SIEMENS

Guide Specification for Variable Frequency Drives
Siemens SED2 (1/2-125HP)
Division 15/16

PART 1-GENERAL

1.01 DESCRIPTION
This specification is to cover a complete Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor. The drive shall be manufactured by Siemens, be designed specifically for variable torque applications, and shall be designated "SED2 Series" or approved equal.

The drive manufacturer shall supply the AC drives and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of fifteen years.

1.02 QUALITY ASSURANCE
A. Referenced Standards:
1. Institute of Electrical and Electronic Engineers (IEEE)
a) Standard 519-1992, IEEE Guide for Harmonic Content and Control
2. Underwriters laboratories
a) UL508C
3. National Electrical Manufacturer's Association (NEMA)
a) ICS 7.0, AC Adjustable Speed Drives

B. Testing:
All printed circuit boards shall be completely tested and burned-in before being assembled into the completed VFD. The VFD shall then be subjected to a computerized systems test (cold), burn-in, and computerized systems test (hot). The burn-in shall be at 104 °F (4Õ°C), at full rated load. All testing and manufacturing procedures shall be ISO 9001 certified.

C. Qualifications:
VFDs and options shall be UL and cUL listed as a complete assembly. VFDs and options shall be CE labeled as a component.

PART 2 – PRODUCTS

2.01 VARIABLE FREQUENCY DRIVES
The Variable Frequency Drives (VFDs) shall be solid state, with a Pulse Width Modulated (PWM) output. The VFD package as specified herein shall be enclosed in a NEMA 1 enclosure, completely assembled and tested by the manufacturer. The VFD shall employ a full wave rectifier (to prevent input line notching), capacitors, and Insulated Gate Bipolar Transistors (IGBT's) as the output-switching device. The drive efficiency shall be 96% or

better at full speed and full load. Displacement power factor shall be no less than 0.98 at all speeds and loads.

Harmonic Distortion Control

The VFD design shall incorporate mechanisms that lower the harmonic currents caused by the drive as compared to standard six-pulse drives onto the AC power line. This design shall be HVAC specific low DC link capacitance. Harmonic distortion at the drive is not to exceed 29% without the use of additional components such as line reactors or DC link chokes.

Harmonic calculations shall be supplied upon request based on a single line diagram of the electrical system. This diagram shall include transformer(s) KV, kVA and impedance percentage to accurately predict the harmonic levels at the PCC (Point of Common Coupling), as specified by IEEE519-1992. The calculations shall be made with the point of the common coupling being the utility feeder.

Specifications:

1. Input voltage 208-240, 380-480, 575-600 VAC +/- 10%, 3 phase, 48-63 Hz.
2. Voltage tolerance + or – 10% of specified line voltage.
3. Output Frequency 0 to 150 Hz. Operation above 60 Hz shall require programming changes to prevent inadvertent high-speed operation.
4. Environmental operating conditions: 0 to 40°C, 0 to 1000 meters above sea level, less than 95% humidity, non-condensing.
5. Enclosure shall be rated NEMA 1 or as specifically mentioned elsewhere.

All VFDs shall have the following standard features:

1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad is to be used for local control, for setting all parameters, and for stepping through the displays and menus. The keypad shall be removable, capable of remote mounting. An optional keypad shall allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
2. The keypad shall include Hand, Auto, Stop selections. When in “Hand”, the VFD will be started and the speed will be controlled from the up/down arrows. When in “Off”, the VFD will be stopped. When in “Auto”, the VFD will start via an external contact closure and the VFD speed will be controlled via an external speed reference. The drive shall incorporate “bumpless transfer” of speed reference when switching between “Auto” and “Hand” modes.
3. An optional Advanced Operator Interface (AOP) shall be available for local control, for setting all parameters, and for stepping through the displays and menus. The display shall as a minimum be 4 lines x 30 characters in size. The keypad shall be removable, capable of remote mounting, and shall have it’s own non-volatile memory. An optional keypad shall allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.

4. The following operating information displays shall be standard using an optional VFD digital display. All applicable operating values shall be capable of being displayed in engineering (user) units. All parameters viewed from the list below shall be capable of

being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable).

- Output Frequency
- Motor Current
- Calculated Motor Power (kW)
- Output Voltage
- Analog Input Values
- Keypad Reference Values
- KWh meter (resettable)
- Digital input status
- Motor Speed (RPM, %, or Engineering units)
- Calculated Motor Torque
- DC Bus Voltage
- Heatsink Temperature (deg F)
- Analog Output Value
- Elapsed Time Meter (resettable)
- MWh meter
- Digital output status

5. The VFD's shall include a Quick Start feature that leads the user through the most typical HVAC required parameters.
6. 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.
7. The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
8. The VFD shall also be capable of DC injection braking that can be employed to stop a free wheeling motor prior to starting to avoid overvoltage nuisance tripping.
9. The VFD shall have the ability to be programmed to automatically extend the ramp-down time as required to keep the drive from tripping on over-voltage caused by regeneration of power by the load
10. If the input reference (0/4-20mA or 0/2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD 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 communication bus.
11. The customer terminal strip shall be isolated from the line and ground.
12. The drive shall employ current limit circuits to provide trip free operation:
    - The Slow Current Regulation limit circuit shall be adjustable to 150% (minimum) of the VFD's normal duty current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.
    - The Current Switch-off limit shall be fixed at 180% (minimum, instantaneous) of the VFD's normal duty current rating.
13. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute in every 10 minutes.

14. The VFD shall incorporate a Pump Controller/Cascade function which allows for staging of three (3) individual pumps. Used for constant pressure/constant flow systems. The VFD parameters can be set to switch digital outputs once full speed is reached on the inverter-controlled motor.

15. The VFD shall be capable of sensing a loss of load (broken belt / no water in pump) or high current mechanical sensing failure, and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus.

All VFDs to have the following adjustments:

2. Four (4) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.
3. A custom PID preset for HVAC & fluid systems, allow a pressure or flow signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 100 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID setpoint shall be adjustable from the VFD keypad, analog inputs, digital inputs, or over the communications bus. A Hibernation mode shall be included in the PID functions. This feature shall allow the motor to be stopped when at minimum speed for a user defined period, for additional energy savings.
4. VFD PID shall incorporate pre-configured sensor selections that automatically configure the scaling for the selected sensor.
5. Two (2) programmable analog inputs shall accept a current, voltage, or Ni 1000 sensor level input signal for speed reference, or for reference and actual (feedback) signals for PID controller.
6. Analog inputs shall include a filter to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 ma and 0 - 10 Volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz. Process variables shall be capable of being inverted.
7. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. One digital input is to be utilized as a customer safety connection point for fire, freeze, and smoke interlocks (Enable). These inputs can also be used to activate the setpoints of individual control loops.
8. Two (2) programmable analog output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.
9. Two (2) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; Continuous current rating 2 amps RMS. Outputs shall be full form C relay contacts; open collector outputs are not acceptable.
10. Fifteen (15) programmable preset speeds.
11. Two independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 650 seconds.
12. The VFD shall Ramp or Coast to a stop, as selected by the user.
13. The displayed operating information shall be user selectable.
14. Up to 20 parameters shall be user selected for storing in a user grouping for ease of configuration and customization.

The VFD shall have the following protection circuits. In the case of a protective trip, the drive shall announce the fault condition on the keypad display:

- Overcurrent
- Overvoltage
- Undervoltage
- Overtemperature, Heatsink Temperature
- Ground Fault either running or at start
- Adaptable Electronic Motor Overload (I 2 t). The Electronic Motor Overload protection shall protect the motor based on speed, load curve, and external fan parameter. Circuits, which are not speed dependant, are unacceptable. The electronic motor overload protection shall be UL Listed for this function.

Speed Command Input shall be via any of the following:

1. Keypad
2. Two Analog inputs, each capable of accepting a 0-20mA, 4-20mA, 0-10V, 2-10V signal, and direct NI 1000 temperature sensor input.
3. Serial Communications

Communications

1. The VFD shall have an RS-485 port as standard. The standard protocol shall be selectable between Siemens Building Technologies, Inc. P1 (FLN) protocol, and Johnson Controls Inc. N2 Metasys protocol. There shall be an optional LON (LONMARK) interface and Modbus interface.
2. Serial communication capabilities shall include, but not be limited to, run-stop control; speed set adjustment, proportional/integral/derivative PID control (Set Point) adjustments, and accel/decel time adjustments. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed/frequency, current (in amps), % torque, power (kW), relay outputs, digital inputs and diagnostic warning and fault information. Additionally, remote (LAN) VFD fault reset shall be possible. A minimum of 15 field parameters shall be capable of being monitored.

PART 3 – EXECUTION

3.01 INSTALLATION

1. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.
2. The electrical contractor shall complete power wiring. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.02 START-UP

1. Certified factory start-up shall be provided 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.

3.03 PRODUCT SUPPORT

1. Factory trained application engineering and service personnel that are thoroughly familiar with the SED2 drive products offered will be locally available at both the specifying and installation locations.

3.04 WARRANTY

1. Warranty shall be 24 months from the date of shipment (with certified start-up).

OPTIONAL FEATURES – [Select as necessary] Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly.

1. Electronic Bypass Controller –
    a. Control of bypass operation shall be done by a membrane keypad.
    b. Both Local bypass and Remote bypass control shall be provided. When Remote bypass is enabled, the building automation system will be able to start and stop the motor for such things night-time shut down.
    c. The bypass package shall include the ability for the user to enable interlocked start features that will not allow the motor to run in drive hand, drive auto or bypass until a confirming end switch has been closed.
    d. User selectable auto bypass feature based on a drive relay shall be included. This will allow the user to have the motor operated in bypass mode when the drive faults or for purposes selected by the user through parameterization.
    e. User selectable essential service shall be provided that allows a contact closure to operate the motor at full speed, ignoring all calls to stop.
    f. Multiple status lights shall show system operation. These shall include bypass contactor closed, drive input contactor closed (when supplied), drive output contactor closed, hand bypass operation, remote bypass operation, remote start closed, interlocked start enabled, interlocked start proofed, overload fault, and safety fault.
    g. Electronic bypass shall be either two or three contactor type. On three contactor bypass units the user shall be able to test the drive both energized and de-energized by use of a selector that operates the input contactor without regard of the output contactor.
    h. Contactors shall be interlocked to ensure that both the drive output and bypass contactors do not close simultaneously.
    i. Two safety inputs shall be available for customer connecting. If either of these inputs opens, the electronic bypass will not operate the motor in bypass or drive mode.

These inputs are typically used for such things as fire alarm and freeze stat.

j. A class 10 motor overload shall protect the motor in bypass mode. The drive's built-in motor overload shall protect the motor in drive mode.

k. Control voltage if the bypass panel will be supplied by a step down 120vac secondary transformer w/ a fused primary and secondary.

2. Door / cover interlocked disconnect switch which will disconnect all input power from the drive, bypass and all internally mounted options. The disconnect handle shall be through the door, and be pad-lockable in the "Off" position.

3. Input short circuit protection may be by motor rated fuses or circuit breaker Expensive custom semi-conductor fuses will not be required.

4. Optional line or load reactor, when supplied, shall be mounted in the options/bypass enclosure.

End