Tech-note

Control with UniOP - CoDeSys

This manual contains detailed information for using the CoDeSys softlogic system from 3S as the software PLC in the HMIcontrol solution for the UniOP family of HMI products.

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1 Overview

This manual describes the UniOP HMIcontrol system based on the CoDeSys control software.
The documentation covers:
- SCM03-C and SCM11-C control modules factory-loaded with CoDeSys run-time,
- UniOP local I/O subsystems
- CANopen distributed I/O interface (for SCM03-C only).

This manual is not intended to be a reference for CoDeSys programming. If you need a CoDeSys programming manual please refer to the appropriate documentation.

1.1 UniOP and CoDeSys Control Solutions

At the core of HMIcontrol there are the SCM03-C or SCM11-C PLC modules. Control modules based on CoDeSys are compatible with **all** UniOP panels with firmware 5.12 or higher.

SCM03-C CANopen master interface
SCM11-C Ethernet interface, supports also basic TCP/IP Ethernet connectivity for UniOP

The SCM03-C/SCM11-C modules physical memory configuration is reported in Table 1.

	Data Memory	**Code Memory**
SCM03-C	128KB	196KB
SCM11-C	1MB	1MB

Table 1

They both have a typical scan time measured for the execution of BOOL instructions written in IL language of 350 $\mu s / K$.

CoDeSys is the complete development environment for the SCM03-C/SCM11-C PLC modules. CoDeSys offers the PLC programmer a simple approach to the powerful IEC languages.

The original documentation of CoDeSys will be installed when the software is installed. The available documentation includes a clear and detailed presentation of the software and contains also a useful "First Steps with CoDeSys" that should be your first guide in getting confidence with the system.

The main technical data of the SCM control modules are shown in the table.

CPU	32 bit MIPS RISC processor
Clock speed	24Mhz
Flash memory	1 MB (512 KB reserved)
SDRAM memory	SCM03-C 2 MB SCM11-C 8 MB
CPU supervision (Reset, Watchdog)	Yes
Interface	SCM03-C CAN interface with optical isolation SCM11-C Ethernet 10BASE-T

Table 2

1.2 System Configurations

You can apply the HMIcontrol systems in different configurations. The possible configurations are the same as the ones already available for the ISaGRAF-based controllers.

1.2.1 Compact Stand-alone Controller

The HMIcontrol system can be used to build very compact standalone HMI and PLC systems. Input/output is available via the UIM internal modules.

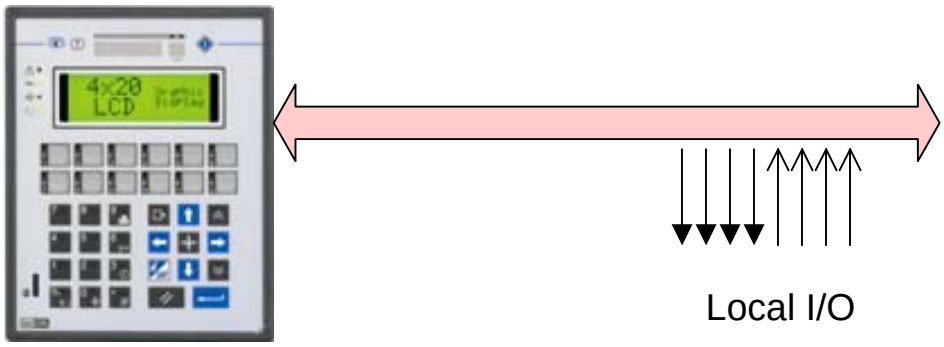


Figure 1

1.2.2 Controller with Distributed I/O

A built-in fieldbus interface is provided with the HMIcontrol modules. Configurations with local and distributed I/O are possible.

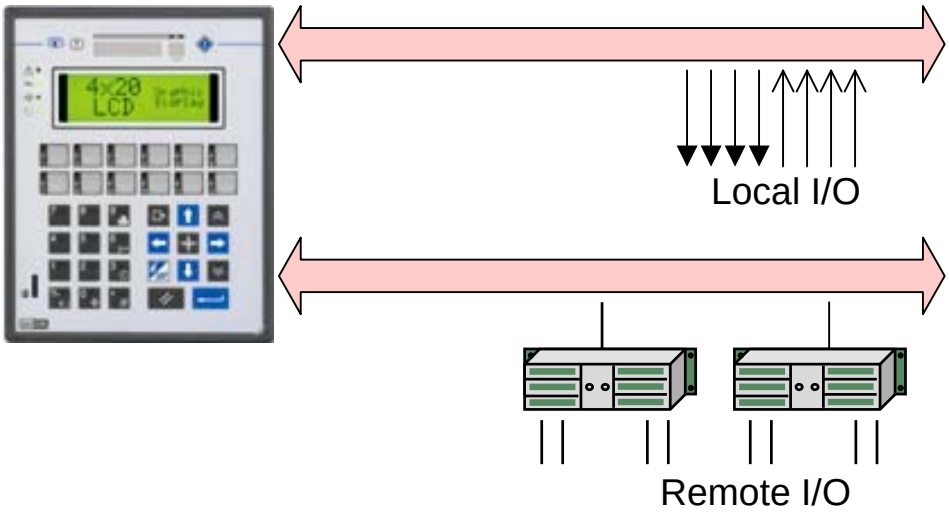


Figure 2

Note: *this configuration is only possible with SCM03-C.*

1.2.3 HMIcontrol Connectivity

An HMIcontrol system still offers the same connection capabilities of the UniOP products. Control capability can be combined with connection to a conventional controller (PLC).

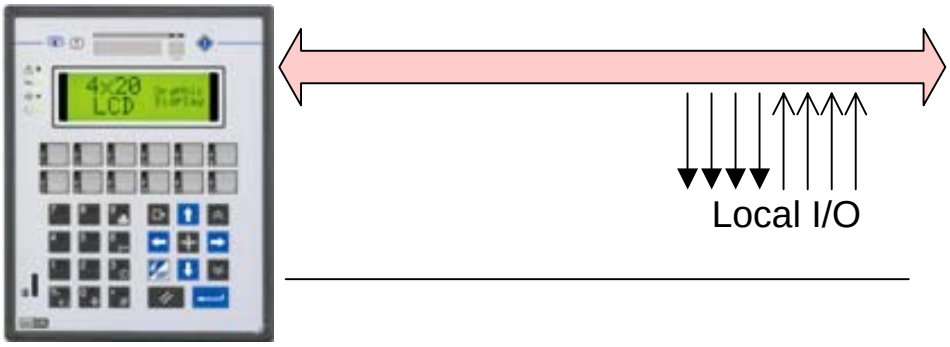


Figure 3

1.3 Requirements and Limitations

The following firmware and software versions are required to work with the CoDeSys HMIcontrol systems:

	Version
UniOP Designer	6.03 or higher
UniOP Firmware	5.12 or higher
CoDeSys	2.3.2 or higher

Table 3

Hardware types –0045 and –0050 have only one slot available for the communication or control module and, if one SCM module is used, it is no longer possible to plug one additional TCM module. Special products equipped with the double module communication board (TCA11 option) are available for special projects.
Use of local I/O is limited to certain UniOP models.
The current implementation of CoDeSys on SCM11-C does not offer drivers for Ethernet distributed I/O.

2 Getting Started

The following chapter describes the basic steps to follow in order to get HMIcontrol running on the SCM03-C/SCM11-C control modules.

2.1 Installing the SCM Control Module

The SCM Control Module must be installed in the socket available for TCM Communication Modules.
The Control Module must be installed with the panel powered off. Once the power supply is connected again the UniOP firmware will recognize the new module.

Follow this procedure to install the module in the operator panel:
1. Turn off the operator panel.
2. Using a screwdriver, unscrew (not completely) the two screws “A” fixing the rear cover (shown in Figure 4).
3. Remove the rear cover.
4. Plug the module in the slot with red connectors and make sure the connectors are properly latched.
5. Re-install the rear cover.
6. Fix the screws “A”
7. Stick in the area “B” the label indicating the type of module that has just been plugged in.

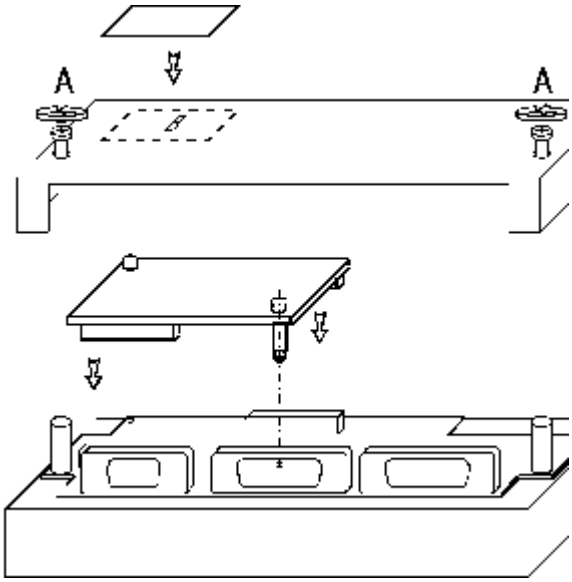


Figure 4

2.2 Control Module Diagnostic

The System Menu of UniOP provides some basic diagnostic information on the operation of the communication and control modules.
To view the diagnostic information:
1. Make sure the operator panel is in Operation Mode
2. Recall the System Menu

3. Scroll down the display to show the bottom row of the page
4. The diagnostic information will be shown as in the example below:

```
SCM03 0 H160 X130 OK
SCM03            type of module
0 H160 X130      internal version codes
OK               confirms the correct installation of the control module.
```

5. SCM firmware version can be read directly in system menu; when the SCMxx line is highlighted by the cursor, press the right arrow key to display the version information.

Since essentially the same hardware is used for both ISaGRAF and CoDeSys internal controllers, a proper version numbering scheme has been defined to identify the type of the Internal Controller installed in the module.
The Table 4 shows the rules.

	ISaGRAF	**CoDeSys**	**TCP/IP only**
SCM03	1.xxY	4.xxY	-
SCM11	2.xxY	4.xxY	1.xxY

Table 4

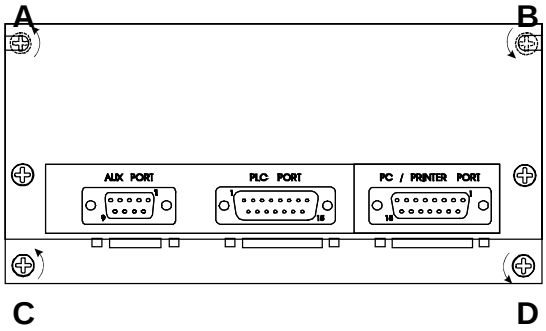
In the above table the “xx” stands for a version number between 01 and 99. The number is normally incremented at each revision of the firmware that includes new features or any major enhancements. “Y” stands for a letter between A and Z. The letter is changed to identify any minor modification in the firmware such as bug fixing.

Versions 1.xxY identify the old SCM11 modules with no iPLC support.
SCM11-C modules always include the TCP/IP software usable for all Ethernet based UniOP protocols.
SCM03-C modules always include the CAN interface.

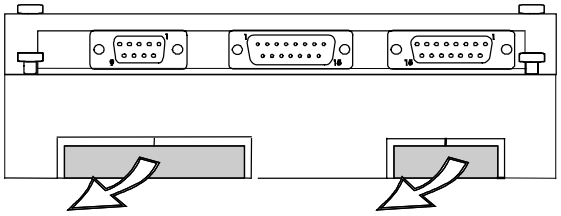
Internal I/O modules can only be installed in operator panels with hardware type –0050.
Follow the procedure described below to install an internal I/O module.

1) Turn off the operator panel and remove all cables.
2) Unscrew (but not remove) with the crosshead screwdriver the four screws A, B, C, and D.
3) Remove the rear cover.
4) Insert the UIM03 module
5) Fix the UIM03 module with the two screws E and F.
6) Plug the UIM03 internal flat cable connector in to the red connector and make sure they are properly latched.
7) Remove the side protection inserts from the rear box.
8) Replace the rear cover, and fix the screws A, B, C, D.
9) Stick the labels indicating the pin assignment.

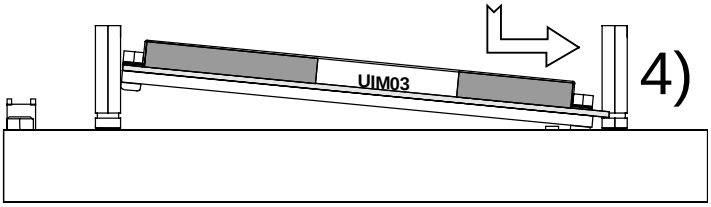
2)


A
B
AUX PORT
PLC PORT
PC / PRINTER PORT
C
D

3)

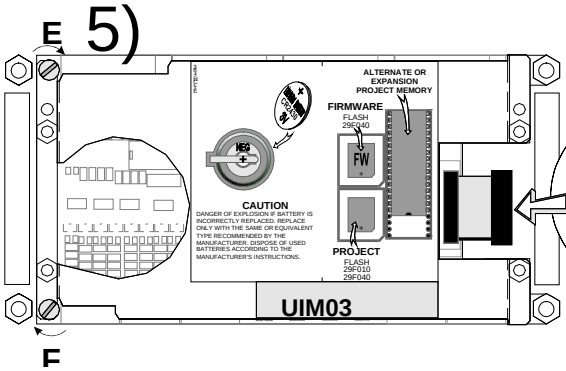


7)

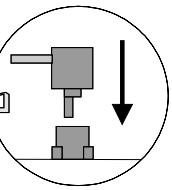

UIM03

4)

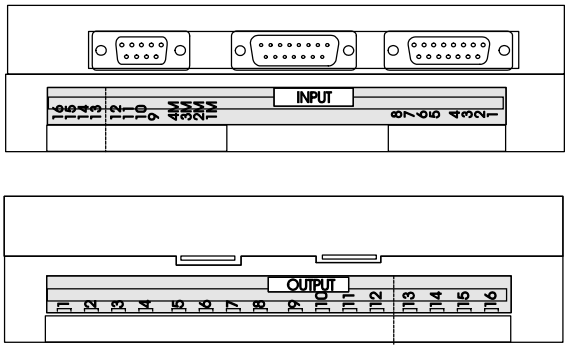
5)


E
ALTERNATE OR
EXPANSION
PROJECT MEMORY
FIRMWARE
FLASH
29F040
FW
NEO
CAUTION
PROJECT
FLASH
29F010
29F040
UIM03
F

6)



9)


INPUT
OUTPUT

2.3 I/O Module Diagnostic

The System Menu of UniOP provides some basic diagnostic information on the operation of the internal I/O modules.
To view the diagnostic information:

1. Make sure the operator panel is in Operation Mode
2. Recall the System Menu
3. Scroll down the display to show the bottom row of the page
4. The diagnostic information will be shown as in the example below:

`UIM03 0 H160 X130 OK`

`UIM03`	type of module
`0 H160 X130`	internal version codes
`OK`	confirms the correct installation of the control module.

2.4 Installing the CoDeSys Programming System

The CoDeSys programming software can be downloaded for free from the 3S web site at the following address:

http://www.3s-software.com/index.shtml/download

The download page is accessible only after a free registration that will be processed by 3S within a couple of days but normally faster.

A special 'target module' is required to allow the standard CoDeSys package to program systems based on SCM03-C and SCM11-C.
The UniOP Target-Package-Support required to support the SCM03-C and SCM11-C hardware is available for download from the www.uniop.com web site in the Document area under the CoDeSys folder.
The Target support is provided as a zip file that can be un-zipped in any directory respecting the internal folder structure.
The CoDeSys installation package includes a tool for Target installation.
The tool is called "Install Target" and can be used both for checking the installed target support packages and for installing new ones. To install the SCM Target Support Package just click "Open" and locate in the hard disk the file with extension ".tnf" that was supplied with the zip package. The target tool does the rest of the installation automatically.
The Install Target tool can be found in the CoDeSys program group that you will find in the Start Menu after the installation of the software.

The Install Target tool is shown in Figure 5.

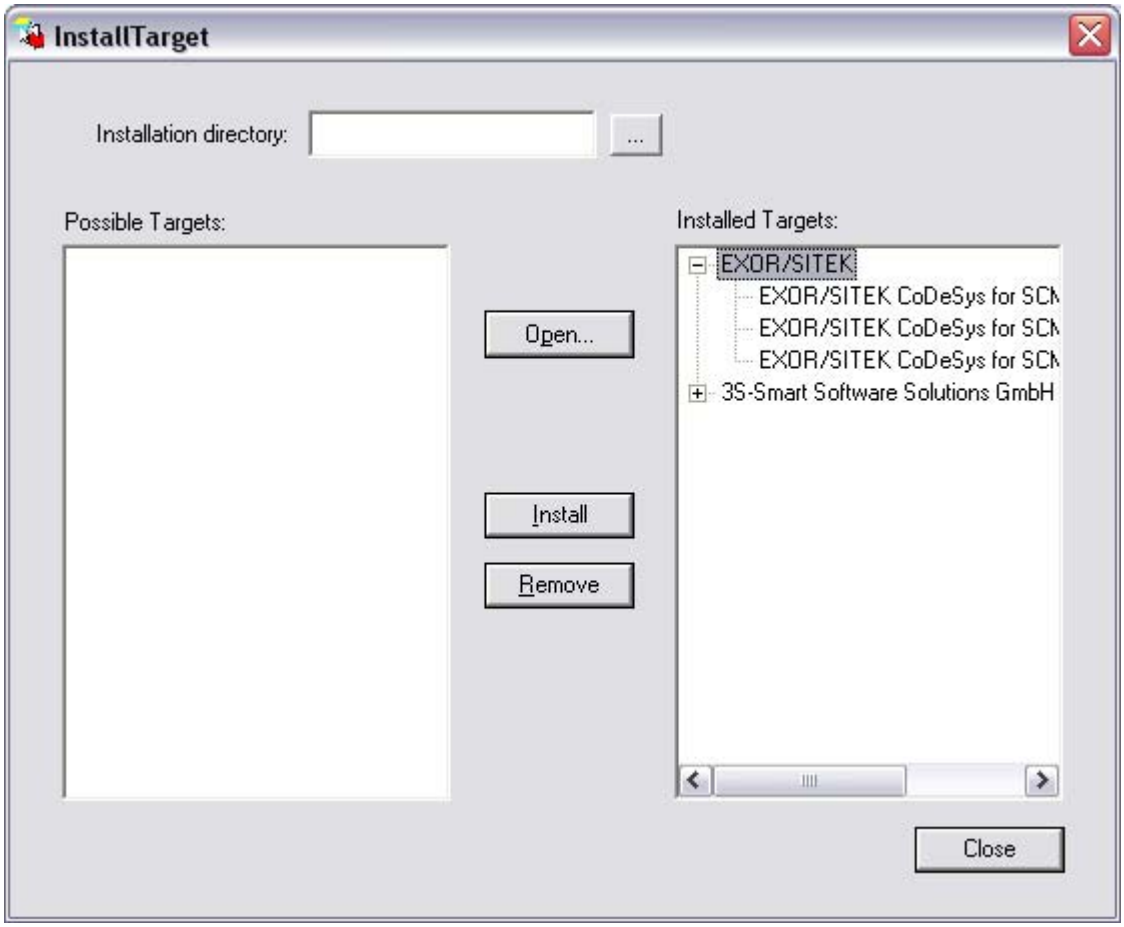


Figure 5

2.4.1 Updating old Target Support Packages

Target Support Package should be always aligned with the CoDeSys firmware version installed on the SCM module.

The first official and releasable CoDeSys firmware for SCM modules is the V4.01F.

SCM modules equipped with CoDeSys firmware version V4.01F requires target support package version V1.02 or greater.

Any new version of the CoDeSys “Target Support Package” can be installed over the existing one; this would keep the support for the older modules, still requiring old versions of the support package. Start the “Install target” tool from the 3S CoDeSys program group, click “Open”, select the .TNF file from the “Target Support Package” folder, click on “EXOR/SITEK” and click “Install”.

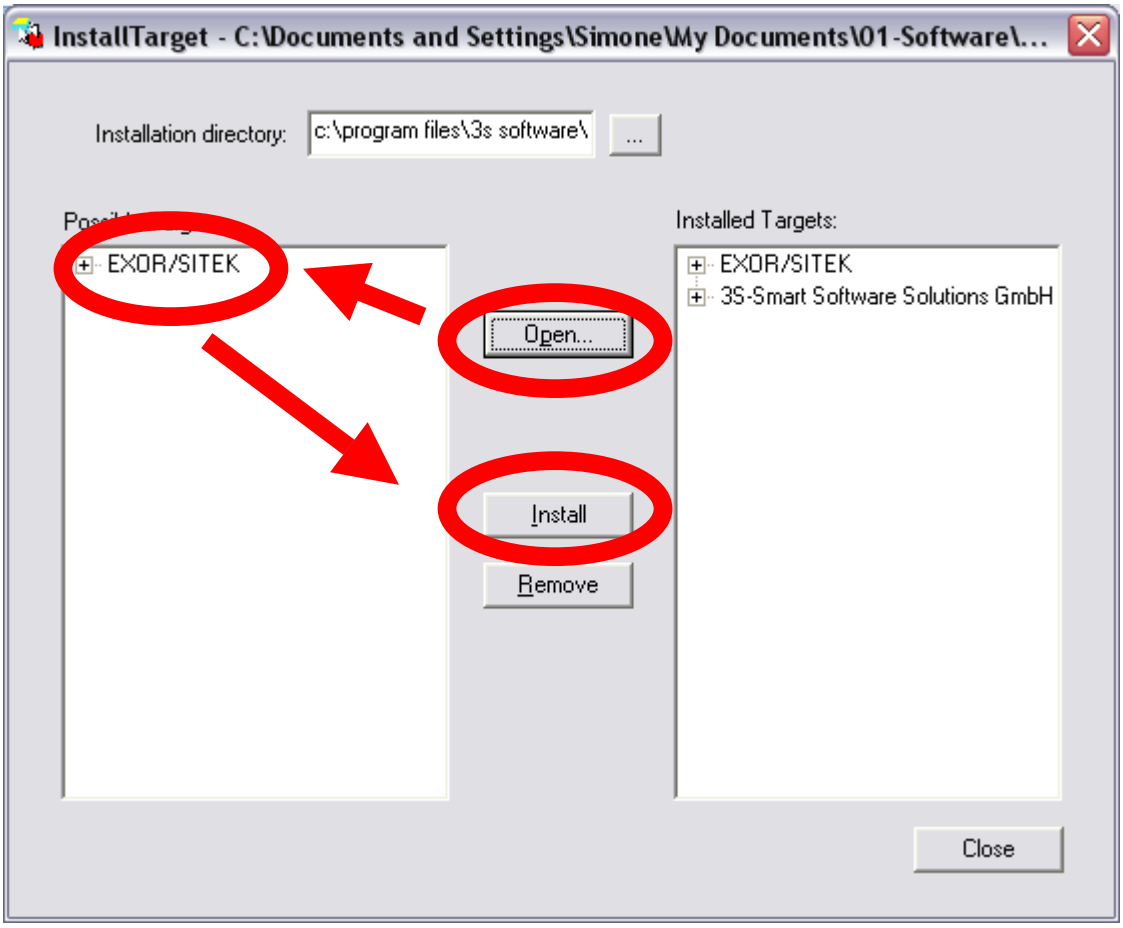


Figure 6

Depending on the presence of old support packages, the software will ask to overwrite existing settings; please confirm to overwrite them.
After the new Support Package has been installed the conversion of existing projects may require some steps depending on the level of compatibility of the new Support Package in compare with the old one. The conversion is done automatically by the CoDeSys programming software when opening the old application. Any update of the "Target Support Package" will come together with proper instruction for existing projects conversion, if needed.

2.5 Setting-up the Communication

The HMIcontrol system is composed by two subsystems, the UniOP Operator Panel and the SCM Internal Controller Module.
Programming both subsystems will be via the same serial communication link.
The SCM11-C module offers, as a more efficient alternative, an Ethernet interface that can be used for:

- Programming the internal PLC,
- communication with an external controller using a UniOP Ethernet communication protocol and finally
- programming UniOP.

The set-up of the CoDeSys communication is described in the following chapters.

2.5.1 Setting-up the Port for the CoDeSys Programming Software

Select “Online\Communication Parameters” in the CoDeSys programming software. The “Communication Parameters” dialog will appear as shown in Figure 7.
The first time this dialog is opened, the user will be requested to specify the channel for the connection with the PLC. Connection channels can be created with the “New…” button.

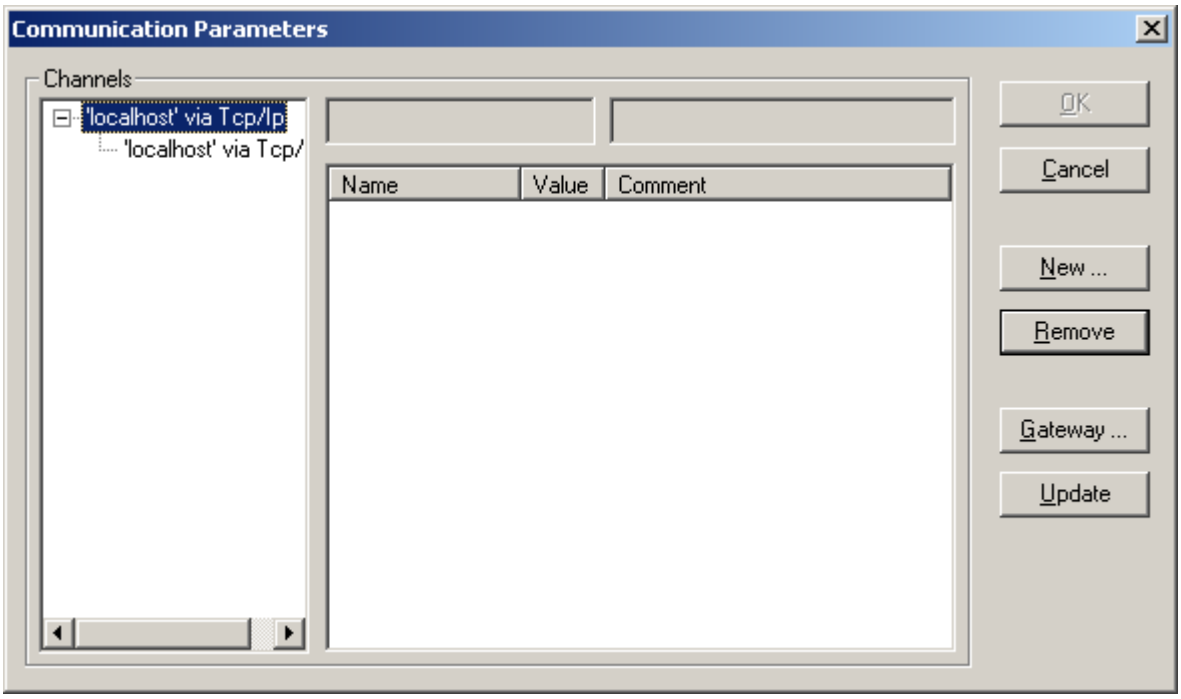


Figure 7

When defining a new channel, the type and all the relevant parameters can be defined in the dialog box shown in Figure 8.
The following options are possible:

SCM03-C	Serial (RS232)
SCM11-C	Serial (RS232)
	TCP/IP (Level 2)

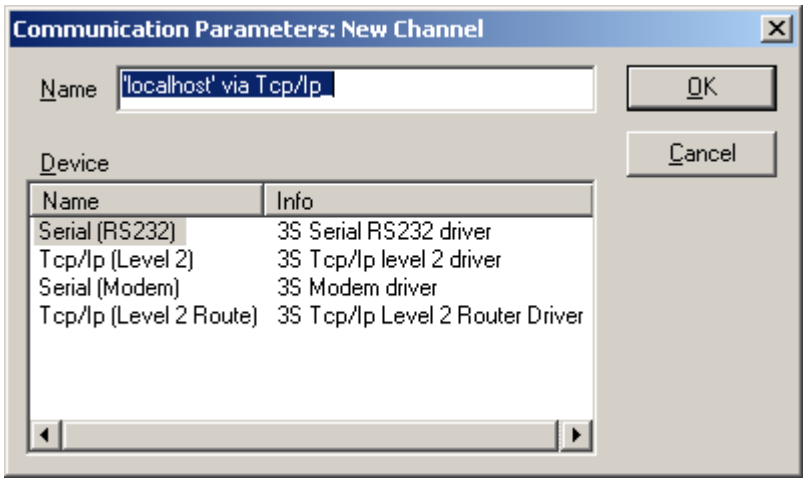


Figure 8

Default parameters for both serial port connection and Ethernet connection are correct for operation with UniOP.
When defining the driver for Ethernet connection, the “Address” parameter shown in Figure 9 must contain the IP address assigned to the SCM11-C module.

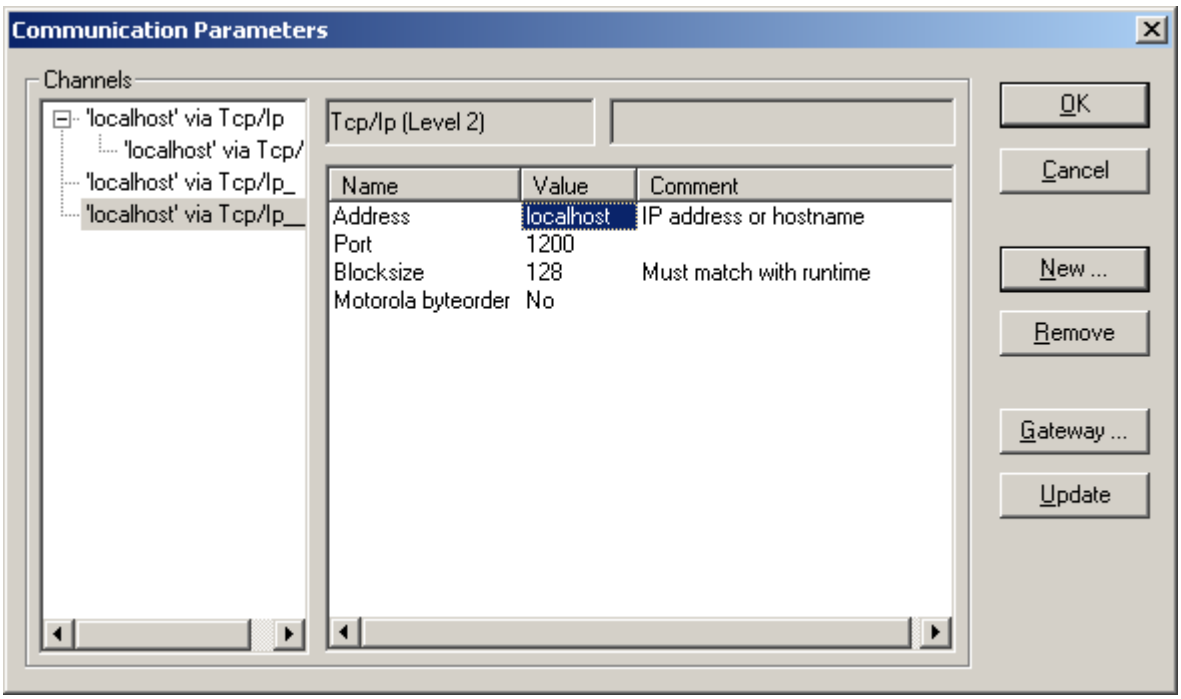


Figure 9

2.5.1.1 Setting the IP address in SCM11-C Control Modules

Ethernet programming for SCM11-C modules is possible only if the UniOP panel is equipped with firmware version V5.20 or greater.
Setting the IP address of the module follows the standard rules for UniOP IP address setup.

2.5.2 Communicating with the Internal Controller

When UniOP does not contain a valid project, it stays in Configuration Mode; in this situation the PLC port is assigned by default to the Internal Controller.
To program the Internal Controller when no project is loaded in the panel, use the normal UniOP programming cable connected to the PLC port of the panel.
If the operator panel has no PC/Printer Port, then the PC/PLC Port will be used also for communication with the Designer software. The Internal Controller will be programmable only after a valid project has been transferred and the panel is in Operation Mode.
If the SCM11-C module is used, then the Ethernet port is always available for communication with the PLC run-time system.
When a valid project is present in UniOP and the panel is in Operation Mode, the System Menu will allow the user selecting the mode of communication for the Internal Controller using the following procedure:

- recall the System Menu in the panel,
- use the Up/Down arrow keys to scroll the menu lines until PC/Printer or PLC are highlighted,
- use the Left/Right arrow keys to change the assignment of the selected port.

Two options related to the Internal Controller are available for each UniOP port:

Application Mode	ports should always be assigned to the Internal Controller in Application Mode if it has to be used for normal operations such as application downloading and debugging
Service Mode	Service Mode is reserved for special Internal Controller maintenance and should not be used

The Port is assigned to the Internal Controller in Application Mode when the corresponding row of the System Menu displays the text "**Application**". This message is reduced to "**A**" for displays with 20 characters per row.
When the PC/Printer port is not assigned to the Internal Controller, it reports the printer status as usual.
When the PLC port is not assigned to Internal Controller and the Designer project does not use an external controller, the System Menu contains the string "**NOT IN USE**" in the PLC row. In case an external controller is used, the PLC row reports the communication error code as usual.

Note *any modification to the port assignment done in System Menu becomes effective after you exit the menu.*

Communication with the Internal Controller is possible both when the panel is in Configuration Mode and when it is in Operation Mode.
Standard UniOP programming cables CA2 or CA114 can be used to connect the CoDeSys software UniOP. A gender changer may be required to connect to the UniOP PLC port.

2.5.2.1 Limitations

There are some limitations in the configurations available for programming the Internal Controller. This chapter provides an overview.

1. If UniOP contains a valid project that uses the PLC port to communicate with an external controller and it is in Operation Mode, then communication with the Internal Controller is not allowed through the PLC Port, because it is already assigned to the PLC communication.

2. If UniOP contains a valid project configured to work with Remote Pass-through, the communication with the Internal Controller through the PC/Printer Port is not allowed. The PC/Printer port is already assigned to wait for incoming commands for the Remote Pass-through operation.

3. If UniOP contains a valid project configured to use the UniNet network and the PC/Printer port is assigned to network communication, the same UniOP port cannot be used to communicate with the UniOP Internal Controller. A similar consideration applies in case the PLC port is used as network port: communication with the PLC is not allowed through the same port.

4. If UniOP contains a valid project where the external controller is configured with a protocol that requires a TCM module, then the Internal Controller may not work properly. Operations with external controllers that require Ethernet interface via SCM11-C are instead always allowed.

The table below summarizes the most common cases in the connection with the Internal Controller.

UniOP Mode	Communication Ports	Selection in System Menu	Connect Internal Controller to
Configuration	PC/Printer+PLC	-	PLC Port
	PC/PLC	-	Programmable only in Operation Mode
Operation	PC/Printer+PLC	PLC: Application	PLC Port
	PC/Printer+PLC	Printer: Application	PC/Printer Port
	PC/PLC	Printer: Application	PC/PLC Port

Table 5

3 HMI Programming

UniOP Designer software version 6.03 or higher is required to program the HMI panel equipped with the SCM03-C/SCM11-C modules when the use of the Internal Controller is required.

3.1 Enabling the Internal Controller CoDeSys

UniOP supports three different modes of operation of the Internal Controller.
The mode of operation can be selected in the dialog box “Project\Configure Controllers” as shown in Figure 10.

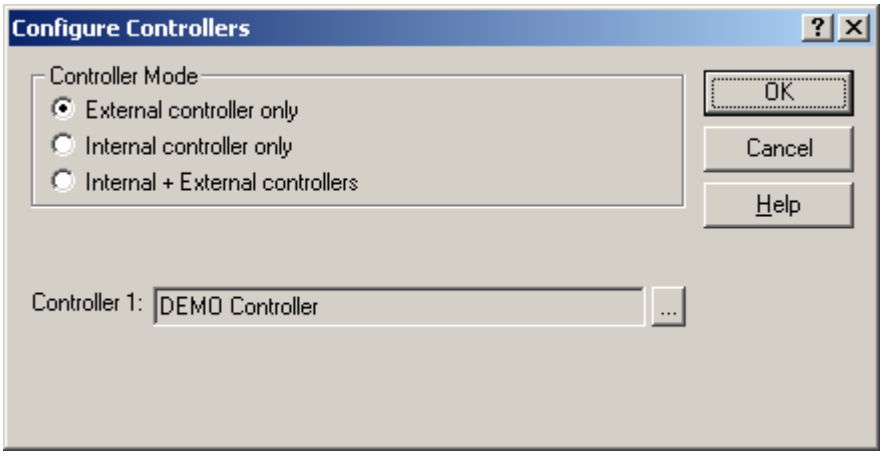


Figure 10

3.1.1 No Internal Controller

If you select “External Controller Only” from the “Configure Controllers” dialog box, the UniOP HMI panels will not activate the internal controller. UniOP will communicate to an external controller using the communication driver selected from the list of drivers displayed when you click on the reference button.
This option can be chosen also when an SCM03-C/SCM11-C Control Module is present in the system. In this case the Control Module will not be activated.

3.1.2 Stand Alone Operation

Selecting “Internal Controller Only” from the “Configure Controllers” dialog box will activate the Internal Controller in the HMIcontrol system. UniOP will not communicate to an external controller via the PLC Port. HMI projects will only reference the Internal Controller.

Note *If the Designer project is configured to use the Internal Controller and SCM03-C/SCM11-C module is not installed on the panel, the project will not run properly. Additionally, using a TCMxx module with a project configured to use the Internal Controller may result in an unexpected behavior.*

3.1.3 Operation with External Controller

Operation “Internal + External Controller” is the most general configuration. UniOP is connected to an external controller via the PLC port or Ethernet port and the Internal Controller is also activated. The Internal Controller will work independently of the communication with the external controller. When operation with external controller has been selected, the Designer will always present the Source Selection dialog box when entering communication references for all dynamic data items. The Source Selection dialog box lets the user choose the location of the requested data.

3.1.4 Selecting the Internal Controller Type

After selecting one of the modes including Internal Controller in the “Configure Controllers” dialog box, Designer will prompt you for the Internal Controller type selection showing the dialog box of Figure 11.

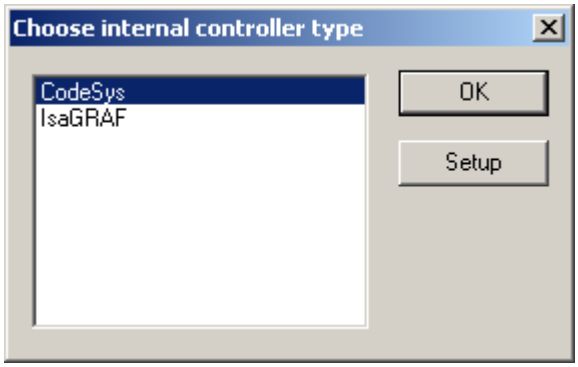


Figure 11

Note *Use SCM03 and SCM11 for ISaGRAF. Use SCM03-C and SCM11-C for CoDeSys.*

3.1.5 UniNet and the Internal Controller

Internal Controllers are compatible with the UniNet network. The data of the Internal Controller running in any operator panel configured as UniNet server is available to all clients in the network.

Internal Controllers appear in the list of available data sources in the Source Selection dialog box. See figure below.

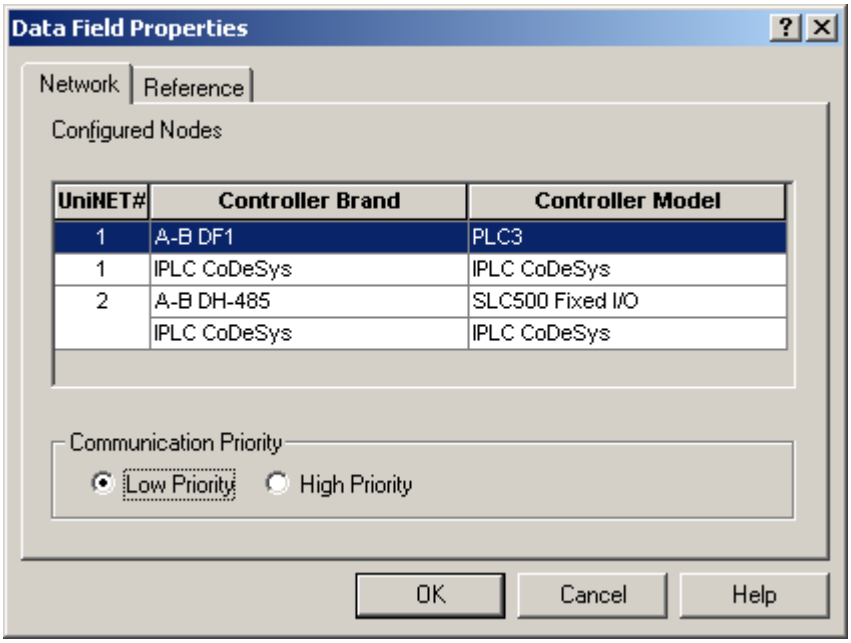


Figure 12

3.2 The Tag Editor

The Designer Tag Editor supports direct import of the tag file generated by the CoDeSys programming software.

3.2.1 Importing a Tag File

The CoDeSys programming software saves a list of all the names used into the PLC program in a file with extension ".sym". This file is stored in the application folder.
The software creates the ".sym" file only if the option "Dump symbol entries" is selected in the CoDeSys Option, under "Symbol Configuration" as shown in Figure 13.
You may need eventually to check the configuration of the symbol file in order to be sure that symbols are created for all variables in all POUs. Please refer to CoDeSys documentation for additional information.

Figure 13

A new version of the ".sym" file is created each time the project is built. Symbol files should be re-imported in Designer Tag Editor to update the Designer's tag list every time they are updated.

The CoDeSys symbol file can be imported in Designer selecting the "Import tags" command from the "File" menu of the Tag Editor. The first step of the import process is shown in Figure 14; in the list of the available controllers the CoDeSys is listed as "iPLC CoDeSys".

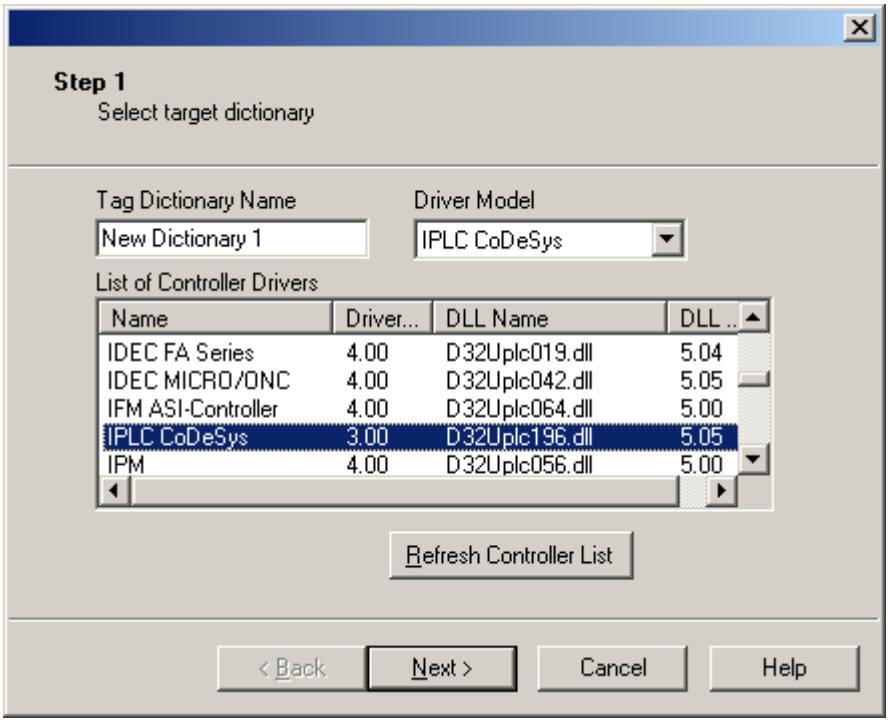


Figure 14

The second step is shown in Figure 15.

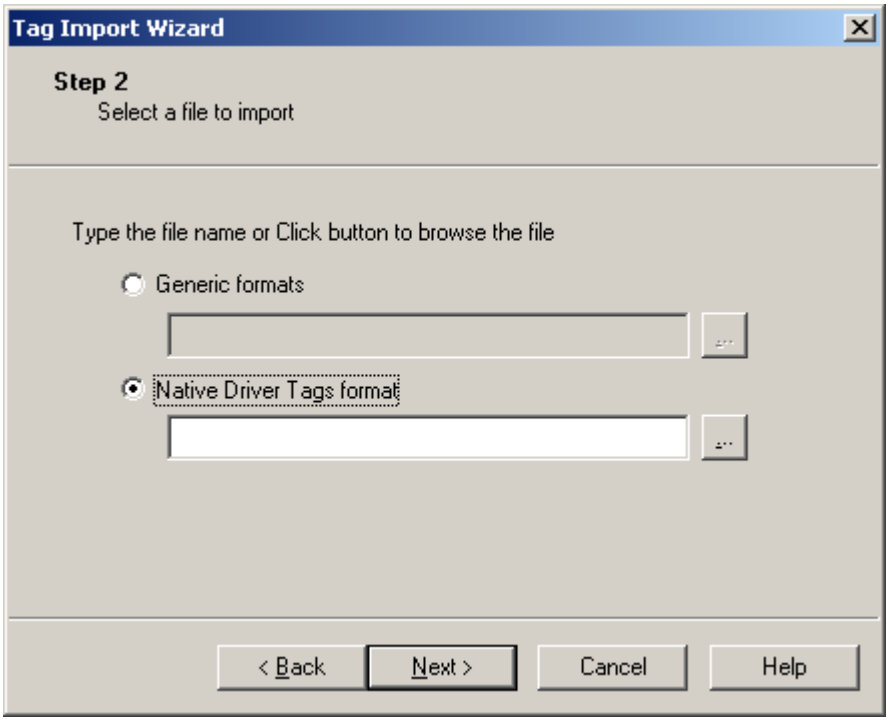


Figure 15

Support for CoDeSys native tag format is provided selecting the “Native Driver Tags format” radio button.

Any new set of tags imported in Tag Editor after the first one will be imported as a new Dictionary. The new Dictionary should be properly linked to the Designer project when enabling the Tag Support under “Project\Configure Tag Dictionaries…”

Note: *New Tags can be ONLY created starting from CoDeSys programming software. The Designer tag database must not be changed.*

3.2.2 Source Selection Dialog Box

If the Internal Controller set-up uses only the internal PLC, the “Define Field” dialog box immediately appears and includes only the CoDeSys variables as shown in Figure 16.

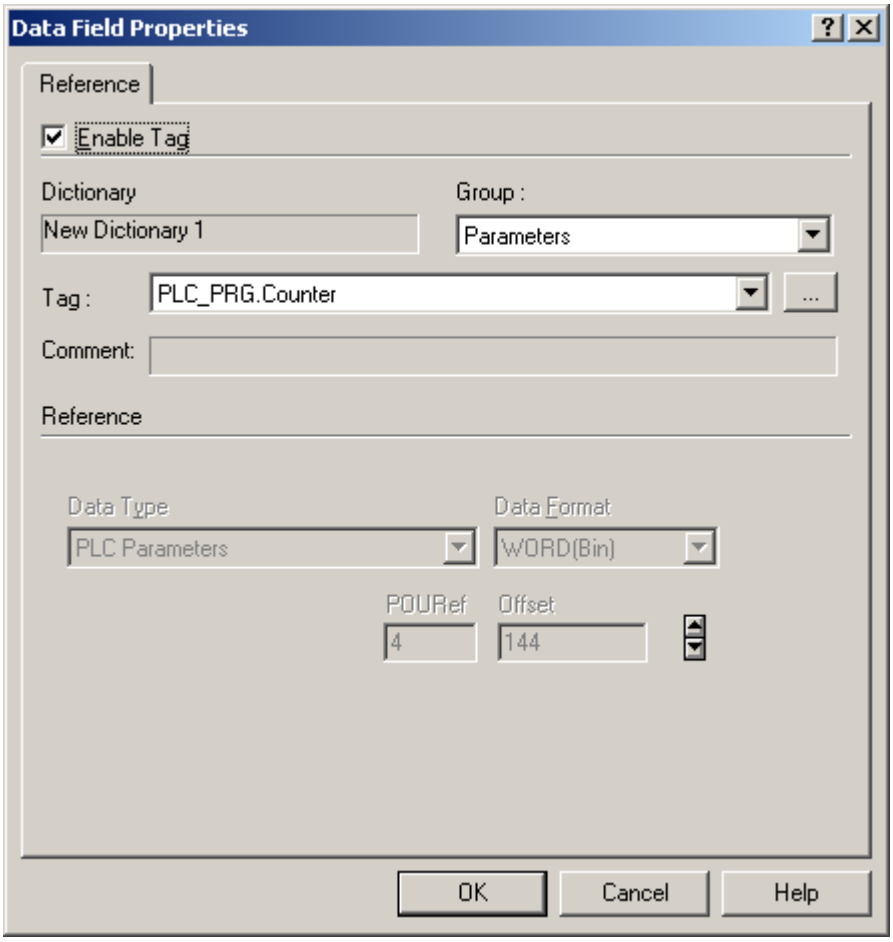


Figure 16

If the Internal Controller set-up is configured to use a combination of internal PLC and an external controller, the “Network” tab allows the source selection of the variable to be added as shown in Figure 17.

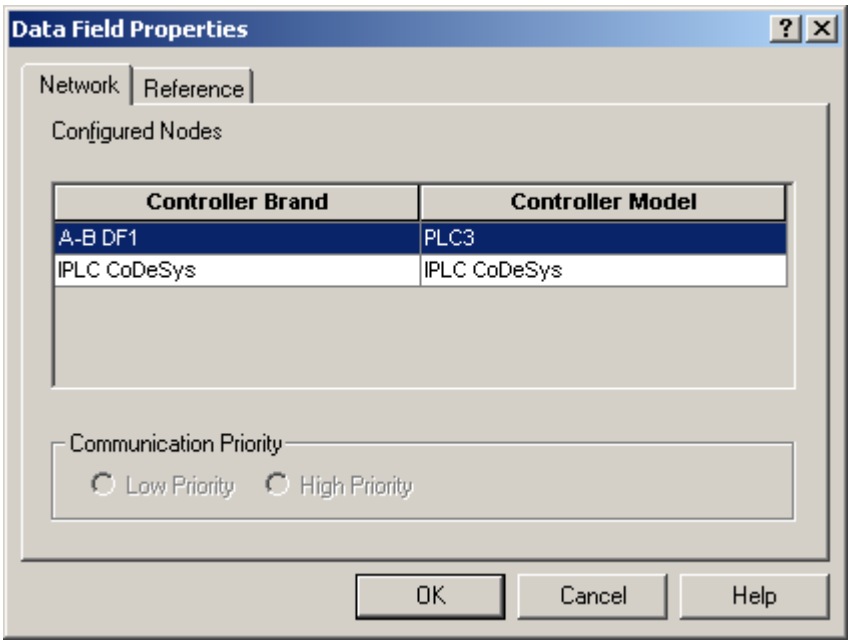


Figure 17

3.2.3 Using the Internal Controller with UniNet

If the UniNET network has been enabled and any of the UniNET servers includes an Internal Controller, then the Internal Controllers appears in the list of available data sources in the Network tab of the Data Field Properties.

An example is given in the rest of this chapter
The UniNET network has been configured according to Figure 18; the network has two panels both configured as Server and both configured to use their internal PLC, the “Network” tab of the Define Field dialog box will appear as shown in Figure 19.

There are four possible sources for a reference to be added:
- the external controller connected to the UniNET node 1 (Hitachi H series)
- the internal controller of the panel that has UniNET node 1
- the external controller connected to the UniNET node 2 (GE Fanuc 90)
- the internal controller of the panel that has UniNET node 2

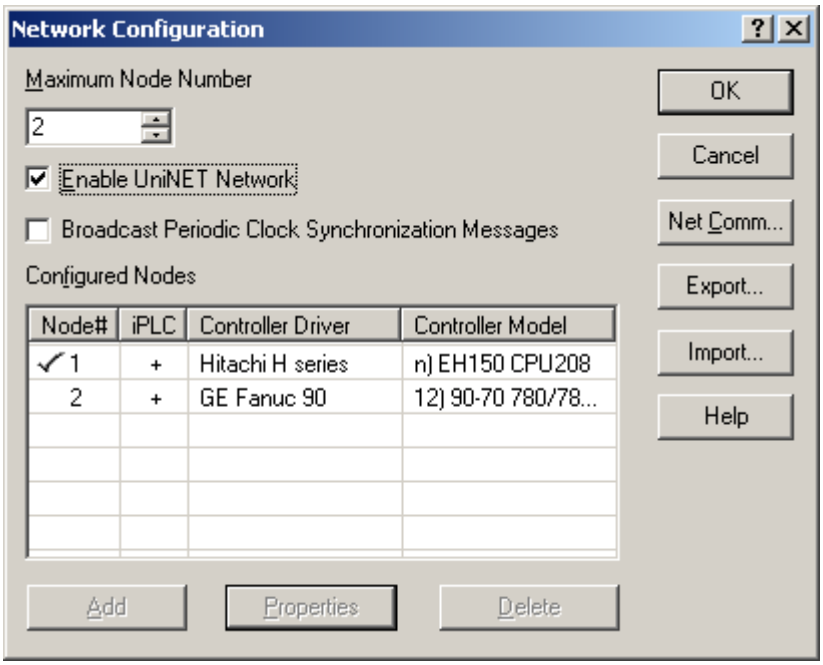


Figure 18

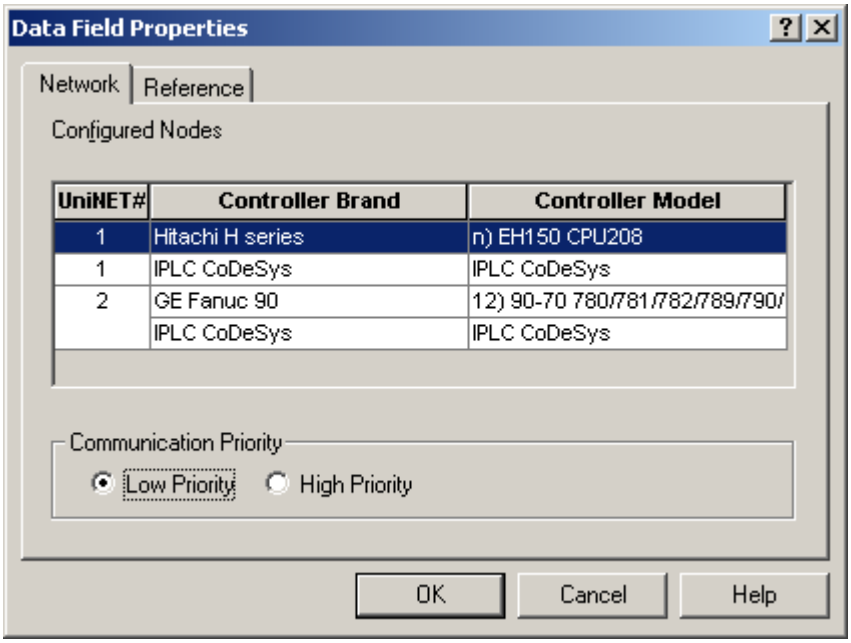


Figure 19

3.2.4 Data Field Dialog Box for the Internal Controller

The “Data Field” dialog box for an Internal Controller data item is show in Figure 20.

The “Enable Tag” checkbox allows browsing the Tag list created or imported in the Designer project. See chapter 3.2 for detailed description of the Tag Editor.

In a CoDeSys system the following data types are available:
- PLC Memory
- PLC Input
- PLC Output
- PLC Retain
- PLC Parameter
- Internal Panel Memory

The CoDeSys user program data is divided into “segments” as shown in the table below.

Segment		Type
0	%M	Memory
1	%I	Input
2	%Q	Output

Table 6

If the option “Retain in own segment” is on, retain variables are in segment 3.
Global and POU (**P**rogram **O**rganization **U**nit) local variables without direct address are in the subsequent segments, starting with segment 4. If the option “Retain in own segment” is off, they start at segment 3.
The reference to variables in the CoDeSys system consists of “POUref” (the segment), Offset and size. Detailed description will be given in the following sections.

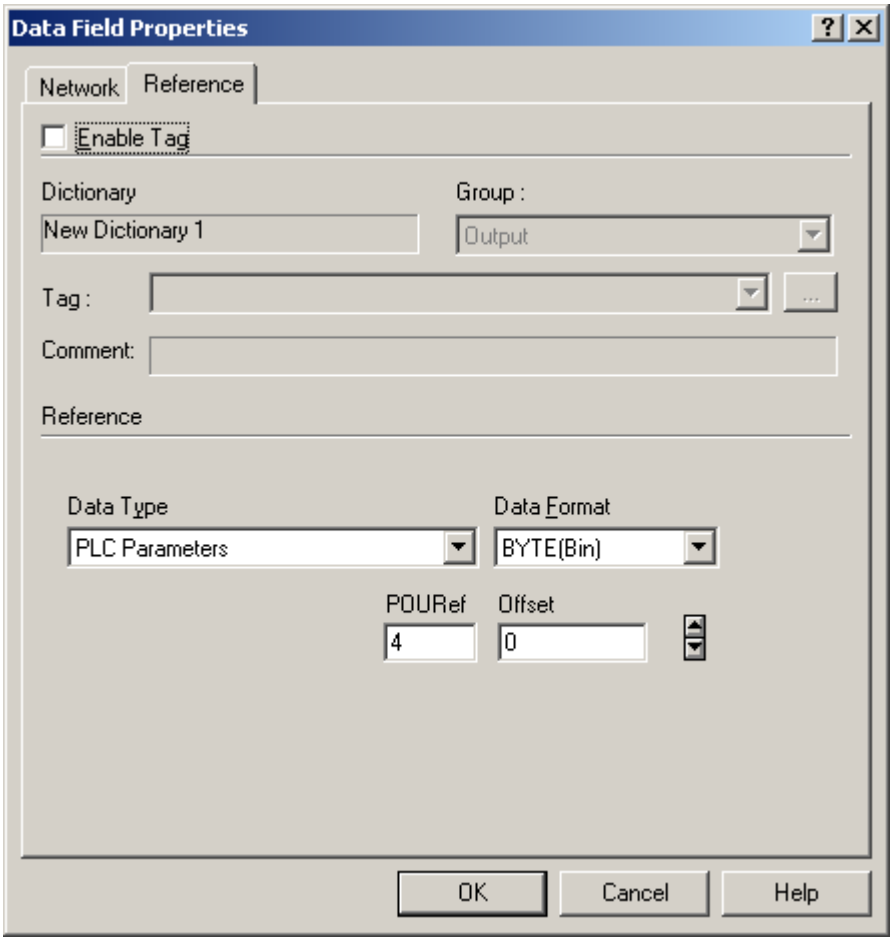
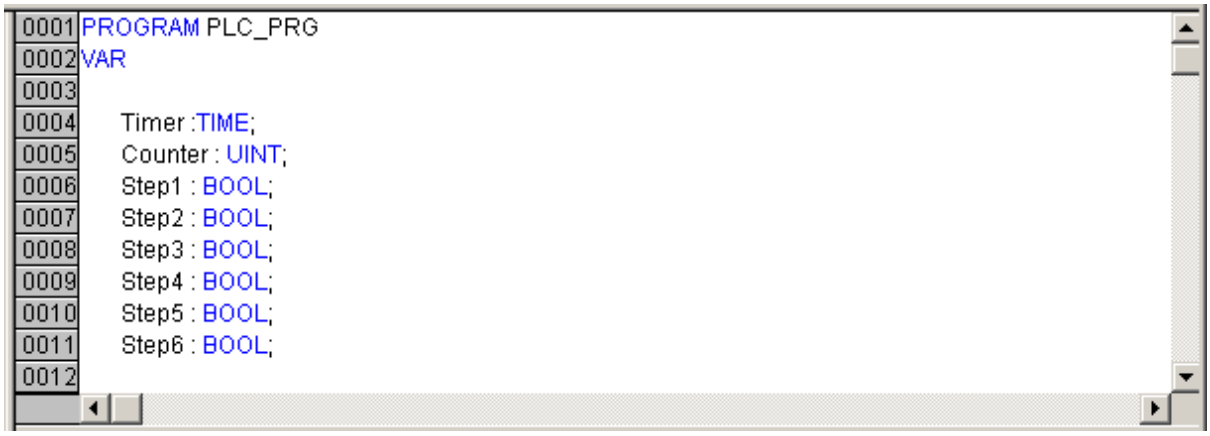


Figure 20

All variables used in a CoDeSys program must be declared in the “Declaration Editor”. The CoDeSys “Declaration Editor” is shown in Figure 21.
The Declaration Editor is used to declare variables of POUs and global variables, for data type declarations, and in the Watch and Receipt Manager



```
0001 PROGRAM PLC_PRG
0002 VAR
0003
0004     Timer :TIME;
0005     Counter : UINT;
0006     Step1 : BOOL;
0007     Step2 : BOOL;
0008     Step3 : BOOL;
0009     Step4 : BOOL;
0010     Step5 : BOOL;
0011     Step6 : BOOL;
0012
```

Figure 21

3.2.5 PLC Memory

Variable of type “PLC Memory” refer to the flag memory area in the PLC.

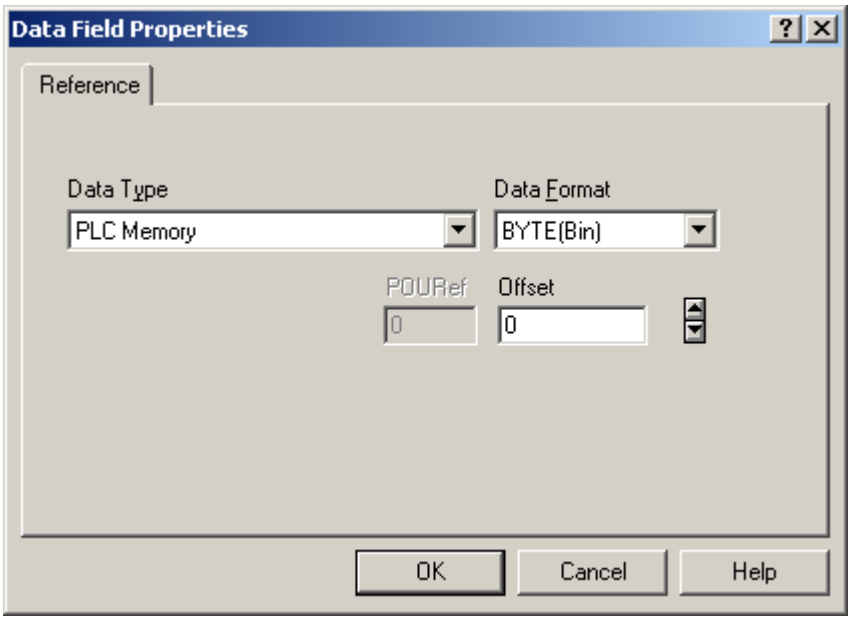


Figure 22

3.2.6 PLC Input and PLC Output

Variable of type “PLC Input” refer to the variables configured as “Input variables” in the “PLC Configuration” tool. The “PLC Configuration” tool can be opened from the “Resources” tree in the CoDeSys programming software.
The CoDeSys “PLC Configuration” window is shown in Figure 23.

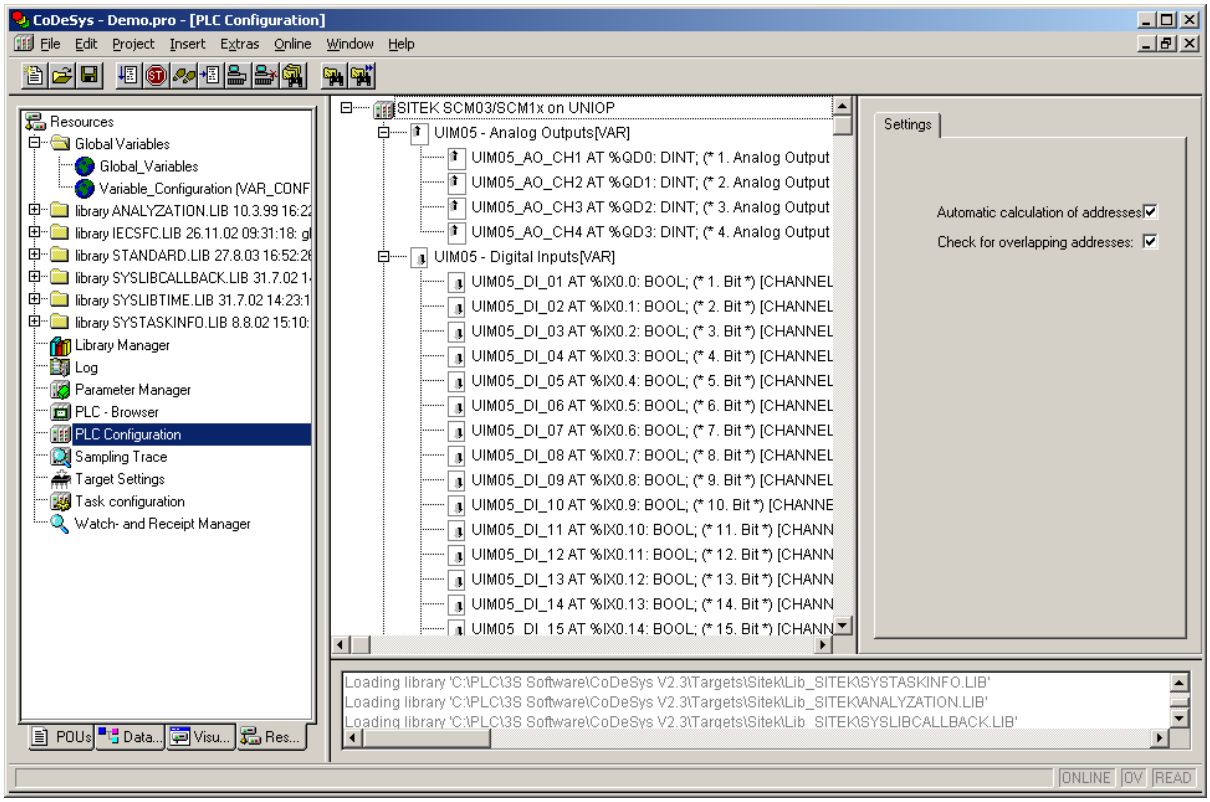


Figure 23

Input and Output points can be addresses either using tags or pointing directly to them (direct addressing mode).
Designer can specify 4 different Data Types for Input and Output, depending on the size of the element you want to address.

The data types for Input are:
PLC Input (X) to address bit elements
PLC Input (B) to address byte elements
PLC Input (W) to address word elements
PLC Input (D) to address double word elements

The data types for Output are:
PLC Output (X) to address bit elements
PLC Output (B) to address byte elements
PLC Output (W) to address word elements
PLC Output (D) to address double word elements

The different data types must be used depending on the PC Configuration built into the CoDeSys PLC program; the mnemonics are compatible.

3.2.7 PLC Retain

Variables of type “PLC Retain” refer to CoDeSys variables declared in the “Declaration Editor” in the section enclosed between the keywords VAR_RETAIN and END_VAR.
These variables maintain their value when the controller is powered off and even after an uncontrolled shutdown of the controller.

The content of retain variables is saved when the device is turned off and restored at the following power-up.

Note *UniOP firmware can allocate memory for retentive variables ONLY when the panel is in Operation Mode.*

There is a limit to the maximum number of retentive variables that can be defined. The current implementation will support a maximum of up to 2048 bytes.

At programming time it will be responsibility of the programmer to ensure that the maximum amount of available memory will not be exceeded. When compiling the project, the CoDeSys software will use the specific Target Settings information to check if the total amount of retentive variables has been exceeded.

As SCM has no on-board battery backup, removing the SCM controller from the unit will result in losing the information of the retentive memories.

The content of retentive memories will also be lost in the following cases:
- a new project file has been downloaded to UniOP
- a new firmware has been downloaded to UniOP
- the SCM module is moved from one UniOP panel to another
- a new PLC program is downloaded to the SCM

Note: *Retentive Memory mechanism is activated only 2 power cycles after CoDeSys project download or UniOP firmware download.*

3.2.8 PLC Parameter

The data type “PLC Parameter” refers to all POU local and global variables. The POUref parameter is editable depending on the fact that the retain variables are allocated in a separate segment.
Target settings for SCM03-C/SCM11-C uses always by default a separate segment (the number 3) for all the retain variables.
Retain settings are in the “Target Settings” dialog box as shown in Figure 25. They are fixed and cannot be changed by the user.

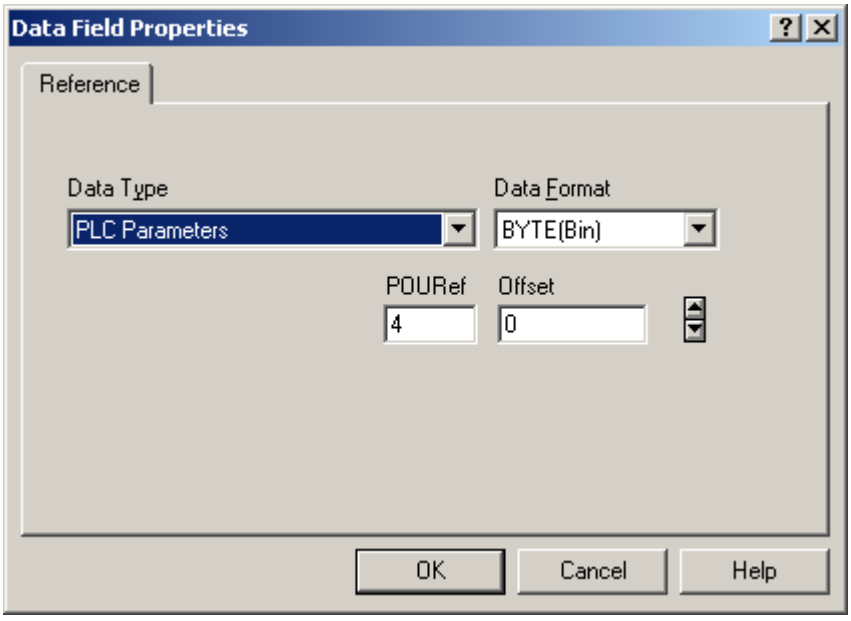


Figure 24

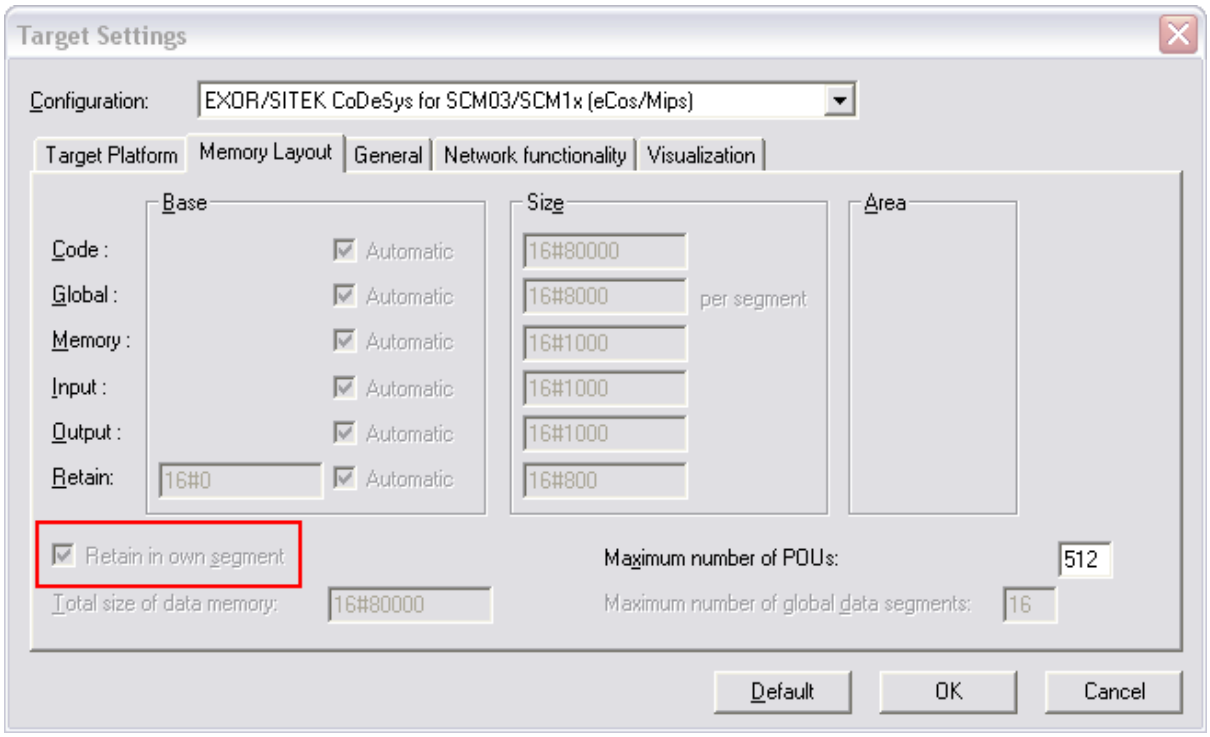


Figure 25

3.2.9 Internal Panel Memory

The variables of type Internal Panel Memory refer to an internal memory structure, located in the UniOP panel. Accessing this memory does not involve any communication with the iPLC controller memory.

3.3 Using the RDA

The Reserved Data Area can be configured in the memory of the Internal Controller.
To use the RDA a certain number of Tag's with contiguous addresses must be configured in the CoDeSys program.
The easiest way to declare a list of variables in CoDeSys, which can be considered "contiguous", is to use an array as shown in Figure 26 and address the RDA using the tags.

```
0028
0029   RDA: ARRAY[1..36] OF USINT;
0030   Alarms:ARRAY[1..4] OF USINT;
0031   Mailbox: ARRAY[1..40] OF USINT;
0032
```

Figure 26

The array must contain bytes elements declared in CoDeSys as unsigned short integer (USINT).
The absolute address into the controller memory segment of a variable declared in CoDeSys is only visible in the symbol file created by the programming software at compile time.
The CoDeSys array structure ensures that all its elements have contiguous addresses; the first element of the array can be used as offset reference for the RDA area.

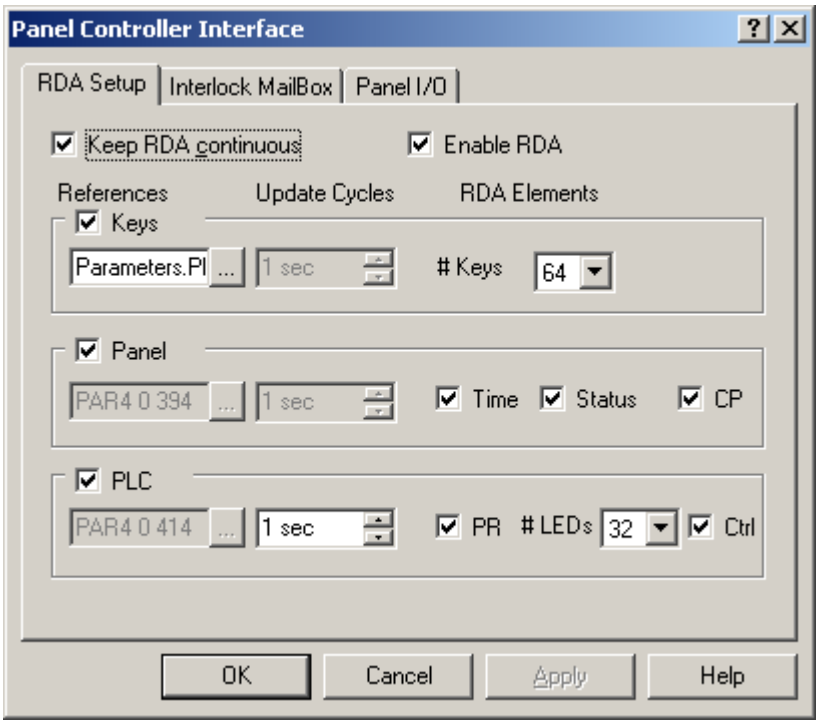


Figure 27

If the "Keep RDA Contiguous" check box is enabled, Designer calculates the proper address of the RDA segments, showing the absolute memory address into the PLC memory.

Considering the example of variable declaration shown in Figure 26, the Keyboard area is mapped as shown in the Figure 28.

Tag	RDA[4]								RDA[3]								RDA[2]								RDA[1]							
Bit	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
	F32	F31	F30	F29	F28	F27	F26	F25	F24	F23	F22	F21	F20	F19	F18	F17	F16	F15	F14	F13	F12	F11	F10	F9	F8	F7	F6	F5	F4	F3	F2	F1

Figure 28 – The Keyboard Area

Tag	RDA[8]								RDA[7]								RDA[6]								RDA[5]							
Bit	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
	Day								Month								Reserved								Day of week							
	Minutes								Seconds								Year								Hour							

Figure 29 – The Panel Area

Tag	RDA[12]								RDA[11]								RDA[10]								RDA[9]							
Bit	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
	L16	L15	L14	L13	L12	L11	L10	L9	L8	L7	L6	L5	L4	L3	L2	L1	PR (Page Request)															

Figure 30 – The PLC Area

3.4 Programming the Mailbox

The Mailbox can be configured in the Internal Controller memory area using an array of bytes (USINT). To the mailbox should be reserved an array of minimum 40 bytes in length.

Tag	Mailbox[4]								Mailbox[3]								Mailbox[2]								Mailbox[1]							
Bit	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
	Command/Response Word																Status Word															
	Parameter 1																Parameter 0															
	Parameter 3																Parameter 2															
	….																…..															

Figure 31 – The Mailbox

3.5 Alarms

The Alarm area in the Internal Controller memory is organized as bytes. An array of bytes (USINT) can be configured to handle Alarms.
Alarm bits are organized according to Figure 32.

Tag	Alarm[4]								Alarm[3]								Alarm[2]								Alarm[1]							
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	A32	A31	A30	A29	A28	A27	A26	A25	A24	A23	A22	A21	A20	A19	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1

Figure 32 – The Alarm Area

3.6 Alternative Approach to RDA, Alarms and Mailbox

Instead of using arrays the Controller interface areas can be defined statically into the iPLC memory declaring all variables as global with their corresponding names.

As an example, the RDA Keys area can be declared as follows:

```
(* RDA : Keys area *)
      RDA_Keys1                    AT %MW0: WORD;
      RDA_Keys2                    AT %MW1: WORD;
```

```
      RDA_Keys3                    AT %MW2: WORD;
      RDA_Keys4                    AT %MW3: WORD;
```

The RDA Panel area can be declared as follows:

```
(* RDA : panel area *)
      RDA_RTC_DayOfWeek            AT %MB8: BYTE;
      RDA_RTC_Month                AT %MB10: BYTE;
      RDA_RTC_Day                  AT %MB11: BYTE;
      RDA_RTC_Hour                 AT %MB12: BYTE;
      RDA_RTC_Year                 AT %MB13: BYTE;
```

This means that the individual bits in the Status word can be identified as follows:

```
      RDA_S0                       AT %MX8.0:BOOL;
      RDA_S1                       AT %MX8.1:BOOL;
      RDA_S2                       AT %MX8.2:BOOL;
      RDA_S3                       AT %MX8.3:BOOL;
      RDA_S4                       AT %MX8.4:BOOL;
      RDA_S5                       AT %MX8.5:BOOL;
      RDA_S6                       AT %MX8.6:BOOL;
      RDA_S7                       AT %MX8.7:BOOL;
      RDA_S8                       AT %MX8.8:BOOL;
      RDA_S13                      AT %MX8.13:BOOL;
      RDA_S14                      AT %MX8.14:BOOL;
      RDA_S15                      AT %MX8.15:BOOL;
```

A Similar approach is valid also for the Mailbox area:

```
(* MailBox mapping *)

      MB_Start                     AT%MB42:BYTE;

      MB_Status                    AT %MW21:WORD;
      MB_CmdResp                   AT %MW22:WORD;
      MB_Param00                   AT %MW23:WORD;
      MB_Param01                   AT %MW24:WORD;
      MB_Param02                   AT %MW25:WORD;
      MB_Param03                   AT %MW26:WORD;
      MB_Param04                   AT %MW27:WORD;
      MB_Param05                   AT %MW28:WORD;
      MB_Param06                   AT %MW29:WORD;
      MB_Param07                   AT %MW30:WORD;
      MB_Param08                   AT %MW31:WORD;
      MB_Param09                   AT %MW32:WORD;
      MB_Param10                   AT %MW33:WORD;
      MB_Param11                   AT %MW34:WORD;
      MB_Param12                   AT %MW35:WORD;
      MB_Param13                   AT %MW36:WORD;
      MB_Param14                   AT %MW37:WORD;
      MB_Param15                   AT %MW38:WORD;
      MB_Param16                   AT %MW39:WORD;
      MB_Param17                   AT %MW40:WORD;
```

The main advantage of this approach would be the natural possibility to overlay the variables definition and to give to each word, byte or bit the proper tag for a proper reference into the PLC program and later into the Designer project.
This approach requires of course accepting that a fixed memory area in the controller memory is allocated and reserved to UniOP RDA.

3.7 Transferring Data with the Internal Controller

The UniOP Data Transfer function can be used to copy data from an external controller to the CoDeSys memory. Data can also be copied from the internal CoDeSys memory to the external controller memory.

The Data Transfer process has different options based on the different Data Format of the data involved in the copy process.
Source and target tag data format should be always compatible.

In case more than one variable needs to be copied using data transfer, the physical memory address of all the elements must be contiguous. The easiest way to obtain this is in CoDeSys is configuring an array.

Before starting a copy operation the Data Transfer module checks the byte order convention used by the Source and the Target addresses. In UniOP the so-called Intel data format (little endian) is considered not inverted; the Motorola format (big endian) is considered inverted.
When Source and Target are both inverted or not inverted the Data Transfer module does not apply any transformation.
If Source and Target have different byte ordering, the Data Transfer module applies a byte swap according to the rules explained in Figure 33.

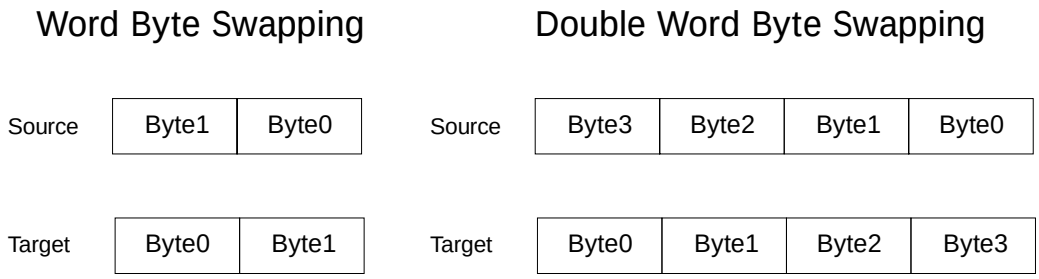


Figure 33

3.8 UniOP Communication Diagnostic

UniOP provides some useful communication diagnostic information in the System Menu. This is available also for the internal controller. When the communication error status LED is available, it will also include status information for the Internal Controller.

There are various cases, depending on the system configuration:

1) The Designer project is configured to use an external controller along with the SCM application, the UniOP COMM LED blinks when an error occurs in the communication link with the external controller or when the error is detected in the link with SCM. In case of a communication error with the external controller, the System Menu provides the communication error code as usual.

2) The Designer project is configured to use only the Internal Controller. In this case the Communication status LED blinks when a communication error with the SCM occurs. The UniOP System Menu does not provide any information about the nature of the communication error. Communication error with the internal PLC should never appear.

Note *UniOP will communicate with the CoDeSys Internal Controller even if the PLC application is not running. This is different from internal controllers based on ISaGRAF where no communication is possible when the PLC runtime is stopped.*

4 Using the Internal Controller

The UniOP Internal Controller is fully compatible with the CoDeSys standard.
The description of the CoDeSys programming tool is contained in the CoDeSys manual distributed with the package; please refer to this documentation for detailed information.

4.1 Target Settings

Target Settings are accessible from the “Resources” tag of the CoDeSys programming software. Please note that most of the options are fixed and cannot be changed by the user.

This chapter includes the basic explanation of the options available in the EXOR/SITEK Target Settings.

A complete explanation of all the options is available in the CoDeSys online help. The tools provided by 3S to the OEMs allow a high level of customization of the Target Settings dialog depending on the specific hardware requirements and capabilities. Most of the options described in the on line help are not available in the EXOR/SITEK Target Support Package. This is not an error but the result of the OEM decision to keep the interface as simple as possible leaving to the user the possibility to control only some of the most important options.

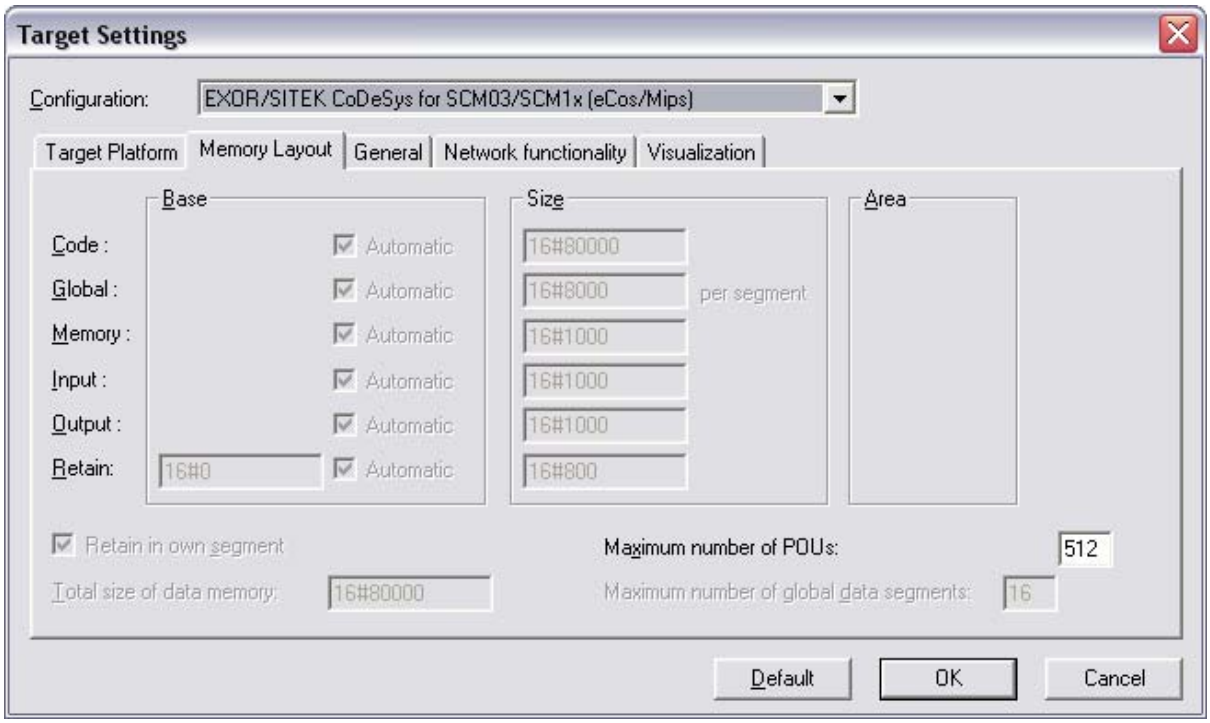


Figure 34

Figure 34 shows the “Memory Layout” tab of the Target Settings.
The “Maximum number of POUs” specifies the max number of POU allowed in a project.
The maximum number of POUs supported by the SCM03-C and SCM11-C modules is 1024.
The user can specify here any number; at compilation time CoDeSys will verify that the actual number of POU defined in the project does not exceed the value specified in target settings.
Please note that at download time, if the number of POUs used is greater than 1024, it will be not possible to download the project to the target.

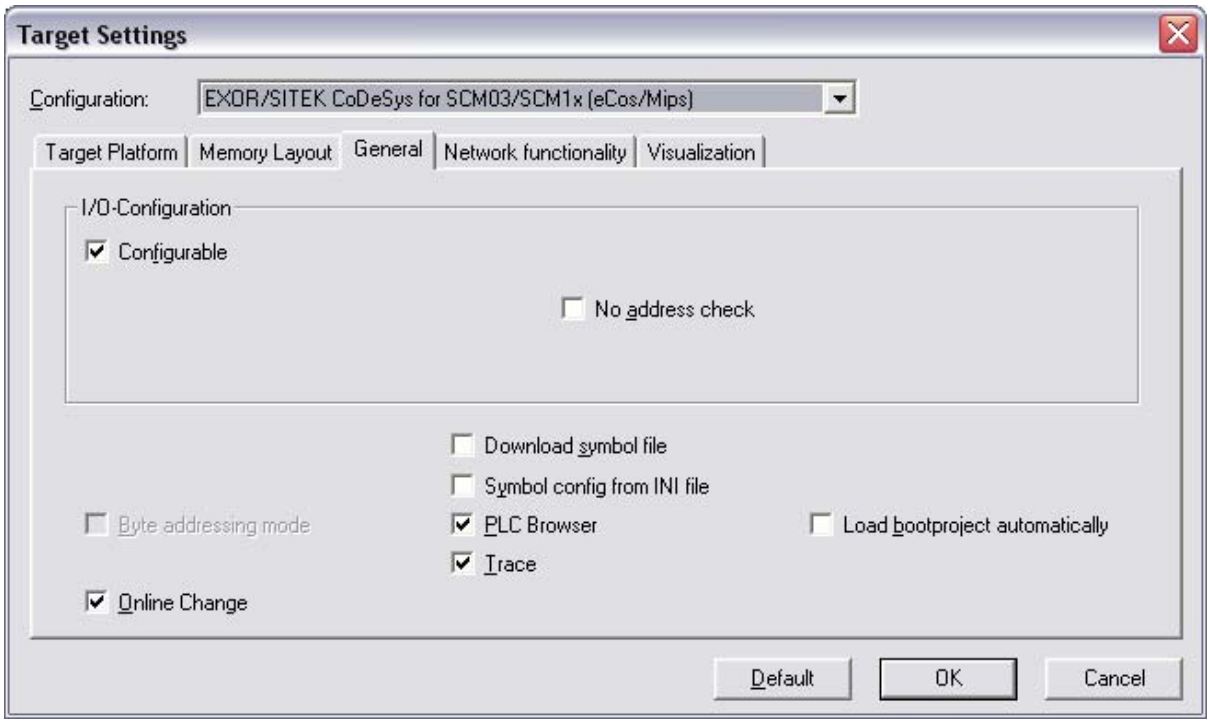


Figure 35

Figure 35 shows the “General” tab and the customizable options available for the EXOR/SITEK target.

Network operation is at the moment not supported. Visualization capabilities are at the moment not supported. The corresponding tabs in Target Setting do not contain any information.

4.2 Setting-up the PLC Configuration

The PLC configuration of the Internal Controller must be defined in the “PLC Configuration” tool available under the “Resources” tag as shown in Figure 36.

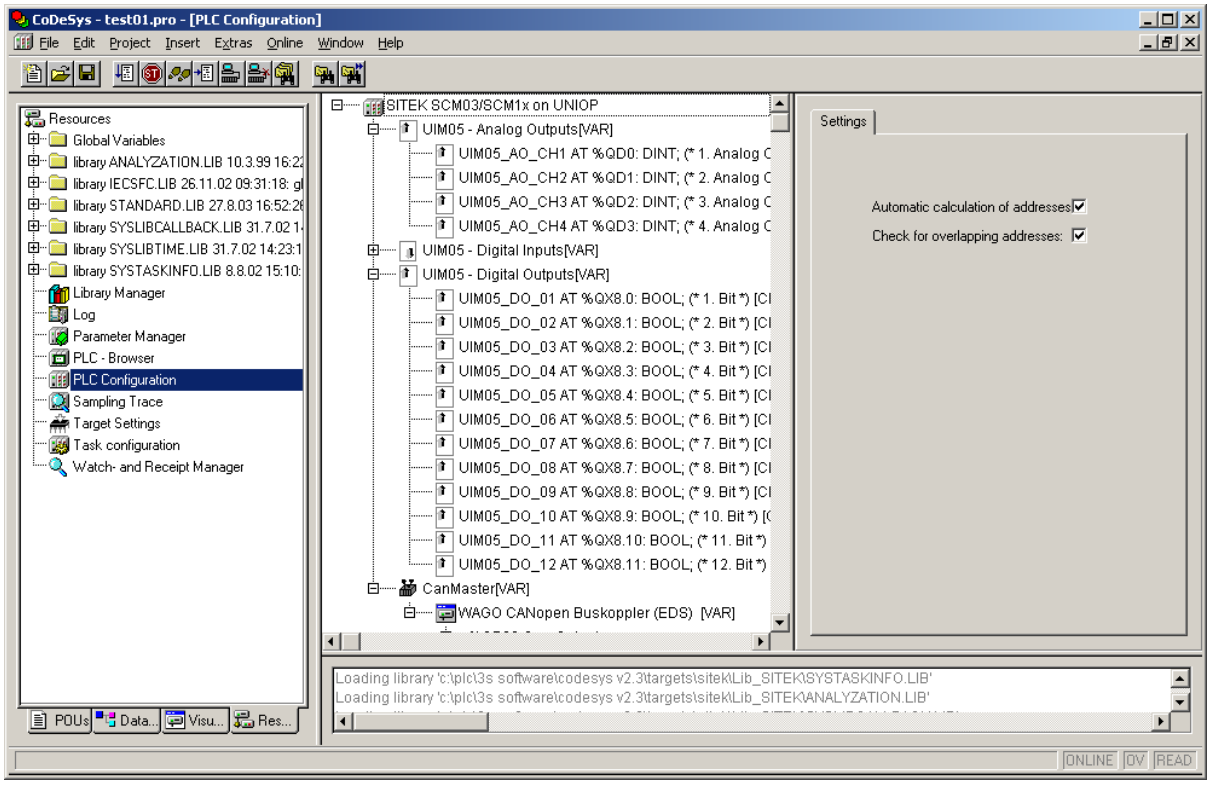


Figure 36

To obtain a valid PLC Configuration, the target settings must be properly configured. CoDeSys implementation for UniOP SCM modules, corresponds to the target “CoDeSys for eCos/Mips on SCM03/SCM1x SITEK S.p.A.”, as shown in Figure 37.

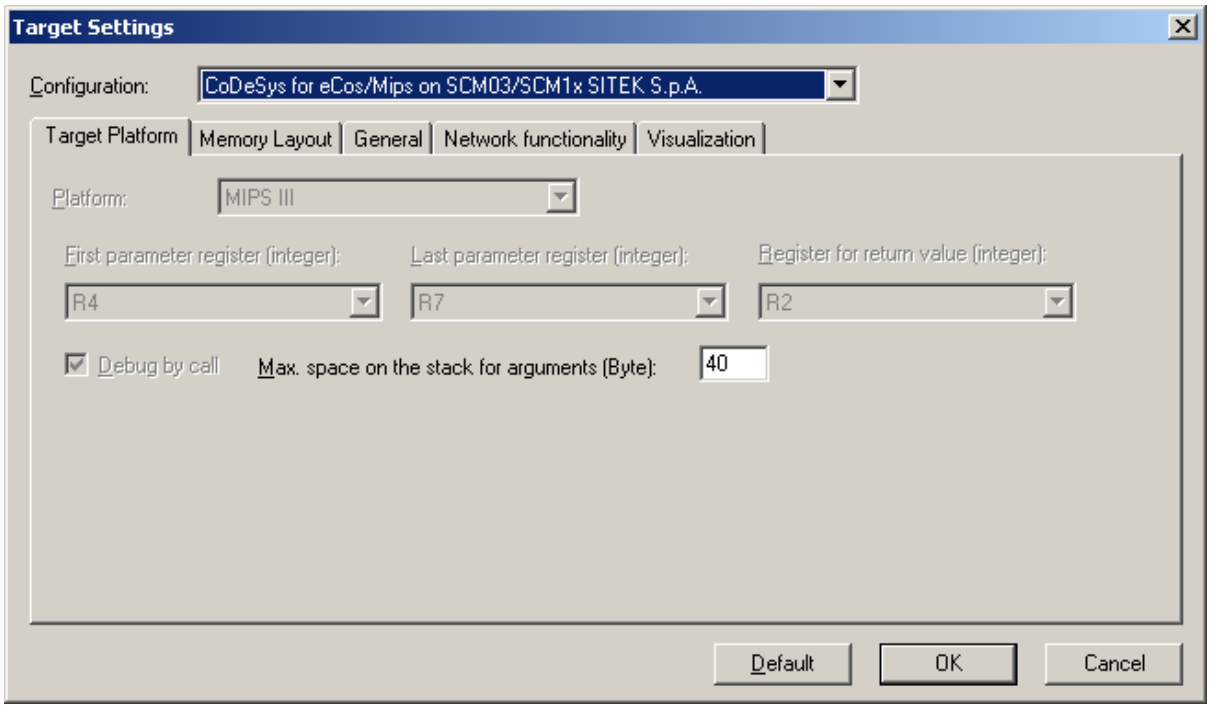


Figure 37

The correct selection of the target ensures a proper configuration of the CoDeSys programming software environment.

4.2.1 Configuring CANopen Distributed I/O

Distributed I/O systems based on the CANopen fieldbus interface of the SCM03-C can be easily configured using the I/O Connection tool.

Note: *SCM11-C modules DO NOT have the CANopen interface; present chapter refers ONLY to SCM03-C modules*

The Internal Controller CANopen master interface must be configured adding the “CanMaster” device in the PLC Configuration tool. Right-click over the root of the tree as shown in Figure 38 to select the device from a list of available boards.

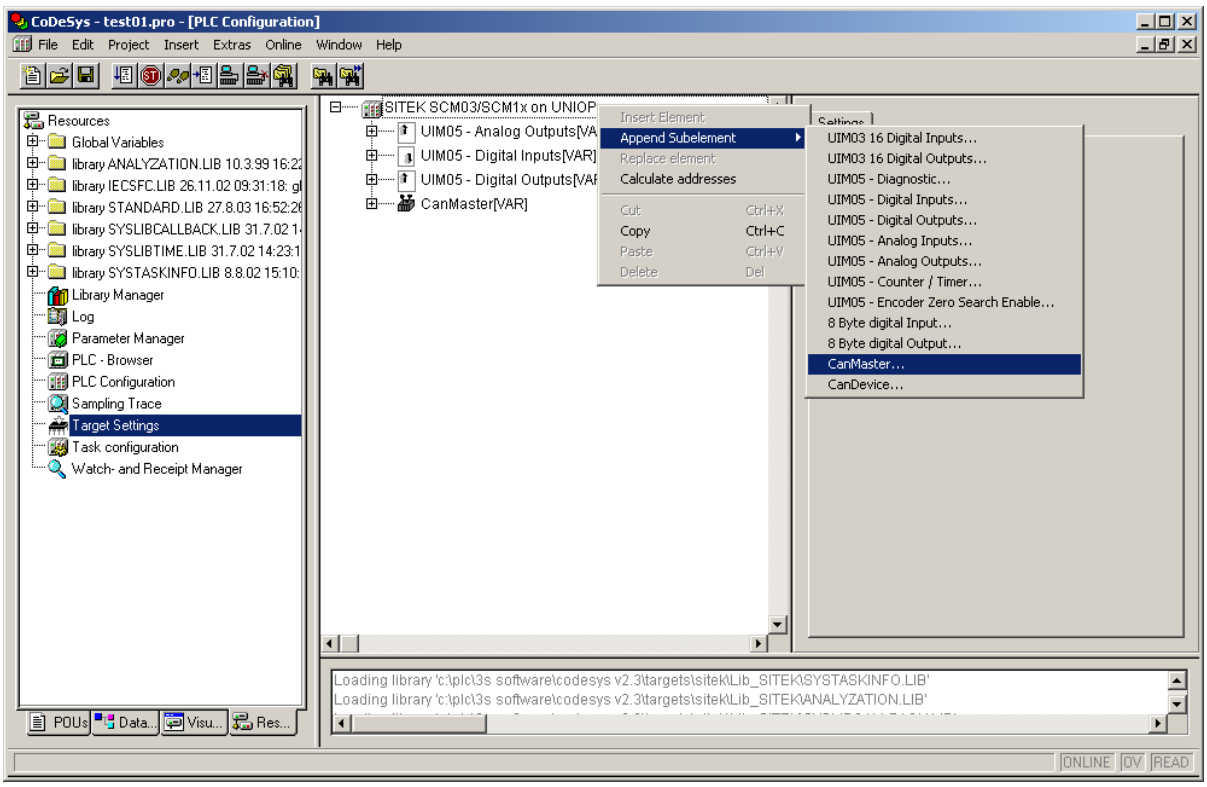


Figure 38

The parameters of the CAN controller are configurable in the rightmost part of the PLC Configuration dialog, once the CAN Master device has been selected in the tree with one mouse click. The configuration window is shown in Figure 39.

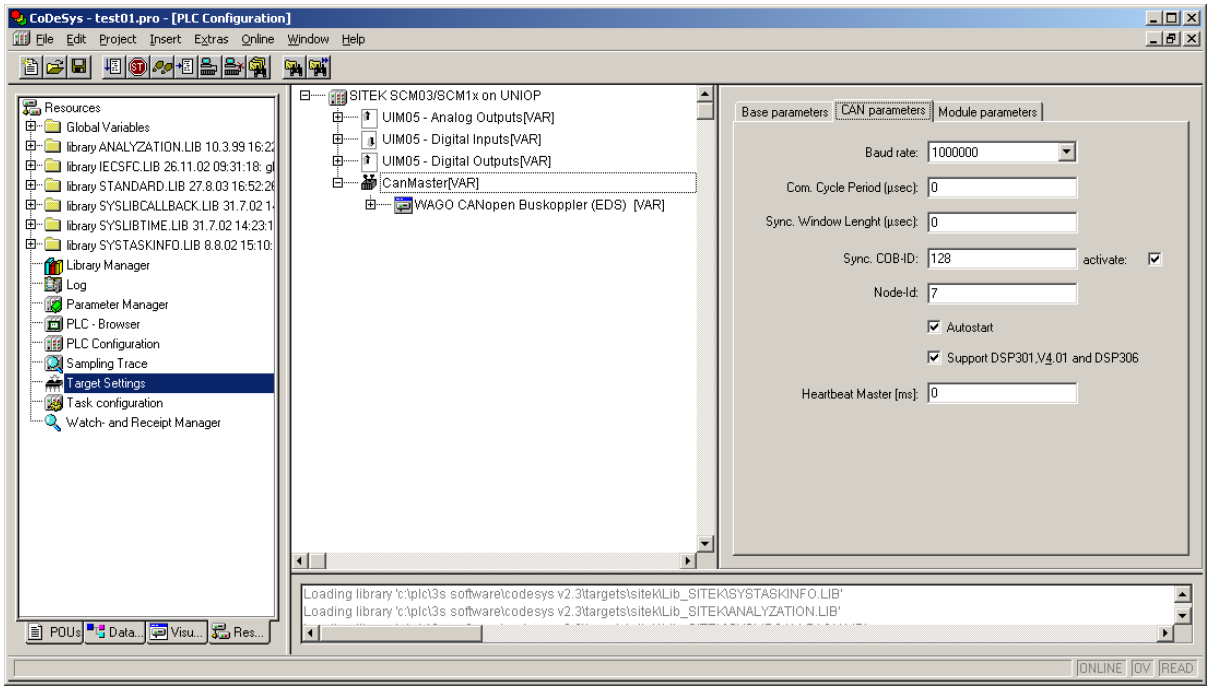


Figure 39

A complete and detailed description on how the CAN controller should be configured and about the configuration of CAN slave devices is included in the CoDeSys User Manual in chapter “6.5.7 – Configuration of CAN Modules”.
The next chapter provides a description of the CanMaster parameters in connection with the SCM03-C hardware and EXOR CoDeSys implementation.

4.2.2 Configuring the CANopen controller

The parameters of the CAN interface are grouped in three tabs accessible on the right part of the PLC Configuration tool when the CanMaster board is selected.

4.2.2.1 Base parameters

Figure 40 shows the “Base Parameters” tab.

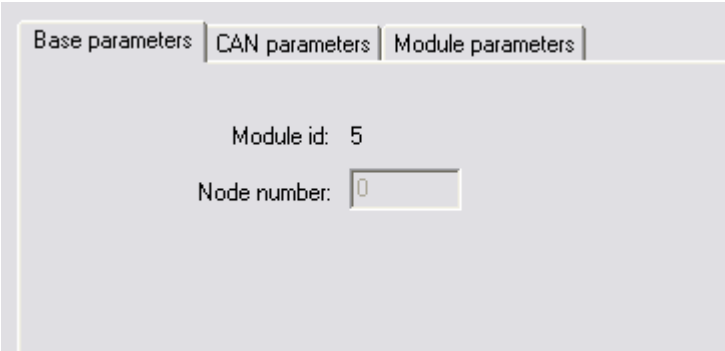


Figure 40

The parameters have the following meaning:

Module id	CoDeSys internal identifier used to recognize the board; it is a read only parameter displayed just for user information
Node number	CoDeSys internal identifier assigned by the programming software depending on the order of the board in the PLC Configuration layout; it is a read only parameter displayed just for user information

4.2.2.2 CAN parameters

Figure 41 shows the "CAN Parameters" tab; it contains all the parameters related to the bus configuration.

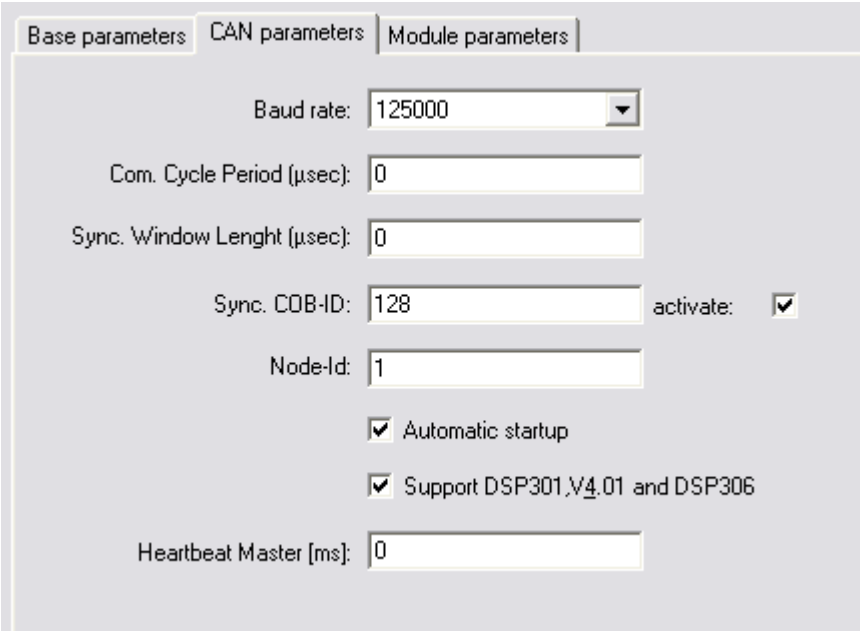


Figure 41

Baud rate	baud rate settings for the bus speed
Com. Cycle Period	specifies the communication cycle interval related to the PDO messages exchange; if set to 0, the default value for communication cycle is set equal to 20ms; note that this is not an inferior limit; minimum allowed value is in fact 1ms
Sync. Window Len.	not supported
Sync. COB-ID	the default value (128) reflect the CiA standard for CANopen; the COB-ID can be changed depending on installation requirements
Activate	allows to specify whenever the Sync should be used or not
Node-Id	node number assigned to the CAN master; even if it can be specified, it is actually not used since the CoDeSys implementation on SCM modules does not support the SDO server functionality
Automatic Startup	specifies if the NMT startup command should be sent automatically to all configured slaves at power up or not
Support DSP301…	enables the controls for the heartbeat and of the Modular Slaves; Modular Slaves is a concept defined by CiA and refers to the usage of a bus coupler that allows connecting several combination of modules (please refer to CiA documentation for further details)
Heartbeat…	not supported

4.2.2.3 Module Parameters

Figure 42 shows the “Module Parameters” tab. It includes the controls to enable CoDeSys to handle CAN controllers when the hardware offers this possibility.
Current implementation of CoDeSys and SCM related hardware does not support this functionality.

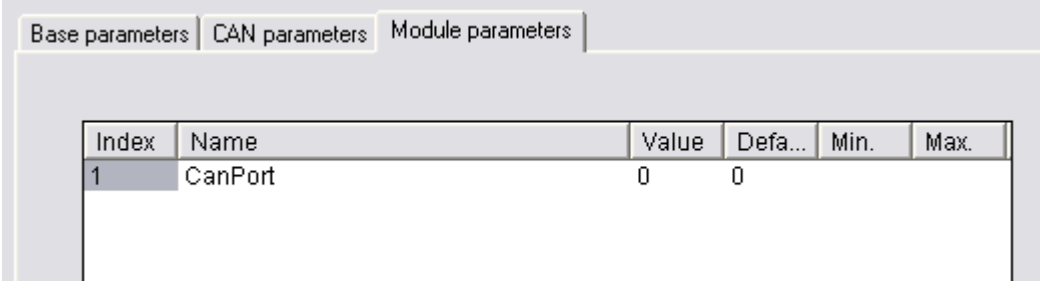


Figure 42

4.2.3 Settings for CAN Slaves

The configuration for the slaves has a common part, which is independent from the EDS. Figure 43 shows the “CAN Parameters” tab of a generic CAN Slave.

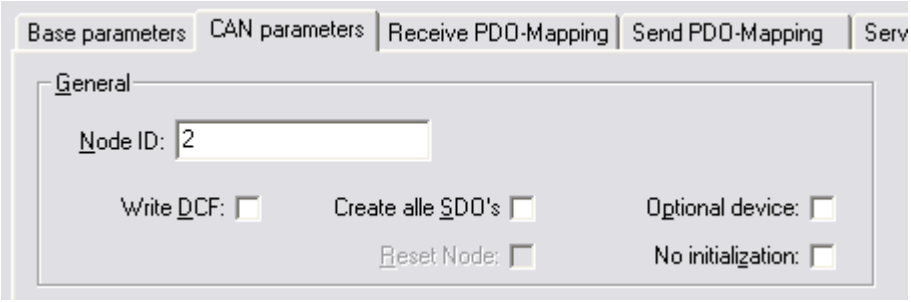


Figure 43

The meaning of the parameters is the following:

Create all SDO’s	specifies whenever the SDO messages for the slave configuration, dependant on the PDO mapping, should be created for all objects (option activated) or just for the modified objects (option not activated); in this second case, please make sure the EDS file loaded in CoDeSys is matching the hardware device features, otherwise some required SDO messages will be erroneously skipped
No initialization	if activated the sequence of SDO messages required for the device initialization (PDO mapping) will not be created
Optional device	not supported

4.3 PLC Programming

The CoDeSys software is based on the IEC 61131-3 standard. It includes the 5 standard programming languages defined in the IEC 61131-3 model:

- **SFC**: Status Flow Chart
- **FBD**: Function Block Diagram

- **LD**: Ladder Diagram
- **ST**: Structured Text
- **IL**: Instruction List

In addition the **CFC** Continuous Function Chart language has been included.

Please refer to the CoDeSys documentation for all the necessary information and details about programming languages.

4.4 PLC Project Upload

PLC project Upload is supported in the UniOP implementation.
To upload a project from the SCM module, select the command Open from the File menu and click on the "PLC" button to specify the source of the open action.

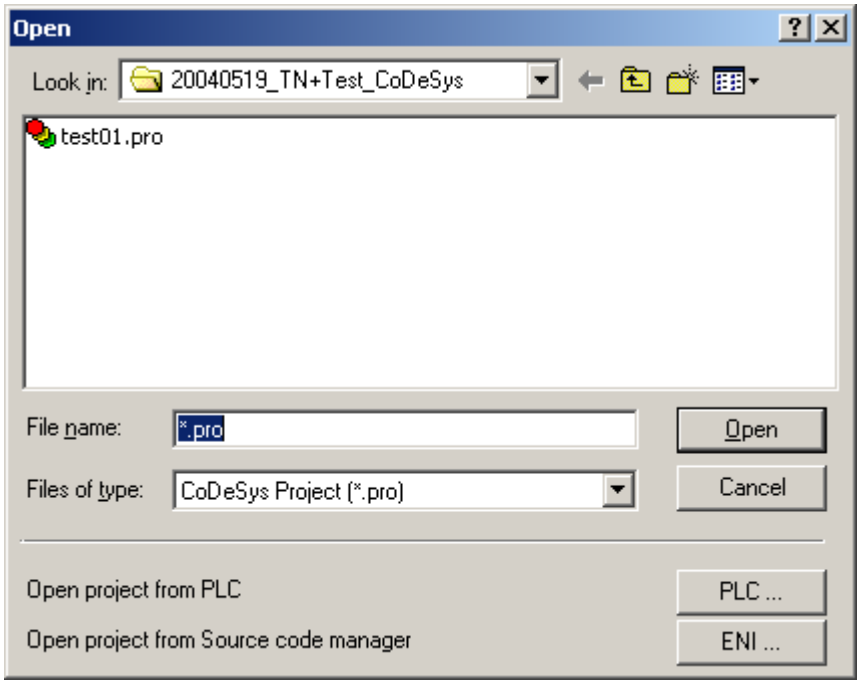


Figure 44

When opening a program from PLC, CoDeSys requires the specification of the target settings; they should be as shown in Figure 45.

Figure 45

Project upload can be executed only if the project source code has been downloaded to the target device.
The "Source code download" command is available form the "Online" menu of the CoDeSys programming software.

4.5 Programming the CANopen Interface

Connection to special CANopen devices may require direct access to some CAN commands. Function blocks are available for this purpose. This chapter describes the most important cases.

Note: *SCM11-C modules DO NOT have the CANopen interface; present chapter refers ONLY to SCM03-C modules*

4.5.1 Access to Remote Variables Using SDO Protocol

The SDO protocol can be used to access any remote variable, defined according to the CANopen standard. The SCM03-C CANopen master works as SDO client and remote nodes are servers. While in PDO mode the transmission is normally cyclical and automatic, in SDO mode the data exchange is normally single-shot. Each session can normally transfer only one data item. This means that the SDO protocol is much slower than the PDO protocol.

Two Function Blocks are available to configure communication via the SDO protocol.

EXOR_CAN_SDO_RD	read remote variables
EXOR_CAN_SDO_WR	write remote variables

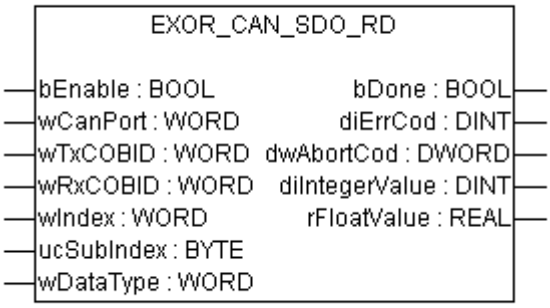


Figure 46

The parameters for the EXOR_CAN_SDO_RD function block are:

wIndex	address of CAN object inside the remote node, as defined by the manufacturer
ucSubindex	address of single variable inside the object
wDataType	one of the data types supported by CAN.
wCanPort	identifies the CAN controller channel
wTxCOBID	specifies the COD ID of the transmit SDO
wRxCOBID	specifies the COD ID of the receiving SDO
bEnable	enable bit

Returned values are:

bDone	flag indicating the operation is executed.
diErrCod	error code of the operation. It is generated by the client and it is valid only after operation has been completed. Value 0 means a successful

	operation.
dwAbortCode	code sent by the server in case the operation is aborted. It is returned by the function block as received from the remote device, so refer to CAN standard definition or to specific technical description of the server (remote device).
diIntegerValue	value of the read variable in integer format
rFloatValue	value of the read variable in float format

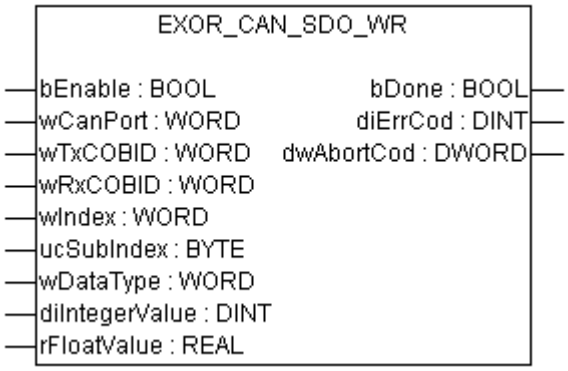


Figure 47

The parameters for the EXOR_CAN_SDO_WR function block are:

bEnable	enable bit
wCanPort	identifies the CAN controller channel
wTxCOBID	specifies the COD ID of the transmit SDO
wRxCOBID	specifies the COD ID of the receiving SDO
wIndex	address of the CAN object inside the remote node, as defined by the manufacturer
ucSubindex	address of single variable inside the object
wDataType	one of the data types supported by CAN.
diIntegerValue	is the value to be written in integer format
rFloatValue	is the value to be written in float format

Returned values are:

bDone	is a flag indicating the operation is executed.
diErrCod	error code of the operation. It is generated by the client and it is valid only after operation is completed. Value 0 means a successful operation.
dwAbortCode	this is the code returned by the server in case the operation is aborted. It is reported as received, so refer to CAN standard definition or to specific technical description of the server.

5 Internal Controller Hardware Manual

This chapter describes some implementation-specific issues in the CoDeSys kernel developed for use with the SCM03-C controller module.

5.1 The CAN Interface

The SCM03-C controller module includes a CAN bus interface implemented according to the CAN protocol specifications 2.0 A.
This CAN controller supports only Standard frame format (2.0 A) with bit rates up to 1 Mbit/s.

The following transfer functions have been implemented:

- Transfer rate and timing
- Message framing (Part A)
- Arbitration accordingly to Part A specifications
- Automatic retransmission in case of lost arbitration or error detection
- Acknowledgement
- Message validation
- Error detection and error signaling
- Global Identifier masking (for 11-bit and 29-bit long identifiers)
- Interrupt or data polling driven software supported
- Automatic transfer of data frame (prepared in SDRAM buffer) triggered by one bit setting
- Automatic receive of data packets with the allowed frame identifier
- 32 separated SDRAM memory buffers for data packets having the node corresponding ID
- Fully implemented CAN error fault confinement
- Automatic detection of Bus off state
- Detection of the heavily disturbed CAN bus and warning

Bit timing is done in a sophisticated way to allow fine-tuning of real systems in case of communication problems.
Programming the parameter baudRateKbps to the value 0 enables the use of custom timing
The resulting baud rate is calculated using the formula:

Bit frequency = 8 MHz / (Prescaler * (1 + Tsetup + Thold))

Valid values for parameters are:

Prescaler	1 to 64
Tsetup	1 to 8
Thold	1 to 4

Other two parameters can affect the behavior of the CAN controller:

SyncJumpWidth: defines the number of time quanta (8 MHz / Prescaler) allowed to accept a SYNC pulse. Valid values are 1 to 4.

SampleMode: defines the number of times the bit is sampled before is considered valid. Valid values are 0 (1 sample) and 1 (3 samples). It is currently not used in SCM03-C where the bus line is always sampled once.

5.2 Watchdog

The SCM03-C controller module includes a watchdog circuit that forces the restart of the module in case of software crashes. The watchdog timer is enabled when the PLC program is running; the control time is fixed and is approximately 1.6 seconds.
The PLC program can re-trigger the watchdog timer calling a special function called WDRESET.

Note *Calling the function WDRESET in a program loop can cause a deadlock condition that will not be resolved by the watchdog system.*

5.3 Timer resolution

The resolution of CoDeSys timers is 1 millisecond. When a timer value is defined it is internally translated to the corresponding number of milliseconds.
The resolution of the internal Real Time Clock is 1 millisecond allowing the maximum resolution of timers. Note that the execution time of the PLC program may apparently affect the resolution of timers.

5.4 CAN Master Operate Functions (EXOR_CAN_IO_CTRL)

To control special features of CAN master, the Function “EXOR_CAN_IO_CTRL” shown hereafter is used.
This function can act on CanMaster Module, one of the connected CAN slaves or one of the Tx or Rx PDOs of the slaves, depending on the parameters, as explained below.

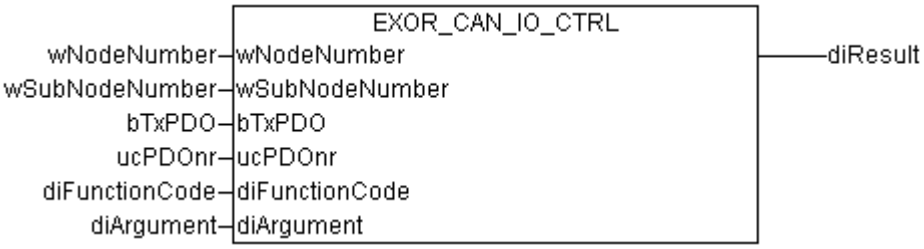


Figure 48

This function can be found in “EXOR_CANopen.lib” file.

The input parameters have the following meaning:

wNodeNumber Each board in the CoDeSys PLC Configuration Editor has a progressive Node Number starting from zero; this is assigned by CoDeSys and is visible in the “Base Parameters” of the board. This parameter identifies the board to which the “diFunctionCode” and “diArgument” parameters will be passed. This must be the Node Number of a CanMaster board.

wSubNodeNumber This is the Node Number of the Sub Element, i.e. the CAN Slave Node appended to the CanMaster to which the IO_CTRL is directed to. If this value is set to 0xFFFF, then the IO_CTRL is directed to the CanMaster Module itself.

bTxPDO This parameter selects if the IO_CTRL is directed to a Tx or Rx PDO of the selected CAN Slave Node. If TRUE then TX PDO is selected. It's unused if parameter ucPDOnr is set to 0xFF.

ucPDOnr This parameter selects to which PDO the IO_CTRL is directed. Zero is the first PDO defined for the selected CAN Slave Node. If this parameter is set to 0xFF, then the IO_CTRL is directed to the CAN Slave Node itself

diFunctionCode This parameters selects the Function to direct to the selected item (Functions Codes are listed in the tables below)

diArgument This is the parameter of the Function; the significance varies from Function to Function.

The Operate Function returns the following output:

diIoCtrlResult This is the return value; the significance varies depending on the selected function.

The following tables show the various Functions Codes for EXOR_CAN_IO_CTRL, depending if the IO_CTRL is directed to CanMaster, CAN Slave Node, Rx PDO or Tx PDO, a different set of Functions is possible.

EXOR_CAN_IO_CTRL Functions Codes List Functions Code Directed to CanMaster Module itself (wSubNodeNumber == 0xFFFF)		
Function Code	**Argument**	**Description**
1	Any	Return the QuickStatus, i.e. the global status: 0 means all ok, otherwise the error code (for a list of error codes please see below).
2	Any	All the errors are collected in an Error FIFO, so that no error event is lost. This function fetches one error from the Error FIFO. The 32 bits integer returned contains the error code (see the list below) in the lower 16 bits and the NodeId in the higher 16 bits. If there are no error events it returns 0.

Table 7

EXOR_CAN_IO_CTRL Functions Codes List Functions Code Directed to CAN Slave Node (ucPDOnr == 0xFF)		
Function Code	**Argument**	**Description**
0	Any	Returns the current status of the device to which the specified I/O variable is connected. 0 means no errors; otherwise the error code is reported (see error codes list below).

Table 8

EXOR_CAN_IO_CTRL Functions Codes List Functions Code Directed to TX PDOs (bTxPDO TRUE)		
Function Code	**Argument**	**Description**
5	Val	Sets the transmission frequency (expressed in number of scan cycles), by default one PDO is sent at each scan cycle.
7	Val	Set new CAN ID (11 bits) and LENGHT of PDO. The passed Value must contain in lower 16 bits the new CAN ID, in the upper 16 bits the new LENGTH.

Table 9

EXOR_CAN_IO_CTRL Functions Codes List Functions Code Directed to RX PDOs (bTxPDO FALSE)		
Function Code	**Argument**	**Description**
3	Any	The number of received PDOs since last call to this operate is returned.
7	Val	Set new CAN ID (11 bits) of PDO. The passed Value must contain the new CAN ID.

Table 10

5.5 Error Codes

The CoDeSys programming software allows to show in its status bar some diagnostic message related to the PLC operation. The following table contains a list of all the possible error codes. Errors marked as “Fatal” are those preventing the operation of the CANopen I/O driver.

0	OK, no errors
1	EXOR.CANopen.CANCFG: (Fatal) [SlotNr] Invalid baudrate
2	EXOR.CANopen: (Fatal) [SlotNr] Invalid board (example: an old board version)
3	EXOR.CANopen: (Fatal) [SlotNr] Too many boards defined
4	EXOR.CANopen: (Fatal) [SlotNr] Missing Configuration board (it should be before any CANopen board)
5	EXOR.CANopen: (Fatal) [SlotNr] Invalid Node ID (1 - 127)
6	EXOR.CANopen: (Fatal) [SlotNr] Invalid PDO Length (0 - 8)
7	EXOR.CANopen: Node [NodeId] has Guarding Error (toggling bit or status incorrect)
8	EXOR.CANopen: Node [NodeId] is Dead (Node does not reply)
9	EXOR.CANopen: Node [NodeId] restarted (Node is alive again)
10	EXOR.CANopen.CANM????: (Fatal) [SlotNr] Missing preceding CANMICFG or CANMOCFG board (see tech note)
11	EXOR.CANopen.CANM????: (Fatal) [SlotNr] Invalid Offset
12	EXOR.CANopen.CANSDO??: Function Block CANSDORD/WR: Too many SDO/PDO
13	EXOR.CANopen.CANSDO??: Function Block CANSDORD/WR: Invalid parameter/s
14	EXOR.CANopen.CANSDO??: Function Block CANSDORD/WR: Invalid reply from remote SDO server
15	EXOR.CANopen.CANSDORD: Function Block CANSDORD: Returned size differs from requested size
16	EXOR.CANopen.CANSDO??: Function Block CANSDORD/WR: No reply timeout
17	EXOR.CANopen: CAN Error Bus Offstate
18	EXOR.CANopen: CAN Error STAT_ERR_PASSIV
19	EXOR.CANopen: CAN Error STAT_WARN
20	EXOR.CANopen: CAN Error STAT_STUFF_ERR

21 EXOR.CANopen: CAN Error STAT_FORM_ERR
22 EXOR.CANopen: CAN Error STAT_ACK_ERR
23 EXOR.CANopen: CAN Error STAT_BIT_ERR
24 EXOR.CANopen: CAN Error STAT_CRC_ERR

5.6 CAN Master Diagnostic Information

When adding a “CAN Master” board in the PLC Configuration, an area of 144 bytes is allocated starting at the indicated diagnostic address, as shown in the next picture:

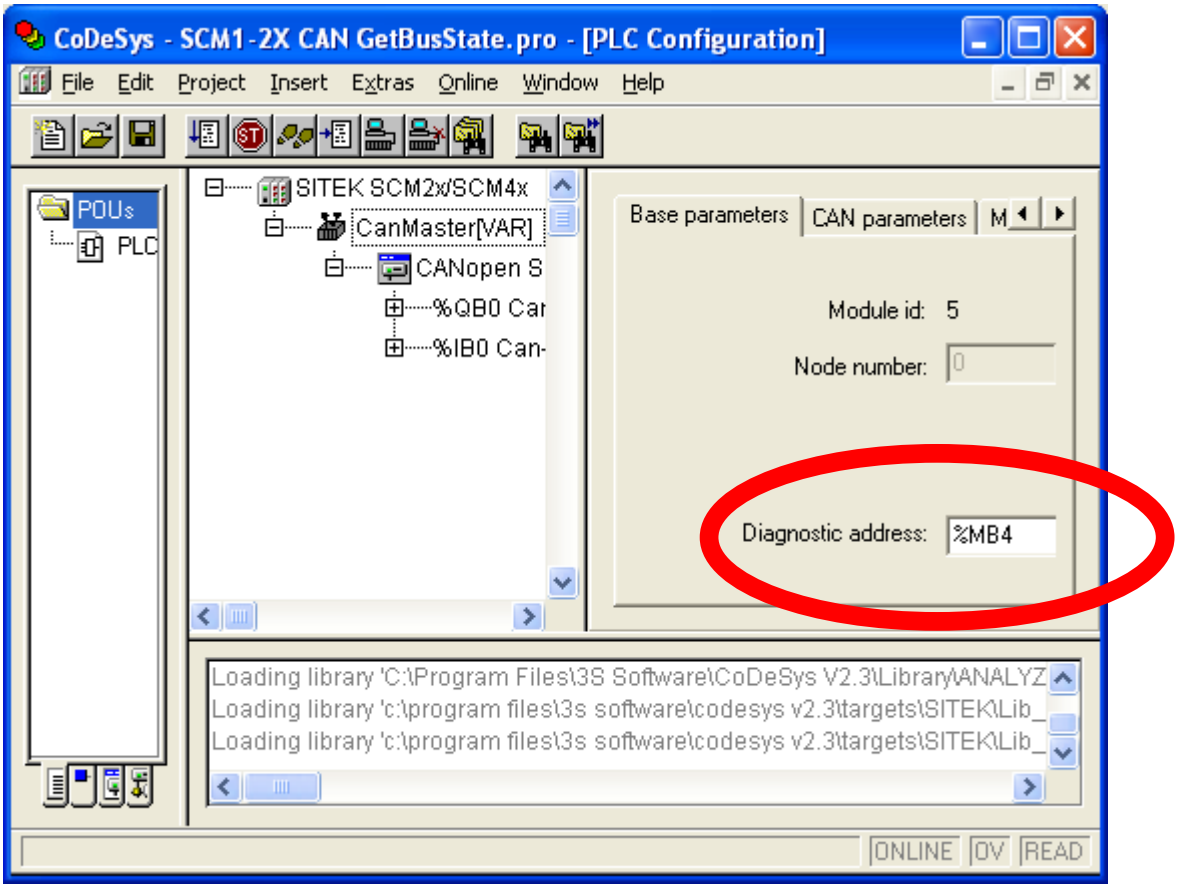


Figure 49

When the “CAN Master” board is added to your project, **after** the first compilation, the library “EXOR_CANopen.lib” is automatically included, as shown in the following figure:

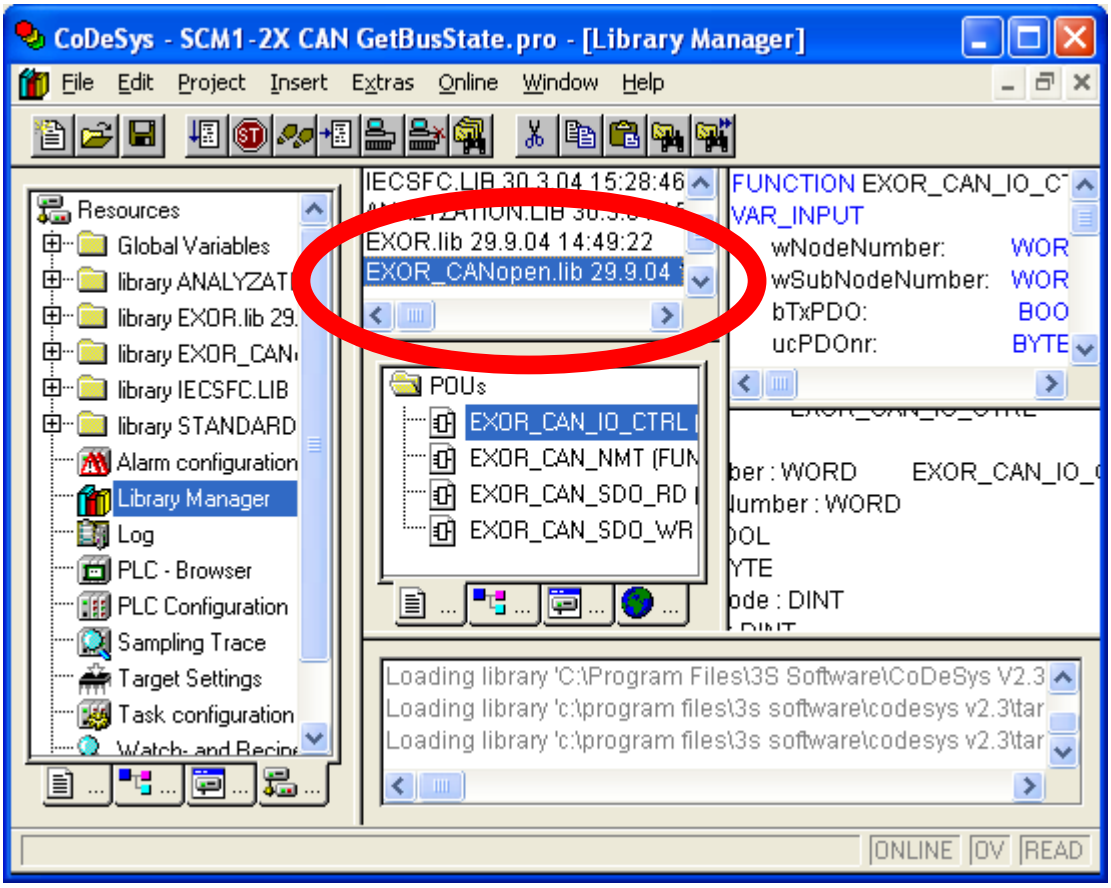


Figure 50

Inside this library the **GetBusState user data type** is defined, as described below:

```
TYPE GETBUSSTATE :
STRUCT
      BOLDENABLE : BOOL;
      ENABLE: BOOL;
      DRIVERNAME:POINTER TO STRING;
      DEVICENUMBER:INT;
      READY:BYTE;
      STATE:INT;
      EXTENDEDINFO:ARRAY[0..129] OF BYTE;
END_STRUCT
END_TYPE
```

where:

BOLDENABLE	Always TRUE
ENABLE	Always TRUE
DRIVERNAME	"CANopen Master"
DEVICENUMBER	CanPort chosen in the CANMaster configuration
READY	TRUE if running
STATE	Quick Status: 0 (zero) means OK, other values are error codes, see

	"ERROR CODES" table
EXTENDEDINFO	Elements 0, 128 and 129 are not used. Elements 1 to 127 contain the state of nodes 1 to 127. Significance of the bits in each byte is: Bit 0: Bus module exists in PLC configuration. Bit 1: Bus module is available in bus system. Bit 2: Bus module reports error.

Table 11

In the user application can be included a variable of this type which must point at the "Diagnostic Address" of the "CAN Master" board, as shown in Figure 51.

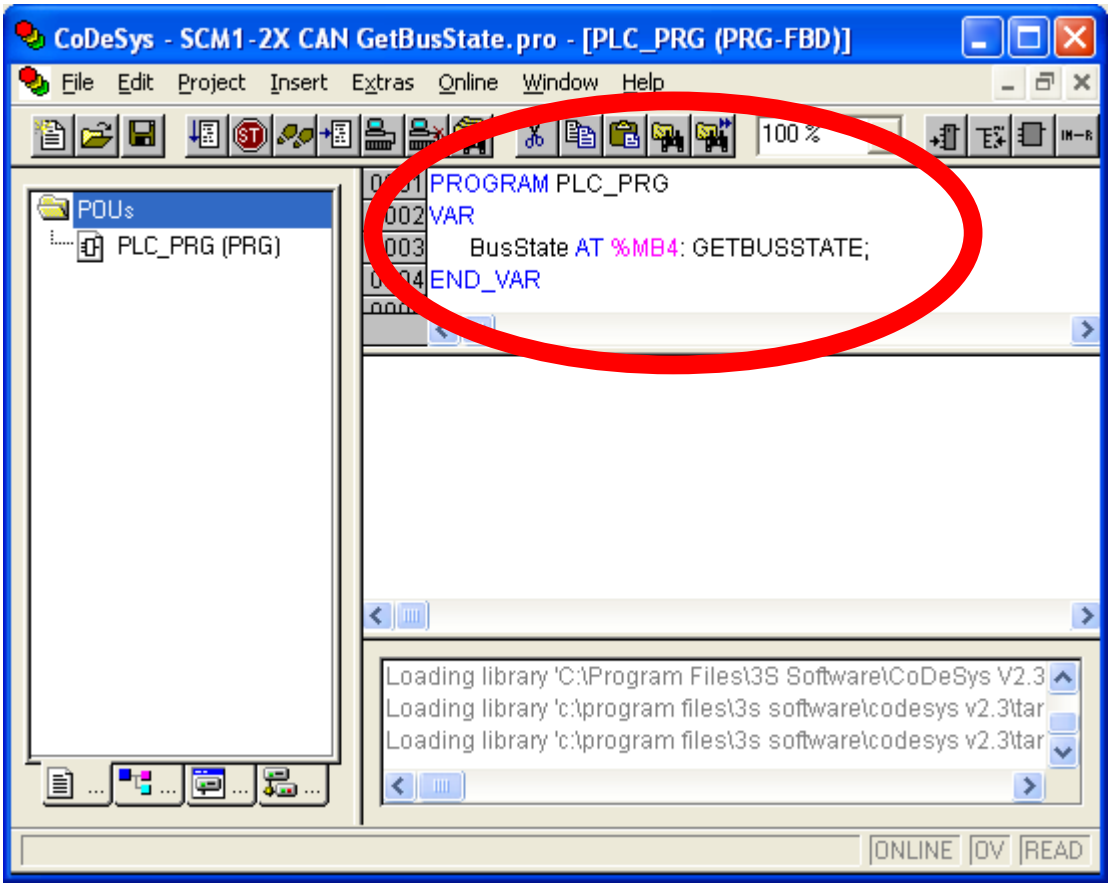


Figure 51

This "GetBusState" user data type complies with the CoDeSys standard method of obtaining diagnostic information for fieldbus I/O as explained in the CoDeSys help.