# Anybus-CC Communication Manual

Frequency Inverter

Series: CFW-11

Language: English

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# Summary

# About this Manual

This manual provides the necessary information for the operation of the CFW-11 frequency inverter using the Anybus-CC communication module. This manual must be used together with the CFW-11 user manual.

## Abbreviations and Definitions

| | |
|---|---|
| ASCII | American Standard Code for Information Interchange |
| CAN | Controller Area Network |
| CIP | Common Industrial Protocol |
| CSMA/CD | Carrier Sense Multiple Access/Collision Detection |
| DP | Decentralized Periphery |
| FMS | Fieldbus Message Specification |
| HMI | Human Machine Interface |
| IP | Internet Protocol |
| MAC | Medium Access Control |
| MS | Module Status |
| NS | Network Status |
| ODVA | Open DeviceNet Vendor Association |
| OP | Operation Mode |
| PI | Profibus International |
| PLC | Programmable Logic Controller |
| ST | Status |
| TCP | Transmission Control Protocol |
| UDP | User Datagram Protocol |

## 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 Fieldbus

The Fieldbus is a digital communication system used in the industry to interconnect automation primary elements, such as PLC's, drives, valves, sensors, actuators, etc., as illustrated in the figure below.

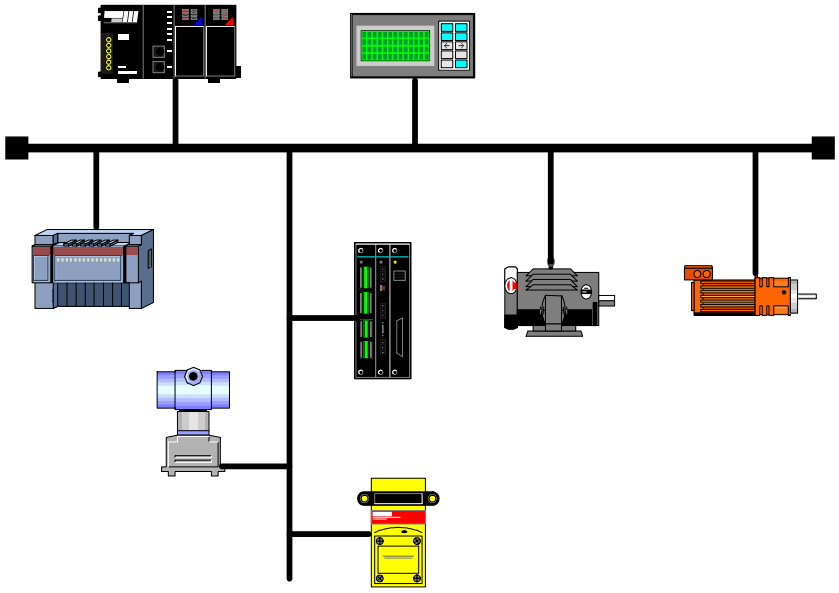


***Figure 1.1 -*** *Illustration of a Fieldbus network*

The concept that was born at the end of the 1980s, it appeared as an alternative to the limited analogue systems (4-20mA and +/-10V). In this type of control the installation of long wires and cables from each device to the central controller was frequent. This LED to high cabling costs, difficult maintenance and also compromised the system expansion.

The first industrial digital networks that appeared used proprietary solutions created by big manufactures. There was no concern with interaction or standardization. The customer options regarding suppliers were restricted.

However the crescent demand for process improvements turned this situation around. Several technologies appeared. Standardization became important because of the involved costs. Organizations responsible for the promotion and update of networks and protocols (many open) were created. User groups with the purpose of mutual help also appeared.

Nowadays, there is a great variety of protocols in the market, each one with its advantages and disadvantages. It is up to the user/project designer to evaluate what the necessary requirements for the application are, and choose among the available options.

Regardless of the choice, the main advantages of the industrial networks are:

☑ Significant reduction in cable and installation costs;
☑ Reduction in the *start-up* time;
☑ More reliability and efficiency;
☑ Addition, removal and replacement of equipment with the network under load (supply);
☑ Integration of several suppliers (standardization);
☑ Effective process monitoring;
☑ Configuration of devices via the network.

By means of the Anybus-CC communication modules, the CFW-11 supports three protocols widely spread in the industry: DeviceNet, Profibus DP-V1 and EtherNet/IP. Besides this, by means of passive modules, RS232 and RS485/422 interfaces are also available.

The characteristics of the Anybus-CC modules, as well as the protocols used with those modules, will be presented next.

# 2 Accessory Kits (Active Modules)

In order to make available a DeviceNet, Profibus DP-V1 or EtherNet/IP interface for the CFW-11 frequency inverter, it is necessary to use one of the communication kits described next. Information on the installation of those kits can be obtained in the guide that comes with the kits.

## 2.1 DeviceNet

### 2.1.1 DEVICENET-05 Kit

- ☑ WEG part number: 10413655.
- ☑ Composed by the Anybus ABCC-DEV communication module, mounting instructions and a "torx" screw driver for fixing the module.
- ☑ ODVA certified interface.
- ☑ It allows the programming of the drive via network configuration software.

### 2.1.2 Connector Pin Functions

The DeviceNet communication module presents a male *plug-in* connector with the following pin assignment:

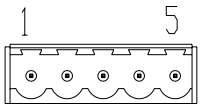



*Table 2.1 - DeviceNet plug-in connector pin assignment*

| Pin | Name | Function |
|---|---|---|
| 1 | V- | Power supply negative pole |
| 2 | CAN_L | CAN_L signal |
| 3 | Shield | Cable shield |
| 4 | CAN_H | CAN_H signal |
| 5 | V+ | Power supply positive pole |

### 2.1.3 Indications

- ☑ MS LED: bicolor LED (green/red). Indicates the communication module status.
- ☑ NS LED: bicolor LED (green/red). Indicates the DeviceNet network status.

Consult sections 5.8 and 5.9 for a better interpretation of the indications above.

### 2.1.4 Connection with the Network

For the connection of the inverter using the DeviceNet active interface, the following points must be observed:

- ☑ It is recommended to use cables specific for CAN/DeviceNet networks.
- ☑ Grounding of the cable shield at only one point, thus avoiding current loops. This point is normally the network own power supply. If there is more than one power supply, only one of them must be connected to the protective ground.
- ☑ Termination resistors must be installed only at the extremes of the main bus, even if there are derivations.

☑ The network power supply must be able to supply the current for all the equipment *transceivers*. The CFW-11 DeviceNet module consumes approximately 50mA.

### 2.1.5 Module Configuration

In order to configure the DeviceNet module, follow the steps indicated below:

☑ With the inverter switched off, install the module on the XC44 connector. Make sure it is fitted in correctly and secured by the screws.
☑ Apply power to the inverter.
☑ Observe the content of the parameter P0723. Verify if the module was recognized. The detection occurs automatically and does not require any intervention from the user. The MS LED from the module must be on in green. During the module acknowledgement phase a warning message will be showed on the product HMI.
☑ Set the inverter network address by means of the parameter P0725.
- Valid values: 0 to 63.

☑ Set the communication rate in P0726.
- 0 = 125kbps;
- 1 = 250kbps;
- 2 = 500kbps;
- 3 = Autobaud.

☑ Program in P0727 the number of words to be exchanged with the network master. Exactly the same value must be set in the DeviceNet master. For this adjustment being complete, it is necessary to program a value different from 0 (zero) in parameters P0728 to P0739 (refer to the section P0727 – Anybus).
- Valid values: 2 to 9.

☑ Cycle power at the CFW-11 so that the changes become effective.
☑ Connect the network cable to the module.
☑ Register the configuration file (EDS file) in the network configuration software[1].
☑ Add the CFW-11 to the *scan list* of the master.
☑ Choose a method for data exchange with the master in the network configuration *software,* i.e., *polled, change of state, cyclic* or *bit-strobe.* The CFW-11 DeviceNet module supports all those types of I/O data, besides of the *explicit* (acyclic data).
☑ If everything is configured correctly, the NS LED will go on in green. It is in that condition that the cyclic data exchange between the drive and the master of the network effectively occurs.

For more information regarding the mentioned parameters, refer to the section 4.

### 2.1.6 Access to the Parameters

After the EDS file registration in the network configuration software, the user will get access to the equipment complete parameter list, which can be accessed via *explicit messages*.

Refer to the PLC software programming documentation for details on the use of this resource.

[1] The CFW-11 DeviceNet communication module will be recognized by the network configuration software as Anybus- CC DeviceNet.

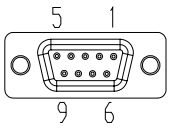
## 2.2 Profibus DP-V1

### 2.2.1 PROFIBUS-05 Kit

- ☑ WEG part number: 10413654.
- ☑ It is composed by the Anybus ABCC-DPV1 communication module, mounting instructions and a "torx" screw driver for fixing the module.
- ☑ Interface certified by Profibus International.
- ☑ It supports DP-V1 (acyclic messages).

### 2.2.2 Connector Pin Functions

The Profibus DP-V1 communication module has a female DB9 connector with the following pin assignment:




[2]

*Table 2.2 - Profibus female DB9 connector pin assignment*

| Pin | Name | Function |
|---|---|---|
| 1 | - | - |
| 2 | - | - |
| 3 | B-Line (+) | RxD/TxD positive |
| 4 | RTS | *Request To Send* |
| 5 | GND | Ground (isolated from the RS485 circuit) |
| 6 | +5V | +5V for active termination (isolated from the RS485 circuit) |
| 7 | - | - |
| 8 | A-Line (-) | RxD/TxD negative |
| 9 | - | - |

### 2.2.3 Indications

- ☑ ST LED: bicolor LED (green/red). Indicates the communication module status.
- ☑ OP LED: bicolor LED (green/red). Indicates the operation mode status.

Consult sections 6.4 and 6.5 for a better interpretation of the indications above.

### 2.2.4 Connection with the Network

For the connection of the inverter using the Profibus active interface, the following points must be observed:

- ☑ It is recommended to use a shielded cable with a twisted pair of wires, preferable one specific for Profibus. The connector must also be compatible with the Profibus specification.
- ☑ The cable must be laid separately (and far away if possible) from the power cables.
- ☑ All the network devices must be properly grounded, if possible at the same point. The cable shield must also be connected to the protective ground. The Profibus connector itself uses to have a space for the connection of the cable shield.

[2] The CFW-11 requires the use of a 180° connector.

☑ Termination resistors must be installed only at the extremes of the main bus, even if there are derivations. Normally switches for enabling those resistors are present in the Profibus connector.

### 2.2.5 Module Configuration

In order to configure the Profibus DP-V1 module follow the steps indicated below:

☑ With the inverter switched off, install the module on the XC44 connector. Make sure it is fitted in correctly and secured by the screws.
☑ Apply power to the inverter.
☑ Observe the content of the parameter P0723. Verify if the module was recognized. The detection occurs automatically and does not require any intervention from the user. The ST LED from the module must be on in green. During the module acknowledgement phase a warning message will be showed on the product HMI.
☑ Set the inverter network address by means of the parameter P0725.
- Valid values: 1 to 126.
☑ It is not necessary to set the communication rate for the module. Profibus uses autobaud and, therefore, this configuration is done by means of the network master.
☑ Program in P0727 the number of words to be exchanged with the network master. Exactly the same value must be set in the Profibus master. For this adjustment being complete, it is necessary to program a value different from 0 (zero) in the parameters P0728 to P0739 (refer to the section P0727 – Anybus ).
- Valid values: 2 to 9.
☑ Cycle the power of the CFW-11, so that the modifications become effective.
☑ Register the configuration file (GSD file) in the network configuration software[3].
☑ Add the CFW-11 to the device list of the master, adjusting the number of words according to the P0727 setting.
☑ Connect the network cable. If everything is configured correctly, the OP LED will go on in green. It is in that condition that the cyclic data exchange between the drive and the master of the network effectively occurs.

NOTE!
In the Profibus network configuration software one must first select all the input words, and then select the output words, up to the amount of words programmed at P0727.

For more information regarding the mentioned parameters, refer to the section 4.

### 2.2.6 Access to the Parameters

The PROFIBUS-05 communication kit allows parameter reading/writing services by means of DP-V1 acyclic functions. The parameter mapping is done based on the *slot* and *index* addressing, as showed in the equationing below:

☑ *Slot*: (parameter number - 1) / 255.
☑ *Index*: (parameter number -1) MOD 255.

NOTE: MOD represents the remainder of the division.

[3] The CFW-11 with Profibus DP-V1 communication module will be recognized by the network configuration software as Anybus-CC Profibus DP-V1.

## 2.3 EtherNet/IP

### 2.3.1 ETHERNETIP-05 Kit

- ☑ WEG part number: 10509967.
- ☑ Composed by the Anybus ABCC-EIP communication module, mounting instructions and a "torx" screw driver for fixing the module.
- ☑ Standard RJ45 connector.
- ☑ ODVA certified interface.
- ☑ It allows access (reading/writing) to certain parameters via WEB.

### 2.3.2 Connector

The EtherNet/IP communication module has a common female RJ45 connector. The same mounting standard (T-568A or T-568B) used in cables for office networks can also be adopted for the industrial environment.

However, the drive installation site must be verified. Cables and connectors normally used in office networks use to be fragile. They cannot withstand high temperatures, high mechanic stress, excessive vibration and do not have a high protection degree. The responsible for the plant installation must evaluate those factors and suggest adaptations according to the needs.

### 2.3.3 Indications

- ☑ MS LED: bicolor LED (green/red). Indicates the communication module status.
- ☑ NS LED: bicolor LED (green/red). Indicates the EtherNet/IP network status.
- ☑ LINK LED: green LED. Indicates connection (link) and also activity in the network.

Consult sections 7.6, 7.7 and 7.8 for a better interpretation of the indications above.

### 2.3.4 Connection with the Network

For the connection of the inverter using the EtherNet/IP active interface, the following points must be observed:

- ☑ The CFW-11 must be connected to an EtherNet/IP network by means of *switches. Hubs* are not recommended because they do not use the channel in an efficient way (great number of collisions).
- ☑ The most common topology is in star, exactly the way it is done with computer networks.
- ☑ It is recommended to use equipment (cables, *switches*) prepared for industrial environment.
- ☑ Each cable segment (*switch* ⇔ CFW-11) with a maximum length of 90m.

### 2.3.5 Module Configuration

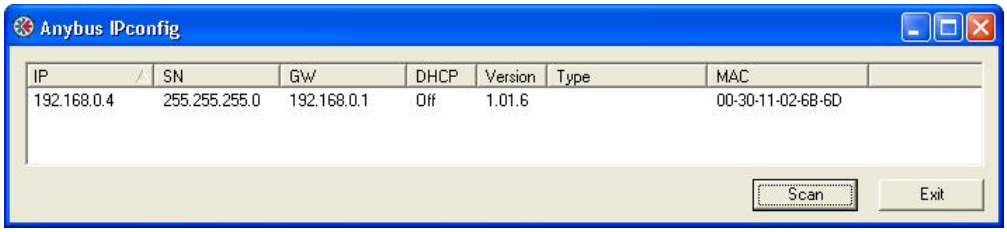
In order to configure the EtherNet/IP module follow the steps indicated below:

- ☑ With the inverter switched off, install the module on the XC44 connector. Make sure it is fitted in correctly and secured by the screws.
- ☑ Apply power to the inverter.
- ☑ Observe the content of the parameter P0723. Verify if the module was recognized. The detection occurs automatically and does not require any intervention from the user. The MS and NS LEDs from the module must be flashing in green[4].

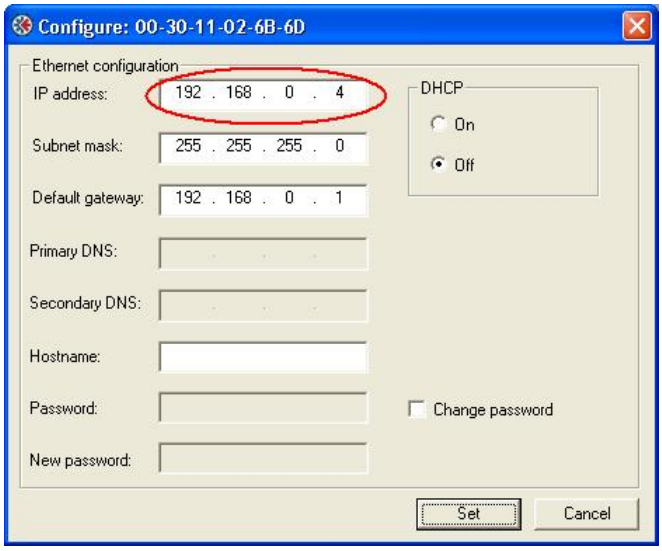
[4] The CFW-11 with EtherNet/IP communication module will be recognized by the network configuration software as Anybus-CC EtherNet/IP.

☑ Connect a network cable to the module. The other extreme of the cable must be connected to a *hub/switch* or, occasionally a PC (for the PC ⇔ CFW-11 connection use a *cross-over* cable). If the network cable is installed correctly, the LINK LED will go on in green indicating that a successful connection occurred. If this does not occur, make sure the cable is in good conditions and the *hub/switch* is on.

☑ With the aid of a PC connected to the same network where the CFW-11 with the EtherNet/IP is, execute the HMS AnyBus IPconfig[5] program. This software will scan the network for the module. In the example below a module with the IP 192.168.0.4 was found.




☑ In order to change those configurations, double-click the module IP address. The window below will be displayed. Set those parameters according to the network where the CFW-11 will be installed. Remember that the IP address is unique, i.e, each equipment in the network has its own. The IP duplicity is a critical fault and causes serious communication problems among the devices.




☑ Program in P0727 the number of words to be exchanged with the network master. Exactly the same value must be set in the EtherNet/IP master.

☑ Connect the network cable to the module.

☑ Register the configuration file (EDS file) in the network configuration software[4].

☑ If everything is configured correctly, the NS LED will go on in green and the LINK LED will start blinking indicating normal network activity.

For more information regarding the mentioned parameters, refer to the section 4.

### 2.3.6 Communication Rate

The CFW-11 with EtherNet/IP kit works in networks with 10Mbps or 100Mps rates, in half-duplex or full-duplex mode. When working at 100Mbps full-duplex, the effective communication rate doubles, changing to 200Mbps.

The communication rate setting is done only via software, as illustrated below:

☑ In order to perform such setting, it is necessary to have a PC with an Internet Browser connected to the same network (same IP addressing range) of the CFW-11.

[5] It is available on the CD-ROM that comes with the inverter.

☑ Open the browser and type the *hostname* or the IP address of the CFW-11. In the example below we use the IP 192.168.0.4.

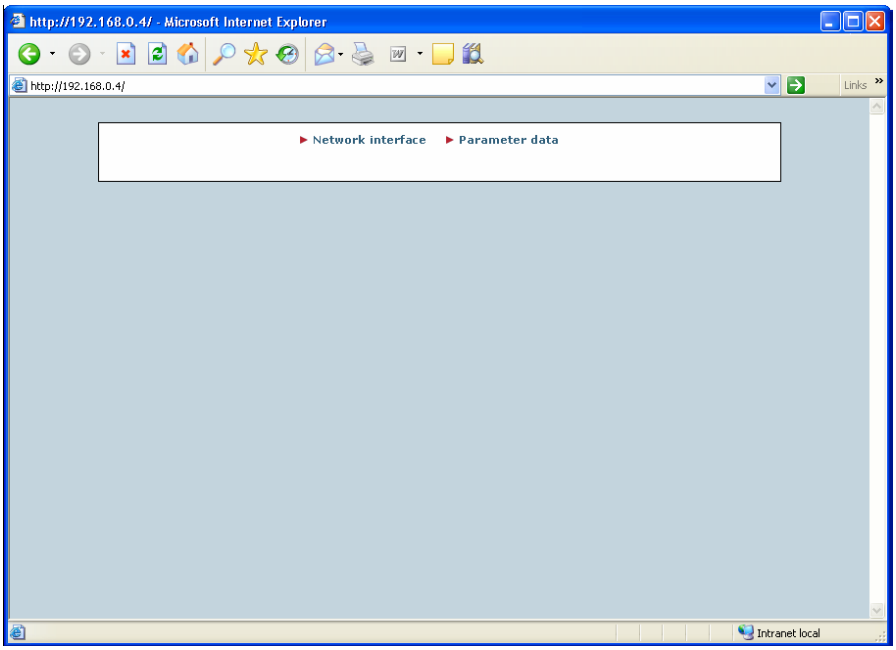



***Figure 2.1*** *- Opening window*

☑ Click on 'Network interface'. A window with information about the communication module will be displayed.

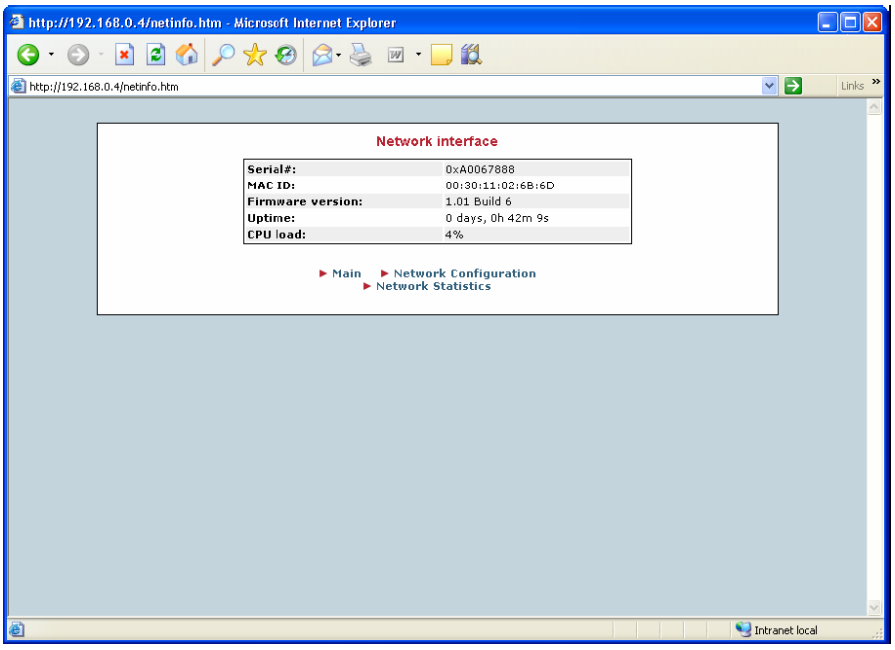



***Figure 2.2*** *- Interface information*

☑ Next, click on 'Network Configuration'. In order to set the communication rate select the option 'Comm Settings'.
☑ Save the modifications clicking on the 'Store Settings' button.

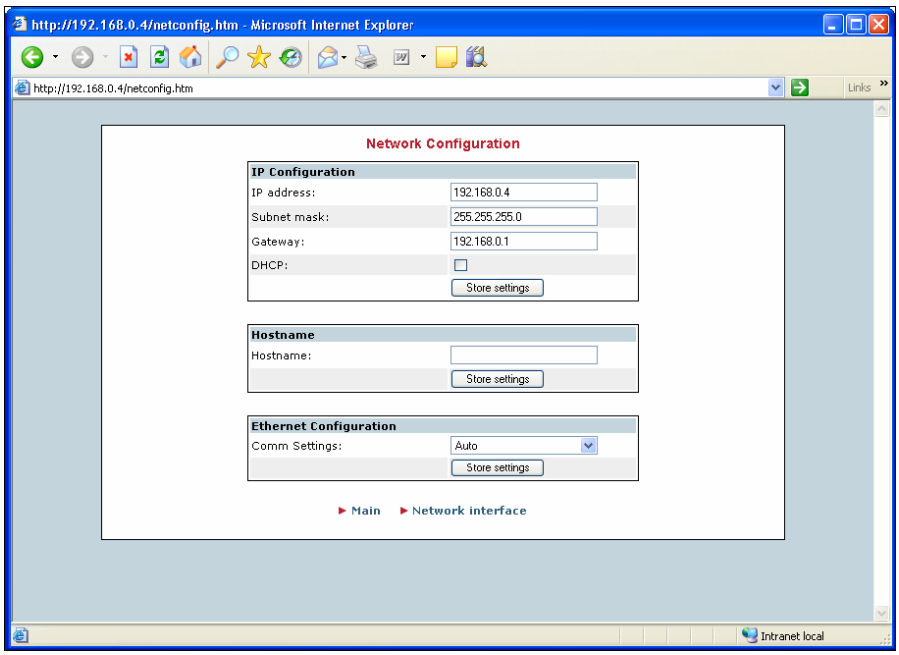



*Figure 2.3 - Interface configuration*

### 2.3.7 Access to the Parameters via WEB

The CFW-11 allows access for the reading and writing, via web, of certain parameters previously programmed by the user (refer to the section P0727 – Anybus). This function allows the operator to monitor the drive status, being necessary only a computer with access to the industrial plant network.

In order to use this function follow the steps indicated below:

☑ Make sure the drive is *online*. Verify the Anybus communication status via the parameter P0724.
☑ Again, it is necessary to have a PC with an Internet Browser connected to the same network (same IP addressing range) of the CFW-11.
☑ Open the browser and type the *hostname* or the IP address of the CFW-11. In this example below the drive has the IP 192.168.0.4. The window showed in Figure 2.1 will be displayed.
☑ Click on 'Parameter data'. Another window containing the reading and writing parameters will be showed. In this case two reading parameters (Logical Status and 13 bit Speed) and two writing parameters (Anybus-CC Control and Anybus-CC Speed Ref.) are showed. This window will show all the parameters programmed by the user via P0727.

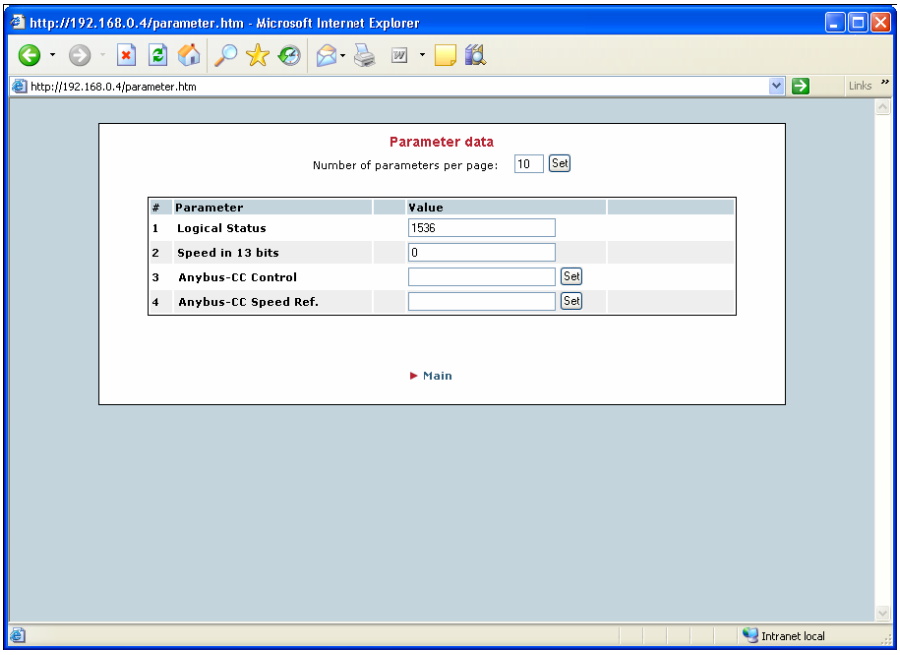



*Figure 2.4 - Window with the drive parameters*

**Important:** The parameter writing via WEB (acyclic) is performed in a way similar to the I/O data (cyclic). Thus, if a specific variable is accessible via cyclic as well as acyclic connections, one will be overwritten by the other. In the case above, writing in the 'Anybus-CC control' word will be almost immediately overwritten by the value sent via the I/O cyclic connection. The same happens with the 'Anybus-CC speed Ref.' word. In this case one gets the wrong impression that the command had not been executed.

# 3 Accessory Kits (Passive Modules)

In order to make available a RS232 or a RS485/422 interface for the CFW-11, one of the communication kits described next can be used. The operation of those modules follows the same principle of the serial interface. For this reason it is not possible to use them simultaneously with the RS485-01, RS232-01 and CAN/RS485-01 communication kits. If this occurs, the A130 alarm message will be showed on the HMI to indicate hardware incompatibility.

These passive devices work only as physical layer converters, not performing any processing over the data flow. This means that any serial protocol programmed in P0312 (Modbus-RTU, TP) can be used with these interfaces.

Refer to the CFW-11 Serial Communication Manual for more information on the operation of those modules. Installation instructions for those modules can be obtained in the installation guide that comes with the kit.

## 3.1 RS232

### 3.1.1 RS232-05 Kit

- ☑ WEG part number: 10413656.
- ☑ Composed by the Anybus ABCC-RS232 communication module (drawing at the left), mounting instructions and a "torx" screw driver for fixing the module.
- ☑ It allows transmission rates up to 115.2kbps.

### 3.1.2 Connector Pin Functions

The RS232 communication module presents a male DB9 connector (XC8) with the following pin assignment:

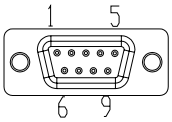



*Table 3.1 - RS232 DB9 male connector pin assignment*

| Pin | Name | Function |
|---|---|---|
| 1 | - | - |
| 2 | RxD | RS232 data reception |
| 3 | TxD | RS232 data transmission |
| 4 | - | - |
| 5 | GND | Ground |
| 6 | - | - |
| 7 | RTS | *Request To Send* |
| 8 | - | - |
| 9 | - | - |

### 3.1.3 Indications

☑ PWR LED: Green LED. When on, it indicates that the module is powered.

### 3.1.4 Connection with the Network

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

☑ Use good quality cables, preferably shielded.
☑ Keep the cable length within the limits stipulated by the standard, normally about 10m.
☑ Avoid passing the cables close to output and input power cables.

## 3.2 RS485/422

### 3.2.1 RS485-05 Kit

☑ WEG part number: 10413657.
☑ Composed by the Anybus ABCC-RS485 (drawing at the left), mounting instructions and a "torx" screw driver for fixing the module.
☑ It allows transmission rates up to 115.2kbps.

### 3.2.2 Connector Pin Functions

The RS485/422 interface module presents a female DB9 connector with the following pin assignment:

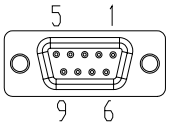



*Table 3.2 - RS485/422 female DB9 connector*

| Pin | RS422 Mode | RS485 Mode | Function |
|---|---|---|---|
| 1 | *Term Pwr* | *Term Pwr* | +5V for active termination (isolated) |
| 2 | - | - | - |
| 3 | - | - | - |
| 4 | *Mode Select* | *Mode Select* | Ground for RS422 mode; Not connected in RS485 mode |
| 5 | GND | GND | Isolated ground |
| 6 | RxD | - | Data reception line in RS422 mode<br>Not connected in RS485 mode |
| 7 | RxD (inverted) | - | |
| 8 | TxD | RxD/TxD | Data transmission line in RS422 mode<br>Bidirectional data line in RS485 mode. |
| 9 | TxD (inverted) | RxD/TxD (inverted) | |

### 3.2.3 Indications

☑ PWR LED: Green LED. When on, it indicates that the module is powered.

### 3.2.4 Connection with the Network

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

☑ Use good quality shielded cables.
☑ Keep the cable length within the limits stipulated by the standard, normally about 1000m.

- ☑ Even being the RS485 more robust than the RS232 because of its cables using signals in differential mode (balanced signals), avoid passing them close to power cables.
- ☑ Put termination resistors between the data signal wires (RxD/TxD and TxD/RxD) at the network extreme nodes. This will avoid reflections in the line.

# 4 Inverter Programming

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

## 4.1 Symbols for the Proprieties Description

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

**P0105 – 1st/2nd Ramp Selection**

**P0220 – Local/Remote Selection Source**

**P0221 – Speed Reference Selection – Local Situation**

**P0222 – Speed Reference Selection – Remote Situation**

**P0223 – Selection of the Rotation Direction - Local Situation**

**P0224 – Start/Stop Selection – Local Situation**

**P0225 – Jog Selection - Local Situation**

**P0226 – Selection of the Rotation Direction - Remote Situation**

**P0227 – Start/Stop Selection – Remote Situation**

**P0228 – Jog Selection - Remote Situation**

These parameters are used in the configuration of the source of commands for the local and remote mode of the inverter CFW-11. So that the inverter is controlled through the Anybus-CC interface, one of the available 'Anybus-CC' in the parameters options must be selected.

The detailed description of these parameters are found in the Programming the CFW-11 Manual.

**P0313 – Action in Case of Communication Error**

Range: 0 = Off
1 = Ramp Stop
2 = General Disab.
3 = Change to LOC
4 = Change to LOCAL keeping the commands and the reference
5 = Fault trip

Default: 0

Proprieties: CFG, Net

Access groups via HMI:

01 PARAMETER GROUPS
└ 49 Communication
└ 111 Status/Commands

Description:
It allows the selection of the action to be executed by the inverter when a communication problem occurs.

*Table 4.1 - Values for parameter P0313*

| Options | Description |
|---|---|
| 0 = Inactive | No action is taken and the inverter remains in the existing status |
| 1 = Disable via Start/Stop | A stop command with deceleration ramp is executed and the motor stops according to the programmed deceleration ramp |
| 2 = Disable via General Enable | The inverter is disabled by removing the general enabling and the motor coasts to stop |
| 3 = Change to Local | The inverter commands change to local |
| 4 = Change to LOCAL keeping the commands and the reference | The inverter is changed to the local mode; However, the enabling and reference commands received via the network , in case the inverter had been programmed for start/stop via HMI or 3-wire and reference via HMI or electronic potentiometer, are kept in the local mode |
| 5 = Fault Trip | Instead of an alarm, a communication error causes a fault at the inverter, so that it becomes necessary to perform the inverter fault reset in order to get it back to normal operation. |

For the Anybus-CC interface, the events of offline Anybus-CC module (alarm A129/fault 229) and Anybus-CC module access error (alarm A130/fault F230), are considered communication errors.

The actions described in this parameter are executed by means of the automatic writing of the respective bits on the control via Anybus-CC – P0686. In order to be effective, it is necessary that the inverter be programmed to be controlled via Anybus. This programming is done by means of parameters P0220 up to P0228.

## P0680 – Logical Status

**Range**: 0000h – FFFFh **Default:** -

**Proprieties:** RO

**Access groups via HMI:**

01 PARAMETER GROUPS
∟ 49 Communication
∟ 111 Status/Commands

**Description:**
It allows to the user the identification of the inverter status.

| Bits | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 to 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Function | Fault condition | Manual/ Automatic | Undervoltage | LOC/REM | JOG | Speed Direction | General Enabling active | Ramp enabled | In Alarm condition | In configuration mode | Second Ramp | Reserved |

*Table 4.2 - P0680 bit functions*

| Bits | Values |
|---|---|
| Bits 0 to 4 | Reserved. |
| Bit 5<br>Second Ramp | 0: The inverter is configured to use as acceleration and deceleration ramp for the motor, the first ramp, programmed at the parameters P0100 and P0101.<br>1: The inverter is configured to use as acceleration and deceleration ramp for the motor, the second ramp, programmed at the parameters P0102 and P0103. |
| Bit 6<br>In Configuration Mode | 0: Inverter operating normally.<br>1: Inverter in configuration mode. Indicates a special condition when the inverter cannot be enabled:<br>☑ Executing the self tuning routine;<br>☑ Executing guided start-up routine;<br>☑ Executing the HMI copy function;<br>☑ Executing the flash memory card guided routine;<br>☑ There is a parameter setting incompatibility;<br>☑ Without power supply at the inverter power section.<br>Note: It is possible to obtain the exact description of the special operation mode at parameter P0692. |
| Bit 7<br>Alarm Condition | 0: The inverter is not in alarm condition.<br>1: The inverter is in alarm condition.<br>Note: The alarm number can be read by means of the parameter P0048 – Current Alarm. |
| Bit 8<br>Ramp Enabled (RUN) | 0: The motor is stopped.<br>1: The inverter is driving the motor at the set point speed, or executing either the acceleration or the deceleration ramp. |
| Bit 9<br>General Enabling Active | 0: General enabling is not active.<br>1: General enabling is active and the inverter is ready to run the motor. |
| Bit 10<br>Speed Direction | 0: The motor is rotating counterclockwise.<br>1: The motor is rotating clockwise. |
| Bit 11<br>JOG | 0: JOG function inactive.<br>1: JOG function active. |
| Bit 12<br>LOC/REM | 0: Inverter in local situation.<br>1: Inverter in remote situation. |
| Bit 13<br>Undervoltage | 0: No undervoltage.<br>1: With undervoltage. |
| Bit 14<br>Manual/ Automatic | 0: PID in manual mode.<br>1: PID in automatic mode. |
| Bit 15<br>Fault Condition | 0: The inverter is not in a fault condition.<br>1: Any fault has been recorded by the inverter.<br>Note: The fault number can be read by means of the parameter P0049 – Current Fault. |

## P0681 – Motor Speed in 13 bits

**Range:** -32768 – 32767 **Default:** 0

**Proprieties:** RO

**Access groups via HMI:**

01 PARAMETER GROUPS
- 49 Communication
  - 111 Status/Commands

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

- ☑ P0681 = 0000h (0 decimal) → motor speed = 0 rpm
- ☑ P0681 = 2000h (8192 decimal) → motor speed = nominal speed

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

8192 – 1800 rpm
2048 – speed in rpm

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

Speed in rpm = 450 rpm

Negative values in this parameter indicate motor rotating in counterclockwise sense of rotation.

## P0686 – Control Word via Anybus-CC

**Range:** 0000h – FFFFh **Default:** 0000h

**Proprieties:** RO, Anybus

**Access groups via HMI:**

01 PARAMETER GROUPS
∟ 49 Communication
∟ 111 Status/Commands

**Description:**
It is the inverter control word via Anybus-CC interface. This parameter can only be changed via the Anybus-CC interface. For the other sources (HMI, Serial, etc.) it behaves like a reading only parameter.

In order that the commands written in this parameter be executed, it is necessary that the inverter be programmed to be commanded via Anybus-CC. This programming is done by means of parameters P0105 and P0220 to P0228.

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

| Bits | 15 to 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|
| Function | Reserved | Fault reset | Reserved | Second Ramp Use | LOC/REM | JOG | Speed Direction | General Enabling | Start/Stop |

*Table 4.3 - P0682 bit functions*

| Bits | Values |
|---|---|
| Bit 0<br>Start/Stop | 0: It stops the motor with deceleration ramp.<br>1: The motor runs according to the acceleration ramp until reaching the speed reference value. |
| Bit 1<br>General Enabling | 0: It disables the inverter, interrupting the supply for the motor.<br>1: It enables the inverter allowing the motor operation. |
| Bit 2<br>Speed Direction | 0: To run the motor in a direction opposed to the speed reference.<br>1: To run the motor in the direction indicated by the speed reference. |
| Bit 3<br>JOG | 0: It disables the JOG function.<br>1: It enables the JOG function. |
| Bit 4<br>LOC/REM | 0: The inverter goes to the local situation.<br>1: The inverter goes to the remote situation. |
| Bit 5<br>Second Ramp Use | 0: The inverter uses as acceleration and deceleration ramp for the motor, the first ramp times, programmed at the parameters P0100 and P0101.<br>1: The inverter uses as acceleration and deceleration ramp for the motor, the second ramp times, programmed at the parameters P0102 and P0103. |
| Bits 6 | Reserved. |
| Bit 7<br>Fault reset | 0: No function.<br>1: If in a fault condition, then it executes the inverter reset. |
| Bits 8 to 15 | Reserved. |

## P0687 – Speed Reference via Anybus-CC

**Range:** -32768 – 32767 **Default:** 0

**Proprieties:** RO, Anybus

**Access groups via HMI:**

01 PARAMETER GROUPS
∟ 49 Communication
∟ 111 Status/Commands

Description:
It allows the programming of the speed reference for the inverter via Anybus-CC interface. This parameter can only be changed via Anybus-CC interface. For the other sources (HMI, Serial, etc.) it behaves like a reading only parameter.

In order that the reference written in this parameter be used, it is necessary that the inverter be programmed for using the speed reference via Anybus-CC. This programming is done by means of parameters P0221 and P0222.

This word uses a 13 bit resolution with signal to represent the motor nominal speed:

☑ P0683 = 0000h (0 decimal) → speed reference = 0 rpm
☑ P0683 = 2000h (8192 decimal) → speed reference = nominal speed

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

$$\begin{array}{l} 1800 \text{ rpm} - 8192 \\ 900 \text{ rpm} - 13 \text{ bit reference} \end{array} \qquad 13 \text{ bit reference} = \frac{900 \times 8192}{1800}$$

13 bit reference = 4096 (value corresponding to 900 rpm in a 13 bit scale)

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

☑ Bit 2 = 1 and P0683 > 0: reference for clockwise speed direction
☑ Bit 2 = 1 and P0683 < 0: reference for counterclockwise speed direction
☑ Bit 2 = 0 and P0683 > 0: reference for counterclockwise speed direction
☑ Bit 2 = 0 and P0683 < 0: reference for clockwise speed direction

## P0695 – Digital Output Values

**Range:** 0000h-FFFFh **Default:** 0000h

**Proprieties:** Net

**Access groups via HMI:**

01 PARAMETERS GROUPS
∟ 49 Communication
∟ 111 Status/Commands

Description:
It makes possible the control of the digital output through the network interfaces (Serial, USB, CAN, etc.). This parameter cannot be modified through the HMI.

Each bit of this parameter corresponds to the desired value for the digital output. So the corresponding digital output can be in accordance with its values, it is necessary that its function be programmed for "P0695 Content", in the P0275 parameters to P0280.

| Bits | 15 to 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|
| Function | Reserved | Value for DO5 | Value for DO4 | Value for DO3 (RL3) | Value for DO2 (RL2) | Value for DO1 (RL1) |

*Table 4.4 - Bits Functions for the P0695 parameter*

| Bits | Values |
|---|---|
| Bit 0<br>Value for DO1 (RL1) | 0 : DO1 output open<br>1 : DO1 output closed |
| Bit 1<br>Value for DO2 (RL2) | 0 : DO2 output open<br>1 : DO2 output closed |
| Bit 2<br>Value for DO3 (RL3) | 0 : DO3 output open<br>1 : DO3 output closed |
| Bit 3<br>Value for DO4 | 0 : DO4 output open<br>1 : DO4 output closed |
| Bit 4<br>Value for DO5 | 0 : DO5 output open<br>1 : DO5 output closed |
| Bits 5 to 15 | Reserved |

## P0696 – Value 1 for Analog Output

## P0697 – Value 2 for Analog Output

## P0698 – Value 3 for Analog Output

## P0699 – Value 4 for Analog Output

**Range:** -32768 – 32767 **Default:** 0

**Proprieties:** Net

**Access groups via HMI:**

01 PARAMETERS GROUPS
- 49 Communication
  - 111 Status/Commands

**Description:**
It makes possible the control of the analogical output through the network interfaces (Serial, USB, CAN, etc.). This parameter cannot be modified through the HMI.

The value written in these parameters is used as value for the analogical output, since the desired function of the analogical output is programmed for "Content P0696/P0697/ P0698/ P0699", in the parameters P0251, P0254, P0257 or P0260.

The value must be written in a scale of 15 bits (7FFFh = 32767)[6] to represent 100% of the desired value for the output, in other words:

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

In this example the P0696 parameter was shown, but the same scale is used for parameters P0697/P0698/P0699. For example, it is desired to control the value of analogical output 1 through the serial. In this case it is request to do the following programming:

- ☑ To choose the one of the parameters from P0696 to P0699 to be the value used for analogical output 1. In this example, we will choose the P0696.
- ☑ To program, in the function of the analogical output 1 (P0254), the option "P0696 Content".
- ☑ Through the serial interface, to write in the P0696 the desired value for analogical output 1, between 0 and 100 %, in accordance with the scale of the parameter.

**NOTE!**
In case that the analogical output be programmed to operate from -10V to 10V, negative values for these parameters must be used to command the output with negative values of tension, in other words, -32768 up to 32767 represents a variation of tension from -10V to 10V in the analogical output.

[6] For the actual output resolution, refer to the CFW-11 manual.

## P0723 – Anybus Identification

**Range:** 0 to 25 **Default:** -

**Proprieties:** RO, Anybus

**Access groups via HMI:**

01 PARAMETER GROUPS
∟ 49 Communication
∟ 114 Anybus

**Description:**
It allows identifying the Anybus-CC module connected to the CFW-11.

*Table 4.4 - P0723 bit functions*

| Options | Model |
|---|---|
| 0 = Inactive | No communication module is installed |
| 1 = RS232 | RS232 passive module |
| 2 = RS422 | RS485/422 passive module installed and configured for RS422 |
| 3 = USB | USB passive module |
| 4 = Serial Server | Serial Server (Ethernet) passive module |
| 5 = Bluetooth | Bluetooth passive module |
| 6 = Zigbee | Zigbee passive module |
| 7 = WLAN | WLAN passive module |
| 8...9 = Reserved | Reserved for future use |
| 10 = RS485 | Passive module RS485/422 installed and configured for RS485 |
| 11...15 = Reserved | Reserved for future use |
| 16 = Profibus DP | Profibus DP active module |
| 17 = DeviceNet | DeviceNet active module |
| 18 = CANopen | CANopen active module |
| 19 = EtherNet/IP | EtherNet/IP active module |
| 20 = CC-Link | CC-Link active module |
| 21 = Modbus-TCP | Modbus-TCP active module |
| 22 = Modbus-RTU | Modbus-RTU active module |
| 23 = Profinet IO | Profinet IO active module |
| 24 = Reserved | Reserved for future use |
| 25 = Reserved | Reserved for future use |

## P0724 – Anybus Communication Status

**Range:** 0 = Disabled
1 = Not Supported
2 = Access Error
3 = Offline
4 = Online

**Default:** -

**Proprieties:** RO, Anybus

**Access groups via HMI:**

01 PARAMETER GROUPS
∟ 49 Communication
∟ 114 Anybus

**Description:**
It informs the communication module status.

*Table 4.5* - *P0724 options*

| Status | Description |
|---|---|
| 0 = Inactive | Anybus-CC communication module was not detected. |
| 1 = Not Supported | The detected Anybus-CC module is not supported by the CFW-11 inverter. |
| 2 = Access Error | Data access problem between inverter and Anybus-CC communication module has been detected. |
| 3 = *Offline* | Communication problems. There is no cyclic data exchange with the master. |
| 4 = *Online* | Normal communication. Cyclic and acyclic data exchange between the CFW-11 and the network master is effective. |

## P0725 – Anybus Address

**Range:** 0 to 255 **Default:** 0

**Proprieties:** Anybus

**Access groups via HMI:**

01 PARAMETER GROUPS
∟ 49 Communication
∟ 114 Anybus

**Description:**
It allows configuring the CFW-11 address in the network. The address range varies according to the used protocol. For DeviceNet the higher limit is 63 (0 to 63) and for Profibus it is 126 (1 to 126). For EtherNet/IP the node address is defined by the **HMS Anybus IPconfig,** and follows the Internet Protocol (IP) rules.

Refer to the section 2.3.5 for details on the EtherNet/IP module configuration.

## P0726 – Anybus Communication Rate

**Range:** 0 to 3 **Default:** 0

**Proprieties:** Anybus

**Access groups via HMI:**

01 PARAMETER GROUPS
∟ 49 Communication
∟ 114 Anybus

**Description:**
It allows programming the desired value for the Anybus-CC communication rate, in bits per second. This rate must be the same for all the devices connected to the network and varies according to the used protocol.

- ☑ DeviceNet: 0=125kbps, 1=250kbps, 2=500kbps and 3=autobaud.
- ☑ Profibus[7]: Auto-baud (communication rate defined by the master).
- ☑ EtherNet/IP[7]: 10/100Mbps half- or full-duplex (configured by the module own WEB server).

[7] Parameter not visible on the HMI.

## P0727 – Anybus I/O Words

**Range:** 2 = 2 Words
3 = 3 Words
4 = 4 Words
5 = 5 Words
6 = 6 Words
7 = 7 Words
8 = 8 Words
9 = PLC11 Board

**Default:** 2

**Proprieties:** Anybus

**Access groups via HMI:**

01 PARAMETER GROUPS
└ 49 Communication
└ 114 Anybus

**Description:**

- **For the options from 2 to 8 words:**

It allows programming number of I/O words that will be exchanged with the network master. Two reading and two writing words are already predefined.

They are:

Anybus Reading #1 = P0680 (Logical Status)
Anybus Reading #2 = P0681 (Speed in 13 bits)

Anybus Writing #1 = P0686 (Anybus-CC Control)
Anybus Writing #2 = P0687 (Anybus-CC Speed Reference)

The other reading and writing words are defined by the parameters P728 to P739.

- **For the option 9 – PLC 11 board:**

If this option is selected, the amount of I/O words exchanged with the master, as well as the contents of each word, have to be configured using the PLC-11 board programming software - WLP. In this case there will be no predefined words, and the parameters P0728 to P0739 will have no function.

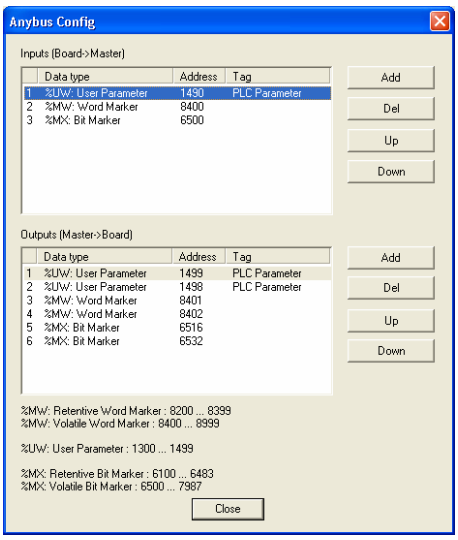



*Figure 4.1 - Example of I/O data programming using the WLP software*

In order to get more information on this function, refer to the documentation of the WLP software.

NOTE!
After downloading the I/O words configuration through the WLP, the power of the inverter must be cycled.

## P0728 – Anybus Reading #3

## P0729 – Anybus Reading #4

## P0730 – Anybus Reading #5

## P0731 – Anybus Reading #6

## P0732 – Anybus Reading #7

## P0733 – Anybus Reading #8

**Range:** 0 to 1499 **Default:** 0 (disabled)

**Proprieties:** Anybus

**Access groups via HMI:**

01 PARAMETER GROUPS
∟ 49 Communication
∟ 114 Anybus

**Description:**
These parameters allow the user to program the reading of any other parameter of the equipment[8] via the network. In other words, they contain the number of another parameter.

E.g., P0728 = 5. In this case the content of P0005 (motor frequency) will be sent via network. This way the motor frequency will be read on the PLC memory position corresponding to the third reading word.

**NOTE!**
- If the PLC11 board is used, it is also possible to program the PLC11 board parameters to be transmitted via Anybus-CC.
- These parameters are not used if P0727 = 9 (PLC11 board). In this case, the programming of data transmitted and received via network is done through the WLP software.

## P0734 – Anybus Writing #3

## P0735 – Anybus Writing #4

## P0736 – Anybus Writing #5

## P0737 – Anybus Writing #6

## P0738 – Anybus Writing #7

## P0739 – Anybus Writing #8

**Range:** 0 to 1499 **Default:** 0 (disabled)

**Proprieties:** Anybus

**Access groups via HMI:**

01 PARAMETER GROUPS
∟ 49 Communication
∟ 114 Anybus

**Description:**
These parameters allow the user to program the writing of any other parameter of the equipment[9] via the network. In other words, they contain the number of another parameter.

[8] Except parameter P0000 that is considered invalid.
[9] Except parameter P0000 that is considered invalid.

E.g., P0734 = 100. In this case the content to be written in P0100 will be sent via network. This way the PLC memory position corresponding to the third writing word must contain the value for P0100.

**NOTE!**

- If the PLC11 board is used, it is also possible to program the PLC11 board parameters to be transmitted via Anybus-CC.
- These parameters are not used if P0727 = 9 (PLC11 board). In this case, the programming of data transmitted and received via network is done through the WLP software.

# 5 DeviceNet Protocol

## 5.1 Introduction

Introduced in 1994, DeviceNet is an implementation of the *Common Industrial Protocol* (CIP) for industrial communication networks. Developed originally by Allen-Bradley, it had its technology transferred to the ODVA that, since then, keeps, publishes and promotes DeviceNet and other networks based on the CIP[10] protocol. Furthermore, it uses the *Controller Area Network* (CAN) protocol for the data link and access to the medium, layers 2 and 1 of the OSI/ISO model, respectively.

Used mainly for the connection of industrial controllers and I/O devices, the protocol follows the model producer-consumer, supports multiple communication modes and has priority between messages.

It is a system that can be configured to operate in master-slave architecture as well as in a distributed point-to-point architecture. Besides, it defines two kinds of messages, I/O (process data) and *explicit* (configuration and parameter setting). It also has mechanisms to detect duplicated addresses and for node isolation in case of critical faults.

A DeviceNet network can have up to 64 devices, addressed from 0 to 63. Any of them can be used. There is no restriction, although the 63 should be avoided because it is usually used for commissioning.

## 5.2 Physical Layer

DeviceNet uses a network topology of the trunk/derivation type that allows the signal wiring as well as the power wiring to be present in the same cable. This power is supplied by a power supply connected directly to the network, which feeds the CAN transceivers of the nodes, and has the following characteristics:

- ☑ 24Vdc;
- ☑ DC output isolated from the AC input;
- ☑ Current capacity compatible with the installed equipment.

The used transmission rate depends on the size (cable length) of the network, as showed in the table below.

*Table 5.1 - Network size x Transmission rate*

| Transmission rate | Network size | Derivation | |
|---|---|---|---|
| | | Maximum | Total |
| 125kbps | 500m | 6m | 156m |
| 250kbps | 250m | | 78m |
| 500kbps | 100m | | 39m |

In order to avoid reflections in the line, it is recommended the installation of termination resistors at the line extremes, because the absence of them may cause intermittent errors. This resistor must have the following characteristics, according to the protocol specification:

- ☑ 121Ω;
- ☑ 0,25W;
- ☑ 1% tolerance.

For DeviceNet, several types of connectors can be used, sealed as well as open ones. The definition of the type to be used depends on the application and on the equipment operation environment. The CFW-11 uses a 5 wire *plug-in* connector, and its pin assignment is showed in section 2. For a complete description of the connectors used with DeviceNet, consult the protocol specification.

[10] CIP actually represents a family of networks. DeviceNet, EtherNet/IP and ControlNet use CIP in the application layer. The difference among them is primordially in the data link and physical layers.

## 5.3 Data Link Layer

The DeviceNet data interlacing layer is defined by the CAN specification, which defines two possible states; dominant (logic level 0) and recessive (logic level 1). A node can bring the network to the dominant state if it transmits any information. Thus, the bus will only be in the recessive state if there where no transmitting nodes in the dominant state.

CAN uses the CSMA/NBA to access the physical medium. This means that a node, before transmitting, must verify if the bus is free. In case it is, then the node can initiate the transmission of its telegram. In case it is not, then the node must await. If more than one node access the network simultaneously, a priority mechanism takes action to decide which one will have priority over the others. This mechanism is not destructive, i.e., the message is preserved even if there is a collision between two or more telegrams.

CAN defines four types of telegrams (*data, remote, overload* and *error*). Among them, DeviceNet uses only the *data frame* and the *error frame*.

Data is moved using the data frame. This frame structure is used in the Figure 5.1.

The errors, however, are indicated by means of the error frames. CAN has a very robust error verification and confinement. This assures that a node with problems does not impair the communication in the network.

For a complete description of the errors, consult the CAN specification.

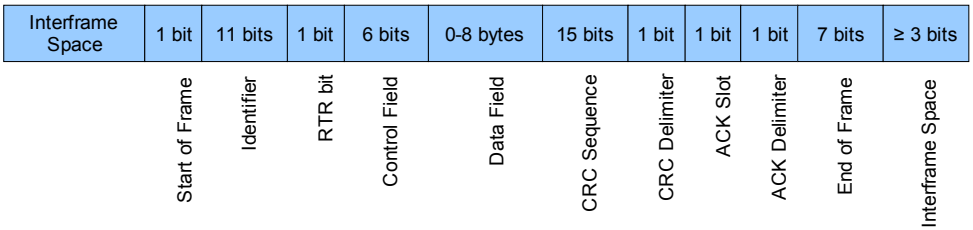



*Figure 5.1 - CAN data frame*

## 5.4 Network and Transport Layers

DeviceNet requires that a connection be established before data exchange with the device takes place. In order to establish this connection each DeviceNet node must implement the *Unconnected Message Manager* (UCMM) or the *Group 2 Unconnected Port*. Those two allocation mechanisms use messages of the explicit type to establish a connection, which will then be used for process data exchange between one node and the other. This data exchange uses messages of the I/O type (refer to item 5.7).

The DeviceNet telegrams are classified in groups, which define specific functions and priorities. Those telegrams use the identifier field (11 bits) of the CAN data frame to uniquely identify each one of the messages, thus assuring the CAN priority mechanism.

A DeviceNet node can be a client, a server or both. Furthermore, clients and servers can be producers and/or consumers of messages. In a typical client node, for instance, its connection will produce requests and will consume answers. Other client or server connections will only consume messages. In other words, the protocol allows several connection possibilities among the devices.

The protocol also has a resource for detection of nodes with duplicated addresses (Mac ID). Avoiding that duplicated addresses occur is, in general, more efficient than trying to locate them later.

## 5.5 Application Layer – CIP Protocol

In the application layer, DeviceNet uses the *Common Industrial Protocol (CIP)*. It is a protocol strictly orientated to objects, used also by ControlNet and EtherNet/IP. In other words, it is independent from the physical medium and from the data link layer. The Figure 5.2 presents the structure of this protocol.

The CIP has two main purposes:

☑ Transport of I/O devices control data.
☑ Transport of configuration and diagnosis information of the system being controlled.

A DeviceNet node (master or slave) is then molded by a set of CIP objects, which encapsulate data and services, thus determining its behavior.

There are obligatory objects (each device must have) and optional objects. Optional objects are those that mold the device according to the category (called profile) to which they belong, as: AC/DC drive, bar code reader or pneumatic valve. For being different, each one of these will contain a group of also different objects.

For more information refer to the DeviceNet specification. It presents the complete list of devices already standardized by the ODVA, as well as the objects that compose it.

## 5.6 Configuration File

Every DeviceNet node has a configuration file associated[11]. This file contains important information about the device operation[12].

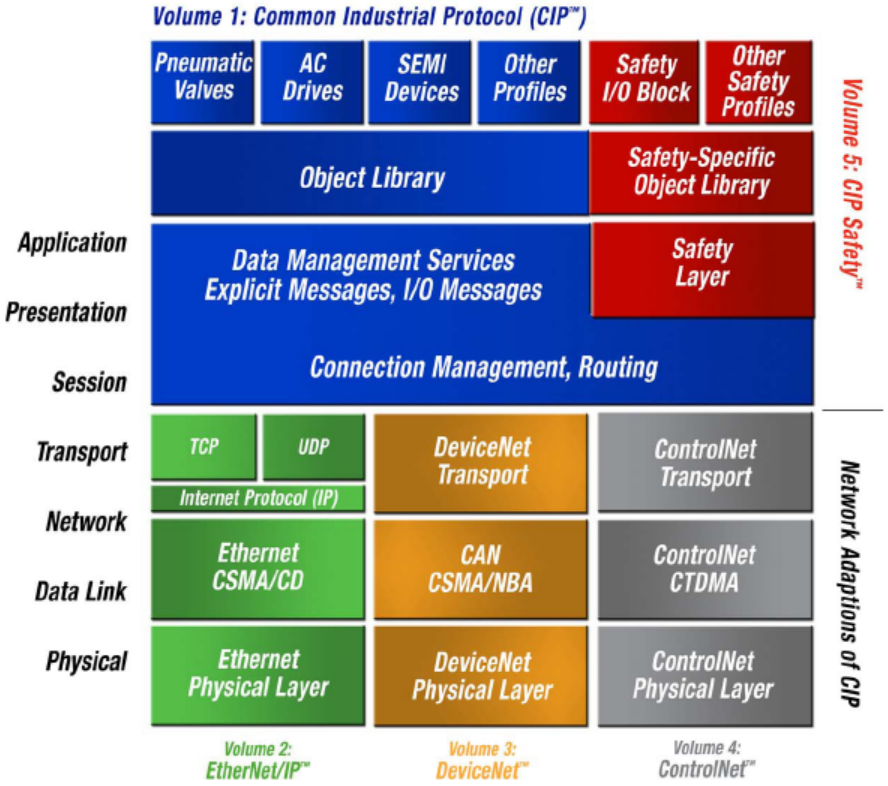



*Figure 5.2 - CIP protocol structure in layers*

## 5.7 Communication Modes

The DeviceNet protocol presents two basic types of messages, I/O and explicit. Each one of them is adequate to a specific kind of data, as described below:

[11] Known as EDS file.

[12] The CFW-11 with DeviceNet communication module will be recognized by the network configuration software as Anybus-CC DeviceNet.

- ☑ I/O: It is a kind of synchronous telegram dedicated to the movement of priority data between one producer and one or more consumers. They are divided according to the data exchange method. The main types are:
  - *Polled*: It is a communication method where the master sends one telegram to each of the slaves of its list (*scan list*). As soon as receiving the request, the slave responds promptly to the request from the master. This process is repeated until all be consulted, starting again the cycle.
  - *Bit-strobe*: It is a communication method where the master sends to the network a telegram containing 8 data bytes. Each bit from those 8 bytes represents a slave that, if addressed, responds according to the programmed.
  - *Change of State*: It is a communication method where the data exchange between master and slave occurs only when changes in the monitored/controlled values happened, until a certain time limit. When this limit is reached, the transmission and reception will occur even if there were no changes. The configuration of this time variable is done in the network configuration program.
  - Cyclic: It is another communication method very similar to the previous one. The only difference stays in the production and consume of messages. In this type, every data exchange occurs in regular time intervals, whether or not they had been changed. This time period is also adjusted in the network configuration software.
- ☑ Explicit: It is a kind of general purpose telegram and without priority. It is mainly used for asynchronous tasks like the parameter settings and the configuration of the equipment.

### 5.7.1 Predefined Master/Slave Connections Set

DeviceNet uses fundamentally a point-to-point message model. However, it is quite common to use a predefined communication model based on the master/slave mechanism.

This model uses a simplified message movement of the I/O type, very common in control applications. An advantage of this method is that the necessary requests to run it are generally less than for the UCMM. Even simple devices with limited resources (memory, 8 bit processor) are capable of executing the protocol.

## 5.8 Status of the DeviceNet Module

DeviceNet defines two status, one for the communication module (MS) and other for the network (NS).

The MS LED indicates the conditions of the module, i.e., whether or not it is able to work. The table below shows the possible status:

*Table 5.2 - DeviceNet module status*

| Status | Description |
|---|---|
| Off | Without power supply |
| Green | Operational module and in normal conditions |
| Flashing green/red | Equipment performing a self-diagnosis. It occurs during the initialization |

## 5.9 Status of the DeviceNet Network

The NS LED indicates the status of the DeviceNet network. The next table presents a brief description of those status.

*Table 5.3 - DeviceNet network status*

| Status | Description |
|---|---|
| Off | Without power supply or not *online*. Communication cannot be established |
| Flashing green | Device is *online*, but not connected. Slave has successfully completed the MacID verification procedure. This means that the configured communication rate is correct (or was detected correctly in the case of auto-baud use) and that there are no other nodes in the network with the same address. However, in this stage there is no communication with the master yet |
| Green | Operational device and in normal conditions. The master has allocated a set of I/O type connections with the slave. In this stage data exchange by means of I/O type connections does effectively occur |
| Flashing red | One or more I/O type connections have expired |
| Red | It indicates that the slave cannot enter the network because of addressing problems or due to the occurrence of *busoff*. Verify if the address is being used by another equipment and if the chosen communication rate is correct or if there are installation problems |
| Flashing green/red | Equipment performing a self-diagnosis. It occurs during the initialization |

# 6 Profibus DP-V1 Protocol

## 6.1 Introduction

Profibus is an open digital communication system much used in process and manufacture automation. It was created in Germany in the late eighties; it is one of the most used field networks in industry. It is independent from manufacturers and its standardization is assured by standards and it is regulated by the Profibus International (PI) and by the national organizations of the member countries.

It can be used both in high speed data transmission, as well as in complex automation tasks. It includes, therefore, different communication profiles (DP and FMS). It offers also different application profiles for process automation devices, such as transmitters and valves, as well as profiles for drives.

A Profibus network may contain up to 126 stations in one communication bus, addressed from 1 to 126 among masters and slaves.

In the next sections only characteristics of the DP profile will be presented.

## 6.2 Basic Characteristics

DP is the Profibus profile most frequently used. Optimized for high speed and low cost, it was projected specially for the communication between automation control systems and distributed I/O devices.

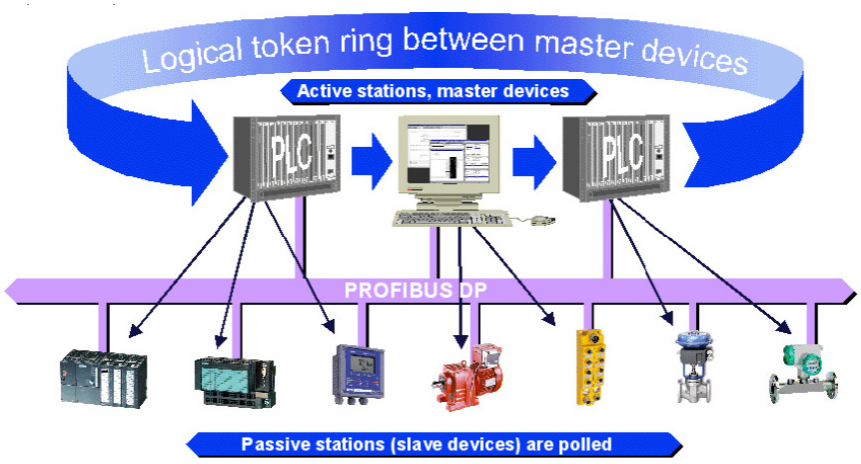



*Figure 6.1 - Multi-master Profibus DP network*

Profibus distinguishes its devices between masters and slaves (Figure above). Masters determine the data communication in the bus. A master can send messages, without any external request, every time it has access right to the bus (token); they are also called active stations. Slaves are remote devices like I/O modules, transducers, valves, drives, etc.; they do not have access right to the bus and can only send messages to the master when requested; they are also called passive stations.

Profibus DP is also a multi-master system. This means that several active stations can exist in the same bus controlling different slaves. In this case, a telegram called token is passed among the masters in order to guarantee a single access right to the bus. Therefore, the access to the Profibus bus includes the procedure of the token passing among the active stations and the master-slave procedure for the communication of masters with the slaves.

### 6.2.1 Protocol Architecture

Profibus is based on international standards, being its protocol architecture oriented to the OSI (Open Systems Interconnection) layer model from ISO. In this model the layer 1 (physical layer) defines the physical characteristics

of the transmission. The layer 2 (data link layer) defines the access protocol to the medium. And the layer 7 (application layer) defines the application functions.

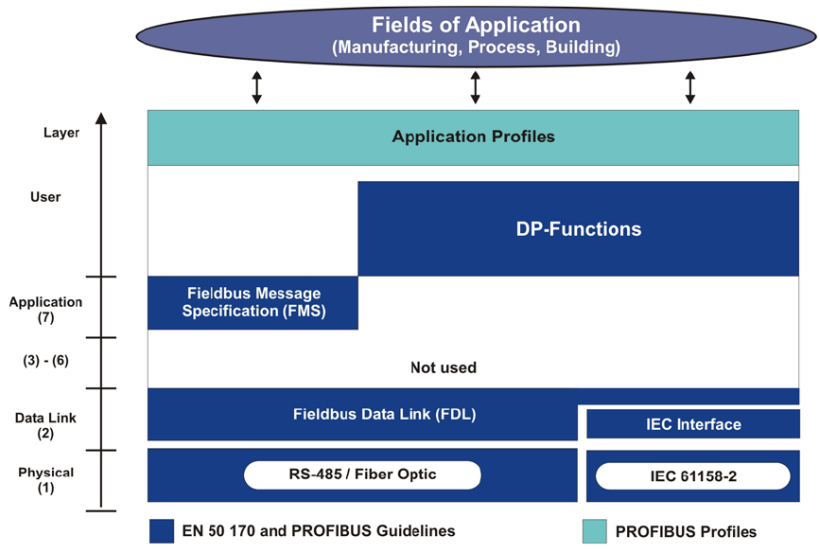



*Figure 6.2 - Profibus protocol layers*

Profibus DP uses only the layers 1, 2 and the interface with the user.

### 6.2.2 Transmission Medium

The RS485 standard is most common transmission technology used with Profibus DP. Its application comprises all the areas where a high transmission rate plus a simple and inexpensive installation is necessary. Thus, a cable with a single shielded twisted pair of wires is sufficient. This topology, of the linear bus type, allows the addition and removal of nodes from the network in operation without damage to the other stations.

Another option besides the metallic pair is the optical fiber. It can be used in environments with high electromagnetic interference or when one wants to increase the maximum length of the network with high communication rates. In this case the resulting topology is the star or the ring.

In a Profibus network each segment can contain up to 32 stations. The use of repeaters (maximum of 4) allows that up to 126 stations be present in a single network.

In order to avoid reflections in the line signal, the protocol specification recommends the installation of termination resistors at the extremes of the network main trunk. The lack of those terminations can cause intermittent errors in the nodes.

The figure below shows how the termination resistors must be connected.

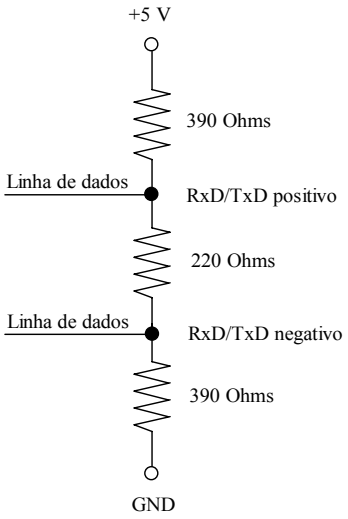



*Figure 6.3 - Profibus network termination*

### 6.2.3 Transmission Rates and Connectors

Profibus defines that transmission rates between 9600bps and 12Mbps can be selected. This configuration, done once for the whole network, must be done during the system initialization. This rate is a function of the maximum length of each segment of the network. The next table presents the allowed value range.

*Table 6.1 - Transmission rate x Length of each segment*

| Transmission rate (kbps) | Length of each segment (m) |
|---|---|
| 9.6; 19.2; 45.45; 93.75 | 1200 |
| 187.5 | 1000 |
| 500 | 400 |
| 1500 | 200 |
| 3000, 6000, 12000 | 100 |

Another important factor is the master scan cycle period. The Figure 6.4 links the communication rate with the number of network stations. Generally for a specific rate, the bigger the number of nodes, the longer the time necessary for consulting them. This must be considered if the application has severe time related restrictions.

The standard connector used by Profibus is the female DB9. The Table 2.2 shows the signals present at each pin of that interface.

Any DB9 connector that complies with the Profibus specification can be used with the CFW-11, except for the 90° models, due to the mechanic characteristics of the product.

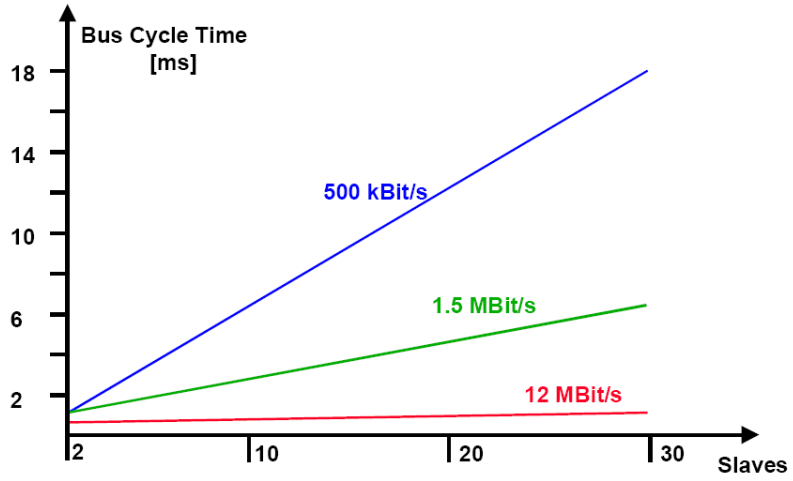



*Figure 6.4 - Communication rate x Number of slaves*

## 6.3 Configuration File

Each Profibus DP node has an associated[13] configuration file. This file contains important information about the device operation and must be registered in the network configuration software[14].

## 6.4 Communication Module Status

The ST LED indicates the conditions of the module, i.e., whether or not it is able to work. The table below shows the possible status.

*Table 6.2 - Profibus DP-V1 module status*

| Status | Description |
|---|---|
| Off | Without power supply or not initialized |
| Green | Initialized module |
| Flashing green | Initialized, but in event diagnosis |
| Red | With error |

## 6.5 Operation Mode Status

The OP LED provides information on the status of the network operation mode. The next table presents a brief description of those status.

*Table 6.3 – Operation mode status*

| Status | Description |
|---|---|
| Off | Without power supply or not *online* |
| Green | Device *online* and with data transfers |
| Flashing green | *Online* but in the clear *State* (outputs are not updated) |
| Flashing red (1 blink) | Parameter setting error |
| Flashing red (2 blinks) | Indicates error in the Profibus configuration |

[13] Known as GDS file.

[14] The CFW-11 with Profibus DP-V1 module will be recognized by the network configuration software as Anybus-CC Profibus DP-V1.

# 7 EtherNet/IP Protocol

## 7.1 Introduction

EtherNet/IP was introduced in 2001, one more member of the protocol family that use the CIP (the same used by DeviceNet) in the application layer, as illustrated in the figure below. CIP comprises a wide message application suite and services for a variety of industrial automation applications, including control, security, synchronization, configuration and information.

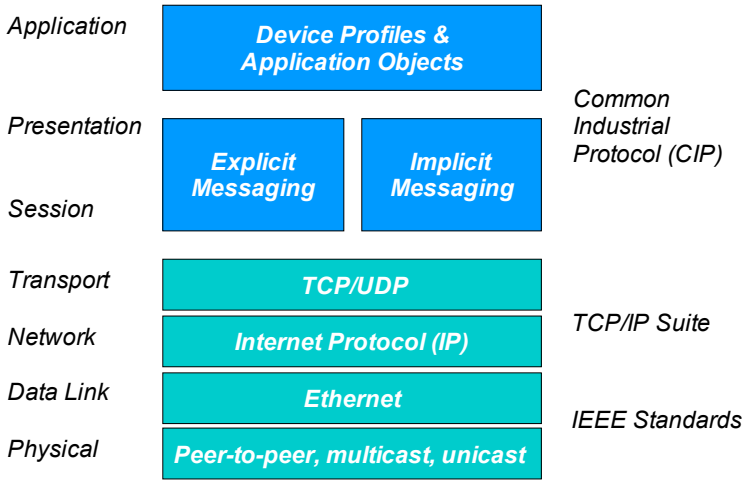



*Figure 7.1 - EtherNet/IP protocol layers*

Due to a strong integration existent between the TCP/IP protocols suite and the EtherNet, the user has the possibility of integrating in single communication architecture the corporative network and the "Plant Floor" network. The benefit of this integration reflects in the involved costs, since this is a technology proved and used to connect millions of computers worldwide.

EtherNet/IP offers, besides this one, other benefits:

- ☑ The producer-consumer architecture allows controlling, configuring and collecting data simultaneously from several intelligent devices dispersed in the network.
- ☑ It allows accommodating a great number of devices in a network. There are no restrictions regarding the number of connected nodes, as normally occurs in field networks.
- ☑ Compatibility with standard Internet protocols, like http, ftp and dhcp.
- ☑ Compatibility with IEEE Ethernet standards, allowing rates of 10, 100 and even 1000Mbps.
- ☑ Architecture compatible with commercial Ethernet installations that include copper, fiber optics and wireless.
- ☑ The option to use shielded cables and robust connectors, as RJ45 IP67 and M12.

## 7.2 Physical Layer

EtherNet/IP uses the IEEE 802.3 standard for the physical layer, the same as used in computer networks. This standard specifies the used physical medium, it defines the data frame format for transportation of the packages between devices and gives a set of rules for determining how the network devices respond when two or more try to access the channel simultaneously. This mechanism is called CSMA/CD (Carrier Sense Multiple Access/Collision Detection).

EtherNet/IP is configured using a series of equipments (*hubs*, *switches*, routers) that segment the network with the purpose of increasing the data control and safety. The typical topology used is the star. In this configuration cables make the connection point-to-point from the concentrating elements (*hubs, switches,* etc.) and the industrial equipments. It is recommended that the cable length be not superior to 90m. Ethernet Cat5 cables should be preferably used, because they present higher noise immunity.

Based on the project requirements, optical fibers can be used instead of metallic cables. This solution uses to be adopted when the environment presents a high noise level (high electromagnetic interference) or when distances longer then 100m must be covered.

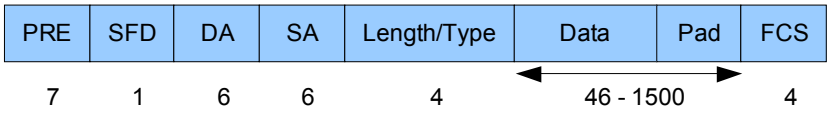
## 7.3 Data Link Layer

The IEEE 802.3 specification is also the standard used for the transmission of data packages between devices. Ethernet uses the CSMA/CD to assure single access to the communication channel.

Originally, Ethernet operate din *half-duplex* mode, i.e., each node could only send or receive data, but not simultaneously. Delays and package collisions occurred, but were not worrisome because the kind of traffic was not requiring real time response. The increasing demand for higher performance and speed forced the revision of the protocol specification, which passed thereafter to count with the *full-duplex* mode. In this mode, there is a channel dedicated to the transmission and another to the reception. Therefore, the *full-duplex* does not use the CSMA/CD protocol for controlling the access to the physical medium.

This associated to other measures, increased the certainty level of the network to the point it passed to be used in industrial applications for process control.

IEEE 802.3 contains also the MAC (Media Access Control) protocol, responsible for the network devices "talk". It uses a single address composed by 6 bytes (called "MAC address") to identify the network nodes. The control of the uniqueness of this address is responsibility of the IEEE and of the Ethernet controller manufacturer.




PRE = Preamble

SFD = Start of Frame

DA = Destination Address

SA = Source Address

FCS = Frame Check Sequence

***Figure 7.2** - Structure of an Ethernet frame*

The Figure 7.2 shows the structure of an Ethernet frame. The main fields of this frame are the source and destination addresses (SA and DA respectively) and the data field. The frame data field contains effectively the data to be transported, and may contain up to 1500 bytes.

The combination of real time control with high data transport capability makes the EtherNet/IP a solution more and more attractive.

## 7.4 Network and Transport Layers

In the network and transport layers, EtherNet/IP uses the Internet standard, the TCP/IP protocol suite. The *Transmission Control Protocol/Internet Protocol* is the responsible for the sending of messages among devices. TCP/IP provides the necessary resources for implementing a totally functional network, i.e., addressing mechanism, establishment of connection and data exchange.

The TCP/IP protocol suite is composed by:

☑ TCP: connection oriented protocol, unicast, which provides data flow control, fragmentation and message acknowledgement. The nodes must interpret each message, execute the request and send an answer. It is ideal for reliable transmissions of great amounts of data. EtherNet/IP uses TCP to encapsulate CIP explicit messages, generally used for configuration and diagnosis.

☑ IP: protocol used in package routing, it has the ability to send messages to the recipient even when there are broken routes. Every equipment in an Ethernet network is identified by an unique IP address. E.g. 192.168.0.2.

For critical control messages (real time), EtherNet/IP uses UDP over IP. Implicit messages (I/O) use this form of data transfer because the data meaning is predefined at the moment the connection is established, minimizing the processing time during the execution.

## 7.5 Configuration File

Following the example of what happens with the networks presented previously, EtherNet/IP uses a configuration file (also called EDS file) to describe the main operational characteristics of the equipment. It must be registered in the network configuration software, exactly as it is done with DeviceNet.

Consult the used PLC documentation for more details.

## 7.6 EtherNet/IP Module Status

EtherNet/IP defines two status, one for the communication module (MS) and other for the network (NS). The MS LED indicates the conditions of the module. The Table 7.1 shows the possible status:

*Table 7.1 - Operation mode status*

| Status | Description |
|---|---|
| Off | Without power supply |
| Green | Module controlled by a scanner in RUN mode |
| Flashing green | Not configured or scanner in IDLE mode |
| Red | Unrecoverable fault. Equipment must be reinitialized |
| Flashing red | Recoverable fault. The return to the normal state occurs automatically after the fault cause has been corrected |
| Flashing green/red | Equipment performing self-test. Occurs during the initialization |

## 7.7 Status of the EtherNet/IP Network

The NS LED indicates the EtherNet/IP network conditions.

*Table 7.2 - EtherNet/IP network status*

| Status | Description |
|---|---|
| Off | Without power supply |
| Green | Module controlled by a scanner in RUN mode |
| Flashing green | Not configured or scanner in IDLE mode |
| Red | Unrecoverable fault. Equipment must be reinitialized to leave this status |
| Flashing red | Recoverable fault |
| Flashing green/red | Equipment performing self-test. Occurs during the initialization |

## 7.8 Link/Connection Status

The LINK LED indicates the status of the network physical connection, as well as the activity on the bus.

*Table 7.3 - Connection status*

| Status | Description |
|---|---|
| Off | Without connection, without activity |
| Green | Connection has been established |
| Flashing green | Activity in the bus. It indicates that there is effectively data exchange between master and slave |

# 8 Faults and Alarms Related to the Anybus-CC Communication

## A129/F229 – Anybus-CC Module Offline

Description:
It indicates interruption in the Anybus-CC communication. The communication module went to the Offline state.

Actuation:
It occurs when for any reason there is an interruption in the communication between the CFW-11 and the network master.

In this case the alarm A129 or the fault F229, depending on the P0313 programming, will be signalized through the HMI. In case of alarms, the alarm indication will automatically disappear at the moment the condition that caused the error no longer exists.

It occurs only when the inverter is *online.*

Correction:
- ☑ Verify cables and connectors. A bad contact in these elements may cause intermittent alarms.
- ☑ Make sure the PLC is in execution mode (RUN).

## A130/F230 – Anybus-CC Module Access Error

Description:
It indicates Anybus-CC comunication module access error.

Actuation:
It occurs when the control board is not able to read information from the module or when there is hardware incompatibility.

In this case the alarm A130 or the fault F233, depending on the P0313 programming, will be signalized through the HMI. It is necessary to cycle power of the inverter so that a new attempt to access the Anybus-CC module be made.

Correction:
- ☑ Verify if the Anybus-CC module is fitted in correctly on the XC44 connector.
- ☑ Make sure there are not two options (WEG board and passive Anybus-CC module) installed simultaneously having the same interface (RS232 or RS485). In such case the WEG optional board will have preference over the Anybus-CC module that will remain disabled and indicating A130.