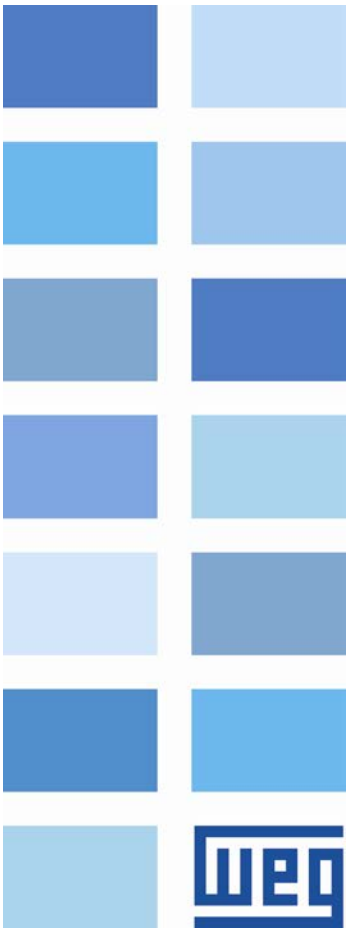
BACnet

CFW-11

User's Manual



BACnet User's Manual

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CONTENTS

ABOUT THE MANUAL

The BACnet communication protocol is available in the CFW-11 frequency inverter special software version (Ve) 5.3x. This version is derived from the standard version 5.1X, with the following modifications:

- The CANopen, Profibus and DeviceNet communication protocol has been removed;
- The BACnet MS/TP and SymbiNet communication protocol has been added.

This manual provides the necessary information for the operation of the CFW-11 frequency inverter using the BACnet protocol. This manual must be used together with the CFW-11 user manual.

ABBREVIATIONS AND DEFINITIONS

ASCII	American Standard Code for Information Interchange
PLC	Programmable Logic Controller
HMI	Human-Machine Interface
ro	Read-only
rw	Read/write

NUMERICAL REPRESENTATION

Decimal numbers are represented by means of digits without suffix. Hexadecimal numbers are represented with the letter 'h' after the number.

DOCUMENTS

The BACnet protocol for the CFW-11 was developed based on the following specifications and documents:

Document	Version	Source
Standard 135-2004	1.0	ANSI/ASHRAE/ISO

In order to obtain this documentation, consult BACnet ORG, witch is the organization that currently maintains, publishes and updates the information regarding the BACnet network.

1 INTRODUCTION TO THE SERIAL COMMUNICATION

In a serial interface, the data bits are sent sequentially through a communication channel, or busbar. Several technologies use serial communication for data transfer, including the RS232 and RS485 interfaces.

The standards that specify the RS232 and RS485 interfaces, however, do specify neither the format nor the character sequence for data transmission and reception. In this sense, besides the interface, it is also necessary to identify the protocol used for the communication.

The BACnet MS/TP network defines the BACnet message exchange using the RS485 interface as the physical layer.

The characteristics of the RS485 serial interfaces available in the CFW-11 frequency inverter, as well as the BACnet protocol, will be presented next.

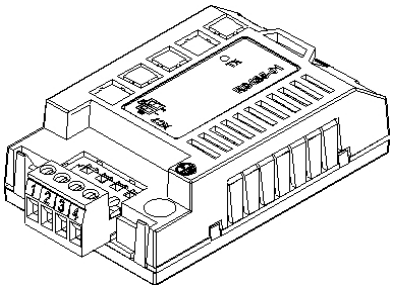
2 BACNET COMMUNICATION ACCESSORY

In order to make a BACnet interface available for the CFW-11 frequency inverter, it is necessary to use one of the RS485 communication kits described next. Information on the installation of these modules in the frequency inverter can be obtained in the guide that comes with the kit.

2.1 RS485

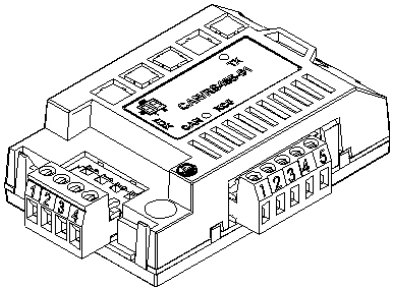
The CFW-11 presents two options for using the RS485 interface, described next.

2.1.1 RS485-01 Kit



- WEG part number: 10051957.
- Composed by the RS485 communication module (drawing at the left), mounting instructions and fixing screw.
- The interface follows the EIA-485 standard.
- It allows baud rates from 9600 bits/s to 57600 bit/s.
- The interface is electrically isolated and with differential signal, which grants more robustness against electromagnetic interference
- It allows the connection of up to 32 devices to the same segment. More devices can be connected by using repeaters. [1]
- A maximum bus length of 1000 meters.

2.1.2 CAN/RS485-01 Kit



- WEG part number: 10051960.
- Composed by the CAN/RS485-01 communication module (drawing at the left), mounting instruction and fixing screw.
- It has the same characteristics as the RS485-01 interface, plus a CAN interface, for applications where the operation with both interfaces is necessary.

2.1.3 Connector Pinout

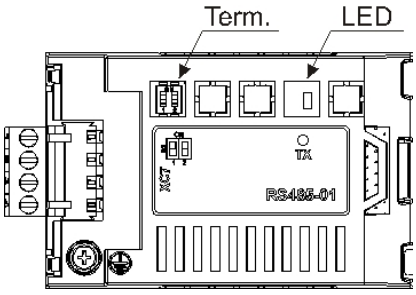
The RS485 communication module presents a 4-wire plug-in terminal strip (XC7) with the following pinout:

Table 2.1: *4-wire RS485 terminal strip pinout*

Terminal	Name	Function
1	A-Line (-)	RxD/TxD negative
2	B-Line (+)	RxD/TxD positive
3	GND	0V isolated from the RS485 circuit
4	Ground	Terra (shield)

1 The limit number of devices that can be connected to the network depends also on the used protocol.

2.1.4 Indications and Switches



- **TX LED:** LED for the indication of data transmission by the frequency inverter, in green color.
- **Termination resistor (S1):** switch for enabling the termination resistor, necessary for the RS485 interface. This resistor must be enabled (position ON) only at the devices located at the extremes of the main bus.

2.1.5 Connection with the RS485 Network

The following points must be observed for the connection of the frequency inverter using the RS485 interface:

- It is recommended the use of a shielded cable with a twisted pair of wires.
- It is also recommended that the cable has one more wire for the connection of the reference signal (GND). In case the cable does not have the additional wire, then the GND signal must be left disconnected.
- The cable must be laid separately (and far away if possible) from the power cables.
- All the network devices must be properly grounded, preferably at the same ground connection. The cable shield must also be grounded.
- Enable the termination resistors only at two points, at the extremes of the main bus, even if there are derivations from the bus.

2.2 ANYBUS-CC

The RS485 interface can also be made available by using the passive Anybus-CC kit available for RS485. Refer to the Anybus-CC Communication Manual for information on this kit.

3 INTRODUCTION TO THE BACNET COMMUNICATION

BACnet, acronym for "Building Automation Control Network", is a protocol defined by the ANSI/ASHRAE/ISO Standard 135-2004. The protocol defines a model for building-automation, describing the interaction between devices and systems. The protocol defines:

- Data and commands structured in an object-oriented model;
- Services that describe the access to data;
- A flexible network architecture.

The BACnet standard defines six types of communication networks for transporting BACnet messages, as showed in the Figure 3.1. The type of network defines the physical and data link layers. The six types of networks are:

- BACnet ARCnet;
- BACnet Ethernet;
- BACnet Lontalk;
- BACnet MS/TP;
- BACnet Point-to-Point;
- BACnet IP;

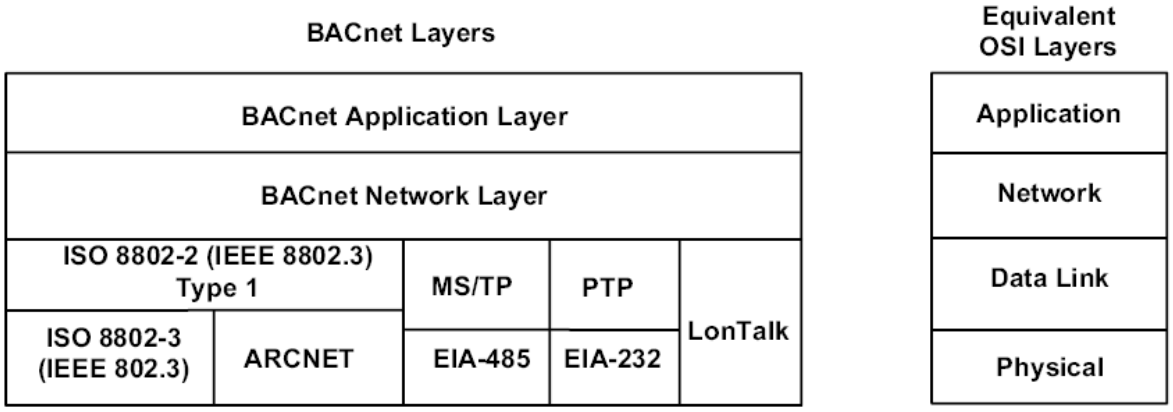


Figure 3.1: *BACnet protocol architecture*

A BACnet equipment contains an information collection defined as objects and properties.

A BACnet object represents physical or virtual information of the equipment, as a digital or analog input, control variables and parameters. The BACnet standard defines 25 types of objects. Each object is identified by a propriety called Object Identifier, which codifies the object instance type in a 32-bit binary number.

A BACnet property represents characteristics or information of a BACnet object. It is through the properties that other elements can access the equipment information. The property access can be defined as read-only or writing/reading. The BACnet specification defines services that are grouped in five categories:

- Object access
- Device Management
- Alarm and event
- File transfer
- Virtual terminal

BACnet equipments can be classified in six different profiles according to the set of services made available:

- BACnet Operator Workstation (B-OWS)
- BACnet Building Controller (B-BC)
- BACnet Advanced Application Controller (B-AAC)
- BACnet Application Specific Controller (B-ASC)
- BACnet Smart Actuator (B-AS)
- BACnet Smart Sensor (B-SS)

3.1 BACNET MS/TP

In the CFW-11, the BACnet protocol was developed using the RS485 standard for the physical and data link layers, called BACnet MS/TP (Master Slave/Token Passing). BACnet MS/TP nodes can be divided into two groups, master nodes and slave nodes, according to the node address range.

The access control to the communication mean is performed in two ways:

- Master/Slave (MS): It is used in the communication between a master node and a slave node;
- Token passing (TP): Communication only among master nodes. A logical ring is defined and the master that has the token can establish communication with slave nodes and other masters.

In a BACnet MS/TP network, the nodes are initialized and enter the IDLE state, waiting for the arrival of a telegram, which can be:

- Invalid frame: it remains in IDLE;
- Not desired frame: it remains in IDLE;
- Token: it enters the USE TOKEN state, executes the necessary communication (with slaves or other masters) and passes the token to the next node;
- Reception of a Poll of Master: it sends a telegram to the node with the address in the Source Address field;
- Reception of a DataNoReplay: it signalizes the reception to the higher layers;
- Reception of a DataNeedingReplay: it signalizes the reception to the higher layers and sends the requested response.

3.1.1 BACnet MS/TP Message Structure

The BACnet specification defines that the frame can have from 0 up to 501 bytes (octets), and that each byte is composed by 8 bits without parity, with start and stop bits, as showed in the Figure 3.2.

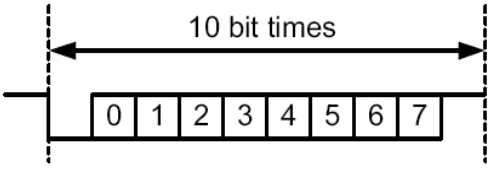


Figure 3.2: *Byte structure*

Reception (RX): The maximum time between bytes (Tframegap) is of 20-bit times, and the minimum time between frames (Tturnaround) after the last byte stop bit is of 40-bit times, according to the Figure 3.3.

Transmission (TX): The RTS signal must be disabled after the end of the stop bit time (Tpostdrive), which is of 15-bit times.

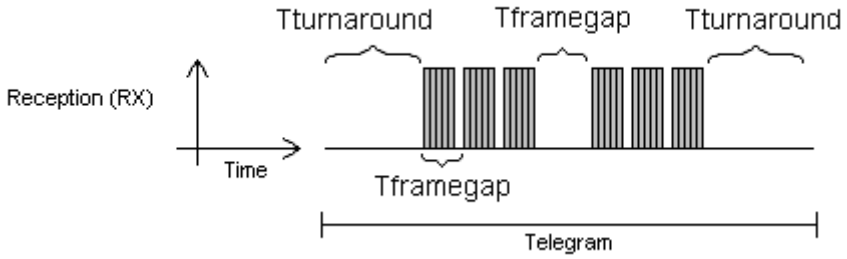


Figure 3.3: *BACnet data reception*

Header and data, as Figure 3.4 illustrates, form the BACnet data frame.

HEADER								DATA		
0x55	0xFF	Frame type	Destination address	Source address	Length	Length	CRC	Data	CRC	CRC

Figure 3.4: *BACnet Frame*

Preamble: It is formed by two bytes with the 55h and FFh values respectively.

Frame type: The BACnet specification defines eight frame types, from 0 to 7. Frame Types 8 through 127 are reserved for the specification improvement, and from 128 through 255 are reserved for each vendor specific frames. The defined types are:

- 0 Token
- 1 Poll for master
- 2 Reply to poll for master
- 3 Test request
- 4 Test response
- 5 BACnet data expecting reply
- 6 BACnet data not expecting reply
- 7 Reply postponed

Only master nodes must acknowledge frame types 0, 1 and 2, the slave nodes must ignore them.

Token (0) frame type: it is used in the relationship between master nodes. It does not present data. The master node that has the token can initiate the communication. After sending the maximum number of data frames (Nmax_info_frames) and waiting any expected replies, it must pass the token to the next master.

Poll for Master (1) frame type: It is transmitted periodically during the configuration. It is used to discover the presence of other masters in the network and to determine the token sequence. Master nodes must respond and slave nodes must ignore it. It does not present data.

Reply to Poll for Master (2) frame type: It is the response of the master nodes to the Poll for Master (frame type 1). It does not present data.

Test Request (3) frame type: It is used to start the communication in the MS/TP network. It is applied to send a particular piece of information to a node.

Test Response (4) frame type: It is the response to a Test Request.

BACnet Data Expecting Reply (5) frame type: It is used by master nodes to convey the data parameter of a DL_UNITDATA.request that presents destination address, data, priority and message code, waiting for a response from the destination node.

BACnet Data not Expecting Reply (6) frame type: It is used by master nodes to convey the data parameter of a DL_UNITDATA.request that presents destination address, data, priority and message code. It does not wait for a response from the destination node.

Reply Postponed (7) frame type: It is used by master nodes to indicate that the response to a Data Expecting Reply frame will be sent later. It does not present data.

Destination and source addresses: It is formed by two bytes, destination and source, respectively.

Length: It is formed by two bytes that inform the number of data bytes in the message.

Header CRC: The last part of the header is the fields for checking header transmission errors. The used method is the CRC-8 (Cycling Redundancy Check).

Data: It may present from 0 to 501 bytes, according to the BACnet specification. Data in the CFW-11 can present up to 59 bytes.

Data CRC: The last part of the telegram is the field for checking data transmission errors. The used method is the CRC-16 (Cycling Redundancy Check).

3.2 ADDRESS

It presents an address range from 0 to 254, where:

- The range from 0 to 127 is reserved for master or slave nodes;
- The range from 128 to 254 is used only by slave nodes.

The broadcast telegram must have FFh (255) in the destination address field.
The serial address is set using parameter P0308 in the CFW-11.

3.3 BACNET PROFILE

The BACnet profile developed for the CFW-11 is the B-ASC, with communication management services and data sharing that presents the following BIBBs (BACnet interoperability Building Blocks):

- DATA SHARING:
  - DS-RP-B: ReadProperty;
  - DS-WP-B: WriteProperty.

- DEVICE and NETWORK MGMT:
  - DM-DDB-B: WHO IS / I AM;
  - DM-TS-B: Device Management-Time Synchronization-B
  - DM-RD-B: Device Management-Reinitialize Device-B.

3.3.1 ReadProperty (DS-RP-B)

A BACnet client (node performing a request to a server node) uses the ReadProperty service to obtain a BACnet object property value. This service allows reading access to the properties that have the R (reading) access type.

3.3.2 WriteProperty (DS-WP-B)

A BACnet client uses the WriteProperty service to modify the value of a specific BACnet object property. This service allows writing access to the properties that have the W (write) or C (commandable) access type.

3.3.3 WHO IS / I AM (DM-DDB-B)

The WHO IS / I AM service is used to identify the devices connected to the network. The WHO IS message is sent by the BACnet controller, and the nodes respond with an I AM message, informing their Object Identifier and address. The I AM message is transmitted in broadcast, and can be transmitted during initialization or continuous, according to the parameter P0764.

3.3.4 Device Management-Time Synchronization-B (DM-TS-B)

The Time Synchronization service implemented in the CFW-11 executes date and time updating according to the received date and time.

3.3.5 Device Management-Reinitialize Device-B (DM-RD-B)

The Reinitialize Device service is used to remotely reinitialize the equipment, and uses a password to validate the service execution. The BACnet standard defines that the password is a string (set of ASCII characters) with up to 20 positions. The password used for the CFW-11 remote reinitialization is the same one used to allow the access for parameter content modifications, informed in the parameter P0000. This password can be a number between 0000 and 9999.

The BACnet password for the CFW-11 is a 4-character string. Therefore, the BACnet password can be a number between 0000 and 9999. E.g., considering that the CFW-11 default password is 5, the remote reinitialization service will only be executed if the received password is “0005”.

4 INVERTER PROGRAMMING

Next, only the CFW-11 frequency inverter parameters related to the BACnet communication will be presented.

4.1 SYMBOLS FOR THE PROPERTIES DESCRIPTION

RO	Read-only parameter
CFG	Parameter that can be changed only with a stopped motor
Net	Parameter visible on the HMI if the inverter has the network interface installed – RS232, RS485, CAN, Anybus-CC, Profibus – or if the USB interface is connected
Serial	Parameter visible on the HMI if the inverter has the RS232 or RS485 interface installed
USB	Parameter visible on the HMI if the inverter USB interface is connected

P0105 – 1ST/2ND RAMP SELECTION

P0220 – LOCAL/REMOTE SELECTION SOURCE

P0221 – SPEED REFERENCE SELECTION – LOCAL SITUATION

P0222 – SPEED REFERENCE SELECTION – REMOTE SITUATION

P0223 – FORWARD/REVERSE SELECTION – LOCAL SITUATION

P0224 – RUN/STOP SELECTION – LOCAL SITUATION

P0225 – JOG SELECTION – LOCAL SITUATION

P0226 – FORWARD/REVERSE SELECTION – REMOTE SITUATION

P0227 – RUN/STOP SELECTION – REMOTE SITUATION

P0228 – JOG SELECTION – REMOTE SITUATION

These parameters are used in the configuration of the command source for the CFW-11 frequency inverter local and remote situations. In order that the device be controlled through the BACnet interface, the options 'serial' available in these parameters, must be selected.

The detailed description of these parameters is found in the CFW-11 programming manual.

P0308 – SERIAL ADDRESS

Range:	0 to 255	**Default:** 1
Properties:	CFG	
Access groups via HMI:	01 PARAMETER GROUPS └ 49 Communication └ 113 Serial RS232 / 485	

Description:
It allows programming the address used for the inverter serial communication. It is necessary that each device in the network has an address different from all the others. The valid addresses for this parameter depend on the protocol programmed in P0312:

- P0312 = 1 (TP) → valid addresses: 1 to 30.
- P0312 = 2 (Modbus-RTU) → valid addresses: 1 to 247.
- P0312 = 3 (BACnet MS/TP)→ valid addresses: 0 to 254.

NOTE!
The equipment must be initialized when the serial address is changed and the BACnet protocol selected.

P0310 – SERIAL BAUD RATE

Range:	0 = 9600 bits/s 1 = 19200 bits/s 2 = 38400 bits/s 3 = 57600 bits/s	**Default:** 1
Properties:	CFG	
Access groups via HMI:	01 PARAMETER GROUPS └ 49 Communication └ 113 Serial RS232 / 485	

Description:
It allows programming the baud rate for the serial communication interface, in bits per second. This baud rate must be the same for all the devices connected to the network.

P0311 – SERIAL INTERFACE BYTE CONFIGURATION

Range:	0 = 8 data bits, no parity, 1 stop bit 1 = 8 data bits, even parity, 1 stop bit 2 = 8 data bits, odd parity, 1 stop bit 3 = 8 data bits, no parity, 2 stop bits 4 = 8 data bits, even parity, 2 stop bits 5 = 8 data bits, odd parity, 2 stop bits	**Default:** 1
Properties:	CFG	
Access groups via HMI:	01 PARAMETER GROUPS └ 49 Communication └ 113 Serial RS232 / 485	

Description:
It allows programming the number of data bits, parity and stop bits of the serial interface bytes. This configuration must be identical for all the devices connected to the network.

NOTE!
The option 0 (default) must be selected for the BACnet protocol.

P0312 – SERIAL PROTOCOL

Range:	1 = TP 2 = Modbus RTU 3 = BACnet MS/TP	**Default:** 2
Properties:	CFG	
Access groups via HMI:	01 PARAMETER GROUPS └ 49 Communication └ 113 Serial RS232 / 485	

Description:
It allows selecting the desired protocol for the serial interface.

P0313 – COMMUNICATION ERROR ACTION

Range: 0 = Inactive **Default:** 1
1 = Disable via Run/Stop
2 = Disable via General Enable
3 = Change to Local
4 = Change to Local keeping commands and reference
5 = Causes a Fault

Properties: CFG

Access groups via HMI: 01 PARAMETER GROUPS
└ 49 Communication
└ 111 Status and commands

Description:
It allows the selection of the action to be executed by the device, if it is controlled via network and a communication error is detected.

Table 4.1: *P0313 options*

Options	Description
0 = Inactive	No action is taken and the drive remains in the existing status.
1 = Disable via Run/Stop	A stop command with deceleration ramp is executed and the motor stops according to the programmed deceleration ramp.
2 = Disable via General Enable	The drive is disabled by removing the General Enabling and the motor coasts to stop.
3 = Change to Local	The drive commands change to Local.
4 = Change to Local keeping commands and reference	The drive commands change to Local, but the status of the enabling and speed reference commands received via network are kept, providing that the drive has been programmed to use in Local mode the commands via HMI, or 3-wire start/stop and speed reference via either HMI or electronic potentiometer.
5 = Causes a Fault	Instead of an alarm, the communication error causes an drive fault, so that a drive fault reset becomes necessary in order to restore normal operation.

The following events are considered communication errors:

Serial communication (RS232/RS485):
- A128 alarm/F228 fault: Serial communication timeout

The actions described in this parameter are executed by means of the automatic writing of the selected actions in the respective bits of the interface control words. Therefore, in order that the commands written in this parameter be effective, it is necessary that the device be programmed to be controlled via the used network interface (with exception of option “Causes a Fault”, which blocks the equipment even if it is not controlled by network). This programming is achieved by means of parameters P0220 to P0228.

P0314 – SERIAL WATCHDOG

Range: 0.0 to 999.0s **Default:** 0.0

Properties: CFG

Access groups via HMI: 01 PARAMETER GROUPS
└ 49 Communication
└ 111 Status and commands

Description:
It allows programming a time limit for the detection of serial interface communication error. If the frequency inverter remains without receiving valid telegrams longer than the time programmed in this parameter, it will be considered that a communication error has occurred, the alarm A128 will be showed on the HMI and the option programmed in P0313 will be executed.

After being powered up, the frequency inverter starts counting this time from the first received valid telegram. The value 0.0 disables this function.

P0316 – SERIAL INTERFACE STATUS

Range:	0 = Inactive 1 = Active 2 = Watchdog error	**Default:** -
Properties:	RO	
Access groups via HMI:	01 PARAMETER GROUPS └ 49 Communication └ 111 Status and commands	

Description:
It allows identifying whether the RS232 or RS485 serial interface board is properly installed, and whether the serial communication presents errors.

Table 4.2: *P0316 options*

Options	Description
0 = Inactive	Inactive serial interface. It occurs when the device does not have the RS232 or RS485 board installed.
1 = Active	Installed and acknowledged RS232 or RS485 interface board.
2 = Watchdog error	The serial interface is active, but a serial communication error has been detected - A128 alarm/F228 fault.

P0680 – STATUS WORD

Range:	0000h to FFFFh	**Default:** -
Properties:	RO	
Access groups via HMI:	01 PARAMETER GROUPS └ 49 Communication └ 111 Status and commands	

Description:
It allows the device status monitoring. Each bit represents a specific status:

Bits	15	14	13	12	11	10	9	8	7	6	5	4	3 to 0
Function	Fault condition	(PID) Automatic	Undervoltage	LOC/REM	JOG	Speed direction	Active General Enable	Motor Running	Alarm condition	In configuration mode	Second ramp	Active fast stop	Reserved

Table 4.3: *P0680 parameter bit functions*

Bits	Values
Bits 0 to 3	Reserved.
Bit 4 Active quick stop	0: The fast stop command is not active. 1: The drive is executing the fast stop command. **This bit is mapped in the BV4 object**
Bit 5 Second ramp	0: The drive is configured to use the first ramp values, programmed in P0100 and P0101, as the motor acceleration and deceleration ramp times. 1: The drive is configured to use the second ramp values, programmed in P0102 and P0103, as the motor acceleration and deceleration ramp times. **This bit is mapped in the BV5 object**
Bit 6 In configuration mode	0: The drive is operating normally. 1: The drive is in the configuration mode. It indicates a special condition during which the drive cannot be enabled: Executing the self-tuning routine Executing the oriented start-up routine Executing the HMI copy function Executing the flash memory card self-guided routine There is a parameter setting incompatibility There is no power at the drive power section **This bit is mapped in the BV6 object**
Bit 7 Alarm condition	0: The drive is not in alarm condition. 1: The drive is in alarm condition. Note: The alarm number can be read by means of the parameter P0048 – Present Alarm. **This bit is mapped in the BV7 object**
Bit 8 Motor Running	0: The motor is stopped. 1: The drive is running the motor at the set point speed, or executing either the acceleration or the deceleration ramp. **This bit is mapped in the BV8 object**
Bit 9 Active General Enable	0: General Enable is not active. 1: General Enable is active and the drive is ready to run the motor. **This bit is mapped in the BV9 object**
Bit 10 Speed direction	0: The motor is running in the reverse direction. 1: The motor is running in the forward direction. **This bit is mapped in the BV10 object**
Bit 11 JOG	0: Inactive JOG function. 1: Active JOG function. **This bit is mapped in the BV11 object**
Bit 12 LOC/REM	0: Drive in Local mode. 1: Drive in Remote mode. **This bit is mapped in the BV12 object**
Bit 13 Undervoltage	0: No Undervoltage. 1: With Undervoltage. **This bit is mapped in the BV13 object**
Bit 14 Manual/ Automatic	0: PID in manual mode. 1: PID in Automatic mode. **This bit is mapped in the BV14 object**
Bit 15 Fault condition	0: The drive is not in a fault condition. 1: The drive has detected a fault. Note: The fault number can be read by means of the parameter P0049 – Present Fault. **This bit is mapped in the BV15 object**

P0681 – MOTOR SPEED IN 13 BITS

Range:	- 32768 to 32767	**Default:** -
Properties:	RO	
Access groups via HMI:	01 PARAMETER GROUPS └ 49 Communication └ 111 Status / Commands	

Description:
It allows monitoring the motor speed. This word uses 13-bit resolution with signal to represent the motor synchronous speed:

- P0681 = 0000h (0 decimal) → motor speed = 0
- P0681 = 2000h (8192 decimal) → motor speed = synchronous speed

Intermediate or higher speed values in rpm can be obtained by using this scale. E.g. for a 4 pole motor and 1800 rpm of synchronous speed if the value read is 2048 (0800h), then, to obtain the speed in rpm one must calculate:

8192 => 1800 rpm
2048 => Speed in rpm

$$\text{Speed in rpm} = \frac{1800 \times 2048}{8192}$$

Speed in rpm = 450 rpm

Negative values in this parameter indicate that the motor is running in the reverse direction.

This parameter is mapped in the ANV28 object.

P0682 – SERIAL CONTROL WORD

Range:	0000h to FFFFh	**Default:** 0000h
Properties:	-	
Access groups via HMI:	01 PARAMETER GROUPS └ 49 Communication └ 111 Status and commands	

Description:
It is the device BACnet interface control word. This parameter can only be changed via serial interface. For the other sources (HMI, etc.) it behaves like a read-only parameter.

In order to have those commands executed, it is necessary to program the equipment to be controlled via serial. This programming is achieved by means of parameters P0105 and P0220 to P0228.

Each bit of this word represents a command that can be executed.

Bits	15 to 8	7	6	5	4	3	2	1	0
Function	Reserved	Fault reset	Quick stop	Second ramp	LOC/REM	JOG	Speed direction	General enable	Run/Stop

Table 4.4: P0682 parameter bit functions

Bits	Values
Bit 0 Run/Stop	0: It stops the motor with deceleration ramp. 1: The motor runs according to the acceleration ramp until reaching the speed reference value. **This bit is mapped in the object BV16**
Bit 1 General enable	0: It disables the drive, interrupting the supply for the motor. 1: It enables the drive allowing the motor operation. **This bit is mapped in the object BV17**
Bit 2 Speed direction	0: To run the motor in a direction opposed to the speed reference. 1: To run the motor in the direction indicated by the speed reference. **This bit is mapped in the object BV18**
Bit 3 JOG	0: It disables the JOG function. 1: It enables the JOG function. **This bit is mapped in the object BV19**
Bit 4 LOC/REM	0: The drive goes to the Local mode. 1: The drive goes to the Remote mode. **This bit is mapped in the object BV20**
Bit 5 Second ramp	0: The drive uses the first ramp values, programmed in P0100 and P0101, as the motor acceleration and deceleration ramp times. 1: The drive is configured to use the second ramp values, programmed in P0102 and P0103, as the motor acceleration and deceleration ramp times. **This bit is mapped in the object BV21**
Bit 6 Quick stop	0: It does not execute the quick stop command. 1: It executes the quick stop command. Note: This function is not allowed with control types (P0202) V/f or VVW. **This bit is mapped in the object BV22**
Bit 7 Fault reset	0: No function. 1: If in a fault condition, then it executes the reset. **This bit is mapped in the object BV23**
Bits 8 to 15	Reserved.

P0683 – SERIAL SPEED REFERENCE

Range: -32768 to 32767 **Default:** 0
Properties: -
Access groups via HMI: 01 PARAMETER GROUPS
└ 49 Communication
└ 111 Status and commands

Description:

It allows programming the motor speed reference via the BACnet interface. This parameter can only be changed via serial interface. For the other sources (HMI, etc.) it behaves like a read-only parameter.

In order that the reference written in this parameter be used, it is necessary that the drive be programmed to use the speed reference via serial. This programming is achieved by means of parameters P0221 and P0222.

This word uses a 13-bit resolution with signal to represent the motor synchronous speed.

- P0683 = 0000h (0 decimal) → speed reference = 0
- P0683 = 2000h (8192 decimal) → speed reference = synchronous speed

Intermediate or higher reference values can be programmed by using this scale. E.g. for a 4 pole motor and 1800 rpm of synchronous speed, to obtain a speed reference of 900 rpm one must calculate:

1800 rpm => 8192
900 rpm => 13 bit reference

$$13\ bit\ reference = \frac{900 \times 8192}{1800}$$

13 bit reference = 4096 => Value corresponding to 900 rpm in a 13 bit scale

This parameter also accepts negative values to revert the motor speed direction. The reference speed direction, however, depends also on the control word - P0682 - bit 2 setting:

- Bit 2 = 1 and P0683 > 0: reference for forward direction
- Bit 2 = 1 and P0683 < 0: reference for reverse direction
- Bit 2 = 0 and P0683 > 0: reference for reverse direction
- Bit 2 = 0 and P0683 < 0: reference for forward direction

This parameter is mapped in the ANV29 object.

P0696 – VALUE 1 FOR ANALOG OUTPUTS

P0697 – VALUE 2 FOR ANALOG OUTPUTS

P0698 – VALUE 3 FOR ANALOG OUTPUTS

P0699 – VALUE 4 FOR ANALOG OUTPUTS

Range:	-32768 to 32767	**Default:** 0
Properties:	-	
Access groups via HMI:	01 PARAMETER GROUPS └ 49 Communication └ 111 Status and commands	

Description:
They allow the control of the analog outputs by means of network interfaces (Serial, CAN, etc.). These parameters cannot be changed via HMI.

The value written in these parameters is used as the analog output value, providing that the function for the desired analog output be programmed for “P0696 / P0697 / P0698 / P0699 value”, at the parameters P0251, P0254, P0257 or P0260.

The value must be written in a 15-bit scale (7FFFh = 32767)[2] to represent 100 % of the output desired value, i.e.:

- P0696 = 0000h (0 decimal) → analog output value = 0 %
- P0696 = 7FFFh (32767 decimal) → analog output value = 100 %

The showed example was for P0696, but the same scale is also used for the parameters P0697 / P0698 / P0699. For instance, to control the analog output 1 via serial, the following programming must be done:

- Choose a parameter from P0696, P0697, P0698 or P0699 to be the value used by the analog output 1. For this example, we are going to select P0696.
- Program the option “P0696 value” as the function for the analog output 1 in P0254.
- Using the network interface, write in P0696 the desired value for the analog output 1, between 0 and 100 %, according to the parameter scale.

BACnet objects of the ANALOG OUTPUT type mold the analog outputs, where:
- ANO0 - P0696.
- ANO1 - P0697.
- ANO2 - P0698.

[2] For the actual output resolution, refer to the product manual.

- AN03 - P0699.

NOTE!
If the analog output is programmed for working from -10 V to 10 V, negative values for this parameter must be used to command the output with negative voltage values, i.e., -32768 to 32767 represent a variation from -10 V to 10 V at the analog output.

P0760 – BACNET EQUIPMENT INSTANCE – HIGH PART

Range:	1 a 247	**Default:** 1
Properties:	CFG	
Access groups via HMI:	01 Parameter Groups └ 49 Communication └ 113 Serial RS232 / 485	

Description:
It defines the high part of the BACnet equipment instance.

NOTE!
Refer to the parameter P0761 description for more details.

P0761 – BACNET EQUIPMENT INSTANCE – LOW PART

Range:	0 to 9999	**Default:** 0
Properties:	CFG	
Access groups via HMI:	01 Parameter Groups └ 49 Communication └ 113 Serial RS232 / 485	

Description:
It defines the low part of the BACnet equipment instance.

The BACnet standard defines that the equipment instance must be unique in the network and it must present a value between 0 and 4194304. The BACnet instance will compose the Object Identifier property of the DEVICE object, which defines the equipment characteristics in the network.

The BACnet instance can be defined automatically or manually:

Automatically:
If the values of parameters P0760 and P0761 are set 0 (default value), the inverter will automatically create the BACnet instance based on the vendor BACnet ID (WEG BACnet ID = 359) and the serial address. For this configuration, the user must only inform the serial address at the parameter P0308.

BACnet instance = BACnet ID + Serial address

Example 1: serial address = 102

Instance = 359102

Example 2: serial address = 15

Instance = 359015

NOTE!
The instance created automatically is not showed at the parameters P0760 and P0761, which remain with the value 0.

Manual:
The BACnet instance is defined by using the parameters P0760 and P0761. The P0760 parameter content is multiplied by 10000 and added to the P0761 parameter content.

Example 1: Instance = 542786

542786 / 10000 = 54.2786

P760 = 54 (whole part)
P761 = 2786 (fractional part)

Example 2: Instance = 66789

66789 / 10000 = 6.6789

P760 = 6 (whole part)
P761 = 6789 (fractional part)

Example 3: Instance = 35478

35478 / 10000 = 3.5478

P760 = 3 (whole part)
P761 = 5478 (fractional part)

NOTE!
The parameters P0760 and P0761 allow adjusting a maximum value of 4199999. However, the maximum instance value will be 4194304.

NOTE!
The equipment must be initialized when the contents of parameters P0760 and P0761 are changed.

P0762 – MAXIMUM MASTER NUMBER

Range:	0 to 127	**Default:** 127
Properties:	CFG	
Access groups via HMI:	01 Parameter Groups └ 49 Communication └ 113 Serial RS232 / 485	

Description:
It defines the highest allowable address for master nodes.

NOTE!
The equipment must be initialized when the content of the parameter P0762 is changed.

P0763 – MAXIMUM NUMBER OF MS/TP FRAMES

Range:	1 to 65535	**Default:** 1
Properties:	CFG	
Access groups via HMI:	01 Parameter Groups └ 49 Communication └ 113 Serial RS232 / 485	

Description:
It defines the number of telegrams that the node can transmit when it receives the token. Then it must transmit the token to the next node.

NOTE!
The equipment must be initialized when the content of the parameter P0763 is changed.

P0764 – I AM TRANSMISSION

Range:	0 = Power Up 1 = Continuous	**Default:** 0
Properties:	RO	
Access groups via HMI:	01 Parameter Groups └ 49 Communication └ 113 Serial RS232 / 485	

Description:
The I AM telegram is used to identify the node in the BACnet network. When the option 1, periodically, is selected, then an I AM telegram is sent every 200 ms.

NOTE!
The equipment must be initialized when the content of the parameter P0764 is changed.

P0765 – NUMBER OF RECEIVED TOKENS

Range:	0 to 65535	**Default:** -
Properties:	RO	
Access groups via HMI:	01 Parameter Groups └ 49 Communication └ 113 Serial RS232 / 485	

Description:
It is the counter of the number of tokens received from other BACnet nodes. It allows the serial communication verification.

5 BACNET OBJECT MODELING

A BACnet object represents physical or virtual equipment information, as a digital input or parameters. The CFW-11 presents the following object types:

- ANALOG INPUT;
- ANALOG OUTPUT;
- ANALOG VALUE;
- BINARY INPUT;
- BINARY OUTPUT;
- BINARY VALUE;
- DEVICE OBJECT.

Each object type defines a data structure composed by properties that allow the access to the object information. The Table 5.1 shows the implemented properties for each CFW-11 object type.

Table 5.1: *Properties of the BACnet objects*

Property	DEVICE	ANALOG INPUT	ANALOG OUTPUT	ANALOG VALUE	BINARY INPUT	BINARY OUTPUT	BINARY VALUE
Object Identifier	X	X	X	X	X	X	X
Object Name	X	X	X	X	X	X	X
Object Type	X	X	X	X	X	X	X
System Status	X						
Vendor Name	X						
Vendor Identifier	X						
Model Name	X						
Firmware Revision	X						
Application Software Version	X						
Description	X						
Protocol Version	X						
Protocol Revision	X						
Protocol service supported	X						
Protocol object types Supported	X						
Object List	X						
Max APDU Len Accepted	X						
Segmentation Supported	X						
APDU timeout	X						
Number of APDU retries	X						
Max Master	X						
Max info frames	X						
Device Address Binding	X						
Database revision	X						
Present Value		X	X	X	X	X	X
Status Flags		X	X	X	X	X	X
Event State		X	X	X	X	X	X
Out of Service		X	X	X	X	X	X
Units		X	X	X	X	X	X
Priority Array			X	X		X	X
Relinquish Default			X	X		X	X
Polarity					X	X	

* The Priority Array and Relinquish Default properties are available for objects with type C (commandable) access.

Each object presents an identifier unique in the network, called Object Identifier. The Object Identifier property is composed by two parts:

Object Type – 10 bits	Object instance– 22 bits

Each object can present one of the following access types:

R	Read-only
C	Commandable object. Presents a priority arrangement
W	Write-only
W/R	Writing and reading

The commandable (C) access type presents a 16-level priority arrangement, where priority 1 is the highest and 16 the lowest. If all the priorities are disabled (NULL), the value of the Relinquish Default property is given to the Present Value property.

5.1 ANALOG INPUT (ANI) OBJECT

It represents an analog input that can have its value read by the controller. CFW-11 ANALOG INPUT type objects are described in the Table 5.2. The ANALOG INPUT objects are of the REAL type

Table 5.2: *ANALOG INPUT objects*

Object instance	Object name	Description	Unit	Access type
ANI0	AI1 Value	Accesses the contents of the parameter P0018	%	R
ANI1	AI2 Value	Accesses the contents of the parameter P0019	%	R
ANI2	AI3 Value	Accesses the contents of the parameter P0020	%	R
ANI3	AI4 Value	Accesses the contents of the parameter P0021	%	R

5.2 ANALOG OUTPUT (ANO) OBJECT

It represents an analog output that can have its value written by the controller. CFW-11 ANALOG OUTPUT type objects are described in the Table 5.3. The ANALOG OUTPUT objects are of the REAL type

Table 5.3: *ANALOG OUTPUT objects*

Object instance	Object name	Description	Unit	Access type
ANO0	AO1 Value	Accesses the contents of the parameter P0696	-	C
ANO1	AO2 Value	Accesses the contents of the parameter P0697	-	C
ANO2	AO3 Value	Accesses the contents of the parameter P0698	-	C
ANO3	AO4 Value	Accesses the contents of the parameter P0699	-	C

5.3 ANALOG VALUE (ANV) OBJECT

They represent system control parameters that can be read, written or commanded by the controller. CFW-11 ANALOG VALUE type objects are described in the Table 5.4. The ANALOG VALUE objects are of the REAL type

Table 5.4: *ANALOG VALUE objects*

Object instance	Object name	Description	Unit	Access type
ANV0	Motor Speed	Motor speed – P0002	RPM	R
ANV1	Motor Current	Motor current – P0003	Amps	R
ANV2	DC Link Voltage (Ud)	DC link voltage – P0004	V	R
ANV3	Motor Frequency	Motor frequency – P0005	Hz	R
ANV4	Motor Voltage	Motor voltage – P0007	V	R
ANV5	Motor Torque	Motor torque – P0009	%	R
ANV6	Output Power	Output power – P0010	KW	R
ANV7	IGBTs Temperature U	Temperature of the U IGBTs – P0030	°C	R
ANV8	IGBTs Temperature V	Temperature of the V IGBTs – P0031	°C	R
ANV9	IGBTs Temperature W	Temperature of the W IGBTs – P0032	°C	R
ANV10	Rectifier Temperature	Temperature of the rectifier – P0033	°C	R
ANV11	Internal Air Temp	Temperature of the internal air – P0034	°C	R
ANV12	PID Process Variable	PID process variable value – P0040	%	R
ANV13	PID Setpoint Value	PID setpoint value – P0041	%	R
ANV14	Time Powered	Number of inverter powered hours – P0042	H	R
ANV15	Time Enabled	Number of inverter enabled hours – P0043	H	R
ANV16	kWh Output Energy	Counter of the output KWh – P0044	H	R
ANV17	Fan Enabled Time	Fan enabled time – P0045	H	R
ANV18	Present Alarm	Present alarm – P0048	-	R

ANV19	Present Fault	Present fault – P0049	-	R
ANV20	Last Fault	Last fault – P0050	-	R
ANV21	Acceleration Time	Acceleration time – P0100	s	C
ANV22	Deceleration Time	Deceleration time – P0101	s	C
ANV23	PID Proportional Gain	PID proportional gain –P0520	-	C
ANV24	PID Integral Gain	PID integral gain – P0521	-	C
ANV25	PID Differential Gain	PID differential gain – P0522	-	C
ANV26	Keypad PID Setpoint	PID keypad setpoint– P0525	%	C
ANV27	Wake Up Band	PID wake up band – P0535	%	C
ANV28	Speed in 13 bits	Motor speed in 13 bits - P0681	%	R
ANV29	Serial/USB Speed Ref.	Speed reference via serial – P0683	-	C
ANV30	MBOX parameter	MBOX parameter	-	W/R
ANV31	MBOX data	MBOX data	-	W/R
ANV32	SoftPLC Parameter 1	SoftPLC parameter 1 – P1010	-	C
ANV33	SoftPLC Parameter 2	SoftPLC parameter 2 – P1011	-	C
ANV34	SoftPLC Parameter 3	SoftPLC parameter 3 – P1012	-	C
ANV35	SoftPLC Parameter 4	SoftPLC parameter 4 – P1013	-	C
ANV36	SoftPLC Parameter 5	SoftPLC parameter 5 – P1014	-	C
ANV37	SoftPLC Parameter 6	SoftPLC parameter 6 – P1015	-	C

The CFW-11 programming manual presents the detailed description of each parameter.

5.3.1 MBOX

It is a structure that allows reading and writing CFW-11 parameters. The following objects compose this structure:

- ANV30: informs the parameter number
- ANV31: informs the datum read from or written into the parameter
- BV33: parameter reading command
- BV34: parameter writing command

Procedure for reading a parameter via MBOX:

1. Inform the parameter number in the ANV30 object Present Value property;
2. Write 1 in the BV33 object Present Value property;
3. Check the value read in the ANV31 object Present Value property. The read value will be an integer, without the decimal point representation. E.g., 20.0 will be read as 200 in the MBOX.

Procedure for writing a parameter via MBOX:

1. Inform the parameter number in the ANV30 object Present Value property;
2. Inform the value to be written in the parameter in the ANV31 object Present Value property. The value to be written must be an integer, without the decimal point representation. E.g., 20.0 must be written as 200 in the MBOX.
3. Write 1 in the BV34 object Present Value property.

5.4 BINARY INPUT (BIN) OBJECT

It represents a physical digital input that can have its status read by the controller. CFW-11 BINARY INPUT type objects are described in the Table 5.5 and in the Table 5.6. The Table 5.5 describes the BIN objects for the parameter P0012 bits, and the Table 5.6 describes the BIN objects for the parameter P0013 bits.

Table 5.5: *Parameter P0012 BINARY INPUT objects*

Object instance	Object name	Description	Active/ inactive	Access type
BIN0	DI1 Status	DI1 digital input status (P0012 parameter BIT 0)	ON/OFF	R
BIN1	DI2 Status	DI2 digital input status (P0012 parameter BIT 1)	ON/OFF	R
BIN2	DI3 Status	DI3 digital input status (P0012 parameter BIT 2)	ON/OFF	R
BIN3	DI4 Status	DI4 digital input status (P0012 parameter BIT 3)	ON/OFF	R
BIN4	DI5 Status	DI5 digital input status	ON/OFF	R

		(P0012 parameter BIT 4)		
BIN5	DI6 Status	DI6 digital input status (P0012 parameter BIT 5)	ON/OFF	R
BIN6	DI7 Status	DI7 digital input status (P0012 parameter BIT 6)	ON/OFF	R
BIN7	DI8 Status	DI8 digital input status (P0012 parameter BIT 7)	ON/OFF	R
BIN8	Reserved			
BIN9	Reserved			
BIN10	Reserved			
BIN12	Reserved			
BIN13	Reserved			
BIN14	Reserved			
BIN15	Reserved			

Table 5.6: *Parameter P0013 BINARY INPUT objects*

Object instance	Object name	Description	Active/ inactive	Access type
BIN16	DO1 Status	DO1 digital output status (P0013 parameter BIT 0)	ON/OFF	R
BIN17	DO2 Status	DO2 digital output status (P0013 parameter BIT 1)	ON/OFF	R
BIN18	DO3 Status	DO3 digital output status (P0013 parameter BIT 2)	ON/OFF	R
BIN19	DO4 Status	DO4 digital output status (P0013 parameter BIT 3)	ON/OFF	R
BIN20	DO5 Status	DO5 digital output status (P0013 parameter BIT 4)	ON/OFF	R
BIN21	Reserved			
BIN22	Reserved			
BIN23	Reserved			
BIN24	Reserved			
BIN25	Reserved			
BIN26	Reserved			
BIN28	Reserved			
BIN29	Reserved			
BIN30	Reserved			
BIN31	Reserved			
BIN32	Reserved			

5.5 BINARY OUTPUT (BOUT) OBJECT

It represents a physical digital output that can have its status changed by the controller. CFW-11 BINARY OUTPUT type objects are described in the Table 5.7.

Table 5.7: *BINARY OUTPUT objects*

Object instance	Object name	Description	Active/inactive	Access type
BOUT0	DO1 Value	DO1 digital output (P0695 parameter BIT 0)	ON/OFF	C
BOUT1	DO2 Value	DO2 digital output (P0695 parameter BIT 1)	ON/OFF	C
BOUT2	DO3 Value	DO3 digital output (P0695 parameter BIT 2)	ON/OFF	C
BOUT3	DO4 Value	DO4 digital output (P0695 parameter BIT 3)	ON/OFF	C
BOUT4	DO5 Value	DO5 digital output (P0695 parameter BIT 4)	ON/OFF	C

5.6 BINARY VALUE (BV) OBJECT

They represent system control parameter bits that can be read, written or commanded by the controller. CFW-11 BINARY VALUE type objects are described in the Table 5.8, Table 5.9 and Table 5.10.

Table 5.8: *Parameter P0680 BINARY VALUE objects*

Object instance	Object name	Description	Unit	Access type
BV0	Reserved			
BV1	Reserved			

BV2	Reserved			
BV3	Reserved			
BV4	Reserved			
BV5	2nd Ramp Select	Second ramp (P0680 parameter BIT 5)	ON/OFF	R
BV6	In configuration mode	Configuration mode (P0680 parameter BIT 6)	ON/OFF	R
BV7	Alarm condition	Alarm (P0680 parameter BIT 7)	ON/OFF	R
BV8	Ramp Enabled (RUN)	Enabled Ramp (P0680 parameter BIT 8)	ON/OFF	R
BV9	General Enabling active	General enable (P0680 parameter BIT 9)	ON/OFF	R
BV10	Speed Direction	Speed direction (P0680 parameter BIT 10)	ON/OFF	R
BV11	JOG	JOG (P0680 parameter BIT 11)	ON/OFF	R
BV12	LOC/REM	LOC/REM (P0680 parameter BIT 12)	ON/OFF	R
BV13	Undervoltage	Undervoltage (P0680 parameter BIT 13)	ON/OFF	R
BV14	Manual/Automatic	Manual/automatic (P0680 parameter BIT 14)	ON/OFF	R
BV15	Fault condition	Fault (P0680 parameter BIT 15)	ON/OFF	R

Table 5.9: *MBOX BINARY VALUE objects*

Object instance	Object name	Description	Active/inactive	Access type
BV33	MBOX read	Command to read the contents of the parameter specified in the ANV30 object.	ON/OFF	W
BV34	MBOX write	Command to write the contents specified in the ANV31 object in the parameter specified in the ANV30 object.	ON/OFF	W

The section 5.3.1 describes the MBOX operation.

Table 5.10: *Parameter P0682 BINARY VALUE objects*

Object instance	Object name	Description	Active/inactive	Access type
BV16	Run/Stop	Run/stop (P0682 parameter BIT 0)	ON/OFF	C
BV17	General Enabling	General enable (P0682 parameter BIT 1)	ON/OFF	C
BV18	Direction of Rotation	Speed direction (P0682 parameter BIT 2)	ON/OFF	C
BV19	JOG	JOG (P0682 parameter BIT 3)	ON/OFF	C
BV20	LOC/REM	LOC/REM (P0682 parameter BIT 4)	ON/OFF	C
BV21	Second Ramp Use	Second ramp (P0682 parameter BIT 5)	ON/OFF	C
BV22	Quick Stop	Quick Stop (P0682 parameter BIT 6)	ON/OFF	C
BV23	Fault reset	Fault reset (P0682 parameter BIT 7)	ON/OFF	C
BV24	Reserved			
BV25	Reserved			
BV26	Reserved			
BV27	Reserved			
BV28	Reserved			
BV29	Reserved			
BV30	Reserved			
BV31	Reserved			

5.7 DEVICE OBJECT

The DEVICE object informs the BACnet equipment characteristics. Its properties represent those characteristics and they are described in the Table 5.1. There must be only one DEVICE object at each BACnet equipment.

6 FAULTS AND ALARMS RELATED TO THE SERIAL COMMUNICATION

A128/F228 – TIMEOUT FOR SERIAL COMMUNICATION

Description:
It is the only alarm/fault related to the serial communication indicates that the equipment stopped receiving valid serial telegrams for a period longer than the one programmed in P0314.

Operation:
The parameter P0314 allows programming a period of time during which the equipment must receive at least one valid telegram via the RS232 / RS485 serial interface – with address and error-checking field correct – otherwise, it will be considered that there was any problem in the serial communication. The time counting initiates after the reception of the first valid telegram. This function can be used by any serial protocol supported by the equipment.

After the serial communication timeout has been identified, the A128 alarm or F228 fault message will be showed on the HMI, depending on the P0313 programming. For alarms, if the communication is reestablished and new valid telegrams are received, the alarm indication will be removed from the HMI.

Possible Causes/Correction:
- Verify factors that could cause failures in the communication (cables, installation, and grounding).
- Make sure that the master sends telegrams to the equipment in intervals shorter than the programmed in P0314.
- Disable this function at P0314.

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