AS3

Engineering Specification

PART 1 – GENERAL

1.1 Scope

This specification shall cover Toshiba AS3 low voltage AC, Adjustable Speed Drives (ASD's). All specifications within apply except where noted.

1.2 References

The drive shall comply with the following:

A. National Electric Manufactures Association (NEMA) Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
B. National Electrical Code (NEC2008, NFPA 70).
C. International Electrical Code. (IEC 146 ,CE mark)
D. Japanese Standards Association (JIS C60068-2-6).
E. Underwriters Laboratory approval (UL & cUL)

1.3 Qualifications

1.3.1 Manufacturer History

The manufacturer shall not have less than 20 years of experience in ASD manufacturing.

1.3.2 Certification

The manufacturer of the drive shall be ISO 9001 and ISO 14001 certified manufacturing facility.

1.3.3 After Sales Support

Service and support shall be available either directly from the manufacturer or from a network of factory trained distributors and certified service centers located throughout North America

1.3.4 Motor Drive Compatibility

The manufacturer shall produce both AC drives and motors at the same location. This will allow for close coordination of the design of both pieces of equipment and a better resultant motor drive package.

PART 2 – VARIABLE FREQUENCY DRIVES

2.1 General

A. This specification covers AC adjustable speed drives for industrial applications.

2.2 Design Criteria

2.2.1 General

A. Overall hardware design shall be for maximum flexibility, robustness, serviceability, and reliability.
B. Power Terminations shall be oversized for the drive current rating to allow for flexibility and ease of connection on all power terminations.
C. All ratings shall contain a minimum of two ground termination points.
D. Power Terminations shall be clearly labeled with both the US (NEMA) standards (L1, L2...T2) and IEC standards (R, S…W).
E. The drive shall employ the latest technology in packaging, heat sink design, and cooling to minimize overall size and weight without degrading performance or functionality.
F. Standard drive enclosure shall be rated UL Type 1 on smaller frame sizes. Larger units shall be IP00 with an optional conduit kit to meet requirements for UL Type 1.
G. The drive shall be capable of mounting with the heat sink external to the cabinet or panel on which the drive is mounted (heat-sink-out-the-back).
    1. Mounting shall require an optional flange kit.
    2. External heat sink portion of the ASD shall be rated IP55.
    3. External mounting shall remove roughly 90% of heat loss from the enclosure.
H. Power Semiconductor heat sinks contain one or more thermal sensors monitored by the Microprocessor to prevent semiconductor damage caused by excessive heat or fan loss.
I. All frame sizes of the drive shall come with an electronics operator interface (EOI) and standard customer terminal strip.
J. Conformal coating shall be used on the critical areas of the printed circuit boards.

2.2.2 Environment

The drive shall be capable of operating in the following ambient conditions without de-rate:
A. Ambient temperature: -10 to +50 °C (60° C with de-rate).
B. Not to be exposed to direct sunlight.
C. Environment to be free of corrosive and explosive gasses.
    a. However, frame sizes A1 to A6 are rated for the following conditions.
        i. Chemical pollution resistance class 3C3 conforming to EN/IEC 60721-3-3 Ed. 2
        ii. Dust pollution resistance class 3S3 conforming to EN/IEC 60721-3-3 Ed. 2
D. Relative humidity: 5 to 95% non-condensing. (IEC 60068-2-3)
E. Elevation Limits:
    a. 1000 meters (3300 ft.) without de-rate.
    b. 3000 meters with a current de-rate of 1% per 100 meters above 1000 meters.

c. 2000 meters with a corner grounded distribution system.

F. Shock: 5.9m/s^2{0.6G} or less (10 to 55 Hz).

The drive shall not suffer any adverse effects from long term storage in the following ambient environmental conditions:

A. Ambient temperature: -25 to +65 °C
B. Relative humidity: 5 to 98% non-condensing
C. Elevation: to 5000 meters

2.2.3 Input Power

A. The drive main input power shall be rated:
   1. Three-phase 200 – 240VAC 50/60Hz
   2. Three-phase 380 – 480VAC 50/60Hz
B. The drive shall have an input voltage tolerance of ± 10% of rated input voltage (-15% with de-rate)
C. The drive shall have an input frequency tolerance of ± 5% of rated input frequency.
D. The efficiency of the drive shall be a minimum of 97.0% at full load at full speed.
E. The drive shall have a displacement power factor greater than 0.95 (lagging) over the entire speed range.

2.2.4 Converter Section (Input)

A. On smaller frame sizes, the drive employs a full three phase diode bridge rectifier to convert input AC power to DC. This arrangement will make use of a soft charge resistor and contactor to prevent excessive inrush current on the DC bus
   i. 240V drives: Up to and including 20Hp (HD)
   ii. 480V drives: Up to and including 25Hp (HD)
B. On larger frame sizes, a hybrid SCR/Diode front end is used. These units shall be soft charged via control of the SCRs.
   i. 240V drives: Up to and including 75Hp (HD)
   ii. 480V drives: Up to and including 450Hp (HD)
C. The drive input shall be insensitive to input phase sequence.
D. The drive shall have an input phase loss fault that may be defeated if desired.
E. Drive shall be capable of operating at reduced capacity in the event of the loss of an input phase.
F. Semiconductors on all ratings are sized (current) to allow full operation and overload capabilities at minimum input voltage.
G. PIV Ratings of the rectifier diodes shall be as follows:
   1. 240V drives—rectifier minimum PIV rating of 800V
   2. 480V drives—rectifier minimum PIV rating of 1600V
H. An isolation transformer shall not be required for operation on most standard distribution systems.
I. The converter section is usable on either 50 Hz or 60 Hz distribution systems.

2.2.5 DC Bus Section

A. Overall DC Bus design is passive capacitive filter or a capacitive and inductive filter to minimize ripple and maximize power-loss ride-through.
B. The DC bus voltage and current are monitored by the control section to prevent damage to either the drive or the driven equipment.
C. The DC bus connections shall use tin plated copper bus bar.
D. The drives shall have the following bus capacitance voltage ratings:
    1. 240V drives—400 VDC (minimum)
    2. 480V drives—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 use power transistors or time delay relays.
G. The DC Bus Section has complete power terminations to allow:
    1. Rectifier Isolation (positive side)
    2. Line regeneration using third party units
    3. DC Link inductor
    4. Common DC bussing applications
    5. DC input
H. A readily visible LED shall indicate when DC voltages are present on the bus.
I. To allow dissipation of regenerated energy, the drive shall feature a built in, microprocessor controlled, dynamic braking transistor on small and medium frame sizes. Larger frame sizes will offer the dynamic braking transistor as an option adder. Refer to the table below for details. The dynamic braking transistor is an IGBT power semiconductor that is sized to allow 100% motor braking torque when connected to an appropriately sized resistor.

Voltage	Included	Option
230V	1/2 HP(HD)-60HP (ND)	60HP(HD)-100HP(ND)
480V	1HP(HD)-125HP(ND), 250HP(HD), 350HP(ND)	125HP (ND)-250HP (ND), 300HP(HD)-500HP(ND)

J. The dynamic braking transistor shall be protected from damage due to excessive currents by the microprocessor.

2.2.6 Inverter Section (output)

A. The inverter section shall make use of the latest generation of trench non-punch through IGBT power switching transistors to convert DC voltage to a three-phase, variable voltage, variable frequency, and sinusoidal coded PWM waveform.
B. IGBT initialization testing shall be performed by the control section on each power up.
C. The inverter section shall not require commutation capacitors.
D. The drive shall have software and hardware designed to limit reflected wave caused by long motor cable lengths.
E. The drive IGBT ratings will be as follows:
    1. 240V drives – IGBT minimum Vce rating 600V.
    2. 480V drives – IGBT minimum Vce rating 1200V.

F. The drive's output inverter section shall output a Pulse Width Modulated (PWM) square wave. The Drive shall be capable of modulating the pulses of this square wave to control the root mean square voltage and frequency applied to the motor.
G. The PWM square wave output shall have an adjustable switching frequency (carrier frequency) that may be adjusted to allow the reduction of audible noise and improvement in operations.
H. All IGBTs shall have reversed biased diodes (free-wheeling) to prevent IGBT failure when subjected to motor discharge spikes.
I. All inverter section IGBTs must be sized to allow the drive to operate at the following conditions.

	Continuous Current	Current OL for 60 Seconds	Current OL for 2 Seconds
Heavy Duty	110%	150%	180%*
Normal Duty	105%	120%	135%

* 165% for frames A7 & A8

J. The inverter section shall be capable of sensing and interrupting a phase-to-phase or phase-to ground fault on the output of the drive.
K. The output voltage shall be adjustable from 0 to rated input voltage. The output frequency range shall be adjustable for a maximum frequency output of 590 Hz.

2.2.7 Control Section

A. The control section of the drive shall provide complete operational control of the application while also offering monitoring and protection of the drive itself
B. The drive shall attempt to protect itself from damage and fault conditions in any situation regardless of end user programming.
C. The drive shall employ the latest algorithms to operate a variety of applications in either constant or variable torque modes using the following Volts/Hertz control modes.
   i. Constant torque
   ii. Variable torque
   iii. Automatic torque boost
   iv. Energy Savings
   v. Dynamic energy savings (for fan and pump)
   vi. Control for a permanent magnet (PM) motor
   vii. A user programmable, 5 point V/F pattern
   viii. Sensor-less vector control based on current vectors
   ix. Sensor-less vector control based on voltage vectors
   x. PG feedback vector control based on current vectors
   xi. PG feedback vector control based on voltage vectors
D. The drive shall employ two 32 bit microprocessors of the latest industrial design.
   1. The first microprocessor shall be dedicated solely to controlling the output waveform and power performance of the drive.
   2. The second microprocessor shall be used to provide expanded application and control options for the standard drive.
E. The microprocessor logic circuits shall be isolated from power circuits.

F. Where switching logic power supplies are utilized, they shall be powered from the DC bus section of the drive and not from input AC power.
G. Microprocessor diagnostics are performed (on application of power) to prove functionality and viability of the microprocessor.
H. Memory cyclic redundancy check (CRC) shall be performed on each application of power to confirm the integrity of EEPROM and UVPROM memories.
I. The drive shall be capable of being configured to perform motor diagnostics at operation or when power is applied to prevent damage to the drive due to a grounded or shorted motor. This feature may be disabled when using a low impedance motor.
J. Operating system firmware shall be capable of 'flash' upgrading shall enhancements to the operating system firmware become available.
K. All drive ratings shall be equipped with four RJ45 ports:
    1. 2-wire RS485 communication connector 1 – Connected beneath the standard drive keypad, this port is the primary connection point for external options.
    2. 2-wire /4-wire RS485 communication port – For customer communication directly to the control section of the drive and drive software
    3. Two Ethernet ports – For Modbus TCP functions and Ethernet/IP functions, including Embedded Web Server

2.2.8 Electronics Operator Interface (EOI)

A. The Drive shall be supplied with a standard keypad style EOI that may be used for programming, monitoring and operation of the drive
B. The EOI shall consist of a full-English LCD display along with input buttons and a touch wheel for navigation and control
C. For security, the EOI functionality and access may be limited and password protected preventing an unauthorized user from accessing parameters, functions, or monitoring.
D. The drive shall not require the keypad for normal operations when control is via the standard terminal strip or communications.
E. The EOI Programming section shall provide quick access to the most commonly used drive parameters while allowing access to all programming points in the drive via extended parameters functionality.
F. The drive EOI shall employ and easy programming mode which can be used to limit programming options to the most commonly used parameters within the drive for quick setup of the ASD.
G. The EOI shall allow the user to modify and add parameters to the easy programming list to customize the drive for specific applications.
H. The EOI monitoring section shall allow real time monitoring of the following details of the drive
    1. Direction of rotation
    2. Digital and analog input & output terminal status
    3. Information on the four most recent faults.
    4. Cumulative run timer (resettable)
    5. Number of starts
    6. Maintenance alarm
    7. Output frequency
    8. Frequency command

9. Output current
10. Input voltage (DC Detection)
11. Output voltage
12. Compensated frequency
13. Speed feedback
14. Torque
15. Torque command
16. Torque current
17. Exciting current
18. PID feedback value
19. Motor & inverter overload factors
20. Braking resistor load and overload factor
21. Input & Output power
22. Pattern run information
23. Signed data for output frequency, torque and current

I. The EOI shall store the most recent eight faults in memory.
J. The Drive EOI shall retain the full monitor information from the drive at the time of each fault.
K. The EOI shall allow the user to control operation of the ASD (start/stop and frequency set-point).
L. Optional cable and mounting kit for the Drive shall allow for remote mounting of the keypad on panels or at remote sites.
M. EOI shall show QR codes accessible via "-i-" button for drive fault, parameter information, and warranty registration, which will provide immediate access to a dedicated web link for support and maintenance.
N. EOI shall be capable of multiple languages.
O. EOI shall utilize a programmable real time clock.
P. EOI shall have the ability to adjust contrast settings.
Q. EOI shall have an automatic time out adjustment setting.
R. By default, EOI shall turn red when drive faults.
S. EOI shall have trip resolution methods available on the screen when drive faults.
T. EOI shall have a "Copy" function for saving parameters to drive or keypad.

2.2.9 Control Terminal Strip

A. The standard control terminals strip (CTS) shall contain all necessary terminals for complete control and monitoring of the drive during typical operation.
B. The CTS shall make all control wiring on the drive, as well as any optional control devices, accessible via a single access panel.
C. The CTS shall mount using a single retained screw.
D. The CTS shall, at a minimum, contain the following terminals:
   1. Eight multifunction digital (discrete) inputs independently configurable for any of 84 functions.
      a. Sink or source logic selectable.
      b. Normally open/closed operation selectable via software.
      c. S4/S5 shall have PG feedback ability

2. One multifunction, discrete, form C, relay contact output programmable to any of 111 functions.
   a. Normally open/closed operation selectable via software.
   b. Contacts rated for 250VAC, 2A or 30VDC, 1A.
3. Two multifunction, discrete, form A, relay contact outputs programmable to any of 111 functions.
   a. Normally open/closed operation selectable via software.
   b. Contacts rated for 250VAC, 2A or 30VDC, 1A.
4. One 0-10VDC analog input, internal impedance shall be 31.5kΩ.
5. One multifunction, 4– 20mA analog input. Internal impedance shall be 250Ω.
6. One 0-±10VDC analog input. This terminal shall be capable of bi-directional input commands; internal impedance shall be 31.5kΩ
7. Two 0 – 10Vdc or 4 – 20mA, software selectable analog outputs, programmable to any of 162 functions.
8. One 24VDC power supply output.
9. One 24VDC power input for connecting external control power supply option
10. One 10VDC power supply output.
11. Two Safe-Torque-Off (STO) function inputs that comply with safety standard IEC61800-5-2.
12. One open collector, multifunction digital/pulse train output
    a. 24VDC-50mA
    b. Pulse train output up to 30 kpps, 50% duty cycle

E. Standard CTS shall have the option to add extra terminals using clip-in-place option cards.

2.3 Functionality

2.3.1 Acceleration and Deceleration

A. The drive shall contain four sets of independently configurable acceleration/deceleration times.
B. Each set shall be configurable as to both acceleration and deceleration time and pattern.
C. Acceleration and deceleration times are adjustable from 0.01 seconds to 6000 seconds
D. Available acceleration and deceleration patterns are:
   1. Linear
   2. S-Curve 1
   3. S-Curve 2 (over-speed curve)
E. The patterns allow for the user to develop and customize application-specific patterns.
F. The drive shall have four different acceleration/deceleration times. It shall be possible to switch between these sets via discrete input, electronics operator interface, communications options or on a pre-defined user selectable output frequency.
G. An automatic acceleration/deceleration selection shall be made available. This function shall automatically adjust the acceleration and deceleration time of the unit for maximum performance.
H. The drive shall incorporate over-voltage stall and over-current stall settings, in the acceleration and deceleration times, to prevent damage to the driven equipment. Shall acceleration or

deceleration settings exceed the ability of the motor to accelerate or decelerate the driven equipment the drive shall automatically adjust the times.

2.3.2 Braking

A. The drive will have, either built in or as an option adder, an IGBT transistor for dynamic braking. The braking transistor shall be controlled by the drive's microprocessor based control system and allows, with the addition of an optional resistor, an economical means of rapidly stopping a high inertia load with up to 100% braking torque.
B. The braking transistor, braking resistor, and associated circuitry shall be fully protected by adjustable protection parameters.
C. In addition to dynamic braking, the drive shall be capable of injecting a DC current into the motor stator to aid in slowing the motor. This braking method shall be available in either normal or emergency stopping modes.
D. The drive shall be capable of over-fluxing the motor stator to provide up to 30% braking.

2.3.3 Control modes

A. The adjustable speed drive shall have two distinct modes of operation:
    1. Speed control as V/Hz, sensor-less vector, or feedback vector.
    2. Torque control, both sensor-less vector and feedback vector.
B. The drive shall have the ability to switch between modes of operation while running.

2.3.4 Current Detection and Protection

A. Programmable current detection and protection include:
    1. Over-current stall adjustable from 10 to 200% in Heavy Duty (HD) mode, and 10 to 160% in Normal Duty (ND) mode.
    2. Configurable undercurrent detection and response.
    3. UL recognized, speed sensitive, motor overload trip curves adjustable from 10 to 100% of drive Current rating.
    4. Motor 150% OL time limits adjustable from 10 to 2400 seconds.
    5. Overload reduction frequencies to optimize the speed sensitive motor overload to the application & motor characteristics.
    6. Configurable over-torque detection levels, times, and reactions.

2.3.5 Critical (skip) Frequencies

A. To avoid mechanical resonant frequencies, the drive shall have programming for three programmable critical or skip frequencies.
B. The jump frequencies may be any frequency less than or equal to the programmed value of maximum frequency.
C. The jump frequencies shall have a user selectable bandwidth of 0 to 30 Hz.

2.3.6 Drooping Control

A. The drive shall have a Drooping Control, also called Load Sharing, algorithm that may be used to evenly share the load among multiple motors that are mechanically coupled to a common load.
B. The drive shall have drooping parameters that allow the user complete control over drooping gain, speed droop and multiple load levels, drooping filters, and drooping torque range.

2.3.7 Process Control (PID)

A. The drive shall have two internal and external proportional, integral and derivative (PID) control algorithms.
B. Feedback for the PID algorithm shall be configurable for direct or inverse reaction.
C. The drive shall be capable of accepting either a 4-20mA or a 0-10V feedback signal from an external device.
D. The drive shall be capable of operating full time in PID mode or PID may be enabled via discrete input, Electronic Operator Interface, or communications protocol.
E. A discrete output terminal shall be able to be configured to indicate maximum deviation from set-point.

2.3.8 Electronic Thermal Motor Protection

A. The drive shall have four independently configurable electronic thermal motor protection levels. These levels will allow the drive to trip based on a motor current that, while less than the drives maximum current is greater than the motor's maximum current.
B. The electronic thermal motor protection level may be set by the Electronic Operator Interface, discrete input, communication protocol, or fixed frequency.
C. The Electronic Thermal Motor Protection shall be speed sensitive and adjustable for motors with speed ranges of 2:1 to 10000:1.
D. The Electronic Thermal Motor Protection levels shall have configurable 150% motor FLA time limits allowing the user to adjust the I^2T protection slope.
E. Correctly setting the electronic thermal motor protection level shall allow the drive to be used as a UL class 10 motor overload protection device.
F. The drive overload protection shall be capable of automatically de-rating the overload trip point when the unit is operated at a low speed.

2.3.9 Emergency-Off Modes and Settings

A. Emergency off response shall be configurable to deceleration stop using the currently assigned deceleration time or another deceleration time, coast-to-stop or stop using DC injection braking.
B. Emergency stop shall be operator initiated via:
    a. EOI
    b. Discrete input (multiple E-OFF inputs allowed)
    c. Communication protocol

2.3.10 Jog

A. The drive shall have an option for jog run which will allow the motor to run in a specified direction, at a low speed for positioning or initial setup of equipment.
B. Jog may be initiated from an appropriately configured input terminal, Electronic Operator Interface, or via communication protocol.
C. Jog frequency may be configured for any frequency from 0.0Hz to 20Hz.
D. Jog stop method shall be user configurable to coast, controlled deceleration or DC Injection.

2.3.11 Motor Operated Pot (MOP) Emulation

A. The drive shall have a built in motor operated pot (MOP) emulation that allows discrete momentary inputs to raise or lower speed, a third input may be assigned to clear speed input.
B. MOP configuration functions include, user-set MOP speed increments, user-set loss of power response, and MOP input terminals.

2.3.12 Override Control

A. The drive shall have a built in override control which allows one or more analog signals to act as a trim source to a frequency command.
B. Override may be configured as either an additive input, which may add or subtract frequency from a primary frequency reference, or as a multiplicative input which adds or subtracts frequency as a percentage of the primary reference and the given input.
C. Override shall be assigned to any analog input, communication option, or Electronic Operator Interface.

2.3.13 Over-voltage Stall

A. The drive shall have the capability of performing an over-voltage stall to prevent faulting caused by too rapid a deceleration.
B. During deceleration, over-voltage stall shall extend deceleration time when the DC bus voltage reaches a user configurable level.
C. The drive shall have the ability to mitigate regenerative energy caused by cyclic overhauling loads. The drive will compensate for rising DC Bus levels by momentarily increasing output frequency.

2.3.14 Preset Speeds

A. The drive shall be capable of accepting a frequency command via a discrete input. This input will cause the drive to run at a user selectable preset speed.
B. The drive shall be capable of operating at any of 31, user selectable preset speeds using 5 discrete input terminals in a binary count arrangement.
C. Each preset speed may have different, user defined, direction, accel/decel times (1 of 4) and patterns, and motor protection characteristics.

2.3.15 Ride-through

A. The drive shall be capable, in the event of a power failure, of using the inertial energy of the motor rotor and driven equipment to maintain control power.
B. In the event of a power failure of not more than 10 cycles, the drive shall be capable of maintaining normal operation without interruption.
C. The drive shall have a user-selectable under-voltage stall level.
D. After either a loss of power or an under-voltage stall, the drive shall have the ability to synchronize its restart and acceleration with other driven equipment.

2.3.16 Retry/Restart

A. The drive shall have the ability to automatically restart on non-critical faults.
B. The drive shall have a user-selectable number of retry attempts, with a maximum of 10 attempts.
C. If the drive fails to restart after all attempts, the unit will shut down and provide fault indication.

2.3.17 Soft Stall

A. For variable torque loads, the drive shall have the ability to reduce the output frequency to the motor in the event of a current which exceeds either the settings of electronic thermal motor protection setting or the drive's rated full load amps.
B. If the current demand of the application drops to a nominal level within a specified time, the output frequency shall return to the commanded output frequency.

2.3.18 Torque Limiting

A. In order to prevent damage to driven equipment in the event of high torque, the drive shall have the ability to limit the maximum torque which the motor can develop.
B. The drive shall have user selectable torque limits from 0 to 250% of rated motor torque.
C. The drive shall have separate, user selectable torque limits for both positive and negative torque operations.
D. The torque limits may also be set dynamically by using one of the analog inputs on the drive control terminal strip, the electronics operator interface, or via communications.

2.3.19 Torque Control Mode

A. The drive shall have the ability to accept and maintain a set-point for torque rather than speed.
B. When operating in the "torque mode" the drive shall be capable of accepting a torque command from either the electronics operator interface, digital or analog inputs on the standard control terminal strip or communication protocol.
C. The drive shall have separate settings for maximum speed while operating in Torque mode to prevent the motor from running away.
D. The drive shall be capable of switching from speed control mode to torque control mode via a digital input on the standard control terminal strip. The drive shall be capable of switching from speed to torque mode or vice versa without stopping the motor.

E. When the drive is operating in torque control mode, the motor speed will be variable and it is not possible to control the motor speed precisely in this mode.

2.3.20 Vector Motor Modeling

A. The drive shall make use of the latest in vector control technologies. The drive shall have vector control algorithms for both open loop vector control and vector control which makes use of a pulse train feedback from a PG encoder on the motor shaft.
B. The drive shall use a mathematical model of the connected motor.
C. The motor parameters may be adjusted by the user
D. The drive shall also use an internal auto-tune algorithm to detect motor parameters and create a more accurate motor model for use in vector control topologies.
E. The drive shall use both a current vector control algorithm as well as a voltage vector control algorithm.
   1. The current vector control algorithm shall be used on single motor applications where the motor is the same size as the drive.
   2. The voltage vector control algorithm can be used on multiple motor applications and applications where the motor is significantly smaller than the drive.

2.3.21 Application Specific Parameters

A. The drive shall contain a number of parameters specific to various industrial applications.

2.3.22 Logic operator

A. The drive shall have parameters for basic logic operations and comparison. These operators shall function in such a way as to allow the drive to be operated similar to a small programmable logic controller.
B. The parameters shall include basic digital logic operations; AND, OR, ST, SET, RESET
C. The parameters shall include comparison Operations >, <, ≥, ≤, ≠.
D. The drive shall also have available, 2 counters and 5 timers.
E. All logic operator parameters shall be integrated with the drives internal registers and control terminal strip. Allowing for monitoring of internal conditions as well as inputs and outputs on the CTS.

2.3.23 Calendar Function

A. The drive shall utilize the real time clock to operate the Calendar function.
B. Current time shall be set by parameters.
C. Time zone, daylight savings, and holidays shall be set by parameters.
D. The Drive shall have Event time stamp functions.

2.3.24 Pump Control Function

A. Drive shall control multiple pump motors allowing for saved power of the water pump system.

B. Drive shall control multiple pumps via digital outputs, RS485 communication, or Ethernet communication.

2.3.25 Permanent Magnet (PM) Motor Control

A. Drive shall be able to control Permanent Magnet (PM) motors.
B. Drive shall have parameters to properly set up and run PM Motor.

2.3.26. Position Control Function

A. Drive shall have built-in positioning control function to make the motor stop at a commanded position.
B. Drive shall make calculations to ensure difference between number of command pulses and number of feedback pulses equals zero.

2.4 Protection

2.4.1 Status Indicators

The drive EOI shall have indication for the following conditions:

- Auto-tuning
- Communication abnormality
- DC Braking
- Deceleration stop at power failure
- Display digits overflow
- Easy Mode
- Emergency Off
- Fire speed run/Forced run
- Forward Jog
- Forward/Reverse search
- Initialization
- Lower Limit
- Motor shaft fixing
- Password
- Password failure
- Regional Setting
- Reset command acceptable
- Retry
- Restart
- Reverse Jog
- Run Sleep
- Servo lock
- Standby

- Upper Limit

2.4.2 Alarms

The drive EOI shall have alarm indication for the following alarms. In addition, the drive shall allow one of the digital outputs to be programmed to change state upon an alarm condition.

- STO Activated
- Under-voltage
- Retry
- Point Setting Alarm
- Clear Enabling Indication
- Emergency Stop enabling indication
- Setting Error Alarm
- DC Braking
- Shaft Fixing in Control
- Panel Indication Overflow
- Initialize
- Auto-tuning
- Lower Limit Time-out Stop
- Momentary Power Loss Slowdown
- Tuning Error
- Over-current Pre-alarm
- Over-voltage Pre-alarm
- Overload Pre-alarm
- Overheat Pre-alarm
- Communication Error
- Panel Disconnection
- Key Failure
- Analog input disconnection
- Control power option

2.4.3 Faults

The drive EOI shall clearly annunciate the following fault conditions. In addition, one of the drive digital outputs shall be factory set to change state upon a fault condition.

- Over-current (Acceleration)
- Over-current (Deceleration)
- Over-current (Run)
- Over-current (U-phase arm)
- V-phase Short Over-current (V-phase arm)
- W-phase Short Over-current (W-phase arm)
- Over-current (load side at start)

- Over-current (Braking resistor)
- Overheat
- External thermal trip
- Overload (inverter)
- Overload (motor)
- Overload (Braking resistor)
- Overload (IGBT)
- Over-voltage (Acceleration)
- Over-voltage (Deceleration)
- Over-voltage (Run)
- Over-torque
- Over-torque/over-current
- Low Current Operation
- PTC Failure
- STO circuit fault
- Under-voltage
- Emergency Off
- EEPROM fault Initial Read Error
- Grounding Fault
- Output phase loss
- Input phase loss
- Rush current suppression relay fault
- RAM fault
- ROM fault
- Braking unit internal fault
- CPU Communication
- CPU fault
- Communication Time-out of Braking unit
- Communication Time-out (Embedded Ethernet)Communication Time-out (RS485)
- Communication Time-out (option)
- Gate Array Fault
- Current Detector fault
- Control power option failure
- Optional Unit Fault
- Auto-tuning error
- Motor Constant Setting Error
- Inverter Type Error
- Analog Input disconnecting
- Sequence Error
- PG Encoder Error
- PM control error
- Abnormal Speed Error
- Terminal Input Error
- Abnormal CPU2

- Embedded Ethernet fault
- V/f Control Error
- Battery of panel failure
- Cooling fan fault
- CPU1 Fault
- CPU2 Fault
- Abnormal Logic Input Voltage
- Option fault (slot A)
- Option fault (slot B)
- Option fault (slot C)
- Stop Position Retaining Error
- Brake answer error
- Servo lock error
- GD2 auto-tuning error
- Preparation signal cut during position control
- Position detection upper limit excess

2.4.4 Fault Tracing

The ASD shall have the ability to store up to 10 seconds worth of data on up to four monitor items. The data can be stored in the ASD memory on either a trip or on an input trigger. Stored data can be read back via drive software for integral fault tracing and troubleshooting.

2.5 Software and Communication

2.5.1 Programming Software

The drive manufacturer shall offer a Windows® based programming software that provides the same functionality as the EOI with additional capabilities for data logging, trending, storing and restoring multiple parameter sets.

Cascading windows shall allow a user interface similar to the look and feel of the EOI while allowing direct parameter access. Trending and monitoring functions shall allow up to five items to be graphically displayed on a standard trend chart and logged to a historical data file for future reference.

Computer requirements to run the software are: (at minimum)

- The software shall be capable of running on any standard PC using Windows 98®, XP®, Vista®, 8® or 10®.

2.5.2 Communications

The drive shall be capable of complete control, monitoring and programming via any one of the following industrial communications protocols.

- RS485 (2 or 4 wire Embedded)
- CANopen
- DeviceNet™
- EtherCAT
- PROFIBUS DP
- PROFINET IO
- Modbus® TCP/IP (Embedded)
- Modbus® RTU (Embedded)
- Ethernet/IP (Embedded)
- Toshiba Serial Bus (TSB) protocol

2.5.3. Embedded Web Server

The drive shall have a built-in Web Server function utilizing the embedded Ethernet. Web server must have login and password administration, and can be managed remotely from a PC, smart phone, or tablet.