Type H-3
Three-Phase High Speed Directional Relay

Application
This relay operates from three-phase voltage and current to provide high-speed directional discrimination during faults on power systems.

The direction of power flow for both phase and ground faults can be detected by the H-3. To assure correct operation during ground faults, it is necessary that the minimum line-to-ground current be at least three times the maximum load current. Thus, if the fault and load current flow is in opposition, the fault current will produce sufficient net torque to assure correct relay operation.

Low ground current occurs most frequently on impedance grounded systems. If positive directional indication cannot be obtained under all system conditions, a separate ground directional relay is recommended.

The H-3 relay can be supplied with either a watt characteristic (applied voltage and current in phase for maximum torque) or with a 45° characteristic (applied voltage lagging current by 45° for maximum torque).

The H-3 relay with watt characteristic is frequently used to detect reverse power conditions and prevent "motoring" of generators, or to trip a circuit breaker when power flow is in the undesired direction.

Application Guide®

<table>
<thead>
<tr>
<th>Relay</th>
<th>Application and Maximum Torque Angle</th>
<th>Rating: Ac</th>
<th>Volts</th>
<th>Operation Indicator</th>
<th>Contactor Switch (CS)</th>
<th>Indicating Contactor Switch (ICS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Amps</td>
<td>Line-Line</td>
<td>Neutral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H-3</td>
<td>Line Protection 1 leads V by 45°</td>
<td>5</td>
<td>120</td>
<td>...</td>
<td>1.0 amp dc</td>
<td>1.0 amp dc</td>
</tr>
<tr>
<td></td>
<td>Generator Projection (Watt Relay)</td>
<td>...</td>
<td>70</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>I in phase with V</td>
<td>...</td>
<td>120</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

1. Single-pole double-throw contacts, 60 hertz, relay has electrically independent contacts, circuit-opening and circuit-closing.
High Speed Directional Relay

**Construction and Operation**

**Type H-3**
Consists of a polyphase directional unit (with current coil applied to the center leg of each electromagnet in the H-3). Two seal-in contactor switches (CS1 and CS2) and two operation indicators. (See figure 1)

1. **Stationary Contact**

2. **Moving Contact**
   - Will close 30 amperes at 250 volts dc
   - Normally closed (front view) on H-3.

3. **Polyphase Directional Unit**

4. **Operation Indicators**
   - Targets drop to indicate tripping operation.

**Contactor Switch**
Seal-in the relay trip circuit after the main contact has closed. Will carry 30 amperes at 250 volts dc until the breaker is tripped and the auxiliary "a" switch opens.

**Directional Unit**
H-3
Upon occurrence of a fault, causes rotation of the relay contact shaft in accord with the direction of system power flow.
H-3 Directional Unit Phase Angle Characteristics

Figure 2 shows typical phase angle curve of the directional unit for 45° characteristic, 60 hertz relays with balanced three-phase power with no spring restraint applied. Zero torque line at various three-phase current values and at 2 volts and 115 volts of applied delta voltage is shown along the two voltage reference lines. Maximum torque occurs when applied current leads applied voltage by 45°, using the 90° connection.

For the 45° relay characteristic, the standard 90° connection is used to provide wye current and delta voltage. Maximum torque occurs when system fault current lags its unity power factor position by 45°.

The watt relay characteristic utilizes wye current and wye voltage, and maximum torque occurs when voltage and current are in phase.

H-3 relay has adjustable spring restraint to hold relay contacts in non-trip position when relay is de-energized, prohibiting incorrect operation upon loss of load.

Figure 3
High Speed Directional Relay

Time Curves For 50 and 60 Hz H-3 Relay (Based on Relay Contact Opening of .035 Inch)
For Both Watt and 45° Characteristic Relays At Maximum Torque Angle

H-3 Relay at Maximum Torque Angle, For Three-Phase Faults

Characteristics
Minimum Pickup Values
H-3: 60 hertz three-phase minimum pickup without spring restraint is 0.08 ampere at 115 volts; 0.15 ampere at 10 volts; and 5.0 amperes at 1 volt. Single-phase minimum pickup currents are approximately three times of those of the three-phase values.

Burden and Rating Data
45° Characteristic Values For 120 Volts, 5 Amperes, 60 Hertz

<table>
<thead>
<tr>
<th>Current Circuit</th>
<th>Voltage Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance: Ohms</td>
<td>Watts</td>
</tr>
<tr>
<td>Reactance: Ohms</td>
<td>Vars</td>
</tr>
<tr>
<td>Impedance: Ohms</td>
<td>Volts-Ampere</td>
</tr>
<tr>
<td>0.050</td>
<td>1.35</td>
</tr>
<tr>
<td>0.052</td>
<td>1.29</td>
</tr>
<tr>
<td>0.072</td>
<td>1.82</td>
</tr>
<tr>
<td>46° lag</td>
<td>36.5° lag</td>
</tr>
<tr>
<td>2070</td>
<td>4.59</td>
</tr>
<tr>
<td>1520</td>
<td>3.40</td>
</tr>
<tr>
<td>2580</td>
<td>5.71</td>
</tr>
</tbody>
</table>

Power Factor
Continuous Rating (Amperes or Volts) 5 120
One-Second Current (Amperes) 240

Trip-Circuit Data
Coil Only
Relay Type | Rating: Amps, Dc | Resistance: Ohms, Dc | Amps Continuous | 1 Second
---|---|---|---|---
Operation Indicator | H-3 | 1.0 | 18 | 2.5 | 70
Contactor Switch (CS) | H-3 | 1.0 | .84 | 1.9 | 28

Internal Wiring (Front View)
H-3 Relay, FT-22 Case

Center Element
Contactor Switch
Right Element
Left Element
Current Test Jack
Flextest Switch
Shorting Switch
Case Terminals
Operation Indicator

With relative instantaneous polarities as shown, the make contact closes and the moving element rotates counter clockwise (top view).

Fig. 6

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External Wiring
H-3 Relay, Watt Connection

Station Bus  Phase Rotation 1, 2, 3

Device Numbers
32—Polyphase Directional Relay, H-3
CS1—Auxiliary Contactor Switch
CS2—Power Circuit Breaker
52—Power Circuit Breaker

Vectors at 100% P.F. Power in Tripping Direction

Fig. 7

September, 1990
High Speed Directional Relay

External Wiring

H-3 Relay, Directional Overcurrent Phase Protection Of A Three Phase Line Using Three Type CO Torque Controlled Relays, Directionally Controlled By One Type H-3 And One Type MG-6 Relay

Station Bus

Phase Rotation 1, 2, 3

1 2 3

Pos

V1 V2 V3

DC Trip Bus

32 10

H3 = CS1

32X

ICS

32X

32X

51-2 51-3

51 10

ICS

51-1

ICS

51

1

2

3

Phase

1 2 3

Tripping Direction

Device Numbers

51—Overcurrent Relay, CO
ICS—Indicating Contactor Switch
32—Polyphase Directional Relay, H-3
CS1—Auxiliary Contactor Switches
52X—Auxiliary Relay, MG-6
52—Breaker Auxiliary Contact
52TC—Breaker Trip Coil

Note: Nominal Voltage of 32X Relay Should be Approximately 1/2 Control Voltage R_E Equal to 67X Coil Resistance

Fig. 5

Vectors at 100% P.F Power in Tripping Direction

September, 1990
## High Speed Directional Relay

### Weights and Carton Dimensions

<table>
<thead>
<tr>
<th>Relay Type</th>
<th>Case Type</th>
<th>Weight: lbs. Approx.</th>
<th>Domestic Shipping Carton Dimensions: Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-3</td>
<td>FT-22</td>
<td></td>
<td>12 x 15 x 15</td>
</tr>
</tbody>
</table>

### Further Information

- List Prices: PL 41-020
- Technical Data: TD 41-025
- Instructions: IL 41-226.2
- Renewal Parts: PDP 41-935
- Flexifit Case Dimensions: DB 41-076
- Contactor Switches: DB 41-081
- Other Protective Relays:
  - Application Selector Guide, TD 41-016

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### Type H-3

#### Three Phase High Speed Directional Relay

**Power Flow, Directional, Three Phase (Device Number: 32)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Application</th>
<th>Rating: Ac</th>
<th>Operation Indicator</th>
<th>Contactor Switch (CI)</th>
<th>Indicating Contact Switch (CS)</th>
<th>Relay Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Amps</td>
<td>Volts</td>
<td>Line-to-Line</td>
<td>Line-to-Neutral</td>
<td>1.0 amp dc</td>
</tr>
<tr>
<td>H-3</td>
<td>Line protection</td>
<td>5</td>
<td>120</td>
<td>...</td>
<td>...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>by 45°</td>
<td>200</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Generator protection</td>
<td>5</td>
<td>...</td>
<td>...</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in phase (wait relay)</td>
<td>120</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td></td>
</tr>
</tbody>
</table>

- 50-Hertz relays and auxiliaries can be supplied at same price. Order "Similar to Style Number . . . . . . . . . . . . , except 50 Hertz".
- H-3 relays have electrically independent contacts, circuit opening and circuit closing.
- 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. 0-20.0 amperes 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.