

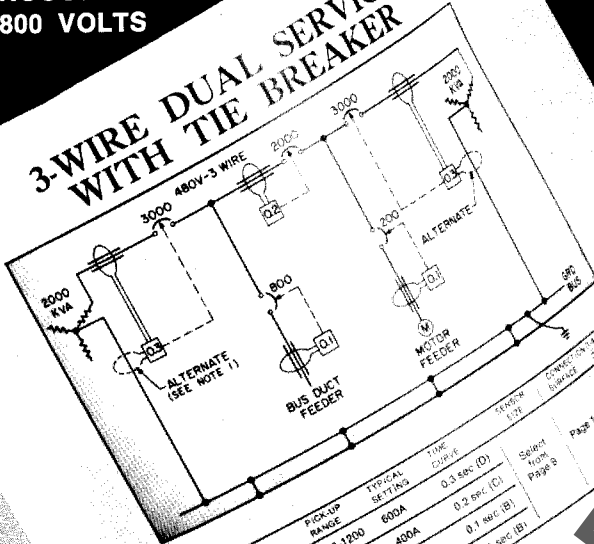
GROUND-FAULT PROTECTION APPLICATION GUIDE



Bulletin 18.1-4A

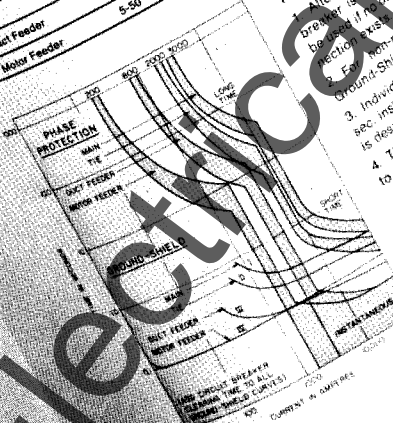
120 VOLTS THROUGH
13,800 VOLTS

3-WIRE DUAL SERVICE WITH TIE BREAKER



CIRCUIT	PICK-UP RANGE	TYPICAL SETTINGS	TIME COORDINATE	SELECT FROM
I Main	200-1200	600A	0.3 sec (D)	Page 10
II Tie	200-1200	400A	0.2 sec (C)	Page 11
III Bus Feeder	200-1200	200A	0.1 sec (B)	Page 9
IV Motor Feeder	5-50	5-10A	0.1 sec (B)	Page 11

- NOTES**
1. Alternate location of sensor on bus breaker is more economical and safer if no other neutral ground connection exists.
 2. Non-related tie breaker may be used.
 3. Individual load circuits can be 200 sec. instead of 0.1 sec. if faster tripping is desired.
 4. The data on this page also applies to solidly-grounded delta systems.



1. Any ground protection included in the motor feeder switchboards should use a 0.1 sec. time curve.
2. Alternate location of sensor on main breaker is more economical and safer if no other neutral ground connection exists.
3. Individual load circuits can be 200 sec. instead of 0.1 sec. if faster tripping is desired.
4. The data on this page also applies to solidly-grounded delta systems.

GROUND SHIELD®

FOR SOLID, LOW-RESISTANCE AND HIGH-RESISTANCE GROUNDING SYSTEMS
5-50 AMPERE 2, 8, 12, 18 & 24 CYCLE OPERATION
200-1200 AMPERE 8, 12, 18 & 30 CYCLE OPERATION

WHAT CAN AN UNDETECTED GROUND FAULT DO IN ONLY A MATTER OF SECONDS?

It can—and does—destroy circuits and equipment, create prolonged down-time, lose production time, burn equipment, buildings and people. Modern circuit protective devices guard against high magnitude fault currents. But relatively low-value short circuits to ground, below the protected zone of conventional overcurrent phase devices, can go undiscovered, until too late.

In order to combat this dangerous situation I.T.E. offers GROUND-SHIELD—a fast, highly accurate and simple Ground-Protection system. Its components consist of a ground-sensor current transformer and a solid-state relay which respond only to ground faults to protect the system in the ground-fault damage zone.

Illustration A shows the unprotected "ground-fault damage zone" below the standard circuit breaker instantaneous and long-time protected zones. Faults to ground in this area may result in severe arcing and finally burndown.

NOW YOU CAN BE PROTECTED AGAINST

WIRING BURNDOWN

WITH

I.T.E. GROUND-SHIELD

GROUND-SHIELD is a simple, accurate, fast-acting ground-fault protection system which provides a zone of protection below the standard circuit breaker instantaneous and long-time protected zones.

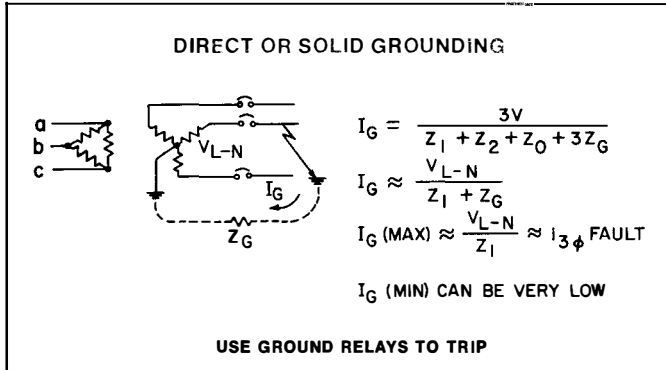
Illustration B shows how GROUND-SHIELD coordinates with standard circuit breaker overcurrent trip devices to provide protection in the "ground-fault damage zone" until now not protected against low-magnitude ground faults.

Contents

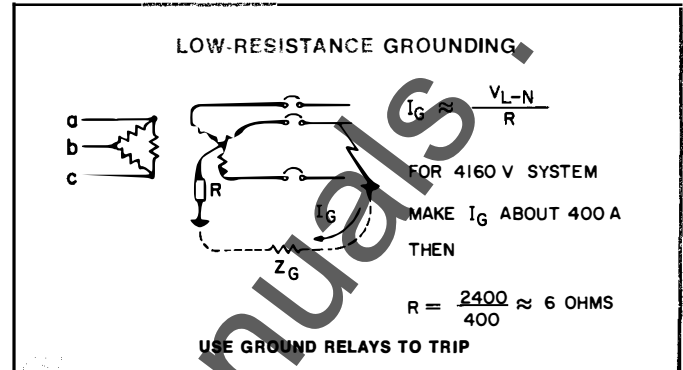
Methods of System Grounding	3	4-Wire Single Service With Relayed Tie Feeder	17
Direct or Solid Grounding	3	4-Wire Dual Service With Relayed Tie Breaker	18
Low-Resistance Grounding	3	4-Wire Dual Service With Non-Relayed Tie Breaker ..	19
High-Resistance Grounding	3	Dual Service 4-Wire Schematics	20
Ungrounded Systems	3	Incorrect Application	20
Interrupters used with Ground-Fault Relays	3	Relayed Tie Breaker A-C, D-C Control	20
Description of Ground-Fault Protective Systems	4-5	Non-Relayed Tie Breaker A-C, D-C Control	20
Ratings and Characteristics	6	Typical Hospital Scheme	21
Time-Coordinated Scheme	6	Zone-Interlocking Coordination Scheme	21
Installation of Sensors	7	Power Plant Auxiliary Circuits	22
Installation of Relays	8	Solidly Grounded	22
Comparison—Solid-State vs Electro-Mechanical	8	Low-Resistance Grounded	22
Construction Features	9	High-Resistance Grounded	22
Dimensions	9	High-Resistance Grounded Systems	22
Wiring Diagrams—Surface Case	10	Low-Voltage 480 Volts	22
Testing	10-11	Medium-Voltage 2.4 to 38kV	22
Wiring Diagrams—Drawout Case	11	Special Detecting, Alarm, Tripping and	
Low-Voltage Solidly Ground Systems		Monitoring Schemes	23
3-Wire Single Service Without Tie Feeder	12	Motor Circuit Application	24-25
3-Wire Single Service With Tie Feeder	13	Differential Relays, 3-Phase Loads	26-27
3-Wire Dual Service Without Tie Breaker	14	Selection, Ordering and Specifications	28-29
3-Wire Dual Service With Tie Breaker	15	Codes, NEC, UL and OSHA	Rear Cover
4-Wire Single Service Without Tie Feeder	16		

METHODS OF SYSTEM GROUNDING

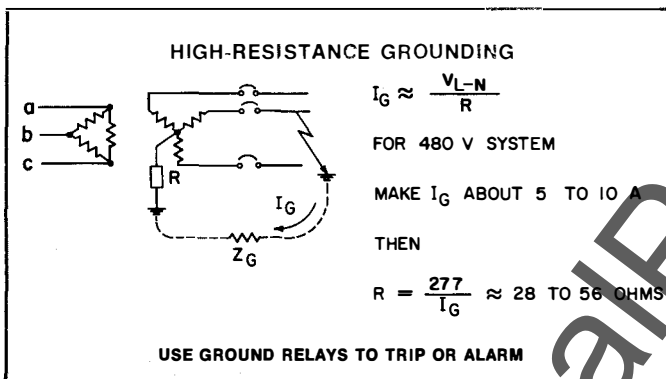
The following illustrate the four most common methods of system grounding. Selection of the optimum method is based upon each system's electrical characteristics and load service requirements.



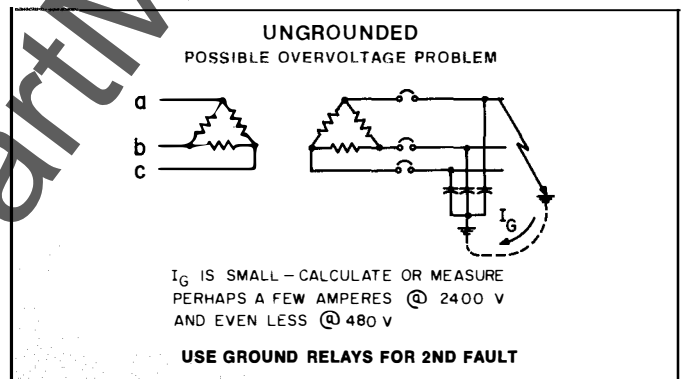
1. Direct or solid grounding is used with all 4-wire systems and those 3-wire systems where ground faults are to be cleared promptly. It is used primarily in low-voltage commercial and industrial distribution systems (120-600 volts). See Pages 12-23.



2. Low-resistance grounding limits ground-fault currents to reduce damage yet allows sufficient ground current for relaying of medium-voltage systems (2400-13,800 volts). See Pages 22-23.

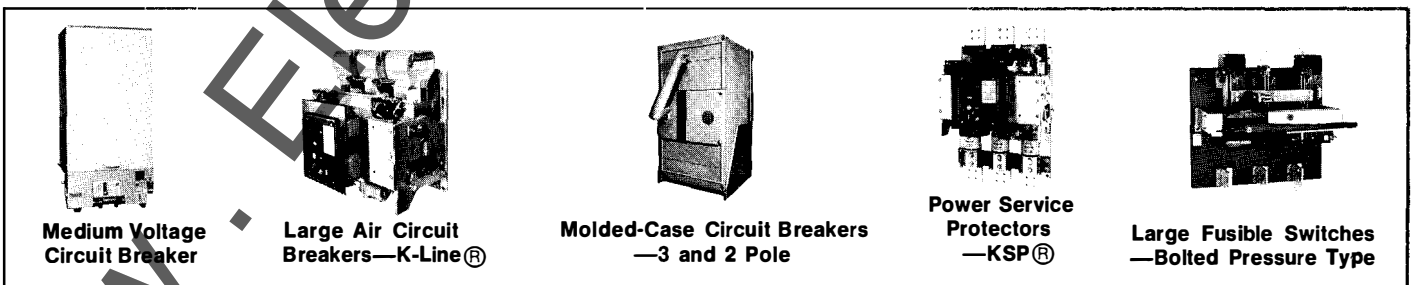


3. High-resistance grounding limits ground-fault currents to very small values. Therefore a ground fault may be either cleared or used to sound an alarm on those critical circuits where continuity of service is paramount. See Pages 22-23.



4. Ungrounded systems may be used where system capacitance is sufficiently low to preclude the danger of over voltages. Ground-fault currents are generally too small to detect except by bus voltage ground detectors. See Page 23.

INTERRUPTERS USED WITH GROUND-FAULT RELAYS

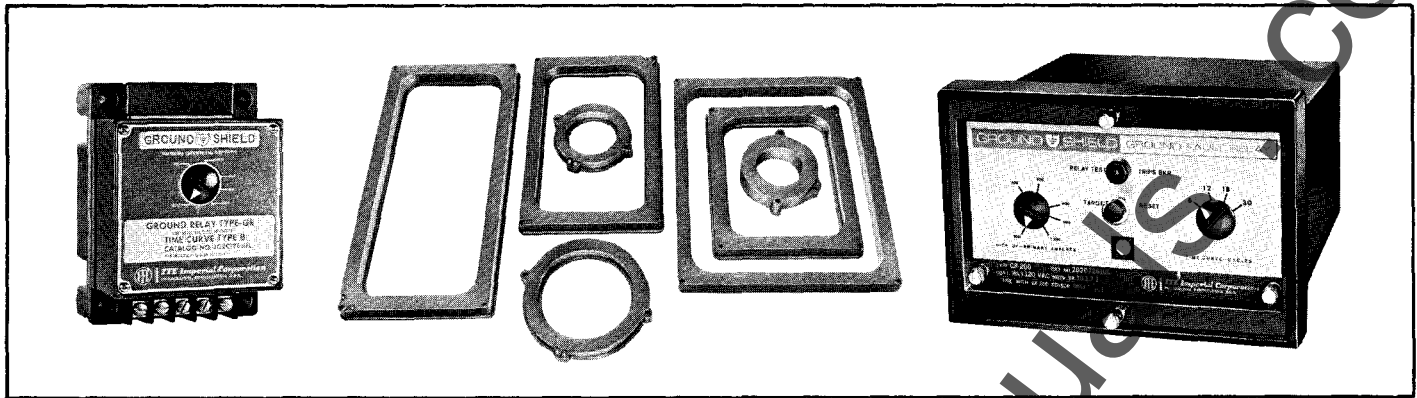


Common interrupting devices which can be used with ground-fault relays are power circuit breakers, low-voltage power circuit breakers, molded-case circuit breakers, service protectors, and certain load-break, switch-fuse combinations and contactors. First, care should be taken to insure that the switch interrupting rating is sufficient to handle ground faults of all magnitudes which would be cleared faster than the associated fuse maximum clearing curve. Secondly, it is necessary that the interrupter device be

equipped with a fast tripping mechanism with ability to interrupt the ground fault within several cycles from energization of trip coil. Circuit breaker and fuse combinations equipped with shunt-trip coils are well adapted to the GROUND-SHIELD Protective System.

NOTE: Interrupters shown are manufactured by I-T-E Imperial Corporation. However, GROUND-SHIELD can be used with any suitable interrupter, regardless of make.

DESCRIPTION OF GROUND-FAULT PROTECTIVE SYSTEMS



INTRODUCTION—THE I-T-E GROUND SHIELD

GROUND-SHIELD is the registered family trademark for a variety of solid-state relay systems designed to protect electrical distribution circuits and electrical loads from the damage caused by the inadvertent flow of ground-fault currents. Three (3) systems are offered: (1) **GR-5** and **GR-200**, (2) **GRM**—motor circuit applications, and (3) **GRD**—three-phase differential. See pages 24 and 25 for GRM and pages 26 and 27 for GRD.

APPLICATION

The GR-5 and GR-200 GROUND-SHIELD Systems offer fast, sensitive protection against ground-faults including destructive, low-magnitude, arcing ground-faults in solid and resistance grounded distribution systems. They consist of a special-design, core-balancing current transformer (sensor) and a low-burden, solid-state ground relay.

The ground sensors are available with small or large-window configurations designed to enclose all phase and neutral bus or cable conductors. These sensors will respond only to ground-fault currents. Balanced or unbalanced load currents, two-phase or three-phase short circuits not involving a ground return conductor, will have no effect on the sensor. Two (2) pickup ranges are available, one with 5 ampere minimum sensitivity, and one with 200 ampere minimum sensitivity. The 5A system (GR-5 relay) with 5-50A pickup adjustment is used for protection of individual loads such as motors and transformers. On high-resistance grounded systems the 5-50A relay is used for both circuit and load protection. The 200 ampere system (GR-200) relay with 200-1200A pickup adjustment is used for circuit protection.

The 5A system provides five time-current curves of definite time shape (Figure 1A). Four time-current curves are available for the 200A system and are shown in Figure 1B. All relay calibrations are in primary amperes. Tripping of the desired breaker (coordination) is obtained by applying relays with successively faster curves progressing from source to load circuits. Relays are available for surface mounting and semi-flush panel mounting.

Application of these GROUND-SHIELD Systems is simple and direct. One sensor and one relay are used with any type of circuit. The sensor is selected by physical size; the relay by sensitivity range and speed of operation. 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 application does not require special insulated enclosure construction or other similar complexities.

THEORY OF OPERATION

The sensor has a zero output under normal conditions since the vector summation of current flowing through all phases A, B, C and the neutral, N, is zero. $I_A + I_B + I_C + I_N = 0$. Therefore, there is no resultant current flow through the sensor. If a fault-to-ground occurs, the vector summation of $I_A + I_B + I_C + I_N$ is not equal to zero. The resultant current flow through the sensor window is the ground-fault current, I_G . The sensor now has an output $I_G/N = I_s$, where N is the sensor turns ratio and I_s is the secondary current output.

This sensor output is applied to the relay. At a predetermined primary ampere pickup setting, which is field adjustable, the relay will operate to signal the circuit protective device to interrupt the circuit. The relay is designed to operate on 120V a-c, 48V d-c or 125V d-c control power (32V d-c and 250V d-c are special).

ARCING FAULTS UNDER 200 AMPERES

Since the energy released in an arcing fault is the product of the arc current times the arc voltage, arcing faults under 200A magnitude are a minimal problem (except in load windings). If the arc voltage is large, (longer arc length) then the arc is unstable at 200A and will be self-extinguishing. If the arc length is small or the arc develops across an insulation path, then the arc voltage is small. This combined with a low arc current produces a minimal rate of arc damage. Therefore, the long-time element alone on a 50-100A branch breaker will prevent extensive damage.

Only for the condition where the fault occurs in a load winding, such as a motor or transformer is there a possibility of sustained

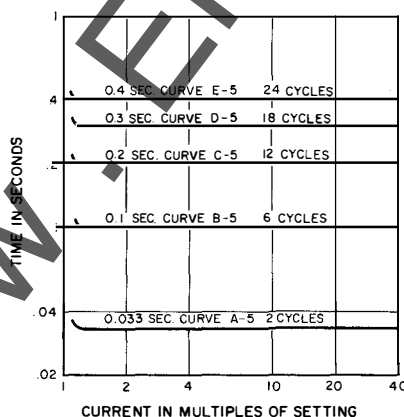


FIGURE 1A

GR-5 Relay

GR-200 Relay

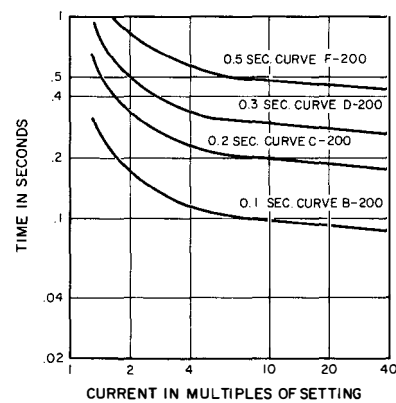


FIGURE 1B

low-current ground faults. This can cause magnetic iron burning which can entail expensive or time consuming repairs. In these individual load applications involving large or important motors and transformers, ground-fault relays with pickup settings of 5A and a time delay of less than 0.1 second is recommended.

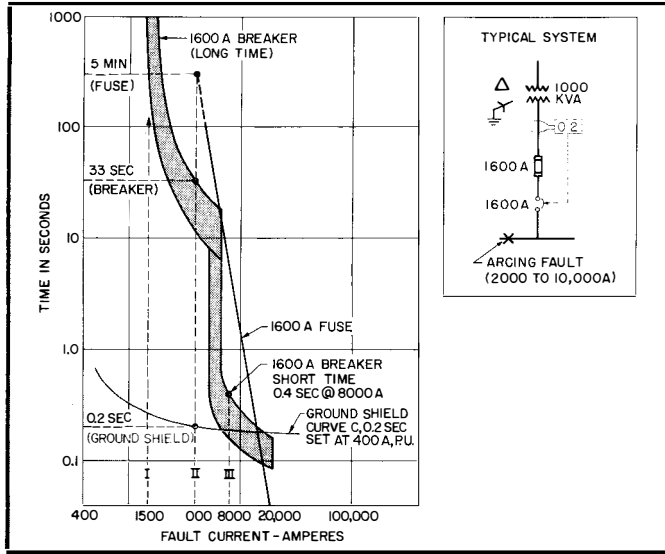


FIGURE 2

BASIC NEED FOR GROUND-SHIELD

The basic need for ground-fault protection in low-voltage systems is illustrated in Figure 2. Shown is a 1000kVA service transformer with a 1600 ampere main breaker (with typical long-time and short-time characteristics) and fuse. A 1500A ground-fault (Point I) on the 480Y/277 grounded neutral system would not be detected by this breaker. A 4000A ground-fault (Point II) could persist for about 33 seconds even if the minimum long-time band were used. An 8,000 ampere ground fault (Point III) would be cleared within about .2 to .4 seconds by the short-time device, assuming it is present, otherwise, between 8 to 20 seconds would elapse before the fault is cleared. For the assumed 8,000A fault, even though the current values are the calculated result using all source, circuit and arc impedances, the actual RMS circuit values passing through the circuit breaker can be considerably lower. This is because of the spasmodic nature of the fault caused by (1) arc elongating blow-out effects, (2) physical flexing of cables and some bus structures due to mechanical stresses, (3) self-clearing attempts and arc re-ignition, and (4) shifting of the arc terminals from point to point on the grounded enclosure (as well as on the faulted conductors for non-insulated construction). All of these effects tend to reduce the RMS value of fault currents. Figure 2 also illustrates that a ground-fault which would normally produce 8,000A under stabilized conditions and which results in an effective

value of only 4000A (Point II) would have a maximum clearing time of 33 seconds instead of the normally expected maximum of .4 seconds. Other fault interrupting devices such as fuses (Note from Figure 2 that a 1600A fuse takes 5 minutes to clear a 4000A fault) which have far slower operating times at low fault currents, have even a greater need for supplementary ground-fault protection. Most of these devices have time-current characteristics which delay tripping for about 100 seconds for fault currents 200% to 300% of normal continuous current rating.

Note the interrupting time for a curve C, GR-200 relay would be about .2 seconds on a 4000 ampere ground-fault and less than .4 seconds on a 1500 ampere ground-fault.

SETTINGS

Ground-Fault Protection On Mains Only

An example of this approach is shown by Figure 3. Here we have a 3000A main with long-time and short-time trips, a 1200A feeder with long-time and instantaneous trips, and a molded case breaker in a branch circuit with thermal and instantaneous trips. The ground protection on the main will coordinate with both instantaneous trips if given about 0.2 seconds time delay with a relatively flat characteristic.

The problem arises where do we set the minimum ground pickup? For full coordination with all feeders, the setting would have to be above 6000A (above the instantaneous setting of the largest feeder) obviously, this is too high. For excellent protection against ground-faults, the pickup setting should be about 200A. This, however, produces loss of coordination for ground-faults at "A" between 200A and 1000A magnitude and loss of coordination for faults at "B" between 200A and 6000A magnitude. Thus, while the 200A setting on one main will provide excellent arcing fault protection, we can expect the main breaker to trip for certain feeder faults where heretofore we were accustomed to having these handled by the feeder or branch breakers. In short, we have lost a rather substantial degree of coordination. In some applications this loss of coordination can be tolerated.

Under the circumstances, the best setting is approximately a 1200A pickup. Here we have protection against the most severe arcing faults and we have only lost coordination on faults between 1200A and 6000A. The above scheme is fairly common, but is still clearly a compromise which should be noted.

Ground-Fault Protection On Mains And Feeders

An example of this approach is shown by Figure 4. Here, we have included ground protection on the 3000A main and also on all feeders above roughly 400 to 800A. This application shows a 200A minimum pickup with a time delay of 0.1 second on each feeder in addition to a 400A minimum pickup and a 0.3 second time delay on the main.

In this example, the main breaker is fully coordinated with each feeder breaker. Also both main and feeders have sufficiently low settings to provide excellent arcing fault protection. There is some loss of coordination between the feeder and branch devices but this is felt to be acceptable in most applications.

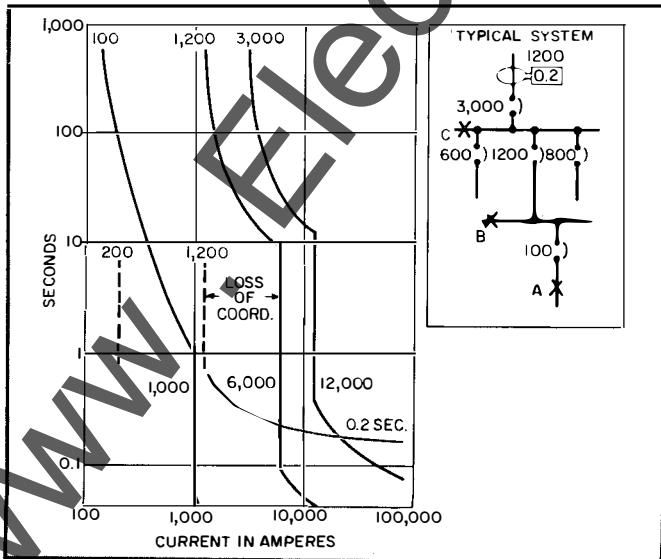


FIGURE 3

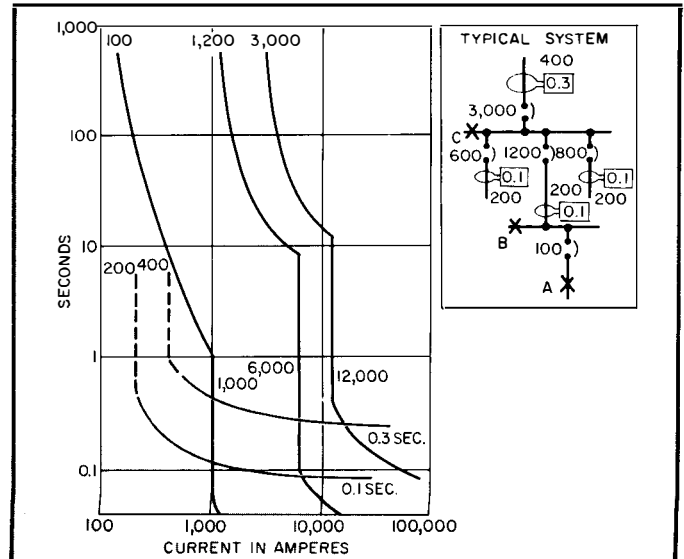


FIGURE 4

RATINGS & CHARACTERISTICS

TYPE GR-5 RELAY

SURFACE AND SEMI-FLUSH (Drawout) CASE, INDIVIDUAL LOADS AND HIGH RESISTANCE CIRCUITS

- PROTECTION** —For individual motors, transformers, etc. Also for load and circuit protection in high resistance grounded circuits.
- SENSITIVITY** —Adjustable from 5-50 amperes ($\pm 10\%$ or 1 ampere).
- SPEED OF OPERATION** —2, 6, 12, 18 or 24 cycle; adjustable on semi-flush model.
- OUTPUT RATING** —30 Amperes rms for 2 cycles.
7.5 Amperes rms for 1 second.
1 Ampere continuous (DC models only).
- TARGET INDICATOR** —Standard on semi-flush model. Prominent, shock-proof, retains memory with loss of control power.
- PUSH-TO-TEST BUTTON** —Standard on semi-flush model.
- MOMENTARY WITHSTAND** —80,000 Amperes rms, ground-fault current.
- SENSOR SIZES** —2", 3", 5" and 8" toroidal. (For rectangular and split-toroidal sensors, consult your nearest Sales Office.)

TYPE GR-200 RELAY

SURFACE AND SEMI-FLUSH (Drawout) CASE FOR MAIN, FEEDER AND BRANCH CIRCUITS

- PROTECTION** —For circuit protection: Main, Feeders and Branches.
- SENSITIVITY** —Adjustable from 200 to 2000 amperes ($\pm 10\%$).
- SPEED OF OPERATION** —6, 12, 18 or 30 cycle; adjustable on semi-flush model.
- OUTPUT RATING** —30 Amperes rms for 2 cycles.
7.5 Amperes rms for 1 second.
1 Ampere continuous (DC models only).
- TARGET INDICATOR** —Standard on semi-flush model.
- PUSH-TO-TEST BUTTON** —Standard on semi-flush model.
- MOMENTARY WITHSTAND** —80,000 Amperes rms, ground-fault current.
- SENSOR SIZES** —2", 3", 5" and 8" toroidal. 10" x 13", 10" x 17", 10" x 24" and 16" x 20" rectangular. For split sensors, consult your nearest Sales Office.

PHYSICAL CHARACTERISTICS

The ground relay is furnished in two different physical designs. (1) A surface-mounting type with front wiring connections. Typically, this type case could be mounted inside a switchgear instrument compartment. (2) A semi-flush design for panel mounting, arranged for wiring connections to rear studs. This case is provided with drawout facilities, target indicator, push-to-test button and adjustable operating curves.

The ground sensor consists of a wound core of small cross section with a uniformly distributed secondary winding. The entire assembly is cast in epoxy. The window openings are sized to facilitate installation over flared bus duct terminals, odd bus configurations, and large size or multiple cables as well as for flexibility in mounting. Cable spacers are provided for some round sensors for ease of installation.

TIME-COORDINATED SCHEME

SELECTION TABLE

MAIN
Select PICKUP 100A higher than highest feeder PICKUP (1200A maximum).
Select TIME to between 0.3 sec. and 0.5 sec.

FEEDERS
Select PICKUP from table below.
Select TIME to between 0.1 sec. and 0.3 sec.

BRANCHES
Select branch PICKUP and TIME at lowest values.

ONE LINE DIAGRAM

Largest Branch Fuse Size	Highest Branch Inst. Setting	Feeder Pickup
25	200	200
50	400	400
75	600	600
100	800	800
150 up	1100 up	1100

TYPICAL SYSTEM

The 1971 National Electrical Code **requires** ground-fault protection for service (main) disconnecting means rated **1000 amperes or more** (480V grounded wye). It also recognizes that ground-fault protection is **desirable** for services rated **less than 1000 amperes** and points to the need for additional protection on **"feeders and branch circuits** where maximum continuity of electrical service is necessary."

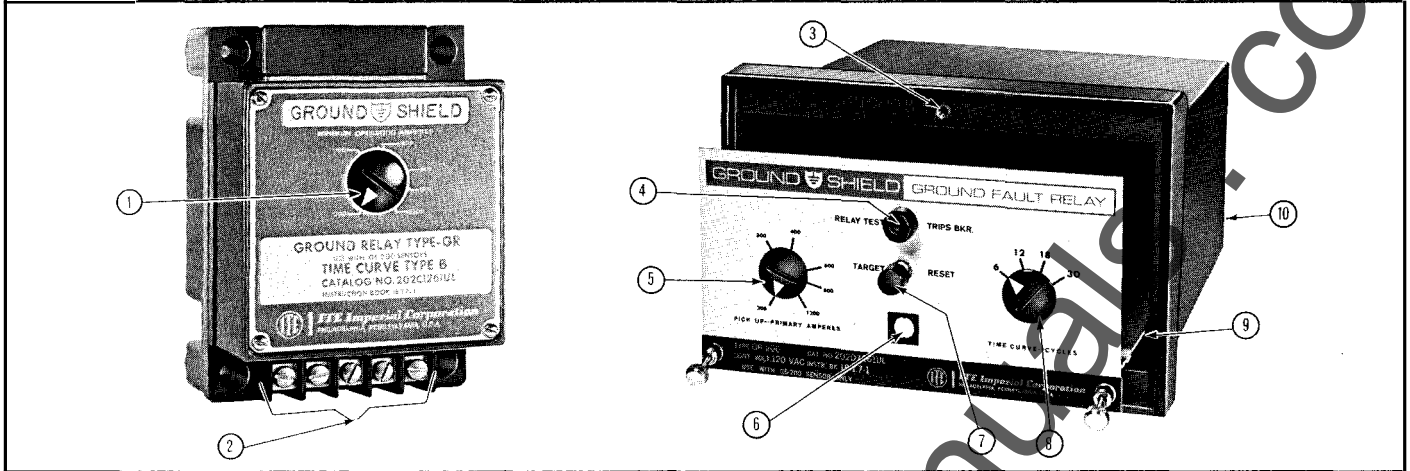
It must be understood that Ground Protection on "mains only" involves a compromise in regard to selective coordination.

Typical application data is presented here to assist in the selection of proper relay settings.

GROUND-SHIELD RELAYS		
TYPE	PICKUP RANGE	TIME RANGE
GR-200	200-1200A	.1 - .5 Sec.
GR-5	5-50A	Inst. - .4 Sec.
GRM	10A	Inst.
GRD (3#)	2A	Inst.

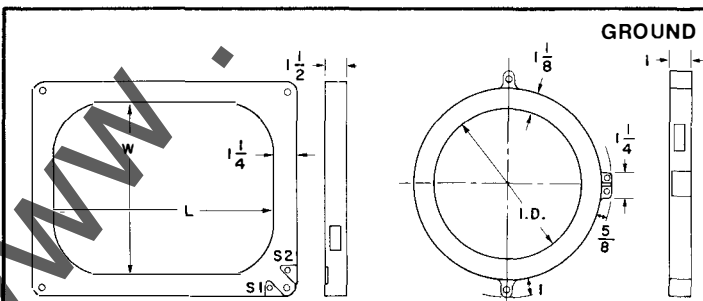
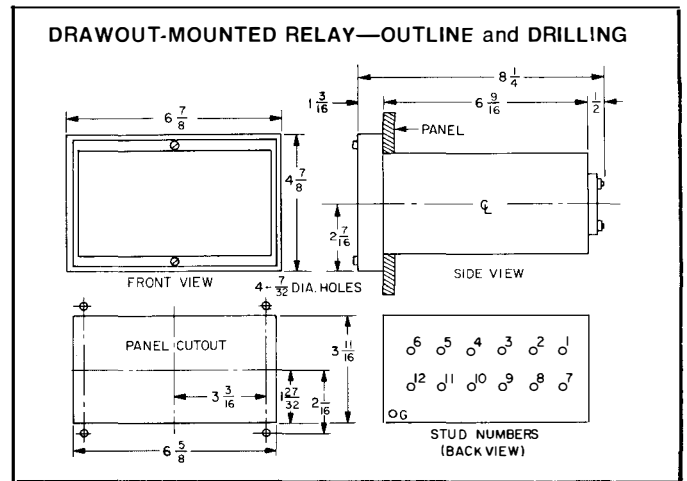
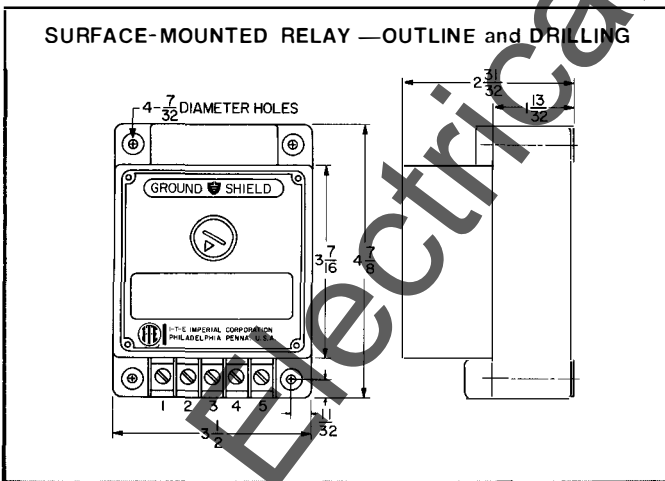
- ① GRD differential protection is recommended for motors larger than 150 HP.
- ② Ground relays may be required for larger branch circuits if feeder-branch coordination is essential, such as in hospital power systems. (See page 21).
- ③ GR-5 or GRM protection is recommended for single motor circuits larger than 25 HP, or single transformer circuits larger than 20kVA.

CONSTRUCTION FEATURES



- ① **Dial-Selected Primary Amperes**
Type GR200 relay: 200-1200 ampere range
Type GR5 relay: 5-50 ampere range
One operating time curve per relay.
- ② **Front-Wired Terminal Board**
Standard relay has 5 terminals: 1, 2, 3, 4, 5
Charge-control relay connections: 6, 10
- ③ **Plexiglass Cover Retainers**
Two retainers attach cover to relay case.
- ④ **Built-In Test Button**
Checks relay operation by fault simulation. Sits behind plexiglass cover to prevent accidental operation.
- ⑤ **Dial-Selected Primary Amperes**
Type GR200 relay: 200-1200 ampere range
Type GR5 relay: 5-50 ampere range
- ⑥ **Positive Target Indicator**
Shock-proof, no power drain. Retains correct status. Memory, independent of control power.
- ⑦ **Target Reset**
Target indicator is electrically reset by depressing pushbutton.
- ⑧ **Dial-Selected Operating Times**
Type GR200 relay: 0.1 - 0.5 second range
Type GR5 relay: .033 - 0.4 second range
- ⑨ **Drawout Circuit Board**
100% drawout board is withdrawn using two pull-knobs.
- ⑩ **Rear-Wiring Stud Connections**
Standard relay has 5 terminals: 3, 4, 7, 8, 12
Charge-control relay connections: 1, 2
Alarm contacts connections: 9, 10, 11

DIMENSIONS



Note: All dimensions in inches. Other sensor sizes will be made available as applications arise.

- ① Rectangular Sensors are non-standard with 5-50A system.
- ② Rectangular Sensors should be applied with 1 1/2" or more clearance from the sensor to the nearest current carrying bus.

RECTANGULAR ①

W	L	Minimum Recommended Clearance ②
10	13	1 1/2
10	17	1 1/2
10	24	2
16	20	2

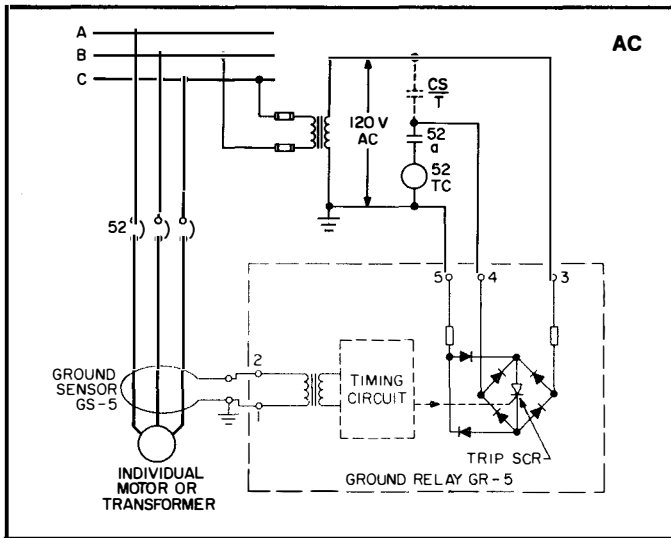
TOROIDAL

I.D.	Minimum Recommended Clearance ③
2	0
3	0
5	1/2
8	1

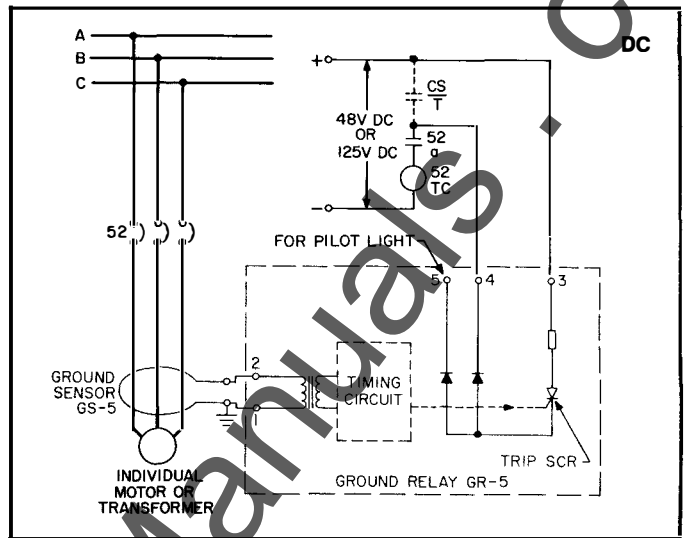
- ③ Cable spacers are provided with Toroidal Sensors to maintain recommended cable clearance from sensor. Cable spacers are provided with 5" and 8" Toroidal Sensors to maintain recommended cable clearance from sensor.
- ④ Split sensors are available. Inquire for dimensions.



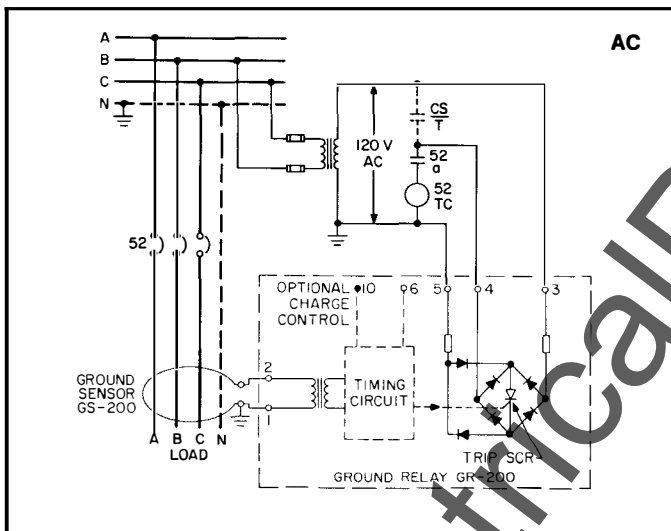
WIRING-SURFACE CASE



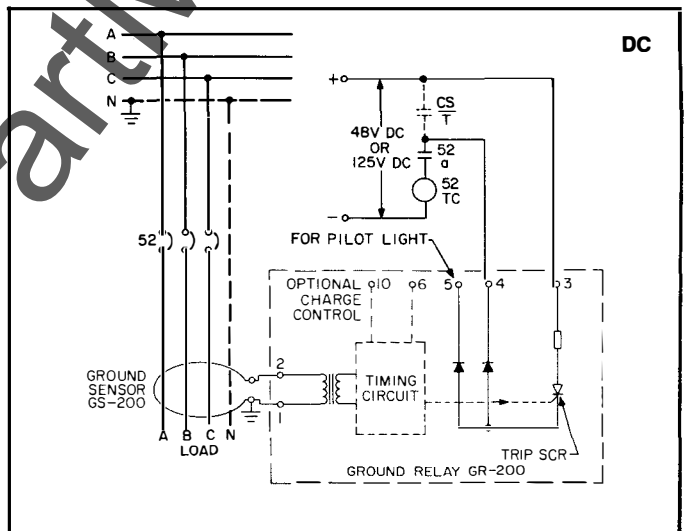
5-50A AC Individual Loads



5-50A DC Individual Loads



200A-1200A AC Circuit Protection



200A-1200A DC Circuit Protection

System neutral must NOT be grounded on the load side of the ground sensor, i.e. at downstream panelboards.

TESTING

OPERATIONAL TESTS

It is not necessary to schedule periodic maintenance and testing of this ground-protection system. However, if tests are desired to confirm the proper functioning of the ground system, one of the following procedures can be used. NOTE: With drawout relays, above tests can be substituted by a simple push-to-test button operation.

MOUNTED IN SWITCHGEAR

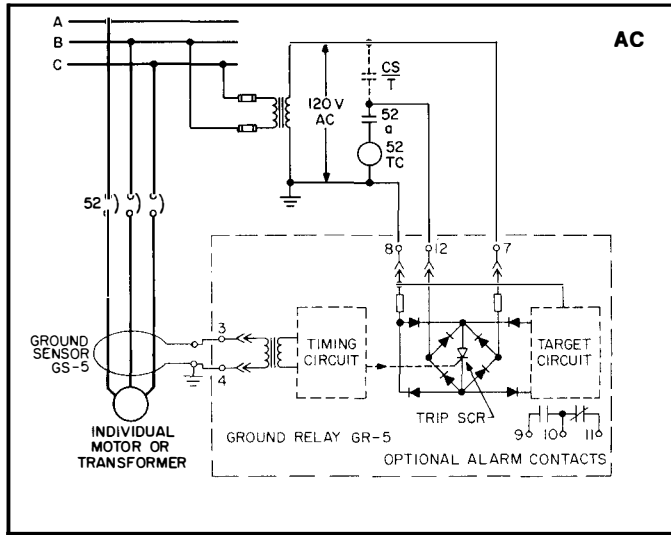
- 1) After de-energizing main, set GR relay to minimum amperes.
- 2) Loop a test coil of approximately #14 wire through the sensor window. Special multiturn test cables are available.
- 3) Apply enough test amperes so that the ampere turns exceed the relay ampere setting. The relay will trip the breaker. Immediately return test current to zero.

PRECAUTION: Relay output circuit will be damaged unless a "normally open" auxiliary switch opens trip circuit after trip operation.

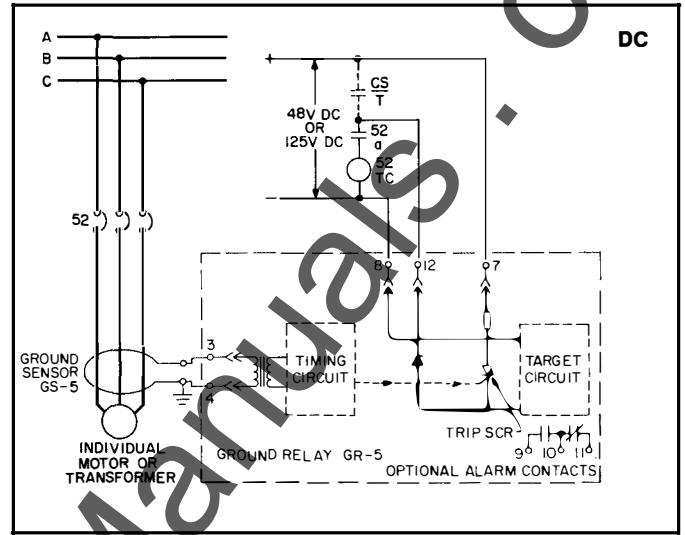
BENCH TESTS (Without Circuit Breaker)

- 1) Set GR relay to minimum amperes.
- 2) Connect relay and sensor as shown in Figure 1 (typical).
- 3) Apply enough test amperes so that the ampere turns exceed the relay ampere setting. Auxiliary relay will pick up when GR relay operates. Immediately return test current to zero.

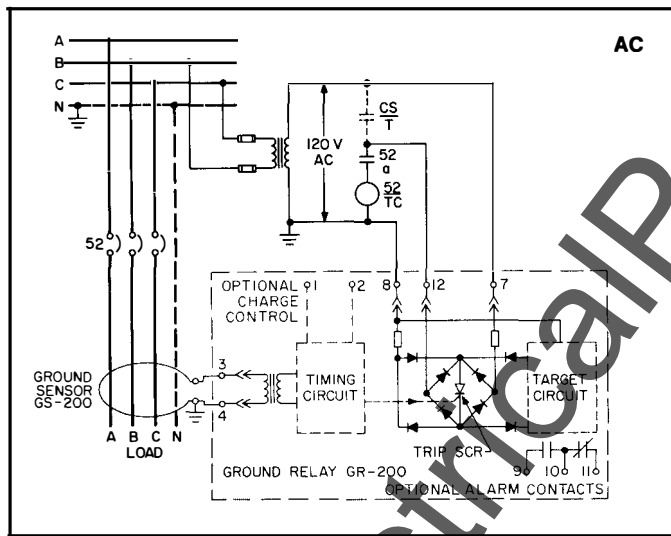
WIRING-DRAWOUT CASE



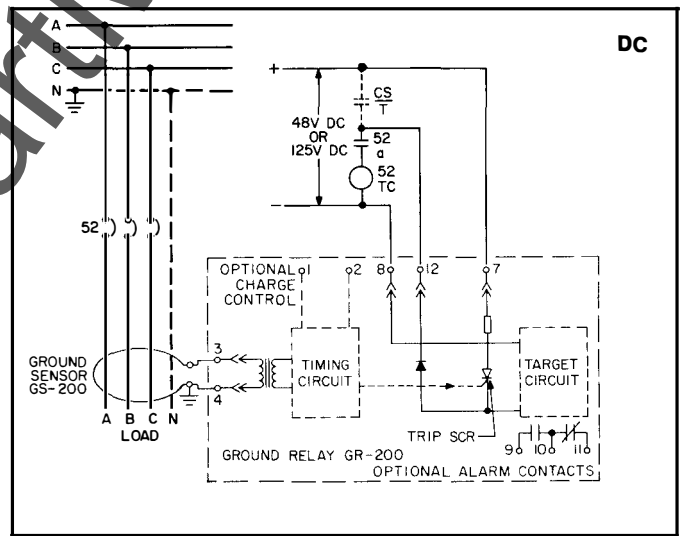
5-50A AC Individual Loads



5-50A DC Individual Loads



200A-1200A AC Circuit Protection

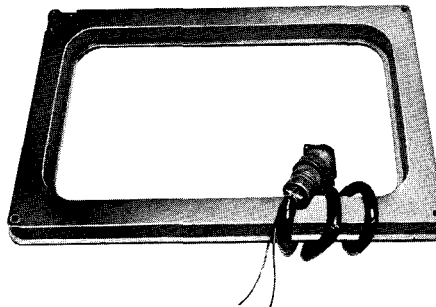


200A-1200A DC Circuit Protection

System neutral must NOT be grounded on the load side of the ground sensor, i.e. at downstream panelboards.



Push-to-Test



Multiturn test cable

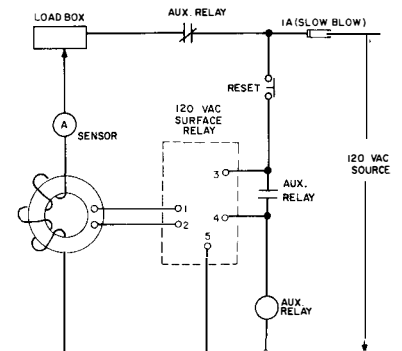
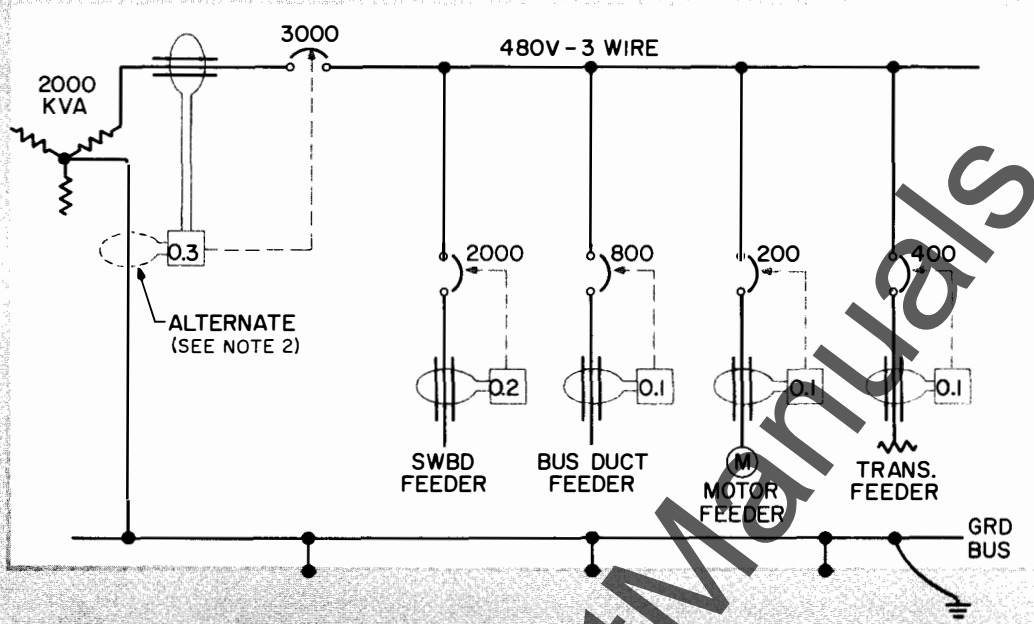
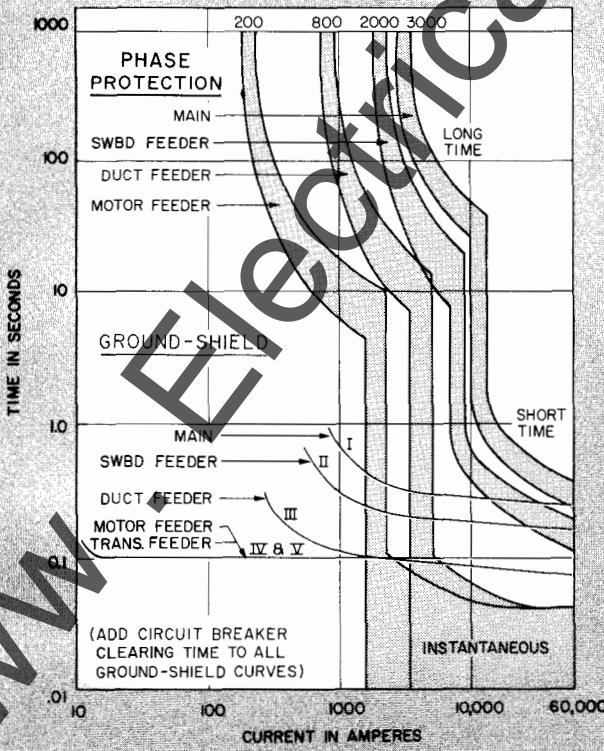


Figure 1—Bench Test

3-WIRE SINGLE PHASE WITHOUT THE NEUTRAL



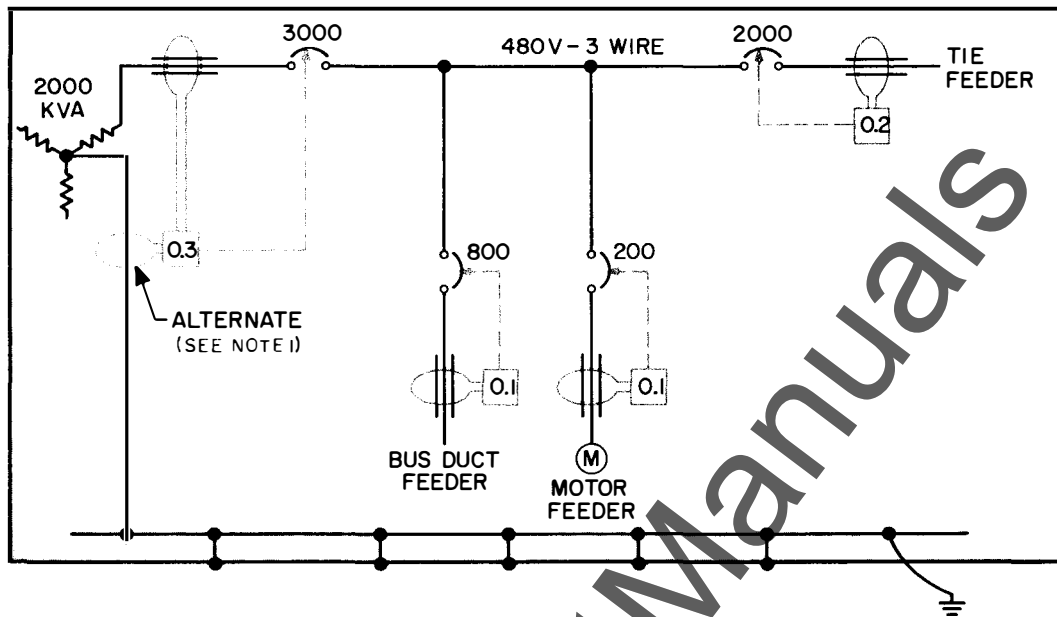
CIRCUIT	PICK-UP RANGE	TYPICAL SETTING	TIME CURVE	SENSOR SIZE	CONNECTION DIAGRAM	
					SURFACE	DRAWOUT
I Main	200-1200	600A	0.3 sec (D)	Select from Page 9	Page 10	Page 11
II Swb'd. Fdr.	200-1200	400A	0.2 sec (C)			
III Duct Feeder	200-1200	200A	0.1 sec (B)			
IV Motor Feeder	5-50	5-10A	0.1 sec (B)			
V Transformer Fdr.	5-50	5-10A	0.1 sec (B)			



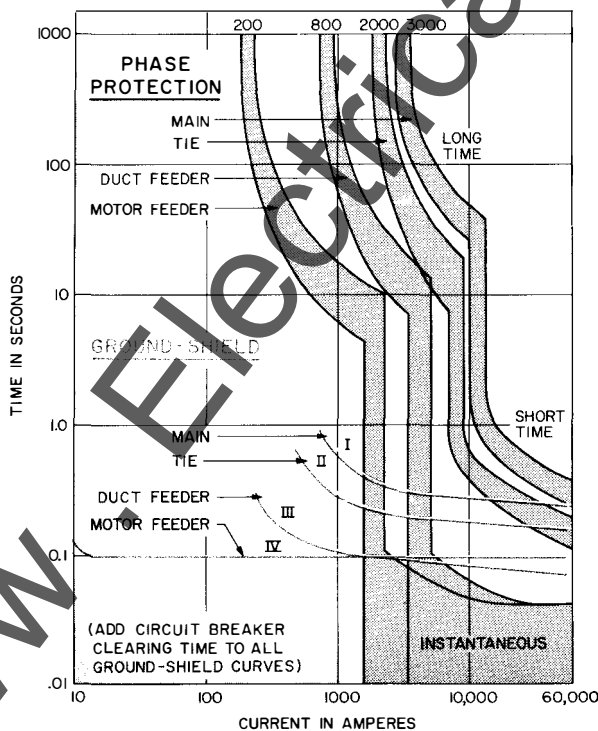
NOTES

1. Any ground protection included in remote feeder switchboards should use a 0.1 sec. time curve.
2. Alternate location of sensor on main breakers is more economical and may be used if no other neutral ground connection exists.
3. Individual load circuits can be .033 sec. instead of 0.1 sec. if faster tripping is desired.
4. The data on this page also applies to solidly-grounded delta systems.

3-WIRE SINGLE SERVICE WITH TIE FEEDER



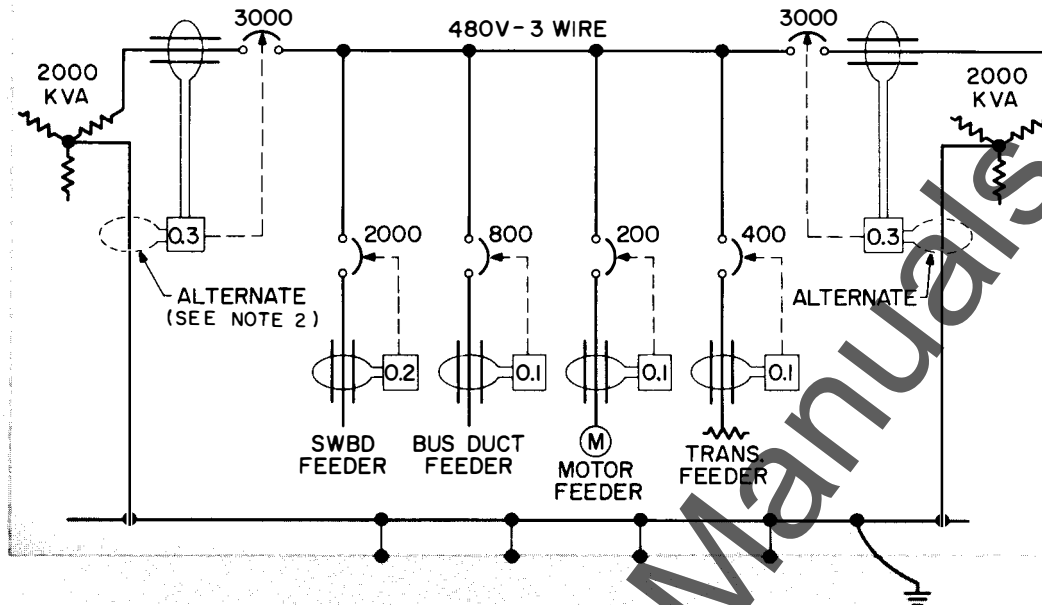
CIRCUIT	PICK-UP RANGE	TYPICAL SETTING	TIME CURVE	SENSOR SIZE	CONNECTION DIAGRAM	
					SURFACE	DRAWOUT
I Main	200-1200	600A	0.3 sec (D)	Select from Page 9	Page 10	Page 11
II Tie	200-1200	400A	0.2 sec (C)			
III Duct Feeder	200-1200	200A	0.1 sec (B)			
IV Motor Feeder	5-50	5-10A	0.1 sec (B)			



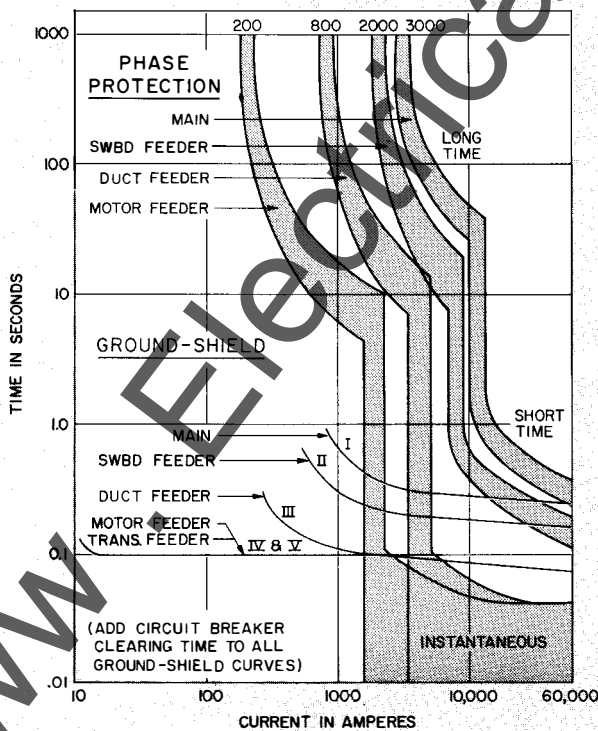
NOTES

1. Alternate location of sensor on main breaker is more economical and may be used if no other neutral ground connection exists.
2. For non-relayed tie feeder omit Ground-Shield from tie.
3. Individual load circuits can be .033 sec. instead of 0.1 sec. if faster tripping is desired.
4. The data on this page also applies to solidly-grounded delta systems.

3-WIRE DUAL SERVICE WITHOUT TIE BREAKER



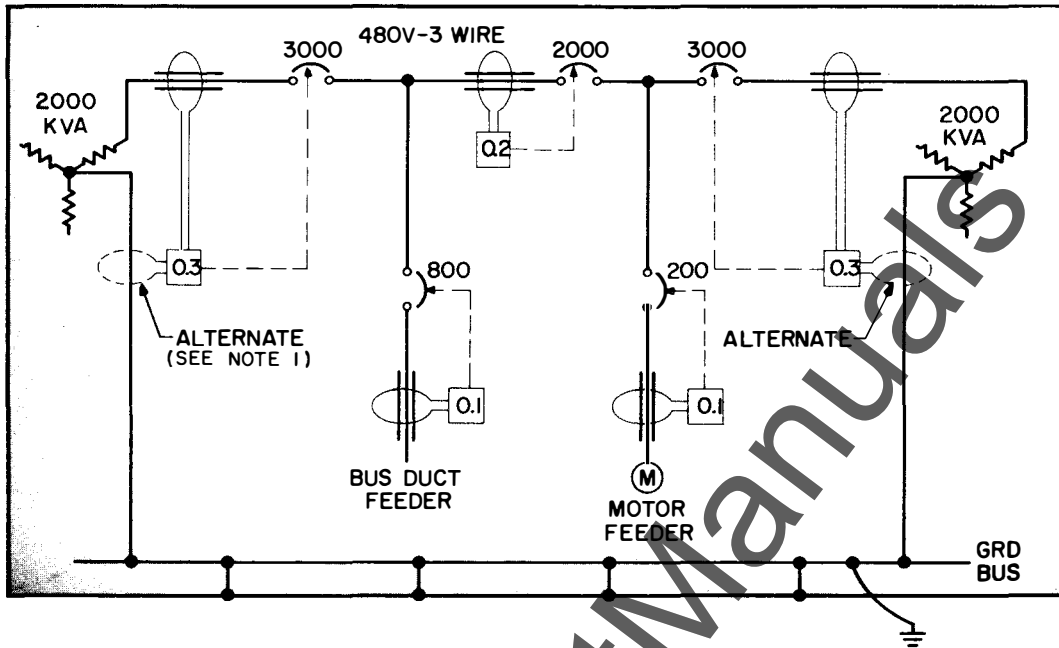
CIRCUIT	PICK-UP RANGE	TYPICAL SETTING	TIME CURVE	SENSOR SIZE	CONNECTION DIAGRAM	
					SURFACE	DRAWOUT
I Main	200-1200	600A	0.3 sec (D)	Select from Page 9	Page 10	Page 11
II Swb'd. Fdr.	200-1200	400A	0.2 sec (C)			
III Duct Feeder	200-1200	200A	0.1 sec (B)			
IV Motor Feeder	5-50	5-10A	0.1 sec (B)			
V Transformer Fdr.	5-50	5-10A	0.1 sec (B)			



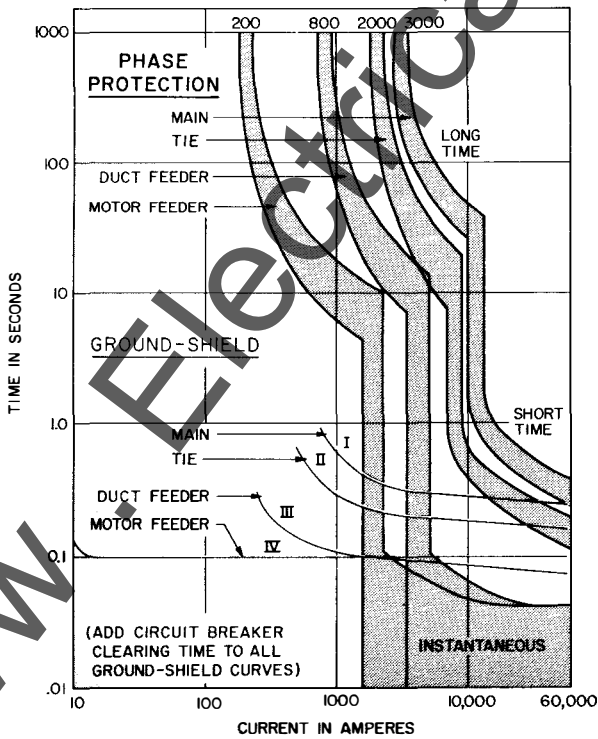
NOTES

1. Any ground protection included in remote feeder switchboards should use a 0.1 sec. time curve.
2. Alternate location of sensor on main breaker is more economical and may be used if no other neutral ground connection exists.
3. Individual load circuits can be .033 sec. instead of 0.1 sec. if faster tripping is desired.
4. The data on this page also applies to solidly-grounded delta systems.

3-WIRE DUAL SERVICE WITH TIE BREAKER



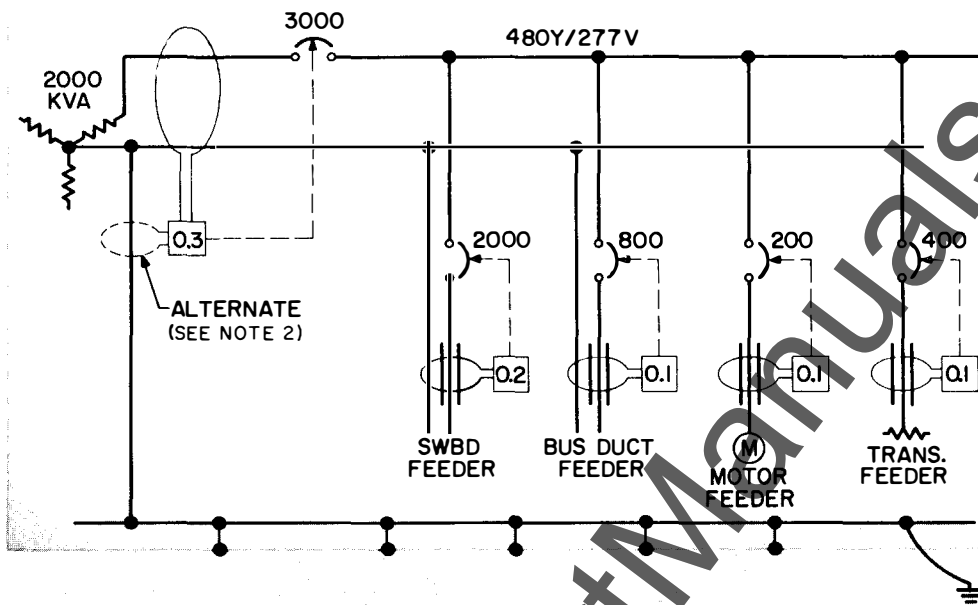
CIRCUIT	PICK-UP RANGE	TYPICAL SETTING	TIME CURVE	SENSOR SIZE	CONNECTION DIAGRAM	
					SURFACE	DRAWOUT
I Main	200-1200	600A	0.8 sec (D)	Select from Page 9	Page 10	Page 11
II Tie	200-1200	400A	0.2 sec (C)			
III Duct Feeder	200-1200	200A	0.1 sec (B)			
IV Motor Feeder	5-50	5-10A	0.1 sec (B)			



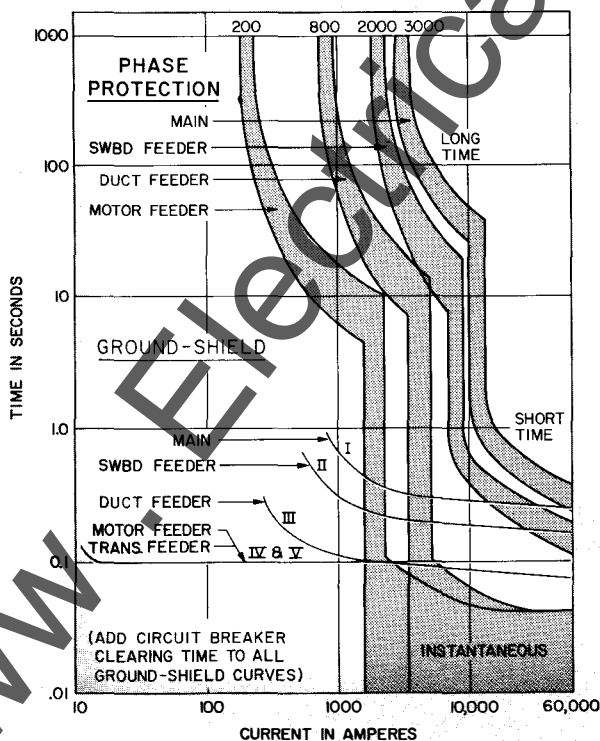
NOTES

1. Alternate location of sensor on main breaker is more economical and may be used if no other neutral ground connection exists.
2. For non-relayed tie breaker omit Ground-Shield from tie.
3. Individual load circuits can be .033 sec. instead of 0.1 sec. if faster tripping is desired.
4. The data on this page also applies to solidly-grounded delta systems.

4-WIRE SINGLE SERVICE WITHOUT TIE FEEDER



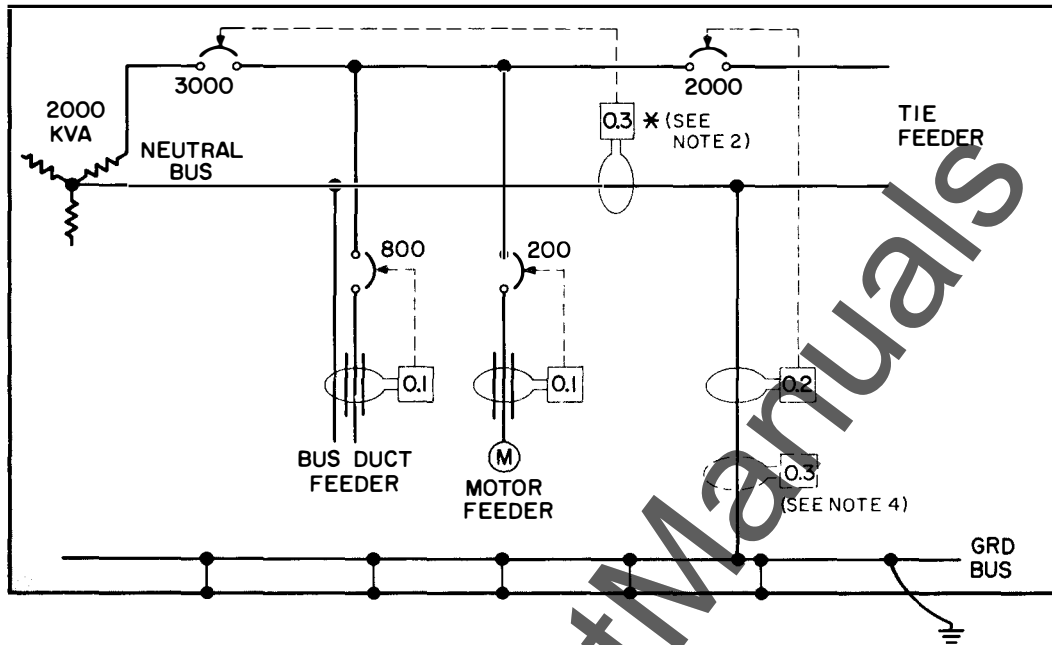
CIRCUIT	PICK-UP RANGE	TYPICAL SETTING	TIME CURVE	SENSOR SIZE	CONNECTION DIAGRAM	
					SURFACE	DRAWOUT
I Main	200-1200	600A	0.3 sec (D)	Select from Page 9	Page 10	Page 11
II Swb'd. Fdr.	200-1200	400A	0.2 sec (C)			
III Duct Feeder	200-1200	200A	0.1 sec (B)			
IV Motor Feeder	5-50	5-10A	0.1 sec (B)			
V Transformer Fdr.	5-50	5-10A	0.1 sec (B)			



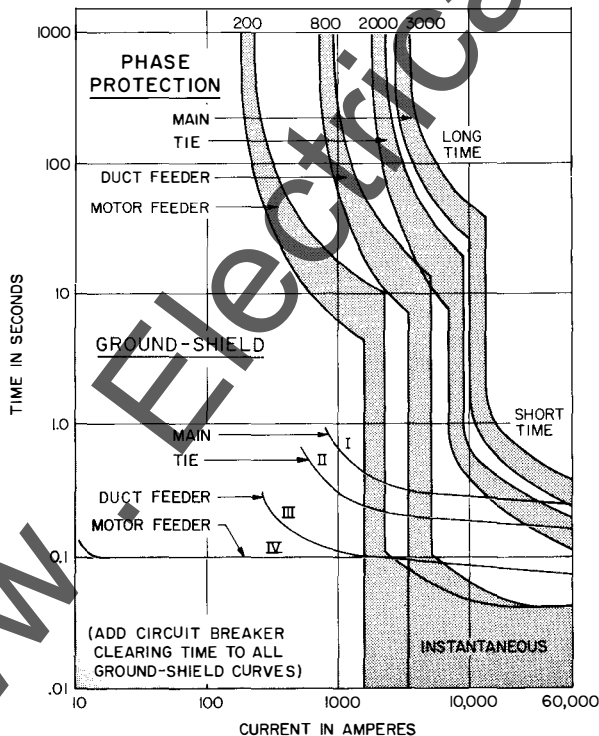
NOTES

1. Any ground protection included in remote feeder switchboards should use a 0.1 sec. time curve.
2. Alternate location of sensor on main breaker is more economical and may be used if no other neutral ground connection exists.
3. Individual load circuits can be .033 sec. instead of 0.1 sec. if faster tripping is desired.
4. The data on this page also applies to solidly-grounded delta systems.

4-WIRE SINGLE SERVICE WITH RELAYED TIE FEEDER



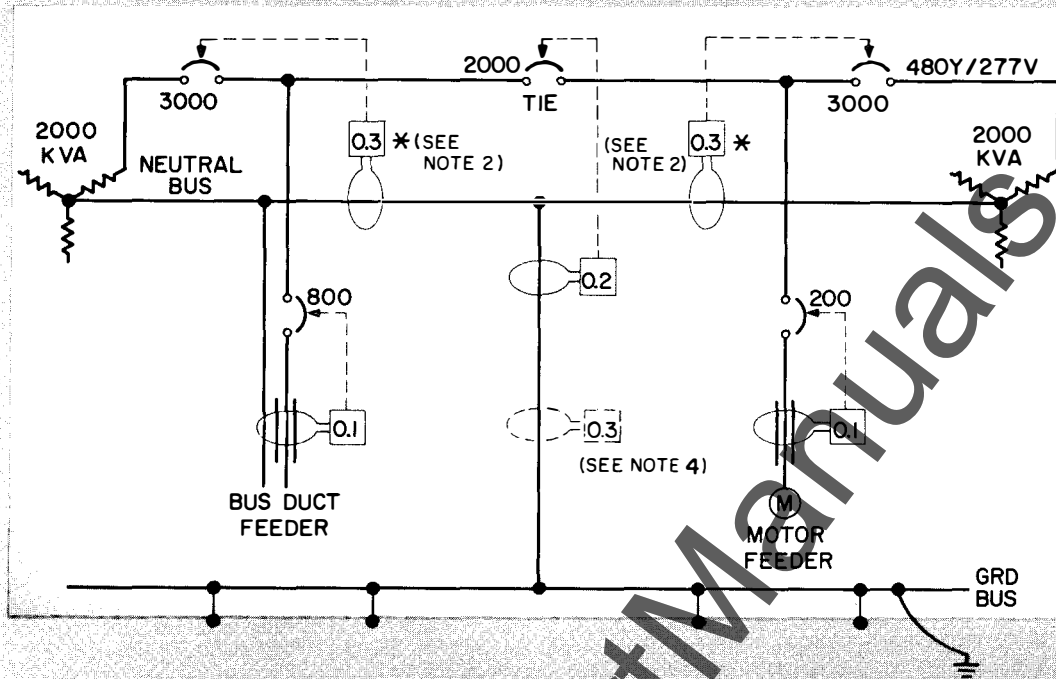
CIRCUIT	PICK-UP RANGE	TYPICAL SETTING	TIME CURVE	SENSOR SIZE	CONNECTION DIAGRAM	
					SURFACE	DRAWOUT
I Main (Note 2)	200-1200	600A	0.3 sec (D)	Select from Page 9	Page 10	Page 11
II Tie	200-1200	400A	0.2 sec (C)			
III Duct Feeder	200-1200	200A	0.1 sec (B)			
IV Motor Feeder	5-50	5-10A	0.1 sec (B)			



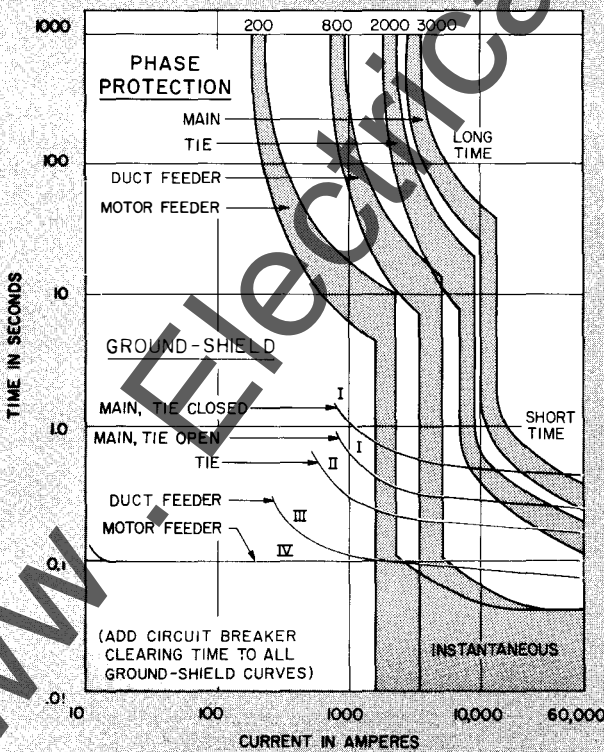
NOTES

- Specify shunt trip and one extra a-switch on tie circuit breaker.
- Ground-Shield relay has pickup restrained by tie breaker auxiliary switch. Specify charge-control shorting terminals on this relay. See schematic page 20.
- Neutral-to-ground connection must be made as shown. Tap each feeder neutral on proper side of this tee point.
- If back-up protection is desired under the closed-tie condition, specify an additional 0.3 sec. relay connected to trip the main breaker.
- Individual load circuits can be .033 sec. instead of 0.1 sec. if faster tripping is desired.
- The data on this page also applies to solidly-grounded delta systems.

4 WIRE DUAL SERVICE WITH RELAYED TIE BREAKER



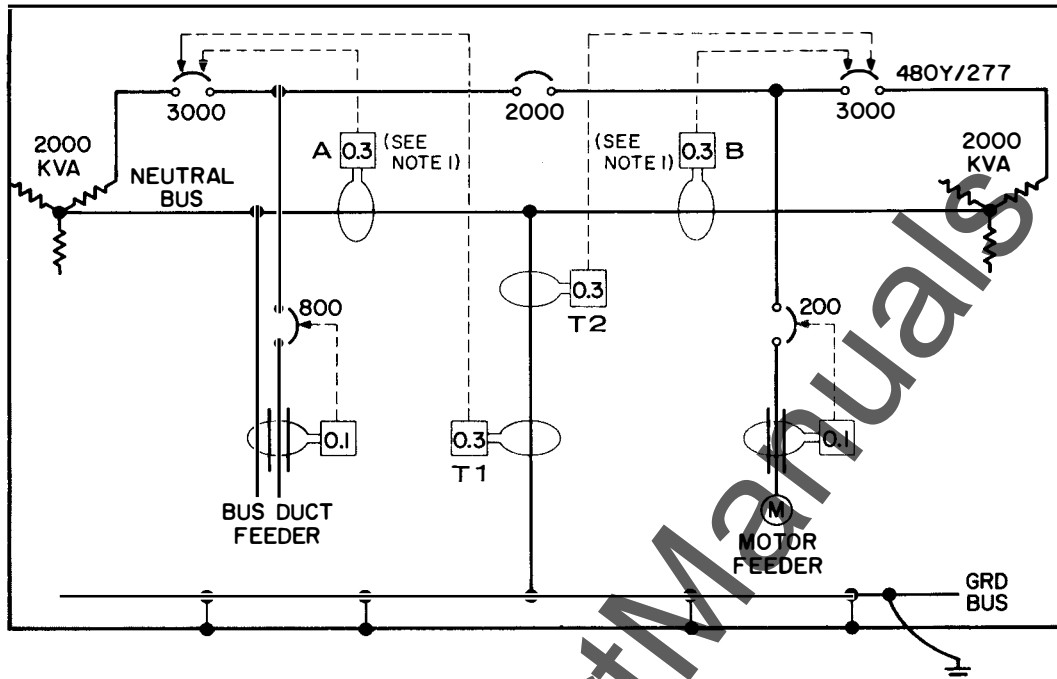
CIRCUIT	PICK-UP RANGE	TYPICAL SETTING	TIME CURVE	SENSOR SIZE	CONNECTION SURFACE	DIAGRAM DRAWOUT
I Main (Note 2)	200-1200	600A	0.3 sec (D)	Select from Page 9	Page 10	Page 11
II Tie	200-1200	400A	0.2 sec (C)			
III Duct Feeder	200-1200	200A	0.1 sec (B)			
IV Motor Feeder	5-50	5-10A	0.1 sec (B)			



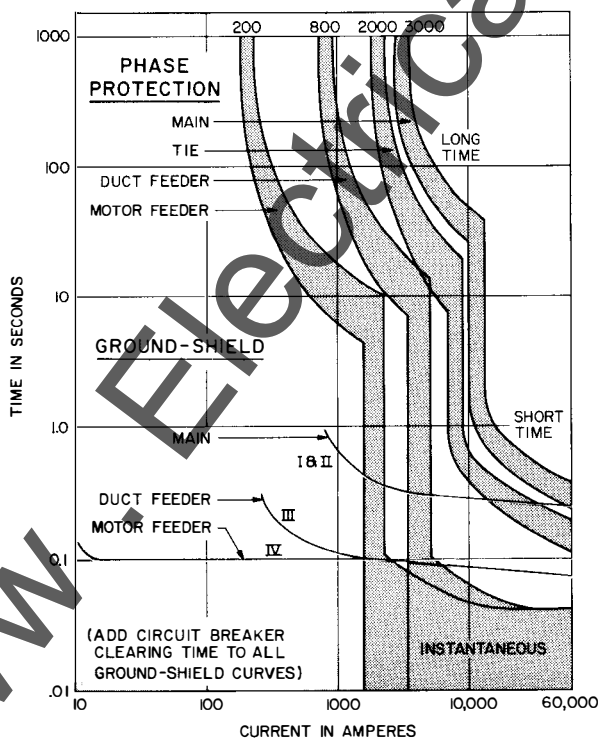
NOTES

1. Specify shunt trip and two a-switches on tie breaker.
2. Ground-Shield relay has pickup restrained by tie breaker auxiliary switches. Specify charge-control shorting terminals on these two relays. See schematic on page 20.
3. Neutral-to-ground connection must be made as shown. Tap each feeder neutral on proper side of this tee point.
4. If back-up protection is desired under the closed-tie condition, specify an additional 0.3 sec. relay connected to trip the main breakers.
5. Individual load circuits can be .033 sec. instead of 0.1 sec. if faster tripping is desired.
6. The data on this page also applies to solidly-grounded delta systems.

4-WIRE DUAL SERVICE WITH NON-RELAYED TIE BREAKER



CIRCUIT	PICK-UP RANGE	TYPICAL SETTING	TIME CURVE	SENSOR SIZE	CONNECTION DIAGRAM	
					SURFACE	DRAWOUT
I Main (Tie Open)	200-1200	600A	0.3 sec (D)	Select from Page 9	Page 10	Page 11
II Main (Tie Closed)	200-1200	600A	0.3 sec (D)			
III Duct Feeder	200-1200	200A	0.1 sec (B)			
IV Indv. Motor Feeder	5-50	5-10A	0.1 sec (B)			



NOTES

1. Specify two a-switches and two b-switches on tie breaker. See schematic on page 20. Alternate scheme may be used by employing charge-control relays as described on page 18.
2. This scheme is suitable for both normally closed tie and for key interlocked main and tie schemes.
3. For normally closed tie schemes the pickup settings of the relays connected to the sensors located around the neutral bus may have to be set higher (i.e. approximately 1200A). This will allow for normal neutral load unbalance.
4. Neutral-to-ground connection must be made as shown. Tap each feeder neutral on proper side of this tee point.
5. Individual load circuits can be .033 sec. instead of 0.1 sec. if faster tripping is desired.
6. The data on this page also applies to solidly-grounded delta systems.

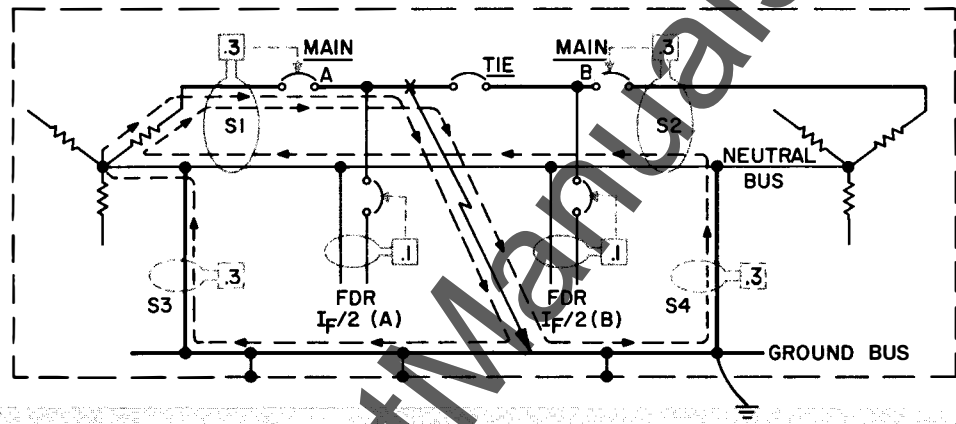
DUAL SERVICE

SPECIAL PRECAUTIONS—Must be taken when applying ground-fault relaying on 4-wire dual service or double-ended substations. This applies to main and tie breaker schemes as shown below and on pages 17, 18, and 19. The switchgear neutral bus should be connected to the switchgear ground bus at **ONE POINT ONLY** (Pages 17, 18, and 19 show the correct methods). The system diagram below illustrates an incorrect method using two points

of connection, and demonstrates that **BOTH** main breakers will trip for a fault on either bus. The relayed tie diagrams below show that special GR-200 charge controlled relays are utilized for the main breakers of the schemes on pages 17 and 18. Change-controlled relays are demobilized by auxiliary switches so that they operate only when tie breaker is open. The non-relayed tie diagrams cover the scheme shown on page 19.

EXAMPLE OF AN INCORRECT APPLICATION

FIG. 1—Two neutral bus-to-ground bus connections will cause both main breakers to trip for a fault in either bus. See page 12 for correct single point neutral bus-to-ground bus connection.



WIRING DIAGRAMS

FIGURE 2

4-wire dual service with relayed tie breaker D-C control

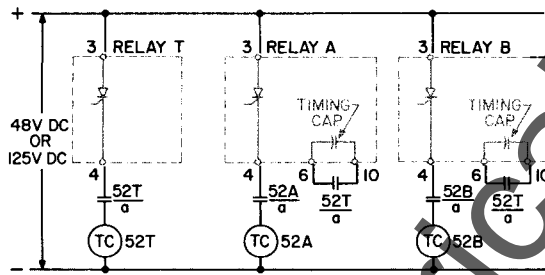


FIGURE 3

4-wire dual service with relayed tie breaker A-C control

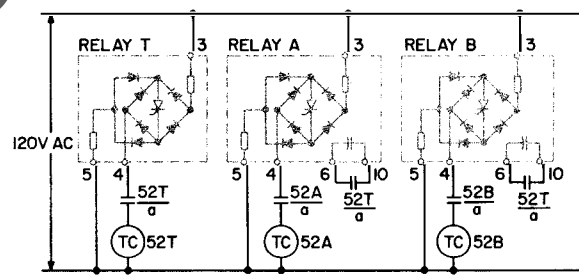


FIG. 2 and FIG. 3—Special charge-controlled Ground-Shield relays A & B are applied on main breakers A & B of 4-wire dual service circuit, page 18. These diagrams are for surface case. (For drawout case terminal numbers see page 11.)

FIGURE 4

4-wire dual service without relayed tie breaker D-C control

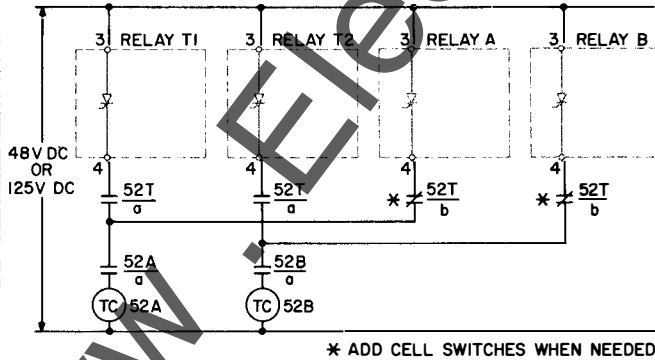


FIGURE 5

4-wire dual service without relayed tie breaker A-C control

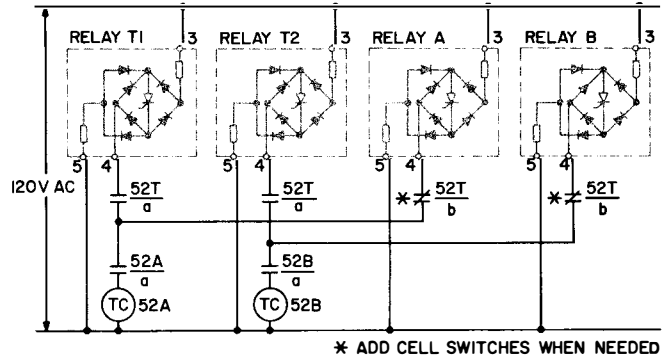
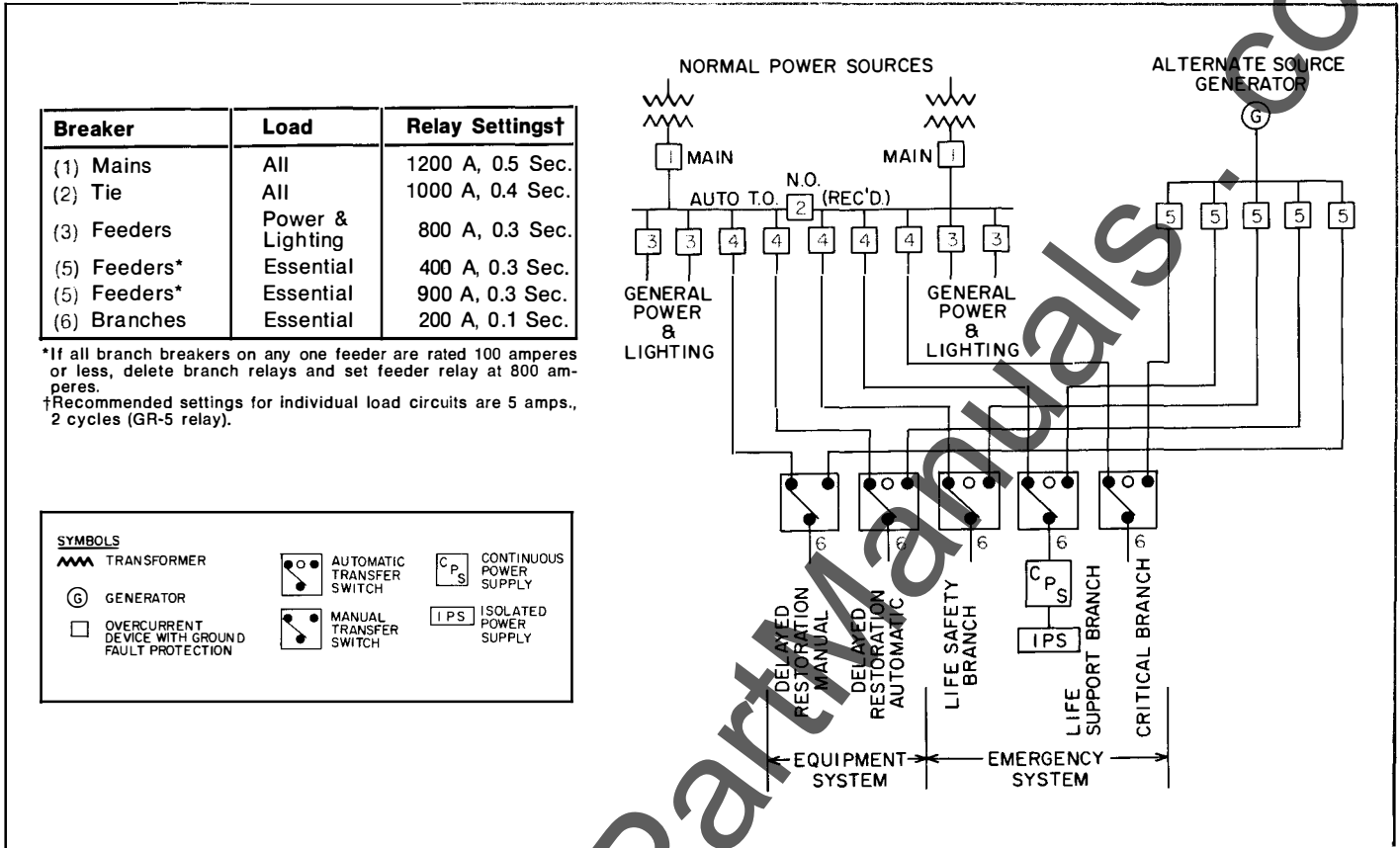
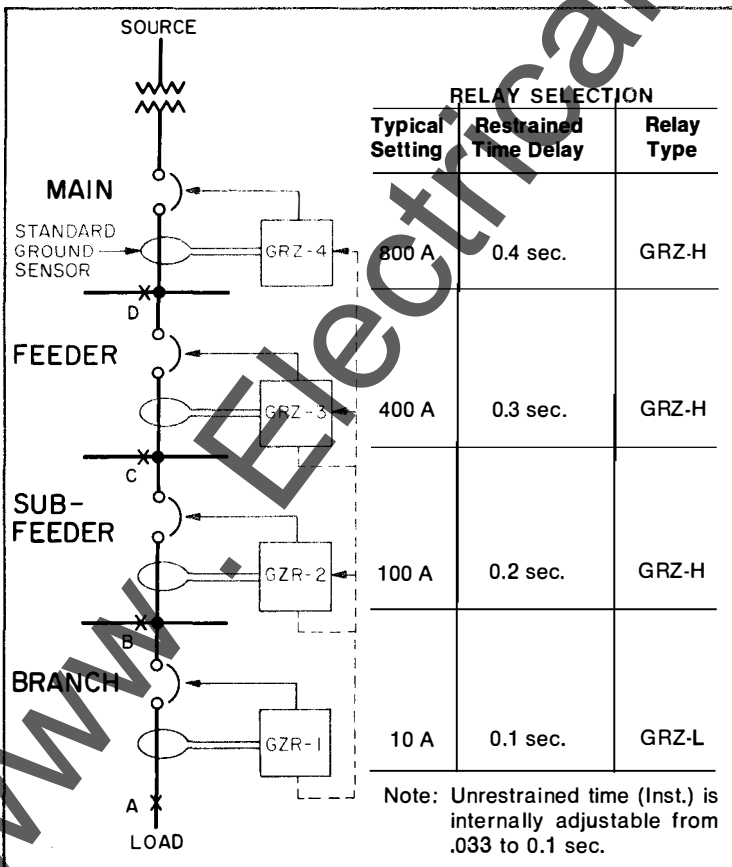


FIG. 4 and FIG. 5—Auxiliary switches are used for tie-open and tie-closed conditions. Use standard Ground-Shield relays. Refer to circuit on page 19. These diagrams are for surface case. (For drawout case terminal numbers see page 11.)

TYPICAL HOSPITAL SYSTEM



ZONE-INTERLOCKING SCHEME



This coordination scheme is for those few special applications where exceptionally fast tripping is necessary for all feeders throughout the entire system to reduce damage.

Note that although the relay time can be reduced appreciably, the circuit breaker mechanism and arcing time (plus safety margin) will still be present.

OPERATION:

- GRZ-1 will sense a ground fault at A when it exceeds 10 amperes. It will instantly* initiate tripping of the BRANCH breaker and send restraining signals (transfer from inst. operation to time delayed operation) to GRZ-2 and GRZ-3 (GRZ-2 and GRZ-3 will then back up GRZ-1 on a time coordinated basis). GRZ-4 will be restrained by GRZ-2 if ground fault exceeds 100 amperes.
 - GRZ-2 will sense a ground fault at B when it exceeds 100 amperes. It will instantly* initiate tripping of the SUB-FEEDER breaker and send restraining signals to GRZ-3 and GRZ-4.
 - GRZ-3 will sense a ground fault at C when it exceeds 400 amperes. It will instantly* initiate tripping of the FEEDER breaker and send a restraining signal to GRZ-4.
 - GRZ-4 will sense a ground fault at D when it exceeds 800 amperes. It will instantly* initiate tripping of the MAIN breaker.
- *Internally adjustable from .033 to .1 sec.

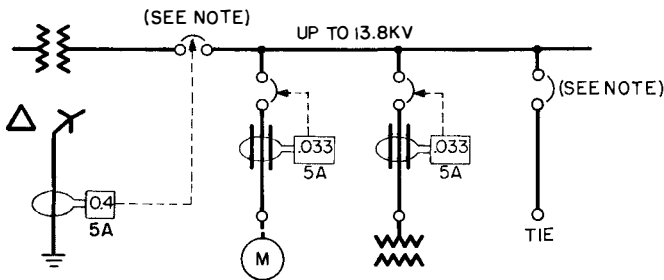
NOTE: A BLOCK signal (prevents trip) can be sent to the MAIN in place of a RESTRAIN signal (delays trip).

SPECIAL RELAY FEATURES: Drawout construction
 Target standard
 Push-to-test button standard
 Adjustable time .033 to .4 sec.
 Choice of two pick-up ranges:
 Type GRZ-H 100-1000 Amps
 Type GRZ-L 5-50 Amps

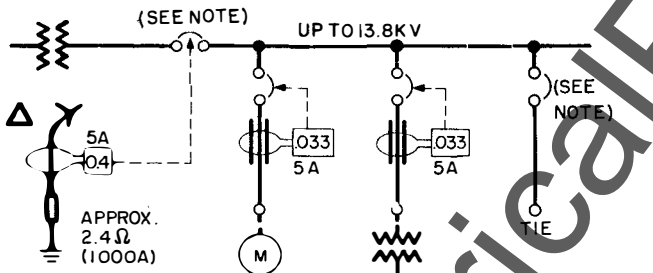
POWER PLANT AUXILIARY CIRCUITS

Optimum ground-fault protection of power plant auxiliary motors and transformers is necessary because these are loads essential to service continuity.

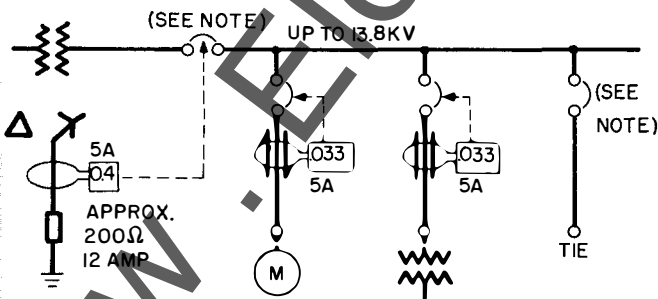
Ground-Shield can provide sensitivity of 5 amperes primary fault current. This protection detects faults near the winding neutrals and prevents iron burning thus precluding expensive repairs with long down times.



SOLIDLY GROUND SYSTEM—Ground-fault currents are maximum enabling ground relays to protect very nearly 100% of motor windings.



LOW-RESISTANCE GROUND SYSTEM—Ground-fault currents are limited to about 500-1000A. Ground relays protect nearly all motor windings.

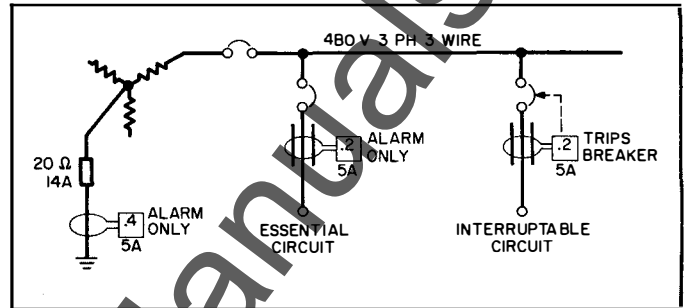


HIGH-RESISTANCE GROUND SYSTEM—Ground-fault currents are kept small so that relays can be used to sound alarm and also to indicate the grounded feeder.

Note: Use single-phase Circuit-Shield overcurrent relay type ITE-51S in residual ground connections.

HIGH-RESISTANCE GROUNDED SYSTEMS

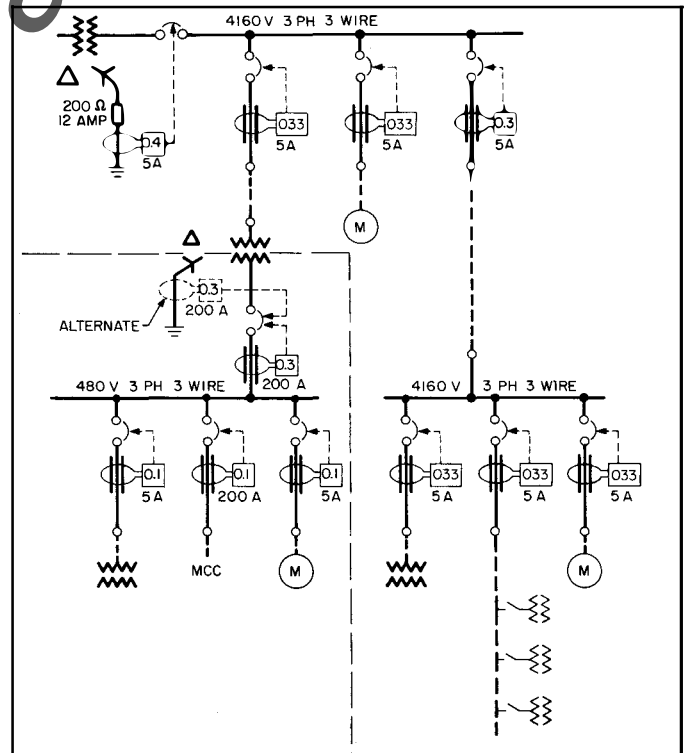
High-resistance grounded systems give the option of tripping or merely sounding an alarm upon the occurrence of a ground fault. Ground-fault current is limited to 10-15 amperes; sufficient to prevent over-voltage problems which occur on some ungrounded systems.



TYPICAL 480 VOLT SYSTEM—both main and feeders are equipped with ground relays.

Type A circuits are those which cannot be interrupted immediately but which will be taken out of service to locate ground fault at earliest practical time.

Type B circuits are those which should be cleared immediately while fault currents are low, perhaps for safety considerations. These circuits are allowed to trip automatically upon occurrence of ground faults.

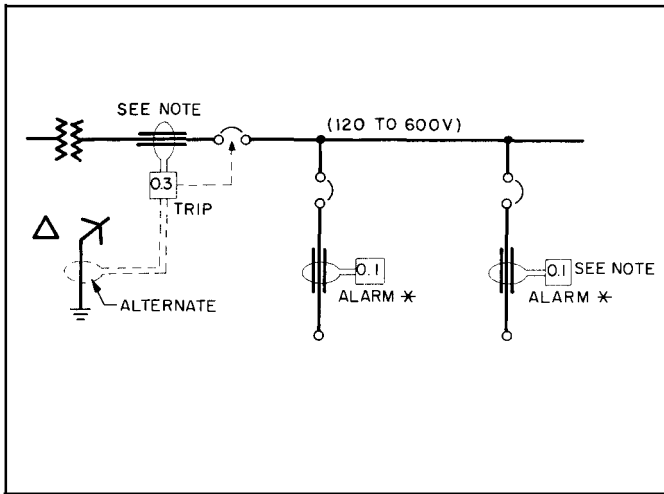


TYPICAL 4160 VOLT SYSTEM—Ground relays are applied on main and all feeder circuits. Time curves are coordinated with about 0.2 Sec between series breakers. Excellent ground protection is obtained for all motor and transformer loads. Relays can be used for either trip or alarm only on essential circuits.

The 480V solidly-grounded sub-system can be treated as a separate system relative to ground-fault protection. (Any delta winding of a two winding transformer isolates ground faults in either system from affecting the other system).

SPECIAL DETECTING, ALARM, TRIPPING & MONITORING SCHEMES

SOLID AND LOW-RESISTANCE GROUNDED SYSTEMS



Application — Where GROUND-SHIELD on main breaker provides tripping protection and GROUND-SHIELD on feeders provide sensitive alarm and indication. Continuity of service maintained for low-magnitude ground faults.

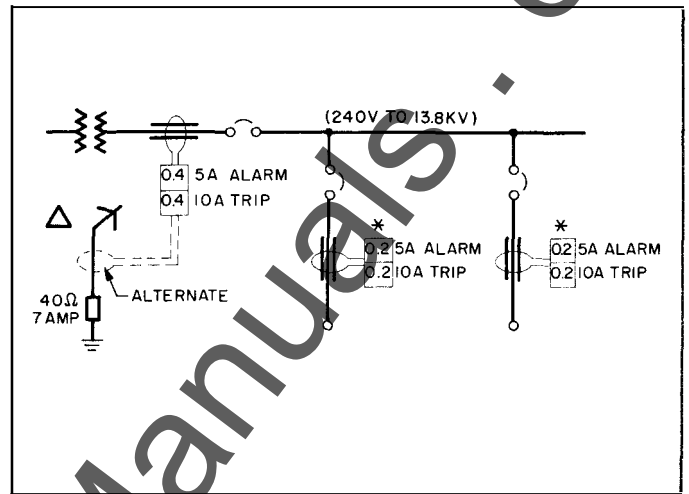
Main — Use standard GROUND-SHIELD, pickup range 200-1200A.

Feeders — Select any round or rectangular sensor size.

Select 5-50A pickup, surface or drawout relay, or GSM relay self powered. Contact Switchgear Div. for pickup sensitivity with GSM relay. Consult your nearest Sales Office.

*Ground indication can be provided with an ammeter and pushbutton connected to sensor secondary if desired.

HIGH-RESISTANCE GROUNDED SYSTEMS



Application — System provides alarm and indicates the feeder on which first ground fault occurs.

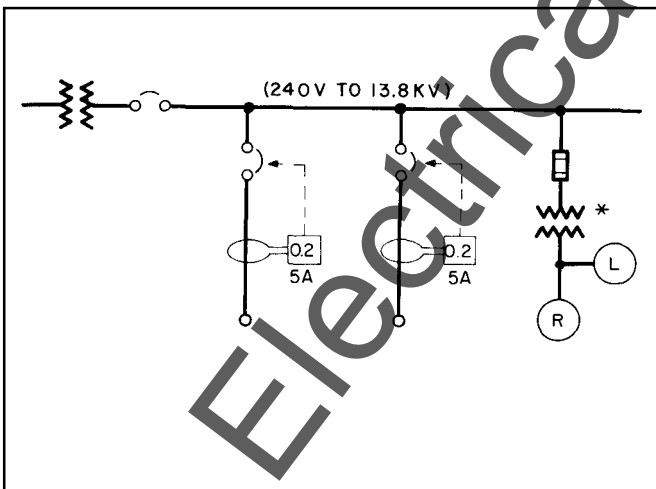
— System selectively trips proper breakers if second ground fault occurs before first fault is removed.

Main — Use (2) 5-50A Standard relays and (1) sensor.

Feeders — Use (2) 5-50A standard relays and (1) sensor.

*Ground indication can be provided with an ammeter and pushbutton connected to sensor secondary if desired.

UNGROUNDED SYSTEMS

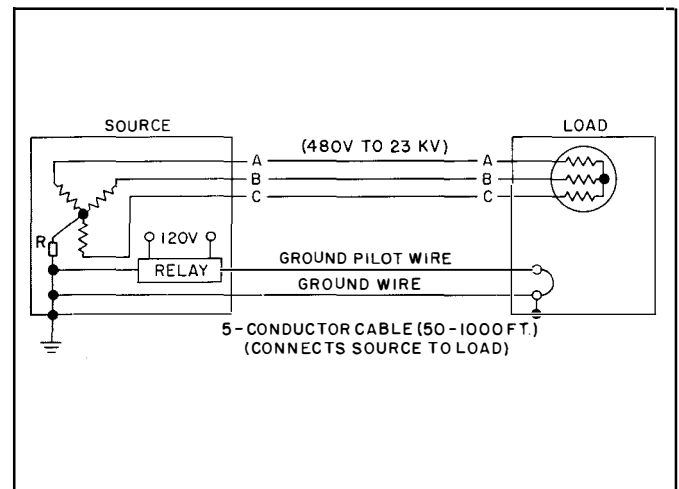


Application — Use on ungrounded systems. Ground relays on feeders provide tripping protection for second ground fault. This decreases the hazards of continued operation with the first ground fault present until that fault is located and cleared.

Feeders — Use 5-50A standard GROUND-SHIELD system.

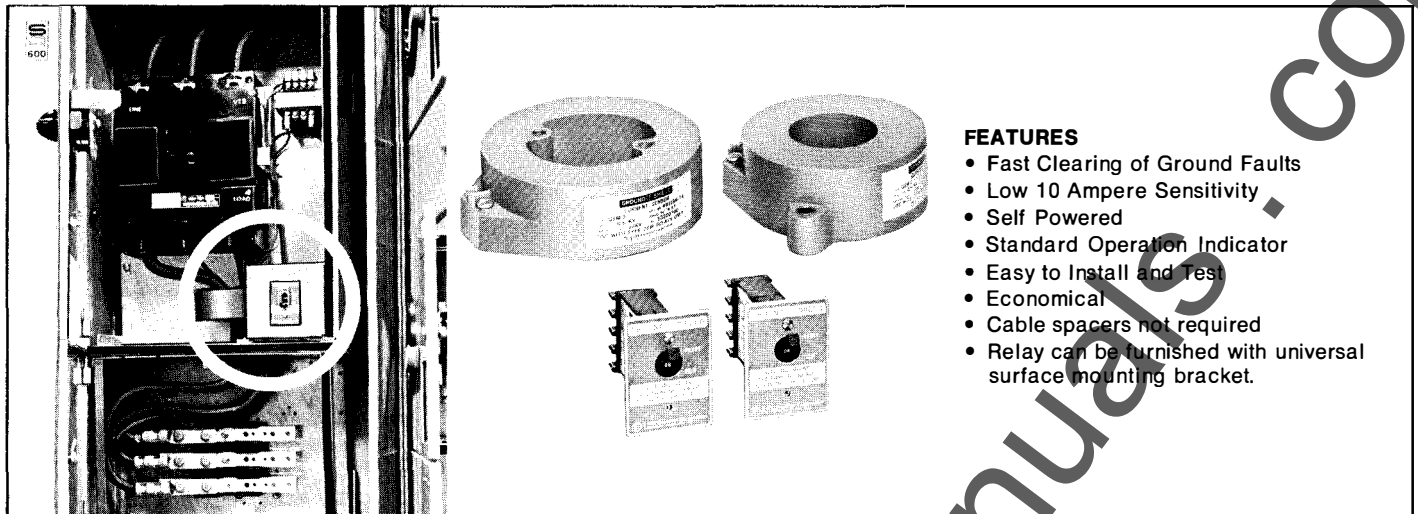
Note — For higher capacity delta systems it is recommended that the system neutral be established and high-resistance scheme used. Contact your nearest Sales Office for recommendation providing single-line diagram and service continuity needs.

GROUND WIRE MONITORING SYSTEM



Application — Used to monitor ground wire for portable source and load equipment for mining and quarry installations. Provides alarm if continuity of ground wire is accidentally broken at any time. GROUND-SHIELD monitor relay is housed in standard drawout case.

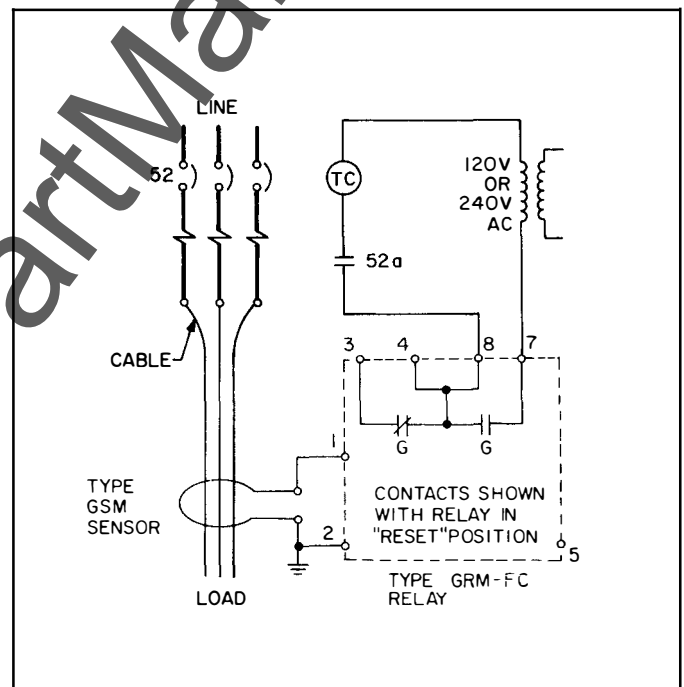
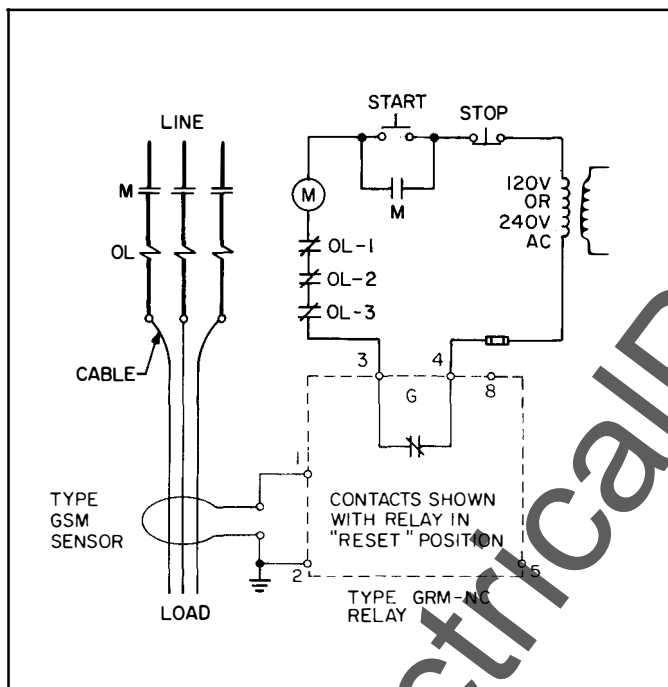
MOTOR CIRCUIT APPLICATION



FEATURES

- Fast Clearing of Ground Faults
- Low 10 Ampere Sensitivity
- Self Powered
- Standard Operation Indicator
- Easy to Install and Test
- Economical
- Cable spacers not required
- Relay can be furnished with universal surface mounting bracket.

WIRING DIAGRAMS



Connect jumper bar from 1 to 5 on terminal block when Type GSM-1 Sensor (2" Dia. window) is used. Remove jumper bar when GSM-2 (3" Dia.) is used.

GRM SYSTEM APPLICATION

This GROUND-SHIELD system offers fast, sensitive and inexpensive protection against ground faults in individual motor starter and contactor circuits (type GRM-NC) and electrical distribution systems using molded-case circuit breakers with shunt trips (type GRM-FC).

The system consists of a special small diameter current transformer (sensor) and an instantaneous, mechanically latched ground relay with a 10 ampere sensitivity. The ground sensor, which encircles all phase conductors, comes in 2" (GSM-1) and 3" (GSM-2) inside diameters.

THEORY OF OPERATION

The sensor has a zero current output under normal conditions since the vector summation of current flowing through all phases is zero.

Therefore, there is no resultant current flow through the sensor.

If a ground-fault occurs, the vector summation of $I_A + I_B + I_C$ is not equal to zero. The resultant current flow through the sensor window is the ground fault current, I_G . The sensor now has an output, which is applied to the relay. If the primary ground fault current exceeds 10 amperes, the relay will instantly operate to signal the contactor (GRM-NC) or breaker (GRM-FC) to clear the circuit.

These relays do not require control voltage for their operation, since their operation indicator is manually reset.

PHYSICAL CHARACTERISTICS

The ground sensor consists of a wound core with a uniformly distributed secondary winding. The entire assembly is cast in epoxy. Cable spacers are not required.

The ground relay is furnished in two types (same physical design).

(1) The GRM-NC with a normally closed output contact. (2) The GRM-FC with form C output contacts. Both relay types are equipped with an operation indicator and can be furnished with a universal surface mounting bracket.

RATINGS AND CHARACTERISTICS

PROTECTION — For small individual motors.
For larger motors (50 HP and above) types GR 5 and GRD are recommended.
With contactor circuits use GRM-NC.
With molded-case breaker circuits use GRM-FC.

SENSITIVITY — 10 Amperes rms \pm 10%.

SPEED OF OPERATION — Instantaneous, no intentional time delay.

OUTPUT CONTACT RATINGS — GRM-NC: 15 amperes at 250V ac or 50V dc; GRM-FC: 10 amperes at 250V ac or 50V dc (RESISTIVE LOAD).

OPERATION INDICATOR — Provided by reset handle.

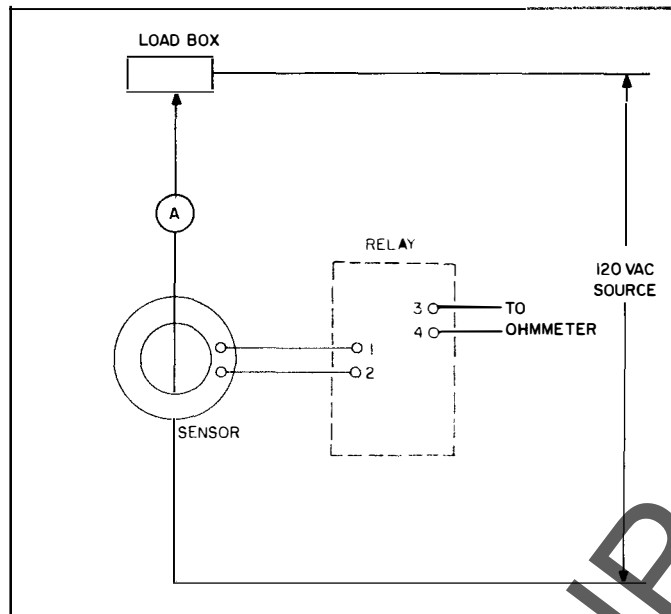
MOMENTARY WITHSTAND — 25,000 Amperes rms.

SENSOR SIZES — 2" and 3" diameter are standard. (4" diameter special).

SENSOR MOUNTING — To enclose all phase conductors.

SENSOR-RELAY CONNECTORS — At least AWG # 16. (not longer than 300 feet).

TESTING



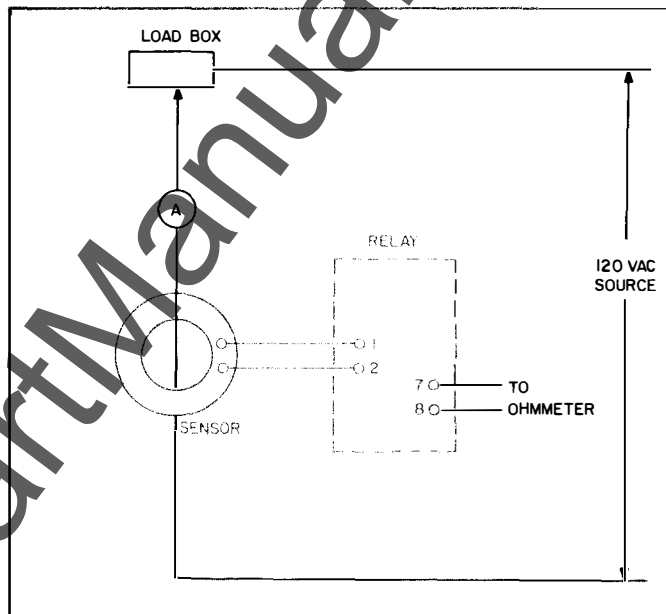
GRM-NC RELAY

Relay Handle Position

Reset
Trip

Contact 3 — 4

Closed
Open



GRM-FC RELAY

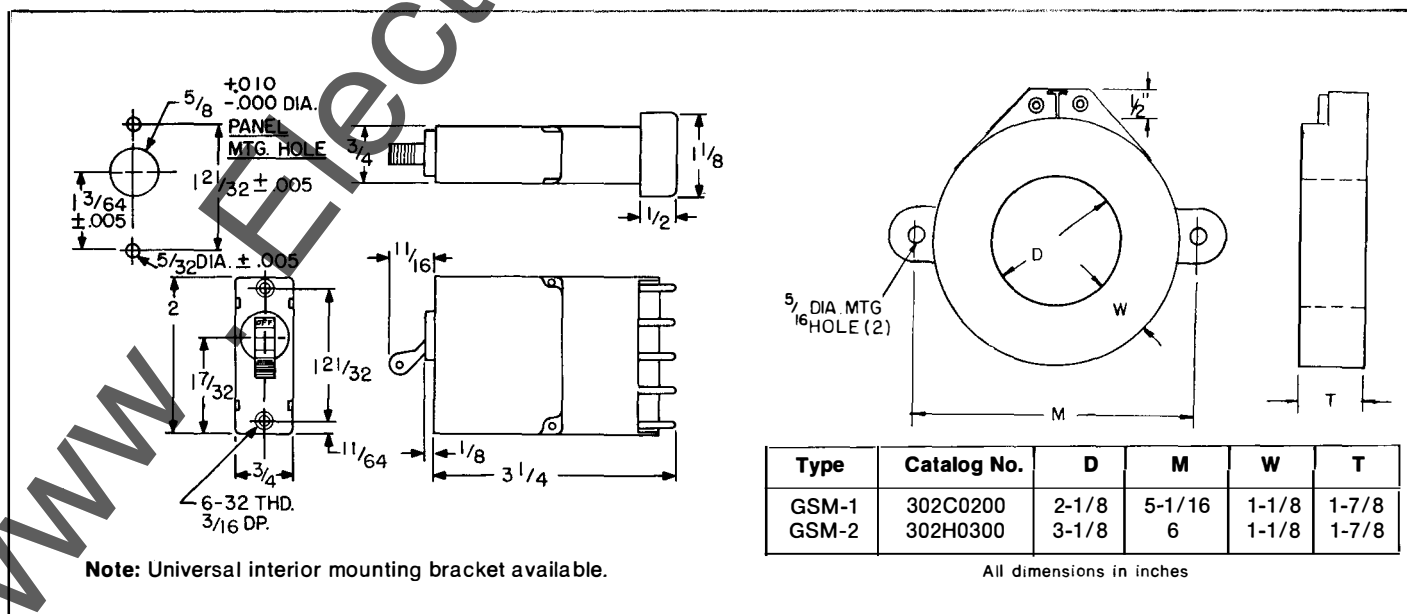
Relay Handle Position

Reset
Trip

Contact 7 — 8

Open
Closed

DIMENSIONS

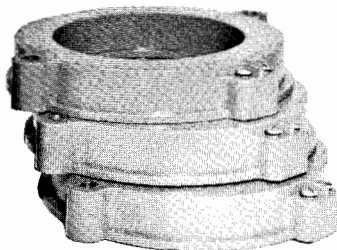


Note: Universal interior mounting bracket available.

Type	Catalog No.	D	M	W	T
GSM-1	302C0200	2-1/8	5-1/16	1-1/8	1-7/8
GSM-2	302H0300	3-1/8	6	1-1/8	1-7/8

All dimensions in inches

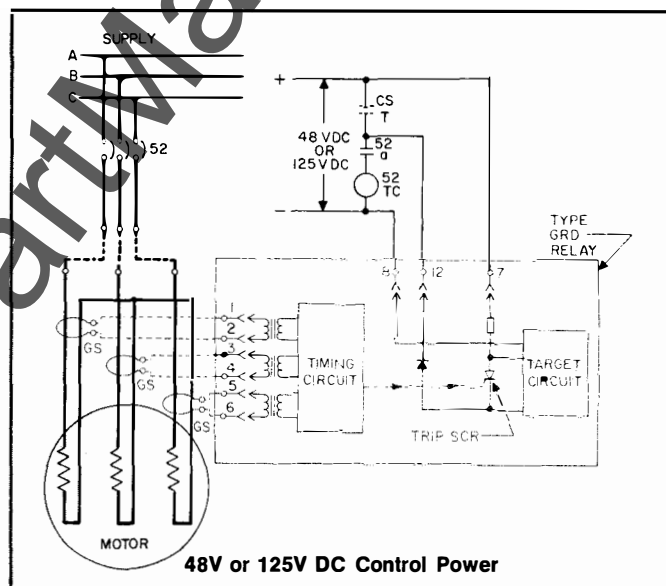
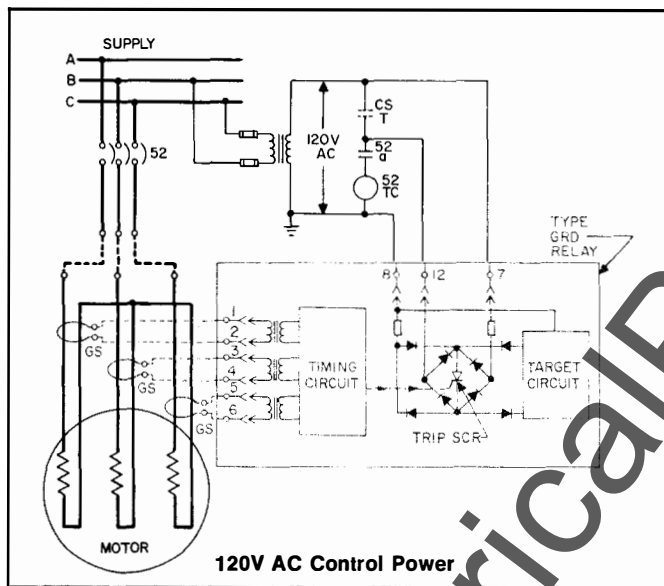
DIFFERENTIAL RELAYS FOR 3-PHASE LOADS



FEATURES

- Fast clearing
- Detects Phase-to-Phase and Phase-to-Ground Faults
- 2 Ampere Sensitivity — Primary Amperes
- Semi-flush Drawout Case
- Shock-proof Target
- Push-to-Test Button

WIRING DIAGRAMS



GRD SYSTEM APPLICATION

This GROUND-SHIELD differential system provides fast, sensitive protection against phase-to-phase or phase-to-ground faults occurring in 3-phase motors, generators, reactors, etc. This system consists of three solid-core current sensors type GS-5 and one 3-phase, solid-state ground differential relay type GRD, which operates the shunt-trip device on the circuit breaker. The ground differential relay and the associated current sensors are connected in a self-balancing scheme. The GROUND-SHIELD differential system has a sensitivity of 2 amperes primary fault current, operates in 2 cycles, and is significantly more economical than comparable conventional differential relays operated from current transformers.

OPERATION INDICATOR

An operation indicator is provided as a standard feature of the semi-flush drawout relay.

The operation indicator shows international orange when the relay operates due to a ground fault. The indicator retains correct status memory independent of control power.

Reset is accomplished by pressing the reset pushbutton.

PUSH-TO-TEST FEATURE

A push-to-test button is provided as a standard feature of the semi-flush drawout relay.

This test feature enables one to check the operation of an installed system by applying an input signal to the relay which then operates in a normal manner to trip its associated interrupting device.

The pushbutton is recessed to prevent accidental operation.

THEORY OF OPERATION

Each sensor has a zero current output under normal conditions since the current flowing into each phase exactly balances out with the current flowing out of that phase. Therefore, there is no resultant current flow through the sensor. If a phase-to-phase or a phase-to-ground fault occurs, the current summation is not equal to zero. The sensor now has an output, which is applied to the relay. If the primary fault current exceeds 2 amperes, the relay will instantly operate to signal the circuit protective device to interrupt the circuit. The relay is designed to operate on 120 VAC, 48 VDC or 125 VDC control sources.

PHYSICAL CHARACTERISTICS

The ground sensors are GS-5 (same type used with the GR-5 relay). The ground relay is of a semi-flush design for panel mounting arranged for wiring connections to rear studs. The case is provided with drawout facilities, target indicator and a push-to-test button.

RATINGS AND CHARACTERISTICS

PROTECTION—For 3-Phase motors, generators, reactors, resistors, capacitors and similar loads.

SENSITIVITY—2 Amperes primary fault current, phase-to-phase or phase-to-ground.

SPEED OF OPERATION—2 cycles or less.

TARGET INDICATION—Prominent, positive, retains position with loss of control power.

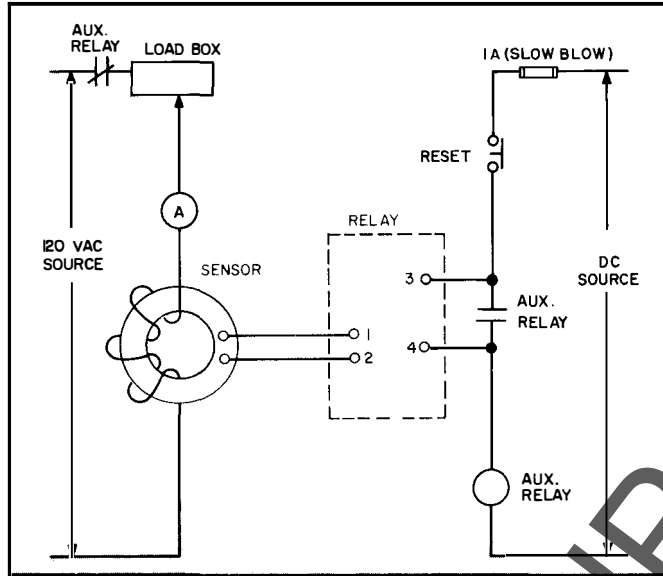
INPUT CIRCUIT RATINGS—80,000A for 2 cycles
60,000A for 30 cycles
300A continuous for alarm duty.

OUTPUT SCR—48V DC; 125V DC; 120V AC
30A for 6 cycles
7.5A for 60 cycles.

SENSOR SIZES—2", 3", 5", 8" diameter are standard.
(For special sizes or shapes, contact your nearest I-T-E District Sales Office.)

TEST FEATURE—Built-in push-to-test button.

TESTING



BENCH TEST

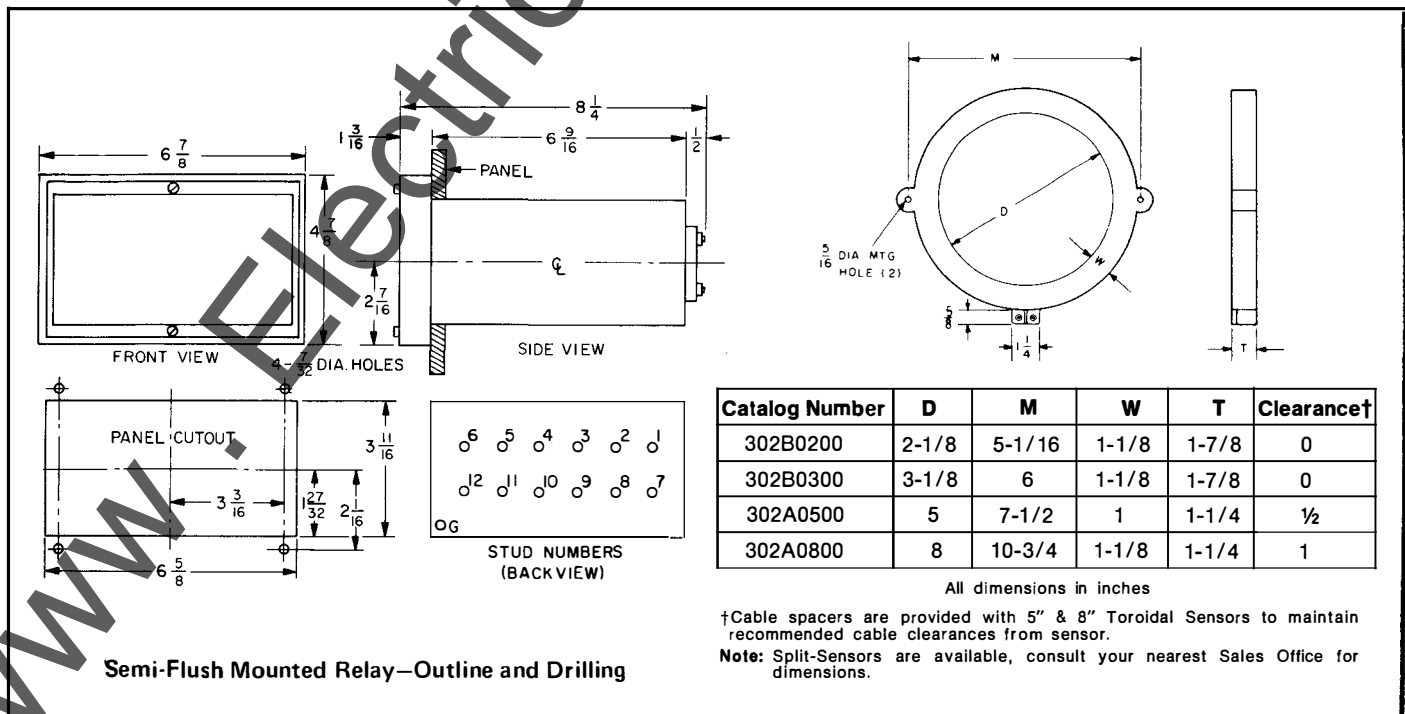
Typical bench test circuit for 48V and 125V DC relay. (When mounted and wired in switchgear, relay can be tested with built-in push-to-test feature.)

1. Connect relay and any one of the three sensors as shown.
2. Increase the primary current so that approximately 2 amperes flow through the sensor window. Auxiliary relay will pick-up when GRD relay operates. Immediately return the test current to zero after relay operates.
3. To repeat test, push reset push-button to drop out auxiliary relay. Also push GRD relay target reset push-button.
4. Repeat steps 2 and 3 above, applying test current to terminals 1-2 and terminals 5-6, one pair at a time (in place of terminals 3-4).

MOUNTED IN SWITCHGEAR

1. Apply 2 amperes through any of the three sensor windows. The relay will trip the breaker. Immediately return test current to zero.

DIMENSIONS



SELECTION

ORDERING

To select a GROUND-SHIELD ground-fault protection system the following five items must be considered and specified:

- A. Select a relay case type. Choose between surface mounting type (adjustable pickup) or drawout semi-flush design (adjustable pickup, adjustable time curves, operation indicator and test button).

TYPICAL: **SURFACE MTG.**

- B. Select a control-power voltage for the relay. Choose between 48 and 125 volts dc or 120 volts ac. (Applications at 32 and 250 volts dc should be referred to Sales Office. For applications at 208, 240 and 480 volts ac utilize a control-power transformer connected phase-to-phase to reduce to 120 volts ac).

TYPICAL: **120 VAC**

- C. Select a relay pickup range. Choose either GR-200 (200-1200A for circuit and bus protection), or GR-5 (5-50A for individual motors, transformers, etc.) primary ground-fault ampere range.

TYPICAL: **GR-200**

- D. Select a time-current characteristic curve. Choose from the family of curves to match the pickup range selected in Item B. Select fastest curve for individual load and allow 0.1 to 0.2 seconds (0.2 preferred) time delay between each step of coordination. (With drawout case, time curve need not be specified since time delay is adjustable.)

TYPICAL: **0.3 SECONDS**

- E. Select a sensor size. Sensor should be large enough to enclose the bus or cable configuration, allowing recommended clearance from bus or cable to any surface of sensor.

TYPICAL: **10" x 17" RECTANGULAR.**

Example: Relay catalog **202C3261UL**; Sensor catalog **302B1017UL**.

**TYPES
GR
&
GS**

To select a GROUND-SHIELD system for MCC, three items must be considered and specified:

- A. Select a relay type, GRM-NC to operate a contactor or GRM-FC to operate a molded case breaker.

TYPICAL: **TYPE GRM-NC**

- B. Select relay mounting. Panel mounted is standard; surface mounting bracket is optional.

TYPICAL: **PANEL MOUNTED**

- C. Select a sensor size. Sensor should be large enough to enclose the three cables.

TYPICAL: **3" ROUND**

Example: Relay catalog **202E0413**; Sensor catalog **302H0300**.

**TYPES
GRM
&
GSM**

To select a GROUND-SHIELD system for 3-phase differential protection-three items must be considered and specified:

- A. Select relay (only 1 type available)

TYPICAL: **TYPE GRD**

- B. Select a control-power voltage for the relay. Choose between 48 and 125 volts dc or 120 volts ac. (Applications at 32 and 250 volts dc should be referred to Sales Office. For applications at 208, 240 and 480 volts ac utilize a control-power transformer connected phase-to-phase to reduce to 120 volts ac).

TYPICAL: **125VDC**

- C. Select size of sensors. Each sensor (3-required) should be large enough to enclose the two cables (each end of a single-phase winding or a three-phase motor).

TYPICAL: **(3) 5" ROUND**

Example: Relay catalog **202D0541**; Sensor catalog **302A0500UL**.

**TYPES
GRD
&
GS**

RELAYS

TYPE GR GROUND RELAYS — SURFACE CASE

Operating Time - Curve cy sec	Control Voltage ①	Catalog Numbers	
		Adjustable ② 5 - 50 A	Adjustable ② 200 - 1200 A
A 2 .033	48 VDC	202C0131 UL	—
B 6 .1		202C1131 UL	202C1231 UL
C 12 .2		202C2131 UL	202C2231 UL
D 18 .3		202C3131 UL	202C3231 UL
E 24 .4		202C4131 UL	202C4231 UL
F 30 .5		—	202C5231 UL
A 2 .033	125 VDC	202C0141 UL	—
B 6 .1		202C1141 UL	202C1241 UL
C 12 .2		202C2141 UL	202C2241 UL
D 18 .3		202C3141 UL	202C3241 UL
E 24 .4		202C4141 UL	202C4241 UL
F 30 .5		—	202C5241 UL
A 2 .033	120 VAC	202C0161 UL	—
B 6 .1		202C1161 UL	202C1261 UL
C 12 .2		202C2161 UL	202C2261 UL
D 18 .3		202C3161 UL	202C3261 UL
E 24 .4		202C4161 UL	202C4261 UL
F 30 .5		—	202C5261 UL

TYPE GR GROUND RELAYS—DRAWOUT CASE

Control Voltage ①	Catalog Numbers	
	Adjustable ② 5 - 50 A	Adjustable ② 200 - 1200 A
	Adjustable 2, 6, 12, 18, 24 cy	Adjustable 6, 12, 18, 30 cy
48 VDC	202D6131 UL	202D7231 UL
125 VDC	202D6141 UL	202D7241 UL
120 VAC	202D6161 UL	202D7261 UL

TYPE GRM GROUND RELAYS

10 A Fixed - Inst. Operation	Catalog Numbers
Application	Relay
MOTOR CONTROL CENTER STARTERS CONTACTORS	202E0413 (Type GRM-NC)
MOLDED CASE BREAKERS	202E0414 (Type GRM-FC)

TYPE GRD GROUND RELAYS—DRAWOUT CASE

Control Voltage	Catalog Numbers
	Instantaneous Operation 2A Pickup
	Use with (3) 5 - 50 A Sensors
48 VDC	202D0531
125 VDC	202D0541
120 VAC	202D0561

① For other voltages contact the nearest Sales Office.

② For special type GR relays with 2-40 ampere or 20-200 ampere range contact your nearest Sales Office.

SPECIFICATIONS

SENSORS

Note: Blue color denotes purchaser supplied options. *Italics* denote I-T-E exclusive features.

The ground-fault protection described herein is intended for use on a () volt, 3-phase, (3-) (4-) wire (solidly) (low-resistance) (high-resistance) grounded (delta) (wye) 60 Hz., (single) (dual) service system (with) (without) tie.

Adjustment knobs shall be of the friction type, flush design, to avoid accidental movement.

A. FOR MAIN, TIE, FEEDER, AND BRANCH CIRCUITS.

Ground-fault protection shall consist of a ground sensor encircling (all phase conductors including neutral in a 4-wire system) (neutral-to-ground connection only) connected to a solid-state ground relay which initiates tripping of the (main) (tie) (feeder) (branch) circuit-interrupting device. Ground protection shall be adjustable from 200 to 1200 primary amperes. Circuit-interrupter shunt trip and relay shall operate from a (120V ac) (48V dc) (125V dc) control source.

Select (a) or (b)

(a) Relay case shall be for surface (internal swgr.) mounting. Time-current characteristic shall provide (0.1) (0.2) (0.3) (0.4) (0.5) seconds operation at about 10 times pickup.

(b) Relay case shall be of the drawout type for front of panel mounting. Time-current characteristic shall be adjustable to provide 4 time settings ranging between 0.1 to 0.5 seconds operation at about 10 times pickup. Relay shall be provided with a **shock-proof operation indicator which retains memory with loss of control power.** Relay shall include a **built-in, push-to-test button.**

B. FOR SINGLE MOTORS, TRANSFORMERS, ALSO HIGH-RESISTANCE GROUNDED SYSTEMS.

Ground-fault protection shall consist of a ground-sensor encircling all phase conductors, connected to a solid-state ground relay which initiates tripping of the circuit interrupting device. Ground protection shall be adjustable from 5 to 50 primary amperes. Circuit-interrupter shunt trip and relay shall operate from a (120V ac) (48V dc) (125V dc) control source.

Select (a) or (b)

(a) Relay case shall be for surface (internal swgr.) mounting. Time-current characteristic shall provide (0.033) (0.1) (0.2) (0.3) (0.4) seconds operation at about 10 times pickup.

(b) Relay case shall be of the *drawout* type for front of panel mounting. Time-current characteristic shall be adjustable to provide 4 time settings ranging between 0.033 to 0.4 seconds operation at about 10 times pickup. Relay shall be provided with a **shock-proof operation indicator which retains memory with loss of control power.** Relay shall include a **built-in, push-to-test button.**

A. FOR INDIVIDUAL MOTOR CIRCUITS

Ground-fault protection equipment shall consist of a small diameter ground sensor encircling all phase conductors, connected to a **mechanically-latched, manually-reset relay (no control power required)** which initiates opening of the circuit interrupting device. Ground protection shall be fixed at 10 primary amperes and operate instantaneously. Relay shall have (normally-closed output contact for contactor holding coil) (normally-open closed contacts for molded-case breaker). Operation indicator must be included. **Output contacts should be rated (15A continuous (250V) for normally-closed (holding coil) duty) or (10A (250V) resistive making duty if normally-open type).** Relay indicator positions shall be marked "trip" and "reset".

A. FOR DIFFERENTIAL PROTECTION

Phase and ground-fault protection equipment shall consist of three current sensors, one encircling each phase (in and out) plus **one 3-phase solid-state semi-flush mounted drawout ground-differential relay.** The ground-differential relay and the associated current sensors are connected in a self-balancing scheme. Sensitivity shall be factory adjusted at **2 primary amperes** and operation shall occur within 2 cycles or less. Relay shall be provided with a **shock-proof operation indicator which retains memory with a loss of control power.** Relay shall also include a **built-in push-to-test button.**

Circuit-interrupter shunt-trip and relay shall operate from a (120V ac) (48V dc) (125V dc) control source.

TYPE GS GROUND SENSORS

Size & Shape	Catalog Numbers	
	5 - 50 A	200 - 1200 A
2" Round	302B0200 UL	302B0200 UL
3" Round	302B0300 UL	302B0300 UL
5" Round	302A0500 UL	302B0500 UL
8" Round	302A0800 UL	302B0800 UL
8" Split Core	302D0800 UL	302D0800 UL
10" x 13" Rectangular	—	202B1013 UL
10" x 17" Rectangular	302B1017 UL†	302B1017 UL
10" x 24" Rectangular	—	302B1024 UL
16" x 20" Rectangular	—	302B1620 UL

†Application must be referred to the nearest Sales Office .

TYPE GSM SENSORS

10 A Fixed - Inst. Operation Catalog Numbers		
Application	Size	Sensor
MOTOR CONTROL CENTER STARTERS CONTACTORS	2"	302C0200 (Type GSM-1)
	3"	302H0300 (Type GSM-2)
MOLDED CASE BREAKERS	2"	302C0200 (Type GSM-1)
	3"	302H0300 (Type GSM-2)

TYPE GS GROUND SENSORS

Sensors Shape	Catalog Numbers
	5 - 50 A
2" Round	302B0200 UL
3" Round	302B0300 UL
5" Round	302A0500 UL
8" Round	302A0800 UL
5" Split Core	302D0500 UL
8" Split Core	302D0800 UL

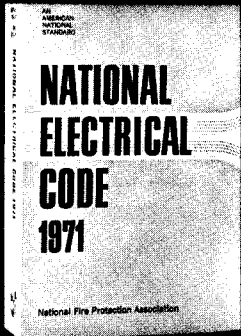
TYPES
GR
&
GS

TYPES
GRM
&
GSM

TYPES
GRD
&
GS

CODES & STANDARDS

1971 NATIONAL ELECTRICAL CODE



230.95. Ground-fault protection of equipment.

Ground-fault protection of equipment shall be provided for grounded wye electrical services of more than 150 volts to ground, but not exceeding 600 volts phase-to-phase for any service disconnecting means rated 1,000 amperes or more. The ground-fault protection may consist of overcurrent devices or combination of overcurrent devices and current transformers or other equivalent protective equipment which shall operate to cause the service disconnecting means to open all ungrounded conductors of the faulted circuit at fault current values of 1,200 amperes or more.

Fine Print Note

When a switch and fuse combination is used, the fuses employed shall be capable of interrupting any current higher than the interrupting capacity of the switch during a time when the ground-fault protective system will not cause the switch to open.

It is recognized that ground-fault protection is desirable for service disconnecting means rated less than 1000 amperes on grounded systems having more than 150 volts to ground, not exceeding 600 volts phase-to-phase.

Ground-fault protection that functions to open the service disconnecting means will not protect service conductors or the service disconnecting means but will limit the damage to conductors and equipment on the load side of the ground-fault protection.

This added protective equipment at the service equipment will make it necessary to review the over-all wiring system for proper selective overcurrent protection coordination. Additional installations of ground-fault protective equipment will be needed on feeders and branch circuits where maximum continuity of electrical service is necessary.

UNDERWRITERS' LABORATORIES



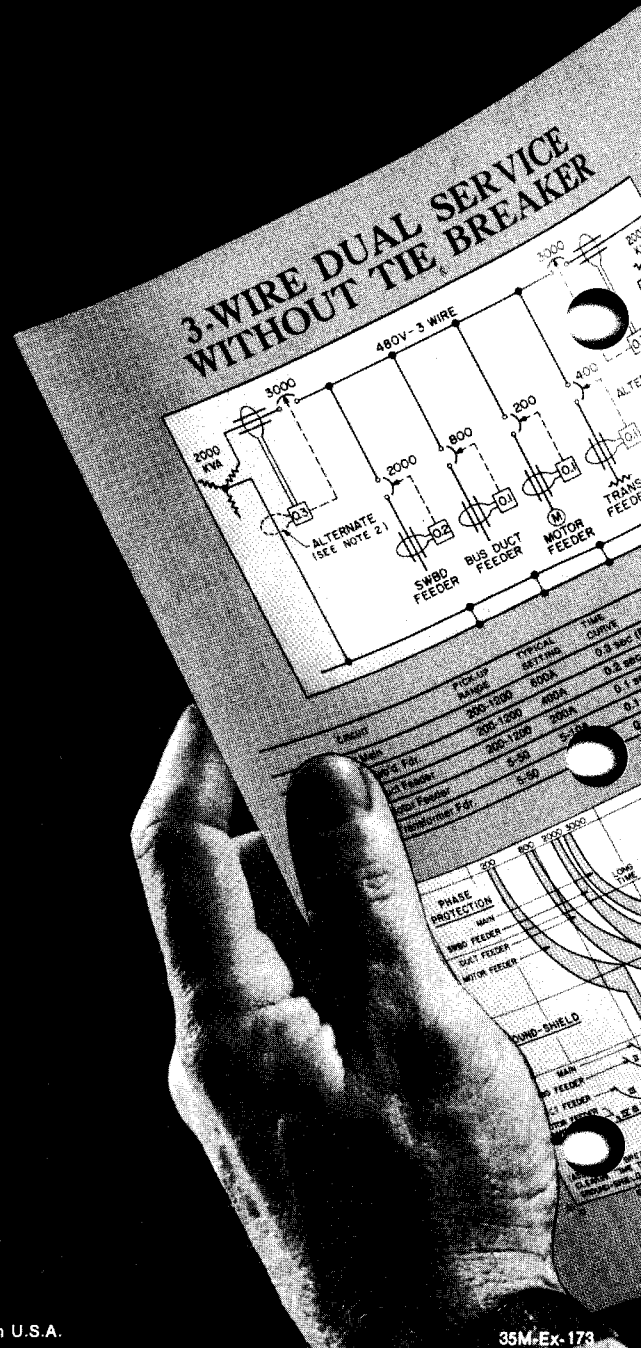
An independent, not-for-profit organization testing for public safety.

GROUND-SHIELD has successfully met UL requirements in the areas of:

Construction Performance	Temperature Calibration	Overload Endurance	Withstand Markings	Component Failure Fault Conditions
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OCCUPATIONAL SAFETY & HEALTH ACT

The 1971 National Electrical Code was officially adopted on March 15, 1972 as the electrical standard of the Occupational Safety and Health Act of 1970. At the same time, the term "acceptable" was added to the electrical section of the Act and defined as: "An installation or equipment is acceptable to the Assistant Secretary of Labor, and approved within the meaning of this subpart S: (1) if it is accepted, or certified, or listed, or labeled, or otherwise determined to be safe by a nationally recognized testing laboratory, such as, but not limited to, Underwriters' Laboratories, Inc. and Factory Mutual Engineering Corp.; . . ."



ITE Imperial
CORPORATION