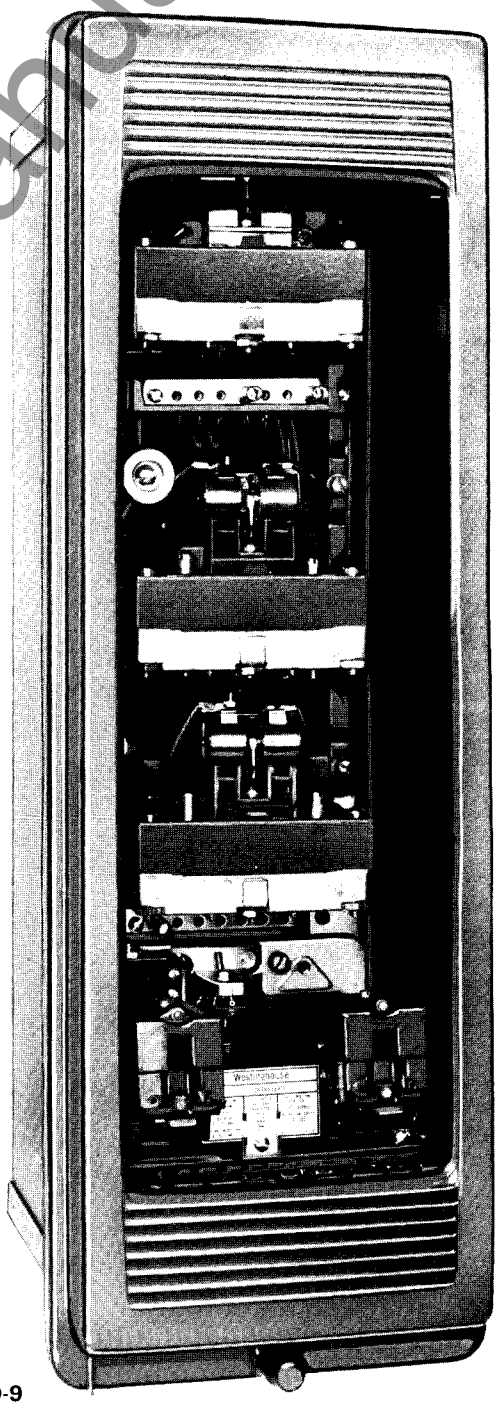
Westinghouse Electric Corporation
Relay-Instrument Division
Newark Plant, Newark, NJ

April, 1976
Supersedes DB 41-130B dated January, 1967
E, D, C/2013/DB

For Phase or Ground Fault Detection –
Transmission Lines and Feeder Circuits

Directional Overcurrent Relays Types IRC, IRP, IRD, IRQ, IRV

IRV-8



IRD-9

Application

Ground Relays – Current and/or Voltage Polarization

The IRP, IRC and IRD line of relays are ground directional overcurrent relays. The time overcurrent and instantaneous overcurrent units are directionally controlled.

The IRC relays are current polarized; IRP relays are voltage polarized; and IRD relays are dual polarized; that is, they can be polarized from a potential source, from a local ground source or from both simultaneously.

Ground Relays – Negative Sequence

The type IRQ line of relays have a directional unit which operates on negative sequence current and voltage while the overcurrent unit operates on residual or ground current. Negative sequence filters connected between the directional unit and the current and voltage transformers supply the negative sequence current and voltage.

IRQ relays are intended for use at locations where present equipment or system conditions do not permit the use of conventional types of directional ground relays operating entirely on residual current and voltage.

A typical application of IRQ relays would be at an ungrounded substation on a grounded system where only two voltage transformers are available or where the potential transformers are on the low side of a wye-delta or delta-wye power transformer bank.

Phase Relays

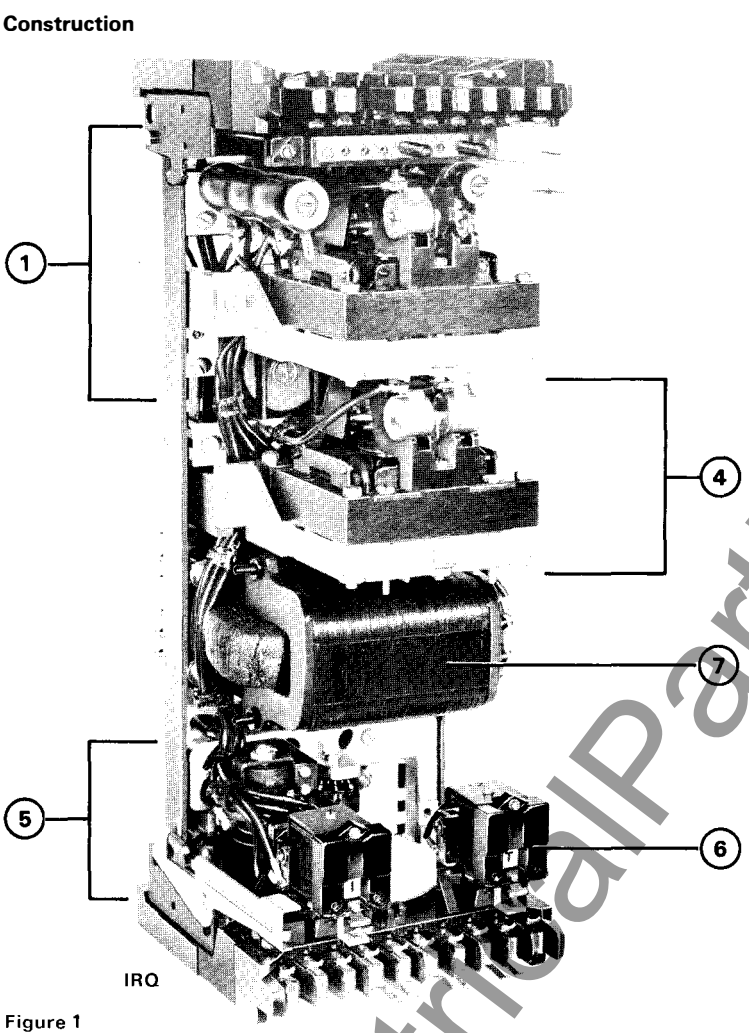
The IRV line of relays are phase directional overcurrent relays. The time overcurrent and instantaneous overcurrent units are directionally controlled

IRV relays are polarized by positive sequence phase-to-phase voltage.

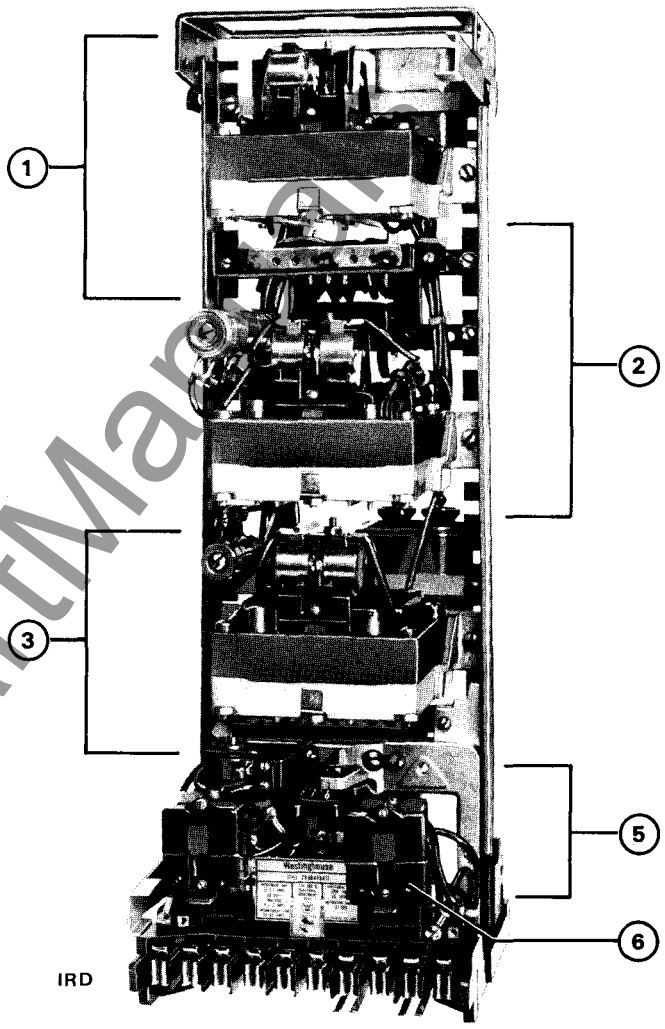
Selector Guide

Protection	Directional Unit Polarization	Time Characteristics							Flexitest Case Type	Device Number
		Short	Long	Definite	Moderately Inverse	Inverse	Very Inverse	Extremely Inverse		
Phase Fault Detection	Voltage polarized by system line-to-line voltage	IRV-2	IRV-5	IRV-6	IRV-7	IRV-8	IRV-9	IRV-11	FT-31	67
Ground Fault Detection	Current Polarized by residual current	IRC-2	IRC-5	IRC-6	IRC-7	IRC-8	IRC-9	IRC-11	FT-31	67N
	Voltage Polarized by residual voltage	IRP-2	IRP-5	IRP-6	IRP-7	IRP-8	IRP-9	IRP-11	FT-31	67N
	Voltage and/or Current Polarized by voltage source,or local ground current source; or both simultaneously	IRD-2	IRD-5	IRD-6	IRD-7	IRD-8	IRD-9	IRD-11	FT-41	67N
	Voltage and current Polarized by negative sequence voltage and current	IRQ-2	IRQ-5	IRQ-6	IRQ-7	IRQ-8	IRQ-9	IRQ-11	FT-42	67N

Construction



IRQ



IRD

Figure 1

(1) Instantaneous Overcurrent Unit (I)

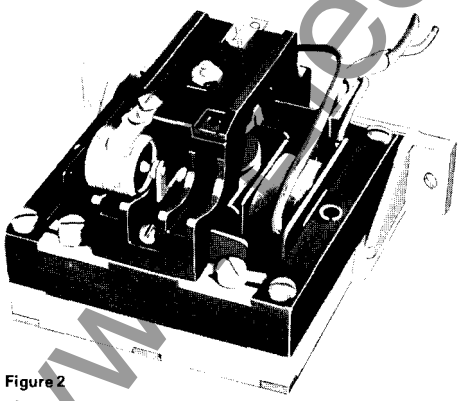


Figure 2

IRC, IRP, IRD, IRQ Ground Relays

This unit is a product type induction cylinder operating as a result of the interaction of two out-of-phase air gap fluxes.The unit is free of vibrations at heavy currents and provides fast, trouble-free reliable operation.

Each of the two pairs of pole windings are energized by ground current from the operating circuit. A capacitor is series-connected with one pair of pole windings to obtain the desired time-phase relationship between the current in the two pairs of coils in order to develop the necessary rotational torque.

As shown in figures 5, 6, 7 and 9, the normally closed contact of the directional unit is connected across one pair of pole windings of the instantaneous overcurrent unit. This contact shunts the operating current around the pole windings, preventing the instantaneous overcurrent unit from developing rotational torque.

Under fault conditions, the short on the instantaneous overcurrent unit coils is removed, allowing the unit to commence closing its contacts almost simultaneously with the directional unit contact, providing high speed operation.

A saturating transformer, having taps on its primary winding, is used to feed the instantaneous overcurrent unit. Tap value current is the minimum current required to just close the relay contacts.

Use of the tapped transformer supplies the same amount of energy to the overcurrent unit for any tap setting at any given multiple of tap current. Consequently, the unit has a constant burden and torque level throughout its entire range, as well as one time curve for the full range. See figure 11.

A non-linear resistor (Varistor) connected across the secondary winding of the transformer and overcurrent unit coils reduces the voltage peaks applied to the phase shifting capacitor and the overcurrent unit.

IRV Phase Relay

The design of the instantaneous overcurrent unit of the IRV phase relay is similar to the ground relays except it receives its energy from the phase current transformers. Also, as shown in figure 8, the capacitor phase shifting circuit is controlled by the normally open contact of the directional unit. This contact also controls operation of the CS-1 auxiliary switch which in turn torque-controls the time overcurrent unit.

(2) Zero Sequence Current Polarized Directional Unit (D)

(3) Zero Sequence Voltage Polarized Directional Unit (D)

(4) Negative Sequence (Current and Voltage) Polarized Directional Unit (D)

The directional unit is also a product type induction cylinder unit similar in construction to the instantaneous overcurrent unit. The electromagnet has two series-connected operating coils mounted opposite to each other.

Interaction of the fluxes generated results in rotation of the cylinder. The directional unit requires no settings.

Refer to Figures 10, 12 and 13 for operating time values.

(5) Time Overcurrent Unit (CO)

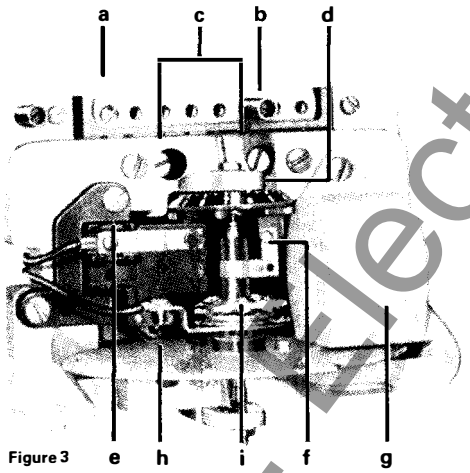


Figure 3

A main tapped coil is placed in the center leg of an "E" type laminated magnetic structure on types -5, -6, -7, -8, and -9. Flux produced by this coil returns through the two outer legs of the electromagnet. A shading coil on the left leg of the electromagnet creates an out-of-phase flux which reacts with the main coil flux in the air gap of the electromagnet to cause disc rotation in the contact closing direction.

Electromagnet for types -2 and -11 are similar in construction, except both outer legs have windings to produce the necessary out-of-phase fluxes required for contact-closing rotational torque.

a. Tap Block

Indicates minimum current required to just close the relay contacts.

b. Tap Screw

Two supplied. When changing taps, the spare is inserted into the new position prior to removal of the previous setting tap screw. This prevents open circuiting of the associated current transformers.

c. Magnetic Plugs

May be screwed into or out of the magnetic circuit to control saturation and to adjust calibration at high currents. Damping magnet and spring adjustments permits calibration at low currents.

d. Time Dial

Indicates initial position of the moving contact over a 270° range. Indexed positions from ½ (minimum time) to 11 (maximum time).

e. Stationary Contact

Made of pure silver. Will close 30 amperes at 250 volts dc. Has sufficient wipe to assure positive contact. In fast breaker reclosing schemes which require quick-opening relay contacts, the metal plate is reversed, holding the stationary contact fixed against the backstop. On double trip relays, adjustment of 1/64" (.3969 mm) contact follow or "wipe" is obtained by use of a vernier adjusting screw on the stationary contact plate.

f. Moving Contact

Also pure silver. It is clamped to the insulated section of the induction disc shaft. Contacts will close 30 amperes at 250 volts dc.

g. Damping Magnet

A high strength Alnico damping magnet is used to control operating time of the relay at low current values.

h. Induction Disc

Spiral shaped to compensate for the spring windup throughout moving contact travel, i.e., provides accurate pickup at any disc position.

i. Spring Adjuster

Used to set the minimum trip current of the relay, and to provide in-between tap pickup adjustment, when desired.

(6) Indicating Contactor Switch (ICS) (Partially Disassembled)

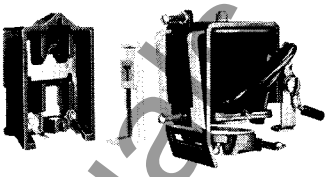


Figure 4

Dc operated. Has a clapper type magnetic armature to which leaf-spring contacts are attached.

When energized, the moving contacts bridge the stationary contacts, completing the trip circuit. The ICS contacts are connected in parallel with the main relay contacts, relieving them of carrying heavy trip currents.

During operation, an operation indicator target drops. The target is orange color, and highly visible.

Taps on the front of the unit provide connection for either 0.2 (left) or 2.0 (right) amperes dc pickup operation.

When using a 125 or 250 volt dc auxiliary WL relay, the 0.2 amp tap is recommended. The 2.0 amp tap is used on 24 or 48 volt dc circuits.

(7) Negative Sequence Filter

This filter is fed by negative sequence current and negative sequence voltage, and consists of reactors and resistors connected as shown in figure 9. (IRQ relays only.)

(8) Auxiliary Switch (CS-1)

Small solenoid dc switch. A tapped resistor is used to allow the use of CS-1 on 24, 28, 125, or 250 Vdc systems.

Operation of CS-1 is controlled by the directional unit (D) which in turn directionally controls the time overcurrent unit (CO). When sufficient power is flowing in the trip direction, CS-1 will operate and permit the time overcurrent unit to operate.

The IRV relays have a second contact on the CS-1 unit which will seal in the coil through the break contact of the I unit. This relieves the make contact of the directional unit (D) from carrying the CS-1 coil current. The break contact of the D unit breaks this seal-in by shorting the CS-1 coil. The break contact of the instantaneous overcurrent unit (I) also breaks the seal-in of the CS-1 coil to prevent tripping on reversed faults where the directional unit was preclosed on load current.

Internal Wiring (Front View)

IRC-2, IRC-5, IRC-6, IRC-7, IRC-8, IRC-9, IRC-11 for Ground Fault Detection ① (FT-31 Case)

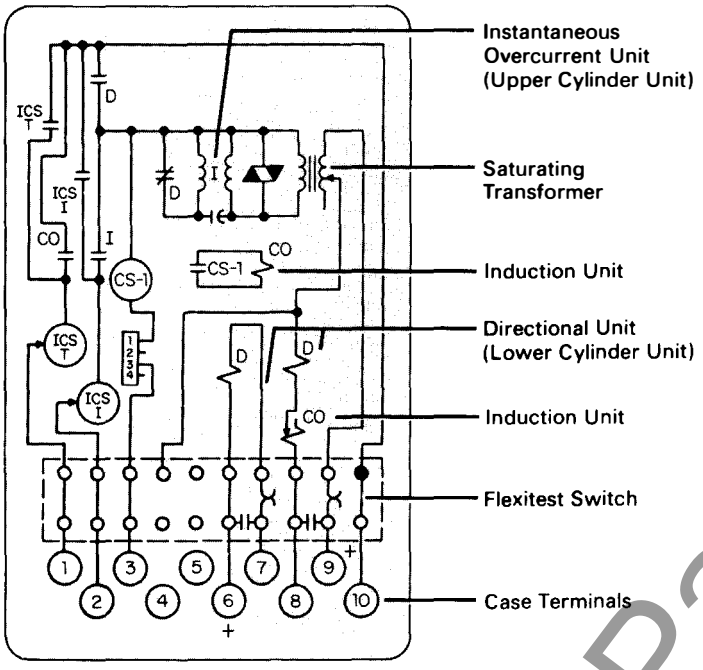


Figure 5 184A034 (Sub. 5)

IRP-2, IRP-5, IRP-6, IRP-7, IRP-8, IRP-9, IRP-11 for Ground Fault Detection ① (FT-31 Case)

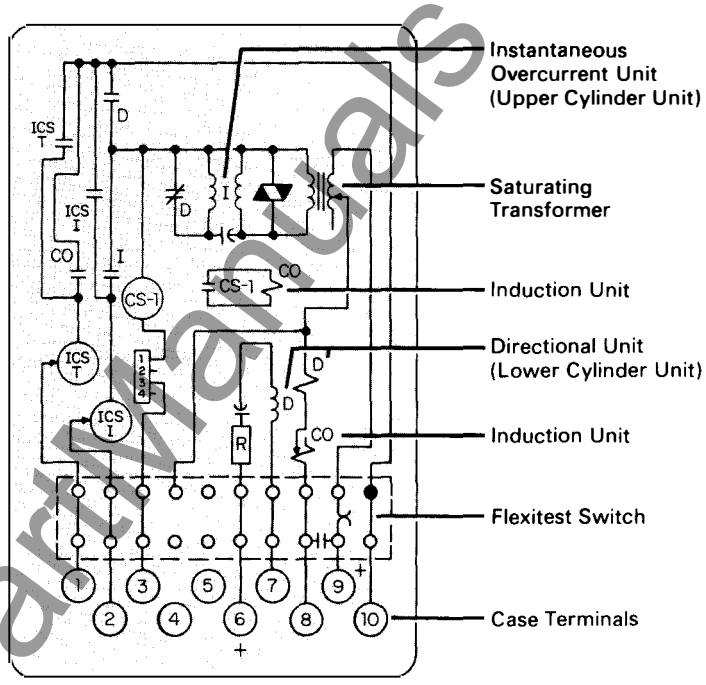


Figure 6 184A033 (Sub 5)

IRD-2, IRD-5, IRD-6, IRD-7, IRD-8, IRD-9, IRD-11 for Ground Fault Detection ① (FT-41 Case)

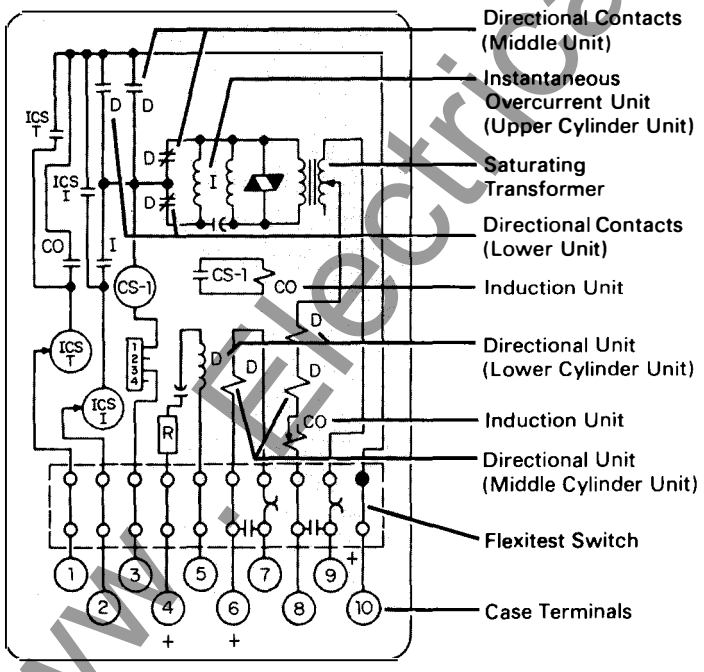


Figure 7 184A020 (Sub. 7)

IRV-2, IRV-5, IRV-6, IRV-7, IRV-8, IRV-9, IRV-11 for Phase Fault Detection ① (FT-31 Case)

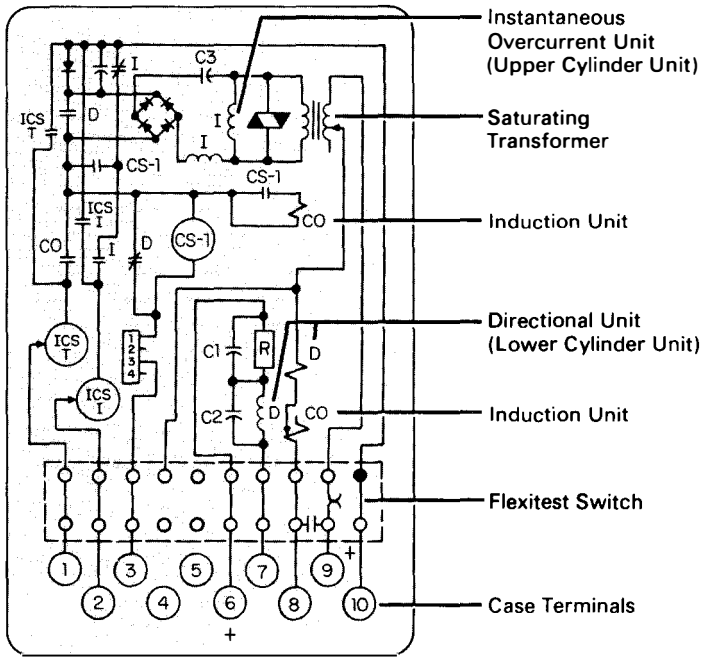


Figure 8 185A421 (Sub. 3)

① With Instantaneous Polarity as Shown (+), Open Directional Contacts Close.

IRQ-2, IRQ-5, IRQ-6, IRQ-7, IRQ-8, IRQ-9, IRQ-11 for Ground Fault Detection (FT-42 Case)

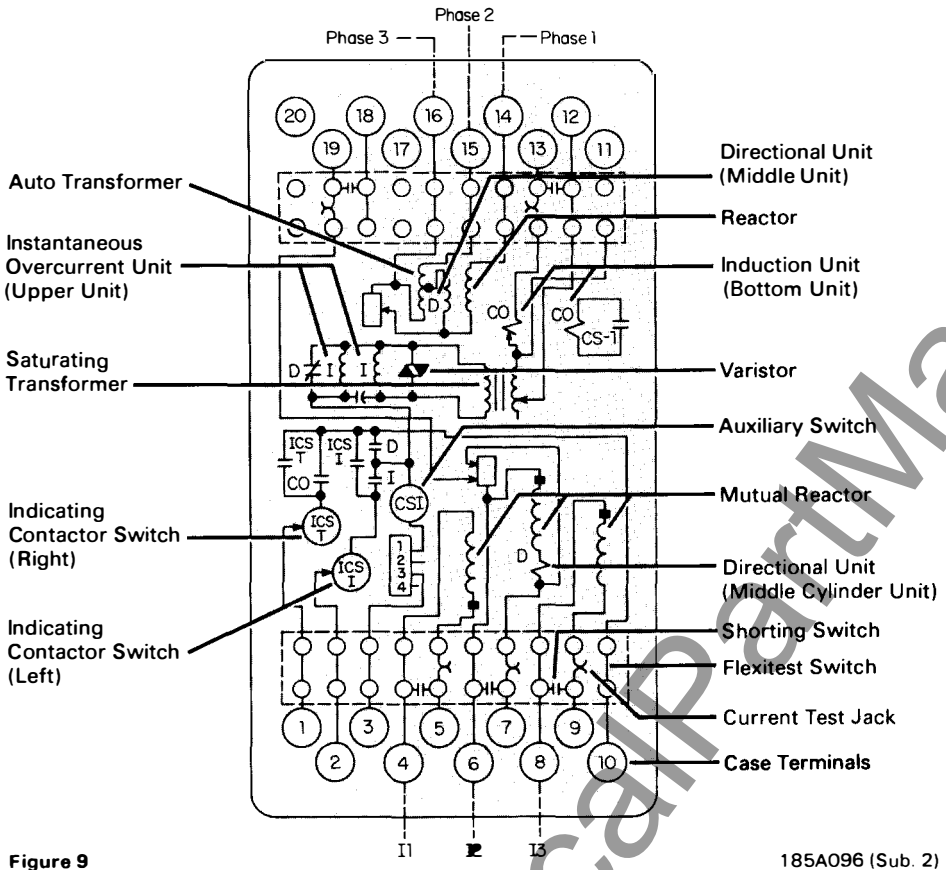


Figure 9

185A096 (Sub. 2)

Relay Settings

The instantaneous and time-overcurrent units require setting, whereas the directional unit does not.

On both overcurrent units, the tap selected determines the minimum pickup or contact-closing current of the unit. Selective time dial settings on the time-overcurrent unit can be determined by referring to the time current curves in the appropriate Instruction Leaflet.

CS-1 Coil Operating Time

Operating time of the CS-1 auxiliary switch is approximately 5 milliseconds.

CS-1 Coil Resistance (Ohms)

1165 ohms for 24/48/125/250 volt relays except the 24 volt IRV which has a 110 ohm coil.

Typical Time Curves

IRC, IRD, IRP Directional Unit

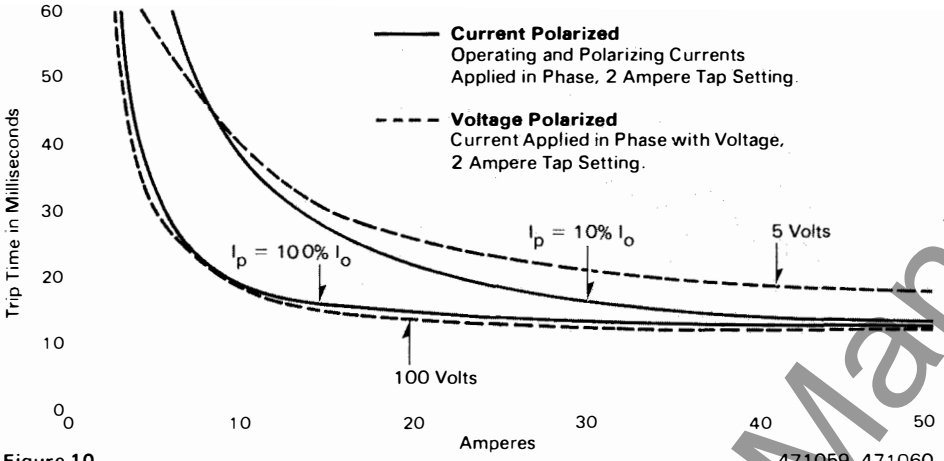


Figure 10 471059, 471060

IRC, IRP, IRD, IRQ, IRV Instantaneous Overcurrent Unit

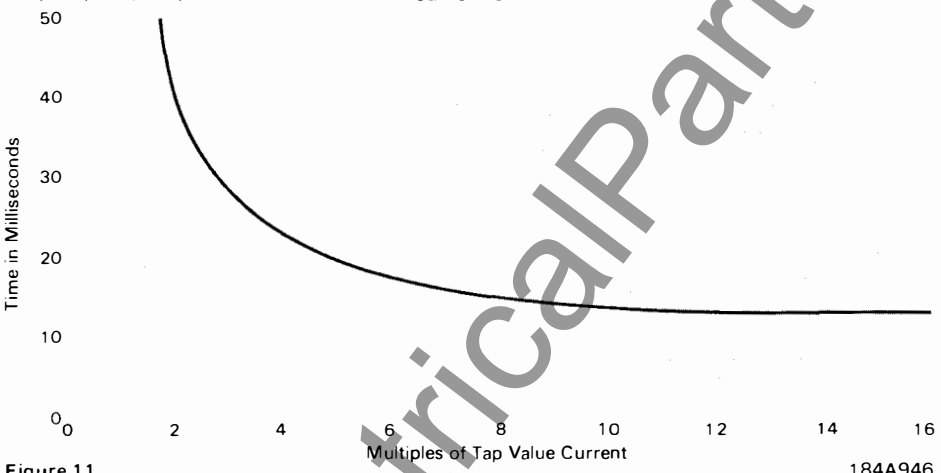


Figure 11 184A946

IRV Directional Unit

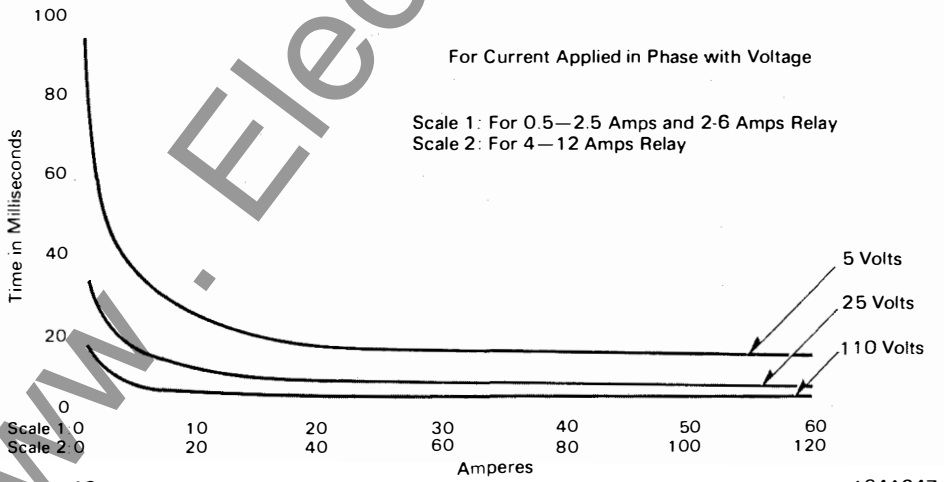


Figure 12 184A947

IRQ Directional Unit

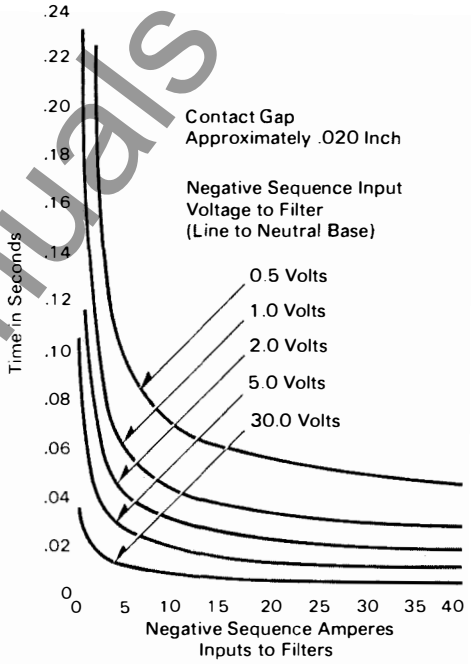


Figure 13 184A995

Sensitivity Curve

IRQ Directional Unit

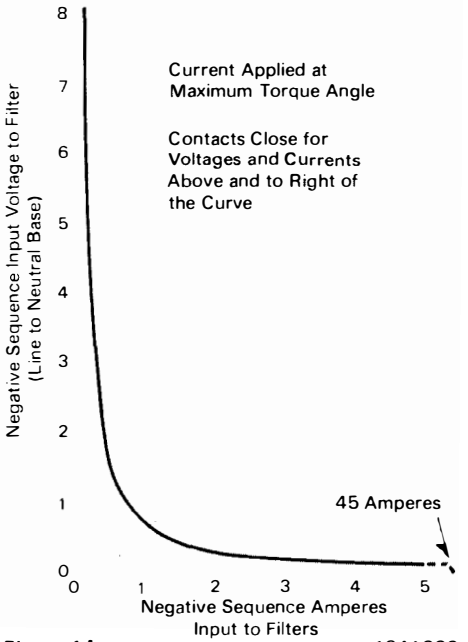


Figure 14 184A996

External Wiring

Type IRC for Ground Fault Detection

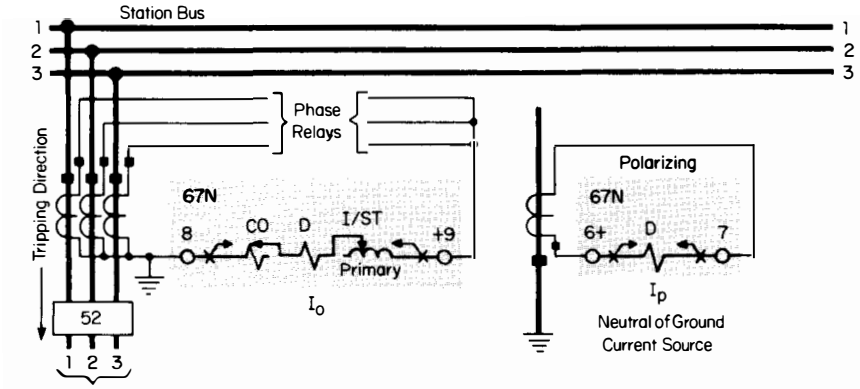


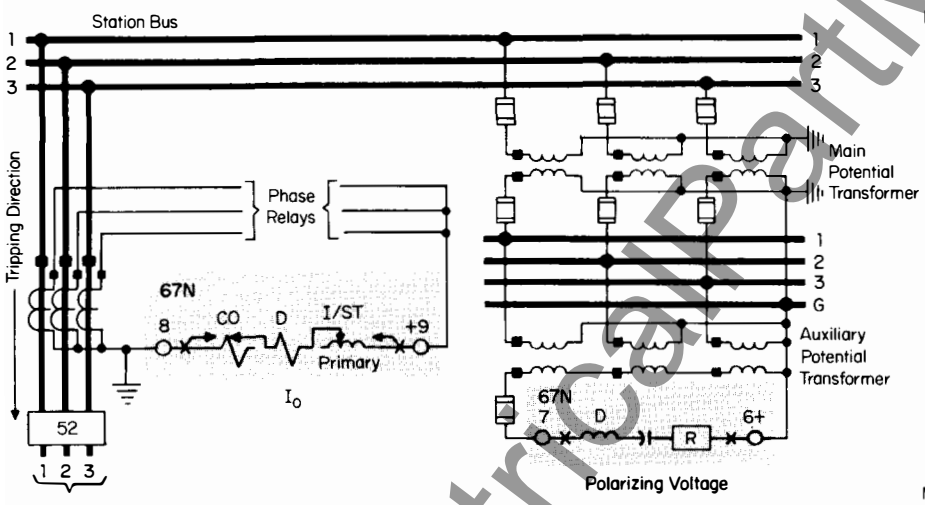
Figure 15 289B507 (Sub. 2)

Device Number Chart (Figures 15, 16, 17)

- 67N —Directional Overcurrent Relay, Type IRC, IRD, or IRP
- D —Directional Unit
- D/U —Upper Directional Unit
- D/L —Lower Directional Unit
- CO —Time-Overcurrent Unit
- I —Instantaneous-Overcurrent Unit
- I/ST —Saturating Transformer for Instantaneous-Overcurrent Unit
- ICS —Indicating Contactor Switch
- CS-1 —Auxiliary Contactor Switch
- 52 —Power Circuit Breaker
- 52a —Breaker Auxiliary Contact
- 52TC —Breaker Trip Coil
- Io —Operating Current
- Ip —Polarizing Current

Note: Figure 16 dc trip bus circuit applies to Figure 15 as well.

Type IRP for Ground Fault Detection



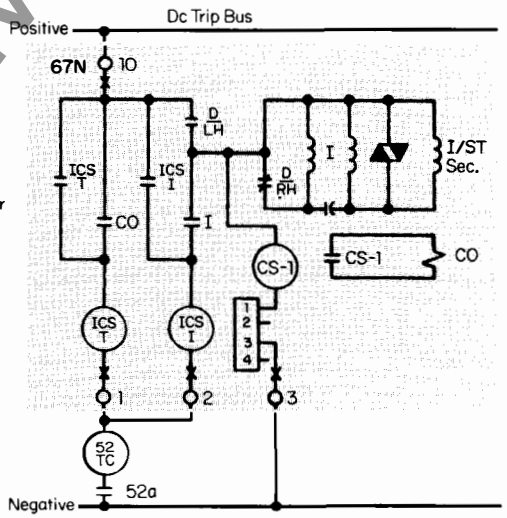
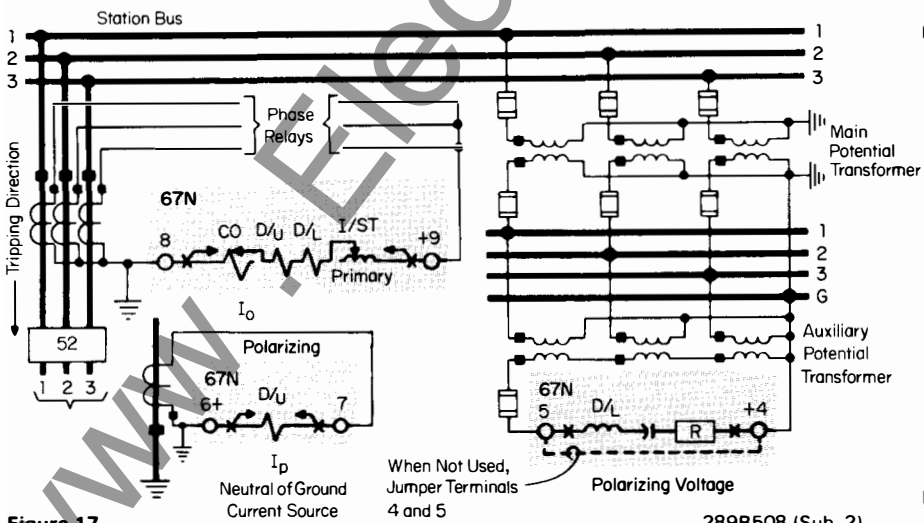


Figure 16 289B506 (Sub. 3)

Type IRD for Ground Fault Detection



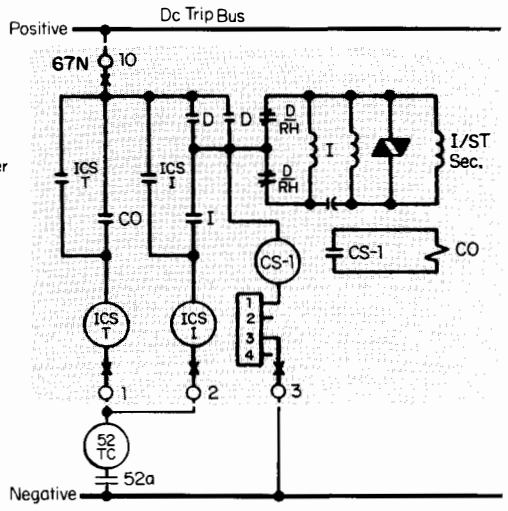
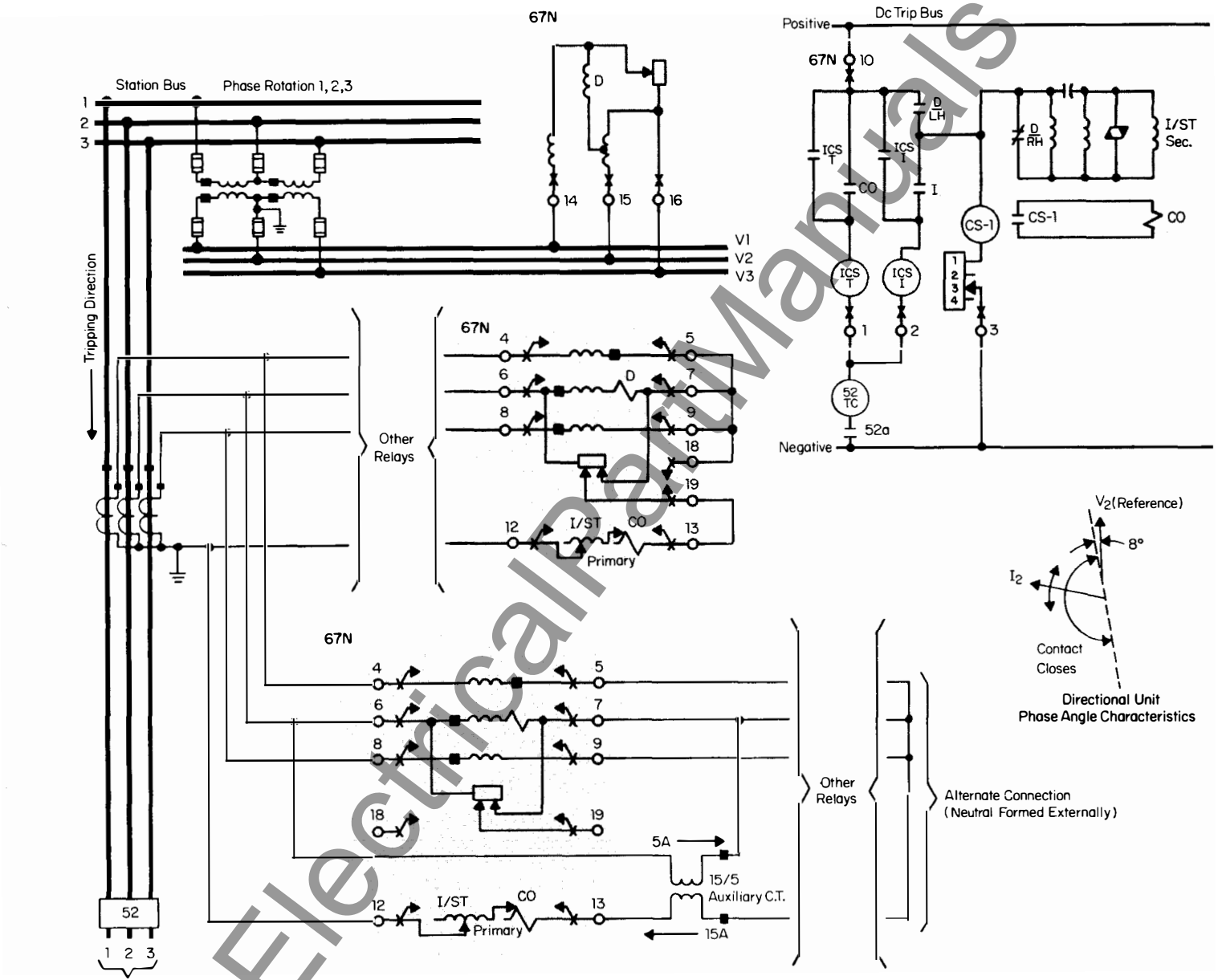


Figure 17 289B508 (Sub. 2)

External Wiring, Continued

Type IRQ for Ground Fault Detection



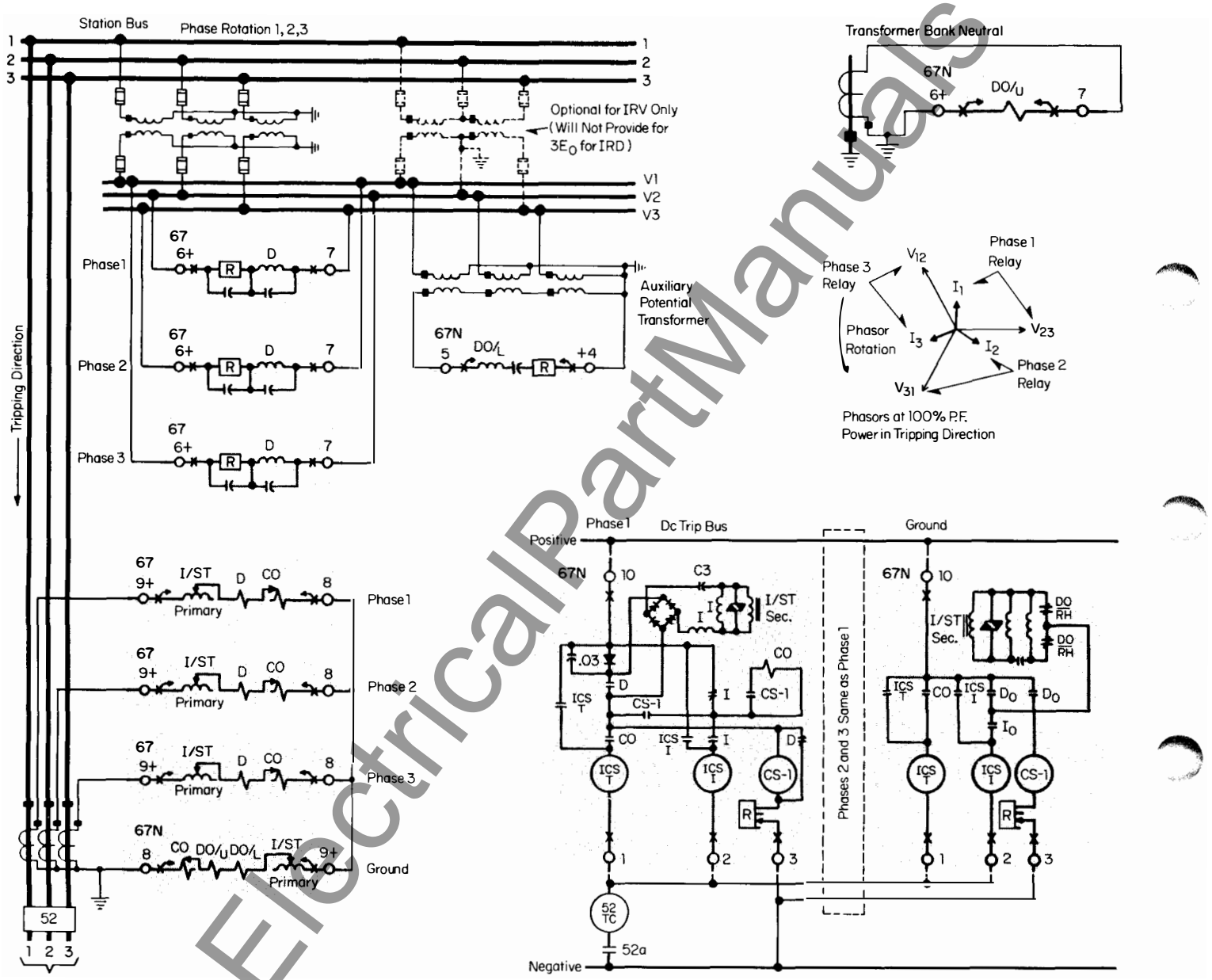
Device Number Chart

67N —Directional Overcurrent Negative Sequence Ground Relay, Type IRQ
D —Directional Unit
I —Instantaneous-Overcurrent Unit
CO —Time-Overcurrent Unit
I/ST —Saturating Transformer for Instantaneous Overcurrent Unit
ICS —Indicating Contactor Switch
CS-1 —Auxiliary Contactor Switch
52 —Power Circuit Breaker
52a —Breaker Auxiliary Contact
52TC —Breaker Trip Coil

Figure 18

External Wiring, Continued

Types IRV and IRD for Phase and Ground Fault Detection



Device Number Chart

67	—Phase Directional Overcurrent Relay, Type IRV	CO	—Time-Overcurrent Unit	I/ST	—Saturating Transformer for Instantaneous Overcurrent Unit
67N	—Ground Directional Overcurrent Relay, Type IRD	D Do	—Directional Unit	52	—Power Circuit Breaker
I, Io	—Instantaneous-Overcurrent Unit	CS-1	—Auxiliary Switch	52a	—Breaker Auxiliary Contact
		ICS-T ICS-I	—Indicating Contactor Switches	52TC	—Breaker Trip Coil

Figure 19

290B747 (Sub. 3)

Characteristics: IRC, IRP, IRD, IRV

Burden Data and Thermal Capacities, Instantaneous – Overcurrent Unit (I)

Ratings

Range	Amps Continuous	1-Second ①	Range	Amps Continuous	1-Second ①
0.5-2	5	100	**4-16**	10	200
1-4	8	140	**10-40**	10	200
2-8	8	140	**20-80**	10	200

① Thermal capacities for short times other than 1 second may be calculated on the basis of time being inversely proportional to the square of the current.

Volt-Ampere Burden See Instr. Leaflets 41-133 and 133.3

Burden Data and Thermal Capacities, Directional Unit (D)

(a) Polarizing Circuit

Relay Type	Burden in Volt-Amps ① @ 120 V	@ 5 A	P.F. Angle ②	Rating Continuous	1-Second	30-Second
IRC		1.45	8° Lag		230 Amp	
IRP	11.2		28° Lead	120 Volts		208 Volts ③
IRD (Current Unit)		1.45	8° Lag		230 Amp	
IRD (Voltage Unit)	11.2		28° Lead	120 Volts		208 Volts ③
IRV	12.5		15° Lead	132 Volts		

① Voltages taken with Rectox type voltmeter.
② Degrees current lags or leads voltage @ 120 V on voltage polarized units & @ 5 A on current polarized units.
③ 10 second rating is 345 Volts.

(b) Operating circuit, See Instruction Leaflets 41-133 for IRC, IRD, IRP relays & 41-133.3 for IRV relays.

(c) Directional Unit Sensitivity

Relay Type	Tap Range in Amps	Minimum Pickup Volts	Minimum Pickup Amps	Phase Angle
IRC, IRD Current Unit	0.5-2.5	. . .	0.5	I_o leading I_p by 40°
	2-6	. . .	0.57	in phase
	4-12	. . .	1.0	I_o leading I_p by 40°
		. . .	1.3	in phase
IRP, IRD Voltage Unit	0.5-2.5	1	2	I lagging V by 60°
	2-6	1	4	I in phase with V
	4-12	1	4	I lagging V by 60°
		1	8	I in phase with V
IRV Voltage Unit	0.5-2.5	1.2	2	I leading V by 30°
	2-6	1.2	2.3	I in phase with V
	4-12	1.2	4	I leading V by 30°
		1.2	4.6	I in phase with V

Characteristics: IRQ ①

Burden data for the Sequence Filter and the Directional Unit

A. Current Burden at 60 hertz

Phase	Continuous Rating, Amps	1-Second Rating, Amps	Watts at 5 Amps	Volt-Amperes at 5 Amps	Power Factor Angle
Positive Sequence Current Applied (no output current to the directional unit)					
1	10	150	5.4	7.5	44° Lag
2	10	150	5.5	5.5	0°
3	10	150	.35	1.28	74° Lag
Zero Sequence Currents Applied					
1	..	...	4.66	5.5	32°
2	..	...	4.92	5.0	10°
3	..	...	3.30	3.7	27°

B. Voltage Burden at 60 hertz Positive Sequence Currents Applied, See IL 41-133.2

C. Instantaneous Overcurrent Unit Operating Current Circuit – 60 hertz

Range	Continuous Rating (Amperes)	One Second Rating † (Amperes)
0.5-2	5	100
1-4	8	140
2-8	8	140
4-16	10	200
10-40	10	200
20-80	10	200

† Thermal capacities for short times other than one second may be calculated on the basis of time being inversely proportional to the square of the current.
① Characteristics apply to complete IRQ relay, not to individual units.

Shipping Weights and Carton Dimensions

Relay Type	Flexitest Case Type	Weight: Pounds (kg) Net	Shipping	Domestic Shipping Carton Dimensions: Inches (cm)
IRC	FT-31	32 (14.5)	30 (13.6)	8 x 10 x 21 (20.3 x 25.4 x 53.3)
IRP	FT-31	23 (10.4)	30 (13.6)	8 x 10 x 21 (20.3 x 25.4 x 53.3)
IRD	FT-41	27 (12.2)	34 (15.4)	8 x 10 x 21 (20.3 x 25.4 x 61)
IRV	FT-31	26 (11.8)	33 (14.9)	8 x 10 x 21 (20.3 x 25.4 x 53.3)
IRQ	FT-42	29 (13.2)	36 (16.3)	8 x 10 x 21 (20.3 x 25.4 x 61)

Westinghouse Electric Corporation
Relay and Telecommunications Division
Coral Springs, FL 33065

July, 1987
Supersedes Descriptive Bulletin 41-130A
dated June, 1969
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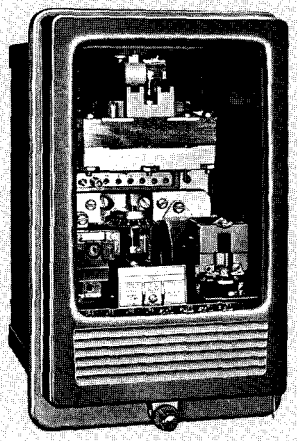
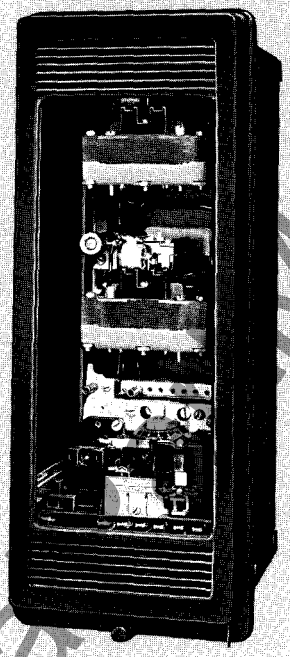
For Phase and Ground Fault Detection
On Transmission Lines And Feeder Circuits

Directional Overcurrent Relays

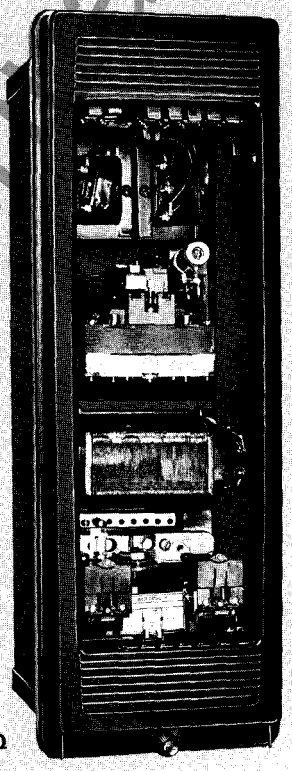
Types CR, CRC, CRP, CRD, CRQ



Type CR-9



Type CRD-8



Type CRQ

Application

Types CR, CRC, CRP, CRD

These relays are used to disconnect transmission and feeder circuits when the current through them in a given direction exceeds a predetermined value.

Type CRQ

This relay provides overcurrent ground detection. The directional unit operates on negative sequence current and voltage, and the overcurrent unit operates on residual or ground current.

The CRQ is applicable for ground protection at an ungrounded substation on grounded systems where only two potential transformers are available, or where the potential transformers are on the delta side of a wye-delta or delta-wye power transformer bank.

Selector Guide

Protection Desired	Directional Unit Polarization	Time Characteristic							Flexitest Case Type	Device Number
		Short	Long	Definite	Moderately Inverse	Inverse	Very Inverse	Extremely Inverse		
Phase Fault Detection	**Voltage Polarized** By System Line-To-Line Voltage	CR-2	CR-5	CR-6	CR-7	CR-8	CR-9	CR-11	FT-21	67
Ground Fault Detection	**Current Polarized** By Residual Current	CRC-2	CRC-5	CRC-6	CRC-7	CRC-8	CRC-9	CRC-11	FT-21	67N
	Voltage Polarized By Residual Voltage	CRP-2	CRP-5	CRP-6	CRP-7	CRP-8	CRP-9	CRP-11	FT-21	67N
	Voltage And/Or Current Polarized By Voltage Source, Or Local Ground Current Source, Or Both Simultaneously	CRD-2	CRD-5	CRD-6	CRD-7	CRD-8	CRD-9	CRD-11	FT-31	67N
	Voltage And Current Polarized By Negative Sequence Voltage and Current	CRQ-2	CRQ-5	CRQ-6	CRQ-7	CRQ-8	CRQ-9	CRQ-11	FT-42	67N

Construction and Operation

Type CR-9

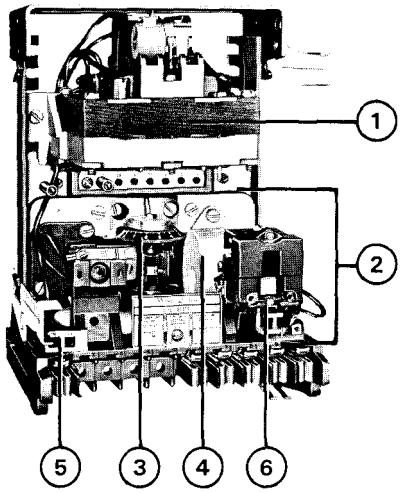


Fig. 1

Type CRD-8

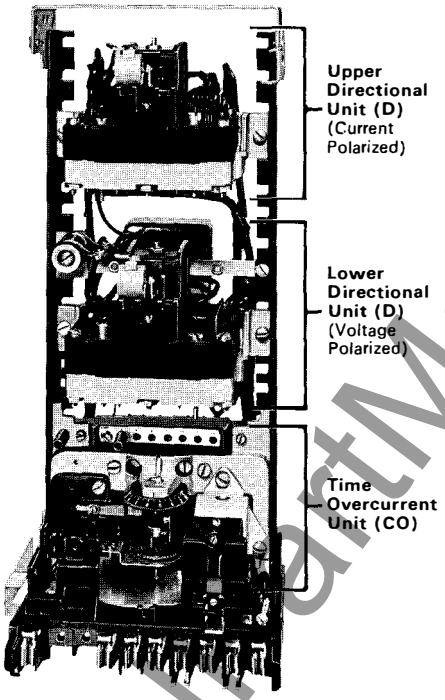


Fig. 2

Type CRQ-9

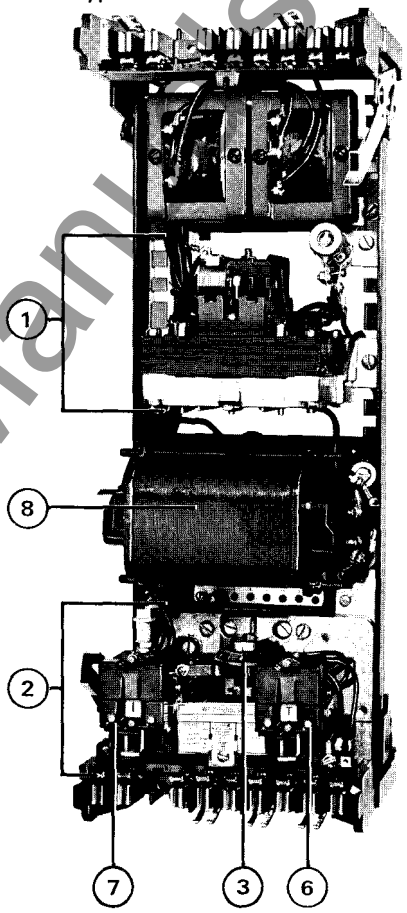


Fig. 3

1 **Directional Unit (D)**

Induction cylinder type unit. Operates on the interaction between the polarizing circuit flux and the operating circuit flux.

At 20 amperes operating current with 120 volts, 60 hertz applied, the operate time of this unit is approximately 10 milliseconds.

2 **Overcurrent Unit (CO)**

The electromagnets for these relays have a main tapped coil located on the center leg of an "E" type laminated structure that produces a flux which divides and returns through the outer legs. A shading coil causes the flux through the left leg to lag the main pole flux. The out-of-phase fluxes produced in the air gap cause a contact closing torque.

3 **Time Dial**

Indicates initial position of the moving contact over a 270° range. It is indexed from position ½ (minimum time) to position 11 (maximum time).

4 **Damping Magnet**

5 **Induction Disc**

6 **Indicating Contactor Switch (ICS)**

Dc operated. A target drops to indicate a tripping operation.

Taps on the front of the unit provide connection for either 0.2 (left) or 2.0 (right) amperes dc pickup operation. When using a 125 or 250 volt dc auxiliary WL switch, the 0.2 ampere tap is used. The 2.0 ampere tap is used on 24 or 48 volt dc circuits.

7 **Indicating Instantaneous Trip**

Ac operated and adjustable over a range of 1 to 4 times minimum pickup.

8 **Negative Sequence Filter**

The current and voltage filters consist of reactors and resistors connected together as shown in the figures 13 & 14.

Operation

Characteristic Time Curve Selection

When the generation is fixed at a constant value and fault current variation is primarily due to the location of the fault along a line, the selection of a relay with a more inverse time characteristic is desirable to obtain selective coordination with adjacent relays.

When the generation fluctuates within large limits such as day time peak and night time low, the tripping time of a relay with an inverse characteristic becomes too dependent on the magnitude of the fault current to permit a smooth coordination so that the relay with definite minimum time is the preferred choice.

Settings

Tap Range

Taps Available

0.5	0.6	0.8	1.0	1.5	2.0	2.5
2	2.5	3	3.5	4	5	6
4	5	6	7	8	10	12

The current range selected depends upon the fault current available at the protected line, as determined by a system study. The lower tap range (0.5-2.5 amperes) is usually applied for ground fault protection, since phase faults result in higher fault currents requiring 2-6 or 4-12 amp range.

Example of Settings For A Loop Protection

Figure 4 illustrates a loop system with one generating station equipped with overcurrent relays and four substations equipped with directional overcurrent relays. Arrows indicate the direction overcurrent must flow to trip the relays, and the time values represent the operating time of the relays as determined by the time dial position.

Considering a fault at M, current will flow to the fault from substations B and C. The 0.35 second relay will trip at substation C and the 0.85 second relay will trip at substation B. While the same fault current flows through the 0.6 second relay at station D, and the 0.85 second relay at station E, the 0.35 second relay at station C will operate and close its contacts before the 0.6 relay at D, or the 0.85 relay at E can trip

Time Dial

Time dial settings determine the operating time of the relay. The effect of the time dial adjustment is shown on the curves in Performance Data 41-100.

Spring Adjuster

By rotation of the spring adjuster, it is possible to obtain continuous pickup current values between the tap settings, thus permitting a precise time coordination.

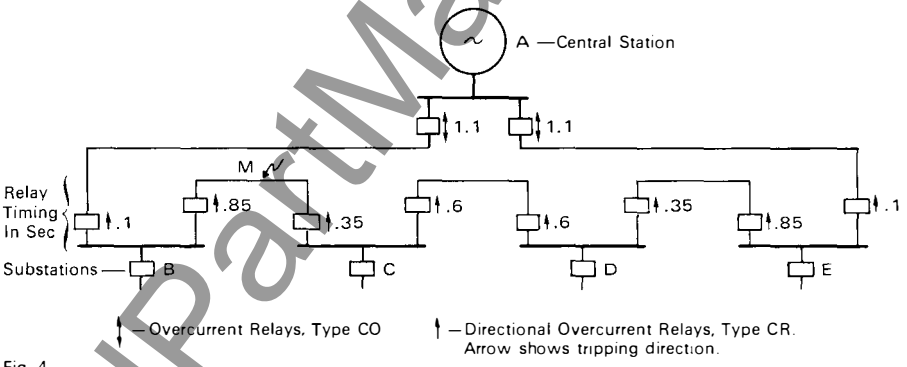


Fig. 4

Internal Wiring Diagrams (Front View)

With Relative Instantaneous Polarity as shown the Directional Unit Contacts close

CR-2, CR-5, CR-6, CR-7, CR-8, CR-9, CR-11 Phase Relay With IIT, Spst, FT-21 Case

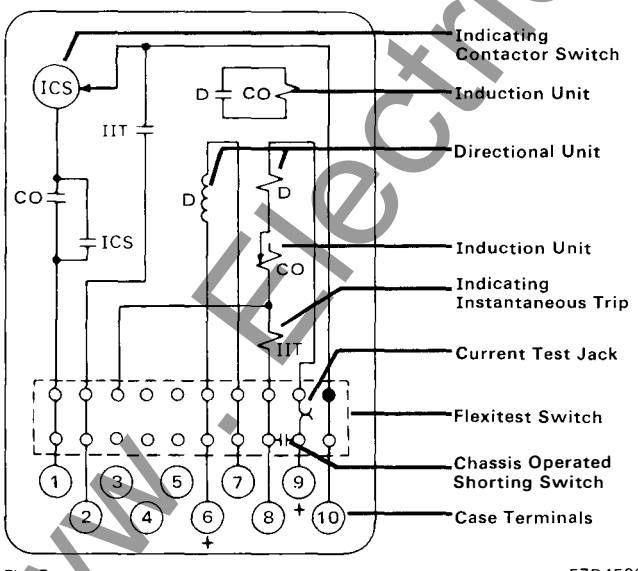


Fig. 5 57D4520

CR-2, CR-5, CR-6, CR-7, CR-8, CR-9, CR-11 Phase Relay, Dpst, FT-21 Case

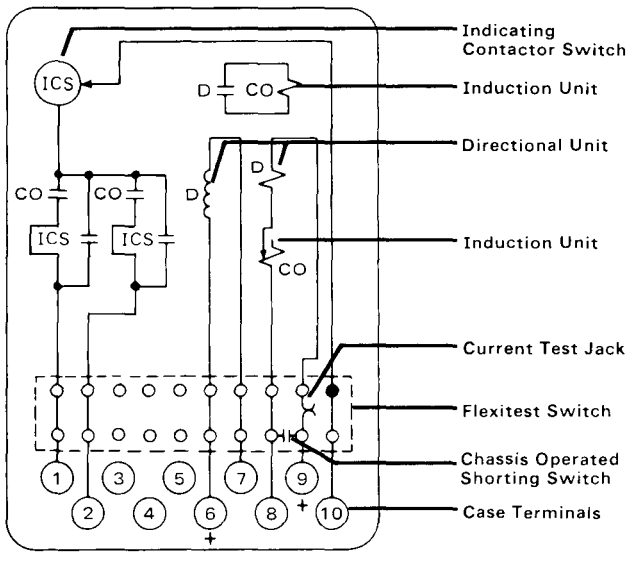


Fig. 6 57D4547

Internal Wiring Diagrams (Front View) With Relative Instantaneous Polarity as shown the Directional Unit Contacts close.

CRC-2, CRC-5, CRC-6, CRC-7, CRC-8, CRC-9, CRC-11 Ground Relay With IIT, Spst, FT-21 Case

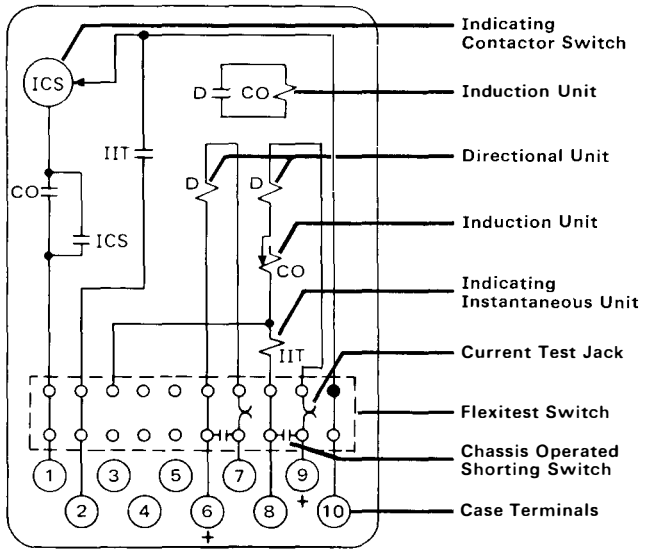


Fig. 7 57D4540

CRC-2, CRC-5, CRC-6, CRC-7, CRC-8, CRC-9, CRC-11 Ground Relay, Dpst, FT-21 Case

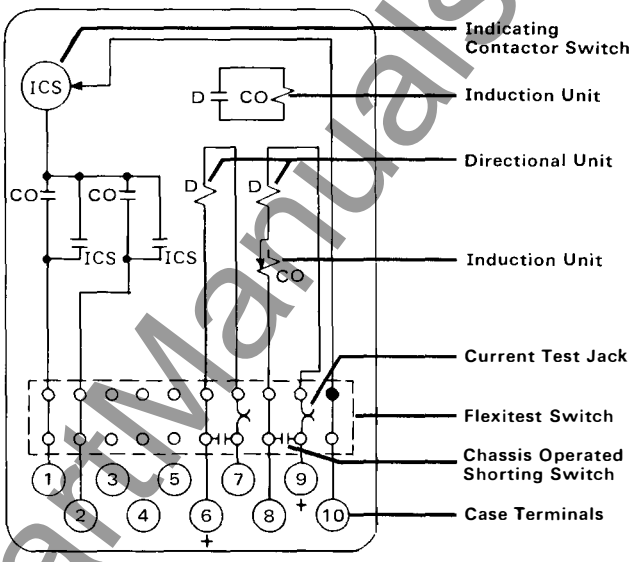


Fig. 8 57D4543

CRD-2, CRD-5, CRD-6, CRD-7, CRD-8, CRD-9, CRD-11 With IIT; Spst, FT-31 Case

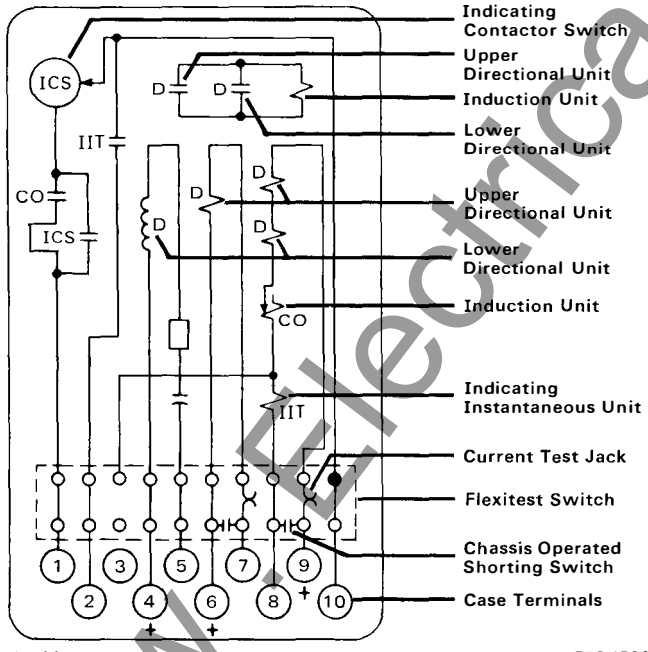


Fig. 11 57D4560

CRD-2, CRD-5, CRD-6, CRD-7, CRD-8, CRD-9, CRD-11, Dpst, FT-31 Case

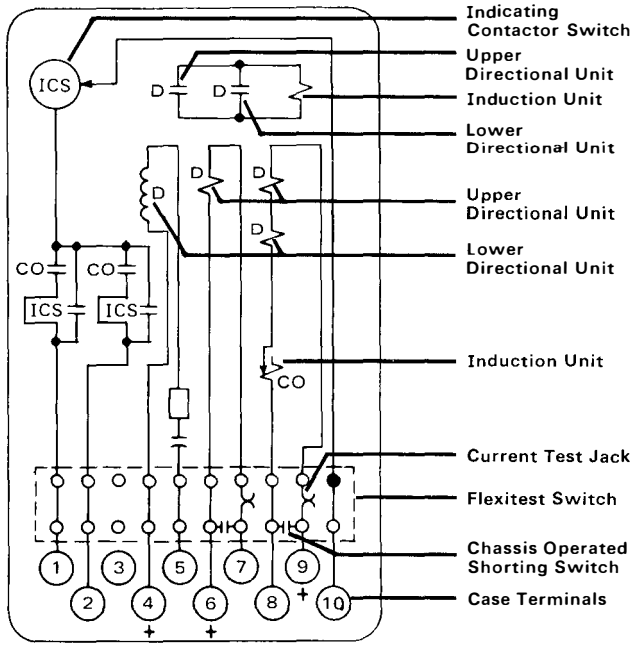


Fig. 12 57D4559

CRP-2, CRP-5, CRP-6, CRP-7, CRP-8, CRP-9, CRP-11 Ground Relay With IIT, Spst, FT-21 Case

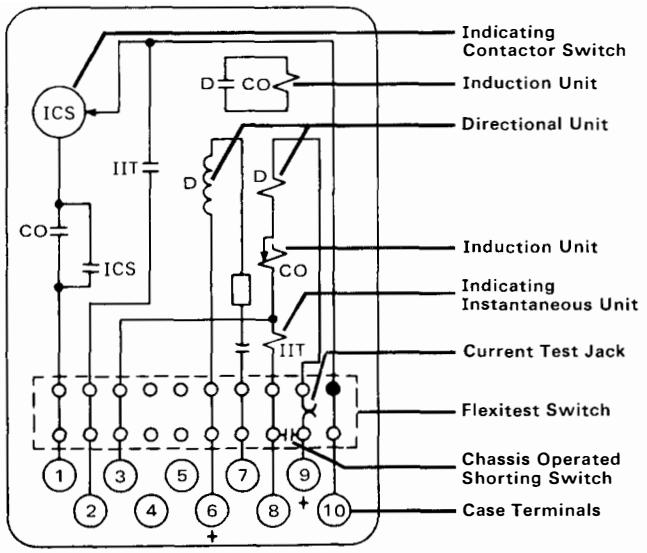


Fig. 9 57D4546

CRP-2, CRP-5, CRP-6, CRP-7, CRP-8, CRP-9, CRP-11 Ground Relay, Dpst, FT-21 Case

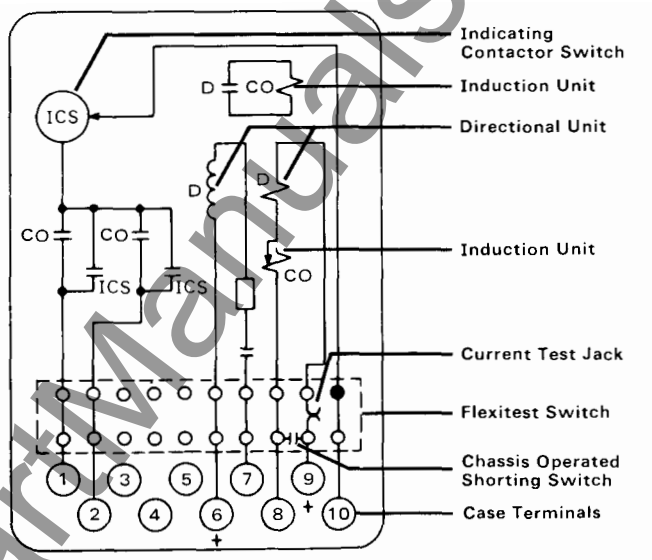


Fig. 10 57D4541

CRQ-2, CRQ-5, CRQ-6, CRQ-7, CRQ-8, CRQ-9, CRQ-11 With IIT, Spst, FT-42 Case

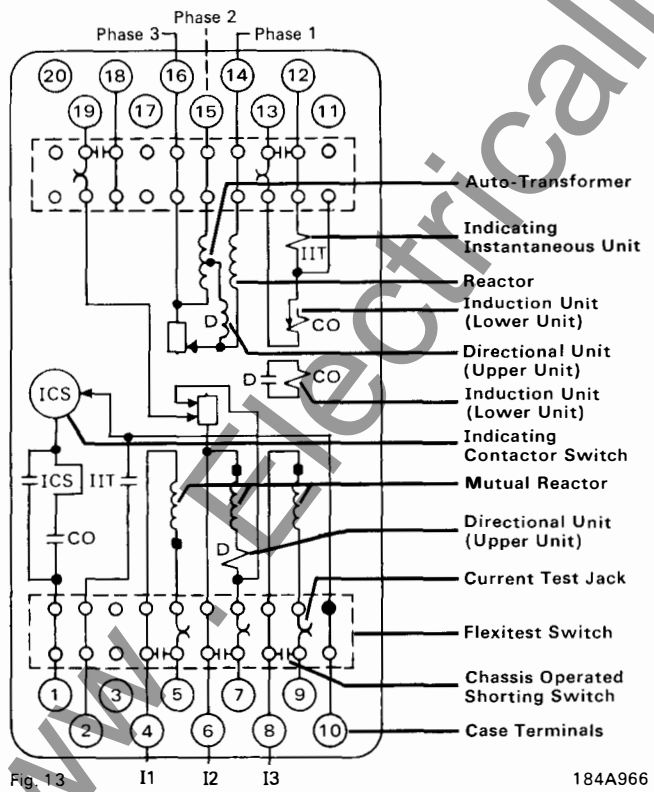


Fig. 13 184A966

CRQ-2, CRQ-5, CRQ-6, CRQ-7, CRQ-8, CRQ-9, CRQ-11, Dpdt, FT-42 Case

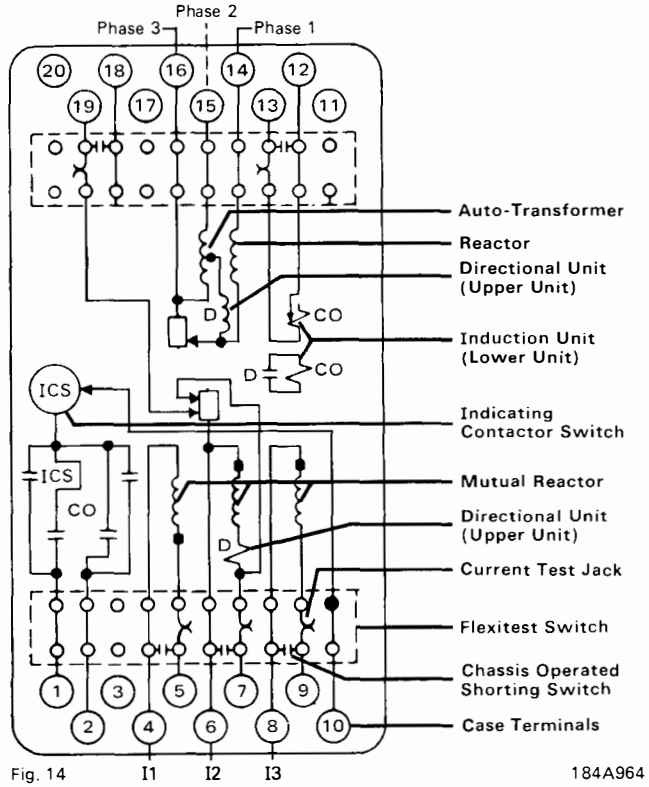


Fig. 14 184A964

Characteristics

Time

The time characteristics of the time overcurrent relays are designated by specific numbers:

Characteristic	Number
Short Time	2
Long Time	5
Definite Time	6
Moderately Inverse Time	7
Inverse Time	8
Very Inverse Time	9
Extremely Inverse Time	11

The relays are generally available in the following overcurrent unit current ranges:

Range	Taps						
0.5-2.5	0.5	0.6	0.8	1.0	1.5	2.0	2.5
2-6	2	2.5	3	3.5	4	5	6
4-12	4	5	6	7	8	10	12

Relays may have either single or double circuit closing contacts for tripping either one or two circuit breakers.

Indicating Instantaneous Trip (IIT)

Relays are available with IIT units having the following current ranges.

0.5 — 2.0 amp	10-40 amps
1-4 amps	20-80 amps
2-8 amps	40-160 amps
4-16 amps	

The operating time of this unit is approximately one cycle at 3 times pickup setting.

Trip Circuit

The main contacts will safely close 30 amperes at 250 volts dc, and the seal-in contacts of the Indicating Contactor Switch (ICS) will safely carry this current long enough to trip a circuit breaker.

The IIT Contacts also will carry 30 amperes at 250 volts dc and carry this current long enough to trip a circuit breaker.

Trip-Circuit Constants

Indicating Contactor Switch

0.2 amp tap — 6.5 ohms dc resistance
2.0 amp tap — 0.15 ohms dc resistance

Directional Unit (D)

CR Relay

This voltage polarized relay is intended for phase fault protection. The directional unit has its maximum torque when the current leads the voltage by approximately 30°. The directional unit minimum pickup is 1 volt and 4 amperes at its maximum torque angle for the 4 to 12 ampere range relays, and 1 volt and 2 amperes for the 2 to 6 ampere and 0.5 to 2.5 ampere range relays.

The directional unit should be connected using the current in one-phase wire, and the potential across the other two-phase wires. This connection is commonly referred to as the 90° connection. When utilizing the 90° connection, the maximum torque of the relay occurs when the fault current lags its 100% power factor position by approximately 60°. See Figure 17.

Negative Sequence Directional Unit Sensitivity Curve

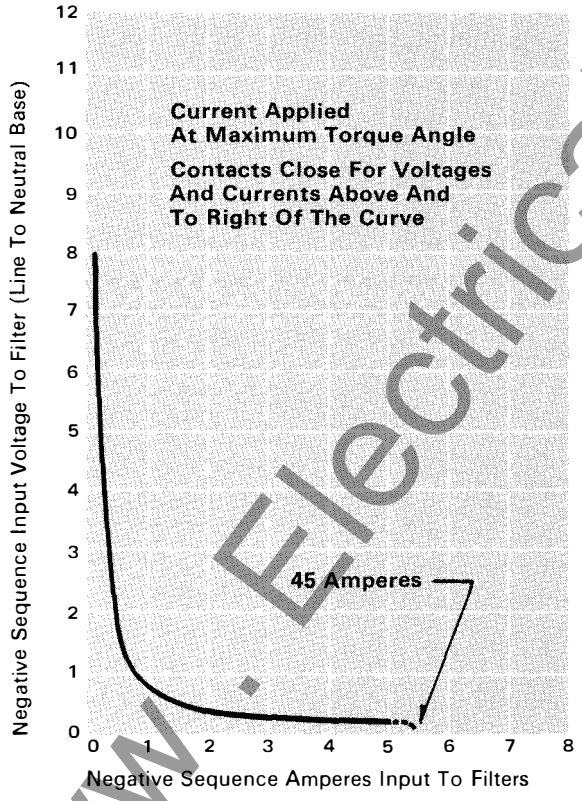


Fig. 15 184A996

Negative Sequence Directional Unit Time Curve

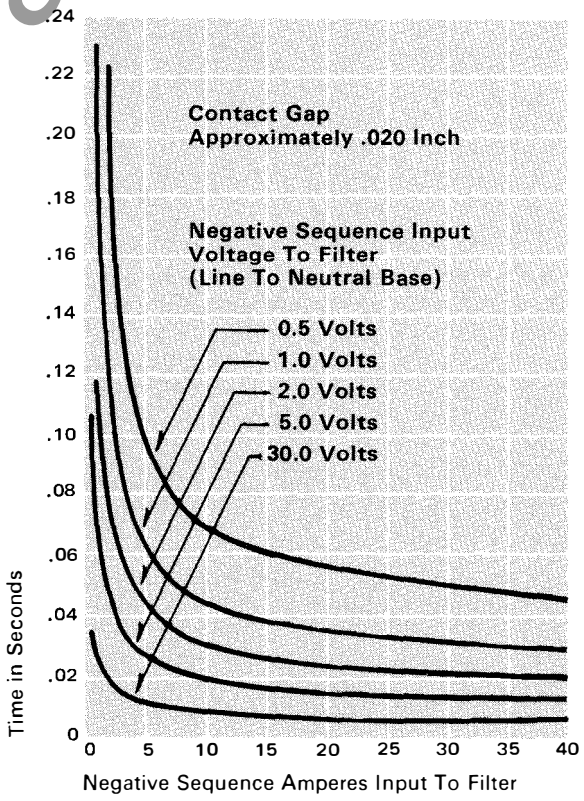


Fig. 16 184A995

CRC Relay

Current polarized, this relay is intended for ground fault protection, and operates on residual current. See Figure 18. The type CRC has its maximum torque when the operating current leads the polarizing current by approximately 40°. The directional unit minimum pickup is 0.5 ampere in each winding in phase for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

CRP Relay

This voltage polarized relay is intended for ground fault protection and has its maximum torque when the current lags the voltage by approximately 60°. The shifting of the maximum torque angle is accomplished by the use of an internally mounted phase shifter as illustrated in Figure 10.

The CRP operates on residual voltage and residual current. See Figure 19.

The directional unit minimum pickup is 1 volt and 2 amperes at its maximum torque angle for the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays.

CRD Relay

Dual polarized, the CRD is intended for ground fault protection. It can be polarized from a potential source, from a local ground source, or from both simultaneously.

The CRD utilizes the directional unit of the Type CRC in conjunction with the directional unit and phase shifting mechanism of the CRP. The directional contacts are connected in parallel to torque control a common overcurrent unit. See Figure 12.

The current-polarized directional unit of the CRD operates on residual currents, while the potential polarized directional unit operates on residual voltage and residual current. See Figure 20.

For the 0.5 to 2.5 ampere and the 2 to 6 ampere range relays, the minimum pickup of the current polarized unit is 0.5 ampere in each winding in-phase, and the minimum pickup for the voltage polarized unit is 1 volt and 2 amperes with the current lagging voltage by 60°.

CRQ Relay

The directional unit minimum pickup is approximately 0.76 volt-amperes (e.g. 0.19 volt and 4 amperes) in terms of negative sequence quantities applied at the relay terminals at the maximum torque angle of approximately 98° (current leading voltage).

A typical sensitivity curve for the negative sequence directional unit is shown in Figure 15.

The time vs. current characteristic for the directional unit is shown in Figure 16.

Burden Data (All Burdens at 60 Hertz)

Type CRQ

Current Burden

The current burden of the relay with positive sequence currents applied (no output current to the directional unit) is as follows:

Phase	Continuous Rating: Amps	One Second Rating: Amps	Watts At 5 Amps	Volt-Amps at 5 Amps	Power Factor Angle
1	10	150	5.4	7.5	44° Lag
2	10	150	5.5	5.5	0°
3	10	150	.35	1.29	74° Lag

Current burden of the relay with zero sequence currents is as follows:

Phase	Watts at 5 Amps	Volt-Amps at 5 Amps	Power Factor Angle
1	4.66	5.5	32°
2	4.92	5.0	10°
3	3.30	3.7	27°

Voltage Burden

Voltage burden of the CRQ with position sequence voltage applied (no output voltage to the directional unit) is as follows:

Potential Transformer Across Phase	Volts	Watts	Volt-Amps	Power Factor Angle
Burden Values on Three Star Connected Potential Transformers. Values at Star Voltage of 66.4 Volts (115 Volts Delta).				
1	115	0	26.8	90° Lag
2	115	0.2	0.3	48° Lag
3	115	23.2	27.0	30° Lag
Burden Values On Two Open-Delta Potential Transformers. Values at 115 Volts.				
12	115	−23.2	46.5	120° Lag
23	115	46.6	46.6	0°
23	115	.10	0.48	58° Lag
31	115	23.2	46.5	60° Lag
31	115	23.2	46.6	60° Lag
12	115	0.50	0.52	2° Lead
Burden Values on Three Delta Connected Transformers. Values at 115 Volts.				
31	115	15.4	31.0	60° Lag
12	115	− 7.8	15.6	120° Lag
23	115	15.6	15.6	0°

Burden Data, continued

Directional Unit

Operating Circuit

Relay Type	Ampere Range	Burden In Volt-Amperes ① At Minimum Tap Value Current	At 3 Times Minimum Tap Value Current	At 10 Times Minimum Tap Value Current	At 20 Times Minimum Tap Value Current	Power Factor Angle ②	Continuous Rating In Amps	1-Second Rating In Amps ③
CR	0.5-2.5	0.03	0.23	2.8	11.5	34.5	10	230
	2-6	0.44	4.08	48.0	182.0	34.5	10	230
	4-12	0.53	5.0	59.2	236.0	25.0	12	280
CRC	0.5-2.5	0.033	0.30	3.3	14.2	44.0	10	230
	2-6	0.58	5.28	58.0	240.0	42.5	10	230
	4-12	0.64	6.12	70.0	272.0	. . .	12	280
CRP	0.5-2.5	0.03	0.23	2.8	11.5	34.5	10	230
	2-6	0.44	4.08	48.0	182.0	34.5	10	230
	4-12	0.48	4.62	53.6	216.0	. . .	12	280
CRD	.5-2.5	0.07	0.59	6.6	26.0	45.0	10	230
	2-6	1.04	9.9	106.0	420.0	45.0	10	230
	4-12	1.16	10.8	121.2	472.0	. . .	12	280

Polarizing Circuit

Relay	Burden In Volt-Amperes ① At 120 Volts	At 5 Amps	Power Factor Angle ⑥	Thermal Rating 1 Second	30 Seconds	Continuous
CR	11.5	. . .	58° Lag	. . .	. . .	. . .
CRC CRD ④	. . .	1.45	8° Lag	230 Amps	. . .	208 Volts
CRP CRD ⑤	11.2	. . .	28° Lead	. . .	208 Volts	. . .

Minimum Pickup Value

Relay Type	Tap Range In Amps	Minimum Pickup Volts	Amps	Phase Angle
CR Voltage Unit	0.5-2.5	1	2	I leading V by 30°
	2-6	1	2.3	I in phase with V
	4-12	1	4	I leading V by 30°
		1	4.6	I leading V by 30°
CRC CRD Current Unit	0.5-2.5	. . .	0.5	I_0 leading Ip by 40°
	2-6	. . .	.65	in phase
	4-12	. . .	1.0	I_0 leading Ip by 40°
		. . .	1.3	in phase
CRP CRD Voltage Unit	0.5-2.5	1	2	I lagging by 60°
	2-6	1	4	I in phase with V
	4-12	1	4	I lagging V by 60°
		1	8	I in phase with V

● Voltages taken with rectifier type voltmeter

② Degrees current lags voltage at tap value current.

③ Thermal capacities for short time other than one-second may be calculated on the basis of time being inversely proportional to the square of the current. For example, on the 0.5-2.5 amp range, the one-second rating is 88 amps. To obtain the 0.5 second rating time-overcurrent unit (CO), the appropriate formula is. $I^2t=K$, where K is the square of the one-second rating in amperes:

$I^2t = (88)^2 = 7744$

$t = 0.5$

$0.5\ I^2 = 7744$

$I^2 = 15488$

$I = \sqrt{15488} = 124.4$

④ Current unit.

● Voltage unit.

⑥ Degrees operating current leads or lags (as indicated) polarizing voltage or polarizing current

Overcurrent Unit

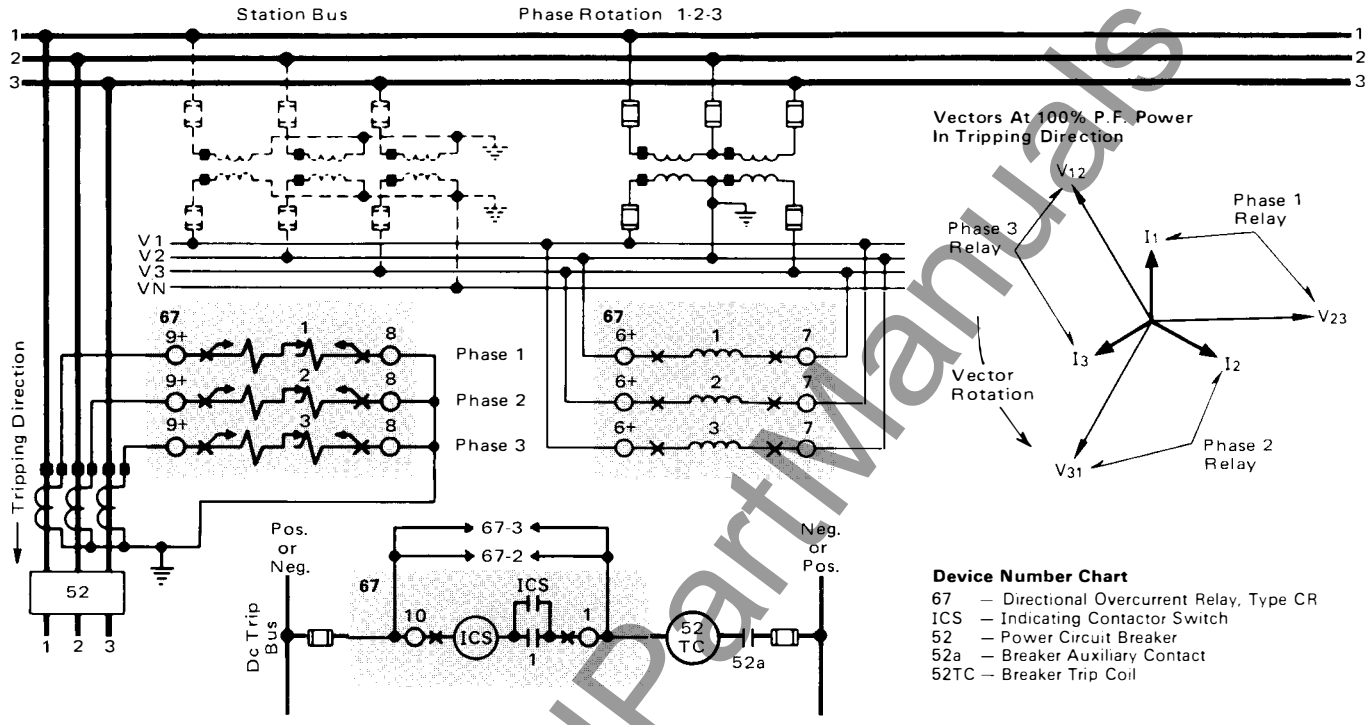
For burden data and thermal capacities of CR, CRC, CRP, and CRD overcurrent units, see Information Leaflet 41-131. For type CRQ, see Information Leaflet 41-163.2. For time curves, see Performance Data 41-100.

ICS and IIT Units

For burden data, thermal capacity, see Performance Data 41-100.

External Wiring Diagrams

CR Relay for Phase Protection



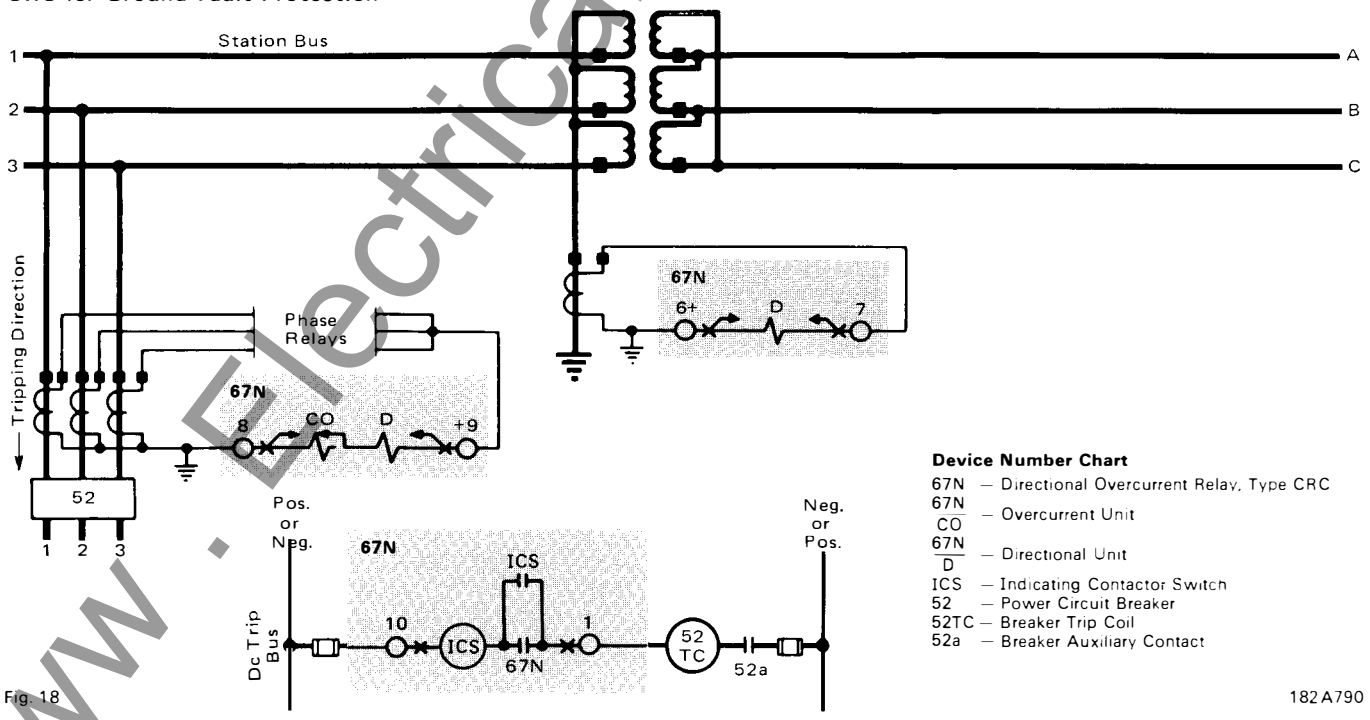
Device Number Chart

67 — Directional Overcurrent Relay, Type CR
ICS — Indicating Contactor Switch
52 — Power Circuit Breaker
52a — Breaker Auxiliary Contact
52TC — Breaker Trip Coil

Fig. 17

182A793

CRC for Ground Fault Protection



Device Number Chart

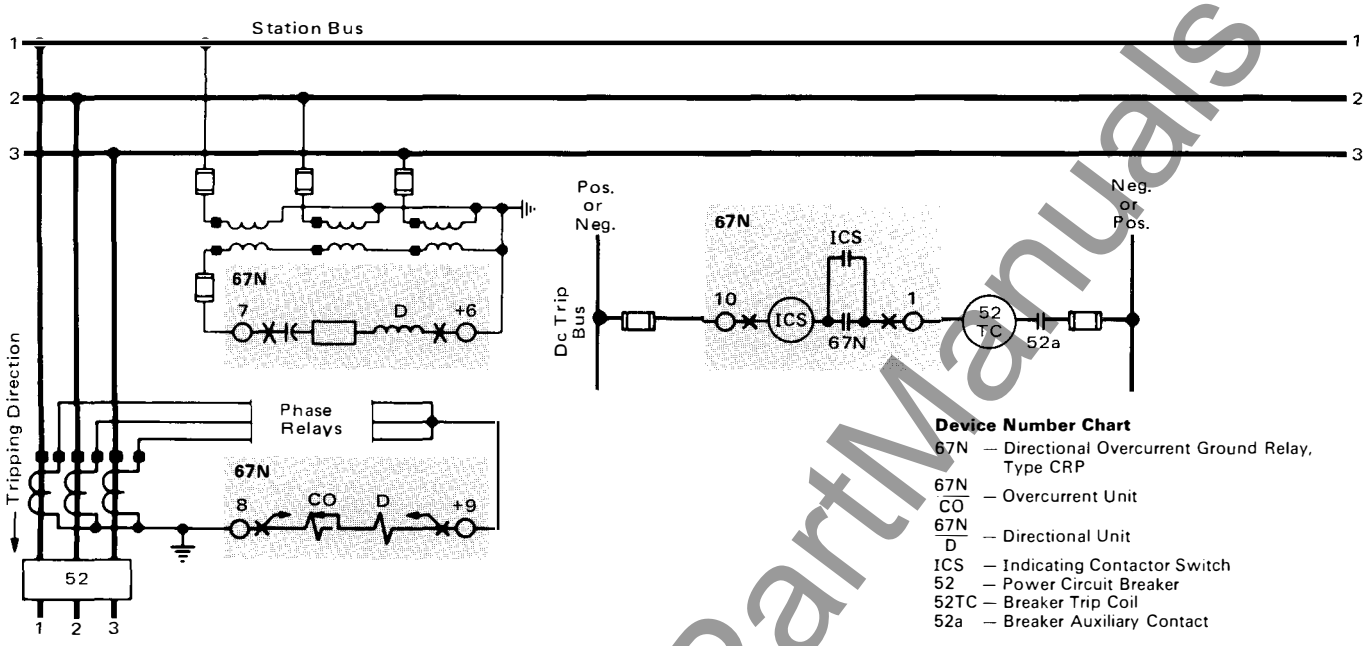
67N — Directional Overcurrent Relay, Type CRC
67N/CO — Overcurrent Unit
67N/D — Directional Unit
ICS — Indicating Contactor Switch
52 — Power Circuit Breaker
52TC — Breaker Trip Coil
52a — Breaker Auxiliary Contact

Fig. 18

182A790

External Wiring Diagrams, continued

CRP For Ground Fault Protection

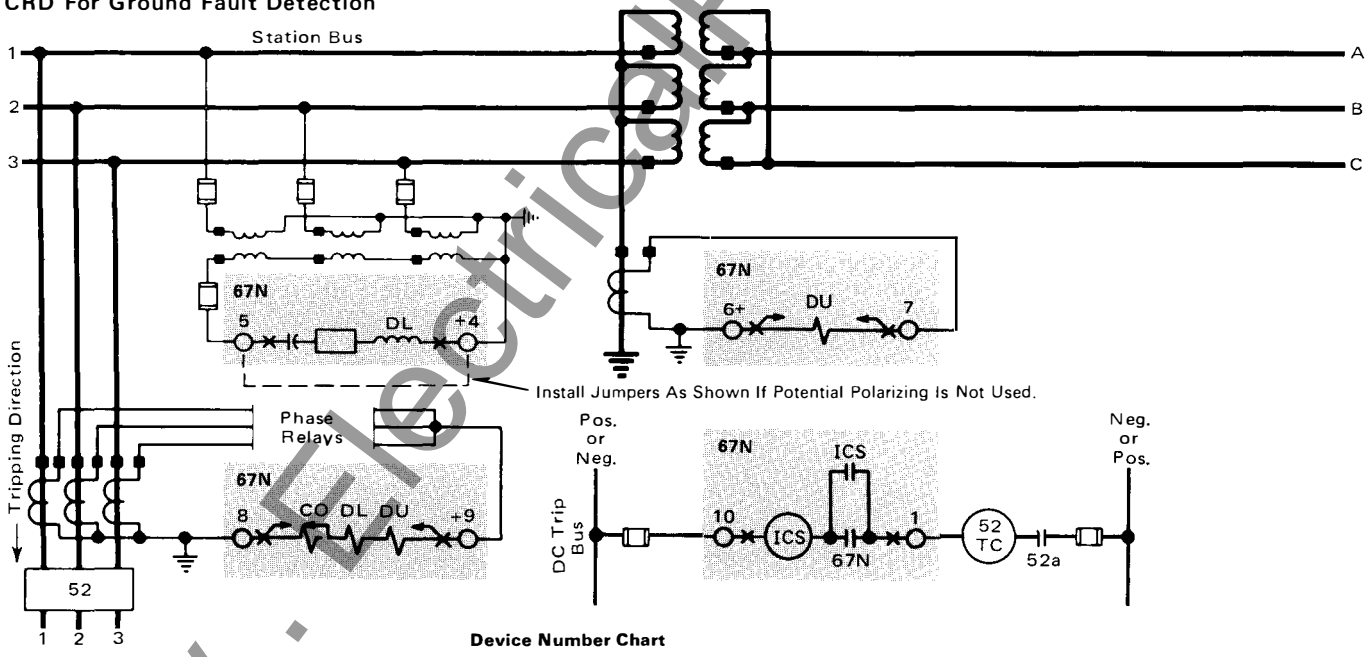


Device Number Chart

67N — Directional Overcurrent Ground Relay, Type CRP
67N/CO — Overcurrent Unit
67N/D — Directional Unit
ICS — Indicating Contactor Switch
52 — Power Circuit Breaker
52TC — Breaker Trip Coil
52a — Breaker Auxiliary Contact

Fig. 19 182A792

CRD For Ground Fault Detection

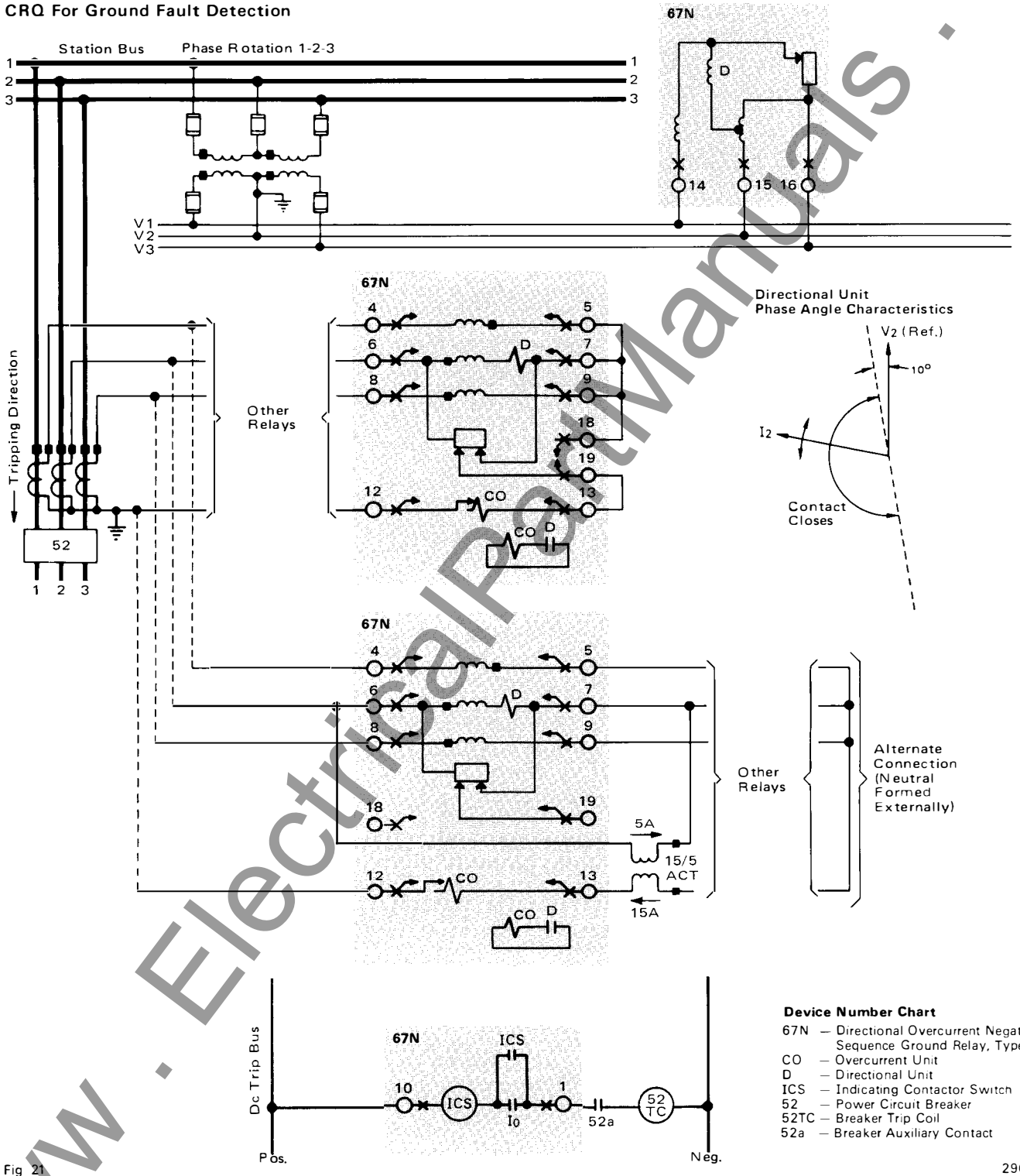


Device Number Chart

67N — Directional Overcurrent Ground Relay, Type CRD
67N/CO — Overcurrent Unit
67N/DL — Lower Directional Unit
67N/DU — Upper Directional Unit
ICS — Indicating Contactor Switch
52 — Power Circuit Breaker
52TC — Breaker Trip Coil
52a — Breaker Auxiliary Contact

Fig 20 182A791

CRQ For Ground Fault Detection



Device Number Chart

67N — Directional Overcurrent Negative Sequence Ground Relay, Type CRQ
CO — Overcurrent Unit
D — Directional Unit
ICS — Indicating Contactor Switch
52 — Power Circuit Breaker
52TC — Breaker Trip Coil
52a — Breaker Auxiliary Contact

Fig 21

290B496

Shipping Weights and Carton Dimensions

Relay Type	Flexitest Case Type	Weight: Lbs, Approx.		Domestic Shipping Carton Dimensions: Inches
		Net	Shipping	
CR	FT-21	13	16	8 x 10 x 15
CRC	FT-21	14	17	8 x 10 x 15
CRP	FT-21	14	17	8 x 10 x 15
CRD	FT-31	20	27	8 x 10 x 21
CRQ	FT-42	29	36	8 x 10 x 24

For burden data and thermal capacity of ICS and IIT units, see Performance Data 41-100.

Further Information

Prices And Ordering Information: PL 41-020
Case Dimensions: DB 41-075
CO Overcurrent Time Curves: PD 41-100
Instructions: CR, CRC, CRP, CRD: IL 41-131; CRQ: IL 41-163.2
Renewal Parts Data: RPD 41-131A1
Other Westinghouse Protective Relays: SG 41-100A, SG 41-100B

Westinghouse Electric Corporation
Relay and Telecommunications Division
Coral Springs, FL 33065

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