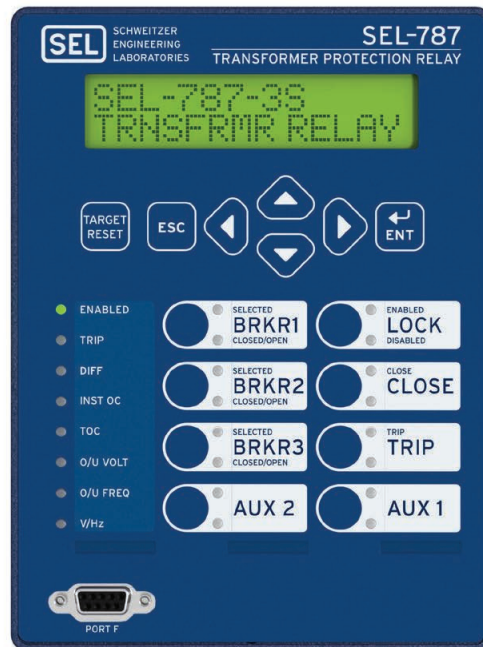# SEL-787-3/-4

Transformer Protection Relay

The only compact platform with REF and up to four-terminal protection.

- User-selected restricted earth fault (REF) element quickly detects ground faults close to the transformer neutral.

- Up to four-terminal, dual-slope percentage differential protection with harmonic blocking and restraint enhances security.

- Single platform with multiple I/O options reduces design, procurement, commissioning, and maintenance costs.

- Optional single-phase voltage input for synchronism check or station battery monitor.

SEL

Functional Overview

Model Features	SEL-787-3E	SEL-787-3S	SEL-787-4X
Windings protected	3-winding	3-winding	4-winding
CT/PT Inputs			
Phase voltage inputs	3	3	0
Differential current inputs	9	9	12
Neutral current	1	0	0
VS/VBAT channel	0	1	0
Protection Elements			
24 — Volts/Hertz	•	•	
25 — Synchronism Check		•	
27P — Undervoltage (Phase)	•	•	
27S — Undervoltage (Synchronism or Battery Voltage)		•	
32 — Directional Power	•	•	
49R — RTD Thermal*	•	•	•
50BF — Overcurrent (Breaker Failure)	•	•	•
50N — Neutral Overcurrent	•		
50 (P,G,Q) — Overcurrent (Phase, Ground, Neg. Seq.)	•	•	•
59 (P,G,Q) — Overvoltage (Phase, Ground, Neg. Seq.)	•	•	
59S — Overvoltage (Synchronism or Battery Voltage)		•	
81 (O,U) — Over-/Underfrequency	•	•	
87 — Current Differential	•	•	•
87G — Restricted Earth Fault (REF) Differential	•	º	º
Additional Functions			
85RIO — SEL MIRRORED BITS® Communications	•	•	•
BF — Breaker Failure	•	•	•
BW — Breaker Wear Monitoring	•	•	•
DFR — Event Reports	•	•	•
ENV — SEL-2600 RTD Module Support*	•	•	•
LDP — Load Data Profiling	•	•	•
LGC — SELOGIC® Control Equations	•	•	•
LOP — Loss-of-Potential	•	•	•
MET — High-Accuracy Metering	•	•	•
RTD — 10 Internal or 12 External (see ENV) RTD Inputs*	•	•	•
RTU — Remote Terminal Unit	•	•	•
SER — Sequential Events Recorder	•	•	•
TFE — Through Fault Event Monitor	•	•	•
PMU — Synchronized Phasor Measurement	•	•	•

*Optional feature
º Not shown, but 87G REF differential protection is available if Winding Three is reassigned for REF.

SEL-787-3E
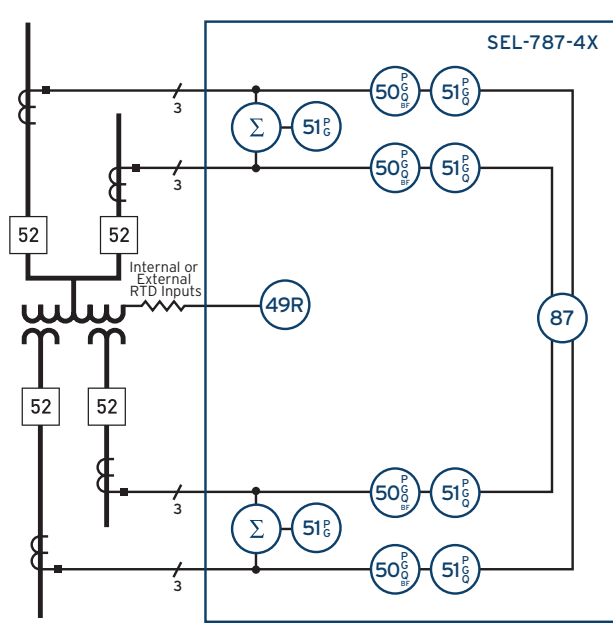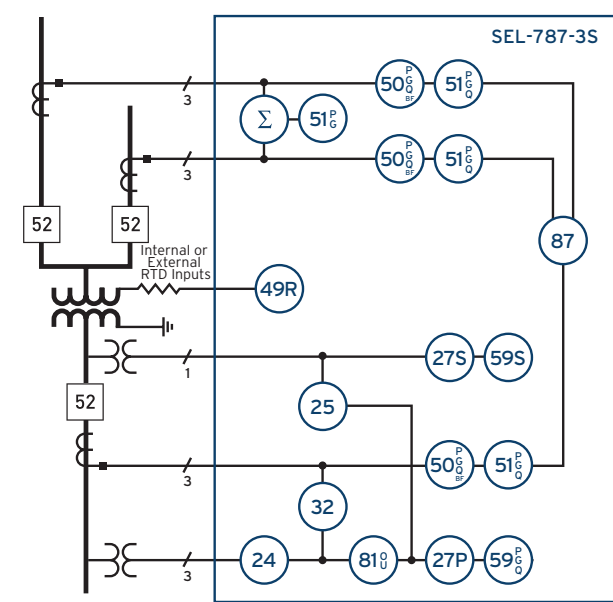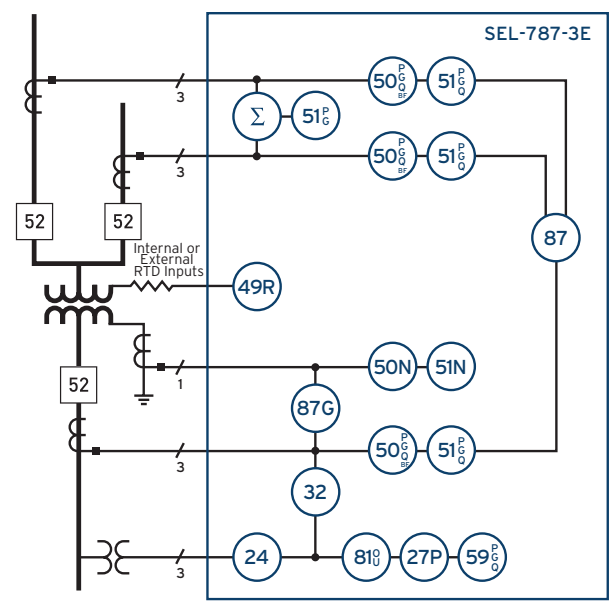
SEL-787-3S

SEL-787-4X

Key Features

Differential Protection

The SEL-787-3/-4 provides dual-slope differential protection with harmonic blocking and restraint for as many as four terminals, and as many as three independent REF elements for sensitive ground-fault detection in grounded-wye transformers. Standard overcurrent elements provide backup protection, including phase, negative-sequence, residual-ground, and neutral-ground elements. Breaker failure protection for as many as four three-pole breakers is available.

Transformer Monitoring

Measure and track accumulated through-fault current levels, and use optional 4 to 20 mA or resistance temperature detector (RTD) thermal inputs to monitor ambient, load tap changer (LTC) tank, or transformer oil temperatures.

Flexible Communications

Advanced protocols, such as IEC 61850, IEC 60870-5-103, Modbus® (RTU and TCP/IP), the Simple Network Time Protocol (SNTP), DNP3 (serial and LAN/WAN), ASCII, Telnet, and FTP, support communications using legacy and modern supervisory and control systems.

Proven Hardware

The SEL-787-3/-4 Relays operate in extreme conditions, with an operating temperature range of −40° to +85°C (−40° to +185°F). They are designed to work in harsh substation environments and tested to verify that they exceed requirements for reliable operation in the presence of vibration, electromagnetic interference, and other adverse environmental conditions. Optional conformal coating provides extra protection in caustic environments.

Product Overview

Large 2 × 16 character LCD

32 customizable display messages
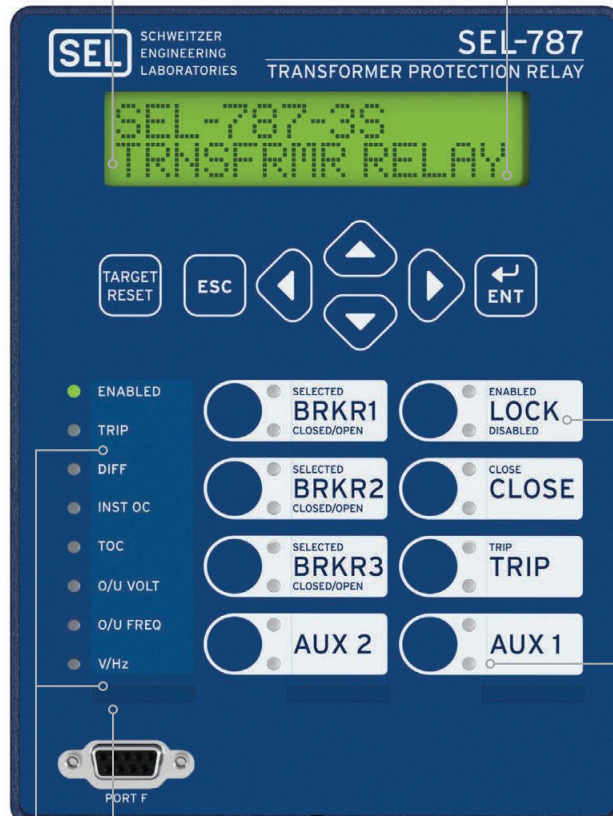
Customizable pushbuttons and labels

Two programmable tricolor LEDs per pushbutton

Programmable front-panel tricolor LEDs

User-configurable label kit included with relay

24/48 Vdc, 125/250 Vdc, or 120/240 Vac power supply

2 digital inputs (DI) and 3 digital outputs (DO)

Optional copper or fiber-optic Ethernet, Modbus® TCP, DNP3, IEC 61850, IEC 60870-5-103, and more

EIA-232 serial port (P3) and fiber-optic EIA-232 serial port (P2) with IRIG-B input

Positions for optional input/output (I/O) cards (listed below)

Positions for current and voltage options (listed below)

MIRRORED BITS® communications, IEC 60870-5-103, DNP3, or Modbus protocol (available on multiple ports)
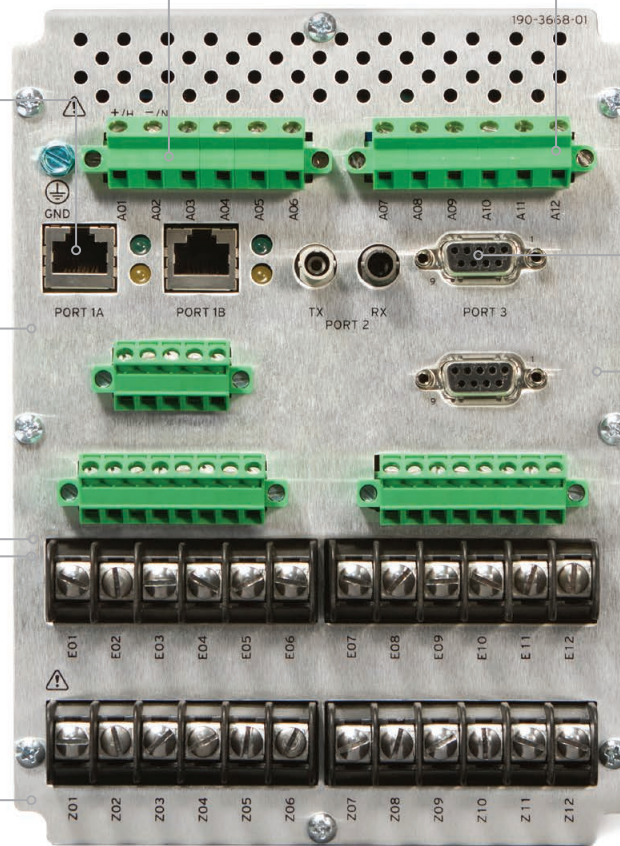
Optional I/O Cards
Serial communications card (EIA-232/-485)*
3 digital inputs (DI)/4 digital outputs (DO)/1 4–20 mA analog output (AO)*
4 DI/4 DO*
8 DO*
8 DI*
4 DI/3 DO (2 Form C, 1 Form B)*
4 analog inputs (AI)/4 AO*
10 RTD input*

*Additional cost

| Optional Current and Voltage Cards	
6 currents (Slot Z) and 6 currents (Slot E)	787-4X
6 currents (Slot Z) and 3 currents, 1 neutral current, 3 voltages (Slot E)	787-3E
6 currents (Slot Z) and 3 currents, 3 voltages, 1 voltage (battery or synchronism check) (Slot E)	787-3S

Applications

## Transformer Differential Protection

SEL-787-3E
Protect 3-winding/3-terminal transformers. Select options for phase voltage and neutral current inputs. Add communications and I/O options to match your application requirements.
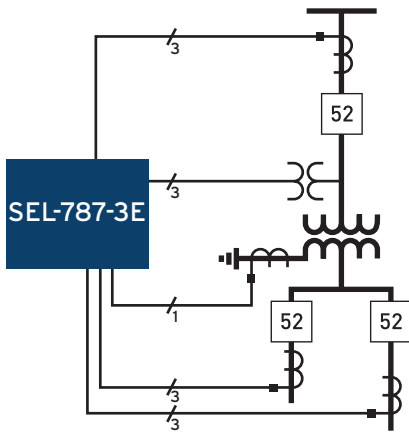
The figure above shows SEL-787-3E with the neutral CT option applied towards REF protection. Additionally, Winding Three in all three models can be configured for REF or differential protection.
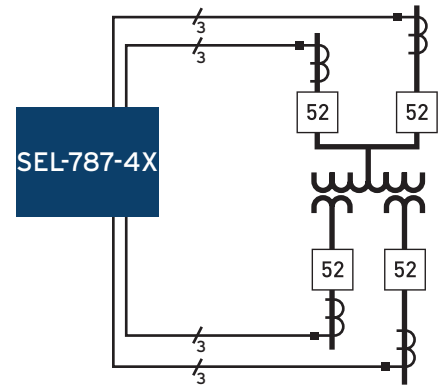
SEL-787-3S
Protect 3-winding/3-terminal transformers. Select options for phase voltage as well as synchronism check (shown in this figure) or station dc battery monitoring. Add I/O and communications options as needed.
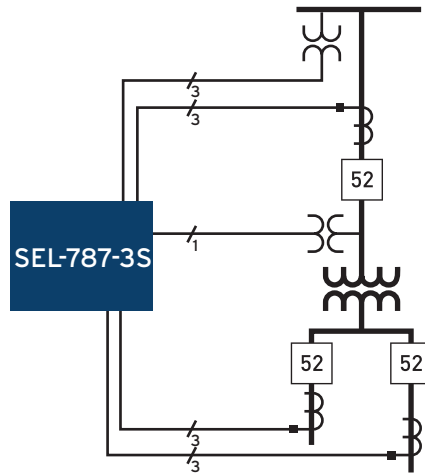
SEL-787-4X
Protect 4-terminal transformers. Choose from various I/O and communications options for your application.

Integration

Integration/Language Support

Integrate relays using multiple protocol options, and securely manage local and remote access for protection, monitoring, and control. Manage the SEL-787-3/-4 Relays in either Spanish or English through a secure network via serial or Ethernet communications to centrally monitor and manage transformers, share data between substations, and integrate relays inside the control house. Supported protocols include:

- IEC 61850
- Mirrored Bits
- IEC 60870-5-103
- SNTP
- DNP3
- Telnet
- Modbus
- FTP
- ASCII

```
=>>aju l

Ajustes Logica Grupo 1

Habilitadores de SELogica

SELOGICA LATCHES (N,1-32)
VS/TEMPORIZADORES (N,1-32)
CONTADORES SELOGICA (N,1-32)
VAR MATEMATICAS (N,1-32)

Ecuaciones Latch Bits

SET01   := R_TRIG SV01T AND NO
?
RST01   := R_TRIG SV01T AND LT
?
SET02   := ( PB02 AND R_TRIG S
           52A2 AND LT06 ) OR
?
RST02   := SV03T OR R_TRIG SV0
SET03   := ( PB03 AND R_TRIG S
           ) OR ( 52A3 AND LT0
?
RST03   := ( SV04T OR R_TRIG S
?
SET04   := NA
RST04   := NA
?
SET05   := PB05 AND R_TRIG SV0
?
RST05   := ( PB05 OR PB06 OR P
SET06   := PB06 AND R_TRIG SV0
?
RST06   := ( PB05 OR PB06 OR P
SET07   := PB07 AND R_TRIG SV0
?
RST07   := ( PB05 OR PB06 OR P
?
SET08   := NA
RST08   := NA
?

Ajustar VS/Temporizadores

ACTIVAR TEMPOR VS (0.00-3000.0
DEACTIVAR TEMPOR VS (0.00-3000
Entrada VS (SELogic)
SV01    := 50P31P
?
ACTIVAR TEMPOR VS (0.00-3000.0
DEACTIVAR TEMPOR VS (0.00-3000
Entrada VS (SELogic)
SV02    := SV01T
?
ACTIVAR TEMPOR VS (0.00-3000.0
DEACTIVAR TEMPOR VS (0.00-3000
Entrada VS (SELogic)
SV03    := SV02T
?
```

```
=>>aju r

Reporte Ajustes de

Criterio Activacion SER

Activar Auto Eliminacion (Y,N)          ESERDEL := N        ?

Listas Arranques SER
SERn = Hasta 24 elementos Relay-Word separados por espacios o comas.
Use NA para dehabilitar el ajuste. SP

SER1    := 87R 87R1
SER2    := TRIP
?
SER3    := TRIPXFMR
?
SER4    := SALARM
?

Aliases Relay-Word Bit
ALIASn = 'RW Bit'(espacio)Alias(espacio)'Texto Activado'(espacio)'Texto Desactiv
ado'.
Texto Alias, Activado, Desactivado puede tenet hasta 15 caracteres.
Use NA para desactivar ajuste.

Enable ALIAS (N,1-20)                    EALIAS  := 3        ?
ALIAS1  := PB01 FP_LOCK PICKUP DROPOUT
ALIAS2  := PB02 FP_CLOSE PICKUP DROPOUT
?
ALIAS3  := PB03 FP_TRIP PICKUP DROPOUT
?

Ajustes Reporte Eventos

ARRANCAR EVENTO (SELogic)
ER      := 0
?
LONGITUD EVENTO (15,64,180 cic)          LER     := 15       ?
LONGITUD PREFALLA (1-10 cic)             PRE     := 1        ?

Activar Fst Msg R
FMRnNAM = Caracteres validos.
FMRN = Hasta 24 Cantidades Analogicas separadas por espacios o comas.
Use NA para desactivar ajuste.

Nombre FMR1 (9 caracteres)               FMR1NAM := FMR1     ?
Leer Fast Message FMR1 (24 cantidades analogicas)
FMR1    := NA
?
Nombre FMR2 (9 caracteres)               FMR2NAM := FMR2     ?
Leer Fast Message FMR2 (24 cantidades analogicas)
FMR2    := NA
?
Nombre FMR3 (9 caracteres)               FMR3NAM := FMR3     ?
Leer Fast Message FMR3 (24 cantidades analogicas)
```

SEL-787-3/-4 Specifications

General	
AC Current Inputs	5 A or 1 A nominal
AC Voltage Inputs	300 Vac continuous, 600 Vac for 10 seconds
Output Contacts	The relay supports Form A, B, and C outputs.
Optoisolated Control Inputs	DC/ac control signals: 250, 220, 125, 110, 48, 24 V
Frequency and Phase Rotation	System frequency: 50, 60 Hz Phase rotation: ABC, ACB Frequency tracking: 15–70 Hz (requires ac voltage inputs)

Communications Ports	Standard EIA-232 (2 ports)
	    Location: front panel, rear panel
	    Data speed: 300–38,400 bps
	EIA-485 port (optional)
	    Location: rear panel
	    Data speed: 300–19,200 bps
	Standard multimode fiber-optic port
	    Location: rear panel
	    Data speed: 300–38,400 bps
	Ethernet port (optional)
	    Single/dual 10/100BASE-T copper (RJ45 connector)
	    Single/dual 100BASE-FX (LC connector)

Communications Protocols	SEL, Modbus, DNP3, FTP, TCP/IP, Telnet, SNTP, IEC 61850, IEC 60870-5-103, Mirrored Bits communications, EVMSG, and IEEE C37.118 (synchrophasors)
Processing Specification	AC voltage and current inputs: 32 samples per power system cycle Protection and control processing: 4 times per power system cycle

Power Supply	125/250 Vdc or 120/240 Vac
	    Input voltage range: 85–264 Vac; 85–300 Vdc
	24/48 Vdc
	    Input voltage range: 19.2–60.0 Vdc

Operating Temperature	−40° to + 85°C (−40° to +185°F) Note: LCD contrast is impaired for temperatures below −20°C (−4°F) and above +70°C (+158°F).