T13 - Installation Considerations for Drives
Field Installations
Do These Look Familiar to You?

High power, signal wire, unshielded Ethernet cable and 24V DC were mixed together throughout this panel.

Option module with and without corrosion.

Magnetic dust found inside drive enclosure.

Spacing above drive half as much as recommended.

35% of escalated issues are preventable installation or environment related!
Why Are We Talking about This?

A little work upfront saves a lot of work on the back end…

- Guidelines/rules/recommendations documented throughout our manuals
- Not unique to Rockwell Automation® drives
- Technology changes have allowed greater power density
- Compliance requirements (RoHS) have changed electronics
- Proper installation and drive environment can help prevent issues
Poor Installation Practices
What Type of Problems Can Occur?

- Unintentional machine stopping
- Errors and accuracy issues in products produced
  - Registration errors in printing, poor quality print job
  - Dimension errors in machining, poor quality products
  - Inconsistent batches or mixes
  - Inconsistent control of process systems
- Network communication errors and slow downs
- Unable to listen to telephone, radio, residential or commercial
- Damage to electronic equipment
- Others…
Poor Installation Practices

Overall Impacts

- Overall a loss in functionality of a system which could mean…
  - Loss in production
  - Loss of revenue
  - Poor quality of manufactured goods
  - Time delays in commissioning
  - Increased costs
Installation and environmental recommendations are stated in user manuals
- Available for purchase at time of order
- Available on the web via Literature Library

Wiring and grounding recommendations are stated in our guidelines
- **DRIVES-IN001** – Wiring and Grounding Guidelines for PWM AC Drives
- **DRIVES-AT003** – Industry Installation Guidelines for PWM AC drives
  - Applies to all drives (Allen-Bradley® & competitors)
Installation/Environment recommendations are stated in manuals

- **750-IN001** – PowerFlex® 750-Series Drives Installation Instructions
- **520-UM001** – PowerFlex® 520-Series Drives User Manual
Installation/Environment recommendations are stated in manuals

- **DRIVES-IN001** – Wiring and Grounding Guidelines for PWM AC Drives
- **DRIVES-AT003** – Industry Installation Guidelines for PWM AC Drives
Drive Installation

1. Drive Input
   - Power Distribution
     - Source Impedance
     - Grounding Scheme

2. Drive Panel
   - Environmental
     - Minimum Clearances/Environmental Specifications
     - Atmosphere
   - Drive Configuration
     - Power Jumper Configuration
     - Ground Practices

3. Drive Output
   - Cabling Type (Length, Properties, Routing)
Drive Input

- Power Distribution - Chapter 2 of Drives-IN001
  - Source Impedance
    - Symptoms: Input Failures, Overvoltage/Undervoltage Faults
    - Max Supply KVA
    - Line Reactor – helps with line sags and spikes

Table 9 - AC Line Impedance Recommendations for PowerFlex 525 Drives

<table>
<thead>
<tr>
<th>Drive</th>
<th>Drive Catalog Number</th>
<th>Volts</th>
<th>kW (hp)</th>
<th>Max Supply KVA (1)</th>
<th>3% Line Reactor Open Style 132V</th>
<th>Reactor Inductance (mH)</th>
<th>Reactor Current Rating (amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PowerFlex 525</td>
<td>200</td>
<td>0.4 (0.5)</td>
<td>25</td>
<td>3R1-3</td>
<td>0.5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>0.75 (1.0)</td>
<td>50</td>
<td>3R1-3</td>
<td>4</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>1.5 (2.0)</td>
<td>50</td>
<td>3R1-3</td>
<td>1.5</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>2.2 (3.0)</td>
<td>50</td>
<td>3R1-3</td>
<td>1.25</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>3.7 (5.0)</td>
<td>50</td>
<td>3R1-3</td>
<td>0.8</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>5.5 (7.5)</td>
<td>100</td>
<td>3R1-3</td>
<td>0.5</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

Table 12 - AC Line Impedance Recommendations for PowerFlex 753/755 Drives (Continued)

<table>
<thead>
<tr>
<th>Drive</th>
<th>Drive Catalog Number</th>
<th>Volts</th>
<th>kW (hp)</th>
<th>Max Supply KVA (1)</th>
<th>3% Line Reactor Open Style 132V</th>
<th>Reactor Inductance (mH)</th>
<th>Reactor Current Rating (amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PowerFlex 753/755</td>
<td>300</td>
<td>2.2 (3.0)</td>
<td>500</td>
<td>3R1-3</td>
<td>6.5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>For PowerFlex 753, replace 206 with 204</td>
<td>400</td>
<td>4.0 (5.0)</td>
<td>500</td>
<td>3R1-3</td>
<td>3</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>400</td>
<td>5.5 (7.5)</td>
<td>750</td>
<td>3R1-3</td>
<td>2.5</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>400</td>
<td>7.5 (10)</td>
<td>750</td>
<td>3R1-3</td>
<td>1.5</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>400</td>
<td>11 (15)</td>
<td>750</td>
<td>3R1-3</td>
<td>1.2</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>400</td>
<td>15 (20)</td>
<td>750</td>
<td>3R1-3</td>
<td>0.8</td>
<td>35</td>
<td></td>
</tr>
</tbody>
</table>
### Table 9 - AC Line Impedance Recommendations for PowerFlex 525 Drives

<table>
<thead>
<tr>
<th>Drive</th>
<th>Drive Catalog Number</th>
<th>Volts</th>
<th>kW (Hp)</th>
<th>Max Supply kW (1)</th>
<th>% Line Reactor Open Style 1321-1</th>
<th>Reactor Inductance (mH)</th>
<th>Reactor Current Rating (amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powerflex 525</td>
<td>25BB2P5</td>
<td>240</td>
<td>0.4 (0.5)</td>
<td>25</td>
<td>3-B</td>
<td>6.5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>25BB5P0</td>
<td>240</td>
<td>0.75 (1.0)</td>
<td>50</td>
<td>3-B</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>25BB8P0</td>
<td>240</td>
<td>1.5 (2.0)</td>
<td>50</td>
<td>3-B</td>
<td>1.5</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>25BB012</td>
<td>240</td>
<td>2.2 (3.0)</td>
<td>50</td>
<td>12-A</td>
<td>1.25</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>25BB017</td>
<td>240</td>
<td>3.7 (5.0)</td>
<td>50</td>
<td>18-A</td>
<td>0.8</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>25BB024</td>
<td>240</td>
<td>5.5 (7.5)</td>
<td>100</td>
<td>25-A</td>
<td>0.5</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>25BB032</td>
<td>240</td>
<td>7.5 (10.0)</td>
<td>150</td>
<td>35-A</td>
<td>0.4</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>25BB048</td>
<td>240</td>
<td>11.0 (15.0)</td>
<td>150</td>
<td>55-A</td>
<td>0.5</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>25BB062</td>
<td>240</td>
<td>7.5 (10.0)</td>
<td>150</td>
<td>80-B</td>
<td>0.4</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>25D01P4</td>
<td>480</td>
<td>0.4 (0.5)</td>
<td>15</td>
<td>3-B</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>25D02P3</td>
<td>480</td>
<td>0.75 (1.0)</td>
<td>30</td>
<td>3-C</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>25D04P0</td>
<td>480</td>
<td>1.5 (2.0)</td>
<td>50</td>
<td>3-B</td>
<td>6.5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>25D06P0</td>
<td>480</td>
<td>2.2 (3.0)</td>
<td>75</td>
<td>3-B</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>25D0010</td>
<td>480</td>
<td>3.7 (5.0)</td>
<td>100</td>
<td>3-B</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>25D0013</td>
<td>480</td>
<td>5.5 (7.5)</td>
<td>120</td>
<td>13-B</td>
<td>2.5</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>25D0017</td>
<td>480</td>
<td>7.5 (10.0)</td>
<td>150</td>
<td>18-B</td>
<td>1.5</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>25D0024</td>
<td>480</td>
<td>11.0 (15.0)</td>
<td>200</td>
<td>25-B</td>
<td>1.2</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>25D0030</td>
<td>480</td>
<td>15.0 (20.0)</td>
<td>200</td>
<td>35-B</td>
<td>0.8</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>25D0037</td>
<td>480</td>
<td>18.5 (25.0)</td>
<td>500</td>
<td>45-B</td>
<td>0.7</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>25D0043</td>
<td>480</td>
<td>22.2 (30.0)</td>
<td>500</td>
<td>45-B</td>
<td>0.7</td>
<td>45</td>
</tr>
</tbody>
</table>

### Table 12 - AC Line Impedance Recommendations for PowerFlex 753/755 Drives (Continued)

<table>
<thead>
<tr>
<th>Drive</th>
<th>Drive Catalog Number</th>
<th>Volts</th>
<th>kW (Hp)</th>
<th>Max Supply kW (1)</th>
<th>% Line Reactor Open Style 1321-1</th>
<th>Reactor Inductance (mH)</th>
<th>Reactor Current Rating (amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powerflex 753/755</td>
<td>20G_05P0</td>
<td>480</td>
<td>2.2 (3)</td>
<td>500</td>
<td>3-B</td>
<td>6.5</td>
<td>4</td>
</tr>
<tr>
<td>For Powerflex 753, replace 20G with 20F</td>
<td>20G_05P0</td>
<td>480</td>
<td>2.2 (3)</td>
<td>500</td>
<td>3-B</td>
<td>6.5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>20G_0011</td>
<td>480</td>
<td>5.5 (7.5)</td>
<td>750</td>
<td>3-B</td>
<td>2.5</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>20G_0014</td>
<td>480</td>
<td>7.5 (10)</td>
<td>750</td>
<td>3-B</td>
<td>1.5</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>20G_0022</td>
<td>480</td>
<td>11 (15)</td>
<td>750</td>
<td>3-B</td>
<td>1.2</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>20G_0027</td>
<td>480</td>
<td>15 (20)</td>
<td>750</td>
<td>3-B</td>
<td>0.8</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>20G_0034</td>
<td>480</td>
<td>18.5 (25)</td>
<td>100</td>
<td>3-B</td>
<td>0.8</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>20G_0040</td>
<td>480</td>
<td>22 (30)</td>
<td>100</td>
<td>3-B</td>
<td>0.8</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>20G_0052</td>
<td>480</td>
<td>30 (40)</td>
<td>100</td>
<td>3-B</td>
<td>0.8</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>20G_0065</td>
<td>480</td>
<td>37 (50)</td>
<td>100</td>
<td>3-B</td>
<td>0.8</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>20G_0077</td>
<td>480</td>
<td>45 (60)</td>
<td>100</td>
<td>3-B</td>
<td>0.8</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>20G_0096</td>
<td>480</td>
<td>55 (75)</td>
<td>100</td>
<td>3-B</td>
<td>0.8</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>20G_125</td>
<td>480</td>
<td>75 (100)</td>
<td>1000</td>
<td>3-B</td>
<td>0.3</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>20G_0140</td>
<td>480</td>
<td>75 (100)</td>
<td>1000</td>
<td>3-B</td>
<td>0.2</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>20G_0156</td>
<td>480</td>
<td>90 (125)</td>
<td>1500</td>
<td>3-B</td>
<td>0.15</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td>20G_0186</td>
<td>480</td>
<td>110 (150)</td>
<td>1500</td>
<td>3-B</td>
<td>0.15</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td>20G_0248</td>
<td>480</td>
<td>150 (200)</td>
<td>2000</td>
<td>3-B</td>
<td>0.11</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>20G_0362</td>
<td>480</td>
<td>187 (250)</td>
<td>2500</td>
<td>3-B</td>
<td>0.075</td>
<td>320</td>
</tr>
<tr>
<td></td>
<td>20G_0458</td>
<td>480</td>
<td>224 (300)</td>
<td>2500</td>
<td>3-B</td>
<td>0.06</td>
<td>320</td>
</tr>
<tr>
<td></td>
<td>20G_0490</td>
<td>480</td>
<td>260 (350)</td>
<td>3000</td>
<td>3-B</td>
<td>0.055</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>20G_0545</td>
<td>480</td>
<td>298 (400)</td>
<td>3500</td>
<td>3-B</td>
<td>0.04</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>20G_0617</td>
<td>480</td>
<td>336 (450)</td>
<td>4000</td>
<td>3-B</td>
<td>0.029</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>20G_0675</td>
<td>480</td>
<td>373 (500)</td>
<td>4750</td>
<td>3-B</td>
<td>0.029</td>
<td>4750</td>
</tr>
</tbody>
</table>
Drive Input

- **Power Distribution - Chapter 2 of Drives-IN001**
  - AC Line Voltage & AC Line Impedance
- **When to add a line reactor**
  - Low line impedance (Less than 1% line reactance)
  - Supply transformer KVA rating more than10 times drive without DC link choke or 20 times drives with DC link choke
  - Line has power factor correction capacitors
  - Line has frequent power interruptions
  - Line has intermittent noise spikes in excess of 6 KV
  - Incoming voltage imbalances greater than 2% (cause large unequal currents in a drive)
Power Distribution - Chapter 2 of DRIVES-IN001

- Grounding
  - Symptoms: Equipment Damage, Overvoltage Faults, Ground Faults
    - Solid Ground
    - High Resistance Ground
    - Ungrounded

- Rockwell Automation can support all three schemes
  - Some competitors only support solidly grounded
Drive Input

- Power Distribution - Chapter 2 of DRIVES-IN001
  - **Solid Ground Wye**– Recommended
    - Controlled path for common mode noise current
    - Consistent line-to-ground voltage reference that minimizes insulation stress
    - Accommodation for system surge protection schemes
    - Fewer technical support calls when this scheme is used
    - The only system allowed for CE compliance
Drive Input

- Power Distribution - Chapter 2 of DRIVES-IN001
  - High Resistance Ground Wye
    - Potential nuisance ground fault detection trips caused by drive operation
    - Potential equipment damage
Drive Input

- Power Distribution - Chapter 2 of DRIVES-IN001
  - Ungrounded
    - System level ground fault detection or suppression may be required (use of zig-zag transformer for ground fault detection)
    - High voltages can be present between the chassis of the drive and the internal power structure components causing undue stress on insulation
    - Dangerous – ground faults on the primary will show primary voltage potential to ground on the secondary side
Drive Input

- Drive Configuration – 750-IN001 or 520-UM001
  - Power Jumper Configuration
    - Symptoms: Equipment Damage, Ground Faults

### Table 29 - Recommended Power Jumper Configurations Wall Mount Frames 1…7

<table>
<thead>
<tr>
<th>Power Source Type</th>
<th>Jumper PE-A (1)(2)</th>
<th>Jumper PE-B (DC Bus Common mode Caps)</th>
<th>Benefits of Correct Configuration on Power Source Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Non-Solid Ground</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• AC fed ungrounded</td>
<td>Disconnected</td>
<td>Disconnected</td>
<td>Helps avoid severe equipment damage when ground fault occurs</td>
</tr>
<tr>
<td>• Impedance grounded</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• B phase grounded</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• DC fed from an active converter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Solid Ground</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• AC fed solidly grounded</td>
<td>Connected</td>
<td>Connected</td>
<td>UL compliance, Reduced electrical noise, Most stable operation, EMC compliance, Reduced voltage stress on components and motor bearings</td>
</tr>
<tr>
<td>• DC fed from passive rectifier</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>which has a solidly grounded AC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>source</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) When MOWs are disconnected, the power system must have its own transient protection to insure known and controlled voltages.
(2) Frame 5…7 Common DC Input drives do not have the PE-A jumper.

CAUTION

See "Drive Power Jumper Configuration" in PowerFlex Installation Instructions before applying power. Failure to properly configure power jumpers may result in erratic operation, non-compliance, and/or severe equipment damage. For panel and machine builders, transfer this tag to the point at which your customer will connect input power (e.g. disconnect, breaker, terminals, etc.).
Drive Panel

- Environmental – 520-UM001
  - Minimum Clearances/Environmental Specifications
    - Symptoms: Reduced Life & Over Temperature Faults
Drive Panel

Environmental

Atmosphere – DRIVES-AT003

- Symptoms: Drive Failures, Nuisance Faults
- RoHS – Changed Materials
  - Heavy Metals no longer allowed
    - Stable
    - Low reactivity to many corrosive gases
  - Environment requirements have not changed, but current materials react differently
- Electronics smaller and closer in proximity
- 3rd parties can evaluate corrosion and offer solutions
- Conformal coating implemented to improve reliability

VFD
**Environmental – DRIVES-AT003**

- Atmosphere

**Rockwell Automation® Atmospheric Requirements**

**All Mounting Styles and Frames**

- Protect the cooling fan by avoiding dust or metallic particles.
- Do not expose to a corrosive atmosphere.
- Protect from moisture and direct sunlight (unless rated for outdoor use).

**Important**

- Drive must not be installed in an area where the ambient atmosphere contains volatile or corrosive gas, vapors or dust. If the drive is not going to be installed for a period of time, it must be stored in an area where it will not be exposed to a corrosive atmosphere.

**Competitor Atmospheric Requirements**

Hermetically sealed cabinet units with degree of protection IP54 or higher can also be built easily with liquid-cooled systems. With hermetically sealed cabinets, fans combined with air-to-water heat exchangers must also be installed in the cabinets in order to dissipate the power losses from the converter electronics (see table below) and from the bus bars, fuses and air-cooled components such as reactors and filters at the input and output ends which are discharged to the air inside the cabinet.
Drive Panel

- Drive Configuration – DRIVES-IN001
  - Grounding Practices
    - Symptoms: Ground Faults, Communication Faults
    - Motor ground directly back to drive, then from drive to panel ground
    - Motor cable shield directly back to drive (either PE or drive chassis), then from drive to panel ground
Ethernet Grounding

- PowerFlex® 520-Series Drives
  - Connect CS1/CS2 to a clean ground in a ring topology
  - Connect C1/C2 to a clean ground in a star topology

<table>
<thead>
<tr>
<th>CS1/CS2 terminals</th>
<th>Provides a clean ground for the communication bus cable shields. CS1 or CS2 should be connected to a clean ground or PE ground on the drive.</th>
</tr>
</thead>
</table>

- This terminal is tied to the RJ-45 port shield. Tie this terminal to a clean ground in order to improve noise immunity when using external communication peripherals.
- This is the signal common for the communication signals.

Dual network interface
EtherNet/IP card
CS1/CS2 terminal

Built-in
EtherNet/IP card
C1/C2 terminal
Wire/Cable Types

Shielded Cable

- Shielded cable contains all of the general benefits of multi-conductor cable with the added benefit of a copper-braided shield that can contain much of the noise generated by a typical AC drive.

- Shielded cable can also help reduce shaft voltage and induced bearing currents for some applications.

Armored Cable

- Cable with continuous aluminum armor is often recommended in drive system applications or specific industries.

- Armored cable offers most of the advantages of standard shielded cable and also combines considerable mechanical strength and resistance to moisture.

- Space the ground conductors symmetrically around the power conductors. Verify that the ground conductors are rated for full drive ampacity.
Drive Output

- Cabling – Appendix A of Drives-IN001
  - Length
    - Symptoms: Motor Failures, Overcurrent Faults

Table 46 - PowerFlex 753 and 755 Wall Mount Drives, 400V Shielded/Unshielded Cable – Meters (Feet) (continued)

<table>
<thead>
<tr>
<th>Frame</th>
<th>kW</th>
<th>1000V</th>
<th>1200V</th>
<th>1485V</th>
<th>1600V</th>
<th>1000V</th>
<th>1200V</th>
<th>1485V</th>
<th>1600V</th>
<th>1000V</th>
<th>1200V</th>
<th>1485V</th>
<th>1600V</th>
</tr>
</thead>
<tbody>
<tr>
<td>182</td>
<td>2</td>
<td>24.4</td>
<td>327.3</td>
<td>374.3</td>
<td>366.8</td>
<td>368.2</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
</tr>
<tr>
<td>4</td>
<td>24.4</td>
<td>91.4</td>
<td>152.4</td>
<td>212.4</td>
<td>366.8</td>
<td>368.2</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
</tr>
<tr>
<td></td>
<td>160</td>
<td>2.46</td>
<td>327.3</td>
<td>374.3</td>
<td>366.8</td>
<td>368.2</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
</tr>
<tr>
<td>4</td>
<td>24.4</td>
<td>91.4</td>
<td>152.4</td>
<td>212.4</td>
<td>366.8</td>
<td>368.2</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
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<tr>
<td></td>
<td>200</td>
<td>24.4</td>
<td>91.4</td>
<td>152.4</td>
<td>212.4</td>
<td>366.8</td>
<td>368.2</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
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</tr>
<tr>
<td>4</td>
<td>24.4</td>
<td>91.4</td>
<td>152.4</td>
<td>212.4</td>
<td>366.8</td>
<td>368.2</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
<td>600</td>
<td>182.9</td>
</tr>
</tbody>
</table>

3

Motor
Reflective Wave at VFD and at Motor

300 Ft of cable
### Cabling – Chapter 1 of Drives-IN001

#### Properties
- **Symptoms:** Overcurrent Faults, Ground Faults

#### Table 1 - Recommended Cable Design

<table>
<thead>
<tr>
<th>Type</th>
<th>Max Wire Size</th>
<th>Where Used</th>
<th>Rating/Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>2 AWG</td>
<td>Standard installations 100 Hp or less</td>
<td>600V, 90°C (194°F) XHHW/2/RHW-2</td>
<td>Four tinned copper conductors with cross-linked polyethylene (XLPE) insulation</td>
</tr>
<tr>
<td>Type 2</td>
<td>2 AWG</td>
<td>Standard installations 100 Hp or less with brake conductors</td>
<td>600V, 90°C (194°F) RHH/RHW-2</td>
<td>Four tinned copper conductors with XLPE insulation plus one shielded pair of brake conductors.</td>
</tr>
<tr>
<td>Type 3</td>
<td>500 MCM AWG</td>
<td>Standard installations 150 Hp or more</td>
<td>Tray-rated 600V, 90°C (194°F) RHH/RHW-2</td>
<td>Three tinned copper conductors with XLPE insulation and three bare copper grounds and polyvinyl chloride (PVC) jacket.</td>
</tr>
<tr>
<td>Type 4</td>
<td>500 MCM AWG</td>
<td>Water, caustic chemical, crush resistance</td>
<td>Tray-rated 600V, 90°C (194°F) RHH/RHW-2</td>
<td>Three bare copper conductors with XLPE insulation and three copper grounds on 10 AWG and smaller. Acceptable in Class I and II, Division I and II locations.</td>
</tr>
<tr>
<td>Type 5</td>
<td>500 MCM AWG</td>
<td>690V applications</td>
<td>Tray-rated 2000V, 90°C (194°F)</td>
<td>Three tinned copper conductors with XLPE insulation. Three bare copper grounds and PVC jacket. <strong>IMPORTANT:</strong> If terminator network or output filter is used, connector insulation must be XLPE, not PVC.</td>
</tr>
</tbody>
</table>

[Diagram of a motor with wiring connections]
Drive Output – Cable Charging Currents

Short Cable between drive and motor - 3 m

 Longer Cable between drive and motor - 30 m
Drive Output

- Cabling – Chapter 4 of Drives-IN001
  - Routing
    - Symptoms: Comm Faults, I/O Loss of Signal
Segregation and Shielding Concepts

Wire segregation vs. shield

Minimum segregation is 150 mm (6.0 in.) within a panel

Clean Zone

Dirty Zone

Grounded steel shield allows minimal segregation distance.

Shielding example

Faraday Shielding
Faraday Shield From Panduit

The shielded wiring duct routes, separates, and shields sensitive wiring from noise emission

- Up to 20 dB noise reduction, 90% noise voltage reduction (up to 6 inches air space)
- Lead-free PVC with metallic foil finish
- UL recognized continuous use temperature – 122°F (50°C)
- Provided with mounting holes
- Base and cover length is 6 feet
- Use with Type C cover (purchased separately)
Drive Output

- Cabling – Chapter 6 of Drives-IN001
  - Other hardware
    - Common Mode Cores

Another effective method of reducing common mode noise is to attenuate the noise before it can reach the ground grid. Install a common mode ferrite core on the output cables to reduce the amplitude of the noise to a level that makes it relatively harmless to sensitive equipment or circuits. Common mode cores are most effective when multiple drives are in a relatively small area. For more information, refer to 1321-M Common Mode Chokes Instructions, publication 1321-5.0.

Follow these guideline as a general rule for installing common mode chokes:

- If the distance between the drive and motor, or the drive and input transformer, is greater than 22.8 m (75 ft), and
- If sensitive circuits with leads greater than 22.8 m (75 ft), such as encoders, analog or capacitive sensors, are routed in or out of the cabinet near the drive or transformer, then
  Install common mode chokes.
Common Mode Noise
What Do Common Mode Chokes Do?

Inverter Output Voltage

Common Mode Current

Current with Common Mode Chokes

\[ V = L \frac{di}{dt} \]

\[ \Delta V_{\text{ground}} = L_{\text{ground}} \times \frac{di}{dt} \]
What Else to Watch Out For

- Cabling inside and outside of the panel
  - Encoder cable routing and shielding
  - EtherNet/IP cable selection and routing
    - Common Mode Cores
What Can You Do?

- All drives customers (new installs, migrations, switching to a new drive product) should review their entire drive system from line to load
- Download latest manuals
  - DRIVES-IN001 (Wiring and Grounding Guidelines for PWM AC Drives)
  - DRIVES-AT003 (Industry Installation Guidelines for PWM AC Drives)
  - 750-IN001 (PowerFlex® 750 Installation Instructions)
  - 520-UM001 (PowerFlex® 520 User Manual)
Thank You!