SCHWEITZER ENGINEERING LABORATORIES, INC.
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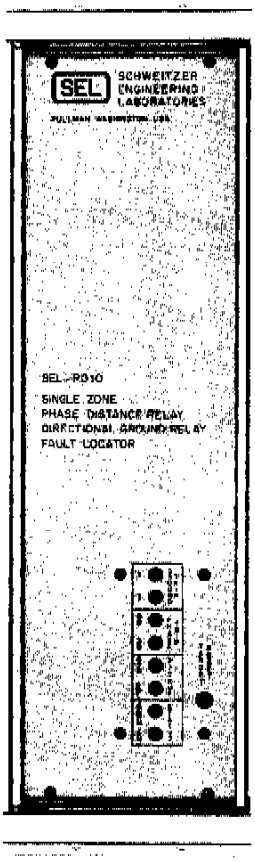
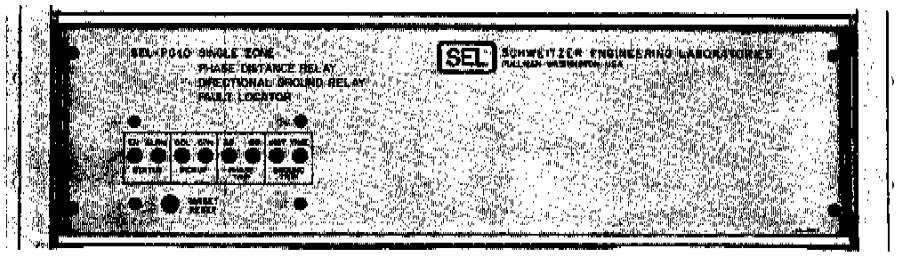
SEL-PG10

Also Available In LOW-PROFILE Package

SINGLE-ZONE PHASE DISTANCE RELAY GROUND DIRECTIONAL OVERCURRENT RELAY AND FAULT LOCATOR





* ONE ZONE OF PHASE DISTANCE PROTECTION
* INSTANTANEOUS GROUND OVERCURRENT PROTECTION
* RESIDUAL TIME-OVERCURRENT ELEMENT WITH SELECTABLE CURVES
* NEGATIVE- AND ZERO-SEQUENCE GROUND DIRECTIONAL ELEMENTS
* PHASE AND GROUND TIMERS PROVIDE ZONE OR BACKUP COORDINATION
* PROGRAMMABLE OUTPUT LOGIC FOR FLEXIBLE APPLICATION
* FIVE CONTACT INPUTS FOR MONITORING EXTERNAL EVENTS
* FAULT LOCATING * EVENT REPORTING * METERING
* AUTOMATIC SELF TESTING * RS232C COMMUNICATIONS

GENERAL DESCRIPTION

The SEL-PG10 ONE-ZONE PHASE DISTANCE RELAY AND GROUND DIRECTIONAL OVERCURRENT RELAY WITH FAULT LOCATOR provides a single zone of high-speed and time-delayed protection for transmission and distribution lines and cables. It combines a single-zone polyphase distance relay (21P) with a directional instantaneous residual-overcurrent relay and a time-overcurrent relay (67NI and 67NT), yet occupies less panel space than a single zone-packaged electromechanical distance relay.

It is designed to replace one electromechanical zone-packaged relay in upgrade applications where the benefits of backup ground protection, fault locating, event reporting, and remote communications are desired.

Because it occupies less panel space than common electromechanical distance relays, and since it is available in a vertical or horizontal form factor, retrofit is conveniently accomplished with very little effort.

Its low price makes it attractive for use as a fault locator or a backup relay. For backup applications, timers are included for delayed tripping initiated by the phase distance or the instantaneous residual-overcurrent elements.

The SEL-PG10 Relay Function Block Diagram illustrates the basic configuration of the protective capabilities.

Analog inputs from current and voltage transformers are delivered to the protective relaying elements and saved for additional features, such as metering and fault locating.

The relay elements process the analog data. Some intermediate logic is performed, such as overcurrent supervision of the mho elements and directional supervision of the residual-overcurrent elements.

The status of the intermediate results and some other information are recorded in the Relay Word.

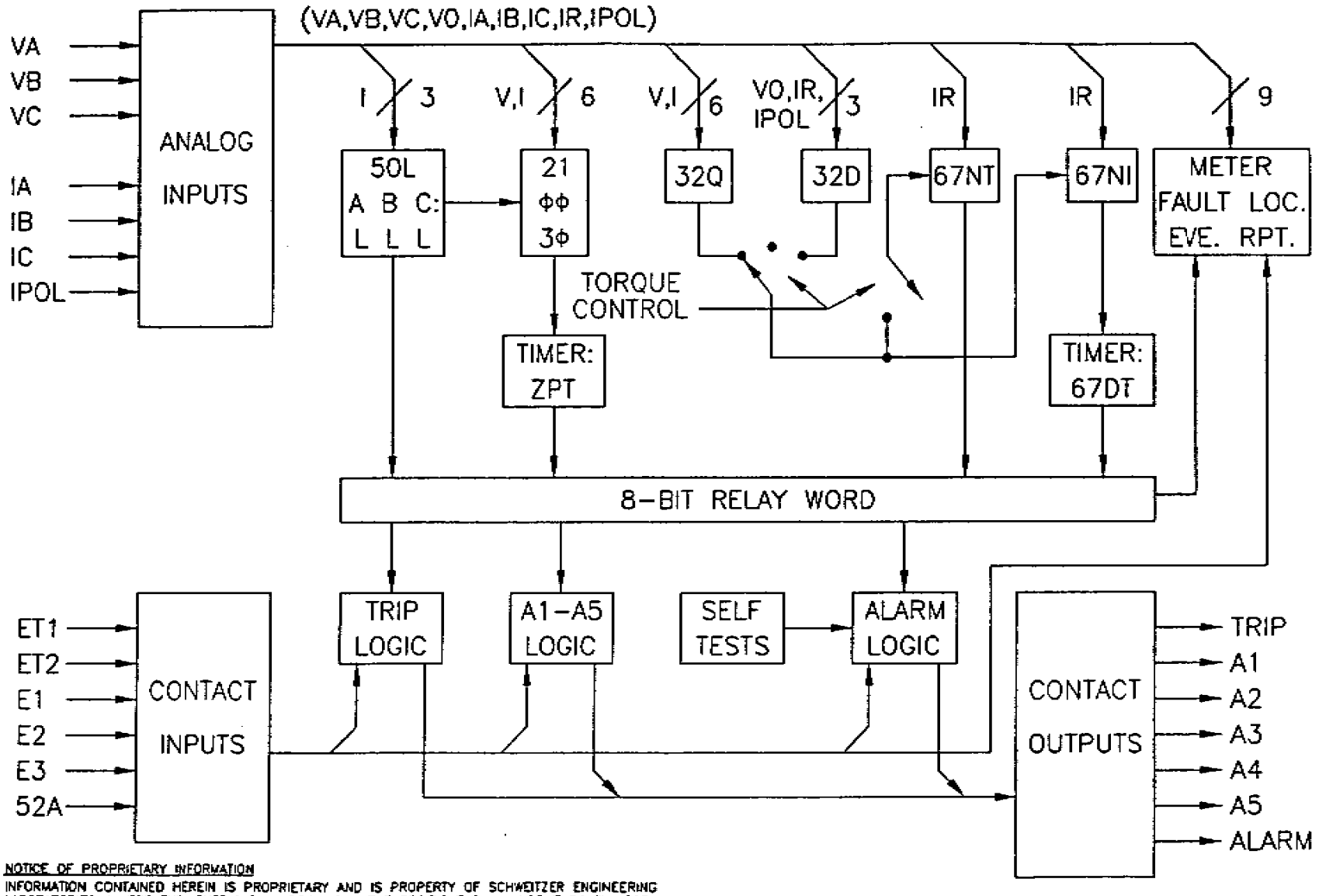
Logic for controlling the output relays uses the Relay Word data. Most of that logic is programmable by logic masks.

APPLICATIONS

The SEL-PG10 relay's event-reporting and fault-locating features economically provide valuable engineering and operating information, eliminating the need for event recorders and oscillographs in most applications. Its instrument transformer burden is negligible.

Time-Step Relaying

The SEL-PG10 relay provides one zone of time-step protection, with separate timers for phase and ground faults.



DWG. A7-0321
DATE: 8/10/88

SEL-PG10 RELAY FUNCTION BLOCK DIAGRAM

Backup Relaying

The SEL-PG10 relay can be applied for phase and ground backup. Its programmability and remote-access capabilities allow the relay settings to be adjusted remotely to meet virtually any contingency.

In line terminals using electromechanical polyphase relays for phase-to-phase and three-phase faults, consider replacing one of the electromechanical relays with an SEL-PG10 relay to obtain phase distance AND ground directional overcurrent protection, fault locating, event reporting, and other features. No additional panel space is required, as the SEL-PG10 relay is available for vertical and horizontal mounting.

Fault Locating and Event Reporting

The SEL-PG10 relay is the most economical approach to adding fault locating and event reporting to line positions already equipped with adequate relaying.

SPECIFICATIONS

Relay Functions
- Mho characteristics for phase-phase and three-phase faults
  - One phase-to-phase zone
  - One three-phase zone
- Residual overcurrent protection for ground faults
  - One instantaneous element
  - One definite time element
  - One time element with four selectable curve shapes
- Negative- and zero-sequence directional elements for ground faults. Zero-sequence element is dual polarized.
- Phase overcurrent elements supervise mho elements.

Relay Elements

Phase overcurrent:
- 50A, 50B, 50C (phase fault detectors)
- Pickup: 0.5 to 40 A, +/- 0.1 A +/- 2% of setting.
- Transient Overreach: 5% of set pickup.

Distance element specifications:

Phase distance:
- 21P: 0.125 to 32 ohms

Three-phase distance:
- 21ABC: 0.125 to 32 ohms

Torque Angle Setting: 47 - 90 degrees in one-degree steps.

Operating times:

Mho elements operate in 10 - 45 ms (25 ms typical), including output relay delay.

A 0 - 2000 cycle timer is provided for the mho elements.

Steady-state Error:
5% of set reach +/- 0.01 ohm at angle of maximum torque for V > 5 V and I > 2 A.

10% of set reach +/- 0.01 ohm at angle of maximum torque for 5 > V > 1 V and 0.5 < I < 2 A.

Mho Transient Overreach:
5% of set reach, plus steady-state error.

Mho Memory polarization:
Three-phase element is memory polarized using voltage from a four-cycle memory.

Ground Overcurrent:

67NT residual time-overcurrent element:
Selectable curve shape (4 curves).
Pickup: 0.25 to 6.3 A, 0.05 A +/- 2% of setting.

67NI residual-overcurrent element:
Pickup: 0.25 A to 48 times 67NT pickup.
Transient overreach: 5% of set pickup.
A 0 - 2000 cycle timer is provided for the 67NI.

Ground Directional Elements:

Negative-sequence directional element:
Angle: same as mho element setting.
Sensitivity: 0.07 to 0.30 VA of negative sequence, depending on distance relay settings, at max torque angle and V2 > 0.17V.

Zero-sequence directional element:
Voltage polarization:
Angle: same as mho element setting.
Sensitivity: (0.5 volts) * (51N pickup setting) in units of zero-seq. volts times residual amps and V0 > 0.17V.
Current polarization:
Angle: Zero degrees.
Sensitivity: (0.5 amps) * (51N pickup setting) in units of residual amps squared and Ipol > 0.5 amps.

Fault Location — Fault location is computed from event reports stored following each fault. Algorithm compensates for prefault current for improved accuracy for high-resistance faults.

Fault Reporting — A data record is retained for each of the 12 most recent faults, which includes current, voltage, relay element, input contact and output contact information. The report may also be triggered by command or contact closure. When tripping occurs after the end of the event report, a second report is triggered at tripping.

Self Testing	Analog AC channel offset errors Stall timer monitors processor Power supply voltage checks Setting checks RAM, ROM, and A/D converter tests
Rated Input Voltage	115 volt nominal phase-to-phase, 3 phase 4 wire connection
Rated Input Current	5 amps per phase nominal 15 amps per phase continuous 390 amps for one second thermal rating
Output Contact Current	30 amp make per IEEE C37-90 para 6.6.2 6 amp carry continuously MOV protection provided
Logic Input Ratings	60 - 200 VDC for 125 VDC relays 25 - 60 VDC for 48 VDC relays Current = 6 mA at nominal voltage
Power Supply	125 Volt: 85 - 200 VAC or VDC; 12 watts 48 Volt: 30 - 60 VDC; 12 watts
Dielectric Strength	Routine tested: V, I inputs: 2500 VAC for 10 seconds Other: 3000 VDC for 10 seconds (excludes RS-232)
Interference Tests	IEEE C37-90 SWC test (type tested) IEC 255-6 interference test (type tested)
Impulse Tests	IEC 255-5 0.5 joule 5000 volt test (type tested)
RFI Tests	Type-tested in field from a 1/4-wave antenna driven by 20 watts at 150 MHz and 450 MHz, randomly keyed on and off, at a distance of 1 meter from relay.
Dimensions	5 1/4" x 19" x 13". Mounts in standard 19" relay rack. Also available for vertical mounting.
Unit Weight	21 pounds
Shipping Weight	32 pounds, including two instruction manuals
Operating Temperature	-20 deg C to + 55 deg C
Burn-in Temperature	Each SEL-PG10 relay is burned in at 60 deg C for 100 hours

Basic Protective Capabilities

The SEL-PG10 relay provides protection for transmission line faults of all types.

Three-Phase Faults:

The three-phase mho element is supervised by three overcurrent elements, which must all pick up. For positive action for close-in three-phase faults, four cycles of memory polarization are provided.

Phase-Phase Faults:

The phase-phase mho element is based on the compensator-distance principle, and has no response for three-phase faults. It is supervised by three overcurrent elements, of which at least one must pick up. A timer is provided which is driven by the phase-phase and three-phase mho elements. It may be used as a zone timer or as a backup-coordination timer. It may also be set to zero when no delay is required.

Ground Faults:

Ground fault protection consists of an instantaneous residual overcurrent element and a residual time-overcurrent element.

Directionality is determined by a negative-sequence directional element and a dual-polarized zero-sequence element. Settings select the negative-sequence element, or neither, either or both sources of zero-sequence polarization. To securely discriminate between forward- and reverse-direction faults, the directional elements have a torque threshold which must be exceeded before the fault direction is declared.

Four curve shapes (moderately inverse, inverse, very inverse, extremely inverse) of the residual time-overcurrent element are user-selectable. This element is either nondirectional or forward-reaching.

LOGIC DESCRIPTION

Relay Elements

single-phase overcurrent relays	50A 50B 50C	(phase fault detectors)
three-phase mho distance	21ABC	
line-line mho distance	21P	
residual time-overcurrent pickup	67NP	T.C. or nondirectional
residual time-overcurrent trip	67NT	T.C. or nondirectional
residual inst-overcurrent	67N	T.C.
negative-sequence directional	32Q	
zero-sequence dual pol directional	32D	

Timers

GTMR	Ground timer for definite-time ground element
PTMR	Phase-phase and three-phase fault timer

Enables From Setting Procedure

32QE	Enables 32Q
32VE	Enables voltage polarization of 32D
32IE	Enables current polarization of 32D
67NTC	Selects directional torque control for time-overcurrent relay

Contact Inputs

EXT1	External trigger 1 for event report
EXT2	External trigger 2 for event report
E1	Event 1
E2	Event 2
E3	Event 3
52A	Circuit breaker monitor

Contact Outputs

TRIP	Circuit breaker trip
A1	Programmable output 1
A2	Programmable output 2
A3	Programmable output 3
A4	Programmable output 4
A5	Programmable output 5
ALARM	System alarm

INTERMEDIATE LOGIC

The logic equations developed below represent combinations of the relay elements and other conditions. In the following equations the "*" indicates logical "and", and the "+" indicates logical "or".

50L = 50A + 50B + 50C	Phase fault current supervision
3P50 = 50A * 50B * 50C	Three-phase fault current supervision
ZABC = 21ABC * 3P50	Three-phase fault
ZP = 21P * 50L	Phase-to-phase fault
DF = 32QF * 32QE + 32DF * 32IE + 32DF * 32VE + NOT(32QE + 32VE + 32IE)	Forward direction

(If 32QE=32VE=32IE=NO then DF=1, i.e., disabling the directional elements makes the ground elements nondirectional.)

67NI = 67N * DF

ZPT = (ZABC + ZP) * PTMR — Phase or three-phase fault timeout

67DT = 67NI * GTMR — Definite-time ground timeout

RELAY WORD

Relay elements and intermediate logic results are represented in an eight-bit relay word. The user selects bits in this word to perform the desired functions for tripping or controlling the five programmable outputs. The selected bits are stored in masks for each function. The user programs the bits in these masks with the LOGIC command.

Relay Word:

50L	ZABC	ZP	ZPT	67NP	67NT	67NI	67DT

The use of the relay word and programmable masks provides the user with great flexibility in applying the SEL-PG10 relay, without rewiring panels or changing jumpers on circuit boards.

OUTPUT EQUATIONS

The logic for controlling the TRIP output and five output relays (A1-A5) is programmable for flexibility and for testing. The logic is programmed by setting masks for various conditions, which are applied to the general relay word.

The general forms for each of the output equations follow:

Let R = relay word

MT = mask for trip

then: TRIP = R * MT

close TRIP = TRIP
open TRIP = NOT(TRIP) * NOT(52A + TARGET RESET button pushed) * (60 ms minimum TRIP)

A1 = R * MA1
A2 = R * MA2
A3 = R * MA3
A4 = R * MA4
A5 = R * MA5

The "*" symbol indicates logical "and", and the "+" indicates logical "or".

The function of the ALARM output relay is fixed. It responds to self-test failures, to setting changes, and to password violations.

SETTING PROCEDURE

The SET command invokes the relay setting procedure. Each setting is presented and prompted for in turn. If a new setting value is desired, it is entered in response to the appropriate prompt, while just pressing carriage return retains the old setting and prompts for the next one.

In the example shown, only the XO value was changed. It was changed from 259.40 to 248.57. Note that the new value of 248.57 is presented at the end of the procedure before enabling, along with all other settings. This provides a final inspection for typographical or other errors.

As a convenience, the operator could have typed END in response to the prompt for Line Length (or any other setting except Relay ID), and gone directly to the final presentation of settings, without having to scroll through the rest of the prompts.

```
=>>SET

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

ID    : Example 230 kV Line                ?

R1    : (Ohms pri)..... = 13.90    ?
X1    : ..... = 79.96    ?
R0    : ..... = 41.50    ?
X0    : ..... = 259.40   ? 248.57 <- operator changes X0
LL    : Line Length (mi)..... = 100.00   ?        <- could type END here

CTR   : ..... = 200.00   ?
PTR   : ..... = 2000.00  ?
MTA   : Max Torque Angle (deg) = 80.80    ?
LOCAT: Locate faults (Y/N)... = Y         ?

Z%    : Reach (% line)..... = 80.00    ?
PTMR  : Dly-Phase (cyc)..... = 0.00    ?
50L   : PU (Amps pri)..... = 100.00   ?

67NP  : PU (Amps pri)..... = 100.00   ?
67NTD: Time Dial..... = 3.00    ?
67NC  : Curve (1,2,3,or4)..... = 2         ?
67NTC: Torque Ctrl (Y/N) .... = Y         ?

67NIP: PU (Amps pri)..... = 1000.00  ?
GTMR  : Dly-Gnd (cyc)..... = 0.00    ?

32QE  : Enable (Y/N)..... = N         ?
32VE  : ..... = Y         ?
32IE  : ..... = Y         ?

TIME1: Port 1 timeout (min).. = 5         ?
TIME2: ..... = 0         ?
AUTO  : Auto port (1,2)..... = 2         ?
RINGS: (1-30)..... = 3         ?
```

```
New settings for: Example 230 kV Line

R1   =13.90    X1   =79.96    R0   =41.50    X0   =248.57   LL   =100.00
CTR  =200.00   PTR  =2000.00  MTA  =80.80    LOCAT=Y
Z%   =80.00    PTMR =0.00     50L  =100.00
67NP =100.00   67NTD=3.00     67NC =2        67NTC=Y
67NIP=1000.00  GTMR =0.00
32QE =N        32VE =Y        32IE =Y
TIME1=5        TIME2=0        AUTO =2        RINGS=3


OK (Y/N) ? Y
Please wait...
Enabled
```

SAMPLE EVENT REPORT

Example 230 kV Line Date: 7/28/88 Time: 11:22:11.329

FID=SEL-PG10-R100-V656mpc-D880724

	Currents (amps)				Voltages (kV)			Relays	Outputs	Inputs
IPOL	IR	IA	IB	IC	VA	VB	VC	52266 01177 P3PIT	TAAAAAA P12345L	EEEEE5 TT1232 12 A
3	0	799	-305	-481	132.8	-52.1	-80.8	*....	.....	.....*
-3	4	-101	736	-632	-16.0	123.0	-106.7	*....	.....	.....*
-3	0	-796	302	485	-132.8	52.0	80.9	*....	.....	.....*
0	-3	98	-739	626	16.0	-123.0	106.7	*....	.....	.....*
6	-1	796	-302	-481	132.9	-52.0	-80.9	*....	.....	.....*
0	3	-101	739	-629	-16.1	123.0	-106.5	*....	.....	.....*
-3	1	-793	305	481	-132.8	52.1	80.9	*....	.....	.....*
0	-4	104	-736	636	16.1	-123.3	106.3	*....	.....	.....*
-3	1	787	-308	-488	132.9	-51.8	-80.7	*....	.....	.....*
3	4	-98	736	-629	-16.2	123.2	-106.5	*....	.....	.....*
3	-2	-790	308	488	-132.9	51.8	80.8	*....	.....	.....*
-3	-3	98	-739	626	16.2	-123.1	106.6	*....	.....	.....*
0	1	793	-305	-485	132.8	-51.9	-80.9	*....	.....	.....*
-3	93	3	683	-591	-16.7	122.8	-106.7	*....	.....	.....*
3	45	-551	160	440	-122.4	56.3	85.2	*....	.....	.....*
3	-620	-591	-374	349	14.2	-123.9	105.7	*...P	...*...	.....*
-6	129	349	-13	-223	104.6	-63.6	-92.5	*...P	...*...	.....*
3	1173	1186	69	-79	-11.4	125.2	-104.5	*...P	...*...	.....*
3	-371	-396	3	25	-96.1	67.1	96.2	*..*P	*..*.*.	.....*
-3	-1309	-1306	-6	9	11.6	-125.1	104.4	*..*P	*..*.*.	.....*
0	397	400	3	-6	94.9	-67.6	-96.7	*..*P	*..*.*.	.....*
-3	1329	1318	-3	0	-11.7	125.2	-104.2	*..*P	*..*.*.	.....*
0	-402	-396	-3	6	-94.7	67.6	96.6	*..*P	*..*.*.	.....
3	-1330	-1325	3	-3	11.7	-125.3	104.2	*..*P	*..*.*.	.....
0	403	400	0	0	94.7	-67.5	-96.6	*..*P	*..*.*.	.....
3	1328	1328	0	3	-11.6	125.3	-104.2	*..*P	*..*.*.	.....
0	-402	-406	0	-3	-94.8	67.5	96.7	*..*P	*..*.*.	.....
-3	-1329	-1321	3	-6	11.7	-125.2	104.0	*..*P	*..*.*.	.....
0	402	406	-3	6	94.8	-67.5	-96.6	*..*P	*..*.*.	.....
0	1330	1318	0	6	-11.9	125.2	-104.1	*..*P	*..*.*.	.....
0	-402	-406	0	-6	-94.7	67.4	96.6	*..*P	*..*.*.	.....
0	-1330	-1318	-3	-3	11.8	-125.3	104.2	*..*P	*..*.*.	.....
-3	403	400	3	3	94.9	-67.3	-96.6	*..*P	*..*.*.	.....
0	1238	1230	0	0	-11.4	125.4	-103.9	*..*P	*..*.*.	.....
6	-449	-440	0	3	-105.1	63.2	92.3	*..*P	*..*.*.	.....
0	-711	-705	0	0	13.9	-124.3	105.2	*...P	...*...	.....
-6	276	271	3	-3	122.6	-56.0	-85.2	*...P	...*...	.....
3	155	151	0	0	-16.6	123.2	-106.5	*...P	...*...	.....
0	-32	-28	-6	-3	-131.5	52.4	81.8	*...P	...*...	.....
-3	-20	-25	0	0	16.5	-123.4	106.3	.....	.....	.....
6	3	6	3	3	132.7	-51.7	-81.3	.....	.....	.....
-3	2	6	0	0	-16.5	123.5	-106.1	.....	.....	.....
-3	1	-3	0	0	-132.8	51.4	81.2	.....	.....	.....
6	-1	3	3	-3	16.6	-123.3	106.0	.....	.....	.....

Event : AG Location : 50.06 mi 4.06 ohms sec
Duration: 6.00 Flt Current: 1382.3

R1 =13.90	X1 =79.96	R0 =41.50	X0 =248.57	LL =100.00			
CTR =200.00	PTR =2000.00	MTA =80.80	LOCAT=Y				
Z% =80.00	PTMR =0.00	50L =100.00					
67NP =100.00	67NTD=3.00	67NC =2	67NTC=N				
67NIP=1000.00	GTMR =0.00						
32QE =N	32VE =Y	32IE =Y					
TIME1=5	TIME2=0	AUTO =2	RINGS=3				

Logic settings:

MT	MA1	MA2	MA3	MA4	MA5
66	40	20	08	04	02

EXPLANATION OF EVENT REPORT

Example 230 kV Line Date: 7/28/88 Time: 11:22:11.329

FID=SEL-PG10-R100-V656mpc-D880724

	Currents (amps)				Voltages (kV)			Relays 52266 01177 P3PIT	Outputs TAAAAAA P12345L	Inputs EEEEE5 TT1232 12 A
IPOL	IR	IA	IR	IC	VA	VB	VC			
3	45	-551	160	440	-122.4	56.3	85.2	*....	.....	.....*
3	-620	-591	-374	349	14.2	-123.9	105.7	*...P	...*...	.....*
-6	129	349	-13	-223	104.6	-63.6	-92.5	*...P	...*...	.....*
3	1173	1186	69	-79	-11.4	125.2	-104.5	*...P	...*...	.....*
3	-371	-396	3	25	-96.1	67.1	96.2	*..*P	*..*.*.	.....*
-3	-1309	-1306	-6	9	11.6	-125.1	104.4	*..*P	*..*.*.	.....*

Event : AG Location : 50.06 mi 4.06 ohms sec
Duration: 6.00 Flt Current: 1382.3

R1 =13.90 X1 =79.96 R0 =41.50 X0 =248.57 LL =100.00
CTR =200.00 PTR =2000.00 MTA =80.80 LOCAT=Y
Z% =80.00 PTMR =0.00 50L =100.00
67NP =100.00 67NTD=3.00 67NC =2 67NTC=N
67NIP=1000.00 GTMR =0.00
32QE =N 32VE =Y 32IE =Y
TIME1=5 TIME2=0 AUTO =2 RINGS=3

Logic settings:

MT	MA1	MA2	MA3	MA4	MA5
66	40	20	08	04	02

Currents and voltages are in primary Amps and KV. Rows are 1/4 cycle apart. Time runs down page. Obtain phasor RMS value and angle using any entry as Y-component, and the entry immediately underneath as the X-component. For example, from bottom rows, IAY = -396, IAX = -1306. Therefore, IA = 1365 amps RMS primary, at an angle of ATAN(-396/-1306) = -163 degrees, with respect to the sampling clock.

<FID>	Firmware Identification Data
<Relays>	Columns show states of internal relay elements ---> Designators 50P : phase overcurrent ..... : 50L ---> * Z13 : 3-phase distance ..... ---> * 21P : 2-phase distance ..... ---> * 67I : inst ground overcurrent : 67NI ---> * 67T : ground time-overcurrent ---> P,T
<Outputs>	Columns show states of output contacts: ON = "*" , OFF = "." TP=TRIP, A1-A5=PROGRAMMABLE, AL=ALARM
<Inputs>	Columns show states of input contacts: ET1=EXTERNAL TRIGGER 1, ET2=EXTERNAL TRIGGER 2, E1-E3=EXTERNAL EVENT, 52A=PCB A-CONTACT
<Event>	Fault type indication is one of the following: AG,BG,CG = single-phase, AB,BC,CA = 2-phase, ABG,BCG,CAG = 2-phase to ground, ABC = 3-phase followed by a "T" if a TRIP triggered the report Other indication is EXT = externally or otherwise triggered
<Location>	Distance to fault in miles. 999999 is indeterminate distance
<ohms sec>	Distance to fault in secondary ohms. 999999 is indeterminate
<Duration>	Fault duration determined from relay element(s) pickup time
<Flt Current>	Max phase current (primary amps) taken near middle of fault
R1,X1,R0,X0	Primary series impedance settings for transmission line
LL	Line length corresponding to specified line impedances
CTR, PTR	Current and potential transformer ratios (XTR:1)
MTA	Maximum torque angle for mho elements
LOCAT	Enable or disable fault locator (Y/N)
Z%	Reach of 3- and 2-phase mhos, percent of line length (LL)
PTMR	Phase fault timer for 3- and 2-phase faults
50L	Phase-overcurrent setting
67NP,TD,C,TC	GND time-overcurrent Pickup, Time-Dial, Curve, Torque Control
67NIP	Ground instantaneous-overcurrent pickup setting
GTMR	Ground timer for ground faults
32QE,VE,IE	Ground fault directionality from (V2,I2), or (V0/IP,I0)
TIME1,2	Communications port timeout intervals (automatic log-off)
AUTO	Port assignment for automatic message transmissions
RINGS	Number of rings to wait before modem answers telephone
<Logic settings>	See LOGIC command for a description of mask settings

SAMPLE COMMAND DISPLAYS

=>>HISTORY

The date, time, and type of event are shown for each of the twelve most recent events. If the event is a fault, the distance, duration, and current are shown. An example of the display is shown below:

Example 230 kV Line Date: 7/28/88 Time: 01:45:40

#	DATE	TIME	TYPE	DIST	DUR	CURR
1	7/28/88	09:03:01.092	AG	100.21	7.25	798.1
2	7/28/88	09:02:11.167	AG	74.97	4.00	1022.0
3	7/28/88	09:02:10.962	AG	25.21	7.25	2120.9
4	7/28/88	09:00:13.345	BC	25.52	7.25	3167.6
5						
6						
7						
8						
9						
10						
11						
12						

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

=>>METER

Example 230 KV Line Date: 7/28/88 Time: 13:27:05

	A	B	C	AB	BC	CA
I (A)	994	995	994	1723	1724	1724
V (kV)	134.4	134.3	134.2	233.1	232.8	232.9

P (MW)	350.91
Q (MVAR)	67.82

P and Q are positive when the power flow is in the direction of the reach of the relay, i.e., out from the bus and into the line.

=>>STATUS

Example 230 KV Line Date: 7/28/88 Time: 11:04:56

SELF-TESTS

W=Warn F=Fail

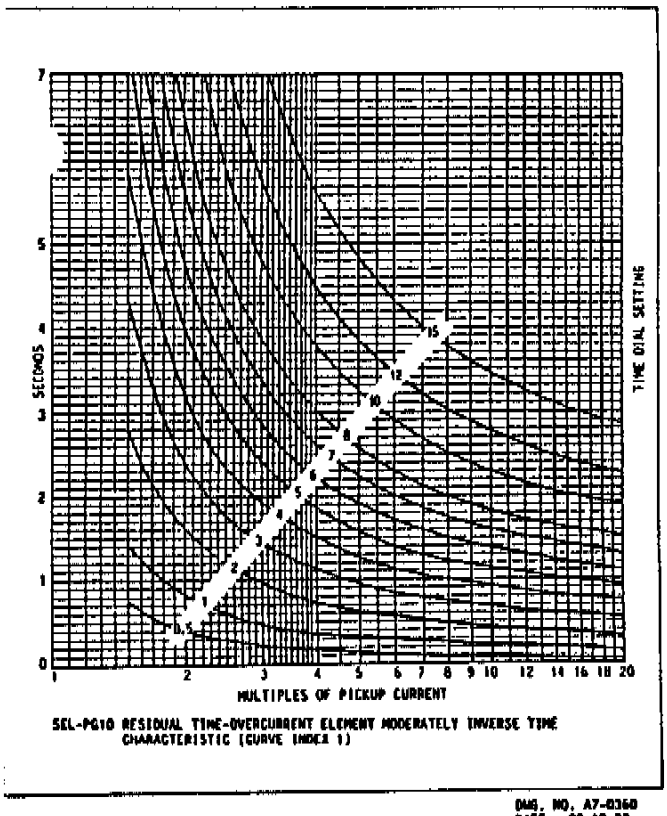
	IP	IR	IA	IB	IC	VA	VB	VC
OS	0	0	2	2	4	-2	-2	-2
PS	4.99		15.14		-14.85			
RAM	ROM		A/D		MOF	SET		
OK	OK		OK		OK	OK		

=>>TARGETS

The eight-LED display on the front panel can be programmed to show targets (default), Relay Word bits, contact inputs and contact outputs, as shown below. This feature is especially useful for testing individual relay elements.

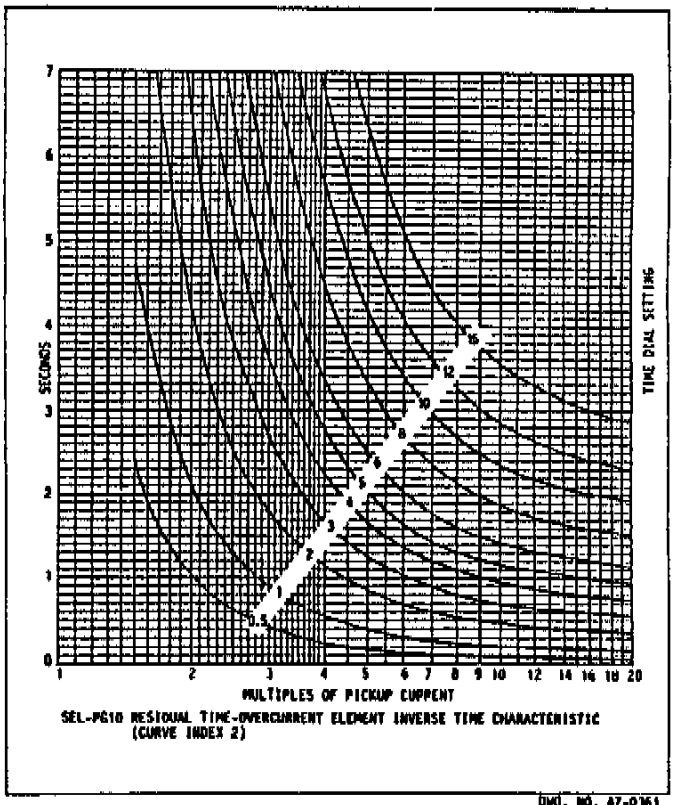
LED:	1	2	3	4	5	6	7	8	
N									
0	EN	ALRM	50L	67N	3-PH	2-PH	INST	TIME	RELAY TARGETS
1	50L	ZABC	ZP	ZPT	67NP	67NT	67NI	67DT	RELAY WORD #1
2			52A	E3	E2	E1	EXT2	EXT1	CONTACT INPUTS
3		TRIP	A1	A2	A3	A4	A5	ALRM	CONTACT OUTPUTS

The front panel targets can be reset and cleared remotely or locally using the target command. Type "TARGET R <RETURN>" to reset and clear the targets.



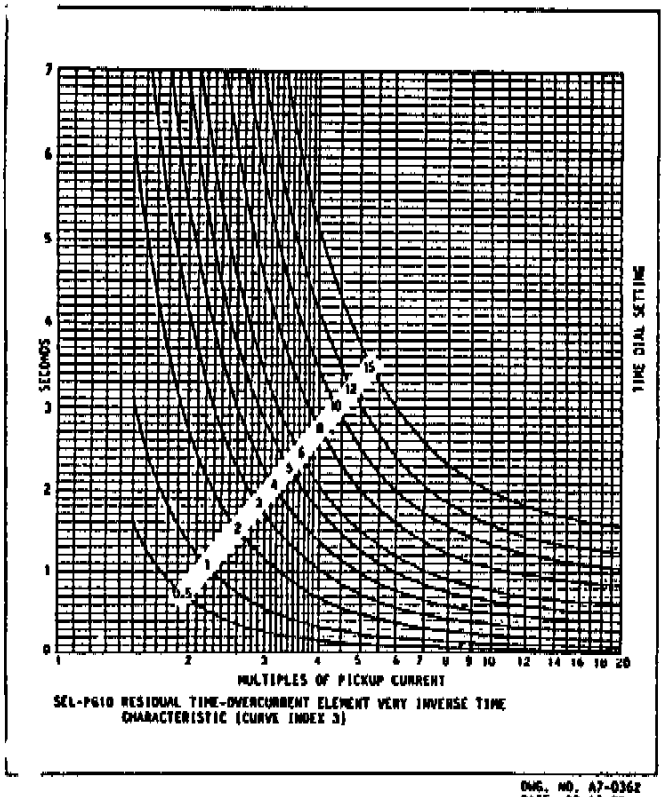
SEL-PG10 RESIDUAL TIME-OVERCURRENT ELEMENT MODERATELY INVERSE TIME CHARACTERISTIC (CURVE INDEX 1)

DWG. NO. A7-0360
DATE: 09-13-88



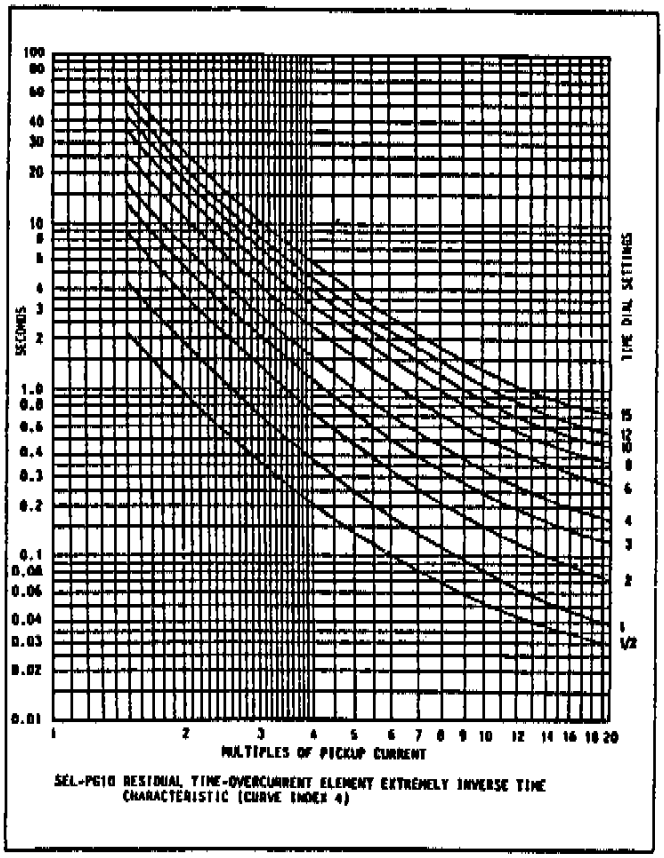
SEL-PG10 RESIDUAL TIME-OVERCURRENT ELEMENT INVERSE TIME CHARACTERISTIC (CURVE INDEX 2)

DWG. NO. A7-0361
DATE: 09-13-88



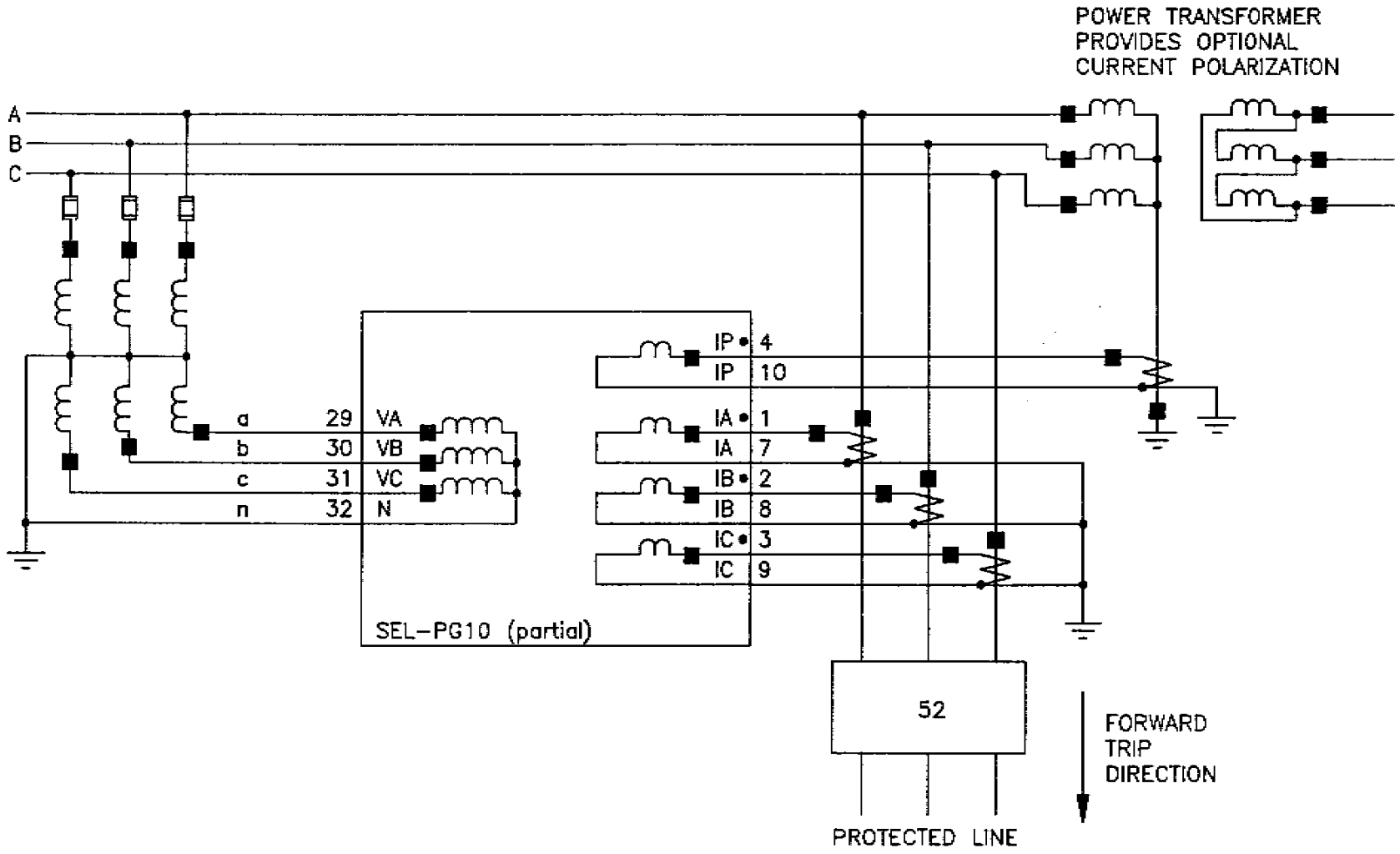
SEL-PG10 RESIDUAL TIME-OVERCURRENT ELEMENT VERY INVERSE TIME CHARACTERISTIC (CURVE INDEX 3)

DWG. NO. A7-0362
DATE: 09-13-88



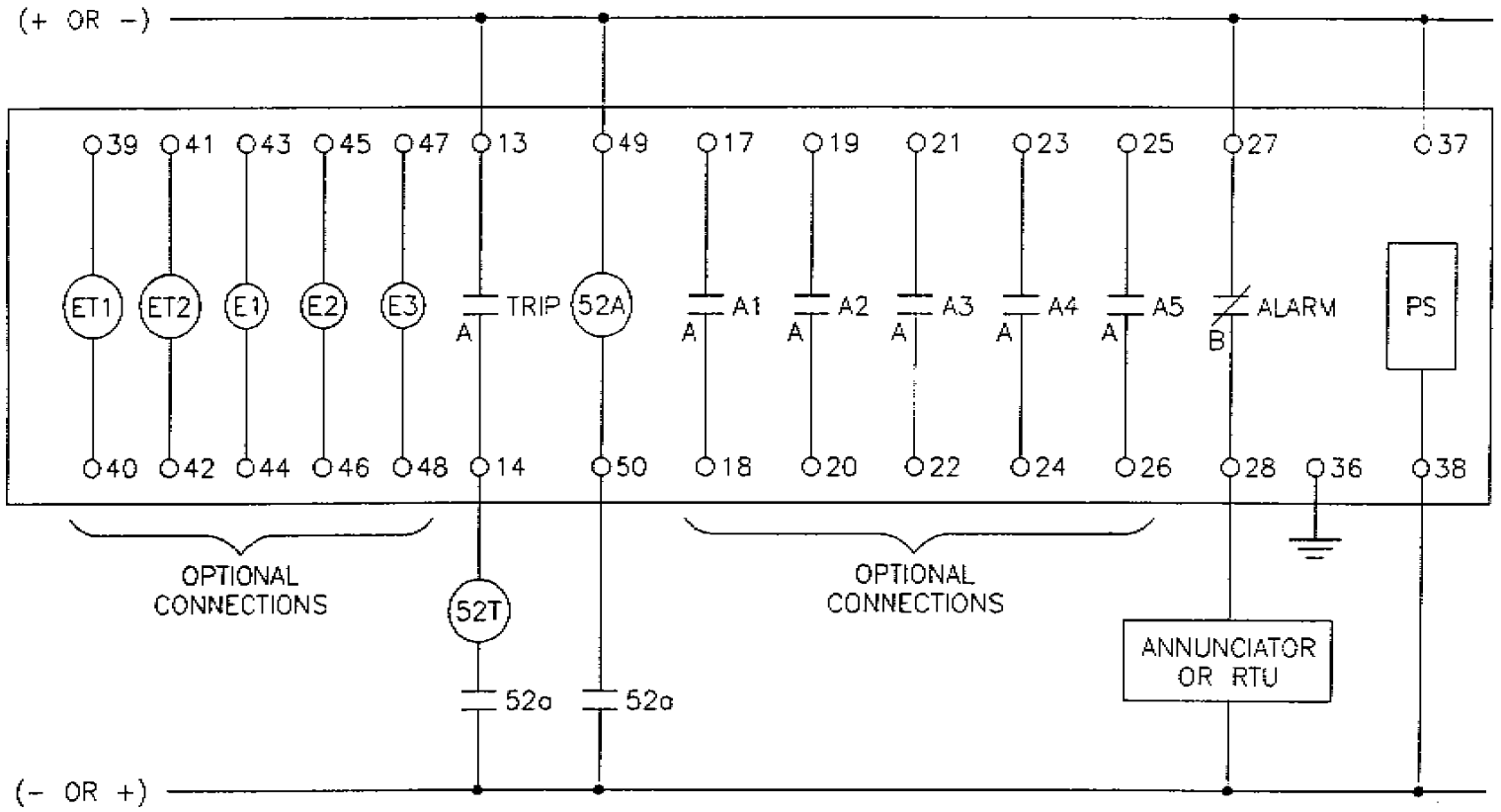
SEL-PG10 RESIDUAL TIME-OVERCURRENT ELEMENT EXTREMELY INVERSE TIME CHARACTERISTIC (CURVE INDEX 4)

DWG. NO. A7-0363
DATE: 09-13-88



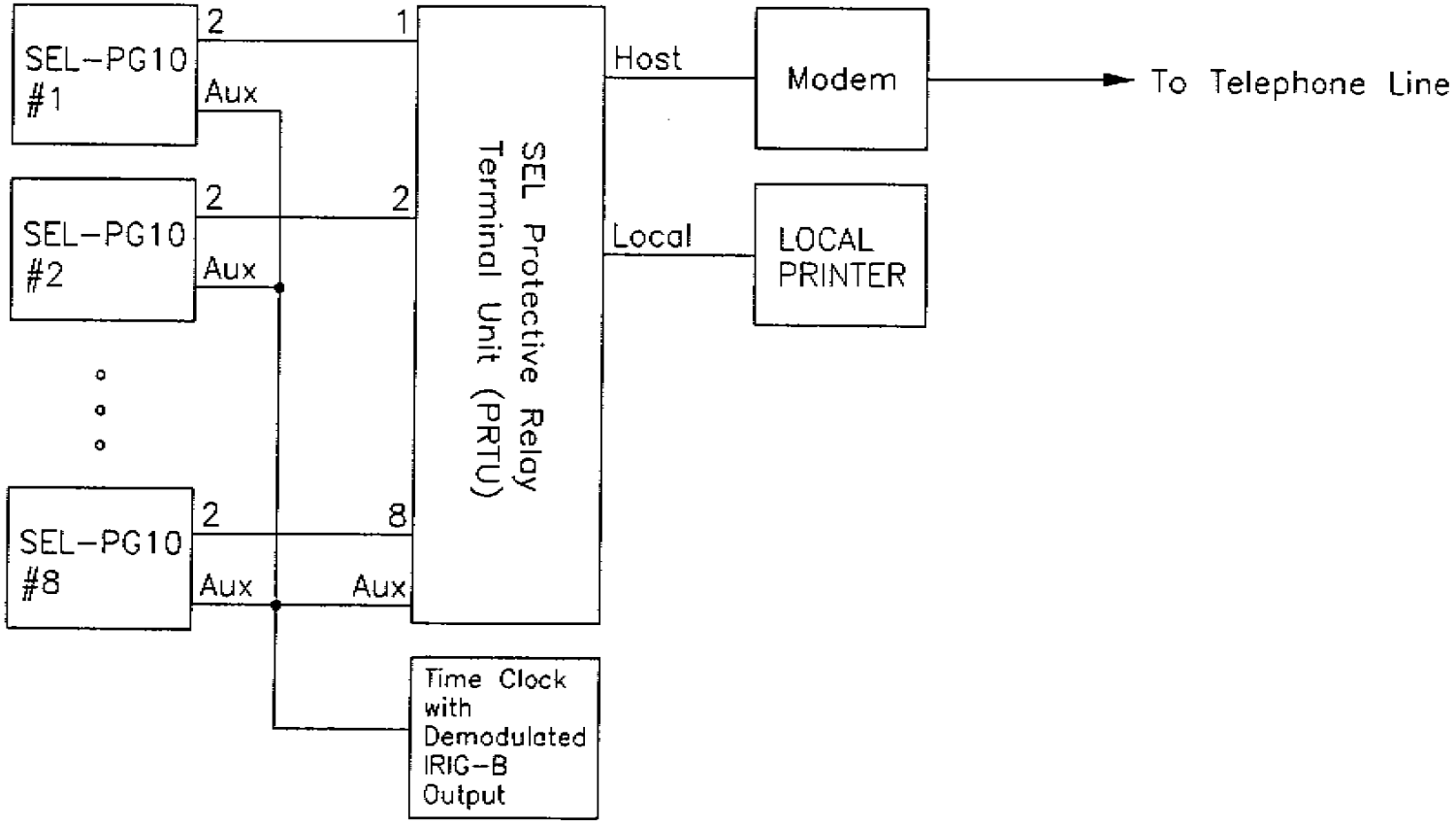
SEL-PG10 EXTERNAL CURRENT AND VOLTAGE CONNECTIONS

DWG. NO. A7-0322
DATE: 08-30-88



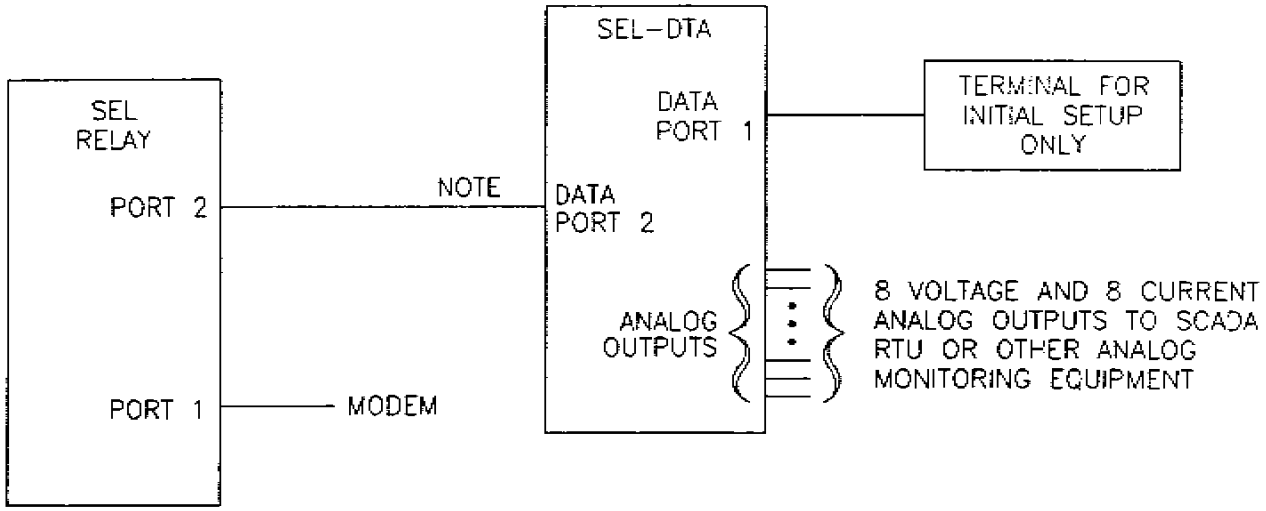
SEL-PG10 DC EXTERNAL CONNECTION DIAGRAM (TYPICAL)

DWG. NO. A7-0350
DATE: 10-12-88



SEL-PG10 COMMUNICATIONS AND CLOCK CONNECTIONS
MULTIPLE UNITS AT ONE LOCATION

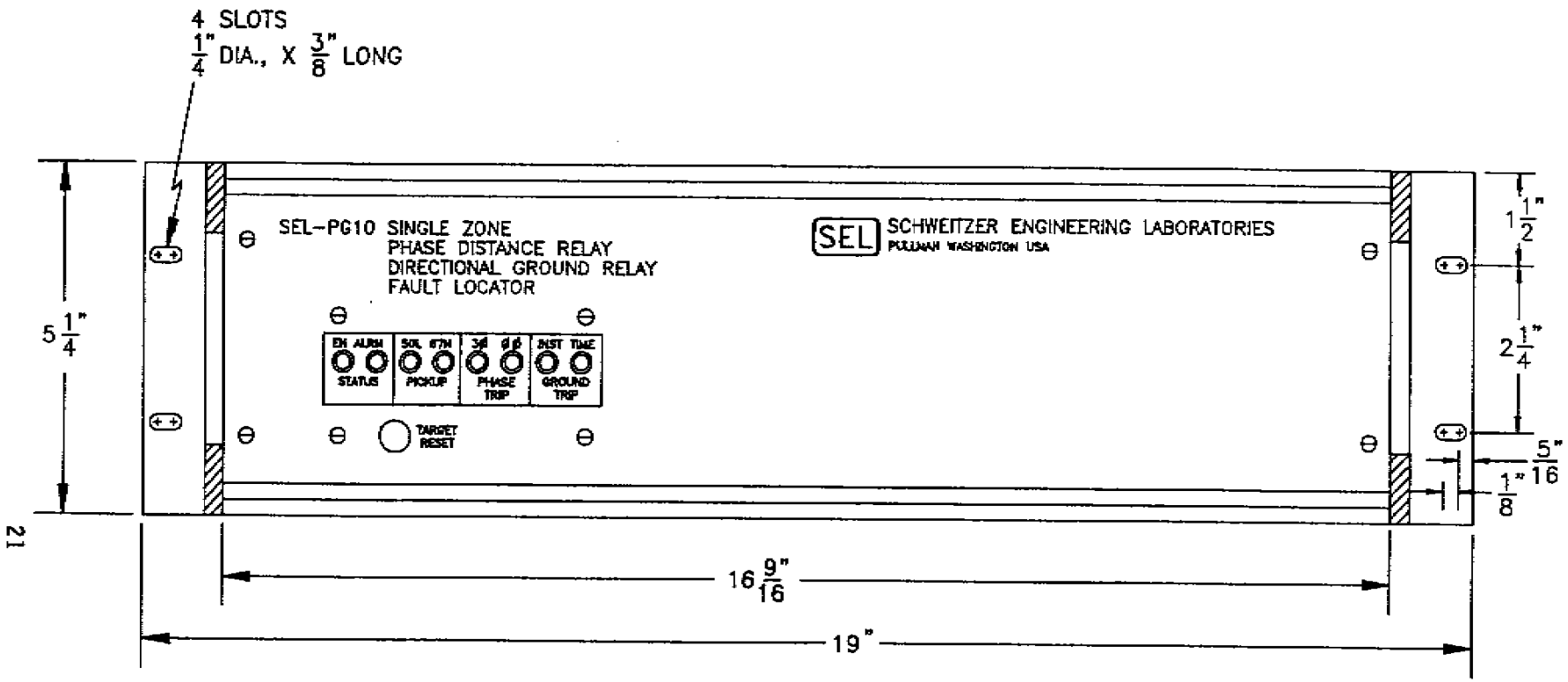
DWG. NO. A7-0324
DATE: 08-30-88



NOTE: SEL-DTA DISPLAY/TRANSDUCER ADAPTER (DTA)
DATA AND CONTROL POWER

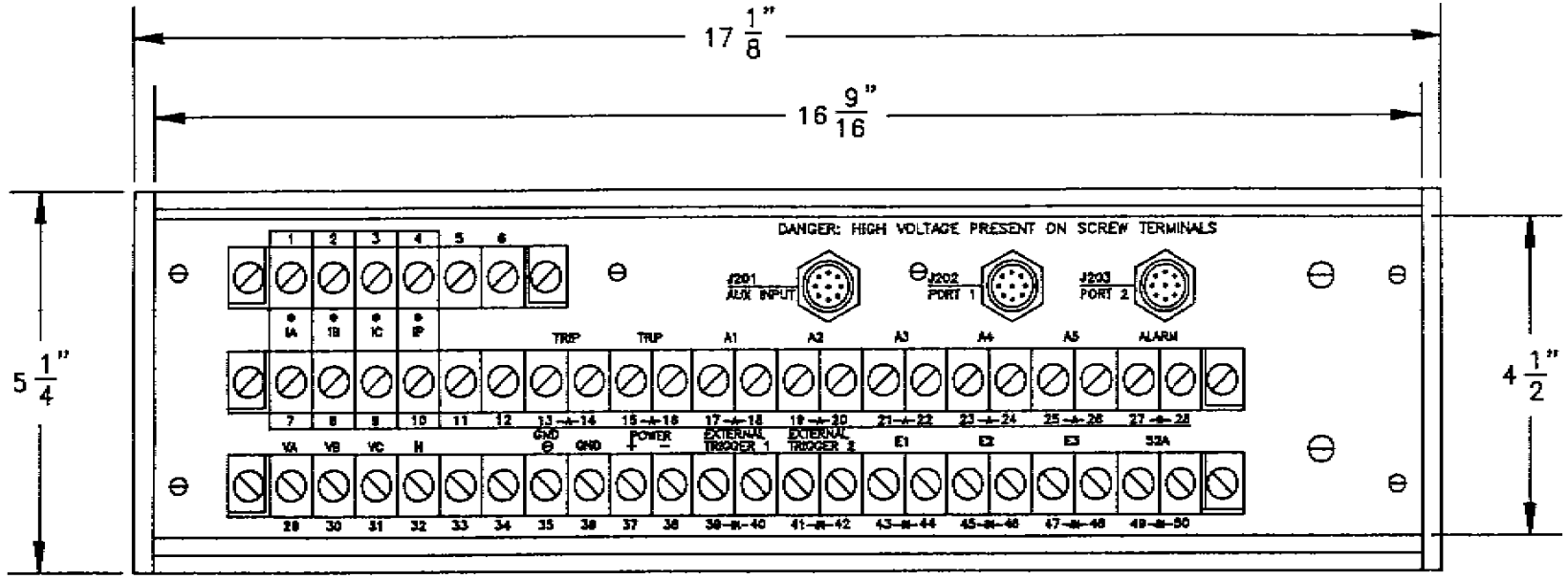
SEL RELAY COMMUNICATIONS DIAGRAM FOR CONNECTION TO THE SEL-DTA

DWG. NO. A7-0413
DATE: 10-07-88



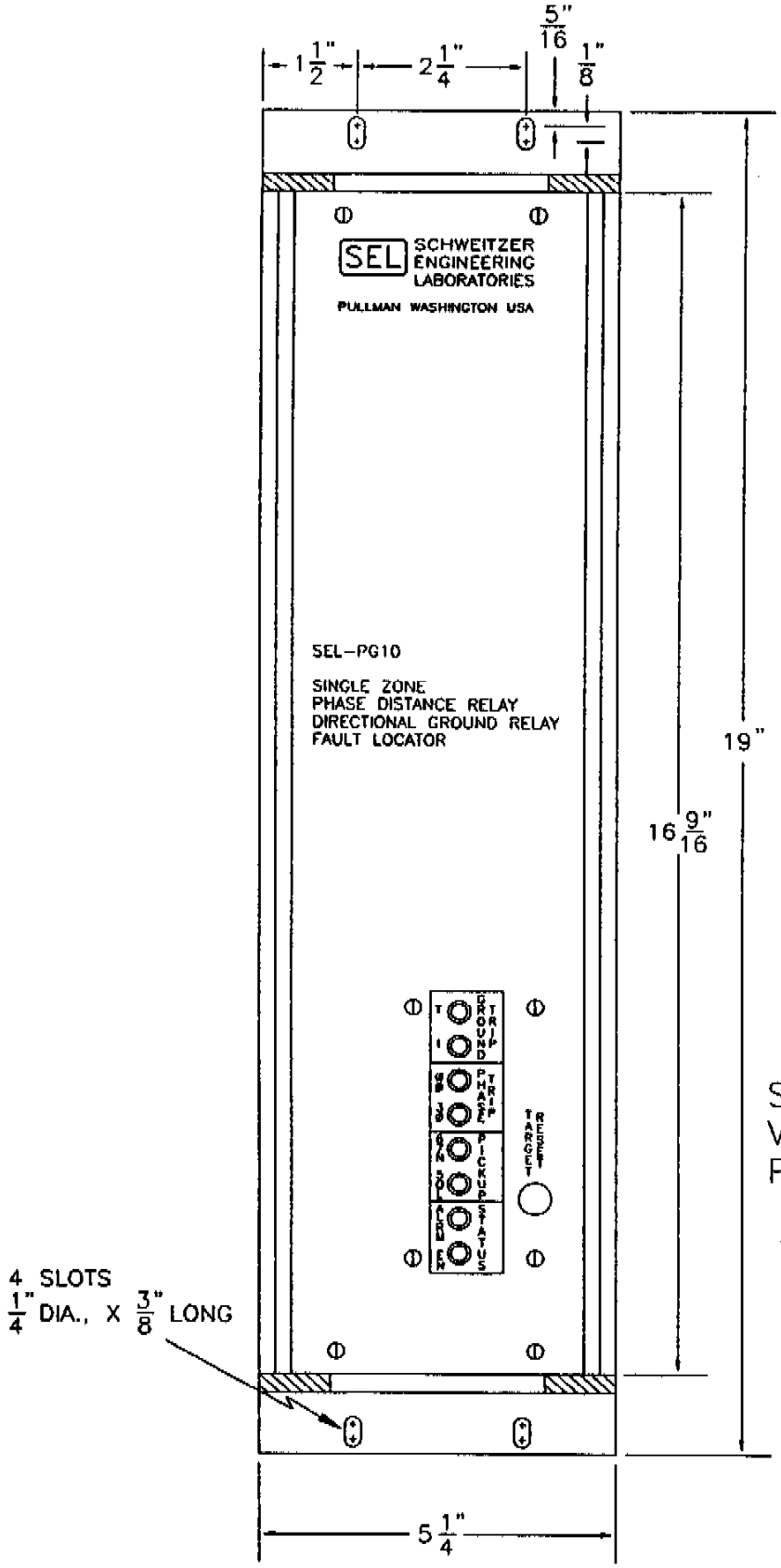
SEL-PG10 HORIZONTAL FRONT PANEL DRAWING

DWG. NO. A7-0327
DATE: 08-18-88



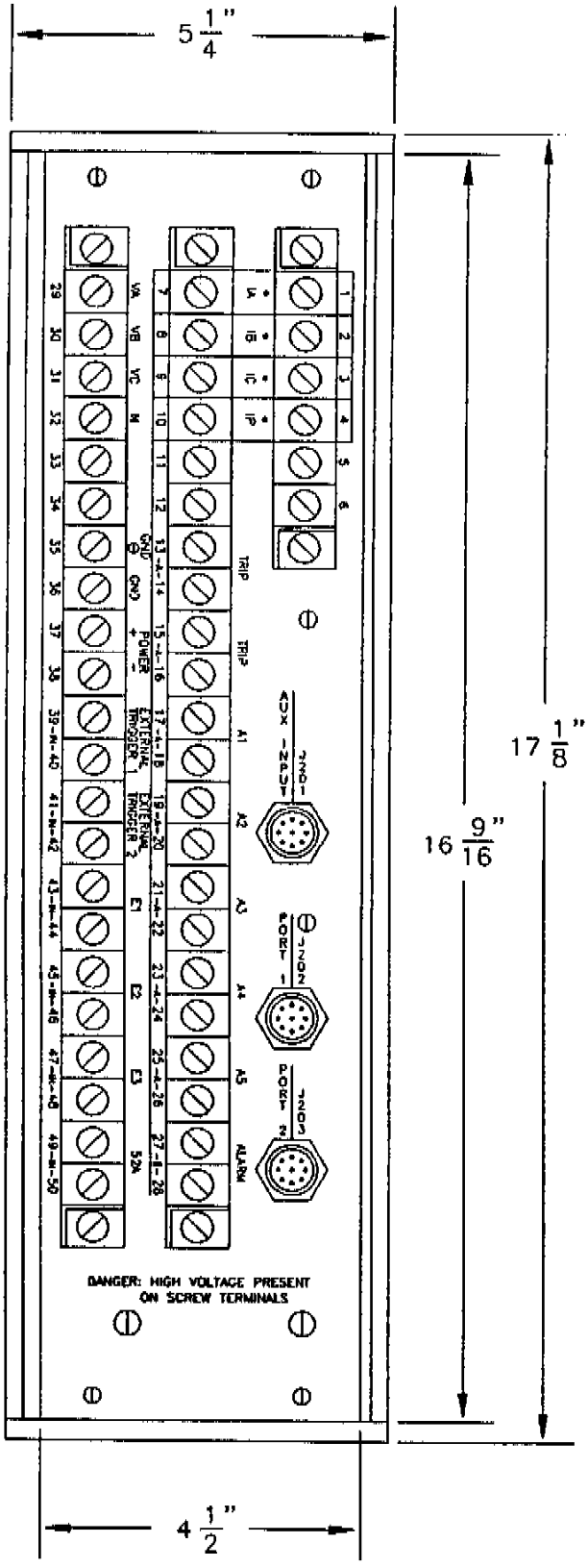
SEL-PG10 HORIZONTAL REAR PANEL DRAWING

DWG. NO. A7-0326
DATE: 08-26-88



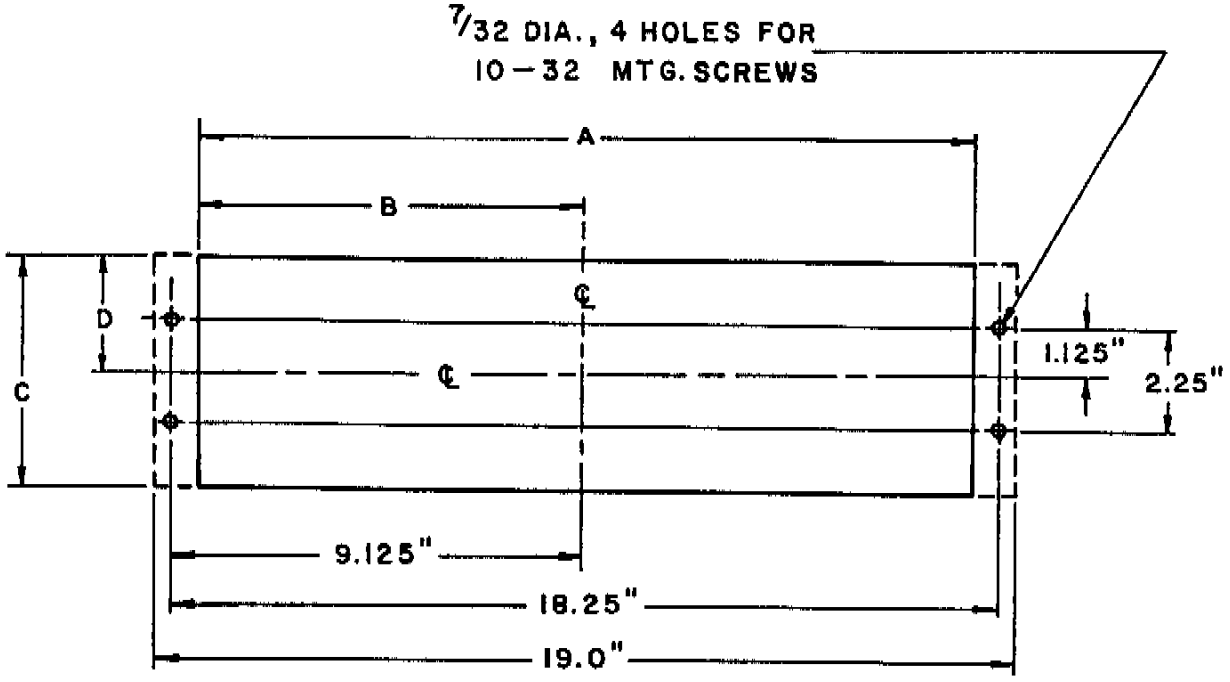
SEL-PG10 VERTICAL FRONT PANEL DRAWING

DWG. NO. A7-0329
DATE: 08-26-88



SEL-PG10 VERTICAL REAR PANEL DRAWING

DWG. NO. A7-0328
DATE: 08-18-88



DIMENSION A:
CASE: 17.00"
CUT OUT: 17.25" - 17.875"
17.375" PREFERRED

DIMENSION B:
CASE: 8.5"
CUT OUT: 8.625" - 8.9375"
8.688" PREFERRED

DIMENSION C:
CASE: 5.25"
CUT OUT: 5.35" - 5.45"

DIMENSION D:
CASE: 2.625"
CUT OUT: 2.675" - 2.725"

NOTE: ALL INSTRUMENTS MAY BE MOUNTED HORIZONTALLY (AS SHOWN) OR VERTICALLY.

PANEL CUTOUT AND DRILL PLAN FOR SEMI-FLUSH MOUNTING OF 5.25 INCH HIGH CASE

DWG. NO. A7-0174
DATE 5/11/87 JS
REV. 3/9/88

SEL-PG10 DISTANCE RELAY/FAULT LOCATOR COMMAND SUMMARY

Level 0

ACCESS Answer password prompt (if password protection enabled) to gain access to Level 1. Three unsuccessful attempts pulses ALARM relay.

Level 1

2ACCESS Answer password prompt (if password protection enabled) to gain access to Level 2. This command always pulses the ALARM relay.

DATE Show or set date. DAT 2/3/86 sets date to Feb. 3, 1986. This setting is overridden when IRIG-B synchronization occurs. Pulses the ALARM relay and illuminates the ALRM LED momentarily when a different year is entered than the one previously stored.

EVENT Show event record. EVE 1 shows long form of most-recent event.

HISTORY Show DATE, TIME, EVENT TYPE, FAULT LOCATION, DURATION, and CURRENT for the 12 most-recent faults.

IRIG Force immediate execution of time-code synchronization task.

METER Show primary current, voltage, real and reactive power. METER runs once. METER N runs N times

QUIT Return to Access Level 0 and reset targets to target 0.

SHOWSET Show the relay settings and logic settings -- does not affect the settings. The logic settings are shown in hexadecimal format for each.

STATUS Show self-test status.

TARGETS Show data and set target lights as follows:

TAR 0: Relay Targets	TAR 1: RELAY WORD
TAR 2: Contact Inputs	TAR 3: Contact Outputs

TAR R: Returns to TAR 0 and clears

Be sure to return TAR 0 when done, so LEDs display fault targets.

TIME Show or set time. TIM 13/32/00 sets clock to 1:32:00 PM. This setting is overridden when IRIG-B synchronization occurs.

TRIGGER Trigger and save an event record. (Type of event is EXT).

Level 2

LOGIC* Show or set logic masks MT, MA1-MA5.

PASSWORD Show or set passwords. Pulses the ALARM relay closed and illuminates the ALRM LED momentarily when new passwords are set.
PAS 1 OTTER sets Level 1 password to OTTER.
PAS 2 TAIL sets Level 2 password to TAIL.

SET* Initiate setting procedure.

Use the following to separate commands and their parameters:
space, comma, semicolon, colon, slash.

* ALARM relay closes and ALRM target LED illuminates momentarily while new settings are stored in EEPROM and event data buffers are cleared.

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SEL/11-88