

Specification Number: 23 09 33

Product Name: FRENIC-Eco AC Drives for Variable Torque Fan & Pump Applications (1-125Hp at 208/230V and 1-900Hp at 460V)

PART 1: GENERAL

1.01 SUMMARY

- A. This specification provides the requirements for variable frequency AC drives, herein identified as drive, for variable torque fan and pump applications.

1.02 REFERENCES

- A. UL 508C – UL Standard for Safety for Power Conversion Equipment
- B. NFPA 70 – National Electric Code (NEC)
- C. NEMA – Application Guide For AC Adjustable Speed Drive Systems
- D. NEMA ICS 7.1 – Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems

1.03 SUBMITTALS

- A. A submittal package shall be furnished for approval by the Engineer prior to factory shipment of the drive. The submittal package shall consist of the following:
 - 1. Cover sheet containing product features, rated voltage, horsepower, current rating, product model number and equipment tag numbers when applicable.
 - 2. Product outline drawing that provides the overall and mounting dimensions and required clearances for installation.
 - 3. Electrical diagram showing power and control wiring.

1.04 WARRANTY

- A. The manufacturer shall cover the drive under warranty for a period of 36 months from date shipment.

1.05 QUALITY ASSURANCE

- A. The drive manufacturer shall have 20 years of experience, as a minimum, in the development, design, construction, and application of variable frequency AC drives. Brand labeled drive products shall not be accepted.
- B. The drive manufacturer shall have an existing service organization.
- C. The drive manufacturer shall have the ability to perform a complete failure analysis.
- D. The drive unit shall be tested with a motor load.

PART 2: PRODUCT

2.01 MANUFACTURERS

- A. The drives furnished shall be FRENIC-Eco series by Fuji Electric or prior approved equal.

2.02 GENERAL DESCRIPTION

- A. The drive shall convert three phase input AC power to an adjustable frequency and voltage output to control the speed of a three phase AC squirrel cage induction motor.
- B. The drive input power section shall utilize a full wave 6-pulse bridge design incorporating diode rectifiers to convert the fixed AC line voltage and frequency to fixed DC voltage. The drive input power section is insensitive to phase sequence of the AC line voltage.

- C. The drive output power section shall change fixed DC voltage to adjustable frequency AC voltage utilizing insulated gate bipolar transistors (IGBT's) producing a PWM output. Soft-switching IGBTs and gate control design shall be utilized to reduce motor terminal dV/dt and allow for motor cable lead lengths as follows without the need for drive output reactors or filters.
 - 1. Motors with 1000V insulation ratings: up to 66ft in cable length
 - 2. Motors with 1300V insulation ratings: up to 165ft in cable length for drives rated 5Hp and smaller, up to 328ft in cable length for drives rated 7.5Hp and above
 - 3. Motors with 1600V insulation ratings: up to 165ft in cable length for drives rated 5Hp and smaller, up to 1312ft in cable length for drives rated 7.5Hp and above

2.03 CONSTRUCTION

- A. The drive shall be of open type construction with the availability of additional covers to meet Type 1 enclosure requirements.
- B. All customer control and power wiring terminals/connections shall be clearly identified; hand written labels are not acceptable. Field wiring torque requirements shall be provided in the drive instruction manual.

2.04 APPLICATION DATA

- A. The drive shall be properly rated and sized to operate a variable torque load.
- B. The drive output frequency range shall be from 0.5Hz to 120Hz.

2.05 ENVIRONMENTAL RATINGS

- A. The drive shall be designed to operate in an ambient temperature of -10 C to 50 C (14 F to 104 F).
- B. Storage temperature range shall be -25 C to 70 C (5 F to 140 F)
- C. Relative humidity range shall be 5% to 95%, non-condensing
- D. The drive shall be rated to operate at altitudes less than or equal to 1000m (3300ft). For altitudes exceeding 1000m (3300ft), de-rate the drive output current by 1% per 100m (330ft).

2.06 RATINGS

- A. The drive offering shall cover 1 through 125Hp at 208/230VAC and 1 through 900Hp at 460VAC, with a common drive controller platform.
- B. The drive unit shall operate from an input voltage of [200 to 230VAC] ++OR++ [380 to 480VAC] with a tolerance of +10% to -15%.
- C. Input frequency shall be 60Hz +/-5%.
- D. Drive displacement power factor shall be 0.97 lagging or higher.
- E. Drive efficiency at 100% speed and load shall be 95% higher, depending on the drive switching frequency setting.
- F. The drive output current shall be capable of continuous operation at a minimum of 100% rated motor full-load current in accordance with NEC Table 430.250.
- G. The drive overload capacity shall be not less than 120% for 1 minute.

2.07 PROTECTION

- A. The drive shall be UL-508C listed for use on distribution systems with 100kA rms available fault current, based upon UL short-circuit testing. The drive shall not require the use of semi-conductor fuses.
- B. The drive shall contain a programmable I²t motor thermal overload protection UL-508C listed and as required by NEC with load and speed sensitive motor protection and include thermal memory retention in the event of an unintentional power loss or shutdown.
- C. The drive shall provide the following protective functions by monitoring, sensing, acting upon, and displaying the type of protective feature activated on the keypad's LED display:
 - Over-current during acceleration
 - Over-current during deceleration
 - Over-current during running at constant speed
 - Ground Fault

Overvoltage during acceleration
 Overvoltage during deceleration
 Overvoltage during running at constant speed
 Under-voltage
 Input phase loss
 Output phase loss
 Over temperature of heat sink
 Over temperature of internal control
 Over temperature of externally connected device
 Over temperature of the motor via motor thermistor input
 Drive overload
 DC bus fuse open/blown
 Abnormal condition in charge circuit
 Motor overload
 Memory error
 Keypad communication error
 CPU error
 Option card communication error
 Option card error
 Operational procedure error
 Motor tuning or wiring error
 RS-485 communication error
 Data Save error during under-voltage condition
 Power printed circuit board error

- D. The drive shall contain a programmable overload avoidance parameter to reduce or fold back the drive output frequency under an overload condition and be able to provide an output status during this operational condition.
- E. The drive shall contain provisions for programming an output status signal to indicate the serviceable components on the drive are in need of replacement. This signal shall provided indication for DC bus capacitors, electrolytic capacitors on the printed circuit boards, and cooling fans.
- F. The drive shall be able to display the capacitance of the DC bus capacitors, cumulative run time of the electrolytic capacitor on the printed circuit boards, and cumulative run time of the cooling fans for scheduling of preventative maintenance.
- G. The drive shall contain a momentary power loss ride-through of 15 milliseconds to continue operating the motor under load, longer ride-through times for the drive's control circuitry shall be provided and will be dependent upon the inertia of the connected motor load.
- H. An analog input signal loss detection feature shall be provided and shall be programmable to run at a preset speed or allow the drive to decelerate to a stop and contain the ability to provide an output signal to indicate the signal loss status.
- I. For alarm or fault conditions including: over-current, overvoltage, over-temperature, motor overload, or drive overload, the drive shall provide an automatic reset feature that is programmable for up to 10 reset attempts with programmable reset intervals ranging from 0.5 to 20 seconds.
- J. The drive shall contain input surge protection by utilizing Metal Oxide Varistors (MOVs).
- K. The drive shall contain LED indication for signifying potentially dangerous voltage in present on the DC bus.
- L. The drive shall contain a programmable current limit function; the drive's output frequency shall automatically decrease to maintain the output current below the programmed value.

- M. The drive shall incorporate a programmable motor preheat feature to prevent condensation build up in the motor when it is stopped due to a damp environment or sudden change in surrounding temperature.

2.08 ADJUSTMENTS & CONFIGURATIONS

- A. The drive shall provide a selectable speed reference; keypad, 0-10Vdc analog input, 4-20mA analog input, sum of 0-10Vdc and 4-20mA analog inputs, and UP/DOWN from digital input. A selection between normal and inverse operation in regards the speed reference shall be provided. The drive output frequency accuracy shall be +/-0.2% of maximum frequency at 15 C to 35 C for analog inputs and +/-0.01% of maximum frequency using the drive's keypad.
- B. Acceleration and deceleration ramp times shall be adjustable from 0 to 3600 seconds. Quantity two independent acceleration and deceleration ramp times shall be available and selectable using a digital input.
- C. The acceleration and deceleration pattern shall be adjustable for: linear, S-curve, or Curvilinear.
- D. The deceleration mode shall be selectable from normal deceleration or coast-to-stop.
- E. The drive shall include a programmable torque boost function to provide additional starting torque, beyond the default starting torque of 50%, as necessary per the application.
- F. In the event of a momentary loss of power, the drive shall be programmable to restart once power is returned
- G. Low and high drive output frequency limits shall be adjustable from 0Hz to 120Hz.
- H. The drive shall be capable of stopping the motor by the selection of DC injection braking. The braking frequency, level, and time shall be programmable.
- I. The drive shall contain adjustable start and stop frequencies in the range of 0.5Hz to 60Hz.
- J. In order to reduce audible motor noise the drive shall contain adjustable switching frequency with settings ranging from 0.75kHz to 15kHz based on the rating of the drive.
- K. The drive shall provide two programmable analog output signals, that can be selected to output a signal proportional to: output frequency, output current, output voltage, output torque, load factor, input power, PID feedback, DC bus voltage, universal output, motor output, test output, PID process set-point, and PID process output. One analog output signal shall be configurable between 0-10Vdc or 4-20mA and the other analog output signal shall be a fixed 4-20mA output.
- L. The drive shall contain a selectable energy savings function that, when selected, automatically reduces the drive output voltage at steady state operation to the level only required to meet the torque requirement of the load. This function shall also reduce power consumption of the drive to maximize energy savings for both the drive and the motor. The energy savings function shall automatically deactivate during acceleration or deceleration of the load.
- M. The drive shall provide quantity 7 programmable inputs with a choice from 36 selectable functions and include the capability to receive negative input logic. The drive programmable inputs shall be configurable for sink or source logic.
- N. The drive shall provide quantity 5 programmable outputs with a choice from 39 selectable functions and include the capability to provide negative output logic. The drive output types shall include: quantity 1 form C contacts, quantity 1 form A contacts, and quantity 3 open collector outputs.
- O. Detection of low drive output torque shall be provided with the detection level and time programmable.
- P. There shall be three programmable skip frequency operation points with a bandwidth adjustment of 0Hz to 30Hz.
- Q. Motor parameters shall allow manual input of the motor characteristics and the drive shall provide a Motor Auto-tuning feature that automatically adjusts the drive's preloaded motor

- characteristics to match the actual connected motor characteristics. The Auto-tuning feature shall allow the user to decide if the motor's shaft shall rotate or not during the tuning process.
- R. The drive shall provide selectable cooling fan control to either allow the cooling to continuously run while the drive is powered or to stop the cooling fan from running once the internal temperature inside the drive drops below a predetermined value while the drive is not running but still powered.
 - S. The drive shall have the ability to start into a rotating motor, at any speed and direction, then accelerate or decelerate the motor to the speed reference set-point without stopping the motor, tripping the drive, or component failure under normal operating conditions.
 - T. A reverse lockout parameter shall be available to prevent the drive from running the motor in the reverse direction.
 - U. Automatic deceleration shall be provided to extend the deceleration time where the load inertia causes the DC bus voltage to rise in order to avoid tripping the drive on an over-voltage condition.
 - V. PID control shall be incorporated in the drive with the following programmable features: stop frequency and adjustable time delay for low speed (Sleep Mode), starting frequency, upper and lower operational limits, upper and lower alarm limits, normal or inverse operation, process set-point type, and process feedback type.
 - W. Multiple pump motor control logic shall be incorporated in the drive to allow the sequence control of multiple pump motors using either a fixed pump motor connected to the drive or alternating the pump motor connected to the drive. Using the fixed pump motor control logic, the drive's pump software shall control the speed of one pump motor and provide sequence control of up to 4 additional pump motors powered across the line to meet the system flow requirements. Using the alternating pump motor control logic, the drive's pump control software shall provide sequence control of up to 3 pump motors and switch between controlling each of the motors from the drive to across the line in order to meet the system flow requirements.
 - X. In addition to the drive being pre-programmed to operate most common applications, the drive shall provide a QUICK-SET programming menu that provides the user with a limited and basic list of parameters that may need adjusted per the application.

2.09 KEYPAD DISPLAY AND INTERFACE

- A. The drive shall contain a backlit graphic liquid crystal display (LCD) and a five digit LED display. The LCD screen shall display up to 5 lines of text to provide a display for: programming, diagnostics, I/O check, operation status, maintenance information, copy function, and communication debugging. The LED display shall provide indication of: output frequency, output current, output voltage, percent torque, input power, PID process set-point, PID feedback, PID output, load factor, and motor output. The LED display and the LCD display shall function independently of the programming mode to allow programming and monitoring of the drive simultaneously.
- B. The keypad shall provide a separate Local-Remote key to allow switching between local and remote operation modes for the drive.
- C. The keypad shall be common across the entire product series.
- D. The keypad shall be capable of copying drive parameters between different rated drives within the product series. The keypad shall be able to contain three sets of parameter data for copying to different drives or for different application set-ups.
- E. Data protection shall be provided to prevent unauthorized persons from changing the drives parameters through the keypad.

2.10 SERIAL COMMUNICATION

- A. The drive shall contain Modbus RTU, Metasys N2, and APOGEE FLN (P1) as built-in protocols not requiring the use of additional hardware. The user shall be able to select one of these communication protocols via the drive's keypad and programming menu.

- B. Additional communication protocols shall include: BACnet, LONWORKS, Profibus-DP, and DeviceNet, and Ethernet [IP] ++ OR ++ [Modbus/TCP] ++ OR ++ [BACnet IP]

PART 3: INSTALLATION

3.01 INSPECTION

- A. Inspect the product for any signs of physical damage.
- B. Verify that the location is ready to receive the drive and the dimensions are as indicated.
- C. Verify that the enclosure type is suitable for the environment for which it will be installed.

3.02 PROTECTION

- A. Protect the drive from water and other contaminants during storage and installation.
- B. Protect internal components from metal shavings and other wiring/installation debris that might be present during installation.
- C. Scratched painted surfaces are to be repainted to match original color and finish to prevent corrosion.

3.03 INSTALLATION

- A. Install per manufacturer's instructions and drawings provided.
- B. Verify all motor protective parameters are set correctly, per local and national codes, for the applied motor.

3.04 START-UP AND TRAINING

- A. The drive manufacturer shall have factory-trained personnel available for start-up and training.

3.05 DOCUMENTATION

- A. The drive shall be shipped with a printed instruction manual.

END OF SECTION