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CoNeT Mobile Lab 3

PROFINET ON PHOENIX CONTACT PLATFORM

-CML User Manual –

Revision 1.0

Co-operative Network Training

Education and Culture DG
Lifelong Learning Programme

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1. General description

CoNeT Mobile Lab – PROFINET on Phoenix Contact platform is one of the seven Mobile Labs, which have been developed in the CoNeT-Project. This Mobile Lab focuses on PROFINET on Phoenix Contact hardware using a multivendor system, where the main device is PROFINET-PLC from Phoenix Contact.

The goal of the practical course is to understand modern PROFINET technologies. The participants on the course will acquire practical skills in setting up and adjusting complex automated systems based on modern PROFINET technologies. To help achieve these aims a special CoNeT box was developed. The box is described below. Figure 1 shows the box interface.

Fig. 1. CoNeT Mobile Lab – front view

The main aims of the project are:

To train automation engineers, maintenance engineers, process workers and under- and post-graduates in modern network technology applied to control operations and automated solutions. This will raise productivity in assembly and manufacturing industries.

To develop hands-on training modules at different levels of complexity aimed at students and company employees. It is anticipated that trainees who are already employed will need to fit their learning around existing family or work commitments, therefore the materials will be broken up into ‘bite-sized’ discrete packages and flexible modes of delivery will be used including the use of both ICTs and face-to-face teaching.

To assemble mobile laboratories. These portable labs can be transported between companies and universities and used to complement the training modules. Annual intensive seminars will be organized in cooperation with industry for the participants.

2. CML Hardware

Fig. 2 CML hardware

Figure 2 shows the following hardware:

1)Programmable logic controller
2)Physical process periphery components
3)Industrial PC
4)PROFINET-PROFIBUS Proxy
5)Power components
6)Process simulation terminal
7)Axioline I/O system
8)Siemens I/O system
9)Wago I/O system

1.1 Wiring diagram of the CML

1.1.1 Signal Connections

In the CML two connection technologies are used: PROFINET and PROFIBUS.

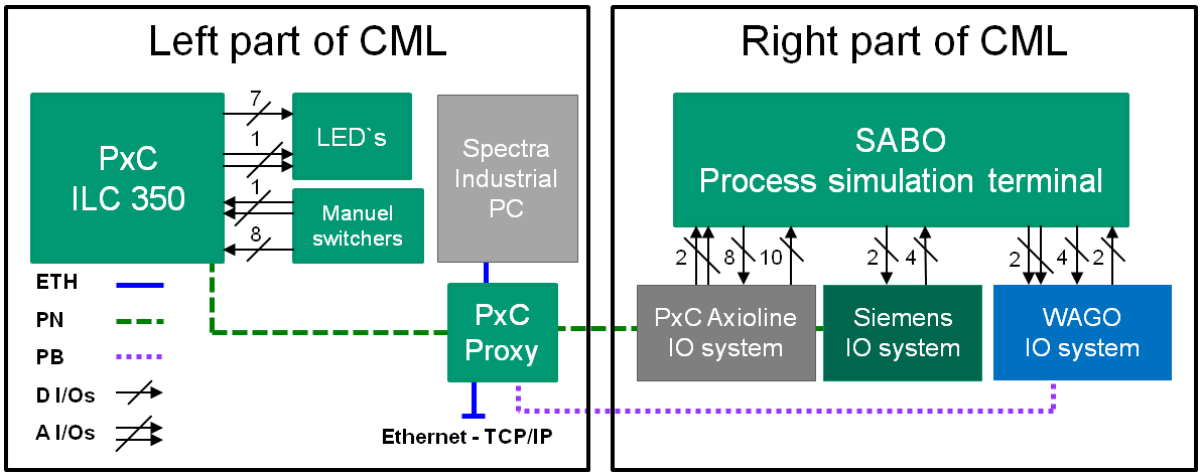

Fig. 3 Signal Connections diagram

Figure 3 illustrates the signal connections between the box components.

1.1.2 Power supply

Two power supply units are used in this CML. One with nominal output voltage 12 Volts and another one with 24 Volts. Actually the voltage 12 Volts is used just by industrial PC. All other components are using the 24 Volts. The power supply wiring diagram for the box components is illustrated on the Fig. 4.

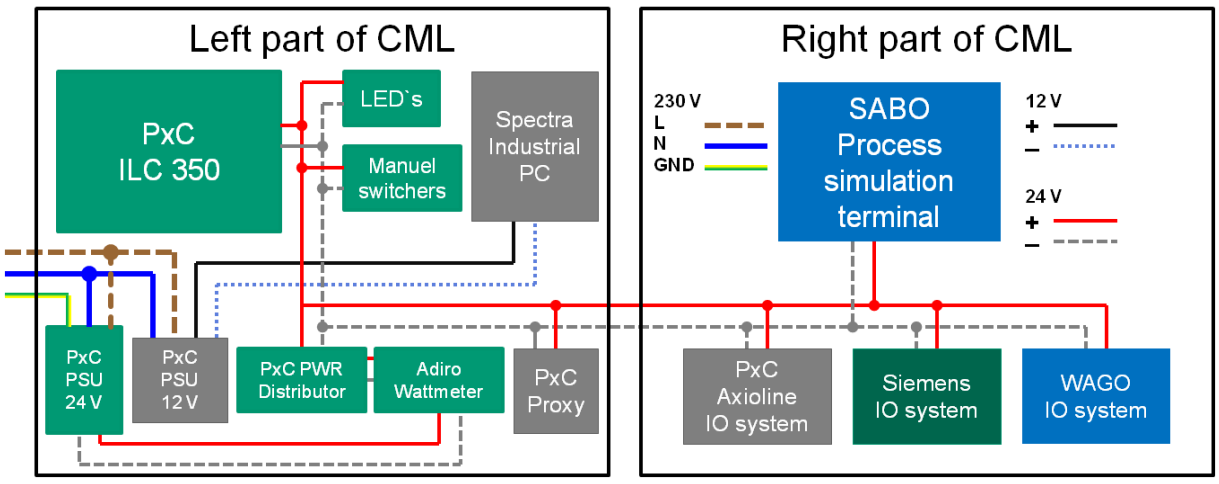

Fig. 4 Power supply wiring diagram

1.2 Description of the components

1.2.1 Programmable Logic Controller (PLC)

The CML uses a programmable logic controller *PN Inline-Controller ILC 350 PN* with flash memory (Fig. 5)

Fig. 5: Inline-Controller ILC 350 PN with Flash Memory card and additional analog I/Os

A programmable logic controller (PLC) or programmable controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or lighting fixtures. PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed or non-volatile memory. A PLC is an example of a real time system since output results must be produced in response to input conditions within a fixed time, otherwise unintended operation will result.

The Inline Controller is seamlessly configured and programmed according to IEC 61131 using the *PC WorX* automation software. *PC WorX* can be used locally on the serial interface or via the network (Ethernet). The powerful processor can be programmed in all five IEC 61131 programming languages and ensures quick control task processing.

The integrated Ethernet connection (using twisted pair cable) provides for the Ethernet connectivity. Throughout the Ethernet network the Inline Controller can be reached via Ethernet and TCP/IP. Integrated communication functions enable direct and effective data exchange via Ethernet.

The Ethernet TCP/IP protocol is used for universal possibilities to communicate with the Inline Controller. Using the TCP/IP to send and receive communication blocks according to the IEC 61131-5 standard, information between Inline Controllers, e.g., necessary coupling variables, can be exchanged via Ethernet. This enables distributed, modular automation solutions to be configured.

Fig. 6: Inline-Controller ILC 350 PN with Flash memory card

When using the INTERBUS AX OPC server, Inline Controller data are available in the Ethernet network in a standardized format and can be used for the different visualization packages. When operating the *ILC 350 PN* via the Ethernet interface the PROFINET protocol can additionally be used.

The I/O level is connected to the Inline Controller using INTERBUS. The Inline Controller can also be used as the head of an INTERBUS Inline station. It is possible to connect an Inline local bus as well as a remote bus. In this way you can create a complete INTERBUS system using the Inline Controller as the distributed control system.

The PLC is equipped with three digital input modules with four channels each and with one digital output module with four channels. Also connected to the PLC are one analog input

module with two channels *IL AI 2/SF-PAC* and one analog output module *IB IL AO 1/U/SF-PAC*. All these I/O are connected via INTERBUS technology.

Analog Inputs IB IL AI 2/SF-PAC

The analog Inline input terminals (Fig. 7) are suited to connecting conventional sensors for the acquisition of current and voltage signals.

Fig. 7 Analog Inline input

Particular features of the modules are: high accuracy of measurement, extremely rapid acquisition of measurement values, excellent noise suppression and common mode rejection, measurement value acquisition with a resolution of 16 bits.

It goes without saying that you also have advantages in handling with the analog Inline input terminals, such as multiwire connection or automatic contact with the grounding conductor when the terminal is snapped onto the DIN rail. The Inline terminals can be labeled using hinged labeling fields. The fields have insert cards that can be labeled individually to suit the application. Additionally, there is the proven ZBFM-6... Zack strip for labeling the terminal points.

Analog Output IB IL AO 1/U/SF-PAC

Fig. 8 Analog Inline output

The analog Inline output terminals (Fig. 8) are used in applications in which analog actuators are to be addressed. With these terminals, common current and voltage output ranges can be configured individually.

The analog signals are made available with a resolution of 16 bits. Physical process peripheric components of the CML

Light indicators block

Fig. 9 EMG 22-LED 7S24

The light indicator block is used for the monitoring of output signals. This block consists of 2 devices: *EMG 22-LED 7S24* (Fig. 9) and *UM 45-IB-DI SIM8* (Fig. 10).

EMG 22-LED 7S/24 has 7 LEDs and can be used to detect digital output signals. UM 45-IB-DI SIM8 is a block of bar LEDs and can be used to detect the level of analog signal.

Fig. 10 UM 45-IB-DI SIM8

Light indicator modules simplify the monitoring of processes of electronic control systems. and are useful tools for troubleshooting. The LED indicators can be labeled individually.

Manual inputs block

Fig. 11 EMG 30-SP 10K LIN

In the CML, a manual inputs block is represented by two devices: a setpoint value potentiometer *EMG 30-SP 10K LIN* (Fig. 11) and 8-way simulator *UM 45-IB-DISIM8* (Fig. 12). A setpoint value potentiometer is used to set setpoints manually with resistance value 10 kΩ.

Fig. 12 UM 45-IB-DISIM8

It is possible to set the output voltage in the area 0÷10 V. An 8-way simulator consists of 8 switchers and makes possible the manual input of up to 8 digital signals.

1.2.2 Industrial PC

Fig. 13 Industrial PC Spectra NISE 100 K1.3

The Industrial-PC NISE 100 K1.3 from NEXCOM (Fig. 13) is an extremely compact and robust industrial mini-PC which is suitable for all uses requiring small size and optimum performance. The PC is equipped with an Intel® Atom™ N270 Processor with 1,6 GHz Frequency, which is famous for its very low electricity consumption. One of the main advantages is the possibility of installing the Windows operating system (not Windows Embedded). NISE 100 is a very good mini-PC for a huge number of applications such as access control, digital sign-posting, information terminal, configuration of the automation system, programming of the controller in automation technology and so on.

The installation of an industrial PC inside the box has a lot of advantages. Only a display, mouse and keyboard are needed and, once connected, the CML is ready to use (similar to Plug&Play devices). No installation outside the box is required which is why there are no problems with software versions and updates. All software and technical documentation is pre-installed on the DIN rail PC inside the box.

1.2.3 PROFINET-PROFIBUS Proxy

Fig. 14 PROFINET-PROFIBUS Proxy FL NP PND-4TX PB

To enable the integration of devices supporting communication technologies other than PROFINET we need to use the Proxy.

The CML uses a PROFINET-PROFIBUS Proxy FL NP PND-4TX PB from Phoenix Contact. Fig. 14 illustrates this device. The Proxy combines a managed switch with four ports with integrated PROFINET IO proxy for PROFIBUS. The Proxy is a PROFINET IO device and supports PROFINET conformance class B. It uses a 10/100Base-T(X) Ethernet twisted pair interface. In PROFIBUS DP it is represented as a Class 1 master and uses PROFIBUS DP protocols (IEC 61158 Type 3 and IEC 61784), supporting PROFIBUS DP master connection up

to 12 Mbps (RS-485 copper technology). Proxy makes possible the Connection of a PROFIBUS DP system to a PROFINET IO controller from Phoenix Contact. To complete the configuration it is necessary to use PC WorX

1.2.4 Power components

DC Wattmeter

Fig. 15 DC Wattmeter BGEL0174

The DC-wattmeter *BGEL0174* from Adiro (Fig. 15) is an electronic power measuring instrument to max. 120 W for low voltage under 30 V DC with a maximum current measurement of 5 A. µController determines from the voltage and current measurement an actual power consumption and the total consumption. These are indicated in a two line 16-symbol LCD display. Total consumption can be reset by the key press. Actual power consumption is given as an analog value, voltage signal 0-10 V and current signal 4-20 mA.

Power Distributor

Fig. 16 Power distributor FLK-PVB 2/24

The growing demand to increase packing density, along with providing fast connector terminations, places new demands on terminal point manufactures. Phoenix Contact VARIOFACE modules meet these new requirements. They are compact multi-position units, providing innovative features for installing power distribution in a restricted space.
Module *FLK-PVB 2/24* (Fig. 16) is the power distributor used in the CML. It allows power distribution for two potentials each in even the smallest distributor boxes. The potentials are supplied with screw connection terminal blocks capable of accommodating input wires up to 12 AWG (4mm2) and output wires up to 14 AWG (2.5mm2). The terminals are provided with labeling for P1 and P2 or + and -. The modules have a universal foot and can be mounted on the standard DIN-rails.

Power supply unit 12V

Fig. 17 Power supply unit STEP-PS/1AC/12DC/5

The CML uses the *STEP-PS/1AC/12DC/5* from Phoenix Contact as 12V Power supply (Fig. 17). The new STEP POWER generation of compact power supply units is particularly suitable for installation distributors and flat control panels thanks to its design. The power supply units are available with special output voltage 12 V DC. Its high degree of efficiency and the low standby losses make for high power efficiency. The power supply can be easily assembled on the DIN rail or panel. It gives maximum energy efficiency thanks to low idling losses. A quick startup with LED function monitoring is possible. The power supply provides high operating safety due to long mains buffering under full load and high MTBF (> 500,000 h). It can be used worldwide in all industrial sectors due to a wide-range input and an international approval package. Parallel connection is possible for increased per-

formance and redundancy.

Power supply unit 24V

Fig. 18 Power supply unit QUINT-PS/1AC/24DC/10

24V power supply is provided by *QUINT-PS/1AC/24DC/10* from Phoenix Contact. The compact QUINT POWER power supply units maximize the power available to the system. Even standard power circuit-breakers can be tripped reliably and quickly with SFB technology (Selective Fusebreaking Technology) and six times the nominal current for 12 ms.

Defective current paths are disconnected selectively, the defect is limited and the important system parts remain in operation. A comprehensive diagnostics is carried out by continuously monitoring the output voltage and current. This preventive function monitoring visualizes the critical operating modes and reports them to the control unit before an error occurs. In this power supply quick tripping of standard power circuit breakers with dynamic SFB technology power reserve. It provides a high degree of operational safety due to high MTBF > 500 000 h, long mains buffering times of more than 20 ms, and high dielectric strength up to 300 V AC.

1.2.5 Process simulation

Fig. 19 Process simulation terminal MTB72723

The process simulation terminal simulates real devices and processes and gives a wide variety of examples for studying. The use of real controlled devices makes a mobile lab very specific and increases its dimensions. Due to the solutions offered by the process simulation terminal the mobile lab is very flexible for teaching people from different branches of automation. As its process simulation terminal the CML uses the *MTB72723* master terminal with touch screen (Fig. 19) and the extension module *EWB73010* (Fig. 20). The master terminal can be programmed in IEC 61131-3, CoDeSys. It comes with different simulation examples and it is also possible to create one's own specialized simulation models.

Fig. 20 Extension module EWB73010

The extension-module is connected to the rear of the terminal through CAN BasicOpen technology. The extension module is just an additional variety of an I/O.

1.2.6 Axioline I/O system

An I/O system makes it possible to enlarge the distance between PLC, sensors and actuators. Signal wires are connected to the IO system nearby which transmits information to the PLC via Ethernet or PROFINET technology

Fig. 21 Axioline PN I/O system

Axioline I/O system is an I/O system with reduced internal delay, which makes this system faster than standard I/O systems. The I/O system used (Fig.21) consists of a Bus coupler and I/Os.

Axioline PROFINET Bus coupler

The CML also uses an Axioline PN Bus coupler *AXL BK PN* (Fig. 22). This offers three characteristic features of a modular terminal block: fast response time, easy operation and rugged mechanical design.

Fig. 22 Axioline PN Bus coupler AXL BK PN

Measuring just 50 mm in height, Axioline also fits in flat standard control cabinets. Axioline already supports the PROFINET and SERCOS III Ethernet-based protocols and will support numerous other communication protocols.

The bus coupler links a PROFINET IO network with the Axioline system. Up to 63 Axioline devices can be connected to an existing PROFINET system using the bus coupler. For startup tests you can put the Axioline station into operation independent of the higher-level network either using the service interface or an Ethernet port at the bus coupler.

The device includes the following features: connection with up to 63 other Axioline devices; Ethernet ports (with integrated switch); typical cycle time of the Axioline system bus: 10 µs, approximately; PROFINET RT; minimum cycle time of PROFINET for RT is 250 µs; runtime in the bus coupler is negligible (to 0 µs); firmware can be updated; diagnostic and status indicators.

Digital outputs AXL DI 16/4

The Axioline digital input module AXL DI 16/4 (Fig. 23) is connected to the bus coupler.

The module is designed for use within an Axioline station. It is used to acquire digital signals. The filter times of the inputs can be set to increase noise immunity. Filter times of 100 µs allow the user to implement a counter function with a maximum input frequency of 5 kHz in the application.

Fig. 23 Axioline digital Inputs AXL DI 16/4

Features of the device include: 16 digital inputs according to EN 61131-2 type 1 and Type 3; 24 V, 2.4 mA; connection of sensors in 2, 3, and 4-wire technology; minimum update time < 100 µs, bus-synchronous; filter times can be set in two increments: < 100 µs or 500 µs;

maximum input frequency: 5 kHz; maximum permissible load current per sensor: 2 A; maximal permissible load current of the module: 4 A (2 A for each group of 8 inputs); device type label stored; diagnostic and status indicators.

Digital inputs AXL DO 16/3

The module is designed for use within an Axioline station. It is used to output digital signals. Actuators with up to three wires can be connected. The outputs are short-circuit and overload-protected .

The device, shown in Fig. 24, possesses the following features: 16 digital outputs; 24 V DC, 500 mA; connection of actuators in 2 and 3-wire technology; minimum update time < 100 μs, bus-synchronous; device type label stored; diagnostic and status indicators.

Fig. 24 Axioline digital outputs AXL DO 16/3

Analog outputs AXL AO 8

This module (Fig. 25) is designed for use within an Axioline station. It is used to output analog voltage and current signals.

The device includes: eight analog, bipolar output channels to connect either voltage or current signals; connection of actuators in 2-wire technology; voltage ranges: 0 V ... 10 V, ±10 V, 0 V ... 5 V, ±5 V; current ranges: 0 mA ... 20 mA, 4 mA ... 20 mA, ±20 mA; short-circuit-proof outputs; device type label stored; diagnostic and status indicators.

Fig. 25 Axioline analog outputs AXL AO 8

1.2.7 Siemens-IO-System

Siemens ET 200S peripheral system (Fig. 26) is an IO device on the PROFINET IO. ET 200S is an I/O system. In our case it consists of interface module IM151-3 PN, power module, one digital input module, two digital output modules inserted onto the terminal module and terminating module. The use of Siemens devices makes the automation system a multivendor system.

Fig. 26 Siemens PN I/O system

The ET 200S distributed I/O system is a discretely modular, highly flexible DP slave for connection to process signals on a central controller or a field bus. ET 200S supports field bus type PROFINET IO. ET 200S has protection class IP 20.

Fig. 27 Interface module IM151-3 PN

Interface module IM151-3 PN

Interface module IM151-3 PN (Fig.27.), with an integrated 2.port switch, connects ET 200S to the PROFINET IO. The device name and backup data can be saved on SIMATIC Micro Memory Card. Interface module (IM151-3 PN) supports Ethernet-services like ping, arp, Netdiagnostics (SNMP) / MIB-2, LLDP. IM151-3 PN, and has onboard LEDs as diagnostic alarms. IM151-3 PN can be connected to a maximum of 63 modules. Isochronous Real-Time-Communication is possible. The minimal Actualization time is 250 μs with IRT. The maximum bus connection is 2 m.

1.2.8 WAGO-IO-System

Fig. 28 WAGO Profibus IO system

The WAGO-I/O-SYSTEM 750 is a modular, PROFIBUS I/O system. The structure consists of an ECO fieldbus coupler (Fig. 28) and up to 64 connected fieldbus modules (3 in our case) for any kind of signal. Together, these make up the fieldbus node. The end module completes the node.

An I/O system makes it possible to increase the distance between PLC, sensors and actuators. Signal wires are connected to the IO system nearby that transmit information to the PLC via Ethernet or PROFINET technology.

WAGO PROFIBUS bus coupler

Fig. 29 WAGO PB buscoupler

Figure 29 shows the WAGO Fieldbuscoupler PROFIBUS DP ECO *750-343* used in the CML.

The ECO fieldbus coupler is designed for applications with a reduced scale I/O requirement. It uses digital only process data or small amounts of analogs. The coupler has an integrated supply terminal for system voltage. The field power jumper contacts are supplied via a separate supply module. When initializing, the buscoupler determines the module structure of the node, to create the process image in PROFIBUS. In order to optimize addresses, the I/O modules with a bit width smaller than 8 are grouped in one byte. It is furthermore possible to deactivate I/O modules and to modify the image of the node according to the connected signals without having to modify the existing application. The diagnosis concept is based on diagnostics according to the EN 50170 standard. Therefore, the programming of modules is not necessary to interpret the diagnostic information from each manufacturer.

Digital input module 750-402

The digital input module 750-402 (Fig. 30) receives control signals from digital field devices (sensors, switches, etc.). The module is a 2- to 3-conductor device and has 4 input channels. Two sensors may be directly connected to the module. As an example, two 3-conductor sensors can be directly connected using connection 24V, 0V and signal input DI1 or DI2.

Fig. 30 Digital input module

The connection of more sensors to signal inputs DI3 and DI4 requires a field side connection module (750-614) for 24V and for 0V, if need be. Each input module has an RC noise rejection filter with a time constant of 3.0 ms. The status of the input channels is indicated via status LEDs.

An optocoupler is used for electrical isolation between the bus and the field side. Any configuration of the input modules is possible when designing the fieldbus node. Grouping of module types is not necessary. The field side supply voltage of 24V for the input module is derived from adjacent I/O modules or from a supply module. The supply voltage for the field side is made automatically through the individual I/O modules by means of power jumper contacts.

Digital output module 750-504

The connected load is switched via the digital output from the control system. The module has four output channels. Two actuators may be directly connected to the module. As an example, two 2-conductor actuators may be directly connected using connection 0 V and signal output DO 1 or 0 V and signal output DO 2. The connection of more actuators to signal outputs DO 3 and DO 4 requires a field side connection module (750-614) for 24V and for 0V, if need be.

Fig. 31 Digital output module

The output channels are electrically short-circuit-protected and

allow high-side switching. This means that the status of the output channels is "high" if the output channels switch to 24 V supply voltage for the field side. The supply voltage for the field side is derived from an adjacent supply module by means of power jumper contacts. The status of the four output channels is indicated via green status LEDs. As with the Digital Input Module 750-402, an optocoupler is used for electrical isolation between the bus and the field side. Any configuration of the output modules is possible when designing the fieldbus node. Grouping of module types is not necessary. The field side supply voltage of 24 V for the output module is derived from adjacent I/O modules or from a supply module. The supply voltage for the field side is made automatically through the individual I/O modules by means of power jumper contacts.

Analog input module 750-468

Fig. 32 Analog input module

The analog input module and its variations receive signals with the standardized values of 0-10 V. The module (illustrated in Fig.32) has four input channels. The fieldside signals may be received via the connections AI 1 and Common (ground) or AI 2 and Common (ground). The connection of more sensors to signal inputs AI 3 and AI 4 requires a suitable measure (for example with a WAGO 4-conductor through terminal block 280-833) for the Common (ground) and the Shield (screen) connection, if need be. The Shield (sceen) is directly connected to the DIN rail. A capacitive connection is made automatically when snapped onto the DIN rail. The input signal of each channel is electrically isolated and will be transmitted with a resolution of 12 bits. The operational readiness and the trouble-free internal data bus communication of the channels are indicated via a green function LED. Any configuration of the input modules is possible when designing the Fieldbus node. Grouping of module types is not necessary The voltage supply is done via system voltage.

End Module 750-600

The end module 750-600 (shown in Fig. 33) is used to terminate the internal bus of a Fieldbus node. This module completes the internal data circuit and ensures correct data flow. The end module is placed at the end of a fieldbus node. The end module 750-600 has no display elements.

Fig. 33 End module

1.3 Process interface description

For a simple simulation, the internal inputs and outputs of the PLC are connected to the LEDs and manual inputs. The simulation models use connections with bus couplers. The connection list is shown in Table 1.

Table 1 CML connection list

SABO		Siemens		WAGO			AXIOLINE			PxC ILC 350			
		2DI	4DO	***2DI***	2DO	***4AI***	***16DI***	16DO	8AO	***12DI***	4DO	**2AI**	1AO
Main (Base)	DA00	***x***											
	DA01	***x***											
	DA02			***x***									
	DA03			***x***									
	DE00		x										
	DE01		x										
	DE02		x										
	DE03		x										
Extension module (CANopen)	DA00						***x***						
	DA01						***x***						
	DA02						***x***						
	DA03						***x***						
	DA04						***x***						
	DA05						***x***						
	DA06						***x***						
	DA07						***x***						
	DE00				x								
	DE01				x								
	DE02							x					
	DE03							x					
	DE04							x					
	DE05							x					
	DE06							x					
	DE07							x					
	AA00					***x***							
	AA01					***x***							
	AE00								x				
	AE01								x				
	AE02								x				
	AE03								x				
	ZE00							x					
	ZE01							x					
8 Switchers	8 DO									***8***			
8 LED's	8 DI										4		
Pot.meter	1 AO											**x**	
Bar LED's	1 AI												x

For example, if we want to know how the Siemens I/O system is connected to the SABO terminal, we have to find the markers which connect the SABO I/Os on the horizontal line and Siemens I/Os on the vertical line (see Table 2).

Table 2 Example of the connection list

SABO		Siemens	
		2DI	4DO
Main (Base)	DA00	*x*	
	DA01	*x*	
	DA02		
	DA03		
	DE00		x
	DE01		x
	DE02		x
	DE03		x

This connection is also represented in Fig. 34. and is marked in red.

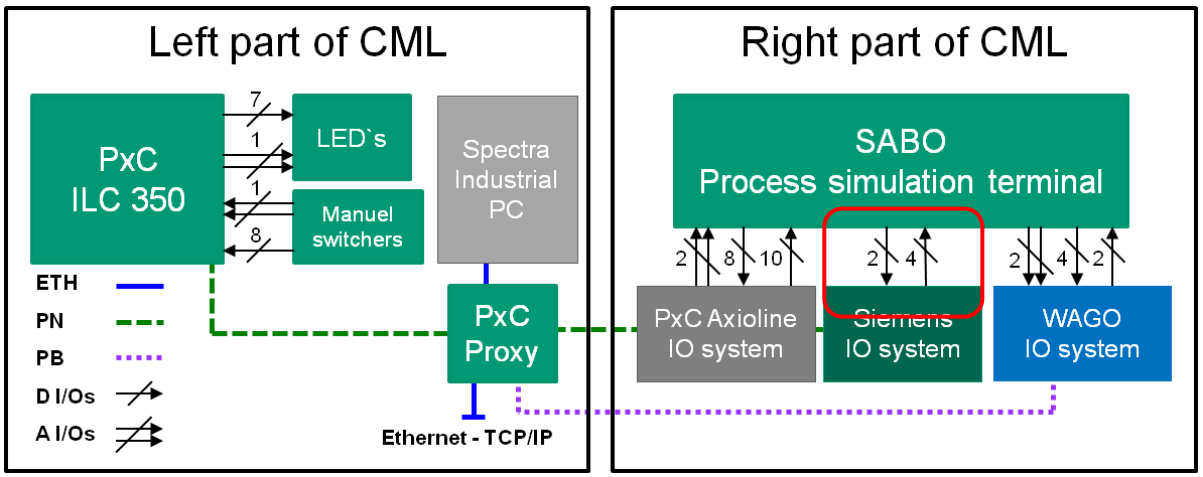

Fig. 34 Signal Connections diagram

According to this information we can see that the devices are connected in the following way:

Sabo		Siemens
DO00	→	DI00
DO01	→	DI01
DI00	←	DO00
DI01	←	DO01
DI02	←	DO02
DI03	←	DO03

That means, that the signal that is going out from the first digital output of the SABO terminal, is received by the first digital input of the Siemens I/O system.

2 CML Software

2.1 Overview

The operating system Windows XP SP3 is installed on an Industrial PC. This makes the mobile lab the autonomous system with its own configuration device. All software components are installed on an *Industrial PC.*

2.2 Software components

For this CML the use of three special software components is recommended.

- **PCWORX** is the IEC-61131-based automation software from PHOENIX CONTACT. It is designed for PC-based programmable controllers such as the Field Controller (FC) and the stand-alone Remote Field Controller (RFC/ILC) boards. PC-WorX should be pre-installed to the Industrial PC and is used for automation system configuration and controller programming.
- **CoDeSys** is a development environment for programming controller applications according to the international industrial standard IEC 61131-3. The term CoDeSys is an acronym and stands for **Co**ntroller **De**velopment **Sys**tem. CoDeSys is developed and marketed by the German software company 3S-Smart Software Solutions located in the Bavarian town of Kempten. Version 1.0 was released in 1994. CoDeSys is free of charge and can be downloaded from the company's website. With the help of CoDeSys some new process simulation models can easily be created.

- **Wireshark** Wireshark is cross-platform, using the GTK+ widget toolkit to implement its user interface, and using pcap to capture packets; it runs on various Unix-like operating systems including Linux, Mac OS X, BSD, and Solaris, and on Microsoft Windows. There is also a terminal-based (non-GUI) version called TShark. Wireshark, and the other programs distributed with it, such as TShark, are free software, released under the terms of the GNU General Public License. This program should be used for net analyzing.

2.2.1 PC-WorX

PC WorX is the automation software, which combines programming according to IEC 61131, fieldbus configuration, and diagnostics.

The programming system is based on modern 32-bit Windows technology and enables easy handling for the user by means of zooming, drag & drop, and dockable windows. IEC configuration elements can be processed and libraries can be integrated. In addition, the programming system has a powerful debugging system. In PC WorX, all functions can be easily accessed via the menu and you can create a project using only a few dialog boxes. You can then immediately start developing your program.

2.2.2 CoDeSys

In our case CoDeSys is used for creation of process simulation models which will be downloaded on SABO terminal.

CoDeSys doesn’t need any license. All five programming languages for application programming defined in the IEC 61131-3 are available in the CoDeSys development environment.

The development of the program is possible in 6 different IEC standard editors. Two Textual editors: Instruction list and Structured text. 4 Graphical editors: Ladder Diagram, Function block diagram, Sequential function chart. An additional graphical editor available in CoDeSys, not defined in the IEC standard, is Continuous Function Chart

2.2.3 Wireshark

Wireshark is a free and open-source packet analyzer. A network packet analyzer will try to capture network packets and tries to display that packet data in a way which is as detailed as possible. You could think of a network packet analyzer as a measuring device used to examine what's going on inside a network cable, just like a voltmeter is used by an electrician to examine what's going on inside an electric cable (but at a higher level, of course). In the past, such tools were either very expensive, proprietary, or both. However, with the advent of Wireshark, all that has changed. Wireshark is perhaps one of the best open source packet analyzers available today.

In our case we want to see the dataflow between hardware components connected to the Ethernet network.

3 Appendices

3.1 List of hardware documentation

Table 3 List of hardware documentation

Name of the Component	Function of the Component	Manufacturer	Type of document	Name of the document
ILC 350 PN	PLC	Phoenix Contact	User Manual	um_en_ilc_330_350_6959_en_05
			Data Sheet	2876928 ILC 350 PN_eng
AI 2/SF-PAC	Analog Inputs	Phoenix Contact	Data Sheet	2861302 IB IL AI 2SF-PAC_eng
			Installation List	il_sys_inst_um_e_6452_en_02
AO 1/U/SF-PAC	Analog Outputs	Phoenix Contact	Data Sheet	db_gb_ib_il_ao_1_u_sf_5736c1_gb
EMG 22-LED 7S24	LED	Phoenix Contact	Data Sheet	db_en_emg_led_101169_en_01
UM 45-IB-DI SIM8	Bar LED	Phoenix Contact	Data Sheet	UM 45-IB-DI SIM8_ds_eng
EMG 30-SP 10K LIN	Value potentiometer	Phoenix Contact	Data Sheet	2942124 EMG 30-SP 10K LIN_eng
UM 45-IB-DISIM8	8-way simulator	Phoenix Contact	Data Sheet	2962997_UM 45-IB-DISIM8_eng
NISE100 K1.3	Industrial PC	NEXCOM	Data Sheet	NISE100 Data sheet
			User Manual	NISE 100 User Manual(20100402)
			Reference Guide	NISE100 Quick Reference Guide 20090612
FL NP PND-4TX PB	Proxy	Phoenix Contact	Data Sheet	db_en_fl_np_pnd_4tx_pb_7744_en_04
			Application note	ah_en_fl_np_pnd_4tx_pb_update_8120_en_00
BGEL0174	DC-Wattmeter		Data Sheet	BGEL0174_DC-Wattmeter_DBK_de
			User Manual	BGEL0174_DC-Wattmeter_BDA_de
FLK-PVB 2 24	Power distributor	Phoenix Contact	Data Sheet	db_en_flk_pvb_2__5087808
STEP-PS 1AC12DC5	PSU 12V	Phoenix Contact	Data Sheet	db_en_step_ps_1ac_12dc_5_103504_en_02
QUINT-PS 1AC24DC	PSU 24V	Phoenix Contact	Data Sheet	db_en_quint_ps_1ac_24dc_10_103128_en_03
mtb72723_24	Sim. Terminal	SABO	Data Sheet	Sabo_mtb72723_24_d1
EWB73010_D1	Extention Module	SABO	Data Sheet	EWB73010_D1e
AXL BK PN	Bus Coupler	Phoenix Contact	Data Sheet	db_en_axl_bk_pn__me_7992_en_01
			User Manual	um_en_axl_sys_inst_7982_en_00
			Application note	ah_en_pc_worx_axl_pro_8071_en_01
AXL DI 16 4	Digital Inputs	Phoenix Contact	Data Sheet	db_en_axl_di_16_4__me_7987_en_01
AXL DO 16 3	Digital Outputs	Phoenix Contact	Data Sheet	db_en_axl_do_16_3__me_7988_en_01
AXL AO 8	Analog Outputs	Phoenix Contact	Data Sheet	db_en_axl_ao_8__me_7990_en_01
ET200S IM151-3	Bus Coupler	Siemens	User Manual	et200s_im151_3_pn_high_feature_manual_en-US_en-US
750-343	Bus Coupler	WAGO	Data Sheet	d0750-343000en
			User Manual	m012110e
750-402	Digital Inputs	WAGO	Data Sheet	d040200e
			User Manual	m040200e
750-468	Analog Inputs	WAGO	Data Sheet	d046800e
			User Manual	m046800e
750-504	Digital Outputs	WAGO	Data Sheet	d050400e
			User Manual	m050400e
750-600	Final Block	WAGO	Data Sheet	d060000e
			User Manual	m060000e

3.2 List of software documentation

Software title: name of the PDF file – WWW-Link

PC WorX → um_qs_en_pc_worx_7127_en_02 (Quick start)

CoDeSys → http://www.3s-software.com (the manuals will be installed with program installation)

WireShark → http://www.wireshark.org