IB-18.2.7-1
ISSUE H

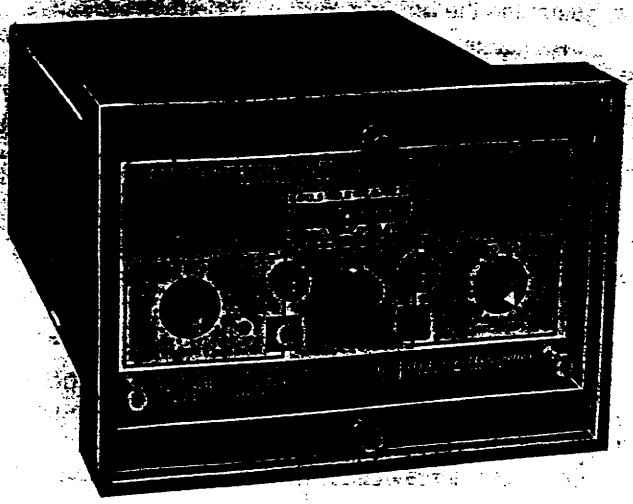
CLARE UNDW COPY

I-T-E SOLID-STATE OVERCURRENT RELAYS

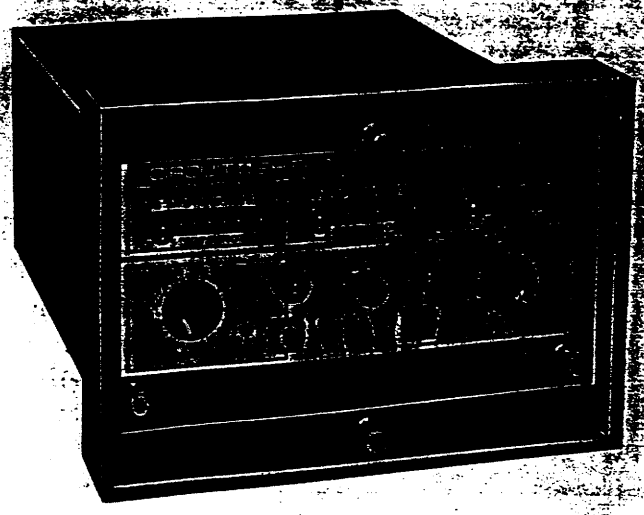
INSTRUCTIONS

DRAWOUT SEMI-FLUSH MOUNTED
SINGLE-PHASE AND THREE-PHASE RELAYS

INVERSE ITE-51I	SHORT TIME ITE-51S
VERY INVERSE ITE-51Y	LONG TIME ITE-51L
EXTREMELY INVERSE ITE-51E	DEFINITE TIME ITE-51D
INSTANTANEOUS ITE-50	LONG TIME INVERSE ITE-51IM:
INVERSE INSTANTANEOUS ITE-50I	LONG TIME VERY INVERSE ITE-51YM



SINGLE PHASE
FOR RESIDUAL GROUND PROTECTION



THREE PHASE
FOR PHASE PROTECTION

GOULD-BROWN BOVERI

INSTRUCTIONS FOR CIRCUIT-SHIELD™ SOLID-STATE RELAYS
DRAWOUT SEMI-FLUSH MOUNTED
SINGLE-PHASE AND THREE-PHASE

TABLE OF CONTENTS

INTRODUCTION

These instructions contain the information required to properly install, operate and test the complete CIRCUIT-SHIELD line of solid-state overcurrent relays.

The CIRCUIT-SHIELD 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 (1) through twelve (12).

CURRENT, TIME, and INST. pickup controls are located on the front panel behind a removable clear plexiglass cover.

TIME and INST. target indicators are also mounted on the front panel. Both targets are 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. Unlike conventional relay contacts, solid-state outputs are rated for a particular control voltage. If rectified AC voltage is used in place of a battery, proper filtering will be required to insure SCR "Holding Current".

3. 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.

4. When applying input current to protective relays, be sure to interrupt the input current immediately after the relay operates.

5. 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. Parallel a resistance with a low current coil to guarantee the holding current, if necessary.

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

7. 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.

8. Be sure to note the connections to terminals 9, 10, and 11 (described under CONNECTIONS on page 3) required for the proper operation of the TIME and INSTANTANEOUS elements. Jumper links are supplied with all relays.

9. Only the lower circuit board of the CIRCUIT-SHIELD overcurrent relay is removable. This board should insert smoothly. Do not use force.

10. Note that removal of the tap block pin is equivalent to setting the highest tap.

11. 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 or the fixed 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 ITE sales engineer should you desire to repair or recaliabrate 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 Gould Incorporated 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 2.

Connections

External connection diagram is shown in Figure 1.

For the instantaneous function to be operable Terminals 9 and 10 must be externally shorted. Instantaneous relay operation can be cancelled for reclosing applications by using an external supervisory contact connected to these terminals.

For the TIME function to be operable on relays supplied with torque control (CAT. 223 _ _ _ _ _) terminals 10 and 11 must be externally shorted. The TIME function can be cancelled for directional or voltage control by using an external supervisory contact connected to these terminals.

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 Fig. 2 below. In all applications this terminal should be wired to ground.

Special care must be taken to connect control power in the proper polarity. Reversing plus (+) and minus (−) will cause SCR A and SCR B to block the flow of trip current and the relay will not function. For capacitor trip applications, the plus (+) output of the capacitor trip device must be connected to terminal 7 of the relay, the negative (−) to terminal 8.

3. SETTINGS

Current Pickup Taps

A tap block for each phase is located on the relay front panel. Each tap block provides for seven (7) pickup settings which are marked in CT secondary amperes. When a pin is pulled out, that phase switches to the maximum tap setting. The pin may be moved with the relay in service.

Time Dial

One of ten (10) time-current curves is selected by a two-element control labeled TIME on the left side of the relay front panel.

a) A ten position SWITCH giving discrete steps 1 through 10.

b) A screwdriver adjusted VERNIER providing continuous time adjustment between steps.

When the vernier, marked "ADJ", is turned to the extreme counterclockwise position, the time-current curve shown on the switch has been selected. The vernier provides a continuous time adjustment between the switch selected curve and the curve indicated by the next higher number. Intermediate positions can be verified by test.

Instantaneous

Instantaneous pickup is selected by the potentiometer dial on the right side of the relay front panel. The dial is labeled "INST." The markings indicate multiples of the pickup tap setting.

For example, if the phase one (1) tap is set at six (6) amperes and the INST. dial is set at eight (8), the INST. setting is:

6 amps X 8 = 48 amps

Consequently, an instantaneous trip will occur at 48 amps in phase one (1) of the relay.

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

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.

It is customary to test the trip circuit of electro-mechanical overcurrent relays by manually closing the trip contacts to trip their associated circuit breakers. If the contacts are allowed to part before the seal-in contact closes, the relay contacts are eroded by the arc. Also, high transient voltages will appear from trip bus to positive.

This problem is avoided in the CIRCUIT-SHIELD overcurrent relay by the operational test feature. Separate pushbuttons labeled "TRIP" are provided for the TIME and INST. functions. The pushbuttons, recessed to prevent accidental operations, will cause the breaker to trip.

A portion of the control voltage is applied to the time circuit when the TIME pushbutton is depressed. The time delay circuit then produces a trip signal, in a time corresponding to approximately two (2) multiples of current tap setting, (at nominal control voltage), and the TIME target operates. For this test the INST. pickup must be set above (2) multiples or the INST. element will trip first.

Similarly, a portion of the control voltage is applied to the INST. circuit when the INST. pushbutton is depressed, producing a trip signal and operating the INST. target.

On special three phase relays with individual phase targets, the tests described will cause the middle phase target to operate in addition to the TIME or INST. target.

Drawout Element

Lower drawout circuit boards of the same catalog number are interchangeable and will operate in either a single phase or a three phase relay case. The board is removed by using the metal pull knobs on its front panel. Removing the board will not cause an open C.T. secondary or a false trip, therefore, the board may be changed while the relay is in service.

Note that the relay is identified by a serial number on the under side of the circuit board and on a label on the inside of the case; under normal circumstances, case and board should be kept as a unit.

The relay time-current characteristic and control voltage rating is determined by the drawout element. This nameplate data will be found on the front panel of the drawout element.

Test Accessory

A test accessory which can be used to quickly check the primary C.T.'s, the upper non-drawout input section of the relay, control power, and the continuity of the trip circuit is available from the factory. This drawout test accessory is plugged into the relay in place of the drawout element to make the checks. See IB-18.2.7-4 for details.

APPLICATION DATA

CIRCUIT-SHIELD overcurrent relays provide overcurrent protection phase-to-phase or phase-to-ground. They are designed to be operated by standard five (5) ampere secondary current transformers. The output circuit (trip circuit) will operate conventional circuit breaker trip coils at the DC voltage specified on the relay nameplate.

These relays can be used for all applications where conventional electromechanical relays are used. They come in seven different time-current curve families, INVERSE (51I), VERY INVERSE (51Y), EXTREMELY INVERSE (51E), SHORT TIME (51S), LONG TIME (51L), DEFINITE TIME (51D), LONG TIME INVERSE (51IM), and LONG TIME VERY INVERSE (51YM). A standard INSTANTANEOUS function or a special INVERSE INSTANTANEOUS function can be furnished as an option with any of the time families or as a separate INST(50) relay.

These overcurrent relays are offered with the following pickup ranges:

Range	Taps‡
0.1 - 0.5	0.1, 0.15, 0.2, 0.25, 0.3, 0.4, 0.5
0.5 - 2.0	0.5, 0.6, 0.8, 1.0, 1.2, 1.5, 2.0
1.5 - 6.0	1.5, 2.0, 2.5, 3, 4, 5, 6
2 - 5	2.5, 2.8, 3.1, 3.5, 4.0, 4.5, 5.0
4 - 12	4, 5, 6, 7, 8, 10, 12

‡When tap plug is removed, affected phase reverts to the maximum pickup.

Any one of six control voltages can be obtained: 24Vdc, 48Vdc, 125Vdc, 250Vdc, 175Vdc (120Vac capacitor trip), 350Vdc (240Vac capacitor trip).

TOLERANCES

TIME PICKUP .....±5% of tap setting

TIME DELAY

dial #10 (2-20 multiples) .....±5%
dial #1 (2-20 multiples) .....10 ms or ±10% (whichever is larger)

INST. PICKUP .....±10% of pickup amps (tap x dial setting)

RATINGS

TEMPERATURE

Nominal .....25°C ambient
Additional ±5% tolerance .....−15°C to +55°C
Must operate .....−30°C to +70°C

FREQUENCY

Nominal .....60 Hertz
Additional ±5% tolerance .....+1 to −3 Hertz

INPUT CIRCUIT

Phase one (1) current — terminals 1 and 2.
Phase two (2) current — terminals 3 and 4.
Phase three (3) current — terminals 5 and 6.

The current input for single-phase relays is made at terminals 3 and 4.

Each input current is fed to a tapped transformer primary. The secondary winding produces a voltage across a burden resistor. This voltage is rectified and supplied to the static circuitry.

The pickup of the static circuit is adjusted to the desired pickup current by tap selection of the transformer primary turns.

INPUT CURRENT RATINGS

Time	Tap Range, A	Input Current, 1 Ø or 3 Ø (CT Secondary Amperes)
1 Second	0.1 - 0.5 0.5 - 2.0 1.5 - 6.0 2.5 - 5.0	300 multiples of pickup tap setting or 235 A rms, whichever is less.
	4 - 12	300 multiples of pickup tap setting or 390 A rms. whichever is less.
Continuous	All Ranges	1.5 multiples of pickup tap setting.

BURDEN

The burden of the Circuit Shield overcurrent relay is very low, allowing the use of current transformers which would give unsatisfactory performance if they were driving electro-mechanical relays.

Because the input characteristic of the Circuit Shield relay is nonlinear, an impedance cannot be specified, however, the burden voltage across the relay current input terminals can be readily calculated for any given value of current transformer secondary current:

TAP (AMPS)	RDC OHMS
0.5	.092
0.6	.078
0.8	.065
1.0	.055
1.2	.048
1.5	.040
2.0	.032
1.5	.042
2.0	.034
2.5	.038
3.0	.026
4.0	.022
5.0	.020
6.0	.0185
4	.020
5	.020
6	.0185
7	.0175
8	.017
10	.0165
12	.0165

$$V = \frac{1.0}{I_T} + I_S \times R$$

V = burden voltage (volts)
I_S = current transformer secondary current (amperes)
I_T = relay pickup current tap setting (amperes)
R = D.C. resistance of relay input circuit (ohms) (select from table)

NOTES:

1. for units with 0.1 to 0.5A tap range, the Is x R term is negligible.
2. for units with 2 to 5A tap range, use values shown for 1.5 to 6A unit.

OUTPUT CIRCUIT

The CIRCUIT-SHIELD overcurrent relay energizes the breaker trip coil by means of an output SCR. Two SCR's are provided, one for the time delay and one for the instantaneous circuit as indicated in the wiring diagram shown in Figure 1.

As shown, relay terminal 7 is connected to the control power positive, with the trip coil connected to relay terminal 12 through a 52/a contact.

SCR A is gated by the time delay circuit, while SCR B is gated by the instantaneous circuit.

Note that once an SCR is gated (turned on), it will remain in conduction until its anode current falls below its holding current which typically is 5 to 20 milliamperes. Consequently, the trip coil current must be interrupted with the 52/a contact.

OUTPUT TRIP CIRCUIT RATINGS

Nominal Voltage	Range of Operation	Max. Current, Amps DC		
		6 Cycles	1 Second	Continuous
48 Vdc	28 - 60	30	15	1
125 Vdc	70 - 140			
250 Vdc	140 - 280			
* 175 Vdc	100 - 195			
* 350 Vdc	200 - 385			

*Capacitor Trip Applications

TARGET CIRCUITS

The target indicators for the TIME and INST. circuits are polarity sensitive devices which are set by current flow through the corresponding trip SCR.

Target reset is accomplished by the control power connection (terminals 7 and 8 of Figure 1) through the TARGET RESET pushbutton.

Standard 3 phase relays (CAT 2 _ 3T _ _ _) have two targets — TIME and INST. Special 3 phase relays (CAT 2 _ 3P _ _ _) have five targets — TIME, INST., and individual PHASE targets. These three additional targets will indicate which phase currents are in excess of tap setting when the relay trips the breaker.

50 Hz OPERATION

These relays are suitable for 50 Hz systems; however, the time current curves shown on pages 7 to 15 are for 60 Hz operation. Contact the factory for 50 Hz curves.

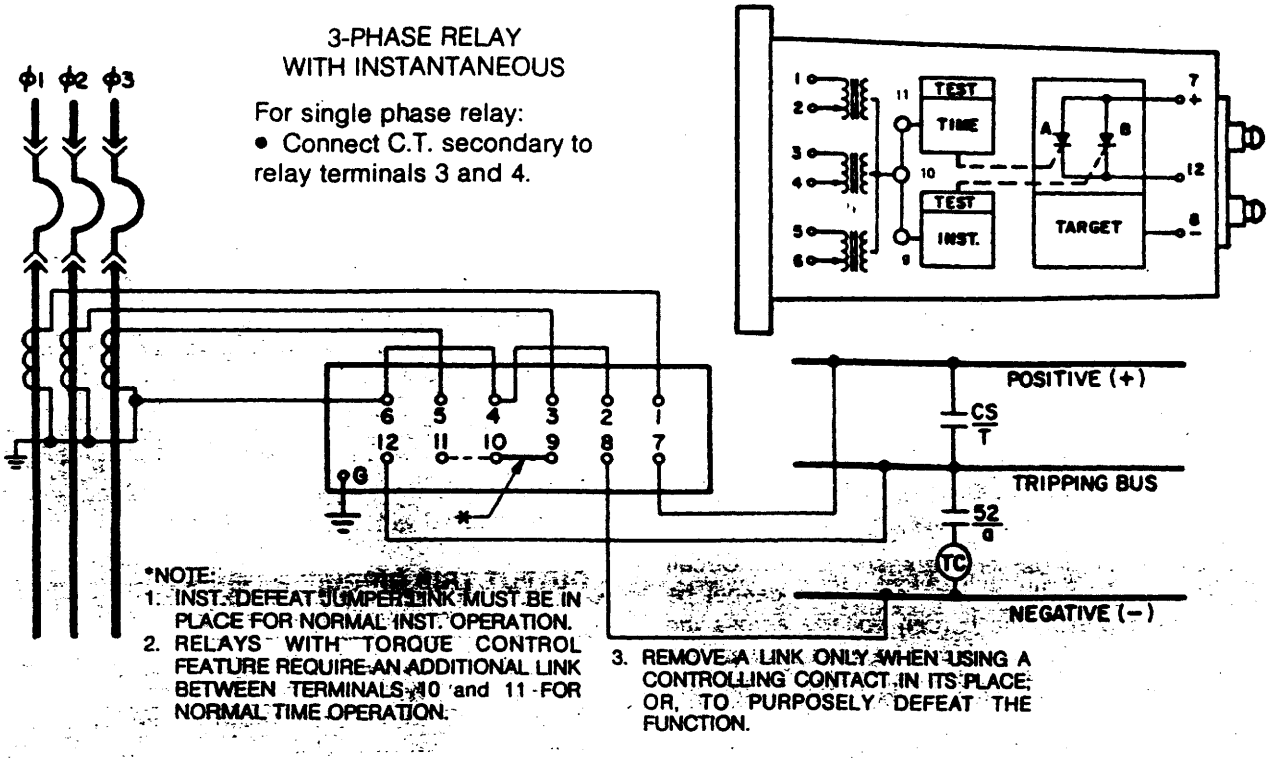


Fig. 1 — 3-Phase CIRCUIT-SHIELD Wiring Diagram

DRAWOUT SEMI-FLUSH MOUNTED RELAY

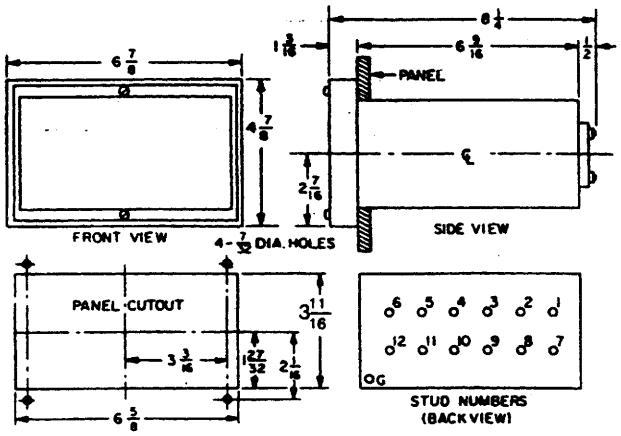
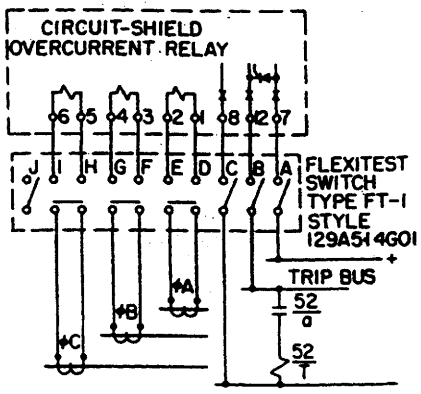


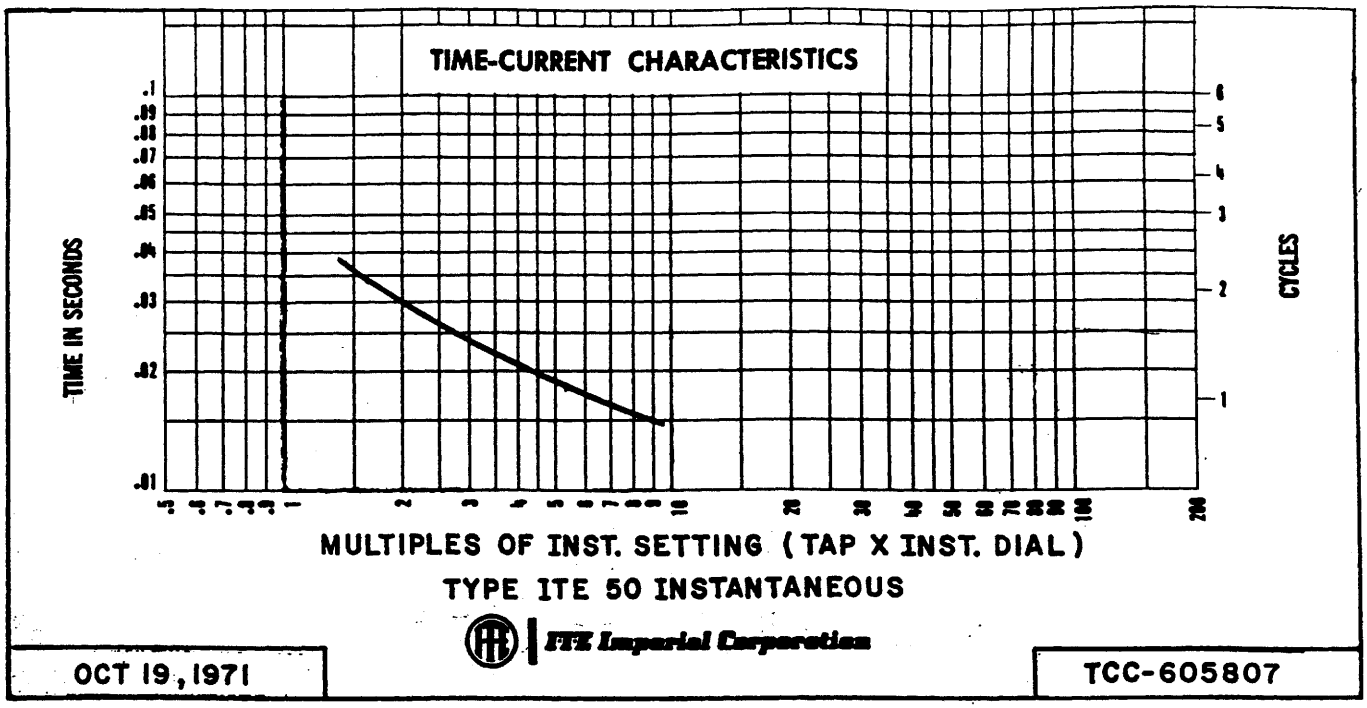
Fig. 2 — Overcurrent Relay Outline and Drilling

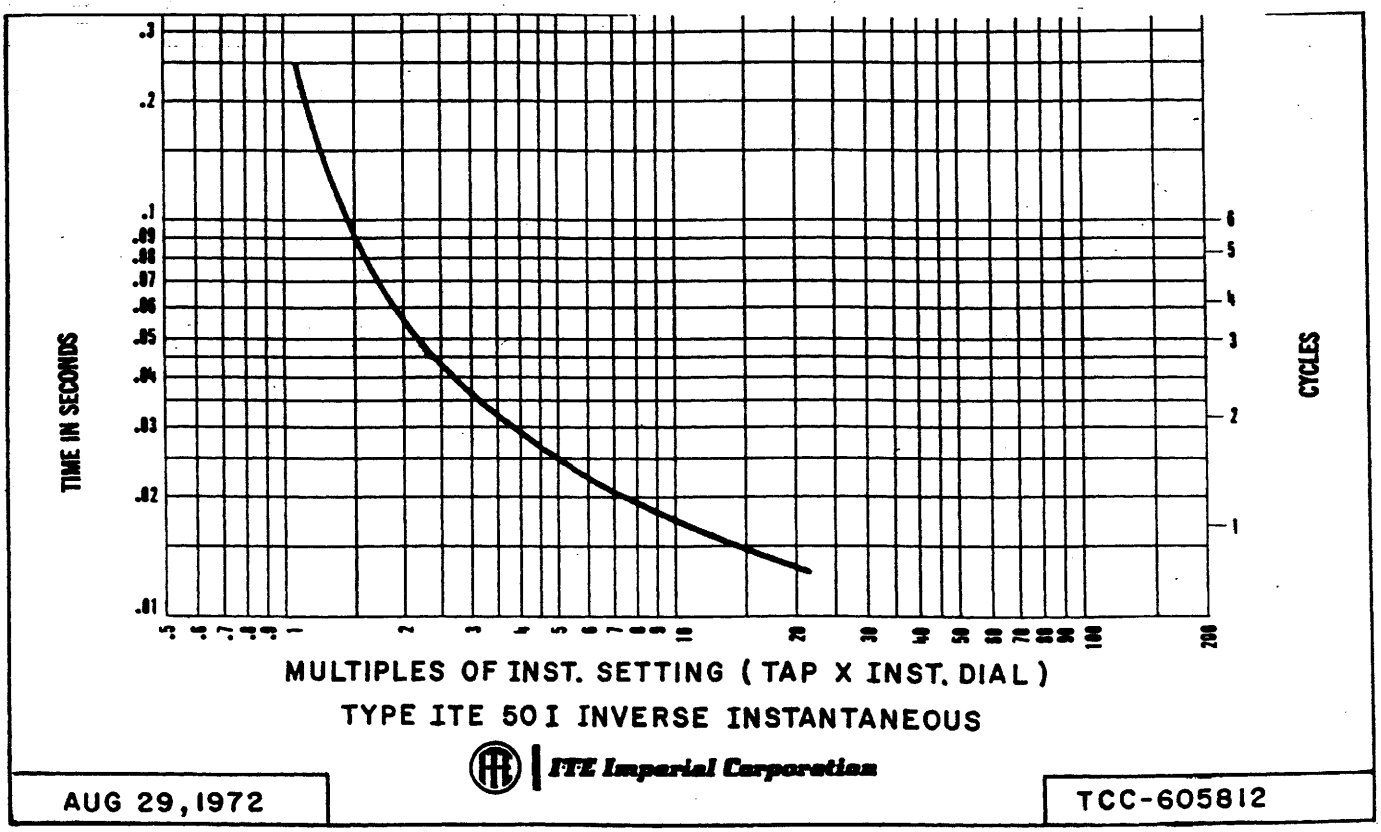


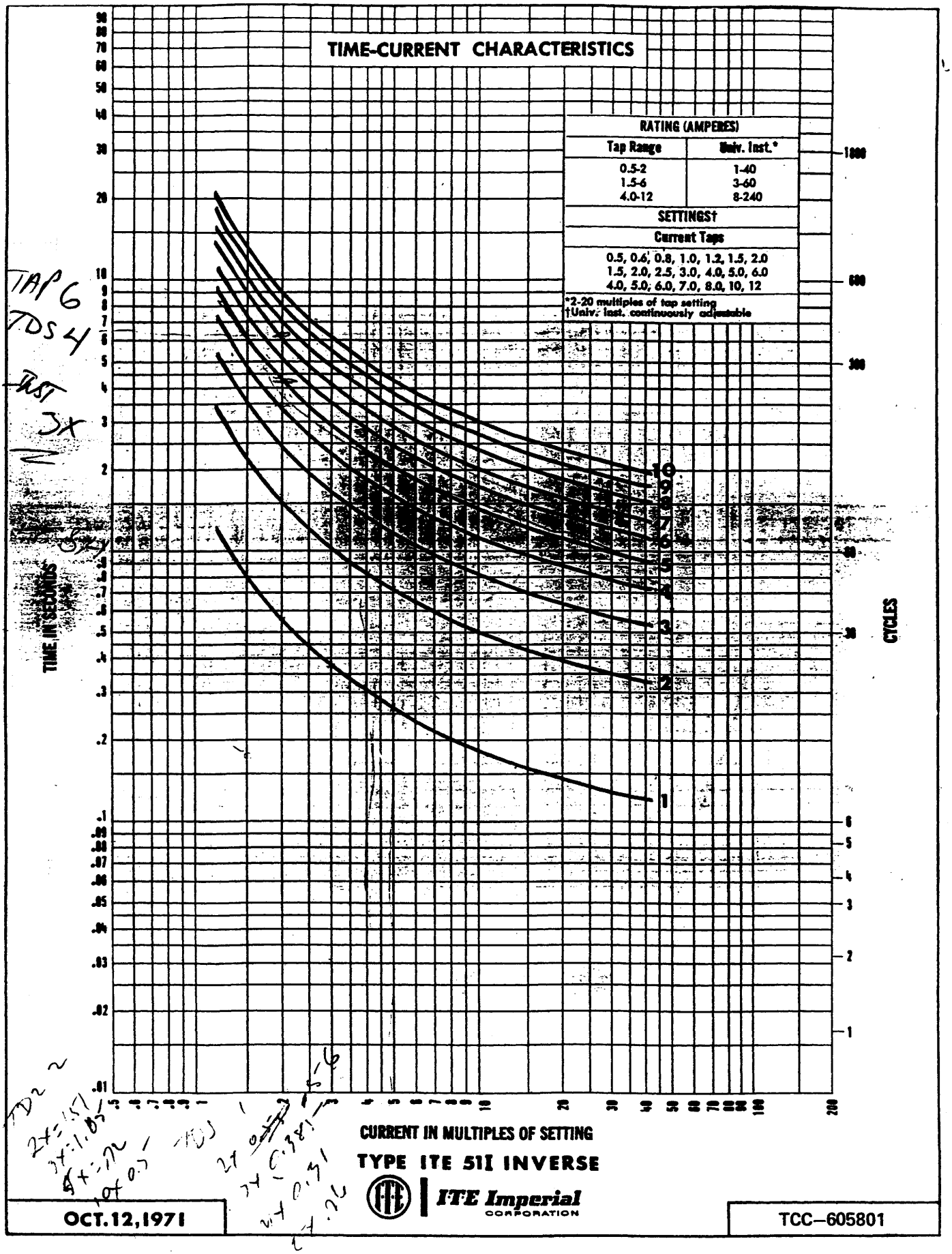
Suggested arrangement for drawout type test facilities to be used by those wishing to maintain their conventional test procedures when checking ITE's solid-state overcurrent relays.

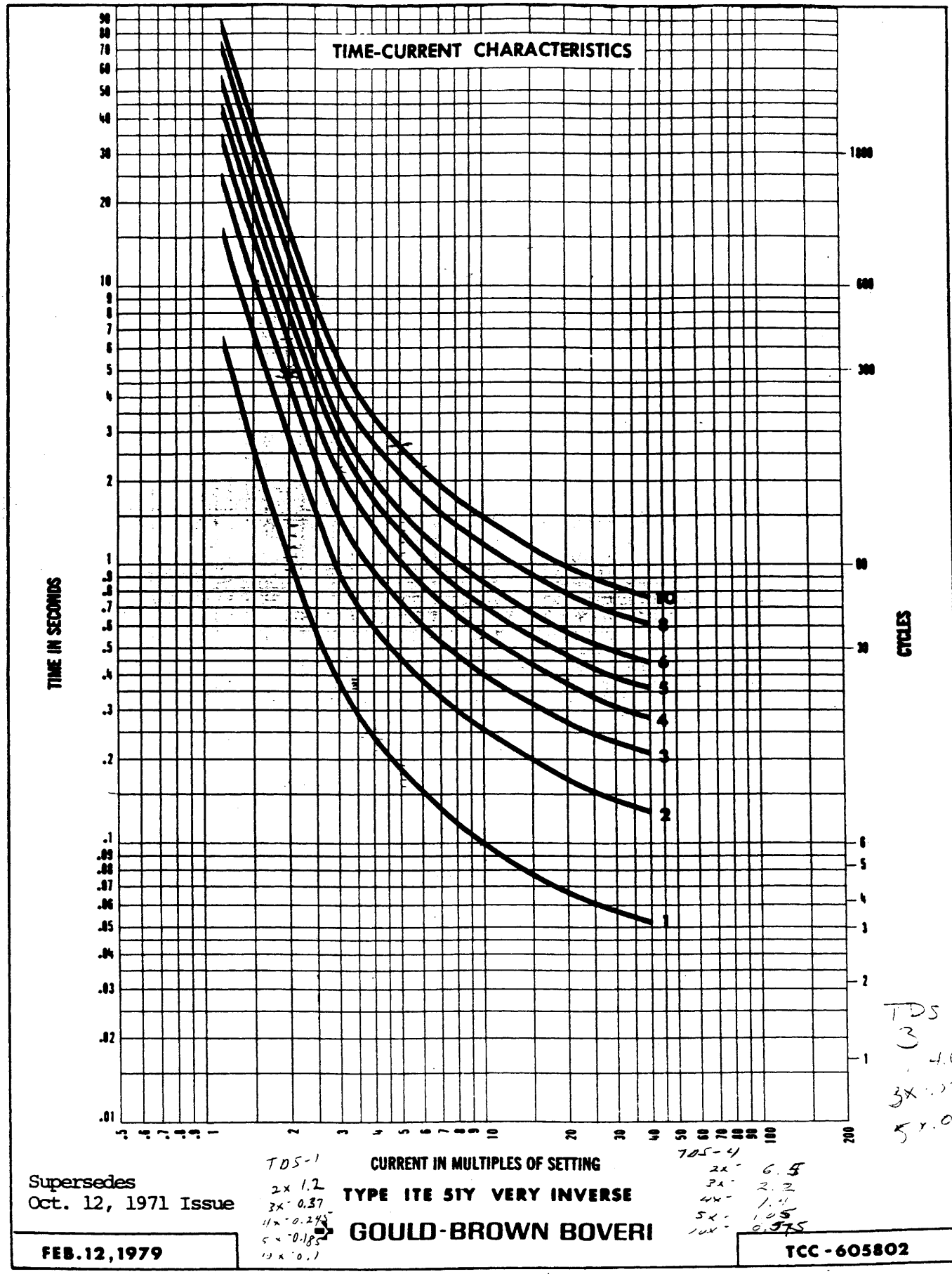
This sketch shows Westinghouse's Flexitest Switch. However, G.E., States, Meter Devices, or other types can be used.

Fig. 3 — CIRCUIT-SHIELD Connections to FT-1 Flexitest Test Switch


TIME-CURRENT CHARACTERISTICS
TIME IN SECONDS
CYCLES
MULTIPLES OF INST. SETTING (TAP X INST. DIAL)
TYPE ITE 50 INSTANTANEOUS
ITE Imperial Corporation
OCT 19, 1971
TCC-605807


TIME IN SECONDS
CYCLES
MULTIPLES OF INST. SETTING (TAP X INST. DIAL)
TYPE ITE 50I INVERSE INSTANTANEOUS
ITE Imperial Corporation
AUG 29, 1972
TCC-605812


TIME-CURRENT CHARACTERISTICS
RATING (AMPERES)
Tap Range
Univ. Inst.*
0.5-2
1.5-6
4.0-12
1-40
3-60
8-240
SETTINGS†
Current Taps
0.5, 0.6, 0.8, 1.0, 1.2, 1.5, 2.0
1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 6.0
4.0, 5.0, 6.0, 7.0, 8.0, 10, 12
*2-20 multiples of tap setting
†Univ. Inst. continuously adjustable
TIME IN SECONDS
CYCLES
CURRENT IN MULTIPLES OF SETTING
TYPE ITE 51I INVERSE
ITE Imperial CORPORATION
OCT. 12, 1971
TCC–605801



Supersedes
Oct. 12, 1971 Issue

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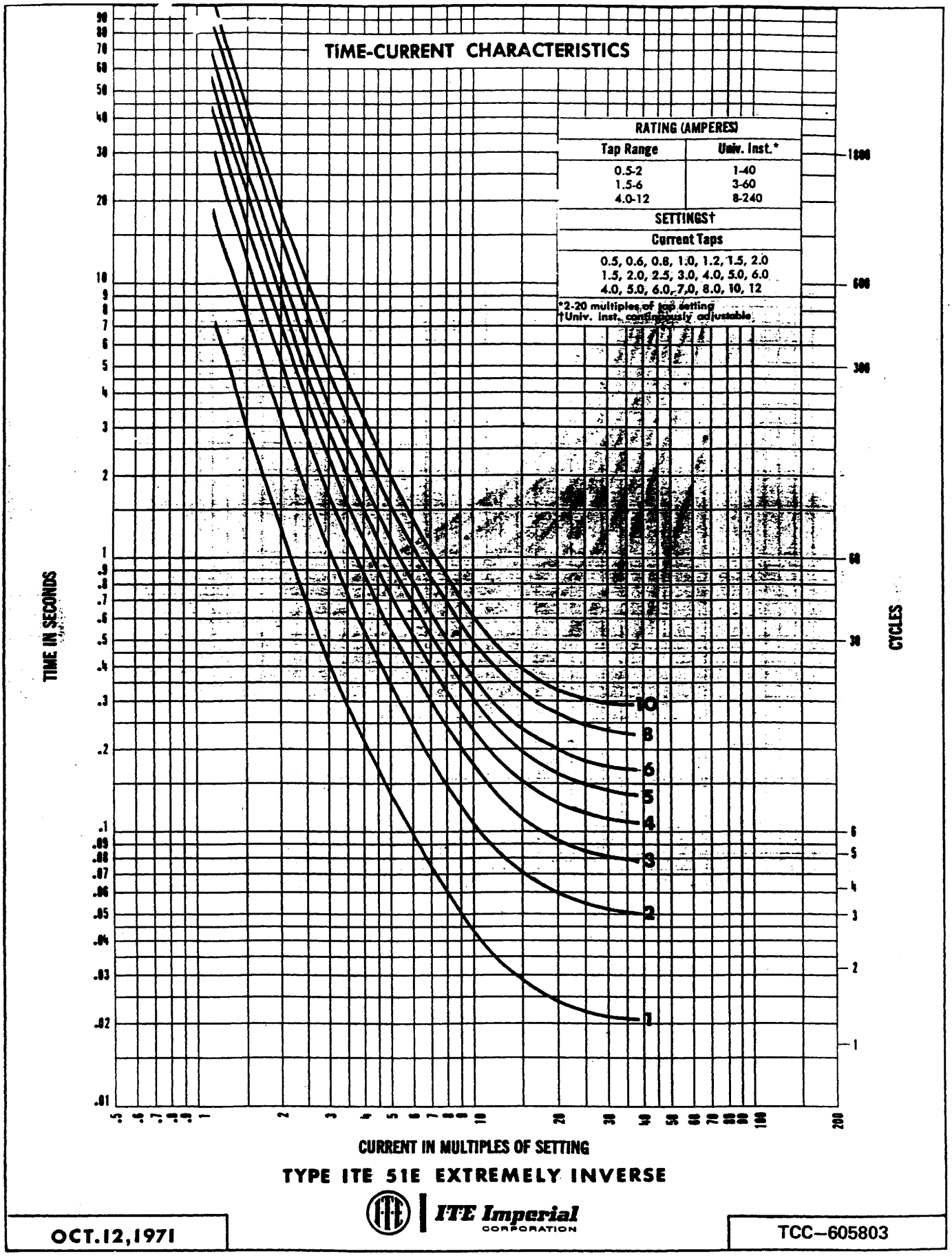
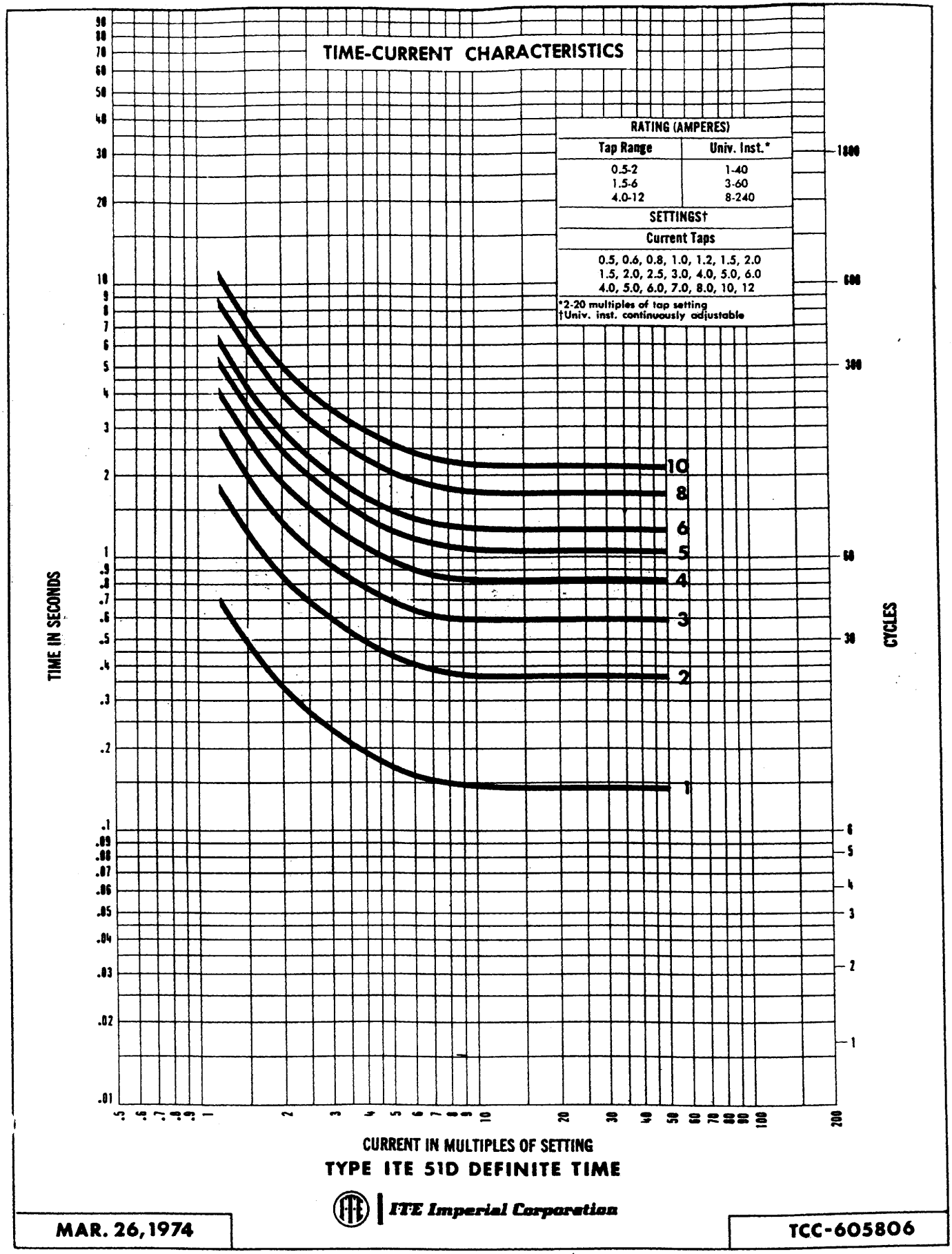
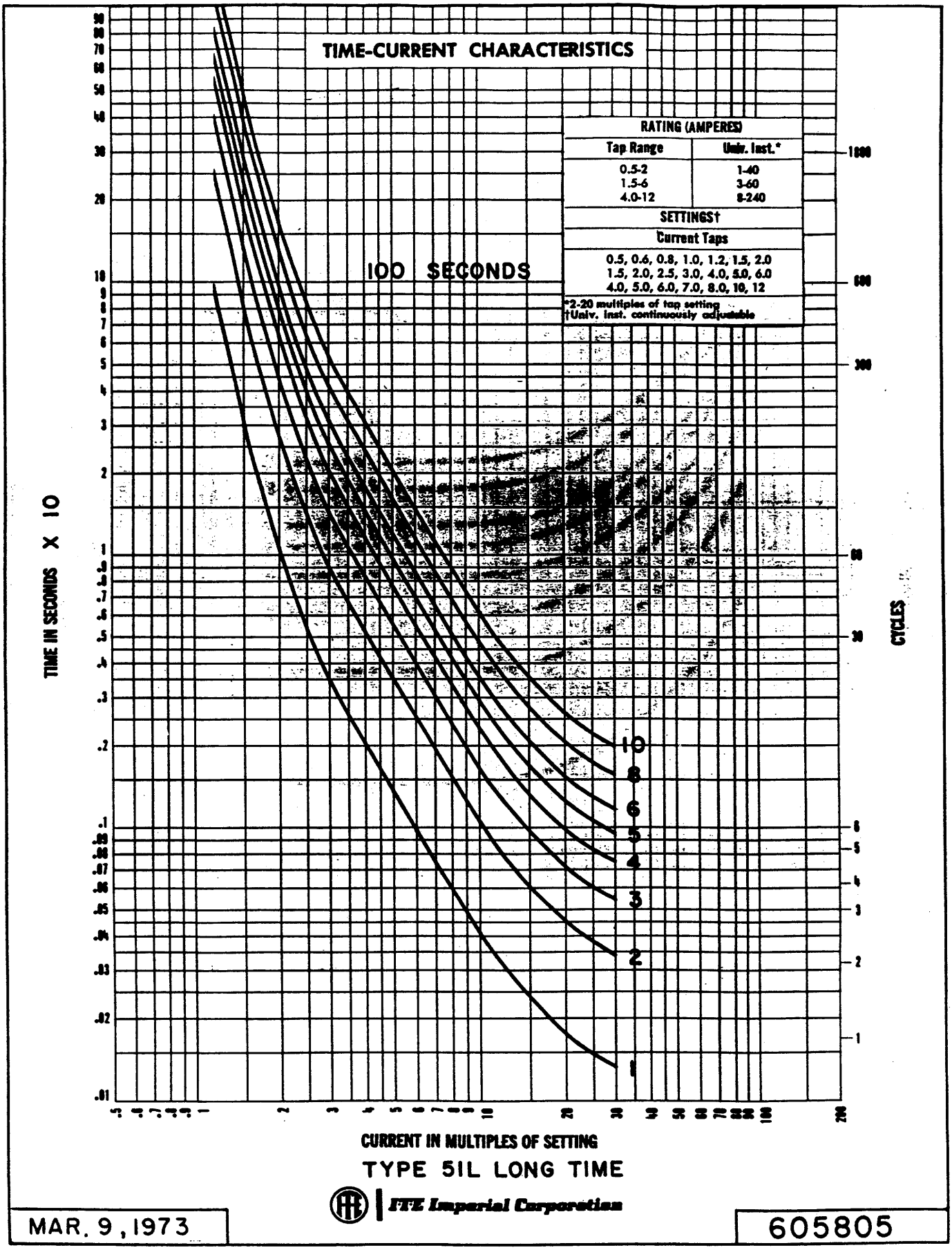
TCC-605802


TIME-CURRENT CHARACTERISTICS
RATING (AMPERES)
Tap Range
Univ. Inst.*
0.5-2
1.5-6
4.0-12
1-40
3-60
8-240
SETTINGS†
Current Taps
0.5, 0.6, 0.8, 1.0, 1.2, 1.5, 2.0
1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 6.0
4.0, 5.0, 6.0, 7.0, 8.0, 10, 12
*2-20 multiples of tap setting
†Univ. inst., continuously adjustable
TIME IN SECONDS
CYCLES
CURRENT IN MULTIPLES OF SETTING
TYPE ITE 51E EXTREMELY INVERSE
ITE Imperial CORPORATION
OCT.12,1971
TCC–605803



Supersedes curve dated 10/12/71

SOLID-STATE OVERCURRENT RELAYS



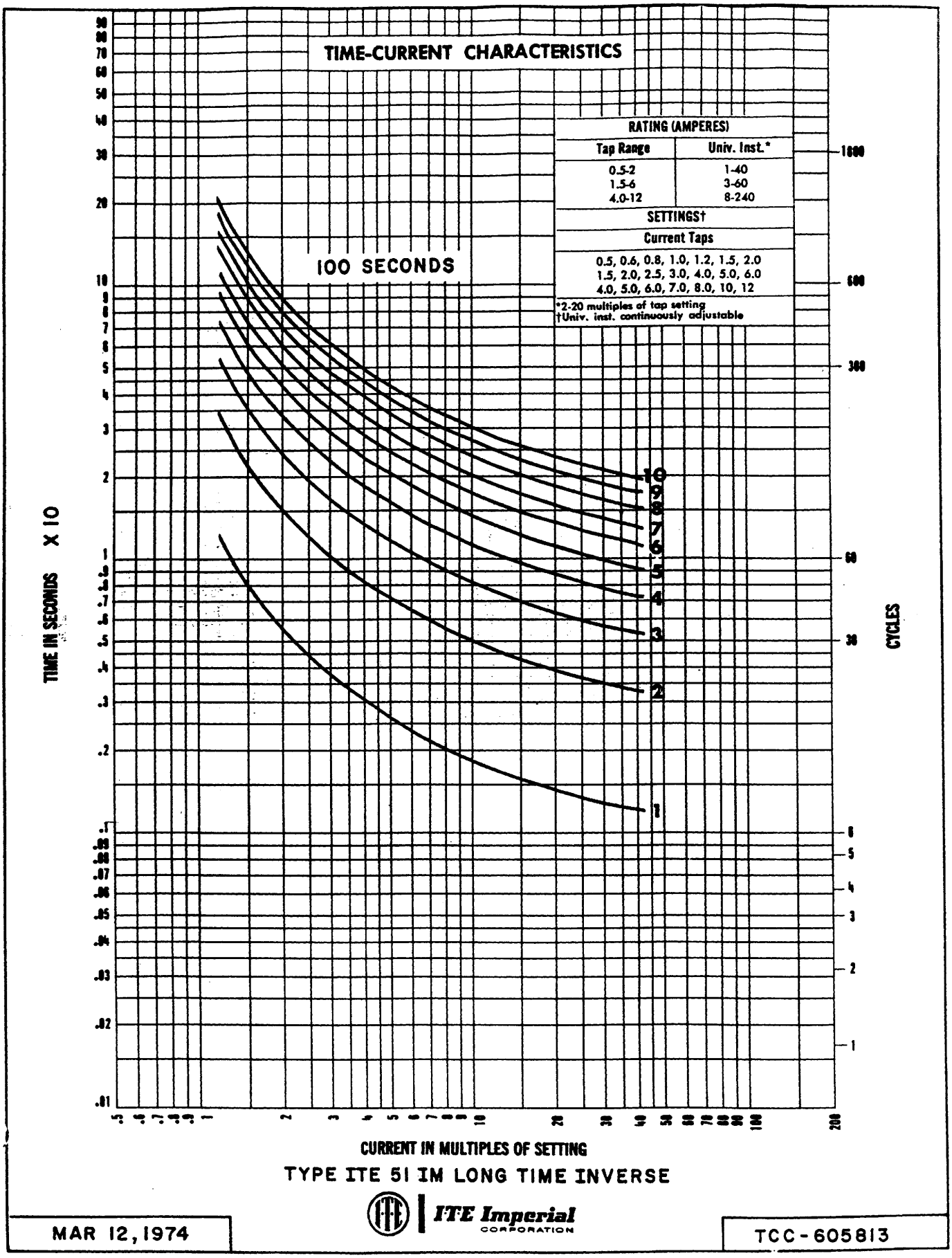
TYPE 51L LONG TIME

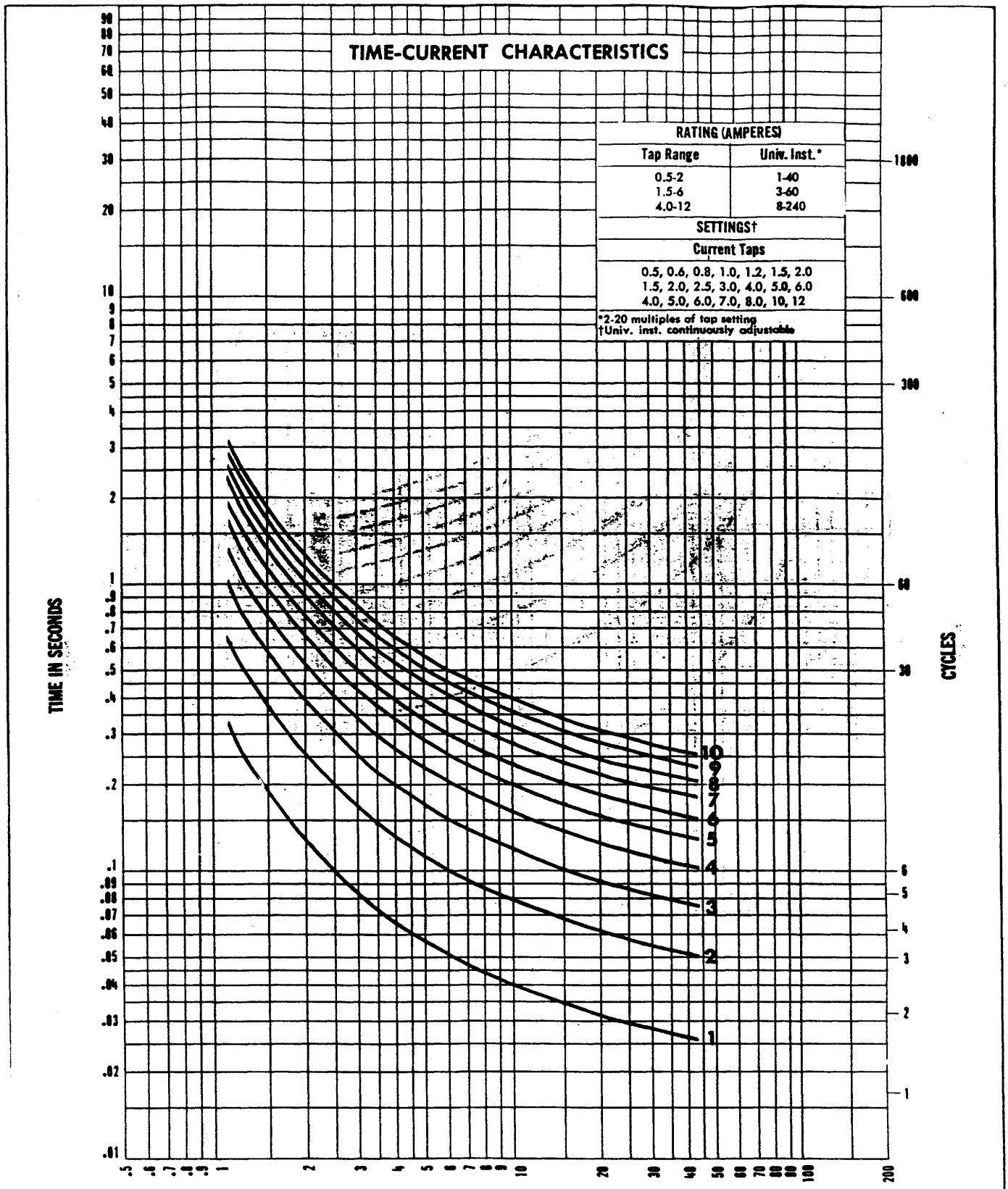
ITE Imperial Corporation

MAR. 9, 1973

605805

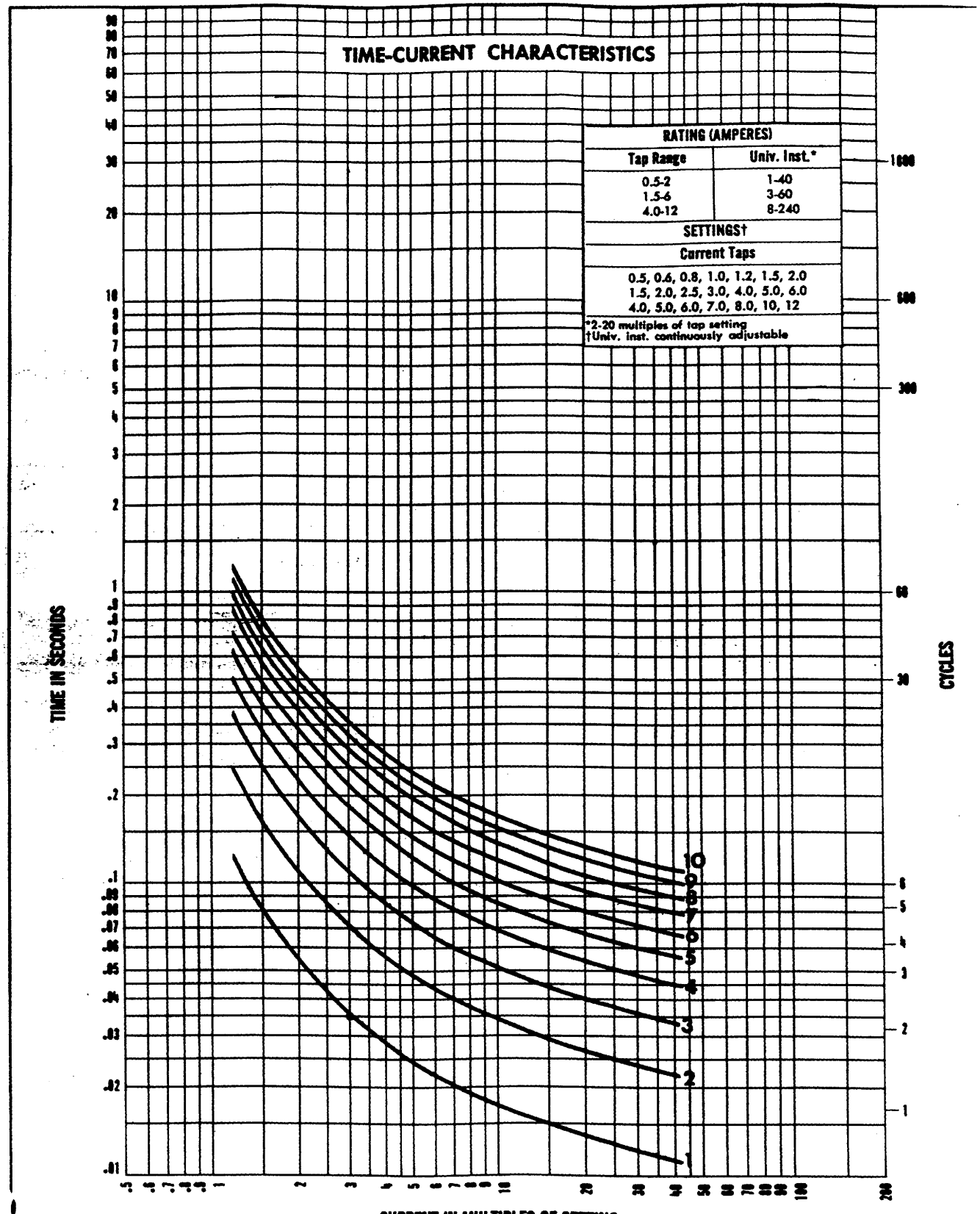
Supersedes curve dated 10/19/71


TIME-CURRENT CHARACTERISTICS
100 SECONDS
RATING (AMPERES)
Tap Range
Univ. Inst.*
0.5-2
1.5-6
4.0-12
1-40
3-60
8-240
SETTINGS†
Current Taps
0.5, 0.6, 0.8, 1.0, 1.2, 1.5, 2.0
1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 6.0
4.0, 5.0, 6.0, 7.0, 8.0, 10, 12
*2-20 multiples of tap setting
†Univ. inst. continuously adjustable
TIME IN SECONDS X 10
CYCLES
CURRENT IN MULTIPLES OF SETTING
TYPE ITE 51 IM LONG TIME INVERSE
ITE Imperial CORPORATION
MAR 12, 1974
TCC-605813



TYPE ITE 51S SHORT TIME

ITE Imperial CORPORATION



TYPE ITE 51S (SP) SHORT TIME (SP)

ITE Imperial Corporation

MAY 1, 1972

TCC-605808

CALIBRATION TESTING

1. MAINTENANCE AND RENEWAL PARTS

No maintenance is required on the CIRCUIT-SHIELD relay. Should the relay be damaged physically or electrically due to improper connections or applications, we recommend that a new relay be ordered from the factory. When ordering, state the type relay, catalog number, control voltage, and serial number.

By specifying the relay catalog number, a circuit description bulletin and schematic may be obtained from your ITE sales engineer should you desire to repair and recalibrate the relay.

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 together and disconnect grounding wire before applying test voltage.

3. ACCEPTANCE TESTS

Follow calibration test procedure under paragraph 4. Check the following points: time dial 1, current 5 times pickup; time dial 10, current 10 times pickup; time dial 10, current 5 times pickup. Operating times should be within ±5% of the times shown on the time-current characteristic curve.

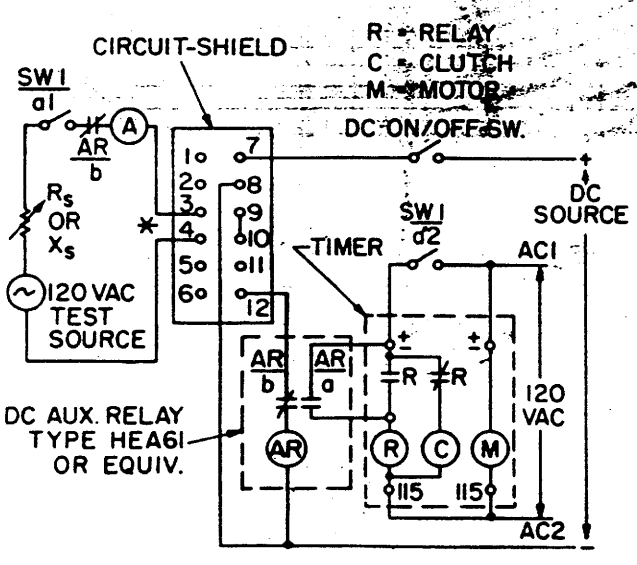


Fig. 4 — Calibration Test Circuit

4. CALIBRATION TESTS (Also see Appendix A)

Connect the CIRCUIT-SHIELD relay to the test source, proper DC control voltage (to match relay), and synchronous timer as shown in Figure 4. Also, set pickup tap to desired value.

TIME — Pickup

1) Set TIME dial to required value.
2) With DC source off, preset test current to 95% of pickup value.
3) With DC on, apply test current. No trip should occur.
4) With DC off, preset test current to 105% of pickup value.
5) With DC on, apply test current. The relay should trip and operate the TIME target. (Allow sufficient time) giving INST. target.
6) Reset target by pressing the RESET pushbutton.

TIME — Delay Curve

1) Set INST. dial to maximum position (20X).
2) Set TIME dial to required value, per time-current curves.
3) With DC off, preset test current to 300% of pickup value.
4) With DC on apply test current. The relay should trip in a time within the tolerances shown on page 4.
5) Reset target by pressing the RESET pushbutton.

INST. — Pickup

1) Set INST. dial to required value.
2) With DC off, preset current to 90% of required value (TAP X INST. DIAL).
3) With DC on, apply test current. Relay should not trip on INST. (i.e. no INST. target indication).
4) With DC off, preset test current to 110% of required value.
5) With DC on, apply test current. Relay should trip giving INST. target.
6) Reset target by pressing the RESET pushbutton.

NOTE: If a rectifier is to be used as the DC source for testing, the filter capacitor should be at least 250 ufd.

***NOTE:** FOR 3-PHASE RELAYS, PHASES A & C CAN BE SIMILARLY TESTED BY ALTERNATELY CONNECTING THE TEST SOURCE TO 1—2 and 5—6.

NOTE: Auxiliary relays with coil resistances greater than 10 ohms/volt must have a parallel resistor added across the relay coil. Size resistor to draw 100 ma current from DC source

APPENDIX A

CIRCUIT-SHIELD TEST TABLES

NOTE: You need not use these tables if you desire to make the standard receiving calibration check described under calibration testing.

When testing protective relays with test sources of limited capacity the accuracy of test results is affected by the wave shape of the test current. Where extremely accurate calibration test are desired, the attached test Tables prepared under laboratory conditions with standard CIRCUIT-SHIELD relays can be used:

Table 1 — Resistance Testing
("STATES" resistance bank #33560.R)

Table 2 — Reactance Testing
("G.E." reactor, #6054975)

Table 3 — MULTI-AMP Unit (SR-51 test set)

Note that the test current wave distortion is more apparent at the low current tap setting (highest relay burden) and at high current multiples (lowest test source impedances).

CIRCUIT-SHIELD solid-state overcurrent relays have been designed with a low burden characteristic. This relay burden is such that the primary current transformer will not saturate at high fault current values if the CT is selected so that its saturation point is above one multiple of the relay pickup setting. This is accomplished by a specially designed input transformer in the relay which saturates at just above pickup current. In addition to improving the accuracy performance of the primary current transformer, this feature also effectively prevents internal solid-state components from being subjected to high currents and voltages under fault conditions.

CONSULT FACTORY FOR TEST CURRENT CORRECTIONS TO BE USED FOR TEST SETS NOT LISTED IN THIS APPENDIX.

TABLE 1
CIRCUIT-SHIELD OVERCURRENT RELAY
TEST CURRENT CORRECTION — RESISTANCE TESTING
120 VOLT SOURCE (FIXED)

(STATES #33560.R)

TEST CURRENT MULT.	0.5-2 AMP TAP RANGE							1.5-6 AMP TAP RANGE		4-12 AMP TAP RANGE						
	0.5	0.6	0.8	1.0	1.2	1.5	2.0	2.5	3	4	5	6	7	8	10	12
PICKUP	0.50	0.60	0.80	1.00	1.20	1.50	2.00	2.50	3.00	4.00	5.00	6.00	7.00	8.00	10.00	12.00
2X	1.02	1.22	1.62	2.02	2.42	3.02	4.02	5.02	6.02	8.02	10.00	12.00	14.00	16.00	20.00	24.00
3X	1.56	1.86	2.46	3.06	3.65	4.55	6.05	7.55	9.05	12.10	15.10	18.10	21.10	24.10	30.10	36.10
4X	2.12	2.51	3.31	4.11	4.91	6.11	8.11	10.10	12.10	16.10	20.10	24.10	28.10	32.11	40.10	48.10
5X	2.70	3.19	4.19	5.19	6.19	7.68	10.20	12.70	15.20	20.20	25.20	30.20	35.20	40.20	50.20	60.18
6X	3.30	3.89	5.09	6.28	7.48	9.28	12.30	15.30	18.30	24.30	30.30	36.30	42.30	48.30		
8X	4.57	5.36	6.94	8.53	10.10	12.50	16.50	20.50	24.50	32.50	40.50	48.50	56.50			
10X	5.95	6.92	8.88	10.90	12.90	15.80	20.80	25.80	30.80	40.81	50.80					
15X	9.94	11.30	14.20	17.10	20.00	24.50	31.90	39.40	46.90							
20X	14.90	16.50	20.10	23.90	27.80	33.70	43.60	53.50								

This table lists corrected test currents for one (1) to twenty (20) multiples of each tap setting available on CIRCUIT-SHIELD relays. These test currents cause the relay to produce the trip time corresponding to current transformer (CT) operation, as will be encountered in actual service.

TABLE 2

CIRCUIT-SHIELD OVERCURRENT RELAY
TEST CURRENT CORRECTION — REACTANCE TESTING
120 VOLT SOURCE (ADJUSTABLE)

(G.E. REACTOR #6054975)

TEST CURRENT MULT.	0.5	0.6	X_S=24Ω 0.8	1.0	1.2	1.5	2.0	X_S=12Ω 2.5	3	4	5	X_S=6Ω 6	7	8	X_S=3Ω 10	12
PICKUP	0.50	0.60	0.80	1.00	1.20	1.50	2.00	2.50	3.00	4.00	5.00	6.00	7.00	8.00	10.00	12.00
2X	1.08	1.21	1.61	2.00	2.40	3.00	4.00	5.00	6.00	8.00	10.00	12.00	14.00	16.00	20.00	24.00
3X	1.52	1.81	2.41	3.00	3.60	4.50	6.00	7.50	9.00	12.00	15.00	18.00	21.00	24.00	30.00	36.00
4X	2.05	2.41	3.20	4.00	4.80	6.00	8.00	10.00	12.00	16.00	20.00	24.00	28.00	32.00	40.00	48.00
5X	2.55	3.04	4.00	5.00	6.01	7.50	10.00	12.50	15.00	20.00	25.00	30.00	35.00	40.00	50.00	60.00
6X	3.06	3.64	4.90	6.00	7.20	9.05	12.05	15.00	18.00	24.00	30.25	36.00	42.00	48.00	60.00	72.00
8X	4.06	4.90	6.55	8.05	9.75	12.15	16.05	20.10	24.30	32.40	41.00	49.00	56.00	64.00	80.00	
10X	5.35	6.35	8.25	10.40	12.30	15.25	20.50	25.50	31.00	41.50	51.50	62.50	71.50	80.00		
15X	7.85	9.55	12.40	15.50	18.90	22.70	30.45	40.00	47.00	61.80	78.00					X_S=0.5Ω
20X	10.70	13.20	16.60	22.00	25.00	31.25	46.50	63.00	67.00							

0.5-2 AMP TAP RANGE
1.5-6 AMP TAP RANGE
4-12 AMP TAP RANGE

This table lists corrected test currents for one (1) to twenty (20) multiples of each tap setting available on CIRCUIT-SHIELD relays. These test currents cause the relay to produce the trip time corresponding to current transformer (CT) operation, as will be encountered in actual service.

When using a tapped reactance in series with a variable voltage source to test CIRCUIT-SHIELD relays, the desired test current should be set using the largest possible reactance, as indicated in the chart above for a 120 Vac source.

TABLE 3

For specific test instructions using MULTI-AMP SR-51 Test Set see page 15.

CIRCUIT-SHIELD OVERCURRENT RELAY
TEST CURRENT CORRECTION — MULTI-AMP TEST SET

(MULTI-AMP SR-51)

80 VOLT TAP: use data to left of bold line.
40 VOLT TAP: use data to right of bold line.

TEST CURRENT MULT.	0.5	0.6	0.5-2 AMP TAP RANGE 0.8	1.0	1.2	1.5	2.0	1.5-6 AMP TAP RANGE 2.5	3	4	5	4-12 AMP TAP RANGE 6	7	8	10	12
PICKUP	0.50	0.60	0.80	1.00	1.20	1.50	2.00	2.50	3.00	4.00	5.00	6.00	7.00	8.00	10.00	12.00
2X	1.55	1.58	1.87	2.25	2.59	3.15	4.10	5.05	6.10	8.10	10.00	12.00	14.20	16.00	20.00	24.30
3X	3.35	3.34	3.49	3.85	4.29	5.01	6.40	7.80	9.40	12.30	15.30	18.30	21.30	24.30	30.20	36.50
4X	5.10	4.89	5.09	5.45	6.00	6.90	8.70	10.40	12.30	16.50	20.40	24.50	28.50	32.00	40.50	48.80
5X	6.78	6.50	6.60	7.00	7.70	8.81	11.00	13.30	16.00	20.80	25.50	30.80	35.60	41.20	51.00	62.00
6X	8.10	7.90	7.95	8.50	9.30	10.50	13.30	16.00	19.00	25.00	30.60	37.00	44.20	49.50	61.80	74.00
8X	10.80	10.40	10.60	11.30	12.40	14.30	17.80	21.80	25.20	33.00	41.50	51.50	59.50	65.50		
10X	13.30	12.90	13.30	14.00	15.60	18.00	22.30	27.00	31.00	40.90	55.00	65.00	75.00	82.00		
15X	18.80	18.70	18.60	20.50	22.50	25.00	32.00	39.00	52.00	65.00	79.00				40 VOLT TAP	
20X	24.00	24.30	24.00	26.00	29.50	32.50	42.00	61.00	70.00	85.00						

This table lists corrected test currents for one (1) to twenty (20) multiples of each tap setting available on CIRCUIT-SHIELD relays. These test currents cause the relay to produce the trip time corresponding to current transformer (CT) operation, as will be encountered in actual service.

The SR-51, which operates from a 120 Vac source, uses a transformer with step down taps to produce a wide range of currents useful in general relay testing. Since the series impedance of the transformer provides a fixed source impedance, a variable autotransformer is used to adjust the level of input current. This fixed source impedance is in general not large enough compared to the non-linear relay impedance to guarantee sine wave test current.

TESTING WITH MULTI-AMP SR-51 TEST SET

EQUIPMENT NEEDED

1. MULTI-AMP MODEL SR-51 RELAY TEST SET and

2. Small AUXILIARY RELAY with DC coil to match CIRCUIT-SHIELD relay voltage rating and with a set of normally open contacts. Auxiliary relays with coil resistances greater than 10 ohms per volt must have a parallel resistor added across the relay coil.

TEST PROCEDURES

ALWAYS REFER TO MANUFACTURER'S LITERATURE BEFORE TESTING.

TYPE OF TESTS

Pickup — Timing Circuit
Time/Current Characteristics
Pickup — Instantaneous Circuit

SETUP OF CONTROLS BEFORE TEST

Control	Position
"Power ON" switch	OFF
"Timer Operation Selector" switch	Upper — "N.O. MOM" Lower — "CONT."
"Main Control"	Zero (counterclockwise)
"Aux. Power" switch	"INT."
"Voltmeter Range" switch	150
"Voltmeter Selector" switch	"DC"
"Aux. Selector" switch	"DC 150"
"Aux. Control"	Zero (counterclockwise)
"AC Range" switch	10A
"DC Range" switch	5A
"Main Ammeter Range" switch	So that desired test current will be read on upper 1/3 of meter scale.
"Voltage Relay Test" (DET) switch	Set "NORM"
"Output #1 - #2" switch	Output #1

PICKUP TEST — TIME CIRCUIT

1. Connect the Multi-Amp relay tester to a suitable source of power as indicated on the nameplate and ground. BE SURE THE MAIN SWITCH IS OFF. CHECK THE "POWER ON" LIGHT.

2. Connect relay input circuit (Relay Terminals 1-2, 3-4, or 5-6) to the right-hand common and the 80 volt tap of "Output #1" of test set.

3. Connect Relay Terminals 7-8 to "DC Output" binding posts of test set. NOTE: Relay Terminal 7 should be connected to positive (+). Reversed polarity can damage relay.

4. Connect output circuit of relay (Relay Terminals 8 and 12) to operating coil of the small DC auxiliary relay.

5. Connect normally open contacts of the DC auxiliary relay to the "Relay Contacts" binding posts of the test set.

6. Turn "Power ON" switch ON. "Power ON" light should glow.

7. Initiate unit by pressing and holding "Initiate" switch.

8. Rotate "Aux. Control" clockwise until DC voltage of relay under test is observed on voltmeter. Release "Initiate" switch.

9. Preset ammeter needle using "Pointer Preset" to ½ division below desired test current. Desired test current is relay tap value less 5%.

10. Set test current desired by jogging the "Initiate" switch and rotating "Main Control" (clockwise) to increase output until the ammeter needle quivers. Hold in "Initiate" switch and rotate the "Main Control" until test current is read on ammeter. Release "Initiate" switch.

11. Set "Timer Operation Selector" switch: Upper to "N.O. MAINT."; Lower to "TIMER".

12. Reset timer to zero with "Timer Reset" lever.

13. Initiate test set by pressing "Initiate" switch. Relay input circuit will "see" test current. Relay SHOULD NOT operate to de-energize test set under these conditions (allow 1-1½ minutes). De-energize test set by turning "Power ON" switch OFF.

14. Remove one lead from "DC Output" binding posts.

15. Turn "Power ON" switch ON. Reset "Timer Operation Selector" switch: Upper to "N.O. MOM."

16. Repeat Steps 9 through 12 above, except test current should be relay tap value +5%.

17. Replace DC lead that was removed in Step 14.

BE SURE TO MAKE TEST CURRENT CORRECTION
PER TABLE 3 WHEN SETTING TEST CURRENT

18. Adjust "Time Operation Selector" switch: Upper to "N.O. MAINT."

19. Initiate test set by pressing "Initiate" switch. Relay input circuit will "see" test current and SHOULD operate to de-energize test set and stop timer (allow sufficient time). Relay time target should operate.

20. Turn test set OFF.

TIME DELAY TEST

1. Reset "Timer Operation Selector" switch: Upper to "N.O. Mom."

2. Repeat Steps 1 through 9 under "PICKUP TEST — TIME CIRCUIT," except the value of test current should be obtained from Table 3.

3. Remove one lead from "DC Output" binding post.

4. Initiate unit by pressing "Initiate" switch.

5. Set test current desired by jogging the "Initiate" switch and rotating "Main Control" (clockwise) to increase current until ammeter needle quivers. Hold in "Initiate" switch and rotate "Main Control" to make final current adjustment. Release "Initiate" switch.

6. Replace DC lead that was removed in Step 3.

7. Set "Timer Operation Selector" switch: Upper to "N.O. MAINT."; Lower to "TIMER".

8. Reset timer to zero with "Timer Reset" lever.

9. Initiate unit by pressing "Initiate" switch. Timer will run and test current will be indicated on ammeter. The relay test set will automatically cut off and the timer will stop when relay operates to fire the SCR which energizes the DC auxiliary relay to close its contacts. Relay time target should show.

10. Note the relay under test must be energized with DC to reset relay target.

11. Turn test set OFF.

PICKUP TEST — INSTANTANEOUS CIRCUIT

1. If test current will exceed 42 amperes, use 40 volt tap on test set "Output #1".

2. Jumper terminals 9 and 10 on relay.

3. Repeat Steps 1 through 8 under "PICKUP TEST — TIME CIRCUIT".

4. Preset ammeter needle using "Pointer Preset" to ½ division below desired test current. Desired test current is relay instantaneous setting less 10%. Obtain value of test current from Table 3.

5. Remove one lead from "DC Output" terminal.

6. Set "Timer Operation Selector" switch: Upper to "N.O. MOM."; Lower to "FAST TRIP".

7. Jog "Initiate" switch and rotate "Main Control" clockwise until test current is read on ammeter. Release "Initiate" switch.

8. Replace DC lead removed in Step 5 above.

9. Press and hold "Initiate" switch. Relay instantaneous circuit SHOULD NOT pick-up to stop timer (allow 0.30 second). Reset relay target.

10. Remove one lead from "DC Output" terminal.

11. Repeat Step 7 except test current should be relay instantaneous setting + 10%. Obtain value of test current from Table 3.

12. Replace DC lead removed in Step 10.

13. Press and hold "Initiate" switch. Relay instantaneous circuit should pick up to fire its SCR to energize the DC coil of auxiliary relay to stop timer. Relay instantaneous target should operate.

14. Release "Initiate" switch.

WARNING!!! CURRENT INDICATED ON AMMETER IS PRESENT IN RELAY CIRCUIT UNTIL "INITIATE" SWITCH IS RELEASED. Therefore, it is important to perform this test rapidly.

15. Turn test set OFF.

16. Record all test results.

***NOTE:** For 0.5-2 ampere tap range, the settings should be ±20% instead of ±10%.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes the matter should be referred to GOULD, INC.

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GOULD-BROWN BOVERI

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I.T.E. MAINTENANCE PROCEDURE

5 AND 15KV C.B.'s.

Refer to instruction manual 1B-2807-51C-5KV
1B-2807-50A-15KV

Upon removal of breaker, record:

(A) Date
(B) Breaker Serial Number
(C) Substation
(D) Cell
(E) Counter reading in full

1. Pre-maintenance operations check.

   (A) Electric trip and close.
   (B) Manual trip and close.
   (C) Trip free.
   (D) Check that there is a "Trip", "Close", and "Trip", when the closing spring is charged in the close position.

2. Remove barriers and covers and clean with an Oil-Free solvent.

3. Arc chute examination check list.

   (A) Liner sheets.
   (B) Arc plate assemblies.
   (C) Jump Gap area
      (1) Erosion or pitting of rear horn spacers.
      (2) Warped or cracked jump gap plates.
      (3) Eroded disconnect end pin bushings.
   (D) Erosion or distortion of front runners.

4. Arc Chute Cleaning.

   (A) Wipe all metal parts with a dry cloth to remove any dirt or dust accumulation.
   (B) Wipe all insulating parts with an oil free solvent.

5. Main contacts.

   (A) Remove dirt and grease with an oil free solvent.

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DRAWN BY:	I.T.E. 5 & 15 KV CIRCUIT BREAKERS	SCALE:
CHECKED BY:		DATE:
APPROVED BY:		DRAWING NO: MM-6-A

Note: Discoloration of the main contacts does not indicate damage. This condition can be removed by closing and opening the breaker under "No load conditions". Should the main contacts show slight pitting, remove small burrs by following the contact contour with a fine file. A small amount of pitting will not interfere with the operation of the breaker. Therefore it is not necessary to remove pitting completely.

(B) Adjustments (bridge pivot pressure) refer to appropriate 5 or 15KV instruction manual.
(C) Adjustments (contact pressure) refer to appropriate 5 or 15KV instruction manual.
(D) Make ducter readings on main contacts and record.

6. Operating Mechanism.

(A) Check for movement of all latches and rollers.
(B) Check for correct operation of puffers.
(C) Check all nuts, bolts. cotter pins for tightness.
(D) Check all electrical connections for tightness.
(E) Adjustments latch check.

Note: This is applicable only to the 5KV breakers refer to instruction manual 5KV.

(F) Check that the motor limit switch operates correctly.
(G) Check the continuity of all the "A" and "B" contacts of the auxiliary switch.
(H) Check the control wiring to print (acceptance test)
(I) Record the distance between the left hand arcing tips when the 52A trip contact makes.
(J) Check that the counter operates correctly.

7. Racking Mechanism.

(A) Adjustments - refer to appropriate 5 or 15KV instruction manual.
(B) Check that the breaker will trip free if the racking mechanism is in between any of the three stops (connected, test and disconnected).
(C) Check that the racking mechanism cannot be operated when the breaker is closed.

8. Primary Disconnect Studs and Ground Connection.

(A) Remove old grease and check contact wipe.
(B) Re-lubricate with GE D50H47 contact grease.

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9. Secondary Disconnect Assembly.

   (A) Remove old grease and inspect for misalignment and damage.
   (B) Re-lubricate with G.E. D50H47 contact grease.

10. Electrical Tests.

   (A) Pickup voltage of trip coil expressed in % of rated voltage.
   (B) Pickup voltage of X coil expressed in % of rated voltage.
   (C) Pickup voltage of Y coil expressed in % of rated voltage.
   (D) Operation check of the spring charging motor.

11. Dielectric withstand tests.

   (A) Control wiring (use 15KV hypot at 500 volts)
      1. Remove the spring loading motor from the circuit by the disconnecting switch on the front of the breaker.
      2. Jumper all the pins on the secondary disconnect plug.
      3. Connect the hypot to the secondary disconnect plug and the breaker frame.
      4. Record leakage current.
   (B) Main contacts and arc chutes (use 15KV hypot at 15KV)
      1. Close the breaker.
      2. Ground the breaker frmae and bond the phases not under test to the breaker frame.
      3. Connect the hypot to the phase under test and the breaker frame.
      4. Record leakage current on each phase.
      5. Open the breaker.
      6. Bond the lower studs of the breaker to the frame.
      7. Separately hypot each of the upper studs of breaker.
      8. Record the leakage current on each phase.

12. Dielectric Loss Tests.

   (A) Main contacts and arc chutes.
      1. Open the breaker.
      2. Ground the breaker frame.
      3. Bond all the breaker studs except the one under test, to the breaker frame.
      4. Connect the impedance bridge from the stud undertest to the breaker frame.
      5. Record the dissipation factor as read on the impedance bridge.
      6. Repeat test for all breaker studs.