IB 7.1.1.7-2
Issue A

INSTRUCTIONS

Ground Protection Systems

GROUND FAULT PROTECTION SYSTEMS

Type GR-5

5-50 Amperes

2-40 Amperes

20-200 Amperes

100-1000 Amperes

ABB POWER T&D COMPANY INC.
ALLENTOWN, PENNSYLVANIA, USA

TABLE OF CONTENTS

INTRODUCTION

These instructions contain the information required to properly install, operate, and test the GR-5 family of ground fault relay systems. The system consists of a Type GS current sensor and a solid state relay. The drawout style unit includes adjustable pickup, adjustable time delay, an operation indicator, and a built-in test feature.

PRECAUTIONS

The following precautions should be observed when applying these systems:

1. Incorrect wiring may result in damage. Be sure wiring agrees with the connection diagram for the particular relay before energizing.

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

3. Do not attempt to manually operate target vanes on the drawout style relay. The target can be damaged by manual operation with a pointed object.

4. Do not apply high voltage tests to solid state relays. If a control wiring insulation test is required, withdraw the circuit board so that connections in the rear of the case are broken before applying test voltage.

5. Be sure that the trip circuit includes an "a" switch to interrupt the output current. Solid state output circuits have inherently high momentary ratings, but low or zero continuous capability.

6. The output load (trip coil or auxiliary relay) must draw at least 0.1 ampere to insure operation.

7. The entire circuit board of the drawout style relay is removable. This board should insert smoothly. Do not use force.

8. Sensors are 600 V class devices. Follow air and surface clearance requirements of electrical equipment design.

9. Follow test instructions to verify that the relay system is in proper working order. If a relay is found to be inoperative, we suggest that it be returned to the factory for repair. 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 sales engineer should you desire to attempt repair. CAUTION: Since troubleshooting entails working with energized equipment, caution should be taken to avoid personal shock. Only competent technicians familiar with good safety practices should service these devices.

PLACING THE RELAY INTO SERVICE

1. RECEIVING, HANDLING, STORAGE

Upon receipt of the 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 BBC Brown Boveri, Inc. Sales Office. Keep the relay clean and dry and use normal care in handling to avoid mechanical damage.

2. INSTALLATION

Mounting

The sensors should be mounted so as to enclose all conductors except the ground conductor. Cable conductors should be bundled tightly and centered in the sensor window. If more than one conductor per phase is used, conductors should be bundled in sets of A-B-C phases (not in sets of each phase). The sensor should not be mounted in a manner that would put stress on the mounting bushings. Refer to sensor outline drawings for other important information on the particular sensors you are applying.

When mounting a ground sensor over shielded cable or metal sheathed cable, certain precautions must be taken to assure proper operation:

a) Shielded Cable - on shielded cable, the shielding tape must be connected to ground at a point on the cable side (opposite switchgear bus side) of the current sensor. If the ground wire is connected to the shield on the switchgear bus side of the sensor window, the ground wire must be brought back through the sensor window before being connected to the ground bus.

b) Metal Sheathed Cable - when a ground sensor is applied over sheathed cable which is terminated at a pothead, the pothead mounting must be insulated from ground (600 volt insulation level) and the ground wire from the pothead body brought back through the sensor window before being connected to the ground bus.

Connections

Typical wiring diagrams are given in Figs. 4 and 5. Wires from the sensor to the relay should be at least #14 guage wire and no more than 1000 feet in length. Larger wire should be used for greater distances. Total lead resistance of wires from sensor to relay should be no more than 5 ohms.

Terminals of the current sensor and the drawout case relay are suitable for both copper and aluminum wire; however, copper wire is generally preferred for protective circuits such as these.

A circuit breaker auxiliary switch, 52a, must always be used in series with the shunt trip coil to prevent thermal damage to the tripping circuit.

These relays cannot be used directly with a capacitor trip device. Consult factory for alternate relay connection arrangements.

The drawout case relay has a metal front panel which is connected through printed circuit board runs and connector wiring to terminal "G" at the rear of the relay case. This terminal should be wired to ground in all applications.

Rectangular sensors, catalog series 302L and 302T, require a jumper link between terminals T and S1 on the sensor for proper operation

Operation with Low Current
Trip Coils or Auxiliary Relays:

The output circuit of the relay consists of a silicon controlled rectifier (SCR). To insure proper operation, at least 0.1 amperes must flow in the output circuit when a "trip" is called for. For AC applications, the output circuit is designed so that all coils having less than 980 ohms, 60 Hz impedance, will guarantee the required holding current down to 90 Vac. For DC applications, coil resistances of greater than 10 ohms per volt require that a resistor be added in parallel with the coil to assure sufficient current flow. Recommended resistor values are:

a) for 48 Vdc, 1000 ohms, 20 watt rating (3.6 watts max dissipation.)
b) for 125 Vdc, 2500 ohms, 20 watt rating (7.8 watts max dissipation.)

3. SETTINGS

PRIMARY TRIP AMPERES

This is a switch which selects the minimum operating current (pickup). The dial is calibrated in terms of the ground fault current on the PRIMARY system. See the RATINGS section for a listing of the discrete steps provided by this dial.

TIME CURVE

This switch selects the operating time of the relay. The relay has a definite-time characteristic curve which is shown on page 8.

Note: Relay settings are usually determined as part of a system coordination study. When protecting individual loads, such as a motor, minimum settings are usually desirable, but may not always be achievable. Load characteristics such as inrush, and cable or bus bar routing through the sensor may require higher settings to avoid nuisance operations on energization.

APPLICATION DATA

BBC Ground Fault Relay Systems provide fast, sensitive protection against ground faults on grounded electrical distribution systems. The system consists of a special design current transformer which is called a ground sensor, and a solid state ground relay. The ground sensor encircles all 3 phase conductors and neutral if present, and provides an output signal to the ground relay when a ground fault occurs on the circuit. The ground relay operates the shunt trip device on the circuit breaker. The ground relay may also be used to initiate an alarm on high resistance grounded systems where a trip is not desired. In some applications the sensor can be mounted on the neutral to ground connection.

Application of these systems is simple and direct. One sensor and one relay are used with any type of circuit. The sensor is selected by the physical size required; it is independent of the circuit current rating. The application does not require special insulated enclosure construction or other similar complexities. The relay is selected by the sensitivity range required to protect the circuit, by the required speed of operation, and by the control voltage supplied. A minimum pickup setting on the relay offers maximum system protection but at a possible sacrifice in selectivity, depending on the downstream equipment characteristics.

The current sensor consists of a wound core of small cross section with a uniformly distributed secondary winding. Solid core units have the entire assembly cast in epoxy. Split core units are separable for easy installation over existing cables and bus.

RATINGS

Input Circuit Withstand Time Period :

	Primary Ground Fault Current
Momentary (2 cycles)	200,000 Amp
Short Time (0.5 sec.)	65,000 Amp
Continuous (alarm duty)	300 Amp (2-40A & 5-50A models)
	1200 Amp (20-200A model
	3000 Amp (100-1000A model)

Pickup Settings :

Model	Pickup Settings (primary current)
2-40A	2, 5, 10, 15, 20, 30, 40
5-50A	5, 10, 15, 20, 30, 40, 50
20-200A	20, 40, 60, 80, 120, 160, 200
100-1000A	100, 200, 300, 400, 600, 800, 1000

Output Circuit :

Thyristor (SCR)

30 amperes, 2 cycles
12.5 amperes, 0.25 sec.
7.5 amperes, 1 sec.
1 ampere, continuous (dc models only)

Relays rated for AC control power have zero continuous output capability

Optional Alarm Contact :

@ 125Vdc	@ 120Vac	
30 A	30A	Tripping
5 A	5A	Continuous
1A	3A	Opening-resistive
.3A	2A	Opening-inductive

Control Power :

See relay nameplate for rating. Models available for 120Vac, 250Vdc, 125Vdc, 48Vdc, 24/32Vdc. Standby drain approximately 0.01 amp.

For AC models, select the size of the control power transformer based on the requirements of the shunt trip coil or aux relay requirements.

TOLERANCES

Pickup Current (primary amperes)

Relay Range	Used With Round Sensors	Used With Rectangular Sensors
2-40 A 5-50 A	+/-10% or 1A whichever is greater	+20% or 2A whichever is greater -10% or 1A whichever is greater
20-200 A 100-1000A	+/-10%	+/-10%

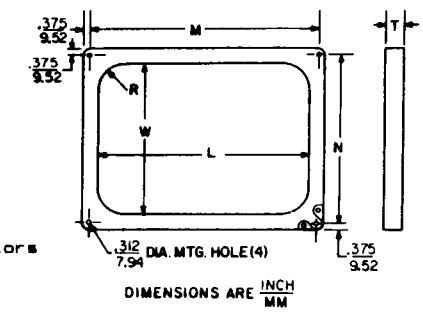
Time Delay

+/-10% or +/-0.01 seconds whichever is greater.

SENSOR DIMENSIONS

Catalog Number	Units	L	W	R	M	N	T	Approx Weight
302B1013UL	in.	13	10	1.75	14.75	11.75	1.5	10.5 lb
	mm.	330	254	44.5	374.7	298.5	38.1	4.8 kg
302B1017UL	in.	17	10	1.75	18.75	11.75	1.5	14 lb
	mm.	432	254	44.5	476.3	298.5	38.1	6.4 kg
302B1024UL	in.	24	10	1.75	25.75	11.75	1.63	20.5 lb
	mm.	610	254	44.5	654.1	298.5	41.3	9.3 kg

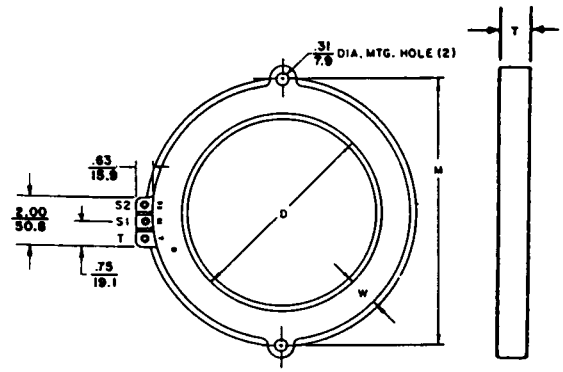
NOTE: apply with 1 inch (25 mm) minimum clearance from sensor to conductors



DIMENSIONS ARE INCH / MM

Catalog Number	Units	D	M	W	T	Approx Weight
302B0200UL	in.	2.125	5.063	1.125	1.875	3 lb
	mm.	54.0	128.6	28.58	47.63	1.4 kg
302B0300UL	in.	3.125	6.00	1.125	1.875	3.5 lb
	mm.	79.5	152.4	28.58	47.63	1.6 kg
302G0500UL	in.	5.00	7.50	1.00	1.25	3.5 lb
	mm.	127	190.5	25.4	31.75	1.6 kg
302G0800UL	in.	8.00	10.75	1.125	1.25	6 lb
	mm.	203	273.1	28.58	31.75	2.7 kg

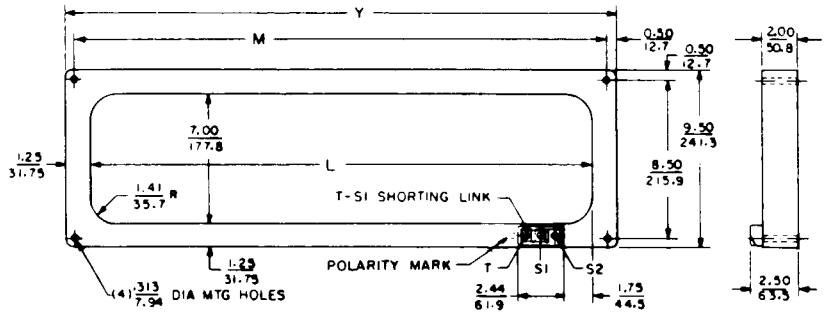
NOTE: Apply with minimum 1 inch (25mm) clearance from sensor to conductors.



Notes:

1. 302B0200UL and 302B0300UL have 2 terminals, S1 and S2.
2. 302G0500UL and 302G0800UL have 3 terminals, S1, S2, and T. When applying with the Type GR-5 relay, connect jumper from T to S1; connect relay to S1-S2.
3. When using the 5 inch or 8 inch sensors, apply with 1 inch (25mm) clearance from sensor to conductors. Tie cables together and center in window for best performance.
4. 302G0500UL replaces earlier models 302A0500UL and 302B0500UL.
5. 302G0800UL replaces earlier models 302A0800UL and 302B0800UL.

CAUTION: Sensors are 600V class devices. Follow air and surface clearance requirements of electrical equipment designs.



DIMENSIONS ARE INCH / MM

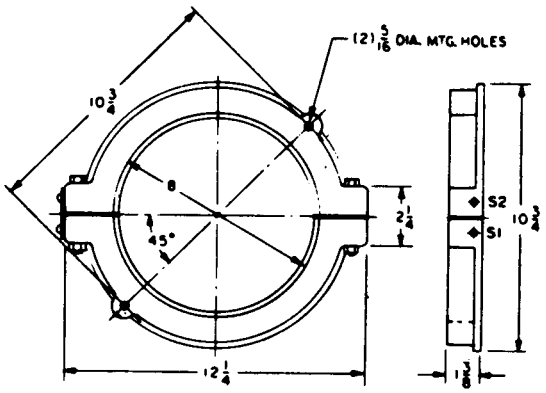
Catalog Number	Units	L	W	M	Y	Approx Weight
302L0721UL	in.	21	7	22.5	23.5	16 lb
	mm.	533	17.8	571.5	596.9	7.3 kg
302L0725UL	in.	25	7	26.5	27.5	18 lb
	mm.	635	17.8	673.1	698.5	8.2 kg
302L0727UL	in.	27	7	28.5	29.5	20 lb
	mm.	686	17.8	723.9	749.3	8.9 kg
302L0731UL	in.	31	7	32.5	33.5	22 lb
	mm.	787	17.8	825.5	850.9	10 kg
302L0737UL	in.	37	7	38.5	39.5	25 lb
	mm.	940	17.8	977.9	1003	11 kg

NOTE: 1. Apply with minimum 1 inch (25 mm) clearance from sensor to conductors.

2. Shorting link required between terminals T and S1.

3. Ground Fault Relay connects to terminals S1 and S2.

INSTALLATION OF SPLIT SENSORS



8" Round Type GS Split Sensor **Cat. No. 302D0800UL**

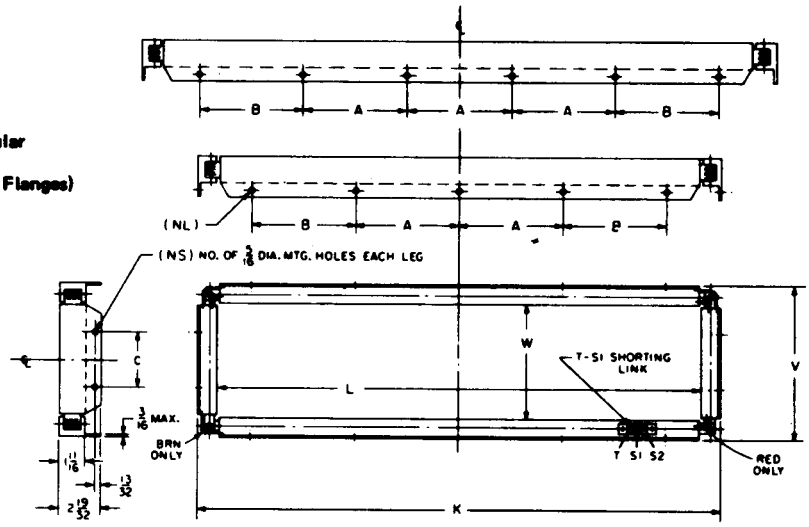
1. Handle the disassembled halves with care to prevent dust or metallic particles from settling on the iron gaps. Gap surfaces should be perfectly CLEAN prior to reassembly.

2. When mounting, make sure there is no mechanical stress imposed on either gap by LOOSELY bolting the sensor to the supports using locking type nuts which lock on the bolt threads.

3. Apply with minimum 1" clearance from sensor to conductors.

All dimensions on this page are in inches.

Type GS Rectangular Sensors (Outside Flanges)



Catalog Number	Size	W	L	V	K	NL	A	B	NS	C
302T0717UL	7 x 17	7-1/8	17-1/8	9-5/8	19-5/8	(3)	6.5	6.5	(2)	4.5
302T0724UL	7 x 24	7-1/8	24-1/8	9-5/8	26-5/8	(4)	6.5	6.5	(2)	4.5
302T0727UL	7 x 27	7-1/8	27-1/8	9-5/8	29-5/8	(4)	6.5	6.5	(2)	4.5
302T0730UL	7 x 30	7-1/8	30-1/8	9-5/8	32-5/8	(5)	6.5	6.5	(2)	4.5
302T0737UL	7 x 37	7-1/8	37-1/8	9-5/8	39-5/8	(6)	6.5	6.5	(2)	4.5
302T1010UL	10 x 10	10-1/8	10-1/8	12-5/8	12-5/8	(2)	6.5	6.5	(2)	6.5
302T1017UL	10 x 17	10-1/8	17-1/8	12-5/8	19-5/8	(3)	6.5	6.5	(2)	6.5
302T1024UL	10 x 24	10-1/8	24-1/8	12-5/8	26-5/8	(4)	6.5	6.5	(2)	6.5
302T1030UL	10 x 30	10-1/8	30-1/8	12-5/8	32-5/8	(5)	6.5	6.5	(2)	6.5

NOTE:

1. Caution: Sensors are 600V class devices. Follow air and surface clearance requirements of electrical equipment designs.
2. Apply with minimum 1 inch clearance from sensor to conductors.
3. Ground Fault relay connects to terminals S1 and S2.
4. Shorting link required T and S1.
5. Any sensor leg is removable. The sensor is shipped with the mounting flanges toward the outside. The sensor can be reassembled with flanges inside.
6. When assembling use care to avoid damage to laminations.
7. Recommended tightening torque for corner bolts is 40 in-lbs. Do not overtighten. We recommend that stack ends be covered or sprayed with rust inhibiting coating such as silicone grease.
8. Reconnect all corner lead connectors. Observe color code.

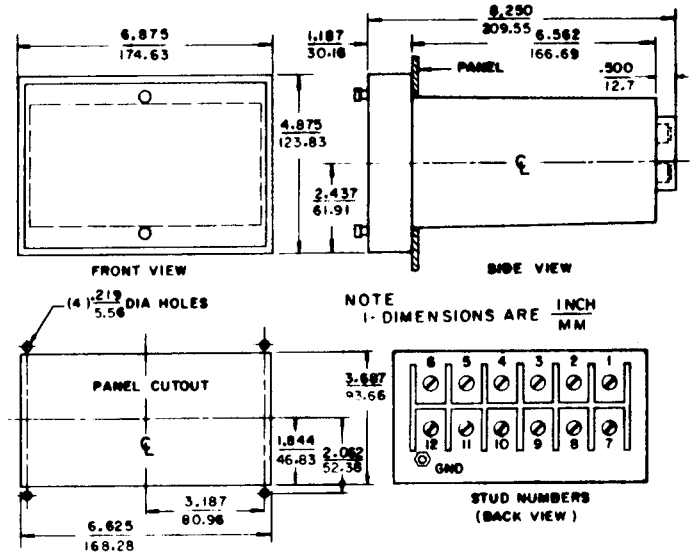
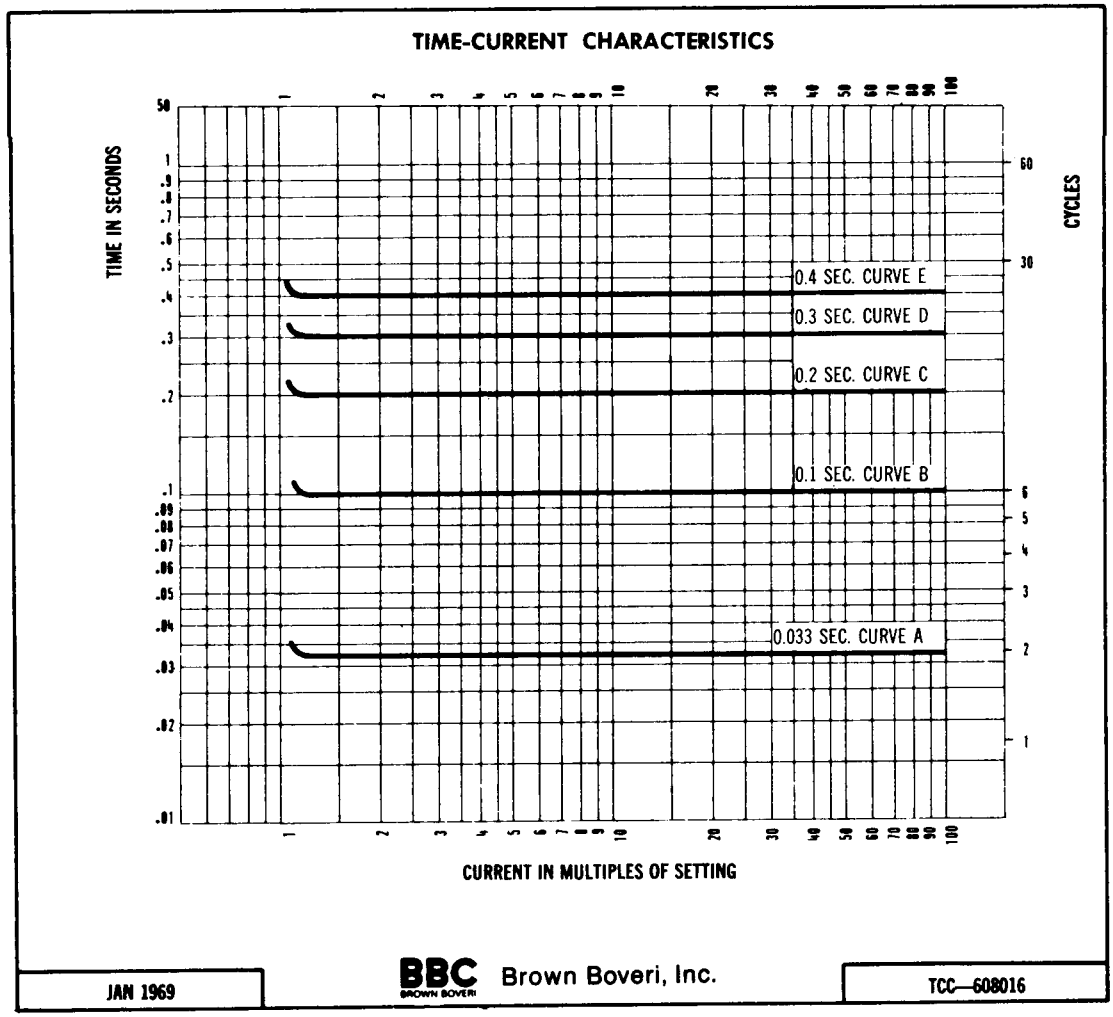


Figure 2: Relay Outline and Panel Drilling

Figure 3: Time-Current Characteristic Curve



WIRING DIAGRAMS

NOTE 1: System "neutral to ground" connection must be on source side of ground sensor. DO NOT ground neutral anywhere downstream from sensor location.

NOTE 2: Control power source should have sufficient capacity to accommodate trip coil inrush current and to avoid excessive voltage collapse during operation.

NOTE 3: Where sensor-relay wiring runs together with power cables, a shielded control cable or twisted pair is recommended.

NOTE 4: Alarm contacts are reset by pressing TARGET RESET button.

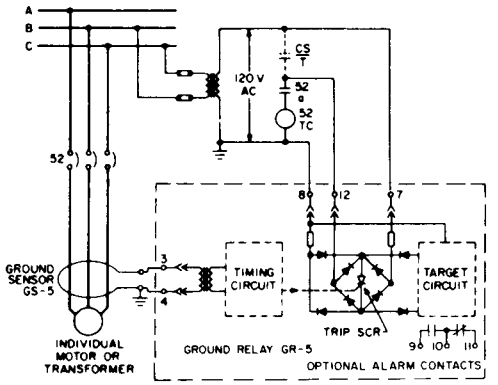


Figure 4: Typical Connections - Type GR5 for 120Vac Control Power

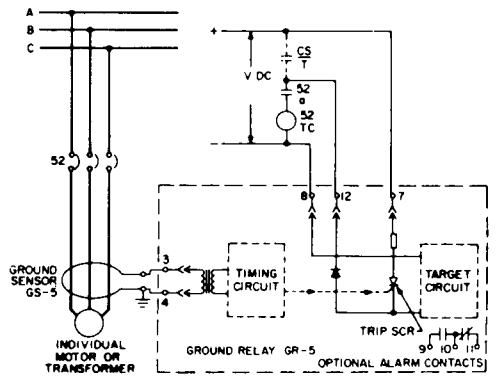


Figure 5: Typical Connections - Type GR5 for DC Control Power

TESTING

1. MAINTENANCE AND RENEWAL PARTS

No routine maintenance is required on these relay systems. Follow test instructions to verify that the relay is in proper working order. We recommend that an inoperative relay be returned to the factory for repair; however, a schematic diagram may be obtained through your local sales engineer should you wish to attempt repairs.

Replacement target head assemblies for the drawout style relay may be ordered should the target become damaged. Also available for the drawout style relay are circuit card extenders. These relays use the 10 point extender, catalog 200X0010.

CAUTION: Since testing and troubleshooting entails working with energized equipment, caution should be taken to avoid personal shock. Only competent technicians familiar with good safety practices should service these devices.

2. HIGH POTENTIAL TESTS

Do not apply high potential tests to solid state relay circuits. If a control wiring insulation test is required, withdraw the circuit board so that the connections in the rear of the case are broken before applying test voltage.

3. ACCEPTANCE TESTS

RELAY MOUNTED IN SWITCHGEAR

See Field Test Instructions, IB 7.1.1.7-9 for tests of completed installations required by the National Electrical Code.

A. BUILT-IN TEST FEATURE

A push to test button is provided as a standard feature of the drawout unit. This feature allows you to check the operation of the system by applying a trip signal to the relay's circuits. The relay then operates to trip the associated interrupting device. The push-button is recessed to prevent accidental operation.

B. PRIMARY-CURRENT TESTING

Tests should be made on a de-energized main circuit. Be sure to take all necessary safety precautions.

1. Set the relay at minimum pickup.

2. Use a multi-turn test cable or loop a test coil of sufficient number of turns and current carrying capacity through the sensor window.

3. Apply control power to the circuit breaker trip circuit and relay.

4. Apply a test signal (signal level = amperes X turns) equal to 1.25 to 2.5 times the pickup setting. The relay should trip the breaker immediately. Since the relay should operate in less than 1 second, the test current should not be applied for more than a few seconds. As an example, assume a 19 turn test cable, a relay setting of 100 amperes: the test current equivalent to a test signal of 125 amperes is 125 amp/19 turns = 6.6 amperes.

5. If the breaker did not trip, interrupt the test current, then check the continuity of the trip circuit, including the trip coil. This can be done by momentarily shorting terminals 7 and 12 on the drawout unit to see if the breaker will trip.

BENCH TESTS (Without Circuit Breaker)

1. Connect relay and sensor as shown for your particular unit in figures 6 or 7.

2. Set the relay at minimum pickup.

3. Increase the test current signal until the relay operates. (Test signal = current X turns on sensor.) Immediately return the test current to zero when the auxiliary relay operates.

4. To repeat the test, actuate the reset switch to drop out the auxiliary relay.

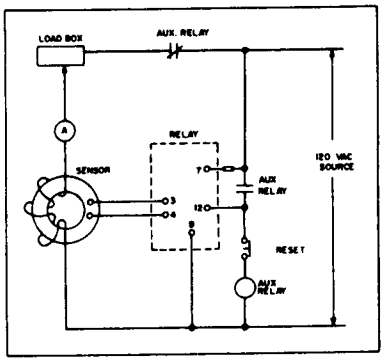


Figure 6: Typical Test Connections
120Vac Rated Relay

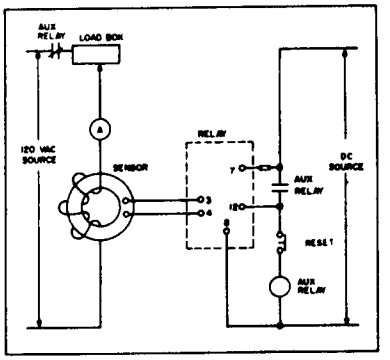


Figure 7: Typical Test Connections
DC Control Rated Relay

CALIBRATION TESTS

If accurate calibration tests for minimum operating current and time delay are required, they should be made by the primary current method using a sensor and relay as a system. See figures 8 and 9 for typical test circuits.

1. Follow bench test procedures above to determine minimum operating current.

2. To check time delay, apply a test signal equivalent to 2.5 times the pickup setting. For example: with a 19 turn test cable and a relay setting of 100 amperes, the test current should be 250/19 = 13 amperes.

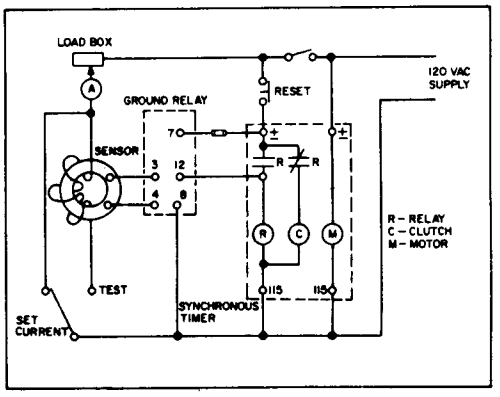


Figure 8: Typical Test Connections
with Timer - 120Vac Relay

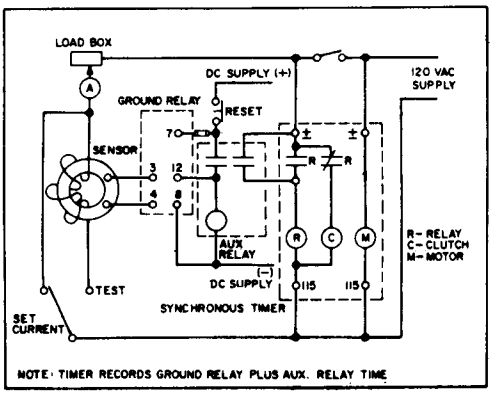


Figure 9: Typical Test Connections
with Timer - DC Rated Relay