YASKAWA

GPD 315/V7 Modbus RTU Technical Manual

Technical References

Refer to the following publications for further information about the GPD315/V7:

- GPD315/V7 Technical Manual
- Publication TM4315

Refer to the following Modicon publication for technical information on Modbus RTU:

- Modicon Modbus Protocol Reference Guide
- Publication PI-MBUS-300 Rev. D

Technical Support Center:

Provide telephone assistance related to installation, start-up, programming, and troubleshooting
For technical phone support call 1-800-541-0939.

Contents

Tables

Figures

Chapter 1
GPD315/V7 and Serial Communication

Introduction

This manual describes the set-up and protocol for Modbus Communication. The GPD315/V7 offers RS-485 and RS-422 serial communication as a standard.

The Modbus RTU protocol requires that the controller communicates using a master-slave technique, in which only one device (the master) can initiate transactions. The other devices (slaves) respond by supplying the requested data to the master, or by taking the action requested. The drive must act in the slave mode.

A complete understanding of the drive programming and operation is required before attempting serial communication operation. A full discussion of programming and operation is covered in the GPD315/V7 technical manual, TM4315.

GPD315 Modbus RTU Specifications

The data that may be sent or received from the drive consists of:
Run Command
Frequency Reference
Fault Contents
Drive Status
Drive Parameter Settings

The following table illustrates whether the serial communication specifications are fixed or user selectable. If the specification is fixed, the fixed value is shown in the last column. If the specification is selectable, the range of allowed values is shown in the last column.

Table 1-1 Serial Setup

Parameter	Description	Type	Range
n154	Baud Rate	Selectable	2400, 4800, 9600, or 19200 bps
N/A	Data Bit	Fixed	8
n155	Parity	Selectable	none, even, or odd
N/A	Stop Bit	Fixed	1
n153	Node/Slave Address	Selectable	maximum of 31 nodes

Chapter 2
GPD315 Modbus RTU Connections

Wiring

Locate terminals S+, S-, R+, and R- on the control terminal block.

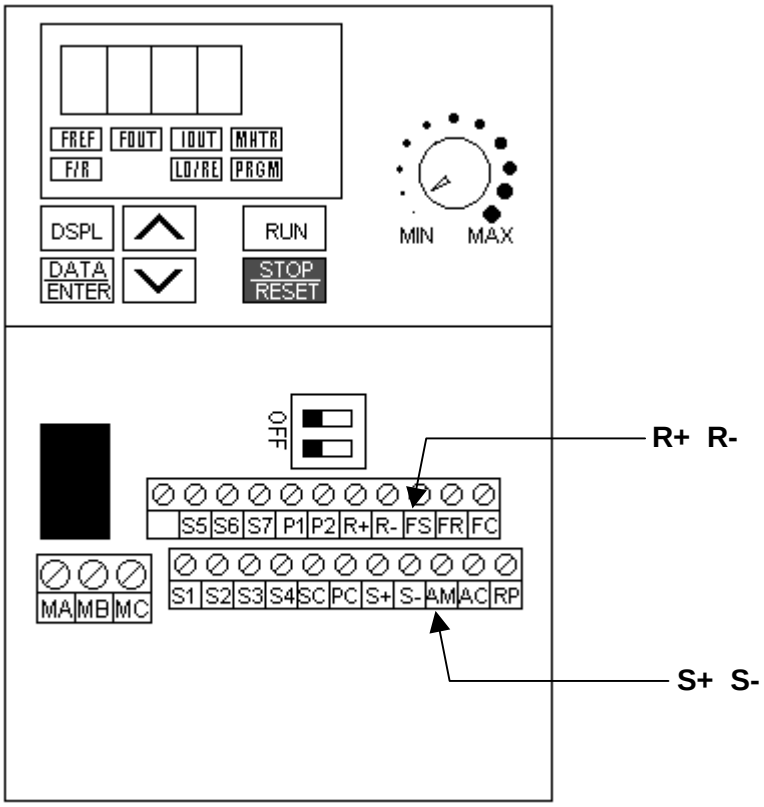

Figure 2-1 Location of Terminals and Dip switches

Twisted pair, shielded wire should be used for all RS-485 connections. The shielded wire should be separated and connected per the drawing below to eliminate interference due to noise.

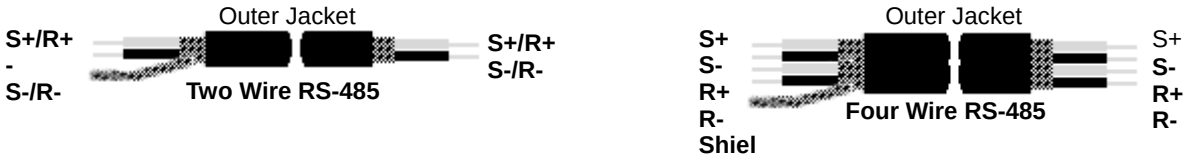

Figure 2-2 Shielded Wire Termination

The function of terminals R+, R-, S+, and S- are described below.

Table 2-1. Functions of Terminals

Terminal Symbol	Functions	Remarks
S+	RS-485 output (+)	Use as output at
S-	RS-485 output (-)	parallel connection
R+	RS-485 input (+)	Us as input at
R-	RS-485 input (-)	parallel connection

It is important to select an appropriate wire size to prevent voltage drop. The table below indicates the suggested wire sizes.

Table 2-2. Applicable Wire Size for Terminal Connections

	[mm^2]	AWG	I [A]	VAC [V]
Twisted wire	1.0	16	12	125
Single wire	1.5	16	12	125
UL	-	22-16	10	300
CSA	-	28-16	10	300
CSA	-	28-16	10	150

When stripping the wire, approximately 5.5 mm should be exposed in order to make a good connection.

Note: Avoid sources of electric interference capable of inducing noise into the cable. Communication and signal wiring should be kept separate from power wiring. Four inches should separate the communications/signal wiring from any low voltage AC or high frequency source. Ten inches should separate the communications/signal wiring from any high voltage cables. If communication or signal wiring must cross power wiring, it must cross at a right angle.

Connecting Multiple Drives

Multiple drives may be connected together. A terminating resistor must be enabled at the start and end of the network. Set SW2 switch 1 to “on” to enable the terminating resistor. SW2 is found just above the upper row of control terminals and consists of two switches. The switch towards the top (labeled “1”) controls the terminating resistor. The following diagram illustrates the connection between multiple drives for RS-485 (half duplex) and RS-422 (full duplex).

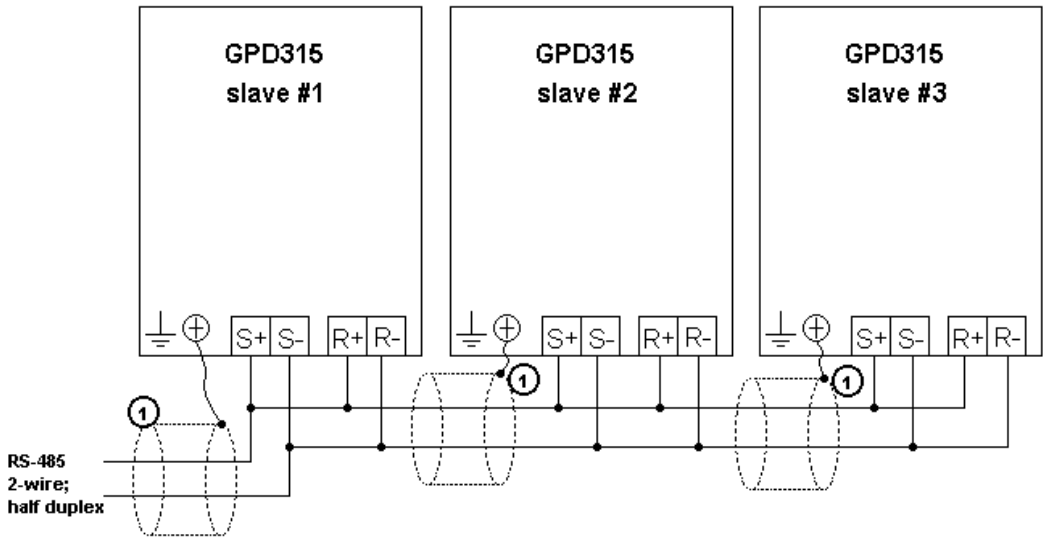

Figure 2.3 Interconnection of Drives using RS-485

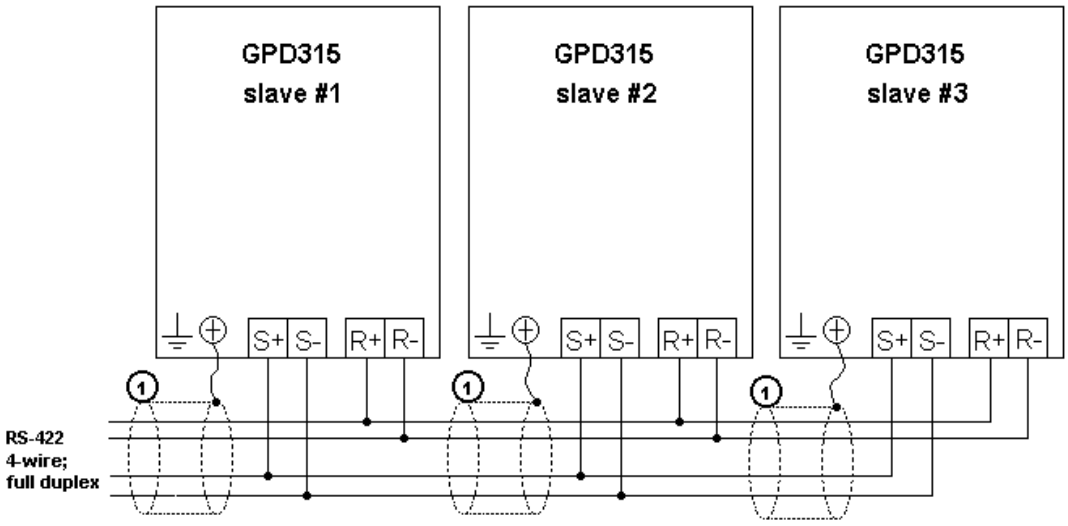

Figure 2.4 Interconnection of Drives using RS-422

Note: The shielded wire should be connected to the drive’s ground terminal.

Chapter 3
GPD315 Communication Parameters

Run/Stop and Frequency Selection

The run/stop and frequency reference commands can originate from serial communication, the digital operator, or the external terminals. The origin of the run/stop command does not have to be the same as the origin of the frequency reference command. Parameter n003 (Operation Method Selection) allows you to set up the origin of the run/stop commands. Parameter n004 (Reference Selection) allows you to set up the origin of the frequency reference command. The charts below illustrate the possible run/stop and frequency reference selections.

Table 3-1. Run/Stop Selection

Parameter n003 Setting	Operation Method Selection
0	Digital Operator
1	External Terminals
2	Serial Communication

The default value of parameter n003 is ‘1’.

Table 3-2. Frequency Reference Selection

Parameter n004 Setting	Frequency Reference Selection
0	Digital Operator Pot
1	Digital Operator
2	Voltage Reference (0-10V)
3	Current Reference (4-20mA)
4	Current Reference (0-20mA)
5	Pulse Train Reference
6	Serial Communication
7	Multi-Function Analog Input (0-10V)
8	Multi-Function Analog Input (4-20mA)
9	Option Board

The default value of parameter n004 is’2’.

Serial Communication Set up Parameters

The GPD315 has parameters used for setting up serial communications. These communication set up parameters are n151 through n155.

Parameter n151 - Modbus Time Out Detection

Parameter n151 is used to determine how the drive will respond to a time out error. A time out is detected if the length of time between Modbus messages exceeds two seconds. The drive will either fault, alarm, or not respond to a time out detection, depending upon how parameter n151 is set.

Table 3-3 below indicates how the drive will respond to a “time out” detection.

Table 3-3. Modbus Time out Detection

Parameter n151 Setting	Description
0	Coast to Stop (fault)
1	Ramp to Stop using n020 (fault)
2	Ramp to Stop using n022 (fault)
3	Continue Operation
4	Disabled

The default setting of parameter n151 is ‘0’.

Parameter n152 - Modbus Frequency Reference Unit

Parameter n152 selects the frequency resolution of the frequency reference and the output frequency monitor.
The output frequency resolution of the GPD315’s digital operator is settable via n035, *Frequency Reference Unit Selection*. If the digital operator resolution is set to 0.1 Hz (n035=0), and the Modbus resolution is changed to 0.01 Hz in n152, the value in the hundredths digit of 0.01 Hz of the received frequency reference is rounded off when displayed on the digital operator.

Table 3-4. Modbus Frequency Reference Unit Selection

Parameter n152 Setting	Frequency Reference Unit Selection
0	0.1 Hz
1	0.01 Hz
2	100% / 30,000
3	0.1%

The default setting of parameter n152 is ‘0’.

Parameter n153 - Modbus Slave Address

Parameter n153 selects the drive’s node or slave address. Each device on the same network must be given a unique address. The setting range of parameter n153 is 0 to 31.

The default setting of parameter n153 is ‘0’.

Parameter n154 - Modbus Baud Rate

Parameter n154 selects the baud rate, as indicated by the following table:

Table 3.5 Modbus Baud Rate Selection

Parameter n154 Setting	Baud Rate(bps)
0	2400
1	4800
2	9600
3	19200

The default setting of parameter n154 is ‘2’.

Parameter n155 - Modbus Parity Selection

Parameter n155 selects the parity, as indicated by the following table:

Table 3.6 Modbus Parity Selection

Parameter n155 Setting	Parity Selection
0	Even
1	Odd
2	None

The default setting for parameter n155 is ‘2’.

Note: It is necessary to recycle drive power for parameters n153 through n155 to take effect.

“ENTER” Command

The GPD315 has two types of memory: ‘Volatile’ and ‘Non-volatile’. Data held in the Volatile memory will be lost when power is removed from the drive. Data held in the Non-volatile memory will be retained when power is removed from the drive. It is necessary to follow each block of parameters with the ENTER command in order to transfer data form Volatile to Non-volatile memory. To send an ENTER command, send a value of 0 to address 900h. See warning below.

Command Data:

The command registers (000H to 009H) are stored in Volatile memory. When writing to a command register the new data becomes active immediately. In the case of a power loss all data stored in these registers will be lost.

Monitor Data:

The monitor registers (020H to 03DH) are stored in Volatile memory. These registers are read only. Any data read from the monitor registers will not be retained during a power loss.

Parameter Data:

The parameter registers (101H to 1D2H) are stored in Non-volatile memory. When writing new data to parameter registers, an ENTER command must be sent for the new data to saved to non-volatile memory. To send an ENTER command, send a value of 0 to address 900h. See warning below.
Some parameter registers may only be written to when the drive is stopped. These are called the non-run operative parameters.

WARNING

Use the ENTER (0900H) command only when necessary! The life of the EEPROM (Non-volatile memory) on the GPD315 will only support a finite number of operations. This means that the ENTER command can only be used a limited number of times. After the specified number of operations, the EEPROM may fault (ERR) requiring replacement of the GPD315 control board.

Chapter 4
Modbus RTU Message Format

Message Functions

In communicating to the GPD315 drive via Modbus RTU, there are three message functions available. The master specifies the function to be executed by the slave according to the function code. The following table shows the types of function codes available, and the length (quantity) and contents of the message according to the function.

Table 4-1 Supported Modbus RTU Function Codes

Function Code (hex)	Function	Command Message		Response Message (Normal)	
		min. (bytes)	max. (bytes)	min. (bytes)	max. (bytes)
3	Read Multiple Registers	8	8	7	21
8	Loop-back test	8	8	8	8
10	Write Multiple Registers	11	25	8	8

The message format varies depending upon the function of the message. For each function, there is a command message from the master and a response message initiated from the slave. The following sections review the format of the command message and the response message for each function.

Read Multiple Registers – Function 03h

The multiple register read function (03h) allows the master to request information from the slave. The command message of a multiple register read is structured as shown below.

Table 4-2 Read Command Message

Slave Address		02h
Function Code		03h
Starting Register	Upper	00h
	Lower	20h
Quantity	Upper	00h
	Lower	04h
CRC-16	Lower	45h
	Upper	F0h

Each GPD315's slave address is set in advance by the drive parameter n153. Valid slave addresses must be in the range of 1 to 31 decimal (1 to 1F hex). No two slaves may have the same address. The master addresses the slave by placing the slave address in the address field of the message. In the command message above, the slave is addressed at 2.

The function code of this message is 03h (read multiple registers).

The starting number is the first register to be read. In the command message above the starting register is 20h, indicating that the first register is the Status Signal. A listing of the GPD315's registers is shown in Chapter 5, Registers.

The quantity indicates how many consecutive registers are to be read. The quantity may range from 1 to 8 registers. If the quantity is greater than 8, an error code of '3' is returned in the fault response message. In this example there are four consecutive registers to be read: 20h, 21h, 22h and 23h.
A CRC-16 value is generated from a calculation using the values of the address, function code, and data sections of the message. The procedure for calculating a CRC-16 is described at the end of this chapter. When the slave receives the command message it calculates a CRC-16 value and compares it to the one in CRC-16 field of the command message. If these two CRC-16 values are the same the slave has received the proper command message. If the two CRC-16 values are not the same the slave will not respond.

If the command message has a valid slave address, function code, starting register, and quantity value, the slave will respond with a normal response message. If the command message has an invalid slave address, function code, starting register, and/or quantity the slave will respond with a fault response message.

Normal Response Message

Table 4-3 Read Normal Response Message

Slave Address		02h
Function Code		03h
Number of Data Bytes		08h
Starting Register	Upper	17h
	Lower	70h
Next Register	Upper	17h
	Lower	70h
Next Register	Upper	01h
	Lower	09h
Last Register	Upper	00h
	Lower	00h
CRC-16	Lower	38h
	Upper	ACh

The normal response message contains the same slave address and function code as the command message, indicating to the master which slave is responding and to what type of function it is responding.

The number of data bytes is the number of data bytes returned in the response message. The number of data bytes is actually the quantity (in the command message) times 2, since there are two bytes of data in each register.

The data section of the response message contains 8 upper and 8 lower bits of data for each register that has been read from the drive.

A CRC-16 value is generated from a calculation using the values of the address, function code, number of data bytes, and register data sections of the message. The procedure for calculating a CRC-16 value is described at the end of this chapter. When the master receives the response message it calculates a CRC-16 value and compares it to the one in the CRC-16 field of the response message. If these two CRC-16 values are the same the master has received the proper response message.

Fault Response

Table 4-4 Read Fault Response Message

Slave Address		02h
Function Code		83h
Error Code		02h
CRC-16	Lower	30h
	Upper	F1h

The fault response message contains the same slave address as the command message, indicating to the master which slave is responding.

The function code of a fault response message is actually a value of 80h plus the original function code of 03h. This indicates to the master that the message is a fault response message, instead of a normal response message.

The error code indicates where the error occurred in the command message. The value of 2h in the error code field of this fault response message, indicates that the command message requested data be read from an invalid register. A complete listing of the error codes is shown in Chapter 6, Troubleshooting and Error Codes.

A CRC-16 value is generated from a calculation using the values of the address, function code, and error code sections of the message. The procedure for calculating a CRC-16 value is described at the end of this chapter. When the master receives the fault response message it calculates a CRC-16 value and compares it to the one in the CRC-16 field of the fault response message. If these two CRC-16 values are the same the master has received the proper fault response message.

Loop-back Test - 08h

The loop-back test function (08h) is used for checking signal transmission between master and slaves. The command message format is shown below.

Table 4-5 Loop Back Command Message

Slave Address		01h
Function Code		08h
Test Code	Upper	00h
	Lower	00h
Data	Upper	A5h
	Lower	37h
	Upper	ACh
CRC-16	Lower	Dah
	Upper	8Dh

Each GPD315's slave address is set in advance by the drive parameter n106. Valid slave addresses must be in the range of 1 to 31 decimal (1 to 1F hex). No two slaves may have the same address. The master addresses the slave by placing the slave address in the address field of the message. In the command message above, the slave is addressed at 1.

The function code of this message is 08h (loop-back test).

The test code must be set to ‘0000’. This function specifies that the data passed in the command message is to be returned (looped back) in the response message.

The data section contains arbitrary data values. These data values are used to verify that the slave receives the correct data.

A CRC-16 value is generated from a calculation using the values of the address, function code, test code, and data sections of the message. The procedure for calculating a CRC-16 is described at the end of this chapter. When the slave receives the command message it calculates a CRC-16 value and compares it to the one in CRC-16 field of the command message. If these two CRC-16 values are the same the slave has received the proper command message. If these two CRC-16 values are not the same the slave does not respond.

If the command message has a valid slave address, function code, test code, and data value, the slave will respond with a normal response message. If the command message has an invalid slave address, function code, test code, and/or data value the slave will respond with a fault response message.

Loop Back Normal Response

Table 4-6 Loop Back Normal Response Message

Slave Address		01h
Function Code		08h
Test Code	Upper	00h
	Lower	00h
Data	Upper	A5h
	Lower	37h
	Upper	ACh
CRC-16	Lower	Dah
	Upper	8Dh

Loop Back Fault Response

Table 4-7 Loop Back Fault Response Message

Slave Address		01h
Function Code		88h
Error Code		01h
CRC-16	Lower	87h
	Upper	C0h

The fault response message contains the same slave address as the command message, indicating to the master which slave is responding.

The function code of a fault response message is actually a value of 80h plus the original function code of 08h. This indicates to the master that the message is a fault response message, instead of a normal response message.

The error code indicates where the error occurred in the command message. A complete listing of the error codes is shown in Chapter 6, Troubleshooting and Error Codes.

A CRC-16 value is generated from a calculation using the values of the address, function code, and data sections of the message. The procedure for calculating a CRC-16 value is described at the end of this chapter. When the master receives the fault response message it calculates a CRC-16 value and compares it to the one in the CRC-16 field of the fault response message. If these two CRC-16 values are the same the master has received the proper fault response message.

Write Multiple Registers - 10h

The multiple register write function (10h) allows the master to write data to the drive's registers. The multiple register write message format is shown below.

Table 4-8 Write Command Message

Slave Address		01h
Function Code		10h
Starting Register	Upper	00h
	Lower	01h
Quantity	Upper	00h
	Lower	02h
Number of Data Bytes		04h
First Register Data	Upper	00h
	Lower	01h
Next Register Data	Upper	02h
	Lower	58h
CRC-16	Lower	63h
	Upper	39h

Each GPD315's slave address is set in advance by the drive parameter n153. Valid slave addresses must be in the range of 1 to 31 decimal (1 to 1F hex). No two slaves may have the same address. The master addresses the slave by placing the slave address in the address field of the message. In the command message above, the slave is addressed at 1.

By setting the slave address to zero (0) in the address section of the message, the master can send operation signals (register 1h) and frequency reference (register 2h) to all slaves on the network. The master can send a single transmission to all the slaves simultaneously. This is called simultaneous broadcasting. In a simultaneous broadcast message all of the slaves on the network act upon one message. Simultaneous Broadcast registers are shown in Chapter 5, Registers.

The function code of this message is 10h (write multiple registers).

The starting register number is the first register to be written to. In the command message above the starting number is 01h, indicating that the first register is the frequency reference. A listing of the GPD315's registers is shown in Chapter 5, Registers.

The quantity indicates how many consecutive registers are to be written to. The quantity may range from 1 to 8 registers. If the quantity is greater than 8, an error code of '3' is returned in the fault response message. In this command message there is two consecutive registers to be written to: 01h-Operation Command and 02h- Frequency Reference.

The number of data bytes is the number of bytes of data to be written to the drive. The number of data bytes is actually the quantity times 2, since there are two bytes of data in each register.

The data section of the response message contains 8 upper and 8 lower bits of data for each register that is being written to.

A CRC-16 value is generated from a calculation using the values of the address, function code, starting register number, quantity, number of data bytes, and data sections of the message. The procedure for calculating a CRC-16 is described at the end of this chapter. When the slave receives the command message it calculates a CRC-16 value and compares it to the one in CRC-16 field of the command message. If these two CRC-16 values are the same the slave has received the proper command message. If these two CRC-16 values are not the same the slave does not respond.

If the command message has a valid slave address, function code, starting register number, quantity, number of data bytes, and data values, the slave will respond with a normal response message. If the command message has an invalid slave address, function code, starting register number, quantity, number of data bytes, and/or data values the slave will respond with a fault response message.

Write Registers Normal Response

Table 4-9 Write Registers Normal Response Message

Slave Address		01h
Function Code		10h
Starting Register	Upper	00h
	Lower	01h
Quantity	Upper	00h
	Lower	02h
CRC-16	Lower	10h
	Upper	08h

The normal response message contains the same slave address and function code as the command message, indicating to the master which slave is responding and to what type of function it is responding.

The starting number is the first register that was written to. In the response message above the starting number is 01h, indicating that the first register is the operation command.

The quantity indicates how many consecutive registers were written to.

A CRC-16 value is generated from a calculation using the values of the address, function code, starting register number, and quantity value of the message. The procedure for calculating a CRC-16 value is described at the end of this chapter. When the master receives the response message it calculates a CRC-16 value and compares it to the one in the CRC-16 field of the response message. If these two CRC-16 values are the same the master has received the proper response message.

Write Registers Fault Response

Table 4-10 Write Registers Fault Response Message

Slave Address		01h
Function Code		90h
Error Code		02h
CRC-16	Lower	CDh
	Upper	C1h

The fault response message contains the same slave address as the command message, indicating to the master which slave is responding.

The function code of a fault response message is actually a value of 80h plus the original function code of 10h. This indicates to the master that the message is a fault response message, instead of a normal response message.

The error code indicates where the error occurred in the command message. The value of 2h in the error code field of this fault response message, indicates that the command message requested data to be written to an invalid register. A complete listing of the error codes is shown in Chapter 6, Troubleshooting and Error Codes.

A CRC-16 value is generated from a calculation using the values of the address, function code, and error code sections of the message. The procedure for calculating a CRC-16 value is described at the end of this chapter. When the master receives the fault response message it calculates a CRC-16 value and compares it to the one in the CRC-16 field of the response message. If these two CRC-16 values are the same the master has received the proper response message.

No Response Message

The slave disregards the command message and does not return the respond message in the following cases:

1. In simultaneous broadcasting of data (slave address field is 0), all slaves execute but do not respond.
2. When a communication error (overrun, framing, parity, or CRC-16) is detected in the command message.
3. When the slave address in the command message does not coincide with the address set in the slave.
4. When the time interval of data composing the message exceeds the GPD315's set 2 second time-out detection period.
5. When the command message data length is not proper.

CRC-16

At the end of the message, the data for CRC error checking is sent in order to detect errors in signal transmission. In Modbus RTU, the error check is conducted in the form of a CRC-16 (Cyclical Redundancy Check). The CRC field checks the contents of the entire message. It is applied regardless of any parity check method used for the individual characters of the message.

The CRC field is two bytes, containing 16-bit binary value. The CRC value is calculated by the transmitting device, which appends the CRC to the message. The receiving device recalculates a CRC during receipt of the message, and compares the calculated value to the actual value it received in the CRC field. If the two values are not equal, an error results.

The CRC is started by first preloading a 16-bit register to all 1's. Then a process begins of applying successive 8-bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits, and the parity bit (if one is used) do not apply to the CRC.

During generation of the CRC, each 8-bit character is exclusive OR 'ed with the register contents. Then the result is shifted in the direction of the least significant bit (LSB), with a zero filled into the most significant bit (MSB) position. The LSB is extracted and examined. If the LSB is a 1, the register is then exclusive OR 'ed with a preset, fixed value (A001h). If the LSB is a 0, no exclusive OR takes place.
This process is repeated until eight shifts have been performed. After the last (eighth) shift, the next 8-bit byte is exclusive OR 'ed with the register's current value, and the process repeats for eight more shifts as described above. The final contents of the register, after all the bytes of the message have been applied, is the CRC value.

For applications using a host computer, a detailed example of a CRC generation using Quick Basic is shown on the following page.

CRC-16 Calculation Example:

```
crcsum# = &HFFFF&
crcshift# = &H0&
crcconst# = &HA001&

CLS
PRINT "**************************************************"
PRINT
PRINT "              CRC-16 calculator"
PRINT
PRINT "**************************************************"
PRINT "If entering data in hex, preceed the data with '&H'"
PRINT "       Example:  32decimal = 20hex = &H20"
PRINT "**************************************************"
PRINT

INPUT "Enter the number of bytes in the message: ", maxbyte
FOR bytenum = 1 TO maxbyte STEP 1
        PRINT "Enter byte "; bytenum; ":":
        INPUT byte&
        byte& = byte& AND &HFF&
        crcsum# = (crcsum# XOR byte&) AND &HFFFF&
        FOR shift = 1 TO 8 STEP 1
                crcshift# = (INT(crcsum# / 2)) AND &H7FFF&
                IF crcsum# AND &H1& THEN
                        crcsum# = crcshift# XOR crcconst#
                ELSE
                        crcsum# = crcshift#
                END IF
        NEXT shift
NEXT bytenum

lower& = crcsum# AND &HFF&
upper& = (INT(crcsum# / 256)) AND &HFF&

PRINT "Lower byte (1st) = ", HEX$(lower&)
PRINT "Upper byte (2nd) = ", HEX$(upper&)
```

Figure 4-1 CRC Calculation in Quick Basic

```
// *buf          pointer to character array that contains the characters to used calculate CRC
// bufLen        number of characters to calculate CRC for
// *crc          pointer to the array that contains the calculated CRC

void    getMBCRC(char *buf, int bufLen, char *crc) {
        unsigned long crc_0 = 0xffff;                   // Declare and initialize variables
unsigned long crc_1 = 0x0000;
int i,j;

        for (i=0; i<bufLen; i++) {                      // Loop through characters of input
array
            crc_0 ^= ((unsigned long)buf[i] & 0x00ff);  // XOR current character with 0x00ff
            for (j=0;j<8;j++) {                         // Loop through characters bits
                crc_1 = (crc_0 >> 1) & 0x7fff;          // shift result right one place and
store
                if (crc_0 & 0x0001)                     // if pre-shifted value bit 0 is set
                    crc_0 = (crc_1 ^ 0xa001);           // XOR the shifted value with 0xa001
                else                                    // if pre-shifted value bit 0 is not set
                    crc_0 = crc_1;                      // set the pre-shifted value equal to
                                                        the shifted value

                }
            }
        crc[0] = (unsigned char)((crc_0/256) & 0x00ff); //      Hi byte
        crc[1] = (unsigned char)(crc_0 & 0x00ff);       //      Lo byte
return;
        }
```

Figure 4-2 CRC Calculation in C

Chapter 5
Parameter Tables

Simultaneous Broadcast Registers (Write Only)

Table 5-1 Simultaneous Broadcast Registers

Register	Name	Bit	Description		
0001h	Operation Signals	0	Run Command	1: Run	0: Stop
		1	Direction Command	1: Reverse	0: Forward
		2	Not Used [1]		
		3	Not Used [1]		
		4	External Fault	1: Fault (EF0)	
		5	Fault Reset	1: Fault Reset	
		6	Not Used [1]		
		7	Not Used [1]		
		8 - F	Not Used [1]		
002h	Frequency Reference [2]				

Command Registers (Read/Write)

Table 5-2 Command Registers

Register	Name	Bit	Description		
0000h	Reserved				
0001h	Operation Signals	0	Run Command	1: Run	0: Stop
		1	Direction Command	1: Reverse	0: Forward
		2	External Fault	1: Fault (EF0)	
		3	Fault Reset	1: Fault Reset	
		4	Multi-function Input Reference 1	(Function selection by n050)	
		5	Multi-function Input Reference 2	(Function selection by n051)	
		6	Multi-function Input Reference 3	(Function selection by n052)	
		7	Multi-function Input Reference 4	(Function selection by n053)	
		8	Multi-function Input Reference 5	(Function selection by n054)	
		9	Multi-function Input Reference 6	(Function selection by n055)	
		A	Multi-function Input Reference 7	(Function selection by n056)	
		B - F	Not Used [1]		
0002h	Frequency Reference [2]				
0003h	V/f Gain		(1000/100%)	2.0% - 200.0%	
0004h – 0008h	Reserved [3]				
0009h		0	Multi-function Output 1	(Enabled when n057 = 18)	1: Contact ON
		1	Multi-function Output 2	(Enabled when n058 = 18)	1: Photo coupler 1 ON
		2	Multi-function Output 3	(Enabled when n059 = 18)	1: Photo coupler 2 ON
		3 - F	Not Used [1]		
000A – 001Fh	Reserved [3]				

Monitor Registers (Read Only)

Table 5-3 Monitor Registers

Register	Name	Bit	Description		
0020h	Status Signals	0	During Run	1: Run	0: Stop
		1	Direction	1: Reverse	0: Forward
		2	Inverter Ready	1: Ready	
		3	Fault	1: Fault	
		4	Data Set Error	1: Error	
		5	Multi-function output 1	1: Contact ON	
		6	Multi-function output 2	1: Photo coupler ON	
		7	Multi-function output 3	1: Photo coupler ON	
		8 - F	Not Used [1]		
0021h	Fault Content	0	Overcurrent	(OC)	
		1	Overvoltage	(OV)	
		2	Inverter Overload	(OL2)	
		3	Inverter Overheat	(OH)	
		4	Not Used [1]		
		5	Not Used [1]		
		6	PID Feedback	(FbL)	
		7	External Fault (EF, EF0), Emergency Stop	(STP)	
		8	Hardware Fault	(Fxx)	
		9	Motor Overload	(OL1)	
		A	Overtorque Detection	(OL2)	
		B	Undertorque Detection	(OL3)	
		C	Power Loss	(UV1)	
		D	Control Power Supply Fault	(UV2)	
		E	MEMOBUS communications Timeout	(CE)	
		F	Operator Connection Fault	(OPR)	
0022h	Data Link Status	0	During Data Writte		
		1	Not Used [1]		
		2	Not Used [1]		
		3	Limit Fault		
		4	Matching Fault		
		5	Not Used [1]		
		6	Not Used [1]		
		7	Not Used [1]		
		8 - F	Not Used [1]		
0023h	Frequency Reference [2]				
0024h	Output Frequency [2]				
0025h – 0026h	Reserved [3]				
0027h	Output Current		0.1A		
0028h	Output Voltage		1V		
0029h – 002Ah	Reserved [3]				
002Bh	External Input Status	0	Terminal S1	1: Contact ON	
		1	Terminal S2	1: Contact ON	
		2	Terminal S3	1: Contact ON	
		3	Terminal S4	1: Contact ON	
		4	Terminal S5	1: Contact ON	
		5	Terminal S6	1: Contact ON	
		6	Terminal S7	1: Contact ON	
		7 - F	Not Used [1]		

Table 5-3 Monitor Registers (continued)

002Ch	Fault Content	0	During Run	1: Running
		1	During Zero Speed	1: @ Zero Speed
		2	Speed Agree	1: @ Speed
		3	Minor Fault	1: Minor Fault
		4	Frequency Detection 1	1: Output Freq ≤ n095
		5	Frequency Detection 2	1: Output Freq ≥ n095
		6	Ready	1: Inverter Ready
		7	Undervoltage Detection	1: @ Undervoltage
		8	Baseblock	1: @ Baseblock
		9	Frequency Reference Source	0: Serial 1: Frequency Reference 1 or Analog
		A	Run Command Source	0: Serial 1: Operator or External Terminal
		B	Overtorque Detection	1: Overtorque
		C	Undertorque Detection	1: Undertorque
		D	Fault Retry	
		E	Fault	1: Fault
		F	Serial Communications Timeout	1: Serial Communications Timeout
002Dh	External Terminal Output Status	0	Contact	1: Contact ON
		1	Photo Coupler 1	1: Photo Coupler 1 ON
		2	Photo Coupler 2	1: Photo Coupler 2 ON
		3 - F	Not Used [1]	
002Eh – 0030h	Reserved [3]			
0031h	DC Bus Voltage		1vdc	
0032h	Torque Monitor		100% = Motor Rated Torque	
0033h	Not Used [1]			
0034h	Not Used [1]			
0035h	Elapsed Time		1hr	
0036h	Reserved [3]			
0037h	Output Power[4]		1W	
0038h	PID Feedback Capacity		±100%	
0039h	PID Input Capacity		±100%	
003Ah	PID Output Capacity		±100%	
003Bh – 003Ch	Reserved [3]			
003Dh	Comm Error	0	CRC Error	
		1	Data Length Error	
		2	Not Used [1]	
		3	Parity Error	
		4	Overrun Error	
		5	Framing Error	
		6	Timeout	
		7 - F	Not Used [1]	
003Eh – 00FFh	Reserved [3]			
0900h	Enter[5]			

Drive Parameter Registers (Read/Write)

Table 5-4 Drive Parameters

Parameter	ADDR	Name	Set	Description	Default
n001	0101h	Password / Initialization	0	N001 Can Be Read And Set; N002-N179 Others Read Only	1
			1	N001-N039 Can Be Read And Set	
			2	N001-N067 Can Be Read And Set	
			3	N001-N113 Can Be Read And Set	
			4	N001-N179 Can Be Read And Set	
			5	Not Used[1]	
			6	Clear Fault Record Only	
			7	Not Used[1]	
			8	2-Wire Initialization (Parameters n180 – n210 re not initialized)	
			9	3-Wire Initialization (Parameters n180 – n210 re not initialized)	
			10	2-Wire Initialization (Us) (Parameters n180 – n210 re not initialized)	
			11	3-Wire Initialization (Us) (Parameters n180 – n210 re not initialized)	
			12	2-Wire Initialization (European)[4]	
			13	3-Wire Initialization (European)[4]	
			15	All Parameters Can Be Read And Set	
			20	Initialize All Parameters To Factory Defaults	
n002	0102h	Control Method	0	V/F Control (initialized only by n001 set to 10 or 11)	0
			1	Open Loop Vector (initialized only by n001 set to 10 or 11)	
n003	0103h	Operation Method	0	Digital Operator	1
			1	Terminal	
			2	Serial Communication	
			3	Option PCB[4]	
n004	0104h	Reference Selection	0	Digital Operator Pot	2
			1	Frequency Reference 1 (N024)	
			2	Voltage Reference (0-10v)	
			3	Current Reference (4-20 Ma)	
			4	Current Reference (0-20 Ma)	
			5	Pulse Train Reference	
			6	Serial Communication (Address 002h)	
			7	Option PCB[4]	
n005	0105h	Stop Method	0	Ramp To Stop	0
			1	Coast To Stop	
n006	0106h	Reverse Prohibit	0	Reverse Run Enabled	0
			1	Reverse Run Disabled	
n007	0107h	Stop Key Function	0	Stop Key Enabled.	0
			1	Stop Key Is Active Only When N003 Is Set From Digital Operator	
n008	0108h	Frequency Reference Selection Local	0	Frequency Ref. From Digital Operator Pot	0
			1	Frequency Ref. From N024	
n009	0109h	Freq. Ref. Enter Req.	0	Enter Required To Accept	0
			1	Enter Not Required To Accept	
n010	010Ah	Operator Connection Detection	0	Disabled	0
			1	Enabled (Operator Connection Fault Detect)	
n011	010Bh	Max. Output Frequency	50.0 - 400.0Hz		60.0
n012	010Ch	Max. Voltage	0.1 - 255.0 (230V Drive) 0.2 - 510.0 (460 V Drive)		230 460
n013	010Dh	Freq. @ Max. Voltage	0.2 - 400.0Hz		60

Table 5-4 Drive Parameters (continued)

Parameter	ADDR	Name	Set	Description	Default
n014	010Eh	Mid. Output Frequency	0.1 - 399.9hz		1.5
n015	010Fh	Voltage @ Mid. Frequency	0.1 - 255.0 (230v Drive) 0.2 - 510.0 (460 V Drive)		12.0 24.0
n016	0110h	Min. Output Frequency	0.1 - 10.0hz		1.5
n017	0111h	Voltage @ Min. Frequency	0.1 - 255.0 (230v Drive) 0.2 - 510.0 (460 V Drive)		12.0 24.0
n018	0112h	Accel / Decel Time Unit	0	0.1s	0
			1	0.01s	
n019	0113h	Acceleration Time 1	000.0 – 999.9 or 1000 – 6000 Seconds (n018 = 0) 00.00 – 99.99 or 100.0 – 600.0 Seconds (n018 = 1)		10.0
n020	0114h	Deceleration Time 1	000.0 – 999.9 or 1000 – 6000 Seconds (n018 = 0) 00.00 – 99.99 or 100.0 – 600.0 Seconds (n018 = 1)		10.0
n021	0115h	Acceleration Time 2	000.0 – 999.9 or 1000 – 6000 Seconds (n018 = 0) 00.00 – 99.99 or 100.0 – 600.0 Seconds (n018 = 1)		10.0
n022	0116h	Deceleration Time 2	000.0 – 999.9 or 1000 – 6000 Seconds (n018 = 0) 00.00 – 99.99 or 100.0 – 600.0 Seconds (n018 = 1)		10.0
n023	0117h	S-Curve Selection	0	No S-Curve	0
			1	0.2 Second	
			2	0.5 Second	
			3	1.0 Second	
n024	0118h	Frequency Reference 1	0.00 - 9.99hz or 100.0 - 400.0hz		6.00
n025	0119h	Frequency Reference 2	0.00 - 9.99hz or 100.0 - 400.0hz		0.00
n026	011Ah	Frequency Reference 3	0.00 - 9.99hz or 100.0 - 400.0hz		0.00
n027	011Bh	Frequency Reference 4	0.00 - 9.99hz or 100.0 - 400.0hz		0.00
n028	011Ch	Frequency Reference 5	0.00 - 9.99hz or 100.0 - 400.0hz		0.00
n029	011Dh	Frequency Reference 6	0.00 - 9.99hz or 100.0 - 400.0hz		0.00
n030	011Eh	Frequency Reference 7	0.00 - 9.99hz or 100.0 - 400.0hz		0.00
n031	011Fh	Frequency Reference 8	0.00 - 9.99hz or 100.0 - 400.0hz		0.00
n032	0120h	Jog Frequency Reference	0.00 - 9.99hz or 100.0 - 400.0hz		6.00
n033	0121h	Frequency Reference Upper Limit	0.0 - 110%		100.0
n034	0122h	Frequency Reference Lower Limit	0.0 - 110%		0.0
n035	0123h	Frequency Reference Unit Selection	0	0.01 Hz (< 100Hz); 0.1Hz (100 Hz >=100Hz)	0
			1	0.1%	
			2-39	RPM	
			40-3999	User Setting	
n036	0124h	Motor Rated Current	0-150% Of Inverter Rated Output Current		[6]
n037	0125h	Electronic Motor Overload Protection	0	Standard Motor	0
			1	Standard Motor – Short Term	
			2	Disabled	

Table 5-4 Drive Parameters (continued)

Parameter	ADDR	Name	Set	Description	Default
n038	0126h	Motor Overload Protection Time Constant	1 - 60 Minutes		8
n039	0127h	Cooling Fan Operation	0	Operates Only When Drive Is Running	0
			1	Operates With Power Is ON	
n040-n049	0128h - 0131h	Reserved[3]			
n050	0132h	Multi-Function Input 1 Terminal S1	1	Run Forward (2 Wire Sequence)	1
			2	Run Reverse (2 Wire Sequence)	
			3	External Fault (N.O. Contact)	
			4	External Fault (N.C. Contact)	
			5	Fault Reset	
			6	Multi-Speed Reference 1	
			7	Multi-Speed Reference 2	
			8	Multi-Speed Reference 3	
			9	Multi-Speed Reference 4	
			10	Jog Reference	
			11	Accel/Decel Time Switch Command	
			12	External Baseblock (N.O. Contact)	
			13	External Baseblock (N.C. Contact)	
			14	Speed Search From Max. Output Frequency	
			15	Speed Search From Set Frequency	
			16	Accel/Decel Hold	
			17	Local/Remote Switch	
			18	Serial/Terminal Control Switch	
			19	Emergency Stop Fault (N.O. Contact) (Stop Method n005)	
			20	Emergency Stop Alarm (N.O. Contact) (Stop Method n005)	
			21	Emergency Stop Fault (N.C. Contact) (Stop Method n005)	
			22	Emergency Stop Alarm (N.C. Contact) (Stop Method n005)	
			23	PID Cancel	
			24	PID Integral Reset	
			25	PID Integral Hold	
			26 - 33	Reserved[3]	
n051	0133h	Multi-Function Input 2 Terminal S2	Same As Parameter n050		2
n052	0134h	Multi-Function Input 3 Terminal S3	0	Forward/Reverse[7]	3
			1 - 25	Others same as parameter n050	
n053	0135h	Multi-Function Input 4 Terminal S4	Same As Parameter n050		5
n054	0136h	Multi-Function Input 5 Terminal S5	Same As Parameter n050		6
n055	0137h	Multi-Function Input 6 Terminal S6	Same As Parameter n050		7
n056	0138h	Multi-Function Input 7 Terminal S7	1 – 25	Same as parameter n050	10
			34	Up/Down command[8]	
			35	Self-Test	

Table 5-4 Drive Parameters (continued)

Parameter	ADDR	Name	Set	Description	Default
n057	0132 9h	Multi-Function Output 1 (MA-MB-MC)	0	@ Fault	1
			1	@ Running	
			2	@ Speed Agree	
			3	@ Zero Speed	
			4	Frequency Detection ≤n095	
			5	Frequency Detection ≥n095	
			6	Overtorque Detection (N.O. Contact)	
			7	Overtorque Detection (N.C. Contact)	
			8	Reserved[3]	
			9	Reserved[3]	
			10	Minor Fault	
			11	@ Baseblock	
			12	@ Run Mode	
			13	Inverter Ready	
			14	@ Fault Retry	
			15	@ Undervoltage	
			16	@ Reverse	
			17	@ Speed Search	
			18	Serial Communications	
			19	@ PID Feedback Loss	
n058	013Ah	Multi-Function Output 2 (PHC1-PHCC)	Same As Parameter n057		1
n059	013Bh	Multi-Function Output 2 (PHC2-PHCC)	Same As Parameter n057		2
n060	013Ch	Analog Freq. Ref. Gain	0 – 255%		100
n061	013Dh	Analog Freq. Ref. Bias	±100%		0
n062	013Eh	Analog Freq. Ref. Time Constant	0.00 – 2.00 Seconds	(0.00 Disables)	0.10
n063	013Fh	Reserved[3]			
n064	0140h	Reserved[3]			
n065	0141h	Monitor Output	0	Analog Monitor Output	0
			1	Pulse Monitor Output (±12vdc±10%) (Max. 20mA)	
n066	0142h	Monitor Item	0	Output Frequency (10vdc/Max Output Frequency)	0
			1	Output Current (10vdc/Drive Rated Current)	
			2	DC Bus Voltage (10vdc/400vdc [800vdc])	
			3	Torque (10vdc/Drive Rated Torque)	
			4	Output Power (10vdc/Drive Rated kW)	
n067	0143h	Monitor Gain	0.01 – 2.00		1.00
n068	0144h	Analog Freq. Ref. Gain	±255%	(Operator Voltage Input)	100

Table 5-4 Drive Parameters (continued)

Parameter	ADDR	Name	Set	Description	Default
n069	0145h	Analog Frequency Ref. Bias	±100%	(Operator Voltage Input)	0
n070	0146h	Analog Freq. Ref. Filter Time Constant	0.00 To 2.00 Seconds 0.00 = Filter Disabled	(Operator Voltage Input)	0.10
n071	0147h	Analog Frequency Ref. Gain	±255%	(Operator Current Input)	100
n072	0148h	Analog Frequency Ref. Bias	±100%	(Operator Current Input)	0%
n073	0149h	Analog Freq. Ref. Filter Time Constant	0.00 - 2.00 Seconds 0.00 = Filter Disabled	(Operator Current Input)	0.10
n074	014Ah	Pulse String Freq. Ref. Gain	±255%		100
n075	014Bh	Pulse String Freq. Ref. Bias	±100%		0
n076	014Ch	Pulse String Freq. Ref. Filter Time Constant	0.00 - 2.00 Seconds 0.00 = Filter Disabled		0.10
n077[4]	014Dh	Multi-Function Analog Input Selection	0	Multi-Function Analog Input Disabled	0
			1	Aux. Frequency Reference (FREF2)	
			2	Frequency Gain (FGAIN)	
			3	Frequency Bias (FBIAS)	
			4	Output Voltage Bias (VBIAS)	
n078[4]	014Eh	Multi-Function Analog Input	0	0 – 10V (Operator Terminal)	0
			1	4 – 20ma (Operator Terminal)	
n079[4]	014Fh	Multi-Function Analog Frequency Bias	0 – 50%	(100%/Max. Output Freq. (n011))	10
n080	0150h	Carrier Frequency	1 To 4	Carrier Frequency = set value * 2.5kHz	4[6]
			7 To 9	1 – 2.5kHz (Synchronous)	
n081	0151h	Momentary Power Loss Selection	0	Operation Does Not Continue	0
			1	Operation Continues within momentary power loss ride through	
			2	Continuous Operation (No UV1 Fault)	
n082	0152h	Fault Retries	0 - 10 Attempts		0
n083	0153h	Prohibit Frequency 1	0.00 - 9.99hz or 100.0 - 400.0hz	(0.000 Disables)	0.00
n084	0154h	Prohibit Frequency 2	0.00 - 9.99hz or 100.0 - 400.0hz	(0.000 Disables)	0.00
n085	0155h	Prohibit Frequency 3	0.00 - 9.99hz or 100.0 - 400.0hz	(0.000 Disables)	0.00
n086	0156h	Prohibit Freq. Deadband	0.00 - 25.50hz	(0.00 Disables N083-N085)	0.00
n087	0157h	Elapsed Time Function	0	Operation Time Elapses When Power Is On.	0
			1	Operation Time Elapses When Drive Is Running	
n088	0158h	Elapsed Time (Initial Value)	0 - 9999hr		0
n089	0159h	DC Injection Current	0 – 100%	(0% = Baseblock)	50

Table 5-4 Drive Parameters (continued)

Parameter	ADDR	Name	Set	Description	Default
n090	015Ah	DC Injection Time @ Stop	0.0 - 25.5 Seconds	(0.0 = Disabled)	0.5
n091	015Bh	DC Injection Time @ Start	0.0 - 25.5 Seconds	(0.0 = Disabled)	0.0
n092	015Ch	Stall Prevention During Decel	0	Enabled	0
			1	Disabled	
n093	015Dh	Stall Prevention During Accel	30 - 200%	(200% = Disabled	170
n094	015Eh	Stall Prevention During Run	30 - 200%	(200% = Disabled)	160
n095	015Fh	Frequency Detection Level	0.00 - 9.99hz or 100.0 - 400.0hz		0.00
n096	0160h	Overtorque Detection 1	0	Detection Disabled.	0
			1	Detects Only @ Speed Agree; Operation Continues	
			2	Detects Only @ Speed Agree; Coast To Stop	
			3	Detects During Run; Operation Continues	
			4	Detects During Run; Coast To Stop	
n097	0161h	Overtorque Detection 2	0	Detected By Output Torque	0
			1	Detected By Output Current	
n098	0162h	Overtorque Detection Level	30 - 200%		160
n099	0163h	Overtorque Detection Time	0.1 - 10.0 Seconds		0.1
n100	0164h	Up/Down Memory Hold	0	Output Frequency is Not stored when using up/down function	0
			1	Output Frequency is stored when using up/down function	
n101	0165h	Reserved[3]			
n102	0166h	Reserved[3]			
n103	0167h	Torque Compensation Gain	0.0 - 2.5		1.0
n104	0168h	Torque Compensation Time Constant	0.0 - o 25.5 Seconds	(0 Disables Primary Delay Filter)	0.3
n105	0169h	Torque Compensation Iron Loss	0.0 – 999.9W or 1000 – 6550W		[6]
n106	016Ah	Motor Rated Slip	0.0 - 20.0hz		[6]
n107	016Bh	Motor Line-To-Line Resistance	0.000 – 9.999ω or 10.00 – 65.50ω		[6]
n108	016Ch	Motor Leakage Inductance	0.00 – 99.99mh or 100.0 - 655.0mh		[6]
n109	016Dh	Torque Limiter	0 - 250%	(Vector Control Mode)	150
n110	016Eh	Motor No-Load Current	0 - 99%		[6]
n111	016Fh	Slip Compensation Gain	0.0 - 2.5		0.0
n112	0170h	Slip Compensation Time Constant	0.0 - 25.5 Seconds	(0.0 Disables Primary Delay Filter)	2.0
n113	0171h	Slip Compensation During Regen	0	Disabled	0
			1	Enabled	
n114	0172h	Reserved[3]			
n115[4]	0173h	Stall Prevention During Run	0	Disabled (Level Based On N094)	0
			1	Enabled (Level At FMAX Is N094 X 0.4)	

Table 5-4 Drive Parameters (continued)

Parameter	ADDR	Name	Set	Description	Default
n116[4]	0174h	Stall Prevention Accel/Decel	0	Disabled (Follows Accel/Decel Time 1)	0
			1	Enabled (Follows Accel/Decel Time 2)	
n117-119	0175-0177h	Reserved[3]			
n120	0178h	Frequency Reference 1	0.00 .- 9.99Hz or 100.0 - 400.0Hz		0.00
n121	0179h	Frequency Reference 2	0.00 .- 9.99Hz or 100.0 - 400.0Hz		0.00
n122	017Ah	Frequency Reference 3	0.00 .- 9.99Hz or 100.0 - 400.0Hz		0.00
n123	017Bh	Frequency Reference 4	0.00 .- 9.99Hz or 100.0 - 400.0Hz		0.00
n124	017Ch	Frequency Reference 5	0.00 .- 9.99Hz or 100.0 - 400.0Hz		0.00
n125	017Dh	Frequency Reference 6	0.00 .- 9.99Hz or 100.0 - 400.0Hz		0.00
n126	017Eh	Frequency Reference 7	0.00 .- 9.99Hz or 100.0 - 400.0Hz		0.00
n127	017Fh	Frequency Reference 8	0.00 .- 9.99Hz or 100.0 - 400.0Hz		0.00
n128	0180h	PID Control Selection	0	PID Disabled	0
			1	PID Enabled (D=Feed Forward)	
			2	PID Enabled (D=Feedback)	
			3	PID Enabled, Reference +PID (D=Feed Forward)	
			4	PID Enabled, Reference +PID (D=Feedback)	
			5	Inverted PID Enabled (D=Feed Forward)	
			6	Inverted PID Enabled (D=Feedback)	
			7	Inverted PID Enabled, Ref. +PID (D=Feed Forward)	
			8	Inverted PID Enabled, Ref. +PID (D=Feedback)	
n129	0181h	PID Feedback Gain	0.00 - 10.00		1.00
n130	0182h	Proportional Gain	0.0 - 25.0	(0.0 Disables P Control)	1.0
n131	0183h	Integral Time	0.0 - 360.0	(0.0 Disables I Control)	1.0
n132	0184h	Derivative Time	0.00 - 2.50	(0. Disables D Control)	0.00
n133	0185h	PID Offset Adjustment	±100	(100% Of Max. Output Frequency)	0
n134	0186h	Integral Upper Limit	±100	(100% Of Max. Output Frequency)	100
n135	0187h	PID Output Delay Time	0.0 - 10.0 Seconds		0.0
n136	0188h	PID Feedback Loss Detection	0	Disabled	0
			1	Enabled (Operation Continues: Fbl Alarm)	
			2	Enabled (Drive Shuts Down: Fbl Fault)	
n137	0189h	PID Feedback Loss Detection Level	0 - 100%	(100% Of Max. Output Frequency)	0
n138	018Ah	PID Feedback Loss Detection Time	0.0 - 25.5 Seconds		1.0

Table 5-4 Drive Parameters (continued)

Parameter	ADDR	Name	Set	Description	Default
n139	018Bh	Energy-Saving Control	0	Disabled	0
			1	Enabled (Must Be In V/F Control Mode)	
n140	018Ch	Energy-Saving Coefficient K2	0.0 - 999.9 or 1000 - 6550		[6]
n141	018Dh	Energy-Saving Voltage Low Limiter @60hz	0 - 120%		50
n142	018Eh	Energy-Saving Voltage Low Limiter @6 Hz	0 - 25%		12
n143	018Fh	Power Supply Average Time	1 - 200	(1 = 24ms)	1
n144	0190h	Search Voltage Limiter	1 - 100%		0
n145	0191h	Search Step @ 100%	0.1 - 10.0%		0.5
n146	0192h	Search Step @ 5%	0.1 - 10.0%		0.2
n147	0193h	Motor Rated Voltage	150.0 - 255.0 Volts 300.0 - 510.0 Volts		200.0 400.0
n148	0194h	Reserved[3]			
n149	0195h	Pulse Input Scaling[9]	100 - 3300	(1 - 33khz)	2550
n150	0196h	Pulse Monitor Output Frequency	0	1440 Hz / Max. Output Frequency	0
			1	1f Output	
			6	6f Output	
			12	12f Output	
			24	24f Output	
			36	36f Output	
n151	0197h	Modbus Time Out Detection	0	Enabled (Coast To Stop)	0
			1	Enabled (Ramp To Stop - N020)	
			2	Enabled (Ramp To Stop - N022)	
			3	Enabled (Operation Continues, Alarm)	
			4	Disabled	
n152	0198h	Modbus Frequency Reference Unit	0	0.1 Hz / 1	0
			1	0.01 Hz / 1	
			2	100% / 3000	
			3	0.1% / 1	
n153[11]	0199h	Modbus Slave Address	0 - 31		0
n154[11]	019Ah	Modbus Baud Rate	0	2400 Bps	2
			1	4800 Bps	
			2	9600 Bps	
			3	19200 Bps	
n155[11]	019Bh	Modbus Parity	0	Even Parity	2^{10}
			1	Odd Parity	
			2	No Parity	
n156[11]	019Ch	Modbus Send Delay	0 - 65ms		10
n157[11]	019Dh	Modbus RTS Control	0	Enabled	0
			1	Disabled (Rs-422; 1 To 1 Communication)	
n158	019Eh	Motor Code Energy Saving Control	0 - 70		[6]

Table 5-4 Drive Parameters (continued)

Parameter	ADDR	Name	Set	Description	Default
n159	019Fh	Energy-Saving Voltage Upper Limit @60Hz	0 - 120%		120
n160	01A0h	Energy-Saving Voltage Upper Limit @6Hz	0 - 25%		16
n161	01A1h	Search Power Supply Detect Hold Width	0 - 100%		10
n162	01A2h	Power Detection Filter Time Constant	0 - 255	(1 = 4ms)	5
n163	01A3h	PID Output Gain	0.0 - 25.0		1.0
n164	01A4h	PID Feedback Selection	0	0 – 10v Terminal Fr	0
			1	4 – 20ma Terminal FR	
			2	0 – 20ma Terminal FR	
			3	0 – 10v Operator Terminal	
			4	4 – 20ma Operator Terminal	
			5	Pulse Input	
n165-n174	01A5-01AFh	Reserved[3]			
n175	01B0h	Carrier Freq. Deceleration @ Low Speed	0	Disabled	0
			1	Enabled @ Output Freq. ≤ 5 and Output Current ≤ 110% Carrier Frequency is automatically reduced to 2.5kHz	
n176[11]	01B1h	Parameter Copy Function	rdy	Ready Status	rdy
			rEd	Read Executes	
			CPy	Copy Executes	
			vFy	Verify Executes	
			vA	Drive Capacity Display	
			Sno	Software No. Display	
n177[11]	01B2h	Parameter Read Prohibit	0	Read Prohibited	0
			1	Read Allowed	
n178	01B3h	Fault History	Four Newest Events Are Displayed.		-
n179	01B4h	Software No.	Lower Four Digits Of Software Numbers Are Displayed.		-
n180	01B4h	Output Voltage Limiter	0	Enabled	0
			1	Disabled	
n181	01B5h	Electronic Thermal Inverter Protection	0	Enabled	0
			1	Disabled	
n182	01B6h	Simple AVR Selection	0	Enabled	0
			1	Disabled	
n183	01B7h	RS485 Terminal Monitor	0	Modbus Communication At PC Connection	0
			1	Modbus Communication (Test Mode) At PC	
n184	01B8h	Hunting Prevent Gain	0.00 To 2.55	(V/F Control Mode Only)	[6]
n185	01B9h	Hunting Prevent Time Constant	1 To 255	(1 = 2ms)	[6]
n186	01BAh	Magnetic Flux Hunting Prevent Gain	0.00 To 1.00	(Vector Control Mode Only)	0.05
n187	01BBh	D-Axis Hunting Prevent Gain	0.00 To 2.55	(Vector Control Mode Only)	[6]

Table 5-4 Drive Parameters (continued)

Parameter	ADDR	Name	Set	Description	Default
n188	01BCh	Q-Axis Hunting Prevent Gain	0.00 - 2.55	(Vector Control Mode Only)	[6]
n189	01BDh	Power Factor Angle Detect Filter Time	1 - 255	(1 = 4ms) (@ Accel/Decel)	20[6]
n190	01BEh	Power Factor Angle Detect Filter Time	1 - 255	(1 = 4ms) (@ Speed Agree)	80[6]
n191	01BFh	IGBT Voltage Drop	0.0 - 10.0V	(Vector Control Mode Only)	[6]
n192	01C0h	On-Delay Compensation	0 - 255	(1 = 62.5ns)	[6]
n193	01C1h	R1 Auto-Tuning Selection	0	Enabled (Time Constant 0.6s) (Vector Control Mode Only)	0
			1	Enabled (Time Constant 2.0s) (Vector Control Mode Only)	
			2	Disabled (Vector Control Mode Only)	
n194	01C2h	Factory Setting MNTR Display	0	Disabled	0
			1	Enabled	
n195-n198	01C3-01C6h	Reserved[3]			
n199	01C7h	Current Detect Adj. Gain U-Phase	0.000 - 2.000		1.000[6]
n200	01C8h	Current Detect Adj. Gain V-Phase	0.000 - 2.000		1.000[6]
n201	01C9h	Current Detect Adj. Gain W-Phase	0.000 - 2.000		1.000[6]
n202	01CAh	Current Detect Delay Comp	±999µs	(Vector Control Mode Only)	10
n203	01CBh	Rated Current Conversion Coefficient	0.000 - 2.000		1.000[6]
n204	01CCh	2/3 Phase Modulation Switch Level	0 - 110%	(0 Sets All Areas to 2 Phase Modulation)	30
n205	01CDh	CLB Selection	0	Enabled	0
			1	Disabled	
n206	01CEh	OC Number Of Retries	0 - 9 Times		4
n207	01CFh	Display Mode At Power Off	Setting Disabled		-
n208	01D0h	Memory Hold Output Frequency	Setting Disabled		-
n209	01D1h	Order Selection Parameter	0 - 100		0
n210	01D2h	kVA Selection	0 - 255		[6]

Notes:

1 Not Used registers and bits must be programmed with 0
2 Frequency reference depends on the setting of n152
3 Reserved registers cannot be accessed
4 Available in 10020 software or later
5 Range dependant on n018 setting
6 Value differs according to inverter capacity
7 Set to 0, Forward/Reverse command is set to terminal S3. S1 becomes the Run command and S2 the Stop command.
8 Up/Down command is set to terminal S7 with S6 becoming the Up command and terminal S7 the Down command.
9 Pulse frequency is 0 - 30kHz
10 Initialized to 0 by n001 set to 8 or 9 or initialized to 2 by n001 set to 10 or 11
11 Parameter cannot be set via Modbus (MEMOBUS)

Chapter 6
Error Codes and Troubleshooting

Communication Error

Once the data sent from the PLC is received the drive, the received data is checked for CRC, parity, overrun, framing, and receiving buffer overflow. If all checked items pass, the data has been received normally. A communication error (CE) is declared if any data item cannot be received within 2 seconds.
The GPD315 drive will operate according to the setting of parameter n151 when a communication error (CE) occurs. The settings of n151 are as follows:

Table 6-1 n151 Settings

n151 Setting	Description
0	Coast to Stop (fault)
1	Ramp to Stop using n020 (fault)
2	Ramp to Stop using n022 (fault)
3	Operation continues (alarm)

Modbus Error Codes

If there is an error in the command message, an error code will be returned in the response message. A fault response message is structured as follows:

Table 6-2 Modbus Error Message

Slave Address		02h
Function Code		83h
Error Code		02h
CRC-16	Lower	30h
	Upper	F1h

The following table indicates the fault code for the specific type of fault that occurred.

Table 6-3 Modbus Error Codes

Error Code	Name	Fault Content
01h	Function Error	Unregistered Function Code
02h	Register No. Error	Unregistered Register Number
03h	No. of Errors	Number of data > 16
21h	Data Setting Error	Upper/Lower limit exceeded in write-in data
22h	Write-in Error	Write-in is disabled for the register specified*

*Write-in would be disabled during the following conditions:
1. Parameters and/or Enter command was attempted to write-in during a run command from the PLC.
2. Parameters and/or Enter command was attempted to write-in during UV occurence from the PLC.
3. When “F04” fault occurred, and parameters other than the n01= 0,8,9,10,11, and 20 (initialize) were attempted to write-in from the PLC.
4. Parameters were attempted to write-in during data store from the PLC.
5. Read data was attempted to write-in from the PLC.

Chapter 7
Command Priority

Command Priority

The setting of parameter n003 determines the origin of operation commands. This was discussed in detail in chapter 3, Setting GPD315 Parameters for Communication. Some commands may be accessed by a source other than the one set up by parameter n003, as illustrated in the tables 1, 2, and 3 on the following pages.

How to use the Command Priority Tables:

First, determine the source of control you wish to use for your GPD315 drive. Then the n003 parameter should be set up for the desired control you have chosen. (See the table below for parameter settings.) Select the appropriate Command Priority table on the following pages based upon what type of operation your drive is set up for.

Table 7-1 n003 Settings

n003 Setting	Operation Command Reference	Use Table:
0	Digital Operator	**7-3**
1	External Terminals	**7-2**
2	Serial Communication	**7-1**

The left hand column of the Command Priority tables is the source of the operation command (serial communication, external terminals, and the Digital Operator). The middle column lists the functions or commands, and the right most column indicates whether the functions are operational or not available from each source.

Set up for Serial Communication Control

The first table indicates the functions or commands that can be accessed via serial communication, external terminals, or the digital operator when the drive's parameter n003 is set up for serial communication (n003 = 3). The "O" indicates that the function is Operable from that source, and "n/a" indicates that the function is not available from that source.

Table 7-1: Set up for Serial Communication Control

From	Data Code	Bit No.	Data Description	Function Availability
SERIAL COMM.	001h	0	Run Command	O
		1	Forward / Reverse	O
		2	External Fault	O
		3	Fault Reset	O (1)
		4	Multi-function Input Reference 1	O
		5	Multi-function Input Reference 2	O
		6	Multi-function Input Reference 3	O
		7	Multi-function Input Reference 4	O
		8	Multi-function Input Reference 5	O
		9	Multi-function Input Reference 6	O
		A	Multi-function Input Reference 7	O
	003h-		unused	-
	008h			
	009h	0	Multi-function Output - Contact	O (2)
		1	Multi-function Output – Photo coupler 1	O (3)
		2	Multi-function Output – Photo coupler 2	O (4)
		3-7	unused	-
EXTERNAL TERMINALS	Forward Run (2 wire); Run Command (3 wire)			n/a
	Reverse Run (2 wire); Stop Command (3 wire)			n/a
	Multi-function input terminal S3			(5)
	Multi-function input terminal S4			(5)
	Multi-function input terminal S5			(5)
	Multi-function input terminal S6			(5)
	Multi-function input terminal S7			(5)
DIGITAL OPERATOR	Run Command			n/a
	Stop Command			O (6)
	Fault Reset			O (1)
	Local / Remote			O (1)

Notes:
1. Effective when run command received from PLC is "0" while in stopped condition.
2. Effective when n057 is "18".
3. Effective when n058 is "18".
4. Effective when n059 is "18".
5. The availability of the multi-function input terminals vary depending upon the settings of n052, n053, n054, n055, and n056 (the multi-function input settings). See technical manual TM 4315.
6. Effective only when n007 is "0".

Set up for External Terminals Control

Table two indicates the functions or commands that can be accessed via serial communication, external terminals, or the digital operator when the drive's parameter n003 is set up for external terminal control (n003 = 1). The "O" indicates that the function is Operable from that source, and "n/a" indicates that the function is not available from that source.

Table 7-2: Set up for External Terminals Control

From	Data Code	Bit No.	Data Description	Function Availability
SERIAL COMM.	001h	0	Run Command	n/a
		1	Forward / Reverse	n/a
		2	External Fault	O
		3	Fault Reset	O (1)
		4	Multi-function Input Reference 1	O
		5	Multi-function Input Reference 2	O
		6	Multi-function Input Reference 3	O
		7	Multi-function Input Reference 4	O
		8	Multi-function Input Reference 5	O
		9	Multi-function Input Reference 6	O
		A	Multi-function Input Reference 7	O
	003h-		unused	-
	008h			
	009h	0	Multi-function Output 1 - Contact	O (4)
		1	Multi-function Output 2 – Photo coupler 1	O (4)
		2	Multi-function Output 3 – Photo coupler 2	O (4)
		3-7	unused	-
EXTERNAL TERMINALS	Forward Run (2 wire); Run Command (3 wire)			O
	Reverse Run (2 wire); Stop Command (3 wire)			O
	Multi-function input terminal S3			O (2)
	Multi-function input terminal S4			O (2)
	Multi-function input terminal S5			O (2)
	Multi-function input terminal S6			O (2)
	Multi-function input terminal S7			O (2)
DIGITAL OPERATOR	Run Command			n/a
	Stop Command			O (3)
	Fault Reset			O (1)
	Local / Remote			O (1)

Notes:
1. Effective only when in the stopped condition.
2. The availability of the multi-function input terminals vary depending upon the settings of n052, n053, n054, n055, and n056 (the multi-function input settings). See technical manual TM 4315.
3. Effective only when n007 is "0".
4. Effective when n057, n058, and n059 are set to "18".

Set up for Digital Operator Control

Table three indicates the functions or commands that can be accessed via serial communication, external terminals, or the digital operator when the drive's parameter n003 is set up for digital operator control (n003 = 0). The "O" indicates that the function is Operable from that source, and "n/a" indicates that the function is not available from that source.

Table 7-3: Set up for Digital Operator Control

From	Data Code	Bit No.	Data Description	Function Availability
SERIAL COMM.	001h	0	Run Command	n/a
		1	Forward / Reverse	n/a
		2	External Fault	O
		3	Fault Reset	O (1)
		4	Multi-function Input Reference 1	O
		5	Multi-function Input Reference 2	O
		6	Multi-function Input Reference 3	O
		7	Multi-function Input Reference 4	O
		8	Multi-function Input Reference 5	O
		9	Multi-function Input Reference 6	O
		A	Multi-function Input Reference 7	O
	003h-		unused	-
	008h			
	009h	0	Multi-function Output 1 - Contact	O (3)
		1	Multi-function Output 2 – Photo coupler 1	O (3)
		2	Multi-function Output 3 – Photo coupler 2	O (3)
		3-7	unused	-
EXTERNAL TERMINALS	Forward Run (2 wire); Run Command (3 wire)			n/a
	Reverse Run (2 wire); Stop Command (3 wire)			n/a
	Multi-function input terminal S2			O (2)
	Multi-function input terminal S3			O (2)
	Multi-function input terminal S4			O (2)
	Multi-function input terminal S5			O (2)
	Multi-function input terminal S6			O (2)
DIGITAL OPERATOR	Run Command			O
	Stop Command			O
	Fault Reset			O (1)
	Local / Remote			O

Notes:
1. Effective only when in stopped condition.
2. The availability of the multi-function input terminals vary depending upon the settings of n052, n053, n054, n055, and n056 (the multi-function input settings). See technical manual TM 4315.
3. Effective when n057, n058, and n059 are set to "18".

Appendix A
Product Specifications

The following table indicates the environmental specifications for the GPD315 drive.

Table A-1 Product Specifications

Environmental Conditions	
Ambient Temperature	-10 to +50 degrees C (+14 to +122 degrees F)
Storage Temperature (1)	-20 to +60 degrees C (-4 to +140 degrees F)
Relative Humidity	95% RH or less (non-condensing)
Altitude	3280 feet (1,000 m) or less
Vibration	Up to 1G at less than 20 Hz; up to 0.2 G at 20 - 50 Hz

GPD 315/V7 Modbus RTU

Yaskawa technical support *is available to provide telephone assistance for* ***installation, programming, & troubleshooting*** *of Yaskawa drives. All support is available during normal business hours. Emergency breakdown support is available on a 24 hour / 7 day basis.*

Help us help you. When you call, please have the following information available.

- *Have this manual at hand. The support associate will refer to it.*
- *Drive model and all nameplate data.*
- *Motor type, brand, and all nameplate data.*

For Troubleshooting, additional information may be required.

- *Power distribution information (type – delta, wye; power factor correction; other major switching devices used; voltage fluctuations)*
- *Installation wiring (separation of power & control wire; wire type/class used; distance between drive and motor, grounding.*
- *Use of any devices between the drive & motor (output chokes, etc.).*

Please phone us at 1-800-541-0939 for technical support.

Additional technical information is available at www.drives.com.

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