INSTRUCTIONS

GEK-73300-1

TEST SET Cat. No. TAK-TS2

For Testing the SST and ECS Solid-state Overcurrent Trip Devices Used on Type AK/AKR LVPCB's

CIRCUIT PROTECTIVE DEVICES DEPT.
PLAINVILLE, CONNECTICUT USA

GENERAL ELECTRIC

CONTENTS

Testing SST and ECS Solid-state Trip Devices with TEST SET TAK-TS2

INTRODUCTION

GENERAL

Test Set Cat. No. TAK-TS2 is a portable instrument designed for field testing the performance of the following solid-state overcurrent trip devices:

- SST and ECS types used on AK and AKR low voltage power circuit breakers.
- VersaTrip Mod 2 types used on molded case breakers and the insulated case Power-Break breakers.

The TAK-TS2 functions identically to and supersedes its predecessor TAK-TS1 model, but has the added capability for testing the VersaTrip Mod 2 trip devices.

This publication covers testing of the SST and ECS devices only. A companion manual, GEK-73300-2, provides the instructions for testing VersaTrip Mod 2.

THE TRIP DEVICE "SYSTEM"

The "trip device" is a complete system comprising the following components:

1. Solid-state Programmer Unit.
2. Phase Current Sensors.
3. Magnetic Flux Shift Trip Device.
4. Fourth-wire Neutral Sensor for Type SST Units containing a Ground Fault trip element for use on three-phase, four-wire load circuits.

All components except the Neutral Sensor are integrally mounted on the circuit breaker. When used, the Neutral Sensor is separately mounted in the bus or cable compartment of the switchgear. In drawout construction it is automatically connected to the trip device on the breaker via a drawout secondary disconnect block.

TEST MODES

The TAK-TS2 Test Set is used to perform the various trip device tests in two basic modes:

A — Programmer Unit Only
B — Complete Trip Device System

WARNING: *THESE TESTS MUST BE CONDUCTED ONLY ON A DEENERGIZED BREAKER COMPLETELY DISCONNECTED FROM ITS PRIMARY AND CONTROL POWER SOURCES.*

MODE A — PROGRAMMER UNIT ONLY

Tests are conducted with the programmer unit disconnected from the breaker. During the tests, the programmer unit can remain mounted on the breaker or may be completely removed from it.

Test Scope

1. Verify the time-current characteristics and pick-up calibration of the various trip elements. Designations for the trip elements are abbreviated as:

LT	- Long Time
ST	- Short Time
INST	- Instantaneous
GF	- Ground Fault

2. Verify operation of the Fault Trip indicators on Programmer units so equipped.

MODE B — COMPLETE TRIP DEVICE SYSTEM

For these tests, the programmer unit is connected to the breaker through the test set.

Test Scope

1. All Programmer Only tests above, plus the provision to optionally switch the Programmer's output to activate the Magnetic Flux Shift Trip Device to verify its operation via physically tripping the breaker.
2. Check continuity of the Phase Sensors.

SPECIFICATIONS

Input: 105-125 Vac 50/60 Hz
Power Consumption: 150 watts maximum
Weight: 20 pounds
Dimensions: 15 in. L x 9 in. H x 9¾ in. D

APPLICABLE TIME-CURRENT CURVES

ECS: LT, ST & INST GES-6032
SST: LT, ST & INST GES-6033
Ground Fault GES-6034, 6035

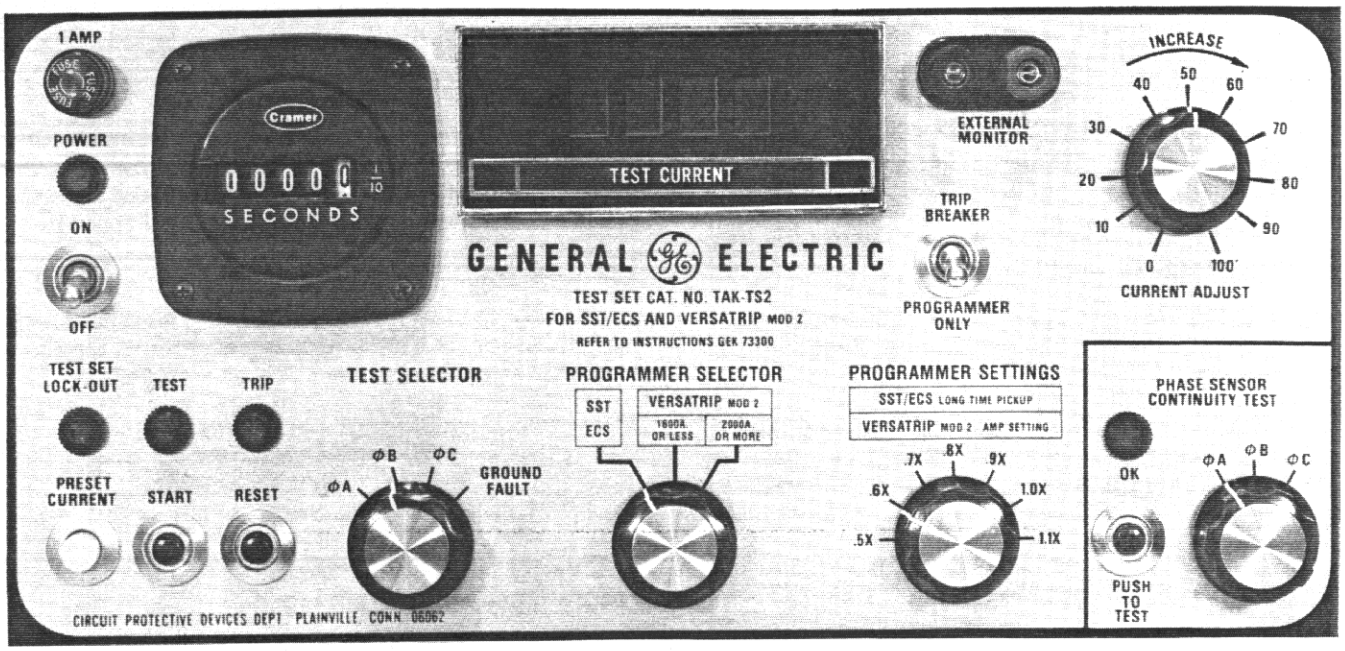


Fig. 1. Front panel

OPERATING CONTROLS

The Test Set indicators and operating controls are self identified on the front panel pictured above.

ON-OFF SWITCH

Applies 115 VA-c input power to the test set. A red companion LED indicator, located directly above, illuminates when the switch is ON. Protection is provided by a one ampere fuse located above the indicator light.

PRESET CURRENT BUTTON

Enables the operator to pre-establish (via the CURRENT ADJUST control) the desired test current prior to initiating a test. For this control to function, the programmer unit must be connected to the test set.

START BUTTON

Initiates the test by applying current to the programmer. The current persists until the unit trips or the reset button is actuated.

RESET BUTTON

Resets the test set logic so that a new test sequence can be initiated. It also stops a test in progress.

TEST SELECTOR

Positioned according to the trip element under test — phase overcurrent or GROUND FAULT.

PROGRAMMER SELECTOR

Set according to the type of trip device to be tested, i.e. SST/ECS; VersaTrip Mod 2 rated 1600 A or less; VersaTrip Mod 2 rated 2000 A or more. Set on SST/ECS for all tests described in this manual.

PROGRAMMER LONG TIME PICKUP SETTING SELECTOR

Establishes a test current magnitude consistent with and specifically for each LT pickup set point on the programmer. *For all phase current testing (LT, ST and INST elements), the position of this control must match the setting on the programmer.*

PHASE SENSOR CONTINUITY TEST

This section of the panel contains controls for checking electrical continuity of each phase sensor circuit. The selector determines the phase to be tested. Proper continuity exists when the OK LED indicator lights up when the PUSH TO TEST button is depressed. No light signifies that a high resistance or open circuit exists in the CT or its wiring harness.

CURRENT ADJUST KNOB

A variable transformer for establishing the desired level of test current to be applied to the programmer.

TRIP BREAKER — PROGRAMMER ONLY SWITCH

Provides a choice of two test modes:

"Programmer Only" Position **(Mode A)**

The programmer's trip signal output is confined to the test set circuitry and cannot trip the breaker.

"Trip Breaker" Position **(Mode B)**

The programmer's trip signal output is directed to the circuit breaker's magnetic trip device to physically trip the breaker. This mode establishes the integrity of the magnetic trip device and the programmer's capability to actuate it.

TEST CURRENT METER

Provides digital readout of the magnitude of the test current being applied to the programmer unit.

ELAPSED TIME METER

A mechanical counter which records the programmer's tripping time in seconds and tenths. It must be manually reset after completion of each test.

NOTE: *When operating the test set from a 50 Hz supply, readings of the Elapsed Time Meter must be multiplied by 1.2.*

TEST SET LOCK-OUT INDICATOR

To prevent possible damage to the programmer unit when subjected to abnormally prolonged or continuous testing at high current levels, a lock-out circuit is provided. This circuit monitors the current-time input to the programmer such that when a predetermined limit is exceeded, the test set becomes inoperative for a period of approximately 70 seconds. It then automatically resets to its normal operating state. A lock-out condition exists whenever the TEST SET LOCK-OUT indicator is lit.

TRIP INDICATOR

An LED which, when lit, indicates that an acceptable trip signal has been delivered by the programmer. Conversely, a trip not accompanied by the light signifies that the trip signal amplitude is too low. Upon completion of a test, the TRIP indicator stays lit until the RESET or PRESET CURRENT button is depressed.

TEST INDICATOR

This LED lights whenever the PRESET CURRENT or START controls are activated.

EXTERNAL MONITOR JACKS, TEST SET ACCURACY

The test current values displayed on the Test Current Meter are accurate to within ± three percent of the meter reading. These limits are contingent upon a clean sine wave input voltage to the test set. Wave distortion can cause additional error.

Should greater accuracy be desired, provision is made for connecting external instruments via the EXTERNAL MONITOR jacks on the front panel. These jacks are connected across an isolated, precision 0.2 ohm resistor in series with the test current circuit. Output at these jacks is shown in Table 1.

The EXTERNAL MONITOR jacks may be employed also in conjunction with a storage oscilloscope for more accurate trip time measurement. For trip times less than one second, the test set time meter is capable of a single digit approximation only (nearest 0.1 second).

TABLE 1 — EXTERNAL MONITOR OUTPUT

TEST SET CONTROL POSITIONS		A-c MILLIVOLT OUTPUT PER UNIT OF TEST CURRENT (± 1%)
TEST SELECTOR	PROGRAMMER LONG TIME PICKUP SETTING*	
ϕA, ϕB or ϕC	0.6X	60
	0.7X	70
	0.8X	80
	0.9X	90
	1.0X	100
	1.1X	110
GROUND FAULT	Not Applicable	100

Example: Output @ Test Current Meter Reading of 6.00 on LT Pickup Test with 1.1 LT Pickup Setting = 110 x 6.0 = 660 mv ± 1%

*X = Sensor ampere rating or tap setting

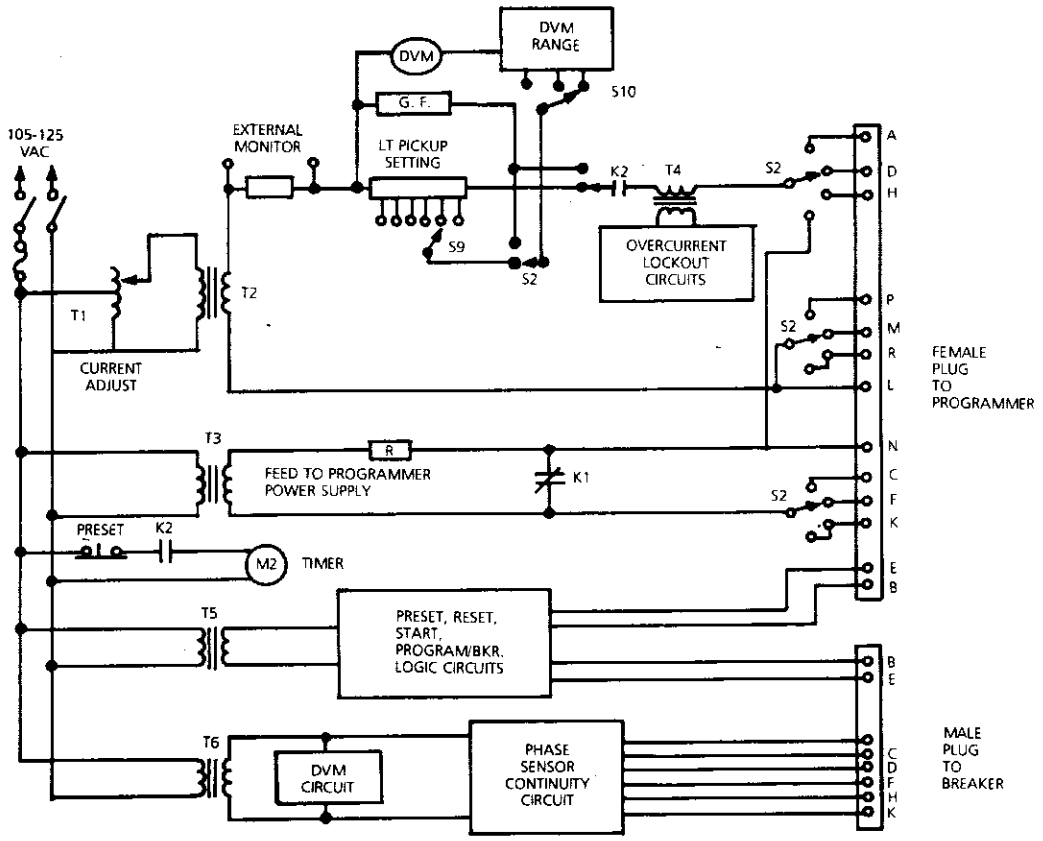


Fig. 2. Simplified Schematic of Test Set TAK-TS2

THE TEST SET CIRCUIT

A brief description of the test set circuitry is given below. Refer to the simplified schematic of Figure 2.

1. Input voltage is applied to the test set through a three-wire power cord with a ground conductor. The chassis and metal parts are grounded to protect the operator.

2. Output voltages are isolated from the input voltage by means of multiple winding iron core transformers.

3. All power to the test set is supplied through the ON-OFF switch and a one ampere slo-blo fuse.

4. T2 is a 12.6 volt filament transformer that provides low-voltage simulated fault signal currents to the programmer via the TEST SELECTOR switch S2 when relay contact K2 is closed. The test current is adjusted by variable transformer T1.

Switches S2, S9 and S10 provide the appropriate resistor selection for the digital meter.

The EXTERNAL MONITOR is a precision shunt resistor which provides an output that is an accurate representation of the test current.

5. The overcurrent lock-out circuit protects the programmer from prolonged or continuous testing at high current levels. Once energized, the circuit will lock out the test set for approximately 70 seconds and then automatically reset.

6. T3 is an isolation transformer that feeds the power supply of the programmer. Power is transferred when relay K1 is energized (normally closed contact opens). K1 is energized slightly before K2 in order to ensure that power supply voltage is available before test current is applied.

7. Power is applied to the timer by relay contact K2.

8. Transformer T5 powers the test set logic circuitry.

9. Transformer T6 powers the PHASE SENSOR CONTINUITY TEST circuit and the drive circuitry for the digital voltmeter.

10. A complete schematic diagram and parts list is given on pages 16 & 17.

CONNECTING THE TEST SET

SAFETY PRECAUTIONS

WARNING: *BEFORE CONNECTING THE TEST SET TO THE BREAKER TRIP DEVICE SYSTEM, ENSURE THAT THE CIRCUIT BREAKER IS COMPLETELY DISCONNECTED FROM ITS POWER SOURCE. ON DRAWOUT EQUIPMENT, RACK THE BREAKER TO ITS DISCONNECTED POSITION. VERIFY THAT THE BREAKER IS TRIPPED.*

CAUTION: *NEVER DISENGAGE THE HARNESS CONNECTOR FROM THE PROGRAMMER UNIT ON A BREAKER THAT IS ENERGIZED AND CARRYING LOAD CURRENT. THIS WILL OPEN-CIRCUIT THE CURRENT SENSORS, ALLOWING DANGEROUS AND DAMAGING VOLTAGES TO DEVELOP. SEE FIG. 3.*

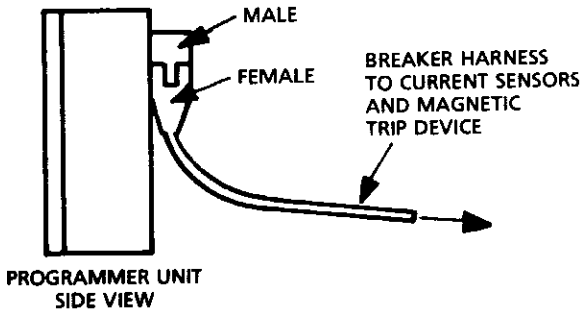


Fig. 3. Normal "In Service" breaker connection

CONNECTIONS

NOTE: *Before proceeding with the following connection work, ensure that the test set power supply cord is not connected.*

"Programmer Only" Test (Mode A) (See Fig. 4)

1. Disconnect the breaker harness from the programmer unit.

2. Plug the test set female connector lead to the receptacle on the rear of the programmer.

3. The test set male connector lead need not be connected to the breaker harness for "Programmer Only" testing. However, the Fig. 5 connection should be used if "Complete System" tests are to be run also.

"Complete System" Test (Mode B) (See Fig. 5)

1. Disconnect the breaker harness from the programmer unit and reconnect its female connector to the male connector lead from the test set.

2. Plug the test set female connector lead into the receptacle on the rear of the programmer.

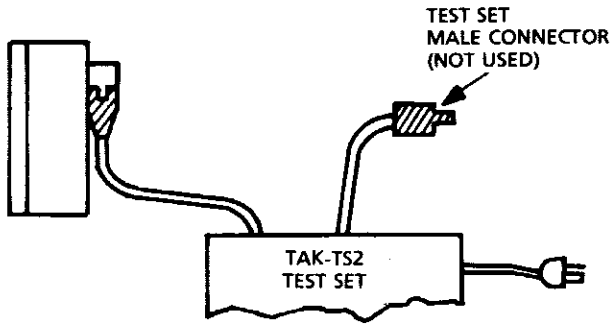


Fig. 4. Connection for Programmer Only test

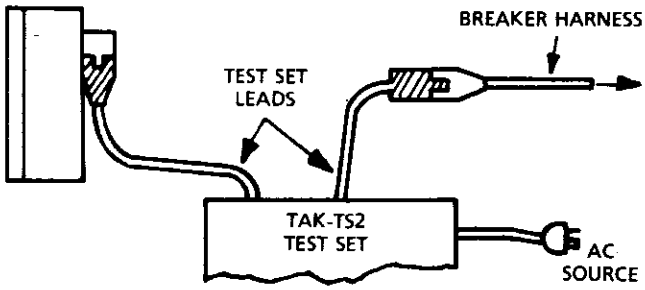


Fig. 5. Connection for Complete System test

PRELIMINARY TEST PROCEDURE

Conduct the following steps before starting functional tests.

1. Position the test set controls as follows:

   PROGRAMMER SELECTOR: Set to SST/ECS for all tests covered by this manual.

   CURRENT ADJUST: Rotate to zero

   TEST SELECTOR: ϕA

   TRIP BREAKER — PROGRAMMER ONLY: As desired.

   PROGRAMMER LONG-TIME PICKUP SETTING: Must match the programmer's LT pickup setting.

2. Record the "In Service" settings of the programmer so that its set points can be restored upon completion of testing.

3. Connect the test set power cord to the 105-125 VA-c power source.

4. Turn power ON.

5. Push the START button. The elapsed time meter will start to run and the TEST indicator should light and remain lit.

6. Push the RESET button. The elapsed time meter will stop and the TEST indicator light will go out.

7. Mechanically reset the elapsed time meter. Functional testing may now begin as described individually for each trip element in subsequent pages.

LONG TIME PICKUP TEST

PURPOSE — Verify that pickup (tripping) occurs within tolerance. This requires two tests at any selected pickup setting:

1. Test for NO PICKUP at a current slightly below the published lower tolerance limit. See Note 1.
2. Test for PICKUP at a current slightly above the published upper tolerance limit. See Note 2.

TEST PROCEDURE

NO PICKUP

1. Programmer settings:

   LONG TIME DELAY — set on MIN band. The INT or MAX bands may be used if desired.

2. Position Test Set controls:

PROGRAMMER LONG TIME PICKUP SETTING	Must match the programmer's LT pickup setting
TEST SELECTOR	ϕ A, B or C

3. TEST CURRENT: Preset at the NO PICKUP value in Table 2.
4. Reset timer and RESET button.
5. Push START. Allow test to run until time delay of Table 2 has expired. Unit should NOT PICKUP.

   For 50 Hz operation, multiply timer readings by 1.2.

PICKUP

1. Programmer settings: Same as NO PICKUP.
2. Position Test Set controls: Same as NO PICKUP.
3. TEST CURRENT: Preset at the PICKUP value in Table 2.
4. Reset timer and RESET button.
5. Push START. Allow test to run until unit trips. The time meter reading should conform to Table 2 limits.

   For 50 Hz. operation, multiply timer readings by 1.2.

   If unit does not trip within the specified time, repeat the test, carefully monitoring and readjusting the test current as necessary. Transient dips in the supply voltage could lower the test signal current below its pickup value, causing the programmer's timing circuit to reset.

Repeat the above tests on the other phases.

TABLE 2
LONG TIME PICKUP

TEST FOR	TEST CURRENT	TEST LIMITS TIME IN SECONDS		
		MIN BAND	INT BAND	MAX BAND
NO PICKUP	0.88	300	725	1650
PICKUP	1.18	<200	<500	<1200

IF TEST RESULTS DO NOT CONFORM, SEE PAGE 15

NOTES:

1. *Lower test limits are extended below the published pickup tolerance to allow for test set accuracy.*
2. *Upper test limits exceed the published pickup tolerance to allow for test set accuracy plus nominal dips in test set supply voltage. During testing, the test current should be monitored and adjusted if necessary.*

LONG TIME DELAY TEST

PURPOSE — Verify that the LT characteristic conforms to its upper and lower band limits. This test requires measurement of delay times at three different test currents.

TEST PROCEDURE

1. Set programmer on desired LT delay band.

2. Position Test Set controls:

PROGRAMMER LONG TIME PICKUP SETTING	Must match the programmer's LT pickup setting
TEST SELECTOR	ϕ A, B or C

3. TEST CURRENT: Select three test currents from Table 3. Preset the first value.

   NOTE: *These values must be less than the programmer's short time and instantaneous pickup settings, otherwise a premature trip signal will be delivered by those trip elements.*

4. Reset timer and RESET button.

5. Push START. Allow test to run until trip occurs. TIME meter reading should conform to Table 3 limits.

   For 50 Hz. operation, multiply timer readings by 1.2.

6. Repeat the above test at the two other test currents. This step verifies the linearity of the T-C characteristic.

7. Repeat the test on the other phases at one test current.

Repeat the above test series on the other delay bands.

TABLE 3
LONG TIME DELAY

TEST CURRENT	TEST LIMITS* TIME IN SECONDS		
	MIN BAND	INT BAND	MAX BAND
1.50	60.2-101.8	150.7-254.6	337.5-570.3
2.00	33.8-57.3	84.6-143.2	189.6-320.8
3.00	15.0-25.5	37.6-63.7	84.3-142.6
4.00	8.4-14.3	21.1-35.8	47.4-80.2
5.00	5.4-9.2	13.5-22.9	30.3-51.4
6.00	3.7-6.4	9.4-15.9	21.0-35.7
7.00	2.7-4.7	6.9-11.7	15.4-26.2
8.00	2.1-3.6	5.3-9.0	11.8-20.0
9.00	1.6-2.8	4.1-7.1	9.3-15.8
10.00	1.3-2.3	3.3-5.7	7.5-12.8

*Reflecting the ±3% test set accuracy, all test limits are extended beyond the published band limits of the time-current curves. During testing, the test current should be monitored and readjusted if necessary.

IF TEST RESULTS DO NOT CONFORM, SEE PAGE 15

SHORT TIME PICKUP TEST

PURPOSE — Verify that pickup occurs within tolerance. This requires two tests at any selected pickup setting:

1. Test for NO PICKUP at the lower tolerance limit.
2. Test for PICKUP at the upper tolerance limit.

TEST PROCEDURE

NO PICKUP

1. Programmer settings:

   ST DELAY BAND — As desired.

   INST PICKUP — Must be set higher than the ST pickup setting, otherwise the unit will trip first via the INST element.

2. Position Test Set controls:

PROGRAMMER LONG TIME PICKUP SETTING	Must match the programmer's LT pickup setting
TEST SELECTOR	ϕ A, B or C

3. TEST CURRENT: Preset the lower limit (NO PICKUP) test current from Table 4.
4. Reset timer and RESET button.
5. Push START. The unit must not trip in less than one second. However, a trip may occur after one second due to a signal from the LT element.

   For 50 Hz operation, multiply timer readings by 1.2.

PICKUP

1. Programmer settings — Same as NO PICKUP.
2. Position Test Set controls — Same as NO PICKUP.
3. TEST CURRENT: Preset the upper limit (PICKUP) test current from Table 4.
4. Reset timer and RESET button.
5. Push START. The unit must trip in less than one second, as indicated by the timer.

   For 50 Hz operation, multiply timer readings by 1.2.

ACTUAL PICKUP VALUE (if desired)

Starting at the lower tolerance limit (Table 4), test incremental increases in test current until a trip occurs in less than one second as indicated by the timer. Push the PRESET CURRENT button, read the actual pickup value.

Repeat the above tests for at least one setting on each of the other phases.

TABLE 4 — SHORT TIME PICKUP

PROGRAMMER ST PICKUP SETTING *	TEST CURRENT			
	60 Hz		50 Hz	
	LOWER LIMIT (NO PICKUP)	UPPER LIMIT (PICKUP)	LOWER LIMIT (NO PICKUP)	UPPER LIMIT (PICKUP)
1.75L	1.53	1.98	1.48	1.93
2L	1.75	2.27	1.69	2.20
2.25L	1.96	2.55	1.91	2.48
2.5L	2.18	2.83	2.11	2.75
3L	2.61	3.40	2.54	3.30
4L	3.49	4.54	3.39	4.40
5L	4.36	5.67	4.24	5.50
6L	5.23	6.80	5.08	6.59
8L	6.98	9.07	6.78	8.79
10L	8.73	11.33	8.47	10.99

*L = Long Time pickup setting

IF TEST RESULTS DO NOT CONFORM, SEE PAGE 15

SHORT TIME DELAY TEST

PURPOSE — Provide an approximate indication that time delay occurs within the time band selected. Due to the small time magnitudes involved (0.5 seconds or less), the timer's right digit provides only a rough approximation of the actual trip time. If a more accurate reading is desired, the EXTERNAL MONITOR jacks may be employed as described previously in OPERATING CONTROLS.

TEST PROCEDURE

1. Programmer settings:

   INST PICKUP — MAX.

   ST PICKUP — MIN.

   ST DELAY BAND — As desired.

2. Position Test Set controls:

PROGRAMMER LONG TIME PICKUP SETTING	Must match the programmer's LT pickup setting
TEST SELECTOR	ϕ A, B or C

3. TEST CURRENT: Preset a test value two steps higher than the programmer's ST pickup setting (e.g., preset 5 for a pickup setting of 3). This avoids measurement at the knee of the time-current curve where the time delay may be longer than the band limits given in Table 5.

4. Reset timer and RESET button.

5. Push START. Observe trip time.

Repeat the above test on the other delay bands, then check at least one band on each of the other phases.

TABLE 5
SHORT TIME DELAY

DELAY BAND	PUBLISHED BAND LIMITS — TIME IN SECONDS	
	LOWER	UPPER
MIN	0.095	0.19
INT	0.21	0.32
MAX	0.35	0.50

IF TEST RESULTS DO NOT CONFORM, SEE PAGE 15

INSTANTANEOUS PICKUP TEST

PURPOSE — Verify that pickup occurs within tolerance. This requires two tests at any selected pickup setting:

1. Test for NO PICKUP at the lower tolerance limit.
2. Test for PICKUP at the upper tolerance limit.

TEST PROCEDURE

NO PICKUP

1. Position Test Set controls:

PROGRAMMER LONG TIME PICKUP SETTING	Must match the programmer's LT pickup setting
TEST SELECTOR	ϕ A, B or C

2. TEST CURRENT: Preset the lower limit (NO PICKUP) test current from Table 6.
3. Reset timer and RESET button.
4. Push START. The unit must not trip instantaneously — the INST element is not activated at these lower limit values. However, the unit is subject to and will respond to a time delayed trip signal from the LT element. Also, if so equipped, it responds to any ST element whose pickup is set below the INST setting. In either event the delayed trip produces definite movement of the timer, a positive indication that the unit did not trip via the INST mode.

PICKUP

1. Position Test Set controls: Same as NO PICKUP.
2. TEST CURRENT: Preset the upper limit test current from Table 6.
3. Reset timer and RESET button.
4. Push START. The unit must trip immediately as indicated by little or no discernible timer movement.

ACTUAL PICKUP VALUE (if desired)

Starting at the lower tolerance limit (Table 6), test incremental increases in test current until an INST trip occurs (no discernible timer movement). Push the PRESET CURRENT button, read the actual pickup value.

Repeat the above tests for at least one setting on each of the other phases.

TABLE 6
INSTANTANEOUS PICKUP

PROGRAMMER INST PICKUP SETTING *	TEST CURRENT			
	60 Hz		50 Hz	
	LOWER LIMIT (NO PICKUP)	UPPER LIMIT (PICKUP)	LOWER LIMIT (NO PICKUP)	UPPER LIMIT (PICKUP)
4L	3.49	4.54	3.39	4.40
5L	4.36	5.67	4.24	5.50
6L	5.23	6.80	5.08	6.59
8L	6.98	9.07	6.78	8.79
10L	8.73	11.33	8.47	10.99
12L	10.47	13.60	10.16	13.19

*L = Long Time pickup setting

IF TEST RESULTS DO NOT CONFORM, SEE PAGE 15

GROUND FAULT PICKUP TEST

PURPOSE — Verify that pickup occurs within tolerance. This requires two tests at any selected pickup setting:

1. Test for NO PICKUP at the lower tolerance limit.
2. Test for PICKUP at the upper tolerance limit.

TEST PROCEDURE

NO PICKUP

1. Position Test Set controls:

   TEST SELECTOR: Ground Fault

2. TEST CURRENT: Preset the lower limit (NO PICKUP) test current from Table 7.

3. Reset timer and RESET button.

4. Push START. The unit should not trip, timer will read greater than one second delay. Discontinue the test after one second. If the test is allowed to run longer than 30 seconds, a trip signal can be received from the LT element for some programmer setting combinations.

   For 50 Hz operation, multiply timer readings by 1.2.

PICKUP

1. Position Test Set controls — Same as NO PICKUP.

2. TEST CURRENT: Preset the upper limit (PICKUP) test current from Table 7.

3. Reset timer and RESET button.

4. Push START. The unit must trip in less than one second as indicated by the timer.

   For 50 Hz operation, multiply timer readings by 1.2.

ACTUAL PICKUP VALUE (if desired)

Starting at the lower tolerance limit (Table 7), test incremental increases in test current until a trip occurs in less than one second as indicated by the timer. Push the PRESET CURRENT button, read the actual pickup value.

TABLE 7 — GROUND FAULT PICKUP

PROGRAMMER GF PICKUP SETTING *	TEST CURRENT			
	60 Hz		50 Hz	
	LOWER LIMIT (NO PICKUP)	UPPER LIMIT (PICKUP)	LOWER LIMIT (NO PICKUP)	UPPER LIMIT (PICKUP)
0.18X	0.157	0.204	0.152	0.198
0.2X	0.174	0.227	0.169	0.220
0.22X	0.192	0.249	0.186	0.242
0.25X	0.218	0.283	0.212	0.275
0.27X	0.235	0.306	0.229	0.297
0.3X	0.260	0.340	0.254	0.330
0.35X	0.305	0.397	0.296	0.385
0.37X	0.323	0.419	0.313	0.406
0.4X	0.348	0.453	0.339	0.440
0.5X	0.436	0.567	0.424	0.550
0.6X	0.523	0.680	0.508	0.659
0.7X	0.611	0.793	0.593	0.769
0.8X	0.698	0.906	0.678	0.879
1.0X	0.873	1.133	0.847	1.099
1.2X	1.047	1.360	1.016	1.318

IF TEST RESULTS DO NOT CONFORM, SEE PAGE 15

*X = Sensor ampere rating or tap setting

GROUND FAULT DELAY TEST

PURPOSE

Provide an approximate indication that time delay occurs within the time band selected. Due to the small time magnitudes involved (0.5 seconds or less), the timer's right digit provides only a rough approximation of the actual trip time. If a more accurate reading is desired, the EXTERNAL MONITOR jacks may be employed as described previously in OPERATING CONTROLS.

PROCEDURE

1. Position Test Set controls:

   TEST SELECTOR — Ground Fault

2. TEST CURRENT — Preset the "current adjust" control to the fully clockwise position. This ensures that the test current is well above the knee of the curve for all GROUND FAULT pickup settings.

3. Reset timer and RESET button.

4. Push START. Observe trip time.

5. Repeat test on the other time bands.

TABLE 8
GROUND FAULT DELAY

DELAY BAND	PUBLISHED BAND LIMITS — TIME IN SECONDS	
	Lower	Upper
MIN.	0.065	0.15
INT	0.165	0.27
MAX	0.30	0.43

IF TEST RESULTS DO NOT CONFORM, SEE PAGE 15

PHASE SENSOR CONTINUITY TEST

PURPOSE

Check continuity of the breaker-mounted phase sensors.

NOTE 1. The test set does not measure accuracy of the phase sensors. This can be established only by testing the complete trip device as a system in conjunction with the breaker, using a commercially available high current - low-voltage test set.

NOTE 2. The test set is not for use in testing the equipment-mounted neutral sensor employed with SST trip devices equipped with a ground fault trip element for three-phase, four-wire applications. This neutral sensor is excluded from the scope of the circuit breaker/trip device test procedures, and instead should be treated as an integral part of the maintenance and testing activity associated with the switchgear equipment.

PROCEDURE

1. Ensure all power is removed from the circuit breaker and that the male connector from the test set is connected to the female connector of the circuit breaker harness.

2. Select the phase to be tested.

3. Push the PUSH-TO-TEST button. The OK light must light while the PUSH-TO-TEST button is depressed. Absence of the OK light indicates a high resistance or open circuit in the CT or wiring harness. The PUSH-TO-TEST button must be released between tests.

FAULT TRIP INDICATORS

As an accessory, programmer units may be equipped with pop-out fault trip indicators. These plungers pop out each time their respective trip element delivers a trip signal. If a programmer trips on LT overload, only that indicator is activated. For short circuits a single indicator serves both the ST and INST elements and is activated by either. The GF indicator (when used) responds only to a ground fault trip.

When testing programmers so equipped, the trip indicators are functioning properly if they activate each time their respective trip element trips.

IF TEST RESULTS DO NOT CONFORM

— Review the test instructions to see that the proper procedure is being followed.

— Check all settings on the programmer unit.

— Is the PROGRAMMER SELECTOR switch in the correct position for the PROGRAMMER being tested?

— Is the TEST SELECTOR switch in the GROUND FAULT position for ground fault testing? In the ϕA, ϕB or ϕC position for all other tests?

— Does the PROGRAMMER LONG-TIME PICKUP SETTING control on the test set match the programmer's LT pickup setting?

— Is the TRIP BREAKER — PROGRAMMER ONLY switch in the proper mode?

— Are all cable connectors fully engaged?

— If the ST element trips too soon or at too low a level, the INST pickup setting is probably too low. The INST pickup must be set at a higher value than the ST element. Pickup band tolerances must also be recognized.

— Timer makes noise but does not operate. Push RESET button. Manually reset timer.

— When using 50Hz power, the timer reading must be multiplied by 1.2.

— See Section OPERATING CONTROLS regarding test set accuracy. Is the TEST CURRENT meter zeroed?

— Use the EXTERNAL MONITOR jacks as described in OPERATING CONTROLS to check the current level that is being applied to the programmer unit. These jacks may be used also to monitor trip time.

— If results do not conform after repeating the test(s), replace the programmer. Do not reinstall a defective programmer on the circuit breaker.

COMPLETION OF TESTS

After trip device testing has been completed, the following procedures must be diligently executed preparatory to restoring the circuit breaker to service:

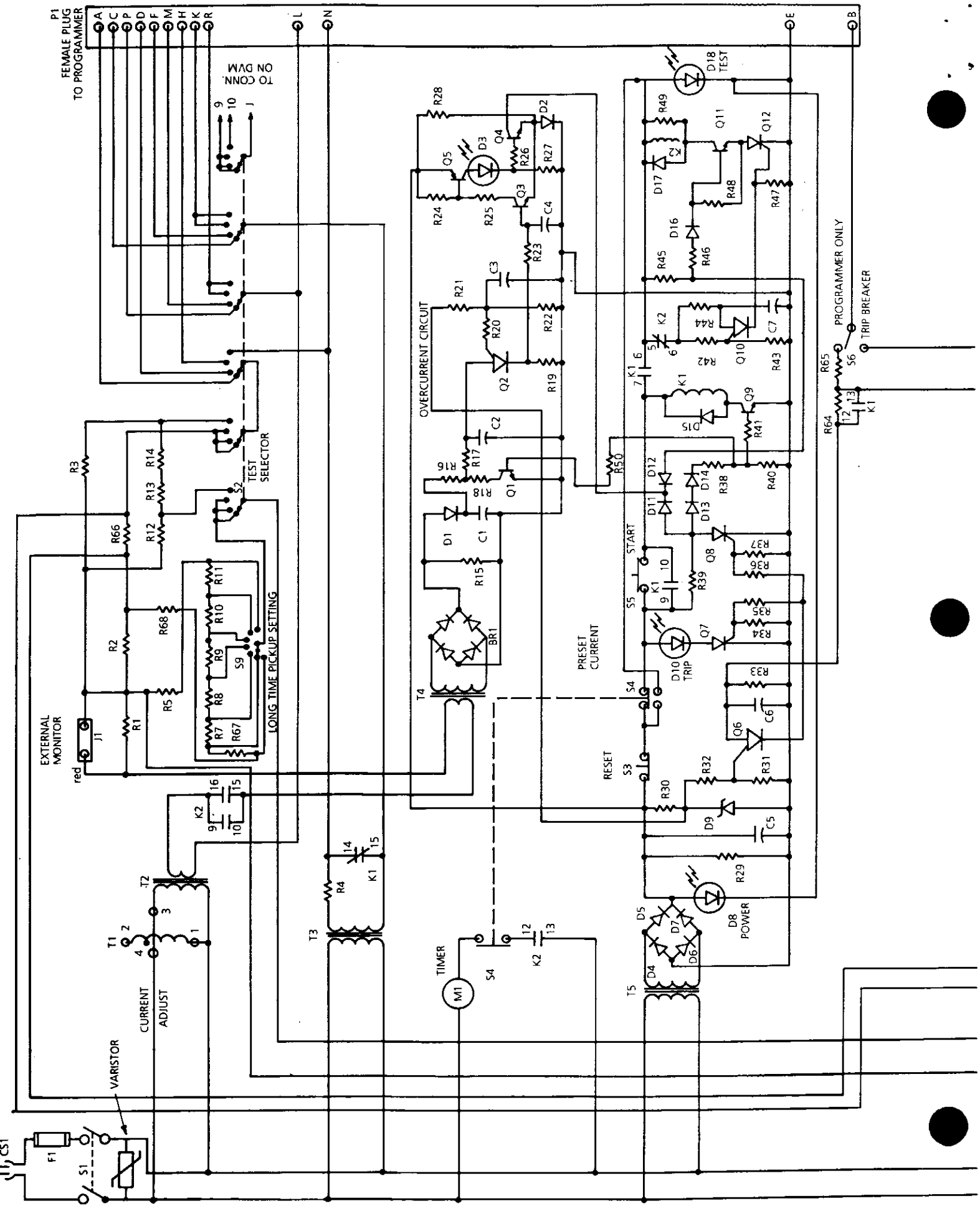
– *Ensure that the breaker is fully disconnected from any power source.*

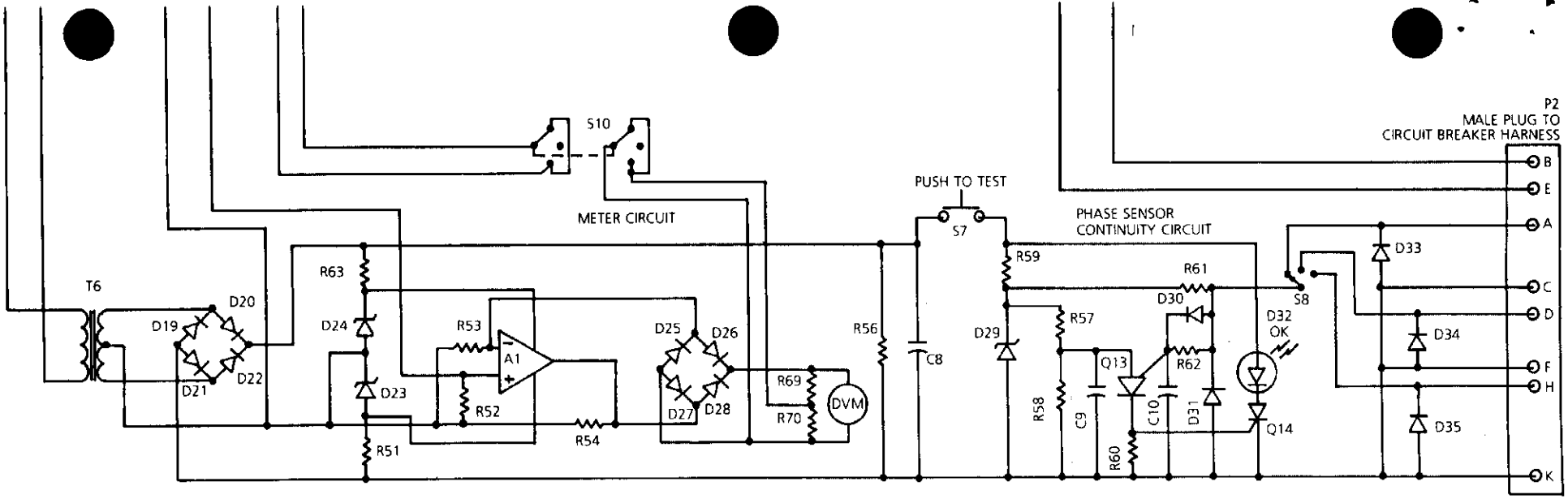
– *Disengage the test set connectors from the programmer and the female circuit-breaker harness connector.*

– *Reconnect the female harness connector to the programmer unit. Failure to do this voids the breaker's automatic trip system.*

– *Reset all trip indicators on the programmer (when used).*

– *If the programmer's adjustment knobs were moved to different settings during testing, restore them to their "as received" settings.*


P1
FEMALE PLUG
TO PROGRAMMER
A
C
P
D
F
M
H
K
R
L
N
E
B
TO CONN.
ON DVM
9
10
J
R28
D2
Q4
D3
Q5
R26
R27
Q3
R24
R25
C4
R23
C3
R21
R20
R22
Q2
R19
C2
R17
R16
R18
Q1
D1
C1
R15
BR1
T4
OVERCURRENT CIRCUIT
R3
R14
R13
R12
R66
S2
TEST
SELECTOR
R11
R10
R9
R8
R7
R67
S9
LONG TIME PICKUP SETTING
R2
R68
R5
R1
J1
EXTERNAL
MONITOR
red
K2
16
15
9
10
T2
T1
2
3
4
1
CURRENT
ADJUST
VARISTOR
CS1
F1
S1
R4
14
15
K1
T3
TIMER
M1
S4
12
13
K2
D18
TEST
R49
Q11
Q12
D17
K2
R48
R47
D16
R46
R45
K2
R44
C7
5
6
R42
Q10
R43
K1
6
7
K1
Q9
D15
R41
R50
D12
D14
R38
R40
D11
D13
START
S5
K1
10
9
R39
Q8
R37
R36
R35
R34
Q7
D10
TRIP
PRESET
CURRENT
S4
R33
C6
Q6
RESET
S3
R32
R31
R30
D9
C5
R29
D8
POWER
D5
D7
D6
D4
T5
PROGRAMMER ONLY
TRIP BREAKER
R65
S6
R64
12
13
K1



PARTS LIST

RESISTORS	
R1	0.2 Ohm ± .1% – 25W
R2	0.5 Ohm ± 1% – 50W
R3	20.0 ± 1% – 25W
R4	3000 Ohm ± 5% – 10W
R5, R12, R58	1K ± 1% ¼W
R7	261 ± 1% ¼W
R8	196 ± 1% ¼W
R9	154 ± 1% ¼W
R10	121 ± 1% ¼W
R11	100 ± 1% ¼W
R13	715 ± 1% ¼W
R14	7870 ± 1% ¼W
R15	806 ± 1% ½W
R16, R17, R18, R32	100K ± 1% ¼W
R19, R20, R44, R52, R62	1 MEG ± 10% – ¼W
R21	332K ± 1% – ¼W
R22	681K ± 1% – ¼W
R23, R24, R28	51K ± 5% – ¼W
R25	22K ± 5% – ¼W
R26, R34, R37, R40, R48, R60	1K ± 5% – ¼W
R27	220 ± 5% – ¼W
R30, R39, R45	2.2K ± 5% – ½W
R31	34K ± 1% – ¼W
R33	10 ± 1% – 3W
R35, R36, R41	2.2K ± 5% – ¼W
R38, R46	4.7K ± 5% – ¼W
R42, R43	10K ± 5% – ¼W
R47	270 ± 5% – ¼W
R49	2.7K ± 5% – ½W
R51, R63	1K ± 5% – ½W
R53	1406 ± 0.1% – ⅛W
R54, R50	100K ± 5% – ¼W

RESISTORS	
R56	100K ± 10% – ½W
R57	3.65K ± 1% – ¼W
R59	100 ± 5% – 2W
R61	680 ± 5% – ½W
R64	560 ± 5% – ½W
R65	68 ± 5% – ½W
R66	1.0 ± 1% 50W
R67	365 Ω ± 1% ¼W
R68	549 Ω ± 1% ¼W
R69, R70	1500 ± 0.1% ⅛W

CAPACITORS	
C1	1.0 ± 10% – 250 VDC
C2	270 ± 10% – 15 VDC (Tantalum)
C3, C4, C6, C9, C10	.1 ± 10% – 100 VDC
C5, C8	150 – 75 VDC (Aluminum)
C7	.33 ± 10% – 50 VDC

DIODES	
BRI	Varo VE18
D1, D2, D11, D12, D13, D14, D16, D25, D26, D27, D28, D30	1N4148
D4, D5, D6, D7, D15, D17, D19, D20, D21, D22, D31, D33, D34, D35	1N5060
D3, D8, D10, D18, D32	LED – 28V – 20 ma
D9	15V ± 1% – 1W
D23, D24	1N4740 – 10V – 1W
D29	1N5352B – 15V – 5W

TRANSISTORS AND SCRS	
Q1, Q3, Q4, Q9, Q11	GES930LF18
Q2, Q6, Q10, Q13	2N6028
Q5	2N5087
Q7, Q8, Q12, Q14	C103B
A1	OP. Amp. MC1741CP

SWITCHES	
S1	JBT ST22K
S2	Centralab SA2021-4C-000
S3	Grayhill 4002
S4	Grayhill 46-05-08-502-0101
S5, S7	Grayhill 4001
S6	JBT ST12D
S8, S9	Centralab SA2001-4C-000
S10	Centralab SA2003-4C-000

TRANSFORMERS	
T1	Variable Transformer G.E. 9T92A1
T2	Stancor P8641
T3	Triad N-48X
T4	G.E. 5678743G4
T5, T6	Stancor P8601

MISCELLANEOUS	
Relays K1, K2	Allied T154-4C-28 VDC
Connector P1	Amp 201298-1
Connector P2	Amp 201297-1
DVM	Digitec 2770-02
EXTERNAL MONITOR JACK	H. H. Smith 269RB
TIMER	Cramer 636S10084
VARISTOR	V150LA20A

Fig. 6. Schematic and Parts List — Test Set TAK-TS2 (Dwg. 139C4767)

GENERAL ELECTRIC

CIRCUIT PROTECTIVE DEVICES DEPT.
PLAINVILLE, CONNECTICUT