Ethernet

CFW300-CETH

User's Guide

Ethernet User's Guide

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The information below describes the reviews made in this manual.

Version	Revision	Description
-	R00	First edition
-	R01	Added EtherNet/IP protocol.

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1 ABOUT THE MANUAL

This manual supplies the necessary information for the operation of the CFW300 frequency converter using the Ethernet interface. This manual must be used together with the CFW300 user's manual and programming manual.

ABBREVIATIONS AND DEFINITIONS

ASCII American Standard Code for Information Interchange
CRC Cycling Redundancy Check
LSB Least Significant Bit/Byte
MSB Most Significant Bit/Byte
ro Read only
rw Read/write
cfg Configuration

1.1 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.

1.2 DOCUMENTS - MODBUS TCP

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 Messaging On TCP/IP Implementation Guide, October 24th 2006.	V1.0b	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.

1.3 DOCUMENTS - ETHERNET/IP

The EtherNet/IP protocol was developed based on the following specifications and documents:

Document	Version	Source
CAN Specification	2.0	CiA
Volume One - Common Industrial Protocol (CIP) Specification	3.26	ODVA
Volume Two - EtherNet/IP Adaptation of CIP	1.24	ODVA
Media Planning and Installation Manual - EtherNet/IP	PUB00148R0	ODVA

In order to obtain this documentation, consult ODVA, which is nowadays the organization that keeps, publishes and updates the information related to the EtherNet/IP network.

2 MAIN CHARACTERISTICS

Below are the main characteristics for communication of the frequency converter CFW300 with CFW300-CETH accessory.

- The interface follows the Fast Ethernet 100BASE-TX standard.
- It allows communication using the 10 or 100 Mbps rates in half or full duplex mode.
- It has a built-in, two-port Ethernet switch.
- The Ethernet ports work with Auto-MDIX (automatic medium-dependent interface crossover), a technology which automatically detects the type of cable used and configures the connection accordingly, eliminating the need of cross-over cables.
- It has a built-in WEB server (HTTP), which provides access to configuration and parameterization of the equipment.

2.1 MODBUS TCP SPECIFIC CHARACTERISTICS

- Operates as Modbus TCP server.
- The server provides up to 4 simultaneous Modbus TCP connections.
- Allows data communication for equipment operation and parameterization, as well as markers and data used for CFW300 ladder programming.

2.2 ETHERNET/IP SPECIFIC CHARACTERISTICS

- It is supplied with an EDS file for the network master configuration.
- Allows up to 8 input words and 8 output words for cyclic data communication.
- Acyclic data available for parameterization.
- Up to 4 CIP Class 1 and Class 3 connections.
- Support to Unconnected Explicit Messages.

3 INTERFACE DESCRIPTION

The CFW300 uses an accessory to provide a Ethernet interface for communication. Characteristics for this interface are presented below.

3.1 ETHERNET ACCESSORY

CFW300-CETH:

- Supplied items:
  - Installation guide.
  - Ethernet communication module.

3.2 CONNECTORS

The accessory for Ethernet communication has two RJ45 connectors for network connection. The connector pin out follows the Fast Ethernet 100BASE-TX standard, using two pairs of cables for data transmission and reception.

The housings of the Ethernet connectors, which are normally connected to the cable shield, have connections between themselves.

3.3 INDICATION LEDS

The Ethernet accessory has a Speed LED and a Link LED indicator in each Ethernet connector, and one bicolor LED for status indication. These LEDs have the following functions and indications.

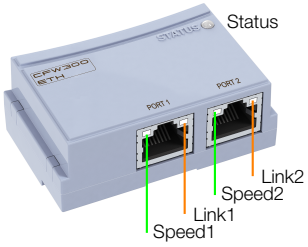

Table 3.1: *Speed LED*

State	Description
Off	10 Mbps.
Green, solid	100 Mbps.

Table 3.2: *Link LED*

State	Description
Off	No link or powered off.
Ambar, solid	Link up, no activity.
Ambar, flashing	Link up and activity.

Table 3.3: *Status LED*

Status	Description	Comments
Off	No power	-
Flashing green/red	Equipment performing self-diagnosis	It occurs during initialization.
Green, fast flashing (100ms ON / 100ms OFF)	DHCP enabled, waiting for receiving IP Address configuration.	-
Green, flashing (500ms ON / 500ms OFF)	Module enabled, waiting for connections	-
Green, solid	At least one Modbus TCP or EtherNet/IP Class 1 connection established.	-
Green, solid flickering	Receiving requests via Modbus TCP connections or EtherNet/IP Class 3 (explicit).	-
Red, flashing (500ms ON / 500ms OFF)	Recoverable error.	Indicates failure to exchange data between accessory and product.
Red, solid	Fatal error	Reinitializing the equipment is required.

4 ETHERNET NETWORK INSTALLATION

This chapter presents recommendations related to equipment installation in an Ethernet network.

4.1 IP ADDRESS

Every equipment in an Ethernet network needs an IP address and subnet mask.

The IP addressing is unique in the network, and each equipment must have a different IP. The subnet mask is used to define which IP address range is valid in the network.

The CFW300 frequency converter allows the use of two methods for programming these features, programmable via P850:

- Parameters: uses the configurations of IP address, mask and gateway as programmed on equipment parameters.
- DHCP: enable the configuration of the CFW300 via DHCP server. The DHCP can automatically assign IP addresses, subnet mask, etc. to the devices on the network. The configurations performed via parameters are disregarded.

4.2 COMMUNICATION RATE

The Ethernet interfaces of the CFW300 frequency converter is always in AUTO mode, and can communicate using the 10 or 100 Mbps rates in half or full duplex mode.

NOTE!
It is important that, for each Ethernet connection made between two points, the baud rate and the duplex mode are set to the same option. If the option AUTO is used in one of the points, you must set the other point also to AUTO, or to half duplex mode.

4.3 CABLE

Recommended characteristics of the cable used in the installation:

- Standard Ethernet cable, 100Base-TX (FastEthernet), CAT 5e or higher.
- Shielded cable.
- Maximum length between devices: 100 m.

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

4.4 NETWORK TOPOLOGY

To connect CFW300 frequency converter in an Ethernet network, usually the star connection is made using an industrial switch.

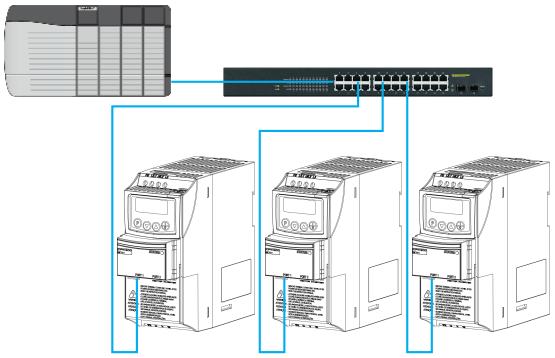

Figure 4.1: Star topology

It is also possible to make the connection in daisy chain, allowing a topology equivalent to a bus.

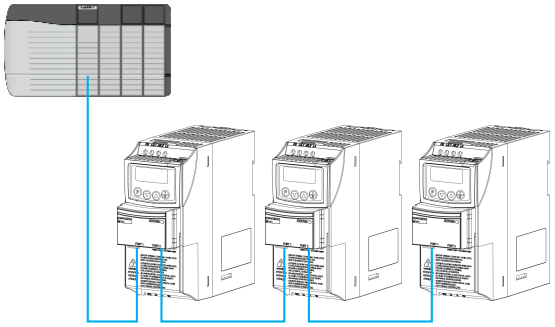

Figure 4.2: Daisy chain topology

NOTE!
When the equipment is turned off, the built-in switch is also deactivated, preventing communication with the subsequent equipment.

4.5 RECOMMENDATIONS FOR GROUNDING CONNECTION AND CABLE ROUTING

The correct connection with the ground decreases problems caused by interference in an industrial environment. The following are some recommendations about grounding and cable routing:

- Always use shielded twisted pair Ethernet cables and connectors with metallic housing.
- Connect the equipment grounding via grounding terminal. Avoid the cable connection on multiple grounding points, especially where there are grounds with different potentials.
- Pass signal cables and communication cables in dedicated pathways. Prevent laying these cables next to power cables.

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.

P313 - Action for Communic. Error

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

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 5.1: *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.

P680 - Logical Status

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 = Foward Bit 11 = JOG Bit 12 = Remote Bit 13 = Subvoltage Bit 14 = Reserved Bit 15 = Fault
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 5.2 on page 5-2.

Table 5.2: *P680 bits function*

Bit	Value/Description
Bit 0 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 … 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
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:** inverter 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 Foward	**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 Subvoltage	**0:** no undervoltage **1:** with undervoltage
Bit 14 Reserved	-
Bit 15 Fault	**0:** inverter is not in fault state **1:** some fault registered by the inverter

P681 - 13-Bit Speed

Range:	0 to FFFF (hexa)
Properties:	ro

Description:

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

P684 - CO/DN/DP/ETH Control

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
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 5.3 on page 5-3. The value of P684 is indicated in hexadecimal.

Table 5.3: *P684 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
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 P100 and P101 **1**: acceleration and deceleration ramp by P102 and P103
Bit 6 Reserved	-
Bit 7 Fault Reset	**0**: no function **1**: if in fault state, reset the fault
Bit 8 … 15 Reserved	-

P685 - CO/DN/DP/ETH Speed Ref

Range:	0 to FFFF (hexa)
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):

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

P695 - DOx Value

Range:	0 to 7F (hexa) Bit 0 = DO1 Bit 1 = DO2 Bit 2 = DO3 Bit 3 = DO4
Properties:	ro

Description:

Parameters used 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 5.4: *P695 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.

P696 - AOx Value 1

P697 - AOx Value 2

Range:	0 to FFFF (hexa)
Properties:	ro

Description:

Parameters used 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.

5.2 ETHERNET

See below the parameters to configure and operate the Ethernet interface.

P850 - IP Address Config

Range:	0 = Parameters 1 = DHCP
Properties:	cfg

Description:
It allows to choose how to set the IP address for CFW300-CETH accessory.

Table 5.5: *P850 options*

Indication	Description
0 = Parameters	The programming of the IP address, configurations of the subnet mask and gateway must be done through parameters P851 to P859.
1 = DHCP	Enables the DHCP function. The IP address and other network configurations are received from a DHCP server via network.

NOTE!
After changing this configuration, for the modification to be effective, the equipment must be turned off and then turned on again.

P851 - IP Address 1

P852 - IP Address 2

P853 - IP Address 3

P854 - IP Address 4

Range:	0 to 255
Properties:	cfg

Description:

These parameters allow you to program the IP address of the Ethernet interface. It is valid only if P850 = Parameters.

Each parameter programs one octet of the IP address, where the P851 is the most significant octet. The programmed IP address, then, has the format “P851.P852.P853.P854”.

NOTE!
After changing this configuration, for the modification to be effective, the equipment must be turned off and then turned on again.

P855 - CIDR Sub-net

Range:	0 = Reserved 1 = 128.0.0.0 2 = 192.0.0.0 3 = 224.0.0.0 4 = 240.0.0.0 5 = 248.0.0.0 6 = 252.0.0.0 7 = 254.0.0.0 8 = 255.0.0.0 9 = 255.128.0.0 10 = 255.192.0.0 11 = 255.224.0.0 12 = 255.240.0.0 13 = 255.248.0.0 14 = 255.252.0.0 15 = 255.254.0.0 16 = 255.255.0.0 17 = 255.255.128.0 18 = 255.255.192.0 19 = 255.255.224.0 20 = 255.255.240.0 21 = 255.255.248.0 22 = 255.255.252.0 23 = 255.255.254.0 24 = 255.255.255.0 25 = 255.255.255.128 26 = 255.255.255.192 27 = 255.255.255.224 28 = 255.255.255.240 29 = 255.255.255.248 30 = 255.255.255.252 31 = 255.255.255.254
Properties:	cfg

Description:

This parameters allow you to program the sub-net mask for the Ethernet interface. It is valid only if P850 = Parameters.

Table 5.6: P855 options

Indication	Description
0 = Reserved	Reserved.
1 = 128.0.0.0	Subnet mask.
2 = 192.0.0.0	Subnet mask.
3 = 224.0.0.0	Subnet mask.
4 = 240.0.0.0	Subnet mask.
5 = 248.0.0.0	Subnet mask.
6 = 252.0.0.0	Subnet mask.
7 = 254.0.0.0	Subnet mask.
8 = 255.0.0.0	Subnet mask.
9 = 255.128.0.0	Subnet mask.
10 = 255.192.0.0	Subnet mask.
11 = 255.224.0.0	Subnet mask.
12 = 255.240.0.0	Subnet mask.
13 = 255.248.0.0	Subnet mask.
14 = 255.252.0.0	Subnet mask.
15 = 255.254.0.0	Subnet mask.
16 = 255.255.0.0	Subnet mask.
17 = 255.255.128.0	Subnet mask.
18 = 255.255.192.0	Subnet mask.
19 = 255.255.224.0	Subnet mask.
20 = 255.255.240.0	Subnet mask.
21 = 255.255.248.0	Subnet mask.
22 = 255.255.252.0	Subnet mask.
23 = 255.255.254.0	Subnet mask.
24 = 255.255.255.0	Subnet mask. Factory setting.
25 = 255.255.255.128	Subnet mask.
26 = 255.255.255.192	Subnet mask.
27 = 255.255.255.224	Subnet mask.
28 = 255.255.255.240	Subnet mask.
29 = 255.255.255.248	Subnet mask.
30 = 255.255.255.252	Subnet mask.
31 = 255.255.255.254	Subnet mask.

NOTE!
After changing this configuration, for the modification to be effective, the equipment must be turned off and then turned on again.

P856 - Gateway 1

P857 - Gateway 2

P858 - Gateway 3

P859 - Gateway 4

Range:	0 to 255
Properties:	cfg

Description:

These parameters allow you to program the IP address of the default gateway for the Ethernet interface. It is valid only if P850 = Parameters.

Each parameter programs one octet of the gateway address, where the P856 is the most significant octet. The programmed gateway IP address, then, has the format “P856.P857.P858.P859”.

NOTE!
After changing this configuration, for the modification to be effective, the equipment must be turned off and then turned on again.

P860 - MBTCP: Communication Status

Range:	0 = Disabled 1 = No connection 2 = Connected 3 = Timeout Error
Properties:	ro

Description:

This parameter indicates Modbus TCP communication status.

Table 5.7: P860 options

Indication	Description
0 = Disabled	Communication disabled, no accessory.
1 = No connection	Communication enabled, but no active Modbus TCP connection.
2 = Connected	At least one active Modbus TCP connection.
3 = Timeout Error	Device detected timeout at Modbus TCP communication, programmed through P868.

P863 - MBTCP: Active Connections

Range:	0 to 4
Properties:	ro

Description:

This parameter indicates the number of active Modbus TCP connections.

The equipment allows up to 4 simultaneous Modbus TCP connections. If a connection is inactive for approximately 1 minute, the connection is closed automatically by the server.

P865 - MBTCP: TCP Port

Range:	0 to 9999
Properties:	cfg

Description:

This parameter allow you to program the TCP port for Modbus TCP connections.

Port 502 is the default TCP port for Modbus TCP connections, and is always available. If it is required to have any additional port to establish Modbus TCP connections, you can program the number of another TCP port in this parameter.

NOTE!
For the changes in this parameter be effective, the equipment must be powered off and on again.

P868 - MBTCP: Timeout

Range:	0.0 to 999.9 s
Properties:	cfg

Description:

Protection against fault in the Modbus TCP communication.

In case the product does not receive valid Modbus TCP telegrams for a period longer than the setting, a communication error will be indicated, alarm A149 or fault F249 will be displayed on the Keypad, depending on the programming of P313, and the action programmed will be executed.

Time will start counting from the first valid telegram received.

The value 0.0 disables this function.

P869 - EIP: Master Status

Range:	0 = Run 1 = Idle
Properties:	ro

Description:

It indicates the DeviceNet network master status. It may be in operation mode (Run) or in configuration mode (Idle).

Table 5.8: *P869 options*

Indication	Description
0 = Run	Reading and writing telegrams are processed normally and updated by the master.
1 = Idle	Only the reading telegrams from the slaves are updated by the master. Writing, in this case, remains disabled.

P870 - EIP: Communication Status

Range:	0 = Disabled 1 = No connection 2 = Connected 3 = Timeout in I/O Connection 4 = Reserved
Properties:	ro

Description:

This parameter indicates EtherNet/IP communication status.

Table 5.9: *P870 options*

Indication	Description
0 = Disabled	No interface, interface disabled or with no IP address configured.
1 = No connection	Communication enabled, but no I/O connections are established with network master.
2 = Connected	Communication enabled and I/O connection established with network master. At this state, device effectively perform data exchange through network.
3 = Timeout in I/O Connection	I/O connection has timed out.
4 = Reserved	Reserved.

P871 - EIP: Data Profile

Range:	0 to 3 = Reserved 4 = 120/170: CIP Basic Speed + I/O 5 = 121/171: CIP Extended Speed + I/O 6 to 7 = Reserved 8 = 100/150: Manufac. Speed + I/O 9 to 10 = Reserved
Properties:	cfg

Description:

Table 5.10: *P871 options*

Indication	Description
0 ... 3 = Reserved	Reserved.
4 = 120/170: CIP Basic Speed + I/O	Program I/O instances 120/170, with 2 read words + 2 write words predefined according to ODVA AC/DC Drive profile Basic Speed, plus configurable I/O words using parameters.
5 = 121/171: CIP Extended Speed + I/O	Program I/O instances 121/171, with 2 read words + 2 write words predefined according to ODVA AC/DC Drive profile Extended Speed, plus configurable I/O words using parameters.
6 ... 7 = Reserved	Reserved.
8 = 100/150: Manufac. Speed + I/O	Program I/O instances 100/150, with 2 read words + 2 write words predefined according to manufactures specific profile, plus configurable I/O words using parameters.
9 ... 10 = Reserved	Reserved.

NOTE!
After changing this configuration, the modification witll be effective only if there is no I/O connection active.

P872 - Ethernet Read Word #3

P873 - Ethernet Read Word #4

P874 - Ethernet Read Word #5

P875 - Ethernet Read Word #6

P876 - Ethernet Read Word #7

P877 - Ethernet Read Word #8

Range:	0 to 9999

Description:

These parameters allow the user to program the content of read words 3 to 8 (slave sends to the master). Using these parameters, it is possible to program the number of other parameter whose content shall be made available in the input area of the network master.

For instance, in case it is necessary to read the motor current in amperes from the inverter, the value 3 must be programmed in some of these parameters, since the parameter P003 is the parameter that contains this information. Note that the reading value of any parameter is represented with a 16-bit word. Even if the parameter has a decimal resolution value, the value is transferred with no decimal indication. For instance, if the parameter P003 has the value 4.7, the value transferred via network will be 47.

These parameters are only used if the equipment is programmed in parameter P871 to use options 4, 5 or 8, which have fixed words plus configurable I/Os.

The first parameter of this list programmed with the value 0 (zero) disables the reading of this word and the subsequent ones. The total number of words that must be programmed for reading in the network master then depends on how many parameters values other than 0 have been programmed in sequence.

P880 - Ethernet Write Word #3

P881 - Ethernet Write Word #4

P882 - Ethernet Write Word #5

P883 - Ethernet Write Word #6

P884 - Ethernet Write Word #7

P885 - Ethernet Write Word #8

Range:	0 to 9999

Description:

These parameters allow the user to program the content of write words 3 to 8 (masters sends to the slave). Using these parameters, it is possible to program the number of other parameter whose content shall be made available in the output area of the network master.

For instance, in case it is necessary to write the acceleration in the device, the value 100 must be programmed in some of these parameters, since the parameter P100 is the parameter where this information is programmed. Note that the written value of any parameter is represented with a 16-bit word. Even if the parameter has a decimal resolution value, the value is transferred with no decimal indication. For instance, if you want to set the parameter P100 with the value 5.0s, the value 50 should be written via network.

These parameters are only used if the equipment is programmed in parameter P871 to use options 4, 5 or 8, which have fixed words plus configurable I/Os.

The first parameter of this list programmed with the value 0 (zero) disables the writing of this word and the subsequent ones. The total number of words that must be programmed for writing in the network master then depends on how many parameters values other than 0 have been programmed in sequence.

P889 - Ethernet Interface Status

Range:	0 to 3 (hexa) Bit 0 = Link 1 Bit 1 = Link 2
Properties:	ro

Description:

Parameter for status indication of Ethernet interface.

Table 5.11: *P889 bits function*

Bit	Value/Description
Bit 0 Link 1	**0:** No link at port 1. **1:** Link active at port 1.
Bit 1 Link 2	**0:** No link at port 2. **1:** Link active at port 2.

6 OPERATION IN THE MODBUS TCP NETWORK – SERVER MODE

6.1 AVAILABLE FUNCTIONS

In the Modbus specification are defined the functions used to access different types of data. In the CFW300, in order to access those data the following services (or functions) have been made available:

Table 6.1: *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.

6.2 MEMORY MAP

The frequency converter CFW300 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.

6.2.1 Parameters

The CFW300 Modbus communication is based on the reading/writing of the equipment parameters. All the drive parameters list is made available as 16-bit holding registers type. The data addressing is done with the offset equal to zero, which means that the parameter number corresponds to the register number. The following table illustrates the parameters addressing, which can be accessed as holding register.

Table 6.2: *Parameters Access - Holding Registers*

Parameter	Modbus data address (decimal)
P000	0
P001	1
⋮	⋮
P100	100
⋮	⋮

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):

- P680 (holding register address 680): Status word
- P681 (holding register address 681): Motor speed

Command (writing):

- P684 (holding register address 684): Command Word
- P685 (holding register address 685): Speed Reference

Refer to the Programming Manual for a complete parameter list of the equipment.

NOTE!

- All the parameters are treated as holding registers. 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 above 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.

6.2.2 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 CFW300. Refer to the SoftPLC documentation for the description of those markers, as well as for the addresses via Modbus.

6.3 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 server may detect problems and send an error message, indicating the kind of problem found:

Table 6.3: *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.

7 OPERATION IN THE ETHERNET/IP NETWORK

7.1 I/O DATA

The I/O data for control and monitoring of the equipment is programmed through parameters P871 to P885. Using these parameters it is possible to define the I/O words format and the number of words to communicate with the master.

Monitoring (Read)

Table 7.1: *Programming of the I/O words*

	Instance	16 bits word	Function	Option of P871 + P872 ... P877
Const	150, 170, 171	#1	Status Word	2
Programable		#2	Motor Speed	3
		#3	Ethernet Read Word #3	4
		#4	Ethernet Read Word #4	5
		#5	Ethernet Read Word #5	8
		⋮	⋮	
		#8	Ethernet Read Word #8	

Control (Write)

Table 7.2: *Programming of the I/O words*

	Instance	16 bits word	Function	Option of P871 + P880 ... P885
Const	100, 120, 121	#1	Control word	2
Programable		#2	Speed reference	3
		#3	Ethernet Write Word #3	4
		#4	Ethernet Write Word #4	5
		#5	Ethernet Write Word #5	8
		⋮	⋮	
		#8	Ethernet Write Word #8	

According to the selected instance, the first two reading words (status and motor speed) and the first two writing words (control and speed reference) may have a different format depending on the profile defined for the instance. Programmable words using parameters P872 ... P877 and P880 ... P885 have similar operation regardless of the selected instance.

7.1.1 Instances 100/150: Manufacturer Specific

Data for control and monitoring of equipment using manufacturer specific profile.

In this profile, the first two predefined reading and writing words use the equipment control and monitoring parameters as indicated below:

Instance 150 - Monitoring

- Status Word: P680 - Logical Status.
- Motor Speed: P681 - 13-Bit Speed.

Instance 100 - Control

- Control Word: P684 - CO/DN/DP/ETH Control.
- Speed Reference: P685 - CO/DN/DP/ETH Speed Ref.

7.1.2 Instances 120/170: ODVA Basic Speed

Data for control and monitoring of equipment using profile AC/DC Drive - Basic Speed.

In this profile, the first two predefined read and write words follow the format defined by the CIP specification according to instances 20/70:

Instance 170 - Monitoring

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
170	0						Running1		Faulted
	1	-							
	2	Speed Actual rpm (low byte)							
	3	Speed Actual rpm (high byte)							

Bit	Value/Description
Bit 0 Faulted	**0**: frequency converter is not in a fault state **1**: Some fault registered by the frequency converter. Note: The number of the fault can be read through parameter P049 – Current Fault.
Bit 1	Reserved.
Bit 2 Running1 (Fwd)	**0**: The motor is not running forward. **1**: The motor is running forward.
Bits 3 to 7	Reserved.

- Byte 1: reserved.
- Bytes 2 and 3: represent the motor speed in RPM.

Instance 120 - Control

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
120	0						Fault Reset		Run Fwd
	1	-							
	2	Speed Reference rpm (low byte)							
	3	Speed Reference rpm (high byte)							

Bit	Value/Description
Bit 0 Run Fwd	**0**: Stop motor **1**: The motor runs in the forward direction.
Bit 1	Reserved.
Bit 2 Fault Reset	**0**: Not used. **1**: : If in a fault condition, it resets the frequency converter.
Bits 3 to 7	Reserved.

- Byte 1: reserved.
- Bytes 2 and 3: represent the speed reference of the motor in RPM.

NOTE!
For this profile, the values read and written via net in these words are internally converted into equivalent values for the product control and monitoring words described in item 7.1.1.

7.1.3 Instances 121/171: ODVA Extended Speed

Data for control and monitoring of equipment using profile AC/DC Drive - Extended Speed.

In this profile, the first two predefined read and write words follow the format defined by the CIP specification according to instances 21/71:

Instance 171 - Monitoring

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
171	0	At Reference	Ref. from Net	Ctrl from Net	Ready	Running2 (Rev)	Running1 (Fwd)	Warning	Faulted
	1	Drive State							
	2	Speed Actual rpm (low byte)							
	3	Speed Actual rpm (high byte)							

Bit	Value/Description
Bit 0 Faulted	**0**: frequency converter is not in a fault state **1**: Some fault registered by the frequency converter. Note: The number of the fault can be read through parameter P049 – Current Fault.
Bit 1 Warning	**0**: frequency converter is not in an alarm state. **1**: Some alarm registered by the frequency converter. The number of the alarm can be read by means of parameter P048 – Current Alarm.
Bit 2 Running1 (Fwd)	**0**: The motor is not running forward. **1**: The motor is running forward.
Bit 3 Running2 (Rev)	**0**: The motor is not running in the reverse direction. **1**: The motor is running in the reverse direction.
Bit 4 Ready	**0**: frequency converter not ready to operate. **1**: frequency converter ready to operate (Ready, Enabled or Stopping states).
Bit 5 Ctrl from Net	**0**: Drive locally controlled. **1**: Drive remotely controlled.
Bit 6 Ref. from Net	**0**: Speed reference is not being sent via DeviceNet. **1**: Indicates speed reference being sent via DeviceNet.
Bit 7 At Reference	**0**: frequency converter has not reached the programmed speed yet. **1**: frequency converter has reached the programmed speed.

- Byte 1 indicates the state of the drive:
  - 0 = Non Existent
  - 1 = Startup
  - 2 = Not Ready
  - 3 = Ready[1]
  - 4 = Enabled[1]
  - 5 = Stopping
  - 6 = Fault Stop
  - 7 = Faulted[1]
- Bytes 2 and 3: represent the motor speed in RPM.

Instance 121 - Control

Instance	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
121	0		NetRef	NetCtrl			Fault Reset	Run Rev	Run Fwd
	1	-							
	2	Speed Reference rpm (low byte)							
	3	Speed Reference rpm (high byte)							

[1] Only these states are presented by the product.

Bit	Value/Description
Bit 0 Run Fwd	**0**: Stop motor **1**: The motor runs in the forward direction.
Bit 1 Run Rev	**0**: Stop motor **1**: The motor runs in the reverse direction.
Bit 2 Fault Reset	**0**: Not used. **1**: If in a fault condition, it resets the frequency converter.
Bits 3 e 4	Reserved.
Bit 5 NetCtrl	**0**: frequency converter selects the local mode. **1**: frequency converter selects the remote mode.
Bit 6 NetRef	**0**: Speed reference via network is disregarded. **1**: Using Speed reference received via network.
Bits 7	Reserved.

- Byte 1: reserved.
- Bytes 2 and 3: represent the speed reference in RPM.

NOTE!
For this profile, the values read and written via net in these words are internally converted into equivalent values for the product control and monitoring words described in item 7.1.1.

7.1.4 Programmable Parameters

Besides the firs two predefined read and write words, for the cyclic communicagtion, it is possible to program up to 6 other parameters for reading and up to 6 other parameters for writing via network, through parameters P872 ... P877 (read) and P880 ... P885 (write).

The detailed description of how to program them is present in the description of these parameters.

7.2 ACYCLIC DATA

In addition to the cyclic data, the interface also provides acyclic data via *explicit messaging*. Using this type of communication, you can access any equipment parameter. Access to this type of data is commonly done using instructions for reading or writing data, which should indicate the class, instance, and attribute to the desired parameter. The item **??** describes how to address the parameters for CFW300 frequency converter.

7.3 EDS FILE

Each device on an EtherNet/IP network has an EDS configuration file, which contains information about the device functions on the network. This file is used by a master or configuration software to program devices present at EtherNet/IP network.

The EDS file is available from WEG website (http://www.weg.net). It is important to note if the EDS configuration file is compatible with the firmware version of the CFW300 frequency converter.

7.4 SUPPORTED OBJECT CLASSES

Any EtherNet/IP equipment is modeled as a set of objects. The objects are responsible for defining the function that each device will perform. In addition to the classes defined by the specification, CFW300 also defines classes for acyclic access to product parameters. The following sections present detailed information about these object classes.

7.4.1 Manufacturer Specific Class

For CFW300 frequency converter, the manufacturer specific classes are used for mapping all device parameters. These classes allow the user to read from and write to any parameter through the network. For this, EtherNet/IP CIP Class 3 messages or Unconnected Explicit messages can be used.

CFW300 uses class 100 for parameter access, and the parameter number is defined according to instance and attribute, as shown in table 7.3:

Table 7.3: *Manufacturer Specific Class*

Class	Instance	Attributes	Accessed Parameters
Class 100 (64h) (Vendor Specific)	1	100 ... 199	Parameters 0 - 99
Class 100 (64h) (Vendor Specific)	2	100 ... 199	Parameters 100 - 199
Class 100 (64h) (Vendor Specific)	3	100 ... 199	Parameters 200 - 299
Class 100 (64h) (Vendor Specific)	4	100 ... 199	Parameters 300 - 399
Class 100 (64h) (Vendor Specific)	5	100 ... 199	Parameters 400 - 499
Class 100 (64h) (Vendor Specific)	6	100 ... 199	Parameters 500 - 599
Class 100 (64h) (Vendor Specific)	7	100 ... 199	Parameters 620 - 699
Class 100 (64h) (Vendor Specific)	8	100 ... 199	Parameters 700 - 799
Class 100 (64h) (Vendor Specific)	9	100 ... 199	Parameters 800 - 899
Class 100 (64h) (Vendor Specific)	10	100 ... 199	Parameters 900 - 999

Por exemplo:

Parameter 23: class 64h, instance 1, attribute 123. This path gives access to P023.
Parameter 100: class 64h, instance 2, attribute 100. This path gives access to P100.
Parameter 202: class 64h, instance 3, attribute 102. This path gives access to P202.

8 WEB SERVER

Ethernet interface also provides a WEB server with a simple page to access CFW300 frequency converter data. You can use a web browser by typing the IP address in the browser address bar, and it will present a web page with links to interface settings and device data.

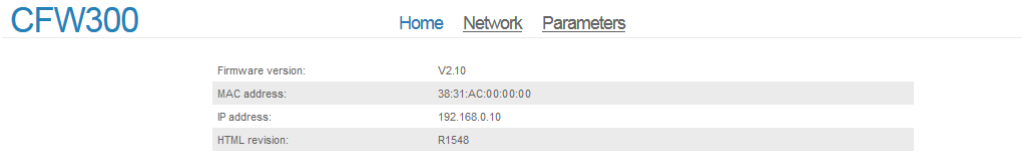

Figure 8.1: *WEB page*

In the interface settings, it presents several fields for programming the IP address, subnet, DHCP, among others. The parameter list of the equipment can also be accessed through the WEB browser via ”Parameters” link.

9 STARTUP GUIDE - MODBUS TCP COMMUNICATION

The main steps to start up the CFW300 frequency converter 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.

9.1 INSTALLING THE ACCESSORY

1. Install the communication accessory, as indicated in the installation guide supplied with the accessory.
2. With the module installed, during the recognition stage, the Status LED test routine will be performed.
3. Observe the content of parameter P028. Check if the module was recognized. The detection is done automatically and does not require the user's intervention.
4. Connect the cables, considering the recommended instructions in network installation, as described in item 4.5:
   - Use shielded cable.
   - Properly ground network equipment.
   - Avoid laying communication cables next to power cables.

9.2 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 (P220 ... P228).
3. Configure communication parameters, such as DHCP, IP address, communication rate, etc. (P850 ... P859).
4. Configure the timeout for the Modbus TCP communication in P868.
5. Program the desired action for the equipment in case of communication fault in P313.
6. Define which data will be read and written at frequency converter CFW300, based on its parameter list. It is not necessary to define I/O words. The Modbus TCP protocol enables direct access to any device parameter, and does not distinguish between cyclic and acyclic data. Among the main parameters that can be used to control the device, we can mention:
   - P0680 - Status Word (read)
   - P0681 - Speed in 13 bits (read)
   - P0684 - Control Word (write)
   - P0685 - Speed reference (write)

9.3 CONFIGURING THE MASTER (CLIENT)

The way the network configuration is done depends greatly on the used client 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 client to access the holding registers, based on the defined equipment parameters to read and write. The register address is based on the parameter number, as shown in table 6.2.
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 P868.

9.4 COMMUNICATION STATUS

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

- The Status and Link LEDs provide information about the status of the interface and communication.
- The parameter P860 indicates the status of communication between the device and the network client.

The client of the network must also supply information about the communication with the server.

10 STARTUP GUIDE - ETHERNET/IP COMMUNICATION

The main steps to start up the CFW300 frequency converter in EtherNet/IP network are described below. These steps represent an example of use. Check out the specific chapters for details on the indicated steps.

10.1 INSTALLING THE ACCESSORY

1. Install the communication accessory, as indicated in the installation guide supplied with the accessory.
2. With the module installed, during the recognition stage, the LED test routine will be performed.
3. Observe the content of parameter P028. Check if the module was recognized. The detection is done automatically and does not require the user's intervention.
4. Connect the cables, considering the recommended instructions in network installation, as described in item 4.5:
   - Use shielded cable.
   - Properly ground network equipment.
   - Avoid laying communication cables next to power cables.

10.2 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 (P220 ... P228).
3. Configure communication parameters, such as DHCP, IP address, communication rate, etc. (P850 ... P859).
4. Program the desired action for the equipment in case of communication fault in P313.
5. Define which I / O instance is used through the parameter 871.
6. Define additional read/write I/O data in parameters P872 ... P877 and P880 ... P885.

10.3 CONFIGURING THE MASTER

The way the network configuration is done depends greatly on the used client 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. Load the EDS file[2] to the list of devices in the network configuration tool.
2. Select CFW300 frequency converter from the available list of devices on the network configuration tool. This can be done manually or automatically, if allowed by the tool.
3. For the master configuration, in addition to the IP address used by the EtherNet/IP module, you must indicate the number of instances of I/O and the amount of data exchanged with the master in each instance. For the communication module for EtherNet/IP, the following values must be programmed:
   - Input instances: 150, 170 or 171, according to the value of P871. The number of words read by the network master also depends on the programming of parameters P872 ... P877.
   - Output Instance: 100, 120, or 121, according to the value of P871. The number of words written by the network master also depends on the programming of parameters P880 ... P885.

Once configured, the status LED will be on in green. It is in this condition that cyclic data exchange effectively occurs between the slave and the master of the network.

[2]The EDS file is available from WEG website (http://www.weg.net). It is important to note if the EDS configuration file is compatible with the firmware version of the CFW300 frequency converter.

10.4 COMMUNICATION STATUS

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

- The Status and Link LEDs provide information about the status of the interface and communication.
- The parameter P870 indicates the status of communication between the device and the network master.
- The parameter P869 indicates if network master is in *IDLE* or *RUN* mode.

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

10.5 OPERATION USING PROCESS DATA

Once the communication is established, the data mapped in the I/O area is automatically updated between master and slave. Among the main parameters that can be used to control the device, we can mention:

- P680 - Logical Status.
- P681 - 13-Bit Speed.
- P684 - CO/DN/DP/ETH Control.
- P685 - CO/DN/DP/ETH Speed Ref.

It is important to know these parameters to program the master as desired for the application.

10.6 ACCESS TO PARAMETERS – ACYCLIC MESSAGES

Besides the I/O data (cyclic) communication, the EtherNet/IP protocol also defines a kind of acyclic telegram (*explicit messages*), used especially in asynchronous tasks, such as parameter setting and configuration of the equipment.

The item **??** describes how to address the parameters of the frequency converter CFW300 via acyclic messages.

11 QUICK REFERENCE OF ALARMS AND FAULTS

Fault / Alarm	Description	Possible Causes
A147 EtherNet/IP Communication Offline	It indicates interruption in the cyclic communication with EtherNet/IP master. It occurs when, for any reason, after the cyclic communication of the master with the product is started, this communication is interrupted.	■ Check the status of the network master. ■ Check the network installation, broken cable or failed/bad contact in the network connections.
A149 Timeout Modbus TCP	It indicates that the device stopped receiving valid telegrams for a period longer than the setting in P868. The time counting starts as soon as it receives the first valid telegram.	■ Check network installation, broken cable or fault/poor contact on the connections with the network, grounding. ■ Ensure the Modbus TCP client always sends telegrams to the equipment in a time shorter than the setting in P868. ■ Disable this function in P868.
F247 EtherNet/IP Communication Offline	It indicates interruption in the cyclic communication with EtherNet/IP master. It occurs when, for any reason, after the cyclic communication of the master with the product is started, this communication is interrupted.	■ Check the status of the network master. ■ Check the network installation, broken cable or failed/bad contact in the network connections.
F249 Timeout Modbus TCP	It indicates that the device stopped receiving valid telegrams for a period longer than the setting in P868. The time counting starts as soon as it receives the first valid telegram.	■ Check network installation, broken cable or fault/poor contact on the connections with the network, grounding. ■ Ensure the Modbus TCP client always sends telegrams to the equipment in a time shorter than the setting in P868. ■ Disable this function in P868.

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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