\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Master Specification Note - Delete this page before use

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



*ABB Inc.*

*Effective January 1, 2019*

*ACH580-PNPT04U-EN REV A*

*Short Form Sample Specification for
6 Pulse & Ultra Low Harmonic*

*Variable Frequency Drives*

*For HVAC Applications*

To remove formatting restrictions use password: ABBHVAC - not recommended

Example styles in this document per CSI Master/Section/Page specifications. Sub paragraphs levels 5 and 6 are added to compensate for all 9 multi-list level styles in Microsoft Word

1. Part
	1. Part | Article
		1. Part | Article | Paragraph
			1. Part | Article | Paragraph | Sub 1
				1. Part | Article | Paragraph | Sub 2

Part | Article | Paragraph | Sub 3

Part | Article | Paragraph | Sub 4

Part | Article | Paragraph | Sub 5

Part | Article | Paragraph | Sub 6

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Master Specification Note: This guide specification is written according to the Construction Specifications Institute (CSI) Format. The section must be carefully reviewed and edited by the Architect or Engineer to meet the requirements of the project. Coordinate this section with drive schedule, other specification sections and the drawings.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

HEATING, VENTILATING & AIR CONDITIONING [23 ## ##]

VARIABLE FREQUENCY DRIVES

1. GENERAL
	1. DESCRIPTION
		1. This specification is to cover a complete Variable Frequency Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with both asynchronous and permanent magnet motors.
		2. The drive manufacturer shall supply the drive and all necessary options as specified. All drives installed on this project shall be from the same manufacturer and have a common user interface (control panel). Drives that are manufactured by a third party and “brand labeled” shall not be acceptable.
		3. This specification is intended to supplement a drive schedule. The drive schedule identifies the optimized BOM for the project and includes quantity, size, voltage, enclosure rating, options, and harmonic mitigation requirements of the drives. IEEE 519-2014 is an electrical system standard for harmonic mitigation and not intended to be applied to an individual piece of equipment. Drives are only one of many sources of harmonics, thus verification of system IEEE 519-2014 compliance is beyond the VFD manufacturer’s scope. The EOR (Engineer of Record) is responsible for conducting an electrical system study and verifying the drive schedule has specified proper harmonic mitigation for the drives.
	2. QUALITY ASSURANCE
		1. Referenced Standards and Guidelines:
			1. Institute of Electrical and Electronic Engineers (IEEE)
				1. IEEE 519-2014
			2. Underwriters Laboratories (as appropriate)
				1. UL 508, 508A, 508C, UL 61800, 61800-5-1, 61800-5-2, UL 1995
			3. The Association of Electrical Equipment and Medical Imaging Manufacturers (NEMA)
				1. NEMA ICS 7-2014, Adjustable Speed Drives
			4. International Electrotechnical Commission (IEC)
				1. EN/IEC 61800
			5. National Electric Code (NEC)
				1. NEC 430.120, Adjustable-Speed Drive Systems
			6. CSA Group
				1. CSA C22.2 No. 274
			7. International Building Code (IBC)
				1. IBC 2018 Seismic – referencing ASCE 7-16 and ICC AC-156
		2. Qualifications:
			1. Drives shall be UL labeled as a complete assembly. The base VFD shall be UL listed for 100 kA SCCR when installed in accordance with the manufacturer’s guidelines.
			2. The base drive shall be CE and meet EN 61800-3 for the First Environment restricted distribution (Category C2).
			3. The base drive shall be seismically certified per 2018 International Building Code (IBC) with a seismic importance factor of 1.5, and minimum 2.5 SDS rating. Seismic certification of equipment and components shall also be provided by OSHPD preapproval.
			4. The base drive shall be SEMI-F47 certified. The drive must tolerate voltage sags to 50% for up to 0.2 seconds, sags to 70% for up to 0.5 seconds, and sags to 80% for up to one second.
			5. Acceptable Manufacturers
				1. ABB ACH Series.
				2. Alternate manufacturer’s requests shall be submitted in writing to the Engineer for approval at least 20 working days prior to bid. Approval does not relieve the supplier of specification requirements.
	3. SUBMITTALS
		1. Submittals shall include the following information:
			1. Outline dimensions, conduit entry locations and weights. Customer connection and power wiring diagrams.
			2. OSHPD preapproval, seismic certification and installation requirements where applicable.
			3. Complete technical product description with complete list of options provided. Any portions of this specification not met must be clearly indicated or the supplier and contractor shall be liable to provide all additional components required to meet this specification.
2. PRODUCTS
	1. VARIABLE FREQUENCY DRIVES
		1. The drive package as specified herein and defined on the drive schedule shall be enclosed in a UL Type enclosure.
		2. The drive shall provide full rated output from a line of +10% to -15% of nominal voltage across an ambient temperature range of -15 to 40° C (5 to 104° F).
		3. All drives shall utilize the same Advanced Control Panel (keypad) user interface.
			1. Plain English text
				1. The display shall be in complete English words for programming and fault diagnostics.
				2. Safety interlock and run permissive status shall be displayed using predetermined application specific nomenclature, such as: Damper end switch or vibration trip. Customized terms, such as: AHU-1 End Switch or CT-2 Vibration shall also be available.
			2. The control panel shall include at minimum the followings controls:
				1. Four navigation keys (Up, Down, Left, Right) and two soft keys.
				2. Hand-Off-Auto selection, Fault Reset, and manual speed control.
				3. A Help key shall include assistance for programming and troubleshooting.
			3. There shall be a built-in time clock in the control panel with 10-year battery backup.
			4. I/O Summary display with a single screen shall indicate and provide:
				1. The status/values of all analog inputs, analog outputs, digital inputs, and relay outputs.
				2. The function of all analog inputs, analog outputs, digital inputs, and relay outputs.
				3. The ability to force all inputs and outputs to either a high, low, or specific value.
			5. The drive shall automatically backup parameters to the control panel. The drive shall allow two additional unique manual backup parameter sets to be stored.
			6. The control panel shall be removable, capable of remote mounting.
			7. The drive shall be able to support a Bluetooth Advanced Control Panel. The Bluetooth control panel shall be FCC and QDL (Qualified Design Listing) certified.
				1. A free app (iOS and Android) shall replicate the control panel on a mobile device or tablet. The control panel’s programming and control functionality shall function on the device. Customizing text, such as AHU-1 End Switch, shall be supported by the device’s keyboard.
				2. Bluetooth connectivity shall allow uploading, downloading, and emailing of parameters.
				3. Bluetooth connectivity shall include two pairing modes: Always discoverable with a fixed passcode, and manual discovery with a unique generated passcode every pairing.
		4. All drives shall have the following hardware features/characteristics as standard:
			1. Two (2) programmable analog inputs, two (2) programmable analog outputs, six (6) programmable digital inputs, and three (3) programmable Form-C relay outputs.
			2. The drive shall include an isolated USB port for interface between the drive and a laptop.
			3. An auxiliary power supply rated at 24 VDC, 250 mA shall be included.
			4. At a minimum, the drives shall have internal impedance equivalent to 5% to reduce the harmonics to the power line. 5% impedance may be from dual (positive and negative DC link) chokes, or AC line reactor. Drives with only one DC link choke shall add an AC line reactor integral to the drive enclosure. Reference the drive schedule to determine if additional harmonic mitigation is required for the system to comply with IEEE 519-2014. If Active Front End (Ultra Low Harmonic) drives are specified on the schedule, they must meet the following characteristics:
				1. An IGBT based active front end shall be used for mitigation of low frequency harmonics. A LCL filter shall be installed in front of the IGBTs to remove high frequency harmonics.
				2. Limit the current distortion to 3% total harmonic current distortion, when measured at the lugs of the drive.
				3. The drive shall provide full motor nameplate voltage while operating the motor at nameplate RPM. The output IGBTs must be modulating and in control of the motor during this 100% speed/load operating condition. The specified 3% current distortion and 1.0 displacement power factor shall be achievable during this operating condition.
				4. The hardware structure of the front end shall boost the DC bus voltage by 10% during low line conditions.
				5. Displacement power factor shall be 1.0 throughout the speed range.
			5. The drive shall have variable speed primary cooling fans.
			6. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds every minute.
			7. The input current rating of the drive shall not be greater than the output current rating.
			8. Circuit boards shall be coated per IEC 60721-3-3; Chemical gasses Class 3C2 and Solid particles Class 3S2.
			9. Coordinated AC transient surge protection system consisting of 4 MOVs (phase-to-phase and phase-to-ground), a capacitor clamp, and internal chokes. The MOVs shall comply with UL 1449 4th Edition.
			10. The drive shall include a robust DC bus to provide short term power-loss ride through. An inertia-based ride through function should help maintain the DC bus voltage during power loss events. Drives with control power ride through only, are not acceptable.
		5. All drives shall have the following software features as standard:
			1. A Fault Logger that stores the last 16 faults in non-volatile memory. The most recent 5 faults save at least 9 data points, including but not limited to: Time/date, frequency, DC bus voltage, motor current, DI status, temperature, and status words.
			2. An Event Logger that stores the last 16 warnings or events that occurred, in non-volatile memory. Events shall include, but not limited to: Warning messages, checksum mismatch, run permissive open, start interlock open, and automatic reset of a fault.
			3. Programmable start methods: Flying-start, Normal-start, and Brake-on-start.
			4. Programmable loss-of-load (broken belt / coupling) indication. This function to include a programmable time delay to eliminate false loss-of-load indications.
			5. Motor heating function to prevent condensation build up in the motor. Motor heating adjustment, via parameter, shall be in “Watts.”
			6. There shall be a run permissive circuit for damper or valve control.
			7. Four separate start interlock (safety) inputs shall be provided. The control panel will display the specific safety(s) that are open.
			8. The drive shall include a switching frequency control circuit that reduces the switching frequency based on actual drive temperature. It shall be possible to set a minimum and a target switching frequency.
			9. The ability to automatically restart after non-critical faults.
			10. PID functionality shall be included in the drive.
			11. Drive shall be compatible with an accessory that allows the control board to be powered from an external 24 VDC/VAC source.
			12. A computer-based software tool shall be available to allow a laptop to program the drive. The drive shall be able to support programming without the need for line voltage. All necessary power shall be sourced via the laptop USB port.
			13. The drive shall include a fireman’s override mode.
		6. Security Features
			1. The drive manufacture shall clearly define cybersecurity capabilities for their products.
			2. The drive shall include password protection against parameter changes. There shall be multiple levels of password protection including: End User, Service, Advanced, and Override.
			3. A checksum feature shall be used to notify the owner of unauthorized parameter changes made to the drive.
			4. The “Hand” and “Off” control panel buttons shall have the option to be individually disabled (via parameter) for drives mounted in public areas.
		7. Network Communications
			1. The drive shall have an EIA-485 port with removable terminal blocks. The onboard protocols shall be BACnet MS/TP, Modbus, and Johnson Controls N2. Optional communication cards for BACnet/IP and LonWorks shall be available.
			2. The drive shall have the ability to communicate via two protocols at the same time, one onboard protocol and one option card based protocol.
			3. The drive shall not require a power cycle after communication parameters have been updated.
			4. The embedded BACnet connection shall be a MS/TP interface. The drive shall be BTL Listed to Revision 14 or later.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Master Specification Note: Variable Frequency Drive options are included in the following paragraphs. All required options must be defined on the drive schedule.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* + 1. Disconnect – A circuit breaker or disconnect switch shall be provided when indicated on the drive schedule. The disconnect shall be door interlocked and padlockable. Drive input fusing shall be included on all packaged units that include a disconnecting means. All disconnect configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.
		2. Bypass – Bypass drive packages shall be provided when indicated on the drive schedule. All drive/bypass configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.
			1. The drive and bypass package shall be a complete factory wired and tested bypass system consisting of a padlockable disconnect device, drive output contactor, bypass contactor, and drive input fuses.
			2. The bypass control shall be powered by a three-phase switch mode power supply with a voltage tolerance of +30%, -35%. Single-phase power supplies and control power transformers (CPT) are not acceptable.
			3. The drive and bypass package shall be seismic certified and labeled to the IBC with a seismic importance factor of 1.5. Seismic certification shall include OSHPD preapproval.
			4. All bypass packages shall utilize a LCD bypass control panel (keypad) user interface. The bypass control panel must be a separate display from the drive control panel.
			5. All bypasses shall have the following hardware features/characteristics as standard:
				1. Six (6) digital inputs and five (5) Form-C relay outputs.
				2. Drive isolation fuses shall be provided. Bypass designs which have no such fuses, or that only incorporate fuses common to both the drive and the bypass are not acceptable.
				3. The bypass shall be able to detect a single-phase input power condition while running in bypass, disengage the motor, and provide a single-phase input power indication.
				4. The bypass shall be designed for stand-alone operation and be completely functional in both Hand and Automatic modes, even if the drive and/or drive’s control board has failed.
			6. All bypasses shall have the following software features as standard:
				1. Programmable loss-of-load (broken belt / coupling) indication shall be functional in drive and bypass mode.
				2. Run permissive and start interlock control functionality shall be functional in bypass mode.
				3. The bypass control shall monitor the status of the drive and bypass contactors and indicate when there is a welded contactor contact or open contactor coil.
				4. The bypass shall include a selection for either manual or automatic transfer to bypass.
				5. The drive and bypass shall be designed to operate as an integrated system when in Override mode. There shall be four selectable Override modes: Bypass only, drive only, drive then transfer-to-bypass upon fault, and force to stop.
			7. Network communications – the bypass shall include BACnet MS/TP, Modbus, and Johnson Controls N2 as standard. Optional communication cards for BACnet/IP and LonWorks shall be available.
1. EXECUTION
	1. INSTALLATION
		1. The responsible party shall install the drive in accordance with the drive’s installation manual.
		2. Installation shall be in accordance with national, state and local building and electrical codes.
	2. START-UP
		1. Start-up shall be provided for each drive by an authorized local service provider.
	3. PRODUCT SUPPORT
		1. Factory trained support personnel shall be locally available at both the specifying and installation locations. A toll free 24/365 technical support line connected to factory support personnel located in the US and Canada shall be available.
		2. Training shall include installation, programming and operation of the drive, bypass and network communications. Owner training shall be provided locally upon request.
	4. WARRANTY
		1. The drive Product Warranty shall be 30 months from the date of shipment from the factory. The warranty shall include: Parts, on-site labor, and travel time and travel costs, or replacement of the complete drive as determined by the drive manufacturer’s technical support.

End of Section