

Specification Number: FECA-TE-157

Product Name: FRENIC-ACE AC Drives for General Purpose Applications 1/8 – 40Hp at 230V and
½ - 450Hp 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.
- E. The drive shall be designed for a calculated life of 10 years. Operating factors shall be an ambient air temperature of 40 degrees C or less and an average load of 80% or less (ND) or 100% (HD)

PART 2: PRODUCT

2.01 MANUFACTURERS

- A. The drives furnished shall be FRENIC-ACE 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 both variable torque and constant torque loads.
- B. The drive output frequency range shall be from 0.04Hz to 500Hz (configuration dependent).
- C. The drive shall be capable of the following control methods:
 - 1. V/f control (IM)
 - 2. Dynamic torque vector control (IM)
 - 3. V/f control with slip compensation (IM)
 - 4. V/f with speed sensor (IM)
 - 5. Dynamic torque vector control with speed sensor (IM)
 - 6. Vector control with speed sensor (IM)
 - 7. Vector control sensorless (PMSM)

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 122°F).
- B. In transport temperature range shall be -25°C to 70°C (-13°F to 158°F)
- C. Storage temperature range shall be -25°C to 65°C (-13°F to 149°F)
- D. Relative humidity range shall be 5% to 95%, non-condensing
- E. The drive shall be rated to operate at altitudes less than or equal to 1000m (3300ft). For altitudes exceeding 1000m (3300ft), derate by following table.

Altitude	Output current derating factor
1000m or lower (3300 ft or lower)	1
1000 to 1500m (3300 to 4900 ft)	0.97
1500 to 2000m (4900 to 6600 ft)	0.95
2000 to 2500m (6600 to 8200 ft)	0.91
2500 to 3000m (8200 to 9800 ft)	0.88

- F. The drive shall incorporate cooling fans with sealed connections and additional coatings to extend fan life.
- G. The drive shall utilize copper bus bars with Nickel and Tin plating for corrosion protection.
- H. The drive shall be in compliance with RoHS directive 2002/96/EC as it pertains to the use of restricted substances.

2.06 RATINGS

- A. The drive offering shall cover 1/8 – 40Hp at 230VAC and ½ - 450Hp at 460VAC, with a common drive controller platform.
- B. The drive unit shall operate from an input voltage of [200 to 240VAC] ++OR++ [380 to 480VAC] with a tolerance of +10% to -15%.
- C. Input frequency shall be 50Hz, 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 shall be multiple rated for
- H. High carrier High Duty (HHD) application for single phase input 230V series.
High carrier Normal Duty (HND) and High carrier High Duty (HHD) applications for three phase input 230V series.
High carrier Normal Duty (HND) and High carrier High Duty (HHD) applications and Normal Duty (ND) and High Duty (HD) applications for three phase 460V series.
- I. Single phase input using three phase input 230V and 460V drive. (derating is required)
- J. The drive overload capacity shall be 120% for 1 minute in HND and ND mode or 150% for 1 minute for HD mode, 150% for 1 minute and 200% for 0.5 seconds in HHD mode.

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 require the use of Class J or Class CC fuses for FRN0010E2S-2GB to FRN0020E2S-2GB and FRN0002E2S-4GB to FRN0012E2S-4GB. All other models shall require the use of Class J or Class CC fuses or a breaker.
- 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:
 - Overcurrent during acceleration
 - Overcurrent during deceleration
 - Overcurrent during running at constant speed
 - Short-circuit
 - Ground fault
 - Overvoltage during acceleration
 - Overvoltage during deceleration
 - Overvoltage during running at constant speed
 - Undervoltage
 - Input phase loss
 - Output phase loss detection
 - Overheat of heat sink
 - Overheat of internal control
 - Overheat of charging resistors
 - Overheat of braking resistors
 - Overload n
 - External alarm input
 - Fuse blown
 - Charging circuit abnormality

- Brake transistor abnormality
- Over-speed
- Motor Electronic thermal
- Motor PTC thermistor
- Overload early warning
- Command loss detected
- Memory error
- Keypad communications error
- CPU error
- Option communications error
- Option error
- Operation
- Tuning error
- RS-485 communications error (port1)
- RS-485 communications error (port2)
- Step-out detection
- Speed mismatch or excessive speed deviation
- Data save error during undervoltage
- Hardware error
- Positioning control error
- Abnormal setting related to the PG option card
- Mock alarm
- CAN bus communication error
- PID feedback wire break detection
- Enable circuit failure
- Customizable logic abnormality
- Locked by password

- D. Configuration of “Light Alarms” shall be permissible in the drive. These alarms shall display an alarm condition without faulting or disrupting the operation of the drive in any other way.

- Overheating of the heatsink
- External alarm
- Inverter overheat
- Overheating of charging resistor
- Overheating of braking resistor
- Motor overload
- Optional communication error
- Option error
- RS-485(port1) communication error
- Inconsistent speed (excessive speed deviation)
- RS-485 (port2) communication error
- CAN bus communication error
- Positioning control error
- PID feedback wire break detection

- E. The drive shall display a warning condition without faulting or disrupting the operation of the drive.

- DC fan lock detected (460V type 0203 or above)
- Motor overload early warning
- Heatsink overheat early warning
- Life early warning
- Reference command loss detected

PID warning output
Low torque detected
Thermistor detection (PTC)
Machine life (cumulative motor run time error)
Machine life (number of startups error)

- F. 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.
- G. 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 provide indication for DC bus capacitors, electrolytic capacitors on the printed circuit boards, and cooling fans.
- H. The drive shall be able to display the capacitance level 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.
- I. 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.
- J. 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.
- K. 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 20 seconds.
- L. The drive shall contain input surge protection by utilizing Metal Oxide Varistors (MOVs).
- M. The drive shall contain LED indication for signifying potentially dangerous voltage in present on the DC bus.
- N. 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.
- O. 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.
- P. The drive shall include an internal electronic overload for the protection of a braking resistor connected to the internal braking transistor.

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 6000 seconds. 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 drive shall have a programmable, non-linear, V/f pattern function. There shall be programming capability for 5 separate points.
- E. The deceleration mode shall be selectable from normal deceleration or coast-to-stop.

- F. 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.
- G. In the event of a momentary loss of power, the drive shall be programmable to restart once power is returned
- H. Low and high drive output frequency limits shall be adjustable from 0Hz to 500Hz (configuration dependent).
- I. 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.
- J. The drive shall contain adjustable start and stop frequencies in the range of 0Hz to 60Hz.
- K. In order to reduce audible motor noise the drive shall contain adjustable switching frequency with settings ranging from 0.75kHz to 16kHz based on the rating of the drive.
- L. 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, calibration output, PID process set-point, and PID process output. Position error in master-follower operation, heat sink temperature, PG feedback, customizable logic output. Both analog output signals shall be configurable between 0-10Vdc or 4-20mA.
- M. 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.
- N. The drive shall provide quantity 7 programmable inputs with a choice from 60 selectable functions and include the capability to receive negative input logic. The drive programmable inputs shall be configurable for sink or source logic.
- O. The drive shall have quantity 2 digital input that is dedicated for compliance to EN safety compliance. This input is compliant with "STO" EN/ISO 13849-1, SIL3, PI=e, cat. 3.
- P. The drive shall provide quantity 3 programmable outputs with a choice from 78 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 2 open collector outputs.
- Q. Detection of low drive output torque shall be provided with the detection level and time programmable.
- R. There shall be three programmable skip frequency operation points 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 have the capability of storing 4 separate sets of motor data and have the ability to switch between them via digital inputs.
- U. 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.
- V. 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.
- W. A reverse lockout parameter shall be available to prevent the drive from running the motor in the reverse direction.

- X. 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.
- Y. The drive shall have a pre-excitation function which will ensure that motor magnetic flux is established to allow for motor torque before the start command is released.
- Z. The drive shall have a speed droop function which shall allow for load sharing applications where two drives and two motors are connected to a single piece of machinery.
- AA. The drive shall have a Servo Lock function which will hold the motor shaft in position while the RUN command is removed or the reference frequency is below the stop frequency.
- BB. 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.
- CC. A programmable logic area shall be available for customized functionality internal to the drive. Logic includes 200 steps and digital: 13, timer: 5, analog: 25, digital and analog: 12 function blocks.
- DD. Brake control shall be incorporated in the drive with adjustments for adaptability to specific applications.
- EE. The drive shall have a digital input capable of receiving a pulse train input for speed reference.
- FF. 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 five digit LED display. The LED 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, programming, diagnostics, I/O check, operation status, maintenance information, copy function, and communication debugging. The LED display shall function independently of the programming mode to allow programming and monitoring of the drive simultaneously.
- B. The keypad shall be common across the entire product series.
- C. Password protection shall be provided to prevent unauthorized persons from changing the drive's parameters through the keypad.
- D. There shall also be available an optional keypad with USB connection capability for easy connection of the keypad to available programming software and high performance LCD keypad to available text display and data copy function.

2.10 SERIAL COMMUNICATION

- A. The drive shall contain Modbus RTU as a built-in protocol not requiring the use of additional hardware. The user shall be able to select this communication protocol via the drive's keypad and programming menu.
- B. Additional communication protocols shall include: Profibus-DP, and DeviceNet, and Ethernet/ProfiNet, CANOpen, CC-Link.

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