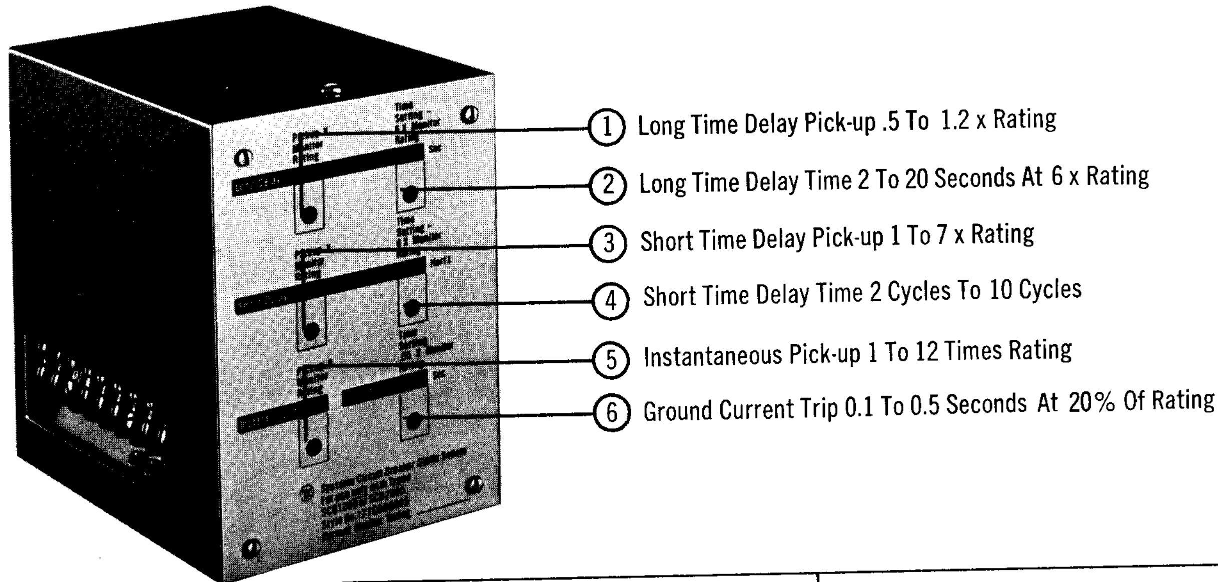
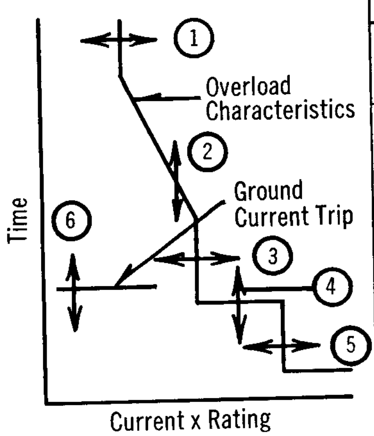
Instructions for Installation of SCB Static Sensor

I.L. 13784-A
File 29-820





Style No.			Trip Characteristics		
SCB2500	SCB1200 SCB2000	SCB600		Grd. Trip Ind.	Inst. Trip Ind.
177C090G01	177C090G01	177C090G06	① ② ⑤		
177C090G02	177C090G02	177C090G07	① ② ⑤ ⑥		
-------	177C090G03	-------	① ② ③ ④		
-------	177C090G04	-------	① ② ③ ④ ⑥		
177C090G05	177C090G05	177C090G10	① ② ③ ④ ⑤ ⑥		
177C090G13	177C090G13	177C090G16	① ② ⑤ ⑥	X	
-------	177C090G14	-------	① ② ③ ④ ⑥	X	
177C090G15	177C090G15	177C090G18	① ② ③ ④ ⑤ ⑥	X	
177C090G20	177C090G20	177C090G23	① ② ⑤		X
177C090G21	177C090G21	-------	① ② ⑤ ⑥		X
177C090G22	177C090G22	177C090G25	① ② ③ ④ ⑤ ⑥		X
177C090G26	177C090G26	177C090G28	① ② ⑤ ⑥	X	X
177C090G27	177C090G27	177C090G29	① ② ③ ④ ⑤ ⑥	X	X

Figure 1 - Construction and Operation of Static Sensor

The Westinghouse Systems Circuit Breakers (SCB) are modern circuit breakers designed for coordinated systems protection at a modest cost. In addition to quality and design innovations, you get versatility for protection systems never before available in such compact circuit breakers.

The key to the new SCB is the adjustable, solid state, electronic sensor which provides the trip action. This feature gives designers of switchboards, power centers, and other electrical packages flexibility for obtaining selective tripping, ground-current monitoring, and ground-fault protection, as well as excellent coordination with other breakers or protective devices in the electrical system.

Westinghouse Systems Circuit Breakers are available in three sizes – SCB-600, SCB-1200, and SCB-2000. Each size is rated at 100 percent of its continuous-current capa-

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bility. This means that the SCB can be applied in equipment assemblies up to 100 percent of the nameplate rating.

The SCB is a simple solution to a complex problem – coordinated systems protection. The basic breaker has four major parts: a static sensor, current monitors, a frame, and a special flux transfer shunt-trip device.

SCB Static Sensor

Figure 1 illustrates the construction and operation of the SCB Static Sensor and how the adjustments affect the trip time versus current characteristic curve.

Operation of Systems Circuit Breaker

Figure 2 is a simplified block schematic diagram of the Westinghouse Systems Circuit Breaker. It shows the basic operating sequences involved in the breaker's tripping functions.

The SCB solid-state tripping system consists of 10 major elements: 1. current monitors; 2. auxiliary transformers; 3. rectifier bridges; 4. power-and-signal circuit; 5. long-delay tripping circuits; 6. short-delay tripping circuits; 7. instantaneous-tripping circuit; 8. ground-tripping circuit; 9. trigger circuit; 10. flux-transfer shunt-trip device.

The current monitors are coils similar to standard through-type current transformers and are designed to mount on the rear-connection bus of the circuit breaker. At the nominal or continuous-current rating of the breaker, each current monitor's output to the static sensor is 2.5 amperes for the 600A sensors and 5A for the 1200 and 2000A sensors. At overloads, the current monitors output rises in close proportion to the overload current in the circuit-breaker bus. The design of the monitors is such that the close proportion is maintained up to overloads of 12 times the breaker nominal current rating to insure the accuracy of the tripping characteristics of the entire Systems Circuit Breaker. Trip characteristic curves are shown in Figure 3.

The signal current from the monitors goes to the auxiliary transformer where it is stepped down to milliampere levels. The output of the auxiliary transformers is rectified by the rectifier bridges to direct-current power for use by the other circuits of the static sensor.

The power-and-signal circuit serves two separate and distinct purposes. First, it acts as the power supply for energizing the shunt-trip coil. It does this by charging a condenser with direct current supplied by the current mon-

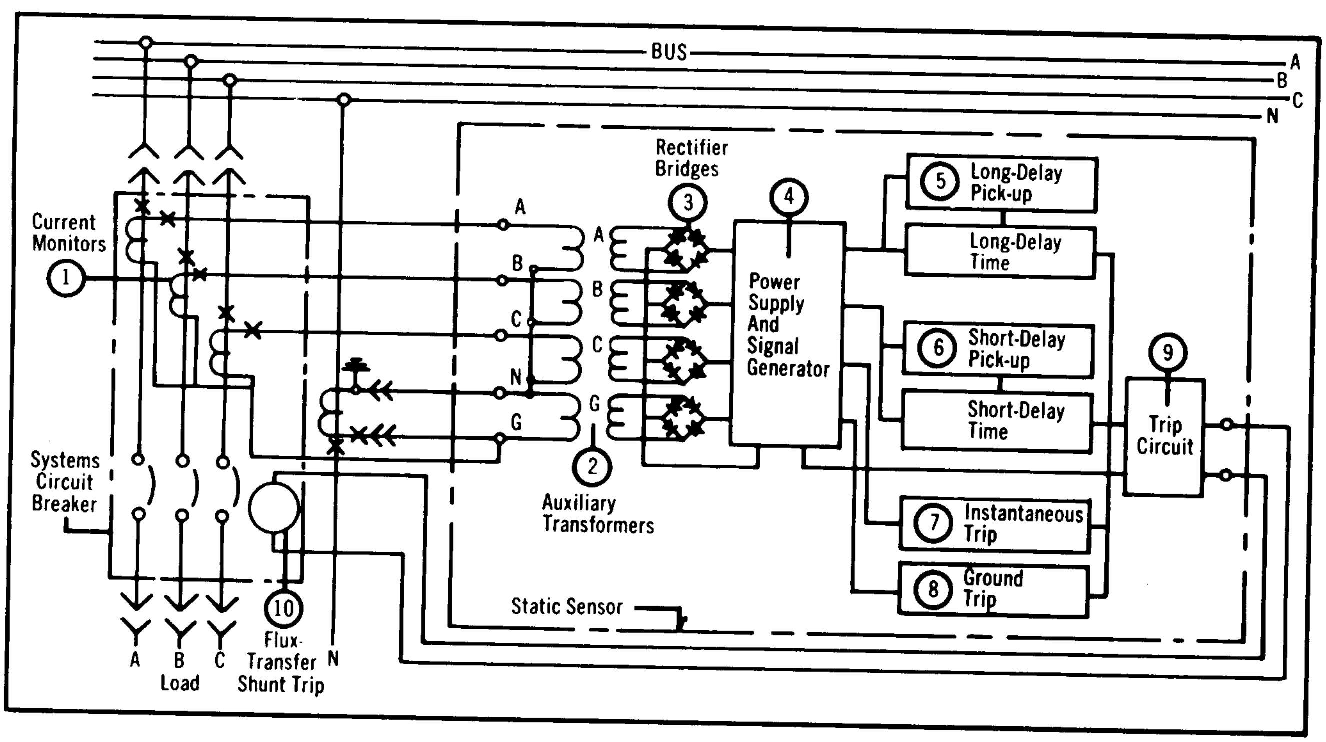
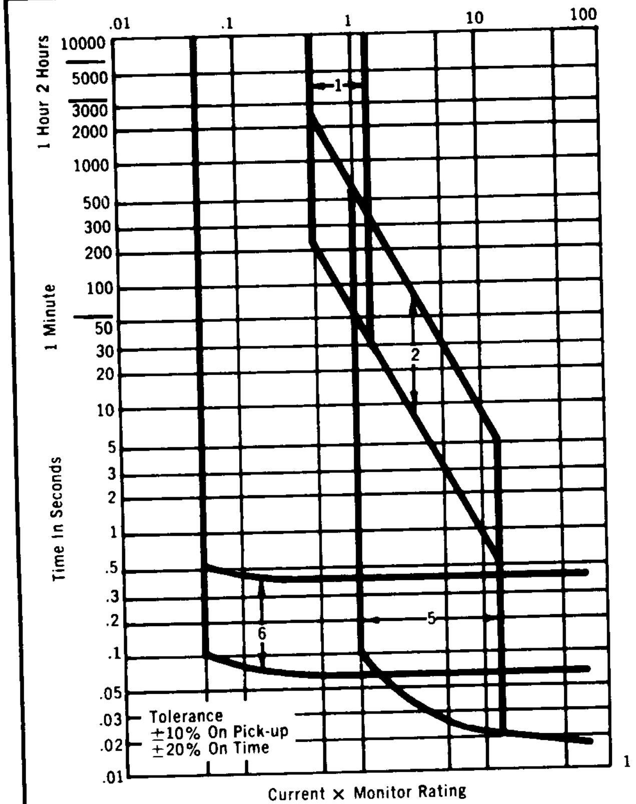


Figure 2 - Schematic Diagram - Complete Systems Circuit Breaker



SCB Static Sensor

1 Style Number

SCB1200 SCB2000	SCB600	Trip Characteristics
177C090G01	177C090G06	1, 2, 5,
177C090G02	177C090G07	1, 2, 5, 6

1. Long Delay Pick-up
2. Long Delay
5. Instantaneous Pick-up
6. Ground

SCB Static Sensor

2 Style Number

SCB1200 SCB2000	Trip Characteristics
177C090G03	1, 2, 3, 4
177C090G04	1, 2, 3, 4, 6

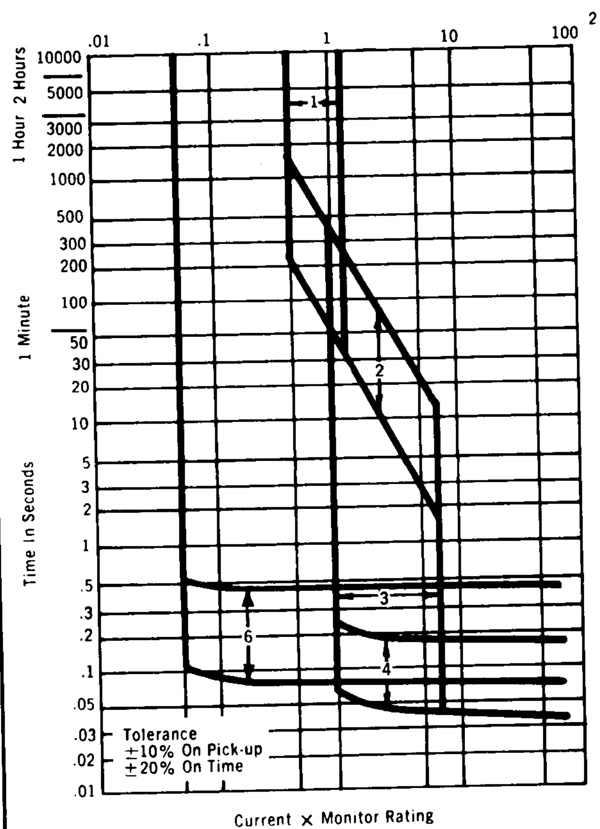
1. Long Delay Pick-up
2. Long Delay
3. Short Delay Pick-up
4. Short Delay
6. Ground

SCB Static Sensor

3 Style Number

SCB1200 SCB2000	SCB600	Trip Characteristics
177C090G05	177C090G10	1, 2, 3, 4, 5, 6

1. Long Delay Pick-up
2. Long Delay
3. Short Delay Pick-up
4. Short Delay
5. Instantaneous Pick-up
6. Ground



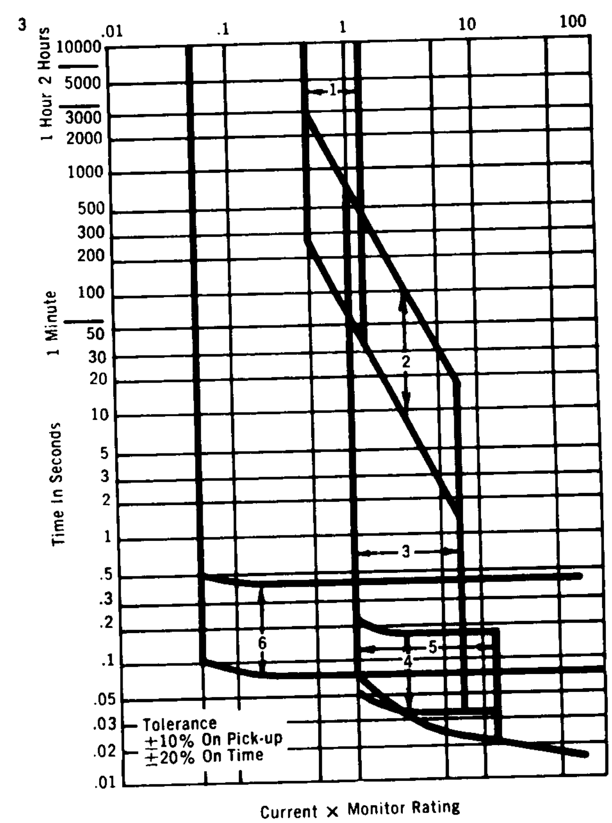


Figure 3 - Current Monitor Rating Curves

itors, auxiliary transformers, and rectifier bridges. When tripping is called for by the other static-sensor circuits, the fully charged condenser discharges to the shunt coil which in turn opens the circuit breaker contacts. Because the condenser is charged by signal current which is taken from the bus being monitored, no outside power source is needed to operate the shunt-trip unit. The other sensor circuits also draw operating power from the capacitor and the rectifier bridge.

Second, the power-and-signal circuit supplies a signal for the sensing and triggering circuits.

Overload-Operation Sequence

When an overload current appears in the breaker bus, the voltage from the rectifiers increases proportionally to the overload current and acts as a signal to operate timing circuits in the trip circuits. These timing circuits, which signal the trigger circuit to discharge the condenser through the shunt-trip coil, cause the breaker to trip according to the trip curve established by the trip settings on the static sensor. Operations of the long-delay, short-delay, and instantaneous trip parts of the sensor are the same in 3-wire and 4-wire 3-phase distribution systems.

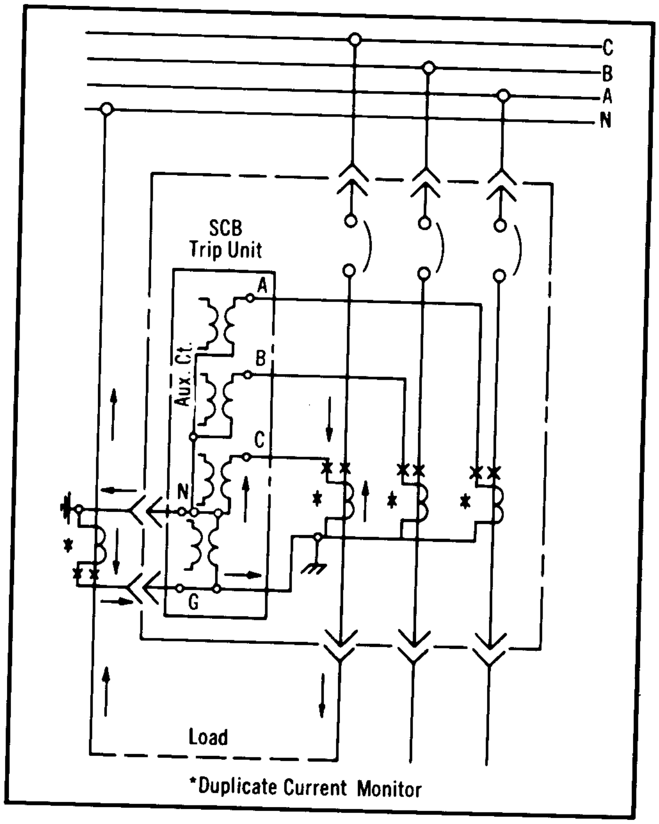


Figure 4 - Polarity of Circuit Monitors in 4-Wire System Circuit Breaker

Ground-Fault Tripping in a 3-Wire Distribution System

Under normal conditions, i.e., with no ground fault, all current in the system flows through poles A, B, and C of the Systems Circuit Breaker. (See Figure 4) Correspondingly, these currents are reflected in the three current monitors, and must all pass through the primary of the auxiliary transformer G. This results in no output from transformer G because the currents of a 3-phase system cancel each other out completely, even when the circuit load is unbalanced and the current is not equal in all three phases.

When a ground fault occurs, the ground-fault current will flow in auxiliary transformer G only. There will then be an uncanceled current in the secondary of auxiliary transformer G and this will result in a d-c signal to the power-and-signal circuit. If the fault current is higher than 5 percent of the continuous-current rating of the breaker, the ground-trip circuit will signal the trigger circuit to discharge the condenser in the power-and-signal circuit . . . and the breaker will trip open.

Ground-Fault Tripping in a 4-Wire Distribution System

The Westinghouse Systems Circuit Breaker needs only the addition of a fourth current monitor to apply it for ground-fault tripping on a 4-wire power-distribution system. As Figure 2 shows, the additional current monitor is mounted on the neutral bus. In a 4-wire power system, current will flow in the neutral bus when an unbalanced load causes the 3-phase currents to be unequal, even in the absence of a ground fault. Because this neutral-line current escapes detection by the three current monitors in the power lines, the total current in auxiliary transformer G would not be zero and the sensor would falsely report a ground fault. The purpose of the fourth current monitor is to reflect any neutral-wire current to auxiliary transformer G so that all current components will cancel when the load is unbalanced and there is no ground fault.

When a ground fault occurs, the operation is the same as in the 3-wire power system. Ground fault current in the neutral wire appears in the primary winding of auxiliary transformer G only . . . and tripping occurs in the same sequence as in the 3-wire system. Two important points should be noted about the neutral-line current monitor:

1. It should be identical to each of the monitors in the phase lines. Even if its output deviates by only a few percent from the output of the line monitors, the difference could be enough to cause the ground-fault tripping of the breaker instead of time-delay overload tripping.

2. Current monitors must be connected carefully for proper polarity as shown in Figure 4. The direction of current flow in the neutral monitor must be opposite the flow in the line monitor. When ground-fault tripping is not required, polarities need not be observed.

Ground Trip Indicator (GTI)

The GTI is an option which can be obtained on the SCB Static Sensors that have the ground trip circuit. See Figure 1. It enables the user to tell if the circuit has had a ground fault. If a ground fault occurs of sufficient magnitude to cause the Static Sensor to start timing, but not of sufficient duration to cause the System Circuit Breaker to trip, the GTI will indicate this fault.

The GTI requires the application of 120 VAC control power to the Static Sensor. This is connected between D1 and D2 of units with this option. The indicator is connected in series with a SPST momentary switch, used to reset the GTI, between TP3 and TP4. The indicator light and reset switch must be ordered separately and the light has to be of the resistive type. It also requires that, if you wish to check "Long Delay Pick-Up," you connect the D.C. voltmeter between TP1 and TP2. See Figure 5.

Testing is accomplished by putting 1.5 amperes between G and N. The indicator should come on. Remove the current and the indicator should stay on. Throw the reset switch and the indicator should go out.

Instantaneous Trip Indicator

The Instantaneous Trip Indicator is an option which can be obtained on the SCB Static Sensors that have the instantaneous trip circuit. See Figure 1. It enables the user to tell if the circuit has had a short circuit fault.

The Instantaneous Indicator requires the application of 120 VAC control power to the Static Sensor. This is connected between D1 and D2 of units with this option. The indicator is connected in series with a SPST momentary switch, used to reset the Instantaneous Indicator, between TP5 and TP6. The indicator light and reset switch must be ordered separately and the light has to be the resistive type. It also requires that, if you wish to check "Long Delay Pick-Up," you connect the D.C. voltmeter between TP1 and TP2. See Figure 5.

Testing is accomplished by putting 65 amperes between A and N. The Indicator should come on. Remove the current and the indicator should stay on. Throw the reset switch and the indicator should go out.

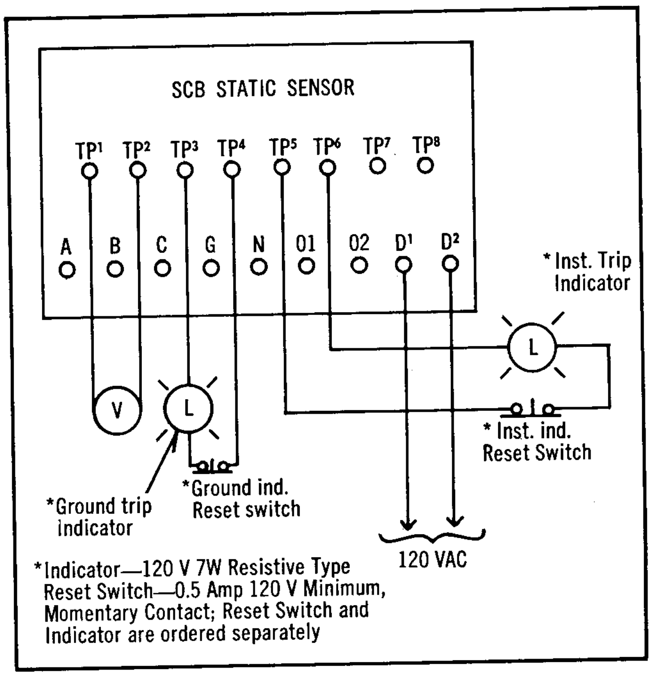


Figure 5 - Static Sensor

Flux-Transfer Shunt-Trip Device

The shunt-trip device, Figure 6, used in the Systems Circuit Breaker permits tripping the breaker with a low-energy electrical signal. The term "flux transfer" refers to the magnetic principle upon which it operates. Figure 6 shows the trip device in the *reset* position. It is held in this position by two permanent magnets (1). Their magnetic flux lines pass through the U-shaped frame (2) and the magnetic sleeve of the armature (3), and because the "up" position is the shortest magnetic path, the armature is held up against the top of the H-frame.

Compressed spring (4) stores the energy for tripping the breaker. It is held compressed by the permanent magnets (1) which exert a slightly stronger force than the spring does.

When direct current from the capacitor in the static sensor passes through the pulse coil (5), an electromagnetic flux is set up in a direction opposite to the flux

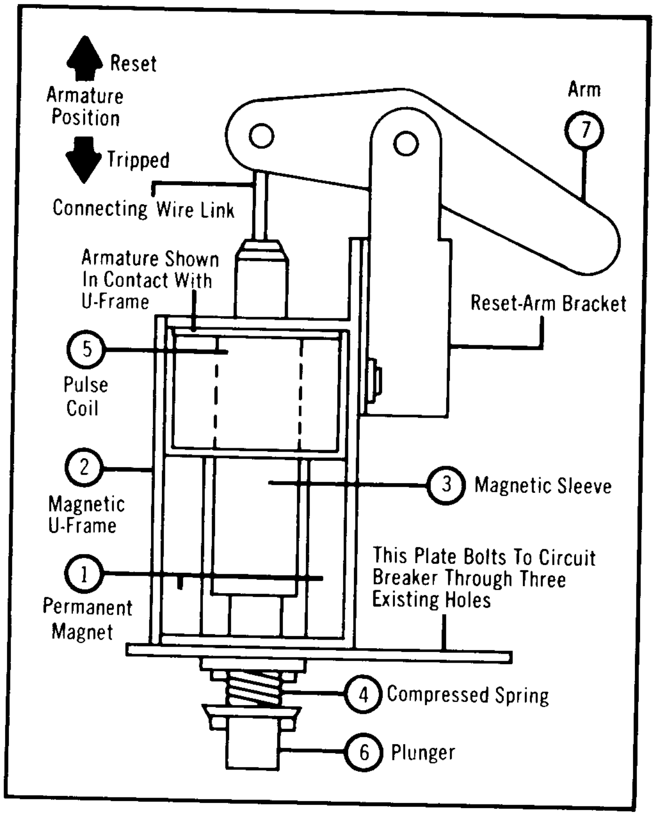


Figure 6 - Flux-transfer Shunt-tripping Device

of the permanent magnets. This opposing flux weakens the magnetic force exerted on the armature, the spring overcomes the magnetic force and forces the armature down.

The plunger (6) at the end of the armature strikes the trigger release rocker in the Systems Circuit Breaker trip unit, and trips the contacts open. As the contacts open, part of the moving mechanism strikes reset arm (7) in a downward direction, raises the armature, compresses the spring, and resets the device. The circuit breaker is immediately ready for tripping again and the person who resets the breaker does not need to remember to reset the shunt trip device.

Field Test Procedure

Westinghouse Systems Circuit Breakers are easily tested in the field. All 600 ampere frame current monitors have a 2.5 ampere output and all 1200 and 2000 ampere current monitors have a 5-ampere output when the current in the breaker equals the continuous-current rating of the breaker, regardless of the breaker rating. All breakers can be checked with the same few simple items of equipment – an ordinary ammeter, voltmeter, single-pole switch and stopwatch make up the only test equipment needed in addition to a source of alternating current that is variable from zero to fifty amperes.

To check the accuracy of the setting of each adjustment dial connect the test circuit as shown in Figure 7 with power supply connected to static sensor terminals A and N (these terminals connect to phase A) and proceed as follows:

Long-Delay Tripping

1. *Pickup:* Slowly increase the current from zero and take a current reading when the voltmeter needle jumps to approximately 30 volts. The ratio of this current to 2.5 or

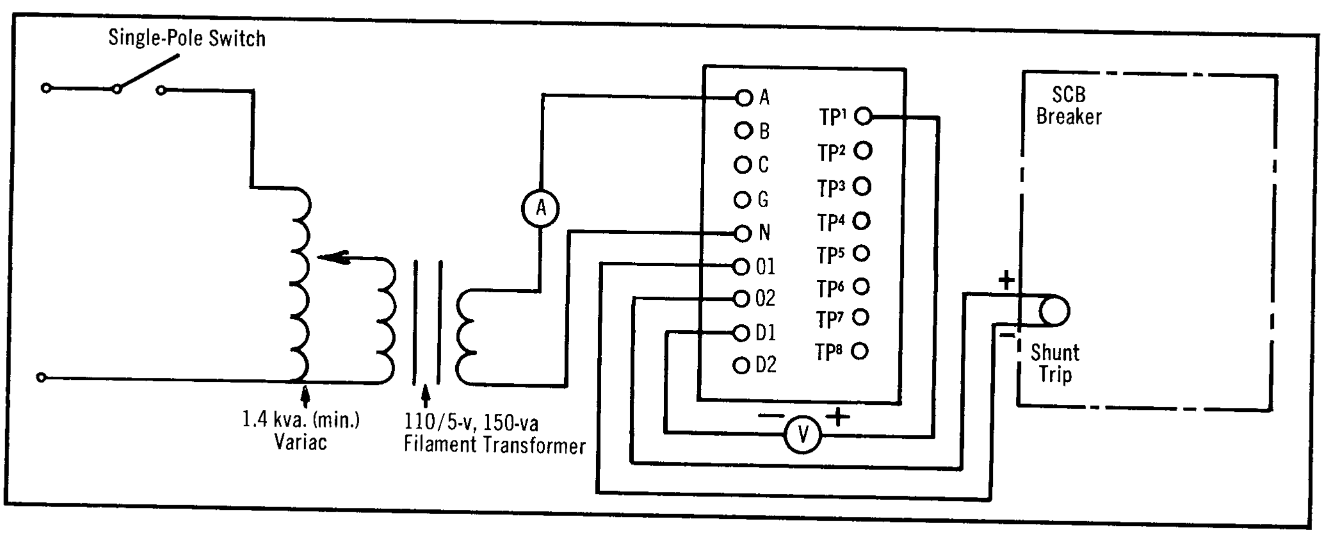


Figure 7 - Test Circuit

5 amperes should be within 10 percent of the long-delay pickup-current setting of the static trip unit. For example, if the ammeter indicated 3 amperes at the 30-volt point, with a 5 ampere input sensor the indicated ratio would be 3/5 or .60. If the actual setting were 65, the test figure would be within the limits of accuracy; that is 65 $\pm$ 10 percent is a range of 59 to 75 and the test figure of 60 falls within the range.

2. *Trip time:* Adjust current to 30 amperes then open the switch. Close switch and start timing with the stopwatch. Breaker should trip within 20 percent of time trip setting. (Note: if the short delay and/or instantaneous pickup is less than 6x, raise the short- delay and/or instantaneous trip settings above 6x or check long-delay trip time at current less than short-delay or instantaneous pickup settings. Refer to proper characteristic curve to determine the trip time at currents less than 6x.)

Short-Delay Tripping

1. *Pickup:* Increase the current and note the current reading at which the breaker trips. Current must be increased fast enough to prevent tripping by long-time-delay circuits. Leave the power-supply control at this setting for reference in testing the short-delay time.

2. *Short-delay time:* After performing the short-delay-pickup test, open the switch. Now advance the power-supply-current control above the setting that tripped the breaker in the pickup-current test. Close the switch. Breaker should trip almost instantaneously i.e., from 2 to 10 cycles (.03 to .16 sec.).

Elaborate methods and equipment would be necessary to determine short-delay-trip time accurately. For field testing, it is sufficient to observe whether the breaker trips in less than one second.

Instantaneous Trip

Because the instantaneous trip time is not adjustable, it is necessary to check only the pickup setting. Follow the same procedure as in the short-delay-pickup test. If the sensor has a short-delay, trip must be made ineffective by connecting test point TP2 of the sensor to terminal DI.

The tests as described check phase A of the sensor and all other components of the Systems Circuit Breaker. To check the other two phases, B and C, it is necessary to conduct just one of any of the preceding tests to make sure that tripping elements are working because only one sensing and triggering circuit is used for all phases and it is common to all poles.

Ground-Current Tripping

Ground-current tripping can be checked by passing a current greater than .125 ampere for the 600 ampere sensors and .25 ampere for the 1200 and 2000 ampere sensors through terminals N and G. Here again, it is sufficient to note whether the breaker trips in less than one second.

These tests check all components of the Systems Circuit Breaker except the current monitors. It is hardly possible that these can become defective unless they are physically damaged.

To test the complete system including current monitors a testing stand must be used. The testing stand must be capable of producing currents equal to the full rating and overload currents of the system. The three phase-bus current monitors are mounted on the circuit-breaker assembly and can be checked at a testing stand. But the ground current monitor of a four-wire system cannot be checked without removing it from the fixed buswork in the switchboard.

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