



**User Manual for the
*HE660GGM100***

**Modbus™
Gateway Module**

**Second Edition
09 August 2000**

MAN0026-02

PREFACE

This manual explains how to use the Horner APG Genius Gateway Module (GGM).

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

Revisions to This Manual

This version (MAN0026-03) of the **Modbus™ Gateway User Manual** contains the following revisions, additions and deletions:

1. Converted manual into Word format.
2. Changed company name from Horner Electric, Inc. to Horner APG, LLC.

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CHAPTER 1: INTRODUCTION

Congratulations on your purchase of the Horner APG Genius Gateway (GGM)! The HE660GGM100 is a Modbus-to-Genius Gateway module which allows a RTU/ModbusTM Master to access Genius Bus Data, as though it were Modbus I/O. Modbus is a communications protocol used widely in distributed control systems (DCS), supervisory control and data acquisition systems (SCADA), and remote terminal unit (RTU) installations. GE Fanuc's Genius I/O Network is a versatile and powerful Distributed I/O system offering superior performance and diagnostic capabilities. Horner APG's Genius Gateway (GGM) allows DCS, SCADA, and RTU applications to use Genius as its I/O system.

1.1 What You Have

The Horner APG Genius Gateway Module (GGM) comes complete with the following items:

- A. Stand-alone GGM in a backplate mountable aluminum enclosure.
- B. IBM compatible I/O mapping utility (Available February, 1993).
- C. This manual.

1.2 Genius Gateway Features

The Horner GGM provides the following features:

- A. Self-enclosed in a backplate mountable aluminum enclosure.
- B. Integrated Genius Network Interface board (GENI) for communications on GE Fanuc's Genius Distributed I/O Network.
- C. Standard 9-pin RS232 port, communicating with Modbus slave protocol.
- D. Genius Hand Held Monitor (HHM) port for convenient network configuration.
- E. Spare HE-BUS option slot for use with optional RS-232, RS-485, and modem boards.

1.3 Hardware Description

The Genius Gateway (HE660GGM100) consists of four main components, and one optional component. They are:

- A) Metal Enclosure (2 pieces).
- B) Main Circuit Board.
- C) Genius Network Interface (GENI) Board.
- D) Modbus Configuration Board.
- E) (Optional) Auxiliary Serial Board. (HE-BUS architecture).

The block diagram of the GGM is illustrated in **Figure 1.1**.

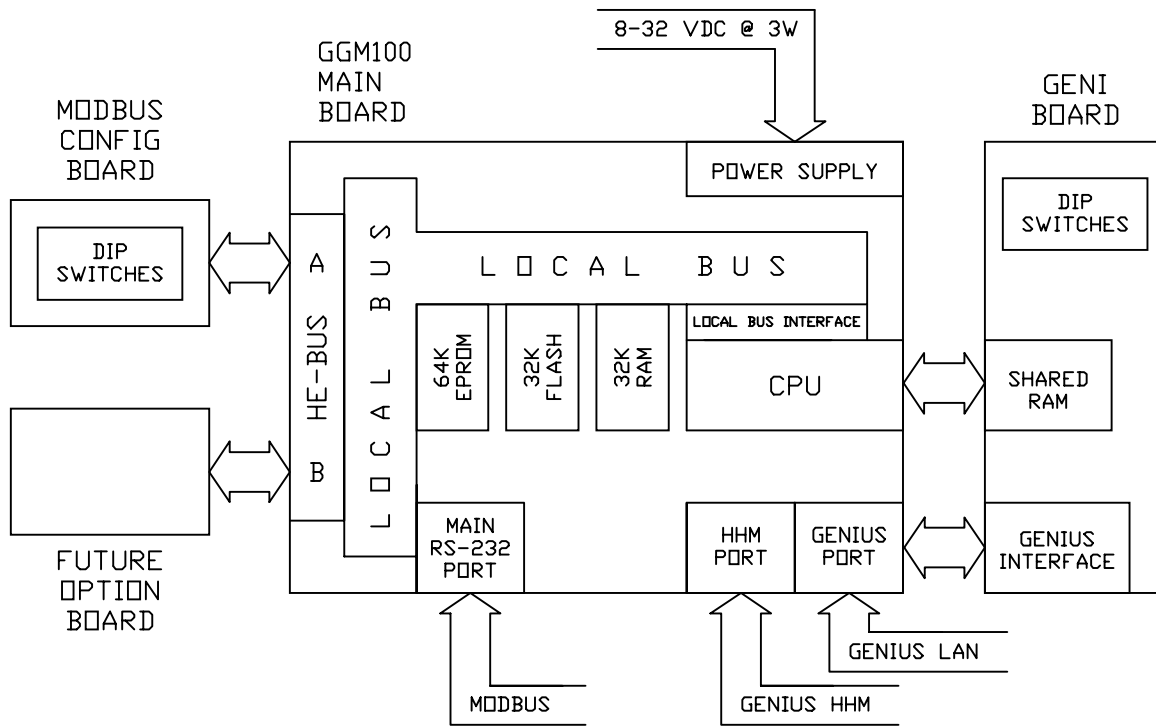


Figure 1.1 – GGM100 Block Diagram

1.4 Specifications

Table 1.1 – Specifications	
Mounting Requirements	Backplate mountable (no NEMA rating)
Dimensions	10.25"H x 4"H x 5.25"D
Genius Communications	Genius Network Interface (GENI)
Modbus Communications	RS-232 (up to 19.2k baud)
Power Requirements	8-32 VDC, 3W
Operating Environment	0 to 60°C (32 to 140°F)
	0 to 95% relative humidity (non-condensing)
Non-volatile Memory	32K Flash EPROM (Atmel AT29256)

CHAPTER 2: INSTALLATION

2.1 Mounting Requirements

The GGM is designed for permanent backplate mounting. To install the GGM:

- A. Drill four starter holes in the mounting surface (backplate) as located from the drawing in Appendix A.
- B. Secure the GGM to the backplate with four #8-32 screws.

2.2 Power Requirements

The GGM requires a DC supply voltage between 8 and 32 volts. A maximum of 3W will be drawn by the GGM. The GGM power connector is a removable, three-position screw connector. The pinout for the connector is drawn on the cover of the GGM, and is recreated in **Figure 2.1**.

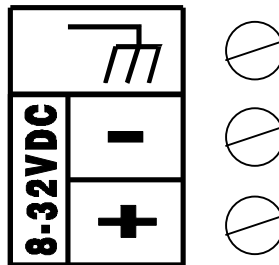


Figure 2.1 – Power Connector Pinout

2.3 Genius Network Connection

The GGM connects to the Genius LAN as a typical Genius I/O block would. The connection is drawn on the front of the GGM, and is reproduced in **Figure 2.2**.

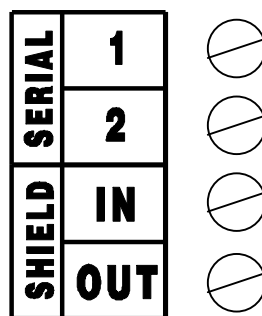


Figure 2.2 – Genius Connector Pinout

2.4 Main RS-232 Connector

The Main RS-232 port on the GGM is the Modbus/RTU communications link to the GGM. The pinout for the 9-pin "D" connector is illustrated in **Table 2.1**.

Pin	Signal
1	DCD
2	TXD
3	RXD
4	DTR
5	GND
6	DSR
7	CTS
8	RTS
9	RI

2.5 GENI Configuration

The GGM's integrated GENI board is equipped with a bank of 8 "DIP" switches. These dip switches are exposed on the left side of the GGM. These switches are used to configure the Genius "bus" address or "Device Number" for the GGM, and to set the Genius baud rate.

Each device on the Genius network must have a unique "Device Number" (0 to 31). The GGM may be configured for any device number. When shipped from the factory, the GGM dip switches are configured for device number 29, and for communication baud rate of 153.6K standard. Available dip switch settings are illustrated on the GGM itself, and in **Figure 2.3** below.

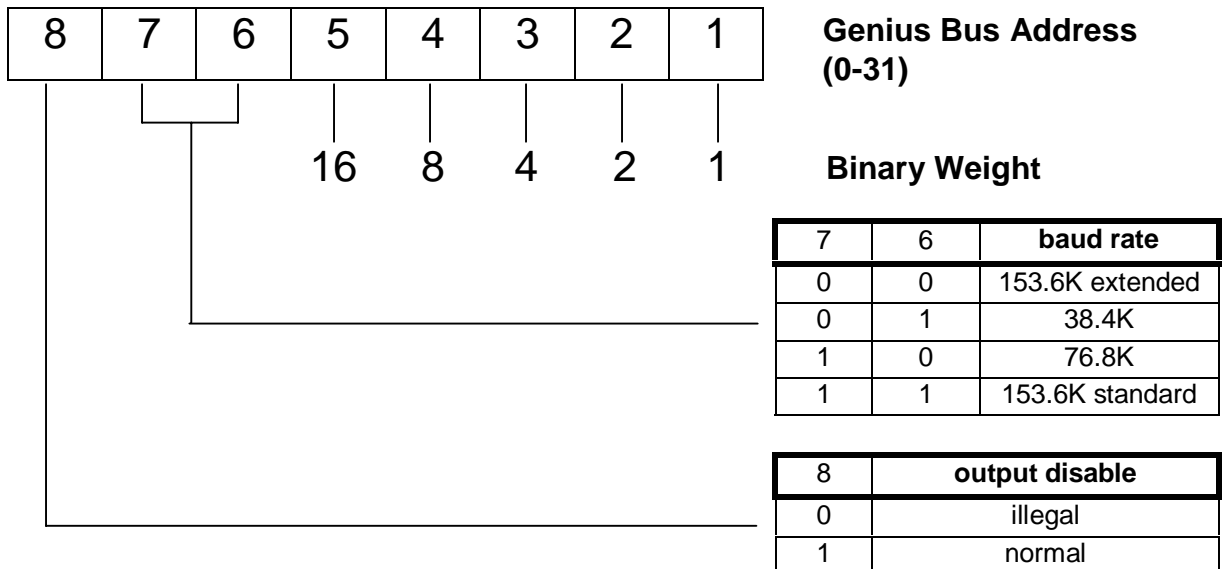


Figure 2.3 – GENI DIP Switch Assignments

2.6 Modbus Configuration

The GGM's Modbus Main RS-232 port is configured with two, 8-position dip switches which are mounted on a circuit board in one of the GGM's expansion slots. These switches are labeled SW1 and SW2, and are accessible from the front of the GGM. Proper configuration of the switches is illustrated in **Figure 2.4**, below.

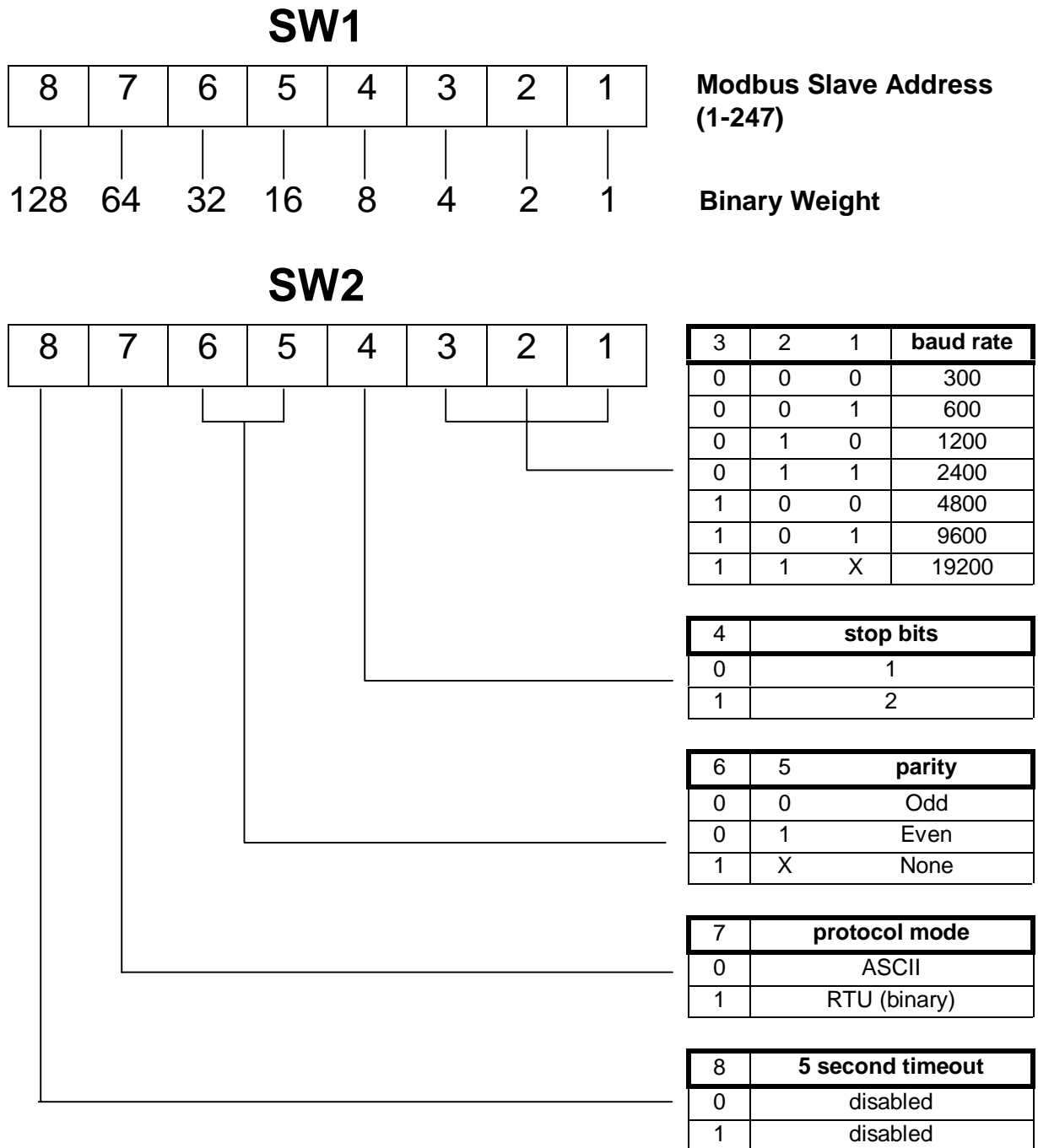


Figure 2.3 – Main RS-232 Port Modbus DIP Switch Assignments

NOTES

CHAPTER 3: OPERATION

As mentioned previously in the introduction, the GGM100 allows Genius Distributed I/O to be used with devices communicating with Modbus protocol, as if the Genius I/O was Modbus I/O. The GGM acts at once as a Genius master and a Modbus slave.

This chapter describes both sides of the GGM's communications, first with Genius and second with Modbus. Later in the chapter it describes how the GGM allows the two protocols to interact with one another - the mapping of Genius I/O into the Modbus I/O scheme.

3.1 Genius Bus Data

The Genius bus uses a token passing protocol, and consists of up to 32 Genius Devices numbered from 0 to 31.

As a Genius Bus Controller, the GGM100:

1. Must be assigned a Genius Device Number from 0 to 31 (see Chapter 2),
2. can access Genius Bus Input and Output data from the other 31 Genius Devices,
3. can provide its own Genius Bus Input and Output Data and
4. can exchange datagrams with the other 31 Genius Devices.

Each Genius Device (including the GGM100 itself) may provide the following Genius Bus Data:

1. Genius Bus Input Data - up to 128 bytes
2. Genius Bus Output Data - up to 128 bytes

The GGM100 provides 12 bytes of Genius Bus Input Data of its own as follows:

1. Genius Bus Error Count - 2 bytes
2. Genius Bus Scan Time (mS) - 2 bytes
3. Genius Device Map Error Status - 4 bytes
4. Genius Device Present Status - 4 bytes

For information on the Genius Bus Data bytes provided by other Genius Devices, refer to their individual user's manuals.

3.2 Genius Bus Datagrams

As mentioned above, the GGM100 can exchange datagrams with other Genius Devices.

Some datagrams are handled automatically by the GGM100, such as the "Set Status Table Address" datagram, and datagrams associated with "log-on" and "log-off" of Genius Devices.

For other datagrams, the GGM100 simply acts as a datagram exchange buffer for the Modbus Master. This is accomplished via the two special Modbus Commands "Receive Datagram" and "Transmit Datagram" described later on

3.3 Modbus I/O

Modbus uses a Master/Slave protocol, and consists of one Modbus Master and up to 247 Modbus Slaves numbered from 1 to 247.

As a Modbus Slave, the GGM100:

1. must be assigned a Modbus Slave Address from 1 to 247 (see Chapter 2) and
2. responds to commands received from the Modbus Master.

A Modbus Master sends commands to the GGM100's Modbus Slave Address, to access its simulated Modbus I/O, to obtain status information or to exchange datagrams with a Genius Device.

A Modbus Slave may contain the following Modbus I/O:

1. Output Coils - up to 65,536 bits
2. Input Contacts - up to 65,536 bits
3. Holding Registers - up to 65,536 words
4. Input Registers - up to 65,536 words

A Modbus Slave maintains the following status information:

1. Exception Status - 8 bits
2. Bus Message Count - 16 bits
3. Bus CRC Error Count - 16 bits
4. Bus Exception Error Count - 16 bits
5. Slave Message Count - 16 bits
6. Slave No Response Count - 16 bits

The GGM100's Exception Status byte is defined below in **Figure 3.1**.

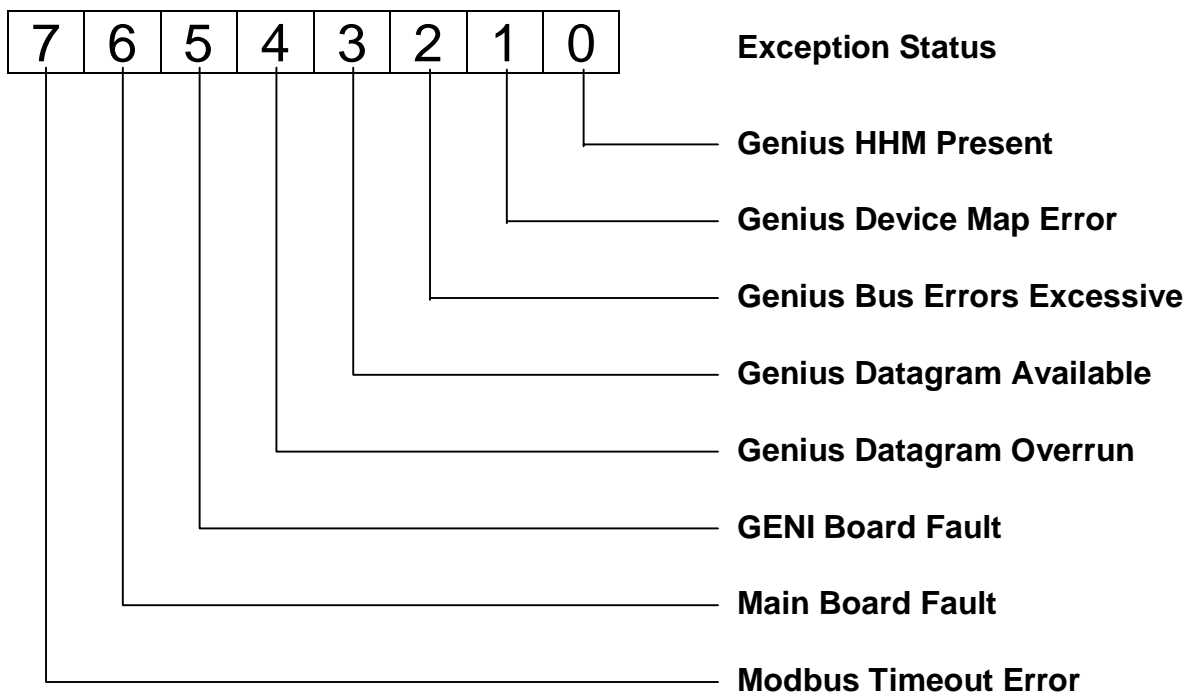


Figure 3.1 – GGM Exception Status Register

3.4 Standard Modbus Commands and Responses

The Modbus Master sends Modbus Commands to Modbus Slaves and receives Modbus Responses returned by Modbus Slaves.

Modbus Commands and Modbus Responses consist of "message frames" in either ASCII or RTU (binary) format, which contain the following information:

1. Slave Address
2. Function Code
3. Data
4. Error Check Code

If a Modbus Command's Slave Address matches a Modbus Slave's Slave Address, that Slave executes the indicated Function Code and then returns a Modbus Response back to the Modbus Master.

If a Modbus Command's Slave Address is zero, ALL Modbus Slaves execute the indicated Function Code and DO NOT return Modbus Responses. Note that only Function Codes 5, 6, 15, 16, 72, and some sub-functions of Function 8 may be "broadcast" in this way.

If a Modbus Slave detects an error, it DOES NOT execute the indicated Function Code, but may return an Exception Response.

Data contained in Modbus Commands and Modbus Responses is dependent on the Function Code, while Error Check Codes are used to validate message frames.

The GGM100 supports the standard Exception Codes listed below in **Table 3.1**:

Table 3.1 – GGM100 Supported Exception Codes	
Code	Meaning
01	Illegal Function
02	Illegal Data Address
03	Illegal Data Value
04	Failure in Associated Device

The GGM100 supports the standard Function Codes listed in **Table 3.2** on Page 18. The standard Function 8 (Loopback Diagnostic Test) Sub-function Codes are listed in **Table 3.3** on Page 18.

For more specific information on the standard Exception codes, Function Codes, and Sub-function Codes listed in this chapter, refer to documentation provided by AEG/Modicon.

3.5 Special Modbus Commands and Responses

The GGM100 supports two special Modbus commands, listed in **Table 3.4** on Page 18.

These Modbus Commands are used for exchanging datagrams between the Modbus Master and Genius Devices.

The formats for these commands and for their associated responses are described in detail in the Appendix.

Table 3.2 – GGM Supported Function Codes					
Code	Meaning	I/O	Type	Min	Max
01	Read Coil Status	I	Bit	1	2000
02	Read Input Status	I	Bit	1	2000
03	Read Holding Registers	I	Word	1	125
04	Read Input Registers	I	Word	1	125
05	Force Single Coil	O	Bit	1	1
06	Preset Single Register	O	Word	1	1
07	Read Exception Status	I	Bit	8	8
08	Loopback Diagnostic Test	(See Table 3.2)			
15	Force Multiple Coils	O	Bit	1	2000
16	Preset Multiple Registers	O	Word	1	125

Table 3.3 – GGM Supported Loopback Diagnostic Test (Function 8) Sub-functions		
Code	Meaning	I/O
00	Return 2-byte query data	I
01	Re-start communications hardware (no response)	O
02	Return 16-bit diagnostics register	I
03	Change ASCII mode delimiter (LF is default)	O
04	Force Slave into listen only mode (no response)	O
10	Clear counters and diagnostic register	O
11	Return 16-bit bus message count	I
12	Return 16-bit bus CRC error count	I
13	Return 16-bit bus exception error count	I
14	Return 16-bit Slave message count	I
15	Return 16-bit slave no response count	I

Table 3.4 – GGM Special Function		
Code	Meaning	I/O
68	Receive Datagram	I
72	Transmit Datagram	O

3.6 Genius Bus Data to Modbus I/O Mapping

Before the GGM may be used by the Modbus Master to access a Genius Device's Data, the Genius Device must be configured with a Reference Address, which maps the Genius Device's Data to specific Modbus I/O

The Reference Address is a 16-bit value which may be programmed into a Genius Device by using the Genius Hand-Held Monitor. For complete instructions for this process, see Chapter 4.

Figure 3.2 shows Modbus I/O and a Genius Device's Data available for mapping. The connecting arrows show how they may be mapped to each other.

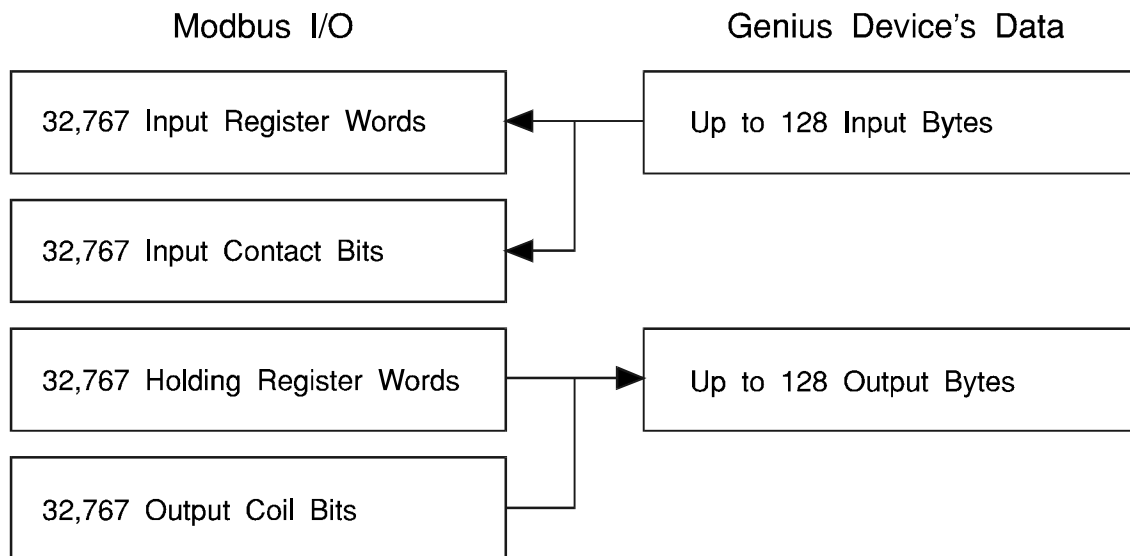


Figure 3.2 – Genius to Modbus I/O Mapping

The GGM100 uses a Genius Device's Reference Address to map its Genius Bus Input and Output Data to Modbus I/O as illustrated in Figure 3.3. If the Reference Address is either 0 or 0FFFFH, the Genius Device's data is not mapped into Modbus I/O at all, but is available for use by other Genius Bus Controllers.

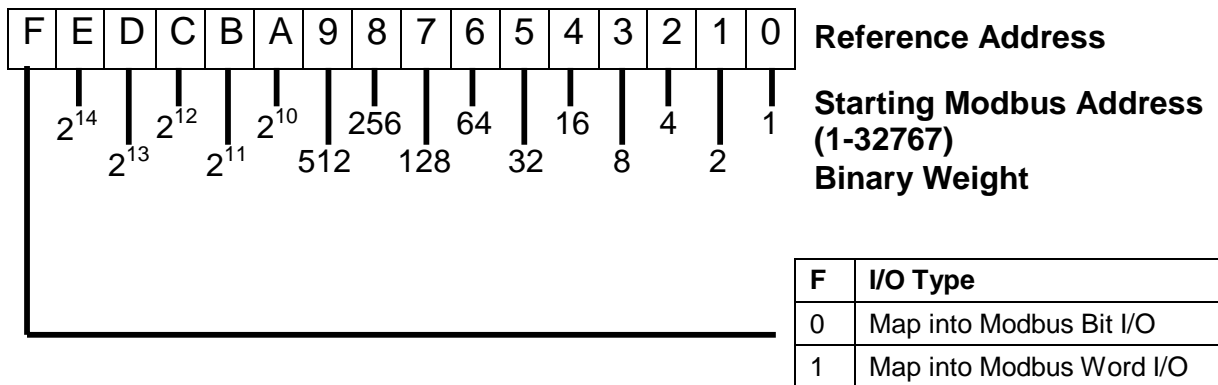


Figure 3.3 – Genius reference Address for Modbus I/O Mapping

3.7 Programming the Starting Modbus Reference with the Hand Held Monitor

Assigning a Modbus Reference to a Genius Device is accomplished with the Genius Hand Held Monitor. The procedure is slightly different for digital and non-digital I/O blocks.

Programming Digital Blocks

1. Configure the Hand Held Monitor as a Series 5 Host.
2. Make "Active" the I/O Block to be configured.
3. Assign an I/O address. Legal values are 1-32767. The HHM will show the address as I/OX-Y, where X is the starting Modbus bit address, and Y is the ending address.

Programming Analog Blocks (Including PowerTRAC)

1. Configure the Hand Held Monitor as a Series 6 Host.
2. Make "Active" the I/O Block to be configured.
3. Assign a REG address. Legal values are 1-32767. The HHM will show the address as REGX-Y, where X is the starting Modbus word address, and Y is the ending address.

CHAPTER 4: MAPPING GENIUS I/O INTO MODBUS

As mentioned previously, there are four different types of Modbus data; Holding (output) Registers, Input Registers, Output Coils, and Input Contacts. Each Genius Block must be mapped into one or more of these data types.

Mapping of Genius I/O into Modbus data types is accomplished by setting a "reference address" in each Genius I/O Block. This reference address is a 16-bit register, the lower 15 bits of which indicate the starting Modbus address, and the upper bit of which indicates register type (bit or word). The GGM maps Genius I/O into a Modbus I/O map by reading the reference address from each Genius block, as well as the block configuration information which specifies which I/O points are inputs and which are outputs.

Assigning the reference address for each block is accomplished with the Genius Hand Held Monitor (HHM). The I/O Block setup procedure is similar to the setup of a Genius block for use with a Series 5 or Series 6 Genius Bus Controller. There are some peculiarities to this setup procedure, and the prescribed procedure should be carefully followed. This procedure is outlined in the remainder of this chapter.

4.1 Genius Hand Held Monitor Setup

The Hand Held Monitor must be configured as a Series Six or Series Five Host in order to properly set the Modbus Reference Address. This is accomplished via the following steps:

<u>Display</u>	<u>Press:</u>
F1:HHM UTILITIES F2:ANALYZE F3:CONFIGURATION F4:	F1
F1:HHM CONFIG F2:HHM SELF TEST F3:HELP F4:	F1
HHM CONFIG BLOCK NO. 0 chng nxt	nxt

Display

Press:

HHM CONFIG
LANGUAGE =
ENGLISH
tgl entr nxt

nxt

HHM CONFIG
SELECT HOST CPU
SERIES 90
tgl entr nxt

tgl

HHM CONFIG
SELECT HOST CPU
SERIES SIX
tgl entr nxt

tgl(entr for Series 6)

HHM CONFIG
SELECT HOST CPU
SERIES FIVE
tgl entr nxt

entr

APPENDIX A: SERIAL PORT WIRING

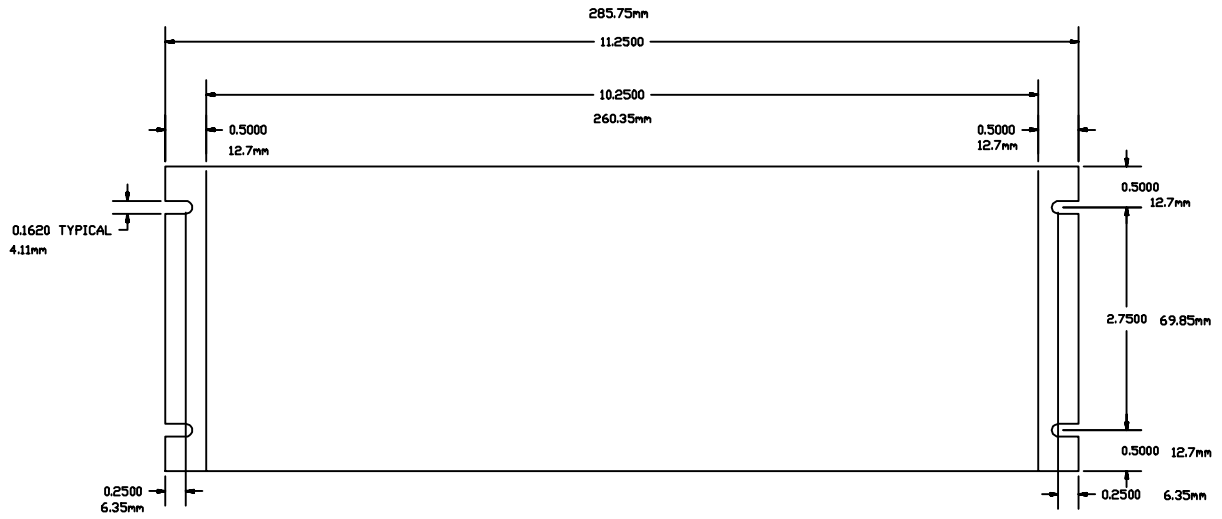


Figure A.1 – GGM Back Plate

NOTES