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# **GM3T RS485**

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## **M-BUS COMMUNICATION PROTOCOL**

**Version 1 Revision 0**

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## 1.1 Introduction

GM3T-RS485 supports the M-BUS protocol by using the adapter G MBUS ADP. In this document only the information necessary to read Data Measurement from GM3T RS485 has been reported (not all the parts of the protocol have been implemented).

## 1.2 M-BUS functions

The below reported functions are available in GM3T RS485:

- Single control character procedure SND\_NKE
- Data Transfer (Request/Respond Procedure REQ/RSP)
- Reset function
- Switching Baudrate function
- Primary Data Request (SND\_UD)

### 1.2.1 Single control character procedure SND\_NKE

The questioned procedure is useful to start up the communication either after a communication's interruption or just at the beginning of it. The master sends a Request Frame to Slave which responds with a single character (E5h) if it is correctly addressed. Therefore, SND\_NKE is an initialization procedure.

It is necessary to use the SND\_NKE function to initialize the Slave's answer with the first frame.

Request frame (From Master to Slave)

Description	Length	Value	Note
Start	1 byte	10h	
Control	1 byte	40h	
Physical Address (Slave)	1 byte	1 to F7h (1 to 247)	
Check Sum	1 byte		Check Sum: is the arithmetical sum (without carry) of the Control Field and the Physical Address (Slave).
Stop	1 byte	16h	

Response frame in case of correct action (From Slave to Master)

Description	Length	Value	Note
Confirm Character	1 byte	E5h	

After the reception of a valid telegram the Slave has to wait between before answering (see also EN1434-3), as shown in the Table below (three Slave BAUDRATEs are available).

BAUD RATE	Min.	Max.	EM24/EM21
300 BAUD	36,6 ms	1,15 s	50 ms
2400 BAUD	4,6 ms	187,5 ms	50 ms
9600 BAUD	1,2 ms	84,4 ms	50 ms

Response frame in case of incorrect action (From Slave to Master)

When a fault has been detected as a result of the checks (Start/Parity/stop bits per character, Start/Check Sum/Stop Character per telegram format), the transmission will not be accepted and the reply will not be sent by the slave to master. The master must interpret the lack of a reply as a fault or wrong address.

1.2.2 Request/Respond Procedure (REQ/RSP)

This procedure is requested from Master to Slave and typically generates the complete data transfer from Slave to Master according to Class 2, EN 1434-3. All data are transferred through M-bus. The complete serial Slave Response can take either three Long Frames (GM3T RS485). If the Slave has been previously programmed through a Primary Data Request (SND\_UD) then the Request/Respond Procedure (REQ/RSP) returns only the selected data.

Long Frame	GM3T RS485
#1 (transmitted first)	Energy and Active Power Measurement
#2	Current and Voltage Measurement
#3	Reactive Power Measurement – Power Factors
#4	<i>Not present</i>
#5	<i>Not present</i>

The DIF byte contains the coding for each transmitted parameter (32-bit integer or 16-bit integer). VIF/VIFE bytes contain the measurement unit and its multiplier. There are three categories:

- Primary unit measurement
- Extended unit measurement
- User's measurement

Each Data measurement available in the GM3T RS485 is packed with its DIF, VIF, VIFE, Data field, this last contains the numerical representation of the measured value. VIFE is not present in case of Primary unit measurement. Transmission order is shown in Table 1. In the Data Field, the LSB is transmitted/received first.

Request frame (From Master to Slave) – REQ\_UD2 → RSP\_UD

Description	Length	Value	Note
Start	1 byte	10h	
Control	1 byte	01FV1011b	F = FCB-Bit V = FCV-Bit (set to one if the FCB/FCV protocol is active)
Physical Address (Slave)	1 byte	1 to F7h (1 to 247)	
Check Sum	1 byte		Check Sum; is the arithmetical sum (without carry) of the Control Field and the Physical Address (Slave)
Stop	1 byte	16h	

Response frame in case of correct action (From Slave to Master)

Description	Length	Value	Note
Start	1 byte	68h	
L Field	1 byte		L Field: is the bytes' number calculated starting from the Control Field up to the MDH Field (if the latter is present; otherwise up to the last byte of the Data User).
L Field	1 byte		See above.
Start	1 byte	68h	
Control	1 byte	08h	
Physical Address (Slave)	1 byte	1 to F7h (1 to 247)	
CI	1 byte	72h	
Ident. Nr.	4 Byte		This parameter has to be defined
Manufr.	2 Byte	1C36h	"GAV", ID Manuf. according to EN60870
Version	1 Byte		Read from GM3T RS485
Medium	1 Byte	02h	02h = Electricity
Access No.	1 Byte		Incremented after each REQ_UD2 procedure
Status	1 Byte		
Signature	2 Byte	00h	It is always 00 GM3T RS485
DIF	1 byte		Coding of the first transmitted value
DIFE	1 byte		Coding of sub-unit only (max #4 DIFE)
VIF	1 byte		Unit and Multiplier of the first transmitted value
VIFE	1 byte		Unit and Multiplier of the first transmitted value (optional)
Data	2 or 4 byte		First transmitted value (single measure)
....	...	...	
MDH	1 Byte	1Fh	In the last Long Frame of the slave the questioned byte is 0Fh. The latter (0Fh) indicates that the slave has been completely read.
Check Sum	1 byte		Check Sum: is the arithmetical sum (without carry)

			starting from Control Field to the MDH Field (if present, otherwise the last Data byte)
Stop	1 byte	16h	

NOTE: each transferred measurement requires: DIF, DIFE (optional), VIF, VIFE (optional) and Data (2 or 4 Byte). See also Table 1.

The device supports the **FCB/FCV-bit transfer protocol**. This mechanism is activated if the FCB-bit is set to one in the Request Frame generated by the Master, otherwise the mechanism is ignored by the Slave. The FCB/FCV protocol allows a safer transfer from Slave to Master when the Slave response has more than one Long Frame. After a SND\_NKE Procedure, the Master transmits in the REQ\_UD2 → RSP\_UD a Control Field with FCB-bit set to one (Control Field = 7Bh) and the Slave will reply with the first Long Frame. If this data is correctly received from the Master, the Master itself will send to the Slave a new Request Frame with the FCB-bit cleared (Control Field = 5Bh), hence the Slave will send the next Long Frame. On the contrary, if the Master did not correctly receive the first Long Frame from the Slave, it can send to the Slave the Control Field = 7Bh another time, in this way the Slave will repeat the First Long Frame. The same is valid for the Second Long Frame. The last Long Frame transmitted by the Slave does not have the MDH Field, this absence has to be interpreted by the Master as the receipt of the last Long Frame from the Slave. After a SND\_NKE procedure, the slave is always set on the first frame, even if the last transmitted frame was not the last.

“Version” Field, which is directly read from the device, gives the GM3T RS485 version:

“Version” Field HEX	“Version” Field DEC	Device
39h	57	GM3T RS485

The meter supports the “secondary address” addressing and its research through the wild card. The latter corresponds to the nibble “Fh” and can substitute one BCD digit of the secondary address so that, during the slave’s selection, it can be ignored. It is so possible to address groups of slaves whose secondary address is the same except for the wild card. An appropriate algorithm allows the master to identify all slaves among those present in the network. In particular, in GM3T RS485 the secondary address is fixed and equal to 01020304 (BCD).

The sub unit function allows to mark electrical variables with the same engineering unit (for example: Wsys, WL1, WL2 and WL3 whose engineering unit is Watt). The meter supports the sub-unit (refer to the Table 1).

### 1.2.3 Reset Function

This function code is used by the Master and resets the Slave. After a Reset, the FCB/FCV-bit mechanism is re-initialized. Also, a Primary Data Request is automatically de-selected.

#### Request frame

Description	Length	Value	Note
Start	1 byte	68h	
L	1 byte	03h	
L	1 byte	03h	
Start	1 byte	68h	
Control	1 byte	53h or 73h	
Physical Address (Slave)	1 byte	1 to F7h (1 to 247)	
CI	1 byte	50h	Application Reset Code
Check Sum	1 byte		Chek Sum: is the arithmetical sum (without carry) of Control Field, Physical Address (Slave) and CI-Field.
Stop	1 byte	16h	

#### Response frame (correct action)

Description	Length	Value	Note
Confirm Character	1 byte	E5h	

### 1.2.4 Switching Baudrate Function

The Master can set the Slave's Baud rate to a different value from 2400 BAUD (default) as a matter of fact, 300 and 9600 BAUDs are available. The Slave confirms the correctly received request by transmitting the E5h character and the old baudrate and uses the new baudrate from now on.

#### Request frame

Description	Length	Value	Note
Start	1 byte	68h	
L	1 byte	03h	
L	1 byte	03h	
Start	1 byte	68h	
Control	1 byte	53h or 73h	
Physical Address (Slave)	1 byte	1 to F7h (1 to 247)	
CI	1 byte	B8h/BBh/BDh	B8h = 300 BAUD, BBh = 2400 BAUD, BDh = 9600 BAUD
Check Sum	1 byte		Check Sum is the arithmetical sum (without carry) of Control Field, Physical Address (Slave) and CI-Field.
Stop	1 byte	16h	

#### Response frame (correct action)

Description	Length	Value	Note
Confirm Character	1 byte	E5h	

### 1.2.5 Primary Data Request (SND\_UD)

The Master unit can acquire only a partition of all data stored in the energy module GM3T RS485, by specifying the desired VIF, VIFE in a Primary Data Request procedure. It is possible to program the Slave in order to obtain one or more measurement. The slave confirms the request with the E5h character. From now on, each REQ\_UD2 → RSP\_UD will generate the transfer of the only selected data instead of all Data Slave. For example, with 08h, FDh, 48h, the Master programs the Slave to obtain only the Volt\*10 Data. With 08h, FFh, 03h only the Hz\*10 measurement will be obtained. With the string : 08h, FDh, 48h, 08h, FFh, 03h both Volt\*10 and Hz\*10 are programmed. Note that the Data response is generated only starting from the next REQ\_UD2 → RSP\_UD. The Slave Response could take more than a Long Frame, in this case the FCB/FCV-bit Protocol should be activated from the Master.

#### Request frame (from Master to Slave)

Description	Length	Value	Note
Start	1 byte	68h	
L	1 byte		L Field is the number of byte calculated starting from the Control Field up to the last byte of the Data User.
L	1 byte		See above.
Start	1 byte	68h	
C	1 byte	53h or 73h	
Physical Address	1 byte	1 to F7h (1 to 247)	
CI	1 byte	51h	
Selector char	1 byte	08h	
Requested VIF #1	1 byte		
Requested VIFE #1 (if present)	1 byte		
Selector char	1 byte	08h	
Requested VIF #2	1 byte		
Requested VIFE #2 (if present)	1 byte		
...	...	...	...
Check Sum	1 byte		Check Sum is the arithmetical sum (without carry) starting from the Control Field until to the last requested VIF (or VIFE)
Stop	1 byte	16h	

#### Response frame (correct action)

Description	Length	Value	Note
Confirm Character	1 byte	E5h	

1.2.6 Special Addresses

**Primary test address = FEh** is a test address, the slave always answers to the special address if no errors are present. The Slave answer contains its own Primary Address. The address FEh is normally used for point to point communication.

**Primary broadcast address = FFh** is a broadcast address, the slave executes the request received from the Master without generating any response on the M-Bus. Used by master for SND\_NKE.

Address =FDh it is used by the master when questioning slaves using the secondary address instead of the primary address.

## 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 int	32	0 .. $2^{32}-1$
UINT64	ULINT	Unsigned long integer	64	0 .. $2^{64}-1$
IEEE754 SP		Single-precision floating-point	32	$-(1+[1 -2^{-23}]) \times 2^{127} .. 2^{128}$

For all the formats the M-Bus byte order always is LSB->MSB (the LSB is transmitted/received first), as described in EN 60870-5-4 standard.

#### 2.1.1 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:

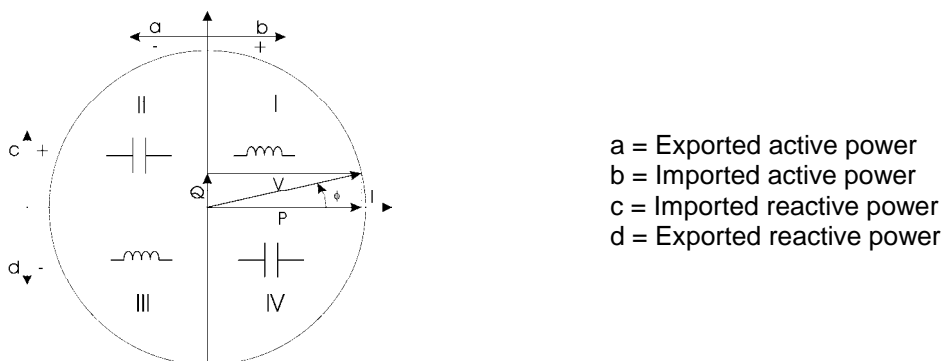


Fig. 1 : Geometric Representation

### 2.2 Maximum and minimum electrical values in GM3T RS485

The maximum electrical input values are reported in the following table. If the input is above the

maximum value the display shows “----”.

**Table 2.2-1 – GM3T RS485**

	AV5 input option		AV6 input option	
	Max value	Min value	Max value	Min value
VL-N	485V	0	150V	0
VL-L	840V	0	260V	0
A	6,5A	0	6,5A	0
VT	6000	1.0	6000	1.0
CT	60000	1.0	60000	1.0

The overflow indication “----“ is displayed when the MSB value of the relevant variable is 7FFFh.

**2.3 Instantaneous variables and meters**

**Table 1 - GM3T RS485**




Length (byte)	VARIABLE ENG. UNIT	Data Format	Notes	#SUB UNIT	VIF byte	VIFE byte
<b>FRAME #1 (transmitted first)</b>						
4	KWh(+) TOT	INT32	Engineering unit: Wh*100	0	1	-
4	Kvarh(+) TOT	INT32	Engineering unit: Varh*100	0	1	1
4	W L1	INT32	Engineering unit: Watt*0.1	1	1	-
4	W L2					
4	W L3					
4	W Σ	INT32	Engineering unit: Watt*0.1	0	1	-
<b>FRAME #2</b>						
4	A L1	INT32	Engineering unit: Ampere* 0.001	1	1	1
4	A L2	INT32				
4	A L3	INT32				
4	V L1-N	INT32	Engineering unit: Volt*0.1	1	1	1
4	V L2-N	INT32				
4	V L3-N	INT32				
4	V L-N Σ	INT32				
4	V L1-L2	INT32				
4	V L2-L3	INT32				
4	V L3-L1	INT32				
4	V L-L Σ	INT32	4			
2	Hz	INT16	Engineering unit: Hz	0	1	1
<b>FRAME #3</b>						
4	VA L1	INT32	Engineering unit: VA*0.1	1	1	1
4	VA L2	INT32				
4	VA L3	INT32				
4	VA Σ	INT32	Engineering unit: VA*0.1	0	1	1
4	VAR L1	INT32	Engineering unit: Var*0.1	1	1	1
4	VAR L2	INT32				
4	VAR L3	INT32				
4	VAR Σ	INT32	Engineering unit: Var*0.1	0	1	1
2	PF L1	INT16	Negative values correspond to lead(C), positive value correspond to lag(L) Engineering unit: PF*0.001	1	1	1
2	PF L2	INT16				
2	PF L3	INT16				
2	PF Σ	INT16				
2	Phase sequence	INT16	Value -1 correspond to L1-L3-L2 sequence, value 0 correspond to L1-L2-L3 sequence	0	1	1

**Table 2 – GM3T RS485 M-Bus Measurement Unit Coding (VIF/VIFE).**

Measurement Unit	VIF	VIFE	
Watt*0.1	00101010b = 2Ah	-	<b>PRIMARY M-BUS CODES</b>
Wh*100	00000101b = 05h	-	
Volt*0.1	11111101b = FDh	01001000b = 48h	
Ampere*0.001	11111101b = FDh	01011001b = 59h	
VAR*0.1	11111111b = FFh	00000001b = 01h	<b>EXTENSION OF M-BUS CODES (Manufacturer Specific)</b>
PF*0.001	11111111b = FFh	00000010b = 02h	
VARh*100	11111111b = FFh	00000100b = 04h	
Phase sequence	11111111b = FFh	00000110b = 06h	
VA*0.1	11111111b = FFh	00000111b = 07h	
Hz	11111111b = FFh	00001000b = 08h	

Watt L1*0.1	11111111b = FFh	00001101b = 0Dh
Watt L2*0.1	11111111b = FFh	00001110b = 0Eh
Watt L3*0.1	11111111b = FFh	00001111b = 0Fh
Ampere L1*0.001	11111111b = FFh	00010010b = 12h
Ampere L2*0.001	11111111b = FFh	00010011b = 13h
Ampere L3*0.001	11111111b = FFh	00010100b = 14h
Volt L1-N*0.1	11111111b = FFh	00010110b = 16h
Volt L2-N*0.1	11111111b = FFh	00010111b = 17h
Volt L3-N*0.1	11111111b = FFh	00011000b = 18h
Volt L1-L2*0.1	11111111b = FFh	00011001b = 19h
Volt L2-L3*0.1	11111111b = FFh	00011010b = 1Ah
Volt L3-L1*0.1	11111111b = FFh	00011011b = 1Bh
VA L1*0.1	11111111b = FFh	00011100b = 1Ch
VA L2*0.1	11111111b = FFh	00011101b = 1Dh
VA L3*0.1	11111111b = FFh	00011110b = 1Eh
VAR L1*0.1	11111111b = FFh	00100001b = 21h
VAR L2*0.1	11111111b = FFh	00100010b = 22h
VAR L3*0.1)	11111111b = FFh	00100011b = 23h
PF L1*0.001	11111111b = FFh	00100100b = 24h
PF L2*0.001	11111111b = FFh	00100101b = 25h
PF L3*0.001	11111111b = FFh	00100110b = 26h

Colors:

-  = Primary M-Bus Codes
-  = Extension of Primary M-Bus Codes
-  = Manufacturer Specific