CIRCUIT SHIELD®

High Speed Directional Relays

Catalog Series 425

Type 32	Positive Sequence Directional Relay
Type 32Q	Negative Sequence Directional Relay
Type 32D	Zero Sequence Directional Relay

ABB Power T&D Company, Inc.

Type 32 Directional Relay with Sector Control

Table of Contents

Introduction

These instructions contain the information required to properly install, operate, and test the types 32, 32D, and 32Q solid-state directional relays.

The most common application of these high-speed directional relays is to supervise the operation of other relays based on the direction of current flow in the system.

The relay is housed in a semi-flush drawout relay case suitable for conventional panel mounting.

All connections to the relay are made at terminals located on the rear of the case and are clearly numbered.

All controls are mounted on the front panel behind a clear cover.

Type 32, 32D, and 32Q Directional Relays with catalog numbers starting with 425 offer totally drawout construction with integral test facilities. Current transformer shorting is accomplished by a direct acting spring and blade assembly upon removal of the relay from it's case. Sequenced disconnects eliminate any possibility of nuisance tripping during withdrawal or insertion of the relay if the normally open contacts are used in your scheme.

Precautions

The following precautions should be taken when applying solid state relays:

- Incorrect wiring may result in damage. Be sure wiring agrees with the connection diagram for the particular relay before the relay is energized. Be sure control power is applied in the correct polarity before applying control power.
- Apply only the rated control voltage marked on the relay front panel. For relays with dual rated control voltage, withdraw the relay from the case and check that the moveable link on the lower circuit board is in the correct position for the system control voltage.

Placing The Relay Into Service

Receiving, Handling, and 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 your ABB representative.

Installation

Mounting

The outline dimensions and panel drilling and cutout information is given in Figure 1.

Connections

All ABB Circuit Shield™ protective relays have metal front panels which are connected through printed circuit board runs and connector wiring to a terminal at the rear of the relay case. The terminal is marked "G" and is located as shown in Figure 1. In all applications this terminal should be wired to ground.

Before energizing the relay , for relays with a dual control voltage rating, the relay element should be withdrawn from it's case, and a visual check be made to insure that the movable control voltage link on the lower circuit board has been placed on the correct position for the system control voltage. Models rated for 250Vdc control power include a dropping resistor mounted on the outside of the case.

Output Contacts and Indicators

Two styles of output contacts are used in these relays:

- Models with sealed reed type output contacts are preferred when the directional relay is used to torque-control a Type 51 , a Type Micro 51, a Type MMCO, or a Type Microshield O/C overcurrent relay. These models also have a self resetting, light emitting diode operation indicator, which is lighted when the current is in the tripping direction.
- Models with heavier duty telephone relay type output contacts are preferred when the directional relay will be used to operate other devices, such as an auxiliary relay, or pneumatic timer. These models have a target indicator (standard) , or a LED indicator (special).

Overcurrent Relay Torque-Control

If you are using a 425 series directional relay to torque-control overcurrent relay, you must determine the method of torque-control employed. Be sure to check the instruction book of the overcurrent relay for these details.

Certain relays in the ABB Circuit-Shield product line have torque-control links installed on the rear terminal block of the relay. With the link in place, its associated overcurrent element is active. To control that element with a 425 series relay, the link must be removed and a normally open contact from the 425 relay connected across the same terminals. When the 425 relay determines current is in the tripping direction, its output contact closes to allow the overcurrent relay to measure the current magnitude. For relays employing the shorting link method (e.g. 423, 443, 468, 427Q series), each torque control input must be assigned

to an individual contact of the directional relay - you must not connect any in parallel. Torque-control wiring should be relatively short and not leave the relay panel. In unusual circumstances where the controlling relay and controlled relay are some distance apart, an interposing auxiliary relay mounted near the controlled relay should be used.

Other relays such as the 446 series Micro51 single-phase overcurrent relay, and the multiphase MSOC overcurrent relay require that dc control voltage be applied to the torque-control input in order to allow the relay to measure the current. In this case, one side of the 425 series relay's output contact is connected to positive dc control voltage and the other side to the torque-control input of the overcurrent relay. Parallel operation of inputs of this type from one contact of the directional relay is allowable.

Front Panel Controls

Maximum Torque Angle

The characteristic angle of the relay is continuously adjustable over a specified range using this front panel dial. The dial is marked 0-90 degrees. Refer to details on each relay type for the detailed meaning of the adjustment.

Optional Sector Width Adjustment

Sector width control allows the angle of the tripping sector to be reduced. This is useful in applications where load current under certain system operating conditions may be close to, or within, the tripping sector if the standard 180° sector were to be used. The continuous adjustment range of the front panel Sector Width dial is 30° to 180°. See Figure 11 and also the photo on page 2.

Note that the sensitivity of the relay is significantly reduced as the sector is reduced. This reduction in sensitivity is illustrated in Figures 13 and 14.

In providing directional control of time-overcurrent relays with instantaneous elements, a hazard always exists in the race between one directional unit dropping out and the instantaneous element picking up. This problem can be avoided in some applications by using the Type 32 with adjustable sector-width.

For the example shown in Figure 12, the application requires setting each of the four Type 32 relays at each end of the parallel lines, with a maximum torque angle of, say 90^0, and a sector width of 90^0. As shown, no 32 relay picks up due to load current.

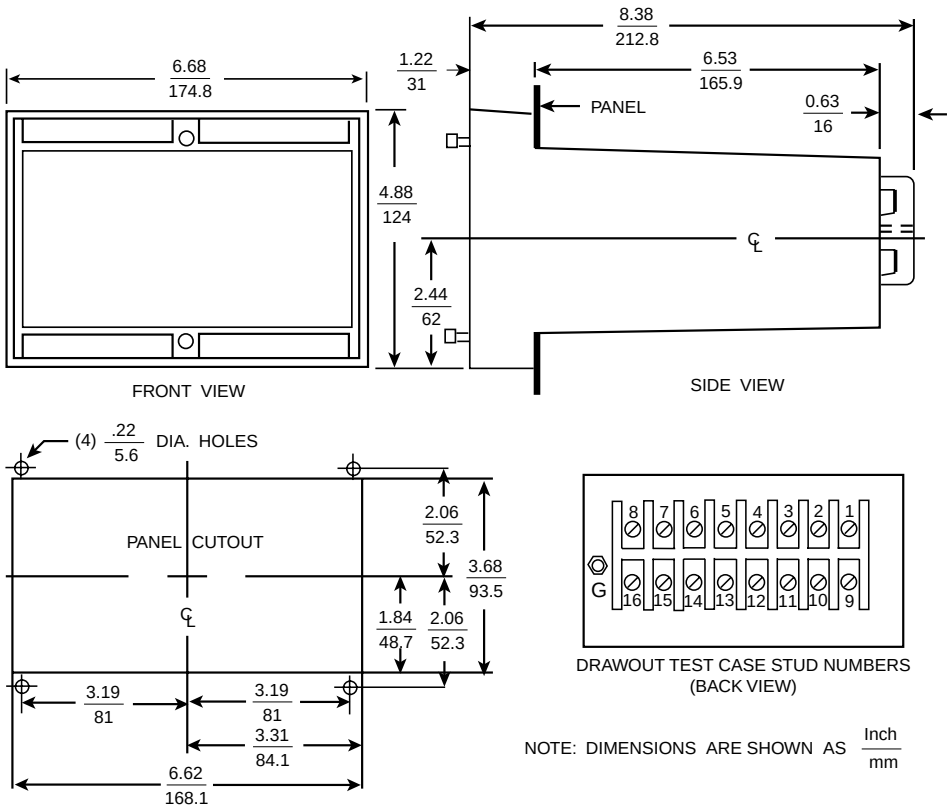


Figure 1: Relay Outline and Panel Drilling

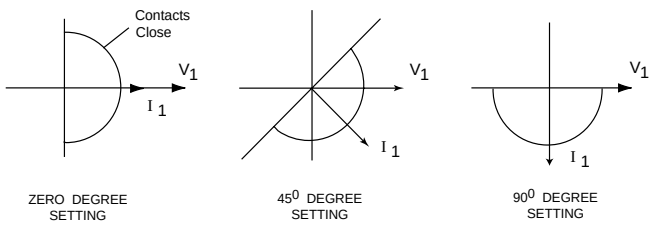
APPLICATION – Type 32

The Type 32 relay is designed for two distinct applications: as the controlling element in directional-controlled time-overcurrent fault protection (Device 67), or as a reverse power relay.

For protection against phase-to-phase, or three phase faults, the Type 32 is used in conjunction with any of the several types of ABB time-overcurrent relays that include torque control provisions. These include Circuit Shield Types 51, 50, 50D, 50H, Micro-51; and the Microshield O/C. Various combinations of controlled time only, or time and instantaneous protection are available by selection of the connections between the 32 and 51 units. This combination represents Device Number 67.

Since the 32 compares the direction of the positive sequence current relative to the positive sequence voltage, in certain cases it may be used to provide ground fault as well as phase fault protection. The requirements for this application are that the minimum ground fault current be greater then the phase overcurrent relay setting, and that the ratio of ground fault current to load current be greater then three times. If these requirements cannot be guaranteed, the application requires separate ground fault protection, such as a combination of Type 32 Q (or 32 D) , controlling a residually connected Type 51. (This combination represents Device Number 67N).

See Figures 2 and 4 for typical connections.



32

Type 32 - Maximum Torque Angle

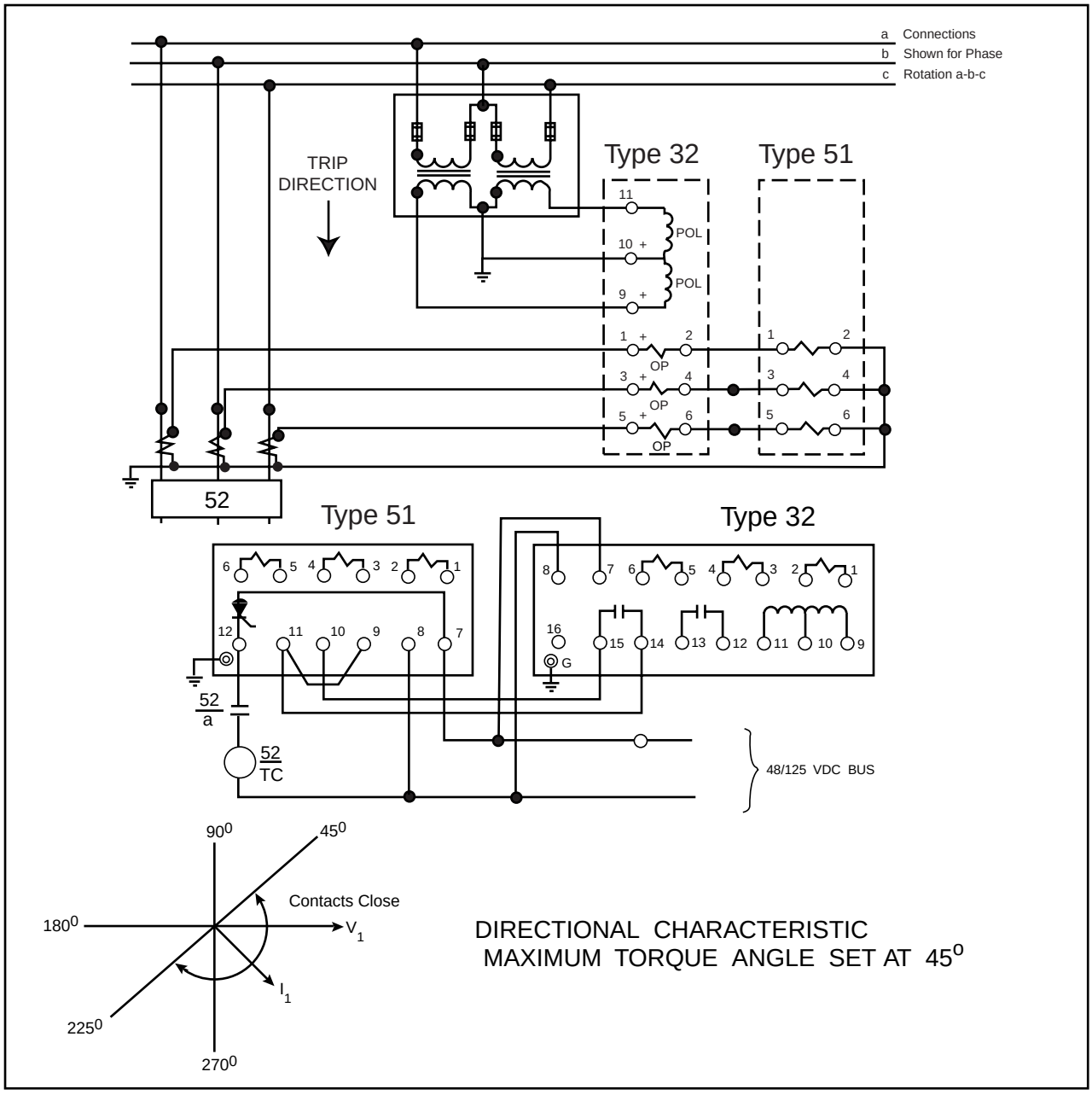
The maximum torque angle of the relay is adjustable form I_1 lag V_1 between 0° and 90°. 45° is an appropriate setting for most applications. However, in unusual situations, the adjustment of the maximum torque angle may be varied to suit the application. For example, lines operating at high leading power factor angles could cause certain single phase directional units to pick up undesirably when using the conventional quadrature connection most frequently used with these types. While 45° is probably suitable even for the most highly leading power factor applications, the 32 can be set to accommodate any angle up to 90°, by reducing the setting toward the 0° position.

Tie Line Protection

The Type 32 finds application as a fast, sensitive, three-phase reverse power relay on a tie between a utility distribution system and an industrial site that has cogeneration, where no power is to be supplied by the cogenerator to the utility. In this application the maximum torque angle should be set to zero. A timer such as the Circuit-Shield Type 62T with timing range 0.01 to 0.99 seconds, should be operated by the Type 32, with the timer tripping the tie breaker after a short delay. See Figure 3.

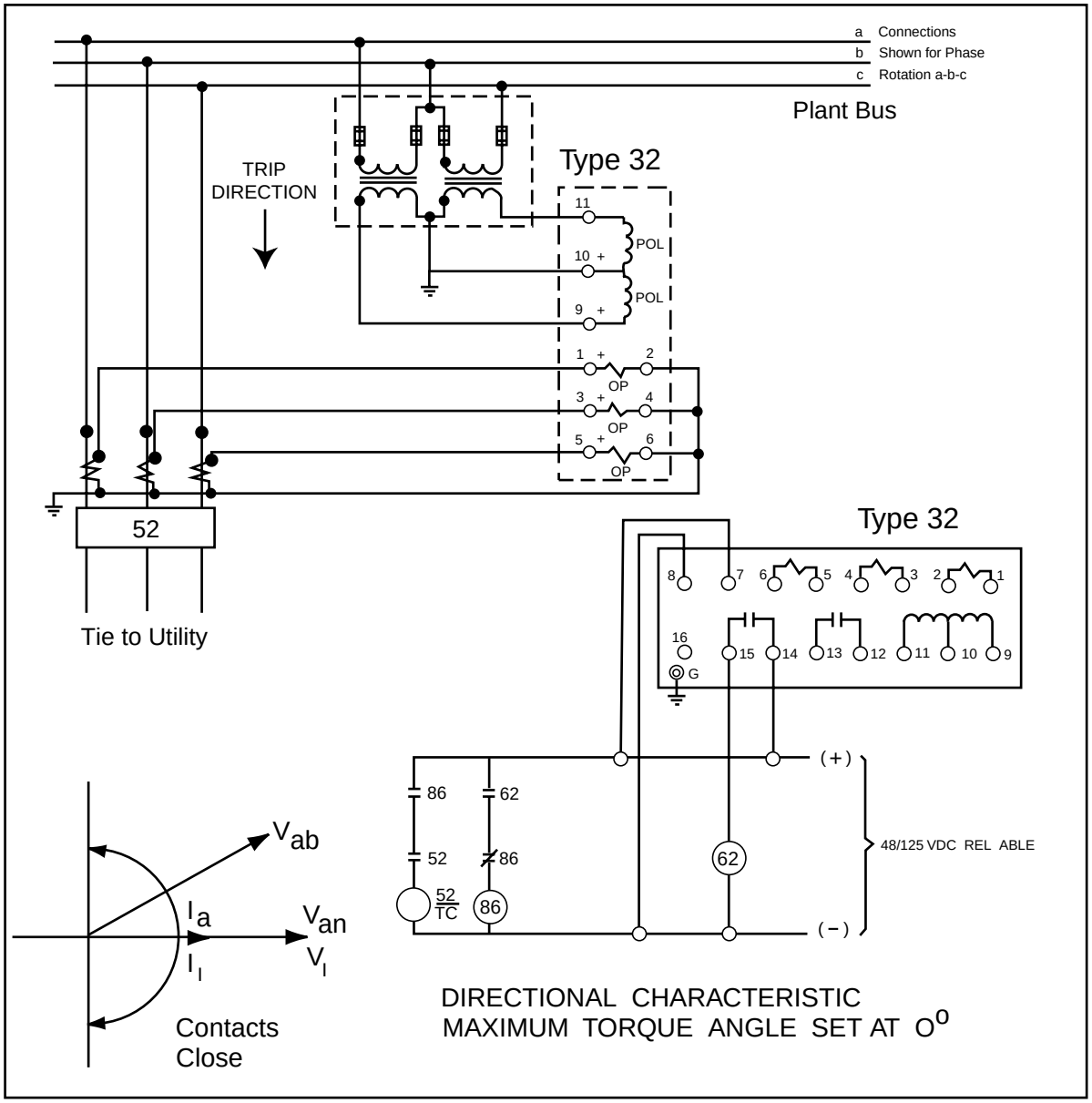
PHASE ROTATION

Note: All diagrams in this instruction book are based on a-b-c phase rotation. For phase rotation a-c-b, both voltage and current connections must be swapped for Types 32 and 32Q. Swap 3-5; and 4-6; 10-11.



Notes: 1. Three-phase time-overcurrent shown is Type 51, catalog series 423.
2. WYE connected potential transformers may be used in place of open-delta connection shown.

Figure 2: Typical Connections, Device 67, Phase Directional Overcurrent using Type 32 and 423 Catalog Series Type 51 Three-Phase Overcurrent Relay



Notes: 1. WYE connected potential transformers may be used in place of the open-delta connection shown.
2. Device 62 is a timing relay such as Type 62T, catalog series 417T.

Figure 3: Typical Connections for Type 32, used for Three-Phase Reverse Power Detection

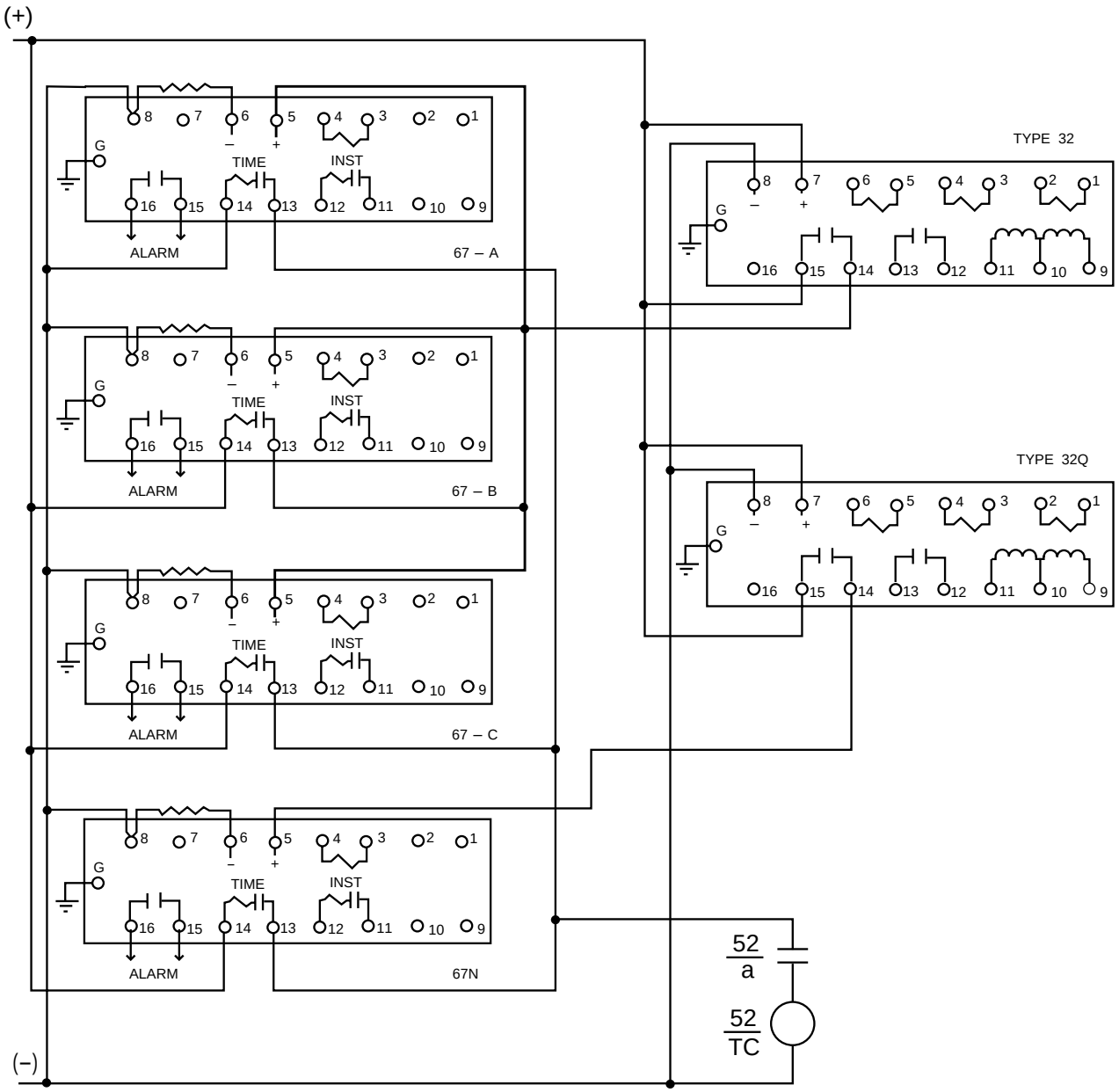


Figure 4: Typical Control Connections - Type Micro-51 used with Circuit-Shield Types 32 and 32Q in a Directional Phase and Ground Overcurrent Scheme

Application - Type 32Q

The Type 32Q is typically used to control a single-phase residually-connected overcurrent relay to provide directional time-overcurrent protection for ground faults, Device 67N. See Figures 4 and 5 for typical connections of the Type 32Q.

The Type 32Q employs sequence filters to determine the negative-sequence content of both the polarizing voltage and operate current, and then compares the phase relationship of these quantities in order to establish direction.

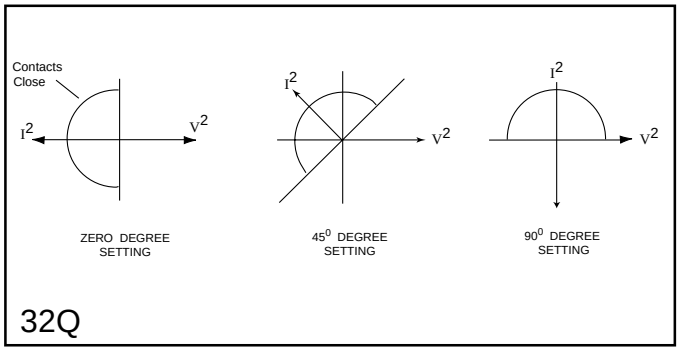
The Type 32Q is preferred over the Type 32D in those cases where incorrect zero sequence polarization results from mutual induction between paralleled lines, or in stations having no zero sequence polarizing quantities.

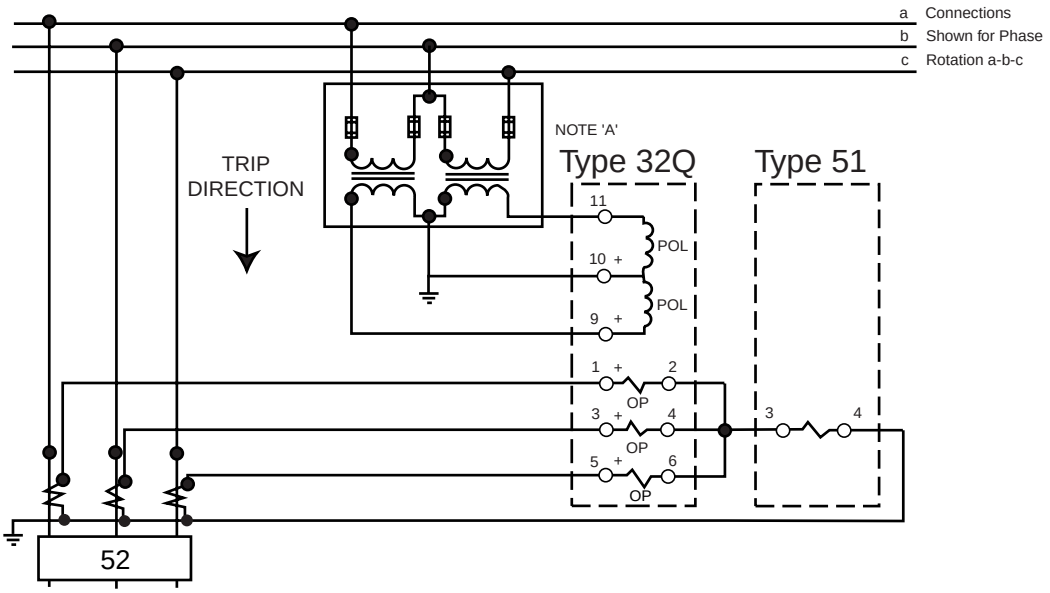
The Type 32Q is especially well suited to medium-voltage metalclad switchgear applications since it can be applied with two potential transformers connected in open-delta.

The polarization voltage may also be derived from (3) wye connected pt's, where the line-to-line secondary voltage is nominally 100, 110, or 120 volts.

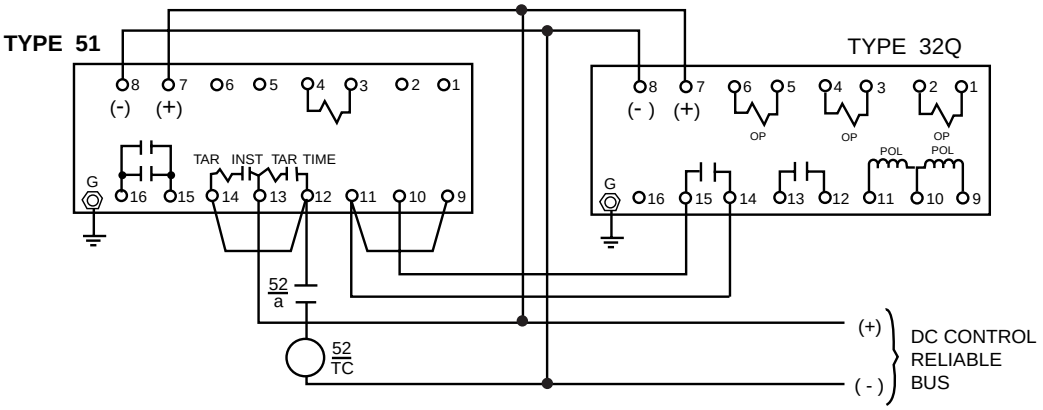
Type 32 Q - Maximum Torque Angle

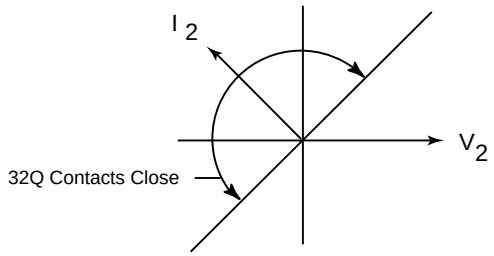
The operating characteristic is shown below. The front panel dial is calibrated 0-90 degrees and corresponds to a range of 180-90 degrees I2 leads V2. Maximum torque angle equals (180 degrees minus the dial setting). A dial setting of 45 degrees would be typical for most applications.





NOTE A: - OR 3 P.T.'S CONNECTED Y - Y.





PHASOR DIAGRAM SHOWN FOR 135^0 MAXIMUM TORQUE ANGLE.
(Type 32Q Dial Setting 45^0) PHASORS DRAWN FOR I_2 AT MAX. TORQUE ANGLE.

Figure 5: Typical Connections, Device 67N, Ground Directional Overcurrent using Type 32Q and 443 Catalog Series Type 51 Single-Phase Overcurrent Relay

Application - Type 32D

This relay may be used as the zero sequence directional unit in conjuction with any of the ABB single-phase time-current relays that have torque-control provisions, or the multiphase relays that have provision for torque-controlling the ground overcurrent element.

The Type 32D may be polarized from either a current source (Io) or a potential source (Vo). See Figures 6 & 7 for typical connections.

Note that since the Type 32D is not a product type relay, the minimum operating current is not a function of the magnitude of the polarization quantity.

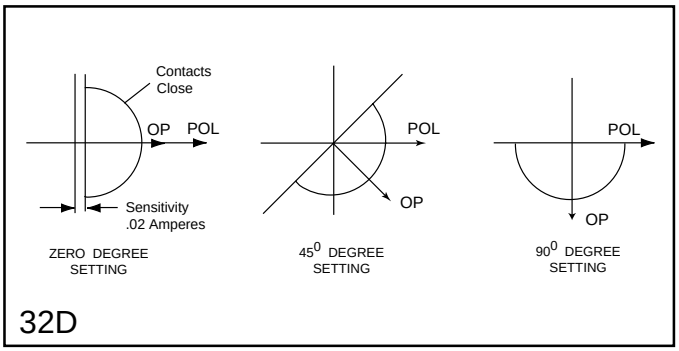
The Type 32D also finds application in ground differential protection for wye connected generators and wye connected transformer windings (also known as restricted earth fault protection). Contact the factory for typical wiring diagrams. Units with 0.1A or 0.4A sensitivity would normally be used for this application.

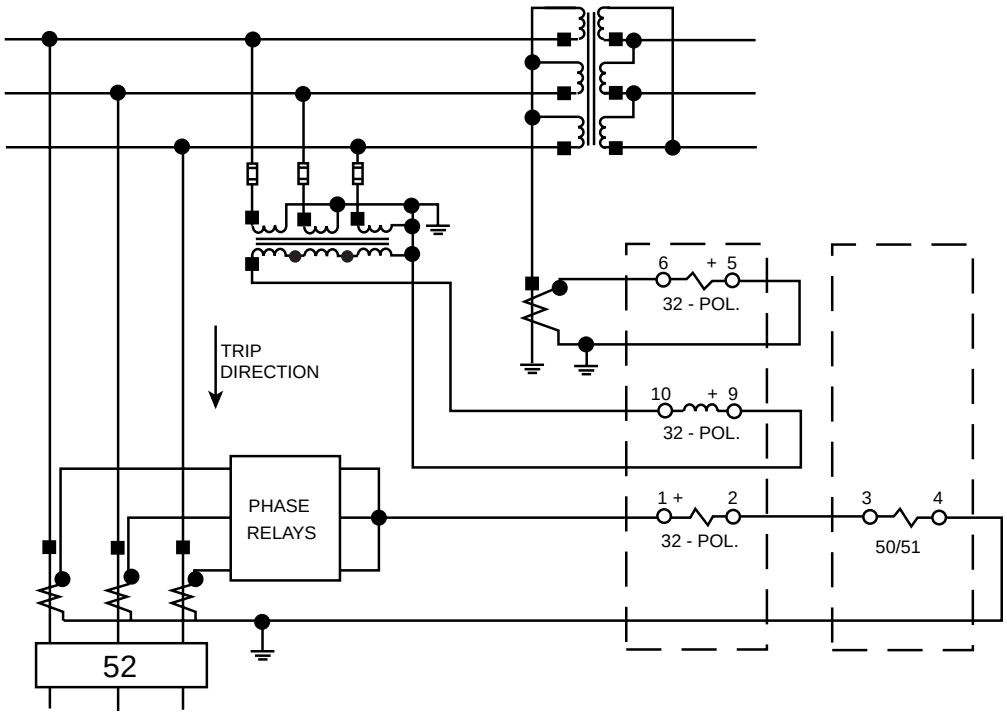
A special version of the Type 32D is available for application on 25 Hz. systems, catalog number 425G1070.

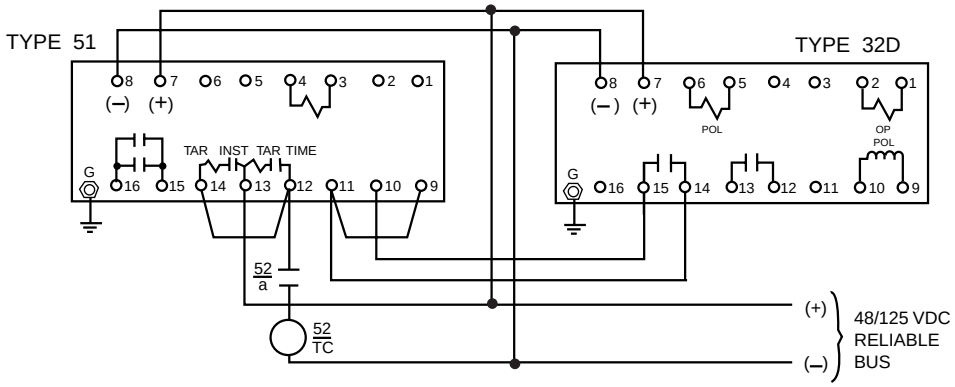
Type 32D - Maximum Torque Angle

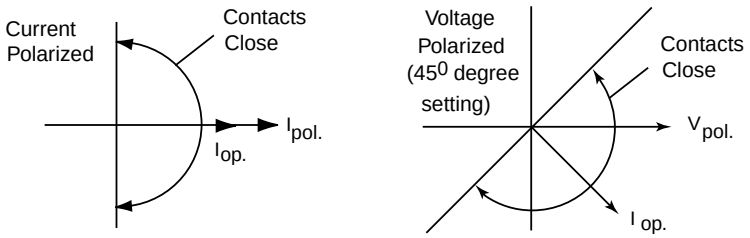
The operating characteristic is shown below. The polarizing quantity (POL) is either current (I_O) or voltage (V_O). The front panel dial is calibrated 0 to 90 degrees, and corresponds to I_{op} LAGS I_{POL} or V_{POL}.

A special version of the Type 32D with maximum torque angle adjustment I_{op} LEADS V_{pol} is available (catalog number 425D4070) and is used for ground fault detection on medium voltage ungrounded systems. Contacts from the Type 32D and a Type 59G would be wired in series to control the associated ground overcurrent relay, such as a Type 50D. Contact the factory for additional details of this application.



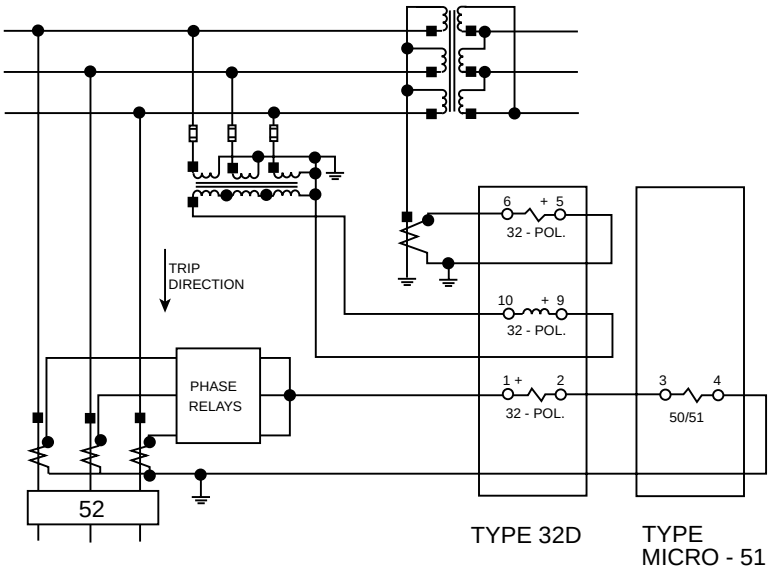






PHASORS SHOWN FOR OPERATING CURRENT
AT MAXIMUM TORQUE ANGLE.

Figure 6: Typical Connections, Device 67N, Ground Directional Overcurrent using Type 32D and 443 Catalog Series Type 51 Single-Phase Overcurrent Relay



Notes: 1. Type 32D can be polarized from either the zero sequence voltage source or the current source.

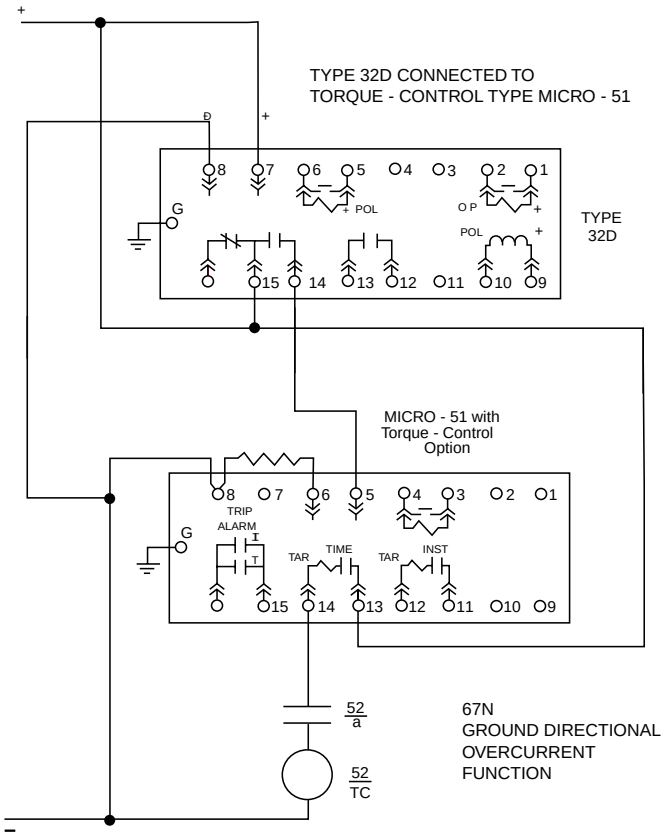


Figure 7: Typical Connections, Device 67N, Ground Directional Overcurrent using Type 32D and 446S Catalog Series Type Micro-51 Single-Phase Overcurrent Relay

Specifications

	Types 32, 32Q	Type 32D
Input Circuit Ratings		
Potential:	120V, nominal, 50 or 60 Hz. 160V, maximum continuous	120V, nominal, 50 or 60 Hz. 210V, maximum continuous
Current:	5A, nominal 10A, maximum continuous 390A, 1 second	5A, nominal 10A, maximum continuous 390A, 1 second
Burden		
Potential:	0.3VA per phase at 120V	0.3VA at 120V
Current:	1.0VA phases A and C at 5A 2.0VA phase B at 5A	0.7VA at 5A
Sensitivity:	Standard models at maximum torque angle 0.02A at 120V 0.02A at 1.0V Models with reduced sensitivity available, see listings of catalog numbers elsewhere in this booklet.	0.02A at 120V 0.02A at 2.0V 0.02A at 0.02A
Maximum Torque Angle Adjustment:	Type 32: 0-90 degrees I_1 lag V_1 Type 32Q: 180-90 deg. I_2 lead V_2 For Type 32Q maximum torque angle equals (180^0- dial setting)	0-90 degrees I_{op} lag V_{pol} 0-90 degrees I_{op} lag I_{pol}
Optional Sector Control	Continuously Adjustable 30-180 degrees	
Control Power Drain: (typical)	24/32 Vdc rating 12 ma standby, 70 ma trip 48/125 Vdc rating 10 ma standby, 30 ma trip 48/110 Vdc rating 10 ma standby, 35 ma trip 220 Vdc rating 10 ma standby, 20 ma trip 250 Vdc rating 10 ma standby, 20 ma trip	
Output Circuit Rating:	See catalog number listings. Units with reed relay type outputs suitable only for torque-controlling other relays. Units with tripping contacts are suitable for trip circuit supervision or for operating auxiliary relays. Rating of tripping contacts: at 125Vdc: 30 A, 5 A, 0.3 A at 250Vdc: 30 A, 5 A, 0.1 A 30 A tripping; 5 A continuous; 0.3 A break inductive	
Operating Time:	Pickup and Dropout: 20 milliseconds typical	
Operating Temperature:	Minus 20 to plus 70 degrees C.	
Seismic Capability:	More than 6g ZPA biaxial broadband multifrequency vibration without damage or malfunction per ANSI/IEEE C37.98.	
Transient Immunity:	1 Mhz Oscillatory and Fast Transient Tests per ANSI/IEEE C37.90.1 and IEC-255	
Weights:		
Shipping	5.2 lbs (2.4 kg)	4.9 lbs (2.2 kg)
Net	4.5 lbs (2.1 kg)	4.2 lbs (1.9 kg)

Type 32 Polyphase High Speed Directional Relay

Type	Protection	Maximum Torque Angle	Sector Width	Sensitivity	Contacts	Internal Connections	Control ⑤ Voltage	Catalog ① Number
32	Three Phase Phase-to-Phase 60 Hertz ①	Adjustable 0° to 90° I_1 lag V_1	180°	0.02A at 1V	②	16D425A	24/32 Vdc	425P0090
							48/125 Vdc	425P0070
							250 Vdc	425P0050
			30° - 180°				24/32 Vdc	425P0091
							48/125 Vdc	425P0071
							250 Vdc	425P0051
			180°	0.4A at 1V	③		24/32 Vdc	425P0093
							48/125 Vdc	425P0073
							48/125 Vdc	425P0176
			30° - 180°	0.02A at 1V	④		24/32 Vdc	425P0097
							48/125 Vdc	425P0077
							24/32 Vdc	425P0098
							48/125 Vdc	425P0078

① For 50 Hertz applications, change letter in catalog number from P to F for Type 32.

② This model preferred when directional relay will be used to control a Type 51 Relay as in directionally controlled overcurrent relay schemes. This model includes self-resetting indicator lamp.

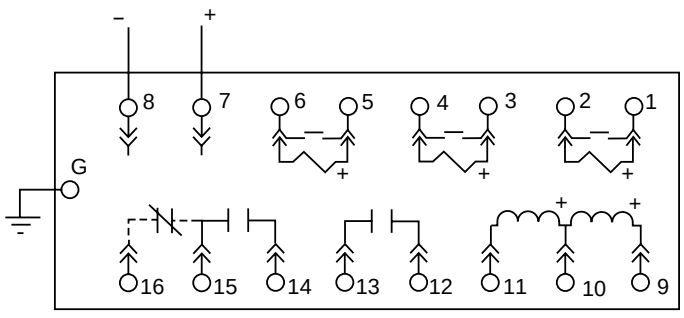
③ This model required when directional relay will be used to operate auxillary relay or trip circuit breaker, as in reverse power schemes. A normally closed contact between terminals 15 and 16 will be supplied in addition to the standard (2) normally open contacts. This model includes manually reset target.

④ This model required when directional relay will be used to operate auxillary relay or trip circuit breaker. A normally closed contact between terminals 15 and 16 will be supplied in addition to the standard (2) normally open contacts. This model includes self-resetting indicator lamp.

⑤ Models available for 110 Vdc and 220 Vdc. Consult factory.

Internal Connection Diagram

16D425A Type 32
Directional Relay
Drawout Test Case



NC CONTACT 15 – 16 SUPPLIED ONLY ON UNITS WITH TRIPPING CONTACTS

Type 32Q Negative Phase Sequence High Speed Directional Relay

Type	Protection	Maximum Torque Angle	Sector Width	Sensitivity	Contacts	Internal Connections	Control ⑤ Voltage	Catalog ① Number
32Q	Ground-Fault Negative Phase Sequence 60 Hertz ①	Adjustable 90° to 180° I_2 lead V_2	180°		②	16D425A	24/32 Vdc	425Q3090
							48/125 Vdc	425Q3070
							250 Vdc	425Q3050
			30° - 180°	0.02A at 1V			24/32 Vdc	425Q3091
							48/125 Vdc	425Q3071
							250 Vdc	425Q3051
					③		24/32 Vdc	425Q3093
							48/125 Vdc	425Q3073
			180°	0.4A at 1V			48/125 Vdc	425Q3176
							24/32 Vdc	425Q3097
							48/125 Vdc	425Q3077
			30° - 180°	0.02A at 1V	④		24/32 Vdc	425Q3098
							48/125 Vdc	425Q3078
			180°	0.1A at 1V			48/125 Vdc	425Q3277

① For 50 Hertz applications, change letter in catalog number from Q to J for Type 32Q.

② This model preferred when directional relay will be used to control a Type 51 Relay as in directionally controlled overcurrent relay schemes. This model includes self-resetting indicator lamp.

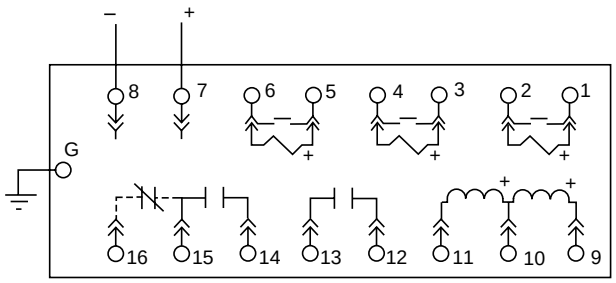
③ This model required when directional relay will be used to operate auxillary relay or trip circuit breaker. A normally closed contact between terminals 15 and 16 will be supplied in addition to the standard (2) normally open contacts. This model includes manually reset target.

④ This model required when directional relay will be used to operate auxillary relay or trip circuit breaker. A normally closed contact between terminals 15 and 16 will be supplied in addition to the standard (2) normally open contacts. This model includes self-resetting indicator lamp.

⑤ Models available for 110 Vdc and 220 Vdc. Consult factory.

Internal Connection Diagram

16D425A Type 32Q
Directional Relay
Drawout Test Case



NC CONTACT 15 –16 SUPPLIED ONLY ON UNITS WITH TRIPPING CONTACTS

Type 32D Dual Polarized High Speed Directional Relay

Type	Protection	Maximum Torque Angle	Sector Width	Sensitivity	Contacts	Internal Connections	Control ⑤ Voltage	Catalog ① Number
32D	Ground-Fault Zero Sequenced Polarized 60 Hertz ①	Adjustable 0° to 90° I_{OP} lag V_{POL} or I_{OP} lag I_{POL}	180°	0.02A at 2V	②	16D425B	24/32 Vdc	425D1090
							48/125 Vdc	425D1070
							250 Vdc	425D1050
			30° - 180°				24/32 Vdc	425D1091
							48/125 Vdc	425D1071
							250 Vdc	425D1051
			180°	0.4A at 1V	③		24/32 Vdc	425D1093
							48/125 Vdc	425D1073
							48/125 Vdc	425D1176
			30° - 180°	0.02A at 2V	④		24/32 Vdc	425D1097
							48/125 Vdc	425D1077
							24/32 Vdc	425D1098
							48/125 Vdc	425D1078

① For 50 Hertz applications, change letter in catalog number from D to K for Type 32D.

② This model preferred when directional relay will be used to control a Type 51 Relay as in directionally controlled overcurrent relay schemes. This model includes self-resetting indicator lamp.

③ This model required when directional relay will be used to operate auxillary relay or trip circuit breaker, as in reverse power schemes. A normally closed contact between terminals 15 and 16 will be supplied in addition to the standard (2) normally open contacts. This model includes manually reset target.

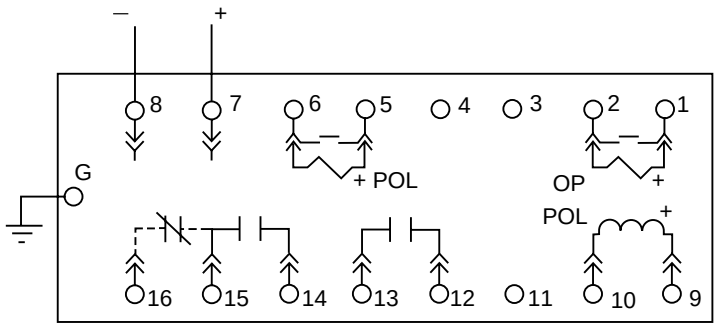
④ This model required when directional relay will be used to operate auxillary relay or trip circuit breaker. A normally closed contact between terminals 15 and 16 will be supplied in addition to the standard (2) normally open contacts. This model includes self-resetting indicator lamp.

⑤ Models available for 110 Vdc and 220 Vdc. Consult factory.

Internal Connection Diagram

16D425B Type 32D

Directional Relay
Drawout Test Case



NC CONTACT 15 - 16 SUPPLIED ONLY ON UNITS WITH TRIPPING CONTACTS

TESTING

Maintenance and Renewal Parts

No routine maintenance is required on the 425 catalog series directional relays. Follow test instructions to verify that the relay is in proper working order. We recommend that an inoperative unit be returned to the factory for repair; however, a schematic diagram will be provided on request. Renewal parts will be quoted by the factory on request.

425 Series Units

Metal handles provide leverage to withdraw the relay assembly from the case. Removing the unit in an application that uses the normally closed contact may result in an operation. Removing a unit that is torque-controlling an associated relay such as an overcurrent relay will likely defeat the protection provided by that relay. The assembly is identified by the catalog number stamped on the front panel and by a serial number stamped on the bottom of the circuit board.

Test connections are readily made to the drawout relay unit by means of standard banana plugs. Current connections are made to the vertical posts at the blade assembly. Control power and output connections are made at the rear vertical circuit board. This rear board is marked for easy identification of the connection points.

Should separation of the upper and lower circuit boards be necessary, remove (2) screws that attach the left and right handle assemblies to the upper printed circuit board. Certain units also require the removal of the (2) screws on the bottom of the lower board that secure the board to the backplane board. The lower circuit board can then be withdrawn forward from the printed circuit connector. An 18 point extender board is available from the factory (catalog number 200X0018) if access to this assembly is required for troubleshooting.

Test Plug

A test plug assembly, catalog 400X0001, is available for use with the 425 series units. This device plugs into the relay case on the switchboard and allows access to all external circuits wired to the case, including the ct circuits. See Instruction Book IB 7.7.1.7-8 for details on the use of this device.

High Potential Tests

High potential tests are not recommended. A hi-pot test was performed at the factory before shipping. If a control wiring insulation test is required, withdraw the relay element from the case before applying the test voltage.

Built-in Test Feature

Tests should be made on a de-energized main circuit. If tests must be made on an energized circuit, be sure to take all necessary precautions. Control power must be available to make this test.

The built-in test is provided as a convenient functional test of the relay and associated circuitry. When you press the test button the relay will operate (in the tripping direction) and its output contacts will transfer. When the button is released the relay will reset. Note that if the 425 series relay is being used to control an overcurrent relay, operation of the directional relay output may or may not result in the operation of the overcurrent relay, depending on the level of ac input current being seen by the overcurrent relay at that time.

Acceptance Tests

Acceptance tests on these relays consists of checking the pickup current with input conditions at the maximum torque angle, and then with a higher level of current, checking the tripping sector phase angles to confirm the directional characteristic.

Type 32

Typical test connections for the Type 32 are shown in Figure 8. If the relay has dual control voltage rating, check the position of the internal control voltage selector before applying dc control voltage.

Apply the polarizing voltage per Figure 8 and the Table of Test Parameters. Increase the operate current equally in all phases and compare to the relay's rating. For the standard 0.02A sensitivity, the relay should pick up at 0.025A or less. Increase the current to 1.0A and vary the phase angles equally (lead or lag) in all three phases to determine the tripping sector. The limits of operation should be per page 21, with a +/-7.5 degree tolerance.

Type 32Q

Typical test connections for the Type 32Q are shown in Figure 8. If the relay has dual control voltage rating, check the position of the internal control voltage selector before applying dc control voltage.

Apply the polarizing voltage per Figure 8 and the Table of Test Parameters. Increase the operate current equally in all phases and compare to the relay's rating. For the standard 0.02A sensitivity, the relay should pick up at 0.025A or less. Increase the current to 1.0A and vary the phase angles equally (lead or lag) in all three phases to determine the tripping sector. The limits of operation should be per page 21, with a +/-7.5 degree tolerance.

Type 32D

Typical test connections for the Type 32 are shown in Figure 9. If the relay has dual control voltage rating, check the position of the internal control voltage selector before applying dc control voltage.

Apply the polarizing voltage to terminals 9 and 10. Increase the operate current and compare to the relay's rating. For the standard 0.02A sensitivity, the relay should pick up at 0.025A or less. Increase the current to 1.0A and vary the phase angle (lead or lag) to determine the tripping sector. The limits of operation should be per page 21, with a +/-7.5 degree tolerance.

Remove the polarizing voltage and apply 1 ampere polarizing current to terminals 5 and 6. Increase the operate current and compare to the relay's rating. For the standard 0.02A sensitivity, the relay should pick up at 0.025A or less. Increase the current to 1.0A and vary the phase angle (lead or lag) to determine the tripping sector. The limits of operation should be per page 21, with a +/-7.5 degree tolerance.

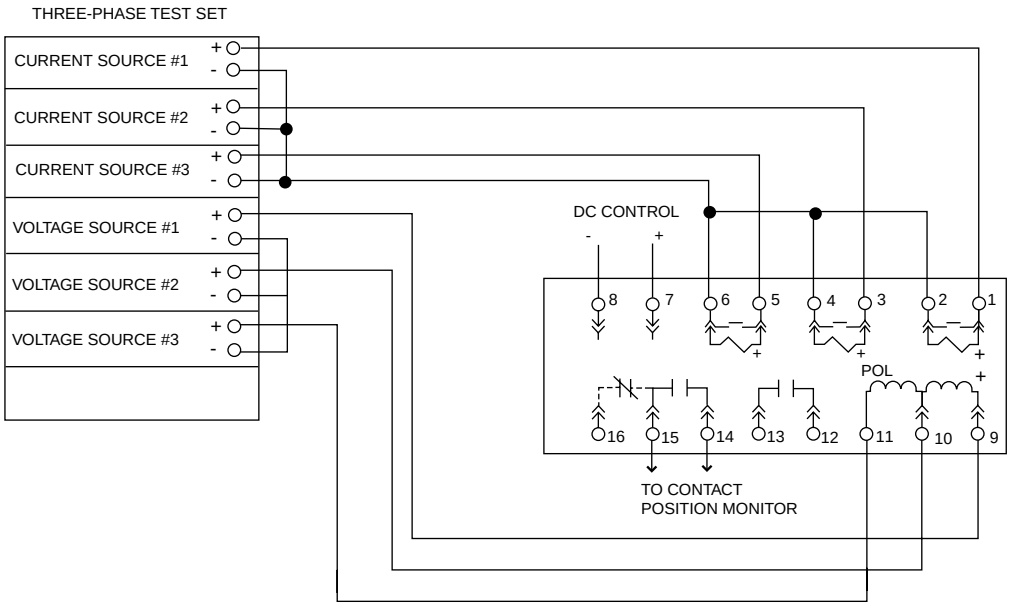


Figure 8: Types 32 and 32Q - Typical Test Connections

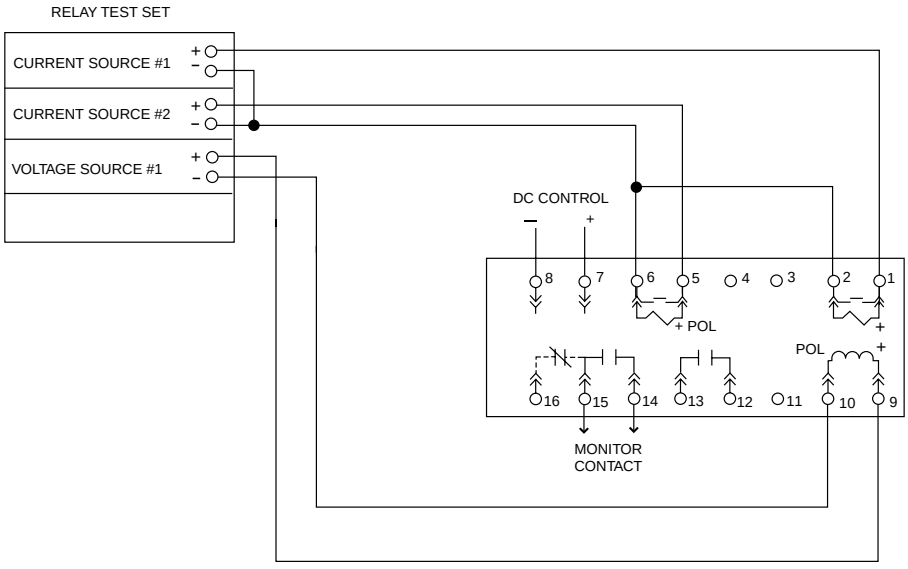


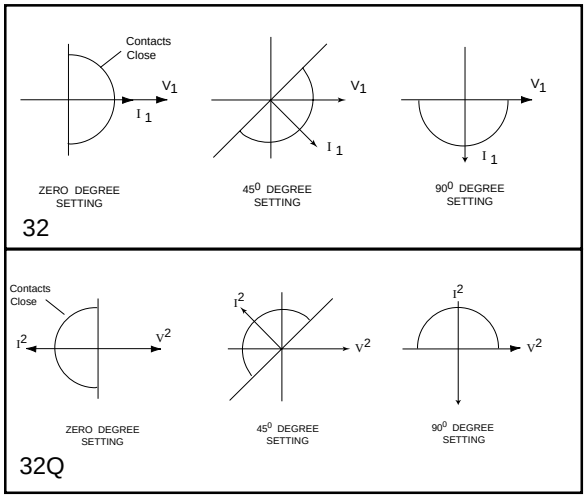
Figure 9: Type 32D - Typical Test Connections

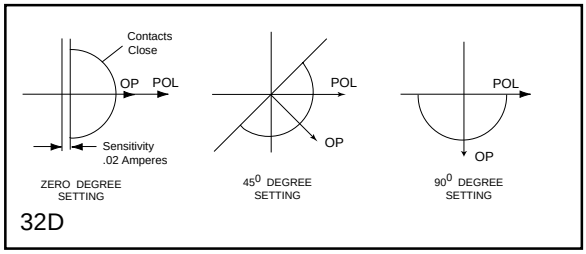
In the following Chart, “MTA” is the maximum torque angle of the relay MTA +120 means the test source phase angle should be 120 degrees leading the maximum torque angle. MTA —120 means a source setting of 120 degrees lagging the Maximum Torque angle.

For the Types 332 and 32D, the MTA is equal to the dial setting and is lagging from zero degrees by that value.

For the Type 32Q, the MTA is leading from zero degrees and is equal in degrees to 180 minus the dial setting.

Test-Setup Parameters						
	Current Sources			**Voltage Sources**		
	Source #1	Source #2	Source #3	Source #1	Source #2	Source #3
Type 32 Pickup Test	I @ MTA	I @ MTA-120 °	I @ MTA+120 °	65v @ 0 deg	65v @ 120 lag	65v @ 120 lead
Vary current magnitude equally on all three current sources to determine operating point of the relay.						
Type 32 Characteristic Angle	1A@MTA	1A @ MTA-120°	1A @ MTA+120 °	65v @ 0 deg	65v @ 120 lag	65v @ 120 lead
Vary phase angle of all three current sources equally and simultaneously to determine operating characteristic angles. Tripping characteristic should be 90 degrees on either side of the Maximum Torque Angle (+/- 7.5 degrees).						
Type 32Q Pickup Test	I @ MTA	I @ MTA +120°	I @ MTA -120 °	65v @ 0 deg	65v @ 120 lead	65v @ 120 lag
Vary current magnitude equally on all three current sources to determine operating point of the relay.						
Type 32Q Characteristic Angle	1A@MTA	1A @ MTA +120°	1A @ MTA -120 °	65v @ 0 deg	65v @ 120 lead	65v @ 120 lag
Vary phase angle of all three current sources equally and simultaneously to determine operating characteristic angles. Tripping characteristic should be 90 degrees on either side of the Maximum Torque Angle (+/- 7.5 degrees).						
Type 32D Pickup Test	I @ MTA	—	—	65v @ 0 deg	—	—
Vary current magnitude to determine the operating point of the relay at the Maximum Torque Angle.						
Type 32D Characteristic Angle	1A@MTA	—	—	65v @ 0 deg	—	—
Vary phase angle to determine operating characteristic angles. Tripping characteristic should be 90 degrees on either side of the Maximum Torque Angle (+/- 7.5 degrees).						
Type 32D Characteristic Angle	1A@MTA	1A@ 0 degrees	—	—	—	—
Vary phase angle to determine operating characteristic angles. Tripping characteristic should be 90 degrees on either side of the Maximum Torque Angle (+/- 7.5 degrees).						





Appendix

Theory of Operation - Type 32

The Circut Shield Type 32 is a three-phase directional relay, consisting of:

Positive-phase sequence voltage segregating network, Positive-phase sequence current segregation network, and one single-phase directional element.

These elements are represented in Figure 10.

Sequence Voltage Network

As shown in Figure 10, the relay is connected to the (delta) voltages, V_{ab} and V_{bc}, through the input transformers. On the secondary side, V_{bc} is phase shifted by 60° lead, and V_{ab} by 0°. These quantities are summed at V_x.

$$\text{Since } V_a = V_0 + V_1 + V_2$$
$$V_b = V_0 + a^2 V_1 + aV_2$$
$$V_c = V_0 + a V_1 + a^2 V_2$$

$$\text{and } V_{ab} = V_a - V_b = V_1(1 - a^2) + V_2(1 - a)$$
$$= \sqrt{3}V_1 e^{j30} + \sqrt{3}V_2 e^{j330}$$

$$V_{bc} = V_b - V_c = V_1(a^2 - a) + V_2(a - a^2)$$
$$= \sqrt{3}V_1 e^{j270} + \sqrt{3}V_2 e^{j90}$$

$$\text{then } V_x \sim V_{ab} e^{j0} + V_{bc} e^{j60}$$
$$= \sqrt{3}V_1 (e^{j30} + e^{j330}) + \sqrt{3}V_2 (e^{j330} + e^{j150})$$
$$= 3V_1 (e^{j0}) + \text{zero}$$

That is, V_x is proportional to the magnitude of the positive-sequence component only.

Sequence Current Network

The relay is supplied with the three phase currents, I_a, I_b and I_c through the input transformers. As shown in Figure 10, the CT_A has a double wound primary, with I_B wound series opposing I_A. Thus, the secondary current of CT_A is proportional to (I_A - I_B). Similarly, the secondary current of CT_B is proportional to (I_B - I_C). Each secondary is loaded with a resistance R, across each of which appear voltages proportional to these (delta) currents.

The equations for the current network proceed analogous to those for the voltage network, with the conclusion that

$$RI_x \sim RI_1 e^{j0}$$

that is, proportional to the positive sequence component only.

Directional Unit

This is a single-phase unit, polarized with the output of the positive sequence voltage segregating network (V_1). The operating current is the output of the current network, proportional to I_1. Thus the relay compares the direction of I_1 to V_1.

"*Maximum Torque*" angle is adjustable from 0 to 90°, that is I_1 lag V_1 by the selected angle. This relationship is shown on Page 5 for settings of 0°, 45°, and 90°. Selection of the angle is easily made by a dial on the front panel.

Typical sensitivity curves are shown in Figures 13 and 14. Note that these are not product-type relays, and so the minimum operating current is not a function of the voltage. The operation of the relay requires only that the voltage be above the minimum (1v) and the current above the minimum (.02A at the maximum torque angle), for a 180° sector width.

The directional unit is of "block-block" design which requires a timer setting equivalent to 90° (4.16 milliseconds at 60 Hz) for a 180° tripping characteristic. Certain models of the TYPE-32 are provided with an adjustable timer which allows setting the timer for a sector width from 30° to 180°. A reduction of sensitivity occurs as the sector is narrowed. Refer to Figures 13 and 14.

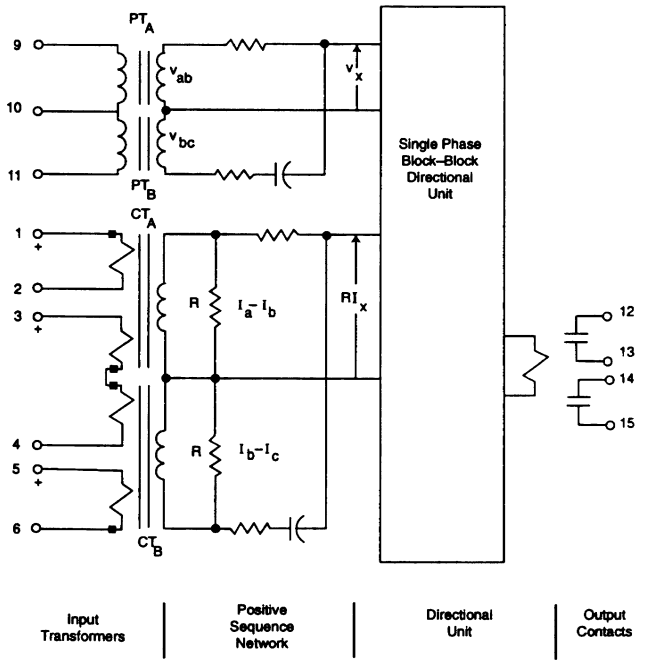


Figure 10: Simplified Circuit Arrangement

Type 32 with Sector Control

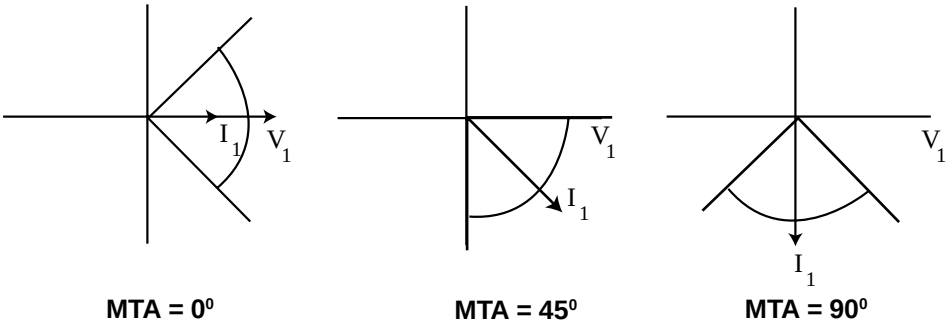


Figure 11: Sector Width Adjusted to 90⁰ in Each Case

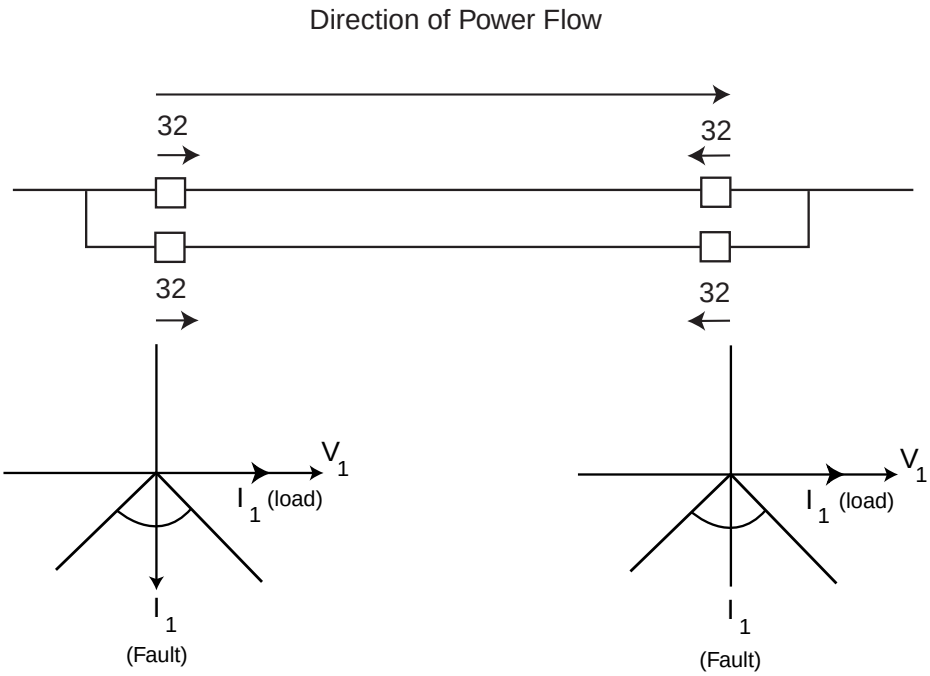


Figure 12: Phasors for Load and Fault at Each End of Line Positive Direction of Current Assumed Into the Line at Each End

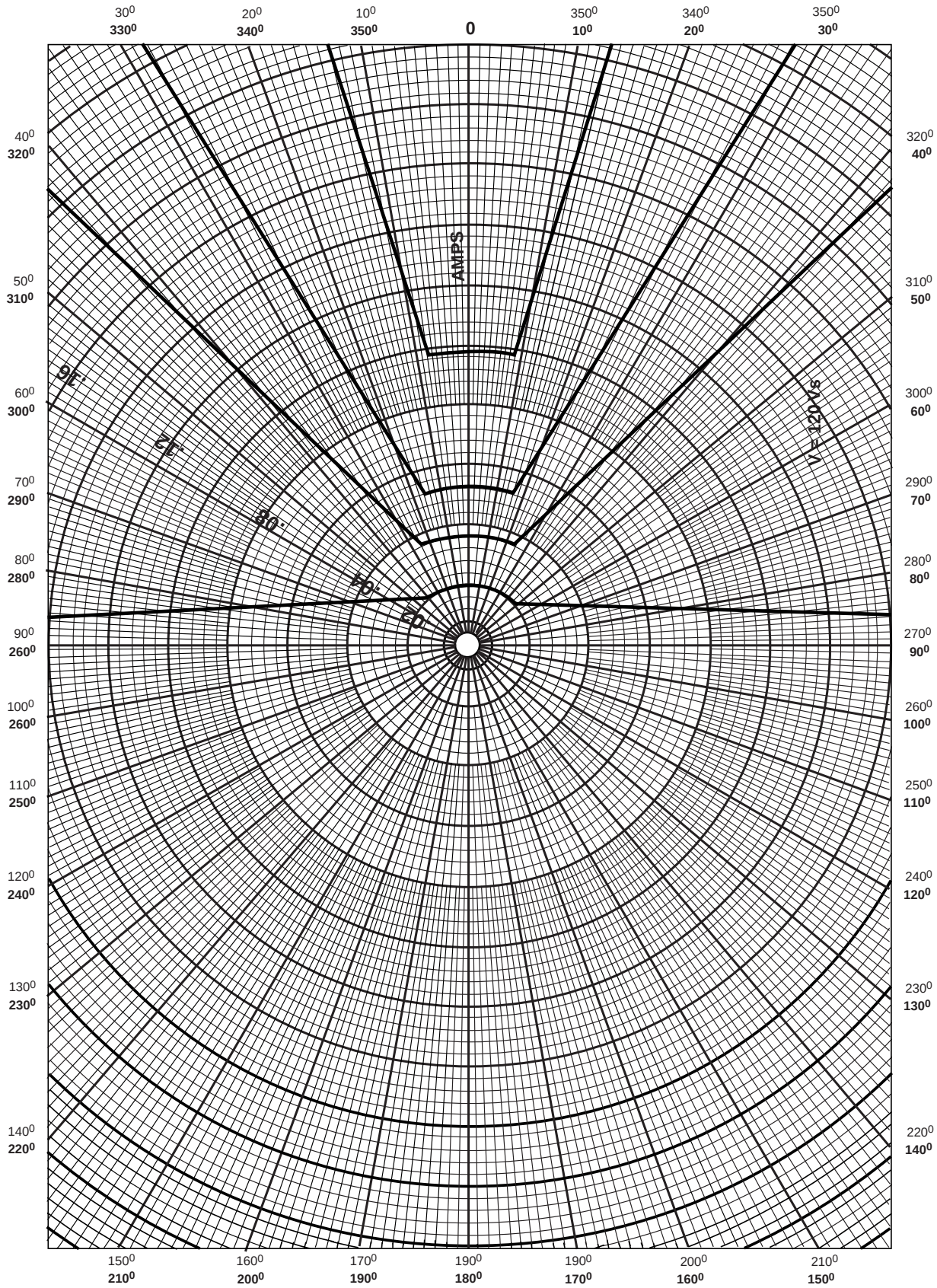


Figure 13: Type 32 Operating Characteristic at 120V Polarization

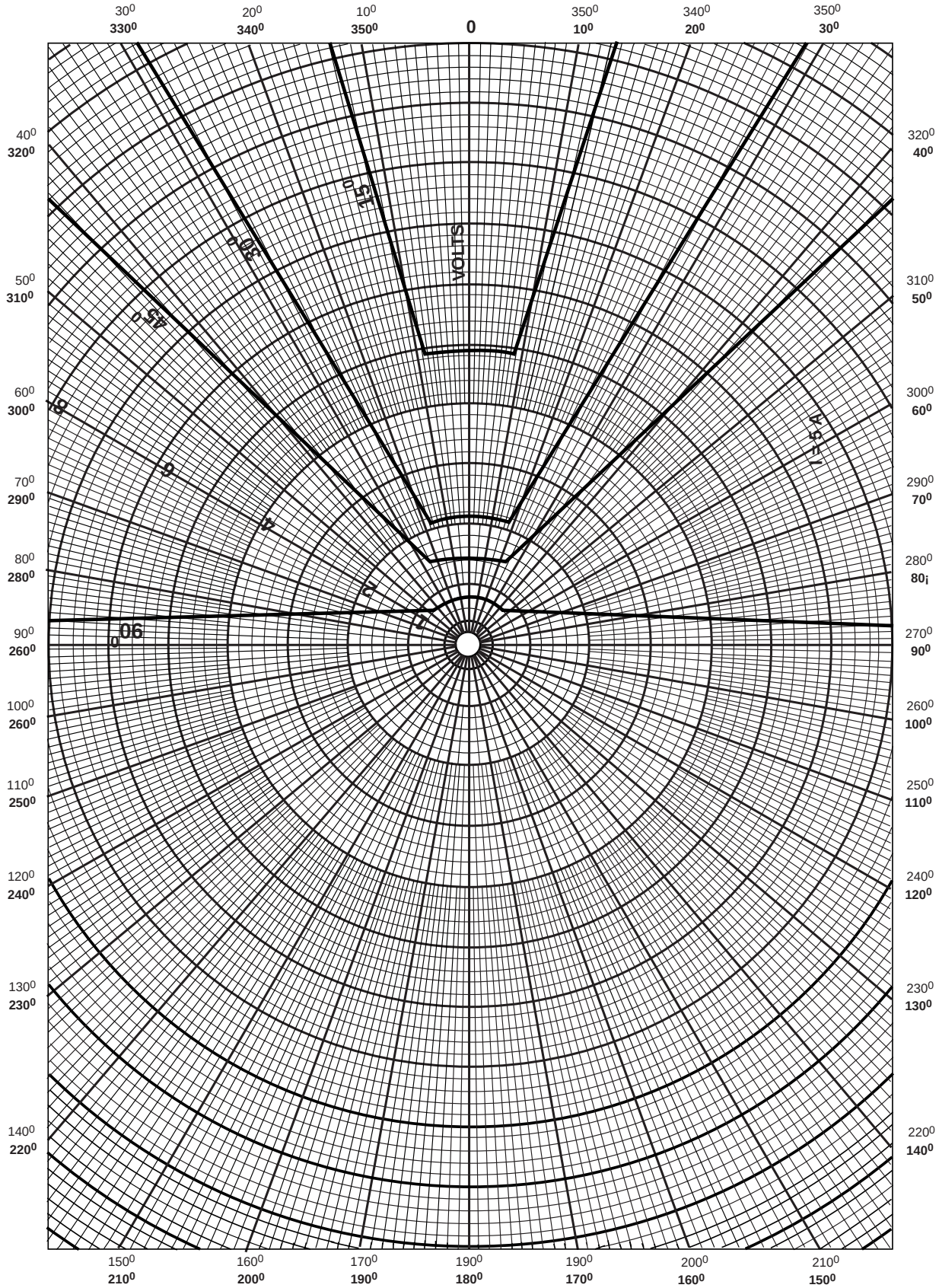


Figure 14: Type 32 Operating Characteristic at 5 Amps Operate Current

Users Notes:

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Instruction Booklet

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Supersedes Issue C

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in conjunction with installation, operation or maintenance. Should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to your local ABB Power T&D Company, Inc. sales representative.

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