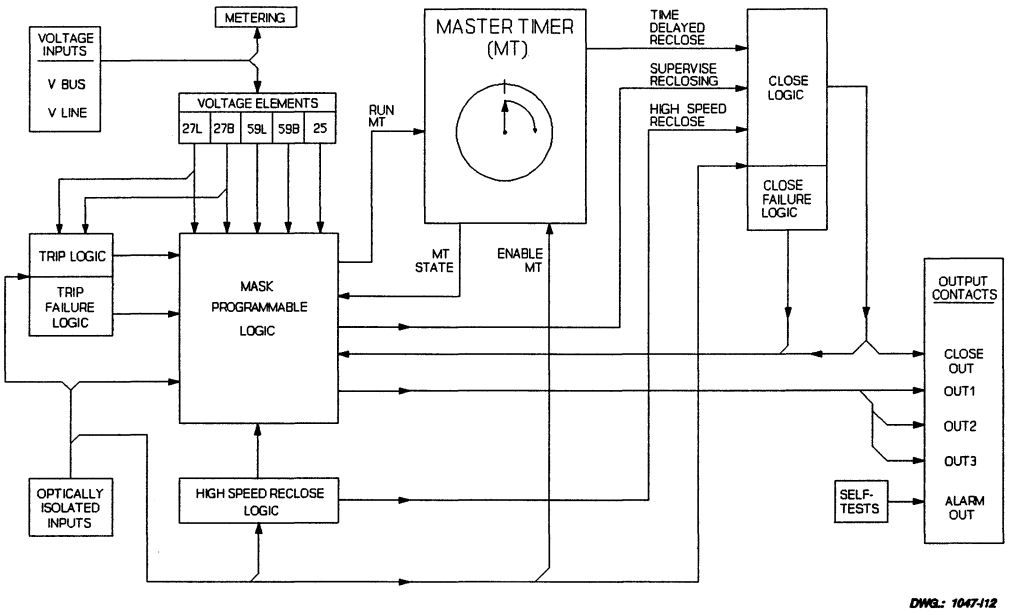


Figure 2.2: SEL-279 Relay Function Block Diagram

Inputs - see Figures 2.1 and 2.2

Voltage Inputs

The relay ac voltage inputs (terminals 29 through 40) are connected to potential transformers on both sides of a circuit switching device. These inputs can be connected to three-phase (wye or delta) or single-phase (phase-to-neutral or phase-to-phase) voltage sources in any combination for the bus and line. The voltages are used for dead bus or line (27B or 27L), hot bus or line (59B or 59L), and synchronism checking elements (25). These voltage elements and combinations of these voltage elements form logic elements (called bits) in the Relay Word (see Tables 2.1 and 2.2 on the following pages). Metering is also available.

Optically Isolated Inputs

The optically isolated inputs (terminals 11 through 28) are energized from external dc voltage via external contacts or switches. These logic inputs read the circuit breaker or switching device position, initiate or block high speed reclosures, and enable or disable reclosing features (one-cycle pickup and dropout debounce on all inputs). Certain enabling inputs in combination with the voltage elements form logic elements (called bits) in the Relay Word.

Voltage Element Accuracy

0 to 230 V rms, ±1 V rms ±3% of setting.

Programmable Logic Masks

Use logic masks to select Relay Word bits (Table 2.1 below) to control the reclosing process.

Logic Mask	Specific Logic Mask Purposes
MTR	Mask for Master Timer Run: • selects which Relay Word bits control Master Timer timing
MT1	Mask for Master Timer Setpoint 1 Time Reclose Conditions
MT2	Mask for Master Timer Setpoint 2 Time Reclose Conditions
MT3	Mask for Master Timer Setpoint 3 Time Reclose Conditions
MT4	Mask for Master Timer Setpoint 4 Time Reclose Conditions
MT5	Mask for Master Timer Setpoint 5 Time Reclose Conditions
MT6	Mask for Master Timer Setpoint 6 Time Reclose Conditions
MT7	Mask for Master Timer Setpoint 7 Time Reclose Conditions
MT8	Mask for Master Timer Setpoint 8 Time Reclose Conditions • At each setpoint, the relay asserts the CLOSE OUT contact if at least one of the Relay Word bits selected in the corresponding logic mask is asserted
HSR	Mask for High Speed Reclose Supervision Conditions: • select Relay Word bits for supervising high speed reclosing (if no bits are selected, high speed reclosing is unsupervised)
OUT1	Mask for Programmable Output Contact OUT1: • select Relay Word bits to operate output contact OUT1
OUT2	Mask for Programmable Output Contact OUT2: • select Relay Word bits to operate output contact OUT2
OUT3	Mask for Programmable Output Contact OUT3: • select Relay Word bits to operate output contact OUT3
ER	Mask for Event Report Generation: • select Relay Word bits to generate event reports

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**	**HLDB**	**DLHB**	**HLHB**	**DLDB**
Row 2	**HLD1**	**HLD2**	**DLH1**	**DLH2**	**HLHS**	**HOT**	**DEAD**	**52B**
Row 3	**DB1**	**DB2**	**HL1**	**HL2**	**DL1**	**DL2**	**HB1**	**HB2**
Row 4	**CLOS**	**TRIP**	**HSRN**	**RSET**	**CYCL**	**LOCK**	**25I**	**25T**
Row 5	**HD1M**	**HD2M**	**DH1M**	**DH2M**	**CF**	**TF**	**HSRT**	**MTT**

Table 2.2 on the following page lists the definition of each bit in the Relay Word. Where intermediate logic is involved, it is included in the definition of the Relay Word bit. See Section 5: APPLICATIONS for more settings details and examples.

Table 2.2: Relay Word Bit Definitions

Bit		Definition
27B	=	Dead bus element - asserts for bus voltage below setting 27B (no input check)
27L	=	Dead line element - asserts for line voltage below setting 27L (no input check)
59B	=	Hot bus element - asserts for bus voltage above setting 59B (no input check)
59L	=	Hot line element - asserts for line voltage above setting 59L (no input check)
HLDB	=	**59L** * **27B** (no input check)
DLHB	=	**27L** * **59B** (no input check)
HLHB	=	**59L** * **59B** (no input check)
DLDB	=	**27L** * **27B** (no input check)
HLD1	=	**59L** * **27B** * 52B * HL/DB 1 input asserted
HLD2	=	**59L** * **27B** * 52B * HL/DB 2 input asserted
DLH1	=	**27L** * **59B** * 52B * DL/HB 1 input asserted
DLH2	=	**27L** * **59B** * 52B * DL/HB 2 input asserted
HLHS	=	**25T** * HL/HB input asserted
HOT	=	**59L** * **59B** * 52B * HL/HB input asserted
DEAD	=	**27L** * **27B** * 52B * HL/HB input asserted
52B	=	52B (no voltage checks)
DB1	=	**27B** * 52B * HL/DB 1 input asserted
DB2	=	**27B** * 52B * HL/DB 2 input asserted
HL1	=	**59L** * 52B * HL/DB 1 input asserted
HL2	=	**59L** * 52B * HL/DB 2 input asserted
DL1	=	**27L** * 52B * DL/HB 1 input asserted
DL2	=	**27L** * 52B * DL/HB 2 input asserted
HB1	=	**59B** * 52B * DL/HB 1 input asserted
HB2	=	**59B** * 52B * DL/HB 2 input asserted
CLOS	=	Follows state of the CLOSE OUT contact (see Figure 2.4)
TRIP	=	Dead line/Dead bus/Trip condition or OPEN command (see Figure 2.5)
HSRN	=	Successful high speed reclose timer timeout (30-cycle pulse) - use in testing
RSET	=	Master Timer is in the Reset State (see Figure 2.3)
CYCL	=	Master Timer is in the Reclose Cycle State (see Figure 2.3)
LOCK	=	Master Timer is in the Lockout State (see Figure 2.3)
25I	=	Instantaneous Synchronism Check element (=25***59L*59B***52B)
25T	=	Time Delayed Synchronism Check element (**25I** time qualified by setting 25D)
HD1M	=	**HLD1** reclose attempt latched until the Reset State
HD2M	=	**HLD2** reclose attempt latched until the Reset State
DH1M	=	**DLH1** reclose attempt latched until the Reset State
DH2M	=	**DLH2** reclose attempt latched until the Reset State
CF	=	Close Failure condition (see Figure 2.4)
TF	=	Trip Failure condition (see Figure 2.5)
HSRT	=	High speed reclose timer timing - use in testing
MTT	=	Master Timer timing - use in testing

Note: 52B = Circuit breaker open
25 = Magnitude of bus and line phasor voltage difference less than setting 25DV

Master Timer

All time delayed reclosing is performed by the Master Timer. High speed reclosing is controlled by an independent timer. The Master Timer has three states: Reset, Reclose Cycle, and Lockout. Time setting MTPD (Master Timer Period Delay) specifies the Master Timer timing limit (see Figure 2.3).

Master Timer timing is controlled by the MTR (Master Timer Run) logic mask. Select Relay Word bits with the MTR logic mask which represent reclose conditions appropriate for your reclosing scheme (most likely from Relay Word rows 2 and 3). The Master Timer pulls away from the reset state (Master Timer time=0) and starts timing in the reclose cycle state when at least one selected condition comes true and the Master Timer is enabled. If no selected condition is true or the Master Timer is not enabled, the Master Timer stops timing.

The Master Timer is not enabled if any of the following occur:

- the EMT input (Enable Master Timer) is deasserted
- the CLOSE OUT contact asserts
- the **TRIP** Relay Word bit asserts
- the Outage Condition Restoration scheme is operating (see Section 5: APPLICATIONS)
- setting MTPD=0 (see Section 5: APPLICATIONS)
- the high speed reclose timer is timing

If none of these six conditions is true and a condition selected by the MTR mask is true, the Master Timer begins timing again.

Time Delayed Reclosing

Select reclosing times with eight settable Master Timer Setpoint Time Delays, MT1D through MT8D (see Figure 2.3). Each setpoint has a corresponding Master Timer Setpoint Time Reclose Condition logic mask, MT1 through MT8, respectively.

When the Master Timer reaches a time setpoint, the corresponding logic mask is compared with the present state of the Relay Word. If at least one selected Relay Word bit in the logic mask is asserted, the CLOSE OUT contact closes (see Figure 2.4). The selected bits are most likely from Relay Word rows 2 and 3.

If the reclosure is successful, the Master Timer times to MTPD time and stops (still remaining

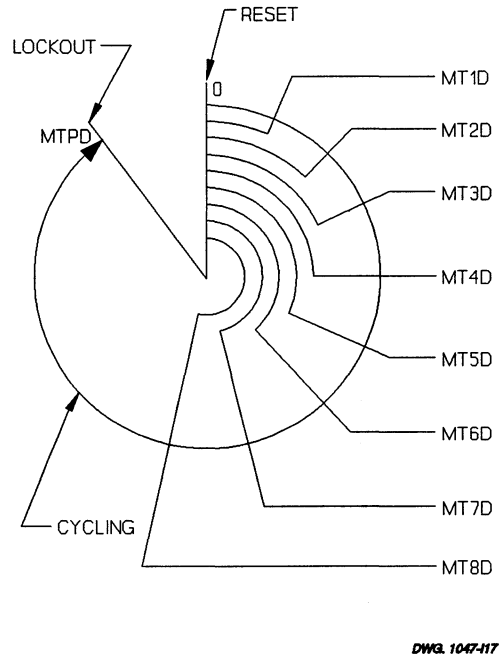


Figure 2.3: Master Timer Setpoints

in the reclose cycle state). Then the reset timer (setting RS1D) starts timing and the relay goes to the reset state after it expires (then Master Timer time=0).

If the reclosure is unsuccessful and there are no remaining reclose attempts (no remaining set setpoint times), then conditions selected by the MTR (Master Timer Run) logic mask cause the relay to time to MTPD time. When time MTPD is reached, the relay goes to the lockout state.

See Section 5: APPLICATIONS for more settings details and examples.

High Speed Reclosing

Asserting input HSRI (High Speed Reclose Initiate) initiates single-shot high speed reclosing only if the Master Timer is enabled, the relay is in the reset state, and the breaker is closed. After successful initiation, the relay goes to the reclose cycle state and the high speed reclose timer times (setting HSRD). This timer is turned off and high speed reclosing is aborted if any of the following occur:

- the HSRB input (High Speed Reclose Block) is asserted
- the relay is in the lockout state
- the EMT input (Enable Master Timer) is deasserted
- the CLOSE OUT contact asserts (except for high speed reclosing)
- the **TRIP** Relay Word bit asserts

If time HSRD successfully expires, the CLOSE OUT contact closes (see Figure 2.4), subject to optional supervision by the HSR (High Speed Reclose Supervision) logic mask. High speed reclosing is unsupervised if no bits are selected in the HSR logic mask. If bits are selected, they are usually from Relay Word rows 1 and 4 (just bits **25I** and **25T** in row 4).

If the circuit breaker trips after the high speed reclose attempt, setting HSRL (High Speed Reclose Lockout) provides the option to go directly to the lockout state.

If the high speed reclosure is successful, the Master Timer times to MTPD time and stops (still remaining in the reclose cycle state). Then the reset timer (setting RS1D) starts timing and the relay goes to the reset state after it expires (then Master Timer time = 0; see Figure 2.3).

If the high speed reclosure is unsuccessful, the relay can proceed with time delayed reclosures if desired, but setpoint time MT1D is skipped. If there are no remaining reclose attempts (no remaining set setpoint times), then conditions selected by the MTR (Master Timer Run) logic mask cause the relay to time to MTPD time. When time MTPD is reached, the relay goes to the lockout state.

See Section 5: APPLICATIONS for more settings details and examples.

Lockout State

The relay goes to the lockout state (Master Timer at time MTPD; see Figure 2.3) if any one of the following conditions occur:

- Reclosing is unsuccessful and there are no remaining reclose attempts (no remaining set setpoint times), then conditions selected by the MTR (Master Timer Run) logic mask cause the relay to time to MTPD time and the relay goes to the lockout state
- Setting HSRL = Y (High Speed Reclose Lockout) and the circuit breaker trips open after a high speed reclose attempt
- The close failure timer expires (setting CFD), asserting the **CF** Relay Word bit (see Figure 2.4)
- The Master Timer Limit Delay setting, MTLD, times out (signifies that the relay was in the reclose cycle state too long) and no reset conditions are present
- The DTL (Drive-To-Lockout) input is asserted

Leave the Lockout State - go to the Reset State

If the circuit breaker is successfully closed, the Reset Condition 1 Delay setting, RS1D, starts timing. If the circuit breaker remains closed, time RS1D expires and the relay goes to the reset state (the Master Timer is then at time 0; see Figure 2.3). If voltage from one or both sides of the circuit breaker is connected to the relay, the Reset Condition 1 scheme uses these voltages as part of the reset qualification conditions, along with the closed breaker.

See Section 5: APPLICATIONS for more settings details and examples.

Other Reset Schemes

Only reset time setting RS1D has been discussed in the preceding reclosing and lockout explanations. RS1D and other reset schemes (RS2D and RS3D) are discussed in detail in Section 5: APPLICATIONS.

Dead Line/Dead Bus/Trip Scheme

The Dead Line/Dead Bus/Trip scheme logic asserts the **TRIP** bit when the DL/DB input is asserted and voltages on both sides of the closed circuit switching device are dead for a settable amount of time (setting DLDBD). If voltage from only one side of the circuit switching device is connected to the relay, this scheme can still operate (only this voltage is monitored then). Assign the **TRIP** bit to a programmable output contact to trip the circuit switching device (see Figure 2.5).

See Section 5: APPLICATIONS for more settings details and examples.

Output Contacts

The CLOSE OUT contact (terminals 1 and 2) closes for time delayed or high speed reclosures (see Figure 2.4). The ALARM OUT contact (terminals 9 and 10) closes in response to any self-test failure, loss-of-power, or setting changes.

The programmable OUT1, OUT2, and OUT3 contacts (terminals 3 through 8) close when at least one Relay Word bit selected by their respectively labeled logic masks asserts.

See Section 5: APPLICATIONS for more settings details and examples.

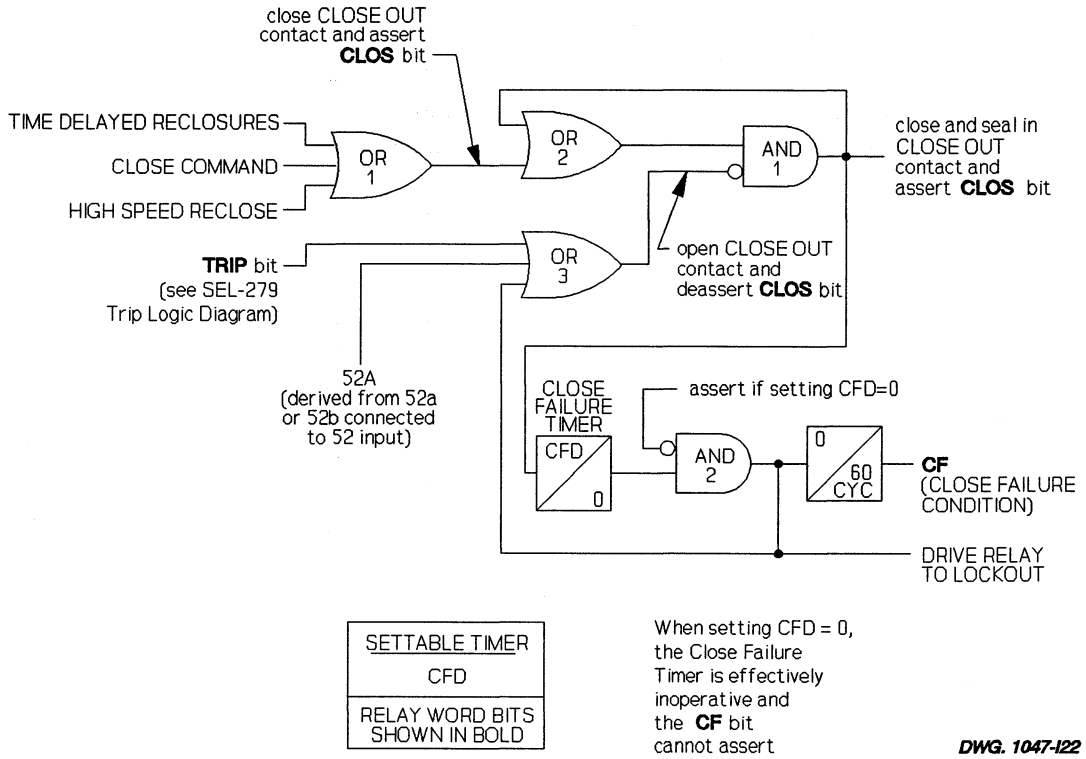


Figure 2.4: SEL-279 Relay Close Logic Diagram

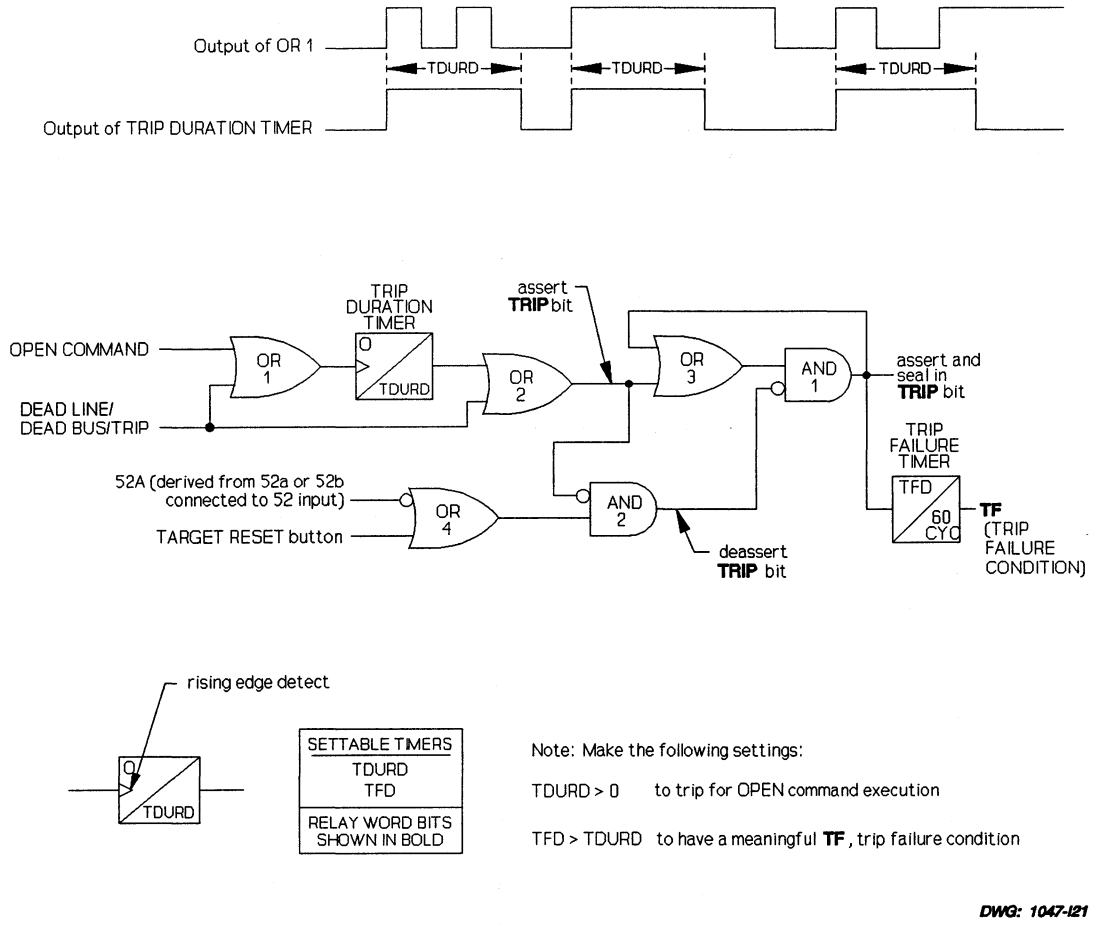


Figure 2.5: SEL-279 Relay Trip Logic Diagram

SETTINGS

More settings details and examples are found in Section 3: COMMUNICATIONS (SHOWSET, LOGIC, and SET commands), Section 4: EVENT REPORTING (Figures 4.1 and 4.2), and in Section 5: APPLICATIONS.

METERING

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

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.

RECLOSE Targets

The RECLOSE targets indicate the type of reclose that occurred (see Figure 2.6).

HS	asserts for operation of the high speed reclose scheme
HL/DB	asserts for a time delayed reclose due to reclose condition **HLD1**, **HLD2**, **DB1**, **DB2**, **HL1**, or **HL2**
DL/HB	asserts for a time delayed reclose due to reclose condition **DLH1**, **DLH2**, **DL1**, **DL2**, **HB1**, or **HB2**
HL/HB/SYN	asserts for a time delayed reclose due to reclose condition **HLHS**

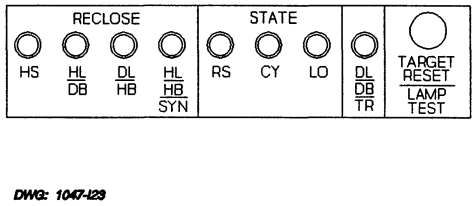
When the relay goes from the Reset State to the Reclose Cycle State to automatically reclose the breaker for a new event, the previous RECLOSE targets unlatch. For each new reclosure, the corresponding RECLOSE target latches. The targets are cumulative.

After the Reclose Cycle State:

- the relay enters the Reset State if a reclosure was successful
- or the relay enters the Lockout State if the attempted reclosures were unsuccessful.

The RECLOSE targets remain latched whether the relay enters the Reset State or the Lockout State. If the relay goes from the Lockout State to the Reset State, the RECLOSE targets remain latched, too.

The RECLOSE targets also unlatch if the Dead Line/Dead Bus/Trip scheme operates while the relay is in the Reset State.



TARGET LEGEND	
HS	HIGH SPEED
HL/DB	HOT LINE / DEAD BUS
DL/HB	DEAD LINE / HOT BUS
HL/HB/SYN	HOT LINE / HOT BUS / SYNCHRONISM
RS	RESET
CY	RECLOSE CYCLE
LO	LOCKOUT
DL/DB/TR	DEAD LINE / DEAD BUS / TRIP

Figure 2.6: SEL-279 Relay Front Panel Targets and Legend

STATE Targets

The STATE targets indicate the state of the relay and respectively follow the Relay Word bits **RSET**, **CYCL**, and **LOCK**.

Master Timer Timing

The Master Timer can only time when the relay is in the Reclose Cycle State. When the Master Timer is timing, the Reclose Cycle target LED (CY) flashes on and off. If the relay is in the Reclose Cycle State and the Master Timer is not timing, target LED CY remains illuminated constantly.

DL/DB/TR Target

The DL/DB/TR target asserts for operation of the Dead Line/Dead Bus/Trip scheme.

Dead Line/Dead Bus/Trip Scheme Operation in the Reset State

If both the following conditions are true:

- The relay is in the Reset State
- And a dead line/dead bus/closed breaker condition is time-qualified by the Dead Line/Dead Bus/Trip scheme,

then the following targeting action takes place:

- The Dead Line/Dead Bus/Trip scheme issues a trip (Relay Word bit **TRIP** asserts),
- Target DL/DB/TR latches,
- And all existing RECLOSE targets are unlatched.

Eventually the bus or line becomes "hot," and the relay enters the Reclose Cycle State to re-energize the remaining "dead" line or bus. Target DL/DB/TR remains latched.

After the Reclose Cycle State:

- the relay enters the Reset State if a reclosure was successful
- or the relay enters the Lockout State if the attempted reclosures were unsuccessful.

Target DL/DB/TR remains latched whether the relay enters the Reset State or the Lockout State. If the relay goes from the Lockout State to the Reset State, the target DL/DB/TR remains latched, too.

When the relay goes from the Reset State to the Reclose Cycle State to automatically reclose the breaker for a new event, target DL/DB/TR unlatches if it wasn't just latched in the most recent time in the Reset State.

Dead Line/Dead Bus/Trip Scheme Operation in the Reclose Cycle State

If the Dead Line/Dead Bus/Trip scheme operates while the relay is in the Reclose Cycle State (e.g., for faulted bus section isolation), target DL/DB/TR latches and remains latched until the relay again enters the Reclose Cycle State from the Reset State for a new event.

Dead Line/Dead Bus/Trip Scheme Operation in the Lockout State

If the Dead Line/Dead Bus/Trip scheme operates while the relay is in the Lockout State (e.g., a breaker is manually closed into a faulted bus section and another breaker clears the fault, leaving a dead line/dead bus/closed breaker condition for the breaker that was manually closed), target DL/DB/TR latches and remains latched until the relay again enters the Reclose Cycle State from the Reset State for a new event.

The RECLOSE and DL/DB/TR targets also unlatch if one of the following occurs:

- The TARGET RESET/LAMP TEST button is pushed
- The TARGET R command is executed
- A setting or logic change is made with the SET 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.

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 at least 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 OFFSETS	50 mV	W	NO	NO	no contact assertion
	75 mV	F	NO	NO	one second contact pulse
MASTER OFFSET	50 mV	W	NO	NO	no contact assertion
	75 mV	F	NO	NO	one second contact pulse

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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 assertions of the TRIP output, 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 SET or LOGIC commands.

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

Relay output appears boxed and in the following format:

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

SERIAL PORT CONNECTIONS AND CONFIGURATIONS

Port 1 and Port 2 are EIA RS-232-C 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

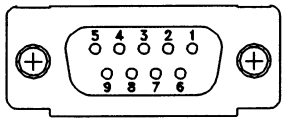
This format may not be changed.

Table 3.1 lists port pin assignments and signal definitions.

Table 3.1: SEL-279 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.

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



(female chassis connector, as viewed from outside panel)

Figure 3.1: 9-Pin Connector Pin Number Convention

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 25% full.

The relay transmits XOFF (ASCII hex 13) when the buffer is over 75% full. The relay deasserts the RTS output when the buffer is approximately 95% 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% 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-279 Relay                    Date: 1/1/93   Time: 01:01:01

SEL-279
=
```

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-279 Relay                   Date: 1/1/93   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-279 Relay                Date: 1/1/93   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/upper case/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-279 Relay                Date: 5/1/93   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-279 Relay                Date: 5/1/93   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.

COUNTER

The relay monitors breaker closure. Every time it detects such, it increments the breaker closure counter. It discriminates between relay closures and external closures. If the Relay CLOSE OUT contact is asserted when the breaker closes, the closure is counted as a relay closure. Otherwise, it is counted as an external closure.

The COUNTER command displays the accumulated number of breaker closures and the date from which they were accumulated.

```
=>COUNTER <ENTER>

Example SEL-279 Relay                Date: 1/30/94  Time: 11:15:53

Relay Closures = 12        From: 1/14/94  10:05:43
External Closures = 1      From: 1/29/94  17:52:12

=>
```

An operation suggestion is that after the relay is powered-up, settings are made, and the date and time are set, then execute the COUNTER R command. This resets both closure counters to zero and enters the present date and time for the accumulation starting point. The COUNTER R command discussion follows.

COUNTER R

The COUNTER R command resets the accumulated number of breaker closures to zero. It also stores the present date and time for the accumulation starting point.

An operation suggestion is that after the relay is powered-up, settings are made, and the date and time are set, then execute the COUNTER R command. This resets both closure counters to zero and enters the present date and time for the accumulation starting point.

```
=>COUNTER R <ENTER>
Reset Breaker Closure Counter:
Are you sure (Y/N) ? Y <ENTER>

Example SEL-279 Relay                Date: 1/30/94  Time: 11:20:09

Relay Closures = 0         From: 1/30/94  11:20:09
External Closures = 0      From: 1/30/94  11:20:09

=>
```

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 30, 1993, enter:

```
=>DATE 4/30/93 <ENTER>
4/30/93
=>

=>DATE <ENTER>
4/30/93
=>
```

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 SET or LOGIC 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
=>
```

Setting Event Report Type (ERT) determines the event report format. Section 4: EVENT REPORTING explains the generation and analysis of event reports.

HISTORY

Setting ERT (Event Report Type) determines the format of the information generated by the relay and accessed by the HISTORY command. The setting choices are:

ERT = 1 or 2 — 1 = standard 60-cycle event report
2 = sequence-of-event report

See Section 4: EVENT REPORTING for more information on the ERT setting.

HISTORY command (setting ERT = 1, standard 60-cycle event report)

HISTORY displays the date, time, event type, Master Timer position, and targets for each of the last twelve events. The full 60-cycle event reports also include this information (**EVENT n** to display).

```
=>HISTORY <ENTER>

Example 279 Relay              Date:  5/1/93       Time:11:15:12

#   DATE        TIME         EVENT   MT pos. at CYC 6   TARGETS
1  5/1/93   05:02:48.625   CLOS          300           DLHB CY
2  4/14/93  08:07:40.129   TRIG            0           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 6th row of data in the report. All reports trigger at row 6.

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

OPEN:	OPEN command execution
TRIG:	TRIGGER command execution
Relay Word bit:	event report generated by a Relay Word bit selected in the ER logic mask picking up. The bit is then listed as the event type (e.g., **CLOS**)

"MT pos. at CYC 6" refers to the Master Timer position when the event report was triggered. All event report triggering is referenced to the 6th row (CYC 6) of the full event report.

The TARGETS column lists the front panel targets illuminated at event report initiation.

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

HISTORY command (setting ERT = 2, sequence-of-event report)

The HISTORY command accesses short history summaries of the information available with the EVENT command. It is only necessary to type HIS and use the Enter/Return key to scroll through the history summaries. Or type HIS n ("n" is the event number; n = 1 is the most recent event, n = 12 is the oldest event) to jump to the history summary of interest and then scroll to the older history summaries that follow with the Enter/Return key. When the oldest history summary has been scrolled to (i.e., HIS 12), the scrolling ends and a new command has to be entered at the prompt (=>).

Up to twelve (12) history summaries can be stored if the total cumulative number of lines does not exceed 144. If the total number of lines for the cumulative history summaries exceeds 144 lines, the oldest history summary is discarded to keep the number of lines no greater than 144.

If an EVENT command reclosing event is discarded because the cumulative number of lines exceeds 300 (see Section 4: EVENT REPORTING), the corresponding HISTORY command history summary is not necessarily discarded. The oldest history summary is discarded only when the total number of lines for the cumulative history summaries exceeds 144 lines.

The first line of any history summary is referenced from when the relay last entered the Reset State. Two example HISTORY command history summaries follow.

In example HIS 1 (the most recent automatic reclose event), note that the relay has been in the Reset State since 7/13/93. Notice also that this first line is time-referenced one cycle after the last line printed out in example HIS 2. One history summary ends when the relay enters the Reset State anew (e.g., HIS 2) and another history summary begins one cycle later (e.g., HIS 1). The second line in HIS 1 is the relay entering the Reclose Cycle State from the Reset State. The relay goes from the Reclose Cycle state to the Lockout State after an unsuccessful dead line/hot bus reclose attempt. Eventually, the relay goes to the Reset State again after a manual close. This history summary is six lines long.

In following example HIS 2, the start condition is the relay giving a dead line/dead bus/trip while in the Reset State. The relay then enters the Reclose Cycle State and returns to the Reset State again after a successful dead line/hot bus reclose. This history summary is five lines long. Note that example HIS 2 is a short summary of the example event report shown in Figure 4.2 in Section 4: EVENT REPORTING.

For the HISTORY command summary events, the start condition can only be:

- The relay entering the Reset State anew (time referenced one cycle later)

The second line that follows can only be:

- The relay entering the Reclose Cycle State from the Reset State (as in HIS 1),
- The relay entering the Lockout State from the Reset State,
- Or the relay giving a dead line/dead bus/trip while in the Reset State (as in HIS 2).

The end condition can only be:

- The relay ending up in the Reset State again.

The additional information in between the second line and the end condition can only be from the following:

- The relay entering the Reclose Cycle State from the Reset State, after a dead line/dead bus/trip (as in HIS 2),
- The relay giving an automatic reclose while in the Reclose Cycle State (as in both HIS 1 and HIS 2),
- The relay giving a dead line/dead bus/trip,
- The relay going to the Lockout State (as in HIS 1),
- The breaker being closed while the relay is in the Lockout State (as in HIS 1).

```
=>HIS <ENTER>

HIS 1

Example SEL-279 Relay

FID=SEL-279-R403-V6-931217-E2

                              Targets
                           HHDH 79  D
                           SLLL     L
                        MT    DHH RCL D
  Date       Time       pos.  BBB SYO B  Event

07/13/93 18:06:22.145     0 ..*. *.. *  Reset State
09/29/93 22:13:45.112     1 .... .*. .  entered Reclose Cycle State (DL/HB)
09/29/93 22:13:50.095   300 ..*. .*. .  dead line/hot bus reclose
09/29/93 22:14:35.146  3000 ..*. ..* .  Lockout State
09/29/93 22:21:42.735  3000 ..*. ..* .  breaker closed
09/29/93 22:22:02.786  3000 ..*. *.. .  Reset State

Press ENTER/RETURN for next history, CTRL X to abort

? <ENTER>

HIS 2

Example SEL-279 Relay

FID=SEL-279-R403-V6-931217-E2

                              Targets
                           HHDH 79  D
                           SLLL     L
                        MT    DHH RCL D
  Date       Time       pos.  BBB SYO B  Event

06/07/93 04:56:31.989     0 .*.. *.. .  Reset State
07/13/93 18:05:07.034     0 .... *.. *  dead line/dead bus/trip
07/13/93 18:05:12.078     1 .... .*. *  entered Reclose Cycle State (DL/HB)
07/13/93 18:05:17.061   300 ..*. .*. *  dead line/hot bus reclose
07/13/93 18:06:22.128  3000 ..*. *.. *  Reset State

Press ENTER/RETURN for next history, CTRL X to abort

?
```

The header at the top of a history summary lists the information in the ID setting. The following line is the Firmware Identification Data (FID=SEL-279-....).

The history summary columns Date and Time list the date and time that the event in the Event column occurred. The MT pos. column lists the Master Timer position (in cycles) when the event in the Event column occurred. The Targets columns list the status of the front panel targets when the event in the Event column occurred. The Target columns are listed in the same order as the front panel targets.

The following are the possible messages that can be printed in the Event column of the history summaries:

Table 3.2: HISTORY Command Event Column Messages (Setting ERT = 2)

Event Column Message	Triggering Condition
Lockout State (DTL)	DTL (Drive-to-Lockout) input asserted.
Lockout State (CF)	Close failure condition takes the relay to the Lockout State
Lockout State	Relay went to the Lockout State for any other reason (e.g., no successful reclosing attempts)
high speed reclose	High speed reclose attempt
hot line/dead bus reclose	Hot line/dead bus reclose attempt
dead line/hot bus reclose	Dead line/hot bus reclose attempt
hot line/hot bus/synch. reclose	Hot line/hot bus/synchronism check reclose attempt
Reset State	relay enters the Reset State
entered Reclose Cycle State (HSRI)	relay entered the Reclose Cycle State because of a successful high speed reclose initiation
entered Reclose Cycle State (HL/DB)	relay entered the Reclose Cycle State and voltage conditions are hot line/dead bus
entered Reclose Cycle State (DL/HB)	relay entered the Reclose Cycle State and voltage conditions are dead line/hot bus
entered Reclose Cycle State (HL/HB)	relay entered the Reclose Cycle State and voltage conditions are hot line/hot bus
entered Reclose Cycle State	relay entered the Reclose Cycle State and none of the above voltage conditions are true
breaker closed	breaker is closed from the Lockout State
dead line/dead bus/trip	relay issues a dead line/dead bus/trip

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:

V1: voltage at V1 terminal inputs
V3: voltage at V3 terminal inputs
V5: voltage at V5 terminal inputs

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 279 Relay              Date:  5/1/93       Time:11:15:12

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

=>
```

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-279                          Date: 5/1/93   Time: 01:45:40

=
```

SHOWSET

SHOWSET displays the relay and logic mask 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 logic mask settings. Settings ranges and explanations are found in Section 5: APPLICATIONS.

```
=>SHOWSET <ENTER>

Settings for: Example SEL-279 Relay

Settings:

BSPT =3         LNPT =1         27B  =7         27L  =7
59B  =56        59L  =56        25DV =17        25D  =120
MT1D =300       MT2D =600       MT3D =1800      MT4D =0
MT5D =0         MT6D =0         MT7D =0         MT8D =0
MTPD =3000      RS1D =1200      RS2D =0         RS3D =0
CFD  =0         DLDBD=300       TDURD=7         TFD  =0         HSRD =0
MTED =0         MTCD =0         MTLD =0         52   =B         HSRL =N
ERT  =2         TIME1=15        TIME2=0         AUTO =2

Logic Mask settings:

MTR  MT1  MT2  MT3  MT4  MT5  MT6  MT7  MT8  HSR  OUT1  OUT2  OUT3
00   00   00   00   00   00   00   00   00   00   00    00    00
A8   20   80   08   00   00   00   00   00   00   00    00    00
00   00   00   00   00   00   00   00   00   00   00    00    00
00   00   00   00   00   00   00   00   00   00   40    00    00
00   00   00   00   00   00   00   00   00   00   00    00    00

=>
```

Each logic mask settings display column shows the masks for the five rows of the Relay Word.

Logic mask settings appear in hexadecimal format. Table 3.3 provides equivalencies between hexadecimal (hex) and binary numbers. Use the table when you examine logic settings in event reports and the SHOWSET display.

Table 3.3: Hexadecimal/Binary Conversion

Hexadecimal	Binary	Hexadecimal	Binary
0	0000	8	1000
1	0001	9	1001
2	0010	A	1010
3	0011	B	1011
4	0100	C	1100
5	0101	D	1101
6	0110	E	1110
7	0111	F	1111

For example, consider row 2 of logic mask MT1 (Master Timer setpoint 1 Time Reclose Conditions), which is set to 20 hex format. Using the table, convert 20 to binary:

20 -> 0010 0000.

Now, build row 2 of the Relay Word for the MT1 logic mask as follows:

HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B
0	0	1	0	0	0	0	0
_____	2	_____	_____	_____	0	_____	

The ER (Event Report Generation) mask is not functional, nor accessible or printed out if setting ERT (Event Report Type) is set as:

ERT = 2

If setting ERT is set as:

ERT = 1

then the ER mask is functional, accessible, and printed out right after the OUT3 logic mask.

See Section 4: EVENT REPORTING for more information on the ERT setting.

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 3.4: Target LED Assignment

LED:	1	2	3	4	5	6	7	8	
N									
0	HS	HLDB	DLHB	HLHB	RS	CY	LO	DLDB	Front Panel Targets
1	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	Relay Word row 1
2	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	Relay Word row 2
3	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	Relay Word row 3
4	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	Relay Word row 4
5	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	Relay Word row 5
6	DH1	HD2	HD1	EMT	DTL	HSRB	HSRI	52	Inputs
7	ALRM	OUT3	OUT2	OUT1	CLOS	DLDB	HLHB	DH2	Output Contacts/Inputs

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 R4. Target headings repeat every eight rows. You cannot use parameter k without parameter n.

```
=>TARGET 4 10 <ENTER>

CLOS  TRIP  HSRN  RSET  CYCL  LOCK  25I   25T
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     0

CLOS  TRIP  HSRN  RSET  CYCL  LOCK  25I   25T
0     0     0     1     0     0     0     0
0     0     0     1     0     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 timeout or set both TIME1 and TIME2 to zero. This halts automatic port timeout.

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

HS    HLDB  DLHB  HLHB  RS    CY    LO    DLDB
0     0     0     0     1     0     0     0

=>
```

If setting ERT = 2 and the TARGET R command is executed and targets are actually cleared, the relay generates a line of data (see Section 4: EVENT REPORTING).

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

If setting ERT = 1 and the TRIGGER command is executed, a 60-cycle event report is generated. After command entry, the relay responds "Triggered" and displays a record summary.

```
=>TRIGGER <ENTER>
Triggered

=>

Example SEL-279 Relay          Date:  5/1/93     Time:  07:25:20

Event: TRIG          Targets: HLHB RS
MT pos. at CYC 6:  0

=>
```

If setting ERT = 2 and the TRIGGER command is executed, a line of data is generated.

Section 4: EVENT REPORTING explains setting ERT and lists the ways that 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

The CLOSE command asserts the CLOSE OUT contact when jumper JMP104 is installed on the main board, the circuit breaker status input indicates an open circuit breaker, and the **TRIP** Relay Word bit is not asserted. The CLOSE OUT contact then remains closed until the circuit breaker status input indicates that the circuit breaker has closed or until the close failure timer (setting CFD) expires (see Figure 2.4).

To close the circuit breaker with this command, type **CLOSE <ENTER>**. The relay responds with the message: "Close BREAKER (Y/N) ?" **Y <ENTER>** yields a second prompting string: "Are you sure (Y/N) ?" Type **Y <ENTER>** to assert the CLOSE OUT contact if the **TRIP** bit is not asserted. 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 <ENTER>
Close BREAKER (Y/N) ? Y <ENTER>
Are you sure (Y/N) ? Y <ENTER>
Breaker CLOSED
=>>

Example SEL-279 Relay           Date:  5/1/93     Time:  07:25:20

Event: CLOS            Targets: LO
MT pos. at CYC 6: 3000

=>>
```

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

LOGIC n

The LOGIC command programs the masks which control the reclosing process, programmable output contacts, and event report generation. The n parameter specifies the mask to program. The masks are listed in Section 2: SPECIFICATIONS. The Relay Word bit choices for the masks are also listed in Section 2.

The logic programming procedure requires you to enter changes to the mask or press **<ENTER>** to indicate no change. Each mask is split into sections which correspond to the five rows of the Relay Word.

The LOGIC command displays a header and settings for each row of the Relay Word. Next it displays a question mark prompt and waits for input. Enter only ones and zeros with no separating spaces as input; one selects and zero deselects a member of the Relay Word. Press **<ENTER>** when a group is satisfactory. If you wish to change any member of the group, you must re-enter all eight members, even if some remain the same. The relay repeats logic settings and the question mark prompt after entry of each row to allow corrections.

When all data are entered for each row, the relay displays the new 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.

In the following MT1 logic mask setting example, Relay Word bit **DLH1** is set to supervise reclosing at setpoint 1 time (MT1D).

Set the other masks in a similar manner.

The ER (Event Report Generation) mask is not functional, nor accessible if setting ERT (Event Report Type) is set as:

ERT = 2

See Section 4: EVENT REPORTING for more information on the ERT setting.

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

LOGIC command example for the MT1 (Master Timer Setpoint 1 Time Reclose Conditions) mask:

```
=>>LOGIC MT1 <ENTER>

1 selects, 0 deselects.

27B   27L   59B   59L   HLDB  DLHB  HLHB  DLDB
 0     0     0     0     0     0     0     0
? <ENTER>
HLD1  HLD2  DLH1  DLH2  HLHS  HOT   DEAD  52B
 0     0     0     0     0     0     0     0
? 00100000 <ENTER>
 0     0     1     0     0     0     0     0
? <ENTER>
DB1   DB2   HL1   HL2   DL1   DL2   HB1   HB2
 0     0     0     0     0     0     0     0
? <ENTER>
CLOS  TRIP  HSRN  RSET  CYCL  LOCK  25I   25T
 0     0     0     0     0     0     0     0
? <ENTER>
HD1M  HD2M  DH1M  DH2M  CF    TF    HSRT  MTT
 0     0     0     0     0     0     0     0
? <ENTER>

New MT1 :

27B   27L   59B   59L   HLDB  DLHB  HLHB  DLDB
 0     0     0     0     0     0     0     0
HLD1  HLD2  DLH1  DLH2  HLHS  HOT   DEAD  52B
 0     0     1     0     0     0     0     0
DB1   DB2   HL1   HL2   DL1   DL2   HB1   HB2
 0     0     0     0     0     0     0     0
CLOS  TRIP  HSRN  RSET  CYCL  LOCK  25I   25T
 0     0     0     0     0     0     0     0
HD1M  HD2M  DH1M  DH2M  CF    TF    HSRT  MTT
 0     0     0     0     0     0     0     0

OK (Y/N) ? Y <ENTER>
Enabled

Example SEL-279 Relay    Date: 5/1/93  Time: 14:25:00


=>>
```

OPEN

The OPEN command asserts the **TRIP** Relay Word bit when jumper JMP104 is installed on the main board. The **TRIP** bit remains asserted for at least the duration of TDURD (you must enter a TDURD setting greater than zero). The **TRIP** bit deasserts only if the circuit breaker opens or if you push the TARGET RESET button on the front panel (see Figure 2.5).

To open the power circuit breaker by command, type **OPEN <ENTER>**. The prompt "Open BREAKER (Y/N) ?" is transmitted. Answering **Y <ENTER>** yields a second prompt: "Are you sure (Y/N) ?" Answering **Y <ENTER>** again asserts the **TRIP** bit as

described above. The **TRIP** bit has to be assigned to a programmable output contact that is wired to trip the circuit breaker.

```
=>>OPEN <ENTER>
Open BREAKER (Y/N) ? Y<ENTER>
Are you sure (Y/N) ? Y<ENTER>
Breaker OPEN
=>>

Example SEL-279 Relay           Date:  5/1/93     Time:  07:25:20

Event: OPEN           Targets: RS
MT pos. at CYC 6: 0

=>>
```

After OPEN command execution, if the relay responds "Breaker CLOSED" instead of "Breaker OPEN," the circuit breaker status input did not indicate circuit breaker opening.

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 follow. Settings ranges and explanations are found in Section 5: APPLICATIONS.

```
=>>SET <ENTER>

SET clears events. CTRL-X cancels.
Enter data, or RETURN for no change
                                                    settings changes
ID   : Example SEL-279 Relay          ? <ENTER>

BSPT : Bus PT conn 0,1,3..... = 3 ? 1 <ENTER>  single-phase bus PT connection
LNPT : Line.................. = 1 ? <ENTER>
27B  : Bus dead, V sec....... = 7 ? <ENTER>
27L  : Line.................. = 7 ? <ENTER>

59B  : Bus hot, V sec........ = 56 ? <ENTER>
59L  : Line.................. = 56 ? <ENTER>
25DV : Synch chk diff, V sec... = 17 ? <ENTER>
25D  : Synch chk dly, cyc..... = 120 ? <ENTER>
```

```
MT1D : setpnt 1 dly, cyc....... = 300 ? <ENTER>
MT2D : 2....................... = 600 ? <ENTER>
MT3D : 3....................... = 1800 ? <ENTER>
MT4D : 4....................... = 0 ? <ENTER>

MT5D : 5....................... = 0 ? <ENTER>
MT6D : 6....................... = 0 ? <ENTER>
MT7D : 7....................... = 0 ? <ENTER>
MT8D : 8....................... = 0 ? <ENTER>

MTPD : Cyc period, cyc......... = 3000 ? <ENTER>
RS1D : Reset 1 dly, cyc........ = 1200 ? <ENTER>
RS2D : Reset 2 dly, cyc........ = 0 ? <ENTER>
RS3D : Reset 3 setpnt dly, cyc. = 0 ? <ENTER>

CFD  : Cl fail dly, cyc........ = 0 ? <ENTER>
DLDBD: DLDB trip dly, cyc...... = 300 ? <ENTER>
TDURD: Trip dur, cyc........... = 7 ? <ENTER>
TFD  : Trip fail dly, cyc...... = 0 ? <ENTER>
HSRD : HSR dly, cyc............ = 0 ? <ENTER>

MTED : Outage dly (PU), min.... = 0 ? <ENTER>
MTCD : Coord dly (DO), min..... = 0 ? <ENTER>
MTLD : Cyc limit dly, min...... = 0 ? <ENTER>
52   : A=52A,B=52B............. = B ? A <ENTER>  52a connected to input 52
HSRL : LO if unsuccess HSR, Y/N = N ? <ENTER>

ERT  : Event, 1=60 cyc, 2=SOE.. = 2 ? <ENTER>
TIME1: Port 1 timeout, min..... = 15 ? <ENTER>
TIME2: ........................ = 0 ? <ENTER>
AUTO : Autoport 1,2,3.......... = 2 ? <ENTER>

New settings for: Example SEL-279 Relay

Settings:

BSPT =1       LNPT =1       27B  =7       27L  =7
  °             °             °            °
  °             °             °            °
MTED =0       MTCD =0       MTLD =0       52   =A       HSRL =N
ERT  =2       TIME1=15      TIME2=0       AUTO =2
OK(Y/N) ? Y <ENTER>
Please wait...
Enabled

Example SEL-279 Relay    Date: 5/1/93   Time: 11:00:00

=>>
```

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

SEL-279 RELAY COMMAND SUMMARY

Access Level 0

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

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.

COUNTER Displays circuit breaker closure counter values (relay and external).

COUNTER R Resets circuit breaker closure counters (relay and external).

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 EVE or EVE 1 shows newest event report; EVE 12 shows oldest (n=1 through 12).

HISTORY Shows Date, Time, Event, Master Timer position, and Targets, for the last twelve events.

METER n Displays present terminal voltage values 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 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 R1
TAR 2: Relay Word row R2	TAR 3: Relay Word row R3
TAR 4: Relay Word row R4	TAR 5: Relay Word row R5
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 time (e.g., TIM 13/32/00 sets clock to 1:32:00 PM). To display time enter TIME.

TRIGGER Triggers and saves an event record (event type is TRIG).

Access Level 2

CLOSE Closes circuit breaker, if allowed by jumper JMP104 setting.

LOGIC n Shows or sets logic masks MTR, MT1 through MT8, HSR, OUT1, OUT2, OUT3, and ER. Command pulses ALARM OUT contact closed for one second and clears event buffers when new settings are stored.

OPEN Opens circuit breaker, if allowed by jumper JMP104 setting.

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 = RS1D, the setting procedure starts at setting RS1D, bypassing all settings before RS1D). 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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EVENT REPORTING
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EVENT REPORTING

CHOOSE BETWEEN EVENT REPORT TYPES

Setting ERT (Event Report Type) determines the format of the information generated by the EVENT and HISTORY commands. The setting choices are:

ERT = 1 or 2	1 = standard 60-cycle event report
	2 = sequence-of-events event report

This section discusses the information available via the EVENT command (see Section 3: COMMUNICATIONS for information on the HISTORY command).

When ERT = 2, the ER logic mask is not functional nor accessible and does not print out.

EVENT REPORTING FUNCTION WHEN SETTING ERT = 1

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 60 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

• OPEN command execution
• TRIGGER command execution
• Relay Word bit selected by the Event Report Generation mask (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 (ID setting)
- Date and time of event
- Event type
- Front panel targets
- Master Timer position in relation to the 6th row of the full event report.

The following is an example summary event report.

```
Example SEL-279 Relay          Date:  5/21/93     Time:  07:25:20

Event: OPEN            Targets: RS
MT pos. at CYC 6: 0

=>>
```

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 SET or LOGIC commands

Full Event Report

The full event report contains 60 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.

Relay elements, inputs, and output contact states appear in the right-hand columns of the event report. "*" indicates assertion; "." indicates deassertion (see Figure 4.1).

Note: There is a one-cycle pickup and dropout debounce on all optically-isolated inputs, but this debounce is not shown in the event reports; the event reports display the "raw" input.

Table 4.2: Event Report Column Definitions (setting ERT = 1)

Column	Definition
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)
25I	Instantaneous Synchronism Check (**25I** Relay Word bit)
25T	Time Delayed Synchronism Check (**25T** Relay Word bit)
Timing	Timers timing
MT	Master Timer (**MTT** Relay Word bit)
HSR	High speed reclose
79R	Reset state (**RSET** Relay Word bit)
79C	Reclose cycle state (**CYCL** Relay Word bit)
79L	Lockout state (**LOCK** Relay Word bit)
Bkr	Circuit breaker alarms
TF	Trip Failure (**TF** Relay Word bit)
CF	Close Failure (**CF** Relay Word bit)
Out	Output contacts
CLO	CLOSE OUT (**CLOS** Relay Word bit)
1	OUT1
2	OUT2
3	OUT3
ALR	ALARM OUT
Inputs	Optically isolated inputs
52	Circuit breaker status
HSRI	High speed reclose initiate
HSRB	High speed reclose block
DTL	Drive-to-lockout
EMT	Enable Master Timer
HLD1	Hot line/dead bus/reclose 1
2	Hot line/dead bus/reclose 2
DLH1	Dead line/hot bus/reclose 1
2	Dead line/hot bus/reclose 2
HLHB	Hot line/hot bus/synchronism reclose
DLDB	Dead line/dead bus/trip

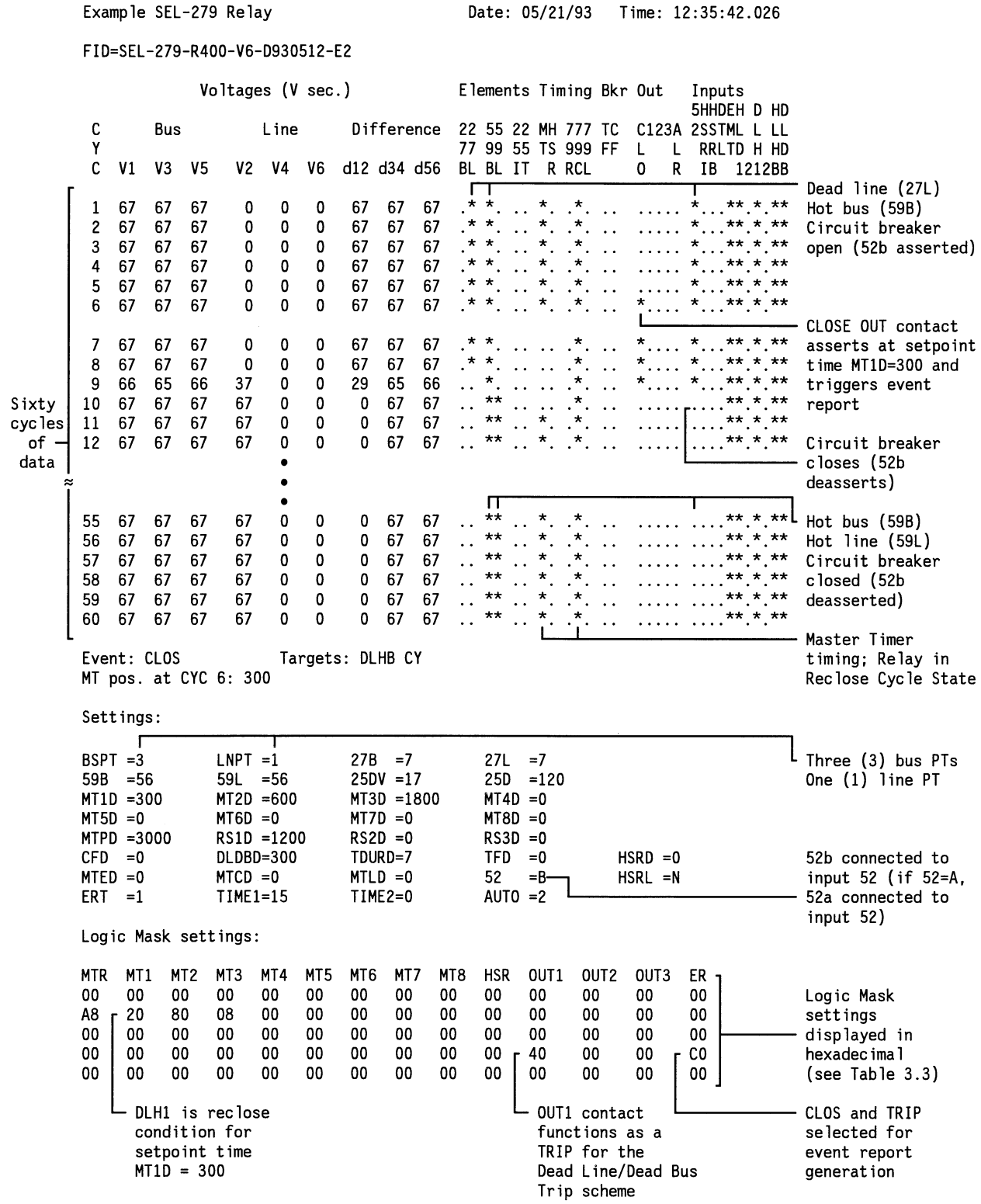

Figure 4.1: Example Event Report (setting ERT = 1)

Master Timer Position

The event summary following the 60-cycle report references the Master Timer position to row 6 of the report, the time at which the event report was generated (MT pos. at CYC 6: 300; see Figure 4.1). The MT (Master Timer timing) column assists in knowing the position of the Master Timer elsewhere in the report. For example, at row 5 the position is 299 cycles and at row 4 the position is 298 cycles, etc. At rows 7 through 10 the position remains at 300 (Master Timer not timing). At row 11 the Master Timer starts timing again (position increments to 301 cycles).

If the relay is in the reset state (column 79R) the Master Timer position is 0. If the relay is in the lockout state (column 79L) the Master Timer position is equal to setting MTPD.

View Entire High Speed Reclose Operation in One Event Report

If high speed reclosing is used, select Relay Word bit **HSRT** (high speed reclose timer timing) in the ER (Event Report Generation) logic mask. Assert the HSRI (High Speed Reclose Initiate) input and view the generated event report. Note the HSRI input is asserted at row 6 in the report (Inputs column HSRI). Fifty four more columns remain in the report and for most high speed reclose schemes this is more than ample time to see the subsequent closure in the same report.

EVENT REPORTING FUNCTION WHEN SETTING ERT = 2

The ER (Event Report Generation) mask is not functional, nor accessible if setting ERT = 2.

The SEL-279 Relay generates a line of data any time there is a change in the targets, relay elements, output contacts, or inputs of the relay. Each row is time-stamped, and dated. An example event follows in Figure 4.2.

These lines of data are grouped into the twelve (12) most recent reclosing events. If the cumulative number of lines for the twelve events is greater than 300, the oldest event is discarded to keep the cumulative number of lines no greater than 300. Thus, the number of stored events could be less than twelve if some event is very long. The event report buffers are cleared if control power is lost or setting changes are made via the SET or LOGIC commands.

Access the events with the EVENT command. It is only necessary to type EVE n ("n" is the event number; n = 1 is the most recent event, n = 12 is the oldest event).

Table 4.3 gives row-by-row explanation of the example event in Figure 4.2. Table 4.4 gives event column descriptions. Note that single-phase voltages V1 and V2 for the bus and line, respectively, are displayed in volts secondary. When any one of these columns changes (except the Master Timer position and the line and bus voltage values in volts secondary), the relay generates a line of data, time-stamps it, and dates it.

An event begins when the SEL-279 Relay enters the Reset State anew. The lines that follow will print out when there is any change in targets, relay elements, output contacts, inputs of the relay, or the TRIGGER command is executed. The event ends when the relay returns to the Reset State again via any of the following paths:

- Reset State - Reclose Cycle State - Reset State.
- Reset State - Reclose Cycle State - Lockout State - Reset State.
- Reset State - Lockout State - Reset State.

Note that the example event in Figure 4.2 follows the path:

Reset State - Reclose Cycle State - Reset State.

It begins when the voltages go dead when the relay is in the Reset State (a dead line/dead bus/trip follows) and ends when the relay is back in the Reset State again after a successful dead line/hot bus reclose.

```
=>EVE 2 <ENTER>

Example SEL-279 Relay

FID=SEL-279-R403-V6-931217-E2

                                  Targets    Voltages    S T F  Out    Inputs
                                 HHDH 79  D   (V sec.)    y i a        5HHDEH D HD
                                 SLLL     L  bus   line  n m i  C123A  2SSTML L LL
                           MT     DHH RCL D              c e l  L   L   RRLTD H HD
  Date        Time        pos.   BBB SYO B  V1    V2    h r    O   R    IB  1212BB

06/07/93 04:56:31.989       0  .*.. *.. .  67 h  67 h  . . .  .....  ....**.*.**
07/13/93 18:05:02.017       0  .*.. *.. .   0 d   0 d  . . .  .....  ....**.*.**
07/13/93 18:05:07.034       0  .... *.. *   0 d   0 d  . . .  .*...  ....**.*.**
07/13/93 18:05:07.085       0  .... *.. *   0 d   0 d  . . .  .....  *...**.*.**
07/13/93 18:05:12.078       1  .... .*. *  67 h   0 d  . m .  .....  *...**.*.**
07/13/93 18:05:17.061     300  ..*. .*. *  67 h   0 d  . m .  *....  *...**.*.**
07/13/93 18:05:17.078     300  ..*. .*. *  67 h   0 d  . . .  *....  *...**.*.**
07/13/93 18:05:17.128     300  ..*. .*. *  67 h  67 h  . . .  .....  ....**.*.**
07/13/93 18:05:17.145     301  ..*. .*. *  67 h  67 h  . m .  .....  ....**.*.**
07/13/93 18:06:02.128    3000  ..*. .*. *  67 h  67 h  . . .  .....  ....**.*.**
07/13/93 18:06:22.128    3000  ..*. *.. *  67 h  67 h  . . .  .....  ....**.*.**

Settings:

BSPT =3         LNPT =1         27B  =7         27L  =7
59B  =56        59L  =56        25DV =17        25D  =120
MT1D =300       MT2D =600       MT3D =1800      MT4D =0
MT5D =0         MT6D =0         MT7D =0         MT8D =0
MTPD =3000      RS1D =1200      RS2D =0         RS3D =0
CFD  =0         DLDBD=300       TDURD=7         TFD  =0         HSRD =0
MTED =0         MTCD =0         MTLD =0         52   =B         HSRL =N
ERT  =2         TIME1=15        TIME2=0         AUTO =2

Logic Mask settings:

MTR  MT1  MT2  MT3  MT4  MT5  MT6  MT7  MT8  HSR  OUT1  OUT2  OUT3
00   00   00   00   00   00   00   00   00   00   00    00    00
A8   20   80   08   00   00   00   00   00   00   00    00    00
00   00   00   00   00   00   00   00   00   00   00    00    00
00   00   00   00   00   00   00   00   00   00   40    00    00
00   00   00   00   00   00   00   00   00   00   00    00    00
```

Figure 4.2: Example Event Report (setting ERT = 2)

Table 4.3: Row-by-row Explanation of Example Event Report in Figure 4.2

Time	Explanation
04:56:31.989	The relay has been in the Reset State (target RS asserted) since this time on 6/7/93, after a successful hot line/dead bus reclose (target HL/DB asserted).
18:05:02.017	The bus and line voltages go dead ("d" appears in both voltage columns V1 and V2).
18:05:07.034	Output contact OUT1 = TRIP asserts for a dead line/dead bus/trip. Target DLDB asserts and all previous RECLOSE targets are cleared.
18:05:07.085	Breaker opens (column 52 asserts - 52b contact) so output contact OUT1 = TRIP deasserts.
18:05:12.078	Bus voltage goes hot again ("h" appears in voltage column V1), the Master Timer starts timing ("m" appears in Timer column), and the relay goes into the Reclose Cycle State (target RS deasserts and target CY asserts).
18:05:17.061	CLOSE OUT contact asserts (column CLO asserts) at a reclose setpoint time (= 300 cycles) for a Dead Line/Hot Bus reclose condition (target DLHB asserts; Master Timer position = 300).
18:05:17.078	Master Timer stops timing ("m" goes away in Timer column) because the CLOSE OUT contact is asserted.
18:05:17.128	The line comes hot ("h" appears in voltage column V2), and the CLOSE OUT contact deasserts (column CLO deasserts) because the breaker closed (column 52 deasserts - 52b contact).
18:05:17.145	The Master Timer starts timing again ("m" appears in Timer column) because the CLOSE OUT contact is deasserted and reset conditions are present.
18:06:02.128	The Master Timer stops timing (Master Timer position = 3000; "m" goes away in Timer column). The reset timer starts timing. The reset timer is set at 1200 cycles (20 seconds).
18:06:22.128	The reset timer times out after 20 seconds, and the relay is back in the Reset State again (target CY deasserts and target RS asserts; Master Timer position = 3000). For the next cycle, the Master Timer is at position 0 and the next event report begins.

Table 4.4: Event Report Column Definitions (setting ERT = 2)

Column	Definition
MT pos.	Master Timer position (in cycles).
Targets	Follows the targets on the front panel of the relay - same order left-to-right (the column designations are abbreviated somewhat from the front panel designations). "*" if target illuminated, "." if target off.
Voltages	V1 voltage on bus voltage input V1, in volts secondary. V2 voltage on line voltage input V2, in volts secondary. If "h" follows the voltage, it is deemed "hot" by the relay voltage elements: **59B** Relay Word bit asserted (for V1). **59L** Relay Word bit asserted (for V2). If "d" follows the voltage, it is deemed "dead" by the relay voltage elements. **27B** Relay Word bit asserted (for V1). **27L** Relay Word bit asserted (for V2). If "." follows the voltage, it is deemed neither "hot" nor "dead" by the relay voltage elements (must be in between). **59B** and **27B** Relay Word bits both deasserted (for V1). **59L** and **27L** Relay Word bits both deasserted (for V2). If "B" follows the voltage, both "hot" and "dead" relay voltage elements are asserted (must be overlap in the voltage threshold settings). **59B** and **27B** Relay Word bits both asserted (for V1). **59L** and **27L** Relay Word bits both asserted (for V2).
Synch	If "i" is displayed, **25I** Relay Word bit is asserted. If "t" is displayed, **25T** Relay Word bit is asserted (**25T** is a time-qualified **25I**). If "." is displayed, **25I** and **25T** are both deasserted.
Timer	If "m" is displayed, **MTT** Relay Word bit is asserted. If "h" is displayed, **HSRT** Relay Word bit is asserted (if **HSRT** is asserted, **MTT** can't be asserted). If "." is displayed, **MTT** and **HSRT** are both deasserted.
Fail	If "t" is displayed, **TF** Relay Word bit is asserted. If "c" is displayed, **CF** Relay Word bit is asserted. If "B" is displayed, **TF** and **CF** are both asserted. If "." is displayed, **TF** and **CF** are both deasserted.
Out	Follows the output contacts on the rear panel of the relay. "*" if output contact asserted, "." if output contact not asserted.
Inputs	Follows the opto-isolated inputs on the rear panel of the relay. "*" if input energized , "." if input not energized.

Note: There is a one-cycle pickup and dropout debounce on all optically-isolated inputs, but this debounce is not shown in the event reports; the event reports display the "raw" input.

Event Report Line Generation Methods

As previously discussed, the relay generates a line of data any time there is a change in the targets, relay elements, output contacts, or inputs of the relay. Each row is time-stamped, and dated. An example event is shown in Figure 4.2.

The relay generates a line of data any time the TRIGGER command is executed. To distinguish this line, a "T" is printed after the Master Timer position column value.

Additionally, the relay generates a line of data any time the TARGET RESET button is pushed. To distinguish this line, an "R" is printed after the Master Timer position column value.

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. The summary event report is the first and second lines of the history summary that corresponds to the event report.

For example, history summary HIS 2 in the HISTORY command discussion (setting ERT=2) in Section 3: SPECIFICATIONS corresponds to example event report EVE 2 in Figure 4.2. The summary event report for this event is the first and second lines of history summary HIS 2:

```
Example SEL-279 Relay

FID=SEL-279-R403-V6-931217-E2

                              Targets
                            HHDH 79  D
                            SLLL     L
                         MT   DHH RCL D
  Date       Time       pos.  BBB SYO B  Event

06/07/93 04:56:31.989     0 .*.. *.. .  Reset State
07/13/93 18:05:07.034     0 .... *.. *  dead line/dead bus/trip
```

The first line shows how long the relay has been in reset (since 6/7/93 in this example). The "action" begins on the second line.

Note: The concise information available via the HISTORY command is usually sufficient enough to analyze a reclosing operation. The more detailed information available via the EVENT command is needed only infrequently to analyze unusual or special reclosing operations or for testing purposes. See the HISTORY command discussion (setting ERT=2) in Section 3: COMMUNICATIONS for more details on the information available via the HISTORY command.

FIRMWARE IDENTIFICATION

The SEL-279 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-279)
[RN] = Revision Number (e.g., 400)
[VS] = Version Specifications (e.g., 6)
[RD] = Release Date (e.g., YYMMDD = 930512)
[ER] = Version Specification: EEPROM

For the SEL-279 Relay family, 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

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, Inc. for information concerning available versions of the SEL-279 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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APPLICATIONS

IMPLEMENT RECLOSING SCHEMES OF VARYING COMPLEXITY

The SEL-279 Relay is the ideal relay for all types of reclosing schemes. Logic masks select reclose conditions from the Relay Word elements (bits). The reclose conditions can be:

- As simple as just checking for an open circuit breaker
- Or more complex with additional voltage and/or synchronism condition checks

Each reclose time has a dedicated reclose condition logic mask. Up to eight (8) reclose times can be set. Reclose times can be enabled/disabled by inputs.

A dedicated logic mask selects supervising conditions for high speed reclosing. High speed reclosing can also be left unsupervised.

The reclose and relay failure functions have dedicated output contacts (CLOSE OUT and ALARM OUT, respectively). The remaining three output contacts (OUT1, OUT2, and OUT3) are programmed by individual logic masks. For example, they can function as:

- A trip output contact for dead line/dead bus/closed breaker tripping
- A lockout alarm
- A memory output contact to signal the adjacent reclosing relay of reclosing action

A dedicated logic mask selects Relay Word bits to trigger event reports. The event reports show the status of system voltages, relay elements, output contacts and inputs over a 60-cycle time window with cycle resolution. Event reports simplify reclosing scheme performance evaluation. For example, an event report can be generated for high speed reclose initiation. The 60-cycle event report will encompass the initiation and reclose for the high speed operation. Event reporting economically provides valuable engineering and operating information, eliminating the need for event recorders and oscillographs in most applications.

RECLOSING RELAY RETROFIT JOBS

The SEL-279 Relay is ideal for reclosing relay retrofit jobs. It is optimally suited to replace electromechanical reclosing relays that operate on the rotating cam timer principle. The SEL-279 Relay has a Master Timer that emulates the operation of a rotating cam timer.

The SEL-279 Relay also has voltage and synchronism check elements and can replace the additional voltage and synchronism check relays required in an electromechanical reclosing relay installation. The compact size of the SEL-279 Relay make it especially convenient for crowded substation panels. Both horizontal and vertical mounting configurations are available.

SETTINGS EXPLANATION

Bus and Line Potential Transformer Connections (BSPT, LNPT)

Make the following settings to specify voltage connections to the voltage inputs:

BSPT Bus Potential setting - voltage connection to bus voltage inputs V1, V3, V5

LNPT Line Potential setting - voltage connection to line voltage inputs V2, V4, V6

The voltage inputs (V1, V3, V5, V2, V4, and V6) are each separately available with two terminals each.

The setting choices for BSPT and LNPT are:

0 No voltage connected
1 Single-phase voltage connected (phase-to-neutral or phase-to-phase)
3 Three-phase voltage connected (wye or delta - configured by user)

Settings BSPT and LNPT determine the nature of the undervoltage, overvoltage, and synchronism check elements and other functions that are derived from the bus and line voltage inputs:

27B Dead Bus element (and Relay Word bit) derived from bus voltage inputs
27L Dead Line element (and Relay Word bit) derived from line voltage inputs
59B Hot Bus element (and Relay Word bit) derived from bus voltage inputs
59L Hot Line element (and Relay Word bit) derived from line voltage inputs
25I Instantaneous Synchronism Check element (and Relay Word bit) derived from bus and line voltage inputs
25T Time Delayed Synchronism Check element (and Relay Word bit) derived from time-qualified **25I**

If BSPT = 0

- **27B** = logical 1
- **59B** is inoperative (= logical 0)
- **25I** and **25T** are both inoperative (= logical 0)
- Reset Condition 2 scheme is inoperative
- Bus voltage is disregarded for:
  - The Dead Line/Dead Bus/Trip scheme
  - The Outage Condition Restoration scheme
  - Reset Condition schemes 1 and 3

If BSPT = 1

- Connect single-phase voltage to bus voltage input V1
- **27B** and **59B** operate as single-phase elements off of voltage input V1
- **25I** and **25T** operate as single-phase elements [V1 (bus) paired with V2 (line)]

If BSPT = 3

- Interconnect bus voltage inputs V1, V3, and V5 in a wye or delta configuration
- Connect three-phase wye or delta voltage to bus voltage inputs V1, V3, and V5
- **27B** and **59B** operate as three-phase elements

If LNPT = 0

- **27L** = logical 1
- **59L** is inoperative (= logical 0)
- **25I** and **25T** are inoperative (both = logical 0)
- Reset Condition 2 scheme is inoperative
- Line voltage is disregarded for:

    - The Dead Line/Dead Bus/Trip scheme
    - The Outage Condition Restoration scheme
    - Reset Condition schemes 1 and 3

If LNPT = 1

- Connect single-phase voltage to line voltage input V2
- **27L** and **59L** operate as single-phase elements off of voltage input V2
- **25I** and **25T** operate as single-phase elements [V2 (line) paired with V1 (bus)]

If LNPT = 3

- Interconnect line voltage inputs V2, V4, and V6 in a wye or delta configuration
- Connect three-phase wye or delta voltage to line voltage inputs V2, V4, and V6
- **27L** and **59L** operate as three-phase elements

If <u>both</u> BSPT = 3 and LNPT = 3:

- **25I** and **25T** operate as three-phase elements

    - V1 (bus) paired with V2 (line)
    - V3 (bus) paired with V4 (line)
    - V5 (bus) paired with V6 (line)

If both BSPT = 0 and LNPT = 0, then additionally:

- The Dead Line/Dead Bus/Trip scheme is inoperative
- The Outage Condition Restoration scheme is inoperative

Dead Bus or Line and Hot Bus or Line Element Thresholds (27B, 27L, 59B, 59L)

Make the following settings to specify voltage element operating thresholds (range: 0 to 270 volts secondary):

27B Dead Bus Voltage Threshold for dead bus element, **27B**. If bus voltage goes below the 27B threshold setting, the **27B** element asserts, indicating a dead bus.

27L Dead Line Voltage Threshold for dead line element, **27L**. If line voltage goes below the 27L threshold setting, the **27L** element asserts, indicating a dead line.

59B Hot Bus Voltage Threshold for hot bus element, **59B**. If bus voltage goes above the 59B threshold setting, the **59B** element asserts, indicating a hot bus.

59L Hot Line Voltage Threshold for hot line element, **59L**. If line voltage goes above the 59L threshold setting, the **59L** element asserts, indicating a hot line.

Select threshold settings based upon your utility standards. The previously discussed BSPT and LNPT settings determine whether the voltage elements operate as single-phase or three-phase elements.

Synchronism Checking (25DV, 25D)

The Synchronism Check Difference Voltage setting (25DV; range: 0 to 270 volts secondary) is the threshold against which the magnitude of the phasor difference between paired bus and line voltages is compared. Previously discussed settings BSPT and LNPT determine whether the comparison is done for all three phases, a single phase, or not at all (synchronism check disabled).

The Instantaneous Synchronism Check element (**25I**) asserts if all the following conditions are true:

- The magnitude of the phasor voltage difference between the paired line and bus voltage is less than the 25DV setting,
- Bus and line voltages are healthy (**59B** and **59L** asserted), and
- The circuit breaker is open.

The Synchronism Check Delay setting (25D; range: 0 to 16383 cycles) provides the time qualification for the Time Delayed Synchronism Check element (**25T**). Element **25T** asserts (= logical 1) after element **25I** has been time qualified for 25D time.

The synchronism checking elements **25I** and **25T** are inoperative (= logical 0) if any of the following settings are made:

- BSPT = 0
- LNPT = 0
- 25DV = 0

Reclose Times (MT1D through MT8D)

Make the following settings to specify reclose times on the Master Timer (range: 0 to 16383 cycles; see Figure 5.1):

MT1D	Master Timer Setpoint 1 Time Delay
.	.
.	.
.	.
MT8D	Master Timer Setpoint 8 Time Delay

Set the setpoint times in any order (e.g., MT2D = 1800 cycles, MT4D = 420 cycles). If a setpoint time is set equal to 0 cycles (e.g., MT3D = 0), the setpoint time is inoperative.

When the Master Timer reaches a setpoint time, reclose conditions for the given setpoint time are checked. Corresponding logic masks (MT1 through MT8) select reclose conditions from the Relay Word bits.

For example, when the Master Timer reaches setpoint time MT2D, the reclose conditions selected by corresponding mask MT2 are checked and if any one selected condition in mask MT2 is true, the CLOSE OUT contact asserts.

Reclose Cycle Timing Range Limit (MTPD)

The Master Timer times in the reclose cycle state. It does not time in the reset or lockout states. The Master Timer Period Delay setting (MTPD) specifies the upper limit of the Master Timer time range in the reclose cycle state (range: 0 to 16383 cycles; see Figure 5.1).

Set MTPD longer than any of the Master Timer Setpoint Time Delays (MT1D through MT8D). If a setpoint time is set longer than time MTPD (e.g., setpoint time MT4D = 3900 cycles and MTPD = 3600 cycles), the setpoint time is inoperative.

After the circuit breaker successfully recloses, the Master Timer times to time MTPD and

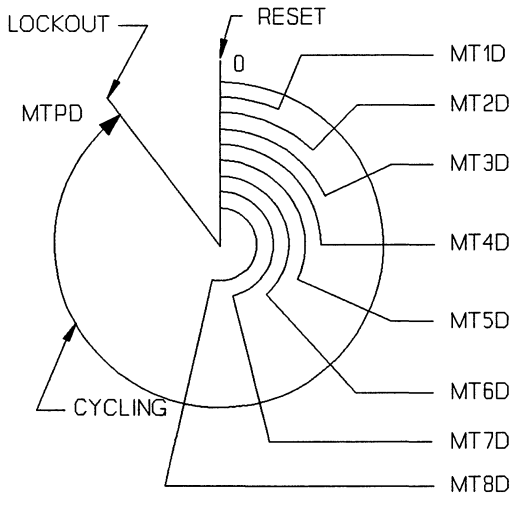


Figure 5.1: SEL-279 Relay Master Timer Setpoint Times

stops. Then a reset timer starts to time (Reset Condition 1 Delay, RS1D). If the circuit breaker remains closed, reset time RS1D expires and the relay goes to the reset state (the Master Timer is then at time 0).

If the circuit breaker does not successfully reclose for any attempt, Master Timer Run conditions (selected with the Master Timer Run mask, MTR) cause the Master Timer to time to time MTPD after all automatic reclose attempts are exhausted. Since no reset conditions are present, the relay then immediately goes to the lockout state (the Master Timer remains at time MTPD).

If the Master Timer Period Delay is set equal to 0 cycles (MTPD = 0), the relay remains in the lockout state and no high speed or time delayed reclosing is possible. The relay is effectively inoperative.

Reset Timing (RS1D, RS2D, RS3D)

Three reset condition schemes/times are available to take the relay to the reset state (range: 0 to 16383 cycles):

RS1D After the circuit breaker successfully recloses, the Master Timer times to time MTPD and stops (see Figure 5.1). Then the Reset Condition 1 Delay setting, RS1D, starts timing (it is independent of the Master Timer). If the circuit breaker remains closed, time RS1D expires and the relay goes to the reset state (the Master Timer is then set at time = 0).

If the relay is in the lockout state (Master Timer is at time MTPD) and the circuit breaker is then successfully closed, the Master timer remains at time MTPD and the Reset Condition 1 Delay setting, RS1D, starts timing. If the circuit breaker remains closed, time RS1D expires and the relay goes to the reset state (the Master Timer is then at time 0).

If voltage from one or both sides of the circuit breaker is connected to the relay, the Reset Condition 1 scheme uses these voltages as part of the reset qualification conditions, along with the closed breaker (looking for "hot" voltage; see preceding write-up on settings BSPT and LNPT).

Disable Reset Condition 1 scheme by setting RS1D = 0.

RS2D If all the following are true:

- The relay is not in the reset state
- Hot line/hot bus/open breaker
- The HL/HB input is deasserted
- The Master Timer is enabled
- The Master Timer is not timing (stalled)

then the relay eventually goes to the lockout state after the Master Timer Limit Delay (MTLD) expires or the relay remains in the reclose cycle state indefinitely if setting MTLD = 0.

The Reset Condition 2 Delay setting (RS2D) takes the relay to the reset state instead. If all the previously listed conditions are true, the RS2D timer begins to time (it is independent of the Master Timer). If time RS2D expires, the relay goes to the reset state (the Master Timer is then at time 0).

One application is for a normally open circuit breaker (see Figure 5.2). Line 1 is the preferred source for the bus - line 2 is an alternate source via normally open (N.O.) circuit breaker 2. If a fault occurs on the bus and circuit breaker 1 then trips, each SEL-279 Relay sees the conditions:

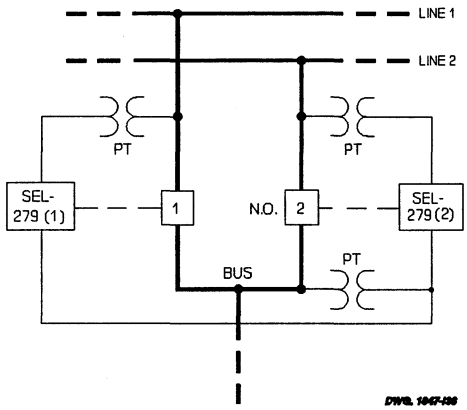


Figure 5.2: Breaker 2 Is Normally Open (N.O.)

- hot line/dead bus/open breaker

and each relay is set to start timing toward a time delayed reclosure to restore the bus. Line 1 is the preferred source, so breaker 1 recloses first. If the reclosure is successful, the SEL-279(2) relay now sees the conditions:

- hot line/hot bus/open breaker

which are its normal conditions. Input HL/HB is deasserted on the SEL-279(2) Relay because it never is to reclose for hot line/hot bus conditions - breaker 2 is to remain normally open for these conditions. The Reset Condition 2 scheme is the only way the SEL-279(2) Relay can be brought from the reclose cycle state back to the reset state for its normal hot line/hot bus/open breaker conditions.

If the Master Timer Limit Delay setting (MTLD) is used, set MTLD > RS2D.

Disable Reset Condition 2 by setting by setting RS2D = 0.

RS3D Reset Condition 3 Setpoint Time Delay setting, RS3D, is a setpoint time on the Master Timer much like the Master Timer Setpoint Time Delay settings (compare Figure 5.3 to Figure 5.1). If the Master Timer times to setpoint time RS3D and the circuit breaker is closed, the relay goes immediately to the reset state (the Master Timer is then at time 0).

If voltage from one or both sides of the circuit breaker is connected to the relay the Reset Condition 3 scheme uses these voltages as part of the reset qualification conditions, along with the closed breaker (looking for "hot" voltage; see preceding write-up on settings BSPT and LNPT).

One application is to set setpoint time RS3D to take the relay to the reset state relatively soon after a successful high speed reclosure. Otherwise the relay has to time all the way to time MTPD and then time to reset on Reset Condition 1 Delay setting, RS1D (see preceding write-up on setting RS1D).

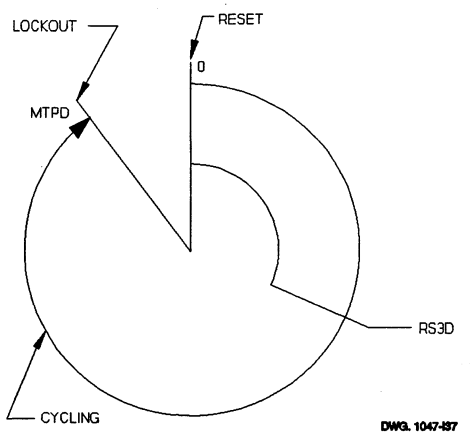


Figure 5.3: SEL-279 Relay Reset Condition 3 Setpoint Time

Disable Reset Condition 3 scheme by setting RS3D = 0.

Close Failure Timing (CFD)

The Close Failure Delay setting (CFD; range: 0 to 16383) limits the amount of time the CLOSE OUT contact asserts. When the CLOSE OUT contact asserts for a reclose, the CFD timer starts timing. If the circuit breaker status input (52) indicates that the circuit breaker has closed, the CLOSE OUT contact deasserts and the CFD timer resets. If the 52 input doesn't indicate that the circuit breaker closed, the CFD timer continues to time and when it times out the CLOSE OUT contact deasserts and the CFD timer resets (see Figure 2.4).

If setting CFD = 0 and the CLOSE OUT contact asserts for a reclose, it remains asserted indefinitely until the 52 input indicates that the circuit breaker closed.

Trip Logic (DLDBD, TDURD, TFD)

The Dead Line/Dead Bus/Trip Delay setting (DLDBD; range: 0 to 16383 cycles) time-qualifies a dead line/dead bus/closed circuit breaker condition before the **TRIP** bit asserts in the Relay Word. The DL/DB input has to be asserted to enable this dead line/dead bus/closed breaker trip scheme. Assign the **TRIP** bit to a programmable output contact (e.g., OUT1 = **TRIP**). OUT1 contact then trips the circuit breaker on a dead power system so that the system can be restored piecewise when voltage returns. If voltage from only one side of the circuit breaker is connected to the relay, this scheme can still operate (only this voltage is monitored then; see preceding write-up on settings BSPT and LNPT). Setting DLDBD times independently of the Master Timer.

Disable the Dead Line/Dead Bus/Trip scheme by setting DLDBD = 0.

The Trip Duration setting (TDURD; range: 0 to 63 cycles) is determined by the minimum length of time you wish to assert the **TRIP** bit in the Relay Word. The **TRIP** bit asserts for the greater of the TDURD setting or the duration of the trip condition (see Figure 2.5).

Set the Trip Failure Delay setting (TFD; range: 0 to 63 cycles) a margin longer than the maximum expected breaker trip time. When the **TRIP** bit asserts, the TFD timer starts timing. If the **TRIP** bit is asserted longer than TFD time, the **TF** bit asserts in the Relay Word (see Figure 2.5).

Set TFD > TDURD to have a meaningful **TF** indication.

High Speed Reclose Timing (HSRD)

The High Speed Reclose Delay setting (HSRD; range: 0 to 63 cycles) provides the intended time delay between high speed reclose initiation (via the High Speed Reclose Initiate input, HSRI) and the assertion of the CLOSE OUT contact. Setting HSRD times independently of the Master Timer.

Disable the High Speed Reclosing scheme by setting HSRD = 0.

Outage Condition Restoration Scheme (MTED, MTCD)

The Outage Condition Restoration scheme delays the enabling of the Master Timer after a long station outage. This permits you to decide which line or bus section to restore first for gradual system restoration after a station outage.

The Master Timer Extended Outage Delay setting (MTED; range: 0 to 2880 minutes) time-qualifies the station outage as "long." The MTED timer only starts timing after the controlled circuit breaker has been tripped by the Dead Line/Dead Bus/Trip scheme while in the reset state. If the outage persists, the MTED timer times out and the Master Timer is disabled.

Once the Master Timer has been disabled by timer MTED timeout, it waits for voltage restoration to at least one side of the open circuit breaker before timing toward enabling the Master Timer again.

The Master Timer Coordination Delay setting (MTCD; range: 0 to 2880 minutes) delays the enabling of the Master Timer when voltage is restored to at least one side of the open circuit breaker after the station outage. The MTCD timer starts timing when voltage is restored to at least one side of the open breaker. If the voltage remains, the MTCD timer times out and the Master Timer is enabled again. The SEL-279 Relay now times toward a time delayed reclose of the controlled breaker.

In a station with several breakers controlled by SEL-279 Relays, when a bus section is restored after a station outage, the reclosing of the connected line and bus-tie breakers can be staggered by implementing the Outage Condition Restoration scheme. This provides gradual system restoration, rather than all the reclosing relays starting to time at once when the bus section is restored. Different MTCD settings amongst all the SEL-279 Relays provide the "staggered," gradual system restoration.

If voltage from only one side of the circuit breaker is connected to the relay, this scheme can still operate (only this voltage is monitored then; see preceding write-up on settings BSPT and LNPT).

Disable the Outage Condition Restoration scheme by setting MTED = 0. The settings are in minutes, not cycles.

Limiting Overall Reclose Cycle Time (MTLD)

The Master Timer Limit Delay setting (MTLD; range: 0 to 2880 minutes) limits the amount of time the Master Timer is in the reclose cycle state (Relay Word bit **CYCL**). The reclose cycle state is the state in which the Master Timer times and reclose attempts are made. If the MTLD timer times out, the relay goes to the lockout state and the MTLD timer resets.

The Master Timer Limit Delay should be set greater than the Master Timer Period Delay (MTLD > MTPD). If the MTLP timer times out but reset conditions are present, the relay delays going to lockout state and continues timing to reset.

Disable the Master Timer Limit scheme by setting MTLD = 0. Then the Master Timer can stay in the reclose cycle state indefinitely. The setting is in minutes, not cycles.

Circuit Breaker Status Input Type (52)

The Circuit Breaker Status Input setting, 52, specifies if the circuit breaker auxiliary contact connected to the 52 input of the relay is a 52a or 52b contact (52 = A or 52 = B).

Option to go to Lockout for a Trip Following a High Speed Reclosure (HSRL)

High speed reclosing can be stressful on circuit breakers. If a circuit breaker trips after a high speed reclose attempt, it may be desirable to go directly to the lockout state so as not to further stress the circuit breaker with additional time delayed reclosures and trips.

The High Speed Reclose Lockout setting, HSRL, takes the relay directly to the lockout state when a circuit breaker trips after a high speed reclose attempt if HSRL = Y. Setting HSRL = N allows reclosing to proceed with time delayed reclosures after an unsuccessful high speed reclose attempt.

Choose Between Event Report Types (ERT)

Setting ERT determines the format of the information generated by the relay and accessed by the EVENT and HISTORY commands. The setting choices are:

ERT = 1 or 2	1 = standard 60-cycle event report
	2 = sequence-of-events event report

When ERT = 2, the ER logic mask is not functional and is not accessible at all - does not print out either.

See Section 3: COMMUNICATIONS (EVENT and HISTORY command discussions) and Section 4: EVENT REPORTING for more information.

Serial Communications Port Timeouts (TIME1, TIME2)

Settings TIME1 and TIME2 control timeout for serial communications ports Port 1 and Port 2, respectively. The setting range is 0 to 30 minutes in one minute increments.

A setting of zero (0) keeps the port continually active (no timeout). Such a setting is needed if the port is to transmit automatic messages to some externally connected device (e.g., printer, SCADA, etc.).

Designate Serial Communications Ports for Automatic Messages (AUTO)

The AUTO setting selects Port 1, Port 2, or both serial ports for automatically transmitted messages. If a port is connected to an SEL-PRTU, the AUTO setting must direct automatic messages to that port. The following list shows the effect of each possible setting:

AUTO Setting	Automatic Message Destination Port
1	1
2	2
3	1 and 2

Event summaries, self-test warnings, and failure reports are automatically transmitted from port(s) designated automatic regardless of access level if the designated port is not timed out.

Reclose Timing Conditions (MTR)

The Master Timer Run mask, MTR, selects conditions from the Relay Word bits to cause the Master Timer to time toward the reclose setpoint times, MT1D through MT8D (see Figure 5.1). These run conditions are usually selected from the second and third rows of the Relay Word (see Tables 2.1 and 2.2), in which the Relay Word bits are products of:

- Various line and bus voltage conditions,
- Open circuit breaker status,
- And enabling input states.

The selected Master Timer Run conditions are usually a compilation of all the conditions chosen as individual Master Timer Setpoint Time Reclose Conditions. This is so the Master Timer can time to enabled reclose setpoint times (see the following discussion).

Reclose Conditions (MT1 through MT8)

The Master Timer Setpoint Time Reclose Conditions masks (MT1 through MT8) select reclose conditions to be checked only when the Master Timer reaches the corresponding setpoint time (MT1D through MT8D; see Figure 5.1).

The reclose conditions are usually selected from the second and third rows of the Relay Word (see Tables 2.1 and 2.2), in which the Relay Word bits are products of:

- Various line and bus voltage conditions,
- Open circuit breaker status,
- And enabling input states.

For example, at setpoint time MT2D, the reclose conditions selected by corresponding mask MT2 are checked and if any one selected condition in mask MT2 is true, the CLOSE OUT contact asserts. Usually only one Relay Word bit is chosen for each Master Timer Setpoint Time Reclose Conditions mask (only specific conditions permit reclosing to take place for a given setpoint time).

High Speed Reclose Supervision Conditions (HSR)

The High Speed Reclose Supervision Conditions mask, HSR, selects conditions from the Relay Word to supervise high speed reclosing. If no conditions are selected by the HSR mask, high speed reclosing is unsupervised.

The high speed reclose supervision conditions are usually selected from the first and fourth rows of the Relay Word (see Tables 2.1 and 2.2), in which the Relay Word bit conditions contain:

- Various line and bus voltage conditions
- Synchronism check status

The circuit breaker status is checked as part of the CLOSE OUT contact logic. The circuit breaker must be open for a reclose to occur.

When the High Speed Reclose Delay, HSRD, expires, the HSR mask is checked and if one of the selected supervising conditions is true, the CLOSE OUT contact asserts.

When the High Speed Reclose Delay, HSRD, expires and no supervising conditions are selected in the HSR mask, the CLOSE OUT contact asserts without any check made of the HSR mask.

Programmable Output Contacts (OUT1, OUT2, OUT3)

The Programmable Output Contact masks (OUT1, OUT2, and OUT3) select the conditions to assert the output contacts OUT1, OUT2, and OUT3 (the masks and output contacts are labeled the same). The conditions are usually selected from the fourth and fifth rows of the

Relay Word (see Tables 2.1 and 2.2). For example, by selecting conditions from these rows, the output contacts can operate as:

- A trip output contact for dead line/dead bus/closed breaker tripping
- A lockout alarm
- A memory output contact to signal the adjacent reclosing relay of reclosing action
- An output contact useful in testing

Generating Event Reports (ER)

The Event Report Generation mask (ER) selects conditions to generate sixty (60) cycle event reports if setting ERT = 1. Each selected Relay Word bit is monitored individually. If a selected condition asserts (goes from logical 0 to 1) and an event report is not presently being generated, an event report is generated. Relay Word bits are listed in Tables 2.1 and 2.2.

The **CLOS** Relay Word bit would likely be selected in the ER mask. Then whenever the CLOSE OUT contact asserts, an event report is generated.

SETTINGS EXAMPLE

This settings example is for a looped 115 kV transmission substation with two circuit breakers (see Figure 5.4).

Setting Example Operation Requirements

Fault on 115 kV transmission line 1

Circuit breaker 1 trips for a fault on line 1. Five seconds (300 cycles) later circuit breaker 1 recloses to test line 1.

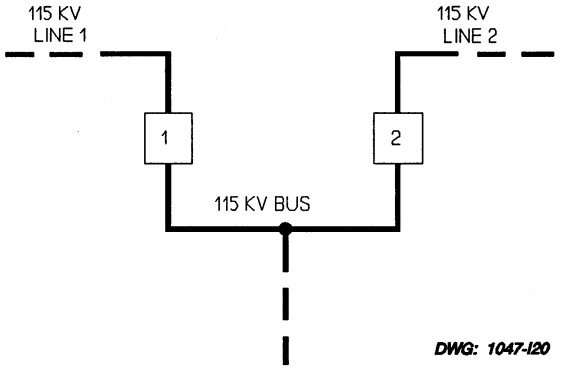


Figure 5.4: 115 kV Looped Substation

Fault on 115 kV transmission line 2

Circuit breaker 2 trips for a fault on line 2. Circuit breaker 2 does not reclose to test line 2. Line 2 is tested from the remote end. If line 2 is successfully re-energized from the remote end, then circuit breaker 2 recloses by synchronism check.

Fault on 115 kV bus

Circuit breakers 1 and 2 trip for a fault on the 115 kV bus. Ten seconds (600 cycles) later circuit breaker 1 recloses to attempt to restore power to the bus. If the attempt is successful, circuit breaker 2 recloses by synchronism check. If the attempt by circuit breaker 1 is unsuccessful, circuit breaker 2 does not then attempt to restore power to the bus.

After circuit breakers 1 and 2 trip for the bus fault, if circuit breaker 1 is not able to reclose first to attempt to restore power to the bus, then circuit breaker 2 recloses to attempt to restore power to the bus. If the attempt is successful, circuit breaker 1 recloses by synchronism check. If the attempt by circuit breaker 2 is unsuccessful, circuit breaker 1 does not then attempt to restore power to the bus.

In general, if one automatic reclose attempt has been made to restore power to the bus, no other automatic reclose attempt is made.

Area Outage

If a persistent outage occurs to the substation and the voltage on both sides of closed circuit breaker 1 remains dead for five (5) seconds, circuit breaker 1 trips.

If a persistent outage occurs to the substation and the voltage on both sides of closed circuit breaker 2 remains dead for five (5) seconds, circuit breaker 2 trips.

This tripping process sectionalizes the power system so that it can be piecewise restored when voltage returns up to the open breakers.

Operator Control of Reclosing Schemes

When system conditions change, the operator has to be able to change the reclosing schemes by contact or switch operation. For example in the preceding **Fault on 115 kV transmission line 2** write-up, circuit breaker 2 is not to reclose to test line 2. If system conditions change, there may be instances where circuit breaker 2 should test line 2. The operator has to be able to enable/disable the scheme to test the line as well as have control over the other reclosing schemes.

Settings Example SEL-279 Relay Settings

SEL-279 Relay settings and explanation are given to meet the above requirements. A separate SEL-279 Relay controls each circuit breaker (see Figure 5.5):

SEL-279(1) Relay controls circuit breaker 1

SEL-279(2) Relay controls circuit breaker 2

Three-phase 115 kV bus potential is connected to each SEL-279 Relay. Single-phase 115 kV line potential is connected from each 115 kV transmission line to the respective SEL-279 Relay.

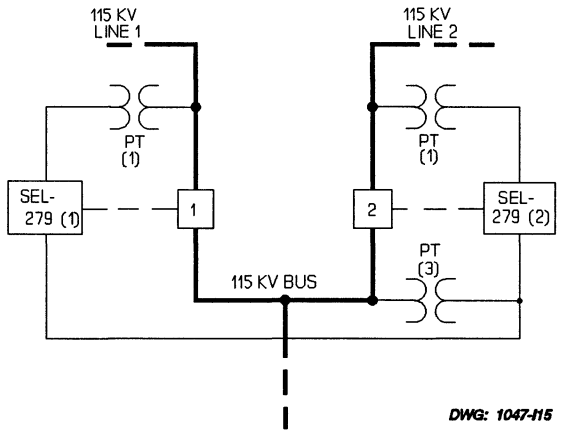


Figure 5.5: Voltage Connections to SEL-279 Relays

The relay settings will be identified for each relay [SEL-279(1) or SEL-279(2)].

■ **Identifier (ID)**

The SEL-279 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. Typical identifiers include an abbreviation of the line terminal and substation name.

ID = BREAKER 1, 115 KV LINE 1, LOOP SUB [SEL-279(1)]

ID = BREAKER 2, 115 KV LINE 2, LOOP SUB [SEL-279(2)]

- Setting Limit Check

The identifier string is limited to 39 characters. Characters entered after the 39th character are ignored.

- Other Settings Affected

None.

■ **Bus Voltage Connection (BSPT)**

Connect three-phase, wye-connected, 115 kV bus potential (secondary) to bus voltage inputs V1, V3, and V5 on both SEL-279 Relays. Set the Bus Voltage Connection setting the same for both relays:

BSPT = 3 [SEL-279(1)]

BSPT = 3 [SEL-279(2)]

- Setting Limit Check

The setting is limited to values 0, 1, or 3:

0 - no voltage connected to bus voltage inputs V1, V3, or V5
1 - connect single-phase voltage to bus voltage input V1
3 - three-phase voltage connected to bus voltage inputs V1, V3, and V5

- Other Settings Affected

27B, 59B, 25DV

■ **Line Voltage Connection (LNPT)**

Connect single-phase, line-to-neutral, 115 kV line potential (secondary) from 115 kV transmission lines 1 and 2 to line voltage input V2 on the SEL-279(1) and SEL-279(2) Relays, respectively. Set the Line Voltage Connection setting the same for both relays:

LNPT = 1 [SEL-279(1)]

LNPT = 1 [SEL-279(2)]

This setting results in single-phase synchronism check between voltages V1 and V2.

- Setting Limit Check

The setting is limited to values 0, 1, or 3:

0 - no voltage connected to line voltage inputs V2, V4, or V6
1 - connect single-phase voltage to line voltage input V2
3 - three-phase voltage connected to line voltage inputs V2, V4, and V6

- Other Settings Affected

27L, 59L, 25DV

■ Dead Bus Voltage Threshold (27B)

The previously discussed setting, BSPT = 3, is set the same for both SEL-279 Relays. Thus, the Dead Bus element (**27B** Relay Word bit) is a three-phase element.

The bus potential transformer secondary voltages connected to bus voltage inputs (V1, V3, and V5) have to each be below the Dead Bus Voltage Threshold setting (27B) in order for **27B** to assert, indicating a dead bus.

27B = 7 [SEL-279(1)]

27B = 7 [SEL-279(2)]

- Setting Limit Check

0 to 270 V (secondary), 1 V increments

- Other Settings Affected

None.

■ Dead Line Voltage Threshold (27L)

The previously discussed setting, LNPT = 1, is set the same for both SEL-279 Relays. Thus, the Dead Line element (**27L** Relay Word bit) is a single-phase element.

The line potential transformer secondary voltages connected to the respective relay line voltage V2 inputs have to be below the Dead Line Voltage Threshold setting (27L) in order for **27L** to assert, indicating a dead line.

27L = 7 [SEL-279(1)]

27L = 7 [SEL-279(2)]

- Setting Limit Check

0 to 270 V (secondary), 1 V increments

-Other Settings Affected

None.

■ Hot Bus Voltage Threshold (59B)

The previously discussed setting, BSPT = 3, is set the same for both SEL-279 Relays. Thus, the Hot Bus element (**59B** Relay Word bit) is a three-phase element.

The bus potential transformer secondary voltages connected to bus voltage inputs (V1, V3, and V5) have to each be above the Hot Bus Voltage Threshold setting (59B) in order for **59B** to assert, indicating a hot bus.

59B = 56 [SEL-279(1)]

59B = 56 [SEL-279(2)]

- Setting Limit Check

0 to 270 V (secondary), 1 V increments

- Other Settings Affected

None.

■ Hot Line Voltage Threshold (59L)

The previously discussed setting, LNPT = 1, is set the same for both SEL-279 Relays. Thus, the Hot Line element (**59L** Relay Word bit) is a single-phase element.

The line potential transformer secondary voltages connected to the respective relay line voltage V2 inputs have to be above the Hot Line Voltage Threshold setting (59L) in order for **59L** to assert, indicating a hot line.

59L = 56 [SEL-279(1)]

59L = 56 [SEL-279(2)]

- Setting Limit Check

  0 to 270 V (secondary), 1 V increments

- Other Settings Affected

  None.

■ Synchronism Check Difference Voltage (25DV)

The Line Voltage Connection setting LNPT = 1 (single-phase line voltage connection to V2) dictates single-phase synchronism check, involving just bus voltage V1 and line voltage V2. The Bus Voltage Connection setting is BSPT = 3 (three-phase bus voltage connected), but LNPT =1 is the limiting factor in determining synchronism check operation.

In Figure 5.6, ϕ is the maximum phase angle across the circuit breaker allowed for synchronism check reclosing. No phase angle setting is made in the SEL-279 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 5.6. Knowing the desired maximum phase angle ϕ, the 25DV setting is derived as follows:

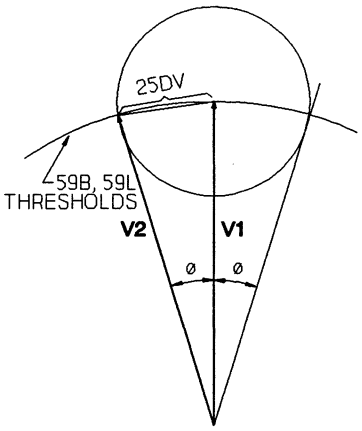
$$\sin(\phi/2) = (25DV/2)/(59B)$$

Solving for setting 25DV:

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

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

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



DWG: 1047-I30

Figure 5.6: SEL-279 Relay Synchronism Check

- Setting Limit Check

  0 to 270 V (secondary), 1 V increments

- Other Settings Affected

  None.

■ Synchronism Check Delay (25D)

The Synchronism Check Delay setting (25D) provides the time qualification for the Time Delayed Synchronism Check element (Relay Word bit **25T**). Setting 25D is related to the maximum slip frequency as follows (setting 25D set in cycles):

$$\text{max. slip freq.} = [2\phi/(360 \text{ degrees/slip cycle})][(1/25D)(60 \text{ cycles/second})]$$

$$= \{\phi/[3(25D)]\}[(\text{slip cycle}\cdot\text{cycles})/(\text{degrees}\cdot\text{second})]$$

The maximum slip frequency is the maximum frequency difference between voltages V1 and V2 that can be tolerated for synchronism check reclosing (see Figure 5.6). Solving for setting 25D:

$$25D = \{\phi/[3(\text{max. slip freq.})]\}[(\text{slip cycle}\cdot\text{cycles})/(\text{degrees}\cdot\text{second})]$$

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

$$25D = \{17°/[3(0.0472 \text{ slip cycles/second})]\}[(\text{slip cycle}\cdot\text{cycles})/(\text{degrees}\cdot\text{second})]$$

$$= 120 \text{ cycles}$$

■ Master Timer Setpoint Time Delays (MT1D through MT8D)

Make the following Master Timer Setpoint Time Delay settings, per previously discussed operation requirements (see Figures 5.7 and 5.8):

MT1D = 300	test line 1 after trip for line fault	[SEL-279(1)]
MT2D = 600	restore bus power after trip for bus fault	
MT3D = 1800	synchronism check reclose	
MT1D = 300	test line 2 after trip for line fault	[SEL-279(2)]
MT2D = 1200	restore bus power after trip for bus fault	
MT3D = 1800	synchronism check reclose	

Set the other Master Timer Setpoint Time Delay settings (MT4D through MT8D) in both relays equal to zero (= 0; the setpoint times are inoperative).

Note: Setpoint time MTID for the SEL-279(2) Relay is assigned for testing line 2, even though circuit breaker 2 is not to test line 2, per given operation requirements. The enable input on the SEL-279(2) Relay that corresponds to this function is disabled, thus effectively making time MT1D inoperative. If it is ever decided in the future that circuit breaker 2 should test line 2, then the enable input can be asserted. More details follow concerning this.

- Setting Limit Check

  0 to 16383 cycles, 1-cycle steps

- Other Settings Affected

  MTPD, mask settings MT1 thru MT8

■ Master Timer Period Delay (MTPD)

For both relays, the last set Master Timer Setpoint Time Delay is the same, MT3D = 1800 cycles (see Figures 5.7 and 5.8). Set MTPD greater than the last set Master Timer Setpoint Time Delay:

```
MTPD = 3000                                          [SEL-279(1)]

MTPD = 3000                                          [SEL-279(2)]
```

- Setting Limit Check

  0 to 16383 cycles, 1-cycle steps

- Other Settings Affected

  MT1D thru MT8D, MTLD

■ Reset Condition Delays (RS1D, RS2D, RS3D)

Only Reset Condition 1 scheme is used in this example. After the circuit breaker successfully recloses, the Master Timer times to time MTPD and stops. Then Reset Condition 1 Time Delay timer (setting RS1D) starts to time. If the circuit breaker remains closed, time RS1D expires and the relay goes to the reset state (see Figures 5.7 and 5.8).

```
RS1D = 1200                                          [SEL-279(1)]
RS2D = 0      (Reset Condition 2 scheme is inoperative)
RS3D = 0      (Reset Condition 3 scheme is inoperative)

RS1D = 1200                                          [SEL-279(2)]
RS2D = 0      (Reset Condition 2 scheme is inoperative)
RS3D = 0      (Reset Condition 3 scheme is inoperative)
```

- Setting Limit Check

  0 to 16383 cycles, 1-cycle steps

- Other Settings Affected

  None.

■ **Close Failure Delay (CFD)**

This feature isn't used in this example.

CFD = 0 (inoperative) [SEL-279(1)]

CFD = 0 (inoperative) [SEL-279(2)]

With CFD = 0, when the CLOSE OUT contact asserts for a reclose it remains asserted indefinitely until the 52 input indicates that the circuit breaker closed (see Figure 2.4).

- Setting Limit Check

  0 to 16383 cycles, 1-cycle steps

- Other Settings Affected

  None.

■ **Dead Line/Dead Bus/Trip Delay (DLDBD)**

Set this qualification time the same for both relays:

DLDBD = 600 [SEL-279(1)]

DLDBD = 600 [SEL-279(2)]

Setting DLDBD times independently of the Master Timer.

- Setting Limit Check

  0 to 16383 cycles, 1-cycle steps

- Other Settings Affected

  None.

■ **Trip Duration (TDURD)**

Set this time the same for both relays (see Figure 2.5).

TDURD = 10 [SEL-279(1)]

TDURD = 10 [SEL-279(2)]

- Setting Limit Check

  0 to 63 cycles, 1-cycle steps

- Other Settings Affected

  TFD

■ Trip Failure Delay (TFD)

This feature isn't used in this example.

TFD = 0 [SEL-279(1)]

TFD = 0 [SEL-279(2)]

With TFD = 0, the **TF** Relay Word bit asserts when the **TRIP** Relay Word bits asserts. The **TF** bit is not assigned to any output contact function.

If the **TF** bit is being used, set TFD > TDURD to have a meaningful **TF**, trip failure condition (see Figure 2.5).

- Setting Limit Check

  0 to 63 cycles, 1-cycle steps

- Other Settings Affected

  TDURD

■ High Speed Reclose Delay (HSRD)

High speed reclosing is not used in this example.

HSRD = 0 (inoperative) [SEL-279(1)]

HSRD = 0 (inoperative) [SEL-279(2)]

This setting shuts down high speed reclosing.

- Setting Limit Check

  0 to 63 cycles, 1-cycle steps

- Other Settings Affected

  None.

■ **Master Timer Extended Outage Delay (MTED)**

The Outage Condition Restoration scheme is not used in this example.

MTED = 0 (inoperative) [SEL-279(1)]

MTED = 0 (inoperative) [SEL-279(2)]

This setting shuts down the Outage Condition Restoration scheme.

- Setting Limit Check

0 to 2880 minutes, 1-minute steps (set in minutes, not cycles)

- Other Settings Affected

MTCD

■ **Master Timer Coordination Delay (MTCD)**

The Outage Condition Restoration scheme is not used in this example. The setting MTED = 0 already shuts down the Outage Condition Restoration scheme. Thus the setting of MTCD is inconsequential, but it is set to zero anyway.

MTCD = 0 [SEL-279(1)]

MTCD = 0 [SEL-279(2)]

- Setting Limit Check

0 to 2880 minutes, 1-minute steps (set in minutes, not cycles)

- Other Settings Affected

None.

■ **Master Timer Limit Delay (MTLD)**

The Master Timer Limit Delay setting limits the amount of time the Master Timer is in the reclose cycle state. This feature is not used in this example:

MTLD = 0 (inoperative) [SEL-279(1)]

MTLD = 0 (inoperative) [SEL-279(2)]

This setting allows the Master Timer to stay in the reclose cycle state indefinitely.

- Setting Limit Check

  0 to 2880 minutes, 1-minute steps (set in minutes, not cycles)

- Other Settings Affected

  MTPD

■ Circuit Breaker Status Input (52)

A 52b circuit breaker auxiliary contact is connected to input 52 on both relays:

  52 = B

- Setting Limit Check

  A (for 52a), B (for 52b)

- Other Settings Affected

  None.

■ High Speed Reclose Lockout (HSRL)

High Speed Reclosing is not used in this example. The setting HSRD = 0 already shuts down high speed reclosing. Thus the setting of HSRL is inconsequential, but it is set to N anyway.

  HSRL = N [SEL-279(1)]

  HSRL = N [SEL-279(2)]

- Setting Limit Check

  Y (go to lockout after unsuccessful HSR), N (don't go to lockout after unsuccessful HSR)

- Other Settings Affected

  None.

■ **Event Report Type (ERT)**

The sequence-of-events type event report is desired:

ERT = 2 [SEL-279(1)]

ERT = 2 [SEL-279(2)]

- Setting Limit Check

1 = standard 60-cycle event report, 2 = sequence-of-events event report

- Other Settings Affected

mask setting ER

■ **Timeout (TIME1, TIME2)**

Port 2 transmits automatic messages, so TIME2 = 0.

TIME1 = 15 [SEL-279(1)]

TIME1 = 15 [SEL-279(2)]

TIME2 = 0 [SEL-279(1)]

TIME2 = 0 [SEL-279(2)]

- Setting Limit Check

0 to 30 minutes, 1-minute steps (= 0, no timeout)

- Other Settings Affected

AUTO

■ **Autoport (AUTO)**

Port 2 transmits automatic messages:

AUTO = 2 [SEL-279(1)]

AUTO = 2 [SEL-279(2)]

- Setting Limit Check

AUTO Setting	Automatic Message Destination Port
1	1
2	2
3	1 and 2

- Other Settings Affected

None.

■ **Master Timer Run logic mask (MTR)**

The following Relay Word bits are selected by the MTR logic mask in both relays:

HLD1	Hot Line - Dead Bus - Breaker Open - HL/DB 1 input asserted	[SEL-279(1)]
DLH1	Dead Line - Hot Bus - Breaker Open - DL/HB 1 input asserted	
HLHS	Hot Line - Hot Bus - Breaker Open - Synchronism - HL/HB input asserted	

HLD1	Hot Line - Dead Bus - Breaker Open - HL/DB 1 input asserted	[SEL-279(2)]
DLH1	Dead Line - Hot Bus - Breaker Open - DL/HB 1 input asserted	
HLHS	Hot Line - Hot Bus - Breaker Open - Synchronism - HL/HB input asserted	

Note: A relay input is part of the logic of each of the above Relay Word bits (e.g., input HL/DB 1 for Relay Word bit **HLD1**). An operator can assert or deassert an input, via a wired-up switch or contact, to enable or disable reclosing for the corresponding reclosing condition. This capability fulfills the requirement **Operator Control of Reclosing Schemes** in the preceding **Setting Example Operation Requirements** portion of this section.

If the relay is in the reset state, the Master Timer will start timing if both the following conditions are met:

1. Any one of the conditions selected by the MTR logic mask comes true, and
2. The Master Timer is enabled.

The Master Timer immediately enters the reclose cycle state and continues to time toward the reclose setpoint times as long as the above numbered conditions remain true (see Figures 5.7 and 5.8). If the conditions do not remain true, the Master Timer stops timing and "stalls" in position until the conditions come true again.

The Relay Word bits are selected by entering a numeral 1.

MTR logic mask [same for SEL-279(1) and SEL-279(2)]								Event Report Hexadecimal Code
27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
0	0	0	0	0	0	0	0	00
HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
1	0	1	0	1	0	0	0	A8
DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
0	0	0	0	0	0	0	0	00
CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
0	0	0	0	0	0	0	0	00
HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	
0	0	0	0	0	0	0	0	00

Note that for each relay the above selected Relay Word bits are a compilation of all the Relay Word bits selected in the following Master Timer Setpoint Reclose Condition masks (MT1, MT2, and MT3).

See Table 3.2 in Section 3: COMMUNICATIONS to convert event report hexadecimal code to binary.

■ Master Timer Setpoint Time Reclose Conditions logic masks (MT1 through MT8)

The following Relay Word bits are selected by the indicated reclose conditions logic masks for both relays (see Figures 5.7 and 5.8):

Reclose cond. logic mask	Selected Relay Word bit	Corresponding setpoint times SEL-279(1)	SEL-279(2)
MT1	**DLH1**	MT1D=300	MT1D=300
MT2	**HLD1**	MT2D=600	MT2D=1200
MT3	**HLHS**	MT3D=1800	MT3D=1800

The Master Timer times in the reclose cycle state when at least one condition selected by the Master Timer Run mask (MTR) is true and the Master Timer is enabled. When the Master Timer reaches a setpoint time, the reclose conditions selected by the corresponding reclose conditions logic mask are checked. If any one selected condition is true, the CLOSE OUT contact is asserted.

The Relay Word bits are selected by entering a numeral 1.

MT1 logic mask [same for SEL-279(1) and SEL-279(2)]

27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	Event Report Hexadecimal Code
0	0	0	0	0	0	0	0	00
HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
0	0	1	0	0	0	0	0	20
DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
0	0	0	0	0	0	0	0	00
CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
0	0	0	0	0	0	0	0	00
HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	
0	0	0	0	0	0	0	0	00

MT2 logic mask [same for SEL-279(1) and SEL-279(2)]

27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	Event Report Hexadecimal Code
0	0	0	0	0	0	0	0	00
HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
1	0	0	0	0	0	0	0	80
DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
0	0	0	0	0	0	0	0	00
CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
0	0	0	0	0	0	0	0	00
HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	
0	0	0	0	0	0	0	0	00

MT3 logic mask [same for SEL-279(1) and SEL-279(2)]

27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	Event Report Hexadecimal Code
0	0	0	0	0	0	0	0	00
HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
0	0	0	0	1	0	0	0	08
DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
0	0	0	0	0	0	0	0	00
CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
0	0	0	0	0	0	0	0	00
HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	
0	0	0	0	0	0	0	0	00

No Relay Word bits are selected in logic masks MT4 through MT8 in both relays. The corresponding setpoint times (MT4D through MT8D) in both relays are set to zero (=0), thus disabling these setpoint times.

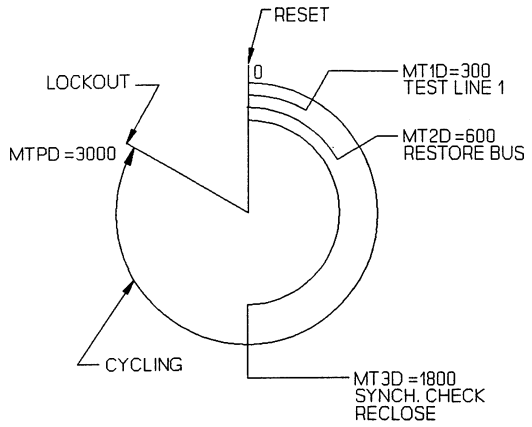


Figure 5.7: SEL-279(1) Relay Master Timer Setpoint Times

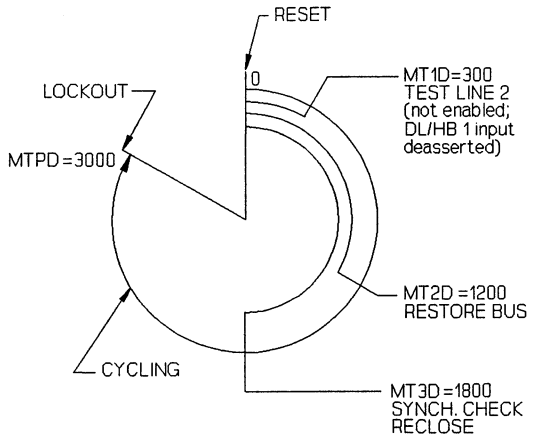


Figure 5.8: SEL-279(2) Relay Master Timer Setpoint Times

■ High Speed Reclose Supervision Conditions logic mask (HSR)

High Speed Reclosing is not used in this example. The setting HSRD = 0 already shuts down high speed reclosing. Thus the setting of the HSR logic mask is inconsequential, but no Relay Word bits are selected in the HSR logic mask anyway.

■ Programmable Output Contact logic masks (OUT1, OUT2, OUT3)

The Relay Word **TRIP** bit is selected by the OUT1 logic mask in both relays to control the operation of the OUT1 contact. The **TRIP** bit asserts if the following conditions are met:

1. the dead line/dead bus/closed breaker condition is time qualified by the Dead/Line/Dead Bus/ Trip Delay setting (DLDBD =300 cycles)
2. the Dead Line/Dead Bus/Trip scheme enable input is asserted (DL/DB)

OUT1 contact functions as the dead line/dead bus/trip. Relay Word bits are selected by entering a numeral 1.

OUT1 logic mask [same for SEL-279(1) and SEL-279(2)]

27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	Event Report Hexadecimal Code
0	0	0	0	0	0	0	0	00
HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
0	0	0	0	0	0	0	0	00
DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
0	0	0	0	0	0	0	0	00
CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
0	1	0	0	0	0	0	0	40
HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	
0	0	0	0	0	0	0	0	00

The Relay Word **HD1M** bit is selected by the OUT2 logic mask in both relays to control the operation of the OUT2 contact. The **HD1M** bit asserts when the relay attempts a **HLD1** (Hot Line/Dead Bus/Breaker Open) reclose - it does not matter whether the reclose attempt is successful or not. Relay Word bit **HLD1** is set as a reclose condition in mask MT1 for setpoint time MT1D in both relays.

Once asserted, the **HD1M** bit deasserts when the relay is in the reset state again.

OUT2 contact functions as an interlock (see Figure 5.10). Its function is explained in the following RECLOSING ACTION EXAMPLE. Relay Word bits are selected by entering a numeral 1.

OUT2 logic mask [same for SEL-279(1) and SEL-279(2)]

27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	Event Report Hexadecimal Code
0	0	0	0	0	0	0	0	00
HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
0	0	0	0	0	0	0	0	00
DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
0	0	0	0	0	0	0	0	00
CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
0	0	0	0	0	0	0	0	00
HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	
1	0	0	0	0	0	0	0	80

OUT3 contact is not used in either relay. Thus, no Relay Word bits are selected in the OUT3 logic mask for each relay.

■ Event Report Generation logic mask (ER)

Setting ERT = 2, so the ER logic mask is not functional and is not accessible at all - does not printout either.

RECLOSING ACTION EXAMPLE

Transient 115 kV Bus Fault

Using the preceding example settings, SEL-279 Relay response to a transient 115 kV bus fault is detailed (see Figure 5.9). The SEL-279 Relays are applied as per Figure 5.5.

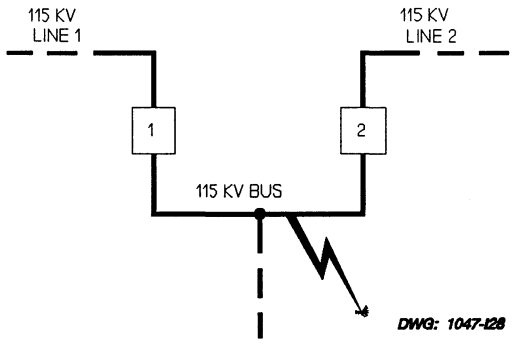


Figure 5.9: Transient 115 kV Bus Fault

DC Interconnections between the SEL-279 Relays

The DC control for the SEL-279 Relays is shown in Figure 5.10. Notice the interconnection of the OUT2 "b" contact of one relay supervising the HL/DB 1 (Hot Line/Dead Bus 1) reclose enable input of the other relay. If an OUT2 relay is asserted, the OUT2 "b" contact opens, de-energizing the supervised HL/DB 1 input. Thus, no hot line/dead bus reclosing can take place with the SEL-279 Relay whose HL/DB 1 input is de-energized. The application for this interconnection is explained in the following example.

Notice also that the DL/HB 1 (Dead Line/Hot Bus 1) reclose enable input of SEL-279(2) Relay is de-energized (switch open). Even though a dead line/hot bus reclose is selected for reclose setpoint time MT1D = 300 (**DLH1** selected in corresponding reclose condition logic mask MT1), it can never occur because input DL/HB 1 is de-energized. 115 kV line 2 has to be tested from the remote end.

Transient 115 kV Bus Fault - Successful Reclosure

Circuit Breakers Trip and Both SEL-279 Relays Start to Time

Refer to the time-lines in Figure 5.11. After both circuit breakers trip for the bus fault (indicated by circuit breaker auxiliary contacts $52b_1$ and $52b_2$ asserting), both SEL-279 Relays sense the conditions:

- hot line
- dead bus
- circuit breaker open

and their Master Timers start timing because Relay Word bit **HLD1** is selected in the MTR (Master Timer Run) logic mask and the conditions that make up **HLD1** are all true for each respective relay:

HLD1 hot line - dead bus - circuit breaker open - HL/DB 1 (Hot Line/Dead Bus 1 reclose enable) input asserted

Master Timer setpoints:

MT2D = 600 [(SEL-279(1)]

MT2D = 1200 [(SEL-279(2)]

have corresponding reclose condition logic masks (MT2) set with Relay Word bit **HLD1**, also (see Figures 5.7 and 5.8).

The relays time right past their first setpoints:

MT1D = 300 [(SEL-279(1)]

MT1D = 300 [(SEL-279(2)]

because the corresponding reclose condition logic masks (MT1) are set with Relay Word bit **DLH1** and present power system conditions are <u>not</u> those that constitute the **DLH1** bit:

DLH1 dead line - hot bus - circuit breaker open - DL/HB 1 (Dead Line/Hot Bus 1 reclose enable) input asserted

SEL-279(1) Relay Recloses First; SEL-279(2) Relay Stops

The SEL-279(1) Relay reaches its MT2D setpoint first and closes circuit breaker 1, restoring power to the 115 kV bus. Note that its Master Timer stops timing while its CLOSE OUT contact is asserted. After the successful reclose, reset conditions are present and the SEL-279(1) Relay Master Timer times to time MTPD. The Master Timer stops at time MTPD and then times on reset time RS1D. When RS1D expires, the SEL-279(1) Relay returns to the reset state.

Note: When the SEL-279(1) Relay asserts its CLOSE OUT contact at setpoint MT2D to close circuit breaker 1, the Master Timer of the SEL-279(2) Relay stops timing. This occurs because the SEL-279(1) Relay asserts its OUT2 contact at the same time (see Figure 5.10; OUT2 is configured as a "b" contact). OUT2 contact is programmed with Relay Word bit **HD1M** and it latches up when an **HLD1** reclose attempt is made, de-energizing the HL/DB 1 input of the SEL-279(2) Relay. Thus, the SEL-279(2) Relay stops timing for the present conditions:

- hot line 2
- dead bus
- circuit breaker 2 open

The reasoning behind this logic is the SEL-279(1) Relay makes the first attempt to restore power to the 115 kV bus and if it is unsuccessful, the SEL-279(2) Relay is prevented from making an attempt to restore power to the bus, too.

OUT2 unlatches when the SEL-279(1) Relay is in the reset state again.

The successful reclosure changes the system conditions apparent to the SEL-279(2) Relay:

- hot line 2
- hot bus
- circuit breaker 2 open

SEL-279(2) Relay Starts to Time again toward Reclosure

A synchronism check now has to be made. After the synchronism check is time qualified (setting 25D), Relay Word bit **HLHS** asserts. The SEL-279(2) Relay Master Timer starts to time because Relay Word bit **HLHS** is selected in the MTR (Master Timer Run) logic mask and the conditions that make up **HLHS** are all true:

HLHS hot line - hot bus - circuit breaker open - time-qualified synchronism check - HL/HS (Hot Line/Hot Bus/Synchronism reclose enable) input asserted

Master Timer setpoint:

MT3D = 1800 [(SEL-279(2)]

has its corresponding reclose condition logic mask (MT3) set with Relay Word bit **HLHS**, also (see Figure 5.8).

The SEL-279(2) Relay times right past setpoint MT2D = 1200 because the corresponding reclose condition logic mask (MT2) is set with Relay Word bit **HLD1** and present power system conditions are <u>not</u> those that constitute the **HLD1** bit:

HLD1 hot line - dead bus - circuit breaker open - HL/DB 1 (Hot Line/Dead Bus 1 reclose enable) input asserted

The SEL-279(2) Relay reaches setpoint MT3D = 1800 and closes circuit breaker 2, restoring the system to its normal state (both circuit breakers closed). Note that its Master Timer stops timing while its CLOSE OUT contact is asserted. After the successful reclose, reset conditions are present and the SEL-279(2) Relay Master Timer times to time MTPD. The Master Timer stops at time MTPD and then times on reset time RS1D. When RS1D expires, the SEL-279(2) Relay returns to the reset state.

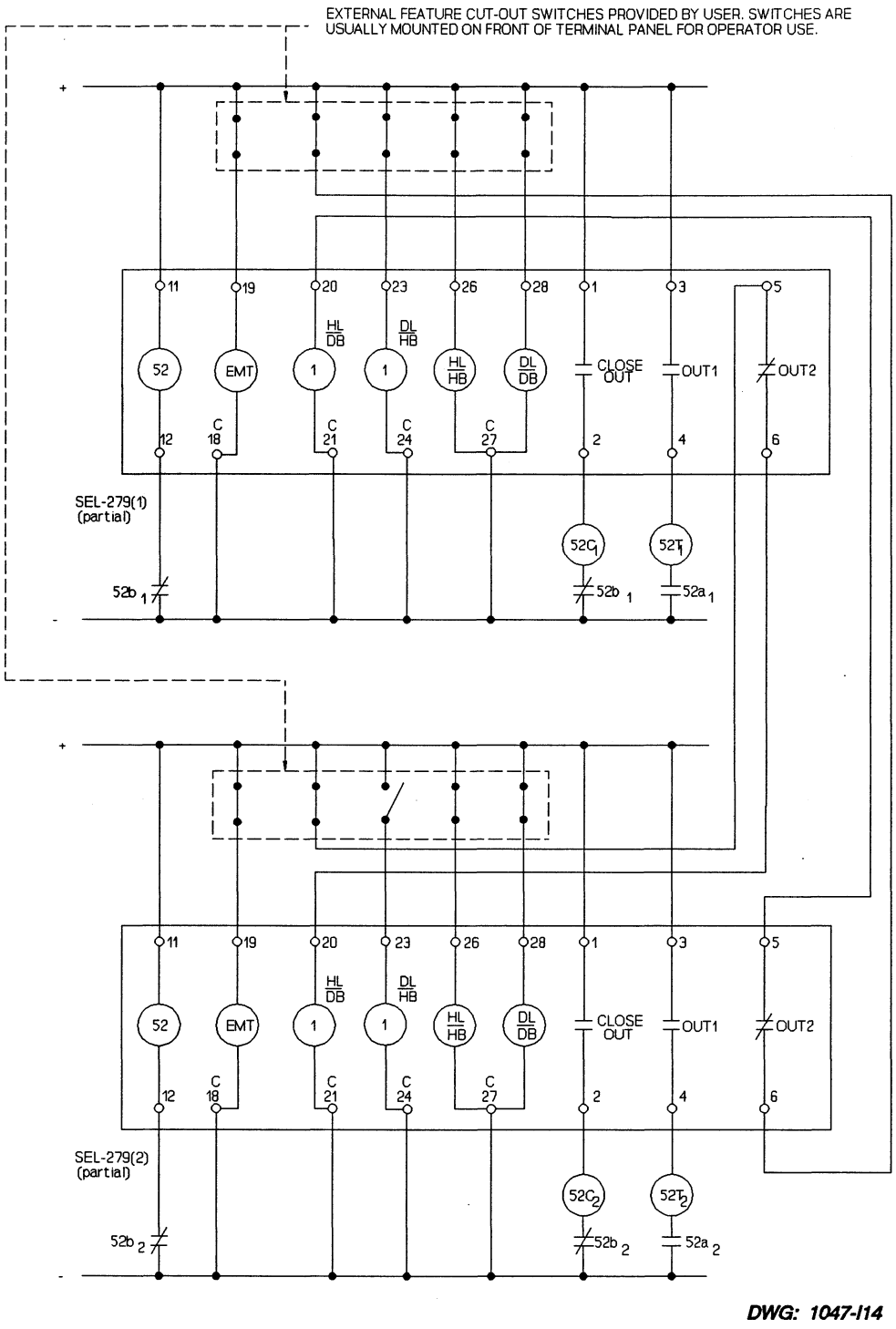


Figure 5.10: SEL-279 Relay DC External Connections for 115 kV Looped Substation

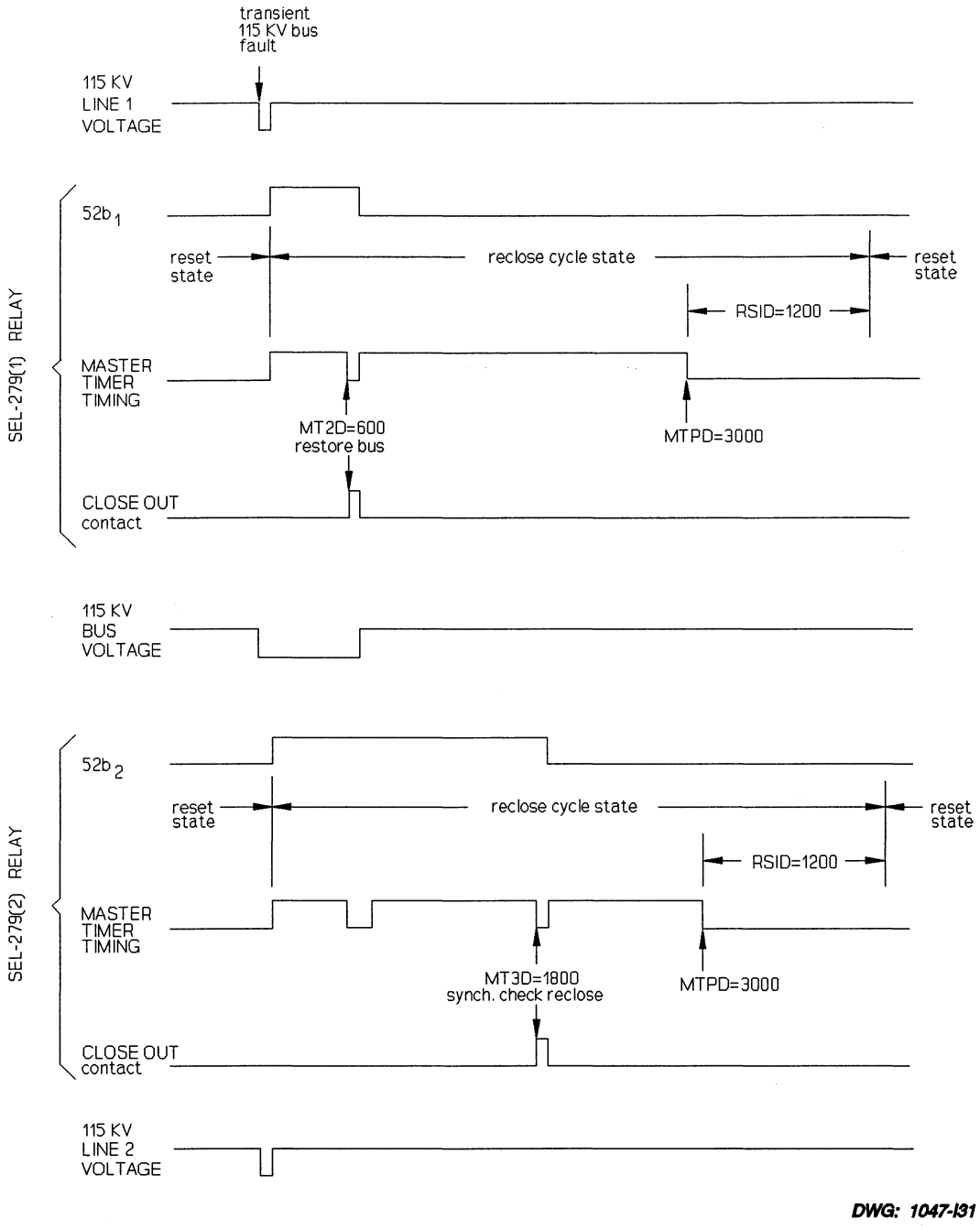


Figure 5.11: 115 kV Bus Restoration Timing

DATE _____

SETTINGS SHEET
FOR THE SEL-279 RELAY

Relay Identifier (39 char.) ID = _____

Bus PT Connection	(0, 1, 3)	BSPT	=
Line PT Connection	(0, 1, 3)	LNPT	=
Dead Bus Voltage Threshold	(0 - 270 V. sec.)	27B	=
Dead Line Voltage Threshold	(0 - 270 V. sec.)	27L	=
Hot Bus Voltage Threshold	(0 - 270 V. sec.)	59B	=
Hot Line Voltage Threshold	(0 - 270 V. sec.)	59L	=
Synchronism Check Difference Voltage	(0 - 270 V. sec.)	25DV	=
Synchronism Check Delay	(0 - 16383 cycles)	25D	=
Master Timer Setpoint 1 Time Delay	(0 - 16383 cycles)	MT1D	=
Master Timer Setpoint 2 Time Delay	(0 - 16383 cycles)	MT2D	=
Master Timer Setpoint 3 Time Delay	(0 - 16383 cycles)	MT3D	=
Master Timer Setpoint 4 Time Delay	(0 - 16383 cycles)	MT4D	=
Master Timer Setpoint 5 Time Delay	(0 - 16383 cycles)	MT5D	=
Master Timer Setpoint 6 Time Delay	(0 - 16383 cycles)	MT6D	=
Master Timer Setpoint 7 Time Delay	(0 - 16383 cycles)	MT7D	=
Master Timer Setpoint 8 Time Delay	(0 - 16383 cycles)	MT8D	=
Master Timer Period Delay	(0 - 16383 cycles)	MTPD	=
Reset Scheme 1 Delay	(0 - 16383 cycles)	RS1D	=
Reset Scheme 2 Delay	(0 - 16383 cycles)	RS2D	=
Reset Scheme 3 Delay	(0 - 16383 cycles)	RS3D	=
Close Failure Delay	(0 - 16383 cycles)	CFD	=
Dead Line Dead Bus Trip Delay	(0 - 16383 cycles)	DLDBD	=
Trip Duration Delay	(0 - 63 cycles)	TDURD	=
Trip Failure Delay	(0 - 63 cycles)	TFD	=
High Speed Reclose Delay	(0 - 63 cycles)	HSRD	=
Master Timer Extended Outage Delay	(0 - 2880 minutes)	MTED	=
Master Timer Coordination Delay	(0 - 2880 minutes)	MTCD	=
Master Timer Limit Delay	(0 - 2880 minutes)	MTLD	=
Circuit Breaker Status Input	(A=52A, B=52B)	52	=
High Speed Reclose Lockout	(Y, N)	HSRL	=
Event Report Type	(1=60 cyc, 2=SOE)	ERT	=
Port 1 Timeout Delay	(0 - 30 minutes)	TIME1	=
Port 2 Timeout Delay	(0 - 30 minutes)	TIME2	=
Port for Automatic Messages	(1, 2, 3)	AUTO	=

SETTINGS SHEET
FOR THE SEL-279 RELAY

MASK: MTR (MASTER TIMER RUN)

									HEXADECIMAL REPRESENTATION SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

MASK: MT1 (MASTER TIMER SETPOINT 1)

									HEXADECIMAL REPRESENTATION SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

MASK: MT2 (MASTER TIMER SETPOINT 2)

									HEXADECIMAL REPRESENTATION SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

SETTINGS SHEET
FOR THE SEL-279 RELAY

HEXADECIMAL REPRESENTATION

MASK: MT3 (MASTER TIMER SETPOINT 3)

									SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

HEXADECIMAL REPRESENTATION

MASK: MT4 (MASTER TIMER SETPOINT 4)

									SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

HEXADECIMAL REPRESENTATION

MASK: MT5 (MASTER TIMER SETPOINT 5)

									SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

SETTINGS SHEET
FOR THE SEL-279 RELAY

HEXADECIMAL REPRESENTATION

MASK: MT6 (MASTER TIMER SETPOINT 6)

									SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

HEXADECIMAL REPRESENTATION

MASK: MT7 (MASTER TIMER SETPOINT 7)

									SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

HEXADECIMAL REPRESENTATION

MASK: MT8 (MASTER TIMER SETPOINT 8)

									SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

SETTINGS SHEET
FOR THE SEL-279 RELAY

MASK: HSR (HIGH SPEED RECLOSE SUPERVISION)

									HEXADECIMAL REPRESENTATION SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

MASK: OUT1 (PROGRAMMABLE OUTPUT CONTACT OUT1)

									HEXADECIMAL REPRESENTATION SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

MASK: OUT2 (PROGRAMMABLE OUTPUT CONTACT OUT2)

									HEXADECIMAL REPRESENTATION SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

SETTINGS SHEET
FOR THE SEL-279 RELAY

HEXADECIMAL REPRESENTATION

MASK: OUT3 (PROGRAMMABLE OUTPUT CONTACT OUT3)

									SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

HEXADECIMAL REPRESENTATION

MASK: ER (EVENT REPORT GENERATION)

									SETTING
ROW # 1: RELAY WORD BINARY REPRESENTATION	27B	27L	59B	59L	HLDB	DLHB	HLHB	DLDB	
ROW # 2: RELAY WORD BINARY REPRESENTATION	HLD1	HLD2	DLH1	DLH2	HLHS	HOT	DEAD	52B	
ROW # 3: RELAY WORD BINARY REPRESENTATION	DB1	DB2	HL1	HL2	DL1	DL2	HB1	HB2	
ROW # 4: RELAY WORD BINARY REPRESENTATION	CLOS	TRIP	HSRN	RSET	CYCL	LOCK	25I	25T	
ROW # 5: RELAY WORD BINARY REPRESENTATION	HD1M	HD2M	DH1M	DH2M	CF	TF	HSRT	MTT	

INSTALLATION
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INSTALLATION

Mounting

The SEL-279 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 6.3.

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 the Enable Master Timer (EMT) input, you must apply control voltage to the EMT input terminals 18 and 19.

Inputs 52, HSRI, and HSRB are individually isolated and a terminal pair is brought out for each input. There are no internal connections between these control inputs.

Inputs DTL, EMT, HL/DB1, HL/DB2, DL/HB1, DL/HB2, HL/HB, and DL/DB are paired, two inputs to a common terminal. See Figures 6.2 and 6.6.

Control outputs are dry relay contacts rated for tripping 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 labelled 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, since their current-carrying capacity is less than control-power short circuit current 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 twelve feet or less are recommended, and the cable length should never exceed 100 feet. Use shielded communications cable for lengths greater than ten 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.

OPEN/CLOSE Command Enable Jumper

With jumper JMP104 in place, the OPEN and CLOSE commands are enabled. If you remove jumper JMP104, OPEN and 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
CLOSE OUT	JMP7
OUT1	JMP6
OUT2	JMP5
OUT3	JMP4
ALARM OUT	JMP3

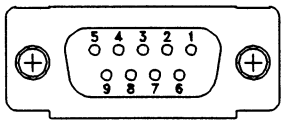
Communication Port External Power Jumpers

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.

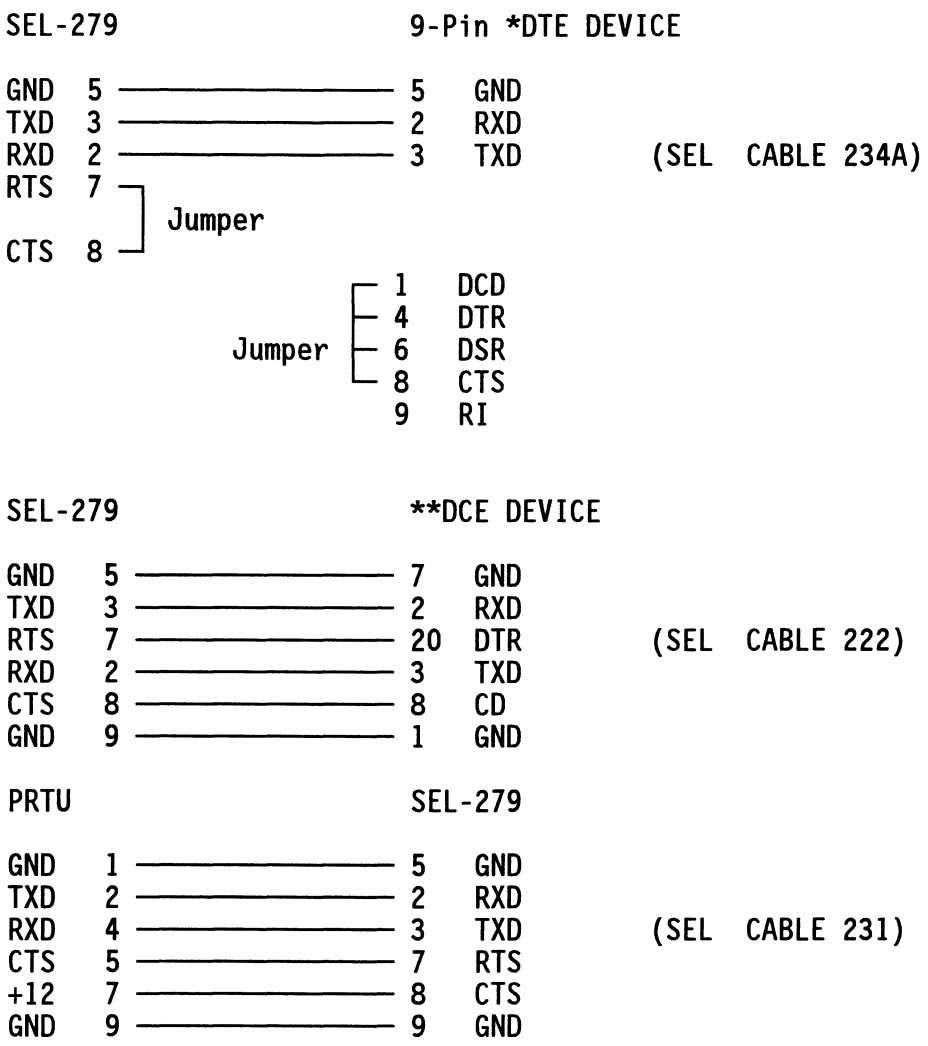
A pin definition of the nine-pin port connectors and cabling information for the EIA-232 ports appears in Figure 6.1. The following cable listings show several types of EIA-232 cables. These and other cables are available from SEL. Cable configuration sheets are also available at no charge for a large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



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

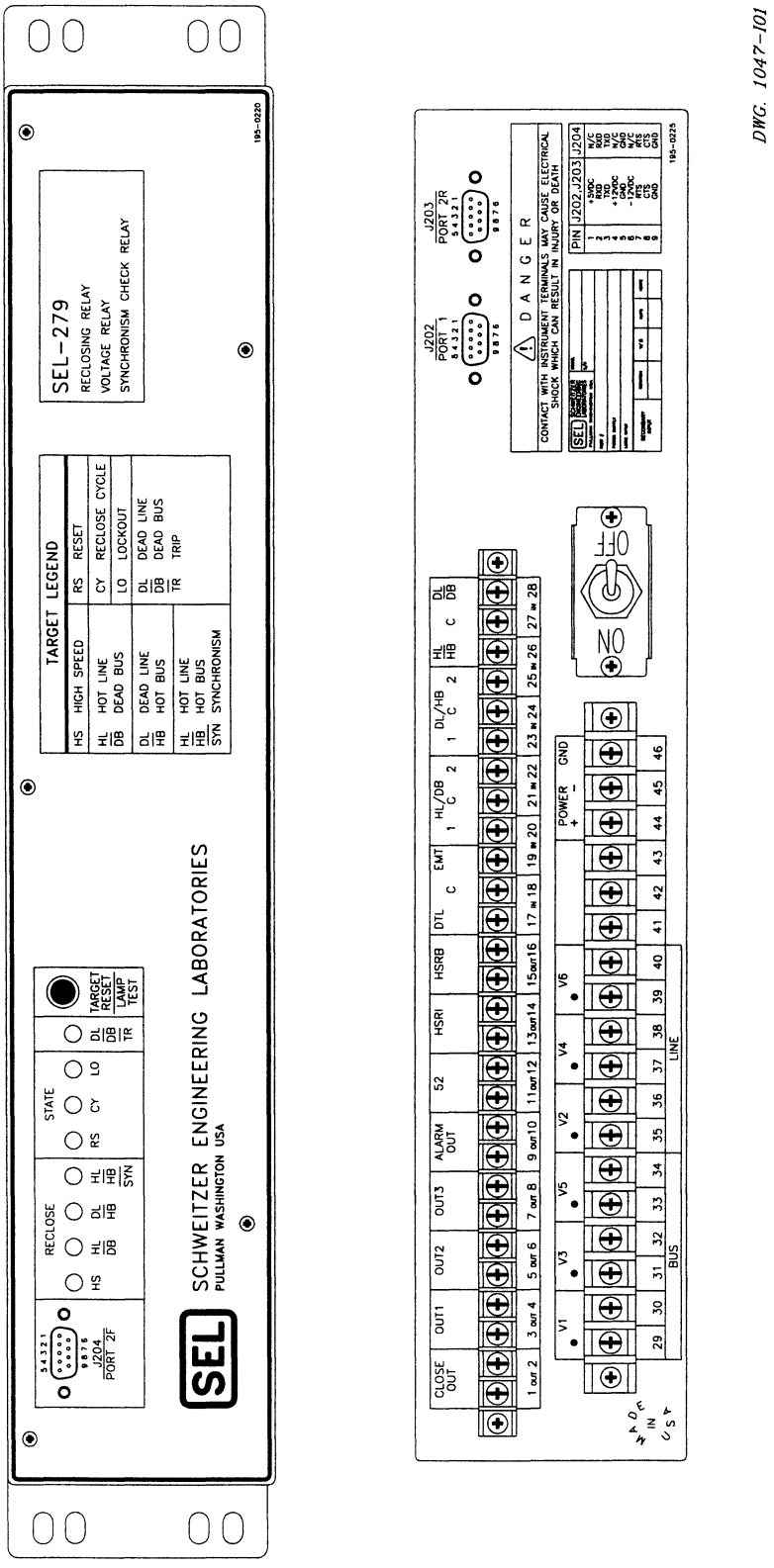


Figure 6.2: SEL-279 Relay Horizontal Front and Rear Panel Drawings

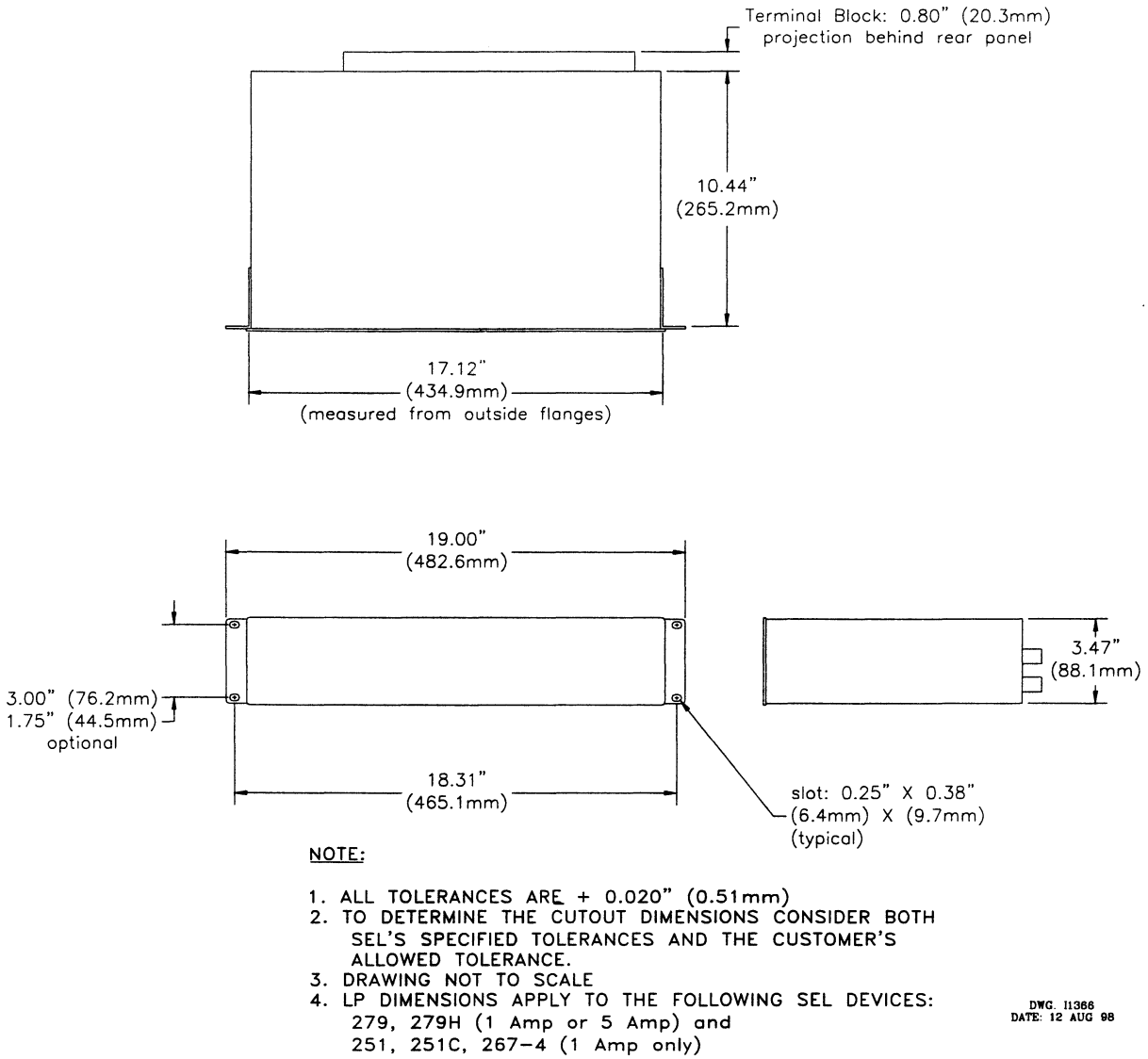


Figure 6.3: Relay Dimensions and Drill Plan

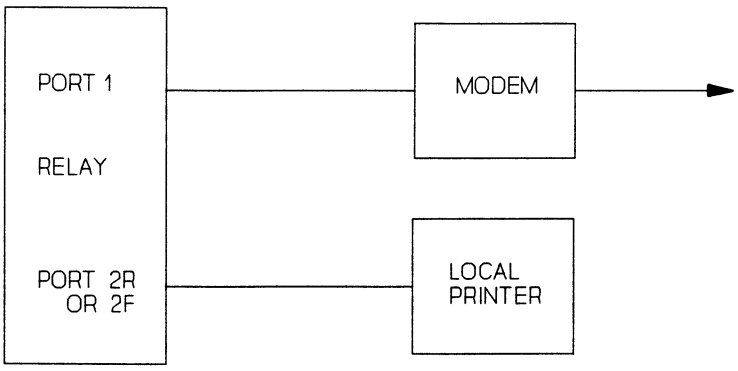


Figure 6.4: Communications - One Unit at One Location

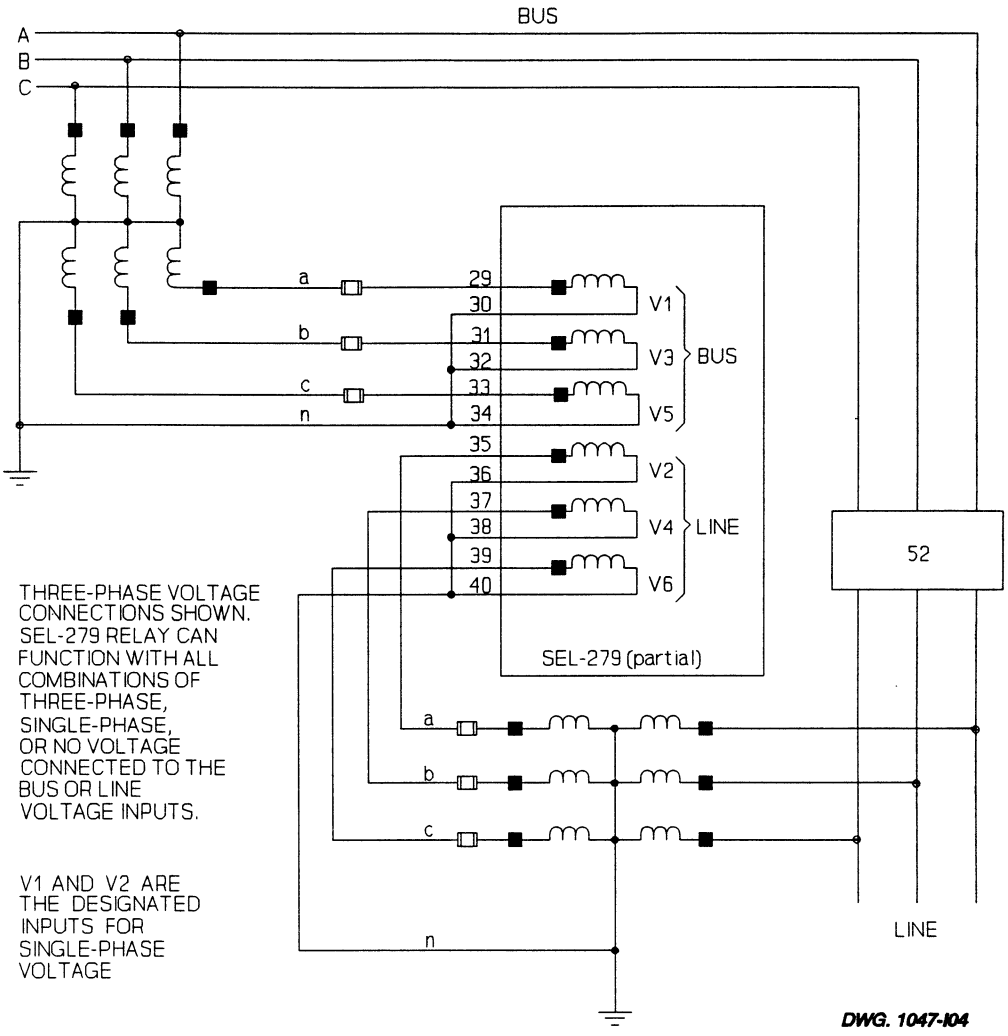


Figure 6.5: SEL-279 Relay Typical AC External Wye-Connected Voltage
(Can also be wired for Delta-Connected Voltages)

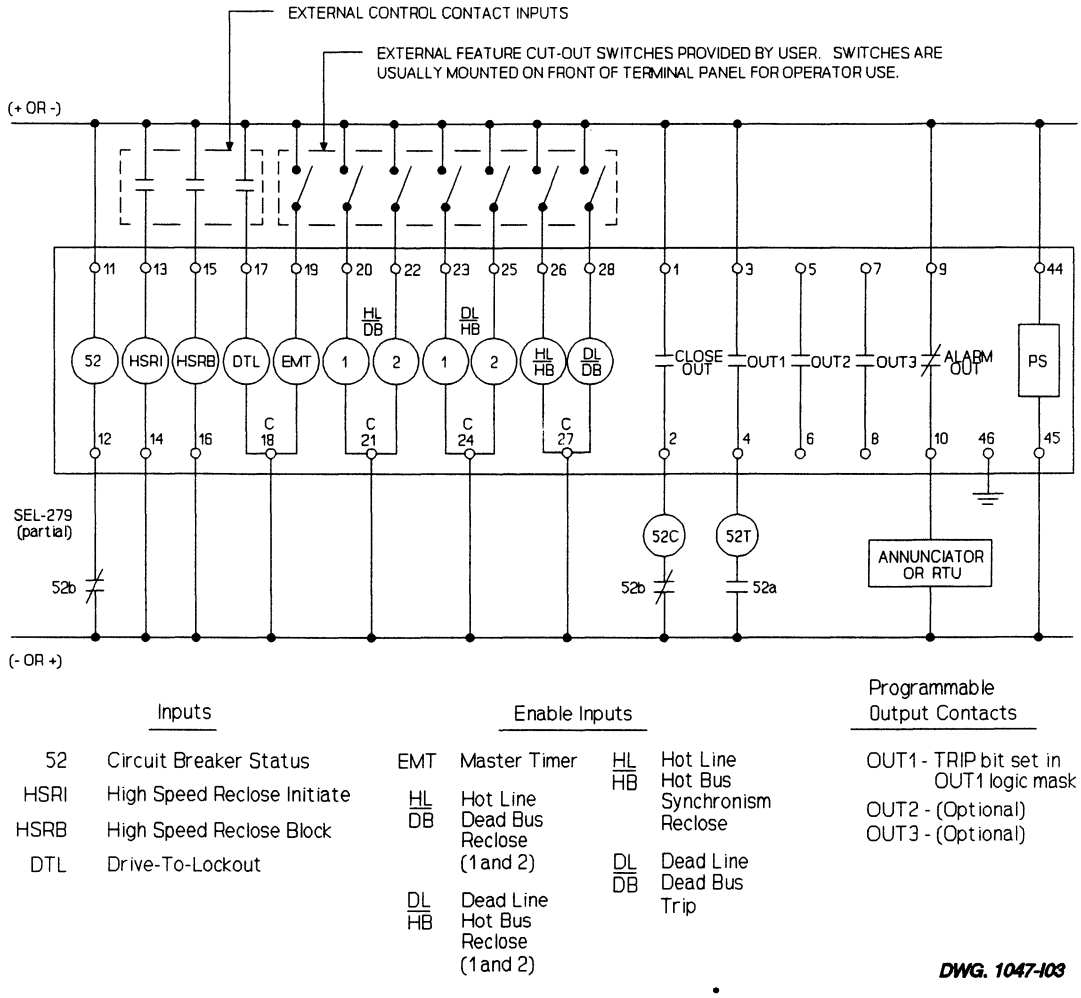


Figure 6.6: SEL-279 Relay Typical DC External Connections

MAINTENANCE & TESTING
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MAINTENANCE & 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 sixty-cycle event report in response to user selected 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.

Low-Level Test Interface (patents pending)

The SEL-279 Relay has low-level test interface between the calibrated input module and the separately-calibrated processing module. You may test the relay in either of two ways: conventionally, by applying ac current signals to the relay inputs; or by applying low magnitude ac voltage signals to the low-level test interface. Access the test interface by removing the relay front panel.

Figure 7.1 shows the interface connections. This drawing also appears on the inside of the relay front panel. Remove the ribbon cable between the two modules to access the outputs of the input module and the inputs to the processing module (relay main board).

You can test the relay processing module using signals from the SEL-RTS Low-Level Relay Test System. Never apply voltage signals greater than 20 volts peak-peak to the low-level test interface. Figure 7.1 shows the signal scaling factors.

You can test the input module two different ways:

- Measure the outputs from the input module with an accurate voltmeter, and compare the readings to accurate instruments in the relay input circuits, or
- replace the ribbon cable, execute the METER command, and compare the relay readings to accurate instruments in the relay input circuits.

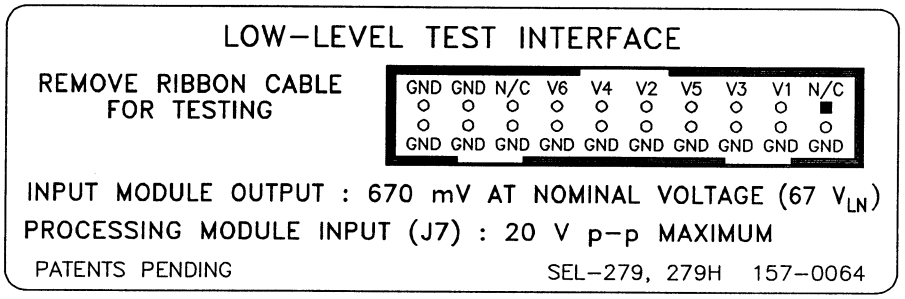

Figure 7.1: Low-Level Test Interface

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 left most LED illuminates. Using LED illumination as an indicator, you can measure the 2 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 SET 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 chapter 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
- Trip Logic

We recommend testing the SEL-279 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 RS-232-C serial interface
2. Interconnecting cable between terminal and relay
3. Source of control power
4. Source of single-phase voltages
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/upper case/brackets: **<ENTER>**.

Relay output appears in the following format:

```
Example SEL-279 Relay                Date: 4/5/93   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 7.2 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.

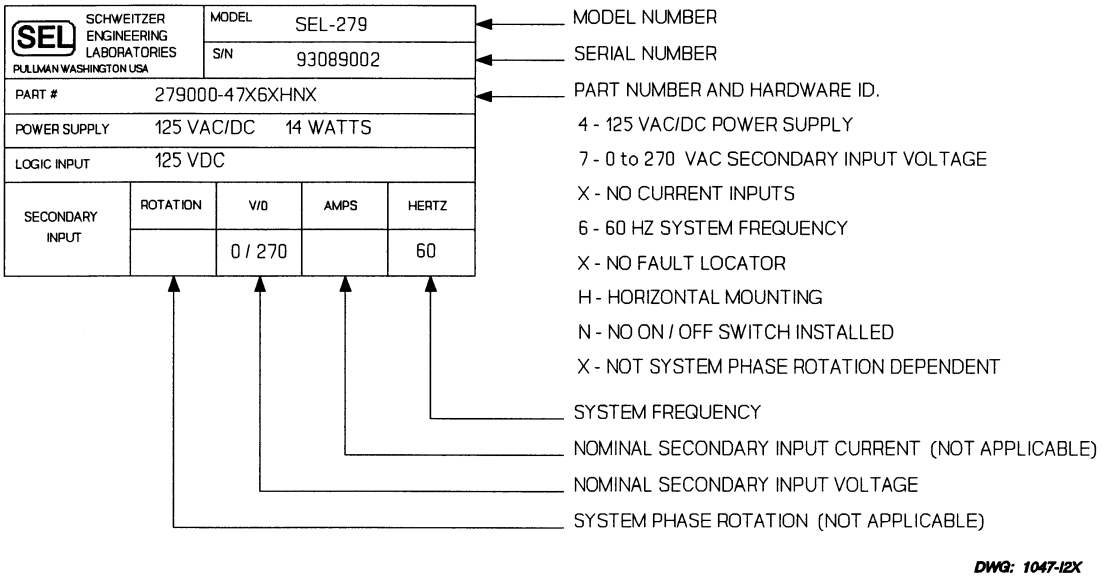

Figure 7.2: Relay Part Number and Hardware Identification Sticker

■ 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 7.3 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.

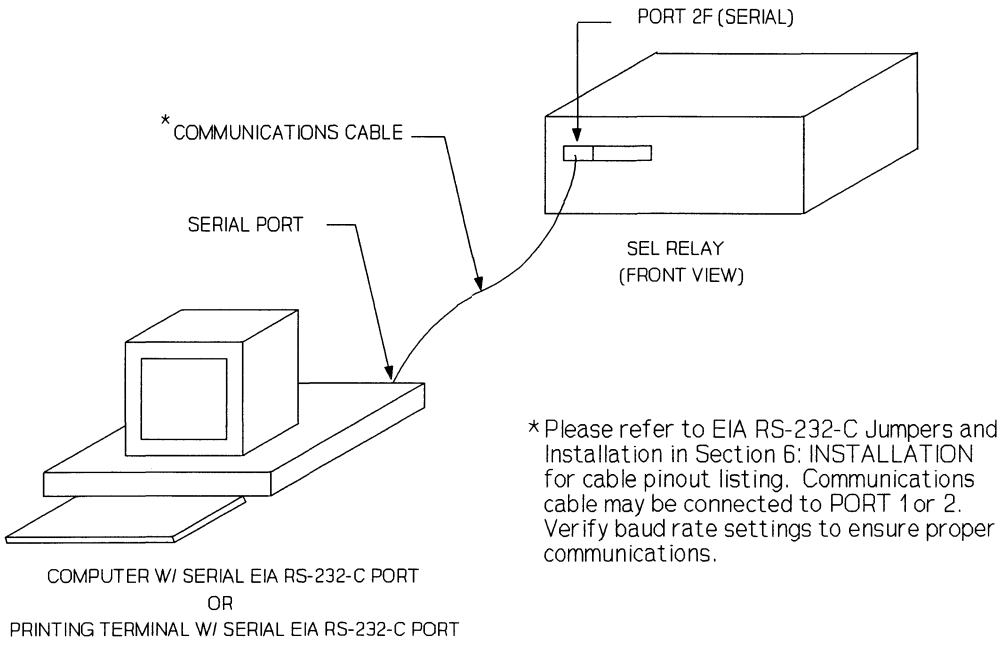

Figure 7.3: Communications Interface Setup

- **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-279 Relay                    Date: 4/5/93   Time: 01:01:01

SEL-279
=
```

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 Trouble-shooting 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:

```
=>SHOWSET <ENTER>

Settings for: Example SEL-279 Relay

Settings:

BSPT =3         LNPT =1         27B  =7         27L  =7
59B  =56        59L  =56        25DV =17        25D  =120
MT1D =300       MT2D =600       MT3D =1800      MT4D =0
MT5D =0         MT6D =0         MT7D =0         MT8D =0
MTPD =3000      RS1D =1200      RS2D =0         RS3D =0
CFD  =0         DLDBD=300       TDURD=7         TFD  =0         HSRD =0
MTED =0         MTCD =0         MTLD =0         52   =B         HSRL =N
ERT  =2         TIME1=15        TIME2=0         AUTO =2

Logic Mask settings:

MTR  MT1  MT2  MT3  MT4  MT5  MT6  MT7  MT8  HSR  OUT1  OUT2  OUT3
00   00   00   00   00   00   00   00   00   00   00    00    00
A8   20   80   08   00   00   00   00   00   00   00    00    00
00   00   00   00   00   00   00   00   00   00   00    00    00
00   00   00   00   00   00   00   00   00   00   40    00    00
00   00   00   00   00   00   00   00   00   00   00    00    00

=>
```

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 7.4. Apply 67 V rms and turn power back on.

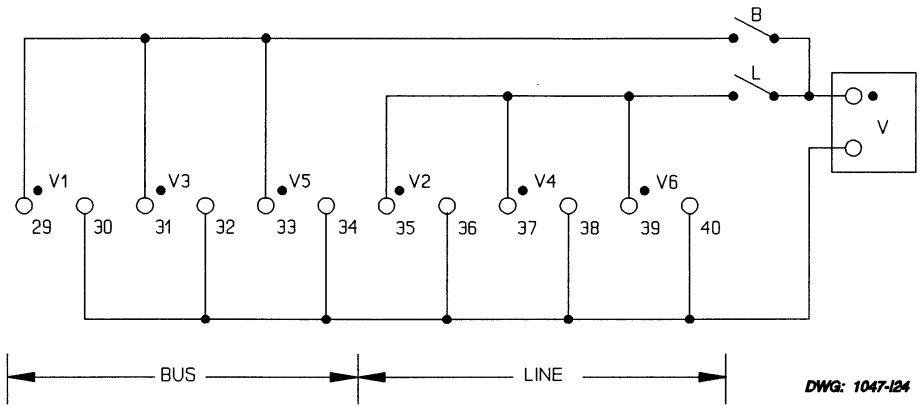

Figure 7.4: SEL-279 Relay Voltage Test Connections

■ 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 7.4.

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

```
=>METER <ENTER>
Example 279 Relay              Date:  04/15/93       Time:11:15:12
V1=0    V3=0    V5=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 279 Relay              Date:  04/15/93       Time:11:15:12
V1=67   V3=67   V5=67   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 279 Relay              Date:  04/15/93       Time:11:15:12

V1=67   V3=67   V5=67   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 Figures 6.? and 6.? 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	HS	HL DB	DL HB	HL HB SYN	RS	CY	LO	DL DB TR
TAR 6	DH1	HD2	HDI	EMT	DTL	HSRB	HSRI	52
Terminal numbers	23,24	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	HS	HL DB	DL HB	HL HB SYN	RS	CY	LO	DL DB TR
TAR 7	ALRM	OUT3	OUT2	OUT1	CLOS	DLDB	HLHB	DH2
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.

RECLOSING FUNCTION TEST

Purpose: Test the reclosing functions and the output contacts of the relay.

Equipment Required

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

1. Terminal with EIA RS-232-C serial interface
2. Interconnecting cable between terminal and relay
3. Source of relay control power
4. Source of single-phase voltage
5. Ohmmeter or contact opening/closing sensing device
6. Timer with contact inputs for start and stop
7. Breaker simulator

Method:
1. Gain Level 2 Access (see ACCESS and 2ACCESS commands in Section 3: COMMUNICATIONS) to make a few relay settings to prepare for the reclosing test. These settings changes are made to the factory settings that the relay comes with (listed in step 8 of the preceding Checkout Procedure in this section).

2. Type **SET 52 <ENTER>**.

3. Enter A in place of B for setting 52 and **<ENTER>**.

4. Then type **END** and **<ENTER>**.

5. All the settings then display for review. Make sure that setting 52 = A. This setting requires that 52a logic be wired up to the input labeled 52 for circuit breaker status.

6. If the settings are OK, type **Y** and **<ENTER>** at the "OK(Y/N) ?" prompt. The ALARM OUT contact pulses momentarily as the new setting is enabled.

7. Type **LOGIC OUT1 <ENTER>**.

   Following the explanation given for the LOGIC command in Section 3: COMMUNICATIONS, set only the **DLH1** bit to control the OUT1 contact. The ALARM OUT contact pulses momentarily as the new OUT1 logic mask setting is enabled.

8. Type **LOGIC OUT2 <ENTER>**.

   Following the explanation given for the LOGIC command in Section 3: COMMUNICATIONS, set only the **CLOS** bit to control the OUT2 contact. The ALARM OUT contact pulses momentarily as the new OUT2 logic mask setting is enabled.

9. Type **LOGIC OUT3 <ENTER>**.

   Following the explanation given for the LOGIC command in Section 3: COMMUNICATIONS, set only the **CLOS** bit to control the OUT3 contact. The ALARM OUT contact pulses momentarily as the new OUT3 logic mask setting is enabled.

10. Set-up relay and test apparatus as per Figures 7.5 and 7.6. The ac voltage source should be at 67 V rms.

    Close switch B to energize the bus voltages. Close the breaker simulator to assert the 52 input and energize the line voltages. Close switch 1 to enable the Master Timer (input EMT). Close switch 2 to enable the Dead Line/Hot Bus 1 enable input (DL/HB 1)

    Note: In Figure 7.5 when the breaker simulator opens, the line voltage is de-energized. This test simulates the bus as the source. The reclosing condition is:

    - dead line
    - hot bus
    - breaker open

    This condition is embodied in Relay Word bit **DLH1**. **DLH1** is selected by the MTR logic mask as a condition to run the Master

Timer and by the MT1 logic mask as the reclose condition at set-point time MT1D = 300 cycles.

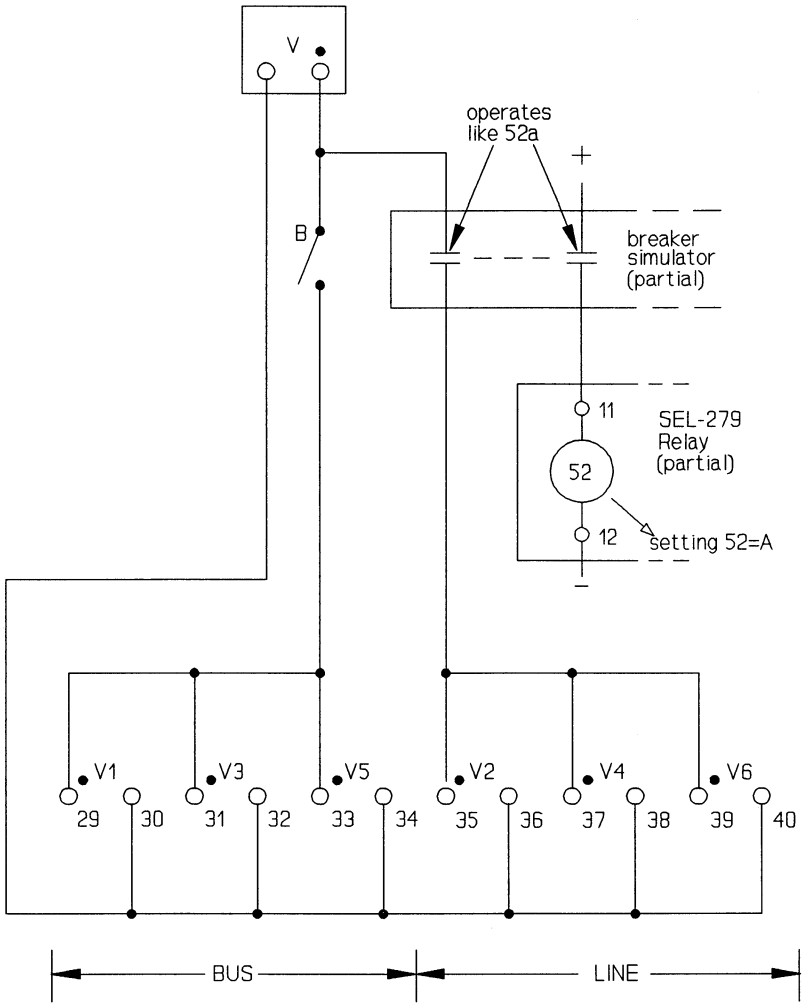

Figure 7.5: SEL-279 Relay Reclosing Function Test - AC Connections

11. Wire OUT1 contact to the "start" input on the timer. OUT1 contact asserts when condition **DLH1** comes true.

    Wire OUT2 contact to the "stop" input on the timer. OUT1 contact asserts when condition **CLOS** comes true (the CLOSE OUT contact is asserted).

    Note: The timer qualifies the setpoint time MT1D = 300 cycles. When condition **DLH1** comes true (the breaker opens and the line goes dead), the relay leaves the reset state and enters the reclose cycle state (see Figure 7.7). In the reclose cycle state, the Master Timer

times for 300 cycles and reaches setpoint time MT1D. At setpoint time MT1D, **DLH1** is the set reclose condition and the CLOSE OUT contact and the **CLOS** Relay Word bit assert.

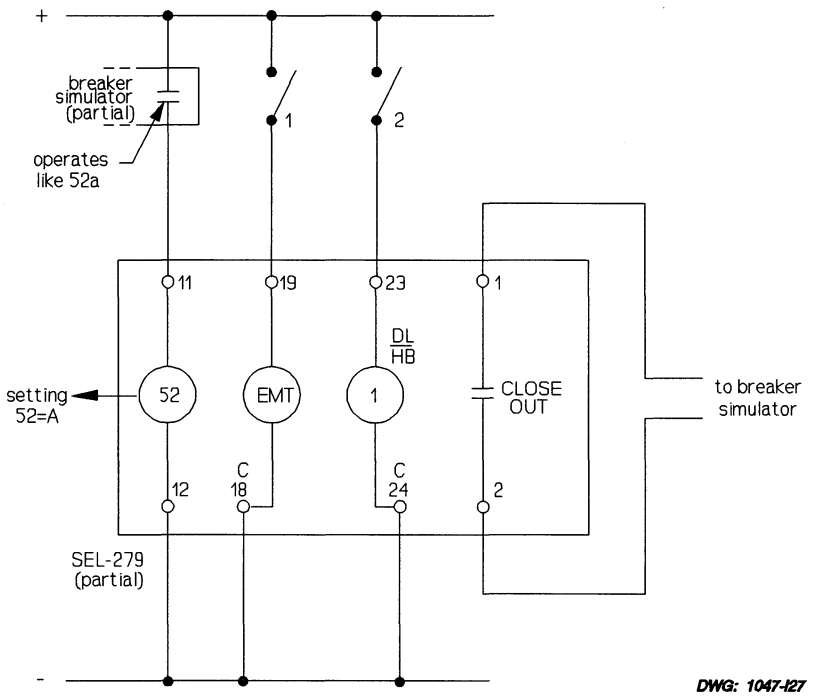

Figure 7.6: SEL-279 Relay Reclosing Function Test - DC Connections

12. The relay should be in the reset state (front panel RS LED lit; closing the switches listed in step 10 accomplishes this).

    Trip the breaker simulator. The front panel RS LED extinguishes and the CY LED flashes. The timer starts timing.

    300 cycles (5 seconds) later, the relay recloses the breaker simulator and the timer stops. The front panel DL/HB LED lights.

    65 seconds after the reclose, the relay goes to the reset state (front panel RS LED lights). This time is figured as follows (see Figure 7.7):

$$\begin{aligned}(\text{MTPD} - \text{MT1D}) + \text{RS1D} &= (3000 - 300) + 1200 \\ &= 3900 \text{ cycles} \\ &= 65 \text{ seconds}\end{aligned}$$

    Read and then reset the timer. The reading should be very close to 300 cycles (5 seconds). This qualifies setpoint time MT1D=300 (see Figure 7.7).

13. Repeat step 12 again, but trip the breaker simulator again right after the reclose. 45 seconds after the attempted reclose, the SEL-279 Relay goes to the lockout state and the front panel LO LED lights. This time is figured as follows (see Figure 7.7):

$$\begin{aligned} \text{MTPD - MT1D} &= 3000 - 300 \\ &= 2700 \text{ cycles} \\ &= 45 \text{ seconds} \end{aligned}$$

Note: None of the other reclose setpoint times that follow setpoint time MT1D = 300 have DLH1 as a reclose condition. Thus, the Master Timer times right by them to lockout.

14. Close the breaker simulator and the SEL-279 Relay times on reset time RS1D = 1200 cycles (20 seconds) and then the front panel RS LED lights.

15. Output contacts CLOSE OUT, OUT1, and OUT2 are used in the above tests. Thus they are proven operational. Step 12 can be repeated again with OUT3 contact monitored. OUT3 contact asserts when the CLOSE OUT contact asserts.

16. Repeat step 12 again, but have switch 1 opened, de-energizing the EMT input (disabling the Master Timer). Notice that nothing happens (the front panel RS LED remains lit).

    Close switch 1 and notice that the reclosing process proceeds.

17. Repeat step 12 again, but have switch 2 opened, de-energizing the DL/HB 1 input (disabling Dead Line/Hot Bus 1 reclose condition, DLH1). Notice that nothing happens (the front panel RS LED remains lit).

    Close switch 2 and notice that the reclosing process proceeds.

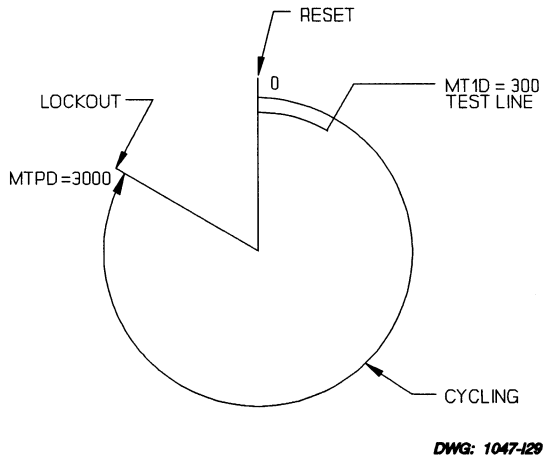

Figure 7.7: SEL-279 Relay Reclosing Function Test Timing

RELAY CALIBRATION

The SEL-279 Relay is factory calibrated to a very high degree of accuracy. If you suspect that the relay is out of calibration, please contact the factory. We can provide instructions for returning the relay for factory recalibration.

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 timeout interval set to a value other than zero.

6. Board failure.

Terminal Displays Meaningless Characters

1. 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

1. EPROM failure. Replace EPROM(s).

Self-Test Failure: RAM

1. 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 5 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

If you have any questions regarding the performance, application, or repair of this or any other SEL product, do not hesitate to contact the factory. Our staff is always happy to assist you.

Schweitzer Engineering Laboratories, Inc.
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Pullman, WA 99163-5603
Tel: (509) 332-1890
FAX: (509) 332-7990

APPENDICES
TABLE OF CONTENTS

APPENDIX A - FIRMWARE VERSIONS IN THIS MANUAL

This manual covers SEL relays that contain firmware bearing the following part numbers and revision numbers:

Firmware Part/Revision No.	Description of Firmware
No change to manual; removes sensitivity to "CON" input.	
SEL-279-R404	60 Hz
SEL-279-R451	50 Hz
This firmware includes the option for "sequence-of-events" style event reports, new targeting logic, and the COUNT command, which counts breaker closures.	
SEL-279-R403	60 Hz
SEL-279-R450	50 Hz

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:

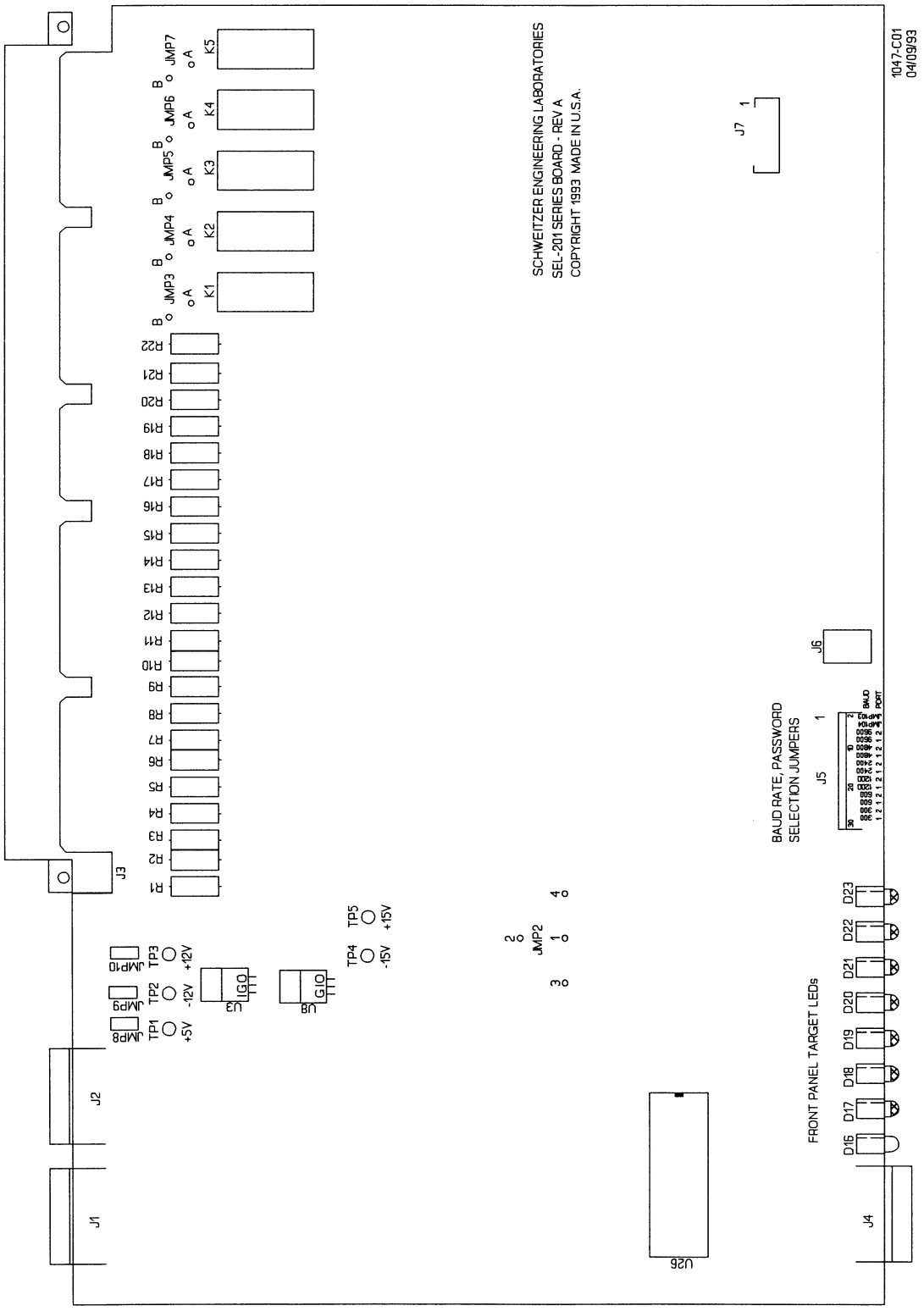
FID=**SEL-279-R400**-V6-D930512-E2

For a detailed explanation of the FID refer to Section 4: EVENT REPORTING.

The following table shows firmware that does not precisely match this manual:

Firmware Part/Revision No.	Description of Firmware
SEL-279-R402	60 Hz
SEL-279-R401	60 Hz
SEL-279-R400	60 Hz initial release

APPENDIX B - SEL-279 RELAY MAIN BOARD JUMPER CONNECTOR AND SOCKET LOCATIONS



SEL-279 RELAY COMMAND SUMMARY

Access Level 0

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

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.

COUNTER Displays circuit breaker closure counter values (relay and external).

COUNTER R Resets circuit breaker closure counters (relay and external).

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 EVE or EVE 1 shows newest event report; EVE 12 shows oldest (n=1 through 12).

HISTORY Shows Date, Time, Event, Master Timer position, and Targets, for the last twelve events.

METER n Displays present terminal voltage values 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 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 R1
TAR 2: Relay Word row R2	TAR 3: Relay Word row R3
TAR 4: Relay Word row R4	TAR 5: Relay Word row R5
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 time (e.g., TIM 13/32/00 sets clock to 1:32:00 PM). To display time enter TIME.

TRIGGER Triggers and saves an event record (event type is TRIG).

Access Level 2

CLOSE Closes circuit breaker, if allowed by jumper JMP104 setting.

LOGIC n Shows or sets logic masks MTR, MT1 through MT8, HSR, OUT1, OUT2, OUT3, and ER. Command pulses ALARM OUT contact closed for one second and clears event buffers when new settings are stored.

OPEN Opens circuit breaker, if allowed by jumper JMP104 setting.

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 = RS1D, the setting procedure starts at setting RS1D, bypassing all settings before RS1D). 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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COUNTER Displays circuit breaker closure counter values (relay and external).

COUNTER R Resets circuit breaker closure counters (relay and external).

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 EVE or EVE 1 shows newest event report; EVE 12 shows oldest (n=1 through 12).

HISTORY Shows Date, Time, Event, Master Timer position, and Targets, for the last twelve events.

METER n Displays present terminal voltage values 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 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 R1
TAR 2: Relay Word row R2	TAR 3: Relay Word row R3
TAR 4: Relay Word row R4	TAR 5: Relay Word row R5
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 time (e.g., TIM 13/32/00 sets clock to 1:32:00 PM). To display time enter TIME.

TRIGGER Triggers and saves an event record (event type is TRIG).

Access Level 2

CLOSE Closes circuit breaker, if allowed by jumper JMP104 setting.

LOGIC n Shows or sets logic masks MTR, MT1 through MT8, HSR, OUT1, OUT2, OUT3, and ER. Command pulses ALARM OUT contact closed for one second and clears event buffers when new settings are stored.

OPEN Opens circuit breaker, if allowed by jumper JMP104 setting.

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 = RS1D, the setting procedure starts at setting RS1D, bypassing all settings before RS1D). 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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