LISTEN.
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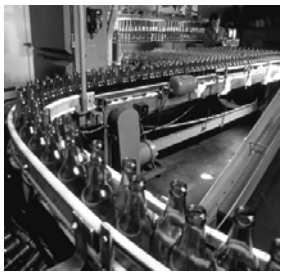
Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives



INSTALLATION INSTRUCTIONS

ALLEN-BRADLEY • ROCKWELL SOFTWARE

Rockwell Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. *Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls* (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at **http://www.rockwellautomation.com/literature**) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

Important: Identifies information that is critical for successful application and understanding of the product.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequences.

Shock Hazard labels may be located on or inside the equipment (e.g., drive or motor) to alert people that dangerous voltage may be present.

Burn Hazard labels may be located on or inside the equipment (e.g., drive or motor) to alert people that surfaces may be at dangerous temperatures.

The information below summarizes the changes to the *Wiring and Grounding Guidelines for Pulse Width Modulated AC Drives*, publication DRIVES-IN001, since the last release.

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Glossary

Overview

The purpose of this manual is to provide you with the basic information needed to properly wire and ground Pulse Width Modulated (PWM) AC drives.

Who Should Use This Manual

This manual is intended for qualified personnel who plan and design installations of Pulse Width Modulated (PWM) AC drives.

Recommended Documentation

The following publications provide general drive information.

Title	Publication	Available...
Installing, Operating and Maintaining Engineered Drive Systems (Reliance Electric)	D2-3115-2	
Safety Guidelines for the Application, Installation and Maintenance of Solid State Control	SGI-1.1	www.rockwellautomation.com/literature
IEEE Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources	IEEE 518	
Recommended Practice for Powering and Grounding Electronic Equipment - IEEE Emerald Book	IEEE STD 1100	
Electromagnetic Interference and Compatibility, Volume 3	N/A	RJ White - publisher Don White Consultants, Inc., 1981
Grounding, Bonding and Shielding for Electronic Equipment and Facilities	Military Handbook 419	
IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems	IEEE Std 142-1991	
National Electrical Code (ANSI/NFPA 70)	Articles 250, 725-5, 725-15, 725-52 and 800-52	
Noise Reduction Techniques in Electronic Systems	N/A	Henry W. Ott Published by Wiley-Interscience
Grounding for the Control of EMI	N/A	Hugh W. Denny Published by Don White Consultants
Cable Alternatives for PWM AC Drive Applications	IEEE Paper No. PCIC-99-23	
EMI Emissions of Modern PWM AC Drives	N/A	IEEE Industry Applications Magazine, Nov./Dec. 1999
EMC for Product Designers	N/A	Tim Williams Published by Newnes
Application Guide for AC Adjustable Speed Drive Systems	N/A	NEMA www.nema.org
IEC 60364-5-52 Selection & Erection of Electrical Equipment - Wiring systems	N/A	IEC www.iec.ch
Don't Ignore the Cost of Power Line Disturbance	1321-2.0	www.rockwellautomation.com/literature

Manual Conventions

The following words are used throughout the manual to describe an action:

Word	Meaning
Can	Possible, able to do something
Cannot	Not possible, not able to do something
May	Permitted, allowed
Must	Unavoidable, you must do this
Shall	Required and necessary
Should	Recommended
Should Not	Not recommended

General Precautions

ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged before performing any work on the drive. Measure the DC bus voltage at the +DC & –DC terminals of the Power Terminal Block. The voltage must be zero.

Wire/Cable Types

AC drive installations have specific requirements for cables. Wire or cable selection for a drive application must consider a variety of criteria.

The following section covers the major issues and proper selection of cable. Recommendations are made to address these issues. Cable materials and construction must consider the following:

- Environment including moisture, temperature and harsh or corrosive chemicals.
- Mechanical needs including geometry, shielding, flexibility and crush resistance.
- Electrical characteristics including cable capacitance/charging current, resistance/voltage drop, current rating and insulation. Insulation may be the most significant of these. Since drives can create voltages well in excess of line voltage, the industry standard cables used in the past may not represent the best choice for customers using variable speed drives. Drive installations benefit from using cable that is significantly different than cable used to wire contactors and push buttons.
- Safety issues including electrical code requirements, grounding needs and others.

Choosing incorrect cable can be costly and may adversely affect the performance of your installation.

General

Material

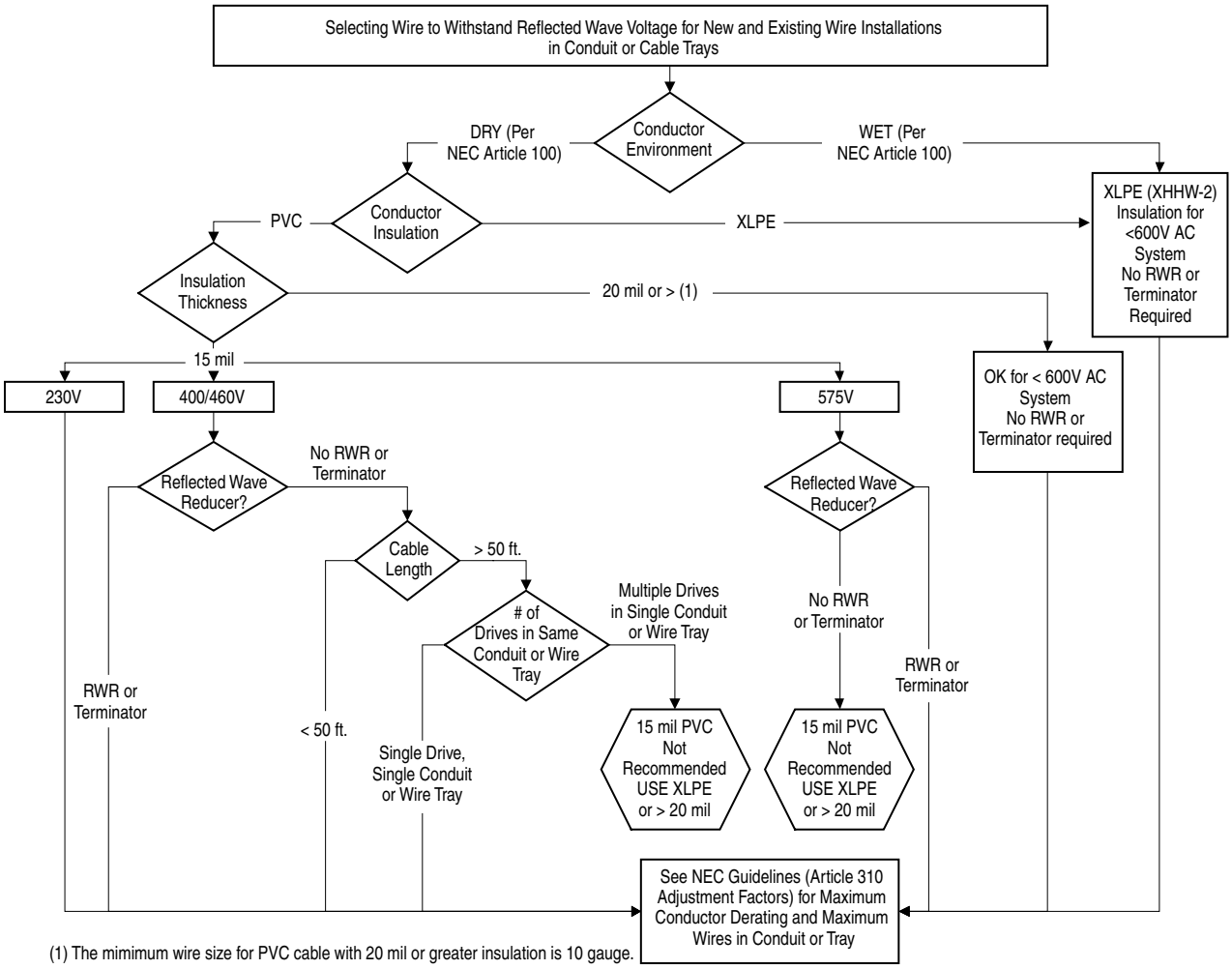
Use Copper wire only. The wire clamp type terminals in Allen-Bradley drives are made for use with copper wire only. If you use aluminum wire the connections may loosen.

Wire gauge requirements and recommendations are based on 75 degrees C. Do not reduce wire gauge when using higher temperature wire.

Exterior Cover

Whether shielded or unshielded, the cable must be chosen to meet all of the application requirements. Consideration must be given to insulation value and resistance to moisture, contaminants, corrosive agents and other invasive elements. Consult the cable manufacturer and the chart below for proper selection.

Figure 1.1 Wire Selection Flowchart



(1) The mimimum wire size for PVC cable with 20 mil or greater insulation is 10 gauge.

Temperature Rating

In general, installations in surrounding air temperature of 50° C should use 90°C wire (required for UL) and installations in 40°C surrounding air temperature should use 75°C wire (also required for UL). Refer to the drive user manual for other restrictions

The temperature rating of the wire affects the required gauge. Be certain to meet all applicable national, state and local codes.

Gauge

The proper wire size is determined by a number of factors. Each individual drive user manual lists a minimum and maximum wire gauge based on the amperage rating of the drive and the physical limitations of the terminal blocks. **Local or national electrical codes also set the required minimum gauge based on motor full load current (FLA).** Both of these requirements should be followed.

Number of Conductors

While local or national electrical codes may determine the required number of conductors, certain configurations are recommended. Figure 1.2 shows cable with a single ground conductor, which is recommended for drives up to and including 200 HP (150 kW). Figure 1.3 shows cable with three ground conductors, which is recommended for drives larger than 200 HP (150 kW). The ground conductors should be spaced symmetrically around the power conductors. The ground conductor(s) should be rated for full drive ampacity.

Figure 1.2 Cable with One Ground Conductor

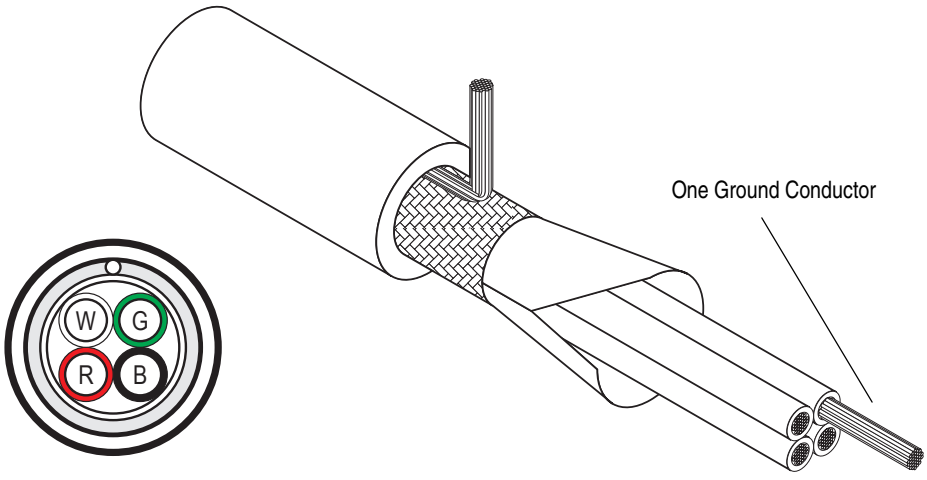
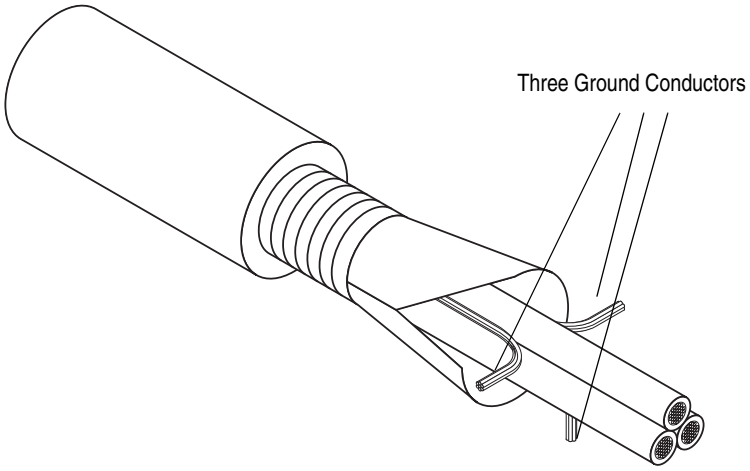


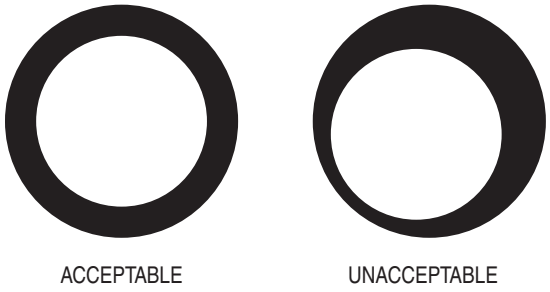
Figure 1.3 Cable with Three Ground Conductors



Insulation Thickness and Concentricity

Selected wire must have an insulation thickness of equal to or more then 15 mils (0.4 mm/0.015 in.). The quality of wire should not have significant variations on concentricity of wire and insulation.

Figure 1.4 Insulation Concentricity



Geometry

The physical relationship between individual conductors plays a large role in drive installation.

Individual conductors in conduit or cable tray have no fixed relationship and are subject to a variety of issues including: cross coupling of noise, induced voltages, excess insulation stress and others.

Fixed geometry cable (cable that keeps the spacing and orientation of the individual conductors constant) offers significant advantages over individual loose conductors including reducing cross coupling noise and insulation stress. Three types of fixed geometry multi-conductor cables are discussed below: Unshielded, shielded, and armored.

Table 1.A Recommended Cable Design

Type	Max. Wire Size	Where Used	Rating/Type	Description
Type 1	2 AWG	Standard Installations 100 HP or less	600V, 90°C (194°F) XHHW2/RHW-2	Four tinned copper conductors with XLPE insulation
Type 2	2 AWG	Standard Installations 100 HP or less with Brake Conductors	600V, 90°C (194°F) RHH/RHW-2	Four tinned copper conductors with XLPE insulation plus one (1) shielded pair of brake conductors.
Type 3	500 MCM AWG	Standard Installations 150 HP or more	Tray rated 600V, 90°C (194°F) RHH/RHW-2	Three tinned copper conductors with XLPE insulation and (3) bare copper grounds and PVC jacket.
Type 4	500 MCM AWG	Water, Caustic Chemical, Crush Resistance	Tray rated 600V, 90°C (194°F) RHH/RHW-2	Three bare copper conductors with XLPE insulation and three copper grounds on 10 AWG and smaller. Acceptable in Class I & II, Division I & II locations.
Type 5	500 MCM AWG	690V Applications	Tray rated 2000V, 90°C (194°F)	Three tinned copper conductors with XLPE insulation. (3) bare copper grounds and PVC jacket. **Note**: If terminator network or output filter is used, connector insulation must be XLPE, not PVC.

Unshielded Cable

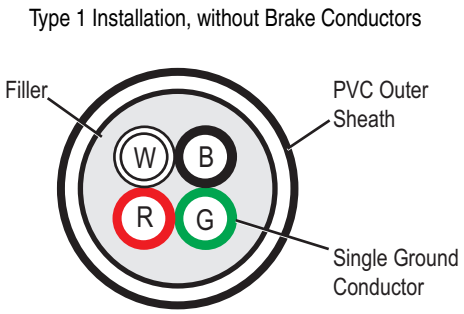
Properly designed multi-conductor cable can provide superior performance in wet applications, significantly reduce voltage stress on wire insulation and reduce cross coupling between drives.

The use of cables without shielding is generally acceptable for installations where electrical noise created by the drive does not interfere with the operation of other devices such as: communications cards, photoelectric switches, weigh scales and others. Be certain the installation does not require shielded cable to meet specific EMC standards for CE, C-Tick or FCC. Cable specifications depend on the installation Type.

Type 1 & 2 Installation

Type 1 or 2 installation requires 3 phase conductors and a fully rated individual ground conductor without or with brake leads. Refer to Table 1.A for detailed information and specifications on these installations.

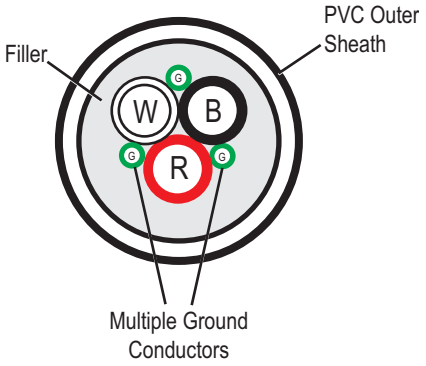
Figure 1.5 Type 1 Unshielded Multi-Conductor Cable without Brake Leads



Type 3 Installation

Type 3 installation requires 3 symmetrical ground conductors whose ampacity equals the phase conductor. Refer to Table 1.A for detailed information and specifications on this installation.

Figure 1.6 Type 3 Unshielded Multi-Conductor Cable



The outer sheathing and other mechanical characteristics should be chosen to suit the installation environment. Consideration should be given to surrounding air temperature, chemical environment, flexibility and other factors as necessary in all installation 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. Strong consideration for shielded cable should be given for installations with sensitive equipment such as weigh scales, capacitive proximity switches and other devices that may be affected by electrical noise in the distribution system. Applications with large numbers of drives in a similar location, imposed EMC regulations or a high degree of communications/networking are also good candidates for shielded cable.

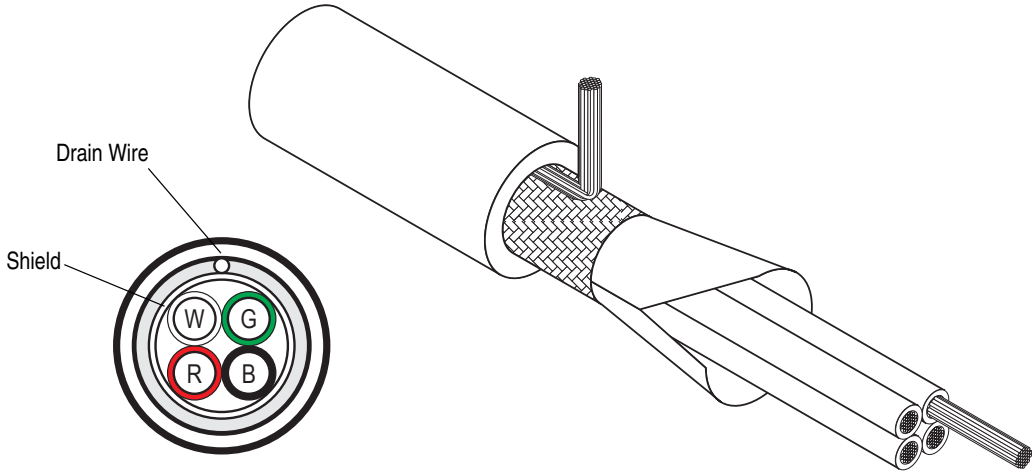
Shielded cable may also help reduce shaft voltage and induced bearing currents for some applications. In addition, the increased size of shielded cable may help extend the distance that the motor can be located from the drive without the addition of motor protective devices such as terminator networks. Refer to Chapter 5 for information regarding reflected wave phenomena.

Consideration should be given to all of the general specifications dictated by the environment of the installation, including temperature, flexibility, moisture characteristics and chemical resistance. In addition, a braided shield should be included and specified by the cable manufacturer as having coverage of at least 75%. An additional foil shield can greatly improve noise containment.

Type 1 Installation

A good example of acceptable shielded cable for Type 1 installation is Belden® 295xx (xx determines gauge) or Anixter B209500-B209507. These cables have 4 XLPE insulated conductors with a 100% coverage foil and an 85% coverage copper braided shield (with drain wire) surrounded by a PVC jacket. For detailed specifications and information on these installations, refer to Table 1.A on page 1-5.

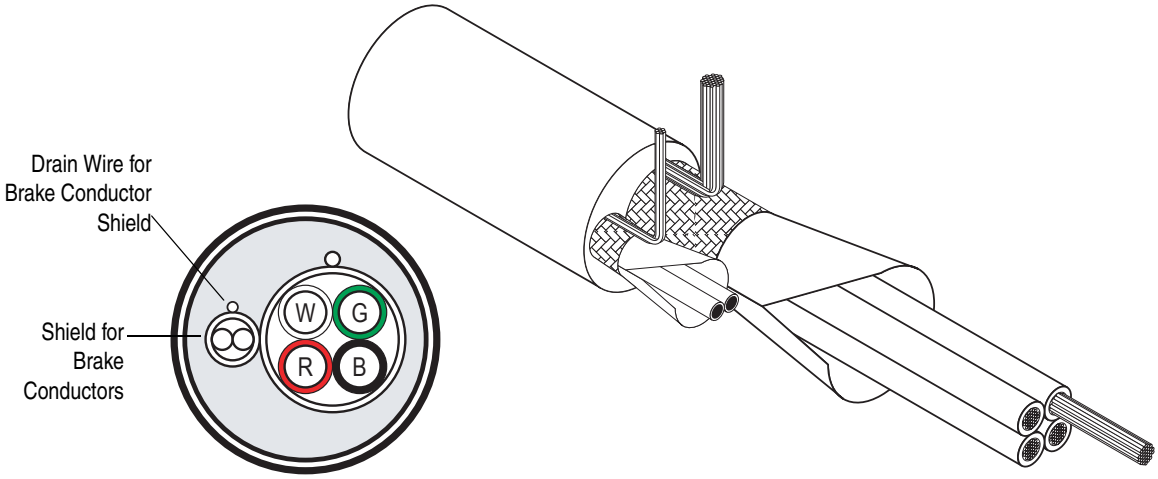
Figure 1.7 Type 1 Installation — Shielded Cable with Four Conductors



Type 2 Installation

A good example of acceptable shielded cable for Type 2 installation is Belden 2951X series cable. This is essentially the same cable as Type 1, plus one (1) shielded pair of brake conductors. For more information on this installation, refer to Table 1.A on page 1-5.

Figure 1.8 Type 2 Installation — Shielded Cable with Brake Conductors



Type 3 Installation

These cables have 3 XLPE insulated copper conductors, 25% minimal overlap with helical copper tape and three (3) bare copper grounds in PVC jacket.

TIP: Other types of shielded cable are available, but the selection of these types may limit the allowable cable length. Particularly, some of the newer cables twist 4 conductors of THHN wire and wrap them tightly with a foil shield. This construction can greatly increase the cable charging current required and reduce the overall drive performance. Unless specified in the individual distance tables as tested with the drive, these cables are not recommended and their performance against the lead length limits supplied is not known. For more information, about motor cable lead restrictions refer to Appendix A, Conduit on page 4-13, Moisture on page 4-18 and Effects On Wire Types on page 5-1.

Armored Cable

Cable with continuous aluminum armor is often recommended in drive system applications or specific industries. It offers most of the advantages of standard shielded cable and also combines considerable mechanical strength and resistance to moisture. It can be installed in concealed and exposed manners and removes the requirement for conduit (EMT) in the installation. It can also be directly buried or embedded in concrete.

Because noise containment can be affected by incidental grounding of the armor to building steel (see Chapter 2) when the cable is mounted, it is recommended the armored cable have an overall PVC jacket.

Interlocked armor is acceptable for shorter cable runs, but continuous welded armor is preferred.

Cable with a single ground conductor is sufficient for drive sizes up to and including 200 HP (150 kW). Cable with three ground conductors is recommended for drive sizes larger than 200 HP (150 kW). The ground conductors should be spaced symmetrically around the power conductors. The ground conductor(s) should be rated for full drive ampacity.

Cable with a Single Ground Conductor

Cable with Three Ground Conductors

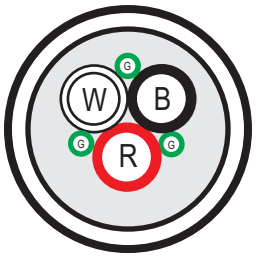
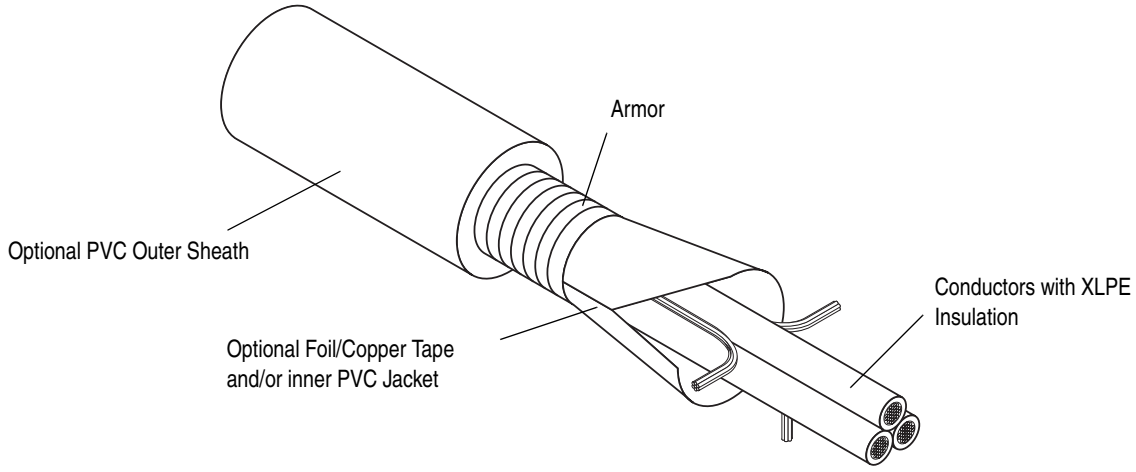


Figure 1.9 Armored Cable with Three Ground Conductors



A good example of acceptable cable for Type 5 installation is Anixter 7V-5003-3G, which has three (3) XLPE insulated copper conductors, 25% minimal overlap with the helical copper tape and three (3) bare copper grounds in PVC jacket. Please note that if a terminator network or output filter is used, connector insulation must be XLPE, not PVC.

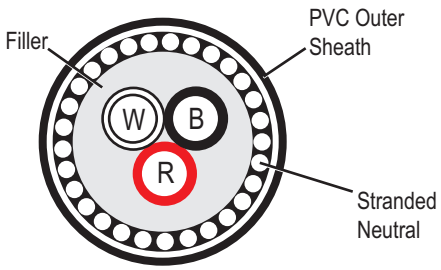
European Style Cable

Cable used in many installations in Europe should conform to the CE Low Voltage Directive 73/23/EEC. Generally recommended are flexible cables with a recommended bend radius of 20 times the cable diameter for movable cable and 6 times the cable diameter for fixed installations. The screen (shield) should be between 70 and 85% coverage. Insulation for both conductors and the outer sheath is PVC.

The number and color of individual conductors may vary, but the recommendation is for 3 phase conductors (customer preferred color) and one ground conductor (Green/Yellow)

Ölflex® Classic 100SY or Ölflex Classic 110CY are examples.

Figure 1.10 European Style Multi-Conductor Cable



Input Power Cables

In general, the selection of cable for AC input power to a drive has no special requirements. Some installations may suggest shielded cable to prevent coupling of noise onto the cable (see Chapter 2) and in some cases, shielded cable may be required to meet noise standards such as CE for Europe, C-Tick for Australia/New Zealand, and others. This may be especially true if an input filter is required to meet a standard. Each individual drive user manual will show the requirements for meeting these types of standards. Additionally, individual industries may have required standards due to environment or experience.

For AC variable frequency drive applications that must satisfy EMC standards for CE, C-Tick, FCC or other, Rockwell Automation may recommend that the same type of shielded cable specified for the AC motors be used between the drive and transformer. Check the individual user manuals or system schematic note sheets for specific additional requirements in these situations.

Motor Cables

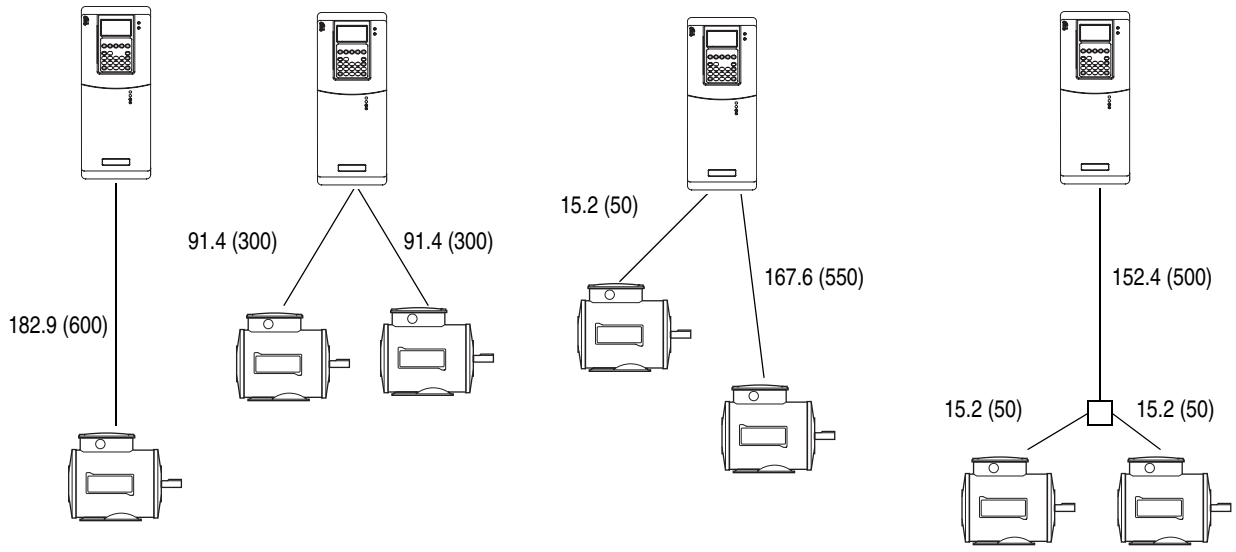
The majority of recommendations regarding drive cable address issues caused by the nature of the drive output. A PWM drive creates AC motor current by sending DC voltage pulses to the motor in a specific pattern. These pulses affect the wire insulation and can be a source of electrical noise. The rise time, amplitude, and frequency of these pulses must be considered when choosing a wire/cable type. The choice of cable must consider:

1. The effects of the drive output once the cable is installed
2. The need for the cable to contain noise caused by the drive output
3. The amount of cable charging current available from the drive
4. Possible voltage drop (and subsequent loss of torque) for long wire runs

Keep the motor cable lengths within the limits set by the drive's user manual. Various issues, including cable charging current and reflected wave voltage stress may exist. If the cable restriction is listed because of excessive coupling current, apply the methods to calculate total cable length, as shown in Figure 1.11. If the restriction is due to voltage reflection and motor protection, tabular data is available. Refer to Appendix A for exact distances allowed.

Figure 1.11 Motor Cable Length for Capacitive Coupling

All examples represent motor cable length of 182.9 meters (600 feet)



Important: For multi motor applications review the installation carefully. Consult your distributor drive specialist or Rockwell Automation directly, when considering a multi motor application with greater than two motors. In general most installations will have no issues. However high peak cable charging currents can cause drive over-currents or ground faults.

Cable for Discrete Drive I/O

Discrete I/O such as Start and Stop commands can be wired to the drive using a variety of cabling. Shielded cable is recommended, as it can help reduce cross-coupled noise from power cables. Standard individual conductors that meet the general requirements for type, temperature, gauge and applicable codes are acceptable if they are routed away from higher voltage cables to minimize noise coupling. However, multi-conductor cable may be less expensive to install. Control wires should be separated from power wires by at least 0.3 meters (1 foot)

Table 1.B Recommended Control Wire for Digital I/O

Type (1)	Wire Type(s)	Description	Minimum Insulation Rating
Unshielded	Per US NEC or applicable national or local code	–	300V, 60°C (140°F)
Shielded	Multi-conductor shielded cable such as Belden 8770 (or equiv.)	0.750 mm^2 (18 AWG), 3 conductor, shielded.	

(1) The cable choices shown are for 2 channel (A&B) or three channel (A,B & Z) encoders. If high resolution or other types of feedback devices are used, choose a similar cable with the correct gauge and number of conductor pairs.

Analog Signal and Encoder Cable

Always use shielded cable with copper wire. Wire with insulation rating of 300V or greater is recommended. Analog signal wires should be separated from power wires by at least 0.3 meters (1 foot). It is recommended that encoder cables be run in a separate conduit. If signal cables must cross power cables, cross at right angles. Terminate the shield of the shielded cable as recommended by manufacturer of the encoder or analog signal device.

Table 1.C Recommended Signal Wire

Signal Type/ Where Used	Wire Type(s)		Description	Minimum Insulation Rating
Standard Analog I/O	Belden 8760/9460 (or equiv.)		0.750 mm^2 (18 AWG), twisted pair, 100% shield with drain [5].	300V, 75-90° C (167-194° F)
Remote Pot	Belden 8770 (or equiv.)		0.750 mm^2 (18 AWG), 3 cond., shielded	
Encoder/Pulse I/O Less 30.5 m (100 ft.)	Combined:	Belden 9730 (or equivalent) [1]	0.196 mm^2 (24 AWG), individually shielded.	
Encoder/Pulse I/O 30.5 m (100 ft.) to 152.4 m (500 ft.)	Signal:	Belden 9730/9728 (or equivalent) [1]	0.196 mm^2 (24 AWG), individually shielded.	
	Power:	Belden 8790 [2]	0.750 mm^2 (18 AWG)	
	Combined:	Belden 9892 [3]	0.330 mm^2 or 0.500 mm^2 [3]	
Encoder/Pulse I/O 152.4 m (500 ft.) to 259.1 m (850 ft.)	Signal:	Belden 9730/9728 (or equivalent) [1]	0.196 mm^2 (24 AWG), individually shielded.	
	Power:	Belden 8790 [2]	0.750 mm^2 (18 AWG)	
	Combined:	Belden 9773/9774 (or equivalent) [4]	0.750 mm^2 (18 AWG), individually shielded pair.	

[1] Belden 9730 is 3 individually shielded pairs (2 channel plus power). If 3 channel is required, use Belden 9728 (or equivalent).

[2] Belden 8790 is 1 shielded pair.

[3] Belden 9892 is 3 individually shielded pairs (3 channel), 0.33 mm^2 (22 AWG) plus 1 shielded pair 0.5 mm^2 (20 AWG) for power.

[4] Belden 9773 is 3 individually shielded pairs (2 channel plus power). If 3 channel is required, use Belden 9774 (or equivalent).

[5] If the wires are short and contained within a cabinet which has no sensitive circuits, the use of shielded wire may not be necessary, but is always recommended.

Communications

DeviceNet

DeviceNet cable options, topology, distances allowed and techniques used are very specific to the DeviceNet network. Refer to *DeviceNet Cable System Planning and Installation Manual*, publication DN-6.72.

In general, there are 4 acceptable cable types for DeviceNet media. These include:

1. Round (Thick) cable with an outside diameter of 12.2 mm (0.48 in) normally used for trunk lines but can also be used for drop lines
2. Round (Thin) cable with an outside diameter of 6.9 mm (0.27 in) normally used for drop lines but may also be used for trunk lines
3. Flat cable normally used for trunk lines
4. KwikLink drop cable used only in KwikLink systems.

Round cable contains five wires: one twisted pair (red and black) for 24V DC power, one twisted pair (blue and white) for signal and a drain wire (bare).

Flat cable contains four wires: one pair (red and black) for 24V DC power and one pair (blue and white) for signal.

Drop cable for KwikLink is a 4-wire unshielded gray cable.

The distance between points, installation of terminating resistors and chosen baud rate all play a significant part in the installation. Again, refer to the DeviceNet Cable System Planning and Installation Manual for detailed specifics.

ControlNet

ControlNet cable options, topology, distances allowed and techniques used are very specific to the ControlNet network. For more information refer to *ControlNet Coax Cable System Planning and Installation Manual*, publication 1786-6.2.1.

Depending on the environment at the installation site there are several types of RG-6 quad shield cables that may be appropriate. The standard cable recommended is A-B Cat # 1786-RG6, Quad Shield coax (Belden 3092A). Country, state or local codes such as the U.S. NEC govern the installation.

For:	Use this Cable Type
Light Industrial	• Standard PVC • CM-CL2
Heavy Industrial	• Lay-on Armored • Light Interlocking Armor
High/Low Temperature or Corrosive (Harsh Chemicals)	• Plenum-FEP • CMP-CL2P
Festooning or Flexing	• High Flex
Moisture: direct burial, with flooding compound, fungus resistant	• Flood Burial

The allowable length of segments and installation of terminating resistors play a significant part in the installation. Again, refer to the *ControlNet Coax Cable System Planning and Installation Manual* for detailed specifics.

Ethernet

The Ethernet communications interface wiring is very detailed as to the type of cable, connectors and routing. Because of the amount of detail required to bring Ethernet into the industrial environment, planning an installation should be done by following all recommendations in the *Ethernet/IP Media Planning and Installation Guide*, publication ENET-IN001.

In general, Ethernet systems consist of specific cable types (STP shielded Cable or UTP unshielded cable) using RJ45 connectors that meet the IP67 standard and are appropriate for the environment. Cables should also meet TIA/EIA standards at industrial temperatures.

Shielded cable is always recommended when the installation may include welding, electrostatic processes, drives over 10 HP, Motor Control Centers, high power RF radiation or devices carrying current in excess of 100 Amps. Shield handling and single point grounding, also discussed in this document, play an extremely important role in the proper operation of Ethernet installations.

Finally, there are distance and routing limitations published in detail.

Remote I/O and Data Highway Plus (DH+)

Only 1770-CD, Belden #9463 is tested and approved for Remote I/O and DH+ installations.

The maximum cable length depends on the chosen baud rate:

Baud Rate	Maximum Cable Length
57.6 KBPS	3,048 m (10,000 ft.)
115.2 KBPS	1524 m (5000 ft.)
230.4 KBPS	762 m (2500 ft.)

All three connections (blue, shield and clear) must be connected at each node.

Do not connect in star topology. Only two cables may be connected at any wiring point. Use either series or daisy chain topology at all points.

Serial (RS232/485)

Standard practices for serial communications wiring should be followed. Belden 3106A or equivalent is recommended for RS232. It contains one twisted pair and 1 signal common. Recommended cable for RS485 is 2 twisted pair with each pair individually shielded.

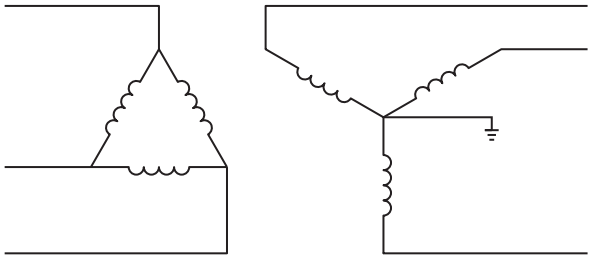
Power Distribution

This chapter discusses different power distribution schemes and factors which affect drive performance.

System Configurations

The type of transformer and the connection configuration feeding a drive plays an important role in its performance and safety. The following is a brief description of some of the more common configurations and a discussion of their virtues and shortcomings.

Delta/Wye with Grounded Wye Neutral

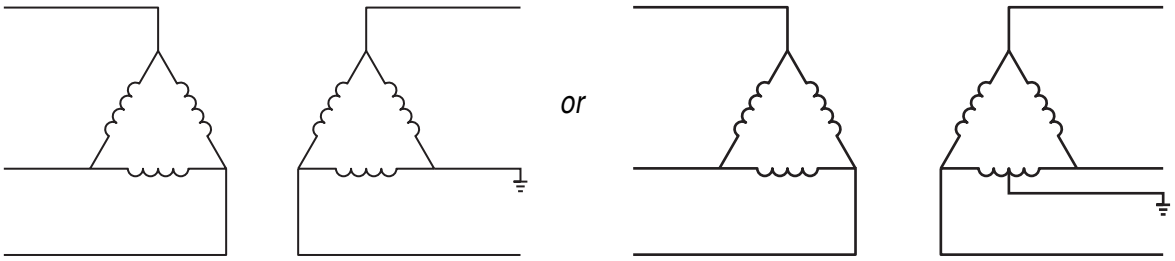


Delta/Wye with Grounded Wye Neutral is the most common type of distribution system. It provides a 30-degree phase shift. The grounded neutral provides a direct path for common mode current caused by the drive output (see Chapter 3 and Chapter 6).

Rockwell Automation strongly recommends the use of grounded neutral systems for the following reasons:

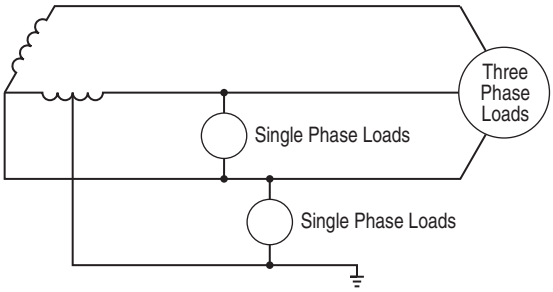
- Controlled path for common mode noise current
- Consistent line to ground voltage reference, which minimizes insulation stress
- Accommodation for system surge protection schemes

Delta/Delta with Grounded Leg or Four-Wire Connected Secondary Delta



Delta/Delta with Grounded Leg or Four-Wire Connected Secondary Delta is a common configuration with no phase shift between input and output. The grounded center tap provides a direct path for common mode current caused by the drive output.

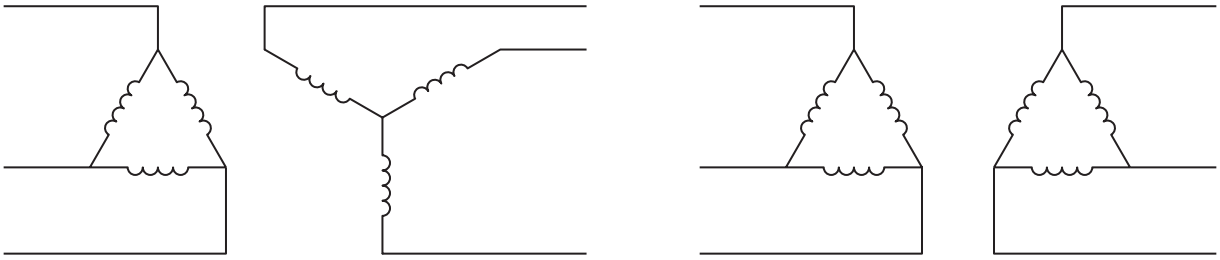
Three-Phase Open Delta with Single-Phase Center Tapped



Three-Phase Open Delta with Single-Phase Center Tapped is a configuration providing a Three-Phase delta transformer with one side tapped. This tap (the neutral) is connected to earth. The configuration is called the antiphase grounded (neutral) system.

The open delta transformer connection is limited to 58% of the 240V, single-phase transformer rating. Closing the delta with a third single-phase, 240V transformer allows full rating for the two single-phase, 240V transformers. The phase leg opposite the midpoint has an elevated voltage when compared to earth or neutral. The “hottest” high leg must be positively identified throughout the electrical system. It should be the center leg in any switch, motor control, three-phase panel board, etc. The NEC requires orange color tape to identify this leg.

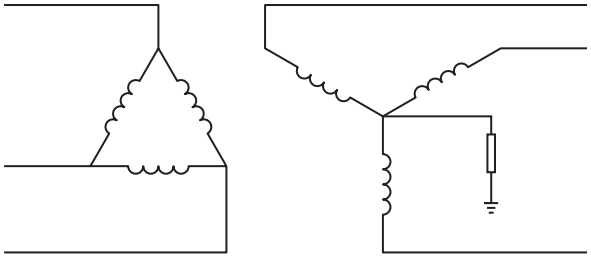
Ungrounded Secondary



Grounding the transformer secondary is essential to the safety of personnel and safe operation of the drive. Leaving the secondary floating allows dangerously high voltages between the chassis of the drive and the internal power structure components. Exceeding the voltage rating of the drive's input MOV (Metal Oxide Varistor) protection devices could cause a catastrophic failure. In all cases, the input power to the drive should be referenced to ground.

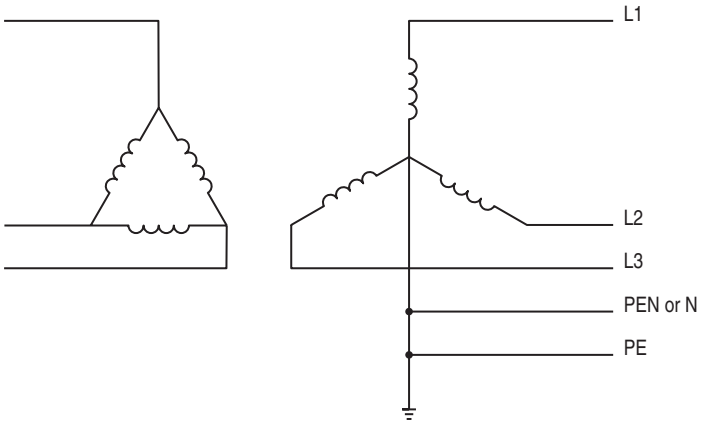
If the system is ungrounded, other general precautions such as a system level ground fault detector or system level line to ground suppressor may be necessary or an isolation transformer must be considered with the secondary of the transformer grounded. Refer to local codes regarding safety requirements. Also refer to Surge Protection MOVs and Common Mode Capacitors on page 2-17.

High Resistance Ground



Grounding the wye secondary neutral through a resistor is an acceptable method of grounding. Under a short circuit secondary condition, any of the output phases to ground will not exceed the normal line to line voltage. This is within the rating of the MOV input protection devices on the drive. The resistor is often used to detect ground current by monitoring the associated voltage drop. Since high frequency ground current can flow through this resistor, care should be taken to properly connect the drive motor leads using the recommended cables and methods. In some cases, multiple drives (that may have one or more internal references to ground) on one transformer can produce a cumulative ground current that can trigger the ground fault interrupt circuit. Refer to Surge Protection MOVs and Common Mode Capacitors on page 2-17.

TN-S Five-Wire System



TN-S five-wire distribution systems are common throughout Europe, with the exception of the United Kingdom and Germany. Leg to leg voltage (commonly at 400V) powers three-phase loads. Leg to neutral voltage (commonly at 230V) powers single-phase loads. Neutral is a current conducting wire, and connects through a circuit breaker. The fifth wire is a separate ground wire. There is a single connection between ground and neutral, typically in the distribution system. There should be no connections between ground and neutral within the system cabinets.

AC Line Voltage

In general all Allen-Bradley drives are tolerant to a wide swing of AC line voltage. Check the individual specification for the drives you are installing.

Incoming voltage imbalances greater than 2% can cause large unequal currents in a drive. An input line reactor may be necessary when line voltage imbalances are greater than 2%.

AC Line Impedance

To prevent excess current that may damage drives during events such as line disturbances or certain types of ground faults, drives should have a minimum amount of impedance in front of them. In many installations, this impedance comes from the supply transformer and the supply cables. In certain cases, an additional transformer or reactor is recommended. If any of the following conditions exist, serious consideration should be given to adding impedance (line reactor or transformer) in front of the drive:

A. Installation site has switched power factor correction capacitors.

B. Installation site has lightning strikes or voltage spikes in excess of 6000V Peak.

C. Installation site has power interruptions or voltage dips in excess of 200VAC.

D. The transformer is too large in comparison to the drive. See impedance recommendation tables Table 2.A on page 7 through Table 2.H on page 13 that are specific to each drive. **Using these tables will allow the largest transformer size for each product and rating based on specific differences in construction, and is the preferred method to follow.**

Otherwise, use one of the two following more conservative methods:

1. For drives without built-in inductors, add line impedance whenever the transformer kVA is more than 10 times larger than the drive kVA, or the percent source impedance relative to each drive is less than 0.5%.
2. For drives with built-in inductors, add line impedance whenever the transformer kVA is more than 20 times larger than the drive kVA, or the percent source impedance relative to each drive is less than 0.25%.

To identify drives with built-in inductors, see the product specific tables. The shaded rows identify products ratings without built-in inductors.

Use the following equations to calculate the impedance of the drive and transformer:

Drive Impedance (in ohms)

$$Z_{drive} = \frac{V_{line - line}}{\sqrt{3} * I_{input - rating}}$$

Transformer Impedance (in ohms)

$$Z_{xfmr} = \frac{V_{line - line}}{\sqrt{3} * I_{xfmr - rated}} * \% \text{ Impedance}$$

or

$$Z_{xfmr} = \frac{(V_{line - line})^2}{VA} * \% \text{ Impedance}$$

% Impedance is the nameplate impedance of the transformer
Typical values range from 0.03 (3%) to 0.06 (6%)

Transformer Impedance (in ohms)

$$Z_{xfmr} = \frac{V_{line - line}}{\sqrt{3} * I_{xfmr - rated}} * \% \text{ Impedance}$$

% Impedance is the nameplate impedance of the transformer
Typical values range from 0.03 (3%) to 0.06 (6%)

Example: The drive is rated 1 HP, 480V, 2.7A input.
The supply transformer is rated 50,000 VA (50 kVA), 5% impedance.

$$Z_{drive} = \frac{V_{line - line}}{\sqrt{3} * I_{input - rating}} = \frac{480V}{\sqrt{3} * 2.7} = 102.6 \text{ ohms}$$

$$Z_{xfmr} = \frac{(V_{line - line})^2}{VA} * \% \text{ Impedance} = \frac{480^2}{50{,}000} * 0.05 = 0.2304 \text{ Ohms}$$

Note that the percent (%) impedance has to be in per unit (5% becomes 0.05) for the formula.

$$\frac{Z_{xfmr}}{Z_{drive}} = \frac{0.2304}{102.6} = 0.00224 = 0.22\%$$

0.22% is less than 0.5%. Therefore, this transformer is too big for the drive and a line reactor should be added.

Note: *Grouping multiple drives on one reactor is acceptable; however, the reactor percent impedance must be large enough when evaluated for each drive separately, not evaluated for all loads connected at once.*

These recommendations are merely advisory and may not address all situations. Site specific conditions must be considered to assure a quality installation.

Table 2.A AC Line Impedance Recommendations for Bulletin 160 Drives

	Drive Catalog Number[1]	Volts	kW (HP)	Max Supply kVA[2]	3% Line Reactor Open Style 1321-	Reactor Inductance (mH)	Reactor Current Rating (Amps)
160	AA02	240	0.37(0.5)	15	3R4-B	6.5	4
	AA03	240	0.55 (0.75)	20	3R4-A	3	4
	AA04	240	0.75 (1)	30	3R4-A	3	4
	AA08	240	1.5 (2)	50	3R8-A	1.5	8
	AA12	240	2.2 (3)	75	3R12-A	1.25	12
	AA18	240	3.7 (5)	100	3R18-A	0.8	18
	BA01	480	0.37(0.5)	15	3R2-B	20	2
	BA02	480	0.55 (0.75)	20	3R2-A	12	2
	BA03	480	0.75 (1)	30	3R2-A	12	2
	BA04	480	1.5 (2)	50	3R4-B	6.5	4
	BA06	480	2.2 (3)	75	3R8-B	3	8
	BA10	480	3.7 (5)	100	3R18-B	1.5	18

(1) Shaded rows identify drive ratings without built-in inductors

(2) Maximum suggested KVA supply without consideration for additional inductance

Table 2.B AC Line Impedance Recommendations for Bulletin 1305 Drives

	Drive Catalog Number[1]	Volts	kW (HP)	Max Supply kVA[2]	3% Line Reactor Open Style 1321-	Reactor Inductance (mH)	Reactor Current Rating (Amps)
1305	-AA02A	240	0.37(0.5)	15	3R4-A	3	4
	-AA03A	240	0.55 (0.75)	20	3R4-A	4	4
	-AA04A	240	0.75 (1)	30	3R8-A	1.5	8
	-AA08A	240	1.5 (2)	50	3R8-A	1.5	8
	-AA12A	240	2.2 (3)	75	3R18-A	0.8	18
	-BA01A	480	0.37 (0.5)	15	3R2-B	20	2
	-BA02A	480	0.55 (0.75)	20	3R2-B	20	2
	-BA03A	480	0.75 (1)	30	3R4-B	6.5	4
	-BA04A	480	1.5 (2)	50	3R4-B	6.5	4
	-BA06A	480	2.2 (3)	75	3R8-B	3	8
	-BA09A	480	3.7 (5)	100	3R18-B	1.5	18

(1) Shaded rows identify drive ratings without built-in inductors

(2) Maximum suggested KVA supply without consideration for additional inductance

Table 2.C AC Line Impedance Recommendations for PowerFlex 4 Drives

	Drive Catalog Number[1]	Volts	kW (HP)	Max Supply kVA	3% Line Reactor Open Style 1321-	Reactor Inductance (mH)	Reactor Current Rating (Amps)
PowerFlex 4	22AB1P5	240	0.2 (0.25)	15	3R2-A	12	2
	22AB2P3	240	0.4 (0.5)	25	3R4-B	6.5	4
	22AB4P5	240	0.75 (1.0)	50	3R8-B	3	8
	22AB8P0	240	1.5 (2.0)	100	3R8-A	1.5	8
	22AB012	240	2.2 (3.0)	125	3R12-A	1.25	12
	22AB017	240	3.7 (5.0)	150	3R18-A	0.8	18
	22AD1P4	480	0.4 (0.5)	15	3R2-B	20	2
	22AD2P3	480	0.75 (1.0)	30	3R4-C	9	4
	22AD4P0	480	1.5 (2.0)	50	3R4-B	6.5	4
	22AD6P0	480	2.2 (3.0)	75	3R8-C	5	8
	22AD8P7	480	3.7 (5.0)	100	3R8-B	3	8

(1) Shaded rows identify drive ratings without built-in inductors

Table 2.D AC Line Impedance Recommendations for PowerFlex 40 Drive

	Drive Catalog Number[1]	Volts	kW (HP)	Max Supply kVA[2]	3% Line Reactor Open Style 1321-	Reactor Inductance (mH)	Reactor Current Rating (Amps)
PowerFlex 40	22BB2P3	240	0.4 (0.5)	25	3R4-B	6.5	4
	22BB5P0	240	0.75 (1.0)	50	3R8-B	3	8
	22BB8P0	240	1.5 (2.0)	50	3R8-A	1.5	8
	22BB012	240	2.2 (3.0)	50	3R12-A	1.25	12
	22BB017	240	3.7 (5.0)	50	3R18-A	0.8	18
	22BB024	240	5.5 (7.5)	100	3R25-A	0.5	25
	22BB033	240	7.5 (10.0)	150	3R35-A	0.4	35
	22BD1P4	480	0.4 (0.5)	15	3R2-B	20	2
	22BD2P3	480	0.75 (1.0)	30	3R4-C	9	4
	22BD4P0	480	1.5 (2.0)	50	3R4-B	6.5	4
	22BD6P0	480	2.2 (3.0)	75	3R8-C	5	8
	22BD010	480	3.7 (5.0)	100	3R8-B	3	8
	22BD012	480	5.5 (7.5)	120	3R12-B	2.5	12
	22BD017	480	7.5 (10.0)	150	3R18-B	1.5	18
	22BD024	480	11.0 (15.0)	200	3R25-B	1.2	25
	22BE1P7	600	0.75 (1.0)	20	3R2-B	20	2
	22BE3P0	600	1.5 (2.0)	30	3R4-B	6.5	4
	22BE4P2	600	2.2 (3.0)	50	3R4-B	6.5	4
	22BE6P6	600	3.7 (5.0)	75	3R8-C	5	8
	22BE9P9	600	5.5 (7.5)	120	3R12-B	2.5	12
	22BE012	600	7.5 (10.0)	150	3R12-B	2.5	12
	22BE019	600	11.0 (15.0)	200	3R18-B	1.5	18

(1) Shaded rows identify drive ratings without built-in inductors

(2) Maximum suggested KVA supply without consideration for additional inductance

Table 2.E AC Line Impedance Recommendations for PowerFlex 400 Drives

	Drive Catalog Number[1]	Volts	kW (HP)	Max Supply kVA[2]	3% Line Reactor Open Style 1321-	Reactor Inductance (mH)	Reactor Current Rating (Amps)[3]
PowerFlex 400	22CB012	240	2.2 (3.0)	50	3R12-A	N/A	N/A
	22CB017	240	3.7 (5.0)	50	3R18-A	N/A	N/A
	22CB024	240	5.5 (7.5)	200	3R25-A	0.5	25
	22CB033	240	7.7 (10.0)	275	3R35-A	0.4	35
	22CB049	240	11 (15.0)	350	3R45-A	0.3	45
	22CB065	240	15 (20.0)	425	3R55-A	0.25	55
	22CB075	240	18.5 (25.0)	550	3R80-A	0.2	80
	22CB090	240	22 (30.0)	600	3R100-A	0.15	100
	22CB120	240	30 (40.0)	750	3R130-A	0.1	130
	22CB145	240	37 (50.0)	800	3R160-A	0.075	160
	22CD6P0	480	2.2 (3.0)	N/A	N/A	N/A	N/A
	22CD010	480	3.7 (5.0)	N/A	N/A	N/A	N/A
	22CD012	480	5.5 (7.5)	N/A	N/A	N/A	N/A
	22CD017	480	7.5 (10)	N/A	N/A	N/A	N/A
	22CD022	480	11 (15)	N/A	N/A	N/A	N/A
	22CD030	480	15 (20)	N/A	N/A	N/A	N/A
	22CD038	480	18.5 (25)	N/A	N/A	N/A	N/A
	22CD045	480	22 (30)	N/A	N/A	N/A	N/A
	22CD060	480	30 (40)	N/A	N/A	N/A	N/A
	22CD072	480	37 (50)	N/A	N/A	N/A	N/A
	22CD088	480	45 (60)	N/A	N/A	N/A	N/A
	22CD105	480	55 (75)	N/A	N/A	N/A	N/A
	22CD142	480	75 (100)	N/A	N/A	N/A	N/A
	22CD170	480	90 (125)	N/A	N/A	N/A	N/A
	22CD208	480	110 (150)	N/A	N/A	N/A	N/A

(1) Shaded rows identify drive ratings without built-in inductors

(2) Maximum suggested KVA supply without consideration for additional inductance

(3) N/A = Not Available at time of printing

Table 2.F AC Line Impedance Recommendations for PowerFlex 70 Drives

	Drive Catalog Number[1]	Volts	kW (HP)	Max Supply kVA[2]	3% Line Reactor Open Style 1321-	Reactor Inductance (mH)	Reactor Current Rating (Amps)[3]
PowerFlex 70	20AB2P2	240	0.37 (0.5)	25	3R2-D	6	2
	20AB4P2	240	0.75 (1)	50	3R4-A	3	4
	20AB6P8	240	1.5 (2)	50	3R8-A	1.5	8
	20AB9P6	240	2.2 (3)	50	3R12-A	1.25	12
	20AB015	240	4.0 (5)	200	3R18-A	0.8	18
	20AB022	240	5.5 (7.5)	250	3R25-A	0.5	25
	20AB028	240	7.5 (10)	300	3R35-A	0.4	35
	20AB042	240	11 (15)	1000	3R45-A	0.3	45
	20AB054	240	15 (20)	1000	3R80-A	0.2	80
	20AB070	240	18.5 (25)	1000	3R80-A	0.2	80

	Drive Catalog Number[1]	Volts	kW (HP)	Max Supply kVA[2]	3% Line Reactor Open Style 1321-	Reactor Inductance (mH)	Reactor Current Rating (Amps)[3]
PowerFlex 70	20AC1P3	400	0.37 (0.5)	30	3R2-B	20	2
	20AC2P1	400	0.75 (1)	50	3R2-B	20	2
	20AC3P4	400	1.5 (2)	50	3R4-B	6.5	4
	20AC5P0	400	2.2 (3)	75	3R4-B	6.5	4
	20AC8P0	400	4.0 (5)	100	3R8-B	3	8
	20AC011	400	5.5 (7.5)	250	3R12-B	2.5	12
	20AC015	400	7.5 (10)	250	3R18-B	1.5	18
	20AC022	400	11 (15)	300	3R25-B	1.2	25
	20AC030	400	15 (20)	400	3R35-B	0.8	35
	20AC037	400	18.5 (25)	750	3R35-B	0.8	35
	20AC043	400	22 (30)	1000	3R45-B	0.7	45
	20AC060	400	30 (40)	1000	3R55-B	0.5	55
	20AC072	400	37 (50)	1000	3R80-B	0.4	80
	20AD1P1	480	0.37 (0.5)	30	3R2-B	20	2
	20AD2P1	480	0.75 (1)	50	3R2-B	20	2
	20AD3P4	480	1.5 (2)	50	3R4-B	6.5	4
	20AD5P0	480	2.2 (3)	75	3R4-B	6.5	4
	20AD8P0	480	3.7 (5)	100	3R8-B	3	8
	20AD011	480	5.5 (7.5)	250	3R12-B	2.5	12
	20AD015	480	7.5 (10)	250	3R18-B	1.5	18
	20AD022	480	11 (15)	300	3R25-B	1.2	25
	20AD027	480	15 (20)	400	3R35-B	0.8	35
	20AD034	480	18.5 (25)	750	3R35-B	N/A	N/A
	20AD040	480	22 (30)	1000	3R45-B	N/A	N/A
	20AD052	480	30 (40)	1000	3R55-B	N/A	N/A
	20AD065	480	37 (50)	1000	3R80-B	N/A	N/A
	20AE0P9	600	0.37 (0.5)	30	3R2-B	20	2
	20AE1P7	600	0.75 (1)	50	3R2-B	20	2
	20AE2P7	600	1.5 (2)	50	3R4-C	9	4
	20AE3P9	600	2.2 (3)	75	3R4-C	9	4
	20AE6P1	600	4.0 (5)	100	3R8-C	5	8
	20AE9P0	600	5.5 (7.5)	250	3R8-B	3	8
	20AE011	600	7.5 (10)	250	3R12-B	2.5	12
	20AE017	600	11 (15)	300	3R18-B	1.5	18
	20AE022	600	15 (20)	400	3R25-B	1.2	25
	20AE027	600	18.5 (25)	1000	3R35-B	0.8	35
	20AE031	600	22 (30)	1000	3R35-B	0.8	35
	20AE042	600	30 (40)	1000	3R45-B	0.7	45
	20AE051	600	37 (50)	1000	3R55-B	0.5	55

(1) Shaded rows identify drive ratings without built-in inductors

(2) Maximum suggested KVA supply without consideration for additional inductance

(3) N/A = Not Available at time of printing

Table 2.G AC Line Impedance Recommendations for PowerFlex 700/700S Drives

	Drive Catalog Number	Volts	kW (HP)	Max Supply KVA[1]	3% Line Reactor Open Style 1321-	Reactor Inductance (mH)	Reactor Current Rating (Amps)
PowerFlex 700/700S Note: For PowerFlex 700S, replace 20B with 20D.	20BB2P2	240	0.37 (0.5)	100	3R2-D	6	2
	20BB4P2	240	0.75 (1)	125	3R4-A	3	4
	20BB6P8	240	1.5 (2)	200	3R8-A	1.5	8
	20BB9P6	240	2.2 (3)	300	3R12-A	1.25	12
	20BB015	240	3.7 (5)	400	3R18-A	0.8	18
	20BB022	240	5.5 (7.5)	500	3R25-A	0.5	25
	20BB028	240	7.5 (10)	750	3R35-A	0.4	35
	20BB042	240	11 (15)	1000	3R45-A	0.3	45
	20BB052	240	15 (20)	1000	3R80-A	0.2	80
	20BB070	240	18.5 (25)	1000	3R80-A	0.2	80
	20BB080	240	22 (30)	1000	3R100-A	0.15	100
	20BB104	240	30 (40)	1000	3R130-A	0.1	130
	20BB130	240	37 (50)	1000	3R130-A	0.1	130
	20BB154	240	45 (60)	1000	3R160-A	0.075	160
	20BB192	240	55 (75)	1000	3R200-A	0.055	200
	20BB260	240	75 (100)	1000	3R320-A	0.04	320
	20BC1P3	400	0.37 (5)	250	3R2-B	20	2
	20BC2P1	400	0.75 (1)	250	3R2-B	20	2
	20BC3P5	400	1.5(2)	500	3R4-B	6.5	4
	20BC5P0	400	2.2 (3)	500	3R4-B	6.5	4
	20BC8P7	400	4 (5)	500	3R8-B	3	8
	20BC011	400	5.5 (7.5)	750	3R12-B	2.5	12
	20BC015	400	7.5 (10)	1000	3R18-B	1.5	18
	20BC022	400	11 (15)	1000	3R25-B	1.2	25
	20BC030	400	15 (20)	1000	3R35-B	0.8	35
	20BC037	400	18.5(25)	1000	3R45-B	0.7	45
	20BC043	400	22 (30)	1000	3R45-B	0.7	45
	20BC056	400	30 (40)	1000	3R55-B	0.5	55
	20BC072	400	37 (50)	1000	3R80-B	0.4	80
	20BC085	400	45 (60)	1000	3R130-B	0.2	130
	20BC105	400	55 (75)	1000	3R130-B	0.2	130
	20BC125	400	55 (75)	1000	3R130-B	0.2	130
	20BC140	400	75 (100)	1000	3R160-B	0.15	160
	20BC170	400	90 (125)	1500	3R200-B	0.11	200
	20BC205	400	110 (150)	1500	3R200-B	0.11	200
	20BC260	400	132 (175)	2000	3RB320-B	0.075	320

	Drive Catalog Number	Volts	kW (HP)	Max Supply KVA[1]	3% Line Reactor Open Style 1321-	Reactor Inductance (mH)	Reactor Current Rating (Amps)
PowerFlex 700/700S Note: For PowerFlex 700S, replace 20B with 20D.	20BD1P1	480	0.37 (0.5)	250	3R2-B	20	2
	20BD2P1	480	0.75 (1)	250	3R2-B	20	2
	20BD3P4	480	1.5 (2)	500	3R4-B	6.5	4
	20BD5P0	480	2.2 (3)	500	3R4-B	6.5	4
	20BD8P0	480	4.0 (5)	500	3R8-B	3	8
	20BD011	480	5.5 (7.5)	750	3R12-B	2.5	12
	20BD014	480	7.5 (10)	750	3R18-B	1.5	18
	20BD022	480	11 (15)	750	3R25-B	1.2	25
	20BD027	480	15 (20)	750	3R35-B	0.8	35
	20BD034	480	18.5 (25)	1000	3R35-B	0.8	35
	20BD040	480	22 (30)	1000	3R45-B	0.7	45
	20BD052	480	30 (40)	1000	3R55-B	0.5	55
	20BD065	480	37 (50)	1000	3R80-B	0.4	80
	20BD077	480	45 (60)	1000	3R80-B	0.4	80
	20BD096	480	55 (75)	1000	3R100-B	0.3	100
	20BD125	480	75 (100)	1000	3R130-B	0.2	130
	20BD140	480	75 (100)	1000	3R160-B	0.15	160
	20BD156	480	90 (125)	1500	3R160-B	0.15	160
	20BD180	480	110 (150)	1500	3R200-B	0.11	200
	20BE0P9	600	0.37 (0.5)	250	3R2-B	20	2
	20BE1P7	600	0.75 (1)	250	3R2-B	20	2
	20BE2P7	600	1.5 (2)	500	3R4-B	6.5	4
	20BE3P9	600	2.2 (3)	500	3R4-B	6.5	4
	20BE6P1	600	4.0 (5)	500	3R8-B	3	8
	20BE9P0	600	5.5 (7.5)	750	3R8-B	3	8
	20BE011	600	7.5 (10)	750	3R12-B	2.5	12
	20BE017	600	11 (15)	750	3R25-B	1.2	25
	20BE022	600	15 (20)	750	3R25-B	1.2	25
	20BE027	600	18.5 (25)	1000	3R35-B	0.8	35
	20BE032	600	22 (30)	1000	3R35-B	0.8	35
	20BE041	600	30 (40)	1000	3R45-B	0.7	45
	20BE052	600	37 (50)	1000	3R55-B	0.5	55
	20BE062	600	45 (60)	1000	3R80-B	0.4	80
	20BE077	600	55 (75)	1000	3R80-B	0.4	80
	20BE099	600	75 (100)	1200	3R100-B	0.3	100
	20BE125	600	90 (125)	1400	3R130-B	0.2	130
	20BE144	600	110 (150)	1500	3R160-B	0.15	160

(1) Maximum suggested KVA supply without consideration for additional inductance

Table 2.H AC Line Impedance Recommendations for Bulletin 1336 Drives

	Drive Catalog Number[1]	Volts	kW (HP)	Max Supply kVA[2][3]	3% Line Reactor Open Style 1321-	Reactor Inductance (mH)	Reactor Current Rating (Amps)[4]
1336 Family- Plus Plus II Impact Force	AQF05	240	0.37 (0.5)	25	3R4-A	3.0	4
	AQF07	240	0.56 (0.75)	25	3R4-A	3.0	4
	AQF10	240	0.75 (1)	50	3R8-A	1.5	8
	AQF15	240	1.2 (1.5)	75	3R8-A	1.5	8
	AQF20	240	1.5 (2)	100	3R12-A	1.25	12
	AQF30	240	2.2 (3)	200	3R12-A	1.25	12
	AQF50	240	3.7 (5)	275	3R25-A	0.5	25
	AQF75	240	5.5 (7.5)	300	3R25-A	0.5	25
	A7	240	5.5 (7.5)	300	3R25-A	0.5	25
	A10	240	7.5 (10)	350	3R35-A	0.4	35
	A15	240	11 (15)	600	3R45-A	0.3	45
	A20	240	15 (20)	800	3R80-A	0.2	80
	A25	240	18.5 (25)	800	3R80-A	0.2	80
	A30	240	22 (30)	950	3R80-A	0.2	80
	A40	240	30 (40)	1000	3R130-A	0.1	130
	A50	240	37 (50)	1000	3R160-A	0.075	160
	A60	240	45 (60)	1000	3R200-A	0.55	200
	A75	240	56 (75)	1000	3RB250-A	0.045	250
	A100	240	75 (100)	1000	3RB320-A	0.04	320
	A125	240	93 (125)	1000	3RB320-A	0.04	320
	BRF05	480	0.37 (0.5)	25	3R2-B	20	2
	BRF07	480	0.56 (0.75)	30	3R2-B	20	2
	BRF10	480	0.75 (1)	30	3R4-B	6.5	4
	BRF15	480	1.2 (1.5)	50	3R4-B	6.5	4
	BRF20	480	1.5 (2)	50	3R8-B	3.0	8
	BRF30	480	2.2 (3)	75	3R8-B	3.0	8
	BRF50	480	3.7 (5)	100	3R12-B	2.5	12
	BRF75	480	5.5 (7.5)	200	3R18-B	1.5	18
	BRF100	480	7.5 (10)	275	3R25-B	1.2	25
	BRF150	480	11 (15)	300	3R25-B	1.2	25
	BRF200	480	15 (20)	350	3R25-B	1.2	25
	B015	480	11 (15)	350	3R25-B	1.2	25
	B020	480	15 (20)	425	3R35-B	0.8	35
	B025	480	18.5 (25)	550	3R35-B	0.8	35
	B030	480	22 (30)	600	3R45-B	0.7	45
	B040	480	30 (40)	750	3R55-B	0.5	55
	B050	480	37 (50)	800	3R80-B	0.4	80
	B060	480	45 (60)	900	3R80-B	0.4	80
	B075	480	56 (75)	1000	3R100-B	0.3	100
	B100	480	75 (100)	1000	3R130-B	0.2	130
	B125	480	93 (125)	1400	3R160-B	0.15	160
	B150	480	112 (150)	1500	3R200-B	0.11	N200
	B200	480	149 (200)	2000	3RB250-B	0.09	250
	B250	480	187 (250)	2500	3RB320-B	0.075	320
	B300	480	224 (300)	3000	3RB400-B	0.06	400
	B350	480	261 (350)	3500	3R500-B	0.05	500
	B400	480	298 (400)	4000	3R500-B	0.05	500
	B450	480	336 (450)	4500	3R600-B	0.04	600
	B500	480	373 (500)	5000	3R600-B	0.04	600
	B600	480	448 (600)	5000	3R750-B	0.029	750

	Drive Catalog Number[1]	Volts	kW (HP)	Max Supply kVA[2][3]	3% Line Reactor Open Style 1321-	Reactor Inductance (mH)	Reactor Current Rating (Amps)[4]
1336 Family- Plus Plus II Impact Force	B700	480	(700)	5000	3R850-B	0.027	850
	B800	480	(800)	5000	3R1000-B	0.022	1000
	BP/BPR250	480	187 (250)	N/A	N/A	N/A	N/A
	BP/BPR300	480	224 (300)	N/A	N/A	N/A	N/A
	BP/BPR350	480	261 (350)	N/A	N/A	N/A	N/A
	BP/BPR400	480	298 (400)	N/A	N/A	N/A	N/A
	BP/BPR450	480	336 (450)	N/A	N/A	N/A	N/A
	BX040	480	30 (40)	N/A	N/A	N/A	N/A
	BX060	480	45 (60)	N/A	N/A	N/A	N/A
	BX150	480	112 (150)	N/A	N/A	N/A	N/A
	BX250	480	187 (250)	N/A	N/A	N/A	N/A
	CWF10	600	0.75 (1)	25	3R4-C	9	4
	CWF20	600	1.5 (2)	50	3R4-C	9	4
	CWF30	600	2.2 (3)	75	3R8-C	5	8
	CWF50	600	3.7 (5)	100	3R8-B	3	8
	CWF75	600	5.5 (7.5)	200	3R8-B	3	8
	CWF100	600	7.5 (10)	200	3R12-B	2.5	12
	CWF150	600	11 (15)	300	3R18-B	1.5	18
	CWF200	600	15 (20)	350	3R25-B	1.2	25
	C015	600	11 (15)	300	3R18-B	1.5	18
	C020	600	15 (20)	350	3R25-B	1.2	25
	C025	600	18.5 (25)	500	3R25-B	1.2	25
	C030	600	22 (30)	600	3R35-B	0.8	35
	C040	600	30 (40)	700	3R45-B	0.7	45
	C050	600	37 (50)	850	3R55-B	0.5	55
	C060	600	45 (60)	900	3R80-B	0.4	80
	C075	600	56 (75)	950	3R80-B	0.4	80
	C100	600	75 (100)	1200	3R100-B	0.3	100
	C125	600	93 (125)	1400	3R130-B	0.2	130
	C150	600	112 (150)	1500	3R160-B	0.15	160
	C200	600	149 (200)	2200	3R200-B	0.11	200
	C250	600	187 (250)	2500	3R250-B	0.09	250
	C300	600	224 (300)	3000	3R320-B	0.075	320
	C350	600	261 (350)	3000	3R400-B	0.06	400
	C400	600	298 (400)	4000	3R400-B	0.06	400
	C450	600	336 (450)	4500	3R500-B	0.05	500
	C500	600	373 (500)	5000	3R500-B	0.05	500
	C600	600	448 (600)	5000	3R600-B	0.04	600
	C650	600	(650)	5000	3R750-B	0.029	750
	C700	600	(700)	5000	3R850-B FN-1	0.027	850
	C800	600	(800)	5000	3R850-B FN-1	0.027	850
	CP/CPR350	600	261 (350)	N/A	N/A	N/A	N/A
	CP/CPR400	600	298 (400)	N/A	N/A	N/A	N/A

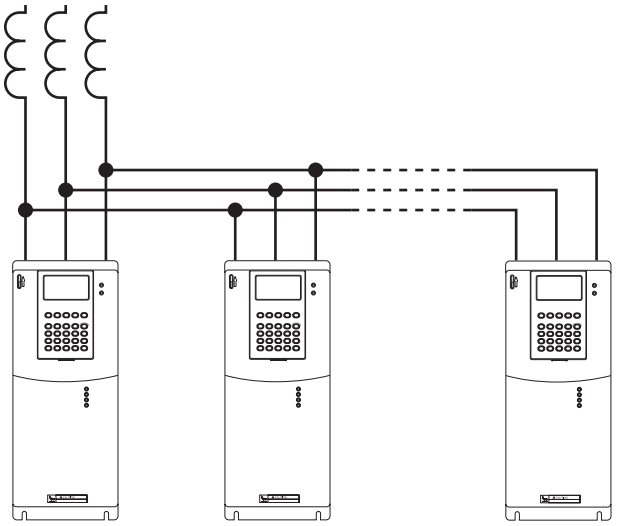
(1) Shaded rows identify drive ratings without built-in inductors

(2) Maximum suggested KVA supply without consideration for additional inductance

(3) 2000 KVA represents 2MVA and Greater

(4) N/A = Not Available at time of printing

Multi-Drive Protection



Multiple drives on a common power line should each have their own line reactor. Individual line reactors provide filtering between each drive to provide optimum surge protection for each drive. However, if it is necessary to group more than one drive on a single AC line reactor, use the following process to verify that the AC line reactor provides a minimum amount of impedance:

1. In general, up to 5 drives can be grouped on one reactor.

2. Add the input currents of the drives in the group.

3. Multiply that sum by 125%.

4. Use publication 1321-2.0 to select a reactor with a maximum continuous current rating greater than the multiplied current.

5. Verify that the impedance of the selected reactor is more than 0.5% (0.25% for drives with internal inductors) of the smallest drive in the group by using the formulas below. If the impedance is too small, select a reactor with a larger inductance and same amperage, or regroup the drives into smaller groups and start over.

$$Z_{drive} = \frac{V_{line - line}}{\sqrt{3} * I_{input - rating}}$$

$$Z_{reactor} = L * 2 * 3.14 * f$$

L is the inductance of the reactor in henries and f is the AC line frequency

Example: There are 5 drives, each is rated 1 HP, 480V, 2.7 amps. These drives do not have internal inductors.

Total current = 5 * 2.7 amps = 13.5 amps

125% * Total current = 125% * 13.5 amps = 16.9 amps

From publication 1321-2.0, we selected the reactor 1321-3R12-C, which has a maximum continuous current rating of 18 amps and an inductance of 4.2 mH (0.0042 henries).

$$Z_{drive} = \frac{V_{line\ -\ line}}{\sqrt{3} * I_{input\ -\ rating}} = \frac{480}{\sqrt{3} * 2.7} = 102.6\ Ohms$$

$$Z_{reactor} = L * (2 * 3.14) * f = 0.0042 * 6.28 * 60 = 1.58\ Ohms$$

$$\frac{Z_{reactor}}{Z_{drive}} = \frac{1.58}{102.6} = 0.0154 = 1.54\%$$

1.54% is more than the 0.5% impedance recommended. The 1321-3R12-C can be used for the (5) 2.7 amp drives in this example.

Surge Protection MOVs and Common Mode Capacitors

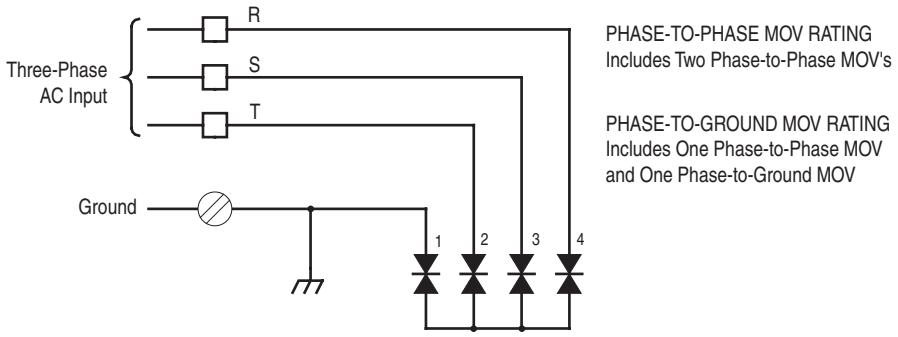
ATTENTION: When installing a drive on an ungrounded, high-resistance or B phase grounded distribution system, disconnect the phase-to-ground MOV circuit and the common mode capacitors from ground.

Note: *In some drives, a single jumper connects both the phase-to-ground MOV and the common mode capacitors to ground.*

MOV Circuitry

Most drives are designed to operate on three-phase supply systems with symmetrical line voltages. To meet IEEE 587, these drives are equipped with MOVs that provide voltage surge protection as well as phase-to-phase and phase-to-ground protection. The MOV circuit is designed for surge suppression (transient line protection) only, not for continuous operation.

Figure 2.1 Typical MOV Configuration



With ungrounded distribution systems, the phase-to-ground MOV connection can become a continuous current path to ground. Exceeding the published phase-to-phase, phase-to-ground voltage or energy ratings may cause physical damage to the MOV.

Suitable isolation is required for the drive when there is potential for abnormally high phase-to-ground voltages (in excess of 125% of nominal line-to-line voltage), or when the supply ground is tied to another system or equipment that could cause the ground potential to vary with operation. An isolation transformer is strongly recommended when this condition exists.

Common Mode Capacitors

Many drives also contain common mode capacitors that are referenced to ground. In installations with ungrounded or high resistive ground systems, the common mode capacitors can capture high frequency common mode or ground fault currents. This can cause bus overvoltage conditions, which could lead to damage or drive faults. Systems which are ungrounded or have one phase grounded (commonly called B phase grounded) apply higher than normal voltage stresses directly to the common mode capacitors, which can lead to shortened drive life or damage.

Using PowerFlex Drives with Regenerative Units

ATTENTION: If a Regenerative unit (i.e. 1336 REGEN) or other Active Front End (AFE) is used as a bus supply or brake, the common mode capacitors should be disconnected as described in the Drive User Manual. This will guard against possible equipment damage.

DC Bus Wiring Guidelines

DC bus wiring refers to connecting the DC bus of an AC drive to the DC connections on another piece of equipment. That equipment could include any or all of the following:

- Additional AC drive
- Non-Regenerative DC Bus Supply
- Regenerative DC Bus Supply
- Regenerative Braking Module
- Dynamic Braking Module
- Chopper Module

For further information on the types of common DC bus configurations and applications refer to *AC Drives in Common Bus Configurations* (publication DRIVES-AT002).

Drive Line-up

Generally, it is desirable to have the drive line-up match the machine layout. However, if there is a mix of drive frame sizes used in the line-up, the general system layout should have the largest drives located closest to the rectifier source. The rectifier source need not be at the left end of the system line-up. Many times it is advantageous to put the rectifier in the middle of the line-up, minimizing the distances to the farthest loads. This is needed to minimize the energy stored in the parasitic inductance of the bus structure and thus lower peak bus voltages during transient operation.

The system must be contained in one contiguous line-up. The bus cannot be interrupted to go to another cabinet for the remainder of the system drives. This is needed to maintain low inductance.

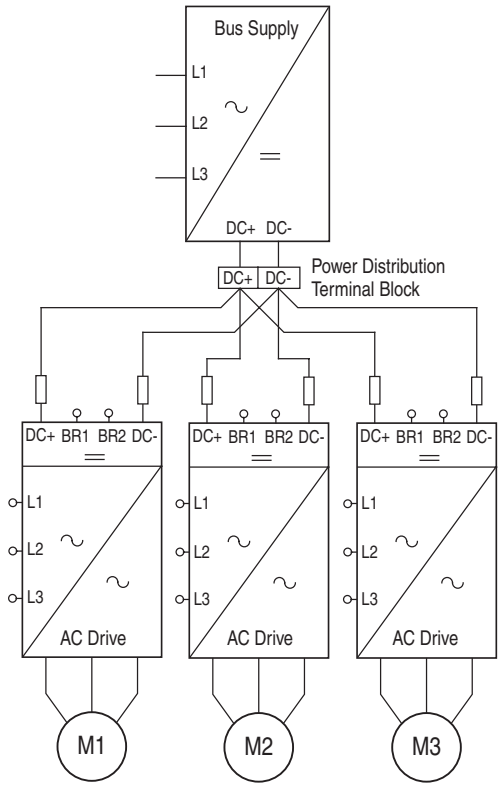
DC Bus Connections

General

The interconnection of drives to the DC bus, and the inductance levels between the drives, should be kept to a minimum for reliable system operation. Therefore, a low inductance-type DC bus should be used, 0.35 µH/m or less.

The DC bus connections should not be “daisy chained.” Configuration of the DC bus connections should be in a “star” configuration to allow for proper fusing.

Figure 2.2 Star Configuration of Common Bus Connections



Bus Bar vs. Cable

- DC Bus Bar is recommended.
- When DC Bus Bar cannot be used, use the following guidelines for DC Bus cables:
  - Cable should be twisted where possible, approximately 1 twist per inch.
  - Cable rated for the equivalent AC voltage rating should be used. The peak AC voltage is equivalent to the DC voltage. For example, the peak AC voltage on a 480V AC system no load is 480 x 1.414 = 679 Volts peak. The 679 Volts peak corresponds to 679 Volts DC at no load.

Braking Chopper

Connection of the brake unit should be closest to the largest drive. If all are the same rating, then closest to the drive that regenerates the most.

In general, brake units should be mounted within 3 meters (10 feet) of the drive. Resistors for use with chopper modules must be located within 30 meters (100 feet) of the chopper module. Refer to the respective braking product documentation for details.

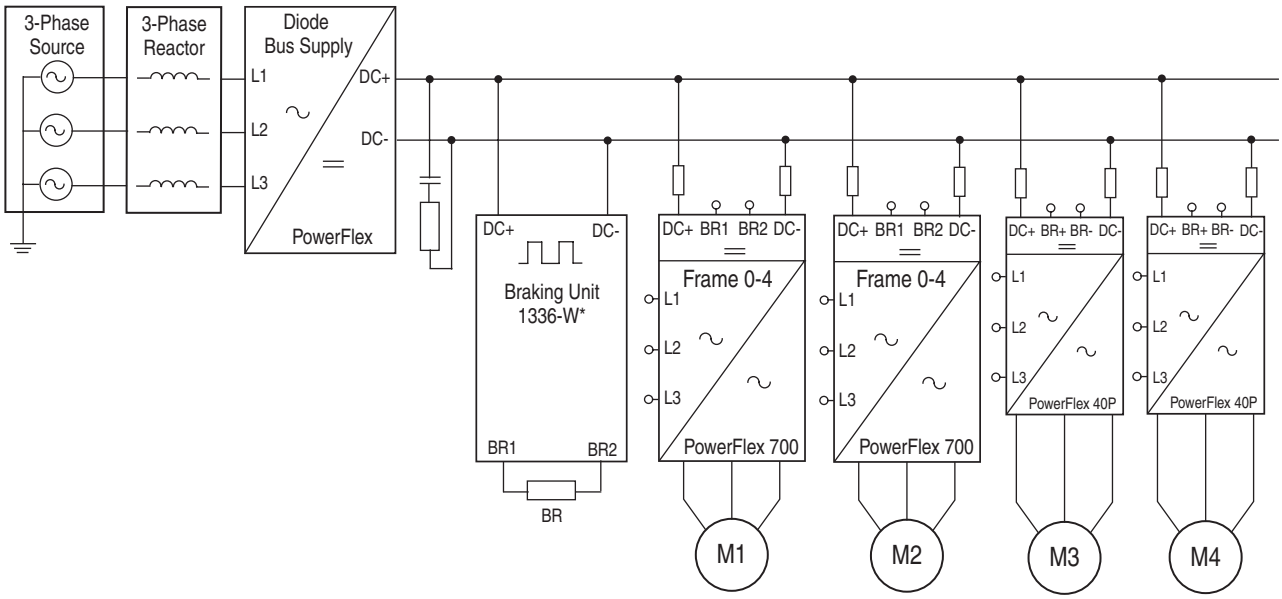
An RC snubber circuit is required when using the 1336-WA, WB or WC Brake Chopper in the configurations listed below:

1. A non-regenerative bus supply configuration using a PowerFlex Diode Bus Supply.
2. A shared AC/DC Bus configuration containing a PowerFlex 700/700S Frame 0-4 drive or PowerFlex 40P drive.
3. A shared DC Bus (Piggy Back) configuration when the main drive is a PowerFlex 700/700S Frame 0 to 4 or PowerFlex 40P drive.

The RC snubber circuit is required to prevent the DC bus voltage from exceeding the 1200V maximum Brake Chopper IGBT voltage. The 1336 Brake Chopper power-up delay time is 80 milliseconds. During this time, the IGBT will not turn on. The RC snubber circuit must always be connected to the DC bus (located close to the braking chopper) to absorb the power-on voltage overshoot (see Figure 2.3).

The specifications for the RC snubber are:
R = 10 ohm, 100 W, low inductance (less than 50 µH)
C = 20 µF, 2000V

Figure 2.3 Configuration Example of Diode Bus Supply w/PowerFlex 700 Frame 0-4, PowerFlex 40P, 1336-W Braking Chopper and RC Snubber Circuit.



Grounding

This chapter discusses various grounding schemes for safety and noise reduction.

An effectively grounded scheme or product is one that is “intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to prevent the buildup of voltages which may result in undue hazard to connected equipment or to persons” (as defined by the US National Electric Code NFPA70, Article 100B). Grounding of a drive or drive system is done for 2 basic reasons: safety (defined above) and noise containment or reduction. While the safety ground scheme and the noise current return circuit may sometimes share the same path and components, they should be considered different circuits with different requirements.

Grounding Safety Grounds

The object of safety grounding is to ensure that all metalwork is at the same ground (or Earth) potential at power frequencies. Impedance between the drive and the building scheme ground must conform to the requirements of national and local industrial safety regulations or electrical codes. These will vary based on country, type of distribution system and other factors. Periodically check the integrity of all ground connections.

General safety dictates that all metal parts are connected to earth with separate copper wire or wires of the appropriate gauge. Most equipment has specific provisions to connect a safety ground or PE (protective earth) directly to it.

Building Steel

If intentionally bonded at the service entrance, the incoming supply neutral or ground will be bonded to the building ground. Building steel is judged to be the best representation of ground or earth. The structural steel of a building is generally bonded together to provide a consistent ground potential. If other means of grounding are used, such as ground rods, the user should understand the voltage potential, between ground rods in different areas of the installation. Type of soil, ground water level and other environmental factors can greatly affect the voltage potential between ground points if they are not bonded to each other.

Grounding PE or Ground

The drive safety ground - PE must be connected to scheme or earth ground. This is the safety ground for the drive that is required by code. This point must be connected to adjacent building steel (girder, joist), a floor ground rod, bus bar or building ground grid. Grounding points must comply with national and local industrial safety regulations or electrical codes. Some codes may require redundant ground paths and periodic examination of connection integrity. Global Drive Systems requires the PE ground to be connected to the transformer ground feeding the drive system.

RFI Filter Grounding

Using an optional RFI filter may result in relatively high ground leakage currents. Therefore, the filter must only be used in installations with grounded AC supply systems and be permanently installed and solidly grounded to the building power distribution ground. Ensure the incoming supply neutral is solidly connected to the same building power distribution ground. Grounding must not rely on flexible cables or any plug or socket that may be accidentally disconnected. Some codes may require redundant ground connections. Periodically check the integrity of all connections. Refer to the instructions supplied with the filter.

Grounding Motors

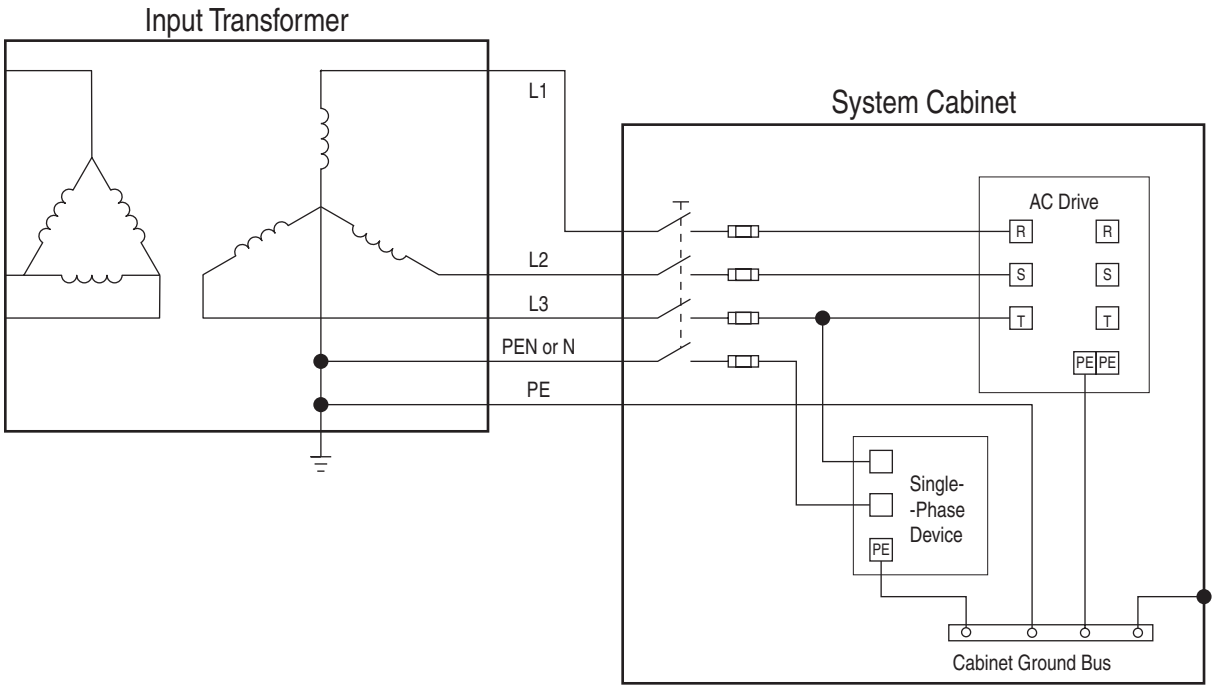
The motor frame or stator core must be connected directly to the drive PE connection with a separate ground conductor. It is recommended that each motor frame be grounded to building steel at the motor. Refer to Cable Trays in Chapter 4 for more information.

Grounding and TN-S Five-Wire Systems

Do not connect ground to neutral within a system cabinet, when using a TN-S five-wire distribution system. The neutral wire is a current conducting wire. There is a single connection between ground and neutral, typically in the distribution system.

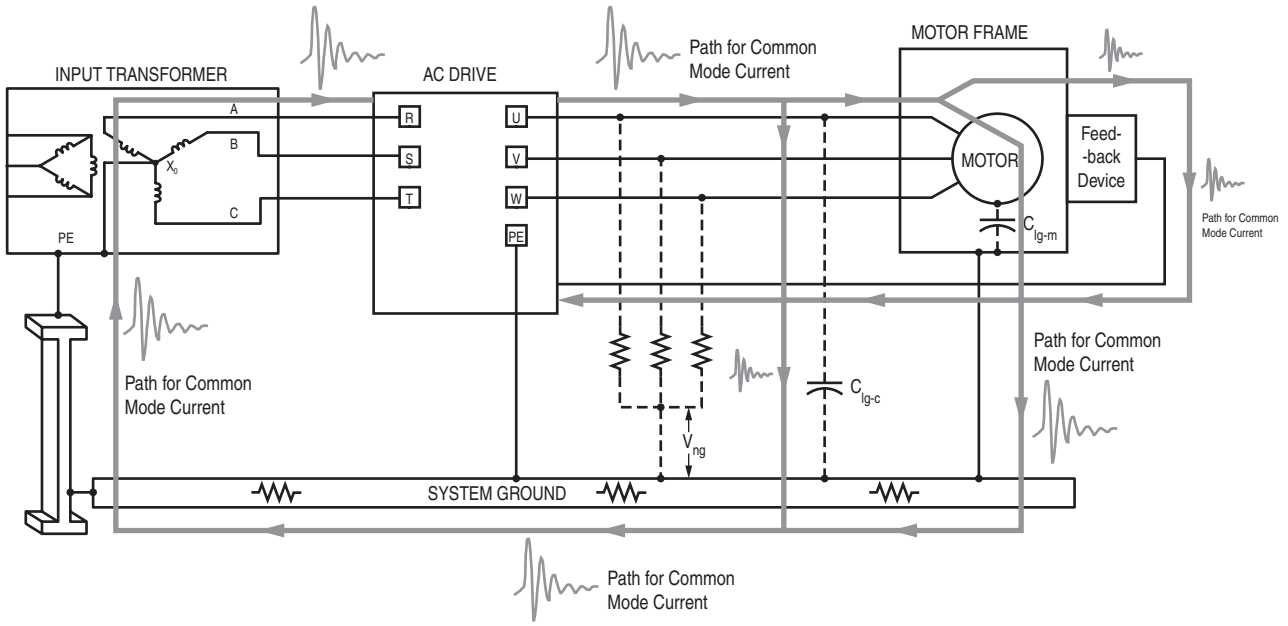
TN-S five-wire distribution systems are common throughout Europe, with the exception of the United Kingdom and Germany. Leg to leg voltage (commonly at 400V) powers three-phase loads. Leg to neutral voltage (commonly at 230V) powers single-phase loads.

Figure 3.1 Cabinet Grounding with a TN-S Five-Wire System



Noise Related Grounds

It is important to take care when installing PWM AC drives because output can produce high frequency common mode (coupled from output to ground) noise currents. These currents cause sensitive equipment to malfunction if they are allowed to propagate.

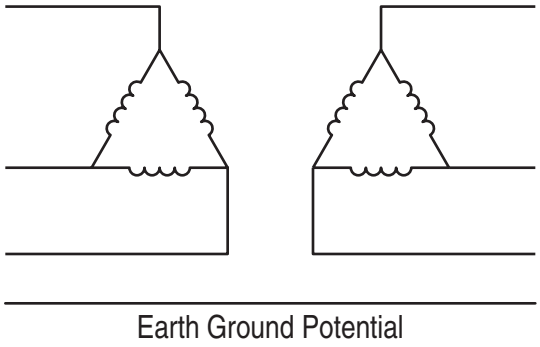


The grounding scheme can greatly affect the amount of noise and its impact on sensitive equipment. The power scheme is likely to be one of three types:

- Ungrounded Scheme
- Scheme with High Resistance Ground
- Fully Grounded Scheme

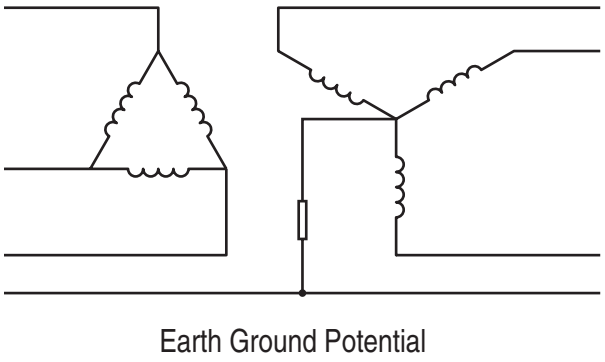
An ungrounded scheme, as shown in Figure 3.2, does not provide a direct path for the common mode noise current, causing it to seek other uncontrolled paths. This causes related noise issues.

Figure 3.2 Ungrounded Scheme



A scheme with a high resistance ground, shown in Figure 3.3, provides a direct path for common mode noise current, like a fully grounded scheme. Designers, who are concerned with minimizing ground fault currents, commonly choose high resistance ground schemes.

Figure 3.3 Scheme with High Resistance Ground



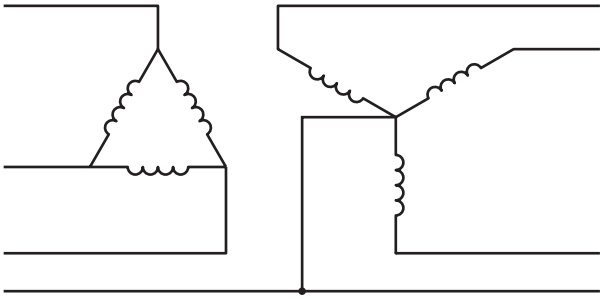
A fully grounded scheme, shown in Figure 3.4, provides a direct path for common mode noise currents. The use of grounded neutral systems is recommended for the following reasons:

– Controlled path for common mode noise current

– Consistent line to ground voltage reference, which minimizes insulation stress

– Accommodation for system surge protection schemes

Figure 3.4 Fully Grounded Scheme

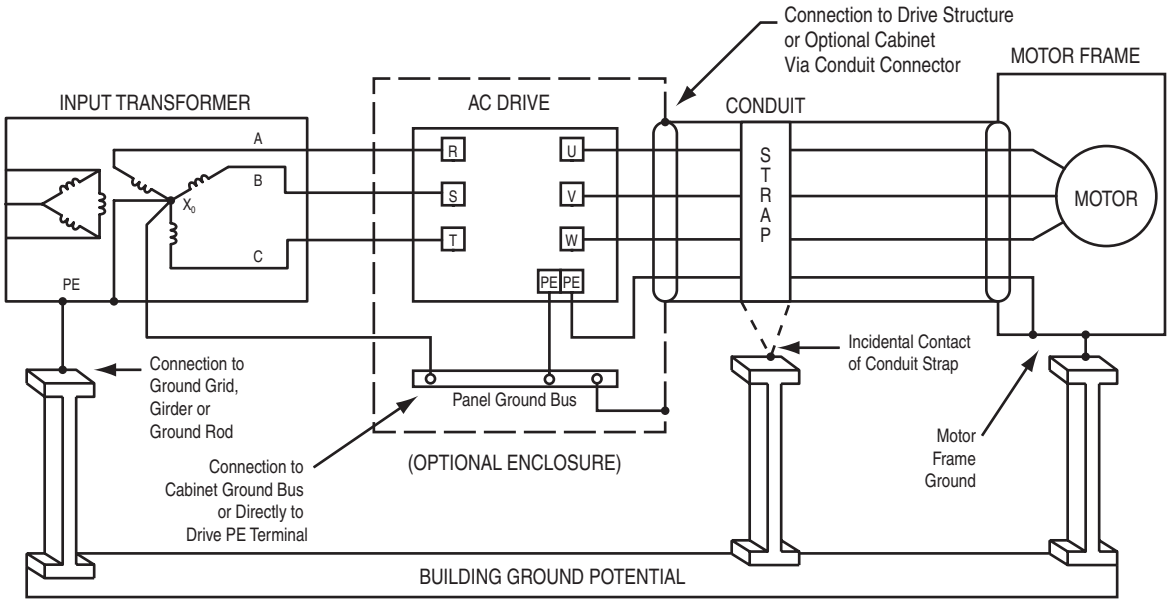


Earth Ground Potential

The installation and grounding practices to reduce common mode noise issues can be categorized into three ratings. The scheme used must weigh additional costs against the operating integrity of all scheme components. If no sensitive equipment is present and noise is not be an issue, the added cost of shielded cable and other components may not be justified.

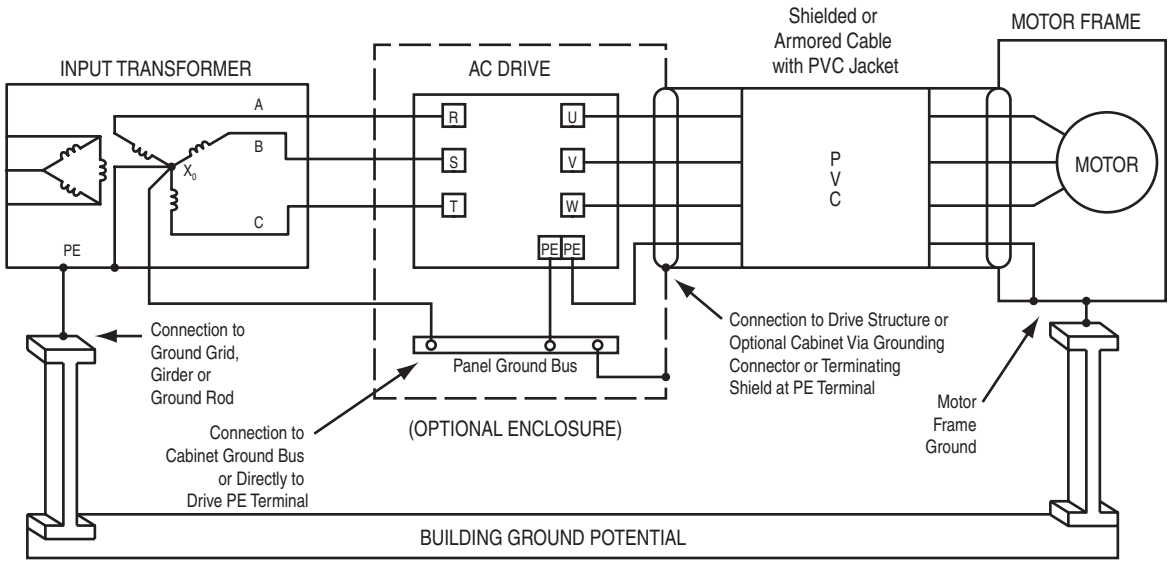
Acceptable Grounding Practices

The scheme shown below is an acceptable ground layout for a single drive installation. However, conduit may not offer the lowest impedance path for any high frequency noise. If the conduit is mounted so that it contacts the building steel, it is likely that the building steel will offer a lower impedance path and allow noise to inhabit the ground grid.



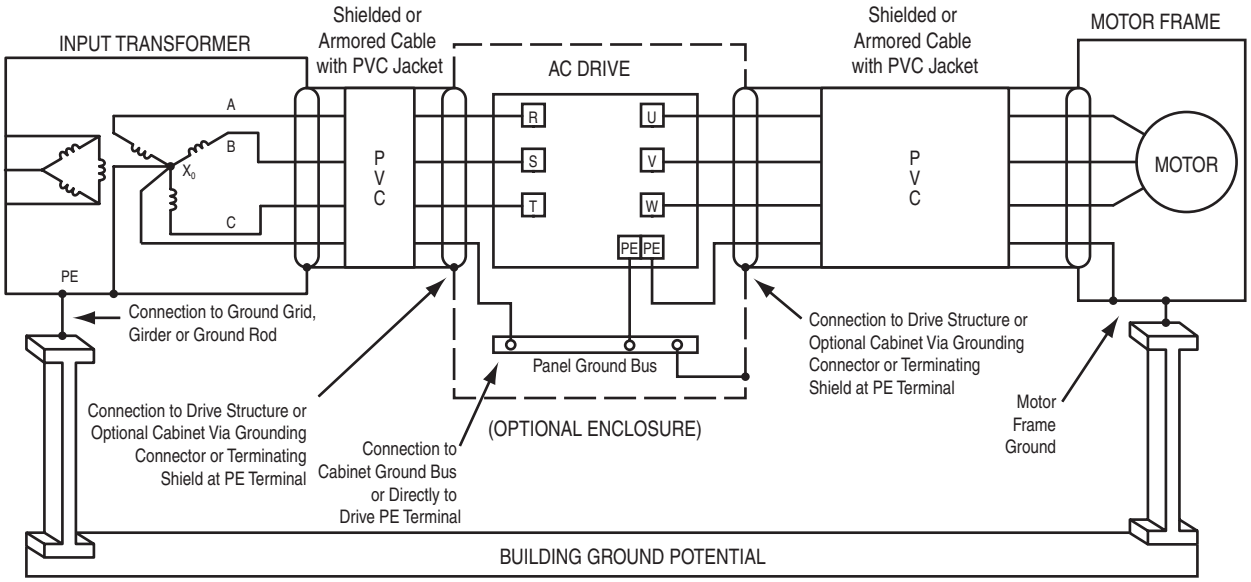
Effective Grounding Practices

This scheme replaces the conduit with shielded or armored cable that has a PVC exterior jacket. This PVC jacket prevents accidental contact with building steel and reduces the possibility that noise will enter the ground grid.



Optimal - Recommended Grounding Practices

The fully grounded scheme provides the best containment of common mode noise. It uses PVC jacketed, shielded cable on both the input and the output to the drive. This method also provides a contained noise path to the transformer to keep the ground grid as clean as possible.



Cable Shields

Motor and Input Cables

Shields of motor and input cables must be bonded at both ends to provide a continuous path for common mode noise current.

Control and Signal Cables

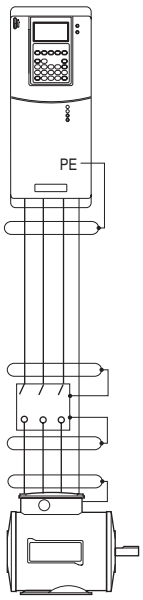
Shields of control cables should be connected at one end only. The other end should be cut back and insulated.

- The shield for a cable from one cabinet to another must be connected at the cabinet that contains the signal source.
- The shield for a cable from a cabinet to an external device must be connected at the cabinet end, unless specified by the manufacturer of the external device.

Never connect a shield to the common side of a logic circuit (this will introduce noise into the logic circuit). Connect the shield directly to a chassis ground.

Shield Splicing

Figure 3.5 Spliced Cable Using Shieldhead Connector



If the shielded cable needs to be stripped, it should be stripped back as little as possible to ensure that continuity of the shield is not interrupted. Avoid splicing motor power cables when ever possible. Ideally, motor cables should run continuously between the drive and motor terminals. The most common reason for interrupted cable/shield is to incorporate an “at the motor” disconnect switch. In these cases, the preferred method of splicing is to use fully shielded bulkhead connectors.

Single Point

A single safety ground point or ground bus bar should be directly connected to the building steel for cabinet installations. All circuits including the AC input ground conductor should be grounded independently and directly to this point/bar.

Isolated Inputs

If the drive’s analog inputs are from isolated devices and the output signal is not referenced to the ground, the drive’s inputs do not need to be isolated. An isolated input is recommended to reduce the possibility of induced noise if the transducer’s signal is referenced to ground and the ground potentials are varied (Refer to Noise Related Grounds on page 3-3). An external isolator can be installed if the drive does not provide input isolation.

Notes:

Practices

This chapter discusses various installation practices.

Mounting

Standard Installations

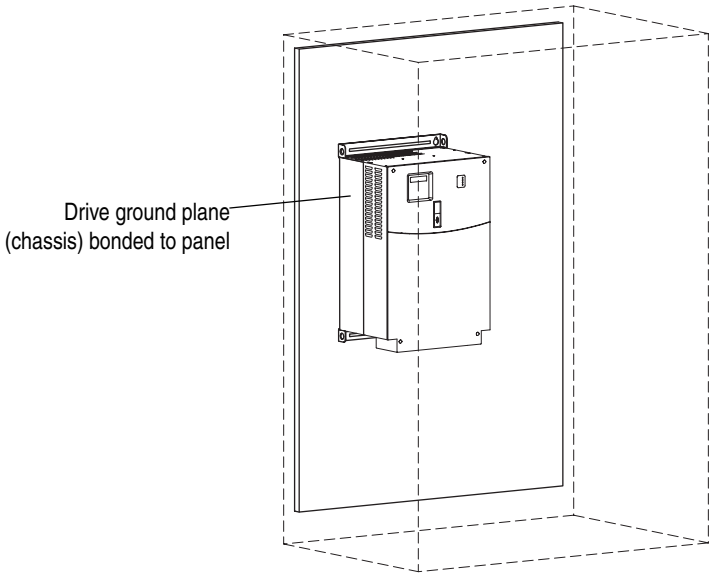
There are many criteria in determining the appropriate enclosure. Some of these include:

- Environment
- EMC Compatibility/Compliance
- Available Space
- Access/Wiring
- Safety Guidelines

Grounding to the Component Mounting Panel

In the example below, the drive chassis ground plane is extended to the mounting panel. The panel is made of zinc-plated steel to ensure a proper bond between chassis and panel.

Figure 4.1 Drive Chassis Ground Plane Extended to the Panel



Note: Where TE and PE terminals are provided, ground each separately to the nearest point on the panel using flat braid.

In an industrial control cabinet, the equivalent to the copper ground layer of a PCB is the mounting panel. To make use of the panel as a ground plane it should be made of zinc-plated mild steel. If painted, remove the paint at each mounting and grounding point.

Zinc-plated steel is strongly recommended due to its inherent ability to bond with the drive chassis and resist corrosion. The disadvantage with painted panels, apart from the cost in labor to remove the paint, is the difficulty in making quality control checks to verify if the paint has been properly removed, and any future corrosion of the unprotected mild steel may compromise noise performance.

Plain stainless steel panels are also acceptable but are inferior to zinc-plated mild steel due to their higher ohms-per-square resistance.

Though not always applicable, a plated cabinet frame is also highly desirable since it makes a high frequency bond between panel and cabinet sections more reliable.

Doors

For doors 2 m (78 in.) in height, ground the door to the cabinet with two or three braided straps.

EMC seals are not normally required for industrial systems.

EMC Specific Installations

A steel enclosure is recommended. A steel enclosure can help guard against radiated noise to meet EMC standards. If the enclosure door has a viewing window, it should be a laminated screen or a conductive optical substrate to block EMC.

Do not rely on the hinge for electrical contact between the door and the enclosure - install a grounding wire. For doors 2 m (78 in.) in height, two or three braided grounding straps between the door and the cabinet should be used. EMC gaskets are not normally required for industrial systems.

Layout

Plan the cabinet layout so that drives are separated from sensitive equipment. Choose conduit entry points that allow any common mode noise to remain away from PLCs and other equipment that may be susceptible to noise. Refer to Moisture on page 4-18 for additional information.

Hardware

You can mount the drive and/or mounting panel with either bolts or welded studs.

Figure 4.2 Stud Mounting of Ground Bus or Chassis to Back Panel

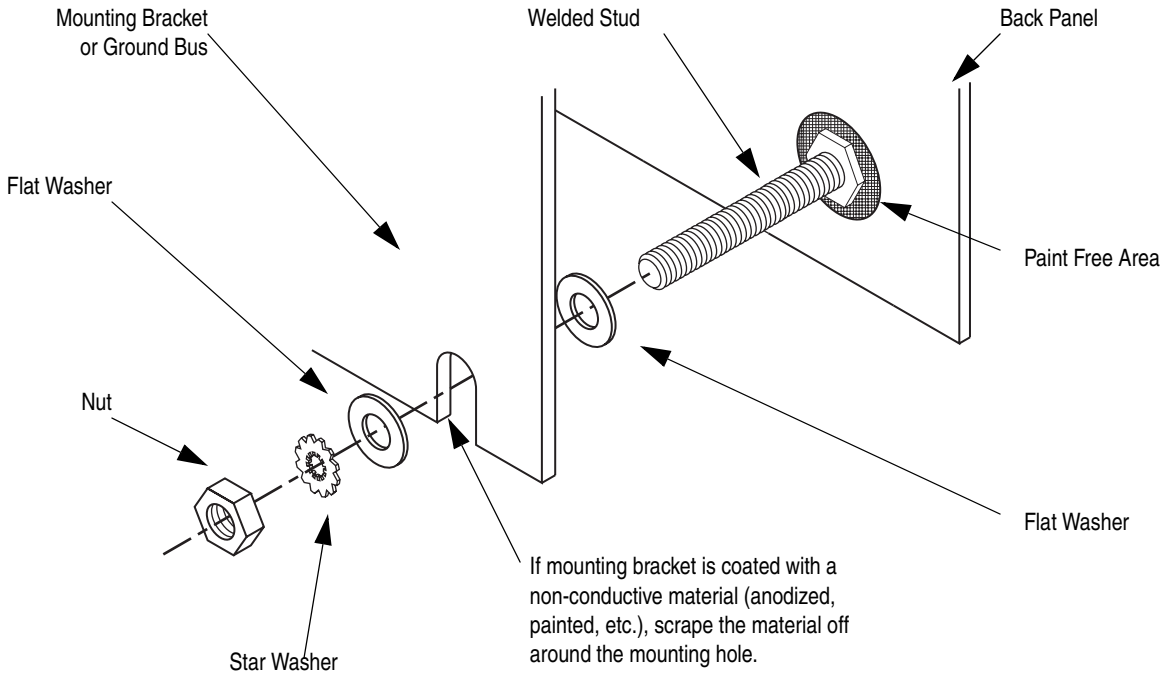
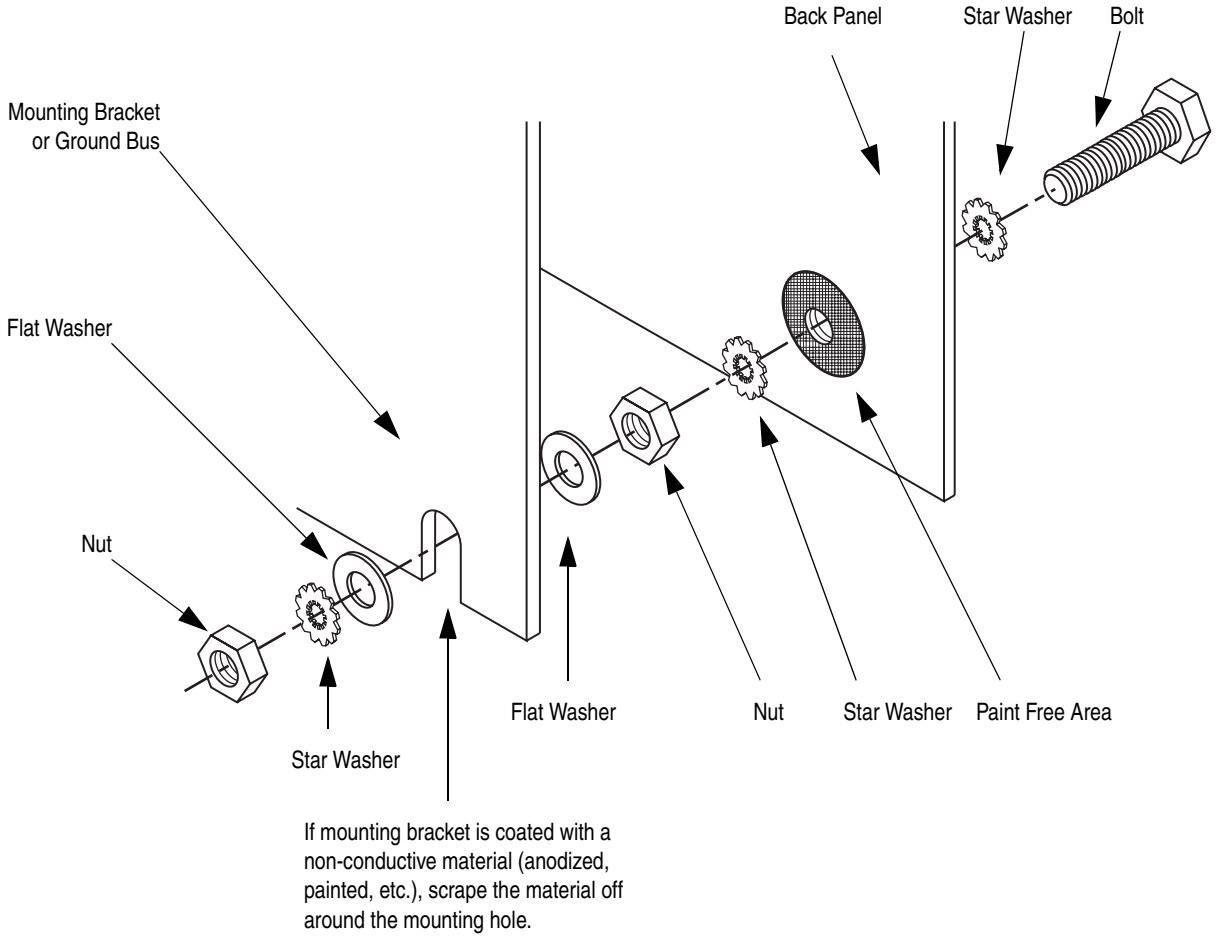


Figure 4.3 Bolt Mounting of Ground Bus or Chassis to Back Panel



If the drive chassis does not lay flat before the nuts/bolts are tightened, use additional washers as shims so that the chassis does not bend when you tighten the nuts.

Conduit Entry

Entry Plates

In most cases, the conduit entry plate will be a paint-free conductive material. The surface of the plate should be clean of oil or contaminants. If the plate is painted, use a connector that cuts through the paint and makes a high quality connection to the plate material

Or

Remove the paint around the holes to the bare metal one inch in from the edge of the plate. Grind down the paint on the top and bottom surfaces. Use a high quality joint compound when reassembling to avoid corrosion.

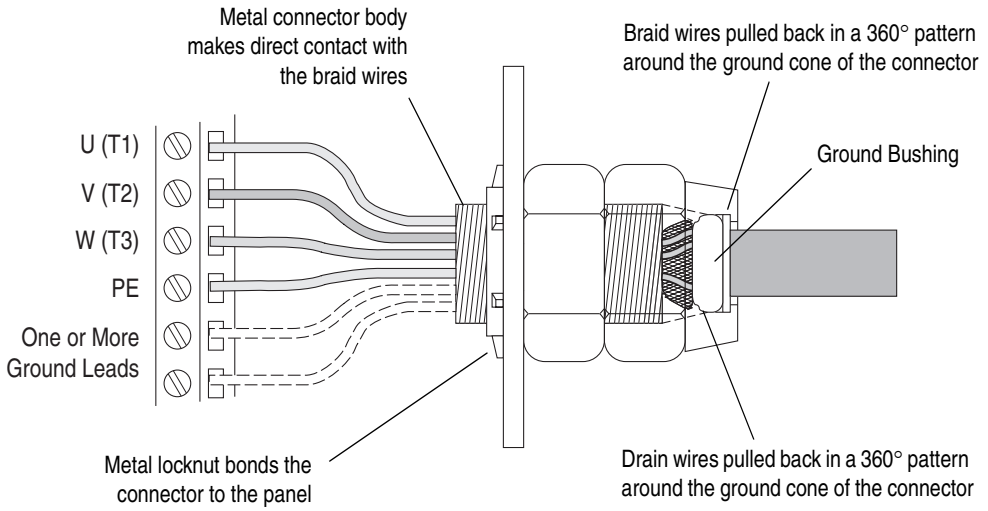
Cable Connectors/Glands

Choose cable connectors or glands that offer the best cable protection, shield termination and ground contact. Refer to Shield Termination on page 4-15 for more information.

Shield terminating connectors

The cable connector selected must provide good 360° contact and low transfer impedance from the shield or armor of the cable to the conduit entry plate at both the motor and the drive or drive cabinet for electrical bonding. SKINTOP® MS-SC/MS-SCL cable grounding connectors and NPT/PG adapters from LAPPUSA are good examples of this type of shield terminating gland.

Figure 4.4 Terminating the Shield with a Connector

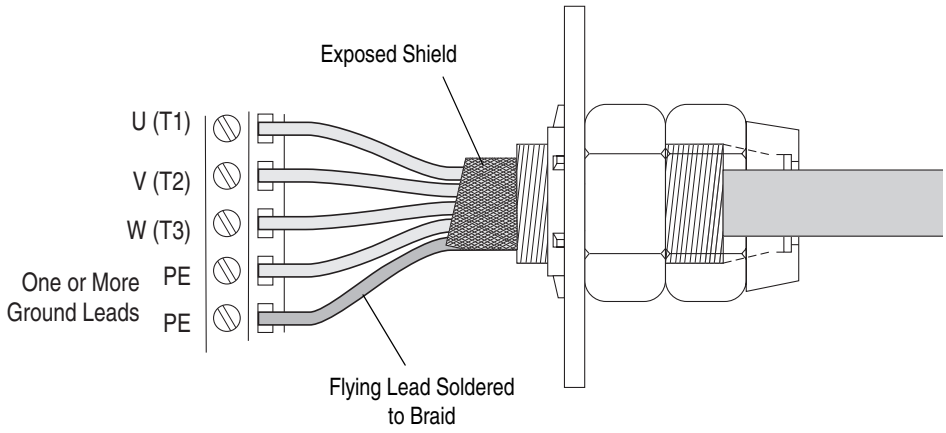


Important: This is mandatory for CE compliant installations, to meet requirements for containing radiated electromagnetic emissions.

Shield termination via Pigtail (Lead)

If a shield terminating connector is not available, the ground conductors or shields must be terminated to the appropriate ground terminal. If necessary, use a compression fitting for ground conductor(s) and/or shields together as they leave the cable fitting.

Figure 4.5 Terminating the Shield with a Pigtail Lead



Important: This is an acceptable industry practice for most installations. to minimize stray common mode currents

Pigtail termination is the least effective method of noise containment.

It is not recommended if:

- the cable length is greater than 1 m (39 in.) or extends beyond the panel
- in very noisy areas
- the cables are for very noise sensitive signals (for example, registration or encoder cables)
- strain relief is required

If a pigtail is used, pull and twist the exposed shield after separation from the conductors. Solder a flying lead to the braid to extend its length.

Ground Connections

Ground conductors should be connected with care to assure safe and adequate connections.

For individual ground connections, star washers and ring lugs should be used to make connections to mounting plates or other flat surfaces that do not provide proper compression lugs.

If a ground bus system is used in a cabinet, follow the bus bar mounting diagrams.

Figure 4.6 Connections to Ground Bus

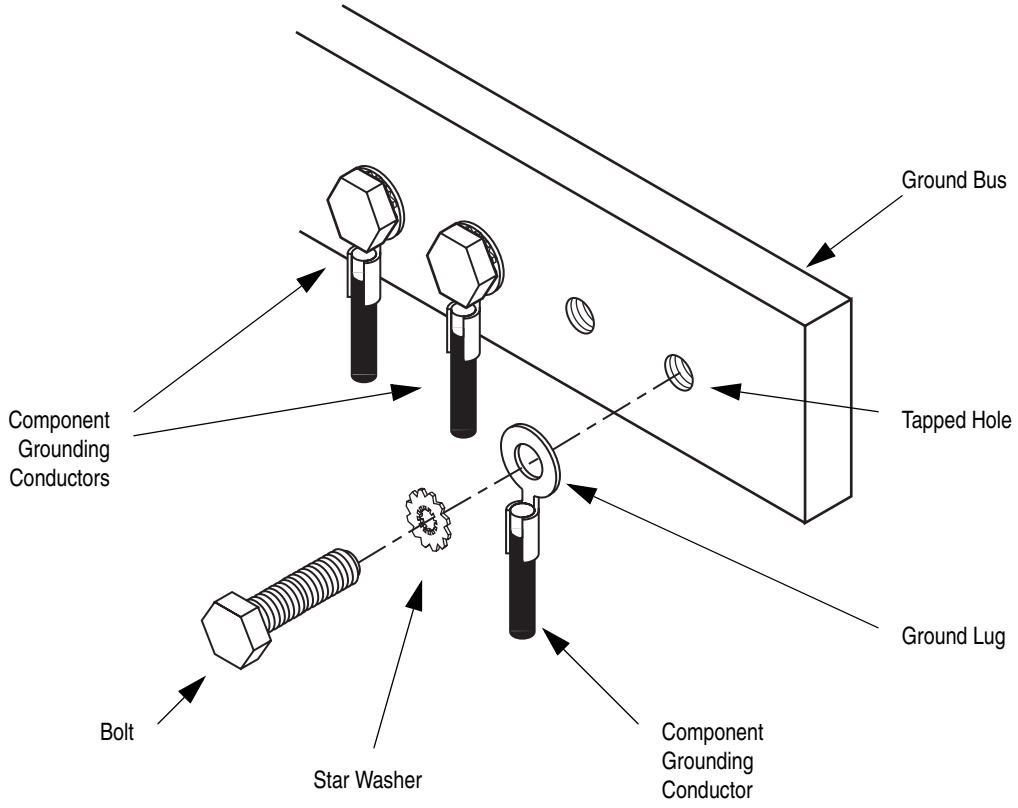
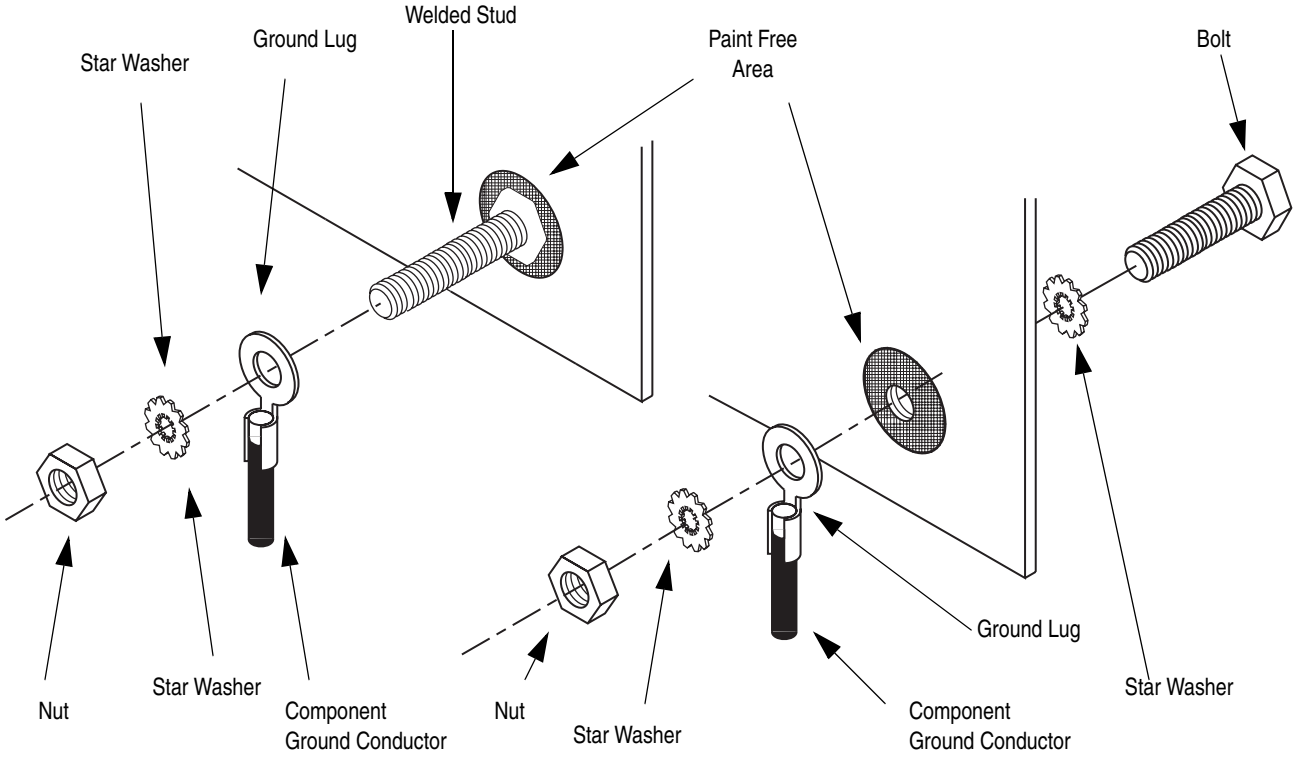
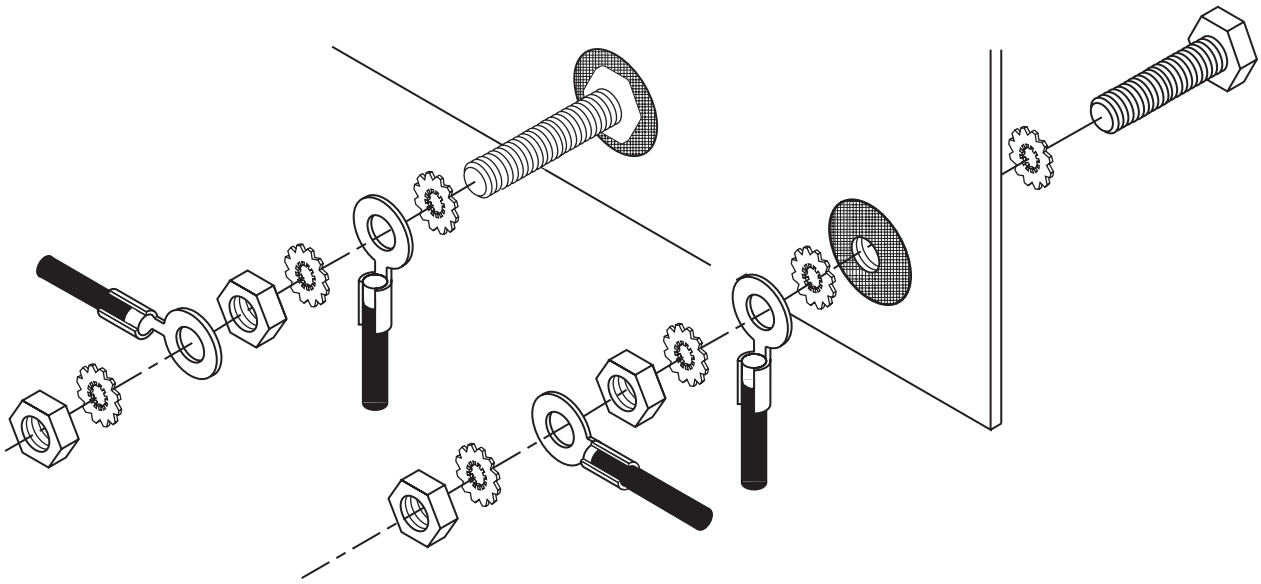


Figure 4.7 Ground Connections to Enclosure Wall



Do not lay one ground lug directly on top of the other. This type of connection can become loose due to compression of the metal lugs. Sandwich the first lug between a star washer and a nut with another star washer following. After tightening the nut, sandwich the second lug between the first nut and a second nut with a captive star washer.

Figure 4.8 Multiple Connections to Ground Stud or Bolts



Wire Routing

General

When routing wiring to a drive, separate high voltage power and motor leads from I/O and signal leads. To maintain separate routes, route these in separate conduit or use tray dividers.

Table 4.A Cable and Wiring Recommendations

Category	Wiring Level	Signal Definition	Signal Examples	Minimum Spacing (in inches) between Levels in Steel Conduits (Cable Trays)					Spacing Notes
				1	2/3/4	5/6	7/8	9/10/11	
Power	1	AC Power (600V or greater)	2.3kV 3-Ph AC Lines	0	3 (9)	3 (9)	3 (18)	Refer to Spacing Note 6	Refer to Spacing Notes 1, 2 and 5
	2	AC Power (less than 600V)	460V 3-Ph AC Lines	3 (9)	0	3 (6)	3 (12)	Refer to Spacing Note 6	Refer to Spacing Notes 1, 2 and 5
	3	AC Power	AC Motor						
	4	Dynamic Brake Cables	Refer to Spacing Note 7						
Control	5	115V ac/dc Logic	Relay Logic/PLC I/O Motor Thermostat	3 (9)	3 (6)	0	3 (9)	Refer to Spacing Note 6	Refer to Spacing Notes 1, 2 and 5
		115V ac Power	Power Supplies, Instruments						
	6	24V ac/dc Logic	PLC I/O						
Signal (Process)	7	Analog Signals, DC Supplies	Reference/Feedback Signal, 5 to 24V DC	3 (18)	3 (12)	3 (9)	0	1 (3)	Refer to Spacing Notes 2, 3, 4 and 5
		Digital (Low Speed)	TTK						
	8	Digital (High Speed)	I/O, Encoder, Counter Pulse Tach						
Signal (Comm)	9	Serial Communication	RS-232, 422 to Terminals/Printers	Refer to Spacing Note 6			1 (3)	0	
	11	Serial Communication (greater than 20k total)	ControlNet, DeviceNet, Remote I/O, Data Highway						

Example: Spacing relationship between 480V ac incoming power leads and 24V dc logic leads.

- 480V ac leads are Level 2; 24V dc leads are Level 6.
- For separate steel conduits, the conduits must be 3 inches (76 mm apart).
- In a cable tray, the two groups of leads must be 6 inches (152 mm) apart.

Spacing Notes:

1. Both outgoing and return current carrying conductors are pulled in the same conduit or laid adjacent in tray.
2. The following cable levels can be grouped together:

   A.Level 1: Equal to or above 601V.

   B.Levels 2, 3, & 4 may have respective circuits pulled in the same conduit or layered in the same tray.

   C.Levels 5 & 6 may have respective circuits pulled in the same conduit or layered in the same tray. **Note**: Bundle may not exceed conditions of NEC 310.

   D.Levels 7 & 8 may have respective circuits pulled in the same conduit or layered in the same tray. **Note**: Encoder cables run in a bundle may experience some amount of EMI coupling. The circuit application may dictate separate spacing.

   E.Levels 9, 10 & 11 may have respective circuits pulled in the same conduit or layered in the same tray. **Note**: Communication cables run in a bundle may experience some amount of EMI coupling and corresponding communication faults. The application may dictate separate spacing.
3. Level 7 through Level 11 wires must be shielded per recommendations.
4. In cable trays, steel separators are advisable between the class groupings.
5. If conduit is used, it must be continuous and composed of magnetic steel.
6. Spacing of Communication cables Levels 2 through 6 is the following:

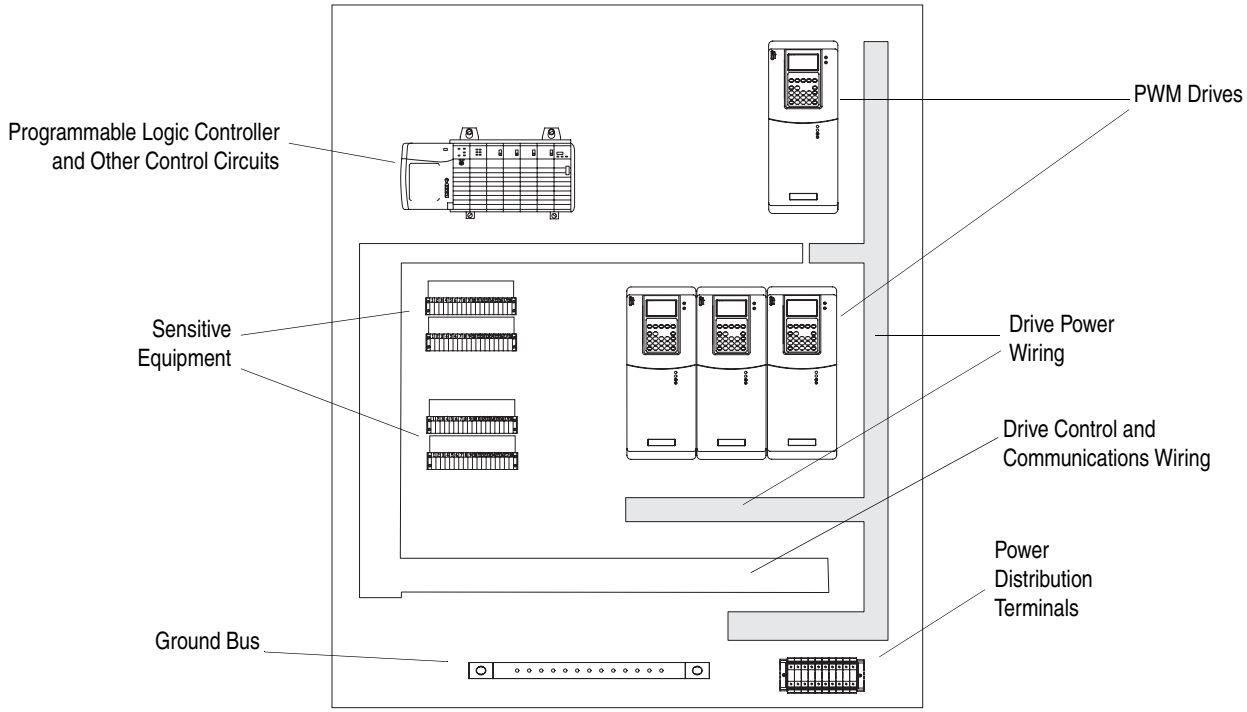
Conduit Spacing	Through Air Spacing
115V = 1 inch	115V = 2 inches
230V = 1.5 inches	230V = 4 inches
460/575V = 3 inches	460/575V = 8 inches
575 volts = proportional to 6 inches Per 1000V	575V proportional to 12 inches Per 1000V

7. If more than one brake module is required, the first module must be mounted within 3.0 m (10 ft.) of the drive. Each remaining brake module can be a maximum distance of 1.5 m (5 ft.) from the previous module. Resistors must be located within 30 m (100 ft.) of the chopper module.

Within A Cabinet

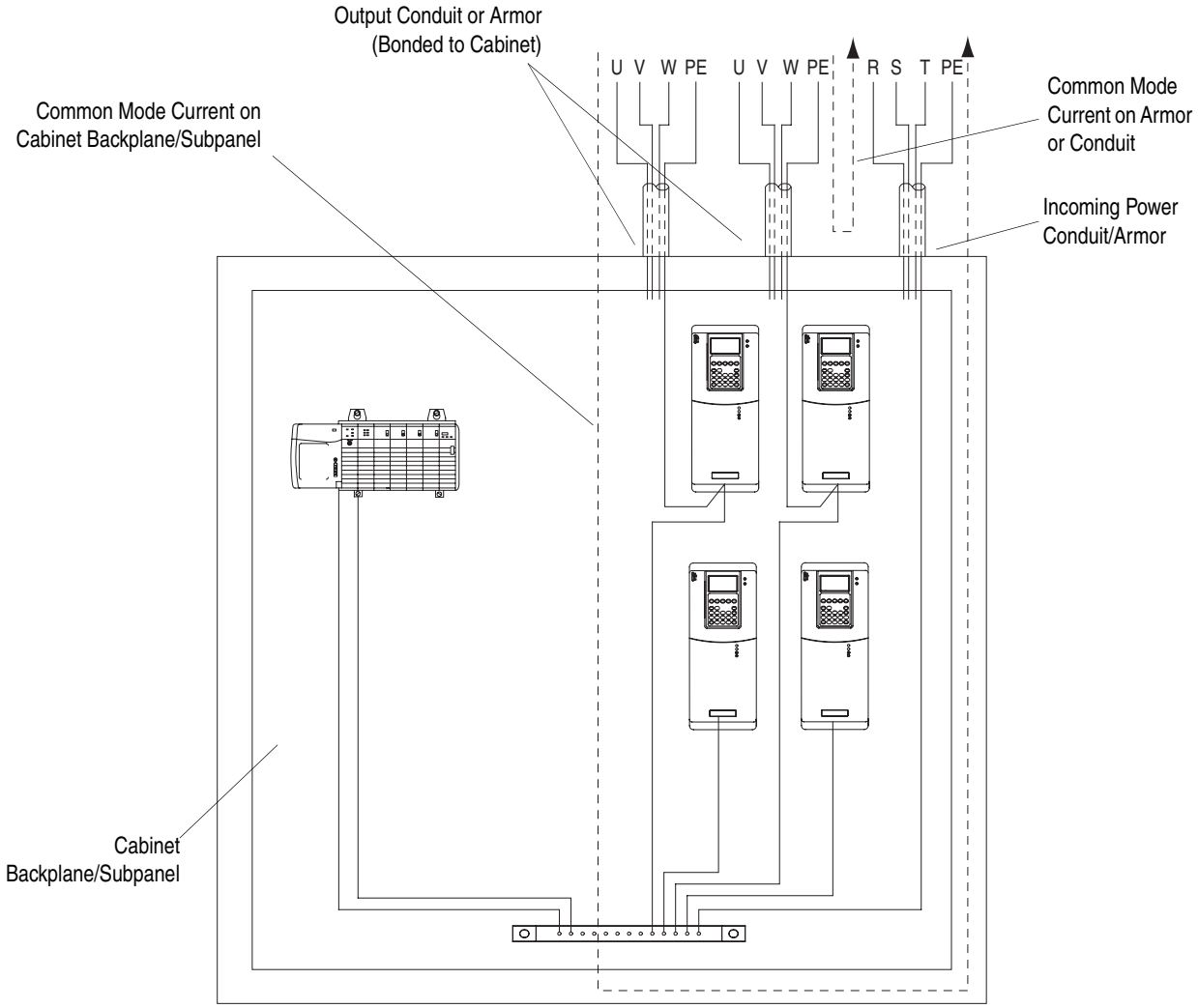
When multiple equipment is mounted in a common enclosure, group the input and output conduit/armor to one side of the cabinet as shown in Figure 4.9. Separating any Programmable Logic Controller (PLC) or other susceptible equipment cabling to the opposite side will minimize many effects of drive induced noise currents.

Figure 4.9 Separating Susceptible Circuits



Common mode noise current returning on the output conduit, shielding or armor can flow into the cabinet bond and most likely exit through the adjacent input conduit/armor bond near the cabinet top, well away from sensitive equipment (such as the PLC). Common mode current on the return ground wire from the motor will flow to the copper PE bus and back up the input PE ground wire, also away from sensitive equipment (Refer to Proper Cabinet Ground - Drives & Susceptible Equipment on page 4-12). If a cabinet PE ground wire is run it should be connected from the same side of the cabinet as the conduit/armor connections. This keeps the common mode noise shunted away from the PLC backplane.

Figure 4.10 Proper Cabinet Ground - Drives & Susceptible Equipment



Within Conduit

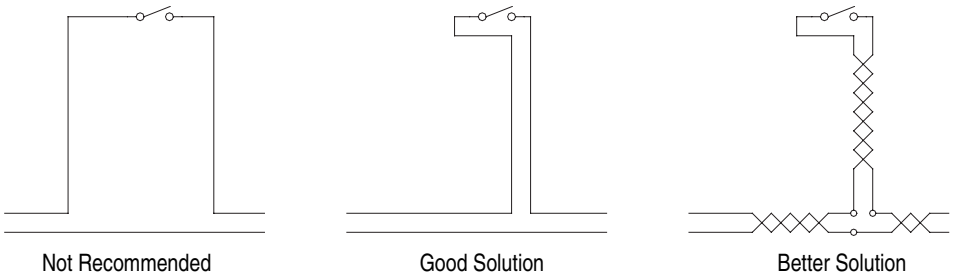
Do not route more than 3 sets of motor leads (3 drives) in the same conduit. Maintain fill rates per applicable electrical codes. **Do not** run power or motor cables and control or communications cables in the same conduit. If possible, avoid running incoming power leads and motor leads in the same conduit for long runs.

Loops, Antennas and Noise

When routing signal or communications wires, avoid routes that produce loops. Wires that form a loop can form an efficient antenna. Antennas work well in both receive and transmit modes, these loops can be responsible for noise received into the system and noise radiated from the system. Run feed

and return wires together rather than allow a loop to form. Twisting the pair together further reduces the antenna effects. Refer to Figure 4.11.

Figure 4.11 Avoiding Loops in Wiring



Conduit

Magnetic steel conduit is preferred. This type of conduit provides the best magnetic shielding. However not all applications allow the use of magnetic steel conduit. Stainless steel or PVC may be required. Conduit other than magnetic steel will not provide the same level of shielding for magnetic fields induced by the motor and input power currents.

Conduit must be installed so as to provide a continuous electrical path through the conduit itself. This path can become important in the containment of high frequency noise.

To avoid nicking, use caution when pulling the wire. Insulation damage can occur when nylon coated wiring such as THHN or THWN is pulled through conduit, particularly 90°bends. Nicking can significantly reduce or remove the insulation. Use great care when pulling nylon coated. Do not use water based lubricants with nylon coated wire such as THHN.

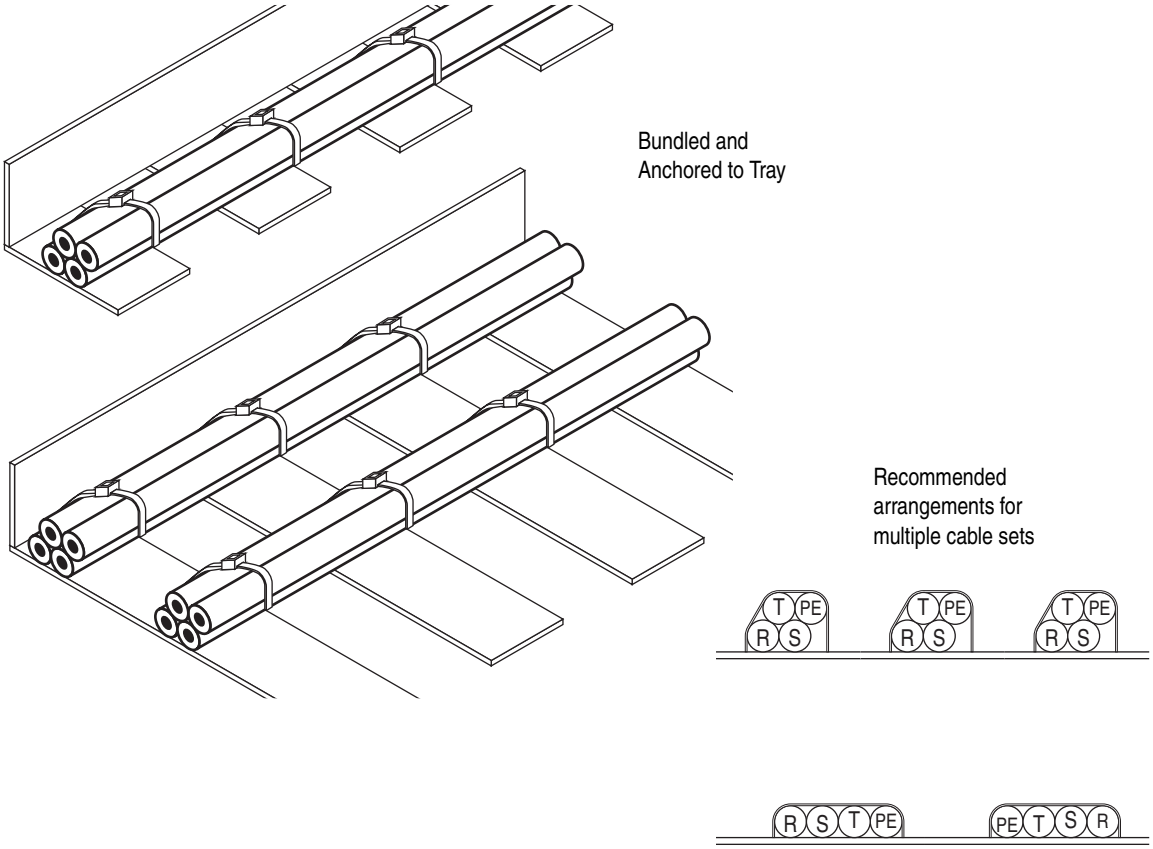
Do not route more than 3 sets of motor cables in one conduit. Maintain the proper fill rates per the applicable electrical codes.

Do not rely on the conduit as the ground return for a short circuit. Route a separate ground wire inside the conduit with the motor or input power wires.

Cable Trays

When laying cable in cable trays, do not randomly distribute them. Power cables for each drive should be bundled together and anchored to the tray. A minimum separation of one cable width should be maintained between bundles to reduce overheating and cross-coupling. Current flowing in one set of cables can induce a hazardous voltage and/or excessive noise on the cable set of another drive, even when no power is applied to the second drive.

Figure 4.12 Recommended Cable Tray Practices



Carefully arrange the geometry of multiple cable sets. Keep conductors within each group bundled. Arrange the order of the conductors to minimize the current which induced between sets and to balance the currents. This is critical on drives with power ratings of 200 HP (150 kW) and higher.

Maintain separation between power and control cables. When laying out cable tray for large drives make sure that cable tray or conduit containing signal wiring is separated from the conduit or trays containing power or motor wiring by 3 feet or more. Electromagnetic fields from power or motor currents can induce currents in the signal cables. Dividers also provide excellent separation.

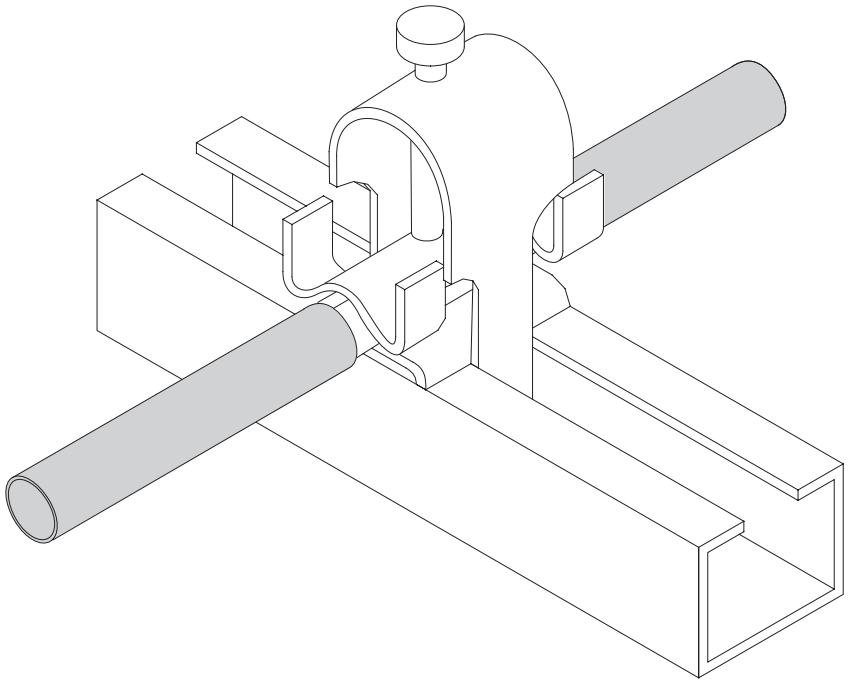
Shield Termination

Refer to Shield Splicing on page 3-7 to splice shielded cables. The following methods are acceptable if the shield connection to the ground is not accomplished by the gland or connector. Refer to the table associated with each type of clamp for advantages and disadvantages.

Termination via circular clamp

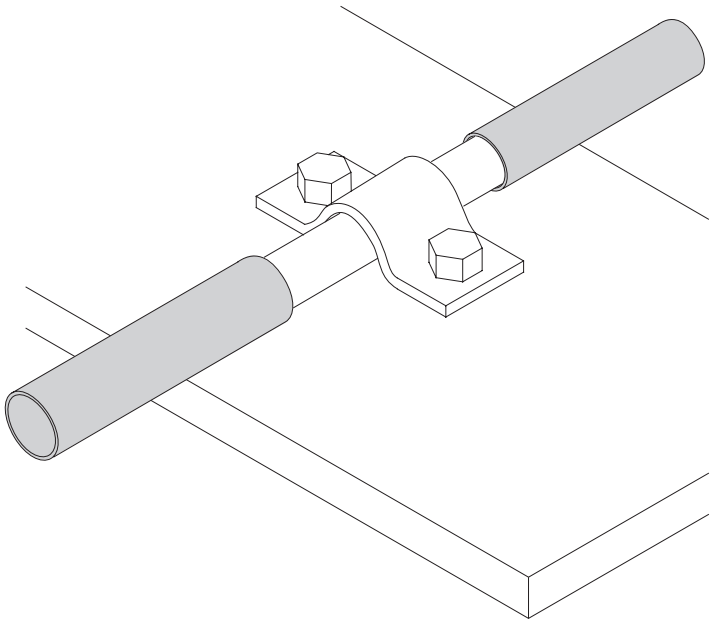
Clamp the cable to the main panel closest to the shield terminal using the circular section clamping method. The preferred method for grounding cable shields is clamping the circular section of 360°bonding, as shown in Figure 4.13. It has the advantage of covering a wide variety of cable diameters and drilling/mounting is not required. Its disadvantages are cost and availability in all areas.

Figure 4.13 Commercial Cable Clamp (Heavy Duty)



Plain copper saddle clamps, as shown in Figure 4.14, are sold in many areas for plumbing purposes, but are very effective and available in a range of sizes. They are low cost and offer good strain relief as well. You must drill mounting holes to use them.

Figure 4.14 Plain Copper Saddle Clamp



Shield Termination via Pigtail (Lead)

If a shield terminating connector is not available, the ground conductors and/or shields must be terminated to the appropriate ground terminal. If necessary, use a compression fitting on the ground conductor(s) or shield together as they leave the cable fitting.

Pigtail termination is the least effective method of noise containment.

It is not recommended if:

- the cable length is greater than 1 m (39 in.) or extends beyond the panel.
- being used in very noisy areas
- the cables are for very noise sensitive signals (for example, registration or encoder cables)
- strain relief is required

If a pigtail is used, pull and twist the exposed shield after separation from the conductors. To extend the length, solder a flying lead to the braid.

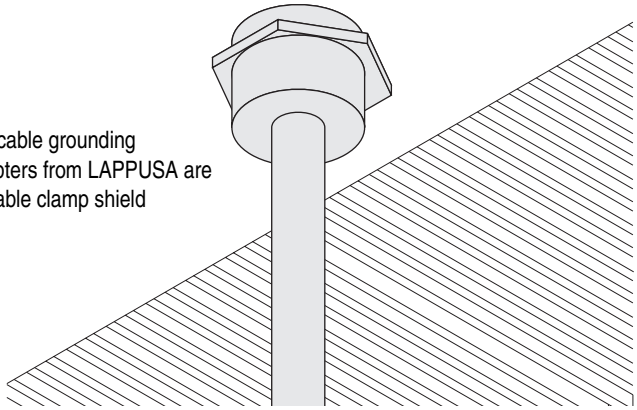
Shield Termination via Cable Clamp

Standard Cable

Grounding Cable glands are a simple and effective method for terminating shields while offering excellent strain relief. They are only applicable when entry is through a cabinet surface or bulkhead.

The cable connector selected must provide good 360° contact and low transfer impedance from the shield or armor of the cable to the conduit entry plate at both the motor and the drive or drive cabinet for electrical bonding.

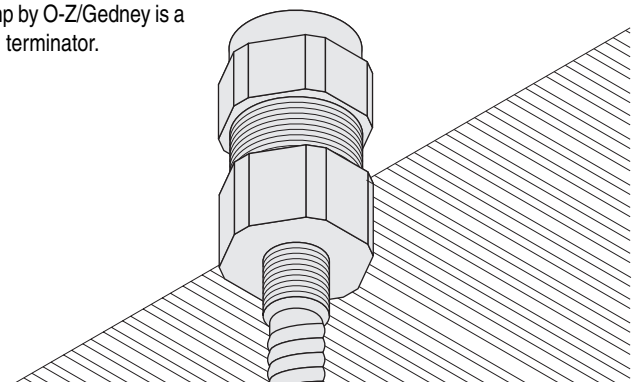
SKINTOP® MS-SC/MS-SCL cable grounding connectors and NPT/PG adapters from LAPPUSA are good examples of standard cable clamp shield terminating gland.



Armored Cable

Armored cable can be terminated in a similar manner to standard cable.

The Tek-Mate™ Fast-Fit cable clamp by O-Z/Gedney is a good example of an armored cable terminator.



Conductor Termination

Terminate power, motor and control connections to the drive terminal blocks. User manuals list minimum and maximum wire gauges, tightening torque for terminals and recommended lug types if stud connections are provided. Use a connector with 3 ground bushings when using a cable with 3 ground conductors. Bending radii minimums per the applicable electrical code should be followed.

Power TB

Power terminals are normally fixed (non-pull apart) and can be cage clamps, barrier strips or studs for ring type crimp lugs depending on the drive style and rating. Cage clamp styles may require a non-standard screwdriver. Crimp lugs will require a crimping tool. On smaller sizes, a stripping gauge may be provided on the drive to assist in the amount of insulation to remove. Normally the three phase input is not phase sensitive. That is, the sequence of A,B,C phases has no effect on the operation of the drive or the direction of motor rotation.

Control TB

Control terminal blocks are either pull apart or fixed (non pull apart). Terminals will be either spring clamp type or barrier strip. A stripping gauge may be provided on the drive to assist in the amount of insulation to remove. Some control connections, such as analog input and output signals, are polarity sensitive. Consult the applicable user manual for correct connection.

Signal TB

If an encoder or tachometer feedback is used, a separate terminal block or blocks may be provided. Consult the user manual for these phase sensitive connections. Improper wiring could lead to incorrect drive operation.

Cables terminated here are typically shielded and the signals being carried are generally more sensitive to noise. Carefully check the user manual for recommendations on shield termination. Some shields can be terminated at the terminal block and others will be terminated at the entry point.

Moisture

Refer to NEC Article 100 for definitions of Damp, Dry and Wet locations. The U.S. NEC permits the use of heat-resistant thermoplastic wire in both dry and damp applications (Table 310-13). However, PVC insulation material is more susceptible to absorbing moisture than XLPE (Cross Linked polyethylene) insulation material (XHHW-2) identified for use in wet locations. Because the PVC insulating material absorbs moisture, the corona inception voltage (CIV) insulation capability of the “damp” or “wet” THHN was found to be less than ½ of the same wire when “dry.” For this

reason, certain industries where water is prevalent in the environment have refrained from using THHN wire with IGBT drives.

Belden 29500 style cable is a PVC jacketed, shielded type TC with XLPE conductor insulation designed to meet NEC code designation XHHW-2 (use in wet locations per the U.S. NEC, Table 310-13). Based on Rockwell Automation research, tests have determined this cable is notably superior to loose wires in dry, damp and wet applications and can significantly reduce capacitive coupling and common mode noise. Other cable types for wet locations include continuous welded armor cables or CLX designation.

Notes:

Reflected Wave

This chapter discusses the reflected wave phenomenon and its impact on drive systems.

Description

The inverter section of a drive does not produce sinusoidal voltage, but rather a series of voltage pulses created from the DC bus. These pulses travel down the motor cables to the motor. The pulses are then reflected back to the drive. The reflection is dependent on the rise time of the drive output voltage, cable characteristics, cable length and motor impedance. If the voltage reflection is combined with another, subsequent pulse, peak voltages can be at a destructive level. A single IGBT drive output may have reflected wave transient voltage stresses of up to twice (2 pu or per unit) the DC bus voltage between its own output wires. Multiple drive output wires in a single conduit or wire tray further increase output wire voltage stress between multi-drive output wires that are touching. Drive #1 may have a (+) 2 pu stress while drive #2 may simultaneously have a (-) 2 pu stress.

Effects On Wire Types

Wires with dielectric constants greater than 4 cause the voltage stress to shift to the air gap between the wires that are barely touching. This electric field may be high enough to ionize the air surrounding the wire insulation and cause a partial discharge mechanism (corona) to occur. The electric field distribution between wires increases the possibility for corona and greater ozone production. This ozone attacks the PVC insulation and produces carbon tracking, leading to the possibility of insulation breakdown.

Based on field and internal testing, Rockwell Automation/Allen-Bradley has determined conductors manufactured with Poly-Vinyl Chloride (PVC) wire insulation are subject to a variety of manufacturing inconsistencies which can lead to premature insulation degradation when used with IGBT drives. Flame-retardant heat-resistant thermoplastic insulation is the type of insulation listed in the NEC code for the THHN wire designation. This type of insulation is commonly referred to as PVC. In addition to manufacturing inconsistencies, the physical properties of the cable can change due to environment, installation and operation, which can also lead to premature insulation degradation. The following is a summary of our findings:

Due to inconsistencies in manufacturing processes or wire pulling, air voids can also occur in the THHN wire between the nylon jacket and PVC insulation. Because the dielectric constant of air is much lower than the dielectric constant of the insulating material, the transient reflected wave voltage might appear across these voids. If the corona inception voltage

(CIV) for the air void is reached, ozone is produced. Ozone attacks the PVC insulation leading to a breakdown in cable insulation.

Asymmetrical construction of the insulation has also been observed for some manufacturers of PVC wire. A wire with a 15 mil specification was observed to have an insulation thickness of 10 mil at some points. The smaller the insulation thickness, the less voltage the wire can withstand.

THHN jacket material has a relatively brittle nylon that lends itself to damage (i.e. nicks and cuts) when pulled through conduit on long wire runs. This issue is of even greater concern when the wire is being pulled through multiple 90° bends in the conduit. These nicks may be a starting point for CIV leading to insulation degradation.

During operation, the conductor heats up and a “coldflow” condition may occur with PVC insulation at points where the unsupported weight of the wire may stretch the insulation. This has been observed at 90° bends where wire is dropped down to equipment from an above wireway. This “coldflow” condition produces thin spots in the insulation which lowers the cable's voltage withstand capability.

Refer to NEC Article 100 for definitions of Damp, Dry and Wet locations. The U.S. NEC permits the use of heat-resistant thermoplastic wire in both dry and damp applications (Table 310-13). However, PVC insulation material is more susceptible to absorbing moisture than XLPE (Cross Linked polyethylene) insulation material (XHHN-2) identified for use in wet locations. Because the PVC insulating material absorbs moisture, the Corona Inception Voltage insulation capability of the “damp” or “wet” THHN was found to be less than ½ of the same wire when “dry.” For this reason, certain industries where water is prevalent in the environment have refrained from using THHN wire with IGBT drives. Rockwell Automation strongly suggests the use of XLPE insulation for wet areas.

Length Restrictions For Motor Protection

To protect the motor from reflected waves, limit the length of the motor cables from the drive to the motor. Each drive's user manual lists the lead length limitations based on drive size and the quality of the insulation system in the chosen motor.

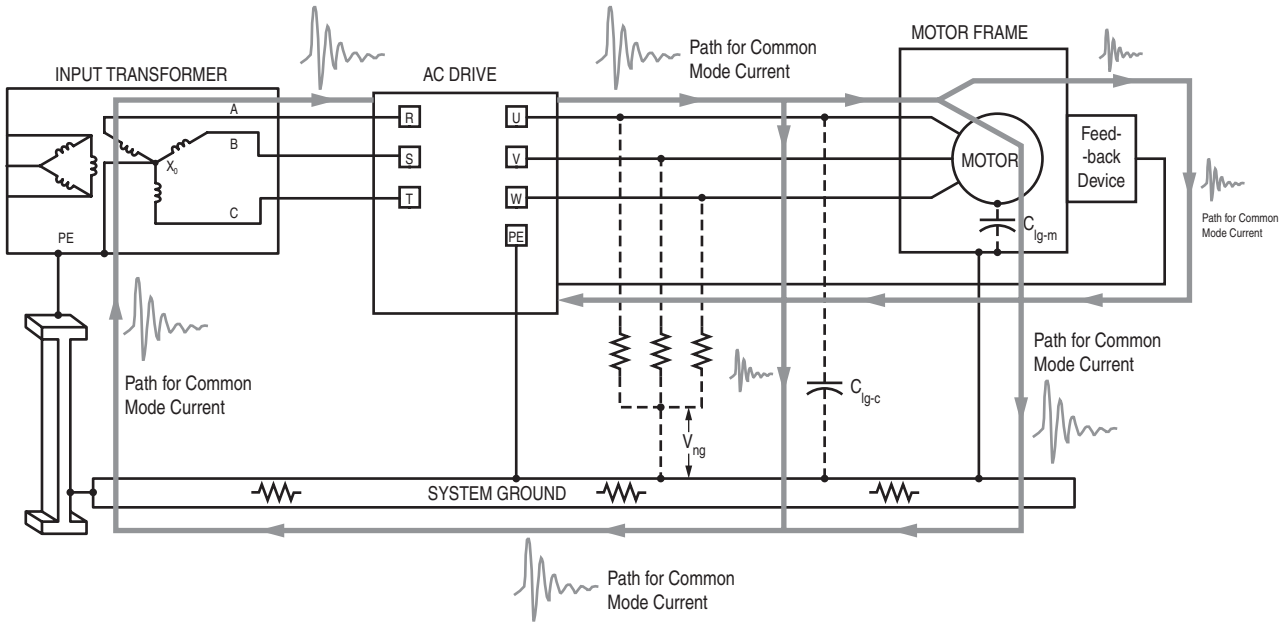
If the distance between drive and motor must exceed these limits, contact the local office or factory for analysis and advice. Refer to Appendix A for complete tables.

Electromagnetic Interference

This chapter discusses types of electromagnetic interference and its impact on drive systems.

What Causes Common Mode Noise

Faster output dv/dt transitions of IGBT drives increase the possibility for increased Common Mode (CM) electrical noise. Common Mode Noise is a type of electrical noise induced on signals with respect to ground.



There is a possibility for electrical noise from drive operation to interfere with adjacent sensitive electronic equipment, especially in areas where many drives are concentrated. Generating common mode currents by varying frequency inverters is similar to the common mode currents that occur with DC drives. Although AC drives produce a much higher frequency then DC drives (250 kHz - 6MHz). Inverters have a greater potential for exciting circuit resonance because of very fast turn on switches causing common mode currents to look for the lowest impedance path back to the inverter. The dv/dt and di/dt from the circulating ground currents can couple into the signal and logic circuits, causing improper operation and possible circuit damage. When conventional grounding techniques do not work you must use high frequency bonding techniques. If installers do not use these techniques, motor bearing currents increase and system circuit boards have the potential to fail prematurely. Currents in the ground system may cause problems with computer systems and distributed control systems.

Containing Common Mode Noise With Cabling

Cable type has a great effect on the ability to contain common mode noise in a system that incorporates a drive.

Conduit

The combination of a ground conductor and conduit contains most capacitive current and returns it to the drive without polluting the ground grid. A conduit may still have unintended contact with grid ground structure due to straps, support, etc. The AC resistance characteristics of earth are generally variable and unpredictable, making it difficult to predict how noise current will divide between wire, conduit or the ground grid.

Shielded or Armored Power Cable

The predominant return path for common mode noise is the shield/armor itself when using shielded or armored power cables. Unlike conduit, the shield/armor is isolated from accidental contact with grounds by a PVC outer coating. Making the majority of noise current flow in the controlled path and very little high frequency noise flows into the ground grid.

Noise current returning on the shield or safety ground wire is routed to the drive PE terminal, down to the cabinet PE ground bus, and then directly to the grounded neutral of the drive source transformer. Take care when bonding the armor or shield to the drive PE. A low impedance cable or strap is recommended when making this connection, as opposed to the smaller gauge ground wire either supplied as part of the motor cable or supplied separately. Otherwise, the higher frequencies associated with the common mode noise will find this cable impedance higher and look for a lower impedance path. The cable's radiated emissions are minimal because the armor completely covers the noisy power wires. Also, the armor prevents EMI coupling to other signal cables that might be routed in the same cable tray.

Another effective method of reducing common mode noise is to attenuate it before it can reach the ground grid. Installing a common mode ferrite core on the output cables can 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 located in a relatively small area. For more information see the *1321-M Common Mode Chokes Instructions*, publication 1321-5.0.

As a general rule:

IF the distance between the drive and motor or the distance between drive and input transformer is greater than 75 feet.

AND

IF sensitive circuits with leads greater then 75 feet such as: encoders, analog, or capacitive sensors are routed, in or out of the cabinet, near the drive or transformer

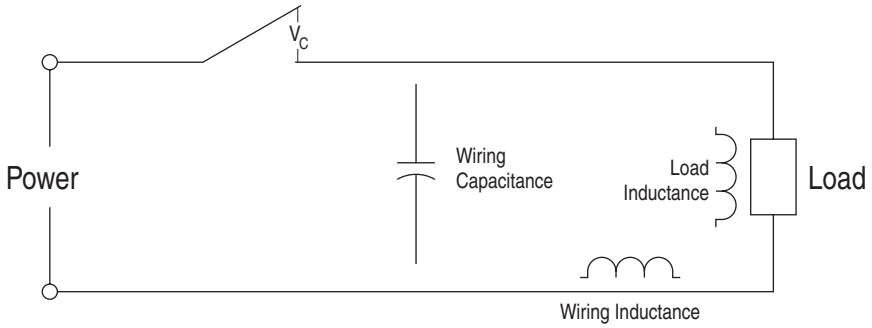
THEN

Common mode chokes should be installed.

How Electromechanical Switches Cause Transient Interference

Electromechanical contacts cause transient interference when switching inductive loads such as relays, solenoids, motor starters, or motors. Drives, as well as other devices having electronic logic circuits, are susceptible to this type of interference.

Examine the following circuit model for a switch controlling an inductive load. Both the load and the wiring have inductance, which prevents the current from stopping instantly when the switch contacts open. There is also stray capacitance in the wiring.

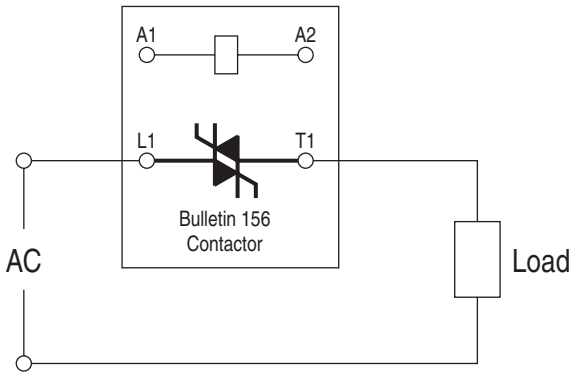


Interference occurs when the switch opens while it is carrying current. Load and cable inductance prevents the current from immediately stopping. The current continues to flow, and charges the capacitance in the circuit. The voltage across the switch contacts (VC) rises, as the capacitance charges. This voltage can reach very high levels. When the voltage exceeds the breakdown voltage for the space between the contacts, an arc occurs and the voltage returns to zero. Charging and arcing continues until the distance between the contacts is sufficient to provide insulation. The arcing radiates noise at an energy levels and frequencies that disturb logic and communication circuits.

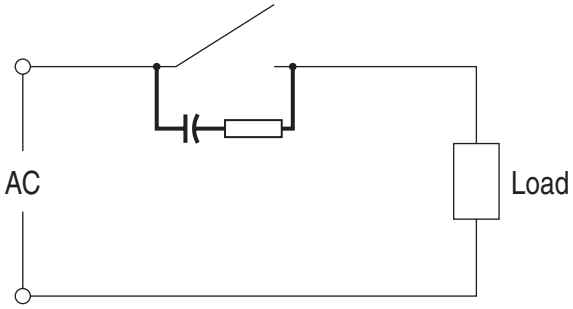
If the power source is periodic (like AC power), you can reduce the interference by opening the contact when the current waveform crosses zero. Opening the circuit farther from zero elevates the energy level and creates more interference.

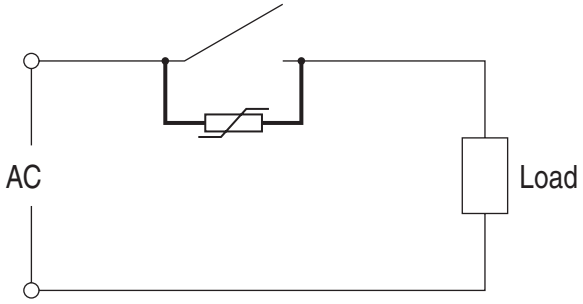
How to Prevent or Mitigate Transient Interference from Electromechanical Switches

The most effective way to avoid this type of transient interference, is to use a device like an Allen-Bradley Bulletin 156 contactor to switch inductive AC loads. These devices feature “zero cross” switching.

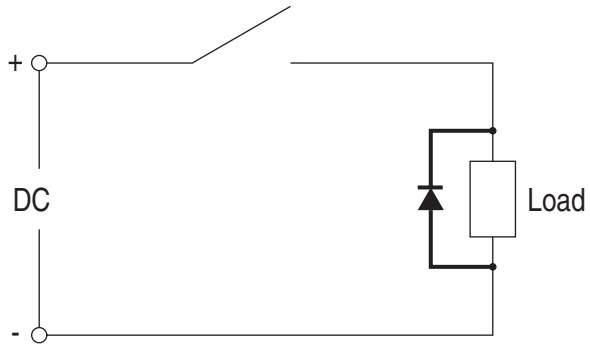


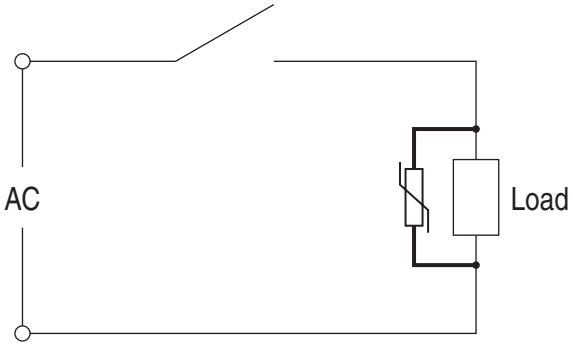
Putting Resistive-Capacitive (RC) networks or Voltage Dependant Resistors (Varistors) across contacts will mitigate transient interference. Make sure to select components rated to withstand the voltage, power and frequency of switching for your application.

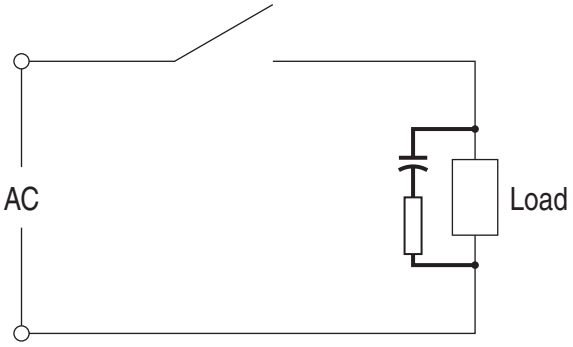




A common method for mitigating transient interference is to put a diode in parallel with an inductive DC load or a suppressor in parallel with an inductive AC load. Again, make sure to select components rated to withstand the voltage, power and frequency of switching for your application. These methods are not totally effective, because they do not entirely eliminate arcing at the contacts.

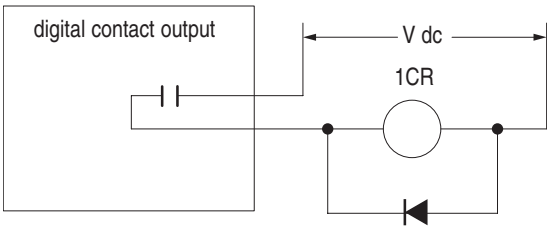






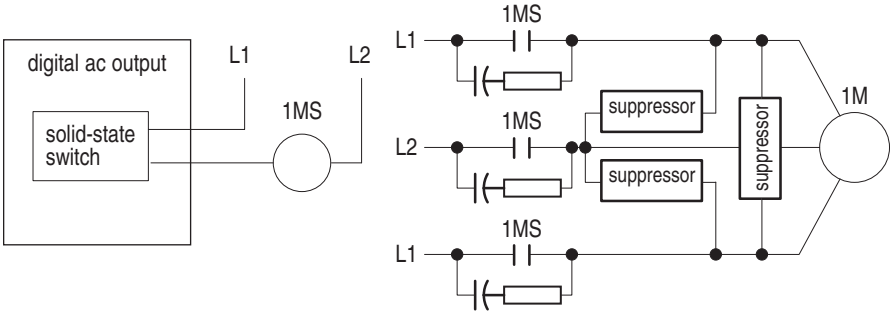
The following table contains examples which illustrate methods for mitigating transient interference.

Examples of Transient Interference Mitigation



Example 1:
A contact output controls a dc control relay.

The relay coil requires a suppressor (blocking diode) because it is an inductive device controlled by a dry contact.

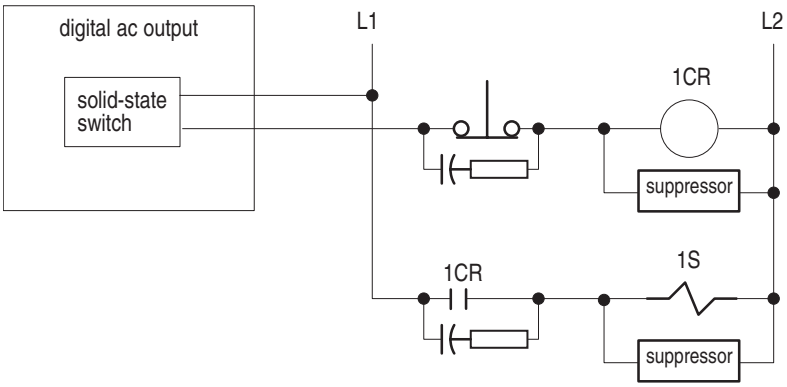


Example 2:
An ac output controls a motor starter, contacts on the starter control a motor.

The contacts require RC networks or Varistors.

The motor requires suppressors because it is an inductive device.

An inductive device controlled by a solid state switching device (like the starter coil in this example) typically does not require a suppressor.

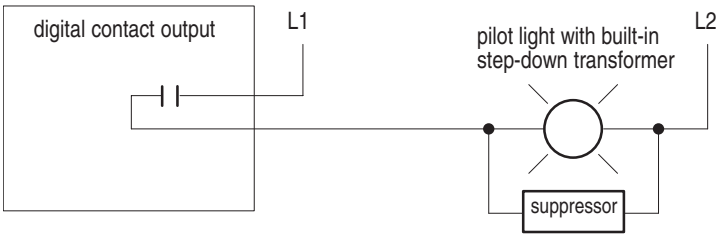


Example 3:
An ac output controls an interposing relay, but the circuit can be opened by dry contacts. Relay contacts control a solenoid coil.

The contacts require RC networks or Varistors.

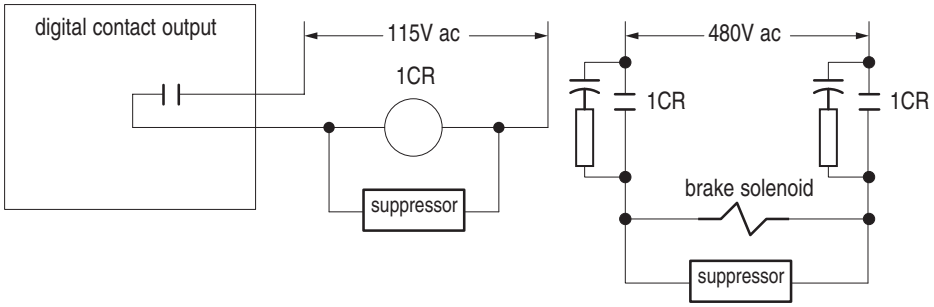
The relay coil requires a suppressor because it is an inductive device controlled by dry contacts.

The solenoid coil also requires a suppressor because it is an inductive device controlled by dry contacts.



Example 4:
A contact output controls a pilot light with a built in step-down transformer.

The pilot light requires a suppressor because its transformer is an inductive device controlled by a dry contact.



Example 5:
A contact output controls a relay, which controls a brake solenoid.

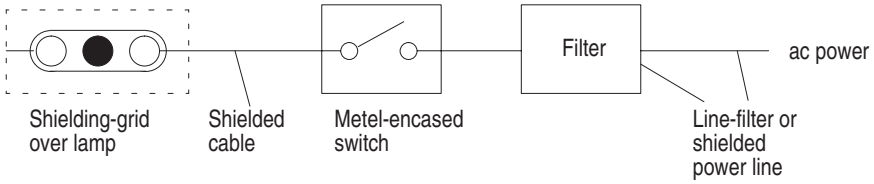
The contacts require RC networks or Varistors.

Both the relay and the brake solenoid require suppressors because they are both inductive devices controlled by dry contacts.

Enclosure Lighting

Fluorescent lamps are also sources of EMI. If you must use fluorescent lamps inside an enclosure, the following precautions may help guard against EMI problems from this source as shown in the figure below:

- install a shielding grid over the lamp
- use shielded cable between the lamp and its switch
- use a metal-encased switch
- install a filter between the switch and the power line, or shield the power-line cable



Bearing Current

The application of pulse-width modulated (PWM) inverters has led to significant advantages in terms of the performance, size, and efficiency of variable speed motor controls. However, the high switching rates used to obtain these advantages can also contribute to motor bearing damage due to bearing currents and Electric Discharge Machining (EDM). Bearing damage on motors supplied by PWM inverters is more likely to occur in applications where the coupling between the motor and load is not electrically conductive (such as belted loads), when the motor is lightly loaded, or when the motor is in an environment with ionized air. Other factors, such as the type of grease and the type of bearings used may also affect the longevity of motor bearings. Motor manufacturers that design and manufacture motors for use with variable frequency drives can offer solutions to help mitigate these potential problems.

Motor Cable Length Restrictions Tables

The distances listed in each table are valid only for specific cable constructions and may not be accurate for lesser cable designs, particularly if the length restriction is due to cable charging current (indicated in tables by shading). When choosing the proper cable, note the following definitions:

Unshielded Cable

- Tray cable - fixed geometry without foil or braided shield but including an exterior cover
- Individual wires not routed in metallic conduit

Shielded Cable

- Individual conductors routed in metallic conduit
- Fixed geometry cables with foil or braided shield of at least 75% coverage
- Belden 295xx or Alcatel C1202 needed, as indicated by individual table for specific drive
- Continuous weld or interlocked armored cables with no twist in the conductors (may have and optional foil shield)

Important: Certain shielded cable constructions may cause excessive cable charging currents and may interfere with proper application performance, particularly on smaller drive ratings. Shielded cables that do not maintain a fixed geometry, but rather twist the conductors and tightly wrap the bundle with a foil shield may cause unnecessary drive tripping. Unless specifically stated in the table, the distances listed ARE NOT applicable to this type of cable. Actual distances for this cable type may be considerably less.

Type A Motor

- No phase paper or misplaced phase paper
- Lower quality insulation systems
- Corona inception voltages between 850 and 1000 volts

Type B Motor

- Properly placed phase paper
- Medium quality insulation systems
- Corona inception voltages between 1000 and 1200 volts

1488V Motor

- Meets NEMA MG 1-1998 section 31 standard
- Insulation can withstand voltage spikes of 3.1 times rated motor voltage due to inverter operation.

1329 R/L Motor

- AC variable speed motors are “Control-Matched” for use with Allen-Bradley drives.
- Motor designed to meet or exceed the requirements of the Federal Energy Act of 1992.
- Optimized for variable speed operation and include premium inverter grade insulation systems, which meet or exceed NEMA MG1 (Part 31.40.4.2).

In the following PowerFlex 70/700, 700H, 700L & 700S tables, a "●" in any of the latter columns will indicate that this drive rating can be used with an Allen-Bradley Terminator (1204-TFA1/1204-TFB2) and/or Reflected Wave Reduction Device with Common Mode Choke (1204-RWC-17) or without choke (1204-RWR2).

- For the Terminator, the maximum cable length is 182.9 meters (600 feet) for 400/480/600V drives (not 690V). The PWM frequency must be 2 kHz. The 1204-TFA1 can be used only on low HP (5 HP & below), while the 1204-TFB2 can be used from 2-800 HP.
- 1204 Reflected Wave Reduction Device (all motor insulation classes):
  - 1204-RWR2-09
    2 kHz: 182.9m (600 ft.) at 400/480V and 121.9m (400 ft.) at 600V.
    4 kHz: 91.4m (300 ft.) at 400/480V and 61.0m (200 ft.) at 600V.
  - 1204-RWC-17
    2 kHz: 365.8m (1200 ft.) at 400/480/600V.
    4 kHz: 243.8m (800 ft.) at 400/480V and 121.9m (400 ft.) at 600V.

  For both devices, power dissipation in the damping resistor limits maximum cable length.

The 1321-RWR is a complete reflected wave reduction solution available for many of the PowerFlex drives. If available, a 1321-RWR catalog number will be indicated in the "Reactor/RWR" column. When not available, use the reactor and resistor information provided to build a solution.

For Further Information on ...	*see Publication ...*
1321-RWR	1321-TD001
1204-RWR2	1204-5.1
1204-RWC	1204-IN001
1204-TFxx	1204-IN002

PowerFlex 4 and 40 Drives

The drive should be installed as close to the motor as possible. Installations with long motor cables may require the addition of external devices to limit voltage reflections at the motor (reflected wave phenomena). See Table A.A for recommendations.

The reflected wave data applies to all frequencies 2 to 16 kHz.

For 240V ratings, reflected wave effects do not need to be considered.

Table A.A Maximum Cable Length Recommendation

Reflected Wave		
380-480V Ratings	**Motor Insulation Rating**	**Motor Cable Only[1]**
	1000 Vp-p	15 meters (49 feet)
	1200 Vp-p	40 meters (131 feet)
	1600 Vp-p	170 meters (558 feet)

(1) You can extend cable lengths by installing reactors at the drive end or other reflected wave mitigation devices (RWRs or Terminators) at the motor end. Consult factory for recommendations.

PowerFlex 400 Drives

The drive should be installed as close to the motor as possible. Installations with long motor cables may require the addition of external devices to limit voltage reflections at the motor (reflected wave phenomena). See Table A.B for recommendations. The reflected wave data applies to all frequencies 2 to 10 kHz. For 240V ratings, reflected wave effects do not need to be considered.

Table A.B Maximum Cable Length Recommendation

Reflected Wave		
380-480V Ratings	**Motor Insulation Rating**	**Motor Cable Only(1)**
	1000 Vp-p	7.6 meters (25 feet)
	1200 Vp-p	22.9 meters (75 feet)
	1600 Vp-p	152.4 meters (500 feet)

(1) You can extend cable lengths by installing reactors at the drive end or other reflected wave mitigation devices (RWRs or Terminators) at the motor end. Consult factory for recommendations.

PowerFlex 70 & 700 Drives

Table A.C PowerFlex 70 (Standard/Enhanced) & 700 (Standard/Vector), 400V Shielded/Unshielded Cable - *Meters (Feet)*

Drive Frame		Rating		No Solution				Reactor Only				Reactor + Damping Resistor or 1321-RWR				Reactor/RWR *(see page A-22)*	Resistor		Available Options			
70	700	kW	kHz	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
A	0	0.37	2	7.6 (25)	53.3 (175)	53.3 (175)	53.3 (175)	91.4 (300)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)				●		●	●
			4	7.6 (25)	53.3 (175)	53.3 (175)	53.3 (175)	18.3 (60)	91.4 (300)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)						●	●
		0.75	2	7.6 (25)	83.8 (275)	83.8 (275)	83.8 (275)	91.4 (300)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)				●		●	●
			4	7.6 (25)	76.2 (250)	76.2 (250)	76.2 (250)	18.3 (60)	91.4 (300)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)						●	●
		1.5	2	7.6 (25)	83.8 (275)	83.8 (275)	83.8 (275)	91.4 (300)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)				●	●	●	●
			4	7.6 (25)	76.2 (250)	76.2 (250)	76.2 (250)	18.3 (60)	91.4 (300)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						●	●
B		2.2	2	7.6 (25)	137.2 (450)	182.9 (600)	182.9 (600)	91.4 (300)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)				●	●	●	●
			4	7.6 (25)	91.4 (300)	152.4 (500)	182.9 (600)	18.3 (60)	91.4 (300)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						●	●
		4	2	7.6 (25)	137.2 (450)	243.8 (800)	243.8 (800)	91.4 (300)	243.8 (800)	243.8 (800)	243.8 (800)	243.8 (800)	243.8 (800)	243.8 (800)	243.8 (800)	1321-RWR8-DP				●		●
			4	7.6 (25)	91.4 (300)	152.4 (500)	213.4 (700)	18.3 (60)	91.4 (300)	243.8 (800)	243.8 (800)	182.9 (600)	243.8 (800)	243.8 (800)	243.8 (800)	1321-RWR8-DP						●
C		5.5	2	7.6 (25)	137.2 (450)	304.8 (1000)	304.8 (1000)	91.4 (300)	304.8 (1000)	304.8 (1000)	304.8 (1000)	304.8 (1000)	304.8 (1000)	304.8 (1000)	304.8 (1000)	1321-RWR12-DP				●		●
			4	7.6 (25)	91.4 (300)	152.4 (500)	213.4 (700)	18.3 (60)	91.4 (300)	304.8 (1000)	304.8 (1000)	182.9 (600)	304.8 (1000)	304.8 (1000)	304.8 (1000)	1321-RWR12-DP						●
	1	7.5	2	7.6 (25)	137.2 (450)	365.8 (1200)	365.8 (1200)	91.4 (300)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR18-DP				●		●
			4	7.6 (25)	91.4 (300)	152.4 (500)	213.4 (700)	18.3 (60)	91.4 (300)	365.8 (1200)	365.8 (1200)	182.9 (600)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR18-DP						●
D		11	2	7.6 (25)	137.2 (450)	365.8 (1200)	365.8 (1200)	91.4 (300)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR25-DP				●		
			4	7.6 (25)	91.4 (300)	152.4 (500)	213.4 (700)	18.3 (60)	91.4 (300)	365.8 (1200)	365.8 (1200)	182.9 (600)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR25-DP						
	2	15	2	7.6 (25)	137.2 (450)	365.8 (1200)	365.8 (1200)	91.4 (300)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR35-DP				●		
			4	7.6 (25)	91.4 (300)	152.4 (500)	213.4 (700)	18.3 (60)	91.4 (300)	365.8 (1200)	365.8 (1200)	182.9 (600)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR35-DP						
D		18.5	2	7.6 (25)	137.2 (450)	365.8 (1200)	365.8 (1200)	91.4 (300)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR35-DP				●		
			4	7.6 (25)	91.4 (300)	152.4 (500)	213.4 (700)	18.3 (60)	91.4 (300)	365.8 (1200)	365.8 (1200)	182.9 (600)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR35-DP						

Drive Frame		Rating		No Solution				Reactor Only				Reactor + Damping Resistor or 1321-RWR				Reactor/RWR *(see page A-22)*	Resistor		Available Options			
70	700	kW	kHz	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
D	**3**	22	2	7.6 (25)	137.2 (450)	365.8 (1200)	365.8 (1200)	91.4 (300)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR45-DP				●		
			4	7.6 (25)	91.4 (300)	152.4 (500)	213.4 (700)	18.3 (60)	91.4 (300)	365.8 (1200)	365.8 (1200)	182.9 (600)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR45-DP						
E		30	2	7.6 (25)	137.2 (450)	304.8 (1000)	365.8 (1200)	91.4 (300)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR55-DP				●		
			4	7.6 (25)	91.4 (300)	152.4 (500)	213.4 (700)	18.3 (60)	91.4 (300)	365.8 (1200)	365.8 (1200)	182.9 (600)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR55-DP						
		37	2	12.2 (40)	137.2 (450)	304.8 (1000)	365.8 (1200)	91.4 (300)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR80-DP				●		
			4	12.2 (40)	91.4 (300)	152.4 (500)	213.4 (700)	18.3 (60)	91.4 (300)	365.8 (1200)	365.8 (1200)	182.9 (600)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR80-DP						
	4	45	2	12.2 (40)	137.2 (450)	304.8 (1000)	365.8 (1200)	91.4 (300)	304.8 (1000)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR80-DP				●		
			4	12.2 (40)	91.4 (300)	152.4 (500)	213.4 (700)	24.4 (80)	91.4 (300)	365.8 (1200)	365.8 (1200)	152.4 (500)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR80-DP						
	5	55	2	12.2 (40)	137.2 (450)	304.8 (1000)	365.8 (1200)	91.4 (300)	274.3 (900)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR100-DP				●		
			4	12.2 (40)	91.4 (300)	152.4 (500)	213.4 (700)	24.4 (80)	91.4 (300)	365.8 (1200)	365.8 (1200)	152.4 (500)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR100-DP						
		75	2	18.3 (60)	137.2 (450)	304.8 (1000)	365.8 (1200)	91.4 (300)	213.4 (700)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR130-DP				●		
			4	18.3 (60)	91.4 (300)	152.4 (500)	213.4 (700)	30.5 (100)	91.4 (300)	304.8 (1000)	365.8 (1200)	152.4 (500)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR130-DP						
	6	90	2	18.3 (60)	137.2 (450)	304.8 (1000)	365.8 (1200)	91.4 (300)	213.4 (700)	365.8 (1200)	365.8 (1200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR160-DP				●		
			4	18.3 (60)	91.4 (300)	152.4 (500)	213.4 (700)	30.5 (100)	91.4 (300)	365.8 (1200)	365.8 (1200)	121.9 (400)	243.8 (800)	365.8 (1200)	365.8 (1200)	1321-RWR160-DP						
		110	2	24.4 (80)	137.2 (450)	274.3 (900)	365.8 (1200)	76.2 (250)	198.1 (650)	365.8 (1200)	365.8 (1200)	274.3 (900)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR200-DP				●		
			4	24.4 (80)	91.4 (300)	152.4 (500)	213.4 (700)	36.6 (120)	91.4 (300)	365.8 (1200)	365.8 (1200)	121.9 (400)	213.4 (700)	365.8 (1200)	365.8 (1200)	1321-RWR200-DP						
		132	2	24.4 (80)	137.2 (450)	274.3 (900)	365.8 (1200)	61.0 (200)	182.9 (600)	365.8 (1200)	365.8 (1200)	243.8 (800)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR250-DP				●		
			4	24.4 (80)	91.4 (300)	152.4 (500)	213.4 (700)	36.6 (120)	91.4 (300)	365.8 (1200)	365.8 (1200)	91.4 (300)	182.9 (600)	365.8 (1200)	365.8 (1200)	1321-RWR250-DP						
	7	160	2	24.4 (80)	121.9 (400)	243.8 (800)	365.8 (1200)	61.0 (200)	152.4 (500)	304.8 (1000)	365.8 (1200)	243.8 (800)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-3RB320-B	50	225		●		
			4	24.4 (80)	91.4 (300)	152.4 (500)	182.9 (600)	36.6 (120)	91.4 (300)	182.9 (600)	274.3 (900)	91.4 (300)	182.9 (600)	365.8 (1200)	365.8 (1200)	1321-3RB320-B	50	450				
		180	2	24.4 (80)	121.9 (400)	243.8 (800)	365.8 (1200)	61.0 (200)	152.4 (500)	304.8 (1000)	365.8 (1200)	243.8 (800)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-3RB320-B	50	225		●		
			4	24.4 (80)	91.4 (300)	152.4 (500)	182.9 (600)	36.6 (120)	91.4 (300)	182.9 (600)	274.3 (900)	91.4 (300)	182.9 (600)	365.8 (1200)	365.8 (1200)	1321-3RB320-B	50	450				
	8	200	2	24.4 (80)	121.9 (400)	243.8 (800)	365.8 (1200)	61.0 (200)	152.4 (500)	304.8 (1000)	365.8 (1200)	243.8 (800)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-3RB400-B[1]	20	495		●		
			4	24.4 (80)	91.4 (300)	152.4 (500)	182.9 (600)	36.6 (120)	91.4 (300)	182.9 (600)	228.6 (750)	91.4 (300)	182.9 (600)	304.8 (1000)	365.8 (1200)	1321-3RB400-B[1]	20	990				
		240	2	24.4 (80)	121.9 (400)	243.8 (800)	365.8 (1200)	61.0 (200)	152.4 (500)	304.8 (1000)	365.8 (1200)	243.8 (800)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-3R400-B[1]	20	495		●		
			4	24.4 (80)	91.4 (300)	152.4 (500)	182.9 (600)	36.6 (120)	91.4 (300)	167.6 (550)	213.4 (700)	91.4 (300)	182.9 (600)	304.8 (1000)	365.8 (1200)	1321-3RB400-B[1]	20	990				
		280	2	24.4 (80)	121.9 (400)	213.4 (700)	304.8 (1000)	45.7 (150)	121.9 (400)	304.8 (1000)	365.8 (1200)	228.6 (750)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-3R500-B[1]	20	495		●		
			4	24.4 (80)	91.4 (300)	152.4 (500)	182.9 (600)	36.6 (120)	91.4 (300)	167.6 (550)	213.4 (700)	91.4 (300)	182.9 (600)	304.8 (1000)	365.8 (1200)	1321-3R500-B[1]	20	990				
		300	2	24.4 (80)	121.9 (400)	213.4 (700)	259.1 (850)	45.7 (150)	121.9 (400)	304.8 (1000)	365.8 (1200)	228.6 (750)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-3R600-B[1]	20	495		●		
			4	24.4 (80)	91.4 (300)	152.4 (500)	182.9 (600)	36.6 (120)	91.4 (300)	167.6 (550)	213.4 (700)	91.4 (300)	182.9 (600)	304.8 (1000)	365.8 (1200)	1321-3R600-B[1]	20	990				
	8	350	2	24.4 (80)	121.9 (400)	213.4 (700)	259.1 (850)	45.7 (150)	121.9 (400)	304.8 (1000)	365.8 (1200)	228.6 (750)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-3R600-B[1]	20	495		●		
			4	24.4 (80)	91.4 (300)	152.4 (500)	182.9 (600)	36.6 (120)	91.4 (300)	167.6 (550)	213.4 (700)	91.4 (300)	182.9 (600)	304.8 (1000)	365.8 (1200)	1321-3R600-B[1]	20	990				

Drive Frame		Rating		No Solution				Reactor Only				Reactor + Damping Resistor or 1321-RWR				Reactor/RWR *(see page A-22)*	Resistor		Available Options			
70	700	kW	kHz	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
	9	400	2	24.4 (80)	91.4 (300)	152.4 (500)	213.4 (700)	36.6 (120)	91.4 (300)	304.8 (1000)	365.8 (1200)	198.1 (650)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-3R750-B[2]	20	735		●		
			4	24.4 (80)	91.4 (300)	137.2 (450)	167.6 (550)	36.6 (120)	91.4 (300)	152.4 (500)	182.9 (600)	76.2 (250)	137.2 (450)	274.3 (900)	365.8 (1200)	1321-3R750-B[2]	20	1470				
	10	500	2	24.4 (80)	91.4 (300)	152.4 (500)	213.4 (700)	36.6 (120)	91.4 (300)	304.8 (1000)	365.8 (1200)	198.1 (650)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-3R850-B[2]	20	735		●		
			4	24.4 (80)	91.4 (300)	137.2 (450)	167.6 (550)	36.6 (120)	91.4 (300)	152.4 (500)	182.9 (600)	76.2 (250)	137.2 (450)	274.3 (900)	365.8 (1200)	1321-3R850-B[2]	20	1470				

(1) Requires two parallel cables.
(2) Requires three parallel cables.

Table A.D PowerFlex 70 (Standard/Enhanced) & 700 (Standard/Vector), 480V Shielded/Unshielded Cable - *Meters (Feet)*

Drive Frame		Rating		No Solution				Reactor Only				Reactor + Damping Resistor or 1321-RWR				Reactor/RWR *(see page A-22)*	Resistor		Available Options			
70	700	HP	kHz	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
A	**0**	0.5	2	7.6 (25)	12.2 (40)	53.3 (175)	53.3 (175)	7.6 (25)	91.4 (300)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)				●		●	●
			4	7.6 (25)	12.2 (40)	53.3 (175)	53.3 (175)	7.6 (25)	12.2 (40)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)						●	●
		1	2	7.6 (25)	12.2 (40)	83.8 (275)	83.8 (275)	7.6 (25)	91.4 (300)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)				●		●	●
			4	7.6 (25)	12.2 (40)	76.2 (250)	76.2 (250)	7.6 (25)	12.2 (40)	121.9 (400)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)						●	●
		2	2	7.6 (25)	12.2 (40)	83.8 (275)	83.8 (275)	7.6 (25)	91.4 (300)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)				●	●	●	●
			4	7.6 (25)	12.2 (40)	76.2 (250)	76.2 (250)	7.6 (25)	12.2 (40)	121.9 (400)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						●	●
B		3	2	7.6 (25)	12.2 (40)	129.5 (425)	129.5 (425)	7.6 (25)	91.4 (300)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)				●	●	●	●
			4	7.6 (25)	12.2 (40)	121.9 (400)	121.9 (400)	7.6 (25)	12.2 (40)	121.9 (400)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						●	●
		5	2	7.6 (25)	12.2 (40)	137.2 (450)	182.9 (600)	7.6 (25)	91.4 (300)	243.8 (800)	243.8 (800)	182.9 (600)	243.8 (800)	243.8 (800)	243.8 (800)	1321-RWR8-DP			●	●	●	●
			4	7.6 (25)	12.2 (40)	121.9 (400)	182.9 (600)	7.6 (25)	12.2 (40)	121.9 (400)	243.8 (800)	182.9 (600)	243.8 (800)	243.8 (800)	243.8 (800)	1321-RWR8-DP					●	●
C		7.5	2	7.6 (25)	12.2 (40)	137.2 (450)	182.9 (600)	7.6 (25)	91.4 (300)	304.8 (1000)	304.8 (1000)	182.9 (600)	304.8 (1000)	304.8 (1000)	304.8 (1000)	1321-RWR12-DP				●		●
			4	7.6 (25)	12.2 (40)	121.9 (400)	182.9 (600)	7.6 (25)	12.2 (40)	121.9 (400)	304.8 (1000)	182.9 (600)	304.8 (1000)	304.8 (1000)	304.8 (1000)	1321-RWR12-DP						●
	1	10	2	7.6 (25)	12.2 (40)	137.2 (450)	182.9 (600)	7.6 (25)	91.4 (300)	365.8 (1200)	365.8 (1200)	182.9 (600)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR18-DP				●		●
			4	7.6 (25)	12.2 (40)	121.9 (400)	182.9 (600)	7.6 (25)	12.2 (40)	121.9 (400)	304.8 (1000)	182.9 (600)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR18-DP						●
D		15	2	7.6 (25)	12.2 (40)	137.2 (450)	182.9 (600)	7.6 (25)	91.4 (300)	365.8 (1200)	365.8 (1200)	182.9 (600)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR25-DP				●		
			4	7.6 (25)	12.2 (40)	121.9 (400)	182.9 (600)	7.6 (25)	12.2 (40)	121.9 (400)	304.8 (1000)	182.9 (600)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR25-DP						
	2	20	2	7.6 (25)	12.2 (40)	137.2 (450)	182.9 (600)	7.6 (25)	91.4 (300)	365.8 (1200)	365.8 (1200)	182.9 (600)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR35-DP				●		
			4	7.6 (25)	12.2 (40)	121.9 (400)	182.9 (600)	7.6 (25)	12.2 (40)	121.9 (400)	304.8 (1000)	182.9 (600)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR35-DP						
		25	2	7.6 (25)	12.2 (40)	137.2 (450)	182.9 (600)	7.6 (25)	76.2 (250)	365.8 (1200)	365.8 (1200)	182.9 (600)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR35-DP				●		
			4	7.6 (25)	12.2 (40)	121.9 (400)	182.9 (600)	7.6 (25)	12.2 (40)	121.9 (400)	274.3 (900)	152.4 (500)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR35-DP						
	3	30	2	7.6 (25)	12.2 (40)	137.2 (450)	182.9 (600)	7.6 (25)	76.2 (250)	365.8 (1200)	365.8 (1200)	182.9 (600)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR45-DP				●		
			4	7.6 (25)	12.2 (40)	121.9 (400)	182.9 (600)	7.6 (25)	12.2 (40)	121.9 (400)	243.8 (800)	152.4 (500)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR45-DP						
E		40	2	7.6 (25)	12.2 (40)	137.2 (450)	182.9 (600)	7.6 (25)	76.2 (250)	365.8 (1200)	365.8 (1200)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR55-DP				●		
			4	7.6 (25)	12.2 (40)	106.7 (350)	152.4 (500)	7.6 (25)	12.2 (40)	106.7 (350)	228.6 (750)	121.9 (400)	243.8 (800)	365.8 (1200)	365.8 (1200)	1321-RWR55-DP						

Drive Frame		Rating		No Solution				Reactor Only				Reactor + Damping Resistor or 1321-RWR				Reactor/RWR *(see page A-22)*	Resistor		Available Options			
70	700	HP	kHz	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
E	3	50	2	12.2 (40)	18.3 (60)	137.2 (450)	182.9 (600)	12.2 (40)	61.0 (200)	304.8 (1000)	365.8 (1200)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR80-DP				●		
			4	7.6 (25)	12.2 (40)	91.4 (300)	152.4 (500)	12.2 (40)	18.3 (60)	106.7 (350)	228.6 (750)	91.4 (300)	243.8 (800)	365.8 (1200)	365.8 (1200)	1321-RWR80-DP						
	4	60	2	12.2 (40)	18.3 (60)	137.2 (450)	182.9 (600)	12.2 (40)	61.0 (200)	304.8 (1000)	365.8 (1200)	137.2 (450)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR80-DP				●		
			4	7.6 (25)	12.2 (40)	91.4 (300)	152.4 (500)	12.2 (40)	24.4 (80)	91.4 (300)	228.6 (750)	76.2 (250)	213.4 (700)	365.8 (1200)	365.8 (1200)	1321-RWR80-DP						
	5	75	2	12.2 (40)	18.3 (60)	137.2 (450)	182.9 (600)	12.2 (40)	61.0 (200)	274.3 (900)	365.8 (1200)	137.2 (450)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR100-DP				●		
			4	7.6 (25)	12.2 (40)	91.4 (300)	152.4 (500)	12.2 (40)	24.4 (80)	91.4 (300)	182.9 (600)	76.2 (250)	182.9 (600)	365.8 (1200)	365.8 (1200)	1321-RWR100-DP						
		100	2	12.2 (40)	24.4 (80)	137.2 (450)	182.9 (600)	12.2 (40)	61.0 (200)	243.8 (800)	365.8 (1200)	137.2 (450)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR130-DP				●		
			4	7.6 (25)	18.3 (60)	91.4 (300)	152.4 (500)	12.2 (40)	30.5 (100)	91.4 (300)	152.4 (500)	61.0 (200)	137.2 (450)	304.8 (1000)	304.8 (1000)	1321-RWR130-DP						
	6	125	2	12.2 (40)	24.4 (80)	137.2 (450)	182.9 (600)	12.2 (40)	61.0 (200)	243.8 (800)	365.8 (1200)	121.9 (400)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR160-DP				●		
			4	7.6 (25)	18.3 (60)	91.4 (300)	152.4 (500)	12.2 (40)	30.5 (100)	91.4 (300)	152.4 (500)	61.0 (200)	106.7 (350)	243.8 (800)	274.3 (900)	1321-RWR160-DP						
		150	2	12.2 (40)	24.4 (80)	137.2 (450)	182.9 (600)	12.2 (40)	61.0 (200)	243.8 (800)	304.8 (1000)	91.4 (300)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-RWR200-DP				●		
			4	7.6 (25)	24.4 (80)	91.4 (300)	152.4 (500)	12.2 (40)	30.5 (100)	91.4 (300)	152.4 (500)	45.7 (150)	76.2 (250)	243.8 (800)	274.3 (900)	1321-RWR200-DP						
		200	2	12.2 (40)	30.5 (100)	137.2 (450)	182.9 (600)	12.2 (40)	61.0 (200)	243.8 (800)	304.8 (1000)	76.2 (250)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-RWR250-DP				●		
			4	7.6 (25)	24.4 (80)	91.4 (300)	121.9 (400)	12.2 (40)	36.6 (120)	91.4 (300)	121.9 (400)	45.7 (150)	76.2 (250)	213.4 (700)	274.3 (900)	1321-RWR250-DP						
	7	250	2	12.2 (40)	30.5 (100)	137.2 (450)	167.6 (550)	12.2 (40)	61.0 (200)	198.1 (650)	259.1 (850)	76.2 (250)	243.8 (800)	365.8 (1200)	365.8 (1200)	1321-3RB320-B	50	225		●		
			4	7.6 (25)	24.4 (80)	91.4 (300)	121.9 (400)	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	45.7 (150)	76.2 (250)	213.4 (700)	274.3 (900)	1321-3RB320-B	50	450				
		250	2	12.2 (40)	30.5 (100)	137.2 (450)	167.6 (550)	12.2 (40)	61.0 (200)	198.1 (650)	259.1 (850)	76.2 (250)	243.8 (800)	365.8 (1200)	365.8 (1200)	1321-3RB320-B	50	225		●		
			4	7.6 (25)	24.4 (80)	91.4 (300)	121.9 (400)	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	45.7 (150)	76.2 (250)	213.4 (700)	274.3 (900)	1321-3RB320-B	50	450				
	8	300	2	12.2 (40)	30.5 (100)	106.7 (350)	152.4 (500)	12.2 (40)	45.7 (150)	137.2 (450)	198.1 (650)	61.0 (200)	243.8 (800)	365.8 (1200)	365.8 (1200)	1321-3RB400-B[1]	20	495		●		
			4	7.6 (25)	24.4 (80)	91.4 (300)	121.9 (400)	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	45.7 (150)	76.2 (250)	213.4 (700)	274.3 (900)	1321-3RB400-B[1]	20	990				
		350	2	12.2 (40)	30.5 (100)	106.7 (350)	152.4 (500)	12.2 (40)	45.7 (150)	137.2 (450)	198.1 (650)	61.0 (200)	243.8 (800)	365.8 (1200)	365.8 (1200)	1321-3R400-B[1]	20	495		●		
			4	7.6 (25)	24.4 (80)	91.4 (300)	121.9 (400)	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	45.7 (150)	76.2 (250)	167.6 (550)	259.1 (850)	1321-3RB400-B[1]	20	990				
		400	2	12.2 (40)	30.5 (100)	106.7 (350)	152.4 (500)	12.2 (40)	45.7 (150)	137.2 (450)	182.9 (600)	61.0 (200)	213.4 (700)	365.8 (1200)	365.8 (1200)	1321-3R500-B[1]	20	495		●		
			4	7.6 (25)	24.4 (80)	91.4 (300)	121.9 (400)	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	45.7 (150)	76.2 (250)	167.6 (550)	259.1 (850)	1321-3R500-B[1]	20	990				
		450	2	12.2 (40)	30.5 (100)	106.7 (350)	152.4 (500)	12.2 (40)	45.7 (150)	137.2 (450)	182.9 (600)	61.0 (200)	213.4 (700)	365.8 (1200)	365.8 (1200)	1321-3R600-B[1]	20	495		●		
			4	7.6 (25)	24.4 (80)	91.4 (300)	121.9 (400)	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	45.7 (150)	76.2 (250)	167.6 (550)	259.1 (850)	1321-3R600-B[1]	20	990				
		500	2	12.2 (40)	30.5 (100)	106.7 (350)	152.4 (500)	12.2 (40)	45.7 (150)	121.9 (400)	152.4 (500)	61.0 (200)	182.9 (600)	304.8 (1000)	365.8 (1200)	1321-3R600-B[1]	20	495		●		
			4	7.6 (25)	24.4 (80)	91.4 (300)	121.9 (400)	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	45.7 (150)	76.2 (250)	167.6 (550)	243.8 (800)	1321-3R600-B[1]	20	990				
	9	600	2	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	12.2 (40)	45.7 (150)	106.7 (350)	137.2 (450)	61.0 (200)	152.4 (500)	274.3 (900)	365.8 (1200)	1321-3R750-B[2]	20	735		●		
			4	7.6 (25)	24.4 (80)	91.4 (300)	121.9 (400)	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	45.7 (150)	61.0 (200)	152.4 (500)	213.4 (700)	1321-3R750-B[2]	20	1470				
	10	700	2	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	12.2 (40)	45.7 (150)	106.7 (350)	137.2 (450)	61.0 (200)	152.4 (500)	274.3 (900)	365.8 (1200)	1321-3R850-B[2]	20	735		●		
			4	7.6 (25)	24.4 (80)	91.4 (300)	121.9 (400)	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	30.5 (100)	61.0 (200)	152.4 (500)	213.4 (700)	1321-3R850-B[2]	20	1470				

(1) Requires two parallel cables.

(2) Requires three parallel cables.

Table A.E PowerFlex 70 (Standard/Enhanced) & 700 (Standard/Vector), 600V Shielded/Unshielded Cable - *Meters (Feet)*

Drive Frame		Rating		No Solution		Reactor Only		1321-RWR		RWR *(see page A-22)*	Available Options			
70	700	HP	kHz	1488V	1850V	1488V	1850V	1488V	1850V	Cat. No.	TFA1	TFB2	RWR2	RWC
A	0	1	2	42.7 (140)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)		●		●	●
			4	30.5 (100)	121.9 (400)	30.5 (100)	121.9 (400)	121.9 (400)	121.9 (400)				●	●
		2	2	42.7 (140)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)		●		●	●
			4	30.5 (100)	137.2 (450)	30.5 (100)	152.4 (500)	152.4 (500)	152.4 (500)				●	●
B		3	2	42.7 (140)	152.4 (500)	152.4 (500)	182.9 (600)	182.9 (600)	182.9 (600)		●		●	●
			4	30.5 (100)	137.2 (450)	30.5 (100)	152.4 (500)	182.9 (600)	182.9 (600)				●	●
		5	2	42.7 (140)	152.4 (500)	152.4 (500)	243.8 (800)	243.8 (800)	243.8 (800)	1321-RWR8-EP	●		●	●
			4	30.5 (100)	137.2 (450)	30.5 (100)	152.4 (500)	243.8 (800)	243.8 (800)	1321-RWR8-EP			●	●
C		7.5	2	42.7 (140)	152.4 (500)	152.4 (500)	304.8 (1000)	304.8 (1000)	304.8 (1000)	1321-RWR12-EP				●
			4	30.5 (100)	137.2 (450)	30.5 (100)	152.4 (500)	304.8 (1000)	304.8 (1000)	1321-RWR12-EP				●
	1	10	2	42.7 (140)	182.9 (600)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR12-EP				●
			4	30.5 (100)	137.2 (450)	30.5 (100)	152.4 (500)	304.8 (1000)	365.8 (1200)	1321-RWR12-EP				●
D		15	2	42.7 (140)	182.9 (600)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR18-EP				
			4	30.5 (100)	137.2 (450)	30.5 (100)	152.4 (500)	304.8 (1000)	365.8 (1200)	1321-RWR18-EP				
	2	20	2	42.7 (140)	182.9 (600)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR25-EP		●		
			4	30.5 (100)	137.2 (450)	30.5 (100)	152.4 (500)	304.8 (1000)	365.8 (1200)	1321-RWR25-EP				
		25	2	42.7 (140)	182.9 (600)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR35-EP		●		
			4	30.5 (100)	137.2 (450)	30.5 (100)	152.4 (500)	304.8 (1000)	365.8 (1200)	1321-RWR35-EP				
	3	30	2	42.7 (140)	182.9 (600)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR35-EP		●		
			4	30.5 (100)	137.2 (450)	36.6 (120)	152.4 (500)	304.8 (1000)	365.8 (1200)	1321-RWR35-EP				
E		40	2	42.7 (140)	182.9 (600)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR45-EP		●		
			4	30.5 (100)	137.2 (450)	36.6 (120)	152.4 (500)	304.8 (1000)	365.8 (1200)	1321-RWR45-EP				
		50	2	42.7 (140)	182.9 (600)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR55-EP		●		
			4	36.6 (120)	137.2 (450)	45.7 (150)	152.4 (500)	304.8 (1000)	365.8 (1200)	1321-RWR55-EP				
	4	60	2	42.7 (140)	182.9 (600)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR80-EP		●		
			4	36.6 (120)	137.2 (450)	45.7 (150)	152.4 (500)	274.3 (900)	365.8 (1200)	1321-RWR80-EP				
	5	75	2	42.7 (140)	182.9 (600)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR80-EP		●		
			4	36.6 (120)	137.2 (450)	45.7 (150)	152.4 (500)	274.3 (900)	365.8 (1200)	1321-RWR80-EP				
		100	2	42.7 (140)	182.9 (600)	152.4 (500)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR100-EP		●		
			4	42.7 (140)	137.2 (450)	45.7 (150)	152.4 (500)	274.3 (900)	365.8 (1200)	1321-RWR100-EP				
	6	125	2	42.7 (140)	182.9 (600)	121.9 (400)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR130-EP		●		
			4	42.7 (140)	137.2 (450)	45.7 (150)	152.4 (500)	228.6 (750)	365.8 (1200)	1321-RWR130-EP				
		150	2	42.7 (140)	182.9 (600)	121.9 (400)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR160-EP		●		
			4	42.7 (140)	137.2 (450)	45.7 (150)	152.4 (500)	198.1 (650)	365.8 (1200)	1321-RWR160-EP				

Table A.F PowerFlex 700 (Standard/Vector), 690V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution		Reactor Only		Reactor + Damping Resistor		Reactor *(see page A-22)*	Resistor		Available Options			
Frame	kW	kHz	*1850V*	*2000V*	*1850V*	*2000V*	*1850V*	*2000V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
4	45	2	30.5 (100)	106.9 (350)	91.4 (300)	152.4 (500)	365.8 (1200)	365.8 (1200)	1321-3R80-C	50	345				
		4	24.4 (80)	76.2 (250)	36.6 (120)	121.9 (400)	213.4 (700)	274.3 (900)	1321-3R80-C	50	690				
	55	2	30.5 (100)	106.9 (350)	91.4 (300)	152.4 (500)	365.8 (1200)	365.8 (1200)	1321-3R80-C	50	345				
		4	24.4 (80)	76.2 (250)	36.6 (120)	106.9 (350)	213.4 (700)	274.3 (900)	1321-3R80-C	50	690				
5	75	2	30.5 (100)	106.9 (350)	91.4 (300)	152.4 (500)	365.8 (1200)	365.8 (1200)	1321-3R100-C	50	345				
		4	30.5 (100)	76.2 (250)	36.6 (120)	106.9 (350)	213.4 (700)	274.3 (900)	1321-3R100-C	50	690				
	90	2	30.5 (100)	106.9 (350)	91.4 (300)	152.4 (500)	365.8 (1200)	365.8 (1200)	1321-3R130-C	50	375				
		4	30.5 (100)	76.2 (250)	36.6 (120)	106.9 (350)	182.9 (600)	274.3 (900)	1321-3R130-C	50	750				
6	110	2	30.5 (100)	106.9 (350)	91.4 (300)	152.4 (500)	365.8 (1200)	365.8 (1200)	1321-3R160-C	50	375				
		4	30.5 (100)	76.2 (250)	36.6 (120)	99.1 (325)	152.4 (500)	274.3 (900)	1321-3R160-C	50	750				
	132	2	30.5 (100)	106.9 (350)	91.4 (300)	152.4 (500)	365.8 (1200)	365.8 (1200)	1321-3R200-C	50	375				
		4	30.5 (100)	76.2 (250)	36.6 (120)	83.8 (275)	152.4 (500)	274.3 (900)	1321-3R200-C	50	750				

PowerFlex 700H

Table A.G PowerFlex 700H, 400V Shielded/Unshielded Cable – *Meters (Feet)*

Drive			No Solution				Reactor Only				Reactor + Damping Resistor or 1321-RWR				Reactor/RWR *(see page A-22)*	Resistor		Available Options			
Frame	kW	kHz	1000V	1200V	1488V	1600V	1000V	1200V	1488V	1600V	1000V	1200V	1488V	1600V	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
9	132	2	24.4 (80)	48.8 (160)	76.2 (250)	137.2 (450)	24.4 (80)	48.8 (160)	365.8 (1200)	365.8 (1200)	121.9 (400)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-RWR320-DP				●		
	160	2	24.4 (80)	48.8 (160)	76.2 (250)	137.2 (450)	24.4 (80)	48.8 (160)	365.8 (1200)	365.8 (1200)	121.9 (400)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-RWR320-DP				●		
10	200	2	24.4 (80)	48.8 (160)	76.2 (250)	121.9 (400)	24.4 (80)	48.8 (160)	365.8 (1200)	365.8 (1200)	121.9 (400)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-3R500-B	20	495 (3)		●		
	250	2	24.4 (80)	48.8 (160)	61.0 (200)	121.9 (400)	24.4 (80)	48.8 (160)	365.8 (1200)	365.8 (1200)	121.9 (400)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-3R500-B	20	495 (3)		●		
11	315	2	18.3 (60)	42.7 (140)	61.0 (200)	121.9 (400)	18.3 (60)	42.7 (140)	365.8 (1200)	365.8 (1200)	121.9 (400)	243.8 (800)	365.8 (1200)	365.8 (1200)	1321-3R600-B	20	495 (3)		●		
	355	2	18.3 (60)	42.7 (140)	61.0 (200)	121.9 (400)	18.3 (60)	42.7 (140)	304.8 (1000)	365.8 (1200)	121.9 (400)	243.8 (800)	365.8 (1200)	365.8 (1200)	1321-3R750-B	20	495 (3)		●		
	400	2	18.3 (60)	42.7 (140)	61.0 (200)	121.9 (400)	18.3 (60)	42.7 (140)	274.3 (900)	365.8 (1200)	121.9 (400)	243.8 (800)	365.8 (1200)	365.8 (1200)	1321-3R750-B	20	735 (4)		●		
12 (1)	450	2	18.3 (60)	42.7 (140)	61.0 (200)	121.9 (400)	18.3 (60)	42.7 (140)	243.8 (800)	365.8 (1200)	121.9 (400)	243.8 (800)	365.8 (1200)	365.8 (1200)	2 x 1321-3RB400-B	40	375 (4)		●		
	500	2	12.2 (40)	42.7 (140)	61.0 (200)	121.9 (400)	18.3 (60)	42.7 (140)	243.8 (800)	365.8 (1200)	121.9 (400)	243.8 (800)	365.8 (1200)	365.8 (1200)	2 x 1321-3R500-B	40	375 (4)		●		
	560	2	12.2 (40)	42.7 (140)	61.0 (200)	121.9 (400)	18.3 (60)	42.7 (140)	243.8 (800)	365.8 (1200)	121.9 (400)	243.8 (800)	365.8 (1200)	365.8 (1200)	2 x 1321-3R500-B	20	525 (5)				
13	630 (2)	2	12.2 (40)	61.0 (200)	99.1 (325)	167.6 (550)	36.6 (120)	61.0 (200)	304.8 (1000)	365.8 (1200)	198.1 (650)	274.3 (900)	365.8 (1200)	365.8 (1200)	2 x 1321-3R600-B	20	525 (5)				
	710 (2)	2	12.2 (40)	61.0 (200)	99.1 (325)	167.6 (550)	36.6 (120)	61.0 (200)	304.8 (1000)	365.8 (1200)	198.1 (650)	274.3 (900)	365.8 (1200)	365.8 (1200)	2 x 1321-3R750-B	20	525 (5)				
	800 (2)	2	12.2 (40)	61.0 (200)	99.1 (325)	167.6 (550)	36.6 (120)	61.0 (200)	304.8 (1000)	365.8 (1200)	198.1 (650)	274.3 (900)	365.8 (1200)	365.8 (1200)	2 x 1321-3R750-B	20	525 (5)				

(1) Frame 12 drives have dual inverters and require two output reactors. The resistor ratings are per phase values for each reactor.

(2) Some Frame 13 drives require two output reactors to match drive amp rating. The resistor ratings are per phase values for each reactor.

(3) Resistor specification is based on two cables per phase.

(4) Resistor specification is based on three cables per phase.

(5) Resistor specification is based on four cables per phase.

Table A.H PowerFlex 700H, 480V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution				Reactor Only				Reactor + Damping Resistor or 1321-RWR				Reactor/RWR *(see page A-22)*	Resistor		Available Options			
Frame	**HP**	**kHz**	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	**Cat. No.**	**Ohms**	**Watts**	**TFA1**	**TFB2**	**RWR2**	**RWC**
9	200	2	12.2 (40)	24.4 (80)	42.7 (140)	76.2 (250)	12.2 (40)	24.4 (80)	106.9 (350)	152.4 (500)	61.0 (200)	167.6 (550)	304.8 (1000)	365.8 (1200)	1321-RWR320-DP				●		
	250	2	12.2 (40)	24.4 (80)	42.7 (140)	76.2 (250)	12.2 (40)	24.4 (80)	91.4 (300)	121.9 (400)	61.0 (200)	152.4 (500)	304.8 (1000)	365.8 (1200)	1321-RWR320-DP				●		
10	300	2	12.2 (40)	24.4 (80)	42.7 (140)	76.2 (250)	12.2 (40)	24.4 (80)	76.2 (250)	91.4 (300)	61.0 (200)	121.9 (400)	304.8 (1000)	365.8 (1200)	1321-3RB400-B	20	495 (3)		●		
	350	2	12.2 (40)	24.4 (80)	42.7 (140)	76.2 (250)	12.2 (40)	24.4 (80)	76.2 (250)	91.4 (300)	61.0 (200)	121.9 (400)	304.8 (1000)	365.8 (1200)	1321-3R500-B	20	495 (3)		●		
	450	2	12.2 (40)	24.4 (80)	36.6 (120)	61.0 (200)	12.2 (40)	24.4 (80)	61.0 (200)	91.4 (300)	61.0 (200)	121.9 (400)	274.3 (900)	365.8 (1200)	1321-3R500-B	20	495 (3)		●		
11	500	2	12.2 (40)	24.4 (80)	36.6 (120)	61.0 (200)	12.2 (40)	24.4 (80)	61.0 (200)	91.4 (300)	61.0 (200)	121.9 (400)	243.8 (800)	365.8 (1200)	1321-3R750-B	20	495 (3)		●		
	600	2	12.2 (40)	24.4 (80)	36.6 (120)	61.0 (200)	12.2 (40)	24.4 (80)	45.7 (150)	91.4 (300)	45.7 (150)	121.9 (400)	243.8 (800)	365.8 (1200)	1321-3R750-B	20	735 (4)		●		
12 (1)	700	2	12.2 (40)	24.4 (80)	36.6 (120)	61.0 (200)	12.2 (40)	24.4 (80)	45.7 (150)	91.4 (300)	45.7 (150)	106.9 (350)	243.8 (800)	365.8 (1200)	2 x 1321-3RB400-B	40	375 (4)		●		
	800	2	12.2 (40)	24.4 (80)	36.6 (120)	61.0 (200)	12.2 (40)	24.4 (80)	45.7 (150)	91.4 (300)	45.7 (150)	106.9 (350)	243.8 (800)	365.8 (1200)	2 x 1321-3R500-B	40	375 (4)		●		
	900	2	12.2 (40)	24.4 (80)	36.6 (120)	61.0 (200)	12.2 (40)	24.4 (80)	45.7 (150)	91.4 (300)	45.7 (150)	106.9 (350)	243.8 (800)	365.8 (1200)	2 x 1321-3R500-B	20	525 (5)				
13	1000 (2)	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	45.7 (150)	152.4 (500)	304.8 (1000)	365.8 (1200)	2 x 1321-3R600-B	20	525 (5)				
	1200 (2)	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	45.7 (150)	152.4 (500)	304.8 (1000)	365.8 (1200)	2 x 1321-3R750-B	20	525 (5)				
	1250 (2)	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	45.7 (150)	152.4 (500)	304.8 (1000)	365.8 (1200)	2 x 1321-3R750-B	20	525 (5)				

(1) Frame 12 drives have dual inverters and require two output reactors. The resistor ratings are per phase values for each reactor.
(2) Some Frame 13 drives require two output reactors to match drive amp rating. The resistor ratings are per phase values for each reactor.
(3) Resistor specification is based on two cables per phase.
(4) Resistor specification is based on three cables per phase.
(5) Resistor specification is based on four cables per phase.

Table A.I PowerFlex 700H, 600V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution		Reactor Only		Reactor + Damping Resistor or 1321-RWR		Reactor/RWR *(see page A-22)*	Resistor		Available Options			
Frame	**HP**	**kHz**	*1488V*	*1850V*	*1488V*	*1850V*	*1488V*	*1850V*	**Cat. No.**	**Ohms**	**Watts**	**TFA1**	**TFB2**	**RWR2**	**RWC**
9	150	2	30.5 (100)	54.9 (180)	36.6 (120)	152.4 (500)	213.4 (700)	365.8 (1200)	1321-RWR200-EP				●		
	200	2	30.5 (100)	54.9 (180)	36.6 (120)	121.9 (400)	182.9 (600)	365.8 (1200)	1321-RWR250-EP				●		
10	250	2	30.5 (100)	54.9 (180)	36.6 (120)	91.4 (300)	182.9 (600)	365.8 (1200)	1321-3RB250-B	50	315		●		
	350	2	30.5 (100)	45.7 (150)	30.5 (100)	76.2 (250)	167.6 (550)	365.8 (1200)	1321-3RB320-B	20	585 (3)		●		
	400	2	30.5 (100)	45.7 (150)	30.5 (100)	61.0 (200)	167.6 (550)	365.8 (1200)	1321-3RB400-B	20	585 (3)		●		
	450	2	30.5 (100)	45.7 (150)	30.5 (100)	61.0 (200)	152.4 (500)	365.8 (1200)	1321-3R500-B	20	585 (3)		●		
11	500	2	30.5 (100)	45.7 (150)	30.5 (100)	45.7 (150)	152.4 (500)	365.8 (1200)	1321-3R500-B	20	585 (3)		●		
	600	2	30.5 (100)	45.7 (150)	30.5 (100)	45.7 (150)	152.4 (500)	365.8 (1200)	1321-3R600-B	20	585 (3)		●		
12 (1)	700	2	30.5 (100)	45.7 (150)	30.5 (100)	45.7 (150)	152.4 (500)	365.8 (1200)	2 x 1321-3RB320-B	40	300 (3)		●		
	800	2	30.5 (100)	45.7 (150)	30.5 (100)	45.7 (150)	137.2 (450)	365.8 (1200)	2 x 1321-3RB400-C	40	480 (4)		●		
	900	2	30.5 (100)	45.7 (150)	30.5 (100)	45.7 (150)	121.9 (400)	365.8 (1200)	2 x 1321-3R400-B	40	480 (4)				
13	1000	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-3R1000-C	20	960 (4)				
	1100	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-3R1000-B	10	1440 (5)				
	1300 (2)	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	2 x 1321-3R600-B	20	720 (5)				

(1) Frame 12 drives have dual inverters and require two output reactors. The resistor ratings are per phase values for each reactor.
(2) Some Frame 13 drives require two output reactors to match drive amp rating. The resistor ratings are per phase values for each reactor.
(3) Resistor specification is based on two cables per phase.
(4) Resistor specification is based on three cables per phase.
(5) Resistor specification is based on four cables per phase.

Table A.J PowerFlex 700H, 690V Shielded/Unshielded Cable – *Meters (Feet)*

Drive			No Solution		Reactor Only		Reactor + Damping Resistor		Reactor *(see page A-22)*	Resistor		Available Options			
Frame	kW	kHz	*1850V*	*2000V*	*1850V*	*2000V*	*1850V*	*2000V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
9	160	2	15.2 (50)	30.5 (100)	15.2 (50)	30.5 (100)	243.8 (800)	304.8 (1000)	1321-3RB250-C	50	480				
	200	2	15.2 (50)	30.5 (100)	15.2 (50)	30.5 (100)	243.8 (800)	304.8 (1000)	1321-3RB250-C	50	480				
10	250	2	15.2 (50)	30.5 (100)	15.2 (50)	30.5 (100)	243.8 (800)	304.8 (1000)	1321-3RB320-C	50	480				
	315	2	15.2 (50)	30.5 (100)	15.2 (50)	30.5 (100)	213.4 (700)	304.8 (1000)	1321-3RB400-C	20	945 (3)				
	355	2	15.2 (50)	30.5 (100)	15.2 (50)	30.5 (100)	213.4 (700)	304.8 (1000)	1321-3R500-C	20	945 (3)				
	400	2	15.2 (50)	30.5 (100)	15.2 (50)	30.5 (100)	213.4 (700)	304.8 (1000)	1321-3R500-C	20	945 (3)				
11	450	2	15.2 (50)	30.5 (100)	15.2 (50)	30.5 (100)	213.4 (700)	304.8 (1000)	1321-3R600-C	20	945 (3)				
	500	2	15.2 (50)	30.5 (100)	15.2 (50)	30.5 (100)	213.4 (700)	304.8 (1000)	1321-3R600-C	20	945 (3)				
	560	2	15.2 (50)	30.5 (100)	15.2 (50)	30.5 (100)	182.9 (600)	304.8 (1000)	1321-3R750-C	20	945 (3)				
12 (1)	630	2	15.2 (50)	30.5 (100)	15.2 (50)	30.5 (100)	182.9 (600)	304.8 (1000)	2 x1321-3RB400-C	40	480 (3)				
	710	2	15.2 (50)	30.5 (100)	15.2 (50)	30.5 (100)	182.9 (600)	304.8 (1000)	2 x1321-3R500-C	40	645 (4)				
	800	2	15.2 (50)	30.5 (100)	15.2 (50)	30.5 (100)	182.9 (600)	304.8 (1000)	2 x1321-3R500-C	40	645 (4)				
13	900 (2)	2	30.5 (100)	68.6 (225)	61.0 (200)	91.4 (300)	243.8 (800)	304.8 (1000)	2 x1321-3R600-C	40	645 (4)				
	1000 (2)	2	30.5 (100)	68.6 (225)	48.8 (160)	91.4 (300)	243.8 (800)	304.8 (1000)	2 x1321-3R600-C	20	840 (5)				
	1100 (2)	2	30.5 (100)	68.6 (225)	48.8 (160)	91.4 (300)	243.8 (800)	304.8 (1000)	2 x1321-3R750-C	20	840 (5)				

(1) Frame 12 drives have dual inverters and require two output reactors. The resistor ratings are per phase values for each reactor.
(2) Some Frame 13 drives require two output reactors to match drive amp rating. The resistor ratings are per phase values for each reactor.
(3) Resistor specification is based on two cables per phase.
(4) Resistor specification is based on three cables per phase.
(5) Resistor specification is based on four cables per phase.

PowerFlex 700L

Table A.K PowerFlex 700L w/700VC Control, 400V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution				Reactor Only				Reactor + Damping Resistor				Reactor *(see page A-22)*	Resistor		Available Options			
Frame	kW	kHz	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
2	200	2	24.4 (80)	91.4 (300)	152.4 (500)	213.4 (700)	30.5 (100)	76.2 (250)	228.6 (750)	365.8 (1200)	152.4 (500)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-3R400-B (1)	20	495		●		
		4	24.4 (80)	91.4 (300)	121.9 (400)	152.4 (500)	18.3 (60)	76.2 (250)	137.2 (450)	182.9 (600)	76.2 (250)	137.2 (450)	274.3 (900)	365.8 (1200)	1321-3R400-B (1)	20	990				
3A	370	2	24.4 (80)	91.4 (300)	152.4 (500)	213.4 (700)	30.5 (100)	76.2 (250)	228.6 (750)	365.8 (1200)	152.4 (500)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-3R750-B (1)	20	735		●		
		4	24.4 (80)	91.4 (300)	121.9 (400)	152.4 (500)	18.3 (60)	76.2 (250)	137.2 (450)	182.9 (600)	76.2 (250)	137.2 (450)	274.3 (900)	365.8 (1200)	1321-3R750-B (1)	20	1470				
3B	715	2	24.4 (80)	76.2 (250)	129.5 (425)	160.0 (525)	91.4 (80)	76.2 (250)	152.4 (500)	228.6 (750)	152.4 (500)	274.3 (900)	365.8 (1200)	365.8 (1200)	2 x 1321-3R600-B (2)	20	525				
		4	18.3 (60)	76.2 (250)	121.9 (400)	152.4 (500)	18.3 (60)	76.2 (250)	121.9 (400)	152.4 (500)	76.2 (250)	137.2 (450)	274.3 (900)	365.8 (1200)	2 x 1321-3R600-B (2)	20	1050				

(1) Requires two parallel cables.
(2) Requires four parallel cables.

Table A.L PowerFlex 700L w/700VC Control, 480V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution				Reactor Only				Reactor + Damping Resistor				Reactor *(see page A-22)*	Resistor		Available Options			
Frame	HP	kHz	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
2	300	2	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	12.2 (40)	36.6 (120)	99.1 (325)	137.2 (450)	61.0 (200)	137.2 (450)	274.3 (900)	365.8 (1200)	1321-3R400-B[1]	20	495		●		
		4	7.6 (25)	24.4 (80)	83.8 (275)	114.3 (375)	7.6 (25)	24.4 (80)	83.8 (275)	114.3 (375)	30.5 (100)	61.0 (200)	152.4 (500)	213.4 (700)	1321-3R400-B[1]	20	990				
3A	600	2	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	12.2 (40)	36.6 (120)	99.1 (325)	137.2 (450)	61.0 (200)	137.2 (450)	274.3 (900)	365.8 (1200)	1321-3R750-B[1]	20	735		●		
		4	7.6 (25)	24.4 (80)	83.8 (275)	114.3 (375)	7.6 (25)	24.4 (80)	83.8 (275)	114.3 (375)	30.5 (100)	61.0 (200)	152.4 (500)	213.4 (700)	1321-3R750-B[1]	20	1470				
3B	1150	2	12.2 (40)	24.4 (80)	83.8 (275)	114.3 (375)	12.2 (40)	30.5 (100)	91.4 (300)	121.9 (400)	61.0 (200)	137.2 (450)	274.3 (900)	365.8 (1200)	2 x 1321-3R600-B[2]	20	525				
		4	7.6 (25)	24.4 (80)	83.8 (275)	114.3 (375)	7.6 (25)	24.4 (80)	83.8 (275)	114.3 (375)	30.5 (100)	61.0 (200)	152.4 (500)	213.4 (700)	2 x 1321-3R600-B[2]	20	1050				

(1) Requires two parallel cables.
(2) Requires four parallel cables.

Table A.M PowerFlex 700L w/700VC Control, 600V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution		Reactor Only		Reactor + Damping Resistor		Reactor *(see page A-22)*	Resistor		Available Options			
Frame	HP	kHz	*1488V*	*1850V*	*1488V*	*1850V*	*1488V*	*1850V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
3A	465	2	24.4 (80)	106.7 (350)	24.4 (80)	365.8 (350)	182.9 (600)	365.8 (1200)	1321-3R500-B[1]	20	585		●		
		4	18.3 (60)	61.0 (200)	18.3 (60)	61.0 (200)	76.2 (250)	190.5 (625)	1321-3R500-B[1]	20	1170				
3B	870	2	18.3 (60)	91.4 (300)	18.3 (60)	91.4 (300)	152.4 (500)	274.3 (900)	1321-3R850-B[2]	20	960				
		4	18.3 (60)	61.0 (200)	18.3 (60)	61.0 (200)	53.3 (175)	137.2 (450)	1321-3R850-B[2]	20	1920				
3B	1275	2	18.3 (60)	83.8 (275)	18.3 (60)	83.8 (275)	137.2 (450)	274.3 (900)	2 x 1321-3R600-B[3]	20	720				

(1) Requires two parallel cables.
(2) Requires three parallel cables.
(3) Requires four parallel cables.

Table A.N PowerFlex 700L w/700VC Control, 690V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution		Reactor Only		Reactor + Damping Resistor		Reactor *(see page A-22)*	Resistor		Available Options			
Frame	kW	kHz	*1488V*	*1850V*	*1488V*	*1850V*	*1488V*	*1850V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
3A	355	2	24.4 (80)	45.7 (150)	24.4 (80)	45.7 (150)	228.6 (750)	304.8 (1000)	1321-3R500-C[1]	20	960		●		
		4	24.4 (80)	45.7 (150)	24.4 (80)	45.7 (150)	76.2 (250)	121.9 (400)	1321-3R500-C[1]	20	1920				
3B	657	2	24.4 (80)	45.7 (150)	24.4 (80)	45.7 (150)	182.9 (600)	228.6 (750)	1321-3R850-C[2]	20	1290				
		4	24.4 (80)	45.7 (150)	24.4 (80)	45.7 (150)	76.2 (250)	121.9 (400)	1321-3R850-C[2]	20	2580				
3B	980	2	24.4 (80)	45.7 (150)	24.4 (80)	45.7 (150)	182.9 (600)	228.6 (750)	2 x 1321-3R600-C[3]	20	840				

(1) Requires two parallel cables.
(2) Requires three parallel cables.
(3) Requires four parallel cables.

Table A.O PowerFlex 700L w/700S Control, 400V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution				Reactor Only				Reactor + Damping Resistor				Reactor *(see page A-22)*	Resistor		Available Options			
Frame	kW	kHz	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
2	200	2	18.3 (60)	68.6 (225)	99.1 (325)	167.6 (550)	36.6 (120)	68.6 (225)	274.3 (900)	335.3 (1100)	152.4 (500)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-3R400-B[1]	20	495		●		
		4	18.3 (60)	68.6 (225)	99.1 (325)	167.6 (550)	36.6 (120)	68.6 (225)	274.3 (900)	335.3 (1100)	152.4 (500)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-3R400-B[1]	20	990				
3A	370	2	18.3 (60)	68.6 (225)	99.1 (325)	167.6 (550)	36.6 (120)	68.6 (225)	274.3 (900)	335.3 (1100)	152.4 (500)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-3R750-B[1]	20	735		●		
		4	18.3 (60)	68.6 (225)	99.1 (325)	167.6 (550)	36.6 (120)	68.6 (225)	274.3 (900)	335.3 (1100)	152.4 (500)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-3R750-B[1]	20	1470				
3B	715	2	12.2 (40)	68.6 (225)	99.1 (325)	167.6 (550)	36.6 (120)	68.6 (225)	274.3 (900)	335.3 (1100)	152.4 (500)	274.3 (900)	365.8 (1200)	365.8 (1200)	2 x 1321-3R600-B[2]	20	525				
		4	12.2 (40)	68.6 (225)	99.1 (325)	167.6 (550)	36.6 (120)	68.6 (225)	274.3 (900)	335.3 (1100)	152.4 (500)	274.3 (900)	365.8 (1200)	365.8 (1200)	2 x 1321-3R600-B[2]	20	1050				

(1) Requires two parallel cables.
(2) Requires four parallel cables.

Table A.P PowerFlex 700L w/700S Control, 480V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution				Reactor Only				Reactor + Damping Resistor				Reactor *(see page A-22)*	Resistor		Available Options			
Frame	HP	kHz	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
2	300	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	61.0 (200)	213.4 (700)	304.8 (1000)	365.8 (1200)	1321-3R400-B[1]	20	495		●		
		4	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	61.0 (200)	213.4 (700)	304.8 (1000)	365.8 (1200)	1321-3R400-B[1]	20	990				
3A	600	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	61.0 (200)	213.4 (700)	304.8 (1000)	365.8 (1200)	1321-3R750-B[1]	20	735		●		
		4	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	61.0 (200)	213.4 (700)	304.8 (1000)	365.8 (1200)	1321-3R750-B[1]	20	1470				
3B	1150	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	45.7 (150)	152.4 (500)	304.8 (1000)	365.8 (1200)	2 x 1321-3R600-B[2]	20	525				
		4	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	45.7 (150)	152.4 (500)	304.8 (1000)	365.8 (1200)	2 x 1321-3R600-B[2]	20	1050				

(1) Requires two parallel cables.
(2) Requires four parallel cables.

Table A.Q PowerFlex 700L w/700S Control, 600V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution		Reactor Only		Reactor + Damping Resistor		Reactor *(see page A-22)*	Resistor		Available Options			
Frame	HP	kHz	*1488V*	*1850V*	*1488V*	*1850V*	*1488V*	*1850V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
3A	465	2	18.3 (60)	76.2 (250)	18.3 (60)	76.2 (250)	182.9 (600)	304.8 (1000)	1321-3R500-B[1]	20	585		●		
		4	18.3 (60)	76.2 (250)	18.3 (60)	76.2 (250)	182.9 (600)	304.8 (1000)	1321-3R500-B[1]	20	1170				
3B	870	2	18.3 (60)	61.0 (200)	18.3 (60)	61.0 (200)	152.4 (500)	228.6 (750)	1321-3R850-B[2]	20	960				
		4	18.3 (60)	61.0 (200)	18.3 (60)	61.0 (200)	152.4 (500)	228.6 (750)	1321-3R850-B[2]	20	1920				
3B	1275	2	12.2 (40)	45.7 (150)	12.2 (40)	45.7 (150)	121.9 (400)	228.6 (750)	2 x 1321-3R600-B[3]	20	720				

(1) Requires two parallel cables.
(2) Requires three parallel cables.
(3) Requires four parallel cables.

Table A.R PowerFlex 700L w/700S Control, 690V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution		Reactor Only		Reactor + Damping Resistor		Reactor *(see page A-22)*	Resistor		Available Options			
Frame	kW	kHz	*1488V*	*1850V*	*1488V*	*1850V*	*1488V*	*1850V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
3A	355	2	24.4 (80)	45.7 (150)	24.4 (80)	45.7 (150)	228.6 (750)	304.8 (1000)	1321-3R500-C[1]	20	960		●		
		4	24.4 (80)	45.7 (150)	24.4 (80)	45.7 (150)	182.9 (600)	228.6 (750)	1321-3R500-C[1]	20	1920				
3B	657	2	24.4 (80)	45.7 (150)	24.4 (80)	45.7 (150)	182.9 (600)	228.6 (750)	1321-3R850-C[2]	20	1290				
		4	24.4 (80)	45.7 (150)	24.4 (80)	45.7 (150)	182.9 (600)	228.6 (750)	1321-3R850-C[2]	20	2580				
3B	980	2	24.4 (80)	45.7 (150)	24.4 (80)	45.7 (150)	182.9 (600)	228.6 (750)	2 x 1321-3R600-C[3]	20	840				

(1) Requires two parallel cables.
(2) Requires three parallel cables.
(3) Requires four parallel cables.

PowerFlex 700S

Table A.S PowerFlex 700S, 400V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution				Reactor Only				Reactor + Damping Resistor or 1321-RWR				Reactor/RWR *(see page A-22)*	Resistor		Available Options			
Frame	kW	kHz	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
1	0.75	2/4	7.6 (25)	83.8 (275)	83.8 (275)	83.8 (275)	91.4 (300)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)				●		●	●
	1.5	2/4	7.6 (25)	106.9 (350)	182.9 (600)	182.9 (600)	91.4 (300)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)				●	●	●	●
	2.2	2/4	7.6 (25)	106.9 (350)	182.9 (600)	182.9 (600)	91.4 (300)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)				●	●	●	●
	4	2/4	7.6 (25)	106.9 (350)	243.8 (800)	243.8 (800)	91.4 (300)	243.8 (800)	243.8 (800)	243.8 (800)	243.8 (800)	243.8 (800)	243.8 (800)	243.8 (800)	1321-RWR8-DP				●		●
	5.5	2/4	7.6 (25)	106.9 (350)	274.3 (900)	304.8 (1000)	91.4 (300)	274.3 (900)	304.8 (1000)	304.8 (1000)	304.8 (1000)	304.8 (1000)	304.8 (1000)	304.8 (1000)	1321-RWR12-DP				●		●
	7.5	2/4	7.6 (25)	106.9 (350)	274.3 (900)	365.8 (1200)	91.4 (300)	274.3 (900)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR18-DP				●		●
	11	2/4	7.6 (25)	106.9 (350)	274.3 (900)	365.8 (1200)	91.4 (300)	274.3 (900)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR25-DP				●		
2	15	2/4	7.6 (25)	106.9 (350)	274.3 (900)	365.8 (1200)	91.4 (300)	274.3 (900)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR25-DP				●		
	18.5	2/4	7.6 (25)	106.9 (350)	274.3 (900)	365.8 (1200)	91.4 (300)	274.3 (900)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR35-DP				●		
3	22	2/4	7.6 (25)	106.9 (350)	274.3 (900)	365.8 (1200)	91.4 (300)	274.3 (900)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR45-DP				●		
	30	2/4	7.6 (25)	106.9 (350)	274.3 (900)	365.8 (1200)	91.4 (300)	274.3 (900)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR55-DP				●		
	37	2/4	12.2 (40)	91.4 (300)	274.3 (900)	365.8 (1200)	76.2 (250)	243.8 (800)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR80-DP				●		
4	45	2/4	12.2 (40)	106.9 (350)	274.3 (900)	365.8 (1200)	76.2 (250)	304.8 (1000)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR80-DP				●		
5	55	2/4	12.2 (40)	106.9 (350)	274.3 (900)	365.8 (1200)	61.0 (200)	274.3 (900)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR100-DP				●		
	75	2/4	18.3 (60)	91.4 (300)	213.4 (700)	304.8 (1000)	45.7 (150)	243.8 (800)	365.8 (1200)	365.8 (1200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR130-DP				●		
6	90	2/4	18.3 (60)	91.4 (300)	213.4 (700)	304.8 (1000)	45.7 (150)	213.4 (700)	365.8 (1200)	365.8 (1200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR160-DP				●		
	110	2/4	24.4 (80)	91.4 (300)	213.4 (700)	274.3 (900)	45.7 (150)	182.9 (600)	365.8 (1200)	365.8 (1200)	274.3 (900)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR200-DP				●		
	132	2/4	24.4 (80)	91.4 (300)	182.9 (600)	243.8 (800)	45.7 (150)	152.4 (500)	365.8 (1200)	365.8 (1200)	243.8 (800)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR250-DP				●		

Drive			No Solution				Reactor Only				Reactor + Damping Resistor or 1321-RWR				Reactor/RWR (see page A-22)	Resistor		Available Options			
Frame	kW	kHz	1000V	1200V	1488V	1600V	1000V	1200V	1488V	1600V	1000V	1200V	1488V	1600V	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
9	132	2	24.4 (80)	91.4 (300)	182.9 (600)	243.8 (800)	45.7 (150)	152.4 (500)	365.8 (1200)	365.8 (1200)	243.8 (800)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR320-DP				●		
	160	2	24.4 (80)	91.4 (300)	152.4 (500)	213.4 (700)	45.7 (150)	121.9 (400)	365.8 (1200)	365.8 (1200)	243.8 (800)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR320-DP				●		
10	200	2	24.4 (80)	76.2 (250)	121.9 (400)	182.9 (600)	36.6 (120)	91.4 (300)	304.8 (1000)	365.8 (1200)	243.8 (800)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-3R500-B	20	495 (3)		●		
	250	2	24.4 (80)	76.2 (250)	99.1 (325)	167.6 (550)	36.6 (120)	76.2 (250)	304.8 (1000)	365.8 (1200)	228.6 (750)	335.3 (1100)	365.8 (1200)	365.8 (1200)	1321-3R500-B	20	495 (3)		●		
11	315	2	18.3 (60)	68.6 (225)	99.1 (325)	167.6 (550)	36.6 (120)	68.6 (225)	304.8 (1000)	365.8 (1200)	228.6 (750)	335.3 (1100)	365.8 (1200)	365.8 (1200)	1321-3R600-B	20	495 (3)		●		
	355	2	18.3 (60)	68.6 (225)	99.1 (325)	167.6 (550)	36.6 (120)	68.6 (225)	304.8 (1000)	365.8 (1200)	228.6 (750)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-3R750-B	20	495 (3)		●		
	400	2	18.3 (60)	68.6 (225)	99.1 (325)	167.6 (550)	36.6 (120)	68.6 (225)	304.8 (1000)	365.8 (1200)	228.6 (750)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-3R750-B	20	735 (4)		●		
12 (1)	450	2	18.3 (60)	68.6 (225)	99.1 (325)	167.6 (550)	36.6 (120)	68.6 (225)	304.8 (1000)	365.8 (1200)	228.6 (750)	274.3 (900)	365.8 (1200)	365.8 (1200)	2 x 1321-3RB400-B	40	375 (4)		●		
	500	2	12.2 (40)	68.6 (225)	99.1 (325)	167.6 (550)	36.6 (120)	68.6 (225)	304.8 (1000)	365.8 (1200)	198.1 (650)	274.3 (900)	365.8 (1200)	365.8 (1200)	2 x 1321-3R500-B	40	375 (4)		●		
	560	2	12.2 (40)	68.6 (225)	99.1 (325)	167.6 (550)	36.6 (120)	68.6 (225)	304.8 (1000)	365.8 (1200)	198.1 (650)	274.3 (900)	365.8 (1200)	365.8 (1200)	2 x 1321-3R500-B	20	525 (5)				
13	630 (2)	2	12.2 (40)	61.0 (200)	99.1 (325)	167.6 (550)	36.6 (120)	61.0 (200)	304.8 (1000)	365.8 (1200)	198.1 (650)	274.3 (900)	365.8 (1200)	365.8 (1200)	2 x 1321-3R600-B	20	525 (5)				
	710 (2)	2	12.2 (40)	61.0 (200)	99.1 (325)	167.6 (550)	36.6 (120)	61.0 (200)	304.8 (1000)	365.8 (1200)	198.1 (650)	274.3 (900)	365.8 (1200)	365.8 (1200)	2 x 1321-3R750-B	20	525 (5)				
	800 (2)	2	12.2 (40)	61.0 (200)	99.1 (325)	167.6 (550)	36.6 (120)	61.0 (200)	304.8 (1000)	365.8 (1200)	198.1 (650)	274.3 (900)	365.8 (1200)	365.8 (1200)	2 x 1321-3R750-B	20	525 (5)				

(1) Frame 12 drives have dual inverters and require two output reactors. The resistor ratings are per phase values for each reactor.
(2) Some Frame 13 drives require two output reactors to match drive amp rating. The resistor ratings are per phase values for each reactor.
(3) Resistor specification is based on two cables per phase.
(4) Resistor specification is based on three cables per phase.
(5) Resistor specification is based on four cables per phase.

Table A.T PowerFlex 700S, 480V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution				Reactor Only				Reactor + Damping Resistor or 1321-RWR				Reactor/RWR (see page A-22)	Resistor		Available Options			
Frame	HP	kHz	1000V	1200V	1488V	1600V	1000V	1200V	1488V	1600V	1000V	1200V	1488V	1600V	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
1	1	2/4	7.6 (25)	12.2 (40)	83.8 (275)	83.8 (275)	7.6 (25)	91.4 (300)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)	152.4 (500)				●		●	●
	2	2/4	7.6 (25)	12.2 (40)	83.8 (275)	83.8 (275)	7.6 (25)	91.4 (300)	182.9 (600)	182.9 (600)	152.4 (500)	182.9 (600)	182.9 (600)	182.9 (600)				●	●	●	●
	3	2/4	7.6 (25)	12.2 (40)	106.9 (350)	152.4 (500)	7.6 (25)	91.4 (300)	182.9 (600)	182.9 (600)	152.4 (500)	182.9 (600)	182.9 (600)	182.9 (600)				●	●	●	●
	5	2/4	7.6 (25)	12.2 (40)	106.9 (350)	152.4 (500)	7.6 (25)	91.4 (300)	243.8 (800)	243.8 (800)	152.4 (500)	243.8 (800)	243.8 (800)	243.8 (800)	1321-RWR8-DP			●	●	●	●
	7.5	2/4	7.6 (25)	12.2 (40)	106.9 (350)	152.4 (500)	7.6 (25)	91.4 (300)	304.8 (1000)	304.8 (1000)	152.4 (500)	304.8 (1000)	304.8 (1000)	304.8 (1000)	1321-RWR12-DP				●		●
	10	2/4	7.6 (25)	12.2 (40)	106.9 (350)	152.4 (500)	7.6 (25)	91.4 (300)	365.8 (1200)	365.8 (1200)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR18-DP				●		●
	15	2/4	7.6 (25)	12.2 (40)	106.9 (350)	152.4 (500)	7.6 (25)	91.4 (300)	365.8 (1200)	365.8 (1200)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR25-DP				●		
2	20	2/4	7.6 (25)	12.2 (40)	106.9 (350)	152.4 (500)	7.6 (25)	91.4 (300)	365.8 (1200)	365.8 (1200)	182.9 (600)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR25-DP				●		
	25	2/4	7.6 (25)	12.2 (40)	106.9 (350)	152.4 (500)	7.6 (25)	76.2 (250)	365.8 (1200)	365.8 (1200)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR35-DP				●		
3	30	2/4	7.6 (25)	12.2 (40)	106.9 (350)	152.4 (500)	7.6 (25)	76.2 (250)	365.8 (1200)	365.8 (1200)	152.4 (500)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR45-DP				●		
	40	2/4	7.6 (25)	12.2 (40)	106.9 (350)	152.4 (500)	7.6 (25)	76.2 (250)	365.8 (1200)	365.8 (1200)	121.9 (400)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR55-DP				●		
	50	2/4	12.2 (40)	18.3 (60)	106.9 (350)	152.4 (500)	12.2 (40)	61.0 (200)	304.8 (1000)	365.8 (1200)	121.9 (400)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR80-DP				●		

Drive			No Solution				Reactor Only				Reactor + Damping Resistor or 1321-RWR				Reactor/RWR *(see page A-22)*	Resistor		Available Options			
Frame	**HP**	**kHz**	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	*1000V*	*1200V*	*1488V*	*1600V*	**Cat. No.**	**Ohms**	**Watts**	**TFA1**	**TFB2**	**RWR2**	**RWC**
4	60	2/4	12.2 (40)	18.3 (60)	91.4 (300)	152.4 (500)	12.2 (40)	61.0 (200)	304.8 (1000)	365.8 (1200)	91.4 (300)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR80-DP				●		
5	75	2/4	12.2 (40)	18.3 (60)	91.4 (300)	152.4 (500)	12.2 (40)	61.0 (200)	274.3 (900)	365.8 (1200)	91.4 (300)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR100-DP				●		
	100	2/4	12.2 (40)	24.4 (80)	91.4 (300)	137.2 (450)	12.2 (40)	61.0 (200)	243.8 (800)	365.8 (1200)	91.4 (300)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR130-DP				●		
6	125	2/4	12.2 (40)	24.4 (80)	91.4 (300)	137.2 (450)	12.2 (40)	61.0 (200)	243.8 (800)	365.8 (1200)	76.2 (250)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR160-DP				●		
	150	2/4	12.2 (40)	24.4 (80)	91.4 (300)	137.2 (450)	12.2 (40)	61.0 (200)	243.8 (800)	304.8 (1000)	76.2 (250)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-RWR200-DP				●		
	200	2/4	12.2 (40)	30.5 (100)	91.4 (300)	137.2 (450)	12.2 (40)	61.0 (200)	243.8 (800)	304.8 (1000)	61.0 (200)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-RWR250-DP				●		
9	200	2	12.2 (40)	30.5 (100)	91.4 (300)	152.4 (500)	12.2 (40)	45.7 (150)	152.4 (500)	228.6 (750)	61.0 (200)	274.3 (900)	365.8 (1200)	365.8 (1200)	1321-RWR320-DP				●		
	250	2	12.2 (40)	30.5 (100)	91.4 (300)	152.4 (500)	12.2 (40)	45.7 (150)	121.9 (400)	182.9 (600)	61.0 (200)	243.8 (800)	365.8 (1200)	365.8 (1200)	1321-RWR320-DP				●		
10	300	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	61.0 (200)	243.8 (800)	304.8 (1000)	365.8 (1200)	1321-3RB400-B	20	495[3]		●		
	350	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	61.0 (200)	243.8 (800)	304.8 (1000)	365.8 (1200)	1321-3R500-B	20	495[3]		●		
	450	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	61.0 (200)	213.4 (700)	304.8 (1000)	365.8 (1200)	1321-3R500-B	20	495[3]		●		
11	500	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	61.0 (200)	213.4 (700)	304.8 (1000)	365.8 (1200)	1321-3R750-B	20	495[3]		●		
	600	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	61.0 (200)	213.4 (700)	304.8 (1000)	365.8 (1200)	1321-3R750-B	20	735[4]		●		
12[1]	700	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	45.7 (150)	182.9 (600)	304.8 (1000)	365.8 (1200)	2 x 1321-3RB400-B	40	375[4]		●		
	800	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	45.7 (150)	182.9 (600)	304.8 (1000)	365.8 (1200)	2 x 1321-3R500-B	40	375[4]		●		
	900	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	45.7 (150)	182.9 (600)	304.8 (1000)	365.8 (1200)	2 x 1321-3R500-B	20	525[5]				
13	1000[2]	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	45.7 (150)	152.4 (500)	304.8 (1000)	365.8 (1200)	2 x 1321-3R600-B	20	525[5]				
	1200[2]	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	45.7 (150)	152.4 (500)	304.8 (1000)	365.8 (1200)	2 x 1321-3R750-B	20	525[5]				
	1250[2]	2	12.2 (40)	30.5 (100)	61.0 (200)	121.9 (400)	12.2 (40)	45.7 (150)	61.0 (200)	121.9 (400)	45.7 (150)	152.4 (500)	304.8 (1000)	365.8 (1200)	2 x 1321-3R750-B	20	525[5]				

(1) Frame 12 drives have dual inverters and require two output reactors. The resistor ratings are per phase values for each reactor.
(2) Some Frame 13 drives require two output reactors to match drive amp rating. The resistor ratings are per phase values for each reactor.
(3) Resistor specification is based on two cables per phase.
(4) Resistor specification is based on three cables per phase.
(5) Resistor specification is based on four cables per phase.

Table A.U PowerFlex 700S, 600V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution		Reactor Only		Reactor + Damping Resistor or 1321-RWR		Reactor/RWR *(see page A-22)*	Resistor		Available Options			
Frame	**HP**	**kHz**	*1488V*	*1850V*	*1488V*	*1850V*	*1488V*	*1850V*	**Cat. No.**	**Ohms**	**Watts**	**TFA1**	**TFB2**	**RWR2**	**RWC**
1	1	2/4	30.5 (100)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)	121.9 (400)				●		●	●
	2	2/4	30.5 (100)	152.4 (500)	121.9 (400)	152.4 (500)	152.4 (500)	152.4 (500)				●	●	●	●
	3	2/4	30.5 (100)	152.4 (500)	121.9 (400)	182.9 (600)	182.9 (600)	182.9 (600)				●	●	●	●
	5	2/4	30.5 (100)	152.4 (500)	121.9 (400)	243.8 (800)	243.8 (800)	243.8 (800)	1321-RWR8-EP			●	●	●	●
	7.5	2/4	30.5 (100)	152.4 (500)	121.9 (400)	304.8 (1000)	304.8 (1000)	304.8 (1000)	1321-RWR8-EP				●		●
	10	2/4	30.5 (100)	152.4 (500)	121.9 (400)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR12-EP				●		●
	15	2/4	30.5 (100)	152.4 (500)	121.9 (400)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR18-EP				●		
2	20	2/4	30.5 (100)	152.4 (500)	121.9 (400)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR25-EP				●		
	25	2/4	30.5 (100)	152.4 (500)	121.9 (400)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR25-EP				●		

Drive			No Solution		Reactor Only		Reactor + Damping Resistor or 1321-RWR		Reactor/RWR *(see page A-22)*	Resistor		Available Options			
Frame	**HP**	**kHz**	*1488V*	*1850V*	*1488V*	*1850V*	*1488V*	*1850V*	**Cat. No.**	**Ohms**	**Watts**	**TFA1**	**TFB2**	**RWR2**	**RWC**
3	30	2/4	30.5 (100)	152.4 (500)	121.9 (400)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR35-EP				●		
	40	2/4	30.5 (100)	152.4 (500)	121.9 (400)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR45-EP				●		
	50	2/4	36.6 (120)	152.4 (500)	121.9 (400)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR55-EP				●		
4	60	2/4	36.6 (120)	152.4 (500)	121.9 (400)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR80-EP				●		
5	75	2/4	36.6 (120)	152.4 (500)	121.9 (400)	365.8 (1200)	365.8 (1200)	365.8 (1200)	1321-RWR80-EP				●		
	100	2/4	42.7 (140)	152.4 (500)	121.9 (400)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR100-EP				●		
6	125	2/4	42.7 (140)	152.4 (500)	121.9 (400)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR130-EP				●		
	150	2/4	42.7 (140)	152.4 (500)	121.9 (400)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR160-EP				●		
9	150	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR200-EP				●		
	200	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-RWR250-EP				●		
10	250	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-3RB250-B	50	315		●		
	350	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-3RB350-B	20	585 (3)		●		
	400	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-3RB400-B	20	585 (3)		●		
	450	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-3R500-B	20	585 (3)		●		
11	500	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-3R500-B	20	585 (3)		●		
	600	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-3R600-B	20	585 (3)		●		
12 (1)	700	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	2 X 1321-3RB320-B	40	300 (3)		●		
	800	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	2 X 1321-3RB400-C	40	480 (4)		●		
	900	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	2 X 1321-3R400-B	40	480 (4)				
13	1000	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-3R1000-C	20	960 (4)				
	1100	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	1321-3R1000-B	10	1440 (5)				
	1300 (2)	2	42.7 (140)	152.4 (500)	61.0 (200)	304.8 (1000)	365.8 (1200)	365.8 (1200)	2 X 1321-3R600-B	20	720 (5)				

(1) Frame 12 drives have dual inverters and require two output reactors. The resistor ratings are per phase values for each reactor.
(2) Some Frame 13 drives require two output reactors to match drive amp rating. The resistor ratings are per phase values for each reactor.
(3) Resistor specification is based on two cables per phase.
(4) Resistor specification is based on three cables per phase.
(5) Resistor specification is based on four cables per phase.

Table A.V PowerFlex 700S, 690V Shielded/Unshielded Cable - *Meters (Feet)*

Drive			No Solution		Reactor Only		Reactor + Damping Resistor		Reactor *(see page A-22)*	Resistor		Available Options			
Frame	kW	kHz	*1850V*	*2000V*	*1850V*	*2000V*	*1850V*	*2000V*	Cat. No.	Ohms	Watts	TFA1	TFB2	RWR2	RWC
5	45	2/4	30.5 (100)	76.2 (250)	91.4 (300)	152.4 (500)	365.8 (1200)	365.8 (1200)	1321-3R80-C	50	345/690				
	55	2/4	30.5 (100)	76.2 (250)	91.4 (300)	152.4 (500)	365.8 (1200)	365.8 (1200)	1321-3R80-C	50	345/690				
	75	2/4	30.5 (100)	76.2 (250)	91.4 (300)	152.4 (500)	365.8 (1200)	365.8 (1200)	1321-3R100-C	50	345/690				
	90	2/4	30.5 (100)	76.2 (250)	91.4 (300)	152.4 (500)	365.8 (1200)	365.8 (1200)	1321-3R130-C	50	375/750				
6	110	2/4	30.5 (100)	76.2 (250)	91.4 (300)	152.4 (500)	365.8 (1200)	365.8 (1200)	1321-3R160-C	50	375/750				
	132	2/4	30.5 (100)	76.2 (250)	91.4 (300)	152.4 (500)	365.8 (1200)	365.8 (1200)	1321-3R200-C	50	375/750				
9	160	2	30.5 (100)	68.6 (225)	91.4 (300)	152.4 (500)	274.3 (900)	365.8 (1200)	1321-3RB250-C	50	480				
	200	2	30.5 (100)	68.6 (225)	91.4 (300)	152.4 (500)	274.3 (900)	365.8 (1200)	1321-3RB250-C	50	480				
10	250	2	30.5 (100)	68.6 (225)	76.2 (250)	121.9 (400)	274.3 (900)	365.8 (1200)	1321-3RB320-C	50	480				
	315	2	30.5 (100)	68.6 (225)	76.2 (250)	121.9 (400)	274.3 (900)	365.8 (1200)	1321-3RB400-C	20	945 (3)				
	355	2	30.5 (100)	68.6 (225)	76.2 (250)	121.9 (400)	274.3 (900)	365.8 (1200)	1321-3R500-C	20	945 (3)				
	400	2	30.5 (100)	68.6 (225)	76.2 (250)	121.9 (400)	243.8 (800)	304.8 (1000)	1321-3R500-C	20	945 (3)				
11	450	2	30.5 (100)	68.6 (225)	76.2 (250)	121.9 (400)	243.8 (800)	304.8 (1000)	1321-3R600-C	20	945 (3)				
	500	2	30.5 (100)	68.6 (225)	76.2 (250)	121.9 (400)	243.8 (800)	304.8 (1000)	1321-3R600-C	20	945 (3)				
	560	2	30.5 (100)	68.6 (225)	61.0 (200)	91.4 (300)	243.8 (800)	304.8 (1000)	1321-3R750-C	20	945 (3)				
12 (1)	630	2	30.5 (100)	68.6 (225)	61.0 (200)	91.4 (300)	243.8 (800)	304.8 (1000)	2 X 1321-3RB400-C	40	480 (3)				
	710	2	30.5 (100)	68.6 (225)	61.0 (200)	91.4 (300)	243.8 (800)	304.8 (1000)	2 X 1321-3R500-C	40	645 (4)				
	800	2	30.5 (100)	68.6 (225)	61.0 (200)	91.4 (300)	243.8 (800)	304.8 (1000)	2 X 1321-3R500-C	40	645 (4)				
13	900 (2)	2	30.5 (100)	68.6 (225)	61.0 (200)	91.4 (300)	243.8 (800)	304.8 (1000)	2 X 1321-3R600-C	40	645 (4)				
	1000 (2)	2	30.5 (100)	68.6 (225)	48.8 (160)	91.4 (300)	243.8 (800)	304.8 (1000)	2 X 1321-3R600-C	20	840 (5)				
	1100 (2)	2	30.5 (100)	68.6 (225)	48.8 (160)	91.4 (300)	243.8 (800)	304.8 (1000)	2 X 1321-3R750-C	20	840 (5)				

(1) Frame 12 drives have dual inverters and require two output reactors. The resistor ratings are per phase values for each reactor.
(2) Some Frame 13 drives require two output reactors to match drive amp rating. The resistor ratings are per phase values for each reactor.
(3) Resistor specification is based on two cables per phase.
(4) Resistor specification is based on three cables per phase.
(5) Resistor specification is based on four cables per phase.

1336 PLUS II and IMPACT

To increase the distance between the drive and the motor, some device (RWR or Terminator) needs to be added to the system. Shaded distances are restricted by cable capacitance charging current.

Table A.W 1336 PLUS II/IMPACT Drive, 380-480V - *Meters (Feet)*

			No External Devices[1]				w/1204-TFB2 Term.[1]			w/1204-TFA1 Terminator[1]					Reactor at Drive[1][4]	
			Motor				Motor			Motor					Motor	
			A	B	1329	1329R/L (1600V)	A or B		1329	A		B		1329	A	B or 1329
							Cable Type			Cable Type		Cable Type				
Drive Frame	Drive kW (HP)	Motor kW (HP)	*Any Cable*	*Any Cable*	*Any Cable*	*Any Cable[2]*	*Shld[3]*	*Unshld*	*Any Cable*	*Shld[3]*	*Unshld*	*Shld[3]*	*Unshld*	*Any Cable*	*Any Cable*	*Any Cable*
A1	0.37 (0.5)	0.37 (0.5)	12.2 (40)	33.5 (110)	91.4 (300)	91.4 (300)	Use 1204-TFA1			30.5 (100)	61.0 (200)	30.5 (100)	61.0 (200)	91.4 (300)	22.9 (75)	182.9 (600)
	0.75 (1)	0.75 (1)	12.2 (40)	33.5 (110)	91.4 (300)	91.4 (300)				30.5 (100)	30.5 (100)	30.5 (100)	30.5 (100)	91.4 (300)	22.9 (75)	182.9 (600)
		0.37 (0.5)	12.2 (40)	33.5 (110)	91.4 (300)	91.4 (300)				30.5 (100)	61.0 (200)	30.5 (100)	61.0 (200)	91.4 (300)	22.9 (75)	182.9 (600)
	1.2 (1.5)	1.2 (1.5)	12.2 (40)	33.5 (110)	91.4 (300)	91.4 (300)				30.5 (100)	30.5 (100)	61.0 (200)	61.0 (200)	91.4 (300)	22.9 (75)	182.9 (600)
		0.75 (1)	12.2 (40)	33.5 (110)	91.4 (300)	91.4 (300)				30.5 (100)	30.5 (100)	61.0 (200)	61.0 (200)	91.4 (300)	22.9 (75)	182.9 (600)
		0.37 (0.5)	12.2 (40)	33.5 (110)	114.3 (375)	121.9 (400)				30.5 (100)	30.5 (100)	61.0 (200)	61.0 (200)	121.9 (400)	22.9 (75)	182.9 (600)
A2	1.5 (2)	1.5 (2)	7.6 (25)	12.2 (40)	91.4 (300)	91.4 (300)	91.4 (300)	91.4 (300)	91.4 (300)	30.5 (100)	30.5 (100)	91.4 (300)	61.0 (200)	91.4 (300)	22.9 (75)	182.9 (600)
		1.2 (1.5)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	91.4 (300)	182.9 (600)	182.9 (600)	30.5 (100)	30.5 (100)	91.4 (300)	61.0 (200)	182.9 (600)	22.9 (75)	182.9 (600)
		0.75 (1)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	30.5 (100)	30.5 (100)	91.4 (300)	61.0 (200)	182.9 (600)	22.9 (75)	182.9 (600)
		0.37 (0.5)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	30.5 (100)	30.5 (100)	91.4 (300)	61.0 (200)	182.9 (600)	22.9 (75)	182.9 (600)
	2.2 (3)	2.2 (3)	7.6 (25)	12.2 (40)	91.4 (300)	91.4 (300)	182.9 (600)	182.9 (600)	182.9 (600)	Use 1204-TFB2					22.9 (75)	182.9 (600)
		1.5 (2)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						22.9 (75)	182.9 (600)
		0.75 (1)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						22.9 (75)	182.9 (600)
		0.37 (0.5)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						22.9 (75)	182.9 (600)
A3	3.7 (5)	3.7 (5)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						22.9 (75)	182.9 (600)
		2.2 (3)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						22.9 (75)	182.9 (600)
		1.5 (2)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						22.9 (75)	182.9 (600)
		0.75 (1)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						22.9 (75)	182.9 (600)
		0.37 (0.5)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						22.9 (75)	182.9 (600)
A4	5.5-15 (7.5-20)	5.5-15 (7.5-20)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						24.4 (80)	182.9 (600)
B	11-22 (15-30)	11-22 (15-30)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						24.4 (80)	182.9 (600)
C	30-45 (X40-X60)	30-45 (40-60)	7.6 (25)	12.2 (40)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						76.2 (250)	182.9 (600)
D	45-112 (60-X150)	45-112 (60-150)	12.2 (40)	30.5 (100)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						61.0 (200)	91.4 (300)
E	112-187 (150-250)	112-187 (150-250)	12.2 (40)	53.3 (175)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						182.9 (600)	182.9 (600)
F	187-336 (250-450)	187-336 (250-450)	18.3 (60)	53.3 (175)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						182.9 (600)	182.9 (600)
G	187-448 (X250-600)	187-448 (250-600)	18.3 (60)	53.3 (175)	114.3 (375)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)						182.9 (600)	182.9 (600)

(1) Values shown are for nominal input voltage, drive carrier frequency of 2 kHz or as shown and surrounding air temperature at the motor of 40o C. Consult factory regarding operation at carrier frequencies above 2 kHz. Multiply values by 0.85 for high line conditions. For input voltages of 380, 400 or 415V AC, multiply the table values by 1.25, 1.20 or 1.15, respectively.

(2) These distance restrictions are due to charging of cable capacitance and may vary from application to application.

(3) Includes wire in conduit. Shielded cable is Belden 295xx or equivalent.

(4) A 3% reactor reduces motor and cable stress but may cause a degradation of motor waveform quality. Reactors must have a turn-turn insulation rating of 2100 Volts or higher.

Table A.X 1336 PLUS II/IMPACT Drive, 600V - *Meters (Feet)*

			No External Devices[1]			w/1204-TFB2 Terminator[1]			w/1204-TFA1 Terminator[1]			Reactor at Drive[1][3]		
			Motor			Motor			Motor			Motor		
			A	B	1329R/L[2]	A	B	1329R/L[2]	A	B	1329R/L[2]	A	B	1329R/L[2]
Drive Frame	**Drive kW (HP)**	**Motor kW (HP)**	*Any Cable*	*Any Cable*	*Any Cable*	*Any Cable*	*Any Cable*	*Any Cable*	*Any Cable*	*Any Cable*	*Any Cable*	*Any Cable*	*Any Cable*	*Any Cable*
A4	0.75 (1)	0.75 (1)	NR	NR	NA	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)	**Not Recommended**		
		0.37 (0.5)	NR	NR	NA	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
	1.5 (2)	1.5 (2)	NR	NR	NA	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
		1.2 (1.5)	NR	NR	NA	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
		0.75 (1)	NR	NR	182.9 (600)	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
		0.37 (0.5)	NR	NR	182.9 (600)	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
	2.2 (3)	2.2 (3)	NR	NR	NA	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
		1.5 (2)	NR	NR	NA	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
		0.75 (1)	NR	NR	182.9 (600)	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
		0.37 (0.5)	NR	NR	182.9 (600)	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
	3.7 (5)	3.7 (5)	NR	NR	NA	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
		2.2 (3)	NR	NR	NA	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
		1.5 (2)	NR	NR	182.9 (600)	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
		0.75 (1)	NR	NR	182.9 (600)	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
		0.37 (0.5)	NR	NR	182.9 (600)	NR	182.9 (600)	335.3 (1100)	NR	61.0 (200)	182.9 (600)			
	5.5-15 (7.5-20)	5.5-15 (7.5-20)	NR	9.1 (30)	182.9 (600)	91.4 (300)	182.9 (600)	182.9 (600)	NR	61.0 (200)	182.9 (600)	30.5 (100)	91.4 (300)	182.9 (600)
C	18.5-45 (25-60)	18.5-45 (25-60)	NR	9.1 (30)	182.9 (600)	91.4 (300)	182.9 (600)	182.9 (600)	NR	61.0 (200)	182.9 (600)	30.5 (100)	91.4 (300)	182.9 (600)
D	56-93 (75-125)	56-93 (75-125)	NR	9.1 (30)	182.9 (600)	91.4 (300)	182.9 (600)	182.9 (600)	NR	61.0 (200)	182.9 (600)	61.0 (200)	91.4 (300)	182.9 (600)
E	112-224 (150-X300)	112-224 (150-X300)	NR	9.1 (30)	182.9 (600)	91.4 (300)	182.9 (600)	182.9 (600)	NR	61.0 (200)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)
F	261-298 (350-400)	261-298 (350-400)	NR	9.1 (30)	182.9 (600)	91.4 (300)	182.9 (600)	182.9 (600)	NR	61.0 (200)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)
G	224-448 (300-600)	224-448 (300-600)	NR	9.1 (30)	182.9 (600)	91.4 (300)	182.9 (600)	182.9 (600)	NR	61.0 (200)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)

(1) Values shown are for nominal input voltage and drive carrier frequency of 2 kHz. Consult factory regarding operation at carrier frequencies above 2 kHz.

(2) When used on 600V systems, 1329R/L motors have a corona inception voltage rating of approximately 1850V.

(3) A 3% reactor reduces motor and cable stress but may cause a degradation of motor waveform quality. Reactors must have a turn-turn insulation rating of 2100 Volts or higher.

NR = Not Recommended

NA = Not Available at time of printing

1305

Table A.Y 1305 Drive, 480V, No External Devices at Motor - *Meters (Feet)*

Drive HP (480V)	Motor HP (480V)	(480V) Using a Motor with Insulation V_{P-P}			
		Type A	Type B	1329R/L	
		Any Cable	*Any Cable*	*Shielded Cable* [1]	*Unshielded Cable*
Maximum Carrier Frequency		**4 kHz**	**4 kHz**	**2 kHz**	**2 kHz**
High-Line Derate Multiplier		**0.85**	**0.85**	**0.55**	**0.55**
5	5	9.1 (30)	30.5 (100)	121.9 (400)	121.9 (400)
	3	9.1 (30)	30.5 (100)	121.9 (400)	121.9 (400)
	2	9.1 (30)	30.5 (100)	121.9 (400)	121.9 (400)
	1	9.1 (30)	30.5 (100)	121.9 (400)	121.9 (400)
	0.5	9.1 (30)	30.5 (100)	121.9 (400)	121.9 (400)
3	3	9.1 (30)	30.5 (100)	91.4 (300)	121.9 (400)
	2	9.1 (30)	30.5 (100)	121.9 (400)	121.9 (400)
	1	9.1 (30)	30.5 (100)	121.9 (400)	121.9 (400)
	0.5	9.1 (30)	30.5 (100)	121.9 (400)	121.9 (400)
2	2	9.1 (30)	30.5 (100)	76.2 (250)	121.9 (400)
	1	9.1 (30)	30.5 (100)	121.9 (400)	121.9 (400)
	0.5	9.1 (30)	30.5 (100)	121.9 (400)	121.9 (400)
1	1	9.1 (30)	30.5 (100)	68.6 (225)	121.9 (400)
	0.5	9.1 (30)	30.5 (100)	121.9 (400)	121.9 (400)
0.5	0.5	9.1 (30)	30.5 (100)	45.7 (150)	106.7 (350)

(1) Cable is Belden 295xx series or equivalent.

Table A.Z 1305 Drive, 480V with Devices at Motor - *Meters (Feet)*

Drive HP (460V)	Motor HP (460V)	Reactor at the Drive[1]			With 1204-TFB2 Terminator		With 1204-TFA1 Terminator			
		Using a Motor with Insulation V_{P-P}			Using a Motor with Insulation V_{P-P}		Using a Motor with Insulation V_{P-P}			
		Type A	Type B or 1329R/L		Type A or Type B		Type A		Type B	
		Any Cable	*Shielded* [2]	*Unshielded*	*Shielded* [2]	*Unshielded*	*Shielded* [2]	*Unshielded*	*Shielded* [2]	*Unshielded*
Maximum Carrier Frequency		**2 kHz**	**2 kHz**	**2 kHz**	**2 kHz**	**2 kHz**	**2 kHz**	**2 kHz**	**2 kHz**	**2 kHz**
High-Line Derating Multiplier		**0.85**	**0.85**	**0.85**	**0.85**	**0.85**	**0.85**	**0.85**	**0.85**	**0.85**
5	5	15.2 (50)	182.9 (600)	182.9 (600)	NR	NR	91.4 (300)	61.0 (200)	91.4 (300)	121.9 (400)
	3	15.2 (50)	182.9 (600)	182.9 (600)	91.4 (300)	121.9 (400)	99.1 (325)	61.0 (200)	152.4 (500)	121.9 (400)
	2	15.2 (50)	182.9 (600)	182.9 (600)	121.9 (400)	182.9 (600)	99.1 (325)	61.0 (200)	182.9 (600)	121.9 (400)
	1	15.2 (50)	182.9 (600)	182.9 (600)	121.9 (400)	182.9 (600)	99.1 (325)	61.0 (200)	182.9 (600)	121.9 (400)
	0.5	15.2 (50)	182.9 (600)	182.9 (600)	182.9 (600)	182.9 (600)	99.1 (325)	61.0 (200)	182.9 (600)	121.9 (400)
3	3	15.2 (50)	91.4 (300)	182.9 (600)	NR	NR	91.4 (300)	61.0 (200)	91.4 (300)	121.9 (400)
	2	15.2 (50)	182.9 (600)	182.9 (600)	91.4 (300)	121.9 (400)	99.1 (325)	61.0 (200)	152.4 (500)	121.9 (400)
	1	15.2 (50)	182.9 (600)	182.9 (600)	91.4 (300)	182.9 (600)	99.1 (325)	61.0 (200)	182.9 (600)	121.9 (400)
	0.5	15.2 (50)	182.9 (600)	182.9 (600)	121.9 (400)	182.9 (600)	99.1 (325)	61.0 (200)	182.9 (600)	121.9 (400)
2	2	15.2 (50)	76.2 (250)	167.6 (550)	NR	NR	91.4 (300)	61.0 (200)	91.4 (300)	121.9 (400)
	1	15.2 (50)	182.9 (600)	182.9 (600)	61.0 (200)	61.0 (200)	99.1 (325)	61.0 (200)	121.9 (400)	121.9 (400)
	0.5	15.2 (50)	182.9 (600)	182.9 (600)	91.4 (300)	121.9 (400)	99.1 (325)	61.0 (200)	152.4 (500)	121.9 (400)
1	1	15.2 (50)	68.6 (225)	152.4 (500)	NR	NR	45.7 (150)	61.0 (200)	45.7 (150)	76.2 (250)
	0.5	15.2 (50)	182.9 (600)	182.9 (600)	NR	NR	76.2 (250)	61.0 (200)	76.2 (250)	121.9 (400)
0.5	0.5	15.2 (50)	45.7 (150)	106.7 (350)	NR	NR	NR	NR	NR	NR

(1) IMPORTANT: A 3% reactor reduces motor stress but may cause a degradation of motor waveform quality. Reactors must have a turn-to-turn insulating rating of 2100 volts or higher. Reactors are not recommended for lightly loaded applications because over voltage trips may result at low output frequencies.

(2) Cable is Belden 295xx series or equivalent.

NR = Not Recommended

160

Table A.AA 160 Drive, 480V - *Meters (Feet)*

380-460V Ratings	Motor Insulation Rating - $Volts_{P-P}$	Motor Cable Only		RWR at Drive		Reactor at Motor	
		Shielded [1]	*Unshielded*	*Shielded* [1]	*Unshielded*	*Shielded* [1]	*Unshielded*
4.0 kW (5 HP)	1000	13.7 (45)	6.1 (20)	160.0 (525)	182.9 (600)	99.1 (325)	91.4 (300)
	1200	27.4 (90)	12.2 (40)	160.0 (525)	182.9 (600)	160.0 (525)	129.5 (425)
	1600	160.0 (525)	144.8 (475)	160.0 (525)	182.9 (600)	160.0 (525)	182.9 (600)
2.2 kW (3 HP)	1000	12.2 (40)	12.2 (40)	160.0 (525)	182.9 (600)	68.6 (225)	76.2 (250)
	1200	27.4 (90)	18.3 (60)	160.0 (525)	182.9 (600)	99.1 (325)	129.5 (425)
	1600	160.0 (525)	152.4 (500)	160.0 (525)	182.9 (600)	160.0 (525)	182.9 (600)
1.5 kW (2 HP)	1000	12.2 (40)	12.2 (40)	129.5 (425)	182.9 (600)	99.1 (325)	91.4 (300)
	1200	27.4 (90)	18.3 (60)	129.5 (425)	182.9 (600)	129.5 (425)	137.2 (450)
	1600	152.4 (500)	152.4 (500)	129.5 (425)	182.9 (600)	164.6 (540)	182.9 (600)
0.75 kW (1 HP)	1000	16.8 (55)	12.2 (40)	99.1 (325)	182.9 (600)	99.1 (325)	106.7 (350)
	1200	38.1 (125)	18.3 (60)	99.1 (325)	182.9 (600)	152.4 (500)	137.2 (450)
	1600	152.4 (500)	152.4 (500)	99.1 (325)	182.9 (600)	152.4 (500)	182.9 (600)
0.55 kW (0.75 HP)	1000	13.7 (45)	12.2 (40)	91.4 (300)	182.9 (600)	91.4 (300)	91.4 (300)
	1200	38.1 (125)	18.3 (60)	91.4 (300)	182.9 (600)	152.4 (500)	152.4 (500)
	1600	152.4 (500)	152.4 (500)	91.4 (300)	182.9 (600)	152.4 (500)	182.9 (600)
0.37 kW (0.5 HP)	1000	13.7 (45)	27.4 (90)	91.4 (300)	129.5 (425)	91.4 (300)	129.5 (425)
	1200	38.1 (125)	54.9 (180)	91.4 (300)	129.5 (425)	152.4 (500)	152.4 (500)
	1600	152.4 (500)	152.4 (500)	91.4 (300)	129.5 (425)	152.4 (500)	152.4 (500)

(1) Cable is Belden 295xx series or equivalent.

Table A.AB 160 Drive, 240 & 480V - Cable Charging Current - *Meters (Feet)*

480V Ratings	kHz	Motor Cable Only		RWR at Drive		Reactor at Motor	
		Shielded [1][2]	*Unshielded*	*Shielded* [1][2]	*Unshielded*	*Shielded* [1][2]	*Unshielded*
4.0 kW (5 HP)	2	106.7 (350)	182.9 (600)	91.4 (300)	182.9 (600)	121.9 (400)	182.9 (600)
	4	129.5 (425)	182.9 (600)	106.7 (350)	182.9 (600)	137.2 (450)	182.9 (600)
	8	144.8 (475)	152.4 (500)	NR	NR	137.2 (450)	152.4 (500)
2.2 kW (3 HP)	2	109.7 (360)	182.9 (600)	85.3 (280)	182.9 (600)	121.9 (400)	182.9 (600)
	4	114.3 (375)	182.9 (600)	83.8 (275)	182.9 (600)	121.9 (400)	182.9 (600)
	8	121.9 (400)	152.4 (500)	NR	NR	121.9 (400)	152.4 (500)
1.5 kW (2 HP)	2	91.4 (300)	167.6 (550)	83.8 (275)	182.9 (600)	91.4 (300)	182.9 (600)
	4	91.4 (300)	167.6 (550)	83.8 (275)	182.9 (600)	91.4 (300)	152.4 (500)
	8	99.1 (325)	152.4 (500)	NR	NR	106.7 (350)	152.4 (500)
0.75 kW (1 HP)	2	61.0 (200)	114.3 (375)	61.0 (200)	129.5 (425)	68.6 (225)	121.9 (400)
	4	68.6 (225)	114.3 (375)	61.0 (200)	129.5 (425)	68.6 (225)	114.3 (375)
	8	76.2 (250)	114.3 (375)	NR	NR	68.6 (225)	121.9 (400)
0.55 kW (0.75 HP)	2	54.9 (180)	106.7 (350)	54.9 (180)	114.3 (375)	54.9 (180)	106.7 (350)
	4	54.9 (180)	106.7 (350)	54.9 (180)	114.3 (375)	54.9 (180)	106.7 (350)
	8	54.9 (180)	106.7 (350)	NR	NR	54.9 (180)	106.7 (350)
0.37 kW (0.5 HP)	2	30.5 (100)	99.1 (325)	30.5 (100)	106.7 (350)	30.5 (100)	91.4 (300)
	4	30.5 (100)	99.1 (325)	30.5 (100)	106.7 (350)	30.5 (100)	106.7 (350)
	8	30.5 (100)	99.1 (325)	NR		30.5 (100)	106.7 (350)

240V Ratings	No Reactor		RWR at Drive		Reactor at Motor	
0.37 to 4.0 kW (0.5 to 5 HP) 2 through 8 kHz	*Shielded* [1]	*Unshielded*	*Shielded* [1]	*Unshielded*	*Shielded* [1]	*Unshielded*
	160.0 (525)	182.9 (600)	NR	NR	160.0 (525)	182.9 (600)

(1) When using shielded cable at lightly loaded conditions, cable length recommendations for drives rated 0.75 kW (1 HP) and below are 61 meters (200 feet).
(2) Cable is Belden 295xx series or equivalent.

NR = Not Recommended

1321-RWR Guidelines

- Figure A.1 shows wiring for single inverter drives (PowerFlex 70 Frames A-E, PowerFlex 700 Frames 0-6, PowerFlex 700H Frames 9-11 and PowerFlex 700S Frames 1-11 & 13).

  Figure A.2 describes dual inverter drives (PowerFlex 700H/700S Frame 12).

  Figure A.3 is for single inverter drives that require parallel reactors because the drive amp rating exceeds the rating of the largest available reactor (PowerFlex 700S Frame 13).
- Configurations shown in Figure A.1 and Figure A.3 can be used for single inverter drives with single or parallel cables, and single-motor or multi-motor applications.
- The configuration shown in Figure A.2 is used with dual inverter drives with single or parallel cables, and single-motor or multi-motor applications.
- Filter (RWR or L-R) must be connected at drive output terminals, less than 7.6 meters (25 feet) from the drive.
- See the lead length tables for output reactor and resistor selection. The resistor specification is based on the number of parallel cables used.
- For PowerFlex 700H & 700S Frame 12 drives and some PowerFlex 700S Frame 13 drives, two reactors are required. In this case, the resistor ohms and watts ratings are values per phase for each reactor (see lead length tables for output reactor selection).
- Resistor must be connected to reactor using 150 degree C wire. Select wire gauge based on rated resistor power from the lead length tables.
- Recommended cables include; XLPE, EPR and Hypalon.
- Maximum total cable distance for resistor wires is 6.1 meters (20 feet) or 3 meters (10 feet) per side.

Figure A.1 Filter Wiring for Single Inverter Drive

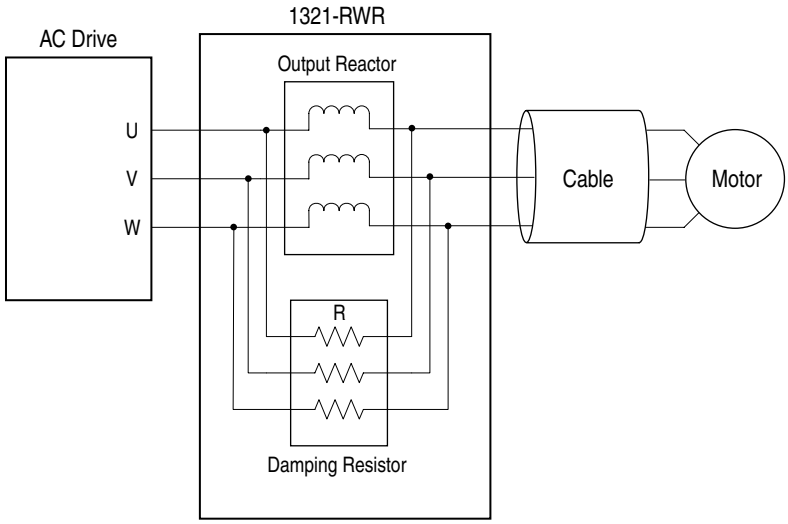


Figure A.2 Filter Wiring for Dual Inverter Frame 12 Drive

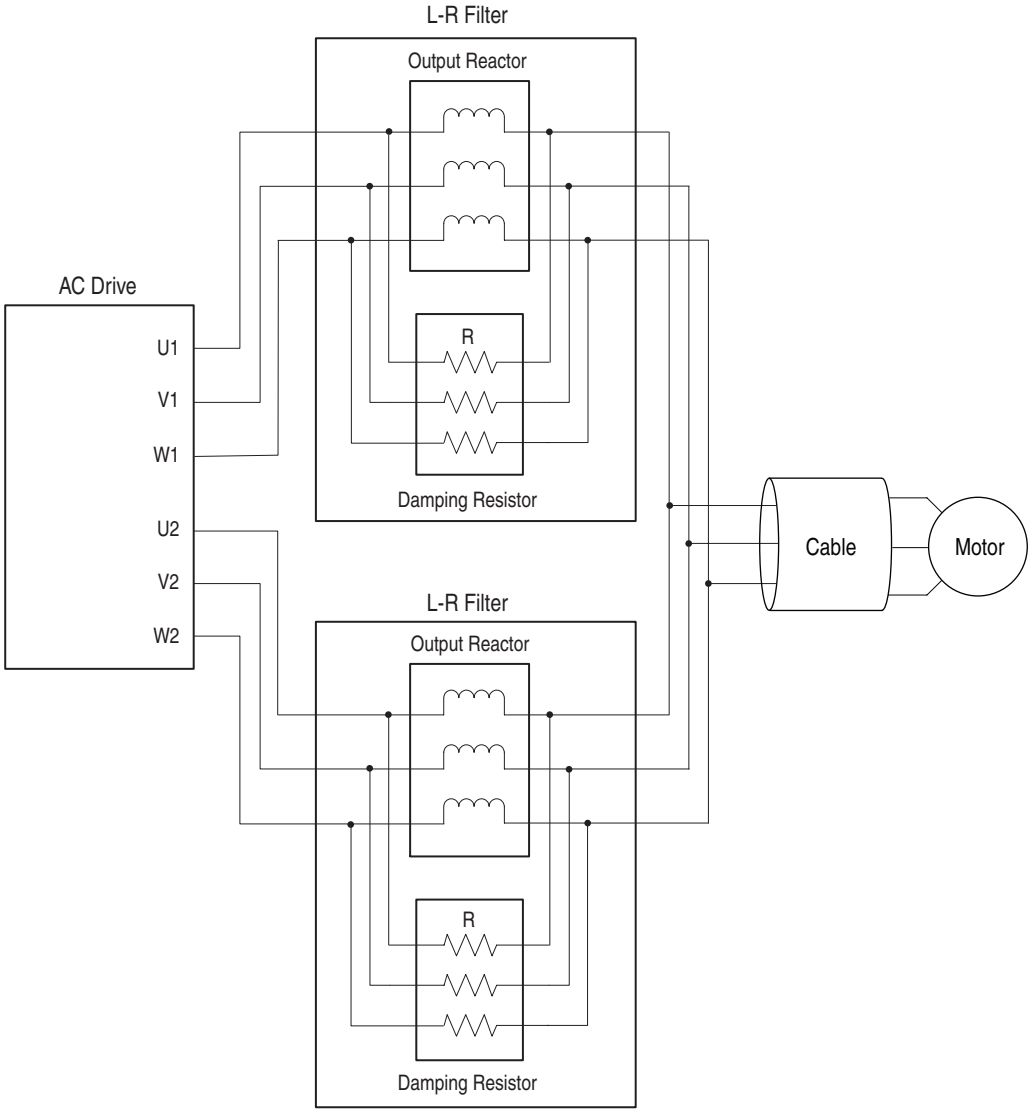
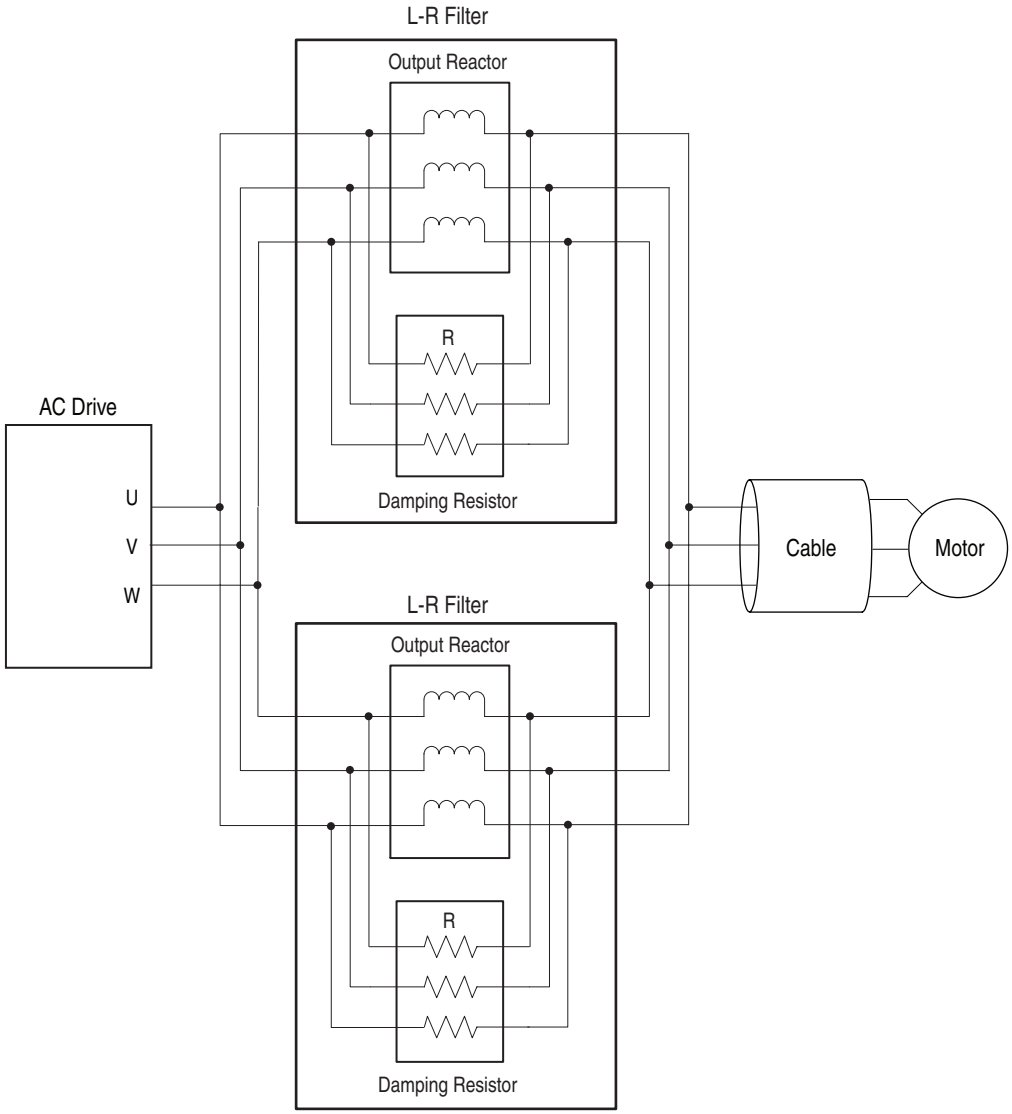


Figure A.3 Filter Wiring for Single Inverter Frame 13 Drive w/ Parallel Reactors



Ambient Air

Air around any equipment cabinet.
See surrounding air for more detail.

Armored

A fixed geometry cable that has a protective “sheath” of continuous metal

Capacitive Coupling

Current or voltage that is induced on one circuit by another because of their close physical proximity. For drive installations it is generally seen in two areas:

1. Coupling between motor leads of two drives, such that the operating drive induces voltage onto the motor leads (and thus the motor) of a non-operating drive.

2. Coupling between the conductors /or shields of motor leads that creates a requirement for more current than the motor itself would demand.

CIV (Corona Inception Voltage)

The amplitude of voltage on a motor or other electrical winding that produces corona (ionization of air to ozone). CIV is increased by adding phase paper, placing windings in the proper pattern and reducing or eliminating air bubbles (voids) in the varnish applied.

Common Mode Core

A ferrite bead or core that can be used to pass control, communications or motor leads through to attenuate high frequency noise. Catalog Number/ Part Number 1321-Mxxx

Common Mode Noise

Electrical noise, typically high frequency, that is imposed on the ground grid, carriers in an electrical system

Conduit

Conductive ferrous electrical metal tubing used to contain and protect individual wires

Damp

Wet locations per U.S. NEC or local code

Discrete

Individual, hard-wired inputs or outputs, typically used for control of the drive (Start, Stop, etc.)

Dry

Dry locations per Per NEC Article 100 or local code

dv/dt

The rate of change of voltage over time

Fill Rates

The maximum number of conductors allowed in a conduit, as determined by local, state or national electrical code.

Fixed Geometry

Cable whose construction fixes the physical position of each conductor within the overall coating, usually with filler material that prevents individual conductors from moving.

IGBT

Insulated Gate Bi-Polar Transistor. The typical power semi conductor device used in most PWM AC drives today

mil

0.001 inches

MOV

Metal Oxide Varistor

NEC

United States National Electric Code NFPA70

Peak Cable Charging Current

The current required to charge capacitance in motor cable. This capacitance has various components:

- conductor to shield or conduit
- conductor to conductor
- motor stator to motor frame

PVC

Polyvinyl Chloride (typically thermoplastic)

RWR

Reflected Waver Reducer, an RL network mounted at or near the drive, used to reduce the amplitude and rise time of the reflected wave pulses. Cat No 1204-RWR2-09-B or 1204-RWR2-09-C

Shielded

Cable containing a foil or braided metal shield surrounding the conductors. Usually found in multi-conductor cable. Shield coverage should be at least 75%.

Signal

Individual hard wired analog inputs or outputs, typically used to issue reference commands or process information to or from the drive.

Surrounding Air Temperature

The temperature of the air around the drive. If the drive is free standing or wall mounted, the surrounding air temperature is room temperature. If the drive is mounted inside another cabinet, the surrounding air temperature is the interior temperature of that cabinet

Terminator

An RC network mounted at or near the motor, used to reduce the amplitude and rise time of the reflected wave pulses. Catalog Number 1204-TFxx

THHN/THWN

U.S. designations for individual conductor wire, typically 75°C or 90°C rated and with PVC insulation and nylon coating.

Unshielded

Cable containing no braided or foil sheath surrounding the conductors. Can be multi-conductor cable or individual conductors.

Wet

Locations with moisture present - see Damp

XLPE

Cross Linked Polyethylene

UL

Underwriters Laboratories

Numerics

1305 Drive **A-20**
1305 Drive, AC Line Impedance **2-7**
1336 Drive, AC Line Impedance **2-13**
1336 Plus II/Impact Drive **A-18**
1336 PLUS II/Impact Drive, 600V **A-19**
160 Drive, Cable Charging Current **A-21**
4, PowerFlex **A-2**
4, PowerFlex, AC Line Impedance **2-8**
40, PowerFlex **A-2**
40, PowerFlex, AC Line Impedance **2-8**
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U.S. Allen-Bradley Drives Technical Support - Tel: (1) 262.512.8176, Fax: (1) 262.512.2222, Email: support@drives.ra.rockwell.com, Online: www.ab.com/support/abdrives

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

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