

PART 1 - GENERAL

1.0 Scope

This specification shall cover Toshiba HX7 Plus-Pack AC Variable Speed Drives, 6-pulse and 12-pulse for 380V - 480V.

1.1 References

The HX7 Plus-Pack drive shall comply with the following:

- A. National Electric Manufactures Association (NEMA) Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- B. National Electrical Code (NEC) NFPA 70.
- C. NEMA 250 Enclosures for Electrical Equipment.
- D. ISO 9001.
- E. UL 508.

1.2 Qualifications

1.2.1 Manufacturer History

Toshiba entered the AC adjustable speed drive market in the US in 1979. Toshiba International Corp continues to specialize in the design and manufacturing of both AC drives and induction motors at it manufacturing facility located in Houston, Texas.

1.2.2 Certification

Toshiba International Corporation, located in Houston Texas, is an ISO9001 certified manufacturing facility.

1.2.3 After Sales Support

Support is available direct from Toshiba's Houston facility or from a network of factorytrained distributors and certified service centers located throughout North America and Canada.

PART 2 – VARIABLE FREQUENCY DRIVES

2.0 General

- A. This specification covers AC adjustable frequency drives for industrial applications.
- B. The manufacturer shall not have less than fifteen years of experience in the manufacture of ASD's.
- C. The manufacturer shall manufacture both AC drives and motors at the same facility.
- D. The drives shall be manufactured in the United States.
- E. The drive should have a common design for all horse power models 50 through 1500HP.



2.1 Design Criteria

2.1.1 Input Power

- A. The drive main input power shall be:
 - I. Three-phase 380V-415V / 50Hz or 400V-480V / 60Hz
- B. The drive shall have a voltage tolerance of $\pm 10\%$.
- C. Input frequency tolerance shall be $\pm 5\%$ for all ratings.
- D. The efficiency of the drive shall be a minimum of 97.0% at full load at full speed. Displacement power factor will be greater than 0.95 lagging over the entire speed range.

2.1.2 Hardware Design

- A. Overall hardware design is for maximum flexibility, robustness, serviceability, and reliability for the most demanding applications.
- B. Power Terminations are oversized for the drive current rating to allow for flexibility on all power terminations.
- C. All ratings contain a minimum of three ground termination points.
- D. Power Terminations are 'finger safe' and clearly labeled with both the US (NEMA) standards (L1, L2, L3; T1, T2, T3) and IEC standards (R, S, T; U, V, W).
- E. The latest technology in packaging, heat sink design, and cooling is utilized to minimize overall size and weight without degrading performance or functionality.
- F. Plastics, where used, are UV resistant.
- G. Standard packaging is NEMA 1 for indoors and NEMA 3R for outdoors.
- H. Power Semiconductor heat sinks contain one or more thermal sensors monitored by the microprocessor to prevent semiconductor damage caused by excessive heat or fan loss.

2.1.3 Converter Section

2.1.3.1 6-Pulse Converter

- A. The drive employs diode bridge rectification to convert AC to DC. SCRs and other switching power devices are not used in the converter section of the drive to minimize line notching and RFI.
- B. The Converter Section is unaffected by phase rotation/phase sequence.
- C. Semiconductors on all ratings are sized (current) to allow full operation and overload capabilities at minimum input voltage.
- D. PIV Ratings of the rectifier will be as follows:
 - I. 460V drives—rectifier minimum PIV rating of 1600V
- E. The HX7 Plus-Pack drive has MOVs mounted phase-to-phase for surge protection.
- F. Isolation transformers are not required for operation on most standard distribution systems.



G. The converter section is usable on 50Hz and 60Hz distribution systems.

2.1.3.1 12-Pulse Converter

- A. The drive employs diode bridge rectification to convert AC to DC. SCRs and other switching power devices are not used in the converter section of the drive to minimize line notching and RFI.
- B. The Converter Section is unaffected by phase rotation/phase sequence.
- C. Semiconductors on all ratings are sized (current) to allow full operation and overload capabilities at minimum input voltage.
- D. PIV Ratings of the rectifier will be as follows:
 - a. 460V drives-rectifier minimum PIV rating of 1600V
- E. The HX7 Plus-Pack drive has MOVs mounted phase-to-phase for surge protection.
- F. The converter section employs two 6-pulse rectifiers which are connected in parallel to the same DC bus.
- G. Each rectifier is protected with a circuit breaker and a fast acting "semiconductor" fuses.
- H. An input **isolation** phase shifting transformer is required to achieve proper harmonic cancelation.
- I. The phase shifting transformer must have 2 secondaries rated at full voltage and shifted with a phase angle of 30°.
- J. The BIL of the transformer's secondaries must be at least 10kV.
- K. The phase shifting transformer is not provided as standard item.
- L. The phase shifting transformer must be designed by an experienced transformer manufacturer who must guarantee the proper voltage magnitude matching and phase angle.
- M. The converter section is usable on 50Hz and 60Hz distribution systems.

2.1.4 DC Bus Section

- A. Overall DC Bus design is passive capacitive filter to minimize ripple and maximize powerloss ride-through.
- B. DC Bus capacitance (total filter capacitance) is sized to eliminate any requirement for bus inductance (for filtering purposes) when the HX7 Plus-Pack is used on a three-phase distribution system.
- C. The DC bus voltage and current are monitored by the control section to prevent damage to either the drive or the driven equipment.
- D. All ratings will contain fast acting fuses in the DC Bus section.
- E. 460V drives bus capacitance voltage rating 800VDC (minimum)



- F. All capacitors have balance/discharge resistors to equalize charge voltage and permit safe discharge on power outage.
- G. Softcharge circuitry does not utilize power transistors.
- H. The DC Bus Section has power terminations allowing:
 - I. Rectifier Isolation (positive side)
 - II. DC Link inductor (163kVA and above)
- K. A readily visible LED indicates when DC voltages are present.

2.1.5 Inverter Section

- A. The inverter section makes use of the latest generation of IGBT power switching transistors to convert DC to three-phase, variable frequency, sinusoidal coded PWM waveform.
- B. IGBT initialization testing is performed by the control section on each power up and run command.
- C. The inverter section does not require commutation capacitors.
- D. All drives have software and hardware to limit reflected wave caused by long motor cable lengths.
- E. The IGBT ratings will be as follows:
 - I. 460V drives IGBT minimum Vce rating 1200V.
- F. All IGBTs have reversed biased diodes (free wheeling) to prevent IGBT failure when subjected to motor discharge spikes.
- G. The PWM carrier frequency is adjustable from .5 5khz or .5-15khz model dependent. Output current derating is required starting at 2.2, 5, or 8khz also model dependent.
- H. IGBTs are sized (current) to allow the drive to operate at 100% (current) continuous and 120% (current) for up to 60 seconds.
- I. To allow dissipation of regenerated energy, all HX7 Plus-Packs contain a microprocessor controlled dynamic braking transistor as an option package. The dynamic braking transistor is fully protected by the microprocessor.
- J. The dynamic braking transistor will not 'turn on' when the drive is not actively engaged in controlling a motor.
- K. Output currents in each phase are monitored using hall-effect current transducers to enabling control of flux current, torque current, and providing protection to both the drive and driven equipment.
- L. The inverter section is capable of sensing and interrupting a phase-to-phase or phase-toground fault on the output of the drive.

2.1.6 Control Section

A. The control section is designed to provide complete monitoring and protection of drive internal operations while communicating with the outside world via one or more user interfaces.



- B. The microprocessor used is the latest design CPU with adjustable frequency drive specific circuitry and firmware.
- C. Proprietary algorithms for sensorless vector speed control, sensorless vector torque control, feedback vector speed, torque, and position control are resident in EEPROM memory and utilized by the microprocessor when applicable.
- D. Microprocessor logic circuits are isolated from power circuits.
- E. Where switching logic power supplies are utilized, they are powered from the DC Bus Section of the drive.
- F. Microprocessor diagnostics are performed (on application of power) to prove functionality and viability of the microprocessor.
- G. Memory cyclic redundancy check (CRC) is performed (on application of power) to prove integrity of EEPROM and UVPROM memories.
- H. Motor diagnostics are performed (on application of power and each start) to prevent damage to a grounded or shorted motor. The motor diagnostics may be disabled when using a low impedance or high-speed motor.
- I. Operating system firmware is capable of 'flash' upgrading should enhancements to the operating system firmware become available.
- J. All ratings contain three communications ports;
 - I. TTL 1200 to 9600 baud rate, automatic baud rate and parity setting.
 - II. RS232/RS485 automatic switching port 1200 to 28400 baud rate.
 - III. OptiBus port, a high speed microprocessor communication bus (direct latch) port.
- K. Multidimensional Data Arrays exist in EEPROM memory for Toshiba EQPIII motors, 2, 4, and 6 pole configuration in both TEFC and ODP up to 350HP to allow rapid configuration and eliminate tuning concerns when the drive is used with a Houston manufactured Toshiba motor.
- L. The control section is designed to allow 'quick change' of the interface sections for both configuration and functionality.

2.1.7 Interface Section

- A. Each drive shall have two user interfaces (in addition to the communication ports) as standard:
 - I. Electronic Operator Interface A 128 X 64 pixels Graphical Backlit LCD display with the ability to display multiple parameters on one screen. The EOI provides complete operating, monitoring, and programming functionality. The EOI is capable of operation from and external power source and firmware operating system is flash upgradeable and may be customized for special applications. The EOI contains a TTL communication port and a RS485 communications port for remote mounting. A Real Time Clock option is available for the EOI that allows provides complete data logging in the event of a fault. Up to 100 faults are stored on the Real Time Clock option.



- II. Terminal Board Interface provides complete operation functionality. Standard terminal board interface provides eight digital inputs, three digital outputs, four analog inputs, two analog outputs, and one pulse output. Inputs and outputs are independently configurable for both scaling and functionality.
- B. The drive retains the ability to function with no attached interface.

2.1.8 Output Power

- A. The output voltage is adjustable from 0 to rated input voltage. The output frequency range is adjustable for a maximum frequency output of 299 Hz. The output (inverter) section of the HX7 Plus-Pack will produce a PWM sinusoidal coded waveform.
- B. The output power switching devices shall be IGBT devices of the latest design.

2.2 Electronics Operator Interface

The EOI provides a convenient method of programming, operating, and monitoring the HX7 Plus-Pack. Utilizing an expanding tree topology, the parameters are grouped in a logical manner allowing rapid access to all parameters. All parameters are displayed in an easily understandable format using plain English for all items.

For quick setup by experienced users, the EOI supports direct access to all parameters without navigating the parameter tree.

The 128 X 64 pixels graphical display allows groupings of multiple, logically associated parameters to be displayed on a single screen.

With back lighting and adjustable contrast, the EOI may be configured for the wide range in ambient lighting found on the plant floor.

The customizable graphical display enables the use of user friendly units such as feet per minute, gallons per hour.

For security, the EOI functionality and access may be limited and password protected preventing an unauthorized user from accessing parameters, functions, or monitoring. Over 124 possible combinations exist for limiting access via the EOI.

2.3 Functionality

2.3.1 Acceleration and Deceleration

The HX7 Plus-Pack contains four sets of independently configurable acceleration / deceleration ramps. Each set is configurable as to both time and pattern. Times are adjustable from 0.01 seconds to 6000 seconds

Available patterns are:

- Linear
- S-Curve 1 and 2

The patterns allow for the user to develop and customize application-specific patterns.

Acceleration/Deceleration sets (total four) are selectable via discrete input, Electronic Operator Interface, communications, or automatic switching based on output frequency.



An automatic acceleration/deceleration selection is available which dynamically structures each change in speed to match conditions of the driven equipment to minimize shock due to changes in velocity and/or load conditions.

Overvoltage stall and overcurrent stall settings prevent damage to the driven equipment should acceleration or deceleration settings exceed the ability of the motor to accelerate or decelerate the driven equipment.

2.3.2 Braking

Each HX7 Plus-Pack has as an integral part of the power and control circuitry an IGBT transistor for dynamic braking. The braking transistor is controlled by the HX7 Plus-Pack microprocessor based control system and allows, with the addition of an optional resistor, an economical means of rapidly stopping a high inertia load with up to 100% braking torque.

The braking transistor, braking resistor, and associated circuitry are fully protected by adjustable protection parameters eliminating the requirement for an external resistor overload protective device.

2.3.3 The "Start-up Wizard"

A 'Start-up Wizard' allows the user to program the drive by supplying fundamental application information such as:

- Motor ratings
- Acceleration/deceleration times and type, etc.
- Minimum and or maximum speeds
- V/Hz pattern
- Control logic/control topology

In addition to the 'Start-Up Wizard, all parameters may be accessed by menu tree navigation, direct access, communications, or Windows based programming software.

2.3.4 Control modes

The HX7 Plus-Pack adjustable speed drive has three distinct modes of operation:

- Speed control as V/Hz, sensorless vector, or feedback vector
- Torque control both sensorless vector and feedback vector
- Position control with feedback vector

The drive has the ability to switch between modes of operation while running.

2.3.5 Current Detection/protection

Programmable current detection and protection include:

- Overcurrent stall adjustable from 0.0 to 250%.
- Configurable undercurrent detection and response.
- UL recognized speed sensitive motor FLA trip curves adjustable from 10 to 100% inverter current rating.
- Motor 150% OL time limits adjustable from 10 seconds to 2400 seconds.



- OL Reduction Frequencies to optimize the speed sensitive motor overload to the application/motor characteristics.
- Configurable overtorque detection levels, times, and reactions.

2.3.6 Critical (skip) Frequencies

To avoid mechanical resonate frequencies, the HX7 Plus-Pack contains three programmable jump frequencies with adjustable bandwidths.

- The jump frequencies may be any frequency less than or equal to the programmed value of maximum frequency.
- The jump frequency bandwidths are ± 20.0 Hertz.

2.3.7 Drooping control

Drooping control, also called Load Sharing, is used to share the load among multiple motors mechanically coupled to a common load. Because of variances in motors and mechanical speed reducers, one motor may experience more load than it counterparts and become overloaded. Drooping allows the overload motor to slow down, thus shedding torque and forcing the other motors to pick up the slack.

The HX7 Plus-Packs drooping parameters allow the user complete adjustment over drooping gain, speed droop and multiple load levels, drooping filters, and drooping torque range.

2.3.8 Process Control (PID)

The HX7 Plus-Pack contains an internal PID control algorithm with adjustable proportional, integral, and differential. Feedback may be configured for direct or inverse reaction and is adjustable to span. PID may be enabled via discrete input, Electronic Operator Interface, or communications. Reaction to loss of feedback is configurable and discrete outputs may be configured to indicate loss of feedback or maximum deviation from setpoint.

2.3.9 Electronic Thermal Motor Protection

The drive contains four independently configurable electronic thermal motor protection levels. The electronic thermal motor protection level may be selected by Electronic Operator Interface, discrete input, communication protocol, or fixed frequency.

The Electronic Thermal Motor Protection is speed sensitive and adjustable for motors with speed ranges of 2:1 to 10000:1 allowing the user to optimize motor protection to suit a variety of motors and applications.

The Electronic Thermal Motor Protection levels have configurable 150% motor FLA time limits allowing the user to adjust the I²T protection slope.

2.3.10 Emergency off Modes and Settings

Emergency off response is configurable to Deceleration Stop, Coast Stop, or DC Injection Stop regardless of the standard stop mode. Emergency stop may be operator initiated via:

- EOI
- Discrete input (multiple E-Stop inputs allowed)
- Communication protocol



2.3.11 Feedback

For process control purposes, the HX7 Plus-Pack will accept feedback signals as either an analog signal, binary digital, BCD digital, communication protocol, or 50% duty cycle pulse train.

2.3.12 Input/Output (I/O)

The standard control terminal board contains:

- Eight discrete inputs independently configurable for any of 69 functions
- Sink or source selectable
- 'true/false' on closure software selectable
- Three discrete relay outputs configurable for any of 58 functions
- Contacts rated 2 amps/250v
- One form 'C'
- Two form 'A'
- Three analog inputs with adjustable gains and bias and 28 functions
- Potentiometer input
- 0-10vdc
- 1 5ma
- 0-20ma
- ±10Vdc differential input
- \pm 5Vdc differential input
- Two analog outputs with adjustable gain and bias (22 different functions)
- 0-1ma or 4-20ma switch selectable
- One 50% duty cycle pulse train output proportional to any of 22 user selectable functions. One to 43.2 kHz at full scale user setting.

All control terminal boards are remote mountable (up to fifteen feet) using a standard 25conductor computer cable.

The standard control terminal board contains provisions for mounting the ASD-ISO-1 option board. The ASD-ISO-1 option board provides for true analog isolation for two analog outputs and one analog input. This is carried out using precision isolation amplifiers that transmit input to output via a capacitive barrier.

2.3.13 Jog

Jog frequency may be configured for any frequency from 0.0Hz to 20Hz. Jog is initiated from an appropriately configured input terminal, Electronic Operator Interface, or communication protocol.

Jog stop method is user configurable to coast, controlled deceleration or DC Injection.

Jog may be configured to allow reversing or only operate in a configured direction.

When jog direction is reverse from direction of motor rotation, the HX7 Plus-Pack jog function will smoothly decelerate the motor to zero then jog in the commanded direction.



2.3.14 Motor Operated Pot (MOP) Emulation

MOP emulation allows digital momentary inputs to raise and lower speed. MOP configuration functions include, MOP increments, MOP Loss of Power Reaction, and MOP Input Terminals.

2.3.15 Override Control

Override control allows one or more analog signals to act as a trim source to a frequency command. Override may be configured as either a additive (or subtractive) input such as -5Hz to +5Hz, or as a percent of frequency command. Override may be assigned to any analog input, communication option, or Electronic Operator Interface.

2.3.16 Overvoltage Stall

Overvoltage stall prevents faults caused by regeneration. During deceleration, overvoltage stall extends deceleration time when bus levels reach a user configurable level. When applied to overhauling loads, the drive will compensate for rising dc bus levels by momentarily increasing output frequency. Two overvoltage stall levels allow complete configuration and control for most cyclic overhauling loads and high inertia loads.

2.3.17 Pattern Run

The Pattern Run feature allows the HX7 Plus-Pack to emulate many of the function of a small programmable logic controller. Useful on any application which requires a set pattern of speed changes, based on either time or contact input, the HX7 Plus-Pack may be programmed for four independent or interactive patterns each consisting of up to 7 changes in speed and/or direction.

Each step may be configured to any of the four accel/decel times and patterns, direction, and timed from either step change, speed reached, or contact closure.

2.3.18 Preset Speeds

Up to 15 preset speeds may be configured in the HX7 Plus-Pack. Each preset speed may have defined direction, 1 of 4 accel/decel times and patterns, and motor protective set. The preset speed may be selected via input terminals (using BCD selection), Electronic Operator Interface, or communication function.

2.3.19 Real Time Clock (Option)

The real time clock option provides fault data logging capabilities for the 100 most recent faults. In addition to the time, date, and name of the fault, data collected may include:

- Running Frequency
- Reference Frequency
- Output Current
- Output Voltage
- Bus Voltage
- Discrete Input Status
- Analog Input Status
- Discrete Output Status
- Excitation Current
- Torque Current



Additional application specific data such as PID Feedback Value is logged when applicable.

The Real Time Clock option maximizes the diagnostic tools available for troubleshooting, problem tracking, and predictive maintenance.

2.3.20 Ridethrough

Ridethrough mode allows the user to configure the HX7 Plus-Pack to utilize motor regenerative voltages to continue operation during brief power outages. Undervoltage detection time and undervoltage stall levels are user configurable items in addition to the HX7 Plus-Packs response to undervoltage conditions.

2.3.21 Retry/Restart

The retry/restart drive function allows the HX7 Plus-Pack to smoothly start a rotating load regardless of the direction of rotation. When enabled, the drive will attempt to restart after a fault. The number of attempts and time between attempts are configurable items.

When used on applications such as remote pump stations, air moving equipment, centrifuges, and stamping machines, the HX7 Plus-Pack will automatically reset and restart the driven equipment after faults such as motor overload, undervoltage, and power loss.

2.3.22 Soft Stall

Soft Stall allows the HX7 Plus-Pack to reduce output frequency when the current requirements of the motor exceed the motor's Electronic Thermal Protection setting. If the current drops below the motors overload protection level within the specified time, the output frequency of the HX7 Plus-Pack will return to the commanded output frequency.

Soft Stall is highly effective in preventing motor overload trips when used on fans, blowers, pumps, and other centrifugal loads which require less torque and current at lower speeds.

2.5 Protection

2.5.1 Status Indicators

- Autotuning
- DC Braking
- Emergency Off
- Retry
- Restart
- ST-CC Open

2.5.2 Alarms

- Overspeed
- Input Line Loss
- Output Line Loss
- Overcurrent
- Overheat
- Overvoltage



- Motor Overcurrent
- Motor Overload
- Undercurrent
- Undertorque
- Clear

2.5.3 Faults

- Sink/Source Error
- Encoder Error
- Overspeed
- EEPROM Error
- Ground Fault Trip
- Open DC Fuse
- Input Line Loss
- Output Line Loss
- Main RAM Fault
- Main ROM Fault
- CPU Fault
- Communication Interrupt Fault
- Option Device Fault
- Main Circuit Undervoltage
- Overcurrent (Acceleration)
- Overcurrent (Deceleration)
- Overcurrent RUN
- U-Phase Short Circuit
- V-Phase Short Circuit
- W-Phase Short Circuit
- Motor Overcurrent
- Dynamic Braking Resistor Overcurrent
- Overheat
- ASD Overload
- Motor Overload
- Overvoltage (Acceleration)
- Overvoltage (Deceleration)
- Overvoltage (Run)
- Control Circuit Undervoltage
- Communication Error
- Under Torque
- Low Current
- Undervoltage Trip Main Circuit
- Undervoltage Trip Control Circuit

2.6 Software and Communication



2.6.1 Programming Software

Toshiba's WindowsTM based programming software provides the same functionality as the EOI with the additional capabilities of data logging, trending, storing and restoring multiple parameter sets.

Cascading windows allow a user interface similar to the EOI in look and feel while allowing direct parameter access for experienced users. Trending and monitoring functions allow up to three items be graphically displayed on a standard trend chart and logged to a historical data file for future reference.

Computer requirements to run the HX7 Plus-Pack software are: (at minimum)

PENTIUM II Processor 50 MHz CD ROM 25 Meg (free) Disc Space Windows 98 or Higher Operating System

2.6.2 Communications

All parameters are accessible from any of the Toshiba supported communication protocols. Communication protocols include:

- RS232
- RS485
- DeviceNet
- Profibus
- Modbus RTU
- Ethernet
- Tosline F10
- Tosline S20

2.7 Environment

Operating environmental ambient conditions without derating shall be:

- Ambient temperature -14° to 122° F (-10° to 50° C). Units 518, 1400 & 1500kVA are rated max 104°F (40°C).
- Altitude 4,500 feet maximum without derating.
- Relative humidity 95% maximum no condensation allowed (100% with space heater option)
- Vibration 0.6G maximum

Storage environmental ambient conditions:

- Temperature: -10° to $+65^{\circ}$ C
- Relative humidity: 5 to 98% non condensing
- Elevation: to 5000 meters

2.8 Service



- The drive manufacturer shall guarantee the operation of the drive against failure due to defects for 18 months after shipment or 12 months of service, whichever comes first.
- The drive manufacturer shall supply a recommended list of spare parts and pricing.

2.9 Enclosure Specifications

- The drive enclosure shall have a locking handle with key.
- Stainless steel U type clamps will be used to prevent water intrusion on the enclosure door when required.
- The drive enclosure shall be floor mount with lifting eyes as well as fork lift provisions on the bottom.
- The drive shall use heat exchangers where necessary for cabinet cooling. Ventilated enclosures for NEMA 3R application are not acceptable.
- The drive enclosure shall be 12-gauge steel.
- The drive shall be painted white for NEMA 3R construction and ANSI 61 gray for NEMA 1 construction.
- The drive shall have an optional external junction box.

PART 3 – APPLICATION CONSIDERATION

3.1 Long Lead Length

All drives shall have software and hardware to limit reflected wave caused by long motor cable lengths. When applied to motors with insulation systems that are compliance with NEMA MG-1-1998 Section IV Part 31, output filters shall not be required when motor lead lengths are within those recommended below.

MODEL	PWM CARRIER FREQUENCY	NEMA MG-1, Section IV, Part 31 Compliant Motors	NEMA MG-1, Section IV, Part 30 Compliant Motors
460V	< 5kHz	600 ft.	200 ft.
	\geq 5kHz	300 ft.	100 ft.

3.1 Sine Wave Filters

An optional built-in output Sine-Wave filter is available on models 200HP and above. The filter is incorporated into a modified PWM adjustable speed drive in order to eliminate most of the high frequency harmonics generated by the pulse width modulation technique and to achieve a sine-wave type voltage operation.

The improved voltage waveform eliminates voltage stress that can cause premature insulation failure, typically found in motors with extreme long leads and transformer step-up applications.



The filter is comprised of and inductance-capacitance network located at the bottom of the cabinet on a ventilated section of the enclosure. Sine-wave filters are available on drives rated NEMA 1 and NEMA 3R.





Fig.2. ASD with output Sine-Wave Filter



PRODUCT RATINGS (Overview)

	HX7 Plus-Pack STANDARD SPECIFICATIONS
Model Range	4660-415L40
Nominal Horsepower Range	60 - 1500
Input Voltage Rating (AC)	380VAC / 480VAC
Input Voltage Tolerance	-10/+10%
Input Frequency	50/60Hz
Input Semiconductors	Three-phase, full wave bridge diode
PWM Carrier Frequency	User adjustable between 0.5kHz to 5kHz or 0.5kHz to 15kHz. ⁽¹⁾
Output Type	Sinusoidal Coded PWM three-phase output
Output Voltage	Automatic regulation, 'fixed', or floating with input.
Output Frequency	0.02 to 299.0Hz. Maximum output user adjustable from 20.00 to 299.0 Hz
Output Transistors	IGBT Power Switching Transistors, latest design generation. Integral hardware to limit DV/DT
Frequency Precision (speed	Analog input ±0.2% of maximum output frequency. Digital input ±0.01% of maximum output
control mode)	frequency.
Discrete (digital) Inputs	Eight independently configurable terminals programmable for any of 67 functions. Reaction software
	reversible (normally open, normally closed) Sink/Source selectable
Discrete (digital) Outputs	One Form 'C', two Form 'A' contact outputs. Contacts rated 250V, 2A. independently programmable
	for any of 56 functions. Reaction software reversible (normally open, normally closed)
Analog Inputs	One input configurable for either 4-20ma or 0-10VDC, One input rated 0-10VDC or 1K to 10K Ohm
	Potentiometer, One bi-polar input rated ± 10 VDC. All analog inputs scalable with independently
	adjustable gain and bias. Analog inputs configurable to any of 26 different functions.
Analog Outputs	Two scalable analog outputs, selectable to 4-20mA or 0-1mA. Programmable for any of 22 different
Communication Ports	One TTL (5V Transistor-Transistor Logic), One RS232/RS485 smart port, One microprocessor
	communication bus port. 11L and RS232/485 ports scan for baud rate and parity setting.
Signal Isolation	Three channel analog isolation available (option ASD-ISO-1) 750VDC true analog isolation
Power Terminations	Input (L1/R, L2/S, L2/T), Output (T1/U, T2/V, T2/W), DCL (PC, PD), DBR [option] (PA, PB)
Environmental Ambient	Temperature: -10 to 50° C ⁽²⁾ , Humidity: 95% non-condensing, Altitude: 4500 ft without derating.



Protective Functions	Forty-seven fully monitored fault and alarm conditions displayed on Electronic Operator Interface and available via communication functions.	
Speed Search (Restart)	Smoothly starts a freewheeling (spinning) motor regardless of direction of rotation or operating mode	
Electronic Operator Interface	128 X 64 pixels Graphical Backlit LCD display with flash upgradeable memory. Full operation, monitoring, and programming functionality. User configurable with complete password protection function. Remote mountable up to 1000 ft from drive. Dual communication ports, TTL and RS485. Optional real time clock with data logging capabilities.	
(1) Current derating may be necessary typeform-specific		

¹⁾ Current derating may be necessary typeform-specific.

⁽²⁾ Units 500HP, 1400HP and 1500HP are rated for 40°C.