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Application Guide

POWER RELAYS

A GUIDE TO THE APPLICATION OF POWER RELAYS FOR THE DETECTION OF OVERPOWER OR REVERSE POWER CONDITIONS ON A POWER SYSTEM

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GENERAL ELECTRIC

A GUIDE TO THE APPLICATION OF POWER RELAYS FOR THE DETECTION OF OVERPOWER OR REVERSE POWER CONDITIONS ON A POWER SYSTEM

This guide covers all of our true power relays as distinguished from directional power and directional overcurrent relays. Its purpose is to pinpoint exactly the relay required for any specific application. All power relays from the most sensitive to the highest ever likely to be used are covered. The most sensitive are in the range of the core loss of a power transformer, that is, of the order of one tenth of one per cent of full load power. They are used for tripping a bank off when it is no longer supplying power.

The more usual application of a reverse power relay is to protect generators from motoring. This can usually be met with the simplest type of induction disc relay which can also provide the time delay which is generally required. These simpler relays are single phase which is usually acceptable because balanced three phase conditions can be assumed and they range from two per cent up to full load power. The guide gives a table on page 11 listing all the types of generators classified by their prime movers which determine the amount of reverse power when they motor. Three-phase power relays are also listed which have sensitivities from one half of one per cent up to ten per cent of full load. These sensitivities require induction-cylinder type relays which in turn are inherently instantaneous so that separate time delay devices are required. Of course the separate time delay relay can be incorporated in the same case as well as separately resulting in five different types of relays which are shown in the table on the other side of this page.

The guide is designed to be used like an encyclopedia. Table I should first be consulted. The introduction spells out the different types listed in the first column and gives their essential differences. Following the introduction the general application of the different types is described after which typical applications are given complete with all the different wiring diagrams and tables listing all the individual ratings of the five different relays.

TABLE - 1

RELAY TYPE	CONNECTIONS		UNITY P-F P.U. RANGES	CONTINUOUS CURRENT RATING	CONTACTS	SPEED OF OPERATION	CASE SIZE	GENERAL APPLICATION
	POTENTIAL	CURRENT	AMPERES △	AMPERES				
ICW51B	1φ L-N 120 VOLTS	1 φ	0.08-0.33 0.21-0.83 0.42-1.67 0.83-3.33	5.0	1 N.O.	ADJUST. TIME DELAY	S1	REVERSE AND/OR OVER POWER
ICW51A	1φ L-L 120 VOLTS OR 208 VOLTS	1 φ	0.07-0.29 0.12-0.48 0.24-0.96 0.48-1.92 0.96-3.84	3.5 5.0 5.0 5.0 5.0	1 N.O.	ADJUST. TIME DELAY	S1	REVERSE AND/OR OVER POWER
GGP53B	3φ L-L 120 VOLTS OR 208 VOLTS	3 φ	0.025-0.3000	5.0	1 N.O.	ADJUST. TIME DELAY	M2	REVERSE POWER
CAP 15B	3φ L-L 120 VOLTS OR 208 VOLTS	3 φ	0.025-0.300	5.0	1 N.O. & 1 N.C.	INST.	S2	REVERSE POWER
CCP13D	3φ L-L 120 VOLTS OR 208 VOLTS	3 φ	0.004-0.012 0.008-0.030	5.0	1 N.O. & 1 N.C.	INST.	M2	REVERSE POWER

△ AT RATED VOLTAGE

INTRODUCTION

The relays covered by this guide are listed in table 1 and are all designed to operate at normal rated voltage to detect reverse power or overpower conditions on a power system. All of these relays with the exception of the ICW51B are suitable for application on three-phase systems only. The ICW51B may be applied on single-phase and two-phase as well as three-phase systems. None of these relays are intended for use as fault protective or regulating devices.

Table 1 compares the salient features and characteristics of the five types of relays. The ICW51A and ICW51B relays are single-phase induction disk devices with inherent time delay; this delay being adjustable as well as the pickup. Because of the band of pick-up ranges that are available, these relays are suitable for the detection of reverse power and/or overpower within their ranges of pickup.

The GGP53B relay is made up of two basic units. The measuring unit is a three-phase, high-speed induction-cup type power unit having a pick-up range of 0.025-0.300 unity power factor amperes at rated voltage. The second unit is an induction disk, a-c operated, adjustable timing unit. Because of its low pickup, this device is basically a reverse power relay.

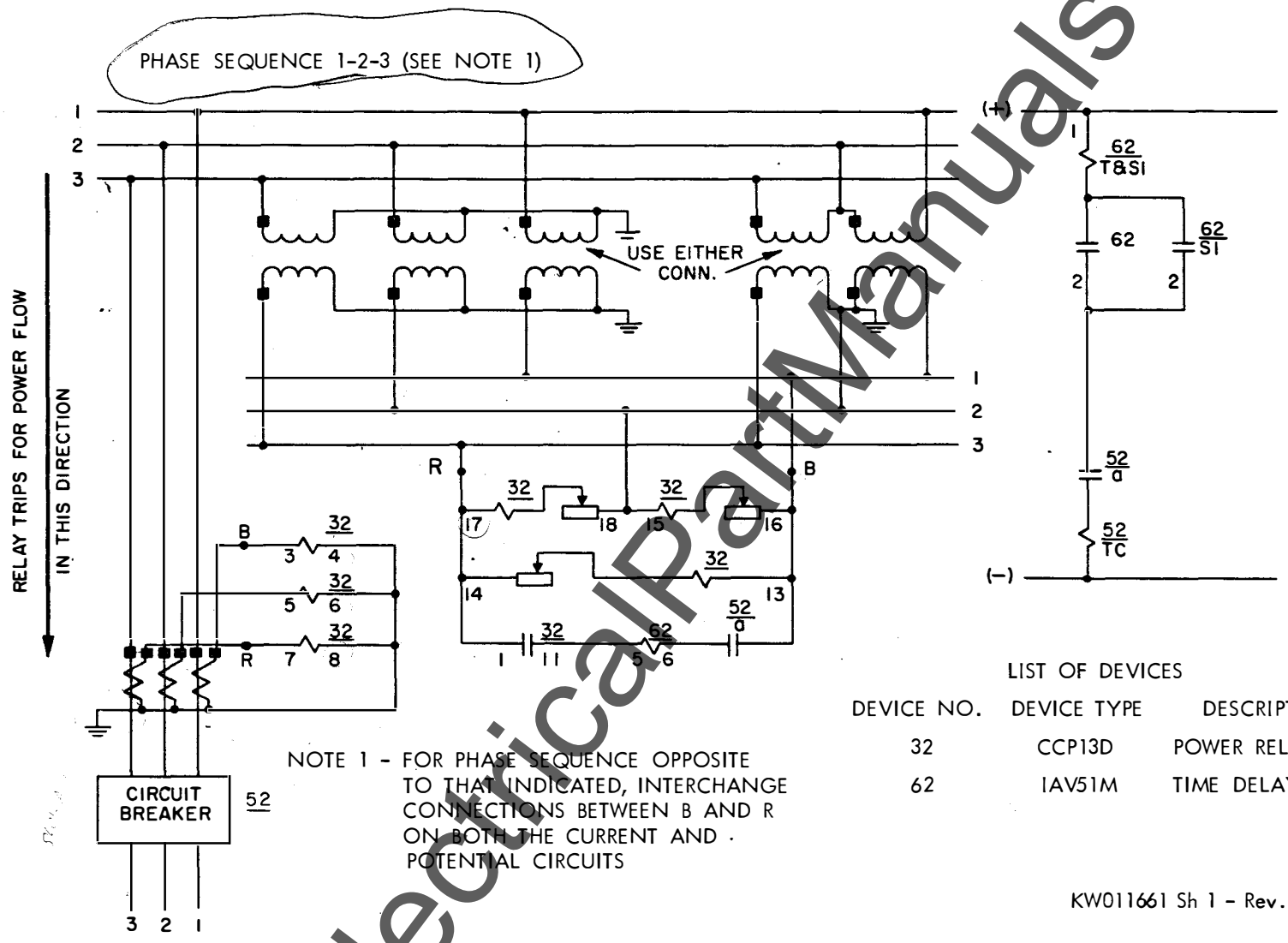
The CAP15B relay is a three-phase, high-speed induction cup power relay that is similar to the power unit of the GGP53B relay. Because of its low pickup, this device is basically a reverse power relay.

The CCP13D relay is a three-phase, high-speed, extremely sensitive power relay. It is made up of three single-phase cup type units all coupled to a common shaft. Because of its very low pick-up range, this device is basically a reverse power relay.

GENERAL APPLICATION

The GGP53B, CAP15B and CCP13D relays are all three-phase devices. Under normal balanced three-phase voltage conditions these relays will develop torques which are directly related to the direction and magnitude of the real component of the three-phase power flowing in the associated circuit. The basic functional differences between the three different relays lies in their sensitivities and their operating times. The GGP53B has a built-in a-c operated timing unit which is adjustable from 1.5 to 30 seconds. Aside from this, it is very much the same as the CAP15B which is an instantaneous device. The CCP13D is more sensitive than both the CAP15B and the GGP53B relays, but like the CAP15B it is an instantaneous device.

Because of the sensitivities and high operating speeds of the CAP15B and CCP13D relays, it is strongly suggested that these devices always be used in conjunction



NOTE 1 - FOR PHASE SEQUENCE OPPOSITE TO THAT INDICATED, INTERCHANGE CONNECTIONS BETWEEN B AND R ON BOTH THE CURRENT AND POTENTIAL CIRCUITS

LIST OF DEVICES

DEVICE NO.	DEVICE TYPE	DESCRIPTION
32	CCP13D	POWER RELAY
62	IAV51M	TIME DELAY RELAY

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EXTERNAL CONNECTIONS FOR CCP13D RELAY WHEN USED WITH IAV51M RELAY

with some kind of a time delay relay. This will prevent undesired operations during system disturbances which may momentarily cause the power flow to be reversed from its normal direction of flow. Applied in conjunction with a time delay relay, the CAP15B is functionally equivalent to the GGP53B. Thus, the CAP15B relay plus a timer need only be considered for application where the timing characteristics of the GGP53B relay are not suitable. The CCP13D, on the other hand, need only be considered where the CAP15B and GGP53B relays do not have the required sensitivity.

Summarizing, the CAP15B and CCP13D relays should always be used in conjunction with a suitable timing relay and the selection of the proper relay should be based primarily on the sensitivity and timing characteristics that are required for the particular application.

The ICW51A and ICW51B relays are single-phase time delay devices which are not as sensitive as the three-phase relays discussed above. From a functional viewpoint, these two types of relays are essentially the same. The major difference between them lies in the difference in connections. The ICW51A requires a single-phase current and the quadrature phase-to-phase voltage. Under balanced system current and voltage conditions, one ICW51A relay will develop a torque which is directly related to the direction and magnitude of the real component of the three-phase power flowing in the associated circuit. This is true because, for balanced conditions, the power in any one phase is equal to one-third of the total three-phase power. Since the relay gets phase-to-phase voltage and single-phase current, it is conveniently calibrated in terms of three-phase watts. When the ICW51A is applied where balanced three-phase voltages exist but the currents are unbalanced, the relay will develop a torque which is directly related to the direction and magnitude of the real component of the three-phase power that would flow if the three currents were balanced and equal to the current in the phase in which the relay current coil is connected.

The ICW51B relay is connected to receive phase-to-neutral voltage and the corresponding phase current. Thus, regardless of system conditions, these relays will measure the real power flowing in the particular phase to which the relay is connected. For balanced three-phase conditions, the three-phase watts will always be three times the individual single-phase watts so one ICW51B may be used to measure three-phase watts. Since the relay receives phase-to-neutral voltage and the associated current it is conveniently calibrated in terms of single-phase watts. Also, because of these connections the ICW51B may be used as a power relay on single-phase and two-phase systems.

TYPICAL APPLICATIONS

The following typical applications for the individual relays have been selected to illustrate the important points of consideration in the selection of the proper relay for a given application.

CCP13D Relay

Because of its sensitivity and its real power directional characteristics, the CCP13D relay finds application where it is required to detect extremely small

PHASE SEQUENCE 1-2-3 (SEE NOTE 1)

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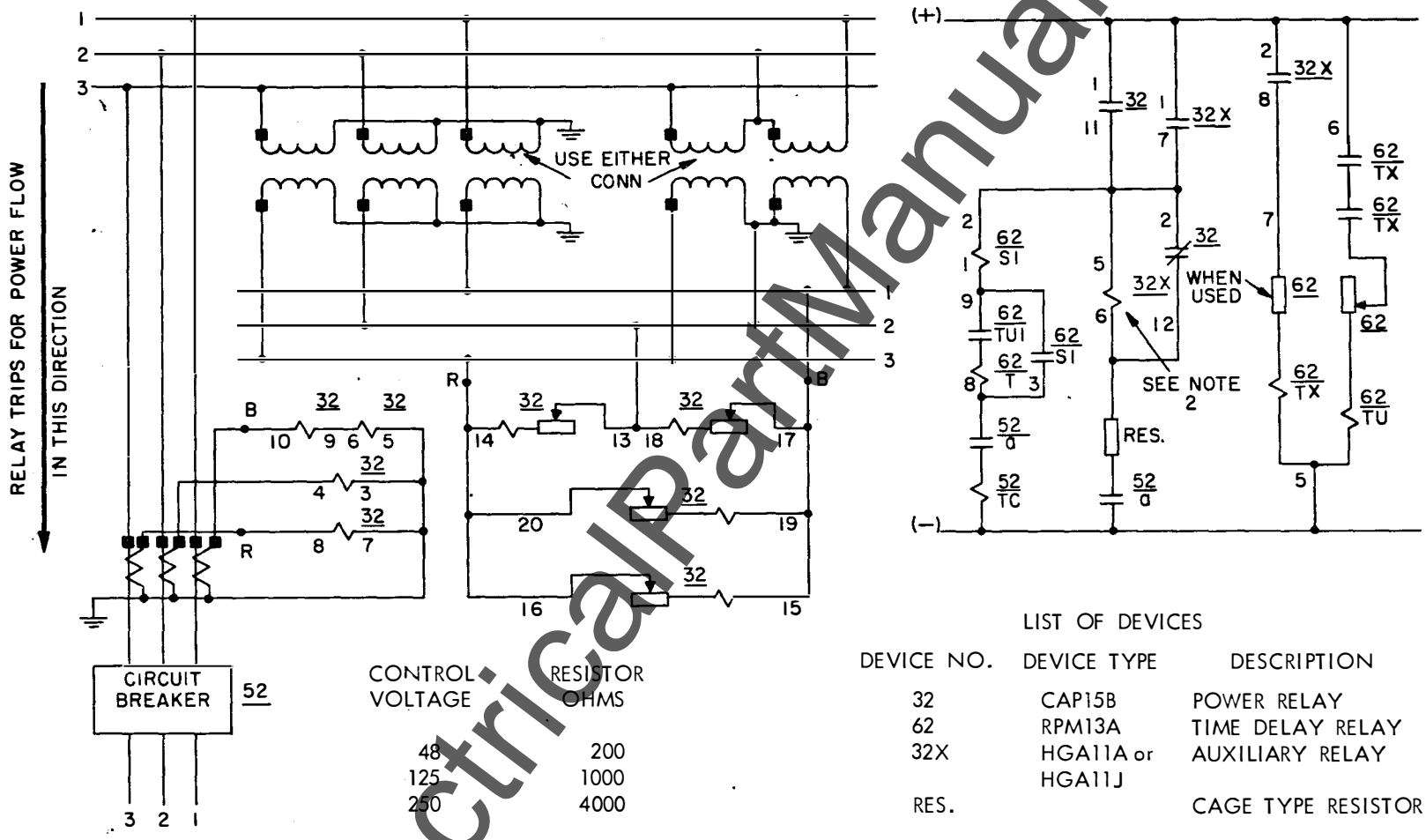


CONTROL VOLTAGE	RESISTOR OHMS
48	200
125	1000
250	4000

LIST OF DEVICES

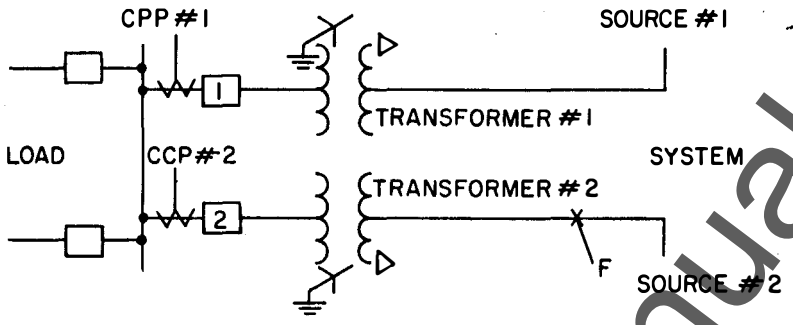
DEVICE NO.	DEVICE TYPE	DESCRIPTION
32	CAP15B	POWER RELAY
62	RPM13A	TIME DELAY RELAY
32X	HGA11A or HGA11J	AUXILIARY RELAY
RES.		CAGE TYPE RESISTOR

NOTE 1 - FOR PHASE SEQUENCE OPPOSITE TO THAT INDICATED, INTERCHANGE CONNECTIONS BETWEEN B & R IN BOTH THE POTENTIAL & CURRENT CIRCUITS.

NOTE 2 - SELECT HGA RELAY WITH CONTINUOUS RATING EQUAL TO 1/2 THE CONTROL VOLTAGE SUPPLY & SELECT A RESISTOR FROM THE TABLE.

EXTERNAL CONNECTIONS FOR CAP15B RELAY WHEN USED WITH RPM13A RELAY

reverse power flow. The classical example of such an application is illustrated below.



Consider the section of a system shown above with the normal direction of load flow being from the system to the load. If a single-phase-to-ground fault were to occur at F, it would be cleared at source #2, but not necessarily at breaker #2 because of delta-wye transformer #2. However, it is desirable to open circuit breaker #2 in order to remove the ground fault which could continue to arc. This can be accomplished by the CCP13D relay associated with circuit breaker #2. The CCP13D is generally sensitive enough to operate on the real component of the exciting current (this is the core loss component) taken by the transformer through circuit breaker #2 when source #2 is removed.

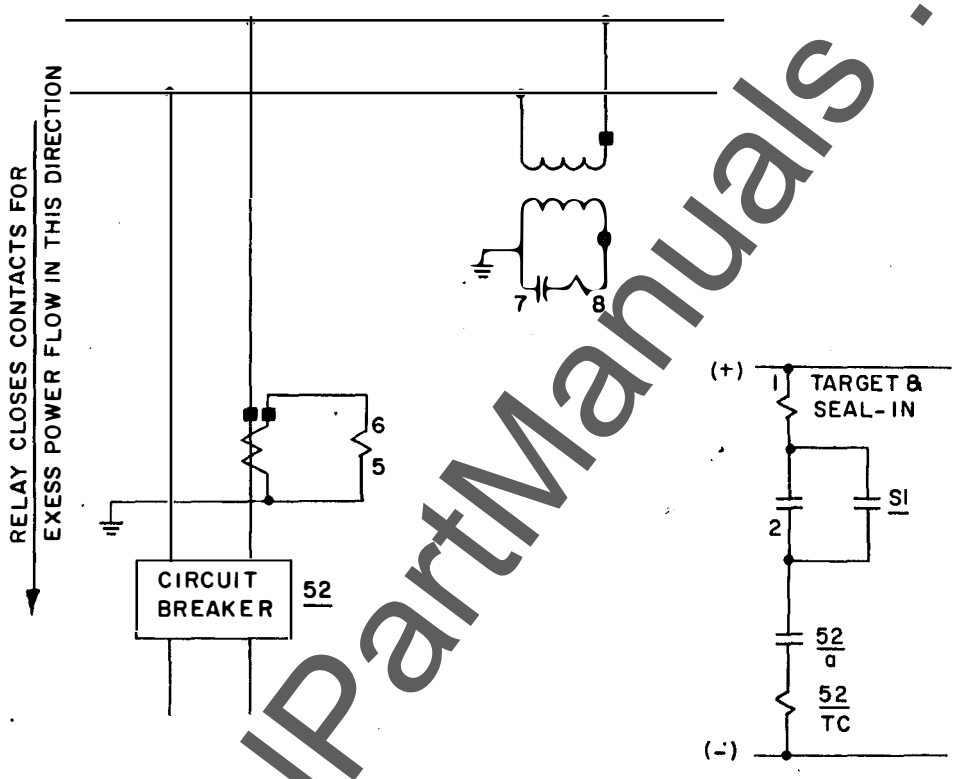
Since the CCP13D is very fast and very sensitive, it could operate for system disturbances that result in momentary reversals of power through one or the other of the two banks. For this reason, the CCP13D should be used in conjunction with some time delay when applied as discussed above. Sketch KW101661 SH1 shows how this can be done with an a-c operated timing relay while sheet 2 of the same sketch illustrates the connections for a d-c timing relay.

When the CCP13D relay is applied as illustrated in sketches KW101661 SH1 and SH2, no holding coil is required. For this reason, a form without a holding coil should be selected, or if a relay with a holding coil is obtained, the holding coil should be by-passed in the relay.

Before the CCP13D is applied, certain calculations should be made to check the sensitivity of the relay against the available core loss component of the associated transformer in order to insure proper operation. In general, the CT's that supply the CCP relay should be selected with the lowest possible ratio without exceeding the 5.0 ampere rating of the relay. A sample calculation is provided below.

Consider the system illustrated above having the following transformer ratings.

10,000 KVA
13,800 Volts wye/138,000 volts delta
Core losses - 15.0 KW at rated voltage.



EXTERNAL CONNECTIONS FOR ICW51B RELAY
AS USED ON A SINGLE-PHASE SYSTEM

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