Modbus RTU

CFW503

User's Guide

User’s Guide

CFW503

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The information below describes the reviews made in this manual.

Version	Revision	Description
-	R00	First edition.

CONTENTS

ABOUT THE MANUAL

This manual supplies the necessary information for the operation of the CFW503 frequency inverter using the Modbus RTU protocol. This manual must be used together with the CFW503 user's manual and programming manual.

ABBREVIATIONS AND DEFINITIONS

ASCII American Standard Code for Information Interchange
CRC Cycling Redundancy Check
EIA Electronic Industries Alliance
RTU Remote Terminal Unit
TIA Telecommunications Industry Association
LSB Least Significant Bit/Byte
MSB Most Significant Bit/Byte
ro Read only
rw Read/write
cfg Configuration

NUMERICAL REPRESENTATION

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

DOCUMENTS

The Modbus protocol was developed based on the following specifications and documents:

Document	Version	Source
MODBUS Application Protocol Specification, December 28th 2006.	V1.1b	MODBUS.ORG
MODBUS Protocol Reference Guide, June 1996.	Rev. J	MODICON
MODBUS over Serial Line, December 20th 2006.	V1.02	MODBUS.ORG

In order to obtain this documentation, consult MODBUS.ORG, which is nowadays the organization that keeps, publishes and updates the information related to the Modbus protocol.

IMPORTANT NOTICE ABOUT CYBERSECURITY AND COMMUNICATIONS

This product/equipment can connect and exchange information through networks and communication protocols. It has been designed and subjected to tests to ensure correct operation with other automation systems using the protocols mentioned in this manual. Therefore, it is essential that the customer understands the responsibilities in connection with information and cybersecurity when using this equipment.

Consequently, it is the exclusive obligation of the customer to adopt in-depth defense strategies and implement policies and measures to ensure the security of the system as a whole, including with regard to communications sent and received by the equipment. Among such measures, we can point out the installation of firewalls, antivirus and malware protection applications, data encryption, authentication control and physical user access.

WEG and its affiliates take no liability for damages or losses arising from cybersecurity breaches, including, but not limited to, unauthorized access, intrusion, information, or data leak and/or theft, denial-of-service attacks, or any other form of security breach. Using this product under conditions for which it was not specifically designed is not recommended and may result in damage to the product, the network, and the automation system. Thus, it is essential that the customer understand that the external intervention by third-party software applications, such as sniffers or applications with similar actions, has the potential to cause interruptions or restrictions in the functionality of the equipment.

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1 MAIN CHARACTERISTICS

Below are the main characteristics for Modbus RTU communication of the frequency inverter CFW503.

- Interface galvanically insulated and with differential signal, providing more robustness against electromagnetic interference.
- It allows the device to operate as Modbus RTU master and slave.
- Allows data communication for equipment operation and parameterization.

1.1 MODBUS RTU

Two transmission modes are defined in the Modbus protocol specification for the serial interface: ASCII and RTU. These modes define the way the message bytes are transmitted. It is not possible to use the two transmission modes in the same network. The CFW503 frequency inverter uses only the RTU mode for the telegram transmission.

It allows up to 247 slaves, but only one master.

It adds to the Modbus PDU an address and error-checking field. The association of these fields to the PDU is called ADU (Application Data Unit).

Modbus RTU telegram format:

- Address: used to identify the slave.
- PDU: Modbus PDU.
- CRC: field for checking the transmission errors.

The master initiates the communication sending a byte with the address of the slave to which the message is destined. When sending the answer, the slave also initiates the telegram with its own address. The master can also send a message to the address 0 (zero), which means that the message is destined to all the slaves in the network (broadcast). In that case, no slave will answer to the master.

The last part of the telegram is the field for checking the transmission errors. The used method is the CRC-16 (Cycling Redundancy Check). This field is formed by two bytes; where first the least significant byte is transmitted (CRC-), and then the most significant (CRC+). The CRC calculation form is described in the protocol specification.

In the RTU mode there is no specific character that indicates the beginning or the end of a telegram. The indication of when a new message begins or when it ends is done by the absence of data transmission in the network, for a minimum period of 3.5 times the transmission time of a data byte (11 bits). Thus, in case a telegram has initiated after the elapsing of this minimum time, the network elements will assume that the first received character represents the beginning of a new telegram. And in the same manner, the network elements will assume that the telegram has reached its end when after receiving the telegram elements, this time has elapsed again.

If during the transmission of a telegram the time between the bytes is longer than this minimum time, the telegram will be considered invalid because the frequency inverter will discard the bytes already received and will mount a new telegram with the bytes that were being transmitted.

For communication rates higher than 19200 bit/s, the used times are the same as for that rate. The Table 1.1 on page 1-1 shows us the times for different communication transmission rates:

Table 1.1: *Communication rates and the time periods involved in the telegram transmission*

Baud rate	T_{11bits}	$T_{3.5x}$
1200 bits/s	9.167 ms	32.083 ms
2400 bits/s	4.583 ms	16.042 ms
4800 bits/s	2.292 ms	8.021 ms
9600 bits/s	1.146 ms	4.010 ms
19200 bits/s	573 μs	2.005 ms
38400 bits/s	573 μs	2.005 ms
57600 bits/s	573 μs	2.005 ms

- T_{11bits} = Time for transmitting one byte of the telegram.
- $T_{3.5x}$ = Minimum interval to indicated beginning and end of a telegram (3.5 x T_{11bits}).

2 INTERFACE DESCRIPTION

The interfaces for serial communication RS485, RS232 or USB available for the CFW503 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.

2.1 RS485 INTERFACE

2.1.1 RS485 Interface Characteristics

- The interface follows the EIA/TIA-485 standard.
- It allows communication baud rates from 9600 up to 38400 Kbit/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 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.

2.1.3 Indications

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

2.1.4 Connection to 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.

2.2 RS232 INTERFACE

2.2.1 Indications

The alarm, fault and status indications of the communication are made through the HMI and parameters of the product.

2.2.2 Connection to the RS232 Network

For the connection of the CFW503 frequency inverter using the RS232 interface, the following points must be observed:

- The frequency inverter RX and TX signals must be connected respectively to the master TX and RX, besides the connection of the reference signal (GND).
- The RS232 interface is very susceptible to interferences. Therefore, the cable used for communication must be as short as possible – always shorter than ten meters.

[1] The limit of devices that can be connected on the network depends on the protocol used.

- The passage of the cable must be done separately (and if possible distant) from the power supply cables.
- All network devices must be properly grounded, preferably to the same connection with the ground.

2.3 PLUG-IN MODULES WITH RS485 INTERFACE

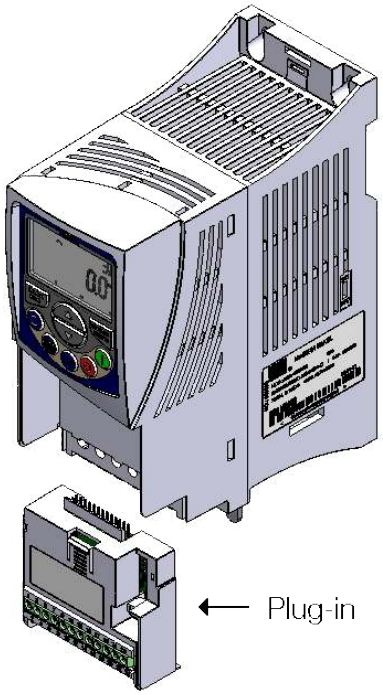

Figure 2.1: *Example of CFW503 plug-in module*

All plug-in modules for frequency inverter CFW503 have at least one standard RS485 interface, identified as Serial (1). This standard RS485 interface has two functions:

- Point to Point Connection with remote keypad.
- Connection via RS485 for network operation.

The selection of the function that will be used for the product is made using parameter P0312.

2.3.1 CFW500-IOS

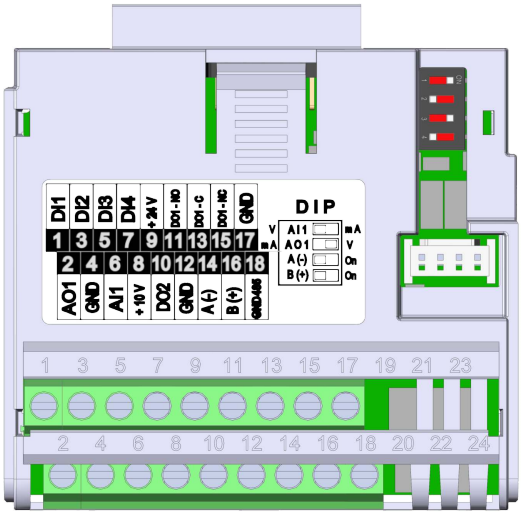

Figure 2.2: *Standard plug-in module (CFW500-IOS).*

For the standard plug-in module, the connection to the RS485 interface is available via the control terminal.

RS485 connector for the module (CFW500-IOS)

The connection for the RS485 interface is available through the terminals using the following pinout:

Table 2.1: *RS485 connector pinout for the module (CFW500-IOS)*

Pin	Name	Function
14	RS485 – A (-)	RS485 (Terminal A)
16	RS485 – B (+)	RS485 (Terminal B)
18	GND	0V Reference

2.4 PLUG-IN MODULES WITH RS485 AND ADDITIONAL INTERFACE

Depending on the installed plug-in module, frequency inverter CFW503 has up to two serial interfaces simultaneously, but only one can be the source of commands or references, the other is remote keypad or Modbus RTU slave using the same rate, parity and address settings as the selection of P0312.

The Serial (1) Interface is the standard interface frequency inverter CFW503 and is present in all plug-in modules via the terminals of the standard RS485 port. The Serial (2) interface is present only in the plug-in modules described below:

NOTE!
It is not possible use the serial interfaces for communication with two different networks. The only allowed simultaneous operation is using Serial (1) connected to the remote keypad, and another programmed protocol to Serial (2).

2.4.1 CFW500-CRS485-B

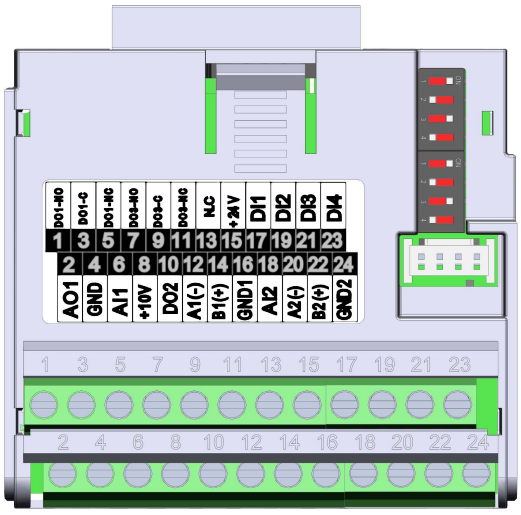

Figure 2.3: *Module with RS485 connection.*

For this plug-in module, in addition to the standard RS485 interface, a second RS485 interface is available. This accessory allows the simultaneous connection of a remote HMI on the standard RS485 interface and a programmable serial interface.

2.4.2 CFW500-CUSB

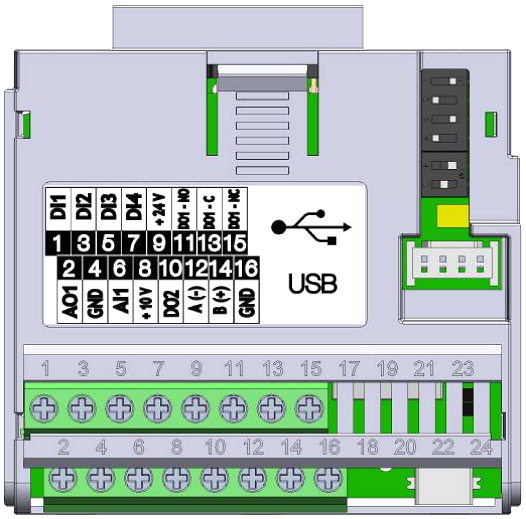

Figure 2.4: *Module with USB connection*

For this plug-in module, in addition to the standard RS485 interface, a USB interface with mini-USB connector is available. When connecting the USB interface, it will be recognized as a USB to serial converter, and a virtual COM port will be created. [2]. Therefore, communication with the drive is done through this COM port.

2.4.3 CFW500-CRS232

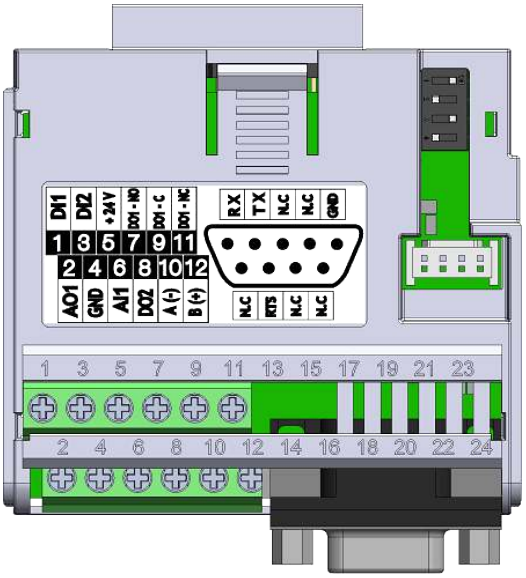

Figure 2.5: *Module with RS232 connection*

For this plug-in module, in addition to the standard RS485 interface, an RS232 interface is available. This accessory allows the simultaneous connection of a remote HMI on the standard RS485 interface and a programmable serial interface.

[2] It is necessary to install the USB driver that is included in the WPS software installation package. The number of the COM port created depends on the availability in the operating system and, after connecting, the system hardware resources must be consulted to identify this port.

3 INSTALLATION OF THE EQUIPMENT IN NETWORK

For the connection of the frequency inverter CFW503 using the RS485 interface, the following points must be observed:

3.1 COMMUNICATION RATE

The RS485 and RS232 interfaces of the CFW503 frequency inverter can communicate using the rates defined on the Table 3.1 on page 3-1.

Table 3.1: *Supported baud rates*

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

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

3.2 ADDRESS IN THE MODBUS RTU NETWORK

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

3.3 TERMINATING 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.

3.4 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.

3.5 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 3.1: *Modbus RTU network installation example*

In order to avoid problems with current circulation caused by difference of potential among ground connections, it is necessary that all 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.

3.6 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.

4 PARAMETERS

Next, the frequency inverter CFW503 parameters related to the Modbus RTU communication will be presented.

P0220 - LOC/REM Selection Src

Adjustable Range:	0 = Always LOC 1 = Always REM 2 = HMI Key LOC 3 = HMI Key REM 4 = DIx 5 = Serial/USB LOC 6 = Serial/USB REM 7 to 8 = Not Used 9 = CO/DN/PB/Eth LOC 10 = CO/DN/PB/Eth REM 11 = SoftPLC	**Factory Setting:**	2
Properties:	cfg		
Access Groups:	NET		

Description:

It defines the command source which will select between Local situation and Remote.

Table 4.1: *P0220 options*

Indication	Description
0 = Always LOC	Always in Local command mode.
1 = Always REM	Always in Remote command mode.
2 = HMI Key LOC	REM/LOC mode change via HMI key.
3 = HMI Key REM	REM/LOC mode change via HMI key.
4 = DIx	REM/LOC mode change via digital input command, as programmed in P0263 to P0270.
5 = Serial/USB LOC	REM/LOC mode change via serial control word - P0682.
6 = Serial/USB REM	REM/LOC mode change via serial control word - P0682.
7 ... 8 = Not Used	Reserved.
9 = CO/DN/PB/Eth LOC	REM/LOC mode change via CO/DN/PB/Eth control word - P0684.
10 = CO/DN/PB/Eth REM	REM/LOC mode change via CO/DN/PB/Eth control word - P0684.
11 = SoftPLC	Change via SoftPLC command.

P0221 - LOC Reference Sel.

P0222 - REM Reference Sel.

Adjustable Range:	0 = HMI Keys 1 = AI1 2 = AI2 3 = AI3 4 = FI 5 = AI1 + AI2 > 0 6 = AI1 + AI2 7 = E.P. 8 = Multispeed 9 = Serial/USB 10 = Not Used 11 = CO/DN/PB/Eth 12 = SoftPLC 13 = Not Used 14 = AI1 > 0 15 = AI2 > 0 16 = AI3 > 0 17 = FI > 0	**Factory Setting:**	0
Properties:	cfg		
Access Groups:	NET		

Description:

It defines the source of the frequency reference in the Local situation and Remote situation.

Table 4.2: *P0221 options*

Indication	Description
0 = HMI Keys	Reference via speed reference parameter HMI (P0121).
1 = AI1	Reference via analog input 1.
2 = AI2	Reference via analog input 2.
3 = AI3	Reference via analog input 3.
4 = FI	Reference via frequency input.
5 = AI1 + AI2 > 0	Combination of reference AI1 + AI2 when greater than 0.
6 = AI1 + AI2	Combination of reference AI1 + AI2.
7 = E.P.	Reference via electronic potentiometer.
8 = Multispeed	Configuration for predefined speeds.
9 = Serial/USB	Reference via serial - P0683.
10 = Not Used	Reserved.
11 = CO/DN/PB/Eth	Reference via CO/DN/PB/Eth - P0685.
12 = SoftPLC	Reference via SoftPLC.
13 = Not Used	Reserved.
14 = AI1 > 0	Condition for reference AI1 greater than 0.
15 = AI2 > 0	Condition for reference AI2 greater than 0.
16 = AI3 > 0	Condition for reference AI3 greater than 0.
17 = FI > 0	Condition for reference FI greater than 0.

P0223 - LOC Rotation Sel.

P0226 - REM Rotation Sel.

Adjustable Range:	0 = Clockwise 1 = Countclockwise 2 = HMI Key (FWD) 3 = HMI Key (REV) 4 = DIx 5 = Serial/USB (F) 6 = Serial/USB (R) 7 to 8 = Not Used 9 = CO/DN/PB/Et(F) 10 = CO/DN/PB/Et(R) 11 = Not Used 12 = SoftPLC	**Factory Setting:**	2
Properties:	cfg		
Access Groups:	NET		

Description:

It defines the source of the “Direction of Rotation” command in the Local and Remote situation.

Table 4.3: *P0223 options*

Indication	Description
0 = Clockwise	Direction of rotation in clockwise (H).
1 = Countclockwise	Direction of rotation in counterclockwise (AH).
2 = HMI Key (FWD)	Clockwise direction of rotation via HMI key.
3 = HMI Key (REV)	Counterclockwise direction of rotation via HMI key.
4 = DIx	Direction of rotation controlled by digital input, as programmed in P0263 to P0270.
5 = Serial/USB (F)	Clockwise direction of rotation via serial control word - P0682.
6 = Serial/USB (R)	Counterclockwise direction of rotation via serial control word - P0682.
7 ... 8 = Not Used	Reserved.
9 = CO/DN/PB/Et(F)	Clockwise direction of rotation via CO/DN/PB/Eth control word - P0684.
10 = CO/DN/PB/Et(R)	Counterclockwise direction of rotation via CO/DN/PB/Eth control word - P0684.
11 = Not Used	Reserved.
12 = SoftPLC	Direction of rotation controlled by SoftPLC.

P0224 - LOC Run/Stop Sel.

P0227 - REM Run/Stop Sel.

Adjustable Range:	0 = HMI Keys 1 = DIx 2 = Serial/USB 3 = Not Used 4 = CO/DN/PB/Eth 5 = SoftPLC	**Factory Setting:**	0
Properties:	cfg		
Access Groups:	NET		

Description:

It defines the source of the “Run/Stop” command in the Local and Remote situation. This command corresponds to the functions implemented in any of the command sources able to enable the motor movement, that is, General Enable, Ramp Enable, Forward Run, Reverse Run, Start, etc.

Table 4.4: P0224 options

Indication	Description
0 = HMI Keys	Reference via HMI key.
1 = DIx	Reference controlled by digital input, as programmed in P0263 to P0270.
2 = Serial/USB	Reference via serial control word - P0682
3 = Not Used	Reserved.
4 = CO/DN/PB/Eth	Reference via CO/DN/PB/Eth control word - P0684.
5 = SoftPLC	Reference controlled by SoftPLC.

P0225 - LOC JOG Selection

P0228 - REM JOG Selection

Adjustable Range:	0 = Disable 1 = HMI Keys 2 = DIx 3 = Serial/USB 4 = Not Used 5 = CO/DN/PB/Eth 6 = SoftPLC	**Factory Setting:**	1
Properties:	cfg		
Access Groups:	NET		

Description:

It defines the source of the JOG function in the Local and Remote situation. The JOG function means a Run/Stop command added to the reference defined by P0122. See the programming manual.

Table 4.5: P0225 options

Indication	Description
0 = Disable	Disabled.
1 = HMI Keys	Control via HMI key.
2 = DIx	Control via digital input, as programmed in P0263 to P0270.
3 = Serial/USB	Control via serial control word - P0682.
4 = Not Used	Reserved.
5 = CO/DN/PB/Eth	Control via CO/DN/PB/Eth control word - P0684.
6 = SoftPLC	Control via SoftPLC.

P0308 - Serial Address

Adjustable Range:	0 to 255	**Factory Setting:**	1
Properties:			
Access Groups:	NET		

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.

P0310 - Serial Baud Rate

Adjustable Range:	0 = 9600 bits/s 1 = 19200 bits/s 2 = 38400 bits/s	**Factory Setting:**	1
Properties:			
Access Groups:	NET		

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 4.6: *P0310 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.

NOTE!
To use the RS485 interface with the remote HMI, it is not necessary to program the communication rate. This rate is only used with the other serial protocols, both through the standard interface and through additional interfaces.

P0311 - 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:			
Access Groups:	NET		

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.

Table 4.7: *P0311 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.

NOTE!
To use the RS485 interface with the remote HMI, it is not necessary to program the communication rate. This rate is only used with the other serial protocols, both through the standard interface and through additional interfaces.

P0312 - Serial Protocol (1/2)

Adjustable Range:	0 = HMI-1 1 = SymbiNet-1 2 = Modbus RTU-1 3 = BACnet-1 4 = Reserved 5 = Master RTU-1 6 = HMI-1/Mbus-2 7 = Modbus RTU-2 8 = HMI-1/BACnet-2 9 = BACnet-2 10 to 11 = Reserved 12 = HMI-1/MBMast-2 13 = RTU Master-2 14 = HMI-1/SymNet-2 15 = SymbiNet-2	**Factory Setting:**	2
Properties:	cfg		
Access Groups:	NET		

Description:

Selects serial port protocol.

Table 4.8: *P0312 options*

Indication	Description
0 = HMI-1	For the standard serial interface (1), this option selects the remote HMI communication protocol.
1 = SymbiNet-1	For the standard serial interface (1), this option selects SymbiNet as the communication protocol.
2 = Modbus RTU-1	For the standard serial interface (1), this option selects Modbus RTU slave as the communication protocol.
3 = BACnet-1	For the standard serial interface (1), this option selects BACnet as the communication protocol.
4 = Reserved	Reserved.
5 = Master RTU-1	For the interface modules with more than one serial interface, this option allows to use the standard interface (1) as master Modbus RTU, and simultaneously to use the additional interface as slave Modbus RTU.
6 = HMI-1/Mbus-2	For the interface modules with more than one serial interface (example: CFW500-CUSB, etc.), this option allows to use the remote HMI connected to standard interface (1), and simultaneously, to use Modbus RTU slave protocol at the additional serial interface (2).
7 = Modbus RTU-2	For the additional serial interface (2), this option selects Modbus RTU slave communication protocol. The standard serial interface (1) remains disabled.
8 = HMI-1/BACnet-2	For the interface modules with more than one serial interface, this option allows to use the remote HMI connected to standard interface (1), and simultaneously to use the additional interface (2) as BACnet.
9 = BACnet-2	For the additional serial interface (2), this option selects BACnet communication protocol. The standard serial interface (1) remains disabled.
10 ... 11 = Reserved	Reserved.
12 = HMI-1/MBMast-2	For the interface modules with more than one serial interface, this option allows to use the remote HMI connected to standard interface (1), and simultaneously to use the drive as Master Modbus RTU at the additional serial interface (2).
13 = RTU Master-2	For the interface modules with more than one serial interface, this option allows to use the standard interface (1) as slave Modbus RTU, and simultaneously to use the drive as Master Modbus RTU at the additional serial interface (2).
14 = HMI-1/SymNet-2	For the interface modules with more than one serial interface, this option allows to use the remote HMI connected to standard interface (1), and simultaneously to use the additional interface (2) as SymbiNet.
15 = SymbiNet-2	For the additional serial interface (2), this option selects SymbiNet communication protocol. The standard serial interface (1) remains disabled.

NOTE!
For further details about Modbus RTU Master, refer to the help menu of the WLP or WPS software and the SoftPLC manual (document number 10001499063).

P0313 - Comm. Error Action

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

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 following events are considered communication errors:

- 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 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 P0220 to P0228.

Table 4.9: *P0313 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 Disab.	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.

P0314 - Serial Watchdog

Adjustable Range:	0 to 999	**Factory Setting:**	0
Properties:			
Access Groups:	NET		

Description:

Defines 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 A0128 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 Interf. Status

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

Description:

It allows identifying whether the serial communication presents errors.

Table 4.10: *P0316 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 - A0128 alarm/ F0228 fault.

P0680 - Logical Status

Adjustable Range:	0 to FFFF (hexa) Bit 0 = Reserved Bit 1 = Run Command Bit 2 = Fire Mode Bit 3 = Reserved Bit 4 = Quick Stop 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 = Undervoltage Bit 14 = Automatic PID Bit 15 = Fault	**Factory Setting:**	-
Properties:	ro		
Access Groups:	NET		

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 value of P0680 is indicated in hexadecimal. The function of each bit of P0680 is described in Table 4.11 on page 4-9.

Table 4.11: *P0680 bits function*

Bit	Value/Description
Bit 0 Reserved	Reserved.
Bit 1 Run Command	**0:** there was no Run command **1:** there was Run command
Bit 2 Fire Mode	**0:** fire Mode function inactive **1:** fire Mode function active
Bit 3 Reserved	Reserved.
Bit 4 Quick Stop	**0:** quick stop inactive **1:** quick stop active
Bit 5 2nd Ramp	**0:** 1st acceleration and deceleration ramp by P0100 and P0101 **1:** 2nd acceleration and deceleration ramp by P0102 and P0103
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
Bit 7 Alarm	**0:** inverter is not in alarm state **1:** inverter is in alarm state
Bit 8 Running	**0:** motor is stopped **1:** motor is running according to reference and command
Bit 9 Enabled	**0:** inverter is disabled **1:** inverter is enabled and ready to run the motor
Bit 10 Forward	**0:** motor is running in the reverse direction **1:** motor is running in the forward direction
Bit 11 JOG	**0:** JOG function inactive **1:** JOG function active
Bit 12 Remote	**0:** inverter in Local mode **1:** inverter in Remote mode
Bit 13 Undervoltage	**0:** no undervoltage **1:** with undervoltage
Bit 14 Automatic PID	**0:** in manual mode (PID function) **1:** in automatic mode (PID function)
Bit 15 Fault	**0:** inverter is not in fault state **1:** some fault registered by the inverter

P0681 - Speed at 13 bits

Adjustable Range:	-32768 to 32767	**Factory Setting:**	-
Properties:	ro		
Access Groups:	NET		

Description:

It defines the 13-bit speed reference. The 13-bit Frequency Reference is a scale based on the motor rated speed (P0402) or on the motor rated frequency (P0403). In the inverter, parameter P0403 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 P0403 is equivalent to the value 8192. Therefore, the maximum value in the range 32767 is equivalent to four times P0403:

- P0681 = 0000h (0 decimal) → motor speed = 0
- P0681 = 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).

P0682 - Serial/USB Control

Adjustable Range:	0 to FFFF (hexa) Bit 0 = Run/Stop Bit 1 = General Enable Bit 2 = Run Forward Bit 3 = JOG Enable Bit 4 = Remote Bit 5 = 2nd Ramp Bit 6 = Quick Stop Bit 7 = Fault Reset Bit 8 to 12 = Reserved Bit 13 = Internal PID Bit 14 = External PID Bit 15 = Reserved	**Factory Setting:**	-
Properties:	ro		
Access Groups:	NET		

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 4.12 on page 4-11. The value of P0682 is indicated in hexadecimal.

Table 4.12: P0682 bits function

Bit	Value/Description
Bit 0 Run/Stop	**0**: stops the motor by deceleration ramp **1**: run the motor according to the acceleration ramp until reaching the speed reference value
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
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)
Bit 3 JOG Enable	**0**: disable JOG function **1**: enable JOG function
Bit 4 Remote	**0**: inverter goes into Local mode **1**: inverter goes into Remote mode
Bit 5 2nd Ramp	**0**: acceleration and deceleration ramp by P0100 and P0101 **1**: acceleration and deceleration ramp by P0102 and P0103
Bit 6 Quick Stop	**0:** disable quick stop **1:** enable quick stop
Bit 7 Fault Reset	**0**: no function **1**: if in fault state, reset the fault
Bit 8 … 12 Reserved	Reserved.
Bit 13 Internal PID	**0:** automatic **1:** manual
Bit 14 External PID	**0:** automatic **1:** manual
Bit 15 Reserved	Reserved.

P0683 - Serial/USB Speed Ref.

Adjustable Range:	-32768 to 32767	**Factory Setting:**	-
Properties:	ro		
Access Groups:	NET		

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 P0221 and P0222.

This word uses a 13-bit resolution with signal to represent the motor rated frequency (P0403):

- P0683 = 0000h (0 decimal) → speed reference = 0.
  P0683 = 2000h (8192 decimal) → speed reference = rated frequency (P0403).

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 - 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

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).

P0695 - DOx Value

Adjustable Range:	0 to 1F (hexa) Bit 0 = DO1 Bit 1 = DO2 Bit 2 = DO3 Bit 3 = DO4 Bit 4 = DO5	**Factory Setting:**	0
Properties:			
Access Groups:	NET		

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 “P0695 value” at parameters P0275 to P0279.

Table 4.13: *P0695 bits function*

Bit	Value/Description
Bit 0 DO1	**0**: DO1 output open. **1**: DO1 output closed.
Bit 1 DO2	**0**: DO2 output open. **1**: DO2 output closed.
Bit 2 DO3	**0**: DO3 output open. **1**: DO3 output closed.
Bit 3 DO4	**0**: DO4 output open. **1**: DO4 output closed.
Bit 4 DO5	**0**: DO5 output open. **1**: DO5 output closed.

NOTE!
Some of the digital outputs may not be available depending on the plug-in module.

P0696 - AOx Value 1

P0697 - AOx Value 2

P0698 - AOx Value 3

Adjustable Range:	-32768 to 32767	**Factory Setting:**	0
Properties:			
Access Groups:	NET		

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 “P0696 / P0697 / P0698 value”, at the parameters P0251, P0254.

The value must be written in a 15-bit scale (7FFFh = 32767) 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 and P0698. For instance, to control the analog output 1 via serial, the following programming must be done:

- Choose a parameter from P0696, P0697, P0698 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.

NOTE!
For CFW503 frequency inverter, the analog output 3 represents the frequency output (FO).

5 OPERATION IN THE MODBUS RTU NETWORK – SLAVE MODE

The CFW503 frequency inverter has the following characteristics when operated as a slave in Modbus RTU network:

- Network connection via RS485 serial interface.
- Address, communication rate and byte format defined by equipment parameters.
- It allows the CFW503 frequency inverter programming and control via the access to parameters.
- It allows accessing all the markers and data used in the ladder program of the CFW503 frequency inverter.

5.1 AVAILABLE FUNCTIONS

In the Modbus specification are defined the functions used to access different types of data. In the CFW503, in order to access those data the following services (or functions) have been made available:

Table 5.1: *Supported Modbus Functions*

Code	Name	Description
01	Read Coils	Reading of bit blocks of the coil type
02	Read Discrete Inputs	Reading of bit blocks of the discrete input type
03	Read Holding Registers	Reading of register blocks of the holding register type
04	Read Input Registers	Reading of register blocks of the input register type
05	Write Single Coil	Writing in a single bit of the coil type
06	Write Single Register	Writing in a single register of the holding type
15	Write Multiple Coils	Writing in bit blocks of the coil type
16	Write Multiple Registers	Writing in register blocks of the holding register type
43	Read Device Identification	Identification of the device model

5.2 MEMORY MAP

The frequency inverter CFW503 has different types of data accessible through the Modbus communication. These data are mapped at data addresses and access functions as described in the following items.

5.2.1 Parameters

The CFW503 frequency inverter Modbus communication is based on the reading/writing of the equipment parameters. All parameters of the equipment are available as 16-bit holding registers. The data addressing is done with the offset equal to zero, which means that the parameter's network address (Net Id) corresponds to the register address. The Table 5.2 on page 5-1 illustrates the parameters addressing, which can be accessed as holding register:

Table 5.2: *Parameters Access - Holding Registers*

Parameter	Modbus data address	
	Decimal	Hexadecimal
P0000	0	0000h
P0001	1	0001h
⋮	⋮	⋮
P0100	100	0064h
⋮	⋮	⋮

It is necessary to know the device list of parameters to be able to operate the equipment. Thus, it is possible to identify what data are needed for the status monitoring and the control of the functions. The main parameters are:

Monitoring (reading):

- P0680 (holding register address 680): Status word.

Command (writing):

- P0682 (holding register address 682): Control word.
- P0683 (holding register address 683): Speed reference.

Refer to the programming manual for a complete parameter list of the equipment.

NOTE!
- Depending on the master that is used, those registers are referenced starting from the base address 40000 or 4x. In this case, the address that must be programmed in the master for a parameter is the address showed in the Table 5.2 on page 5-1 added to the base address. Refer to the master documentation to find out how to access holding registers.
- It should be noted that read-only parameters can only be read from the equipment, while other parameters can be read and written through the network.
- Parameters that have the property *Stopped* are only changed when the motor is stopped.
- The data is transmitted as an integer value, without the indication of the decimal places. For the number of decimal places, see the programming manual.

5.2.2 Memory Markers

Besides the parameters, other types of data as bit markers, word or float, can also be accessed using the Modbus protocol. Those markers are used mainly by the SoftPLC function, available for the CFW503. Refer to the SoftPLC documentation for the description of those markers, as well as for the addresses via Modbus.

5.3 COMMUNICATION ERRORS

Communication errors may occur in the transmission of telegrams, as well as in the contents of the transmitted telegrams.

In the event of a successful reception, during the treatment of the telegram, the slave may detect problems and send an error message, indicating the kind of problem found:

Table 5.3: *Error codes for Modbus*

Error Code	Description
1	Invalid function: the requested function is not implemented for the equipment.
2	Invalid data address: the data address (register or bit) does not exist.
3	Invalid data value: ■ Value out of the allowed range. ■ Writing on data that cannot be changed (read only register or bit).

NOTE!
It is important that it be possible to identify at the client what type of error occurred, in order to be able to diagnose problems during the communication.

6 STARTUP GUIDE

The main steps to start up the CFW503 frequency inverter in Modbus TCP network are described below. These steps represent an example of use. Check out the specific chapters for details on the indicated steps.

6.1 INSTALLING THE ACCESSORY

1. Install the communication accessory, as indicated in the installation guide supplied with the accessory.
2. Observe the content of parameter P0027. See if the module is recognized. Detection is done automatically and requires no user intervention.
3. Connect the cables, considering the recommended instructions in network installation, as described in Section 3 INSTALLATION OF THE EQUIPMENT IN NETWORK on page 3-1:
   - Use shielded cable.
   - Properly ground network equipment.
   - Avoid laying communication cables next to power cables.

6.2 CONFIGURING THE EQUIPMENT

1. Follow the recommendations described in the user manual to program the device parameters related to the motor parameterization, desired functions for the I/O signals, etc.
2. Program the command sources as desired for the application in parameters (P0220 ... P0228).
3. Configure communication parameters, such as address, baudrate, parity, etc. in parameters (P0308 ... P0312).
4. Configure the timeout for the Modbus RTU communication in parameter P0314.
5. Program the desired action for the equipment in case of communication fault in parameter P0313.

6.3 CONFIGURING THE MASTER

The way the network configuration is done depends greatly on the used master and the configuration tool. It is essential to know the tools used to perform this activity. In general, the following steps are necessary to perform the network configuration.

1. Configure the master to access the holding registers, based on the defined equipment parameters to read and write. The register address is based on the parameter's network address (Net Id), as shown in the programming manual.
2. It is recommended that reading and writing are done in a cyclic manner, allowing detection of communication errors by timeout. The period of data update must be in accordance with the value programmed in parameter P0314.

6.4 COMMUNICATION STATUS

Once the network is assembled and the master programmed, it is possible to use the parameters of the equipment to identify some status related to the communication.

- Parameter P0316 indicates the slave communication status.

The master of the network must also supply information about the communication with the slave.

7 QUICK REFERENCE OF ALARMS AND FAULTS

Fault / Alarm	Description	Possible Causes
F0031: Plug-in Comm Lost	Main control cannot establish the communication link with the communication acccessory.	■ Accessory damaged. ■ Poor connection of the accessory. ■ Problem in the identification of the accessory; refer to P0027.
A0128/ F0228: Serial Comm Timeout	Alarma que indica falla en la comunicación serial. Indica que el equipamiento paró de recibir telegramas seriales válidos por un período mayor que el programado en el P0314.	- 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 P0314. - Disable this function by setting P0314 = 0.

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.

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