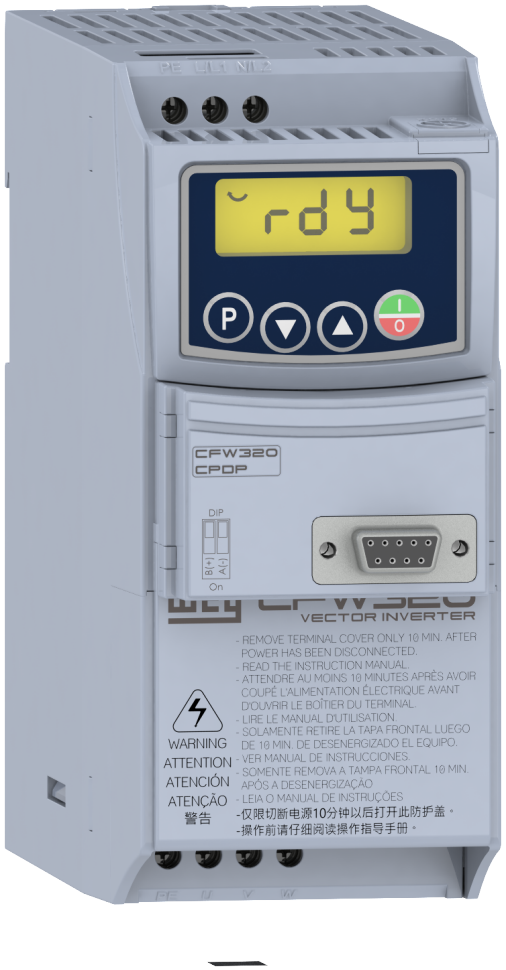
Profibus DP

CFW320-CPDP

User's Guide



Profibus DP User's Guide

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-	R00	First edition

ABOUT THE MANUAL

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

ABBREVIATIONS AND DEFINITIONS

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

NUMERICAL REPRESENTATION

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

1 INTRODUCTION TO THE PROFIBUS DP PROTOCOL

A general overview of Profibus DP protocol, describing the main characteristics and functions, are presented next.

1.1 PROFIBUS DP NETWORK

The term Profibus is used to describe a digital communication system that can be used in several application areas. It is an open and standardized system, defined by the IEC 61158 and IEC 61784 standards, which comprises from the used physical medium to data profiles for certain sets of equipments. In this system, the DP communication protocol was developed with the purpose of allowing a fast, cyclic and deterministic communication between masters and slaves.

Among the several communication technologies that can be used in this system, the Profibus DP technology describes a solution that, typically, is composed by the DP protocol, RS485 transmission medium and application profiles, used mainly in applications and equipments with emphasis in manufacturing automation.

Nowadays, there is an organization named Profibus International, responsible for keeping, updating and publishing the Profibus technology among users and members. More information regarding the technology, as well as the complete protocol specification can be obtained with this organization or with one of the regional associations or competence centers associated to the Profibus International (http://www.profibus.com).

1.2 PROFIBUS DP PROTOCOL VERSIONS

The Profibus DP protocol defines a series of functions for exchanging data between master and slave. The set of functions can be divided in different functional levels, in the following versions:

- **DP-V0:** It is the first version of the protocol, which mainly defines functions to perform cyclic data exchange between master and slave.
- **DP-V1:** It is an extension of the functions defined in the first version; it defines particularly how to perform the exchange of acyclic data between master and slave, besides the cyclic data.
- **DP-V2:** It defines a set of advanced functions such as communication between slaves and isochronous communication mode.

The CFW320 frequency inverter supports the services of the DP-V0 and DP-V1 versions.

1.3 DEVICE TYPES IN A PROFIBUS DP NETWORK

Three different types of equipment are specified in a Profibus network:

- **Slaves:** They are passive stations in the network, which only answer to the requests made by the master.
- **Class 1 Master:** It is responsible for the cyclic data exchange. Typically represented by the PLC, or process or plant control software.
- **Class 2 Master:** It allows the communication in the Profibus DP network through acyclic messages. Typically represented by an engineering or configuration tool used for network commissioning or maintenance.

The CFW320 frequency inverter operates as a slave in the Profibus DP network.

1.4 PHYSICAL LAYER

There are different network transmission types to allow communication in a Profibus network, each one with suitable features according to the demands of different application types. The main transmission modes are:

- **RS485:** this is the most used transmission type for Profibus network. It provides high transmission rates, simple installation and low cost.
- **MBP:** this is specified mainly for applications in chemical and petrochemical industries, for communication in safety areas. The transmission rate is defined at 31.25 kbit/s with the possibility of feeding the devices from the communication bus.

- **Optical Fiber:** this is used mainly in applications where high electromagnetic interference immunity and/or great distances connections are required.

The Profibus DP accessory of CFW320 frequency inverter provides an RS485 interface for network connection.

2 PROFIBUS DP COMMUNICATION INTERFACE

The following Profibus DP accessory is needed in order to enable the device communication in a Profibus DP network. Information about the installation of this module can be found in the guide that came with the accessory.

2.1 PROFIBUS DP INTERFACE CHARACTERISTICS

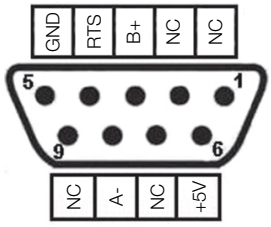
Figure 2.1: *Acessório CPDP*

- WEG part number: 16047208.
- Composed by the Profibus DP-V1 communication module and an installation guide.
- It supports DP-V1 (acyclic messages).

2.2 PIN ASSIGNMENT OF THE CONNECTOR

The Profibus DP-V1 communication module has two connectors to the Profibus network, each one with the following pinout:

Table 2.1: *Profibus female DB9 connector pinout (XC6)*

Connector	Pin	Name	Function
	1	NC	Not Connected
	2	NC	Not Connected
	3	B-Line (+)	RxD/TxD positive (red)
	4	RTS	Request To Send
	5	GND	0V isolated for the RS485 circuit
	6	+5V	+5V isolated for the RS485 circuit
	7	NC	Not Connected
	8	A-Line (-)	RxD/TxD negative (green)
	9	NC	Not Connected

2.3 DIP SWITCHES

At each segment of the Profibus DP network, it is necessary to enable terminating resistors at both end points of the main bus. For this purpose, the Profibus DP communication module has two DIP switches that can be activated (both switches to the ON position) to enable the resistor. The DIP switches should not be activated if the network connector already has the terminating resistors.

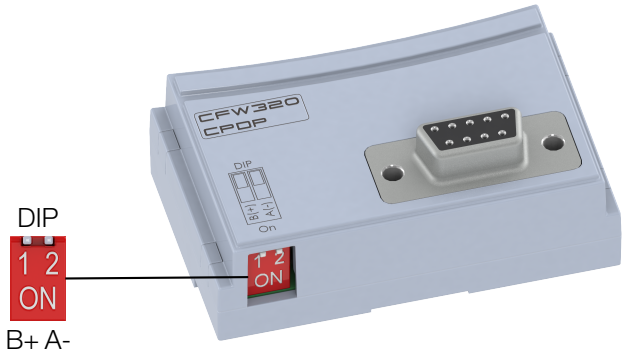


Figure 2.2: *Dip switches position to terminating resistor enable*

Table 2.2: *S1 configuration to Profibus DP network*

Switch Setting	Option
S1.1 = OFF and S1.2 = OFF	Resistive Termination OFF.
S1.1 = ON and S1.2 = ON	Resistive Termination ON.
S1.1 = OFF and S1.2 = ON	Combination not allowed.
S1.1 = ON and S1.2 = OFF	

2.4 INDICATIONS

The alarms, faults and status indications are done through the device HMI and parameters.

WARNING!
For the proper operation of the CFW320 frequency inverter with the CFW320-CPDP module, parameters P308, P310, P311 and P312 must be programmed with the factory settings. For further details refer to the programming manual of the CFW320.

3 PROFIBUS DP NETWORK INSTALLATION

The Profibus DP network, such as several industrial communication networks, for being many times applied in aggressive environments with high exposure to electromagnetic interference, requires that certain precautions be taken in order to guarantee a low communication error rate during its operation. Recommendations to perform the product connection in this network are presented next.

3.1 BAUD RATE

The Profibus DP protocol defines several baud rates that can be used, from 9.6 kbit/s up to 12Mbit/s. The maximum allowed transmission line length depends on the used baud rate, and this correlation is showed on the Table 3.1 on page 10.

Table 3.1: *Supported baud rates and installation size*

Baud Rate	Cable Length
9.6 kbit/s	1200 m
19.2 kbit/s	1200 m
45.45 kbit/s	1200 m
93.75 kbit/s	1200 m
187.5 kbit/s	1000 m
500 kbit/s	400 m
1.5 Mbit/s	200 m
3.0 Mbit/s	100 m
6.0 Mbit/s	100 m
12.0 Mbit/s	100 m

All equipments in the network must use the same baud rate. The CFW320 frequency inverter Profibus DP interface has automatic baud rate detection, according to what has been configured for the network master, and therefore it is not necessary to configure this option.

It is possible to observe the baud rate detected by the board at the parameter P754.

3.2 ADDRESS IN THE PROFIBUS DP NETWORK

Every device in a Profibus DP network, master or slave, is identified through a network address. This address must be different for each device. The CFW320 frequency inverter Profibus DP address is configured through the parameter P750.

3.3 CABLE

It is recommended that the installation be carried out with a type A cable, whose characteristics are described in the Table 3.2 on page 10. The cable has a pair of wires that must be shielded and twisted, in order to guarantee higher immunity against electromagnetic interference.

Table 3.2: *Profibus DP cable characteristics*

Impedance	Capacitance	Resistance in Loop	Diameter of the Cable	Cross Section of the Wire
135 to 165 Ω	30 pf / m	110 Ω / km	> 0.64 mm	> 0.34 mm^2

3.4 CONNECTORS

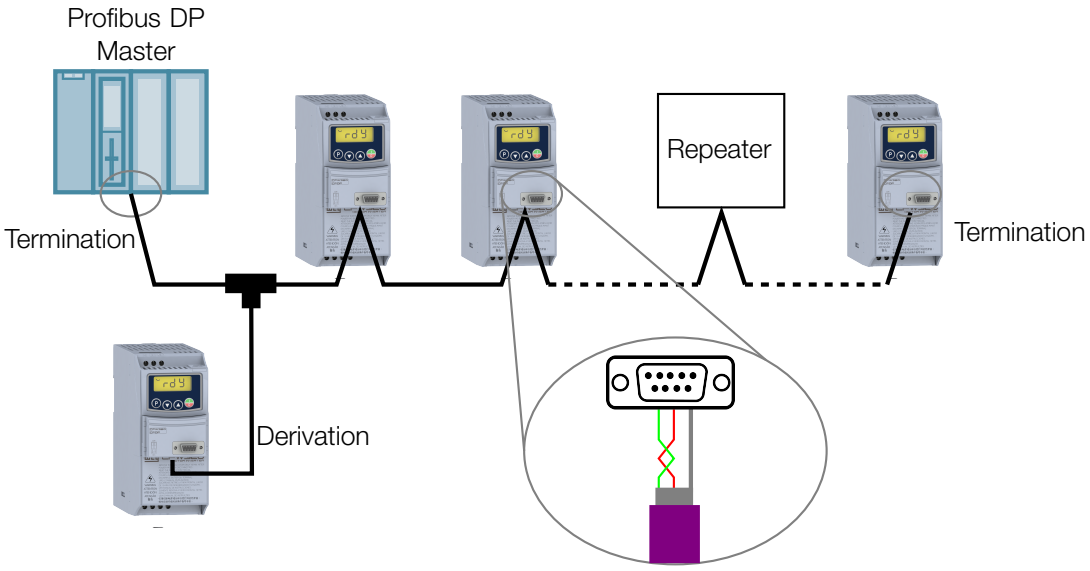
Several connector types can be used for the network connection of the equipment, from simple screw connectors up to very specific connector types for the Profibus network. The connector used in the CFW320 frequency inverter Profibus DP accessory is presented at Section 2.2 on page 8.

3.5 CONNECTION IN THE NETWORK

The Profibus DP protocol, by using the RS-485 physical medium, allows the connection of up to 32 devices per segment without the use of repeaters. By using repeaters, up to 126 addressable equipments can be connected to the network. Each repeater must also be included as a device connected to the segment, even not occupying a network address.

It is recommended that the connection of all the devices present in the Profibus DP network be made coming from the main bus. Generally, the Profibus network connector itself has an input and an output for the cable, allowing the connection to be taken to the other network points. Derivations from the main bus are not recommended, especially for baud rates higher or equal to 1.5Mbits/s.

Figure 3.1: *Profibus DP network installation example*



The Profibus DP network cables must be laid separately (and far away if possible) from the power cables. All the drives must be properly grounded, preferably at the same ground point. The Profibus cable shield must also be grounded. The CFW320 Profibus board connector itself already has a connection with the protective ground and, therefore, makes the connection of the shield to the ground when the Profibus cable is connected to the drive. However a better connection, implemented by clamps that connect the shield to a ground point, is also recommended.

3.6 TERMINATION RESISTOR

At each segment of the Profibus DP network, it is necessary to enable a terminating resistor at the end points of the main bus. The use of specific Profibus network connectors with a switch to enable the resistor is recommended, which must only be enabled (ON position) if the equipment is the first or the last element of the segment. The DIP switches present in the communication module also can be used to enable the termination resistors.

It is important to emphasize that in order to be possible to disconnect the element from the network without impairing the bus, it becomes interesting the use of active terminations, which are elements that have only the termination function. Therefore, any drive of the network can be disconnected from the bus without impairing the termination.

3.7 GSD FILE

Each element of the Profibus DP network has an associated configuration file with the GSD extension. This file describes the characteristics of each equipment and it is used by the Profibus DP network master configuration tool. During the master configuration the GSD configuration file supplied with the equipment must be used.

4 PARAMETERS

4.1 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

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

Description:

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

The actions described in this parameter are executed by means of the automatic writing of the selected actions in the respective bits of the interface control words. Therefore, in order that the commands are effective, it is necessary that the device be programmed to be controlled via the used network interface (with exception of option “Causes a Fault”, which blocks the equipment even if it is not controlled by network). This programming is achieved by means of parameters P220 to P228.

Table 4.1: *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

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

Description:

The inverter status word is unique for all the sources and can only be accessed for reading. It indicates all the relevant operating status and modes of the inverter. The function of each bit of P680 is described in Table 4.2 on page 13.

Table 4.2: *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 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 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

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

Description:

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

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

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

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

8192 => 60 Hz
2048 => Frequency

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

Frequency = 15 Hz

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

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

P684 - CO/DN/DP/ETH Control

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

Description:

The inverter control word has read and write access only via network interface, but read only access is permitted for the other sources (keypad, SoftPLC). Each bit function is described as per Table 4.3 on page 15. The value of P684 is indicated in hexadecimal.

Table 4.3: 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

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

Description:

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

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

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

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

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

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

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

13 bits reference = 4096 => Value corresponding to 30 Hz in a 13 bit scale

This parameter also accepts negative values to revert the motor speed direction. The reference speed direction, however, depends also on the control word - P684 bit 2 setting:

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

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

P695 - DOx Value

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

Description:

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

Table 4.4: *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

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

Description:

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

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

The value written in these parameters is used as the analog output value, providing that the function for the desired analog output be programmed for “P696 / P697 value”, at the parameters P251, P254.

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

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

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

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

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

4.2 PROFIBUS DP

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

P740 - Profibus Comm. Status

Adjustable Range:	0 = Disabled 1 = Access Error 2 = Offline 3 = Config. Error 4 = Param. Error 5 = Clear Mode 6 = Online	**Factory Setting:**	-
Properties:	ro		

Description:

It allows identifying if the Profibus DP interface board is properly installed, besides indicating the status of the communication with the network master.

Table 4.5: *P740 options*

Indication	Description
0 = Disabled	The Profibus interface is not installed.
1 = Access Error	A problem was identified during the Profibus interface initialization.
2 = Offline	The Profibus interface is installed and properly configured, but no cyclic communication is established.
3 = Config. Error	Data received in the I/O configuration telegram are not in accordance with the configurations done through the parameter P751.
4 = Param. Error	Data received in the parameterization telegram does not have valid format/values.
5 = Clear Mode	During data exchange with the master, the slave received a command to enter the clear mode.
6 = Online	I/O data exchange between the slave and Profibus network master is successfully running.

P742 - Profibus Read Word #3

P743 - Profibus Read Word #4

P744 - Profibus Read Word #5

P745 - Profibus Read Word #6

Adjustable Range:	0 to 1199	**Factory Setting:**	0

Description:

It allows programming the content of the input words 3 a 6 (input: drive sends to the master). By using these parameters it is possible to program the number of another parameter whose content must be made available at the network master input area.

If, for instance, one wants to read from the CFW320 frequency inverter the motor current in Amps, one must program

the value 3 in one of these parameters, because the parameter P003 is the one that contains this information. It is worthwhile to remind that the value read from any parameter is represented with a 16 bit word. Even if the parameter has decimal resolution, the value is transmitted without the indication of the decimal places. E.g., if the parameter P003 has the value 4.7A, the value supplied via the network will be 47.

These parameters are used only if the equipment is programmed at the parameter P751 to use the options 2 a 6 (configuration telegrams 100 a 104). Up to 6 words to be read by the network master can be made available, according to the selected option.

The first two input words are fixed and represent the status and the motor speed.

NOTE!
The value 0 (zero) disables the reading in the word. The number of input words, however, keeps the same as programmed at P751.

P746 - Profibus Write Word#3

P747 - Profibus Write Word#4

P748 - Profibus Write Word#5

P749 - Profibus Write Word#6

Adjustable Range:	0 to 1199	**Factory Setting:**	0

Description:

It allows programming the content of the output words 3 a 6 (output: master sends to the drive). Using these parameters, it is possible to program the number of another parameter whose content must be made available at the network master output area.

If, for instance, one wants to write the acceleration ramp value in the CFW320 frequency inverter, one must program the value 100 in one of these parameters, because the parameter P100 is the one where this information is programmed. It is worthwhile to remind that the value written in any parameter is represented with a 16 bit word. Even if the parameter has decimal resolution, the value is transmitted without the indication of the decimal places. E.g., if one wishes to program with the value 5.0s, the value programmed via the network must be 50.

These parameters are used only if the equipment is programmed at the parameter P751 to use the options 2 a 6 (configuration telegrams 100 a 104). Up to 6 words to be written by the network master can be made available, according to the selected option.

The first two output words are fixed and represent the control and the speed reference.

NOTE!
- The value 0 (zero) disables the writing in the word. The number of input words, however, keeps the same as programmed at P751.
- The written parameters using these words are not saved in non-volatile memory. Thus, if the equipment is turned off and on again, these parameters will return to their original value.

P750 - Profibus Address

Adjustable Range:	1 to 126	**Factory Setting:**	1

Description:

It allows programming the slave address in the Profibus DP network. It is necessary that each of the equipments in the network has an address different from the others.

NOTE!
If this parameter is changed, the slave will assume the new configuration only when there is no cyclic communication with the master.

P751 - Profibus Teleg. Sel.

Adjustable Range:	1 = Std. Teleg. 1 2 = Telegram 100 3 = Telegram 101 4 = Telegram 102 5 = Telegram 103	**Factory Setting:**	1

Description:

It allows selecting which configuration telegram is used by the drive during the Profibus DP network initialization. This telegram defines the format and quantity of input/output data exchanged with the network master.

During the network master configuration, by using the GSD file, it is possible to select the desired data module for the exchange of cyclic data between the master and the slave. It is possible to exchange from 2 to 6 input/output (I/O) words (16 bits each), depending on the selected option. The value programmed in this parameter must coincide with the module selected by the network master configuration tool.

The content of the first two input/output words is pre-defined. The other words are programmable through the parameters P742 up to P749:

Table 4.6: *Selection of the I/O words*

	Input (slave -> master)	Word	Output (master -> slave)	
Fixed	Status Word	#1	Control Word	2I/O
Fixed	Motor Speed	#2	Speed Reference	2I/O
Programable	Reading Profibus #3	#3	Writing Profibus #3	3I/O
Programable	Reading Profibus #4	#4	Writing Profibus #4	4I/O
Programable	Reading Profibus #5	#5	Writing Profibus #5	5I/O
Programable	Reading Profibus #6	#6	Writing Profibus #6	6I/O

NOTE!
- The format of the control, status, speed reference and motor speed words depends on the parameter P741 programming.
- If this parameter is changed, the slave will assume the new configuration only when there is no cyclic communication with the master.

Table 4.7: *P751 options*

Indication	Description
1 = Std. Teleg. 1	Allows you to program two I/O words.
2 = Telegram 100	Allows you to program three I/O words.
3 = Telegram 101	Allows you to program four I/O words.
4 = Telegram 102	Allows you to program five I/O words.
5 = Telegram 103	Allows you to program six I/O words.

P754 - Profibus Baud Rate

Adjustable Range:	0 = 9.6 kbit/s 1 = 19.2 kbit/s 2 = 93.75 kbit/s 3 = 187.5 kbit/s 4 = 500 kbit/s 5 = Not Detected 6 = 1500 kbit/s 7 = 3000 kbit/s 8 = 6000 kbit/s 9 = 12000 kbit/s 10 = Reserved 11 = 45.45 kbit/s	**Factory Setting:**	0

Description:

It is a Profibus DP communication specific parameter, defined by the PROFIdrive standard, to indicate the baud rate detected by the Profibus DP interface.

Table 4.8: *P754 options*

Indication	Description
0 = 9.6 kbit/s	9600 bit per second.
1 = 19.2 kbit/s	19200 bit per second.
2 = 93.75 kbit/s	93750 bit per second.
3 = 187.5 kbit/s	187500 bit per second.
4 = 500 kbit/s	500000 bit per second.
5 = Not Detected	Not detected.
6 = 1500 kbit/s	1500000 bit per second.
7 = 3000 kbit/s	3000000 bit per second.
8 = 6000 kbit/s	6000000 bit per second.
9 = 12000 kbit/s	12000000 bit per second.
10 = Reserved	Reserved.
11 = 45.45 kbit/s	45450 bit per second.

5 PROFIBUS DP NETWORK OPERATION

The CFW320 frequency inverter with Profibus DP communication accessory operates as a slave in the network and supports the network services of DP-V0 and DP-V1 communication protocols. Information about the inverter operation using the services specified on these versions is presented bellow.

5.1 PROFIBUS DP-V0

5.1.1 Cyclic Data

The communication via cyclic data allows the data transfer in two directions:

- Input data: Data transmitted from the slave to the master, for monitoring the status and the variables of each slave.
- Output data: Data transmitted from the master to the slave, for control and transmission of operation data to the equipment.

These data are transmitted in regular time periods, defined by the baud rate, number of slaves in the network and the amount of data exchanged with each slave.

The number of input/output (I/O) words available for the CFW320 depends on the format of the configuration telegram, programmed through the parameter P751. It is possible to communicate from 2 to 6 input words and the same number of output words. The contents of these words depend on the setting of the parameters P742 to P749.

The same programming done at the parameter P751 must also be configured at the network master, using a master configuration tool and the CFW320 GSD file, selecting one of the available modules described in the GSD file.

5.1.2 SYNC/FREEZE

The CFW320 frequency inverter supports the SYNC/UNSYNC and FREEZE/UNFREEZE commands. These are global commands that the master can send to all the network slaves, allowing simultaneous update of I/O data in the network equipments.

The SYNC/UNSYNC commands act on the master output data. When receiving a SYNC command, the command and speed reference values received by each slave are frozen. Values received later by the slave are stored, but will only be updated after the reception of a new SYNC command, or after the UNSYNC command, which cancels this function.

The FREEZE/UNFREEZE commands act in a similar form as the SYNC, but their action is associated to the master input data. When receiving a FREEZE command, variable and status values of each slave are frozen. These values remain fixed until a new FREEZE command be received, or after the UNFREEZE command, which cancels this function.

5.2 PROFIBUS DP-V1

In addition to the services defined by the first version of the Profibus DP specification (DP-V0), where it is mainly defined how to perform the exchange of cyclic data for equipment control and monitoring, the CFW320 frequency inverter with the Profibus DP communication accessory also supports the DP-V1 additional services for acyclic communication. Using these services, it id possible to read/write drive parameters using DP-V1 acyclic function, both by the network master (class 1 master) and by a commissioning tool (class 2 master).

5.2.1 Available Services for Acyclic Communication

The device supports the following services for acyclic communication in the Profibus DP network:

- Communication between class 1 master and slave (MS1):
  - Data acyclic reading (DS_Read).

– Data acyclic writing (DS_Write).

- Communication between class 2 master and slave (MS2):
  - Initiates the connection (Initiate).
  - Data acyclic reading (DS_Read).
  - Data acyclic writing (DS_Write).
  - Aborts the connection (Abort).

DP-V1 requests use an SD2 type Profibus DP telegram – with variable data length. This type of telegram has the following fields:

Telegram Header									Data Unit	Telegram End	
SD	LE	LEr	SD	DA	SA	FC	DSAP	SSAP	DU	FCS	ED
68h	xx	xx	68h	xx	xx	xx	xx	xx	xx ...	xx	16h

SD	Telegram start delimiter (Start Delimiter)
LE	Telegram length, from the DA field to the DU (Length)
LEr	Telegram length repetition (Length repeat)
DA	Destination Address
SA	Source Address
FC	Function Code
DSAP	Destination Service Access Point
SSAP	Source Service Access Point
DU	Data unit, size 1 to 244 (Data Unit for DP services)
FCS	Telegram checking byte (Frame Checking Sequence)
ED	Telegram end delimiter (End Delimiter)

In this telegram it matters to describe the data structure in the DU field, where the form to access the drive parameters is defined. The other fields follow the defined by the Profibus specification and, normally, are controlled by the network master.

5.2.2 Data Addressing

In the functions for reading and writing via acyclic data, these data are addressed with a numbering indicating which slot and index are being accessed. The slots can be used to address different physical segments of an equipment (a modular equipment for instance) or even logical segments inside a single equipment. The index indicates which data inside the segment is being accessed.

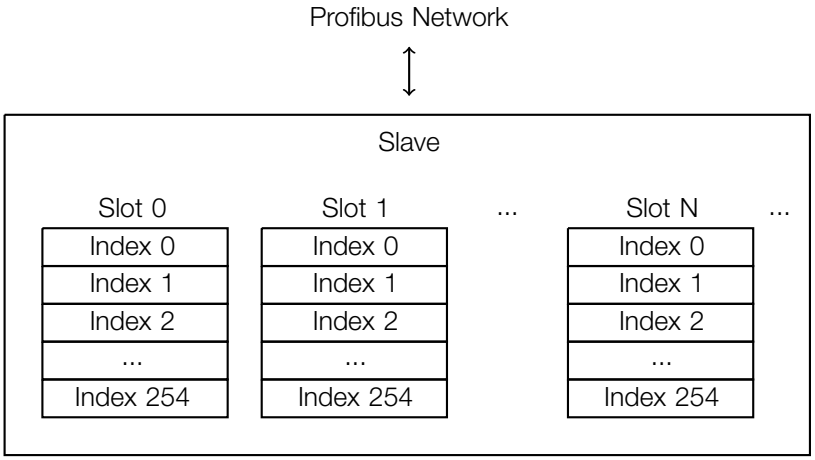


Figure 5.1: *Acyclic Data Addressing*

5.2.3 Reading/Writing DP-V1 Telegrams

In the Profibus DP protocol, the writing (DS_Write) and reading (DS_Read) DP-V1 telegrams used to access the parameters have the following structure:

Writing Telegram (DS_Write):

Request (master->slave)	**Header**	**Data Unit (DU)**					**End**
		Function 5Fh	Slot 0	Index 47	Size n	Request Data (n bytes)	
Positive Response (slave->master)	**Header**	**Data Unit (DU)**					**End**
		Function 5Fh	Slot 0	Index 47	Size 0		
Negative Response (slave -> master)	**Header**	**Data Unit (DU)**					**End**
		Function DFh	Error Decode 128	Error Code 1 xx	Error Code 2 xx		

Reading Telegram (DS_Read):

Positive Response (slave->master)	**Header**	**Data Unit (DU)**					**End**
		Function 5Eh	Slot 0	Index 47	Size 240		
Request (master->slave)	**Header**	**Data Unit (DU)**					**End**
		Function 5Eh	Slot 0	Index 47	Size n	Request Data (n bytes)	
Negative Response (slave -> master)	**Header**	**Data Unit (DU)**					**End**
		Function DEh	Error Decode 128	Error Code 1 xx	Error Code 2 xx		

Each telegram field can assume the following values:

Function	5Fh – Writing request, positive response for writing 5Eh – Reading request, positive response for reading DFh – Negative response for writing DEh – Negative response for reading
Slot	0 (It is the standard slot for accessing the drive parameters, according to PROFIdrive)
Index	47 (It is the standard index for accessing the drive parameters, according to PROFIdrive)
Size	Number of bytes for reading and writing. Writing request: 'n' bytes, according to the number of bytes in the request telegram. Positive response for writing: 0 bytes Reading request: 240 bytes (It requests the maximum number of reading bytes, because the size of the slave response is variable). Positive response for reading: 'n' bytes, according to the number of bytes in the response telegram.
Error Decode	128
Error Code 1	Error code, according to the problem found in the request: B0h: access error – invalid slot B2h: access error – invalid index B5h: access error – modification not allowed for the parameter B6h: access error – modification in read-only parameter B7h: access error – incorrect values for parameter access B8h: access error – invalid parameter number C3h: Resource error – Response not available for the reading request
Error Code 2	0
Request Data	Variable size field of the writing request (DS_Write), which contains the data for accessing the drive parameters.
Response Data	Variable size field of the reading response (DS_Read), which contains the result of the access to the drive parameters.

5.2.4 Data Structure for Parameter Access – WEG

Besides the structure for the access to the parameters according to the PROFIdrive specification, it is also possible to use a simplified structure for the access to the parameters through the following addressing:

- Slot 0.
- Index 48.

With the telegrams described in the Section 5.2.3 on page 23, it is possible to get access to the parameters using the following mechanism:

- Parameter modification: the modification of parameters is performed with a writing telegram (DS_Write), with 4 data bytes, were the two first represent the parameter number and the two last represent the parameter content, always with the most significant byte transmitted first. The response to the writing telegram indicates whether or not the modification was successful.
- Parameter reading: for the reading of parameters, first a writing telegram (DS_Write) with 2 data bytes representing the parameter number must be sent. After this telegram has been successfully sent, a reading telegram (DS_Read) must be sent, and the response will have 2 data bytes with the parameter content.

The reading telegrams as well as the writing telegrams are able to report errors in the parameter requests, according to the codes described for the Error Code 1 field.

The fields with the request and response data contain the structure where the parameters accessed at the drive are defined. In this access the request and response data have the following structure:

Table 5.1: *Request data structure*

Request data header	Request Reference	Request ID	
	DO-ID	Nr. of Parameters (n)	
Parameter address	Attribute	Nr. of Elements	Repeated 'n' times, according to the number of accessed parameters.
	Parameter Number		
	Sub-index		
	⋮		
Parameter value (only for parameter modification requests)	Format	Number of Values	Repeated 'n' times, according to the number of parameters in the header.
	Value 1		
	Value 2...		
	⋮		

Request Reference	A number between 1 and 255 that will be retransmitted in the response telegram.
Request ID	It represents the type of request made to the slave: 1 = Parameter reading 2 = Parameter modification
DO-ID	0
Nr. of Parameters	The number of parameters accessed in the request.
Attribute	10h (request of the parameter value)
Nr. of Elements	For parameters of the array type, it represents the number of elements accessed in the parameter. For the CFW320 only a few parameters specified by the PROFIdrive specification have this format, the other parameters are always formed by a single value, and therefore this field must be set in 0 or 1.
Parameter Number	The number of a drive valid parameter (the most significant byte is transmitted first).
Sub-index	For parameters of the array type, it represents the array element starting from which the access will be made (the most significant byte is transmitted first). For parameters formed by a single item, this field must be set in 0.
Format	It defines the format for the writing parameter. For the CFW320 parameters the value 42h (16 bit word) must be used.
Number of Values	The number of values to be written (defined in the number of elements).
Value	Value to write in the parameter (the most significant byte is transmitted first).

Table 5.2: *Response data structure*

Response data header	Request Reference mirror	Response ID	
	DO-ID mirror	Nr. of Parameters (n)	
Parameter value (only for parameter reading responses, or incase of error)	Format	Number of Values	Repeated 'n' times, according to the number of accessed parameters.
	Value 1 or error code		
	Value 2 or error code...		
	⋮		

Request Reference mirror	A mirror of the value received in the request telegram.
Response ID	It represents the type of response sent by the slave: 1 = Successful parameter reading 2 = Successful parameter modification 129 = Parameter reading with error 130 = Parameter modification with error
DO-Id Mirror	Mirror of the value received in the request telegram.
Nr. of Parameters (n)	The number of parameters accessed in the request.
Format	It defines the format of the accessed parameter: 42h = 16 bit word 44h = Parameter access error
Number of values	The number of values read from the parameter, or the number of error codes from the parameter access.
Value	Value read from the parameter (the most significant byte is transmitted first).
Error code	In case of parameter illegal access (error in reading or writing of any of the parameters), the code of the type of found error will be indicated: 0000h = parameter does not exist 0001h = modification of read-only parameter 0002h = parameter value out of the limits 0003h = indicated sub-index does not exist 0004h = parameter not of the array type 0005h = incorrect format for the parameter 0009h = description not available (only value) 000Fh = text not available (only value) 0016h = incorrect access to the parameter 0017h = unknown format 0018h = incorrect number of values

5.2.5 Example of Telegrams for Acyclic Access to the Parameters

Below are shown examples of sequences to access the parameters of the drive. As aforementioned, every access to the parameters is performed first with a writing telegram with the request, and then with a reading telegram to obtain the result of the request.

Example1: reading of the motor speed (P002) and current (P003) parameters.

Request (made by the master using the telegram DS_Write):

Byte Number	Field	Value	Description
1	Request Reference	1	
2	Request ID	1	Reading Request
3	DO-ID	0	
4	Number of Parameters	2	Reading of 2 Parameters
5	Attribute	10h	Reading of the parameter value
6	Number of Elements	1	Reading of only one value
7	Parameter number (byte + sig.)	0	Number of the first parameter read = P002
8	Parameter number (byte - sig.)	2	
9	Sub-index (high part)	0	Parameter has no sub-index
10	Sub-index (low part)	0	
11	Attribute	10h	Reading of the parameter value
12	Number of Elements	1	Reading of only one value
13	Parameter number (byte + sig.)	0	Number of the second parameter read = P003
14	Parameter number (byte - sig.)	3	
15	Sub-index (byte + sig.)	0	Parameter has no sub-index
16	Sub-index (byte - sig.)	0	

Positive response (sent by the slave in the response of telegram DS_Read)
Assuming P002 = 100 rpm and P003 = 5.0 A

Byte Number	Field	Value	Description
1	Request Reference	1	Copied from the request telegram
2	Request ID	1	Positive reading request
3	DO-ID	0	
4	Number of Parameters	2	Reading of 2 Parameters
5	Format	42h	WORD-type value (16 bits)
6	Number of values	1	Reading of only one value
7	Parameter value (byte + sig.)	0	P002 = 100 rpm
8	Parameter value (byte - sig.)	100	
9	Format	42h	WORD-type value (16 bits)
10	Number of values	1	Reading of only one value
11	Parameter value (byte + sig.)	0	P003 = 5.0 A
12	Parameter value (byte - sig.)	50	

Negative response (sent by the slave in the response of telegram DS_Read)
Assuming error in the reading of the second parameter

Byte Number	Field	Value	Description
1	Request Reference	1	Copied from the request telegram
2	Request ID	129	Negative reading request
3	DO-ID	0	
4	Number of Parameters	2	Reading of 2 Parameters
5	Format	42h	WORD-type value (16 bits)
6	Number of values	1	Reading of only one value
7	Parameter value (byte + sig.)	0	P002 = 100 rpm
8	Parameter value (byte - sig.)	100	
9	Format	44h	Reading error
10	Number of values	1	Only one value available
11	Error code (byte + sig.)	0	Error 0000h (assuming that the requested parameter does not exist).
12	Error code (byte - sig.)	0	

Example 2: change of the upper speed limit parameter (P134).

Request (made by the master using the telegram DS_Write)
Assuming desired change to P134 = 1000 rpm.

Byte Number	Field	Value	Description
1	Request Reference	1	
2	Request ID	2	Change request
3	DO-ID	0	
4	Number of Parameters	1	Change of one parameter
5	Attribute	10h	Change of the parameter value
6	Number of Elements	1	Change of only one value
7	Parameter number (byte + sig.)	0	Number of the changed parameter = P134
8	Parameter number (byte - sig.)	134	
9	Sub-index (high part)	0	Parameter has no sub-index
10	Sub-index (low part)	0	
11	Format	42h	WORD-type value (16 bits)
12	Number of values	1	Only one value changed
13	Parameter value (byte + sig.)	03h	P134 = 1000 rpm
14	Parameter value (byte - sig.)	E8h	

Positive response (sent by the slave in the response of telegram DS_Read):

Byte Number	Field	Value	Description
1	Request Reference	1	Copied from the request telegram
2	Request ID	2	Positive change request
3	DO-ID	0	
4	Number of Parameters	1	Change of one parameter

Negative response, assuming error in the change (sent by the slave in the response of telegram DS_Read):

Byte Number	Field	Value	Description
1	Request Reference	1	Copied from the request telegram
2	Request ID	130	Negative change request
3	DO-ID	0	
4	Number of Parameters	2	Change of one parameter
5	Format	44h	Error in the change
6	Number of values	1	Only one value available
7	Error code (byte + sig.)	0	Error 0002h (assuming the value for the parameter is off limits).
8	Error code (byte - sig.)	2	

6 STARTUP GUIDE

The main steps to start up the CFW320 frequency inverter in Profibus DP 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 P028. Check if the module was recognized. The detection is done automatically and does not require the user's intervention.
3. Connect the cable to the accessory, considering the recommended instructions in network installation, as described in Section 3 on page 10:
   - 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 (P220 ... P228).
3. Configure communication parameters, such as address and data profile in P750 and P741.
4. Program the desired action for the equipment in case of communication fault in parameter P313.
5. Define which data will be read and written at frequency inverter CFW320 using Section 5 on page 21.

6.3 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 GSD file[1] to the list of devices in the network configuration tool.
2. Select CFW320 frequency inverter from the available list of devices on the network configuration tool. This can be done manually or automatically, if allowed by the tool.
3. During the configuration of the network, it is necessary to define the amount of I/O data communicated between frequency inverter CFW320 and the master, as described in Section 4.2 on page 17. Among the main parameters that can be used to control the device, we can mention:
   - P680 - Status word (read)
   - P681 - Motor speed (read)
   - P684 - Control word (write)
   - P685 - Speed reference (write)

[1] The GSD file is available from WEG website (http://www.weg.net). It is important to note if the GSD configuration file is compatible with the firmware version of the CFW320 frequency inverter.

6.4 COMMUNICATION STATUS

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

- The parameter P740 indicate the status of communication between the device and the network master.

Once configured, the network status P740 indicates Online. It is in this condition that cyclic data exchange effectively occurs between the slave and the master of the network. The master of the network must also supply information about the communication with the slave.

6.5 OPERATION USING PROCESS DATA

Once the communication is established, the data mapped in the I/O area is automatically updated between master and slave.

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

6.6 ACCESS TO PARAMETERS – ACYCLIC MESSAGES

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

The GSD file provides the full parameter list of the equipment, which can be accessed via *DS_Read* and *DS_Write*. The Section 5.2.1 on page 21 how to address the parameters of the frequency inverter CFW320 via acyclic messages.

7 QUICK REFERENCE OF ALARMS AND FAULTS

Fault / Alarm	Description	Possible Causes
F032 Comm. Plug-in module comunication 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 P028.
A138 Profibus DP Interface in Clear Mode	It indicates that the inverter received the command from the Profibus DP network master to go into clear mode.	■ Check the network master status, ensuring it is in the run mode.
A139 Offline Profibus DP Interface	It indicates interruption in the communication between the Profibus DP network master and the inverter. The Profibus DP communication interface went into offline status.	■ Check if the network master is correctly configured and operating properly. ■ Check for short-circuit or poor contact on the communication cables. ■ Check if the cables are not misconnected or inverted. ■ Check if the termination resistors with the right value were installed only at the end of the main bus. ■ Check the network installation in general - cabling, grounding.
F238 Profibus DP Interface in Clear Mode	It indicates that the inverter received a command from the Profibus DP network master to enter the clear mode.	■ Verify the network master status, making sure it is in the execution mode (Run).
F239 Offline Profibus DP Interface	It indicates an interruption in the communication between the Profibus DP network master and the inverter. The Profibus DP communication interface went into offline status.	■ Check if the network master is correctly configured and operating properly. ■ Check for short-circuit or poor contact on the communication cables. ■ Check if the cables are not misconnected or inverted. ■ Check if the termination resistors with the right value were installed only at the end of the main bus. ■ Check the network installation in general - cabling, grounding.

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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