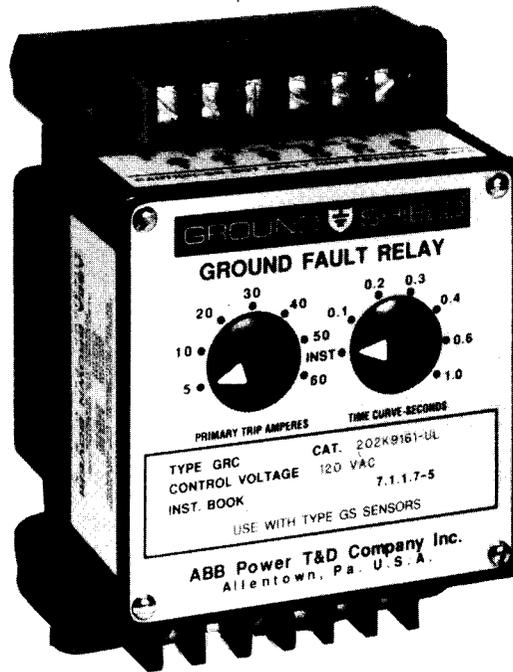


## INSTRUCTIONS

### Solid-State Ground Fault Relay System

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TYPE GRC  
Surface Mounted



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

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## INTRODUCTION

These instructions contain the information required to properly install, operate, and test the type GRC Ground Fault Relay System.

The Type GRC relay has both adjustable pickup current and time delay settings and is designed for use as a system with a type GS Ground Sensor, to provide time-current coordinated ground fault protection.

The relay can be used with or without a test and monitoring panel. Refer to Instruction Book IB 7.1.1.7-10 for information and interconnections for the companion type TMC and type TMS Ground Fault Monitor Panels.

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 BBC Brown Boveri, Inc.

## PRECAUTIONS

The following precautions should be taken when applying these relays:

1. Incorrect wiring may result in damage to the relay. Be sure wiring agrees with the connection diagram for the particular relay before the relay is energized.
2. Do not apply high voltage tests to solid-state relays. If a control wiring insulation test is required, bond all terminals together before applying test voltage.
3. 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 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 inoperative unit be repaired and retained as a spare.
4. 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. Use normal care in handling to avoid mechanical damage. The relay 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 mounting information are given in Figure 1. The relay should be mounted in a location where the settings are accessible and can be adjusted without danger to the operator.

Terminal and basic circuit identification will be found in Figure 2.

The sensor should be mounted so as to enclose all phase conductors and the neutral conductor if supplied (but not the ground conductor). For applications other than dual source, the connection between neutral and ground must be made ahead of the sensor. In some service applications the sensor can be installed around the main bonding jumper (neutral to ground bus connection). If a separate grounding electrode conductor is connected to the neutral in this case, it too should be routed through the sensor window. On four wire systems with dual sources, special consideration must be given to the location of the sensors. Check the factory on the use of the no-trip input to the relay for these applications.

Cable conductors should be bundled tightly and centered in the sensor window. Rectangular sensors should be applied with 1 inch or more clearance from the sensor to the nearest current carrying bus. The sensor should not be mounted in a manner that would put stress on the mounting bushings.

For information on installation of split sensors, refer to page 9.

When mounting a ground sensor over shielded cable or metal sheathed cable, certain precautions must be taken so that proper relay operation is assured: 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.

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

A typical external connection diagram for a ground fault protective system is shown in Figure 3.

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

Special care must be taken to connect control power of proper voltage, frequency, and polarity. Reversing plus (+) and minus (-) on relays designed for D.C. control power will cause the SCR to block the flow of trip current and the relay will not function.

The Type GRC relay will accept a "No-Trip" contact input at terminals 9 and 10. (See Figure 2.) This control input is used to prevent relay operation in certain double-ended substation applications. Operation is blocked when contact is closed.

Wires from the sensor to the relay should be at least #14 gauge wire and no more than 100 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 0.5 ohm.

The relay terminals are intended to accommodate copper wire only.

### 3. SETTINGS

#### PRIMARY TRIP AMPERES

This switch selected current pickup setting is calibrated in primary side ground fault current amperes.

#### TIME CURVE - SECONDS

This switch selected setting determines the time required, once the ground current is above pickup, for the relay to close its output circuit to trip the breaker. The range of adjustment is Instantaneous (2 cycles) to 1.0 seconds (60 cycles). The time-current characteristic is definite time - see Page 8. (Note: on earlier models, the range of time adjustment was Instantaneous to 0.5 seconds (30 cycles)).

#### RESET

The Type GRC relay restores itself to functional status upon opening of the circuit breaker auxiliary contact (52a) and does not require manual reset.

If an external auxiliary relay is used as shown in Figure 4, it should be reset by a separate push button or momentary type switch.

## APPLICATION DATA

The Ground-Shield ground fault protection system provides 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 relay. The ground sensor which encircles all phase conductors and the neutral conductor if supplied, provides an output to the ground relay when a ground fault occurs in the circuit. The ground relay operates the shunt trip device on the circuit breaker. In some applications, the ground sensor can be put around the neutral connection to ground to operate the main protective device. For additional information, refer to the NEMA Application Guide for Ground Fault Protective Devices for Equipment, PB 2.2-1983.

### RATINGS

Major ratings appear on the front panel or labels on the unit.

Input Signal: current from a secondary winding of a type GS sensor.

Input Withstand: (sensor primary current) 200 kA RMS for 0.033 sec., 65 kA RMS for 0.5 sec., 3,000A RMS continuous (20-240A and 100-1200A units), 300A RMS continuous (2-24A and 5-60A units).

Primary Trip Amperes: The following ranges are offered:

2-24 Amperes	(Switch selected: 2, 4, 8, 12, 16, 20, 24A)
5-60 Amperes	(Switch selected: 5, 10, 20, 30, 40, 50, 60A)
20-240 Amperes	(Switch selected: 20, 40, 80, 120, 160, 200, 240A)
100-1200 Amperes	(Switch selected: 100, 200, 400, 600, 800, 1000, 1200A)

The relays require an external control power source to operate shunt trip coils, auxiliary relays, or other utilization devices:

Control Voltage: See relay nameplates for nominal control voltage. Maximum voltage is nominal plus 10%.

Minimum Operating Control Voltage:  
55% of nominal for AC relays  
80% of nominal for DC relays

Output Polarity: Fixed for DC relays (no output on control voltage reversal); full cycle AC for AC relays. Output circuit: thyristor (SCR) switch.

Control Source Drain: Approximately 10mA (stand-by). Control power transformer size depends only on shunt trip coil requirements, EXCEPT when type TMS monitor is used, control power transformer must be capable of supplying sensor test current. See Instruction Book for Monitor, IB 7.1.1.7-10.

Output Ratings:

30 amps RMS for 0.033 seconds  
 12.5 amps RMS for 0.25 seconds  
 7.5 amps RMS for 1 second  
 1 amp RMS continuous (DC models); 0 amp continuous (AC models)

NOTE: The output circuit of the relay acts as a solid state switch on the output side. Hence, the output current depends only on the impedance and wiring of shunt trip coils. Check output ratings against shunt trip coil current requirements to assure compatibility and prevent damage.

ASSOCIATED DEVICESGround Sensors

The relays are intended for protection of solidly or resistance grounded power systems and are used in conjunction with type GS magnetic sensors which encircle the ground-return or the power conductors (3-4 conductors of 3-phase loads; 2 conductors of single phase loads). Sensors detect zero-sequence or ground fault currents. 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 or bus.

Application to circuits is independent of power circuit current ratings. Select from the tables below by the physical opening necessary to accommodate the power circuit conductors.

The sensors are 600V class insulation. The sensors can be used in high voltage power systems providing proper clearances between HV conductors and the surface of the sensor are maintained, or if insulated HV cables are utilized.

Although copper wire is preferred for protective circuits, the sensor terminals are intended to accommodate copper or aluminum conductors.

TYPE GS GROUND SENSORS

<u>SOLID CORE</u>		<u>SPLIT CORE</u>	
<u>SIZE &amp; SHAPE</u>	<u>CATALOG NUMBERS</u>	<u>SIZE &amp; SHAPE</u>	<u>CATALOG NUMBERS</u>
2" Round	302B0200UL	8" Round	302D0800UL
3" Round	302B0300UL	7" x 7" Rectangular	302T0707UL
5" Round	302B0500UL	7" x 17" Rectangular	302T0717UL
8" Round	302B0800UL	7" x 24" Rectangular	302T0724UL
7" x 21" Rectangular	302L0721UL	7" x 27" Rectangular	302T0727UL
7" x 25" Rectangular	302L0725UL	7" x 30" Rectangular	302T0730UL
7" x 27" Rectangular	302L0727UL	7" x 37" Rectangular	302T0737UL
7" x 31" Rectangular	302L0731UL	10" x 10" Rectangular	302T1010UL
7" x 37" Rectangular	302L0737UL	10" x 17" Rectangular	302T1017UL
10" x 13" Rectangular	302B1013UL	10" x 24" Rectangular	302T1024UL
10" x 17" Rectangular	302B1017UL	10" x 30" Rectangular	302T1030UL
10" x 24" Rectangular	302B1024UL		

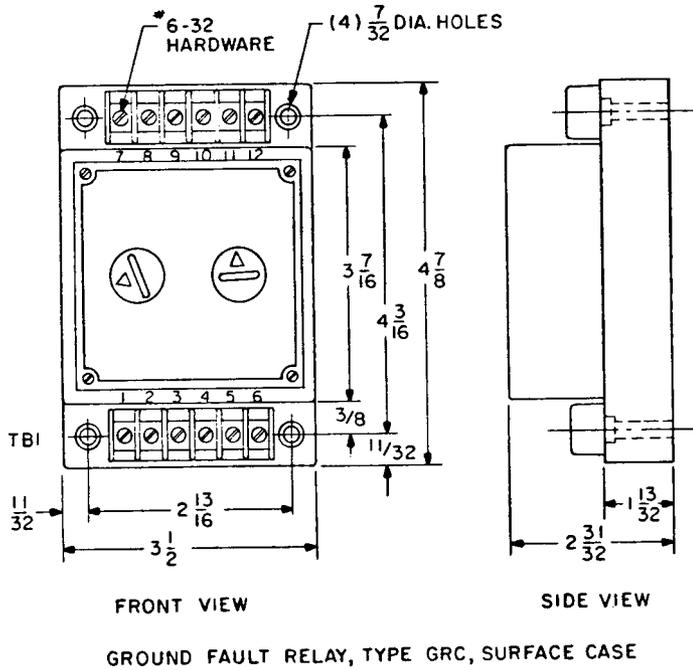


Figure 1: Relay Outline

NOTES:

1. External jumper connecting terminals 5 and 4 is required when the relay is used without the type TMC or TMS Monitor.
2. On sensors provided with the T terminal a shorting link is required between terminals T and S1, EXCEPT when type TMS Monitor is used.

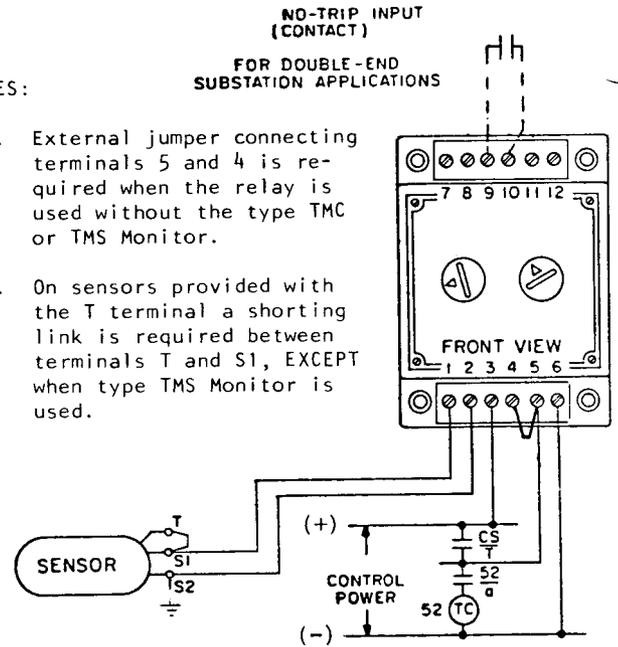


Figure 2: Type GRC Relay Connections With DC Control Power

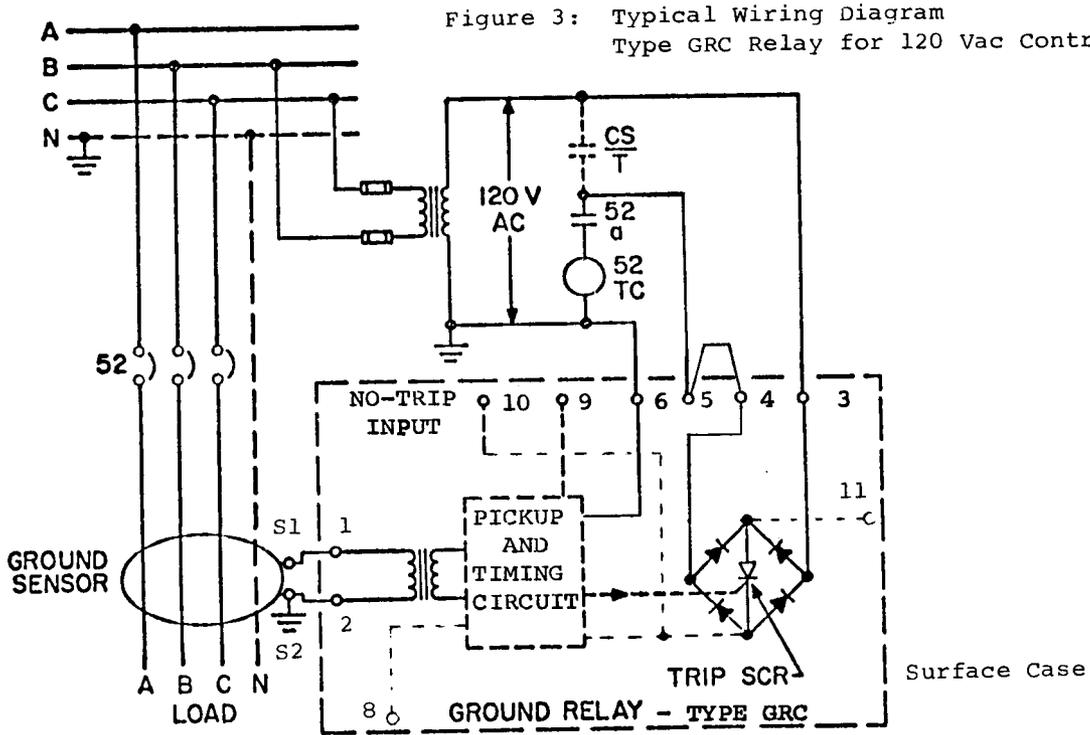


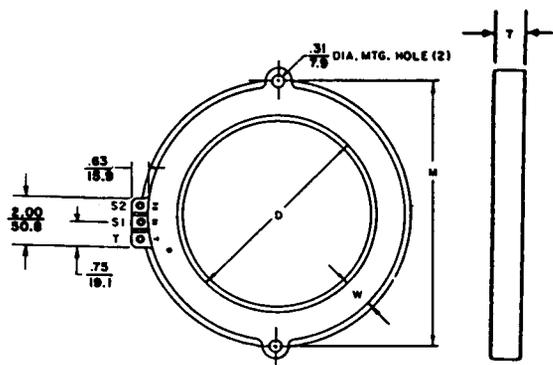
Figure 3: Typical Wiring Diagram  
Type GRC Relay for 120 Vac Control Power

NOTES:

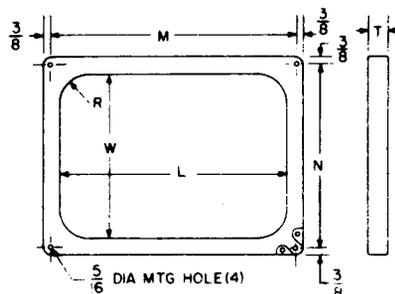
1. System "neutral to ground" connection must be on source side of ground sensor at the Service. DO NOT ground neutral anywhere downstream from sensor location except for special dual fed circuits (e.g. double-ended substations).
2. Control power source should have sufficient capacity to accommodate trip coil inrush current and to avoid excessive voltage collapse during operation.
3. External jumper connecting relay terminals 4 and 5 required when relay is used without type TMC or TMS monitor panel.
4. On sensors provided with the T terminal, a shorting link is required between Terminals T and S1, EXCEPT when the type TMS monitor is used.

**SENSOR DIMENSIONS**

**SOLID CORE**



**NOTE: All dimensions are in inches.**



Catalog Number	D	M	W	T
302B0200	2-1/8	5-1/16	1-1/8	1-7/8
302B0300	3-1/8	6	1-1/8	1-7/8
302G0500	5	7-1/2	1	1-1/4
302G0800	8	11-3/4	1-1/8	1-1/4

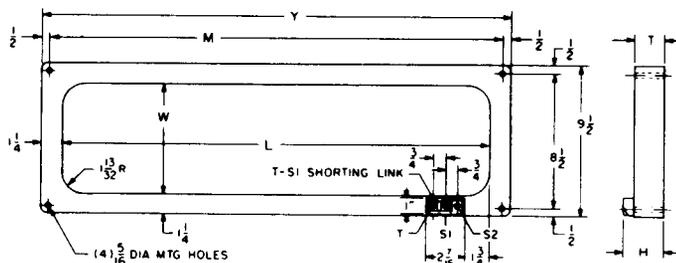
Catalog Number	Size	L	W	R	M	N	T
302B1013	10 x 13	13	10	1-3/4	14-3/4	11-3/4	1-1/2
302B1017	10 x 17	17	10	1-3/4	18-3/4	11-3/4	1-1/2
302B1024	10 x 24	24	10	1-3/4	25-3/4	11-3/4	1-5/8

**CAUTION:** Apply with minimum 1 inch clearance from sensor to conductors.

**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 GRC 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.

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



**NOTE:**

- Apply with minimum 1 inch clearance from sensor to conductors.
- Ground Fault relay connects to terminals S1 and S2.
- Shorting link required T to S1, EXCEPT when type TMS monitor is used.

Catalog Number	Size	W	L	M	Y	T	H
302L0721	7 x 21	7	21	22-1/2	23-1/2	2	2-1/2
302L0725	7 x 25	7	25	23-1/2	27-1/2	2	2-1/2
302L0727	7 x 27	7	27	28-1/2	29-1/2	2	2-1/2
302L0731	7 x 31	7	31	32-1/2	33-1/2	2	2-1/2
302L0737	7 x 37	7	37	38-1/2	39-1/2	2	2-1/2

Disconnect Device

Type GRC relays are normally used to open disconnecting means, such as shunt-trip circuit breakers or bolted pressure contact switches. The input requirements for the shunt trip must be compatible with the output ratings of the ground fault sensing relay. A Class I ground fault protection device (UL1053) is one which does not incorporate means to prevent opening of the disconnecting means at high levels of fault current and is intended for use with (1) circuit breakers, (2) fused circuit breakers, (3) fused switches having an interrupting rating not less than 12 times their ampere rating, or (4) fused switches having integral means to prevent disconnecting at levels of fault current exceeding the contact interrupting rating of the switch.

Operation of Auxiliary Relays

The output circuit of the type GRC relay consists of a silicon controlled rectifier (SCR) which is turned on (equivalent to a contact closure) by the timing circuit and is held "on" by the flow of coil current. The circuit can be connected to operate (pick up) an auxiliary (control) relay.

In A.C. application, approximately 0.1 amperes is required to insure that the SCR is held on. Coil impedances should be below 1000 ohms (60 Hz.). A normally open "a" contact must be used and wired as shown in Figure 4.

In D.C. applications, auxiliary relays with coil resistances greater than 10 ohms/V must have a resistor added in parallel across the relay coil. Recommended resistance values are:

NOMINAL VOLTS D.C.	OHMS	WATTS	RECOMMENDED WATT RATING
48	1000	3.6	20
125	2500	8	20

When using an auxiliary relay, a seal-in contact and a reset contact are usually required. See the arrangement in Figure 4 as a guide.

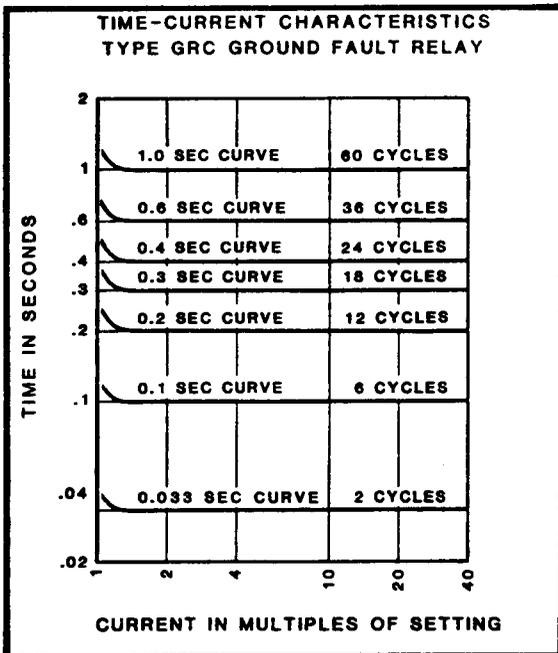
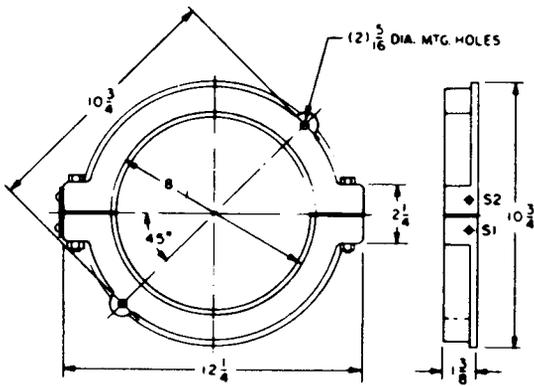


Figure 5: Time-Current Characteristics

Note: certain earlier models of the type GRC Ground Relay were provided with the following time settings: 0.033, 0.1, 0.2, 0.3, 0.4, 0.5 seconds.

INSTALLATION OF SPLIT SENSORS



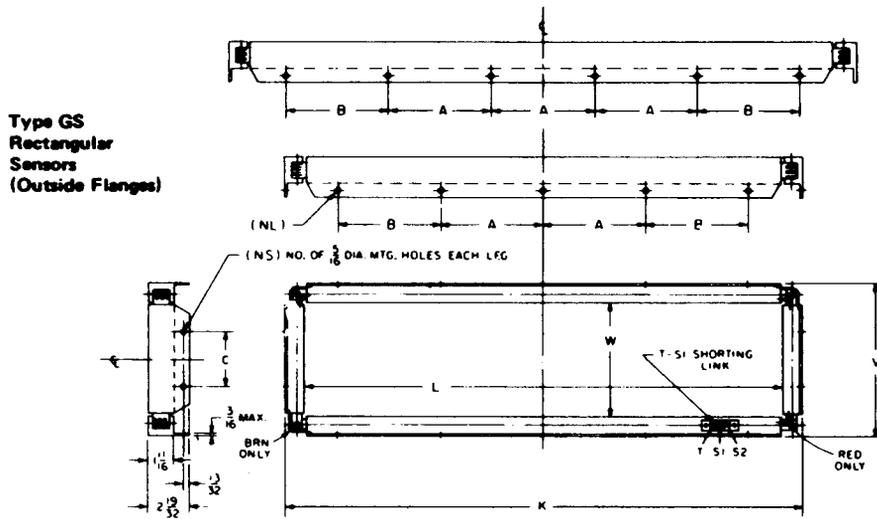
8" Round Type GS Split Sensor Cat. No. 302D0800UL

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.



Catalog Number	Size	W	L	V	K	NL	A	B	NS	C
302T0717 UL	7 x 17	7-1/8	17-1/8	9-5/8	19-5/8	(3)	6.5	6.5	(2)	4.5
302T0724 UL	7 x 24	7-1/8	24-1/8	9-5/8	26-5/8	(4)	6.5	6.5	(2)	4.5
302T0727 UL	7 x 27	7-1/8	27-1/8	9-5/8	29-5/8	(4)	6.5	6.5	(2)	4.5
302T0730 UL	7 x 30	7-1/8	30-1/8	9-5/8	32-5/8	(5)	6.5	6.5	(2)	4.5
302T0737 UL	7 x 37	7-1/8	37-1/8	9-5/8	39-5/8	(6)	6.5	6.5	(2)	4.5
302T1010 UL	10 x 10	10-1/8	10-1/8	12-5/8	12-5/8	(2)	6.5	6.5	(2)	6.5
302T1017 UL	10 x 17	10-1/8	17-1/8	12-5/8	19-5/8	(3)	6.5	6.5	(2)	6.5
302T1024 UL	10 x 24	10-1/8	24-1/8	12-5/8	26-5/8	(4)	6.5	6.5	(2)	6.5
302T1030 UL	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, EXCEPT when type TMS monitor is used.
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 the stack ends be covered or sprayed with rust inhibiting coating such as silicone grease.
8. Reconnect all corner lead connectors. Observe color code.

## TESTING

The GRC Ground Fault Relay does not require routine maintenance; however, periodic tests are desirable to confirm proper operation. Follow test instructions to verify that the relay is in proper working order. If a relay is found to be inoperative, we recommend it be returned to the factory for 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.

### Field Testing

Sensors and relays are subjected to factory tests and calibration in accordance with established procedures.

Field testing may introduce many variables or errors due to non-sinusoidal wave shapes, power source regulation or metering accuracy which could prevent an accurate check of the system performance or calibration unless the test personnel are thoroughly familiar with proper techniques. Therefore, the field tests should initially and generally be limited to a functional or "Go/No Go" type to ascertain proper installation or to determine if the devices are furnishing the protection for which they were installed.

Follow instructions, observe caution notes and use proper test equipment and facilities to gain test experience for special tests.

Also, see IB 7.1.1.7-9, Field Testing of Ground Fault Systems, for information on tests of completed installations required by NEC.

### 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.

If type TMC or type TMS Ground Fault Test and Monitoring Panels are used with type GRC relays, the relay can be tested with or without tripping of circuit breakers by referring to instructions in IB 7.1.1.7-10.

To test the relay and associated ground sensor, a test cable or winding of sufficient number of turns and current carrying capacity can be looped through the sensor window and energized for not more than one second from any convenient AC source or test set. To test operation or timing, the test ampere-turns (winding turns x test current) should be at least 1.25 to 2.5 times the relay pickup current setting unless pickup current tests are being conducted with gradual increase of the test current. Immediately return the test current to zero after breaker or auxiliary relay operation. Go/No-Go sensor and relay testing is simplified if the relay is used with a type TMS monitor and a type GS ground sensor that includes a test winding (terminal T).

### Bench Tests - (Without Circuit Breaker)

Operational tests of AC powered relays could be conducted by temporarily short-circuiting relay terminals 8 and 10, or connecting relays to type TMC or type TMS Ground Fault Monitors (see IB 7.1.1.7-10).

For more extensive tests, and especially for DC powered relays, the test circuit per Figure 4 is recommended. Refer to ASSOCIATED DEVICES section for proper selection of auxiliary relays. Until the test conditions are verified, it is recommended that a fuse be inserted in series with the trip output lead (terminal 5) to protect the relay while being tested. This fuse should be 1 ampere slow blow, such as Chase-Shawmut Cat. No. TRM, or Littlefuse Type 3AG.

**TOLERANCES**

Pickup Current Settings (primary amperes)

RELAY PICK-UP RANGE	USED WITH ROUND SENSORS	USED WITH RECTANGULAR SENSORS
2-24A 5-60A	$\pm 10\%$ of 1A whichever is greater	+20% or 2A whichever is greater -10% or 1A whichever is greater
20-240A	$\pm 10\%$	$\pm 10\%$
100-1200A*	$\pm 10\%$	$\pm 10\%$

\*Except 1200A setting which is +0/-20%.

Time Delay

$\pm 10$  percent or  $\pm 0.01$  seconds whichever is greater.

Figure 4: Bench Test Circuit

