TOSHIBA

G9/H9 Adjustable Speed Drive Engineering Specification

ASD Applications and Marketing

September 17, 2008
Revision 1.2

PART 1 – GENERAL

1.0 Scope

This specification shall cover Toshiba G9 and H9 AC Adjustable Speed Drives. All specifications within apply except where noted.

1.1 References

The G9/H9 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. IEC 146 International Electrical Code.
D. JIS C60068-2-6.
E. ISO 9001.
F. UL 508.
G. C-UL.

1.2 Qualifications

1.2.1 Manufacturer History

Toshiba entered the AC adjustable speed drive market in the US in 1979. Toshiba International Corporation continues to specialize in the design and manufacturing of both AC drives and induction motors at its manufacturing facility 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 from Toshiba's Houston facility directly or from a network of factory-trained 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 ASD manufacturing.
C. The manufacturer shall manufacture both AC drives and motors.
D. The drives shall be manufactured in the United States.

2.1 Design Criteria

2.1.1 Input Power

A. The drive main input power shall be:
   I. Three-phase 200 – 240VAC 50/60 Hz
   II. Three-phase 380 – 480VAC 50/60 Hz

B. The drive shall have a voltage tolerance of ±10% for all 200V and 400V drives.

C. Input frequency tolerance shall be ±2 Hz 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.

E. The G9/H9 drive frames size 5B (see appendix A) and smaller will achieve a 100KAIC rating when the required circuit breakers are installed ahead of the drive. The G9/H9 frame size 6 and above are rated 200KAIC standard.

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...T2) and IEC standards (R, S…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. Standard packaging is NEMA 1.

G. Interrupting current rating of 200KAIC for all ratings above frame 5B.

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

A. On frame sizes 2 – 5 the drive employs diode bridge rectification to convert AC to DC. On frames 6 – 13 a hybrid SCR/Diode front end is used. The soft charge contact and resistor are removed from the circuit.

B. The Converter Section is unaffected by phase rotation or 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 shall be as follows:

   I. 240V drives—rectifier minimum PIV rating of 800V

   II. 480V drives—rectifier minimum PIV rating of 1600V

E. The G9/H9 drives have MOVs mounted phase-to-phase for surge protection.

F. An isolation transformer is not required for operation on most standard distribution systems.

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

2.1.4 DC Bus Section

A. Overall DC Bus design is passive capacitive filter to minimize ripple and maximize power-loss ride-through.

B. An internally installed DC Link Reactor is standard in frame size six and above.

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. 240V drives – bus capacitance voltage rating 400VDC (minimum).

E. 480V 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. Soft-charge circuitry does not use power transistors nor time delay relays.

H. The DC Bus Section has complete power terminations to allow:

  I. Rectifier Isolation (positive side)

  II. Line regeneration using third party units

  III. DC Link inductor

  IV. Common DC bus applications

  V. DC input

K. A readily visible LED indicates when DC voltages are present.

L. The DC Bus section is designed to permit common DC bussing of multiple drives.

2.1.5 Inverter Section

A. The inverter section makes use of the latest generation of IGBT power switching transistors to convert DC to a three-phase, variable frequency, and sinusoidal coded PWM waveform.

B. IGBT initialization testing is performed by the control section on each power up.

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. 240V drives – IGBT minimum V_{ce} rating 600V.

  II. 480V drives – IGBT minimum V_{ce} rating 1200V.

F. All IGBTs have reversed biased diodes (free wheeling) to prevent IGBT failure when subjected to motor discharge spikes.

G. PWM switching frequencies (Carrier Frequency) are adjustable to allow the reduction of audible noise. Actual ranges are typeform dependent and may require a current derate.

H. G9 IGBTs are sized (current) to allow the drive to operate at 115% continuous current and 150% current for up to 120 seconds up through frame 8 (except VT130G9U4600). Units frame 9 and above operate at 110% continuous current and have an over-current rating of 150% for 60 seconds.

I. H9 IGBTs are sized for 100% continuous current and 120% current for 60 seconds.

J. To allow dissipation of regenerated energy, all G9s feature a microprocessor controlled dynamic braking transistor. The dynamic braking transistor is an IGBT power semiconductor that is sized to allow 100% motor braking torque when connected to an appropriate resistor. The H9 drive includes a dynamic braking transistor through frame size 12.

K. The dynamic braking transistor is fully protected by the microprocessor.

L. The inverter section is capable of sensing and interrupting a phase-to-phase or phase-to-ground 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, and feedback vector speed control reside in EEPROM memory and are 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 confirm the integrity of EEPROM and UVPROM memories.

H. ASD may be configured to perform motor diagnostics at startup or when power is applied to prevent damage to a grounded or shorted motor. This feature may be disabled when using a low impedance motor.

I. Operating system firmware is capable of ‘flash’ upgrading should enhancements to the operating system firmware become available.

J. All ratings contain an RS-485 communications port capable of 2-wire (half duplex) or 4-wire (full duplex) communication.

K. 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 132 X 64 Graphical Backlit LCD display with the ability to display multiple lines on one screen and a 4 character 7-segment LED display. The EOI provides complete operating, monitoring, and programming functionality. The EOI is capable of operation from and external power source. The firmware operating system is flash upgradeable and may be customized for special applications. The EOI contains an RS485 communications port for remote mounting. A Real Time Clock is standard for the EOI and provides data logging in the event of a fault. Up to 20 faults may be stored on the Real Time Clock.

   II. Terminal Board Interface – Standard terminal board interface provides eight discrete inputs, three discrete outputs, one isolated analog input, three non-isolated analog inputs, two analog outputs, one pulse output, and one input for bringing in external 24Vdc control power. Inputs and outputs are independently configurable for both scaling and functionality.

B. The drive retains the ability to function in remote mode with no attached display unit.

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 section of the G9/H9 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

A. The EOI provides a convenient method of programming, operating, and monitoring the G9/H9. 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.

B. For quick setup by experienced users, the EOI supports direct access to all user program parameters.

C. The 132 X 64 graphical display allows groupings of multiple, logically associated parameters to be displayed on a single screen.

D. A separate 4-character 7-segment LED allows for easy viewing of the running frequency or fault code.

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

F. The customizable graphical display enables the use of user defined units such as feet per minute or gallons per hour.

G. For security, the EOI functionality and access may be limited and password protected preventing an unauthorized user from accessing parameters, functions, or monitoring.

2.3 Functionality

2.3.1 Acceleration and Deceleration

The G9/H9 contains four sets of independently configurable acceleration/deceleration ramps. Each set is configurable as to both time and pattern. Times are adjustable from 0.01seconds 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.

Over-voltage stall and over-current 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 G9/H9 has as an integral part of the power and control circuitry an IGBT transistor for dynamic braking. The braking transistor is controlled by the G9/H9s 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.

In addition to the dynamic braking, DC injection braking configurable for both standard and Emergency Off is also included, allowing full motor current applied as DC to rapidly bring a rotating load to a stop.

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 G9/H9 adjustable speed drive has two distinct modes of operation:

- Speed control as V/Hz, sensorless vector, or feedback vector.
- Torque control both sensorless vector and 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:

- Over-current stall adjustable from 10 to 165%.
- Configurable undercurrent detection and response.
- UL recognized speed sensitive motor FLA trip curves adjustable from 10 to 100% drive current rating.
- Motor 150% OL time limits adjustable from 10 to 2400 seconds.
- OL Reduction Frequencies to optimize the speed sensitive motor overload to the application/motor characteristics.
- Configurable over-torque detection levels, times, and reactions.

2.3.6 Critical (skip) Frequencies

To avoid mechanical resonate frequencies, the G9/H9 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 maximum bandwidths are ±15.0 Hz.

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 its counterparts and become overloaded. Drooping allows the overloaded motor to slow down, thus shedding torque and forcing the other motors to pick up the slack.

The G9/H9s 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 G9/H9 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. A discrete output terminal may be configured to indicate 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 set by the 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. This allows 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 I^2T protection slope.

2.3.10 Emergency Off Modes and Settings

Emergency Off response is configurable to either Deceleration Stop, Coast Stop, DC Injection Stop, or Decelerated Stop as defined in the Decel #4 setting regardless of the standard stop mode. Emergency stop may be operator initiated via:

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

2.3.11 Feedback

For process control purposes, the G9/H9 will accept feedback signals as either an analog current or voltage or may use the PG feedback option.

2.3.12 Input/Output (I/O)

The standard control terminal board is comprised of:

- Eight discrete inputs independently configurable for any of 55 functions.
- Sink or source selectable discrete inputs.
- True/False on closure that is software selectable.
- Three discrete relay outputs configurable for any of 127 functions with positive or negative logic.
- Contacts rated for 2 amps at either 30Vdc or 120VAC.
- One form ‘C’ contact.
- Two form ‘A’ contacts.
- Three analog inputs with adjustable gain and bias settings.
- Potentiometer input (0 – 10Vdc).
- 0 – 20mA isolated input or 0 – 10Vdc isolated input (user-selectable).
- ±10Vdc differential input.
- Two analog outputs with adjustable gain and bias (56 different functions).
- 0 – 10Vdc or 4 – 20mA software selectable FM analog output.
- One 50% duty cycle pulse train input.

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 via communications.

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

2.3.14 Motor Operated Pot (MOP) Emulation

MOP emulation allows discrete momentary inputs to raise or lower speed. MOP configuration functions include, user-set MOP increments, user-set Loss of Power response, 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 an 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 Over-voltage Stall

Over-voltage stall helps to prevent faults caused by regeneration. During deceleration, over-voltage 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.

2.3.17 Pattern Run

The Pattern Run feature allows the G9/H9 to emulate many of the functions of a programmable logic controller. Useful on any application which requires a set pattern of speed changes, based on either time or contact input, the G9/H9 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 G9/H9. 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

The Real Time Clock is standard and provides fault data logging capabilities for the 20 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
- Run Timer
- Compensated Frequency
- Feedback
- Torque
- Torque Reference
- PID Feedback
- Motor Overload
- ASD Overload
- DBR Overload
- Motor Load
- ASD Load
- DBR Load

- Input Power
- Output Power
- Discrete Output Status
- Excitation Current
- Torque Current

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

2.3.20 Ride-through

Ride-through mode allows the user to configure the G9/H9 to utilize motor regenerative voltages to continue operation during brief power outages. Under-voltage detection time and under-voltage stall levels are user configurable items in addition to the response of the G9/H9 to under-voltage conditions.

2.3.21 Retry/Restart

The retry/restart drive function allows the G9/H9 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 G9/H9 will automatically reset and restart the driven equipment after faults such as motor overload, under-voltage, and momentary power loss.

2.3.22 Soft Stall

Soft Stall allows the G9/H9 to reduce output frequency when the current requirements of the motor exceed the Electronic Thermal Protection setting. If the current drops below the motors overload protection level within the specified time, the output frequency of the G9/H9 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.

2.3.23 Torque Limiting

Toshiba's Torque Limiting function prevents mechanical shock to rotating equipment by allowing a user to establish a maximum torque limit. When enabled, the G7 will prevent motor torque in excess of the user programmed torque limit.

Separate Torque Limits are configurable for positive and negative torque, and are user adjustable from 0 to 250% motor torque. This allows complete torque control over both the motoring and generating regions on applications such as vibratory feeders and stamping machines.

2.3.24 Torque Speed Limiting

Speed limits unique to torque control modes are configurable for both forward and reverse operation. The use of torque speed limits prevents mechanical damage on torque applications such as winders and other web handling applications in which loss of torque may occur.

2.3.25 Vector Motor Modeling

Regulation of speed and torque is dependent on the accuracy of a mathematical motor model. The drive has the ability to estimate certain electrical motor constants as well as measure them. A combination of these abilities allows the drive to closely approximate the motor model. Toshiba's proprietary auto-tuning algorithm accurately tunes the G9/H9 to motors produced by other manufactures and compensates for changes in motor characteristics due to load and internal temperature.

2.4 Protection

2.4.1 Status Indicators

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

2.4.2 Alarms

- ST Signal OFF
- Under-voltage
- Retry
- Point Setting Alarm
- Clear Enabling Indication
- Emergency Stop enabling indication
- Setting Error Alarm
- DC Braking
- Shaft Fixing in Control
- Panel Indication Overflow
- Initialize
- Auto-tuning
- Lower Limit Time-out Stop
- Momentary Power Loss Slowdown
- Tuning Error
- Over-current Pre-alarm
- Over-voltage Pre-alarm
- Overload Pre-alarm
- Overheat Pre-alarm
- Communication Error

2.4.3 Faults

- Over-current (Acceleration)
- Over-current (Deceleration)
- Over-current (Run)
- U-phase Short
- V-phase Short
- W-phase Short
- Over-current (at start)
- DBR Over-current
- Overheat
- Overheat (external device)
- Inverter Overload
- Motor Overload
- DBR Overload
- Over-voltage (Acceleration)
- Over-voltage (Deceleration)
- Over-voltage (Run)
- Over-torque
- Low Current Operation
- Under-voltage
- Emergency Off
- EEPROM Error
- Initial Read Error
- Ground Fault
- Output Phase Failure
- Input Phase Failure
- Main unit RAM fault
- Main unit ROM fault
- CPU fault
- Communication Time-out Error
- Gate Array Fault
- Output Current Detector Error
- Optional Unit Fault
- Tuning error
- Motor Constant Setting Error
- Inverter Type Error
- Analog Input Terminal Voltage
- Sequence Error
- Encoder Error
- Speed Error
- Terminal Input Error
- Abnormal CPU2 Communication
- V/f Control Error
- CPU1 Fault
- CPU2 Fault
- Abnormal Logic Input Voltage
- Option 1 Error
- Option 2 Error
- Stop Position Retaining Error

2.5 Software and Communication

2.5.1 Programming Software

Toshiba's Windows® 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 ASD Pro software are: (at minimum)

PENTIUMII Processor®
50 MHz
CD ROM
100 Meg (free) Disc Space
Windows 98® or Higher Operating System

2.5.2 Communications

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

- RS485
- DeviceNet™ (DEV002Z)
- PROFIBUS DP (PDP002Z)
- PROFINET IO
- Modbus® TCP/IP
- Modbus® RTU
- Ethernet/IP
- BACnet/IP
- Toshiba TSB

2.6 Environment

Operating environmental ambient conditions without derating shall be:

- Temperature: -10 to +40 °C .
- Not to be exposed to direct sunlight.
- Environment to be free of corrosive and explosive gases.
- Relative humidity: 5 to 95% non condensing.
- Elevation: to 1000 meters (2200 ft.) without derate.
  - 3000 meter maximum with a current derate of 1% per 100 meters.
  - 2000 meter maximum with a corner grounded distribution system.
- Shock: $5.9 m/s^2$ {0.6G} or less (10 to 55 Hz). Compliant with JIS C60068-2-6.

Storage environmental ambient conditions:

- Temperature: -25 to +65 °C
- Relative humidity: 5 to 98% non condensing
- Elevation: to 5000 meters

PART 3 – APPLICATION CONSIDERATION

3.1 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-1-1998 Section IV Part 31 Compliant Motors[2]
220V	All	1000 feet
460V	< 5kHz	600 feet
	≥ 5kHz	300 feet

APPENDIX A – G9/H9 Frame Chart

TOSHIBA 9 -Series Frame Chart

Frame	Family	Voltage	HP	FLA
2	G9	230V	0.75	3.5
	G9	230V	1	4.2
	G9	230V	2	6.9
	G9	460V	1	2.7
	G9	460V	2	3.6
	G9	460V	3	5.0
3	G9	230V	3	10.0
	G9	230V	5	15.2
	G9	460V	5	9.1
	H9	230V	3	9.6
	H9	230V	5	15.2
	H9	460V	5	7.6
	H9	460V	7.5	11.0
4	G9	230V	7.5	23.8
	G9	460V	7.5	12.4
	G9	460V	10	15.3
	H9	230V	7.5	22.0
	H9	230V	10	28.0
	H9	460V	10	14.0
5A	G9	230V	10	28.6
	G9	460V	15	24.0
	H9	460V	15	21.0
	H9	460V	20	27.0
5B	G9	230V	15	46.8
	G9	230V	20	57.2
	G9	460V	20	28.6
	G9	460V	25	35.7
	H9	230V	15	42.0
	H9	230V	20	54.0
	H9	230V	25	68.0
	H9	460V	25	34.0
	H9	460V	30	40.0
6	G9	230V	25	76.0
	G9	460V	30	42.0
	H9	230V	30	80.0
	H9	460V	40	52.0
7A	G9	460V	40	57.2
	G9	460V	50	68.5
	H9	460V	50	65.0
	H9	460V	60	77.0

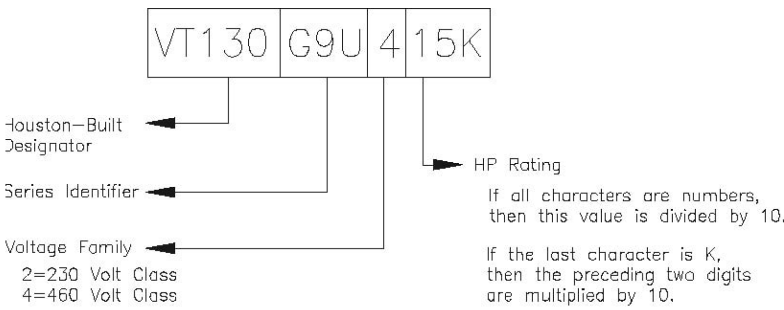
Frame	Family	Voltage	HP	FLA
7B	G9	230V	30	90.0
	G9	230V	40	104.0
	G9	230V	50	152.0
	G9	230V	60	176.0
	H9	230V	40	104.0
	H9	230V	50	130.0
	H9	230V	60	154.0
	H9	230V	75	192.0
8	G9	460V	60	81.5
	G9	460V	75	100.8
	G9	460V	100	138.7
	H9	460V	75	96.0
	H9	460V	100	124.0
	H9	460V	125	156.0
9	G9	230V	75	221.0
	G9	460V	125	179.0
	H9	230V	100	248.0
	H9	460V	150	180.0
10	G9	230V	100	285.0
	G9	460V	150	215.0
	H9	230V	125	312.0
	H9	460V	200	240.0
11	G9	460V	200	259.0
	H9	460V	250	302.0
12	G9	460V	250	314.0
	H9	460V	300	361.0
	H9	460V	350	414.0
13	G9	460V	300	387.0
	G9	460V	350	427.0
	H9	460V	400	477.0

APPENDIX B – G9 Enclosure Dimensions

Enclosure Dimensions

The part numbering convention for the G9 ASD is as indicated below. Use this information to identify a model type (typeform).

G9 Part Numbering Convention.



The enclosure dimensions for each typeform are listed below along with the associated conduit plate. The conduit plates that are referenced in Table 16 are shown in Figures 29, 30, and 31.

Note: *The Type 1 enclosed versions of these drives meet or exceed the specification* ***UL 50- 1995****, the* ***Standard for Heating and Cooling Equipment****, and complies with the applicable requirements for installation in a compartment handling conditioned air.*

Note: *All Toshiba ASD enclosures carry an IP20 rating.*

Enclosure Dimensions

Table 16. 230-Volt G9 ASD Systems.

Model Number VT130G9U	Enclosure Figure Number	A Height (in/cm)	B Width (in/cm)	C Depth (in/cm)	D Mounting Hole Height (in/cm)	E Mounting Hole Width (in/cm)	R Mounting Hole Radius	Conduit Plate (Figure 29, 30, and 31)
2010	Figure 25	11.2/28	5.2/13	6.1/16	8.7/22	4.5/11	0.24/6	Figure 29-A
2015								
2025								
2035		12.4/32	6.1/16	6.6/17				
2055								
2080	Figure 26	15.0/38	6.9/18	6.6/17	11.1/28	6.2/16	0.24/6	Figure 29-B
2110		15.1/38	8.3/21	7.6/19				Figure 29-C
2160		19.3/49	9.1/23	7.6/19	15.2/39	8.3/21		Figure 29-D
2220								
2270	Figure 27	25.9/66	11.1/28	13.2/34	25.0/64	8.0/20		Figure 29-E
2330								

Table 16. (Continued) 230-Volt G9 ASD Systems.

<table>
<tr><th>Model Number VT130G9U</th><th>Enclosure Figure Number</th><th>A Height (in/cm)</th><th>B Width (in/cm)</th><th>C Depth (in/cm)</th><th>D Mounting Hole Height (in/cm)</th><th>E Mounting Hole Width (in/cm)</th><th>R Mounting Hole Radius</th><th>Conduit Plate (Figure 29, 30, and 31)</th></tr>
<tr><td>2400</td><td rowspan="3">Figure 27</td><td rowspan="3">33.1/84</td><td rowspan="3">14.3/36</td><td rowspan="3">15.0/38</td><td rowspan="3">32.3/82</td><td rowspan="3">8.0/20</td><td rowspan="3">0.38/10</td><td rowspan="3">Figure 30-G</td></tr>
<tr><td>2500</td></tr>
<tr><td>2600</td></tr>
<tr><td>2750</td><td rowspan="2">Figure 28</td><td>51.7/131</td><td>14.6/37</td><td>17.6/45</td><td>50.2/128</td><td>9.2/23</td><td rowspan="2">0.69/18</td><td>Figure 30-I</td></tr>
<tr><td>210K</td><td>53.1/135</td><td>15.7/40</td><td>17.6/45</td><td>51.7/131</td><td>9.9/25</td><td>Figure 30-J</td></tr>
</table>

Table 17. 460-Volt G9 ASD Systems.

<table>
<tr><th>Model Number VT130G9U</th><th>Enclosure Figure Number</th><th>A Height (in/cm)</th><th>B Width (in/cm)</th><th>C Depth (in/cm)</th><th>D Mounting Hole Height (in/cm)</th><th>E Mounting Hole Width (in/cm)</th><th>R Mounting Hole Radius</th><th>Conduit Plate (Figure 29, 30, and 31)</th></tr>
<tr><td>4015</td><td rowspan="4">Figure 25</td><td rowspan="3">11.2/28</td><td rowspan="3">5.2/13</td><td rowspan="3">6.1/16</td><td rowspan="4">8.7/22</td><td rowspan="4">4.5/11</td><td rowspan="4">0.24/6</td><td rowspan="4">Figure 29-A</td></tr>
<tr><td>4025</td></tr>
<tr><td>4035</td></tr>
<tr><td>4055</td><td>12.4/32</td><td>6.1/16</td><td>6.6/17</td></tr>
<tr><td>4080</td><td rowspan="5">Figure 26</td><td rowspan="2">15.0/38</td><td rowspan="2">6.9/18</td><td rowspan="2">6.6/17</td><td rowspan="2">11.1/28</td><td rowspan="2">6.2/16</td><td rowspan="5">0.24/6</td><td rowspan="2">Figure 29-B</td></tr>
<tr><td>4110</td></tr>
<tr><td>4160</td><td>15.1/38</td><td>8.3/21</td><td>7.6/19</td><td>11.1/28</td><td>7.5/19</td><td>Figure 29-C</td></tr>
<tr><td>4220</td><td rowspan="2">19.3/49</td><td rowspan="2">9.1/23</td><td rowspan="2">7.6/19</td><td rowspan="2">15.4/39</td><td rowspan="2">8.3/21</td><td rowspan="2">Figure 29-D</td></tr>
<tr><td>4270</td></tr>
<tr><td>4330</td><td rowspan="6">Figure 27</td><td>25.9/66</td><td>11.1/28</td><td>13.2/34</td><td>25.0/64</td><td rowspan="6">8.0/203</td><td rowspan="6">0.38/10</td><td>Figure 29-E</td></tr>
<tr><td>4400</td><td rowspan="2">30.8/78</td><td rowspan="2">11.1/28</td><td rowspan="2">14.3/36</td><td rowspan="2">29.7/75</td><td rowspan="2">Figure 29-F</td></tr>
<tr><td>4500</td></tr>
<tr><td>4600</td><td rowspan="3">36.1/92</td><td rowspan="3">14.3/36</td><td rowspan="3">15.3/39</td><td rowspan="3">35.3/90</td><td rowspan="3">Figure 30-H</td></tr>
<tr><td>4750</td></tr>
<tr><td>410K</td></tr>
<tr><td>412K</td><td rowspan="6">Figure 28</td><td>51.7/131</td><td>14.6/37</td><td>17.6/45</td><td>50.2/128</td><td>9.1/23</td><td rowspan="6">0.69/18</td><td>Figure 30-I</td></tr>
<tr><td>415K</td><td>53.2/135</td><td>15.7/40</td><td>17.6/45</td><td>51.7/131</td><td rowspan="2">9.9/25</td><td>Figure 30-J</td></tr>
<tr><td>420K</td><td>63.1/160</td><td>15.0/38</td><td>17.6/45</td><td>61.6/157</td><td>Figure 30-K</td></tr>
<tr><td>425K</td><td>68.5/174</td><td>18.9/48</td><td>17.6/45</td><td>67.0/170</td><td>13.8/35</td><td>Figure 30-L</td></tr>
<tr><td>430K</td><td rowspan="2">70.0/178</td><td rowspan="2">25.6/65</td><td rowspan="2">17.6/45</td><td rowspan="2">68.5/174</td><td rowspan="2">21.3/54</td><td rowspan="2">Figure 31-M</td></tr>
<tr><td>435K</td></tr>
</table>

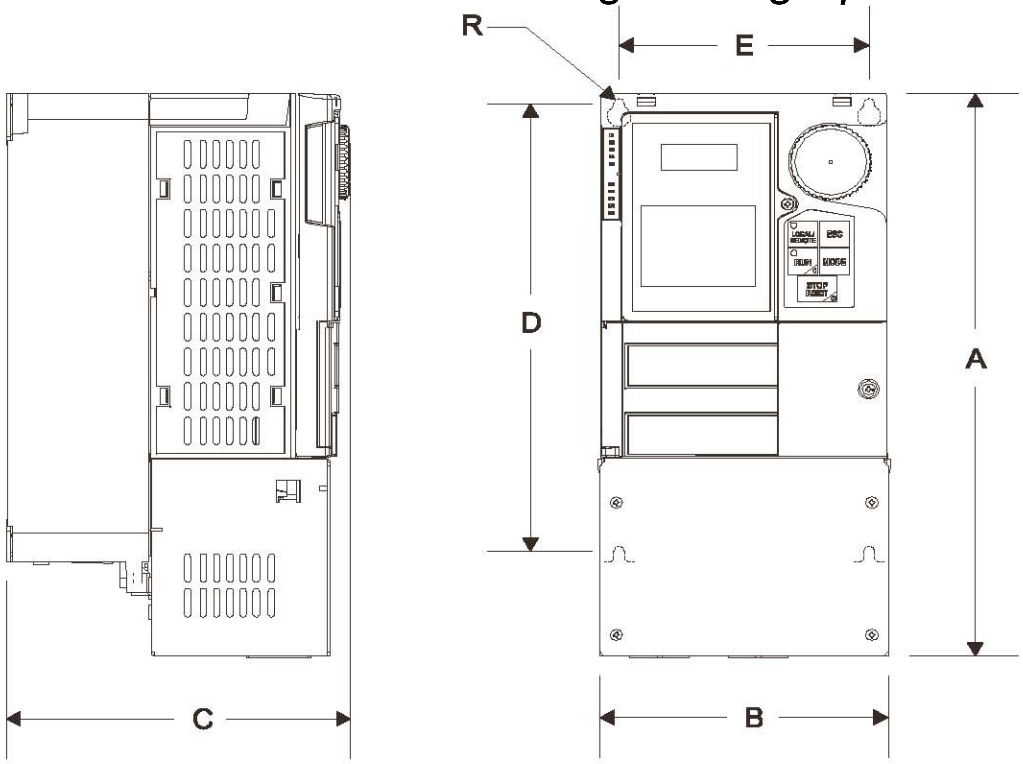


Figure 26.

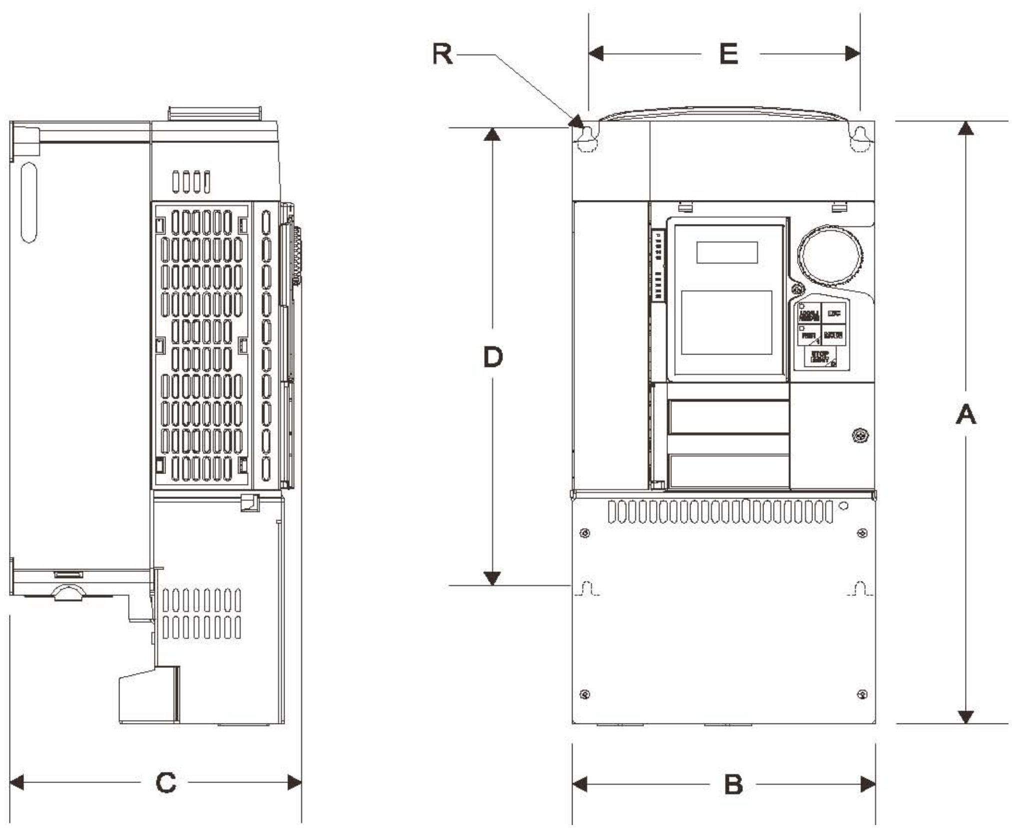
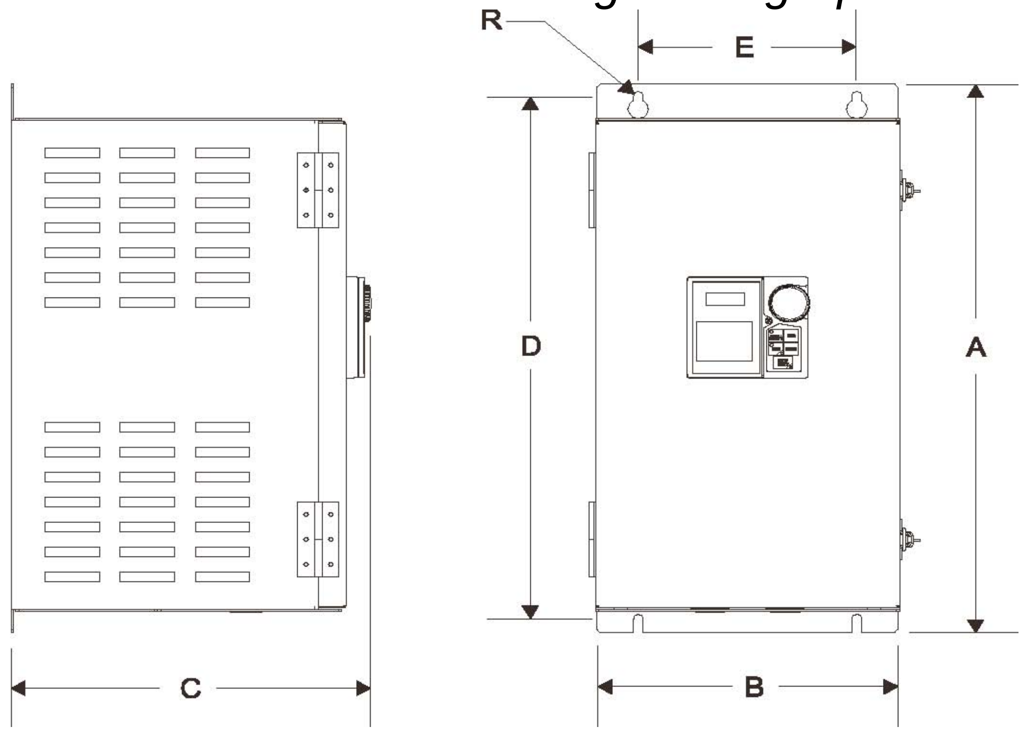
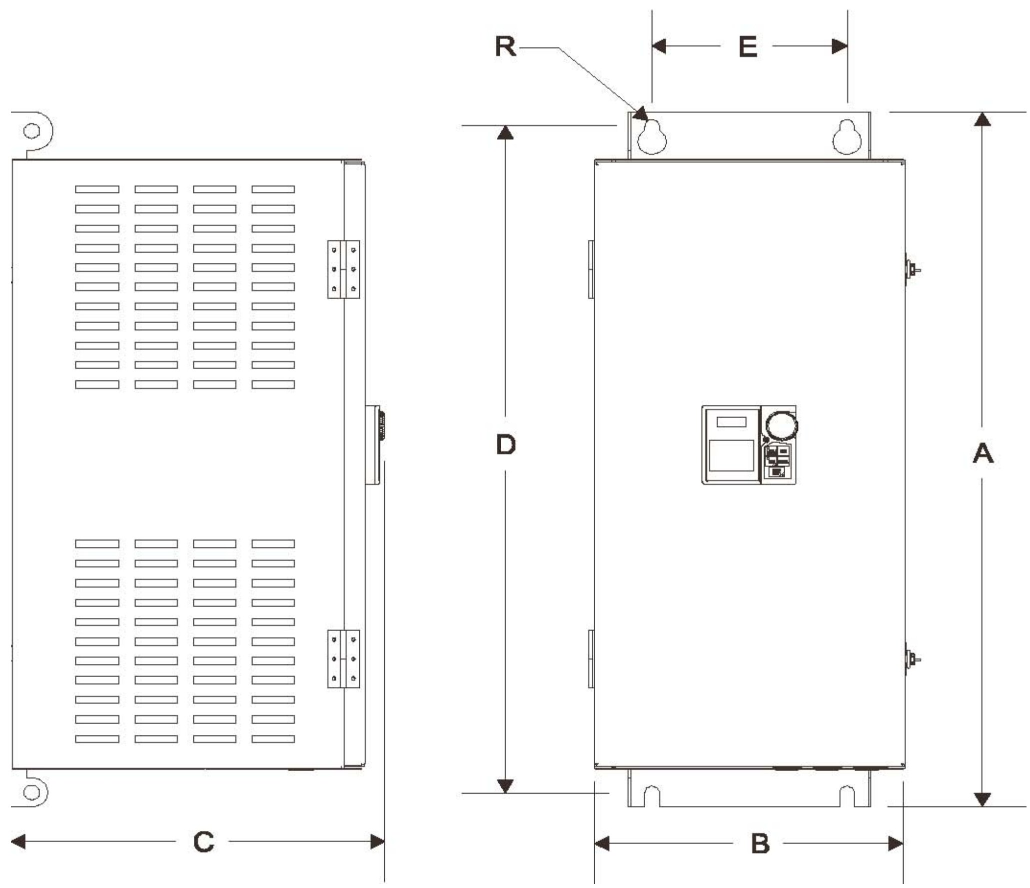
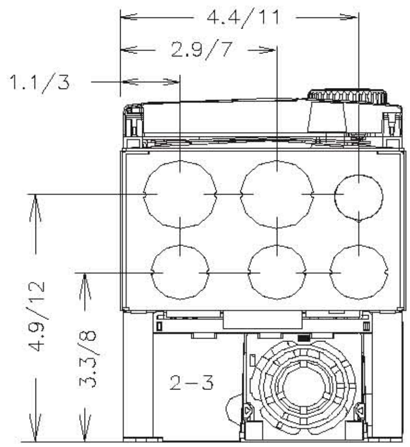


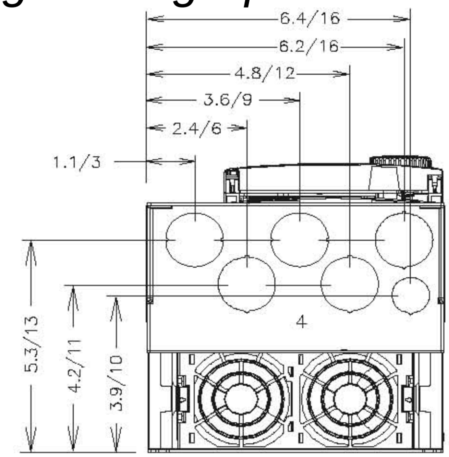
Figure 26. Figure 28.


R
E
D
A
C
B

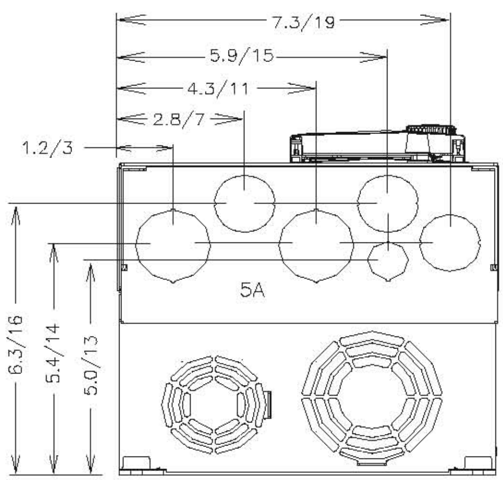

R
E
D
A
C
B


4.4/11
2.9/7
1.1/3
4.9/12
3.3/8
2-3

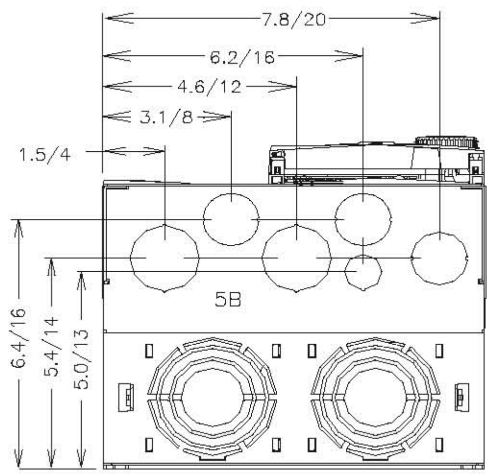
A


6.4/16
6.2/16
4.8/12
3.6/9
2.4/6
1.1/3
5.3/13
4.2/11
3.9/10
4

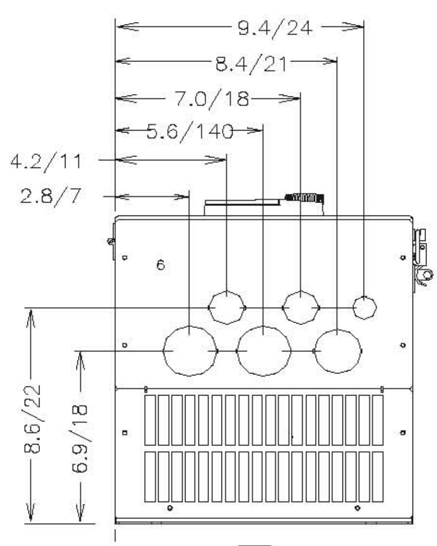
B


7.3/19
5.9/15
4.3/11
2.8/7
1.2/3
6.3/16
5.4/14
5.0/13
5A

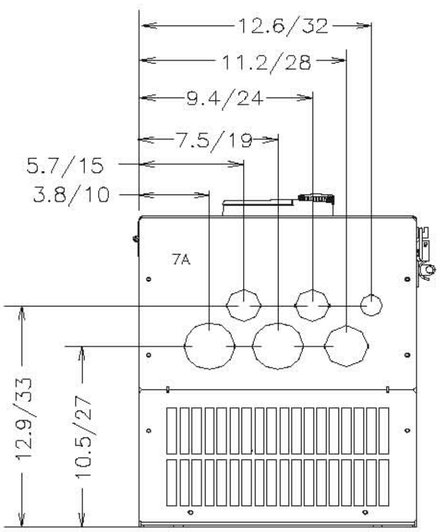
C


7.8/20
6.2/16
4.6/12
3.1/8
1.5/4
6.4/16
5.4/14
5.0/13
5B

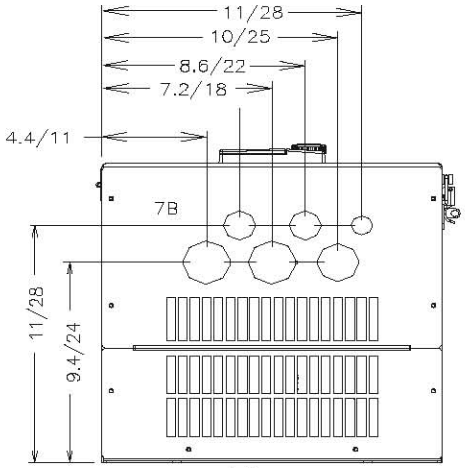
D


9.4/24
8.4/21
7.0/18
5.6/140
4.2/11
2.8/7
6
8.6/22
6.9/18

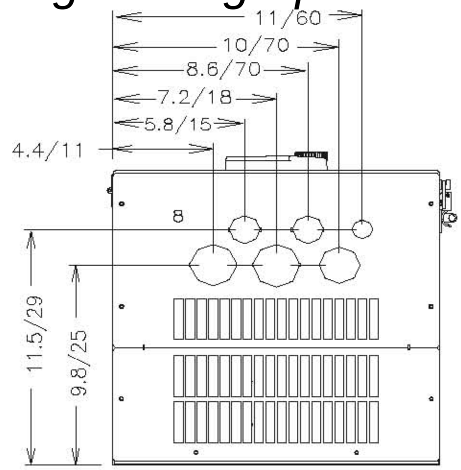
E


12.6/32
11.2/28
9.4/24
7.5/19
5.7/15
3.8/10
7A
12.9/33
10.5/27

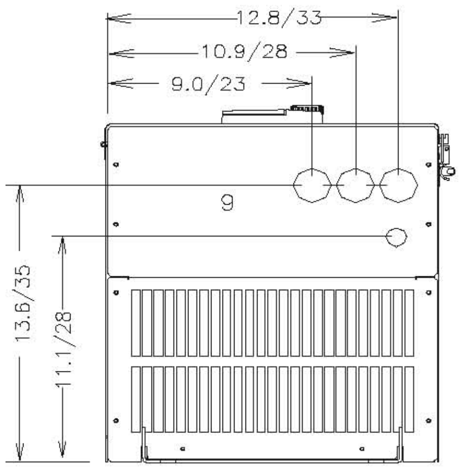
F


11/28
10/25
8.6/22
7.2/18
4.4/11
7B
11/28
9.4/24

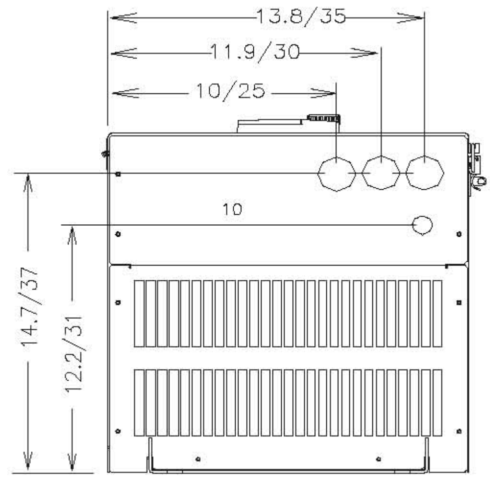
G


11/60
10/70
8.6/70
7.2/18
5.8/15
4.4/11
8
11.5/29
9.8/25

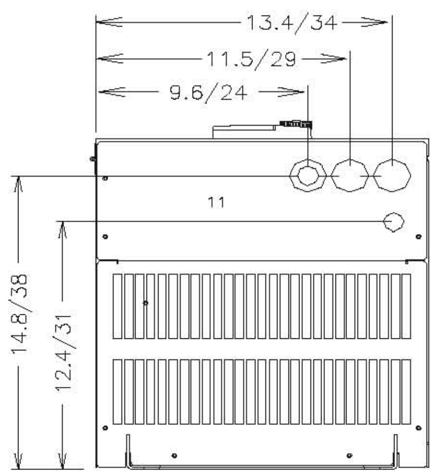
H


12.8/33
10.9/28
9.0/23
9
13.6/35
11.1/28

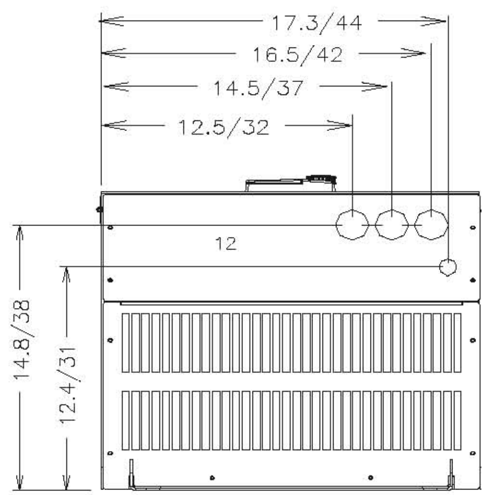
I


13.8/35
11.9/30
10/25
10
14.7/37
12.2/31

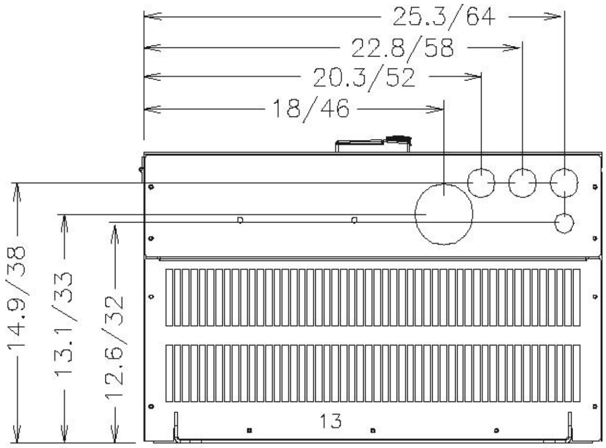
J


13.4/34
11.5/29
9.6/24
11
14.8/38
12.4/31

K


17.3/44
16.5/42
14.5/37
12.5/32
12
14.8/38
12.4/31

I



M

APPENDIX C – H9 Enclosure Dimensions

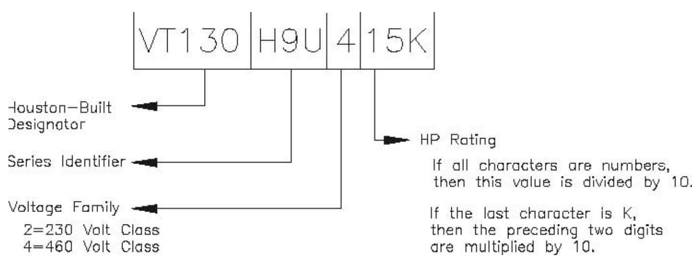
Enclosure Dimensions and Conduit Plate Information

The H9 ASD part numbering convention is as indicated below.

The enclosure dimensions for each typeform and the associated conduit plate type are listed in Tables 16 and 17.

The conduit plates that are referenced in Tables 16 and 17 are shown in Figures 35, 36, and 37.

H9 Part Numbering Convention.



Note: *The Type 1 enclosed versions of these drives meet or exceed the specification* ***UL 50-1995****, the* ***Standard for Heating and Cooling Equipment****, and complies with the applicable requirements for installation in a compartment handling conditioned air.*

Note: *All Toshiba ASD enclosures carry an IP20 rating.*

Enclosure Dimensions

Table 16. 230-Volt H9 ASD Systems.

Model Number VT130H9U	Enclosure Figure Number	A Height (in/mm)	B Width (in/mm)	C Depth (in/mm)	D Mounting Hole Height (in/mm)	E Mounting Hole Width (in/mm)	R Mounting Hole Diameter (in/mm)	Conduit Plate (Figure 35, 36, and 37)
2035	Figure 32	12.4/315	6.1/155	6.6/168	8.7/221	4.5/114	0.24/6.10	Figure 35-A
2055								
2080		15.0/381	6.9/175	6.6/168	11.1/282	6.2/158		Figure 35-B
2110								Figure 35-C
2160		19.3/490	9.1/231	7.6/193	15.2/386	8.3/211		Figure 35-D
2220								
2270								
2330	Figure 33	25.9/658	11.1/282	13.2/335	25.0/635	8.0/203	0.24/6.10	Figure 35-E
2400		33.1/841	14.3/363	15.0/381	32.3/820		0.38/9.65	Figure 36-G
2500								
2600								
2750								

Table 16.Table Continuation 230-Volt H9 ASD Systems.

<table>
<tr><th>Model Number VT130H9U</th><th>Enclosure Figure Number</th><th>A Height (in/mm)</th><th>B Width (in/mm)</th><th>C Depth (in/mm)</th><th>D Mounting Hole Height (in/mm)</th><th>E Mounting Hole Width (in/mm)</th><th>R Mounting Hole Diameter (in/mm)</th><th>Conduit Plate (Figure 35, 36, and 37)</th></tr>
<tr><td>210K</td><td rowspan="2">Figure 34</td><td>51.7/1313</td><td>14.6/371</td><td>17.6/447</td><td>50.2/1275</td><td>9.2/234</td><td rowspan="2">0.69/17.53</td><td rowspan="2">Figure 36-I</td></tr>
<tr><td>212K</td><td>53.1/1349</td><td>15.7/399</td><td>17.6/447</td><td>51.7/1313</td><td>9.9/252</td></tr>
</table>

Table 17. 460-Volt H9 ASD Systems.

<table>
<tr><th>Model Number VT130H9U</th><th>Enclosure Figure Number</th><th>A Height (in/mm)</th><th>B Width (in/mm)</th><th>C Depth (in/mm)</th><th>D Mounting Hole Height (in/mm)</th><th>E Mounting Hole Width (in/mm)</th><th>R Mounting Hole Diameter (in/mm)</th><th>Conduit Plate (Figure 35, 36, and 37)</th></tr>
<tr><td>4055</td><td rowspan="7">Figure 32</td><td rowspan="2">12.4/315</td><td rowspan="2">6.1/155</td><td rowspan="3">6.6/168</td><td rowspan="2">8.7/221</td><td rowspan="2">4.5/114</td><td rowspan="5">0.24/6.10</td><td rowspan="2">Figure 35-B</td></tr>
<tr><td>4080</td></tr>
<tr><td>4110</td><td>15.0/381</td><td>6.9/175</td><td rowspan="3">11.1/282</td><td>6.2/158</td><td>Figure 35-C</td></tr>
<tr><td>4160</td><td rowspan="2">15.1/384</td><td rowspan="2">8.3/211</td><td rowspan="2">7.6/193</td><td rowspan="2">7.5/191</td><td rowspan="2">Figure 35-D</td></tr>
<tr><td>4220</td></tr>
<tr><td>4270</td><td rowspan="2">19.3/490</td><td rowspan="2">9.1/231</td><td rowspan="2">7.6/193</td><td rowspan="2">15.2/386</td><td rowspan="2">8.3/211</td><td rowspan="3">0.24/6.10</td><td rowspan="2">Figure 35-E</td></tr>
<tr><td>4330</td></tr>
<tr><td>4400</td><td rowspan="6">Figure 33</td><td>25.9/658</td><td>11.1/282</td><td>13.2/335</td><td>25.0/635</td><td rowspan="6">8.0/203</td><td>Figure 35-F</td></tr>
<tr><td>4500</td><td rowspan="2">30.8/782</td><td rowspan="2">11.1/282</td><td rowspan="2">14.3/363</td><td rowspan="2">29.7/754</td><td rowspan="5">0.38/9.65</td><td rowspan="2">Figure 36-H</td></tr>
<tr><td>4600</td></tr>
<tr><td>4750</td><td rowspan="3">36.1/917</td><td rowspan="3">14.3/363</td><td rowspan="3">15.3/389</td><td rowspan="3">35.3/897</td><td rowspan="3">Figure 36-I</td></tr>
<tr><td>410K</td></tr>
<tr><td>412K</td></tr>
<tr><td>415K</td><td rowspan="6">Figure 34</td><td>51.7/1313</td><td>14.6/371</td><td rowspan="6">17.6/447</td><td>50.2/1275</td><td>9.2/234</td><td rowspan="6">0.69/17.53</td><td>Figure 36-J</td></tr>
<tr><td>420K</td><td>53.1/1349</td><td>15.7/399</td><td>51.7/1313</td><td rowspan="2">9.9/252</td><td>Figure 36-K</td></tr>
<tr><td>425K</td><td>63.1/1603</td><td>15.0/381</td><td>61.6/1565</td><td>Figure 36-L</td></tr>
<tr><td>430K</td><td rowspan="2">68.5/1740</td><td rowspan="2">18.9/480</td><td rowspan="2">67.0/1701</td><td rowspan="2">13.8/351</td><td rowspan="3">Figure 37-M</td></tr>
<tr><td>435K</td></tr>
<tr><td>440K</td><td>70.0/1778</td><td>25.6/650</td><td>68.5/1740</td><td>21.3/541</td></tr>
</table>

Figure 32. See Tables 16 and 17 for actual dimensions.

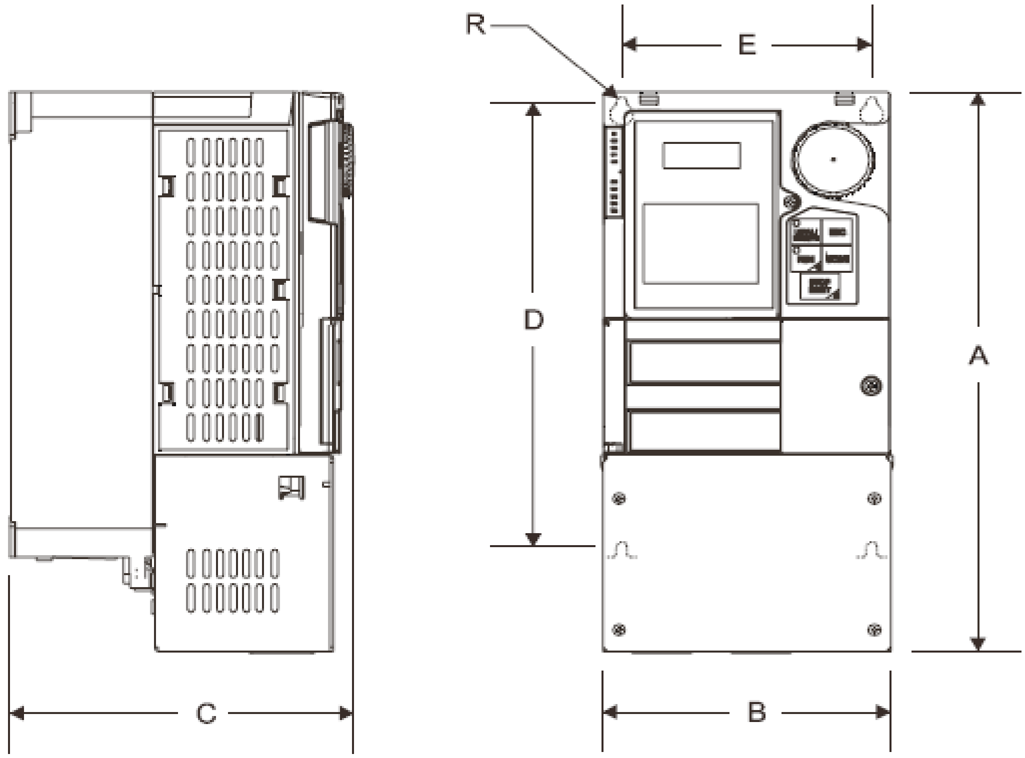


Figure 33. See Tables 16 and 17 for actual dimensions.

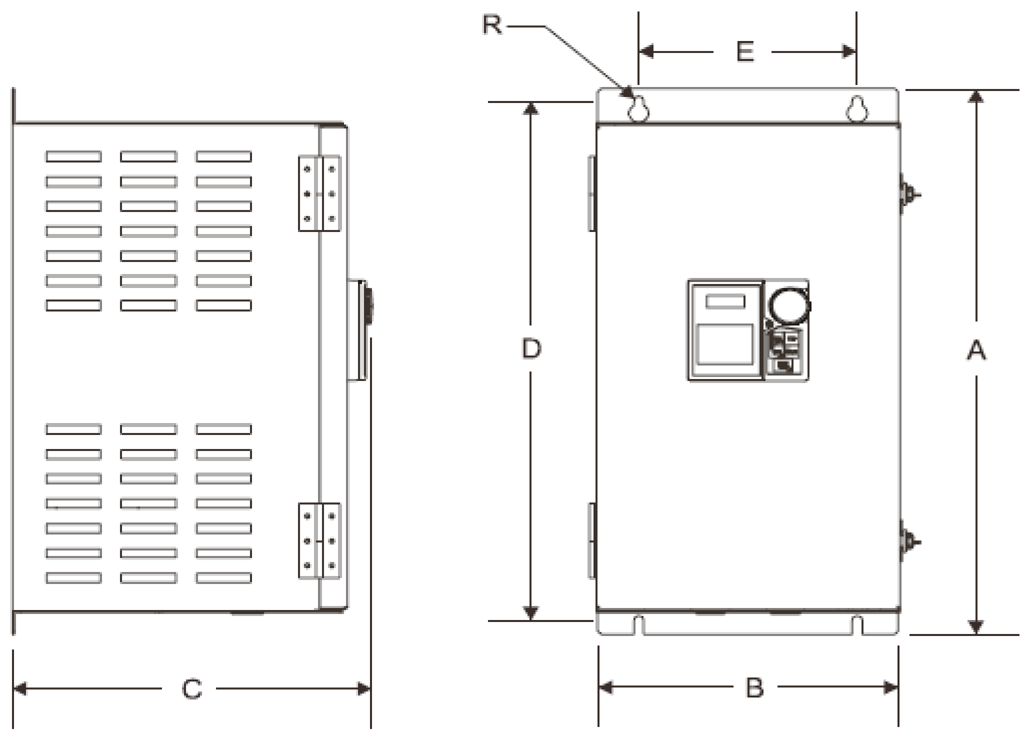
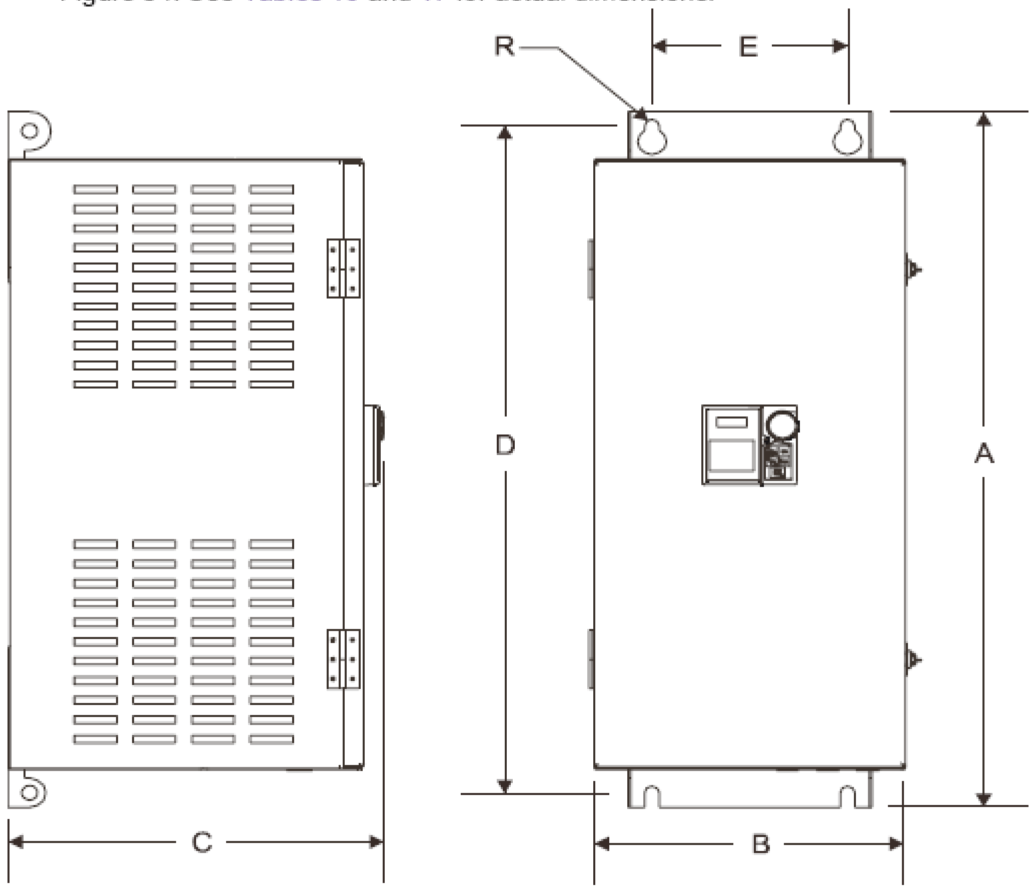
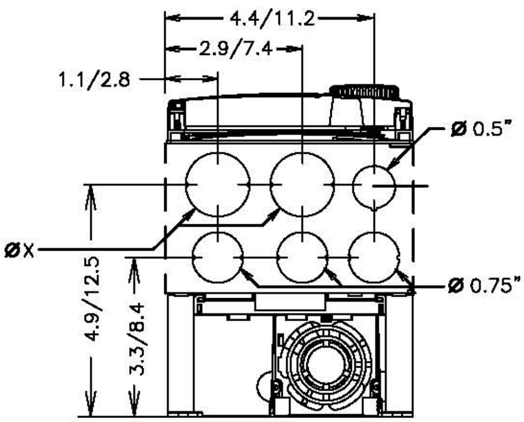


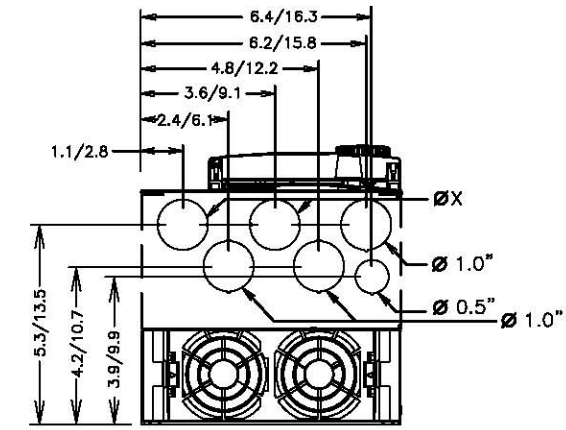
Figure 34. See Tables 16 and 17 for actual dimensions.



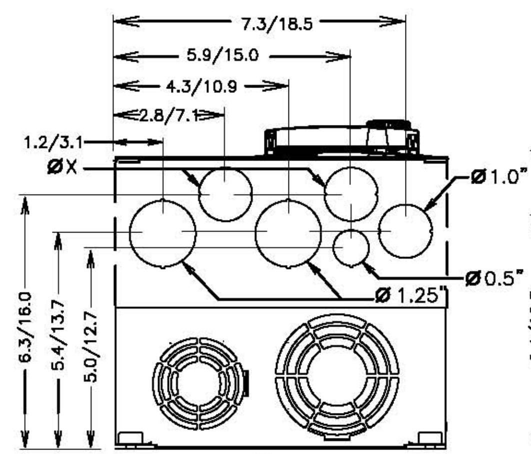
ØX = Concentric Knockous for Diameter Sizes 0.5", 0.75", and 1.0" Conduit.



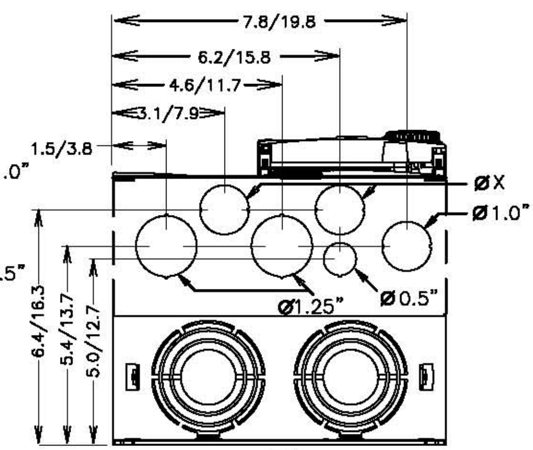
A



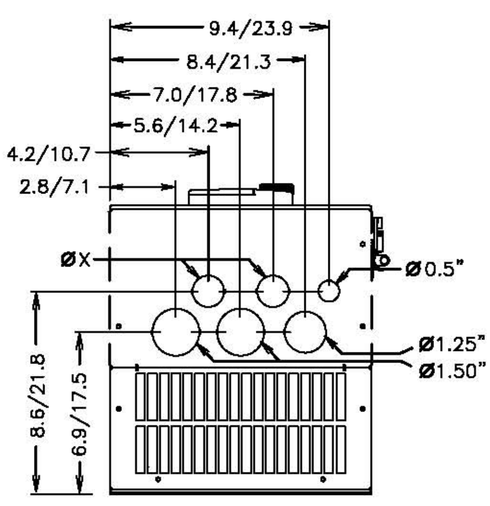
B



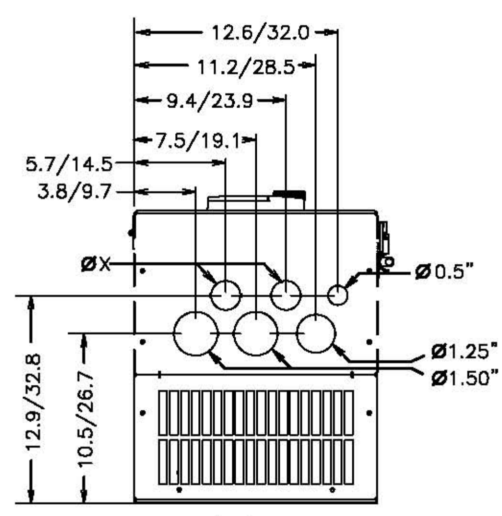
C



D

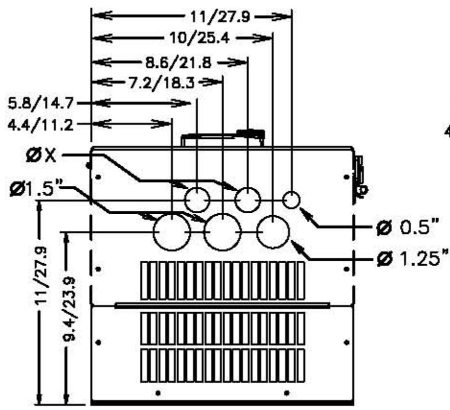


E

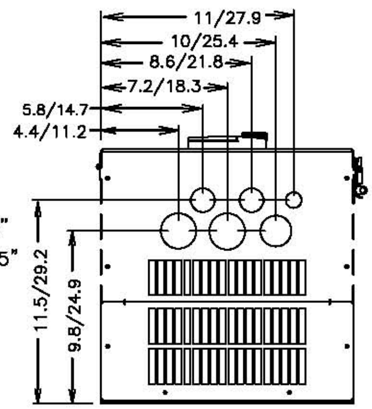


F

ØX = Concentric Knockous for Diameter Sizes 0.5", 0.75", and 1.0" Conduit.

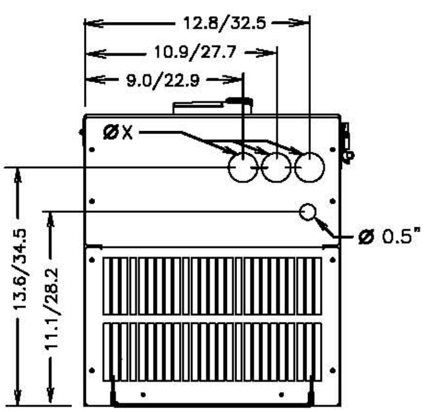


G

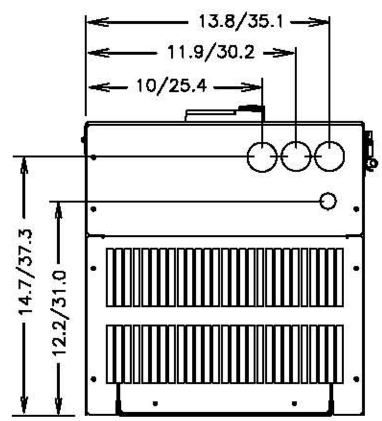


Conduit Ø = Same as G

H

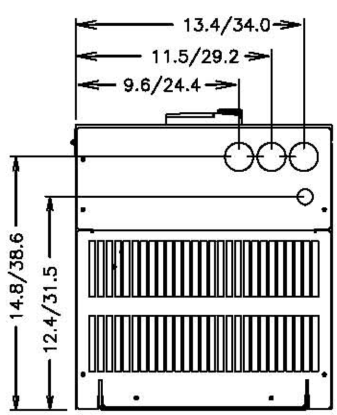


I



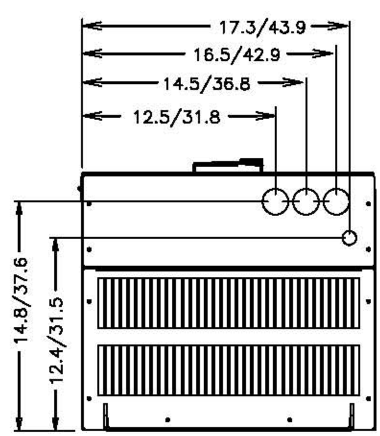
Conduit Ø = Same as I

J



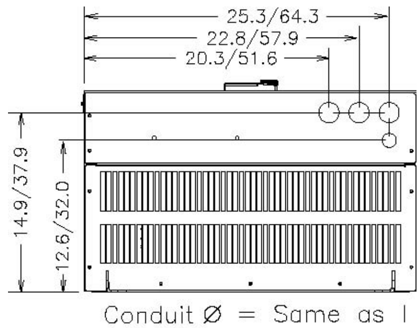
Conduit Ø = Same as I

K



Conduit Ø = Same as I

L



M

APPENDIX D – ASD-MTG-KIT9

ASD-MTG-KIT9 Installation Procedure

The ASD may be controlled from a remotely-mounted **Electronic Operator Interface** (EOI**)**.

The EOI can operate up to distances of up to 15 feet away from the ASD via the RS485 Port.

An EOI extender cable is required for remote mounting. Extender cables are available in lengths of 7, 10, or 15 feet and may be ordered through your sales representative.

Required Remote-mount Hardware

EOI Remote-Mount Assembly

•ASD-MTG-KIT9 Assy.

Extender Cables

•Cable, RJ45, 7 ft. — P/N ASD-CAB7F

•Cable, RJ45, 10 ft. — P/N ASD-CAB10F

•Cable, RJ45, 15 ft. — P/N ASD-CAB15F

Mounting Precautions

Mount the unit securely in a well ventilated area that is out of direct sunlight using the four mounting studs of the **ASD-MTG-KIT9** Assy. The ambient operating temperature of the EOI is 14 – 104° F
(-10 – 40° C).

Read and adhere to the Safety Precautions and Warnings of the Installation and Operation Manual of the ASD.

When mounting the **ASD-MTG-KIT9**:

•Select a mounting location that is easily accessible by the user.

•Avoid installation in areas where vibration, heat, humidity, dust, metal particles, or high levels of electrical noise (EMI) are present.

•Do not install the EOI where it may be exposed to flammable chemicals or gasses, water, solvents, or other fluids.

•Turn the power on only after securing the front cover or securing the door of the ASD.

Plate Installation and Module Removal/Installation

Reference Figures 1 and 2 on pg. 2 for instructions 5 – 8 below.

1.At the Remote EOI mounting location, identify and mark the locations of the 4.56” by 4.44” hole and the four 7/32” screw holes (see *Figure 1*).

2.Cut the 4.56” by 4.44” rectangular mounting hole.

3.Drill the four 7/32” screw holes for the four mounting studs of the Bezel plate.

4.Attach and secure the Bezel plate to the front side of the mounting location using the four #10 flat washers, #10 split lock washers, and the 10-32 hex nuts.

5.Remove the **Display Module** from the EOI of the ASD.

6.Install the **Connector Module** onto the ASD.

7.Install the **Display Module** into the **ASD-MTG-KIT9** assembly.

When installing the **Connector Module** or the **Display Module** into the housing ensure that the left side of the module is inserted first with the top and bottom catches securely in place (see Phillips screws at underside of display). This ensures the proper alignment and electrical connection of the CNX connector of the PCB within the module. Then gently hold the display in place while securing the Phillips mounting screw.

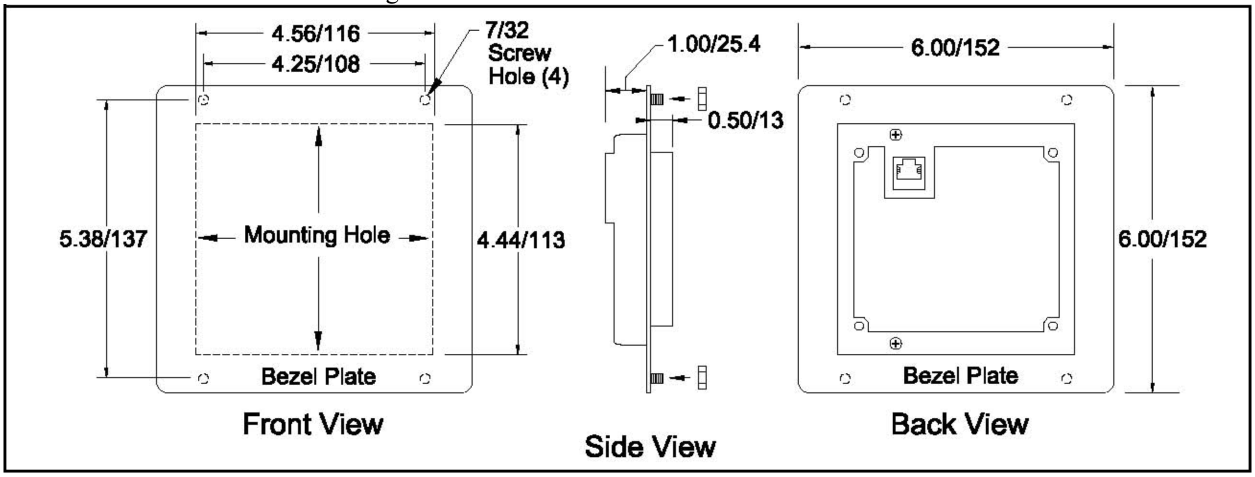
If improperly seated, the periphery of the module will not be flush with the module housing surface and the unit will not function properly.

Note:*Refer to the Installation and Operation Manual of the ASD for further information on removing/installing the Display Module.*

8.Connect the RJ-45 extension cable from the **Connector Module** to the **Display Module**.

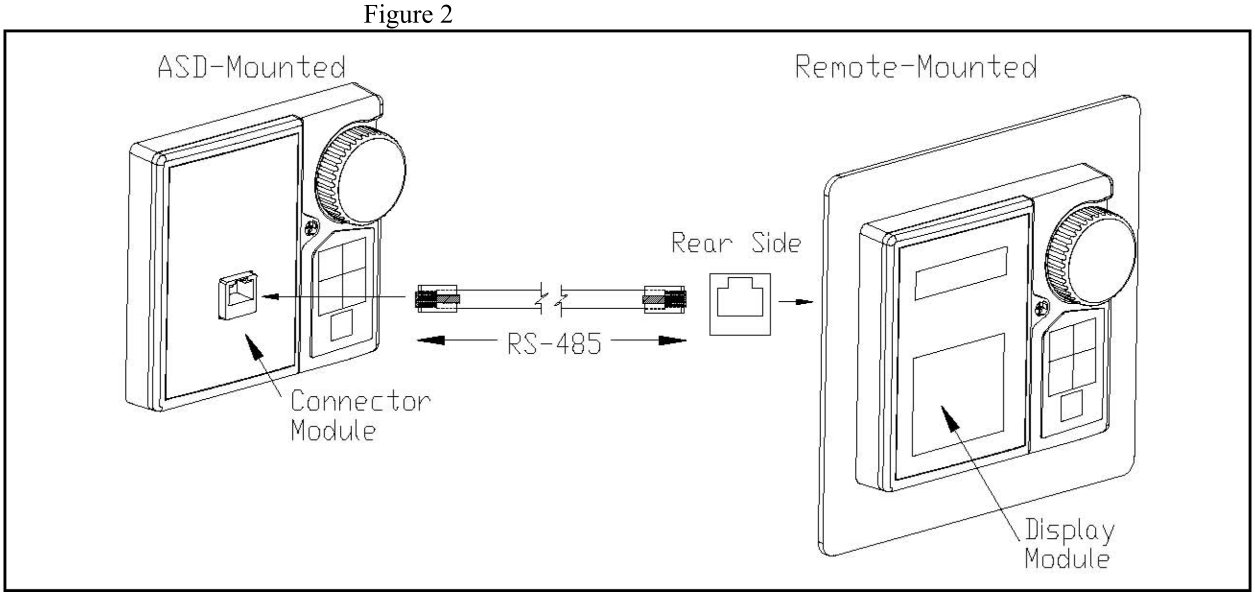
ASD-MTG-KIT9 Mounting and Connection

Figure 1.



Bezel Plate Dimensions (inches/mm).

Figure 2



. ASD-MTG-KIT9 Connection.