PHASE TECHNOLOGIES

Engineering Specifications for

LHX SERIES

Variable Frequency Drives

1. GENERAL

This specification describes the features and design of a low-harmonic variable frequency drive (VFD) for operating three-phase electric motors from either a single-phase or three-phase source. The VFD shall draw current and voltage from the utility source in a sinusoidal manner with low total harmonic distortion (THD). The input stage shall also employ electronic power factor correction to maintain near unity power factor while operating loads. The VFD shall comply with IEEE 519-2014, the standard for allowable harmonic distortion on utility mains, to maintain power quality for other utility customers and prevent damage to or interference with utility equipment, such as distribution transformers and smart meters. The VFD shall have a soft-start feature to reduce current in-rush and line disturbance when starting motor loads.

1.1 Qualifications

The VFD shall be designed in accordance and comply with:

1.1.1 National Electrical Code (NEC)

1.1.2 Underwriters Laboratories (UL) Standard 61800-5-1

1.1.3 FCC Article 15, Section J

1.1.4 IEEE 519-2014

1.1.5 UL 508C

1.2 Manufacturing and Quality Assurance

1.2.1 The manufactured product shall be manufactured in Rapid City, USA.

1.2.2 The cost of components of the manufactured product that are mined, produced, or manufactured in the US is greater than 55% of the total cost of all components of the manufactured product, which satisfies the requirements of the Build America Buy America Act.

1.2.3 All printed circuit boards shall have a full functional test before being assembled in the VFD. The fully-assembled VFD shall then be subjected to a full-load test.

1.3 Submittals

1.3.1 The submittals shall include wiring diagrams for power and control wiring; cabinet drawings showing dimensions, weights, mounting details, and required clearances; and complete technical product description.

222 Disk Drive, Rapid City, SD 57701 *phasetechnologies.com* 605-343-7934

2. VFD DESIGN AND FUNCTION

2.1 The VFD shall be based on a double-IGBT conversion design, with an active switching module in series with an L/C filter rectifying the incoming AC power to DC. The input module shall draw input current in a sinusoidal fashion with a power factor near unity. The output module shall be a three-phase IGBT inverter that produces a three-phase pulse-width-modulated (PWM) voltage for operation of AC motor loads.

2.2 The VFD shall be designed to operate AC induction motors.

2.3 The VFD shall be capable of the following control modes:

2.3.1 Open loop V/f control

2.3.2 Vector torque control

2.4 The VFD shall create no more than 5% current distortion at 80% load or greater.

2.5 The VFD shall create no more than 2% voltage distortion at 80% load or greater.

2.6 The VFD shall be designed to regenerate power back to the grid under certain load conditions.

2.7 VFD Operating Functions shall include:

2.7.1 Normal Operation: The VFD shall be equipped to accept analog or digital motor control signals for automatic operation of motor loads and shall be equipped to operate in manual mode, over-riding automatic motor control.

2.7.2 Protective Functions: The VFD shall have the ability to automatically shut down to protect both the VFD and the load from damage. A graphic display shall allow the operator to identify the reason for shutdown from a variety of faults including:

2.7.2.1 Internal short in the VFD

2.7.2.2 Overheating of the VFD (thermal overload)

2.7.2.3 Low utility line voltage

2.7.2.4 Short between the output lines

2.7.2.5 Excessive load demand

2.7.2.6 High utility line voltage

2.7.2.7 Line to ground fault

2.7.2.8 Under current fault

2.7.2.9 Motor phase loss

2.7.2.10 High/low bus voltage

2.7.3 Automatic Restart Delay: The VFD shall be equipped with an adjustable restart time delay to prevent all loads on the utility from restarting simultaneously when power returns after an outage.

2.7.4 Automatic derates shall slow the drive down to avoid Over Temperature and Overcurrent faults. These derates can be turned off.

2.7.5. Switching frequency shall be programmable from 2kHz to 5 kHz.

2.7.6 Acceleration and Deceleration rates shall be programmable for up to three linear ramp speed adjustments.

2.7.7 Three programmable skip frequencies to avoid operating the load at unstable speeds.

2.7.8 A programmable cycle counter to prevent continuous short-cycling of load.

2.7.9 A micro SD card slot for reprogramming software and for importing/exporting parameters so that parameters can be transferred between drives.

2.8 Control I/O

2.8.1 A minimum of four discrete, programmable, inputs shall be provided.

2.8.2 Minimum of two 240VAC, 10 A rated programmable relays shall be provided, as well as two 120VAC, 250 mA rated programmable relays.

2.8.2.1 All relays shall be programmable to perform at minimum the following functions:

2.8.2.1.1 General warning and fault conditions

2.8.2.1.2 Provide reference when VFD output is engaged

2.8.2.1.3 Provide reference when VFD faults

2.8.2.1.4 Allow the system to operate in Lead/Lag or Multiplex modes

2.8.3 Minimum of two analog 4-20 mA inputs that will allow proportional speed control or PID control.

2.8.4 Minimum of one 0-10VDC input that will allow for proportional speed control

2.8.5 Minimum of one 0-10VDC output for analog feedback

2.8.6 Minimum of one 4-20 mA output for analog feedback

2.8.7. An optional I/O expansion board shall be available to increase:

2.8.7.1 Digital inputs to eight total

2.8.7.2 Relay outputs to eight total (four 240VAC, 10A; and four 120VAC, 250mA)

2.9 Keypad Operation

2.9.1 A keypad and a backlit graphic display, that communicates programmable parameters and VFD-status in plain English.

2.9.2 A consistent user interface across all models and ratings.

2.10 Serial Communications

2.10.1 The following communication protocols:

2.10.1.1 Modbus RTU

2.10.1.2 Modbus IP

2.10.1.3 BACnet MS/TP

2.10.1.4 BACnet IP

2.10.2 An interface for sending commands and reading registers via personal computer.

3. SPECIFICATIONS

3.1 The VFD shall operate continuously at full output without de-rating while subjected to ambient temperatures of 0° to 40° C.

3.2 The VFD shall operate up to 95% relative humidity, non-condensing.

3.3 Standard duty models shall have an overload current capacity of 120% of rated current for one minute out of five minutes.

3.4 Heavy duty models shall have an overload current capacity of 150% of rated current for one minute out of five minutes.

3.5 The VFD shall operate continuously at full output without de-rating at elevation up to 3,300 feet MSL. VFD must be de-rated 0.25% for every 100 feet above 3,300 feet.

3.6 The VFD shall be designed with an L/C filter on the input. An optional external L/C/L filter is available for installations with severe harmonics.

3.7 Input Current Characteristics:

3.6.1 The VFD shall operate at near unity power factor.

3.6.2 Input current shall be true sinusoidal and contain less than 5% total harmonic distortion (THD).

3.6.3 Input Voltage Range: The VFD shall operate from 1Φ or 3 Φ, 50/60 Hz, nominal 240V or 480V.

3.8 Output Power Characteristics

3.7.1 The 3Φ output shall be variable voltage, variable frequency, pulse-width-modulated voltage

4. PHYSICAL REQUIREMENTS

4.1 Cabinet Construction: The enclosure shall be constructed with painted galvannealed (A60) steel and galvanized (G90) steel, 0.039 in. (1.0 mm) minimum thickness.

4.2 Enclosures will be provided with hanging brackets. A floor-mount kit can be purchased for some systems.

4.3 Corrosion Protection: All parts shall be of corrosion resistant material or plated or painted as corrosion protection.

4.4 The VFD shall be supplied in an Open Type enclosure or an indoor NEMA Type 1 enclosure.

4.5 Electrical Connections: The VFD shall include input and output terminals for hard-wired connections. The enclosure shall provide an area suitable for input and output conduit openings.

5. WARRANTY

5.1 The manufacturer shall guarantee the VFD to be free from material defects and workmanship for a period of two years from purchase.