



Allen-Bradley

PowerFlex[®]

Diode Bus Supply

User Manual

www.abpowerflex.com

**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.ab.com/manuals/gi>) 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 the Rockwell Automation Company 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, the Rockwell Automation Company cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation Company with respect to use of information, circuits, equipment, or software described in this manual.

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



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 the hazard
- recognize the consequences

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



Shock Hazard labels may be located on or inside the drive to alert people that dangerous voltage may be present.



Burn Hazard labels may be located on or inside the drive to alert people that surfaces may be at dangerous temperatures.

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Notes:

Overview

The purpose of this manual is to provide you with the basic information needed to install, start-up and troubleshoot the PowerFlex Diode Bus Supply.

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Who Should Use this Manual?

This manual is intended for qualified personnel. You must be able to program and operate Adjustable Frequency AC Drive devices.

Reference Materials

The following manuals are recommended for general drive information:

Title	Publication	Available Online at ...
Industrial Automation Wiring and Grounding Guidelines	1770-4.1	(1)
Preventive Maintenance of Industrial Control and Drive System Equipment	DRIVES-SB001A-EN-E	www.ab.com/manuals/dr
Safety Guidelines for the Application, Installation and Maintenance of Solid State Control	SGI-1.1	www.ab.com/manuals/gi
A Global Reference Guide for Reading Schematic Diagrams	0100-2.10	(1)
Guarding Against Electrostatic Damage	8000-4.5.2	www.ab.com/manuals/gi

(1) Not available online, contact your local Rockwell Automation Sales Office

For detailed PowerFlex 700 information including specifications:

Title	Publication	Available . . .
PowerFlex Reference Manual	PFLEX-RM001D-EN-E	on the CD supplied with the drive or at www.ab.com/manuals/dr
Common Bus Application Guide	TBD	TBD

Manual Conventions

- In this manual we refer to the PowerFlex Adjustable Frequency AC Drive as; drive or PowerFlex Drive.
- The following words are used in 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
Shall	Required and necessary
Should	Recommended
Should Not	Not Recommended

General Precautions



ATTENTION: This Bus Supply contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, reference A-B publication 8000-4.5.2, “Guarding Against Electrostatic Damage” or any other applicable ESD protection handbook.



ATTENTION: An incorrectly applied or installed Bus Supply can result in component damage or a reduction in product life. Wiring or application errors, such as, incorrect or inadequate AC supply, or excessive ambient temperatures may result in malfunction of the system.



ATTENTION: Only qualified personnel familiar with adjustable frequency AC drives and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

ATTENTION: Only connect Rockwell Automation common DC bus AC drives with built-in precharge circuit to the Bus Supply’s common DC bus output. See Appendix A for available Drives.



ATTENTION: To avoid an electric shock hazard, verify that the voltage on the DC bus terminals (which are connected to the DC bus capacitors of the Inverter) has discharged before performing any work on the Bus Supply. Measure the DC bus voltage at the +DC and -DC terminal of the Output Power Terminals. The voltage must be zero.

Catalog Number Explanation

The catalog numbering scheme of the PowerFlex Diode Bus Supply is shown below.

21N	D	120	A	E
Product	Voltage Rating	Rating	Enclosure	Documentation

Product	
Name	Code
PowerFlex Diode Bus Supply	21N

Version & Voltage Rating			
Input Voltage	Source Type	Output Voltage	Cat. Code
240-480V AC	3 Phase	325-650V DC	D
500/600V AC	3 Phase	675/810V DC	E

Rating - Output Amps @ 480V AC In		
Amps	Frame	Cat. Code
120.0	2	120

Rating - Output Amps @ 600V AC In		
Amps	Frame	Cat. Code
120.0	2	120

Enclosure Type and Conformal Coating			
Rating	Style	Coating	Code
NEMA 1 / IP20	Standard Drive	No	A
NEMA 1 / IP20	Standard Drive	Yes	M

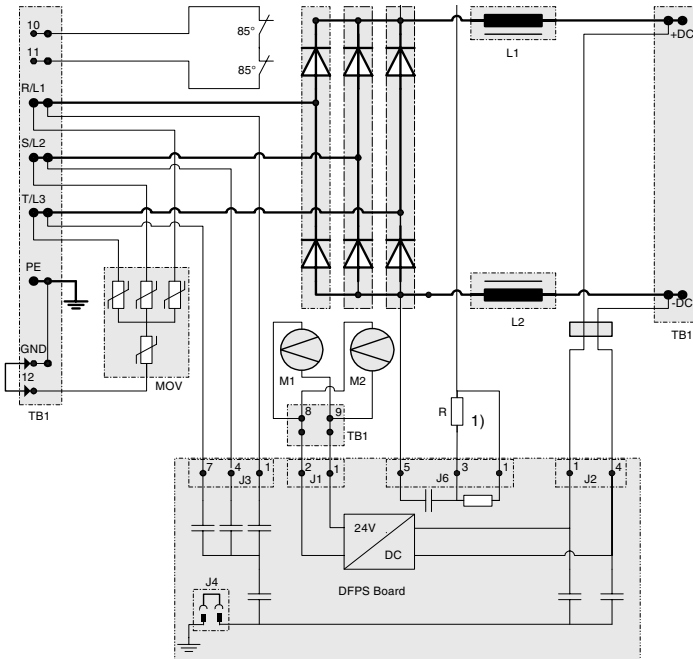
Documents & Shipping Cartons		
Documents	Ship Cart.	Code
English U. M.	Yes	E

Description and Schematic Diagram

The Diode Bus Supply is a single-direction power converter for the front-end of common DC bus drive systems and converts an incoming 3-phase, AC line voltage into a common DC bus voltage and current.

The primary electrical components of the Bus Supply are:

- **Six-Pulse, Full-Wave, 3-Phase-Diode-Bridge Rectifier Unit** direct connected to the three line input terminals.
- Two **temperature sensors** in the heat-sink for thermal protection of the diode-bridge rectifier.
- **EMC-Filtering:** The two **DC bus chokes** form together with the capacitor circuits in the input and the DC bus of the PowerFlex drive a radio interference filter RFI, which meets the requirements of EMC Product Standard 61800-3 for the industrial environment. The chokes also reduce line harmonics and peak currents in the AC line and the bridge circuit.
- **MOV and capacitor snubber circuits** routed to the 3 input phases.
- Two **fans** are connected to the 24V DC Power Supply on the **DFPS Board**.



1) On 480V units the connection from DC+ to J6-1 is used (J6-3 is open).

On 600V units the connection from DC+ to J6-3 via resistor R is used (J6-1 is open).

Installation/Wiring

This chapter provides information on mounting and wiring the PowerFlex Diode Bus Supply.

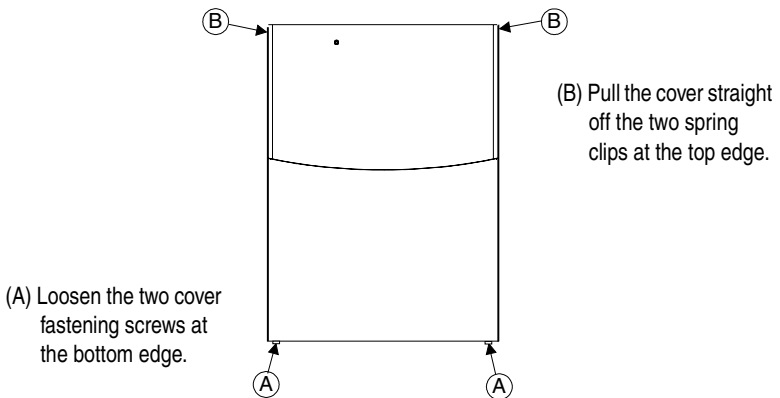
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Most start-up difficulties are the result of incorrect wiring. Every precaution must be taken to assure that the wiring is done as instructed. All items must be read and understood before the actual installation begins.

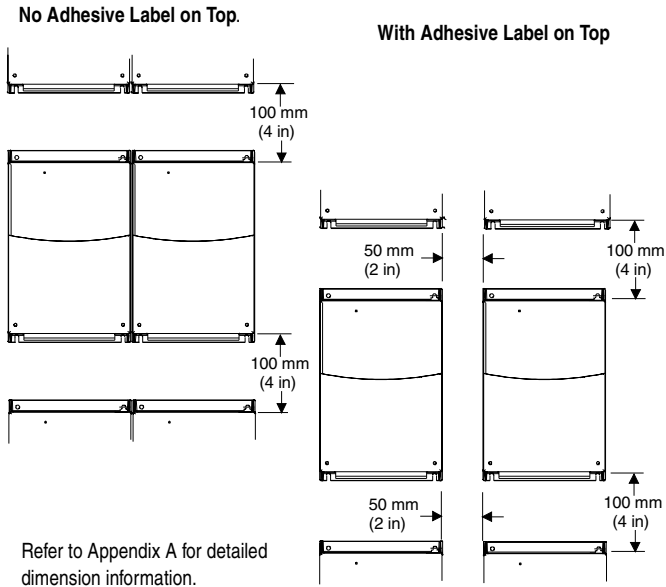


ATTENTION: The following information is merely a guide for proper installation. The Rockwell Automation company cannot assume responsibility for the compliance or the noncompliance to any code, national, local or otherwise for the proper installation of this drive or associated equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.

Opening the Cover



Minimum Mounting Clearances



Ambient Operating Temperatures

PowerFlex Diode Bus Supply units are designed to operate at 0° to 40°C ambient. Remove the label from the top to operate the Bus Supply in ambients between 41° and 50°C.

Important: Removing the adhesive label changes the enclosure rating from NEMA Type 1 Enclosed to Open Type.

AC Supply Source Considerations

PowerFlex Diode Bus Supply units are suitable for use on a circuit capable of delivering up to a maximum of 200,000 rms symmetrical amperes, and a maximum of 600 volts.



ATTENTION: To guard against personal injury and/or equipment damage caused by improper fusing or circuit breaker selection, use only the recommended line fuses/circuit breakers specified in Appendix A.

If a system ground fault monitor (RCD) is to be used, only Type B (adjustable) devices should be used to avoid nuisance tripping.

Unbalanced or Ungrounded Distribution Systems

If phase to ground voltage will exceed 125% of normal line to line voltage or the supply system is ungrounded, refer to the *PowerFlex Reference Manual*.



ATTENTION: PowerFlex Diode Bus Supply units contain protective MOVs and common mode capacitors that are referenced to ground. These devices should be disconnected if the Bus Supply is installed on an ungrounded distribution system. See page [1-6](#) for jumper locations.

Input Power Conditioning

If any of the following conditions exist, refer to the *PowerFlex Reference Manual*.

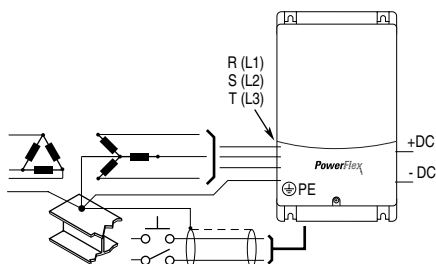
- Frequent power outages
- Ungrounded AC supply source
- Facility has power factor correction capacitors
- Input voltage variations that:
 - Exceed drive operating specifications
 - Cause rapid increases in drive bus voltage

General Grounding Requirements

The Safety Ground terminal - PE must be connected to system ground. Ground impedance must conform to the requirements of national and local industrial safety regulations and/or electrical codes. The integrity of all ground connections should be periodically checked.

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

Figure 1.1 Typical Grounding



Safety Ground Terminal - PE

This is the safety ground for the Bus Supply that is required by code. This point must be connected to adjacent building steel (girder, joist), a floor ground rod or bus bar (see above). Grounding points must comply with national and local industrial safety regulations and/or electrical codes.

RFI Filter Grounding

Using an external 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** (bonded) to the building power distribution ground. Ensure that the incoming supply neutral is solidly connected (bonded) to the same building power distribution ground. Grounding must not rely on flexible cables and should not include any form of plug or socket that would permit inadvertent disconnection. Some local codes may require redundant ground connections.

The integrity of all connections should be periodically checked. Refer to the instructions supplied with the filter.

Fuses and Circuit Breakers

The PowerFlex Diode Bus Supply can be installed with either input fuses or an input circuit breaker. National and local industrial safety regulations and/or electrical codes may determine additional requirements for these installations.



ATTENTION: The PowerFlex Diode Bus Supply does not provide branch short circuit protection. Specifications for the recommended fuse or circuit breaker to provide protection against short circuits and overload are provided in the Appendix A.

To avoid overloading the Bus Supply, the following requirements for selecting suitable fuses/circuit breakers apply in addition to the guidelines given in the PowerFlex 700 User Manual:

If available amp ratings of fuses/circuit breakers do not match the tables in the Appendix A, the closest rating that exceeds the sum rating of the connected drives should be chosen. The maximum sum rating for the continuous output current of the connected drive(s) is limited to **110A**. Examples for maximum drive rating:

Drive Rating Sum	Output Current Sum	Fuse (non time del.)	CB
30 + 22kW, 400V	99A	400 A max.	250A
2 x 40kW, 480V	104A	350 A max.	300A

Power Wiring



ATTENTION: National Codes and standards (NEC, VDE, BSI etc.) and local codes outline provisions for safely installing electrical equipment. Installation must comply with specifications regarding wire types, conductor sizes, branch circuit protection and disconnect devices. Failure to do so may result in personal injury and/or equipment damage.

Cable Types Acceptable for 200-600 Volt Installations

General

A variety of cable types are acceptable for drive installations. For many installations, unshielded cable is adequate, provided it can be separated from sensitive circuits. As an approximate guide, allow a spacing of 0.3 meters (1 foot) for every 10 meters (32.8 feet) of length. In all cases, long parallel runs must be avoided. Do not use cable with an insulation thickness less than or equal to 15 mils (0.4 mm/0.015 in.).

UL installations in 50°C ambient must use 600V, 90°C wire.

UL installations in 40°C ambient should use 600V, 75°C wire.

Unshielded

THHN, THWN or similar wire is acceptable for drive installation in dry environments provided adequate free air space and/or conduit fill rates limits are provided. **Do not use THHN or similarly coated wire in wet areas.** Any wire chosen must have a minimum insulation thickness of 15 Mils and should not have large variations in insulation concentricity.

EMC Compliance

Refer to [EMC Instructions on page 1-10](#) for details.

Cable Trays and Conduit

If cable trays or large conduits are to be used, refer to guidelines presented in the *PowerFlex 700 Reference Manual*.



ATTENTION: To avoid a possible shock hazard caused by induced voltages, unused wires in the conduit must be grounded at both ends. For the same reason, if a drive sharing a conduit is being serviced or installed, all drives using this conduit should be disabled. This will help minimize the possible shock hazard from “cross coupled” motor leads.

Terminals

Figure 1.2 Terminals and Jumpers Location

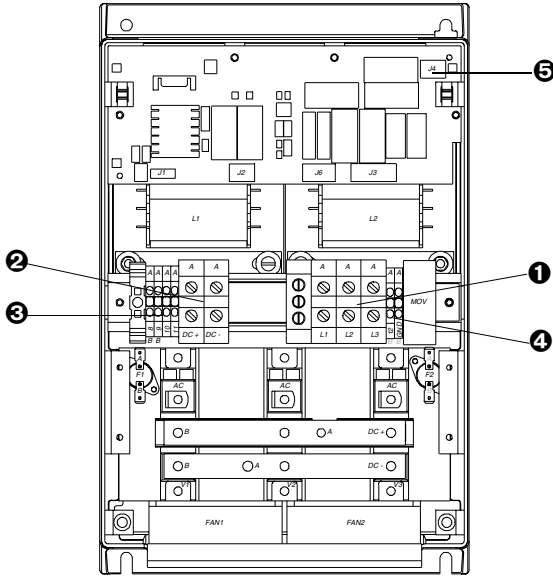


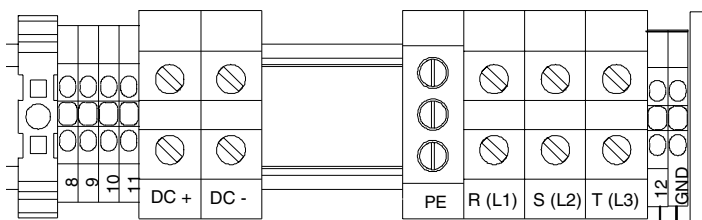
Table 1.A Terminal Specifications

No.	Name	Wire Size Range ⁽¹⁾		Torque
		Maximum	Minimum	
①	Input Power Terminals with Protection Earth Terminal PE	35 mm ² (2 AWG)	0.75 mm ² (18 AWG)	3.3N-m (30 lb.-in.)
②	DC Bus Terminals			
③ ④	Control Terminals	2.5 mm ² (14 AWG)	0.25 mm ² (22 AWG)	0.8N-m (7lb.-in.)

(1) Maximum/minimum sizes that the terminals will accept - these are not recommendations.

⑤ Jumper J4, see Disconnecting MOVs.

Figure 1.3 Power and Control Terminals Arrangement



Power Terminals	Description	Notes
R	R (L1)	AC Line Input Power
S	S (L2)	AC Line Input Power
T	T (L3)	AC Line Input Power
+DC	DC Bus (+)	DC Bus Connection (+)
-DC	DC Bus (-)	DC Bus Connection (-)
PE	PE Ground	Safety Ground
Control Terminals		
8	24V Fan Supply	Internal connection to extend fan supply leads (Must be disconnected in case of fan replacement)
9		
10	NC Contact Output	Opens at power stack overtemperature (Refer to Appendix A for contact ratings)
11		
12	Jumper MOV's to Ground	For disconnecting MOV's between phase and ground remove this jumper. (Refer to next page for details)
GND		

Control Wiring

Important points to remember about control wiring:

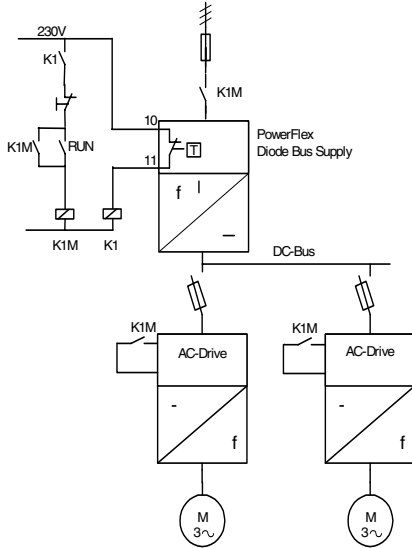
- Always use copper wire.
- Wire with an insulation rating of 600V or greater is recommended.
- Control wires outside the cabinet should be separated from power wires by at least 0.3 meters (1 foot).

Drive Run interlock

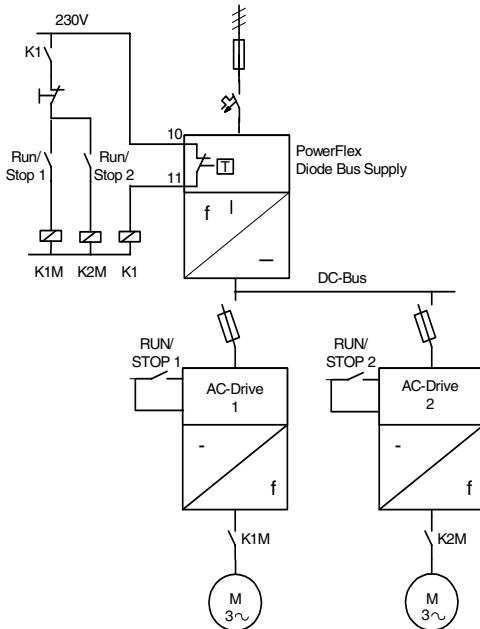
To protect the Bus Supply from Overtemperature, the normally closed contacts (Bus Supply Overtemperature - terminals 10 and 11) should be wired to either the AC-line input contactor of the Bus Supply or the Run interlock circuit (enable input) of each connected drive, to make sure that the drives are stopped in case of Bus Supply Overtemperature.

Control Wiring Examples

A. Several drives, running together



B. Several drives, running independent, 2-wire control



Disconnecting MOVs and Common Mode Capacitors

PowerFlex Diode Bus Supply units contain protective MOVs and common mode capacitors that are referenced to ground. To prevent damage, these devices should be **disconnected if the unit is installed on an ungrounded distribution system** where the line-to-ground voltages on any phase could exceed 125% of the nominal line-to-line voltage.

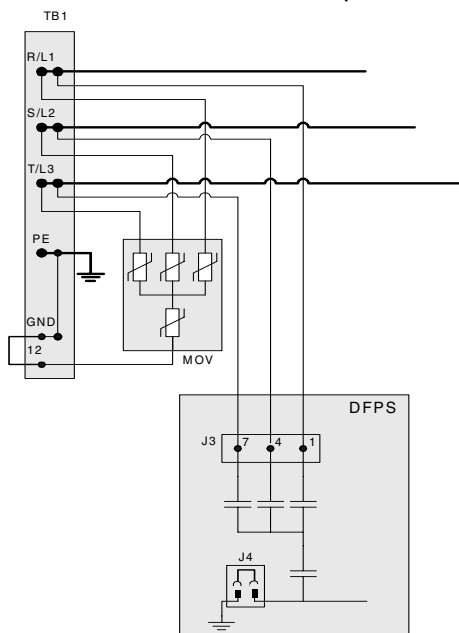
To disconnect these devices, remove the jumpers shown in [Figure 1.2 on page 1-6](#) and the Figure below. Jumper J4 can be removed by carefully pulling the jumper straight out. See the *PowerFlex 700 Reference Manual* for more information on ungrounded system installation.



ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged before removing/installing jumpers. Measure the DC bus voltage at the +DC & -DC terminals of the Power Terminal Block. The voltage must be zero.

Jumper	Removes	Location (Figure 1.2)	No.
12 - GND	MOVs to Ground	Control Terminals	④
J4	Common Mode Capacitors to Ground	(on DFPS board)	⑤

Figure 1.4 Phase to Ground MOV and Common Mode Capacitors Removal



EMC Instructions

CE Conformity

Conformity with the Low Voltage (LV) Directive and Electromagnetic Compatibility (EMC) Directive has been demonstrated using harmonized European Norm (EN) standards published in the Official Journal of the European Communities. PowerFlex Diode Bus Supply Units comply with the EN standards listed below when installed according to the User Manual.

CE Declarations of Conformity are available online at:
<http://www.ab.com/certification/ce/docs>.

Low Voltage Directive (73/23/EEC)

- EN50178 Electronic equipment for use in power installations
- EN60204-1 Safety of machinery – Electrical equipment of machines

EMC Directive (89/336/EEC)

- EN61800-3 Adjustable speed electrical power drive systems Part 3: EMC product standard including specific test methods.

Harmonic Emissions

Electronic converters such as the Bus Supply can cause conducted low frequency disturbances (harmonic emissions) to the supply network. The two inductors in the DC-bus circuit will remarkably reduce the harmonics produced by the Bus Supply, but the magnitude of harmonic emissions depends upon the network impedance at the point where the unit is connected to the network. Currently, there are no mandatory harmonic emission limits related to CE compliance for equipment connected to private power networks. Upon request, Rockwell Automation can provide information regarding harmonic emissions from the Bus Supply.

General Notes

- If the adhesive label is removed from the top of the Bus Supply, it must be installed in an enclosure with side openings less than 12.5 mm (0.5 in.) and top openings less than 1.0 mm (0.04 in.) to maintain compliance with the LV Directive.
- The DC bus cable to the inverter should be kept as short as possible in order to avoid electromagnetic emission as well as capacitive currents. Therefore the inverter should be located in the same cabinet as the Bus Supply Unit.
- Use of line filters in ungrounded systems is not recommended.
- The PowerFlex Diode Bus Supply with built-in RFI filter satisfies CE EMC emission limits for the industrial environment. If used in a residential or domestic environment it may cause radio interference. The user is required to take measures to prevent interference, in addition to the essential requirements for CE compliance listed below, if necessary.
- Conformity of the drive with CE EMC requirements does not guarantee an entire machine installation complies with CE EMC requirements. Many factors can influence total machine/installation compliance.

Essential Requirements for CE Compliance

Conditions 1-3 listed below **must be** satisfied for PowerFlex Diode Bus Supply to meet the requirements of **EN61800-3**.

1. Standard PowerFlex CE compatible Bus Supply and inverter.
2. Grounding as described on page 1-4.
3. Control wiring leaving the cabinet must be braided, shielded cable with a coverage of 75% or better, metal conduit or equivalent attenuation.

For further conditions refer to the PowerFlex 700 Reference Manual.

Start Up / Troubleshooting

This chapter describes how you start up and troubleshoot the PowerFlex Diode Bus Supply.

For information on . . .	See page . . .
Start-Up	2-1
Power On LED	2-2
Troubleshooting	2-2



ATTENTION: Power must be applied to the Bus Supply and the Inverter to perform the following start-up procedure. Some of the voltages present are at incoming line potential. To avoid electric shock hazard or damage to equipment, only qualified service personnel should perform the following procedure. Thoroughly read and understand the procedure before beginning. If an event does not occur while performing this procedure, **Do Not Proceed. Remove Power** including user supplied control voltages. User supplied voltages may exist even when main AC power is not applied to the Bus Supply. Correct the malfunction before continuing.

Start-Up

Before Applying Power to the Bus Supply

1. Confirm that all inputs are connected to the correct terminals and are secure.
2. Verify that AC line power at the disconnect device is within the rated value of the Bus Supply.
3. Verify that the output *Bus Supply Overtemperature* is correctly wired.

This normally closed contact output is used to stop the drive. Verify that this interlock has been wired correctly according to the users specification. Two examples are shown on page 1-8.

Applying AC Power to the Bus Supply

- ❑ 1. Apply AC power to the Bus Supply.

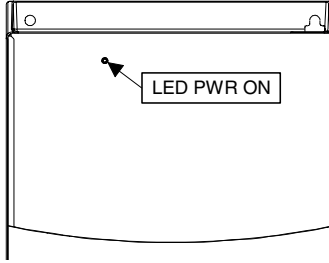
The green *Power On* LED should be on if power is applied to terminals R, S, T (L1, L2, L3).

- ❑ 2. If the green *Power On* LED is not on at this point, refer to [Table 2.A](#).

Power On LED

The green *Power On* LED is visible through the front panel and will be illuminated if power is applied.

Figure 2.1 Power on Indicator



Troubleshooting

Table 2.A Possible Faults and Corrective Actions

Fault	Cause	Corrective Action
Heatsink Over Temperature	Heatsink temperature exceeds maximum rating.	<ol style="list-style-type: none"> 1. Verify that maximum ambient temperature has not been exceeded. 2. Check fans for correct operation. 3. Check for excess load on the bus supply.
DC Output Voltage Loss	Loss of DC Bus Power and Loss of 24V Power	<ol style="list-style-type: none"> 1. Check 3-Phase AC Incoming Power for undervoltage or phase loss. 2. Check 3-Phase Input CB or Fusing. 3. Check Diode Bridge. 4. Check DC Chokes.
	Loss of 24V Power only	<ol style="list-style-type: none"> 1. Check 24V DC Power Supply Board DFPS. 2. Check fans for correct operation. 3. Check Over-Temperature Switches.

Specifications

This appendix provides electrical, environmental, functional and physical, specifications of the PowerFlex Diode Bus Supply and selection tables for AC input devices.

For information on . .	See page . .
PowerFlex Diode Bus Supply Specifications	A-1
Dimensions	A-3
Fuse & Circuit Breaker Ratings	A-4

PowerFlex Diode Bus Supply Specifications



Specifications					
Input/Output Ratings					
AC Input Voltage Ranges:	200 - 480V Unit			500- 600V Unit	
Nominal AC Input Voltage:	240V	400V	480V	500V	600V
Nominal DC Bus Voltage:	325V	540V	648V	675V	810V
Continuous rms AC Input Current	105A	105A	105A	105A	105A
Continuous DC Bus Current	120A	120A	120A	120A	120A
Voltage Tolerance:	-10% of minimum, +10% of maximum.				
Frequency Tolerance:	47-63 Hz.				
Displacement Power Factor	0.92 lagging (entire speed range)				
Efficiency:	99.5% at rated amps, nominal line volts.				
Line transients:	up to 6000 volts peak per IEEE C62.41-1991				
Heat Dissipation	500 W				
Max. Short Circuit Current Rating: Using Recommended Fuse or Circuit Breaker Type	Maximum short circuit current rating to match specified fuse/circuit breaker capability.				
Method:	The Bus Supply can be used for 6 pulse or 12 pulse configuration.				
Control Output Specifications					
Heat sink temperature sensor	The two temperature sensors trip if heatsink temperature exceeds 85 degrees Celsius				
Temperature sensor contact output rating (max.)	Resistive Rating: 15A at 125V AC, 10A at 250V AC, 7A at 24V DC Inductive Rating: 10A at 125V AC, 6A at 250V AC				

Specifications

Approvals and Standards Compliance

The Bus Supply is designed to meet the following specifications:

- NFPA 70 - US National Electrical Code
- NEMA ICS 3.1 - Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- NEMA 250 - Enclosures for Electrical Equipment
- IEC 146 - International Electrical Code.

	UL and cUL Listed to UL508C and CAN/CSA-C2.2 No. 14-M91
	Marked for all applicable European Directives EMC Directive (89/336/EEC) Emissions EN 61800-3 Adjustable Speed electrical power drive systems Part 3 Immunity EN 61800-3 Second Environment, Restricted Distribution Low Voltage Directive (73/23/EEC) EN 60204-1 Safety of Machinery –Electrical Equipment of Machines EN 50178 Electronic Equipment for use in Power Installations

Environmental Specifications

Altitude:	1000 m (3300 ft) max. without derating. Above 1000 m the derating for the output current is 1% per 100 m.
Ambient Operating Temperature without derating:	
Open Type / IP00:	0 to 50 degrees C (32 to 122 degrees F)
NEMA Type 1 / IP20:	0 to 40 degrees C (32 to 104 degrees F)
Storage Temperature (all const.):	-40 to 70 degrees C (-40 to 158 degrees F)
Relative Humidity:	5 to 95% non-condensing
Shock:	15G peak for 11ms duration (±1.0 ms)
Vibration:	0.152 mm (0.006 in.) displacement, 1G peak

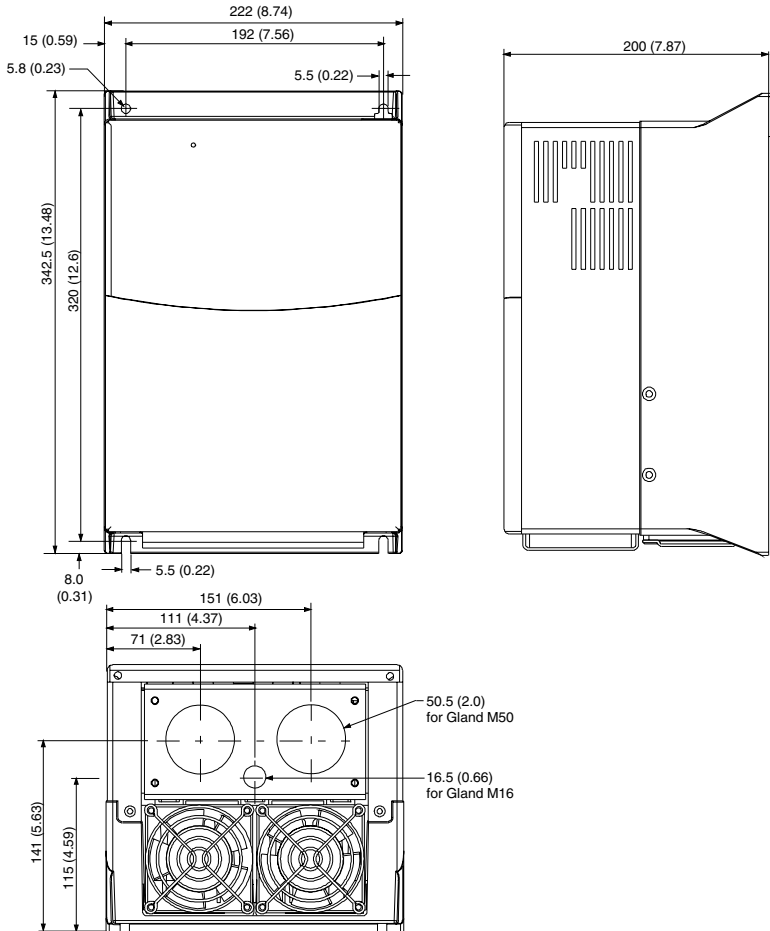
Permitted AC-Drives for connection to the DC-Bus Supply

	PowerFlex AC Drives with built-in precharge circuit 1336 and GV3000 AC Drives
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Dimensions

The overall dimensions and mounting holes of the PowerFlex Diode Bus Supply are the same as those of the PowerFlex 700 Frame 2 Drive.

Figure A.1 Bus Supply Dimensions



Dimensions are in millimeters and (inches)

Approximate Shipping Weight: 23 kg (50.7 lb)

Fuse & Circuit Breaker Ratings

The tables on the following page provide DC Bus Supply ratings (including continuous, 1 minute and 3 second) and recommended AC line input fuse and circuit breaker information. Both types of short circuit protection are acceptable for UL and IEC requirements. Sizes listed are the recommended sizes based on 40 degree C and the U.S. N.E.C. Other country, state or local codes may require different ratings.

Fusing

If fuses are chosen as the desired protection method, refer to the recommended types listed below. If available amp ratings do not match the tables provided, the closest fuse rating that exceeds the DC Bus Supply rating should be chosen.

- IEC – BS88 (British Standard) Parts 1 & 2⁽¹⁾, EN60269-1, Parts 1 & 2, type gG or equivalent should be used.
- UL – UL Class CC, T, RK1 or J must be used.

Circuit Breakers

The "non-fuse" listings in the following tables include circuit breakers (inverse time or instantaneous trip). **If one of these is chosen as the desired protection method**, the following requirements apply.

- IEC and UL – Both types of devices are acceptable for IEC and UL installations.

⁽¹⁾ Typical designations include, but may not be limited to the following; Parts 1 & 2: AC, AD, BC, BD, CD, DD, ED, EFS, EF, FF, FG, GF, GG, GH.

AC Input Currents and Recommended Protection Devices

Bus Supply Catalog Number	Frame	Input Ratings		Output Amps			Dual Element Time Delay Fuse		Non-Time Delay Fuse		Circuit Breaker ⁽³⁾ Amps	Motor Circuit Protector ⁽⁴⁾ Amps
		Amps	kVA	Cont.	1 Min.	3 s	Min. ⁽¹⁾	Max. ⁽²⁾	Min. ⁽¹⁾	Max. ⁽²⁾		
240 Volt / 60 Hz AC Input				120	180	240	125 IEC gG or 150 UL Class CC	125 IEC gG or 150 UL- Class CC	TBD	TBD	200	150
21ND120	3	105	44									
400 Volt / 50 Hz AC Input												
21ND120	3	105	73									
480 Volt / 60 Hz AC Input												
21ND120	3	105	87									
500 Volt / 50 Hz AC Input												
21NE120	3	105	91									
600 Volt / 60 Hz AC Input												
21NE120	3	105	109									

Notes:

- (1) Minimum protection device size is the lowest rated device that supplies maximum protection without nuisance tripping.
- (2) Maximum protection device size is the highest rated device that supplies DC Bus Supply protection.
- (3) Circuit Breaker - inverse time breaker.
- (4) Motor Circuit Protector - instantaneous trip circuit breaker.

Notes:



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