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FPC5010

Compact VFD Bypass Package

Specification Guide

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1.0 GENERAL

1.1 PURPOSE

This specification shall establish the minimum requirements for adjustable frequency drive equipment. Drives that do not meet these requirements shall not be acceptable. The adjustable frequency drive equipment shall be the GP10 as furnished by Saftronics, Inc.

1.2 DRIVEN EQUIPMENT

The Drive shall be capable of operating a NEMA design B squirrel cage induction motor with a full load current equal to or less than the continuous output range of the Drive. At base speed (60 hertz) and below, the Drive shall operate in constant volts per hertz mode. Above base speed (60 hertz), the Drive may selectively operate in either a constant volt per hertz mode or a constant voltage extended frequency mode.

1.3 DRIVE CONSTRUCTION

The adjustable frequency Drive shall be a sinusoidal PWM type Drive with sensor-less Dynamic Torque Vector Control capability. The Drive shall be provided in a NEMA 1 enclosure at all ratings. NEMA 4 enclosures shall be available up to 15 HP ratings, NEMA 12 enclosures shall be available for 15 through 30 HP ratings, and IP00 enclosures shall be available for 40 HP and above. The Drive shall be of modular construction for ease of access to control and power wiring, and maintenance. It shall consist of the following general components:

1.3.1 Full wave diode rectifier to convert AC supply to a fixed DC voltage.

1.3.2 DC link capacitor

1.3.3 Insulated Gate Bipolar Transistor (IGBT) power section, for variable torque applications. The power section shall use vector dispersal pulse width modulated (PWM) control and soft switching IGBTs to reduce noise and allow longer cable length from drive to motor.

1.3.4 The Drive shall be microprocessor based with an LED and LCD display to monitor operating conditions. The Drive display section shall allow for local operation and setting of Drive function codes and display fault indication and reasons associated with the fault. The LED display shall offer nine (9) different display settings and the LCD shall have the capacity to display five (5) lines of information at a time.

1.3.5 Separate control and power terminal boards, with option plug shall be provided by the drive to allow for remote operation.

1.3.6 The Drive shall have an RS485 port as a standard and options for communicating with recognized industry standard device level networks such as DeviceNet, Modbus Plus, LonWorks and Metasys N2.

1.3.7 The keypad shall be capable of copying, uploading and downloading Drive function codes.

2.0 OPERATING CONDITIONS

2.0.1 The Drive's operating ambient temperature range shall be -10oC to 50oC. Storage temperatures shall be between -25oC to 65oC.

2.0.2 The relative humidity range shall be 5-95% non-condensing.

2.0.3 The Drive shall be suitable for operation at altitudes up to 3300 feet without de-rating.

2.0.4 The Drive shall meet IEC 61200-2 for vibration levels.

2.0.5 The Drive shall be capable of side-by-side installation with zero clearance at 30 HP and below.

3.0 STANDARDS

3.0.1 The Drive shall be UL listed and not require external fuses. The Drive shall also be CE labeled and comply with standards EN 61800-3 for EMC compliance and EN 61800-2 for low voltage compliance.

3.0.2 The Drive shall be designed in accordance with applicable portions of NEMA standards.

3.0.3 The Drive shall be compatible with the installation requirements of interpretive codes such as National Electric Code (NEC) and Occupational Safety & Health Act (OSHA).

3.0.4 The Drive shall be capable of operating in compliance with IEEE 519-1992.

4.0 INPUT POWER

4.0.1 The Drive design shall be such that it will be available for use either with 200-230 or 380-480 VAC, 3-phase power input.

4.0.2 The Drive shall be able to withstand voltage variations of -15% to +10% and imbalance no greater than 3% without tripping or affecting Drive performance.

4.0.3 System frequency shall be 50 or 60 Hertz with a maximum frequency variation of +5%.

4.0.4 The displacement power factor of the Drive shall be 0.95 lagging or higher with the use of a DC reactor. (Note: Displacement power factor is not the same as the actual power factor.)

4.0.5 Drive efficiency at rated load shall be 96% or higher depending on Drive's operating carrier frequency and rating.

4.0.6 Line notching, transients, and harmonics on the incoming line shall not affect Drive performance.

5.0 OUTPUT POWER

5.0.1 The Drive shall be capable of horsepower ratings from fractional through 600 HP (variable torque) and output frequencies up to 120 Hertz. It shall also have an energy saver feature with the capability of selecting a V/Hz automatic control function that will modify the V/Hz curve based on light load characteristics that will minimize power consumption.

5.0.2 Drive output voltage shall vary with frequency to maintain a constant volts/hertz ratio up to base speed (60 hertz) output. Constant or linear voltage output shall be supplied at frequencies greater than base speed (60 hertz).

5.0.3 Rated output voltage shall be programmable for motor ratings from 180 to 240 volts, or from 320 to 480 volts.

5.0.4 The Drive shall be capable of a minimum of 100% rated current in continuous operation, in accordance with the requirements of NEC Table 430-150.

5.0.5 The Drive one minute overload current rating shall be 110% of rated current for Variable Torque applications and 150% for Constant Torque applications.

6.0 DRIVE FEATURES

6.0.1 The Drive shall have a graphic back-lit liquid crystal display (LCD) which can be configured to display frequency, current, function code set points, or Drive status and fault codes. It shall display 4 lines with 13 characters of text, providing display of:

Programming Mode: Function Code Numbers, Set points, and Status.
Diagnostic Mode: Fault Indication Codes. (See Section 9.1)
I/O Check Mode: Analog and digital input/output signal status.
Copy Function Mode: Function Data Copy.

6.0.2 The Drive shall display operating data, fault information, and programming prompts in English with graphic representations of functions where applicable. The Drive shall have six (6) different language LCD readout capabilities (English, French, German, Italian, Spanish, and Japanese).

6.0.3 The drive shall have four digital LED readouts, providing display of: Output Current, Output Voltage, Output Frequency, Frequency Reference, Motor Synchronous Speed (adjustable for 2 to 12 pole motors), Line Speed (calibration adjustable from 0 to 200% of frequency, with 0.01% resolution), kW power consumption, PID setting value, PID remote set value, PID feedback value, and Torque calculations value.

6.0.4 The Drive shall also have a built in keypad that shall be extendible, by optional cable, to a remote location up to 100 feet from the Drive. The keypad shall include the following buttons, allowing 3 modes of operation: Forward/Reverse/Stop/Jog keys, Drive reset key, Reference increment/decrement keys.

6.0.5 The Drive shall be capable of remote mounting with simple connection to the keypad or via an RS485 serial port.

6.0.6 Upon a fault condition, the LCD shall display Drive current, voltage, frequency, torque, DC link voltage, operating hours, I/O terminal status, and temperature at the time of fault. The last four (4) faults will be stored in memory and selectively be dis played on the LCD.

6.0.7 Unless the application requires it, the Drive shall operate as an open-loop control system requiring no feedback devices.

6.0.8 The Drive shall accept and follow a selectable external frequency reference of either analog 0-5 VDC, 0±10 VDC, 4-20mA with signal inversion.

6.0.9 The Drive shall maintain the output frequency to within 0.2% of reference when the reference is analog, and to within .01% of reference when the reference is digital (Speed level inputs from keypad, contact closure or digital interface).

6.0.10 The Drive shall maintain set frequency regardless of load fluctuations.

6.0.11 The Drive shall be capable of at least 4 different acceleration rates and 4 different deceleration rates. Each acceleration and deceleration rate shall be independently adjustable from 0.01 to 3600 seconds.

6.0.12 The Drive will have a default starting torque of 50% with adjustment to 120% when the Dynamic Torque Vector Control function is activated.

6.0.13 The Drive will have the capability of determining motor characteristics to optimize its operation through the use of pre-programmed motor data information or self-tuning operation where the Drive can determine the motor characteristics initially.

6.0.14 The Drive shall allow the user to select whether the shaft does or does not move during auto-tune.

6.0.15 The Drive Auto-tune will include an online mode that automatically and dynamically compensates the drive's regulator for changes in motor temperature.

6.0.16 The Drive shall offer three selectable acceleration/deceleration patterns: linear, S-curve, and non-linear for variable torque loads.

6.0.17 The drive shall have selectable torque (voltage) boost settings that will enable smooth acceleration of high inertia or high static friction type loads during starting. One level will allow for automatic calibration that will compensate for the ac motor's primary resistance (IR compensation); one level is to be set for variable torque loads; one level is to be for proportional torque loads where torque is directly related to set speed, or for constant torque loads. A second Torque Boost function setting is to be available for a 2nd motor with different characteristics and/or set of operating requirements.

6.0.18 The Drive shall have a selectable Automatic Torque Boost function that will adjust motor torque based on the operating load conditions.

6.0.19 All Drive Operating Function Codes shall be stored in non-volatile memory (EEP ROM). Potentiometer adjustments are not required nor allowed. The Drive will have a default set of Function Code settings.

6.0.20 The Drive shall have adjustable switching frequency settings ranging from 0.75 kHz to15 kHz to limit and adjust the level of audible motor noise.

Ranges:	Up to 30 HP	0.75 -15 kHz
	30 to 100 HP	0.75- 10 kHz
	125 HP and greater	0.75 - 6 kHz

6.0.21 The Drive shall be able to operate with its output disconnected for troubleshooting and startup.

6.0.22 The Drive shall have a reference filter that eliminates the effects of noise that may be present in the analog signals.

6.0.23 The Drive shall have a selectable function to prevent reverse operation of the drive.

6.0.24 The Drive shall be able to reset itself up to ten (10) times (adjustable with adjustable intervals of 2-20 seconds) after over-current, over-voltage, overheating, and overload faults.

6.0.25 The Drive shall be able to operate after a voltage dip below 175 VAC on 230 VAC input power and 310 VAC on 460 VAC input power for 15 milliseconds at 85% full load current without any disturbances in output power delivered to the load. If power exceeds this level, six (6) different modes or active and inactive restart modes will be available.
The decrease in motor speed will be adjustable in the event of a momentary power outage.

6.0.26 The Drive shall have a programmable start frequency, adjustable from 0.1 to 60 hertz, with a 1 hertz resolution (refer to 7.9), with a holding time adjustable from 0.1 to 10 seconds.

6.0.27 The Drive shall have the ability to operate in a sensor-less, dynamically controlled torque vector mode for applications that require improved motor speed control and operating characteristics.

6.0.28 The Drive shall have IGBT soft switching and a low noise control power supply sys tem to reduce the noise from the drive.

7.0 SPEED CONTROL

7.1 Drive base frequency shall be programmable 25 to 120 hertz with 1 hertz resolution, and the maximum frequency shall be programmable from 50 to 120 hertz, both with 1 hertz resolution.

7.2 The Drive shall have both low frequency limit and high frequency limit functions. Each will be programmable from 0 to 120 hertz with 1Hz resolution.

7.3 The Drive shall have a frequency bias (starting frequency) function programmable from -120 to +120 Hz of maximum frequency, with 0.1 Hz resolution.

7.4 Drive frequency gain shall be programmable from 0-200%, with 0.1% resolution.

7.5 The Drive shall be capable of at least fifteen (15) independently programmable pre set frequencies, adjustable from 0.00 to 120.00 hertz.

7.6 The Drive shall be capable of selectable operation in Pattern (programmed cycles) Operation using up to the fifteen (15) preset speeds with at least seven (7) independently programmable timers with an adjustment range of 0.00 to 6000 seconds, four acceleration and deceleration ramp rates, as well as a hold command at set frequency and a reset command to restart the programmed cycle.

7.7 The Drive shall be capable of motor slowdown or stop by selectable regenerative (to the DC link) dynamic braking while following one of the four selectable deceleration ramps, and control the braking torque by setting it's value from 0, 20 to 150%, 999 (no limit) of Drive rating. It will also be capable of changing the rate of deceleration automatically by stopping the braking action long enough to avoid Drive over-voltage trip.

7.8 The Drive shall be capable of starting into a rotating load (forward or reverse) and shall smoothly accelerate or decelerate to the set point without experiencing component damage.

7.9 The Drive shall be capable of stopping by selectable DC injection braking. It shall be adjustable from 0 to 100% braking level and have a programmable starting frequency for DC braking (0.2-60 hertz) and programmable braking time (0.1 to 30.0 seconds).

7.10 The Drive shall have a start Frequency Setting that incorporates a Holding Time at the Frequency Setting, adjustable up to 10 seconds in duration.

7.11 The Drive shall provide at least three selectable skip frequencies with programmable bandwidths, adjustable 0 to 30 Hz, which will not allow operation at or near mechanical resonance speeds.

7.12 The Drive shall provide selectable slip compensation, which will sense output cur rent and adjust output frequency, to improve motor speed fluctuations. This will allow approximately 1% or less (depending in the slip value selected) speed regulation with out the use of a speed feedback device. This function is to be adjustable over a range
of 0 to 15.00 Hz.

7.13 The Drive shall have Droop operation, balancing drooping characteristics to speed and load variations. This function shall be adjustable from -9.9 to 0.0 Hz.

7.14 The Drive shall be constructed to support external signals, whether variable reference or discrete inputs, from distances up to 66 feet when proper cable is used.

7.15 Required Drive performance criteria includes:

Frequency Control Range: 0.1 to 120 Hertz		
Frequency Stability:	Digital reference:	+ 0.01 % of maximum frequency
	Analog reference:	+ 0.2 % of maximum frequency
Frequency Resolution:	Digital reference:	0.01 Hz at max. frequency up to 99.99 Hz 0.1 Hz at max. frequency 100 Hz and above
	Analog reference:	1/3000 at max. frequency

8.0 ENCLOSURE

8.1 Enclosure: VFD Systems will be mounted in a NEMA 1 enclosure.

8.1.1 Operator control station shall be available with the following features:

a. Local/Remote switch for selecting operation either from the operator control station or from a remote location. Both start/stop and speed reference signals will be selected by a single switch.
b. Reset pushbutton.
c. Start pushbutton.
d. Stop pushbutton.

8.1.2 As required by the contract drawings, supply a pad-lockable door interlocked input circuit breaker rated 14 KAIC, fused disconnect rated 200 KAIC or a non-fused disconnect.

8.1.3 Three (3) contactor bypass to fully isolate the VFD. The VFD must be able to be run for testing purposes while the motor is operating in the bypass mode. The contactors will be AC3 rated for continuous duty.

8.1.4 Output 3 phase current sensing class 20 overload relay to provide motor protection in either the VFD or bypass mode. As an option, provide class 30 overloads to allow for the long starting time required by large axial fans. See contract drawings.

8.1.5 Provide the following switches and indication lights:

a. Inverter/Off/Bypass switch for selection of inverter or bypass mode.
b. Test/Off/Run switch for maintenance of inverter while operating motor in bypass.
c. Power on light (Red).
d. Motor Fault light (Amber).
e. Bypass Run light (Green).

8.2 RFI Filters: As an option, the VFDs will be supplied with input RFI filters designed to meet FCC class A, CISPR, and VDE specification.

8.3 Based on the one-line diagrams and information supplied by the contractor, the VFD manufacturer will provide calculations specific to this installation, showing total harmonic voltage distortion of the VFDs are less then 5%. Input line filters will be sized and provided as required by the VFD manufacturer to ensure compliance with the IEEE standard 519-1981, guide for static power converters. Acceptance of this calculation must be completed prior to VFD installation. Calculations will be provided upon request, after receipt of site-specific information.

9.0 DRIVE CONTROL & OPTIONS

9.1 The Drive shall accept inputs from external dry contacts for the following functions:

9.1.1 Run forward command
9.1.2 Run reverse command
9.1.3 Multi-step frequency selection
9.1.4 Acceleration/Deceleration time selection
9.1.5 Stop command
9.1.6 Coast to stop command
9.1.7 Alarm reset
9.1.8 Trip command (external fault)
9.1.9 Jogging operation
9.1.10 Frequency setting 2 and Frequency setting 1
9.1.11 Motor 2 and Motor 1 setting
9.1.12 DC brake command
9.1.13 Torque limiter 2 and Torque limiter 1
9.1.14 Switching operation between line and inverter (50 and 60 Hz)
9.1.15 Speed Increase command
9.1.16 Speed Decrease command
9.1.17 Write enable for keypad
9.1.18 PID control cancel
9.1.19 Inverse mode changeover
9.1.20 Interlock signal
9.1.21 Link enable
9.1.22 Universal DI
9.1.23 Pick up start mode
9.1.24 Forced stop command
9.1.25 Forced stop command with Deceleration time

9.2 The Drive shall be capable of selectable external start/stop control, either 2-wire or 3-wire type.

9.3 The frequency reference shall be from, selectively, an external speed potentiometer, external analog signals (0-5 VDC, 0±10 VDC, 4 to 20mA with signal inversion), from the built in keypad, or from bus communication.

9.4 The Drive shall provide an adjustable (to a maximum of 0-200% / 10.3 VDC) analog output and a frequency pulse output. The analog output shall be selectively proportional to either output frequency (before or after slip compensation), output current, output voltage, output torque, load factor, input power, PID feedback value, tachometer feedback value, DC link voltage. The frequency pulse output shall be suitable for both an analog meter indication as well as digital frequency indication.

9.5 The Drive shall provide selectable outputs indicating the following:

9.5.1 8.5.1. Four (4) Programmable digital open collector outputs and a dry contact output for:

9.5.1.1 Inverter running
9.5.1.2 Frequency equivalence signal
9.5.1.3 Frequency level detection
9.5.1.4 Torque polarity
9.5.1.5 Torque limiting
9.5.1.6 Auto-restarting
9.5.1.7 Overload early warning
9.5.1.8 Keypad operation mode
9.5.1.9 Inverter stopping
9.5.1.10 Ready input
9.5.1.11 Line/Inverter changeover
9.5.1.12 Motor 2 / Motor 1
9.5.1.13 Auxiliary terminal
9.5.1.14 Time-up signal
9.5.1.15 Cycle completion time
9.5.1.16 Stage No Indication (1, 2, and 4)
9.5.1.17 Alarm Indication (1, 2, 4, and 8)
9.5.1.18 Fan operation signal
9.5.1.19 Auto resetting
9.5.1.20 Universal DO
9.5.1.21 Overheat early warning
9.5.1.22 Second frequency level detection
9.5.1.23 Second overload early warning
9.5.1.24 Terminal C1 off signal

9.5.2 Transistor outputs (Y1 to Y4) are either sink or source operation.

9.6 The Drive shall be compatible with the LonWorks, Metasys N2, and Modbus by an option card and allow for communication interface either directly or via third party interface boards.

9.7 The Drive keypad shall have the capability to store Function Codes that are either preset, internal, or are operational code settings used for a specific application. The keypad shall be able to download function codes into other drives.

10.0 PROTECTIVE AND DIAGNOSTIC FEATURES

10.1 When a fault occurs, the Drive shall have a controlled shut down sequence. The reason for the fault condition shall be enunciated on the LED display, and the LCD graphic screen shall display the current, temperature, frequency, and voltage at the time of the fault as well as potential reasons for the condition. The Drive shall monitor, sense, and display the following fault conditions:

10.1.1 Over-current during acceleration
10.1.2 Over-current during deceleration
10.1.3 Over-current during constant speed operation
10.1.4 Ground fault
10.1.5 Input phase loss
10.1.6 Fuse blown
10.1.7 Over-voltage during acceleration
10.1.8 Over-voltage during deceleration
10.1.9 Over-voltage during constant speed operation
10.1.10 Under-voltage
10.1.11 Overheating of heatsink
10.1.12 External thermal relay
10.1.13 Over-temperature of internal air
10.1.14 Overheating at Dynamic Braking circuit
10.1.15 Motor 1 overload
10.1.16 Motor 2 overload
10.1.17 Inverter unit overload
10.1.18 Over-speed
10.1.19 Memory Error
10.1.20 Keypad panel communication error
10.1.21 CPU error
10.1.22 Option error (quantity 2)
10.1.23 Operational procedure error
10.1.24 Output wiring error / Impedance imbalance
10.1.25 Modbus-RTU error

10.2 The Drive shall have a selectable Torque Limiting function for both motoring and braking that will sense an overload condition and will reduce frequency and current temporarily until the load reaches acceptable levels. If the overload condition is not settled in the proper amount of time, the Drive will trip on overload. The Torque Limiting shall be programmable from 20-150% of Drive rated motor torque (30 HP and below) and from 20-150% of Drive rated motor torque (40 HP and above), with 1% resolution.

10.3 The Drive shall have a selectable electronic inverse time thermal overload function as required by NEC and UL Standard 991 for an AC Induction Motor (Refer to applicable codes for specific installation requirements). The overload shall be programmable from 20 - 135% of Drive rated current.

10.4 The Drive shall have an over-voltage protection function that operates if supply voltage rises above rated value or by motor's regeneration.

10.5 The Drive shall treat short circuits in either the output load or the output module as an over-current.

10.6 If the Drive heat sink temperature exceeds approximately 100oC, the Drive will shut down on over temperature fault.

10.7 The Drive shall provide output ground fault protection.

10.8 The Drive shall provide LED indication of DC bus voltage, which, when lit, will signify to maintenance people the presence of potentially dangerous voltage.

11.0 QUALITY ASSURANCE

11.1 All Drives shall be 100% factory tested to ensure proper performance upon delivery.

11.2 The Drive vendor shall provide a warranty for material and workmanship, for a period of twelve months after start up or 18 months after shipment, whichever occurs first.

12.0 START-UP SERVICE AND TRAINING

12.1 Drive operational and maintenance training and/or startup service shall be offered by the Drive vendor separately. The Drive vendor shall have factory trained personnel at field locations convenient to the installation site, available for trouble shooting and/or startup assistance.

13.0 DOCUMENTATION

13.1 An instruction manual, complete with wiring diagrams, schematics, operating, and maintenance instructions, shall be provided with the Drive at the time of shipment.

14.0 SPARE PARTS

14.1 Spare parts shall be available locally through local stocking distributors.

15.0 WARRANTY AND START UP

15.1 Certified factory start-up will be provided for each drive by a factory authorized service center. In addition, a minimum of 8 hours classroom training will be provided for the facilities maintenance personnel.

15.2 The VFD will carry a two (2) year manufacturers standard warranty from date of shipment. Warranty will include all parts and on-site labor. An additional year warranty shall be available with factory certified start up assistance. An optional extended warranty (up to a total of five (5) years) will be available for additional charge.