



Instruction Manual

Vertical Bypass/Non Bypass Panel

Safety

WARNING

EQUIPMENT HAZARD!

The vertical bypass/non bypass panel contains dangerous voltages when connected to mains voltage. It is strongly recommended that all electrical work conform to the National Electrical Code (NEC) and all national and local regulations. Installation, start-up and maintenance should be performed only by qualified personnel. Failure to follow the NEC or local regulations could result in death or serious injury.

Motor control equipment and electronic controls are connected to hazardous mains voltages. Extreme care should be taken to protect against shock. The user must be protected against supply voltage and the motor must be protected against overload in accordance with applicable national and local regulations. Be sure equipment is properly grounded. Wear safety glasses whenever working on electric control or rotating equipment.

WARNING

UNINTENDED START!

When the vertical bypass/non bypass panel is connected to AC input power, the motor may start at any time. The drive, panel, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when panel and drive are connected to AC input power could result in death, serious injury, or equipment or property damage.

Warning against unintended start

When the vertical bypass/non bypass panel is connected to mains, the motor may be started by means of an external switch, a serial bus command, an input reference signal, or a cleared fault condition. Use appropriate cautions to guard against an unintended start.

WARNING

GROUNDING HAZARD!

For operator safety, it is important to ground drive, vertical bypass panel, and motor properly. Follow the grounding guidelines of local and national codes. Failure to follow grounding guidelines could result in death or serious injury.

Grounding

Correct protective grounding of the equipment must be established in accordance with national and local codes. Ground currents are higher than 3mA.

Safety Guidelines

1. Disconnect the drive and vertical bypass/non bypass panel from mains before commencing service work
2. DO NOT touch electrical parts of the vertical bypass/non bypass panel or drive when mains is connected. After mains has been disconnected, wait 15 minutes before touching any electrical components or read the label on vertical bypass/non bypass panel.
3. The user must be protected against supply voltage and the motor must be protected against overload in accordance with applicable national and local regulations.
4. While programming parameters, the motor may start without warning. Activate the [Off] key on the LCP when changing parameters.
5. The [Off] key on the LCP does not isolate the drive from mains voltage and is not to be used as a safety switch.

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1 Introduction

1.1.1 Purpose of the Manual

This manual is intended to provide 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, and 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 Overview

A variable frequency drive regulates the speed and operation of an electric motor. 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. The vertical non bypass panel is always configured with a disconnect switch and fuses to protect the drive. The vertical bypass panel allows switching between running the motor from the drive (variable speed) or across the line input power (constant speed).

The vertical bypass panel comes with one of two control options:

- The electromechanical bypass (EMB2)
- Electronically controlled bypass (ECB)

The EMB2 is operated by a selector switch on the front of the panel. The EMB2 controls a motor by switching between drive control, operation in bypass, or off. In addition, a test selection 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 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 that 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 LCP. 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 EMB2 in *5 Electromechanical Bypass (EMB2) Operation* and ECB in *6 Electronically Controlled Bypass (ECB) Operation* of this manual.

1.1.3 Typical Bypass Operation

With contactors M1 and M2 closed and contactor M3 open, 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 referred to as test mode. With contactors M1 and M2 open and contactor M3 closed, the motor is running in bypass from the line input power.

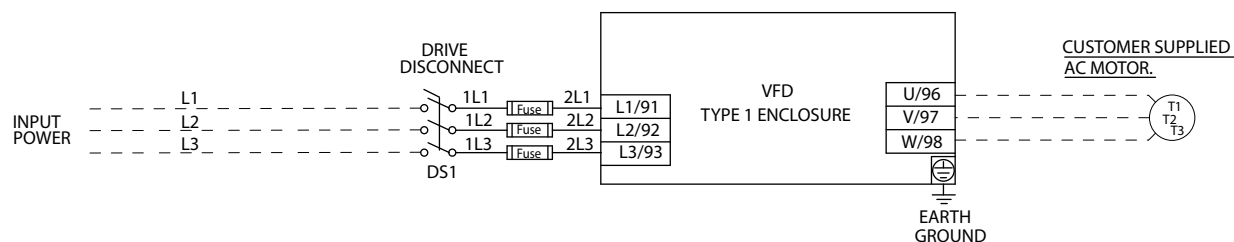
1.2 Bypass Circuits

1.2.1 Three-contactor Bypass

The bypass circuit consists of a bypass contactor (M3) interlocked with a drive output contactor (M2), a drive input contactor (M1), and an overload relay. For the EMB2, a door mounted Drive/OFF/Bypass/Test Selector switch is used to electrically select whether the motor is powered by the drive, connected to the full speed bypass, or disconnected from both. The test position applies power to the motor through the bypass (M3 closed) contactor but removes power from the drive (M2 open) while keeping the drive powered (M1 closed). A Pilot light indicates when in bypass. For the ECB, control selection is made through the drive keypad 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.

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



130BX360.11

Figure 1.1 Basic Non Bypass Circuit

1.3 Bypass Options

1.3.1 Common Run/Stop with Bypass

Allows a remote signal to initiate operation in either drive control or bypass depending upon the position of the bypass selector switch.

1.3.2 Automatic Bypass

This feature automatically transfers the motor 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 prior to transfer to bypass. Run permissive or safety circuit signals override the auto bypass function and may prevent or delay bypass operation.

1.3.3 Run Permissive in Bypass

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

1.3.4 Basic Fire Mode in Bypass

This option switches the panel to bypass whenever a remote fire mode signal 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 for emergency situations. The motor will continue to run in bypass until fire mode is removed or the drive, panel, or motor fails. External safety signals and motor overload are ignored when in fire mode.

1.3.5 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 6.1.13 ECB Advanced Fire Mode.

1.3.6 Overload Protection

This thermally activated device provides mechanical overload protection for the motor 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. The overload provides Class 20 motor protection.

1.4 Bypass Platform Configurations

The two bypass platform configurations are ECB 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 (EMB2) Operation* for additional details on the EMB2 and 6 *Electronically Controlled Bypass (ECB) Operation* for the ECB.

Control Features	EMB2	ECB
Safety Interlock	X	X
Common Start / Stop	X	X
Automatic Bypass	X	X
Run Permissive	X	X
Basic Fire Mode	X	X
Advanced Fire Mode		X
Serial Communication		X

Table 1.2 Bypass Configurations

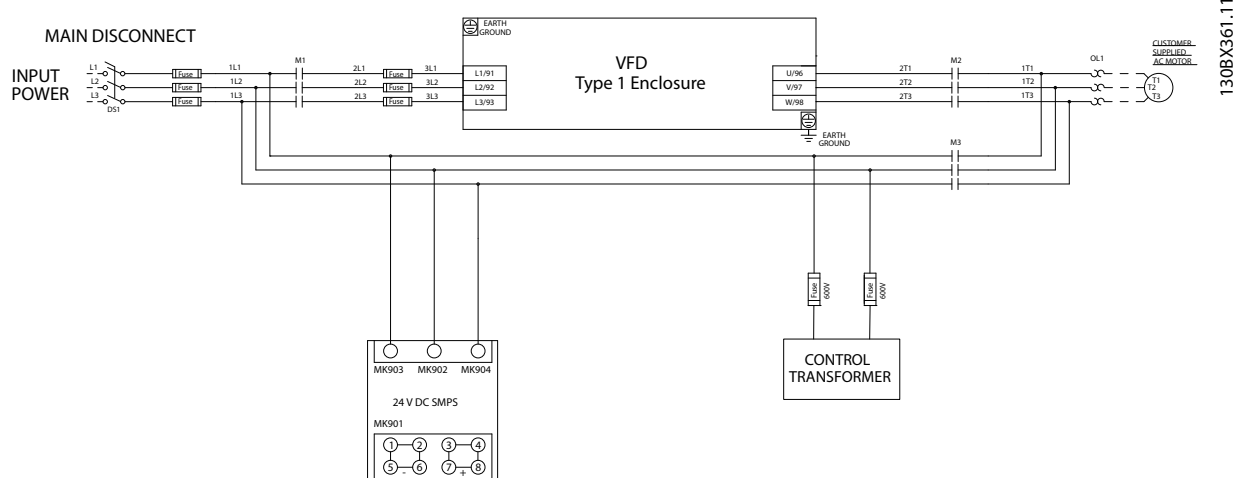


Figure 1.2 Basic Bypass Circuit

1.5 Switch Mode Power Supply

The VFD's logic circuitry is backed up by an independent panel-mounted switch mode power supply so if the drive loses power, control and communication functions are maintained. The SMPS converts three-phase AC input power to 24 V DC 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 sec. to initialize at power-up. The SMPS will maintain a 24 V DC output with a low input line voltage. The 200 Volt SMPS will maintain the 24 V DC output with a line voltage as low as 150 V AC and the 600 V SMPS to 335 V AC. Refer to Figure 1.2.

1.5.1 Control Transformer

A control transformer is included on larger horsepower units where the contactor coils are AC. The control transformer steps down the line input voltage to 120V AC. The coils of AC contactors are isolated from the Switch Mode Power Supply via relays.

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. (Bypass panel only.)

- **Disconnect without fuses.** For user-supplied fuses option. (Bypass panel only.)
- **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. The switch must be moved to the RESET position momentarily after the fault has been cleared to reset the circuit breaker. (Bypass panel only.)
- **Main Disconnect with drive fuses.** Non-bypass panel two-position (ON/OFF) rotary switch that disconnects the main AC line power to the drive only.

1.6.2 Mode Selector Switch

The mode selector switch is used for 3-contactor bypass on EMB2 units. The selector switch allows the operator to select from four modes of operation.

Drive mode: When drive mode is selected, the M1 and M2 contactors are closed allowing power to flow in and out of the drive to the motor.

Off mode: This mode opens all contactors removing any power to the motor.

Bypass mode: When bypass mode is selected, the M3 contactor closes and allows the motor to run directly from the input line power.

Test mode: Test mode closes the M1 and M3 contactors and allows the motor to be powered by the input line power. This also allows the drive to power up without being connected to the motor. Refer to *Figure 1.2*.

1.6.3 Panel Configurations

The VLT FC Drive Series comes in two panel enclosure types. One is the non bypass and the other is the bypass. See *Table 1.3* for descriptions and available options.

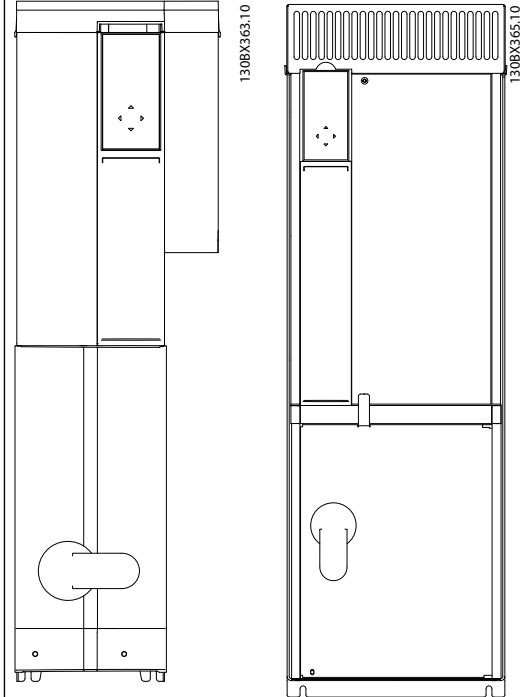
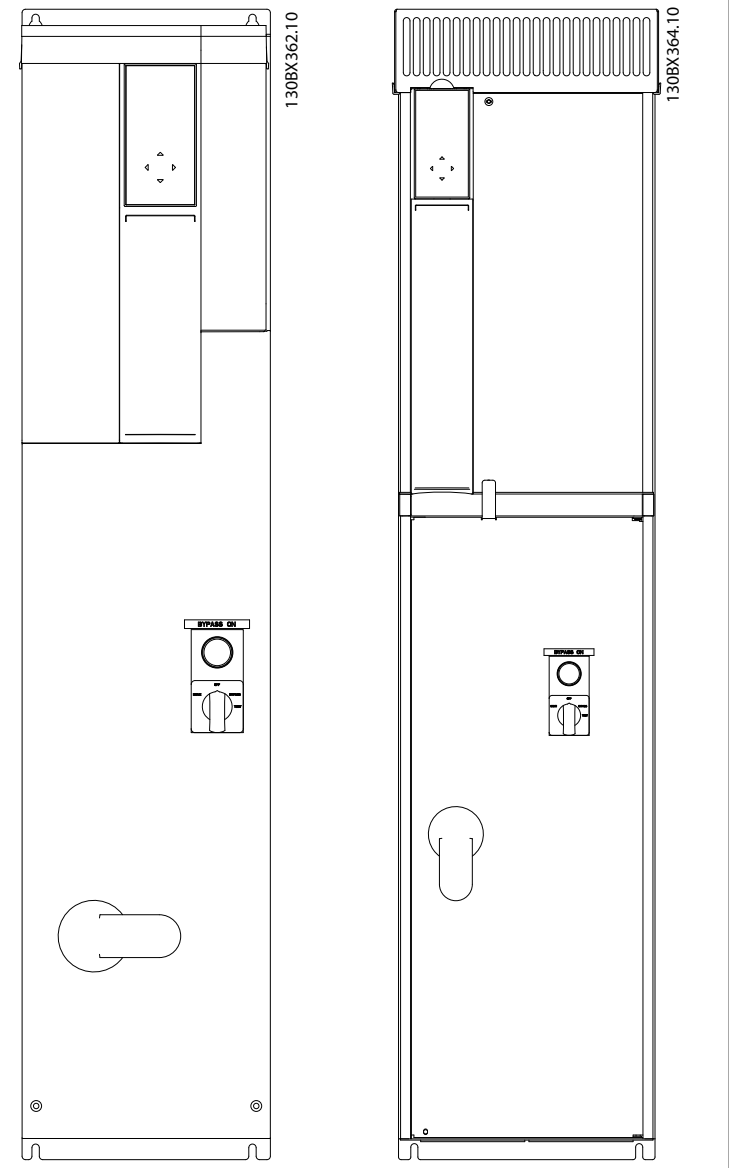
Non bypass	Bypass
	
Drive plus both of the following: 1. Fuses 2. Disconnect	Drive with bypass: 1. Fuses 2. Disconnect/Circuit Breaker 3. Contactors 4. Power Supply 5. Control Module

Table 1.3 Tier Definitions and Features

1.6.4 Panel Voltage and Frame Ratings

Table 1.4 Table 1.5 defines the voltage and hp ratings of the frames sizes for the panel. See 8 Appendix for overall and mounting dimensions.

Panel P2 (B3 - Drive)	Bypass	Non Bypass	
	FC102/202/322	FC102/202/322	FC302
Volts VAC	HP (KW)		
208 & 230	7.5 (5.5) - 15 (11)	7.5 (5.5) - 15 (11)	7.5 (5.5) - 10 (7.5)
460 & 600	15 (11) - 25 (18.5)	15 (11) - 25 (18.5)	15 (11) - 20 (15)
Panel P3 (B4 - Drive)	Bypass	Non Bypass	
	FC102/202/322	FC102/202/322	FC302
Volts VAC	HP (KW)		
208	20 (15)	20 (15) - 25 (18.5)	15 (11) - 20 (15)
230	20 (15) - 25 (18.5)		
460 & 600	30 (22) - 50 (37)	30 (22) - 50 (37)	25 (18.5) - 40 (30)
Panel P4 (C3 - Drive)	Bypass	Non Bypass	
	FC102/202/322	FC102/202/322	FC302
Volts VAC	HP (KW)		
208	25 (18.5) - 40 (30)	30 (22) - 40 (30)	25 (18.5) - 30 (22)
230	30 (22) - 40 (30)		
460 & 600	60 (45) - 75 (55)	60 (45) - 75 (55)	50 (37) - 60 (45)
Panel P5) (C4 - Drive)	Bypass	Non Bypass	
	FC102/202/322	FC102/202/322	FC302
Volts VAC	HP (KW)		
208 & 230	50 (37) - 60 (45)	50 (37) - 60 (45)	40 (30) - 50 (37)
460 & 600	100 (75) - 125 (90)	100 (75) - 125 (90)	75 (55) - 100 (75)

Table 1.4 Panel Voltage and Frame Ratings

1.7 Power Component Functions

1.7.1 Power Fusing

For main panel power fuses, only use the specified fuse or an equivalent replacement. For drive fuses only use the specified fuse. See the fuse ratings label on the inside cover of the unit or Table 3.2 Table 3.3, Table 3.3 Table 3.4, Table 3.4 Table 3.5 and Table 3.5 Table 3.6.

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 all bypass and non-bypass panels.

5,000 or 100,000 amp SCCR

The bypass panel supplied with a non fusible Main Disconnect Switch is 5,000 amps short-circuit current rating (SCCR). The bypass panel supplied with a Fusible disconnect or circuit breaker is 100,000 amp SCCR. The non bypass panel supplied with a non-fusible Main Disconnect is 100,000 amp SCCR. See the panel label for SCCR rating.

NOTE!

The 600 V circuit breaker option is 5,000 amp (SCCR).

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.

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.



Figure 2.1 Sample Panel Label

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

2.1.2 Pre-installation Check

1. Compare panel model number to what was ordered.
2. Ensure each of the following are rated for the same voltage:
 - Drive
 - Panel
 - Power line
 - Motor
3. Ensure that the panel output rating is equal to or greater than motor total full load current for full motor performance.
 - Motor power size and 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 the drive and motor.
 - Two speed motors must be wired permanently for full speed.
 - Y-start, Δ -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 (1000m) 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 be 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 TYPE 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.

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 that the equipment be mounted in a cabinet with fresh air ventilation and that corrosive compounds be kept 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 tools in *Table 3.1* are recommended for installation of the panel.

TOOLS
Spreader bar capable of lifting up to 750 lbs. Max diameter 0.5 in.
Forklift, crane, hoist or other lifting device capable of handling up to 750 lbs. (Qualified device operator available for operating the equipment.)
Metric Socket Set: 7 - 19mm
Socket Extensions: 4, 6, and 12 inch
Torx driver set: T10 - T40
Torque wrench: 6 - 375 lbs-in
Allen Wrenches: 1/8, 3/16, 1/4, & 5/16 inches
Metric or English wrenches: 7 - 19mm

Table 3.1 Tools Required

3.1.2 Drive Fuses

To maintain UL, the drive fuses should be replaced only with the fuses specified in , , , and . If an alternate drive fuse is desired please consult the factory. See the specifications label inside the cover of the unit for acceptable replacement drive fuses. A sample of this data can be seen in *Table 3.6*

208 V AC							
HP (KW)	UL Motor Current	Panel (FC102/202/322) Non Bypass & Bypass	Main Fuse (FC102/202/322) Danfoss (Bussman)	Drive Fuse (FC102/202/322) Danfoss (Bussman)	Transformer Fuse (FC102/202/322) Danfoss (Bussman)	Panel (FC302) Non Bypass	Drive Fuse (FC302) Danfoss (Bussman)
7.5 (5.5)	24.2	P2	34035600 (LPJ-40-SP)	176F8953 (JJN-50)		P2	176F8953 (JJN-50)
10 (7.5)	30.8		34035700 (LPJ-50-SP)	176F8953 (JJN-50)			176F8955 (JJN-60)
15 (11)	46.2		34042800 (LPJ-70-SP)	176F8955 (JJN-60)		P3	176F8957 (JJN-80)
20 (15)	59.4	P3	34042900 (LPJ-90-SP)	176F8957 (JJN-80)			176F8960 (JJN-125)
25 (18.5)	74.8	P3 - Non Bypass P4 - Bypass	34043100 (LPJ-125-SP)	176F8960 (JJN-125)		P4	176F8960 (JJN-125)
30 (22)	88	P4	34043200 (LPJ-150-SP)	176F8960 (JJN-125)			174N6538 (JJN-150)
40 (30)	114		34043300 (LPJ-175-SP)	174N6538 (JJN-150)		P5	174N6839 (JJN-200)
50 (37)	143	P5	34042300 (LPJ-250-SP)	174N6839 (JJN-200)	34046200 (FNQ-R-1.25)		174N6840 (JJN-250)
60 (45)	169		34042300 (LPJ-250-SP)	174N6840 (JJN-250)	34046200 (FNQ-R-1.25)		

Table 3.2 Drive Fuses 208 V

230 V AC							
HP (KW)	UL Motor Current	Panel (FC102/202/322) Non Bypass & Bypass	Main Fuse (FC102/202/322) Danfoss (Bussman)	Drive Fuse (FC102/202/322) Danfoss (Bussman)	Transformer Fuse (FC102/202/322) Danfoss (Bussman)	Panel (FC302) Non Bypass	Drive Fuse (FC302) Danfoss (Bussman)
7.5 (5.5)	22	P2	34042600 (LPJ-35-SP)	176F8953 (JJN-50)		P2	176F8953 (JJN-50)
10 (7.5)	28		34042700 (LPJ-45-SP)	176F8953 (JJN-50)			176F8955 (JJN-60)
15 (11)	42		34042800 (LPJ-70-SP)	176F8955 (JJN-60)		P3	176F8957 (JJN-80)
20 (15)	54	P3	34042900 (LPJ-90-SP)	176F8957 (JJN-80)			176F8960 (JJN-125)
25 (18.5)	68		34043000 (LPJ-100-SP)	176F8960 (JJN-125)		P4	176F8960 (JJN-125)
30 (22)	80	P4	34043100 (LPJ-125-SP)	176F8960 (JJN-125)			174N6538 (JJN-150)
40 (30)	104		34043200 (LPJ-150-SP)	174N6538 (JJN-150)		P5	174N6839 (JJN-200)
50 (37)	130	P5	34043400 (LPJ-200-SP)	174N6839 (JJN-200)	34046200 (FNQ-R-1.25)		174N6840 (JJN-250)
60 (45)	154		34042300 (LPJ-250-SP)	174N6840 (JJN-250)	34046200 (FNQ-R-1.25)		

Table 3.3 Drive Fuses 230 V

460 V AC							
HP (KW)	UL Motor Current	Panel (FC102/202/322) Non Bypass & Bypass	Main Fuse (FC102/202/322) Danfoss (Bussman)	Drive Fuse (FC102/202/322) Danfoss (Bussman)	Transformer Fuse (FC102/202/322)) Danfoss (Bussman)	Panel (FC302) Non Bypass	Drive Fuse (FC302) Danfoss (Bussman)
15 (11)	21	P2	34042600 (LPJ-35-SP)	176F8952 (JJS-40)		P2	176F8952 (JJS-40)
20 (15)	27		34035600 (LPJ-40-SP)	176F8952 (JJS-40)			176F8954 (JJS-50)
25 (18.5)	34		34035700 (LPJ-50-SP)	176F8954 (JJS-50)		P3	176F8956 (JJS-60)
30 (22)	40	P3	34035800 (LPJ-60-SP)	176F8956 (JJS-60)			176F8958 (JJS-80)
40 (30)	52		176U5037 (LPJ-80-SP)	176F8958 (JJS-80)			176F8959 (JJS-100)
50 (37)	65		34043000 (LPJ-100-SP)	176F8959 (JJS-100)		P4	176F8961 (JJS-125)
60 (45)	77	P4	34043100 (LPJ-125-SP)	176F8961 (JJS-125)			176F9078 (JJS-150)
75 (55)	96		34043200 (LPJ-150-SP)	176F9078 (JJS-150)		P5	34051200 (JJS-200)
100 (75)	124	P5	34043400 (LPJ-200-SP)	34051200 (JJS-200)	34046000 (FNQ-R-0.60)		00002051 (JJS-250)
125 (90)	156		34042300 (LPJ-250-SP)	00002051 (JJS-250)	34046000 (FNQ-R-0.60)		

Table 3.4 Drive Fuses 460 V

600 V AC							
HP (KW)	UL Motor Current	Panel (FC102/202/322) Non Bypass & Bypass	Main Fuse (FC102/202/322) Danfoss (Bussman)	Drive Fuse (FC102/202/322) Danfoss (Bussman)	Transformer Fuse (FC102/202/322) Danfoss (Bussman)	Panel (FC302) Non Bypass	Drive Fuse (FC302) Danfoss (Bussman)
15 (11)	17	P2	34035500 (LPJ-30-SP)	176F9076 (JJS-35)		P2	176F9076 (JJS-35)
20 (15)	22		34042600 (LPJ-35-SP)	176F9076 (JJS-35)			176F9077 (JJS-45)
25 (18.5)	27		34042700 (LPJ-45-SP)	176F9077 (JJS-45)		P3	176F8954 (JJS-50)
30 (22)	32	P3	34035700 (LPJ-50-SP)	176F8954 (JJS-50)			176F8956 (JJS-60)
40 (30)	41		34035800 (LPJ-60-SP)	176F8956 (JJS-60)			176F8958 (JJS-80)
50 (37)	52		176U5037 (LPJ-80-SP)	176F8958 (JJS-80)		P4	176F8959 (JJS-100)
60 (45)	62	P4	34043000 (LPJ-100-SP)	176F8959 (JJS-100)			176F8961 (JJS-125)
75 (55)	77		34043100 (LPJ-125-SP)	176F8961 (JJS-125)		P5	176F9078 (JJS-150)
100 (75)	99	P5	34043200 (LPJ-150-SP)	176F9078 (JJS-150)	34053600 (FNQ-R-0.50)		130G0488 (JJS-175)
125 (90)	125		34043400 (LPJ-200-SP)	130G0488 (JJS-175)	34053600 (FNQ-R-0.50)		

Table 3.5 Drive Fuses 600 V

3.1.3 Internal Main Panel Fuses

Use only the specified fuse or an equivalent replacement for the internal main fuses. See the specifications label inside the cover of the unit for acceptable replacement main fuses. A sample of this can be seen in *Table 3.6*.

Fuse	Description	Manufacturer	Part Number/Size
F13A & C	Primary Transformer	Bussmann	FNQ-R-0.50
F15A, B, & C	Main Fuses	Bussmann	LPJ-30-SP
F16A, B, & C	Drive Fuses	Bussmann	JJS-35
F900, F901,F902	SMPS - Power Supply	Bussmann	FWH-020A6F, 500V

Table 3.6 Sample Fuse Rating Label

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 a solid steel spreader bar for lifting. Slide the spreader bar through the two (2) lifting holes on the panel. Lifting rings are 0.59in (15mm) in diameter (see *Figure 3.1*). If VFD mounting screws interfere with the spreader bar, lifting hooks can be used instead of the lifting bar.
- Connect the spreader bar to a hoist or other lifting device.
- Carefully lift the unit and secure it to the wall. Refer to *8 Appendix* for dimensional drawings to determine fasteners size and location.

3.2.3 Forklift

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

3.2.4 Shipping Weights

Weights listed in *Table 3.7* are approximate for base units. Options can add or reduce weight of unit. Weights listed are in lbs.

Frame	Non Bypass Panel	Bypass Panel
P2	36	84
P3	66	106
P4	106	167
P5	155	248

Table 3.7 Approximate Shipping Weights

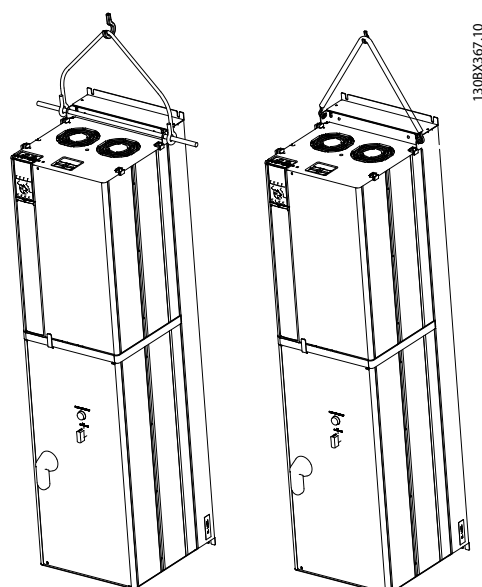


Figure 3.1 Proper Lifting Method

3.3 Cooling

- Only mount the drive and panel vertically.
- Panels rely on the ambient air for cooling. It is important to observe the limitations on ambient air temperature. The maximum ambient temperature for all bypass panels is 40°C and 45°C for non bypass panels. Derating concerns start above 3300 feet elevation above sea level.
- Most panels may be mounted side-by-side without additional side clearance. However, the P2 (B3 frame size) units require 1.5 in. minimum clearance between units (see *Figure 3.2*).
- Top and bottom clearance is required for cooling (see *Figure 3.3*). Generally, 2 to 10 inches (50 to 250mm) minimum clearance is required, depending upon the hp (kW) of the unit. See the dimensional drawings in *8 Appendix* for specific requirements.
- No additional back plate is required for drives with the bypass and non bypass panels.

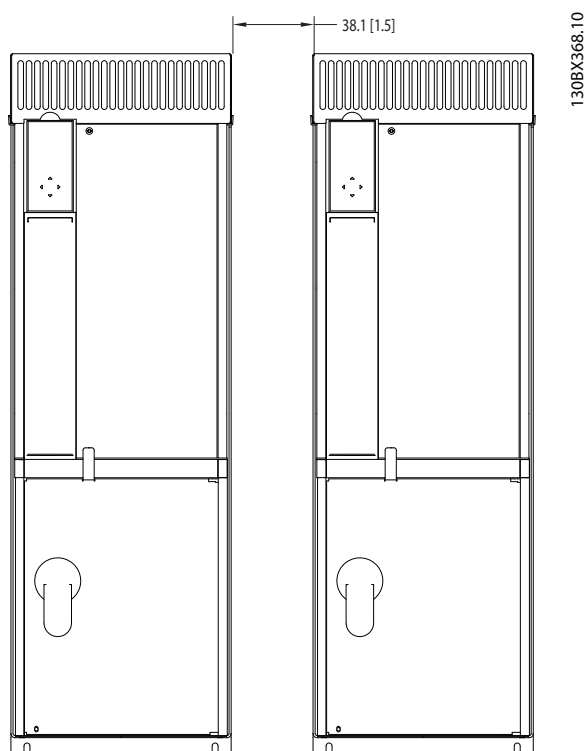


Figure 3.2 Side Cooling Clearance

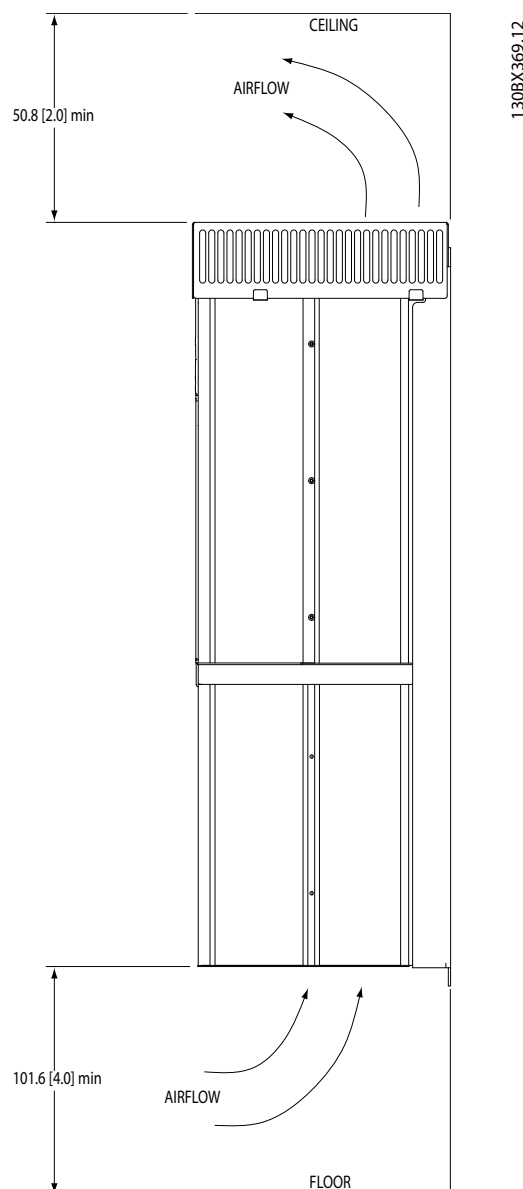


Figure 3.3 Cooling Airflow

3.4 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 3mA.
- A dedicated ground wire is required.
- Wear safety glasses whenever working on electric control or rotating equipment.

NOTE!

Make all power connections with a minimum of 60°C/ 140°F rated copper wire.

⚠ 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.

- Because the motor wiring carries high frequency electrical pulses, it is important that no other wires are run together. 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.

At least three separate conduits must be connected to the panel (Figure 3.4).

- Power into the panel (and ground back to the distribution panel)
- Power from the panel to the motor and earth insulated motor 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.

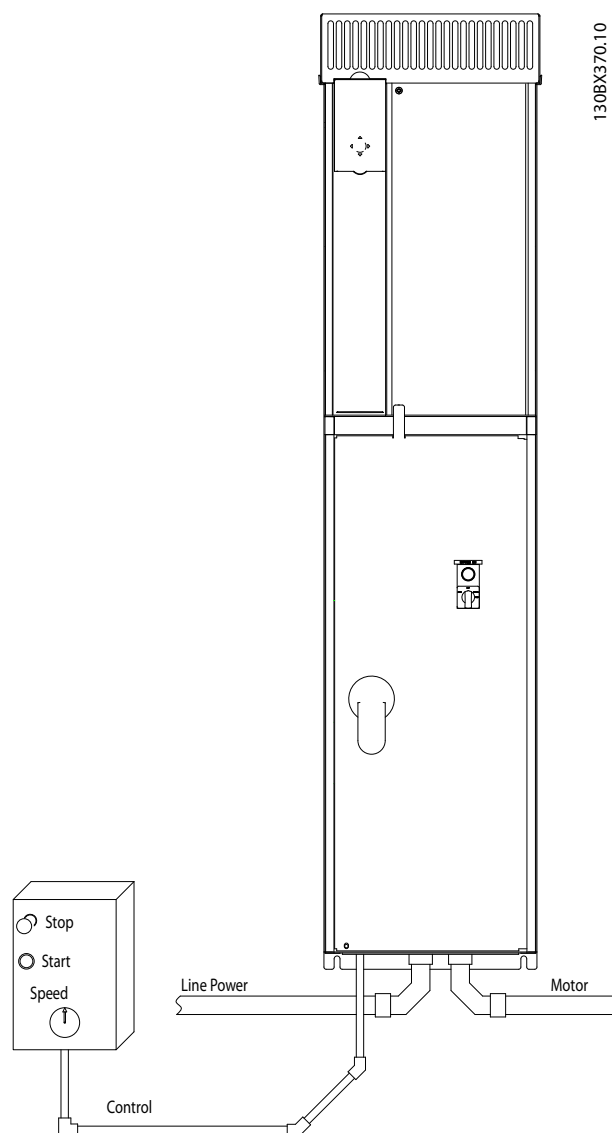


Figure 3.4 Power Connections

3.4.1 Component Identification & Customer Connection

Mechanical layout drawings are intended to provide the installer or equipment user with component identification and location for that specific unit. *Figure 3.5* represents a typical layout drawing. *Table 3.8* provides definitions for drawing reference designators. (Not all reference designators are shown.)

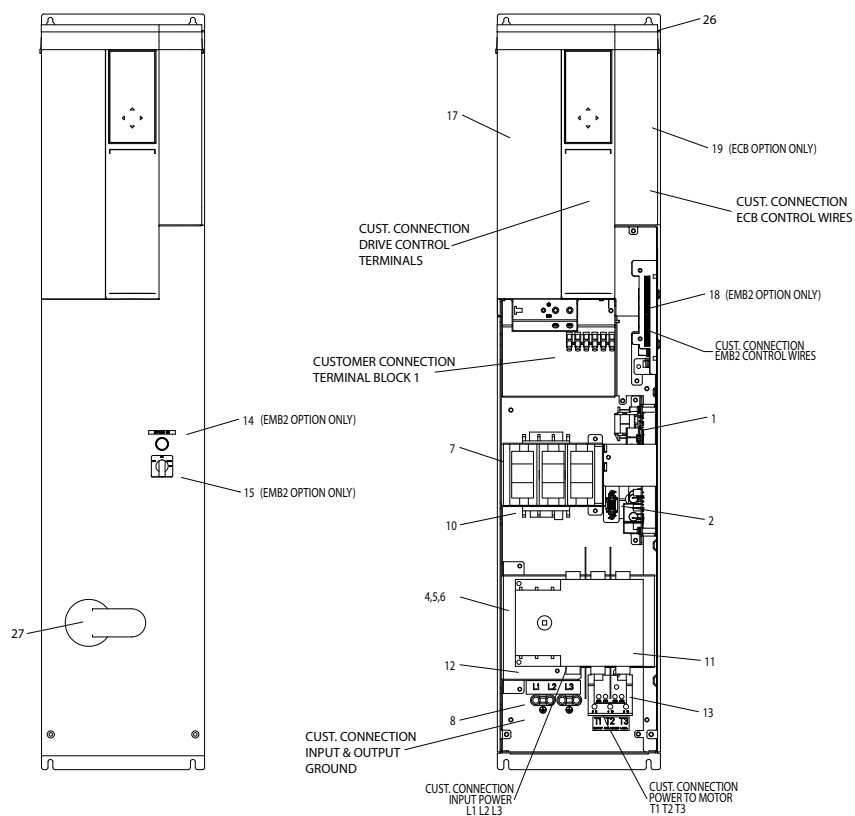


Figure 3.5 P2 Bypass Mechanical Layout Diagram

ID	Device	Definition	ID	Device	Definition
1	24 V DC	Panel 24 V DC SMPS	15	S1	Auto Bypass Selector Switch
2	HPC	High Pot Connector	16	TF	120 V AC control transformer
3	F13	T1 primary fuse	17	VFD	Variable frequency drive
4	CB1	Main Circuit Breaker	18	EMB2	Control Module
5	DS1	Main or Drive Disconnect	19	ECB	Control Module
6	F15	Main fuse	20	TB1-C	Terminal block 1 - Control
7	F16	Drive fuse	21	TB1-P	Terminal block 1 - Power
8	GND	Ground terminal	22	PR1	Control Relay for M1 Contactor
9	LCP	LCP	23	PR2	Control Relay for M2 Contactor
10	M1	Drive Input contactor	24	PR3	Control Relay for M3 Contactor
11	M2	Drive Output contactor	25	UVM	Under voltage module
12	M3	Bypass contactor	26	TC	Top Cover
13	OL1	Overload for Motor	27	DH	Disconnect Handle
14	PL1	Bypass indicator light			

Table 3.8 Reference Designator Definitions

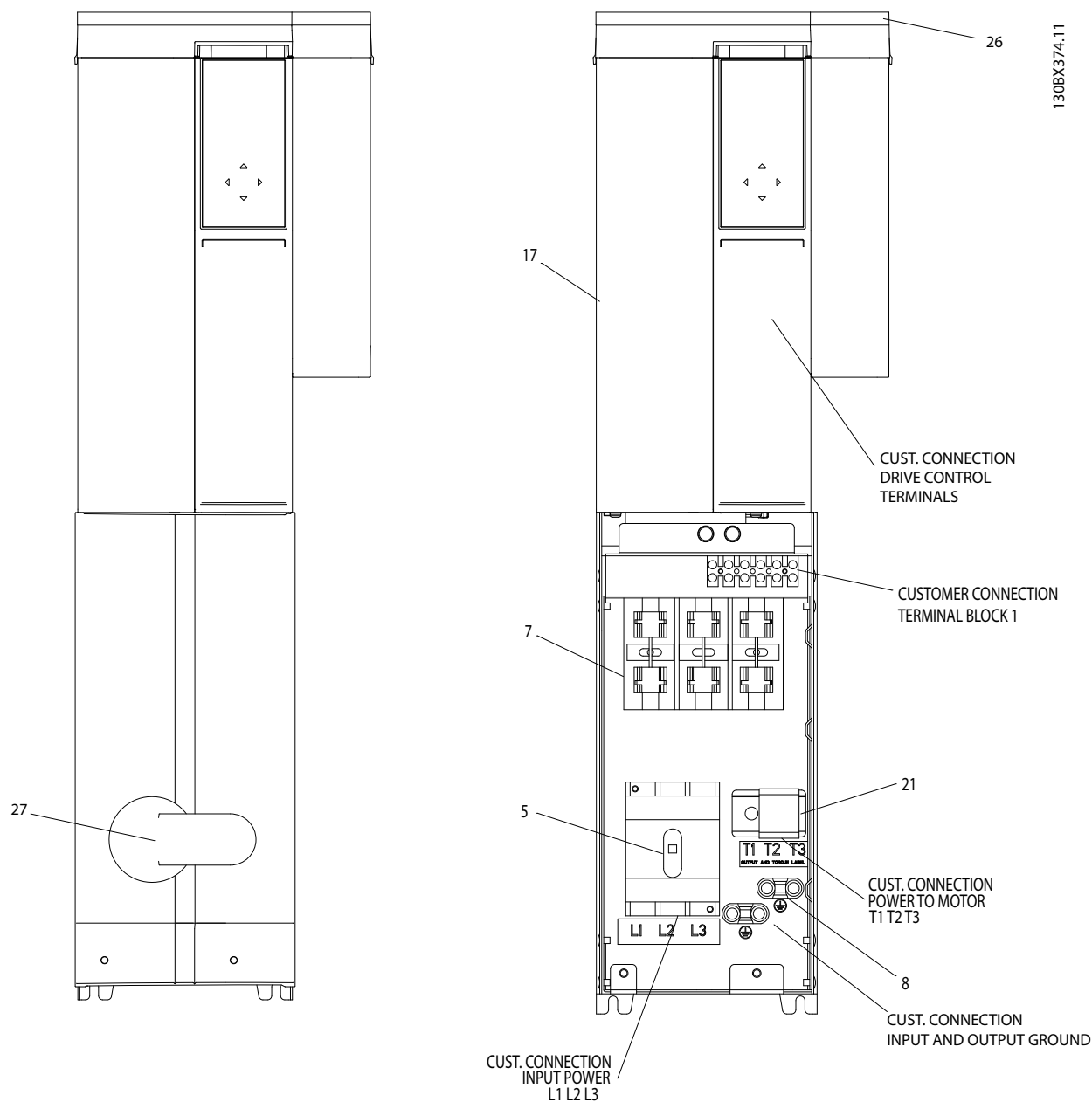
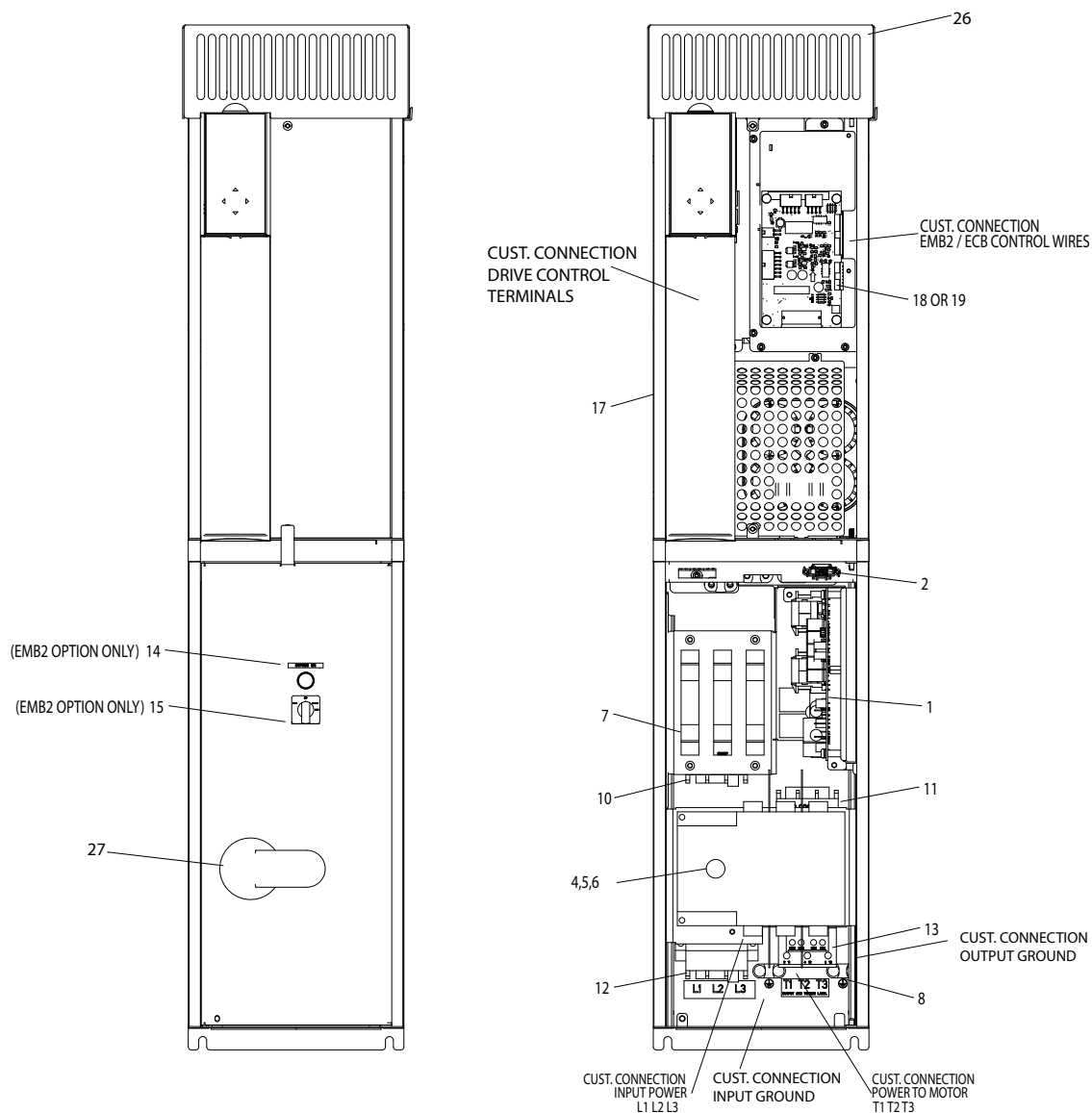


Figure 3.6 P2 Non Bypass Mechanical Layout Diagram.

See Table 3.8 for reference designator definitions.



130BX375.12

Figure 3.7 P3 Bypass Mechanical Layout Diagram.

See Table 3.8 for reference designator definitions.

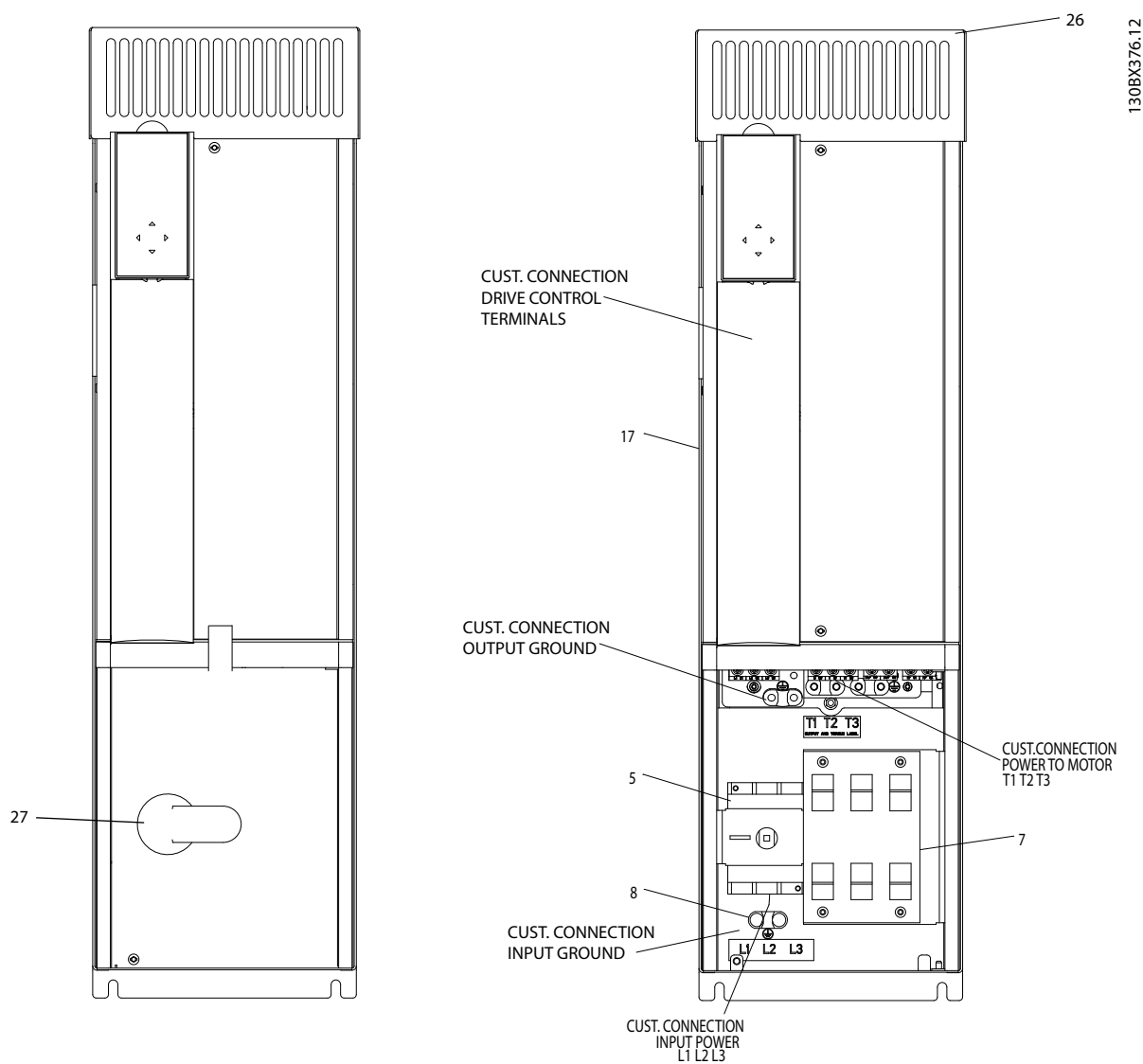


Figure 3.8 P3 Non Bypass Mechanical Layout Diagram.

See Table 3.8 for reference designator definitions.

Figure 3.9 P4 Bypass Mechanical Layout Diagram.

See *Table 3.8* for reference designator definitions.

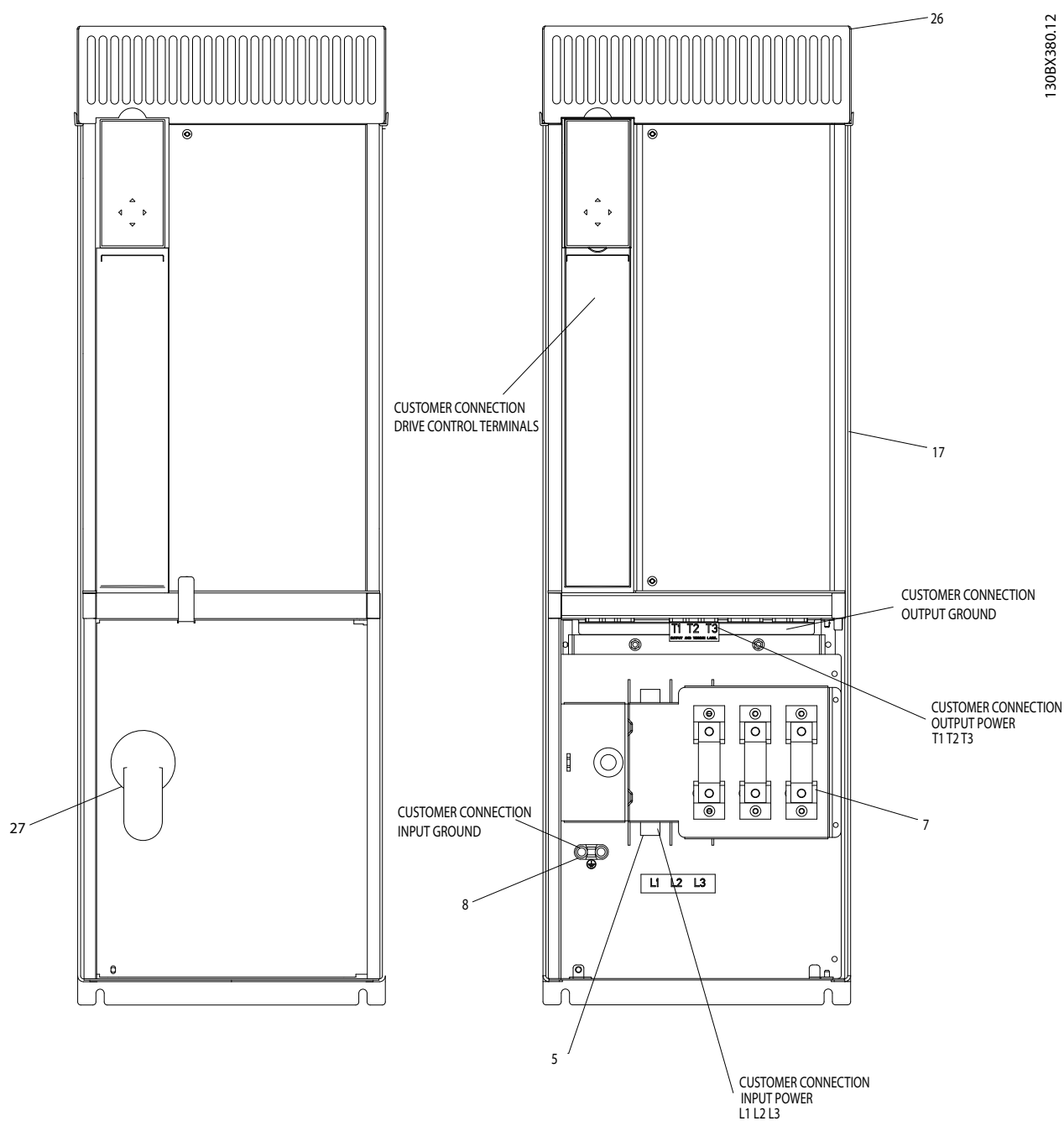


Figure 3.10 P4 Non Bypass Mechanical Layout Diagram.

See Table 3.8 for reference designator definitions.

3

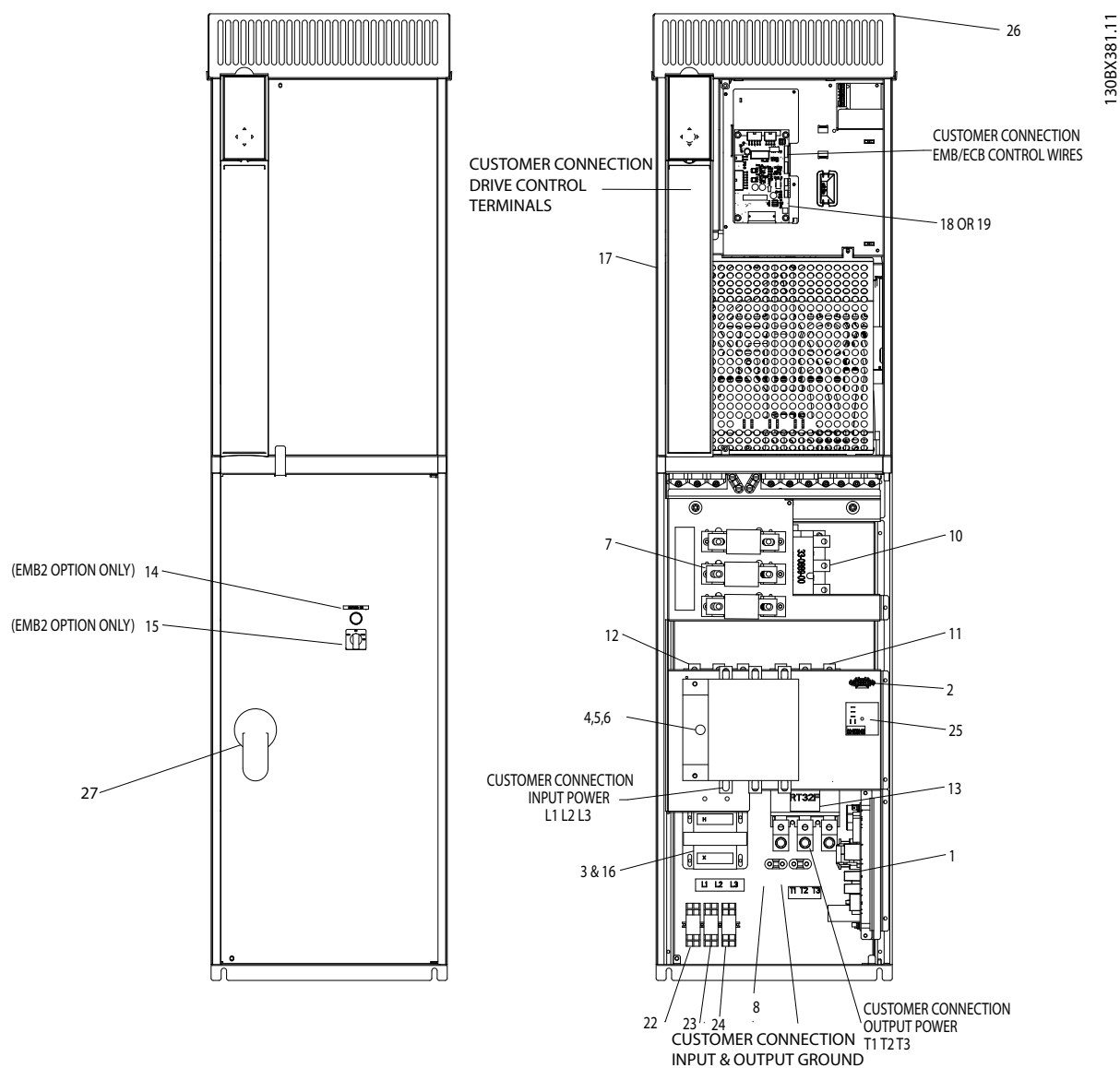


Figure 3.11 P5 Bypass Mechanical Layout Diagram.

See Table 3.8 for reference designator definitions.

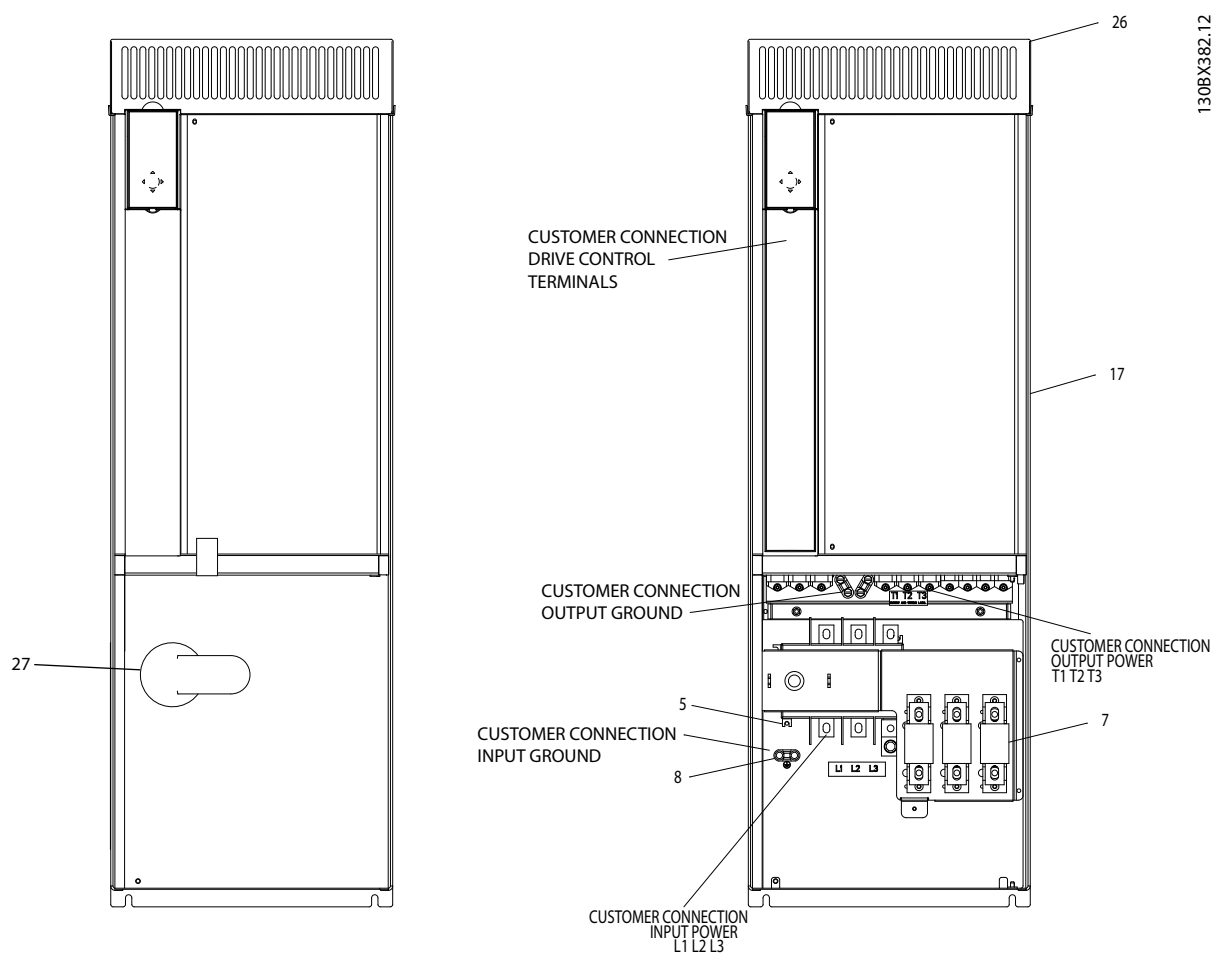


Figure 3.12 P5 Non Bypass Mechanical Layout Diagram.

See Table 3.8 for reference designator definitions.

3.4.2 Wire and Cable Access

- Refer to through for wire routing and termination locations.
- Removable access knockout covers are provided for cable connections (see *Figure 3.13* and *Figure 3.14*).
- 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 upper section of the panel. Connections to the ECB and EMB2 are in this area except on the P2 bypass panels.
- Power connections are typically towards the bottom side of the panel.
- Control wiring should be isolated from power components inside the unit as much as possible. Danfoss has included hardware to allow for the separation.
- See the mechanical layout drawings in through for connection details and recommended wire routing.

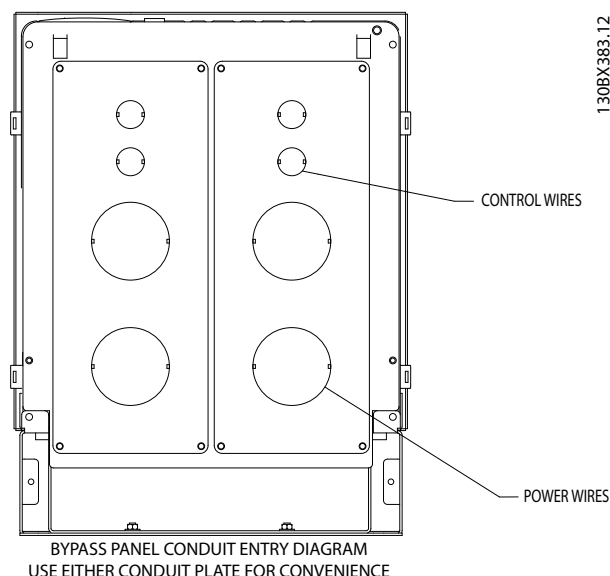


Figure 3.13 Bypass Panel Conduit Entry Diagram

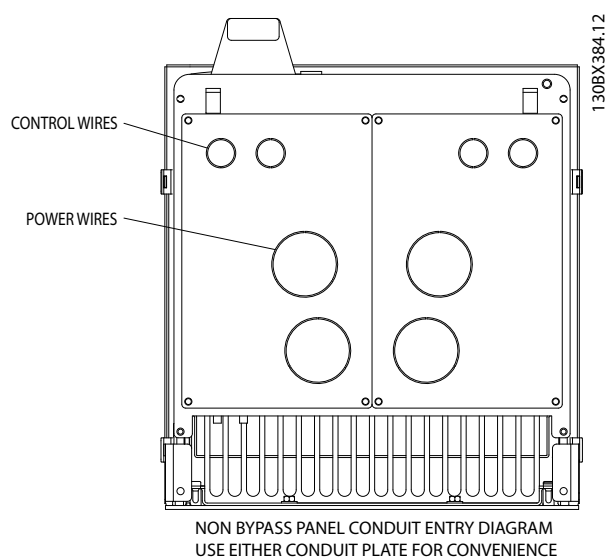


Figure 3.14 Non Bypass Panel Conduit Entry Diagram

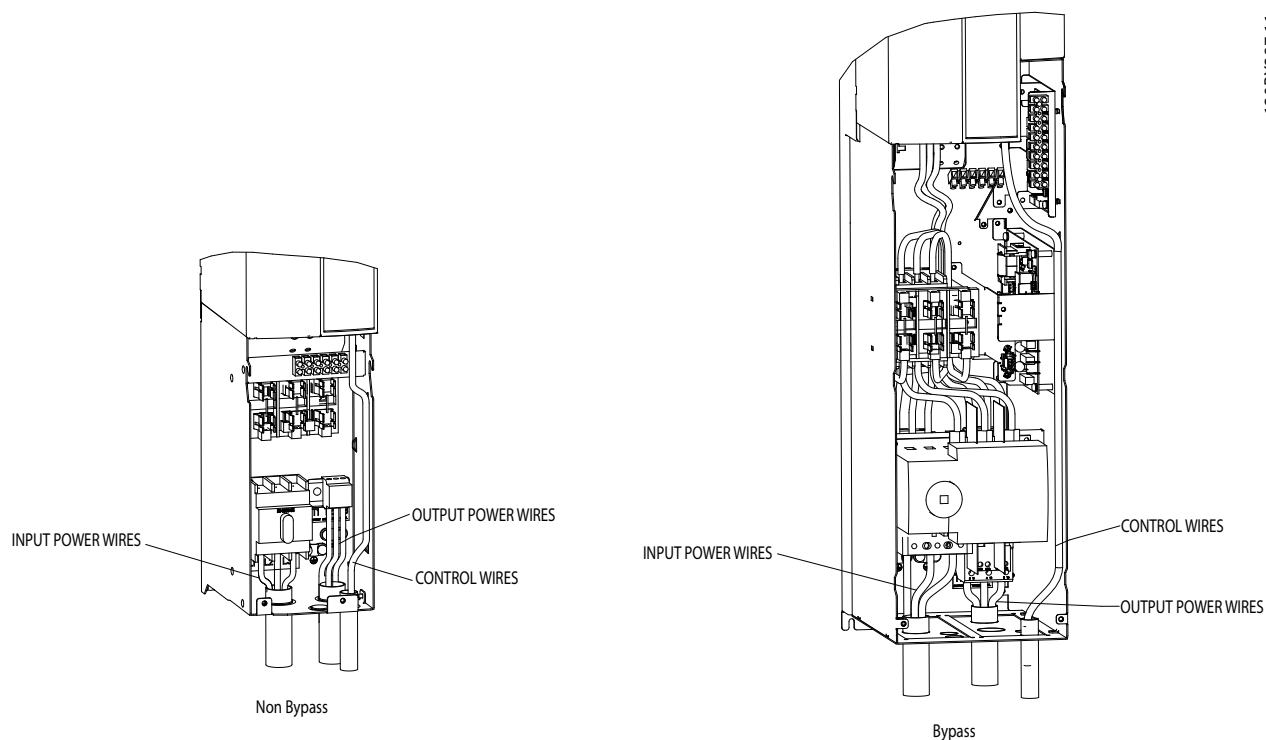


Figure 3.15 P2 Panel

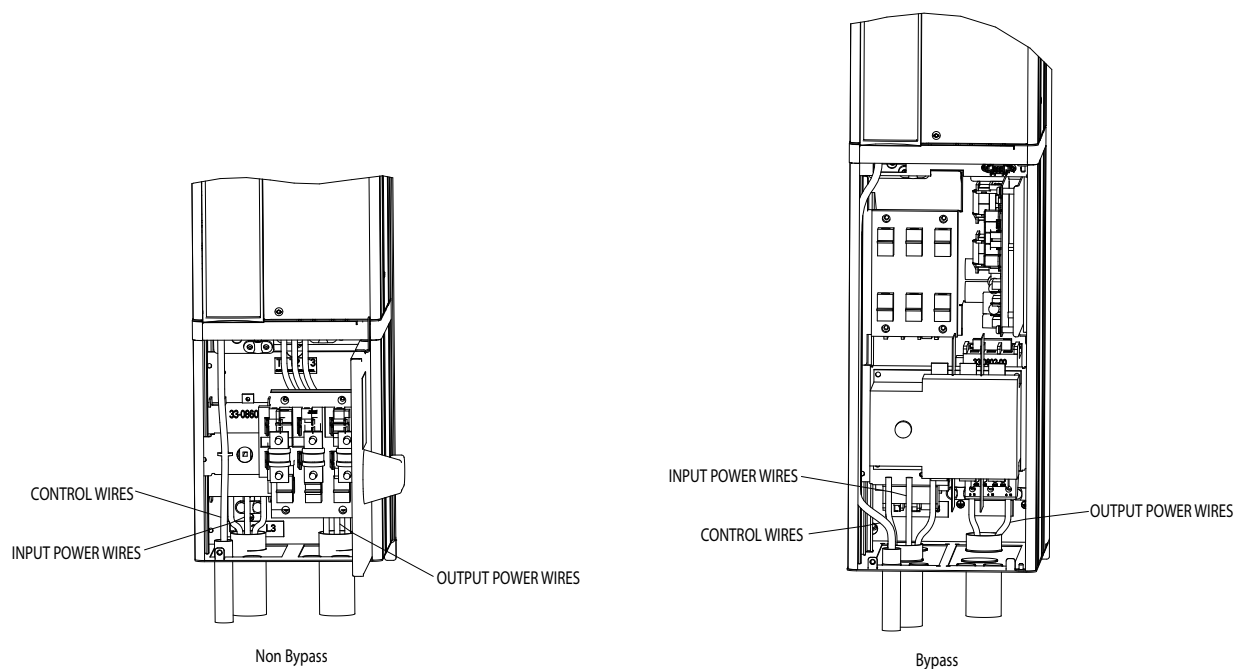


Figure 3.16 P3 Panel

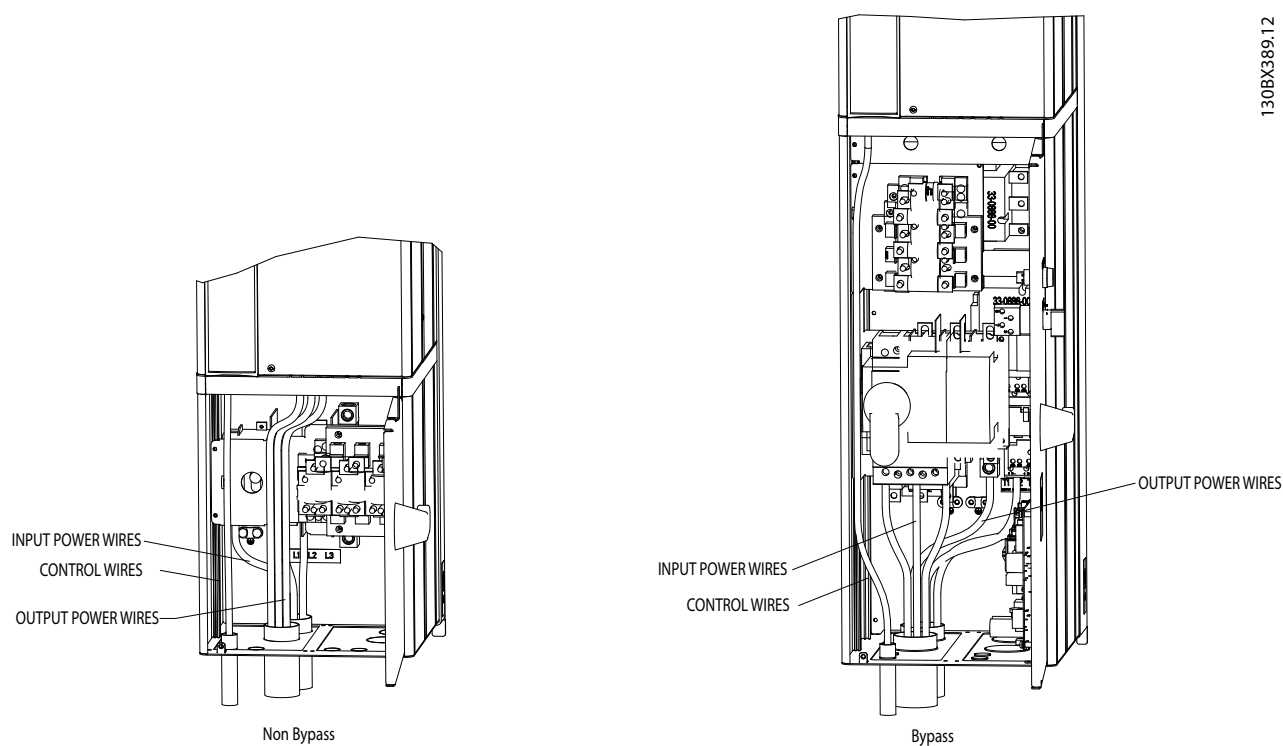


Figure 3.17 P4 Panel

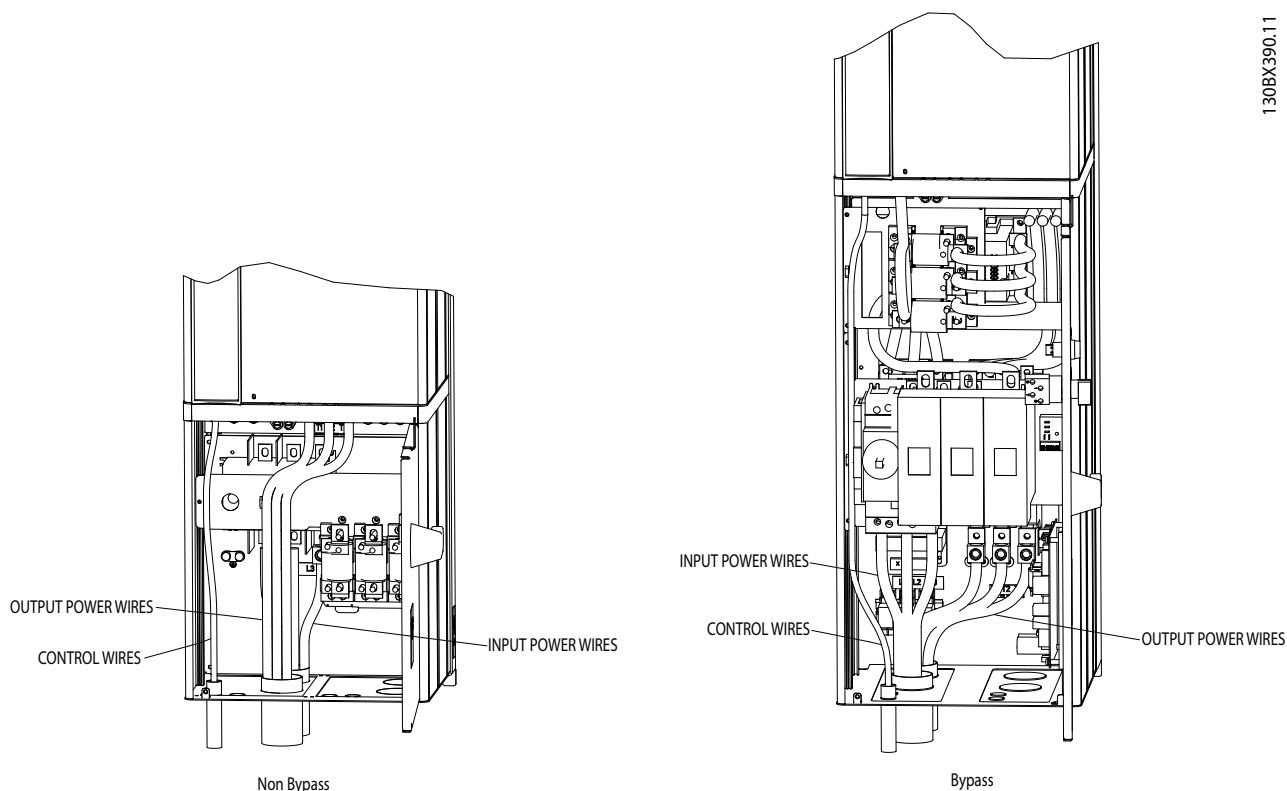


Figure 3.18 P5 Panel

3.4.3 Wire Size

⚠ WARNING

ELECTROCUTION AND FIRE HAZARDS WITH IMPROPERLY INSTALLED AND GROUNDED FIELD WIRING! Improperly installed and grounded field wiring poses FIRE & ELECTROCUTION hazards. To avoid these hazards, you **MUST** follow requirements for field wiring installation and grounding as described in the National Electrical Codes (NEC) and your local/state electrical codes. All field wiring **MUST** be performed by qualified personnel. Failure to follow these requirements could result in death or serious injury.

NOTE!

Make all power connections with minimum 60 or 75°C/140 or 155°F rated copper wiring for installations in North America.

Installation
Vertical Bypass/Non Bypass Panel

208 V AC						
HP (KW)	UL Motor Current	Panel (FC102/202/322) Non Bypass & Bypass	Panel (FC302) Non Bypass	Maximum Field Wiring Size Class B or C	Field Ground Wiring Size Class B or C	Minimum Temperature Wire Rating "°C" Copper Conductor
7.5 (5.5)	24.2	P2	P2	8 AWG	10 AWG	60
10 (7.5)	30.8			8 AWG	10 AWG	60
15 (11)	46.2		P3	4 AWG	10 AWG	60
20 (15)	59.4	P3		3 AWG	10 AWG	60
25 (18.5)	74.8	P3 - Non Bypass P4 -Bypass	P4	2 AWG	8 AWG	60
30 (22)	88	P4		2 AWG	8 AWG	60
40 (30)	114		P5	1/0 AWG	6 AWG	75
50 (37)	143	3/0 AWG		6 AWG	75	
60 (45)	169			4/0 AWG	6 AWG	75
230 V AC						
HP (KW)	UL Motor Current	Panel (FC102/202/322) Non Bypass & Bypass	Panel (FC302) Non Bypass	Maximum Field Wiring Size Class B or C	Field Ground Wiring Size Class B or C	Minimum Temperature Wire Rating "Degree C" Copper Conductor
7.5 (5.5)	22	P2	P2	10 AWG	10 AWG	60
10 (7.5)	28			8 AWG	10 AWG	60
15 (11)	42		P3	6 AWG	10 AWG	60
20 (15)	54	P3		4 AWG	10 AWG	60
25 (18.5)	68	P4	P4	3 AWG	8 AWG	60
30 (22)	80			3 AWG	8 AWG	60
40 (30)	104	P5	P5	1 AWG	6 AWG	75
50 (37)	130			2/0 AWG	6 AWG	75
60 (45)	154				3/0 AWG	6 AWG

Table 3.9 Wire Size Chart, 208 and 230 V

460 V AC						
HP (KW)	UL Motor Current	Panel (FC102/202/322) Non Bypass & Bypass	Panel (FC302) Non Bypass	Maximum Field Wiring Size Class B or C	Field Ground Wiring Size Class B or C	Minimum Temperature Wire Rating "°C" Copper Conductor
15 (11)	21	P2	P2	10 AWG	10 AWG	60
20 (15)	27			8 AWG	10 AWG	60
25 (18.5)	34		P3	P3	6 AWG	10 AWG
30 (22)	40	6 AWG			10 AWG	60
40 (30)	52	4 AWG			10 AWG	60
50 (37)	65	P4	P4	3 AWG	8 AWG	60
60 (45)	77			1 AWG	8 AWG	60
75 (55)	96		P5	P5	1 AWG	8 AWG
100 (75)	124	2/0 AWG			6 AWG	75
125 (90)	156				3/0 AWG	6 AWG
600 VAC						
HP (KW)	UL Motor Current	Panel (FC102/202/322) Non Bypass & Bypass	Panel (FC302) Non Bypass	Maximum Field Wiring Size Class B or C	Field Ground Wiring Size Class B or C	Minimum Temperature Wire Rating "Degree C" Copper Conductor
15 (11)	17	P2	P2	10 AWG	10 AWG	60
20 (15)	22			10 AWG	10 AWG	60
25 (18.5)	27		P3	P3	8 AWG	10 AWG
30 (22)	32	8 AWG			10 AWG	60
40 (30)	41	6 AWG			10 AWG	60
50 (37)	52	P4	P4	4 AWG	10 AWG	60
60 (45)	62			3 AWG	8 AWG	60
75 (55)	77		P5	P5	1 AWG	8 AWG
100 (75)	99	1 AWG			8 AWG	60
125 (90)	125				2/0 AWG	6 AWG

Table 3.10 Wire Size Chart 460 and 600 V

3.4.4 Wire Type Rating

- The wire style rating specifications are provided in Table 3.9 and Table 3.10

3.4.5 Terminal Tightening Torques

- Tighten all connections to the torque specifications provided in Table 3.11 and Table 3.12
- The torque specifications are also located on the tightening torque and wire rating label inside the panel cover. See Table 3.14 for a sample of the torque and wire rating data.

208 V									
HP (KW)	Panel (FC102/202/322) Non Bypass & Bypass	Panel (FC302) Non Bypass	Non Bypass		Bypass				Ground Wire Torque lb-in (N-m)
			Input	Output	Input			Output	
					Drive Disconnect Switch L1, L2, & L3 Torque lb-in (N-m)	Motor T1, T2, & T3 Torque lb-in (N-m)	Disconnect Switch (w/o Fuses) UL508A L1, L2, & L3 Torque lb-in (N-m)		
7.5 (5.5)	P2	P2	55 (6.2)	16 (1.8)	7 (0.8)	30 (3.3)	40 (4.5)	24 (2.7)	40 (4.5)
10 (7.5)			55 (6.2)	16 (1.8)	7 (0.8)	30 (3.3)	40 (4.5)	24 (2.7)	40 (4.5)
15 (11)			55 (6.2)	16 (1.8)	18 (2)	120 (13.5)	45 (5)	50 (5.6)	40 (4.5)
20 (15)	P3 - Non Bypass	P3	55 (6.2)	40 (4.5)	18 (2)	120 (13.5)	50 (5.6)	50 (5.6)	40 (4.5)
25 (18.5)			70 (7.9)	40 (4.5)	55 (6.2)	200 (22.5)	50 (5.6)	50 (5.6)	40 (4.5)
30 (22)	P4 - Bypass	P4	200 (22.5)	40 (4.5)	200 (22.5)	200 (22.5)	50 (5.6)	50 (5.6)	40 (4.5)
40 (30)			200 (22.5)	88.5 (10)	200 (22.5)	200 (22.5)	50 (5.6)	275 (31)	40 (4.5)
50 (37)			200 (22.5)	88.5 (10)	200 (22.5)	500 (56.5)	274 (31)	275 (31)	40 (4.5)
60 (45)	P5		200 (22.5)	124/212.4 (14/24) *Note 1	200 (22.5)	500 (56.5)	274 (31)	275 (31)	40 (4.5)
230 V									
HP (KW)	Panel (FC102/202/322) Non Bypass & Bypass	Panel (FC302) Non Bypass	Non Bypass		Bypass				Ground Wire Torque lb-in (N-m)
			Input	Output	Input			Output	
					Drive Disconnect Switch L1, L2, & L3 Torque lb-in (N-m)	Motor T1, T2, & T3 Torque lb-in (N-m)	Disconnect Switch (w/o Fuses) UL508A L1, L2, & L3 Torque lb-in (N-m)		
7.5 (5.5)	P2	P2	55 (6.2)	16 (1.8)	7 (0.8)	30 (3.3)	40 (4.5)	24 (2.7)	40 (4.5)
10 (7.5)			55 (6.2)	16 (1.8)	7 (0.8)	30 (3.3)	40 (4.5)	24 (2.7)	40 (4.5)
15 (11)			55 (6.2)	16 (1.8)	18 (2)	120 (13.5)	45 (5)	50 (5.6)	40 (4.5)
20 (15)	P3	P3	55 (6.2)	40 (4.5)	18 (2)	120 (13.5)	50 (5.6)	50 (5.6)	40 (4.5)
25 (18.5)			70 (7.9)	40 (4.5)	55 (6.2)	200 (22.5)	50 (5.6)	50 (5.6)	40 (4.5)
30 (22)	P4 - Bypass	P4	70 (7.9)	40 (4.5)	55 (6.2)	200 (22.5)	50 (5.6)	50 (5.6)	40 (4.5)
40 (30)			200 (22.5)	88.5 (10)	200 (22.5)	200 (22.5)	50 (5.6)	50 (5.6)	40 (4.5)
50 (37)			200 (22.5)	88.5 (10)	200 (22.5)	200 (22.5)	274 (31)	275 (31)	40 (4.5)
60 (45)	P5		200 (22.5)	124 (14)	200 (22.5)	500 (56.5)	274 (31)	275 (31)	40 (4.5)
*Note 1 - Tightening of terminals for different cable dimensions x/v, where x <0.147in sq [95mm sq] and v>0.147 in sq [95mm sq]									

*Note 1 - Tightening of terminals for different cable dimensions x/y, where x <0.147in sq [95mm sq] and y>0.147 in sq [95mm sq]

Table 3.11 Tightening Torques, 208 and 230 V

460 V									
HP (KW)	Panel (FC102/202/322) Non Bypass & Bypass	Panel (FC302) Non Bypass	Non Bypass		Bypass				Ground Wire Torque lb-in (N-m)
			Input	Output	Disconnect Switch (w/o Fuses) UL508A L1, L2, & L3 Torque lb-in (N-m)	Disconnect Switch Fusible UL98 L1, L2, & L3 Torque lb-in (N-m)	Circuit Breaker L1, L2, & L3 Torque lb-in (N-m)	Output	
15 (11)	P2	P2	55 (6.2)	16 (1.8)	7 (0.8)	30 (3.3)	40 (4.5)	24 (2.7)	40 (4.5)
20 (15)			55 (6.2)	16 (1.8)	7 (0.8)	30 (3.3)	40 (4.5)	24 (2.7)	40 (4.5)
25 (18.5)			55 (6.2)	16 (1.8)	7 (0.8)	30 (3.3)	45 (5)	24 (2.7)	40 (4.5)
30 (22)	P3	P3	55 (6.2)	40 (4.5)	18 (2)	30 (3.3)	45 (5)	50 (5.6)	40 (4.5)
40 (30)			55 (6.2)	40 (4.5)	18 (2)	120 (13.5)	50 (5.6)	50 (5.6)	40 (4.5)
50 (37)			55 (6.2)	40 (4.5)	18 (2)	120 (13.5)	50 (5.6)	50 (5.6)	40 (4.5)
60 (45)	P4	P4	70 (7.9)	88.5 (10)	55 (6.2)	200 (22.5)	50 (5.6)	50 (5.6)	40 (4.5)
75 (55)			200 (22.5)	88.5 (10)	200 (22.5)	200 (22.5)	50 (5.6)	50 (5.6)	40 (4.5)
100 (75)			200 (22.5)	124 (14)	200 (22.5)	200 (22.5)	274 (31)	275 (31)	40 (4.5)
125 (90)	P5	P5	200 (22.5)	124 (14)	200 (22.5)	500 (56.5)	274 (31)	275 (31)	40 (4.5)
*Note 1 - Tightening of terminals for different cable dimensions x/y, where x < 0.147in sq [95mm sq] and y > 0.147 in sq [95mm sq]									

Table 3.12 Tightening Torques, 460 V

600 V									
HP (KW)	Panel (FC102/202/322) Non Bypass & Bypass	Panel (FC302) Non Bypass	Non Bypass		Bypass				Ground Wire Torque lb-in (N-m)
			Input	Output	Disconnect Switch (w/o Fuses) UL508A L1, L2, & L3 Torque lb-in (N-m)	Disconnect Switch Fusible UL98 L1, L2, & L3 Torque lb-in (N-m)	Circuit Breaker L1, L2, & L3 Torque lb-in (N-m)	Output	
15 (11)	P2	P2	Drive Disconnect Switch L1, L2, & L3 Torque lb-in (N-m)	Motor T1, T2, & T3 Torque lb-in (N-m)	7 (.79)	17 (1.92)	62 (7)	Single Motor Overload T1, T2, & T3 Torque lb-in (N-m)	40 (4.5)
20 (15)			55 (6.2)	16 (1.8)	7 (.79)	30 (3.3)	62 (7)	24 (2.7)	40 (4.5)
25 (18.5)			55 (6.2)	16 (1.8)	7 (.79)	30 (3.3)	62 (7)	24 (2.7)	40 (4.5)
30 (22)	P3	P3	55 (6.2)	40 (4.5)	7 (.79)	30 (3.3)	62 (7)	50 (5.6)	40 (4.5)
40 (30)			55 (6.2)	40 (4.5)	18 (2)	30 (3.3)	62 (7)	50 (5.6)	40 (4.5)
50 (37)			55 (6.2)	40 (4.5)	18 (2)	120 (13.5)	62 (7)	50 (5.6)	40 (4.5)
60 (45)	P4	P4	55 (6.2)	88.5 (10)	55 (6.2)	120 (13.5)	62 (7)	50 (5.6)	40 (4.5)
75 (55)			70 (7.9)	88.5 (10)	55 (6.2)	200 (22.5)	62 (7)	50 (5.6)	40 (4.5)
100 (75)			200 (22.5)	124 (14)	200 (22.5)	200 (22.5)	200 (22.5)	275 (31)	40 (4.5)
125 (90)	P5	P5	200 (22.5)	124 (14)	200 (22.5)	200 (22.5)	200 (22.5)	275 (31)	40 (4.5)
*Note 1 - Tightening of terminals for different cable dimensions x/y, where x <0.147in sq [95mm sq] and y>0.147 in sq [95mm sq]									

Table 3.13 Tightening Torques, 600 V

Field Connection	Tightening Torque lb-in (N-m)	Temperature & Type Rating
L1, L2, L3/Ground	25 (2.8) 25 (2.8)	Use 75°C Copper Conductor
2T1, 2T2, 2T3/Ground	25 (2.8) 25 (2.8)	Use 75°C Copper Conductor
TB1	25 (2.8) 25 (2.8)	Use 75°C Copper Conductor

Table 3.14 Sample Tightening Torque and Wire Rating Label

3.4.6 Input Line Connection

CAUTION

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 disconnect switch.
- Torque terminals in accordance with the information provided in *Table 3.11* and *Table 3.12* on the label inside the panel cover.
- **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

ELECTROCUTION AND FIRE HAZARDS WITH IMPROPERLY INSTALLED AND GROUNDED FIELD WIRING!

Improperly installed and grounded field wiring poses FIRE & ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in the National Electrical Codes (NEC) and your local/state electrical codes. All field wiring MUST be performed by qualified personnel. Failure to follow these requirements could result in death or serious injury.

⚠ 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 overload 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 the option panel properly. Failure to do so 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 for input ground.
- Connect the ground wire directly to a reliable earth ground. Grounding studs are provided on the back plate of the panel for grounding.
- Do not use conduit connected to the panel as a replacement for a ground wire.
- A high strand count ground wire is preferred for dissipating high frequency electrical noise.
- Keep the ground wire connections as short as possible.
- Ground the motor to the panel with insulated wire run inside metal conduit with motor leads.

3.4.9 Control Wiring

Detailed instructions for terminal connection, control wiring installation, and operation are shown in Section 5 Electromechanical Bypass (EMB2) Operation and Section 6 Electronically Controlled Bypass (ECB) Operation.

- 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 3.4.2 *Wire and Cable Access* for details.

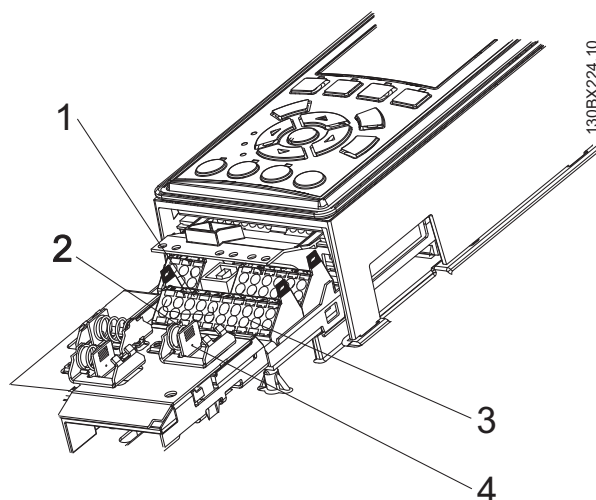


Figure 3.19 Control Terminals Location

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

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 3.19) 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.

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.

- Also provided are two Form C relay outputs that are in various locations depending upon the drive configuration and size.

3.4.11 Drive Control Terminals

Definitions of the drive terminals are summarized in Table 3.15.

- 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.

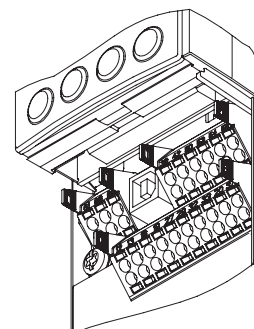


Figure 3.20 Removable Drive Connectors and Terminals

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 parameter 5-00 for PNP operation. Maximum output current is 200 mA total for all 24V loads.
18, 19, 32, 33	Digital inputs. Selectable for NPN or PNP function in parameter 5-00. Default is PNP.
27, 29	Digital inputs or outputs. Programmable for either. Parameter 5-01 for terminal 27 and 5-02 for 29 selects input/output function. Default setting is input.
20	Common for digital inputs. To use for digital input common, program parameter 5-00 for NPN operation.
39	Common for analog output.
42	Analog output. Programmable for various functions in parameter 6-5*. 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 3.15 Drive Control Terminals Functions

4 Start Up

1. Input power to the 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 the 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 do so could result in death, serious injury or damage to equipment.

2. 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.
3. Use ohmmeter to confirm continuity of the motor by measuring T1-T2, T2-T3, and T3-T1.
4. Use ohmmeter to confirm open on input by measuring L1-L2, L2-L3, and L3-L1. Note that 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.
5. Inspect the panel for loose connections on terminals.
6. Check *Table 3.9* and *Table 3.10* for proper ground wire: panel to main building distribution ground, and panel to motor ground.
7. Confirm control connections terminated per connection diagrams supplied with the equipment.
8. Check for external devices between drive panel output and motor. It is recommended that no devices be installed between the motor and drive.
9. Record motor nameplate data; hp, voltage, full load amps (FLA), and RPM. It will be needed to match motor and drive later on.
10. Confirm that incoming power voltage matches drive label voltage and motor nameplate voltage.

11. For multiple winding motors, the 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 panel must be replaced with one of appropriate rating. Do not attempt to run the unit. Failure to match FLA to unit maximum amp rating may result in equipment damage.

12. Confirm motor FLA is equal to or less than maximum panel output current. Some motors have higher than normal NEMA currents.
13. Check that the overload relay is set for FLA of connected motor. Service factor is built into overload relay. Relay trips at 120% of setting.
14. For drive start up procedures, see drive instruction manual.

4.1.1 Inspection Prior to Start Up

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

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, 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 for serial communication. Ensure the shield is terminated correctly.
EMC considerations	Check for proper installation with regard to electromagnetic capability.
Environmental conditions	See panel label for the maximum ambient operating temperature. Humidity levels must be less than 95% non-condensing. Attitude less than 3300 feet.
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 panel requires a dedicated ground wire from its chassis to the building ground. It is required 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. Run insulated motor ground wire back to panel in conduit with motor wires.
Input and output power wiring	Check for loose connections. Check for proper fusing or circuit breakers.
Panel interior	Panel interior must be free of dirt, metal chips, moisture, and corrosion. Check for harmful airborne contaminants such as sulfur based compounds.
Proper Cooling Clearance	Panels require top and bottom clearance adequate to ensure proper air flow for cooling. See <i>Figure 3.2</i> and <i>Figure 3.3</i>
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 when mounting panel.

Table 4.1 Inspection prior to Startup

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 EMB2. The ECB uses pushbuttons on the drive keypad while the EMB2 uses a selector switch on the front of the panel. Be familiar with the operation of these devices prior to start up.

⚠ WARNING

EQUIPMENT HAZARD!

The panel contains 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-startup procedure.
2. Ensure that all operator devices are in the OFF position. The main disconnect switch on the front of the electromechanical bypass panel must be in the OFF position. The panel door should be closed.
3. Keep main disconnect switch in the OFF position and apply voltage to the panel.
4. Confirm that input line voltage is balanced within 3%. If not, correct the input voltage imbalance before proceeding.

CAUTION

MOTOR START!

Ensure that motor, system, and any attached equipment is ready for start. Failure to do so could result in personal injury or equipment damage.

5. If a bypass is connected, place the Mode Selector Switch in drive mode. Apply power by turning the main disconnect switch to the ON position.
6. Enter drive programming data per the drive instruction manual.
7. Check motor rotation direction in drive control as follows.
 - 7a Put panel in drive mode.
 - 7b Hand start drive at minimum speed (see drive instruction manual for details).
 - 7c Confirm directional rotation.
 - 7d If incorrect, stop the drive, remove power, and lock out.
 - 7e Reverse connection of T1 & T2 motor leads. Do not change incoming power leads.
 - 7f Remove lockout and apply power.
 - 7g Confirm directional rotation.
8. Check motor rotation direction in bypass as follows.
 - 8a Momentarily bump motor in bypass.
 - 8b Confirm directional rotation.
 - 8c If incorrect, stop drive, remove power, and lock out.
 - 8d Reverse connection of L1 & L2 input power leads to the main disconnect. Do not change motor leads.
 - 8e Confirm directional rotation.

- 9a Put the unit in drive mode.
- 9b Check motor current on motor terminals T1, T2, and T3. Verify the motor amps are within drive and motor rated current and are balanced within 3%. If incorrect, see *7.1 Start Up Troubleshooting* for isolation procedures.
- 9c Check input current on input terminals L1, L2, and L3. Verify that current is within FLA of drive and balanced within 3%. If incorrect, see *7.1 Start Up Troubleshooting* for isolation procedures.
10. Check motor current in bypass mode on the motor terminals.
 - 10a Put the unit in bypass mode.
 - 10b Check full load amps on terminals T1, T2, and T3. Verify the motor amps are within motor FLA rated current and balanced within 3%. If incorrect, see *7.1 Start Up Troubleshooting* for isolation procedures.

For steps 11-13, see *5 Electromechanical Bypass (EMB2) Operation* and *6 Electronically Controlled Bypass (ECB) Operation* for details.

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

CAUTION

FULL SPEED OPERATION!

Ensure that the motor, system, and any attached equipment is ready for full speed operation. The user assumes all responsibility for assuring the 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 motor current in drive mode on the motor terminals.

5 Electromechanical Bypass (EMB2) Operation

5.1.1 Typical Control Connections for Common HVAC Applications

Drive Terminal	Parameter Number	Parameter Name	Value Number	Value Name	Function
27	500	Digital I/O Mode	0	PNP	External Interlock
27	501	Term 27 mode	0	Input	External Interlock
29	502	Term 29 Mode	1	Output	Auto Bypass
18	510	Term 18 digital input	8	Start	Common run/stop
19	511	Term 19 digital input	52	Run Permissive	Run Permissive
27	512	Term 27 digital input	7	External Interlock	External Interlock
29	531	Term 29 digital output	160	No Alarm	Auto Bypass
01 & 02	540 [0]	Relay 1 function	167	Start Command Active	Run Permissive
01 & 02	540 [0]	Relay 1 off delay	0.00 seconds	Off Delay	Run Permissive

Table 5.1 EMB2 Default Parameter Settings for Common HVAC Applications

If the drive is reinitialized, be sure that these settings are maintained or reset for proper bypass.

Name	Function	Drive Terminals	EMB2 X59	EMB2 X55
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			11, 12
Run Enable (for run permissive)	Input Command			1, 2
Safety Stop	Input Command			5, 6
Drive Fault	Output Status		5, 6, 7	
Fire Mode	Input Command			7, 8
Drive Mode	Output Status		1, 2	
Bypass Mode	Output Status		3, 4	
Fire Mode	Output Status			9, 10

Table 5.2 Common Functions for Controlling Motor using Bypass and Typical Terminal Connections.

Commands enable drive functions. Status reports describe conditions, but do not enable a function.

CONTACT SEQUENCE CHART FOR S1
X INDICATES CONTACT CLOSED

CONTACT	POSITION	DRIVE	OFF	BYPASS	TEST
1-2		X			X
3-4				X	X
5-6		X			
7-8					X

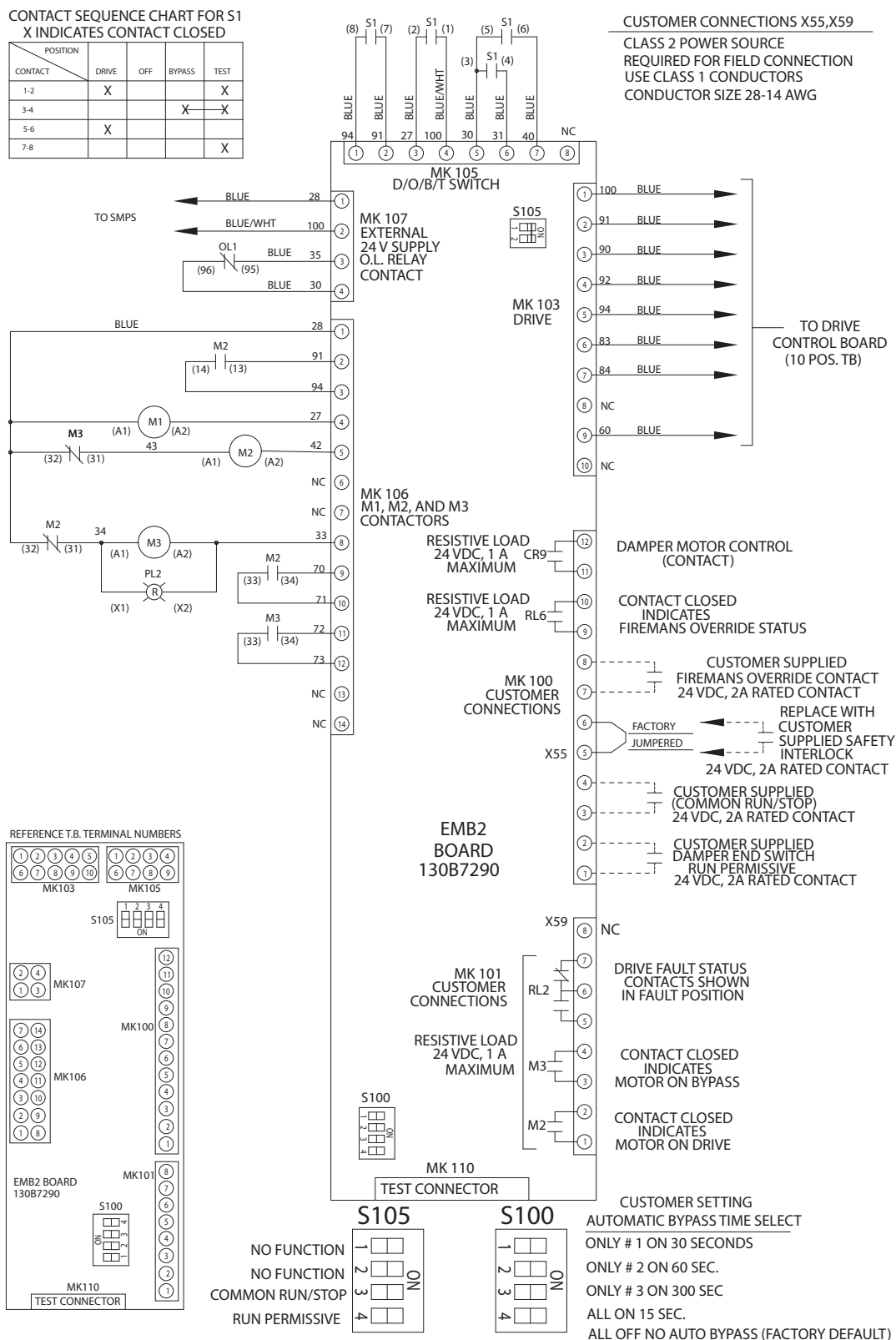


Figure 5.1 Customer Side EMB2 Control Card Terminal Connections

5.1.2 EMB2 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 (S100) located on the EMB2 bypass control card (see *Figure 5.1*). A fault condition enables a delay timer prior to 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.

Prior to Enabling Auto Bypass

- Complete the start-up procedure to verify that the 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 the 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 S100 located on the bypass control card. (Times are approximate.)

- All OFF = no auto bypass operation
- 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 EMB2 Common Run/Stop

General Information

The common run/stop function provides remote run and stop control of the motor 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.

Prior to 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 drive keypad 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, turn switch four on dip switch S105. This allows the bypass to start when the bypass switch is placed in the bypass position.
- Remove 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 on the drive control card.

5.1.4 EMB2 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 enabled by factory default and can be disabled by switching dip switch #4 on S105 to the on position or placing a jumper wire between terminal 1 and 2 of the X55 customer connector.

Prior to Enabling Run Permissive

- Complete the start-up procedure to verify that 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 manual provided for information on programming the run permissive function.

Operation

- A start command can be from local hand start on the drive keypad or a remote auto start signal through digital input connector X55 terminals 3 and 4, or via the serial communications input.
- In response to a start command, an output request is sent from X55 terminals 11 and 12 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 the factory-installed jumper wire on connector X55, terminals 1 and 2.
- Wire the output run request to connector X55, terminals 11 and 12.
- 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 or use dip switch 4 on S105.

5.1.5 EMB2 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 over-current 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.

Prior to 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 the range of the current dial, reconfirm that the motor hp and voltage are within the option panel (and drive) rating. If greater than the FLA rating, replace the panel with one of a proper rating.

CAUTION

MOTOR DAMAGE!

Repeated attempts to reset an overload can cause motor damage. Correct the overload condition and let the overload and motor return to normal operating temperature before resetting. See motor manufacturer's recommendations for time between start attempts. Failure to correct the overload condition and let the 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 sec. or less at 600% current and normal operating temperature. This allows for high motor inrush current for 20 sec. 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.

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 the 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.

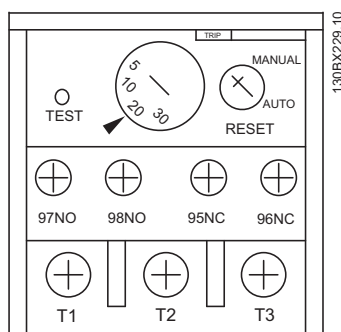


Figure 5.2 Sample Overload Device

5.1.6 EMB2 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 panel is in operational mode. When open, power is interrupted to the drive output and bypass contactors and relays, and the bypass ignores all run commands except for fire mode operation. 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 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 a safety interlock in the circuit.

Safety Interlock Function Setup

- Remove factory-installed jumper between terminals 5 and 6 on connector X55
- Wire safety input to terminals 5 and 6 on connector X55

5.1.7 EMB2 Fire Mode

General Information

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

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

5.1.8 EMB2 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 X59 terminals 5, 6, and 7. In normal operation, the relay is powered and terminal 5 is closed with terminal 7 open. In a fault condition, power to the relay is lost and the relay positions automatically reverse, signaling the fault condition. Terminal 6 is common to both.

Fault Reporting Function Setup

- Fault reporting status is connected to connector X55, output terminals 5, 6, and 7.

5.1.9 EMB2 Switches

Mode selector switch.

A panel mounted 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 providing power to the drive (M1 and M3). See *Figure 1.2*.

6 Electronically Controlled Bypass (ECB) Operation

6.1 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.

1. LCP Display
2. Menu keys
3. Menu navigation
4. Control keys

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 3.20*) 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 the [Main Menu] key or [Quick Menu] key on the LCP keypad. 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-**. (See *Table 6.1* for factory default parameter settings for drives with an ECB.) Bypass functions are programmed in parameter group 31-** (see *Table 6.4*). See the drive's supporting materials for detailed programming instructions.

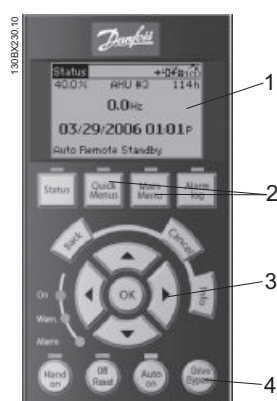


Figure 6.1 Local Control Panel (LCP)

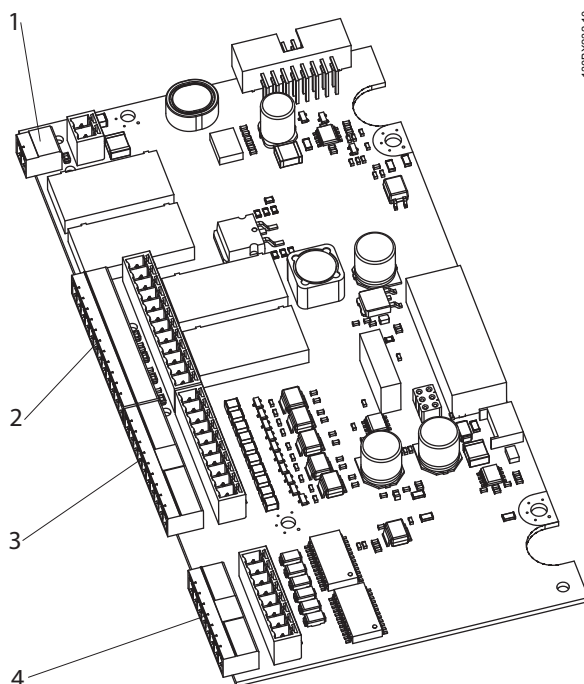
Parameter	Parameter name	Setting title	Setting	Function
5-01	Term 27 Mode	Input	0	Customer Interlock
5-02	Term 29 Mode	Output	1	Auto bypass
5-10	Term 18 digital input	Start	8	Common run/stop
5-11	Term 19 digital input	Run Permissive	52	Run Permissive
5-12	Term 27 digital input	External Interlock	7	Customer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

Table 6.1 Parameter Group 5-** Factory Default Settings

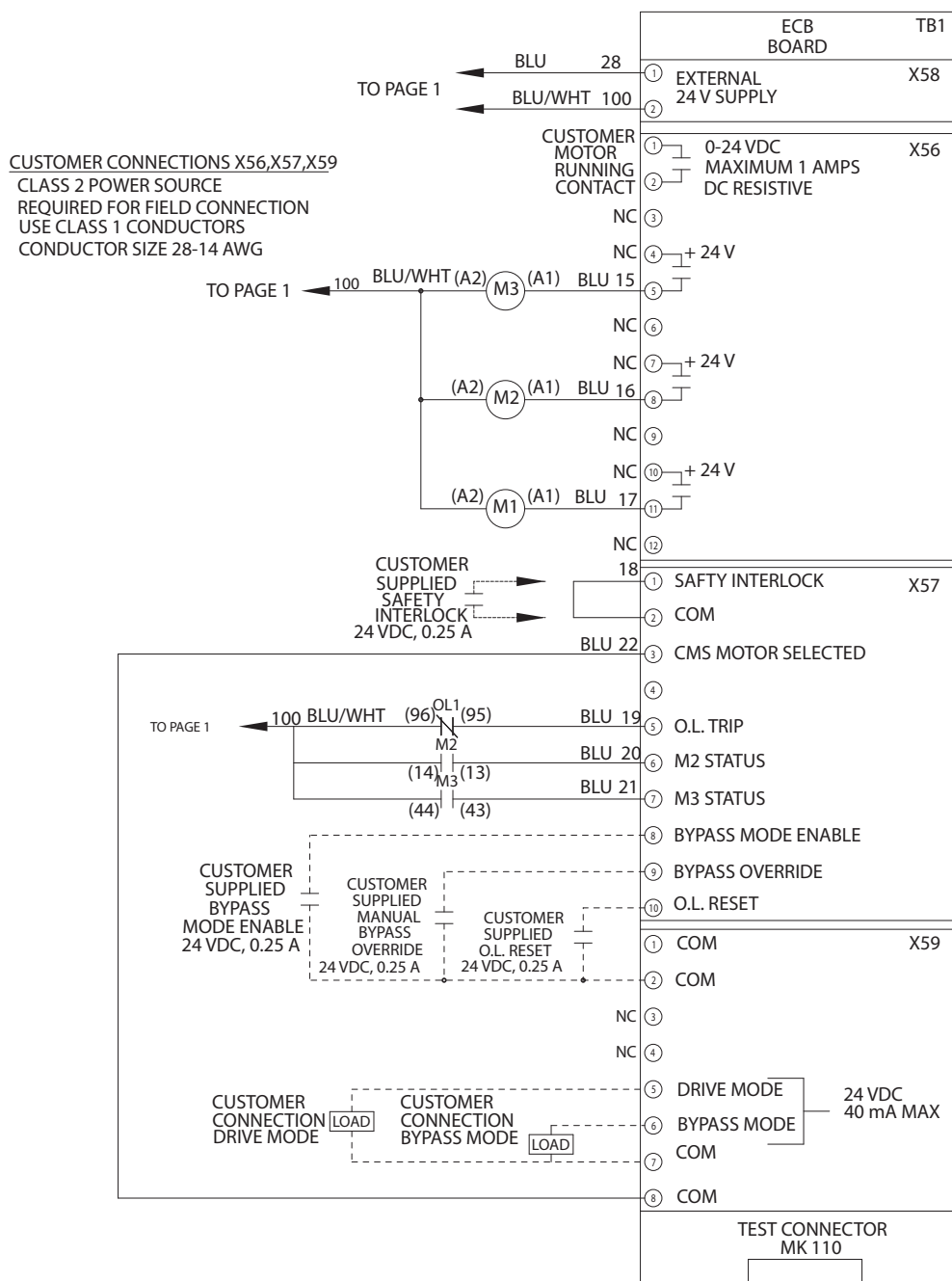
6.1.2 ECB Control Card

The ECB control card (see *Figure 6.2*) 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 6.2* for ECB control card terminal types and functions.



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



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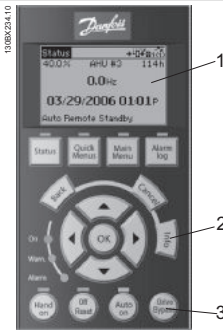
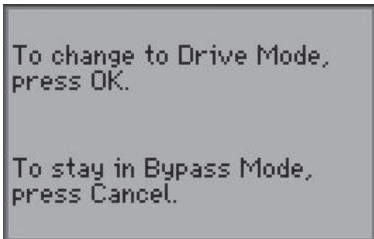
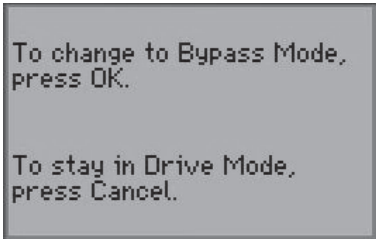
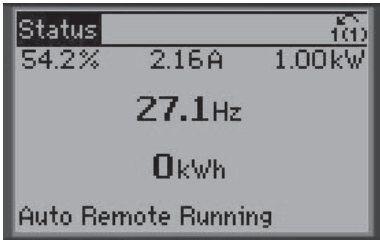
Figure 6.2 ECB Control Card Terminal Connections

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 VDC digital output
	6	Digital output indicates panel is in Bypass Mode	24 VDC 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 6.2 ECB Card Terminals

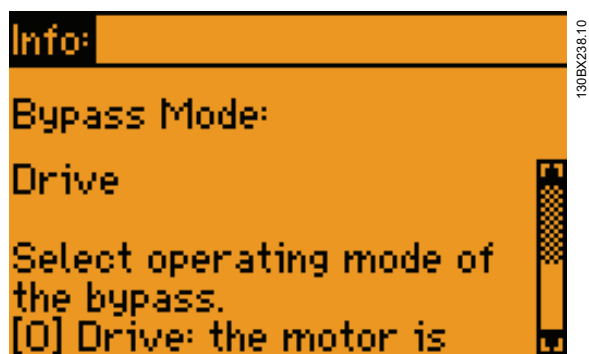
6.1.3 ECB Drive or Bypass Selection

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

<p>1. Press [Drive Bypass]. Display changes to show bypass and drive mode options (shown in Step 2).</p>	 <p>1 = Display 2 = Info key 3 = Drive/Bypass Option Key</p>
<p>2. When running in drive mode, press [OK] on LCP to activate bypass mode or press CANCEL to remain in drive mode. In bypass, the motor will run at full speed.</p>	
<p>3. When running in drive mode, press [OK] on the LCP to activate drive mode or press [Cancel] to remain in bypass mode.</p>	
<p>4. Press [Status] to return to drive status display.</p>	

NOTE!

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

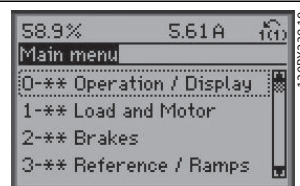


6.1.4 ECB Programming

Use the LCP and display 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:

1. Press [Main Menu] on the LCP to access parameter groups. (Note that the memory function of the menu returns to the most recently used function. Use [Back] to return to the main menu index when necessary.)

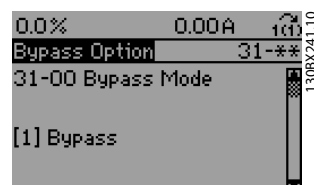


2. Press [▲] or [▼] to scroll through parameter groups. A dotted outline surrounds the selected group. Bypass options are found in parameter group 31-** *Bypass*.



3. Press [OK] to enter the selected parameter group.

4. Press [▲] or [▼] to scroll through the parameter list.



5. Press [OK] again to enter programming mode, which allows changing parameter options or data. Option is inverse highlighted.

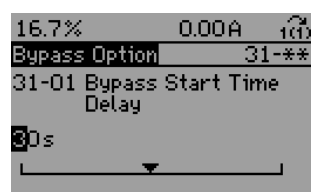
6. Press [▲] or [▼] to scroll through programmable options.

7. Press [OK] again to activate the selection or [Cancel] to cancel.

8. For entering numeric values, press [►] or [◄] to select numeric digit, then Press [▲] or [▼] to scroll through digit numbers 0-9. Selected digit is inverse highlighted.

9. Press [OK] to activate the selection or [Cancel] to cancel.

10. Press [Status] to return to operational display data or [Back] to return to parameter menu options.



6.1.5 ECB Hand/OFF/Auto

General Information

The [Hand on], [Off Reset], and [Auto on] keys on the 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.

Prior to Enabling Hand/OFF/Auto

- Complete the start-up procedure to verify that 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 [Off Reset] and [Drive Bypass], *Table 6.3* 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 the [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 the [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 the 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 No.	Key	Function
00-44	[Off Reset]	This disables or enables the [Off Reset] key on LCP. (0) disabled, (1) enabled, (2) password Default value is (1) enabled.
00-45	[Drive Bypass]	This disables or enables the [Drive Bypass] key on LCP. (0) disabled, (1) enabled, (2) password Default value is (1) enabled.

Table 6.3 LCP Control Keys Programming

6.1.6 ECB Mode of Operation

General Information

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

Prior to 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] to prevent operation of the motor.

Operation

- **Drive mode:** The motor is connected to and controlled by the drive. Contactors M1 and M2 are closed while contactor M3 is open. 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 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-**. See Table 6.4.

Par. No.	Selection	Function
31-00	Bypass Mode	Selects source of motor power. (0) Drive (drive mode) (1) Bypass (bypass mode)
31-01	Bypass Start Time Delay	Sets a delay time for starting in bypass that allows for external actions to take place prior to line starting the motor. 0-60 sec. (default value is 5 sec.)
31-02	Bypass Trip Time Delay	Setting a value other than 0 sec. enables auto bypass. Bypass trip delay sets the delay time before switching to bypass mode when the drive has a fault. 0-300 sec. (default is 0 sec. = OFF)
31-03	Test Mode Activation	Setting enabled puts bypass in test mode. See the manual for warnings and cautions. (0) disabled (default value) (1) enabled
31-10	Bypass Status Word	Read-only display, which shows the bypass status in hex. See the next table for details. 0, 216-1 (default value is 0)
31-11	Bypass Running Hours	Read only display which shows bypass running hours.

Table 6.4 Bypass Parameter Functions

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

Table 6.5 Parameter 31-10 Bypass Status Word Bit Definitions

6.1.7 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

1. 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

6.1.8 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.

Prior to 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 [Drive Bypass] and select drive mode.

Auto Bypass Function Setup

Enable auto bypass by changing parameters in group 31 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 sec. default or set as desired up to 60 sec.
- 31-02, *Bypass trip time delay*. Setting the timer at anything other than 0 time activates auto bypass. Leave at 5 sec. default or set as desired up to 60 sec.

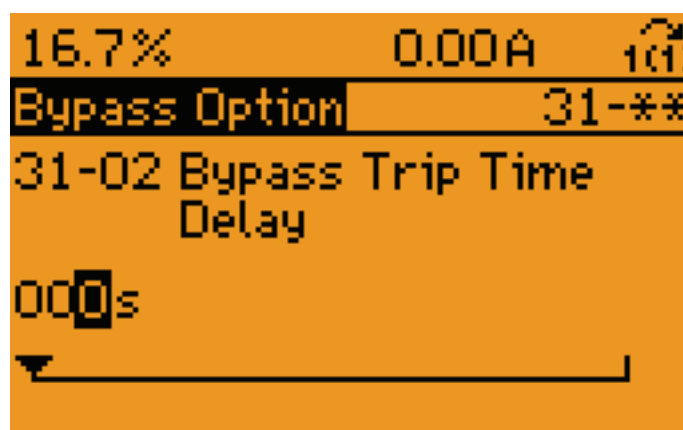


Figure 6.3 Bypass Trip Time Delay

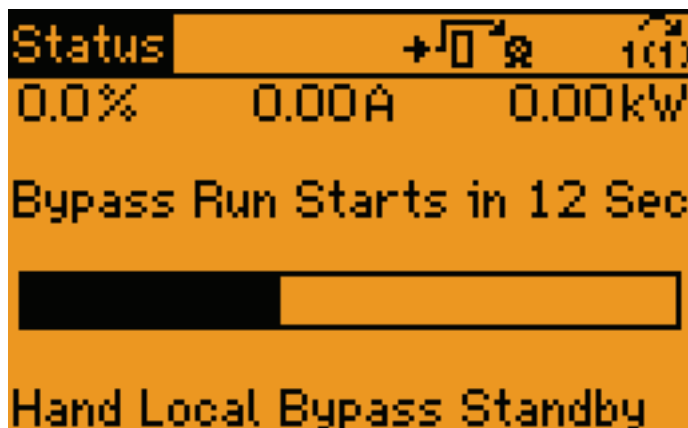


Figure 6.4 Drive Display with Bypass Start Time Delay Active

6.1.9 ECB Run Permissive

General Information

With run permissive active, the drive sends a run request and waits for a remote response 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.

Prior to 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.

6.1.10 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.

Prior to 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 the range of the current dial, reconfirm that the motor HP and voltage are within the option panel (and drive) rating. 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 the overload condition and let the overload and motor return to normal operating temperature before resetting. See motor manufacturer's recommendations for time between start attempts. Failure to correct the overload condition and let the 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 sec. or less at 600% current and normal operating temperature. This allows for high motor inrush current for 20 sec. 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.

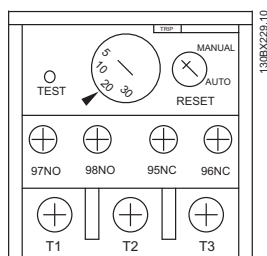


Figure 6.5 Sample Overload Device

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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 testing.
- 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.

6.1.11 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.

6.1.12 ECB Common Run/Stop

General Information

The common run/stop function provides remote run and stop control of the motor 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.

Prior to 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).

6.1.13 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.

Prior to 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 the command is removed or the unit fails.
- 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.

The drive monitors the ECB card communication and detects when communication stops. An ECB card failure or communication error could cause this. Contact Danfoss using the phone number on the back of this manual for technical support if this happens. The phone number can also be found on the label inside the panel cover.

Fault Reporting Function Setup

- Automatic function. No set up required.

6.1.14 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 keypad display, 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.

7 Start Up Troubleshooting

7.1.1 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 parameter 14-20, the system will either automatically reset this alarm or require the [Off Reset] key to be pressed.
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 7.1 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 parameter 31-01.
Bypass Activates in:	Indicates the number of sec. left until the system automatically activates Bypass Mode. Time delay can be adjusted using parameter 31-02.

Table 7.2 Panel Status Display (ECB only)

Start Up Troubleshooting

Vertical Bypass/Non Bypass Panel

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 7.3 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.

Start Up Troubleshooting

Vertical Bypass/Non Bypass Panel

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.

8 Appendix

8.1.1 Dimensions

	P2 NON-BYPASS	P2 BYPASS	P3 NON-BYPASS	P3 BYPASS	P4 NON-BYPASS	P4 BYPASS	P5 NON-BYPASS	P5 BYPASS
A	8.86 [225.0]	9.11 [231.4]	9.57 [243.0]	9.57 [243.0]	12.69 [322.3]	12.69 [322.2]	15.13 [384.3]	15.13 [384.2]
A1	6.66 [169.1]	-	-	-	-	-	-	-
B	29.92 [759.9]	41.77 [1061.0]	34.33 [872.0]	43.23 [1098.0]	39.58 [1005.4]	54.38 [1381.4]	45.79 [1163.1]	59.64 [1514.9]
C	11.45 [290.9]	15.94 [405.0]	11.23 [285.2]	17.70 [449.6]	14.78 [375.5]	17.99 [457.0]	14.78 [375.4]	18.01 [457.5]
D	-	1.10 [28.0]	0.59 [15.0]	0.59 [15.0]	0.59 [15.0]	0.59 [15.0]	0.59 [15.0]	0.59 [15.0]
a	5.51 [140.0]	7.87 [200.0]	7.87 [200.0]	7.87 [200.0]	10.63 [270.0]	10.63 [270.0]	12.99 [330.0]	12.99 [330.0]
b	28.80 [731.5]	41.02 [1042.0]	32.13 [816.0]	41.18 [1046.0]	37.32 [948.0]	51.89 [1318.0]	43.54 [1106.0]	57.09 [1450.0]
c	0.27 [6.8]	0.27 [6.8]	0.33 [8.5]	0.33 [8.5]	0.33 [8.5]	0.33 [8.5]	0.33 [8.5]	0.33 [8.5]
d	0.39 [10.0]	0.43 [11.0]	0.47 [12.0]	0.39 [10.0]	0.47 [12.0]	0.59 [15.0]	0.47 [12.0]	0.59 [15.0]
e	0.49 [12.5]	0.65 [16.5]	0.72 [18.4]	0.61 [15.5]	0.91 [23.0]	0.75 [19.0]	0.94 [24.0]	0.79 [20.0]
f	0.27 [6.9]	0.27 [6.8]	-	-	-	-	-	-
g	0.47 [12.1]	0.47 [12.0]	-	-	-	-	-	-
h	0.49 [12.5]	0.65 [16.5]	-	-	-	-	-	-
j	0.31 [8.0]	0.31 [8.0]	-	-	-	-	-	-
k	0.32 [8.0]	0.31 [8.0]	-	-	-	-	-	-

8.1.2 Mechanical Diagrams

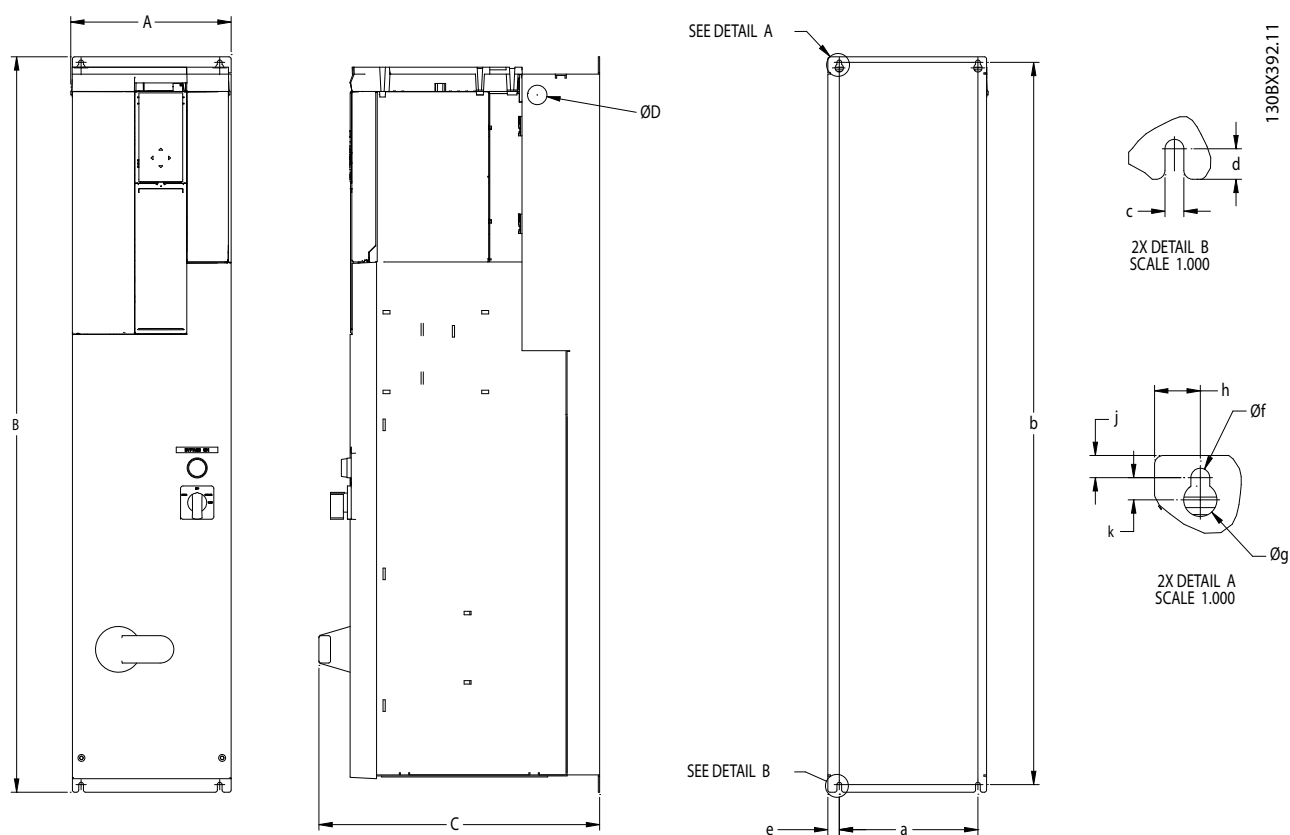


Figure 8.1 P2 Bypass

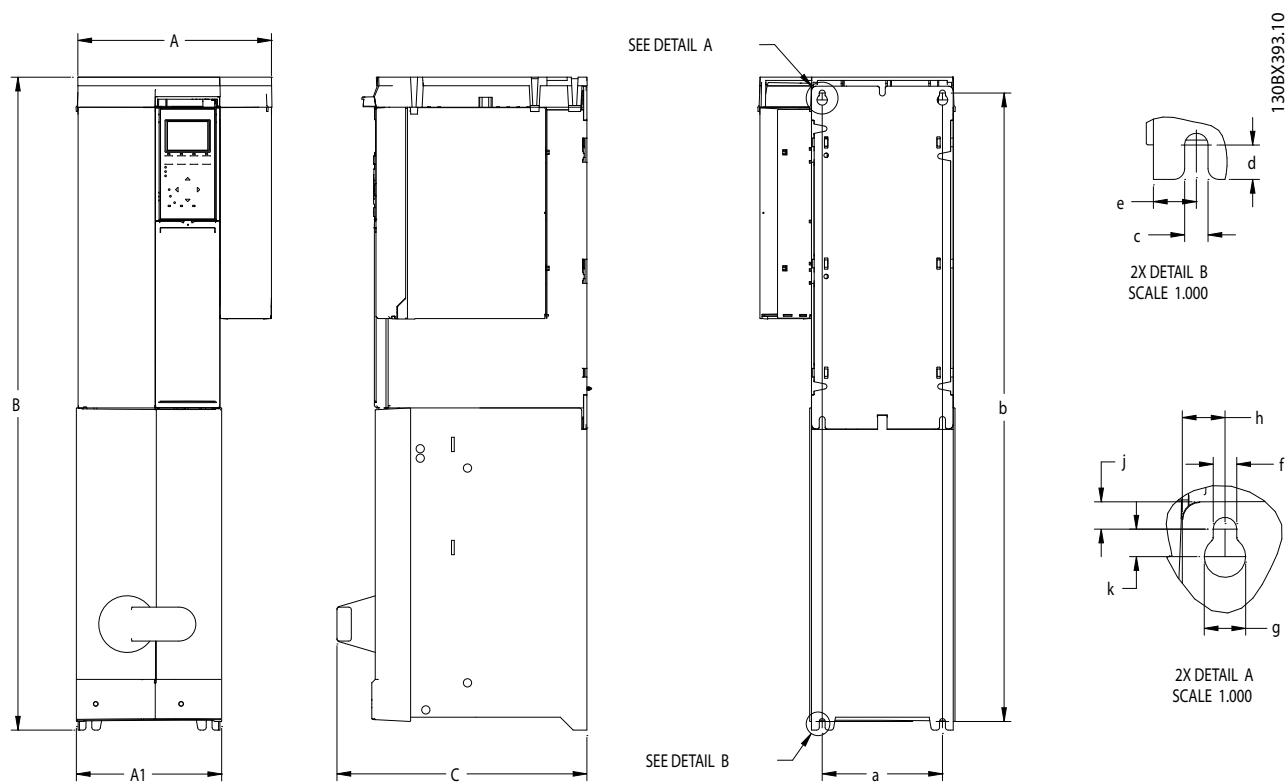


Figure 8.2 P2 Non-bypass

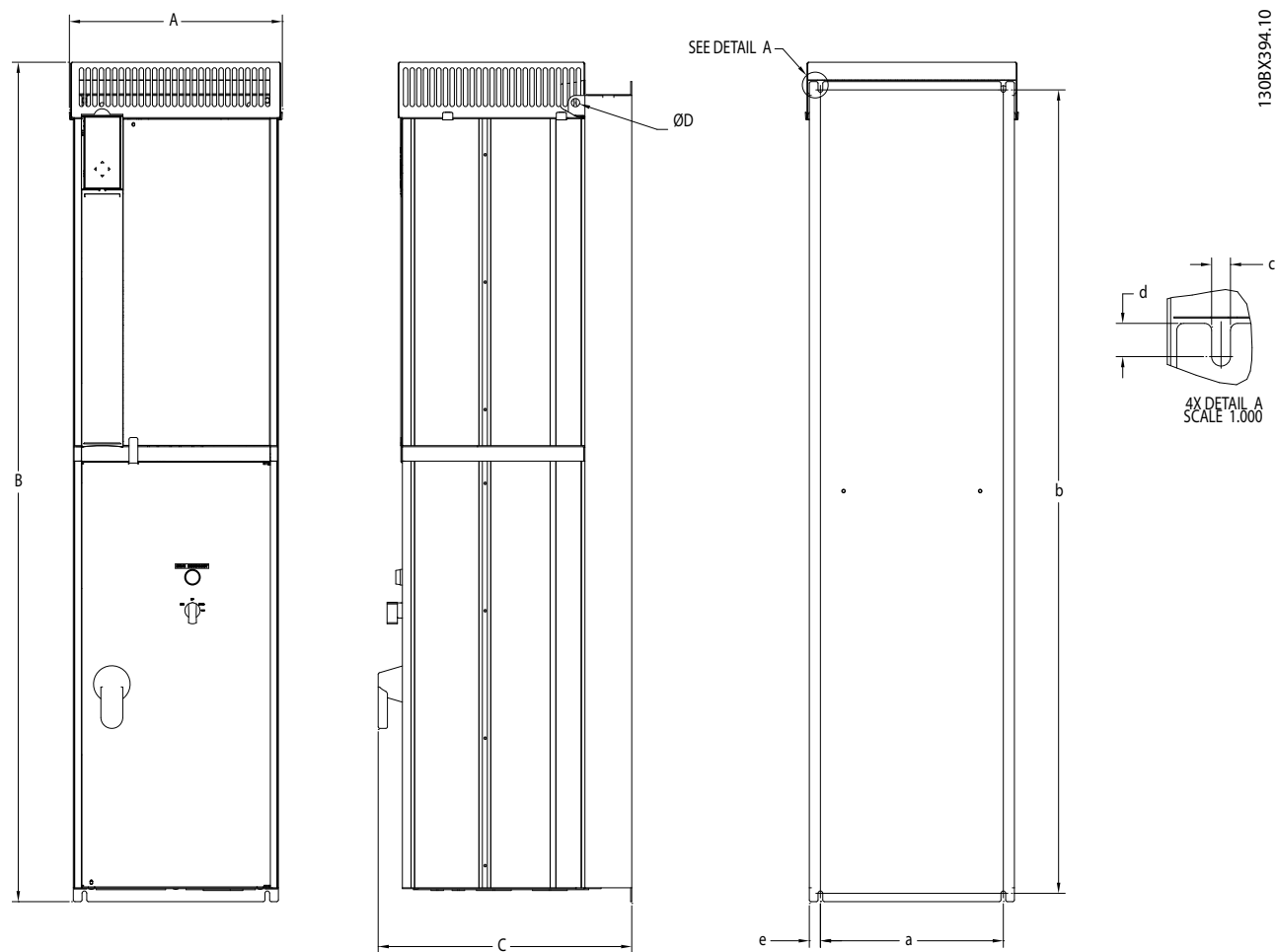


Figure 8.3 P3 P4 P5 Bypass

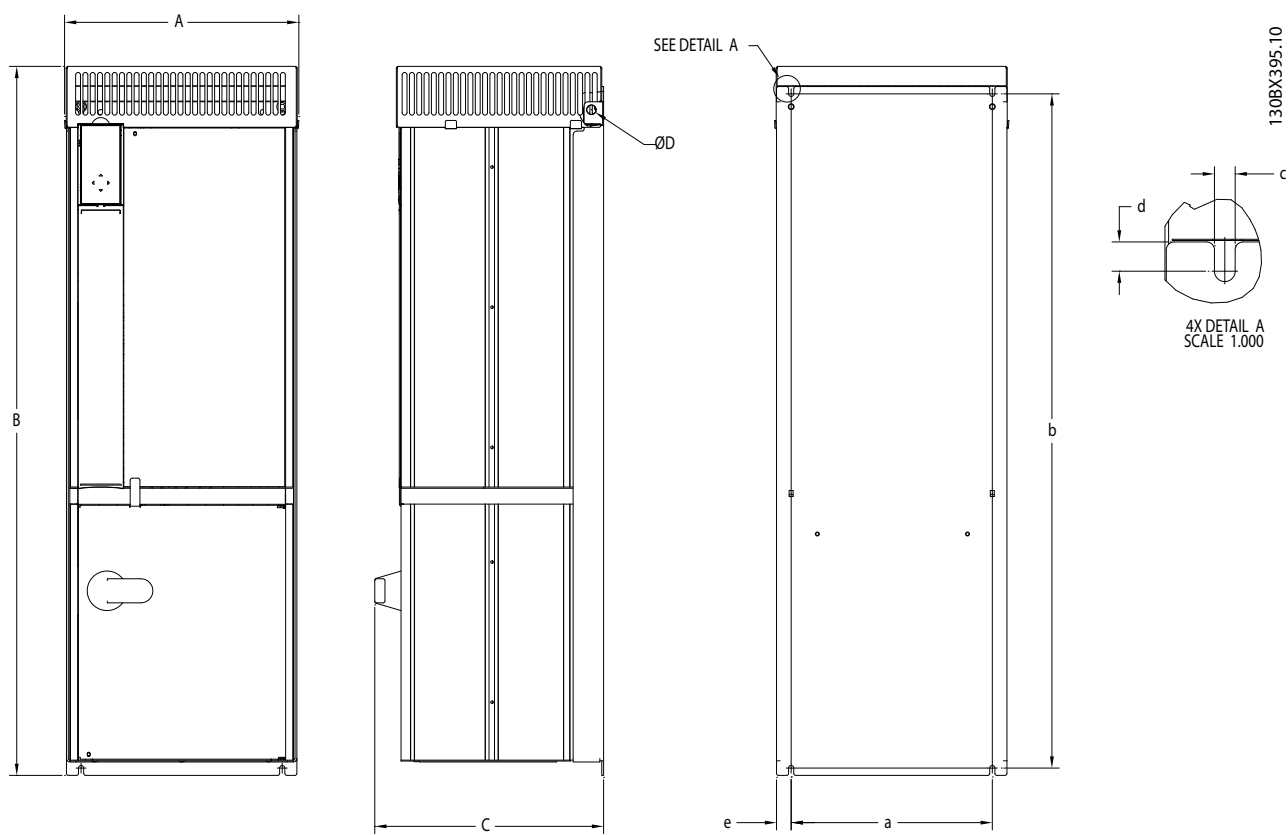


Figure 8.4 P3 P4 P5 Non-bypass

8.1.3 Typical Wiring Diagrams

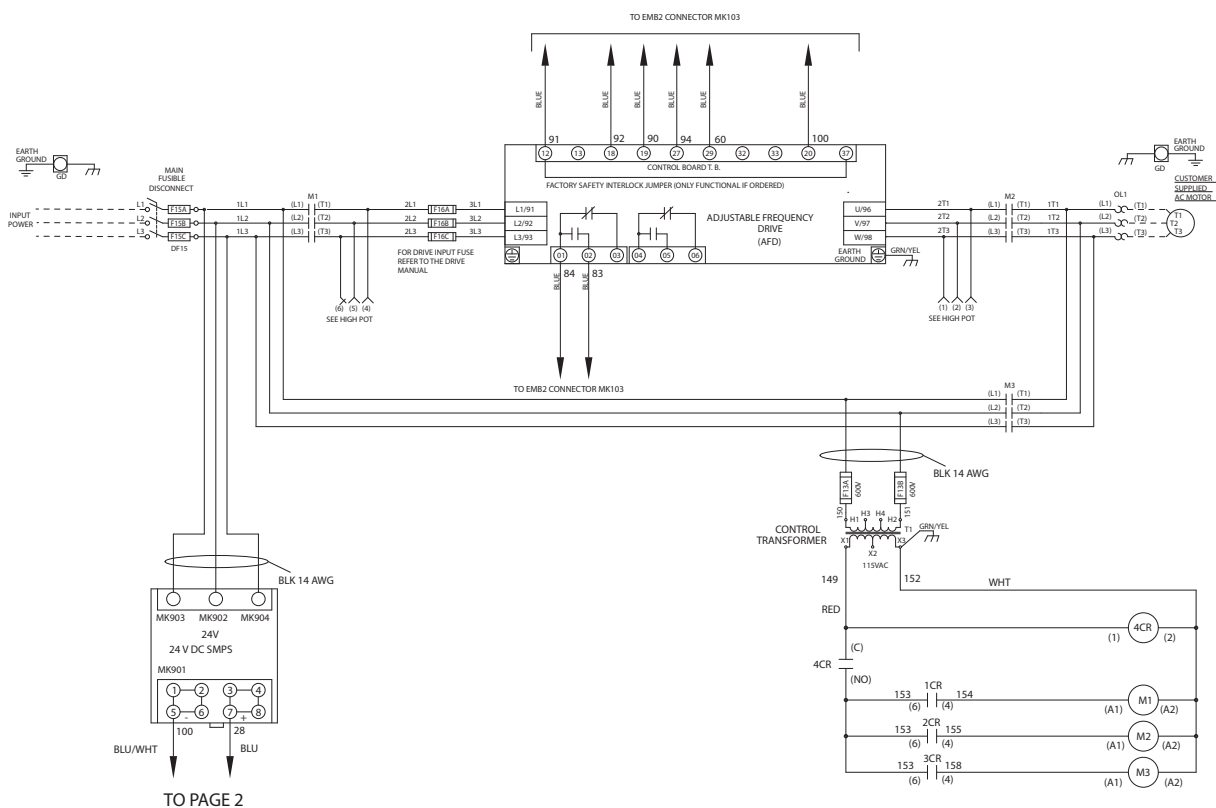


Figure 8.5 EMB2 with Control Relay, Part 1

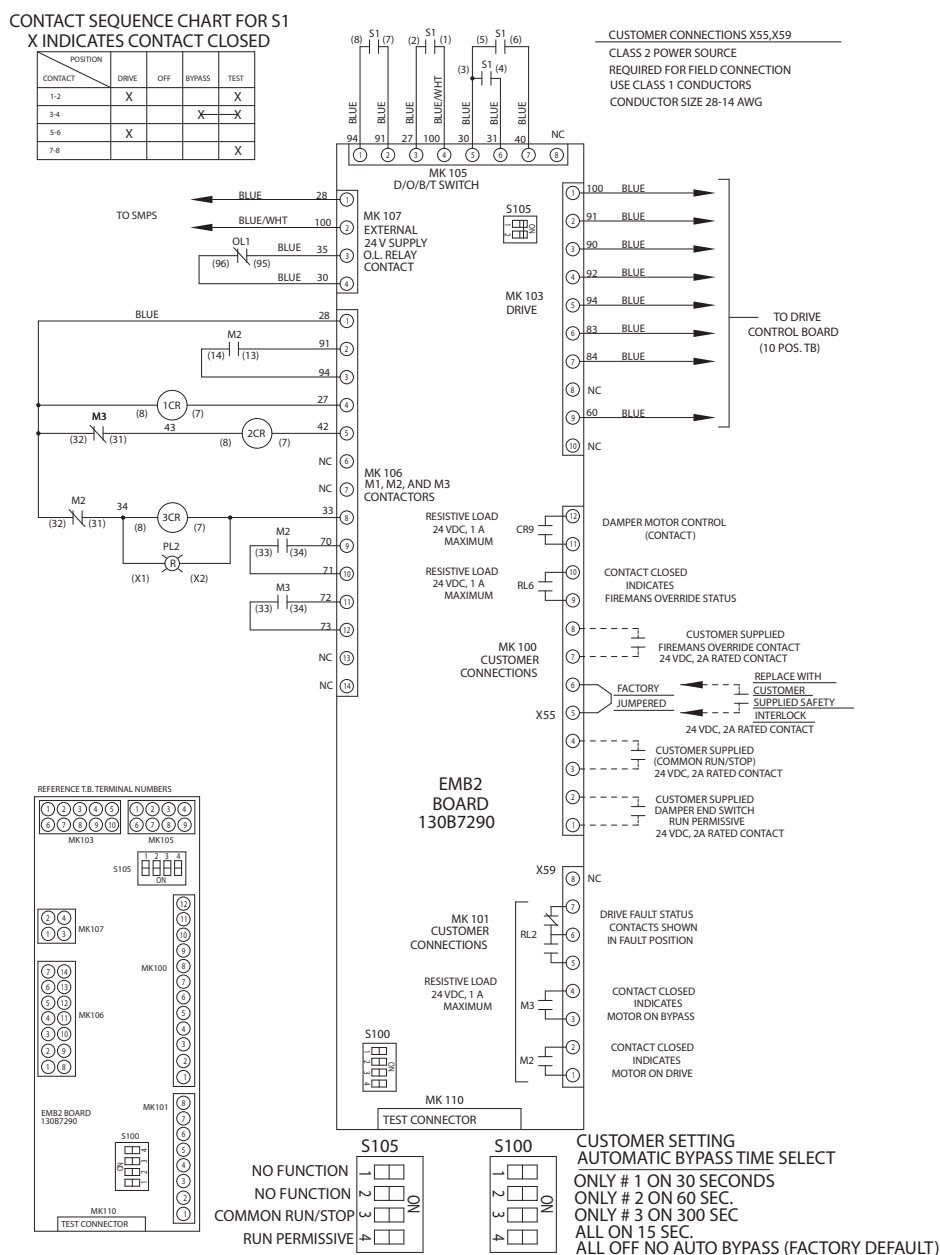
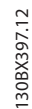


Figure 8.6 EMB2 with Control Relay, Part 2



8

CONTACT SEQUENCE CHART FOR S1
X INDICATES CONTACT CLOSED

CONTACT	POSITION	DRIVE	OFF	BYPASS	TEST
1-2		X			X
3-4				X	X
5-6		X			
7-8					X

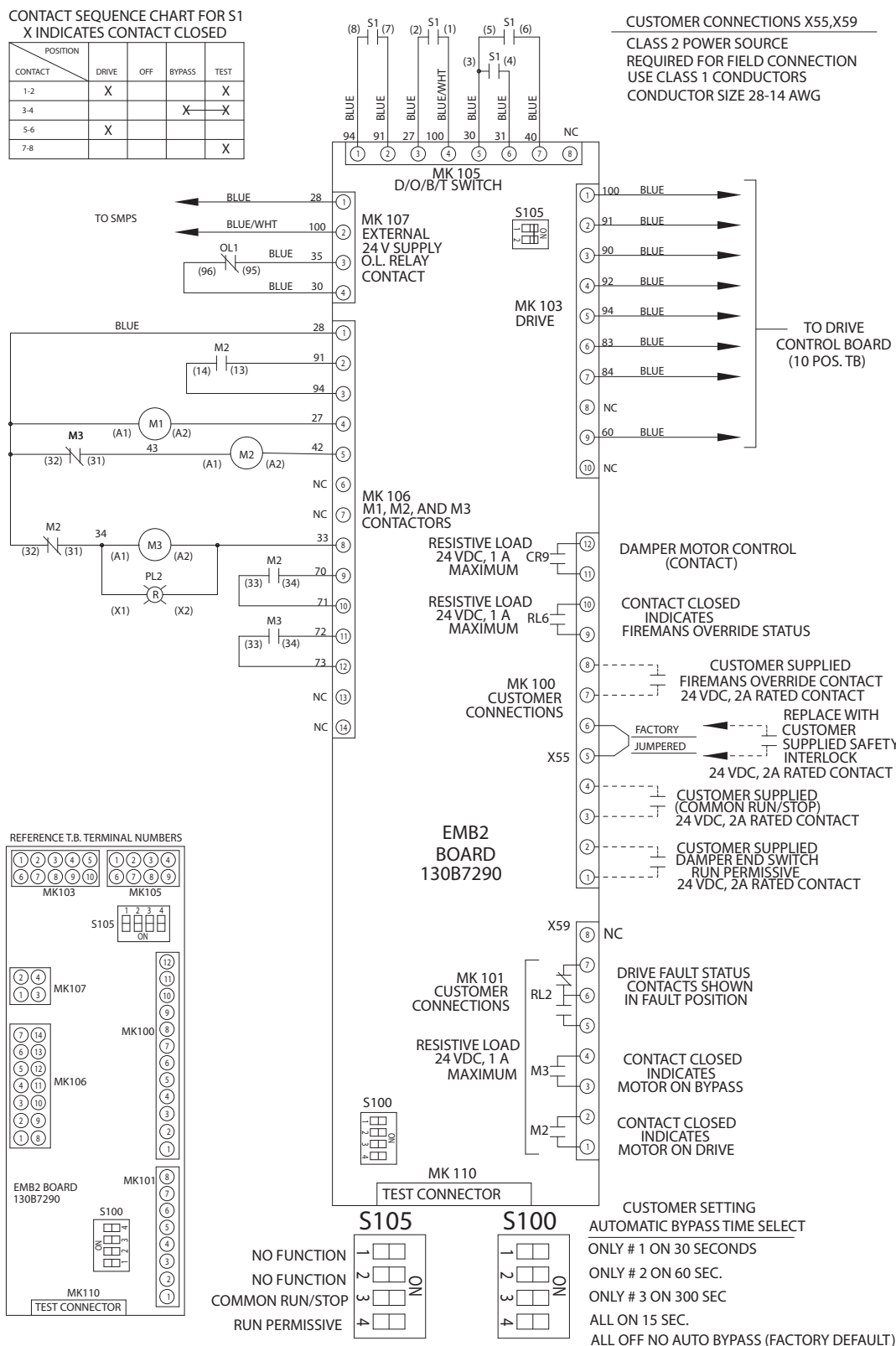


Figure 8.8 EMB2, Part 2

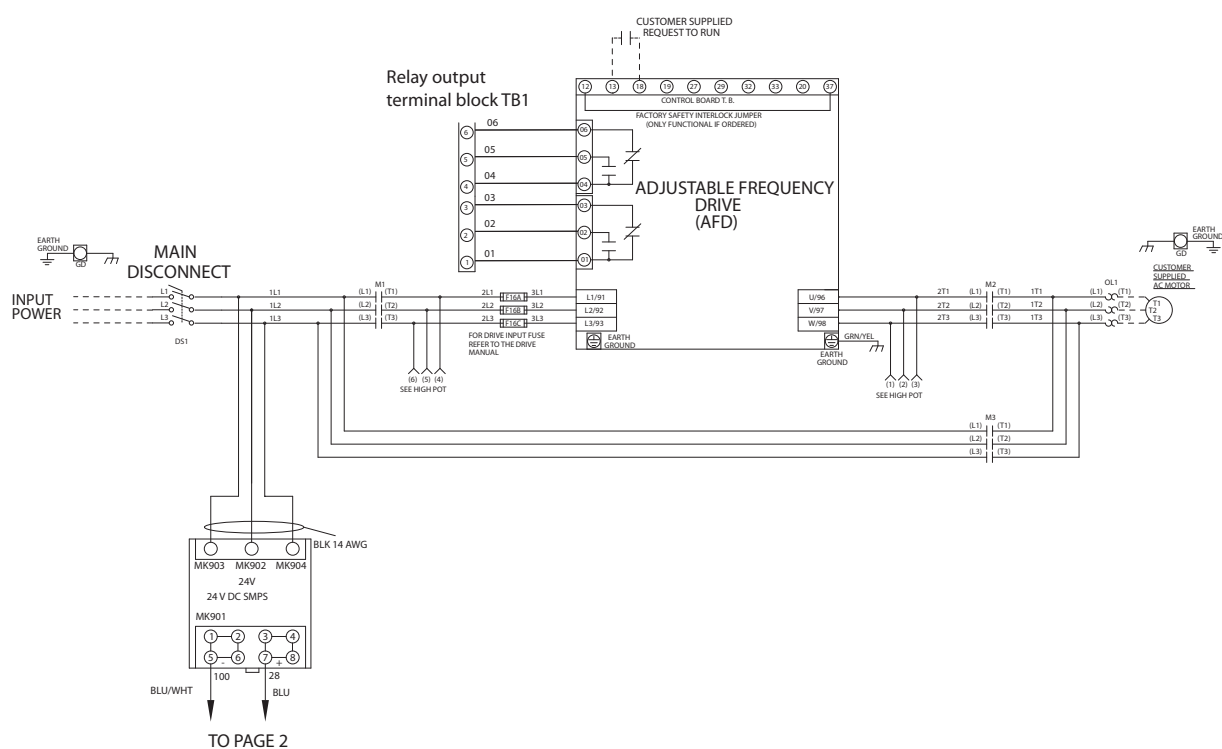


Figure 8.9 ECB, Part 1

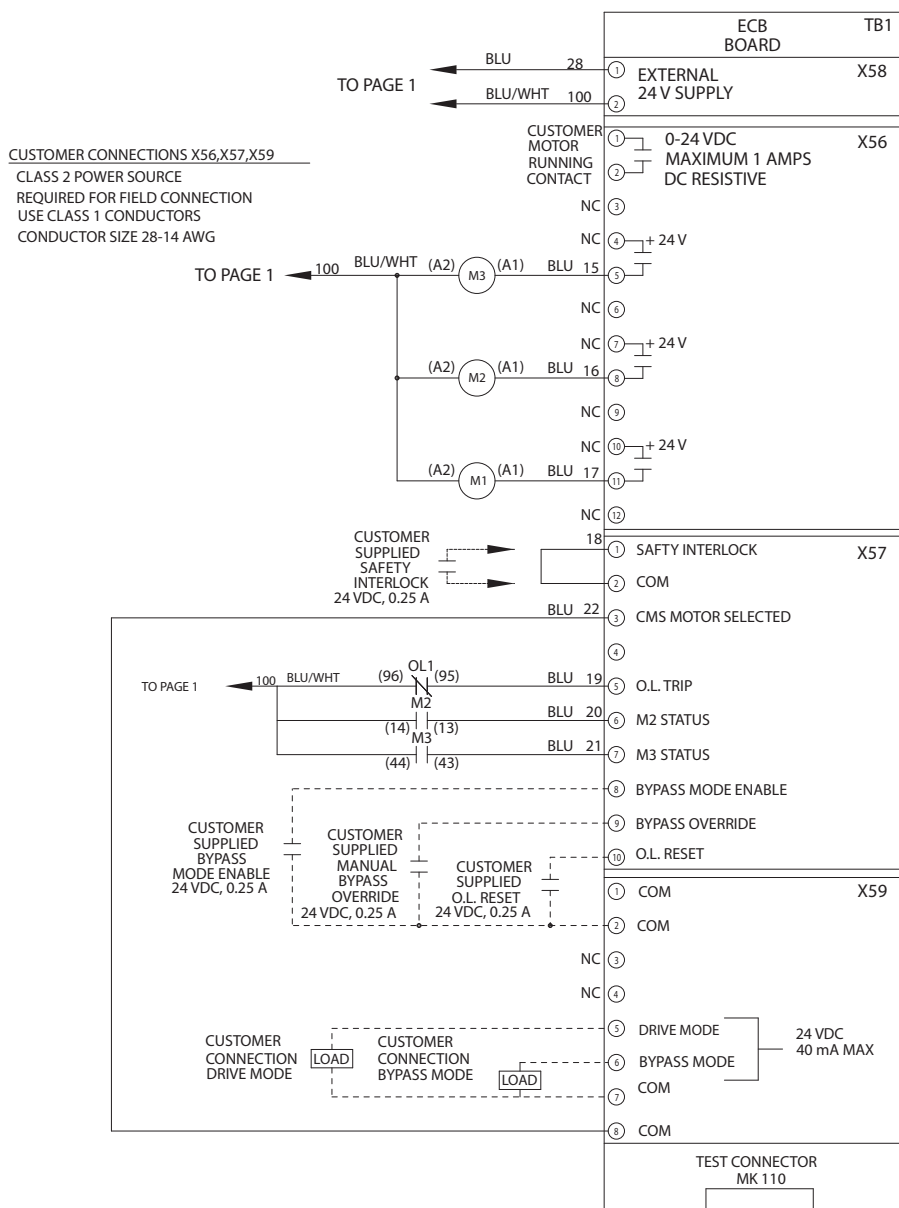


Figure 8.10 ECB, Part 2

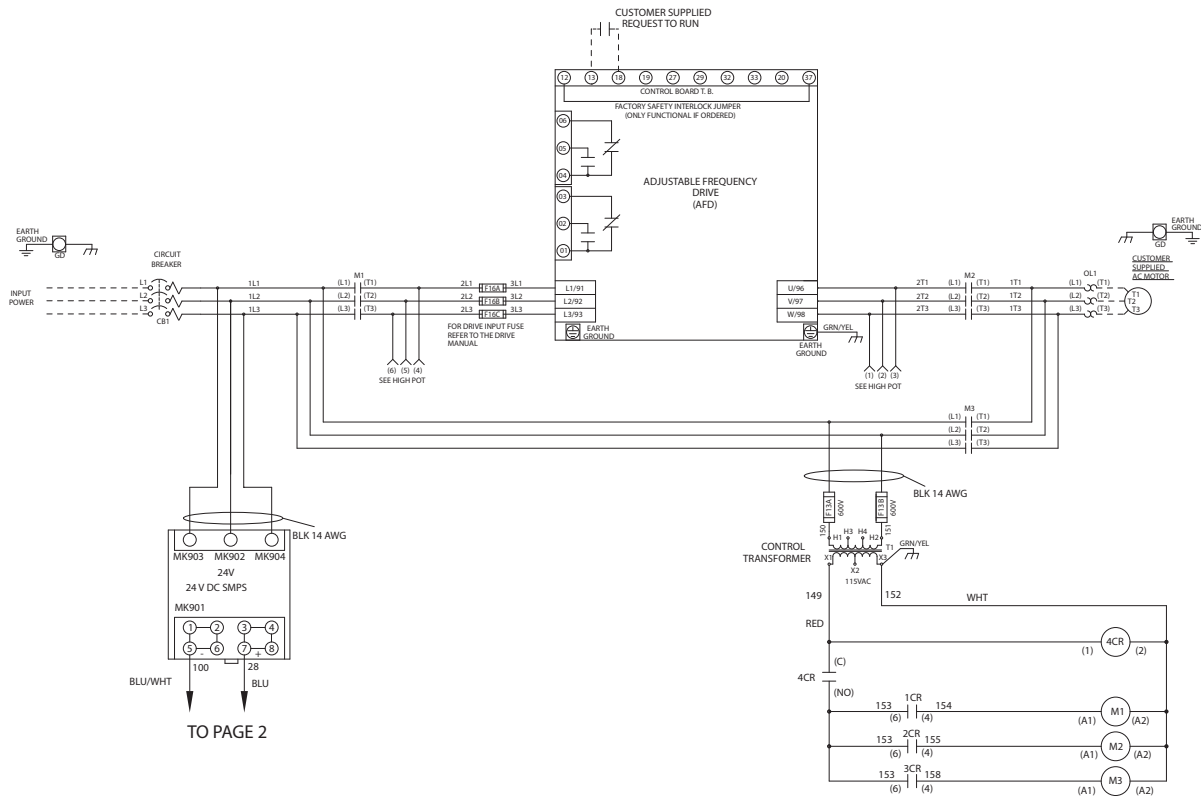


Figure 8.11 ECB with Control Relays, Part 1



Figure 8.12 ECB with Control Relays, Part 2

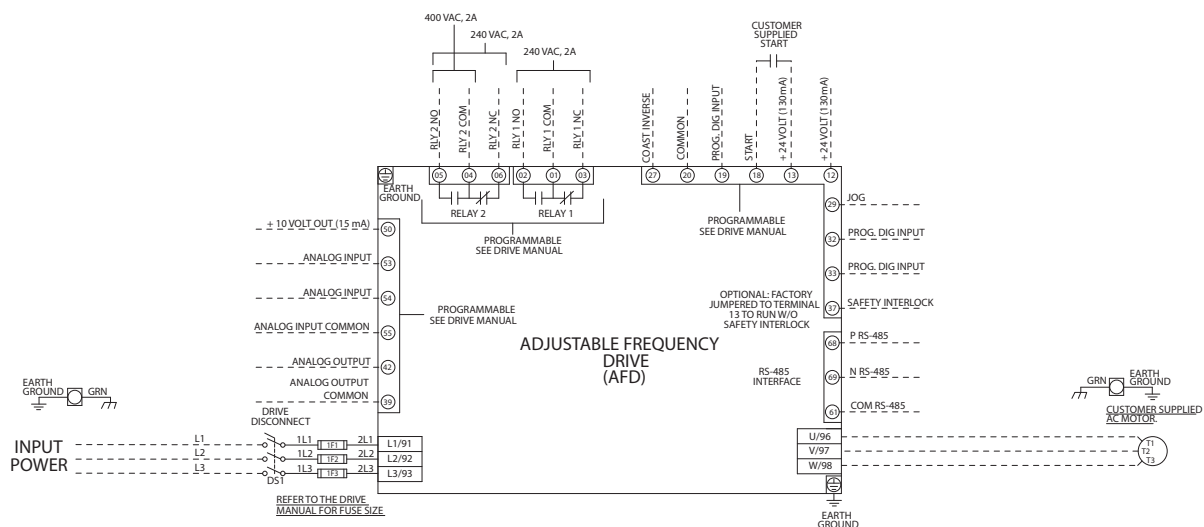


Figure 8.13 Non-bypass



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4401 N. Bell School Rd.
Loves Park IL 61111 USA
Phone: 1-800-432-6367
1-815-639-8600
Fax: 1-815-639-8000
www.danfossdrives.com

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