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sigmadue Control Unit CU-02

σ2 SERIES

User Manual
M.U. CPU-CB/CU-02-5/14.04
Cod. J30 - 478 - 1A CU02 E

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Prerequisites

The products described in this manual should be installed, operated and maintained only by qualified application programmers and software engineers who are almost familiar with EN 61131-3 concepts of PLC programming, automation safety topics and applicable national standards.

Using this manual

Specifications within the text of this manual are given in the International System of Units (SI), with non SI equivalents in parentheses.

Fully Capitalized words within the text indicate markings found on the equipment.

Words **in bold** style within the text indicate markings found in the Configuration Tools.

Warnings, Cautions and Notes are used to emphasize critical instructions:

DANGER!

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

Caution

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

Note: Highlights important information about an operating procedure or the equipment.

Current Documentation on the Internet

Make sure you are always working with the latest version of this document.

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http://www.ascontecnologic.com

Chapter 1
Hardware description

The system described in this User Manual is mainly composed of three components:

- Ascon sigma**due** series CPU (CU-02), ready to work with OpenPCS EN 61131-3 compliant programming system;
- Ascon sigma**due** I/O-CB remote I/O series of modules;
- Infoteam OpenPCS programming system.

sigma**due** CPU is a powerful processing unit, based on an ARM RISC processor, different types of memory and several communication ports.

sigma**due** I/O-CB is a complete family of I/O analogue and digital remote modules with special functions, based on the CANopen protocol over a CAN bus.

Infoteam OpenPCS is a powerful and useful standard programming system for PLC applications.

It is a clearly structured, easily operated tool for editing, compiling, debugging, managing and printing PLC applications in all the development phases.

OpenPCS supports EN61131-3 programming under Windows server 2003, Windows XP SP2 or Windows Vista 32 bit.

Ascon sigma**due** line is based on the sigma**due** remote I/O system, combining its functionality with the capabilities of a PLC. The modular concept and the possibility of fieldbus networking means that you can adapt the system to your requirements quickly and easily. This gives the sigma**due** automation system an especially economical price/performance ratio.

This User Manual handbook introduces you to work with sigma**due** CPU line and the Infoteam OpenPCS programming system.

It explains how to install the hardware and software, and how to start up the system. Information on maintenance, troubleshooting and service are also included.

1-1 Architecture

From the programmer's point of view, a complete system is made up as in "*Figure 1.1 - Programming the sigmadue Control Unit"* below:

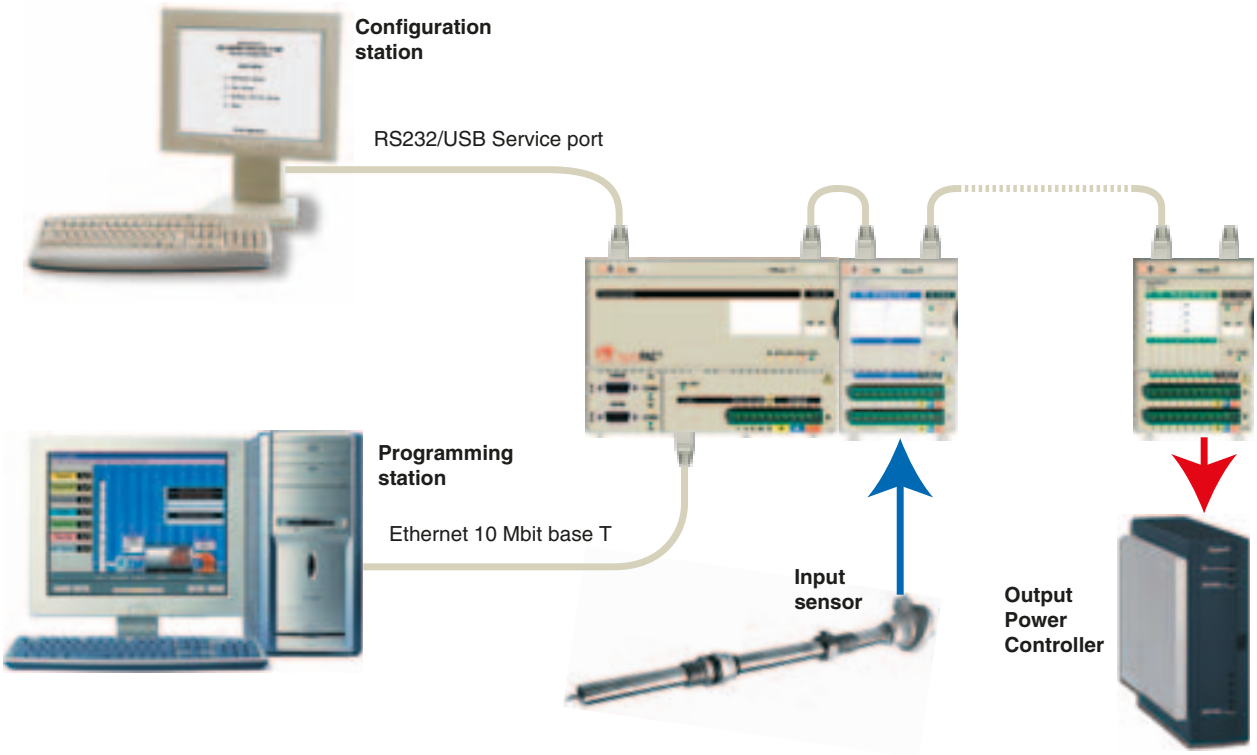


Figure 1.1 - Programming the sigma**due** *Control Unit*

In "*Figure 1.1 - Programming the sigmadue Control Unit"* the configuration station (VT100 terminal) and the PC with OpenPCS are displayed as two different devices, but it is possible to use just one PC to run both OpenPCS and a VT100 emulator (e.g. HyperTerminal).

1-1-1 Communication ports

The CPU has 3 fixed communication ports (*see figure 2*):

- The CAN port will be used for the connection, through a CANopen network, to the distributed I/O;
- The Ethernet port (TCP/IP) will be used for the connection, through a LAN network, to the PC with the Infoteam OpenPCS environment, for:
  - Programming, Debuging and commissioning;
  - Modbus TCP data exchange;
- The Service RS232 port will be used as:
  - Configuration port of the device with VT100 terminal;
  - Standard ASCII serial port;
  - Modbus RTU data exchange.

In addition to the three mentioned fixed ports, a plug in board can be added (see Ordering Codes), by which the communication capabilities are increased, e.g.:

- Two channels RS232/485 with Modbus RTU protocol (master or slave);
- Profibus DP (slave).

Pinout of all communication Ports are described hereafter and in the "*CU02 Installation Manual*" **[6]**.

1-1-2 Auxiliary digital I/O

DI General Purpose Digital Input or RUN/STOP program functionality

ALARM General Fault Relay Output (IEC 61131 Watch Dog function);

WAKE UP Isolated General Purpose Digital Output (can be used, in conjunction with the Real Time Clock, for unattended applications).

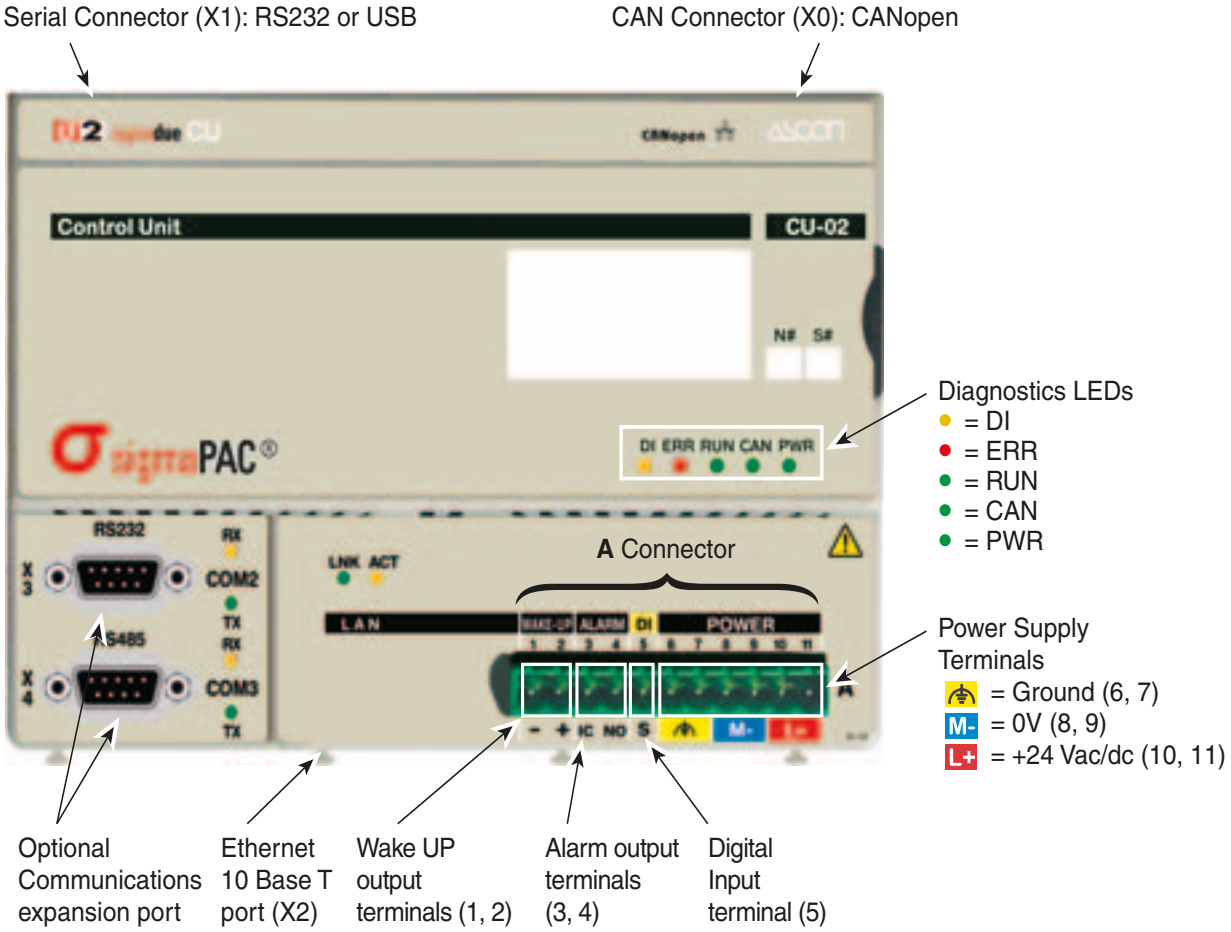


Figure 1.2 - Control Unit I/O and Communication Ports

1-1-3 Diagnostics LEDs

Referring to "*Figure 1.2 - Control Unit I/O and Communication Ports*" a description of the LEDs functions is given in the table below.

LED	Color	Action (note 1)	Description
DI	Yellow	ON	Digital Input active
ERR	Red	ON	Error on CANopen network
RUN	Green	ON	Program running (with no errors)
RUN	Green	OFF	Program stop (with no errors)
RUN	Green	Flickering	Back-Up battery low
RUN	Green	Single flash	Error in configuration file, reset to default
RUN	Green	Blinking	Checksum error in VAR RETAIN data
RUN	Green	Triple flash	Checksum error VAR % RETAIN (note 2)
CAN	Green	ON/OFF	RUN LED for CANopen Network
PWR	Green	ON	Power Supply ON

Table 1.1 - Diagnostics LEDs description

Notes: 1. As the ON/OFF sequence of the LEDs has a specific meaning, it is important that the user recognizes each LED status:

Sequence	Meaning
OFF	the LED is not lit
Steady ON	the LED is lit in a stable way
Blinking	the LED blinks at a frequence of 2.5 Hz (slow)
Flickering	the LED blinks at a frequence of 10 Hz (fast)
Single flash	the LED lits once for at least 200 ms
Double flash	the LED lits twice with pulses of 200 ms each
Triple flash	the LED lits three with pulses of 200 ms each

2. The first time some %M variable has been defined as RETAIN (see *"Retain Config Menu" on page 16*), the system needs to reboot in order to create the dedicated files. The error indication will disappear automatically.

Chapter 2
Installation

2-1 Mechanical installation

The sigma**due** Control Unit and the I/O modules are designed to be installed on standard DIN rails.
As the CPU has, on board, a CAN termination, it must be installed at one end of the CAN chain.
Up to 127 I/O modules can be connected in chain to each CPU. This value is the theoretical limit, Ascon spa reccomends to never exceed the number of 32 units.

2-1-1 Installing modules and Removing modules

A complete description on how the modules can be mounted on or removed from a DIN Rail can be found in the "*Control Unit CU-02 Installation Manual*" **[6]**.

2-2 Electrical installation

Refer to: "*Figure 1.2 -Control Unit I/O and Communication Ports*" "*Control Unit CU-02 Installation Manual*" **[6]** for details.

2-2-1 Connect the communication cables

CANopen remote I/O Port

For CANopen I/O modules connection (**X0**). I/O modules are connected with the included cables in a daisy chain fashion. The RJ45 type connectors have the pinout:

Pin	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Signal	CANH	CANL	CAN-GND	NC	NC	CAN-SHLD	CAN-GND	CAN-V+

Serial Port

RS232 service port (X1)
The connector X1 on the CPU module is an RJ45 type, with the following pinout:

Pin	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Signal	NC	NC	NC	GND	RX	TX	NC	NC

USB service port (X1)
When installed , the connector X1 on the Contro Unit is a B type USB standard connector. The pinout of this cable is meaningless as the connection is standard.

Ethernet 10baseT

For OpenPCS development station (**X2**). The connector on the CPU module is an RJ45 type, with the following pinout:

Pin	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Signal	TX+	TX-	RX+	NC	NC	RX-	NC	NC

2-2-2 Connector “A” connections

Power supply

Use the 6 poles on the right of the “**A**” connector and respect the polarity. Each of these terminals is doubled in order to allow the user to power, using an additional terminal block, other devices or sensors.

Pin	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Name	**-**	**+**	**IC**	**NO**	**S**	**FE**	**FE**	**M-**	**M-**	**L+**	**L+**
Function	**WAKE UP**		**ALARM**		**DI**	**F. EARTH**		**POWER SUPPLY**			
Signal						FE	FE	**0V**	**0V**	**+24V**	**+24V**

Power Supply

Auxiliary ports

The 5 poles on the left of the “**A**” connector are auxiliary ports.

Pin	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Name	**-**	**+**	**IC**	**NO**	**S**	**FE**	**FE**	**M-**	**M-**	**L+**	**L+**
Function	**WAKE UP**		**ALARM**		**DI**	**F. EARTH**		**POWER SUPPLY**			
Signal	COM	OUT	COM	OUT	INPUT	FE	FE	**0V**	**0V**	**+24V**	**+24V**

Auxiliary ports

Wake up Software activated Digital Output. 24Vdc, 0.2A high side power switch, terminals 1 and 2;

Alarm Relay type digital output. SPST NO 24V, 1A, terminals 3 and 4;

DI 24Vdc digital Input, terminal 6. The return path can be linked to terminal M- (terminal 8 or 9) or to Wake-Up terminal (teminal 1).

Chapter 3
CPU setup

At start-up, the system starts a configuration session to perform the setup of the CPU devices. The user can insert the CPU setup data using a dumb VT100 terminal or a Personal Computer with Hyper Terminal program.. In *Appendix B* is inserted the tree structure of the setup menus.

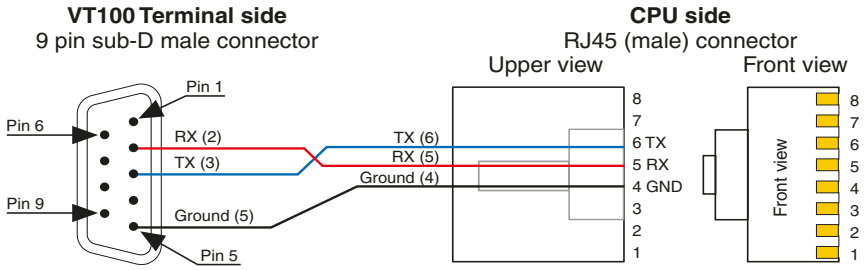
3-1 Connection of the CPU Setup Terminal

There are 2 ports available on the CPU to enter the configuration session: the **X0** port for the serial RS232 connection or the LAN port for the ethernet connection. Depending on the setup method used, the user must:

- Set the **X0** or the LAN port (consult the "*CU-02 Installation Manual*" **[9]** for details);
- Provide the proper connection cable;
- Set the correct communications parameters;
- Run the communications program.

3-1-1 RS232 Serial Communications Connection

In order to connect a VT100 terminal or a PC with Hyper Terminal program, install an RS232 cable having the following characteristics:



Setting the communications parameters

At this point the user must configure the HyperTerminal in order to communicate with the correct COM Serial port. The number of the COM port linked to the USB connector can be found in:
Start\ControlPanel\System\Hardware\Peripherals\Ports (COM and LPT)
Using the COM port number open a new session of HyperTerminal and set the default communication parameters for the service port:

Baud rate	9600
Data	8bit
Stop bit	1
Parity	None
Flow Control	None

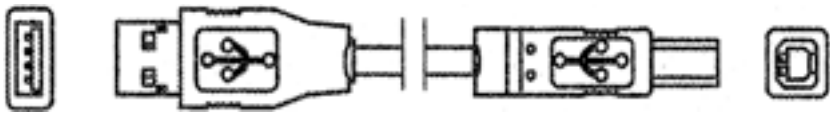
3-1-2 USB Serial Communications Connection

Installing the cable

In order to connect a Personal Computer using the USB (optional) connection, install an USB standard cable having an USB type “B” connector (CPU side) and an USB type “A” connector (PC side). This type of cable is standard for the USB connections and the installation is easy as each connector has only one insertion versus.

PC side — USB Type A Connector

CPU side — USB Type B Connector



Installing the USB driver

1. In Internet at the address:
   http://www.ftdichip.com/Drivers/VCP.htm
   locate the FT232B device and download the latest driver for the Operating System installed on the PC.
2. Connect the USB cable between the CPU and the PC.
3. Install the 2 drivers as explained in the installation manual, first the one of the USB device, then the driver that links the USB port to a COM port in the Personal Computer.

Setting the communications parameters

Once connected the CPU to the PC with the USB cable, the user must configure the HyperTerminal in order to communicate with the USB port. The number of the COM port linked to the USB connector can be found in:
Start\ControlPanel\System\Hardware\Peripherals\Ports (COM and LPT)
(locate the “*USB to COM #*” entry). Using the COM port number open a new session of HyperTerminal and set the default communication parameters for the service port:

Baud rate	9600
Data	8bit
Stop bit	1
Parity	None
Flow Control	None

3-1-3 Setting the Communications Parameters of the CPU RS232 Service Port

The default configuration for the Service RS232 port is:

Baud rate	9600
Data	8bit
Stop bit	1
Parity	None
Flow Control	None

During the configuration session it will be possible to change the baudrate, stop bit and parity. When the communications parameters of the CPU are changed, the communications parameters of the terminal (or PC) must be changed accordingly. The setup is performed by browsing the menus sent to the VT100 terminal or to the terminal emulation program (HyperTerminal) by the CPU.

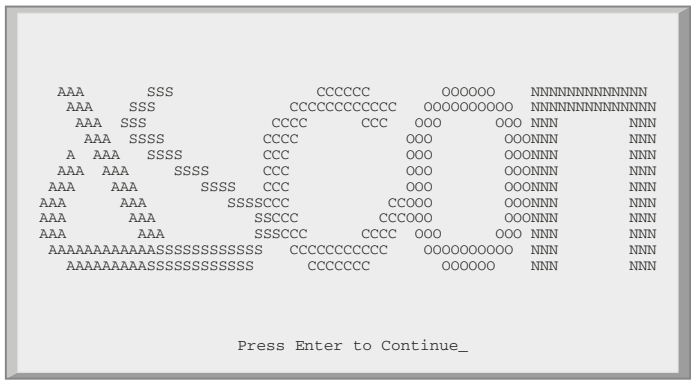
3-1-4 Entering the Setup Menu

The two types of CPU (RS232 and USB) have activation modes of CPU setup program that differ for few actions.

- For a RS232 service port CPU, it is enought to run the HyperTerminal program using the correct configuration file and pressing the connect button.
- In case an USB service port CPU, after having installed and configured the USB driver and HyperTerminal, the user must:
  1. Run the HyperTerminal program using the correct configuration file;
  2. Power on the sigma**due** CPU;
  3. Wait for the audio notification that means that the Personal Computer has recognized and installed the “USB to COM” Driver;
  4. Press the connect button (☎).

Accessing the Main Menu

This procedure is valid for both the types of CPU (RS232 and USB). To start the setup session, press the ENTER (the PC sends a CR character to the CPU) key on the setup terminal **while CAN and ERR LEDs are blinking on the CPU**. If the character CR is not sent before a predefined time (start-up timeout) the system ends the configuration session and starts the PLC application. In this chapter some templates of a configuration session made with Windows Hyper Terminal are shown. After the reception of the first CR character, the welcome screen appears.



Press ENTER again to reach the configuration session Main Menu.

Main Menu

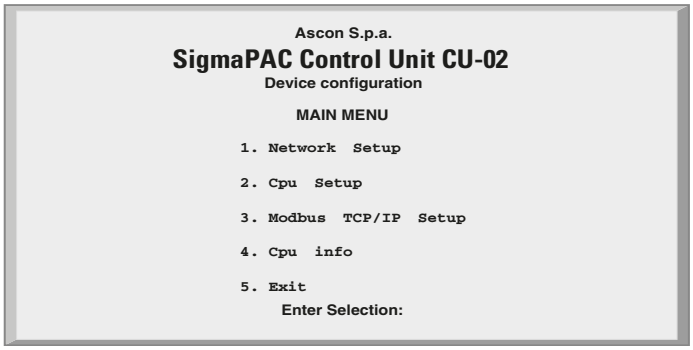


Figure 3.1 - CPU configuration Main Menu

Please note that the system has a further timeout that controls the life of the configuration session; this is the **inactivity** timeout. If the user does not work with the console for a time greater than this timeout, the configuration session will be automatically stopped and the PLC application will be started.
Both the described timeouts can be set during the configuration. The user should not set too short timeouts, thus preventing the possibility to work with the configuration console. To select an item of a menu or to insert a value for a parameter, the user has to type the corresponding number and than press ENTER.

3-2 Main Menu

As in *Figure 3.1 - CPU configuration Main Menu*, the Main menu has four sub menu selections:

Network Setup: To set the parameters of all the communication ports in the CPU;

CPU Setup: To set some parameter of the CPU;

Modbus TCP/IP Setup: Where the user can set the "*priority connection pool*" and the "*security address pool*". Moreover the user can set the number of messages per cycle and the "*broken connection timeout*".

CPU info: To see the release values of the FW, HW of the actual CPU;

Exit: To exit this menu and end the configuration session.

3-2-1 Network Setup Menu

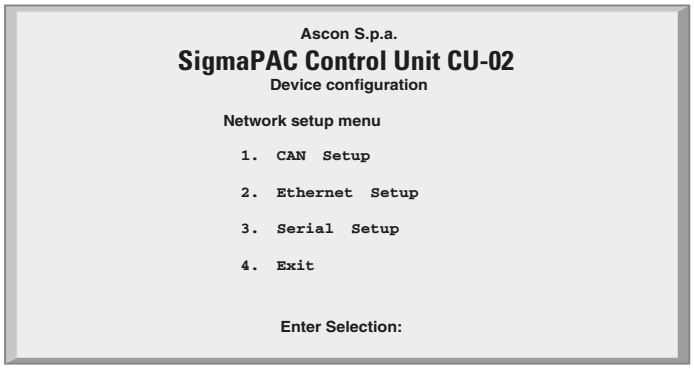


Figure 3.2 - Network Setup Menu

CAN Setup: To set the parameters for the CAN port;

Ethernet Setup: To set the parameters for the Ethernet port;

Serial Setup: To set the parameters for the RS232 port;

Exit: To exit this menu and return to the previous menu.

3-2-2 CPU Setup Menu

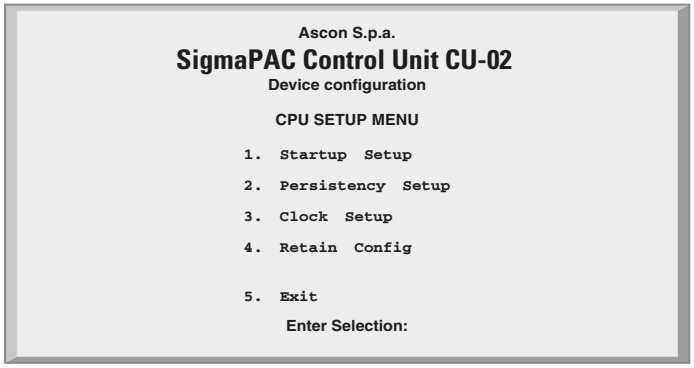


Figure 3.3 - Figure 5 - CPU Setup Menu

Startup Timeout Setup: To set the startup timeouts;

Persistency Setup: To set the parameters that control the saving of PLC program in the retentive memory;

CLOCK Setup: To set the parameters of the CPU real time clock;

Retain Config Retentive Registers Configuration;

Exit: To exit this menu and return to the previous menu.

3-2-3 CAN Setup Menu

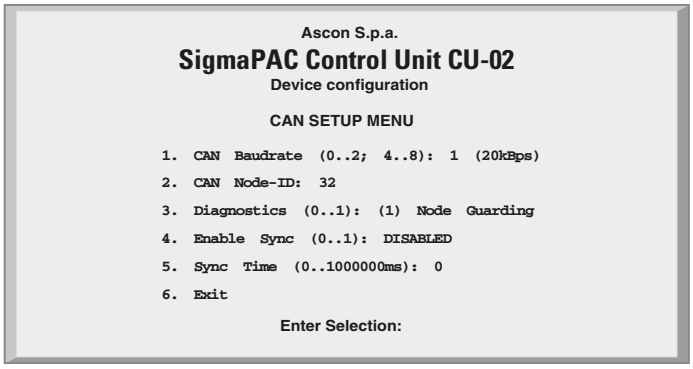


Figure 3.4 - Figure 6 - CAN Setup Menu

CAN Baudrate:To set the baud rate for the CAN network. The correspondence between the baud rate and the number of this item is indicated in Table 3.1 - CAN Network speed (note).

VALUE	0	1	2	4	5	6	7	8
Speed kbps	10	20	50	125	250	500	800	1000

Table 3.1 - CAN Network speed

CAN node ID: To set the Node-ID of the CPU in the CAN network;

Diagnostic: It is possible to work with Heartbeat protocol (default) that allows the CPU to receive a message from every node that is in the network or it is possile to select the Node Guarding protocol (1) in order to set the CPU to send and receive an "*Alive message*" from every node of the network and let the CPU and the nodes to understand if they are working well or there is a problem.

Enable Sync: It is possible to set the Sync communications (process data objects on the CAN network are exchanged when a sync message occours).

Sync time: Generation time in millisecond of the sync message.

Exit: To exit this menu and return to the previous menu.

To change the value of an item the user must select the item number pressing the correnspondig item digit on the keyboard and press ENTER. The screen will then change, asking the user to "*Insert new value:*".

Note: Value 0 (10kbps) is not currently supported by sigma**due** I/O modules.

3-2-4 CPU Info Menu

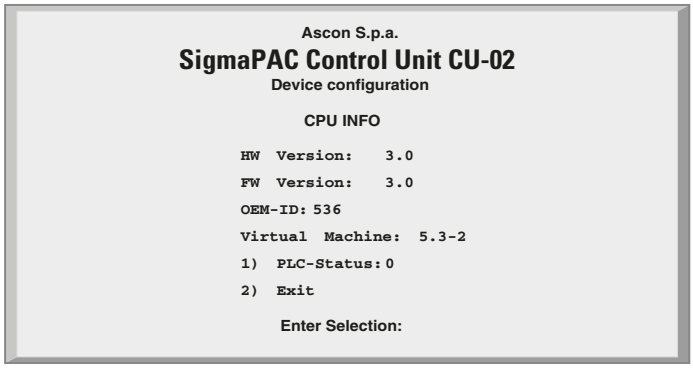


Figure 3.5 - CPU Info

HW version: Revision of the CPU Hadrware;

FW version: Revision of the CPU Firmware;

OEM ID: ASCON code for the runtme Software;

V.MACHINE: Version of the runtime Software (*5-3-2*)

PLC-Status: In this field is pointed out the CPU status:

VALUE	Meaning
0	Normal status
1	Data Configuration Error (DCE)
2	Retain Error (RE)
3	Data Configuration Errorr + Retain Error (DCE + RE)
4	Battery Low (BL)
5	Battery Low + Data Configuration Error (BL + DCE)
6	Battery Low + Retain Error (BL + RE)
7	Battery Low + Retain Error + Data Configuration Error (BL + RE +DCE)

Table 3.2 - Error codes that can be displayed in “CPU Info” screen.

Entering **1** and pressing the return key, the user acqnowledges the alarms active displayed by “CPU Info” screen.

Exit: To Exit this menu and return to the previous menu.

3-2-5 ETHERNET Setup Menu

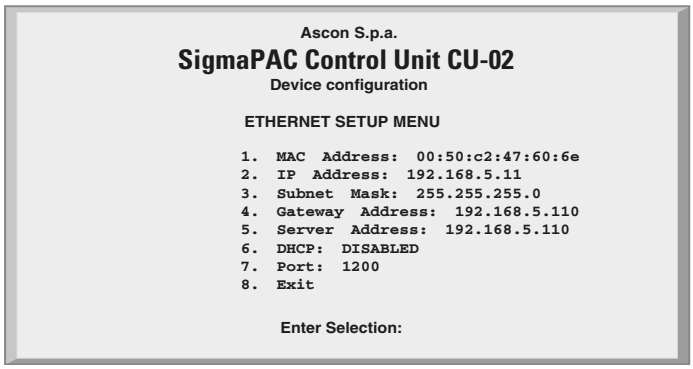


Figure 3.6 - Ethernet Setup Menu

MAC Address: To display the MAC address;

IP Address: To set the IP Address of the device;

Subnet Mask: To set the subnet mask of the device;

Gateway Address: To set the Gateway Address of the device;

Server Address: To set the Server Address of the device;

DHCP: To enable or disable DHCP Client on the device;

Port: To set the Port for the connection with OpenPCS;

Exit: To exit this menu and return to the previous one.

To set items 2, 3, 4 and 5, the user must digit on the keyboard the menu item number and press ENTER. The screen will then change, asking the user to "*insert new value:*". When the system displays the "*insert new value:*" message the user can enter the new values in number and dot notation.
To set DHCP value select item 6 and set 0 to DISABLE or 1 to ENABLE. To set the Port, select item 7 and enter the desired value.

WARNING Please note that items 2, 4 and 5 **MUST** have the same subnet in order to avoid communications problems.

3-2-6 Serial Setup Menu

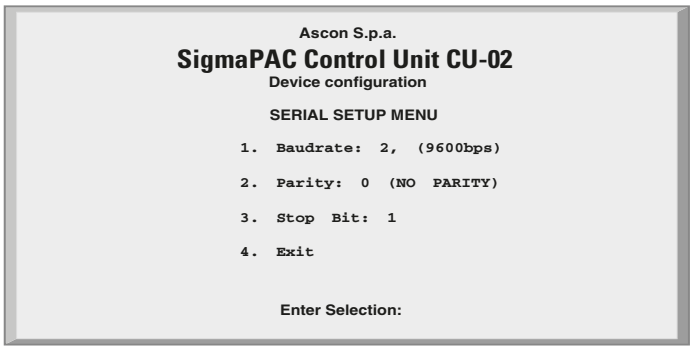


Figure 3.7 - Serial Setup Menu

Baudrate: This choice allows the user to set the baud rate for the RS232 communications port. The correspondence between the baud rate and the item number is specified in Table 3.3 - Serial Port Speed:

VALUE	0	1	2	3	4	5
Speed bps	2400	4800	9600	19200	38400	57600

Table 3.3 - Serial Port Speed

Parity: To set the parity for the RS232 communication port, according to Table 3.4 - Parity;

VALUE	0	1	2
Parity	NONE	EVEN	ODD

Table 3.4 - Parity

Stop Bit: To set the number of stop bits for the RS232 communications. Valid values are1 or 2;

Exit: To exit this menu and return to the previous one.

To change the value of an item, the user has to select the item number and press ENTER. The screen will then change, asking the user to *"Insert new value:*".

3-2-7 CPU Setup Menu

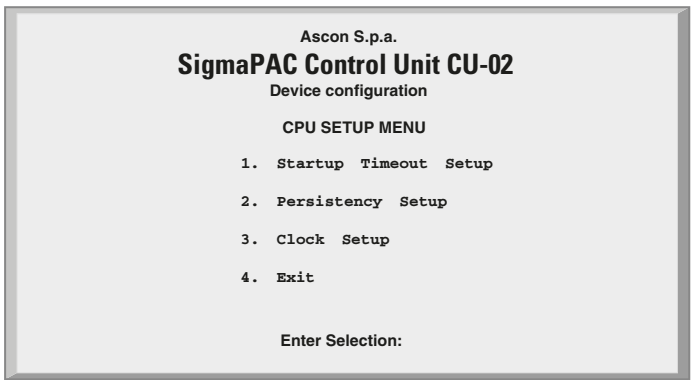


Figure 3.8 - CPU Setup Menu

Startup Timeout Setup: To set the startup timeouts;

Persistency Setup: To set the parameters that control the saving of PLC program in the retentive memory;

CLOCK Setup: To set the parameters of the CPU real time clock;

Exit: To exit this menu and return to the previous menu.

3-2-8 Startup Setup Menu

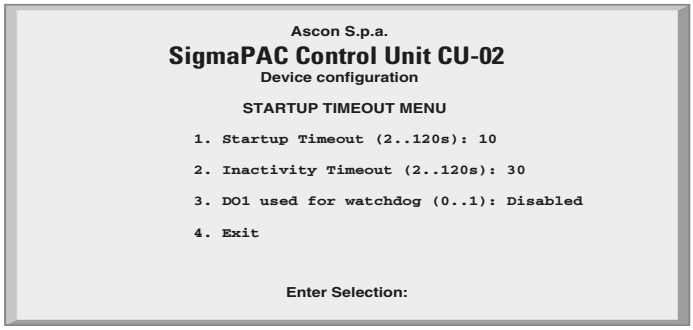


Figure 3.9 - Startup Setup Menu

Startup Timeout: To set the Startup Timeout;

Inactivity Timeout: To set the Inactivity Timeout;

DO1 used by watchdog If enabled, the digital output DO1 could be connected to a software function block to signal a watchdog event

Exit: To exit this menu and return to the previous one;

To change the value of an item, the user has to select the item number and press ENTER. The screen will then change, asking the user to "*insert new value:*".

3-2-9 Persistency Setup Menu

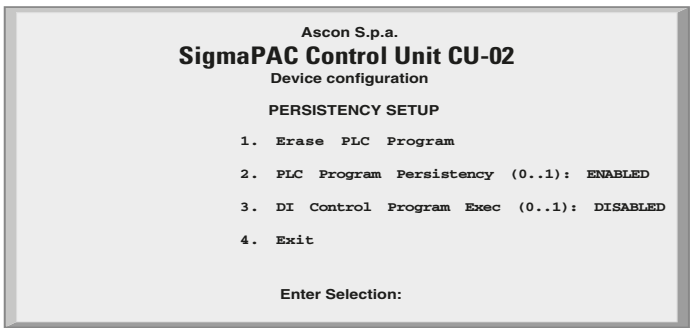


Figure 3.10 - Pesistency Setup Menu

The CPU is able to save a PLC program in persistent memory. This means that, when PLC Program Persistency is *ENABLED*, the program will be automatically loaded and executed at start-up.
Every time the user, during the development activities, downloads a new program to the CPU, this is saved in the persistent memory so, at next device start up, the last downloaded program will be executed.
Saving a program in persistent memory is a time consuming activity. This wait time can be annoying during program development and debugging. For that reason the user may want to disable the automatic program save in persistent memory, making development activities more efficient.
Sometimes can be useful to prevent executing any program at startup time.
Selecting the item "*Erase PLC program*" the retentive memory area reserved to store PLC programs is erased. This activity take some seconds. When the "*Persistency setup menu*" screen reappears then the memory has been erased.

Erase PLC Program:
Selecting the item "*Erase PLC program*" the retentive Memory area reserved to store PLC programs is erased;

PLC Program Persistency (0..1):
The item "*PLC program persistency*" allows the user to configure the program store memory to be retentive or volatile memory;

DI Control Program Exec (0..1):
The Digital Input Control Program Execcan be used as a generic input addressed as % ±x0.0 (default) or can be set as a START (1) or STOP (0) contact for the actual program that is downloaded on the CPU.

Exit: To exit this menu and return to the previous one.

3-2-10 CLOCK Setup Menu

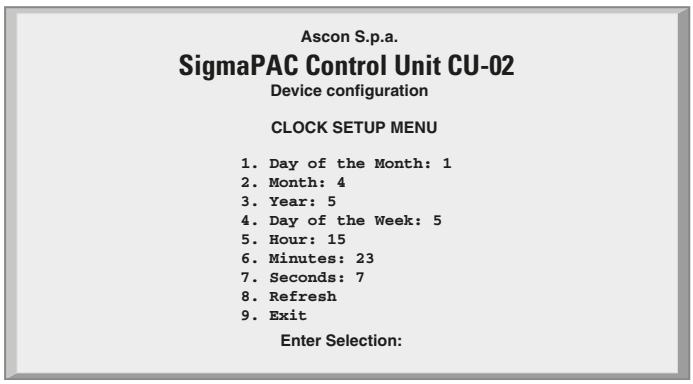


Figure 3.11 - Clock Setup

3-2-11 Retain Config

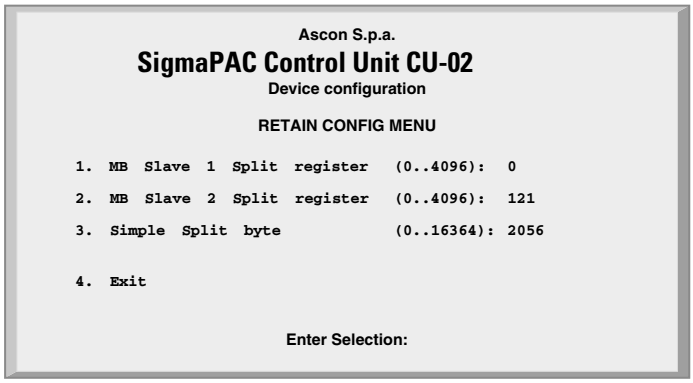


Figure 3.12 - Retain Config Menu

MB Slave 1 Split register	Slave 1 Modbus Memory Area (4096 registers)
MB Slave 2 Split register	Slave 2 Modbus Memory Area (4096 registers)
Simple Split byte	Marker Memory Area (16364 bytes)
Exit	Return to previous menu

Standard and Retentive memory management

The IEC 1131 programming tools allow to declare retentive variables using a specific syntax. These variables are saved and load from the retained memory which has a 32kB size (for security reasons, the memory is duplicated and refreshed during runtime operations). Differently from this automatic mechanism, it is possible to specify, during the boot-up configuration session, the amount of retained variables to be used in the percentage area.

The standard memory locations usable as retentive variables are accessible as registers, up to the maximum amount normally available for each Modbus agent (Slave 1 and Slave 2) and up to 16 kB in the marker area.

In particular, the range of registers available as retentive are:

Modbus Slave 1 : %MW1128.0... %MW9320.0
Modbus Slave 2 : %MW10128.0... %MW18320.0
Marker Area : %MB22000.0... %MB38363.0

Slave 1 4096 registers	Slave 2 4096 registers	Marker 16364 bytes

Figure 3.13 - Percentage retentive areas

In the boot-up configuration session, by a specific dedicated menu, it is possibile to define the number of registers, for each areas, to be used as retentive.
From the main menu select "*CPU setup*" -> "*Retain Config*".

From the "*Retain Config*" menu it is possible to specify the split point between the retentive and the standard memory location.

Note: In case the **ENTIRE** memory will be defined as retentive, the cycle time of the application will be increased of around 12 ms.

In case of a "*Cold start*" command: the standard retentive variables will be reset or will assume the initialization value whereas the percentage retentive variables will be reset. In case of CRC error, the 2 areas are separately reset or initialized.

In case of a "*Warm Start*" command: both the standard and percentage retentive variables will be unaffected. In case of file corruption, the percentage retentive variables will be reset.

In case of a "*Hot start*" command: both the standard and percentage retentive variables will be unaffected.

At the moment it is possibile to upload or download both the retentive memory areas, for the standard and percentage variables, using a TFTP session. The timeframe window to perform this operation is available only during the boot-up phase before the configuration access. To upload or download the retentive memory files, please follow the procedure described at paragraph: "TFTP Protocol Access" on page 27

in chaper 6 paragraph6.1 The name of the files are:

Retentive standard : **/fs2/retain**

Retentive percentage: **/fs2/perc_ret**

Publishing I/O configuration data, Battery and Retain Memory status

During 1131 program execution is possible to recall some information present in certain particular addresses of the percentage memory. In particular:

%M0.0 : Battery satus (**1** low, **0** ok);
%M0.1 : Classic retain memory status at startup (**1** corrupted, **0** ok)
%M0.2 : Percentage retain memory status at startup (**1** corrupted, **0** ok).

The battery status is runtime calculated and updated at the beginning of each cycle. The remaining two flags are released at startup and the value remains unchanged after a warm or a cold startup.

WARNING

At each warm/cold start, the I/O configuration codes are loaded/written in the marker percentage memory. If the same marker percentage memory areas are used to store user application data, pay extreme attention to the fact that at each warm/cold start these memories are written with the I/O configuration codes causing the destruction of the application data.

3-2-12 Modbus TCP/IP Setup

Selecting item 3 on the Main Menu you will arrive at the following menu:

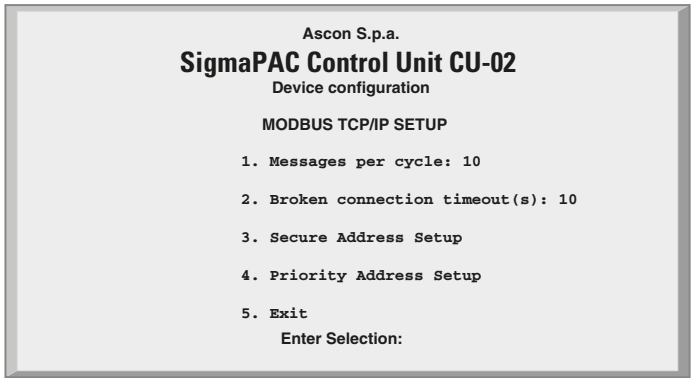


Figure 3.14 - Modbus TCP/IP Setup Menu

Messages per Cycle:

By the first item the user can insert the number of messages processed during each cycle. The inserted value must be comprised between 1 and 50.

Broken Connection Timeout (s):

By the second item you can set the inactivity timeout of a TCP/IP connection (in seconds). The inserted value must be comprised between 10 and 5400. To verify the connection state after a long period of inactivity, the TCP/IP “keepalive” protocol is used. The protocol performs in sequence the following steps:

1. At each received messages the timeout is zeroed;
2. In the case that the programmed timeout is reached, a “probe” message is sent in order to verify if the connection is still active;
3. If an answer to the “probe” is received, then the timeout is zeroed.
4. In case of no answer, the “probe” will be sent again three times, every 10 seconds.
5. After the fourth “probe” has got no answer the connection will be closed.

Secure Address Setup:

Selecting this item a new window will appear displaying the menu called “Secure Address Protocol”(see next);

Exit: exit this menu and return to the previous menu.

3-2-13 Modbus TC/IP Secure ADDRS Table Menu

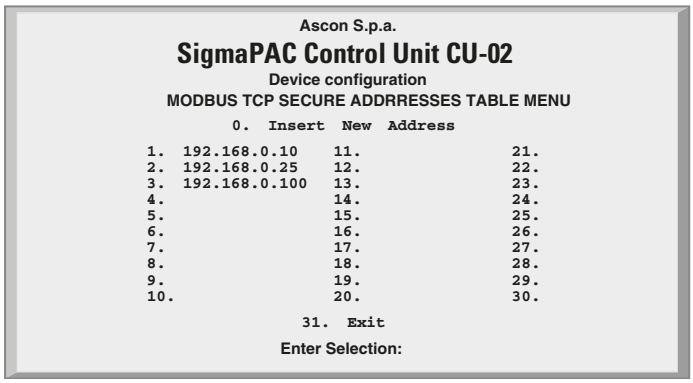


Figure 3.15 - Modbus TCP/IP Secure Address Table Menu

By this menu, in the case the security functions are enabled, the addresses that the Modbus TCP/IP Server can access are set out.
To insert a new address, select 0) first, then type in the new address; it will be inserted in the first free position.
To delete an address, select the number of the address you want to remove.

3-2-14 Modbus TC/IP Priority ADDRS Table Menu

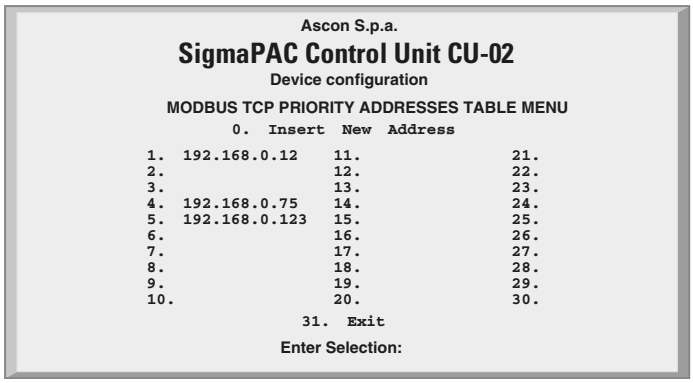


Figure 3.16 - Modbus TCP/IP Secure Address Table Menu

The insertion rules are the same as described for the "*security address pool*".
Addresses inserted in the "*priority connection pool*" are managed by the system in a privileged way. The Modbus TCP/IP server agent can maintain up to 10 TCP connections at the same time. When a new connection request arises and all available connections are engaged, the system shall make a choice.
Since every new request must be satisfied, one of the present active connections shall be closed.
The first candidates that are to closed are the addresses not belonging to the "*priority connection pool*". The second choice is to close the connection not active for the greater amount of time.

Chapter 4
Programming the CPU

4-1 Installing OpenPCS

4-1-1 Hardware and Software Requirements

OpenPCS requires a PC with at least:

- Pentium II, 1GHz;
- 512 MB RAM;
- 16 GB of free disk space;
- CD-ROM and 1024*768 resolution;
- Windows 2003, Windows XP SPII or Windows Vista 32bit.

4-1-2 Installation

OpenPCS is provided on CD-ROM. The CD auto-starts a screen where you can select the software you want to install. If auto-start is not activated or does not work, please start the last distributed OpenPCS programming tool version (e.g. `OpenPCS_Ver_631e.exe` file) available in `X:\SETUP\` folder ("**x**": is the letter assigned to the CD-ROM drive in your PC).
At the end of the installation, you will be asked if you want to install hardware drivers. If you received drivers with your PLC, enter the path to the hardware driver, otherwise select 'Quit'. If you received drivers for your PLC, you also received a licence key for OpenPCS. See Licence Editor for how to insert a licence key. If you do not have a hardware driver or a licence key, OpenPCS is still functional, but restricted to 'SIMULATION'.

Note: Installations to substituted drives are not supported by Windows XP.

4-1-3 Starting OpenPCS

Start Windows and choose:
Start → Programs → infoteam OpenPCS 2008 → infoteam OpenPCS 2008
in the start-menu to open the Framework.

4-1-4 Configuring OpenPCS

In order to work with the Ascon CPU target, you must install in OpenPCS a **`cab`** file. The file **`Ascon_sigmadue_zzzz.cab`** contains all the files describing Ascon sigma**due** Hardware, drivers, examples and utilities (**`zzzz`** are digits to identify the year of the software release).
In the OpenPCS "*Extras*" menu, select "*tools – Driver install…*". "*Select*" the desired cabinet (e.g. Ascon_sigmadue_2009.cab), then "*Install*".

Figure 4.1 - OpenPCS OEM Driver Installation

4-2 OpenPCS Setup

To connect the OpenPCS development system to the Ascon target, a new connection must be defined.
Select "*Connections...*" item in the "*PLC*" menu. In the window of *OpenPCS Connection Setup* select "*New*".
Now in the window "*Edit connection*" it is possible to set the new connection. In the field "*Name*" you can name the new connection.
By pushing the "*Select*" button you can pick the driver that manages the communication with the target: for Ascon CPU is TCP52.

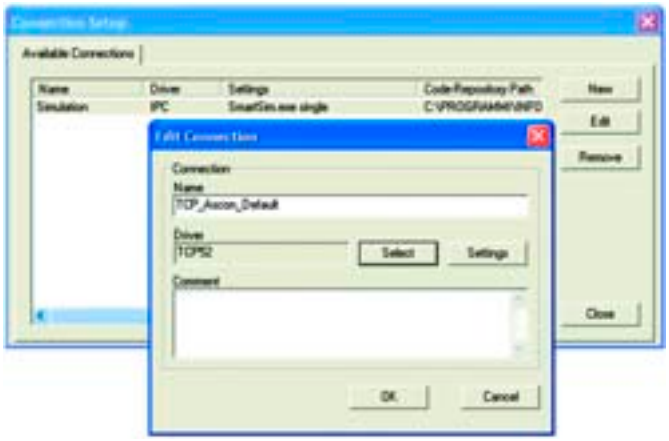


Figure 4.2 - OpenPCS Connection Setup

Now, click "*Settings*" button to set the communication parameters.

Figure 4.3 - TCP Settings

The Port number and IP address must be the same as those configured at the initial CPU configuration session. See the Ethernet setup menu, items 7 and 2. OpenPCS environment is now ready to communicate with the Ascon target.
The project must be set up in order to use the CPU.
Select the "*Resource Properties*" item in the PLC menu, select "*Ascon…*" in the "*Hardware Module*" field, then select the newly created TCP connection in the "*Network Connection*" field.

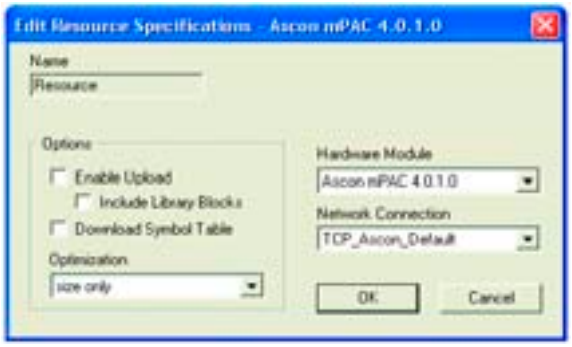


Figure 4.4 - OpenPCS resource Specifications

The code "*Optimization*" menu allows for three choices of compilation: "*Normal*" and "*Speed only*" refers to the NCC: Native Code Compilation, while "*Size only*" refers to the standard code.
Please note that the use of NCC does not permit the user to insert break points in debugging projects.

Setup Communication Timeout

There are several conditions that could make it necessary to set the Ethernet Port communication timeout to a value higher than the default value. This timeout checks the dialogue between OpenPCS and the target CPU. When dealing with large programs, it may be necessary to set a longer driver timeout. The default value of 20000ms can be increased by using the following register key:

```
[HKEY_LOCAL_MACHINE\SOFTWARE\infoteam Software GmbH\
OpenPCS\6.x.x\Online\TcpDriverTimeout_ms]
```

Value = "20000" means a timeout of 20 seconds.

4-3 Communication Ports Protocols

sigma**due** CPU has various communication ports and protocols. The combinations of ports and protocols are shown below:

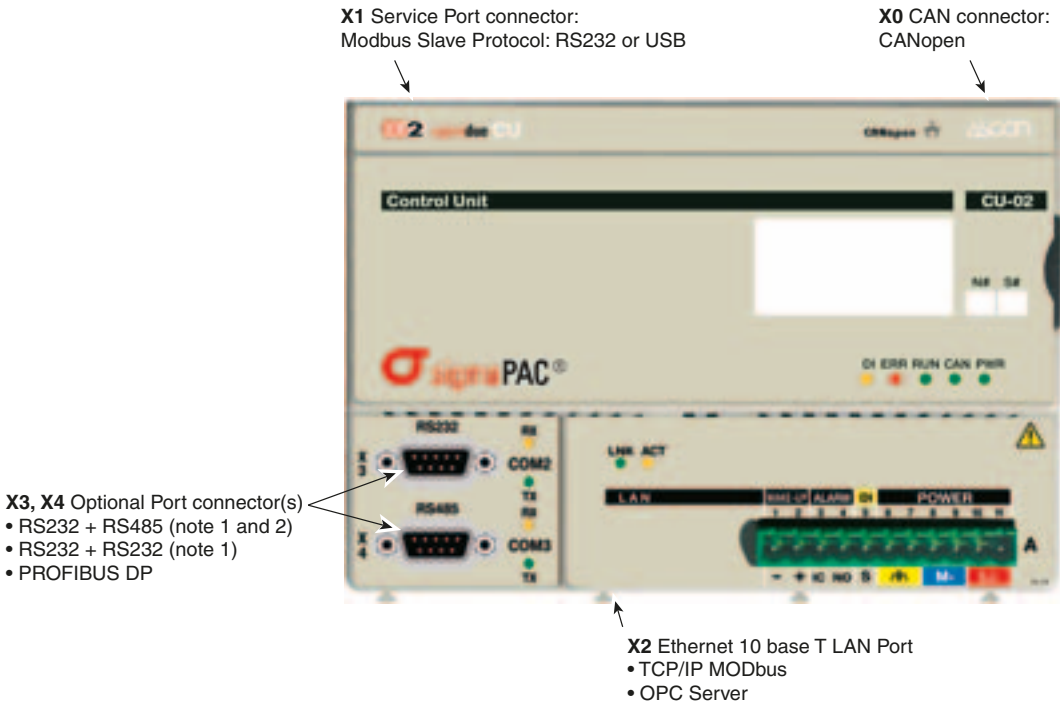


Figure 4.5 - Communication Ports Protocols

Notes: **1.** Modbus Master/Slave

2 Consult the Installation Guide to polarise and terminate the RS485 port.

4-4 Auxiliary digital port

The auxiliary digital port will be available for a PLC project, provided that the resource is mapped on memory area that the project can see. The port is mapped as follows:

Port	Mapping
WAKE-UP output	%QX0.0
Alarm Output	%QX0.1
General purpose digital input	%IX0.0

4-5 Watchdog Timer

Ascon CU-02 CPU contain a watchdog control, controlled by 2 specific FBs. Watchdog is fundamentally a down counter, decremented in 100ms intervals. When the count value reaches zero, two different behaviours of the system may occur, depending on how the configuration is:

- PLC program keeps working, stores the event and force the Alarm relay to OPEN;
- PLC program performs a Reset and starts execution again.

Please note that the Watchdog timer is controlled by FB but it runs independently of the PLC program. Therefore, if the program is stopped, e.g. during a debug session, the timer keeps running, and behaves as programmed when the count reaches zero.

During debug sessions it is advisable to maintain the Watchdog function disabled.

4-6 CANopen Extension for Ascon sigmadue CPU

4-6-1 Introduction

sigma**due** is a system based on two main concepts: the CANopen technology and the IEC61131 standard languages. The integration of these two different worlds is performed by:

- Use of networked variables;
- Direct access to CANopen parameters and functions via predefined low level communication function blocks. CANopen services for CPU programs according to the IEC61131-3 standard are defined in the CiA (CAN in Automation e.V.) Draft Standard 405;
- Use of Ascon IO Library.

Using Networked Variables

Networked variables are the easiest way of data exchange in a CANopen network system. Within the CPU, program access to the network variables occurs in the same way as access to internal, local variables on the CPU. From the point of view of a CPU programmer it is unimportant whether a input variable is assigned to a local input on the CPU device or to an input on a networked expansion device. The use of networked variables only requires basic knowledge of CANopen. In general, a CANopen configuration tool as well as the availability of EDS files for the individual CANopen devices are required for integrating network variables into a CPU.

With the help of network variables it is possible:

- to expand the number of inputs and outputs on the PLC using distributed CANopen I/O devices;
- to exchange process data between various control units, thus realizing decentralized automation control projects;
- to integrate other special CANopen devices from third party vendors into a complex control project and furthermore to build very specific automation control systems using modular components in addition to Ascon sigma**due** CANopen IO modules.

For a detailed description see **[3]** and **[4]**.

Using CANopen Function blocks

CANopen function blocks enable direct access to specific CANopen services, thus offering a high degree of flexibility in the target application. Furthermore, using these function blocks does not require an additional CANopen configuration tool or EDS files. However, using the CANopen function blocks assumes that the user has detailed knowledge about CANopen and its services.

With the help of CANopen function blocks it is possible:

- to directly exchange data with other CANopen nodes via SDO (Service Data Object) or PDO (Process Data Object);
- to enquire and change the state of other CANopen nodes;
- to receive error messages from other CANopen nodes;
- to allow generation of SYNC messages.

For a detailed description see **[3]** and **[4]**.

Using Ascon I/O Library

The function blocks present in the Ascon IO Library enable the access to Ascon sigma**due** CANopen IO modules, providing services that allow the CPU programmer to do not deal with the fieldbus directly. To provide this level of abstraction, the function blocks are based on those described above.

With the help of the function blocks present in the library is possible:

- to directly exchange data with all sigma**due** CANopen module;
- to setup all the module's functionalities;
- to enquire and see the state of the modules;
- to reset the module.

For a detailed description see **[11]** and **[12]**.

Chapter 5
CPU TFTP File Access

5-1 TFTP Protocol Access

The CU-02 unit allows the user to access to the device using the TFTP (Trivial File Transfer Protocol). With this protocol it is possible to upload or download device configuration, the IEC61131 program, the retained variables and error log files. For security reasons, the name and the number of the accessible files are limited and fixed. The following table lists the accessible files:

File Name	Description
/fs1/restore_file	Name of the IEC61131 program file
/fs1/sys_file	Name of the configuration file
/fs1/errlog_file	Name of the RUNTIME errors file
/fs2/retain	Name of the classic retained variable file
/fs2/perc_ret	Name of the % retained variable file

To connect the unit the user needs the IP address of the device (see *"ETHERNET Setup Menu" on page 12* for details) and the logic port used, whic is always **69** for the TFTP. The TFTP protocol has only two different services:

- GET
- PUT

The GET service allows the user to upload a file from the CU-02 unit, while the PUT service allows files to be downloaded.
Using the TFTP client present in the Windows installation (please see *C:\Windows\System32\tftp.exe*) the possible commands are:

- To GET a file from the MP01
  tftp -i <remote host address> get <remote file_name><local file name>
- To PUT a file to the MP01
  tftp -i <remote host address> put <local file name><remote file_name>

For example, if the user wants to GET the configuration file from the CU-02 unit, and store it in a local file named "`configuration.bin`", the command is:
`tftp -i 192.168.5.11 get /fs1/sys_file configuration.bin`

where the IP address of the MP01 is 192.168.5.11.

If the user wants to PUT the IEC61131 program file to the CU-02 unit, using the source file "*Sigma2_CU-02.prs*", the command will be:
`tftp -i 192.168.5.11 put Sigma2_CU-02.prs /fs1/restore_file`

Please note that the application binary file that contains the program compiled with OpenPCS is located in the project folder "`project_root/$GEN$/Resource`" and has always the name "*Sigma2_CU-02.prs*".

5-2 IEC61131-3 OpenPCS Runtime Errors log file

In same cases, it is very useful to have a report of errors organized by date and time in order to understand the source of a possible problem in the application. For this reason it is now available inside the unit a file called `/fs1/errlog_file` that can be downloaded from CU-02. The file is in text mode (can be opened by Windows Notepad, for example) and it is organized in rows. The history goes back to maximum 10 events and it is organized as:

day of the week hh:mm:ss dd-mm-yy error code

Following an example:

Wed	16:37:28	23-04-08	2002
Wed	16:37:25	23-04-08	2002
Wed	16:36:36	23-04-08	2001
Thu	11:56:29	22-04-08	2002

The table of error codes is the following:

Error name	Error Code
kLzsModeConflict	1001
kLzsNoMem	1002
kLzsHardwareError	1003
kLzsInvalidPgm	1004
kLzsDwnldError	1005
kLzsConfigError	1006
kLzsInvalidModCfg	1007
kLzsInvalidPgmNr	1008
kLzsInvalidSegNr	1009
kLzsInvalidSegType	1010
kLzsSegDuplicate	1011
kLzsNoWatchTabEntry	1012
kLzsUnknownCmd	1013
kLzsModeErr	1014
kLzsNetError	1015
kLzsNetRecSizeError	1016
kLzsProcImgRdWrError	1017
kLzsTimerTaskError	1018
kLzsIpVerError	111019
kLzsIpExecError	10101020
kLzsNcExecError	10101021
kLzsNoBkupMem	10101022
kLzsIOConfigError	111023
kLzsNoHDMem	1024
kLzsNotValidInRunState	1025
kLzsCycleLengthExceeded	1101
kLzsRtxBaseTimerLengthExceeded	1102
kLzsNetErrorLastSession	1103
kLzsUplErrorNotEnabled	1104
kLzsHistNoFreeEntry	1105
kLzsHistInvalidID	1106

Error name	Error Code
kLzsNetInitError	1501
kLzsNetIoError	1502
kLzsNetInvalidNodeID	1503
kLzsNetVarCfgError	1504
kLzsNetNIOverflow	1505
kLzsStoreProgInFLash	2000
kLzsNoMemForRetain	2050
kLzsNoMemForPersist	2051
kIpDivisionByZero	2001
kIpArryIndexInvalid	2002
kIpOpcodeInvalid	2003
kIpOpcodeNotSupported	2004
kIpExtensionInvalid	2005
kIpTaskCmdInvalid	2006
kIpPflowNotAvailable	2007
kIpInvalidBitRef	2008
kIpErrorRestoreData	2009
kIpNoValidArrElementSize	2010
kIpInvalidStructSize	2011
kIecGeneralError	3001
kIecFBNotSupported	3002
kIecHardwareError	3003
kLzsStoreProgInFLash	9001
kLzsNoMemForRetain	9002
kLzsNoMemForPersist	9003
kLzsMemAccessAlignErr	9004
kLzsWatchdogReset	9005

The error 1103 it is not saved because it is generated every time the application restarts from a previous error situation. The errors log file is generated in FIFO mode (First In First Out).

Chapter 6
Ascon Tecnologic Function Blocks Libraries

In this chapter are listed the libraries part of Ascon Tecnologic automation CD and those available in the CU-02 firmware device. For each library the complete list of function blocks with a brief description is also indicated. For more details please refer to the specific documentation.

6-1 AT_CU02_Cpu_Lib

The *AT_CU02_Cpu_Lib* is a library which allows to access the control unit (CU-02) resources. These FBs allow the user to set and manage the CANopen network activities: diagnostic, failure management of the connected devices, syncronization. Some of the Function Blocks must be considered *system function blocks* because they implement some particular functionalities dedicated to the CANopen network overall managment (see the "*IEC 61131-3 Function Block Library*" [**11**] manual for details).

Function Block name	Description
S2_CU02	Function block interface for the Control Unit module
SPLIT_ENABLE	Extract the enable signal from the Network connection of the modules
SET_TT [note]	Set the communication type of a CANopen node
SET_TT_MODULE [note]	Set the transmission type parameters of all PDOs of a device
RECOGNIZESIGMAIO [note]	Recognize the module name of a device coming from the sigma**due** I/O line

Note: These are system Function Blocks.

6-2 AT_IO_Modules_Basic_Lib

The *AT_IO_Modules_Basic_Lib* is a library that allows the *OpenPCS* programming environment to access the Ascon Tecnologic's sigma**due** devices. These FBs simplifies the configuration and the access to CANopen[1] I/O modules. A list of available I/O FBs follows:

Function Block name	Description
aDM08TS	Advanced FB to interface the module DM-08TS
bDI16LV	FB to interface the module DI-16LV
bDI32LV	FB to interface the module DI-32LV
bDO04RL	FB to interface the module DO-04RL
bDO08RL	FB to interface the module DO-08RL

Function Block name	Description
bDO04TX	FB to interface the module DO-04TX
bDO16TS	FB to interface the module DO-16TS
bDO16TP	FB to interface the module DO-16TP
bDO32TS	FB to interface the module DO-32TS
bDM08TS	FB to interface the module DM-08TS
bDM16TS	FB to interface the module DM-16TS
bDM32TS	FB to interface the module DM-32TS
bAI02UI	FB to interface the module AI-02UI
bAI04RT	FB to interface the module AI-04RT
bAI08TC	FB to interface the module AI-08TC
bAI08HL	FB to interface the module AI-08HL
bAI08DP	FB to interface the module AI-08DP
bAO08HL	FB to interface the module AO-08HL
bAO08DP	FB to interface the module AO-08DP
bERRORSTATEAN	FB to manage the communications error statuses for analogue output modules
bERRORSTATEDIG	FB to manage the communications error statuses for digital output modules

6-3 AT_Generic_Advanced_Lib

The *AT_Generic_Advanced_Lib* is a function block library that contains a set of generic functionalities that come from the Ascon Tecnologic AC Station Device useful for the IEC 61131 programming (see the "*IEC 61131-3 Function Block Library*" [**4**] manual for details).
The table here reported gives the complete list of the function blocks of the library

Function Block name	Description
AVG_ADV_8REAL	Advanced Instantaneous Average calculation
AVG_MOVING	Moving Average calculation
AVG_RUNNING	Running Average calculation
CHAR_8_ARRAY	Analogue Conversion using 8 points
CHAR_16_ARRAY	Analogue Conversion using 16 points
CHARACTERIZER_8	Linear Interpolation with 8 points
CHARACTERIZER_16	Linear Interpolation with 16 points
COMPARATOR	Comparator with hysteresis Function Block
CONV_AD8	From BYTE to 8 bits
CONV_AD16	From WORD to 8 bits
CONV_AD32	From DWORD to 8 bits
CONV_DA8	From bits to BYTE
CONV_DA16	From bits to WORD
CONV_DA32	From bits to DWORD
COUNTER	Rising Edge Counter
DECODER_8	Decoder Function Block
FLIPFLOP_D	D Type FlipFlop Function Block
FLIPFLOP_JK	JK Type FlipFlop Function Block
HOLD_VALUE	Sample & Hold Function Block
INBETWEEN	Middle Selector Function Block

Function Block name	Description
LIMITER_VALUE	Limiter Function Block
MIN_MAX_SELECTOR	Min/Max Selector Function Block
MONOSTABLE_DS	Monostable with Delay
MONOSTABLE_NED	Monostable with Delay on the Negative Edge
MONOSTABLE_PED	Monostable with Delay on the Positive Edge
MONOSTABLE_PUL	Monostable Pulse Generator
MUX_A8	Analog Multiplexer 8 Input
MUX_A16	Analog Multiplexer 16 Input
MUX_D8	Digital Multiplexer 8 Input
MUX_D16	Digital Multiplexer 16 Input
RESCALE	Rescaling Function Block
POWER_FAIL	Power Fail Condition Monitor
SLOPE_LIMIT	Slope Limiter
TIMER_ADV	Advanced countdown timer function block
TOTALIZER	Totalizer Function Block
TOTALIZER_AVD	Advanced Totalizer Function Block

6-4 AT_Process_Control_Lib

The *AT_Process_Control_Lib* is a function block library dedicated to the process control. It includes advanced function blocks combining the basic PID functions coming within the CU-02 firmware in order to provide a ready to use solution. The most advanced function blocks in the library are a complete standard PID single action controller and the equivalent double action, for heat and cool applications. Advanced auto-tuning function blocks also with the klibrary, using different tuning algorithms such as “Natural Frequency” or “Step Response”.
Follows the complete list of the function blocks available with the library (see the “*IEC 61131-3 Function Block Library*” [**4**] manual for details).

Function Block name	Description
S2_CONTROLLER	Single Action Controller
S2_EZ_TUNE	Tuning with Modified Step Response Algorithm for Single Action Loops
S2_FILTER	First Order Filter
S2_HC_CONTROLLER	Heat and Cool Controller
S2_HC_EZ_TUNE	Tuning with Modified Step Response Algorithm for Heat and Cool Loops
S2_HC_TFUZZY	Tuning with Fuzzy Logic for Heat and Cool Loops
S2_HC_TNATFREQ	Tuning with Natural Frequency Algorithm for Heat and Cool Loops
S2_HC_TSTEPRESP	Tuning with Step Response Algorithm for Heat and Cool Loops
S2_HCMV	AutoMan station for output manual value direct access for double action loop
S2_MV	AutoMan station for output manual value direct access for single action loop
S2_SPLITMV	AutoMan station for output manual value direct access for double action loop with SplitRange
S2_TFUZZY	Tuning with Fuzzy Logic for Single Action Loops
S2_TNATFREQ	Tuning with Natural Frequency Algorithm for Single Action Loops
S2_TSTEPRESP	Tuning with Step Response Algorithm for Single Action Loops

6-5 AT_Communications_Lib

The *AT_Communications_Lib* allows a simplified access to the communication functions of CU-02 CPU (see the "*IEC 61131-3 Function Block Library*" [**4**] manual for details). Follows the complete list of the function blocks available with the library:

Function Block name	Description
COMMS_MNGT_CU02	CU-02 Serial Comm Ports Management
COMMS_MNGT_CU02_PB	CU-02 Profibus Serial Comm Ports Management
MB_MST_SYNC	Modbus Master: Synchronization of operations
MB_MST_RD_COIL	Modbus Master: Coil reading
MB_MST_WR_COIL	Modbus Master: Coil writing
MB_MST_RD_WORD	Modbus Master: Word reading
MB_MST_WR_WORD	Modbus Master: Word writing
MB_16WORD_TO_ARRAY	Modbus Master: packaging of 16 WORD in an array
MB_ARRAY_TO_16WORD	Modbus Master: un-packaging of an array into 16 WORD
MB_MST_RD8_DINT	Modbus Master: conversion and management of 8 DINT read values
MB_MST_RD8_DWORD	Modbus Master: conversion and management of 8 DWORD read values
MB_MST_RD8_REAL	Modbus Master: conversion and management of 8 REAL read values
MB_MST_RD8_UDINT	Modbus Master: conversion and management of 8 UDINT read values
MB_MST_WR8_DINT	Modbus Master: conversion and management of 8 DINT write values
MB_MST_WR8_DWORD	Modbus Master: conversion and management of 8 DWORD write values
MB_MST_WR8_REAL	Modbus Master: conversion and management of 8 REAL write values
MB_MST_WR8_UDINT	Modbus Master: conversion and management of 8 UDINT write values
MB_SLV_RD8_DWORD	Modbus Slave: reading of 8 DWORD values
MB_SLV_RD8_REAL	Modbus Slave: reading of 8 REAL values
MB_SLV_RD16_WORD	Modbus Slave: reading of 16 WORD values
MB_SLV_RD32_DIGITAL	Modbus Slave: reading of 32 digital values
MB_SLV_RD_DIGITAL	Modbus Slave: reading of 1 digital value
MB_SLV_RD_DWORD	Modbus Slave: reading of 1 DWORD value
MB_SLV_RD_REAL	Modbus Slave: reading of 1 REAL value
MB_SLV_RD_WORD	Modbus Slave: reading of 1 WORD value
MB_SLV_WR8_DWORD	Modbus Slave: writing of 8 DWORD values
MB_SLV_WR8_REAL	Modbus Slave: writing of 8 REAL values
MB_SLV_WR16_WORD	Modbus Slave: writing of 16 WORD values
MB_SLV_WR32_DIGITAL	Modbus Slave: writing of 32 digital values
MB_SLV_WR_DIGITAL	Modbus Slave: writing of 1 digital value
MB_SLV_WR_DWORD	Modbus Slave: writing of 1 DWORD value
MB_SLV_WR_REAL	Modbus Slave: writing of 1 REAL value
MB_SLV_WR_WORD	Modbus Slave: writing of 1 WORD value
MODEM_CHECK	Modem operational verification
MODEM_CONF	Modem configuration management
MODEM_SMS_SEND	Modem SMS (Short text Message Service) send management
PROFIBUS_PORT	Set the configuration and data exchange for Profibus DP port of the CU unit
SEND_EMAIL	SMTP server Configuration
SERIAL_PORTS	Set the configuration for the Modbus RTU ports of the CU unit
SYS_OPRS_MNGT	Set communication operational parameters on Modbus RTU and TCP agents
TCP_IP_PORT	Set the configuration for the Modbus TCP port

6-6 AT_IO_Modules_Adv_Lib

The *AT_IO_Modules_Adv_Lib* provides all the functions to manage the sigma**due** series I/O modules. To explicit use of the protocol messages (SDO, PDO, EMCY, SYNC, …) please use configuration files such as EDS and DCF (see the "*I/O Function Block Library*" [**12**] manual for details). The table here reported gives the complete list of the function blocks of the library.

Function Block name	Description
WRITE_OP	Transfer from PLC and display a value on OP
READ_OP	Transfer a value: OP ➡ CPU
UPDATE_OP	Keep updated a local copy of OP database
DI_16LV_STD	Transfer 16 discrete inputs states: module ➡ CPU
DI_16LV_LTH_TIME	Manage the module's Input special functions: • Latched Inputs • Monostable Inputs
DI_32LV_STD	Transfer 32 discrete input states: module ➡ CPU
DO_04RL_STD	Transfer the 4 relay Outputs: CPU ➡ module
DO_04RL_PULSE	Manage the module's Output special functions: • Pulse Output
DO_04TX_STD	Transfer 4 discrete Outputs: CPU ➡ module
DO_04TX_PULSE	Manage the module's Output special functions: • Pulse Output
DO_08RL_STD	Transfer 8 relay Outputs: CPU ➡ module
DO_08RL_PULSE	Manage the module's Output special functions: • Pulse Output
DO_16TS_STD	Transfer 16 discrete Outputs: CPU ➡ module
DO_16TS_PULSE	Manage the module's Output special functions: • Pulse Output
DO_16TP_STD	Transfer 16 discrete Outputs: CPU ➡ module
DO_16TP_PULSE	Manage the module's Output special functions: • Pulse Output
DO_32TS_STD	Transfer 32 discrete Outputs: CPU ➡ module
AI_02UI_STD	Transfer 2 analogue Input: module ➡ CPU
AI_02UI_RESCALE	Scale and Transfer 2 linear analogue Inputs from module to CPU
AI_08HL_STD	Transfer 8 analogue Input: module ➡ CPU
AO_08HL_FAST	Transfer 8 analogue Output: CPU ➡ module in FAST mode
AO_08HL_ENHANCED	Transfer 8 analogue Output: CPU ➡ module in ENHANCED mode
AO_08HL_RAMP	Manage the generation of 8 "ramp" type analogue Outputs
AO_08HL_LINEARIZATION	Manage the "Linearization Table" of 8 custom analogue Outputs
AO_08HL_RESCALE	Scale and Transfer 8 linear analogue Outputs: CPU ➡ module

Function Block name	Description
AO_08HL_FAST_ENHANCED	Select command for FAST/ENHANCED working mode of the module
DM_08TS_STD	Select I/O channels and transfer discrete Input states: module ➨ CPU and discrete Outputs: CPU ➨ module
DM_08TS_PWM_PULSE	Manage the generation of “PWM” AND pulse on ch # 3 and 4
DM_08TS_LTH_TIME	Manage the module’s Input special functions: • Latched Inputs • Monostable Inputs
DM_08TS_FREQ_COUNT_PERIOD	Manage the module’s Input special functions on ch# 1 and 2: • Frequency input • Period measurement • Counter input
DM_16TS_STD	Transfer 8 discrete input states: module ➨ CPU and transfer 8 discrete Outputs: CPU ➨ module
DM_32TS_STD	Transfer 16 discrete input states: module ➨ CPU and transfer 16 discrete Outputs: CPU ➨ module
RPDO	Receive a PDO from the CANopen network
WPDO	Send a PDO on the CANopen network

6-7 Firmware Function Blocks List

The Firmware function blocks coming with the M81 (hardware version 5.0.1.0) are listed in this section. For each of the function blocks a short description is provided (see the “*Ascon Tecnologic Firmware Function Block Library*” [**3**] manual for details): for more details please refer to the specific help documentation available in the OpenPCS programming tool.

Function Block name	Description
ASCON_FLATTEN_TO_REAL	Convert the 4 bytes of the input parameters as the flattened equivalent of a real number which is then output-returned
ASCON_REAL_TO_FLATTEN	Convert the REAL variables in their FLATTEN equivalents
CANOPEN_AUTOLEARN	It performs the network scan and stores the main important parameters of the connected I/O modules
CANOPEN _DEVICE_COMPARE	It compares the characteristics of an I/O module already recognized and saved by the system, between the two network images (flash and RAM memory)
CANOPEN_GET_DEVICE_COM_PAR	If used in conjunction with “CanOPEN_Network_Compare” and “CanOPEN_Autolearn”, returns the I/O module mapping information stored by the previously by the system. It should be used after the network scan has been saved into the memory
CANOPEN_GET_DEVICE_ID	Device data identity retrieval
CANOPEN_NETWORK_COMPARE	It performs a comparison between the connected I/O modules network image and the one already saved into the system memory, with regards to the previously described parameters

Function Block name	Description
CANOPEN_NETWORK_STATUS	It returns information on the network status in case it has been changed for some reasons
CANOPEN_NET_CONTROL_START	It executes the agent able to verify and control the CanOPEN events and stores possible anomaly's situations
CANOPEN_SCAN_DEVICE_COM	It performs the scan of the specified device address to identify the communication characteristics and refreshes the network image acquired by the system within the "CanOPEN_Network_Compare". It must be called cyclically until the end of operations
CANOPEN_SCAN_DEVICE_ID	It performs the identification of the device at the specified address and replace it into the network image created by the system using "CanOPEN_Network_Compare" FB. It must be called cyclically until the end of operations
CAN_ENABLE_CYCLIC_SYNC	Function block for enabling or locking cyclical SYNC messages
CAN_GET_CANOPEN_KERNEL_STATE	Function block for state query of the CANopen kernel of the local PLC
CAN_GET_LOCAL_NODE-ID	Function block for a local node address query
CAN_GET_STATE	Function compent for node state query of various devices
CAN_PDO_READ8	Function block for reading a node's object entries by way of an SDO transfer
CAN_PDO_WRITE8	Function block for sending PDOs and CAN Layer 2 messages throught the network layer
CAN_RECV_BOOTUP	Function block for the Bootup messages of any node from the network layer's receiving buffer
CAN_RECV_BOOTUP_DEV	Function block for reading Bootup messages of a specific node from the receiving buffer of the network layer
CAN_RECV_EMCY	Read a node's emergency messages of a node from the network layer receiving buffer
CAN_RECV_EMCY_DEV	Read a specific node's emergency messages from the network layer receiving buffer
CAN_REGISTER_COBID	Register or erase the receipt of PDOs and CAN Layer 2 messages via the network layer
CAN_SDO_READ8	Read strings from a node's Object Dictionary via SDO transfer
CAN_SDO_READ_STR	Read a node's object entries by way of an SDO transfer
CAN_SDO_ WRITE8	writing node's object entries by way of an SDO transfer
CAN_SDO_WRITE_STR	Write strings to a node's Object Dictionary via SDO transfer
CAN_SEND_SYNC	Send an individual SYNC message
CAN_WRITE_EMCY	Send application specific Emergency-Messages throught the network layer
GET_SUPPORTED_DIAG	It verifies the diagnostic type active on the specific network node address
NET_ASCON_ID	Returns information about the modules connected
NG_RTR	It sends a RTR message to a network node address accordingly to the Node Guarding protocol standards
CLOSE_MODBUS_TCP_SERVER	Disable MBTCP/IP Server

Function Block name	Description
CLOSE_SERIAL_COMM	Close the serial communication port
CONV_ASCII_TO_CHAR	ASCII conversion from binary code to character
CONV_CHAR_TO_ASCII	ASCII conversion from character to binary code
CTRL_HCMV	Automan Station for heat and cool regulation
CTRL_MV	Automan Station for single action regulation
CTRL_PID	PID algorithm
CTRL_SPLITMV	Automan Station for heat and cool regulation with split range
CTRL_SRV	Servomotors algorithm
CTRL_SRV_POS	Servomotors algorithm close loop (potentiometer)
CTRL_TPO	Time proportional output
CTD	Counter Down pulses
CTU	Counter Up pulses
CTUD	Counter Up/Down pulses
ENABLE_MODBUS_TCP_SERVER	Set and activate the MBTCP/IP Server agent
F_TRIG	Falling edge detection
R_TRIG	Rising edge detection
MB_TCP_CLOSE_CONN	Close one of the 10 active connections
MB_TCP_CONN_STATUS	Show the status of a MBTCP/IP connection
MB_TCP_GET_CONN_BY_ADDR	Return information of a connection identified by the IP address of the client
MB_TCP_GET_CONN_CONFIG	Return configuration data of a specified active connection
MEMCOPY_FROM_M	Copies data from %M memory areas
MEMCOPY_TO_M	Copies data into %M memory areas
MEMCPY_I_TO_M	Copy a specific %I memory into a specific %M memory area
MEMCPY_M_TO_M	Copy a specific %M memory into a specific %M memory area
MEMCPY_M_TO_Q	Copy a specific %M memory into a specific%Qmemory area
MEMCPY_Q_TO_M	Copy a specific %Q memory into a specific %M memory area
MODBUS_GET_DIGITAL_SLAVE	Read 16 digital value from a memory area dedicated to a MB slave
MODBUS_GET_SLAVE_DATA	Read registers from a memory area dedicated to a MB slave
MODBUS_MASTER_EXECUTE	Execute a query in compliance with the MB protocol
MODBUS_MASTER_STATUS	Check the status of the MB agent.
MODBUS_SET_DIGITAL_SLAVE	Write 16 digital value to a memory area dedicated to a MB slave
MODBUS_SET_DWORD_DATA	Write two contiguous registers (4 bytes) to a memory area dedicated to a MB slave
MODBUS_SET_WORD_DATA	Write registers to a memory area dedicated to a MB slave

Function Block name	Description
MODBUS_SLAVE_SETTINGS	Set the node_id and timeout parameters of the MB slave agent
MODBUS_SLAVE_STATUS	Check the status of the MB agent
MS_DATALOG_MNGT	Mass Storage datalogging management
MS_INFO	Mass Storage information
OPEN_SERIAL_COMM	Configure the serial port and set the protocol used on it
RAND	Generete random numbers from 0... 65535
RESET_PULSE_COUNTER	Reset the counter value connected to a specific digital input
RTC_SETUP	Set the system clock
RTC_GET_VALUES	Read the system clock
RS	Reset dominant Flip-Flop
SR	Set dominant Flip-Flop
SEND_EMAIL	Set the configuration for a client SMTP to send e-mail
SERIAL_IO_CONFIG	Configure the ASCII serial port
SERIAL_IO_READ	Read data from the ASCII serial port
SERIAL_IO_READ_BYTE	ASCII serial port Byte reading
SERIAL_IO_WRITE	Write data on the ASCII serial port
SERIAL_IO_WRITE_BYTE	ASCII serial port Byte writing
TOF	Delay OFF timer
TON	Delay ON timer
TP	Time pulse generator
WATCHDOG_SET	Configure the system watchdog
WATCHDOG_STATUS	Checking the status of the system watchdog

Appendix A
Reference documents

[1] OpenPCS 6.6.5 – User Manual.

[2] IEC 61131-3: Programming Industrial Automation Systems – Karl-Heinz John, Michael Tiegelkamp - Springer.

[3] CANopen Extension for IEC61131-3 – User manual – Edition March 2005 – Systec Electronic.

[4] CiA DS 405 V2.0: CANopen Interface and Device Profile for IEC61131-3 Programmable Devices.

[5] CiA 301 DSP V4.1: CANopen application layer and communication profile

[6] CU-02 Installation manual (code: J30 - 658 - 1ACU-02 E).

[7] CU-02 User manual (code: J30 - 478 - 1ACU02 E).

[8] sigma**due** I/O modules Installation Manuals: DI-16LV, DI-32LV, DO-04RL, DO-04TX, DO-08RL, DO-16TS, DO-16TP, DO-32TS, AI-02UI, AI-08HL, AO-08HL, DM-08TS, DM-16TS.

[9] sigma**due** I/O modules User Manuals: DI-16LV, DI-32LV, DO- 04RL, DO-04TX, DO-08RL, DO-16TS, DO-16TP, DO-32TS, AI-02UI, AI- 08HL, AO-08HL, DM-08TS, DM-16TS.

[10] Ascon Tecnologic Firmware Function Block Library.

[11] IEC 61131-3 Function Block Library.

[12] I/O Function Block Library.