# Primary High Current Injection

## Field Test Procedure for Modified Differential Ground Fault Protection Systems Class 6036

Instruction Bulletin

**Retain for future use.**

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## HAZARD CATEGORIES AND SPECIAL SYMBOLS

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service or maintain it. The following special messages may appear throughout this bulletin or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

**⚠ DANGER**

**DANGER** indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

**⚠ WARNING**

**WARNING** indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury.

**⚠ CAUTION**

**CAUTION** indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury.

**CAUTION**

**CAUTION**, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result in** property damage.

Provides additional information to clarify or simplify a procedure.

## PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

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# SECTION 1—INTRODUCTION

## Description

This bulletin contains inspection and testing instructions for modified differential ground fault protection systems manufactured by Schneider Electric.
The modified differential ground fault protection system used in Schneider Electric multiple-source switchboard and switchgear line-ups will use one of two types of ground fault current sensing techniques.

The first type is zero sequence sensing, which uses a single sensor to surround all three phase conductors and the neutral conductor. The second type is residual sensing, where each phase and the neutral conductor are surrounded by its own sensor. In normal conditions, the vector sum of the phase currents with the neutral current should equal zero. In a ground fault condition, the vector sum yields a current that is used in a protective relaying scheme to automatically open main or tie circuit breakers (or switches) as required.

*NOTE: All diagrams are shown as residual sensing.*

## Testing

Paragraph 230-95(c) of the National Electrical Code® (NEC)® requires that all ground fault protection systems be performance tested when first installed. Schneider Electric recommends testing be done:

- When the equipment is installed at its permanent location.
- As a part of normal maintenance.
- If the distribution system is altered in any way.

Field testing determines that the ground fault protection system is operational. Consider the following information when using this instruction bulletin:

- The diagrams in this bulletin are provided to illustrate high current injection test connections, but are not intended to depict the ground fault protection system in its entirety as installed in the field. Review all instruction manuals and wiring diagrams provided with the equipment for actual system configuration. Verify that all sensors are installed and wired with correct polarity per the wiring diagrams.
- This field test procedure is not a check of the calibration of any sensing relay.
- Record results within the ground fault test logs (Tables 1–3 on pages 31–33). If test results are not acceptable, recheck the connections and retest. If results are still unacceptable, contact Square D Services at 1-888-Square D (1-888-778-2733).

## Tools Required

The following tools are required to inspect and test the modified differential ground fault protection system:

- A high current injection test unit capable of injecting 1000 A. Test jumpers are typically copper welding cables. Use cables and connections that give low impedance.
- Hand-held test kit by Schneider Electric for Micrologic®
  Type A, H and P trip units.

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## Systems Covered

This test procedure is restricted to the following types of systems:

- Main-Main, Grounded Wye Configuration
- Main-Tie-Main, Grounded Wye, Non-Relayed Tie Configuration
- Main-Tie-Main, Grounded Wye, Relayed Tie Configuration

*NOTE: A relayed system has ground fault protection on the Tie device. A non-relayed system has no ground fault protection on the Tie device.*

*NOTE: Systems with configurations beyond what are covered in this document can be tested with similar methods as those shown. All possible configurations of open and closed circuit breakers must be tested for both TRIP and NO TRIP functionality. TRIP tests always have the TEST JUMPER connected phase-to-ground. NO TRIP tests always have the TEST JUMPER connected phase-to-neutral (if neutral is not present, connect TEST JUMPER phase-to-phase).*


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# SECTION 2—SAFETY PRECAUTIONS

## ⚠ DANGER

**HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH**

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This test procedure must be performed only by qualified electrical personnel.
- Turn off all power before working on or inside the equipment. Assume that circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm that all power is off.
- Always practice lock-out/tag-out procedures according to the OSHA requirements.
- Conduct electrical testing to confirm that no short-circuits were created during installation, maintenance, or testing.
- Carefully inspect your work area and remove any tools and objects left inside the equipment.
- Replace all devices, doors, and covers before turning on power to this equipment.
- All instructions in this manual are written with the assumption that the customer has taken these measures before performing maintenance or testing.

**Failure to follow these instructions will result in death or serious injury.**

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# SECTION 3—MAIN-MAIN, GROUNDED WYE CONFIGURATION

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH**

- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying the equipment before working on or inside the equipment.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors, and covers before turning on power to this equipment.

**Failure to follow these instructions will result in death or serious injury.**

1. Turn off all power supplying this equipment before working on or inside equipment. Use a properly rated voltage sensing device to confirm power is off.
2. Verify that all ground bus bar splices are solidly connected. For each main, verify that the ground bonding connection is made ahead of the neutral disconnect link and on the line side of any ground fault sensor. See Figure 1.
3. For each main, verify that a neutral connection exists from the supply transformer to the equipment.
4. For residual sensing systems, verify that all phase and neutral sensors are connected with correct polarity on both primary and secondary. Refer to the drawings supplied with the equipment.
5. For zero sequence sensing systems, verify that all phase conductors and the neutral pass through the sensor in the same direction, and that grounding conductors do not pass through the sensor. Also, verify that the sensor is connected with the correct polarity on both primary and secondary. Refer to the drawings supplied with the equipment.
6. Remove each main's neutral disconnect link to isolate wiring system neutrals from both supply and ground.
7. Measure the system neutral-to-ground insulation resistance to ensure that no ground connections exist on the load side of the ground fault protection system. The resistance should be at least 1.0 megohm. Remove all connections that exist from neutral-to-ground found during the test. Do not reconnect these grounds after the test is completed.
8. Replace each main's neutral disconnect link.
9. Record all pick-up and time delay settings for each circuit breaker and/or ground fault relay under test in Table 4 on page 34. After testing, return all settings to original values.
10. Adjust the ground fault pick-up setting on each circuit breaker and/or ground fault relay to its lowest current setting.
11. Adjust the ground fault time delay setting on each circuit breaker and/or ground fault relay under test to 0.1 seconds (I2T OUT or OFF).
12. Adjust the long-time, short-time, and instantaneous pick-up and time delay settings on each circuit breaker under test to their highest settings.
13. For each circuit breaker equipped with the Micrologic® Type A, H, or P trip unit, connect a hand-held test unit, and activate the thermal-imaging inhibit function according to the test unit instructions. This step is necessary to inhibit trip history and contact wear counter functions. After testing, de-activate the thermal-imaging inhibit function according to the


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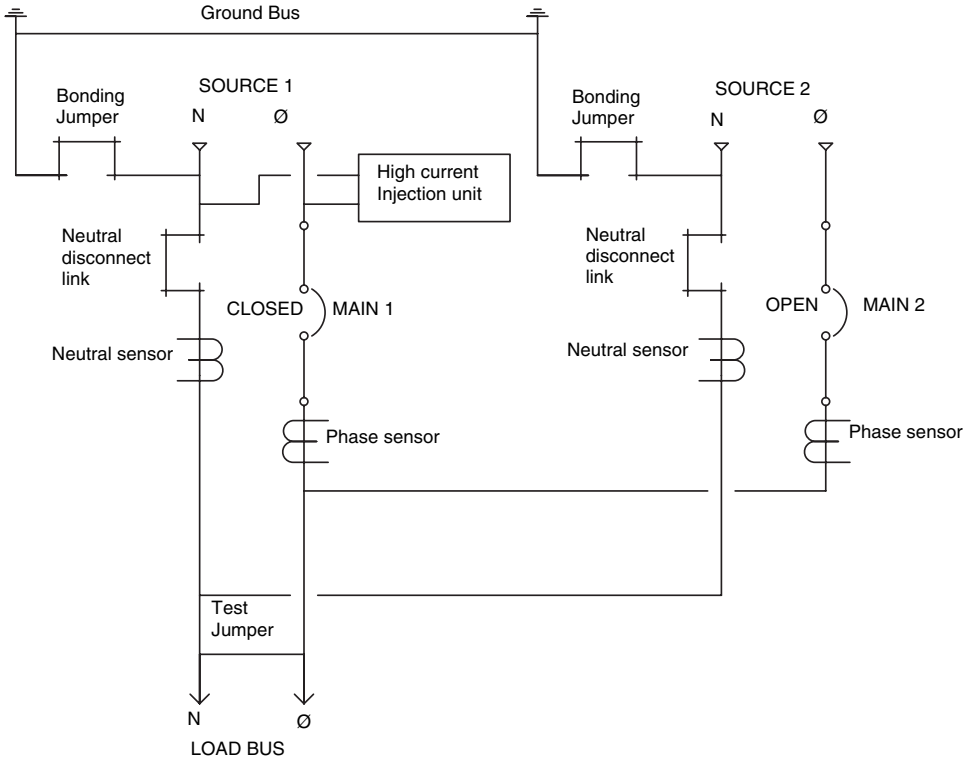
test unit instructions. Refer to bulletin 48049-184-XX for additional information.

14. Disconnect the ground fault protection control power source, if internally derived, and provide control power from an external source. Refer to wiring diagrams supplied for specific connections. After testing, disconnect external control power and re-connect internal control power circuit.

## Test No. 1

1. Close MAIN 1 circuit breaker (or switch), and open MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 1 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 1.
3. On the load bus, connect a high current jumper between Phase A and the neutral (N). See Figure 1.
4. Inject 1000 A into Phase A. MAIN 1 circuit breaker (or switch) should not trip on ground fault. Record the actual results for Test No. 1 in Table 1 on page 31.
5. Repeat Test No. 1 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 1.

**Figure 1: Main-Main Test No. 1 (No Trip) Injection Unit and Test Jumper Connections**

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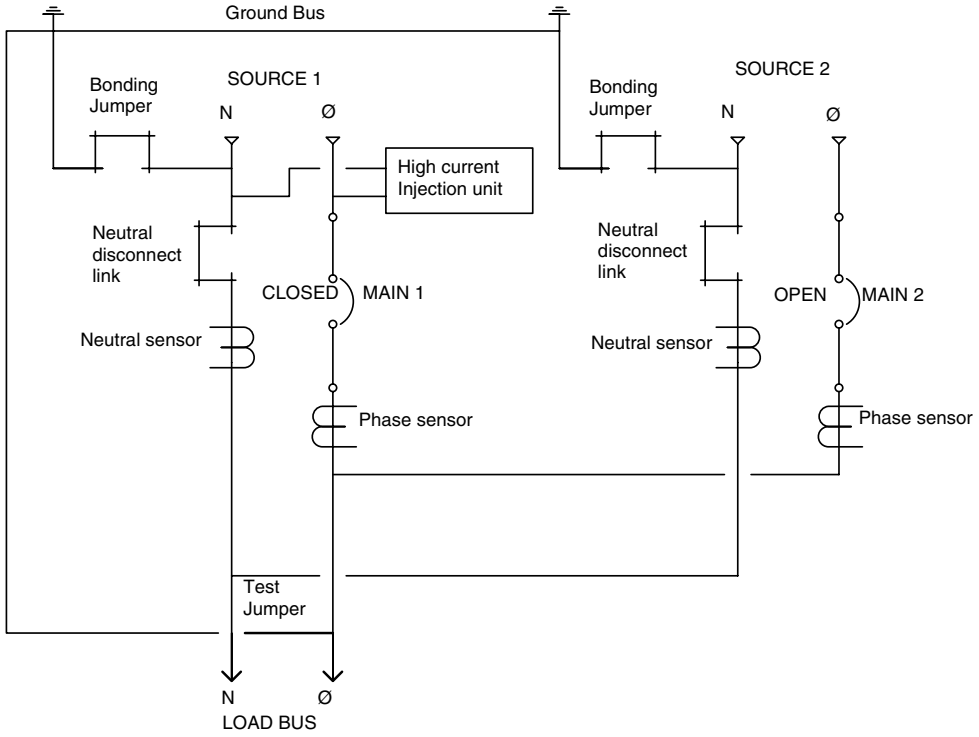
## Test No. 2

1. Close MAIN 1 circuit breaker (or switch), and open MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 1 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 2.
3. On the load bus, connect a high current jumper between Phase A and the ground. See Figure 2.
4. Inject 1000 A into Phase A. MAIN 1 circuit breaker (or switch) should trip on ground fault. Record the actual results for Test No. 2 in Table 1 on page 31.
5. Repeat Test No. 2 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 1.

**Figure 2: Main-Main Test No. 2 (Trip) Injection Unit and Test Jumper Connections**





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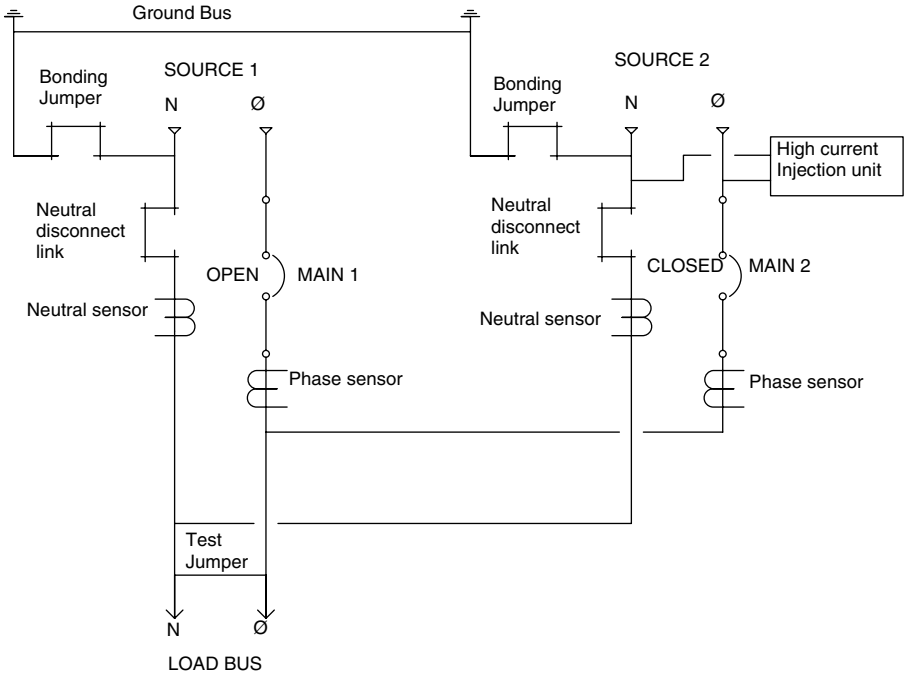
### Test No. 3

1. Close MAIN 2 circuit breaker (or switch), and open MAIN 1 circuit breaker (or switch).
2. On the line side of MAIN 2 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 3.
3. On the load bus, connect a high current jumper between Phase A and the neutral (N). See Figure 3.
4. Inject 1000 A into Phase A. MAIN 2 circuit breaker (or switch) should not trip on ground fault. Record the actual results for Test No. 3 in Table 1 on page 31.
5. Repeat Test No. 3 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 1.

**Figure 3: Main-Main Test No. 3 (No Trip) Injection Unit and Test Jumper Connections**

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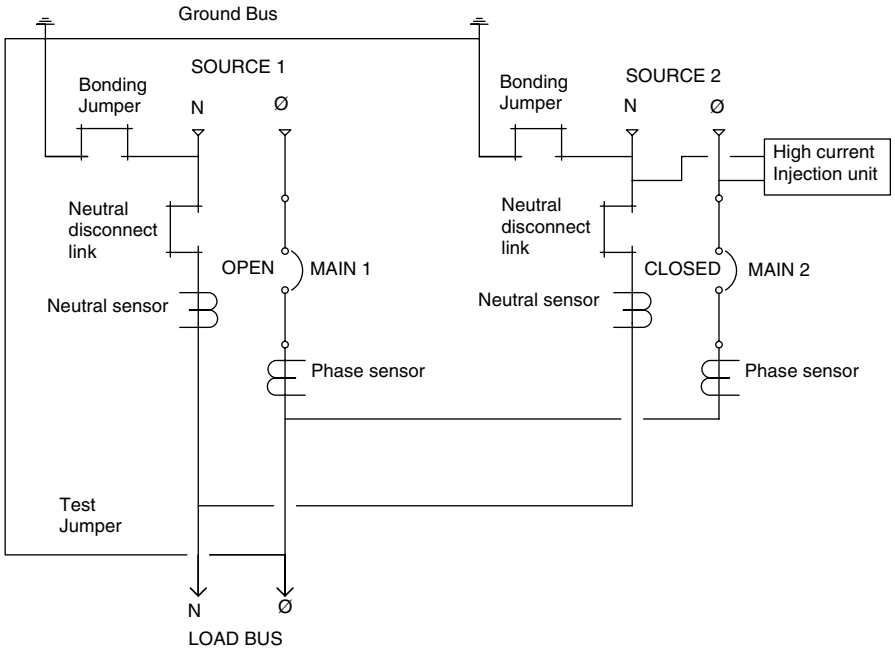
## Test No. 4

1. Close MAIN 2 circuit breaker (or switch), and open MAIN 1 circuit breaker (or switch).
2. On the line side of MAIN 2 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 4.
3. On the load bus, connect a high current jumper between Phase A and the ground. See Figure 4.
4. Inject 1000 A into Phase A. MAIN 2 circuit breaker (or switch) should trip on ground fault. Record the actual results for Test No. 4 in Table 1 on page 31.
5. Repeat Test No. 4 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 1.
6. After testing, return all settings to the original values previously recorded.

**Figure 4: Main-Main Test No. 4 (Trip) Injection Unit and Test Jumper Connections**





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## SECTION 4—MAIN-TIE-MAIN, GROUNDED WYE, NON-RELAYED TIE CONFIGURATION

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH**

- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying the equipment before working on or inside the equipment.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors, and covers before turning on power to this equipment.

**Failure to follow these instructions will result in death or serious injury.**

1. Turn off all power supplying this equipment before working on or inside equipment. Use a properly rated voltage sensing device to confirm power is off.
2. Verify that all ground bus bar splices are solidly connected. For each main, verify that the ground bonding connection is made ahead of the neutral disconnect link and on the line side of any ground fault sensor. See Figure 5.
3. For each main, verify that a neutral connection exists from the supply transformer to the equipment.
4. For residual sensing systems, verify that all phase and neutral sensors are connected with correct polarity on both primary and secondary. Refer to the drawings supplied with the equipment.
5. For zero sequence sensing systems, verify that all phase conductors and the neutral pass through the sensor in the same direction, and that grounding conductors do not pass through the sensor. Also, verify that the sensor is connected with the correct polarity on both primary and secondary. Refer to the drawings supplied with the equipment.
6. Remove each main's neutral disconnect link to isolate wiring system neutrals from both supply and ground.
7. Measure the system neutral-to-ground insulation resistance to ensure that no ground connections exist on the load side of the ground fault protection system. The resistance should be at least 1.0 megohm. Remove all connections that exist from neutral-to-ground found during the test. Do not reconnect these grounds after the test is completed.
8. Replace each main's neutral disconnect link.
9. Record all pick-up and time delay settings for each circuit breaker and/or ground fault relay under test in Table 4 on page 34. After testing, return all settings to original values.
10. Adjust the ground fault pickup setting on each circuit breaker and/or ground fault relay to its lowest current setting.
11. Adjust the ground fault time delay setting on each circuit breaker and/or ground fault relay under test to 0.1 seconds (I2T OUT or OFF).
12. Adjust the long-time, short-time, and instantaneous pick-up and time delay settings on each circuit breaker under test to their highest settings.
13. For each main circuit breaker equipped with the Micrologic® Type A, H, or P trip unit, connect a hand-held test unit, and activate the thermal-imaging inhibit function according to the test unit instructions. This step is necessary to inhibit trip history and contact wear counter functions. After testing, de-

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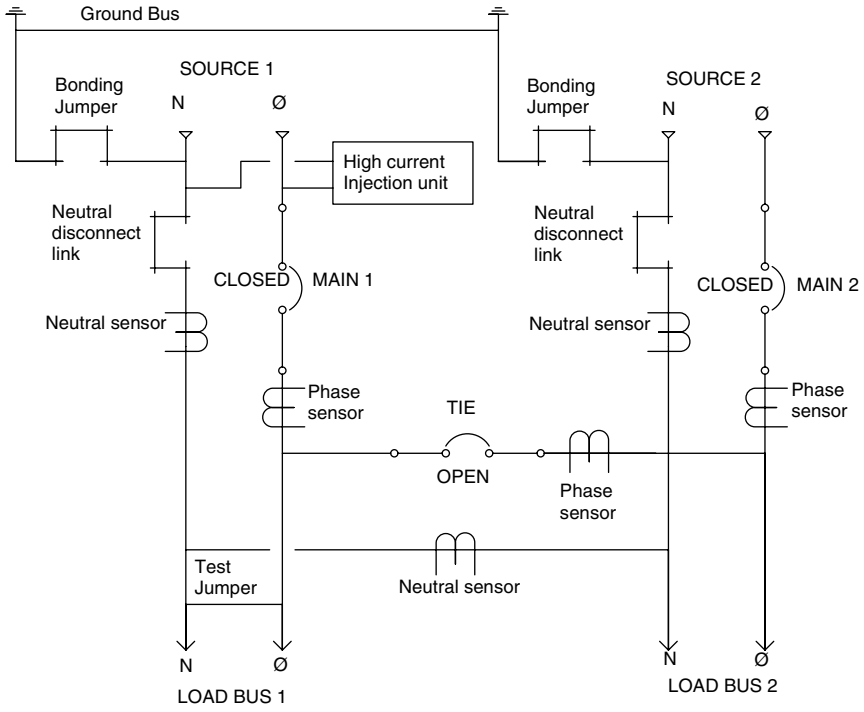
activate the thermal-imaging inhibit function according to the test unit instructions. Refer to bulletin 48049-184-XX for additional information.

14. Disconnect the ground fault protection control power source, if internally derived, and provide control power from an external source. Refer to the wiring diagrams supplied for specific connections. After testing, disconnect external control power and re-connect internal control power circuit.

**Test No. 1**

1. Close MAIN 1 circuit breaker (or switch). Open TIE circuit breaker (or switch), and close MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 1 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 5.
3. On the load bus, connect a high current jumper between Phase A and the neutral (N). See Figure 5.
4. Inject 1000 A into Phase A. MAIN 1 circuit breaker (or switch) should not trip on ground fault. Record the actual results for Test No. 1 in Table 2 on page 32.
5. Repeat Test No. 1 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 2.

**Figure 5: Main-Tie-Main Test No. 1 (No Trip) Injection Unit and Test Jumper Connections**





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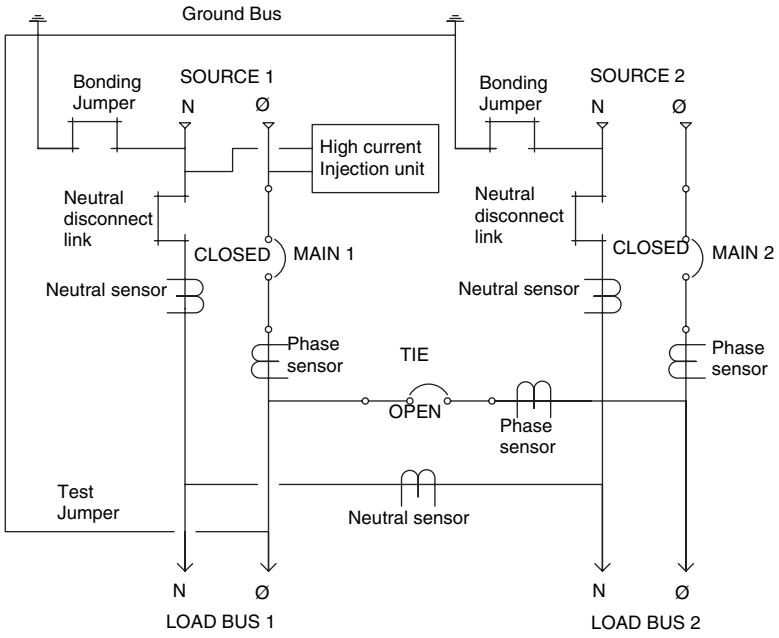
### Test No. 2

1. Close MAIN 1 circuit breaker (or switch). Open TIE circuit breaker (or switch), and close MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 1 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 6.
3. On the load bus, connect a high current jumper between Phase A and the ground. See Figure 6.
4. Inject 1000 A into Phase A. MAIN 1 circuit breaker (or switch) should trip on ground fault. Record the actual results for Test No. 2 in Table 2 on page 32.
5. Repeat Test No. 2 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 2.

**Figure 6: Main-Tie-Main Test No. 2 (Trip) Injection Unit and Test Jumper Connections**

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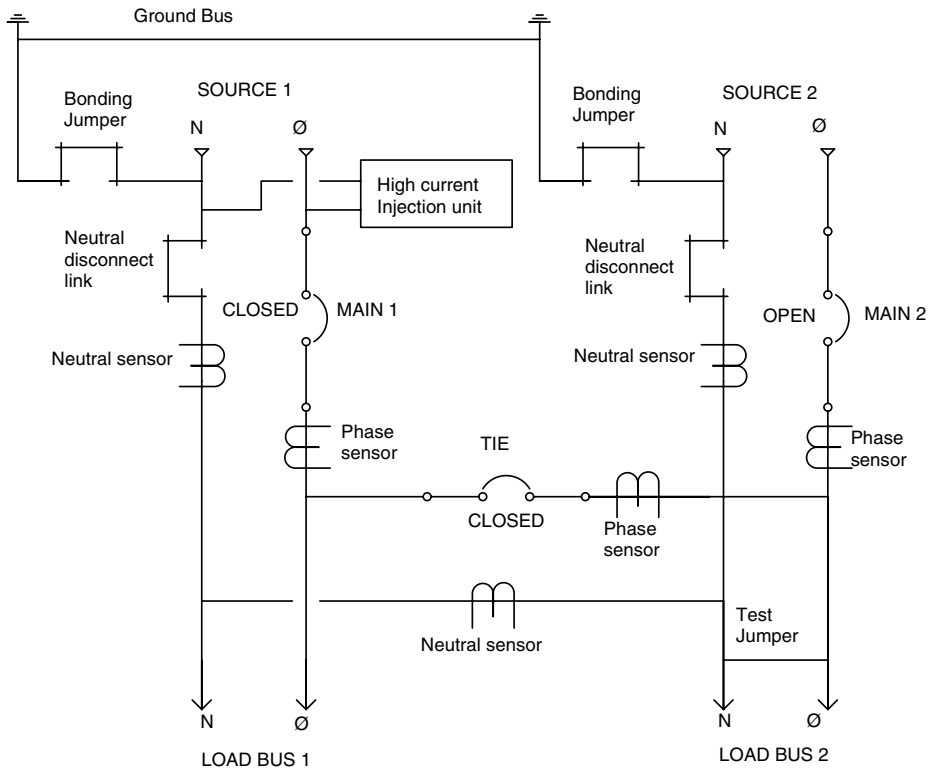
## Test No. 3

1. Close MAIN 1 circuit breaker (or switch). Close TIE circuit breaker (or switch), and open MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 1 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 7.
3. On the load bus, connect a high current jumper between Phase A and the neutral (N). See Figure 7.
4. Inject 1000 A into Phase A. Neither MAIN 1 circuit breaker (or switch) nor TIE circuit breaker (or switch) should trip on ground fault. Record the actual results for Test No. 3 in Table 2 on page 32.
5. Repeat Test No. 3 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 2.

**Figure 7: Main-Tie-Main Test No. 3 (No Trip) Injection Unit and Test Jumper Connections**





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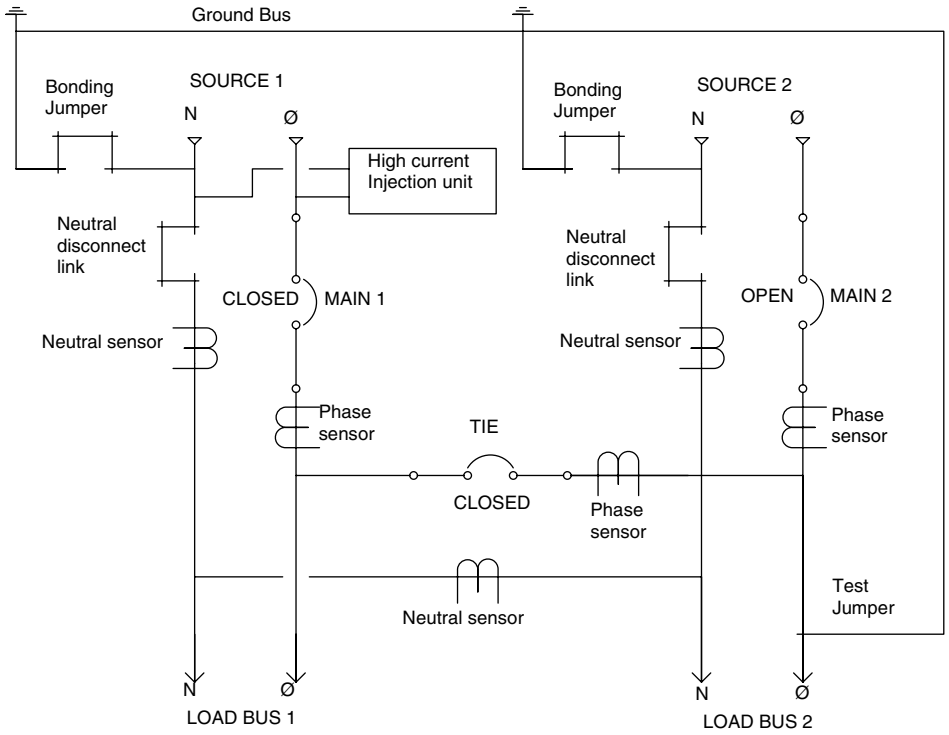
## Test No. 4

1. Close MAIN 1 circuit breaker (or switch). Close TIE circuit breaker (or switch), and open MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 1 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 8.
3. On the load bus, connect a high current jumper between Phase A and the ground. See Figure 8.
4. Inject 1000 A into Phase A. MAIN 1 circuit breaker (or switch) should trip on ground fault, but TIE circuit breaker (or switch) should not trip on ground fault. Record the actual results for Test No. 4 in Table 2 on page 32.
5. Repeat Test No. 4 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 2.

**Figure 8: Main-Tie-Main Test No. 4 (Trip) Injection Unit and Test Jumper Connections**

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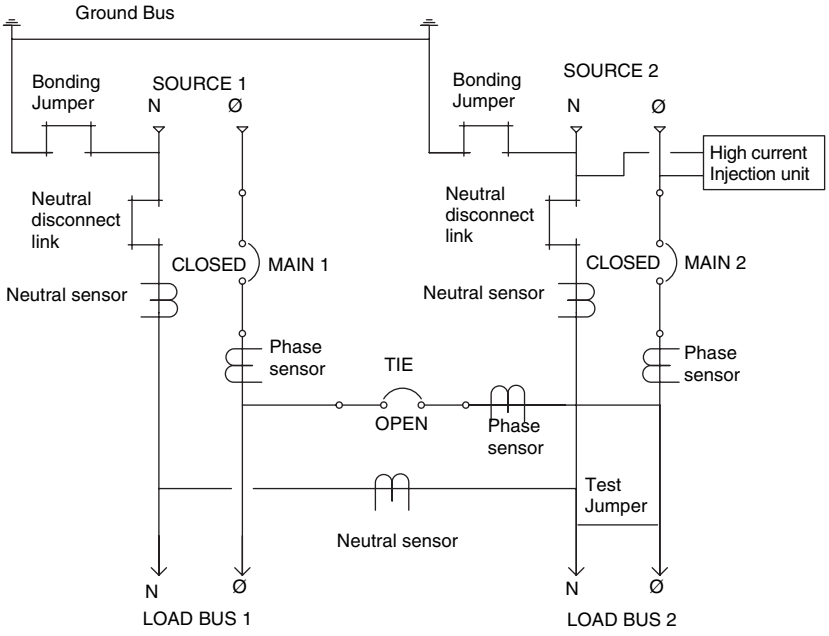
## Test No. 5

1. Close MAIN 1 circuit breaker (or switch). Open TIE circuit breaker (or switch), and close MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 2 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 9.
3. On the load bus, connect a high current jumper between Phase A and the neutral (N). See Figure 9.
4. Inject 1000 A into Phase A. MAIN 2 circuit breaker (or switch) should not trip on ground fault. Record the actual results for Test No. 5 in Table 2 on page 32.
5. Repeat Test No. 5 for Phases B and C (not required for zero sequence systems). Record the actual results for this in Table 2.

**Figure 9: Main-Tie-Main Test No. 5 (No Trip) Injection Unit and Test Jumper Connections**





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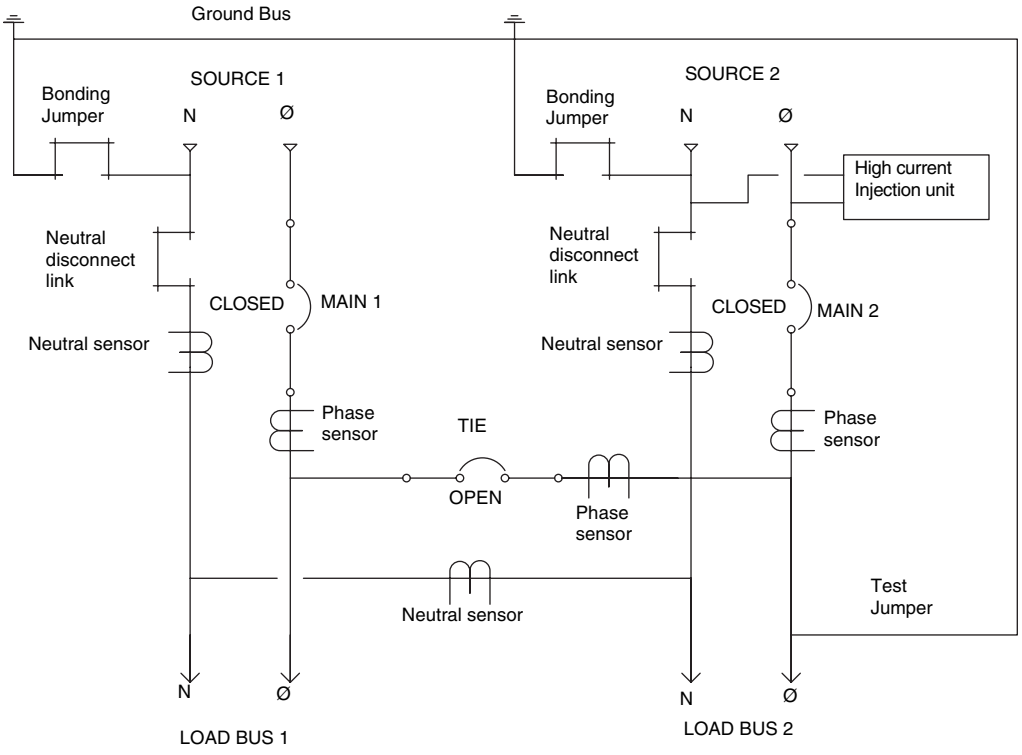
## Test No. 6

1. Close MAIN 1 circuit breaker (or switch). Open TIE circuit breaker (or switch), and close MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 2 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 10.
3. On the load bus, connect a high current jumper between Phase A and the ground. See Figure 10.
4. Inject 1000 A into Phase A. MAIN 2 circuit breaker (or switch) should trip on ground fault. Record the actual results for Test No. 6 in Table 2 on page 32.
5. Repeat Test No. 6 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 2.

**Figure 10: Main-Tie-Main Test No. 6 (Trip) Injection Unit and Test Jumper Connections**

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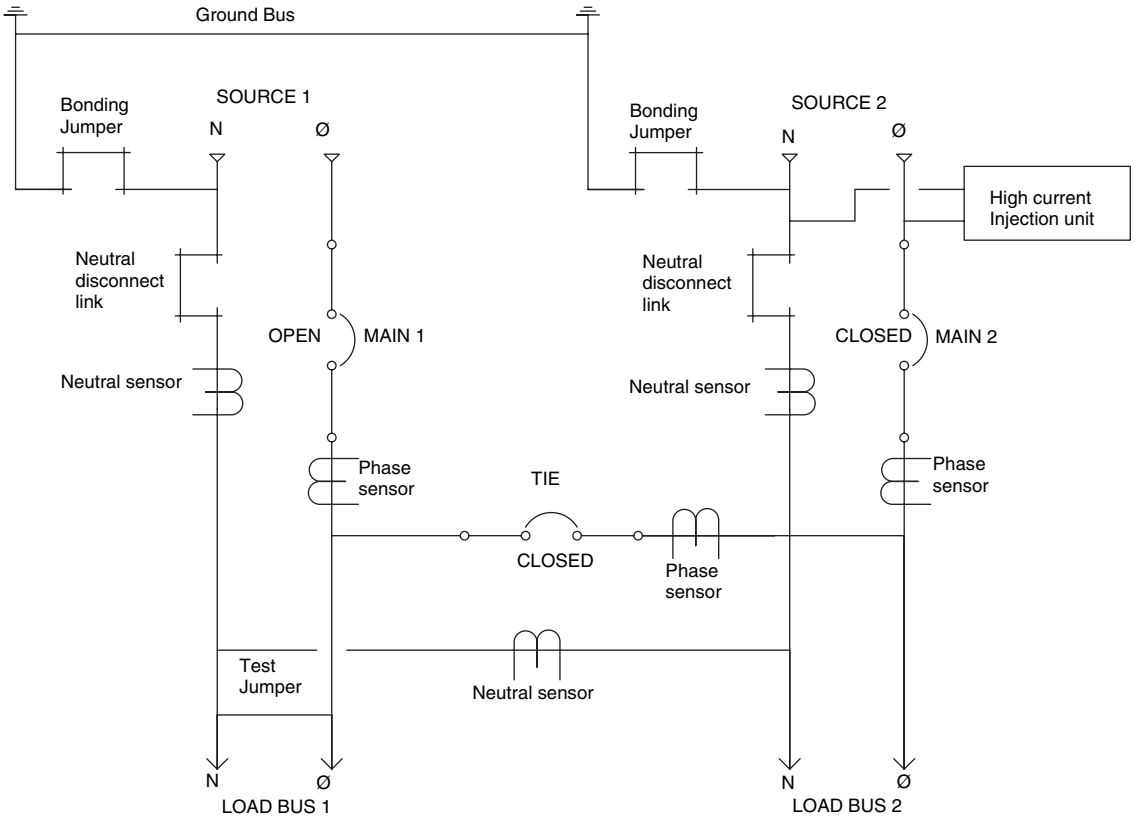
## Test No. 7

1. Open MAIN 1 circuit breaker (or switch). Close TIE circuit breaker (or switch), and close MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 2 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 11.
3. On the load bus, connect a high current jumper between Phase A and the neutral (N). See Figure 11.
4. Inject 1000 A into Phase A. Neither MAIN 2 circuit breaker (or switch) nor TIE circuit breaker (or switch) should trip on ground fault. Record the actual results for Test No. 7 in Table 2 on page 32.
5. Repeat Test No. 7 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 2.

**Figure 11: Main-Tie-Main Test No. 7 (No Trip) Injection Unit and Test Jumper Connections**





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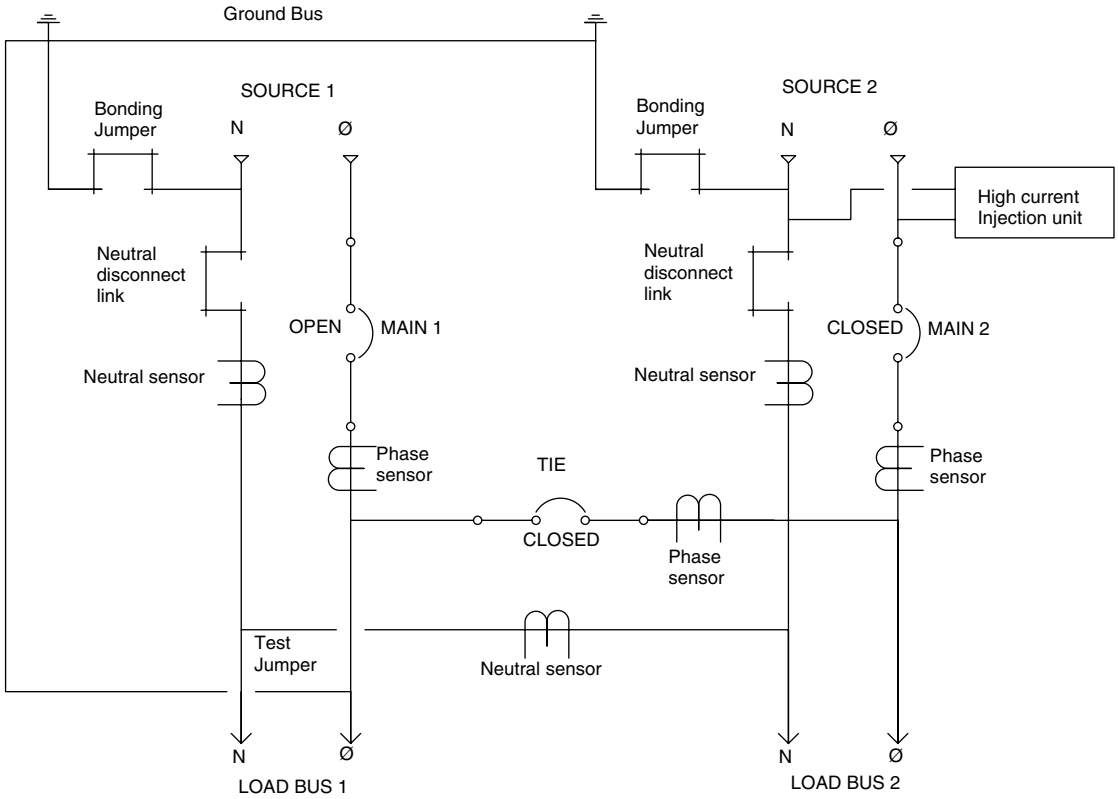
### Test No. 8

1. Open MAIN 1 circuit breaker (or switch). Close TIE circuit breaker (or switch), and close MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 2 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 12.
3. On the load bus, connect a high current jumper between Phase A and the ground. See Figure 12.
4. Inject 1000 A into Phase A. MAIN 2 circuit breaker (or switch) should trip on ground fault, but TIE circuit breaker (or switch) should not trip on ground fault. Record the actual results for Test No. 8 in Table 2 on page 32.
5. Repeat Test No. 8 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 2.
6. After testing, return all settings to the original values previously recorded.

**Figure 12: Main-Tie-Main Test No. 8 (Trip) Injection Unit and Test Jumper Connections**

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# SECTION 5—MAIN-TIE-MAIN, GROUNDED WYE, RELAYED TIE CONFIGURATION

**⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH**

- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying the equipment before working on or inside the equipment.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors, and covers before turning on power to this equipment.

**Failure to follow these instructions will result in death or serious injury.**

1. Turn off all power supplying this equipment before working on or inside equipment. Use a properly rated voltage sensing device to confirm power is off.
2. Verify that all ground bus bar splices are solidly connected. For each main, verify that the ground bonding connection is made ahead of the neutral disconnect link and on the line side of any ground fault sensor. See Figure 13.
3. For each main, verify that a neutral connection exists from the supply transformer to the equipment.
4. For residual sensing systems, verify that all phase and neutral sensors are connected with correct polarity on both primary and secondary. Refer to the drawings supplied with the equipment.
5. For zero sequence sensing systems, verify that all phase conductors and the neutral pass through the sensor in the same direction, and that grounding conductors do not pass through the sensor. Also, verify that the sensor is connected with the correct polarity on both primary and secondary. Refer to the drawings supplied with the equipment.
6. Remove each main's neutral disconnect link to isolate wiring system neutrals from both supply and ground.
7. Measure the system neutral-to-ground insulation resistance to ensure that no ground connections exist on the load side of the ground fault protection system. The resistance should be at least 1 megohm. Remove all connections that exist from neutral-to-ground found during the test. Do not reconnect these grounds after the test is completed.
8. Replace each main's neutral disconnect link.
9. Record all pick-up and time delay settings for each circuit breaker and/or ground fault relay under test in Table 4 on page 34. After testing, return all settings to original values.
10. Adjust the ground fault pick-up setting on each circuit breaker and/or ground fault relay to its lowest current setting.
11. Adjust the ground fault time delay setting on each circuit breaker and/or ground fault relay under test to 0.1 seconds (I2T OUT or OFF).
12. Adjust the long-time, short-time, and instantaneous pick-up and time delay settings on each circuit breaker under test to their highest settings.
13. For each main and tie circuit breaker equipped with the Micrologic® Type A, H, or P trip unit, connect a hand-held test unit, and activate the thermal-imaging inhibit function according to the test unit instructions. This step is necessary to inhibit trip history and contact wear counter


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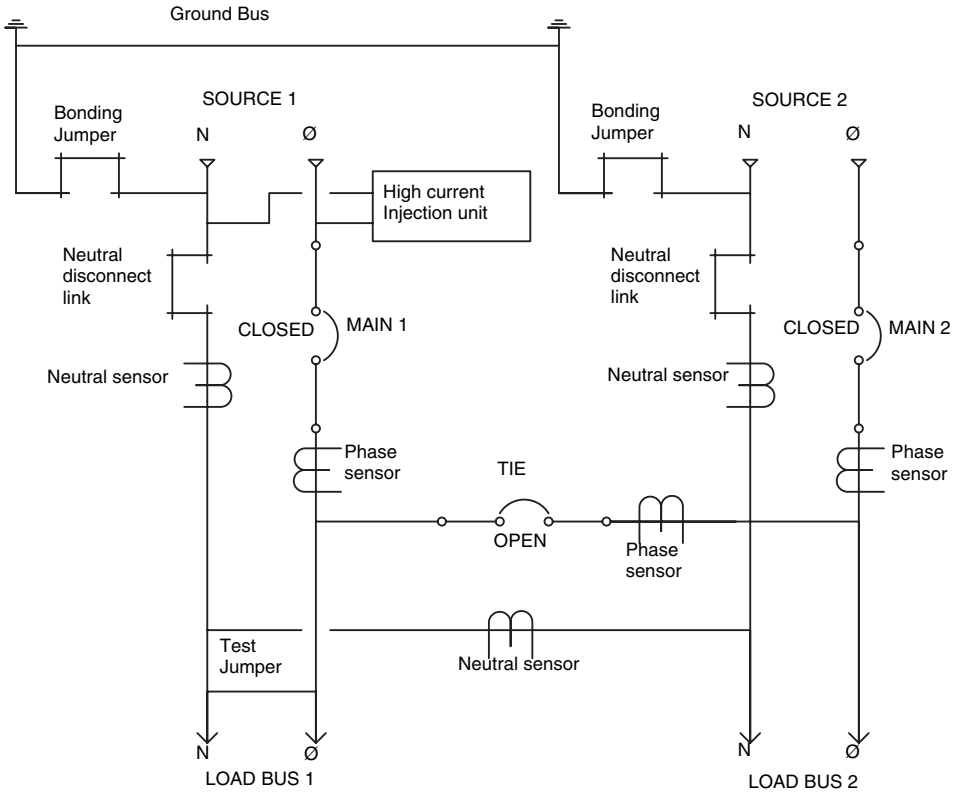
functions. After testing, de-activate the thermal-imaging inhibit function according to the test unit instructions. Refer to bulletin 48049-184-XX for additional information.

14. Disconnect the ground fault protection control power source, if internally derived, and provide control power from an external source. Refer to the wiring diagrams supplied for specific connections. After testing, disconnect external control power and re-connect internal control power circuit.

### Test No. 1

1. Close MAIN 1 circuit breaker (or switch). Open TIE circuit breaker (or switch), and close MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 1 breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 13.
3. On the load bus, connect a high current jumper between Phase A and the neutral (N). See Figure 13.
4. Inject 1000 A into Phase A. MAIN 1 breaker (or switch) should not trip on ground fault. Record the actual results for Test No. 1 in Table 3 on page 33.
5. Repeat Test No. 1 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 3.

**Figure 13: Main-Tie-Main Test No.1 (No Trip) Injection Unit and Test Jumper Connections**

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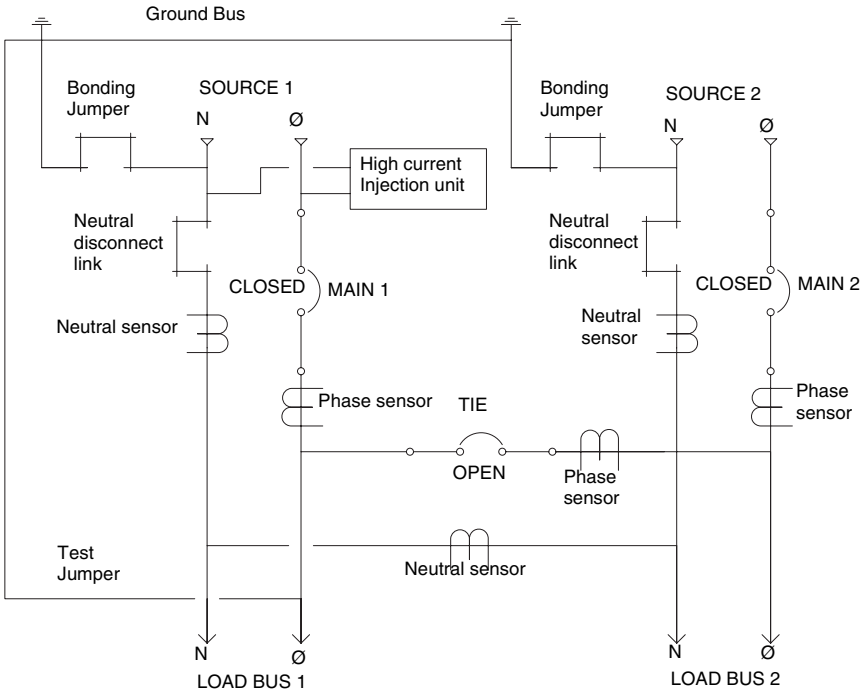
## Test No. 2

1. Close MAIN 1 circuit breaker (or switch). Open TIE circuit breaker (or switch), and close MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 1 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 14.
3. On the load bus, connect a high current jumper between Phase A and the ground. See Figure 14.
4. Inject 1000 A into Phase A. MAIN 1 circuit breaker (or switch) should trip on ground fault. Record the actual results for Test No. 2 in Table 3 on page 33.
5. Repeat Test No. 2 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 3.

**Figure 14: Main-Tie-Main Test No. 2 (Trip) Injection Unit and Test Jumper Connections**





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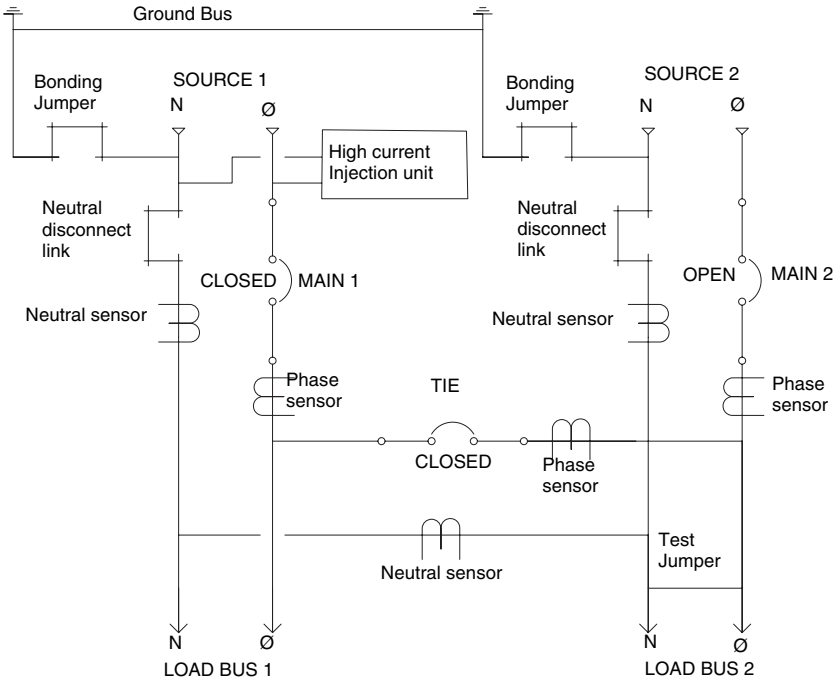
## Test No. 3

1. Close MAIN 1 circuit breaker (or switch). Close TIE circuit breaker (or switch), and open MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 1 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 15.
3. On the load bus, connect a high current jumper between Phase A and the neutral (N). See Figure 15.
4. Inject 1000 A into Phase A. Neither MAIN 1 circuit breaker (or switch) nor TIE circuit breaker (or switch) should trip on ground fault. Record the actual results for Test No. 3 in Table 3 on page 33.
5. Repeat Test No. 3 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 3.

**Figure 15: Main-Tie-Main Test No. 3 (No Trip) Injection Unit and Test Jumper Connections**

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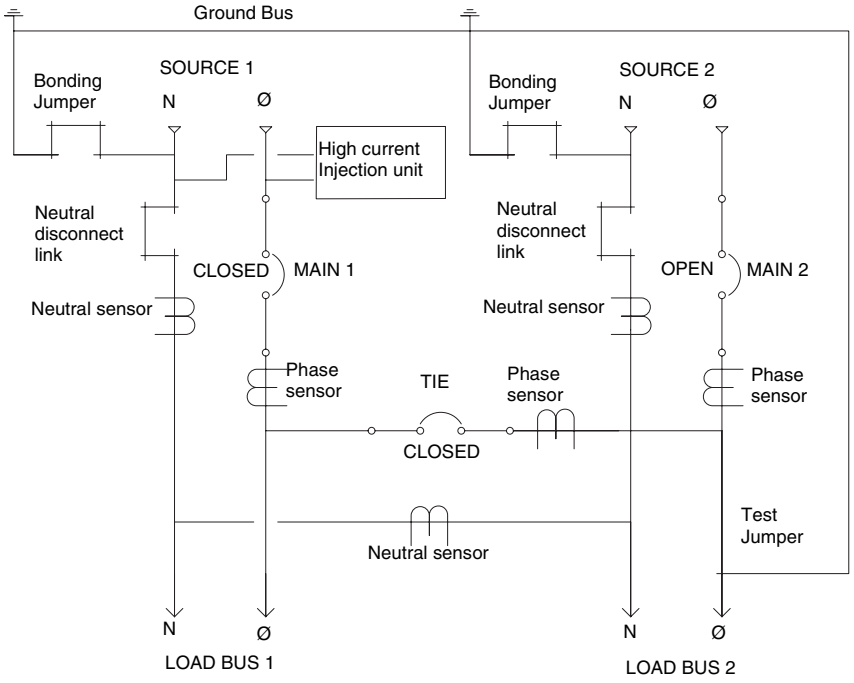
## Test No. 4

1. Close MAIN 1 circuit breaker (or switch). Close TIE circuit breaker (or switch), and open MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 1 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 16.
3. On the load bus, connect a high current jumper between Phase A and the ground. See Figure 16.
4. Inject 1000 A into Phase A. MAIN 1 circuit breaker (or switch) should not trip on ground fault, but TIE circuit breaker (or switch) should trip on ground fault. Record the actual results for Test No. 4 in Table 3 on page 33.
5. Repeat Test No. 4 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 3.

**Figure 16: Main-Tie-Main Test No. 4 (Trip) Injection Unit and Test Jumper Connections**





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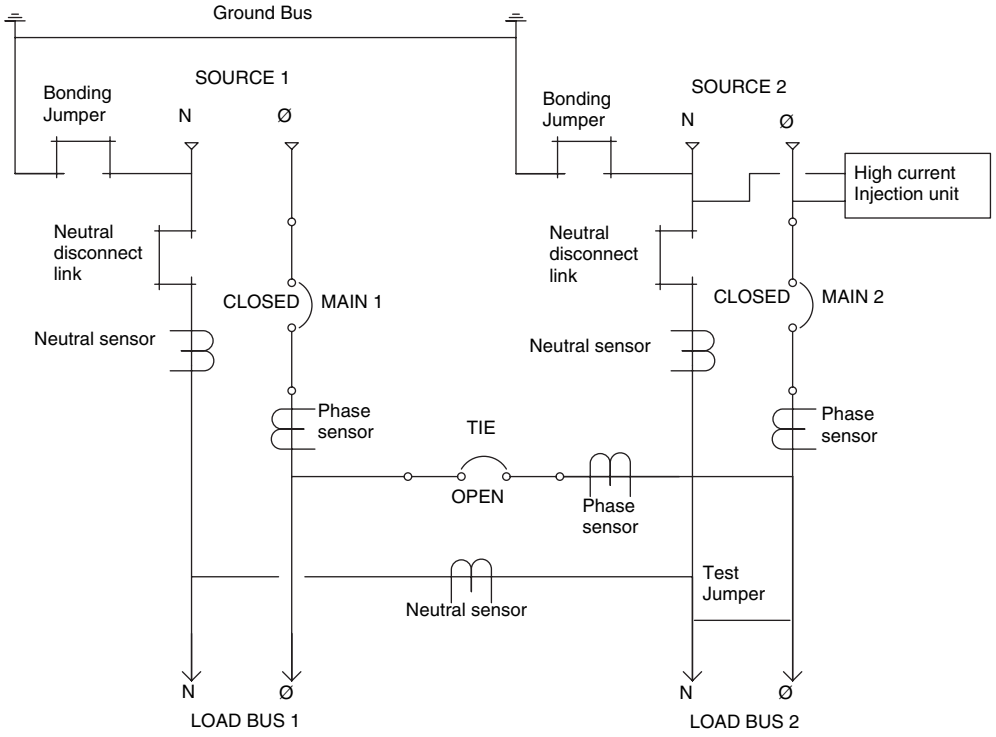
## Test No. 5

1. Close MAIN 1 circuit breaker (or switch). Open TIE circuit breaker (or switch), and close MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 2 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 17.
3. On the load bus, connect a high current jumper between Phase A and the neutral (N). See Figure 17.
4. Inject 1000 A into Phase A. MAIN 2 circuit breaker (or switch) should not trip on ground fault. Record the actual results for Test No. 5 in Table 3 on page 33.
5. Repeat Test No. 5 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 3.

**Figure 17: Main-Tie-Main Test No. 5 (No Trip) Injection Unit and Test Jumper Connections**

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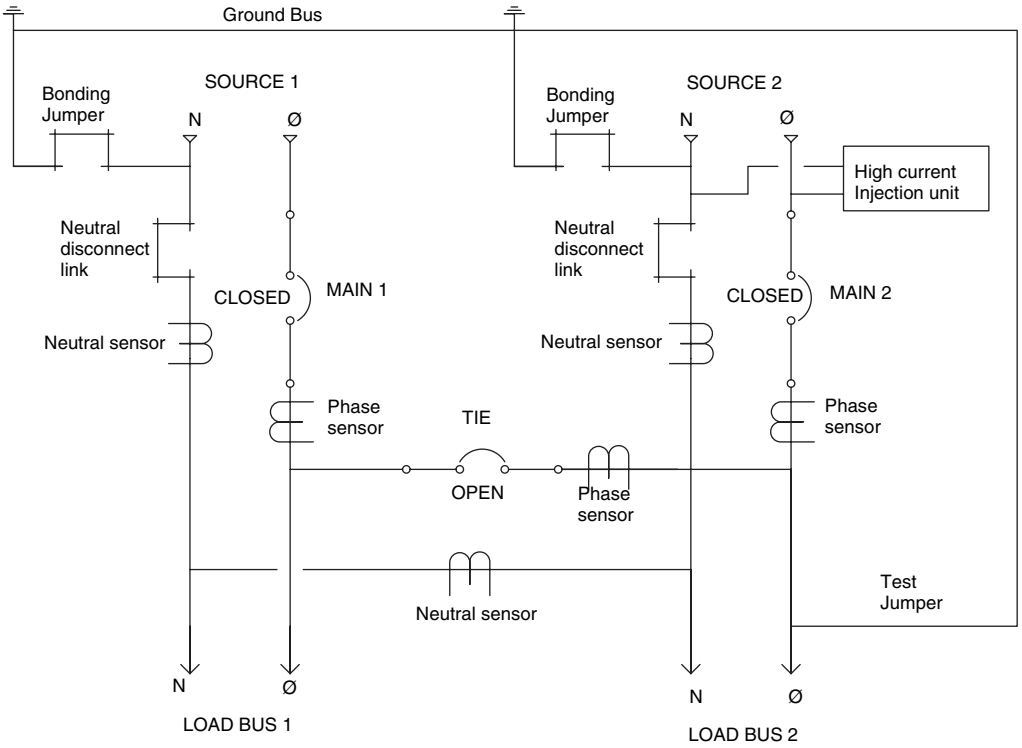
## Test No. 6

1. Close MAIN 1 circuit breaker (or switch). Open TIE circuit breaker (or switch), and close MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 2 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 18.
3. On the load bus, connect a high current jumper between Phase A and the ground. See Figure 18.
4. Inject 1000 A into Phase A. MAIN 2 circuit breaker (or switch) should trip on ground fault. Record the actual results for Test No. 6 in Table 3 on page 33.
5. Repeat Test No. 6 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 3.

**Figure 18: Main-Tie-Main Test No. 6 (Trip) Injection Unit and Test Jumper Connections**





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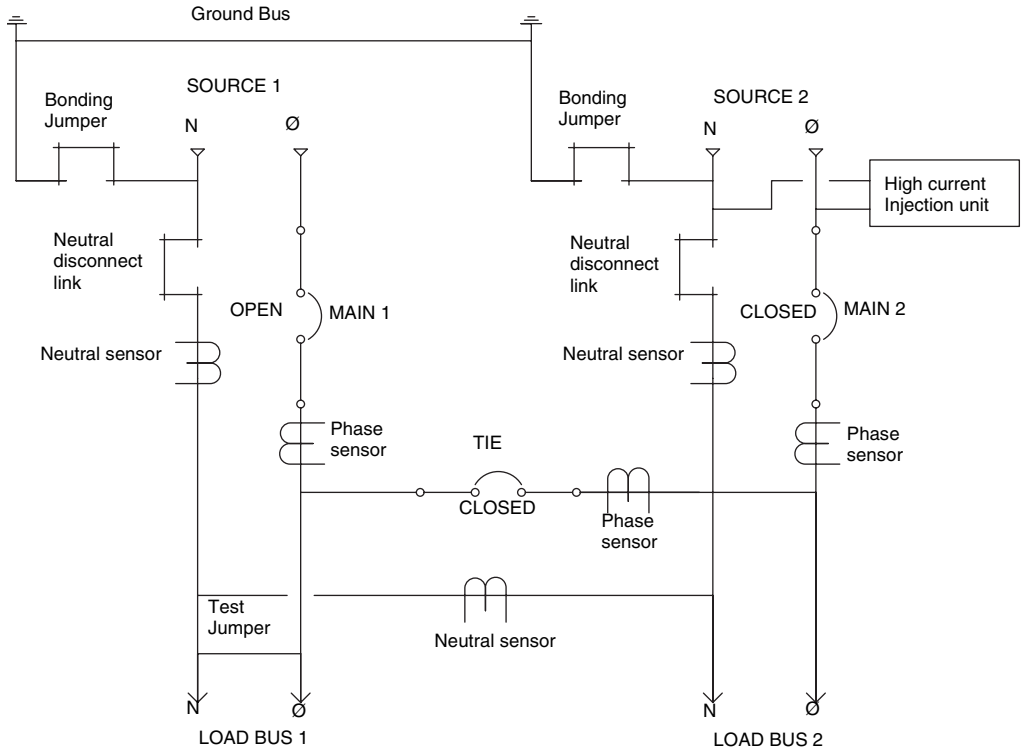
## Test No. 7

1. Open MAIN 1 circuit breaker (or switch). Close TIE circuit breaker (or switch), and close MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 2 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 19.
3. On the load bus, connect a high current jumper between Phase A and the neutral (N). See Figure 19.
4. Inject 1000 A into Phase A. Neither MAIN 2 circuit breaker (or switch) nor TIE circuit breaker (or switch) should trip on ground fault. Record the actual results for Test No. 7 in Table 3 on page 33.
5. Repeat Test No. 7 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 3.

**Figure 19: Main-Tie-Main Test No. 7 (No Trip) Injection Unit and Test Jumper Connections**

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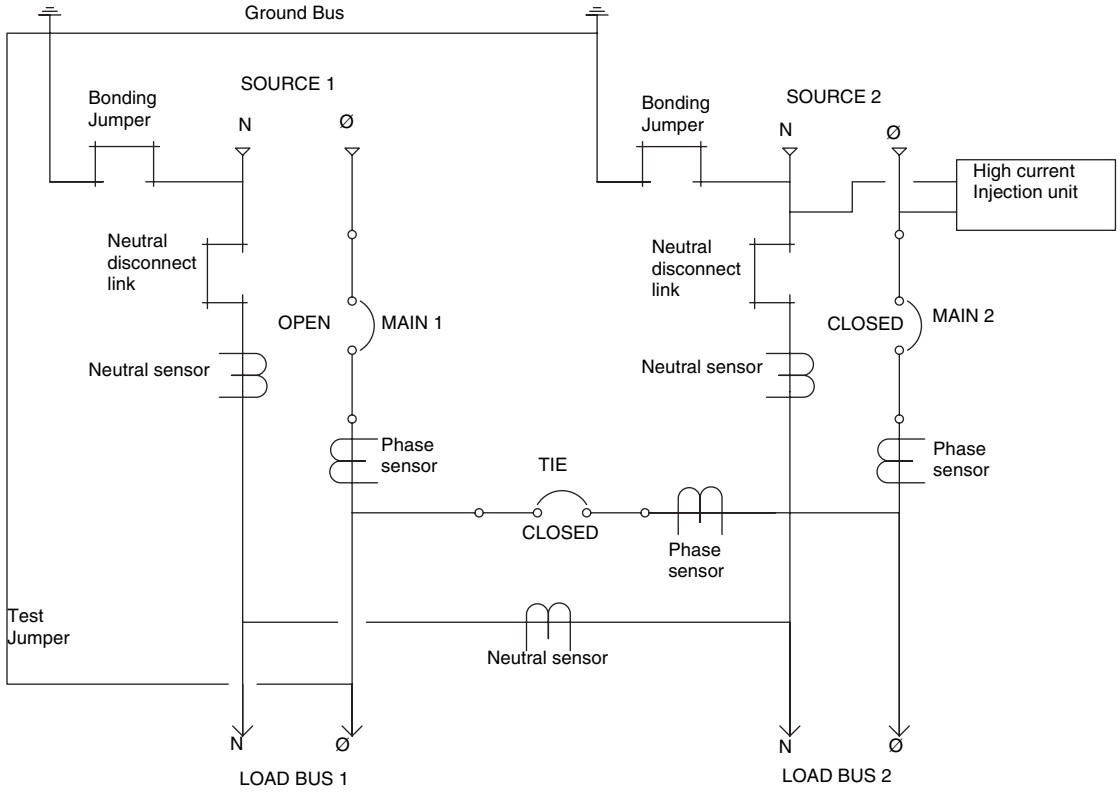
## Test No. 8

1. Open MAIN 1 circuit breaker (or switch). Close TIE circuit breaker (or switch), and close MAIN 2 circuit breaker (or switch).
2. On the line side of MAIN 2 circuit breaker (or switch), connect the high current injection unit between Phase A and the neutral (N). See Figure 20.
3. On the load bus, connect a high current jumper between Phase A and the ground. See Figure 20.
4. Inject 1000 A into Phase A. MAIN 2 circuit breaker (or switch) should not trip on ground fault, but TIE circuit breaker (or switch) should trip on ground fault. Record the actual results for Test No. 8 in Table 3 on page 33.
5. Repeat Test No. 8 for Phases B and C (not required for zero sequence systems). Record the actual results for this test in Table 3.
6. After testing, return all settings to the original values previously recorded.

**Figure 20: Main-Tie-Main Test No. 8 (Trip) Injection Unit and Test Jumper Connections**





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# SECTION 6—MAIN-MAIN TEST PROCEDURE LOG

**Table 1: Main-Main Test Procedure Log**

| Test No. | Jumper Connection | Circuit Breaker Status | | Injection Current | Expected Results | Actual Results | | |
|---|---|---|---|---|---|---|---|---|
| | | MAIN 1 | MAIN 2 | | | Phase A | Phase B | Phase C |
| 1 | Phase of LOAD BUS 1 to Neutral of LOAD BUS 1 | Closed | Open | 1000 A | "No Trip" MAIN 1 Circuit Breaker | | | |
| 2 | Phase of LOAD BUS 1 to Ground of LOAD BUS 1 | Closed | Open | 1000 A | "Trip" MAIN 1 Circuit Breaker | | | |
| 3 | Phase of LOAD BUS 2 to Neutral of LOAD BUS 2 | Open | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker | | | |
| 4 | Phase of LOAD BUS 2 to Ground of LOAD BUS 2 | Open | Closed | 1000 A | "Trip" MAIN 2 Circuit Breaker | | | |

| Test No. | Jumper Connection | Circuit Breaker Status | | Injection Current | Expected Results | Actual Results | | |
|---|---|---|---|---|---|---|---|---|
| | | MAIN 1 | MAIN 2 | | | Phase A | Phase B | Phase C |
| 1 | Phase of LOAD BUS 1 to Neutral of LOAD BUS 1 | Closed | Open | 1000 A | "No Trip" MAIN 1 Circuit Breaker | | | |
| 2 | Phase of LOAD BUS 1 to Ground of LOAD BUS 1 | Closed | Open | 1000 A | "Trip" MAIN 1 Circuit Breaker | | | |
| 3 | Phase of LOAD BUS 2 to Neutral of LOAD BUS 2 | Open | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker | | | |
| 4 | Phase of LOAD BUS 2 to Ground of LOAD BUS 2 | Open | Closed | 1000 A | "Trip" MAIN 2 Circuit Breaker | | | |

| Test No. | Jumper Connection | Circuit Breaker Status | | Injection Current | Expected Results | Actual Results | | |
|---|---|---|---|---|---|---|---|---|
| | | MAIN 1 | MAIN 2 | | | Phase A | Phase B | Phase C |
| 1 | Phase of LOAD BUS 1 to Neutral of LOAD BUS 1 | Closed | Open | 1000 A | "No Trip" MAIN 1 Circuit Breaker | | | |
| 2 | Phase of LOAD BUS 1 to Ground of LOAD BUS 1 | Closed | Open | 1000 A | "Trip" MAIN 1 Circuit Breaker | | | |
| 3 | Phase of LOAD BUS 2 to Neutral of LOAD BUS 2 | Open | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker | | | |
| 4 | Phase of LOAD BUS 2 to Ground of LOAD BUS 2 | Open | Closed | 1000 A | "Trip" MAIN 2 Circuit Breaker | | | |

| Test No. | Jumper Connection | Circuit Breaker Status | | Injection Current | Expected Results | Actual Results | | |
|---|---|---|---|---|---|---|---|---|
| | | MAIN 1 | MAIN 2 | | | Phase A | Phase B | Phase C |
| 1 | Phase of LOAD BUS 1 to Neutral of LOAD BUS 1 | Closed | Open | 1000 A | "No Trip" MAIN 1 Circuit Breaker | | | |
| 2 | Phase of LOAD BUS 1 to Ground of LOAD BUS 1 | Closed | Open | 1000 A | "Trip" MAIN 1 Circuit Breaker | | | |
| 3 | Phase of LOAD BUS 2 to Neutral of LOAD BUS 2 | Open | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker | | | |
| 4 | Phase of LOAD BUS 2 to Ground of LOAD BUS 2 | Open | Closed | 1000 A | "Trip" MAIN 2 Circuit Breaker | | | |

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# SECTION 7—MAIN-TIE-MAIN NON-RELAYED TEST PROCEDURE LOG

**Table 2: Main-Tie-Main Non-Relayed Test Procedure Log**

| Test No. | Jumper Connection | Circuit Breaker Status | | | Injection Current | Expected Results | Actual Results | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MAIN 1 | TIE | MAIN 2 | | | Phase A | Phase B | Phase C |
| 1 | Phase of LOAD BUS 1 to Neutral of LOAD BUS 1 | Closed | Open | Closed | 1000 A | "No Trip" MAIN 1 Circuit Breaker | | | |
| 2 | Phase of LOAD BUS 1 to Ground of LOAD BUS 1 | Closed | Open | Closed | 1000 A | "Trip" MAIN 1 Circuit Breaker | | | |
| 3 | Phase of LOAD BUS 2 to Neutral of LOAD BUS 2 | Closed | Closed | Open | 1000 A | "No Trip" MAIN 1 Circuit Breaker | | | |
| 4 | Phase of LOAD BUS 2 to Ground of LOAD BUS 2 | Closed | Closed | Open | 1000 A | "Trip" MAIN 1 Circuit Breaker | | | |
| 5 | Phase of LOAD BUS 2 to Neutral of LOAD BUS 2 | Closed | Open | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker | | | |
| 6 | Phase of LOAD BUS 2 to Ground of LOAD BUS 2 | Closed | Open | Closed | 1000 A | "Trip" MAIN 2 Circuit Breaker | | | |
| 7 | Phase of LOAD BUS 1 to Neutral of LOAD BUS 1 | Open | Closed | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker | | | |
| 8 | Phase of LOAD BUS 1 to Ground of LOAD BUS 1 | Open | Closed | Closed | 1000 A | "Trip" MAIN 2 Circuit Breaker | | | |

| Test No. | Jumper Connection | Circuit Breaker Status | | | Injection Current | Expected Results | Actual Results | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MAIN 1 | TIE | MAIN 2 | | | Phase A | Phase B | Phase C |
| 1 | Phase of LOAD BUS 1 to Neutral of LOAD BUS 1 | Closed | Open | Closed | 1000 A | "No Trip" MAIN 1 Circuit Breaker | | | |
| 2 | Phase of LOAD BUS 1 to Ground of LOAD BUS 1 | Closed | Open | Closed | 1000 A | "Trip" MAIN 1 Circuit Breaker | | | |
| 3 | Phase of LOAD BUS 2 to Neutral of LOAD BUS 2 | Closed | Closed | Open | 1000 A | "No Trip" MAIN 1 Circuit Breaker | | | |
| 4 | Phase of LOAD BUS 2 to Ground of LOAD BUS 2 | Closed | Closed | Open | 1000 A | "Trip" MAIN 1 Circuit Breaker | | | |
| 5 | Phase of LOAD BUS 2 to Neutral of LOAD BUS 2 | Closed | Open | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker | | | |
| 6 | Phase of LOAD BUS 2 to Ground of LOAD BUS 2 | Closed | Open | Closed | 1000 A | "Trip" MAIN 2 Circuit Breaker | | | |
| 7 | Phase of LOAD BUS 1 to Neutral of LOAD BUS 1 | Open | Closed | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker | | | |
| 8 | Phase of LOAD BUS 1 to Ground of LOAD BUS 1 | Open | Closed | Closed | 1000 A | "Trip" MAIN 2 Circuit Breaker | | | |


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# SECTION 8—MAIN-TIE-MAIN RELAYED TEST PROCEDURE LOG

**Table 3: Main-Tie-Main Relayed Test Procedure Log**

| Test No. | Jumper Connection | Circuit Breaker Status | | | Injection Current | Expected Results | Actual Results | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MAIN 1 | TIE | MAIN 2 | | | Phase A | Phase B | Phase C |
| 1 | Phase of LOAD BUS 1 to Neutral of LOAD BUS 1 | Closed | Open | Closed | 1000 A | "No Trip" MAIN 1 Circuit Breaker | | | |
| 2 | Phase of LOAD BUS 1 to Ground of LOAD BUS 1 | Closed | Open | Closed | 1000 A | "Trip" MAIN 1 Circuit Breaker | | | |
| 3 | Phase of LOAD BUS 2 to Neutral of LOAD BUS 2 | Closed | Closed | Open | 1000 A | "No Trip" MAIN 1 Circuit Breaker "No Trip" TIE Circuit Breaker | | | |
| 4 | Phase of LOAD BUS 2 to Ground of LOAD BUS 2 | Closed | Closed | Open | 1000 A | "No Trip" MAIN 1 Circuit Breaker "Trip" TIE Circuit Breaker | | | |
| 5 | Phase of LOAD BUS 2 to Neutral of LOAD BUS 2 | Closed | Open | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker | | | |
| 6 | Phase of LOAD BUS 2 to Ground of LOAD BUS 2 | Closed | Open | Closed | 1000 A | "Trip" MAIN 2 Circuit Breaker | | | |
| 7 | Phase of LOAD BUS 1 to Neutral of LOAD BUS 1 | Open | Closed | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker "No Trip" TIE Circuit Breaker | | | |
| 8 | Phase of LOAD BUS 1 to Ground of LOAD BUS 1 | Open | Closed | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker "Trip" TIE Circuit Breaker | | | |

| Test No. | Jumper Connection | Circuit Breaker Status | | | Injection Current | Expected Results | Actual Results | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MAIN 1 | TIE | MAIN 2 | | | Phase A | Phase B | Phase C |
| 1 | Phase of LOAD BUS 1 to Neutral of LOAD BUS 1 | Closed | Open | Closed | 1000 A | "No Trip" MAIN 1 Circuit Breaker | | | |
| 2 | Phase of LOAD BUS 1 to Ground of LOAD BUS 1 | Closed | Open | Closed | 1000 A | "Trip" MAIN 1 Circuit Breaker | | | |
| 3 | Phase of LOAD BUS 2 to Neutral of LOAD BUS 2 | Closed | Closed | Open | 1000 A | "No Trip" MAIN 1 Circuit Breaker "No Trip" TIE Circuit Breaker | | | |
| 4 | Phase of LOAD BUS 2 to Ground of LOAD BUS 2 | Closed | Closed | Open | 1000 A | "No Trip" MAIN 1 Circuit Breaker "Trip" TIE Circuit Breaker | | | |
| 5 | Phase of LOAD BUS 2 to Neutral of LOAD BUS 2 | Closed | Open | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker | | | |
| 6 | Phase of LOAD BUS 2 to Ground of LOAD BUS 2 | Closed | Open | Closed | 1000 A | "Trip" MAIN 2 Circuit Breaker | | | |
| 7 | Phase of LOAD BUS 1 to Neutral of LOAD BUS 1 | Open | Closed | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker "No Trip" TIE Circuit Breaker | | | |
| 8 | Phase of LOAD BUS 1 to Ground of LOAD BUS 1 | Open | Closed | Closed | 1000 A | "No Trip" MAIN 2 Circuit Breaker "Trip" TIE Circuit Breaker | | | |

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# SECTION 9—LOG OF TESTS AND SETTINGS

**Table 4: Log of Tests and Settings**

| Date | Test | Circuit Breaker ID | Settings | | Results and Signature |
|---|---|---|---|---|---|
| | | | Pick-Up | Time Delay | |
| | Installation | | | | |
| | | | | | |
| | | | | | |
| |

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