EM24 M1

M-BUS COMMUNICATION PROTOCOL

Version 0 Revision 1

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1.1 Introduction

The M-Bus interface implemented in EM24 M1 models, supports the M-Bus protocol. In this document only the information necessary to read Data Measurement from EM24 M1 has been reported (not all the parts of the protocol have been implemented).

1.2 M-BUS functions

The below reported functions are available on EM24 M1:

- Single control character procedure SND_NKE
- Data Transfer (Request/Respond Procedure REQ/RSP)
- Reset function
- Switching Baudrate function
- Changing Primary Address
- 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 EN13757-3), as shown in the Table below (three Slave BAUDRATEs are available).

BAUD RATE	Min.	Max.	EM24
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 13757-3. All data are transferred through M-bus. The complete serial Slave Response take four Long Frames. 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	EM24
#1 (transmitted first)	Energy Measurement - System Power, System Voltage and Current Measurement
#2	Phase Power and Phase Power Factors Measurement
#3	Phase Voltage and Energy measurement
#4	DMD and Max DMD Measurement

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 EM24 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		
Manufr.	2 Byte	1C36h	"GAV", ID Manuf. according to EN60870
Version	1 Byte		Read from EM24
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 for all
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 FCV-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 instrument version:

"Version" Field HEX	"Version" Field DEC	Device
5Ah	90	EM24DIN M1 (all models)

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.
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, Please, give a look at Table 2

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		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	

1.2.4 Switching Baudrate Function

The Master can set the Slave's Baud rate to a different value from 300 BAUD as a matter of fact, 2400 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 Changing Primary Address

The Master can set the primary address of the Slave. The Slave confirms the correctly received request by transmitting the E5h character and uses the new address from now on.

Request frame

Description	Length	Value	Note
Start	1 byte	68h	
L	1 byte	06h	
L	1 byte	06h	
Start	1 byte	68h	
Control	1 byte	53h or 73h	
Physical Address (Slave)	1 byte	1 to F7h (1 to 247)	
CI	1 byte	51h	
DIF	1 byte	01h	
VIF	1 byte	7Ah	
New Physical Address (Slave)	1 byte	1 to F7h (0 to 247)	
Check Sum	1 byte		Check Sum is the arithmetical sum (without carry) of Control Field, Physical Address (Slave) and CI-Field, DIF, VIF and New Physical Address (Slave)
Stop	1 byte	16h	

Response frame (correct action)

Description	Length	Value	Note
Confirm Character	1 byte	E5h	

1.2.6 Primary Data Request (SND_UD)

The Master unit can acquire only a partition of all data stored in the energy module EM24, 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 up to 20. 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	

1.2.7 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 and Reset function

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 Carlo Gavazzi instruments

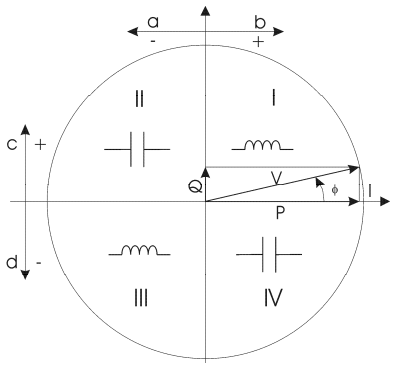
The variables are represented by integers or floating numbers, with 2's complement notation in case of "signed" format, using the following:

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	$-(1+[1-2^{-23}])x2^{127}$ .. 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:



a = Exported active power
b = Imported active power
c = Imported reactive power
d = Exported reactive power

Fig. 1 : Geometric Representation

2.2 Maximum and minimum electrical values

The maximum electrical input values are reported in the following table. If the input is above the maximum value the display shows “EEE”.

Table 2.2-1 – **EM24 M1 (MID and non MID versions)**

	AV9 input option		AV2 input option		AV5 input option		AV6 input option	
	Max value	**Min value**	**Max value**	**Min value**	**Max value**	**Min value**	**Max value**	**Min value**
VL-N	280V	0	280V	0	280V	0	133V	0
VL-L	485V	0	485V	0	485V	0	230V	0
A	65A	0	65A	0	11A	0	11A	0
VT ratio					6000	1.0	6000	1.0
CT ratio					60000	1.0	60000	1.0

The overflow indication “EEE“ is displayed when the MSB value of the relevant variable is 7FFFh.
The overflow indication “-EEE“ is displayed when the MSB value of the relevant variable is 8000h.

2.3 Instantaneous variables and meters

Table 1 - EM24DIN

Length (byte)	VARIABLE ENG. UNIT	Data Format	Notes	#SUB UNIT	VIF byte	VIFE byte
FRAME #1 (transmitted first)						
4	KWh (+) TOT	INT32	Engineering unit: Wh*100	0	1	-
4	Kvarh (+) TOT	INT32	Engineering unit: Varh*100	0	1	1
4	KWh (+) L1	INT32	Engineering unit: Wh*100	1	1	-
4	KWh (+) L2	INT32	Engineering unit: Wh*100	2	1	-
4	KWh (+) L3	INT32	Engineering unit: Wh*100	3	1	-
4	W Σ	INT32	Engineering unit: Watt*0.1	0	1	-
4	VAR Σ	INT32	Engineering unit: Var*0.1	0	1	1
4	VA Σ	INT32	Engineering unit: VA*0.1	0	1	1
2	PF Σ	INT16	Negative values correspond to lead(C), positive value correspond to lag(L). Engineering unit: PF*0.001	0	1	1
4	V L-L Σ	INT32	Engineering unit: Volt*0.1	4	1	1
4	V L-N Σ	INT32		0	1	1
4	A L1	INT32	Engineering unit: Ampere*0.001	1	1	1
4	A L2	INT32		2	1	1
4	A L3	INT32		3	1	1
FRAME #2						
4	W L1	INT32	Engineering unit: Watt*0.1	1	1	-
4	W L2	INT32		2	1	-
4	W L3	INT32		3	1	-
4	VAR L1	INT32	Engineering unit: Var*0.1	1	1	1
4	VAR L2	INT32		2	1	1
4	VAR L3	INT32		3	1	1
4	VA L1	INT32	Engineering unit: VA*0.1	1	1	1
4	VA L2	INT32		2	1	1
4	VA L3	INT32		3	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	1	1
2	PF L3	INT16		3	1	1
FRAME #3						
4	V L1-L2	INT32	Engineering unit: Volt*0.1	5	1	1
4	V L2-L3	INT32		6	1	1
4	V L3-L1	INT32		7	1	1
4	V L1-N	INT32		1	1	1
4	V L2-N	INT32		2	1	1
4	V L3-N	INT32		3	1	1
4	KWh (+) PAR	INT32	Engineering unit: Wh*100	4	1	-
4	Kvarh (+) PAR	INT32	Engineering unit: Varh*100	1	1	1
4	KWh (-) TOT	INT32	Engineering unit: Wh*100	5	1	-
4	Kvarh (-) TOT	INT32	Engineering unit: Varh*100	2	1	1
4	Hour	INT32	Engineering unit: Hour*0.01	0	1	1
2	Hz	INT16	Engineering unit: Hz*0.1	0	1	1
FRAME #4						
4	DMD W Σ	INT32	Engineering unit: Watt*0.1	4	1	-
4	DMD W Σ max	INT32	Engineering unit: Watt*0.1	5	1	-
4	DMD VA Σ	INT32	Engineering unit: VA*0.1	4	1	1
4	DMD VA Σ max	INT32	Engineering unit: VA*0.1	5	1	1
4	DMD A max	INT32	Engineering unit: Ampere*0.001	4	1	1

Table 2 –EM24 M-Bus Measurement Unit Coding (VIF/VIFE).

Measurement Unit	VIF	VIFE	
Watt*0.1	00101010b = 2Ah	–	PRIMARY M-BUS CODES
Wh*100	00000101b = 05h	–	
Volt*0.1	11111101b = FDh	01001000b = 48h	EXTENSION OF PRIMARY M-BUS CODES
VAR*0.1	11111111b = FFh	00000001b = 01h	EXTENSION OF M-BUS CODES (Manufacturer Specific)
PF*0.001	11111111b = FFh	00000010b = 02h	
Hz*0.1	11111111b = FFh	00000011b = 03h	
VARh*100	11111111b = FFh	00000100b = 04h	
VA*0.1	11111111b = FFh	00000111b = 07h	
Hour*0.01	11111111b = FFh	00001001b = 09h	
Wh(-)*100 (exported energy)	11111111b = FFh	00001011b = 0Bh	
VARh(-)*100 (exported energy)	11111111b = FFh	00001100b = 0Ch	
Watt L1*0.1	11111111b = FFh	00001101b = 0Dh	
Watt L2*0.1	11111111b = FFh	00001110b = 0Eh	
Watt L3*0.1	11111111b = FFh	00001111b = 0Fh	
Wsys DMD*0.1	11111111b = FFh	00010000b = 10h	
Wsys DMD max*0.1	11111111b = FFh	00010001b = 11h	
Ampere L1*0.001	11111111b = FFh	00010010b = 12h	
Ampere L2*0.001	11111111b = FFh	00010011b = 13h	
Ampere L3*0.001	11111111b = FFh	00010100b = 14h	
Ampere DMD max*0.001	11111111b = FFh	00010101b = 15h	
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	
VAsys DMD*0.1	11111111b = FFh	00011111b = 1Fh	
VAsys DMD max*0.1	11111111b = FFh	00100000b = 20h	
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	
Wh*100 PAR	11111111b = FFh	00100111b = 27h	
VARh*100 PAR	11111111b = FFh	00101000b = 28h	

Colours:

= Primary M-Bus Codes

= Extension of Primary M-Bus Codes

= Manufacturer Specific

3 REVISIONS

R0: This is the first release of the EM24 M1 (PFA, PFB & X models) communication protocol.
R1: correction of the normative related to the “dedication application layer”.