Sample Specification

Adjustable Speed Drive (ASD)
For constant torque applications with normal duty load requirements

1HP to 550HP from 208VAC to 480VAC

2HP to 150HP at 600VAC

Part 1 – General

1.01 Description

A. This specification describes an AC Adjustable Speed Drive (ASD) used to control the speed/torque of a NEMA Design B induction motor. The Drive must provide a V/Hz, Sensorless Vector and Flux Vector mode of operation.

B. The Drive shall be manufactured by a firm with at least ten (10) years experience in the production of this type of equipment.

1.02 Quality Assurance

A. The Drive manufacturing facility shall be ISO 9001:2000, ISO 14001: 2004 and OSHAS 18001: 1999 certified.

B. The ASD shall be UL listed, cUL Canadian UL listed, and comply with EMC Directive 89/336 EEC, Low Voltage Directive 73/23 EEC and Machinery Directive 98/37 EC in accordance with the European Union's CE directive.

C. All printed circuit boards shall be completely tested and burned-in before being assembled into the completed Drive. The Drive shall then be subjected to a preliminary functional test, minimum one (1) hour burn-in and computerized final test. The burn-in shall be at 104°F (40°C), at full rated load, or cycled load. Drive input power shall be continuously cycled for maximum stress and thermal variation.

D. The Drive shall utilize efficient IGBT technology throughout the entire Drive manufacturer's Power and Voltage range.

E. The Drive shall utilize the same communications architecture for high-speed connectivity throughout the entire Drive manufacturer's Power range.

F. The Drive manufacturer shall have an analysis laboratory to evaluate the failure of any component. The failure analysis lab shall allow the manufacturer to perform complete electrical testing, x-ray components, and decap or delaminate components and analyze failures within the component.

G. The Drive shall utilize surface mount technology in the manufacturing of internal printed circuit boards and electronics, for maximum performance and reliability.

1.03 Submittals

A. The Submittals shall include the following information:

1. Product Overview
2. Dimensional Drawings
3. Submittal Schedule
4. Power Drawings
5. Connection Drawings
6. Engineering Data including Weight

7. Clarifications and Exceptions
8. Rating Tables
9. General Notes
10. General Terms and Conditions
11. Compliance to IEEE 519 - Harmonic analysis for a particular jobsite including Total Harmonic Current Distortion, (THD) Current; Total Harmonic Voltage Distortion, (THD) Voltage; and Total Demand Distortion (TDD).
    a. The Drive manufacturer shall provide calculations, specific to this installation, showing (TDD), at the Point of Common Coupling (PCC), is less than required. Input line filters shall be sized and provided as required by the Drive manufacturer to ensure compliance with IEEE standard 519-1992, IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems. The acceptance of this calculation must be completed prior to Drive installation.
    b. Prior to installation, the Drive manufacturer shall provide the estimated (THD) caused by the Drive. The results shall be based on a computer aided circuit simulation of the total actual system, with information obtained from the power provider and the user.
    c. If the (TDD), at the (PCC), exceeds required levels, the Drive manufacturer is to recommend the additional equipment required to reduce the (TDD) to an acceptable level.

Part 2 – Products

2.01 Adjustable Speed Drives (ASD)

A. The Drive shall be solid state, with a Pulse Width Modulated (PWM) output. The Drive shall be a Sensorless Vector AC to AC converter utilizing the latest insulated gate bipolar transistor (IGBT) technology. The Drive shall employ a Sensorless Vector inner loop torque control strategy that mathematically determines motor torque and flux. The Drive must also provide an optional operational mode for V/Hz or closed loop Flux Vector Operation.

B. Ratings

1. The Drive shall be rated to operate from 3-phase power at 208VAC to 600VAC, +10% /-15%, 48Hz to 63Hz. The Drive shall employ a full wave rectifier to prevent input line notching and operate at a fundamental (displacement) input power factor of 0.98 at all speeds and nominal load. The Drive efficiency shall be 98% or better at full speed and load. An internally mounted AC line reactor or DC choke shall be provided to reduce input current harmonic content, provide protection from power line transients such as utility power factor correction capacitor switching transients and reduce RFI emissions. When a DC choke is utilized it shall be of swinging choke design to mitigate harmonics substantially more than conventional choke designs and shall provide equivalent to a 5% impedance.
2. The overvoltage trip level shall be a minimum of 30% over nominal, and the undervoltage trip level shall be a minimum 35% under the nominal voltage.
3. Output voltage and current ratings shall match the adjustable frequency operating requirements of standard 200-575VAC, 3ph, 60Hz, NEMA Design B motors. The short term normal duty overload current capacity shall be 110% of rated current for one (1) minute out of ten (10) minutes. The short term heavy duty overload current capacity shall be 150% of rated current for one (1) minute out of ten (10) minutes and peak overload capacity shall be 180% for two (2) seconds out of each minute with an instantaneous overcurrent trip at 350% or higher. Output frequency shall be adjustable between 0Hz and 500Hz. Operation above motor nameplate shall require programming changes to prevent

inadvertent high-speed operation. The Drive shall be furnished in a UL Type 1 (NEMA 1) listed enclosure rated for operation at ambient temperatures between -15° and 40°C at an altitude not exceeding 3300 feet, with relative humidity less than 95% and no condensation allowed. The Drive shall be protected from atmospheric contamination by Chemical gasses and Solid particles per IEC 60721-3-3; Chemical gasses Class 3C2 and Solid particles Class 3S2. The Drive shall be protected from vibration per IEC 60721-3-3, Class 3M4 (sinusoidal displacement 3.0 mm (0.12 in.), 2Hz to 9Hz; acceleration 10 m/s^2 (33 ft/s^2), 9Hz to 200Hz).

C. Control Functions and Adjustments

1. Start-up data entries shall include motor nameplate power, speed, voltage, frequency and current.
2. A motor parameter ID function shall automatically define the motor equivalent circuit used by the sensorless vector torque controller.
3. Two independent PID speed/torque loop regulators shall be provided with an autotune function as well as manual adjustments.
4. A dynamic braking chopper shall be provided on all models rated up to 15 horsepower 600V and up to 10 horsepower 240V.
5. A selection of eight (8) preprogrammed application macro parameter sets shall be provided to minimize the number of different parameters to be set during start-up. Macros included as standard are as follows: ABB Standard, 3-Wire, Alternate, Motor Potentiometer, Hand/Auto, PID Control, Pump & Fan Control (PFC), and Torque Control. A selection of two (2) User Defined Parameter Sets shall also be available.
6. Carrier frequency shall be adjustable between 1 and 12 kHz up to 200 HP 480V or 150 HP 600V and between 1 and 4 kHz from 250 through 550 HP 480V. The ASD shall automatically adjust the carrier frequency dependent upon Drive temperature and load. Increased temperatures result in automatically decreased switching frequency to ensure continuous operation of the Drive.
7. Start/Stop control functions shall include two (2) or three-(3) wire start/stop, coast/ramp stop selections, optional dynamic braking and flux braking.
8. The ASD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to reference without safety tripping or component damage (flying start). The ASD shall also be capable of flux braking at start to stop a reverse spinning motor prior to ramp.
9. The ASD shall have the ability to automatically restart after an overcurrent, overvoltage, undervoltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable.
10. Accel/Decel control functions shall include two (2) sets of ramp time adjustments with linear and two (2) s-curve ramp selections.

11. Speed/Torque control functions shall include:

a. Adjustable min./max. speed and/or torque limits
b. Selection of up to seven (7) preset speed settings or external speed control
c. Two (2) independent built-in PID controllers to control a process variable such as pressure, flow or fluid level.
d. Two (2) analog inputs shall be programmable to form a reference by addition, subtraction, multiplication, minimum selection or maximum selection.

12. Output control functions shall include:
    a. Current and torque limit adjustments to limit the maximum Drive output current and the maximum torque produced by the motor. These limits shall govern the inner loop torque regulator to provide tight conformance with the limits with minimum overshoot.
    b. A torque regulated operating mode with adjustable torque ramp up/down and speed/torque limits.
13. The ASD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The Drive shall have user adjustable load curves (motor torque as a function of frequency) defined by five (5) points to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay output shall include programmable time delays that will allow for Drive acceleration from zero speed without signaling a false underload condition.
14. The Drive shall have programmable "Sleep" and "Wake up" functions to allow the Drive to be started and stopped from the level of a process feedback signal.
15. Three (3) programmable critical frequency lockout ranges to prevent the ASD from operating the load continuously at an unstable speed.

D. Static and Dynamic Performance
1. Open loop static speed regulation shall be 0.5 % to 1% of rated motor speed. When motor speed feedback is provided from a suitable encoder, closed loop speed regulation shall be 0.1% of motor nominal speed. Dynamic speed accuracy shall be less than 1%-sec with 100% torque step open loop and 0.5%-sec closed loop with 100% torque step.
2. Torque control response time shall be less than 10 ms with nominal torque. In the torque regulating mode, torque regulating accuracy open loop shall be +/- 5%; torque regulating accuracy closed loop shall be +/- 2%;

E. Operator Control Panel (Keypad)
1. Each ASD shall be equipped with a front mounted operator control panel (keypad) consisting of a backlit, alphanumeric, graphic display and a keypad with keys for Start/Stop, Local/Remote, Up/Down and Help. Two (2) Softkeys will be provided which change functionality depending upon the position within the parameter hierarchy or state of panel.
2. All parameter names, fault messages, warnings and other information shall be displayed in complete English words or standard English abbreviations to allow the user to understand what is being displayed without the use of a manual or cross-reference table.
3. Other languages selectable in addition to American English (Am) shall be as follows: English (European), French, Spanish, Portuguese, German, Italian, Dutch, Danish, Swedish, Finnish, Czech, Polish, Russian, Hungarian and Turkish.
4. The Display shall have contrast adjustment provisions to optimize viewing at any angle.
5. The control panel shall provide a real time clock for time stamping events and fault conditions.

6. The control panel shall include a feature for uploading parameter settings to control panel memory and downloading from the control panel to the same Drive or to another Drive.
7. All Drives throughout the entire power range shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating.
8. The keypad is to be used for local control, for setting all parameters, and for stepping through the displays and menus.
9. The keypad shall be removable and insertable under Drive power, capable of remote mounting, and shall have its own non-volatile memory.
10. The standard operator panel shall provide a start-up, maintenance and diagnostic assistants that guides a new user through initial start-up and commissioning of the Drive as well as provide indications for maintenance and help to diagnose a fault. In addition, a PID assistant, Real-time Clock assistant, Serial Communications assistant, and Drive Optimizer assistant shall be included. A Drive Optimizer assistant permits the user to choose Drive set-up for low nose, drive & motor efficiency or motor control accuracy.
11. During normal operation, one (1) line of the control panel shall display the speed reference, and run/stop forward/reverse and local/remote status. The remaining three (3) lines of the display shall be programmable to display the values of any three (3) operating parameters. At least twenty-six (26) selections shall be available including the following:
    a. Speed/torque in percent (%), RPM or user-scaled units
    b. Output frequency, voltage, current and torque
    c. Output voltage, power and kilowatt hours
    d. Heatsink temperature and DC bus voltage
    e. Status of discrete inputs and outputs
    f. Values of analog input and output signals
    g. Values of PID controller reference, feedback and error signals.
    h. Control interface inputs and outputs shall include:

F. I/O Capabilities

1. Six (6) digital inputs 12 to 24VDC PNP and NPN, all independently programmable with at least twenty-five (25) input function selections. Inputs shall be designed for “dry contact” inputs used with either an internal or external 24 VDC source.
2. Three (3) form C relay contact digital outputs, all independently programmable with at least thirty (30) output function selections. Relay contacts shall be rated to switch a maximum two (2) Amps rms continuous current at a maximum switching voltage of 30VDC or 250VAC. Function selections shall include indications that the Drive is ready, running, reversed and at set speed/torque. General and specific warning and fault indications shall be available. Adjustable supervision limit indications shall be available to indicate programmed values of operating speed, speed reference, current, torque and PID feedback. An optional relay expansion card shall be available to provide three (3) additional relay outputs. This option card shall be integrally mounted.
3. Two (2) analog inputs, each selectable for 0VAC - 10VAC or 4mA - 20mA, and independently programmable with at least ten (10) input function selections. Analog input signal processing functions shall include scaling adjustments, adjustable filtering and signal inversion. If the input reference (4-20mA or 0-10V) is lost, the ASD shall give the user the option of the following: (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the ASD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The Drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus.

4. Two (2) analog outputs providing 0 (4) to 20mA signals. Outputs shall be independently programmable to provide signals proportional to at least twelve (12) output function selections including output speed, frequency, voltage, current and power.

G. Serial communications

1. Serial communication interface modules are available for a wide selection of communication protocols. Available adapters are as follows: EtherNet/IP, Modbus/TCP, DeviceNet, Profibus DP, CANopen, ControlNet and PROFINET IO. Communications modules shall be internally mountable. I/O shall be accessible through the serial communications adapter.
2. The ASD shall have an RS-485 port as standard. The standard embedded protocol shall be Modbus RTU.
3. Serial communication capabilities shall include, but not be limited to, run-stop control; speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, and accel/decel time adjustments. The Drive shall have the capability of monitoring feedback such as process variable feedback, output speed/frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), relay outputs, and diagnostic warning and fault information. Additionally, remote Local Area Network (LAN) ASD fault reset shall be possible. A minimum of fifteen (15) field parameters shall be capable of being monitored. The DDC system shall be able to monitor if the motor is running in the ASD mode or bypass mode (if bypass is specified) over serial communications.
4. The ASD shall allow the DDC to control the Drive's digital and analog outputs via the serial interface. The serial communications interface shall allow for Digital Ouput DO (relay) control and Analog Output (AO) control. This control shall be independent of any ASD function. Examples of possible DO usage are as follows: Opening check valves, opening discharge valves, starting auxiliary equipment, etc. In addition, status of DO's are available over the communications link. Examples of possible AO usage are as follows: Controlling a bypass valve position, throttling valve position, etc. In addition, status of AO's are available over the communications link.

H. The operator panel port shall be connectable to a personal computer interface. Microsoft© Windows based software shall be available for Drive setup, diagnostic analysis, maintenance, monitoring and control. The software shall follow trends and provide real time graphical displays of Drive performance.

I. An additional user interface shall be offered as a palm sized portable, battery operated tool for fast, safe and easy parameter selecting, setting, downloading and uploading to a non-powered drive. It also allows for hiding selected parameters to protect the application.

J. Protective Functions

1. For each programmed warning and fault protection function, the Drive shall display a message in complete English words or Standard English abbreviations. The three (3) most recent fault messages along with time, current, speed, voltage, frequency and DI Status shall be stored in the Drive's fault history. The last ten (10) fault names shall be stored in Drive memory.
2. The Drive shall include internal MOV's for phase to phase and phase to ground line voltage transient protection.
3. Output short circuit withstand rating and ground fault protection rated for 100,000 AIC shall be provided per UL508C without relying on line fuses. Motor phase loss protection shall be provided.
4. The Drive shall provide electronic motor overload protection qualified per UL508C.

5. Protection shall be provided for AC line or DC bus overvoltage at 130% of max. rated or undervoltage at 65% of min. rated and input phase loss.
6. A power loss ride through feature will allow the Drive to remain fully operational after losing power as long as kinetic energy can be recovered from the rotating mass of the motor and load.
7. Stall protection shall be programmable to provide a warning or stop the Drive after the motor has operated above a programmed torque level for a programmed time limit.
8. Underload protection shall be programmable to provide a warning or stop the Drive after the motor has operated below a selected underload curve for a programmed time limit.
9. Over-temperature protection shall provide a warning if the power module temperature is less than 5°C below the over-temperature trip level.
10. Input terminals shall be provided for connecting a motor thermister (PTC type) to the Drive's protective monitoring circuitry. An input shall also be programmable to monitor an external relay or switch contact (klixon).

Part 3 – Execution

3.01 Installation

A. The Drive manufacturer shall provide adequate drawings and instruction material to facilitate installation of the Drive by electrical and mechanical trades people employed by others.

3.02 Start-Up

A. Certified factory start-up is available for each Drive by a factory authorized service center. A certified start-up form shall be filled out for each Drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

B. The factory will extend the normal warranty for the Drive with a certified factory start-up.

3.03 Product Support

Factory trained application engineering and service personnel that are thoroughly familiar with the Drive products offered shall be locally available at both the specifying and installation locations.

3.04 Warranty

1. Standard Warranty shall be 12 months from the date of start-up, not to exceed 24 months from the date of shipment from New Berlin, WI. USA. The warranty shall include all parts.
2. With a certified start-up, an extended warranty shall be 24 months from the date of start-up, not to exceed 30 months from the date of shipment from New Berlin, WI. USA. The warranty shall include all parts, labor, travel time, and expenses. This additional warranty term is only valid after the certified start up has been registered with ABB Technical Support in New Berlin, WI. and the registration must be submitted within 30 days of completion of the certified start-up. The provisions of extended warranty include repair or replacement at the discretion of ABB Inc. and require that the defective unit is returned to ABB freight prepaid by the sender.

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