Connecting UniOP to Simatic S7 Profibus

This Technical Note contains all the information required to connect the UniOP panels to a Profibus DP system with a Simatic S7 master and to take advantage from the advanced data access options supported by the UniOP Profibus DP communication driver.

***Important**: this Technical Note applies only to the Profibus DP communication driver identified by the name 'Profibus DP S7' associated to the Designer file UPLC75.DLL. To run this communication driver it is required a panel of hardware type –0045 equipped with a communication module type TCM08.*

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1. Introduction

The UniOP panel can be connected to the Siemens Simatic S7 family of PLCs via the Profibus DP network. This Technical Note describes the principal points to follow for a successful connection.

A Profibus DP network can contain multiple nodes. A node in a Profibus DP network can be either a Master or a Slave. The Masters in the network have a group of Slaves assigned to them. A Master is able to exchange data with the Slaves that are under its control.

UniOP is always a Slave in a Profibus DP network it is only able to exchange data with a single Master PLC. To enable UniOP to work, a set of special function blocks must be added to the PLC program in the Master PLC. These special function blocks are needed to process the requests from UniOP. These special function blocks use a Data Block, called the UniOP Comm DB within the Master PLC to store configuration information. This approach has the advantage that it offers to the slave panel full access to the data in the PLC, as if the panel was directly connected through the programming port.

There are 4 main steps that you need to follow to make UniOP work with Profibus DP:

1) Configure the Profibus DP network in the project and include UniOP as a slave using the STEP 7 software
2) Add the special function blocks for UniOP to the Master PLCs program
3) Create the UniOP Comm DB in the Master PLC and specify the configuration information in this data block
4) Configure UniOP with the Designer package

These steps are described in greater detail in the following sections.

2. Configuring UniOP as a Slave Station with STEP 7

The Master PLC must be configured to communicate with its Profibus DP slaves. You can do this with the STEP 7 programming package. This package configures the Profibus DP Network attached to the Master PLC (or to the CP communication processor) so that it exchanges data with the specified Slaves. With this package you can select different types of Slaves such as MMI, Remote Inputs/Outputs, etc.

***Note**:* *STEP 7 version 3.1 has been used to create the examples included in this Tech Note . Using another version of the STEP 7 software package may require changes to the procedures described below.*

2.1 Adding the UniOP DDB File to your System

A Profibus DP Slave type file for UniOP is available for the Profibus DP configuration. The filename is EX9649AX.GSD; this file contains the description of the UniOP panels as Profibus DP Slaves.

To include the file in the system, follow the procedure described below:

a) copy the file to the directory \STEP7\S7DATA\GSD
b) update the catalog with the command 'Options/Update DDB Files' in the Hardware Configuration program

This will enable STEP 7 to recognize UniOP as an element of the class 'Additional Field Devices'.

2.2 Network Configuration

The basic steps of the Profibus DP configuration are described below.

a) Create a new STEP 7 project or open an existing project.

b) Configure the system (Hardware Configuration) using components from the Hardware Catalog

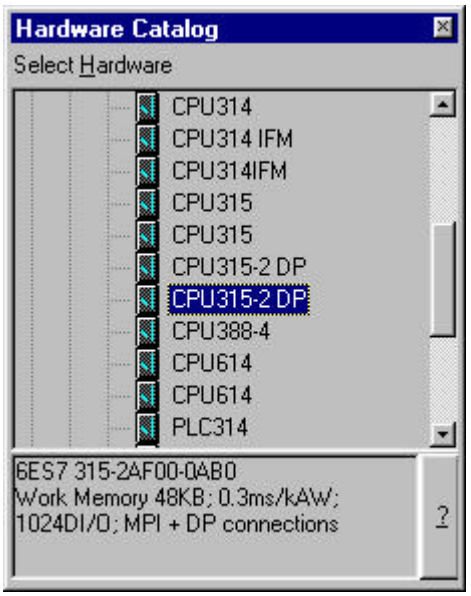

Figure 1 – Hardware Catalog

c) Create and configure the Profibus DP network.

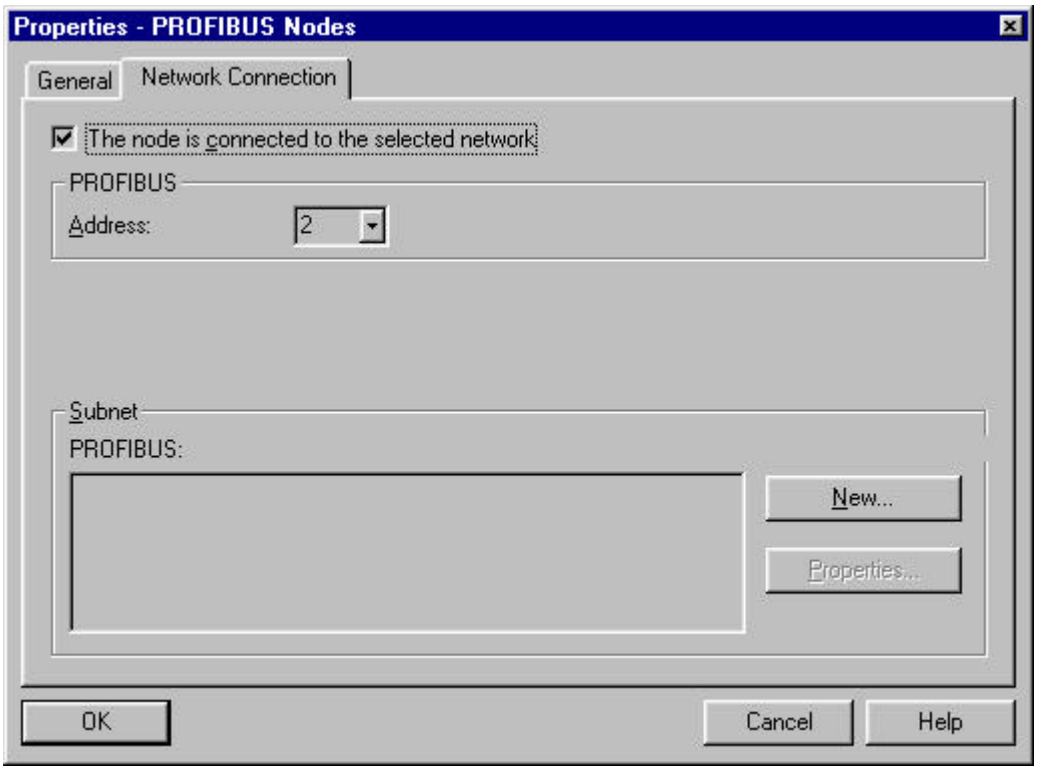

Figure 2 – The Profibus DP network creation

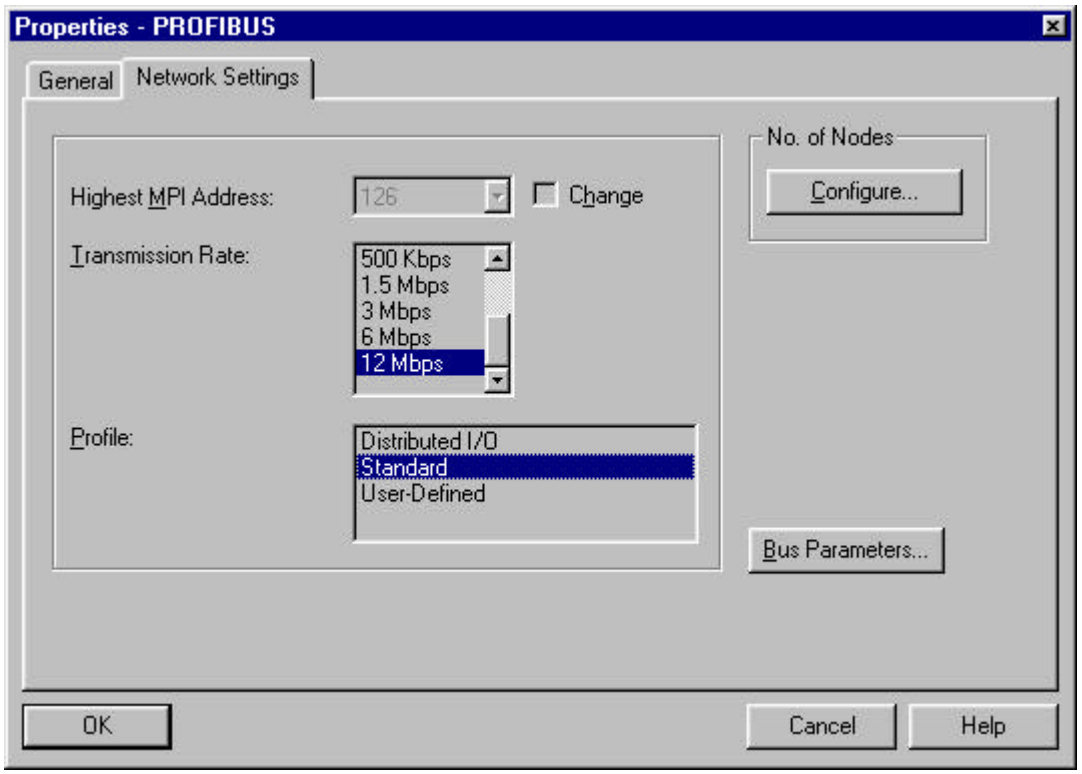

Figure 3 – The Profibus DP network properties

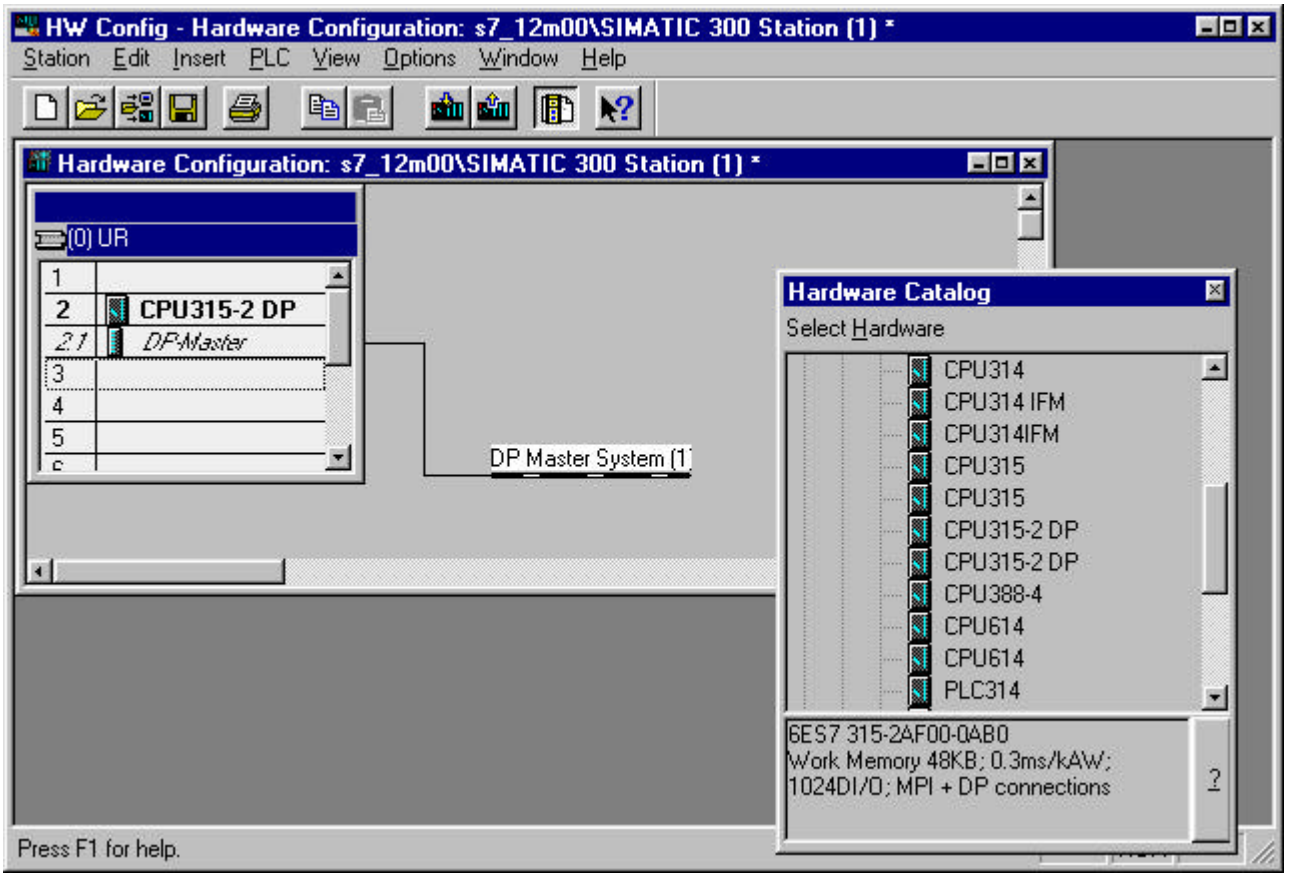

Figure 4 – The Profibus DP network added to the system

The Operator Panels will then be available for selection in the Hardware Catalog as shown in the figure below. Note that the DDB Files must have been updated as described in chapter 2.1.

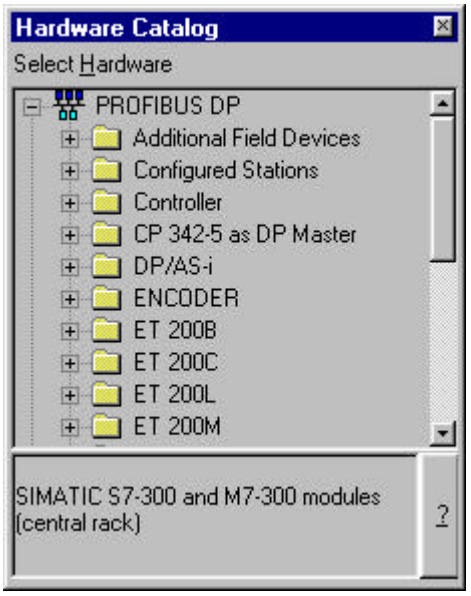

Figure 5 – Hardware Catalog, Additional Field Devices

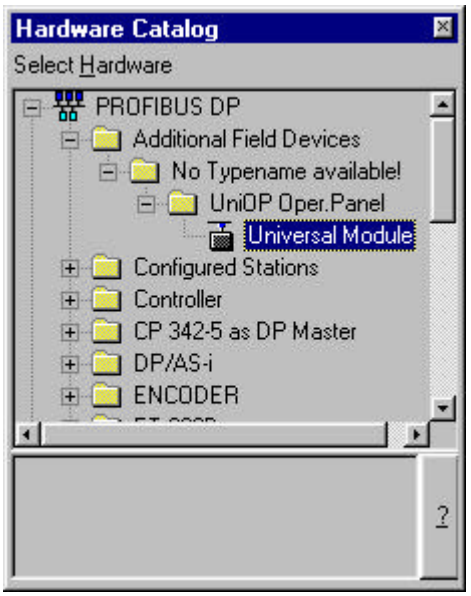

Figure 6 – Device Selection in the Hardware Catalog

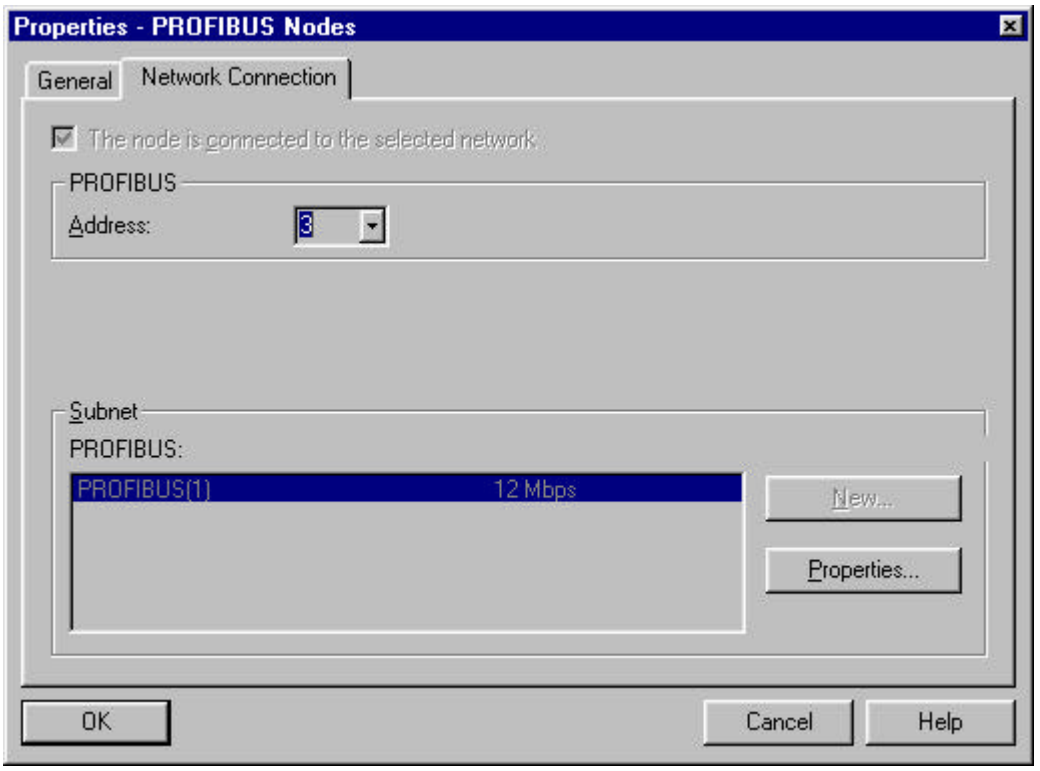

Figure 7 – Profibus Address assignment

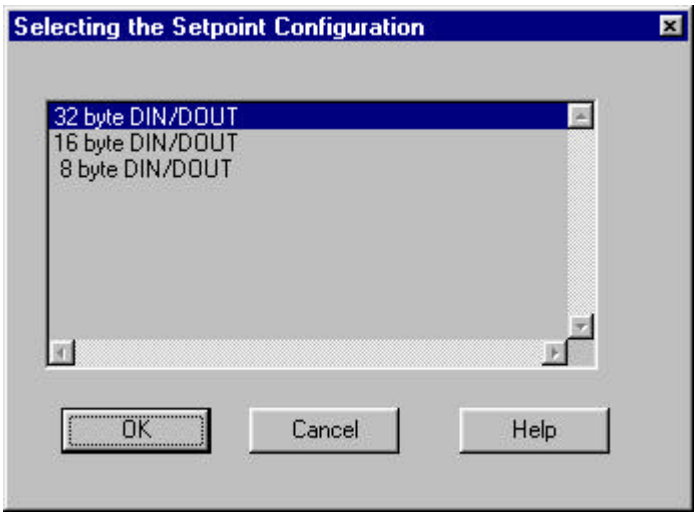

Figure 8 – Selection of Profibus Buffer Size

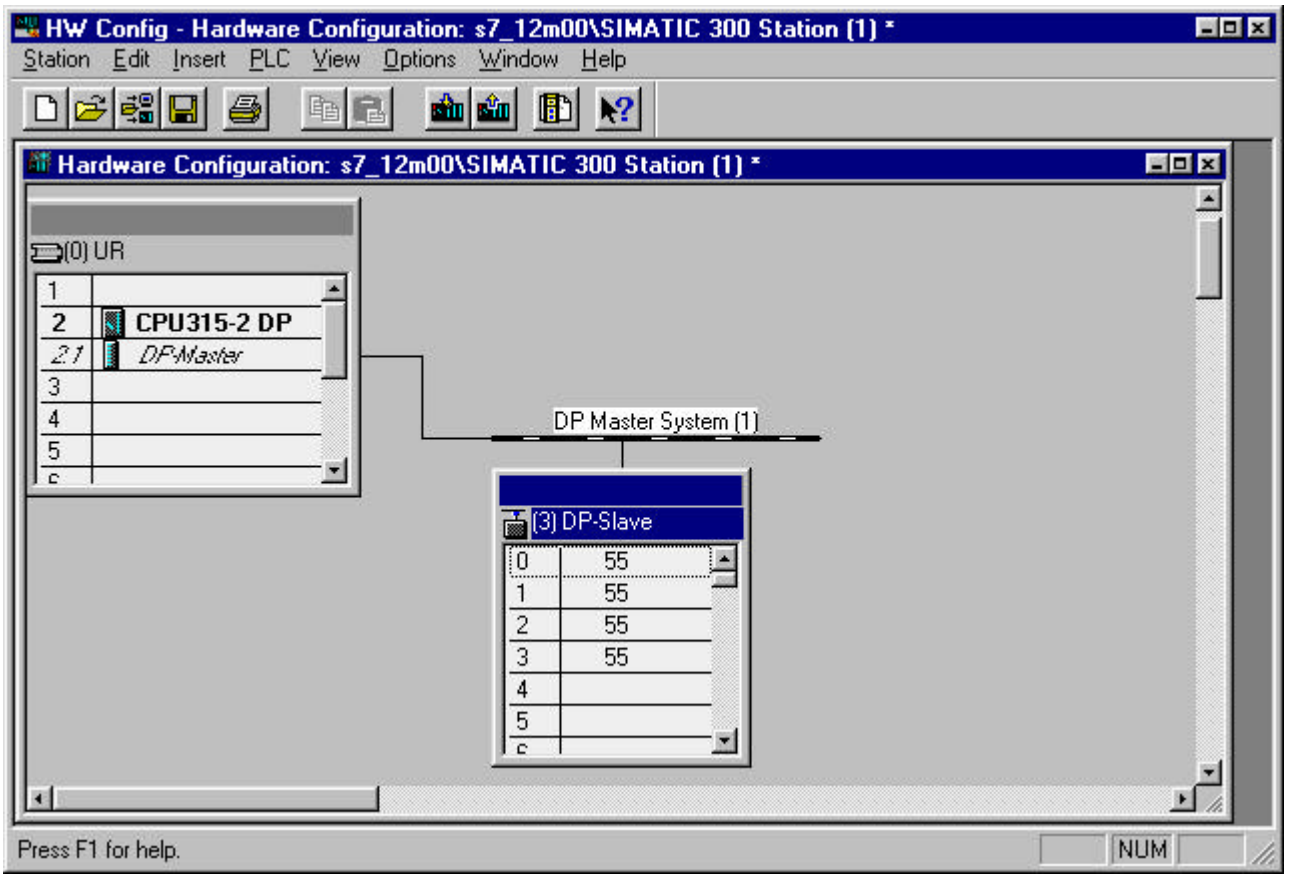

Figure 9 – First Slave has been added

d) Once the Operator Panels have been included in the system configuration, you will have to open the slave configuration and enter the necessary parameters. 2 or 4 blocks must be configured in the DP image area for the device depending on the size of the buffer (16 or 32 bytes) which has been selected in the previous step. UniOP panels can work with a DP image size of 16 bytes or 32 bytes. Using 32 bytes will offer improved communication performance at the expense of an increased memory usage in the process image area.

Configure the blocks in the DP image area. If buffer size of 16 bytes is selected, unused blocks are automatically set to ‘Empty Slot’.

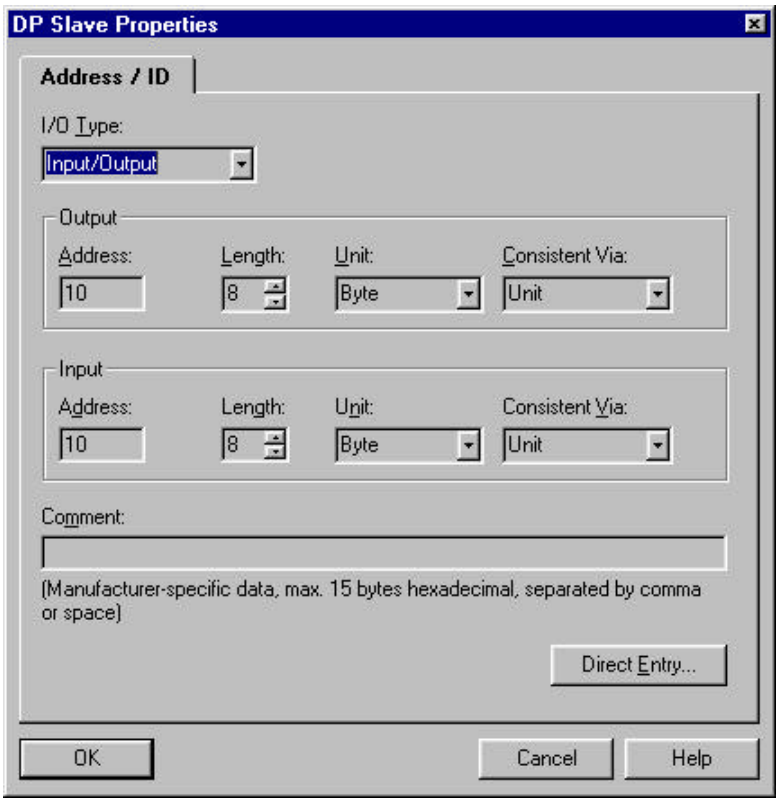

Figure 10 – I/O Block Configuration

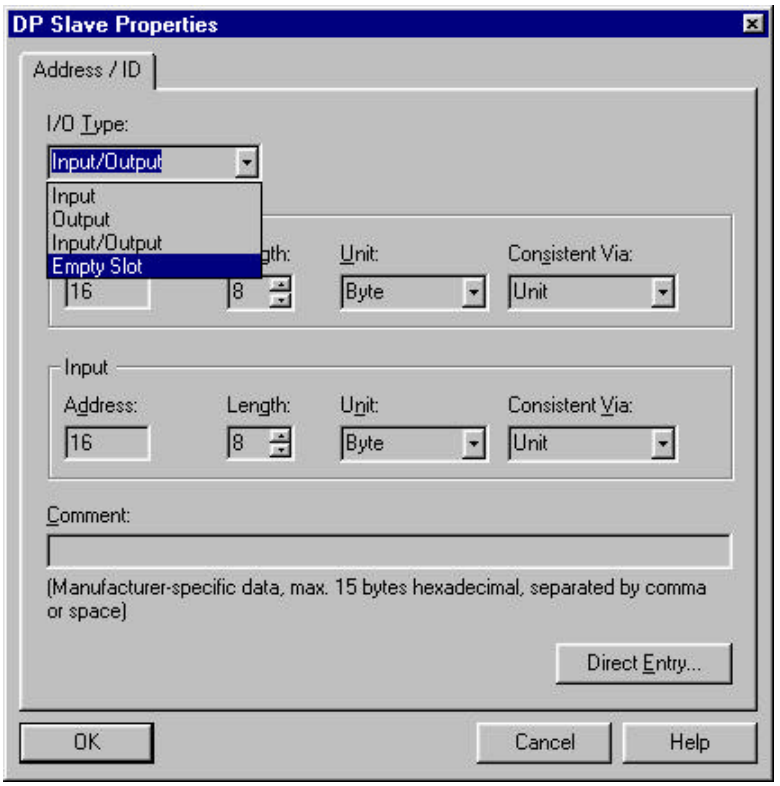

Figure 11 – Empty slot assignment

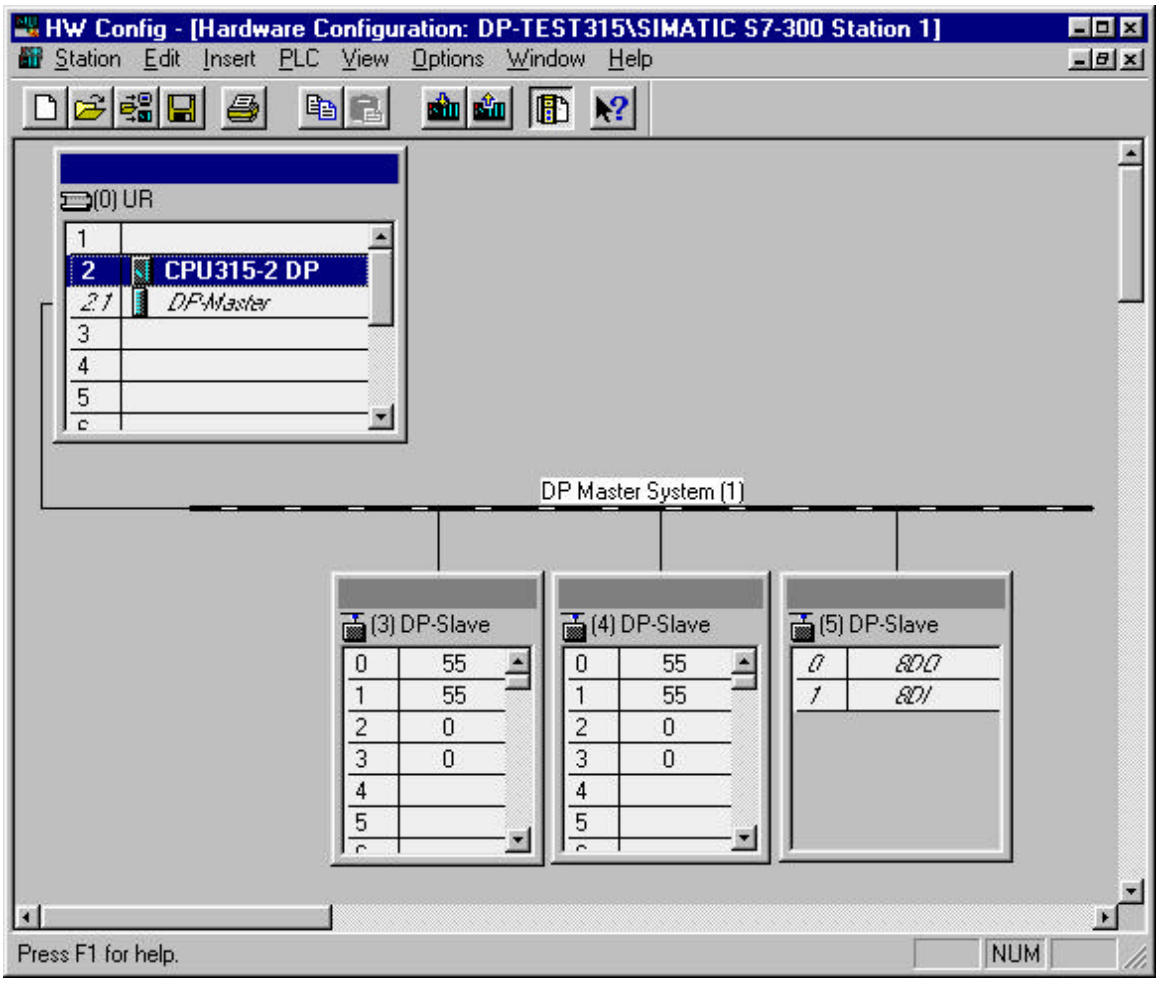

Figure 12 – The complete network configuration

The configuration procedure must be repeated for all the panels to be included as slaves in the Profibus DP network. Finally the system configuration will have to be trasferred to the master PLC.

2.3 DP Image Area with CP 342-5 and CP 443-5

The usage of Profibus DP masters such as the CP 342-5 for the S7-300 and CP 443-5 for the S7-400 requires further considerations.
This chapter does not apply to the cases where an S7 CPU with an integrated Profibus DP port is used (315-2 DP, 413-2 DP and 414-2 DP)
The CP342-5 DP module virtualizes a window of max 240 bytes of DP-Slave peripherals starting at the address defined in the System Configuration (the default address for the first CP342-5 DP is 0x100). This window is not directly addressable by the user program and it will be necessary to use the NCM-S7 library function blocks FC1, FC2, FC3, FC4 to make a copy of this window to a data area that can be directly accessed from the PLC program.

Note: the DP window contains all the Profibus DP peripherals and blocks DP_SEND (FC2), DP_RECEIVE (FC1) need to write/read all used area starting from 0 (relative address in DP window).

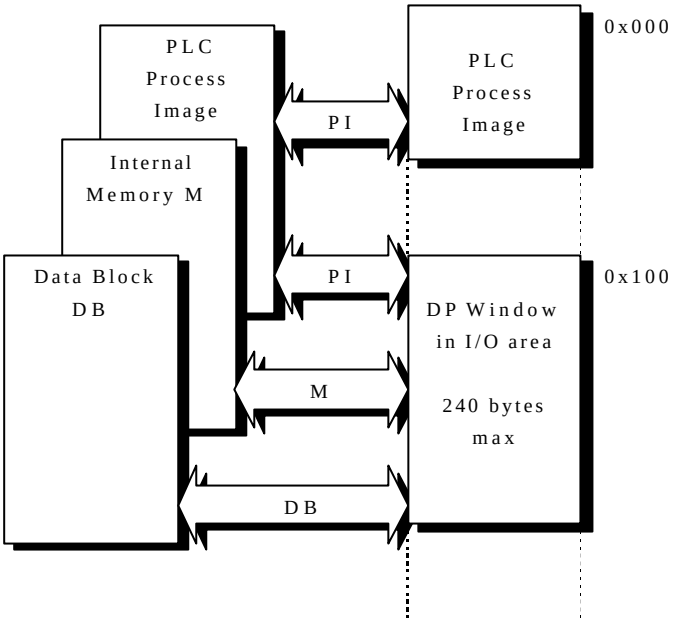

Figure 13 – DP Images with CP

Source and destination of DP window image is defined by a pointer passed to the DP_SEND and DP_RECEIVE function calls.
For additional information refer to the Siemens NCM-S7 manual.

3. Using the UniOP Function Blocks in the Master PLC

To make possible for the UniOP to access all the data in the Master PLC, some support from the PLC program is required. It is accomplished by adding to the user's PLC application some special program modules. Samples of these program modules required to support Profibus communication are available.

The core functionality is provided by one special function block must be added to the user's program. The complete support includes also 2 Data Blocks.
The Function Block and the other blocks are available in the form of ready-to-run sample projects. Function and Data Blocks may be extracted from the sample projects for integration into the user's project.

Apart from adding the special blocks to the PLC program you also need to cyclically call FB1. You can do this by adding a call to FB1 in OB1.

It is important that FB1 is called cyclically, you should not call it only one time, as the function block only processes the requests from the UniOPs when it is called.
UniOP will not be able to communicate with the Master PLC if it is in STOP mode as the special function block will not be called.

Note that if you have multiple UniOPs connected to the Master PLC you do NOT need to call FB1 once for each UniOP. One call to the FB1 for every cycle of the PLC program is sufficient to process all the UniOPs attached to the Master PLC.

3.1 Sample PLC Programs

Several examples of support programs for the Profibus DP communication are available. These programs are provided as STEP7 archives containing either complete projects or program libraries. The examples cover several cases including the use of different CPU's and multiple UniOP panels over the bus.

Filenames are coded according to the rules described below:

- The file name is eight characters long
- The first letter is an internal Exor identifier;
- The following three characters identify the S7 CPU model (**315**, **314**, **414**);
- The 5th character is a letter that indicates if the file contains a complete S7 project with hardware configuration (**P**) or if it contains only a library with the necessary program and data blocks (**L**);
- The 6th character is a number that identifies the number of UniOP panels included as slaves in the Profibus DP network;
- The last number is the release identifier.

The following table lists all available project files.

File Name	CPU Type	Project/Library	Nr. of slave panels	Version
P314P2-1.ARJ	CPU314 + CP342-5 DP	Project	2	1
P315P1-1.ARJ	CPU315-2 DP	Project	1	1
P315P2-1.ARJ	CPU315-2 DP	Project	2	1
P414P1-1.ARJ	CPU414-2 DP	Project	1	1
P414P2-1.ARJ	CPU414-2 DP	Project	2	1
P314L2-1.ARJ	CPU314	Library	2	1
P315L1-1.ARJ	CPU315-2 DP	Library	1	1
P315L2-1.ARJ	CPU315-2 DP	Library	2	1
P414L1-1.ARJ	CPU414-2 DP	Library	1	1
P414L2-1.ARJ	CPU414-2 DP	Library	2	1

4. Creating the UniOP Comm Data Block

The UniOP Comm DB (UniOP Communication Data Block) is used to provide the program modules supporting Profibus DP communication with information it needs about the number of UniOP panels to scan and the addresses for the Input and Output data of the panels in the Master PLCs memory.

The UniOP Comm DB has 2 distinct parts; the first part contains information about the configuration of the Profibus DP network of the PLC while the second part contains information about the various UniOP panels that are connected to this port. Basically this information is a duplication of the data that you enter in the Profibus Master with STEP7.

The Profibus DP Port part is placed in the first 14 bytes of the UniOP Comm DB and has the following format:

DBB0	Number of Panels
DBB1	Frame Length
DBB2	Data Type for Input Buffer
DBB3	Data Type for Output Buffer
DBW4	DB Number (Input Buffer)
DBW6	Input Area Base (Input Buffer)
DBW8	DB Number (Output Buffer)
DBW10	Output Area Base (Output Buffer)
DBB12	Sequence Type
DBB13	Reserved for Internal Use

Number of Panels specifies the total number of UniOP panels that you want to let communicate with the Master PLC.

Frame Length specifies the size of the Profibus buffers used to communicate with the Master. Two buffer sizes are supported: 16 bytes and 32 bytes. Enter the appropriate number in this location. Input and Output buffers always have the same size.

Data Type for Input Buffer specifies the type of PLC data where the Profibus DP input buffer for the panels is located. The Input buffer contains the information received by the Master from the Slave.

Value	Data Type
0	DB
4	I

Note: *in this chapter the terms 'Input' and 'Output' are referred to the Master PLC and not to the slaves. The information entered in this section must be the same entered in the Profibus DP network configuration.*

Data Type for Output Buffer specifies the type of PLC data where the Profibus DP output buffer for the panels is located. The Output buffer contains the information written by the Master to be sent to a Slave.

Value	Data Type
0	DB
5	Q

DB Number (Input Buffer) if the location specified for the Input Buffer is a DB, enter here the DB number.

Input Area Base (Input Buffer) specifies the offset in the Input Buffer where the data for the panels starts.

DB Number (Output Buffer) if the location specified for the Output Buffer is a DB, enter here the DB number.

Output Area Base (Output Buffer) specifies the offset in the Output Buffer where the data for the panels starts.

Sequence Type specifies how you want to handle the case of having Number of Panels set to greater than 1. If you set this item to 0 then the function block will process the requests from all the UniOP panels before returning. If you set this item to 1 then the function block will process the request from only a single panel before returning, it will then process the request for the next panel on the subsequent call. This means that if Sequence Type is set to 0 the requests from the UniOP panels will be processed faster but the execution time of the PLC program will be longer. If the increased execution time of the PLC program causes problems for your application you can set Sequence Type to 1.

Reserved For Internal Use is actually used to keep track of which panel was processed last. This is used if Sequence Type is set to 1.

Following on from the header data comes the UniOP panel data. The number of UniOP panels connected to this port is specified by 'Number of Panels'. Each UniOP panel is assigned 8 bytes in the UniOP Comm DB.

Note: *each panel included in the Profibus DP network must have its descriptor in the Comm Data Block. All descriptors have to be placed in consecutive memory locations.*

The format of the data for a single panel has the following format:

DBW14	Input Area Offset
DBW16	Output Area Offset
DBB18	Reserved
DBB19	Reserved
DBB20	Error Code for Last Request
DBB21	Last Job Number

Input Area Offset this number is added to the Input Area Base (in the header) to obtain the address where this input data for this panel starts.

Output Area Offset this number is added to the Output Area Base (in the header) to obtain the address where this output data for this panel starts.

Error Code for Last Request specifies the Error Code for the last communication request for this panel. You do not need to set this element. The function blocks will actually write to this element to give you an indication of the error status of the communication. This field is therefore just for information. The error codes have the following meaning:

Error Code	Meaning
0	No Request Received
1	Request Processed OK
2	Request Rejected

Last Job Number specifies the Job Number for the last communication request for this panel. Every time the UniOP makes a request it includes the Job Number in the request to the PLC. This Job Number is incremented for every new request. You do not need to set this element. This field is therefore just for information.

4.1 Example

As an example, imagine we have 2 UniOPs attached to a Master PLC that uses I/O addressing and 16 bytes Frame Length. The Input address for the first panel is set to IB16 and the Output address to QB16. The Input address for the second panel is set to IB32 and the Output address to QB32. The UniOP Comm DB would take the following form:

LAD/STL/FBD - [DP-TEST315\SIMATIC S7-300 Station 1\CPU315-2DP1\...\DB41 - <Offline>]

File Edit Insert PLC Debug View Options Window Help

Address	Name	Type	Initial Value	Comment
0.0		STRUCT		
+0.0	NR_P	BYTE	B#16#2	Number of panels
+1.0	FR_LEN	BYTE	B#16#10	Length of frame
+2.0	IN_AM	BYTE	B#16#4	Input area : I
+3.0	OU_AM	BYTE	B#16#5	Output area : Q
+4.0	IN_DBN	WORD	W#16#0	Only with DB input
+6.0	IN_BASOF	WORD	W#16#10	Input area Base Offset
+8.0	OU_DBN	WORD	W#16#0	Only with DB output
+10.0	OU_BASOF	WORD	W#16#10	Output area Base Offset
+12.0	SEQ_TYPE	BYTE	B#16#0	Sequence type : Scan
+13.0	res13	BYTE	B#16#0	Reserved
+14.0	IN1_OFSADJ	WORD	W#16#0	Offset input area panel 1
+16.0	OU1_OFSADJ	WORD	W#16#0	Offset output area panel 1
+18.0	res18	WORD	W#16#0	Reserved
+20.0	ERRCOD1	BYTE	B#16#0	Error code for Panel 1
+21.0	LASTJOBNUM1	BYTE	B#16#0	Last job number for Panel 1
+22.0	IN2_OFSADJ	WORD	W#16#10	Offset input area panel 2
+24.0	OU2_OFSADJ	WORD	W#16#10	Offset output area panel 2
+26.0	res26	WORD	W#16#0	Reserved
+28.0	ERRCOD2	BYTE	B#16#0	Error code for Panel 2
+29.0	LASTJOBNUM2	BYTE	B#16#0	Last job number for Panel 2
=30.0		END_STRUCT		

Press F1 for help. Stat. Data:30 Dyn. Data:0 Modified

Figure 14 – Definition of the UniOP Comm Data Block (Example)

When you download a data block to the PLC or when you modify any values in the data block, you will have to make sure that the modified values are also the current values into the PLC memory. To do this you should change the viewing mode of the data block in the STEP7 software from "Declaration View" to "Data View" as shown in Figure 15.
When you are in Data View mode (see Figure 16), the values in the column 'Actual Value' must match the values on the column 'Initial Value'. If there are some differences you have to correct the wrong value on the 'Actual Value' column and download again the Data Block to the PLC. The 'Actual Value' column displays at any time the actual PLC data values.

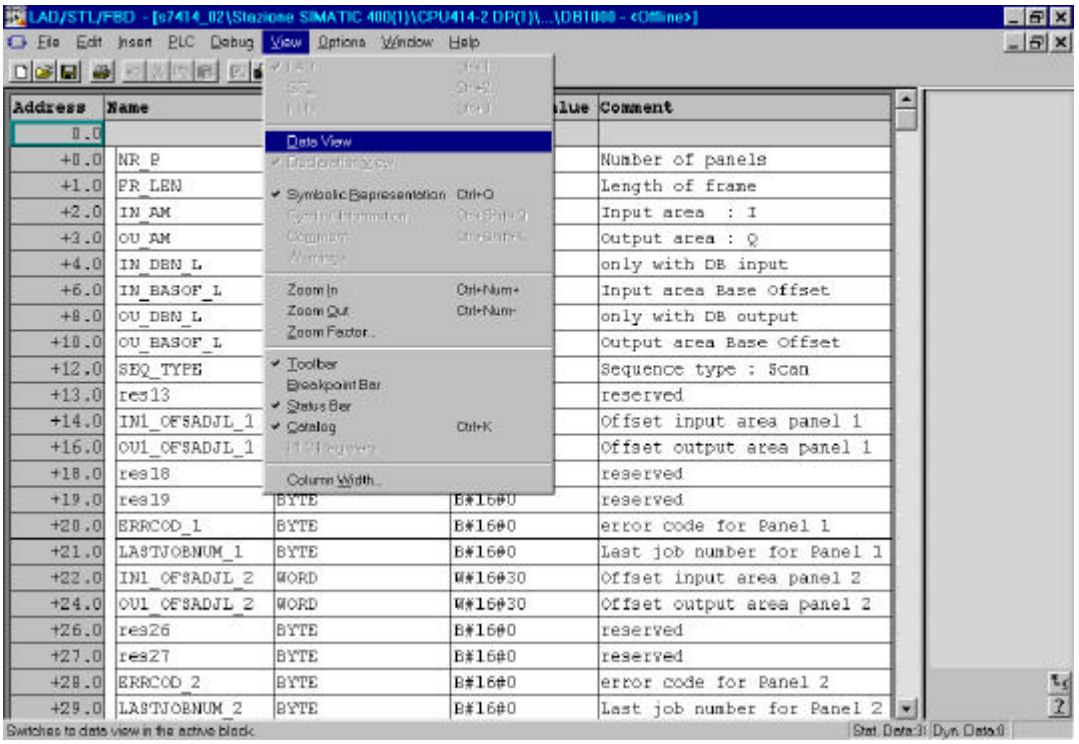

Figure 15 – How to change viewing mode in the STEP7 software

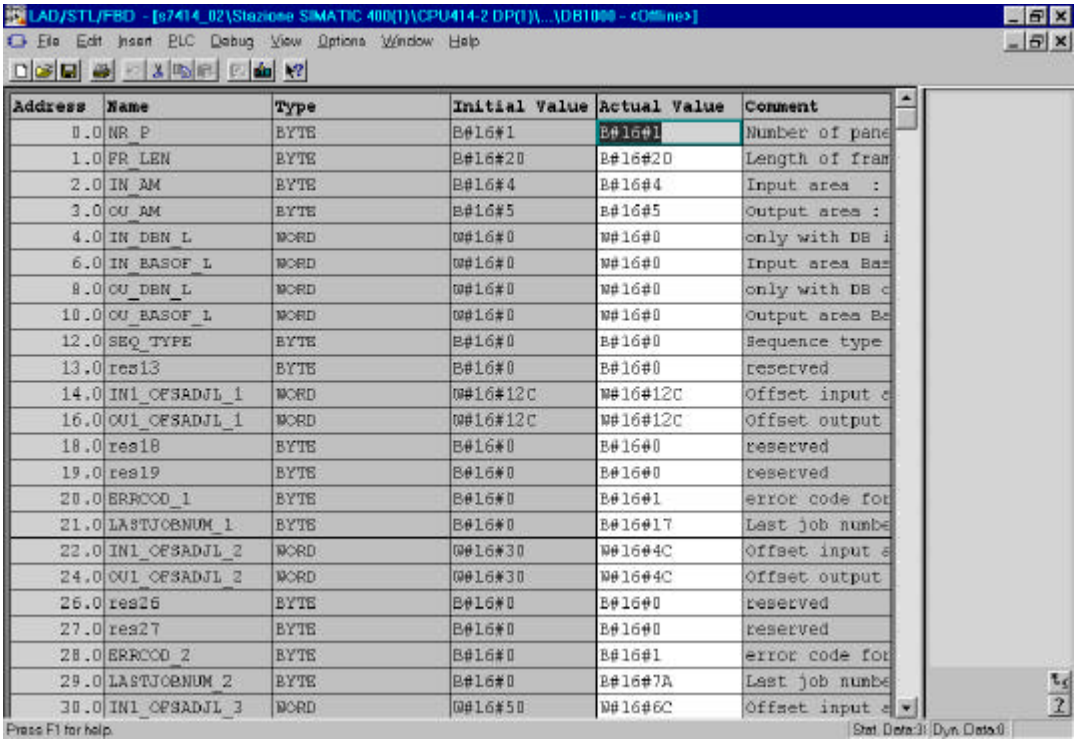

Figure 16 – Data View of Data Block contents

5. Configuring UniOP with Designer for Profibus DP S7

To configure a panel for use with the Profibus DP S7 protocol with the Designer, follow the procedure described in this chapter.

1) Select the option 'Project/Change Communication Driver' and choose 'Profibus DP S7'

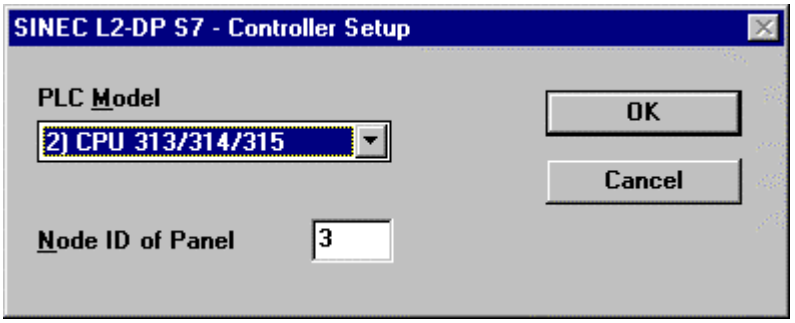

Figure 17 - Controller Setup

2) A UniOP panel in a Profibus DP network is always a Slave that exchanges data with a single Master PLC. Every UniOP in the Profibus DP network must be assigned it's own unique Node address. You do this by entering a number in the 'Node ID of Panel' edit box in the Controller Setup dialog box.

3) Automatic recognition of the baud rate is supported. Communication speeds up to 12 Mb are supported. There is no need to enter the speed of the Profibus DP network

3) The Real Time Clock information in the Reserved Data Area (RDA) is coded in BCD

4) The page number displayed and the page number requested in the RDA are coded in binary.

5) The RDA can be freely positioned within the PLCs Data Block memory.

Note that you can attach more than one UniOP to a single Master PLC.

6. Summary

To get your UniOP up and running as a Profibus DP slave here is a summary of what you need to do:

1. Copy the EX9649AX.GSD file to the STEP 7 GSD subdirectory.
2. Include the UniOP panels as Profibus DP slaves in the Hardware Configuration
3. Include the special function blocks FB1 in the Master PLCs program.
4. Cyclically call FB1 in OB1 of the Master PLC.
5. Configure the UniOP Comm DB to match the Input and Output address specified for the UniOP panels and the buffer size.
6. Create the project files for the UniOP panels. Make sure that the 'Panel Node' specified in the Designer Controller Setup dialog matches the node number used for the UniOP panel in the STEP 7 package.
7. Put the PLC into RUN mode.

7. Troubleshooting

UniOP doesn't communicate, COM LED blinks and the Communication Status shows COM ERR 05 or COM ERR 09:

1. PLC is in STOP or is not turned on?
2. Cable is not connected or is broken?
3. FB1 is not called cyclically from OB1?
4. UniOP has been programmed via the Designer Controller Setup dialog box to have a node number that is the same as another node in the network?
5. The UniOP COMM DB has not been configured properly. Either there is no panel specific block that matches the Input and Output address area for this panel or the UniOP COMM DB has been set to only scan a limited number of panels.
6. Check if there is another slave station configured with the same address as this one.

UniOP doesn't communicate, COM LED blinks and the Communication Status shows COM ERR 04

1. UniOP has been programmed by Designer to access a non-existent data block. Either the RDA or a data item?

PLC fails to go into RUN mode

1. The Master PLC has been configured with STEP 7 to have Response Monitoring enabled for the UniOP panels?
2. The UniOP Comm DB has not been configured properly. Either the addressing mode does not match the actual addressing mode of the Master PLC as configured with STEP 7 or the Input / Output addresses of the UniOP panels do not match the actual Input / Ouput addresses as configured with STEP 7?
3. UniOP has been programmed via the Designer Controller Setup dialog box to have a node number that is the same as another node in the network?

Appendix 1 - Communication Error Codes

Current communication status is displayed in the System Menu of the UniOP. Beside the string describing current state of the communication, there is an additional error code representing the last (which may be not the current one) error encountered. The codes are following:

Code	Description	Notes
0	No error	There are no communication errors and there have been no errors since start-up.
04	Negative acknowledgement to request	occurs when the PLC does not accept the request from UniOP. This error occurs if a non-existent data block is accessed.
05	Time-out error to request	indicates that the communication line has been broken, the PLC has had a power fail or the PLC is in STOP.
06	Ill formed response	means that the response data was received from the PLC but the amount of data received was not what was expected.
07	General communication error	should never happen; it indicates an error in the software.
08	Profibus chip error protect update	indicates an error in the low level handshaking with the internal Profibus chip during the ProtectUpdate operation.
09	Time-out error on chip initialization	indicates a time-out during the network initialization phase. Probably indicates that the communication line has been broken or the PLC has had a power fail or there are two or more slaves with the same node number.
10	Negative acknowledgment in response	occurs when the PLC accepts the request from UniOP but after processing the request returns a NAK

Appendix 2 - Technical Data and Connection Information

The main technical information on the UniOP Profibus DP Slave interface using TCM08 is shown in the table below:

Baudrate	9.6 Kb to 12 Mb
Buffer size	16/32 bytes
Slave address	Software configurable
Optical insulation	Yes
Profibus Connector	Standard, 9 pin female sub-D type

The Aux Port is used for the Profibus DP communication. When the TCM08 communication module is mounted, the Aux Port becomes a standard Profibus connector. A simple point to point connection can be performed with the cable CA128.
In all other cases the usage of special connectors such as the Siemens 6ES7972-0BA20- 0XA0 and 6ES7972-0BB20- 0XA0 is recommended.

Appendix 3 - Requirements and Compatibility

This version of Profibus DP is contained in the Designer DLL file UPLC75.DLL. The initial release level is 3.02 for the communication driver and 5.00 for the DLL (both version numbers can be seen in the Change Controller Driver dialog box of the Designer software).

A communication module of type TCM08 is required. This driver will not work with other communication modules such as the TCM01.
The UniOP panel must have hardware type –0045 and firmware version number 4.10 or higher to support the TCM08 modules.

The new GSD file EX9649AX.GSD is NOT compatible with older versions of the Profibus DP S7 driver (version 3.00 and version 3.01).