Fisher-Rosemount Systems

AC and DC Power and Ground Wiring

Installation Manual
PN1:003
Revision B — October 1995
This manual supercedes the issue dated May 1995.
Please indicate your evaluation of PN1:003 (Revision B — October 1995). Attach extra sheets if needed.

1. How and when do you use this manual?
   - Read entire manual before attempting task
   - Read selected sections before attempting task
   - Read while attempting task
   - Attempt task first
   - Read as last resort

2. How well is the manual’s content organized? Please explain.
   - Excellent — parallels product’s operation, very usable
   - Good — representative of the product’s operation, usable
   - Average — usable but can be improved
   - Fair — not very usable, should be improved
   - Poor — not usable, must be improved
   - No Opinion

3. Is the manual’s content understandable and applicable to the product’s operation? Please explain.
   - Excellent — very easy to understand, very applicable
   - Good — easy to understand, applicable
   - Average — applicable but some sections not easy to understand
   - Fair — not very understandable/applicable, should be improved
   - Poor — not understandable/applicable, must be improved
   - No Opinion

   - Excellent — very easy to understand, extremely usable
   - Good — easy to understand, very usable
   - Average — fairly easy to understand, usable
   - Fair — not easy to understand, should be improved, not very usable
   - Poor — cannot understand, must be improved, totally unusable
   - No Opinion
5. Describe the *amount* of usable information in this manual including tables. Please explain.

- [ ] Too much information — not all required to perform task
- [ ] Proper amount provided — not too much nor too little
- [ ] Too little information — needed additional information to perform task
- [ ] No Opinion

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6. How well is information *cross-referenced* in the manual's individual sections and index? Please explain.

- [ ] Excellent — very easy to locate information, extremely usable
- [ ] Good — easy to locate information, very usable
- [ ] Average — fairly easy to locate information, usable
- [ ] Fair — not easy to locate information, should be improved, not very usable
- [ ] Poor — cannot locate information, must be improved, totally unusable
- [ ] Did Not Use
- [ ] No Opinion

7. How *useful* is the Glossary?

- [ ] Useful
- [ ] Useful but not complete/accurate
- [ ] Not Useful
- [ ] Did Not Use
- [ ] No Opinion

8. What is your *overall impression* of this manual? Please explain.

- [ ] Excellent — met all needs, extremely usable
- [ ] Good — met most of my needs, very usable
- [ ] Average — usable
- [ ] Fair — should be revised, not very usable
- [ ] Poor — must be revised, totally unusable
- [ ] No Opinion
Documentation Map

AC and DC Power and Ground Wiring

This map shows manuals used to plan the installation of a PROVOX® Process Management System. The number, title, and binder location are shown for each document, identifying where specific information is located. See the descriptions on the back of this map for more information.
PROVOX documentation supports each stage of system development.

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**Ordering Information** — To order additional manuals, contact your local sales representative, specifying the number, title, and quantity of each document required.
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Introduction

This installation planning manual provides system-level recommendations and guidelines for AC and DC power and ground wiring of PROVOX® and microPROVOX™ Process Management Systems. Product-level instructions for power and ground wiring is described in product installation manuals.

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Note

Proper power and ground wiring are of prime importance for operator safety, signal integrity, and reliable operation of an instrumentation system. Following the recommendations in this installation planning manual to the maximum extent possible can help you achieve these goals.

All power and ground wiring practices must conform to applicable local codes and regulations. It is believed that the recommendations and guidelines given in this installation planning manual meet or exceed the codes and regulations.

The recommendations and wiring diagrams in this installation planning manual are typical examples rather than specific requirements. Primary emphasis is on safety and proper equipment operation.

While these recommendations and guidelines attempt to cover most situations, there will no-doubt be peculiar installations that may deviate from the norm. In these situations, contact your Fisher-Rosemount Systems representative or sales office for assistance.

1.1 Intended Audience

This installation planning manual is intended for use by plant engineering personnel who are planning and designing the power and ground facilities for a PROVOX or microPROVOX system.
1.2 CE Statement

If you intend to have your PROVOX system certified for compliance to appropriate European Union directives, the following CE statement is extremely important to your ability to achieve that compliance.

---

This manual describes installation and maintenance procedures for products which have been tested to be in compliance with appropriate CE directives. To maintain compliance, these products must be installed and maintained according to the procedures described in this manual. Failure to follow the procedures may compromise compliance.

---

1.3 Structure of this Manual

This manual contains the following sections:

**Section 1** — Introduction: includes an overview of this manual, the intended audience, the stylistic and typographical conventions used, and lists of documents where additional information is available.

**Section 2** — AC Power Requirements: describes the quality and the specifications for the ac power required for the instrumentation system.

**Section 3** — AC Power Distribution: describes the required distribution of ac power to system cabinets, operator consoles and other equipment.

**Section 4** — DC Power Distribution: describes the required distribution of dc power in system cabinets used by the controllers, I/O systems, and other cabinet-mounted equipment.

**Section 5** — Cabinet Alarm Wiring: describes cabinet alarm circuits used to detect loss of power supply output, loss of battery backup, and cabinet over-temperature.

**Section 6** — System Grounding: describes techniques used to assure proper system grounding for optimum instrumentation system operation.

**Section 7** — Earth Grounds: describes how to design and test earth ground systems.

**Section 8** — Lightning Protection: briefly describes lightning protection principles and references for further reading.
1.4 Manual Conventions

This manual uses the following conventions:

- **Acronyms and Abbreviations** — Terms are spelled out the first time they appear in text. Thereafter, only the acronym or abbreviation is used. In addition, the glossary defines the acronyms and abbreviations.

- **Revision Control** — The title page lists the revision level and the printing date of this manual. When the manual is revised, the revision level and the printing date are changed.

- **References** — References to other documents include the name and catalog number for Fisher-Rosemount Systems manuals.

1.5 Warnings, Cautions, and Notes

Warnings, Cautions, and Notes attract attention to essential or critical information in this manual. The types of information included in each are explained in the following:

---

**Warning**

All warnings have this form and symbol. Do not disregard warnings. They are installation, operation, or maintenance procedures, practices, conditions, statements, and so forth, which if not strictly observed, may result in personal injury or loss of life.

---

**Caution**

All cautions have this form and symbol. Do not disregard cautions. They are installation, operation, or maintenance procedures, practices, conditions, statements, and so forth, which if not strictly observed, may result in damage to, or destruction of, equipment or may cause a long term health hazard.
1.6 Related Documents

The planning manuals listed below provide further information for system installation planning:

- PN1:002, Planning the Installation
- PN1:004, Signal Wiring and Highway System Guidelines
- PN1:005, Preventing Electrostatic Damage
- PN1:006 Environmental Conditions for Instrumentation Systems
- PN4:007, Lightning Protection Guidelines for Instrumentation Systems
- PN1:008, Site Evaluation

1.7 Reference Documents

The reference documents listed below are industry standard reference material where further information about power and grounding can be found:

1. Getting Down to Earth, 4th ed., Blue Bell, Pennsylvania; Biddle Instruments. Copies of this publication are available from Biddle Instruments, 510 Township Lane Road, Blue Bell, Pennsylvania, 19422, USA.


3. CSA, C22.1 Canadian Electrical Code, Part 1, Rexdale, Ontario; Canadian Standards Association.

4. ISA,RP60.08 Electrical Guide for Control Centers, Pittsburgh; Instrument Society of America.
1.8 Excellence in Documentation

Our goal is to provide documents that meet your needs. Through surveys and interviews, we continually evaluate our documents as part of the broad Fisher-Rosemount Systems customer-support program. Various manuals are produced for different purposes and for readers with varying backgrounds and experience.

Please assist us in the evaluation of this manual by completing the reader evaluation form located at the front of the document. In addition, if you have any suggestions for specific pages, return a marked-up copy along with your survey.
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2 AC Power Requirements

Commercial ac power utilities normally provide power that meets the voltage and frequency requirements of the instrumentation system. However, plant distribution networks may drop 5 percent or more of the input ac power between the service entrance point to the plant and the final power connection to the various portions of the instrumentation system. Furthermore, starting transients from large motors and other loads connected to the distribution system can cause additional momentary line-voltage reductions as well as possible waveshape distortions. Therefore, accessing ac power requirements and then designing a plant ac distribution system that meets them is critical to reliable, efficient control system operation. This section describes considerations to help you design a good plant ac distribution system.

2.1 AC Power Quality

To maintain good ac power quality, such problems as power loss, intermittent noise, low voltage, or transients and surges on power lines must be controlled or designed around. To suppress electrical noise, a dedicated feeder between the main distribution panel and the instrumentation system branch panel is recommended. If low voltage from the commercial power source or objectionable transients and surges exist, or if noise is a problem even with a dedicated feeder, a device such as a noise filter or voltage regulating power source which reduces input power noise may be required.

Devices which can be used include:

- Isolation transformer
- Noise filters
- Line conditioner
- Voltage regulating power source
- Motor-generator set
- uninterruptible power supply (UPS)

---

Note

It is strongly recommended that isolation transformers be used because they inherently provide good line regulation and transient filtering.
If loss of power from a commercial power source is a probability, a backup power source such as an uninterruptible power supply for critical portions of the control system is recommended.

The instrumentation system should have an ac power source that is isolated from lighting and all other power loads, and each building or site containing instrumentation should have a separate power source or backup power source. These conditions are particularly important for the instrumentation system control center, which generally contains the console or computer and associated equipment.

When an isolation transformer is used, the primary power source should be supplied from the highest line voltage available from the commercial source, and then through a step-down transformer to the required lower voltage for the instrumentation system. Only the instrumentation system should be connected to this step-down transformer; no other ac loads should be connected. The reason for using the highest voltage is to take advantage of the natural noise attenuation which occurs when the voltage and any noise is stepped down.

### 2.2 AC Source Voltage and Frequency

The ac power source should have sufficient capacity to handle equipment inrush overcurrents or surge currents (lasting about ten cycles), and still regulate its output voltage within the nominally rated voltage tolerances for the equipment. This tolerance is measured at the power input to the equipment when the equipment is energized. Table 2-1 lists the voltage and frequency requirements for the dc power supplies which provide dc power to cabinet-mounted PROVOX instruments, such as SR90 and SRx controllers and the Control I/O subsystem.

<table>
<thead>
<tr>
<th>Type CP6101</th>
<th>Type CP6102</th>
<th>Type CP6103</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>Range</td>
<td>Hz</td>
</tr>
<tr>
<td>100</td>
<td>86-113</td>
<td>58-62</td>
</tr>
<tr>
<td>117</td>
<td>102-132</td>
<td>58-62</td>
</tr>
<tr>
<td>200</td>
<td>172-226</td>
<td>58-62</td>
</tr>
<tr>
<td>230/240</td>
<td>204-264</td>
<td>58-62</td>
</tr>
<tr>
<td>Nominal</td>
<td>Range</td>
<td>Hz</td>
</tr>
<tr>
<td>110/115</td>
<td>97-127</td>
<td>48-52</td>
</tr>
<tr>
<td>120/127</td>
<td>107-140</td>
<td>48-52</td>
</tr>
<tr>
<td>220</td>
<td>187-242</td>
<td>48-52</td>
</tr>
<tr>
<td>230/240</td>
<td>204-264</td>
<td>48-52</td>
</tr>
<tr>
<td>Nominal</td>
<td>Range</td>
<td>Hz</td>
</tr>
<tr>
<td>120/240</td>
<td>85-264</td>
<td>47-63</td>
</tr>
<tr>
<td>120/240</td>
<td>204-264</td>
<td>48-52</td>
</tr>
</tbody>
</table>

Power requirements for PROVOX operator consoles and peripheral equipment are listed in their product bulletins. For other equipment using switching power supplies, use only low impedance output power sources. Then use normal transformer load recommendations.
2.3 Recommended Wire Sizes

Wiring from the power source to equipment should be large enough to maintain the voltage at the equipment input terminals within the specified tolerances when all equipment is energized. The wiring must, at a minimum, conform to applicable local, state, and federal codes to ensure that it can conduct the current load safely without overheating.

Recommended wire sizes for various load currents and run lengths are listed in Table 2-2 for 120 volts input power and Table 2-3 for 240 volts input power. Figures in the tables represent one-way distances. Each run length indicates the maximum distance in feet (meters) which each wire size can be to carry the current (listed in the left column) with no more than a 2% voltage drop. If a 4% drop is acceptable, double the distances shown. For a 5% drop, multiply all distances by 2.5.

Table 2-4 presents properties and data for various wire sizes. For countries incorporating metric standards, use the equivalent or larger standard metric wire size from Table 2-5.

<table>
<thead>
<tr>
<th>Load Current (A)</th>
<th>Power (Watts)</th>
<th>Wire size — AWG (mm²)</th>
<th>Run Length — Feet (Meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 (3.31)</td>
<td>10 (5.28)</td>
<td>8 (8.37)</td>
<td>6 (13.30)</td>
</tr>
<tr>
<td>120</td>
<td></td>
<td>622 (189.6)</td>
<td>992 (302.4)</td>
</tr>
<tr>
<td>240</td>
<td></td>
<td>311 (94.8)</td>
<td>496 (151.2)</td>
</tr>
<tr>
<td>360</td>
<td></td>
<td>207 (63.1)</td>
<td>330 (100.6)</td>
</tr>
<tr>
<td>600</td>
<td></td>
<td>124 (37.8)</td>
<td>198 (60.3)</td>
</tr>
<tr>
<td>1200</td>
<td></td>
<td>62 (18.9)</td>
<td>99 (30.2)</td>
</tr>
<tr>
<td>1800</td>
<td></td>
<td>41 (12.5)</td>
<td>66 (20.1)</td>
</tr>
<tr>
<td>2400</td>
<td></td>
<td>31 (9.4)</td>
<td>49 (14.9)</td>
</tr>
<tr>
<td>3000</td>
<td></td>
<td>25 (7.6)</td>
<td>39 (11.9)</td>
</tr>
<tr>
<td>3600</td>
<td></td>
<td>21 (6.4)</td>
<td>33 (10.1)</td>
</tr>
<tr>
<td>4200</td>
<td></td>
<td>18 (5.5)</td>
<td>28 (8.5)</td>
</tr>
<tr>
<td>4800</td>
<td></td>
<td>15 (4.6)</td>
<td>25 (7.6)</td>
</tr>
</tbody>
</table>
### Table 2-2  Recommended Wire Sizes for 120 Volts

<table>
<thead>
<tr>
<th>Load Current (A)</th>
<th>Power (Watts)</th>
<th>Wire Size — AWG (mm²)</th>
<th>Run Length — Feet (Meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>12 (3.31)</td>
<td>10 (5.28)</td>
</tr>
<tr>
<td>45</td>
<td>5400</td>
<td>22 (6.7)</td>
<td>35 (10.7)</td>
</tr>
<tr>
<td>50</td>
<td>6000</td>
<td>20 (6.1)</td>
<td>31 (9.4)</td>
</tr>
</tbody>
</table>

### Table 2-3  Recommended Wire Sizes for 240 Volts

<table>
<thead>
<tr>
<th>Load Current (A)</th>
<th>Power (Watts)</th>
<th>Wire Size — AWG (mm²)</th>
<th>Run Length — Feet (Meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>12 (3.31)</td>
<td>10 (5.28)</td>
</tr>
<tr>
<td>1</td>
<td>240</td>
<td>1243 (378.9)</td>
<td>1983 (604.4)</td>
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<td>480</td>
<td>622 (189.6)</td>
<td>992 (302.4)</td>
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<tr>
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<td>720</td>
<td>414 (126.2)</td>
<td>661 (201.5)</td>
</tr>
<tr>
<td>4</td>
<td>960</td>
<td>311 (94.8)</td>
<td>496 (151.2)</td>
</tr>
<tr>
<td>5</td>
<td>1200</td>
<td>249 (75.9)</td>
<td>396 (120.7)</td>
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<td>2400</td>
<td>124 (37.8)</td>
<td>198 (60.3)</td>
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<tr>
<td>15</td>
<td>3600</td>
<td>83 (25.3)</td>
<td>132 (40.2)</td>
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<td>4800</td>
<td>62 (18.9)</td>
<td>99 (30.2)</td>
</tr>
<tr>
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<td>6000</td>
<td>50 (15.2)</td>
<td>79 (24.1)</td>
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<td>30</td>
<td>7200</td>
<td>41 (12.5)</td>
<td>66 (20.1)</td>
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<td>8400</td>
<td>35 (10.7)</td>
<td>56 (17.1)</td>
</tr>
<tr>
<td>40</td>
<td>9600</td>
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<td>49 (14.9)</td>
</tr>
<tr>
<td>45</td>
<td>10,800</td>
<td>44 (13.4)</td>
<td>70 (21.3)</td>
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<tr>
<td>50</td>
<td>12,000</td>
<td>39 (11.9)</td>
<td>63 (19.2)</td>
</tr>
</tbody>
</table>
### Table 2-3  Recommended Wire Sizes for 240 Volts

<table>
<thead>
<tr>
<th>Load Current (A)</th>
<th>Power (Watts)</th>
<th>Wire Size — AWG (mm²)</th>
<th>Run Length — Feet (Meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>12 (3.31)</td>
<td>10 (5.28)</td>
</tr>
<tr>
<td>60</td>
<td>14,400</td>
<td>52 (15.8)</td>
<td>81 (24.7)</td>
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<tr>
<td>70</td>
<td>16,800</td>
<td>45 (13.7)</td>
<td>70 (21.3)</td>
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<tr>
<td>80</td>
<td>19,200</td>
<td>61 (18.6)</td>
<td>97 (29.6)</td>
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<tr>
<td>90</td>
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<td>54 (16.5)</td>
<td>86 (26.2)</td>
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<td>78 (23.8)</td>
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<td>99 (30.2)</td>
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<tr>
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<td>36,000</td>
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<td>82 (25.0)</td>
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<tr>
<td>200</td>
<td>48,000</td>
<td>39 (11.9)</td>
<td>62 (18.9)</td>
</tr>
</tbody>
</table>

### Table 2-4  Copper Conductor Properties

<table>
<thead>
<tr>
<th>Size AWG/ MCM</th>
<th>Area Cir Mils</th>
<th>*Area mm²</th>
<th>Conductor Stranding</th>
<th>Overall</th>
<th>DC Resistance at 75° C, 167° F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Uncoated</td>
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<tr>
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<td>1620</td>
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<td>0.001</td>
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<tr>
<td>18</td>
<td>1620</td>
<td>0.82</td>
<td>7</td>
<td>0.015</td>
<td>0.002</td>
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<tr>
<td>16</td>
<td>2580</td>
<td>1.31</td>
<td>1</td>
<td>0.051</td>
<td>0.002</td>
</tr>
<tr>
<td>16</td>
<td>2580</td>
<td>1.31</td>
<td>7</td>
<td>0.019</td>
<td>0.003</td>
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<tr>
<td>14</td>
<td>4110</td>
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<td>0.064</td>
<td>0.003</td>
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<td>14</td>
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<td>0.004</td>
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<td>0.005</td>
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<td>6530</td>
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<td>0.011</td>
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<td>0.013</td>
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<tr>
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<td>0.017</td>
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<td>0.027</td>
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<td>41740</td>
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</tr>
<tr>
<td>Size AWG/ MCM</td>
<td>Area Cir Mils</td>
<td>*Area mm²</td>
<td>Conductors Stranding</td>
<td>Overall</td>
<td>DC Resistance at 75° C, 167° F Ohms/kFT</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------</td>
<td>-----------</td>
<td>----------------------</td>
<td>---------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Qty Dia. In.</td>
<td>Dia. In.</td>
<td>Area In.²</td>
</tr>
<tr>
<td>3</td>
<td>52620</td>
<td>26.69</td>
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<td>0.087</td>
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<td>0.292</td>
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<td>0.332</td>
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<td>0.373</td>
</tr>
<tr>
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<td>19</td>
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<td>0.419</td>
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<tr>
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<td>19</td>
<td>0.094</td>
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</tr>
<tr>
<td>4/0</td>
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<td>19</td>
<td>0.106</td>
<td>0.528</td>
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<tr>
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<td>0.082</td>
<td>0.575</td>
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<tr>
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<td></td>
<td>37</td>
<td>0.090</td>
<td>0.630</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>37</td>
<td>0.097</td>
<td>0.681</td>
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<td></td>
<td>37</td>
<td>0.104</td>
<td>0.728</td>
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<td></td>
<td>37</td>
<td>0.116</td>
<td>0.813</td>
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<td>0.992</td>
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<td>0.107</td>
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<td>1000</td>
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<td>61</td>
<td>0.128</td>
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</tr>
<tr>
<td>1250</td>
<td></td>
<td></td>
<td>91</td>
<td>0.117</td>
<td>1.29</td>
</tr>
<tr>
<td>1500</td>
<td></td>
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<td>91</td>
<td>0.128</td>
<td>1.41</td>
</tr>
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<td>1750</td>
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<td>127</td>
<td>0.117</td>
<td>1.52</td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td>127</td>
<td>0.126</td>
<td>1.63</td>
</tr>
</tbody>
</table>

**Note:** These resistance values are valid only for the parameters as given. Using conductors having coated strands, different strand types, and especially different temperatures will change the resistance.

**Note:** The formula for the temperature change is: \( R_2 - R_1 = (1 + a (T_1 - - 20)) \), \( a_{cu} = 0.00393 \)

**Note:** Class B stranding is listed as well as solid for some sizes. Its overall diameter and area is that of its circumscribing circle. The construction information is per NEMA Standard WC8-1976 (Rev 5-1980). The resistance is calculated per National Bureau of Standards Handbook 100, dated 1966 and Handbook 109, dated 1972.

**Note:** Conductors with compact and compressed stranding have about 9 percent and 3 percent, respectively, smaller bare conductor diameters than those shown.

**Note:** The IACS conductivities used bare copper = 100%.

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* This column has been added and is not part of the table in the National Electrical Code.
### Table 2-5  Class 2 Stranded Conductors for Single-core and Multi-core Cables

<table>
<thead>
<tr>
<th>Nominal Cross Section Area (mm²)</th>
<th>Minimum Number of Wires In Copper Conductor</th>
<th>Maximum resistance of Annealed Copper Conductor at 20°C (Ohms/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Circular Conductor</td>
<td>Compacted Conductor</td>
</tr>
<tr>
<td>0.5</td>
<td>7</td>
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<td>0.75</td>
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</tr>
<tr>
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<td>53</td>
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<tr>
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<td></td>
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</tbody>
</table>

**Note:** Extracts from BS63601981 are reproduced by permission of the British Standards Institution. Copies may be obtained from BSI at Linford Wood, Milton Keynes, MK148LE.

**Note:** To obtain the maximum resistance of hard-drawn conductors, the values in columns 5 and 6 should be divided by 0.97.
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3 AC Power Distribution

The ac power supplied to a PROVOX® Process Management System should be taken from an ac power distribution system which is isolated from the power supplied to all other functions in a process control system. In addition, a separate distribution system is recommended for each building containing control system equipment. This isolation can be provided by either an isolation transformer or by an uninterruptible power supply.

Note

To maintain ac power quality, isolation of power supplied to the instrumentation from power supplied to all other functions and the importance of using a different distribution system for each building containing instrumentation cannot be overemphasized.

PROVOX system cabinets and consoles require single-phase power. Commercial computer systems usually require a 120/240 volt circuit, two 120 volt circuits, a 208Y/120 volt circuit, or European 230/240 Vac 50 Hz single phase circuit, depending on computer configuration. If a three-phase distribution system is used, exercise care to balance the load between phases at each power panel, minimizing any voltage differentials between the ac neutral and the grounding conductors.

3.1 System-Level Power Distribution

Figure 3-1 shows a typical system-level power distribution system. Figure 3-2 and Figure 3-3 shows further details of typical ac power distribution and a plant ground system. Input ac power is supplied through an isolation transformer or UPS, with the ac ground point for the instrumentation system established at or near the transformer or UPS.

The ac circuit conductors are routed through the main distribution panel (containing the main disconnect switch) into the circuit breaker panel or panels. This system meets or exceeds the requirements of Article 250 of the National Electrical Code. The isolated grounding system is used for signal reference.
Figure 3-4 provides additional detail for three-phase wiring between an isolation transformer and the main distribution panel.

Figure 3-5 shows an uninterruptible power supply (UPS) used in a three-phase system with an isolation transformer.

Figure 3-6 provides additional detail for single-phase wiring between an isolation transformer and the main distribution panel.

Figure 3-7 shows an uninterruptible power supply (UPS) used in a single-phase system with an isolation transformer.

For large systems, multiple circuit breaker panels should be used. Separate panels are dedicated to system cabinets and to consoles and computers, as shown in Figure 3-1.

Figure 3-8 provides wiring details for a multiple circuit breaker panel installation.

Figure 3-9 provides wiring details for a small system to a single circuit breaker panel.

Both Figure 3-8 and Figure 3-9 show the neutral and ground conductors bonded to separate bus bars inside the circuit breaker panel. The bus bars are electrically isolated from the panel and from each other. Throughout the system, all ac circuit conductors (line, neutral, and ground) are electrically isolated from their conduits and circuit breaker panels.

This conductor isolation is maintained from the isolation transformer or UPS to the point of final connection at the instrumentation equipment. The only connection between neutral, isolated ground, and earth ground is at the main bonding jumper. The insulated grounding conductor should be the same size or larger than the phase and neutral conductors.
Legend

- Utility box for cabinet power connections
- Utility box for isolated ground receptacles
- A single breaker panel may be used for small systems.

Figure 3-1 AC Power Distribution System
Figure 3-2 AC Distribution System Grounding

DO NOT ENCLOSE Grounding Conductors in Metallic Conduit.

For Multi-Cabinet Grouping, Refer to Figure 3-3.
Example of Multiple Cabinets and Power Supplies

Notes:

1. Cabinets are grouped in a maximum of eight so a cabinet ground and local ground bus (LGB) connection will come to the master ground bus (MGB) for each group.

2. Typical ac input for a dc power supply.

Figure 3-3  AC Distribution System Grounding (Continued). DC Grounding also Shown
Notes:
1. Circuit breaker, as required by local codes and regulations
2. Conduit provides a safety ground connection for individual panels.
3. The isolation transformer secondary can be a 208Y/120 Volt, 120 Volt, 120/240 Volt output or European 230/240 Volt.
4. The conductor between the neutral and ground leads and the dedicated AC ground should be as short as physically possible.

Figure 3-4 Three Phase AC Power Input System
Notes:

1. Conduit provides a safety ground connection for individual panels.

2. The conductor between the neutral and ground leads and the dedicated AC ground should be as short as physically possible.

Figure 3-5  Reverse Transfer Uninterruptible Power Supply (UPS) with a Manual Transfer Switch (Three Phase)
AC Input from Commercial Power Source

Isolation Transformer

Main Distribution Panel

Main Disconnect Switch

To Circuit Breaker Panel(s)

Grounded Steel Column

Backup Input

DC/CAB GND

PROVOX® Instrumentation Ground

Dedicated Plant Ground Grid Point

Notes:
1. Circuit breaker, as required by national codes and regulations
2. Conduit provides a safety ground connection for individual panels.
3. The conductor between the neutral and ground leads and the dedicated AC ground should be as short as physically possible.

Figure 3-6 Single Phase AC Power Input System
Notes:
1. Conduit provides a safety ground connection for individual panels.
2. This output can be substituted for the isolation transformer in Figure 3-1.
3. The conductor between the neutral and ground leads and the dedicated AC ground should be as short as physically possible.

Figure 3-7  Reverse Transfer Uninterruptible Power Supply (UPS) with a Manual Transfer Switch (Single Phase)
From Main Power Distribution Panel

Emergency Disconnect Switch

Neutral Bus (Isolated from Breaker Panel)

Ground Bus (Isolated from Breaker Panel)

Main Power Circuit Breaker Panel

Circuit Breaker Panel

System Cabinet Power

Circuit breaker as required by national codes and regulations.

Notes:
1. Conduit provides a safety ground connection for individual panels.
2. Neutral Bus (Isolated from Breaker Panel)
3. Ground Bus (Isolated from Breaker Panel)

Figure 3-8. Multiple Circuit Breaker Panel Wiring
Notes:
1. Conduit provides a safety ground connection for individual panels.
2. Circuit breaker as required by national codes and regulations.
3. Second phase required if console has dual circuit power utility strip.

Figure 3-9 Single Circuit Breaker Panel Wiring
3.2 System Cabinets

All ac power for the system cabinets is routed from a circuit breaker panel, as shown in Figure 3-8 and Figure 3-9, and is connected to the Type CP7101 Power Distribution Panel assembly located in a system cabinet when Type CP6101 or CP6102 Power Supplies are used, or directly to the power supply when a Type CP6103 Power Supply is used.

3.2.1 Using Type CP6101 and CP6102 Power Supplies

Each Type CP7101 Power Distribution Panel assembly contains one or two separate ac circuits, as shown in Figure 3-10. These circuits supply power to the two twistlock receptacles and the duplex receptacle in the panel. One twistlock receptacle is dedicated to the primary power. The second twistlock receptacle is dedicated to the backup power supply, if supply redundancy is selected. The duplex receptacle, with its own circuit breaker, is used for the cooling fans within the cabinet.

Each twistlock receptacle in power distribution panels used in nominal 100 or 120 volt ac systems must be supplied from a separate 20 ampere circuit breaker. Each twistlock receptacle in nominal 200, 220, or 240 volt ac systems must be supplied from a 15 ampere circuit breaker. The duplex receptacle is connected in parallel with the primary twistlock receptacle through a 15 ampere (120 Vac) or 7.5 ampere (240 Vac) circuit breaker internal to the power distribution panel.

All ac power cords between the conduit utility box and the power distribution panel should be connected to the utility box as shown in Figure 3-10. All ac power supplied to a single cabinet grouping must be tied to the same ground system at the power source neutral to ground point.

3.2.2 Using Type CP6103 Power Supply Units

Each Type CP6103 Power Supply Unit contains one or two power supplies, as shown in Figure 3-11. Terminal blocks are provided for two ac input sources which allows each power supply to be connected to a separate ac source. Separate dc output terminals are provided on the front of the housing for each power supply. The chassis of the power supply unit is internally bonded to the ground terminal of each ac input terminal block.
Notes:
1. Connections inside of utility box may be to a terminal block or wire nut connections.
2. Conduit provides a safety ground connection for the utility box.
3. Pushbutton reset circuit breaker rated at 7.5 (240 Vdc) or 15 (120 Vdc) Amperes.
4. Power cable connections to the power distribution panel are factory wired.
5. Example shows NEMA L5-20R receptacle.
6. Example shows NEMA 5-15R receptacles.

Figure 3-10  System Cabinet AC Power Connections for Type CP6101 and Type CP6102 Power Supplies

Inputs from each terminal block are routed through a 1 pole 15 ampere circuit breaker to an auxiliary terminal block for use by auxiliary equipment. The type of equipment normally connected to the auxiliary terminals are cabinet fans, modems, and other light loads. Since the terminal block is tied to the power supply source, you do not want any power problems in the auxiliary to cause the main breaker to trip. Therefore, use a 20 A breaker for 600 W power supply and a 30 A breaker for a 1200 W power supply. In no case, use higher than a 30 A breaker per branch circuit.
Notes:
1. Rocker ON/OFF switch/circuit breaker for auxiliary ac outputs
2. Two wires can be connected to each terminal
3. Input 1 and Input 2 shall be supplied from separate dedicated circuit breakers

Figure 3-11 System Cabinet AC Power Connections for Type CP6103 Power Supply Units
3.3 Consoles and Computers

All ac power for the console or computer equipment is routed from a circuit breaker panel (this can be the same panel as the cabinet equipment), as shown in Figure 3-8 and Figure 3-9. The ac power requirements for the console or computer must be provided at the point of connection to the console or computer equipment. For voltage and frequency requirements, refer to the product bulletin for the equipment.

Power for console components is supplied from a utility power strip located inside each console bay unit or auxiliary console bay assembly as shown in Figure 3-12. All utility power strips in a console grouping must receive power from the same circuit breaker panel. Consoles with a single-circuit utility power strip are supplied single-phase power from separate circuit breakers. A 15 ampere breaker is used for nominal 120 volt ac systems, and a 10 ampere breaker is used for 220 or 240 volt ac systems.

Power for components installed in Type CP9411 System Cabinets and DC9410-Series Control Room Furniture (OWP wall units) is supplied from utility strips (located inside the cabinet or wall unit) as shown in Figure 3-13, Figure 3-14, and Figure 3-15. Figure 3-16 shows the power distribution in the electronics enclosures available for wall units.

For the system cabinets, input power from a breaker is connected to a terminal block inside the cabinet. For wall units, connection to the utility power strip is provided by an IEC input power cord (country specific). All utility power strips in a cabinet grouping must receive power from the same circuit breaker panel. Wall units with single circuit utility power strips are supplied power from separate circuit breakers.

As shown in Figure 3-17, computer cabinets are normally supplied power from a utility box through power cords to a power distribution unit inside the cabinet. For a 120 volt ac, 60 hertz single bay computer, the computer power distribution unit must be supplied either from two single-phase 120 volt power circuits with neutrals connected together, or from a 120/240 volt ac circuit. For a multibay computer, the computer power distribution unit can be supplied from three-phase 208Y/120 volt ac power circuits. Each phase conductor can be supplied through a separate 20 A circuit breaker which is part of a ganged circuit breaker.

For a 220 or 240 volt, 60 hertz, single bay computer, the computer power distribution unit must be supplied from a 20 A circuit breaker, 220 or 240 volt, single-phase branch circuit. For a multibay computer, the computer power distribution unit must be supplied from a 30 A circuit breaker, 220 or 240 volt, single-phase branch circuit.
Power Input from Circuit Breaker Panel

Notes:

1. AC power cable and plug connections to the utility strip are factory wired.

2. For installations which include an isolated ground receptacle, a three-wire, isolated ground receptacle, is supplied with consoles that have a single-circuit utility strip. Installations that do not include an isolated ground receptacle should be connected as shown in Figure 3-18. Example shows NEMA L5-15R receptacle.

3. Power cable connections to the utility power strip are factory wired.

Figure 3-12 Console AC Power Connections

Figure 3-13 Cabinet AC Power Connections
Notes:
1. Auto ranging input voltage
2. Fixed 115 or 230 input voltage
3. Customer supplied breaker and power cord
4. Terminal block (inside cabinet)

Figure 3-14 Type CP9411 System Cabinet Power Distribution
Figure 3-15  DC9410-Series Control Room Furniture Power Distribution
**Figure 3-16  Electronics Enclosure Power Distribution**

**Figure 3-17  Custom Computer AC Power Connections**
3.4 Peripheral Equipment

All peripheral equipment used with consoles and computers is powered either from the utility power strips inside the console or computer cabinet, or from remote isolated ground receptacles. These receptacles are shown in Figure 3-8 and Figure 3-9 and detailed in Figure 3-18. Isolated ground receptacles must be constructed and installed in such a way that the ground terminal is electrically isolated from the conduit and the box in which the receptacle is mounted.

If non-isolated communications or signal wiring is used, each peripheral unit must receive ac power from the same circuit breaker panel as the electronics unit or computer with which it interfaces. The load imposed on the utility power strips by the peripherals and the electronics units should be balanced between the utility power strips as much as possible. However, if possible, connect the power cable for a console printer unit or a console disk unit (hard) to a utility strip which is not supplying power to a console electronics unit or a video display unit.

![Isolated Ground Receptacle](image)

**Figure 3-18 Isolated Ground Receptacle Details**
4 DC Power Distribution

All controller, I/O, multiplexer, or communications devices contained in a system cabinet are powered by a nominal 24 volt dc power distribution system. The system cabinets are available with a laminated bus bar which distributes dc power to the devices in the cabinet. Power to this bus bar can be obtained from system power supply units or from a user-supplied dc source within the processing plant.

4.1 DC Voltage Nomenclature

As you look at PROVOX® equipment dc voltage markings and read the PROVOX manuals, you will find small variations in the dc voltage nomenclature. These variations follow the PROVOX system marking conventions.

The system nominal dc voltage is +24 volts, and cabinet bus bars are marked for the nominal voltage. The dc power supplies produce a range of 24 to 26 Vdc, and the power supplies are marked for their nominal output voltage. For example, the output terminals on the Type CP6103 System Power Supply Unit are marked as +26 Vdc and -26 Vdc. These variations fall within the operating range of dc-powered PROVOX equipment, which is 21 to 29 Vdc.

In this manual and other PROVOX manuals, dc voltages are indicated as 24 Vdc nominal where no particular device is referenced. If, however, a specific device, such as a power supply, is being considered, then the voltage indicated will be the voltage of the device.

4.2 DC Power Supplies

Type CP6101 and CP6102 System Power Supply units mount on EIA rails at the bottom of a PROVOX system cabinet and are provided with ac power through a Type CP7107 Power Distribution Panel. A second power supply unit can be used for backup with both units connected through the power distribution panel. Details for wiring the power supply units are found in the appropriate power supply and power distribution panel installation planning notes. For additional backup and power outage protection, a user-supplied dc power source (either batteries or dc power supplies) can be connected to the power distribution panel.

The Type CP6103 System Power Supply Unit mounts on EIA rails at the bottom of a cabinet and are provided with ac power directly to the ac
input terminal blocks on the power supply unit housing. The unit can house two power supplies, one of which can be used to backup the other. Details for wiring the power supply units are found in *Installing and Maintaining Type CP6103 System Power Supply Unit Manual*, PN2.1:CP6103.

In a multi-cabinet distribution using Type CP6103 System Power Supply Units, a DC Distribution Assembly should be mounted in the central cabinet and used for distributing dc power to the cabinets. The power supply units should be mounted in the central cabinet with the DC Distribution Assembly.

The voltage at the bus bars mounted in the cabinets is nominally 24 volts dc. However, the different voltages available from backup batteries and power supplies, plus the varying voltage drops that occur in the connecting wiring, can cause the voltage at each device to be higher or lower. Be sure that the voltage at the device terminal connections is within the tolerance specified for each individual product (see the appropriate product bulletin for these specifications).

## 4.3 DC Power Recommendations

When designing the dc power distribution system, the overall process strategy needs to be reviewed to make sure that the system can provide the reliability to the process management system as required by the process.

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**Note**

Process management system availability can be an overlooked aspect of dc power distribution system design. Availability is more than simply redundant controllers, I/O cards, and communications. It may also require redundant dc power distribution.

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A good review reveals what level of redundancy is needed. Redundancy can mean simple backup of power supplies, or can mean two separate dc power systems supplying power to separate, but redundant, I/O and controller files in separate cabinets.

Figure 4-1 shows the typical terminations for the Type CP6101 and Type CP6102 System Power Supply units, the Type CP7101 Power Distribution Panel (PDP), and bus bars in system cabinets. Cabinets 1 through 3 show a typical system with three cabinets, three primary supplies, and one backup supply. The backup supply is normally load
sharing with the three primary supplies, so all four supplies are in use. Therefore, should one of the primary supplies or the backup supply fail, there is no power loss at the load.

The backup supply must be connected to the same Local Ground Bus (LGB) as the associated primary supplies. A backup supply can back up a primary supply in a separate cabinet if the total length of multistrand, 8-AWG (8.35 mm²), wire between the backup supply, primary supply, and the local ground bus (LGB) does not exceed 21 feet (6.4m). The length is from the supply to the PDP to the bus bar and back to the power supply common (PSC).

An alternate redundant bus method is also shown in Figure 4-1 at cabinets 4 and 5. This method can be used when two or three adjacent cabinets require a total input current of less than 35 amperes. The bus bars can be connected together and receive power from the redundant power supply unit.

Figure 4-3 illustrates simplex dc power distribution with redundant Type CP6101 and Type CP6102 power supplies and Figure 4-6 illustrates fully redundant dc power distribution with Type CP6101 and Type CP6102 power supplies.

Figure 4-2 shows the typical termination for the Type CP6103 System Power Supply Units and bus bars in system cabinets. Cabinets 1 through 3 show a typical system with three cabinets, three primary supplies, and three secondary supplies. The secondary power supplies are normally load sharing with the primary supplies. If either the primary or secondary supply fails, there is no power loss at the load.

An alternate method is also shown in Figure 4-2 at cabinets 4 and 5. This method can be used when two adjacent cabinets require a total input power of less than one 600 Watt (23 A) or 1200 Watt (46 A) power supply. Both sets of bus bars can be connected to one power supply unit. The bus bars can be installed in separate cabinets or in a front and rear access cabinet.

Figure 4-4 illustrates a dual simplex dc power distribution configuration, with two power supplies in a single Type CP6103 Power Supply Unit.

Figure 4-5 illustrates a redundant dc power distribution configuration with two power supplies in a single Type CP6103 Power Supply Unit.

Figure 4-7 illustrates an alternate dc power distribution with two power supplies in a single Type CP6103 Power Supply Unit, providing power for three cabinets. The terminal blocks (TR1 +/- and TR2 +/-) are installed on a DC Distribution Assembly, and are used to organize and simplify connections. Use No. 8 AWG insulated wire: red for all +24 V wiring and black for all -24 V wiring.

Figure 4-8 shows the general wiring to a DC Distribution Assembly. The terminations on the assembly are arranged similarly to those on a Type
CP6103 Power Supply Unit. The assembly is capable of supplying eight bus bars. It should be mounted below the power supply unit for easy access and organization of dc power wiring.

Figure 4-9 shows the details of the power and alarm connection terminal block on a Type CP6103 Power Supply Unit.

4.4 DC Power Connections

All dc power to the devices located in the system cabinets is obtained from the cabinet laminated bus bar. Terminations of typical products are shown in Figure 4-12 through Figure 4-14 and are detailed in the installation planning manual for each product. Each product requires nominal +24 Vdc and power supply common (PSC) connections. The terminations are made to the laminated bus bar by using stranded wire with a minimum size of 12 AWG (3.30 mm²). Use red wire for +24 Vdc and black for PSC (-24 Vdc).

Connect the PSC circuits at a common point beyond which no additional power supply return currents flow. The connection point can be at the local ground bus (LGB) or master ground bus (MGB) for systems using Type CP6101 and Type CP6102 Power Supplies, at the local ground bus (LGB) for systems using Type CP6103 Power Supply Units.

If dc power for remotely located Control I/O termination panels is obtained from the same source as the Control I/O card files, as shown in Figure 4-10, there must be less than 1 volt drop across the power leads to the termination panels. The distance between the card files and the remote termination panels must not exceed 200 cable feet (61 m). If dc power is applied from a separate source, the ground and returns must be referenced to the same point. Also, ac power must be obtained from the same ac power distribution system.

4.5 Field Transmitter Power

DC power for field transmitters should not be obtained directly from the 24V bus bar, but should be obtained from the fused terminations on the individual card files or termination panels that are designed exclusively for powering the transmitters. AC Power for ac-powered field devices (such as relays, solenoids, and transmitters) must not be the same ac power used to power the process management system. The two ac power sources must be isolated to prevent ground loops.
Figure 4-1. Typical DC Power System and Ground Connections for System Cabinets

Legend:
- PSC = Power Supply Common
- PRI = Dedicated Plant Ground
- SEC = Grounded Steel Column
- COM = Isolation Transformer
- Grid Point
- Grounded Bus Bar

Notes:
1. Breaker for +24V
2. Master ground should be located in center cabinet or area of grouping.
3. Wiring from master ground bus to single-point DC ground bus should be at least No. 1/0 AWG (53.46 mm²) insulated wire.
4. Wiring to local ground bus should be at least No. 4 AWG (8.35 mm²) insulated wire.
5. Optional rear bus bar (typical)
6. Cabinet ground should be at least 0.5 in. (12.7 mm) braid wire.
7. Wiring from local ground bus to master ground bus should be at least No. 10 AWG (53.96 mm²) insulated wire.
8. Wiring to local ground bus should be at least No. 4 AWG (8.35 mm²) insulated wire.

Notes:
- Wiring from local ground bus to master ground bus should be at least No. 10 AWG (53.96 mm²) insulated wire.
- Wiring to local ground bus should be at least No. 4 AWG (8.35 mm²) insulated wire.

Figure 4-1 Typical DC Power System — CP6101/CP6102 Power Supplies

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Figure 4-2. Typical DC Power System and Ground Connections for Cabinets with Type CP6103 Power Supply Units

Notes:
1. Master ground should be located in center cabinet or area of grouping.
2. Wiring from master ground bus to single-point dc ground should be at least No. 1/0 AWG (53.46 mm²) insulated wire.
3. Cabinet ground should be at least 0.5 in. (12.7 mm) braided wire.
4. Wiring from local ground bus to master ground bus should be at least No. 1/0 AWG (53.46 mm²) insulated wire.
5. Wiring to local ground bus should be at least No. 8 AWG (8.35 mm²) insulated wire.
6. Optional rear bus bar (typical)

Legend:
- PSC = Power Supply Common
- PRI = Primary
- SEC = Secondary
- +24V = Normal 24 volts
- 0V = Normal 0 volts
- PS1 = Power Supply 1
- PS2 = Power Supply 2
- Top = System Power Supply Unit
- System Cabinet 1
- System Cabinet 2
- System Cabinet 3
- System Cabinet 4
- System Cabinet 5

Typical DC Power System and Ground Connections for Cabinets with Type CP6103 Power Supply Units
Figure 4-3 Simplex DC Power Distribution with Redundant Type CP6101 and Type CP6102 Power Supplies

Figure 4-4 Dual Simplex DC Power Distribution with a Type CP6103 Power Supply Unit

Note: One power supply housing can handle two power supplies in a simplex or redundant mode of operation. The power supply is mounted in the central cabinet of a three or more cabinet system.
Figure 4-5  Redundant DC Power Distribution with a Type CP6103 Power Supply Unit

Figure 4-6  Fully Redundant DC Power Distribution with Type CP6101 and Type CP6102 Power Supplies

Note: One power supply housing can handle two power supplies in a simplex or redundant mode of operation.
Notes:
1. Local ground and power supply must be located in center cabinet or area of grouping.
2. Wiring from master ground bus to single-point DC ground should be at least No. 4/0 AWG (107.16 mm²) insulated wire.
3. Cabinet ground should be at least 0.5 in. (12.7 mm) braided wire.
4. Optional rear bus bar (typical)
5. Letters indicate wiring from the terminal blocks to the corresponding letters on bus bars: i.e. A to A, B to B, etc.
6. Terminal blocks on the DC Distribution Assembly. The assembly should be installed under the Type CP6103 Power Supply Unit.
7. The bus bar in the cabinet with the power supply must be connected directly to the terminal block on the Type CP6103 Power Supply Unit.

Figure 4-7  Typical DC Power System and Ground Connections for Cabinets with a Type CP6103 Power Supply Unit.
Type CP6103 System Power Supply Unit

DC Distribution Assembly

26 VDC PS1 (PRI)
26 VDC PS2 (Sec)

IN
OUT

Figure 4-8  DC Distribution Assembly and Type CP6103 Power Supply Unit.

Note: the DC Distribution Assembly should be installed under the power supply unit.

Figure 4-9  Terminal Block Details for a Type CP6103 System Power Supply Unit
Notes:
1 Wire must be sized such that the PRI to PSC voltage measured at bus B does not vary more than 1 volt maximum from the PRI to PSC voltage measured at bus A (without the secondary power supply on).
2 For two or more termination cabinets per supply, use a DC Distribution Assembly arrangement in the central cabinet for busing the power.
3 Cabinets grounds are tied together and brought back to the MGB or PIG. In the case were no MGB is used, only an LGB is tied to the PIG.
4 C, D, E, and F power supply to remote termination bus.
5 The connection may be made from a DC Distribution Assembly instead of a power supply unit.

Figure 4-10  Control I/O Remote Termination Power
Notes:

1. Dashed lines indicate connection when using redundant power. When simplex power is used, jumper termination primary +24V and secondary +24V together.

2. Wires from +24V and PSC buses to cardfiles should be insulated and stranded of size 12 AWG (3.3 mm²).

Figure 4-11  Control I/O Power Connections
Notes:
1. Dashed lines indicate connections when using redundant power. When simplex power is used, jumper termination primary +24V and secondary +24V together.
2. Wires from +24V and PSC buses to cardfiles should be insulated and stranded of size 12 AWG (3.3 mm²).

Figure 4-12  Control I/O Power Connections (Continued)
Notes:

1. When redundant terminations are needed, the use of redundant power is recommended.
2. Wires from +24V and PSC buses to cardfiles should be insulated and stranded of size 12 AWG (3.3 mm²).

Figure 4-13 Control I/O Power Connections (Continued)
Notes:
1. Wires from +24V and PSC buses to cardfiles should be insulated and stranded of size 12 AWG (3.3 mm$^2$).

Figure 4-14 Highway Device Power Connections
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5 Cabinet Alarm Wiring

PROVOX® system cabinets can be equipped with alarm circuits to detect loss of output from a power supply unit, loss of battery backup, cabinet over-temperature, and loss of power to an installed PROVOX device. As shown in Figure 5-1, Figure 5-2, and Figure 5-4, the outputs of the device alarm circuits are connected in series to operate an alarm relay.

When you use Types CP6101 and CP6102 System Power Supplies, the alarm relay is included in the Type CP7101 Power Distribution Panel (PDP). When you use Type CP6103 System Power Supply Unit, the alarm relay is included in the unit.

The alarm relay provides a dry contact closure to a user-supplied external alarm annunciator. If a controller card file, a local traffic director, or a network traffic director has two power converter cards installed in a single card file, the two alarm circuit outputs are connected in series to indicate a low voltage or loss of output from either power converter card.

The alarm circuits are flexible for any application. Although the alarm circuits for a single cabinet are typically connected in series to provide a single cabinet alarm, as shown in Figure 5-1, Figure 5-2, and Figure 5-4, each individual circuit or any combination of circuits in a device can be connected to produce individual alarm indications.

5.1 System Using Types CP6101 and CP6102 Power Supply Units

Figure 5-1 shows the alarm connections for a system using a Type CP6101 or Type CP6102 Power Supply Unit, using one or two Type CP7101 Power Distribution Panels (PDP). A fuse pigtail is connected to the PRI 24 Vdc connection at the top of the power bus. This fuse is then connected to the cabinet thermal switch. From the switch, the alarm wiring is routed to any file alarm connections, as shown in Figure 5-4 through Figure 5-3, and to the controller alarm outputs as included in the alarm configuration.

One system alarm can be used, or several, depending on the alarm configuration and the number of PDPs in the system. Alarm wiring can go from cabinet to cabinet in a serial link. As you go from one cabinet to another, you will need to put the thermal switch in the link. The PDP must get 24 V into the alarm input terminals (INTLK) on the PDP. The PSC terminal must be connected to the bus bar. Refer to Figure 5-1 for an illustration of redundant power source alarming.
5.2 System using Type CP6103 Power Supply Units

Figure 5-2 shows the alarm connections for the Type CP6103 System Power Supply Unit. The Type CP6103 Power Supply Unit provides a 26 Vdc power source and protection for the alarm circuit. Connect to the cabinet thermal switch from the power supply, then route through the file and alarm circuits back to the supply.

The power supply unit contains separate alarm connections for each power supply. The alarm and interlock terminal blocks connect to alarm relay contacts and interlocks in the power supplies. The alarm terminal blocks do not require wire terminating lugs.

To cause either power supply relay to function as a combined alarm relay, connect any number of external alarm contacts that are closed during normal equipment operation in series and wire them across the interlock terminal connection of the power supply. If the interlock connections of an installed power supply are not connected to external alarm contacts, jumper the connections to enable the power supply alarm relay to operate properly.

To use only one combined alarm for a cabinet, wire the output alarm contacts for one power supply into the interlock circuit of the other power supply. The alarm chain starts and ends at the power supply alarm interlock (INTLK) connections. Use PS1 and route to the cabinet thermal switch, then to chain, and back to PS1 interlock. This completes the serial alarm chain. If you are not using an alarm chain, jumper the interlock connections. For example, for a redundant system, the PS2 interlock (INTLK) should be jumpered. For two simplex systems which are not using the alarm chain, both interlock circuits would be jumpered.

5.3 Device Alarm Wiring

Figure 5-4 through Figure 5-3 illustrate typical alarm wiring to PROVOX devices installed in a PROVOX system cabinet. All devices being powered from a Type CP6101, CP6102, or CP6103 power supply unit must be referenced to the same LGB or MGB. Devices connected only by a Control I/O bus or PROVOX highway cable do not require the same ground reference since both communication systems provide isolation between the devices.
For simplex operation, use the common terminal and connect to the Alarm 1 terminal. Install the Power/Communications card in Slot 1.

For SR90 controller, connect alarm wiring in series to the alarm contacts for each controller in the file.

For a single alarm output, make the dotted line connection.

Figure 5-1  Types CP6101 and CP6102 Power Supply Alarm Wiring Example
For simplex operation, use the common terminal and connect to the Alarm 1 terminal. Install the Power/Communications card in slot 1.

For an SR90 controller, connect alarm wiring in series to the alarm contacts for each controller in the file.

Figure 5-2  Type CP6103 Power Supply Unit Alarm Wiring Example

Notes:

1 For systems using Types CP6101 and CP6102 System Power Supply Units for see Figure 5-1 for connections. For systems using a Type CP6103 System Power Supply Unit, see Figure 5-2 for connections.

2 Alarm contact 2 path used when secondary power converter card installed. Alarm common path is used instead of alarm contact 2 path for single power converter card.

Figure 5-3  Features of Control I/O Card File Alarm Wiring
Notes:
1. For systems using Types CP6101 and CP6102 System Power Supply Units for see Figure 5-1 for connections. For systems using a Type CP6103 System Power Supply Unit, see Figure 5-2 for connections.
2. When redundant devices are installed, you may wire their alarm contacts in series with the primary units or you may wire them separately as shown in Figure 5-5.

Figure 5-4  Highway Device Alarm Wiring
For systems using Types CP6101 and CP6102 System Power Supply Units for see Figure 5-1 for connections. For systems using a Type CP6103 System Power Supply Unit, see Figure 5-2 for connections.

Figure 5-5  Redundant Highway Device Alarm Wiring
6 System Grounding

The ground network for an instrumentation system is a very critical consideration since this network affects the operation of the entire control system. Thus, the extra time and effort spent in laying out a good ground system will be rewarded by easier startup and more reliable operation.

Poor or faulty grounds are among the most common causes of instrumentation system problems. With the installation of a new instrumentation system, an effective ground network can be installed at the beginning. The expansion of an older system however, may use grounding as it now exists. Depending upon the degree of expansion and the types of ground network deficiencies in the older system, it may be more cost effective to install a new ground network to ensure efficient operation.

6.1 Guidelines for Effective Grounding

Following the guidelines listed below will provide effective grounding for the instrumentation system. Explanations of the guidelines are included in the following subsections.

- Provide a ground network dedicated to the instrumentation system. Do not share a ground network with other plant systems.
- Design the ground network so that it is accessible for testing.
- Isolate console and computer electronics enclosures from metal conduits and building steel. Enclosures should be grounded only by the grounding conductor which is included in their ac power circuits.
- Connect all cabinets within a grouping to the same ground system.
- Provide a single-point ground for all cabinets interconnected by non-isolated signals. Also, provide a single-point ground for all cabinets sharing a backup power supply.
- Provide a low impedance, high integrity, ground path between all instrumentation and the PROVOX® or microPROVOX™ instrumentation plant ground connection.
6.2 Separating AC and DC Grounds

Two separate ground terminations are used for the instrumentation system, as shown in Figure 6-1. One termination is used for the ac ground system and one is used for the dc and cabinet ground system. The systems shown provide a safety return path to earth for faults in the system and provide noise isolation between ac and dc circuits.

6.2.1 AC Ground System

The single-point termination shown in Figure 6-2 and Figure 6-3 provides the ac ground for ac-powered devices in the instrumentation system. The ac ground must conform to all applicable local, state, and federal electrical code requirements for a ground system.

6.2.2 DC Ground System

The single-point termination shown in Figure 6-4 and Figure 6-5, provides the reference for all of the dc power and analog signals of the system cabinet equipment. The dc ground serves as the final termination point for all signal common and power supply common wiring. The power supply common (PSC) is the power return for all 24 volt dc power connections in the system.

6.2.3 Cabinet Ground Considerations

The cabinet ground must remain separate from all other dc ground connections until it is terminated at the single dc and cabinet ground point, as shown in Figure 6-4 and Figure 6-5. The cabinet ground is connected to the same point as the system ac ground at the PROVOX Instrumentation Ground (PIG).

The cabinet ground provides protection to both equipment and personnel from accidental shock hazards. It also provides a direct drain line for any electromagnetic interference (EMI) to which the components of the cabinet may be subjected. This ground must meet all code requirements for a ground system.

The cabinet ground is connected directly to the system cabinet, usually at one of the four mounting studs on the bottom corners of the cabinet. Cabinet grounds are always routed to the center cabinet in a group of cabinets. The console bay unit and console bay assembly do not connect to the cabinet ground. These units are grounded through the ac power wiring.
Wiring from LGB to MGB should be No. 1/0 AWG (53.46mm²) to 4/0 AWG (107.16mm²) insulated wire.

Wiring from MGB to ground grid should be at least No. 4/0 AWG (107.16mm²) insulated wire.

DC grounds from cabinet LGBs should be connected on one side of the MGB and cabinet grounds to the other side.

**Figure 6-1  AC and DC Multiple Cabinet Ground System**
6.3 Ground Wiring

Proper connections, wire sizing, ground impedance, and so forth are extremely important to effective grounding. The following subsections describe these requirements for a PROVOX system.
6.3.1 **Master and Local Ground Buses**

Master ground bus (MGB) assemblies and local ground bus (LGB) assemblies facilitate ground wiring and provide single-point terminations within cabinets or cabinet groupings. The buses can be installed at the factory or can be installed in the field after the instrumentation system is delivered. Both assemblies mount on isolated brackets at either the bottom or top front of the system cabinet. An LGB assembly provides a central termination point for all power supply common (PSC) connections within a cabinet group of eight bays or less. The cabinets can be in either an in-line or back-to-back configuration.

The LGB assembly has one lug in the middle for connection to an MGB assembly. This lug accepts wire sizes of AWG 1/0 to 4/0 (53.46 to 107.16 mm²). For a single grouping of cabinets, a connection can be made directly from the LGB assembly to the instrumentation system dc ground. For more than one cabinet grouping, an MGB assembly should be used to connect the several cabinet groupings together before being connected to the dc ground.

Figure 6-6 shows the details for mounting MGB and LGB assemblies in a system cabinet, and the dimensions of the factory-supplied assemblies. Figure 6-7 shows details for grounding wall frames in OWP consoles.
Figure 6-4  DC/Cabinet Grounding System

Figure 6-5  Multiple Cabinet System Grounding
Notes:
1. Isolate the assembly from the mounting bracket.
2. Ground bus assemblies are mounted in the bottom front of PROVOX® cabinets.

Figure 6-6  Typical System Cabinet Ground Bus Assembly
Wall frame ground should be at least 0.5 in (12.7 mm) braided wire.

**Figure 6-7  Typical OWP Wall Frame Grounding**

Users can fabricate their own master ground bus, but should ensure that the following conditions are met:

- Copper/copper clad steel or hard brass (B16)
- Minimum of 3/8 inch (9.5 mm) thick and 1-3/4 (44.5 mm) inch wide
- Holes for lugs
- Double bolted lugs
- Bus isolated from mounting bracket with standoffs.

Table 6-1 lists the wire sizes which should be used for LGB to MGB, MGB to PIG, and PIG to plant ground wiring.

<table>
<thead>
<tr>
<th>Wire Length</th>
<th>Wire Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 25 feet</td>
<td>1/0</td>
</tr>
<tr>
<td>Up to 50 feet</td>
<td>2/0</td>
</tr>
<tr>
<td>Up to 200 feet</td>
<td>4/0</td>
</tr>
</tbody>
</table>
6.3.2 Single-Point Grounding

In some situations, a single-point ground may not be practical or feasible. For example, cabinets that are connected only by the data highway need not be returned to the same single-point ground.

However, the same single-point ground should be used in the following cases:

- Cabinets are located in the same local area.
- Cabinets are bolted together to form one continuous assembly or unit.
- Cabinets share the same single-ended signal.

This case occurs if one field transmitter is connected to two points in separate cabinets or if an output from a device is used as an input for a device in another cabinet.

- Cabinets are located in separate buildings or in distant separate areas, but the ac power to the cabinets is taken from the same power source without transformer isolation.

6.3.3 Power Supply Common (PSC) Wiring

The power supply common (PSC) should be carried on separate wires from each power supply unit or power distribution panel to their respective cabinet power bus bar. One PSC ground reference is used per power supply unit and is tied from one cabinet power bus bar to the LGB or MGB, as shown in Section 4. The recommended wiring size for these ground points is No. 8 AWG (8.35 mm²) multistrand, with the lengths being as short as possible. PSC wiring should be insulated to avoid unintentional ground loops that can occur if bare wires touch the metal cabinet or each other.

6.3.4 Marking Grounds

Use insulated or jacketed copper wire cable (the use of welding cable is recommended) for the dc ground, ac ground, and cabinet ground connections. To aid in ground identification, identifiable insulation colors (green or green with a yellow stripe) or some labeling method should be used.

All system ground points should be labeled as follows:

FOR INSTRUMENTATION SYSTEM GROUND ONLY. DO NOT USE FOR ELECTRIC ARC WELDER CONNECTION.
6.3.5 Ground Impedance

A high quality instrumentation system ground should provide a ground point that measures one ohm or less to true earth. In some cases, three ohms may be acceptable. In an unfavorable area, it may be necessary to select the best ground impedance available. There are several methods that can be used to obtain a high quality earth ground system, and these methods vary depending upon the soil type and moisture content at the individual location. See section 7 for information about soils and earth grounds.

6.4 File and Shield Grounding

Proper shield and file grounding ensures proper system operation by reducing electromagnetic and radio frequency interference.

6.4.1 For PROVOX Cabinets

PROVOX cabinets supplied by Fisher-Rosemount Systems have welded frames that provide good ground connections between frame members. The EIA rails installed in the cabinets provide proper ground paths for files installed in the cabinets.

To provide a positive ground path for field wiring shields, connect shield wires to the cabinet frame or EIA rails. For large amounts of field wiring, it is suggested that a cable tie panel be installed in the horizontal cable trays. Then, connect the tie panel to the drilled and tapped holes in the EIA rails or cabinet frame, using a short 0.5 inch (13 mm) wide copper braid strap. Use external tooth lockwashers to ensure good metal-to-metal contact. Field wiring and cable shields are described in detail in the installation planning manual, *Wiring and Data Highway Guidelines*, PN1:004.

6.4.2 For OEM Cabinets

For OEM cabinets, drill and tap the frame members and mounting rails to ensure good metal-to-metal contact. Use 0.5 inch (13 mm) wide copper braid to interconnect frame members and mounting rails. Make a 24 inch (610 mm) ground strap for each file, using 12 AWG (3.31 mm²) stranded copper wire. Attach a number 6 ring terminal to one end and a number 10 ring terminal to the other end of each strap. Connect the number 6 terminal to the back of the file using one of the number 6 screws, securing the back plate to the file assembly. Connect the other end of the strap to the mounting rail with a number 10 screw.
For grounding shields in other enclosures, drill and tap the rail and connect 0.5 inch (13 mm) wide copper braid between the mounting rail and each cable tie panel. Make sure that the mounting rails are strapped to the local ground bus with 0.5 inch (13 mm) copper braid. Use external tooth lockwashers to ensure good metal-to-metal contact. See Figure 6-8 for an illustration of shield grounding.

6.4.3 For Remote Termination Panels

If Control I/O termination panels are remotely mounted on a wall or similar mounting, the panels must be grounded to the PROVOX Instrumentation Ground (PIG).

6.5 Intrinsic Safety Barrier Grounding

In some applications where hazardous gases are present, special handling or special wiring practices must be used. Conformity with local codes and regulations is essential. Several documents present the requirements for hazardous area instrumentation use or code guidelines; contact local authorities for copies of the applicable documents.
Figure 6-9  Typical Ground Connections for Passive Intrinsic Safety Barriers
Notes:

1. Isolation transformer or UPS connected to main power. Disconnect from circuit breaker panel if not required.

2. Main power panel connections to circuit breaker panel; one phase shown for clarity.

3. Master ground bus (MGB), if required. If not, connect local ground bus (LGB) directly to instrumentation system DC ground.

4. Fuse protects input/output circuits. Size large enough to accommodate power consumption of barriers and load.

Figure 6-10 Typical Ground Connections for Active, Galvanic Isolated, Intrinsic Safety Barriers
The ground for passive intrinsic safety barriers should be connected to the same point as the system ground, as shown in Figure 6-9. Ground connections for active, galvanic isolated, intrinsic safety barriers are shown in Figure 6-10. For additional information on intrinsic safety barriers supplied by Fisher-Rosemount Systems, refer to installation manual, *Installing CL6340 and CL6350-Series Intrinsic Safety Products*, PN2.1:CL6340.

### 6.6 Consoles and Computers

Consoles and computers are grounded only to the instrumentation system ac ground, as shown in Figure 3-8, Figure 3-9, Figure 3-12 and Figure 3-13. The conduit carrying the circuit conductors is electrically isolated from the console or computer cabinets. The ac ground to the consoles or computers should be the same size or a size larger than the current-carrying conductors. For example, the line and neutral wires should be No. 12 AWG (3.30 mm²) stranded wire, and the ac ground should be No. 10 AWG (5.27 mm²) stranded wire. To minimize the effect of noise, use wire made of a large number of small conductors for the ac ground. For example, use No. 8 AWG (8.35 mm²) wire composed of 168 strands of No. 30 AWG (0.05 mm²).

### 6.7 Peripheral Devices

Peripheral devices and systems for the PROVOX and microPROVOX instrumentation systems can include such equipment as a high-speed printer, a mass software storage device such as a disk unit, a secondary computer, or even a PROVOX or microPROVOX console. Although physically separated, a common grounding system should exist.

For any area of the instrumentation system where more than one grouping of equipment exists, the common grounding system must be designed so that it does not create excessive current paths. Regardless of the ground types used, the interconnecting wiring must be large enough to safely and adequately handle the currents involved. When other vendor equipment or other types of Fisher-Rosemount Systems equipment are used with PROVOX or microPROVOX I/O or data links, the other equipment should be powered from the same ac power distribution system as the one that powers the PROVOX or microPROVOX instrumentation system. Finally, all of the ground systems need to be tied together.
7 Earth Grounding

Proper earth grounding is extremely important to user safety and efficient operation of an instrumentation system. A good earth ground safely conducts electrical currents, caused by faults, to ground, and a good earth ground can considerably reduce electrical noise. Such noise can cause erroneous control signals in the system. The information in this section provides guidelines for constructing a good earth ground. In all cases, construction of and connection to earth grounds must be in accordance with local, state, and federal codes.

7.1 Designing an Earth Ground

For digital switching circuits, several process instrument industry sources recommend a ground system that ideally has a resistance of one ohm or less between the instrumentation ground system and true earth—with a maximum resistance of no more than three ohms. A resistance of one ohm or less minimizes the phantom errors caused by voltage drops in the ground system.

The ground system for the instrumentation system must be at least as good as any ground associated with any other system. If a ground used with a radio communication system has a one-ohm resistance to true earth, then the ground system used with the instrumentation system must also have one ohm or less resistance to true earth. Both ground systems should be referenced to the plant grid.

For a plant grid, multiple ground rods provide the most effective ground system because:

- The individual rod-to-earth contact resistances are effectively placed in parallel. Adding rods to the system reduces the ground-system-to-earth resistance.
- An element of safety is provided over the single rod system. All ground contact does not depend upon a single rod.

The distance between rods in a multiple rod system must be greater than the immersion depths of the rods. For more information on installing and testing of ground systems, refer to the publication, *Getting Down to Earth* from Biddle Instruments. See subsection 1.7, Reference Documents, for more information.

Figure 7-1 shows an example of a plant grid system. If an existing plant grid is accessible, and if the ground-grid-to-true-earth resistance meets...
the requirements, the existing grid can be used for the instrumentation system ground.

A dedicated point close to the instrumentation system (preferably a ground rod location) is used for the system ground point. The ground rod is connected to one of the plant ground grid rods with 4/0 AWG copper wire. The ends of the wires are thermally welded to the rods. If either the existing grid is not accessible or the resistance is not within specifications, a new grid is required.

Figure 7-2 through Figure 7-7 illustrate various examples of grounding that may be used.

Figure 7-1  Example of Plant Ground Grid System

Notes:
- Ground Rod
- All connecting lines should be at least No. 4/0 AWG (107 16 mm³) copper wire thermal welded to the rods
- Ground connection can be a single rod or one of the configurations shown in the following figures.
Figure 7-2  Grounding Example (UFR Ground System)
Figure 7-3  Grounding Example
Existing Counterpoise System

AC PWR GND

DC/Cabinet Ground from Master Ground Bus

PROVOX® Instrumentation Ground (PIG)

Existing Cable

Existing Buried Copper Cable

New Rod

Dedicated Ground Point for Instrumentation

Figure 7-4  Grounding Example

Existing Ground Grid System

AC PWR GND

DC/Cabinet Ground from Master Ground Bus

PROVOX® Instrumentation Ground (PIG)

Existing Cable

Dedicated Ground Point for Instrumentation

Existing Ground Grid

Figure 7-5  Grounding Example
Figure 7-6  Grounding Example

Figure 7-7  Grounding Example
7.2 Testing an Earth Ground

An earth ground tester, illustrated in Figure 7-8, is used for testing the ground system. The tester measures the resistance between the ground system and the earth. The tester consists of a voltage source, an ammeter, and switches to select the resistance ranges.

![Diagram of Earth Ground Tester](image)

Notes:
1. Disconnect ground cable from system while test is being made.
2. Auxiliary electrodes must be placed in a straight line from the earth ground under test.

Figure 7-8 Typical Test Setup and Connection for Testing an Earth Ground System

The preferred test method is to gather sufficient data to plot the actual curve of resistance versus distance. If plotting is impossible, a simplified Fall-of-Potential Test may be used with a compromise on accuracy. Refer to the publication, *Getting Down to Earth* from Biddle Instruments. See subsection 1.7, Reference Documents, for more information. This book also contains information about using a two-point method of testing for verification.

As a preventive maintenance item, each connection on the grounding system, from the PSC connections through the LGB, MGB, PIG and earth ground connections, needs to be checked annually. This check will ensure that connections are tight, that ground wires are in good condition, and that no contamination exists which can otherwise compromise ground integrity. During the check, the power system connections from power supply units to cabinet bus bars should also be checked.
In areas where damage from electrical storms may occur, a lightning protection system should be installed to protect both equipment and personnel. This protection should include protection for the building, the power distribution system, the PROVOX® highway system, and any cables that run outdoors to other locations. Refer to installation planning manual, *Lightning Protection Guidelines for Instrumentation Systems*, PN4:007, for detailed information.

The following documents also contain information and guidelines for installing lightning protection.

- National Fire Protection Association Inc. (NFPA) Lightning Protection Code NFPA-78
- IEEE Recommended Practices for Grounding of Industrial and Commercial Power Systems IEEE Std. 142
Glossary

A/D
Acronym: Analog-to-Digital, or Analog to Digital Converter

AC or ac
Acronym: alternating current

ACIA
Acronym: Asynchronous Communications Interface Adapter

ADC
Acronym: Analog to Digital Converter

AI
Acronym: Analog Input

AIO
Acronym: Analog Input/Output

ALM
Abbreviation: Alarm

alternating current (AC or ac)
A flow of electricity which cycles to maximum in one direction, decreases to zero, then reverses itself and reaches maximum in the opposite direction, then increases again to zero.

American Wire Gauge (AWG)
The usual system of wire size measurement in the United States. A 14 AWG wire has a cross-sectional area of 2.08 mm; a 000 AWG wire has a cross-sectional area of 85.02 mm. Note that the smaller the AWG value, the larger the wire.

analog
Continuously variable over a given range. A process control system senses a physical variable such as voltage, current, or resistance as an analog value.

analog to digital converter (A/D or ADC)
An integrated circuit device that converts analog signals into a digital form. This enables a digital computer to operate on such signals.

assembly (ASSY)
In PROVOX® systems, a collection of hardware and/or PWB modules, or a single PWB module that is built up from individual components.

ASSY
Abbreviation: Assembly

attenuation
The reduction of signal strength as it travels on a cable.

AWG
Acronym: American Wire Gauge

Baby N Connector
Obsolete variation of BNC.
Bayonet Neil-Councelman Connector
Obsolete variation of BNC.

backplane
A printed circuit board at the rear of the DC6460-Series Console Electronics Unit which, by means of its attached connectors, mates with the modular cards and assemblies installed in the card file.

BNC
An industry-standard term and acronym for a type of connector for coaxial cable that is frequently used for a variety of applications in PROVOX® systems.

bridge
1. A highway communications device used to configure a network of devices by linking together highways that require extensive intercommunications.

2. A device used to interconnect local PROVOX Highway IIs and to separate the traffic on them from the traffic on the network PROVOX Highway II.

Bridge Highway II
A highway that is used to interconnect bridges where there is a high volume of intercommunication.

bus
A general term for a group of signal lines to be considered together, as in a data bus or address bus. The data highway of a PROVOX® system is such a bus.

cable tap
A device for connecting the highway device to the highway cable. (Commonly referred to as a tap.)

carrier band
A type of base-band network used in a process control environment.

CCITT
Acronym: Comite Consultatif International pour Telephonie et Telegraphie, or International Consultative Committee for Telephony and Telegraphy. [See International Consultative Committee for Telephony and Telegraphy]

CHIP
Acronym: Computer/Highway Interface Package

CIA
Acronym: Communications Interface Assembly

CIU
Acronym: Computer Interface Unit

CMOS
Acronym: Complimentary Metal Oxide Semiconductor

Communications Interface Assembly (CIA)
A printed circuit card that links files of PROVOX® devices and the data highway. The CIA provides the timing and data conversion necessary for communications.

complimentary metal oxide semiconductor (CMOS)
A family of digital integrated circuits that use transistors operating in a push-pull mode to carry out logic functions. A CMOS usually is capable of low-powered operation.
Computer/Highway Interface Package (CHIP)
A PROVOX® software product that allows user-written programs to interact with the PROVOX system. There are different CHIP versions, so that any of several types of computers can be the host computer.

console
Generic term for the terminal or device an operator uses to monitor and control a process.

classroom instrumentation (CRI)
Process control equipment designed for installation and operation in a control room environment.

controller
A PROVOX® Integrated Function Controller (IFC) or Unit Operations Controller (UOC) or multiplexer controller (MUX).

current to pneumatic transducer (I/P)
An electro-mechanical device that converts a DC signal (typically 4- to 20-milliamps) to a proportional pneumatic output signal.

cyclic redundancy check (CRC)
A method of error detection in data transmission and data storage. The check evaluates both the number of ones and zeroes in a block (parity) and the position of the values in the block.

D/A
Acronym: Digital to Analog, or Digital to Analog Converter

DAC
Acronym: Digital to Analog Converter

data highway
A data communications network for a limited area that functions as a logical token bus. In a PROVOX Highway II communications system, there are three types of highways: Network Highway II, Bridge Highway II, and Local Highway II.

dB
Acronym: Decibel

dBmV
Acronym: Decibel millivolt

dc
Acronym: direct current

DC
Acronym: direct current

decibel
The relative difference between two signal levels expressed logarithmically.

decibel millivolt
A measure of signal strength that is calculated by using the following formula:
\[ dBmV = 20 \log (\text{signal voltage} \div 1 \text{ millivolt}) \]

device
A piece of electronic hardware that performs one or more prescribed functions.

DI
Acronym: Discrete Input

digital to analog converter (DAC or D/A)
An electronic circuit (usually an IC) that converts a digital signal (digital data) into an analog signal of corresponding value.

digital volt meter (DVM)
A test instrument that measures voltage, current, or resistance, and gives numerical readings.
DIO
Acronym: Discrete Input/Output

discrete
Having either of two states, for example, on or off, or 1 or 0.

discrete input/output (DIO)
The reception and transmission of discrete signals. In PROVOX® systems, DIO usually refers to a discrete input/output card in a controller.

DO
Acronym: Discrete Output

drop cable
The cable that connects a highway device and the cable tap.

DVM
Acronym: Digital Volt Meter

EIA
Acronym: Electronic Industries Association

Electronic Industries Association (EIA)
A group of electronic manufacturers that creates industry standards for communication between electronic devices. Among these standards are RS-232 and RS-449.

electromagnetic interference (EMI)
The general category of electrical noise induced by radio frequency and magnetic, electrostatic, or capacitive coupling.

electrostatic damage (ESD)
Deterioration of integrated circuits due to high levels of static electricity. Symptoms of ESD include degradation of performance, device malfunction, and complete failure.

EMI
Acronym: Electromagnetic Interference

EMX
Acronym: Expanded MUX Controller

full duplex communication
Simultaneous transmission in both directions over a communications channel.

ground
1. A voltage reference point in a system that has a zero voltage potential.
2. A conducting connection between an electrical circuit or equipment and either the earth or some conducting body that serves in place of the earth.

highway
See data highway.

IDI
Acronym: Intelligent Device Interface

IEC
Acronym: International Electrotechnical Commission

IEEE
Acronym: Institute of Electrical and Electronics Engineers

IFC
Acronym: Integrated Function Controller

Input/Output (IO or I/O)
Signal reception and transmission, or signal interfacing. Input, for a process control device, involves accepting and processing signals from field devices. Output, for a process control device, involves converting commands into electrical signals to field devices.
Institute of Electrical and Electronic Engineers (IEEE)
An independent technical organization that defines standards for the electrical, electronic, and computer industries.

interface
An electronic circuit that governs the connection between two devices and helps them exchange data reliably.

International Consultative Committee for Telephony and Telegraphy (CCITT)
A technical organization that develops compatibility and other recommendations for telecommunication, including data communication. (The acronym comes from the organization’s French name.)

International Electrotechnical Commission (IEC)
An international group developing standards and certification in electronics and electrical engineering.

IO or I/O
Acronym: Input/Output

I/O channels
Input/output channels: communications paths from a device to a communications link or other device.

jumper
An electrical connector used to select a particular signal path and bypass alternates on a printed circuit board. The jumper contains a connecting wire, usually within a small plastic rectangle with two receptacles that can be pushed down on a pair of pins sticking up from the board’s surface.

light-emitting diode (LED)
An electronic component that generates a small focused beam of light, in response to a current passing through. LEDs are available in several colors, depending on the type of crystal they contain.

local device (LD)
Any PROVOX® device that resides on a local highway and can communicate directly with a local traffic director.

local ground point (LGP)
A central termination point for all signal common and power supply common circuits within a cabinet group of eight or fewer bays.

Local Highway II
A highway that is used to connect as many as 30 PROVOX devices together into a logical token bus.

local traffic director (LTD)
A communications device that controls the data flow on a local data highway. As many as 30 devices can be on the highway. An LTD also stores and forwards messages to other local areas.

logical ring
See logical token ring.

logical token
A frame that is passed between highway devices giving permission to communicate on the highway.

logical token bus
A communications protocol in which one device on a highway transmits a frame (logical token) while all other devices on the highway receive the token sequentially, but only keep it if it is addressed to them.
**logical token ring**

1. A group of highway devices that pass a token to each other.

2. A communications protocol in which all devices on a highway can transmit and receive frames (logical tokens) simultaneously in a predecessor-successor arrangement.

**LTD**

Acronym: Local Traffic Director

**master ground point (MGP)**

A common termination point for as many as six local ground point (LGP) assemblies.

**MGP**

Acronym: Master Ground Point

**microPROVOX™**


**modem**

Modulator/demodulator: a device that allows a computer to transmit and receive data via a telephone or other communications network.

**MUX**

Abbreviation: Multiplexer

**network device (ND)**

A PROVOX® device that communicates directly with a network traffic director. An network device can be any device, but usually is one that collects information from several local highways. Local traffic directors, consoles, multiplexers, programmable controller interface units (PCIUs), data concentrator units (DCUs), unit operations controllers (UOCs), and trend units are common network devices.

**Network Highway II**

A highway that is used to connect Local Highway IIs and Bridge Highway IIs.

**network traffic director (NTD)**

A PROVOX® device that controls the data flow for the network data highway. The NTD links network devices and local data highways via the local traffic directors.

**NIU**

Acronym: Network Interface Unit

**noise**

Unwanted and typically random signal components that obscure the genuine signal information being sought.

**normally closed (NC)**

Said of a contact pair closed (conducting) when its device or relay coil is not energized. Such a contact pair also is called a break contact.

**normally open (NO)**

Said of a contact pair open (not conducting) when its device or relay coil is not energized.

**NTD**

Acronym: Network Traffic Director

**operational amplifier (OP AMP)**

A high-gain, linear, DC amplifier, typically an integrated circuit, used in a wide variety of applications.

**optical isolation**

The technique of electrically isolating two circuits by converting an electrical signal to an optical signal and back again. Optical isolators commonly consist of an LED and a phototransistor mounted in a DIP.
original equipment manufacturer (OEM)
The firm that makes a product sold by another firm. For example, Hewlett Packard is the OEM for some products sold by Fisher-Rosemount Systems.

PCI
Acronym: Pulse Count Input

PCIU
Acronym: Programmable Controller Interface Unit

plant area
The collection of equipment in a plant that has common manufacturing strategies and alarm strategies.

plant management area (PMA)
A collection of plant process areas (PPAs). A PMA controls the console point reporting load, and indirectly, central processing unit (CPU) loading.

plant process area (PPA)
Within a process-control system, a collection of equipment that uses a common alarm strategy.

PMA
Acronym: Plant Management Area

power supply common (PSC)
The negative terminal of the 24-volt system power supply: a reference for digital signals.

power supply unit (PSU)
In a PROVOX® system, a device or component that converts standard alternating current to the direct current voltage that other system devices need.

printed circuit (PC)
A conduction path of metal on a substrate material which is used to carry signals between electronic components.

printed wiring board (PWB)
A board containing printed circuits (printed wiring) which serves as the mounting base for integrated circuits and other electronic components.

Programmable Controller (PC)
A control machine, built of computer subsystems, that takes the place of electro-mechanical relay panels. Programmable controllers make use of solid-state digital logic.

programmable controller interface unit (PCIU)
A PROVOX® highway device that permits programmable controllers to receive and respond to commands from other PROVOX devices such as consoles, trend units, and UOCs, via the data highway.

programmable logic controller (PLC)
A microprocessor or mini-computer system able to perform simple analog and discrete control. PLCs were developed as replacements for relay control panels, and are typically used for motor control. The acronym PLC is trademarked by Allen-Bradley Company, Inc.

PROVOX®

PSC
Acronym: Power Supply Common

PWB
Acronym: Printed Wiring Board
PWR
Abbreviation: Power

Radio, Electronic, and Television Manufacturers’ Association (RETMA)
Formerly, a group of electronic manufacturers who developed a standard for rack mounting of electronic equipment. Replaced by EIA.

radio frequency interference (RFI)
Inadvertently transmitted energy that falls in the frequency band of radio signals. If this energy is sufficiently strong, it can influence the operation of electronic equipment.

recipe management
A structured method used to develop, store, retrieve, and maintain batch control recipes.

recipe procedure
[See procedure.]

resistance temperature detector (RTD)
A device or element that measures process temperature very accurately. RTDs sense temperature changes by measuring the resistance of a coiled metal wire, typically platinum.

RETMA
Acronym: Radio, Electronic, and Television Manufacturers’ Association

return loss
The relative difference between the level of a signal on a cable and the signal reflected back from an impedance mismatch.

RFI
Acronym: Radio Frequency Interference

RS-232C
An EIA standard for transmitting data serially through a cable 50 feet or less in length.

RTD
Acronym: Resistance Temperature Detector

rule inference
In fuzzy logic control, the process of evaluating if-then rules based on fuzzy variables to determine the logical sum of the individual rules.

rule table
In fuzzy logic control, a matrix of output membership function labels (control actions) based on input membership function labels (conditions).

RWM
Acronym: Read/Write Memory

serial
Sequential: said of data transmitted one bit after another.

serial batch structure
A number of sequential processes. The simplest batch structure.

serial interface
A data transmission device through which bits are sent sequentially.

serial interface unit
A device that lets a computer communicate with other devices of a PROVOX® instrumentation system, via the data highway.

SGP
Acronym: Shield Ground Point

shield ground point (SGP)
A copper bus bar that fits in horizontal cable trays in a system cabinet. This bar is a convenient place to ground signal cable shields.
signal common (SC)
A ground point that provides a reference for analog input and analog output signals in a PROVOX® system. System installers should reference all other DC wiring to power supply common (PSC).

synchronous data link communication (SDLC)
A protocol for communications between synchronized devices. The protocol features bit-level message frames with error checking.

TCP/IP
Acronym: transmission control protocol/internet protocol
A two-part communications protocol (transmission control protocol and internet protocol) that provides reliable and guaranteed transfer of data between two computer programs or networks.

terminal
A point of connection for two or more conductors in an electrical circuit.

token
See logical token.

token bus
A logically independent network of devices that are physically linked together through a specially shielded coaxial trunk cable using cable taps, drop cables, and communication interfaces.

Transceiver Cable
Ethernet/IEEE 802.3 transceiver cable provides the link between your system or server and the Ethernet Transceiver or DELNI.

uninterruptible power supply (UPS)
A backup device for the AC power source. A UPS connects between the AC power source and computer equipment. Should there be a failure of or interruption in the AC power source, the UPS supplies continuous power to the computer.

Unit Operations Controller+ (UOC+)
A unit operations controller (UOC) with advanced control capability, including function sequence table (FST) and logic control point (LCP) functionality, an expanded database, and faster processing.

Universal Asynchronous Receiver/Transmitter (UART)
A device that connects a word-parallel controller or data terminal to a bit-serial communications network.

UOC
Acronym: Unit Operations Controller
VME Communications Interface Assembly (VCIA)
An interface card and adapter assembly that connects the DC6460-Series Console Electronics Unit (VME-bus) to the PROVOX data highway. The VCIA card provides the timing and data conversion necessary for communications. The VCIA adapter assembly mounted on the backplane connects two internal coaxial cables to two BNC connectors on the data highway connection panel.

VME Redundant Communications Interface Assembly II (VRCIA II)
An interface adapter assembly that connects the DC6460-Series Console Electronics Unit (VME-bus) to the PROVOX Highway II token passing bus. The VRCIA II adapter provides the timing and data conversion necessary for communications. The VRCIA II has coaxial connectors for the primary and secondary highway cables. Right-angle adapters are required for the coaxial connectors.

current output (VO)
A terminal, available on a PROVOX controller or multiplexer, that produces a 1- to 5-volt analog output signal.

VRCIA II
Acronym: VME Redundant Communications Interface Assembly

X.25
A CCITT protocol for connecting data terminal equipment to public packet switched networks.
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