FEDERAL PIONEER

FEDERAL PIONEER LIMITED

19 WATERMAN AVENUE TORONTO ONTARIO M4B 1Y2•759-5651

C-3-216-2

INSTRUCTION MANUAL

DIRECT ACTING

SOLID STATE OVERCURRENT TRIP UNIT TYPE SD

FOR USE WITH

LOW VOLTAGE AIR CIRCUIT BREAKERS

DECEMBER 1978

CONTENTS

CONTENTS

1. INTRODUCTION

This Instruction Manual contains descriptive, operating, testing, and maintenance information for Federal Pioneer Solid State Overcurrent Trip Units Type SD used with 600-volt class power systems.

2. DESCRIPTION

2.1 General

Federal Pioneer Overcurrent Trip Units are completely static - there are no mechanical relay contacts. Components used are semi-conductors (including medium scale integrated circuit packages), transformers, capacitors, etc. The circuits are designed for conservative loading of components for long life and minimum maintenance.

By the use of digital and analog integrated micro-circuits, FPE Trip Units have been made more accurate, versatile, compact and reliable than similar electromagnetic and discrete semi-conductor trip devices.

The Overcurrent Trip Unit operates to open the circuit breaker when the circuit current exceeds a preselected current-time relationship. Depending on the selected settings, the tripping may be instantaneous or time-delayed.

Energy to operate the tripping system is obtained solely from the circuit being protected. Other power sources are not required, except for local and remote fault indication.

The complete Solid State Overcurrent Trip system consists of three parts:

a) The primary current sensors;

b) the overcurrent relay;

c) the direct acting shunt trip.

2.2 Current Sensors

Current sensors with tape wound grain - oriented silicon steel cores, are mounted one on each phase on the primary conductors in the circuit breaker, and one on the neutral conductor when required. They provide a signal proportional to the primary current and also supply power to operate the relay and shunt trip device. The sensors selected for a specific circuit breaker establish the current rating of that breaker. Each sensor provides a choice of at least two ratings, depending on the catalogue number (see Fig. 5).

2.3 Solid State Overcurrent Relay

The Solid State Overcurrent Relay receives the signal, senses overloads and faults and determines when to initiate tripping in accordance with preselected instructions. The large amount of power required to activate the direct acting shunt trip is obtained by totally diverting the output of the primary sensors from the monitoring circuitry to an energy accumulating circuit, after a fault condition has been determined.

A metal enclosure, attached to the breaker, houses the relay. Thumbwheel switches, grouped in a single column, are provided on the faceplate for field adjustment of the various pick-up and time delay settings. Although several types of solid state trip units are available, all are the same in size and similar in appearance.

A table of the functional elements in the two basic types of units is shown in Fig. 2. Also shown are the options available to indicate line current magnitude and cause of trip.

2.4 Shunt Trip

When the relay senses a circuit condition that requires the circuit breaker to open, it produces an output that is fed to the shunt trip device. This device causes the circuit breaker to unlatch and open the contacts.

The shunt trip device is a cylindrical push-type solenoid. It is mounted in the circuit breaker such that the plunger is held in reset position by gravity, and is allowed a specified distance of free travel before striking the trip level of the circuit breaker.

3. TYPES OF RELAYS

Two basic types of Solid State Overcurrent Trip Units are available. Similar in many respects, they differ only in their ultimate function. Both types use current sensor inputs and provide an output signal to energize the shunt trip device.

The first type provides only overcurrent protection; being equipped with the instantaneous, short time and long time elements. The second type, in addition to these functions, also provides ground fault protection. Without options, the catalogue numbers of the two relays are, respectively, SD-3 and SD-6.

3.1 Options

Local indication of the tripping element is provided as an option. Light emitting diodes, mounted on the relay faceplate, are used as the trip indicating lamps. Up to a maximum of three LED's are used to indicate the cause of trip: Short Circuit (instantaneous/ short time), Overload (long time) and Ground Fault. A pushbutton is provided on the faceplate to reset the fault indication.

Provision for remote annunciation is also available when local indication is provided. One normally - open contact of an auxiliary relay for each function to be indicated is provided on the back of the overcurrent relay. One terminal of each of the N.O. contacts is commoned within the relay.

Line current indication is available when local indication is provided. The maximum of the three line currents, during normal operation, is indicated on an analog meter mounted on the relay face-plate. The meter scale is in per unit of the primary current sensor ampere tap, with full scale deflection at 1.5 p.u. The meter is internally protected against excessive input.

4. OPERATION

4.1 General

The basic operation of the relay can be described by using the functional block diagram shown in Fig. 4. Appropriate blocks are eliminated for the models not providing Ground Fault protection.

There are three current sensors on the circuit breaker - one on each phase of the primary circuit. When the ground fault protection is provided in 4-wire models, a fourth sensor must be used. The current sensors supply a signal to the overcurrent relay which is proportional to the current in the primary circuit. This signal passes through the set of residually connected auxiliary trans-formers where it is processed to obtain energy storage for tripping, regulated reference voltages and d.c. signal voltages proportional to the ground and phase currents.

The relay can have up to four pick-up trigger elements; instantaneous, short time, long time and ground fault. Each pick-up circuit works independently of the others, and allows its corresponding time circuit to function, except the instantaneous element which has no intentional time delay added. This arrangement increases the reliabi-lity of the relay and provides back-up protection.

4.1.1 Overcurrent Elements

Short circuit and overload protection is provided by the instantaneous short time and long time elements. A composite d.c. signal is produced which is proportional to the magnitude of the maximum current of the three-phase currents being monitored. This signal is compared to preset values in each of the three elements. If it is below a preset value, nothing further happens and the element continues to monitor the system. If it exceeds a preset value, the respective trigger circuit is turned on. If the element has a time delay circuit, the timing operation is initiated. When the proper time delay is reached, or instantaneously depending on the element, the relay transfers itself into a fault condition mode. The d.c. signal is now diverted from the monitoring circuitry to the output trip circuit. This circuit accumulates energy until enough power is available to energize the shunt trip device.

The timing circuit of the long time element produces a constant I^2t function. It is dynamic in behaviour, thus continuously adjusting the timing rate to the amplitude of the existing maximum phase current during the timing operation. The short time element produces a definite time delay at high fault levels. At low fault levels, it exhibits a slightly inverse time-current characteristic because it takes longer for the trip circuit to accumulate sufficient trip energy.

If an overload condition (long time element triggered) disappears and the current magnitude drops to 95% of the preset pick-up level, the timing circuit resets itself (in 30 milliseconds) and remains ready to start the next timing operation. Thus, preventing the breaker from receiving a tripping signal.

When the breaker opens, the signal to the relay disappears so the relay automatically resets itself and turns off the trigger.

4.1.2 Ground Fault Element

In addition to the three overcurrent elements, a fourth element is provided for ground fault protection. The input to this element is obtained by residually connecting the 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 exceeds a preset value, the trigger circuit of the element turns on and the timing operation is initiated. After the preset time delay, the output trip circuit is activated. Energy is accumulated in this trip circuit and ultimately discharged into the shunt trip device. The time required for the accumulation of trip energy causes this element to have a slightly inverse time-current characteristic at low ground fault levels.

4.2 Selecting Settings

The solid state overcurrent relay has a number of control switches that can be set to select specific conditions to cause the breaker to open. Selection of settings is usually made when the breaker is placed in service. Future changes are unnecessary unless load condition or other primary circuit changes are made.

The thumbwheel selector switches are accessible on the front of the relay through a cutout in the faceplate. Each switch is actuated by means of a knurled thumbwheel, and the selected position is indicated by a number, ranging from 0 to 9, appearing on the thumbwheel. The switches are all arranged in one column with the instantaneous pick-up selector as the topmost switch. The correlation between the dial number appearing on a switch and the pick-up level or time delay, depending on the switch function, is shown in a table printed on the relay faceplate adjacent to the switches. The relay provides a fail safe operation if the switch contacts are damaged, in that all functions will operate on the highest settings.

All pick-up and timing functions are independent of each other. Any long time band can be selected to work with any short time band. The selection of settings is, therefore, governed by system design considerations.

5. PERFORMANCE IN SERVICE

Ambient conditions and lengths of service have little effect on the performance of the solid state overcurrent relay. The circuits 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 or bearings to lubricate. For the same reason the relay will withstand severe environmental conditions, often encountered in industrial applications. It will function properly in areas that would affect serviceability of electro-mechanical trip devices.

The relay is compensated for variations in ambient temperature at the relay over the range -20°C to +55°C. The variation from performance at room temperature is within ±5% over that temperature range. The overall variation from nominal values, including production tolerances, is ±8% on the pick-up functions and ±10% on the time delay functions.

6. MAINTENANCE

6.1 General

Each solid state overcurrent relay is tested and calibrated before shipment. It is ready for use after the appropriate settings have been selected and sensor tap setting indicated.

No cleaning, readjusting, lubricating, etc. is required. The only maintenance that is recommended is 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 Trouble Shooting

6.2.1 Failure to Trip

Failure of the circuit breaker to trip in response to overload, short circuit or ground current may be caused by any of the following reasons. Corrective action is indicated with the reason for failure to trip.

6.2.1.1 Sensors improperly connected - check that all terminals are tight, wiring is correct and leads are not broken. Current transformers which have carried load current with the secondary open must be replaced.

6.2.1.2 Shunt trip device open circuited - check that the wiring to the trip device is not broken and polarity marks are observed. Coil resistance should be approximately 30 ohms.

6.2.1.3 Relay set too high - check that pick-up settings on the relay are correct and the correct sensor tap is being used.

6.2.2 Failure to Close

Failure to close and latch the breaker mechanically - failure may result from any one of the following causes. Corrective action is indicated.

6.2.2.1 Failure to close and latch mechanically - check to ensure that the plunger of the shunt trip solenoid is not inhibited from resetting (by gravity). Refer to appropriate circuit breaker instruction manual for mechanical mounting details.

6.2.2.2 Failure to close and latch because of premature overcurrent tripping - check the following causes:

a) Ensure that an overload or short circuit condition does not exist on the load circuit.

b) Ensure that there is no grounding or ground current. Ground current pick-up may be as low as 20% of phase current.

c) Check sensor taps to ensure that setting is properly selected for the required load. Important - check sensor wiring and mounting for marked polarity. A reverse connected sensor generates a high residual connection current which causes ground circuit tripping.

d) Check pick-up setting to ensure setting is at least 120% of the nominal load current. Long and short time delay bands should be such as to override certain predictable overloads such as; motor starting, spot welding and induction oven feeds, etc.

e) Non-sinusoidal current (distorted wave) may cause premature tripping as the solid state circuit is basically a peak metering device.

7. TESTING

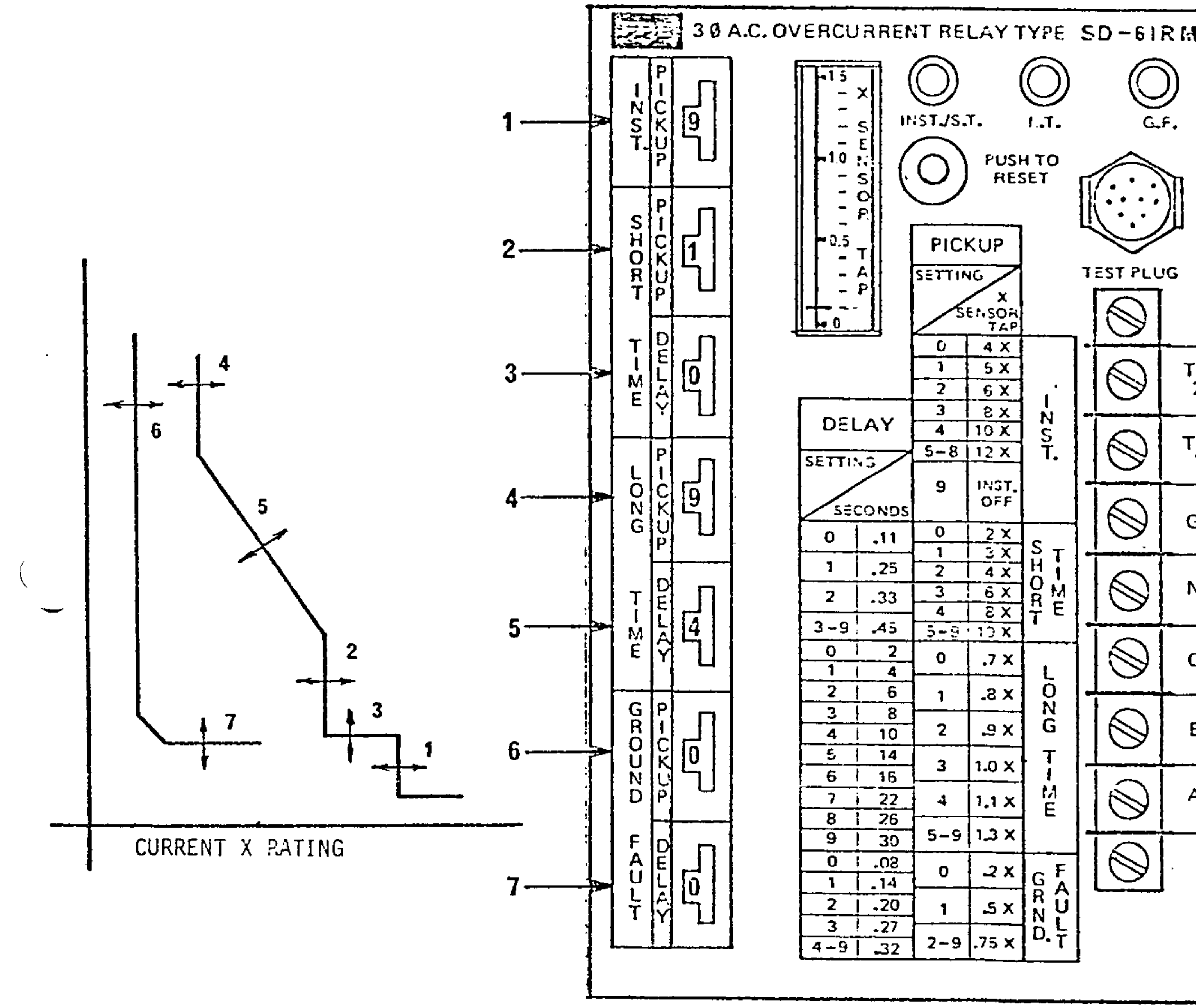
The testing of the overcurrent trip unit is easily accomplished, under field conditions, with the portable FPE Test Set Type DDT-SD. The tests can be done on a complete breaker assembly located in the disconnect position in the cubicle, on the complete breaker on a work table, or on a static trip device completely removed from the breaker, but it is not necessary to remove permanent wiring in order to make any tests. Testing can be done on a breaker exactly as it is used in normal service.

The FPE Test Set Type DDT-SD permits accurate calibration checking of the pick-up and timing functions. It also checks the mechanical operation of the shunt trip device. The test set operates by injecting a current signal into the solid state overcurrent relay simulating secondary current from the current sensors. It is powered from 115V, 60 HZ conventional supply and requires 750 VA. Refer to Instruction Manual C-3-216-5 for the use of the overcurrent. Relay Test Set Type DDT-SD.

	VARIATIONS \ MODELS	SD-3	SD-6	SD-3I	SD-3IR	SD-3IM	SD-3IRM	SD-6I	SD-6IR	SD-6IM	SD-6IRM
RELAY CHARACTERISTICS	INSTANTANEOUS	/	/	/	/	/	/	/	/	/	/
	SHORT TIME	/	/	/	/	/	/	/	/	/	/
	LONG TIME	/	/	/	/	/	/	/	/	/	/
	GROUND FAULT		/					/	/	/	/
OPTIONS	LOCAL INDICATION			/	/	/	/	/	/	/	/
	REMOTE INDICATION				/		/		/		/
	LINE CURRENT METERING					/	/			/	/

LISTING OF STANDARD TYPE SD OVERCURRENT RELAY MODELS

FIG. - 1



FACEPLATE LAYOUT

TYPE SD - 61RM RELAY

FIG. - 2

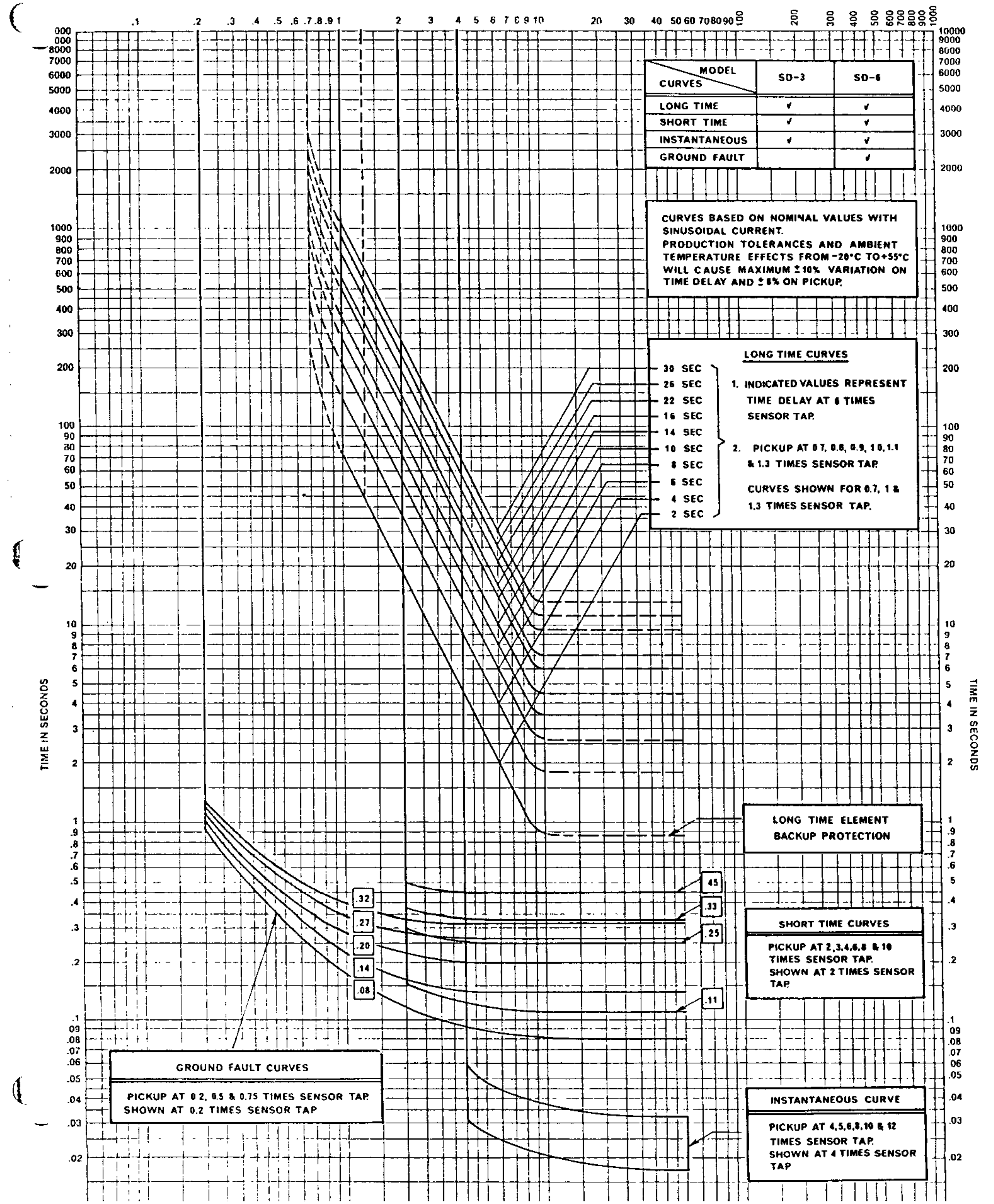
3Ø A.C. OVERCURRENT RELAY, TYPE SD

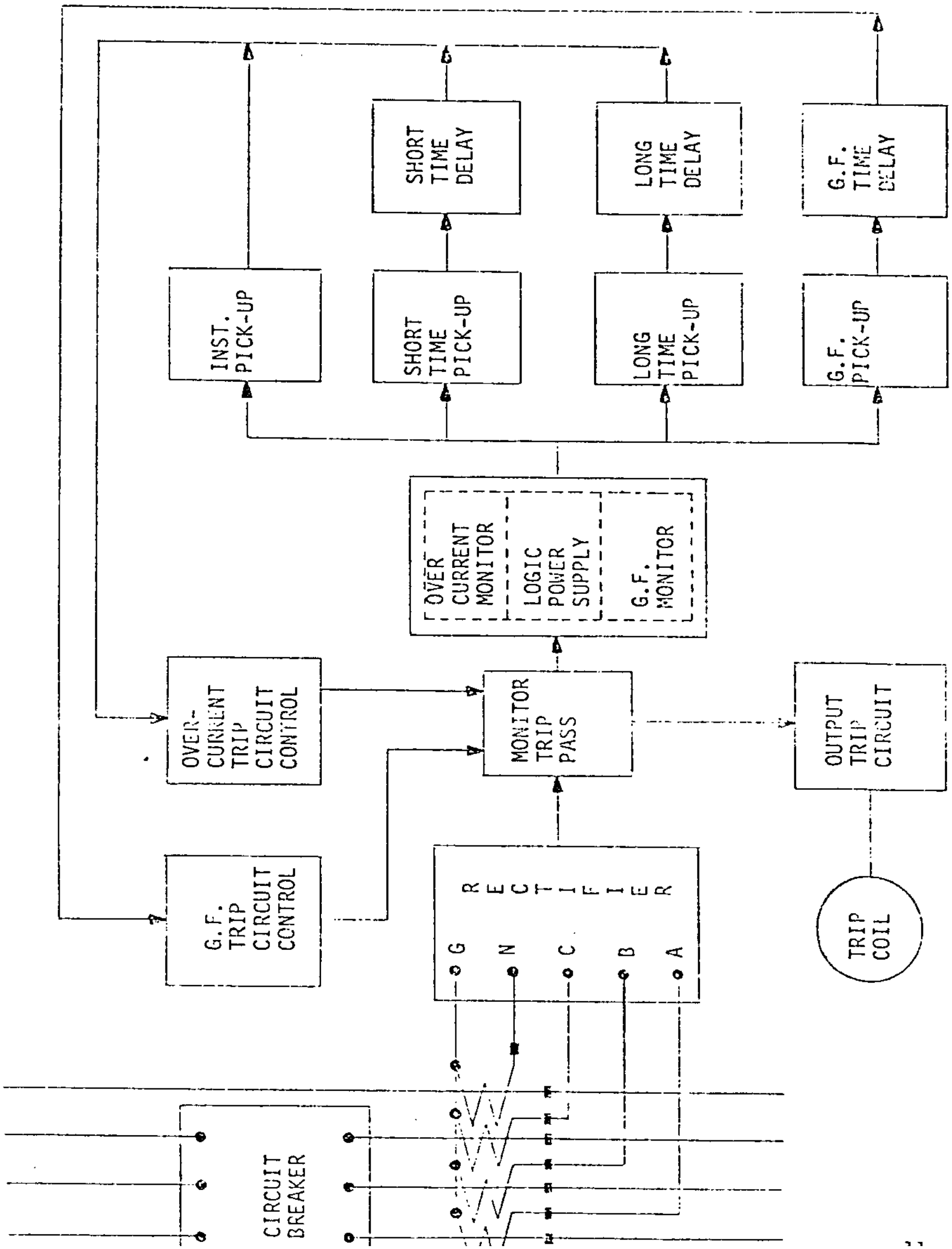
FPÉ FEDERAL PIONEER

C-3-286
JULY, 1980

TIME-CURRENT CHARACTERISTICS

Supersedes Dwg. 132-022B

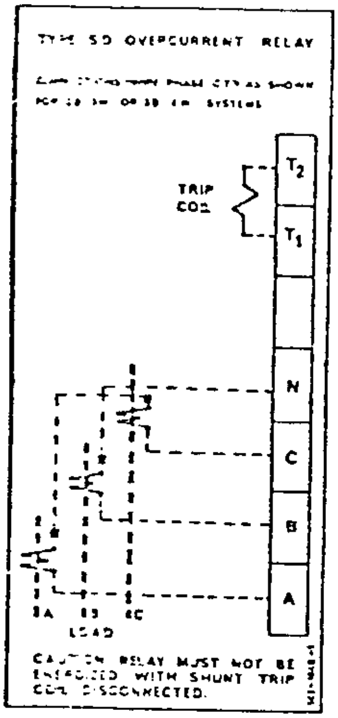


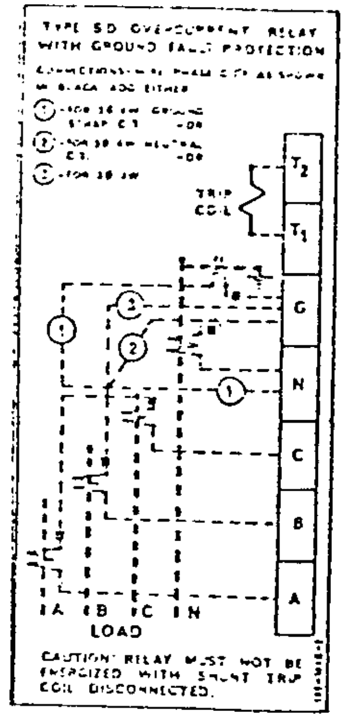

SHORT TIME DELAY
LONG TIME DELAY
G.F. TIME DELAY
INST. PICK-UP
SHORT TIME PICK-UP
LONG TIME PICK-UP
G.F. PICK-UP
OVER CURRENT MONITOR
LOGIC POWER SUPPLY
G.F. MONITOR
OVER-CURRENT TRIP CIRCUIT CONTROL
MONITOR TRIP PASS
OUTPUT TRIP CIRCUIT
G.F. TRIP CIRCUIT CONTROL
RECTIFIER
G
N
C
B
A
TRIP COIL
CIRCUIT BREAKER

SENSOR TYPE	AMPERE TAPS ON CURRENT SENSOR	BREAKER FRAME
CSD-1.5	50, 70, 100, 150	600A 25H-2 1600A 50H-2 2000A 65H-2
CSD-6	250, 400, 600	600A 25H-2 1600A 50H-2 2000A 65H-2
CSD-8	400, 600, 800	800A 35H-2 1600A 50H-2 1600A 25H-2
CSD-16	1000, 1200, 1600	1600A 50H-2 2000A 25H-2
CSD-20	800, 1200, 2000	2000A 65H-2
CSD-30	1200, 2000, 3000	3000A 50H-2 3000A 75H-2 4000A 75H-2 4000A 100H-2 5000A 100H-2
CSD-40	1600, 3000, 4000	4000A 75H-2 4000A 100H-2 5000A 100H-2
CSD-50	3000, 5000	5000A 100H-2
CSD-60	4000, 6000	6000A 100H-2

SENSOR SIZES AND AMPERE TAPS

FIG. - 5





OVERCURRENT TRIP SYSTEM CONNECTIONS