



Specification Number: 23 09 33

Product Name: FRENIC-HVAC AC Drives for Variable Torque Fan & Pump Applications (1-125Hp at 208/230Vac, 1-1000Hp at 460Vac, 1-300Hp at 575Vac)

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
- E. IEC/EN61800-3 EMC Standard Emission Category C2, Immunity 2nd environment

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-HVAC 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. EMC Filter, compliant with EMC Standard IEC/EN61800-3
- D. DC Reactor standard to reduce AC Line harmonic level & complies with EN61000-3-2 & EN61000-3-12
- E. 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 NEMA 1 (optional NEMA 12) construction for ratings up to 60Hp 208Vac 125Hp 460Vac with the availability of additional covers to meet Type 1 enclosure requirements for ratings up to 1000Hp.
- 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.
- C. Removable control terminal boards suitable for transfer to same class of controller.

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 1000Hp 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 0.98 lagging or higher.
- E. Drive true power factor shall be 0.90 or higher
- F. Drive efficiency at 100% speed and load shall be 95% higher, depending on the drive switching frequency setting.
- G. 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.
- H. The drive overload capacity shall be not less than 110% 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
 - AC Fuse blown
 - AC Input Current error
 - 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
 - DC Overvoltage/Under voltage
 - Abnormal condition in charge circuit/Charging Circuit Fault
 - Synchronous Power Frequency error
 - 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
 - Customizable Logic error
 - Enable Circuit error
 - PID Control Feedback error detection
 - PID External Device Feedback error detection
 - Anti-jam
 - Air Filter Clogging error
 - VFD DC cooling Fan locked
 - Low Battery (Option) indication
 - Data Information loss
- 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 20 reset attempts with programmable reset intervals ranging from 0.5 to 60 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.
- N. The drive shall have fire mode (forced operation) where it will ignore the inverter alarms and forcibly retries and maintains operation. It shall also indicate fire mode activated.

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. A quantity four 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 0.75 kHz to 16 kHz 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 for a total of 44 selectable

- functions. Two analog output signals shall be configurable between 0-10Vdc, 0-20mA or 4-20mA.
- 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 and reduce motor heating. 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 67 selectable functions and include the capability to receive negative input logic (sink/source logic selection). The drive programmable inputs shall be configurable for sink or source logic.
 - N. The drive shall provide quantity 6 programmable outputs with a choice from 77 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 4 open collector outputs.
 - O. The drive shall provide a 24Vdc, 50mA source to power a 2 wire process sensor
 - P. The drive provide 2 enable digital inputs signals that would be used in a shutdown mode as defined by IEC61800-5-2.
 - Q. Detection of low drive output torque shall be provided with the detection level and time programmable. Broken Belt detection
 - R. There shall be three programmable skip frequency operation points of 0 to 120Hz with a bandwidth adjustment of 0Hz to 30Hz.
 - S. 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.
 - T. 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.
 - U. 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.
 - V. A reverse lockout parameter shall be available to prevent the drive from running the motor in the reverse direction.
 - W. 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. Also, automatic torque limit control enable during acceleration, deceleration & running.
 - X. PID control shall be incorporated in the drive with the following programmable features: upper and lower operational limits, upper and lower alarm limits, normal or inverse operation, process set-point type, and process feedback type (Flow, Pressure, Temperature & Density units), 7 selectable alarm outputs, feedback failure detection, 3 PID multistep commands, filter clogging prevention and anti jam function consisting of automatic reversal running frequency, reverse running time & number of allowable reverse runs up to 10 times.
 - Y. Wet Bulb temperature presumption control
 - Z. In addition to the drive being pre-programmed to operate most common applications, the drive shall provide a QUICK-SETUP programming menu that provides the user with a limited and basic list of parameters that may need adjusted per the application.
 - AA. The drive shall have customizable logic incorporating timers, logic calculations, counters, flip-flops to set signal priorities, signal edge detection.

2.09 KEYPAD DISPLAY AND INTERFACE

- A. The drive shall contain a backlit graphic liquid crystal display (LCD). The LCD screen shall display up to 8 lines of text to provide a display for: programming, diagnostics, I/O check, operation status, maintenance information, copy function, and communication debugging. The LCD 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 LCD display shall allow programming and monitoring of the drive simultaneously. The LED lights indicate run, warning and alarm conditions.
- B. Electric Power Monitoring function shall include monitoring of AC power Input kW, KWh as well as indicate the kWh cost of electricity.
- C. Keypad shall have Real Time Clock used to record last 10 alarms with date and time; reset function to daylight savings time & Drive Timer operation having 4 timers, with 20 Holiday set points.
- D. The keypad shall provide a separate Local-Remote key to allow switching between local and remote operation modes for the drive.
- E. The keypad shall be common and interchangeable across the entire product series.
- F. The keypad shall be capable of copying drive operating 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.
- G. Data protection shall be provided to prevent unauthorized persons from changing the drives parameters through the keypad. This protection shall be available using function code setting, permissive digital input signal or password.

2.10 SERIAL COMMUNICATION

- A. The drive shall contain Modbus RTU, Metasys N2, and BACnet (MSTP) 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: LONWORKS, Profibus-DP, CANopen, CC-Link and DeviceNet, and Ethernet [IP] ++ OR ++ [Modbus/TCP] ++ OR ++ [BACnet IP] ++ PROFINET IO (Wired and Wireless)

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.