MV electrical network management

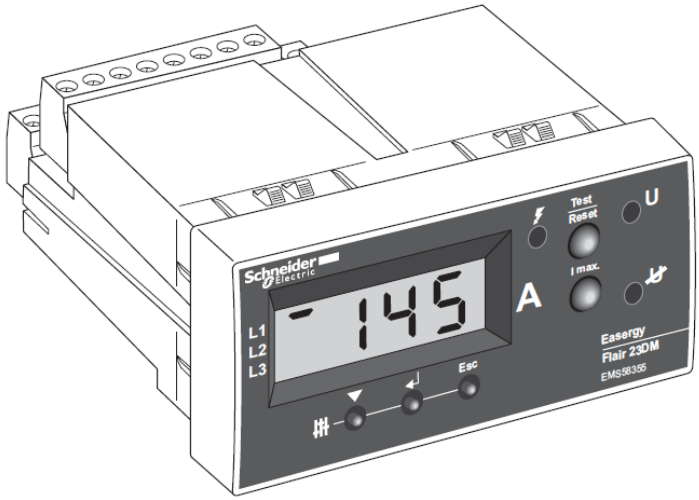
Easergy range

Flair 23DM

Communicating fault passage indicators
For all neutral arrangement system
Voltage detection relay

Modbus communication

Appendix to the user's manual



Schneider Electric

Summary

1 Presentation

The Flair 23DM has a communication port.

Modbus communication allows Flair 23DM relays to be connected to a supervisor or any other device with a master Modbus communication port.

Flair 23DM is always the slave.

Accessible data:

Modbus communication can be used to perform functions remotely such as:

- Reading of measurements, counters and diagnosis
- Reading of status conditions and remote indications
- Transfer of time-tagged events
- Reading of Flair 23DM identification
- Time-setting and synchronization
- Reading of settings
- Remote settings when these have been enabled
- Transmission of remote controls

Modbus protocol principle:

The Modbus protocol is used to exchange data by means of a request-response type mechanism between one station called the master and N slaves. Exchange initialization (sending the request) is always initiated by the master. The slave (Flair 23DM) can only respond to a request sent to it. When the network hardware infrastructure allows, several slaves can be connected to the same master. The request contains a slave number (address) to identify which is the destination. This number must be unique. Slaves that are not destinations ignore the request received.

Modbus Frame structure:

Each exchanged frame consists of a maximum of 255 bytes divided as follows (any frame with an error in format, parity, CRC 16, etc. is ignored):

Slave Number	Function	Data or Sub-Function Code	Control Word
1 byte	1 byte	n bytes	2 bytes
Request destination □ 0: broadcast (all) □ 1...247 (unique)	Refer to the next section	Request or response data (addresses/bit or word values, number of bits/bytes/data words) Sub-function code	CRC 16 (for detection of transmission errors)

The first two fields in the response are usually identical to those in the request.

Modbus Functions Supported

The Flair 23DM Modbus protocol is a subset of the Modbus RTU protocol:

- Data exchange functions
  - 1: read n output bits
  - 2: read n input bits
  - 3: read n output words
  - 4: read n input words
  - 5: write 1 bit
  - 6: write 1 word
  - 15: write n bits
  - 16: write n consecutive words

- Communication management functions
  - 8: read Modbus diagnosis counters
  - 11: read Modbus event counter
  - 43 with sub-function 14: read identification
  - 43 with sub-function 15: read date and time
  - 43 with sub-function 16: write date and time

- Protocol for managing time-tagged events

- Protocol for managing date and time synchronization

Broadcast commands are necessarily write commands. No reply is transmitted by the slaves.

Structure of Exception Frames

An exception frame sent by the destination Flair 23DM for the request consists of the following fields:

Slave Number	Exception Function Code	Exception Code	Control Word
1 byte	1 byte	1 byte	2 bytes
Request destination	Request function code +128 (80h)	Possible codes □ 1: unknown function code □ 2: incorrect address □ 3: incorrect data	CRC 16 (for detection of transmission errors)

Turnaround time

The response time Tr is the time between the end of receipt of a request and sending the response:

Note: Tr includes the silence between 2 frames and is usually expressed for a format of 8 bits, odd parity, 1 stop bit, at 9,600 Bauds.

The Flair 23DM response time is less than 10 ms (for all the speeds supported).

Synchronizing Exchanges

Any character received after a silence lasting more than 3.5 characters is deemed to be the start of a frame.

A minimum silence with more than 3.5 characters must always be kept

between 2 frames.

At 38400 bauds, this silence time is equal to 1,75 ms.

A slave ignores any frame:
- □ received with a physical error on one or more characters (format, parity error, etc.)
- □ with an invalid CRC 16
- □ which is not addressed to it

2 Commissioning and diagnosis

Modbus protocol parameters

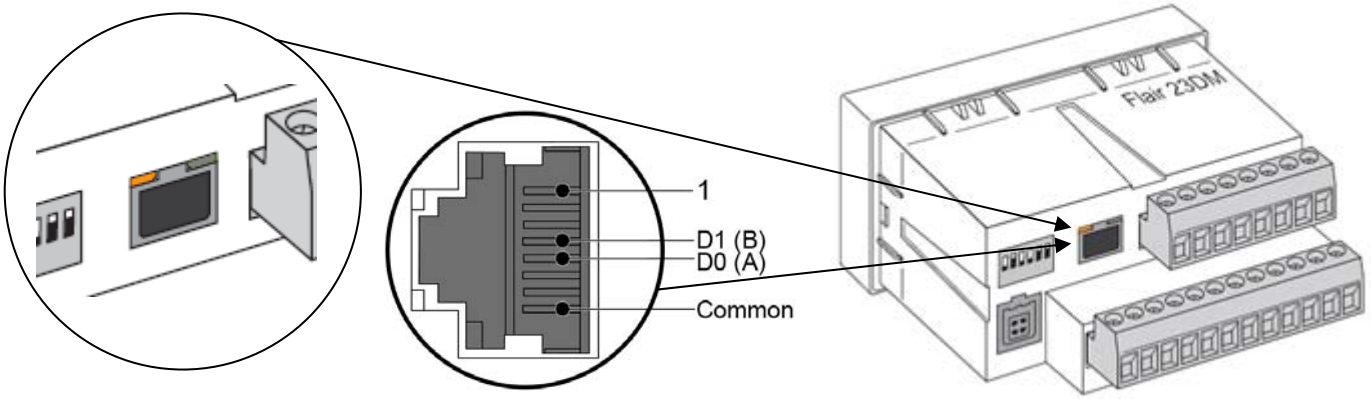
Parameters on HMI	Designation	Authorized values	Display on HMI	Default value
Cubn	Cubicle number	□ 0 (the Modbus address is configurable manually) □ 1…29 (the Modbus address is proposed automatically depending to the cubicle number defined)	**nonE** **1…29**	0
Addr	Modbus address Modbus	1...247 (the Modbus address, configured automatically from the Cubicle number value, is defined as follow: @ = 33+ 5x(CubicleNb-1). The Modbus address can be changed manually, if the one proposed automatically is not appropriate. In this case, modification of the address changes automatically the Cubicle number to 0.	**1…247**	247
bAUd	Baud rate	□ Auto-mode (*) □ 1200 Baud □ 2400 Baud □ 4800 Baud □ 9600 Baud □ 19200 Baud □ 38400 Baud	**Auto** **1.2** **2.4** **4.8** **9.6** **19.2** **38.4**	Auto-mode
Prty	Parity (hidden parameter if Auto-mode activated	□ None (1 stop bit) □ Even (1 stop bit) □ Odd (1 stop bit)	**None** **EUEn** **Odd**	Even
rCnF	Remote control	□ OFF: Remote settings not enabled □ ON: Remote settings enabled	**OFF** **On**	ON
SbO	Selection before execution	□ OFF: Remote control in direct mode □ ON: Remote control in SBO mode (Selection Before Execution)	**OFF** **On**	OFF

(*): The Auto-Mode supports only the values highlighted in gray in the table.

Link activity LED

The Orange LED on the upper and left part of the RJ45 connector is activated when a traffic is detected on the Modbus port. (blinking: 200ms ON / 800 ms OFF)

Note: the second LED on the upper and right part of the RJ45 connector is not used.



Modbus Link Diagnosis

To check that the link is operating correctly, the user can refer to:
1. the link activity LED, on the RJ45 connector of Modbus RS485 link
2. the Modbus diagnosis counters and the Modbus event counter

2.1 Automatic Adaptation of the Configuration: Auto-mode

Presentation

The "Auto-mode" mechanism is a device for simplifying the Modbus device configuration. Its algorithm allows a Flair 23DM (slave) to automatically detect the configuration used on the Modbus link to which it is connected.

Operation

The algorithm in the "Auto-mode" mechanism automatically detects the network parameters by testing the available transmission speeds and parities. The Modbus master must send at least 13 frames on the Modbus network before the "Auto-mode" mechanism algorithm works. There must be enough traffic on the link before the Flair 23DM can be deemed to be absent or in faulty status.

The detection of network parameters begins firstly at maximum speed (38400 baud). Then, if detection is not conclusive, detection continues with the next lower speed (e.g. 19200 baud) and so on in order to detect the suitable speed.

The detected network parameters are deemed to be valid after correct reception of three different frames. In this case, the product will use the detected parameters and will save them in non-volatile memory.

Note: If the Modbus configuration set on the Flair 23DM is modified manually by the installer to fix the speed to a specific value, the "Auto-mode" mechanism will be disabled. The automatic search of network parameters will be only active again if Auto-mode is re-activated manually.

Note: On restarting the Flair 23DM, the saved Modbus parameters on the product will be memorized. In the event of a fault on restarting, the search phase will be disabled.

The research phase is restarted from the last speed memorized by the Auto-mode and it will validates again this speed if 7 valid frames are detected at that speed. Thereafter, the research phase is restarted after 7 successive faults detected during operation.
Moreover, it is possible to disable the "Auto-mode" mechanism and then manually set the Modbus network parameters

Detectable Configurations

The 3 configurations supported by the algorithm are as follows:
- “Even” parity, 1 stop bit
- “Odd” parity, 1 stop bit
- no parity, 1 stop bit

associated with the following 3 transmission speeds:
- 9,600 Baud
- 19,200 Baud
- 38,400 Baud

i.e. a total of 9 detectable configurations.

Note: It is recommended to avoid the format "no parity". When operating on a network "no parity", the Flair23DM select the format "no parity, 1 stop bit" whatever the number of stop bits used by the Master.

2.2 Access to data

Addressing a word

All Flair 23DM data that can be accessed by Modbus communication is organized into 16-bit words. Each word is identified by its address, coded on 16 bits, i.e. from 0 to 65535 (FFFFh).

Addressing a bit

Some data can also be accessed in the form of a bit. The bit address is then deducted from the word address by:

Bit address = (word address x 16) + bit number (0...15).

Example:
Address word 3072 (0C00h)
bit 0 address = C000h
bit 14 address = C00Eh

Undefined Addresses

Only addresses defined in this document should be used. If other addresses are used, the Flair 23DM can either respond with an exception message, or provide non-significant data.

Access mode

The data are direct-access: they are permanently identified by their Modbus address. These can be reached in a single read or write operation, applying to all or part of the relevant zone.
In Flair 23DM, all zones are accessed directly, however for some zones, such as those for time-tagged events, a particular protocol can be used to optimize exchanges with the supervisor. This protocol is specified in the relevant zones.

2.3 List of Address zones

The accessible registers of Flair 23DM that can be read through the communication are grouped in the following table:

Address zones	Word Address Range (Hexadecimal)	Word Address Range (Decimal)	Length (word16)	Access Mode	Access Type
Time synchronization zone	**0002h to 0005h**	**2 to 5**	**4**		
Synchronization zone	0002h to 0005h	2 to 5	4	Direct	Word
Identification zone	**0006h to 003Fh**	**6 to 63**	**58**		
Identification data	0006h to 003Fh	6 to 63	58	Direct	Word
Remote control zone	**00F0h to 00F5h**	**240 to 245**	**6**		
TCS	00F0h to 00F3h	240 to 245	4	Direct	Word / Bit
Remote information's zone	**0100h to 0103h**	**256 to 259**	**2**		
TSS	0100h to 0103h	256 to 259	2	Direct	Word / Bit
Remote metering zone	**0400h to 040Dh**	**1024 to 1037**	**14**		
TM	0400h to 040Dh	1024 to 1037	14	-	-
Counters zone	**0500h to 050Dh**	**1280 to 1293**	**14**		
CNT	0500h to 050Dh	1280 to 1293	14	Direct	Word
Network management zone	**0A20h to 0A2Fh**	**2592 to 2606**	**16**		
Network management	0A20h to 0A2Fh	2592 to 2606	16	Direct	Word
Remote settings zone	**1E00h to 1E2Fh**	**7680 to 7727**	**34**		
Remote setting zone #1	1E00h to 1E12h	7680 to 7698	18	Direct	Word
Remote setting zone #2	1E20h to 1E27h	7712 to 7719	8	Direct	Word
Remote setting zone #3	1E28h to 1E2Fh	7720 to 7727	8	Direct	Word
Event table zone	**E000h to E4B1h**	**57344 to 58545**	**1202**		
Event table	E000h to E4B1h	57344 to 58545	1202	indirect	Word

Note: the address zones not mentioned in this table are reserved addresses.

2.4 Data coding

Format used

Apart from exceptions mentioned in the text, Flair 23DM data is coded in one of the formats below:

- 32S: signed value, coded on 32 bits
- 16S: signed value, coded on 16 bits
- B: bit or set of bits
- ASCII *n*c: string of n characters in ASCII code
- IEC: time coding format on 4 words conforming to IEC 60870-5-4.

32S Format

Flair 2xD does not support 32-bit measurements. This format is only valid for the counters.

In 32S format, the first word is the most significant.

An incalculable value, whether invalid or outside the authorized range, is fixed at 2147483648 (80000000h).

16S Format

An incalculable value, whether invalid or outside the authorized range, is fixed at 32768 (8000h).

ASCII Format

ASCII format is used to code the identification strings for a Flair 23DM.
When the ASCII strings do not fill up the field entirely, they are completed with null bytes.
The first character occupies the most significant byte on the first word, the second the least significant byte on the first word, etc.

IEC Format

The date and time are coded on 4 words, in IEC 60870-5-4 format (bits at 0 in the table are not used: they are always read at 0 and ignored in write mode):

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word	Reserved (0 in read mode, variable in write mode)								0	Year (0...99)						
Word	0	0	0	0	Month (1...12)				0	0	0	Day (1...31)				
Word	0	0	0	Hour (0...23)					0	0	Minutes (0...59)					
Word	Milliseconds (0...59,999)															

Year - 1 byte for years: varies from 0 to 127 years. (1/1/2000 to 31/12/2127).
Month - (4 bits) for months: varies from 1 to 12.
Day – Day of Month, (5 bits): varies from 1 to 31.
Hour - 1 byte for hours: varies from 0 to 23.
Minute - 1 byte for minutes: varies from 0 to 59.
Millisecond - 2 bytes for milliseconds: varies from 0 to 59999.

2.5 Synchronization, identification zone

Introduction

Synchronization, identification, metering, network diagnosis and test zones are accessed directly and do not contain any events.
For each zone, a table contains the following information:

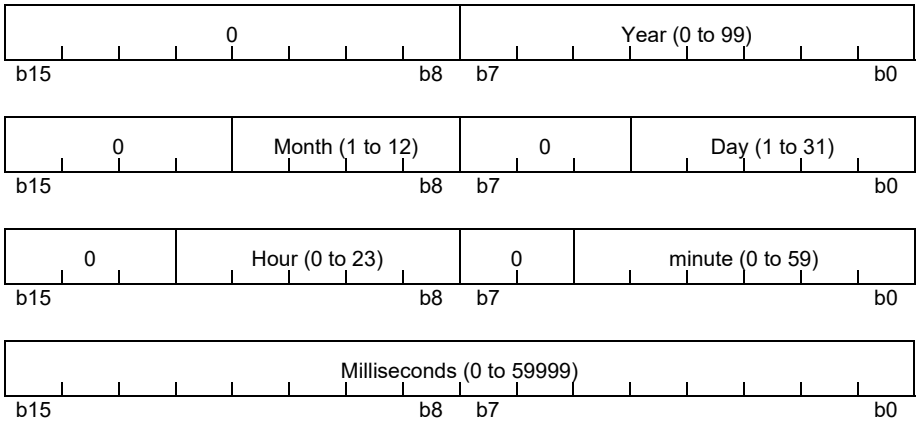
- description of the addresses in the zone
- codes for Modbus functions that can be used in read mode
- codes for Modbus functions that can be used in write mode
- if necessary, the formats and resolution of the stored data

Synchronization zone

The synchronization zone contains the 4 words used to code the absolute time required for time-tagging events:

Description	Address	Read	Write	Format
Binary time (year)	2 (0002h)	3	16	IEC
Binary time (month + day)	3 (0003h)	3	16	
Binary time (hours + minutes)	4 (0004h)	3	16	
Binary time (milliseconds)	5 (0005h)	3	16	

Note: The write operation should be performed on the whole zone and uses start address 0002 with a length of 4 words.

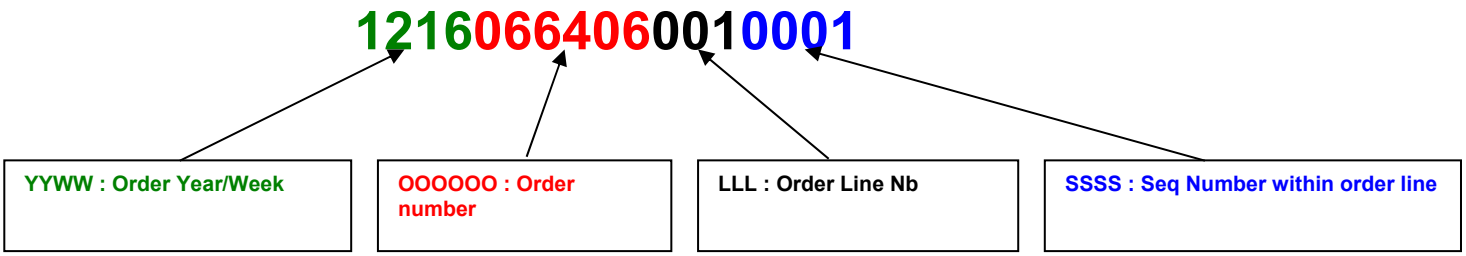


Identification zone

The identification label contains:
- 10 words, used to code the serial number on a Flair 23DM unit
- 1 word for the cubicle number
- 1 word for the product type
- 48 to encode the basic identification of Flair 23DM.

Description	Address	Read	Write	Format	Value
Serial Number	2598…2607 (0A26h...0A2Fh)	3	–	ASCII	(see after)
Cubicle_Number	14 (000Eh)	3	–	16S	1 to 29 0 means not used
Device_Type	15 (000Fh)	3	–	16S	1 = Fault detector
Device Identification	16…63 (0010h...003Fh)	3	–	ASCII	Basic identification

Serial number:
The Flair 23DM provides a specific product coding (serial number) on 17 characters, within a 10 registers area:



The serial number is coded as follows:

Bit➔ Mot⬇	Bit➔ Word⬇	15 14 13 12 11 10 9 8	7 6 5 4 3 2 1 0
2598	0A26h	Order Year (First ASCII character "0" .."9")	Order Year (Second ASCII character "0" .. "9")
2599	0A27h	Order Week (First ASCII character "0" .. "5")	Order Week (Second ASCII character "0" .. "9")
2600	0A28h	Order Number (First ASCII character "0" .."9")	Order Number (Second ASCII character "0" .. "9")
2601	0A29h	Order Number (Third ASCII character "0" .."9")	Order Number (Fourth ASCII character "0" .. "9")
2602	0A2Ah	Order Number (Fifth ASCII character "0" .."9")	Order Number (Sixth ASCII character "0" .. "9")
2603	0A2Bh	OrderLineNb (First ASCII character "0" .. "9")	OrderLineNb (Second ASCII character "0" .. "9")
2604	0A2Ch	OrderLineNb (Third ASCII character "0" .. "9")	SeqNbinLine (First ASCII character "0" .. "9")
2605	0A2Dh	SeqNbinLine (First ASCII character "0" .. "9")	SeqNbinLine (Second ASCII character "0" .. "9")
2606	0A2Eh	SeqNbinLine (Third ASCII character "0" .. "9")	Reserved (NULL=0)
2607	0A2Fh	Reserved (NULL =0)	Reserved (NULL=0)

Product identification:

(see the corresponding chapter)

2.6 Reading of Flair 23DM identification

Introduction

The Read Device Identification function can be used for standard access to the information required for identification of a device.

The description below is a subset of the function options, adapted to the example of Flair 23DM.

The main identification data are also accessible by direct reading of registers at the addresses below.

Note: Data of Group 2A are not accessible by direct reading.

Identification du Flair 23DM

The Flair 23DM identification consists of strings of ASCII characters called *objects*.

The Flair 23DM objects are divided in three groups:

Group	Nb	Object	Value	Lenght	Address	Read
1 Basic	0h	VendorName	“Schneider Electric”	18 (12h)	16…24 (0010h..0018h)	3
	1h	ProductCode (reference coded in EAN13 format)	“(EAN13)3 60648 05158 42”	20 (14h)	25...34 (0019h..0022h)	3
	2h	MajorMinorRevision (application version number)	“xxx.yyy” (i.e.: 001.004)	7	35…38 (0023h..0026h)	3
2A Regular	3h	VendorURL	“www.schneider-electric.com”	26 (1Ah)		3
	4h	ProductName	“FLAIR Serie 20”	14		3
	5h	ModelName (short identification code)	“FLAIR23DM”	8		3
	6h	UserApplicationName	“Exploitation”	12 (0Ch)		3
3 Extended	80h	FirmwareSubRevision number (last field of the application version number)	“zzz” (i.e.: 000)	3	39…40 (0027h..0028h)	3
	81h	PPID MajorMinorRevision (communication protocol version)	“xxx.yyy” (i.e.: 000.002)	7	2592…2595 (0A20h..0A23h)	3
	82h	PPID SubRevision number (last field of the communication protocol version number)	“zzz” (i.e.: 000)	3	2596…2597 (0A24h..0A25h)	3
	83h	Serial number	Refer to the identification zone that describes the serial number format.	17 (11h)	2598…2607 (0A26h..0A2Fh)	3

Note: PPID = Product Protocol Interface Description.

Product Code

The EAN13 code identifies the reference for a Flair 23DM universally in 13 digits:

Standards Organization	Manufacturer	Reference	Checksum
3	60648	05158	42

Request frame

The read identification request frame consists of the following fields:

Field	Size (Bytes)	Value
Slave number	1	1...247
Function code	1	43 (2Bh)
MEI type (sub-function code)	1	14 (0Eh)
Read type	1	01 or 02 or 03 or 04
Not used	1	00
CRC16	2	Calculated

Response frame

The response frame consists of the following fields:

Field	Size (Bytes)	Value
Slave number	1	1...247
Function code	1	43 (2Bh)
MEI type (sub-function code)	1	14 (0Eh)
Read type	1	01 or 02 or 03 or 04
Conformity level	1	131 (83h)
Not used	1	00
Not used	1	00
Number of objects	1	n = 3, 7 or 11, according to the Read type field
First object number	1	obj1
First object length	1	lg1
First object ASCII string	lg1	txt1
...	...	...
nth object number	1	objn
nth object length	1	lgn
nth object ASCII string	lgn	txtn
CRC16	2	Calculated

Exception frame

If an error occurs while processing the request, the Flair 23DM sends an exception frame, consisting of the following fields:

Field	Size (Bytes)	Value
Slave number	1	1...247
Function code increased by 80h	1	171 (ABh)
MEI type (sub-function code)	1	14 (0Eh) or other if MEI type received is incorrect.
Exception code	1	01: MEI type received is incorrect (≠ 14). 02: in cases of individual access (read code 04), if the requested object does not exist. 03: incorrect data (frame length incorrect or read code invalid).
CRC16	2	Calculated

2.7 Measurement and counters zone

Measurement zone

Description	Address Decimal	Address Hexa.	Read	Write	Format	Unit	Range
Phase current I1	1024	0400h	3, 4	–	16S	1 A	0-800 A
Phase current I2	1025	0401h	3, 4	–	16S	1 A	0-800 A
Phase current I3	1026	0402h	3, 4	–	16S	1 A	0-800 A
Residual current Io	1027	0403h	3, 4	–	16S	1 A	0-800 A
Maximeter phase current IM1	1028	0404h	3, 4	–	16S	1 A	0-800 A
Maximeter phase current IM2	1029	0405h	3, 4	–	16S	1 A	0-800 A
Maximeter phase current IM3	1030	0406h	3, 4	–	16S	1 A	0-800 A
% nominal voltage phase V1	1031	0407h	3, 4	–	16S	1 %	0-1000%
% nominal voltage phase V2	1032	0408h	3, 4	–	16S	1 %	0-1000%
% nominal voltage phase V3	1033	0409h	3, 4	–	16S	1 %	0-1000%
% nominal voltage residual V0	1034	040Ah	3, 4	–	16S	1 %	0-1000%
% nominal voltage phase U12	1035	040Bh	3, 4	–	16S	1 %	0-1000%
% nominal voltage phase U13	1036	040Ch	3, 4	–	16S	1 %	0-1000%
% nominal voltage phase U23	1037	040Dh	3, 4	–	16S	1 %	0-1000%

Note: all the TM are read only.

Counters zone

Description	Address Decimal	Address Hexadecimal	Read	Write	Format
Phase + Earth Fault counter	1280 to 1281	0500h to 0501h	R/P	32S	Confirmed fault passages
Phase Fault counter	1282 to 1283	0502h to 0503h	R/P	32S	Confirmed fault passages
Earth Fault counter	1284 to 1285	0504h to 0505h	R/P	32S	Confirmed fault passages
Transient Phase Fault counter	1286 to 1287	0506h to 0507h	R/P	32S	Unconfirmed fault passages
Transient Earth Fault counter	1288 to 1289	0508h to 0509h	R/P	32S	Unconfirmed fault passages
Voltage Presence Loss counter	1290 to 1291	050Ah to 050Bh	R/P	32S	Relay1
Transient Voltage Presence Loss counter	1292 to 1293	050Ch to 050Dh	R/P	32S	Relay1. Duration shorter than minimal duration (T12)

Note: R/P = Read/Preset

Counters for Modbus diagnosis

The diagnosis counters are read using function 8 and sub-codes 000Bh to 0012h depending on the counter.
Function 8 can also be used in echo mode (sub-code 0000h):

Function	Frame Sent	Frame Expected in Response
8 in echo mode	01 08 0000 1234 ED7C	01 08 0000 1234 ED7C

Event counter is read using function 11.

Also accessible as manufacturer data by direct register access:

Description	Address	Read	Write	Format
Reset counters	62464 (F400h)	-	6, 16	1 = reset
Bus Message Count	62465 (F401h)	3		
Bus Communication Error Count	62466 (F402h)	3		
Slave Exception Error Count	62467 (F403h)	3		
Slave Message Count	62468 (F404h)	3		
Slave No Response Count	62469 (F405h)	3		
Idle count	62470 (F406h)	3		If no activity > 80ms

May be displayed also locally on the product by the following operation:
- 5s press on ESC button => the Flair 23DM displays "Fact", blinking
- press left button "▾" within 3s (if not will the product will be reseted)
- navigate to reach "CPT" menu
- use the "↵" button to freeze/unfreeze circular display of counter values
- use Test/Reset button during counter display to reset them (other Reset can be done via communication or general reset of product

Resetting counters

The counters are reset to 0 in the following cases:
- when they reach the maximum value 65535 (FFFFh)
- when they are reset by a Modbus command (function 8, sub-code 000Ah)
- during a power failure of Flair 23DM.

2.8 Remote Control zone

Introduction

Remote control orders are transmitted to the Flair 23DM via pulse type remote control orders using one of the following two modes, chosen via the settings:
- Direct mode
- Confirmed SBO (Select Before Operate) Mode.

Remote Control zone

The remote control zone contains:

Description	Word addresses	Read	Write	Format
Single remote control orders (TCS)	240 (00F0h)	1, 2, 3, 4	5, 6, 15, 16	B
Reserve for TCS	241-242 (00F1h-00F2h)	-	-	-
Selection of single remote control orders	243 (00F3h)	1, 2, 3, 4	5, 6, 15, 16	B
Reserve for selection of TCS	244-245 (00F4h-00F5h)	-	-	-

Single remote control order words

Each Remote Single Command TCS Word is encoded as follows:

TCS16	TCS15	TCS14	TCS13	TCS12	TCS11	TCS10	TCS9	TCS8	TCS7	TCS6	TCS5	TCS4	TCS3	TCS2	TCS1
b15							**b08**	**b07**							**b00**

The remote-control order assigned to each bit in the remote control words (address 00F0h) and remote control selection words (address 00F3h) is predefined:

Word	Bit	Remote Control Word	Selection Word (SBO)	Remote Control Order
		Bit address	Bit address	
240 (00F0h)	00	3840 (0F00h)	3888 (0F30h)	Reset of phase currents maximeter
	01	3841 (0F01h)	3889 (0F31h)	Reset of fault current indication
	02...14	3842…3854 (0F02h...0F0Eh)	3890…3902 (0F32h...0F3Eh)	Reserved
	15	3855 (0F0Fh)	3903 (0F3Fh)	Check of the communication by a visual signalization (*)

(*): This command activates a rapid flash on the LED of fault detection on Flair 23DM for 30 seconds and permit so to check the communication between the master and the Flair 23DM.

The selection word is only used for the "confirmed SBO" mode.

Note: a single remote control order changing to zero does not generate time-tagged events

Command rejection at communication level

Remote command may be rejected at communication level with following reasons:

- exception 3 (Illegal data value) if remote command is inconsistent or in case of select/operate issue (not selected, timeout elapsed, …)
- exception 2 (Illegal Data Address) if requested command is not supported by the Flair 23DM
- exception 6 (Slave Busy) if Flair 23DM is busy (command under execution).
-

Direct mode

If remote control orders are configured in “direct” mode, the remote control order is executed immediately on writing to the remote control word. Resetting is performed by the control logic after the remote control order has been taken into account.

Confirmed SBO mode

The remote control order is executed in two steps:

1. Selection by the supervisor of the command to be sent by writing the bit in the remote control selection word and checking the selection if necessary by re-reading this word.
2. Execution of the command to be sent by writing the bit in the remote control word.

Note: when this mode is selected, it applies to all control orders.

The remote control order is executed if the remote control selection word bit and the associated remote control word bit are set, both word bits are reset by the control logic after the remote control order has been taken into account. Deselection of the selection word bit occurs:

- if the supervisor deselects it by writing in the selection word
- if the supervisor selects (writes) a different bit from that already selected
- if the supervisor sets a bit in the remote control word that does not correspond to that selected (in this case no remote control order will be executed)

No remote control will be executed:

- if the corresponding order is not sent within a period of 30 seconds

2.9 Remote Control Order and Status Zone

Introduction

Status conditions and remote indications are pre-assigned to fault detection or voltage presence functions. They can be read using bit or word functions.

Remote Control Order and Status Zone

The status condition and remote indication zone contains 10 words that group together status bits. It also provides the remote control order feedback code:

Description	Word address	Bit address	Read	Write	Format
Control word	256 (0100h)	1000h...100Fh	1, 2, 3, 4	–	B
Status word	257 (0101h)	1010h...101Fh	1, 2, 3, 4	–	B
Remote indication no. 1 word (TSS 1)	258 (0102h)	1020h...102Fh	1, 2, 3, 4	–	B
Remote indication no. 2 word (TSS 2)	259 (0103h)	1030h...103Fh	–	–	–
Reserved	260…263 (0104h…0108h)	1040h...108Fh	–	–	–

Control word (Address 0100h)

Word	Bit	Bit Address	Status
256 (0100h)	00...03	4096..4099 (1000h...1003h)	Reserved
	04	4100 (1004h)	Flair 23DM time incorrect (no reception of date and time)
	05	4101 (1005h)	Flair 23DM not synchronized (too long time since last refreshment or too big deviation)
	06	4102 (1006h)	Flair 23DM initialization in progress
	07...15	4103..4111 (1007h...100Fh)	Reserved

Note: bit 06 changing to zero doesn't generate time-tagged events.

Status word (Address 0101h)

The status word specifies the main functions when on:

Word	Bit	Bit Address	Status
257 (0101h)	00…12	4112…4124 (1010h…101Ch)	Reserved
	13	4125 (101Dh)	Setting change of Flair 23DM
	14…15	4126…4127 (101Eh…101Fh)	Reserved

Note: bit 13 changing to zero does not generate time-tagged events.

Remote indication No. 1 (Address 0102h)

The remote indication No. 1 signals the status related to the voltage detection:

Word	Bit	Bit Address	Remote indication
258 (0102h)	00	4128 (1020h)	Voltage presence (on all phases)
	01	4129 (1021h)	Voltage presence V1 or U12
	02	4130 (1022h)	Voltage presence V2 or U13
	03	4131 (1023h)	Voltage presence V3 or U23
	04	4132 (1024h)	Residual voltage presence (summation of the three
	05	4133 (1025h)	Transient voltage presence loss (generate an event)
	06	4134 (1026h)	Reserved
	07	4135 (1027h)	Reserved
	08	4136 (1028h)	Voltage absence (on all phases)
	09	4137 (1029h)	Voltage absence V1 or U12
	10	4138 (102Ah)	Voltage absence V2 or U13
	11	4139 (102Bh)	Voltage absence V3 or U23
	12...15	4140…4143 (102Ch...102Fh)	Reserved

Note: voltage presence/absence per phase is valid if corresponding phase voltage measurement is configured as "active". It relates to simple or composed voltages depending on "Voltage Measure Type" parameter.

Remote indication No. 2 (Address 0103h)

The remote indication No. 2 signals the status related to the current fault detection:

Word	Bit	Bit Address	Remote indication
259 (0103h)	00	4144 (1030h)	Phase fault
	01	4145 (1031h)	Earth fault
	02	4146 (1032h)	Earth fault on phase 1
	03	4147 (1033h)	Earth fault on phase 2
	04	4148 (1034h)	Earth fault on phase 3
	05	4149 (1035h)	Transient phase fault
	06	4150 (1036h)	Transient earth fault
	07	4151 (1037h)	Fault by test action
	08	4152 (1038h)	Phase or earth fault
	09...15	4153…4159 (1039h...103Fh)	Reserved

2.10 Time-tagged events

Introduction

The Flair 23DM includes a time-tagged event mechanism so that its operation can be monitored using a supervisor.
This data can be retrieved via the Modbus link.
This data is volatile and will therefore be lost if the product is de-energized.

Event types

The Flair 23DM manages *logic events, a*ny change of state on Flair 23DM logic variable (bit in control, status or remote indication words).

Each event is mainly characterized by:
- an identifier: Modbus address of associated data bit
- a value (for logic events, it is the direction of change)
- a date and time: the event is time-tagged (resolution: 1 ms)

Time-Tagging

Time-tagging of events uses the Flair 23DM internal clock. When an event is detected, the Flair 23DM's current time is associated with it.

During the initialization phase, the clock starts at "1st January 2000 00h 00min 0sec".
It will be re-synchronized to the current date and time after reception of the synchronization or on time setting.
The chronology of detected events remains valid in all cases

Description of how to code an Event

An event is coded on 12 words with the following structure:

Word	Information	Coding
1	Event number	Between 1 and 65535
2...5	Date and time of the event	In IEC 60870-5-4 format
6 (MSB)	Number of associated events	0 (no secondary event associated with the Flair23DM events)
6 (LSB)	Type of data	Boolean (04h)
7	Event identifier	Address of the associated data bit
8...11	Associated data	Direction of the event: - 0: deactivation/disappearance - 1: activation/appearance
12	Primary or secondary event identifier	Between 1 and 65533. Used to identify the event.

Nota:

- Event numbering starts at no. 1 and ends with no. 65535. When event no. 65535 is detected, the next event numbering restarts at no. 1.
- The most significant byte of word no. 6 corresponds to the type of event (primary or secondary). On Flair 23DM, events are always primary type (no associated secondary events).
- The event identifier always corresponds to a Modbus data address defined on the Flair 23DM.
- For Boolean type, words 8, 9 and 10 are set to 0.
- Word 12 is incremented 2 at a time on each event.

Event tables

The Flair 23DM manages an internal storage table with a capacity of 100 events. Upstream of the table, 2 words contain:

- the current number of events present in the queue (between 0 and 100)
- the number of the last detected event

Both these words and the number of the first event in the table form a header that will be used by the supervisor to detect presence of new events.

The table can be seen as a FIFO (First In/First Out) type stack.

		Addresses	Description	Read	Write
Header		57344 (E000h)	Number of events in table	3	–
		57345 (E001h)	Number of last event in table	3	–
	Table of 100 events	57346 (E002h)	Index 0 event (event number)	3	–
		57347…57357 (E003h…E00Dh)	Index 0 event (rest of data)	3	–
		57358…57369 (E00Eh…E019h)	Index 1 event	3	–
		...	...	3	–
		58533…58545 (E4A5h…E4B1h)	Index 99 event	3	–

Note: reading the events table is not “destructive”. An event no. “x” will only be removed from the table if 100 new events have been detected (in other words, event no. “x+100” has been detected).
It is to the Modbus client(s) to detect loss events if the table of events has come full cycle since the last reading from the client(s).

Initializing the Events Table

On starting, the Flair 23DM initializes its events table by filling all the registers (table and header) with the value 0 (no event recorded).

When it starts, the Flair 23DM always adds three events:

- initialization in progress
- date/time incorrect (not configured since start-up)
- not synchronized

These three events are destined for the supervisor for time synchronization and detection of product resetting.

Read sequence

The consultation protocol for time-tagged events includes a standard sequence that can be executed by a supervisor to detect and retrieve new events present on the Flair 23DM.

This sequence is divided into two parts:
- detection of new events on the Flair 23DM
- reading of new events on the Flair 23DM

Detection of new events on the Flair 23DM: new events are detected by periodic reading of the header in the time-tagged events zone (addresses E000h to E002h).

If the “number of last event” in table changes between two header readings, one or more events have been added to the table. The supervisor can then read the new events.

Read Previous Header (n-1)		**Read Current Header (n)**	
Address	**Value**	**Address**	**Value**
57344 (E000h)	X	57344 (E000h)	X
57345 (E001h)	Y	57345 (E001h)	Y
57346 (E002h)	Z	57346 (E002h)	Z

Reading of new events on the Flair 23DM: based on values read in the headers, the supervisor can determine the Modbus register ranges to be read to obtain the new event data.

The number of new events detected equals “Y’-Y”.

The supervisor determines the position (index) in the table of the first and last new event starting from the event number stored at index 0 of the table (“Z’”).

The Modbus register addresses associated with the new events can be deduced from the indexes:
- event start address = E002h + index * 12
- event end address = E002h + (index + 1) * 12 - 1

Loss of Events

If the number of new events exceeds the table capacity, only the 100 most recent events will still be accessible. The oldest events will be lost forever.
The supervisor is responsible for retrieving events from the Flair 23DM. It is up to him to adapt his consultation strategy to avoid the loss of events.

List of possible events

The Flair 23DM has a number of time-tagged events whose descriptions appear below.

Boolean events:

- Data type: Boolean (format code: 04h)
- Possible values: 0 or 1
- The description corresponds to value “1” of the event.
- The two columns on the right indicates the saving conditions of event depending to the type of change of the associated variable.

(0 -> 1 = appearance, 1 -> 0 = disappearance).

Address		Description	0 -> 1	1 -> 0
Dec.	Hexa.			
4100	1004h	Flair 23DM with time incorrect	X	X
4101	1005h	Flair 23DM not synchronized	X	X
4102	1006h	Flair 23DM under initialization	X	
4125	101Dh	Setting change on Flair 23DM	X	
4128	1020h	Voltage presence (on all the phases)	X	X
4129	1021h	Voltage presence (V1 or U12)	X	X
4130	1022h	Voltage presence (V2 or U13)	X	X
4131	1023h	Voltage presence (V3 or U23)	X	X
4132	1024h	Residual voltage presence (summation of the three phases)	X	X
4133	1025h	Transient Voltage presence loss (generate an event)	X	
4136	1028h	Voltage absence (on all the phases)	X	X
4137	1029h	Voltage absence (V1 or U12)	X	X
4138	102Ah	Voltage absence (V2 or U13)	X	X
4139	102Bh	Voltage absence (V3 or U23)	X	X
4144	1030h	Phase fault	X	X
4145	1031h	Earth fault	X	X
4146	1032h	Earth fault on phase 1	X	X
4147	1033h	Earth fault on phase 2	X	X
4148	1034h	Earth fault on phase 3	X	X
4149	1035h	Transient phase fault	X	
4150	1036h	Transient earth fault	X	
4151	1037h	Fault by test action	X	X
4152	1038h	Phase or earth fault	X	X
3840	0F00h	Reset Maximum of current	X	
3841	0F01h	Reset current fault	X	
3855	0F0Fh	Module check	X	

2.11 Access to Remote Settings

Presentation

Access to the Flair 23DM remote settings via the Modbus communication allows:
- remote reading of settings
- remote modification of settings (remote setting), provided this has been enabled.

Settings zones

Description	Word Addresses	Read	Write
Date of last setting	7680…7683 (1E00h…1E03h)	3, 4	–
Remote settings zone no. 1	7684…7698 (1E04h…1E12h)	3, 4	6,16
Remote settings zone no. 2	7712…7719 (1E20h…1E27h)	3, 4	6,16
Remote settings zone no. 3	7720…7727 (1E28h…1E2Fh)	3, 4	6,16

The date of last setting is in IEC 60870-5-4 format.

Remote settings zone no. 1 contains the settings related to the current fault threshold and to the voltage presence/absence threshold.

Remote settings zone no. 2 contains the parameters related to the communication.

Remote settings zone no. 3 contains some other parameters related to measurement and fault detection.

Note: detailed information about these zones will be given in the settings table.

Remote Reading Procedure

To perform remote reading, the supervisor simply reads the value of the Modbus register for the desired setting.

The value of a setting is automatically updated when a value is changed via the user interface or via a remote setting.

Remote Setting Procedure

To perform remote setting, the supervisor should write the new value(s) of one or more parameters.

One or more settings can be the target of a single remote setting request.

A remote setting request will return a Modbus error in the following cases:
- remote settings not enabled (specific product setting)
- product unavailable (processing of a previous remote setting request in progress, or editing during a setting via the user screen)
- one of the settings targeted is not accessible for remote setting.

Taking Account of Remote Setting

The Flair 23DM only applies the new settings values after responding to the Modbus write request.
Flair 23DM checks the consistency of the parameters received and only validates values that correspond to what can be set manually on the HMI (value between min and max and respecting the steps between the values), in order to avoid errors of remote setting. If a parameter does not meet these criteria, an error is returned to the master.

Settings table

- **Remote settings zone no. 1:** parameters of current fault detection and voltage presence/absence

Address Dec.	Address Hexa.	Description	Format	Unit	Range	Default value	Access
7680 to 7683	1E00h to 1E03h	Last setting change date	IEC Date-time	ms	Reading only	-	R
7684	1E04h	Phase fault threshold "I>"	16S	A	100 to 800A or Auto-mode or OFF	Auto-mode	R/W
7685	1E05h	Earth fault threshold "I_0>"	16S	A	5 to 200A (1) or Auto-mode or OFF	Auto-mode	R/W
7686	1E06h	Fault duration	16S	ms	40 to 300ms	60ms	R/W
7687	1E07h	Fault validation time	16S	s	3s, 70s, OFF	70 s	R/W
7688	1E08h	Inrush filtering time	16S	s	3s, 70s, OFF	3s	R/W
7689	1E09h	Automatic fault indication reset on voltage return	16S	s	3s, 70s, OFF	70 s	R/W
7690	1E0Ah	Maximum delay before to reset the fault indication	16S	h	2, 4, 8, 12,16 or 24h	4h	R/W
7691	1E0Bh	Phase Voltage presence threshold	16S	%	40 to 90 % (10% step)	80	R/W
7692	1E0Ch	Residual Voltage presence threshold	16S	%	30 to 60 % (10% step)	30	R/W
61987	F223h	Delay for R1 relay activation on voltage return (T11)	16S	ms	0 (0 s) 1 to 9 / incr.=1 (0,1s to 1s) 10 to 210 / incr.=20 (1s to 21s) 600 to 6000 / incr.=600 (1mn to 10mn) 9000 (15mn) + FFFFh (OFF)	1 (0,1s)	R/W
7694	1E0Eh	Delay for R1 relay release on voltage loss (T12)	16S	ms	0 to 1s (0,1s step) 1 to 3s (0,5s step)	0,1s	R/W
7695	1E0Fh	Voltage absence threshold	16S	%	10 to 30 % (10% step)	20	R/W
61989	F225h	Delay for R2 relay activation on voltage loss (T21)	16S	ms	0 (0 s) 1 to 9 / incr.=1 (0,1s to 1s) 10 to 210 / incr.=20 (1s to 21s) 600 to 6000 / incr.=600 (1mn to 10mn) 9000 (15mn) + FFFFh (OFF)	1 (0,1s)	R/W
7697	1E11h	Delay for R2 relay release on voltage return (T22)	16S	ms	0 to 1s (0,1s step) 1 to 3s (0,5s step)	0,1s	R/W
7698	1E12h	Auto calibration (2)	16S Boolean	-	0 = inactive 1 = active	Inactive	R/W

(1) : 3 phases CTs mounting: 20 to 200A. 2 phases CTs + zero sequence CT mounting: 5 to 200A.
(2) : If active, the Auto calibration is performed at each return of LV supply.

- **Remote settings zone no. 2**: Modbus communication parameters.

Address Dec.	Address Hexa.	Description	Format	Unit	Range	By default value	Access
7712	1E20h	Auto-mode	Boolean	-	0= inactive 1= active	active	R
7713	1E21h	Baud rate	16S	-	1= 4800 baud 2= 9600 baud 3= 19200 baud 4= 38400 baud	Auto-mode (1)	R
7714	1E22h	Parity	16S	-	1 = None 2 = Even 3 = Odd	Even	R
7715	1E23h	Number of stop bits	16S	-	1= 1 stop bit 2= 2 stop bits	1	R
7716	1E24h	Modbus address	16S	-	1 to 247	247	R
7717	1E25h	Cubicle number	16S	-	0 = Not significant Else: 1 to 29	0	R
7718	1E26h	Modbus remote mode (Select before Execute)	16S	-	1= direct mode 2= SBO active (confirmed mode)	Direct	R/W
7719	1E27h	Remote setting	Boolean	-	0 = Not authorized 1 = Authorized	Authorized	R

(1): Speed is predefined at factory at 38400 bauds. If restarted, the Auto-mode restarts from 19200 bauds and then upwards until it detects the real speed.

Rules of configuration:
The number of stop bit is automatically derived from parity defined (2 bits if parity = None).
The modification of the communication parameters (speed, parity, stop bits) is only possible if the Auto-Mode is not activated.
Modifying the cubicle number causes the automatic assignment of the Modbus address:
(@ = 33 + 5*(CubicleNb-1))
Assigning a new Modbus Slave Address automatically resets Cubicle number to 0.

- **Remote settings zone no. 3**: other parameters related to the current fault detection and voltage presence/absence.

Address Dec.	Address Hexa.	Description	Format	Unit	Range	By default value	Access
7720	1E28h	CT mounting	16S	-	1 = Type A (ooo) 2 = Type B (0oo) 3 = Type C (0)	Type A	R
7721	1E29h	CT type	16S	-	1 = CT1 2 = CT2	CT1	R
7722	1E2Ah	Voltage measure type	16S (Boolean)	-	0 = Simple 1 = Composed	Simple (dip switch)	R
7723	1E2Bh	Voltage detection output relays logic	16S (Boolean)	-	0 = Direct 1 = Inverted	Direct (dip switch)	R
7724	1E2Ch	Voltage phase 1	16S (Boolean)	-	0 = Not measured 1 = Measured	Measured (dip switch)	R
7725	1E2Dh	Voltage phase 2	16S (Boolean)	-	0 = Not measured 1 = Measured	Measured (dip switch)	R
7726	1E2Eh	Voltage phase 3	16S (Boolean)	-	0 = Not measured 1 = Measured	Measured (dip switch)	R
7727	1E2Fh	Residual voltage	16S (Boolean)	-	0 = Not measured 1 = Measured	Not measured (dip switch)	R

2.12 Date and Time-Setting and Synchronization

Introduction

The Flair 23DM manages the date and time internally.

If the auxiliary power supply fails, this information continues to be maintained for a period of 5 minutes in the absence of charging current, or longer if there is a charging current and in case of CT mounting type A or B.

The Flair 23DM internal time is used in particular to date alarms and events.

The Flair 23DM also delivers a Flair 23DM time incorrect data item (bit 04) to the control word, indicating the need to set the time.

Time and date setting

When the Flair 23DM is energized, the time can be set if the product receives a specific time setting command via the Modbus communication.

The clock, once set, only starts when the auto-calibration phase is complete.

The time and date are set:

- by writing, in a single block, the new date and time value in the synchronization zone (addresses 0002h to 0005h)
- by using function 43 with sub-function 16.

Synchronization

The time frame is used both for setting the time and synchronizing the Flair 23DM. In this case, it should be transmitted regularly at close intervals (10 to 60 seconds) to obtain a synchronous time. It is usually transmitted by broadcasting (slave number = 0).

In synchronous state, the absence of receipt of a time frame for more than 200 seconds causes a loss of synchronism (bit 05 of the control word at 1).

On receipt of the date and time, the Flair 23DM saves the new date. It also checks whether the difference between this new date and the current date is more than 100 ms. If so, the Flair 23DM changes to non- synchronous state (bit 05 of the control word at 1). It will return to synchronous state (bit 05 of the control word at 0) as soon as the time difference between the new date it has received and the current date is less than 100 ms

Synchronization cycle

Each synchronization cycle is executed as follows:

Phase	Description
1	The supervisor writes its date and time value in the synchronization zone or by function 43-16
2	The Flair 23DM changes to non-synchronous state (bit 05 of the control word at 1) and resets its clock.
3	If the reset amplitude is less than 100 ms, the Flair 23DM changes back to synchronous state.

Events generated

At each power-up, Flair23DM generates successively the following events:
- “Appearance of the incorrect time” event
- “Appearance of the Not synchronous” event

At the first broadcast of synchronization message by master (with date & time), slave generates successively the following events:
- “Disappearance of the incorrect time” event
- “Disappearance of the Not synchronous” event

After loss of synchronization, slave generates the following event:
- “Appearance of the Not synchronous” event

After return of synchronization, slave generates the following event:
- “Disappearance of the Not synchronous” event

Clock accuracy

The clock accuracy is linked to the master and its control of the time frame transmission delay on the communication network. Before sending a time frame, the supervisor must ensure that all the read requests sent have received a response. Synchronization of the Flair 23DM is performed immediately after the frame is received.

For optimum synchronization, the supervisor must compensate for the frame transmission time. The frame transmission time is compensated by the Flair 23DM.

If the frames pass through a gateway (multi-master operation), make sure that this does not slow down the frames.

2.13 Managing the Date and Time Using Function 43

Introduction

Access to and setting the date and time on Flair 23DM is also possible via two sub-functions of the Modbus 43 function. These two sub-functions will be referred to as function 43-15 and function 43-16 hereafter.

Function 43-15

Function 43-15 is a read Flair 23DM date and current time function. It is an alternative to reading the Modbus registers at addresses 0002h to 0005h inclusive.

The IEC 60870-5-4 format is used for data returned by function 43-15 (common to reading via the Modbus registers).

Request frame structure:

Slave Number	Function	MEI Type (Sub-Function Code)	Reserved	Function
1 byte	1 byte	1 byte	1 byte	2 bytes
Request destination: □ 1…247 (unique)	43 (decimal)	15 (decimal)	0	CRC 16

Correct response frame structure:

Slave Number	Function	MEI Type (Sub-Function Code)	Reserved	Data	Control Word
1 byte	1 byte	1 byte	1 byte	8 bytes	2 bytes
Request destination: □ 1…247 (unique)	43 (decimal)	15 (decimal)	0	Date and time in IEC 60870-5-4 format	CRC 16

Function 43-16

Function 43-16 is a write Flair 23DM date and current time function. It is an alternative to writing the Modbus registers at addresses 0002h to 0005h inclusive.

The IEC 60870-5-4 format is used for data supplied to function 43-16 (common to reading via the Modbus registers).

Correct request frame structure:

Slave Number	Function	MEI Type (Sub-Function Code)	Reserved	Data	Control Word
1 byte	1 byte	1 byte	1 byte	8 bytes	2 bytes
Request destination: □ 0: broadcast □ 1…247 (unique)	43 (decimal)	16 (decimal)	0	Date and time in IEC 60870-5-4 format	CRC 16

Response frame structure: No response if it is sent in broadcast mode. Otherwise the response is as follows:

Slave Number	Function	MEI Type (Sub-Function Code)	Reserved	Data	Control Word
1 byte	1 byte	1 byte	1 byte	8 bytes	2 bytes
Request destination: □ 1…247 (unique)	43 (decimal)	16 (decimal)	0	Flair 23DM date and current time in IEC 60870-5-4 format after updating	CRC 16

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