

## **E3 Adjustable Speed Drive Engineering Specification**

### **PART 1 - GENERAL**

#### **1.0 Scope**

This specification shall cover Toshiba E3 AC Variable Frequency Drives, 6 pulse for 230V and 460V.

#### **1.1 References**

- A. National Electric Manufacturers Association (NEMA)
- B. Underwriters Laboratories, Inc. (UL) and CSA
- C. National Electric Code (NEC)
- D. IEEE 519. Compliance of IEEE 519 can be determined after Toshiba performs a harmonics analysis. The analysis will be done after we receive a completed harmonics questionnaire.
- E. ISO 9001

#### **1.2 Submittal**

Submittals shall include Toshiba standard operation manual. Schematics can be obtained from factory upon request.

### **PART 2 – E3 VARIABLE FREQUENCY DRIVE**

#### **2.0 General**

- A. This specification covers AC adjustable frequency drives for HVAC applications.
- B. The manufacturer shall not have less than fifteen years of experience in the manufacture of VFD's.
- C. The manufacturer shall manufacture both AC drives and motors at the same facility.
- D. The drive shall be manufactured in the United States.

#### **2.1 Design Criteria**

- A. The drive should be a PWM (Pulse Width Modulated) transistorized inverter using IGBT's (Insulated Gate Bipolar Transistors) and must be fully digital.

- B. The drive shall utilize Insulated Gate Bipolar Transistor (IGBT's) in its power section.
- C. The E3 VFD shall have 3 basic design criteria
  - 1) **Rectifier Section** that shall include diode bridge rectifier to convert AC to DC.
  - 2) **Filtering Section** that shall include capacitors to eliminate "ripple" affect on the DC bus to produce smooth DC bus voltage.
  - 3) **Switching Section** that shall included Insulated Gate Bipolar Transistors (IGBT) to provided Pulse Width Modulation.

## 2.2 Ratings and overload capability of the VFD

- A. The drive main input power shall be:
  - I. 200V/50Hz or 200V-230V/60Hz for 230V models
  - II. 380V-415V/50Hz or 400V-460V/60Hz for 460V models
- B. The drive shall have a tolerance for voltage  $\pm 10\%$  and frequency  $\pm 2\text{Hz}$ .
- C. The drive overload current shall be 100% continuous and 110% for 1 minute.
- D. The drive should have a common design for all horsepower models:
  - 230V – 3 through 60HP
  - 460V – 5 through 125HP

## 2.3 Control Features

- A. The drive shall have True Torque Control with Automatic energy-saving control.
- B. The drive shall have two (2) frequency priority selection feature.
- C. The drive shall be capable of setting both upper and lower limit frequencies.
- D. The ASD shall automatically adjust the PWM carrier frequency proportional to speed. The range of automatic adjustment shall vary from 15khz to .5khz. The minimum acceptable full speed carrier frequency (60 Hz) with no derating shall be 8 kHz.
- E. The drive shall be capable of PID set point control.
- F. Preset macros for typical HVAC applications such as pumps, fans, cooling towers.
- G. Serial RS232C communications standard.
- H. Automatic cooling fan control based on heat sink temperature for extended fan life.
- I. The drive shall be able to start and stop from a two-wire control (dry contacts), three wire momentary contact closure, keypad, and serial interface.
- J. The drive shall be able to act as a space heater for a motor when the system is not running.
- K. The drive shall have adjustable input and output terminal response time selections to prevent noise effects and chattering.
- L. The drive shall have a built-in control system for commercial power/inverter power switching.

- M. The drive shall have an adjustable retry function after a fault. Both number of attempts (at least 10) and time between (1-10 sec).
- N. The drive shall have an adjustable output short circuit detection selection for standard motor and high-speed motors (very low inductance).
- O. The drive shall have two programmable: volt per hertz patterns, maximum output frequencies, electronic thermal protection settings, stall protections, base frequencies, voltage boosts, and stall protection selections which can be chosen while running to run motor A or motor B.
- P. The drive shall have an analog input filter adjustment to limit the effects of noise on the control signal.
- Q. The drive shall permit switching between local/remote operation as well as manual/auto “on the fly.”
- R. The drive shall have the ability to ignore run commands until a “dampers open” signal is received. In the event a “dampers open” signal is absent the drive shall be capable providing a “close damper” signal. Upon receipt of “drive stop” signal The ASD shall be capable of providing a close damper signal.
- S. The drive shall be provided with “anti-windmilling” or “motor shaft stationary control”
- T. The drive shall have the following user selectable contingencies in the event of loss of analog control signal while the drive is running before loss:
  - i. Run at the user set lower frequency limit.
  - ii. Run at the user set upper frequency limit.
  - iii. Trip with a signal loss fault.
  - iv. Run at user-selected percentage of the last valid frequency signal.

## **2.4 Operational Functions**

- A. The drive shall contain two separate acceleration/deceleration times with auto tuning for optimum setting (0.1 to 6000 seconds) with choice of linear, S, or C curves.
- B. The drive shall be equipped with both local/remote and manual/auto keys on touch pad.
- C. The drive shall be equipped with a quick setup key with 18 most frequently parameters in a HVAC type application.
- D. The drive shall contain fifteen preset speeds, which can be activated from the keypad, terminal inputs, and host computer.
- E. The drive shall have the capability of storable special custom user setting.
- F. The drive shall restart into a rotating motor operating in either the forward or reverse direction and match that frequency.
- G. The drive shall have adjustable soft stall (10% - 150%) which reduces frequency and voltage of the inverter to sustain a run in an overload situation.
- H. The drive shall be capable of performing a time base pattern run using 4 groups of 8 patterns each using the 15 preset speed values for a maximum of 32 different patterns.

- I. The drive shall have adjustable UL listed electronic overload protection (10% - 100%).
- J. The drive shall have a custom programmable volt/hertz pattern.

## **2.5 Input / Output Capabilities**

- A. The drive shall accept the following frequency commands signals:
  - 1) 3k $\Omega$  potentiometer (1k $\Omega$  to 10K $\Omega$  potentiometer connection also possible)
  - 2) 0 to 10 Vdc (Input impedance Z<sub>in</sub>:33k $\Omega$ )
  - 3) 0 to  $\pm$  10 Vdc (Z<sub>in</sub>:67k $\Omega$ ),
  - 4) 0 to  $\pm$  5 Vdc (Z<sub>in</sub>:34k $\Omega$ )
  - 5) to 20mA (Z<sub>in</sub>:500 $\Omega$ ),
  - 6) 15 Preset speeds
  - 7) Motorized speed pot.
- B. The drive shall have 2 programmable analog outputs programmable to 17 choices.
- C. The drive shall have 1 programmable relay output programmable to 67 choices.
- D. The drive shall have 8 programmable digital inputs programmable to 54 choices.
- E. The drive shall have a pulse train output proportional to frequency (48,96,360 times frequency).

## **2.6 Protective Features**

- A. The drive shall contain three critical frequency jump points with individual bandwidth.
- B. The drive shall be UL rated for 200,000 AIC without the use of input fuses.
- C. All drives 460V, 25HP and above shall be equipped with a 3% impedance DC link.
- D. The drive shall have external fault input.
- E. The drive shall be capable of re-setting faults remotely and locally.
- F. The drive shall be programmable to alert the following alarms:
  - 1) Over torque alarm,
  - 2) Inverter overload pre-alarm
  - 3) Motor overload pre-alarm
  - 4) Braking resistor overload pre-alarm
  - 5) Inverter overheat pre-alarm
  - 6) Undercurrent alarm
  - 7) Over current pre-alarm
  - 8) Communication error alarm
  - 9) Cumulative timer alarm
  - 10) Executing retry
- G. The drive shall identify and display the following 33 faults:
  - 1) Over current during acceleration trip
  - 2) Over current during deceleration trip

- 3) Over current during normal run trip
- 4) Over current on the DC Bus during acceleration trip
- 5) Over current on the DC Bus during deceleration trip
- 6) Over current on the DC Bus during normal run trip
- 7) Load end over current trip detected at start-up (output terminals, motor wiring, etc.)
- 8) U-phase short circuit trip detected at start-up
- 9) V-phase short circuit trip detected at start-up
- 10) W-phase short circuit trip detected at start-up
- 11) Overvoltage during acceleration trip
- 12) Overvoltage during deceleration trip
- 13) Overvoltage during normal (constant speed) run trip
- 14) Inverter overloaded trip
- 15) Motor overloaded trip
- 16) Inverter overheat trip
- 17) Emergency off trip message.
- 18) EEPROM failure during write cycle
- 19) EEPROM abnormality during initial reading
- 20) RAM error
- 21) ROM error
- 22) CPU error
- 23) Communication interruption error
- 24) Gate array error
- 25) Output current detection circuit error
- 26) Option PCB error trip
- 27) Low operating current trip
- 28) Main circuit under voltage trip
- 29) Over torque trip
- 30) Software detected earth fault trip
- 31) Hardware detected earth fault trip
- 32) Inverter type form mismatch error
- 33) EEPROM type form mismatch error

## **2.7 Operating Panel and Monitor Functions**

A. The drive digital display shall be capable of monitoring the following 18 functions:

- 1) Post Compensation Output Frequency
- 2) Frequency Command Setting
- 3) Output Current
- 4) Input Voltage
- 5) Output Voltage
- 6) Torque Current
- 7) Excitation Current
- 8) PID Feedback Value

- 9) Motor Overload Ratio
  - 10) Drive Overload Ratio
  - 11) DBR Overload Ratio
  - 12) Input Power
  - 13) Output Power
  - 14) RR Input Value
  - 15) Peak Load Current
  - 16) Peak Input Voltage
  - 17) Kilowatt Hours
  - 18) Megawatt Hours
- B. The drive shall have 320 programmable parameters, which can be changed, while the drive is in run mode.
  - C. The drive's 353 parameters shall be adjustable from the 8 key touchpad or computer link.
  - D. The drive shall be controlled through Palm-Pilot software.
  - E. The drive's 11 key touchpad shall be NEMA 12 rated.
  - F. The drive's keypad shall be capable of being extended 15 feet from the drive.
  - G. The drive shall contain a reset of all parameters to factory default settings or user defaults (whichever one is chosen).
  - H. The drive shall have an elapsed time meter and will save the past four faults in memory.

## **2.8 Optional features**

- A. 12-pulse diode rectification for maximum harmonics attenuation shall be available for 460V drives 25HP through 100HP.
- B. Pneumatic interface (3-15psi) transducers are available upon request.
- C. Isolated input and output transducers are available upon request.
- D. All drives regardless of size/voltage should have isolated bypass capability as an available option.
- E. 600V, E3 drives are also available from 5HP to 125HP. The ratings shall be 540V-660V/60 Hz for 600V models.

### **Communication options to include:**

- 1) Metasys, N2 Interface
- 2) Landis-Steaffa, P1 Interface
- 3) RS485
- 4) Modbus RTU
- 5) Modbus+
- 6) Devicenet
- 7) AB RIO
- 8) Profibus DP
- 9) Lonworks

## **2.9 Drive Environmental Conditions**

- A. Environment - Indoors NEMA 1 metal enclosure, plastic shall not be acceptable.
- B. Ambient temperature - 14°F to 104°F (up to 122°F with cover removed).
- C. Altitude - 3,300 feet maximum without derating.
- D. Relative humidity - 95% maximum (no condensation allowed).
- E. Vibration - 0.5G maximum.

## **Part 3 – Start-up, Training and Warranty**

- A. Start-up and service is available as an additional option
- B. The drive manufacturer shall guarantee the operation of the drive against failure due to defects for 30 months after shipment or 24 months of service, whichever comes first.
- C. If factory authorized personnel perform the startup of the drive the standard warranty is increased to 24 months.
- D. The drive manufacturer shall supply a recommended list of spare parts and pricing through our spare parts list book.