

# *Q7 Adjustable Speed Drive Engineering Specification*

## **PART 1 - GENERAL**

### **1.0. Scope**

This specification shall cover the Toshiba Q7 AC Variable Frequency Drive, 6 pulse for 230V and 460V.

### **1.1. References**

- National Electrical Manufacturers Association (NEMA) Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems
- National Electrical Code (NEC) (NFPA 70)
- NEMA 250 Enclosures for Electrical Equipment
- IEC 146 International Electrotechnical Commission
- ISO 9001
- UL 508

### **1.2. Qualifications**

#### **Manufacturer's History**

Toshiba entered the AC adjustable speed drive market in the US in 1979. Toshiba International Corporation continues to specialize in the design and manufacturing of both AC drives and induction motors at its manufacturing facility located in Houston, Texas.

#### **Certification**

Toshiba International Corporation, located in Houston Texas, is an ISO 9001 certified manufacturing facility.

#### **After Sales Support**

Support is available direct from Toshiba's Houston facility or from a network of factory-trained distributors and certified service centers located throughout North America and Canada.

### **1.3. Submittal**

Submittals shall include Toshiba's standard VFD operation manual. Schematics can be obtained from factory upon request (must be factory trained to receive schematics).

## **PART 2 – Q7 VARIABLE FREQUENCY DRIVE**

### **2.0. General**

- A. This specification covers the Q7 AC variable frequency drives (VFD) for HVAC applications.
- B. The manufacturer shall not have less than fifteen years of experience in the manufacture of VFDs.
- C. The manufacturer shall manufacture both AC drives and motors.
- D. The drive shall be manufactured in the United States.

### **2.1. Design Criteria**

#### **2.1.1. Input Power**

- A. The drive main input power shall be:
  - I. 200V/50Hz or 200V-240V/60Hz for 230V models
  - II. 380V-415V/50Hz or 380V-480V/60Hz for 460V models
- B. The drive shall have a tolerance for voltage  $\pm 10\%$  for all 230V and 460V drives.
- C. The input frequency tolerance shall be  $\pm 2\text{Hz}$ .
- D. The efficiency of the drive shall be a minimum of 95.0% at full load at full speed. Displacement power factor will be greater than 0.95 lagging over the entire speed range.
- E. The drive overload current shall be 100% continuous and 110% for 1 minute.
- F. The drive shall have a common design for all horsepower models:
  - I. 230V – 1 through 150HP
  - II. 460V – 1 through 350HP
- G. The Maximum Short Circuit Current Rating of the Q7 drive (power unit) shall be 200,000A RMS symmetrical for all ratings.
- H. All 230V Q7 drives shall be able to operate based on 200V current capabilities as prescribed in NEC Table 430.150.

### **2.1.2. Hardware Design**

- A. Overall hardware design shall be for maximum flexibility, robustness, serviceability, and reliability for the most demanding applications.
- B. Power Terminations shall be oversized for the drive current rating to allow for flexibility on all power terminations.
- C. All ratings contain a minimum of three ground termination points.
- D. Power Terminations are 'finger safe' and clearly labeled with both the US (NEMA) standards (L1, L2...T2) and IEC standards (R, S...W).
- E. The latest technology in packaging, heat sink design, and cooling is utilized to minimize overall size and weight without degrading performance or functionality.
- F. Plastics, where used, are UV resistant.
- G. Standard packaging is NEMA 1.
- H. The Q7 drive shall have an Interrupting current rating of 200,000A RMS symmetrical for all ratings on the power units.
- I. Power Semiconductor heat sinks contain one or more thermal sensors monitored by the microcontroller to prevent semiconductor damage caused by excessive heat or fan loss.

### **2.1.3. Converter Section**

- A. The Q7 drive shall employ diode bridge rectification to convert AC to DC. SCRs and other switching power devices are not used in the converter section of the drive to minimize line notching and RFI.
- B. The Converter Section shall be unaffected by phase rotation/phase sequence.
- C. Semiconductors on all ratings are sized (current) to allow full operation and overload capabilities at minimum input voltage.
- D. PIV Ratings of the rectifier shall be as follows:
  - I. 230V drives—rectifier minimum PIV rating of 800V
  - II. 460V drives—rectifier minimum PIV rating of 1600V
- E. The Q7 drive has Metal Oxide Varistors (MOV) mounted phase to phase for surge protection. The maximum continuous operating voltage (MCOV) shall be 825VDC. The energy rating for the MOV shall be as follows:
  - I. 230 Joules for the 460V drives
  - II. 150 Joules for the 230V drives
- F. Isolation transformers are not required for operation on most standard distribution systems.
- G. The converter section is usable on 50Hz and 60Hz distribution systems.

### **2.1.4. DC Bus Section**

- A. Overall DC Bus design shall be passive capacitive filter to minimize ripple and maximize power-loss ride-through.
- B. DC Bus capacitance (total filter capacitance) shall be sized to eliminate any requirement for bus inductance (for filtering purposes) when the Q7 drive is used on a three-phase distribution system.
- C. The DC bus voltage and current are monitored by the control section to prevent damage to either the drive or the driven equipment.
- D. All ratings will contain fast acting fuses in the DC Bus section.
  - I. 230V drives – bus capacitance voltage rating 400VDC (minimum)
  - II. 460V drives – bus capacitance voltage rating 800VDC (minimum)
- E. All capacitors shall have balance/discharge resistors to equalize charge voltage and permit safe discharge on power outage.
- F. Soft charge circuitry shall not utilize power transistors or time delay relays.
- G. The DC Bus Section has complete power terminations to allowing:
  - I. Rectifier Isolation (positive side)
  - II. Addition of extended ‘ride through’ capacitor bank
  - III. Line regeneration using third party units
  - IV. DC Link inductor
- H. A readily visible LED (when cover is removed) indicates when DC voltages are present.

### **2.1.5. Inverter Section**

- A. The inverter section makes use of the latest generation of IGBT power switching transistors to convert DC to three phase, variable frequency, and sinusoidal coded PWM waveform.
- B. IGBT initialization testing is performed by the control section on each power up and run command.
- C. The inverter section does not require commutation capacitors.
- D. All drives shall have software and hardware to limit reflected wave caused by long motor cable lengths.
- E. The IGBT ratings will be as follows:
  - I. 230V drives – IGBT minimum  $V_{ce}$  rating 600V
  - II. 460V drives – IGBT minimum  $V_{ce}$  rating 1200V
- F. All IGBTs shall have soft recovery free wheeling diodes to prevent IGBT failure when subjected to motor discharge spikes. This shall apply to the Dynamic Breaking Circuit when available.
- G. PWM switching frequencies are adjustable from 0.5 to 15kHz based on horsepower (please refer manual). Please refer to the operational manual for specific derate based on the horsepower.
- H. IGBTs are sized (current) to allow the drive to operate at 100% (current) continuous and 110% (current) for up to 6000 seconds, 120% for 12 seconds and 150% for 2 seconds.

- I. The instantaneous current limit is set to 250% for 0.2 seconds. The stall protection limit can be set up to 215%. The stall protection shall limit the output frequency and voltage to prevent the drive from tripping.
- J. The Dynamic Breaking circuit shall be available for drives up to 15hp @ 460V and 7.5hp @ 230V.
- K. Output current in each phase shall be monitored using hall-effect current transformers to enabling control of flux current, torque current, and providing protection to both the drive and driven equipment.
- L. The inverter section shall capable of sensing and interrupting a phase to phase or phase to ground fault on the output of the drive.

### **2.1.6. Control Section**

- A. The control section shall be designed to provide complete monitoring and protection of drive internal operations while communicating with the outside world via one or more user interfaces.
- B. The microcontroller logic circuits used is the latest design CPU with adjustable frequency drive specific circuitry and firmware.
- C. The Field Programmable Logic Array (FPGA) shall be used for Pulse Width Modulation (PWM) generation.
- D. Microcontroller logic circuits shall be isolated from power circuits.
- E. Where switching logic power supplies are utilized, they are powered from the DC Bus Section of the drive.
- F. Microcontroller logic circuits diagnostics are performed (on application of power) to prove functionality and viability of the microcontroller logic circuits.
- G. Memory cyclic redundancy check (CRC) is performed (on application of power) to prove integrity of EEPROM and UVPROM memories.
- H. Motor diagnostics are performed (on application of power and each start) to prevent damage to a grounded or shorted motor. The motor diagnostics may be disabled when using a low impedance motor.
- I. Operating system firmware shall be capable of ‘flash’ upgrading if enhancements to the operating system firmware are needed. Special Option ROM may be available for custom programming application.
- J. The Q7 drive shall have:
  - I. Standard RS485 port. TIC shall provide half duplex and full duplex RS485. The half duplex shall be used to “listen”; the full duplex shall be used to “talk” and “listen”.
  - II. Common TTL port
  - III. NanoCom , multiprotocol translator option
- K. Multidimensional Data Arrays (MDA) exists in EEPROM memory for Toshiba EQPIII motors. Motors (2, 4 and 6 poles) in both TEFC and ODP for the appropriate horsepower shall be configurable to eliminate tuning concerns when the drive is used with a Houston manufactured Toshiba motor. The Q7 can be used to tune a TIC Motor, other manufacture motor and any other special motor that does not exist in our MDA table.

- L. The control section is designed to allow 'quick change' of the interface sections for both configuration and functionality.

### **2.1.7. Output Power**

- A. The output voltage is adjustable from 0 to rated input voltage. The output frequency range is adjustable for a maximum frequency output of 299 Hz. The output (inverter) section of the Q7 will produce a PWM sinusoidal coded waveform.
- B. The output power switching devices shall be IGBT devices of the latest design.
- C. All our IGBTs shall be oversized for the current rating of its horsepower ratings.

### **2.1.8. Q7 Keypad**

- A. The Q7 keypad shall be comprised of a backlit LCD display.
- B. The 2 X 16 graphical display (2 rows by 16 characters across) may be used for system monitoring functions, data input to the system and diagnostic performance.
- C. The Speed Ctrl (Local/Remote) key shall toggle the system to and from the Local and Remote modes. The LED is on when the system is in the Local mode. The Local mode allows the Frequency control functions to be carried out via the Q7 Keypad.
- D. The Remote mode enables the Frequency control functions to be carried out via any one of the following methods:
  - I. Control Terminal Strip
  - II. Pulse Input
  - III. Motorized Pot
  - IV. Communication Card
  - V. RS232/485
  - VI. Common TTL
  - VII. Binary/BCD
  - VIII. LCD / LED Keypad
  - IX. Option Card RX2
  - X. RX
  - XI. RR
  - XII. VI/II (Signal Isolator shall be available as an option)
  - XIII. NanoCom Option
- E. The Up/Down arrow key shall be used to increase/decrease the value of the selected parameter or scrolls up/down the menu listing (continues during press and hold).

- F. The Run Mode (Manual/Auto) Key shall allow the Q7 to receive run commands (i.e., Stop, Run, Forward, etc.) from either the Q7 keypad (Manual) or remotely (Auto) (i.e., RS232/485, Option Card RX2 or any other communication option).
- G. The Read / Write Key shall be used to select a menu item to be changed or accepts and records the changed data of the selected field.
- H. The Stop / Reset Key is used to issue the Off command (decelerates to Stop at the programmed rate) if pressed once while in the Manual mode, or initiates an Emergency Off (terminates the ASD output and applies the brake if so configured) if pressed twice quickly from the Manual or Auto mode.
- I. The Run Key shall issue the Run command while in the Manual mode.
- J. The keypad shall have three system status LED and eight keys. The system status LED will be the Local, Run, Manual. These LEDs shall illuminate red while active.
- K. The Setup / Program / Monitor Key (SPM) shall provide access to the root menus. Pressing the SPM key repeatedly loops the system through the active root menus.

### **2.1.9. Integrated Enclosure**

- A. The Integrated Enclosure shall have the Q7 power unit, circuit breaker and/or bypass in one enclosure.
- B. The Integrated Enclosure shall be designed to incorporate the following options:
  - I. Circuit Breaker and 3-contactor bypass (IE option)
  - II. Circuit Breaker and 2-contactor bypass (IC option)
  - III. Circuit Breaker (IA option)
- C. The Integrated Enclosure shall be available for the following rating:
  - I. 460V, 1 – 125hp
  - II. 230V, 1 – 60hp
- D. The Maximum Short Circuit Current Rating of the Integrated Enclosure shall be 100,000A RMS symmetrical for all ratings.
- E. The Integrated Enclosure shall be installed with an external DC link or input line reactor as an option.
- F. Input fuses shall be an option as part of the Integrated Enclosure.

## **2.2. Functionality**

### **2.2.1. Acceleration and Deceleration**

- A. The Q7 drive shall contain two sets of independently configurable acceleration / deceleration ramps. Each set is configurable as to both time and V/Hz pattern. Times are adjustable from 0.01seconds to 6000 seconds.
- B. Available acceleration / deceleration patterns are:
  - I. Linear

- II. S-pattern 1 for quick acceleration and deceleration
- III. S-pattern 2 acceleration and deceleration that decreases the rate of change above the base frequency.
- C. Both 'S' curves allow user adjustment to customize the pattern. Two (2) Acceleration / Deceleration sets are selectable via discrete input, Q7 keypad, communications, or automatic switching based on output frequency.
- D. An automatic acceleration/deceleration selection is available which dynamically structures each change in speed to match conditions of the driven equipment to minimize shock due to changes in velocity and/or load conditions.
- E. Overvoltage stall and overcurrent stall settings prevent damage to the driven equipment should acceleration or deceleration settings exceed the ability of the motor to accelerate or decelerate the driven equipment.

#### **2.2.2. Volt/Hz (V/Hz) Pattern**

- A. The Volts/Hertz (V/Hz) setting functions establishes the relationship between the output frequency and the output voltage.
- B. The Q7 drive shall be configurable to the following V/Hz patterns:
  - I. Constant Torque
  - II. Variable Torque

#### **2.2.3. Current detection / protection**

- A. The Q7 drive shall have Underwriter Laboratories approved overload protection.
- B. Programmable current detection and protection include:
  - I. Overcurrent stall setting adjustable from 0.0 to 250%
  - II. Configurable undercurrent detection and response
  - III. UL recognized speed sensitive motor FLA trip curves adjustable from 10 to 100% inverter current rating
  - IV. OL Reduction Frequencies to optimize the speed sensitive motor overload to the application/motor characteristics
  - V. Configurable overtorque detection levels, times, and reactions

#### **2.2.4. Overvoltage Stall**

- A. Overvoltage stall shall prevent faults caused by regeneration.
- B. During deceleration, overvoltage stall shall extend deceleration time when bus levels reach a user configurable level.
- C. When applied to overhauling loads, the drive shall compensate for rising dc bus levels by momentarily increasing output frequency.
- D. Two overvoltage stall levels shall allow complete configuration and control for most cyclic overhauling loads and high inertia loads.

### **2.2.5. Electronic Thermal Motor Protection**

- A. The Electronic Thermal Protection shall specify the overload current level for the motor.
- B. The value entered shall be as a percentage of the full load amps of the drive or as the full load amps of the motor.
- C. The drive contains four independently configurable electronic thermal motor protection levels.
- D. The electronic thermal motor protection level may be selected by Q7 keypad, discrete input, communication protocol, or fixed frequency.
- E. The Electronic Thermal Motor Protection is speed sensitive and adjustable for motors with speed ranges of 2:1 to 10000:1 allowing the user to optimize motor protection to suit a variety of motors and applications.
- F. The Motor 150% time limit (10 seconds to 2400 seconds) establishes a time that the motor can operate at 150% of its rated current before the drive trips.

### **2.2.6. Soft Stall**

- A. Soft Stall allows the Q7 to reduce output frequency when the current requirements of the motor exceed the motor's Electronic Thermal Protection setting.
- B. If the current drops below the motors overload protection level within the specified time, the output frequency of the Q7 will return to the commanded output frequency.
- C. Soft Stall is highly effective in preventing motor overload trips when used on fans, blowers, pumps, and other centrifugal loads which require less torque and current at lower speeds.
- D. The drive shall have two (2) frequency priority selection features.
- E. The drive shall be capable of setting both upper and lower limit frequencies.

### **2.2.7. Critical (Skip) Frequencies**

- A. To avoid mechanical resonant frequencies, the Q7 contains three programmable jump frequencies with adjustable bandwidths.
- B. The jump frequencies may be any frequency less than or equal to the programmed value of maximum frequency.
- C. The jump frequency bandwidths are independently programmable from  $\pm 0.00$  to  $\pm 20.0$  Hertz.

### **2.2.8. Ridethrough**

- A. Ridethrough mode shall allow the user to configure the Q7 to utilize motor regenerative voltages to continue operation during brief power outages.
- B. Undervoltage detection time and undervoltage stall levels are user configurable items in addition to the Q7 drive response to undervoltage conditions.

#### **2.2.9. Retry/Restart**

- A. The retry/restart drive function shall allow the Q7 drive to smoothly start a rotating load regardless of the direction of rotation.
- B. When enabled, the drive will attempt to restart after a fault.
- C. The number of attempts can be programmed up to ten (10) times.
- D. When used on applications such as remote pump stations, air moving equipment, centrifuges, and stamping machines, the Q7 drive will automatically reset and restart the driven equipment after faults such as motor overload, undervoltage, and power loss.

#### **2.2.10. Process Control (PID)**

- A. The Q7 contains an internal PID control algorithm with adjustable proportional, integral, and differential.
- B. Feedback may be configured for direct or inverse reaction and is adjustable to span. PID may be enabled via discrete input, Q7 keypad, or communications.
- C. Reaction to loss of feedback is configurable and discrete outputs may be configured to indicate loss of feedback or maximum deviation from setpoint.

#### **2.2.11. Emergency off Modes and Settings**

- A. Emergency off response is configurable to deceleration Stop, coast stop, or DC injection stop regardless of the standard stop mode.
- B. Emergency stop may be operator initiated via:
  - I. Q7 Keypad
  - II. Discrete input (multiple E-Stop inputs allowed)
  - III. Communication protocol

#### **2.2.12. Feedback**

- A. For process control purposes, the Q7 will accept feedback signals from the following:
  - I. Analog signal
  - I. Binary digital
  - II. BCD digital
  - III. Communication protocol

IV. 50% duty cycle pulse train.

#### **2.2.13. Jog**

- A. Jog frequency shall be configured for any frequency from 0.0Hz to 10Hz. Jog is initiated from an appropriately configured input terminal, Q7 keypad, or communication protocol.
- B. Jog stop method shall be configurable to coast, controlled deceleration or DC Injection.
- C. Jog shall be configured to allow reversing or only operate in a configured direction.
- D. When jog direction is reverse from direction of motor rotation, the Q7 jog function will smoothly decelerate the motor to zero then jog in the commanded direction.

#### **2.2.14. Motor Operated Pot (MOP) Emulation**

- A. MOP emulation shall allow digital momentary inputs to raise and lower speed.
- B. MOP configuration functions shall include MOP increments, MOP Loss of Power Reaction, and MOP Input Terminals.

#### **2.2.15. Override Control**

- A. Override control allows one or more analog signals to act as a trim source to a frequency command. Override may be configured as either an additive (or subtractive) input such as -5Hz to +5Hz or as a percent of frequency command. Override may be assigned to any analog input, communication option, or Q7 keypad.

#### **2.2.16. Preset Speeds**

- A. The Q7 drive shall have 15 preset speeds.
- B. Each preset speed shall have defined direction, acceleration / deceleration times and patterns and motor protective set.
- C. The preset speeds shall be selected via input terminals (using BCD selection), Q7 keypad, or communication function.

#### **2.2.17. Damper Circuit**

- A. The drive shall have damper circuit to operate both in the inverter mode and bypass mode.
- B. A discrete terminal shall be programmed to disable the system to run if the damper is not fully open.

- C. Damper status shall be conveyed to the drive via a limit switch (provided by others).
- D. The limit switch shall close when the damper is fully open and shall provide 120VAC to the damper coil.
- E. The damper coil shall energize a damper contact closure and this shall enable the system to run the drive.
- F. In both inverter and bypass mode a contactor shall be closed to energize damper motor (provided by others).

#### **2.2.18. Fire-Speed Function**

- A. The S1 input terminal function shall be used as a default for the fire-speed function.
- B. The S1 terminal shall be connected to a fire management system and shall close the contact and run the motor during a fire.

### **2.3. Operational Functions**

- A. The drive shall have the capability of storable special custom user setting.
- B. The drive shall restart into a rotating motor operating in either the forward or reverse direction and match that frequency.
- C. Automatic cooling fan control based on heat sink temperature for extended fan life.
- D. 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.
- E. The drive shall be able to act as a space heater for a motor when the system is not running.
- F. The drive shall have adjustable input and output terminal response time selections to prevent noise effects and chattering.
- G. The drive shall have a built-in control system for commercial power/inverter power switching.
- H. The drive shall have ten (10) adjustable retry functions after a fault.
- I. The drive shall have an adjustable output short circuit detection selection for standard motor and high-speed motors (very low inductance).
- J. The drive shall have four (4) motor settings and two (2) acceleration and deceleration settings.
- K. The drive shall have an analog input filter adjustment to limit the effects of noise on the control signal.
- L. The drive shall permit switching between local/remote operation as well as manual/auto “on the fly.”
- M. The drive shall be provided with “anti-windmilling” or “motor shaft stationary control”.

- N. 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:
  - 1. Run at the user set lower frequency limit
  - 2. Run at the user set upper frequency limit
  - 3. Trip with a signal loss fault
  - 4. Run at the last valid frequency signal

## 2.4. Input / Output Capabilities

- A. The standard control terminal board contains:
  - I. Eight (8) multifunctional programmable discrete inputs
  - II. Sink or source selectable (available as an option)
  - III. 'true/false' on closure software selectable
  - IV. Three (3) discrete configurable relay outputs
  - V. One (1) form 'C'
  - VI. Two (2) form 'A'
  - VII. Three (3) analog inputs with adjustable gains and bias
  - VIII. Potentiometer input
  - IX. 0-10vdc
  - X. 0-1 ma
  - XI. 4-20ma
  - XII.  $\pm 10$ vdc differential input
  - XIII. Two (2) analog outputs with adjustable gain and bias
  - XIV. One 50% duty cycle pulse train
  - XV. One to forty-three kilohertz at full scale user setting
- C. Output contacts rated at 2A / 250VAC with the exception of the FLB relay output rated at 1A / 250VAC
- D. All control terminal boards are remote mountable (up to fifteen feet) using a standard 25-conductor computer cable.
- E. The standard control terminal board contains provisions for mounting the ASD-ISO-1 option board. The ASD-ISO-1 option board provides for true analog isolation for two analog outputs and one analog input. This is carried out using precision isolation amplifiers that transmit input to output via a capacitive barrier.
- F. The drive shall accept the following frequency commands signals:
  - I. 3k $\Omega$  potentiometer (1k $\Omega$  to 10K $\Omega$  potentiometer connection also possible)
  - II. 0 to 10 VDC (Input impedance Zin:33k $\Omega$ )
  - III. 0 to  $\pm 10$  VDC (Zin:67k $\Omega$ )
  - IV. 0 to  $\pm 5$  VDC (Zin:34k $\Omega$ )

- V. 4 to 20mA ( $Z_{in}:500\Omega$ )
- VI. 15 Preset speeds
- VII. Motorized speed pot.

## **2.5. 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. The drive shall have external fault input.
- D. The drive shall be capable of re-setting faults remotely and locally.

### **2.2.5. Status Indicators**

- 1. Autotuning
- 2. Emergency Off
- 3. Retry
- 4. Restart
- 5. ST-CC Open

### **2.2.6. Alarms**

- 1. Overspeed
- 2. Input Line Loss
- 3. Output Line Loss
- 4. Overcurrent
- 5. Overheat
- 6. Overvoltage
- 7. Motor Overcurrent
- 8. Motor Overload
- 9. Undercurrent
- 10. Undertorque
- 11. Clear

### **2.2.7. Faults**

- 1. Overspeed
- 2. EEPROM Error
- 3. Ground Fault Trip
- 4. Open DC Fuse

5. Input Line Loss
6. Output Line Loss
7. Main RAM Fault
8. Main ROM Fault
9. CPU Fault
10. Communication Interrupt Fault
11. Option Device Fault
12. Main Circuit Undervoltage
13. Overcurrent (Acceleration)
14. Overcurrent (Deceleration)
15. Overcurrent RUN
16. U Phase Short Circuit
17. V Phase Short Circuit
18. W Phase Short Circuit
19. Motor Overcurrent
20. Overheat
21. ASD Overload
22. Motor Overload
23. Overvoltage (Acceleration)
24. Overvoltage (Deceleration)
25. Overvoltage (Run)
26. Control Circuit Undervoltage
27. Communication Error
28. Under Torque
29. Low Current
30. Undervoltage Trip Main Circuit
31. Undervoltage Trip Control Circuit

## 2.6. Operating Panel and Monitor Functions

- A. The **Monitor** mode allows for the monitoring of motor performance variables, control settings, and configuration data during motor operation.
- B. There are 30 items that may be monitored from this mode. The items are listed and described below.
  1. **Trip Hold Frequency** — If tripped, this field records the at-trip frequency.
  2. **Past Trip #4** — This feature reads and stores trip records and is the first of four recorded trips.
  3. **Past Trip #3** — This feature reads and stores trip records.
  4. **Past Trip #2** — This feature reads and stores trip records.

5. **Past Trip #1** — This feature reads and stores trip records and is the last of four recorded trips.
6. **Trip Code**— If tripped, this field displays the trip code (e.g., E-Stop).
7. **AM Output**— Displays the AM output as a percentage of its full range.
8. **FM Output** — Displays the FM output as a percentage of its full range.
9. **RX2 Input** — Displays the RX2 input as a percentage of its full range.
10. **RX Input** — Displays the RX input as a percentage of its full range.
11. **VI/II Input** — Displays the VI/II input as a percentage of its full range.
12. **RR Input** — Displays the RR input as a percentage of its full range.
13. **Direction** — Displays the Forward/Reverse status.
14. **Peak Current** — Shows the highest current level achieved since the last startup or reset. This value is displayed as a percentage of the full rating of the ASD.
15. **Kilowatt Hours** — Displays accumulated Kilowatt hours. Read at 2-hour intervals.
16. **Output Power** — Shows the instantaneous output power level of the ASD.
17. **Input Power** — Shows the instantaneous input power level to the ASD.
18. **ASD Load** — Shows the instantaneous load placed on the ASD.
19. **Motor Load** — Shows the instantaneous motor load requirements.
20. **ASD Overload Ratio** — Displays the relationship of time to the magnitude of the ASD overload as a ratio. A higher overload means a shorter run-time in this condition.
21. **Motor Overload Ratio** — Displays the relationship of time to the magnitude of the motor overload as a ratio. A higher overload means a shorter run-time in this condition.
22. **PID Feedback** — Displays the instantaneous PID feedback value.
23. **Post Compensation Frequency** — Displays the output frequency of the ASD after the application of the waveform adjustment compensation for changes in the input voltage.
24. **Run Time** — Displays the accumulated run-time since the last reset or power up of the ASD.
25. **Output Terminals** — Shows the active discrete output terminals.
26. **Input Terminals** — Shows the active discrete input terminals.
27. **Output Voltage** — Shows the instantaneous output voltage as a percentage of the rating of the ASD.
28. **DC Voltage** — Shows the instantaneous DC bus voltage as a percentage of the rating of the ASD.
29. **Output Current** — Shows the instantaneous output current of the ASD.
30. **Frequency Command** — Displays the current frequency command.

- C. The **Monitor** mode is a read-only mode.
- D. The settings cannot be changed from the Monitor mode.
- E. The drive's thirteen (13) key touchpad shall be NEMA 1 rated.
- F. The drive's keypad shall be capable of being extended fifteen (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.

## **2.7. Standard Optional Features**

- A. 12-pulse diode rectification for maximum harmonics attenuation shall be available for 460V drives above 60hp and 230V drive: 30-150hp.
- B. Pneumatic interface (3-15psi).
- C. Isolated input and output using signal isolator board, ASD-ISO-1.
- D. All drives regardless of size/voltage should have isolated bypass capability as an available option.
- E. DC link and Line Reactors.

## **2.8. Communication options to include:**

- A. Metasys, N2 Interface
- B. Landis-Staefa, P1 Interface
- C. Modbus RTU

## **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 CD.