

SECTION 16485 ADJUSTABLE SPEED DRIVES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section of the specification includes the furnishing, installation, connection and testing of a complete AC variable frequency drive (VFD) control system HVAC applications. Provide all equipment required to form a complete, operative, and coordinated system as shown on the drawings and specified herein.

1.2 RELATED SECTIONS

- A. Section 16010 - Electrical General Requirements.

1.3 QUALITY ASSURANCE

- A. All system materials shall be UL-listed for their intended duty.

1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 16010.
- B. Shop Drawings and Product Data:
 - 1. Submit complete and at one time. Provide manufacturer's catalog information showing dimensions, electrical characteristics, and configurations. Isolated items will not be considered for approval, except by prior authorization.
 - 2. A technical data sheet from the manufacturer should be included with the response for each product proposed. This data sheet shall include the physical specifications as well as the electrical characteristic.
 - 3. The following is required for approval, prior to fabrication and installation: Catalog Data Sheets of all manufactured items, including manufacturer and model number.

1.5 SYSTEM COORDINATION

- A. It shall be the Contractor's responsibility to assure that the drive being submitted matches the operating characteristics of the HVAC equipment being served. The Contractor shall review Division 15 submittals for equipment items being served by VFDs and shall coordinated equipment characteristics with the VFD supplier to assure compatibility.

1.6 TRAINING

- A. Provide sufficient training to personnel selected by the Owner on operation and basic maintenance of all systems and equipment.

1.7 PROJECT RECORD DOCUMENTS

- A. Submit record documents under provisions of Section 16010.
- B. Accurately record location of all equipment items.

1.8 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.
- C. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.9 OPERATION AND MAINTENANCE DATA

- A. Submit data under provisions of Section 16010.
- B. Include operating instructions, maintenance and repair procedures.

PART 2 – MATERIALS

2.1 MANUFACTURERS

- A. *Toshiba* model E3
- B. *Reliance*
- C. *Square D*
- D. Substitutions: Or Approved Equal.

2.2 DESCRIPTION

- A. Adjustable Speed Drive shall be a PWM (Pulse Width Modulated) transistorized inverter, using IGBTs (Insulated Gate Polar Transistors), and must be fully digital.
- B. The Drives shall be UL-listed and CSA approved (up to 125 HP).
- C. The Drives shall utilize IGBTs in their power section.

2.3 DRIVE ENVIRONMENTAL CONDITIONS

- A. Environment: Indoors NEMA 1 metal enclosure, plastic shall not be acceptable.
- B. Ambient temperature: 14°F to 104°F (up to 122°F with cover removed).

- C. Altitude: 3,300 feet maximum without derating.
- D. Relative Humidity: 95% maximum (no condensation allowed).
- E. Vibration: 0.5G maximum.

2.4 CONTROL SYSTEM

- A. Drive main input power shall be 200V – 230V/60Hz.
- B. Drives shall have a tolerance for voltage $\pm 10\%$ and frequency $\pm 2\text{Hz}$.
- C. Drives shall have True Torque Control with Automatic energy-saving control.
- D. Drive overload current shall be 100% continuous and 110% for 1 minute.
- E. Drives shall accept the following frequency commands signals: 3k Ω potentiometer (1k Ω to 10K Ω potentiometer connection also possible), 0 to 10 Vdc (Input impedance Z_{in} : 33k Ω), 0 to $\pm 10\text{Vdc}$ (Z_{in} : 67k Ω), 0 to $\pm 5\text{ Vdc}$ (Z_{in} : 34k Ω), 4 to 20mA (Z_{in} : 500k Ω), 15 Preset speeds, motorized speed pot.
- F. Drive shall have selectable input terminal priority.
- G. Drives shall contain three critical frequency jump points with individual bandwidth.
- H. Drives shall be capable of setting both upper and lower limit frequencies.
- I. Drives shall automatically adjust the PWM carrier frequency proportional to speed. The range of automatic adjustment shall vary from 15kHz to .5kHz. The minimum acceptable full speed carrier frequency (60 Hz) with no derating shall be 8 kHz.
- J. The drives shall be capable of PID set point control.
- K. Drives shall include preset macros for typical HVAC applications such as pumps, fans, cooling towers.
- L. Drives shall have serial RS232C communications standard.
- M. Drives shall have automatic cooling fan control based on heat sink temperature for extended fan life.
- N. Options Capability: *Metasys N2, Honeywell, Lonworks, RS485, Modbus, Modbus+, Devicenet, AB RIO, Profibus DP.*
- O. Drives shall be able to start and stop from a two-wire control (dry contacts), three-wire momentary contact closure, keypad, and serial interface.
- P. Drives shall be able to act as a space heater for a motor when the system is not running.
- Q. Drives shall have adjustable input and output terminal response time selections to prevent noise effects and chattering.

- R. Drives shall have a built-in control system for commercial power/inverter power switching.
- S. Drives shall have a, adjustable retry function after a fault. Both number of attempts (at least 10) and time between (1-10 seconds).
- T. Drives shall have an adjustable output short circuit detection selection for standard motor and high-speed motors (very low inductance).
- U. Drives shall have programmable volt per hertz patterns, maximum output frequencies, electronic thermal protection settings, stall protections, base frequencies, voltage boosts and stall protection selections that can be chosen while running to motor A or motor B.
- V. Drives shall have an analog input filter adjustment to limit the effects of noise on the control signal.
- W. Drive shall permit switching between local/remote operation as well as manual/auto “on the fly.”
- X. Drives shall have the ability to ignore run commands until a “dampers open” signal is received. In the event a “dampers open” signal is absent, the drive shall be capable of providing a “close damper” signal. Upon receipt of “drive stop” signal, the VFD shall be capable of providing a “close damper” signal.
- Y. Drives shall be provided with “anti-windmilling” or “motor shaft stationary control.”
- Z. Drives shall have the following user selectable contingencies in the event of loss of analog control signal while the drive is running before loss:
 - 1. Run at the user set lower frequency limit.
 - 2. Run at the user set upper frequency limit.
 - 3. Trip with a signal loss fault.
 - 4. Run at user-selected percentage of the last valid frequency signal.

2.5 OPERATIONAL FUNCTIONS

- A. Drives shall contain two separate acceleration/deceleration times with auto-tuning for optimum setting (0.1 to 6000 seconds) with choice of linear, S, or C curves.
- B. Drives shall be equipped with both local/remote and manual/auto keys on touchpad.
- C. Drives shall be equipped with a quick setup key.
- D. Drives shall contain fifteen preset speeds that can be activated from the keypad, terminal inputs and host computer.
- E. Drives shall have the capability of storable special custom user setting.
- F. Drives shall start into a rotating motor operating in either the forward or reverse direction and match that frequency.

- G. Drives shall have adjustable soft stall (10% - 150%) that reduces frequency and voltage of the inverter to sustain a run in an overload situation.
- H. Drives shall be capable of performing a time base pattern run using 4 groups of 8 patterns each using the 15 preset speed values for a maximum of 32 different patterns.
- I. Drives shall have adjustable UL-listed electronic overload protection (10% - 100%).
- J. Drives shall have a custom programmable volt/hertz pattern.

2.6 PROTECTIVE FEATURES

- A. Drives shall be rated for 20,000 AIC. The use of input fuses to achieve this rating shall not be acceptable.
- B. Drives 25HP and above shall be equipped with either 3% impedance DC link reactors or 3% AC line reactors.
- C. Drives shall have external fault input.
- D. Drives shall be capable of re-setting faults remotely and locally.
- E. Drives shall be programmable to alert the following alarms:
 - 1. Over torque alarm
 - 2. Inverter overload pre-alarm
 - 3. Motor overload pre-alarm
 - 4. Braking resistor overload pre-alarm
 - 5. Inverter overheat pre-alarm
 - 6. Undercurrent alarm
 - 7. Over current pre-alarm
 - 8. Communication error alarm
 - 9. Cumulative timer alarm
 - 10. Executing retry
- F. Drives shall identify and display the following faults:
 - 1. Over current during acceleration trip
 - 2. Over current during deceleration trip
 - 3. Over current during normal run trip
 - 4. Over current on the DC bus during acceleration trip
 - 5. Over current on the DC bus during deceleration trip
 - 6. Over current on the DC bus during normal run trip
 - 7. Load end over current trip detected at start-up (output terminals, motor wiring, etc.)
 - 8. U-phase short circuit trip detected at start-up
 - 9. V-phase short circuit trip detected at start-up
 - 10. W-phase short circuit trip detected at start-up
 - 11. Over voltage during acceleration trip
 - 12. Over voltage during deceleration trip
 - 13. Over voltage during normal (constant speed) run trip
 - 14. Inverter overloaded trip
 - 15. Motor overloaded trip
 - 16. Inverter overheat trip

17. Emergency off trip message
18. EEPROM failure during write cycle
19. EEPROM abnormality during initial reading
20. RAM error
21. ROM error
22. CPU error
23. Communication interruption error
24. Gate array error
25. Output current detection circuit error
26. Option PCB error trip
27. Low operating current trip
28. Main circuit under voltage trip
29. Over torque trip
30. Software detected earth fault trip
31. Hardware detected earth fault trip
32. Inverter type form mismatch error
33. EEPROM type form mismatch error

2.7 MONITOR FUNCTIONS

- A. Drive digital display shall be capable of displaying the following: frequency, % current, current amps, % voltage I/O, voltage in volts I/O, RPM, GPM, I/O watts, torque, and input reference signal, kWh.
- B. Drive shall have 320 programmable parameters that can be changed while the drive is operating. The parameters shall be adjustable from the 8-key touchpad or computer link.
- C. Drives' touchpad shall be NEMA 12 rated and shall be capable of being extended 15 feet from the drive.
- D. Drives shall contain a reset of all parameters to factory default settings or user defaults (whichever one is chosen).
- E. Drives shall have 2 programmable analog outputs programmable to 17 choices.
- F. Drives shall have 1 programmable relay output programmable to 67 choices.
- G. Drives shall have 8 programmable digital inputs programmable to 54 choices.
- H. Drives shall have a pulse train output proportional to frequency (48, 96, 360 times frequency).
- I. Drives shall have an elapsed time meter.

2.8 SERVICE

- A. The drive manufacturer shall guarantee the operation of the drive against failure due to defects for 30 months after shipment or 24 months of service, whichever comes first.
- B. The drive manufacturer shall supply a recommended list of spare parts and pricing.

2.9 OPTIONAL FEATURES

- A. Drive shall be capable of 6-pulse diode rectification for maximum harmonics attenuation.
- B. Drives shall be provided with a pneumatic interface (3015 psi).

PART 3 - EXECUTION

3.1 GENERAL

- A. Do not install equipment and materials that have not been reviewed by the Architect-Engineer. Equipment and materials that are installed without the Architect-Engineer's review or without complying to comments issued with the review shall be removed from the project when so instructed by the Architect-Engineer. No payment will be made for unapproved or removal if it is ordered removed. The Installer shall be responsible for any ancillary costs incurred because of its removal and the installation of the correct equipment and materials.
- B. Obtain detailed information on installation requirements from the manufacturers of all equipment to be furnished, installed or provided. At the start of construction, check all Contract Documents, including all Drawings and all Sections of the specifications for equipment requiring electrical connections and service and verify electrical characteristics of equipment prior to roughing.
- C. Equipment and systems shall not be installed without first coordinating the location and installation of equipment and systems with the General Contractor and all other Trades.
- D. Any and all material installed or work performed in violation of above requirements shall be re-adjusted and corrected by the Installer without charge.
- E. Refer to all Drawings associated with the project, prior to the installation or roughing-in, to determine the exact location of all outlets.
- F. After installation, equipment shall be protected to prevent damage during the construction period. Openings in conduits and boxes shall be closed to prevent the entrance of foreign materials.
- G. Install all systems in strict accordance with the manufacturer's instructions.

3.2 WORK BY OTHERS

- A. Control wiring between VFDs and the DDC Automatic Temperature Control Panel provided under Division 15 shall be provided by the Division 15 subcontractor.

3.3 SYSTEM TESTING

- A. Test Reports: Upon completion and testing of the installed system, test report shall be submitted showing satisfactory system operation, certified by a factory authorized representative.

3.4 ACCEPTANCE DEMONSTRATIONS

- A. Systems installed under this Section shall be demonstrated to the Owner and Architect-Engineer. Demonstrations are in addition to necessary testing and training sessions. Notify all parties at least 7 days prior to the scheduled demonstration. Schedule demonstrations in cooperation with and at times convenient to all parties and so as to not disturb ongoing activities.
- B. Systems shall be tested prior to the demonstrations and each system shall be fully operational and tested prior to arranging the Acceptance Demonstration. Final payments will be withheld until a satisfactory demonstration is provided for all systems indicated or requested.
- C. If the demonstration is not totally complete, performing all functions, features and connections or interfaces with other systems, or if there is a failure during the demonstration, additional demonstrations shall be arranged. Provide and pay for all costs, labor and expenses incurred for all attendees for each additional demonstration required for acceptance and demonstration of complete system operation.
- D. Demonstrations shall be scheduled in ample time to complete all activities prior to final acceptance and Owner occupancy. Demonstrations shall take place at least 30 days prior to the scheduled project completion date and 30 days prior to owner's use and occupancy.

3.5 CLEANING UP

- A. Upon completion of all work, and testing, thoroughly inspect all exposed portions of the installation and completely remove all exposed labels, markings, and foreign material.
- B. Remove material and equipment from areas of work and storage areas.
- C. All equipment shall be clean from dirt, dust, and fingerprints prior to final acceptance.

END OF SECTION