



User Manual for the  
*HE300RSL120*

**N2 System  
Network Communication  
Option Board  
for use with  
GE AF300E\$ Inverter**

First Edition  
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## PREFACE

This manual explains how to use the Horner APG's N2 System Network Communication Option Board.

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**Note: The programming examples shown in this manual are for illustrative purposes only. Proper machine operation is the sole responsibility of the system integrator.**

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## CHAPTER 1 - INTRODUCTION

### 1.1 Product Description

The HE300RSL120 is a plug-in option board for the GE AF300E\$ Inverter, which allows remote control of a drive through the N2 network. This option board allows N2 network access to the Inverter's configuration, control and status parameters. Configuration parameters can be accessed either remotely through N2 Internal points or through the local keypad. Likewise, control and status parameters can be accessed through N2 Analog/Binary I/O points or through the Inverter's local control terminal and keypad. Local/Net control switch contacts are provided on the option board that allows an optional switch to select either network or local control of the Inverter.

The HE300RSL120 supports a connection-based link over N2 through the master polling mechanism. Should this connection be lost (Loss-of-Network), three configurable options are provided to give the user control over how the drive responds.

The HE300RSL120 Option Board is a printed circuit assembly that mounts inside the housing of a GE AF-300E\$ Inverter. It connects to the Inverter through a multi-pin connector that is located under the front cover and next to the keypad connector. It has a 5-pin 'pluggable' screw-terminal connector that is used to connect a N2 cable. Also provided is a 5-pin screw-terminal-strip, which is used to connect an optional local/net control switch.

The HE300RSL120 Option Board contains its own microprocessor and memory. It communicates with the GE AF-300E\$ Inverter through a provided serial communications channel. This serial communications channel provides access to the drive's control, status and configuration parameters.

### 1.2 Overview of N2 Communications Bus

The N2 Communications Bus is local network supported by Johnson Controls, Inc. for use on the Metasys® line of products. The N2 communications protocol links controllers and I/O devices to a Network Communications Module (NCM) which is linked to a master device. N2 is based on the proven Opto-22® Optomux® protocol and consists of a single twisted pair RS485 network running at 9600 baud. For more information on installing devices on the N2 network, refer to Johnson Controls, Inc., N2 Communications Bus, Technical Bulletin #LIT 636018.

### 1.3 N2 Communication Compliance

Drive Status is returned over the N2 network through Analog and Binary Input (AI/BI) point types. N2 overrides of these point types are not supported. These input point type values are returned from an intermediate buffer maintained by the option board's scan routine to substantially increase the network response time.

Drive Control is provided over the N2 network through Analog and Binary Output (AO/BO) point types. While N2 overrides are required to manipulate these point types, releasing the respective overrides does NOT modify the last written value. Override values are first written to a buffer which are loaded to the Inverter later by the option board's scan routine. Intermediate buffering is required to increase network response time due to slow communications between the option board and the inverter.

Function Code parameter access (and additional status and control) is typically through the Analog Data Integer (ADI) point types. When using ADI point types, either N2 overrides or direct writes may be used; however, releasing overrides values do NOT modify the last written value. Reading or writing ADI point types is not buffered by the option board and can take a significant amount of network time to complete. Alternately, two AI and two AO points can be assigned (internally) to ADI data items and provide buffered and scaled access to those ADI points. However, as noted above, when using the AO point types to access ADI data items, releasing the overrides do NOT modify the last value written.

All N2 point types always return reliable status.

Analog and Binary overrides/writes return an Invalid Data error (N10) if the data point is not accessible (protected, inaccessible while in motion, or in manual override).

Read/Write to Analog/Binary I/O Regions	800 $\mu$ S
Read/Write to Integer Internal	130mS
Poll min.	1.8mS
Poll max. (OCS fully loaded)	10.8mS

While the RS485 (N2) port is isolated, the loading presented by the option-card-line-drivers limit the number of devices on the associated N2 segment to 32 (as opposed to the standard 50). Switchable End-of-Line (EOL) termination (220 ohms) is not provided and must be added externally if the option card is the last physical device on the N2 “daisy chain”.

#### **1.4 Additional Information**

Inverter wiring, configuration and operation are covered in the manuals supplied with the GE Inverter.

GE Drives: GEI-100211 AF-300E\$ 1/2 - 300 Horsepower Instructions

Johnson Controls, Inc.: N2 Communications Bus, Technical Bulletin, #LIT 636018

## CHAPTER 2 - INSTALLATION

### 2.1 Installation Hardware

Included in the packaging with the AF-300E\$ option board are the following items:

- a. The option card
- b. One HE300KIT399 (consisting of one 0.5 inch plastic standoff, one M3 x 5 screw and one lock washer) for drives under 40 hp
- c. One HE300KIT401 (consisting of one 0.63 inch metal standoff, one metal bracket, two plastic fasteners, four M3 x 5 screws and four lock washers) for drives 40 hp and larger
- d. The User Manual for the HE300RSL120

#### 2.1.1 *The Installation Procedure for Drives Under 40 Horsepower*

The AF-300E\$ Communications Option Cards are designed to integrate seamlessly with the AF-300E\$ drive. The option card is installed within the drive cover so that the NEMA rating of the drive is maintained.

1. Power down the drive.
2. Remove the cover the AF-300E\$ drive as shown in the diagram below.

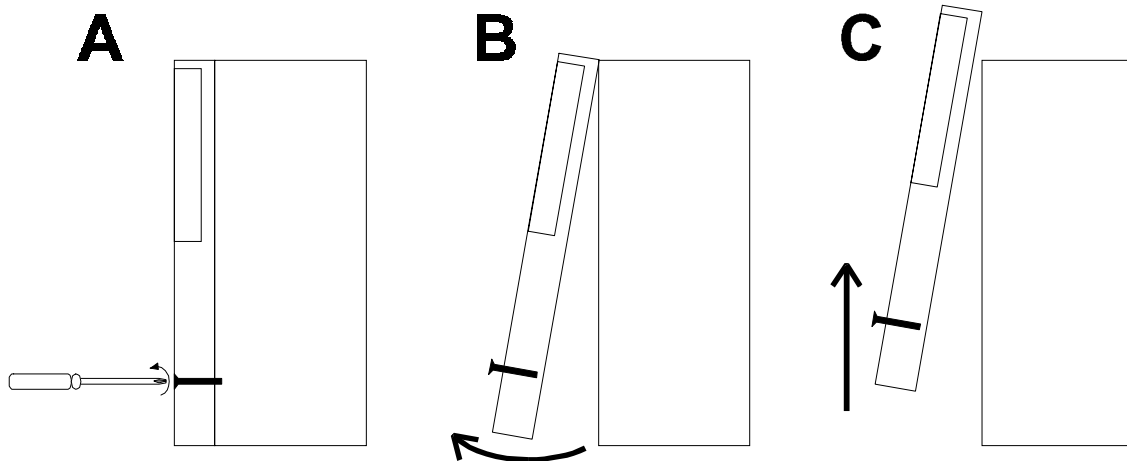
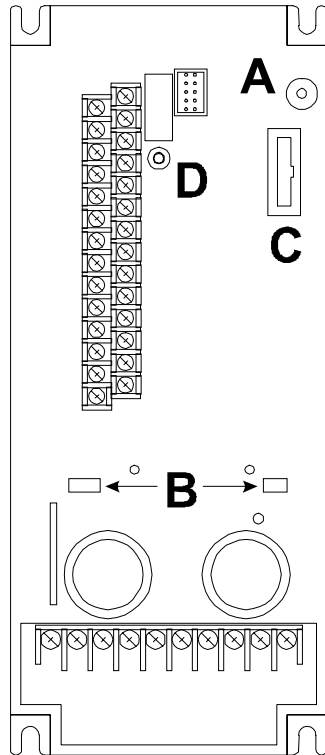


Figure 2.1- Drive Front Cover Removal Procedure



3. Install the supplied plastic 1/2" standoff (A') in hole (A).

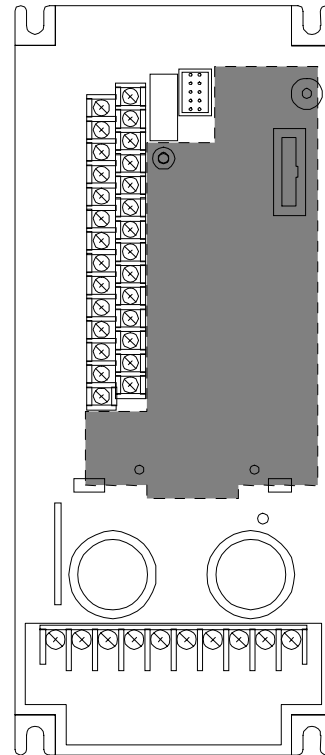
**1/2HP AF-300E\$ Viewed from the Front.**



**Fig. 2.2 - Figure Drive Mounting Holes and Connectors (left)**

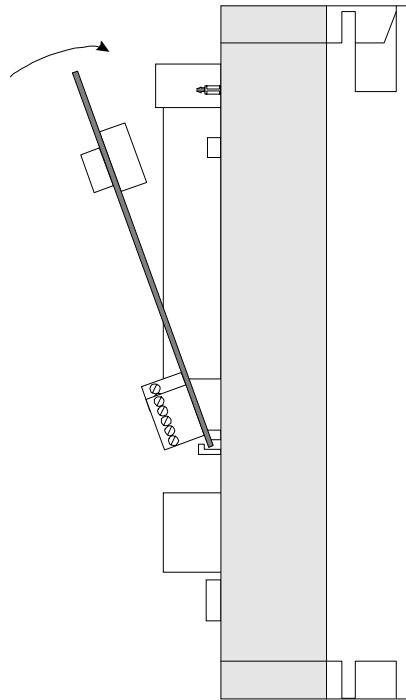


**Fig. 2.3 - Mounting Hardware (Not to Scale)**



**Fig. 2.4 - Option Board Location (right)**

4. Install the HE300RSL120 option board. Use the plastic guides (B) to properly align the bottom of the option board. Snap the option board into the standoff (A') and option connector (C).
5. Install the supplied M3 x 5 screw (D') with washer in hole D to secure the option board.
6. Verify that jumper JP4 is removed and JP3 is on the two pins closest to the "E".
7. After completing field wiring to the removable terminal strip(s), replace the front cover.
8. Power up the drive as needed.

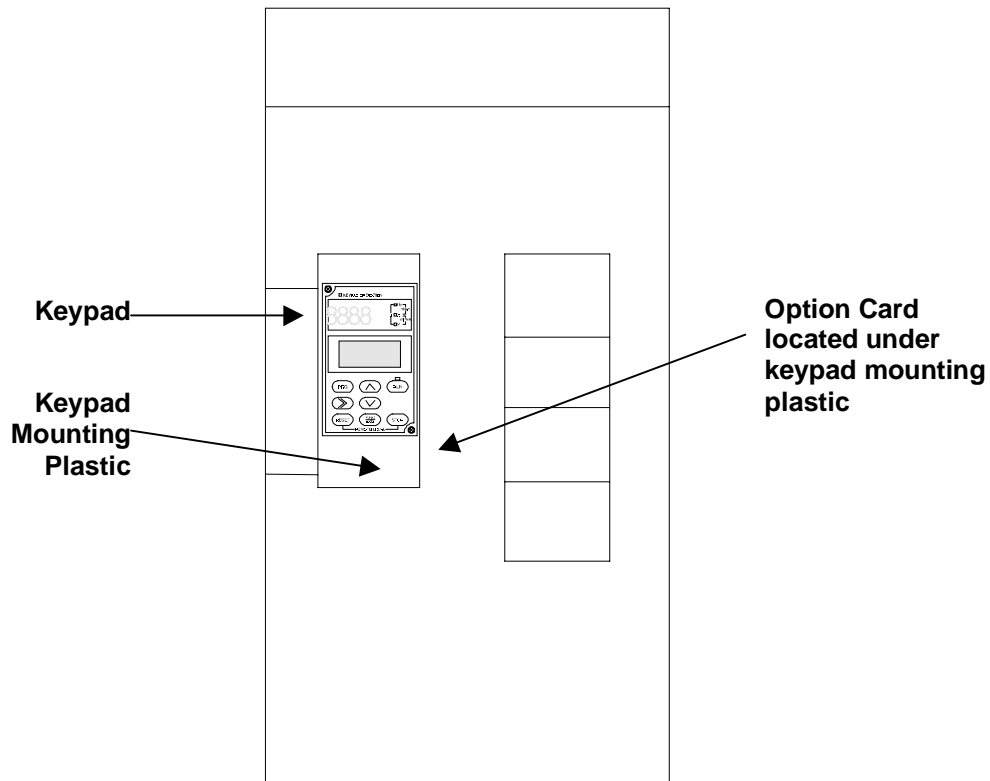


**Figure 2.5 - Installing the Option Board  
(Side View of AF-300E\$ 1/2HP shown)**

## **2.2 The Installation Procedure for Drives 40 Horsepower and Larger**

The AF-300E\$ Communications Option Board has been designed to integrate seamlessly with the AF-300E\$ Drive. The option board is installed within the drive cover so that the NEMA rating of the drive is maintained. See Figure 2.6.

1. Power down the drive.
2. Remove the cover from the AF-300E\$ using the 11 screws on the front panel.
3. Remove the keypad and the keypad mounting plastic (4 screws) shown below.



**Figure 2.6 – Drive Keypad, Keypad Mounting Plastic and Option Board Location  
(Drive shown is a 40HP AF-300E\$ viewed from the front .)**

4. Install corner brackets (A') on bottom corners of interface board (A).
5. Install corner brackets (A') on metal brackets (B') using the supplied M3 x 5 screws and lock washers in the corner bracket mounting holes (C).

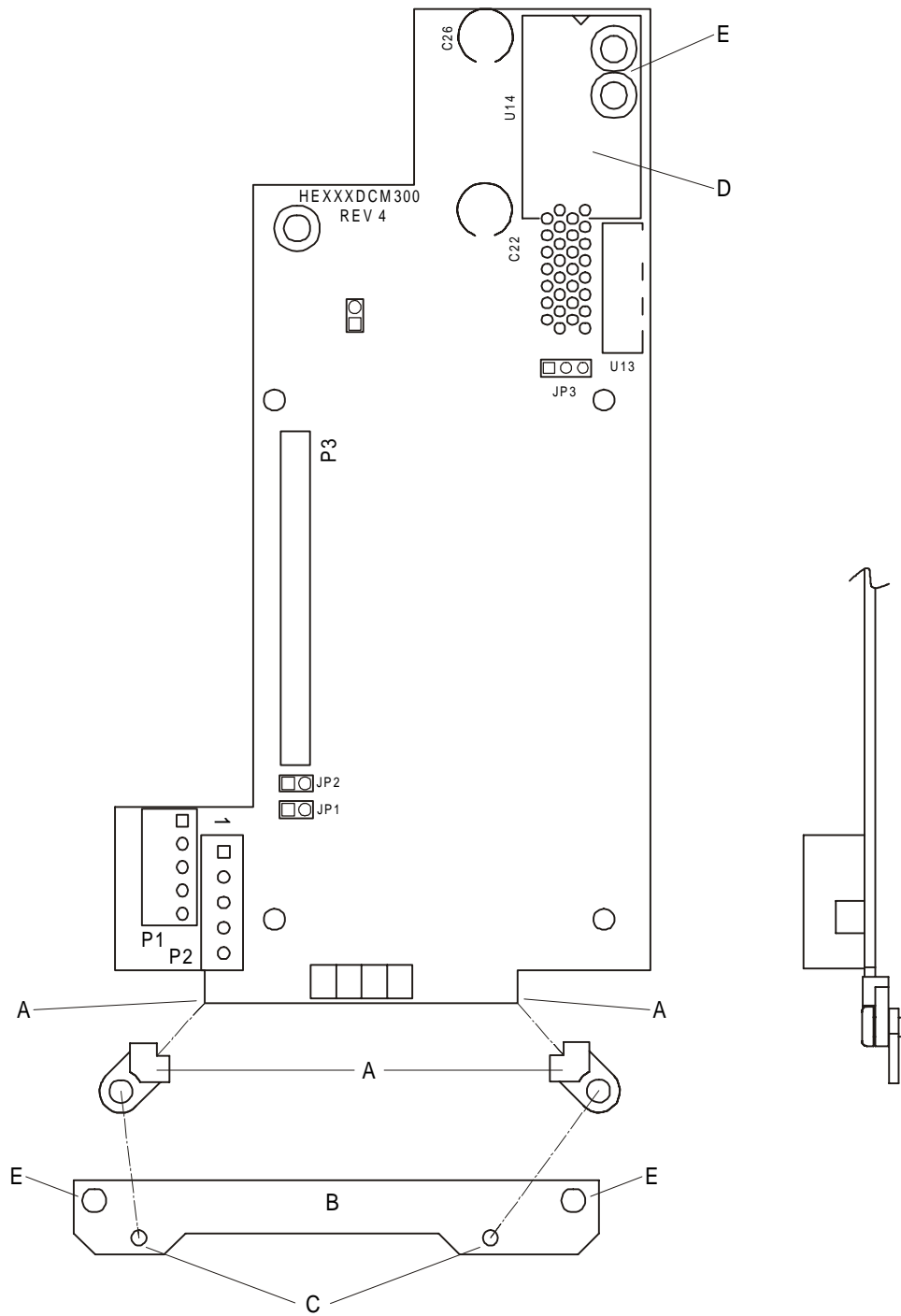


Figure 2.7 – Option Board Assembly (Front and Side View)

6. Install the assembled board into the drive using the M3 x 5 screws and lock washers in the mounting holes (E). If you used the plastic standoff in the upper right hand corner of the board you may need to use one of the M3 x 5 screws from the HE300KIT399.
7. Verify that jumper JP4 is installed and JP3 is on the two pins closest to the "E".
8. Replace the keypad mounting plastic and the keypad.
9. After completing field wiring to the terminal strip(s), replace the front cover.
10. Power up the drive as needed.

#### *2.2.1 Procedures for Using Metal Standoff*

The metal standoff included with the HE300KIT401 can be used in place of the plastic standoff that comes with the drive. **The plastic standoff is the preferred method of installation, but if the metal standoff is going to be used, the steps below must be followed.**

1. Once the keypad and keypad mounting plastic is removed, remove the plastic standoff in the upper right corner of the drive board by holding the screw under the standoff with a finger while unscrewing the plastic standoff.
2. Once the standoff is removed, screw on the metal standoff that is supplied with the HE300KIT401.
3. To remove the board you may need to use a pair of fine tipped pliers to squeeze the tip of the metal standoff together in order for the board to snap of the standoff.

2.3 N2 Cable Connector (Refer to Figure 2.7 for Plug Location.)

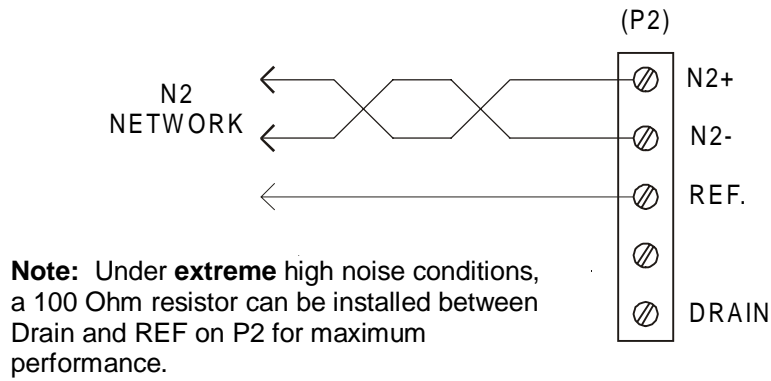


Figure 2.8 – N2 Cable

2.4 Local/Net Contact Connection (Refer to Figure 2.7 for Plug Location.)

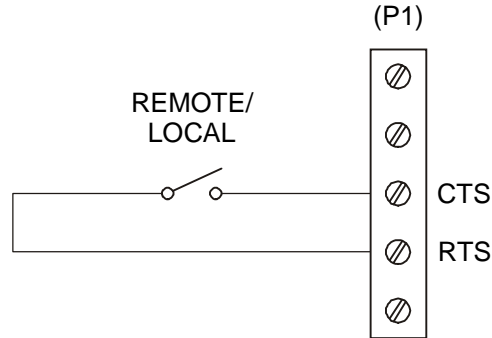


Figure 2.9 – Local/Net Connection

## CHAPTER 3 - CONFIGURATION

### 3.1 Option Function Codes Overview (N2 Configuration)

Before the option board can be accessed over the network, the N2 address, Loss-of-Network function and timeout value, and optional AI/AO parameter selectors must be configured. Access to these parameters is only through the Inverter's keypad. Since keypad write access to Function Codes are sometimes blocked when in Net mode, the Local/Net switch may need to be placed in Local when configuring these parameters.

When an option board such as the HE300RSL120 is installed in the Inverter, an extra set of Function Codes not defined in the Inverter's instruction manual appears at the end of the Function Code list when examined with the keypad. These codes which are referred to as Option Function Codes can be identified with a 'P' prefixed. These Option Function Codes are used to store and display configuration parameters dedicated to the installed option board. The HE300RSL120 uses only the first 9 of these Option Function Codes for the N2 configuration parameters. Option Function Codes are stored in the Inverters EEPROM and are "remembered" even if the option board is changed out.

**WARNING: Since EEPROM's have a limited write life (in the order of 100,000 writes), continuous writing to the P00 Option function code can cause premature failure of the configuration memory.**

During the configuration process, if any of the first 9 Option Function Codes exceed their respective limits, an option board fault (Er5) is generated. Whenever an option board fault occurs (Er5), the option board writes (if enabled) a specific error indicator to Option Function Code P00. Should this occur, the user could examine P00 to determine what caused the option board fault. If an Option Function Code value is out of limits, the P00 value will be between 101 to 108. The 100 digit represents a configuration fault and the 1's digit represents the "P0x" code that is out of bounds.

To enable specific fault indication in P00, set its associated value to any value other than 255. Note that an option board fault (Er5) can also be generated on a loss-of-network. Since loss-of-network faults can occur frequently as part of normal operation, the P00 specific fault indication should be disabled after configuration to save the Inverter's EEPROM memory from excessive writes. To disable specific fault indication, set P00's value to 255 with the keypad. Should an option board fault (Er5) occur later with this indication disabled, it can be re-enabled to display the specific fault value as long as the error condition still exists. To re-enable, temporarily set the mode to Local and use the keypad to set P00 to zero. Then set the mode back to Net, and the specific fault value appears in the P00 Option Function Code.

### 3.2 Accessing Option Function Codes through the Inverter's Keypad

Access to the Option Function Codes is only available through the Inverter's keypad. This section summarizes how to use the Inverter's keypad to set the Option Function Codes. For more information on using the Inverters keypad, refer to the associated Inverter's User Manual.

1. After powering up the drive, the drive's keypad LCD displays the following:

```
STOP
PRG > DATA SET
>> > LED SEL
```

This display indicates that the drive is in STOP mode, and that the PRG key must be pressed in order to set the drive data.

2. Press the PRG key. The display now shows the start of the list of the normal drive parameters as follows:

```
00  FREQ COMND
01  OPR METHOD
02  MAX Hz
03  BASE Hz-1
```

The Option Function Codes are at the bottom of the list, and cannot be seen until the cursor keys are pressed multiple times to display them. After pressing the UP or DOWN cursor keys repeatedly, the option card parameters are finally displayed as follows (note that holding the cursor keys down continuously causes the display to scroll quickly):

```
P00  OPTION 0
P01  OPTION 1
P02  OPTION 2
P03  OPTION 3
```

**NOTE:** For illustrative purposes, the option parameter P00 is set to a value of 25.

In order to set P00, use the cursor keys (UP and/or DOWN) to highlight P00.

**NOTE:** The highlight is represented below with the underlined text.

3. Pressing the FUNC/DATA key shows the current value of P00.

```
P00  OPTION 0
      0
0~255
```

The bottom line of the display flashes between the allowable data range (in this case 0~255) and the prompt **STORE > F/D KEY**. Should the keypad not have write access (because the option card is in Net mode), **OPTION ACTIVE** is displayed instead. In this case, switch the Local/Net switch to Local position. Should the keypad not have write access (because Data Protect feature is active), **DATA PRT** is displayed. In this case, refer to the Inverter's User Manual to deactivate this feature.

The current value of the parameter is shown on the third line (in this case 0). Pressing the cursor keys (UP, DOWN or >>) causes the new value to change. See the Inverter's User's Manual for detailed instructions on keypad data entry operation. In this case, pressing the UP key will cause the new value to increment, and move the current stored value from the third line to the second line, as shown below:



<b>P00 OPTION 0</b> <b>0</b> <u><b>25</b></u> <b>0~255</b>
---

4. When the option parameter is at the desired value (in this case 25), pressing the FUNC/DATA key will cause the parameter to be stored. As the data is being stored, the bottom line of the display will show a **DATA STORING** message. After the data has been stored, the option parameter list will return to the display and the next option parameter will be highlighted, as shown below:

<u><b>P01</b></u> <b>OPTION 1</b> <b>P02</b> <b>OPTION 2</b> <b>P03</b> <b>OPTION 3</b> <b>P04</b> <b>OPTION 4</b>
---

Because option parameter P00 was just edited, option parameter P01 is now highlighted.

**NOTE: It is important to note that the keypad will allow a larger data value to be input than is legal for a given parameter.** Option Function Code parameters with illegal data values will be flagged by the option card when drive control is transferred from the keypad to the option card.

### 3.3 Setting Option Function Codes (Network Operation)

Set the Option Function Codes through the Inverter's keypad to the values shown below.

1. **Set P00 - Option Card Fault indicator** [ 0 - enable, 255 - disable ] (may be set by firmware if Er5)
2. **Set P01 - Station Id** [ 1-255 ]  
 N2 allows addressing of up to 255 different bus addresses. Address 0 is reserved.

**Care must be taken not to assign the same address to different devices on the same network.**

### 3. Set P02 – Network Mode Control Configuration

<b>P02</b>	<b>Data Setting</b>	<b>Description</b>
0	XX0	Drive Control from Network
	XX1	Drive Control from keypad or terminal strip
1	X0X	Freq. Reference from Network
	X1X	Freq. Reference from keypad or terminal strip
2	0XX	Function Code input from Network
	1XX	Function Code input from keypad

When the Net/Manual switch is set to Net, the above configuration defines which parameters are controlled by the network.

#### 4. Set P03 – Loss-of-Communications Action

Table 3.2 – Loss-of-Communications	
P03	Action
0	Er5 trips and stops the motor. Fault cannot be reset until the communications is reestablished or placed in manual.
1	Drive maintains the state of operation at the time of communications loss
2	Drive transfers control of the drive to the drive terminal strip (or) keypad.

#### 5. Set P04 – Loss of Communications Timeout

The parameter sets the amount of time that occurs (after the last N2 Poll request is sent) *before* the drive determines that communications is lost. Parameter is in terms of minutes. Johnson Controls, Inc. recommends setting the parameter for 10 minutes. A value of zero shuts off the communications timer and prevents a Loss-of-Network action (which is used strictly for testing purposes only).

#### 6. Set P05 - User defined drive parameter for AI type, point number 7

#### 7. Set P06 - User defined drive parameter for AI type, point number 8

#### 8. Set P07 - User defined drive parameter for AO type, point number 2

#### 9. Set P08 - User defined drive parameter for AO type, point number 3

The user may assign any ADI point number from the drive parameter table to these fields. Note that AI points are read-only. The parameters are converted to the scaled float value automatically. Assigning the following ADI point numbers to the user defined AO points is to be avoided since they are already being accessed by the option board scanner:

- 96 - High resolution Frequency Setting
- 97, 98 - Terminal Input (words)
- 123 - Option Status (control point configuration)

Selecting zero for the user defined drive parameter disables the point. Note that if P05 or P07 is zero, P06 or P08 respectively must also be zero.

### 3.4 Setting Inverter Function Codes (Drive Operation)

Before a drive is started, the Inverter's Function Codes need to be initialized. The Function Codes define the Inverter's operation and are defined in the Inverter's User Manual. Inverter Function Codes are stored in EEPROM and may be configured either with the keypad or over the N2 network. If configured over the N2 network, the Function Code number being modified must be translated to an ADI point number. This information is provided in the drive parameter table.

The current state of Option Function Code P03 and the Local/Net switch determines if the network or keypad has write access to the Inverter's Function Codes.

## CHAPTER 4 - OPERATION

### 4.1 Power-Up

At power-up, the option board examines the 'option' function codes (P0x) that are programmable by the user through the keypad. These parameters, which are only available at the keypad when the option board is installed, controls the operation of the option board on the N2 network. This examination is a rough check only to determine if the parameters are within range for valid network operation. The following checks are made:

P01	N2 Network Id > 0
P02	Network Control Configuration (each digit < 2)
P03	Loss of Communications Action (< 3)
P05-P08	Option parameters within acceptable range (if enabled)

Should any of these tests fail, the option board immediately causes the Inverter to Er5 with the appropriate error response placed in P00 (if enabled). Furthermore, it is not possible to start the drive regardless of the local/net switch position until these parameters are corrected. Correction of a parameter through the keypad automatically causes the Er5 to be reset. However, if one of the following option function codes is also incorrect, the Er5 remains in effect. If correcting a parameter does not release Er5 as expected, recheck P00 to determine the offending option function code.

Once the option function codes are verified, the option board initializes the N2 port with the values from those codes and then examines the state of the local/net contact. If the contact is closed, the option board toggles to 'Net' mode and the Inverter waits (time specified in P04) for an N2 poll message. Should communications fail to be established within this time-out period, the drive reverts to the configured Loss-of-Communications action. If the contact is open, the option card toggles to 'Local' mode, and the Inverter indefinitely assumes the state defined by the keypad and the local terminal contacts regardless of any network errors.

### 4.2 Local/Net mode

The option board provides two modes of operation (Local/Net), which are controllable through an optional external switch. Shorting the switch contacts activates Net mode while opening the switch contacts returns the option board to Local mode. When Net mode is selected, the Inverter is controlled over the N2 network. Otherwise, in Local mode, the Inverter is controlled through the keypad and/or local control terminal. Should the Local/Net switch or wiring fail and the circuit opens, the option board reverts to Local mode. It is valid to switch between modes during normal operation. However, precautions need to be observed to prevent adverse motor changes.

While in Net mode, the actual amount of Inverter control over the network is configurable. This is possible because the Inverter controls are divided into three subsets of parameters: Drive control, Frequency reference and Function codes. Drive control is a set of discrete inputs, which controls items such as direction, run, stop and reset. The Frequency reference is the analog input that sets the speed of the drive. The Function Codes are both discrete and analog values which tune the operation of the drive.

Each of these control subsets can be individually configured for control over the network when the option board is in Net mode. Individual configuration is through option function code P02 which contains a bit for each subset. When a subset bit is cleared in P02 and the Net mode is selected, that respective subset is controlled over the network. Therefore, the user is free to limit which subset(s) may be controlled from the network. When the option board is in Local mode, all subsets revert to local keypad and terminal control regardless of the P02 configuration. The following describes each control subset and its reaction to Local and Net modes. Each subset is considered in Net mode when both its respective flag is cleared in P02 and the optional switch is in Net position.

The Drive control inputs, when in Local mode, are received from the inverter's control terminal. The keypad may also be placed in line with these controls to provide final localized start/stop control (when configured with Function Code 00). When in Net mode, the Drive control inputs instead come from the N2 Binary Outputs (BO1-16). However, note that the keypad may still be placed in line with the controls to maintain localized control of Run/Stop.

Both the inverter's control terminal and N2 Binary Outputs: FWD, REV, RST and BX are equivalent in operation. However, the inverter's control terminal X1 through X5 are not exactly duplicated by the N2 Binary Outputs. This is because inverter control terminal inputs X1-X5 are routed (through Function Code 32) to selected special control functions. Alternately, N2 Binary Outputs can control these functions directly typically bypassing Function Code 32 entirely. The following compares the difference between the control terminal X1-X5 inputs (Local mode) and the corresponding N2 Binary Outputs (Net mode) and their dependency on Function Code 32.

Action	Inverter Terminals	FC32	N2 Binary Outputs	FC32
Multistep speed selection	X1,X2, [X3]	0[0]xx	X1,X2,X3	N/a
Up/Dn speed (from zero)	X1,X2	1xxx	Up/Dn	1xxx
Up/Dn speed (from previous)	X1,X2	2xxx	Up/Dn	2xxx
Speed from line Hz.	X3	x1]xx / x2xx	Pu	N/a
Acc/Dec selection	X4,[X5]	xx0[0]	RT1/RT2	N/a
Speed from C1 (current input)	X4	xx1x	Not supported	
DC Brake	X4	xx2x	DCB	Xx2x
Select Motor 2	X5	xxx1	VF2	N/a
Data protect	X5	Xxx2	Not supported	

The Frequency reference, when in Local mode, can be configured (through Function Code 00) to come from the keypad or control terminal (analog) inputs. When in Net mode, the Frequency reference comes from N2 Analog Output (AO1). Note that this output is in terms of frequency and is a floating-point number with resolution good to 6 places.

Function Code access, when in Local mode, is through the keypad. When in Net mode, access to the Function Codes over the network is possible through N2 Analog Data Integer (ADI) point types. When accessing ADI points through the network, the value is passed as an integer which may be bit packed in an unique format. See the drive parameter table in Appendix A for a list of the Function Codes and their associated format.

The Inverter maintains a separate set of Drive control and Frequency reference parameters for each mode. The set that is actively controlling the Inverter is dependent on that subset's respective Local/Net mode. Note that even if the Drive control or Frequency reference subset is not currently in the Net mode, their Net mode parameters are still modifiable over the network.

However, the Inverter only maintains a single set of Function Codes regardless of the mode. The Net mode for the Function Code parameters simply selects which access point (network or keypad) has write access to the Function Codes. Attempting to write a Function Code from the Network while in Local mode returns a Network error message of 'Invalid Data'. Likewise, attempting to write to a Function Code from the keypad while under Net mode returns a keypad message of 'Option Active'. While write access is selected by the mode, read access is always available from either the keypad or the network regardless of the mode.

	<b>Local</b>	<b>Net</b>
<b>Physical Control Terminal</b>	Active	Inactive
<b>Network Binary Outputs *</b>	Inactive (accessible)	Active
<b>Local Freq Reference **</b>	Active	Inactive
<b>Network Freq Reference</b>	Inactive(accessible)	Active
<b>Keypad Function Code Access</b>	Read + Write	Read Only
<b>Network Function Code Access</b>	Read Only	Read + Write
<p>* Keypad start button can be assigned for final start control even under network control. Keypad stop button functions as an emergency stop even under network control.</p> <p>** Local frequency control can be assigned to either the keypad or terminal analog input.</p>		

Inverter status information is always available both at the keypad and network status points regardless of the mode. Included in the network status information is a bit (NetCtrl) which reflects the state of the Local/Net mode (external switch). A master controller can use this information in determining if it currently controlling the configured subsets. Additional status information not returned in the predefined AI points is available through ADI type points. See the drive parameter table for mapping information (param. numbers 109 – 122).

Switching from Manual to Net also causes the P(xx) parameters to be read and the network reconfigured if any are changed which would modify network operation. This allows the configuration to be changed without power-cycling the inverter.

### **4.3 Loss of Network**

The option board tracks the incoming N2 Poll messages and maintains a timeout timer. If the option board is in Net mode and does not receive a N2 Poll message with-in the timeout period, it assumes that the network connection has been lost. The option board then toggles drive control to one of three Loss-of-Network options that may be preprogrammed by the user through P03.

Under startup conditions when the option board is in Net mode and network communications has not yet been established, the drive is held in stop mode for the configured timeout period. If communications has not been established by the end of that time-out period, the option board then toggles drive control to the preprogrammed Loss-of-Network action. The timeout period of the timer is configurable through P04; however, Johnson Controls, Inc. recommends that the period be set to 10 minutes.

The Loss-of-Network configuration parameter may be preset to one of three values: 0-Fault (Er5), 1-Use\_Last\_Values and 3-Use\_Term\_Value. The following describes the actions of the drive for each of these values. Each description assumes that both the Terminal and Frequency control subsets are configured to be active when in Net mode. Should either of these control subsets not be configured in P02, its associated network parameter is never active and may be ignored in the following descriptions.

**a. 0 - Fault**

When communications are lost, the Inverter immediately control-stops the drive and faults with an ER5. When network communications are restored, both the network Terminal and Frequency control parameters are zero, which maintains the drive at stop until the master issues new override values. Additionally, the ER5 must be reset either locally or over the network (depending on the current Local/Net mode) before any motion commands are accepted. Note that the reset command is not accepted as long as terminal FWD or REV bits are set.

The user can take local control of the drive when in ER5 by switching to Local mode and issuing a reset at the Inverter's local terminal or keypad (Note that terminal controls must reflect a stop state before a reset can be issued). Switching back to Net mode with the network still inactive causes an ER5 to re-occur. Switching back to Net mode with the network restored causes the drive to revert control to the network Terminal and Frequency parameters, which is zero until new overrides are issued.

**b. 1 - Use\_Last\_Values**

When communications are lost, the Inverter continues to run using the last received network Terminal and Frequency control parameters. When network communications are restored, the current network Terminal and Frequency control parameters continue to be used until new overrides are issued.

**WARNING: When in this mode, the only way to stop the drive is through local control. This requires either a switch to Local mode <or> use the STOP button on the local keypad. It is the user's responsibility to take the appropriate safety precautions.**

The user can take local control of the drive while in this state by switching to Local mode. Switching back to Net mode with the network still inactive reverts control back to the network Terminal and Frequency control parameters. However, the network Terminal and Frequency control parameters are reset to zero at that time. That is, if the user switches back to Net mode before the network is restored, the drive is stopped regardless of the state of the last N2 Overrides. Switching back to Net mode with the network restored switches control to the network Terminal and Frequency control parameters.

**c. 2 - Use\_Term\_Values**

When communications are lost, the drive reverts to local Terminal and Frequency control parameters (as if option board was placed in Local mode). When network communications are restored, the drive reverts control to network Terminal and Frequency parameters, which are reset to zero until new overrides are issued.

**WARNING: When in this mode, the drive reverts to the current state set at the terminal. It is the user's responsibility to preset this to a safe state.**

The user can take local control of the drive while in this mode by switching to manual. This essentially does nothing since the local Terminal and Frequency parameters are already being used. Switching back to Net mode with the network still inactive essentially does nothing since the drive continues to use the local Terminal and Frequency controls until the network is active. Switching back to Net mode with the network restored switches control to the network Terminal and Frequency control parameters, which are zero until new overrides are issued.

**Note:** If FWD or REV contacts are closed at terminal at power-up an ER6 is generated.

#### 4.4 Network Access to Inverter Parameters

Use Table 4.4 to determine the mapping of Drive control, Frequency reference and inverter status parameters to the associated N2 Network Point Type (region) and Address. .

Note that Table 4.4 only includes BI, AI, BO and AO point types which are sufficient to provide basic operation of the inverter. However, any of the Inverter parameters not accessible through these point types are accessible through ADI point types. Thus, access to additional inverter control, status and the full set of Function Code is still available over the network. The ADI point mapping to Inverter parameter table is presented in Appendix A. Since ADI points are integer values, some inverter parameters may be bit packed in an unfamiliar decimal format. Also included in Appendix A are the format definitions for these inverter parameters.

As noted above, network access to AI and AO point types is quick and scaled, but access to ADI points is significantly slow and the point values are unscaled (or uniquely formatted). To accommodate users that may wish to access an Inverter parameters not included in the BI, AI, BO, AO point group on a constant basis, two AI and two AO points are provide which may be user mapped to any ADI point. Access to these user defined AI/AO points are buffered to increase network speed and are scaled to a floating point value as that presented by the keypad.

Write/override access to Function Codes can be blocked depending on the current state of Data-Protect, Run-Mode-Protect and NetCtrl. Should any of these conditions exist, a cryptic network error "Invalid Data" (N10) is returned through either AI/AO or ADI access. Furthermore, attempts to write a value which is out-of-limits is also blocked. If the out-of-limits access is through ADI, an "Invalid Data" (N10) is returned. If out-of-limits access is through AI/AO, no error indication is given; however, the value is not updated.

Data-Protect is a Function Parameter that can be set by the user that prevents further access to any Function Parameter (other than Data-Protect) by either the keyboard or network. Additionally, the local terminal X5 can be configured to provide the same functionality. However, local terminal X5 only blocks network access to Function Parameters if Terminal control is in Local mode. Note that local terminal X5 blocks keypad access to Function Parameters regardless of the Local/Net mode.

**IMPORTANT: READ THE FOLLOWING NOTE BEFORE ATTEMPTING COMMUNICATIONS ON THE NETWORK:**

**NOTE:** It is imperative that the user complete the configuration process (beginning in Chapter 3) to setup the drive address and timeout timer (P04=10 minutes according to Johnson Controls recommendations). Loss of communications may result if the drive is not properly configured and the timeout timer is not reset by a poll for “a change of state” (COS) that is directly addressed to the drive.

**Table 4.4 - N2 I/O Point Map**

NPT <sup>1</sup>	NPA <sup>2</sup>	Units	Point Description	Range/Value	Notes
AI	1	Hz	Output Frequency	-300.0 - +300.0	Low resolution (may not equal AO1)
AI	2	%	Output Current	% rated	
AI	3	%	Output Voltage	% rated	
AI	4	%	Output Torque	% rated	
AI	5		Trip history (word 1)	Byte packed	See drive parameter 107 format
AI	6		Trip history (word 2)	“	See drive parameter 108 format
AI	7	<sup>3</sup>	User Defined	<sup>4</sup>	Select index from drive parameter table (formatted)
AI	8				
BI	1		Fwd	0-Off 1-On	Run control status
BI	2		Rev		
BI	3		BX (coast stop)	“	In parallel with terminal BX
BI	4		DCB (dc brake stop)	“	
BI	5		Drive Run commanded	“	
BI	6		Drive Fault	“	See keypad display or AI5
BI	7		NetCntl	“	Net/Manual switch in Net mode
BI	8		THR (E Stop ok)	“	Monitors terminal THR
BI	9		Data protect	“	Write access to Function Codes blocked
BI	10		Y1	“	Dependent on F47 configuration
BI	11		Y2		
BI	12		Y3		
BI	13		Y4		
BI	14		Y5		
BI	15		Keypad Control	“	Keypad start/stop in series w/control
BI	16		Keypad State	“	Keypad start status
AO	1	Hz	Frequency control	-300.0 - +300.0	High resolution (scaled in frequency)
AO	2	<sup>3</sup>	User Defined	<sup>4</sup>	Select index from drive parameter table (formatted)
AO	3				
BO	1		Fwd	0-Off 1-On	Run commands
BO	2		Rev		Do not activate both consecutively
BO	3		BX	“	Coast stop
BO	4		DCB (DC brake)	“	Requires F32 = xx2x
BO	5		Reserved	“	Must be set to zero
BO	6		Reset	“	Must transition OFF-ON-OFF
BO	7		X1 (select preset freq. setpoint)	“	Dependent on F20-F26 configuration
BO	8		X2		
BO	9		X3		
BO	10		RT1 (select preset accel/decel)	“	Dependent on F33-F38 configuration
BO	11		RT2		
BO	12		Up (inc freq. setpoint)	“	Requires F32 = 1xxx/2xxx.
BO	13		Dn (dec freq. setpoint)		Requires Manual Freq. Reference.
BO	14		PU (set equal to line freq)	“	
BO	15		VF2 (use drive 2 parameters)	“	Drive must be stopped to switch
BO	15		Reserved	“	Must be set to zero

<sup>1</sup> Network Point Type  
<sup>2</sup> Network Point Address  
<sup>3</sup> Individually defined, see Table A1  
<sup>4</sup> Individually defined, converted from integer packed value (Table A1) to linear floating point representation



#### 4.5 Option Board Faults (Er5)

An option board fault causes the Inverter to enter an **Er5** error state. Generally, an option card fault is due to an invalid configuration parameter or a Loss-of-Communications error. Option Function Code P00 (if enabled) can be examined to determine the specific error.

Table 4.5 – Option Board Faults	
101	Invalid Id (must be greater than zero)
102	Invalid Network control (each field must be 0-1)
103	Invalid Loss-of-Communications (must be less than 3)
105	Invalid attribute for User defined AI7 (must be less than 124)
106	Invalid attribute for User defined AI8 (must be less than 124)
107	Invalid attribute for User defined AO1 (must be less than 102)
108	Invalid attribute for User defined AO2 (must be less than 102)
201	Connection time-out

## APPENDIX A: DRIVE PARAMETERS AND FORMATS

### A1.1 General

The Drive Parameters listed in Table A.1 describe the "access" information needed by the master to access any of the Inverter parameters (Command, Status and Function Codes). Note that these values may be bit packed in unique formats. Use the format descriptions in the following Table A1 for decoding the data.

Table A1 – Drive Parameters								
ADI Number	Parameter Description	FC	Minimum	Maximum	Unit	Format	Read/Write	Change While Running
1	Frequency Command	00	0	2	-	0	R/W	N
2	Operation Method	01	0	1	-	0	R/W	N
3	Maximum Frequency	02	50	400	Hz	0	R/W	N
4	Base Frequency 1	03	50	400	Hz	0	R/W	N
5	Rated Voltage 1	04	0, 80	480	V	0	R/W	N
6	Acceleration Time 1	05	0.01	3600	s	5	R/W	Y
7	Deceleration Time 1	06	0.01	3600	s	5	R/W	Y
8	Torque Boost 1	07	0	20	-	1	R/W	Y
9	Elec. Thermal OL (Select)	08	0	2	-	0	R/W	Y
10	Elec. Thermal OL (Level)	09	Ratedx20	Ratedx135	A	6	R/W	Y
11	Restart after Power Failure	10	0	4	-	0	R/W	N
12	Frequency Limiter (High)	11	0	400	Hz	0	R/W	Y
13	Frequency Limiter (Low)	12	0	400	Hz	0	R/W	Y
14	Bias Frequency	13	0	400	Hz	0	R/W	Y
15	Gain (Freq. Setting Signal)	14	0	200	%	1	R/W	Y
16	Torque Limiter (Driving)	15	20	180, 255	%	0	R/W	Y
17	Torque Limiter (Braking)	16	0, 20	180, 255	%	0	R/W	Y
18	DC Brake (Starting Freq.)	17	0	60	Hz	1	R/W	Y
19	DC Brake (Brake Level)	18	0	100	%	0	R/W	Y
20	DC Brake (Braking Time)	19	0	30	s	1	R/W	Y
21	Multistep Freq Setting 1	20	0	400	Hz	2	R/W	Y
22	Multistep Freq Setting 2	21	0	400	Hz	2	R/W	Y
23	Multistep Freq Setting 3	22	0	400	Hz	2	R/W	Y
24	Multistep Freq Setting 4	23	0	400	Hz	2	R/W	Y
25	Multistep Freq Setting 5	24	0	400	Hz	2	R/W	Y
26	Multistep Freq Setting 6	25	0	400	Hz	2	R/W	Y
27	Multistep Freq Setting 7	26	0	400	Hz	2	R/W	Y
28	Elec. Thermal OL (DB Res.)	27	0	2	-	0	R/W	Y
29	Slip Compensation Control	28	-9.9	5	Hz	1	R/W	Y
30	Torque Vector Control	29	0	1	-	0	R/W	N
31	Number of Motor Poles	30	2	14	-	0	R/W	N
32	Function Block (32-41)	31	0	1	-	0	R/W	Y
33	X1 - X5 Terminal Function	32	0	0x2222	-	11	R/W	N

ADI Number	Parameter Description	FC	Minimum	Maximum	Unit	Format	Read/Write	Change While Running
34	Acceleration Time 2	33	0.01	3600	s	5	R/W	Y
35	Deceleration Time 2	34	0.01	3600	s	5	R/W	Y
36	Acceleration Time 3	35	0.01	3600	s	5	R/W	Y
37	Deceleration Time 3	36	0.01	3600	s	5	R/W	Y
38	Acceleration Time 4	37	0.01	3600	s	5	R/W	Y
39	Deceleration Time 4	38	0.01	3600	s	5	R/W	Y
40	Base Frequency 2	39	50	400	Hz	0	R/W	N
41	Rated Voltage 2	40	0, 80	480	V	1	R/W	N
42	Torque Boost 2	41	0.1	20	-	1	R/W	Y
43	Function Block (43-51)	42	0	1	-	0	R/W	Y
44	FMP Terminal (Pulse Rate Mult.)	43	6	100	-	0	R/W	Y
45	FMP Terminal (Voltage Adjust)	44	50	120	-	0	R/W	Y
46	FMA Terminal (Voltage Adjust)	45	65	103	-	0	R/W	Y
47	FMA Terminal (Function)	46	0	3	-	0	R/W	Y
48	Y2 - Y5 Terminal Function (low word)	47	0	0xFFFF	-	12	R/W	N
49	Y1 Terminal Function (high word)		0	0xF	-	13	R/W	N
50	FAR Function Signal (Hysteresis)	48	0	10	Hz	1	R/W	Y
51	FDT Function (Level)	49	0	400	Hz	0	R/W	Y
52	FDT Function (Hysteresis)	50	0	30	Hz	1	R/W	Y
53	OL Function Signal (Level)	51	Ratedx20	Ratedx13 5	A	6	R/W	Y
54	Function Block (53-59)	52	0	1	-	0	R/W	Y
55	Jump Frequency (Jump Freq. 1)	53	0	400	Hz	0	R/W	N
56	Jump Frequency (Jump Freq. 2)	54	0	400	Hz	0	R/W	N
57	Jump Frequency (Jump Freq. 3)	55	0	400	Hz	0	R/W	N
58	Jump Frequency (Hysteresis)	56	0	30	Hz	0	R/W	N
59	Starting Frequency (Freq.)	57	0.2	60	Hz	1	R/W	N
60	Starting Frequency (Holding Time)	58	0	10	s	1	R/W	N
61	Freq. Setting Signal Filter	59	0.01	5	s	2	R/W	Y
62	Function Block (61-79)	60	0	1	-	0	R/W	Y
63	LED Monitor (Function)	61	0	8	-	0	R/W	Y
64	LED Monitor (Display at Stop Mode)	62	0	1	-	0	R/W	Y
65	Coeff. for Machine & Line Speed	63	0.01	200	-	2	R/W	Y
66	LCD Monitor	64	0	4	-	0	R/W	Y

ADI Number	Parameter Description	FC	Minimum	Maximum	Unit	Format	Read/Write	Change While Running
67	Pattern Operation (Mode Select)	65	0	3	-	0	R/W	N
68	Pattern Operation (Stage 1)	66	0	6000	s/-	7	R/W	Y
69	Pattern Operation (Stage 2)	67	0	6000	s/-	7	R/W	Y
70	Pattern Operation (Stage 3)	68	0	6000	s/-	7	R/W	Y
71	Pattern Operation (Stage 4)	69	0	6000	s/-	7	R/W	Y
72	Pattern Operation (Stage 5)	70	0	6000	s/-	7	R/W	Y
73	Pattern Operation (Stage 6)	71	0	6000	s/-	7	R/W	Y
74	Pattern Operation (Stage 7)	72	0	6000	s/-	7	R/W	Y
75	Acc./Dec. Pattern (Mode Select)	73	0	2	-	0	R/W	N
76	Energy Saving Operation	75	0	1	-	0	R/W	N
77	Rev. Phase Sequence Lock	76	0	1	-	0	R/W	N
78	Data Initializing (Data Reset)	77	0	1	-	0	R/W	N
79	Language (Japanes/English)	78	0	3	-	0	R/W	Y
80	LCD Display Brightness	79	0	10	-	0	R/W	Y
81	Function Block (81-94)	80	0	1	-	0	R/W	Y
82	Motor Sound (Carrier Frequency)	81	0	10	-	0	R/W	Y
83	Auto Restart (Restart Time)	82	0	5	s	1	R/W	N
84	Auto Restart (Freq. Fall Rate)	83	0	100	Hz/s	2	R/W	N
85	Auto Reset (Times)	84	0	7	-	0	R/W	Y
86	Auto Reset (Reset Interval)	85	2	20	s	0	R/W	Y
87	Motor 1 (Capacity)	86	0	3	-	0	R/W	N
88	Motor 1 (Rated Current)	87	0	2000	A	6	R/W	N
89	Motor 1 (No-Load Current)	88	0	2000	A	6	R/W	N
90	Motor 2 (Rated Current)	89	0	2000	A	6	R/W	N
91	Motor 1 Impedance (Tuning)	90	0	1	-	0	R/W	N
92	Motor 1 Impedance (%R1 Setting)	91	0	50	%	2	R/W	Y
93	Motor 1 Impedance (%X1 Setting)	92	0	50	%	2	R/W	Y
94	Data Protection	95	0	1	-	0	R/W	N
95*	Additional V1 Analog Voltage		-10	10	V	0	R/W	Y
96	High Res. Frequency Setting (Pulses)		-6000	6000	Pulse	14	R/W	Y
97	Terminal Input/Output (low word)		BIT MAP	BIT MAP	-	4	R/W	Y
98	Terminal Input/Output (high word)		BIT MAP	BIT MAP	-	4	R/W	Y
99*	Output Frequency Compensation Input		-6000	6000	Pulse	14	R/W	Y

ADI Number	Parameter Description	FC	Minimum	Maximum	Unit	Format	Read/Write	Change While Running
100	Drive Torque Limit Setting		20	180, 255	%	0	R/W	Y
101	Braking Torque Limit Setting		0, 20	180, 255	%	0	R/W	Y
102	Output Frequency		-6000	6000	Pulse	14	R	Y
103	Output Current				%	10	R	Y
104	Output Voltage				%	10	R	Y
105	Output Torque				%	10	R	Y
106	Operation Status		BIT MAP	BIT MAP	-	8	R	Y
107	Trip History (low word)				-	3	R	Y
108	Trip History (high word)				-	3	R	Y
109	Inverter Capacity				-	15	R	Y
110	Total Operation Time				h	0	R	Y
111	Inverter Rated Current				A	16	R	Y
112	Fin Temperature				C	0	R	Y
113	Internal Temperature				C	0	R	Y
114	Output Terminal Condition		BIT MAP	BIT MAP	-	9	R	Y
115	V2 Terminal Voltage				V	1	R	Y
116	V1 terminal Voltage				V	1	R	Y
117	C1 Terminal Current				mA	1	R	Y
118**	FMP Frequency				Pulse	0	R	Y
119	FMP Output Voltage				V	1	R	Y
120	FMA Output Voltage				V	1	R	Y
121	Inverter Terminal Input (low word)		BIT MAP	BIT MAP	-	4	R	Y
122	Inverter Terminal Input (high word)		BIT MAP	BIT MAP	-	4	R	Y
123	Option Status		BIT MAP	BIT MAP	-	17	R/W	Y

\*Not normally active in Network mode. Requires direct manipulation of ADI point 123.  
\*\*Not active at this time.

## A1.2 Data Formats

FORMAT 0
Direct Translation

FORMAT 1	
READ	WRITE
/10	X10

FORMAT 2	
READ	WRITE
/100	X100



Abbreviation Definitions	
FWD	Run Drive Forward
REV	Run Drive Reverse
HLD	Hold Last Command
BX	Coast Stop Command
THR	Do Not Set (Masks Terminal THR)
RST	Fault Reset
X1,X2,X3	Select Preset Speed
RT1,RT2	Select Preset Acc/Dec Rates
UP	Increment Set Frequency
DOWN	Decrement Set Frequency
PU	Line To Inverter Transition
AUT	SELECT 4-20ma FOR FREQ SETTING
DCB	Dc Brake Command
VF2	2 <sup>nd</sup> Motor V/F Selection
PRT	DATA PROTECTION (Monitor Only)

FORMAT 5															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	BASE		ACCELERATION / DECELERATION TIME									
<b>BASE</b>		<b>ACCEL / DECEL TIME</b>													
<b>0</b>	10ms	<b>1-999</b>	0.01-9.99s												
<b>1</b>	0.1s	<b>100-199</b>	10.0-99.9s												
<b>2</b>	1s	<b>100-199</b>	100-999s												
<b>3</b>	10s	<b>100-360</b>	1000-3600s												

FORMAT 6															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	BASE		CURRENT DATA									
<b>BASE</b>		<b>CURRENT DATA</b>													
<b>0</b>	0.01A	<b>1-999</b>	0.01-9.99A												
<b>1</b>	0.1A	<b>100-999</b>	10.0-99.9A												
<b>2</b>	1.0A	<b>100-999</b>	100-999A												
<b>3</b>	10A	<b>100-200</b>	1000-2000A												

FORMAT 7															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DIR		TIME SELECT			BASE		ACCELERATION / DECELERATION TIME								
DIRECTION		TIME SELECT			BASE		ACCEL / DECEL TIME								
0	FWD	0	TIME 1		0	0.01S	1-999		0.01-9.99A						
1	REV	1	TIME 2		1	0.1S	100-999		10.0-99.9A						
		2	TIME 3		2	1.0S	100-999		100-999A						
		3	TIME 4		3	10S	100-600		1000-6000A						

FORMAT 8			
3	2	1	0
DC Brake Applying	RUN	REVERSE	FORWARD
7	6	5	4
Keypad Operation Status (LED)	Data Change Priority Option Side: 1, Keypad Side: 0	RUN Command by Keypad	Trip Condition

FORMAT 9							
7	6	5	4	3	2	1	0
0	0	0	Y5	Y4	Y3	Y2	Y1

FORMAT 10
(DRIVE VALUE / 4096) X NAMEPLATE VALUE = DESIRED VALUE
DRIVE VALUE / 40.96 = PERCENT VALUE

FORMAT 11															
WRITE															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
X1/X2 TERMINAL (0-FH)				X3 TERMINAL (0-FH)				X4 TERMINAL (0-FH)				X5 TERMINAL (0-FH)			
READ															
7	6	5	4	3	2	1	0								
X5		X4		X3		X1/X2									



FORMAT 12															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Y2 TERMINAL (0-FH)				Y3 TERMINAL (0-FH)				Y4 TERMINAL (0-FH)				Y5 TERMINAL (0-FH)			

FORMAT 13															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	Y1 TERMINAL (0-FH)			

FORMAT 14															
PULSES TO FREQUENCY = PULSES / 15															
FREQUENCY TO PULSES = absolute value of (FREQUENCY X 15)															

FORMAT 15			
200V Series		400V Series	
Capacity (HP)	Data	Capacity (HP)	Data
1/4	2	1/2	131
1/2	3	1	132
1	4	2	133
2	5	3	134
3	6	5	135
5	7	7.5	136
7.5	8	10	137
10	9	15	138
15	10	20	139
20	11	25	140
25	12	30	141
30	13	40	142
40	14	50	143
50	15	75	144
75	16	55	145
55	17	100	146
100	18	125	147
125	19	150	148
		175	149
		200	150
		250	151
		300	152

FORMAT 16	
Capacity (HP)	FORMULA
30HP and below	CURRENT = DATA / 100
40HP and above	CURRENT = DATA / 10

<b>FORMAT 17</b>			
<b>3</b>	<b>2</b>	<b>1</b>	<b>0</b>
Terminal Input (Run Command Input) thru option card (See also P1)	High Resolution Frequency Setting thru option card (See also P0)	0	0
<b>7</b>	<b>6</b>	<b>5</b>	<b>4</b>
0	1 = Local (Keypad) Control, 0 = Remote (Option Card) Control	Function Input thru Option card	Output Frequency Compensation thru Option card
<b>11</b>	<b>10</b>	<b>9</b>	<b>8</b>
0	0	0	0
<b>15</b>	<b>14</b>	<b>13</b>	<b>12</b>
0	0	0	0