C-3-217-2

INSTRUCTION MANUAL

FEDERAL PIONEER LIMITED

OVERCURRENT TRIP UNIT

TYPE USD

Pin # on Page 9

Prepared by: Charles Ho
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Typed by: dm

FEDERAL PIONEER

OVERCURRENT TRIP UNIT
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1. INTRODUCTION

This Instruction Manual contains descriptive operating, testing and maintenance information for Federal Pioneer Limited Solid State Overcurrent Trip Unit, Type USD for protection of low voltage power systems.

2. DESCRIPTION

2.1 General

The Solid State Overcurrent Trip System Type USD protects low voltage power systems against damage caused by overloads and faults. The types of protection offered are overload, short circuit and ground fault. Zone Selective Instantaneous Protection (ZSIP) is also available for short circuits and ground faults.

The trip unit operates to open a low voltage circuit breaker in accordance with a set of programmable time-current characteristics. Tripping energy for the operation of the circuit breaker is obtained solely from the circuit being protected. Fault indication requires the use of control power.

The components used for the measurement of primary current, for the detection of fault conditions and for the provision for trip energy are semiconductors, capacitors, transformers, etc. Thus, except for the shunt trip, and the mechanical relay contacts for remote fault indication, the trip is completely static.

All parts of this system are designed for conservative loading of components for long life and minimum maintenance. The extensive use of digital and analog integrated circuits make this trip system more accurate, versatile, compact and reliable than electromagnetic trip divices.

The complete solid state overcurrent trip system consists of the following parts:

a) the primary current sensors,
b) the overcurrent relay, and
c) the direct acting shunt trip solenoid.

2.2 Current Sensors

The current sensors interface the USD relay with the power system. The core of the current sensors is tape wound with grain oriented silicon steel. Three current sensors for monitoring the three phase currents are mounted on the primary conductors. The extra sensor required when ground fault protection is provided is mounted on the neutral conductor, or on the ground strap. The sensors selected for a specific circuit breaker establish the rating of that breaker. Each sensor provides a choice of at least two current ratings.

2.3 USD Relay

The USD Relay receives information on the primary current from the current sensors, senses overloads and faults and determines when to initiate tripping in accordance with independent programmable time current characteristics. The power required to activate the direct acting shunt trip solenoid is obtained from the current sensors. After a fault condition has been determined, the relay diverts the output of the phase current sensors, or the output of the neutral sensor from the monitoring circuitry into an energy accumulating circuit which generates a trip pulse.

A single metal enclosure houses the current matching transformers, the power supply, the programmable logic, the programming switches and the output trip pulse generator. The ZSIP system and optional fault indication circuits are also housed in the same enclosure.

Interconnection of the USD relay with the primary current sensors and the shunt trip solenoid is accomplished through a labelled terminal block mounted on the faceplate of the relay. Connections for control power local indication, remote indication and the ZSIP is accomplished by means of a colour coded wiring harness. The wiring harness is attached to a 10 pin connector that plugs and locks into the side of the relay enclosure.

2.4 Shunt Trip

The shunt trip device is a cylindrical solenoid which is mounted in the circuit breaker in such a way that the plunger is held in the reset position by gravity. When the USD relay supplies the solenoid with a trip pulse, the plunger is allowed a specified distance of free travel before striking the trip lever of the circuit breaker.

2.5 Types of Solid State Overcurrent Trip Units

Two basic types of Solid State Overcurrent Trip Units are available. Both types use the current sensors, the appropriate USD relay and the shunt trip solenoid.

The first type provides only overcurrent protection; being equipped with instantaneous, short time and long time elements. The second type, in addition to these functions, also provides ground fault protection and zone selective interlocking protection (ZSIP) for the short time and ground fault elements.

The first type of trip unit utilizes the USD-3 solid state relay. The second type utilizes the USD-6 solid state relay. This relay is available with six different sets of pick up settings for the ground fault element. Both USD-3 and USD-6 relays are available with optional fault indication packages.

3. OPERATION

3.1 General

The functional block diagram of Figure 1 attached, illustrates the operation of the USD relay. Appropriate blocks are eliminated for models not providing ground fault protection and ZSIP.

There are three current sensors on the circuit breaker monitoring the primary phase current. If ground fault protection is required on 3 phase 4 wire power systems, a fourth sensor must be used. The current sensors supply currents to the relay which are proportional to the currents in the primary circuit. These currents are converted to d.c. signals by means of a set of residually connected auxiliary transformers and a set of rectifiers. These signals are used to provide energy for tripping, regulated logic power supply voltage and signals proportional to the gorund and phase currents.

The relay may have up to four pickup elements; INSTANTANEOUS, SHORT TIME, LONG TIME and GROUND FAULT. Each pickup circuit works independently of the other and triggers its corresponding time delay circuit. The instantaneous element has no intentional time delay.

3.2 Overcurrent Elements

Overload and short circuit protection are provided jointly by the LONG TIME, SHORT TIME, and INSTANTANEOUS elements. The signal in the relay which is proportional to the highest of the three phase primary current is compared to preset values in each of the three elements. If it does not exceed any of the preset pickup levels, the relay continues to monitor the system. If the current signals exceed a preset pickup setting, the respective time delay circuit will start timing. When the proper time delay is reached, the relay transfers itself into a fault mode. The output from the phase sensors is diverted totally into the energy accumulating circuit. When enough energy has been accumulated, a trip pulse is supplied to the shunt trip solenoid.

The LONG TIME element has the inverse (I^2t=constant) bands. The SHORT TIME element has four definite time bands which become slightly inverse at low fault levels and an inverse (I^2t=constant) band. The LONG TIME element has ten inverse (I^2t=constant) bands. The INSTANTANEOUS element has no intentional time delay other than that needed by the relay to initialize itself and accumulate trip energy. All I^2t functions are dynamic in behaviour and are continuously adjusting the time rate to the existing maximum phase current during the timing operation.

3.3 Ground Fault Element

The input signal for the GROUND FAULT element is obtained from the residually connected auxiliary transformers in the relay. This allows ground current detection in both 3 phase 3 wire and 4 wire systems. If the ground current signal exceed the preset pickup value, the ground fault time delay circuit starts timing. On reaching the preset time delay, the output trip circuit is activated

The signal output representing the ground current is diverted into the energy accumulating circuit and ultimately discharged into the shunt trip solenoid. When the indication is provided, a trip caused by a ground fault is normally registered by the G.F. indication LED, locally, and by the G.F. normally open contacts, remotely. It should be noted, however, that since ground fault current is also phase current and may therefore be overcurrent, the overcurrent element indicators may also register the fault. The ground fault levels, because of the time needed to accumulate trip energy, and become definite at high ground fault levels.

3.4 The ZSIP Functions

Selectivity between the main breaker and feeder breakers is conventionally obtained by using time coordinated trip devices. The time delay of the trip device furthest downstream is set to minimum and it increases from one zone to the next with the main breaker's trip device having the highest time delay setting. The disadvantage of this method is that as the fault levels increase for zones closer to the main breaker, the time to clear faults in these zones increases, and the power system must endure the high current fault until the time delay expires.

With the trip devices in the ZSIP mode, the trip device that senses a fault in its zone proceeds to trip immediately. It also sends a restraint signal to the upstream trip devices and causes them to revert to their time coordinated protection mode. Therefore instantaneous protection against faults is provided in all zones.

In the USD relay, the ZSIP is available on the SHORT TIME element and the GROUND FAULT element and the operation is based on the above concepts. The transmission of the SHORT TIME restraint and ground fault restraint signals is achieved via one pair of signal wires. This minimizes the number of auxiliary terminals on the breaker and the number of wires needed for this purpose. To achieve transmission of two singals over the same set of wires, the USD relay is equipped with an encoder which conditions the outgoing restraint signals and a decoder to separate the incoming restraint signals and restrain the appropriate elements.

3.5 Selecting Settings

The USD relay has a number of thumbwheel switches that enable the user to program the desired time current protection profile in the field, see Figure 2 attached.

The thumbwheel switches are accessible on the front panel of the relay through a cutout in the faceplate. Each switch is actuated by a knurled thumbwheel and the selected position is indicated by a number ranging from 0 to 9, appearing on the thumbwheel. The correlation between the dial number appearing on each switch and the pickup level or time delay is shown on a table adjacent to each switch. The contact surfaces of these switches are gold plated to assure long lasting and positive electrical contact. Should any switch contact of any element become open, the relay will automatically operate on the highest setting of that element as a backup protection.

All pickup and timing functions are independent of each other. The selection of settings are therefore governed by system design considerations.

Relays incorporating the ZSIP function are equipped with a screw driver actuated, 3 position, rotary switch. This switch, available on the faceplate of the unit, enables the user to program the desired mode of operation. The first position of the switch, marked ZSIP means that both short time and ground fault elements are restrained by downstream relays to prevent instantaneous operation on a downstream fault. The second position, marked G.F. ZSIP, ST, TCP (Time Coordinated Protection) means that there is ZSIP on the ground fault element only and the short time element is self-restrained. The third position marked TCP means that both ground fault and short time elements are self-restrained. It should be noted that the position of this switch has no influence on the restraint out signal of the relay. This feature is useful when the last relay downstream has to be in the TCP mode while upstream relays are in the ZSIP mode.

4. SPECIFICATIONS

4.1 Scope

The specifications cover the USD Solid State Overcurrent Trip System for use on the Federal Pioneer Ltd. low voltage power air circuit breakers .

The trip unit complies with the American National Standard for trip devices for a.c. low voltage circuit breakers (ANSI C37.17-1972).

4.2 Current Sensor Ratings

4.2.1 - 100% continuous current settings are available at;

50A	600A	3000A
70A	800A	3200A
100A	1000A	4000A
150A	1200A	5000A
250A	1600A	6000A
400A	2000A	

4.2.2 - the types of sensors available along with the taps of each sensor and the circuit breaker frame sizes with which these current sensors can be used are given in Table 1 attached.

4.2.3 - the excitation characteristics of the sensors and their secondary d.c. resistance are given in Figure 3 attached.

4.3 Relay Configurations

The models and options available with each model are detailed in Table 2 attached.

4.4 Long Time Element

4.4.1 - Pickup settings available: 0.6X, 0.7X, 0.8X, 0.9X, 1.0X, 1.1X the sensor tap setting.

4.4.2 - Pickup tolerance: ±8% based on symmetrical sinusoidal current at 50/60Hz.

4.4.3 - Time Delay Bands: 10 calibrated bands are provided ranging from

I^2t = 72 seconds to I^2t = 1.080 seconds (I in per unit)

with nominal time delays of 2, 4, 6, 8, 10, 14, 16, 22, 26 and 30 seconds at 600% rated sinusoidal current 50/60Hz.

4.4.4 - Time Delay Tolerance: ± 10 % based on symmetrical sinusoidal current at 50/60Hz.

4.5 Short Time Element

4.5.1 - Pickup settings available: 2X, 3X, 4X, 6X, 8X, and 10X the sensor settings.

4.5.2 - Pickup tolerance: ±8% based on symmetrical sinusoidal current at 50/60Hz.

4.5.3 - Time Delay Bands: Four definite time bands with nominal time delays of 0.11 second, 0.25 second, 0.33 second, 0.45 second and an inverse band I^2t = 19.8 second (I in per unit) with time delay of 0.55 seconds at 600% rated sinusoidal current, 50/60Hz.

4.5.4 - Time Delay tolerance: ±10% based on symmetrical sinusoidal current at 50/60Hz.

4.5.5 - The SHORT TIME delay in the ZSIP mode with no restraint is approximately 50 m seconds regardless of the SHORT TIME delay setting.

4.6 Instantaneous Element

4.6.1 - Pickup settings available: 4X, 5X 6X, 8X, 10X and 12X the sensor tap setting.

4.6.2 - Tolerance: ±8% based on symmetrical sinusoidal current at 50/60Hz.

4.6.3 - The pickup switch has an "OFF" position. When this setting is selected, the instantaneous element will not pickup unless the breaker closes on a fault that exceeds 13X the sensor tap setting, in which case a discriminator will initiate tripping.

The discriminator circuit shall activate the trip pulse generator of the relay instantaneously provided one of the following conditions exists;

a) The breaker closes on a fault of 13X the sensor setting or greater and,

b) A fault of 13X the sensor tap setting or greater occurs while the breaker is supplying a load of less than 0.04X the sensor tap setting.

If the breaker closes and the current is greater than 0.04X; but less than 13X the sensor tap setting, the discriminator monitors the current for 40 milliseconds and if the fault level of 13X is not exceeded during this time, the discriminator shall switch itself off.

4.6.4 - The operating time of the relay for fully offset single phase faults at the interrupting capacity of the circuit breaker with X/R 6.6, is 33m seconds. This operating time represents the time taken by the relay to energize itself, sense the fault, activate its trip energy accumulating circuit and transmit the trip pulse to the shunt trip solenoid.

4.7 Ground Fault Element

4.7.1 - Four pickup ranges are available which enable the user to compose a trip unit with the current sensors CSD-1.5, CSD-6, CSD-8, CSD-16, CSD-20, CUD-30, CUD-32 and CUD-40, that will meet the 1200A maximum pickup requirement of service protection equipment. The table below groups the current sensors with the appropriate pickup settings;

Sensor Type	Pickup Settings (Multiple of Sensor Tap)
CSD-1.5 CSD-6 CDS-16	0.2, 0.3, 0.4, 0.5, 0.6, 0.7
CSD-20	0.2, 0.25, 0.3, 0.4, 0.5, 0.6
CUD-30 CUD-32	0.2, 0.22, 0.24, 0.28, 0.32, 0.36
CUD-40 CUD-60	0.2, 0.22, 0.24, 0.26, 0.28, 0.30

4.7.2 - Tolerance: ±8% based on symmetrical sinusoidal current at 50/60Hz.

4.7.3 - Time Delay Bands: 5 calibrated bands are provided that are slightly inverse at low fault levels and become definite at fault levels exceeding 500% rated current. The definite time delays provided are 0.08, 0.14, 0.20, 0.26, and 0.32 seconds. In the inverse region these become 0.17, 0.23, 0.29, 0.35, 0.40 seconds with 100% rated current.

4.7.4 - Time Delay tolerance: ±10% based on symmetrical sinusoidal current at 50/60Hz.

4.7.5 - In the ZSIP mode with no restraint, the ground fault element initiates tripping approximately 20m seconds after pickup occurs.

The time current characteristics in Figure 4 attached should be consulted for the operating time of the relay under currents other than those specified here.

4.8 Output Trip Pulse

The USD relay provides a trip pulse output with a minimum energy of 0.98 joules. This pulse has an initial voltage of 140V and its rate of decay depends on the impedance of the shunt trip solenoid. This energy is approximately that stored in a 100 F capacitor charged to 140V d.c.

4.9 Test Signals

A test plug is mounted on the faceplate of the relay to provide access to appropriate signals so that the operation of the relay can be checked by means of a Test Set or other metering devices. The signals available on the test plug are;

PIN #	SIGNAL
1	Test Set input signal
2	"
3	"
4	"
5	Instantaneous pickup/inhibit
6	Short time pickup/inhibit
7	Long time pickup/inhibit
8	Ground fault pickup/inhibit
9	Overcurrent trip inhibit
10	Logic common
11	Ground fault trip signal (delay)
12	Overcurrent trip signal (delay)

4.10 Relay Impedance (Burden)

The impedance of the overcurrent elements and ground fault element seen by the secondary of the current sensors at different current levels are shown in Figures 5a and 5b attached.

4.11 Reset Time

If a fault condition disappears and the current magnitude drops to 95% of the pickup level of any element, the relay resets in approximately 30m seconds. If the breaker trips, the signals to the relay disappear and the relay resets automatically. The fault indicators, if used, must be reset manually with the pushbutton on the relay faceplate.

Under arcing ground fault conditions, the ground fault element of the USD operates to carry through the missing cycles or half cycles in the definite time region and trip. In the inverse region where energy accumulation contributes considerably to the delay, the arcing ground fault is integrated with time and a trip is generated as soon as trip energy has been accumulated.

4.12 Performance in Service

The circuits in the USD relay are stable and show excellent repeatability over long periods of time. Service involving frequent operations will not cause the characteristics to change or drift, since there are no mechanical moving parts to wear.

The USD relay is compensated for variations in ambient temperature over the range -20°C to +55°C. The tolerance over this temperature range is ±8% on the pickup and ±10% on the time delay of all the elements.

Operation outside this temperature range is possible. Consult the factory for further information, specifying the required temperature range.

5. TESTING

5.1 Secondary Injection

Testing of the overcurrent trip system with secondary injection is easily accomplished, under field conditions, with the Federal Pioneer portable Test Set Type DDT-USD. The test can be done on a complete breaker assembly located in the disconnect position in the cubicle, on the complete breaker on a work bench, or on a static trip device completely removed from the breaker. It is not necessary, however, to remove any wiring in order to do any of these tests. The type DDT-USD test unit permits checking pickup and timing functions as well as the operation of the shunt trip solenoid.

The type DDT-USD test unit can, in addition, check the functions of the trip unit with the circuit breaker in service. The Instruction Manual C-3-217-4 of the test unit should be consulted.

5.2 Primary Injection

5.2.1 If it is desired to check the current sensor operation it will be necessary to test the breaker by primary current injection methods. This involves connecting the power poles of the breaker to a controlled source of current. The advantage of this system is that the entire sensor-relay- trip coil system operation is verified. The disadvantage is that suitable equipment required for such testing is heavy, extensive and difficult to use.

5.2.2 The test equipment for single phase tests should provide 50/60Hz. sinuisoidal current to the breaker power pole terminals. The connectors to double-stab poles (on higher current breakers) should be arranged to divide the current between the two stabs equally. If complete testing of all pickup positions of the USD is desired the test equipment should be capable of 1200% of the breaker current rating for at least .04 seconds and 600% of the current rating for 30 seconds. For minimum testing the test equipment should be capable of 600% current rating for at least 2 seconds. This will enable testing on all elements to be performed on the lowest settings for INSTANTANEOUS PICKUP, SHORT TIME PICKUP and LONG TIME DELAY elements.

5.2.3 The test equipment should include a timer which starts when the current is switched on and stops when the current is switched off (breaker trips). It should be capable of measuring time intervals from .01 seconds to 2000 seconds accurately.

5.2.4 The open circuit voltage of the current souce must be at least 10 volts when set at the test current.

5.2.5 Test connections to the breaker should be as short as possible, otherwise, current capability will be limited and only minimum testing achieved.

5.2.6 Before attempting testing the USD relay, the element and setting to be tested must be decided. To ensure that other elements do not interfere with the test it will be necessary to set pickup and/or delay settings higher than those under test.

5.2.7 For USD-6 types mounted in drawout breakers removed from the cubicle it will be necessary to connect a test jumper to complete the secondary circuit between the sensors and the USD relay terminals since the current is normally completed by a permanent jumper or external sensor, depending on the type of system being used.

5.2.8 The jumper may be connected to the contacts of the rear mounted terminal blocks as shown in Figure 8. The actual terminals used varies from one breaker to another, the requiring use of the appropriate breaker wiring diagram to determine actual location.

5.2.9 For overcurrent tests (not ground fault) jumper A only must be installed. For ground fault tests jumper B only must be installed.

5.2.10 Alternatively, the connections may be made directly from the common terminal of the sensors to either the N or G terminal of the relay for overcurrent or ground fault tests respectively.

5.2.11 It is necessary to provide 120VAC, 2.5 VA control power if it is desired to check indication lamps or remote outputs.

5.2.12 To check ZSIP functions it will be necessary to connect a RESTRAINT signal to obtain time delay operation of GROUND FAULT and SHORT TIME elements (otherwise trip will be instantaneous). This can be achieved by using a SELF RESTRAINT method whereby a test jumper is connected between RESTRAINT OUT and RESTRAINT IN terminals (on the side mounted 10 pin plug). A switch may be wired for convenient control as shown in Figure 8.

5.2.13 For USD-6 types used with fixed breakers, a direct connection between the sensor common and either the N or G terminals of the USD will allow testing of overcurrent or ground fault respectively.

5.2.14 After each test in which the breaker has tripped, it must again be charged and closed before proceeding with the next test.

5.2.15 After the conclusion of the tests the relay settings must be restored to their original values. The jumper, if any, should be removed from the auxiliary contacts. The arcing and main and main contacts of the breaker must be inspected and serviced as required by the breaker **Manual C-3-233.**

5.2.16 Care should be taken when using magnetic pickup devices for measuring current (eg. clip-on ammeters, current sensors etc) to ensure that the readings are not being influenced by the strong magnetic field from high-current carrying conductors.

5.2.17 Since the published characteristics are defined for ideal testing arrangements, additional tolerances may be required to allow for field conditions (eg. wareforms may not be sinusoidal). The trip time of the breaker should also be added to time delay measurements (approximately half a cycle) when performing primary current injection tests.

CAUTION

Since much of the testing involves currents considerably higher than the continuous ratings of the breaker and the trip device, care should be exercised in not overheating it. Sufficient cooling time must be allowed between tests.

6. MAINTENANCE

6.1 General

Each Solid State Overcurrent Relay is tested and calibrated before shipment. It is ready for use after it has been interconnected with the rest of the components of the trip unit and the appropriate settings have been selected.

The only maintenance recommended is the periodic verification that the relay is functioning. This may be supplemented as desired by checking the calibration and inspection for loose or broken external wiring.

6.2 Troubleshooting

6.2.1 - Failure to Trip: Failure of the circuit breaker to trip in response to a fault may be caused by any of the reasons listed below. Corrective action is indicated with the reason for failure to trip.

(a) Relay set too high - check that the pickup settings on the relay are correct and that the correct sensor tap is used,

(b) Sensors improperly connected - check that all connections are tight, wiring is correct and leads not broken. Any current sensor with open-circuited secondary must be replaced.

(c) Shunt trip solenoid open- circuited - check that the wiring to the trip solenoid is not broken. The d.c. resistance of the coil should be approximately 30 ohms.

6.2.2 - Failure to Close: Failure of the circuit breaker to close and latch mechanically may be due to the reasons listed below. Corrective action is as indicated.

(a) The shunt trip solenoid - check to ensure that the plunger of the shunt trip solenoid is not inhibited from resetting. Refer to the circuit breaker instruction manual for mechanical mounting details.

(b) Ensure that an overload or short circuit does not exist in the load circuit.

(c) Check that there is no ground current exceeding the pickup setting.

(d) Check sensor taps to ensure that the setting is properly selected for the required load. Check sensor wiring and mounting for marked polarity. A reverse connected current sensor generates a high residual current which causes the Ground Fault element of the relay to trip the breaker.

(e) Check that pickup and delay settings are such as to override certain predictable short term overloads, such as; motor starting, spot welding, induction oven feeds, etc.

(f) Nonsinusoidal current may cause premature tripping since the solid state relay incorporated peak responding circuits for pickup.

If none of the above helps, the USD relay must be tested with a DDT-USD test unit, if one is available. It may then be decided that the relay must be returned to Federal Pioneer for repairs. In such a case it will be a great help to the Service Department if the source of complaint is documented and reported as accurately as possible. The element which fails to function properly along with the setting or settings must be noted. Also, the condition under which improper operation was noted ie. during initial testing, during maintenance, etc. and the type of testing equipment used. This will enable the quick repair and return of the unit.

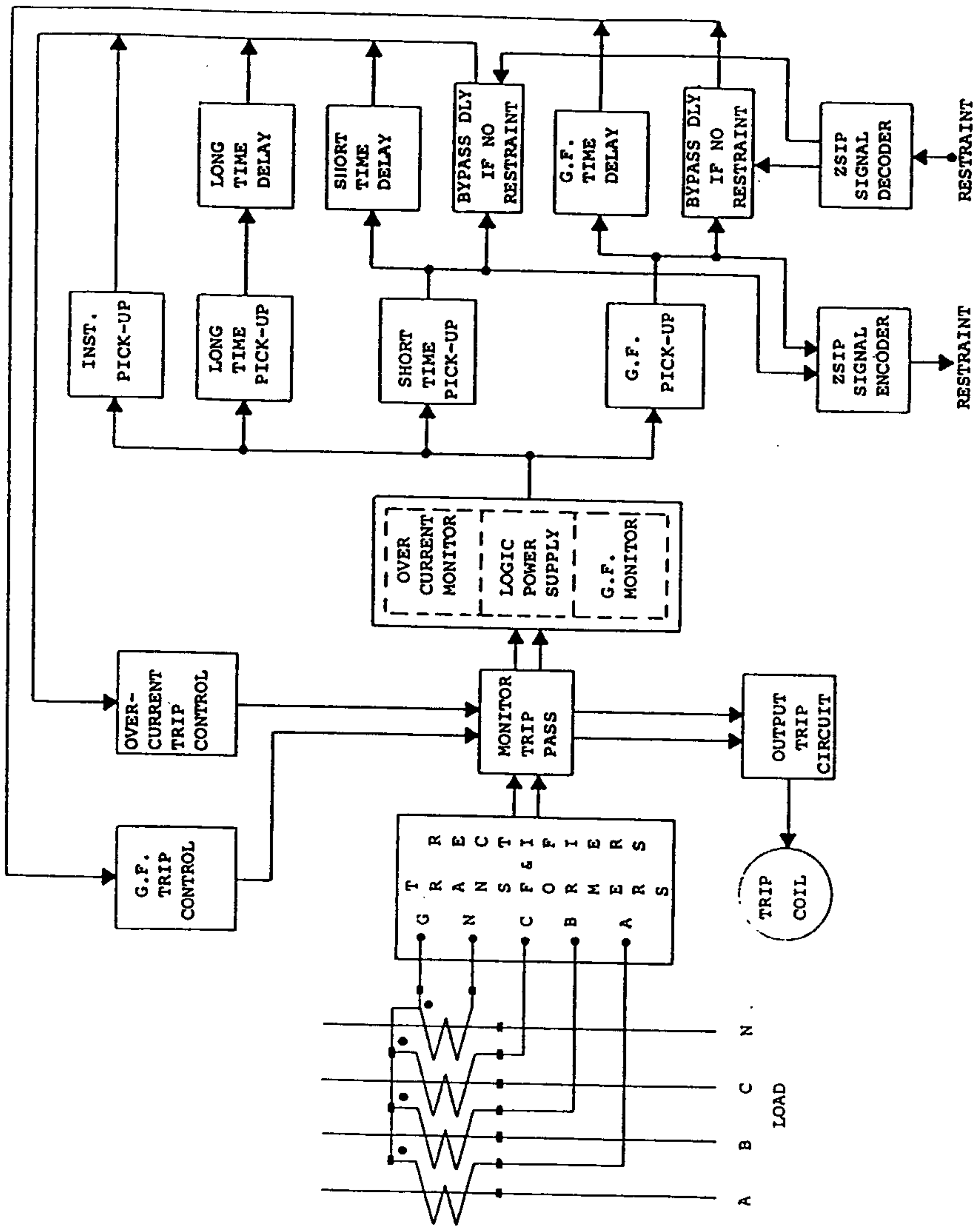


FIG. 1 FUNCTIONAL BLOCK DIAGRAM

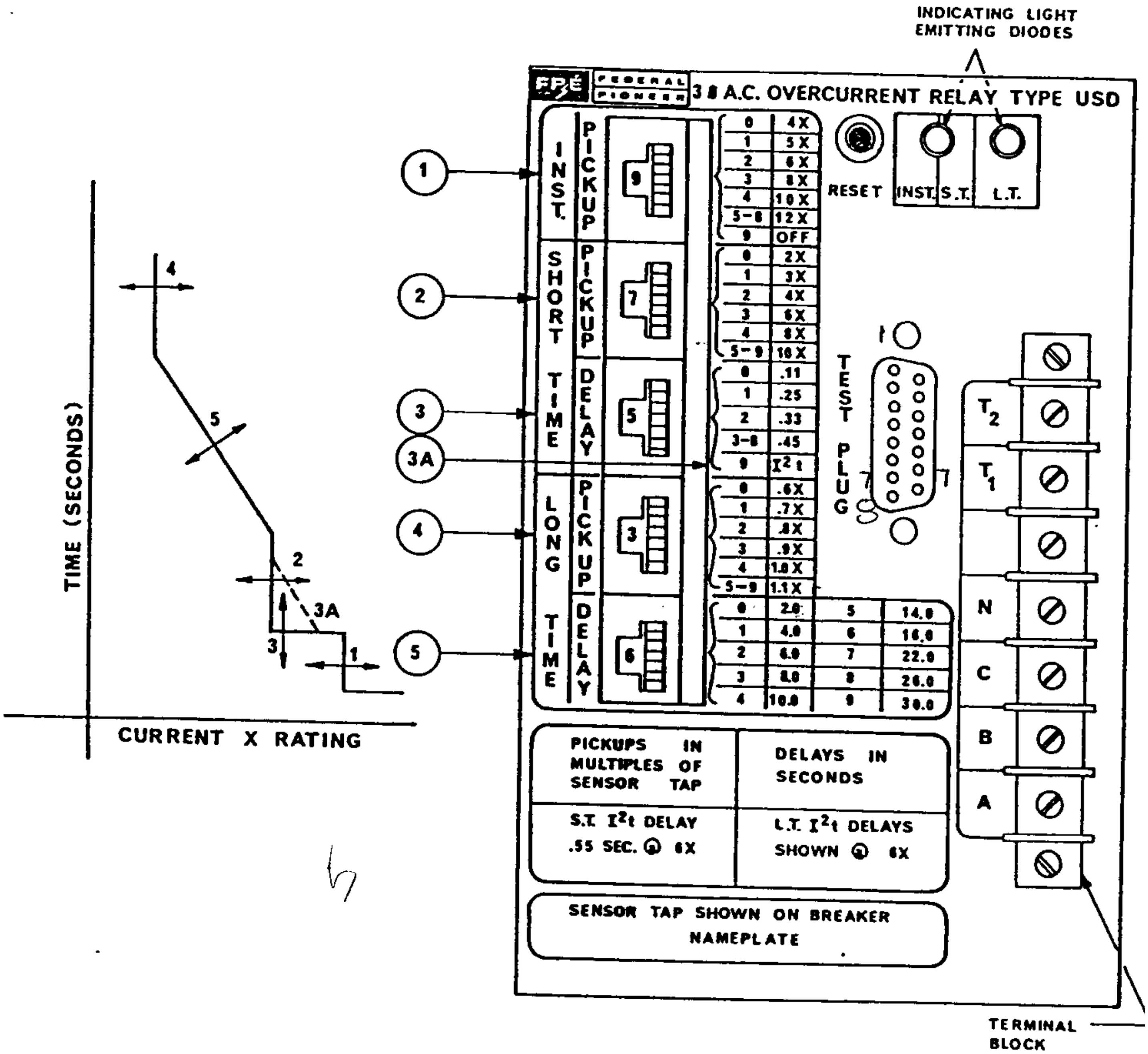
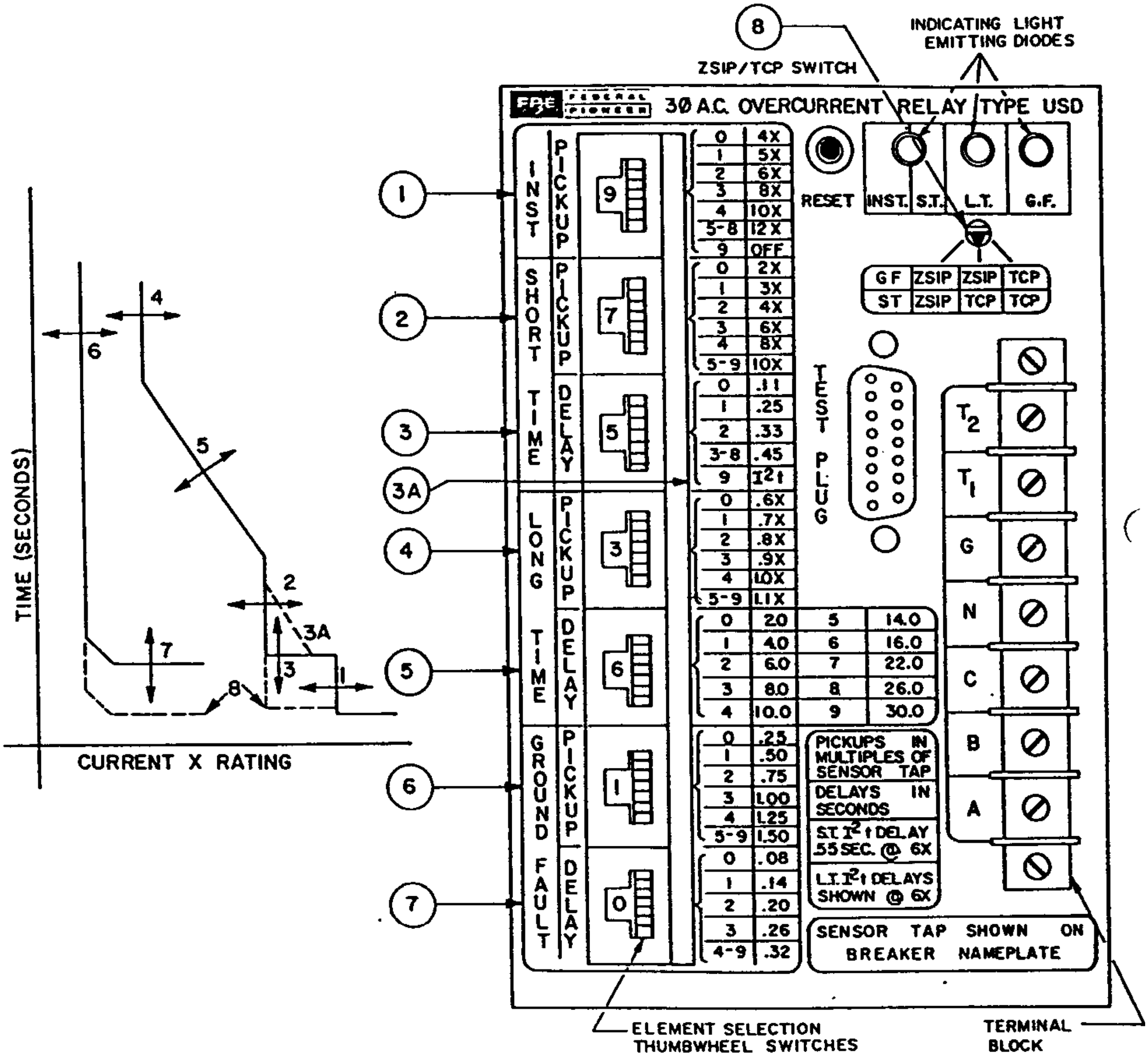


FIG. 2a FACEPLATE LAYOUT - TYPE USD -3IR

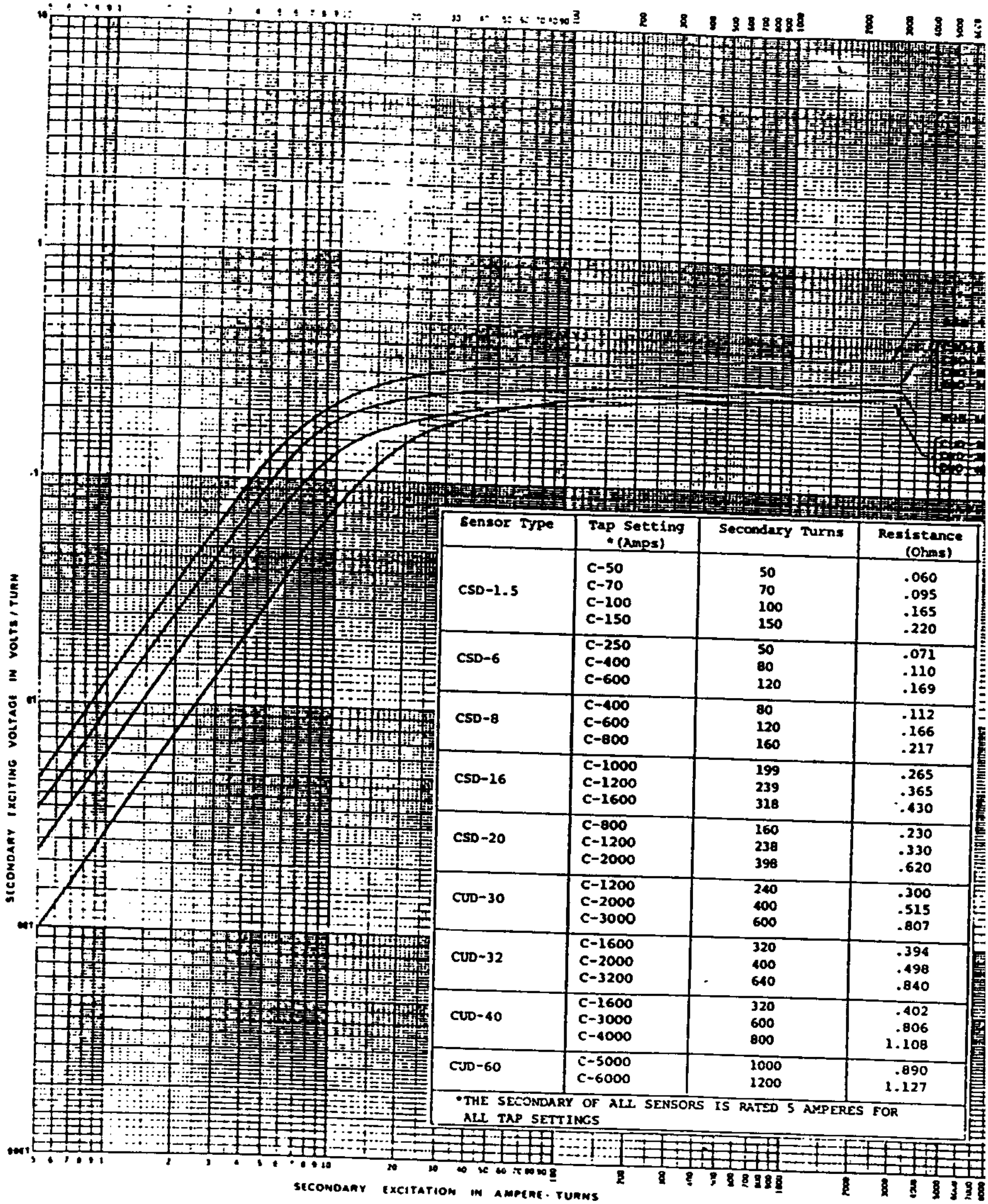


0	4X
1	5X
2	6X
3	8X
4	10X
5-8	12X
9	OFF
0	2X
1	3X
2	4X
3	6X
4	8X
5-9	10X
0	.11
1	.25
2	.33
3-8	.45
9	I²t
0	.6X
1	.7X
2	.8X
3	.9X
4	1.0X
5-9	1.1X

0	2.0	5	14.0
1	4.0	6	16.0
2	6.0	7	22.0
3	8.0	8	26.0
4	10.0	9	30.0

0	.25
1	.50
2	.75
3	1.00
4	1.25
5-9	1.50
0	.08
1	.14
2	.20
3	.26
4-9	.32

FIG. 2B FACEPLATE LAYOUT - TYPE USD - 6IR - 8 RELAY



Sensor Type	Tap Setting *(Amps)	Secondary Turns	Resistance (Ohms)
CSD-1.5	C-50 C-70 C-100 C-150	50 70 100 150	.060 .095 .165 .220
CSD-6	C-250 C-400 C-600	50 80 120	.071 .110 .169
CSD-8	C-400 C-600 C-800	80 120 160	.112 .166 .217
CSD-16	C-1000 C-1200 C-1600	199 239 318	.265 .365 .430
CSD-20	C-800 C-1200 C-2000	160 238 398	.230 .330 .620
CUD-30	C-1200 C-2000 C-3000	240 400 600	.300 .515 .807
CUD-32	C-1600 C-2000 C-3200	320 400 640	.394 .498 .840
CUD-40	C-1600 C-3000 C-4000	320 600 800	.402 .806 1.108
CUD-60	C-5000 C-6000	1000 1200	.890 1.127

*THE SECONDARY OF ALL SENSORS IS RATED 5 AMPERES FOR ALL TAP SETTINGS

FIG. 3 CHARACTERISTICS OF CURRENT SENSORS

OVERCURRENT TRIP UNIT
TYPE USD

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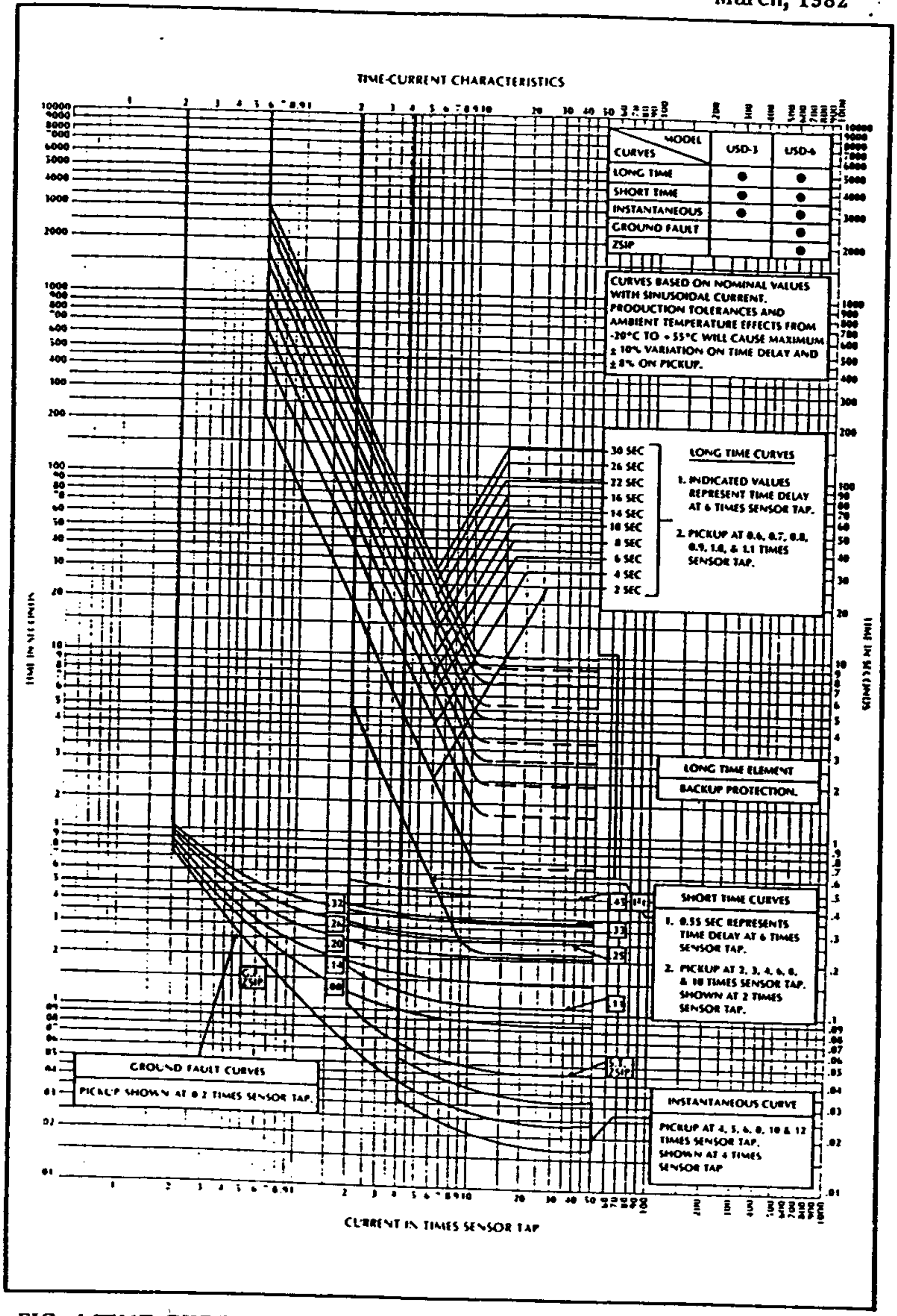


FIG. 4 TIME CURRENT CHARACTERISTICS OF USD RELAY

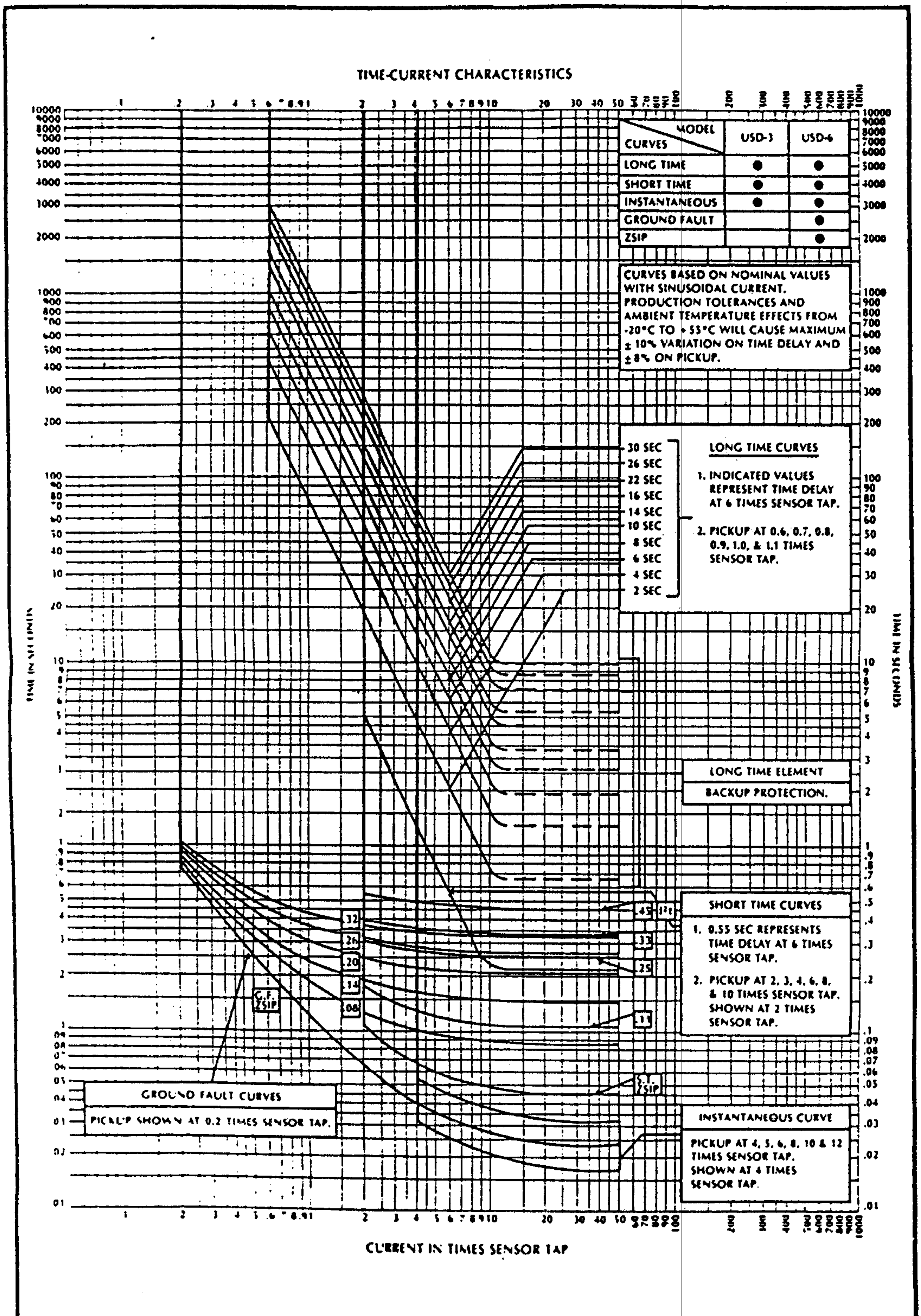


FIG. 4 TIME CURRENT CHARACTERISTICS OF USD RELAY

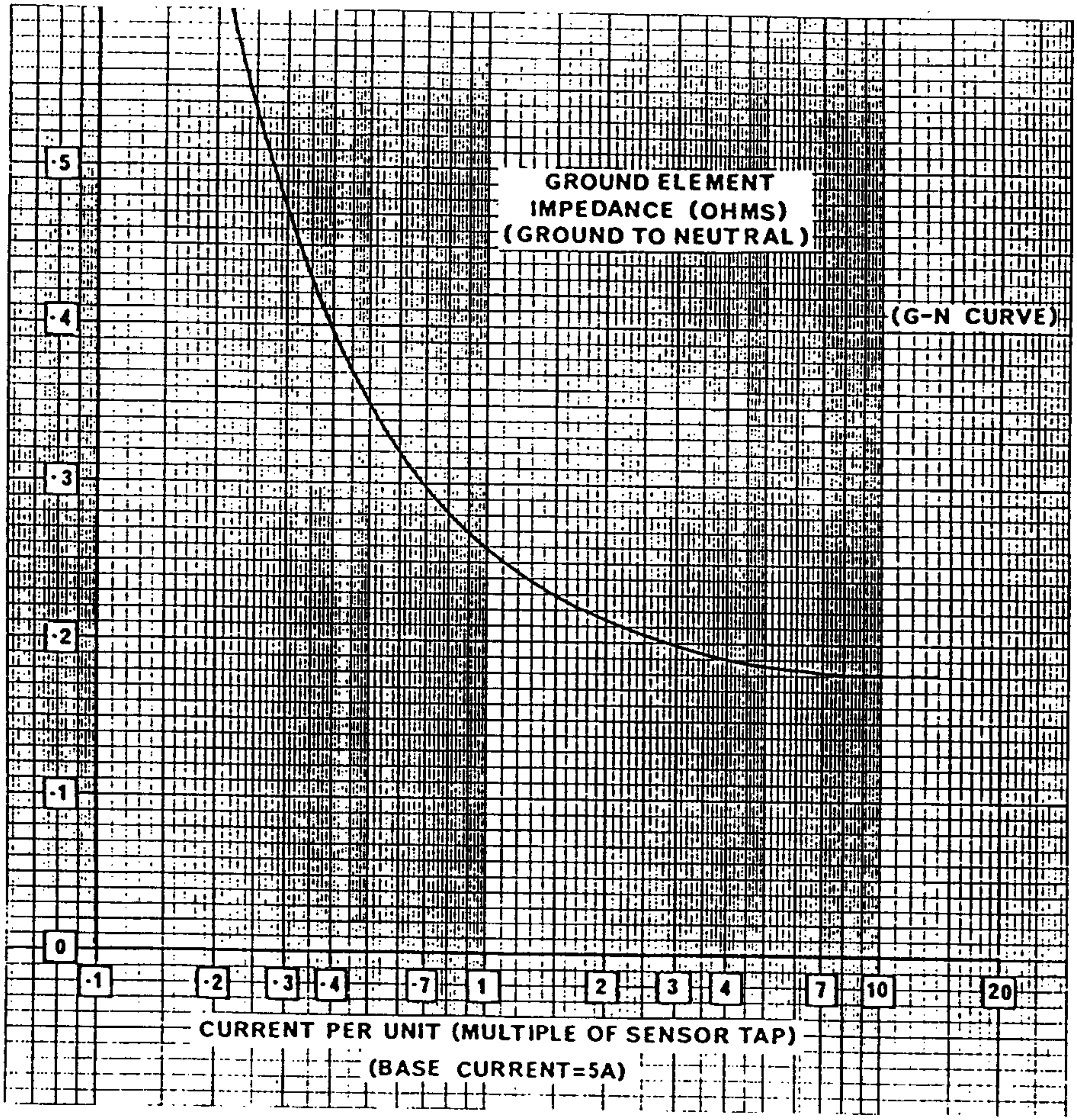


FIG. 5a INPUT IMPEDANCE OF SOLID STATE OVERCURRENT RELAY TYPE USD

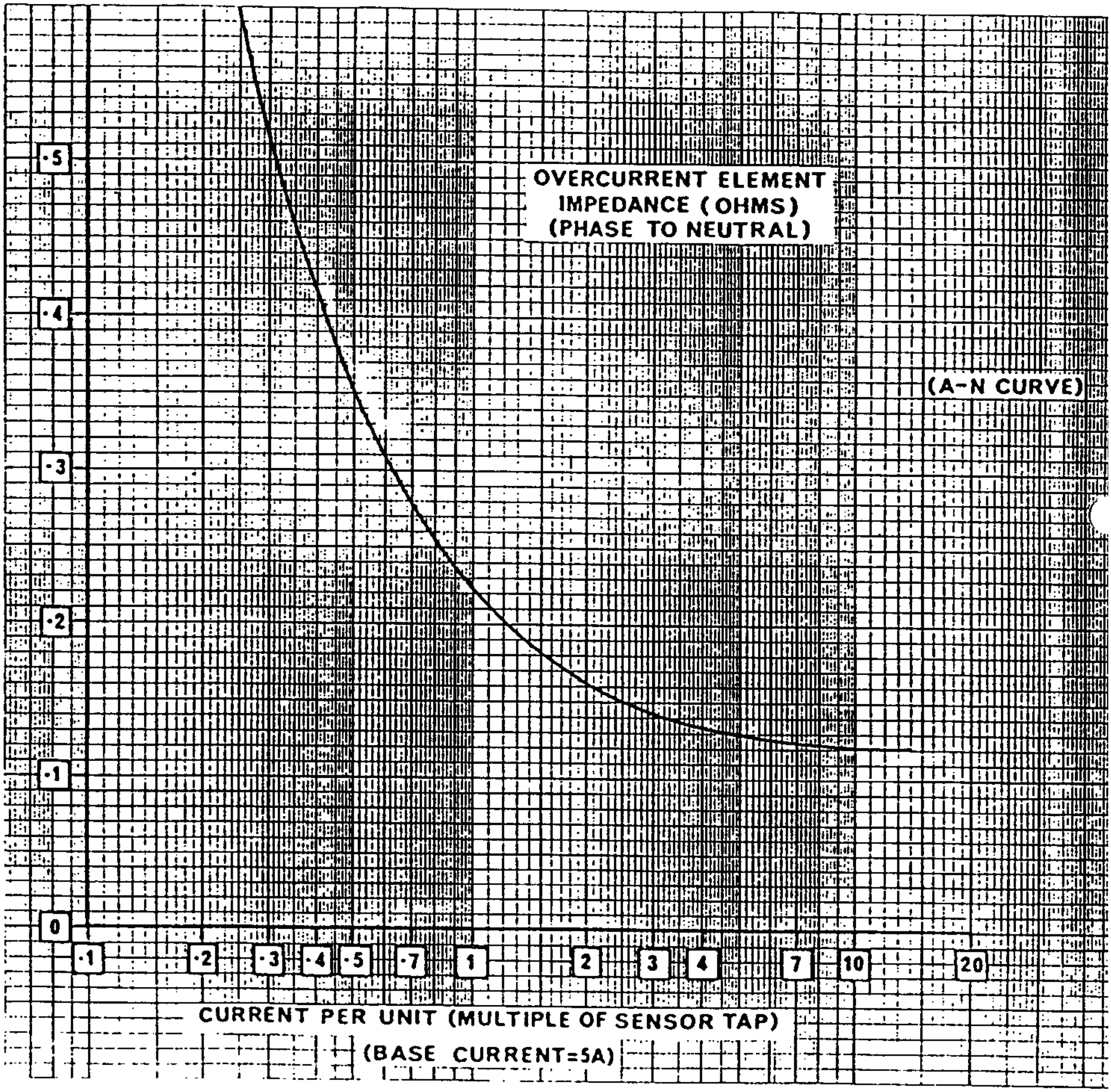
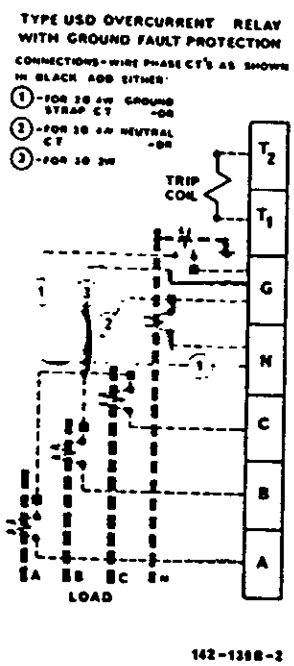
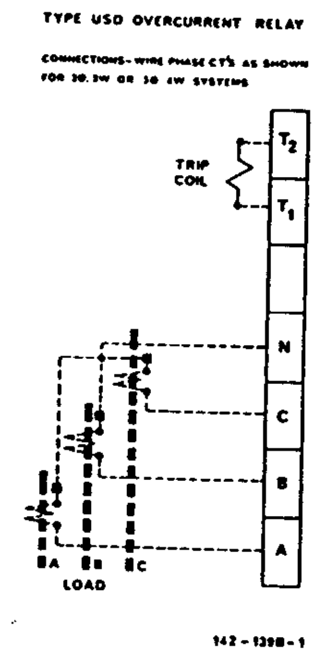


FIG. 5b INPUT IMPEDANCE OF SOLID STATE OVERCURRENT RELAY TYPE USD



USD-6 AND -6IR



USD-3 AND -3IR

FIG. 6 OVERCURRENT TRIP SYSTEM CONNECTIONS

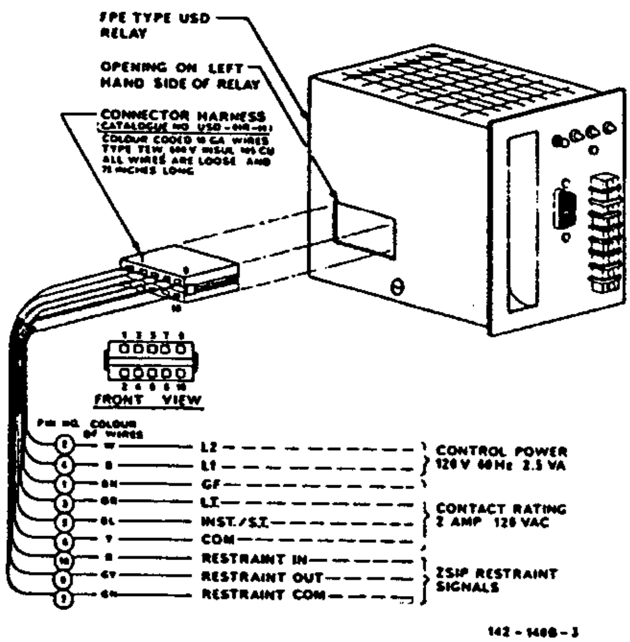


FIG. 7a REMOTE INDICATION AND ZSIP CONNECTIONS FOR USD-6IR

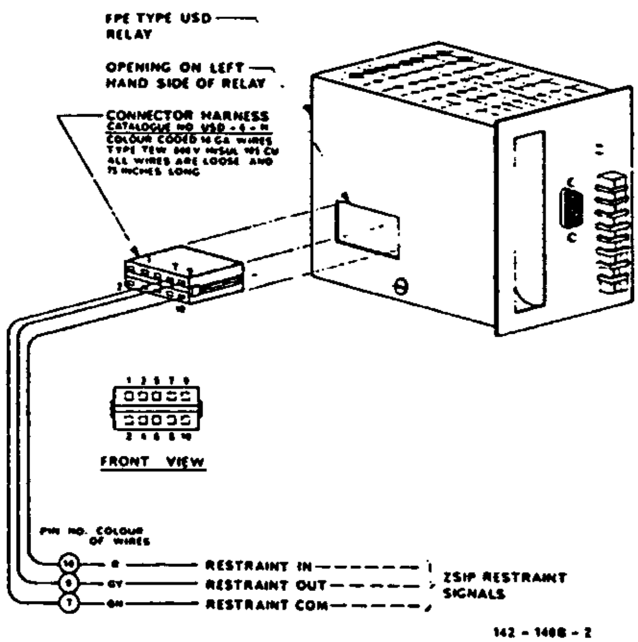


FIGURE 7b ZSIP CONNECTIONS FOR USD-6

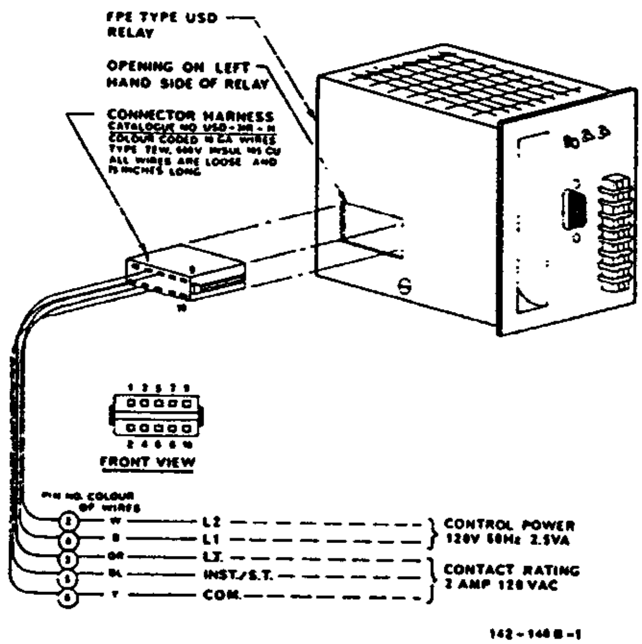


FIGURE 7c REMOTE INDICATION CONNECTIONS FOR USD-3IR

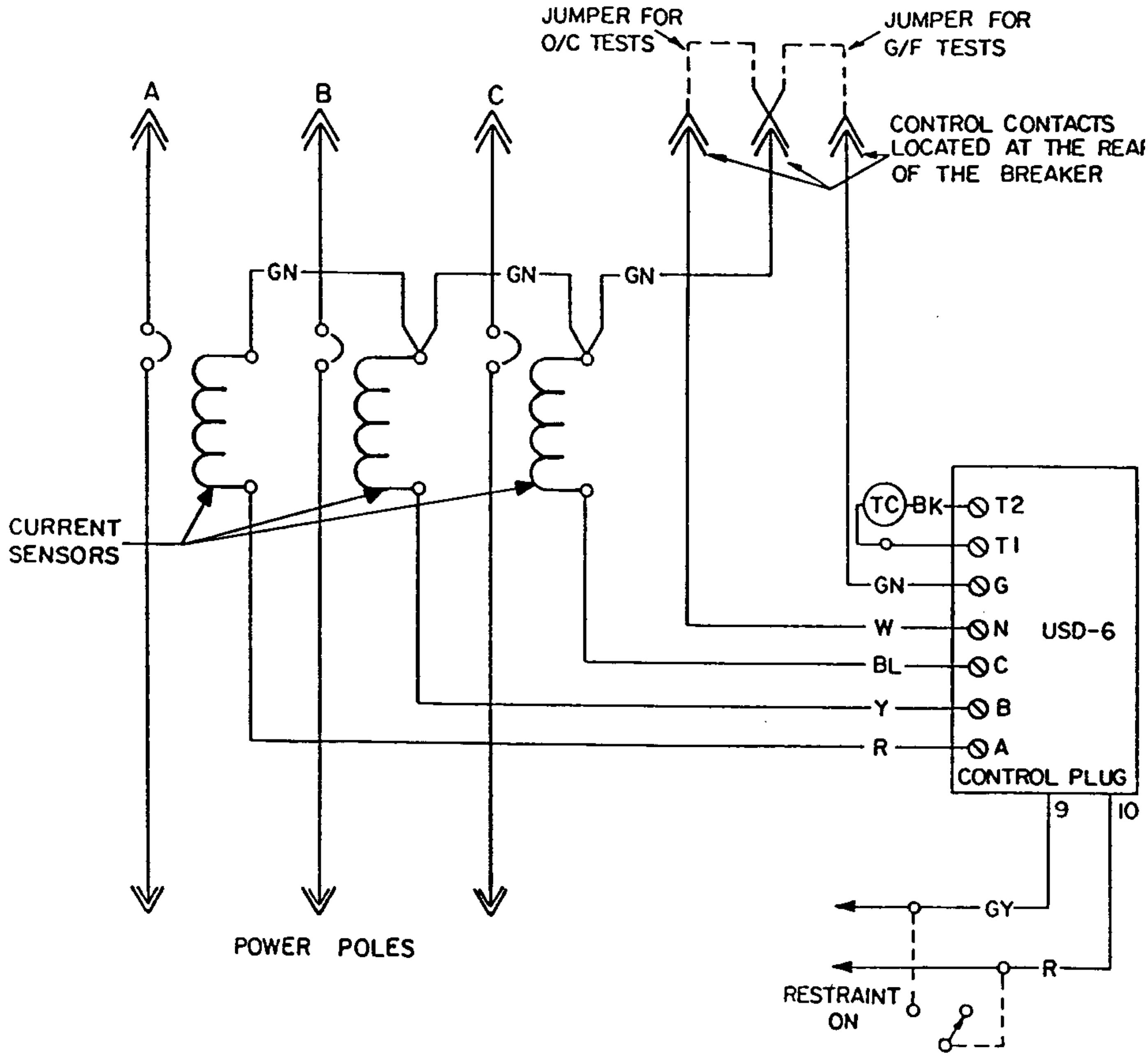


TABLE 8 TEST CONNECTIONS FOR PRIMARY INJECTION TESTS

TABLE 1 Current Sensor Sizes and Ampere Taps

Sensor Type	Taps Available In Primary Taps	Breaker	Frame
CSD-1.5	50, 70, 100, 150	600A 800A 1600A 2000A	30H-3, 30HL-3 30H-3, 30HL-3 50H-3, 50HL-3 50H-3, 50HL-3
CSD-6	250,400,600	600A 800A 1600A 2000A	30H-3, 30HL-3 30H-3, 30HL-3 50H-3, 50HL-3 50H-3, 50HL-3
CSD-8	400, 600, 800	800A 1600A 2000A	30H-3, 30HL-3 50H-3, 50HL-3 50H-3, 50HL-3
CSD-16	1000, 1200, 1600	1600A 2000A	50H-3, 50HL-3 50H-3, 50HL-3
CSD-20	800, 1200, 2000	2000A	60H-3, 50HL-3
CUD-30	1200, 2000, 3000	3000A 3000A 3200A 3200A 3200A 4000A	50H-3, 50 HL-3 75H-3, 75HL-3 75H-3, 75HL-3 50H-3, 50HL-3 75H-3, 75HL-3 100H-3, 100HL-3
CUD-40	1600, 3000, 4000	4000A 5000A	100H-3, 100HL-3 100H-3, 100HL-3
CUD-60	5000, 6000	6000A	100H-3, 100HL-3

TABLE 2 Standard USD Overcurrent Relay Models

CHARACTERISTIC/MODELS	USD-3	USD-3IR	USD-6*	USD-6IR*
LONG TIME	X	X	X	X
SHORT TIME WITHOUT ZSIP	X	X		
INSTANTANEOUS	X	X	X	X
GROUND FAULT WITH ZSIP			X	X
LOCAL AND REMOTE INDICATION		X		X

*Add the following suffixes:

16 for use with CSD-1.5, CSD-6, CSD-8 and CSD-16
20 for use with CSD-20
32 for use with CUD-30 and CUD-32
40 for use with CUD-40 and CUD-60