

Specification Guide for Siemens BT300 HVAC Variable Frequency Drives Division 15/16

Part 1 - General

1.01 Description

This specification covers the complete Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard Type Design B induction motor. The drive shall be manufactured by Siemens, be designed specifically for variable torque applications, and shall be designated "BT300 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) UL508
 - b) UL508C
3. National Electrical Manufacturer's Association (NEMA)
 - a) ICS 7.0 AC Adjustable Speed Drives
4. International Electro technical Commission (IEC)
 - a) EN/IEC 61800-3
5. National Electric Code (NEC)
 - a) NEC 430.120, Adjustable-Speed Drive Systems

B. Testing:

The VFD shall have undergone extensive testing from design to deployment. This testing includes highly accelerated stress testing in extreme temperatures, vibration, and humidity as well as current and voltage variations.

All printed circuit boards shall be completely tested and burned-in before being assembled into the completed VFD. All testing and manufacturing procedures shall be ISO 9001 certified. Test reports for each drive supplied shall be available upon delivery.

C. Qualifications:

VFDs and options shall be UL508 and cUL listed as a complete assembly. The base VFD shall be UL listed for 100 kA SCCR.

The VFD assembly including bypass if specified, shall be seismically certified and labeled in accordance with the 2012 International Building Code (IBC).

The base VFD shall conform to the European Union Electromagnetic Compatibility directive and CE requirement. The VFD shall meet EN 61800-3 for the First Environment restricted level (Category C2).

All enclosures, UL Type 1 and Type 12 (with or without an integral disconnect) shall have the same footprint.

D. Submittals

Submittals shall include the following information:

Outline dimensions, conduit entry location and weights

Customer connection and power wiring diagrams

Complete technical product description include a complete list of options provided

Part 2 - Products

2.01 Variable Frequency Drives

The Variable Frequency Drives (VFDs) shall be solid state, with 6-Pulse Width Modulation (PWM) output. The VFD package as specified herein shall be enclosed in a Type 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 97% or better at full speed and full load. Displacement power factor shall be no less than 0.98 at all speeds and loads.

All VFD provided shall have the following:

- Input voltage 208-240, 380-480 +/- 10% of the nominal voltage.
- VFDs shall be capable of continuous full load operation under the following conditions
 - Voltage tolerance + or – 10% of specified line voltage.

- Output Frequency 0 to 150 Hz. Operation above 60 Hz shall require programming changes to prevent inadvertent high-speed operation.
- Environmental operating conditions: 0 to 40°C, 0 to 1000 meters above sea level, less than 95% humidity, non-condensing.
- Enclosure shall be rated UL Type enclosures 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 and have its own non-volatile memory. The keypad shall be capable of uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
2. The keypad shall include Hand, Auto, and 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. All circuit boards shall be varnished to meet IEC 60068-2-60 Method 1 and be able to withstand hydrogen sulfide (H₂S) and sulfur dioxide (SO₂)
4. A built-in time clock shall be housed in the keypad. The clock shall have a battery backup with 10 years minimum life span, The clock shall be used to date and time stamp faults and record operating parameters at the time of fault.
5. The VFD shall have start-up wizards visible on the keypad for quick access to application macros specifically designed to facilitate start-up.
6. The user shall be able to define any parameter as a favorite using the keypad.
7. The VFD shall have cooling fans designed to be replaced without removing the VFD from the wall or removing the VFD enclosure. The cooling fan shall operate for a period of 10 years before it is replaced.
8. The VFD shall include capacitors which do not require conditioning prior to installation. The VFD shall have an infinite shelf life.
9. The VFD fans shall operate only when require. The user shall have the ability to choose additional cooling fan control.
10. The VFD shall monitor and display using the keypad nine (9) parameters at one time without the need to scroll through multiple screens. Each parameter shall be user defined. The following is a sample of the parameters which can be monitored and view using the keypad. 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	
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Motor Speed (RPM, %, or Engineering units)	Motor Current
Calculated Motor Torque	Calculated Motor Power (kW)
DC Bus Voltage	Heatsink Temperature (deg F)
Output Voltage	Analog Input Values
Analog Output Value	Keypad Reference Values
Elapsed Time Meter (resettable)	KWh meter (resettable)
MWh meter	Digital input status
Digital output status	

11. The VFD's shall include a Quick Start-up wizard that leads the user through the typical HVAC required parameters.
12. 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.
13. 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).
14. 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.
15. 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
16. 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.
17. The VFD shall include two-zone PID controllers that allow the drive to maintain PID control from two separate feedback signals. VFD shall include two PID set point sources, a sleep mode function, PID set point boost and a feed forward function to improve process response.
18. Run permissive circuit shall be included for damper or valve control.
19. The customer terminal strip shall be isolated from the line and ground.
 - duty current rating.
20. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute in every 10 minutes.
21. The VFD shall have integrated harmonic filters equivalent to 5% impedance line reactors. .

22. The VFD shall incorporate a Multi-Pump Controller Wizard capable of controlling up to five motors. The VFD is connected to one motor which is the "regulating" motor connecting and disconnecting the other motors to/from the mains, by means of contactors controlled with relays to maintain a given set point. This function shall have an auto-change function for changing starting order of pumps which allows for equal wear on all pumps.
23. 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.
24. The VFD shall include a motor switch ride through and is enabled or disabled through the keypad. This feature allows the motor maintenance switch to be opened and closed without stopping or tripping the drive.

All VFDs to have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.
2. A custom PID preset for HVAC and 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. A sleep 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.
3. Two (2) programmable analog inputs shall accept a current or voltage.
4. 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.
5. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. These inputs can also be used to activate the setpoints of individual control loops.
6. One (1) 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.
7. Two (3) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 250 Vac and 0.4A at 125 Vac. Outputs shall be full form C relay contacts; open collector outputs are not acceptable.
8. The VFD shall be capable of adding additional I/O as required for the system. The additional I/O shall mount in the drive and not require bypass configuration. Additional I/O include
 - Six (6) additional programmable digital inputs or outputs
 - Five (5) digital inputs with a relay output
 - 2 additional relay outputs with a thermostat
 - One (1) each additional Analog Input and two (2) analog outputs
 - Three (3) relay outputs

9. Fifteen (15) programmable preset speeds.
10. Two independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 3600 seconds.
11. The VFD shall be capable of catching a “spinning motor” as programmed by the user.
12. The VFD shall Ramp or Coast to a stop, as selected by the user.
13. The displayed operating information shall be user selectable and include up to nine parameters which can be viewed and monitored at one time.
14. All applicable operating values shall be displayed in engineering (user) units.
15. The keypad shall include a backlit LCD display. The display shall be in complete words for programming and fault diagnostics.
16. The keypad shall utilize wizards to help navigate your HVAC application. These wizards will walk you through the steps required for PID set-up, Start-up and Multi-pump applications.
17. The VFD shall include a fireman’s override input.
18. All VFDs shall include EMI/RFI filters. The filters shall allow the VFD assembly to be CE marked and meet product standard EN 61800-3 for the First Environment restricted level (Category C2).
19. The VFD shall have an optional integrated disconnect switch which will not add any additional enclosures to the drive and be the same footprint as a drive without an integral disconnect switch.
20. The VFD shall have the following protection circuits. The drive shall announce in full text the fault condition on the keypad display and shall display a HELP function which explains the possible cause of the fault and the possible remedy. The following protection circuits are:
 - Over current
 - Overvoltage
 - Undervoltage
 - Unit over-temperature protection
 - Ground fault protection
 - Mains supervision
 - Motor phase supervision
 - Motor stall protection
 - Motor overload protection
 - Motor underload protection

- Short-circuit protection of +24V

Speed Command Input shall be accomplished using any of the following:

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

Communications

The VFD shall have an RS-485 and Ethernet as standard. The standard embedded protocols shall be BACnet MS/TP, BACnet IP, Modbus RTU, Modbus TCP, Siemens APOGEE P1 (FLN) protocol and Johnson Controls Inc. N2 Metasys protocol. There shall be an optional LON (LONMARK) interface.

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.

Optional Features

Optional features shall be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

Bypass

- Bypass shall be furnished and mounted by the drive manufacturer as defined on the VFD schedule. All VFD with bypass configurations shall be UL Listed as a complete assembly and carry a UL508 label.
- A complete factory wired and tested bypass system consisting of an output and bypass contactors along with a mechanical service switch to isolate the drive from the circuit. A door interlocked, padlockable circuit breaker or optional fused disconnect shall be standard.
- The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the "off" position before either enclosure may be accessed.
- The VFD and bypass package with a fused disconnect shall have a UL listed short circuit rating (SCCR) of 100,000 Amps and this rating shall be indicated on the UL data label.
- Serial communications – the bypass shall be capable of being monitored and/or controlled using serial communications. On-board communications protocols shall include ModBus RTU; ModBus TCP; BACnet MS/TP; BACnet IP; Siemens Industry, Inc. FLN (P1); AND Johnson Controls N2.

- The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process.
- There shall be a keypad adjustment to select manual or automatic transfer bypass.
- The digital inputs for the system shall accept 24 Vac or 24 Vdc. The bypass shall incorporate an internally sourced power supply and not require an external control power source.
- There shall be a run permissive circuit for damper or valve control.
- There shall be a list of conditions which the user can determine when the drive will automatically transfer to bypass operation.
- Each bypass enclosure shall incorporate a diagnostic board for troubleshooting the bypass components.
- Electronic bypass must incorporate an electronic override capability to allow the bypass to run in the event of a catastrophic failure of the control system. The drive will run in bypass and still maintain all safeties.
- Both Local and Remote bypass control shall be provided. When remote bypass is enabled, the bridling automation system will be able to start and stop the motor for such things as night time shut down. .
- 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.
- 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.
- User selectable essential service shall be provided that allows a contact closure to operate the motor at full speed, ignoring all calls to stop.
- Contactors shall be interlocked to ensure that both the drive output and bypass contactors do not close simultaneously.
- 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.

Part 3 – Execution

3.01 Installation

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.

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

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

Factory trained application engineering and service personnel that are thoroughly familiar with the BT300drive products offered will be locally available at both the specifying and installation locations.

3.04 Warranty

Warranty shall be 18 months from date of manufacture or 30 months with certified start-up.

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