Trex-Flow VARIABLE FREQUENCY DRIVES

PART 1 GENERAL OVERVIEW

Product Scope:

The variable speed pump controller shall be a Type E7B full 3 contactor bypass unit by Yaskawa Electric America, Inc with value added manufacturing performed by Filtrex, Inc. The Controller is designed for use with AC induction pump motors incorporating true pump control system logic, and pump terminology embedded within the controller and displayed on the programming operator interface.

The VFD shall be programmed with its pump specific parameters allowing the operator to setup specific control values for a wide range of pumping applications such as constant pressure, constant flow, and level control. The VFD will automatically adjust pump operating conditions, as the process variables change within the defined programmable pump settings while still maintaining optimum pump performance and protection.

The VFD shall be pre-wired (user terminals  installed) and preprogrammed to allow direct interface to the regenerative filter control panel.

The Controller can be configured for Simplex, Duplex, and Triplex pump systems using one master VFD Controller with the ability to add additional pumps, and VFD slave controllers.

Standard variable frequency drives (VFD's) NOT incorporating true pump control, NO Flow & Dead Head detection settings, System Pre-Charge Levels, and alarm messages specific to the pump control system and motor shall not be considered equal or acceptable.

1.01    SECTION INCLUDES

      A.  E7B Variable Frequency Drive (VFD)
      B.   Manufactured by Yaskawa Electric of America, Inc.

1.02    RELATED SECTIONS

1.03    REFERENCES

    A.  NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Variable Frequency Drive Systems.

    B.  NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

    C.  UL, and cUL Approved for both Single & Three Phase Input Voltage

    D.  IEEE Standard 444 (ANSI-C343)

    E.  IEEE Standard 519

    F.  IEC:  146A

    G.  UL 508C (Power Conversion)

    H.  CSA 22.2 No. 14-95 (Industrial Control Equipment)

    I.  UL 1995 (Plenum rating)

    J.  EN 50178 (LVD)

    K.  EN 61800-3

    L.  IEC 529

    M.  FCC CFR 47 Part 15 Subpart B

1.04    SUBMITTALS

    A.  Submit under provisions of Section

    B.  Shop Drawings shall include:  Wiring diagrams, electrical schematics, front and side views of enclosures, overall dimensions, conduit entrance locations and requirements, nameplate legends, physical layout and enclosure details.

    C.  Product Data:  Provide data sheets showing; voltage, ratings of customer use switching and over-current protective devices, short circuit ratings, and weights.

D. Manufacturer's Installation Instructions and Technical Manuals: Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of adjustable speed drive. Document the sequence of operation, cautions and warnings, trouble shooting procedures, spare parts lists and programming guidance.

1.05 QUALITY ASSURANCE

A. VFD shall have a minimum MTBF (mean time between failure) rating of 10 years. (87,600 Hours.)

1.06 OPERATION AND MAINTENANCE DATA

A. Submit under applicable provisions.

B. Include instructions for starting and operating VFD, and describe operating limits, which may result in hazardous or unsafe conditions.

1.07 QUALIFICATIONS

A. Manufacturer must have a minimum of 25 years of documented experience, specializing in variable frequency drives.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site, under applicable provisions.

B. Accept VFD on site in original packing. Inspect for damage.

C. Store in a clean, dry space. Maintain factory wrapping, or provide an additional heavy canvas or heavy plastic cover, to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully, in accordance with manufacturer's written instructions, to avoid damage to components, enclosure, and finish.

1.09    WARRANTY

    A.  Provide VFD warranty, for 5 years from date of startup, not to exceed 18 months from date of shipment. Warranty shall include parts, and labor allowance for repair hours.

PART 2  PRODUCTS

2.01    MANUFACTURERS

    A.  VFD shall be manufactured by Yaskawa Electric America, Inc. model E7B.

    B.  Motors should be inverter duty rated above 240 volt per NEMA MG1 parts 30 and 31, for motor-drive compatibility.

    C.  Interface electronics, user terminals and associated hardware shall be installed by Filtrex, Inc.

2.02    DESCRIPTION

    A.  Provide enclosed variable frequency drives suitable for operation at the current, voltage, and horsepower indicated on the schedule.  Conform to requirements of NEMA ICS 3.1.

2.03    RATINGS

    A.  VFD must operate, without fault or failure, when voltage varies plus 10% or minus 15% from rating, and frequency varies deviation or minus 5% from rating.

    B.  VFD shall be _____ volts, _____ Hz, 3 Phase.

    C.  Displacement Power Factor:  0.98 over entire range of operating speed and load.

    D.  Operating Ambient Temperature:  -10 degrees C to 40 degrees C (14 degrees F to 104 degrees F)

    E.  Humidity:  0% to 95% non-condensing.

    F.  Altitude:  to 3,300 feet, higher altitudes achieved by derating.

    G.  Minimum Efficiency:  96% at half speed; 98% at full speed.

    H.  Starting Torque:  100% starting torque shall be available from 0.5 Hz. to 60 Hz.

    I.  Overload capability:  110% of rated FLA (Full Load Amps) for 60 seconds; 180% of rated FLA, instantaneously.

    J.  The VFD must meet the requirements for Radio Frequency Interference (RFI) above 7 MHz as specified by FCC regulations, part 15, subpart J, Class A devices.

    K.  VFDs must have a minimum short circuit rating of 100K amps RMS  without additional input fusing.

2.04    DESIGN

    A.  VFD shall employ microprocessor based inverter logic, isolated from all power circuits.

    B.  VFD shall include surface mount technology with protective coating.

    C.  VFD shall employ a PWM (Pulse Width Modulated) power electronic system, consisting of:

1. Input Section:
    a. VFD input power stage shall convert three-phase AC line power into a fixed DC voltage via a solid state full wave diode rectifier, with MOV (Metal Oxide Varistor) surge protection.
2. Intermediate Section:
    a. DC bus as a supply to the VFD output Section shall maintain a fixed voltage with filtering and short circuit protection.
    b. DC bus shall be interfaced with the VFD diagnostic logic circuit, for continuous monitoring and protection of the power components.
    c. 20 HP to 150 HP @ 208 VAC, 20 HP to 150 HP @ 240 VAC, and 25 HP to 500 HP 480 VAC, VFDs shall include a DC bus reactor to minimize reflected harmonics.
3. Output Section
    a. Insulated Gate Bipolar Transistors (IGBTs) shall convert DC bus voltage to variable frequency and voltage.
    b. The VFD shall employ PWM sine coded output technology to power the motor.

D. The VFD must be selected for operation at carrier frequencies at or above 5 kHz without derating to satisfy the conditions for current, voltage, and horsepower as indicated on the equipment schedule. Exception to this requirement is allowed only for VFDs providing 506 amps or more.

E. The VFD must have plated bus bar to resist corrosion.

F. VFD shall have an adjustable carrier frequency: The carrier frequency shall have a minimum of six settings to allow adjustment in the field.

G. VFD shall have optional protocols for network communications. These protocols shall be accessible via a RS-422/485 communication port.

H. VFD shall have a quick disconnect, removable control I/O terminal block to simplify control wiring procedures.

I. VFD shall include two independent analog inputs. One shall be 0-10 VDC. The other shall be programmable for either 0-10 VDC or 4-20 mA. Either input shall respond to a programmable bias and gain.

J. VFD shall include a minimum of seven multi-function digital input terminals, capable of being programmed to determine the function on a change of state. These terminals shall provide up to 30 functions, including, but not limited to:
    1. Hand – Off – Auto bypass selection
    2. Detection of external fault condition
    3. Remote Reset
    4. Multi-step speed commands
    5. Run permissive
    6. Floating control

K. VFD shall include two 0-10 VDC or 4-20 mA analog output for monitoring, or "speed tracking" the VFD. The analog output signal will be proportional to output frequency, output current, output power, PI (Proportional & Integral control) feedback or DC bus voltage.

L. VFD shall provide terminals for remote input contact closure, to allow starting in the automatic mode.

M. VFD shall include at least ( 4 ) external fault inputs, which shall be programmable for a normally open or normally closed contact. These terminals can be used for connection of firestats, freezestats, high pressure limits or similar safety devices.

N.  VFD shall include two form "A" contacts and one form "C" contact, capable of being programmed to determine conditions that must be met in order for them to change state.  These output relay contacts shall be rated for at least 5A at
120 VAC and shall provide up to 18 functions, including, but not limited to:
1. Pump Fault
2. Low and High Pressure detection
3. Pump Over Cycling detection
4. Loss of Prime detection.
5. Drive Fault
6. Over/Under Torque detection
7. Not Maintaining Set Point detection.

O.  VFD shall include a power loss ride through of 2 seconds.

P.  VFD shall have DC injection braking capability.

Q.  VFD shall have a motor preheat function to prevent moisture accumulation in an idle motor.

R.  VFD shall include diagnostic fault indication in selected language, last 10 faults storage and heatsink cooling fan operating hours.

S.  VFD shall have a digital operator with dedicated Hand-Off-Auto Bypass keys with program copy and storage functions to simplify set up of multiple drives.  The digital operator shall be interchangeable for all drive ratings.

T.  VFD shall include a front mounted, sealed keypad operator, with an English language illuminated LCD display.  The operator will provide complete programming, program copying, operating, monitoring, and diagnostic capability.  Keys provided shall include industry standard commands for Hand, Off, and Auto functions.

U.  VFD plain language display shall provide readouts of; output frequency in hertz, PI feedback in percent, pump speed in RPM, set point and feedback level in programmable engineering units (PSI, GPM ,etc.) output voltage in volts, output current in amps, output power in kilowatts, D.C. bus voltage in volts, interface terminal status, heatsink temperature and fault conditions.  All displays shall be viewed in an easy-to-read illuminated LCD.

V. VFD unit shall include the following meters to estimate use of energy:
1. Elapsed Time Meter
2. Kilowatt Meter
3. Kilowatt Hour Meter

W. VFD shall include PI control logic, to provide closed loop setpoint control capability, from a feedback signal, eliminating the need for closed loop output signals from a building automation system. The PI controller shall have a differential feedback capability for closed loop control of pumps for pressure, flow or temperature regulation in response to dual feedback signals.

X. An energy saving function shall be available in both open loop (follower mode) and closed loop (PI) control, providing significant energy savings while minimizing operating hours on driven equipment. When the sleep function senses a minimal deviation of a feedback signal from setpoint, or low demand in open loop control, the system reacts by stopping the driven equipment. Upon receiving an increase in speed command signal deviation, the drive and equipment resume normal operation.

Y. VFD shall include loss of input signal protection, with a selectable response strategy including speed default to a percent of the most recent speed.

Z. VFD shall include electronic thermal overload protection for both the drive and motor. The electronic thermal motor overload shall be approved by UL. If the electronic thermal motor overload is not approved by UL, a separate UL approved thermal overload relay shall be provided in the VFD enclosure.

AA. VFD shall include factory settings for all parameters, and the capability for those settings to be reset.

AB. VFD shall include user parameter initialization capability to re-establish project specific parameters

AC. VFD shall include the capability to adjust the following functions, while the VFD is running:
1. Set Point command input.
2. Acceleration adjustment from 0 to 6000 seconds.
3. Deceleration adjustment from 0 to 6000 seconds.
4. Analog monitor display.
5. Removal of digital operator.
AD. VFD shall include:
1. Code compliant service disconnect.
2. Motor protection rapid trip (lighting) overload.

2.05 SOFTWARE FEATURES

Pump specific firmware shall have embedded within the VFD controller. These pump specific software functions and settings shall be standard as minimum. All control features, Alarms, and Faults shall be displayed in intuitive system pump terminology on the digital operator. Parameter codes with abbreviations are not acceptable.

2.06 Hand/Off/Auto Run operation from digital operator without stopping (bumpless transfer). Operator to display current operational mode. Example: Off Mode, Hand Mode, Hand Mode Reference, Automatic Mode, and Bypass mode.
2.07 Digital operator can be configured to lock out "Hand" with only off and auto run enabled.
2.08 Auto Restart on complete power loss. If in Auto Mode without external run control for start/stop, the pump system will automatically restart to maintain set point and cycle through all safety & restart conditions.
2.09 Programmable Engineering units (PSI, GPM, LPH) for set point, feedback, and parameter scaling. It is not acceptable to use percent of VFD parameters for pump level settings.
2.10 Programmable start levels, sleep levels, stop levels with engineering units specific to pump application. Example: PSI, GPM, LPH, etc.
2.11 Programmable scaling for feedback levels with feedback loss protection based on level and delay time. Both of

these functions shall be independent.

2.12   Quick Start Menu for pump settings and startup.

2.13   System Pre-Charge: Programmable settings in pump engineering units that allows for charging of the pump system prior to automatic mode. Dedicated pre-charge system level settings with programmable timers. PI control is turned off and will enable automatically once operation is completed.

2.14   Thrust Bearing: Programmable operation that will allow the pump motor to rapidly accelerate to a fixed speed with independent timers. PI control is turned off and will enable automatically once operation is completed.

2.15   Programmable Low and High Pressure feedback settings with timers.

2.16   Programmable pump over cycling timer.

2.17   Programmable low water & high water input settings.

2.18   Programmable Pump Motor heating level when stopped to control motor condensation.

2.19   Programmable No Flow or Dead Head Pump Curve protection allowing for either settings in Hz, Engineering units (PSI, GPM, etc) or motor RPM.

2.20   Multiplex Operation from master VFD controller to independently operate up to three (3) pumps. System master controller to have independent control settings in engineering units for pump system to turn on and off. System stabilization to also be included.

2.21  Dedicated English Pump Alarms & Messages.
1.  Low Feedback
2.  High Feedback
3.  Low Water
4.  Pump Over Cycling Detection
5.  No Flow Detection
6.  Loss of Prime Detection
7.  Pump Fault
8.  Motor Thermostat Fault
9.  Pre-Charge Mode Active
10.  Thrust Bearing Active
11.  Start Mode Active
12.  Sleep Mode Active
13.  Feedback Loss Detection

2.3 PC Communication Tools

2.07  TESTING and QUALITY CONTROL

A.  In-circuit testing of all printed circuit boards shall be conducted, to insure the proper mounting and correct value of all components.

B.  All printed circuit boards shall be burned in for 4 hours, at 60 degrees C.

C.  Final printed circuit board assemblies shall be functionally tested, via computerized test equipment.  All tests and acceptance criteria shall be preprogrammed.  All test results shall be stored as detailed quality assurance data.

D.  All fully assembled controls shall be functionally tested, with fully loaded induction motors.  The combined test data shall then be analyzed, to insure adherence to quality assurance specifications.

E.  Inspect and production test, under load, each completed VFD assembly.

PART 3  EXECUTION

3.01  EXAMINATION

A.  Verify that surface is suitable for VFD installation.

B.  Do not install VFD until the building environment can be maintained, within the service conditions required by the manufacturer.

3.02  INSTALLATION

A.  Install VFD where indicated, in accordance with manufacturer's written instructions and NEMA ICS 3.

B.  Tighten accessible connections and mechanical fasteners after placing VFD.

C.  Provide a nameplate label on each VFD, identifying rated horsepower, full load amperes, model number, service factor and voltage/phase rating.

3.03    FIELD QUALITY CONTROL

A.  Field inspection and testing to be performed under applicable provisions.

B.  Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

3.04    MANUFACTURER'S FIELD SERVICES

A.  Prepare and start systems under applicable provisions.

3.05    ADJUSTING

A.  Carry out adjusting work under applicable provisions. Make final adjustments to installed VFD, to assure proper operation of system.


END OF SECTION