



**User Manual for the
*HEC-GV3-RTU Option Card***

**RTU/MODBUS Network
Communication
*Option Board for use with Reliance
Electric GV3000 AC Drive***

**Second Edition
10 October 1998**

MAN0183-02

PREFACE

This manual explains how to use the Horner Electric's RTU/MODBUS Network Communication Option Board for use with Reliance Electric GV3000 AC Drive.

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ABOUT PROGRAMMING EXAMPLES

Any example programs and program segments in this manual or provided on accompanying diskettes are included solely for illustrative purposes. Due to the many variables and requirements associated with any particular installation, Horner Electric cannot assume responsibility or liability for actual use based on the examples and diagrams. It is the sole responsibility of the system designer utilizing the RTU/Modbus NETWORK COMMUNICATION OPTION BOARD to appropriately design the end system, to appropriately integrate the RTU/Modbus NETWORK COMMUNICATION OPTION BOARD Module and to make safety provisions for the end equipment as is usual and customary in industrial applications as defined in any codes or standards which apply.

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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SAFETY NOTICES**a. DANGER**

Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install it. Read and understand this manual in its entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

b. DANGER

The user is responsible for conforming to the NEC/CEC and all other applicable local codes. Wiring practices, grounding, disconnects, and over-current protection are of particular importance. Failure to observe this precaution could result in severe bodily injury or loss of life.

c. DANGER

Do not install modification boards with power applied to the controller. Disconnect and lock out incoming power before attempting such installation. Failure to observe this precaution could result in severe bodily injury or loss of life.

CHAPTER 1: INTRODUCTION

1.1 Product Description

The Horner Electric RTU/MODBUS Network Communications Option Board (HEC-GV3-RTU) allows a GV3000 controller to be operated and monitored remotely via an RTU Master. The option board mounts below the regulator board inside the GV3000 controller connected via a flexible ribbon cable. Power for the option board comes from the GV3000 controller power supply.

The option board allows different levels of configuration and tuning of the GV3000 drive registers according to preference and the capability of the RTU Network master. Once configured, the drive can be completely controlled via the option board. Reset, fault code monitoring and complete control can all be accomplished over an RTU network. In many applications, there may be only a network interface connection, hard-wired emergency stop (Function Loss input), and three-phase input and output power wiring.

Control and status information is passed between the drive and the network as 16bit values using RTU READ and PRESET Holding Register commands. Parameters are grouped in such a manner to optimize control, tune and monitor packets. An RTU connection time-out timer may be enabled to determine when RTU control is lost. If RTU control is lost, one of three different drive operation responses can be selected. Commonly used RTU frame protocols (baud, stop bits and data size mode) may be selected from a list or a user configurable frame protocol may be created through the optional PC configuration utility SMARTCFG.

a. Mechanical Description

The option board is a printed circuit assembly that mounts inside a GV3000 Controller. The option board connects to the GV3000 Controller's regulator board via a ribbon cable. A DB15 connector is used to connect the option board to a dual twisted pair RS-422 network. An optional RS-232-to-RS-422 converter may be used to provide an interface to an RS-232 serial connection. The option board also contains 2 LEDs, which provide a visual indication of the state of the option board, time-timer and communications activity.

b. Electrical Description

The option board contains its own microprocessor. The microprocessor connects to one port of the module's dual port memory, while the other port interfaces with the GV3000's regulator. The board contains a watchdog timer, which is enabled when power is turned on to the Controller. The microprocessor must reset the watchdog timer within a specified period or the microprocessor shuts down resulting in a "F 60" code on the GV3000 controller's front-panel display. The option board provides communications through a DB-15 RS-422 communications port.

1.2 Additional Information

The user needs to be familiar with all of the instruction manuals that describe the system configuration. This may include, but is not limited to, the following:

- D2-3323 GV3000 AC General Purpose (Volts/Hz) and Vector Duty Drive Software Startup and Reference Manual Version 4.0 (or later).

- D2-3324 GV3000 AC Power Modules Hardware Reference, Installation and Troubleshooting 1-150 HP @ 380-460 VAC Version 4.0 (or later).

CHAPTER 2: INSTALLATION

2.1 Safety Notices

a. DANGER

Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install it. Read and understand this manual in its entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

b. DANGER

The user is responsible for conforming to the NEC/CEC and all other applicable local codes. Wiring practices, grounding, disconnects, and overcurrent protection are of particular importance. Failure to observe this precaution could result in severe bodily injury or loss of life.

c. DANGER

Do not install modification boards with power applied to the controller. Disconnect and lock out incoming power before attempting such installation. Failure to observe this precaution could result in severe bodily injury or loss of life.

2.2 Installing the HEC-GV3-RTU Option Board

Refer to Figures 2.1 – 2.4.

1. Disconnect and lock-out all incoming power to the GV3000 controller.
2. Loosen the four (4) captive screws at the corners of the GV3000 controller cover and remove the cover. **Refer to Figure 2.2.**
3. Disconnect the ribbon cable that runs between the **right** side of the regulator board and the daughter board from the connector on the daughter board.
4. If the controller is equipped with a fan, disconnect the fan power leads from the connector on the power board.
5. Remove the three (3) screws that fasten the stand-off bracket (to which the regulator board and keypad are mounted) to the controller base, and remove the regulator board/keypad/bracket assembly from the controller.
6. Invert the regulator board/keypad/bracket assembly so that the keypad is on the bottom. The ribbon cable that connects to the daughter board extends from the left of the regulator board, and the ribbon cable that connects to the RTU/Modbus Network Communications Option Board extend from the right of the regulator board. **Refer to Figure 2.1.**
7. Connect the ribbon cable that extends from the **right** side of the regulator board to the connector on the RTU/Modbus Network Communication Option Board.
8. Mount the RTU/Modbus Network Communication Option Board to the underside of the stand-off bracket. Use the two- (2) M3 self-tapping screws and lock washers (provided) on the right side. Use the two (2) plastic rivets to fasten the left side of the board to the stand-off bracket.
9. Re-install the regulator board/keypad/bracket assembly to the controller base.

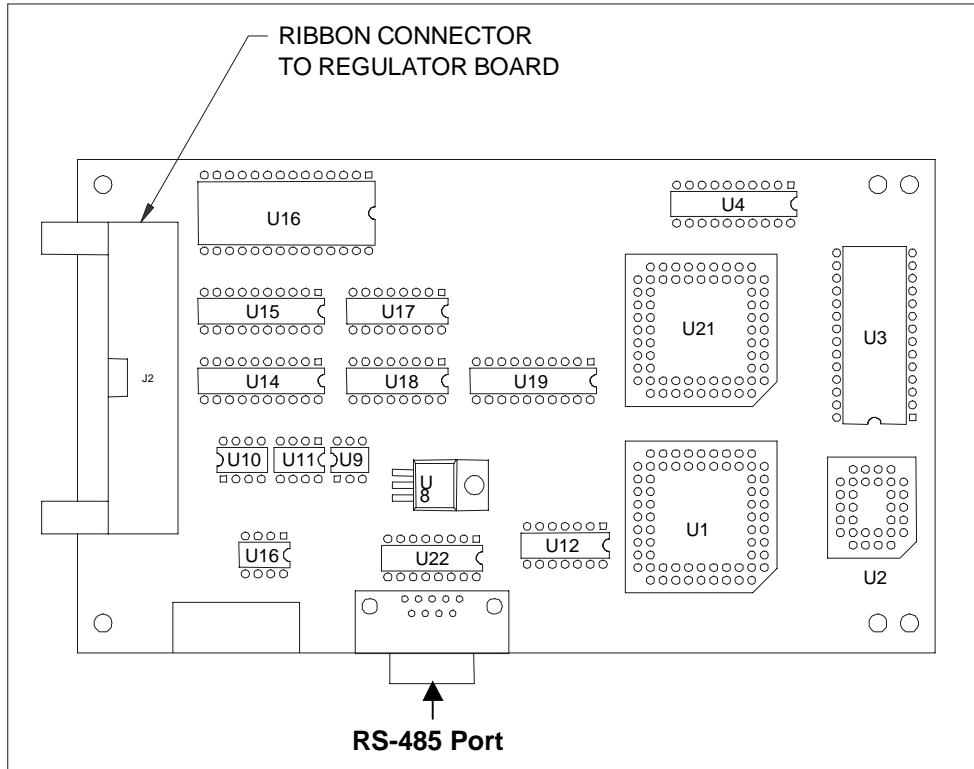


Figure 2.1 – RTU/Modbus Option Board

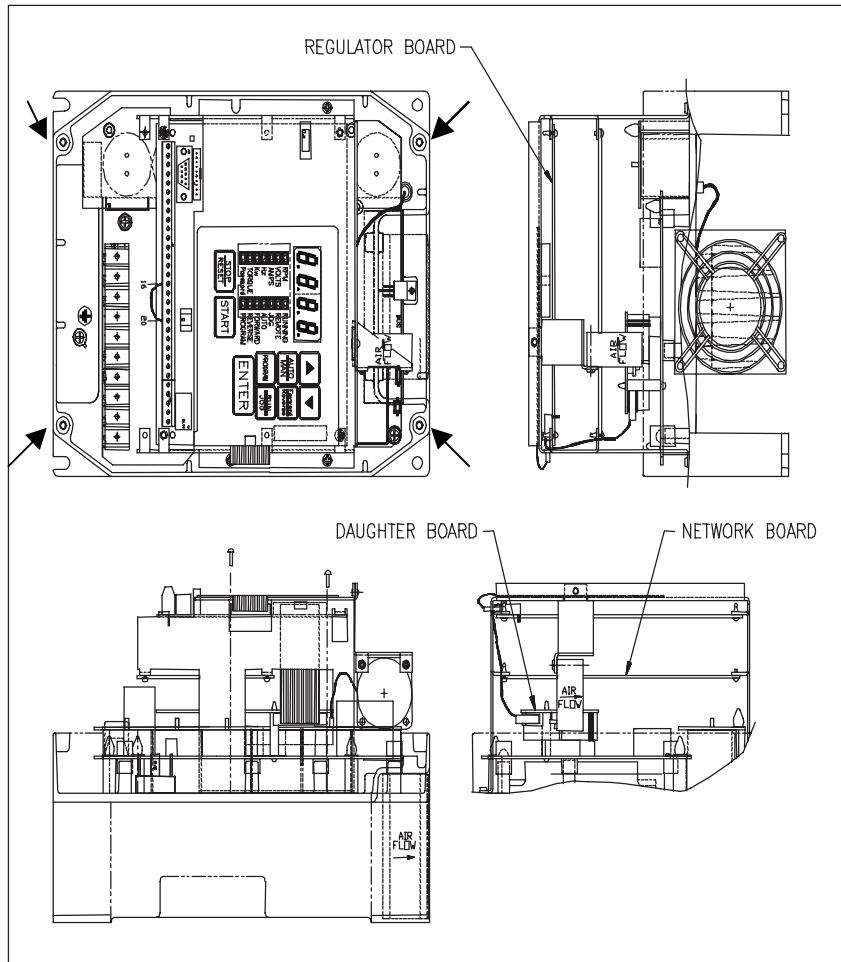


Figure 2.2 – GV3000 Drive (1-5 HP)

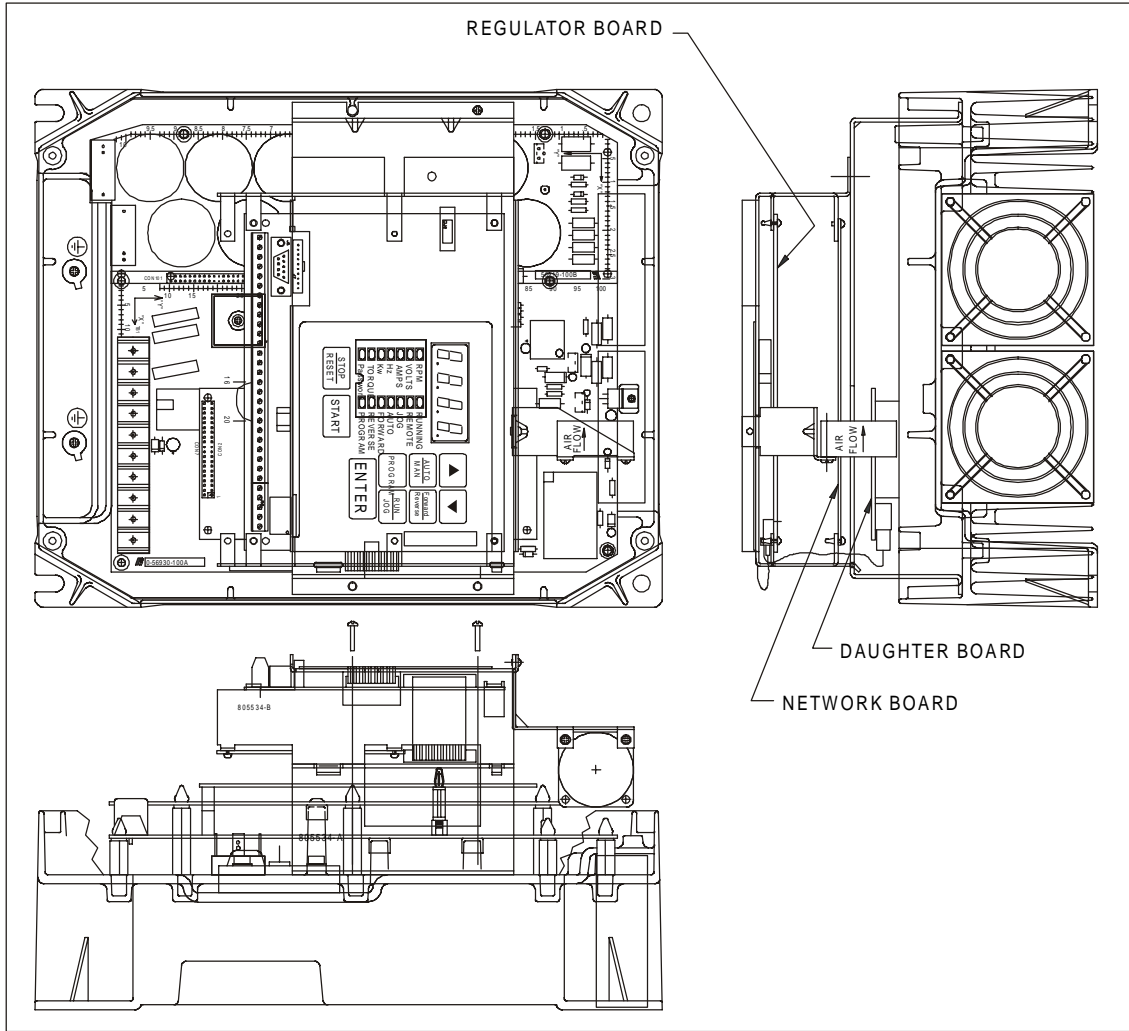


Figure 2.3 – GV3000 Drive (7.5-10 HP)

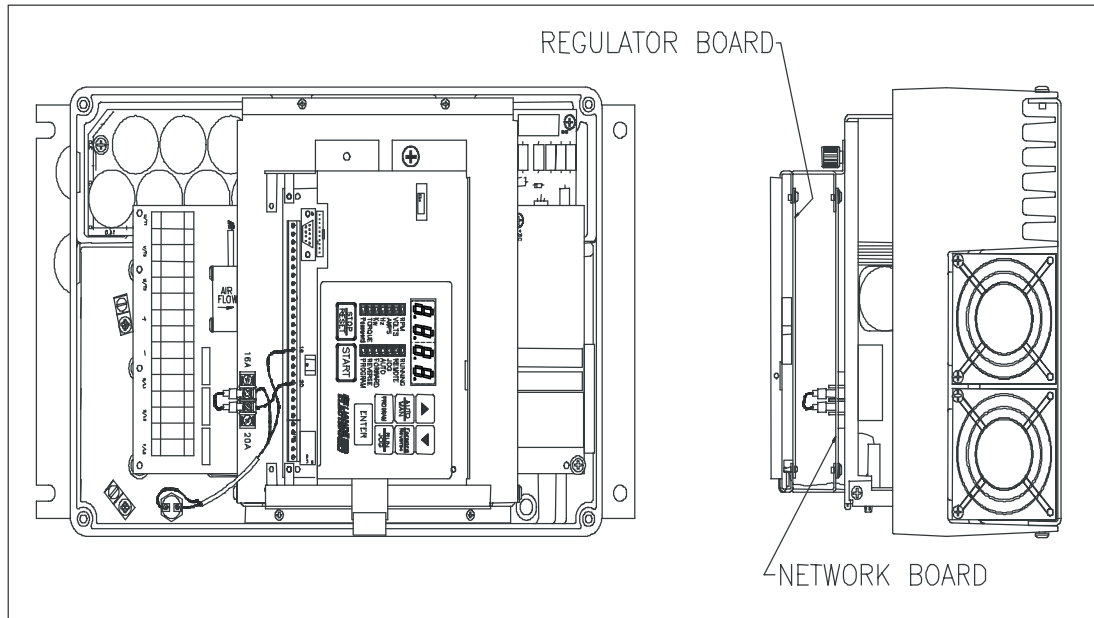


Figure 2.4 – GV3000 Drive (15 – 25 HP)

2.3 Connecting the GV3000 Controller to an RTU Network

When connecting to the RTU/Modbus Communications Bus, the GV3000 drive should be wired with the same cabling as other devices on the network. Refer to the EIA RS-422 standard for cable and termination guidelines. The option board provides an internal 120 ohm terminating resistor for the receive pair which can be strapped by shorting pins 9 and 10 on the DB-15 connector. Only the two end-point devices on the RS-422 cable should have terminators enabled.

Pin	Tag	Direction
1	N/C	-
2	N/C	-
3	N/C	-
4	N/C	-
5	+5V	OUT
6	RTS -	OUT
7	GND	-
8	CTS -	IN
9	Terminator (short 9 & 10 to enable)	-
10	RXD-	IN
11	RXD+	IN
12	TXD -	OUT
13	TXD+	OUT
14	RTS+	OUT
15	CTS -	IN

*Handshake and factory lines are not used for RTU communications and should not be connected.

*An optional RS-422 to RS-232 Adapter is available from Horner Electric. It receives power from pins 5 (+) and 7 (C). The part number is HE693SNP232. When using this adapter, the RS-232 pin-out is as follows:

Pin	Tag	Direction
1	N/C	-
2	TD	OUT
3	RD	IN
4	N/C	-
5	GND	-
6	N/C	-
7	CTS	OUT
8	RTS	IN
9	N/C	-

HEC-GV3-RTU RS-
15-pin D-

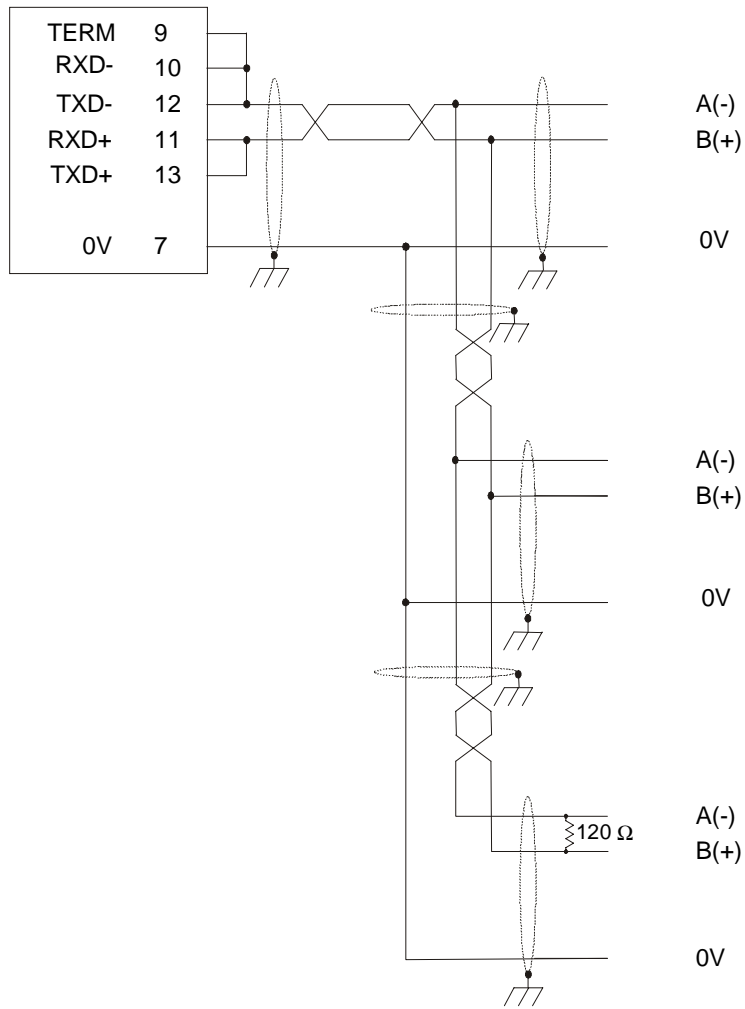


Figure 2.5 – Two-Wire RS-485 Wiring Diagram

CHAPTER 3: CONFIGURATION

3.1 Entering Network parameters

This chapter covers configuration of the option board by entering the respective parameters through the drive's keypad. For instructions on operating the drive's keypad, refer to the GV3000 Installation and Operation Instruction Manual (D2-3287).

The drive becomes active on the RTU network after the following steps are performed:

1. Connect the HEC-GV3-RTU option board to the RTU network through the RS-422 serial connector.
2. Apply power to the drive.
3. Using the keypad, access the Network ID Assignment parameter (P.060) and assign a valid RTU Id to the drive (limited to 1- 55).
4. Using the keypad, access the Network Connection Type parameter (P.061) and select either Basic Drive Connection or Full Drive Connection.
5. Using the keypad, access the Comm Loss Selection parameter (P.062) and select the fault action to be taken on a RTU connection time-out.
6. Using the keypad, access the Network Frame Assignment parameter (P.063) and select either the User-configurable-protocol-frame (1) or one of the predefined protocol frames (2-8).

*Selecting the User-configurable-protocol-frame requires running an external configuration program to set the specific parameters such as baud rate, parity, stop and time-out.

**Note that P.061, P.062 and P.063 can also be accessed and changed via the network.

Serial communications can then be established with an RTU master. Input and Output information can be accessed using the READ_HOLDING_REG and PRESET_HOLDING_REG RTU commands. However, additional requirements must be met before inputs can be transferred to the drive regulator. These requirements are described in Chapter 4.

3.1.1 Network ID Assignment

RTU communication networks can support up to 246 nodes on a network. However, because of network hardware limitations, the number of nodes is generally limited to 32. Each node on an RTU communications network must be assigned a unique ID number. This ID is used by the RTU Master to route commands to the appropriate RTU device. The Network ID Assignment parameter (P.060) contains the ID for this option board and may be any value from 1 to 55.

3.1.2 Network Connection Type

The drive's Network Connection Type parameter defines the scope of status and control that the RTU master has with the connected drive. Two types of data connections are provided: Basic Drive Connection and Full Drive Connection. The Basic Drive Connection (0) limits the number of control and status parameters accessible over the RTU network to the first 64 drive registers. The Full Drive Connection (1) allows RTU access to all drive registers (see section 4.1.5 for further limitations on writes). This selection becomes more prevalent when using the Tune/cnfg enable bit to load configuration and tuning parameters from the RTU network. The drive's network connection type is selected with the Network Connection Type parameter (P.061).

3.1.3 Network Communications (Comm) Loss

The option board maintains a timeout timer that is reset on receiving a valid command. Whenever communication is interrupted (the timer times out), the board immediately notifies the drive regulator of this occurrence, and then waits for the next RTU command to re-establish communications. The drive, then, reacts to the loss of communications according to how the Comm Loss Selection parameter (P.062) has been configured.

a. 0 – IET Fault

If P.062 is equal to 0, the drive considers a Loss of Network Communication as a drive fault resulting in an IET-type stop sequence. To eliminate extraneous fault conditions at power-up of a drive configured for network operation, the drive delays for approximately 10 seconds after power-up before annunciating a fault condition. A fault condition is annunciated thereafter if network communications have not been established or if network communications was established and then lost. In this case, the response to the network communication loss is as follows:

- The drive latches a fault condition and performs a coast stop sequence.
- A fault code is logged in the drive's error log and displayed on the front-panel display ("nCL" = network Comm Loss).
- The front-panel REMOTE LED blinks indicating that the network is inactive.
- Once network communications has been re-established, a drive fault reset is required to re-start the drive. (Note: A fault reset does not clear the error log).

b. 1 – Hold Last Reference

If P.062 is equal to 1, the drive continues to operate using the last reference received from the network master. In this case, the response to network communication loss is as follows:

- A fault does not occur.
- An entry is made into the drive's error log for each active to inactive transition of the network communication status
- The front-panel REMOTE LED blinks indicating that the network is inactive.
- Once network communications has been re-established, the drive follows the reference and sequencing control inputs supplied by the network master. The front-panel REMOTE LED is on continuously indicating that the network is active.

It is important to note that, in this configuration, it may not always be possible to stop the drive over the network. Some form of hardwired stop must be used (e.g., function loss input configured for IET when asserted to stop the drive).

c. 2 – Use Terminal Block Reference

If P.062 is equal to 2, the drive obtains its speed/torque reference from the terminal block analog input and its STOP input from the terminal block STOP input. All other inputs are held at the last values received from the network master.

This allows the network master to continue controlling the drive reference with a direct-wired analog output to input and to STOP the drive with a direct-wired digital output to input. Note that once the drive is stopped while in this mode, it cannot be re-started until network communications is re-established or the operation control source (P.000) is changed. In this case, the response to network communication loss is as follows:

- A fault does not occur.
- An entry is made into the drive's error log for each active to inactive transition of the network communication status.
- The front-panel REMOTE LED blinks indication that the network is inactive.
- Once network communications has been re-established, the drive follows the reference and sequencing control inputs supplied by the network master. The front-panel REMOTE LED is on continuously indicating that the network is active.

It is important to note that, in this configuration, it may not always be possible to stop the drive over the network. Some form of hardwired stop must be used (e.g., function loss input configured for IET when asserted to stop the drive).

3.1.4 Network Frame Assignment

RTU communications protocol supports a variety of frame protocols. However, each node on the same network must be configured the same. The Network Frame Assignment parameter allows the user to select either a typical pre-assigned protocol or create a custom protocol configuration specific to their network. The following table indicates which frame protocol is selected by the value in the Network Frame Assignment parameter (P063):

Table 3.1 – Network Frame Assignment					
Selection	Mode	Baud	Parity	Stop bits	Connection timeout
0	(Run configurator only)				
1	(User-configurable-protocol-frame)				
2	RTU	9600	N	1	6 Sec
3	RTU	9600	O	1	6 Sec
4	RTU	9600	E	1	6 Sec
5	RTU	19.2K	N	1	3 Sec
6	RTU	19.2K	O	1	3 Sec
7	RTU	19.2K	E	1	3 Sec
8	RTU	57.6K	N	1	3 Sec

Since this parameter can be modified by the keypad or the network on-the-fly, use caution to prevent non-intentional loss of communications.

3.2 ASCII Mode Support

Some RTU/Modbus masters transport data over the network in an encoded seven bit ASCII format. This ASCII mode of operation is supported but must be configured by modifying the Mode field in the User-configurable-protocol-frame (which must be selected as the active frame). See Customizing the User-Configurable-Protocol-Frame section below.

3.3 Connection Timeout Timer Adjustment

This timer is used for determining when a Loss of Network Communications occurs. The connection timeout timer is preset to a value determined by the current selection in the Network Frame Assignment parameter. If this period is not acceptable, it can be changed by modifying the Connection timeout field in the User-configurable-protocol-frame (which must be selected as the active frame). The period should be set to a value larger than the expected time between incoming RTU/Modbus commands. The timer may be disabled by setting the period to zero. See Customizing the User-Configurable-Protocol-Frame section below.

3.4 Customizing the User-Configurable-Protocol-Frame (SMARTCFG)

If one of the preset Network Frame Assignment (P.063) selections don't meet the requirements of the network, the User-configurable-protocol-frame selection can be custom tailored with the optional configuration tool SMARTCFG. An optional RS232-to-RS485 converter is also required to communicate with a PC com port. SMARTCFG is a Horner Electric utility that is IBM compatible and only works with Dos version 3.3 or higher. The SMARTCFG utility is used to configure stop bits, baud rates, data types and timeouts..

The User-configurable-protocol selection can be configured to support the following:

Modes:	RTU or ASCII
Baud:	1200, 2400, 4800, 9600, 14.4k, 19.2k, 38.4k and 57.6k
Parity:	None, Odd and Even
Stop bits:	1, 2
Connection time-out:	0 (off) – 120 sec.

The following combinations are not supported and may cause frame errors with some RTU devices.

ASCII, None, 1 stop bit	- Actually transmits two stop bits
RTU, Odd or Even, 2 stop bits.	- Actually only transmits one stop bit

The following steps are required to activate and program the User-configurable-protocol frame selection:

- a. Establish communication with SMARTCFG
 1. Connect to a PC com port though an RS-232-to-RS-422 adapter to the option board communications port.
 2. Apply power to the drive
 3. Using the keypad, access the Network Frame Assignment parameter (P.063) and set it to 0.
 4. Remove power to the drive allowing the keypad indicators to go completely out.
 5. Apply power to the drive and observe for the option card's MS LED to flash RED.
 6. Run SMARTCFG on the PC and configure the parameters.

Note that when the drive is power-cycled with the Network Frame Assignment parameter set to zero, the option board is not capable of RTU communications or drive control. Setting the Network Frame Assignment parameter to zero does not affect current communications until the drive is power-cycled.

b. Set parameters with SMARTCFG

1. Use arrow keys to select option (e.g. baud rate, stop bits, etc.)
2. Press the Enter key after selection is made
3. Press Space Bar key to change parameters of selection
4. After changing the parameters, Press the ESC key to return to main menu
5. Press ESC key once more to exit software utility

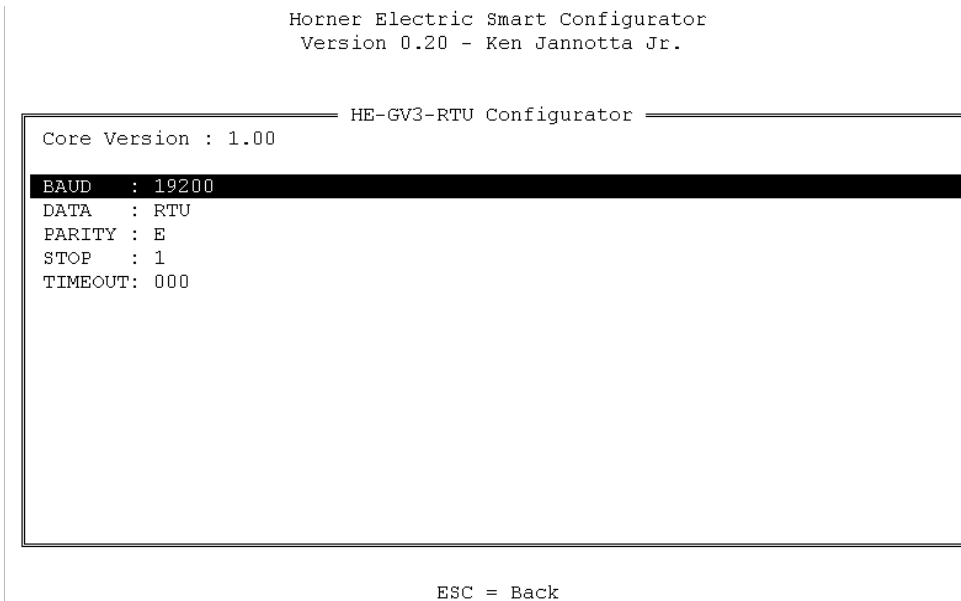


Figure 3.1 – Example Configuration Screen

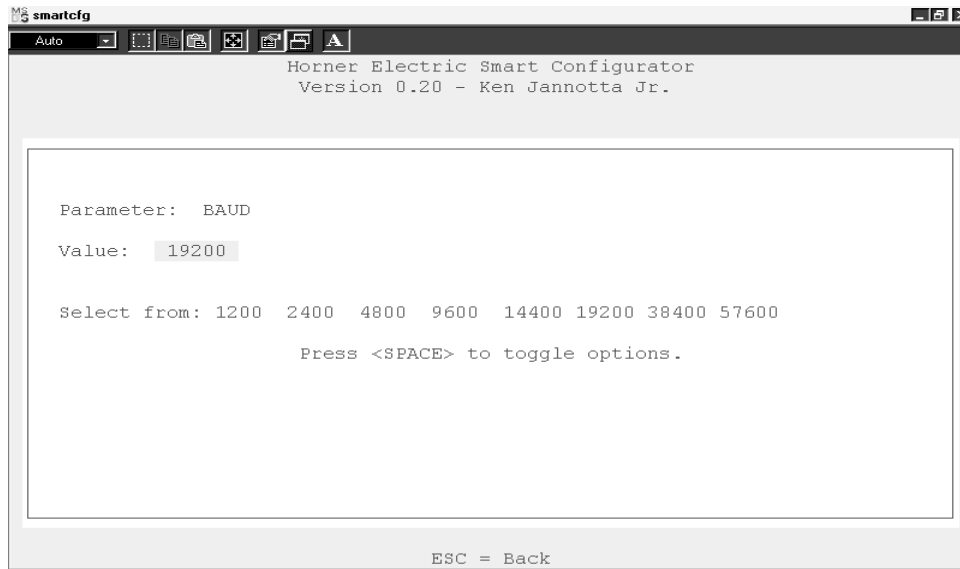


Figure 3.2 – Example Configuration Screen

c. Reset option card from Run-Configurator-only mode

1. Using the keypad, access the Network Frame Assignment parameter (P.063) and set it to 1 (User-Configurable-Protocol-Frame).
2. Once the MS LED begins to flash GREEN, the option board port is configured and ready to control the drive.

CHAPTER 4: OPERATION AND FUNCTIONALITY

4.1 Drive Data Registers Overview

4.1.1 General

The drive is monitored and controlled over the network by reading and writing through RTU/Modbus commands to the drive's data registers. The data registers are addressed over the network by a register number (Reg #) and contain 16 bit values. The data registers are divided into separate types according to function. Generally speaking, the **Tune/Config** registers hold an image of the P.xxx, H.xxx and U.xxx parameters accessible by the drive's keypad and the **Control/Reference** registers hold an image of the drive's physical inputs (start, stop, speed ref., etc). When the drive is configured for network control and other certain conditions are met, the drive registers accessed by the network option card are selected as an alternate source for controlling the drive as opposed to the keypad and/or physical input.

Network data written to the drive's data registers is buffered before it is transferred to the drive's internal regulator. In order to minimize regulator board CPU loading, the rate of transfer of register data to the drive regulator varies for different data register types. Additionally, some register data transfer are blocked until additional conditions are met. The sections that follow describe each data type for input and output register data along with the drive's response and conditions for acceptance of transfer. The presented response times do not include network transfer times.

The drive data registers which may be read or modified are listed in a table in Horner Electric's Supplement (SUP-0096). The table lists the register number, type, access and description for each register.

4.1.2 Input Data Update Response

The drive's input data is categorized as one of three types: control/reference, tunable or configurable. Control/reference inputs include data which require fast update rates. This includes data such as sequencing inputs (start, stop, run/jog, fwd/rev, etc.) and speed/torque reference. Control/reference inputs are transferred from the data registers to the regulator every speed loop scan period (for the GV3000, every 5 milliseconds), or as often as it is required by the drive. For example, if the drive is configured to obtain its torque reference from the option port, it reads this data from the option port every torque loop control scan.

Tunable inputs include parameters which modify the drive's response regardless of the drive's run state. Tunable data includes parameters such as accel/decel rates, min/max limits, gains or offsets, etc. Tunable inputs are transferred from the data register to the regulator whenever the regulator performs the processing of new tunable parameters. This occurs approximately every 100 milliseconds while the drive is running or stopped.

Configurable inputs include parameters, which alter the way that the drive operates in such a way that they cannot be modified while the drive is running. Configuration data includes parameters such as reference source selection, I/O configuration, motor/tach nameplate data, etc. Configurable inputs are transferred from the data registers to the regulator whenever the regulator performs processing of new configuration parameters. This occurs approximately every 100 milliseconds while the drive is stopped. Values sent from the network master while the drive is running are not read in and used by the drive regulator until the drive is stopped.

4.1.3 Output Data Update Response

The drive output data is categorized as one of two types: runtime signal data or tunable- configuration- and-status-data. Runtime signal data includes things such as selected speed reference value, sequencing status (ready, running, etc.), drive fault flags, terminal block digital inputs state, and front-panel display mode values (RPM, Volts, Amps). The information is transferred from the regulator to the data registers every speed loop scan period (for the GV3000, every 5 milliseconds).

Tunable configuration and status data includes all other information provided by the drive which is not defined as runtime signal data. This would typically include all drive parameter values. When accessed via the network, the data provides a complete image of how the drive is configured and operating. Tunable configuration and status data are transferred from the regulator to the data registers whenever the regulator performs the processing of new tunable and configurable input parameters. This occurs every 100 milliseconds.

4.1.4 Limitation on Data Registers Accessible (Basic/Extended)

The data registers are divided into a Basic and Extended set. The Basic set covers the first 64 data registers while the Extended set includes the Basic set plus all remaining data registers. Drive parameter "Network Connection Type" (**P.061**) selects the set and determines which data registers are updated or read by the regulator. While configured to the Basic set, the drive blocks transfer (reading and writing) to data registers above Register number 64.

Normally, networks are not used to access to data registers above register number 64. Therefore, this option is especially useful in limiting the number of Tune/Config parameters which are modified in the regulator when using the Tune/Config option described below. Since the network option board does not provide default values for those Tune/Config data registers over register number 64, each Tune/Config data register above that number must be initialized over the network when using the Extended set and the Tune/Config option.

Note: Use care not to inadvertently set Reg. 61 since this register (P.061) enables the Extended set.

4.1.5 Input Data Transfer Conditions

The network option board must be actively communicating with a master, and it must be selected as the drive's control source (P.000 = OP(2)) in order for **any inputs to be transferred** from the data registers to the drive regulator. Note that the keypad can still be used to change parameter values when the drive control source is the network option. However, any changes made via the keypad are overwritten with data register values when the next input data update occurs. This needs to be kept in mind if parameter changes need to be made while the network option is the control source for the drive.

In addition, a network-controlled "Tune/Cnfg input enable" bit (Drive Control Word: Reg 32, bit 14) is provided to enable the transfer of tunable and configurable register data to the drive regulator. **Until this bit is set ON (1), only Control/Reference data registers are read in by the drive regulator.** This gives the master's application program direct control over when tunable and configurable parameter values are read in by the drive, if at all.

For example, if a master loads Tune/Config parameters, it must first initialize the tunable and configurable parameter data through network messages to the appropriate data registers. Then, a network message setting the "Tune/Cnfg input enable" bit in the Drive Control Word enables the transfer of this data to the drive's data registers. Once the Tune/Config register data is transferred to the drive's regulator, the "Tune/Cnfg input enable" bit must be reset to prevent regulator overhead and un-expected changes in Tune/Config parameters. The "Tune/Config Update synchronization flag" described in Section 4.1.8 can be used to determine when the regulator has transferred the data. Those Tune/Config data registers not explicitly preloaded through network messages contain default values as described in the Appendix B. Note that the default value is not the same as the value previously loaded by the keypad.

Alternately, should the user prefer that inputs are set exclusively by the keypad and that the network only modifies the control/reference data to the drive, the master should not set the "Tune/Cnfg input enable" bit. The drive is, then, configured locally, but start, stop, reset and reference are sent from the network master.

Note: The user needs to exercise caution to prevent the unintentional setting of the Tune/Cnfg input enable bit (Reg 32, bit 14). This could cause the drive to transfer un-initialized tune/config data from the network option card to the drive, which could radically change the operation of the drive.

4.1.6 Output Data Transfer Conditions

All regulator output data is transferred to the data registers continuously. The network does not have to be active, and the network option does not have to be selected as the drive control source (P.000). No output enable control bit is necessary.

4.1.7 Data Transfer Summary

Table 4.1 summarizes the response times to the different drive data types described earlier in this Sections 4.1.2, 4.1.3, and 4.1.6.

Direction	Category	Conditions	Rate
Input (to drive)	Control / Reference	drive running or stopped	5ms
	Tunable	drive running or stopped	100ms
	Configurable	Drive stopped	100ms
Output (from drive)	Runtime	Always	5ms
	Tunable, Configuration & Status	Always	100ms

Figure 4.1 summarizes the conditions which effect transfer of input and output register data to the drive's regulator.

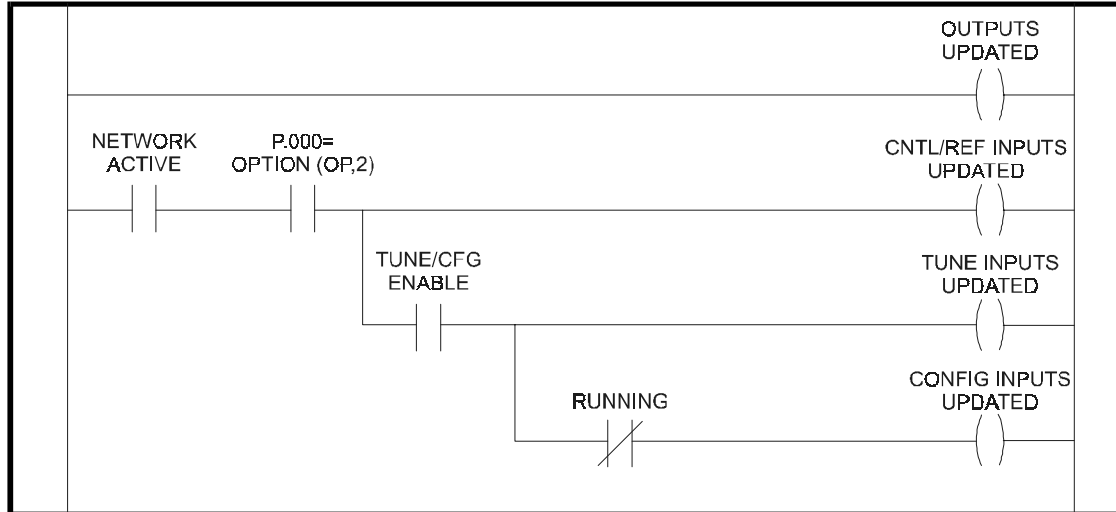


Figure 4.1 - Transfer Condition Logic Summary

4.1.8 Tune/Config Transfer Synchronization Flag

To allow the network master's application program to determine when tunable and configurable inputs have been updated in the drive, a sync write bit (Drive Control Word: Reg. 32, bit 15) is provided which is copied to a sync read bit (Status Word: Reg. 0, bit 7) by the drive. The drive copies the sync write bit to the sync read bit after the drive has read in and processed all tunable and/or configurable input registers. The "Tune/Cnfg input enable" bit must be set (1) in order for this to happen. Note that configurable type inputs are only read in by the drive while it is not running. This does not affect the copying of the sync bit since tunable inputs are still transferred.

By toggling the sync bit in the master and by monitoring the copied value from the drive, the master's application program determines when the drive has read in data. This feature is provided for those applications which may require this type of synchronization. It is not necessary for the master's application program to use it as it has no affect on drive operation.

To determine when changes to tunable and configurable data on the drive have been completed, the master performs the following sequence:

1. Modify the tunable and/or configurable register data in the appropriate network register(s).
2. Set the Tune/Cnfg input enable flag (if not already set).
3. Toggle the network synchronization flag.
4. Monitor the loopbacked copy (read register) of the network synchronization flag until it equals the value written in step 3.

4.1.9 Parameter Processing Error Flag

A "Parameter Processing Error Flag" (Fault Log Entries: Reg. 14, bit 8) is provided to allow the network master to determine whether any parameter values are unacceptable to the drive. If this flag is set (1), then one or more data register values transferred to the drive were rejected. If this flag is not set (0), then all data register values sent to the drive were accepted. Note that the "tune/config inputs enable" bit must be set (1) before the drive can read-in, and consequently process, any Tune/Config parameters. The parameter processing error flag is updated approximately every 100 milliseconds.

4.1.10 Data Retention Timing Requirements

All tunable and configurable drive input register values must be maintained by the network master's application program for at least 100 milliseconds to assure that they are seen by the drive. This is particularly relevant for data which is transition-detected by the drive.

Control/reference data types generally do not have this 100 millisecond requirement since they are scanned by the drive every 5 milliseconds. Special cases to this rule are the start input and the error log clear command. The start input requires a 0 to 1 transition in order to start the drive. The start input from the network may be delayed by the drive for up to 100 milliseconds. This is done to synchronize a drive start to the processing of new configurable data. In order for the network master to assure this 0 to 1 transition is detected by the drive, the network master must maintain **both** the 0 and 1 states for at least 100 milliseconds each. Values which are maintained for less time may not be detected by the drive.

The error log clear command bit is processed every 100 milliseconds even though it is defined as control/reference data. A 0 to 1 transition must be detected by the drive **after the network is active and the control source has been selected to be the network option** for the error log to be cleared. In order for the network master to assure this 0 to 1 transition is detected by the drive, it must maintain **both** the 0 and 1 states for a least 100 milliseconds each.

4.1.11 Inaccessible Drive Parameters (Keypad Only parameters)

There are a few GV3000 parameters which are not accessible through drive data registers, and therefore, are not accessible through the network. Table 4.2 is a list of parameters that are inaccessible. Because most of the inaccessible parameters are related to local drive control functions only, the inability to access the parameters do not limit network control.

Table 4.2 – Inaccessible Parameters	
Description	Parameter
Second menu enable password	P.006
Terminal block digital inputs config	P.007
Terminal block speed reference selection	P.008
Second accel rate	P.017
Second decel rate	P.018
MOP acc/dec rate	P.023
MOP reset configuration	P.024
Multispeed preset 1	P.031
Multispeed preset 2	P.032
Multispeed preset 3	P.033
Multispeed preset 4	P.034
Multispeed preset 5	P.035
Multispeed preset 6	P.036
Multispeed preset 7	P.037
Multispeed preset 8	P.038
Restore parameters defaults command	P.050
Program disable password	P.051
Network drop number	P.060
Vector torque loop self tune enable	U.008

4.1.12 Drive Ready Status Bit

The Drive Ready status bit (Drop_1, Reg 0 Bit 0) is used to indicate that a 0 to 1 transition on the start input starts the drive. The Drive Ready bit is ON (1) when all of the following conditions are met, and OFF (0) when one or more are not met:

- No drive faults are active (Drop_1 Reg 0 Bit 2 = 1)
- Stop input is ON (1) (Drop_1 Reg 32 Bit 1 = 1)
- Front-panel STOP/RESET button is not pressed
- Function loss TB input closed (Drop_1 Reg 0 Bit 12 = 1)
- A download from the serial port (using the CE3000) is not in progress

If in the JOG mode (Drop_1 Reg 0 Bit 3 = 1), then in addition, the vector torque loop self-tune enable parameter must be OFF (U.008 = OFF).

4.2 Network Access to Drive Registers

The drive registers accessible over the network are summarized in SUP0096 - Supplement for Reliance GV3000 Drive Registers, which is provided as part of this document. Based on the information provided in this supplement and section 4.1, the user must decide which of these drive registers to access over the network.

Note: that when the drive Network Connection Type (parameter P.061) is configured for Basic Drive Connection, ONLY the first 64 drive registers contain valid data.

Note: Always verify that ALL tune/config parameters in the current Drive-Connection- set have been initialized to a sane value before writing the Tune/Config-inputs- enabled bit in the first drive command register.

Configuring RTU/Modbus masters can vary in what information is required to access a selected drive register over the network. While it is outside of the scope of this manual to cover configuring a master device, some generalized guidelines are presented. In any case, the RTU/Modbus master documentation should be consulted for configuration details.

Generally, a drive register's offset is entered at the master as either a frame (low level) offset or a PLC (high level) offset. A frame offset directly corresponds to the drive register number presented in SUP0096. In addition, a frame offset configuration generally also requires a command number. The commands required to access drive register data is either Read or Preset Holding register based on whether it is a read or write operation respectively. The low level frame commands supported by the option board are listed in table 4.3 below.

Table 4.3- RTU/Modbus Function Codes			
Function	Code	Valid Offsets	Maximum Length
Read (Holding) Registers	3	0-182	183
Preset Single (Holding) Register	6	0-182*	1
Preset Multiple (Holding) Registers	16	0-182*	183
Read Exception Status	7		
Loopback Maintenance	8	(sub commands: 0,1,4,10-15)	
*Every other 32 word region starting at offset 0 is read only and generates an error if addressed by this command.			

A high level configuration generally only requires a "PLC" register address (offset) to access a drive's data register. The master automatically determines the frame offset and commands to use based on both the PLC address and whether the operation is read or write. The PLC address is based on the Modbus register addressing scheme in which addresses in the 4001-4999 (40001-49999) range correspond to the PLC's analog holding registers. Since the drive's registers appear to the RTU/Modbus network as PLC holding registers, the "PLC" address of a drive's register would be the drive register number 'plus' either 4001 or 40001 (depending on the PLC addressing range supported by the master)

4.3 Network Diagnostics

The option board provides both RTU/Modbus error responses and diagnostic LEDs to aid in troubleshooting. Table 4.4 gives the possible errors (error codes) which the master may return for a point. Table 4.5 shows the status of the option board (MS) and the incoming messages (NS).

Table 4.4 – RTU/Modbus Response Errors		
Error	Code	Reason
Invalid Function Code	1	Requested RTU function code not supported
Illegal Data Address	2	Attempt to access parameter beyond valid offset (or) Attempt to write READ-ONLY parameter.
Illegal Data Value	3	Attempt to read or write more than 125 parameters.

Table 4.5 – Option Board LEDs	
MS Led	Description
Red (Solid)	Factory Diagnostics mode (Contact Technical Support)
Red (Flash)	User-configurable-protocol-frame program mode
Green (Solid)	Network active
Green (Flash)	Network not active (connection time-out timer expired)
NS Led	Description
Red (Flash)	Data activity but invalid frame protocol or RTU/checksum error
Yellow (Flash)	Valid RTU frame with non-match address (normal if other RTU devices communicating)
Green (Flash)	Valid RTU frame addressed to this device.

APPENDIX A: ACCESS TO DRIVE DATA REGISTERS

A1.1. Drive Status

The remote run-time status of the drive is typically returned in Drive Registers 0 through 11. These values reflect the drives actual status regardless of the Control Source or the Auto/Remote mode. Refer to Horner Electric's Supplement (SUP-0096), Table1 (description column) to determine the Drive Register functions. Registers 0, 1 and 5 are covered in more detail in this appendix.

a. Register 0: Status Word

The first half of the word provides a bit-mapped run-time status of the drive similar to that which is displayed by the keypad. The second half of the word provides an indication of the physical inputs to the Control Terminal.

The "drive ready" status bit (Status Word: Reg. 0, bit 0) is used to indicate that a 0 to 1 transition on the start input starts the drive. The drive ready status bit is ON (1) when all of the following conditions are met and OFF (0) when one or more conditions are not met:.

- No drive faults are active (Fault Active: Register 0, bit 2)
- Stop input is ON (1) (!Stop: Register 32, bit 1)
- Front-panel STOP/RESET button is not pressed
- Function loss TB input closed (monitored w/Function Loss: Register 0, bit 12)

b. Register 1: Selected Speed Reference

This register returns the currently selected speed reference. This value is scaled from 0 - 4095 where 4095 is the maximum allowable value. (i.e. The maximum 4095 value may correspond to 10 Volts at the Control Terminal: Analog Speed Reference Input or the maximum value placed in Register 33).

c. Register 5: RPM Display

This value returns the current output frequency (scaled) of the motor. The value returned is scaled according to those formulas presented in the GV3000/SE AC General Purpose (Volts/Hz) and Vector Duty Drive Software Startup and Reference Manual under Speed Display Scaling (P.028).

A1.2 Drive Control

A1.2.1 General

Network run-time drive control consists primarily of manipulating Drive Registers 32, 33, and sometimes, 34. Once in OPTion mode, these parameters is used to control the drive alternately to those values input through the Control Terminal and/or Keypad when the drive is in LOCaL or rEmote mode.

A1.2.2 Register 32: Drive Control Word

The bits in this register are used by the drive alternately to the Discrete voltage inputs to the Control Terminal. Generally, asserting a bit in the Drive Control Word while under OPtion mode performs the same function as asserting a control voltage on the Control Terminal while under reMote mode. Exception and special conditions are listed as follows:

1. Before the drive can be started with the Start bit, the conditions which activate the Drive Ready bit into the Status Word (Register 0) must be active.
2. Start bit must make a high to low transition to start the drive. Once Drive Status indicates the drive started, the Start bit can be reset. The drive is then stopped by releasing the Stop bit .
3. Tune/Cnfg input enable bit causes the drive to accept option card default (or updated) Tune/Config parameters. Setting this bit can severely alter drive operation (See Chapter 4).

A1.2.3 Register 33: Network Speed/torque Reference

This register is used to control the drive's speed reference when the drive is in Option mode, and the Remote/Local control is in Remote mode. This value is scaled such that the 0 is equal to stop, and the value 4095 is equal to full speed.

APPENDIX B: DEFAULT TUNE/CONFIGURATION REGISTERS

The Tune/Config data registers not explicitly preloaded through Explicit network messages contain default values as described in Table B1.

Table B1- Default Tuning/Configuration Register Preload Values	
Register	Default Load Value
32	Stop
33	0
34	0
35	0
36	0
37	20.0
38	20.0
39	5.0
40	60.0
41	100
42	0
43	1.000
44	0
45	0
46	0
47	0
48	0
49	5.0
50	0
51	0
52	1800
53	0
54	0
55	0
56	0
57	0
58	0
59	0
60	0
61	0
62	0
63	P.063