



EF-Series (VFD) Variable Frequency Drives Product Specifications

Product Name: CES EF-Series Variable Frequency Motor Controllers for Pumping Applications
(1–50 hp at 208/230 V and 1–100 hp at 460 V)

SECTION 16420-4.2 (26 29 23.11) Variable Frequency Motor Controllers

PART 1: GENERAL

1.01 SUMMARY

- A. This section provides specification requirements for solid-state, pulse-width modulated (PWM) Adjustable Frequency Drives, herein referred to as AC Drives, for use with NEMA® design AC motors.
- B. The AC Drive supplier shall furnish, field test, and adjust all installed AC Drives for satisfactory operation.
- C. Any exceptions/deviations to this specification shall be indicated in writing and submitted no less than one week prior to bid date.

1.02 REFERENCES

- A. ANSI®/NFPA® 70 - National Electrical Code® (NEC®)
- B. UL 508 - UL Standard for Industrial Control Equipment
- C. UL 508C - UL Standard for Power Conversion Equipment
- D. NEMA ICS 7.1

1.03 SUBMITTALS

- A. A submittal package, including drawings, shall be furnished for the Engineers' approval prior to factory assembly of the AC Drives. These packages shall consist of elementary power and control wiring diagrams, and enclosure outline drawings. The enclosure drawings shall include front and side views of the enclosures with overall dimensions and weights shown, and conduit entrance locations. Standard catalog specification sheets showing voltage, horsepower, and full load current ratings shall be furnished as part of the submittal package.

1.04 WARRANTY

- A. An 18-month warranty, from the date of shipment, shall be provided on materials and workmanship.

1.05 QUALITY ASSURANCE

- A. The manufacturer of the AC Drive shall be a certified ISO 9001 facility.
- B. The AC Drive and all associated optional equipment shall be UL Listed according to UL 508C - Power Conversion Equipment. As verification, a UL label shall be attached on the inside of the combination enclosure. A UL 508A panel builders label does not meet this specification.
- C. The AC Drive shall be designed, constructed, and tested in accordance with UL, cUL NEMA, and NEC standards.
- D. Every power converter shall be tested with an AC induction motor while under load.

PART 2: PRODUCT

2.01 MANUFACTURERS

- A. The AC Drive shall be manufactured by Schneider Electric or previously approved equal. Substitutions must be submitted in writing three weeks prior to the original bid date with supporting documentation demonstrating that the alternative manufacturer meets all aspects of the specifications herein. Supporting documentation should include a line-by-line review of this

specification indicating whether the substitution meets or does not meet each item in this specification.

2.02 GENERAL DESCRIPTION

- A. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage.
- B. The input power section shall utilize a full wave bridge design. The rectifiers shall convert AC line power of fixed voltage and frequency to fixed DC voltage.
- C. The output power section shall change fixed DC voltage to adjustable frequency AC voltage.
- D. The adjustable frequency NEMA (Type 1, 12, or 3R) drive package shall consist of a circuit breaker disconnect, an optional 2- or 3-contactor bypass, 120 V control transformer, and control circuit terminal board for digital and analog field wiring.
- E. The Hand-Off-Auto switch, Speed Potentiometer and Adjustable Frequency Controller-Off-Bypass switch shall be mounted and wired to the drive door or located on the drive keypad.
- F. The entire drive package, including the bypass starter circuit, shall be UL 508C listed and coordinated with NEMA ICS 7.1. A UL 508A panel builders label does not meet this specification.

2.03 CONSTRUCTION

- A. The AC Drive power converter shall be enclosed in a NEMA (Type 1, 12, or 3R) enclosure with a circuit breaker disconnect, user terminal strip connections, and optional bypass controls. The enclosure shall provide dedicated user terminals for power and control device connection.
- B. Provisions shall be included for locking the disconnect in the Off position with a padlock.
- C. All enclosure and heat sink fans shall be accessible from the front and shall not require the removal of the AC drive power converter for fan replacement.

2.04 APPLICATION DATA

- A. The AC Drive shall be sized to operate a variable torque load.
- B. The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 72 Hz.

2.05 ENVIRONMENTAL RATINGS

- A. The AC Drive shall meet IEC 60664-1 Annex A and NEMA ICS 1, UL, and cUL standards.
- B. The AC Drive shall be designed to operate in an ambient temperature from -10 to 40 °C (14 to 104 °F).
- C. AC Drives in Type 3R enclosures shall be designed to operate in an ambient temperature from -10 to 50 °C (14 to 122 °F).
- D. The storage temperature range shall be -25 to 65 °C (-13 to 149 °F).
- E. The maximum relative humidity shall be 95%, non-condensing.
- F. The AC Drive shall be rated to operate at altitudes less than or equal to 3300 ft (1000 m). For altitudes above 3300 ft (1000 m), the AC Drive should be de-rated according to drive specifications up to 10,000 ft.
- G. The AC Drive shall meet the IEC 60721-3-3-3M3 operational vibration specification.
- H. The AC Drive shall include an option which will ensure that the drive is Seismic Qualified to 2003 IBC Level 3 "Extreme" rating with an Importance Factor $I_p=1.5$.

2.06 RATINGS

- A. The AC Drive shall be designed to operate at the input line voltage indicated on the equipment schedule.
- B. The AC Drive shall operate from an input frequency range of 60 Hz $\pm 5\%$.
- C. The displacement power factor shall not be less than 0.95 lagging under any speed or load condition.
- D. The efficiency of the AC Drive shall typically be 96% or greater.
- E. The variable-torque rated AC Drive overcurrent capacity shall be not less than 110% for 1 minute.
- F. The output carrier frequency of the AC Drive shall be programmable at 0.5, 1, 2, 4, 8 or 12 kHz. In addition, the output carrier frequency shall be modulated around the selected frequency.

2.07 PROTECTION

- A. Upon power-up, the AC Drive shall automatically test for valid operation of memory, loss of communication, DC-to-DC power supply, control power, and pre-charge circuit.
- B. The enclosure shall provide a fully coordinated 100,000 AIC current rating marked on the enclosure nameplate, with short circuit coordination to UL 508C Power Conversion Equipment and NEMA

ICS 7.1.

- C. The AC Drive shall be protected against short circuits, between output phases and phase to ground.
- D. The AC drive power converter shall have a ride-through function, which will allow the logic to maintain control for a minimum of one second (60 cycles).
- E. For AC drives that automatically reset after a detected fault is cleared, an auto restart function will provide programmable restart attempts. The time delay before restart attempts will be 1 second, 5 seconds, 10 seconds, and then 1 minute thereafter.
- F. Upon loss of the 4–20 mA analog process follower reference signal, the AC Drive shall be programmable to display a detected fault code.
- G. The AC drive power converter shall have a solid-state UL 508C listed overload protective device and meet IEC 60947.
- H. The output frequency shall be enabled to fold back when the drive is in an overcurrent condition.
- I. There shall be three skip frequency ranges that can be programmed to a bandwidth of to 10 Hz.

2.08 ADJUSTMENTS AND CONFIGURATIONS

- A. The AC Drive will be factory programmed to operate all specified optional devices.
- B. The acceleration and deceleration ramp times shall be adjustable from 0.05 to 999.9 seconds.
- C. The memory shall retain and record run status, detected fault type, motor current, output frequency, elapsed time, mains voltage, motor thermal state, command channel, channel reference active, and status word information in the diagnostic fault history.

2.09 KEYPAD DISPLAY INTERFACE

- A. A graphic display interface shall offer the modification of AC Drive adjustments through a membrane keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, diagnostics fault history, local control, configuration storage, and diagnostics shall be accessible.
- B. The AC Drive model number, torque type, software revision number, horsepower, output current, motor frequency, and motor voltage shall be listed on the drive identification portion of the LCD display.

2.10 OPERATOR CONTROLS

- A. The control power for the digital inputs and outputs shall be 24 Vdc.
- B. The internal power supply shall incorporate automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and will not be damaged if shorted.
- C. Input/Output connection terminals shall be used on all logic and analog signal connections in the power converter.
- D. Two voltage-free relay output contacts will be provided. One of the contacts will indicate the AC Drive detected fault status. The other contact shall indicate a drive run status.
- E. The combination enclosure shall have the following operator controls depending on the options selected:
 - Hand-Off-Auto switch
 - Speed potentiometer (located either in the door or in the power converter)
 - AFC-Off-Bypass switch
- F. The combination enclosure shall include a terminal point connection for a fire/freezestat interlock, to prevent drive (or bypass) operation. The interlock must shut down the motor in both the drive and bypass modes.

2.11 SERIAL COMMUNICATION

- A. The AC Drive shall have serial communications capability for Profibus, LonWorks®, Modbus®, Unitelway, Apogee® P1, Metasys® N2, Ethernet, and BACnet.

2.12 DRIVE ISOLATION AND BYPASS CONTACTORS

- A. The AC Drive shall include electrically interlocked bypass and drive output contactors, circuit breaker disconnect, control circuit transformer, and AFC/OFF/BYPASS switch.
- B. The operator shall have full control of the bypass starter by operation of the AFC/OFF/BYPASS selector switch.
- C. In the AUTOMATIC mode of operation the bypass contactors shall be sequenced by the 120 V autostart contact provided by the user.

- D. The bypass contactor shall be de-energized to provide motor isolation during a drive ready state of operation.
- E. The drive output contactor shall be de-energized during drive bypass operation.

2.13 HARMONIC MITIGATION

- A. Each drive shall include a line reactor or DC bus choke to reduce power system harmonics and provide power quality protection for the internally or externally mounted drive.

PART 3: INSTALLATION

3.01 INSPECTION

- A. Verify that the location is ready to receive work.

3.02 PROTECTION

- A. Before and during the installation, the AC Drive equipment shall be protected from water and site contaminants.

3.03 INSTALLATION

- A. Installation shall be in compliance with the manufacturer's instructions, drawings, and recommendations.
- B. The AC Drive supplier shall provide a representative to inspect the contractor's installation, and to test and start up the AC Drive(s) furnished under this specification.
- C. VFD supplier shall provide wiring interface between BECSys chemical control systems and VFD device. This interface will be designed to allow the VFD to maintain a specific flow (GPM) in the pool/spa recirculation system based on a flow signal delivered from the BECSys controller.

3.04 TRAINING

- A. Training shall be provided by the AC Drive manufacturer, or its authorized factory-certified service provider.

3.05 DOCUMENTATION

- B. The AC Drive supplier shall supply a comprehensive 8-1/2 x 11-inch bound instruction and installation manual that includes wiring diagrams, layout diagrams, and outline dimensions. This manual must be 3-hole punched for insertion into an operating manual supplied by the installing contractor.

Copies of this specification are available from the CES website: www.CESWaterQuality.com