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AD10

System Automation Drive

Specification

Your Leader in Drive Technology

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Guide-Form Specification

1.0 General

1.1 Purpose

This specification shall establish the minimum requirements for adjustable frequency drive equipment. Drives that do not meet these requirements shall not be acceptable. The adjustable frequency drive equipment shall be the AD10 as furnished by Saftronics, Inc.

1.2 Driven Equipment

The drive shall be capable of operating a NEMA design B squirrel cage induction motor with a full load current equal to or less than the continuous output range of the drive. At 60 hertz and below, the drive shall be able to operate in constant volts per hertz mode with a selectable volts per hertz slope. Above 60 hertz, the drive may selectively operate in either a constant volts per hertz mode or a constant voltage extended frequency mode. The drive shall be able to operate in sensorless and field oriented vector control. The flux shall be constant until base speed is achieved and reduced to achieve higher speeds.

1.3 Drive Construction

The adjustable frequency drive shall be a sinusoidal PWM type drive with sensor-less vector, flux vector, and volts per hertz capability. The drive shall be of modular construction for ease of access to control and power wiring and maintenance. It shall consist of the following general components:

1.3.1 Full wave rectification converts supply AC to a fixed DC voltage, with pre-charge on power-up.

1.3.2 DC link capacitors

1.3.3 Insulated Gate Bipolar Transistor (IGBT) power section for either variable or constant torque applications.

1.3.4 The drive shall be microprocessor based with an LED and LCD display to monitor operating conditions. The keypad shall be adjustable to change the viewing angle of the display. The display section shall allow for local operation, setting of drive functions, and display of drive faults. The LED display shall offer six different display settings and the LCD shall have the capacity to display two (2) lines of information at a time.

1.3.5 Separate control and power terminal boards shall be provided.

1.3.6 The drive shall be constructed to have options for communicating, as a minimum, with recognized industry standard device level networks such as DeviceNet, Interbus-S, Profibus, and GENIUS? .

1.3.7 The drive shall be constructed to have the ability to upload and download drive programming data from a user PC, through a RS485 port.

1.3.8 The drive shall be equipped with Windows 95/Windows 98/Windows NT/ Windows 2000 based software package to allow for programming. The software shall be capable of on-line trending of drive and motor parameters, including DC link voltage, output voltage, motor current, and motor speed and shall include a test generator function. The program will include a complete help menu and basic start up ‘wizards’ to aid in programming and start-up.

2.0 Operating Conditions

2.0.1 The drive's operating ambient temperature range shall be -10^{O}C to 40^{O}C, and with provisions for a maximum operating temperature of 50^{O}C. Storage temperatures shall be between -20^{O}C to 55^{O}C.

2.0.2 The humidity range shall be 5-85% non-condensing.

2.0.3 The drive shall be suitable for operation at altitudes up to 3300 feet without de-rating.

2.0.4 The drive shall be suitable for vibration according to EN50178 class 1K4.

3.0 Standards

3.0.1 The drive shall be Underwriters Laboratory (UL), Canadian Underwriters Laboratory (cUL), and CE listed and labeled, indicating compliance with appropriate standards.

3.0.2 The drive shall be designed in accordance with applicable portions of NEMA standards.

3.0.3 The drive shall be compatible with the installation requirements of codes such as National Electric Code (NEC) and Occupational Safety & Health Act (OSHA).

4.0 Input Power

4.0.1 The drive design shall be such that it will be available for use with 380-480 VAC, 3-phase power input.

4.0.2 At 380-480 volts, the drive shall be able to withstand voltage variations of –10% to +15% and imbalance no greater than 3% without tripping or affecting drive performance.

4.0.3 System frequency shall be 50 or 60 Hertz with a maximum frequency variation of $\pm$5%.

4.0.4 The displacement power factor of the drive shall be 0.95 lagging or higher. (Note: Displacement power factor is not the same as the actual power factor.)

4.0.5 Line notching, transients, and harmonics on the incoming line shall not affect drive performance.

4.0.6 The drive shall not require input isolation transformers.

4.0.7 The drive shall be capable of power dip ride through for at least 0.25 seconds for a 0.75 HP rating and for at least 18 seconds for a 200 HP rating.

5.0 Output Power

5.0.1 The drive shall be capable of horsepower ratings from fractional through 200 HP, and output frequencies up to 400 Hertz for 0.75 to 40 HP and 200 Hertz for 50 to 200 HP. It shall also have an energy saver feature with the capability of selecting a V/Hz automatic control function that will modify the V/Hz curve based on light load characteristics that will minimize power consumption.

5.0.2 Drive output voltage shall vary with frequency to maintain a programmable volts/hertz ratio up to 60 hertz output. Constant voltage output shall be supplied at frequencies greater than 60 Hz.

5.0.3 The drive shall be programmable to alternative volts and flux ratios and break points. Rated output voltage shall be programmable for motor ratings from 320 to 480 volts.

5.0.4 The drive shall be capable of a minimum of 100% rated current in continuous operation, in accordance with the requirements of NEC Table 430-150.

5.0.5 The drive one minute overload current rating shall be 150% of rated current, and 200% (1/2 to 30 Hp) for 0.5 seconds without de-rating.

6.0 Drive Features

6.0.1 The drive shall have a back-lit graphic liquid crystal display (LCD) which can be configured to display frequency, current, function code set points, or drive status and fault codes. The display shall have an adjustable viewing angle.

6.0.2 The drive shall also have a built in keypad that shall be extendible, by optional cable, to a remote location up to 1 meter from the drive. The keypad shall include the following devises:
6.0.2.1 Run/Stop keys
6.0.2.2 Function Code select keys
6.0.2.3 Programming keys
6.0.2.4 Drive reset key
6.0.2.5 Reference increment/decrement keys
6.0.2.6 Drive shall have six LED readouts

6.0.3 The keypad shall allow for three modes of adjustment:

6.0.3.1 ***Operating Mode:*** While the drive/motor system is in operation or at a standstill, the following may be adjusted: Output Current, Output Voltage, Output Frequency, Speed Reference, Motor Synchronous Speed (adjustable for 2 to 12 pole motors), Torque Current References, and Line Speed (calibration adjustable from 0 to 200% of frequency, with 0.01% resolution).

6.0.3.2 ***Programming Mode:*** While the drive/motor system is at a standstill, Functions, Set Points, I/O mapping, and Control Modes may be adjusted.

6.0.3.3 ***Diagnostic Mode:*** Faults will be displayed whenever a fault occurs.

6.0.4 Upon a fault condition, the LCD shall display the fault in English on the keypad. The last ten faults will be stored in memory and selectively be displayed on the LCD.

6.0.5 The drive shall be capable of operating as an open-loop control system requiring no feedback devices, a closed-loop control system with a digital encoder, or as a closed-loop control system with a sinusoidal encoder.

6.0.6 The drive shall accept and follow a selectable external speed reference from any of the following input types: analog (0-10 VDC, -10-10 VDC, 0-20 mA or 4-20 mA), digital, 1-60 kOhm motor potentiometer, serial communications, from an encoder, or from LAN interface options.

6.0.7 The drive shall regulate set speed regardless of load fluctuations.

6.0.8 The drive shall be capable of at least 4 different acceleration rates and 4 different deceleration rates. Each acceleration and deceleration rate shall be independently adjustable from 0.1 to 6553.5 seconds.

6.0.9 The drive will have the capability of determining motor characteristics to optimize its operation through the use of pre-programmed motor data information or a self-tuning function. The drive shall determine the motor characteristics initially or when the motor reaches its operating temperature. The drive will also allow manual setting of motor impedance and resistance values to optimize drive performance.

6.0.10 The drive shall offer two selectable acceleration/deceleration patterns: linear and S-Curve.

6.0.11 The drive shall display operating data, fault information, and programming prompts in English.

6.0.12 The drive shall have two selectable switching frequencies to limit and adjust the level of audible motor noise.

Ranges:	0.75 to 40 HP	8 / 16 kHz
	40 to 75 HP	4 / 8 kHz

6.0.13 The drive shall have a reference filter that eliminates the effects of noise that can be present in the analog reference signal.

6.0.14 The drive shall be able to restart after the bus loses power. The time from when main power is restored to the when the drive's output is reapplied to the motor shall be programmable from 0 to 10,000 seconds.

6.0.15 The drive shall be able to reset itself up to 99 times(adjustable) after an over-current, over-voltage, low voltage, overheating and overload faults.

6.0.16 The drive shall be able to restart after a voltage dip. The time to restart shall be programmable from 0 to 65535.

6.0.17 The drive shall have a programmable minimum speed, adjustable from 1 RPM to 200% of base speed with an adjustable holding time from 0 to 10 seconds.

6.0.18 The drive shall be capable of operating in four modes as follows:

6.0.19.1 ***Volts/Hertz Mode:*** While in Voltz/Hertz mode, the drive shall have selectable (manual or automatic) torque (voltage) boost settings, that will enable smooth acceleration of high inertia or high static friction type loads. One level allows for automatic calibration that will compensate for the ac motor's primary resistance (IR compensation); second level is to be set for Variable Torque loads; third is proportional torque loads where torque is directly related to set speed and finally for Constant Torque loads. Also, a second Torque Boost function setting is to be available for a 2nd motor with different characteristics and/or set of operating requirements. The drive shall be able to operate with its output disconnected for trouble shooting and startup. The drive will have a starting torque of 150%. The drive shall maintain the output frequency to within 0.3 times the nominal motor slip, with a resolution of 0.001 Hertz at 50 Hz and 0.005 Hertz at 300 Hz. The drive shall be capable of operating in a control range of 50:1. The drive will be capable of connection to an already spinning motor.

6.0.19.2 ***Sensor-less Vector Mode:*** The drive shall be capable of maintaining speed within 0.3% of the nominal speed, with a resolution of 0.02 to 2.5 times the nominal speed and a control range of 50:1.

6.0.19.3 ***Flux Vector Mode with a digital encoder:*** The drive shall be capable of maintaining speed within 0.02% with a resolution of 0.5 RPM in a control range of 1:1,000.

6.0.19.4 ***Flux Vector Mode with a sinusoidal encoder:*** The drive shall be capable of maintaining speed within 0.01%, with a resolution of 0.25 RPM, and a control range of 10,000:1.

7.0 Drive Speed Control

7.1 The drive shall be capable of at least eight (8) independently programmable preset speed references, adjustable from 0 to 200% of base speed.

7.2 The drive shall be capable of motor slowdown or stop by selectable regenerative (to the DC link) dynamic braking while following one of the four selectable deceleration ramps, and control the braking torque by setting it's value from 20 to 180% of drive rating.

7.3 The drive shall be capable of stopping by selectable DC injection braking.

7.4 The drive shall be equipped with a ramp Freeze function, that maintains the current speed when activated.

7.5 The drive shall provide selectable slip compensation, which will sense output current and adjust output frequency, to improve motor speed fluctuations due to load to within 1/3 of rated motor slip. This will allow approximately 1% or less (depending in the slip value selected) speed regulation without the use of a speed feedback device. The Slip Compensation setting is to be adjustable for both motoring and overhauling loads, as well as to allow for "speed droop" when a motor slip value, greater than the motor's characteristics allow, is required. This function is to be adjustable over a range of -9.9Hz to 5Hz.

8.0 Drive Control & Options

8.1 The drive shall provide four digital inputs from external dry contacts for configurable functions, including the following:

8.1.1 Run forward command
8.1.2 Run reverse command
8.1.3 Start command
8.1.4 Multi-step frequency reference selection
8.1.5 Accel/decel ramp option selection
8.1.6 Stop command
8.1.7 Alarm input
8.1.8 Drive fault reset
8.1.9 Coast Command

The digital inputs will each be capable of accepting 15-50 VDC and have an update rate of 8 milliseconds.

8.2 The drive shall provide three analog inputs with a selectable rating of –10 to 10 VDC, 0 to 10 VDC, 0-20 mA, or 4-20 mA. The resolution will be 11 bits + sign, and the update rate will be 2 milliseconds or less. The inputs shall be programmable for function control, including the following:

8.2.1 Jog reference
8.2.2 Ramp reference
8.2.3 Speed reference
8.2.4 Current references
8.2.5 Speed gains adjusts
8.2.6 Outer loop inputs
8.2.7 Current limit adjusts
8.2.8 Droop adjust
8.2.9 PID adjustments
8.2.10 Flux adjustments
8.2.11 Speed ratio (draw)

8.3 The drive shall provide at least two digital programmable outputs capable of being configured to the following:

8.3.1 Speed zero
8.3.2 Speed threshold
8.3.3 Drive ready
8.3.4 Drive in overload
8.3.5 Undervoltage
8.3.6 Overvoltage
8.3.7 External fault
8.3.8 Motor overtemperature
8.3.9 Speed feedback loss
8.3.10 Braking unit overload

8.4 The drive shall be equipped with two programmable analog outputs with an 11 bits + sign resolution and 2 millisecond update rate. The inputs shall be capable of being associated to the following parameters:

8.4.1 Ramp reference
8.4.2 Speed references
8.4.3 Torque reference
8.4.4 PID output
8.4.5 Voltage
8.4.6 Current
8.4.7 Encoder power output torque
8.4.8 Motor flux
8.4.9 Frequency

8.5 The drive shall be equipped with one normally open relay for drive okay, and one normally open programmable relay rated 250 VAC, 1A, AC11.

8.6 The drive encoder shall have a minimum of 600 PPR and a maximum of 9999 PPR. The maximum frequency of a digital encoder shall be 150 kHz, the maximum for a sinusoidal encoder shall be 80 kHz.

8.7 The drive shall facilitate the addition of the following:

8.7.1 Twelve (12) additional digital inputs, eight (8) additional digital outputs, two (2) additional analog inputs, and four (4) additional analog outputs.

8.7.2 The drive shall facilitate the communication over I/O serial link via a RS-485 protocol signal that will transfer information on operation commands, operating conditions, drive function code settings and fault indications.

8.7.3 The drive shall be compatible with the GE Fanuc GENIUS LAN, DeviceNet, PROFIBUS-DP, and INTERBUS-S and allow for communication interface either directly or via third party interface boards.

9.0 Drive Protective and Diagnostic Features

9.1 When a fault occurs, the drive shall have a controlled shut down sequence. The reason for the fault condition shall be enunciated on the LED display, and the LCD graphic screen shall display the current, temperature, frequency, and voltage at the time of the fault as well as potential reasons for the condition. The drive shall monitor, sense, and display the following fault conditions:

9.1.1 Over-current during acceleration
9.1.2 Over-current during deceleration
9.1.3 Over-current during constant speed operation
9.1.4 Under-voltage (less than rated)
9.1.5 Over-voltage during acceleration
9.1.6 Over-voltage during deceleration
9.1.7 Over-voltage during constant speed operation
9.1.8 Drive over temperature

9.1.9 Dynamic Braking over temperature
9.1.10 Drive Electronic Thermal Overload protection
9.1.11 Motor Electronic Thermal Overload protection
9.1.12 DC Link fuse failure indication
9.1.13 External alarm indication (motor, process, etc.)
9.1.14 Loss of AC power
9.1.15 Drive memory error
9.1.16 Keypad communication error
9.1.17 Option communication/operation error
9.1.18 Drive operating error that is detected during startup
9.1.19 Motor tuning error to detect missing motor connection
9.1.20 Ground fault
9.1.21 Output short circuit
9.1.22 Short circuit

9.2 The drive shall have a selectable Torque Current Limiting function for both motoring and braking that will sense an overload condition and will reduce frequency and current temporarily until the load reaches acceptable levels.

9.3 The drive shall have an over-voltage protection function that operates if DC Link voltage rises above rated.

9.4 If the drive heat sink temperature exceeds approximately 100^{o}C, the drive will shut down on over temperature fault.

9.5 The DC bus shall automatically discharge to below 30 VDC within 5 to 24 minutes, depending on rating after the incoming power is removed.

10.0 Quality Assurance

10.1 All drives shall be 100% factory tested to ensure proper performance upon delivery.

10.2 The drive vendor shall provide a warranty for material and workmanship, for a period of twelve months after start up or 18 months after shipment, whichever occurs first.

11.0 Start-Up Service and Training

Drive operational and maintenance training and/or startup service shall be offered by the drive vendor separately. The drive vendor shall have factory trained personnel at field locations convenient to the installation site, available for trouble shooting and/or startup assistance.

12.0 Documentation

An instruction manual, complete with wiring diagrams, schematics, operating, and maintenance instructions, shall be provided with the drive at the time of shipment.

13.0 Spare Parts

Spare parts shall be available locally through local stocking distributors.