ABB

ADDENDUM 1

IB 7.5.1.7-2
Issue A

SOLID STATE D.C. OVERCURRENT RELAY
INSTRUCTIONS

DRAWOUT SEMI-FLUSH MOUNTED

TYPE ITE-76T D.C. SHUNT OVERCURRENT RELAY
(catalog series 232C-)

FOR TRANSIT APPLICATIONS, AND OTHER
DC APPLICATIONS 700V

INSTRUCTIONS FOR I-T-E SOLID STATE RELAYS
DRAWOUT SEMI-FLUSH MOUNTED
D.C. OVERCURRENT RELAY

TABLE OF CONTENTS

INTRODUCTION

These instructions contain the information required to properly install, operate, and test the Circuit Shield Solid-State D.C. Overcurrent Relay, Type ITE-76T.

The Circuit Shield D.C. Overcurrent Relay is housed in a semi-flush drawout relay case suitable for conventional panel mounting.

All connections to the relay are made at terminals located on the rear of the case and clearly numbered, one through twelve.

The controls for setting the relay are located on the front panel behind a removable clear plastic cover. The relays are factory calibrated.

The test button and target indicator are also located on the front panel. The target is reset by means of a pushbutton extending through the relay cover.

SOLID-STATE RELAY PRECAUTIONS

The following precautions should be taken when applying solid-state relays:

1. Incorrect wiring may result in damage to solid-state relays. Be sure wiring agrees with the connection diagram for the particular relay before the relay is energized. Be sure control power is applied in the correct polarity before applying control power.

2. Apply only the rated control voltage marked on the relay front panel.

3. Do not attempt to manually operate target vanes on CIRCUIT-SHIELD relays. Although the targets return their indication under shock, they can be damaged by manual operation with a pencil or pointed object.

4. Do not apply high voltage tests to solid-state relays. If a control wiring insulation test is required, bond all terminals together and disconnect ground wire before applying test voltage.

WARNING - DO NOT REMOVE THE DRAWOUT ASSEMBLY FROM ITS CASE WITH THE MAIN DC CIRCUIT ENERGIZED AS 600-1200 VOLTS DC WILL BE PRESENT INSIDE THE CASE.

5. The entire circuit assembly of the CIRCUIT-SHIELD d.c. relay is removable. This board should insert smoothly. Do not use force.

6. Follow test instructions to verify that relay is in proper working order. If a relay is found to be defective, return to factory for repair. Immediate replacement of the removable element can be made available from the factory; identify by catalog number. We suggest that a complete spare relay be ordered as a replacement, and the damaged unit repaired and retained as a spare. By specifying the relay catalog number, a schematic may be obtained from your local sales engineer should you desire to repair or recalibrate the relay.

PLACING THE RELAY INTO SERVICE

1. RECEIVING, HANDLING, STORAGE

Upon receipt of the CIRCUIT-SHIELD relay (when not included as part of a switchboard) examine for shipping damage. If damage or loss is evident, file a claim at once and promptly notify the nearest Sales Office. Use normal care in handling to avoid mechanical damage. The CIRCUIT-SHIELD system has no vital moving parts and if kept reasonably clean and dry, has no practical limit to its operating life.

2. INSTALLATION

Mounting

The outline dimensions and panel drilling and cutout information is given in Figure 1.

Connections

A typical external connection diagram is shown in Figure 2. Internal connections are shown in Figure 3.

All CIRCUIT-SHIELD relays have metal front panels which are connected through printed circuit board runs and connector wiring to a terminal at the rear of the relay case. The terminal is marked "G" and is located as shown in Figure 1. In all applications this terminal should be wired to ground.

The wiring from the shunt to the relay is not critical. Twisted pair, #14 AWG uncalibrated leads are recommended.

3. SETTINGS

PICKUP (R/R)
This continuously adjustable dial is used to set the relay's pickup, based on the Rate-of-Rise of current. It is calibrated in multiples of 50 millivolts per second (X50MV/SEC).

TIME (T)
This continuously adjustable dial is used to set the required time delay. It is calibrated in seconds. The rate-of-rise of current must be above pickup for the length of time set on this dial before the relay's output contacts will transfer.

TESTING IN SERVICE

In general, it is not necessary to schedule periodic maintenance and testing of this relay. However, if tests are desired to confirm the proper functioning of the system, the following procedure can be used.

Mounted in Switchgear

Push-to-Test Feature: Tests should be made on a de-energized main circuit. If tests are to be made on an energized circuit, be sure to take all necessary precautions.

A test voltage is applied to the pickup circuit when the test button is depressed. This will simulate an overcurrent condition which will cause an instantaneous breaker trip.

The pushbutton is recessed to prevent accidental operation.

Drawout Element

Drawout circuit boards of the same catalog number are interchangeable. The board is removed by using the metal pull knobs on the front panel. The relay is identified by a catalog number on the front panel and a serial number on the under side of the circuit board.

WARNING - DO NOT REMOVE THE DRAWOUT ASSEMBLY FROM THE CASE WITH THE MAIN DC CIRCUIT ENERGIZED AS DANGEROUS VOLTAGE WILL BE PRESENT INSIDE THE CASE.

APPLICATION DATA

These relays have been designed especially for use with main and feeder circuit breakers to control the supply of D.C. power to the third-rail, or catenary. Several models are available to provide various combinations of protective functions which open the appropriate circuit breaker to isolate the faulty section of the power-distribution system.

The relays are usually mounted on metal-clad switchgear or switchboards, and operate in conjunction with standard, 50 mV shunts.

The wiring from the shunt to the relay is not critical, #14 AWG, twisted pair, uncalibrated leads are recommended.

Solid-state components measure the output of the shunt, and compare it to the pre-set tripping levels provided by the front accessible, calibrated controls. When an abnormal condition is detected, the Type ITE-76T relay closes its contacts to energize the shunt-trip coil of the circuit breaker.

RATE-OF-RISE DETECTOR

Faults, especially arcing faults at the end of a track-section cannot usually be detected by overcurrent devices, since trains starting in the section will often draw more current than the remote fault. If left undetected, the arc may cause erosion of the track and elevated structure. These considerations, as well as those involving personnel safety, require fast and reliable isolation of these faults.

The Rate-of-Rise Detector of the type ITE-76T overcomes the problems associated with overcurrent devices. In most cases, protection can be provided against faults in the most remote section, even though the fault current is less than load currents.

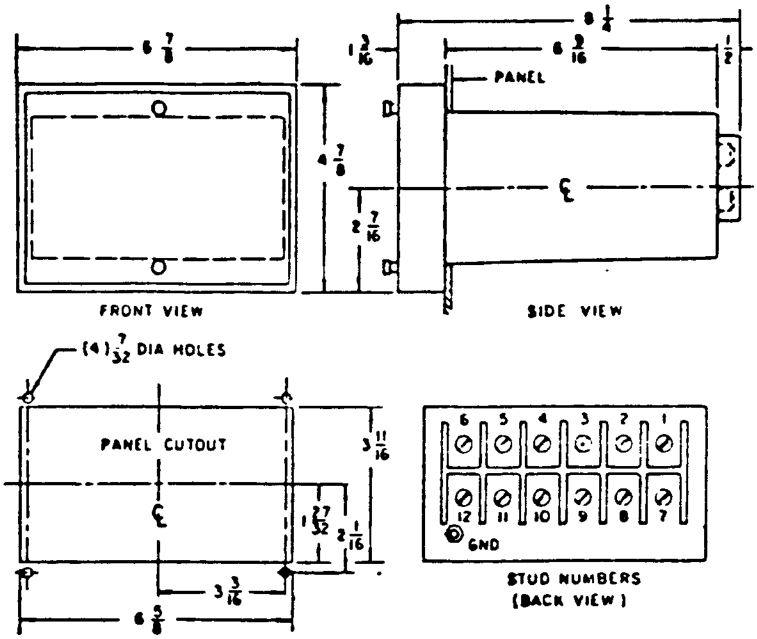


Figure 1 Outline and Drilling

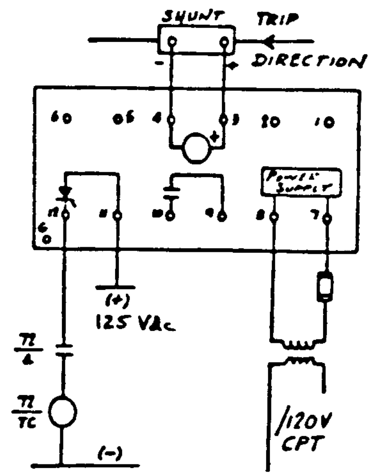
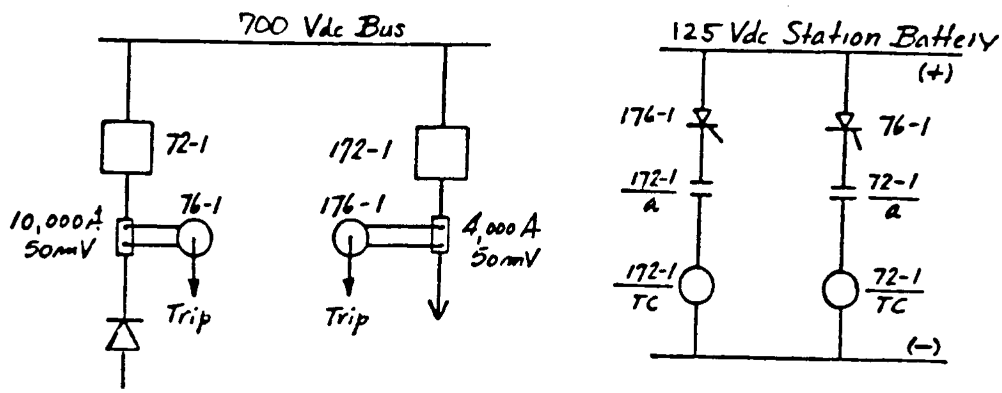


FIGURE 3
INTERNAL CONNECTIONS
AND WIRING

TYPE ITE-76T

FIGURE 2 - TYPICAL APPLICATION



DEVICE LEGEND

72	Cathode Circuit Breaker
172	Feeder Circuit Breaker
76-1	Type ITE-76T, with Instantaneous Only. Trip Direction as shown
176-1	Type ITE-76T, with Rate of Rise Detector Only. Trip Direction as shown.

The choice of relays and proper settings can be shown by the following example: A typical DC distribution system for a transit system might consist of several rectifiers, each rated 3000 kW at 600 Vdc supplying a bus through main (cathode) circuit breakers each rated 8000A dc continuous. Each main breaker position contains a 10,000 amp, 50 mV shunt. The tracks (or catenaries) are supplied through 4000A dc feeder breakers, with 4000 amp 50 mV shunts.

Assume the track resistance to be .04 ohm per mile total, and the track inductance to be .0016 henry per mile, giving a circuit time constant ($T_1 = L/R$) of .04 seconds. Also assume that the longest track section is 2.5 miles.

The various trains in service in modern transit systems require peak starting currents varying in the range of 750 to 1200 amperes per car. These figures apply to both chopper and cam-type starters. For a six-car train, an average peak starting current could be about 6000 amperes, but the peak current thru any feeder can be higher if trains can start simultaneously. Safe practice is to allow for two trains, or 12 kA.

Allowing for 200V arc-drop, an arcing fault at the far end of the 2.5 mile section produces:

$$I_F = \frac{E_1 - V_a}{r_1 x} = \frac{600 - 200}{.04 \times 2.5} = 4 \text{ kA}$$

Since the load current is higher than the fault current, this application requires the R/R Detector.

With T set at .1 second, and DI at 8 kA/sec., the reach is approximately

$$X = \frac{E_1 - V_a}{L_1 \text{ (DI)}} e^{-T/T_1}$$

$$= \frac{600}{1.6 \times 8} e^{-.1/.04}$$

$$= 3.77 \text{ miles}$$

So the detector will reach beyond the end-zone, and clear the minimum fault condition.

The settings can be made several ways, since the reach is determined by both T and DI. Good results are obtained by assuming a DI, then calculating the proper T from the following equation:

$$T = T_1 \ln \left(\frac{I_1}{T_1} \times \frac{1}{DI}\right)$$

Assume DI = 12 kA per second. The arcing fault at 2.5 miles gives I_1 = 4 kA, and T_1 = .04, therefore, in order to just see this fault, set

$$T = .04 \ln \left(\frac{4}{.04} \times \frac{1}{12}\right)$$

$$= .08 \text{ seconds}$$

If necessary, these settings may be trimmed in service to allow for unusual conditions.

RATINGS

Catalog No.	232C---- series
Burden on Shunt	10,000 ohms
Nominal Input Level	50 mVdc
Maximum Continuous	No Limit
Pickup	R/R - Continuously adjustable from 0.2 to 4 P.U. (1 P.U. = 50 mv/sec.) Inst. - 1, 2, 3, 4 P.U. (1 P.U. = 50 mV) TD - 0.5, 0.75, 1.0, 1.25 (1 P.U. = 50 mV)
Operating Time	R/R - Continuously adjustable from 0.05 to 0.4 sec. Inst. - No intentional delay. Approximately 10 milsec. TD - 5, 10, 15, 20 seconds
Control Power	120Vac Reliable Source at .05 Amperes, 50/60 Hz.
Isolation from Ground	Shunt input - 4 KV, Control circuits - 2000 volts
Output Circuit	One thyristor, and one Normally Open Self-Reset Contact
Output Circuit Rating at 125 Vdc	Thyristor (SCR) Output: 30 amps DC for 0.1 second 5 amps DC for 1 second 1 amp DC continuous Contact Output: 15 amp tripping duty 5 amps continuous 1 amp opening resistive 0.3 amps opening inductive

The following apply to the thyristor output circuit:

a. Be sure the trip circuit is interrupted by an "a" contact to remove high currents from solid-state output circuits. Solid-state output circuits have inherently high momentary current ratings and low continuous current ratings. Never exceed the ratings.

b. Load (trip coils or auxiliary relays) must draw at least 0.10 amps to insure operation. SCR's require a minimum current to remain conducting after triggering. Place resistance in parallel with a low current coil to guarantee the holding current if necessary.

Temperature	Nominal	25°C Ambient
	Additional ±5% Tolerance	-15°C to +55°C
	Must Operate	-40°C to +90°C
Tolerances	Rate of Rise Pickup	±10% of Dial Setting
	Rate of Rise Time	±10% of Dial Setting

Time-Current Characteristic Curves

The operating times for the long-time and instantaneous functions are shown in Figure 5.

Since the rate-of-rise tripping function operates on rate-of-rise of current (rather than magnitude of current), it cannot be plotted as a conventional time-overcurrent device. Refer to the Applications Section for details of this function.

TESTING

1. MAINTENANCE AND RENEWAL PARTS

No routine maintenance is required on the relay. Follow test instructions to verify that relay is in proper working order. If a relay is found to be inoperative, return to factory for repair. We recommend that a spare relay be purchased and kept on hand.

For bench testing at low dc voltage, circuit card extenders are available from the factory. Order the 18 point extender, catalog 200X0018.

2. HIGH POTENTIAL TESTS

Do not apply high voltage tests to solid-state relay circuits. If a control wiring insulation test is required, bond all terminals to gether and disconnect grounding wire before applying test voltage.

3. TESTS

Field Testing

Push-to-Test Feature

The push-to-test button is located on the front-panel of the relay and provides a convenient means to check that the relay is functioning properly. It also allows a functional check of the wiring and integrity of the trip coil.

If tests are to be made on an energized main circuit, be sure to take all necessary precautions.

a) Instantaneous Test

Set the P.U. dial (Inst.) to 1. Set the R/R time delay dial to 0.4 sec. Push the trip test button. This will simulate an overcurrent condition which will cause an instantaneous breaker trip. The inst. target will show international orange.

Push the reset button. The target should reset to black.

b) R/R Test

Set the R/R pickup dial (R/R) to 1. Set the R/R time dial to 0.05 sec. Defeat the inst. function by rotating (CW) the inst. dial pointer one position past the 4 P.U. mark. Push the trip test button. This will simulate a fault rate-of-rise condition which will cause a breaker trip. The R/R target will show international orange. Push the target reset. The target should reset to black.

c) TD Test

Set the T.D. pickup to 1 P.U. Set the TD time dial to 5 seconds. Set the R/R time dial to 0.4 sec. Set the R/R pickup dial to max. CW.

Defeat the inst. function by rotating (CW) the inst. dial pointer one position past the 4 P.U. mark. Push the trip test button. Allow sufficient time for trip circuit to time out. The breaker will trip. There should be no target indications.

For Bench Testing Only

See Calibration Test Circuit, Figure 4.

Rate of Rise - Pickup

1. Set R/R Dial to 1 P.U. (Defeat inst. by rotating (CW) the inst. dial pointer one position past the 4 P.U. mark.)

2. With DC off, (adjust the sawtooth output of a Tektronic 535 scope) to 47.5 mv/sec. (95% of required value). Set the sweep time to 0.1 sec./division.

3. With DC on, apply test signal. The relay should not trip (i.e., no R/R target indication).

4. With DC off, adjust test signal to 55 mv/sec.

5. With DC on, apply test sawtooth. The relay should trip giving an R/R target.

6. Reset target by pressing the reset pushbutton.

Rate of Rise - Operating Time

1. Set TIME dial to maximum position (0.05 sec.).

2. With DC off, set R/R pickup dial to 1 P.U.

3. Adjust test equipment for a 100 mv/sec sawtooth signal.

4. With DC on, apply test sawtooth. The relay should trip in a time within ±10% of the dial setting. Check for R/R target indication.

5. Reset target by pressing the reset pushbutton.

Inst. - Pickup

1. Set inst. dial to desired P.U. value. (1 P.U. = 50 mv)

2. Increase the mv trip signal until a trip occurs. This should be ±10 % of the setting.

3. Check for a target indication and reset target.

Overload - Pickup

1. Set T.D. dial to desired P.U. value. (1 P.U. = 50 mv)

2. Increase the mv trip signal until the relay trips. (Allow sufficient time for trip.)

Overload - Time Delay

1. Set T.D. dial to desired time.

2. Apply 2X P.U. pickup setting.

3. The relay should trip within ±10 % of the published curve time value.

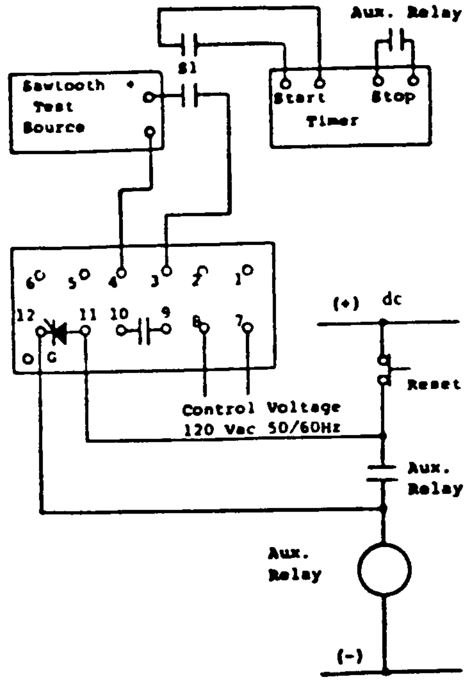


Fig. 4a: Calibration Test Schematic
Rate of Rise Function

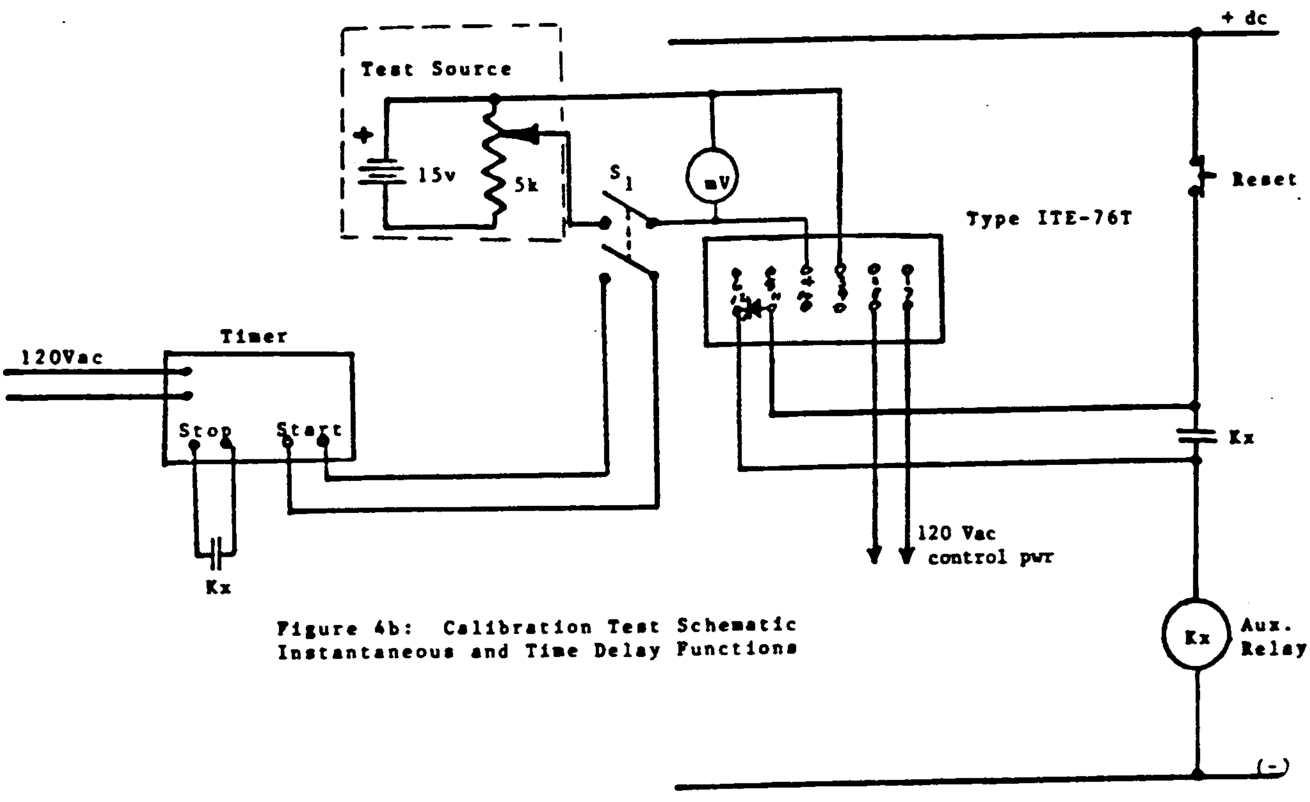


Figure 4b: Calibration Test Schematic
Instantaneous and Time Delay Functions

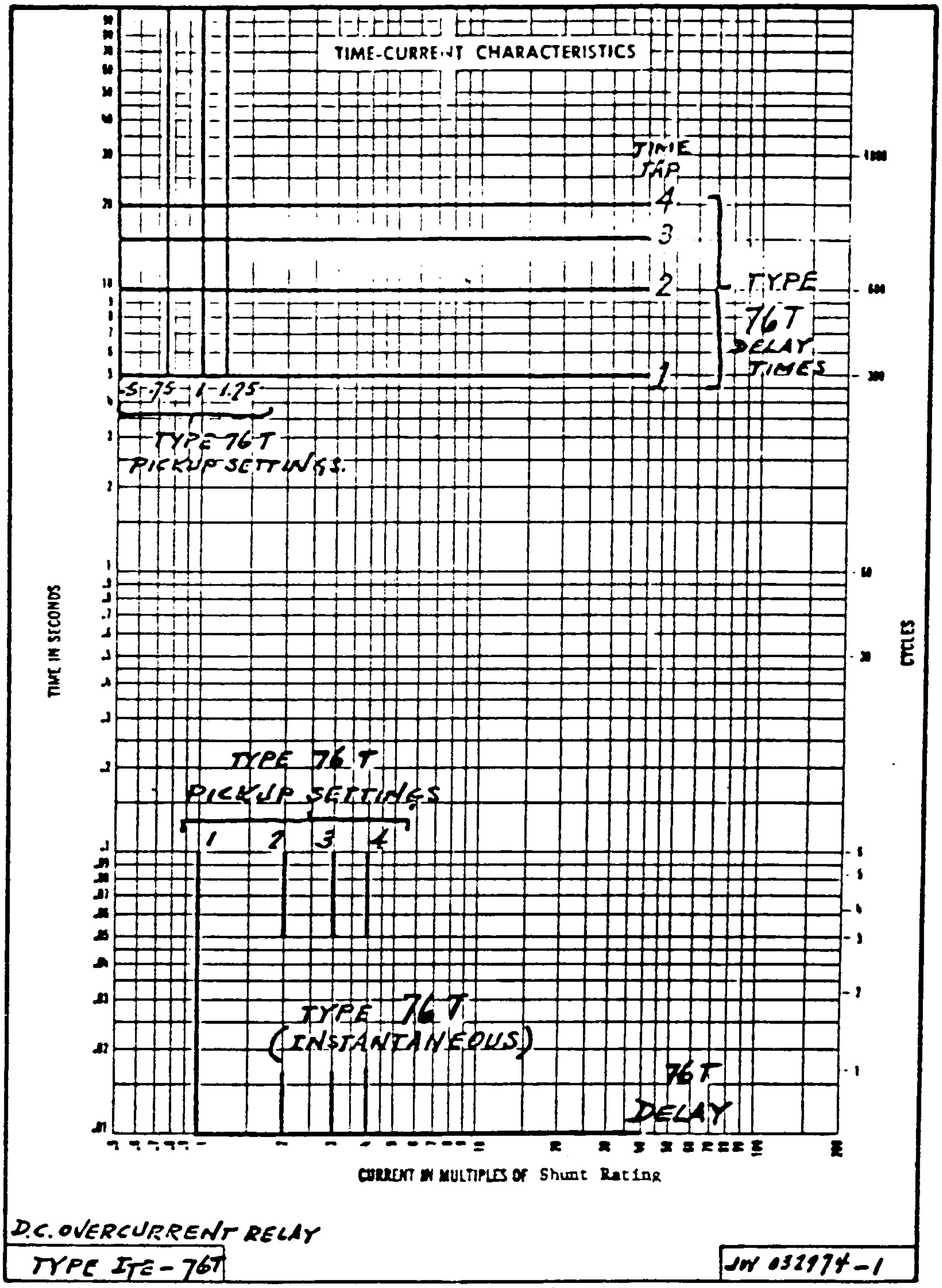


Figure 5: Time-Current Characteristic Curves

Addendum to
IB 7.5.1.7-2(A)

Rev. 1

This addendum covers new models of the ITE-76T not yet included in the main instruction book.

These units are catalog series 232Uxxxx, Unidirectional with Short-time Delay, and catalog series 232Dxxxx, Bidirectional with Short-time

Catalog 232U1027-M includes circuit modifications for a high dropout-to-pickup ratio.

PICKUP TAPS (fixed dial-switch positions; bidirectional units have separate selection for each direction; 1 PU = 50 mv.)

Unidirectional Units:

Catalog 232U1027	0.2, 0.5, 0.8, 1.0, 1.2, 1.6, 2.0	PU

Bidirectional Units:

Catalog 232D1027	0.2, 0.5, 0.8, 1.0, 1.2, 1.6, 2.0 (Forward and Reverse)	PU
Catalog 232D1037		
Forward	0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0	PU
Reverse	0.2, 0.5, 0.8, 1.0, 1.2, 1.6, 2.0	PU

TIME DELAY: definite time characteristic, 90-140 milliseconds.

OPERATION INDICATORS: a yellow LED is provided to indicate operation of the output stage. This LED is self-resetting upon return of the current below pickup.

CONTROL VOLTAGE: 120 Vac, 50/60 Hz.

INTERNAL CONNECTION DIAGRAM:

ITE-76T 12D232B Std. Case