

**PROCUREMENT SPECIFICATION**  
**PowerFlex® 525**  
**Low Voltage AC**  
**Variable Frequency Drive**

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SECTION XX XX XX

**LOW VOLTAGE AC VARIABLE FREQUENCY DRIVE**

**PART 1 GENERAL**

**1.01 SUMMARY**

- A. The Variable Frequency Drive (VFD) system shall contain all components required to meet the performance, protection, safety and certification criteria of this specification.

**1.02 RELATED SECTIONS**

- A. Section 26 05 00 – Common Work Results for Electrical
- B. Section 26 00 00 – Electrical – General Provisions

**1.03 CERTIFICATIONS/REFERENCES**

- A. Certifications and approvals shall include:

- 1. c-UL-us – UL508C and CAN/CSA-C22.2 No. 14-05
- 2. C-Tick – Radiocommunications Act: 1992; Std.: 2008; Labeling Notice: 2008
- 3. CE –
  - a) In conformity with EMC Directive (2004/108/EC) and Low Voltage Directive (2006/95/EC)
  - b) Standards EN 61800-3:2004 and EN 61800-5-1:2007
- 4. TÜV –
  - a) Standards EN ISO 13849-1:2008, EN ISO 13849-2:2008, EN 61800-5-2:2007, EN 61508 PARTS 1-7:2010, EN 62061:2005 and EN 60204-1:2009
  - b) With embedded Safe-Torque-Off function, certified to ISO 13849-1 SIL2/PLd and meets Functional Safety (FS)
- 5. ATEX – Directive 94/9/EC
- 6. KCC – Compliant with Article 58-2 of Radio Waves Act, Clause 3
- 7. GOST-R – Certificate No. POCC US.ME92.H00040
- 8. AC156
- 9. EPRI – Semi F47, IEC 61000-4-34
- 10. RINA – ELE283205CS marine certification
- 11. Lloyd's Register Type Approval Certificate 12/10068(E1)
- 12. RoHS

- B. The VFD shall also meet the appropriate portions of the following specifications:

- 1. NFPA 70 – US National Electrical Code
- 2. NEMA ICS 3.1 – Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems
- 3. IEC 146 – International Electrical Code

#### 1.04 SUBMITTALS

- A. Submit under provisions of Section 01 30 00
- B. Shop Drawings – Approval
  - 1. Elevation Drawings: Shall include dimensional information and conduit routing locations.
  - 2. Unit Descriptions: Shall include amperage ratings, enclosure ratings, fault ratings, nameplate information, etc. as required for approval.
  - 3. Wiring Diagrams:
    - a) Power Diagram: Shall include amperage ratings, circuit breaker frame sizes, circuit breaker continuous amp ratings, etc. as required for approval.
    - b) Control Diagram: Shall include disconnect devices, pilot devices, etc.
  - 4. Major components list.
- C. Product Data Sheets
  - 1. VFD publications.
  - 2. Data sheets and publications on all major components.
- D. Test procedures shall be per the manufacturer's standards.

#### 1.05 CLOSEOUT SUBMITTALS (OPERATION AND MAINTENANCE MANUALS)

- A. Submit under provisions of Section 01 30 00
- B. Shop Drawings – Final as shipped
  - 1. Elevation Drawings: Shall include dimensional information and conduit routing locations.
  - 2. Unit Descriptions: Shall include amperage ratings, enclosure ratings, fault ratings, nameplate information, etc. as required for approval.
  - 3. Wiring Diagrams:
    - a) Power Diagram: Shall include amperage ratings, circuit breaker frame sizes, circuit breaker continuous amp ratings, etc. as required for approval.
    - b) Control Diagram: Shall include disconnect devices, pilot devices, etc.
  - 4. Major components list.
- C. Product Data Sheets
  - 1. VFD publications.
  - 2. Data sheets and publications on all major components.
- D. Test procedures shall be per the manufacturer's standards.
- E. Operation and Maintenance Data
  - 1. Service and Contact information.
  - 2. VFD User Manual.
  - 3. Troubleshooting/Service Manual.

## 1.06 QUALITY ASSURANCE

### A. Qualifications:

#### 1. Manufacturers:

- a) The VFD and all associated optional equipment shall be UL listed or recognized.
- b) The VFD shall contain a UL label attached on the inside of the enclosure cabinet.

#### 2. Suppliers:

- a) All inspection and testing procedures shall be developed and controlled under the guidelines of the supplier's quality system and must be registered to ISO 9001 and regularly reviewed and audited by a third party registrar.
- b) The VFD shall be factory pre-wired, assembled and tested as a complete package.

## 1.07 DELIVERY, STORAGE AND HANDLING

- A. Supplier shall coordinate the shipping of equipment with the manufacturer.
- B. Supplier shall store the equipment in a clean and dry space at an ambient temperature range of -40°C to 85°C (-40°F to 185°F).
- C. The supplier shall protect the units from dirt, water, construction debris and traffic.

## 1.08 WARRANTY

- A. The manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first.
- B. This warranty applies to variable frequency drive systems.

## PART 2 PRODUCTS

### 2.01 MANUFACTURERS

- A. Allen-Bradley – PowerFlex 525 Low Voltage AC Variable Frequency Drive (No substitutions)

### 2.02 RATINGS

- A. The variable frequency drive (VFD) shall be designed to operate in one of the following input voltage classes with -15%/+10% voltage tolerance:
  1. 100 to 120 VAC, 1 phase.
  2. 200 to 240 VAC, 1 phase.
  3. 200 to 240 VAC, 3 phase.
  4. 380 to 480 VAC, 3 phase.
  5. 525 to 600 VAC, 3 phase.
- B. The VFD shall operate from an input frequency range of 47 to 63 Hz.

- C. The VFD shall have a power rating of:
  - 1. 100 to 120V: 0.4 to 1.1 kW / 0.5 to 1.5 HP.
  - 2. 200 to 240V: 0.4 to 15 kW / 0.5 to 20 HP.
  - 3. 380 to 480V: 0.4 to 22 kW / 0.5 to 30 HP.
  - 4. 525 to 600V: 0.4 to 22 kW / 0.5 to 30 HP.
- D. The displacement power factor of the VFD shall be between 1.0 and 0.95, lagging, over the entire speed range.
- E. The efficiency of the VFD shall be a minimum of 97% at full load and speed.
- F. The overload capability shall be:
  - 1. Normal Duty – 110% for up to 1 minute, 150% for up to 3 seconds.
  - 2. Heavy Duty – 150% for up to 1 minute, 180% for up to 3 seconds (200% programmable).
- G. The VFD shall have a maximum output frequency of 500 Hz.
- H. The VFD shall provide UL Listed Class 10 motor overload protection to comply with N.E.C. Article 430.
- I. The VFD shall be designed to operate in the following environmental conditions:
  - 1. Ambient temperature range –
    - a) -20°C to 50°C (-4°F to 122°F).
    - b) -20°C to 60°C (-4°F to 140°F) with current derating.
    - c) -20°C to 70°C (-4°F to 158°F) with current derating and control module fan kit (option).
  - 2. Relative humidity range – 0% to 95% non-condensing.
  - 3. Elevation –
    - a) up to 1000 m (3280 ft.).
    - b) up to 4000 m (13123 ft.) with current derating [2000 m (6561 ft.) for 525 to 600V drives].
  - 4. Shock and vibration –
    - a) Shock: 15G peak for 11 ms duration ( $\pm 1.0$  ms).
    - b) Vibration: 1G peak, 5 to 2000 Hz.

### 2.03 CONSTRUCTION

- A. The variable frequency drive (VFD) shall have a compact footprint and be of modular design to provide for ease of installation and inventory reduction, consisting of:
  - 1. A power module sized to meet the application.
  - 2. A control module common to all VFD ratings.
- B. The VFD shall be IP20/NEMA Open. Optional conduit box in IP21/IP30 NEMA Type 1 shall be available.
- C. The VFD shall be able to be mounted in both vertical and horizontal orientation. Frames A to C shall be able to be installed on a DIN rail. The VFD shall be capable of side-by-side installation.

- D. The VFD shall employ the following power components:
  - 1. Diode or fully gated bridge on the input.
  - 2. Switching logic power supply operating from the DC bus.
  - 3. MOV protection – phase to phase and phase to ground with jumpers to remove the phase to ground unit when applicable.
  - 4. Gold plated plug-in connections on printed circuit boards.
  - 5. Microprocessor-based inverter logic isolated from power circuits.
  - 6. Inverter section with no commutation capacitors.
- E. The VFD shall have a standard built-in 7th IGBT for use as a dynamic braking chopper. This IGBT shall be able to provide at least 100% braking torque on a continuous basis with a properly sized externally-mounted brake resistor.
- F. The VFD shall have two EMC options to comply to IEC 61800-3 specification, each with an optional EMC earthing/grounding plate:
  - 1. Embedded EMC filter – shall achieve 10 m for C2 and 20 m for C3.
  - 2. External EMC filter – shall achieve 30 m for C1 and 100 m for C2 and C3.
- G. The VFD shall have a standard USB port that connects to a PC for upgrading firmware or uploading/downloading parameter configurations.
- H. With its RS-485 port, the VFD shall provide an interface for up to 2 independent peripherals to be connected at one time at 19.2K Bps. Connection and identification of peripheral interface DSI addresses shall require no user adjustments.
- I. The VFD shall have an embedded EtherNet/IP port. A slot shall be available for dual port EtherNet/IP, DeviceNet and PROFIBUS DP adapter cards.
- J. A slot for an optional encoder card shall be available to perform simple positioning control. Closed loop with encoder feedback shall be available to replace slip compensation with trim for improved speed range and regulation.
- K. The VFD shall have embedded control I/O.
- L. The VFD shall have an embedded safe-torque off solution certified to SIL2 / PLd. This requires the use of an external safety relay to meet ISO 13849-1. The safety solution shall maximize safety, increase machine up-time and help protect personnel and equipment. Communications shall be active throughout when safety is initiated.
- M. The VFD's printed circuit board shall be conformal coated, certified to IEC60721-3-2 with 3C2 (Chemical & Gases at the minimum).
- N. The VFD's control module shall have an integral Human Interface Module (HIM).
  - 1. 5-digit LCD display with scrolling text, used to display drive operating conditions, fault/alarm indications and programming information and capable of showing multiple languages via selectable mode.
  - 2. Status LED for drive condition.
  - 3. Status LEDs for communications status, including embedded DSI status, adapter health and communications network status.
  - 4. Keys for navigation, start, stop and reverse.
  - 5. Potentiometer used to control speed of the drive.
- O. The VFD shall have an optional external Human Interface Module (HIM) available in two package styles:
  - 1. A backlit LCD display with graphics capability and rated for IP20/Type 1, used as a handheld terminal by connecting via a separate cable or used in a bezel kit mounted

- to a cabinet/panel. This package style is removable (slides out) without the use of a tool.
2. An IP66/UL Type 4X-12 remote-mounted version for cabinet/panel mounting that is connected via cable.
- P. The VFD's control module shall have available a fan kit to accommodate horizontal mounting and extreme ambient temperatures.

#### 2.04 CONFIGURATION/PROGRAMMING

- A. The variable frequency drive (VFD) shall be configurable using:
1. The HIM's keypad and LCD display.
  2. Connected Components Workbench™ – This software offers configuration and programming.
  3. Studio 5000™ Logix Designer – This software, a single development environment for the entire control system, includes add-on profiles which minimize the need to individually program the required parameters and tags. (Available to VFDs on EtherNet/IP or ControlNet.)
    - a) Autogeneration of descriptive tag names and respective tag data types.
    - b) Wizards available to walk through configuration.
    - c) Copy and paste function to easily duplicate VFDs.
    - d) Single development environment – minimizes errors associated with multiple software tools.
    - e) Configuring entire system from one environment – minimizes I/O mismatch errors.
- B. Through the Studio 5000 Logix Designer, a Logix controller shall be able to use Automatic Device Configuration (ADC) to detect a replaced VFD and download the needed firmware and all configuration parameters. (Available to VFDs on EtherNet/IP.)
- C. With Studio 5000 software,
1. VFD configuration settings shall be stored in the project file and in the control system's PACs. This VFD I/O packet shall consist of:
    - a) VFD status and feedback, command and reference.
    - b) At least 8 data words of inputs and 8 data words of outputs that can be dynamically configured to access any parameter.
  2. VFDs shall be able to be flash-updated directly.

#### 2.05 COMMUNICATIONS

- A. The variable frequency drive (VFD) shall be capable of communications through standard protocols, and EtherNet/IP and DeviceNet shall be the preferred networks.
1. Through its USB port, the VFD shall be capable of direct connection to a PC.
  2. Through its integral RS-485 port, the VFD shall be able to use Modbus RTU:
    - a) For programming from a PC.
    - b) In a multi-drop network configuration.



3. Through its integral Ethernet port, the EtherNet/IP network is supported.
- B. The VFD shall be able to communicate with at least 2 networks at the same time.
- C. The VFD shall have available adapter cards, including:
  1. Dual port EtherNet/IP – to support Device Level Ring topology.
  2. DeviceNet.
  3. PROFIBUS DP.
- D. VFD communications adapters shall have individually selectable fault actions in the case of a communications loss or if the controller is idle (in program mode or faulted):
  1. Faulting the VFD.
  2. Stopping the VFD.
  3. Zeroing data written to the VFD.
  4. Holding the VFD in its last state.
  5. Using a user-selectable fault configuration.

## 2.06 CONTROL FEATURES

- A. The variable frequency drive (VFD) shall be programmable for the following motor control modes:
  1. Volts per Hertz.
  2. Sensorless vector control.
  3. Closed loop velocity vector control.
  4. Sensorless vector control with Economizer.
  5. Permanent magnet motor control (scheduled for a future firmware release).
- B. The VFD shall be capable of open loop and closed loop speed regulation applications.
- C. Programmable features shall include:
  1. Flying start
  2. V/F ratio
  3. Bus regulator
  4. Process PID
  5. Fiber-application-specific features
  6. Common DC bus
  7. 1/2 DC bus operation
  8. Regulation with encoder feedback or analog input
  9. Multi-drive connectivity (with communication option card)
  10. StepLogic Function (relay and timers)
  11. 16 preset speeds
- D. The VFD shall include energy cost reduction potential through energy monitoring features and Economizer and permanent magnet motor control modes.

## 2.07 CONTROL I/O

- A. The variable frequency drive (VFD) shall have 2 analog inputs (1 unipolar and 1 bipolar), independently isolated from the rest of the drive I/O.
- B. The VFD shall have 7 digital inputs (24 VDC, 6 programmable) to provide application versatility.

- C. The VFD shall have 1 analog output that is scalable, 10-bit, suitable for metering or as a speed reference for another drive.
- D. The VFD shall have 2 digital outputs and 2 relay outputs (1 form A and 1 form B) to be used to indicate various drive, motor or logic conditions.

## 2.08 DIMENSIONS

- A. Frame A: 152 mm (5.98 in.) H x 72 mm (2.83 in.) W x 172 mm (6.77 in.) D
- B. Frame B: 180 mm (7.08 in.) H x 87 mm (3.42 in.) W x 172 mm (6.77 in.) D
- C. Frame C: 220 mm (8.66 in.) H x 109 mm (4.29 in.) W x 184 mm (7.24 in.) D
- D. Frame D: 260 mm (10.23 in.) H x 130 mm (5.11 in.) W x 212 mm (8.34 in.) D
- E. Frame E: 300 mm (11.81 in.) H x 185 mm (7.28 in.) W x 279 mm (10.98 in.) D

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that location is ready to receive equipment.
- B. Verify that the building environment can be maintained within the service conditions required by the manufacturer of the VFD.

### 3.02 INSTALLATION

- A. Installation shall be in compliance with all manufacturer requirements, instructions and drawings.

### 3.03 START-UP SERVICE

- A. At a minimum, the start-up service shall include:
  - 1. Perform pre-power check
  - 2. Megger motor resistances: phase-to-phase and phase-to-ground
  - 3. Verify system grounding per manufacturer's specifications
  - 4. Verify power and signal grounds
  - 5. Check connections
  - 6. Check environment
- B. Drive power-up and commissioning:
  - 1. Measure incoming power phase-to-phase and phase-to-ground
  - 2. Measure DC bus voltage
  - 3. Measure AC current unloaded and loaded
  - 4. Measure output voltage phase-to-phase and phase-to-ground
  - 5. Verify input reference signal
- C. All measurements shall be recorded.
- D. Drive shall be tuned for system operation.
- E. Drive parameter listing shall be provided.

**END OF SECTION**