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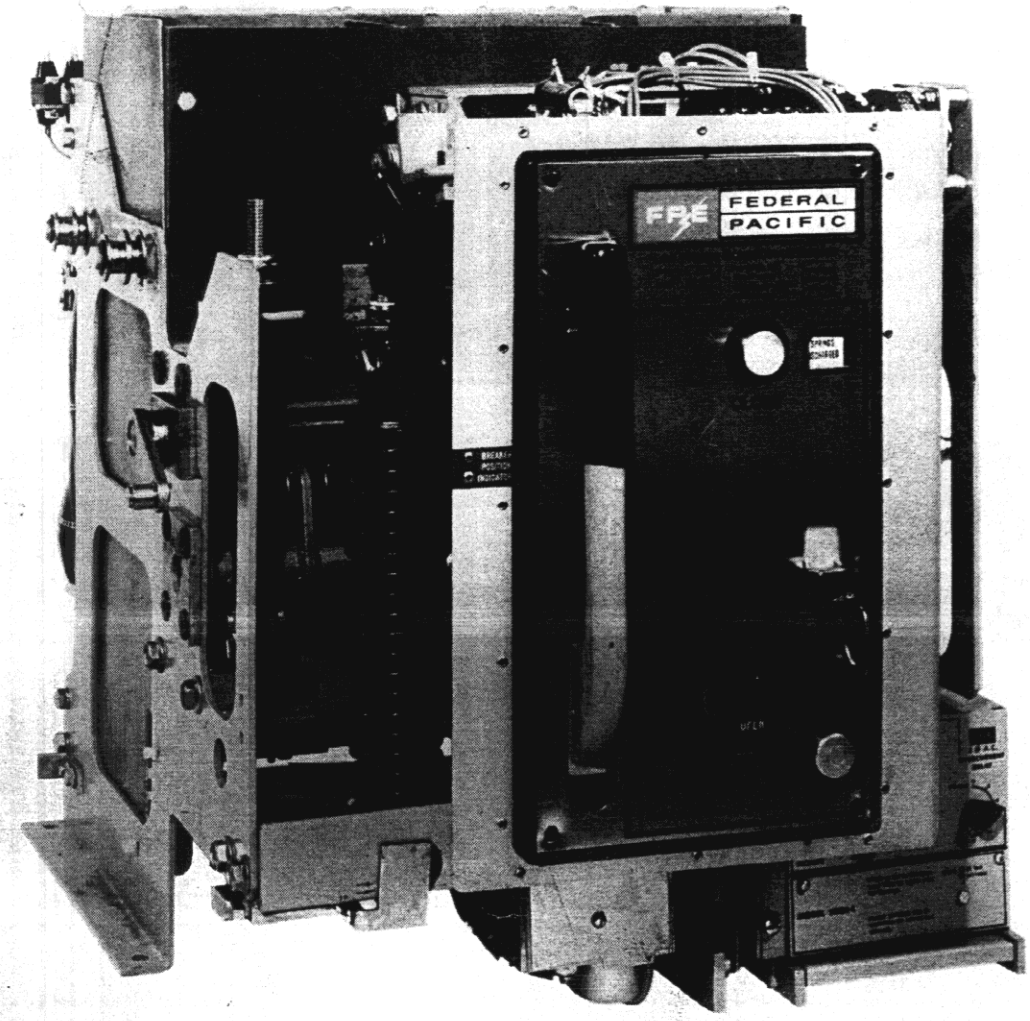
INSTRUCTION MANUAL



STATIC A.C. OVERCURRENT TRIP DEVICES USED WITH FPS-4 POWER CIRCUIT BREAKERS

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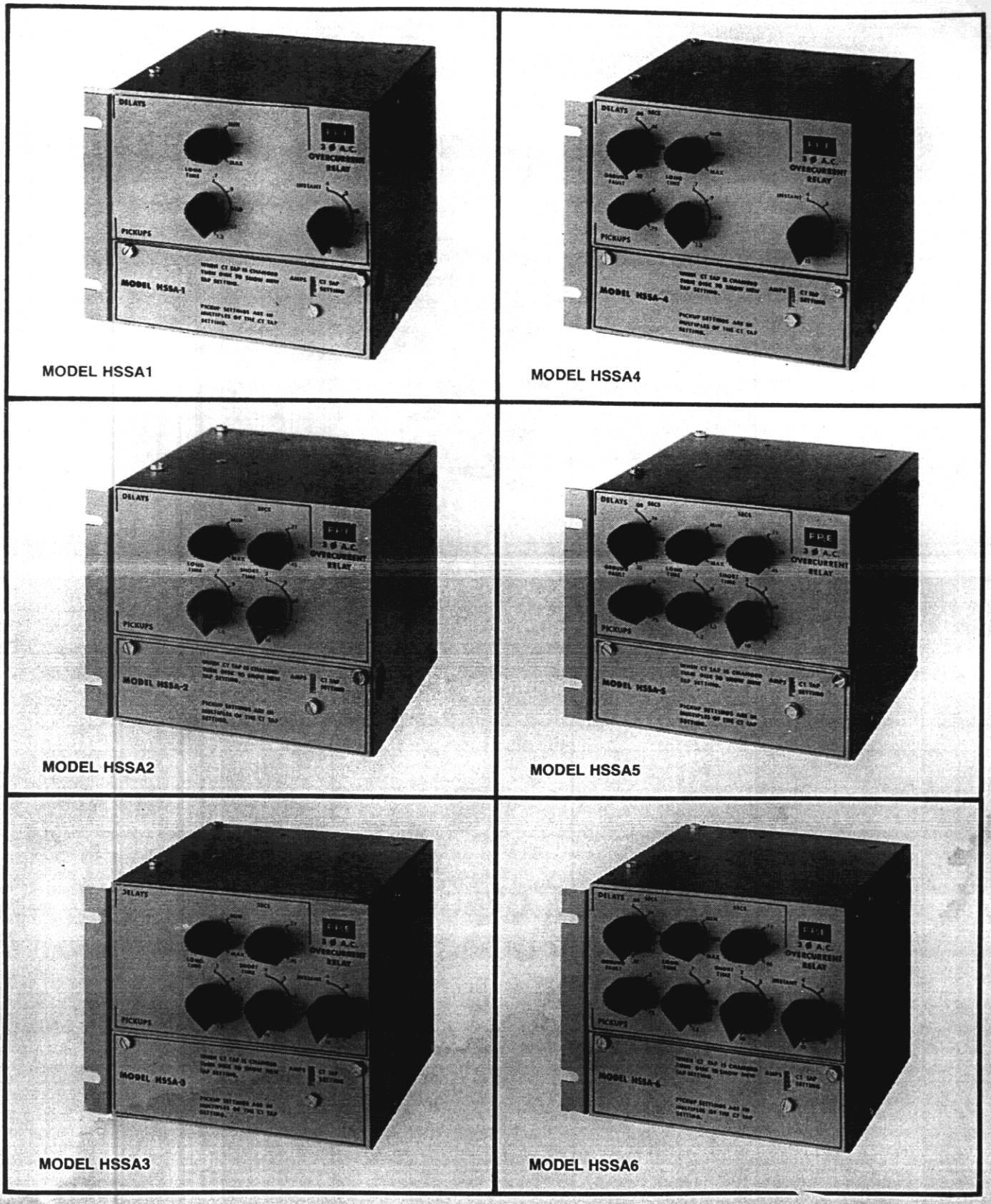


Fig. 1 — Static Overcurrent Trip Devices

INDEX

ILLUSTRATIONS

F — FUNCTIONS AND THEIR CHARACTERISTICS:

1. **Phase Overcurrent Protection**
   (Long Delay; Inverse Time Characteristic)
   a. The Long Delay Pick-Up is adjustable with settings of 0.7, 0.9, 1.0, 1.1, and 1.3 times the current sensor tap rating.
   b. The Long Delay Band is adjustable with three settings:
      Minimum — 6.5 seconds delay at 600% overcurrent
      Intermediate — 19 seconds delay at 600% overcurrent.
      Maximum — 35 seconds delay at 600% overcurrent.

The dependent I^2t characteristics of the long delay function and the individual band widths are shown on Fig. 3 "Time Current Characteristics".

2. **Phase Selective Fault Protection**
   (Short Delay; Definite Time Characteristic)
   a. The Short Delay Pick-Up is adjustable with settings of 2, 3, 4, 6, 8, and 10 times the current sensor tap rating.
   b. The Short Delay Band is adjustable with delays of 0.11 sec, 0.25 sec, and 0.45 sec. The delay is independent of the current magnitude.

3. **Phase Fault Protection**
   (Instantaneous; No Intentional Delay)
   The Instantaneous Pick-Up is adjustable with settings of 4, 5, 6, 8, 10, and 12 times the current sensor tap rating.

4. **Ground Fault Protection**
   (Short Delay; Time Characteristic)
   a. Ground fault pick-up is adjustable with setting of 0.2, 0.5, and 0.75 times the phase current sensor tap rating.
   b. Ground fault time delays (which are independent of fault current) are adjustable with settings of 0.08, 0.14, 0.20, 0.27, and 0.32 seconds. The ground current may be sensed by either a residual current connection of the three-phase sensors and the neutral sensor (4 wire system) or by direct connection to a current sensor on the power system ground strap.

II — Operation

A — GENERAL DESCRIPTION: There are three current sensors on the circuit breaker — one on each phase of the primary circuit. On 4-wire models, an identical current sensor on the neutral is used. The current sensors supply a signal to the static trip device which is proportional to the current in the primary circuit. This signal passes through residually connected set of auxiliary transformers in the solid state trip device where it is processed to obtain energy storage for tripping, regulated reference voltages, and D.C. signal voltages. The trip device responds only to the phase conducting the highest current.

The D.C. voltage signal is compared to a standard reference voltage and operates a trigger circuit when the phase or ground current exceeds the selected pick-up value. The pick-up trigger starts the selected timing function. After the proper delay, the timing circuit fires a static switch which discharges an energy storage capacitor to operate the circuit breaker magnetic latch release.

If the current magnitude drops to less than 90% of the se pick-up level, the static-trip device resets.

The trip device has independent pick-up trigger elements fc phase fault (instantaneous, short time and long time) an ground fault functions.

The ground current may be monitored by either a residua connection with or without a neutral sensor or a direct connec tion using a ground strap sensor. Fig. 5 and 5A shows th various sensor and static device connections.

B — SELECTING SETTINGS: The 3ϕ A.C. overcurrent tri device has a number of control knobs that can be set to selec specific conditions to cause the breaker to open. Selection c settings is usually made when the breaker is placed in service Future changes are unnecessary unless load conditions c other primary circuit changes are made.

All selector switches had "D"-type shafts to assure retention c settings. Turning the knobs beyond the marked settings wi cause the relay to operate at the maximum setting for tha function.

The knobs arranged vertically on the bottom side of the rela panel are pick-up settings. Knobs on the top are the time-dela settings. Fig. 4 shows the ampere values of pick-up current fo the various pick-up settings, functions, and current sensor taps

Circuit breaker current rating depends solely on the sensor selected for the application. The rating may be changed b selecting new tap settings or replacing the current sensors an changing the tap setting indicator disc on the front plate of th relay. The trip device and other components remain un changed. All timing functions are independent of each other Any long-time band can be selected to work with any short-tim band. The selection of settings is, therefore, governed only b system design considerations.

C — SELECTIVE COORDINATION EXAMPLE: The circu breaker directly feeding a phase overload or a ground curren fault should always trip first in a selective trip system. A circui overload on a feeder circuit will trip the feeder circuit breake while the main circuit breaker remains closed to continue serv ing the remaining feeders in the system. All circuit breaker have full interrupting capacity. See Fig. 6 for this example.

1. **THE MAIN CIRCUIT BREAKER:**
   a. **Current sensor** (1600) and long delay pick-up (0.9 1440A) are selected to coordinate with transformer con tinuous current rating of 1200A.
   b. **Long Delay Band** (Min.) is selected to coordinate witl high voltage fuse melting characteristic. The fuse char acteristic is converted to the 480V side of the trans former.
      Note: Some overlapping of the main circuit breaker an fuse characteristic curves is often unavoidable. The maximum fuse is determined by the transformer shor circuit capacity. The minimum current setting of the main circuit breaker depends on the continuous curren rating of the transformer secondary.
   c. **Short Delay Pick-Up** (6 X, 9600 AMP) is safely above the feeder instantaneous pick-up to afford main system short-circuit protection while preventing unnecessary tripping.

d. **The Short Delay Band** (.25 sec. min) is selected to best limit main-bus fault damage while preserving selectivity. Note: Lower limit of short delay curve is above feeder ground delay and phase instantaneous max. time to trip.

e. **The Ground Current Pick-Up** (.2 X, 320A) is selected (lowest setting) for best protection.

f. **The Ground Current Band** (.20 sec.) is selected to coordinate with the feeder ground current band. A 0.05 second spread between main circuit breaker ground current lower limit and feeder circuit breaker ground current upper limit is recommended. This example has 0.08 seconds separation.

2. FEEDER CIRCUIT BREAKER

a. **Current sensor** (500A) and long delay pick-up (1 X 500A) are selected to protect the feeder cables and/or load. Single motor feeder breakers should be set 125% of motor full load current.

b. **The Long Delay Band** (MIN.) is set below the main and as low as practical. Thermal characteristics of sub feeder molded case circuit breakers, fuses, or special loads may further govern the long-delay band selection.

c. **The Instantaneous Pick-Up** (8 X, 4,000A) is set higher than all normal transients. Special consideration is required on motor starting (inst. PU 2X locked rotor current), incandescent illumination, and capacitor switching applications.

d. **The Ground Current Pick-Up** is set (0.2 X, 100A) at the minimum setting. Higher settings may be required to coordinate with down stream ground current protection devices in some applications.

e. **The Ground Current Band** (0.08 sec.) min. delay available is selected to best limit ground fault damage.

D — PERFORMANCE IN SERVICE: Ambient conditions and length of service will have little effect on the performance of the solid state overcurrent trip device. The circuits are stable and will show excellent repeatability over long periods of time. Service involving frequent operations will not cause the characteristics to change or drift since there are no mechanical moving parts to wear or bearings to lubricate.

For the same reason the relay will withstand the severe environmental conditions often encountered in industrial applications. It will function properly in areas that would affect the serviceability of electro-mechanical trip devices.

The solid state trip device will operate the FPS4 circuit breakers within the published characteristics over the temperature range of −40°C to +65°C. Operation outside this temperature range should be referred to Federal Pacific Electric Company, Switchgear Division.

III — MAINTENANCE

A — GENERAL: Each trip device is calibrated and tested before shipment. It is ready for use after the appropriate settings have been selected and current sensor tap setting indicated.

No cleaning readjustment or lubrication is required. The only maintenance that is recommended is periodic verification that the relay and magnet latch release are functioning properly. The relay should be checked for pick-up, timing, and tripping functions. The magnetic latch release mechanical adjustments (See Fig. 18, IN 810.10) should be checked. The sealed dust cover may be removed to clean the magnetic pole faces to correct relatching problems. Use duct seal or similar sticky compound to remove dirt and magnetic particles. The pole faces and keeper must be perfectly clean and dry to function properly. Reinstall the dust cover ensuring it is properly seated on the elastic sealing ring.

All control wiring should be inspected to ensure connections are tight and wires are not damaged or broken.

Warning: The solid-state trip device is factory sealed after calibration and should not be opened. The guarantee is void if the trip device is tampered with or improperly tested. **DO NOT "HYPOT" TEST SOLID STATE TRIP DEVICE TERMINALS.**

B — TROUBLESHOOTING:

a. **Failure to Trip:** Failure of the circuit breaker to trip in response to overload, short circuit, or ground current may be caused by any of the following reasons. Corrective action is indicated with the reason for failure to trip.

1) **CT's improperly connected,** check that all terminals are tight, wiring is correct and leads are not broken. Current transformers which have carried load current with the secondary open must be replaced. Connections to trip unit are located under removable terminal cover. Remove two screws on front of trip device to open for inspection.

2) **Flux transfer magnetic latch release open circuited,** check that the wiring to the trip device is not broken and polarity marks are observed. Coil resistance should be approximately 25 ohms. The dust cover may be removed to permit mechanically releasing the magnetic keeper to test the spring and the loading force on the keeper, Fig. 18, IN 810.10 shows mechanical adjustments.

3) **Relay set too high,** check that pick-up settings on the relay are correct and the correct current sensor tap is being used. Refer to time current curve (Fig. 3) and table of pick-up currents (Fig. 4).

b. **Failure to Close and Latch the Breaker:** Failure to close and latch mechanically may result from any one of the following causes. Corrective action is indicated with the reasons for failure.

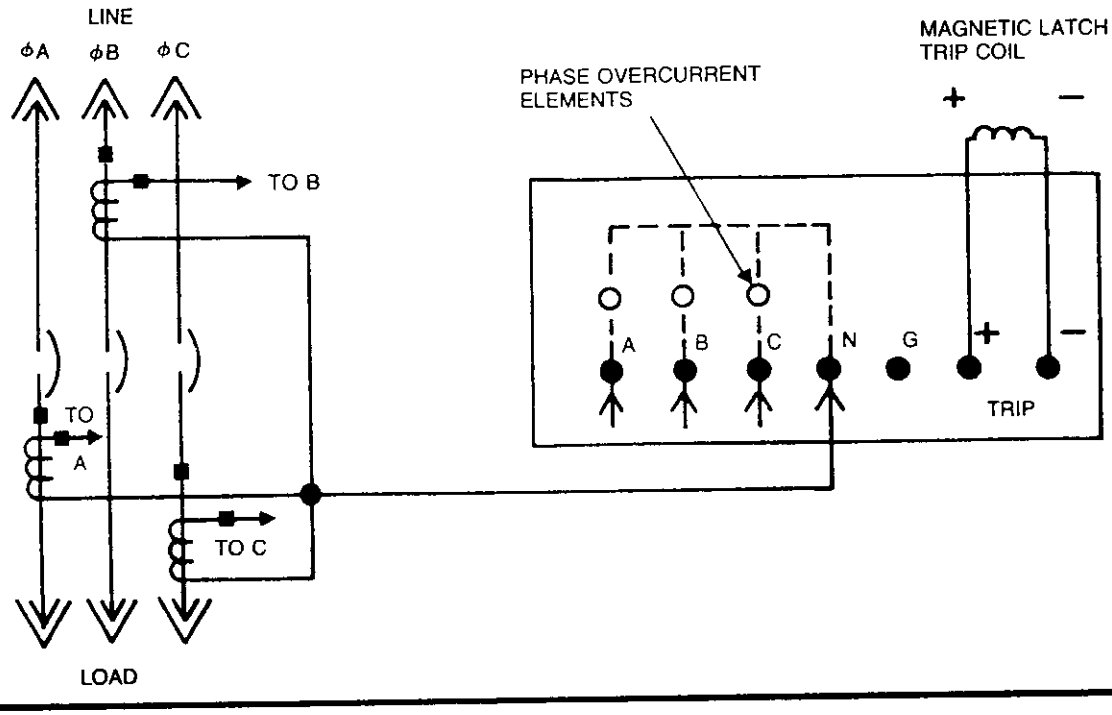
1) **Failure to close and latch mechanically,** check to insure that the magnetic trip release is properly reset by the circuit breaker when the mechanism is charged, open, and relatched. Refer to Fig. 18, IN 810.10 for correct adjustment and test standard. Remove the dust cover and thoroughly clean the magnetic keeper and pole faces. Check to ensure that the keeper is positively magnetically retained. The keeper may be forced off the pole faces to permit cleaning. Refer to appropriate circuit breaker instruction manual.

2) **Failure to close and latch because of prematur overcurrent tripping.** Check the following cause

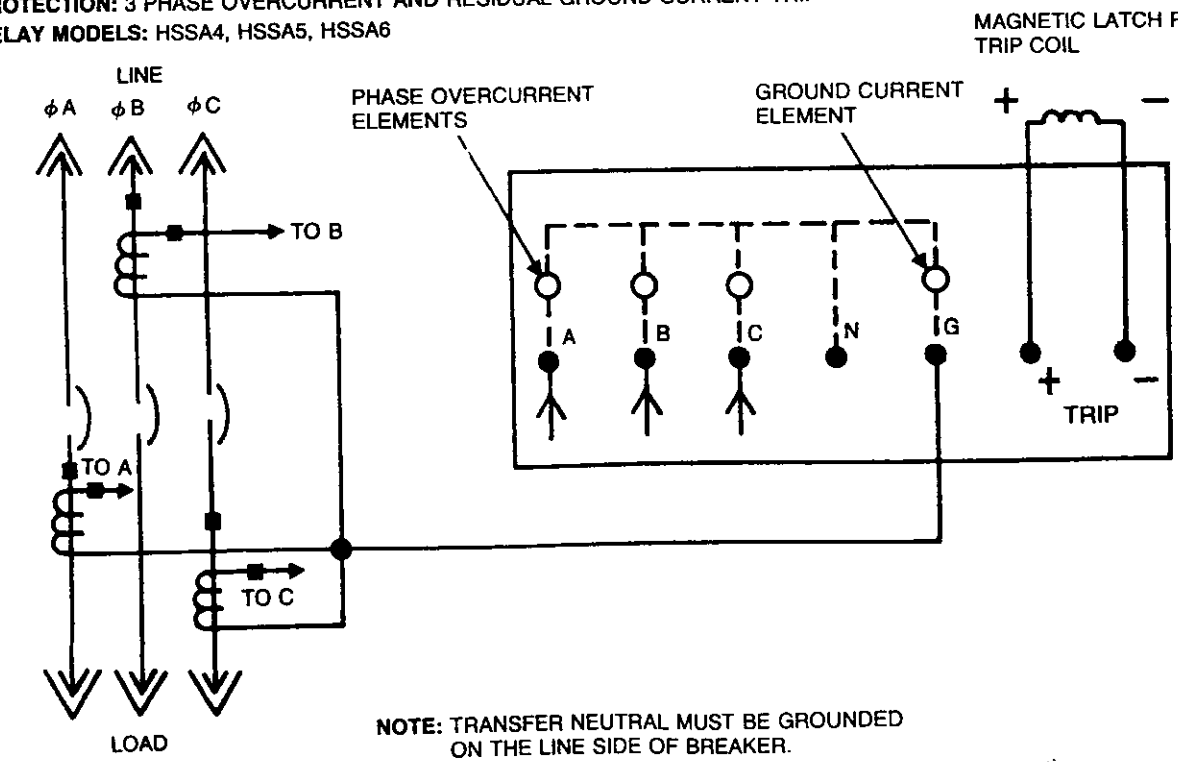
a) Ensure that an overload or short circuit conditic does not exist on the load circuit.

b) Ensure that there is no abnormal grounding ground current. Ground current pick-up may b set as low as 20% of phase current.

SYSTEM: 3 PHASE, 3 WIRE, UNGROUNDED or
3 PHASE, 4 WIRE, WITHOUT GROUND FAULT PROTECTION
PROTECTION: 3 PHASE OVERCURRENT TRIP
RELAY MODELS: HSSA1, HSSA2, HSSA3



SYSTEM: 3 PHASE, 3 WIRE
PROTECTION: 3 PHASE OVERCURRENT AND RESIDUAL GROUND CURRENT TRIP
RELAY MODELS: HSSA4, HSSA5, HSSA6



NOTE: TRANSFER NEUTRAL MUST BE GROUNDED ON THE LINE SIDE OF BREAKER.

Fig. 5 — Current Connections to HSSA Relay

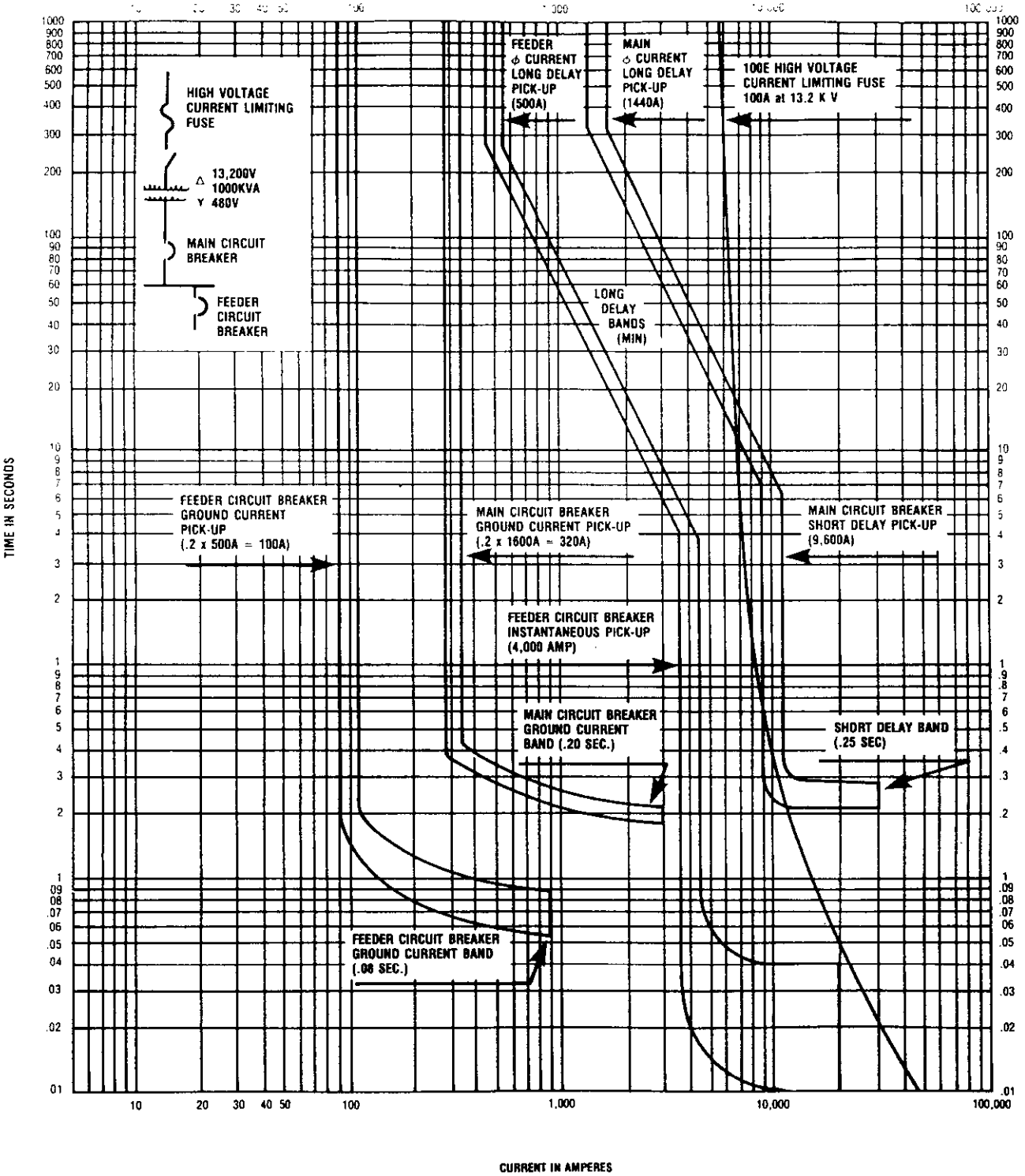


Fig. 6 — Selective Coordination Example

f) **INSTANTANEOUS PICK-UP:**

1) Set the Short Time pick-up on the relay to 10 and set the Instantaneous pick-up on 4.
2) Turn the "Current Adjust" knob fully counter-clockwise and push the "Reset" button.
3) Turn "Function" switch to "Pick-up Instantaneous".
4) Set the "Current" meter switch on "High".
5) Turn the "Current Adjust" knob slowly clockwise, until the relay trips. The current meter should indicate in the green zone marked 4.09 on the meter "High" scale. Other values of instantaneous pick-up may be tested also. Tolerance is ±10%.

g) **GROUND FAULT PICK-UP:**

1) Connect current input to "G" and any "Phase" terminals on the relay. Set the "Ground Fault" pick-up on 0.75 and delay on 0.20 secs.
2) Rotate the "Current Adjust" knob fully counter-clockwise and push the "Reset" button.
3) Set the "Function" switch on "Pick-up" — ground fault.
4) Set the "Current" meter switch on "Low".
5) Rotate the "Current Adjust" knob slowly until relay trips. The current meter should indicate in green marked 0.75 on the "Low" scale on the meter. Other pick-up points may be tested also. The tolerance is +10%.

h) **GROUND FAULT TIME DELAY:**

1) Rotate the "Current Adjust" knob on the test set fully counter-clockwise and push the "Reset" button.
2) Put the "Current" meter switch on "MED".
3) Connect input current leads to "N" and any phase terminal on the relay. Do **not** have current input lead connected to "G" to set the current for time delay check (See Note A).
4) Turn the "Current Adjust" knob to set the current at 2.0 on the meter "MED" scale. Turn "Function" switch to off leaving the "Current Adjust" knob set for 2.0X.
5) Re-connect the current leads to "G" and any phase terminal on the relay. (See Note A).
6) Turn the "Function" switch to "Time — Ground Fault", push the "Reset" button and then push the "Start".
7) The short time meter should indicate the trip time between 0.18 to 0.24 secs.

C. HIGH CURRENT TESTING:

a) It is possible to test the overcurrent relay trip system by passing high current through the circuit breaker primary circuit. The usual high current test equipment operates at very low voltage, and for this reason it may not produce a sinusoidal current through the static trip device. This will show an apparent error. The current wave shape should be checked and allowance made for distortions, if present, when this type of equipment is used.

b) Trip devices equipped with and connected for residual ground current sensing must be re-connected to bypass the ground current sensing element when testing the phase overcurrent trip functions. (See Note A). Move the common current sensor connection (red sensor lead) from the "G" terminal to the "N" terminal on the relay connection terminal board.

c) Ground-current functions may be tested with single phase current through one of the phase sensors when the common connection (red sensor lead) is connected to the "G" terminal and the other sensor lead is connected to a phase terminal (A,B, or C). (See Note A).

d) **Warning:** High current test equipment connection studs must be the same thickness as enclosure terminals and must be properly aligned with circuit breaker studs to avoid thermal and mechanical damage to main isolating cluster assemblies.

NOTE "A"

Testing the ground fault pick-up and time delay requires that the red lead be moved from "G" to "N" and then returned to "G" when testing is completed. When a series resistor is mounted on the outside of the static trip case and connected to the residual ground fault trip circuit, the resistor must be by-passed during the testing. To by-pass the resistor, move the red lead from the resistor and attach it directly to "N", returning it from "N" to the resistor after tests.

RESISTOR APPLICATION DATA

SENSOR RATING	RESISTANCE	RESISTOR RATING
200A-225A-250A	5 Ohms	25 Watts
300A-350A-400A	10 Ohms	25 Watts