EMERSON Climate Technologies

Application Engineering

Copeland brand products

B U L L E T I N

AE8-1405 R2 **June 2015**

EV2 Variable Speed Drive

TABLE OF CONTENTS

Safety Instructions

Copeland Scroll™ variable speed drives are manufactured according to the latest U.S. and European Safety Standards. Particular emphasis has been placed on the user's safety. Safety icons are explained below and safety instructions applicable to the products in this bulletin are grouped on page 3. These instructions should be retained throughout the lifetime of the drive. **You are strongly advised to follow these safety instructions.**

Safety Icon Explanation

⚠ DANGER	DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	NOTICE is used to address practices not related to personal injury.
CAUTION	CAUTION, without the safety alert symbol, is used to address practices not related to personal injury.

Instructions Pertaining to Risk of Electrical Shock, Fire, or Injury to Persons

WARNING	**ELECTRICAL SHOCK HAZARD** • Disconnect and lock out power before servicing. • Discharge all capacitors before servicing. • Use drives with grounded system only. • Allow drive components to electrically discharge for a minimum of two minutes before servicing. • Refer to original equipment wiring diagrams. • Electrical connections must be made by qualified electrical personnel. • Failure to follow these warnings could result in serious personal injury.
WARNING	**BURN HAZARD** • Do not touch the drive until it has cooled down. • Ensure that materials and wiring do not touch high temperature areas of the compressor. • Use caution when brazing system components. • Personal safety equipment must be used. • Failure to follow these warnings could result in serious personal injury or property damage.
CAUTION	**DRIVE HANDLING** • Caution must be used when lifting and installing the drive. Failure to use caution may result in bodily injury. • Personal safety equipment must be used. • Failure to follow these warnings could result in personal injury or property damage.

Safety Statements

- Refrigerant compressors must be employed only for their intended use.
- Only qualified and authorized HVAC or refrigeration personnel are permitted to install, commission and maintain this equipment.
- Electrical connections must be made by qualified personnel.
- All valid standards and codes for installing, servicing, and maintaining electrical and refrigeration equipment must be observed.

INTRODUCTION

This bulletin provides instructions on how to apply an EV2 inverter drive to a variable speed compressor in a safe and reliable manner. The EV2 inverter drive will be referred to throughout this document as the inverter drive or simply the drive.

Product Description

The inverter drive has been developed specifically for the variable speed compressor. The drive will power the compressor, control the compressor running speed, provide compressor and drive protection and communicate with the master controller. The drive requires cooling and is typically installed in the unit near the compressor.

Theory of Drive Operation

The primary purpose of the drive is to convert the 50/60 Hz AC input voltage into a variable frequency, variable voltage output to power the variable speed scroll compressor. The drive conditions the AC input voltage through a series of conditioning processes to arrive at the desired output. The drive first converts the AC input voltage into a DC bus. The DC voltage is then pulse-width modulated to replicate a sinusoidal current at the desired frequency and voltage.

Agency Recognition

UL 60730 -1 CLASS B

Nomenclature

The model number of the drive includes the power rating and nominal voltage input to the drive. **Figure 1** at the end of this bulletin provides a complete explanation of all of the alpha and numeric characters in the drive model number.

Drive Handling

⚠ CAUTION

Caution must be used when lifting and installing the drive. Failure to use caution may result in bodily injury.

NOTICE

Personnel handling the drives in a manufacturing plant environment should guard against static electricity by using the appropriate equipment – antistatic wrist straps and mats.

Mounting

The drive should be located within 5 feet of the compressor since the wiring between the drive and compressor is unshielded. Therefore, the drive will likely be located in the outdoor unit for split and packaged systems. Geothermal systems will likely have the drive installed indoors.

All air-cooled drives are supported inside the HVAC system by an extended heatsink plate. The plate mounts through an opening in the cabinet sheet metal to expose the heat exchanger to the condenser fan air stream. The flange contains a gasketed surface to prevent water from entering the electronics side of the control box.

The flat plate option accommodates installation to systems using the gas or liquid cooled cold plate heat exchanger.

There are holes in the drive mounting flange for mounting purposes. These holes will accommodate a M5 sized screw for mounting.

Drive Dimensions

Please refer to **Figure 2** for a detailed description of the drive dimensions. For the dimensions of the choke and filter board, refer to **Figures 3 and 4**.

Wiring Diagram

Refer to **Figure 5** for a detailed description of the drive wiring diagrams. Refer to **Table 2** for a detailed description of the communication connector pin definition.

Connectivity

Refer to **Table 1** for a detailed description of the drive connections.

Hi-pot Procedure / Set-up

Refer to **Table 4** for drive hi-pot testing information. Please call your Application Engineer for additional details.

Pre-operation Checks

⚠ CAUTION

Check the drive carefully before operating. Make sure that all the wires are correctly and tightly connected. Improper operation may cause fire or injury to persons.

Power On/Off

NOTICE

The drive should use rated AC power supply: 50/60Hz, 208~240V. Using incorrect power supply may cause the drive to be damaged. Users should check the power supply before powering on the drive.

When powering off the drive, make sure the compressor is not running.

Communication Setting

The drive is designed to be used in a master-slave configuration where the master is a system controller. Two standard Modbus® protocols are available: RTU and ASCII.

Users can select RTU Mode or ASCII Mode by writing the value of related register according to the Modbus Map. For example, to select the RTU Mode under ASCII Mode, write 0x2345 passwords to Register 200 to get Modbus Map Access first, and then write 0002H to the register 201. Power off the drive and repower on again, and then the communication mode will be changed to RTU mode. On 201-204, the end user can change baud rate, slave ID, and parity using the register information table. 205 must be set to distinguish compressor model variations.

Users can also change the baud rate, parity and stop bit method. Detailed parameters are in the Modbus Map.

Modbus uses a three layer protocol – physical, data link, and application.

Physical Layer

The physical layer defines the hardware interface to the master. The standard control interface uses a two wire serial communication (RS485 physical layer) scheme. The recommended cable is an 18 AWG stranded copper with 4 conductors and a drain wire.

Data Link Layer

The data link layer defines the reliable transfer of a message transferred from the master to one of the slave devices, and the reliable transfer of the response message back to the master. The drive code sets the default node address of 045 for Modbus RTU and 01 for Modbus ASCII. The desired bit rate communication is 19200 for RTU and 38400 for ASCII.

If the Modbus communications for the VSD is in RTU mode, the default character framing will be a 11 bit character as follows:

1 including Start bit

8 Data bits

1 Even parity

1 Stop bit

Standard 2 byte CRC is used for frame verification.

If the Modbus communications for the inverter is ASCII mode the default character framing will be a 10 bit character as follows:

1 including Start bit

7 Data bits

1 Even parity

1 Stop bit

Modified 2 byte CRC is used for frame verification, not LRC as shown in the Modbus ASCII specification.

Application Layer

The application layer defines the type of message that will be sent and the format of the message. Read data are available through Modbus function code 03 (0x03) read holding registers. See **Example 1**.

Starting addresses 0 to 7 must be handled in a special way: each address (at least 0 to 2) represents a character string (up to 32 byte ASCII). In that case, the byte count in the response frame is the length of the string (which might be odd), and the data part of the frame represents the string as an array of bytes (without any kind of byte swapping). In the request frame, the quantity of registers does not matter (and should be set to 0).

Example 1

Request

Function code	1 Byte	0x03
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	1 to 125 (0x7D)

Response

Function code	1 Byte	0x03
Byte count	1 Byte	2 x N*
Holding Registers	N* x 2 Bytes	

*N = Quantity of Input Registers

Error

Error code	1 Byte	0x83
Exception code	1 Byte	01 or 02 or 03 or 04

01 = Function code not supported
02 = Starting Address + Quantity of registers out of range
03 = Quantity of registers out of range
04 = Read of Input Registers failed

Write data are available through Modbus function code 06 (0x06) write single register. See **Example 2.**

Example 2

Request

Function code	1 Byte	0x06
Register Address	2 Bytes	0x0000 to 0xFFFF
Register Value	2 Bytes	0x0000 to 0xFFFF

Response

Function code	1 Byte	0x06
Register Address	2 Bytes	0x0000 to 0xFFFF
Register Value	2 Bytes	0x0000 to 0xFFFF

Error

Error code	1 Byte	0x86
Exception code	1 Byte	01 or 02 or 03 or 04

01 = Function code not supported
02 = Register Address invalid
03 = Register Value out of range
04 = Write single register failed, this may also occur if configure value is out of bounds.

Input Voltage And Power Interruption

The drives are designed for an input power supply of 208 to 240 volts 50/60 Hz. Published performance for the drive and compressor combination will have a performance tolerance specified on the compressor performance data sheet when the drive input voltage is in the range of 208 to 240 volts.

Power Factor Correction

The drive has active power factor correction. The drive is capable of correcting the AC input current to maximize system efficiency.

Speed Control

The frequency range of EV2 is from 15Hz to 120Hz. If the frequency set by system controller is less than 15Hz but not zero, then the compressor will work at 15Hz. Similarly, if the frequency set by system controller is greater than 120Hz, then the compressor will work at 120Hz.

Start-up

The drive will not start with faults present. Modbus registers 78 through 85 should all be equal to 0. To clear faults, use "Fault Clearing" method shown below.

Start the compressor using the following method:

1. Enable drive by writing '1' to Modbus register 100.
2. Write target frequency to Modbus register 101.

Start-up control is divided into four stages. For a detailed description, refer to **Table 5**. After successful start-up, the compressor will run at the frequency that the system controller is commanding.

Shut Down

A running compressor will shut down in one of three cases:

Case I (Controlled shut down): A '0' is written to Modbus register 100 and/or register 101 dependent upon control strategy. There are 3 stages to finish shutting down sequence. For description of the sequence refer to **Table 6**.

Case II (Faulted condition): When drive faults occur, the drive will shut down the compressor. Major and minor faults have different shutdown sequences. For major faults, the drive trips the compressor immediately (from running frequency to zero frequency). For minor faults, it has the same sequence as Case I. As mentioned above clear faults using the 'Fault Clearing' method shown below.

Case III: Loss of power shut down, this control procedure is the same as major fault shut down.

Fault Clearing

In the Modbus relationship, the drive is considered a slave, and the system controller is the master. Faults will not clear unless they are commanded to.

To clear faults, use the following method:

1. The compressor has been shut down for at least 35 seconds.
2. The fault condition no longer exists (registers 78-85).
3. The drive has received a zero speed command (register 101 = 0).

4. The drive has been disabled (register 100 = 0).
5. Write '1' to register 103.

Faults will not clear unless all items above are true.

Stator Heat Control

In actual use, the system controller may decide whether to preheat or not according to the environment. When preheating is needed, the system controller sends register 100 a compressor enable command and register 102 a stator heating power value. The drive transmits up to 50W DC power to warm up the compressor.

The stator heating is on if the following are true:

1. There are no active errors.
2. Compressor enabled.
3. Compressor speed is set zero.
4. Stator heater power setting is from 10~50.

If the system sends a speed demand to the drive while the stator is heating, the drive will stop stator heating and start the compressor. While running, if the system sends a zero speed command, the drive will shut down the compressor automatically, and then resume the stator heating to the value saved in Stator Heater Power Memory Register (a value or zero = off).

Status Indication

There are three LED for status display with:

LED for COMMS
Operation Indicating LED (Green LED605)

When the drive is in normal state (no protection and fault), the drive is in standby state and the compressor is not running, the LED will blink at 0.5Hz frequency. If the compressor is running, the LED will always be on.

Protection Indicating LED (Yellow LED604)

When the drive is under protection, the yellow LED will blink. Refer to the **Troubleshooting** section of this bulletin for more information.

Hardware Fault Indicating LED (Red LED603)

When the drive is under hardware fault, the red LED will blink. Refer to **Troubleshooting** for more information.

LED for Drive Control (Green LED602)

When the drive is in normal state, whether the compressor is running or standby, the LED will blink at 1Hz frequency. When the drive is under protection or hardware fault, the LED will blink at 8Hz frequency.

N - Yellow LED = PROTECTION

N - Red LED = FAULT

LED for Power Factor Correction (Green LED601)

PFC control circuit has a LED indicator (Green). The status of the LED is only related with PFC.

When the drive PFC is not in operation, the LED will blink at 1Hz frequency. When the PFC is in operation, the LED will be on.

High Pressure Cut Out

CN610 is a 2 port connector. The output is a 3.3VDC signal. The high pressure cutout switch must be normally closed. If the switch is open, the drive will not operate.

Drive Cooling

Because of the power electronics used in the drive and the associated heat generation, drive cooling is required to keep the drive components in their design temperature range. The allowable temperature range of the drive (not the ambient air surrounding the drive) is -13°F to 150°F. Drive temperature should be monitored during system development and during system extreme conditions to ensure that the maximum allowable drive temperature isn't exceeded. The highest drive temperature will typically occurs during high load conditions and/or during high drive ambients. The drive is internally protected against overheating and will shut itself down if overheating or foldback occurs.

Drive Over Temperature Protection

The drive is self protected against high internal temperatures. The drive will perform a controlled shutdown if a high temperature condition is detected. When the internal drive temperature decreases to a safe level the temperature fault condition will clear and the drive will restart the compressor.

Power Interrupt

Power interrupts can result in a drive trip that won't harm the drive. The drive can withstand interrupts of a short duration (<= 10 mS), but will trip on anything longer.

Air Cooled Heat Exchanger

Drives cooled by the aluminum air cooled heat exchanger are designed to be in the air flow stream of the condenser. The air cooled heat exchanger must be installed so that the heat exchanger fins are parallel to the cooling air flow.

Cold Plate Heat Exchanger

The cold plate design can be used when another cooling source is available – suction gas from the evaporator coil, subcooled liquid refrigerant, glycol solution from a geothermal loop, water from a cooling tower, etc. When refrigerant is used for drive cooling, the heat given up by the drive is transferred into the refrigeration system. This can be a net gain for heating applications and a net loss for cooling applications.

The soldering/brazing that is required to connect the cooling source to the cold plate should be performed before the cold plate is attached to the drive, to prevent overheating drive components with the torch.

Fold Back

To protect the drive components or the compressor, the compressor speed will "fold back" or slow down to help reduce risk to components. The fold back events(s) will be flagged in the drive's Modbus registers. This will allow the operating system to respond and mitigate the conditions causing fold back.

For further information refer to **Tables 10-12**

Troubleshooting

The drive may indicate fault or protection for various reasons. If fault or protection occurs, users should power down the drive, check the drive, and check the drive running condition carefully. For the description, check and handling of these faults or protections, please refer to the **Fault and Protection Table** on the following page.

The yellow and red LED of COMM will be displayed in a circulation of blinking for N times (N is the protection code) then be off for 3 seconds. For detailed description of the protections, please refer to **Tables 7 and 8**.

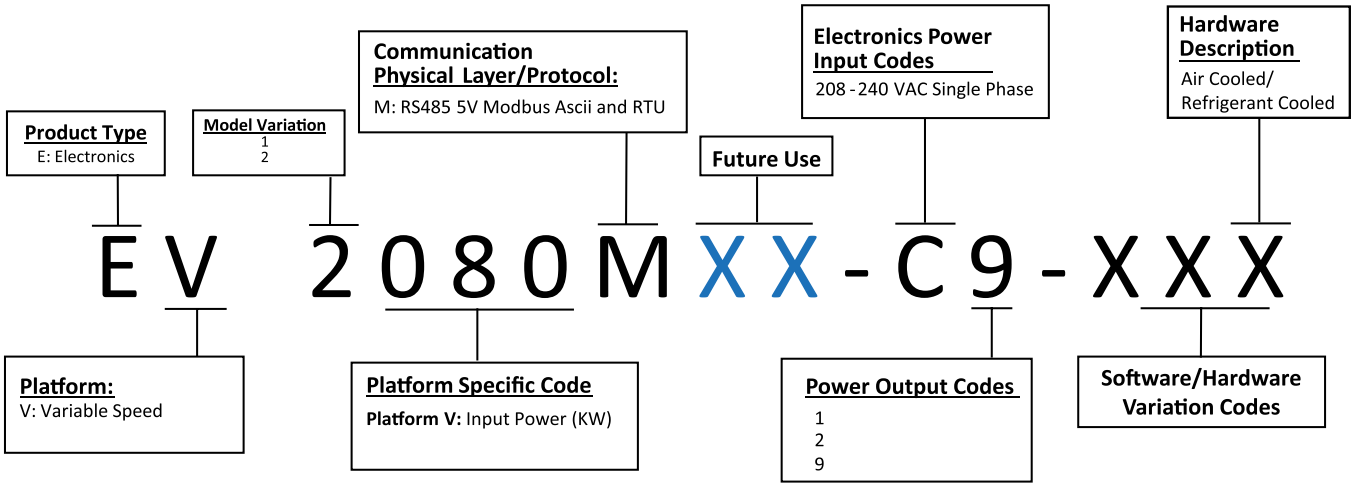
The drive has a series of Modbus registers that log various kinds of faults. A description of these registers is as follows:

Register	78	79	80	81	82	83	84	85
Immediate Shutdown	X		X		X		X	
Controlled Shutdown		X		X		X		X
First Fault Latched	X		X		X		X	
Current Faults		X		X		X		X

- Immediate shutdown = The drive will execute an immediate shut down due to a condition that may cause damage to the drive.
- Controlled shutdown = The drive will execute a controlled shut down due to systemic or temperature related problems.
- First faults latched = When a fault occurs it may cause other faults to happen as well. In order to capture the fault that happened first, these registers only record the ‘first fault latched’.
- Current faults = These registers display all faults that are currently logged by the drive, including the first faults latched.

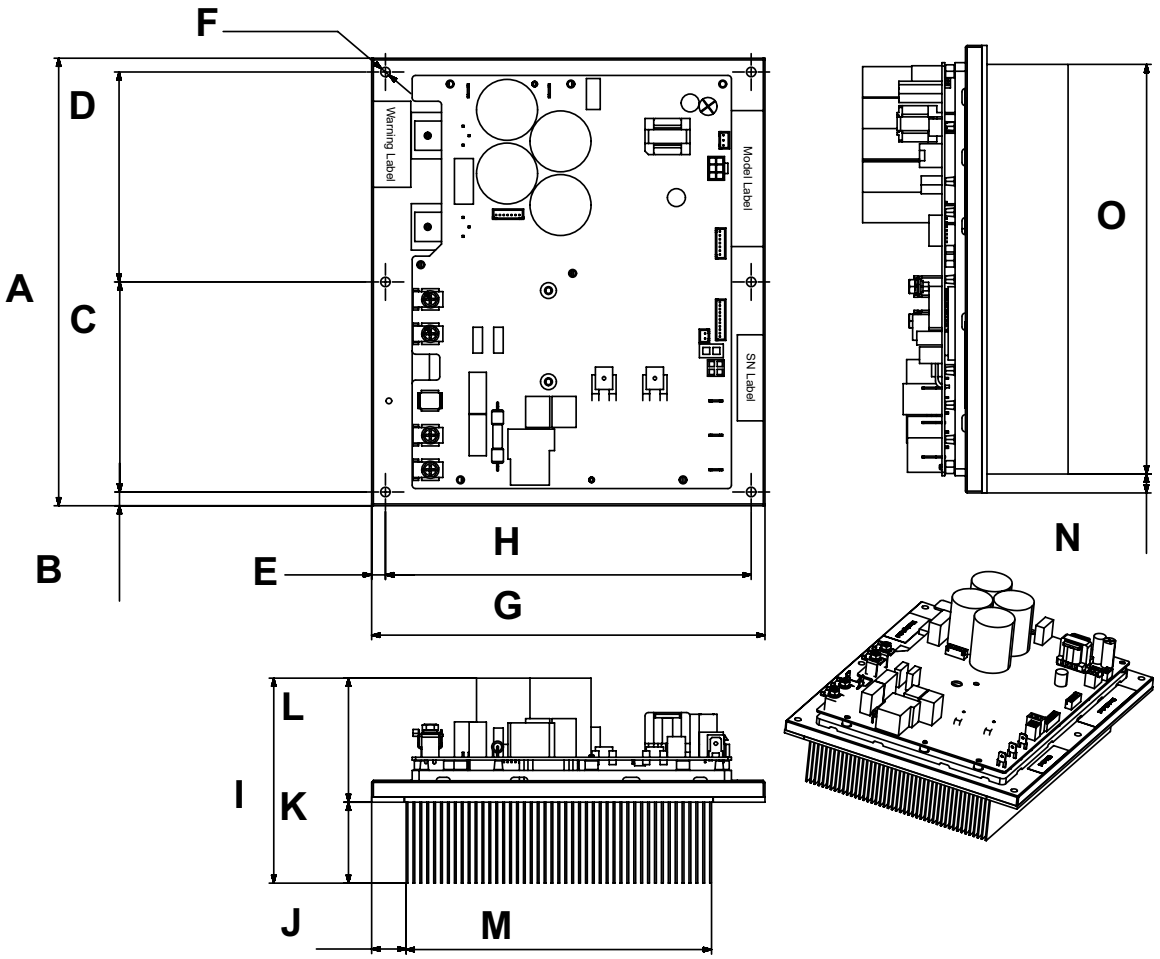
Troubleshooting – Fault and Protection Table

NO.	Registers		Bit	Fault/Protection	Check and Handling
1	78	80	0	Compressor phase overcurrent	Check the compressor U/V/W and the PIM module. Check compressor motor windings.
2	79	81	2	Compressor envelope protection	Compressor current indicates it's operating outside the specifed limit.
3	78	80	1	PFC overcurrent fault	Possibly caused by line noise or internal drive failure. Verify power source is to specification.
					Check line voltage, this can occur if it's < 200 VAC. Also verify the condition system is running in, and that it is to specification.
					Possible drive component issue. If problem persists replace the drive.
4	78	80	2	DC bus over-voltage protection	Check the AC power supply. Verify the compressor is operating with specified limits.
5	78	80	3	DC bus under-voltage protection	
6	78	80	4	AC input over-voltage protection	Check the AC power supply, verify it is within specified limits.
7	78	80	5	AC input under-voltage protection	
8	78	80	11	PIM over-temperature protection	Verify proper airflow over the heatsink of the drive. Remove any obstructions. If problem persists, replace the drive.
9	78	80	12	PFC-IGBT over-temperature protection	
10	78	80	13	Lost rotor	Check Compressor or connections.
11	82	84	0	Inverter current Imbalance protection	Check the compressor U/V/W connection; make sure that they are properly connected.
12	82	84	2	Microelectronic fault	Power cycle the drive. If problem persists, replace drive.
				EEPROM fault	
13	83	85	5	Inverter temperature sensor open fault	Temperature sensing device on the drive are possibly defective. If problem persists, replace the drive.
14	79	81	0	DC voltage low protection	Check the AC power supply.
15	79	81	4	Input current foldback timeout.	Verify the Input Voltage if is at range of operating voltage and load is in proper of Drive Power Limit. If problem persists, replace the drive.
16	79	81	7	Drive and system controller communication fault	Check the communication wire connection. Check the communication parameters are set right.
17	79	81	8	Sensor 2 over-heat protection	Check the compressor and the system.
18	79	81	11	Inverter temperature high protection	Verify proper airflow over the heatsink of the drive. Remove any obstructions. If problem persists, replace the drive.
19	79	81	12	PFC-IGBT temperature high protection	
20	79	81	13	PFC MCU and DSP communication fault	Check the drive running condition makes sure that there is no electro-magnetic interference. Restart the drive, if the problem persists, replace the drive.
21	79	81	14	COMM MCU and DSP communication fault	
22	83	85	6	PFC-IGBT temperature sensor open fault	Temperature sensing device on the drive are possibly defective. If problem persists, replace the drive.
23	79	81	3	Inverter temperature foldback timeout	Verify proper airflow over the heatsink of the drive. Remove any obstructions. If problem persists, replace the drive.
24	78	80	8	Sensor 1 (high pressure) fault	Condensing Pressure beyond limit, system issue.
25	82	84	5	Sensor 1 (low pressure) fault	Condensing Pressure below limit, system issue.
26	82	84	6	Compressor model configuration error	Compressor model and configuration code do not match.
27	82	84	7	High pressure sensor type configuration error	Pressure sensor and configuration code do not match.
28	83	85	2	Sensor 2 open/short fault	Perform resistance check on the sensor to ensure values are within limits.



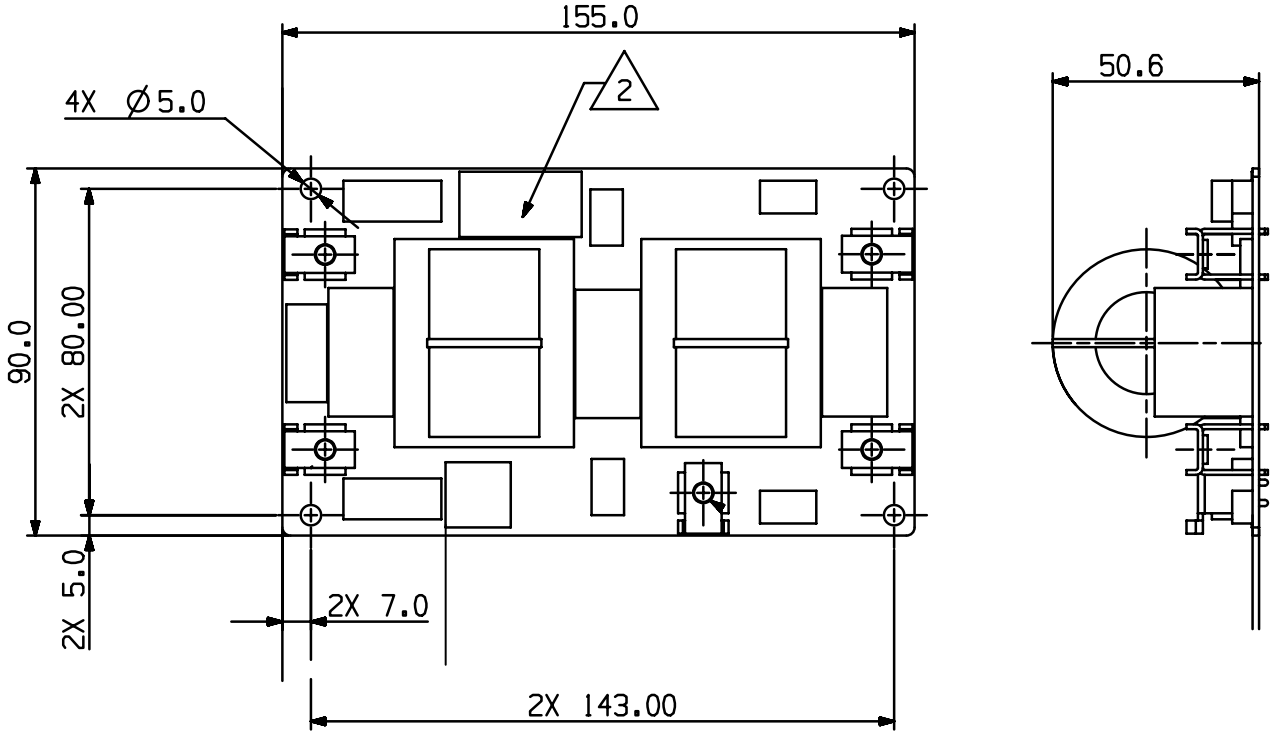
Model Numbers	Capacity
EV2080M-C9-XXX	080 = 8.0kW
EV2055M-C9-XXX	055 = 5.5kW
EV2037M-C9-XXX	037 = 3.7kW

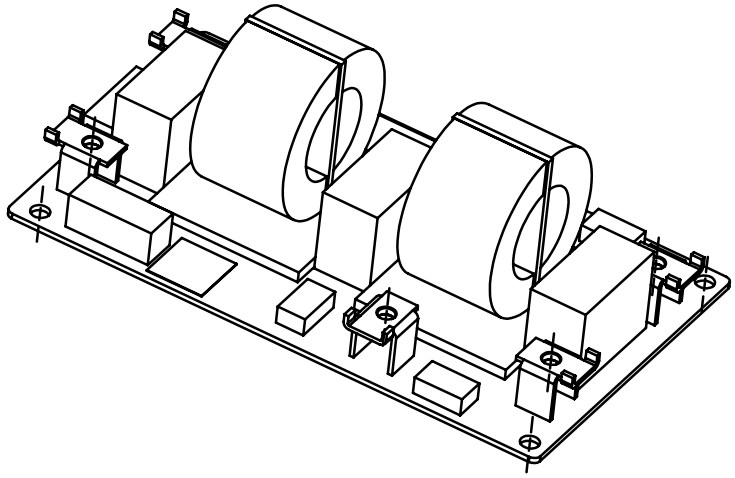
Figure 1 – Electronics Nomenclature



Drive Layout							
	Part #	**LBS.**	**A**	**B**	**C**	**D**	**E**
3.7kW	EV2037M-C9-XXX	7.83	260mm	(2) 8mm	(2) 122mm	(2) 122mm	(3) 8mm
5.5kW	EV2055M-C9-XXX	7.83	260mm	(2) 8mm	(2) 122mm	(2) 122mm	(3) 8mm
8.0kW	EV2080M-C9-XXX	11.34	260mm	(2) 8mm	(2) 122mm	(2) 122mm	(3) 8mm
	Part #	**LBS.**	**F**	**G**	**H**	**I**	**J**
3.7kW	EV2037M-C9-XXX	7.83	(6) Dia.5.5mm	228mm	(3) 212mm	119.1mm	20mm
5.5kW	EV2055M-C9-XXX	7.83	(6) Dia.5.5mm	228mm	(3) 212mm	119.1mm	20mm
8.0kW	EV2080M-C9-XXX	11.34	(6) Dia.5.5mm	228mm	(3) 212mm	156.5mm	20mm
	Part #	**LBS.**	**K**	**L**	**M**	**N**	**O**
3.7kW	EV2037M-C9-XXX	7.83	47mm	72.1mm	177mm	11mm	238mm
5.5kW	EV2055M-C9-XXX	7.83	47mm	72.1mm	177mm	11mm	238mm
8.0kW	EV2080M-C9-XXX	11.34	47mm	107.5 -105.5mm	177mm	11mm	238mm

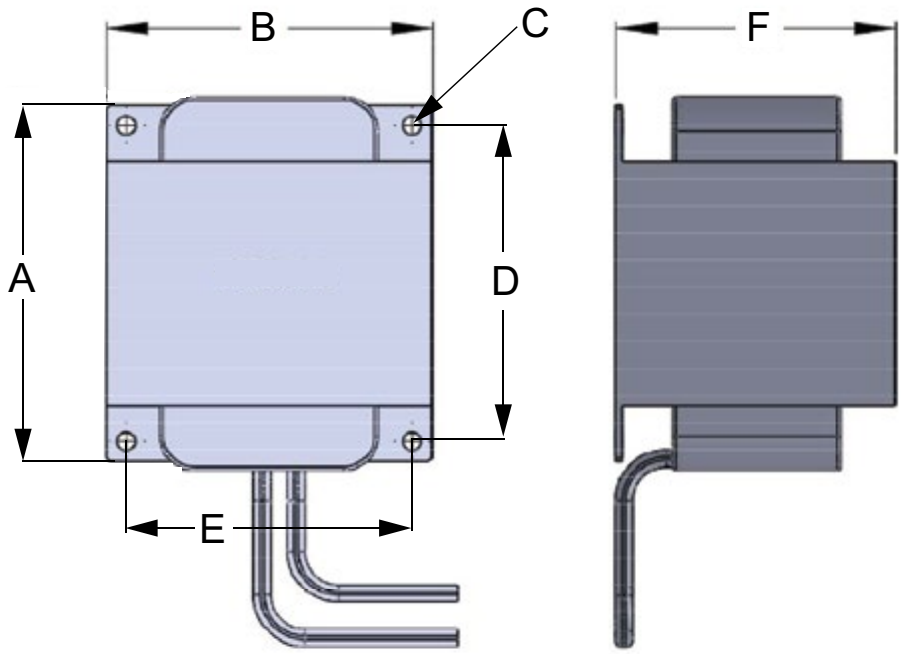
Figure 2 – Dimensions of the Drive Assembly





143-0018-00	1 Phase Filter, US Model
143-0021-00	1 Phase Filter, EU Model

Figure 3 – Top and Side View of Filter Board



Choke Layout								
	Emerson #	**AMPs**	**LBS.**	**A**	**B**	**C**	**D**	**E**
3.7kW	037-0036-00	20	5	76mm	78mm	(4) 4.2mm x 8mm	(2) 64mm	(2) 64mm
5.5kW	037-0035-00	25	6	112mm	96mm	(4) 6mm x 16mm	(2) 88mm	(2) 79mm
8.0kW	037-0037-00	30	11	105mm	96mm	(4) 6mm diameter	(2) 94mm	(2) 84mm

Figure 4 – Dimension of Choke

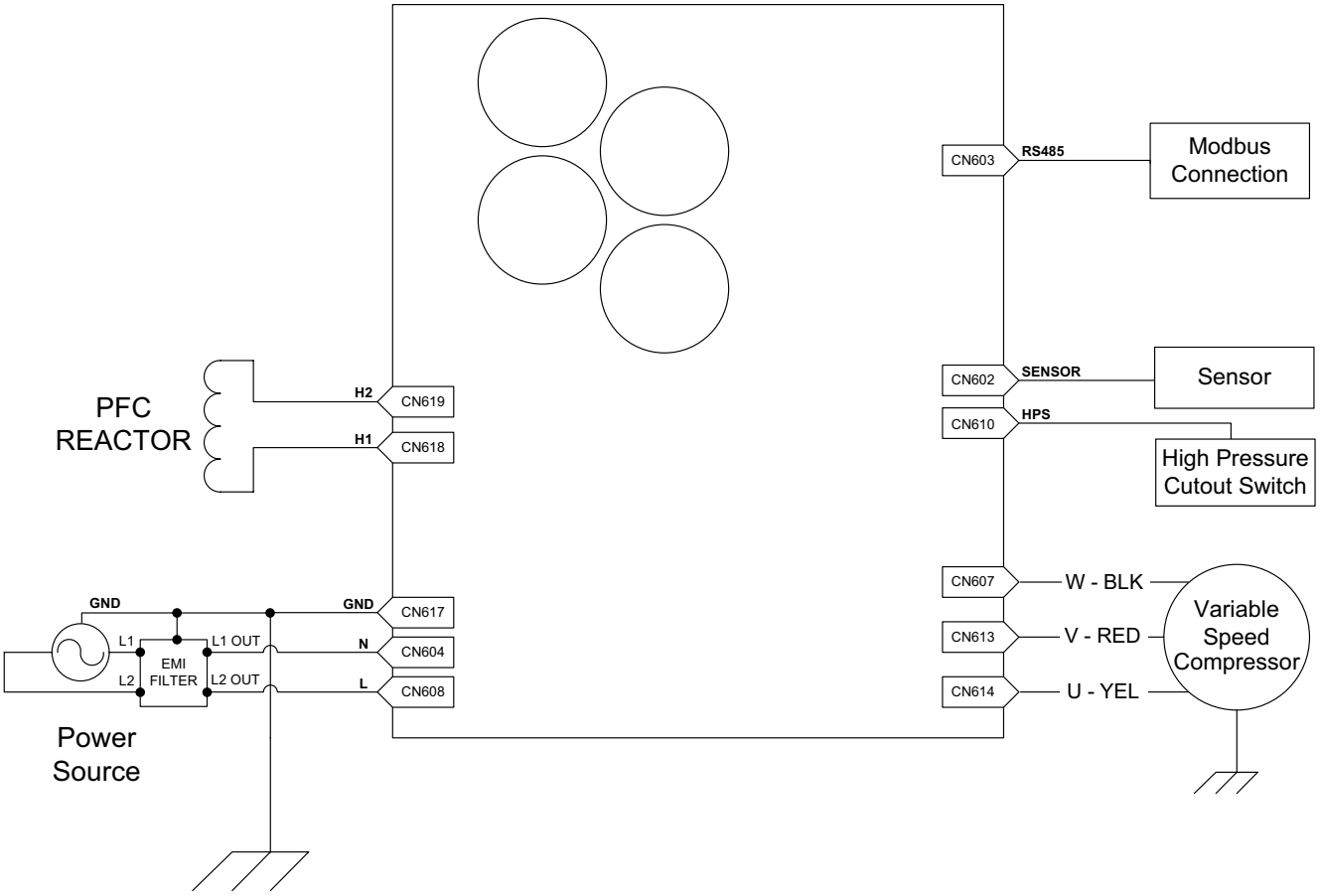


Figure 5 – Wiring Diagram

Table 1 – Connectivity

No.	Terminal Marking	Terminal Description	Location
1	L1/L2/GRN	Power supply	CN608/CN604/CN617
2	H1/H2	PFC choke	CN618/CN619
3	U/V/W	Compressor	CN607/CN613/CN614
4	SENSOR	Sensor	CN602
6	RS485	Communication	CN603
7	HPS	High pressure cut-out	CN610

Table 2 – Communication Connector Pin Definition

Pin Number	Description	Figure
1	RS485 (+)	
2	Not Used	
3	Not Used	
4	RS485 (-)	
5	Common	
6	EMI Drain Wire	

Table 3 - Sensor Connector Pin Definition

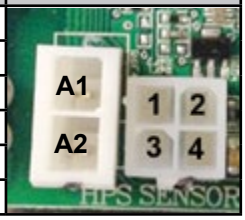
Pin Number	Description	Figure
1	Sensor Pin	
2	3.3VDC	
3	Not Used	
4	Not Used	
A1	High Pressure Signal	
A2	3.3VDC	

Table 4 - Drive Hi-Pot Testing

Test	High-Voltage Connection	Return Connection	Applied Voltage VDC	Maximum Current µAmps
1	Power In Line 1 (Yellow) & Power In Line 2 (Black) & Power-out(Red/ Black/Yellow)	Power-in Earth(Green) & Power-out Ground(Green) & RS485 (Black/White/ Red/Green) & Thermistor Circuit (Black/Red/White)	2500	35
			2500	35

Table 5 – Ramp Up Procedure

Stage	Description	Target Frequency (Hz)	Ramp Up Rate (Hz/s)	Duration (S)
I	Compressor command started	20	10	2
II	Compressor reaches minimum start frequency	25	1	5
III	Compressor remains at platform frequency	25	-	10
IV	Compressor reaches commanded frequency	Commanded	1	-

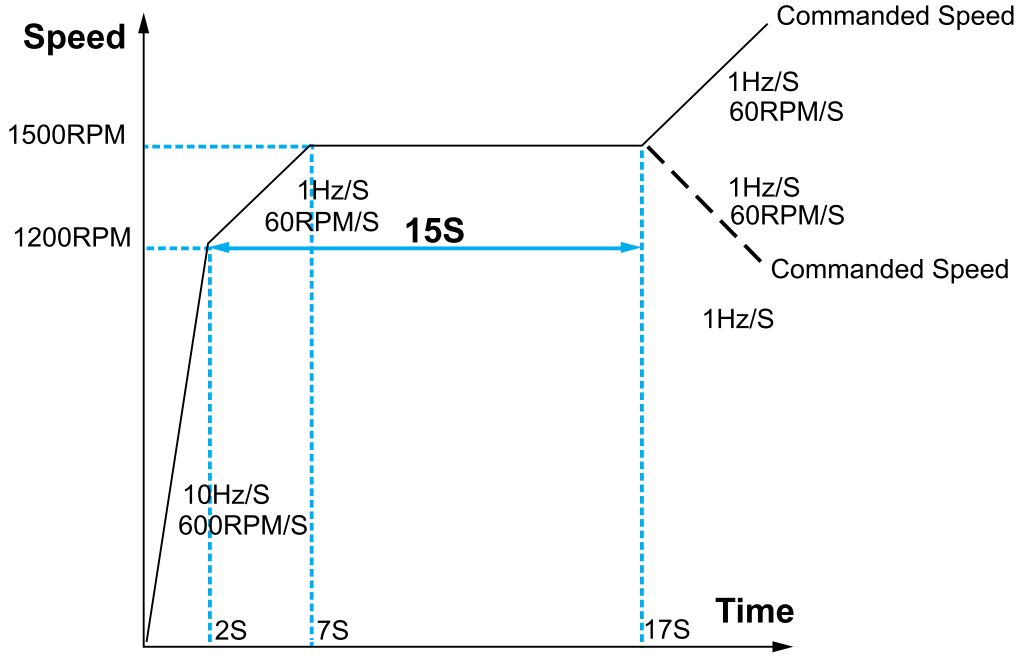


Table 6 – Ramp Down Sequence

Stage	Description	Target Frequency (Hz)	Ramp Down Rate (Hz/s)
I	Compressor gets to 30Hz	30	2
II	Compressor gets to minimum frequency	15	2.5
III	Compressor stop	-	-

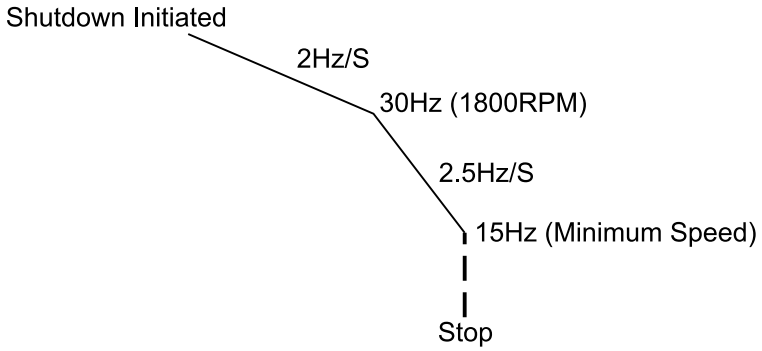


Table 7 – Protection Code of COMM

Name of Protection	Protection Code
Inverter Hardware Over-Current Protection	1
Drive Lost Rotor Position Protection	2
Compressor Phase SW Over-current Protection	3
Inverter Over-Temperature Protection	4
PFC-IGBT Over-temperature Protection	5
Sensor 2 (Thermistor /DLT) Over-Temperature Protection	6
DC Bus Over-voltage Protection	7
DC Bus Under-voltage Protection	8
AC Input Under-voltage Protection	9
AC Input Over-voltage Protection	10
AC Input Over RMS Current Protection	11
PFC Over Peak Current Software Protection	14
PFC-IGBT Over-current Hardware Protection	15
Compressor Envelop Fold Back Protection	16
DC Voltage Low Protection	17
Inverter Temperature High Protection	18
PFC-IGBT Temperature High Protection	19
High Pressure Protection	20
PIM Temperature Fold Back Time Out	21
Compressor Model Configure Error	22
High Pressure Sensor Type Configure Error	23
Fault Lock Out	24

Table 8 – Fault Code of COMM

Name of Hardware Fault	Fault Code
PFC-IGBT Temperature Sensor Open Fault	1
Inverter Temperature Sensor Open Fault	2
Sensor 2 (Thermistor /DLT) Open Fault	3
Compressor Phase Current Sampling Fault	4
AC Input Current Sampling Fault	5
AC Input Voltage Sampling Fault	6
DC Bus Voltage Sampling Fault	7
COM MCU and DSP Communication Fault	8
PFC MCU and DSP Communication Fault	9
Drive and System Controller Communication Fault	11
EEPROM Fault	12
Microelectronic Fault	13
Inverter Current Imbalance Protection	14
Input Current Fold Back Timeout	15

Table 9 – Modbus Map

Read Register	Description	Bytes	Data Format	Modbus Register
Serial and Model Numbers	Drive Model Number	32 Bytes ASCII Character String	EV20XXM-C1-191/891 0XX:Power e.g. 037 = 3.7kW Max Capcity	0
	Drive Serial Number	32 Bytes ASCII Character String	ADXXXXXXX e.g. AD13K0001 AD: Production Code 13:2013,Production Year. K: Month Code, A=Jan, B=Feb,…,L=Dec. 0001: Product Serial Number.	1
Configuration and Status Parameter	Allowed Maximum Speed (for Speed Limit Protection)	2 Bytes	Value: 0~120 = 0~120Hz e.g. : Respond value = 100 Then Maximum Allowed Running Speed = 100Hz	3
	Driver Status	2 Bytes	Bit0: PFC Chip Reset 0 = Normal Working 1= PFC Chip Reset Bit1: DSP Chip Reset 0 = Normal Working 1= DSP Chip Reset Bit2: Drive Running Status 0 = Normal 1= Under Faults Bit3: PFC Status 0 = OFF 1 = ON Bit4: Compressor Status 0 = OFF 1 = ON Bit5: Compressor Parameters Update 0 = No Update 1 = Updating Bit6: Frequency Decending Protection 0 = Normal Working 1 = Under Protection Bit7: Protection State 0 = Normal State 1 = Under Protection Bit8: Frequency Stable Flag 0 = Stable 1 = Not Stable Bit9: Frequency Increase Flag 0 = No Increase 1= Frequency Increase Bit10: Frequcy Decrease Flag 0 = No Decrease 1= Frequency Decrease Bit11: Frequency Set Outsize 0 = Set OK 1= Set Value Outsize Bit12: Compressor Starting Flag 0 = Not Starting 1= Compressor Starting	5
Version Message	PFC MCU Software Version (High Word)	2 Bytes	16.8.8	8
	PFC MCU Software Version (Low Word)	2 Bytes		9
	Comms Main Version (High Word)	2 Bytes	16.8.8	10
	Comms Main Version (Low Word)	2 Bytes		11
	N/A	2 Bytes	16.8.8	12
	N/A	2 Bytes		13
	DSP Main Version (High Word)	2 Bytes	16.8.8	14
	DSP Main Version (Low Word)	2 Bytes		15
Immediate Shut Down Trip Limits	Inverter Over Current	2 Bytes	12.4	16
	PFC Over Current	2 Bytes	12.4	17
	DC Over Voltage	2 Bytes	12.4	18
	DC Under Voltage	2 Bytes	12.4	19
	AC Over Voltage	2 Bytes	12.4	20
	AC Under Voltage	2 Bytes	12.4	21
	Inverter Over Temp	2 Bytes	11.5	22
	PFC Over Temp	2 Bytes	11.5	23

Table 9 – Modbus Map – Continued

Read Register	Description	Bytes	Data Format	Modbus Register
Controlled Shut Down Limits	DC Voltage Low	2 Bytes	12.4	32
	Inverter Temp High	2 Bytes	11.5	35
	PFC Temp High	2 Bytes	11.5	36
	Sensor 2 (Thermistor, DLT) High Limit	2 Bytes	11.5	38
	Sensor 1 (transducer only) High Limit	2 Bytes	11.5	39
Drive Status/ Information	Torque Fold Back Status	2 Bytes	0 = No ; 1 = Yes	48
	Inverter Temp Fold Back Status	2 Bytes	0 = No ; 1 = Yes	49
	Input Current Fold Back Status	2 Bytes	0 = No ; 1 = Yes	50
	Sensor 1 (HP transducer only) Reading	2 Bytes	11.5	58
	Power-Up Status	2 Bytes	0 = Not Ready 1 = Power-Up Complete	59
	Compressor Running Speed (RPM)	2 Bytes	15.1	60
	Torque	2 Bytes	7.9	61
	DC Bus Voltage	2 Bytes	12.4	64
	AC Input Voltage (RMS)	2 Bytes	12.4	65
	AC Input Current (RMS)	2 Bytes	8.8	66
	AC Input Power (RMS)	2 Bytes	16	67
	Motor Phase Current (RMS)	2 Bytes	8.8	68
	Inverter Temp	2 Bytes	11.5	70
	PFC IGBT Temp	2 Bytes	11.5	73
	Sensor 2 (Thermistor, DLT) Reading	2 Bytes	11.5	77
1st Fault Immediate Shut Down I	Hardware, Software or Hall Sensor Error	Bit 0		78
	Software Peak, or Hardware or AC input RMS	Bit 1		
	DC Over Voltage	Bit 2		
	DC Under Voltage	Bit 3		
	AC Input Over Voltage	Bit 4		
	AC Input Under Voltage	Bit 5		
	High Pressure - HP Switch or Transducer Sensor	Bit 8		
	Inverter Over Temp (Short Fault)	Bit 11		
	PFC IGBT Over Temp (Short Fault)	Bit 12		
	Lost Rotor	Bit 13		
1st Fault Controlled Shut Down I	DC Voltage Low	Bit 0		79
	Envelop Torque Limit Timeout	Bit 2		
	PIM Temp. Fold Back Timeout	Bit 3		
	Input Current Fold Back Timeout	Bit 4		
	No Comm. Data Received for 30S	Bit 7		
	High Pressure - Switch or Transducer Sensor	Bit 8		
	Inverter Temp High	Bit 11		
	PFC Temp High	Bit 12		
	DSP to PFC MCU Comms Lost	Bit 13		
	Comms to DSP Lost	Bit 14		

Table 9 – Modbus Map – Continued

Read Register	Description	Bytes	Data Format	Modbus Register
Multiple Faults Immediate Shut Down I	Hardware, Software or Hall Sensor Error	Bit 0		80
	Software Peak, or Hardware or AC Input RMS	Bit 1		
	DC Over Voltage	Bit 2		
	DC Under Voltage	Bit 3		
	AC Input Over Voltage	Bit 4		
	AC Input Under Voltage	Bit 5		
	High Pressure - Switch or Transducer Sensor	Bit 8		
	Inverter Over Temp (Short Fault)	Bit 11		
	PFC IGBT Over Temp (Short Fault)	Bit 12		
	Lost Rotor	Bit 13		
Multiple Faults Control Shut Down I	DC Voltage Low	Bit 0		81
	Envelop Torque Limit Timeout	Bit 2		
	PIM Temp. Fold Back Timeout	Bit 3		
	Input Current Fold Back Timeout	Bit 4		
	No Comm. Data Received for 30S	Bit 7		
	Sensor 2 Fault-Low Temp Open or Short Fault	Bit 8		
	Inverter Temp High	Bit 11		
	PFC Temp High	Bit 12		
	DSP to PFC MCU Comms Lost	Bit 13		
	Comms to DSP Lost	Bit 14		
1st Fault Immediately Shut Down II	Inverter Current Imbalance	Bit 0		82
	Micro Electronic Fault or Drive EEPROM Fault	Bit 2		
	Sensor 1 Fault - High Pressure Sensing Low	Bit 5		
	Compressor Model Configure Error	Bit 6		
	High Pressure Sensor Type Configure Error	Bit 7		
1st Fault Controlled Shut Down II	Sensor 2 Fault-Low Temp Open or Short Fault	Bit 2		83
	Inverter Temp Sensor Open Fault	Bit 5		
	PFC Temp Sensor Open Fault	Bit 6		
	Fault Limit Lockout	Bit 15		
Immediate Shut Down Faults II	Inverter Current Imbalance	Bit 0		84
	Micro Electronic Fault or Drive EEPROM Fault	Bit 2		
	Sensor 1 Fault - High Pressure Sensing Low	Bit 5		
	Compressor Model Configure Error	Bit 6		
	High Pressure Sensor Type Configure Error	Bit 7		
Controlled Shut Down Faults II	Sensor 2 Fault-Low Temp Open or Short Fault	Bit 2		85
	Inverter Temp Sensor Open Fault	Bit 5		
	PFC Temp Sensor Open Fault	Bit 6		
	Fault Limit Lockout	Bit 15		

Table 9 – Modbus Map – Continued

Read/Write Register	Description	Bytes	Data Format	Modbus Register
Standard Commands	Compressor Enable	2 Bytes	0 = Disable 1 = Enable	100
	Compressor Speed Demand (RPM)	2 Bytes	1 RPM/Bit 16.0 - Ex. 4500 RPM = 0x1194	101
	Stator Heater Demand	2 Bytes	0 = Disable 1 Watt/Bit 16.0	102
	Faults Clear Command	2 Bytes	1=Fault Clear , Non-1= No Action	103
Customer Configuration Parameter	Map access Password	2 Bytes	0x2345: Customer Use for 201~207	200
	Modbus Format	2 Bytes	1 = ASCII 2 = RTU	201
	Modbus Slave ID Address	2 Bytes	1-247	202
	Modbus Baud Rate	2 Bytes	9600 = 9600 BPS 19200 = 19200 BPS 38400 = 38400 BPS	203
	Modbus Parity	2 Bytes	1=Even Parity, 1 Stop Bit; 2=Odd Parity, 1 Stop Bit; 3=No Parity, 2 Stop Bits: 4=Even Parity, 2 Stop Bits: 5=Odd Parity, 2 Stop Bits; 6=No Parity, 1 Stop Bit	204
	Compressor Model Number	2 Bytes	0 = Not Programmed 200 = 2 Ton Family 300 = ZPV36K1 - 1500 - 7000RPM 301 = ZPV0212 - 900 - 7200RPM 303 = ZHV0212 - 900 - 7200RPM 305 = ZHW0152 - 900 - 7200RPM 400 = 4 Ton Family 500 = ZPV60K1 - 1500 - 7000RPM 501 = ZPV0382 - 900 - 7200RPM 502 = ZPV0342E - 900 - 7200RPM 503 = ZHV0342 - 900 - 7200RPM 505 = ZHW0302 - 900 - 7200RPM	205
	Sensor 1 (HP SW, HP Transducer)	2 Bytes	0 = Not Configured 1 = Not Utilized 100 = HP Switch N/C 101 = HP Switch N/O 200 = HP transducer 1	206
	Sensor 2 (Scroll Thermistor, DLT)	2 Bytes	0 = N/A 100 = Scroll Thermistor, 10K 200 = DLT 1	207
	PFC Option	2 Bytes	0 = PFC Threshold for US 100 = PFC Thresholds for EU	208

Table 10 - Input Current Foldback

	Condition	Action taken by the Drive
1	Input Current >= Foldback Current	Will Reduce the Speed to Minimum Speed at Rate of 20 rpm Per Second
2	Recovering Current <= Input Current < Foldback Current	Will Remain in the Current Speed
3	Input Current < Recovering Current	Speed Will Be Recovered to Commanded Speed
4	Drive in Foldback State for >=30 sec	Compressor Will Be Tripped

Table 11 - Output Current Foldback

	Condition	Action taken by the Drive
1	Output Current >= Foldback Limit of Operating Speed Range	Will Reduce to Minimum Speed of the Speed Range at Rate of 20 rpm Per Second
2	Recovering Current <= Output Current < Foldback Limit of Operating Speed Range	Will Remain in the Current Speed
3	Output Current < Recovering Current	Speed Will Be Recovered to Commanded Speed
4	Drive in Foldback State for >=30 sec	Compressor Will Be Tripped

Table 12 - Inverter Temperature Foldback

	Condition	Action taken by the Drive
1	Inverter Temperature >= Foldback Temperature	Will Reduce the Speed to Minimum Speed at Rate of 20 rpm Per Second
2	Recovering Temperature <= Inverter Temperature < Foldback Temperature	Will Remain in the Current Speed
3	Inverter Temperature < Recovering Temperature	Speed Will Be Recovered to Commanded Speed
4	Drive in Foldback State for >=30 sec	Compressor Will Be Tripped