

# Variable Frequency Drive (VFD)

# HV600 Mechanical Specification Submittal

# For IP20/UL TYPE 1 Rated Drives

## GENERAL

The HV600 is a high performance PWM (pulse-width-modulated) AC drive. Three-phase input line power is converted to a sine-coded, variable frequency output, which provides optimum speed control of any conventional squirrel cage induction motor. The use of IGBTs (Insulated Gate Bipolar Transistors), with a carrier frequency range of 2 kHz to 12.5 kHz, permits quiet motor operation.

This drive has one control logic board for all horsepower ratings. Printed circuit boards employ surface-mount technology, providing both high reliability, and small physical size of the printed circuit assemblies. The microprocessor delivers the computing power necessary for complete three-phase motor control in building automation systems.

Operating Principle: Input three-phase AC line voltage is first rectified to a fixed DC voltage. Using pulse width modulation (PWM) inverter technology, the DC voltage is processed, to produce an output waveform in a series of variable-width pulses. Unique firmware algorithms optimize motor magnetization through control of voltage, current, and frequency applied to generate a nearly sinusoidal output waveform.

## STANDARDS

UL 508C (Power Conversion)

CSA 22.2 No. 274-2017 (Adjustable Speed Drives)

UL 1995 (Plenum)

CE mark 2006/42/EC MD

CE mark 2014/35/EU LVD

CE mark 2014/30/EU EMC

EN 61800-3

EN 61800-5-1 (LVD)

IEC 60529

IEEE C62.41

BTL Listed

UL, cUL listed; CE marked

CBC, IBC, ASCE7, ICC-ES 156

HCAI (OSHPD)

## ENVIRONMENTAL & SERVICE CONDITIONS

Ambient service temperature:

-10°C to 40°C, 60°C maximum with derate

Ambient storage temperature IP20/UL TYPE 1: -20°C to 70°C

Humidity: 0% to 95%, non-condensing

Altitude: to 1,000 meters; 4,000 meters with derate

Service factor: 1.0

Vibration: 9.81 m/s² (1 G) maximum at 10 to 20 Hz, 2.0 m/s² (0.2 G) at 20 Hz to 55 Hz.

Plenum mounting capable

RoHS 2 Compliant

WEEE Directive

## QUALITY ASSURANCE

In-circuit testing of all printed circuit boards is conducted to ensure proper manufacturing.

Final printed circuit board assemblies are functionally tested via computerized test equipment.

All fully assembled controls are computer tested with induction motor loads to assure unit specifications are met.

The average MTBF (Mean Time Between Failure) is 28 years.

## CONSTRUCTION

VFD power input stage converts three-phase AC line power into a fixed DC voltage via a solid-state full-wave diode rectifier with MOV (Metal Oxide Varistor) surge protection. An internal 5% split choke built in both positive and negative DC bus reduces harmonics for cleaner power.

Intermediate Section of the VFD - DC bus maintains a fixed DC voltage with filtering and short circuit protection as a DC supply to the VFD output section. It is interfaced with the VFD diagnostic logic circuit to continuously monitor and protect the power components.

Output Section of the VFD - Insulated Gate Bipolar Transistors (IGBTs) convert DC bus voltage to a variable frequency and voltage, utilizing a PWM sine-coded output to the motor. Motor noise at 60 Hz is less than 2 dB above the motor noise from across-the-line operation when measured at a distance of one meter.

**POWER AND CONTROL ELECTRONIC HOUSINGS**

IP20/UL Type 1 wall-mounted enclosure: 208 V, 3 thru 100 HP; 480 V, 3 thru 250 HP

Microprocessor-based control circuit

Non-volatile memory (EEPROM); all programming memory is saved when the VFD is disconnected from power.

Digital operator keypad and display provide local control and readout capability:

Hand/Off/Auto commands

Speed Reference command

Reset command

Easy to remove heatsink cooling fan with programmable on/off control.

USB mini-B port for quick and easy PC connection

## PROTECTION

Output current overload rating of 110% for 60 seconds, 140% for 2 seconds, 175% instantaneous

Output short circuit protection

Current limited stall prevention (overload trip prevention) during acceleration, deceleration, and run conditions

Optically isolated operator controls

Fault display

“Hunting” prevention logic

Electronic ground fault protection

Electronic motor overload protection (UL approved)

DC bus charge indication

Heatsink overtemperature protection

Cooling fan operating hours recorded

Input/output phase loss protection

Line voltage sensors to monitor for brownout and blackout conditions with adjustable fault levels to ensure the proper settings pursuant to each application.

Reverse prohibit selectability

Suitable for use on a circuit capable of delivering not more than 100kA RMS symmetrical amperes

 **OPERATION**

Output frequency and speed display can be programmed for other speed-related and control indications, including: RPM, CFM, GPM, PSI, in WC, % of maximum RPM, or custom.

Power loss ride-through (2 seconds capable)

Time delay on start; peak avoidance for smooth generator switchover

VFD accepts either a direct acting or a reverse acting speed command signal.

Bi-directional “Speed Search” capability to start into a rotating load. Two types: current detection and residual voltage detection

DC injection braking, to prevent fan “windmilling”

Remote Run/Stop command input

Two programmable 0 to 10 VDC or 4-20 ma analog outputs, proportional to drive monitor functions including output frequency, output current, output power, PI feedback, output voltage and others

Eight programmable HVAC specific application presets

8-Line, 32-character HOA LCD display provides readout functions that include output frequency, output voltage, output current, output power, DC bus voltage, interface terminal status, PI feedback and fault status.

Over 100 programmable functions, resettable to factory HVAC presets

User parameter initialization to re-establish project specific parameters

Ramp-to-stop or coast-to-stop selection

Auto restart capability: 0 to 10 attempts with adjustable delay time between attempts

One custom selectable Volts/Hertz pattern and multiple preset Volts/Hertz patterns

Auto speed reference input signal, adjustable for bias and gain

While the VFD is running, operational changes in control and display functions are possible, including:

 Acceleration time (0 to 6000 seconds)

 Deceleration time (0 to 6000 seconds)

 Frequency reference command

 Hand/Off/Auto commands

 Monitor display

 Removable digital operator

Automatic energy saving, reduced voltage operation

 **PRODUCT FEATURES**

Displacement power factor of .98 throughout the motor speed range

Internal EMI/RFI filter complies with

EN 61800-3

Data logging – record status for up to 10 monitors with adjustable sample time

Built-In real time clock for time and date stamping events along with timer functions for starting, stopping and speed changes without the need for external controls

Voltmeter, ammeter, kilowatt meter, elapsed run time meter, and heatsink temperature monitoring functions

Two internal (PI) controls

Drive internal PI closed-loop control with selectable engineering units

Independent PI control for use with external device

Sleep function in both closed loop and open loop control

Feedback signal low pass filter

Feedback signal loss detection and selectable response strategy

Feedback signal inverse and square root capability

24 VDC, 150 mA transmitter power supply

Input and output terminal status indication

Diagnostic fault indication

VFD efficiency: 96% at half-speed; 98% at full-speed

“S-curve” soft start / soft stop capability

Run/Fault output contacts

Serial communication loss detection and selectable response strategy

“Up/Down” floating point control capability

Output Frequency 0 to 400 Hz

Controlled speed range of 40:1

Maximum output frequency; 400 Hz

Safe Torque Off: SIL3, PLe

140% starting torque capability, available from 3 Hz to 60 Hz

Remote speed reference (speed command) signal:

0 to 10 VDC (20 kΩ)

4 to 20 mA DC (250 Ω)

Critical frequency rejection capability: three selectable, adjustable bandwidths

Analog/Digital Virtual I/O – internally sends an output to an input (no wiring needed)

Adjustable carrier frequency, from 2 kHz to 12.5 kHz

Dynamic noise control for quiet motor operation

Programmable security code

Cloud service (Yaskawa Drive Cloud) for product registration and parameter storage

Store up to four additional parameter sets in keypad

Integrated PLC (DriveWorks EZ)

Seven programmable multi-function input terminals (24 VDC) providing 60+ programmable features, including:

Customer Safeties

BAS / Damper Interlock

Emergency Override – BAS interlock mode, min/max speed setting,

16 preset speeds

PI control enable / disable

Three programmable multi-function output relays (Form A rated 2 A @ 250 VAC & 30 VDC), providing 50+ functions, including:

Damper control

Hand / Auto Status

Contactor control for external bypass

Overtorque / undertorque detection

Serial communication status

No load detection (broken belt alert)

One fixed “Fault” Form C output relay (Rated 2 A @ 250 VAC & 30 VDC)

Nine preset speeds

Built-in BACnet, Siemens APOGEE FLN, Metasys N2, and Modbus RTU protocols accessible via RS-422/485 communication, which is standard. LonWorks, EtherNet/IP Dual Port (SI-EN3D), Multi-Protocol Ethernet Card and Modbus TCP/IP are optionally available.

BACnet Health monitors including Net Health, Tokens Received/Transmitted, Messages Received/Transmitted, Next/Previous Node Address, Max/Min Master Found, number of Nodes on Network, COV, MSTP Loop Time, CRC Errors, MSTP Tokens Lost/Retry, Deadtime Average

Rotational as well as Stationary motor auto-tuning

“Kinetic Energy Braking” (KEB) function stops the motor in up to half the time it would take without this function.

Control Methods Include:

 V/F Control

 Enhanced PM Motor control

 SynRM Motor Control

Motor Types:

 Induction

 Permanent Magnet

 Synchronous Reluctance

Temperature controlled fans

Side by side mounting (208V up to 40hp and 480V up to 100hp)

LCD keypad with Hand/Off/Auto and Copy keypad functions.

Motor preheat function

Self-regulating lead/lag control for multiple drives (up to 4)

Drive/motor alternation control (share motor run time for lead drive/motor)

Up to four PID setpoints

Draw down level selection for PID setpoint

Anti-no-flow control for deadhead protection

Pre-charge pump functionality

Low city alarm digital input

State/de-state control – add/remove drive based on feedback or output frequency

Single phase foldback

Flash upgradeable firmware

Heatsink overtemperature speed fold-back feature

“Bumpless” transfer between Hand and Auto modes

Emergency override can be used as “smoke purge” function

Fan failure detection and selectable drive action

Programming and firmware upgrade without three-phase main power DriveWizard Mobile

Programming Application

LED Status Ring

Conformal coating (IEC 60721-3-3, IP20/UL TYPE 1: 3C2, 3S2)