



IB 7.1.1.7-4  
Issue B

## INSTRUCTIONS

### Differential Relay System

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# GROUND SHIELD<sup>®</sup>

## DIFFERENTIAL RELAY SYSTEM

### TYPE GRD

For Phase and Ground Fault Protection of  
MOTORS - GENERATORS - REACTORS - 3 PHASE LOADS



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INTRODUCTION

These instructions contain the information required to properly install, operate, and test the ABB Ground-Shield™ Type GRD Machine Differential Relay System.

This system is used to provide fast sensitive differential protection for motors and generators.

These relays are housed in a case suitable for conventional semi-flush panel mounting. All connections to the relay are made at terminals located on the rear of the case and clearly numbered.

Controls are located on the front panel behind a removable clear plastic cover. The target indicator is reset by a pushbutton extending through the cover. Control power must be applied in order to reset the target.

PRECAUTIONS

The following precautions should be taken when applying these systems:

1. Type GS current sensors are 600v class devices. Follow air and surface clearance requirements of electrical equipment designs.
2. Incorrect wiring may result in damage. Be sure wiring agrees with the connection diagram before energizing. Be sure that the dc control voltage is applied in the correct polarity.
3. Apply only the rated ac or dc control voltage marked on the front panel.
4. Be sure the trip circuit is interrupted by an "a" auxiliary contact to stop the flow of trip circuit current upon operation of the breaker.
5. The load on the relay's output (circuit breaker trip coil or auxiliary relay coil) must draw at least 0.1 ampere to insure proper operation. If necessary, add a resistor in parallel with a low current coil to obtain the 0.1A current.
6. High voltage tests are not recommended. If a control wiring insulation test is required, withdraw the unit from its case before applying the test voltage.
7. The circuit board of the relay is removable. The board should insert smoothly. Do not use force.
8. Follow test instructions to verify that the relay is in proper working order.

**CAUTION:** *since troubleshooting entails working with energized equipment, care 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 ABB. Use normal care in handling to avoid mechanical damage. Keep the relay clean and dry.

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## 2. INSTALLATION

### Mounting:

The outline dimensions and panel drilling information for the Type GRD relay is shown in Figure 1.

The dimensions of the ABB Type GS sensors are shown on pages 6 and 7.

The sensors should be mounted with care to avoid undue stress on the mounting bushings. Cable conductors should be centered in the window.

For motors with high inrush current (in excess of 2500 amperes), the two cables should be taped together and roughly centered in the window to eliminate possible nuisance tripping due to leakage flux.

### Connections:

Internal connection diagrams and typical external connections are shown on page 5.

Wires from the sensors to the relays should be at least #14 guage wire and can be used for distances up to 2000 feet. Larger wire should be used for greater distances such that the total one-way lead resistance is less than 5 ohms.

For Type GS sensors with three terminals, the Type GRD relay connects to terminals S1 and S2, and a jumper is required between terminals T and S1. For sensors with two terminals, the relay connects to S1 and S2.

The metal front panel of the relay is connected through printed circuit board runs and connector wiring to the ground terminal on the rear of the case. This terminal is marked "G" and should be wired to ground.

For relays rated for use with dc control power, the dc must be connected in the proper polarity as shown in the wiring diagrams.

A circuit breaker auxiliary switch, 52a, should always be used in series with the shunt trip coil to prevent thermal damage to the relay and tripping circuit, and to reset the output SCR upon circuit breaker operation.

The load on the relay's output (trip coil or auxiliary relay coil) must draw at least 0.1 ampere to insure proper operation. Add resistance in parallel with the coil if necessary to obtain the 0.1A. If an auxiliary relay coil is used, some means to reset such as a 52a switch or manual pushbutton must be provided in series with the coil.

The Type GRD relay can not be used directly on the output of a capacitor trip device. In this situation, use the ac control voltage rated GRD and a hand-reset lockout relay with ac coil. Use the contact of the lockout relay to trip the breaker from the capacitor trip device.

## 3. SETTINGS

### Primary Trip Amperes:

This three position switch sets the pickup current of the relay in terms of the primary side fault current. The settings are 2, 5, 10 amperes.

### Time Curve - Cycles:

This three position switch sets the operating time of the relay. The characteristic is definite time. The settings are 1, 3, 5 cycles.

Note: it may not always be possible in a particular application to use the most sensitive pickup or fastest time delay settings. High motor inrush currents and sensor/cabling configuration may require the use of higher settings to avoid nuisance tripping on motor starting. From a practical standpoint, even a 10 ampere (primary) pickup provides sensitive protection.

**APPLICATION DATA**

The ABB Ground-Shield™ Differential Relay System provides fast sensitive protection against phase-to-ground, phase-to-phase, and three-phase faults for motors and generators. The system consists of 3 ABB Type GS current sensors and 1 three-phase Type GRD relay.

While more sensitive than percentage differential relay schemes, the GRD system is less costly, allowing economical application to smaller machines.

The system is used in the "self-balancing" arrangement where the source side and neutral side conductors of each phase winding of the machine are run through the window of the current sensor. Selection of the current sensors is independent of load current, and is based only on the physical size required to pass the two conductors through the window. For larger machines where this arrangement is physically impractical, refer to the ABB Type 87M Percentage Differential Relay.

Since the same current sensor is used to detect the difference between current into and out of each machine winding, problems of current transformer saturation are avoided. The relay may be located remote from the machine and sensors without the concern for ct saturation characteristics and lead drop as must be considered in percentage differential schemes.

ABB Ground-Shield Type GS sensors must be used with the Type GRD relay. These sensors have the advantage over conventional 50:5A ct's of requiring less mounting space, and availability with many more choices of window opening sizes.

However, in the event that conventional 50:5A or 100:5A window type current transformers have already been supplied with the machine, then the ABB Type 50D three-phase overcurrent relay is recommended. This relay has low burden and provides excellent performance in this application. The usual selection would be 0.2-2A range (secondary amps) giving a 2-20A primary-side range with 50:5 ct's. The appropriate time delay range is 0.01-0.3 seconds, catalog number 468T14x5. Both the Type GRD and 50D are supplied in the same case size.

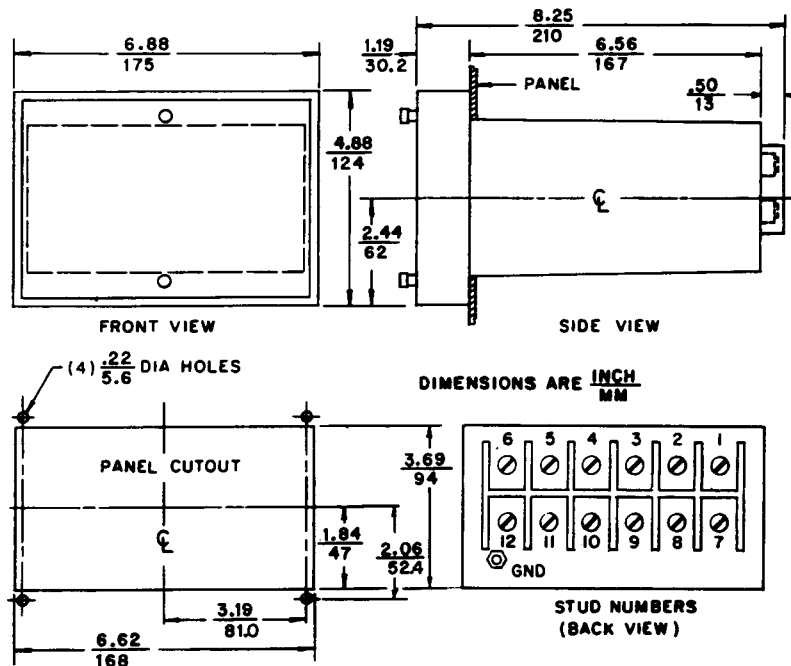


Figure 1: Relay Outline and Panel Drilling

Figure 2: INTERNAL CONNECTION DIAGRAMS

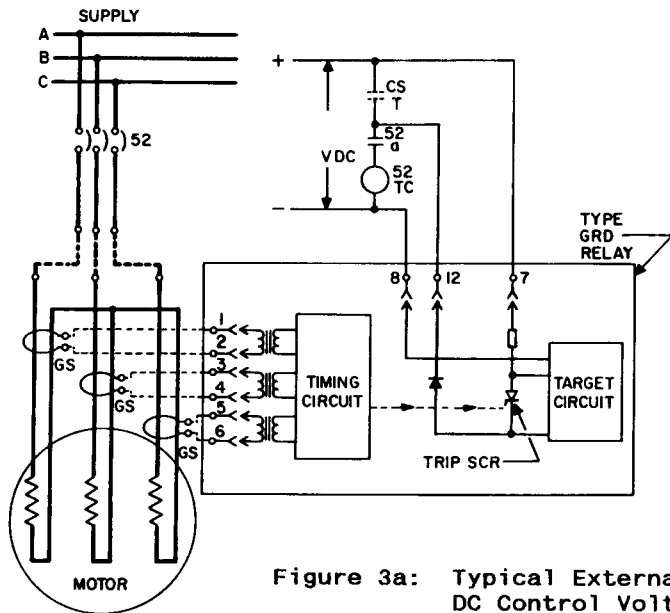
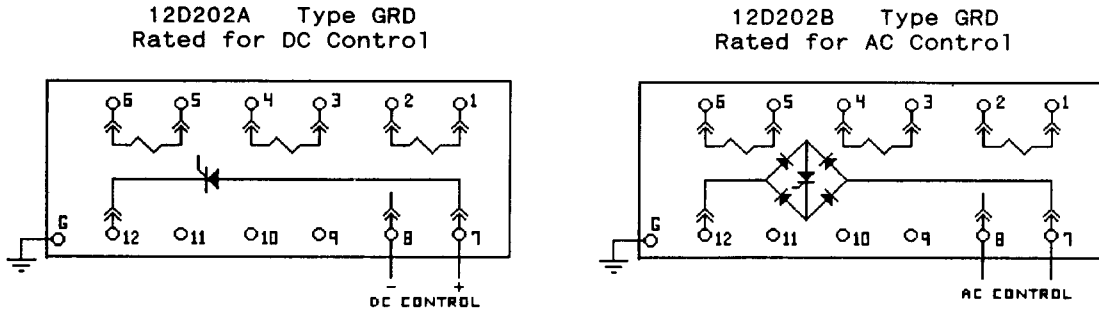


Figure 3a: Typical External Connections  
DC Control Voltage

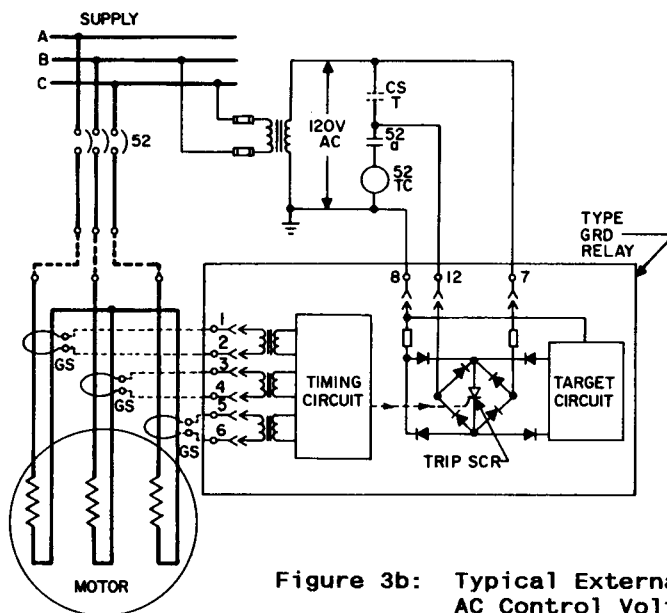
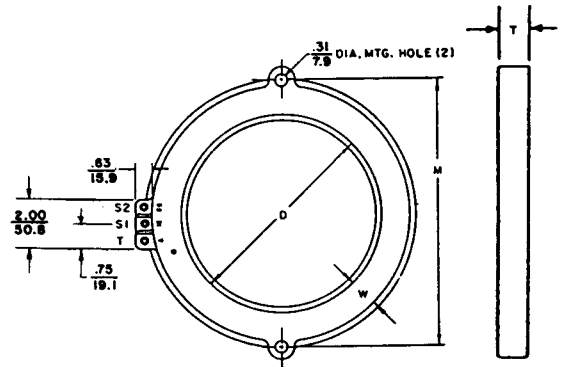


Figure 3b: Typical External Connections  
AC Control Voltage

FIGURE 4a: SENSOR DIMENSIONS - SOLID CORE UNITS

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

| Catalog Number            | Units      | D           | M            | W           | T           | Approx Weight    |
|---------------------------|------------|-------------|--------------|-------------|-------------|------------------|
| 302B0200UL                | in.<br>mm. | 2.125<br>54 | 5.063<br>129 | 1.125<br>29 | 1.875<br>48 | 3.0 lb<br>1.4 kg |
| 302B0300UL                | in.<br>mm. | 3.125<br>79 | 6.00<br>152  | 1.125<br>29 | 1.875<br>48 | 3.5 lb<br>1.6 kg |
| 302G0500UL<br>(see notes) | in.<br>mm. | 5.00<br>127 | 7.50<br>191  | 1.00<br>25  | 1.25<br>32  | 3.5 lb<br>1.6 kg |
| 302G0800UL<br>(see notes) | in.<br>mm. | 8.00<br>203 | 10.75<br>273 | 1.125<br>29 | 1.25<br>32  | 6.0 lb<br>2.7 kg |

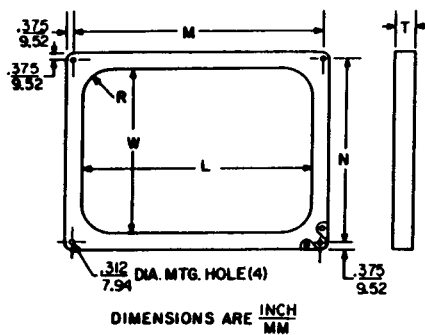


Notes:

- 302B0200UL and 302B0300UL have 2 terminals, S1 and S2.
- 302G0500UL and 302G0800UL have 3 terminals, S1, S2, and T. When applying with the Type GRD relay, connect jumper from T to S1; connect relay to S1-S2.
- 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.
- 302G0500UL replaces earlier models 302A0500UL and 302B0500UL.
- 302G0800UL replaces earlier models 302A0800UL and 302B0800UL.

| Catalog Number | Units      | L         | W         | R          | M            | N            | T          | Approx Weight     |
|----------------|------------|-----------|-----------|------------|--------------|--------------|------------|-------------------|
| 302B1013UL     | in.<br>mm. | 13<br>330 | 10<br>254 | 1.75<br>45 | 14.75<br>375 | 11.75<br>299 | 1.5<br>38  | 10.5 lb<br>4.8 kg |
| 302B1017UL     | in.<br>mm. | 17<br>432 | 10<br>254 | 1.75<br>45 | 18.75<br>476 | 11.75<br>299 | 1.5<br>38  | 14.0 lb<br>6.4 kg |
| 302B1024UL     | in.<br>mm. | 24<br>610 | 10<br>254 | 1.75<br>45 | 25.75<br>654 | 11.75<br>299 | 1.63<br>41 | 20.5 lb<br>9.3 kg |

Note: apply with 1 inch (25mm) minimum clearance from sensor to conductors. Tie cables together and center in the window for best performance.



DIMENSIONS ARE INCH  
MM



Specifications:

Differential Sensitivity: Adjustable 2, 5, 10 amperes, 50/60 Hz.  
(Primary amperes)

Differential Withstand Rating: 100 kA, 0.033 second  
(Primary amperes) 65 kA, 0.5 second  
300 A, continuous

Continuous Phase Current Rating: Limited only by primary bus or cable size.

Operating Time: Adjustable 1, 3, 5 cycles (60 Hz. basis)

Control Voltage Rating: Models available for  
24 vdc 32 vdc all at 0.03 A  
48 vdc 125 vdc standby drain.  
110 vdc 220 vdc  
250 vdc 120 vac

Output Rating: 30 A tripping  
12 A, 0.25 second  
7.5A, 1 second  
1 A, continuous

Operating Temperature: -20° to +75° C.

Seismic Capability: 6g ZPA broadband multifrequency vibration  
per ANSI C37.98.

Dielectric Strength: 1500 Vac, 60 second test.  
(Type GRD relay)

Tolerances: Pickup Current (primary amperes)  
Using round sensor: +/-1 ampere  
Using rectangular sensor: +2/-1 amperes

Time Delay (test current at 2 times pickup)  
Dial Position Allowable Delay  
1 cycle 0.008-0.032 sec.  
3 cycles 0.032-0.07 sec.  
5 cycles 0.064-0.10 sec.

Common Units - Type GRD

| <u>Control Voltage</u> | <u>Catalog Number</u> |
|------------------------|-----------------------|
| 120 Vac                | 202H1561              |
| 24 Vdc                 | 202H1501              |
| 48 Vdc                 | 202H1531              |
| 125 Vdc                | 202H1541              |
| 250 Vdc                | 202H1551              |

(Consult factory for other ratings)



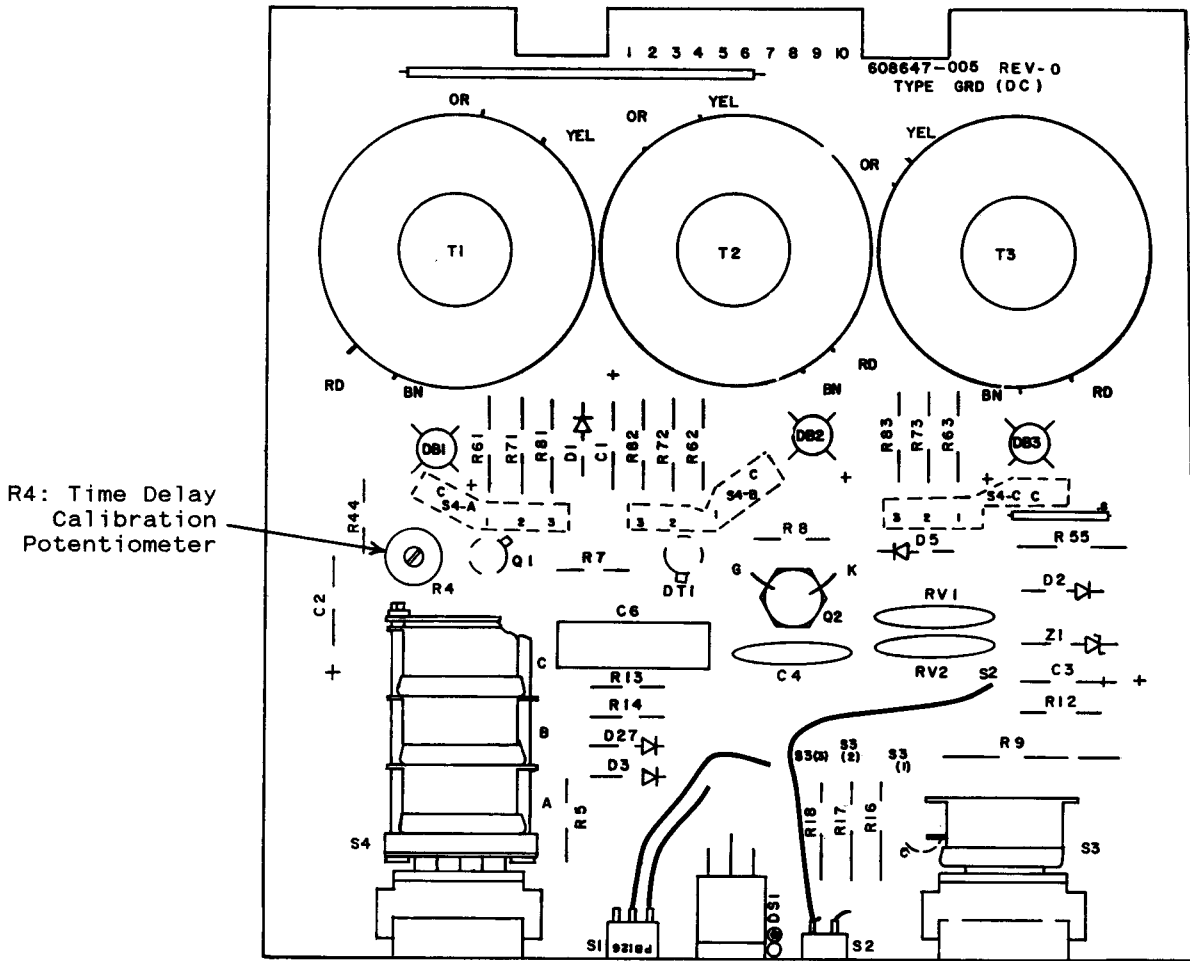


Figure 5: Typical Circuit Board Layout  
Type GRD with DC Control Rating

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## TESTING

### 1. MAINTENANCE AND RENEWAL PARTS

No routine maintenance is required on the ABB Ground-Shield™ Type GRD relay system. 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 will be provided on request. Repair parts will be quoted on request.

*Caution: since troubleshooting entails working with energized equipment, care should be taken to avoid personal shock. Only competent technicians familiar with good safety practices should service these devices.*

If the relay is taken out of service for an extended period, the ground sensor secondaries should be short circuited to prevent the presence of open circuit voltage from the Type GS sensor should a fault occur.

#### Drawout Element:

Drawout circuit boards of the same catalog number are interchangeable. The board is removed from its case using the 2 metal pull knobs on the front panel.

The drawout unit is further identified by a serial number stamped on the bottom of the circuit board.

Obsolete versions: units with a catalog number of the form 202H02x1 are obsolete. Should replacement be necessary use equivalent unit 202H15x1. See listing on page 7.

#### Card Extender:

A circuit card extender is available which may be helpful when troubleshooting. The Type GRD uses the 10 point extender, catalog 200X0010.

### 2. HIGH POTENTIAL TESTS

High voltage insulation tests are not recommended. A high-pot test was performed on the relay at the factory. If a control wiring insulation test is required, remove the drawout unit from its case before applying the test voltage.

### 3. BUILT-IN TEST FEATURE

A built-in test feature is provided to conveniently run a functional test of the relay and associated trip circuit. Tests should be run with a de-energized main circuit. If tests must be made on an energized circuit take all necessary precautions.

When the TRIP test button on the relay is actuated, the pickup, timing, and output stages of the relay should respond to trip the breaker and display the target.

### 4. TESTING WITH PRIMARY CURRENT

#### A. MOUNTED IN SWITCHGEAR:

CAUTION: these tests should be made with the main circuit de-energized.

1. Insert a test wire through the window of any one of the three sensors and connect to an ac test source.
2. Apply control power to the relay and circuit breaker trip circuitry.
3. Note the relay pickup setting on the front panel. Slowly increase the test current to the test wire until the relay trips. Relay and circuit breaker operation should be obtained within the tolerance limits given in the table on page 11. (Do not increase the current above 20 amperes for this test.)
4. Repeat steps 1 - 3 for each of the other 2 current sensors.

Note: if the breaker does not trip, a quick check of the operation of the trip circuit can be made by momentarily shorting terminals 7 and 12 together on the back of the relay.

**B. BENCH TESTING:**

1. Connect the relay and a current sensor as shown in Figure 6a or 6b depending on the control voltage rating, ac or dc, of the relay. The auxiliary relay coil must draw at least 0.1A to insure proper seal-in of the GRD output SCR. Add resistor in parallel with the coil if necessary.
2. Apply the control voltage.
3. Note the relay pickup setting on the front panel (primary amps). Slowly increase the test current until the relay trips. (Do not increase the test current above 20 amperes for this test.) Relay operation should be obtained within the tolerance limits shown on page 8. Return the current source to zero.
4. Repeat the test with the ac test source connected to terminals 1-2 and then to terminals 5-6 to check the other 2 inputs.
5. Timing tests: if necessary, timing tests can be performed by presetting the current to 2 times the pickup setting. Then reset the electronic timer, start the timer with the application of the test current and stop the timer with a contact from the auxiliary relay. However, since the Type GRD is a high speed relay, the operating time of the auxiliary relay can have a large influence on the total operating time to stop the timer. If available, a high speed auxiliary relay should be used. In any case, the operating time of the auxiliary relay should be subtracted from the time displayed in order to determine the operating time of the GRD.

**5. CURRENT SENSOR RATIO**

The ratio of all ABB Ground-Shield Type GS current sensors is 400:1.

**6. IN CASE OF DIFFICULTY**

The most common problem experienced with the Type GRD involves incorrect power cable routing through the sensors. The sensors are typically mounted in a terminal compartment where space is tight and visibility may be poor. Mixing phases or running one conductor through the sensor in the wrong direction will cause the relay to trip immediately upon energization of the machine.

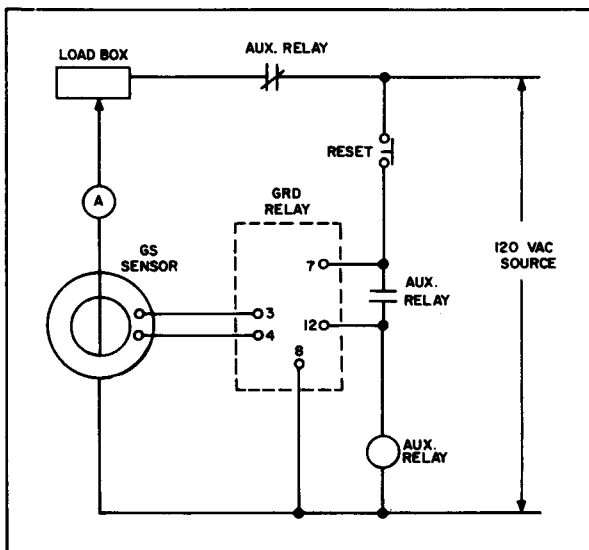


Figure 6a: Typical test connections  
Unit Rated for 120vac

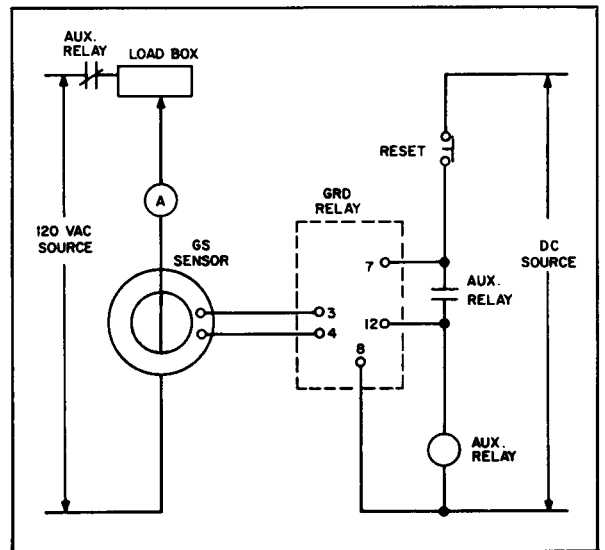


Figure 6b: Typical Test Connections  
Unit Rated for DC Control

Note: do not use full wave rectified ac for a dc control source for relay testing. Some filtering is required: a 100 microfarad capacitor is generally sufficient.