

Sample Specification for ACS580-01 Wall Mount

Part 1 - GENERAL

1.01 DESCRIPTION

- A. This specification is to cover a complete Variable Frequency Drive (VFD aka: VFD, AFD, VFD, Inverter, AC Drive, et al) consisting of a pulse width modulated (PWM) inverter designed for use with a standard AC induction motor, synchronous reluctance (SynRM) and permanent magnet (PM) motors. The VFD must provide a V/Hz or sensor-less vector mode of operation.
- B. The VFD manufacturer shall supply the VFD and all necessary controls as herein specified.
- C. The VFD shall be manufactured by a company with at least twenty (20) years experience in the production of this type of equipment.

1.02 QUALITY ASSURANCE

- A. The VFD manufacturing facility shall be ISO 9001, ISO 14001, and ISO 17025 certified.
- B. All printed circuit boards shall be completely tested before being assembled into the complete VFD. The VFD shall be subjected to a functional test and load test. The load test shall be at full rated load, or cycled load.
- C. The VFD manufacturer shall have an analysis laboratory to evaluate the failure of any component.

1.03 QUALIFICATIONS

- A. The VFD shall meet the following specifications
 - 1. UL-APPROVAL the VFDs shall be available as UL compliant version which complies with the technical regulations of UL according to UL61800-5-1. Manufacturer's statements of UL compliance or pending approval are not accepted. The VFD shall comply with the technical regulations of UL according to UL508C. UL listing document shall be available to confirm VFDs compliance with the requirements
 - 2. NEMA 250:2008 – Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 3. CAN/CSA-C22.2 No. 274 - Canadian Standards Association. The VFD shall be C-UL or CSA listed and carry the appropriate mark.
 - 4. The VFD shall comply with the following IEC / EN guidelines directives. The VFD shall carry CE mark.
 - a. EN/IEC 61800-3
 - b. 2014/35/EU Low Voltage Directive
 - c. 2014/30/EU Electromagnetic compatibility (EMC)
 - d. 2006/42/EC Machinery Directive
 - 5. Functional Safety certified to the following standards:
 - a. IEC 61508 part 1:2010, part 2:2010; capable up to SIL 3
 - b. ISO 13849 part 1:2015, part 2:2012; capable up to PL e (category 3)
 - c. IEC 62061:2015; capable up to SILCL3
 - d. IEC 61800-5-2:2016; capable up to SIL 3
- B. Acceptable manufacturers
 - 1. ABB Inc. ACS580 series of AC VFDs
 - 2. VFD manufacturer must design, manufacture, quality control and life cycle manage all products offered on this project.
 - 3. VFD vendors that brand label products manufactured by others shall not be allowed.

1.04

1.05 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.

Part 2 - DESIGN

2.01 DESCRIPTION

- A. The VFD shall be solid state, with a Pulse Width Modulated (PWM) output. The VFD shall be a Sensor-less Vector AC to AC converter utilizing the latest Insulated Gate Bipolar Transistor (IGBT) technology. The VFD shall employ a Sensor-less Vector inner loop torque control strategy that mathematically determines motor torque and flux. The VFD must also provide an optional operational mode for V/Hz Operation.

2.02 RATINGS

- A. The VFD shall be rated to operate from 3-phase power at one of the following voltage ranges. (208-240), (380-480), (500-600) VAC +10%/-15%, 48Hz to 63Hz and 1-phase power at (230 – 240) VAC +10%/-15%, 48Hz to 63Hz. The VFD 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 ACQ580 standard VFD efficiency shall be 98% or better at full speed and load.
- B. VFDs (208-240Vac) 1-150 Hp, (380-480Vac) 1-350 Hp, (500-600Vac) 2-250 Hp shall have internal chokes (reactors) 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.
- C. The VFD shall be rated to operate at the following environmental operating conditions: ambient temperature 0 to 40°C continuous. VFDs 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.
- D. The VFD shall be offered from 0.75 HP to 350 HP in similar construction and operation, using the same technology.
- E. The VFD shall be rated to operate from input power from 48Hz to 63Hz.
- F. Output voltage and current ratings shall match the adjustable frequency operating requirements of standard NEMA design A or NEMA design B motors.
- G. The Normal Duty overload current capacity shall be 110% of rated current for one (1) minute out of ten (10) minutes.
- H. The Heavy Duty overload current capacity shall be 150% of rated current for one (1) minute out of ten (10) minutes.
- I. The VFD efficiency shall be 98% or better of the full rated capability of the VFD at full speed and load.

2.03 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 VFD shall offer microprocessor based control logic that is isolated from power circuitry.
- D. The VFD shall use the same main control board for all ratings.

- E. Control connections shall remain consistent for all power ratings.
- F. Wall mountable VFDs shall be available from 0.75 to 350HP and have the following features;
 - 1. Offered in UL Type 1 and NEMA Type 12 wall mountable enclosures
 - 2. Include a control panel mounted on the front of the VFD
 - 3. Include coated circuit boards as standard
 - 4. Include internal chokes (reactors) 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
- G. Desired optional features shall be furnished and mounted by the VFD 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 VFD's certification.

2.04 OPERATOR INTERFACE

- A. The VFD shall be equipped with a front mounted operator control panel consisting of a four- (4) line back-lit alphanumeric LCD display that is 240x160 pixels. Configurable displays showing, bar graph and meter. Keypad with keys for Run/Stop, Local/Remote, Increase/Decrease, Reset, Menu navigation and Parameter select/edit.
- B. The control panel shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
- C. The display of the control panel shall have the following features:
 - 1. 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.
 - 2. Additional languages including French, Spanish, Portuguese, German, Italian, Dutch, Danish, Swedish, Finnish, Russian, Turkish and Chinese shall be selectable.
 - 3. 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. 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 control panel 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 VFD and download stored parameter settings to the same VFD or to another VFD 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 ten (10) 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, Torque Control, and Pump / Fan Control
6. Selection shall be offered for both 2-wire and 3-wire Start/Stop control.

2.05 PROTECTIVE FEATURES

- A. For each programmed warning and fault protection function, the VFD shall display a message in complete English words or Standard English abbreviations. The eight (8)) active and most recent fault messages and times shall be stored in the VFD's fault history.
- B. The VFD 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 VFD shall provide electronic motor overload protection qualified per UL61800-5-1.
- 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 VFD shall protect itself against input phase loss.
- H. A power loss ride through feature shall allow the VFD 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 VFD 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 VFD 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 VFD's protective monitoring circuitry. An input shall also be programmable to monitor an external relay or switch contact.

2.06 CONTROL INPUTS AND OUTPUTS

- A. Digital Inputs
 1. Minimum of six (6) digital 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 VFD's internal 24 VDC supply or a customer supplied external 24 VDC supply.
- B. Discrete outputs
 1. Minimum of three (3) 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. Two (2) must be selectable for either a current or a voltage input.
 - b. Analog Input shall have an inaccuracy of $\leq 1\%$ of full scale in both current and voltage modes
2. Inputs shall be independently programmable to provide signals including speed / frequency reference, torque reference or set point, PID set point and PID feedback / actual.
3. Analog input signal processing functions shall include scaling adjustments, adjustable filtering and signal inversion.
4. If the input reference is lost, the VFD shall give the user the option of the following. The VFD 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 VFD speed based on the last good reference received
 - d. Cause a warning to be issued, as selected by the user.

D. Analog Outputs

1. Minimum of two (2) 0 / 4-20 mA analog outputs shall be provided.
2. The analog outputs shall be programmable to give an output signal proportional to frequency, motor speed, output voltage, output current, motor torque, motor power, DC bus voltage, active reference or other defined data

E. Digital Inputs/Outputs

1. The VFD shall have at least six (6) programmable digital inputs (24 VAC and 12 to 24 VDC, PNP or 5 pcs NPN) to connect to external devices, as follows:
 - a. All inputs can be configurable for PTC sensors
 - b. There shall be a programmable run permissive circuit.
 - c. Up to four (4) programmable free text interlock inputs shall be available
 - f. The VFD shall have at least one digital input configurable to receive a pulse signal up to 16 kHz.

F. Safety Inputs

1. Have a Safe Torque Off (STO) terminal integrated in the drive as a standard. The STO function will meet a Safety Integrity Level (SIL) 3 and a Performance Level (PL) e. This function will be certified by a third party approval agency e.g. TUV Nord.

2.07 SERIAL COMMUNICATIONS

- A. The VFD shall be capable of communicating with other VFDs 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-RTU
 2. Ethernet/IP
 3. ModBus-TCP/IP
 4. ControlNet
 5. DeviceNet
 6. Profibus
 7. ProfiNet
 8. CANOpen

- 9. EtherCat
- 10. POWERLINK

- C. Interface modules shall mount directly to the VFD 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. A connection shall also be provided for personal computer interface. Software shall be available for VFD setup, diagnostic analysis, monitoring and control. The software shall provide real time graphical displays of VFD performance.

2.08 CONTROL FUNCTIONS AND ADJUSTMENTS

- A. Output frequency shall be adjustable between 0Hz and 500Hz. 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 VFD 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 VFD shall be capable of starting into a rotating motor with or without existing magnetic flux on the motor regardless of the motor direction. From the time the start signal is given to the VFD to the time the VFD has control of the motor shall not exceed two (2) seconds. Once the VFD has control of the motor it will then accelerate or decelerate the motor to the active reference speed without tripping or faulting or causing component damage to the VFD. The VFD shall also be capable of flux braking at start to stop a reverse spinning motor prior to ramp.
- E. The VFD 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 7 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 energy optimization for optimizing efficiency and limit the audible noise produced by the motor by providing the optimum magnetic flux for any given speed / load operating point.
- I. The VFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The VFD 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 VFD acceleration from zero speed without signaling a false underload condition.

- J. Three (3) programmable critical frequency lockout ranges shall be provided to prevent the VFD from operating the load continuously at an unstable speed.
- K. The VFD shall offer software to select the VFDs action in the event of a loss of the primary speed reference.

Part 3 - OPTIONS

- 3.01 Wall mount VFDs from 0.75 to 350HP
 - A. UL Type 12 (IP55) enclosure.
 - B. VFD control panel mounting on separate enclosure or cabinet door
 - C. Dynamic braking chopper with 100% continuous duty internally mounted in VFD enclosure (up to 30HP as a default for ACS580).
 - D. Second Environment EMC / RFI filter and First environment EMC / RFI filter
 - E. Input and Output extension modules;
 - 1. Analog input and output expansion
 - 2. Digital input and output expansion
 - 3. Speed and position feedback for resolver interface
 - 4. Fieldbus communication modules (protocols);
 - a. DeviceNet
 - b. ControlNet
 - c. EtherNet / IP
 - d. ModBus TCP/IP
 - e. ModBus
 - f. ProfiBus DP
 - g. ProfiNet
 - h. CANopen
 - i. EtherCat
 - j. POWERLINK

Part 4 - EXECUTION

- 4.01 INSTALLATION
 - A. The VFD manufacturer shall provide adequate drawings and instruction material to facilitate installation of the VFD by qualified electrical and mechanical personnel employed by others.
- 4.02 START-UP
 - A. Authorized factory start-up shall be provided for each VFD by a factory authorized service center. A certified start-up form shall be filled out for each VFD 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 VFD with a certified factory start-up.
- 4.03 PRODUCT SUPPORT
 - A. Factory trained application engineering and service personnel that are thoroughly familiar with the VFD 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.

4.04 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 authorized start-up (applicable in the USA and Canada only), 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.