WM15 M-Bus

M-BUS COMMUNICATION PROTOCOL

Version 1 Revision 0

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Index

1 Introduction

The serial interface implemented in WM15 models supports the M-Bus protocol. In this document only the information necessary to read Data Measurement from WM15 has been reported (not all the parts of the protocol have been implemented).

2 M-Bus functions

The below reported functions are available on WM15:

- Single control character procedure SND_NKE
- Data Transfer (Request/Respond Procedure REQ/RSP)
- Reset function
- Switching Baudrate function
- Changing Primary Address
- Reset partial energy counters and meters
- Primary Data Request (SND_UD)

2.1 Single control character procedure SND_NKE

This 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 FAh (1 to 250)	
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 before answering (see also EN13757-3), as shown in the table below (three slave BAUDRATEs are available).

BAUD RATE	Min.	Max.
300 BAUD	36,6 ms	1,15 s
2400 BAUD	4,6 ms	187,5 ms
9600 BAUD	1,2 ms	84,4 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 shall not be accepted and the reply shall not be sent by the slave to master. The master must interpret the lack of a reply as a fault or wrong address.

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, EN13757-3. All data are transferred through M-Bus. The complete serial Slave Response take five 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	WM15
#1 (transmitted first)	Energies, System Powers, System PF, System Voltages and Currents measurement
#2	Phase Powers and Phase PFs measurement
#3	Phase Voltages, Energies and Frequency measurement
#4	Phase Energies, DMD, Max DMD measurement and run hours
#5	THD measurement

The DIF byte contains the coding for each transmitted parameter (16-bit integer, 32-bit integer or 64-bit integer).
DIFE are used to manage subunit.
VIF/VIFE bytes contain the measurement unit and its multiplier. WM15 uses two categories:

- Primary unit measurement
- Extended unit measurement

Each Data measurement available in WM15 is packed with its DIF, DIFE, VIF, VIFE, Data field. This last contains the numerical representation of the measured value. DIFE are not present if the measurement subunit is 0. 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 FAh (1 to 250)	
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 FAh (1 to 250)	
CI	1 byte	72h	
Ident. Nr.	4 Byte		
Manufr.	2 Byte	1C36h	"GAV", ID Manuf. according to EN60870
Version	1 Byte		Read from WM15
Medium	1 Byte	02h	02h = Electricity
Access No.	1 Byte		Incremented after each REQ_UD2 procedure
Status	1 Byte		See relevant paragraph
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 (optional, 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, max #4 VIFE)
Data	2, 4 or 8 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, 4 or 8 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 or has MDH field = 0Fh, this absence/value 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 (decimal)	Device
223	WM1596AV53XOMX, WM1596AV53XOMPFB

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 identification number
- to the byte "FFh" and can substitute a byte in Manufacturer field, Version field or Medium field

so that, during the slave's selection, it can be ignored. It is so possible to address groups of slaves whose secondary address (Identification number + Manufacturer field + Version field + Medium field) 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, see Table 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 FAh (1 to 250)	
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	

2.4 Switching Baudrate Function

The Master can set the Slave's Baud rate. 300, 2400 and 9600 BAUD are available (2400 is the default value). The Slave confirms the correctly received request by transmitting the E5h character with the old baudrate and uses the new baudrate from now on. It is necessary to wait at least 2 seconds after receiving the slave answer in order to WM15 is able to use the new baudrate.

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 FAh (1 to 250)	
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	

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. It is necessary to wait at least 2 seconds after receiving the slave answer in order to WM15 is able to use the new primary address.

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	0 to FAh (0 to 250)	
CI	1 byte	51h	
DIF	1 byte	01h	
VIF	1 byte	7Ah	
New Physical Address (Slave)	1 byte	0 to FAh (0 to 250)	
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	

2.6 Reset partial energy counters and meters

The Master can reset partial energy counters and meters of the Slave using a command with a Manufacturer-specific VIFE. The Slave confirms the correctly received request by transmitting the E5h character. This command resets:

- Partial kWh (+)
- Partial kWh (-)
- Partial kvarh (+)
- Partial kvarh (-)
- Partial kVAh
- Partial run hour meter (+)
- Partial run hour meter (-)

Request frame

Description	Length	Value	Note
Start	1 byte	68h	
L	1 byte	07h	
L	1 byte	07h	
Start	1 byte	68h	
Control	1 byte	53h or 73h	
Physical Address (Slave)	1 byte	0 to FAh (0 to 250)	
CI	1 byte	51h	
DIF	1 byte	01h	
VIF	1 byte	FFh	
VIFE	1 byte	50h	Manufacturer specific VIFE
Coding of available reset	1 byte	01h	Coding of available reset: 01h: Partial energy counters and meters
Check Sum	1 byte		Check Sum is the arithmetical sum (without carry) of Control Field, Physical Address (Slave), CI-Field, DIF, VIF, VIFE and coding of available reset
Stop	1 byte	16h	

Response frame (correct action)

Description	Length	Value	Note
Confirm Character	1 byte	E5h	

2.7 Primary Data Request (SND_UD)

The Master unit can acquire only a partition of all data stored in WM15, 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 32. The slave confirms the request with the E5h character. From now onwards, each REQ_UD2 → RSP_UD shall 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, FBh, 2Eh only the Hz*10 measurement will be obtained. With the string : 08h, FDh, 48h, 08h, FBh, 2Eh 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 maximum 2 Long Frame with maximum 16 measurements each, 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 FAh (1 to 250)	
CI	1 byte	51h	
Selector char	1 byte	08h	
Requested VIF #1	1 byte		
Requested VIFE #1 (if present)	1 byte		
Requested VIFE #1 (if present)	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		
Requested VIFE #2 (if present)	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	

2.8 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.

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

Primary address = 0h: should only be used for new meters which haven't yet been configured. WM15 manages this address as a valid address to help the commissioning of the network but it is recommended not to use it during the normal work of the meter. This is the reason why in all M-Bus functions except for the changing primary address request, the validity range of the primary address is [1 ; 250] and not [0 ; 250] even if primary address 0 works if it is the set primary address in the instrument. This address could be set during calibration of instrument as default setting and via a changing primary address request by M-Bus master. It is not possible setting this address using display programming mode

2.9 Status byte

Status byte is a byte of flags used by slave in REQ/RSP procedure and defined in EN13757-3:2013

5.10 Status byte in meter messages

Table 7 — Coding of the status field

Bit	Meaning with bit set	Significance with bit not set
0,1	See Table 8	See Table 8
2	Power low	Power ok
3	Permanent error	No permanent error
4	Temporary error	No temporary error
5	Specific to manufacturer	Specific to manufacturer
6	Specific to manufacturer	Specific to manufacturer
7	Specific to manufacturer	Specific to manufacturer

Table 8 — Application errors coded with the status field

Status bit 1 bit 0	Application status
0 0	No error
0 1	Application busy
1 0	Any application error
1 1	Abnormal condition / alarm

The status bits shall be used in this meaning:

Power low — Warning - The bit "power low" is set only to signal interruption of external power supply or the end of battery life.

Permanent error — Failure - The bit "permanent error" is set only if the meter signals a fatal device error (which requires a service action). Error can be reset only by a service action.

Temporary error — Warning – The bit "temporary error" is set only if the meter signals a slight error condition (which not immediately requires a service action). This error condition may later disappear.

Any application error — Shall be used to communicate a failure during the interpretation or the execution of a received command, e.g. if a not decrypt able message was received.

Abnormal conditions — Shall be used if a correct working application detects an abnormal behaviour like a permanent flow of water by a water meter.

WM15 manage only these bit (all the others are always set to 0):

Bit	Allowed values	Note
0, 1	0 0: no error 1 1: abnormal condition	
5	0: connection ok 1: connection error	
7	0: virtual alarm set to 0 (no alarm) 1: virtual alarm set to 1 (alarm triggered)	

Abnormal condition happens when an overflow condition occurs to at least one of the following variables:

- Phase-neutral voltages (VL1-N, VL2-N, VL3-N)
- Phase-phase voltages (VL1-L2, VL2-L3, VL3-L1)

- Phase currents (AL1, AL2, AL3)
- System frequency

3 TABLES

3.1 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. IEEE754 SP data format is not managed by WM15

3.2 Instantaneous variables and meters

Table1

Length (byte)	VARIABLE ENG. UNIT	Data Format	Notes	#SUB UNIT	VIF byte	VIFE#1 byte	VIFE#2 Byte
FRAME #1 (transmitted first)							
8	kWh (+) TOT	INT64	Engineering unit: Wh	0	03h		
4	Kvarh (+) TOT	INT32	Engineering unit: kVarh*0,1	0	FBh	82h	75h
4	W	INT32	Engineering unit: Watt*0.1	0	2Ah		
4	VAR	INT32	Engineering unit: kVar*0.0001	0	FBh	97h	72h
4	VA	INT32	Engineering unit: kVA*0.0001	0	FBh	B7h	72h
2	PF	INT16	Negative values correspond to exported active power Positive values correspond to imported active power Engineering unit: PF*0.001	0	FDh	BAh	73h
4	V L-L	INT32	Engineering unit: Volt*0.1	4	FDh	48h	
4	V L-N	INT32		0	FDh	48h	
4	A L1	INT32	Engineering unit: Ampere*0.001	1	FDh	59h	
4	A L2	INT32		2	FDh	59h	
4	A L3	INT32		3	FDh	59h	
FRAME #2							
4	W L1	INT32	Engineering unit: Watt*0.1	1	2Ah		
4	W L2	INT32		2	2Ah		
4	W L3	INT32		3	2Ah		
4	VAR L1	INT32	Engineering unit:k Var*0.0001	1	FBh	97h	72h
4	VAR L2	INT32		2	FBh	97h	72h
4	VAR L3	INT32		3	FBh	97h	72h
4	VA L1	INT32	Engineering unit: kVA*0.0001	1	FBh	B7h	72h
4	VA L2	INT32		2	FBh	B7h	72h
4	VA L3	INT32		3	FBh	B7h	72h
2	PF L1	INT16	Negative values correspond to exported active power Positive values correspond to imported active power Engineering unit: PF*0.001	1	FDh	BAh	73h
2	PF L2	INT16		2	FDh	BAh	73h
2	PF L3	INT16		3	FDh	BAh	73h
FRAME #3							
4	V L1-L2	INT32	Engineering unit: Volt*0.1	5	FDh	48h	
4	V L2-L3	INT32		6	FDh	48h	
4	V L3-L1	INT32		7	FDh	48h	
4	V L1-N	INT32	Engineering unit: Volt*0.1	1	FDh	48h	
4	V L2-N	INT32		2	FDh	48h	
4	V L3-N	INT32		3	FDh	48h	

4	KWh (+) PAR	INT32	Engineering unit: Wh*100	4	05h		
4	Kvarh (+) PAR	INT32	Engineering unit: kVarh*0.1	4	FBh	82h	75h
4	KWh (-) TOT	INT32	Engineering unit: Wh*100	5	05h		
4	Kvarh (-) TOT	INT32	Engineering unit: kVarh*0.1	5	FBh	82h	75h
2	Hz	INT16	Engineering unit: Hz*0.1	0	FBh	2Eh	
FRAME #4							
4	KWh (+) L1	INT32	Engineering unit: Wh*100	1	05h		
4	KWh (+) L2	INT32	Engineering unit: Wh*100	2	05h		
4	KWh (+) L3	INT32	Engineering unit: Wh*100	3	05h		
4	DMD W	INT32	Engineering unit: Watt*0.1	4	2Ah		
4	DMD W max	INT32	Engineering unit: Watt*0.1	5	2Ah		
4	DMD VA	INT32	Engineering unit: kVA*0.0001	4	FBh	B7h	72h
4	DMD VA max	INT32	Engineering unit: kVA*0.0001	5	FBh	B7h	72h
4	Run hour meter	INT32	Engineering unit: Hour*0.01	0	A6h	74h	
4	Run hour meter kWh(-)	INT32	Engineering unit: Hour*0.01	1	A6h	74h	
FRAME #5							
4	THD A1	INT32	Engineering unit: THD*0.01	1	FDh	BAh	74h
4	THD A2	INT32	Engineering unit: THD*0.01	2	FDh	BAh	74h
4	THD A3	INT32	Engineering unit: THD*0.01	3	FDh	BAh	74h
4	THD VL1-N	INT32	Engineering unit: THD*0.01	4	FDh	BAh	74h
4	THD VL2-N	INT32	Engineering unit: THD*0.01	5	FDh	BAh	74h
4	THD VL3-N	INT32	Engineering unit: THD*0.01	6	FDh	BAh	74h
4	THD VL1-L2	INT32	Engineering unit: THD*0.01	7	FDh	BAh	74h
4	THD VL2-L3	INT32	Engineering unit: THD*0.01	8	FDh	BAh	74h
4	THD VL3-L1	INT32	Engineering unit: THD*0.01	9	FDh	BAh	74h

3.3 M-Bus Measurement Unit Coding (VIF/VIFE).

Engineering Unit	VIF	VIFE #1	VIFE #2	
Watt*0.1	00101010b = 2Ah	-	-	**PRIMARY MBUS CODES**
Wh	00000011b = 03h	-	-	
Wh*100	00000101b = 05h	-	-	
Hour*0.01 (operating time)	10100110b = A6h	01110100b = 74h	-	
Volt*0.1	11111101b = FDh	01001000b = 48h	-	**EXTENSION OF PRIMARY MBUS CODES**
Ampere * 0.001	11111101b = FDh	01011001b = 59h	-	
PF*0.001 (dimensionless)	11111101b = FDh	10111010b = BAh	01110011b = 73h	
THD*0.01(dimensionless)	11111101b = FDh	10111010b = BAh	01110100b = 74h	
Hz * 0.1	11111011b = FBh	00101110b = 2Eh	-	
Kvarh * 0.1	11111011b = FBh	10000010b = 82h	01110101b = 75h	
Kvar * 0.0001	11111011b = FBh	10010111b = 97h	01110010b = 72h	
kVA * 0.0001	11111011b = FBh	10110111b = B7h	01110010b = 72h	

Colors:

= Primary M-Bus Codes

= Extension of Primary M-Bus Codes

3.4 Manufacturer-specific VIFE

Note: these VIFEs are introduced by the standard VIF FFh

Description	VIF (standard)	VIFE (Manufacturer-specific)
Reset counters and meters	11111111b = FFh	01010000b = 50h

4 Revisions

V1.0: Start revision