BACnet

CFW320-CRS485

User's Guide

BACnet User's Guide

Series: CFW320

Language: English

Document: 10009156367 / 00

Build 232

Publication Date: 03/2022

The information below describes the reviews made in this manual.

Version	Revision	Description
-	R00	First edition

ABOUT THE MANUAL 5
ABBREVIATIONS AND DEFINITIONS 5
NUMERICAL REPRESENTATION 5
DOCUMENTS 5

1 INTRODUCTION TO THE SERIAL COMMUNICATION 6

2 INTRODUCTION TO THE BACNET PROTOCOL 7
2.1 BACNET NETWORK 7
2.2 BACNET MS/TP 8
2.2.1 BACnet MS/TP Message Structure 8
2.3 ADDRESS 9
2.4 BACNET PROFILE 10
2.4.1 ReadProperty (DS-RP-B) 10
2.4.2 WriteProperty (DS-WP-B) 10
2.4.3 WHO IS / I AM (DM-DDB-B) 10
2.4.4 Device Management-Reinitialize Device-B (DM-RD-B) 10

3 INTERFACE DESCRIPTION 11
3.1 RS485 COMMUNICATION MODULE (CFW320-CRS485) 11
3.1.1 RS485 module's connector 11
3.1.2 RS485 Interface Characteristics 11
3.1.3 Terminating resistor 12
3.1.4 Indications 12
3.1.5 Connection with the RS485 Network 12

4 BACNET NETWORK INSTALLATION 13
4.1 COMMUNICATION RATE 13
4.2 ADDRESS IN THE BACNET NETWORK 13
4.3 TERMINATION RESISTOR 13
4.4 CABLES 13
4.5 CONNECTION IN THE NETWORK 13
4.6 RECOMMENDATIONS FOR GROUNDING AND CABLE PASSAGE 14

5 PARAMETERS 15
5.1 COMMANDS AND COMMUNICATION STATUS 15
5.2 BACNET 23

6 BACNET OBJECT MODELING 26
6.1 BACNET OBJECTS 27
6.1.1 ANALOG INPUT OBJECT 27
6.1.2 ANALOG OUTPUT OBJECT 27
6.1.3 ANALOG VALUE OBJECT 27
6.1.4 BINARY INPUT OBJECT 28
6.1.5 BINARY OUTPUT OBJECT 28
6.1.6 BINARY VALUE OBJECT 28
6.1.7 DEVICE OBJECT 29
6.1.8 Mailbox 29

7 QUICK REFERENCE OF ALARMS AND FAULTS 31

ABOUT THE MANUAL

This manual supplies the necessary information for the operation of the CFW320 frequency inverter using the BACnet protocol. This manual must be used together with the CFW320 user's manual and programming manual.

ABBREVIATIONS AND DEFINITIONS

DP Decentralized Periphery
EIA Electronic Industries Alliance
I/O Input/Output
ro Read only
rw Read/write
SAP Service Access Point

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 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 RS485 interface.

The standards that specify the RS485 interface, 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 CFW320 frequency inverter, as well as the BACnet protocol, will be presented next.

2 INTRODUCTION TO THE BACNET PROTOCOL

2.1 BACNET NETWORK

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 2.1 on page 7. 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.

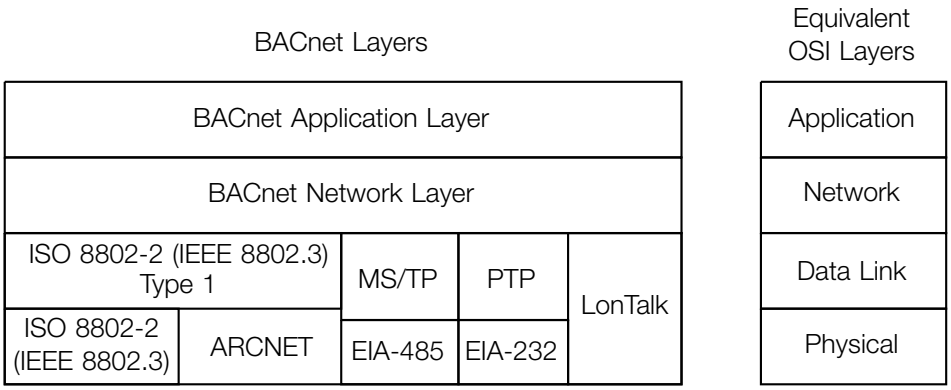

Figure 2.1: *BACnet protocol architecture*

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).

2.2 BACNET MS/TP

In the CFW320, 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.

2.2.1 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 2.2 on page 8.

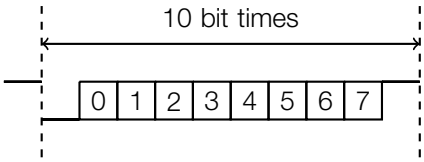

Figure 2.2: *Byte structure*

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 2.3 on page 8.

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

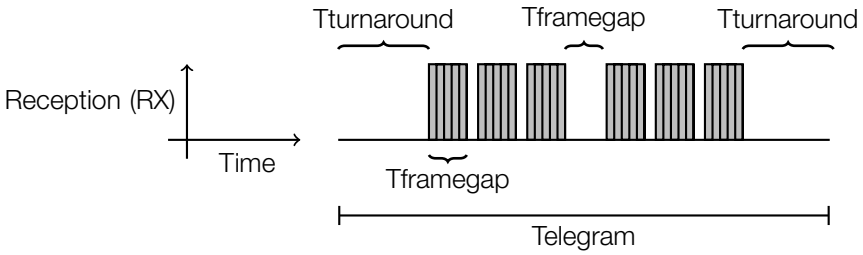

Figure 2.3: *BACnet data reception*

Header and data, as Table 2.1 on page 8 illustrates, form the BACnet data frame.

Table 2.1: *BACnet Frame*

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

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 CFW320 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).

2.3 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 P308 in the CFW320.

2.4 BACNET PROFILE

The BACnet profile developed for the CFW320 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-DCC-B: Device Communication Control;
  - DM-DOB-B: Device Management Dynamic Object Binding B;
  - DM-RD-B: Device Management-Reinitialize Device-B.

2.4.1 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.

2.4.2 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.

2.4.3 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 P764.

2.4.4 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 CFW320 remote reinitialization is the same one used to allow the access for parameter content modifications, informed in the parameter P000. This password can be a number between 0000 and 9999. The BACnet password for the CFW320 is a 4-character string. Therefore, the BACnet password can be a number between 0000 and 9999.

E.g., considering that the CFW320 default password is 5, the remote reinitialization service will only be executed if the received password is “0005”.

3 INTERFACE DESCRIPTION

The interfaces for serial communication RS485, RS232 or USB available for the CFW320 frequency inverter depend on the selected communication module for the product. Following are presented information about the connection and installation of the equipment, using different communication modules.

3.1 RS485 COMMUNICATION MODULE (CFW320-CRS485)

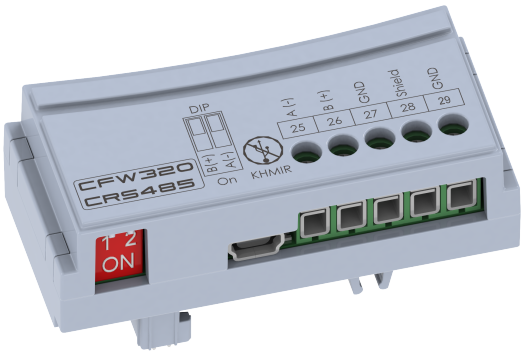

Figure 3.1: *Module with RS485 interface*

This plug-in module for the CFW320 frequency inverter has one RS485 interface. This standard RS485 interface has two functions:

- Point to Point Connection with remote keypad, via mini USB[1] connector.
- Connection via RS485 for network operation, via terminals.

DANGER!
The mini USB connector is not USB compatible, therefore, It cannot be connected to USB ports. This connector only serves as the interface between the frequency inverter and Its remote keypad.

NOTE!
Although RS485 communication signal is available on both connectors – mini USB and control terminal – these signals are the same (internally). For this reason, it is not possible to use RS485 interface as command source or reference source and remote keypad at the same time.

3.1.1 RS485 module's connector

The RS485 interface connections are available via control terminal using the following pin assignment:

Table 3.1: *RS485 connector pinout for the module (CFW320-CRS485)*

Pin	Name	Function
25	RS485 – A (-)	RS485 (Terminal A)
26	RS485 – B (+)	RS485 (Terminal B)
27	GND	0V reference
28	Shield (PE)	Cable shield
29	N.C.	No Connection

3.1.2 RS485 Interface Characteristics

- The interface follows the EIA/TIA-485 standard.
- It allows communication baud rates from 9600 up to 76800 Kbit/s.
- The interface is electrically isolated and with differential signal, which grants more robustness against electromagnetic interference.

[1] For connections that require distances greater than 3 meters, use remote keypad connection via control terminal.

- It allows the connection of up to 32 devices to the same segment. More devices can be connected by using repeaters[2].
- A maximum bus length of 1000 meters.

3.1.3 Terminating resistor

It is necessary to enable a terminating resistor at both ends of the main bus for each segment of the RS485 network. If the equipment located at both ends of the bus does not have termination resistors, use active terminating to enable these resistors.

Table 3.2: *Configuration of the switches to configure the RS485*

Switch Setting	Option
S1.1 = OFF and S1.2 = OFF	RS485 Termination off
S1.1 = ON and S1.2 = ON	RS485 Termination on
S1.1 = OFF and S1.2 = ON	This combination is not allowed
S1.1 = ON and S1.2 = OFF	

3.1.4 Indications

Details on the alarms, communications failures and communication states are made through the keypad (HMI) and product parameters.

3.1.5 Connection with the RS485 Network

The following points must be observed for the connection of the device 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] The limit of devices that can be connected on the network depends on the protocol used.

4 BACNET NETWORK INSTALLATION

For the connection of the frequency inverter CFW320 using the RS485 interface, the following points must be observed:

4.1 COMMUNICATION RATE

The RS485 interfaces of the CFW320 frequency inverter can communicate using the rates defined on the Table 4.1 on page 13.

Table 4.1: *Supported baud rates*

Baud Rate
9600 bit/s
19200 bit/s
38400 bit/s
57600 bit/s
76800 bit/s

All network equipment must be programmed to use the same communication baud rate.

4.2 ADDRESS IN THE BACNET NETWORK

Each BACnet network device must have an address, and may range from 1 to 247. This address must be unique for each equipment.

4.3 TERMINATION RESISTOR

The use of termination resistors at the ends of the bus is essential to avoid line reflection, which can impair the signal and cause communication errors. Termination resistors of 120 Ω | 0.25 W must be connected between the signals +B and -A at the ends of the main bus.

It worth to mention that, in order to allow the disconnection of the element from the network without damaging the bus, it is interesting to put active terminations, which are elements that only play the role of the termination. Thus, any equipment in the network can be disconnected from the bus without damaging the termination.

4.4 CABLES

Recommended characteristics of the cable used in the installation:

- It is recommended the use of a shielded cable with a twisted pair for the signals +B and -A, 24 AWG minimum.
- It is also recommended that the cable has one more wire for the interconnection of the 0V reference signal.
- Maximum length for connection between devices: 1000 m.

To perform the installation, it is recommended the use of shielded cables specific for use in industrial environment.

4.5 CONNECTION IN THE NETWORK

In order to interconnect the several network nodes, it is recommended to connect the equipment directly to the main line without using derivations. During the cable installation the passage near to power cables must be avoided, because, due to electromagnetic interference, this makes the occurrence of transmission errors possible.

Figure 4.1: *BACnet network installation example*

In order to avoid problems with current circulation caused by difference of potential among ground connections, it is necessary that all the devices be connected to the same ground point.

The maximum number of devices connected to a single segment of the network is limited to 32. Repeaters can be used for connecting a bigger number of devices.

4.6 RECOMMENDATIONS FOR GROUNDING AND CABLE PASSAGE

The correct connection to ground reduces problems caused by interference in an industrial environment. Below are some recommendations regarding grounding and cable passage:

- It is recommended the use of equipment suitable for the industrial environment.
- 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.
- Always use shielded cables, as well as connectors with metal housing.
- Use fastening clamps in the main grounding point, allowing a greater contact area between the cable shield and the grounding.
- Avoid connection of the cable in multiple grounding points, especially where groundings of different potentials are present.

5 PARAMETERS

5.1 COMMANDS AND COMMUNICATION STATUS

See below the parameters related to the states and commands through the communication networks available for the frequency inverter.

P680 - Logical Status

Adjustable Range:	0 to FFFF (hexa) Bit 0 = Reserved Bit 1 = Run Command Bit 2 = Fire Mode Bit 3 to 4 = Reserved Bit 5 = 2nd Ramp Bit 6 = Config. Mode Bit 7 = Alarm Bit 8 = Running Bit 9 = Enabled Bit 10 = Forward Bit 11 = JOG Bit 12 = Remote Bit 13 = Subvoltage Bit 14 = Reserved Bit 15 = Fault	**Factory Setting:**	-
Properties:	ro		

Description:

The inverter status word is unique for all the sources and can only be accessed for reading. It indicates all the relevant operating status and modes of the inverter. The function of each bit of P680 is described in Table 5.1 on page 16.

Table 5.1: P680 parameter bit functions

Bit	Value/Description
Bit 0 Reserved	-
Bit 1 Run Command	**0:** there was no Run command **1:** there was Run command This bit is mapped in the BV1 object
Bit 2 Fire Mode	**0:** fire Mode function inactive **1:** fire Mode function active This bit is mapped in the BV2 object
Bit 3 … 4 Reserved	-
Bit 5 2nd Ramp	**0:** 1st acceleration and deceleration ramp by P100 and P101 **1:** 2nd acceleration and deceleration ramp by P102 and P103 This bit is mapped in the BV5 object
Bit 6 Config. Mode	**0:** inverter operating in normal conditions **1:** inverter in configuration state. It indicates a special condition in which the inverter cannot be enabled, because it has parameterization incompatibility This bit is mapped in the BV6 object
Bit 7 Alarm	**0:** inverter is not in alarm state **1:** inverter is in alarm state This bit is mapped in the BV7 object
Bit 8 Running	**0:** motor is stopped **1:** inverter is running according to reference and command This bit is mapped in the BV8 object
Bit 9 Enabled	**0:** inverter is disabled **1:** inverter is enabled and ready to run the motor This bit is mapped in the BV9 object
Bit 10 Forward	**0:** motor is running in the reverse direction **1:** motor is running in the forward direction This bit is mapped in the BV10 object
Bit 11 JOG	**0:** JOG function inactive **1:** JOG function active This bit is mapped in the BV11 object
Bit 12 Remote	**0:** inverter in Local mode **1:** inverter in Remote mode This bit is mapped in the BV12 object
Bit 13 Subvoltage	**0:** no undervoltage **1:** with undervoltage This bit is mapped in the BV13 object
Bit 14 Reserved	-
Bit 15 Fault	**0:** inverter is not in fault state **1:** some fault registered by the inverter This bit is mapped in the BV15 object

P681 - 13-Bit Speed

Adjustable Range:	0 to FFFF (hexa)	**Factory Setting:**	-
Properties:	ro		

Description:

It defines the 13-bit speed reference. The 13-bit Frequency Reference is a scale based on the motor rated speed (P402) or on the motor rated frequency (P403). In the inverter, parameter P403 is taken as the base to determine the frequency reference.

Thus, the 13-bit frequency value has a range of 16 bits with signal, that is, -32768 to 32767; however, the rated frequency in P403 is equivalent to the value 8192. Therefore, the maximum value in the range 32767 is equivalent to four times P403:

- P681 = 0000h (0 decimal) → motor speed = 0
- P681 = 2000h (8192 decimal) → motor speed = rated frequency

Intermediate or higher frequency values can be obtained by using this scale. E.g., for a 60Hz rated frequency motor, if the value read is 2048 (0800h), then, to obtain the value in Hz one must calculate:

8192 => 60 Hz
2048 => Frequency

$$\text{Frequency} = \frac{2048 \times 60}{8192}$$

Frequency = 15 Hz

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

NOTE!
The values transmitted over the network have a scale limitation, allowing a maximum of 4 times the rated frequency of the motor, with saturation in 32767 (or -32768).

P682 - Serial/USB Control

Adjustable Range:	0 to FFFF (hexa) Bit 0 = Ramp Enable Bit 1 = General Enable Bit 2 = Run Forward Bit 3 = JOG Enable Bit 4 = Remote Bit 5 = 2nd Ramp Bit 6 = Reserved Bit 7 = Fault Reset Bit 8 to 15 = Reserved	**Factory Setting:**	-
Properties:	ro		

Description:

The inverter control word has read and write access only via network interface, but read only access is permitted for the other sources (keypad, SoftPLC). Each bit function is described as per Table 5.2 on page 18. The value of P682 is indicated in hexadecimal.

Table 5.2: P682 Parameter bits function

Bit	Value/Description
Bit 0 Ramp Enable	**0**: stops the motor by deceleration ramp **1**: run the motor according to the acceleration ramp until reaching the speed reference value This bit is mapped in the object BV16
Bit 1 General Enable	**0**: disables the inverter, interrupting the power supply to the motor **1**: enables the inverter, allowing the operation of the motor This bit is mapped in the object BV17
Bit 2 Run Forward	**0**: run the motor in the opposite direction of the reference signal (reverse) **1**: run the motor in the direction of the reference signal (forward) This bit is mapped in the object BV18
Bit 3 JOG Enable	**0**: disable JOG function **1**: enable JOG function This bit is mapped in the object BV19
Bit 4 Remote	**0**: inverter goes into Local mode **1**: inverter goes into Remote mode This bit is mapped in the object BV20
Bit 5 2nd Ramp	**0**: acceleration and deceleration ramp by P100 and P101 **1**: acceleration and deceleration ramp by P102 and P103 This bit is mapped in the object BV21
Bit 6 Reserved	-
Bit 7 Fault Reset	**0**: no function **1**: if in fault state, reset the fault This bit is mapped in the object BV23
Bit 8 ... 15 Reserved	-

P683 - Serial/USB Speed Ref.

Adjustable Range:	0 to FFFF (hexa)	**Factory Setting:**	-
Properties:	ro		

Description:

It allows programming the motor speed reference via communication interfaces only. For other sources (HMI, etc.), it behaves as a read-only parameter.

To enable the use of the reference written in this parameter, the product must be programmed to use the speed reference via communication network. This is programming is done using parameters P221 and P222.

This word uses a 13-bit resolution with signal to represent the motor rated frequency (P403):

- P683 = 0000h (0 decimal) → speed reference = 0.
  P683 = 2000h (8192 decimal) → speed reference = rated frequency (P403).
- P685 = 0000h (0 decimal) → speed reference = 0.
  P685 = 2000h (8192 decimal) → speed reference = rated frequency (P403).

Intermediate or higher reference values can be programmed by using this scale. E.g. 60Hz rated frequency, to obtain a speed reference of 30 Hz one must calculate:

60 Hz => 8192
30 Hz => 13 bits reference

$$13 \text{ bits reference} = \frac{30 \times 8192}{60}$$

13 bits reference = 4096 => Value corresponding to 30 Hz 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 - P682 bit 2 setting:

- Bit 2 = 1 and P685 > 0: reference for forward direction
- Bit 2 = 1 and P685 < 0: reference for reverse direction
- Bit 2 = 0 and P685 > 0: reference for reverse direction
- Bit 2 = 0 and P685 < 0: reference for forward direction

NOTE!
The values transmitted over the network have a scale limitation, allowing a maximum of 4 times the rated frequency of the motor, with saturation in 32767 (or -32768).

P695 - DOx Value

Adjustable Range:	0 to F (hexa) Bit 0 = DO1 Bit 1 = DO2 Bit 2 = DO3 Bit 3 = DO4	**Factory Setting:**	-
Properties:	ro		

Description:

It provides access for monitoring and controlling the inverter by using the communication interfaces. Each bit represents the value for a digital output. The value written in this parameter is used as the digital output value, providing that the function for the desired digital output be programmed for “P695 value”.

Table 5.3: *P695 Parameter bits function*

Bit	Value/Description
Bit 0 DO1	**0**: DO1 output open. **1**: DO1 output closed. This bit is mapped in the BO0 object
Bit 1 DO2	**0**: DO2 output open. **1**: DO2 output closed. This bit is mapped in the BO1 object
Bit 2 DO3	**0**: DO3 output open. **1**: DO3 output closed. This bit is mapped in the BO2 object
Bit 3 DO4	**0**: DO4 output open. **1**: DO4 output closed. This bit is mapped in the BO3 object

P696 - AOx Value 1

P697 - AOx Value 2

Adjustable Range:	0 to FFFF (hexa)	**Factory Setting:**	-
Properties:	ro		

Description:

It provides access for monitoring and controlling the inverter by using the communication interfaces.

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 “P696 / P697 value”, at the parameters P251, P254.

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

- P696 = 0000h (0 decimal) → analog output value = 0 %
- P696 = 7FFFh (32767 decimal) → analog output value = 100 %

The showed example was for P696, but the same scale is also used for the parameters P697. For instance, to control the analog output 1 via serial, the following programming must be done:

- Choose a parameter from P696, P697 to be the value used by the analog output 1. For this example, we are going to select P696.
- Program the option “P696 value” as the function for the analog output 1 in P254.
- Using the network interface, write in P696 the desired value for the analog output 1, between 0 and 100 %, according to the parameter scale.

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.

BACnet objects of the ANALOG OUTPUT type mold the analog outputs, where:

- ANO0 - P696.
- ANO1 - P697.

P308 - Serial Address

Adjustable Range:	1 to 247	**Factory Setting:**	1
Properties:	cfg		

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 P312:

- P312 = 2 (Modbus RTU) -> valid addresses: 1 to 247.
- P312 = 3 (BACnet MS/TP) -> valid addresses: 0 to 254.

NOTE!
The equipment must be initialized when the serial address is changed.

P310 - Serial Baud Rate

Adjustable Range:	0 = 9600 bits/s 1 = 19200 bits/s 2 = 38400 bits/s 3 = 57600 bits/s 4 = 76800 bits/s	**Factory Setting:**	1
Properties:	cfg		

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.

Table 5.4: P310 options

Indication	Description
0 = 9600 bits/s	9600 bit per second.
1 = 19200 bits/s	19200 bit per second.
2 = 38400 bits/s	38400 bit per second.
3 = 57600 bits/s	57600 bit per second.
4 = 76800 bits/s	76800 bit per second.

P311 - Serial Bytes Config.

Adjustable Range:	0 = 8 bits, no, 1 1 = 8 bits, even,1 2 = 8 bits, odd, 1 3 = 8 bits, no, 2 4 = 8 bits, even,2 5 = 8 bits, odd, 2	**Factory Setting:**	1
Properties:	cfg		

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 must be selected for the BACnet protocol.

Table 5.5: P311 options

Indication	Description
0 = 8 bits, no, 1	8-bit, no parity, 1 stop bit.
1 = 8 bits, even,1	8 bits, with even parity, 1 stop bit.
2 = 8 bits, odd, 1	8-bit, with odd parity, 1 stop bit.
3 = 8 bits, no, 2	8-bit, no parity, 2 stop bit.
4 = 8 bits, even,2	8-bit, with even parity, 2 stop bit.
5 = 8 bits, odd, 2	8-bit, with odd parity, 2 stop bit.

P312 - Serial Protocol

Adjustable Range:	0 to 1 = Reserved 2 = Modbus RTU Slave 3 = BACnet 4 = Reserved 5 = ModBus RTU Master	**Factory Setting:**	2
Properties:	cfg		

Description:

It configures serial port protocol.

Table 5.6: P312 options

Indication	Description
0 ... 1 = Reserved	Not available.
2 = Modbus RTU Slave	Slave Modbus RTU serial protocol.
3 = BACnet	Bacnet serial protocol.
4 = Reserved	Not available.
5 = ModBus RTU Master	Master Modbus RTU serial protocol.

P313 - Action for Communic. Error

Adjustable Range:	0 = Inactive 1 = Ramp Stop 2 = General Disable 3 = Go to LOC 4 = LOC Keep Enab. 5 = Cause Fault	**Factory Setting:**	1

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.

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 are 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 P220 to P228.

Table 5.7: *P313 options*

Indication	Description
0 = Inactive	No action is taken and the drive remains in the existing status.
1 = Ramp Stop	A stop command with deceleration ramp is executed and the motor stops according to the programmed deceleration ramp.
2 = General Disable	The drive is disabled by removing the General Enabling and the motor coasts to stop.
3 = Go to LOC	The drive commands change to Local.
4 = LOC Keep Enab.	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 = Cause Fault	Instead of an alarm, the communication error causes a drive fault, so that a drive fault reset becomes necessary in order to restore normal operation.

P314 - Serial Watchdog

Adjustable Range:	0.0 to 999.0 s	**Factory Setting:**	0.0 s
Properties:	cfg		

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 P313 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.

P316 - Serial Interf. Status

Adjustable Range:	0 = Inactive 1 = Active 2 = Watchdog Error	**Factory Setting:**	-
Properties:	ro		

Description:

It allows identifying whether the serial communication presents errors.

Table 5.8: P316 options

Indication	Description
0 = Inactive	Serial interface without valid data traffic.
1 = Active	Serial interface with valid data traffic.
2 = Watchdog Error	The serial interface is active, but a serial communication error has been detected - A128 alarm/F228 fault.

5.2 BACNET

See below the parameters to configure and operate the BACnet communication.

P760 - BACnet Dev Inst Hi

Adjustable Range:	0 to 419	**Factory Setting:**	0

Description:

It defines the high part of the BACnet equipment instance.

NOTE!
Refer to the parameter P761 description for more details.

P761 - BACnet Dev Inst Lo

Adjustable Range:	0 to 9999	**Factory Setting:**	0

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 P760 and P761 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 P308.

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 P760 and P761, which remain with the value 0.

Manual:
The BACnet instance is defined by using the parameters P760 and P761. The P760 parameter content is multiplied by 10000 and added to the P761 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 P760 and P761 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 P760 and P761 are changed.

P762 - Max Number of master

Adjustable Range:	0 to 127	**Factory Setting:**	127

Description:

It allows programming the longest address used by a master in the BACnet network, optimizing the communication. All the network devices must be set with the same value in this parameter.

With the standard value (127) for this parameter, any address set for the device can participate in the communication. However, that will make the devices in the network send requests searching for devices in all the address range, hindering the data exchange cycle and the entrance of new devices in the network. By limiting the longest address accepted, addresses above this value are ignored, preventing the search for unnecessary addresses and optimizing the communications.

It is recommended that the devices on the network be addressed in sequence from address 1 on, and that this parameter be set with the same value as the last address of the network.

NOTE!
The equipment must be initialized when the content of the parameter P762 is changed.

P763 - MS/TP Max info Frame

Adjustable Range:	0 to FFFF (hexa)	**Factory Setting:**	1

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 P763 is changed.

P764 - I-AM Msg transmition

Adjustable Range:	0 = Power Up 1 = Continuous	**Factory Setting:**	0

Description:

The I AM telegram is used to identify the node in the BACnet network

NOTE!
The equipment must be initialized when the content of the parameter P764 is changed.

Table 5.9: *P764 options*

Indication	Description
0 = Power Up	When the option 0, power up, is selected, then a I AM telegram is sent in the Power up just.
1 = Continuous	When the option 1, periodically, is selected, then an I AM telegram is sent every 200 ms.

P765 - Token RX Quantity

Adjustable Range:	0 to FFFF (hexa)	**Factory Setting:**	-
Properties:	ro		

Description:

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

6 BACNET OBJECT MODELING

A BACnet object represents physical or virtual equipment information, as a digital input or parameters. The CFW320 frequency inverter 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 6.1 on page 26 shows the implemented properties for each CFW320 object type.

Table 6.1: *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	X	X	X	X	X	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

The Object Type values are defined by the BACnet specification, and object instance is defined by the manufacturer for each object available for communication.

Regarding the Present Value property, each object can present one of the following access types:

R Read-only
C Commandable – uses priority array.
W Write-only
R/W Read/Write – without priority array.

The Commandable (C) access type presents a 16-level priority array, 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.

6.1 BACNET OBJECTS

The parameters of CFW320 frequency inverter are mapped through BACnet objects which are described below.

NOTE!
Check the product manual for parameters details.

6.1.1 ANALOG INPUT OBJECT

It represents an analog input that can have its value read by the controller. CFW320 ANALOG INPUT type objects are described in the Table 6.2 on page 27. The ANALOG INPUT objects are of the REAL type.

Table 6.2: *ANALOG INPUT objects*

Object Identifier	Object name	Related Parameter	Unit	Access type
AI0	AI1 Value	P018	%	R
AI1	AI2 Value	P019	%	R

6.1.2 ANALOG OUTPUT OBJECT

It represents an analog output that can have its value written by the controller. CFW320 ANALOG OUTPUT type objects are described in the Table 6.3 on page 27. The ANALOG OUTPUT objects are of the REAL type.

Table 6.3: *ANALOG OUTPUT objects*

Object Identifier	Object name	Related Parameter	Unit	Access type
AO0	AOx Value 1	P696		C
AO1	AOx Value 2	P697		C

6.1.3 ANALOG VALUE OBJECT

They represent system control parameters that can be read, written or commanded by the controller. CFW320 ANALOG VALUE type objects are described in the Table 6.4 on page 28. The ANALOG VALUE objects are of the REAL type.

Table 6.4: ANALOG VALUE objects

Object Identifier	Object name	Related Parameter	Unit	Access type
AV0	Motor Speed	P002	rpm	R
AV1	Motor Current	P003	A	R
AV2	DC Link Voltage (Ud)	P004	V	R
AV3	Motor Frequency	P005	Hz	R
AV4	Motor Voltage	P007	V	R
AV5	Motor Torque	P009	%	R
AV6	Heatsink Temperature	P030	°C	R
AV7	Present Alarm	P048		R
AV8	Present Fault	P049		R
AV9	Acceleration Time	P100	s	C
AV10	Deceleration Time	P101	s	C
AV11	Speed in 13 bits	P681		R
AV12	Serial/USB Speed Ref.	P683		C
AV100	Mailbox: param. number	-		R/W
AV101	Mailbox: param. value	-		R/W

The CFW320 programming manual presents the detailed description of each parameter.

6.1.4 BINARY INPUT OBJECT

It represents a physical digital input that can have its status read by the controller. CFW320 BINARY INPUT type objects are described in the Table 6.5 on page 28.

Table 6.5: BINARY INPUT objects

Object Identifier	Object name	Related Parameter	State (1 / 0)	Access type
BI0	DI1	P012 – Bit 0	On/Off	R
BI1	DI2	P012 – Bit 1	On/Off	R
BI2	DI3	P012 – Bit 2	On/Off	R
BI3	DI4	P012 – Bit 3	On/Off	R
BI4	DI5	P012 – Bit 4	On/Off	R
BI5	DI6	P012 – Bit 5	On/Off	R
BI6	DI7	P012 – Bit 6	On/Off	R
BI7	DI8	P012 – Bit 7	On/Off	R

6.1.5 BINARY OUTPUT OBJECT

It represents a physical digital output that can have its status changed by the controller. CFW320 BINARY OUTPUT type objects are described in the Table 6.6 on page 28.

Table 6.6: BINARY OUTPUT objects

Object Identifier	Object name	Related Parameter	State (1 / 0)	Access type
BO0	DO1	P695 – Bit 0	On/Off	C
BO1	DO2	P695 – Bit 1	On/Off	C
BO2	DO3	P695 – Bit 2	On/Off	C
BO3	DO4	P695 – Bit 3	On/Off	C

6.1.6 BINARY VALUE OBJECT

They represent system control parameter bits that can be read, written or commanded by the controller. CFW320 BINARY VALUE type objects are described in the Table 6.7 on page 29.

Table 6.7: BINARY VALUE objects

Object Identifier	Object name	Related Parameter	State (1 / 0)	Access type
BV0	Reserved	P680 Bit 0		
BV1	Reserved	P680 Bit 1		
BV2	Fire mode	P680 Bit 2	On/Off	R
BV3	Bypass	P680 Bit 3	On/Off	R
BV4	Quick Stop	P680 Bit 4	Active/Inactive	R
BV5	2nd Ramp	P680 Bit 5	On/Off	R
BV6	Config. Mode	P680 Bit 6	Config/Normal	R
BV7	Alarm	P680 Bit 7	Alarm/No Alarm	R
BV8	Running	P680 Bit 8	Running/Stopped	R
BV9	Enabled	P680 Bit 9	Enabled/Disabled	R
BV10	Forward	P680 Bit 10	Forward/Reverse	R
BV11	JOG	P680 Bit 11	On/Off	R
BV12	Remote	P680 Bit 12	Remote/Local	R
BV13	Subvoltage	P680 Bit 13	Subvoltage/No	R
BV14	Reserved	P680 Bit 14		
BV15	Fault	P680 Bit 15	Fault/No Fault	R
BV16	Ramp Enable	P682 Bit 0	Run/Stop	C
BV17	General Enable	P682 Bit 1	Enable/Disable	C
BV18	Run Forward	P682 Bit 2	Forward/Reverse	C
BV19	JOG Enable	P682 Bit 3	On/Off	C
BV20	Remote	P682 Bit 4	Reset/Off	C
BV21	2nd Ramp	P682 Bit 5	On/Off	C
BV22	Quick Stop	P682 Bit 6	On/Off	C
BV23	Fault Reset	P682 Bit 7	Reset/Off	C
BV29	Intern PID	P682 Bit 13	Manual/Auto	C
BV30	Extern PID 1	P682 Bit 14	Manual/Auto	C
BV31	Extern PID 2	P682 Bit 15	Manual/Auto	C
BV100	Mailbox: exec. read	-	On/Off	R/W
BV101	Mailbox: exec. write	-	On/Off	R/W

NOTE!
In order to have those commands executed, it is necessary that the inverter be programmed to be controlled via serial. This programming is achieved by means of parameters P105 and P220 to P228.

6.1.7 DEVICE OBJECT

The DEVICE object informs the BACnet equipment characteristics. Its properties represent those characteristics and they are described in the Table 6.1 on page 26. There must be only one DEVICE object at each BACnet equipment.

6.1.8 Mailbox

It is a structure that allows reading and writing CFW320 parameters. The following objects compose this structure:

Table 6.8: Mailbox objects

Object Identifier	Object name	Description	Access type
AV100	Mailbox: param. number	Informs the parameter number	R/W
AV101	Mailbox: param. value	Informs the datum read from or written into the parameter	R/W
BV100	Mailbox: exec. read	Parameter reading command	R/W
BV101	Mailbox: exec. write	Parameter writing command	R/W

Procedure for reading a parameter via Mailbox:

1. Write the parameter number in the AV100 object Present Value property;

2. Write 1 in the BV100 object Present Value property;
3. Read the parameter value in the AV101 object Present Value property.

Procedure for writing a parameter via Mailbox:

1. Write the parameter number in the AV100 object Present Value property;
2. Write the value to the parameter in the AV101 object Present Value property;
3. Write 1 in the BV101 object Present Value property.

7 QUICK REFERENCE OF ALARMS AND FAULTS

Fault / Alarm	Description	Possible Causes
A128 Telegram Reception Timeout	It indicates that the device stopped receiving valid telegrams for a period longer than the setting in P314. The time counting starts as soon as it receives the first valid telegram, with correct address and error-checking field.	■ Check network installation, broken cable or fault/poor contact on the connections with the network, grounding. ■ Ensure the master always sends telegrams to the equipment in a time shorter than the setting in P314. ■ Disable this function in P314.
F228 Timeout in Receipt of Telegrams	It indicates that the device stopped receiving valid telegrams for a period longer than the setting in P314. The time counting starts as soon as it receives the first valid telegram, with correct address and error-checking field.	■ Check network installation, broken cable or fault/poor contact on the connections with the network, grounding. ■ Ensure the master always sends telegrams to the equipment in a time shorter than the setting in P314. ■ Disable this function in P314.

Fault and alarm operation:

- Faults operate by indicating their occurrence on the HMI, in the frequency inverter status word (P006), in the present fault parameter (P049) and disabling the motor. They can only be reset with a reset command or de-energizing the frequency inverter.
- Alarms operate by indicating their occurrence on the HMI and in the present alarm parameter (P048). They are automatically reset when the alarm condition ceases existing.

WEG Drives & Controls - Automation LTDA.
Jaraguá do Sul - SC - Brazil
Phone 55 (47) 3276-4000 - Fax 55 (47) 3276-4020
São Paulo - SP - Brazil
Phone 55 (11) 5053-2300 - Fax 55 (11) 5052-4212
automacao@weg.net
www.weg.net