AVTRON
ACCel500 COMMON BUS DC INVERTERS

Frames FI9-FI13

Cleveland, Ohio

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AVTRON INDUSTRIAL AUTOMATION, INC.
Cleveland, Ohio

AVTRON
ACCel500 COMMON BUS DC INVERTERS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Continued)

TITLE PAGE

SAFETY SUMMARY

Read this manual thoroughly and make sure you understand the procedures before you attempt to install, set up, or operate this Avtron® ACCel500 Inverter Unit.

****

W A R N I N G

Hazardous voltages are used in the operation of this equipment and may cause severe personal injury or the loss of life if proper precautions are not taken. The following precautions should be taken to reduce the risk of injury or death.

****

W A R N I N G

Separate motor overcurrent, overload, and overheating protection is required to be provided in accordance with the Canadian Electrical Code, Part I.

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A V E R T I S S E M E N T

Le moteur doit etre muni d'une protection distincte contre les surintensites, la surcharge et la surchauffe conformement au code canadian de l'electricitie, premiere partie.

****

D A N G E R

Hazardous voltage will cause severe injury and death. Turn off and lock out all sources of power before servicing.

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****

D A N G E R

Presence de tensions dangereuses pouvant et perte de vie. Couper l'alimentation avant le depannage de cet equipment.

****

W A R N I N G

DO NOT OPERATE RADIO TRANSMITTERS or CELL PHONES IN THE VICINITY OF THE ACCel500 DRIVE. The ACCel500 Drive is an electronic device. Although it is designed to operate reliably in typical industrial environments, the ACCel500 Drive can be affected by radio and/or cell phone transmitters. It is possible to cause drive faults, inappropriate/unintended drive I/O activity, and unpredictable operation that could result in damage to the ACCel500 Drive, damage to other equipment, or serious injury to personnel.

Radio transmitter interference is a site specific phenomena. Generally, electrical wires connected to terminals on the ACCel500 Drive are the conduits for radio interference. Interference can be minimized by good wiring design and installation practice. It is recommended that signs be posted in and around the drive system, warning of the possibility of interference if the drive is in operation. DO NOT USE radio transmitters or cell phones in the area.

Absence of a radio interference problem is no guarantee that a problem will never occur as conditions and environments can change.

****

W A R N I N G

System Safety Considerations

In safety sensitive applications, it is strongly suggested that the system designer utilize a separate monitoring device to check the ACCel500 inputs and outputs, and other operating characteristics, to enhance the safety of personnel and property.

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W A R N I N G

Accuracy of customer-installed calibration and configuration data is imperative in the operation of this equipment. Incorrect data may cause damage to the ACCel500 drive, motor, and process equipment.

****

W A R N I N G

Motor control equipment and electronic controllers are connected to hazardous line voltages. When servicing drives and electronic controllers, there may be exposed components with housings or protrusions at or above line potential. Extreme care should be taken to protect against shock.

Stand on an insulating pad and make it a habit to use only one hand when checking components. Always work with another person in case an emergency occurs. Disconnect power before checking controllers or performing maintenance. Be sure equipment is properly grounded. Wear safety glasses whenever working on electronic controllers or rotating machinery.

****

W A R N I N G

Only a competent electrician may carry out the electrical installation.

****

W A R N I N G

The components of the power unit of the inverter are live when the ACCel500 inverter is connected to DC supply. Coming into contact with this voltage is extremely dangerous and may cause death or severe injury. The control unit is isolated from mains potential.

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W A R N I N G

The supply and motor terminals are live when the inverter is connected to DC supply, even if the motor is not running.

****

W A R N I N G

The control I/O terminals are isolated from the mains potential. However, the relay outputs and other I/O terminals may have dangerous control voltage present even when the inverter unit is disconnected from the DC supply.

****

W A R N I N G

The inverter has a large capacitive leakage current.

****

W A R N I N G

If the inverter is used as a part of a machine, the machine manufacturer is responsible for providing the machine with a main switch (EN 60204-1).

****

W A R N I N G

Only spare parts delivered by Avtron can be used.

****

C A U T I O N

The ACCel500 inverter is meant for fixed installations only.

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C A U T I O N

Do not perform any measurements when the inverter is connected to the DC supply.

****

****

C A U T I O N

After having disconnected the inverter from the DC supply, wait until the fan stops and the indicators on the keypad go out (if no keypad is attached see the indicator through the keypad base). Wait 5 more minutes before doing any work on inverter connections. Do not even open the cover before this time has expired.

****

C A U T I O N

Do not perform any voltage withstand tests on any part of inverter. There is a certain procedure according to which the tests shall be performed. Ignoring this procedure may result in damaged product.

****

C A U T I O N

Prior to measurements on the motor or the motor cable, disconnect the motor cable from the inverter.

****

C A U T I O N

Do not touch the components on the circuit boards. Static voltage discharge may damage the components.

****

C A U T I O N

Before connecting the inverter to DC supply, make sure that the inverter front and cable covers are closed.

****

C A U T I O N

Ensure that the jumper positions are correct. Running the motor with signal settings that differ from the jumper positions will not harm the inverter but may harm the motor.

****

1. Only qualified personnel familiar with this equipment should be permitted to install, operate, troubleshoot, or repair the apparatus after reading and understanding this manual.

2. Installation of the equipment must be performed in accordance with the National Electrical Code and any other state or local codes. Proper grounding, conductor sizing, and short circuit protection must be installed for safe operation.

3. During normal operation, keep all covers in place and cabinet doors shut.
4. When performing hands-on inspections and maintenance, be sure the incoming AC feed is turned off and locked out. The ACCel500 Drive and motor may have hazardous voltages present even if the AC feed is turned off. ****NOTE**** The armature contactor does not remove hazardous voltages when opened.
5. When necessary to take measurements with the power turned on, do not touch any electrical connection points. Remove all jewelry from wrists and fingers. Make sure test equipment is in safe operating condition.

6. While servicing with the power on, stand on approved insulating material and be sure not to be grounded.

7. Follow the instructions in this manual carefully and observe all danger notices.

GROUNDING AND GROUND FAULT PROTECTION

The ACCel500 inverter must always be grounded with a ground conductor connected to the ground terminal.

The ground fault protection inside the inverter only protects the inverter against ground faults in the motor or the motor cable.

Due to the high capacity currents present in the inverter, fault current protective switches may not function properly. If fault current protective switches are used, they need to be tested with ground fault currents present during possible fault situations.

MOTOR AND EQUIPMENT SAFETY

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C A U T I O N

Before starting the motor, check that the motor is mounted properly and ensure that the machine connected to the motor allows the motor to be started.

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****

C A U T I O N

Set the maximum motor speed (frequency) according to the motor and the machine connected to it.

****

C A U T I O N

Before reversing the motor, make sure that this can be done safely.

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C AU T I O N

Make sure that no power correction capacitors are connected to the motor cable.

****

C A U T I O N

Make sure that the motor terminals are not connected to mains potential.

****

AVTRON
ACCel500 COMMON BUS DC INVERTERS

SECTION I

OVERVIEW

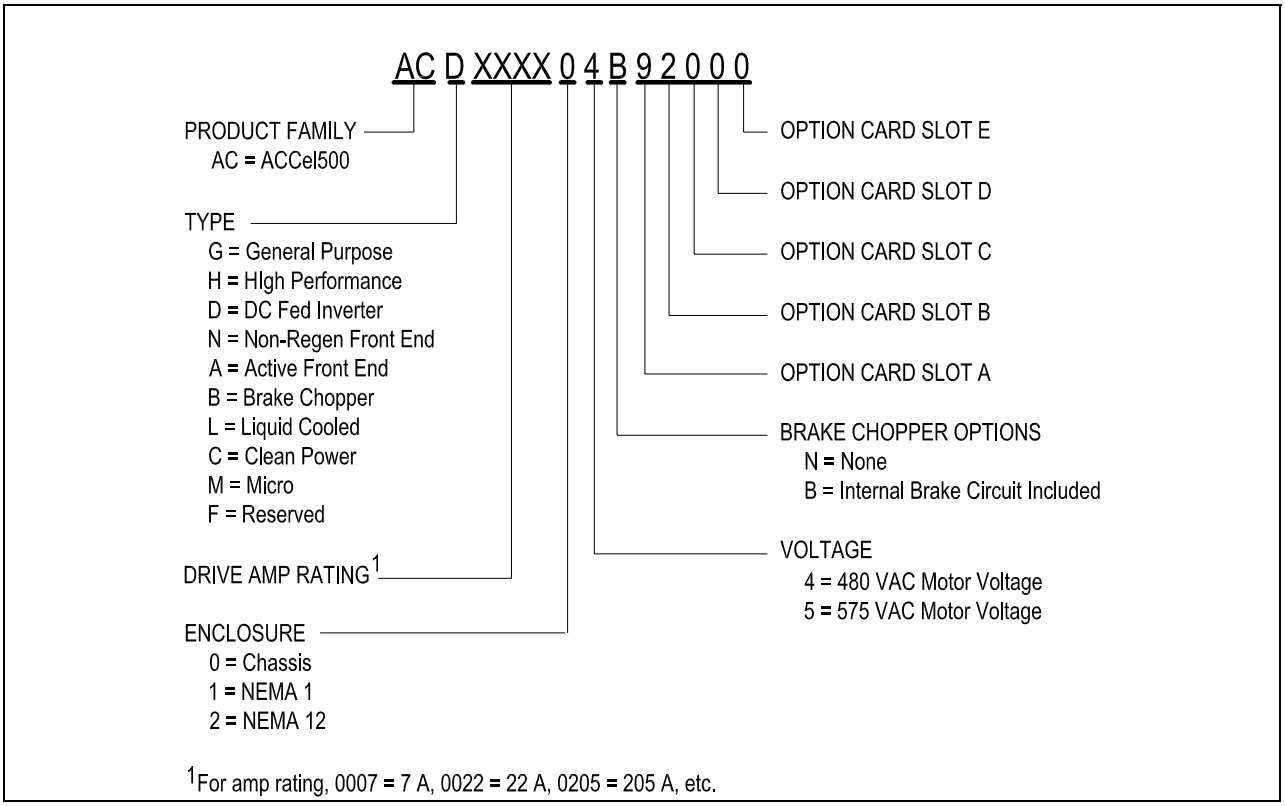
1-1 RECEIVING AND INSPECTION

Avtron ACCel500 Inverter Units have undergone scrupulous tests and quality checks at the factory before they are delivered to the customer. However, after unpacking the product, check that no sign of transportation damage is to be found on the product and that the delivery is complete (compare the type designation of the product to the code below; see Table 1-1).

If the drive has been damaged during shipping, please contact the cargo insurance company or the carrier.

If the delivery does not correspond to your order, contact the supplier immediately.

TABLE 1-1. ACCel500 TYPE DESIGNATION CODE



Standard Features of ACCel500 Inverter Units

- Air cooling
- Standard board
- Alphanumeric control panel with fiber connection
- EMC Class T (EN 61800-3 for IT networks)
- Safety CE / UL
- External charging required
- I/O Modules A1 and A2
- IP00

1-2 STORAGE

If the inverter is to be stored before use, make sure that the ambient conditions are acceptable.

Storage temperature: -40 to 158°F (-40 to 70°C)

Relative humidity: <95%, no condensation

If the inverter is stored for over 12 months, contact Avtron before connecting the inverter to the power supply.

1-3 MAINTENANCE

In normal conditions, ACCel500 inverters are maintenance-free. However, we recommend cleaning the heatsink with compressed air whenever necessary. The cooling fan can easily be changed if required.

It may also be necessary to check the tightening torques of terminals at certain intervals.

1-4 TECHNICAL DATA

Figure 1-1 presents the block diagram of the ACCel500 inverter. Mechanically, the inverter consists of two units; the Power Unit and the Control Unit.

The Power Unit contains an inverter bridge which consists of IGBT switches and produces symmetrical, three-phase PWM-modulated AC voltage to the motor.

The Motor and Application Control Block is based on microprocessor software. The microprocessor controls the motor based on the information it receives through measurements, parameter settings, control I/O, and the control keypad. The motor and application control block control the motor control ASIC which, in turn, calculates the IGBT positions. Gate drivers amplify these signals for driving the IGBT inverter bridge.

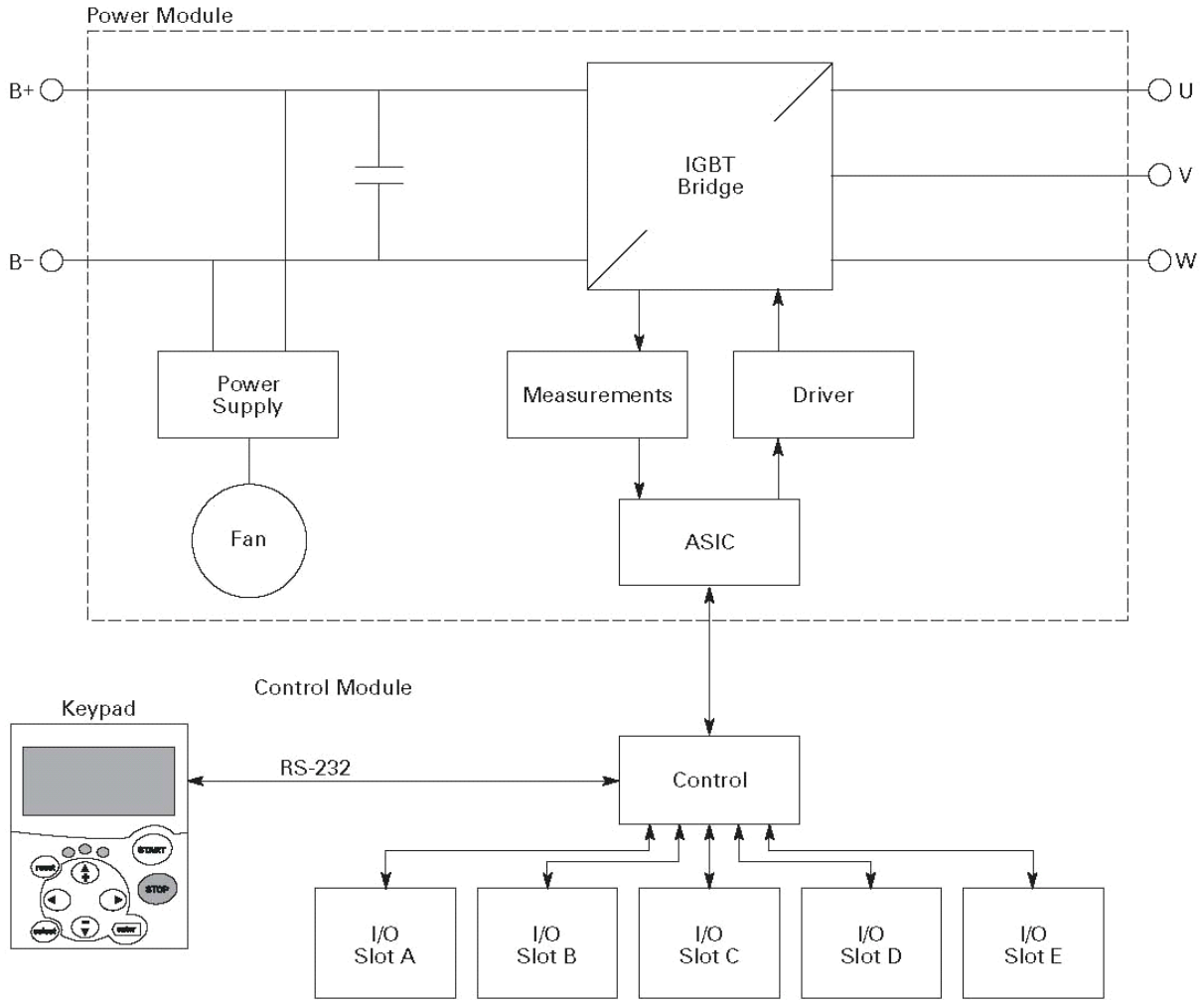


Figure 1-1. ACCel500 Inverter Unit Block Diagram

The control keypad constitutes a link between the user and the inverter. The control keypad is used for parameter setting, reading status data, and giving control commands. It is detachable and can be operated externally and is connected via a cable to the inverter. Instead of the control keypad, a PC can be used to control the inverter if connected through a similar cable.

The basic control interface and the parameters (the Basic Application) are easy to use. If a more versatile interface or parameters are required, a more suitable application can be chosen. See the application manual for more information on the different applications.

Optional I/O expander boards that increase the number of inputs and outputs to be used are also available. For more information, contact Avtron.

1-4.1 POWER RATINGS

Supply Voltage 465 – 800 VDC, Motor Voltage 380 – 500 VAC

High overload = Maximum current IS, 2 sec/20 sec, 150% overloadability, 1 min/10 min

Following continuous operation at rated output current, 150% rated output current (I_H) for 1 min, followed by a period of load current less than rated current, and of such duration that the r.m.s output current, over the duty cycle, does not exceed rated output current (I_H)

Low overload = Maximum current IS, 2 sec/20 sec, 110% overloadability, 1 min/10 min

Following continuous operation at rated output current, 110% rated output current (I_L) for 1 min, followed by a period of load current less than rated current, and of such duration that the r.m.s output current, over the duty cycle, does not exceed rated output current (I_L).

TABLE 1-2. 380 – 500 VAC, 50/60 HZ, THREE-PHASE INVERTERS RATINGS

Nominal Current	Loadability					Motor Shaft Power		Frame	Dimensions and Weight in/lb (mm/kg)
	Low		High			675 VDC Supply			
	Rated Cont. Current I_L (A)	10% Over-load Current (A)	Rated Cont. Current I_H (A)	50% Over-load Current (A)	Max Current I_S	10% Over-load 40°C P(kW)	50% Over-load 50°C P(kW)		
140	170	187	140	210	280	110	90	FI9	9.4 x 40.6 x 14.6/143 (239 x 1030 x 372/65)
170	205	226	170	255	336	132	110	FI9	9.4 x 40.6 x 14.6/143 (239 x 1030 x 372/65)
205	261	287	205	308	349	160	132	FI9	9.4 x 40.6 x 14.6/143 (239 x 1030 x 372/65)
245	300	330	245	368	444	200	160	FI9	9.4 x 40.6 x 14.6/143 (239 x 1030 x 372/65)
300	385	424	300	450	540	250	200	FI10	9.4 x 40.6 x 21.7/220 (239 x 1030 x 552/100)
385	460	506	385	578	693	315	250	FI10	9.4 x 40.6 x 21.7/220 (239 x 1030 x 552/100)
460	520	572	460	690	828	355	315	FI10	9.4 x 40.6 x 21.7/220 (239 x 1030 x 552/100)
520	590	649	520	780	936	400	355	FI12	2x9.4 x 40.6 x 21.7/440 (2x239 x 1030 x 552/200)
590	650	715	590	885	1062	450	400	FI12	2x9.4 x 40.6 x 21.7/440 (2x239 x 1030 x 552/200)
650	730	803	650	975	1170	500	450	FI12	2x9.4 x 40.6 x 21.7/440 (2x239 x 1030 x 552/200)
730	820	902	730	1095	1314	560	500	FI12	2x9.4 x 40.6 x 21.7/440 (2x239 x 1030 x 552/200)
820	920	1012	820	1230	1476	630	560	FI12	2x9.4 x 40.6 x 21.7/440 (2x239 x 1030 x 552/200)
920	1030	1133	920	1380	1656	710	630	FI12	2x9.4 x 40.6 x 21.7/440 (2x239 x 1030 x 552/200)
1030	1150	1265	1030	1545	1854	800	710	FI13	27.9 x 40.6 x 21.8/665 (708 x 1030 x 553/302)
1150	1300	1430	1150	1725	2070	900	800	FI13	27.9 x 40.6 x 21.8/665 (708 x 1030 x 553/302)
1300	1450	1595	1300	1950	2340	1000	900	FI13	27.9 x 40.6 x 21.8/665 (708 x 1030 x 553/302)

NOTE: The rated currents in given ambient temperatures are achieved only when the switching frequency is equal to or less than the factory default.

Supply Voltage 640 – 1100 VDC, Motor Voltage 525 – 690 VAC

High overload = Max current IS, 2 sec/20 sec, 150% overloadability, 1 min/10 min

Following continuous operation at rated output current, 150% rated output current (I_H) for 1 min, followed by a period of load current less than rated current, and of such duration that the r.m.s output current, over the duty cycle, does not exceed rated output current (I_H)

Low overload = Max current IS, 2 sec/20 sec, 110% overloadability, 1 min/10 min

Following continuous operation at rated output current, 110% rated output current (I_L) for 1 min, followed by a period of load current less than rated current, and of such duration that the r.m.s output current, over the duty cycle, does not exceed rated output current (I_L)

All frames are available as NEMA 2 (IP21) and NEMA 13 (IP54).

TABLE 1-3. 525 – 690 VAC, 50/60 HZ, THREE-PHASE INVERTERS RATINGS

Nominal Current	Loadability					Motor Shaft Power		Frame	Dimensions and Weight in/lb (mm/kg)
	Low		High			930 VDC Supply			
	Rated Cont. Current I_L (A)	10% Over-load Current (A)	Rated Cont. Current I_H (A)	50% Over-load Current (A)	Max Current I_S	10% Over-load 40°C P(kW)	50% Over-load 50°C P(kW)		
100	125	138	100	150	200	110	90	FI9	9.4 x 40.6 x 14.6/143 (239 x 1030 x 372/65)
125	144	158	125	188	213	132	110	FI9	9.4 x 40.6 x 14.6/143 (239 x 1030 x 372/65)
144	170	187	144	216	245	160	132	FI9	9.4 x 40.6 x 14.6/143 (239 x 1030 x 372/65)
170	208	229	170	255	289	200	160	FI9	9.4 x 40.6 x 14.6/143 (239 x 1030 x 372/65)
208	261	287	208	312	375	250	200	FI10	9.4 x 40.6 x 21.7/220 (239 x 1030 x 552/100)
261	325	358	261	392	470	315	250	FI10	9.4 x 40.6 x 21.7/220 (239 x 1030 x 552/100)
325	385	424	325	488	585	355	315	FI10	9.4 x 40.6 x 21.7/220 (239 x 1030 x 552/100)
325	416	458	325	488	585	400	355	FI10	9.4 x 40.6 x 21.7/220 (239 x 1030 x 552/100)
385	460	506	385	578	693	450	400	FI12	2x9.4 x 40.6 x 21.7/441 (2x239 x 1030 x 552/200)
460	502	552	460	690	828	500	450	FI12	2x9.4 x 40.6 x 21.7/441 (2x239 x 1030 x 552/200)
502	590	649	502	753	904	560	500	FI12	2x9.4 x 40.6 x 21.7/441 (2x239 x 1030 x 552/200)
590	650	715	590	885	1062	630	560	FI12	2x9.4 x 40.6 x 21.7/441 (2x239 x 1030 x 552/200)
650	750	825	650	975	1170	710	630	FI12	2x9.4 x 40.6 x 21.7/441 (2x239 x 1030 x 552/200)
650	820	902	650	975	1170	800	710	FI12	2x9.4 x 40.6 x 21.7/441 (2x239 x 1030 x 552/200)
820	920	1012	820	1230	1476	900	800	FI13	27.9 x 40.6 x 21.8/665 (708 x 1030 x 553/302)
920	1030	1133	920	1380	1656	1000	900	FI13	27.9 x 40.6 x 21.8/665 (708 x 1030 x 553/302)
1030	1180	1298	1030	1464	1755	1200	1000	FI13	27.9 x 40.6 x 21.8/665 (708 x 1030 x 553/302)

NOTE: The rated currents in given ambient temperatures are achieved only when the switching frequency is equal to or less than the factory default.

TABLE 1-4. TECHNICAL INFORMATION

DESCRIPTION	SPECIFICATION
● Supply Connection	
Input Voltage Vin	465 – 800 VDC; 380 – 500 VAC (-0%. to +0%) 640 – 1100 VDC; 525 – 690 VAC (-0% to +0%) The waviness of the inverter supply voltage, which is formed in rectification of the electric network's alternating voltage in basic frequency, must be less than 50V peak-to-peak.
Input Current I_{in}	(sqrt3 x U_{mot} x I_{mot} x cosφ) / (V_{in} x 0.98)
DC Bank Capacitance	FI9 380 – 500V: 4950 µF; FI9 525 – 690V: 3733 µF FI10 380 – 500V: 9900 µF; FI10 525 – 690V: 7467 µF FI12 380 – 500V: 19800 µF; FI12 525 – 690V: 14933 µF FI13 380 – 500V: 29700 µF; FI13 525 – 690V: 22400 µF
Starting Delay	5 seconds (FI9 and greater)
● Motor Connection	
Output Voltage	3 ~ 0 – V_{in} / 1.4
Continuous Output Current	I_H: Ambient temperature max. +50°C, overload 1.5 x I_H (1 min/10 min) I_L: Ambient temperature max. +40°C, overload 1.1 x I_L (1 min/10 min)
Starting Torque	I_S for two seconds (torque motor dependent)
Peak Current	I_S for 2 seconds every 20 seconds
Output Frequency	0 – 320 Hz ; 7200 Hz (special)
Frequency Resolution	Application dependent
● Control Characteristics	
Control Method	Frequency control V/f Open loop: Sensorless vector control Closed loop: Frequency control Closed loop: Vector control
Switching Frequency (See Parameter 2.6.9)	380 – 500V, 1 – 10 kHz; Factory default 3.6 kHz 525 – 690V, 1 – 6 kHz; Factory default 1.5 kHz
Frequency Reference Analog Input Panel Reference	 Resolution 0.1% (10 bits); Accuracy ±1% Resolution 0.01 Hz
Field Weakening Point	30 – 320 Hz
Acceleration Time	0 – 3000 sec
Deceleration Time	0 – 3000 sec
Braking Torque	DC brake: 30% * T_N (without brake)
● Ambient Conditions	
Ambient Operating Temperature	-10°C (no frost) to +40°C: I_H -10°C (no frost) to +40°C: I_L
Storage Temperature	-40 to 158°F (-40 to 70°C)
Relative Humidity	0 – 95% RH, non-condensing, non-corrosive, no dripping water
Air Quality: – Chemical Vapors – Mechanical Particles	 IEC 721-3-3, unit in operation, Class 3C2 IEC 721-3-3, unit in operation, Class 3S2
Altitude	100% load capacity (no derating) up to 1,000m 1% derating for each 100m above 1000 (maximum, 3000m)
Vibration	5 – 150 Hz

DESCRIPTION	SPECIFICATION

- **Ambient Conditions** (Cont.)

EN 50178/EN 60068-2-6	Displacement amplitude: 1 mm (peak) at 3 – 15.8 Hz Maximum acceleration amplitude: 1G at 15.8 – 150 Hz
Shock	UPS Drop Test (for applicable UPS weights)
EN 50178, EN 60068-2-27	Storage and shipping: Maximum 15G, 11 ms (in package)
Cooling Capacity Required	P_{loss}[kW] approx. P_{mat}[kW] x 0.025
Cooling Air Required	FI9, 677 cfm; FI10, 824 cfm; FI12, 1648 cfm; FI13, 2472 cfm
Unit Enclosure Class	IP00

- **EMC (at Default Settings)**

Immunity	Fulfill all EMC immunity requirements

- **Safety**

	CE, UL, CUL EN 61800-5-1 (2003) See unit nameplate for more detailed approvals.

- **Control Connections**

Analog input voltage	0 to +10V, R_i = 200kΩ, (–10V to +10V joystick control) Resolution 0.1%; Accuracy ±1%
Analog input current	0(4) – 20 mA, R_i = 250Ω differential
Digital inputs (6)	Positive or negative logic; 18 – 30 VDC
Auxiliary voltage	+24V, ±15%, max. 250 mA
Output reference voltage	+10V, +3%, max. load 10 mA
Analog output	0(4) – 20mA; R_L max. 500Ω Resolution 10 bits; Accuracy ±2%
Digital outputs	Open collector output, 50 mA/48V
Relay outputs	2 programmable change-over relay outputs Switching capacity: 24 VDC/8A, 250 VAC/8A, 125 VDC/0.4A Minimum switching load: 5 V/10 mA

- **Protections**

Overvoltage Protection Undervoltage Protection	500V inverters: 911 VDC; 690V inverters: 1200 VDC 500V inverters: 333 VDC; 690V inverters: 460 VDC
Ground Fault Protection	In case of ground fault in motor or motor cable, only the inverter is protected.
Motor Phase Supervision	Trips if any of the output phases are missing.
Overcurrent Protection	Yes
Unit Overtemperature Protection	Yes
Motor Overload Protection	Yes
Motor Stall Protection	Yes
Motor Underload Protection	Yes
Short Circuit Protection of +24V and +10V Reference Voltages	Yes

TABLE 1-5. DC CURRENTS FOR 465 – 800 VDC SUPPLY VOLTAGE

Structure	Inom (Output)	Motor COS	IDC (Input)
FI9	261	.89	304
	300	.89	350
FI10	385	.9	454
	460	.9	542
	520	.9	613
FI12	590	.9	695
	650	.9	766
	730	.91	870
	820	.91	977
	920	.91	1096
	1030	.91	1227
FI13	1150	.91	1370
	1300	.91	1549
	1450	.91	1727

TABLE 1-6. DC CURRENTS FOR 640 – 1100 VDC SUPPLY VOLTAGE

Structure	Inom (Output)	Motor COS	IDC (Input)
FI9	125	.89	146
	144	.89	168
	170	.89	198
	208	.9	245
FI10	261	.9	308
	325	.9	383
	385	.9	454
	416	.9	490
F12	460	.91	548
	502	.91	598
	590	.91	703
	650	.91	774
	750	.91	894
	820	.91	977
FI13	920	.91	1096
	1030	.91	1227
	1180	.92	1421

SECTION II

MOUNTING

2-1 DIMENSIONS

The inverter can be mounted in a vertical position on the back plane of a cubicle. Enough space must be reserved around the inverter to ensure sufficient cooling (see Figure 2-4). You must follow the minimum dimensions for installation (see Tables 2-4 and 2-5). Also, make sure that the mounting plane is relatively even. The inverter is fixed with four screws (or bolts, depending on the unit size). The following pages show the dimensions for the IP00 power module.

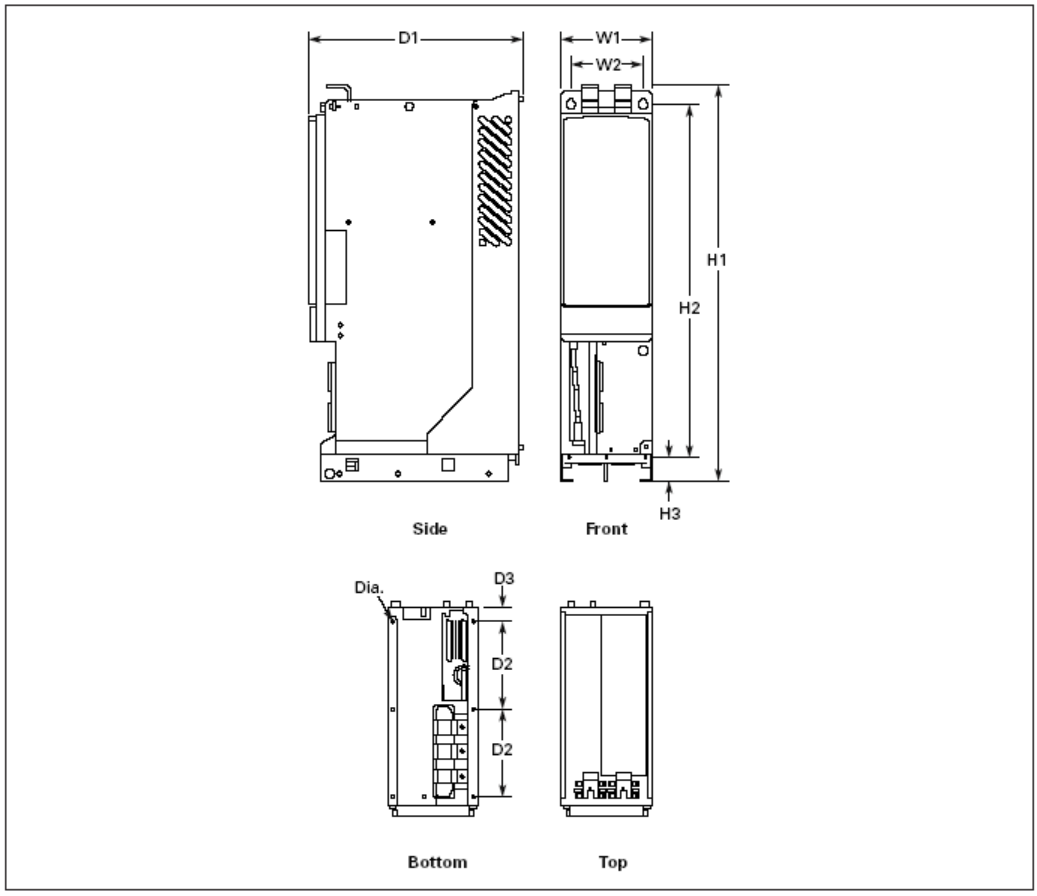


Figure 2-1. ACCel500 FI10 Inverter Dimensions

TABLE 2-1. ACCel500 FI10 INVERTER DIMENSIONS

Inverters	Voltage	Approximate Dimensions in Inches (mm)								
		W1	**W2**	**H1**	**H2**	**H3**	**D1**	**D2**	**D3**	**Dia.**
ACD0208 – 0325	480V/575V	9.4 (239)	7.9 (200)	41.3 (1050)	37.5 (952)	2.4 (60.5)	22.3 (566)	9.1 (230)	2.2 (55)	.37 (9.5)

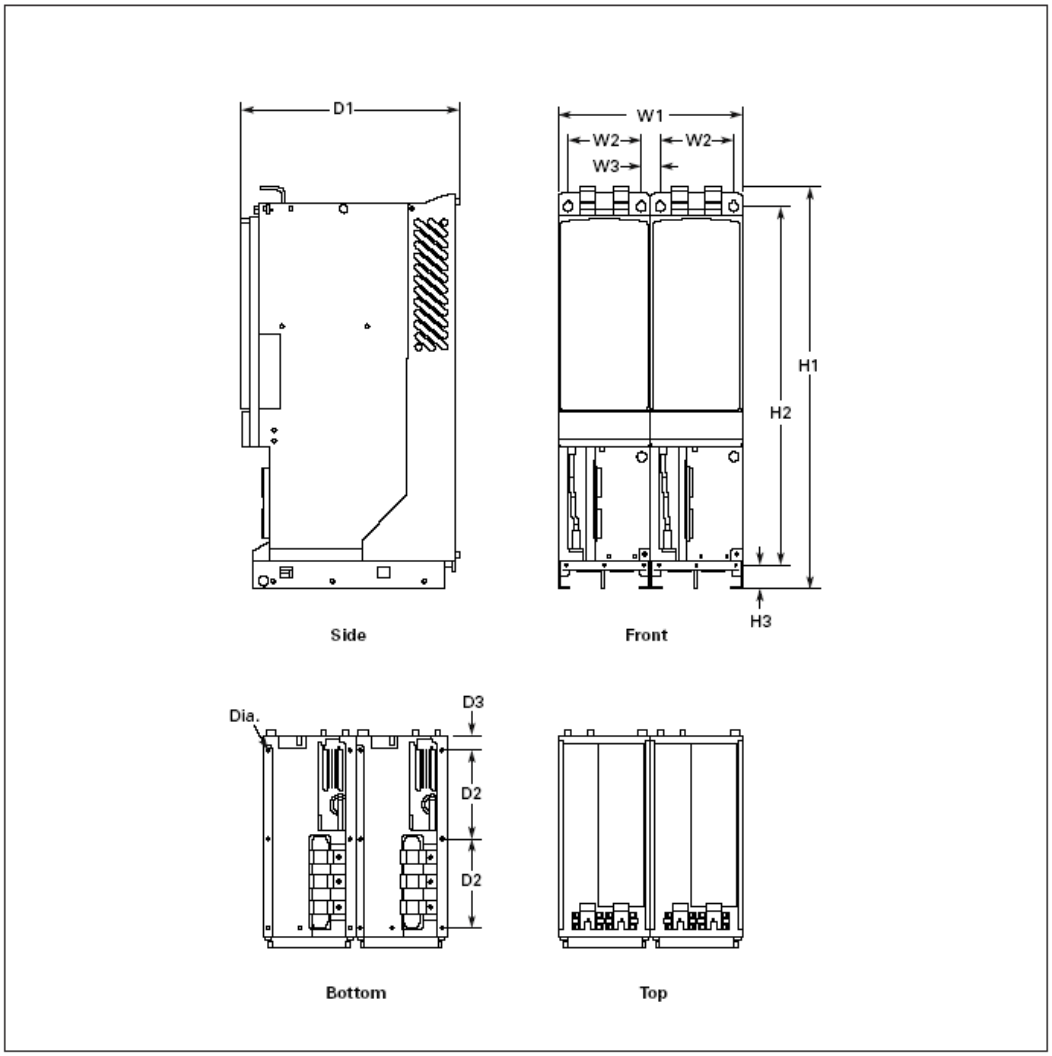


Figure 2-2. ACCel500 FI12 Inverter Dimensions

TABLE 2-2. ACCel500 FI12 INVERTER DIMENSIONS

Inverters	Voltage	Approximate Dimensions in Inches (mm)									
		W1	**W2**	**W3**	**H1**	**H2**	**H3**	**D1**	**D2**	**D3**	**Dia.**
ACD0385 – 0650	480V	18.8 (478)	7.9 (200)	1.1 (28)	41.3 (1050)	37.5 (952)	2.4 (60.5)	22.3 (566)	9.1 (230)	1.6 (41)	.37 (9.5)

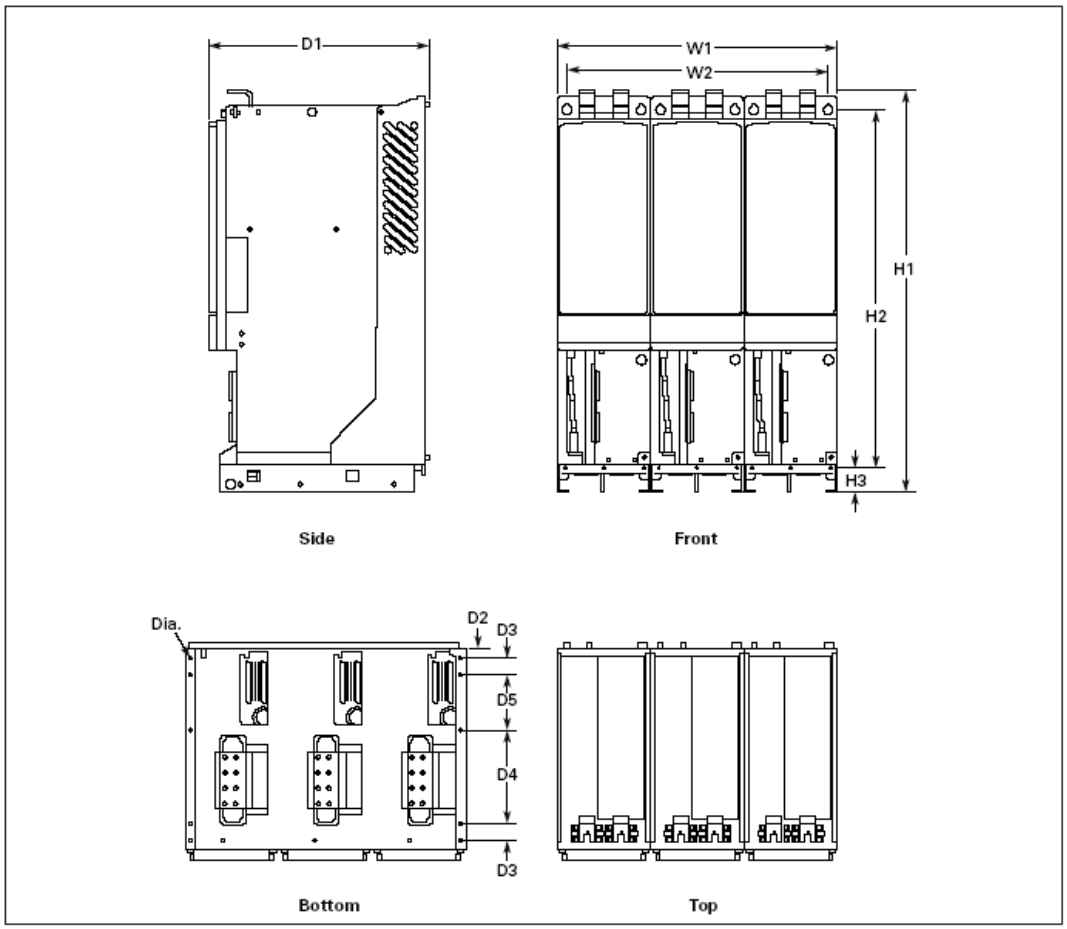


Figure 2-3. ACCel500 FI13 Inverter Dimensions

TABLE 2-3. ACCel500 FI13 INVERTER DIMENSIONS

Inverters	Voltage	Approximate Dimensions in Inches (mm)										
		W1	**W2**	**H1**	**H2**	**H3**	**D1**	**D2**	**D3**	**D4**	**D5**	**Dia.**
ACD0820 – 1300	480V	27.9 (708)	26.7 (677)	41.5 (1055)	37.4 (950)	2.46 (62.5)	22.3 (566)	1.1 (27)	1.6 (40)	9.6 (245)	5.9 (150)	.37 (9.5)

2-2 FAN COOLING

Enough free space must be left around the inverter to ensure sufficient air circulation and cooling. You will find the required dimensions for free space in Table 2-4.

If several units are mounted on top of each other, the required free space equals 2 * C (see Figure 2-4). Moreover, the outlet air used for cooling by the lower unit must be directed away from the air intake of the upper unit. When planning the cooling for the space, take into consideration that the inverter's heat loss is 2.5% of the nominal capacity.

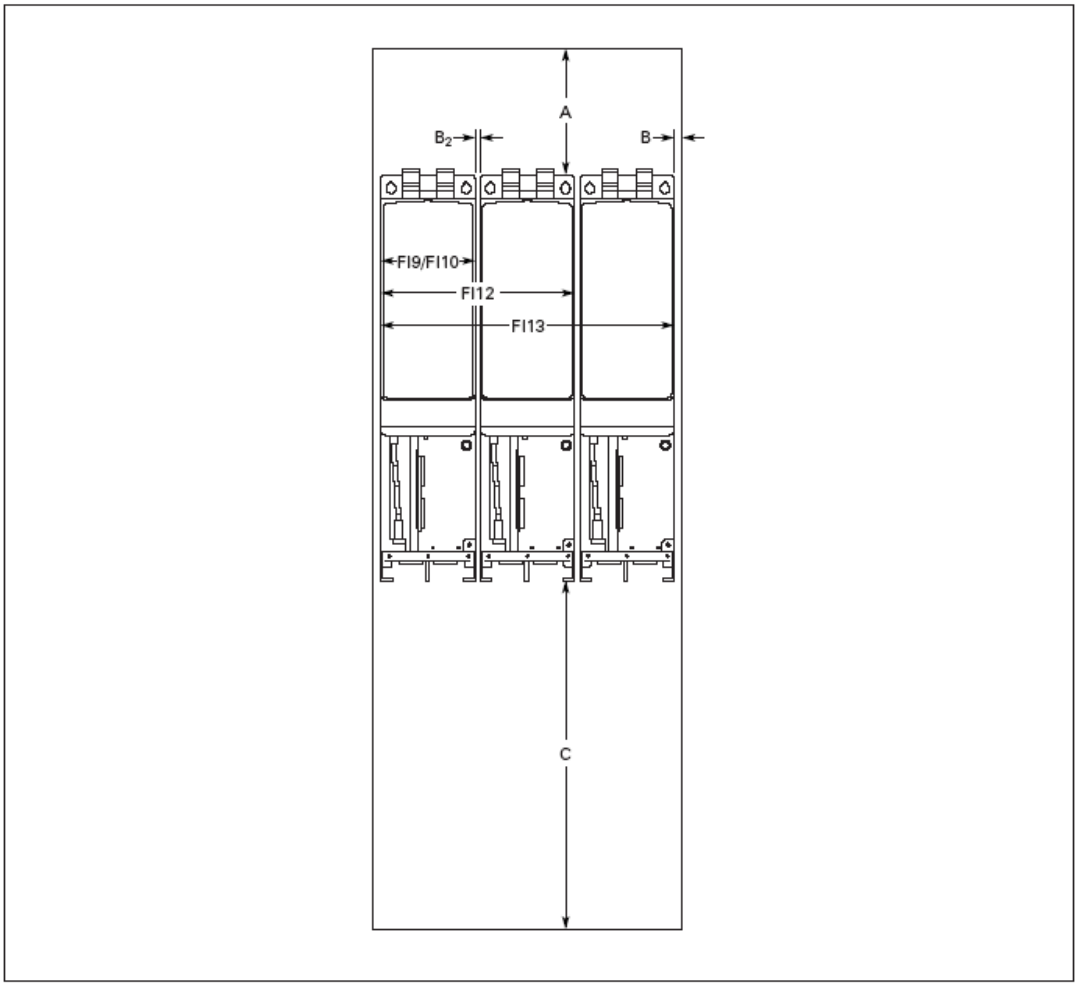


Figure 2-4. Installation Space

TABLE 2-4. MOUNTING SPACE REQUIREMENTS

Nominal Current	Voltage	Approximate Dimensions in Inches (mm)			
		A	B	B_2	C
168 – 300 125 – 208	380 – 500V 525 – 690V	7.9 (200)	.79 (20)		3.9 (100)
385 – 520 261 – 416	380 – 500V 525 – 690V	7.9 (200)	.79 (20)		3.9 (100)
590 – 1030 460 – 820	380 – 500V 525 – 690V	7.9 (200)	.79 (20)	0	3.9 (100)
1150 – 1450 920 – 1180	380 – 500V 525 – 690V	7.9 (200)	.79 (20)	0	3.9 (100)

A = free space above the inverter
B = distance between inverter and cabinet wall
B_2 = distance between two inverters
C = free space underneath of the inverter

TABLE 2-5. REQUIRED COOLING AIR

Nominal Current	Voltage	Greatest Possible Heat Loss (kW)	Cooling Air Required (cfm)	Minimum Air Exhausting Hole on Switchgear (in^2)
168 – 300 125 – 208	380 – 500V 525 – 690V	4.8 4.6	677	77.5
385 – 520 261 – 416	380 – 500V 525 – 690V	8.3 9.1	824	93
590 – 1030 460 – 820	380 – 500V 525 – 690V	16.5 18.0	1648	186
1150 – 1450 920 – 1180	380 – 500V 525 – 690V	23.0 26.0	2472	279

Power Losses

Raising the switching frequency of the drive, to reduce motor noise for example, inevitably affects the power losses and cooling requirements. For more information, contact Avtron.

SECTION III

POWER WIRING

The following wiring diagrams show the supply and motor connections.

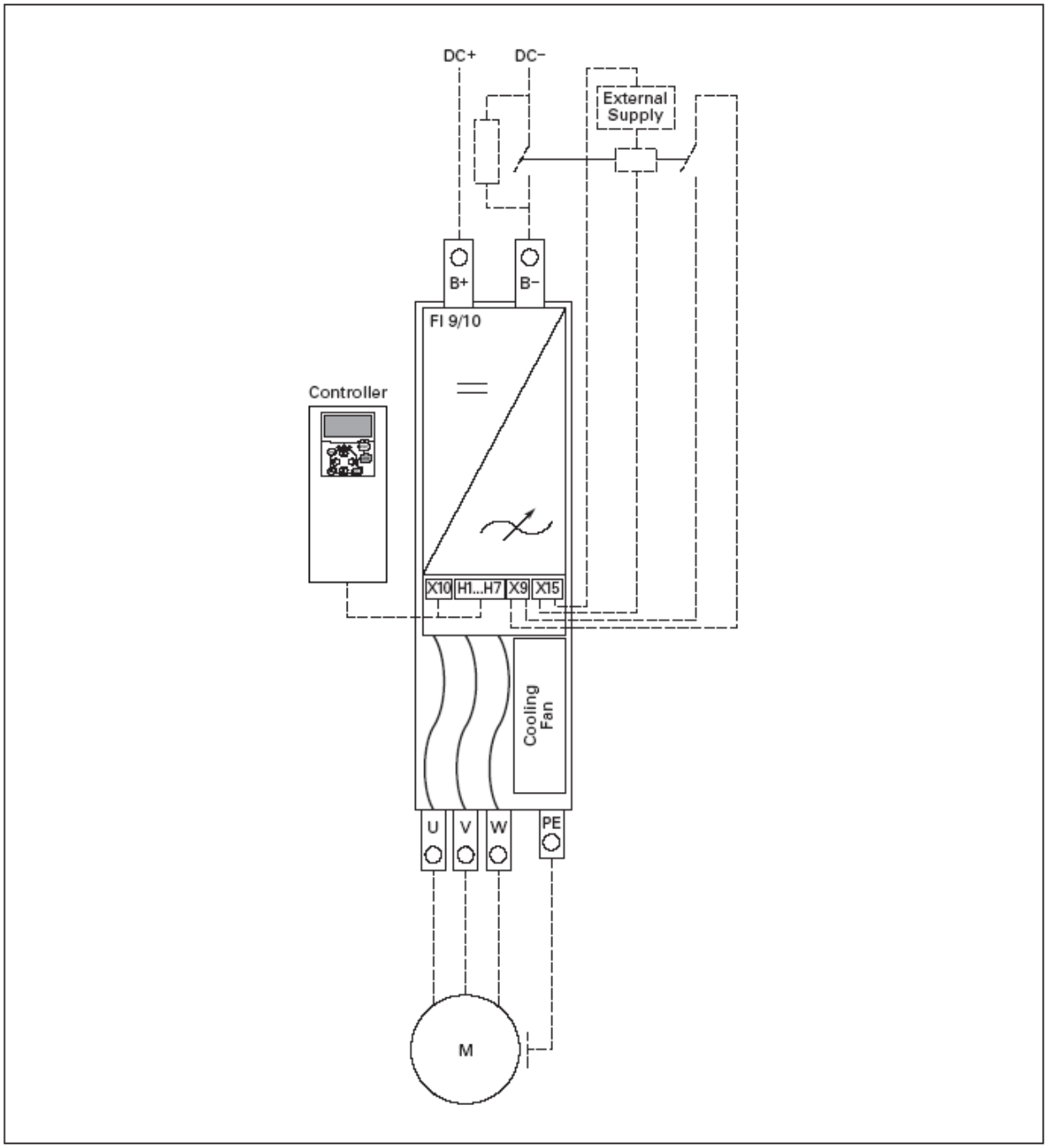


Figure 3-1. Basic Wiring Diagram with Charging

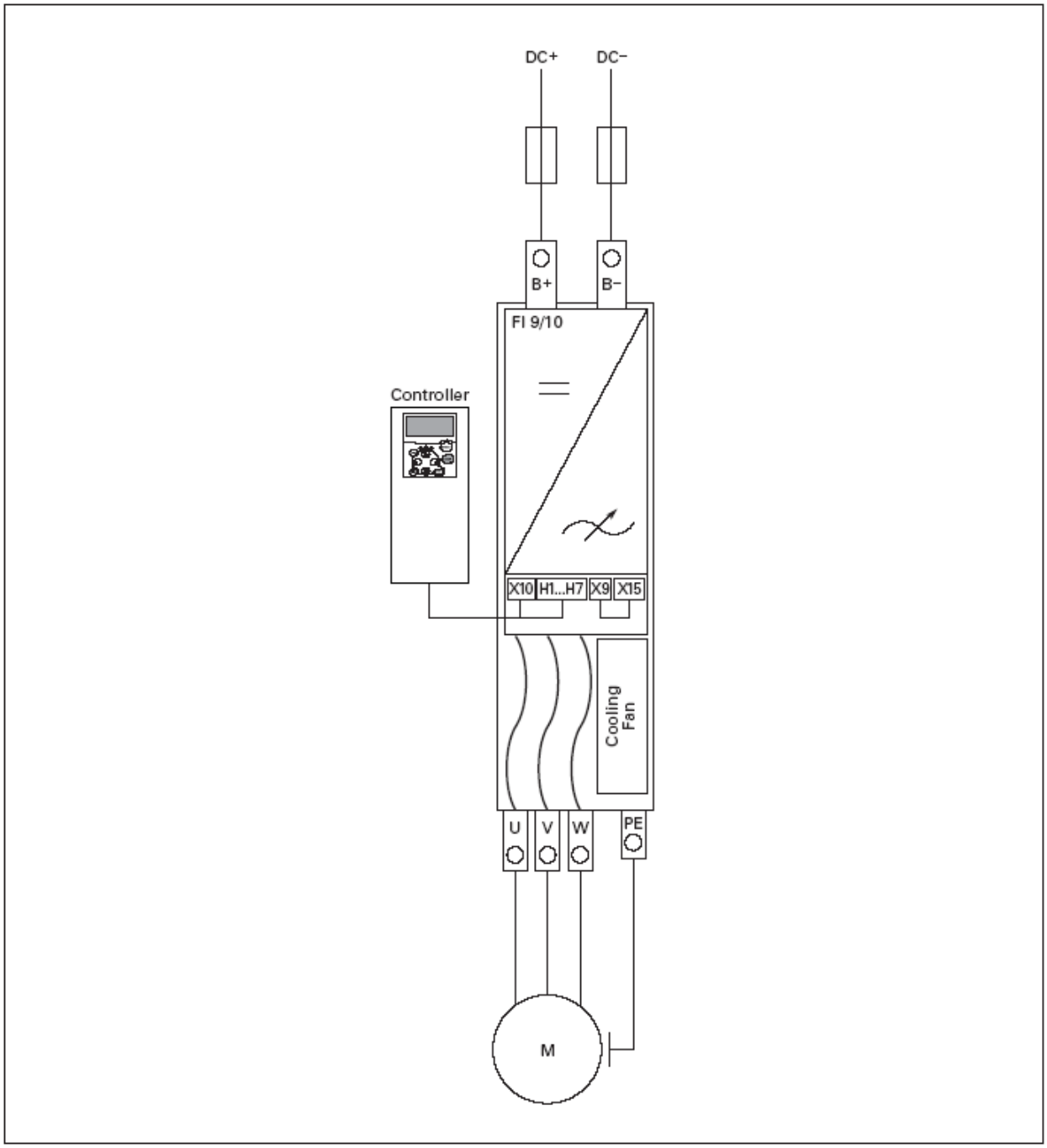


Figure 3-2. Basic Wiring Diagram without Charging

3-1 POWER CONNECTIONS

3-1.1 DC SUPPLY AND MOTOR CABLES

The power cables are connected to terminals DC+ and DC- (R+/B+ and DC terminals when using an external charging circuit) and the motor cables to terminals U, V and W. A cable entry gland should be used at the motor cable end to reach the EMC levels (see Table 3-2).

Use cables with a heat resistance of at least +60°C. The cables and the fuses must be sized according to the inverter nominal output current which you can find on the rating plate. Installation of cables according to UL regulations is presented in section 3-4 and aR fuse sizes in Tables 3-2 and 3-3 below.

If the motor temperature protection of the drive is used as an overload protection, the cable shall be chosen accordingly. If three or more cables are used in parallel for bigger units, each cable requires a separate overload protection.

These instructions apply only to installations with one motor and one cable connection from the inverter to the motor. In any other case, ask the factory for more information.

TABLE 3-1. CABLE TYPES REQUIRED TO MEET STANDARDS

Cable Type	EMC Level T
Supply Cable	Power cable intended for fixed installation and the specific DC voltage. Shielded cable not required.
Motor Cable	Power cable equipped with concentric protection wire and intended for the specific mains voltage.
Control Cable	Screened cable equipped with compact low-impedance shield.

TABLE 3-2. FUSES USED IN 465 – 800 VDC INVERTERS

Nominal Current	Frame	Bussman aR Fuse Type	Fuse Size	Fuse U_n (V)	Fuse I_n (A)	No. of Fuses
140	FI9	170M3819	DIN1	690	400	2
170	FI9	170M3819	DIN1	690	400	2
205	FI9	170M6812	DIN3	690	800	2
245	FI9	170M6812	DIN3	690	800	2
300	FI10	170M8547	3SHT	690	1250	2
385	FI10	170M8547	3SHT	690	1250	2
460	FI10	170M8547	3SHT	690	1250	2
520	FI12	170M8547	3SHT	690	1250	4
590	FI12	170M8547	3SHT	690	1250	4
650	FI12	170M8547	3SHT	690	1250	4
730	FI12	170M8547	3SHT	690	1250	4
820	FI12	170M8547	3SHT	690	1250	4
920	FI12	170M8547	3SHT	690	1250	4
1030	FI13	170M8547	3SHT	690	1250	6
1150	FI13	170M8547	3SHT	690	1250	6
1300	FI13	170M8547	3SHT	690	1250	6

TABLE 3-3. FUSES USED IN 640 – 1100 VDC INVERTERS

Nominal Current	Frame	Bussman aR Fuse Type	Fuse Size	Fuse Un (V)	Fuse In (A)	No. of Fuses
100	FI9	170M4199	1SHT	1250	400	2
125	FI9	170M4199	3SHT	1250	400	2
144	FI9	170M4199	3SHT	1250	400	2
170	FI9	170M4199	3SHT	1250	400	2
208	FI10	170M6305	3SHT	1250	700	2
261	FI10	170M6305	3SHT	1250	700	2
325	FI10	170M6277	3SHT	1250	1000	2
325	FI10	170M6277	3SHT	1250	1000	4
385	FI12	170M6305	3SHT	1250	700	4
460	FI12	170M6305	3SHT	1250	700	4
502	FI12	170M6305	3SHT	1250	700	4
590	FI12	170M6277	3SHT	1250	1000	4
650	FI12	170M6277	3SHT	1250	1000	4
650	FI12	170M6277	3SHT	1250	1000	4
820	FI13	170M6305	3SHT	1250	700	6
920	FI13	170M6277	3SHT	1250	1000	6
1030	FI13	170M6277	3SHT	1250	1000	6

Information about fuses:

gR fuses are designed to protect the device against both overcurrent and short circuits.
aR fuses protect the cables of the device against short circuits.
gG fuses are generally used to protect cables against overcurrent and short circuits.

3-2 INSTALLATION INSTRUCTIONS

1. Before starting the installation, check that none of the components of the inverter are live.

2. If the inverter is installed outside the cubicle, cabinet or device space, you need to install a separate inverter cover in accordance with protection class IP21 requirements (see Figure 3-1). There is no need to install the inverter cover if the inverter is installed in a cubicle, separate cabinet or device space.

3. Place the motor cables sufficiently far from other cables:
   – Avoid placing the motor cables in long parallel lines with other cables
   – If the motor cables runs in parallel with other cables, note the minimum distances between the motor cables and other cables given in Table 3-4.
   – The given distances also apply between the motor cables and signal cables of other systems.
   – The maximum length of the motor cables is 984 feet (300m) (units with power greater than 1.5 kW) and 328 feet (100m) (units with power from 0.75 to 1.5 kW).
   – The motor cables should cross other cables at an angle of 90 degrees.

TABLE 3-4. CABLE DISTANCES

Distance Between Cables in Inches (m)	Shielded Cable in Feet (m)
11.8 (.3)	≥ 193 (59)
39.4 (1.0)	≤ 656 (200)

4. If cable insulation checks are needed, see section 3-5.

5. Connect the cables:
   - Strip the motor and DC supply cables.
   - Remove the screws of the cable protection plate. Do not open the cover of the power unit.
   - Make holes into and pass the cables through the rubber grommets on the bottom of the power unit. The rubber grommets are delivered in a separate bag.
   - Connect the DC supply, motor, and control cables into their respective terminals.
   - For information on the installation of greater units, please contact Avtron or your local distributor.
   - For information on cable installation according to UL regulations, see section 3-4.
   - For information on cable installation according to EMC regulations, see Table 3-1.
   - Make sure that the control cable wires do not come in contact with the electronic components of the unit.
   - If an external brake resistor (optional) is used, connect its cable to the appropriate terminal.
   - Check the connection of the ground cable to the motor and the inverter terminals marked with ⏚.
   - Connect the separate shield of the power cable to the ground terminals of the inverter, motor and the supply center.
   - Attach the cable protection plate with the screws.
   - Ensure that the control cables or the cables of the unit are not trapped between the frame and the protection plate.

3-3 FRAME SIZES

Inverter Frame FI9, Protection Class IP00

Inverter Frame FI10, Protection Class IP00

Inverter Frame FI12, Protection Class IP00

Inverter Frame FI13, Protection Class IP00

Figure 3-3. Frame Sizes

3-4 CABLE INSTALLATION AND THE UL STANDARDS

To meet the UL (Underwriters Laboratories) regulations, a UL-approved copper cable with a minimum heat resistance of +60/75°C must be used.

The terminal tightening torques are given in Table 3-5.

TABLE 3-5. TERMINAL TIGHTENING TORQUES

Nominal Current	Voltage	Frame	Tightening Torque[1] in-lb (Nm)
140 – 245 100 – 170	380 – 500V 525 – 690V	FI9	340 (40)
300 – 460 208 – 325	380 – 500V 525 – 690V	FI10	340 (40)
520 – 920 385 – 650	380 – 500V 525 – 690V	FI12	340 (40)
1030 – 1300 920 – 1030	380 – 500V 525 – 690V	FI13	340 (40)
1600 – 2300 1300 – 1900	380 – 500V 525 – 690V	FI14	340 (40)

[1] Tightening torque of terminal connection to the isolative base.

NOTE: Apply counter torque to the nut on the other side of the terminal when tightening/loosening the terminal screw in order to avoid damage to the terminal.

3-5 CABLE AND MOTOR INSULATION CHECKS

1. **Motor cable insulation checks**. Disconnect the motor cable from terminals U, V and W of the inverter and from the motor. Measure the insulation resistance of the motor cable between each phase conductor as well as between each phase conductor and the protective ground conductor.

   The insulation resistance must be >1MΩ.

2. **DC supply cable insulation checks**. Disconnect the DC supply cable from terminals B- and B+ of the inverter and from DC supply. Measure the insulation resistance between each conductor and ground. The insulation resistance must be >1MΩ.

3. **Motor insulation checks.** Disconnect the motor cable from the motor and open the bridging connections in the motor connection box. Measure the insulation resistance of each motor winding. The measurement voltage must equal at least the motor nominal voltage but not exceed 1,000V.

   The insulation resistance must be >1MΩ.

SECTION IV

CONTROL WIRING

The control unit of the inverter consists of the control board and option boards (see Figures 4-1 and 4-2) connected to the five slot connectors (A to E) on the control board. The control board is connected to the power unit through a D connector (1).

Figure 4-1. Control Board

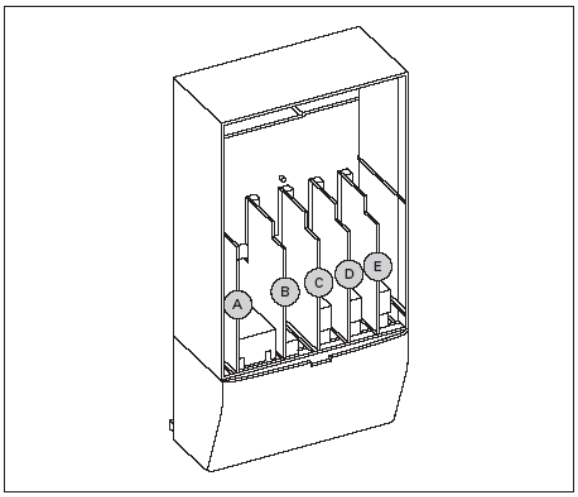


Figure 4-2. Basic and Option Board Connections of the Control Board

When the inverter is delivered from the factory, the control unit usually includes two basic boards (I/O board and relay board), which are normally installed in slots A and B. On the next pages you will find the arrangement of the control I/O and the relay terminals of the two basic boards, the general wiring diagram, and the control signal descriptions. The I/O boards mounted

at the factory are indicated in the type code. For more information on the option boards, see the option board user manual.

The control board can be powered externally (+24V) by connecting the external power source to bidirectional terminal #6 (see Figure 4-5). This voltage is sufficient for parameter setting and for keeping the fieldbus active.

NOTE: If the +24V input of several inverters are connected in parallel, we recommend to use a diode in terminal #6 to avoid the current flowing in the opposite direction, which might damage the control board.

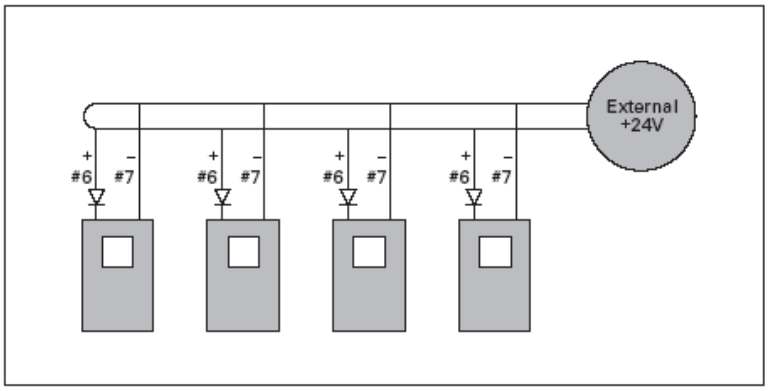


Figure 4-3. Inverters Connected in Parallel

4-1 CONTROL WIRING DETAILS

The basic control connections for boards A2 and A3 are shown in Figures 4-6 and 4-7. You can find the signal descriptions for applications in the application manual.

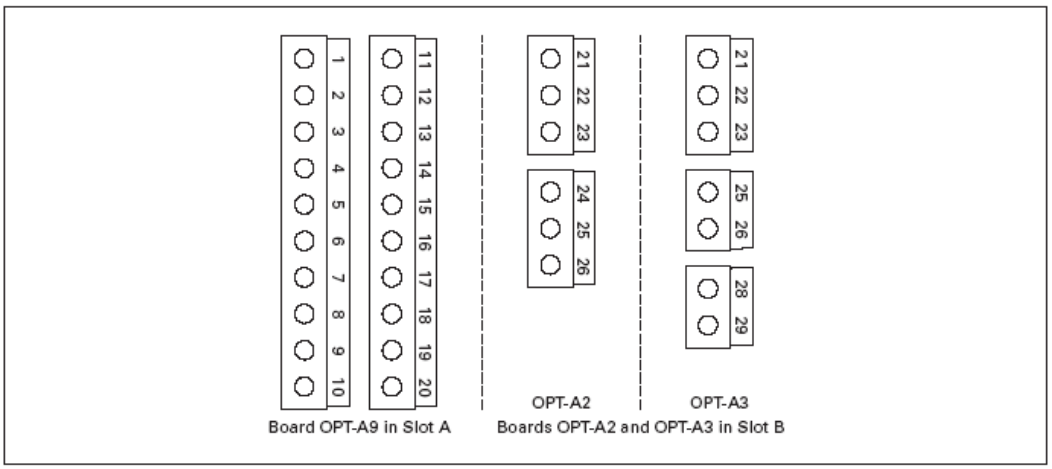


Figure 4-4. I/O Terminals of the Two Basic Boards

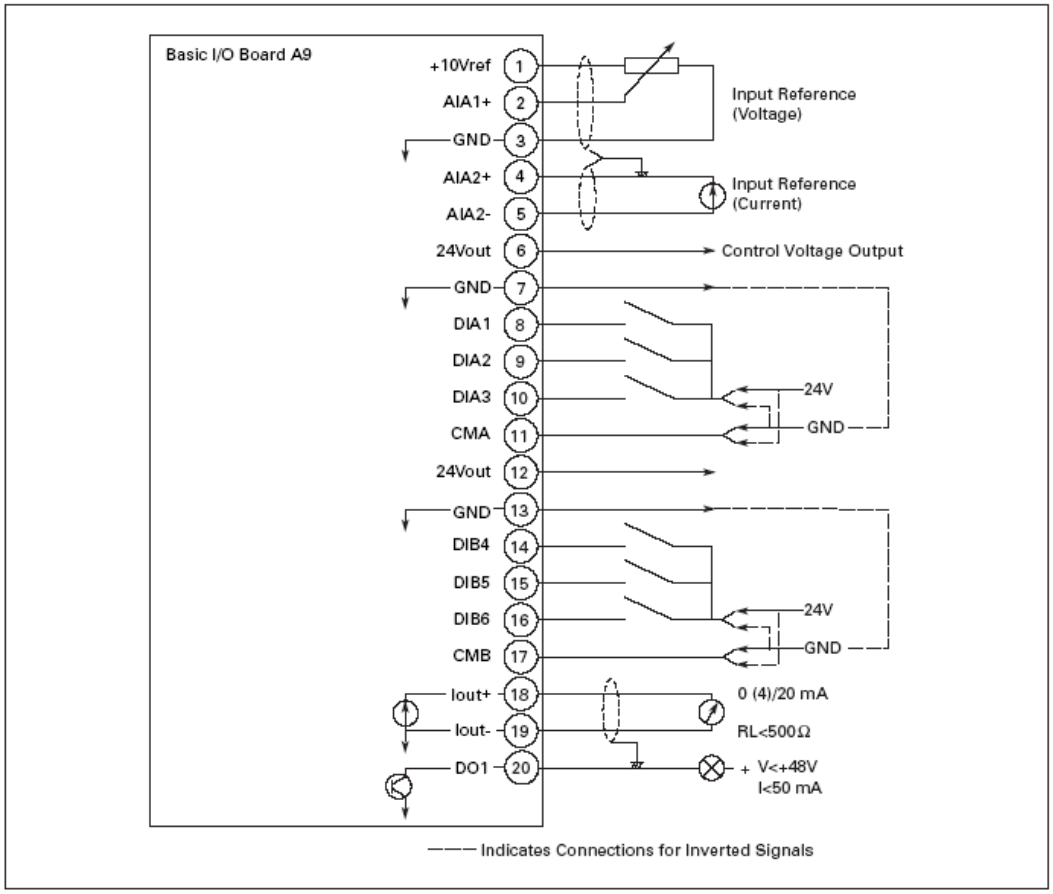


Figure 4-5. Option Board A9 Wiring Diagram

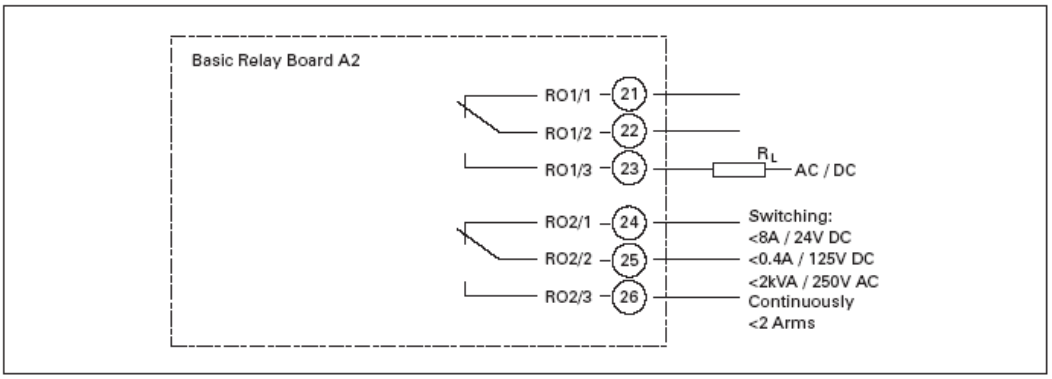


Figure 4-6. Option Board A2 Wiring Diagram

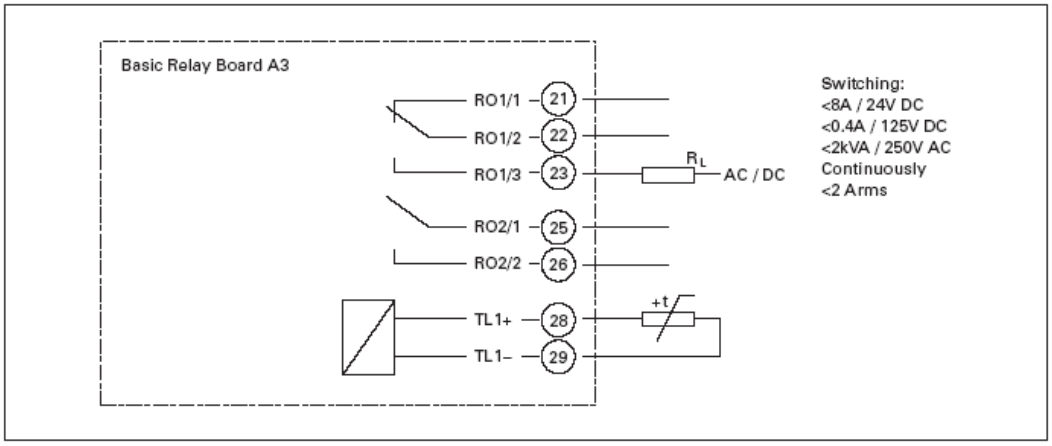


Figure 4-7. Option Board A3 Wiring Diagram

4-2 CONTROL CABLES

The control cables shall be at least 20 AWG screened multicore cables (see Table 4-1). The maximum terminal wire size is 14 AWG for the relay terminals and 16 AWG for other terminals.

You can find the tightening torques of the option board terminals in Table 4-1.

TABLE 4-1. TIGHTENING TORQUES OF OPTION BOARD TERMINALS

Terminal Screw	Tightening Torque lb-in
Relay and thermistor terminals (screw M3)	4.5
Other terminals (screw M2.6)	1.8

4-3 GALVANIC ISOLATION BARRIERS

The control connections are isolated from the mains potential and the GND terminals are permanently connected to ground. See Figure 4-8.

The digital inputs are galvanically isolated from the I/O ground. The relay outputs are also double-isolated from each other at 300 VAC (EN-50178).

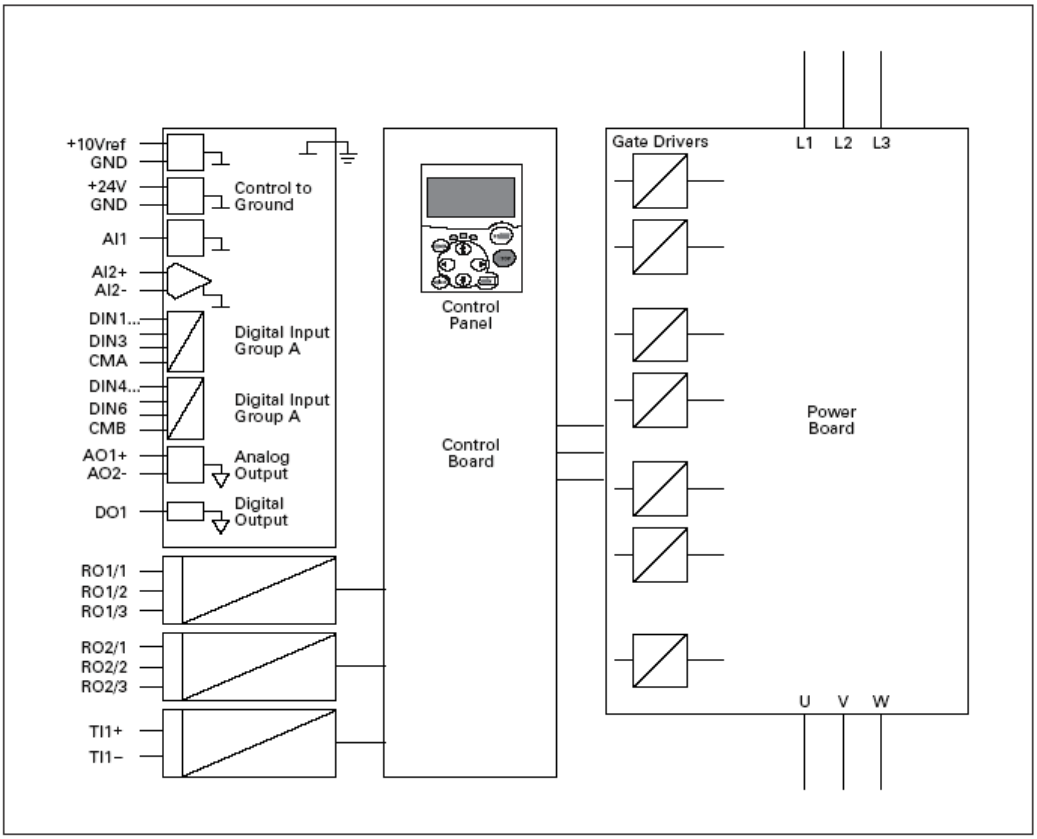


Figure 4-8. Galvanic Isolation Barriers

TABLE 4-2. CONTROL I/O TERMINAL SIGNALS ON OPTION BOARD A9

Terminal		Signal	Technical Information
1	+10 Vref	Reference voltage	Maximum current 10 mA
2	AI1+	Analog input, voltage or current	Selection V or mA with jumper block X1 (see section 4-5) Default: 0 to +10V (Ri = 200 kΩ) (-10V to +10V joystick control, selected with a jumper) 0 to 20 mA (R_i = 250 Ω) Differential input if not connected to ground; Allows ±20V differential mode voltage to GND
3	GND/AI1–	Analog input common	
4	AI2+	Analog input, voltage or current	Selection V or mA with jumper block X1 (see section 4-5) Default: 0 to 20 mA (R_i = 250 Ω) 0 to +10V (Ri = 200 kΩ) (10V to +10V Joy-stick control, selected with a jumper) Differential input if not connected to ground; Allows ±20V differential mode voltage to GND
5	GND/AI2–	Analog input common	
6	24 Vout (bidirectional)	24V auxiliary voltage	±15%; maximum current 250 mA all boards total; 150 mA from single board. Can also be used as external power backup for the control unit (and fieldbus).
7	GND	I/O ground	Ground for reference and controls
8	DIN1	Digital input 1	R_i = min 5kΩ 18 – 30V = "1"
9	DIN2	Digital input 2	
10	DIN3	Digital input 3	
11	CMA	Digital input common A for DIN1, DIN2 and DIN3.	Must be connected to GND or 24V of I/O terminal or to external 24V or GND Selection with jumper block X3 (see section 4-5)
12	24 Vout (bidirectional)	24V auxiliary voltage	Same as terminal #6
13	GND	I/O ground	Same as terminal #7
14	DIN4	Digital input 4	R_i = min 5kΩ 18 – 30V = "1"
15	DIN5	Digital input 5	
16	DIN6	Digital input 6	
17	CMB	Digital input common B for DIN4, DIN5 and DIN6	Must be connected to GND or 24V of I/O terminal or to external 24V or GND Selection with jumper block X3 (see section 4-5)
18	AO1+	Analog signal (+output)	Output signal range: Current 0(4) – 20 mA, RL max. 500Ω or Voltage 0 – 10V, R_L >1kΩ Selection with jumper block X3 (see section 4-5)
19	AO1	Analog output common	
20	DO1	Open collector output	Maximum U_{in} = 48 VDC Maximum current = 50 mA

TABLE 4-3. CONTROL I/O TERMINAL SIGNALS ON OPTION BOARD A2

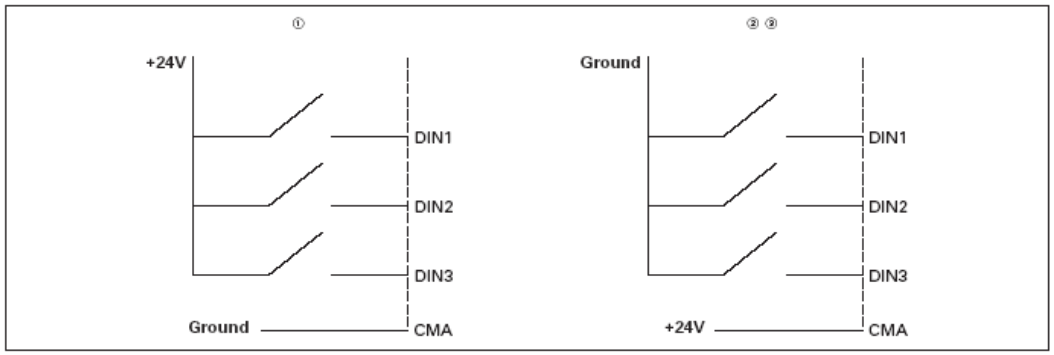
OPTA2				
21	RO1/1	Relay Output 1	Switching capacity	24VDC/8A
22	RO1/2			250VAC/8A
23	RO1/2			125VDC/0.4A
			Min. switching load	5V/10mA
24	RO2/1	Relay Output 2	Switching capacity	24VDC/8A
25	RO2/2			250VAC/8A
26	RO2/3			125VDC/0.4A
			Min. switching load	5V/10mA

4-4 DIGITAL INPUT SIGNAL INVERSIONS

The active signal level depends on which potential the common inputs CMA and CMB (terminals 11 and 17) are connected to. The alternatives are either +24V or ground (0V). See Figure 4-9.

We recommend the use of positive logic in all control connections of the inverter. If negative logic is used, additional appropriate measures are needed to meet the safety regulation requirements.

The 24 volt control voltage and the ground for the digital inputs and the common inputs (CMA, CMB) can be either internal or external.



①Positive logic (+24V is the active signal) = Input is active when the switch is closed.
②Negative logic (0V is the active signal) = Input is active when the switch is closed.
③Requires setting of jumper X3 to position "CMA/CMB isolated from ground."

Figure 4-9. Positive/Negative Logic

4-5 JUMPER SELECTIONS ON OPTION BOARD A9

The user can customize the functions of the inverter to better suit his needs by selecting certain positions for the jumpers on the OPTA9 board. The positions of the jumpers determine the signal type of analogue and digital inputs.

On the A9 basic board, there are four jumper blocks (X1, X2, X3 and X6), each containing eight pins and two jumpers. The selection possibilities of the jumpers are shown in Figure 4-11.

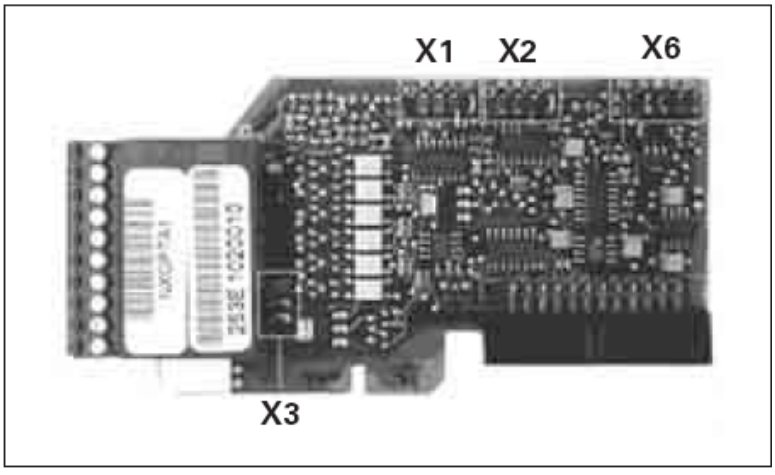


Figure 4-10. Jumper Blocks on Option Board A9

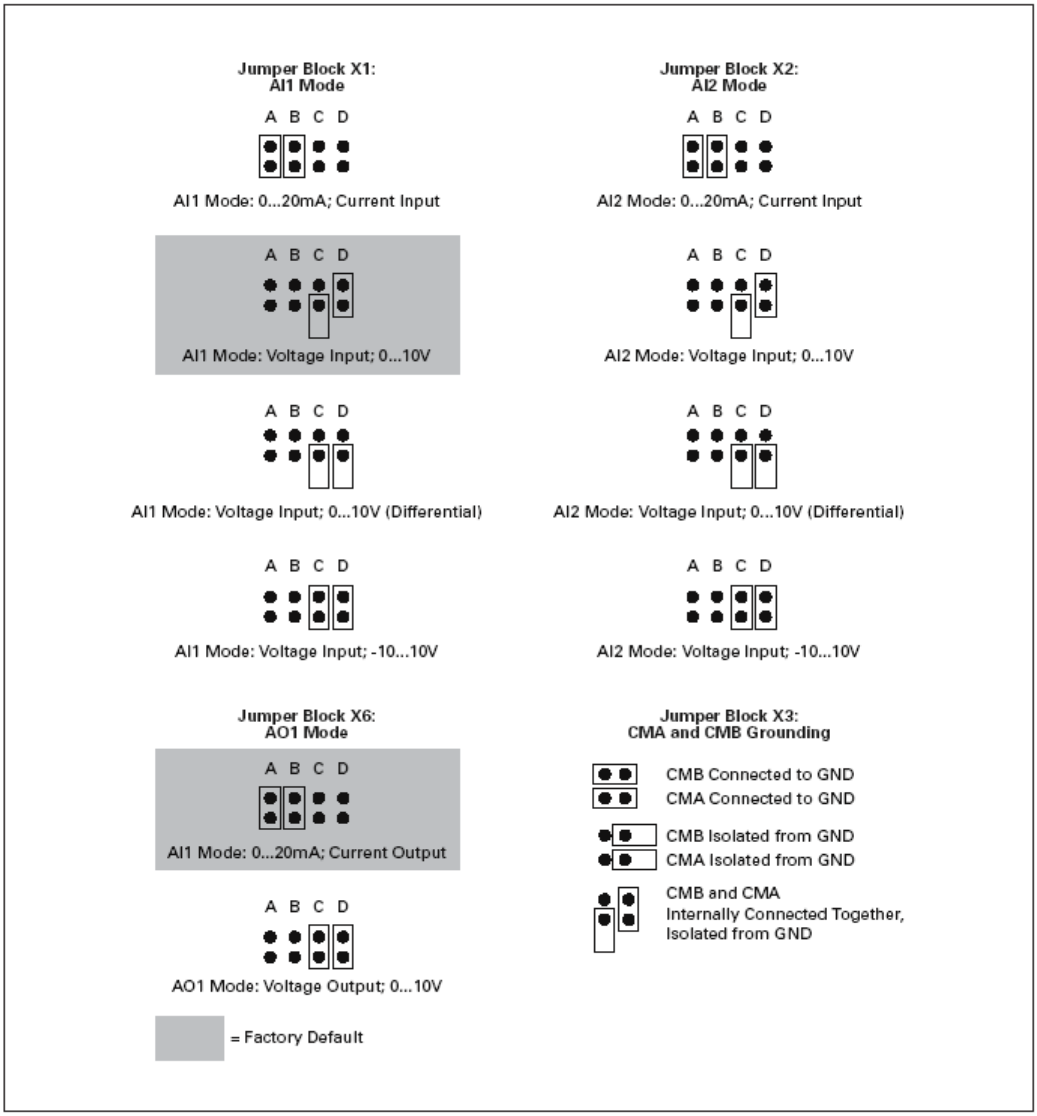


Figure 4-11. Jumper Selection for Option Board A9

****

C A U T I O N

Ensure that the jumper positions are correct. Running the motor with signal settings that differ from the jumper positions will not harm the inverter, but may harm the motor.

****

NOTE: If you change the AI/AO signal content, remember to change the corresponding board parameter in Menu M7.

SECTION V

STARTUP

5-1 SAFETY PRECAUTIONS

Before startup, note the following precautions:

- Internal components and circuit boards of the inverter (except for the galvanically isolated I/O terminals) are live when the inverter is connected to mains potential. Coming into contact with this voltage is extremely dangerous and may cause death or severe injury.

- The motor terminals U, V, W and the DC-link/brake resistor terminals+/- are live when the inverter is connected to DC supply, even if the motor is not running.

- The control I/O terminals are isolated from the mains potential. However, the relay outputs and other I/O terminals may have a dangerous control voltage present even when the inverter is disconnected from DC supply.

- Do not make any connections when the inverter is connected to the DC supply.

- After having disconnected the inverter, wait until the fan stops and the indicators on the keypad go out (if no keypad is attached see the indicator through the keypad base). Wait 5 more minutes before doing any work on inverter connections. Do not open the cover before the time has expired.

- Before connecting the inverter to DC supply, make sure that the inverter's front cover is closed.

- When running, the side of inverter FR8 is hot. Do not touch it with bare hands!

- When running, the back of inverter FR6 is hot. Therefore, it MUST NOT be mounted onto a surface which is not fireproof.

5-2 SEQUENCE OF OPERATION

1. Read the safety instructions in the front of this manual carefully and follow them.

2. After installation, make sure:
   - Both the inverter and the motor are grounded
   - DC supply and motor cables comply with the requirements given in Chapter 3

- Control cables are located as far as possible from the power cables (see Chapter 2), and the shields of the shielded cables are connected to protective ground. The wires must not touch the electrical components of the inverter.
- Common inputs of digital input groups are connected to +24V or the ground of the I/O terminal or the external supply.

3. Check the quality and quantity of cooling air. (See section 2-1.)

4. Check the inside of the inverter for condensation.

5. Check that all Start/Stop switches connected to the I/O terminals are in the Stop position.

6. Connect the inverter to DC supply.

7. Set the parameters according to the requirements of your application (see application manual). Set the following parameters at the least:
   - Motor nominal voltage
   - Motor nominal frequency
   - Motor nominal speed
   - Motor nominal current

   You will find the values needed for the parameters on the motor rating plate.

8. Perform either Test A or B without the motor running:

   Test A — Controls from the I/O Terminals:

   - Turn the Start/Stop switch to ON position.
   - Change the frequency reference (potentiometer).
   - Check in the Monitoring Menu M1 that the value of Output Frequency changes according to the change of frequency reference.
   - Turn the Start/Stop switch to OFF position.

   Test B— Control from the Control Keypad:

   - Change the control from the I/O terminals to the keypad (see the ACCel500 Software Manual).
   - Press the START button on the keypad.
   - Move over to the Keypad Control Menu M3 and Keypad Reference submenu (see the ACCel500 Software Manual) and change the frequency reference with the Browser buttons.
   - Check in Monitoring Menu M1 that the value of Output Frequency changes according to the change of frequency reference.
   - Press the STOP button on the keypad.

9. Perform the start-up tests without the motor being connected to the process. If this is not possible, make sure that each test can be done safely prior to performing it. Inform your co-workers of the tests.

    - Switch off the DC supply voltage and wait until the drive has stopped as advised in section 5-1, Safety Precautions.
    - Connect the motor cable to the motor and to the motor cable terminals of the inverter.
    - Make sure that all Start/Stop switches are in Stop positions.
    - Switch the supply voltage ON.
    - Repeat Test A or B in step 8.

10. Connect the motor to the process (if the start-up test was performed without the motor being connected). Inform our co-workers of the tests.

    - Before running the tests, make sure that this can be done safely.
    - Repeat Test A or B in step 8.