*WEG Low Voltage Drive*

*(1-600HP)*

*Guide Form Specification*

## PART 1 GENERAL

1.01 SCOPE OF WORK

A. This section provides specification requirements for variable frequency drives (VFD), adjustable frequency drives (AFD), and variable speed drives (VSD) or herein identified as AC Drives for use with NEMA® Design B motors.

B. The manufacturer shall furnish, field test, adjust and certify all installed AC Drives for satisfactory operation.

C. Any exceptions or deviations to this specification shall be indicated in writing and submitted with the quotation.

**1.02 REFERENCES**

1. ANSI®/NFPA® 70 - National Electrical Code® (NEC®)
2. CSA® C22.2 No. 14-M91 - Industrial Control Equipment
3. IEC 61000 - Electromagnetic Compatibility
4. NEMA 250 Enclosures for Electrical Equipment
5. NEMA ICS7 - Industrial Control and Systems Adjustable Speed Drives
6. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection Installation and Operation of Adjustable Speed Drives
7. UL® 50 – Enclosures for Electrical Equipment
8. UL 98 – Disconnect Switches
9. UL 507 – Electric Fans
10. UL 508 – Industrial Control Equipment
11. UL 508C – Power Conversion Equipment
12. UL 991 – Safety Tests for Safety Related Controls employing Solid State Devices
13. OSHA® 1910.95 – AC Drive Controller Acoustical Noise

1.03 SUBMITTALS

1. [4] Copies of approval drawings shall be furnished for Engineer’s approval prior to factory assembly of the AC Drives. These drawings 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, conduit entrance locations and nameplate legends.
2. Standard catalog sheets showing voltage, horsepower, maximum current ratings and recommended replacement parts with part numbers shall be furnished for each different horsepower rated AC Drive shall be provided.

1.04 WARRANTY

A. A 12-month parts warranty shall be provided on materials and workmanship from the date of invoice from an authorized distributor. If the brand of the drive and motor are the same, the warranty shall be extended to 36 months.

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 UL508C Power Conversion Equipment. A UL label shall be attached inside each enclosure as verification.

C. The AC Drive shall be designed constructed and tested in accordance with UL, CSA, NEMA and NEC standards.

D. Every power converter shall be quality assurance tested with an AC induction motor under load conditions and subjected to a hi-pot test with all enclosed devices mounted and wired, prior to shipment.

E. Quality Assurance documentation shall be furnished to verify successful completion upon written request of the engineer.

## PART 2 PRODUCT

2.01 MANUFACTURERS

A. The AC Drive shall be provided by WEG Electric Corp or prior approved equal. Substitutions must be submitted in writing three (3) weeks prior to original bid date with supporting documentation demonstrating that the alternative manufacturer meets all aspects of the specifications herein.

B. Alternate control methods other than pulse width modulated (PWM) are not acceptable.

2.02 GENERAL DESCRIPTION

A. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage as defined below and indicated on the drawings or motor control schedules.

1. The AC Drive manufacturer shall use a 6-Pulse bridge rectifier design with dual symmetrical DC link chokes for effective harmonic mitigation. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage. The power section shall be insensitive to phase rotation of the AC line.

B. The output power section shall change fixed DC voltage to adjustable frequency AC voltage. This section shall use insulated gate bipolar transistors (IGBT) as required by the current rating of the motor.

**2.03 CONSTRUCTION**

A. The AC Drive shall be mounted in a NEMA Type 1 enclosure.

B. if the drive is mounted in a cabinet a mechanical interlock shall prevent an operator from opening the AC Drive door when disconnect is in the on position. It shall be possible for authorized personnel to defeat these interlocks.

C. Provisions shall be provided for locking all disconnects in the off position with up to three padlocks.

2.04 MOTOR DATA

* + - * 1. The AC Drive shall be sized to operate the following AC motors defined to match load schedules and type of connection used between motor and load such as direct or through a power-transmission connection:

Motor Horsepower rating(s) – See motor control schedules.

Motor full load ampere ratings coordinated to NEC2005 Table 430-250.

Motor RPM [3600, 1800, 1200] at 60 Hertz.

Motor utilization voltage [208, 230, 460 VAC]

Motor service factor [1.0, 1.15, 1.25]

2.06 APPLICATION DATA

A. The AC Drive shall be sized to operate a [Heavy Duty (150% overload), Normal Duty (110% overload)] load.

B. The speed range shall be from a minimum speed of 0.1 Hertz to a maximum speed of 204 Hertz for V/F control or 0 Hertz to 120 Hertz for Sensorless Vector control.

2.07 ENVIRONMENTAL RATINGS

A. The AC Drive shall meet IEC 60664-1 and NEMA ICS-1 Annex A standards.

B. The AC Drive shall be designed to operate in an ambient temperature from 0 to + 50 degrees C (0 to 122 degrees F) without derating.

C. The storage temperature range shall be -25 to +65 degrees C (-13 to +149 degrees F).

D. The maximum relative humidity shall be 90 percent at 40 degrees C non-condensing or dripping water conforming to IEC 60068-2-3.

E. The AC Drive shall be rated to operate at altitudes less than or equal to 3,300 feet (1000 meters) without derating. For altitudes above 3,300 feet, de-rating factors shall apply by the manufacturer.

F. The AC Drive shall conform to IEC 600721-3-3-3M3 amplitude for Operational Vibration Specifications.

2.08 RATINGS

A. The AC Drive shall be designed to operate from an input voltage of [230, 460VAC] plus 10 percent, minus -15 percent.

B. The AC Drive shall operate from an input voltage frequency range of 48 to 62 Hertz.

C. The displacement power factor shall not be less than 0.98 lagging under any speed or load condition.

D. The efficiency of the AC Drive at 100 percent speed and load shall not be less than 97 percent.

E. The [constant, variable] torque rated AC Drive overcurrent capacity shall be [150 percent, 110 percent] for one minute, every ten minutes.

F. The output carrier frequency of the AC Drive shall be randomly modulated depending on Drive rating for low noise operation. No AC Drive with an operable carrier frequency above 10 kHz shall be allowed.

G. The output frequency shall be from 0.1 to 204 Hertz.

H. The AC Drive will be able to develop rated motor torque at 0.6 Hertz (60 Hertz base) in a Sensorless flux vector (SVC) mode using a standard induction motor without an encoder feedback signal.

**2.09 PROTECTION**

A. Upon power-up shall automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, dynamic brake failure, DC to DC power supply, control power and the pre-charge circuit.

B. UL 508C listed for use on distribution systems with 50,000A available fault current. The AC Drive shall have a coordinated short circuit rating designed to UL 508C and listed on the nameplate.

C. Protection against short circuits, between output phases and ground; and the logic and analog outputs.

D. Minimum AC undervoltage power loss ride-through of 200 milliseconds. The AC Drive shall have the user-defined option of frequency fold-back to allow motor torque production to continue to increase the duration of the powerloss ride-through.

E. Selectable ride through function that will allow the logic to maintain control for a minimum of one second without faulting.

F. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide programmable restart attempts. The programmable time delay before restart attempts shall be unlimited.

G. Deceleration mode programmable for normal and fault conditions. The stop modes shall include free-wheel stop, fast stop and DC injection braking.

H. Upon loss of the analog process follower reference signal, shall fault and/or operate at a user-defined speed set between software programmed low-speed and high-speed settings.

I. Solid state I²t protection that is UL Listed and meets UL 508C as a Class 10 overload protection and meets IEC 60947. The minimum adjustment range shall be from 20 to 150 percent of the nominal output current rating of the AC Drive.

J. Thermal switch with a user selectable pre-alarm that will provide a minimum of 60 seconds delay before over-temperature fault.

K. Use bonded fin heatsink construction for maximum heat transfer.

2.10 ADJUSTMENTS AND CONFIGURATIONS

A. The AC Drive shall self-configure to the main operating supply voltage and frequency. No operator adjustments will be required.

B. Upon power-up, automatically send a signal to the connected motor. The stator resistance data will be measured at rated current. The AC Drive will automatically optimize the operating characteristics according to the stored data.

C. The AC Drive will be factory pre-set to operate most common applications.

D. A choice of two types of acceleration and deceleration ramps will be available in the AC Drive software; linear and S curve.

E. The acceleration and deceleration ramp times shall be adjustable from 0.0 to 999 seconds.

F. The volts per frequency ratios shall be user selectable to meet variable torque loads, normal and high-torque machine applications.

G. The memory shall retain and record run status and fault type of the past eight faults.

H. Slip compensation shall be adjustable from -10% to +10%.

J. The AC Drive shall offer programmable DC injection braking that will brake the AC motor by injecting DC voltage and creating a stationary magnetic pole in the stator. The level of voltage will be adjustable between 0 and 10 percent of rated line voltage and available from 0.0 to 15.0 seconds continuously.

K. Sequencing logic will coordinate the engage and release thresholds and time delays for the sequencing of the AC Drive output, mechanical actuation and DC injection braking in order to accomplish smooth starting and stopping of a mechanical process.

2.11 GRAPHIC TERMINAL DISPLAY INTERFACE

1. A fully functioned HMI with backlit graphic display will be provided. In all modes of operation the HMI shall display drive operating condition, time of day, motor speed and direction of rotation. The display shall include soft keys that are functionally controlled by the text on the LCD screen and a real time clock available for both display and program control. In the programming mode the HMI unit shall display and program all drive parameters. In the monitor mode it the HMI shall have three display options: Bar graph display of up to three variables simultaneously, display of up to three variables in engineering units, or display a single variable in large format LCD characters.
2. As a minimum the selectable outputs that can be monitored shall consist of speed reference, motor speed, motor current, DC link voltage, motor frequency, and motor voltage.
3. The graphic display terminal will consist of programmable function keys. The functions will allow both operating commands and programming options to be preset by the operator. A hardware selector switch will allow the graphic display terminal to be locked out from unauthorized personnel.
4. The graphic display terminal will offer an advanced user menu consisting of parameter setting, I/O map, fault history, and drive configuration. A software lock will limit access to the main menu.
5. A RUN (I) key and a STOP (O) key will command normal starting and stopping as programmed when the AC Drive is in keypad control mode. The STOP key must be active in all control modes.
6. The STOP (O) key will also reset any fault condition when in keyboard mode.
7. A user interface shall be available that is a WINDOWS® based personal computer, serial communication link or detachable graphic terminal display.
8. The keypad and all door mounted controls must be [Type 1, Type 12, Type 4X] rated.
9. The drive shall store the 10 most recent faults, including date and time of fault, and be easily accessible from the keypad.
10. The drive keypad shall be able to easily display the following data at time of last fault:
* Current at last fault
* DC Link at last fault
* Speed at last fault
* Reference Demand at last fault
* Frequency at last fault
* Motor Voltage at last fault
* All Digital Inputs status at last fault
* All Digital Outputs status at last fault

2.12 CONTROL

1. External pilot devices shall be able to be connected to a terminal strip for starting/stopping the AC Drive, speed control and displaying operating status. All control inputs and outputs will be software assignable.
2. 2-wire or 3-wire control strategy shall be defined within the software. 2-wire control allows automatic restart of the AC Drive without operator intervention after a fault or loss of power. 3-wire control requires operator intervention to restart the AC Drive after a fault or loss of power.

C. The control power for the digital inputs and outputs shall be 24 VDC.

D. The internal power supply shall incorporate an automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and not be damaged if shorted or excess current is pulled.

E. All logic connections shall be furnished on screw type terminal strips.

F. There will be (2) two software assignable isolated analog inputs with interference filtering. The analog inputs will be software selectable and consisting of user defined configurations: x-y mA or x-y V.

G. There will be six software assignable logic inputs that will be selected and assigned in the software. The selection of assignments shall consist of forward, reverse, jog, plus/minus speed (2 inputs required), preset speeds (up to 8), auto/manual control, controlled stop, terminal or keypad control, and fault reset.

1. There will be two software assignable analog outputs with interference filtering. The analog outputs shall be selected and assigned in the software. The analog output assignments shall be proportional to the following motor characteristics: frequency, current, power torque, voltage and thermal state. The output signal will be user defined configurations: x-y mA or x-y V.

I. Three voltage-free Form C relay output contacts will be provided. One of the contacts will indicate AC Drive fault status. The other contacts will be user assignable.

K. There shall be a hardware input/output extension module that also provides interlocking and sequencing capabilities. The module shall be fully isolated and housed in a finger-safe enclosure with pull apart terminal strips. The module will add four logic inputs, two analog inputs, two relay outputs, and two analog outputs. All of the I/O will be user assignable in the software as previously defined.

L. The combination enclosure shall have the following 22 mm door-mounted operators:

* Power on pilot light (red)
* Drive run pilot light (green)
* Drive fault pilot light (yellow)
* Hand-Off-Auto selector switch
* Manual speed potentiometer
1. The heat sink fan shall be programmable from the keypad for the following types of operation:
* Running Continuously
* Running only after a preset temperature is reached
* Running only when drive is in Run Mode
1. The heat sink fan shall be monitored by the drive for proper speed and the drive shall fault if the speed falls below 25% of fan rated speed. Total fan run time shall be measured and a Fan Replacement Alarm shall occur indicating that the fan has reached its maximum life of 50,000 operating hours. Fan runtime clock shall be resettable from the keypad when fan
is replaced.
2. The drive shall be capable of communication via serial USP port between the drive and a PC using a vendor supplied programming and monitoring software. This software shall provide programming, documentation, and troubleshooting of drive.

2.13 DYNAMIC BRAKING (APPLICATION DEPENDENT OPTION)

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A. Provisions shall be provided to protect the Dynamic Braking Resistor against overload and overcurent due to dynamic brake switch failure. This protection must be resettable without replacement of fuses or other devices.

B. The dynamic brake resistor shall be provided and connect to existing terminals on the AC Drive. The resistor shall mount externally to the AC Drive enclosure. An Insulated Gate Bipolar Transistor (IGBT) will be provided in the AC Drive to switch excess regenerative energy to the braking resistor. The braking resistor will be of a size calculated to stop 6 times motor inertia at 1.5 per unit motor torque.

2.14 DRIVE ISOLATION/BYPASS CONTACTORS

1. The AC Drive shall include mechanically and electrically interlocked isolation and bypass contactors complete with a Class 10 thermal overload relay, circuit breaker disconnects, control circuit transformer and AUTO/OFF/BYPASS switch.
2. The operator shall have full control of the bypass starter by operation of the AUTO/OFF/BYPASS selector switch.
3. In the AUTOMATIC mode of operation the bypass contactors shall be sequenced by the 120-volt rated auto start contact provided by the user.
4. The isolation contactor for the bypass shall be sequenced to provide motor isolation during a drive ready state of operation.
5. A [Soft Start bypass, Isolation, Transfer] shall be provided for 50 HP and above as indicated on the contract drawings for the emergency bypass mode.

## PART 3 EXECUTION

3.01 INSPECTION

A. Verify that the location is ready to receive work and the dimensions are as indicated.

B. Do not install AC Drive equipment until the building environment can be maintained within the service conditions required by the manufacturer.

3.02 PROTECTION

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

3.03 INSTALLATION

A. Installation shall comply with manufacturer's instructions, drawings and recommendations.

B. The AC Drive manufacturer shall provide an certified technical service representative to supervise the contractor's installation, testing and start-up of the AC Drive(s) furnished under this specification for a maximum total of [1,2,3] days. The start-up service shall be quoted as a separate line item.

3.04 TRAINING

A. An on-site training course of [1, 2] training days shall be provided by an authorized representative of the AC Drive manufacturer plant and/or maintenance personnel and quoted as a separate line item.

END OF SECTION

*Please contact your local WEG distributor or sales representative for specification assistance regarding a particular application. The Variable Frequency Drives specification is recommended for inclusion in Division 16 or 26 (Electrical) for proper coordination with the electrical distribution system.*