

MAKING MODERN LIVING POSSIBLE

*Danfoss*



# Instruction Manual

## VLT® FC Series Option Panel

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# 1 Introduction

## 1.1.1 Purpose of the Manual

This manual provides detailed information for the installation and operation of the vertical panel used in conjunction with a Danfoss variable frequency drive (VFD). To enable efficient handling of the equipment, requirements are provided for installation of:

- mechanical
- electrical
- control wiring
- proper grounding
- environmental considerations

Pre-start and start up procedures are detailed. Also included is a detailed overview of the panel bypass function. In addition, identification of other optional components and their operation and start up troubleshooting instructions are included. For the electronically controlled bypass, additional programming and operation information is provided.

## 1.1.2 Warnings, Cautions and Notices

### Symbols

The following symbols are used in this manual.



Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

## CAUTION

Indicates a situation that may result in equipment or property-damage-only accidents.

## NOTE!

Indicates highlighted information that should be regarded with attention to avoid mistakes or operate equipment at less than optimal performance.

## 1.1.3 Overview

A variable frequency drive regulates the speed and operation of an electric motor(s). The drive is programmable and offers many features and savings compared to operating a motor from unregulated line voltage. The panel is a protective enclosure in which the drive and various optional components are assembled and mounted. One of the most common functions of the standard bypass/non bypass panel is to allow switching between VFD control and running in bypass. In bypass, the motor is operated directly from line input power.

Two types of bypass options are available:

- electromechanical bypass (EMB)
- electronically controlled bypass (ECB)

The EMB is operated by selector switches on the front of the panel. The EMB controls a motor(s) by switching between drive control, operation in bypass, or off. In addition, a test setting is available which disengages the motor from the drive but keeps the drive operational while the motor runs in bypass. The switching function activates contactors that open or close to provide power to the motor through the drive or bypass circuitry, as required.

The ECB also uses contactors to provide power to the motor through the drive or bypass circuitry. However, the ECB contains a local processor which interacts with the drive's control logic for programmable options, remote inputs, and status reporting. The VFD's logic circuitry is backed up by an independent panel-mounted power supply so that, even if the drive loses power, control and communication functions are maintained. Programming and display are provided by the VFD's keypad. An important feature of the ECB is the ability to accept commands from a building automation system (BAS) and to report operational status in return.

See more detailed descriptions of the EMB in *5 Electromechanical Bypass (EMB) Operation* and *6 Electronically Controlled Bypass (ECB) Operation*.

## 1.1.4 Typical Bypass Operation

With contactors M1 and M2 closed and contactor M3 open (see *Figure 1.1*), the motor is running in drive control. Opening contactor M2 removes power to the motor but allows the drive to remain under power. This is the test mode and only available in the three-contactor configuration shown. With contactors M1 and M2 open and contactor M3 closed, the motor is running in bypass from the line input. For a two-contactor configuration, M1 is absent. In this case, contactors M2 and M3 control the options for running in drive or bypass mode. The drive disconnect and fuses shown in *Figure 1.1* are controlled by an ON/OFF disconnect on the bypass panel.

Contactor	Drive Mode	OFF	Bypass Mode	Test Mode
M1	Closed	Open	Open	Closed
M2	Closed	Open	Open	Open
M3	Open	Open	Closed	Closed

Table 1.1 Contactor Operation

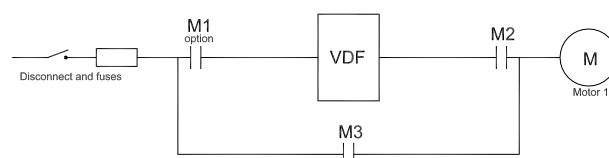


Figure 1.1 Basic 3-contactor Bypass Functions

## 1.2 Bypass Circuits

### 1.2.1 Two-contactor Bypass

This bypass consists of motor starter circuitry used in bypass, a bypass contactor (M3) interlocked with a drive output contactor (M2) mounted in the bypass enclosure. For the electromechanical bypass (EMB), an enclosure-mounted Drive/OFF/Bypass selector is used to electrically select whether the motor is controlled by the drive, connected to the full-speed bypass, or disconnected from both. The contactor and motor starter are controlled by this switch. A light indicates when in bypass. For the electronically controlled bypass (ECB), control selection is made through the LCP by pressing [Drive Bypass] and selecting from the available options shown. Display data indicates when in bypass. A drive disconnect is also available with the two-contactor bypass and is required for the option panel components without bypass.

#### Three-contactor bypass

This bypass consists of motor starter circuitry used in bypass, a bypass contactor (M3) interlocked with a drive output contactor (M2), a drive input contactor (M1), and an overload relay mounted in the option panel. For the EMB, an enclosure mounted Drive/OFF/Bypass/Test switch is used to electrically select whether the motor is driven by the drive, connected to the fullspeed bypass, or disconnected from both. The test position applies power to the motor through the bypass (M3 closed) while removing power to the motor (M2 open) but keeps the drive powered (M1 closed). A light indicates when in bypass. For the ECB, control selection is made through the LCP by pressing the DRIVE BYPASS key and selecting from the available options shown. Display data indicates when in bypass. The circuitry may be supplied with either an input disconnect switch or an input circuit breaker.

## 1.3 Bypass Options

#### Common run/stop with bypass

Allows a common remote signal through the VFD input terminals to initiate operation in either drive control or bypass. A relay closure starts the motor(s) in drive or bypass, depending upon the position of the bypass selector switch.

#### Automatic bypass

Automatically transfers the motor(s) from drive to bypass without operator intervention when a fault condition trips the drive, after a programmable time-out period. The VFD's internal fault circuitry controls this action. The time delay permits all automatically resettable faults to clear before transfer to bypass. Run permissive or safety circuit signals override the auto bypass function and may prevent or delay running in bypass.

#### Run permissive in bypass

With run permissive active, the drive sends a run request and waits for a remote response to before notifying the motor to start. The response indicates the system is safe to operate.

#### Basic fire mode in bypass

This option switches the panel to bypass whenever a remote fire mode command is given to the VFD through the input terminals. In either drive or bypass, fire mode is intended to ignore common safety and overload inputs in emergency situations. The motor will continue to run in bypass until fire mode is removed or the drive or option panel fail. External safety signals and motor overload are ignored when in fire mode.

#### Advanced fire mode in bypass

The advanced fire mode allows for a variety of programmable responses to an external fire mode command signal. Bypass options are programmed through the drive's fire mode parameters. See fire mode section of

the drive manual and support materials for available options.

### Overload protection

This thermally activated device provides mechanical overload protection for the motor(s) while in bypass operation. It measures motor current and is set to the full load amps (FLA) of the motor. A 1.2 x FLA service factor is built-in and maintained, meaning that should the motor current increase above that value, the overload will calculate the level of increase to activate timing for the trip function. The higher the current draw, the quicker the trip response. It provides Class 20 motor protection.

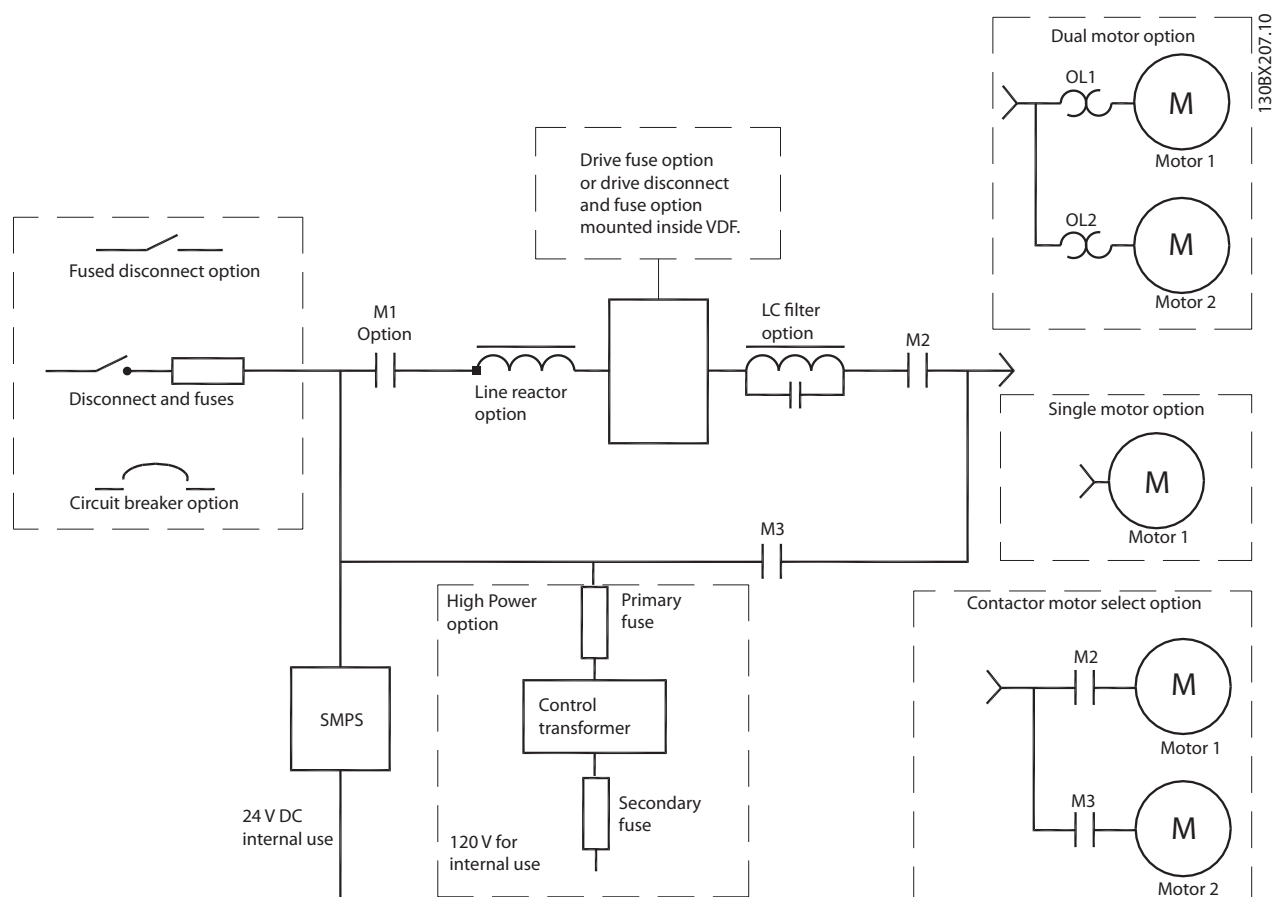
## 1.4 Bypass Platform Configurations

The EMB is available in three platforms: EMB(0), EMB1, and EMB2. The features available as options with each platform are listed in *Table 1.2*. The ECB, also listed below, has all option features available. See *5 Electromechanical Bypass (EMB) Operation* for additional details on the EMB and *6 Electronically Controlled Bypass (ECB) Operation* for the ECB.

Control Feature	EMB(0)	EMB1	EMB2	ECB
Safety Interlock	X	X	X	X
Common Start/Stop		X	X	X
Automatic Bypass			X	X
Run Permissive in Bypass			X	X
Basic Fire Mode			X	X
Advanced Fire Mode				X
Serial Communication				X

**Table 1.2 Bypass Configurations**





## 1.5 Switch Mode Power Supply (SMPS)

The VFD's logic circuitry is backed up by an independent panel-mounted switch mode power supply so that, even if the drive loses power, the control and communication functions are maintained. The SMPS converts three-phase AC input power to 24 VDC control power. Since the SMPS draws power from all three phases, it offers immunity protection from most phase-loss and brown-out conditions. The SMPS is internally protected from short circuit on its output and three board-mounted fuses provide additional protection. The SMPS is not designed for external use and may take up to 5 s to initialize at power-up.

## 1.6 Disconnects

### 1.6.1 Main Disconnect

The main disconnect removes line input power to the drive and bypass. A main disconnect is available in four options.

- Fused disconnect**  
 two-position (ON/OFF) rotary switch, padlock compatible, with three fuses, one on each phase, built into the switch. For safety, the switch must be in the OFF position before the option panel door can be opened
- Disconnect with fuses**  
 Two-position (ON/OFF) rotary switch, padlock compatible, with a fuse block mounted separately from the disconnect. Three fuses, one on each phase, are located on the fuse block. For safety, the switch must be in the OFF position before the option panel door can be opened.
- Disconnect without fuses**  
 For user-supplied fuses option.
- Main circuit breaker**  
 A thermal/ magnetic current interrupt device using an ON/TRIP/OFF/RESET switch. When in the ON position, a trip fault removes power from the drive/bypass circuit and the switch moves to the TRIP setting. It must be moved to the RESET position momentarily after the fault has been cleared to reset the circuit breaker.

### 1.6.2 Drive Disconnect (Optional)

Two-position (ON/OFF) rotary switch disconnects main AC line input power to the drive only.

### 1.6.3 Bypass Selector Switch

The bypass selector switch is used for either the 2-contactor or 3-contactor bypass for EMB units.

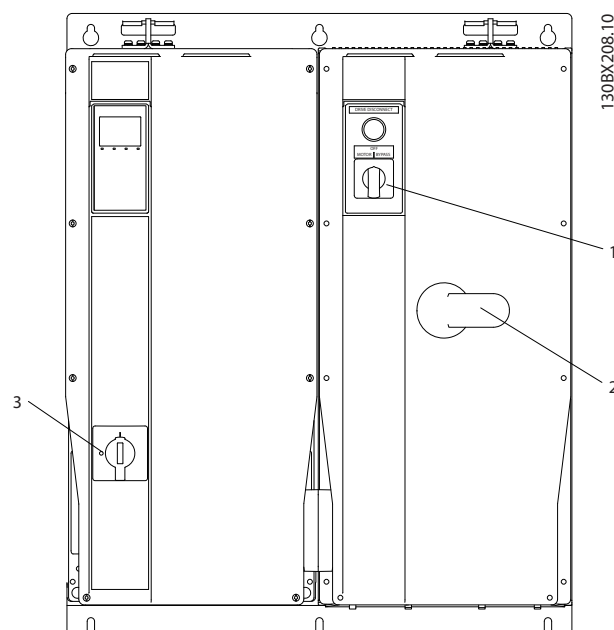


Figure 1.3 Disconnects

1	Bypass selector switch
2	Main disconnect
3	Drive disconnect

Table 1.3 Legend to Figure 1.3

## 1.6.4 Option Panel Configurations

The VLT FC Drive Series has three tiers of option panel enclosure types. These designations are universal for both the EMB and ECB panels as well as drive options without bypass.

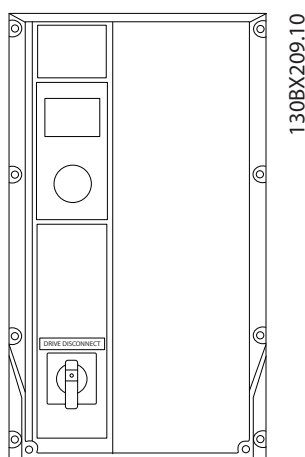


Figure 1.4 Tier 1

Figure 1.4 shows drive plus either or both of the following:

- Fuses
- Disconnect

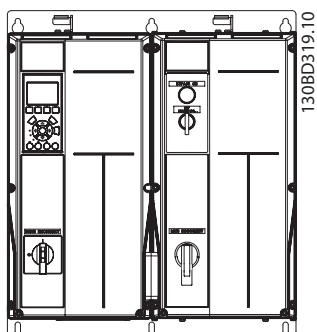


Figure 1.5 Tier 2

Figure 1.5 shows drive with bypass or up to two of the following:

- Contactor motor selection
- dU/dt filter or input AC line reactor (NEMA 1 only)
- Dual motor control

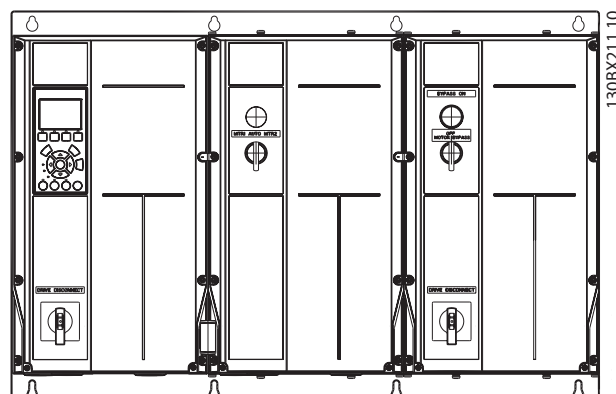


Figure 1.6 Tier 3

Figure 1.6 shows drive with bypass plus up to two of the following:

- Contactor motor selection
- dU/dt filter or input AC line reactor (NEMA 1 only)
- Dual motor control

## 1.6.5 Option Panel Voltage and Frame Ratings

Table 1.4 to Table 1.10 define the voltage and hp ratings of the frames sizes for the option panel. See the mechanical drawing shipped with the unit for dimensions.

	FC 102/202	FC 302
[V AC]	[hp]	[hp]
208-230	1.5-5	1.5-5
460-480	1.5-10	1.5-10
575-600	1.5-10	1.5-10

Table 1.10 Frame D2

	FC 102/202	FC 302
[V AC]	[hp]	[hp]
208-230	1.5-5	1.5-5
460-480	1.5-10	1.5-10
575-600	1.5-10	1.5-10

Table 1.4 Frames A2 to A5

	FC 102/202	FC 302
[V AC]	[hp]	[hp]
208-230	7.5-15	7.5-15
460-480	15-25	15-20
575-600	15-25	15-20

Table 1.5 Frame B1

	FC 102/202	FC 302
[V AC]	[hp]	[hp]
208-230	15-20	15
460-480	30-40	25-30
575-600	30-40	25-30

Table 1.6 Frame B2

	FC 102/202	FC 302
[V AC]	[hp]	[hp]
208-230	25-30	20-30
460-480	50-75	40-60
575-600	50-75	40-60

Table 1.7 Frame C1

	FC 102/202	FC 302
[V AC]	[hp]	[hp]
208-230	40-60	40-50
460-480	100-125	75-100
575-600	100-125	75-100

Table 1.8 Frame C2

	FC 102/202	FC 302
[V AC]	[hp]	[hp]
460-480	150-200	125-150
575-600	150-200	125-150

Table 1.9 Frame D1



## 2 Pre-Installation

### 2.1.1 Receiving Inspection

Inspect the packaging and equipment closely when received. Any indication of careless handling by the carrier should be noted on the delivery receipt, especially if the equipment will not be immediately uncrated. Obtain the delivery person's signed agreement to any noted damages for any future insurance claims. Ensure that the model number and power match the order and intended use for the drive.

#### NOTE!

**IMPORTANT LOST OR DAMAGED GOODS INSPECT THIS SHIPMENT IMMEDIATELY UPON ARRIVAL**

If goods are received short or in damaged condition, insist on a notation of the loss or damage across the face of the freight bill. Otherwise no claim can be enforced against the transportation company. If concealed loss or damage is discovered, notify your carrier at once and request an inspection. This is absolutely necessary. Unless you do this the carrier will not entertain any claim for loss or damage. The agent will make an inspection and can grant a concealed damage notation. If you give the transportation company a clear receipt for equipment that has been damaged or lost in transit, you do so at your own risk and expense. Danfoss IS WILLING TO ASSIST YOU TO COLLECT CLAIMS FOR LOSS OR DAMAGE, BUT WILLINGNESS ON OUR PART DOES NOT MAKE US RESPONSIBLE FOR COLLECTION OF CLAIMS OR REPLACEMENT OF MATERIAL. THE ACTUAL FILING AND PROCESSING OF THE CLAIM IS YOUR RESPONSIBILITY.

Ensure that the model number and power match the order and intended use of the drive.

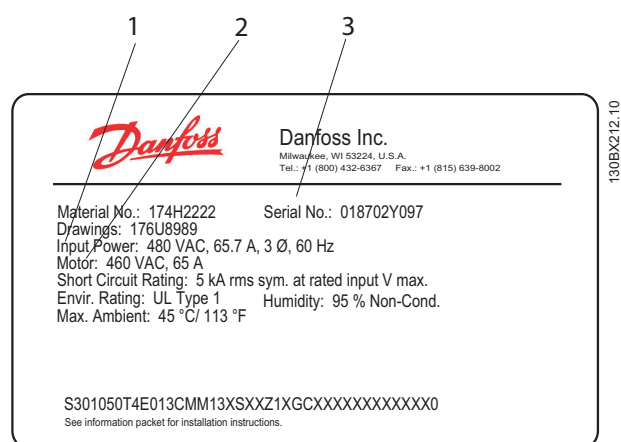


Figure 2.1 Sample Panel Label

1	Panel input rating
2	Panel output rating
3	Serial number

Table 2.1 Legend to Figure 2.1

Ensure that the model number and power match the order and intended use for the drive.

### 2.1.2 Pre-installation Check

1. Compare option panel model number to what was ordered.
2. Ensure each of following are rated for same voltage:
  - Drive
  - Option panel
  - Power line
  - Motor
3. Ensure that panel output rating is equal to or greater than motor total full load current for full motor performance.

- For multiple motor applications, add the full load current ratings of all motors.
- Motor power size and option panel must match for proper overload protection.
- If panel rating is less than motor, full motor output cannot be achieved.

## 4. Check motor wiring:

- Any disconnect between drive and motor should be interlocked to drive safety interlock circuit to avoid unwanted drive trips.
- Do not connect power factor correction capacitors between drive and motor.
- Two speed motors must be wired permanently for full speed.
- Y-start,  $\Delta$ -run motors must be wired permanently for run.

### 2.1.3 Installation Site Check

- Because the panel relies on the ambient air for cooling, it is important to observe the limitations on ambient air temperature. Derating concerns start above 104 °F (40 °C) and 3300 feet (1000 m) elevation above sea level.
- It is important with multiple panels to check wall strength. Make sure that the proper mounting screws or bolts are used.
- Ensure that the wall or floor area for installation will support the weight of the unit.
- If construction work continues after the equipment is mounted, it is important to keep the interior free from concrete dust and similar dirt. If the unit does not have power applied to it, supply a protective covering. It is important to ensure that the components stay as clean as possible. It may be necessary to clean the interior once construction is completed.
- Keep drawings and manuals accessible for detailed installation and operation instructions. It is important that the manuals are available for equipment operators.

## 2.2 Harsh Environments

The mechanical and electrical components within the panel can be adversely affected by the environment. The effects of contaminants in the air, either solid, liquid, or gas, are difficult to quantify and control.

### 2.2.1 Airborne Liquids

Liquids in the air can condense in components. Water carried in the air is easily measured as relative humidity, but other vapors are often more difficult to measure or control. Steam, oil and salt water vapor may cause corrosion of components. In such environments, use TYPE 12 enclosures to limit the exchange of outside air into the option enclosure. Extremely harsh environments may require a higher level of protection.

### 2.2.2 Airborne Solids

Particles in the air may cause mechanical, electrical or thermal failure in components. A NEMA 1 enclosure provides a reasonable degree of protection against falling particles, but it will not prevent the fan from pulling dirty air into the enclosure. A typical indicator of excessive levels of airborne particles is dust around the fan. In dusty environments, use NEMA 12 enclosures.

### 2.2.3 Corrosive Chemicals

In environments with high temperatures and humidity, corrosive gases such as sulfur, nitrogen and chlorine compounds cause corrosion to occur in components. Indications of corrosion are blackened copper or rust on steel or oxidized aluminum. In such environments, it is recommended to mount the equipment in a cabinet with fresh air ventilation and to keep corrosive compounds away. A non-ventilated cabinet fitted with an air conditioner as a heat exchanger may be used. Conformal coated circuit boards may be specified to reduce the corrosive effects of a harsh environment.

## 3 Installation

### 3.1.1 Tools Required

In addition to the standard tool kit, the below listed tools are recommended for installation of the panel.

#### Tools Required

- Spreader bar capable of lifting up to 1000 lbs. Max diameter 0.875 in.
- Forklift, crane, hoist or other lifting device capable of handling up to 1000 lbs. (Qualified device operator available for operating the equipment.)
- Metric Socket Set: 7 to 19 mm
- Socket Extensions: 4, 6, and 12 in
- Torx driver set: T10 to T40
- Torque wrench: 6 - 170 lbs-in

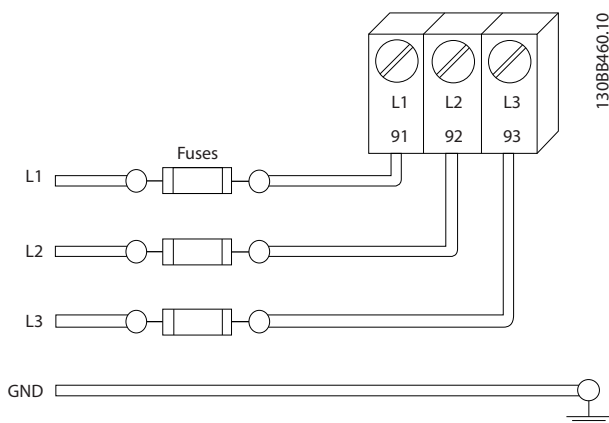


Figure 3.1 Drive Input Fuses

### 3.1.2 Branch Circuit Protection

## CAUTION

### BRANCH CIRCUIT PROTECTION REQUIRED

Provide branch circuit protection in accordance with the National Electrical Code. Failure to provide branch circuit protection in accordance with the NEC could result in equipment or property damage.

### 3.1.3 Drive Fuses

If specified as an enclosure option, drive input fuses will be factory installed in the enclosure. If not factory supplied, they must be provided by the installer as part of installation (see Figure 3.1).

### 3.1.4 Internal Option Panel Fuses

When applicable, use the specified fuse or an equivalent replacement only for internal option panel fuses. Fuse options include the drive disconnect and contactor fuses. See the nameplate label (Figure 3.2) on the inside cover of the unit for option panel fuse ratings.

Fuse	Manufacturer	Part Number/Size
F12	Ferraz-Shawmut	500V FA 5 A
F13	Ferraz-Shawmut	500V FA 10 A
F15	Bussmann	LPJ-25SP
F16	Bussmann	LPJ-35SP
F900, F901, F902	Ferraz-Shawmut	500V FA 4 A
F00	...	600 VAC, 120 A, Class CC

Figure 3.2

## 3.2 Mechanical Installation

### 3.2.1 Lifting

Check the weight of the unit before attempting to lift. Ensure that the lifting device is suitable for safely lifting the panel. If necessary, plan for a hoist, crane or forklift with appropriate rating to move the units.

### 3.2.2 Hoist or Overhead Lift

- Use solid steel spreader bar for lifting. Slide spreader bar through two (2) lifting rings on drive. Lifting rings are 0.75 in (19 mm) in diameter (see Figure 3.3).
- Connect spreader bar to a hoist or other lifting device.
- Lift unit slightly using lifting rings with weight distributed evenly.
- Remove skid and other supports from under drive.
- For floor mounting applications, a floor mounting kit is available from Danfoss specifically designed to anchor drive to floor.



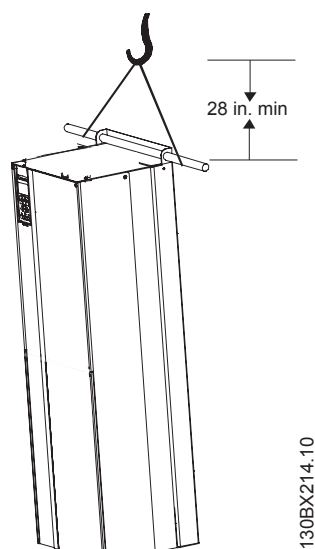


Figure 3.3 Proper Lifting Method

### 3.2.3 Forklift

- Only a competent lift operator with additional support personnel should attempt moving the unit.
- Carefully position forklift and ensure stability before lift.

### 3.2.4 Shipping Weights

#### NOTE!

WEIGHTS LISTED IN *Table 3.1* ARE APPROXIMATE FOR BASE UNITS. OPTIONS CAN ADD OR REDUCE WEIGHT OF UNIT.

Frame	Tier 1 [lbs]	Tier 2 [lbs]	Tier 3 [lbs]
A2-A3	30	35	55
A5	35	55	80
B1	65	85	110
B2	70	105	180
C1	100	145	215
C2	130	190	285
D1	220	420	585
D2	407	662	1037

Table 3.1 Approximate Shipping Weights

### 3.2.5 Cooling

- Mount the drive and panel vertically.
- Option panels rely on the ambient air for cooling, it is important to observe the limitations on ambient air temperature. See *Table 3.2* for temperature rating data. Derating concerns start above 3300 feet elevation above sea level.
- Most option panels with drives may be mounted side-by-side without additional side clearance. A2 and A3 units require 1.5 in. clearance between units (see *Figure 3.4*).
- Top and bottom clearance is required for cooling (see *Figure 3.5*). Generally, 100 to 250 mm (4 to 10 inches) minimum clearance is required, depending upon the hp (kW) of the unit. See the mechanical drawing shipped with the unit for specific requirements.
- No additional back plate is required for drives with the option panel.
- Units may be mounted flush to the wall or free standing. A free-standing mounting kit is available from Danfoss.
- See *Table 3.2* for temperature ratings.

Frame Size	NEMA 1	NEMA 12
A2-A3	45 °C	NA
A5	NA	40 °C
B1-C1	45 °C	40 °C
C2, D1-D2	40 °C	40 °C

Table 3.2 Temperature Ratings

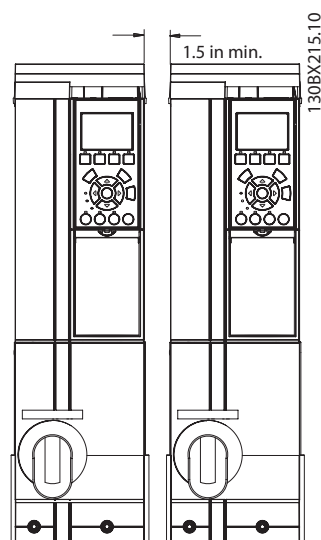


Figure 3.4 Side Cooling Clearance, A-2 and A-3 Frames

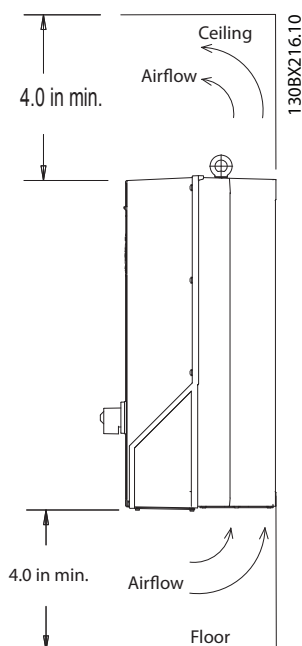


Figure 3.5 Cooling Airflow

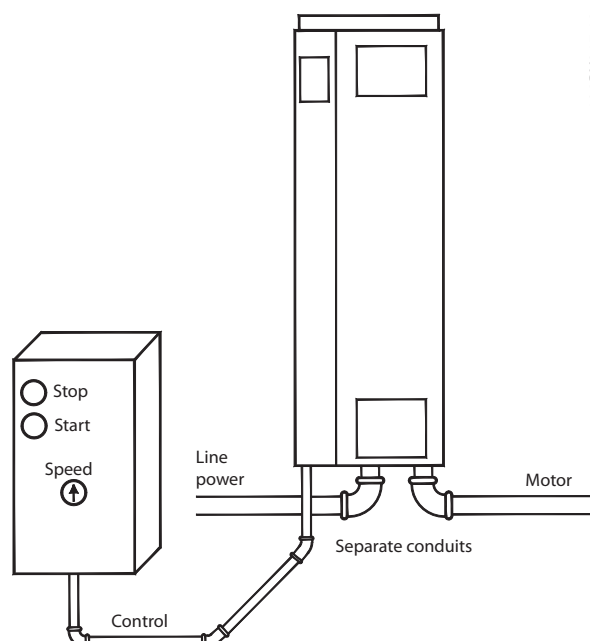


Figure 3.6 Power Connections

### 3.3 Electrical Installation

#### **WARNING**

##### EQUIPMENT HAZARD!

ROTATING SHAFTS AND ELECTRICAL EQUIPMENT CAN BE HAZARDOUS. IT IS STRONGLY RECOMMENDED THAT ALL ELECTRICAL WORK CONFORM TO ALL NATIONAL AND LOCAL REGULATIONS. INSTALLATION, START-UP AND MAINTENANCE SHOULD BE PERFORMED ONLY BY QUALIFIED PERSONNEL. FAILURE TO FOLLOW LOCAL REGULATIONS COULD RESULT IN DEATH OR SERIOUS INJURY.

- Motor control equipment and electronic controls are connected to hazardous line voltages. Extreme care should be taken to protect against electrical hazard.
- Correct protective grounding of the equipment must be established. Ground currents are higher than 3 mA.
- A dedicated ground wire is required.
- Wear safety glasses whenever working on electric control or rotating equipment.

#### **NOTE!**

MAKE ALL POWER CONNECTIONS WITH MINIMUM 75 ° C RATED COPPER WIRING FOR INSTALLATIONS IN NORTH AMERICA.

#### **WARNING**

##### INDUCED VOLTAGE!

RUN OUTPUT MOTOR CABLES FROM MULTIPLE DRIVES SEPARATELY. INDUCED VOLTAGE FROM OUTPUT MOTOR CABLES RUN TOGETHER CAN CHARGE EQUIPMENT CAPACITORS EVEN WITH THE EQUIPMENT TURNED OFF AND LOCKED OUT. FAILURE TO RUN OUTPUT MOTOR CABLES SEPARATELY COULD RESULT IN DEATH OR SERIOUS INJURY.

RUN INPUT POWER, MOTOR WIRING AND CONTROL WIRING IN THREE SEPARATE METALLIC CONDUITS OR RACEWAYS FOR HIGH FREQUENCY NOISE ISOLATION. FAILURE TO ISOLATE POWER, MOTOR AND CONTROL WIRING COULD RESULT IN LESS THAN OPTIMUM DRIVE AND ASSOCIATED EQUIPMENT PERFORMANCE.

- Because the wiring from the option enclosure to the motor carries high frequency electrical pulses, it is important that no other wires are run in this conduit. If the incoming power wiring is run in the same conduit as the motor wiring, these pulses can couple electrical noise back onto the building power grid.

**3**

At least three separate conduits must be connected to the panel option (*Figure 3.6*).

- Power into the option enclosure (and ground back to the distribution panel)
- Power from the option enclosure to the motor (and earth ground)
- Control wiring

Control wiring should always be isolated from the high voltage power wiring.

Avoid getting metal chips into electronics.

Follow the connection procedures as illustrated in the drawing provided with the unit.

### 3.4.1 Component Identification

Mechanical layout drawings are provided inside the cover of each unit with an option panel. These illustrations are intended to provide the installer or equipment user with component identification and location for that specific unit. *Figure 3.7* and *Figure 3.8* represent a typical layout drawing. *Table 3.3* provides definitions for drawing reference designators. (Not all reference designators are shown.)

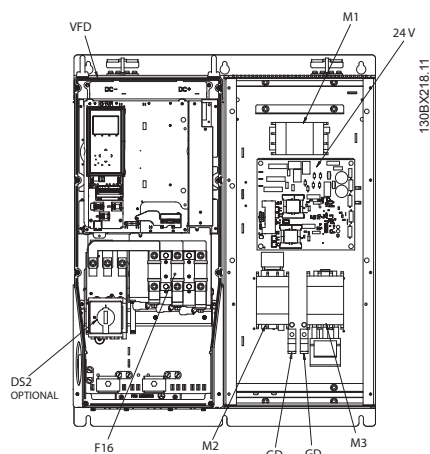


Figure 3.7 Sample Mechanical Layout Diagram

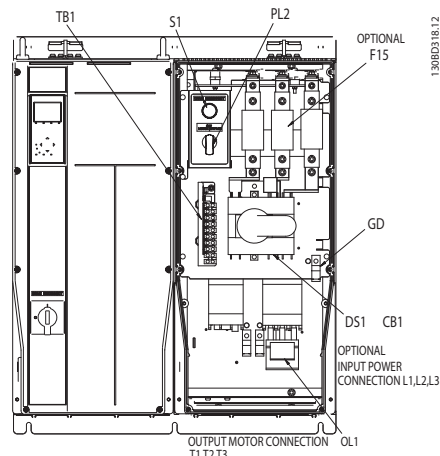


Figure 3.8 Sample Mechanical Layout Diagram

ID	Definition	Function
24 V	Option panel 24 V DC SMPS	Supply 24 V DC control power to option panel for internal use only
CB1	Main Circuit breaker	Provide isolation between option panel and current protection for incoming mains
DS1	Main or line disconnect	Provide isolation between option panel and mains
DS2	Drive disconnect	Provide isolation between VFD and line voltage
DF15	Main fused disconnect	Provide isolation between option panel and mains
DV1	VFD output motor filter	Output filter to provide filtering for PWM drive output wave form
F12	T1 secondary fuse	Current protection for internal 120 V AC control circuit
F13	T1 primary fuse	Current protection for line side of 120 V AC internal control transformer
F15	Line or main fuse	Provide current protection to option panel
F16	Drive fuse	Provide current protection to drive
GD	Ground terminal	Customer connection for power grounds to mains and motor
LR1	VFD input line reactor	Input reactor to provide additional input impedance to drive
M1	VFD input contactor	Provide isolation between VFD and line voltage
M2	VFD output contactor	Provide isolation between VFD and motor
M3	Bypass contactor	Provide line voltage to motor
M4	Motor 1 contactor	Used to select motor 1 operation
M5	Motor 2 contactor	Used to select motor 2 operation
MT1	Motor 1 connection terminal	Provides termination point for motor leads in option panel
OL1	Overload for motor 1	Provide overload protection to motor when running in bypass
OL2	Overload for motor 2	Provide overload protection to motor when running in bypass
PL2	Bypass indicator light	Provides indication when motor is in bypass mode
S1	Bypass selector switch	Operator interface for bypass mode selection on electromechanical bypass
S103	Auto bypass selection switch	4 position switch used to setup auto bypass on EMB2 control option
S2	CMS selector switch	Operator interface for contactor motor selection
T1	120 V AC control transformer	Provide internal 120 V AC supply
T3	120 V AC control transformer	Provide customer 120 V AC supply
TB1	Terminal Block 1	Customer bypass control connections for ECB-CMS and EMB0 control option
VFD	Variable frequency drive	Provide variable frequency and voltage to AC motor
X55	Customer terminal block	Customer control connection terminal block on EMB1 and EMB2 control option
X56	Customer terminal block	Customer control connection terminal block on EMB1 and EMB2 control option
X58	Customer terminal block	Customer control connection terminal block on EMB2 control option

Table 3.3 Reference Designator Definitions

### 3.4.2 Wire and Cable Access

- Determine the wiring path through the option panel enclosure. See the mechanical layout drawing located on the inside cover of the unit for locations to connect power and motor wiring.
- Removable access covers are provided for cable connections (see figure *Conduit Entry Diagrams*). Remove access covers before drilling holes to prevent metal shavings from damaging internal electronic components.
- For some units, access holes are provided for input power, motor leads, and control wiring.
- Run input power, motor wiring, and control wiring in three separate conduits for isolation.

#### NOTE!

**RUN INPUT POWER, MOTOR WIRING AND CONTROL WIRING IN THREE SEPARATE METALLIC CONDUITS OR RACEWAYS FOR HIGH FREQUENCY NOISE ISOLATION. FAILURE TO ISOLATE POWER, MOTOR AND CONTROL WIRING COULD RESULT IN LESS THAN OPTIMUM DRIVE AND ASSOCIATED EQUIPMENT PERFORMANCE.**

- The drive always resides in the left-hand panel when multiple panels are present.
- Power connections are typically on the rightside panel, or far right for tier 3 panel configurations.
- NEMA 12 enclosures available for additional environmental protection.
- Control wiring should be isolated from power components inside the unit as much as possible.
- See the mechanical layout drawing on the inside of the unit's panel and the connection diagram supplied with the unit for connection details.

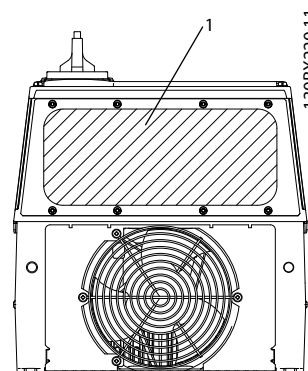


Figure 3.9 Tier 1 (Bottom View)

1	Control wiring
2	Input power
3	Motor power

Table 3.4 Legend to Figure 3.9

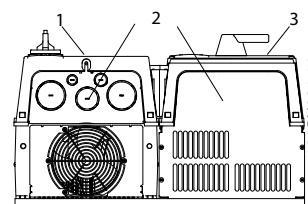


Figure 3.10 Tier 2 (Bottom View) NEMA 1

1	Drive
2	Conduit entry
3	Bypass

Table 3.5 Legend to Figure 3.10

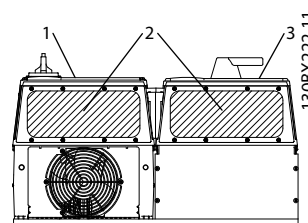


Figure 3.11 Tier 2 (Bottom view) NEMA 12

1	Drive
2	Conduit entry
3	Bypass

Table 3.6 Legend to Figure 3.11

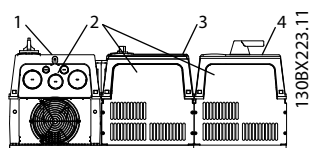


Figure 3.12 Tier 3 (Bottom View) NEMA 1

1	Drive
2	Conduit entry
3	Additional options
4	Bypass

Table 3.7 Legend to Figure 3.12

### 3.4.3 Wire Size

#### NOTE!

MAKE ALL POWER CONNECTIONS WITH MINIMUM 75 °C/167 °F RATED COPPER WIRING FOR INSTALLATIONS IN NORTH AMERICA.

- Size field wiring to NEC and local code requirements. The maximum allowable field wire size for any option panel is shown in *Table 3.8* through *Table 3.15*

	Disc. W/O Mains Fusing	Disc. W Mains Fusing	Disc. W 100KIA SCCR	Circuit Breaker
Type Code Char	CHAR 15&16	CHAR 15&16	CHAR 15&16	CHAR 15&16
Type Code	MD,ND	MM,NM	MN,NN	CD,FD
[HP]	Terminal Cap. [AWG]	Terminal Cap. [AWG]	Terminal Cap. [AWG]	Terminal Cap. [AWG]
0.50	8	4	8	10
0,75	8	4	8	10
1	8	4	8	10
1.5	8	4	8	10
2	8	4	8	10
3	8	4	8	10
5	8	4	8	10
7.50	8	4	4	3
10	8	4	4	3
15	3	4	3	2
20	3	3	3	2
25	1/0	1/0	1/0	1/0
30	1/0	1/0	1/0	300KCM
40	300KCM	300KCM	300KCM	300KCM
50	300KCM	300KCM	300KCM	300KCM
60	300KCM	300KCM	300KCM	300KCM

**Table 3.8 208 V Max Wire - Input**

	OL1 - Single Motor	OL1 - Dual Motor	OL2 - Dual Motor	CMS - M4 & M5	MT1 TB 0R LUG (ECB)
Type Code Char	CHAR 20	CHAR 20	CHAR 20	CHAR 20	CHAR 13&14&18
Type Code	S	D	D	C	NO&D
[HP]	Terminal Cap. [AWG]	Terminal Cap. [AWG]	Terminal Cap. [AWG]	Terminal Cap. [AWG]	Terminal Cap. [AWG]
0.50	8	N/A	N/A	10	12
0.75	8	N/A	N/A	10	12
1	8	N/A	N/A	10	12
1.5	8	8	8	10	12
2	8	8	8	10	12
3	8	8	8	10	12
5	8	8	8	10	4
7.5	8	8	8	8	4
10	8	8	8	8	4
15	1/0	8	8	1/0	4
20	1/0	8 (0.50-10HP)	8 (0.50-10HP)	1/0	4
		1/0 (15-30HP)	8 (0.50-10HP)		
25	1	8 (0.50-10HP)	8 (0.50-10HP)	1/0	1
		1 (15-30HP)	8 (0.50-10HP)		
30	1	1 (15-30HP)	8 (0.50-10HP)	1/0	1
40	4/0	1/0 (15-30HP)	8 (0.50-10HP)	4/0	250 KCM
		1/0 (15-30HP)	1/0 (15-30HP)		
50	4/0	1/0 (15-30HP)	8 (0.50-10HP)	4/0	250 KCM
		1/0 (15-30HP)	1/0 (15-30HP)		
		4/0 (40-60HP)	8 (0.50-10HP)		
60	4/0	1/0 (15-30HP)	1/0 (15-30HP)	4/0	2/0 (DUAL)
		4/0 (40-60HP)	8 (0.50-10HP)		
		4/0 (40-60HP)	1/0 (15-30HP)		

Table 3.9 208 V Max Wire - Output

	Disc. W/O Mains Fusing	Disc. W Mains Fusing	Disc. W 100KIA SCCR	Circuit Breaker
Type Code Char	CHAR 15&16	CHAR 15&16	CHAR 15&16	CHAR 15&16
Type Code	MD,ND	MM,NM	MN,NN	CD,FD
[HP]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]
0.50	8	4	8	10
0.75	8	4	8	10
1	8	4	8	10
1.5	8	4	8	10
2	8	4	8	10
3	8	4	8	10
5	8	4	8	10
7.5	8	4	4	3
10	8	4	4	3
15	3	4	3	2
20	3	4	3	2
25	1/0	1/0	1/0	1/0
30	1/0	1/0	1/0	1/0
40	300KCM	300KCM	300KCM	300KCM
50	300KCM	300KCM	300KCM	300KCM
60	300KCM	300KCM	300KCM	300KCM

Table 3.10 230 V Max Wire - Input



	OL1 - Single Motor	OL1 - Dual Motor	OL2 - Dual Motor	CMS - M4 & M5	MT1 TB 0R LUG (ECB)
Type Code Char	CHAR 20	CHAR 20	CHAR 20	CHAR 20	CHAR 13&14&18
Type Code	S	D	D	C	NO&D
[HP]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]
0.50	8	N/A	N/A	10	12
0.75	8	N/A	N/A	10	12
1	8	N/A	N/A	10	12
1.5	8	8	8	10	12
2	8	8	8	10	12
3	8	8	8	10	12
5	8	8	8	10	4
7.5	8	8	8	8	4
10	8	8	8	8	4
15	1/0	8	8	1/0	4
20	1/0	1/0 (15-30HP)	8 (0.5-10HP)	1/0	4
		8 (0.5-10HP)	8 (0.5-10HP)		
25	1	1 (15-30HP)	8 (0.5-10HP)	1/0	1
		8 (0.5-10HP)	8 (0.5-10HP)		
30	1	1 (15-30HP)	8 (0.5-10HP)	1/0	1
40	4/0	1/0 (15-30HP)	8 (0.5-10HP)	4/0	250KCM
		1/0 (15-30HP)	1/0 (15-30HP)		
50	4/0	4/0 (40-60HP)	8 (0.5-10HP)	4/0	250KCM
		1/0 (15-30HP)	8 (0.5-10HP)		
		1/0 (15-30HP)	1/0 (15-30HP)		
60	4/0	4/0 (40-60HP)	8 (0.5-10HP)	4/0	250KCM
		4/0 (40-60HP)	1/0 (15-30HP)		
		1/0 (15-30HP)	1/0 (15-30HP)		

Table 3.11 230 V Max Wire - Output

	Disc. W/O Mains Fusing	Disc. W Mains Fusing	Disc. W 100KIA SCCR	Circuit Breaker
Type Code Char	CHAR 15&16	CHAR 15&16	CHAR 15&16	CHAR 15&16
Type Code	MD,ND	MM,NM	MN,NN	CD,FD
[HP]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]
0.50	8	4	8	10
0.75	8	4	8	10
1	8	4	8	10
1.5	8	4	8	10
2	8	4	8	10
3	8	4	8	10
5	8	4	8	10
7.5	8	4	8	10
10	8	4	8	10
15	8	4	8	3
20	8	4	4	3
25	8	4	4	3
30	3	4	4	2
40	3	3	3	2
50	1/0	1/0	1/0	1/0
60	1/0	1/0	1/0	1/0
75	1/0	1/0	1/0	300KCM
100	300KCM	300KCM	300KCM	300KCM
125	300KCM	300KCM	300KCM	300KCM
150	250 KCM	250 KCM	250 KCM	250 KCM
200	250 KCM (DUAL)	250 KCM (DUAL)	250 KCM (DUAL)	2/0 (DUAL)
250	250 KCM (DUAL)	250 KCM (DUAL)	250 KCM (DUAL)	250 KCM (DUAL)
300	350 KCM (DUAL)	350 KCM (DUAL)	350 KCM (DUAL)	250 KCM (DUAL)
350	350 KCM (DUAL)	350 KCM (DUAL)	350 KCM (DUAL)	350 KCM (DUAL)

Table 3.12 460 V Max Wire - Input

	OL1 - Single Motor	OL1 - Dual Motor	OL2 - Dual Motor	CMS - M4 & M5	MT1 TB OR LUG (ECB)
Type Code Char	CHAR 20	CHAR 20	CHAR 20	CHAR 20	CHAR 13&14&18
Type Code	S	D	D	C	NO&D
[HP]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]
0.50	8	N/A	N/A	10	12
0.75	8	N/A	N/A	10	12
1	8	N/A	N/A	10	12
1.5	8	8	8	10	12
2	8	8	8	10	12
3	8	8	8	10	12
5	8	8	8	10	12
7.5	8	8	8	10	12
10	8	8	8	10	4
15	8	8	8	8	4
20	8	8	8	8	4
25	8	8	8	8	4
30	1/0	8 (0.50-25HP)	8 (0.50-25HP)	1/0	4
40	1/0	1/0 (30-75HP)	8 (0.50-25HP)	1/0	4
		8 (0.50-25HP)	8 (0.50-25HP)		
50	1	1 (30-75HP)	8 (0.50-25HP)	1/0	1
		8 (0.50-25HP)	8 (0.50-25HP)		
60	1	1 (30-75HP)	8 (0.50-25HP)	1/0	1
		8 (0.50-25HP)	8 (0.50-25HP)		
75	1	1 (30-75HP)	8 (0.50-25HP)	1/0	250KCM
		1 (30-75HP)	1 (30-75HP)		
100	2/0	1/0 (30-75HP)	8 (0.50-25HP)	4/0	250KCM
		1/0 (30-75HP)	1/0 (30-75HP)		
125	4/0	2/0 (100-125HP)	8 (0.50-25HP)	4/0	250KCM
		1/0 (30-75HP)	8 (0.50-25HP)		
		1/0 (30-75HP)	1/0 (30-75HP)		
150	4/0	2/0 (100-125HP)	8 (0.50-25HP)	250 KCM	250 KCM
		2/0 (100-125HP)	1/0 (30-75HP)		
		1/0 (30-75HP)	1/0 (30-75HP)		
200	2/0 (DUAL)	4/0 (100-125HP)	8 (0.50-25HP)	2/0 (DUAL)	2/0 (DUAL)
		4/0 (100-125HP)	1/0 (30-75HP)		
		1/0 (30-75HP)	1/0 (30-75HP)		
250	300 KCM (DUAL)	2/0 (DUAL)(200HP)	8 (0.50-25HP)	300 KCM (DUAL)	350 KCM (DUAL)
		2/0 (DUAL)(200HP)	1/0 (30-75HP)		
		250 KCM (150HP)	1/0 (30-75HP)		
		300KCM (100-125HP)	1/0 (30-75HP)		
		300KCM (100-125HP)	300KCM (100-125HP)		
300	300 KCM (DUAL)	300 KCM (DUAL)(250-350HP)	8 (0.50-25HP)	300 KCM (DUAL)	350 KCM (DUAL)
		300 KCM (DUAL)(250-350HP)	1/0 (30-75HP)		
		2/0 (DUAL)(200HP)	1/0 (30-75HP)		
		250 KCM (150HP)	350KCM (100-125HP)		
		250 KCM (150HP)	250 KCM (150HP)		
		350KCM (100-125HP)	350KCM (100-125HP)		
350	300 KCM (DUAL)	300 KCM (DUAL)(250-350HP)	8 (0.50-25HP)	300 KCM (DUAL)	350 KCM (DUAL)
		300 KCM (DUAL)(250-350HP)	1/0 (30-75HP)		
		2/0 (DUAL)(200HP)	350KCM (100-125HP)		

**Table 3.13 460 V Max Wire - Output**

	Disc. W/O Mains Fusing	Disc. W Mains Fusing	Disc. W 100KIA SCCR	Circuit Breaker
Type Code Char	CHAR 15&16	CHAR 15&16	CHAR 15&16	CHAR 15&16
Type Code	MD,ND	MM,NM	MN,NN	CD,FD
[HP]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]
0.50	8	4	8	10
0.75	8	4	8	10
1	8	4	8	10
1.5	8	4	8	10
2	8	4	8	10
3	8	4	8	10
5	8	4	8	10
7.5	8	4	8	10
10	8	4	8	10
15	8	4	8	3
20	8	4	4	3
25	8	4	4	3
30	8	4	4	2
40	3	4	4	2
50	1/0	1/0	1/0	1/0
60	1/0	1/0	1/0	1/0
75	1/0	1/0	1/0	300KCM
100	300KCM	1/0	1/0	300KCM
125	300KCM	300KCM	300KCM	300KCM
150	250 KCM	250 KCM	250 KCM	2/0 (DUAL)
200	250 KCM (DUAL)	250 KCM (DUAL)	250 KCM (DUAL)	2/0 (DUAL)
250	250 KCM (DUAL)	250 KCM (DUAL)	250 KCM (DUAL)	250 KCM (DUAL)
300	250 KCM (DUAL)	250 KCM (DUAL)	250 KCM (DUAL)	250 KCM (DUAL)
350	250 KCM (DUAL)	250 KCM (DUAL)	250 KCM (DUAL)	250 KCM (DUAL)
400	350 KCM (DUAL)	350 KCM (DUAL)	350 KCM (DUAL)	250 KCM (DUAL)

Table 3.14 600 V Max Wire - Input

	OL1 - Single Motor	OL1 - Dual Motor	OL2 - Dual Motor	CMS - M4 & M5	MT1 TB OR LUG (ECB)
Type Code Char	CHAR 20	CHAR 20	CHAR 20	CHAR 20	CHAR 13&14&18
Type Code	S	D	D	C	NO&D
[HP]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]	Maximum Wire Size [AWG]
0.50	8	N/A	N/A	10	12
0.75	8	N/A	N/A	10	12
1	8	N/A	N/A	10	12
1.5	8	8	8	10	12
2	8	8	8	10	12
3	8	8	8	10	12
5	8	8	8	10	12
7.5	8	8	8	10	12
10	8	8	8	10	12
15	8	8	8	10	4
20	8	8	8	8	4
25	8	8	8	8	4
30	8	8	8	1/0	4
40	1/0	8	8	1/0	4
50	1	1 (40-75HP)	8 (0.50-30HP)	1/0	4
		8 (0.50-30HP)	8 (0.50-30HP)		
60	1	1 (40-75HP)	8 (0.50-30HP)	1/0	1
		8 (0.50-30HP)	8 (0.50-30HP)		
75	1	1 (40-75HP)	8 (0.50-30HP)	1/0	1
		8 (0.50-30HP)	8 (0.50-30HP)		
100	2/0	1/0 (40-75HP)	8 (0.50-30HP)	4/0	250 KCM
		1/0 (40-75HP)	1/0 (40-75HP)		
125	2/0	2/0 (100-125HP)	8 (0.50-30HP)	4/0	250 KCM
		1/0 (40-75HP)	8 (0.50-30HP)		
		1/0 (40-75HP)	1/0 (40-75HP)		
150	4/0	2/0 (100-125HP)	8 (0.50-30HP)	250 KCM	250 KCM
		2/0 (100-125HP)	1/0 (40-75HP)		
		1/0 (40-75HP)	1/0 (40-75HP)		
200	2/0 (DUAL)	2/0 (150-200HP)	8 (0.50-30HP)	2/0 (DUAL)	2/0 (DUAL)
		2/0 (150-200HP)	1/0 (40-75HP)		
		2/0 (100-125HP)	8 (0.50-30HP)		
		2/0 (100-125HP)	1/0 (40-75HP)		
		1/0 (40-75HP)	1/0 (40-75HP)		
250	2/0 (DUAL)	250 KCM (150-200HP)	8 (0.50-30HP)	2/0 (DUAL)	2/0 (DUAL)
		250 KCM (150-200HP)	1/0 (40-75HP)		
		350KCM (100-125HP)	1/0 (40-75HP)		
		350KCM (100-125HP)	350KCM (100-125HP)		
300	300 KCM (DUAL)	2/0 (DUAL)(250HP)	8 (0.50-30HP)	300 KCM (DUAL)	350 KCM (DUAL)
		2/0 (DUAL)(250HP)	1/0 (40-75HP)		
		250 KCM (150-200HP)	1/0 (40-75HP)		
		250 KCM (150-200HP)	350KCM (100-125HP)		
		250 KCM (150-200HP)	250 KCM (150-200HP)		
		350KCM (100-125HP)	350KCM (100-125HP)		
350	300 KCM (DUAL)	300 KCM (DUAL) (300-400HP)	8 (0.50-30HP)	300 KCM (DUAL)	350 KCM (DUAL)
		300 KCM (DUAL) (300-400HP)	1/0 (40-75HP)		
		2/0 (DUAL)(250HP)	1/0 (40-75HP)		
		250 KCM (150-200HP)	350KCM (100-125HP)		
		250 KCM (150-200HP)	250 KCM (150-200HP)		
400	300 KCM (DUAL)	300 KCM (DUAL) (300-400HP)	8 (0.50-30HP)	300 KCM (DUAL)	350 KCM (DUAL)
		300 KCM (DUAL) (300-400HP)	1/0 (40-75HP)		
		2/0 (DUAL)(250HP)	350KCM (100-125HP)		

**Table 3.15 600 V Max Wire - Output**

### 3.4.4 Wire Type Rating

- Use wiring corresponding to the wiring rating specifications provided.
- The wire rating specifications are located on the tightening torque and wire rating label inside the cover of the option panel (see *Figure 3.13*).

### 3.4.5 Terminal Tightening Torques

- Tighten all connections to the torque specifications provided.
- The torque tightening specifications are located on the tightening torque and wire rating label inside the cover of the option panel (see *Figure 3.13*).

Field Conn.	Tightening Torque lb-in (N-m)	Temperature & Type Rating
L1, L2, L3 / GND	25 (2.8) / 25 (2.8)	Use 75 °C Copper Cond.
1T1, 1T2, 1T3 / GND	25 (2.8) / 25 (2.8)	Use 75 °C Copper Cond.
2T1, 2T2, 2T3 / GND	25 (2.8) / 25 (2.8)	Use 75 °C Copper Cond.
TB1	7 (0.8)	Use 60 °C Copper Cond.

1308D321.10

Figure 3.13 Sample Tightening Torque and Wire Rating Label

### 3.4.6 Input Line Connection

#### NOTE!

**RUN INPUT POWER, MOTOR WIRING AND CONTROL WIRING IN THREE SEPARATE METALLIC CONDUITS OR RACEWAYS FOR HIGH FREQUENCY NOISE ISOLATION. FAILURE TO ISOLATE POWER, MOTOR AND CONTROL WIRING COULD RESULT IN LESS THAN OPTIMUM DRIVE AND ASSOCIATED EQUIPMENT PERFORMANCE.**

- Connect 3-phase AC input power wire to terminals L1, L2, and L3. See the connection drawing inside the cover of the unit.
- Depending on the configuration of the equipment, input power may be connected to a circuit breaker or input disconnect.
- Torque terminals in accordance with the information provided on the connection diagram inside the cover of the unit.
- Use with Isolated Input Source. Many utility power systems are referenced to earth ground. Although not as common, the input power may be an isolated source. All drives may be used with an isolated input source as well as with ground reference power lines.

### 3.4.7 Motor Wiring

#### ⚠ WARNING

##### INDUCED VOLTAGE!

**RUN OUTPUT MOTOR CABLES FROM MULTIPLE DRIVES SEPARATELY. INDUCED VOLTAGE FROM OUTPUT MOTOR CABLES RUN TOGETHER CAN CHARGE EQUIPMENT CAPACITORS EVEN WITH THE EQUIPMENT TURNED OFF AND LOCKED OUT. FAILURE TO RUN OUTPUT MOTOR CABLES SEPARATELY COULD RESULT IN DEATH OR SERIOUS INJURY.**

#### NOTE!

**RUN INPUT POWER, MOTOR WIRING AND CONTROL WIRING IN THREE SEPARATE METALLIC CONDUITS OR RACEWAYS FOR HIGH FREQUENCY NOISE ISOLATION. FAILURE TO ISOLATE POWER, MOTOR AND CONTROL WIRING COULD RESULT IN LESS THAN OPTIMUM DRIVE AND ASSOCIATED EQUIPMENT PERFORMANCE.**

- Connect the 3-phase motor wiring to bypass terminals T1 (U), T2 (V), and T3 (W). See the connection drawing inside the cover of the unit.
- Depending on the configuration of the equipment, motor wiring may be connected to an electrical or mechanical overload, a contactor, or terminal block.
- Torque terminals in accordance with the information provided on the connection diagram inside the cover of the unit.
- Motor wiring should never exceed the following maximum distances: 300m (1000 ft) for unshielded 150m (500 ft) for shielded
- Motor wiring should always be as short as practical.

### 3.4.8 Grounding (Earthing)

#### **⚠ WARNING**

**GROUNDING HAZARD!**  
FOR OPERATOR SAFETY, IT IS IMPORTANT TO GROUND OPTION PANEL PROPERLY. FAILURE TO GROUND OPTION PANEL PROPERLY COULD RESULT IN DEATH OR SERIOUS INJURY.

#### **NOTE!**

IT IS THE RESPONSIBILITY OF THE USER OR CERTIFIED ELECTRICAL INSTALLER TO ENSURE CORRECT GROUNDING (EARTHING) OF THE EQUIPMENT IN ACCORDANCE WITH NATIONAL AND LOCAL ELECTRICAL CODES AND STANDARDS.

- Follow all local and national codes for proper electrical equipment grounding (earthing).
- Correct protective grounding of the equipment must be established. Ground currents are higher than 3 mA.
- A dedicated ground wire is required.
- Connect the ground wire directly to a reliable earth ground. Grounding studs are provided on the back plate of the option panel for grounding.
- Do not use conduit connected to the option panel as a replacement for a ground wire.
- Do not ground one panel to another in a "daisy chain" fashion. Each panel must have a dedicated ground connection.
- A high strand count ground wire is preferred for dissipating high frequency electrical noise.
- Keep the ground wire connections as short as possible.

### 3.4.9 Control Wiring

Detailed instructions for terminal functions, control wiring installation, and operation is shown in 5 *Electromechanical Bypass (EMB) Operation* and 6 *Electronically Controlled Bypass (ECB) Operation*.

#### **NOTE!**

**RUN INPUT POWER, MOTOR WIRING AND CONTROL WIRING IN THREE SEPARATE METALLIC CONDUITS OR RACEWAYS FOR HIGH FREQUENCY NOISE ISOLATION. FAILURE TO ISOLATE POWER, MOTOR AND CONTROL WIRING COULD RESULT IN LESS THAN OPTIMUM DRIVE AND ASSOCIATED EQUIPMENT PERFORMANCE.**

- It is recommended that control wiring is rated for 600 V for 480 V and 600 V drives and 300 V for 200-240 V drives.
- Isolate control wiring from high power components in the drive.
- See label inside of panel cover for details.

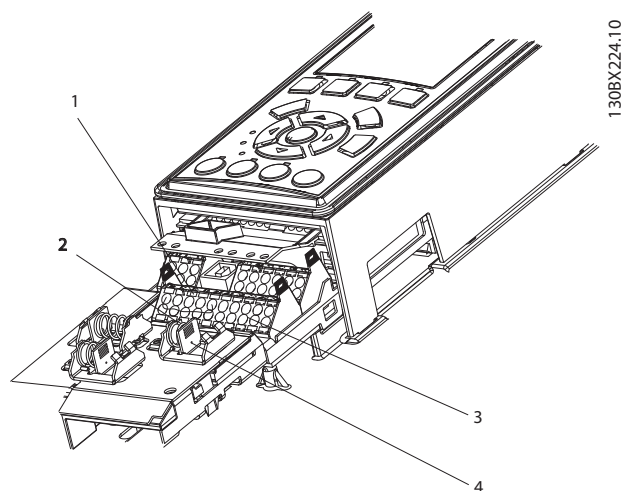


Figure 3.14 Control Terminals Location

1	EIA-485 terminal
2	Jumper wire
3	Control terminals
4	Grounded restraining clips

Table 3.16 Legend to Figure 3.14

### 3.4.10 Serial Communication Bus Connection

The ECB reports serial communication data to host systems through the drive. Connection to the serial communication network is made either through the EIA-485 terminals on the drive (see *Figure 3.14*) or, for other protocols, terminals located on the communication option card. For option card connection, see the option card instructions provided with the unit.

- For ECB serial communication protocols using the EIA-485 terminals, make connections in the following manner.

#### NOTE!

**It is recommended to use braided-shielded, twisted-pair cables to reduce noise between conductors.**

1. Connect signal wires to terminal (+) 68 and terminal (-) 69 on control terminals of drive. (See the drive support materials for wire size and tightening torque.)
2. Terminate shield to grounded restraining clip provided by stripping wire insulation at point of contact.
3. If shielded cabling is used, do not connect the end of the shield to terminal 61.

### 3.4.11 Programming

Serial communication point maps, parameter settings, and other details for bypass option functionality are included in the serial communication materials supplied with the unit.





## 4 Start Up

1. Input power to unit must be OFF and locked out per OSHA requirements. Do not rely on panel disconnect switches.

### **⚠ WARNING**

#### **HIGH VOLTAGE!**

IF INPUT AND OUTPUT CONNECTIONS HAVE BEEN CONNECTED IMPROPERLY, THERE IS POTENTIAL FOR HIGH VOLTAGE ON THESE TERMINALS. IF POWER LEADS FOR MULTIPLE MOTORS ARE IMPROPERLY RUN IN SAME CONDUIT, THERE IS POTENTIAL FOR LEAKAGE CURRENT TO CHARGE CAPACITORS WITHIN OPTION PANEL, EVEN WHEN DISCONNECTED FROM LINE INPUT. FOR INITIAL START UP, MAKE NO ASSUMPTIONS ABOUT POWER COMPONENTS. FOLLOW PRE-START PROCEDURES DESCRIBED BELOW. FAILURE TO FOLLOW PRE-START PROCEDURES DESCRIBED BELOW COULD RESULT IN DEATH, SERIOUS INJURY OR DAMAGE TO EQUIPMENT.

1. Use AC voltmeter to verify there is no voltage on input terminals L1, L2, and L3, phase-to-phase and phase-to-ground, and output terminals T1, T2, and T3, phase-to-phase and phase-to-ground.
2. Use ohmmeter to confirm continuity of motor by measuring T1-T2, T2-T3, and T3-T1.
3. Use ohmmeter to confirm open on input by measuring L1-L2, L2-L3, and L3-L1.

### **NOTE!**

**If an isolation transformer is between the power source and panel, continuity will be present. In this case, visually confirm that motor and power leads are not reversed.**

4. Inspect the panel for loose connections on terminals.
5. Check for proper ground: option panel to main building distribution ground, and option panel to motor ground. See label inside panel cover for proper wire size.
6. Confirm control connections terminated per connection diagrams supplied with the equipment.
7. Check for external devices between drive option panel output and motor. It is recommended that no devices be installed between motor and drive.
8. Record motor nameplate data; hp, voltage, full load amps (FLA), and RPM. It will be needed to match motor and drive later on.
9. Confirm that incoming power voltage matches drive label voltage and motor nameplate voltage.

10. For multiple winding motors, motor must be wired on run winding, not start winding.

### **⚠ CAUTION**

#### **EQUIPMENT DAMAGE!**

IF MOTOR FLA (FULL LOAD AMPERAGE) IS GREATER THAN UNIT MAXIMUM AMPS, DRIVE AND OPTION PANEL MUST BE REPLACED WITH ONE OF APPROPRIATE RATING. DO NOT ATTEMPT TO RUN UNIT. FAILURE TO MATCH FLA TO UNIT MAXIMUM AMP RATING MAY RESULT IN EQUIPMENT DAMAGE.

1. Confirm motor FLA is equal to or less than maximum option panel output current. Some motors have higher than normal NEMA currents.
2. Check that overload relay(s) is set for FLA of connected motor. Service factor is built into overload relay.
3. For drive start up procedures, see drive specific Instruction Manual.

### 4.1.1 Inspection Before Start Up

Before applying power to the unit, inspect the entire installation as detailed in *Table 4.1*.

4

Inspect for	Description
Auxiliary equipment	Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside on input power side of drive or output side to motor. Examine their operational readiness and ensure they are ready in all respects for operation at full speed. Check function and installation of pressure sensors or encoders (etc.) used for feedback to drive. Remove power factor correction caps on motor(s), if present.
Cable routing	Ensure that input power, motor wiring and control wiring are in three separate metallic conduits for high frequency noise isolation. Failure to isolate power, motor and control wiring could result in less than optimum drive and associated equipment performance.
Control wiring	Check for broken or damaged wires and connections. Check the voltage source of the signals, if necessary. The use of shielded cable or twisted pair is recommended. Ensure the shield is terminated correctly.
EMC considerations	Check for proper installation with regard to electromagnetic capability.
Environmental conditions	See option panel label for the maximum ambient operating temperature. Humidity levels must be less than 95% non-condensing.
Fan clearance	Some units have a cooling fan located below the drive and require sufficient clearance for fan removal. See the installation drawing supplied with the unit for clearance requirements.
Fusing and circuit breakers	Check that all fuses are inserted firmly and in operational condition and that all circuit breakers are in the open position.
Grounding	The option panel requires a dedicated ground wire from its chassis to the building ground. It is highly recommended that the motor be grounded to the panel chassis. The use of conduit or mounting of the panel to a metal surface is not considered a suitable ground. Check for good ground connections that are tight and free of oxidation.
Input and output power wiring	Check for loose connections. Check for proper fusing or circuit breakers.
Panel interior	Option panel interior must be free of dirt, metal chips, moisture, and corrosion. Check for harmful airborne contaminants such as sulfur based compounds.
Proper clearance	Option panels require top and bottom clearance adequate to ensure proper air flow for cooling in accordance with the unit size.
Switches	Ensure that all switch and disconnect settings are in the proper position.
Vibration	Look for any unusual amount of vibration the equipment may be subjected to. The panel should be mounted solidly or the use of shock mounts employed.

**Table 4.1 Inspection Before Start Up**

## 4.1.2 Start Up Procedure

In the following procedures, changing the equipment between drive mode and bypass mode is required. Changing modes is different for the ECB and EMB. The ECB uses pushbuttons on the LCP while the EMB uses switches on the front of the panel. Be familiar with the operation of these devices before start up.

### **⚠ WARNING**

#### **EQUIPMENT HAZARD!**

**OPTION PANELS CONTAIN DANGEROUS VOLTAGES WHEN CONNECTED TO LINE VOLTAGE. INSTALLATION, START-UP AND MAINTENANCE SHOULD BE PERFORMED ONLY BY QUALIFIED PERSONNEL. FAILURE TO PERFORM INSTALLATION, START-UP AND MAINTENANCE BY QUALIFIED PERSONNEL ONLY COULD RESULT IN DEATH OR SERIOUS INJURY.**

1. Perform pre-start up procedure.
2. Ensure that all operator devices are in OFF position. Main and drive disconnect switches on front of electromechanical bypass panel must be in OFF position. Panel door(s) closed.
3. Keep main disconnect switch in OFF position and apply voltage to option panel. DO NOT operate drive or bypass at this time.
4. Confirm input line voltage is balanced within 3%. If not, correct input voltage imbalance before proceeding. Repeat procedure after voltage correction, if applicable.

### **NOTE!**

#### **MOTOR START!**

**ENSURE THAT MOTOR, SYSTEM, AND ANY ATTACHED EQUIPMENT IS READY FOR START. FAILURE TO ENSURE MOTOR, SYSTEM, AND ANY ATTACHED EQUIPMENT IS READY FOR START COULD RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE.**

5. To apply power, turn main disconnect (and drive disconnect, when applicable) to ON position. If a bypass is connected, place bypass in drive mode.
6. Enter drive programming data per instructions in drive specific Instruction Manual.

In steps 7 through 11, for a bypass with a contactor motor selection (CMS) option, put the motor selector switch in motor 1 position. Repeat the procedure for motor 2 with the switch position in motor 2. For dual motor applications, check both motors at same time.

7. Check motor rotation direction in drive control as follows.

- a. Put panel in drive mode.
- b. Hand start drive at minimum speed (see drive specific Instruction Manual for details).
- c. Confirm directional rotation.
- d. If incorrect, stop drive, remove power, and lock out.
- e. Reverse connection of any 2 of 3 motor leads at terminal. Do not change incoming power leads.
- f. Remove lockout and apply power.
- g. Confirm directional rotation.

8. Check motor rotation direction in bypass as follows.

- a. Momentarily bump motor in bypass.
- b. Confirm directional rotation.
- c. If incorrect, stop drive, remove power, and lock out.
- d. Reverse connection of any 2 of 3 input power leads at terminal. Do not change motor leads
- f. Confirm directional rotation.

### **⚠ CAUTION**

#### **FULL SPEED OPERATION!**

**ENSURE THAT THE MOTOR, SYSTEM, AND ANY ATTACHED EQUIPMENT IS READY FOR FULL SPEED OPERATION. USER ASSUMES ALL RESPONSIBILITY FOR ASSURING SYSTEM IS ABLE TO SAFELY RUN AT FULL SPEED. FAILURE TO ENSURE THAT THE MOTOR, SYSTEM, AND ANY ATTACHED EQUIPMENT IS READY FOR FULL SPEED OPERATION COULD RESULT IN EQUIPMENT DAMAGE.**

9. Check full load amps in drive mode on motor terminals.

- a. Put unit into drive mode.
- b. Check full load amps on motor terminals T1, T2, and T3. Verify motor amps are within drive and motor rated current and are balanced within 3%. If incorrect, see 8 Start Up Troubleshooting for isolation procedures.

c. Check full load amps on input terminals L1, L2, and L3. Verify that current is within FLA of drive and balanced within 3%. If incorrect, see *8 Start Up Troubleshooting* for isolation procedures.

10. Check full load amps in bypass mode on motor terminals.

a. Put unit into bypass mode.

b. Check full load amps on terminals T1, T2, and T3. Verify motor amps are within motor FLA rated current and balanced within 3%. If incorrect, see *8 Start Up Troubleshooting* for isolation procedures.

For steps 11-13, see *5 Electromechanical Bypass (EMB) Operation* and *6 Electronically Controlled Bypass (ECB) Operation* for details.

11. Check operation of any optional functions to confirm they work, as applicable. Options may include run permissive, fire mode, common start/stop, or others.
12. Exercise safety circuit and verify that unit stops running.
13. Exercise start/stop circuit and verify that unit starts and stops with system in auto mode of operation.

## 5 Electromechanical Bypass (EMB) Operation

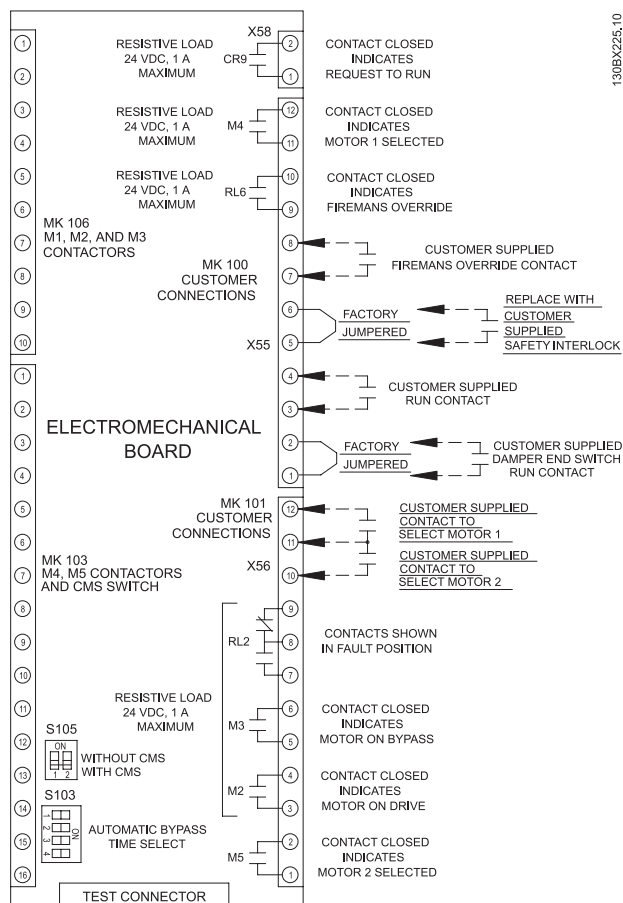


Figure 5.1 Customer-side EMB2 Control Card Terminal Connctions

Conn.	Term.	Input/Output	Type	Function
X55	1	Input	Normally open, dry relay contact	Closed when motor can start to run
	2	Input		
	3	Input	Normally open, dry relay contact	Closed for remote start with common start/stop
	4	Input		
	5	Input	Normally open, dry relay contact	Safety input, open to stop
	6	Input		
	7	Input	Normally open, dry relay contact	Closed to enable Fire Mode
	8	Input		
	9	Output	Normally open, dry relay contact	Closed indicates Fire Mode activated
	10	Output		
	11	Output	Normally open, dry relay contact	Closed indicates Motor 1 selected
	12	Output		
Conn.	Term.	Input/Output	Type	Function
X56	1	Output	Normally open, dry relay contact	Closed indicates Motor 2 selected
	2	Output		
	3	Output	Normally open, dry relay contact	Closed when panel is in Drive Mode
	4	Output		
	5	Output	Normally open, dry relay contact	Closed when panel is in Bypass Mode
	6	Output		
	7	Output	Normally open, dry relay contact	Open when drive is in Fault Condition
	8	Output		
	9	Output	Normally closed form C relay contact	Common for fault relay
	10	Input		
	11	Input	Normally open, dry relay contact	CMS Motor 2, close to select
	12	Input		
Conn.	Term.	Input/Output	Type	Function
X58	1	Output	Normally open, dry relay contact	Closed indicates run requested
	2	Output		

Table 5.1 EMB2 Control Card Terminal Functions

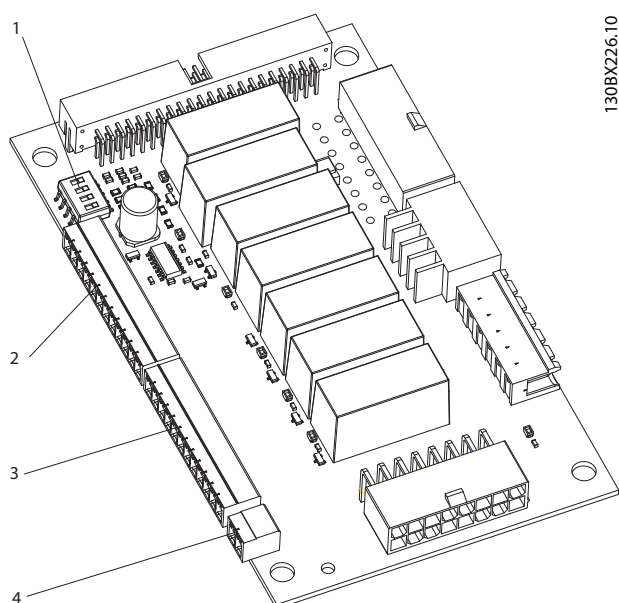


Figure 5.2 EMB2 Control Card

1	Switch S103 autobypass timer
2	Terminal X56
3	Terminal X55
4	Terminal X58

Table 5.2 Legend to Figure 5.2

Drive Terminal	Parameter	Value Number	Value Name	Function
01 & 02	5-40 Function Relay [0] function	167	Start Command Active	Run Permissive
01 & 02	5-40 Function Relay [0] off delay	0.00 s	Off Delay	Run Permissive
19	5-11 Terminal 19 Digital Input	52	Run Permissive	Run Permissive
18	5-10 Terminal 18 Digital Input	8	Start	Common run/stop
27	5-00 Digital I/O Mode	0	PNP	External Interlock
27	5-01 Terminal 27 Mode	0	Input	External Interlock
27	5-12 Terminal 27 Digital Input	7	External Interlock	External Interlock
29	5-02 Terminal 29 Mode	1	Output	Auto bypass
29	5-31 Terminal 29 Digital Output	160	No Alarm	Auto bypass

Table 5.3 EMB2 Parameter Settings

Table 5.3 lists EMB2 default parameter settings for bypass operation. If the drive is reinitialized, be sure that these settings are maintained or reset for proper bypass operation.



Name	Function	Drive Terminals	EMB2 X56	EMB2 X55	EMB2 X58
Remote Drive Start (with common start/ stop)	Input Command			3, 4	
Remote Drive Start (without common start/stop)	Input Command	13, 18			
Motor Running on Drive	Output Status	04, 05, 06			
Run request (for run permissive)	Output Command				1, 2
Run Enable (for run permissive)	Input Command			1, 2	
Safety Stop	Input Command			5, 6	
Drive Fault	Output Status		7, 8, 9		
Fire Mode	Input Command			7, 8	
Remote Motor 1 Select	Input Command		11, 12		
Remote Motor 2 Select	Input Command		10, 11		
Motor 1 Selected	Output Status			11, 12	
Motor 2 Selected	Output Status		1, 2		
Drive Mode	Output Status		3, 4		
Bypass Mode	Output Status		5, 6		
Fire Mode	Output Status			9, 10	

**Table 5.4 Typical HVAC Control Connections**

Table 5.4 lists common functions for controlling a motor(s) with a bypass and the typical terminal connections used. Commands enable drive functions. Status reports describe conditions but do not enable a function.

### 5.1.1 EMB(0) and EMB1

The electromechanical bypass is available in two additional types, the EMB(0) and EMB1. Each has reduced functionality from the EMB2. The figures and tables below list for features and functions available in either type. Table 5.7, Table 5.8 and Table 5.9 list terminal functions for EMB(0) and EMB1, respectively, and EMB1 default parameter settings for bypass operation. If the drive is reinitialized, be sure that these settings are maintained or reset for proper bypass operation.

See the mechanical layout diagram inside the cover of the unit for connector locations within the unit.

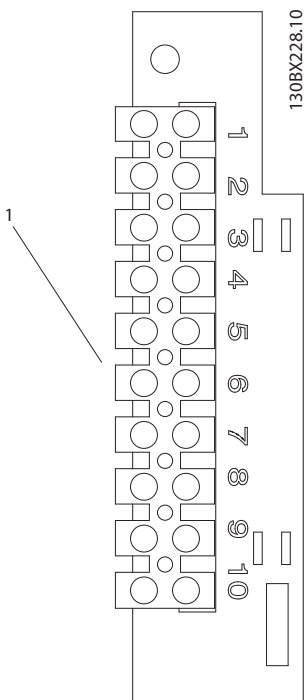


Figure 5.3 EMB(0) Control Connector

1	Terminal TB1
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Table 5.5 Legend to Figure 5.3

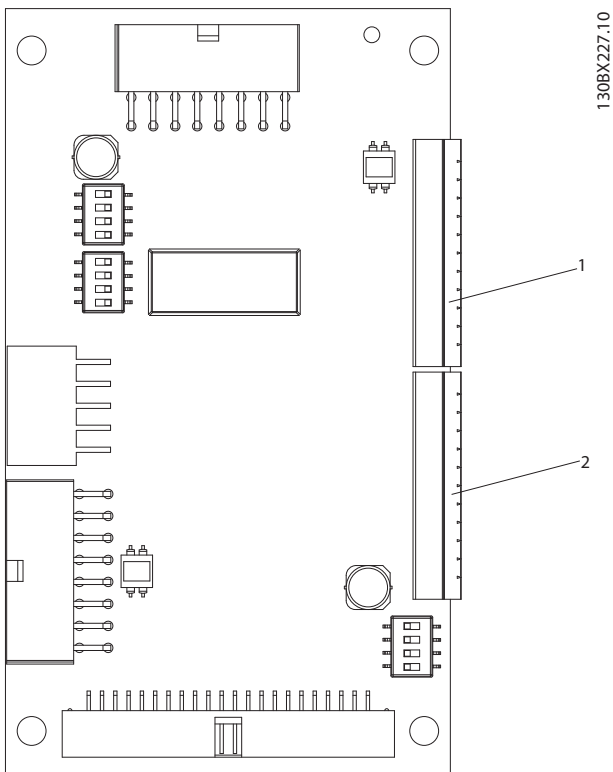


Figure 5.4 EMB1 Control Card

1	Terminal X55
2	Terminal X56

Table 5.6 Legend to Figure 5.4

Conn.	Term.	Input/Output	Type	Function
TB1	1	Input	Normally closed, dry relay contact	Safety input, open to stop
	2	Input		
	3	Common	Not for customer use	Not for customer use
	4	Output	Normally open, dry aux contact	Closed when panel is in drive mode
	5	Output		
	6	Output	Normally open, dry aux contact	Closed when panel is in Bypass Mode
	7	Output		
	8	Input	Normally open, dry contact	CMS Motor 1, close to select
	9	CMS Common	Normally open, dry contact	CMS common
	10	Input	Normally open, dry contact	CMS Motor 2, close to select

Table 5.7 EMB(0) Terminal Functions

Conn.	Term.	Input/Output	Type	Function
X55	1	NA		
	2	NA		
	3	Input	Normally open, dry relay contact	Closed for remote run with common run/stop, close to run
	4	Input		
	5	Input	Normally closed, dry relay contact	Safety input, open to stop
	6	Input		
	7	NA		
	8	NA		
	9	NA		
	10	NA		
	11	Output	Normally open, dry relay contact	Closed indicates Motor 1 selected
	12	Output		
Conn.	Term.	Input/Output	Type	Function
X56	1	Output	Normally open, dry relay contact	Closed indicates Motor 2 selected
	2	Output		
	3	Output	Normally open, dry relay contact	Closed when panel is in Drive Mode
	4	Output		
	5	Output	Normally open, dry relay contact	Closed when panel is in Bypass Mode
	6	Output		
	7	NA		
	8	NA		
	9	NA		
	10	Input	Normally open, dry contact	CMS Motor 2, close to select
	11	Input	Normally open, dry contact	CMS common
	12	Input	Normally open, dry contact	CMS Motor 1, close to select

Table 5.8 EMB1 Terminal Functions

Drive terminal	Parameter	Value number	Value name	Function
18	5-10 Terminal 18 Digital Input	8	Start	Common run/stop
27	5-00 Digital I/O Mode	0	PNP	External Interlock
27	5-01 Terminal 27 Mode	0	Input	External Interlock
27	5-12 Terminal 27 Digital Input	7	External Interlock	External Interlock

Table 5.9 EMB1 Parameter Settings

## 5.1.2 EMB Auto Bypass

### General information

Auto bypass allows a fault condition in the drive to activate running the motor in bypass without operator intervention. Activation of the function is through setting DIP switches (S103) located on the EMB2 bypass control card (see *Figure 5.2*). A fault condition enables a delay timer before tripping the drive into bypass. The fault trip and running in bypass are reported as output from the bypass control card. The auto bypass function is built-in.

### Before enabling auto bypass

- Complete the start-up procedure to verify motor rotation direction in bypass is correct and that the system is ready in all respects for continuous full speed operation in bypass.

### **WARNING**

#### HIGH VOLTAGE!

**REMOVE POWER TO BYPASS PANEL BEFORE SETTING AUTO BYPASS DIP SWITCH SETTINGS. BYPASS CAN CONTAIN HIGH VOLTAGE. FAILURE TO REMOVE POWER TO BYPASS PANEL BEFORE SETTING DIP SWITCHES COULD RESULT IN DEATH OR SERIOUS INJURY.**

### Operation

- With the bypass selector switch in drive and auto bypass enabled, a fault signal from the drive will activate the auto bypass timer.
- If the fault clears before the time delay is complete, the motor remains operating in drive mode. This allows temporary faults, such as a momentary under or over voltage, to clear without transferring the system to bypass.
- If the timer completes its cycle before the fault clears, the panel trips into bypass mode and the motor runs at constant full speed from line input voltage.
- In bypass, the motor will stop if safety or motor overload conditions are exceeded.
- Once auto bypass is activated, the only way to reset the unit back to drive is by operator intervention. Ensure that the fault has been cleared, then rotate the bypass switch to the OFF position momentarily before setting it back to the drive position. This resets the drive and fault timer.

### Auto bypass function setup

Enable auto bypass by closing one or more DIP switches on switch S103 located on the bypass control card. (Times are approximate.)

- All OFF = no auto bypass operation
- 1-3 ON = 15 s delay (minimum)
- Switch 1 only ON = 30 sec. delay
- Switch 2 only ON = 60 sec. delay
- Switch 3 only ON = 300 sec. delay (maximum)
- Switch 4 = Always OFF

## 5.1.3 EMB Common Run/Stop

### General Information

The common run/stop function provides remote run and stop control of the motor(s) in bypass. Without common run/stop, the motor would automatically run at full speed whenever the bypass is activated. The remote signal provides drive control as well as bypass control, making this one input common to both. Common run/stop is enabled by factory default. When used with the run permissive function, common run/stop permits run request operation in bypass.

### Before Enabling Common Run/Stop

- Complete the start-up procedure to verify motor rotation direction in bypass is correct and that the system is ready in all respects for continuous full speed operation in bypass.

### Operation

- A user supplied remote start command wired to connector X55, terminals 3 and 4 initiates remote bypass operation. With common run/ stop, bypass mode cannot be activated by hand on the LCP or by serial communication.

### Common Run/Stop Setup

- Wire input terminals 3 and 4 on connector X55 per the system application.

### To Disable Common Run/Stop

- Common run/stop is enabled by factory default when ordered.
- To disable the feature, jumper terminals 3 and 4 on connector X55. This allows the bypass to start when the bypass switch is placed in the bypass position.
- Remove red wire from terminal 18 of the drive control terminal and insulate the end of the wire to prevent shorting. This is required or the drive will always have a run command.
- If applicable, connect remote run/stop input to terminals 12 and 18 in the drive.

### 5.1.4 EMB Run Permissive

#### General information

Run permissive allows a remote signal to notify the drive to start, indicating the system is safe to operate. Run permissive works in drive or bypass mode. Run permissive is disabled by factory default when ordered by a jumper wire on connector X58 between terminals 1 and 2.

#### Before enabling run permissive

- Complete the start-up procedure to verify motor rotation direction in bypass is correct and that the system is ready in all respects for continuous full speed operation in bypass.
- Verify that the drive is programmed for the run permissive function. See the drive support materials for programming the run permissive function.

#### Operation

- A start command can be from local hand start on the LCP or a remote auto start signal through digital input connector X55, terminals 3 and 4, or the serial communications input.
- In response to a start command, an output request is sent from X58 terminals 1 and 2 to the external equipment (to activate a valve or damper, for example).
- When a return run signal on X55 terminals 1 and 2 is received, the motor is started in either drive or bypass mode, depending upon the bypass switch position.

#### Run permissive function setup

- Remove factory-installed jumper wire on connector X55, terminals 1 and 2.
- Wire the output run request to connector X58, terminals 1 and 2.
- Wire the input run permission to connector X55, terminals 1 and 2 per the system application.

#### Disable run permissive

- Run permissive is enabled by factory default when ordered.
- To disable the run permissive function, jumper between terminals 1 and 2 on connector X55.

### 5.1.5 EMB Overload

#### General information

The overload device provides overcurrent protection for the motor when running in bypass. The thermally activated overload monitors motor current and trips to remove power to the motor if a sustained overcurrent condition exists. A Class 20 overload is standard with a variable setting for motor current. Test and reset buttons are also provided. In drive mode, the drive provides current sensing and trip protection. Fuses provide quick action for high over current conditions.

#### Before enabling overload

- Verify that the overload current dial setting matches the motor FLA rating on the motor nameplate.
- If the motor FLA is greater or less than range of the current dial, reconfirm that the motor hp and voltage are within the option panel (and drive) rating. If less than the FLA rating, replace the overload with the correct size. If greater than the FLA rating, replace the panel with one of a proper rating.

#### **CAUTION**

**MOTOR DAMAGE!**  
**REPEATED ATTEMPTS TO RESET OVERLOAD CAN CAUSE MOTOR DAMAGE. CORRECT OVERLOAD CONDITION AND LET OVERLOAD AND MOTOR RETURN TO NORMAL OPERATING TEMPERATURE BEFORE RESETTING. SEE MOTOR MANUFACTURER'S RECOMMENDATIONS FOR TIME BETWEEN START ATTEMPTS. FAILURE TO CORRECT OVERLOAD CONDITION AND LET MOTOR RETURN TO NORMAL OPERATING TEMPERATURE COULD CAUSE MOTOR DAMAGE.**

#### Operation

Overloads are rated by class. The class is defined by the NEC to determine the maximum time to trip. A Class 20 overload, for example, has a typical trip delay of 20 s or less at 600% current and normal operating temperature. This allows for high motor inrush current for 20 s while the motor is ramping up to synchronous speed. The trip time, however, is based on the percentage of overload. The higher the overload, the shorter the trip time. It is important that the overload class not exceed the motor class rating or motor damage could occur. For dual motor operation, an overload is provided for each motor. For contact motor select, one overload is provided and monitors either motor when selected.

### Overload function setup

- Set the overload current dial to the FLA of the motor. DO NOT add the service factor of the motor into the setting. A service factor of 120% for Class 20 is designed into the overload.
- Pressing the test pushbutton verifies the operation of the overload. The overload should trip when pressed. Use the reset pushbutton to reset the overload after test.
- Reset is used to reset the overload after it trips. If the overload is still hot, wait until the motor reaches normal operating temperature before resetting. The overload offers a manual (hand) or auto reset selection. It is highly recommended to operate in the manual factory setting to prevent the risk of damage to the motor.

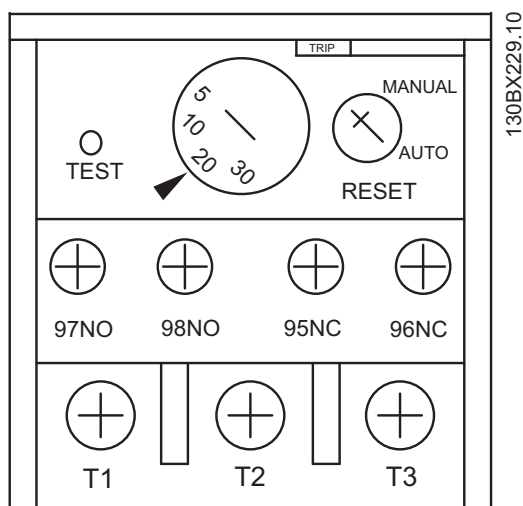


Figure 5.5 Sample Overload Device

### 5.1.6 EMB Safety Interlock

#### General information

The safety interlock feature prevents the drive or bypass from operating. For operation in drive or bypass, the safety interlock input contact must be closed. Only a fire mode command to run in bypass overrides this function. Safety inputs include, but are not limited to, high and low pressure limit switches, fire alarm, smoke alarm, high and low temperature switches, and vibration sensors.

#### Operation

When an external safety input closes, the option panel is in operational mode. When open, power is interrupted to all contactors and relays and the bypass ignores all run commands except for fire mode operation, when enabled. When power is interrupted in drive mode, the drive display indicates an external fault, meaning the problem is external to the drive. In some instances, a fault can be

caused by a failure within the option panel, which will still be reported as an external fault from the drive. A factory installed jumper allows the unit to operate when no safety input is connected. This jumper must be removed when connecting in a safety interlock circuit.

#### Safety interlock function setup

- For EMB1 and EMB2, remove factory-installed jumper between terminals 5 and 6 on connector X55.
- Wire safety input to terminals 5 and 6 on connector X55.
- For EMB(0), wire safety input to connector TB1, terminals 1 and 2.

### 5.1.7 EMB Fire Mode

#### General Information

The fire mode function is built-in. Fire mode runs the motor at full speed in bypass and is intended to ignore common safety, overload, and bypass switch inputs in emergency situations. The motor will continue to run in bypass until fire mode is removed or the unit fails.

#### Before enabling fire mode

- Complete the start-up procedure to verify motor rotation direction in bypass is correct and that the system is ready in all respects for continuous full speed operation in bypass.

#### Operation

- Activation of fire mode is accomplished by closing connector X55, input terminals 7 and 8.
- When activated, a relay overrides the safety circuit, motor overload, and bypass switch (SW1) position.
- Fire mode is deactivated only when removed or fuses blow.
- Fire mode status can be reported through connector X55, terminals 9 and 10, a normally open dry contact that closes when fire mode is active.

#### Fire mode function setup

- Wire fire mode input to connector X55, terminals 7 and 8.
- Wire fire mode status output to connector X55, terminals 9 and 10.

### 5.1.8 EMB Fault Reporting

#### General information

A fault indication is provided if the drive experiences a fault or bypass input power is lost. The EMB2 bypass control card monitors the drive fault output for status reporting. The fault contacts are fail-safe, meaning that if power is removed a fault condition is automatically reported. Fault status is not monitored in bypass operation.

#### Operation

For the EMB2, fault reporting is monitored through a Form-C relay (RL2) on the bypass control board. The relay reports a fault on connector X56 terminals 7, 8, and 9. In normal operation, the relay is powered and terminal 7 is closed with terminal 9 open. In a fault condition, power to the relay is lost and the relay positions automatically reverse, signaling the fault condition. Terminal 8 is the common to both. For the EMB(0) or EMB1, drive terminals 1 (common), 2 and 3 report faults with 2 open and 3 closed in the fault condition.

#### Fault reporting function setup

- For EMB2, fault reporting status is connected to connector X56, output terminals 7, 8, and 9.
- For EMB(0) or EMB1, fault reporting status is connected to drive output terminals 1, 2, and 3.

### 5.1.9 EMB Switches

#### Bypass selector switch

The bypass selector switch is used for either the 2-contactor or 3-contactor bypass.

- **2-contactor bypass**  
A panelmounted Drive/OFF/Bypass selector switch is used to electrically select whether the motor is driven by the drive (M2 contactor), connected to the full-speed bypass (M3 contactor), or disconnected from both. See *Figure 5.6*.
- **3-contactor bypass**  
A panelmounted Drive/OFF/Bypass/Test selector switch is used to electrically select whether the motor is controlled by the drive (M1 and M2 contactors), connected to the full-speed bypass (M3 contactor), or disconnected from both. The test position allows for operation in bypass while still providing power to the drive (M1 and M3). See *Figure 5.6*.

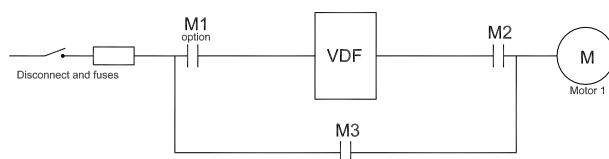


Figure 5.6 Basic 3-contactor Bypass Functions

# 6 Electronically Controlled Bypass (ECB) Operation

## 6.1.1 Overview

Information provided in this section is intended to enable the user to connect control wiring, program functions, and operate the ECB and its optional features.

The ECB contains a local processor located on the ECB control card which interacts with the drive's control logic for programmable options, remote command input, and output status reporting. Rather than panel-mounted operator-activated selector switches, as on the electromechanical option panel, ECB control is provided by the drive's processor.

The ECB also contains a power supply which provides back up for the drive's logic circuitry, so even if the drive loses power, the control and communication functions are maintained.

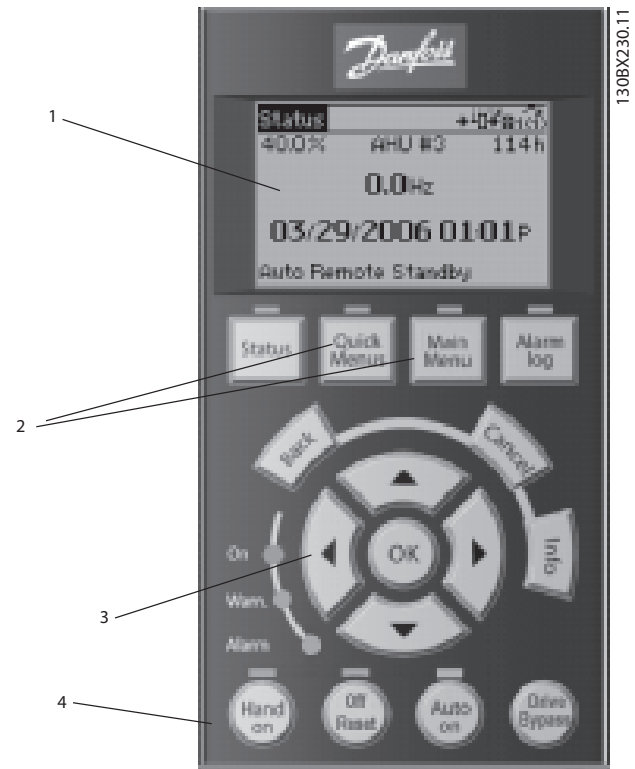


Figure 6.1 Local Control Panel (LCP)

1	LCP display
2	Menu keys
3	Menu navigation
4	Control keys

Table 6.1 Legend to Figure 6.1

Programming and display are provided by the drive's local control panel (LCP). See Figure 6.1. An important feature of the ECB is the ability to accept commands from a building automation system (BAS) and to report operational status in return.

Control wiring connections are made to either the drive's control terminals (see Figure 6.2) or terminals provided on the ECB control card (see Figure 6.2). Drive analog and digital I/O terminals are multifunctional and need to be programmed for their intended use while the terminals on the ECB control card are dedicated for specific functions.

Programming options for drive terminals are seen by pressing [Main Menu] or [Quick Menu] on the LCP. Parameter menus appear in the LCP display. The arrow



keys are used for navigating through the parameter lists.  
Terminal functions are programmed in parameter group 5-

\*\* *Digital In/Out*. (See Table 6.2 for factory default  
parameter settings for drives with an ECB). Bypass  
functions are programmed in parameter group 31-.\*\*

*Bypass Option* (see 6.1.7 *ECB Mode of Operation*). See the  
drive's supporting materials for detailed programming  
instructions.

Parameter	Setting title	Setting	Function
5-01 Terminal 27 Mode	Input	0	Customer Interlock
5-02 Terminal 29 Mode	Output	1	Auto bypass
5-10 Terminal 18 Digital Input	Start	8	Common run/stop
5-11 Terminal 19 Digital Input	Run Permissive	52	Run Permissive
5-12 Terminal 27 Digital Input	External Interlock	7	Customer Interlock
5-31 Terminal 29 Digital Output	No Alarm	160	Auto bypass
5-40 Function Relay (0)	Start Command Active	167	Run Permissive
5-40 Function Relay (0)	Off Delay	0.00 S	Run Permissive

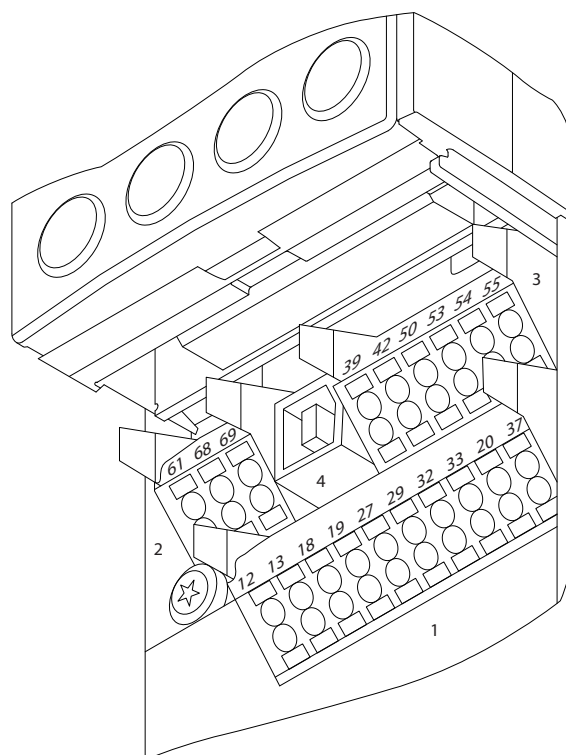
Table 6.2 Parameter Group 5-\*\* *Digital In/Out* Factory Default Settings

## 6.1.2 Drive Control Terminals

Definitions of the drive terminals are summarized in Table 6.3. Figure 6.2 shows the removable drive connectors and terminals.

- Connector 1 provides four digital inputs, two selectable digital inputs or outputs, 24 V DC terminal supply voltage, and a common for optional customer supplied 24 V DC voltage.
- Serial communications use EIA-485 connector 2 with terminal 68 (+) and 69 (-).
- Connector 3 provides two analog inputs, one analog output, 10 V DC supply voltage, and commons for the inputs and output.
- A USB port, connector 4, is also available for use with the MCT 10 Set-up Software available on the Danfoss website.
- Also provided are two Form C relay outputs that are in various locations depending upon the drive configuration and size.

See the drive support materials for detailed instructions.



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Figure 6.2 Drive Control Terminals

Terminal No.	Function
01, 02, 03, 04, 05, 06	Form-C relay output. Useable for AC or DC voltage and resistive or inductive loads. See drive support materials for details on voltage and current ratings and relay location.
12, 13	24 V DC digital supply voltage. Useable for digital inputs and external transducers. To use the 24 V DC for digital input common, program 5-00 Digital I/O Mode for PNP operation. Maximum output current is 200 mA total for all 24 V loads.
18, 19, 32, 33	Digital inputs. Selectable for NPN or PNP function in 5-00 Digital I/O Mode . Default is PNP.
27, 29	Digital inputs or outputs. Programmable for either. 5-01 Terminal 27 Mode for terminal 27 and 5-02 Terminal 29 Mode for 29 selects input/output function. Default setting is input.
20	Common for digital inputs. To use for digital input common, program 5-00 Digital I/O Mode for NPN operation.
39	Common for analog output.
42	Analog output. Programmable for various functions in parameter group 6-5* Analog Output 42. The analog signal is 0 to 20 mA or 4 to 20 mA at a maximum of 500 Ω.
50	10 V DC analog supply voltage. 15 mA maximum commonly used for a potentiometer or thermistor.
53, 54	Analog input. Selectable for voltage (0-10 V) or current (0- or 4-20 mA). Closed is for current and open is for voltage. Switches are located on the drive control card behind the removable LCP. See drive support materials for details.
55	Common for analog inputs.
61	Common for serial communication. Do not use to terminate shields. See drive support materials for proper shield termination.
68 (+), 69 (-)	RS-485 interface. When the drive is connected to an RS-485 serial communication bus, a drive control card switch is provided for termination resistance. ON for termination and OFF for no termination. See drive support materials for details.

Table 6.3 Drive Control Terminals Functions

### 6.1.3 ECB Control Card

The ECB control card (see *Figure 6.3*) provides input connector X57 for commanding bypass operation remotely and output connector X59 for reporting the bypass mode of operation, either drive mode or running in bypass.

See *Table 6.5* for ECB control card terminal types and functions.

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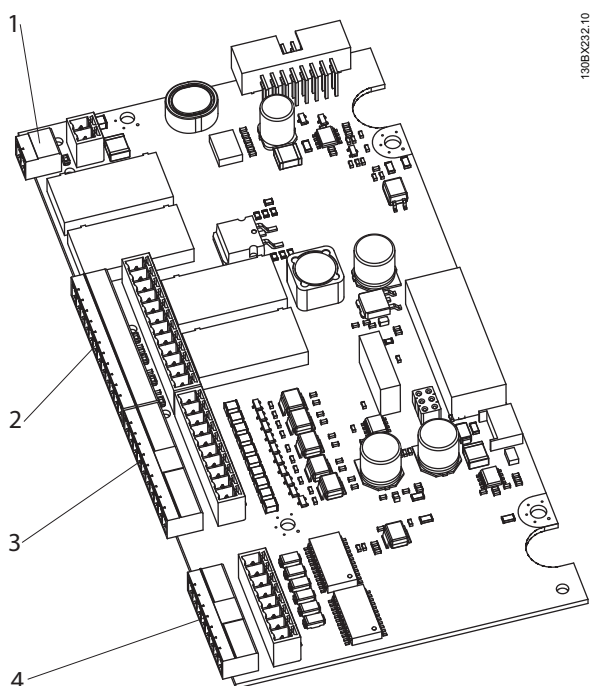


Figure 6.3 ECB Control Card

1	Terminal X58
2	Terminal X56
3	Terminal X57
4	Terminal X59

Table 6.4 Legend to *Figure 6.3*

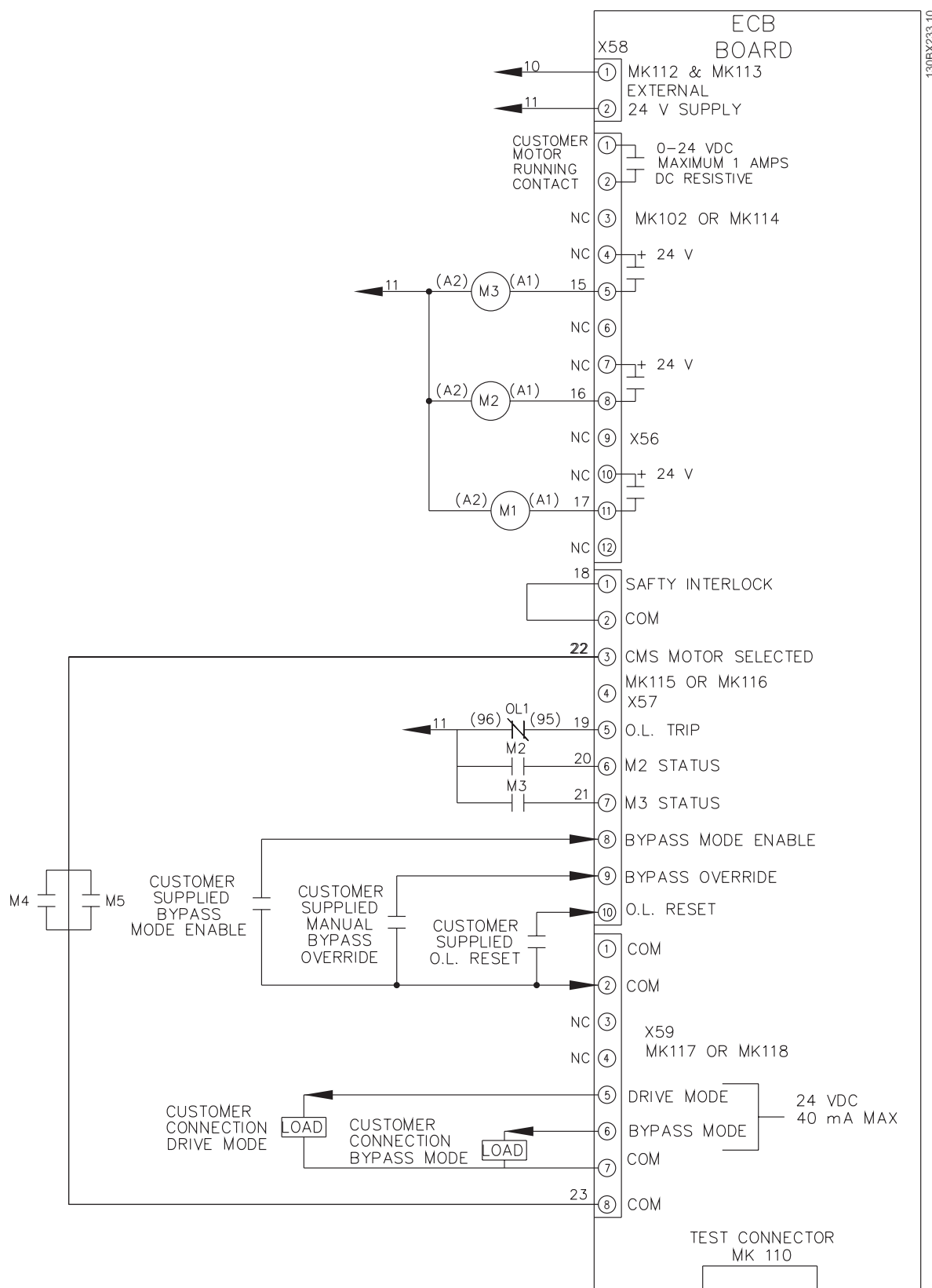


Figure 6.4 ECB Control Card Terminal Connections

Input Conn.	Term.	Function	Type
X57	1	Digital input for safety stop	User supplied dry contact
	2	Common	User supplied dry contact
	3	Factory use only	
	4	No function	
	5	Factory use only	
	6	Factory use only	
	7	Factory use only	
	8	Digital input for remote bypass enable	User supplied dry contact
	9	Digital input overrides system to Bypass Mode ignoring all other inputs and commands, except for safety stop on terminal 1.	User supplied dry contact
	10	Digital input for remote overload reset	User supplied dry contact
Output Conn.	Term.	Function	
X59	1	Common for binary I/O	
	2	Common for binary I/O	
	3	No function	
	4	No function	
	5	Digital output indicates panel is in Drive Mode.	24 V DC digital output
	6	Digital output indicates panel is in Bypass Mode	24 V DC digital output
	7	Common for binary I/O	
	8	Common for binary I/O	
Relay Output	Term.	Function	
X56	1	N.O. contact for running in bypass or drive	Relay output for user
	2	N.O. contact for running in bypass or drive	Relay output for user
	3-12	Factory use only	

Table 6.5 ECB Card Terminals

6.1.4 ECB Drive or Bypass Selection

Use the LCP to switch between the motor running in drive mode or bypass when operating in local control. The display in operating mode is shown in *Figure 6.5*.

1. Press [Drive Bypass]. Display changes to show bypass and drive mode options (shown in Step 2).



Figure 6.5 LCP in Operating Mode

1	Display
2	Info key
3	Drive/Bypass Option Key

Table 6.6 Legend to Figure 6.5

2. When running in drive mode, press [OK] on LCP to activate bypass mode or press [Cancel] to remain in drive mode. In bypass, motor will run at full speed.

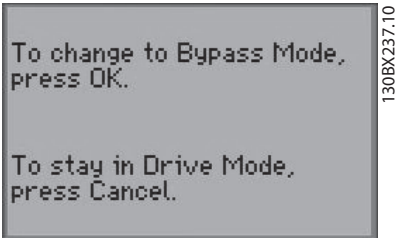


Figure 6.6

3. When running in bypass mode, press [OK] key on keypad to activate drive mode or press [Cancel] to remain in bypass mode.

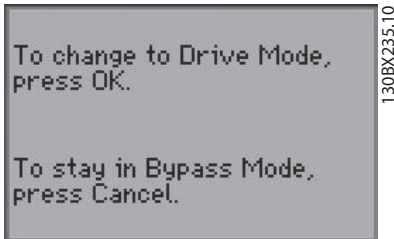


Figure 6.7

4. Press [Status] to return to drive status display.



Figure 6.8

## NOTE!

Pressing [Info] at any time displays tips and guidelines for performing the function currently activated.

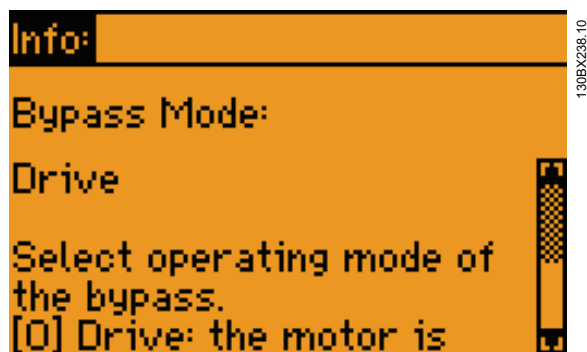


Figure 6.9

### 6.1.5 ECB Programming

Use the LCP for programming ECB functional options. All programming options appear in numbered parameters. Parameters are arranged in groups by related functions. Programming is performed by accessing the parameters through a menu and selecting from displayed options or entering numerical values. See the drives' supporting materials for detailed programming instructions.

Access parameters to program bypass functions in accordance with the following instructions.

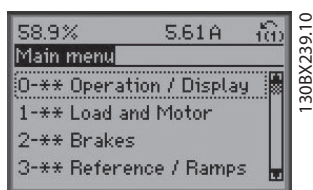


Figure 6.10

1. Press [Main Menu] to access parameter groups.

## NOTE!

Memory function of menu returns to last used function. Use [Back] to return to main menu index.



Figure 6.11

2. Press [▲] or [▼] to scroll through parameter groups. Dotted outline surrounds selected group. Bypass options are found in parameter group 31-  
\*\* *Bypass Option*.
3. Press [OK] to enter selected parameter group
4. Use [▲] or [▼] to scroll through parameter list.

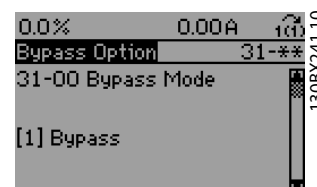


Figure 6.12

5. Press [OK] again to enter programming mode which allows changing parameter options or data. Option is inverse highlighted.
6. Use [▲] or [▼] to scroll through programmable options.
7. Press [OK] again to activate selection or [Cancel] to cancel.

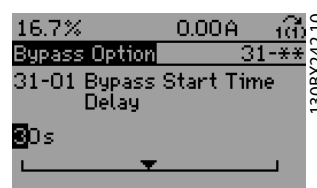


Figure 6.13

8. For entering numeric values, use [◀] or [▶] to select numeric digit, then use [▲] or [▼] to scroll through digit numbers 0-9. Selected digit is inverse highlighted.
9. Press [OK] to activate selection or [Cancel] to cancel.
10. Press [Status] to return to operational display data or [Back] to return to parameter menu options.

## 6.1.6 ECB Hand/Off/Auto

### General information

The [Hand On], [Off Reset], and [Auto On] keys on LCP control both the drive and bypass (see *Figure 6.1*). [Drive Bypass] allows the user to locally select drive or bypass mode of operation. It does not necessarily start or stop the motor.

### Before enabling Hand/Off/Auto

- Complete the start-up procedure to verify motor rotation direction in bypass is correct and that the system is ready in all respects for continuous full speed operation in bypass.

### Programming key functions

For the [Off Reset] and [Drive Bypass] keys, *Table 6.7* lists the parameters that select functions for the control keys. A password protection can also be assigned in these parameters.

### Operation

- [Hand On] allows the user to start the motor locally from the LCP. Press [Hand On] to start the motor locally either in drive or bypass mode.
- [Off Reset] allows the user to stop the motor locally from the LCP. Press [Off Reset] to stop the motor locally, either in drive or bypass mode.
- [Auto On] allows the motor to be started remotely from digital input or serial communications. Press [Auto On] to activate remote motor start and stop from a digital input or serial communications in drive or bypass mode.
- Press [Drive Bypass] to initiate the display to toggle between drive or bypass mode of operation. Press [OK] to accept the change or [Cancel] to cancel the action.

Parameter	Function
0-44 [Off/Reset] Key on LCP	This disables or enables the [Off/Reset] key. [0] Disabled, [1] Enabled, [2] Password. Default value is [1] Enabled.
0-45 [Drive Bypass] Key on LCP	This disables or enables the [Drive Bypass] key. [0] Disabled, [1] Enabled, [2] Password. Default value is [1] Enabled.

Table 6.7 LCP Control Keys Programming

## 6.1.7 ECB Mode of Operation

### General information

The ECB has four modes of operation: drive, bypass, auto bypass, and test. The mode is selected through the LCP and display. Bypass mode select can be accessed directly by pressing [Drive Bypass] on the keypad.

### Before enabling mode of operation

- Complete the start-up procedure and verify motor rotation direction in bypass is correct and that the system is ready in all respects for continuous full speed operation in bypass.
- Press [Off Reset] on the LCP to prevent operation of the motor.

### Operation

#### Drive mode

The motor is connected to and controlled by the drive. Contactors M1 (optional) and M2 are closed while contactor M3 is open. (Contactor M1 for test mode is only present in the 3-contactor configuration.) The motor will not run until a run command is present.

#### Bypass mode

The motor operates at full speed across the line when a run command is present. Contactor M3 is closed and M1 (optional) and M2 are open.

#### Test mode

Test mode puts the panel into bypass mode and will automatically run in bypass. Contactor M1 is closed supplying power to the drive for test purposes while M2 is open. Contactor M3 controls the operation of the motor in bypass, closed to run the motor, open to remove power. The control keys on the LCP will not control the bypass until test mode is removed.

#### Auto bypass mode

When in drive mode, auto bypass is a timed interval that allows a fault condition in the drive to activate running the motor in bypass without operator intervention.

### Mode of operation select

- Mode of operation is programmed through parameter group 31-\*\* *Bypass Option*, see *Table 6.8*.



Parameter	Selection	Function
31-00 Bypass Mode	Bypass Mode	Selects source of motor power. (0) Drive (drive mode) (1) Bypass (bypass mode)
31-01 Bypass Start Time Delay	Bypass Start Time Delay	Sets a delay time for starting in bypass that allows for external actions to take place before line starting the motor. 0-60 s (default value is 5 s)
31-02 Bypass Trip Time Delay	Bypass Trip Time Delay	Setting a value other than 0 s enables auto bypass. Bypass trip delay sets the delay time before switching to bypass mode when the drive has a fault. 0-300 s (default is 0 s = OFF)
31-03 Test Mode Activation	Test Mode Activation	Setting to enabled puts bypass in test mode. See manual for warnings and cautions. (0) disabled (default value) (1) enabled
31-10 Bypass Status Word	Bypass Status Word	Read only display which shows the bypass status in hex. See next table for details. 0, 216-1 (default value is 0)
31-11 Bypass Running Hours	Bypass Running Hours	Read only display which shows bypass running hours.

Table 6.8 Bypass Parameter Functions

Bit	Description
0	<b>Test Mode</b> The Test Mode bit will be true when the ECB is in Test Mode.
1	<b>Drive Mode</b> The Drive Mode bit will be true when the ECB is in Drive Mode.
2	<b>Automatic Bypass Mode</b> The Automatic Bypass Mode bit will be true when the ECB is in Automatic Bypass Mode.
3	<b>Bypass Mode</b> The Bypass Mode bit will be true when the ECB is in Bypass Mode.
4	<b>Reserved</b> This bit is reserved for future use.
5	<b>Motor Running from Bypass/Drive</b> The Motor Running from Bypass/Drive Bit will be true when the motor is running from either the drive or the bypass.
6	<b>Overload Trip</b> The Overload Trip Bit will be true when the ECB detects an overload trip.
7	<b>M2 Contactor Fault</b> The Contactor Fault Bit will be true when an M2 Contactor Fault is detected.
8	<b>M3 Contactor Fault</b> The Contactor Fault Bit will be true when an M3 Contactor Fault is detected.
9	<b>External Interlock</b> The External Interlock Bit will be true when an External Interlock fault is detected.
10	<b>Manual Bypass Override</b> The Manual Bypass Override Bit will be true when the Manual Bypass Override input is true.

Table 6.9 31-10 Bypass Status Word Word Bit Definitions

## 6.1.8 Bypass Status Word Bit Examples

1. Motor running and bypass in drive mode. Status word 22 hexadecimal converts to 00000100010 binary.

Bit	10	9	8	7	6	5	4	3	2	1	0
Binary	0	0	0	0	0	1	0	0	0	1	0

Table 6.10

2. External interlock fault (open) and bypass in bypass mode. Status word 208 hexadecimal converts to 01000001000 binary.

Bit	10	9	8	7	6	5	4	3	2	1	0
Binary	0	1	0	0	0	0	0	1	0	0	0

Table 6.11

## 6.1.9 ECB Auto Bypass

### General information

Auto bypass allows a fault condition in the drive to activate running the motor in bypass without operator intervention. Activation of the function is through setting timer start parameters in the drive programming. Fault trip and running in bypass are reported through the drive display, digital outputs, and serial communications. In addition, the independently powered ECB card is available to report bypass status when the drive is inoperable (control card operative) through its serial communications or digital outputs.

### Before enabling auto bypass

- Complete the start-up procedure to verify motor rotation direction in bypass is correct and that the system is ready in all respects for continuous full speed operation in bypass.

### Operation

- With the auto bypass function enabled, a fault signal from the drive activates the auto bypass timer.
- If the fault clears before the time delay is complete, the motor remains operating in drive mode. This allows temporary faults, such as a momentary under or over voltage, to clear without transferring the system to bypass.
- If the timer completes its cycle before the fault clears, the panel trips into bypass mode and the motor runs at constant full speed from line input voltage.

- In bypass, the motor will stop:
  - if the drive receives a remote stop command
  - local stop ([Off]) on the LCP is pressed
  - a remote start command is removed
  - a safety is open
  - motor overload is tripped
- Once auto bypass is activated, the only way to reset the unit back to drive mode is by operator intervention. Ensure that the fault has been cleared, then press [Bypass] on the LCP and select drive mode.

### Auto bypass function setup

Enable auto bypass by changing parameters in parameter group 31-\*\* *Bypass Option* in the drive extended menu.

- *31-01 Bypass Start Time Delay.* Setting the timer at anything other than 0 time activates start delay in bypass. Leave at 30 s default or set as desired up to 60 s.
- *31-02 Bypass Trip Time Delay.* Setting the timer at anything other than 0 time activates auto bypass. Leave at 5 s default or set as desired up to 60 s.

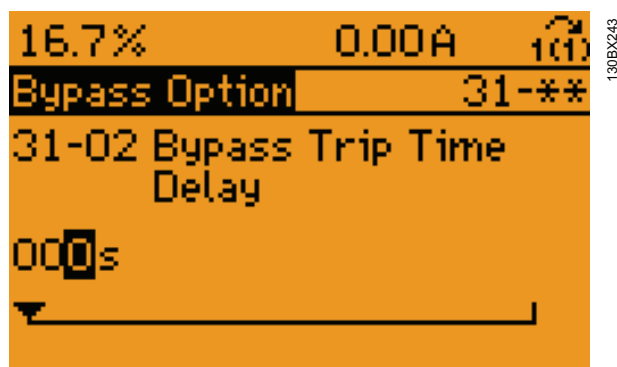


Figure 6.14 Bypass Trip Time Delay

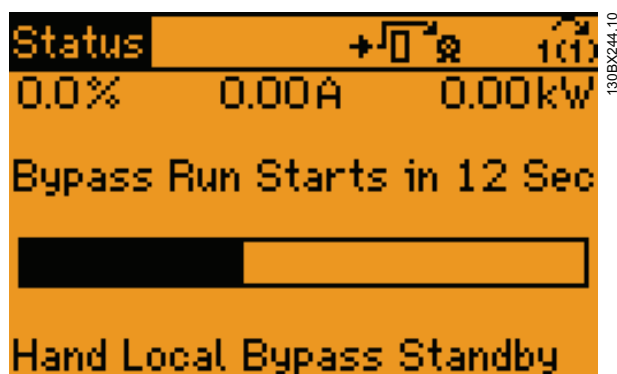


Figure 6.15 Drive Display with Bypass Start Time Delay Active

6

## 6.1.10 ECB Run Permissive

### General information

With run permissive active, the drive sends a run request and waits for a remote response to before notifying the motor to start. The response indicates the system is safe to operate. Run permissive operates from the LCP hand/off/auto select in drive or bypass mode. Run permissive is enabled by programming in the drive parameters.

### Before enabling run permissive

- Complete the start-up procedure to verify motor rotation direction in bypass is correct and that the system is ready in all respects for continuous full speed operation in bypass.
- Verify that the drive is programmed for the run permissive function. See the drive support materials for programming the run permissive function.

### Operation

- A start command can be initiated from local hand start, serial communications, or a remote auto start signal through digital drive input terminals.
- In response to the start command, an output request is sent from the programmable drive relay to the external equipment (to activate a valve or damper, for example).
- When a return run signal on the digital input is received, the motor is started in either drive or bypass, depending upon which mode is active.

### Run permissive function setup

- See the drive manual or support materials for programming and wiring to the drive control terminals.
- Wire the output run request to the drive output terminals selected, and program the terminals for run request.
- Wire the input run command to the drive input terminals selected, and program the terminals for run permissive.

### Disable run permissive

- Disable run permissive through the drive parameters and terminal programming.

## 6.1.11 ECB Overload

### General information

An overload device provides overcurrent protection for the motor when running in bypass. The thermally activated overload monitors motor current and trips to remove power to the motor if a sustained overcurrent condition exists. A Class 20 overload is standard with a variable setting for motor current. Test and reset buttons are also provided. In drive mode, the drive provides current sensing and trip protection. Fuses provide quick action for high over current conditions.

### Before enabling overload

- Verify that the overload current dial setting matches the motor FLA rating on the motor nameplate.
- If the motor FLA is greater or less than range of the current dial, reconfirm that the motor hp and voltage are within the option panel (and drive) rating. If less than the FLA rating, replace the overload with the correct size. If greater than the FLA rating, replace the panel with one of a proper rating.

## CAUTION

### MOTOR DAMAGE!

REPEATED ATTEMPTS TO RESET OVERLOAD CAN CAUSE MOTOR DAMAGE. CORRECT OVERLOAD CONDITION AND LET OVERLOAD AND MOTOR RETURN TO NORMAL OPERATING TEMPERATURE BEFORE RESETTNG. SEE MOTOR MANUFACTURER'S RECOMMENDATIONS FOR TIME BETWEEN START ATTEMPTS. FAILURE TO CORRECT OVERLOAD CONDITION AND LET MOTOR RETURN TO NORMAL OPERATING TEMPERATURE COULD CAUSE MOTOR DAMAGE.

### Operation

Overloads and motors are both rated by class. The class is defined by the NEC to determine the maximum time to trip. A Class 20 overload, for example, has a typical trip delay of 20 s or less at 600% current and normal operating temperature. This allows for high motor inrush current for 20 s while the motor is ramping up to synchronous speed. The trip time, however, is based on the percentage of overload. The higher the overload, the shorter the time.

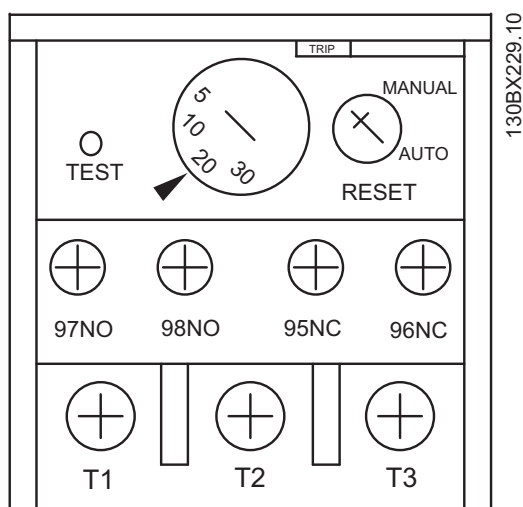


Figure 6.16 Sample Overload Device

### Overload function setup

- Set the overload current dial to the FLA of the motor. DO NOT add the service factor of the motor into the setting. A service factor of 1.2 x FLA is designed into the overload.
- Pressing the test pushbutton verifies the operation of the overload. The overload should trip when pressed. Use the reset pushbutton to reset the overload after test.
- Reset is used to reset the overload after it trips. If the overload is still hot, wait until the motor reaches normal operating temperature before

resetting. The overload offers a manual (hand) or auto reset selection. It is highly recommended to operate in the manual factory setting to prevent the risk of damage to the motor.

## 6.1.12 ECB Safety Interlock

### General information

The safety interlock feature prevents the drive or bypass from operating. Only a fire mode command to run overrides this function. For operation in drive or bypass mode, the safety external interlock input contact must be closed. External inputs include, but are not limited to, high and low pressure limit switches, fire alarm, smoke alarm, high and low temperature switches, and vibration sensors.

### Operation

When an external safety input closes on ECB terminals 1 and 2 on connector X57, the option panel is in operational mode. When open, power to the motor is disabled. The bypass ignores all run commands except for fire mode operation, when applicable. The drive display indicates alarm 221, bypass interlock, meaning the problem is external to the drive. A factory installed jumper between X57 terminals 1 and 2 allows the unit to operate when no safety input is connected. This jumper must be removed when connecting in a safety interlock circuit.

### Safety interlock function setup

- Remove factory-installed jumper between ECB connector X57 terminals 1 and 2 on drive control terminals.
- Wire safety input to connector X57 terminals 1 and 2.
- For technicians familiar with connecting to drive terminals 12 and 27 for safety interlock, be aware that ECB bypass operation will NOT stop with the external fault report. Use terminals 1 and 2 on connector X57, as indicated, for bypass control.

## 6.1.13 ECB Common Run/Stop

### General information

The common run/stop function provides remote run and stop control of the motor(s) while in either drive or bypass. Without common run/stop, the motor would automatically run at full speed whenever the bypass is activated. The remote signal provides drive control as well as bypass control, making this one input common to both. Common run/stop is enabled by factory default. When used with the run permissive function, common run/stop permits run request operation in bypass.

### Operation

A user supplied remote run command wired to drive terminals 13 and 18 initiates remote drive or bypass operation. Common run/stop can also be activated by hand on the LCP or through serial communication. Operation in either drive or bypass is determined by drive or bypass mode selection, not the run/stop command.

### Before enabling common run/stop

- Complete the start-up procedure to verify motor rotation direction in bypass is correct and that the system is ready in all respects for continuous full speed operation in bypass.

### Common run/stop setup

- Wire a remote run/stop to drive input terminals 13 and 18 (default run input). Ensure that parameter 18 is programmed for run (default setting).

## 6.1.14 ECB Advanced Fire Mode

### General information

Drive operation in advanced fire mode is programmable. In the event the drive does not function, the motor is operated in bypass at full speed. Fire mode is intended to ignore common safety and overload inputs in emergency situations. The fire mode function is built-in. See the drive support materials for programmable options.

### Before enabling Fire Mode

- Complete the start-up procedure to verify motor rotation direction in bypass is correct and that the system is ready in all respects for continuous full speed operation in bypass.
- Verify that the drive is programmed for the fire mode function. See the drive support materials for programming the fire mode function.

### Operation

- Activation of fire mode is accomplished by programming the drive for fire mode.
- When activated, the ECB ignores safety circuits and motor overload.
- Fire mode is deactivated only when removed or fuses blow.
- Fire mode status can be reported through serial communications or drive output.

### Fire Mode function setup

- Program drive for fire mode.
- If required, program a drive output for fire mode status.
- See the drive support materials for programming the fire mode function.

## 6.1.15 ECB Fault Reporting

### General information

The ECB monitors bypass contactors M2 and M3 and reports failures to the drive for display and external reporting. The drive also monitors the ECB card for bypass communication errors.

### Operation

ECB detected faults are reported by the drive in three ways: warnings and alarms are displayed on the LCPdisplay, through serial communication, or through output relays. The drive provides a form-C fault relay on terminals 01, 02, and 03. The fault contacts are fail-safe, meaning that if power is removed the contacts close and a fault condition is reported.

The drive monitors the ECB card communication and detects when communication stops. An ECB card failure or communication error could cause this. Contact Danfoss for technical support if this happens.

### Fault reporting function setup

- Automatic function. No set up required.

## 7 Non-bypass Component Functions

### 7.1.1 Power Fusing

For all option panel power fuses, use the specified fuse or an equivalent replacement only. See the fuse ratings label on the inside cover of the unit for option panel fuse ratings.

#### Main fusing

Main fuses are located ahead of the drive and bypass. Main fuses are designed to protect the circuitry within the bypass panel but is not adequate to protect the drive. Main fuses are dual-element, time-delay types and mount inside the bypass enclosure.

#### Drive fusing

Drive fuses are located ahead of the drive and are a fast-acting type. Drive fuses are standard in two-contactor and three-contactor bypasses. A fuse/disconnect enclosure may be used if no options other than a fuse block and disconnect switch are required.

#### 100,000 amp SCCR

The option panel is at least 5,000 amps short-circuit current rating (SCCR). An additional 100,000 amp SCCR is available as an option. See the panel label for SCCR rating.

### 7.1.2 Reactors

#### Input line reactor

This is a 3-phase reactor, mounted on the input to the option panel. This lowpass reactor adds 3% impedance on the line input. The impedance filters noise from the line input to the drive along with the return drive noise on the line. It is not in operation when running across the line.

#### Output dU/dt filter

This is a 3-phase reactor/capacitor-resistor combination. Mounted in series with the output of the drive, it functions to reduce the magnitude of voltage spikes related to PWM wave forms generated by the drive. It allows the use of longer motor leads and reduces insulation stress on motors without interphase insulation. It is not connected to the motor when running across the line.

### 7.1.3 Disconnects

#### Main disconnect

The main disconnect removes line input power to the drive and option panel. A main disconnect is available in four options.

- **Fused disconnect**  
Two-position (ON/OFF) rotary switch, padlock compatible, with three fuses, one on each phase, built into the switch. For safety, the switch must be in the OFF position before the option panel door can be opened or fuses removed.
- **Disconnect with fuses**  
Two-position (ON/OFF) rotary switch, padlock compatible, with a fuse block mounted separately from the disconnect. Three fuses, one on each phase, are located on the fuse block. For safety, the switch must be in the OFF position before the option panel door can be opened.
- **Main circuit breaker**  
A thermal/magnetic current interrupt device using an ON/TRIP/OFF/RESET switch. When in the ON position, a high current fault removes power from the drive/option panel circuit and the switch moves to the TRIP setting. It must be moved to the RESET position momentarily after the fault has been cleared to reset the circuit breaker.
- **Disconnect without fuses**  
For user-supplied fuses option.

#### Drive disconnect

Two-position (ON/OFF) rotary switch disconnects main AC line input power to the drive only.

### 7.1.4 Motor Options

The drive with bypass has three motor combination options available for drive control or for running in bypass: single motor, dual motor, or contact motor select.

#### Single Motor Option

##### General information

The single motor option is when a drive is running one motor or the motor is operating in bypass mode. The drive and motor are normally the same hp. The FLA of the motor must be less than or equal to the maximum output current of the drive.

### Before enabling single motor operation

- Complete the start-up procedure to verify motor rotation direction is correct and that the system is ready in all respects for continuous full speed operation in bypass.

#### Function

There are no special functions related to single motor option.

#### Dual motor option

##### General information

The dual motor option is available for one drive running two motors at the same time or both motors running in bypass. The motors may be of the same or different hp, but combined FLA of the motors must be equal to or less than the maximum output current of the drive.

### NOTE!

**The combined hp of the two motors is not appropriate for sizing the drive; use FLA.**

Both motors respond to drive commands or run at full output speed in bypass. Separate overloads are required since the drive does not monitor individual motor current but the total current draw.

### Before enabling dual motor operation

- Complete the start-up procedure to verify each motor rotation direction is correct and that the system is ready in all respects for continuous full speed operation in bypass.
- When using dual motors, see the drive support materials for any special requirements for running dual motors.

#### Function

For dual motor operation, a separate overload relay is connected to each motor overload. If either overload trips, both motors stop.

#### Contact motor select option

##### General information

The contactor motor select option is available for one drive alternating operation between two motors.

See 7.1.5 *Contact Motor Select* for details on this option.

## 7.1.5 Contactor Motor Select

#### General information

Contact motor select (CMS) is an option available for one drive alternating operation between two motors.

Contactor M4, M5, and switch SW2 are added in the option panel for this function. The motors must be of equal hp and current rating and match the drive rating (as

in single motor operation). Motor selection is made through a panelmounted selector switch (SW2), remotely through control wiring input, serial communications, or the drive's smart-logic controller. Status reporting is available to indicate which motor is in operation.

### Before enabling contactor motor select

- Complete the start-up procedure to verify the motor rotation direction is correct for both motors and that the system is ready in all respects for continuous operation.

#### Operation

- The panel mounted contactor motor select switch (SW2) has three positions: Motor 1/Auto/Motor 2. It is operated by hand for manual operation. The motor 1 position selects motor 1, and the motor 2 position selects motor 2.
- When SW2 is in the auto position, either motor can be selected remotely. (Do not close both contacts at once.)
- The drive's smart-logic controller can alternate motors when SW2 is in auto position. See the drive support materials for details.
- Serial communications commands can alternate motors when SW2 is in auto position. See the drive support materials for details.

#### Motor select status

- The EMB option panel reports the motor selected in either local or remote operation.

#### Contact motor select function setup

For EMB(0) or ECB, see the connection drawing supplied with the unit. For EMB1 or EMB2, make connections as follows.

- For remote control, connect control wiring to connector X56 terminals 11 and 12 for motor 1 operation and to terminals 11 and 10 for motor 2.
- For status reporting, wire to connector X55 terminals 11 and 12 for motor 1 select, and connector X56 terminals 1 and 2 for motor 2 select.

#### Contact motor select switch

This optional switch is provided for contact motor select available with the EMB option when two equally rated motors are operated by one drive. The panel mounted Motor 1/Auto/Motor 2 selector switch provides local control of motor 1 or 2 along with an auto setting that allows for remote motor selection.

## 8 Start Up Troubleshooting

### 8.1.1 Option Panel Alarm and Warnings

Code Number	Title	Definition
220	Overload Trip	Motor overload has tripped. Indicates excess motor load. Check motor and driven load. To reset, press [Off Reset]. Then, to restart the system, press [Auto on] or [Hand on].
221	Bypass Interlock	Bypass interlock has opened and caused the motor to stop. Correct the problem. Depending on the setting of <i>14-20 Reset Mode</i> , the system will either automatically reset this alarm or require pressing the [Off Reset].
222	M2 Open Failed	ECB: The contactor that connects the drive to the motor failed to open. The motor can not be operated.
223	M2 Close Failed	ECB: The contactor that connects the drive to the motor failed to close. The motor can not be operated.
224	M3 Open Failed	ECB: The contactor that connects the motor to the power line has failed to open.
226	M3 Close Failed	ECB: The contactor that connects the motor to the power line has failed to close. The motor can not be operated.
227	Bypass Com Error	Communication between the main control card and the bypass option has been lost. Motor control lost. It will be possible to run the motor using Manual Bypass Override.
228	APU Low Voltage	The Panel Power Supply has failed, or there is a power problem.
229	Motor Disconn.	Terminal 3 on connector X57 of the ECB control card shows an open. This generally means that neither motor has been selected in contactor motor select. Select a motor.

**Table 8.1 Panel Alarms and Warnings (ECB only)**

DisplayText	Definition
Bypass Run Starts in	Indicates the number of sec. until the motor will be started in bypass. This time delay can be adjusted using <i>31-01 Bypass Start Time Delay</i> .
Bypass Activates in	Indicates the number of sec. left until the system automatically activates Bypass Mode. Time delay can be adjusted using <i>31-02 Bypass Trip Time Delay</i> .

**Table 8.2 Panel Status Display (ECB only)**



Symptom	Possible cause	Test	Solution
No function	Missing input power	See startup guide for voltage checks.	Correct voltage at source.
	Missing or open fuses or circuit breaker tripped	See open fuses and tripped circuit breaker in this section for possible causes.	Reset circuit breaker. If fuses, check for opens with power removed from panel.
	Loose connections in panel	Perform pre-startup check for loose connections.	Tighten loose connections in the panel.
	Missing customer connections	Missing customer connections can cause the safety circuit or start signal to be open.	See customer connections and make sure all applicable connections are made or jumpers installed, especially customer interlock.
	Loose customer connections	Check all customer connections for tightness. Loose customer connections can act like an open circuit.	Tighten loose customer connections.
	Customer wires incorrectly terminated	See customer connection drawing and make sure wires are connected to correct terminals.	Correct any wrong connections. This could potentially cause damage to the panel.
	Improper voltage applied	See pre-startup check list.	Correct the voltage mismatch. This could potentially damage the panel. Use caution when applying power.
	Incorrect power connections	See pre-startup check list to see if motor and power leads were swapped.	Correct any wrong connections. This could potentially cause damage to the panel.
	Power disconnect open	Verify that the disconnect or circuit breaker is closed.	Correct any wrong connections. This could potentially cause damage to the panel.
	Operator switches off	Verify that operator devices are in operating position per startup procedures.	Set switches to the correct position.
	OL tripped	A tripped OL will disable the motor from running. Verify that OL relay is in the normal operating position per the manual.	Perform pre-startup checklist and set OL per instructions.
Open power fuses or circuit breaker trip	Improper voltage applied	See pre-startup check list and correct improper voltages.	Correct voltage mismatch. This could potentially damage the panel. Use caution when applying power.
	Incorrect power connections.	Motor and line voltages swapped. Make sure the line in and motor out are on the correct terminals. See pre-startup check list.	Correct any wrong connections. This could potentially cause damage to the panel.
	Power ground fault	Check motor and panel power wires to ground.	Eliminate any ground faults detected.
	Phase to phase short	Motor or panel has a short phase to phase. Check motor and panel phase to phase for shorts.	Eliminate any shorts detected.
	Motor overload	Motor is overloaded for the application.	Perform startup and verify motor current is within specifications. If motor current is exceeding nameplate FLA, reduce the load on the motor.
	Drive overload	Drive is overloaded for the application.	Perform startup and verify that drive current is within specifications. If not, reduce the load on the motor.
	Loose connections	Perform pre-startup check for loose connections.	Tighten loose connections.

Table 8.3 Fault Table

Symptom	Possible cause	Test	Solution
Repeated fuse or circuit breaker fault.	Application problem	Perform startup procedures. Check panel output motor current at full speed and check for excessive over current.	If current is too high, reduce the load on the motor.
	Panel problem	Perform startup procedures. Check panel input current at full load and verify it is within acceptable range.	If current is too high, reduce the load on the motor.
	Power problem	Monitor incoming power for surges, sags and overall quality.	Correct any problems found.
	Motor problem	Test motor for correct function.	Repair or replace motor if a problem is found.
Open control fuse	Improper voltage applied	See pre-startup check list.	Correct voltage mismatch. This could potentially damage the panel. Use caution when applying power.
	Customer wires incorrectly terminated	See the customer connection drawing and make sure the wires are connected to the correct terminals.	Correct any wrong connections. This could potentially cause damage to the panel.
	Control ground fault	Check all control wires for a short to ground.	Correct any ground faults found. This could potentially cause damage to the panel.
	Control short	Check control wires for a short in supply voltage.	Correct any shorts. This could potentially cause damage to the panel.
Open SMPS fuse	Improper voltage applied	See pre-startup check list.	Correct voltage mismatch. This could potentially damage the panel. Use caution when applying power.
	Customer wires incorrectly terminated	See the customer connection drawing and make sure the wires are connected to the correct terminals.	Correct any wrong connections. This could potentially cause damage to the panel.
	Control ground fault	Check all control wires for a short to ground.	Correct any ground faults found. This could potentially cause damage to the panel.
	Control short	Check control wires for a short in supply voltage.	Correct any shorts. This could potentially cause damage to the panel.
Motor rotation incorrect	Rotation incorrect in bypass, drive or both	Motor rotation is backwards in drive mode, bypass mode, or both.	Perform motor rotation procedure in 4 Start Up.

Table 8.4 Fault Table

Symptom	Possible cause	Test	Solution
Overload trips	Motor overloaded	Motor is drawing too much current for the application.	Perform startup and verify motor current is within specifications. If not, reduce the load on the motor.
	Loose connections	Look for signs of overheating on connections to OL.	Perform pre-startup check for loose connections and tighten. Replace any overheated components and wires.
	OL not set correctly	An improperly set OL can cause the OL to trip too soon. See pre-startup procedure for correct setting.	Set correct motor current on OL.
Contactor fails to pull in	Contamination	Remove contactor and check for contamination.	If contamination is found, repair or replace.
	Defective coil	Compare coil resistance to contactor specification. Inspect the coil for signs of overheating and damages.	If readings are not the same or if there are visible signs of damage, replace the coil or contactor.
	Auxiliary contact binding action	Remove auxiliary contacts and test contactor action.	If contactor operates with auxiliaries removed, replace auxiliary contacts.
Contactor fails to drop out	Contamination	Remove the contactor and check for contamination.	If contamination is found, repair or replace.
	Defective coil	Compare coil resistance to functional contactors of the same size.	If readings are not the same or there are visible signs of damage, replace the coil or contactor.
	Auxiliary contact binding action	Remove auxiliary contacts and test contactor action.	If the contactor operates with auxiliaries removed, replace auxiliary contacts.
Mains current imbalance greater than 3%	Problem with mains power	Rotate incoming power leads into option panel one position; A to B, B to C, and C to A.	If the imbalanced leg follows the wire, it is a power problem. Causes can vary. Contact an electrician or power expert for a solution.
	Problem with option panel	Rotate incoming power leads into option panel one position; A to B, B to C, and C to A.	If the imbalanced leg stays on the same option panel input terminal, it is a problem with the option panel. Contact the factory for assistance.
Motor current imbalance greater than 3%	Problem with motor or motor wiring	Rotate outgoing motor leads one position; U to V, V to W, and W to U.	If the imbalanced leg follows the motor lead, the problem is in the motor or wiring to the motor. Causes can vary. Contact an electrician or motor expert for a solution.
	Problem with option panel	Rotate outgoing motor leads one position; U to V, V to W, and W to U.	If the imbalanced leg stays on the same option panel output terminal, it is a problem with the option panel. Contact the factory for assistance.

Table 8.5 Fault Table



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