



Sample Specification for Adjustable Speed Drives  
Rated from 7.5 to 2,800 HP and from 208 to 690 Vac

Part 1 – **GENERAL**

1.01 DESCRIPTION

- A. This specification describes a complete Adjustable Speed AC Drive (ASD) used to control the speed of NEMA design B induction motors used in areas where low harmonic content is desired or mandated.
- B. The drive manufacturer shall supply the Drive and all necessary controls as herein specified.
- C. The ASD shall be manufactured by a company 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 and ISO 14001 certified.
- B. All printed circuit boards shall be completely tested before being assembled into the complete Drive. The Drive shall be subjected to a functional test and load test. The load test shall be at full rated load, or cycled load.
- C. The drive manufacturer shall have an analysis laboratory to evaluate the failure of any component.

1.03 QUALIFICATIONS

- A. The ASD shall meet the following specifications
  - 1. UL 508A and 508C - Underwriter's Laboratory. The ASD shall be UL listed and carry the UL mark.
  - 2. CAN/CSA-C22 No. 14-M91 - Canadian Standards Association. The ASD shall be C-UL or CSA listed and carry the appropriate mark.
  - 3. Institute of Electrical and Electronic Engineers (IEEE). Standard 519-1992, IEEE Guide for Harmonic Content and Control.
  - 4. The ASD shall comply with the following European Union's CE directives. The ASD shall carry CE mark.
    - a. EMC Low Voltage Directive 73/23 EEC
    - b. EMC Directive 89/336 EEC
    - c. Machinery Directive 98/37 EC
- B. Acceptable manufacturers
  - 1. ABB Ultra Low Harmonic (ULH) drive.
  - 2. ASDs that are manufactured by a third party and "brand labeled" shall not be acceptable.
  - 3. ASD power structures that are manufactured by a third party and "brand labeled" shall not be acceptable.

#### 1.04 SUBMITTALS

- A. The Submittals shall include the following information:
1. Outline Dimensions and Weight.
  2. Customer connection and power wiring diagrams.
  3. Complete technical product description including a complete list of options provided.
  4. Compliance to IEEE 519 – Harmonic analysis for particular jobsite including total voltage harmonic distortion and total current distortion. In case an alternative low harmonics solution is offered, the drive manufacturer shall provide calculations, specific to this installation, showing total harmonic current distortion (TDD), at the Point of Common Coupling (PCC), is less than required.

### Part 2 – DESIGN

#### 2.01 DESCRIPTION

- A. The ASD shall be solid state AC to AC inverter controlled device utilizing the latest isolated gate bipolar transistor (IGBT) technology.
- B. The drive shall be an Ultra Low Harmonic Adjustable Speed AC Drive that is designed to comply with standard IEEE 519-1992 when installed into system that already is in compliance with the standard.

#### 2.02 HARMONICS

- A. The Ultra Low Harmonic construction of the ASD shall not contribute any significant harmonics at the input terminals of the ASD, and shall maintain harmonics levels at the ASD's input terminals to levels at or below those listed in "Harmonic Control in Electrical Power Systems, IEEE Std. 519-1992." in the system that already is in compliance with the said standard.
- B. All harmonic management devices must be internal to the ASD enclosure and supplied as a complete solution.
- C. The ASD shall have an active line supply unit which controls the waveform of the input current and reduces the low order harmonic current drawn from the power line. Line currents and voltages shall be nearly sinusoidal. IGBTs shall be used in the rectified and inverter circuits.
- D. Each input phase of the ASD shall incorporate a symmetrical LCL filter arranged in a T- configuration. The inductors are to be series power components that carry the full current of the ASD.
- E. The input current to the ASD shall have a total harmonic content less than 5% of full rated capability at the input terminals of the ASD on power system sized according to IEEE 519-1992 at line voltage unbalance up to 3% and under all motor load conditions.
- F. The ASD shall operate at fundamental power factor 1.0 on the supply side under all motor load conditions.
- G. The input power factor shall be programmable from 0.8 lagging to 0.8 leading, allowing the ASD to be used as a compensating device for installations that are excessively inductive or excessively capacitive in reactive power. The reactive power required by other loads connected to the same distribution system may be compensated for by the providing that ASD has sufficient capacity for reactive and active loads.
- H. The ASD's design shall not compensate for existing harmonic content in the distribution system.

## 2.03 RATINGS

- A. The ASD shall be rated to operate from 3-phase power at 208 VAC to 240 VAC +10/-10% / 380 VAC to 500 VAC +10/-10% / 525 to 690 VAC (600 VAC, UL and CSA) +10/-10%. 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.
- B. The ASD shall be rated to operate at the following environmental operating conditions: ambient temperature 0 to 40°C continuous. ASDs that can operate at 40° C intermittently (during a 24 hour period) are not acceptable and must be oversized. Altitude 0 to 3300 feet above sea level without derating, less than 95% humidity, non-condensing.
- C. The ASD shall be offered from 10 HP to 2,800 HP in similar construction and operation, using the same technology.
- D. The ASD shall be rated to operate from input power from 48 Hz to 63 Hz.
- E. Output voltage and current ratings shall match the adjustable frequency operating requirements of standard NEMA design A or NEMA design B motors.
- F. The normal duty overload current capacity shall be 110% of rated current for one (1) minute out of five (5) minutes.
- G. The heavy duty overload current capacity shall be 150% of rated current for one (1) minute out of five (5) minutes.
- H. The ASD efficiency shall be 97% or better of the full rated capability of the ASD at full speed and load. In case an alternative low harmonics solution is offered, the overall efficiency of the ASD and the harmonic mitigation components shall meet the efficiency requirement.

## 2.04 CONSTRUCTION

- A. All models shall provide a complete, ready-to-install solution.
- B. The latest, most efficient IGBT power technology shall be used. This technology shall be used for all power and voltage ranges offered by the manufacturer.
- C. The ASD shall offer microprocessor based control logic that is isolated from power circuitry.
- D. The ASD shall use the same main control board for all ratings.
- E. Control connections shall remain consistent for all power ratings.
- F. The ASD shall employ an active AC to DC rectifier (commonly referred to as an active supply unit).
- G. The ASD shall be offered in UL Type 1 and NEMA Type 12.
- H. ASDs at and above 150 HP power rating shall be of free-standing construction and shall include the following standard features:
  - 1. Include disconnect switch and fuses as standard.
  - 2. The power modules in the cabinet shall be of a modular construction for quick removal and replacement.

3. To ensure fast and easy handling of the modules in high power range at or above 250 hp, modular power modules and heavy power components such as line filters and power transformers shall be constructed on a wheeled frame and roll directly into and out of the ASD with bus stab connections.
- I. Desired optional features shall be furnished and mounted by the ASD manufacturer and shall also be available as field installable kits as an alternative. All optional features shall carry all of the necessary certifications as described in Section 1.03. Field installed kits shall not affect the ASD's certification.
- 2.05 OPERATOR INTERFACE
- A. The ASD shall be equipped with a front mounted operator control panel consisting of a four- (4-) line by 20-character back-lit alphanumeric LCD display and a keypad with keys for Run/Stop, Local/Remote, Increase/Decrease, Reset, Menu navigation and Parameter select/edit.
  - B. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple ASDs.
  - C. The display of the control unit shall have the following features:
    1. The LCD display shall have contrast adjustment provisions to optimize viewing at angle.
    2. All parameter names, fault messages, warnings and other information shall be displayed in complete American English words or standard American English abbreviations to allow the user to understand what is being displayed without the use of a manual or cross-reference table.
    3. Additional languages including British English, French, Spanish, Portuguese, German, Italian, Dutch, Danish, Swedish, Finnish, Czech and Polish shall be selectable.
    4. 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. The selection shall include at least the following values:
      - a. Speed/torque in percent (%), RPM or user-scaled units
      - b. Output frequency, voltage, current and torque
      - c. Input 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
  - D. The keypad shall be used for local control, for setting all parameters, and for stepping through the displays and menus.
  - E. A copy function to upload and store parameter settings from an ASD and download stored parameter settings to the same ASD or to another ASD shall exist.
  - F. An intelligent start-up assistant shall be provided as standard. The Start-up routine will guide the user through all necessary adjustments to optimize operation.
    1. The Start-Up routine shall include "plug and produce" operation, which automatically recognizes the addition of options and fieldbus adapters and provides the necessary adjustment assistance.
    2. The Start-Up routine shall prompt the user for Motor Nameplate Data including power, speed, voltage, frequency and current.
    3. An auto-tune function shall identify the optimal motor tuning parameters for typical applications.
    4. An auto-tune function shall also be available to tune the PID speed regulator loop. Manual adjustments shall also be allowed.

5. A selection of at least six (6) preprogrammed application macro parameter sets shall be provided to minimize the number of parameter adjustments required during start-up. Macros offered shall include Factory Default, Hand/Auto, PID Control, and Torque Control. A selection of two (2) user defined macros shall also be available.
6. Selection shall be offered for both 2-wire and 3-wire Start/Stop control.

## 2.06 PROTECTIVE FEATURES

- A. For each programmed warning and fault protection function, the ASD shall display a message in complete English words or Standard English abbreviations. The five (5) most recent fault messages and times shall be stored in the ASD's fault history.
- B. The ASD shall include internal MOV's for phase to phase and phase to ground line voltage transient protection.
- C. Output short circuit and ground fault protection rated for 100,000 amps without relying on line fuses shall be provided per UL508C.
- D. Motor phase loss protection shall be provided.
- E. The ASD shall provide electronic motor overload protection qualified per UL508C.
- F. Protection shall be provided for AC line or DC bus overvoltage at 130% of maximum rated voltage or undervoltage at 65% of min. rated voltage.
- G. The ASD shall protect itself against input phase loss.
- H. A power loss ride through feature shall allow the ASD to remain fully operational after losing power as long as kinetic energy can be recovered from the rotating mass of the motor and load.
- I. Stall protection shall be programmable to provide a warning or stop the ASD after the motor has operated above a programmed torque level for a programmed time limit.
- J. Underload protection shall be programmable to provide a warning or stop the ASD after the motor has operated below a selected underload curve for a programmed time limit.
- K. Over-temperature protection shall provide a warning if the power module temperature is less than 5°C below the over-temperature trip level.
- L. Input terminals shall be provided for connecting a motor thermistor (PTC type) to the ASD's protective monitoring circuitry. An input shall also be programmable to monitor an external relay or switch contact.

## 2.07 CONTROL INPUTS AND OUTPUTS

- A. Discrete Inputs
  1. A minimum of six (6) discrete inputs shall be provided.
  2. A minimum of six (6) of the inputs shall be independently programmable with function selections (run/stop, hand-off-auto, etc.).
  3. Inputs shall be designed for use with either the ASD's internal 24 VDC supply or a customer supplied external 24 VDC supply.

**B. Discrete outputs**

1. Minimum of two (2) form C relay contact outputs shall be provided.
2. All outputs shall be independently programmable to activate with at least 30 function selections including;
  - a. Operating conditions such as drive ready, drive running, reversed and at set speed
  - b. General warning and fault conditions
  - c. Adjustable supervision limit indications based on programmed values of operating speed, speed reference, current, torque and PID feedback.
  - d. Relay contacts shall be rated to switch 2 Amps at 24 VDC or 115/230 VAC.

**C. Analog Inputs**

1. Minimum of two (2) analog inputs shall be provided:
  - a. At least one (1) must support bi-polar voltage input.
  - b. Resolution of analog inputs must be at least 11 bit total resolution.
2. All inputs shall be independently programmable with input function selections.
3. A differential input isolation amplifier shall be provided for each input.
4. Analog input signal processing functions shall include scaling adjustments, adjustable filtering and signal inversion.
5. If the input reference is lost, the ASD shall give the user the option of the following. The ASD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus.
  - a. Stopping and displaying a fault
  - b. Running at a programmable preset speed
  - c. Hold the ASD speed based on the last good reference received
  - d. Cause a warning to be issued, as selected by the user.
6. When inputs are used as speed references, reference signal processing shall include increase/decrease floating point control and control of speed and direction using a “joystick” reference signal. Two (2) analog inputs shall be programmable to form a reference by addition, subtraction, multiplication, minimum selection or maximum selection.

**D. Analog Outputs**

1. Minimum of two (2) 0 / 4-20 mA analog outputs shall be provided.
2. Outputs shall be independently programmable to provide signals proportional to output function selections including output speed, frequency, voltage, current and power.

**2.08 SERIAL COMMUNICATIONS**

**A.** The ASD shall be capable of communicating with other ASDs or controllers via a serial communications link. A variety of communications interface modules for the typical overriding control systems shall be available.

**B.** Interface modules shall be available for a wide selection of protocols including but not limited to:

1. Modbus
2. Ethernet IP
3. ControlNet
4. DeviceNet
5. Profibus



- 6. LonWorks
- C. Interface modules shall mount directly to the ASD control board or be connected via fiber optic cables to minimize interference and provide maximum throughput.
- D. I/O shall be accessible through the serial communications adapter. Serial communication capabilities shall include, but not be limited to:
  - 1. Run-Stop control
  - 2. Hand-Off-Auto Control
  - 3. Speed Adjustment
  - 4. PID (proportional/integral/derivative) control adjustments
  - 5. Current Limit
  - 6. Accel/Decel time adjustments
- E. The ASD shall have the capability of allowing the overriding controller to monitor 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.
- F. A connection shall also be provided for personal computer interface. Software shall be available for ASD setup, diagnostic analysis, monitoring and control. The software shall provide real time graphical displays of ASD performance.

## 2.09 CONTROL FUNCTIONS AND ADJUSTMENTS

- A. Output frequency shall be adjustable between 0 Hz and 300 Hz. Operation above motor nameplate shall require programming changes to prevent inadvertent high-speed operation.
- B. Stop mode selections shall include coast to stop and ramp to stop.
- C. The ASD shall be capable of controlling deceleration of a load without generating an overvoltage fault caused by excessive regenerated energy. Overvoltage control on deceleration shall extend the ramp time beyond the programmed value to keep the amount of regenerated energy below the point that causes overvoltage trip.
- D. The ASD shall be capable of starting into a rotating load (flying start) regardless of motor direction. It should then accelerate or decelerate to the active reference without tripping on fault or causing component damage. The ASD shall also be capable of flux braking at start to stop a reverse spinning motor prior to ramp.
- E. 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.
- F. Control functions shall include two (2) sets of acceleration and deceleration ramp time adjustments with linear and an s-curve ramp time selection.
- G. Speed control functions shall include:
  - 1. Adjustable min/max speed limits.
  - 2. Selection of up to 15 preset speed settings for external speed control.
  - 3. Three sets of critical speed lockout adjustments.

- 4. A built-in PID controller to control a process variable such as pressure, flow or fluid level.
- H. Functions shall include flux optimization to limit the audible noise produced by the motor and to maximize efficiency by providing the optimum magnetic flux for any given speed operating point.
- I. The ASD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The ASD shall be programmable 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 ASD acceleration from zero speed without signaling a false underload condition.
- J. Three (3) programmable critical frequency lockout ranges shall be provided to prevent the ASD from operating the load continuously at an unstable speed.
- K. The ASD shall offer software to select the ASDs action in the event of a loss of the primary speed reference.
- L. The ASD shall have fifteen (15) internal adaptive programming blocks capable of twenty (20) different functions. These blocks shall be connectable to ASD's actual signals and functions allowing the user to tailor the ASD to the specific application requirements without additional hardware. These blocks shall be programmable through the standard operator panel and through the use of programming software.

### Part 3 **EXECUTION**

#### 3.01 INSTALLATION

- A. The drive manufacturer shall provide adequate drawings and instruction material to facilitate installation of the Drive by qualified electrical and mechanical personnel employed by others.

#### 3.02 START-UP

- A. Certified factory start-up shall be provided for each ASD by a factory authorized service center. A certified start-up form shall be filled out for each ASD 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 ASD with a certified factory start-up.

#### 3.03 PRODUCT SUPPORT

- A. Factory trained application engineering and service personnel that are thoroughly familiar with the ASD products offered shall be locally available at both the specifying and installation locations.
- B. A 24/365 technical support line shall be available on a toll-free-line.

#### 3.04 WARRANTY

- A. Standard Warranty shall be 12 months from the date of start-up, not to exceed 18 months from the date of shipment. The warranty shall include all parts.
- B. With a certified start-up, warranty shall be 24 months from the date of start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time, and expenses.
- C. There shall be 24/365 support available on a toll-free-line.