GNM1D Series

COMMUNICATION PROTOCOL

Version 0 Revision 1

Index

1.1 Introduction

The RS485 serial interface supports the MODBUS/JBUS (RTU) protocol. In this document only the information necessary to read/write from/to GNM1D SERIES has been reported (not all the parts of the protocol have been implemented).
For a complete description of the MODBUS protocol please refer to the latest revision of the "Modbus_Application_Protocol" document that is downloadable from the www.modbus.org web site.

1.2 MODBUS functions

These functions are available on GNM1D SERIES:
- Reading of n "Holding Registers" (code 03h)
- Reading of n "Input Register" (code 04h)
- Writing of one "Holding Registers" (code 06h)
- Diagnostic (code 08h with sub-function code 00h)
- Broadcast mode (writing instruction on address 00h)

IMPORTANT:
1) In this document the "Modbus address" field is indicated in two modes:
    1.1) "**Modicom address**": it is the "6-digit Modicom" representation with Modbus function code 04 (Read Input Registers). It is possible to read the same values with function code 03 (Read Holding Registers) replacing the first digit ("3") with the number "4".
    1.2) "**Physical address**": it is the "word address" value to be included in the communication frame.
2) The functions 03h and 04h have exactly the same effect and can be used indifferently.
3) The communication parameters are to be set according to the configuration of the instrument (refer to GNM1D SERIES instruction manual)

1.2.1 Function 03h (Read Holding Registers)

This function is used to read the contents of a contiguous block of holding registers (word). The Request frame specifies the <u>starting register address and the number of registers to be read. It is possible to read maximum 50 registers (words) with a single request</u>, when not differently specified.
The register data in the response message are packed as two bytes per register (word), with the binary contents right justified within each byte. For each register, the first byte contains the high order bits (MSB) and the second contains the low order bits (LSB).

Request frame

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	03h	
Starting address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Quantity of registers (**N** word)	2 bytes	1 to 14h (1 to 20)	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (correct action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	03h	
Quantity of requested bytes	1 byte	**N** word * 2	
Register value	**N***2 bytes		Byte order: MSB, LSB
CRC	2 bytes		

Response frame (incorrect action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	Possible exception :
Function code	1 byte	83h	01h: illegal function
Exception code	1 byte	01h, 02h, 03h, 04h (see note)	02h: illegal data address
CRC	2 bytes		03h: illegal data value
			04h: slave device failure

1.2.2   Function 04h (Read Input Registers)

This function code is used to read the contents of a contiguous block of input registers (word). The Request frame specifies the starting register address and the number of registers to be read. It is possible to read maximum 50 register (word) with a single request, when not differently specified.
The register data in the response message are packed as two bytes per register (word), with the binary contents right justified within each byte. For each register, the first byte contains the high order bits (MSB) and the second contains the low order bits (LSB).

Request frame

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	04h	
Starting address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Quantity of registers (**N** word)	2 bytes	1 to 14h (1 to 20)	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (correct action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	04h	
Quantity of requested bytes	1 byte	**N** word * 2	
Register value	**N***2 bytes		Byte order: MSB, LSB
CRC	2 bytes		

Response frame (incorrect action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	Possible exception :
Function code	1 byte	84h	01h: illegal function
Exception code	1 byte	01h, 02h, 03h, 04h	02h: illegal data address
CRC	2 bytes		03h: illegal data value
			04h: slave device failure

1.2.3   Function 06h (Write Single Holding Register)

This function code is used to write a single holding register. The Request frame specifies the address of the register (word) to be written and its content.
The correct response is an echo of the request, returned after the register content has been written.

Request frame

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	06h	
Starting address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Register value	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (correct action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	06h	
Starting address	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
Register value	2 bytes	0000h to FFFFh	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (incorrect action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	Possible exception :
Function code	1 byte	86h	01h: illegal function
Exception code	1 byte	01h, 02h, 03h, 04h	02h: illegal data address
CRC	2 bytes		03h: illegal data value
			04h: slave device failure

1.2.4   Function 08h (Diagnostic with sub-function code 00h)

MODBUS function 08h provides a series of tests to check the communication system between a client (Master) device and a server (Slave), or to check various internal error conditions in a server.
GNM1D SERIES supports only 0000h sub-function code (Return Query Data). With this sub-function the data passed in the request data field is to be returned (looped back) in the response. The entire response message should be identical to the request.

Request frame

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	
Function code	1 byte	08h	
Sub-function	2 bytes	0000h	
Data (**N** word)	**N** *2 bytes	Data	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (correct action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7 (1 to 247)	
Function code	1 byte	08h	
Sub-function	2 bytes	0000h	
Data (**N** word)	**N** *2 bytes	Data	Byte order: MSB, LSB
CRC	2 bytes		

Response frame (incorrect action)

Description	Length	Value	Note
Physical address	1 byte	1 to F7h (1 to 247)	Possible exception :
Function code	1 byte	88h	01h: illegal function
Exception code	1 byte	01h, 02h, 03h, 04h	02h: illegal data address
CRC	2 bytes		03h: illegal data value
			04h: slave device failure

1.2.5   Broadcast mode

In broadcast mode the master can send a request (command) to all the slaves. No response is returned to broadcast requests sent by the master. It is possible to send the broadcast message only with function code 06h using address 00h.

1.3 Application notes

1.3.1 RS485 general considerations

1. To avoid errors due to the signal reflections or line coupling, it is necessary to terminate the bus at the beginning (master side, if not already embedded, by inserting a 120 ohm 1/2W 5% resistor between line B and A) and at the end (in GNM1D by connecting the terminal A- with the terminal T in the last instrument). The network termination is necessary even in case of point-to-point connection and/or of short distances.
2. For connections longer than 1000m or if in the network there are more than 160 instruments (with 1/5 unit load as used in GNM1D SERIES interface), a signal repeater is necessary.
3. For bus connection it is suggested to use an AWG24 balanced pair cable and to add a third wire for GND connection. If a shielded cable is used, connect the shield to GND.
4. The GND should be connected to ground only at the master side.
5. If an instrument does not answer within the "max answering time", it is necessary to repeat the query. If the instrument does not answer after 2 or 3 consecutive queries, it is to be considered as not connected, faulty or reached with a wrong address. The same consideration is valid in case of CRC errors or incomplete response frames.

1.3.2 MODBUS timing
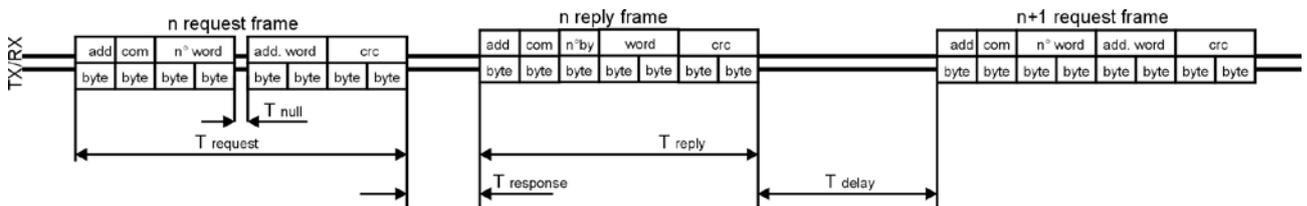
Fig. 1 : 2-wire timing diagram

Timing characteristics of reading function:	ms
T response: Max answering time	500 ms
T response: Typical answering time	40 ms
T delay: Minimum time before a new query	3,5 char
T null: Max interruption time during the request frame	2,5 char

2 TABLES

## 2.1 Data format representation In GARO instruments

The variables are represented by integers or floating numbers, with 2's complement notation in case of "signed" format, using the following:

Format	IEC data type	Description	Bits	Range
INT16	INT	Integer	16	-32768 .. 32767
UINT16	UINT	Unsigned integer	16	0 .. 65535
INT32	DINT	Double integer	32	-2^{31} .. 2^{31}
UINT32	UDINT	Unsigned double integer	32	0 .. 2^{32}-1
UINT64	ULINT	Unsigned long integer	64	0 .. 2^{64}-1
IEEE754 SP		Single-precision floating-point	32	$-(1+[1-2^{-23}])\times2^{127}$ .. 2^{128}

For all the formats the byte order (inside the single word) is MSB->LSB. In INT32, UINT32 and UINT64 formats, the word order is LSW-> MSW.

2.2 Geometric representation

According to the signs of the power factor, the active power P and the reactive power Q, it is possible to obtain a geometric representation of the power vector, as indicated in the drawing below, according to EN 60253-23:
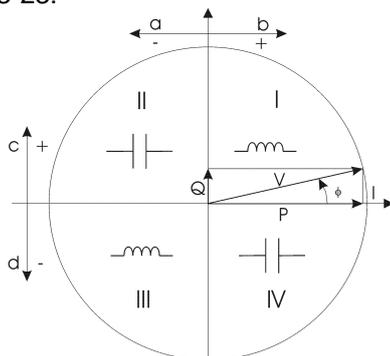
a = Exported active power
b = Imported active power
c = Imported reactive power
d = Exported reactive power

Fig. 2 : Geometric Representation

According to the measurement mode (easy connection or bidirectional), the following sign convention is used in GNM1D SERIES.

- Easy connection mode
    o I always >0
    o P always >0
    o kWh always increasing (MID version, GNM3D version)
    o **kvarh increases only when Q>0**
    o PF only with C and L (without sign) indication

Application	Real measurement	Displayed values	Displayed energies	Notes
Easy connection mode	Quadrant I	A, W, var, L PF	kWh increases, kvarh increases	Measurement A or MID model
	Quadrant II	A, W, -var, C PF	kWh increases, kvarh does not increase	Measurement A or MID model
	Quadrant III	A, W, var, L PF	kWh increases, kvarh increases	Measurement A or MID model
	Quadrant IV	A, W, -var, C PF	kWh increases, kvarh does not increase	Measurement A or MID model

2.3   Maximum and minimum electrical values in GNM1D SERIES

If the input is above the maximum value the display shows "EEE".

	Max value	Min value
VL-N	299V	0
A	54A	0

 The overflow indication "EEE" is displayed when the MSB value of the relevant variable is 7FFFFFFFh (word order FFFF 7FFF).

2.4 Instantaneous variables and meters

MODBUS: read only mode with functions code 03 and 04 — Table 2.4-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
300001	0000h	2	V L-N	INT32	Value weight: Volt*10
300003	0002h	2	A	INT32	Value weight: Ampere*1000
300005	0004h	2	W	INT32	Value weight: Watt*10
300007	0006h	2	VA	INT32	Value weight: VA*10
300009	0008h	2	var	INT32	Value weight: var*10
300011	000Ah	2	W dmd	INT32	Value weight: Watt*10
300013	000Ch	2	W dmd peak	INT32	Value weight: Watt*10
300015	000Eh	1	PF	INT16	Value weight: PF*1000
300016	000Fh	1	Hz	INT16	Value weight: Hz*10
300017	0010h	2	kWh (+) TOT	INT32	Value weight: kWh*10
300019	0012h	2	Kvarh (+) TOT	INT32	Value weight: kvarh*10
300021	0014h	2	kWh (+) PARTIAL	INT32	Value weight: kWh*10
300023	0016h	2	Kvarh (+) PARTIAL	INT32	Value weight: kvarh*10
300025	0018h	2	kWh (+) t1	INT32	Value weight: kWh*10
300027	001Ah	2	kWh (+) t2	INT32	Value weight: kWh*10
300033	0020h	2	kWh (-) TOT	INT32	Value weight: kWh*10
300035	0022h	2	kvarh (-) TOT	INT32	Value weight: kvarh*10

MODBUS: read only mode with functions code 03 and 04 — Table 2.4-2

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
			System variables		
300257	0100h	2	A	INT32	Value weight: Ampere*1000
300259	0102h	2	V L-N	INT32	Value weight: Volt*10
300261	0104h	2	n.a.	INT32	Not available, value =0
300263	0106h	2	W	INT32	Value weight: Watt*10
300265	0108h	2	VA	INT32	Value weight: VA*10
300267	010Ah	2	var	INT32	Value weight: var*10
300269	010Ch	2	PF	INT32	(*) Value weight: PF*1000
300271	010Eh	2	n.a.	INT32	Not available, value =0
300273	0110h	2	Hz	INT32	Value weight: Hz*10
			Total energies and dmd power		
300275	0112h	2	kWh (+) TOT	INT32	Value weight: kWh*10
300277	0114h	2	kvarh (+) TOT	INT32	Value weight: kvarh*10
300279	0116h	2	kWh (-) TOT	INT32	Value weight: kWh*10
300281	0118h	2	kvarh (-) TOT	INT32	Value weight: kvarh*10
300283	011Ah	2	kW dmd	INT32	Value weight: Watt*10
300285	011Ch	2	kW dmd peak	INT32	Value weight: Watt*10
			Other energies		
300329	0148h	2	kWh (+) PARTIAL	INT32	Value weight: kWh*10
300331	014Ah	2	Kvarh (+) PARTIAL	INT32	Value weight: kvarh*10
300339	0152h	2	kWh (+) t1	INT32	Value weight: kWh*10
300341	0154h	2	kWh (+) t2	INT32	Value weight: kWh*10

(*): Negative values correspond to exported active power, positive values correspond to imported active power.

Note Table 2.4-1 and 2.4-2 are equivalent and includes a copy of the same variable values.

Programming parameter note: reading values in addresses not specified in the below tables returns an illegal data address exception.

2.5 Firmware version and revision code

MODBUS: read only mode with functions code 03 and 04 limited to a word at a time   Table 2.5-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
300771	0302h	1	Version code	UINT 16	Value=1: Version "B" Modbus
300772	0303h	1	Revision code	UINT 16	Value=0: Revision "0" etc.

2.6 GARO identification code

MODBUS: read only mode with functions code 03 and 04 limited to a word at a time   Table 2.6-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
300012	000Bh	1	Garo identification code	UINT 16	See table 2.6-2

.
Table 2.6-2

Complete item number	Garo identification code
GNM1D	103

2.7 Programming parameter tables

2.7.1 Password configuration menu

MODBUS: read and write mode   Table 2.7-1

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304097	1000h	1	PASSWORD	UINT 16	Minimum valid value: 0d Maximum valid value: 9999d

2.7.2 System configuration menu

MODBUS: read and write mode   Table 2.7-2

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304099	1002h	1	Measuring system	UINT 16	Value=0: "1P" (1-phase)

2.7.3 Dmd and pulse outs configuration menu

MODBUS: read and write mode   Table 2c

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
	1010h	2	Integration time for dmd power calculation	UINT 32	Value min = 1 Value max = 30

2.7.4 Other functions configuration menu

MODBUS: read and write mode   Table 2.7-2b

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
304354	1101h	1	Tariff management enabling	UINT 16	Value min = 0 (OFF) Value max = 1 (ON) Any other value = OFF
304356	1103h	1	Measurement mode selection	UINT 16	Value min = 0 (A) Value max = 1 (B) Any other value = A

2.7.5 Serial port configuration menu

MODBUS: read and write mode   Table 2.7-3

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
308193	2000h	1	RS485 instrument address	UINT 16	Value min = 1 (default) Value max = 247
308194	2001h	1	RS485 baud rate	UINT 16	Value 1 = 9.6 kbps (default) Value 2 = 19.2 kbps Value 3 = 38.4 kbps Value 4 = 57.6 kbps Value 5 = 115.2 kbps Any other value = 9.6 kbps
308195	2002h	1	RS485 parity	UINT 16	Value 1= no parity (default) Value 2 = even parity Any other value = no parity
308196	2003h	1	Stop bit	UINT 16	Value 1= 1 (default) Value 2 =2 (only if parity is even) Any other value = 1
308197	2004h	1	Max number of words readable with a single Modbus request	UINT 16	Value = 50 (words)

Note: The number of stop bits is fixed to "1" if parity is EVEN.

2.7.6 Reset commands

MODBUS: read and write mode

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
316385	4000h	1	Reset of all partial and tariff meters, kWdmd and kWdmdm peak.	UINT 16	Value=0: reset done Value=1: execute the command All other values produce no effects
316386	4001h	1	Reset of total energy meters (only for non-MID versions, X option)	UINT 16	Value=0: reset done Value=1: execute the command All other values produce no effects
316387	4002h	1	Reset of hour counter (ET112 only)	UINT 16	Value=0: reset done Value=1: execute the command All other values produce no effects

2.7.7 Serial number

MODBUS: read only mode

Modicom address	Physical address	Length (words)	VARIABLE ENG. UNIT	Data Format	Notes
320481	5000h	1	Letter 1 (from SX) Letter 2 (from SX)		MSB: ASCII code LSB: ASCII code
320482	5001h	1	Letter 3 (from SX) Letter 4 (from SX)		MSB: ASCII code LSB: ASCII code
320483	5002h	1	Letter 5 (from SX) Letter 6 (from SX)		MSB: ASCII code LSB: ASCII code
320484	5003h	1	Letter 7 (from SX) Letter 8 (from SX)		MSB: ASCII code LSB: ASCII code
320485	5004h	1	Letter 9 (from SX) Letter 10 (from SX)		MSB: ASCII code LSB: ASCII code
320486	5005h	1	Letter 11 (from SX) Letter 12 (from SX)		MSB: ASCII code LSB: ASCII code
320487	5006h	1	Letter 13 (from SX)		MSB: ASCII code

2.7.8 Note

The default value shall be automatically assigned to the parameters when an out-of-range or invalid value is written.