Code No. LIT-12012112

JC-VSD FP Series II Engineering Guide

0.5 - 50 HP **208 - 240 VAC**
0.5 - 125 HP **380 - 480 VAC**

Johnson Controls

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Introduction

JC-VSD Series II FP

Johnson Controls has led the HVAC industry in variable speed drive (VSD) technology since 1979 with the introduction of the Turbo-Modulator – the variable speed drive specifically designed for centrifugal chiller application. The Johnson Controls involvement in applying electronics to HVAC technology exceeds that of any other company either in the HVAC industry or the electronics industry. Since 1983, when the Air-Modulator was introduced, Johnson Controls has successfully applied thousands of these drives to fans, pumps, and cooling towers providing exceptional energy savings, high-reliability, and performance.

This JC-VSD Series II FP guide is intended as a reference to application and installation information for the HVAC design engineer. The content of this guide provides general theory of operation, application information, key design parameters, and complete specifications.

Why Variable Speed?

Centrifugal fans and pumps are commonly used in HVAC equipment. Because of their centrifugal design, any reduction in the speed at which the fan or pump operates causes a cubic reduction in the horsepower the motor requires. This is represented by the following equation:

$$\frac{(RPM_2)^3}{(RPM_1)^3} = \frac{(HP_2)}{(HP_1)}$$

Example

SPEED%	HP%
100%	100%
90%	73%
80%	51%
70%	34%
60%	22%
50%	13%
40%	7%
30%	3%

This shows that a 10% reduction in the RPM of the fan or pump results in a 27% reduction in horsepower required. Therefore, a means by which the RPM or speed of the fan or pump could be reduced would produce significant energy savings. The JC-VSD FP Series II provides such a means by varying the speed of the fan or pump motor.

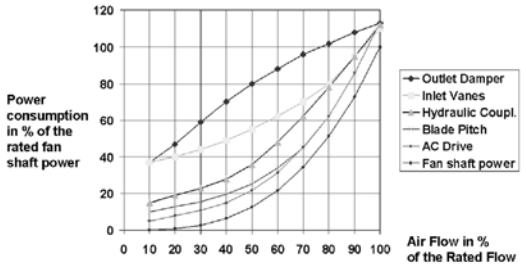
What is a Variable Speed Drive?

A variable speed drive is an electronic device which changes the speed of a motor by changing the frequency and voltage fed to the motor. An AC motor runs at a speed proportional to the frequency applied, as described in the following formula:

$$\text{Synchronous motor speed} = \frac{120 \times \text{frequency}}{\text{Number of motor poles}}$$

The speed is dependent on the frequency; a change in frequency will change the motor speed. The AC motor, however, must also have the voltage vary in the same proportion as the frequency to maintain full torque capabilities throughout the speed range. Therefore, a variable speed drive must change both the frequency and the voltage of the power fed to the motor to vary speed while maintaining torque for the required load.

Fan Power with Different Air Volume Control Methods



Product Description

JCI-VSD FP Series II

The FP Series II is Johnson Controls Low-Voltage AC Drive for the control of three-phase AC motors. Johnson Controls applies this product regularly on YORK® Air Handlers. These AC Drives are also available through YORK® for sale on other HVAC Drive applications. This affords users with the opportunity to have one feature rich AC drive applied throughout a facility for HVAC requirements, with minimal familiarization training, parts and service, allowing Johnson Controls to provide for your total service needs.

The FP Series II is an adjustable frequency AC drive designed specifically for the HVAC market that achieves the ultimate in flexible motor control performance.

With drives ranging from 1 to 125 HP, the FP Series II features an 'intuitively obvious' multi-lingual, full graphic display panel that also provides an assistant to aid users in start-up. The control panel can be mounted on the cover of the drive, or remotely, and can upload, store, and download parameters.

The FP Series II can be used for the simplest to the most demanding HVAC applications. Two integral option slots can be configured with additional relay outputs as well as a host of different communication bus adapters.

The FP Series II has a 110% short term overload rating for one (1) minute out of ten (10) and is capable of 150% short-term overload rating for 2 seconds out of each minute.

Our Active Energy Control algorithm provides best-in-class energy efficiency utilizing patented dynamic V/Hz energy optimization software.

JCI-VSD Series II (Base Drives)

The JCI-VSD Drive is available from 1 to 50 HP in 208/230/240V, and 1 to 125 HP in 380/400/415/440/460/480V, input voltages. The JCI-VSD Drive has six frame sizes (FR4 to FR9) designed for wall mounting. The JCI-VSD Drive has a control panel for user interface, parameter adjustment and drive operation mounted on the front of the drive.

The front section of the JCI-VSD contains the electronics, power and control wire terminals. The rear section forms a cooling channel. The two section construction allows the unit to be installed protruding through a wall, or through the rear wall of a customer supplied enclosure using additional hardware, placing the rear section in a cooling air duct to minimize the heat inside the cabinet. In standard installations, the drive is mounted directly onto a wall. Conduit openings (knock-outs) are provided for bottom and side conduit entry. When mounting inside a customer-supplied cabinet, the conduit box plate is not required.

JCI-VSD FP Series II (Drive with Input Disconnect)

The FP Series II Drive input disconnect is either a fused or non-fused input disconnect switch. The FP Series II is available in a wall mounted enclosure from 1 to 50 HP at 208/230V, and 1 to 125 HP at 460V input voltages. The FP Series II Packaged Drive comes in a standard NEMA 1 galvanized steel enclosure or a NEMA 3R painted product. The FP Series II Packaged Drive has the NEMA 1 base drive mounted on the top of a back panel allowing access to the drive control panel for user interface.The FP Series II Drive provides an enclosed disconnect with door-mounted operator (padlock-able in the OFF position), electronic motor overload protection (provided from the base drive), and provisions for external control connections. Conduit openings (knock-outs) are provided for bottom rear conduit entry. Complete, pre-engineered packages reduce time, effort and the cost of installing the popular drive disconnect option.

When supplied with the UL Type 3R/NEMA 3R Outdoor duty package, the disconnect options and features remain the same as the NEMA 1 unit except for the following:

The NEMA 3R FP Series II is provided in a wall mounted YORK® champagne brown enclosure from 1 to 50 HP at 208/230V, and 1 to 125 HP at 460V. The FP Series II NEMA 3R is provided with control panel for user interface, parameter adjustment and drive operation mounted on the front of the drive protected by a control panel door. The control panel is not visible with the control panel door closed. Conduit openings (knock-outs) are provided for at the bottom and rear of the enclosure. Complete, pre-engineered package drives reduce time, effort and the cost of installing the popular drive disconnect option.

When applying the NEMA 3R enclosure for outdoor duty, keep in mind the package is rated for operation in the direct sunlight from 0°F to 104°F. With the standard derate it may be applied up to 124°F. Note that power must be applied for the space heater for Low Temperature Option to operate and keep the drive warm to allow it to start in cold conditions.

JCI-VSD FP Series II (Drive with Classic Bypass)

The FP Series II Drive with classic bypass is packaged with a fused or nonfused input disconnect switch and a two contactor bypass function that allows the motor to be run at full voltage in the event the drive is shut down for service. The bypass function is configured entirely of standard industrial control components. It includes two mechanically interlocked contactors, a motor overload relay, a control power transformer with primary and secondary fusing, and cover mounted Hand-Off-Auto switch and Drive-Off-Bypass selector switch. Bypass is accomplished by means of the two contactors. One is the bypass contactor used to connect the motor directly to the power line. The other is the drive output contactor that disconnects the motor from

the drive output when operating in the bypass mode. This prevents the "back feeding" that would occur if line voltage were applied to the drive output terminals. The drive output contactor and the bypass contactor are mechanically interlocked to prevent simultaneous operation. Motor overload protection in the bypass mode is provided by a Class 20 motor overload relay. FP Series II Drive W/ Bypass Packages include either a fused or non-fused input disconnect switch with a door mounted external operating handle that is interlocked with the enclosure door and lockable in the OFF position with up to three padlocks. The multi-lingual, alphanumeric drive control panel is mounted on the enclosure door. The drive service switch isolates the drive from the power source for service and provides superior functionality to a three-contactor arrangement.

Drive with Bypass Packages are available in NEMA 1 galvanized steel 1 to 50 HP at 208/230V, and 1 to 125 HP at 460V. Conduit openings (knock-outs) are provided for top/ bottom/ rear conduit entry. Complete, pre-engineered packages reduce time, effort and the cost of installing the popular drive bypass option.

When the FP Series II is provided with the NEMA 3R enclosure option, it is provided in a YORK® champagne brown enclosure. The multi-lingual, alphanumeric drive control panel is mounted on the enclosure door behind a control panel door to protect it from the elements. The control panel is not visable with the control panel door closed. Conduit openings (knock-outs) are provided for at the bottom and rear of the enclosure.

Application Considerations

Because of the variety of uses for the FP Series II, those responsible for the application and control of these drives must satisfy themselves that all necessary steps have been taken to insure that they meet all performance and safety requirements regarding national and local laws, regulations, codes and standards. Unless otherwise noted, FP Series II products found in this Engineering Guide are designed to meet NEMA (National Electrical Manufacturers Association) standards. FP Series II products also carry third party approvals through UL and cUL. Approval for installation in a CE first environment, restricted distribution is also provided with the FP Series II base drive and these products carry the CE mark. The FP Series II Drive with input disconnect or classic bypass are supplied for UL/cUL and are not provided with a CE mark. These listings are based on standard product and any exceptions to this will be noted in the appropriate section.

Branch Circuit Protection (Series II Base Drive)

The Series II base drive does not include a disconnect device. A means to disconnect input power must be installed between the AC power source and the Series II base drive. This branch circuit protection must:

- Be sized to conform to applicable safety regulations, including, but not limited to, both National and local electrical codes.
- Be locked in the open position during installation and maintenance work.

The disconnect device must not be used to control the motor. Instead use the control panel, or commands to the I/O terminals for motor control. Cycling the disconnect device cycles power to the drive's DC capacitors. These capacitors have a maximum limit of 5 cycles in ten minutes.

Fuses

See JC-VSD FP Series II Installation Manual (LIT-12012114) for fuse recommendations for short circuit protection on the drive's input power. These recommendations are not requirements if branch circuit protection is otherwise provided per NEC. UL508A manufacturers are not required to use the recommended fuses for the purpose of UL listing a panel that includes the FP Series II.

Branch Circuit Protection (JCI-VSD Drive with Input Disconnect or Classic Bypass)

The FP Series II Drive with Fused Disconnect or Fused Disconnect and classic bypass is supplied with a means to disconnect input power sized per UL508A, and the disconnect is lockable in the open position.

The FP Series II Drive with Non-Fused Disconnect or Non-Fused Disconnect and classic bypass is supplied with a means to disconnect input power sized per UL508A, and has not been provided with branch circuit fusing. To maintain the 100 KA UL short circuit rating, class J or RK1 fuses must be supplied electrically ahead of the enclosed drive and sized to conform to applicable safety regulations, including, but not limited to, both National and local electrical codes.

Selecting the Correct Drive Capacity

All FP Series II drives are current rated devices. The HP ratings provided are for reference only and are based on typical 4-pole motors at nominal voltages (NEC Table 430-150). If full motor torque is required, ensure the drive has a continuous current rating equal to, or greater than, the full load amp rating of the motor.

Application

General Application Considerations

Horsepower Range

The Johnson Controls VSD FP Series II is a complete product line covering the nominal horsepower sizes from 0.5 HP to 125 HP for 380 to 480V/3-Phase, and 0.5 HP to 50 HP for 208V to 240V/3-Phase. This one product line can be used for the smallest return fan or the largest chilled water pump. The critical sizing parameter is the output current rating of the drive (listed on pages 23- 26). The nameplate FLA rating of the motor(s) should not exceed the output current rating of the drive at 208, 230, 380, or 460-480VAC.

FP Series II are designed with sufficient current capacity to be applied to high efficiency motors. The current capacity complies with the industry's Energy Policy Act (EPACT) motor full load amp ratings. FP Series II FLA output ratings meet or exceed Table 430-150 of the National Electric Code® 1993.

Power Supply

The FP Series II is designed for nominal 380V to 480V (+10%), 48-63 Hz input power, or 208V to 240V (-15%), 48-63 Hz. For other power supply systems, a step transformer should be used. The minimum required kVA rating of the transformer must be calculated as follows:

Transformer kVA =

$$\frac{1.732 \times \text{Line to Line Voltage} \times \text{VFD Input Amps}}{1000}$$

Power factor correction capacitors are not required as the FP Series II maintains a .98 power factor at nominal load.

Example:

399.05 kVA =

$$\frac{1.732 \times 480 \times 480}{1000}$$

In this example the drive is supplied with 480V AC and rated for 480 amps. Based upon the calculation a 400 KVA isolation transformer would be required for the example above. When requesting information from the transformer vendor let them know that 100% of the transformer load will be a variable speed drive.

Location

FP Series II are designed for indoor location, in a NEMA-1 classification area, having 5°F to 104°F (-15°C - 40°C) ambient temperature limits. The relative humidity of the area should be between 0% to 90% non-condensing.

Sufficient clearance (as noted in the dimensional section) to permit normal servicing and maintenance should be provided around the entire unit.

Power Wiring

The FP Series II is equipped with power lugs for easy connection of power wiring. Maximum wiring size for each FP Series II is listed in the power and control wiring drawing, Form 100.04-PA1.2. A single point ground connection is provided in the FP Series II. Power wiring should be sized and installed in accordance with the National Electrical Code (N.E.C.). Copper wire is required for all power wiring connections to the FP Series II.

⚠ WARNING

DO NOT USE ALUMINUM WIRE.

VSD FP Series II Terminals Are Not Rated for Use with Aluminum Wire

For wiring and fuse sizing purposes, follow the guidelines for Rated Input Current and Max Prefuse Amps listed in Performance Data.

Control Wiring / Interface

Johnson Controls provides as standard on FP Series II a single point control interface which accepts standard control signals (4-20mA, 0-10VDC) mounted in the unit. Also available for factory mounting is a pneumatic control interface which accepts a standard 3-15 PSIG control signal.

NOTE

For 380V, 50Hz applications size VFD for FLA that meet or exceed motor FLA.

Fan Applications

Theory of Operation

Variable Air-Volume (VAV) systems have long been accepted as the energy efficient air distribution method. Johnson Controls and other HVAC suppliers have, traditionally, offered Variable Inlet Vanes (VIV) on air handling units to provide this variable air volume capability. VIVs unload the fan by adding a pre-swirl to the air as it enters the fan in such a way as to provide a reduction in head pressure across the fan and a decrease in air flow rate. This causes a change in the operating point of the fan on the system curve (Figure 1) and a subsequent reduction in the horsepower drawn by the fan motor.

Alternatively, the FP Series II unloads the fan by slowing it down. This shifts the RPM curve on which the fan operates. By reducing the RPM curve, the operating point now requires significantly less brake horsepower than a system using VIVs. This is shown in Figure 2. The part load performance comparison is shown in Figure 3.

Application

Variable speed drives can be applied to forward-curved, airfoil or backward-inclined centrifugal fans. When retrofitting the FP Series II to a fan with existing VIVs, the VIVs should either be removed or locked into the wide open position. Leaving the vanes on the fan will require the fan to use more power than if they were removed. The power penalty can range from 5% to 25% of FLA depending on fan size and velocity of air across the vanes. The smaller the fan, the higher the penalty.

Sequence of Operation

The typical variable speed air system is depicted in Figure 4. It consists of an air handling unit being controlled by an FP Series II, duct work, and standard temperature controls. Under full load conditions, the fan is running at full speed and the discharge dampers are fully open, allowing the maximum amount of cooling into the space. As the cooling diminishes, the temperature controls send a signal to the dampers to close; this increases the static pressure in the duct work. A static pressure sensor in the duct work sends a signal through a receiver/controller to the FP Series II, telling it to slow down the motor proportionally.

The reduced motor and fan speed matches the air flow to the space temperature. As the space temperature rises, the dampers open lowering the duct static pressure. A reduction in static pressure will cause the FP Series II to increase the speed of the motor, again matching the air flow to the space temperature.

Figure 1. Fan Curves with Inlet Vane Control

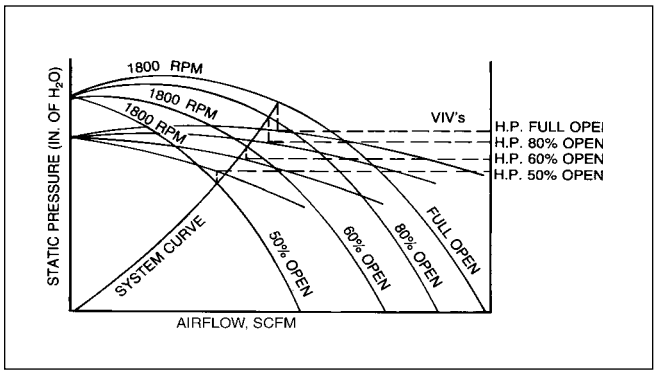


Figure 2. Fan Curves with Variable Speed Control

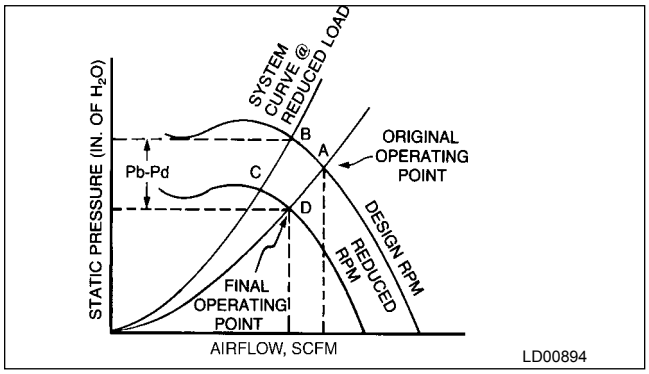


Figure 3. Air-Mod Part Load Performance

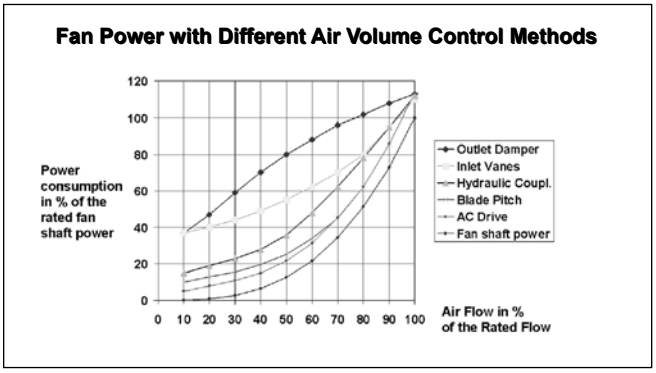
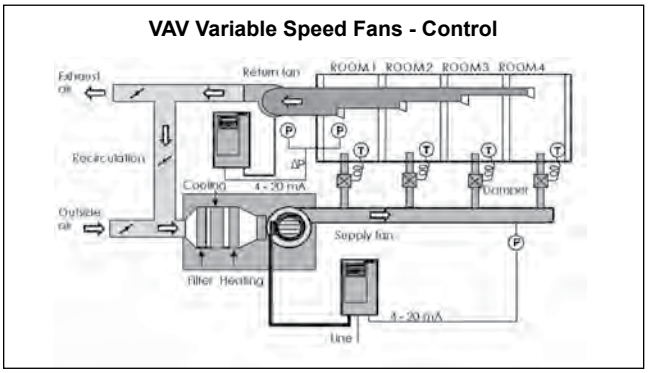


Figure 4. Typical VAV System

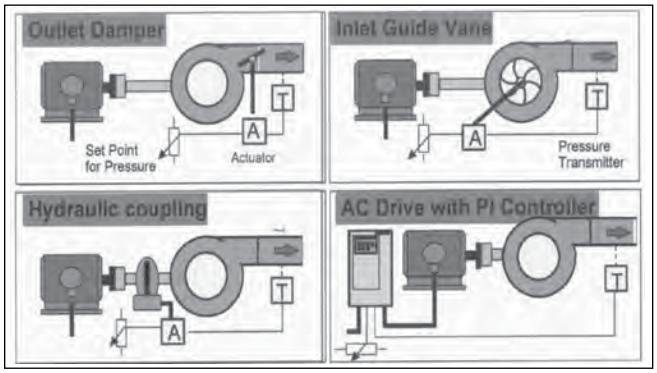


Retrofit Fan Applications

Mechanical Volume Control Retrofit

The FP Series II can be easily retrofitted into existing systems. The existing starter controls can be integrated into the FP Series IIr as well as the existing transducer can be fed into the FP Series III PI controller for set-point control. The existing volume controls (ie: inlet guide vane, discharge damper, etc) can be removed or locked in the full open position. See Figure 5.

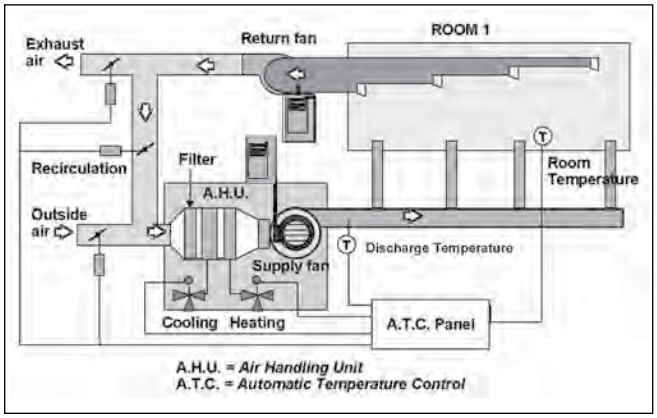
Figure 5. Air Volume Control of the Centrifugal Fan



Constant Volume Retrofit

The simplest of all air conditioning systems is a supply fan unit serving a single zone with constant air volume as shown in Figure 6. Typically, this system is controlled by a automatic temperature control (ATC) panel that cycles the AHU starter ON/OFF based on a temperature of a single zone. This is very inefficient and can be converted to variable volume with an FP Series II which monitors room temperature and discharge temperature to automatically control fan speed by adjusting the frequency output to the motor.

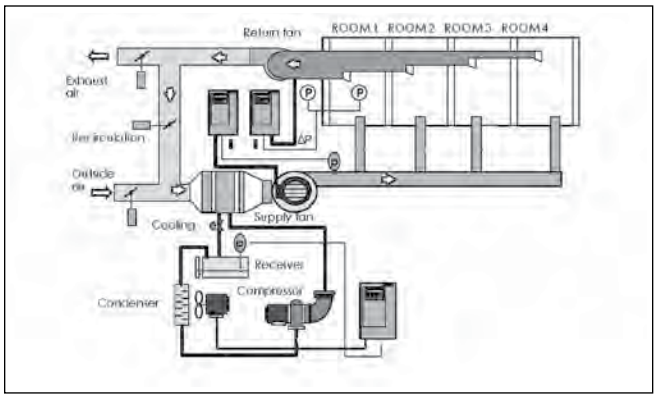
Figure 6. Constant Volume System - Retrofit



Direct Expansion VAV System

FP Series II can also be used on DX systems. The FP Series II can be used to control the supply fan to reduce coil freezing or to control condenser fan speed to optimize head pressure.

Figure 7. Direct Expansion VAV System



Pump Applications

Theory of Operation

Johnson Controls has extensive experience in variable speed pumping and has performed testing in optimum combinations of variable speed pumping. We have found many applications which can benefit from variable speed pumping. We have also found that very few chiller plants benefit from variable condenser water flow control. This section will deal with chilled water systems only.

Though there are many different configurations for chilled water pumping systems, they generally consist of throttling (2-way) valves around the chilled water coils and a bypass around the pump/chiller loop (Figure 8). As cooling needs reduce, the valves are controlled to throttle the water flow to their individual coils. As the valves close, the system pressure increases. A pressure sensor sends a signal to open the bypass valve - maintaining constant flow through the pump and chiller circuit. The result is that full input energy to the motor occurs at all times.

An FP Series II pumping system eliminates the need for a bypass circuit because it slows down the pump in response to the system pressure increase caused by the throttling valves closing. The input energy to the pump motor is reduced significantly as the pump operates at part load conditions and the system pressure is maintained. See Figure 10.

Application

In applications where a low night load or wide variations in cooling load occur, variable speed pumping can provide significant energy savings. In large centrifugal chiller plants with three or more chillers, and/or with a primary/secondary chilled water loop design, variable speed pumping should be considered.

In all variable speed pumping applications, the following must be addressed:

- Chilled water flow and load variations
- Worst case flow/head requirements of a remote water coil or loop
- Minimum chiller water velocity of 3.33 ft./second for proper heat transfer
- Maximum chiller water velocity of 12 ft./second to prevent tube erosion
- Minimum head requirements and pump curve characteristics of the individual pumps
- Potential energy savings

In all cases, the chilled water flow through the cooler must not be allowed to go below the minimum GPM recommended. This corresponds to a tube velocity of 3.33 FPS for most cases. For applications using chilled water below 42°F, the minimum water velocity cannot go below 4.75 FPS. This is a precaution against freezing water inside the cooler tubes.

Sequence of Operation

The sequence of operation of a variable speed pump is similar to the variable speed fan sequence of operation. As cooling load is reduced, throttling valves begin to close off flow to their coils which creates an increase in system pressure. A differential pressure sensor, located in the system, senses this change in pressure and transmits a control signal through a controller to the FP Series II to slow down the pump. As the discharge temperature rises, the throttling valve control will open the valve causing the system differential pressure to drop. The differential pressure control will then increase the speed signal to the FP Series II, increasing the pump discharge pressure to match the system requirements.

Figure 8. VFD Applications - Pumps

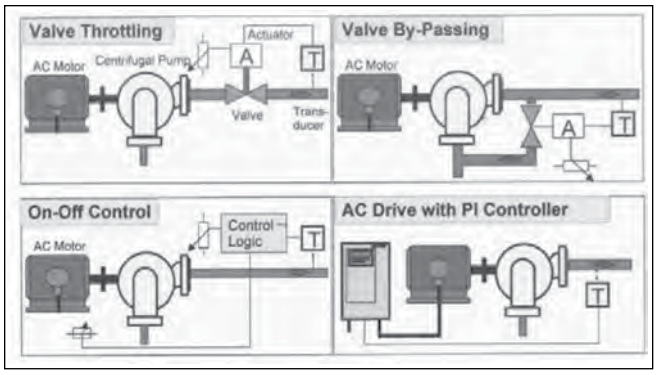
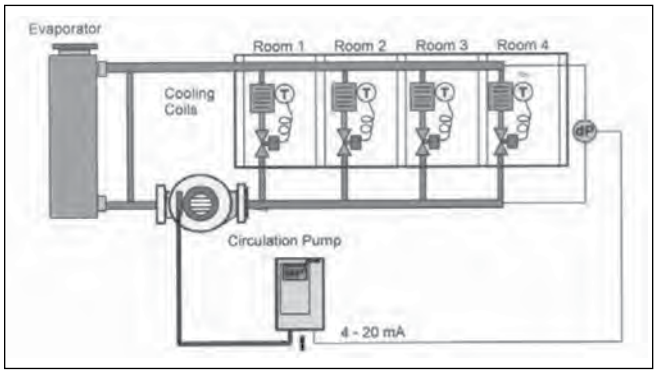


Figure 9. Variable Flow Chilled Water System



Pump and Fan Control

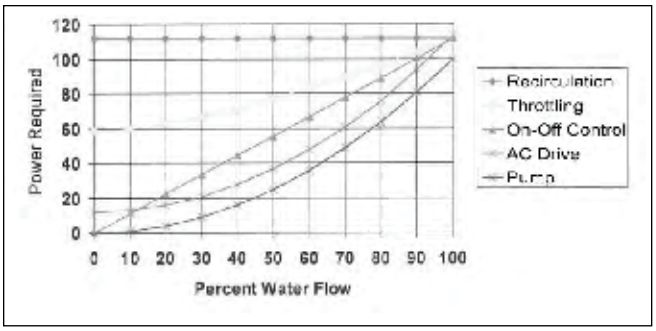
Theory of Operation

The pump and fan control macro (HVAC PFC) of the FP Series II provides on/off commands to control up to three constant speed pumps or fans operating in parallel with the pump or fan controlled by the FP Series II. The PID Setpoint Controller in the FP Series II controls the process pressure or flow by controlling the speed of the motor connected to the FP Series II and starting additional constant speed motors whenever maximum speed operation of the adjustable speed motor is not sufficient to satisfy the process requirement. This feature can eliminate the need for a PLC or pump sequencer.

Adjustments are provided for start and stop points and delay timers. Three step adjustments to the reference and two groups of PID settings can be applied to accommodate different operating characteristics with various numbers of parallel units in operation. An automatic sequence change feature helps ensure equal duty time for all of the motors. Instead of using the PID controller of the FP Series II to regulate the process, an open-loop capacity output command can be used to directly set the flow provided by the parallel combination of pumps or fans.

When the pump and fan control feature is used, the adjustable speed motor is connected to a drive output or optional output contactor and the constant speed motor(s) is connected to a motor starter(s). The optional output contactor and starter(s) are controlled using FP Series II digital (relay) outputs and interlock inputs. Optional digital I/O modules may be required.

Figure 10. Power Consumption with Different Flow Controls



Cooling Tower Applications

Theory of Operation

Typical cooling tower controls reduce capacity at low loads by turning off tower fans. Reducing the fan capacity lowers fan power consumption but could increase condenser water temperature, thus increasing chiller power consumption.

Application

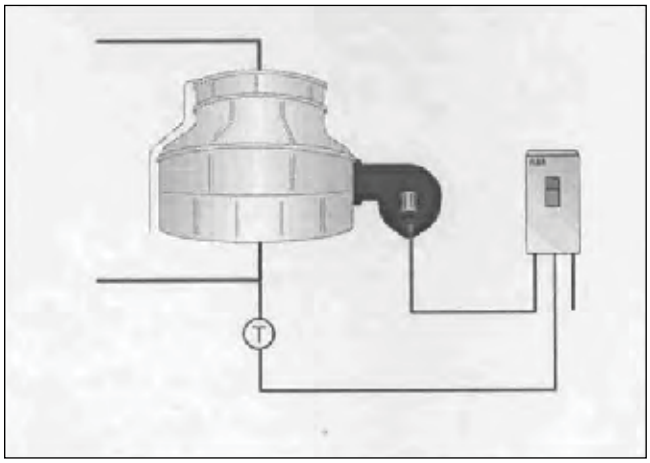
Johnson Controls's extensive experience in optimizing cooling tower performance and chiller performance has taught us that optimum chiller plant power consumption is achieved by minimizing entering condenser water temperature, therefore, tower fans are employed over a large portion of the operating hours. Energy savings can be achieved where:

- Wide swings occur in outdoor ambient or chiller loads
- Chiller is limited to high entering condenser water temperatures.
- Low chiller loads occur
- 24-hour operation with previously mentioned conditions occur

In addition, FP Series II control has been used for soft start and soft cycling of the tower fans to eliminate excessive tower gearbox failure.

When using an FP Series II on a cooling tower fan, condenser water temperature or chiller condenser pressures are generally used to control the speed of the fan. The application can be simplistic, involving a single control parameter or complicated, involving multiple control parameters and vibration sensors tied into the control circuit to de-energize the system upon sensing excessive tower vibration. The needs of each application must be analyzed on an individual basis.

Figure 11. Typical Cooling Tower Application



JCI-VSD Series II Base Drive

JCI-VSD Series II Drives

Features and Benefits

Hardware

- Thin metal capacitor design—ultra-efficient drive operation and extended shelf life (up to five years without reforming)
- Integrated 5% DC link choke with Input surge protection—protects against voltage spikes and provides a clean wave form to the motor
- EMI/RFI filters standard on all drives—meets EMC Category 2 for commercial applications
- Real-time clock—supports calendaring and PLC functionality
- Graphic LCD display and keypad—supports simple menu navigation as well as on-screen diagnostics and troubleshooting
- HAND-OFF-AUTO and drive-bypass selector on keypad—simplifies control
- Standard I/O: 6DI, 2AI, 1AO, 2 Form C RO (NO/NC), 1 Form A RO (NO)— supports requirements for most installations
- Onboard RS 485: Modbus, N2, BACnet—meets needs of most communication requirements
- Onboard Ethernet: BACnet/IP, Modbus/TCP—meets needs of most communication requirements
- Two expansion slots—intended to support additional I/O or communication protocols as necessary
- Quick disconnect terminals for I/O connections—supports fast easy installation

Software

- Active energy control—minimizes energy losses in our motor resulting in industry leading energy efficiency for your application
- Quick Start Wizard upon initial power up—supports fast easy installation
- Copy/paste functionality on drive keypad—allows for fast setup of multiple drives
- Pre-programmed I/O—supports fast easy installation for most applications

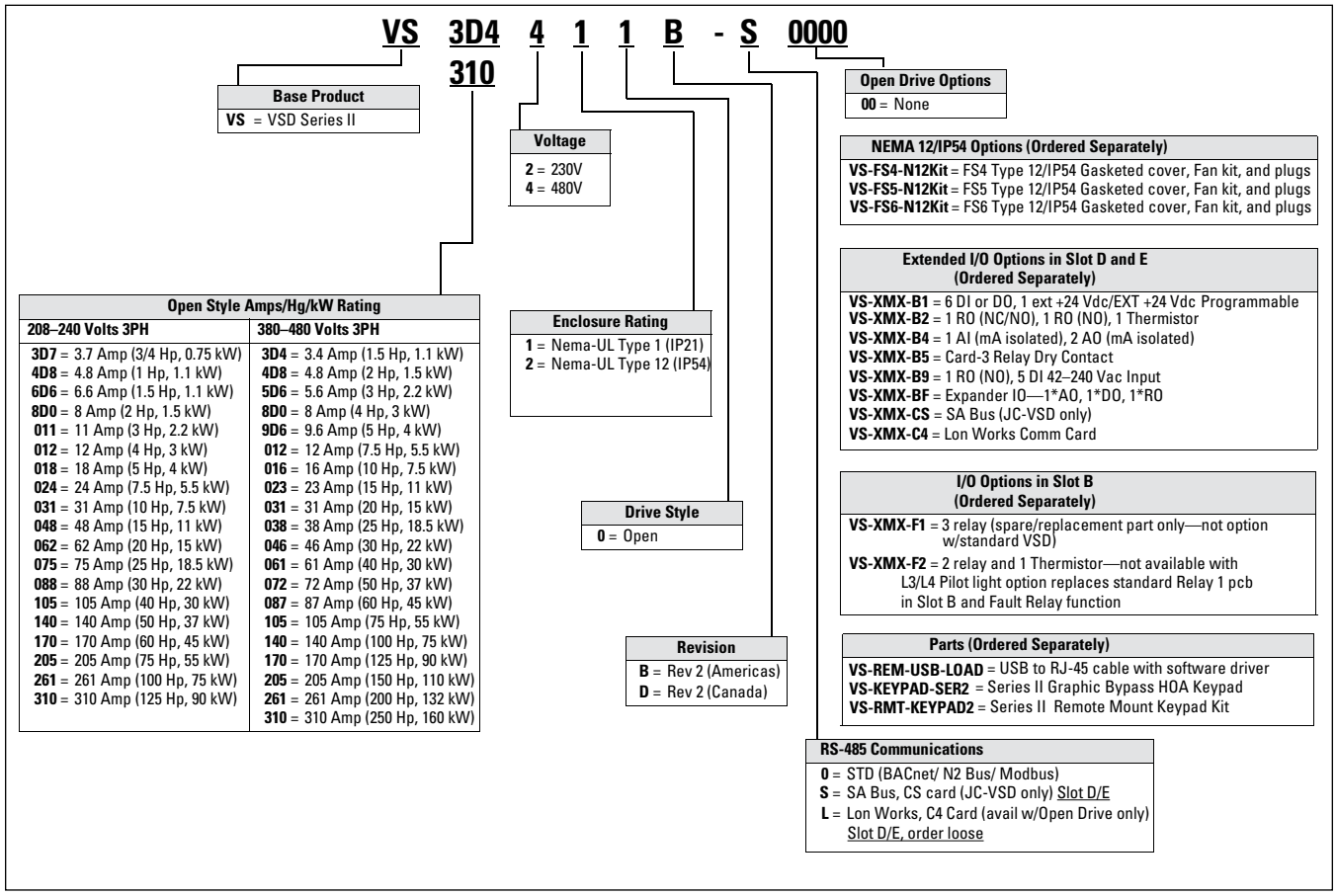
Standards and Certifications

Product

- IEC 61800-5-1
- CE
- UL508C
- cUL
- OSHPD Siesmic Certified
- Plenum Rated

Nomenclature Base Drive Only

JCI-VSD II Series Open Drives Part Number Matrix - (No Bypass or Manual Motor Protector/Disconnect)



Product Selection
JC-VSD Series II Drives—230 Vac

NEMA Type 1/IP21

FS Frame Size	Drive Output Current Low Overload Full Load Amps at 40°C	Horsepower	Assigned Motor Ratings Drive kW 230 Vac/50Hz	230 Vac NEC Amps ①	Low Overload Full Load Amps at 50°C	Catalog Number
4	3.7	0.75	0.55	3.2	2.6	VS3D7210B-00000
	4.8	1	0.75	4.2	3.7	VS4D8210B-00000
	6.6	1.5	1.1	6.6	4.8	VS6D6210B-00000
	8	2	1.5	6.8	6.6	VS8D0210B-00000
	11	3	2.2	9.6	8	VS011210B-00000
	12.5	4	3	N/A	11	VS012210B-00000
5	18	5	4	15.2	12.5	VS018210B-00000
	24	7.5	5.5	22	18	VS024210B-00000
	31	10	7.5	28	24	VS031210B-00000
6	48	15	11	42	31	VS048210B-00000
	62	20	15	54	48	VS062210B-00000
7	75	25	18.5	68	62	VS075210B-00000
	88	30	22	80	75	VS088210B-00000
	105	40	30	104	88	VS105210B-00000
8	140	50	37	130	105	VS140210B-00000
	170	60	45	154	140	VS170210B-00000
	205	75	55	192	170	VS205210B-00000
9	261	100	75	248	205	VS261210B-00000
	310	125	90	N/A	261	VS310210B-00000

NEMA Type 12/IP54

FS Frame Size	Drive Output Current Low Overload Full Load Amps at 40°C	Horsepower	Assigned Motor Ratings Drive kW 230 Vac/50Hz	230 Vac NEC Amps ①	Low Overload Full Load Amps at 50°C	Catalog Number
4	3.7	0.75	0.55	3.2	2.6	VS3D7220B-00000
	4.8	1	0.75	4.2	3.7	VS4D8220B-00000
	6.6	1.5	1.1	6.6	4.8	VS6D6220B-00000
	8	2	1.5	6.8	6.6	VS8D0220B-00000
	11	3	2.2	9.6	8	VS011220B-00000
	12.5	4	3	N/A	11	VS012220B-00000
5	18	5	4	15.2	12.5	VS018220B-00000
	24	7.5	5.5	22	18	VS024220B-00000
	31	10	7.5	28	24	VS031220B-00000
6	48	15	11	42	31	VS048220B-00000
	62	20	15	54	48	VS062220B-00000
7	75	25	18.5	68	62	VS075220B-00000
	88	30	22	80	75	VS088220B-00000
	105	40	30	104	88	VS105220B-00000
8	140	50	37	130	105	VS140220B-00000
	170	60	45	154	140	VS170220B-00000
	205	75	55	192	170	VS205220B-00000
9	261	100	75	248	205	VS261220B-00000
	310	125	90	N/A	261	VS310220B-00000

Note: ① For sizing reference

Product Selection
JC-VSD Series II Drives—460 Vac

NEMA Type 1/IP21

FS Frame Size	Drive Output Current Low Overload Full Load Amps at 40°C	Horsepower	Assigned Motor Ratings Drive kW 400 Vac/50Hz	460 Vac NEC Amps ①	Low Overload Full Load Amps at 50°C	Catalog Number
4	3.4	1.5	1.1	2.1	2.6	VS3D4410B-00000
	4.8	2	1.5	3.4	3.4	VS4D8410B-00000
	5.6	3	2.2	5.6	4.8	VS5D6410B-00000
	8.0	4	3.0	N/A	5.6	VS8D0410B-00000
	9.6	5	4	7.6	8	VS9D6410B-00000
	12	7.5	5.5	11	9.6	VS012410B-00000
5	16	10	7.5	14	12	VS016410B-00000
	23	15	11	21	16	VS023410B-00000
	31	20	15	27	23	VS031410B-00000
6	38	25	18.5	34	31	VS038410B-00000
	46	30	22	40	38	VS046410B-00000
	61	40	30	52	46	VS061410B-00000
7	72	50	37	65	61	VS072410B-00000
	87	60	45	77	72	VS087410B-00000
	105	75	55	96	87	VS105410B-00000
8	140	100	75	124	105	VS140410B-00000
	170	125	90	156	140	VS170410B-00000
	205	150	110	180	170	VS205410B-00000
9	261	200	132	240	205	VS261410B-00000
	310	250	160	302	261	VS310410B-00000

NEMA Type 12/IP54

FS Frame Size	Drive Output Current Low Overload Full Load Amps at 40°C	Horsepower	Assigned Motor Ratings Drive kW 400 Vac/50Hz	460 Vac NEC Amps ①	Low Overload Full Load Amps at 50°C	Catalog Number
4	3.4	1.5	1.1	2.1	2.6	VS3D4420B-00000
	4.8	2	1.5	3.4	3.4	VS4D8420B-00000
	5.6	3	2.2	5.6	4.8	VS5D6420B-00000
	8.0	4	3.0	N/A	5.6	VS8D0420B-00000
	9.6	5	4	7.6	8	VS9D6420B-00000
	12	7.5	5.5	11	9.6	VS012420B-00000
5	16	10	7.5	14	12	VS016420B-00000
	23	15	11	21	16	VS023420B-00000
	31	20	15	27	23	VS031420B-00000
6	38	25	18.5	34	31	VS038420B-00000
	46	30	22	40	38	VS046420B-00000
	61	40	30	52	46	VS061420B-00000
7	72	50	37	65	61	VS072420B-00000
	87	60	45	77	72	VS087420B-00000
	105	75	55	96	87	VS105420B-00000
8	140	100	75	124	105	VS140420B-00000
	170	125	90	156	140	VS170420B-00000
	205	150	110	180	170	VS205420B-00000
9	261	200	132	240	205	VS261420B-00000
	310	250	160	302	261	VS310420B-00000

Note: ① For sizing reference

Onboard Network Communications

Johnson Controls Metasys N2

JCI-VSD Series II Drives provides communication between the drive and a Johnson Controls Metasy® N2 network. With this connection, the drive can be controlled, monitored and programmed from the Metasys system. N2 can be selected and programmed by the drive keypad.

BACnet

JCI-VSD Series II Drives provides communication to BACnet® networks. Data transfer is master-slave/token passing (MS/TP) RS-485.

BACnet IP

1OO Base-T interface.

Modbus TCP

Ethernet based protocol.

Modbus RTU

JCI-VSD Series II Drives provides communication to Modbus® RTU RS-485 as a slave on a Modbus network. Other communication parameters include an address range from 1-247; a parity of None. Odd or Even; and the stop bit is 1.

JCI-VSD Series II Drives Option Board Kits Availaable for Slot B

The factory issued relay option board can be replaced with the following option boards to customize the drive for your application needs. The standard board provides 2 Form C RO (NO/NC) and 1 Form A RO (NO).

Option Boards Mounted in Slot B

Option Kit Description	Optional Kit Catalog Number
I/O expander card, 2RO and thermistor input.	VS-XMX-F2

JCI-VSD Series II Drives Option Board Kits Available for Slots D and E

The JCI-VSD Series II Drives can accommodate a wide selection of expander and adapter option boards to customize the drive for your application needs. The drive's control unit is designed to accept a total of two option boards. The JCI-VSD Series II factory installed standard board configuration includes an I/O board and a relay output board.

Option Boards Mounted in Slot D and E

Option Kit Description	Optional Kit Catalog Number
6 x OI/00, each digital input can be individually programmed as digital output.	VS-XMX-B1
1RO Form C (NO/NC), 1RO Form A (NO), 1 thermistor	VS-XMX-B2
1 x AI, 2 x AO (isolated)	VS-XMX-B4
3 x RO Form A (NO)	VS-XMX-B5
1RO Form A (NO) , 5 DI 42-240 Vac input	VS-XMX-B9
1 x AO, 1 x 00, 1 x RO	VS-XMX-BF
LonWorks® Communication	VS-XMX-C4
SA-BUS Communication	VS-XMX-CS

NEMA Type 1 to NEMA Type 12/IP54 Conversion Kit

The NEMA Type 12/IP54 option kit is used to convert a NEMA Type 1 to a NEMA Type 12 drive. The kit consists of a drive cover, fan kit and plugs.

NEMA Type 12/IP54 Cover

Option Kit Description	Optional Kit Catalog Number
FS4-branded N12/IP54 cover with gasket, plastic plug, fans.	VS-FS4-N12KIT
FS5-branded N12/IP54 cover with gasket, plastic plug, fans.	VS-FS5-N12KIT
FS6-branded N12/IP54 cover with gasket, plastic plug, fans.	VS-FS6-N12KIT

Accessories

Flange Kits

The flange kit is used when the power section heat sink is mounted through the back panel of an enclosure.

Flange Kit NEMA Type 12/IP54

Includes flange, mounting brackets, NEMA Type 12 fan components, air shroud screws and plugs.

Frames FS4-FS7

Description	Catalog Number
NEMA Type 12/IP54	
FS4 N12/IP54 flange kit (mounting N1 drive into N12 enclosure)	VS-FS4-N12FLKIT
FS5 N12/IP54 flange kit (mounting N1 drive into N12 enclosure)	VS-FS5-N12FLKIT
FS6 N12/IP54 flange kit (mounting N1 drive into N12 enclosure)	VS-FS6-N12FLKIT
FS7 N12/IP54 flange kit (mounting N1 drive into N12 enclosure)	VS-FS7-N12FLKIT

Keypad Accessories

Remote Mounting Keypad Kit

Frames FS4-FS9

Description	Catalog Number
Remote mounting keypad kit—bezel and cable	VS-RMT-Keypad2

Replacement Parts

Control Board/Keypad

Description	Catalog Number
Graphic bypass, HOA	VS-Keypad-Ser2

PC Cable

Description	Catalog Number
Remote download USB to AJ-45 cable with software dirver disk	VS-REM-USB-LOAD

Replacement Relay Board in Slot B

Description	Catalog Number
Replacement relay board qty 2 Form C relay, qty 1 Form A relay	VS-XMX-F1

Technical Data and Specifications

JCI-VSD Series II Drives

Description	Specification
Input Ratings	
Input voltage (Vin)	200-240 Vac, 380-480 Vac, -10%/+ 10%
Input frequency (f in)	50/60Hz (variation up to 47-66Hz)
Connection to power	Once per minute or less (typical operation)
Short-circuit withstand rating	100 kAIC
Output Ratings	
Output voltage	0 to Vin/Uin line voltage in
Continuous output current	Ambient temperature max 104 degree F (40 degree C)
IL overload	1.1 x IL (1 min /10 min)
Overload current	110% (1 min /10 min)
Initial output current	150% for two seconds
Output frequency	0 to 320 Hz
Frequency resolution	0.01 Hz
Control Characteristics	
Control method	Frequency control (V /f) open loop sensorless vector control
Switching frequency	1-310 amps FS4-9· default 6kHz
Frequency reference	Analog input· Resolution 0 1% (10-bit). accuracy± 1% Panel reference· Resolution 0.01 Hz
Field weakening point	8 to 320Hz
Acceleration time	0.1 to 3000 seconds
Deceleration time	0.1 to 3000 seconds
Braking torque	DC brake: 30% xTn

Description	Specification
Ambient Conditions	
Ambient operating temperature	FS4-FS9: 14°F (-10°C) no frost to 104°F (40°C) (Drive can operate at 122°F (50°C).
Storage temperature	-40° to 158°F (-40° to 70°C)
Relative humidity	0 to 95% RH, non-condensing, non-corrosive, no dripping water
Air quality	Chemical vapors: IEC 60721-3-3, unit in operation, Class 3C2; Mechanical particles:·IEC 60721-3-3, unit in operation, Class 3S2
Altitude	100% load capacity (no derating) up to 3280 ft (1000m); 1% derating for each 328ft (100m) above 3280 ft (1000m); max. 9842 ft (3000m); 380-480V
Vibration	FS4-FS9· EN 61800 -5-1, EN 60068-2-6; 5 to 150 Hz, displacement amplitude 1 mm (peak) at 5 to 15 8 Hz, max. acceleration amplitude 1 G at 15 8 to 150 Hz
Shock	EN 61800-5-1, EN 60068-2-27 UPS Drop test (for applicable UPS weights) Storage and shipping: max. 15G, 11 ms (in package)
Enclosure class	NEMA Type 1/IP21 or NEMA Type 12/IP54 (keypad required for IP54/Type 12)
Standards	
EMC	Immunity: Fulfills all EMC immunity requirements; Emissions: EN 61800-3, LEVEL H (EMC C2)
Emissions	EMC level dependent +EMC 2· EN61800-3 (2004) Category C2 Delivered with Class C2 EMC filtering as default.
Control Connections	
Analog input voltage	0 to 10V; R = 200 kohms differential Resolution 0.1%; Accuracy +/-1% DIP switch selection (voltage/current)
Analog input current	0 (4) to 20 mA; Ri -250 ohms differential
Digital inputs (6)	Positive or negative logic; 18 to 30 Vdc
Auxiliary voltage	+24V +-10%, max 250 mA
Output reference voltage	+10V +3%, max load 10 mA
Analog output	0 to 10V, 0 (4) to 20 mA; RL max 500 ohms Resolution 10 bit; Accuracy +/-2% DIP switch selection (voltage/current)
Relay outputs	3 programmable, 2 Form C, 1 Form A relay outputs Switching capacity: 24 Vdc/8A, 250 Vac/8A, 125 Vdc/0.4A
Hard wire jumper	Between terminal 6 and 10 (factory default)
DIP switch setting default	RS-485 =off A01 =current A12 =current A11 =voltage

Description	Specification
Protections	
Overcurrent protection	Yes
Overvoltage protection	Yes
DC bus regulation anti-trip	Yes (accelerates or decelerates the load)
Undervoltage protection	Yes
Earth fault protection	Yes (in case of earth fault in motor or motor cable, only the frequency converter is protected)
Input phase supervision	Yes (trips if any of the input phases are missing)
Motor phase supervision	Yes (trips if any of the output phases are missing)
Overtemperature protection	Yes
Motor overload protection	Yes
Motor stall protection	Yes
Motor underload protection	Yes
Short-circuit protection	Yes
Surge protection	Yes (varistor input)
Conformed coated (varnished) boards	Yes (prevents corrosion)

JCI-VSD FP Series II Enclosed Drives

JC-VSD FP Series II Enclosed Drives

FP Series II Base Drive with Disconnect

Features and Benefits

- NEMA 1 or NEMA 3R Design
- FP Series II Base Drive with Active Energy Control
- 5% DC Choke with MOV protection
- Thin Metal Capacitors for extended life
- EMI/RFI Filter
- Real-time Clock
- Standard I/O (6DI/2AI, 1AO, 3Relay Outs)
- Standard Communications (485: N2, Modbus, BACnet I Ethernet: Modbus TCP, BACnet IP)
- Disconnect handle lockable in Off Position
- Fused or Non-fused Disconnect design
- Electronic motor overload (provided from base drive)
- Provisions for External Control Connections

FP Series II Base Drive with Bypass

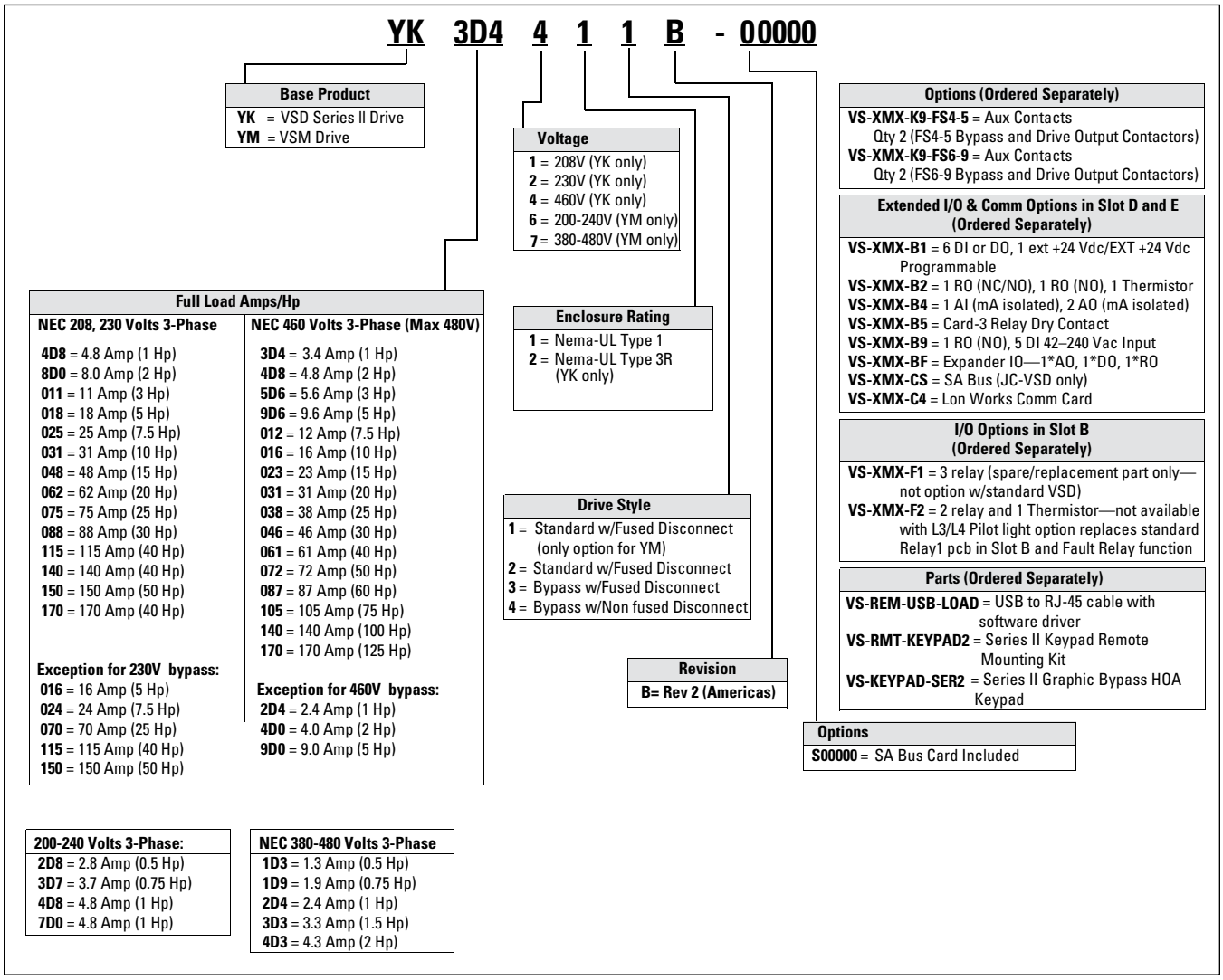
Features and Benefits

- NEMA 1 or NEMA 3R Design
- JC-VSD Base Drive with Active Energy Control
- 5% DC Choke with MOV protection
- Thin Metal Capacitors for extended life
- EMI/RFI Filter
- Real-time Clock
- Standard I/O (6DI/2AI, 1AO, 3Relay Outs)
- Standard Communications (485: N2, Modbus, BACnet I Ethernet: Modbus TCP, BACnet IP)
- Disconnect handle lockable in Off Position
- Fused or Non-fused Disconnect design
- 2-Contactor Bypass with Drive Isolation Switch
- Control power transformer with primary and secondary fusing
- Drive-Off-Bypass and Hand-Off-Auto control switches
- Electronic motor overload (provided from base drive or bypass overload)
- Provisions for External Control Connections
- NEMA 3R design includes internal space heater for low ambient
- NEMA 3R design includes back panel forced air conduit hole for high ambient
- Bypass can be controlled mechanically, electronically and via SA Bus. Reference Appendix C for more info.

Nomenclature

JC-VSD FP Series II

Drives with Disconnect and Drives with Bypass Configurations use this information.



Special Note:

JC-VSD FP Series II

Johnson Controls Product Nomenclature (Smart Code) provides a unique alpha-numeri code that will be used for ordering the defined construction, voltage, current, and installed options for the JC-VSD FP Series II drive. It is used for post-sale support to defined the specifics of the product for ease of continued support.

FP Series II **Micro Drive with Disconnect**

NEMA Type 1 200-240V

Frame Size	Drive Output Current Full Load Amps at 50˚C	HP	Drive kW 230V/50Hz	Fused	Catalog Number
M1	2.8	0.5	0.37	Yes	YM2D8612B-00000
	3.7	0.75	0.55	Yes	YM3D7612B-00000
	4.8	1	0.75	Yes	YM4D8612B-00000
	7	1.5	1.1	Yes	YM7D0612B-00000

FP Series II **Micro Drive with Disconnect**

NEMA Type 1 380-480V

Frame Size	Drive Output Current Full Load Amps at 50˚C	HP	Drive kW 230V/50Hz	Fused	Catalog Number
M1	1.3	0.5	0.37	Yes	YM1D3712B-00000
	1.9	0.75	0.55	Yes	YM1D9712B-00000
	2.4	1	0.75	Yes	YM2D4712B-00000
	3.3	1.5	1.1	Yes	YM3D3712B-00000
	4.3	2	1.5	Yes	YM4D3712B-00000

FP Series II Drive with Disconnect

NEMA Type 1 208V

Frame Size	Drive Output Current Full Load Amps at 40˚C	HP	Drive kW 230V/50Hz	Fused	Drive Output Current Full Load Amps at 50˚C	Catalog Number
A1	4.8	1	0.75	Yes	3.7	YK4D8112B-00000
	8	2	1.5	Yes	6.6	YK8D0112B-00000
	11	3	2.2	Yes	8	YK011112B-00000
	18	5	4	Yes	12.5	YK018112B-00000
A2	25	7.5	5.5	Yes	18	YK025112B-00000
	31	10	7.5	Yes	24	YK031112B-00000
A3	48	15	11	Yes	31	YK048112B-00000
	62	20	15	Yes	48	YK062112B-00000
A4	75	25	18.5	Yes	62	YK075112B-00000
	88	30	22	Yes	75	YK088112B-00000
	140	40	37	Yes	105	YK140112B-00000
A6	170	50	45	Yes	140	YK170112B-00000

FP Series II Drive with Disconnect

NEMA Type 3R 208V

Frame Size	Drive Output Current Full Load Amps at 40˚C	HP	Drive kW 230V/50Hz	Fused	Drive Output Current Full Load Amps at 50˚C	Catalog Number
C1	4.8	1	0.75	Yes	3.7	YK4D8122B-00000
	8	2	1.5	Yes	6.6	YK8D0122B-00000
	11	3	2.2	Yes	8	YK011122B-00000
	18	5	4	Yes	12.5	YK018122B-00000
C2	25	7.5	5.5	Yes	18	YK025122B-00000
	31	10	7.5	Yes	24	YK031122B-00000
C3	48	15	11	Yes	31	YK048122B-00000
	62	20	15	Yes	48	YK062122B-00000
C4	75	25	18.5	Yes	62	YK075122B-00000
	88	30	22	Yes	75	YK088122B-00000
	140	40	37	Yes	105	YK140122B-00000
C6	170	50	45	Yes	140	YK170122B-00000

*For Non-Fused Disconnect products change the 8th digit in the catalog number to a 1. Example YK4D8111B-00000 would be for a Non-Fused product

FP Series II

Drive with Disconnect

NEMA Type 1 230V

Frame Size	Drive Output Current Full Load Amps at 40˚C	HP	Drive kW 230V/50Hz	Fused	Drive Output Current Full Load Amps at 50˚C	Catalog Number
A1	4.8	1	0.75	Yes	3.7	YK4D8212B-00000
	8	2	1.5	Yes	6.6	YK8D0212B-00000
	11	3	2.2	Yes	8	YK011212B-00000
	18	5	4	Yes	12.5	YK018212B-00000
A2	25	7.5	5.5	Yes	18	YK025212B-00000
	31	10	7.5	Yes	24	YK031212B-00000
A3	48	15	11	Yes	31	YK048212B-00000
	62	20	15	Yes	48	YK062212B-00000
A4	75	25	18.5	Yes	62	YK075212B-00000
	88	30	22	Yes	75	YK088212B-00000
	140	40	37	Yes	105	YK140212B-00000
A6	170	50	45	Yes	140	YK170212B-00000

FP Series II

Drive with Disconnect

NEMA Type 3R 230V

Frame Size	Drive Output Current Full Load Amps at 40˚C	HP	Drive kW 230V/50Hz	Fused	Drive Output Current Full Load Amps at 50˚C	Catalog Number
C1	4.8	1	0.75	Yes	3.7	YK4D8222B-00000
	8	2	1.5	Yes	6.6	YK8D0222B-00000
	11	3	2.2	Yes	8	YK011222B-00000
	18	5	4	Yes	12.5	YK018222B-00000
C2	25	7.5	5.5	Yes	18	YK025222B-00000
	31	10	7.5	Yes	24	YK031222B-00000
C3	48	15	11	Yes	31	YK048222B-00000
	62	20	15	Yes	48	YK062222B-00000
C4	75	25	18.5	Yes	62	YK075222B-00000
	88	30	22	Yes	75	YK088222B-00000
	140	40	37	Yes	105	YK140222B-00000
C6	170	50	45	Yes	140	YK170222B-00000

*For Non-Fused Disconnect products change the 8th digit in the catalog number to a 1. Example YK4D8211B-00000 would be for a Non-Fused product

FP Series II **Drive with Disconnect**

NEMA Type 1 460V

Frame Size	Drive Output Current Full Load Amps at 40˚C	HP	Drive kW 400V/50Hz	Fused	Drive Output Current Full Load Amps at 50˚C	Catalog Number
A1	3.4	1	1.1	Yes	2.6	YK3D4412B-00000
	4.8	2	1.5	Yes	3.4	YK4D8412B-00000
	5.6	3	2.2	Yes	4.8	YK5D6412B-00000
	9.6	5	4	Yes	8	YK9D6412B-00000
	12	7.5	5.5	Yes	9.6	YK012412B-00000
A2	16	10	7.5	Yes	12	YK016412B-00000
	23	15	11	Yes	16	YK023412B-00000
A3	31	20	15	Yes	23	YK031412B-00000
	38	25	18.5	Yes	31	YK038412B-00000
	46	30	22	Yes	38	YK046412B-00000
A4	61	40	30	Yes	46	YK061412B-00000
	72	50	37	Yes	61	YK072412B-00000
	87	60	45	Yes	72	YK087412B-00000
	105	75	55	Yes	87	YK105412B-00000
A5	140	100	75	Yes	105	YK140412B-00000
A6	170	125	90	Yes	140	YK170412B-00000

FP Series II **Drive with Disconnect**

NEMA Type 3R 480V

Frame Size	Drive Output Current Full Load Amps at 40˚C	HP	Drive kW 400V/50Hz	Fused	Drive Output Current Full Load Amps at 50˚C	Catalog Number
C1	3.4	1	1.1	Yes	2.6	YK3D4422B-00000
	4.8	2	1.5	Yes	3.4	YK4D8422B-00000
	5.6	3	2.2	Yes	4.8	YK5D6422B-00000
	9.6	5	4	Yes	8	YK9D6422B-00000
	12	7.5	5.5	Yes	9.6	YK012422B-00000
C2	16	10	7.5	Yes	12	YK016422B-00000
	23	15	11	Yes	16	YK023422B-00000
C3	31	20	15	Yes	23	YK031422B-00000
	38	25	18.5	Yes	31	YK038422B-00000
	46	30	22	Yes	38	YK046422B-00000
C4	61	40	30	Yes	46	YK061422B-00000
	72	50	37	Yes	61	YK072422B-00000
	87	60	45	Yes	72	YK087422B-00000
	105	75	55	Yes	87	YK105422B-00000
C5	140	100	75	Yes	105	YK140422B-00000
C6	170	125	90	Yes	140	YK170422B-00000

*For Non-Fused Disconnect products change the 8th digit in the catalog number to a 1. Example YK3D4411B-00000 would be for a Non-Fused product

FP Series II **Drive with Bypass**

NEMA Type 1 208V

Frame Size	Drive Output Current Full Load Amps at 40˚C	HP	Drive kW 230V/50Hz	Fused	Drive Output Current Full Load Amps at 50˚C	Catalog Number
B1	4.8	1	0.75	Yes	3.7	YK4D8113B-00000
	8	2	1.5	Yes	6.6	YK8D0113B-00000
	11	3	2.2	Yes	8	YK011113B-00000
	18	5	4	Yes	12.5	YK018113B-00000
B2	25	7.5	5.5	Yes	18	YK025113B-00000
	31	10	7.5	Yes	24	YK031113B-00000
B3	48	15	11	Yes	31	YK048113B-00000
	62	20	15	Yes	48	YK062113B-00000
B4	75	25	18.5	Yes	62	YK075113B-00000
	88	30	22	Yes	75	YK088113B-00000
	115	40	37	Yes	105	YK115113B-00000
B6	150	50	45	Yes	140	YK150113B-00000

FP Series II **Drive with Bypass**

NEMA Type 3R 208V

Frame Size	Drive Output Current Full Load Amps at 40˚C	HP	Drive kW 230V/50Hz	Fused	Drive Output Current Full Load Amps at 50˚C	Catalog Number
D1	4.8	1	0.75	Yes	3.7	YK4D8123B-00000
	8	2	1.5	Yes	6.6	YK8D0123B-00000
	11	3	2.2	Yes	8	YK011123B-00000
	18	5	4	Yes	12.5	YK018123B-00000
D2	25	7.5	5.5	Yes	18	YK025123B-00000
	31	10	7.5	Yes	24	YK031123B-00000
D3	48	15	11	Yes	31	YK048123B-00000
	62	20	15	Yes	48	YK062123B-00000
D4	75	25	18.5	Yes	62	YK075123B-00000
	88	30	22	Yes	75	YK088123B-00000
	115	40	37	Yes	105	YK115123B-00000
D6	150	50	45	Yes	140	YK150123B-00000

*For Non-Fused Disconnect products change the 8th digit in the catalog number to a 4. Example YK4D8114B-00000 would be for a Non-Fused product

FP Series II **Drive with Bypass**
NEMA Type 1 230V

Frame Size	Drive Output Current Full Load Amps at 40˚C	HP	Drive kW 230V/50Hz	Fused	Drive Output Current Full Load Amps at 50˚C	Catalog Number
B1	4.8	1	0.75	Yes	3.7	YK4D8213B-00000
	8	2	1.5	Yes	6.6	YK8D0213B-00000
	11	3	2.2	Yes	8	YK011213B-00000
	16	5	4	Yes	12.5	YK016213B-00000
B2	24	7.5	5.5	Yes	18	YK024213B-00000
	31	10	7.5	Yes	24	YK031213B-00000
B3	48	15	11	Yes	31	YK048213B-00000
	62	20	15	Yes	48	YK062213B-00000
B4	70	25	18.5	Yes	62	YK070213B-00000
	88	30	22	Yes	75	YK088213B-00000
	115	40	37	Yes	105	YK115213B-00000
B6	150	50	45	Yes	140	YK150213B-00000

FP Series II **Drive with Bypass**
NEMA Type 3R 230V

Frame Size	Drive Output Current Full Load Amps at 40˚C	HP	Drive kW 230V/50Hz	Fused	Drive Output Current Full Load Amps at 50˚C	Catalog Number
D1	4.8	1	0.75	Yes	3.7	YK4D8223B-00000
	8	2	1.5	Yes	6.6	YK8D0223B-00000
	11	3	2.2	Yes	8	YK011223B-00000
	16	5	4	Yes	12.5	YK016223B-00000
D2	24	7.5	5.5	Yes	18	YK024223B-00000
	31	10	7.5	Yes	24	YK031223B-00000
D3	48	15	11	Yes	31	YK048223B-00000
	62	20	15	Yes	48	YK062223B-00000
D4	70	25	18.5	Yes	62	YK070223B-00000
	88	30	22	Yes	75	YK088223B-00000
	115	40	37	Yes	105	YK115223B-00000
D6	150	50	45	Yes	140	YK150223B-00000

*For Non-Fused Disconnect products change the 8th digit in the catalog number to a 4. Example YK4D8214B-00000 would be for a Non-Fused product

FP Series II **Drive with Bypass**

NEMA Type 1 460V

Frame Size	Drive Output Current Full Load Amps at 40˚C	HP	Drive kW 400V/50Hz	Fused	Drive Output Current Full Load Amps at 50˚C	Catalog Number
B1	2.4	1	1.1	Yes	2.6	YK2D4413B-00000
	4	2	1.5	Yes	3.4	YK4D0413B-00000
	5.6	3	2.2	Yes	4.8	YK5D6413B-00000
	9	5	4	Yes	8	YK9D0413B-00000
	12	7.5	5.5	Yes	9.6	YK012413B-00000
B2	16	10	7.5	Yes	12	YK016413B-00000
	23	15	11	Yes	16	YK023413B-00000
B3	31	20	15	Yes	23	YK031413B-00000
	38	25	18.5	Yes	31	YK038413B-00000
	46	30	22	Yes	38	YK046413B-00000
B4	61	40	30	Yes	46	YK061413B-00000
	70	50	37	Yes	61	YK070413B-00000
	80	60	45	Yes	72	YK080413B-00000
	105	75	55	Yes	87	YK105413B-00000
B5	140	100	75	Yes	105	YK140413B-00000
B6	170	125	90	Yes	140	YK170413B-00000

FP Series II **Drive with Bypass**

NEMA Type 3R 460V

Frame Size	Drive Output Current Full Load Amps at 40˚C	HP	Drive kW 400V/50Hz	Fused	Drive Output Current Full Load Amps at 50˚C	Catalog Number
D1	2.4	1	1.1	Yes	2.6	YK2D4423B-00000
	4	2	1.5	Yes	3.4	YK4D0423B-00000
	5.6	3	2.2	Yes	4.8	YK5D6423B-00000
	9	5	4	Yes	8	YK9D0423B-00000
	12	7.5	5.5	Yes	9.6	YK012423B-00000
D2	16	10	7.5	Yes	12	YK016423B-00000
	23	15	11	Yes	16	YK023423B-00000
D3	31	20	15	Yes	23	YK031423B-00000
	38	25	18.5	Yes	31	YK038423B-00000
	46	30	22	Yes	38	YK046423B-00000
D4	61	40	30	Yes	46	YK061423B-00000
	70	50	37	Yes	61	YK070423B-00000
	80	60	45	Yes	72	YK080423B-00000
	105	75	55	Yes	87	YK105423B-00000
D5	140	100	75	Yes	105	YK140423B-00000
D6	170	125	90	Yes	140	YK170423B-00000

* For Non-Fused Disconnect products change the 8th digit in the catalog number to a 4. Example YK2D4414B-00000 would be for a Non-Fused product

Dimensions

FP Series II Size Chart

Use the chart and following tables to determine overall dimensions based on horsepower, voltage, and package configuration. The code (A1-4) signifies the style (A1) and the drive frame size (4).

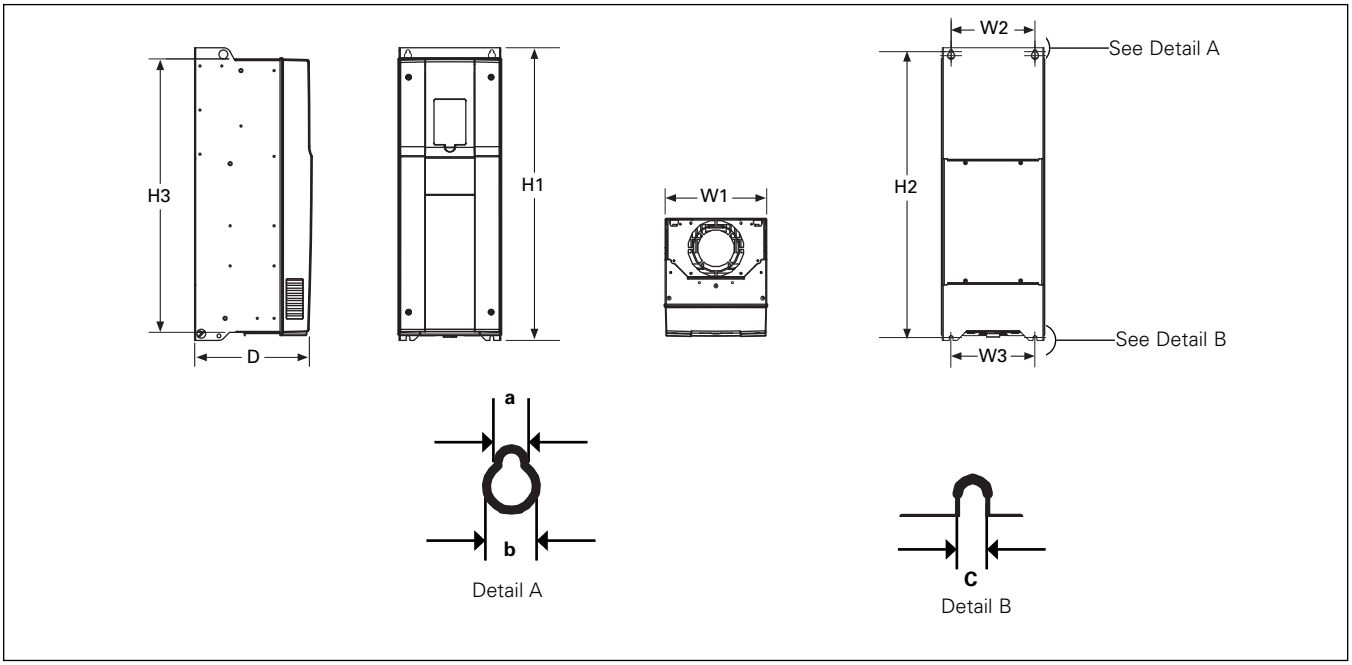
	208 / 230V					460V				
HP	**Base Drive**	**Type 1 Disconnect**	**Type 1 Bypass**	**Type 3R Disconnect**	**Type 3R Bypass**	**Base Drive**	**Type 1 Disconnect**	**Type 1 Bypass**	**Type 3R Disconnect**	**Type 3R Bypass**
1	FS4	A1-4	B1-4	C1-4	D1-4	FS4	A1-4	B1-4	C1-4	D1-4
2	FS4	A1-4	B1-4	C1-4	D1-4	FS4	A1-4	B1-4	C1-4	D1-4
3	FS4	A1-4	B1-4	C1-4	D1-4	FS4	A1-4	B1-4	C1-4	D1-4
5	FS5	A1-5	B1-5	C1-5	D1-5	FS4	A1-4	B1-4	C1-4	D1-4
7.5	FS5	A2-5	B2-5	C2-5	D2-5	FS4	A1-4	B1-4	C1-4	D1-4
10	FS5	A2-5	B2-5	C2-5	D2-5	FS5	A2-5	B2-5	C2-5	D2-5
15	FS6	A3-6	B3-6	C3-6	D3-6	FS5	A2-5	B2-5	C2-5	D2-5
20	FS6	A3-6	B3-6	C3-6	D3-6	FS5	A3-5	B3-5	C3-5	D3-5
25	FS7	A4-7	B4-7	C4-7	D4-7	FS6	A3-6	B3-6	C3-6	D3-6
30	FS7	A4-7	B4-7	C4-7	D4-7	FS6	A3-6	B3-6	C3-6	D3-6
40	FS7	A4-8	B4-8	C4-8	D4-8	FS6	A4-6	B4-6	C4-6	D4-6
50	FS8	A6-8	B6-8	C6-8	D6-8	FS7	A4-7	B4-7	C4-7	D4-7
60	FS8	-	-	-	-	FS7	A4-7	B4-7	C4-7	D4-7
75	FS8	-	-	-	-	FS7	A4-7	B4-7	C4-7	D4-7
100	-	-	-	-	-	FS8	A5-8	B5-8	C5-8	D5-8
125	-	-	-	-	-	FS8	A6-8	B6-8	C6-8	D6-8
150	-	-	-	-	-	FS8	-	-	-	-

Type 1 Micro Disconnect

HP	200-240V	380-480V
0.5	M1-1	M1-1
0.75	M1-2	M1-1
1	M1-2	M1-1
1.5	M1-2	M1-2
2	-	M1-2

Outside Dimensions - Base Drive

Figure 12. Base Drive Outline Dimensions



IP 21 / UL Type 1 - Base Drive Outside Dimensions by Frame Size

	Frame 4		Frame 5		Frame 6		Frame 7		Frame 8	
	mm	in	mm	in	mm	in	mm	in	mm	in
H1	327.5	12.89	419.0	16.50	557.0	21.93	660.0	25.98	965.7	38.02
H2*	313.0	12.32	406.0	15.98	540.5	21.28	645.0	25.39	946.4	37.26
H3	285	11.22	382.0	15.04	514.0	20.24	617.0	24.29	946.4	37.26
W1	128	5.04	144.0	5.67	195.0	7.68	230.0	9.06	290.1	11.42
W2*	100.0	3.94	115.0	4.53	148.0	5.83	190.0	7.48	236.0	9.29
W3*	100.0	3.94	100.0	3.94	148.0	5.83	190.0	7.48	236.0	9.29
D	197.3	7.77	221.6	8.73	236.0	9.29	266.5	10.49	349.6	13.76
a	7	0.28	7.0	0.28	9.0	0.35	8.5	0.34	9	0.35
b	13	0.51	14.0	0.55	15.5	0.61	16.0	0.63	18	0.71
c	7	0.28	7.0	0.28	9.0	0.35	8.5	0.34	11	0.43
Mounting hardware										
	M6	1/4	M6	1/4	M8	5/16	M8	5/16	M8	5/16

* Center to center dimension

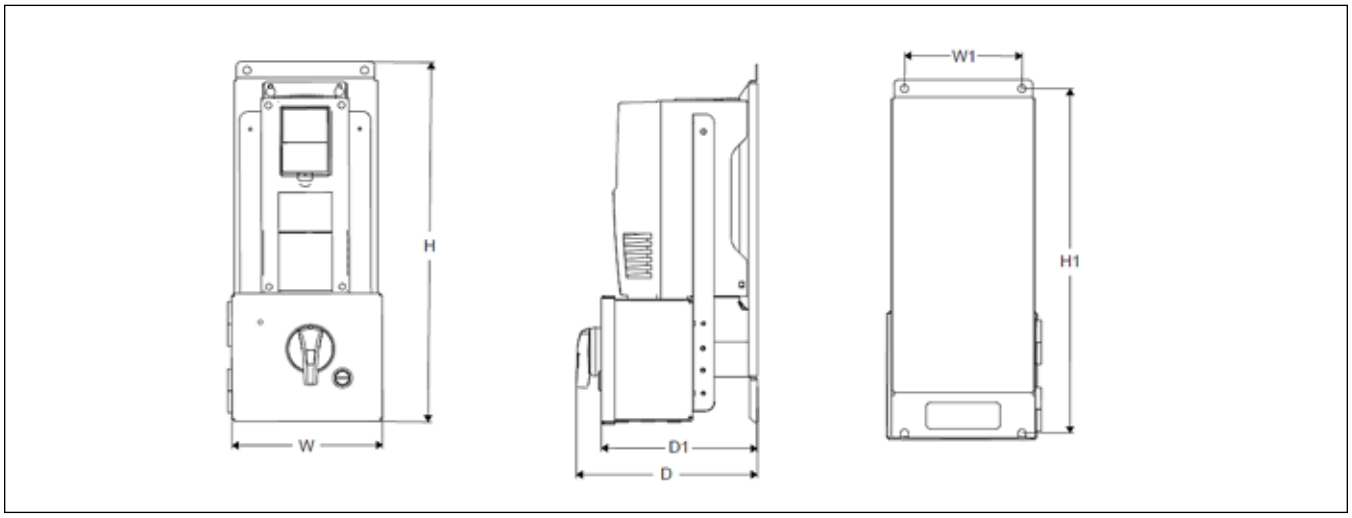
Base Drive Weight by Frame Size **

	Frame 4		Frame 5		Frame 6		Frame 7		Frame 8	
Enclosure	**kg.**	**lb.**	**kg.**	**lb.**	**kg.**	**lb.**	**kg.**	**lb.**	**kg.**	**lb.**
IP 21 / UL Type 1	6	13.2	10	22.00	20	44.1	37.5	82.6	70	154.3

** Weights listed are typical maximum weights by frame size. Any variations within a frame size (due to component sizing for voltage/current ratings and options) are minor.

FP Series II: Type 1 Disconnect Outside Dimensions

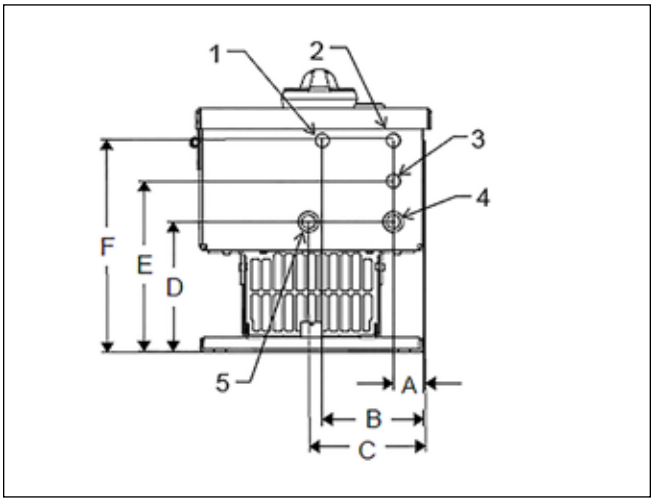
Figure 13. Type 1 Disconnect Outline Dimensions



	Inches						Pounds	
	H	H1	W	W1	D	D1	Weights	Knock Out Style
A1-4	20.61	19.75	8.65	6.75	10.4	8.96	34	1
A1-5	30	29	8.65	6.75	11.18	9.74	54	1
A2-5	30	29	8.65	6.75	11.18	9.74	54	1
A3-5	20.61	19.75	8.65	6.75	10.4	8.96	54	1
A3-6	32.5	31.5	10.4	7.5	11.41	9.97	101	1
A4-6	41.03	39.5	12.4	10.5	13.67	11.97	113	2
A4-7	41.55	39.5	12.4	10.5	13.94	12.25	200	2
A4-8	44.04	39.5	12	10.5	15.86	14.17	363	2
A5-8	44.05	42.06	12	10.5	15.86	14.17	363	2
A6-8	47.65	46.5	16	14.5	15.86	14.17	363	2

Knockout Dimensions (A1-4 through A3-6)

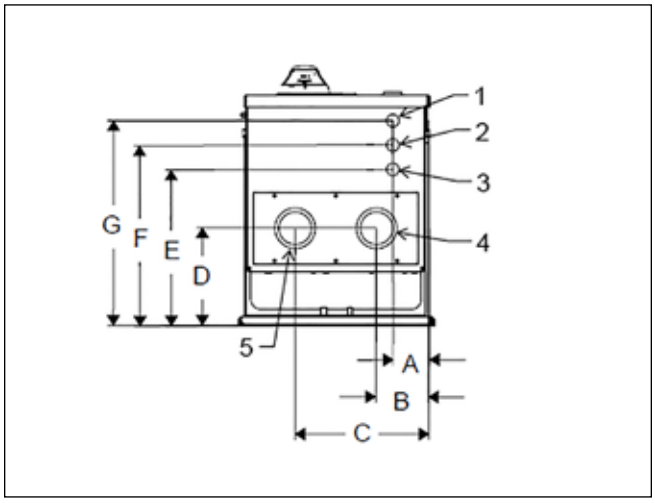
Figure 14. Knockout Dimensions (A1-4 through A3-6)



	Inches							
	A	**B**	**C**	**D**	**E**	**F**	**Conduit 1, 2 & 3**	**Conduit 4 & 5**
A1-4	1.13	3.75	4.22	4.77	6.23	7.60	0.875	1.109 & 0.875
A1-5	1.13	3.75	4.22	5.55	7.05	8.38	0.875	1.109 & 0.875
A2-5	1.13	3.75	4.25	5.55	7.05	8.38	0.875	1.109 & 0.875
A3-5	1.13	3.75	4.28	4.77	6.27	7.60	0.875	1.109 & 0.875
A3-6	1.00	3.63	5.06	5.79	7.29	8.54	0.875	1.380 & 1.109

Knockout Dimensions (A4-6 through A6-8)

Figure 15. Knockout Dimensions (A4-6 through A6-8)

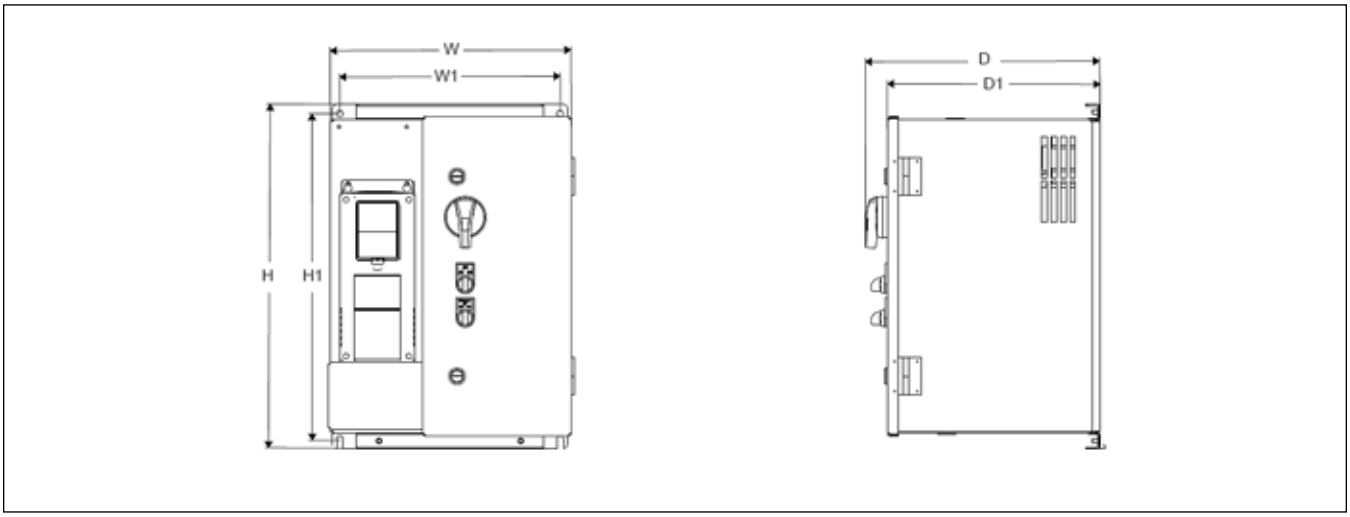


Inches

	A	B	C	D	E	F	G	Conduit 1, 2 &3	Conduit 4 & 5
A4-6	1.70	1.70	7.53	6.12	7.84	9.14	10.44	0.875	1.734 & 1.375
A4-7	1.70	1.70	7.50	6.39	8.12	9.42	10.72	0.875	1.734 & 1.375
A4-8	2.47	3.47	8.47	5.96	9.58	11.08	12.58	0.875	1.734 & 1.375
A5-8	2.53	3.53	8.53	5.96	9.58	11.08	12.58	0.875	1.984 & 1.734
A6-8	4.53	5.53	10.53	5.96	9.58	11.08	12.58	0.875	2,469 & 1.984

FP Series II: Type 1 Bypass Outside Dimensions

Figure 16. Type 1 Bypass Outline Dimensions



	Inches						Pounds
	H	H1	W	W1	D	D1	Weights
B1-4	23	21.75	16.28	14.75	15.7	14.26	64
B1-5	23	21.75	16.28	14.75	15.7	14.26	88
B2-5	30	29	16.28	14.75	15.71	14.27	88
B3-5	31.5	30.5	19.13	17.75	15.7	14.26	88
B3-6	31.5	30.5	19.13	17.75	15.7	14.26	145
B4-6	39.5	38.25	30.13	28.75	17.42	15.73	158
B4-7	42.75	38.25	30.13	28.75	17.42	15.73	262
B4-8	42.9	38.25	30.13	28.75	17.42	15.73	455
B5-8	44	42.75	33.13	31.75	17.42	15.73	455
B6-8	44	42.75	33.13	31.75	17.42	15.73	455

Type 1 Bypass Knockout Dimensions

Figure 17. Top Knockout Dimensions

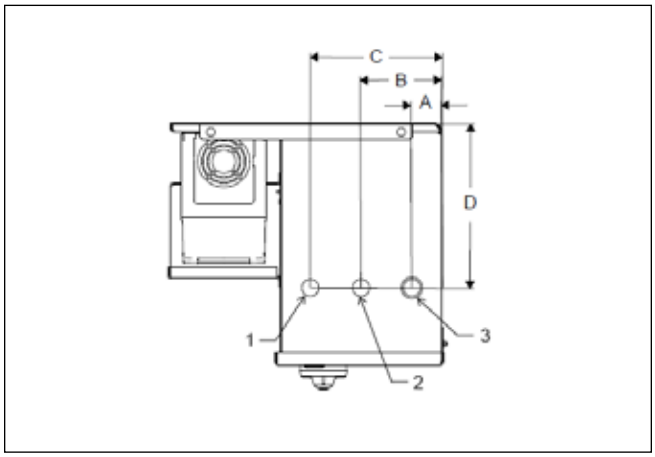
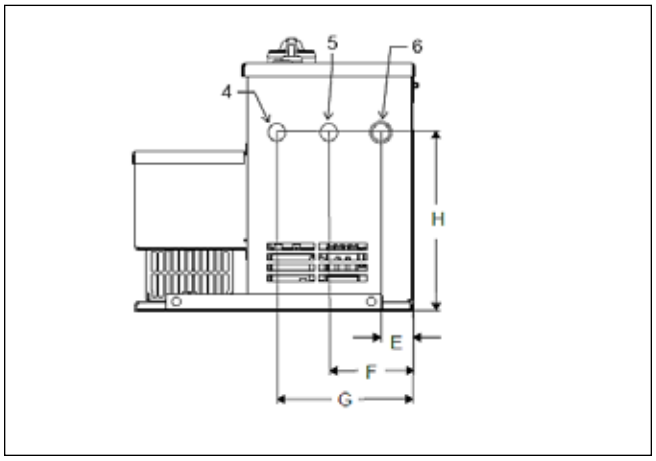


Figure 18. Bottom Knockout Dimensions



Top Knockout Dimensions

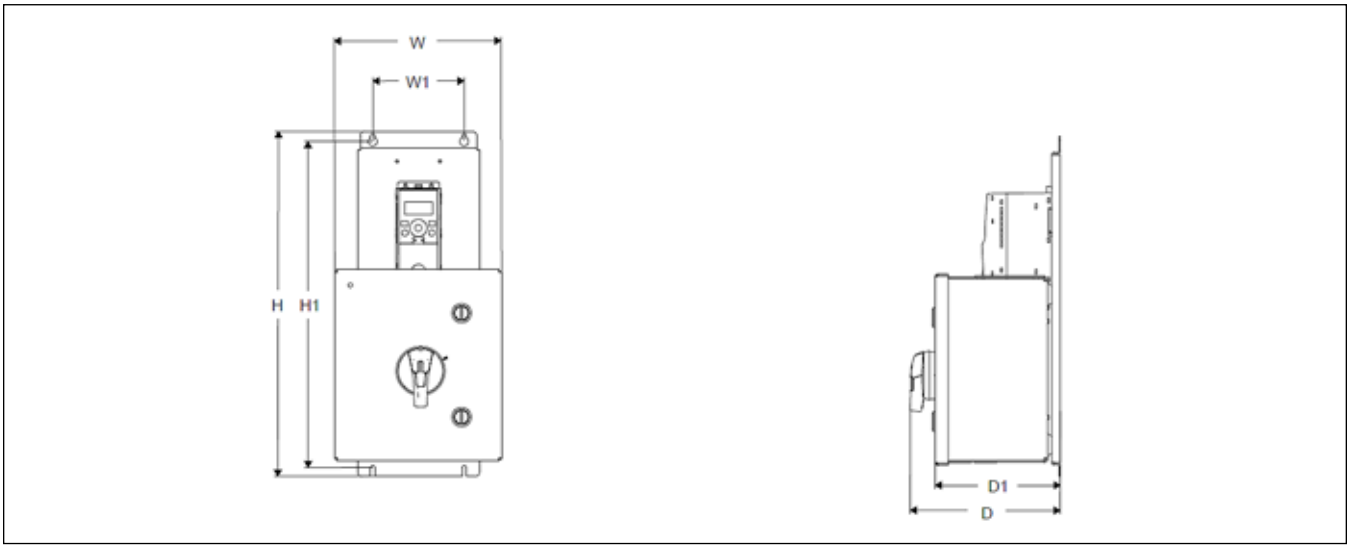
	Inches						
	A	**B**	**C**	**D**	**Conduit 1**	**Conduit 2**	**Conduit 3**
B1-4	1.75	4.75	7.75	9.7	1.109	1.109	1.375 & 1.109
B1-5	1.75	4.75	7.75	9.7	1.109	1.109	1.375 & 1.109
B2-5	1.75	4.75	7.75	9.78	1.109	1.109	1.375 & 1.109
B3-5	2.13	5.13	8.13	9.78	1.109	1.109	1.734 & 1.109
B3-6	2.13	5.13	8.13	9.78	1.109	1.109	1.734 & 1.109
B4-6	6.15	10.15	14	10.26	1.109	1.109	1.980 & 1.109
B4-7	6.15	10.15	14	10.26	1.109	1.109	1.980 & 1.109
B4-8	6.15	10.15	14	10.26	1.109	1.109	1.980 & 1.109
B5-8	6.09	11.09	16.09	10.11	1.375	2.470 & 1.109	2.470 & 1.109
B6-8	6.09	11.09	16.09	10.11	1.375	2.470 & 1.109	2.470 & 1.109

Bottom Knockout Dimensions

	Inches						
	E	**F**	**G**	**H**	**Conduit 4**	**Conduit 5**	**Conduit 6**
B1-4	1.83	4.83	7.83	10.28	1.109	1.109	1.735 & 1.109
B1-5	1.83	4.83	7.83	10.28	1.109	1.109	1.735 & 1.109
B2-5	1.75	4.75	7.75	9.78	1.109	1.109	1.735 & 1.109
B3-5	2.13	5.13	8.13	9.78	1.109	1.109	1.734 & 1.109
B3-6	2.13	5.13	8.13	9.78	1.109	1.109	1.734 & 1.109
B4-6	6.08	10.08	14.08	10.11	1.109	1.109	1.980 & 1.109
B4-7	6.08	10.08	14.08	10.11	1.109	1.109	1.980 & 1.109
B4-8	6.08	10.08	14.08	10.11	1.109	1.109	1.980 & 1.109
B5-8	6.09	11.09	16.09	10.11	1.375	2.470 & 1.109	2.470 & 1.109
B6-8	6.09	11.09	16.09	10.11	1.375	2.470 & 1.109	2.470 & 1.109

FP Series II: Type 1 Micro Disconnect Outside Dimensions

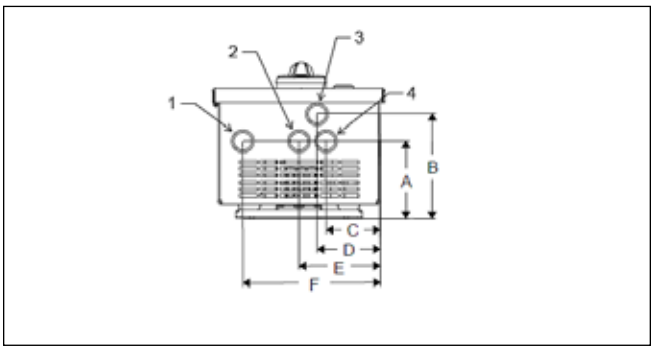
Figure 19. Type 1 Bypass Micro Disconnect



Outline Dimensions

	Inches						Pounds
	H	H1	W	W1	D	D1	Weights
M1-1	19.78	19.03	9.59	5.25	8.61	7.19	13.9
M1-2	19.78	19.03	9.59	5.25	8.61	7.19	15.4

Figure 20. Type 1 Bypass Micro Disconnect

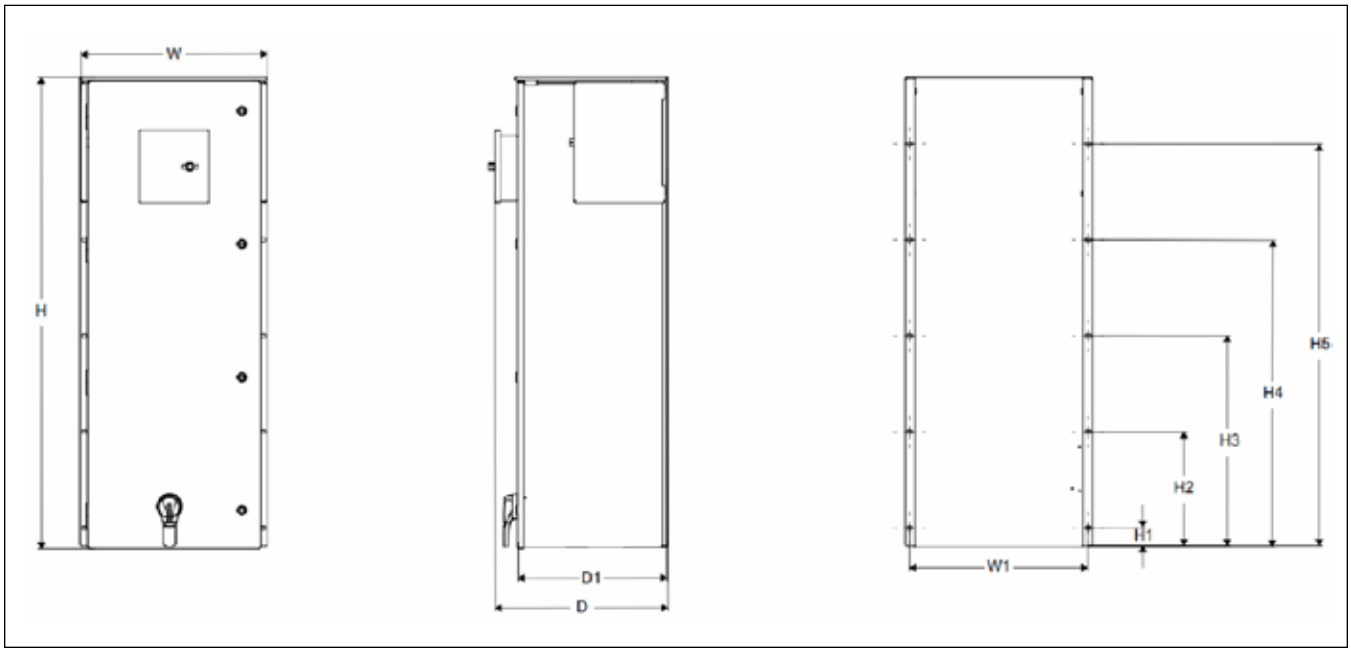


Knockout Dimensions

	Inches						
	A	B	C	D	E	F	Conduit 1, 2, 3, & 4
M1-1	4.03	5.38	3.27	3.77	4.77	7.89	1.125 & 0.875
M1-2	4.03	5.38	3.27	3.77	4.77	7.89	1.125 & 0.875

FP Series II: Type 3R Disconnect

Figure 21. Type 3R Disconnect Outline Dimensions

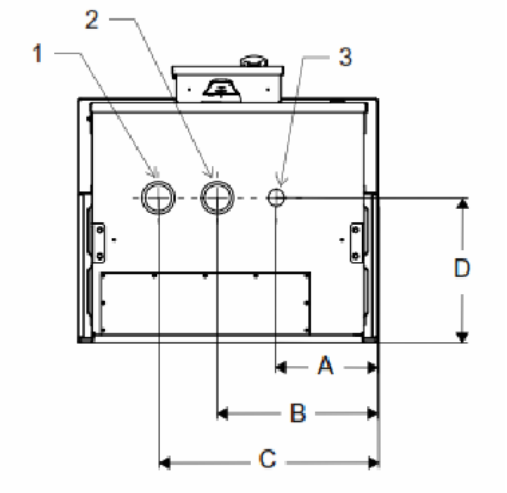


Outline Dimensions

	Inches									
	H	**H1**	**H2**	**H3**	**H4**	**H5**	**W**	**W1**	**D**	**D1**
C1-4	22.79	3.75	11.25	18.75	-	-	15.13	14.19	14.24	11.48
C1-5	22.79	3.75	11.25	18.75	-	-	15.13	14.19	14.24	11.48
C2-5	29.79	4.1	14.1	24.1	-	-	15.13	14.19	14.23	11.48
C3-5	31.72	0.7	9.87	19.03	28.2	-	18.13	17.19	14.23	11.48
C3-6	31.72	0.7	9.87	19.03	28.2	-	18.13	17.19	14.23	11.48
C4-6	53.67	3.37	12.87	22.37	31.87	41.37	17.63	16.61	16.11	13.36
C4-7	53.67	3.37	12.87	22.37	31.87	41.37	17.63	16.61	16.11	13.36
C4-8	53.67	3.37	12.87	22.37	31.87	41.37	17.63	16.61	18.11	15.36
C5-8	53.67	1.87	11.87	21.87	31.87	41.87	21.38	20.36	18.11	15.36
C6-8	57.67	2.2	13.95	25.7	37.45	49.2	22.88	21.86	21.11	18.36

FP Series II: Type 3R Disconnect Knockout

Figure 22. Type 3R Disconnect Knockout Dimensions

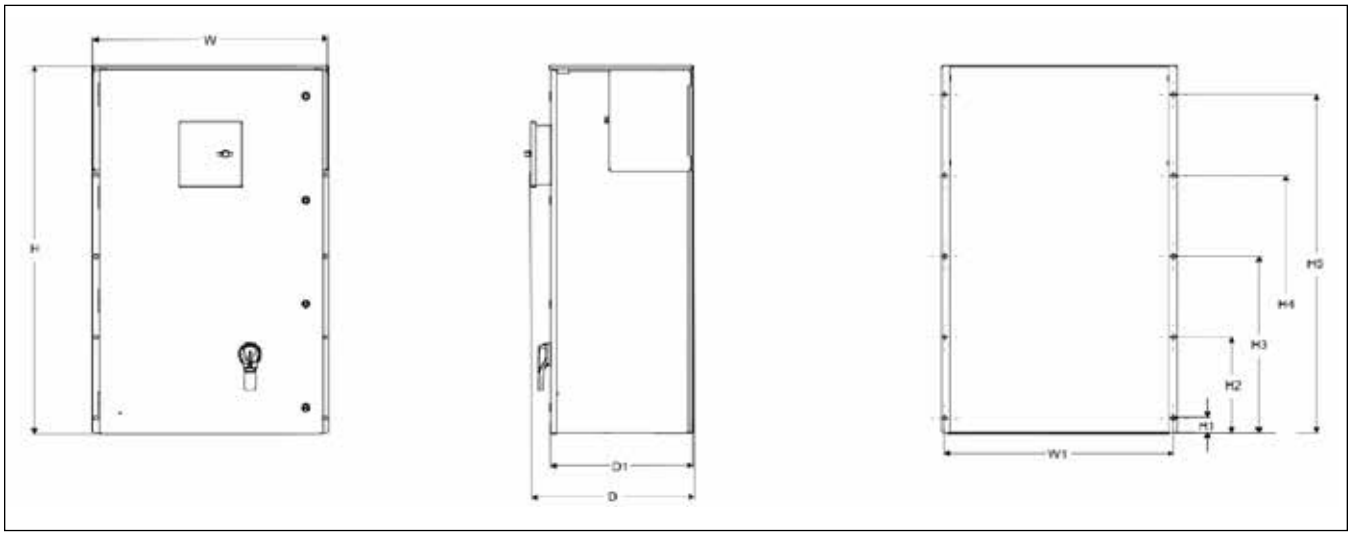


Knockout Dimensions

	Inches						
	A	**B**	**C**	**D**	**1**	**2**	**3**
C1-4	4.99	7.99	10.99	6.07	1.375 & 1.109	1.109	1.109
C1-5	4.99	7.99	10.99	6.07	1.375 & 1.109	1.109	1.109
C2-5	4.99	7.99	10.99	6.57	1.375 & 1.109	1.109	1.109
C3-5	7.99	10.99	13.99	6.57	1.109	1.109	1.734 & 1.109
C3-6	7.99	10.99	13.99	6.57	1.109	1.109	1.734 & 1.109
C4-6	6.49	9.49	12.49	7.58	1.984 & 1.109	1.109	1.109
C4-7	6.49	9.49	12.49	7.58	1.984 & 1.109	1.109	1.109
C4-8	6.49	9.49	12.49	7.58	1.984 & 1.109	1.109	1.109
C5-8	6.24	10.74	15.24	8.08	2.469 & 1.948	2.469 & 1.948	1.375
C6-8	7.74	12.24	16.74	11.08	2.469 & 1.984	2.469 & 1.984	1.375

FP Series II: Type 3R Bypass

Figure 23. Type 3R Bypass Dimensions



Outline Dimensions

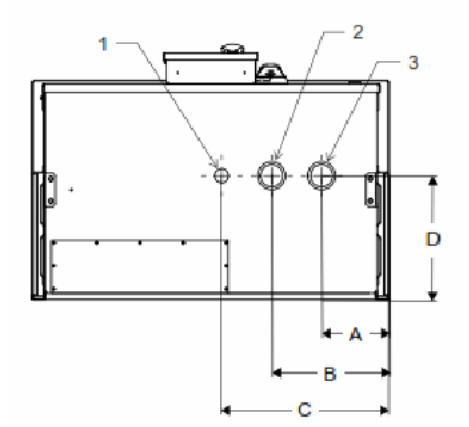
Inches

	H	H1	H2	H3	H4	H5	W	W1	D	D1
D1-4	22.87	1.25	8.75	16.25	-	-	18.13	17.19	17.23	14.48
D1-5	22.87	1.25	8.75	16.25	-	-	18.13	17.19	17.23	14.48
D2-5	22.87	1	8.5	16	-	-	18.13	17.19	17.23	14.48
D3-5	30.74	3.25	13.25	23.25	-	-	21.13	20.19	17.23	14.48
D3-6	30.74	3.25	13.25	23.25	-	-	21.13	20.19	17.23	14.48
D4-6	48.67	1.75	10.25	18.75	27.25	35.75	28.13	27.11	18.11	15.36
D4-7	48.67	1.75	10.25	18.75	27.25	35.75	28.13	27.11	18.11	15.36
D4-8	48.67	1.75	10.25	18.75	27.25	35.75	28.13	27.11	18.11	15.36
D5-8	48.67	2	11.5	21	30.5	40	32.13	31.19	22.11	19.36
D6-8	50.17	2	13	24	35	46	32.13	31.19	22.11	19.36

All dimensions in Inches

FP Series II: Type 3R Bypass Knockout

Figure 24. Type 3R Bypass Knockout Dimensions



Knockout Dimensions

	Inches						
	A	**B**	**C**	**D**	**1**	**2**	**3**
D1-4	4.06	7.06	10.06	9.62	1.109	1.109	1.375 & 1.109
D1-5	4.06	7.06	10.06	9.62	1.109	1.109	1.375 & 1.109
D2-5	4.06	7.06	10.06	9.62	1.109	1.109	1.375 & 1.109
D3-5	4.06	7.06	10.06	9.62	1.109	1.109	1.375 & 1.109
D3-6	4.06	7.06	10.06	9.62	1.109	1.109	1.375 & 1.109
D4-6	6.06	10.56	15.06	11.13	1.109	1.109	1.984 & 1.109
D4-7	6.06	10.56	15.06	11.13	1.109	1.109	1.984 & 1.109
D4-8	6.06	10.56	15.06	11.13	1.109	1.109	1.984 & 1.109
D5-8	6.06	10.56	15.06	11.12	1.375	2.469 & 1.984	2.469 & 1.984
D6-8	6.06	10.56	15.06	11.12	1.375	2.469 & 1.984	2.469 & 1.984

All dimensions in Inches

Features

Standard Features (JC-VSD Series II) Base Drives

Standards

UL, cUL labeled, CE marked, & UL Plenum Rated

EMI/RFI Filter (1st Environment, Restricted Distribution)

Seismic Certification in accordance to

- IBC 2000 referencing ASCE 7-98 and ICC AC156
- IBC 2003 referencing ASCE 7-02 and ICC AC156
- IBC 2006 referencing ASCE 7-05 and ICC AC156

Features

Start-Up Assistants

Diagnostic Assistants

Real Time Clock

Includes Day, Date and Time

Operator Panel Parameter Backup (read/write)

Full Graphic and Multilingual Display for Operator Control, Parameter Set-Up and Operating

Data Display

Output Frequency (Hz)

Speed (RPM)

Motor Current

Calculated % Motor Torque

Calculated Motor Power (kW)

DC Bus Voltage

Output Voltage

Heatsink Temperature

Elapsed Time Meter (reset-able)

KWh (reset-able)

Input / Output Terminal Monitor

PID Actual Value (Feedback) & Error

Fault Text

Warning Text

Three (3) Scalable Process Variable

Displays User Definable Engineering Units

Two (2) Programmable Analog Inputs

Six (6) Programmable Digital Inputs

One (1) Programmable Analog Output

Up to six (6) Programmable Relay Outputs (Three (3) Standard)

Adjustable Filters on Analog Inputs and Outputs

Mathematical Functions on Analog Reference Signals

All Control Inputs Isolated from Ground and Power

Five (5) Resident Serial Communication Protocols

- Johnson Controls N2
- BACnet / IP
- Modbus TCP
- SA-Bus (optional)
- Modbus RTU
- BACnet (MS/TP)

Input Speed Signals

- Current 0 (4) to 20 mA
- Voltage 0 (2) to 10 VDC
- Increase/Decrease Reference Contacts
- (Floating Point)
- Serial Communications

Start/Stop

- 2 Wire (Dry Contact Closure)
- 3 Wire (Momentary Contact)
- Application of Input Power
- Application of Reference Signal (PID Sleep/Wake- Up)
- Serial Communications

Start Functions

- Ramp
- Flying Start
- Premagnetization (DC brake) on Start
- Auto Restart (Reset) – Customer Selectable and
- Adjustable

Stop Functions

- Ramp or Coast to Stop
- DC Braking / Hold at Stop

Accel/Decel

- Two (2) sets of Independently Adjustable Ramps
- Linear or Adjustable 'S' Curve Accel/Decel Ramps

HVAC Specific Application Macros

Separate Safeties (2) and Run Permissive Inputs

Features (continued)

Damper Control

Override Input (Fire Mode)

Timer Functions

Five (5) Daily Start/Stop Time Periods

Three (3) Timers for Collecting Time Periods and Overrides

Seven (7) Preset Speeds

Supervision Functions

Adjustable Current Limit

Electronic Reverse

Programmable Maximum Frequency to 320 Hz

PID Control

- Two (2) Integral Independent Programmable PID
- Setpoint Controllers (Process and External)
- External Selection between Two (2) Sets of Process
- PID Controller Parameters
- PID Sleep/Wake-Up

Motor Control Features

- Scalar (V/Hz) and Vector Modes of Motor Control
- V/Hz Shapes
- Linear
- Squared
- Dynamic Energy Optimization
- IR Compensation
- Slip Compensation
- Six (6) Critical Frequency Lockout Bands

Pre-programmed Protection Circuits

- Overcurrent
- Short Circuit
- Ground Fault
- Overvoltage
- Undervoltage
- Input Phase Loss
- Output Device (IGBT) Overtemperature
- Adjustable Current Limit Regulator
- UL508C approved Electronic Motor Overload (I2T)

Programmable Fault Functions for Protection Include

- Loss of Analog Input
- External Fault
- Motor Thermal Protection
- Stall
- Underload
- Motor Phase Loss
- Ground Fault

5% Equivalent Impedance

- 5% Equivalent Impedance with Internal Reactor(s)

Available Options as Field Installed Kits

Fieldbus Adapter Modules

- LonWorks
- SA-Bus

Standard Features Drive with Input Disconnect or Classic Bypass (JC-VSD FP Series II)

Standards
UL, 508A

Features Unique to Input Disconnect

Input disconnect padlockable in the open position

Optional Fused or non-fused

All features as defined in the Base Drive Feature list

Optional NEMA 3R

Space heater for NEMA 3R

Features Unique to Bypass

Input disconnect lockable in the open position

Optional Fused or non-fused

Control power transformer

Two contactor bypass (electrically interlocked)

Motor Over load (Class 20)

Service Switch

All features as defined in the Base Drive Feature list

Optional NEMA 3R

Space heater for NEMA 3R

Bypass can be controlled mechanically, electrically, and via SA Bus.

Specifications
JC-VSD Series II Base Drives

Input Connection

Input Voltage (U1)	208/220/230/240 VAC 3-phase +/-10% 208/220/230/240 VAC 1-phase +/-10% 380/400/415/440/460/480 VAC 3-phase +/-1 0% 500/575/600 VAC 3-phase +/- 1 0%
Frequency	47-66Hz
Line Limitations:	Max +/-3% of nominal phase to phase input voltage
Fundamental Power Factor (cosj):	0.98 at nominal load
Connection:	L1, L2, L3

Output (Motor) Connection

Output Voltage:	0 to U1 , 3-phase symmetrical, U2 at the field weakening point
Output Frequency:	-320 to 320 Hz.
Frequency Resolution:	0.01 Hz
Continuous Output Current:	
Variable Torque:	1.0 * I2N (Nominal rated output current, Variable Torque)
Short Term Overload Capacity:	
Variable Torque:	1.1 * I2N, (1 min/10 min)
Peak Overload Capacity:	
Variable Torque:	1.50* I2N, (2 sec/1 min)
Base Motor Frequency Range:	0 to 300 Hz
Switching Frequency:	1.5 -10 kHz
Acceleration Time:	0.1 to 3000 s
Deceleration Time:	0.1 to 3000 s
Efficiency:	0.98 at nominal power level
Short Circuit Withstand Rating:	100,000AIC (UL) w/o fuses
Connection:	U, V, W (T1, T2, T3)
Enclosure Style:	UL (NEMA) Type 1, Type 12
Agency Approval Listing and Compliance:	UL, cUL, CE, IBC2000, 2003, 2006

Ambient Conditions, Operation

Air Temperature:	-10° to 40°C (14° to 104°F). Drive can operate at 50°C, reference derating chart for details.
Relative Humidity:	5 to 95%, no condensation allowed
Installation Site Altitude:	0 to 1000 m (3300 ft) above sea level. At sites over 1000 m (3300 ft) above sea level, the maximum power is de-rated 1% for every additional 100 m (330ft). Max altitude is 3000m (9842 ft).
Vibration:	EN6 1800-S-1, EN60068-2-6; 5-150-Hz displacement amplitude 1mm (peak) at 5-15.8 Hz, max accelleration amplitude 1G at 15.8 to 150 Hz OSHPD Seismic Certified.

Ambient Conditions, Storage (in Protective Shipping Package)

Air Temperature: .....-40° to 70°C (-40° to 158°F)
Relative Humidity: .....Less than 95%, no condensation allowed
Vibration:.....In accordance with ISTA 1A and 1B specifications
Shock (IEC 60086-2-29): .....Max 100 m/s2 (330 ft/s2) 11 ms

Ambient Conditions, Transportation (in Protective Shipping Package)

Air Temperature: .....-40° to 70°C (-40° to 158°F)
Relative Humidity: .....Less than 95%, no condensation allowed
Atmospheric Pressure:.....60 to 106 kPa (8.7 to 15.4 PSI)
Vibration:.....See previous page
Shock (IEC 60086-2-29): .....Max 100 m/s2 (330 ft/s2) 11 ms

Cooling Information

Cooling Method:.....Integral fan(s)
Power Loss:.....Approximately 3% of rated power

Analog Inputs

Quantity.....Two (2) programmable
Voltage Reference: .....0 (2) to 10 V, 200kOhm, single ended
Current Reference: .....0 (4) to 20 mA, 250Ohm, single ended
Potentiometer:.....10 VDC, 10 mA (1K to 10KOhms)

Digital Inputs

Quantity.....Six (6) programmable digital inputs
Isolation .....Isolated as one group
Signal Level .....18-30 VDC

Internal Power Supply

Primary Use.....Internal supply for digital inputs
Voltage:.....+24 VDC, max 100 mA
Maximum Current: .....100 mA
Protection: .....Short circuit protected

Relay Outputs

Quantity.....Three (3) programmable relay outputs (2)Form C, (1) Form A
Switching Capacity: .....8 A at 24 VDC or 250 VAC, 0.4 A at 120 VDC
Max Continuous Current: .....2A RMS
Contact Material: .....Silver Cadmium Oxide (AgCdO)

Protections

Single Phase	Protected (input & output)
Overcurrent Trip Limit:	3.5 x I2N instantaneous
Adjustable Current Regulation Limit:	1.3 x I2N (RMS) max.
Overvoltage Trip Limit:	1.30 x UN
Undervoltage Trip Limit:	0.65 x UN
Overtemperature (Heatsink):	+115°C (+239°F)
Auxiliary Voltage:	Short Circuit Protected
Ground Fault:	Protected
Short Circuit:	Protected
Microprocessor fault:	Protected
Motor Stall Protection:	Protected
Motor Underload Protection	Protected
Motor Overtemperature Protection (I2t):	Protected
Input Power Loss of Phase:	Protected
Loss of Reference:	Protected
Short Circuit Current Rating:	100,000 RMS symmetrical Amperes
Input Line Impedance:	5% Equivalent Input Impedance with internal reactor(s)
Printed Circuit Boards	Conformal coated

Notes

U1 = Input Voltage

PN = Power – Normal Duty (HP)

U2 = Output Voltage

2N = Nominal Motor Current Normal Duty

UN = Nominal Motor Voltage

fN = Nominal Motor Frequency

JC-VSD FP Series II Drive with Input Disconnect or Classic Bypass

Input Connection

Input Voltage (U1) ..... 208/230 VAC 3-phase +/-10%
460 VAC 3-phase +/-10%
575 VAC 3-phase +/-10%

Frequency:..... 47 - 66 Hz

Line Limitations: ..... Max +/-3% of nominal phase to phase input voltage

Fundamental Power Factor (cosj):..... 0.98 at nominal load

Connection:..... L1, L2, L3

Output (Motor) Connection

Output Voltage:..... 0 to U1, 3-phase symmetrical, U2 at the field weakening point

Output Frequency:..... -320 to 320 Hz

Frequency Resolution:..... 0.01 Hz

Continuous Output Current:

Variable Torque:..... 1.0 * I2N (Nominal rated output current, Variable Torque)

Short Term Overload Capacity:

Variable Torque:..... 1.1 * I2N, (1 min/10 min)

Peak Overload Capacity:

Variable Torque:..... 1.50 * I2N, (2 sec/1 min)

Base Motor Frequency Range:..... 0 to 300 Hz

Switching Frequency:..... 1.5 to 10 kHz

Acceleration Time:..... 0.1 to 3000 s

Deceleration Time:..... 0.1 to 3000 s

Efficiency:..... 0.98 at nominal power level

Short Circuit Withstand Rating:..... 100,000 AIC (UL). External fusing required for drives with non-fused disconnect.

Connection:..... U, V, W (T1, T2, T3)

Enclosure Style:..... UL (NEMA) Type 1, Galvanized
UL (NEMA) Type 3R (Optional)

Agency Approval Listing and Compliance:..... UL 508 A , cUL,

Ambient Conditions, Operation

Air Temperature:	-10° to 40°C (14° to 104°F). Drive can operate at 50°C, reference derating chart for details.
Relative Humidity:	5 to 95%, no condensation allowed
Installation Site Altitude:	0 to 1000 m (3300 ft) above sea level. At sites over 1000 m (3300 ft) above sea level, the maximum power is de-rated 1% for every additional 100 m (330 ft). Maximum 3000 m (9,842 ft)

Ambient Conditions, Storage (in Protective Shipping Package)

Air Temperature:	-40° to 70°C (-40° to 158°F)
Relative Humidity:	Less than 95%, no condensation allowed

Ambient Conditions, Transportation (in Protective Shipping Package)

Air Temperature:	-40° to 70°C (-40° to 158°F)
Relative Humidity:	Less than 95%, no condensation allowed
Atmospheric Pressure:	60 to 106 kPa (8.7 to 15.4 PSI)
Vibration:	EN6 1800-S-1, EN60068-2-6; 5-150-Hz displacement amplitude 1mm (peak) at 5-15.8 Hz, max accelleration amplitude 1G at 15.8 to 150 Hz OSHPD Seismic Certified.

Cooling Information

Cooling Method:	Integral fan(s)
Power Loss:	Approximately 3% of rated power

Analog Inputs

Quantity	Two (2) programmable
Voltage Reference:	0 (2) to 10 V, 200kOhm, single ended
Current Reference:	0 (4) to 20 mA, 250Ohm, single ended
Potentiometer:	10 VDC, 10 mA (1K to 10 kOhms)

Digital Inputs

Quantity	Six (6) programmable digital inputs
Isolation	Isolated as one group
Signal Level	18-30 VDC, (10V Logic 0)

Internal Power Supply

Primary Use	Internal supply for digital inputs
Voltage:	+24 VDC, max 100 mA
Maximum Current:	100 mA
Protection:	Short circuit protected

Relay Outputs

Quantity	Three (3) programmable relay outputs. (2) Form C, (1) Form A
Switching Capacity:	8 A at 24 VDC or 250 VAC, 0.4 A at 120 VDC
Max Continuous Current:	2A RMS
Contact Material:.	Silver Cadmium Oxide (AgCdO)

Protections (inverter protections- not applicable in bypass)

Single Phase	Protected (input & output)
Overcurrent Trip Limit	3.5 x I2N instantaneous
Adjustable Current Regulation Limit:	1.3 x I2N (RMS) max.
Overvoltage Trip Limit:.	1.30 x UN
Undervoltage Trip Limit:	0.65 x UN
Overtemperature (Heatsink):	+115°C (+239°F)
Auxiliary Voltage:.	Short Circuit Protected
Ground Fault:	Protected
Short Circuit:	Protected
Microprocessor fault:	Protected
Motor Stall Protection:	Protected
Motor Underload Protection	Protected
Motor Overtemperature Protection (I2t):	Protected
Input Power Loss of Phase:	Protected
Loss of Reference:	Protected
Short Circuit Current Rating:	100,000 RMS symmetrical Amperes
Input Line Impedance:	5% Equivalent Input Impedance with internal reactor(s)
Printed Circuit Boards	Conformal coated

Notes

U1 = Input Voltage

PN = Power – Normal Duty (HP)

U2 = Output Voltage

2N = Nominal Motor Current Normal Duty

UN = Nominal Motor Voltage

fN = Nominal Motor Frequency

Definition of NEMA and IEC Environmental Ratings

NEMA and IEC environmental ratings can be confusing at times. Below is a summary of the rating definitions and recommendations for application of each type supported by the JC-VSP FP Series II Drive product family.

NEMA 1, UL type 1

Indoor use primarily to provide a degree of protection against limited amounts of falling dirt.

IP 2 1

(2) Protected against solid foreign objects of 12.5mm diameter and greater

(1) Protected against vertically falling water drops

Recommendation

Installation in clean environment such as a clean room or in another enclosure with higher degree of protection

NEMA 12, UL type 12

Indoor use primarily to provide a degree of protection against circulating dust, falling dirt, and dripping non-corrosive liquids.

IP 5 4

(5) Ingress of dust is not totally prevented, but dust shall not penetrate in a quantity to interfere with satisfactory operation of the apparatus or to impair safety.

(4) Water splashed against the enclosure from any direction shall have no harmful effects

Recommendation

Installation in environments with moderate to significant dust and contaminant particles. Acceptable for most applications on factory floors where dust is present but spraying liquids are not. Regular preventative maintenance for filter changing or cleaning. Inspect drive for dust or particle build up that may limit cooling in the future, clean as needed.

Note: NEMA Type 12 is available in the JCI-VSD Series II product offering and can be mounted in the field. For a Factory Mount (FP Series II), a Special Quote will need to be requested.

NEMA 3R, UL type 3R

Either indoor or outdoor use to provide a degree of protection against falling dirt, rain, sleet, and snow; and that will be undamaged by the external formation of ice on the enclosure.

IP 2 4

(2) Protected against solid foreign objects of 12.5mm diameter and greater

(4) Water splashed against the enclosure from any direction shall have no harmful effects

Recommendation

Installation in outdoor environments where rain and other precipitates are commonly present. Also suitable for indoor installation where dripping or splashing water is present. Not recommended where significant dust and contaminant particles are present.

Guide Specifications

Part 1 - General

1.01 Description

A. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor. It is required that the drive manufacturer have an existing:

- Sales representative exclusively for HVAC products, with expertise in HVAC systems and controls.
- An independent service organization.

B. The drive manufacturer shall supply the drive and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years.

1.02 Quality Assurance

A. Referenced Standards

1. Institute of Electrical and Electronic Engineers (IEEE)
   a) Standard 519-1992, IEEE Guide for Harmonic Content and Control.
2. Underwriters laboratories
   a) UL508C
   b) UL508A
3. National Electrical Manufacturer's Association (NEMA)
   a) ICS 7.0, AC Variable Speed Drives
4. IEC 16800 Parts 1 and 2
5. International Building Code (IBC) (Applies to Base Drive Only)
   a) IBC 2006 Seismic - referencing ASC 7-05 and ICC AC-156

B. Qualifications:

1. VFDs and options shall be UL listed as a complete assembly. VFDs that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. The base VFD shall be UL listed for 100 KAIC at 480VAC max without the need for input fuses.
   a) (OPTION) The VFD shall have an option for a main fused or nonfused disconnect switch with a pad lockable handle UL type 1 enclosed with a coordinated package withstand rating of 100 KAIC at 480VAC max and shall be UL labeled as such.
   b) (OPTION) The VFD shall have an option for a main fused or non-fused disconnect switch with a pad lockable handle, a VFD service disconnect switch to isolate the VFD input and a 2 contactor bypass with motor overload protection in a UL Type 1 enclosure with a coordinated package withstand rating of 100 KAIC at 480VAC max and shall be UL labeled as such.
2. CE Mark – The VFD base drive shall conform to the European Union ElectroMagnetic Compatibility directive, a requirement for CE marking. The VFD shall meet product standard EN 61800-3 for the First Environment restricted level.
3. Acceptable Manufactures
   a) Johnson Controls.
   b) Engineer approved within 2 weeks of bid. Approval does not relieve supplier of specification requirements.

1.03 Submittals

A. Submittals shall include the following information:

1. Outline dimensions, conduit entry locations and weight.
2. Customer connection and power wiring diagrams.
3. Complete technical product description include a complete list of options provided
4. Compliance to IEEE 519 – harmonic analysis for particular job site including total harmonic voltage distortion and total harmonic current distortion (TDD).
   a) The VFD manufacture shall provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors, no exceptions.

Part 2 – Products

2.01 Variable Frequency Base Drives

A. The VFD package as specified herein shall be enclosed in a UL Listed Type 1 enclosure, completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +10% nominal, and -10% nominal voltage as a minimum.

1. Environmental operating conditions: 0 to 40°C continuous. VFDs that can operate at 40° C intermittently (during a 24 hour period) are not acceptable and must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing.
2. Enclosure shall be rated UL type 1 and shall be UL listed as a plenum rated VFD. VFDs without these ratings are not acceptable.
3. An optional UL Type 3R outdoor weatherproof enclosure option shall be available as a standard offering.

B. All VFDs shall have the following standard features:

1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
2. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad.
3. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. There shall be five (5) separate, independent timer functions that have both weekday and weekend settings.
4. The VFDs shall utilize pre-programmed application macros specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.
5. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, operating temperature will be monitored and used to cycle the fans on and off as required.
6. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
7. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 150% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.
9. The VFD shall have an integral 5% impedance to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFDs with only one DC reactor shall add AC line reactors.
10. The VFD shall include a coordinated AC transient pro-tection system consisting of MOVs (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
11. The VFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.
12. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.

13. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

D. All VFDs to have the following adjustments:

1. Six (6) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.
2. Two (2) PID Setpoint controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 100 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID setpoint shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (ie. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network. The setpoints shall be set in Engineering units and not require a percentage of the transducer input.
3. Two (2) programmable analog inputs shall accept current or voltage signals.
4. One (1) programmable analog outputs (0- 20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.
5. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices, typically programmed as follows:

   There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, timeclock control, or serial communications) the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to an VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing". The safety status shall also be transmitted over the serial communications bus. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC.
6. Three (3) programmable digital relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS.
7. Seven (7) programmable preset speeds.
8. Two independently adjustable accel and decel ramps with 1 – 3000 seconds adjustable time ramps.
9. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.

E. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable).

F. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alphanumeric codes are not acceptable):

Output Frequency
Motor Speed (RPM, %, or Engineering units)
Motor Current
Calculated Motor Torque
Calculated Motor Power (kW)
DC Bus Voltage
Output Voltage

G. The VFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the VFD shall operate at an adjustable preset speed. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation.

H. Serial Communications

1. The VFD shall have an RS-485 port as standard. The standard embedded protocols shall be Modbus, Johnson Controls N2 bus, and BACnet MS/TP.

2. Optional protocols for LonWorks, and SA-Bus. The VFD shall have an Ethernet port as standard. The standard embeded protocols shall be ModBus TCP and BACnet IP. Each individual drive shall have an option slot for the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable.

3. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/ derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resetable), operating hours (reset-able), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected, the ability to change the PID setpoint. The DDC system shall also be able to monitor if the motor is running in the VFD mode over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

4 The VFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the DDC system.

5. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good setpoint command and last good DO & PX commands in memory in the event the serial communications connection is lost.

I. EMI / RFI filters. All VFDs shall include EMI/RFI filters. The onboard filters shall allow the VFD assemble to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level.

Part 3 – Execution

11.01 Installation

A. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

B. Power wiring shall be completed by the electrical contractor. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

11.02 Start-Up

A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer

A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD products offered shall be locally available at both the specifying and installation locations. A 24/365 technical support line shall be available on a toll-free line.

11.04 Warranty

A. Warranty shall be 30 months from the date of start-up. The warranty shall include all parts only. With certified start-up, the warranty extends to 39 months, parts AND labor. There shall be 24/365 support available via a toll free phone number.

Glossary

Ambient Temperature The air temperature in the chamber in which a powered electronic unit resides. A unit's heat sinks rely on a lower ambient temperature in order to dissipate heat away from sensitive electronics.

Auto-tuning The ability of a controller to execute a procedure that interacts with a load to determine the proper coefficients to use in the control algorithm. Auto tuning is a common feature of process controllers with PID loops. Auto-tuning is available (for SJ100) as a special command from a digital operator panel. See also digital operator panel.

Base Frequency The power input frequency for which an AC induction motor is designed to operate. Most motors will specify a 50 to 60 Hz value. The inverters have a programmable base frequency, so you must ensure that parameter matches the attached motor. The term base frequency helps differentiate it from the carrier frequency. See also carrier frequency and frequency setting.

Braking Resistor A braking resistor is a resistive load attached to a variable speed drive equipped with Dynamic Braking, referred to as a braking chopper. The resistor is used to dissipate regenera-tive power that exceeds the typical capability of the variable speed drive (see regenerative power).

Break-away Torque The torque a motor must produce to overcome the static friction of a load, in order to start the load moving.

Brushes A sliding electrical connection between a fixed post inside the motor housing and a ring on the motor shaft. Typically used in DC motors or low-cost AC motors, brushes route current to windings on the rotor. AC induction motors with a squirrel-cage design do not have the need for brushes. See also commutation and squirrel cage.

Bypass The term bypass when used in the context of a variable speed drive is a feature of a drive package that incorporates an ability to bypass the variable speed drive in the event it is inoperable and operate the motor on the power line in a traditional manner starting the motor across the power line. The JC-VSD FP is offered with bypass option.

Carrier Frequency The frequency of the constant, periodic, switching waveform that the inverter modulates to generate the AC output to the motor. See also PWM.

CE A regulatory agency for governing the performance of electronic products in Europe. Drive installations designed to have C.E. approval must have particular filter(s) installed in the application.

Choke Also known as inductor or reactor. This device is used to oppose changes in AC current. Its opposition to changes in current is measured in reactance. Reactance is Measurement of the opposition of a circuit or component to an alternating current, expressed in ohms. In variable frequency drive systems a choke, inductor or reactor are used in many different applications, most notably they are used within the variable speed drive in the DC circuit to attempt to minimize the impact of harmonic current draw from the network. Chokes can be applied external to the inverter to minimize the impact of network harmonics. See also harmonics.

DC Injection Braking The inverter DC braking feature stops the AC commutation to the motor, and sends a DC current through the motor windings in order to stop the motor. Also called "DC injection braking," it has little effect at high speed, and is used as the motor is nearing a stop.

Dead Band In a control system, the range of input change for which there is no perceptible change in the output. In PID loops, the error term may have a dead band associated with it. Dead band may or may not be desirable; it depends on the needs of the application.

Digital Operator Pane (DOP) refers first to the operator keypad on the front panel of the inverter. It also includes hand-held remote keypads, which connect to the inverter via a cable. Finally, the DOP Plus is a PC-based software simulation of the keypad devices.

Diode A semiconductor device which has a voltage-current characteristic that allows current to flow only in one direction, with negligible leakage current in the reverse direction. See also rectifier.

Duty Cycle

1. The percent of time a square wave of fixed frequency is on (high) versus off (low).
2. The ratio of operating time of a motor, braking resistor, etc. to its resting time. This parameter usually is specified 0 in association with the allowable thermal rise for the device.

Dynamic Braking

The optional dynamic braking unit also known as a dynamic brake chopper is the electronic switch that is used to dissipate regenerative power from the variable speed drive (see regenerative power). The Dynamic brake requires a braking resistor (a separate additional option) to be operational.

Error

In process control, the error is the difference between the desired value or setpoint (SP) and the actual value of a the process variable (PV). See also process variable and PID Loop.

EMI

Electromagnetic Interference – In motor/drive systems, the switching of high currents and voltages creates the possibility of generating radiated electrical noise that may interfere with the operation of nearby sensitive electrical instruments or devices. This issue is a physics issue that is applicable to all PWM variable speed drives. Certain aspects of an installation, such as long motor lead wire lengths, tend to increase the chance of EMI. Proper installation following the manufacturer's guidelines is the best means of minimizing the impact of this radiated noise from cabling connecting the variable speed drive to the motor.

Four-quadrant Operation

Referring to a graph of torque versus direction, a four-quadrant drive can turn the motor either forward or reverse, as well as decelerate in either direction (see also regenerative power). A load that has a relatively high inertia and must move in both directions and change directions rapidly requires four-quadrant capability from its drive.

Free-run Stop

A method of stopping a motor, caused when the inverter simply turns off its motor output connections. This may allow the motor and load to coast to a stop, or a mechanical brake may intervene and shorten the deceleration time.

Frequency Setting

While frequency has a broad meaning in electronics, it typically refers to motor speed for variable-frequency drives (inverters). This is because the output frequency of the inverter is variable, and is proportional to the attained motor speed. For example, a motor with a base frequency of 60 Hz can be speed controlled with an inverter output varying form 0 to 60 Hz. See also base frequency, carrier frequency, and slip.

Harmonics

According to Fourier Series mathematics, a periodic (repeating) function (waveform) can be expressed as a the summation of a series of pure sine waves of related frequencies. The lowest frequency is the fundamental, while all the other wave components are called harmonics. The square waves used in inverters produce high-frequency harmonics, even though the main goal is to produce lower-frequency sine waves. These harmonics can be harmful to electronics (including motor windings) and cause radiated energy that interferes with nearby electronic devices. A choke is sometimes used to suppress the transmission of harmonics in an electrical system. See also choke.

Horsepower

A unit of physical measure to quantify the amount of work done per unit of time. You can directly convert between horsepower and Watts as measurements of power.

IEEE 519

An industry standard which specifies allowable current and voltage distortion levels in an electrical distribution system. The current distortion levels are defined by the ratio of ISC / IL. Where ISC is the short circuit current available from the source transformer and IL is the maximum load demand current. The resulting ratio defines the allowable TDD total demand distortion which ranges from 5% to 20%. The standard also defines the maximum allowable voltage distortion limits defined as 3% for special applications and 5% for general systems.

IGBT

Insulated Gate Bipolar Transistor (IGBT) – a semiconductor transistor capable of conducting very large currents when in saturation and capable of withstanding very high voltages when it is off. This high-power bipolar transistor is the type used in inverters. Inertia The natural resistance a stationary object to being moved by an external force. See also momentum.

Intelligent Terminal

A configured input or output logic function on the JCI inverters. Each terminal may be assigned one of several functions.

Inverter

A device that electronically changes DC to AC current through a alternating process of switching the input to the output, inverted and non-inverted. A variable speed drive such as the JC-VSD Series II is also called an inverter, since it contains three inverter circuits to generate 3-phase output to the motor.

Isolation Transformer A transformer with 1:1 voltage ratio that provides electrical isolation between its primary and secondary windings. These are typically used on the power input side of the device to be protected. An isolation transformer can protect equipment from a ground fault or other malfunction of nearby equipment, as well as attenuate harmful harmonics and transients on the input power.

Jogging Operation Usually done manually, a jog command from an operator's panel requests the motor/ drive system to run indefinitely in a particular direction, until the machine operator ends the jog operation.

Matrix Filter A passive filter used to mitigate harmonics on the line side of a drive system.

Momentum The physical property of a body in motion that causes it to continue to move in a straight line. In the case of motors, the armature and shaft are rotating and possesses angular momentum.

Multi-speed Operation The ability of a motor drive to store preset discrete speed levels for the motor, and control motor speed according to the currently selected speed preset.

Motor Load In motor terminology, motor load consists of the inertia of the physical mass that is moved by the motor and the related friction from guiding mechanisms. See also inertia.

N.E.C The National Electric Code is a regulatory document that governs electrical power and device wiring and installation in the United States.

NEMA The National Electric Manufacturer's Association. NEMA Codes are a published series of device ratings standards. Industry uses these to evaluate or compare the performance of devices made by various manufacturers to a known standard.

Power Factor (Displacement) A measurement of the time phase difference between the fundamental voltage and fundamental current in an AC circuit. It represents the cosine of the angle of the phase difference.

Power Factor (True) A measurement of the ratio of the real power (kW) to the apparent power (kVA). Distortion power factor takes into account harmonic voltage and current distortion as well as voltage to current displacement.

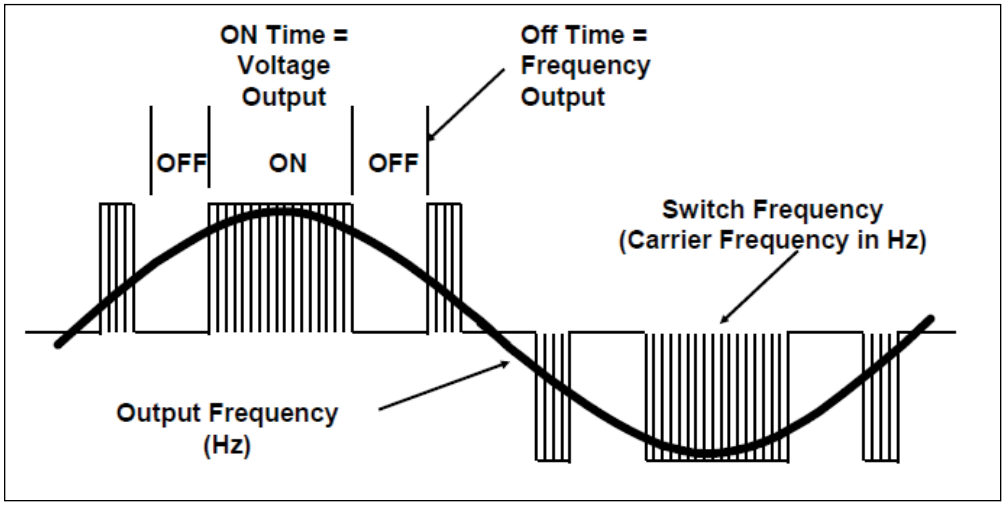
Ride-Through If the supply to a frequency converter is lost, the drive may continue to run without external power supply utilizing the kinetic energy of the rotating motor and driven equipment. The power loss ride-through time depends on the relationship between the load and the inertia of the rotating masses.

PID Loop Proportional - Integral - Derivative – a mathematical model used for process control. A process controller maintains a process variable (PV) at a setpoint (SP) by using its PID algorithm to compensate for dynamic conditions and vary its output to drive the PV toward the desired value. For variable-frequency drives, the process variable is the motor speed. See also error.

Process Variable A physical property of a process which is of interest because it affects the quality of the primary task accomplished by the process. For an industrial oven, temperature is the process variable. See also PID Loop and error.

PWM

Pulse-width modulation: A type of AC adjustable frequency drive that accomplishes frequency and voltage control at the output section (inverter) of the drive. The drive output voltage waveform is at a constant amplitude, and by "chopping" the waveform (pulsewidth-modulating), the average voltage is controlled. The chopping frequency is sometimes called the carrier frequency. The frequency that controls the speed of the motor is shown below as the output frequency. Motor voltage is controlled by the voltage on time versus off time shown of the pulsed DC voltage. In this manner both drive output voltage and drive output frequency can be controlled.



Reactance

The impedance of inductors and capacitors has two components. The resistive part is constant, while the reactive part changes with applied frequency. These devices have a complex impedance (complex number), where the resistance is the real part and the reactance is the imaginary part.

Rectifier

An electronic device made of one or more diodes which converts AC power into DC power. Rectifiers are usually used in combination with capacitors to filter (smooth) the rectified waveform to closely approximate a pure DC voltage source.

Regenerative Braking

A particular method of dissipating regenerative power which is different from a braking chopper and braking resistor where regenerative power is dissipated in heat generated by the resistor during braking. The variable speed drive with regenerative braking can generate the power back on to the power line minimizing heat dissipated into the environment.

Regenerative Power

When a variable speed drive accelerates a load the drive provides voltage and frequency to the motor which define its operating speed and the motor draws current from the variable speed drive based on the motor torque required to accelerate the load. When a motor is decelerated the motor starts to act like a generated and current flow is directed back to the drive. PWM variable speed drives are very efficient with typically 2 to 3% losses. It is these losses that define the variable speed drives ability to absorb regenerative power. When the motor is decelerated the drive must dissipate the energy that exceeds the drives natural losses. In cases where there is not a definite time requirement to stop or reduce a motors speed, variable speed drives have limit functions (typically DC bus over voltage controllers and current limits) that allow the drive to control the rate of deceleration to a level that it can control. In cases where predictable deceleration times or times faster than a motor would coast to a stop are required see braking resistor or regenerative braking. Typically additional pump and fan applications do not require additional supplemental braking capability.

Regulation

The quality of control applied to maintain a parameter of interest at a desired value. Usually expressed as a percent (+/-) from the nominal, motor regulation usually refers to its shaft speed.

Rotor The windings of a motor that rotate, being physically coupled to the motor shaft. See also stator.

Saturation Voltage For a transistor semiconductor device, it is in saturation when an increase in input (gate) current no longer results in an increase in the output (source/drain) current. The saturation voltage is the voltage from the power source to the transistor output (Vsource to Vdrain). The ideal saturation voltage is zero.

Sensorless Vector Control A technique used in variable-frequency drives to rotate the force vector in the motor without the use of a shaft position sensor (angular). Benefits include an increase in torque at the lowest speed and the cost savings from the lack of a shaft position sensor.

Setpoint (SP) The setpoint is the desired value of a process variable of interest. See also Process Variable (PV) and PID Loop.

Single-phase An AC power source consisting of Hot and Neutral wires. An Earth Ground connection usually accompanies them. In theory, the voltage potential on Neutral stays at or near Earth Ground, while Hot varies sinusoidally above and below Neutral. This power source is named Single Phase to differentiate it from three-phase power sources. Some JCI inverters can accept single phase input power, but they all output three-phase power to the motor. See also three-phase.

Slip The difference between the theoretical speed of a motor at no load (determined by its inverter output waveforms) and the actual speed. Some slip is essential in order to develop torque to the load, but too much will cause excessive heat in the motor windings and/or cause the motor to stall.

Squirrel Cage A "nickname" for the appearance of the rotor frame assembly for an AC induction motor.

Stator The windings in a motor that are stationary and coupled to the power input of the motor. See also rotor.

Tachometer 1. A signal generator usually attached to the motor shaft for the purpose of providing feedback to the speed controlling device of the motor. 2. A speed-monitoring test meter which may optically sense shaft rotation speed and display it on a readout.

Thermal Switch An electromechanical safety device that opens to stop current flow when the temperature at the device reaches a specific temperature threshold. In variable-speed drive systems, thermal switches are typically installed at or near the motor, in order to protect the windings from heat damage.

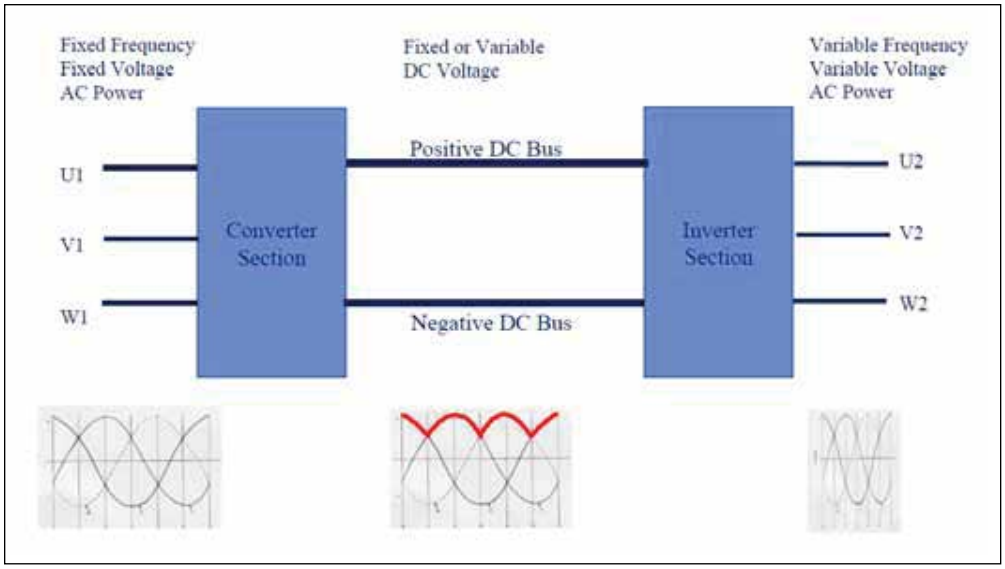
Transistor A solid state, three-terminal device that provides amplification of signals and can be used for switching and control. While transistors have a linear operating range, inverters use them as high-powered switches. Recent developments in power semiconductors has produced transistors capable of handling hundreds of volts and tens of Amperes or more, all with high reliability. The saturation voltage has been decreasing, resulting in less heat dissipation. Hitachi inverters use state-of-the-art semiconductors to provide high performance and reliability, all in a compact package. See also IGBT and saturation voltage.

Trip An event which causes the inverter to stop operation is called a "trip" event (as intripping a circuit breaker). The inverter keeps a history log of trip events. They also require an action to clear.

Twelve Pulse A type of drive system consisting of a phase shift input transformer, (2) six-pulse diode module front ends and an inverter section, used to control a motor and reduce input side line harmonics.

Variable Speed Drive

A variable speed drive is an electronic device used to control the speed of an AC motor. It converts the incoming alternating current (AC) fixed voltage and frequency to a adjustable voltage and frequency output. This adjustable output is connected to a standard AC induction motor to control its speed. The most popular type of Low Voltage (600VAC and below) variable speed Drive is a PWM Inverter. A PWM variable speed drive is a voltage source inverter supplied with converter section made up of a six pulse rectifier (6 diodes creating a three phase full wave bridge) used for conversion of AC voltage from the power line to DC voltage used in the variable speed drive inverter section to generate the PWM output wave form for the motor (see PWM).



Appendix A - Wiring Diagrams

Figure 25. Type 1 Disconnect Schematic

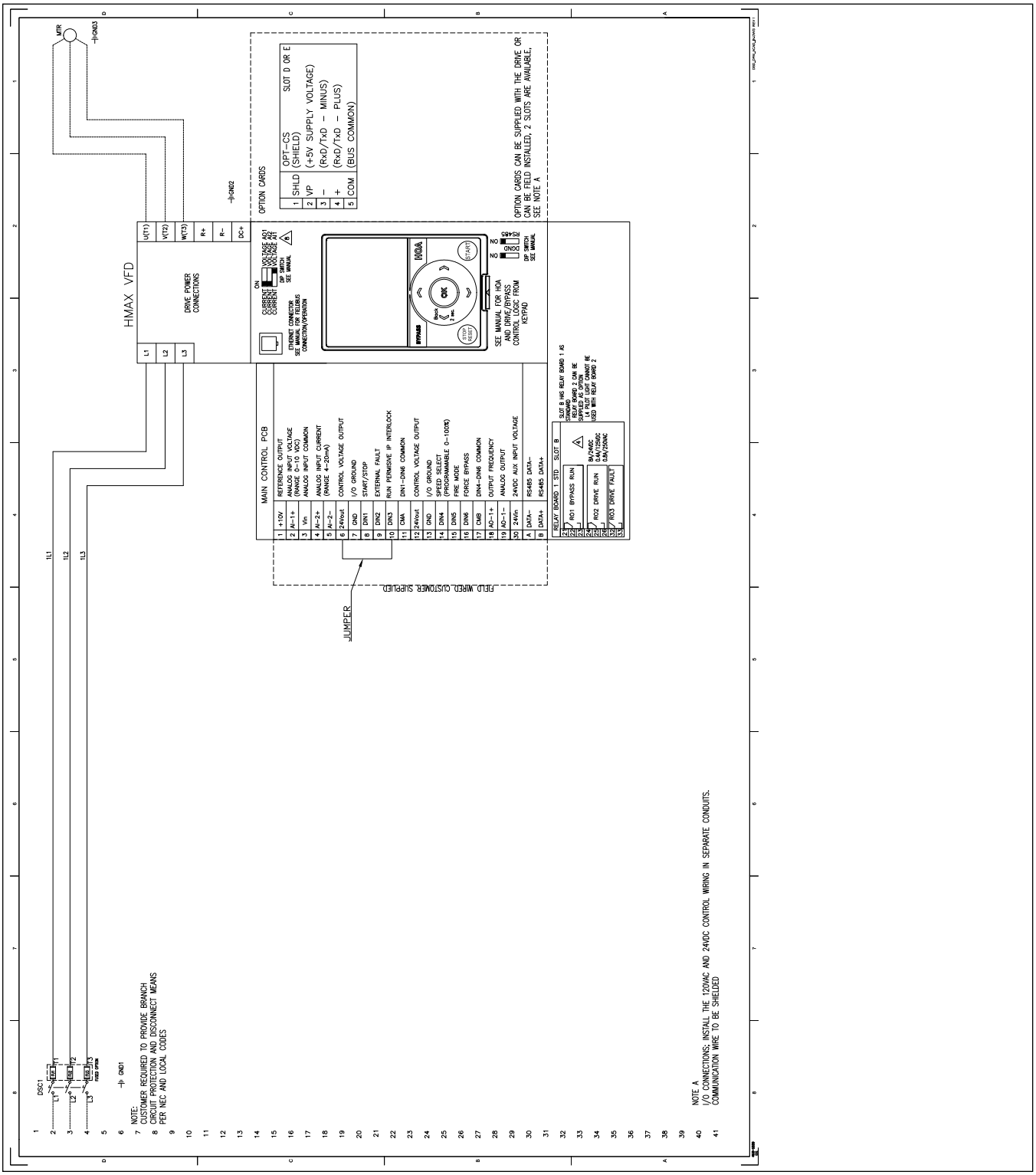


Figure 26. Type 1 Bypass Schematic

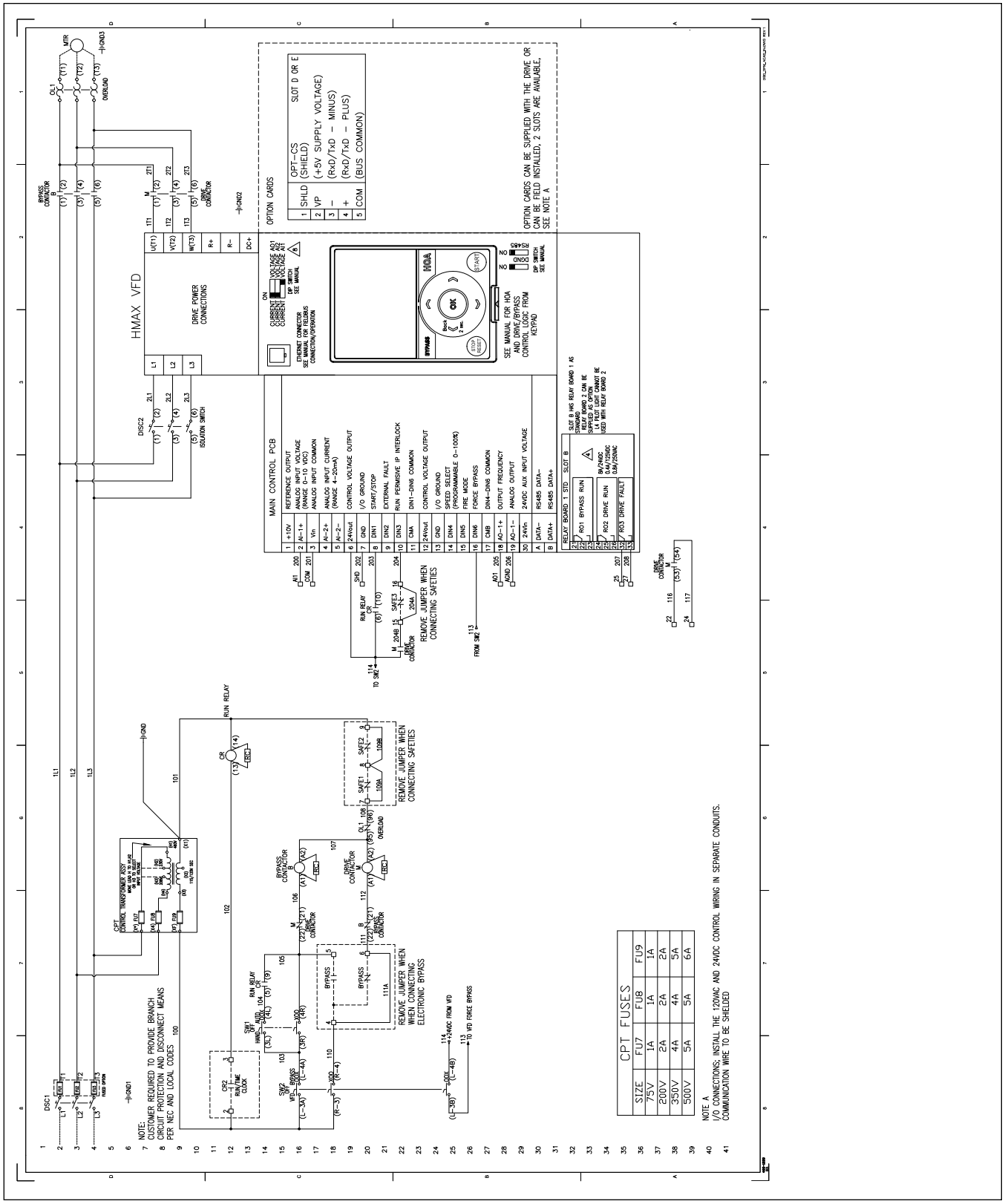


Figure 27. Type 3R Disconnect Schematic"

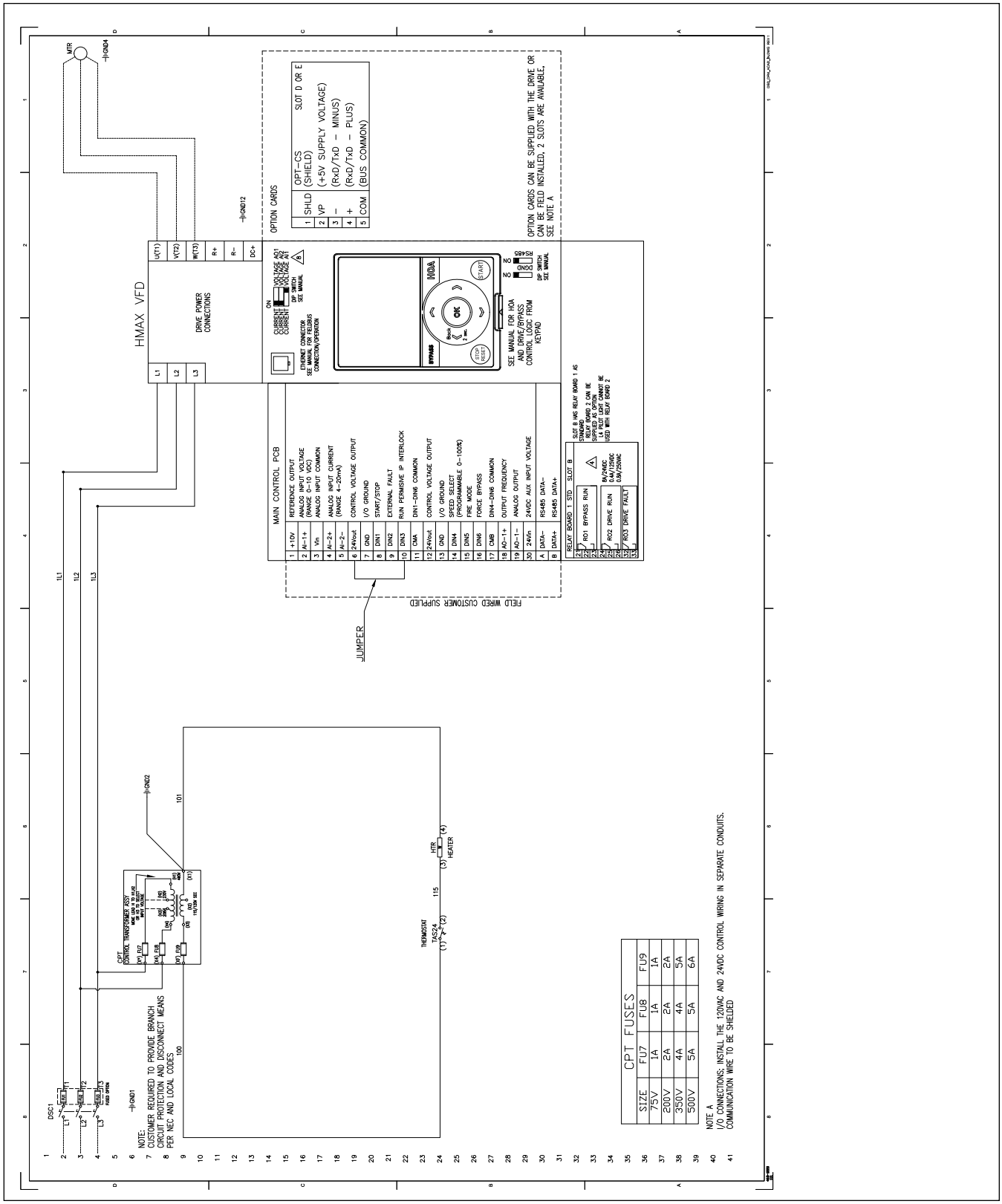


Figure 28. Type 3R Bypass Schematic

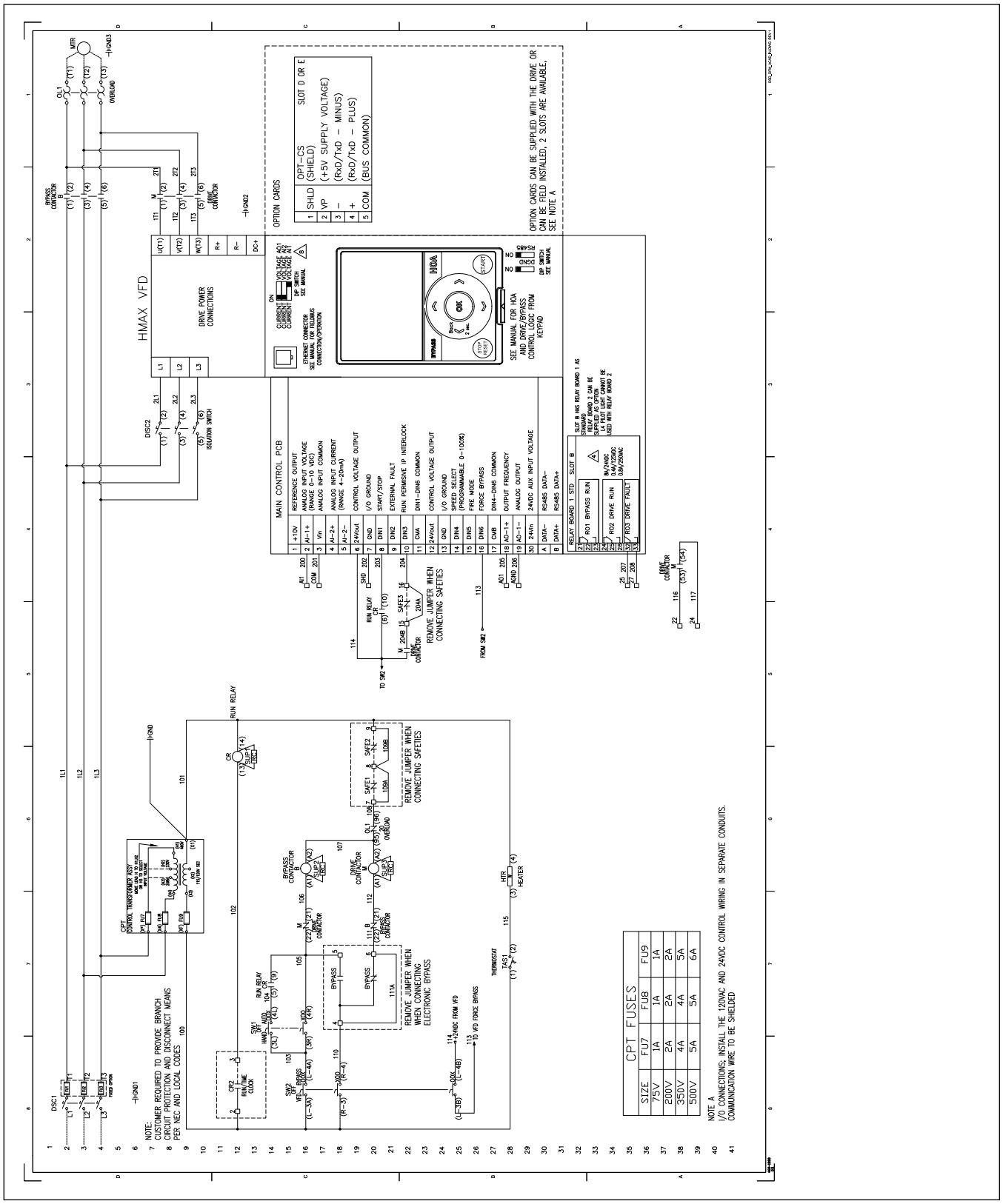
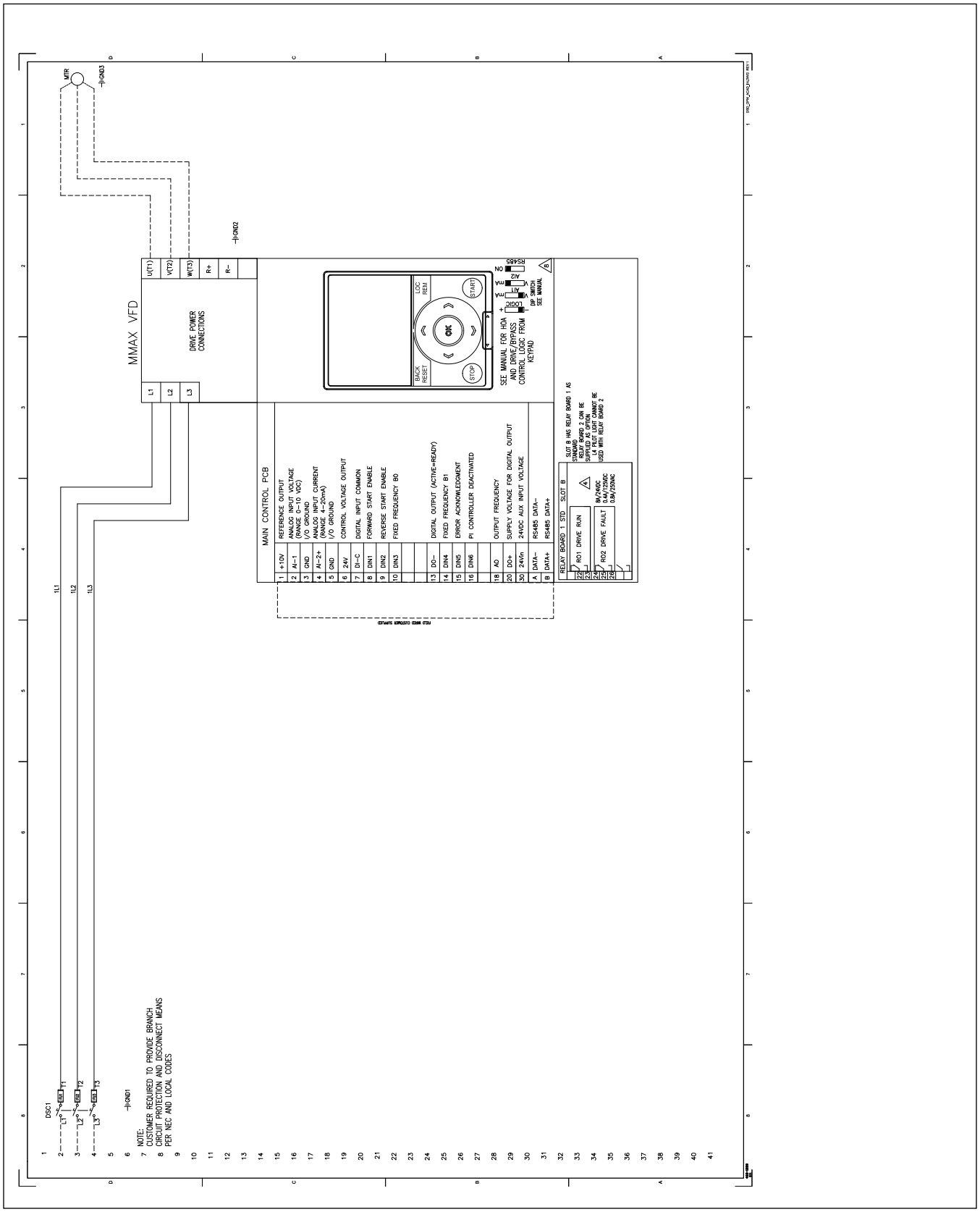


Figure 29. Type 1 Micro Disconnect Schematic



Appendix B - Power Cable Wire Sizes

FP Series II Micro Drive with Disconnect

NEMA Type 1 200-240V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
M1	0.5	YM2D8612B-00000	14	14
	0.75	YM3D7612B-00000	14	14
	1	YM4D8612B-00000	14	14
	1.5	YM7D0612B-00000	14	14

FP Series II Micro Drive with Disconnect

NEMA Type 1 380-480V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
M1	0.5	YM1D3712B-00000	14	14
	0.75	YM1D9712B-00000	14	14
	1	YM2D4712B-00000	14	14
	1.5	YM3D3712B-00000	14	14
	2	YM4D3712B-00000	14	14

FP Series II Drive with Disconnect

NEMA Type 1 208V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
A1	1	YK4D8112B-00000	14	14
	2	YK8D0112B-00000	14	14
	3	YK011112B-00000	14	14
	5	YK018112B-00000	10	10
A2	7.5	YK025112B-00000	8	8
	10	YK031112B-00000	8	8
A3	15	YK048112B-00000	6	6
	20	YK062112B-00000	4	4
A4	25	YK075112B-00000	2	2
	30	YK088112B-00000	2	2
	40	YK140112B-00000	1/0	1/0
A6	50	YK170112B-00000	3/0	3/0

FP Series II Drive with Disconnect

NEMA Type 3R 208V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
C1	1	YK4D8122B-00000	14	14
	2	YK8D0122B-00000	14	14
	3	YK011122B-00000	14	14
	5	YK018122B-00000	10	10
C2	7.5	YK025122B-00000	8	8
	10	YK031122B-00000	8	8
C3	15	YK048122B-00000	6	6
	20	YK062122B-00000	4	4
C4	25	YK075122B-00000	2	2
	30	YK088122B-00000	2	2
	40	YK140122B-00000	1/0	1/0
C6	50	YK170122B-00000	3/0	3/0

* For Non-Fused Disconnect products change the 8th digit in the catalog number to a 1.
Example YK4D8111B-00000 would be for a Non-Fused product.

FP Series II Drive with Disconnect

NEMA Type 1 230V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
A1	1	YK4D8212B-00000	14	14
	2	YK8D0212B-00000	14	14
	3	YK011212B-00000	14	14
	5	YK018212B-00000	12	12
A2	7.5	YK025212B-00000	10	10
	10	YK031212B-00000	8	8
A3	15	YK048212B-00000	6	6
	20	YK062212B-00000	4	4
A4	25	YK075212B-00000	2	2
	30	YK088212B-00000	2	2
	40	YK140212B-00000	1/0	1/0
A6	50	YK170212B-00000	3/0	3/0

FP Series II Drive with Disconnect

NEMA Type 3R 230V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
C1	1	YK4D8222B-00000	14	14
	2	YK8D0222B-00000	14	14
	3	YK011222B-00000	14	14
	5	YK018222B-00000	12	12
C2	7.5	YK025222B-00000	10	10
	10	YK031222B-00000	8	8
C3	15	YK048222B-00000	6	6
	20	YK062222B-00000	4	4
C4	25	YK075222B-00000	2	2
	30	YK088222B-00000	2	2
	40	YK140222B-00000	1/0	1/0
C6	50	YK170222B-00000	3/0	3/0

* For Non-Fused Disconnect products change the 8th digit in the catalog number to a 1. Example YK4D8211B-00000 would be for a Non-Fused product.

FP Series II Drive with Disconnect

NEMA Type 1 460V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
A1	1	YK3D4412B-00000	14	14
	2	YK4D8412B-00000	14	14
	3	YK5D6412B-00000	14	14
	5	YK9D6412B-00000	14	14
	7.5	YK012412B-00000	14	14
A2	10	YK016412B-00000	12	12
	15	YK023412B-00000	10	10
A3	20	YK031412B-00000	8	8
	25	YK038412B-00000	8	8
	30	YK046412B-00000	6	6
A4	40	YK061412B-00000	4	4
	50	YK072412B-00000	4	4
	60	YK087412B-00000	2	2
	75	YK105412B-00000	1	1
A5	100	YK140412B-00000	2/0	2/0
A6	125	YK170412B-00000	3/0	3/0

FP Series II Drive with Disconnect

NEMA Type 3R 460V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
C1	1	YK3D4422B-00000	14	14
	2	YK4D8422B-00000	14	14
	3	YK5D6422B-00000	14	14
	5	YK9D6422B-00000	14	14
	7.5	YK012422B-00000	14	14
C2	10	YK016422B-00000	12	12
	15	YK023422B-00000	10	10
C3	20	YK031422B-00000	8	8
	25	YK038422B-00000	8	8
	30	YK046422B-00000	6	6
C4	40	YK061422B-00000	4	4
	50	YK072422B-00000	4	4
	60	YK087422B-00000	2	2
	75	YK105422B-00000	1	1
C5	100	YK140422B-00000	2/0	2/0
C6	125	YK170422B-00000	3/0	3/0

* For Non-Fused Disconnect products change the 8th digit in the catalog number to a 1. Example YK3D4411B-00000 would be for a Non-Fused product.

FP Series II Drive with Bypass

NEMA Type 1 208V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
B1	1	YK4D8113B-00000	14	14
B1	2	YK8D0113B-00000	14	14
B1	3	YK011113B-00000	14	14
B1	5	YK018113B-00000	10	10
B2	7.5	YK025113B-00000	8	8
	10	YK031113B-00000	8	8
B3	15	YK048113B-00000	6	6
	20	YK062113B-00000	4	4
B4	25	YK075113B-00000	2	2
	30	YK088113B-00000	2	2
	40	YK115113B-00000	1/0	1/0
B6	50	YK150113B-00000	3/0	3/0

FP Series II Drive with Bypass

NEMA Type 3R 208V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
D1	1	YK4D8123B-00000	14	14
	2	YK8D0123B-00000	14	14
	3	YK011123B-00000	14	14
	5	YK018123B-00000	10	10
D2	7.5	YK025123B-00000	8	8
	10	YK031123B-00000	8	8
D3	15	YK048123B-00000	6	6
	20	YK062123B-00000	4	4
D4	25	YK075123B-00000	2	2
	30	YK088123B-00000	2	2
	40	YK115123B-00000	1/0	1/0
D6	50	YK150123B-00000	3/0	3/0

* For Non-Fused Disconnect products change the 8th digit in the catalog number to a 4. Example YK4D8114B-00000 would be for a Non-Fused product.

FP Series II Drive with Bypass

NEMA Type 1 230V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
B1	1	YK4D8213B-00000	14	14
	2	YK8D0213B-00000	14	14
	3	YK011213B-00000	14	14
	5	YK016213B-00000	12	12
B2	7.5	YK024213B-00000	10	10
	10	YK031213B-00000	8	8
B3	15	YK048213B-00000	6	6
	20	YK062213B-00000	4	4
B4	25	YK070213B-00000	2	2
	30	YK088213B-00000	2	2
	40	YK115213B-00000	1	1
B6	50	YK150213B-00000	2/0	2/0

FP Series II Drive with Bypass

NEMA Type 3R 230V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
D1	1	YK4D8223B-00000	14	14
	2	YK8D0223B-00000	14	14
	3	YK011223B-00000	14	14
	5	YK016223B-00000	12	12
D2	7.5	YK024223B-00000	10	10
	10	YK031223B-00000	8	8
D3	15	YK048223B-00000	6	6
	20	YK062223B-00000	4	4
D4	25	YK070223B-00000	2	2
	30	YK088223B-00000	2	2
	40	YK115223B-00000	1	1
D6	50	YK150223B-00000	2/0	2/0

* For Non-Fused Disconnect products change the 8th digit in the catalog number to a 4.
Example YK4D8214B-00000 would be for a Non-Fused product

FP Series II Drive with Bypass

NEMA Type 1 460V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
B1	1	YK2D4413B-00000	14	14
	2	YK4D0413B-00000	14	14
	3	YK5D6413B-00000	14	14
	5	YK9D0413B-00000	14	14
	7.5	YK012413B-00000	14	14
B2	10	YK016413B-00000	12	12
	15	YK023413B-00000	10	10
B3	20	YK031413B-00000	8	8
	25	YK038413B-00000	8	8
	30	YK046413B-00000	6	6
B4	40	YK061413B-00000	4	4
	50	YK072413B-00000	4	4
	60	YK080413B-00000	2	2
	75	YK105413B-00000	1	1
B5	100	YK140413B-00000	2/0	2/0
B6	125	YK170413B-00000	3/0	3/0

Drive with Bypass

NEMA Type 3R 460V

Frame Size	HP	Catalog Number	Input Power Terminations Min AWG	Output Power Terminations Min AWG
D1	1	YK2D4423B-00000	14	14
	2	YK4D0423B-00000	14	14
	3	YK5D6423B-00000	14	14
	5	YK9D0423B-00000	14	14
D1	7.5	YK012423B-00000	14	14
	10	YK016423B-00000	12	12
	15	YK023423B-00000	10	10
D3	20	YK031423B-00000	8	8
	25	YK038423B-00000	8	8
	30	YK046423B-00000	6	6
D4	40	YK061423B-00000	4	4
	50	YK072423B-00000	4	4
	60	YK080423B-00000	2	2
	75	YK105423B-00000	1	1
D5	100	YK140423B-00000	2/0	2/0
D6	125	YK170423B-00000	3/0	3/0

* For Non-Fused Disconnect products change the 8th digit in the catalog number to a 4.
Example YK2D4414B-00000 would be for a Non-Fused product

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Printed in USA
Publication No. LIT-12012112
May 2015