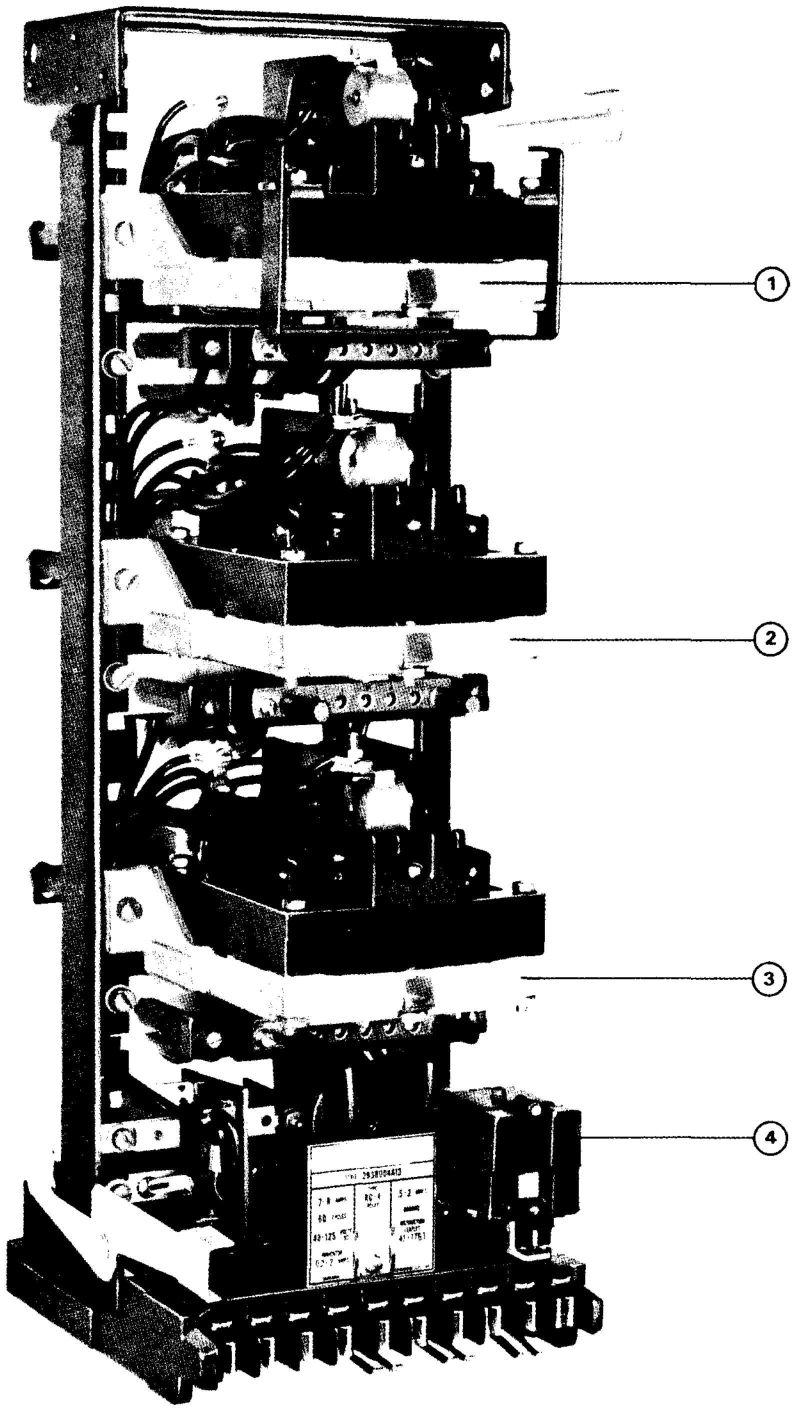
September, 1990
Supersedes Descriptive Bulletin 41-170, pages 1-8, dated May, 1977
Mailed to: E, D, C/41-100A

For Phase and Ground Faults and Breaker Failure Protection Schemes
Device Number: 50

Type KC-4 Current Detector Relay



The type KC-4 relay is a non-directional current or fault detector which operates for all phase and ground faults to supervise the tripping of other protective relays.

It is particularly suited for breaker-failure relaying schemes in which it supervises local back-up tripping, based on the presence or absence of current flow in the protected circuit breaker.

The relay can be applied where the phase units are to be operated indefinitely in the picked up position well below full load. Alternatively, where the relay is to be used as a fault detector (pickup above full load), the 98% or better dropout ratio of the phase and ground units is advantageous.

Specific benefits and techniques for breaker-failure detection using the KC-4 current detector relay are given in subsequent sections.

Construction

The KC-4 relay consists of two cylinder type phase instantaneous overcurrent operating units, one ground overcurrent unit, and an indicating Contactor Switch.

Each overcurrent unit operates to close its contact when current exceeds a specified value. The Indicating Contactor Switch, actuated by closure of one of the cylinder unit contacts, relieves the main contact of carrying the heavy trip current, and also displays a target which indicates operation of the relay. This target is reset by a push rod from outside the relay case.

(1) Phase Instantaneous Overcurrent Unit (I_A)
(2) Phase Instantaneous Overcurrent Unit (I_C)
(3) Ground Instantaneous Overcurrent Unit (I_O)
(4) Indicating Contactor Switch

Benefits of Breaker-Failure Protection
The failure of circuit breakers to interrupt fault current when called upon to trip by relays is a moderately frequent and extremely serious problem in electric power system operation. The example system of Figure 1 has been chosen to illustrate the advantages of local breaker-failure protection over the former practice of depending entirely on remote backup relaying.

In this diagram, the generating station high-voltage bus uses a breaker-and-a-half arrangement. Lines interconnect the station to systems S_1, S_2 and S_3.

Fault L is normally cleared by line relays tripping breakers 5, 6 and 9. Assume, however, that breaker 6 mechanism sticks so that current flow through breaker 6 is not interrupted. Under this condition, back-up protection must function. If remote back-up is relied upon, time delay relays must trip remote breakers 7 and 8. In addition, local generator feed through breaker 6 must be interrupted by tripping breaker 4.

However, if breaker-failure protection is incorporated in the system, the fault is cleared by the tripping of breaker 3. This action provides selective tripping, since as much of the system as possible was left intact. If breakers 4, 7 and 8 must trip, the local generator is lost and unnecessary separation of the generating station from power systems S_1 and S_2 would result. Also, the tapped load would be interrupted unnecessarily instead of being left tied to system S_2.

Remote back-up, in addition to not being selective, may not be sensitive enough because of the relatively small proportion of the total fault current flowing in any one line. For example, in Figure 1, there may be very little current flow in breakers 7 and 8 for fault L because of the large current contribution by the local machines at the generating station. Thus, it may be difficult, or impossible, at breakers 7 and 8 to detect adjacent line faults without depending upon sequential tripping. If the generator feed is interrupted for fault L, such as by tripping breaker 4, the current through breakers 7 and 8 may increase sufficiently for the relays to operate and trip breakers 7 and 8. By this time, however, the system is split into islands, and because of the long time delay required to clear the fault, portions of the system may be unstable.

Although breaker-failure protection offers many advantages, remote back-up cannot be completely eliminated from consideration. For example, assume that in Figure 1 breaker 3 fails for bus fault B. Breaker-failure protection will promptly trip breaker 2, but the fault is still fed by breaker 8. Likewise, if breaker 2 fails with a line fault at M, a remote breaker must trip to clear the fault. Breaker-failure protection trips breaker 3, but breaker 8 continues to feed the fault. Although breaker-failure protection does not complete the job in these examples, it does expeditiously trip the local breaker, making it easier for the remote relays to detect the fault.

In this last pair of examples, dependence on remote back-up can be further reduced by actually letting the breaker 3 failure protection circuit directly trip breaker 8. If the line from breaker 8 is protected by a blocking-type carrier scheme, breaker 3 failure relays can stop carrier transmission, allowing immediate tripping of remote pilot relays. Of course, this assumes that pilot relays at 8 respond to faults B and M regardless of other infeed sources. If this is not the case, a dedicated, direct transfer-trip channel can be provided to trip breaker 8 if either breaker 2 or breaker 3 fails. Note, however, that remote back-up protection should still be provided in case the transfer-trip channel fails, or in case of catastrophic malfunctions which result in total failure of local fault relays to even initiate breaker tripping (e.g., failure of potential supply or station battery).

Further Information
List Prices: PL 41-020
Technical Data: TD 41-025
Instructions: IL 41-776.1
Renewal Parts: RPD 41-954
Flexitest Case Dimensions: DB 41-076
Contactor Switches: DB 41-081
Other Protective Relays:
Application Selector Guide, TD 41-016

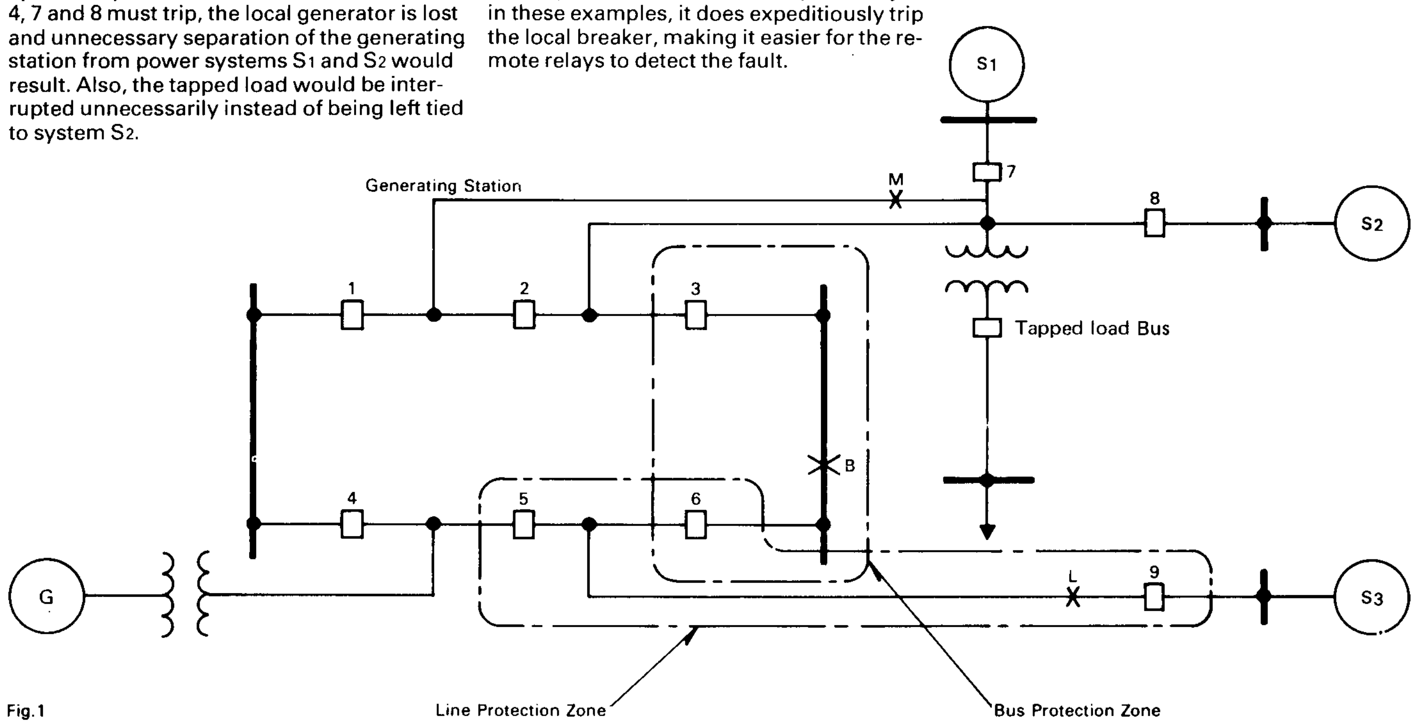


Fig.1

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Supersedes TD 41-020, Type KC-4 on page 36, dated November, 1987
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For Phase and Ground Faults and Breaker Failure Protection Schemes

Type KC-4 Current Detector Relay

Overcurrent, Non-Directional, Instantaneous, For Breaker Failure (Device Number: 50 BF)

Type and Contacts	Ampere Range: Ac		Indicating Contactor Switch③	Control Voltage: Dc	Relay Data		
	Phase Units (2)	Ground Unit			Internal Schematic	Style Number	Case Size
KC-4	0.5-2.0	0.5-2.0	0.2/2.0 amp dc	48/125	188A640	293B004A09	**FT-41**
	1-4	1-4				293B004A10	
Spst-cc	2-8	0.5-2.0				293B004A13⑤	
	2-8	1-4				293B004A14	
	2-8	2-8				293B004A11⑤	
	4-16	4-16			188A640	715B568A19	
	10-40	10-40				293B004A15	
	10-40	10-40	1.0 amp dc		629A915	293B004A16	
	2-8	2-8				293B004A19	
	2-8	0.5-2.0			837A984	715B568A18	
	0.5-2.0	0.5-2.0	0.2/2.0 amp dc	250	188A640	293B004A21	
	1-4	1-4				293B004A22	
	2-8	2-8				293B004A23	
	2-8	0.5-2.0				293B004A25	
	2-8	1-4				293B004A26	
	10-40	10-40				293B004A27	

⑤ Denotes item available from stock.

③ **ICS:** Indicating Contactor Switch (dc current operated) having seal-in contacts and indicating target which are actuated when the ICS coil is energized at or above pickup current setting. Suitable for dc control voltages up to and including 250 volts dc. Two current ranges available: (1) 0.2/2.0 amps dc, with tapped coil. (2) 1.0 amp dc, without taps.

Rating of ICS unit used in specific types of relays is shown in price tables. All other ratings must be negotiated.

When ac current is necessary in a control trip circuit, the ICS unit can be replaced by an **ACS** unit.

The ACS unit may be supplied in place of an ICS unit at no additional cost. Specify system voltage rating on order.