Instruction Leaflet **IL012125EN**

Effective April 2019
Supersedes January 2018

Performance testing for ground fault circuit breakers

NEC Requirements and UL Standards

The National Electric Code under Article 230-95-C requires that any ground-fault protection system be performance tested when first installed. The 2017 NEC requires the test process to be primary current injection for ground fault testing. UL Standard 489 & 1053 require that the minimum instructions contained in this document accompany each ground fault protection system. These instructions are provided to aid you in testing the circuit breaker as a component of the ground fault protection system. The applicable codes and standards remain the governing documents.

⚠ WARNING

ENERGIZED EQUIPMENT MAY CAUSE ELECTRICAL SHOCK OR BURN. REMOVE SOURCE POWER TO THE BREAKER BEFORE CONDUCTING TESTS

REMOVE ANY TEMPORARY CONNECTIONS MADE FOR CONDUCTING TESTS AND RESTORE THE CIRCUIT BREAKER TO PROPER OPERATING CONDITIONS BEFORE RETURNING THE BREAKER TO SERVICE.

General instructions

Field-testing is for functional assessment and not field calibration.

Qualified personnel shall evaluate the interconnected system in accordance with the equipment assembler's detailed instructions. Where a question on proper configuration or operation of the ground fault system exists, consult the specifying engineer and/or equipment assembly manufacturer.

Verify the grounding points of the system to determine that ground paths do not exist that would bypass sensors.

To confirm proper ground fault operation, it is important to perform both trip and no trip type tests. The trip test confirms that magnitudes of test current above the ground fault pick-up setting (I_g) will cause the breaker to trip. The no trip test confirms that magnitudes of test current above the ground fault pick-up setting but routed through the breaker in a way to simulate normal phase and neutral return currents does not cause the breaker to trip.

Make a written record of the tests performed and make it available to the authority having inspection jurisdiction.

Required testing equipment

Use a low voltage (0-24 V), high current, AC source, to generate all test currents. When applying a test current (125% of the I_g setting) be sure that L, S & I settings for phase currents (collectively I_{ph}) will not cause the breaker to trip.

The drawings illustrate commonly used circuit breaker configurations and apply to most molded-case (MCCB), insulated-case circuit breakers (ICCB), and power circuit breakers (a.k.a. ACB) with electronic trip units with ground fault trip or ground fault alarm capability. Consult the specifying engineer and/or equipment assembler for other configurations.

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Note on trip unit "Self-Power" capabilities

The circuit breaker trip unit derives its operating power from the phase current (self-power) or an auxiliary source. For self-power, approximately 35% of the breaker's frame rating (I_n) flowing in one pole or 20% flowing in 2 or 3 poles is sufficient. The status LED will blink (heartbeat) at approximately once per second as an indication of sufficient operating power.

An auxiliary source may be already wired to the trip unit to provide operating power. If that source is active during testing it can supply operating power to the trip unit.

Alternately, for PXR (Power Xpert Release) trip units, the USB port may be used to provide operating power to the trip unit. Either a commercial battery pack or a laptop can be connected via the micro-B USB connection. For Digitrip or PXR trip units, on insulated-case or power circuit breakers, an auxiliary power module may be used to provide operating power to the trip unit through the 2-pin connector on the front.

When testing low ground fault pick-up settings (I_g) without auxiliary power or when passing a test current only through the neutral or external sensor, the trip unit may not receive sufficient energy to self-power. To test under this condition, loop the test current through 2 poles in opposite directions, providing power and cancelling each other with respect to ground fault. Figure 1 shows 2 poles being used to provide operating power for the trip unit while testing another pole or sensor.

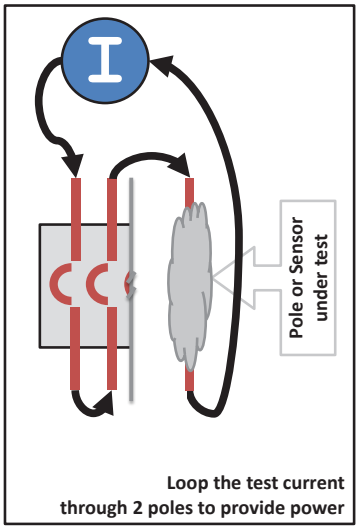

Figure 1.

Circuit breaker ground fault - trip test

1. Remove source power from the system and isolate the circuit breaker and sensors.
2. Apply a test current equal to 125% of the ground fault pick-up setting (I_g) through one pole of the circuit breaker or external sensors, as shown in figure 2.

   This will cause the breaker to trip or alarm (based on settings) on ground fault.
3. Reset the breaker and the alarm indicator.

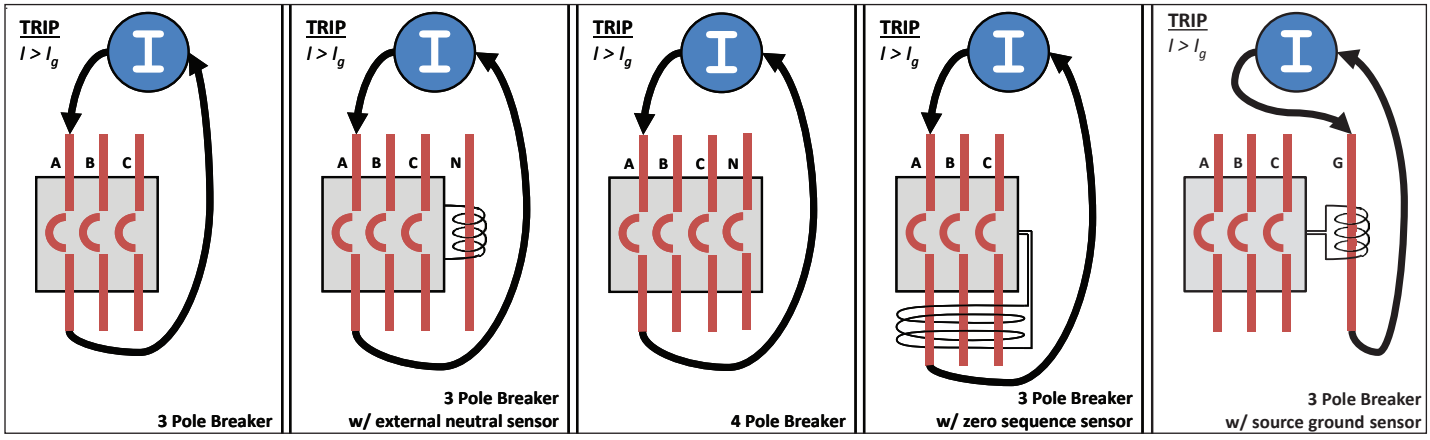

Figure 2. **a** **b** **c** **d** **e**

Circuit breaker ground fault - no trip test

1. Remove source power from the system and isolate the circuit breaker and sensors.
2. Depending on the configuration (see figure 3):
   a. For a 3 pole, 3 pole w/external neutral sensor, 4 pole or 3 pole w/zero sequence sensor (figure 3a, b, c, d): apply a test current equal to 125% of the ground fault pick-up setting (I_g) through one pole of the circuit breaker, returning the test current through another pole or the external neutral sensor.
   b. For a 3 pole w/source ground sensor (figure 3e) apply a test current equal to 75% of the ground fault pick-up setting (I_g) through the source ground sensor.

   The breaker should not trip or alarm on ground.

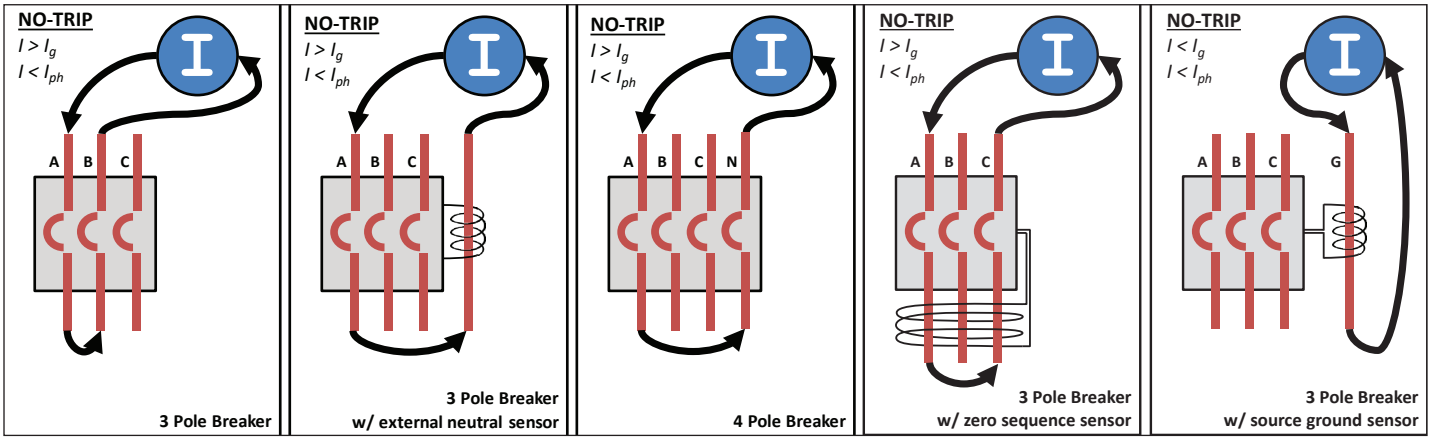

Figure 3. a b c d e

Troubleshooting

Certain behavior of the ground fault performance can provide insight if you are having a problem. Breakers which provide current metering (Optim, Digitrip 1150, PXR 20/25, Digitrip 310+ with Digiview accessory) are especially valuable for troubleshooting. Cause of trip indicators, current magnitudes, and trip-logs can often provide additional insight.

Breaker configuration	Type of test	Symptom	Possible causes
Breakers with external neutral sensor	No-trip test	Breaker trips	If breaker ground current indicated = 2x test current, external neutral sensor is wired backwards or mounted backwards. External neutral sensor polarity dot should be facing towards the source.
			If breaker ground current indicated = test current, check secondary connections from the external neutral sensor are landed on proper terminals on the breaker.
			If breaker ground current indicated = uneven multiple of the test current, check external neutral sensor ratio / rating. External neutral sensor rating must match the breaker frame.
	Trip test	Breaker does NOT trip	Trip unit not getting auxiliary power or insufficient test current to "self-power" trip unit. See "Note on trip unit self-power capabilities" section. Check status LED indication. Should blink approximately once per second indicating sufficient operating power.
			If breaker ground current indicated = 0 amps, external neutral sensor may be wired backwards or mounted backwards. External neutral sensor polarity dot should be facing towards the source.
			If breaker ground current indicated > 0 amps but less than test current, check external neutral sensor ratio / rating. External neutral sensor rating must match the breaker frame.
Breakers without external sensor	No-trip test	Breaker trips	Check test configuration. Test current should be looped through two poles in opposite directions.
	Trip test	Breaker does NOT trip	Trip unit not getting auxiliary power or insufficient test current to "self-power" trip unit. See "Note on trip unit self-power capabilities" section. Check status LED indication. Should blink approximately once per second indicating sufficient operating power.
			If breaker ground current indicated = 0 amps, check test configuration. If looping through multiple poles, ensure current flow through at least 2 of the poles is in the same direction. For example, loop in A-phase, reverse through B-phase, and back in through C-phase.
			If breaker ground current indicated > 0 amps, check test current is set greater than I_g pick-up setting. Refer to published time current curve for trip curve tolerance.

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Printed in USA
Publication No. IL012125EN / TBG 001373
April 2019

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Ground fault protection testing record

Circuit breaker identification: ______________________________

Ground fault settings: GF pick-up: ____________ **GF time:** ____________

Breaker: □ **3-pole** □ **3-pole w/external neutral sensor** □ **4-pole**
□ **3 pole w/zero sequence sensor** □ **3 pole w/source ground sensor**

Date	Breaker setting	Test & current	Notes	Tested by:
	Ground fault (I_g)	□ Trip □ No-trip	□ PASS □ FAIL	
	Pick up:	Current:		
	Time delay:	Time:		
	Ground fault (I_g)	□ Trip □ No-trip	□ PASS □ FAIL	
	Pick up:	Current:		
	Time delay:	Time:		
	Ground fault (I_g)	□ Trip □ No-trip	□ PASS □ FAIL	
	Pick up:	Current:		
	Time delay:	Time:		
	Ground fault (I_g)	□ Trip □ No-trip	□ PASS □ FAIL	
	Pick up:	Current:		
	Time delay:	Time:		
	Ground fault (I_g)	□ Trip □ No-trip	□ PASS □ FAIL	
	Pick up:	Current:		
	Time delay:	Time:		
	Ground fault (I_g)	□ Trip □ No-trip	□ PASS □ FAIL	
	Pick up:	Current:		
	Time delay:	Time:		
	Ground fault (I_g)	□ Trip □ No-trip	□ PASS □ FAIL	
	Pick up:	Current:		
	Time delay:	Time:		