MICROCOMPUTERS

Embedded Systems, the Smart Factory, the Internet of Things and Cyber-Physical Systems – hands-on training

1st Edition

MODERN INDUSTRIAL PROCESSES REQUIRE SMART OPEN- AND CLOSED-LOOP PROCESS CONTROL AND SYSTEM MONITORING. THESE OPERATIONS ARE PERFORMED BY MICROCOMPUTERS – WITH THE ASSISTANCE OF MECHATRONIC EQUIPMENT. FOR THAT REASON, PROGRAMMING IS BECOMING MORE AND MORE IMPORTANT.

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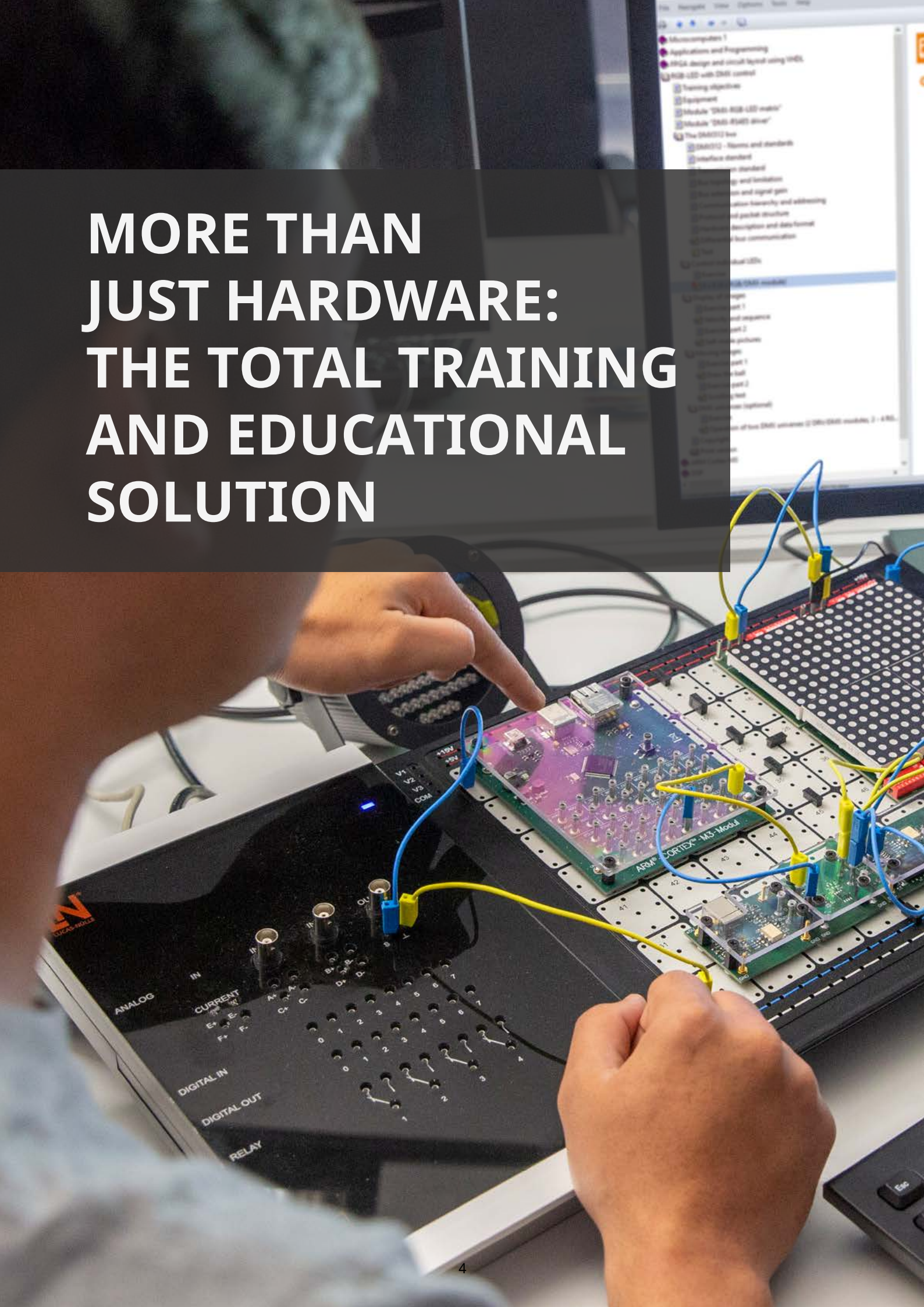
MORE THAN JUST HARDWARE: THE TOTAL TRAINING AND EDUCATIONAL SOLUTION



INTERACTIVE TRAINING ENVIRONMENT

- All microcontroller training systems are integrated into our tried-and-true, didactically designed training and experimenting platform Labsoft
- The UniTrain multimedia desktop laboratory provides a complete solution for your hands-on training instruction
- Every equipment set contains not only hardware but also interactive training software and the matching development environment including all the requisite tools

UniTrain:
the smart instrumentation and process control centre

EXPERIMENTING WITH UNITRAIN – THE HARDWARE FOR LEARNING

UniTrain turns every microcomputer into a learning experience. The Lucas-Nülle multimedia-based experiment lab is the flexible solution for methodical, well-structured learning success.

Your benefits

- A universal training system
- Mobile and deployable anywhere
- Promotes autonomous learning
- Skills and expertise acquired by conducting practical experiments
- Ever-changing demands trigger high motivation
- Safe experimentation thanks to extra-low safety voltage
- Training programs combine both theory and practice
- For the entire field of electrical engineering and electronics

Basic hardware requirements for experiments

1 UniTrain Interface

2 Experimenter

Equipment example

3 Experiment case includes:

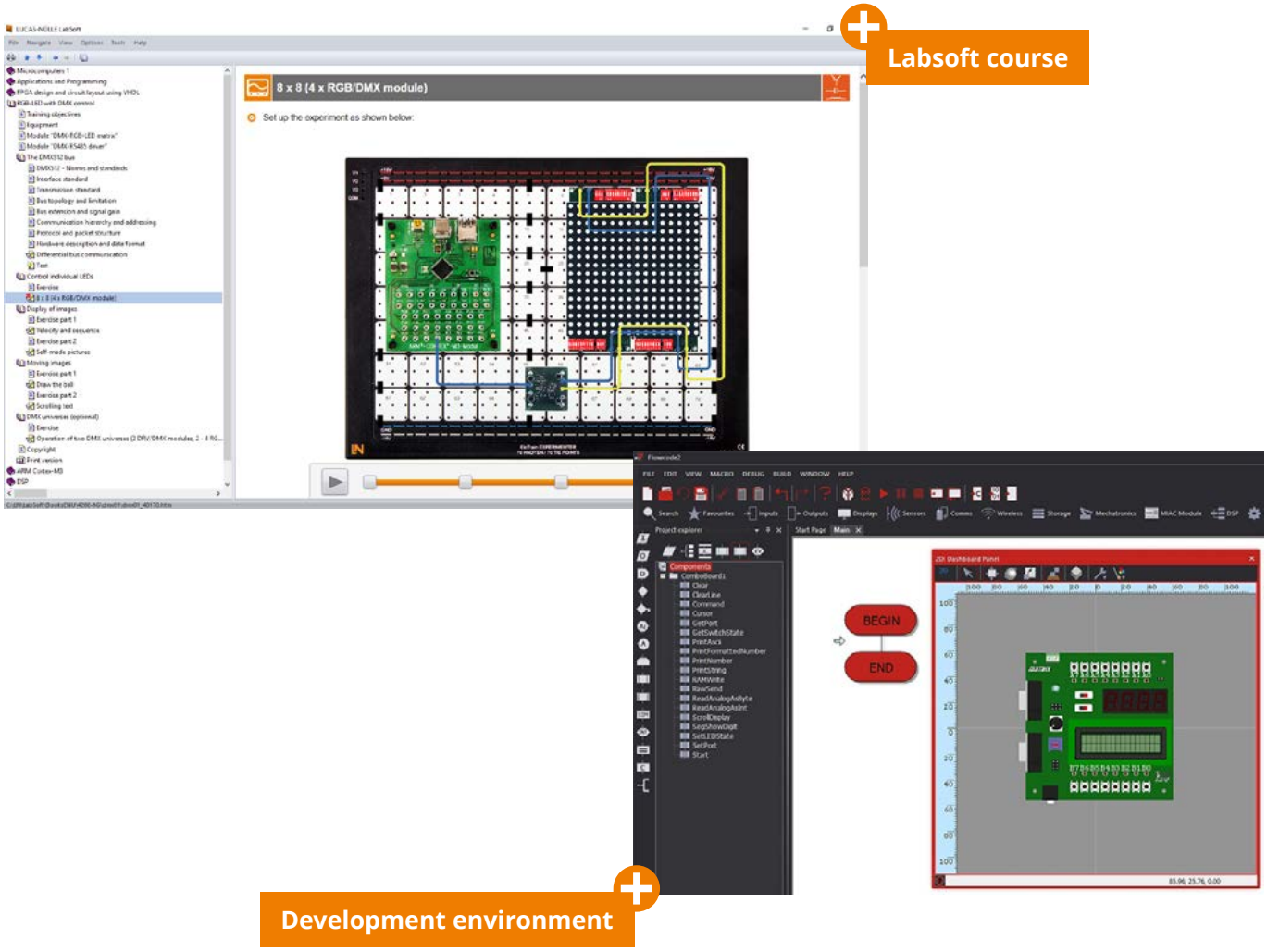
3.1 Microcontrollers

3.2 Interactive multimedia course

3.3 Development environment

Product video
Convince yourself of the product's many advantages.

EXPERIMENTING WITH LABSOFT - THE TRAINING SOFTWARE



LabSoft courses
LabSoft is the practical training platform from Lucas-Nülle. Thanks to simple navigation, the user has free access to all of its content. This smart program is also used to control the UniTrain hardware.

Labsoft saves all of the measurement results for every user – making it the ideal tool to track learning progress.

Your benefits
- Immediate access to all course content
- Control of the interface via virtual instruments
- User-related storage of measurement results
- Capable of local standalone operation, in networks or in combination with an LMS
- Multiple languages: all languages supported by HTML possible

Development environment
The programmer's tool kit is the development environment. This is where the programming code is written, compiled and tested.

Lucas-Nülle provides each and every equipment set with the ideal development environment. The user learns how to operate it in the LabSoft course.

Your benefits
- Practical, hand-on learning using standard industrial programs
- Pre-defined approach
- Integrated debugging, simulation and monitoring tools

LabSoft Classroom Manager (optional)
The comprehensive administration software for learning groups from Lucas-Nülle helps you manage your daily routine. Once installed, the program runs in your local network without needing to access any additional databases or server systems.

Your benefits

- Manager: administer your learning groups
- Reporter: keep an eye on learning progress
- Editor: customise content
- Questioner: create your own exercises
- TestCreator: create your own knowledge and skills test

AT A GLANCE – PROGRAMMING LANGUAGES & DEVELOPMENT ENVIRONMENTS

Different programming languages of varying complexity need to be mastered to program microcomputers.

Using the educationally designed full-service concept based on the UniTrain system, you can use one standard method to train a diverse list of programming languages.

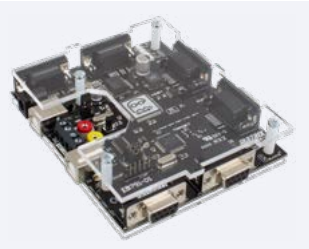
MICROCONTROLLERS & FPGA

8-bit and 16-bit microcontrollers

8-bit Arduino Uno

8-bit PIC16F1937

8-bit PIC16F887



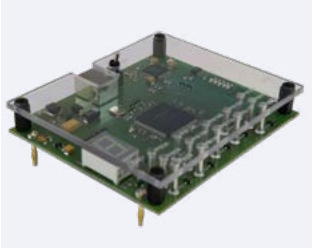
16-bit dsPIC33EP

32-bit microcontroller

32-bit Cortex M3

32-bit ARM AT91SAM7

Programmable logic ICs



FPGA Lattice XP2

FPGA Altera Cyclone IV

Based on the hardware listed here, Lucas-Nülle offers educationally designed and all-encompassing training solutions.

In addition to microcontrollers of varying speeds and accuracy, the basic hardware package also includes programmable logic ICs (FPGAs)


BASIC EQUIPMENT SETS

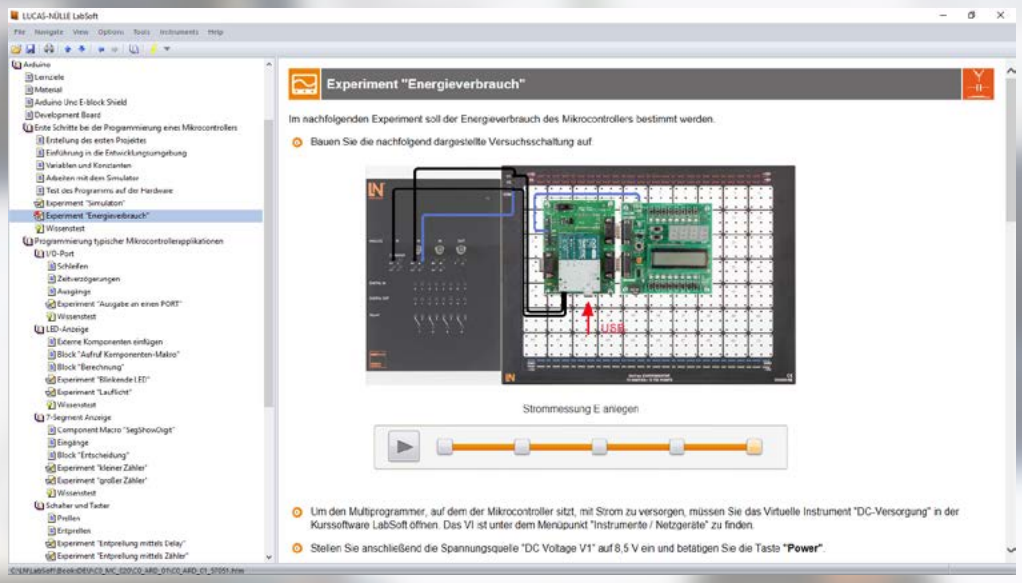
In addition to the hardware components, our basic equipment sets contain all the software tools you need: *

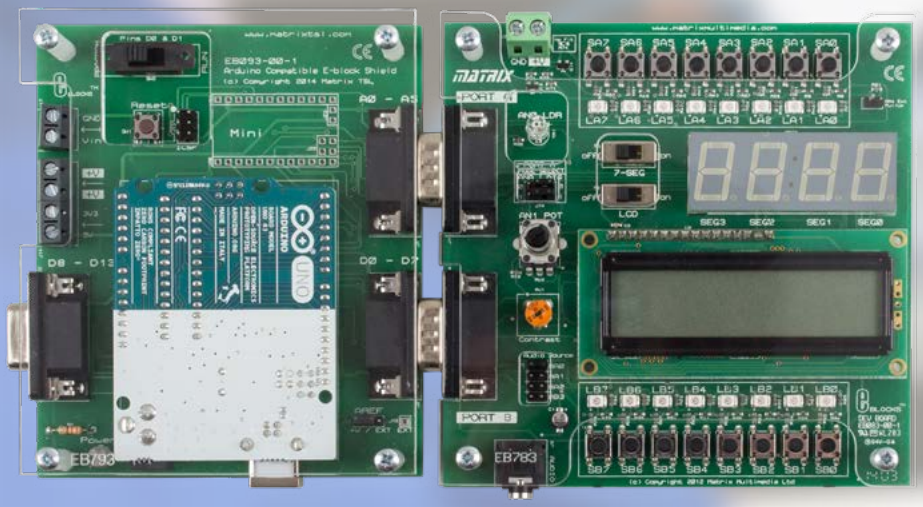
- Microcontroller module with integrated programming interface
- Experiment module with important, typical applications
- Interactive learning software with integrated measuring instruments
- Development environment
- Accessories

*The UniTrain system is not contained in the basic equipment sets.

Your fast and straightforward introduction to microprogramming.

UML PROGRAMMING
... WITH ARDUINO UNO (8-BIT)





Arduino is a rapid prototyping platform. The hardware consists of a programming board with an ATmega328 microcontroller and an application board including a display, LEDs, pushbuttons, switches, sensors etc.

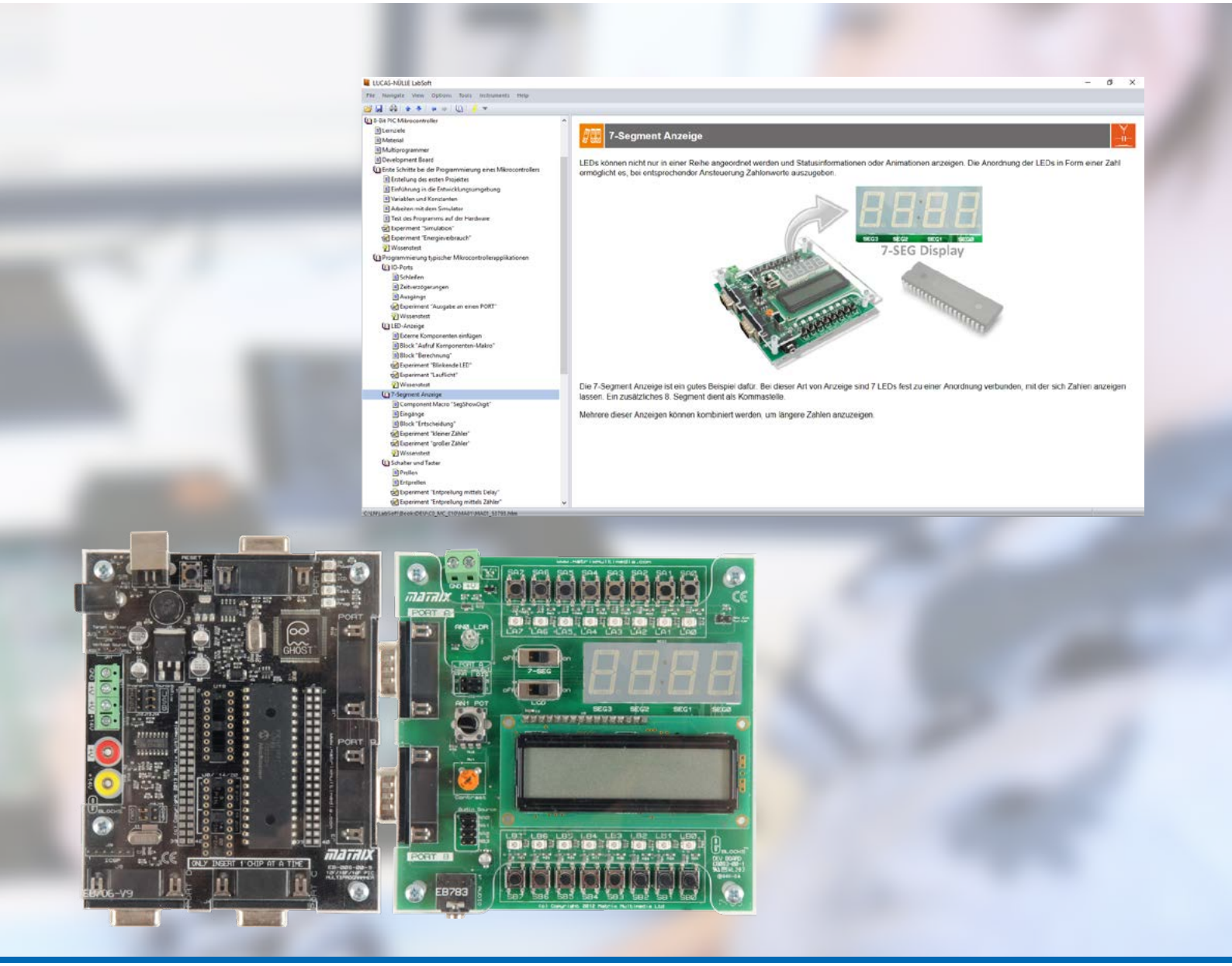
IDE is based on Flowcode and should enable less experienced programmers to gain insight into microcontrollers. Projects of varying complexity can be programmed all the more easily when carried out in the form of flow charts.

Training contents

- Ports and pin configuration of the Arduino UNO
- Commissioning and initial steps in the programming of the microcontroller
- Programming using flow charts (extension possible using C code)
- Compiling, debugging and uploading of the program onto the microcontroller
- Programming typical applications (incl. I/O functions, AD/DA conversion, display output)

Art. no. CO4205-7B

...USING 8-BIT PIC16F1937



Thanks to their numerous variants and models, PIC microcontrollers are ubiquitous and are frequently used in embedded systems.

The PIC16F1937 used here is a typical 8-bit PIC of medium power and, for that reason, extremely well suited as an introduction to PIC programming.

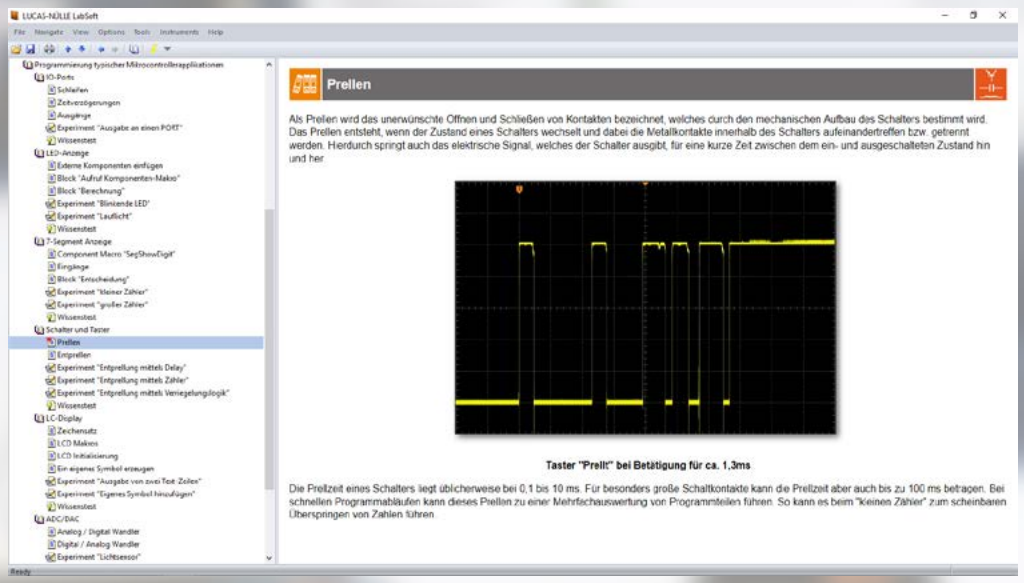
IDE is based on Flowcode and should enable less experienced programmers to gain insight into microcontrollers. Projects of varying complexity can be programmed all the more easily when carried out in the form of flow charts.

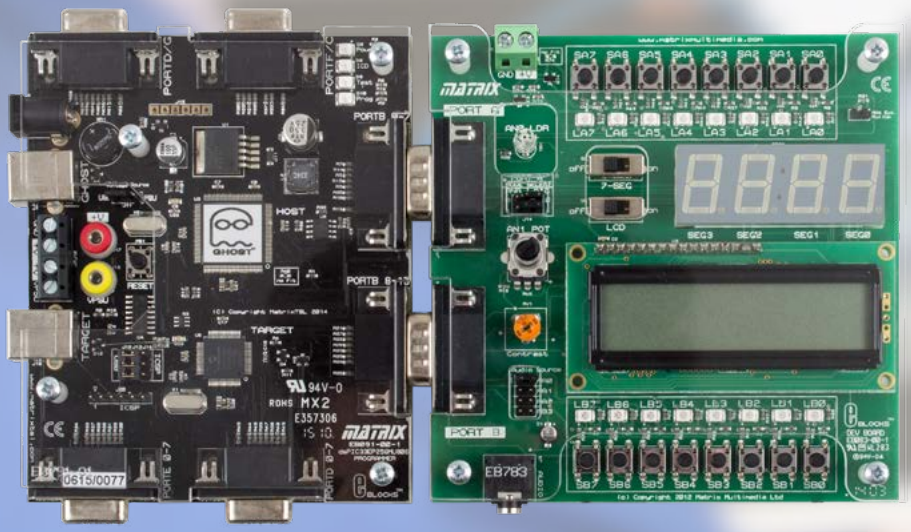
Training contents

- Ports and pin configuration of the PIC16F1937
- Commissioning and initial steps in the programming of the microcontroller
- Programming using Flowcode in flow charts (extension possible using C code)
- Compiling, debugging and uploading of the program onto the microcontroller
- Programming typical applications (incl. I/O functions, AD/DA conversion, display output)

Art. no. CO4205-7A

UML PROGRAMMING
... USING THE 16-BIT DSPIC33EP





The programming module with a dsPIC microcontroller is an excellent choice for an effective introduction to 16-bit architecture.

The integrated GHOST technology permits hardware monitoring in real time.

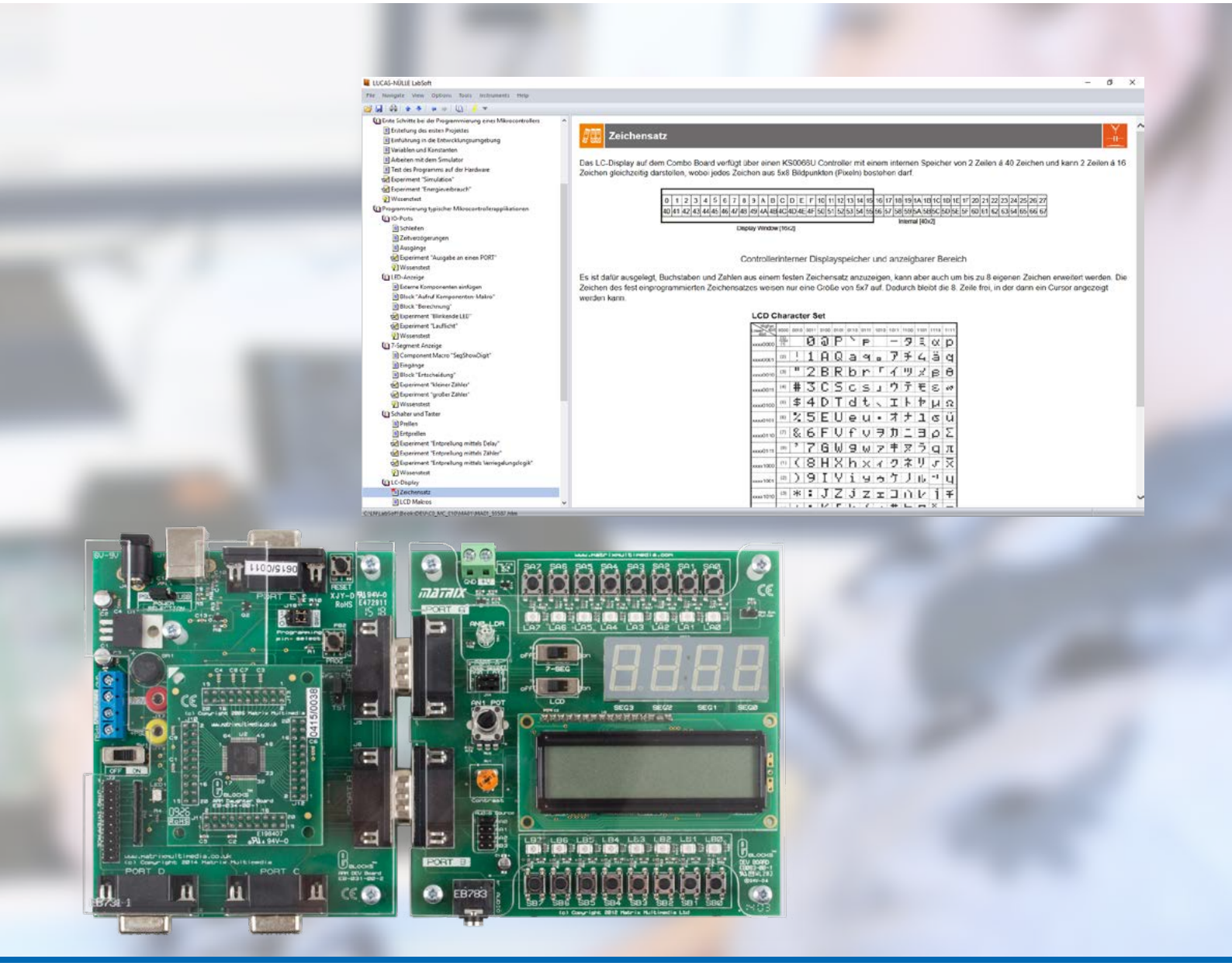
IDE is based on Flowcode and should permit less experiencedprogrammers to gain easier access to microcontrollers. Projects of varying complexity can be programmed all the more easily when carried out in the simple form of flow charts.

Training contents

- Connections, pin configuration and ports of the dsPIC33EP
- Commissioning and initial steps in the programming of the microcontroller
- Programming using Flowcode in flow charts (extension possible using C code)
- Compiling, debugging and uploading of the program onto the microcontroller
- Programming typical applications (incl. I/O functions, AD/DA conversion, display output)

Art. no. CO4205-7C

... WITH THE 32-BIT ARM AT91SAM7



If you need more accuracy, more speed and more memory then the 32-bit microcontrollers are the right choice for you.

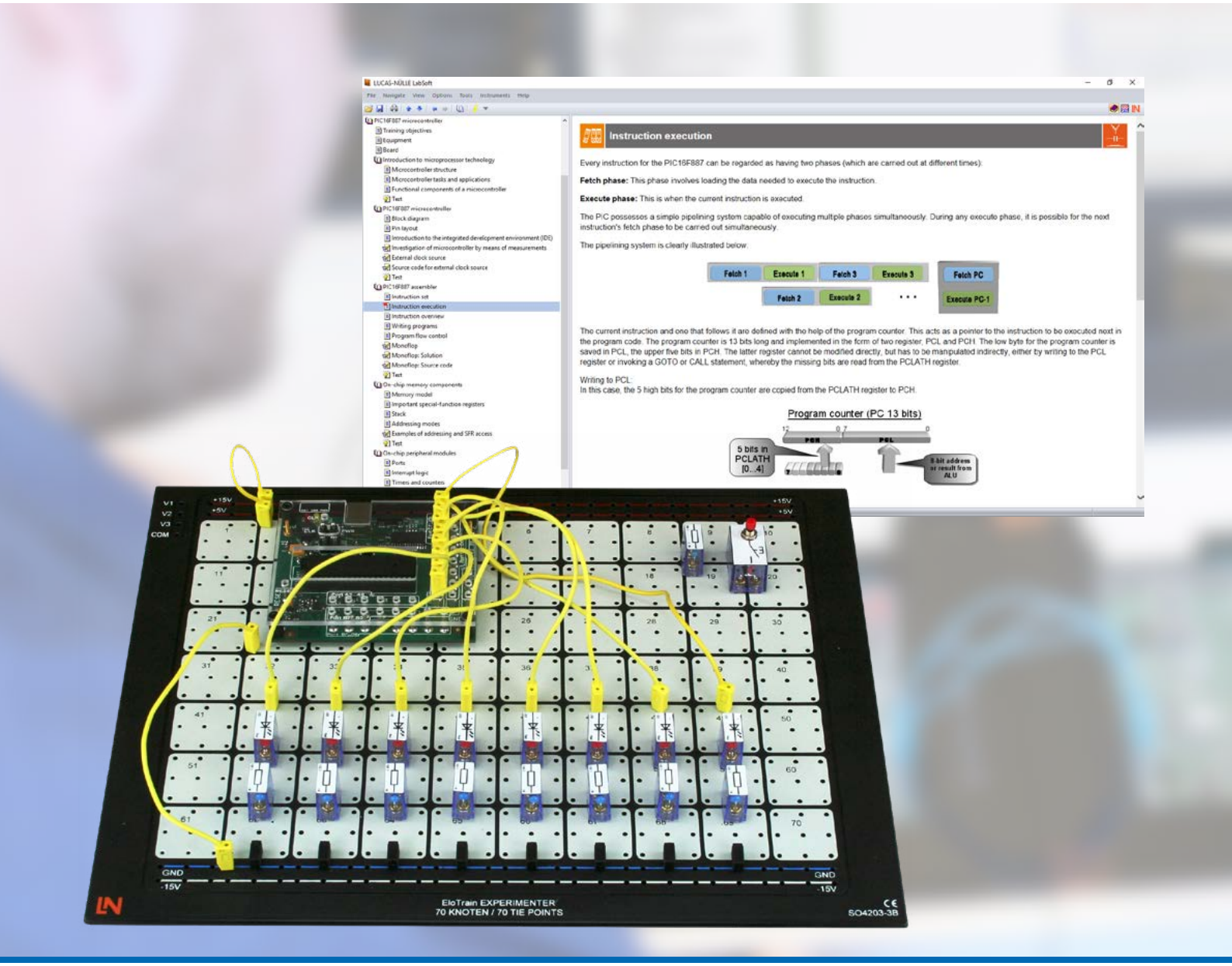
Even in the face of increasing hardware complexity, the multimedia-based course and the development environment Flowcode help you quickly overcome any learning obstacles.

Training contents

- Architecture of the ARM AT91SAM7 microcontroller
- Connections, pin configuration and ports
- Commissioning and initial steps when programming the microcontroller
- Programming using Flowcode in flow charts (extension possible using C code)
- Compiling, debugging and uploading of the program onto the microcontroller
- Programming typical applications (incl. I/O functions, AD/DA conversion, display output)

Art. no. CO4205-7D

ASSEMBLER PROGRAMMING WITH 8-BIT PIC16F887



Embedded programming with Assembler ensures well-founded understanding of internal processes inside a microcontroller and thus helps optimise efficient programming and exploitation of hardware resources.

Thanks to the restricted set of commands for the 8-bit PIC16F887, learning how to use Assembler is particularly easy.

Training contents

- Introduction into the structure, application areas and functional components of microcontrollers
- Introduction into the integrated development environment IDE and the block system with the help of the PIC16F887 microcontroller
- Assembler
- Writing programs and running program routines
- On-chip memory components

Art. no. SO4206-9A

C PROGRAMMING
WITH 32-BIT ARM CORTEX M3

The course contains training on and basic information about the programming environment.

Using simple examples, the trainees become familiar with the design of the microcontroller and its peripheral equipment including structured programming from conception to final solution.

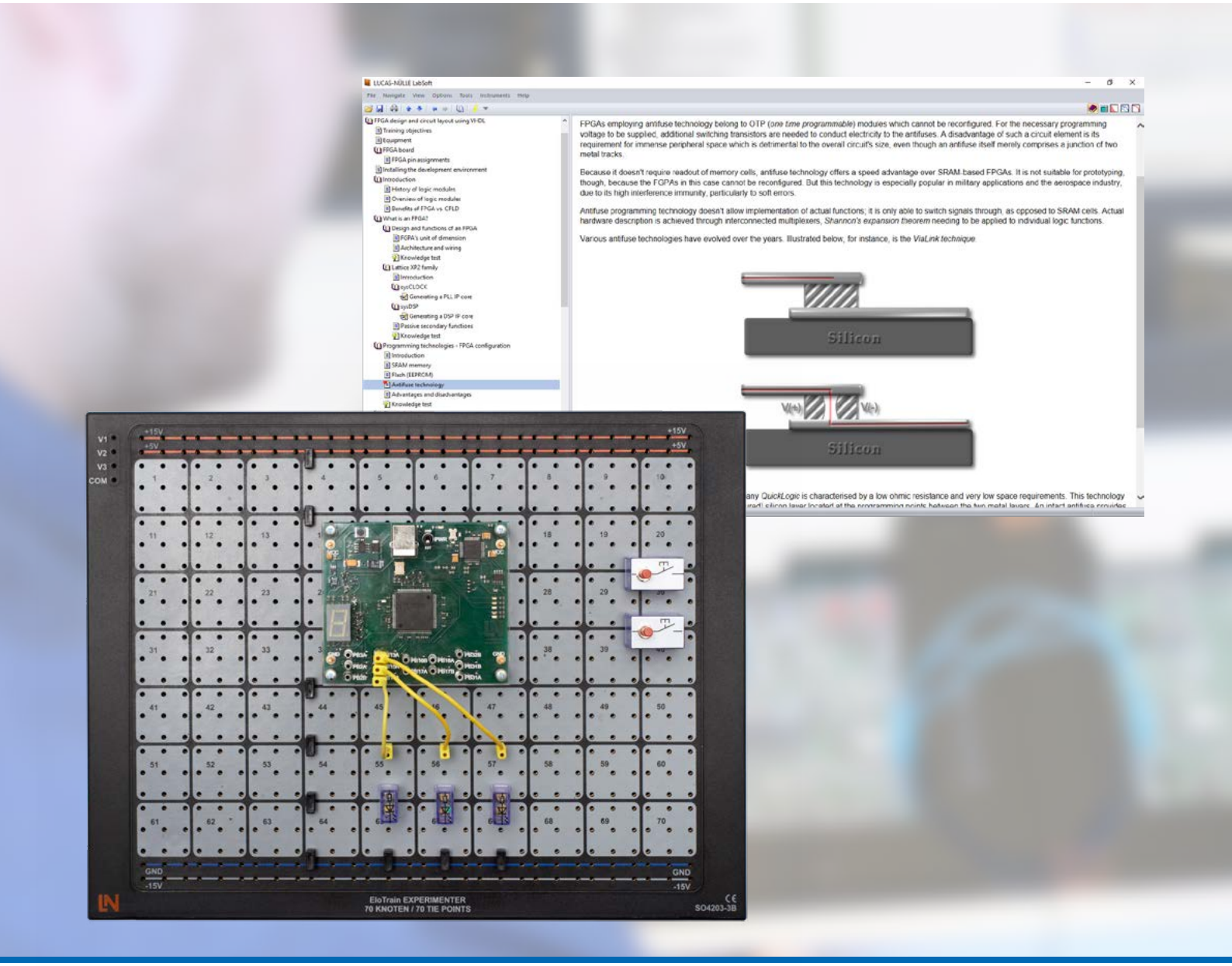
Within the first experiments, different control structures and interrupts are tried out together with the implementation of possible bit manipulations in the programming language C. Ports, port pins and the on-chip analog-digital converter are used.

Training contents

- Introduction to C programming for embedded systems
- Design of the 32-bit microcontroller ARM Cortex M3 and its peripheral equipment
- Structured programming with interrupts and subroutines based on simple applications
- How to use functional unit libraries
- Programming typical microcontroller applications like display controlling with I^2C-bus or AD conversion

Art. no. SO4206-9B

VHDL
WITH AN FPGA LATTICE XP2



In the course of recent years, the power of electronic systems has grown exponentially while at the same time accompanied by continued circuit miniaturisation.

With the aid of programmable logic ICs (FPGAs), it is possible to implement complex operating functions with a minimum of circuitry.

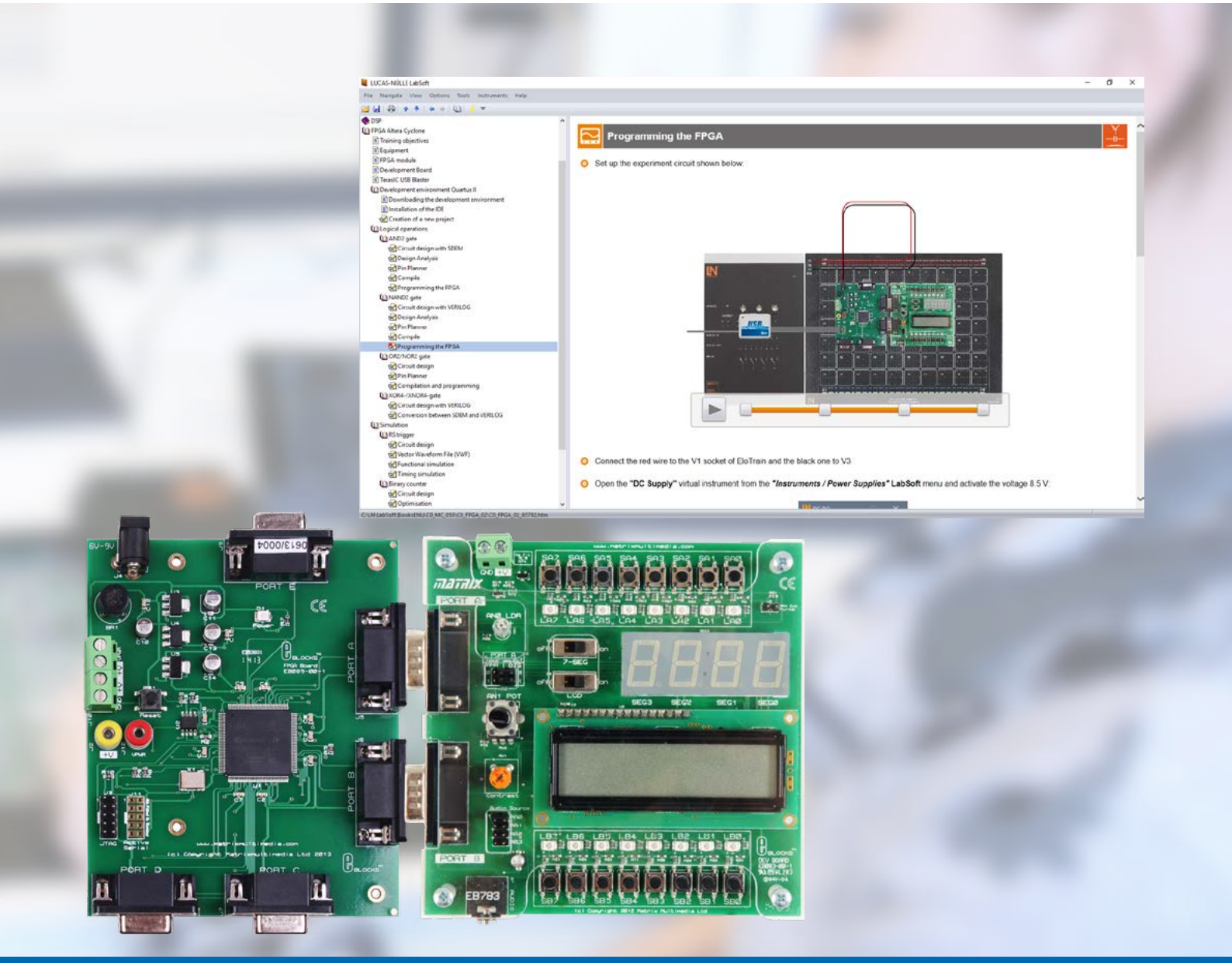
The objective of this course is to familiarise students with the fundamentals of how FPGAs work so that they can actually use FPGAs for their projects.

Training contents

- Introduction to programmable logic
- Design and operation of an FPGA
- Design flow with VHDL
- Learning to work confidently with Lattice IDE
- Extensive information about the Lattice XP2 product range
- Creating your own circuit designs
- Configuring an FPGA

Art. no. SO4206-9E

VERILOG
WITH FPGA ALTERA CYCLONE IV



This equipment set guarantees lightning fast immersion into IDE Quartus II and the VERILOG language used for hardware description

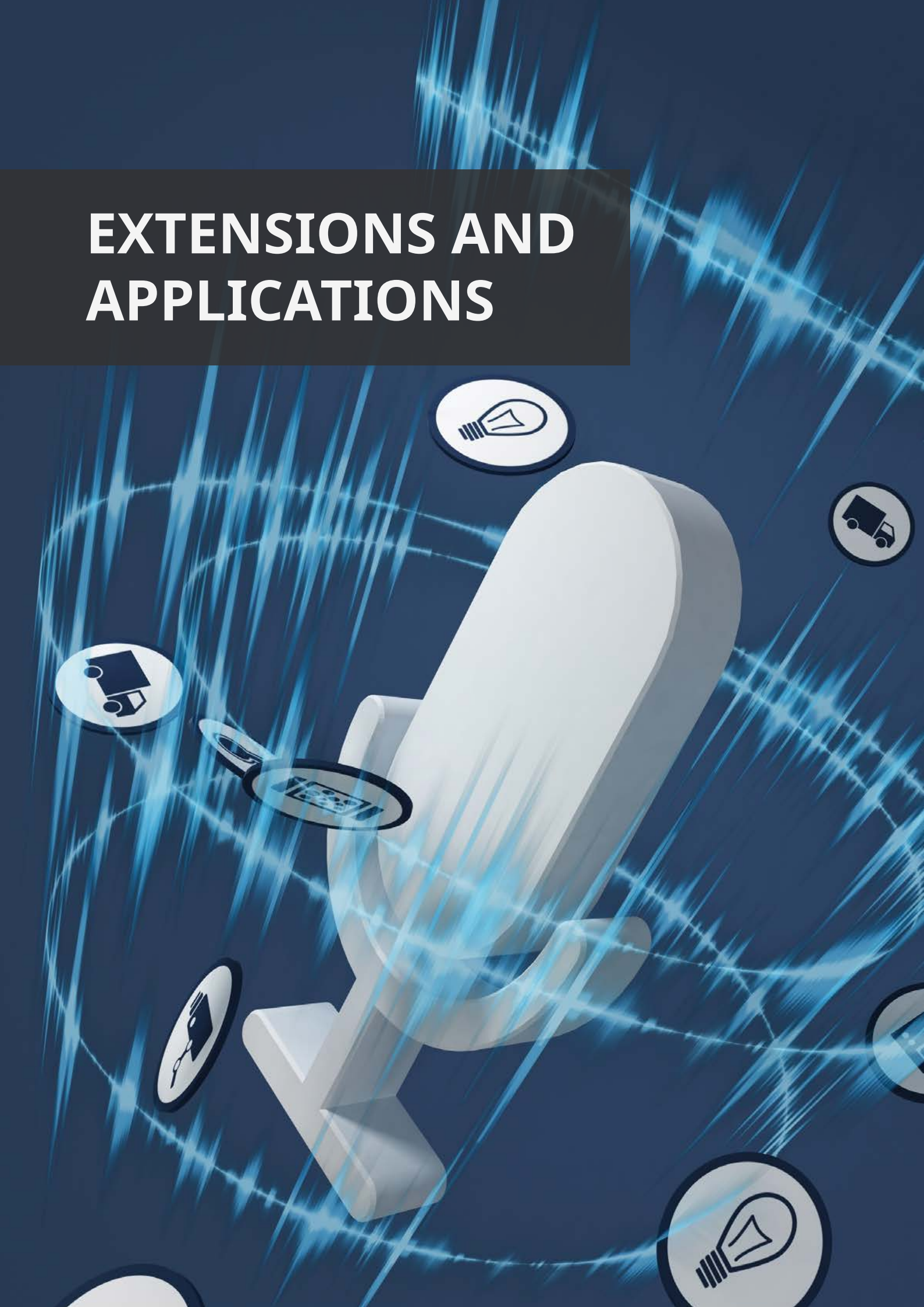
The experiments begin with simple logic operations and then proceed onto the development of smaller applications with several logic blocks.

Training contents

- Introduction to IDE QUARTUS II
- Logic operations AND2 / NAND2 / OR2 / NOR2 / XOR4 /XNOR4
- RS Trigger
- Binary counters
- Event control
- Choosing with IF / ELSE and CASE / ENDCASE
- Functional simulation and timing simulation

Art. no. CO4205-7E

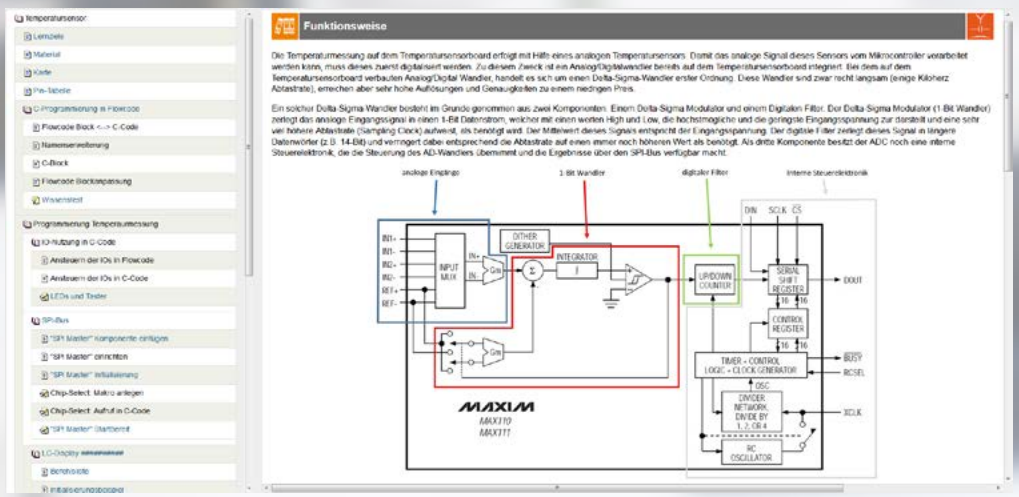
EXTENSIONS AND APPLICATIONS

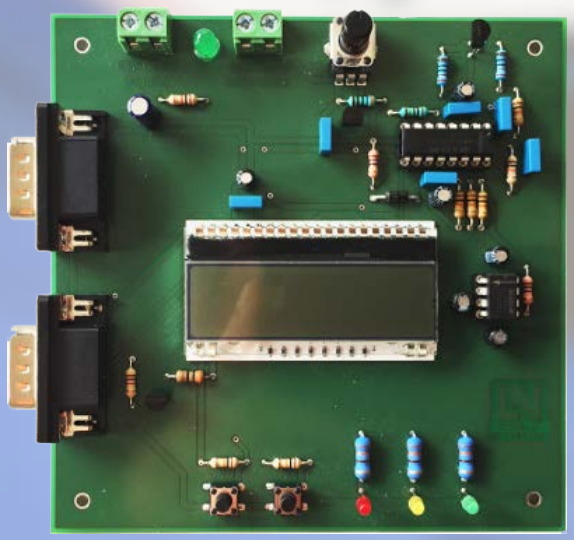


A microcomputer constitutes the "brain" of an intelligent system. But in order to be able to communicate with the external world, it needs "eyes and ears" – various sensors and actuators.

With a variety of extension options it is possible for you to proceed from basic training and move on to practical work in programming applications in various areas.

SUPPLEMENTARY EQUIPMENT
... TEMPERATURE SENSOR MODULE





This equipment set includes a fully operational microcontroller-controlled thermometer with an LCD display.

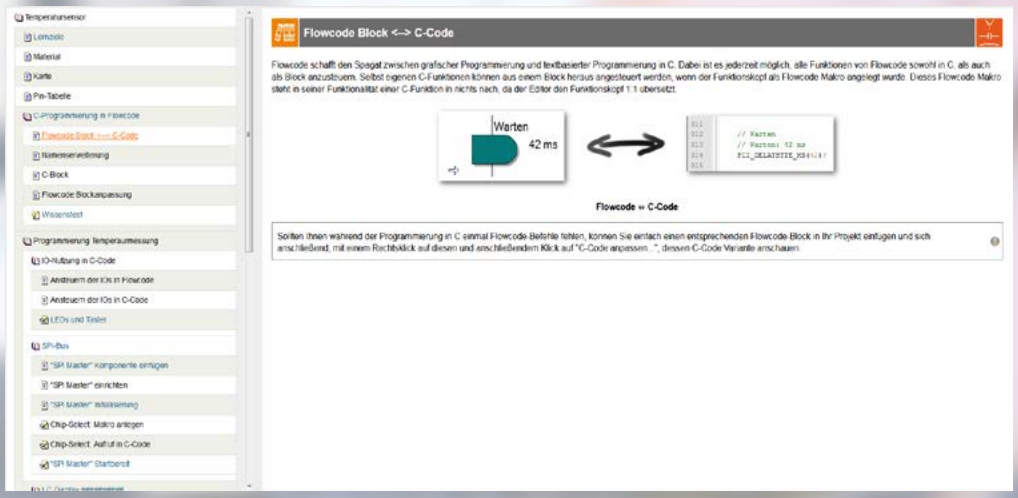
The programming tasks for this project are solved with the help of the Flowcode IDE and using C programming language.

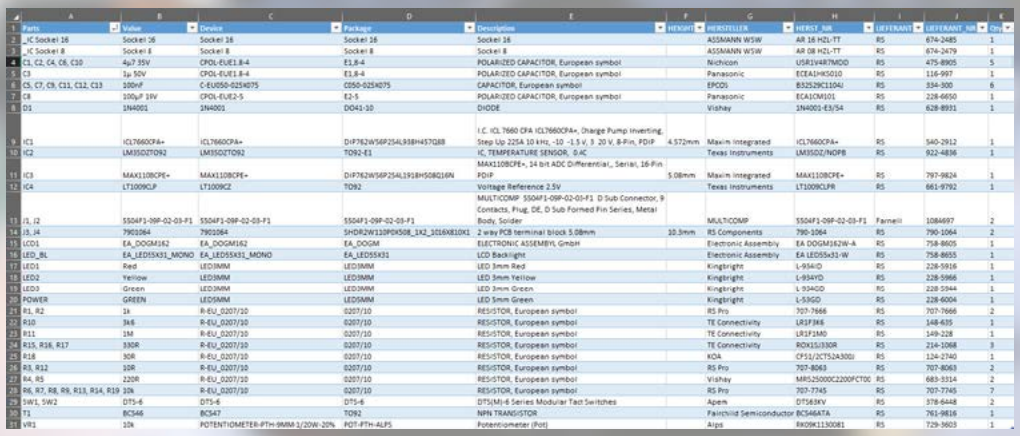
Training contents

- Programming temperature measurement
- IO utilisation in C code
- SPI bus
- LC display
- Analog/Digital converter

Supplementary to the basic equipment set CO4205-7A "8-bit PIC16F1937"
Thermometer (excluding software) compatible with all microcontrollers
Art. no. CO4205-7Y

... TEMPERATURE SENSOR ASSEMBLY KIT





A project to design an electronic device:

This equipment set focuses on soldering exercises and the putting into operation of a thermometer module. Ultimately a software program is created to control the thermometer with Flowcode. As soon as the room temperature is displayed properly the project is completed.

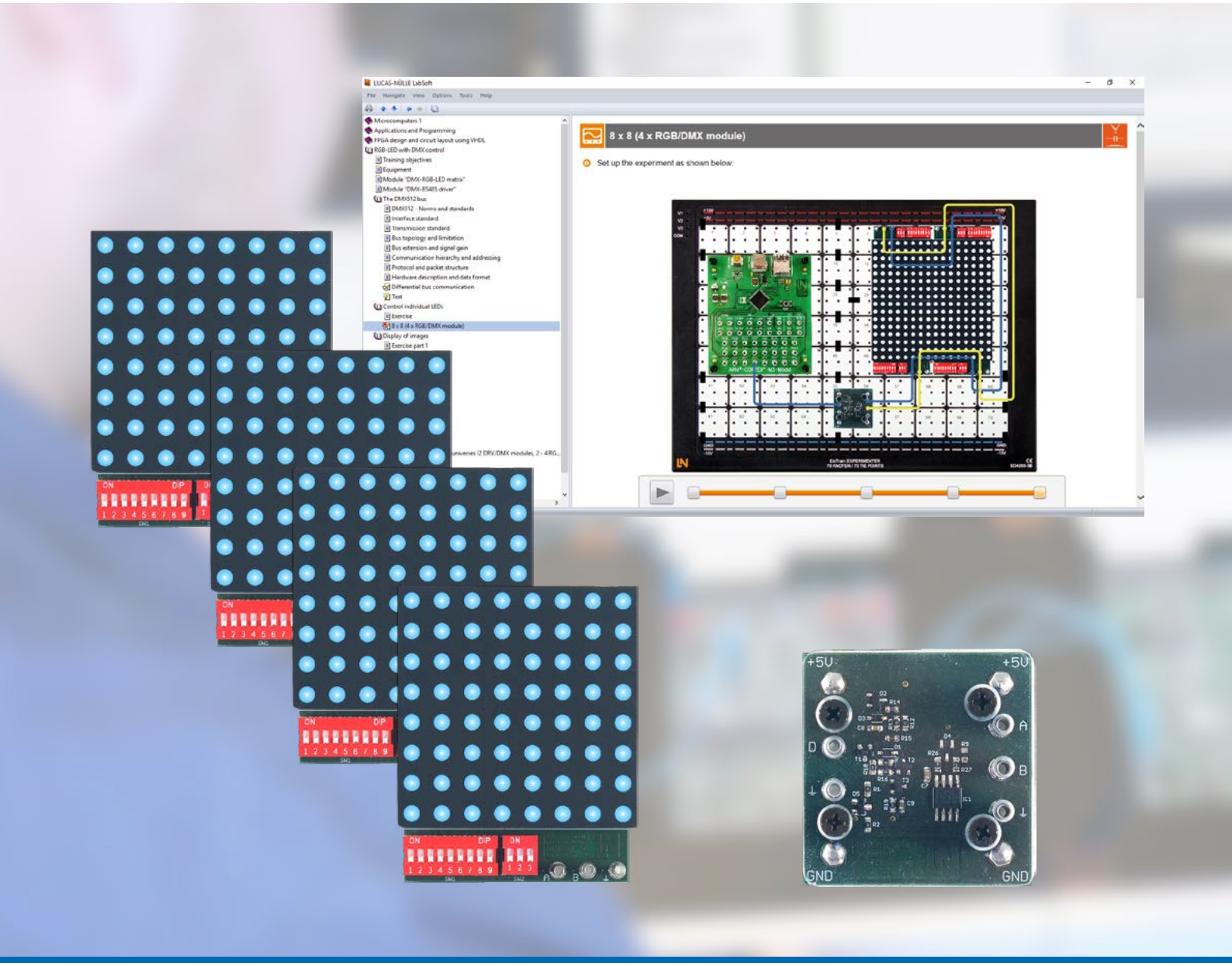
Training contents

- Understanding the circuitry
- Analyzing the assembly diagram
- Soldering exercises
- Putting the thermometer module into operation
- Programming temperature detection function
- Trouble-shooting and debugging

Supplementary to the basic equipment set
CO4205-7A "8-bit PIC16F1937"

Art. no. CO4205-7YB

SUPPLEMENTARY EQUIPMENT SET
... SERIAL DATA TRANSMISSION VIA RS485



The RS465 bus is a classic industrial interface for asynchronous serial data transmission over a balanced line.

Unlike other bus systems the RS485 defines only electrical interface conditions exclusively. The protocol is selected specifically for said application.

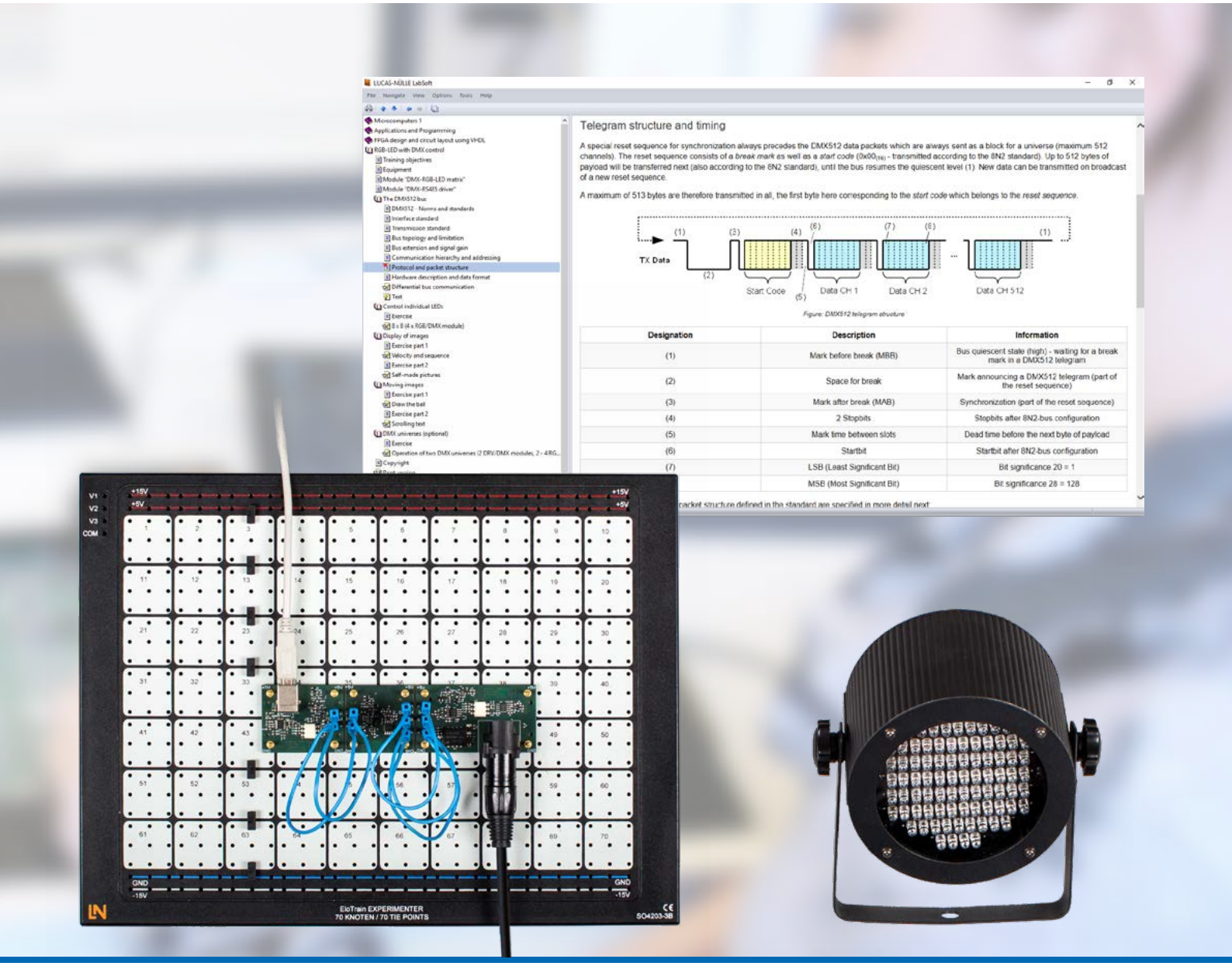
Control operation by means of RGB-LED matrices is carried out using the DMX512 protocol typically used for stage equipment.

Supplement to the basic equipment set SO4206-9B "32-bit Cortex M3"
Bus system (except for software) compatible with all microcontrollers
Art. no. SO4206-9G

Training contents

- RS485 interface
- DMX512 – norms and standards
- Bus topology and limiting
- Bus extension and signal amplification
- Communications hierarchy and addressing
- Protocol and packet design
- Practical exercises

... STAGE EQUIPMENT TECHNOLOGY WITH DMX512



Operating modern stage equipment using the Lucas-Nülle training system:

This equipment is the complement to the serial data transmission set using the RS485 thanks to the addition of a driver and adapter module so that any DMX512-compatible stage equipment can be integrated. This way you can control the lighting, smoke machines and laser beams.

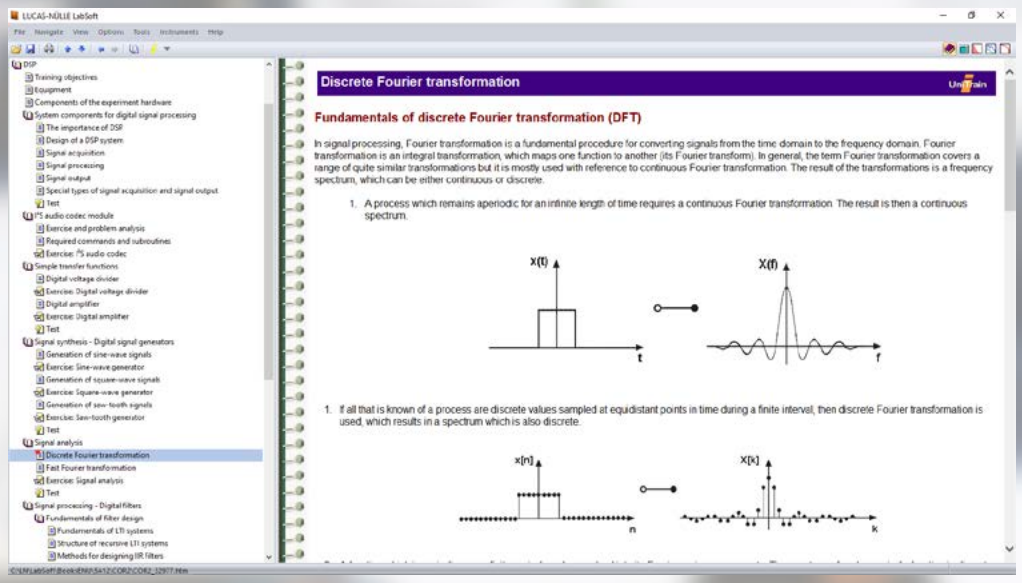
Training contents

- Introduction to DMX512 technology
- Setting up, putting into operation and configuration
- Direct control operation with a simulated "Light Desk"
- Automatic operation control via a microcontroller

Supplement to the equipment set
SO4206-9G "Serial data transmission via RS485"

Art. no. SO4206-9H

SUPPLEMENTARY EQUIPMENT SET ...DIGITAL SIGNAL PROCESSING



The extension includes an Audio-Codec module and an active loudspeaker*.

In this course the basic theoretical context is explained covering various digital transmission functions, filters and signal generators. The theoretical material explored is then put to use when authentic sound effects are programmed.

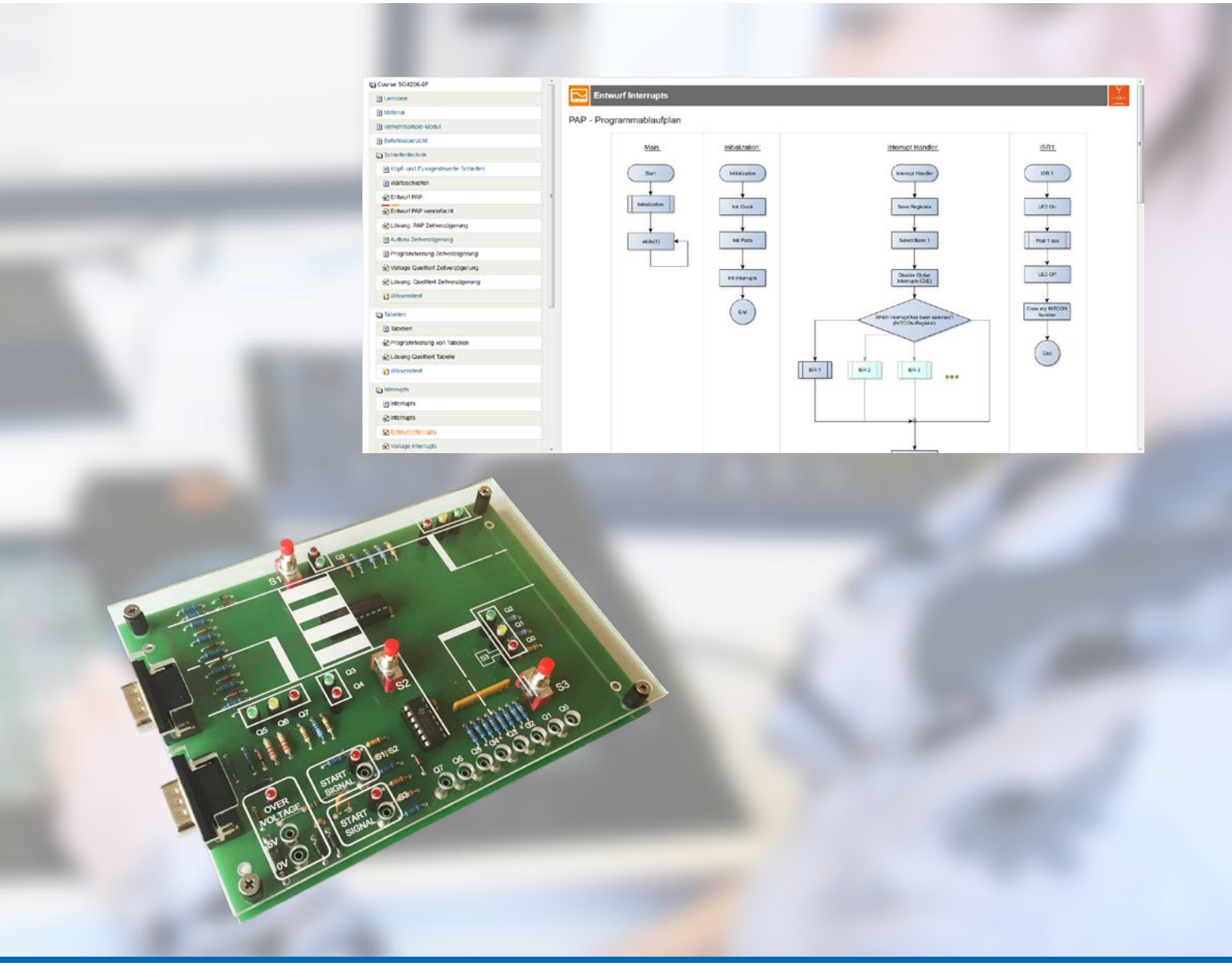
*The loudspeakers included may deviate in terms of model and colour from the speakers depicted in the illustration.

Training contents

- Introduction to DSP
- DSP system components
- Transmission functions
- Digital filters and signal generators

Supplement to the basic equipment set SO4206-9B "32-bit Cortex M3"
Module and loudspeakers (excluding software) are compatible with all microcontrollers
Art. no. SO4206-9C

...TRAFFIC LIGHT CONTROL AT AN INTERSECTION



Using traffic light circuits, the use of microcontrollers can be graphically demonstrated in a routine and realistic application. This equipment set offers a solid and traditional introduction into the application of microcontroller technology.

The exercise can be completed with a variety of programming languages without any difficulty.

Training contents

- Loop technology
- Tables
- Interrupts
- Traffic light control

Complimentary to the basic equipment set CO4205-7A "PIC16F1937"
Traffic light module (without software) compatible with all microcontrollers
Art. no. SO4206-9F

SMART FACTORY (INDUSTRY 4.0) EXTENSIONS

Networking and data exchange are important aspects of the smart factory:

Intelligent machines networked with each other exchange information directly just like people do in social networks in real time. All of these operations are carried out by microcomputer.

As a result, production lines become more flexible, more dynamic and more efficient. Furthermore, these machines also communicate with all of the IT systems inside the company and thus with the entire workforce.

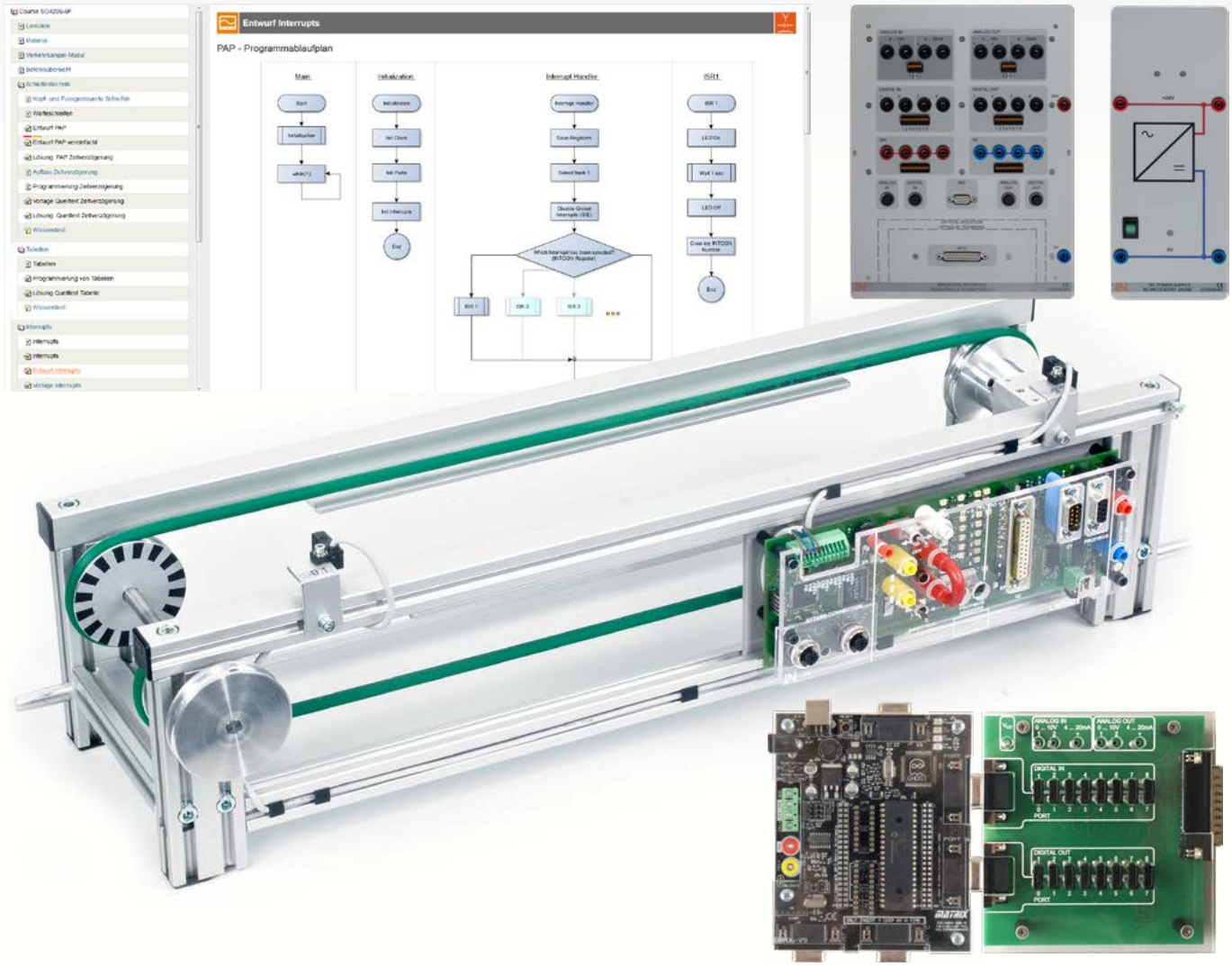
CPS – CYBER-PHYSICAL SYSTEMS

Cyber-physical systems connect IT and software components with the mechatronic equipment. This processinvolves data exchange, open- and closed-loop control operations taking place in real time using a network infrastructure like the Internet.

Essential components are mobile and dynamic equipment and machinery (also including robots), embedded systems and networked, intelligent participants (Internet of things).

So-called cyber-physical systems take on one of the key functions in the smart factory or industry 4.0.

SUPPLEMENTARY EQUIPMENT CYBER-PHYSICAL SYSTEMS



The "Cyber-Physical Systems" project includes several pieces of equipment. This makes it possible to cover the entire spectrum from programming to mechatronic production lines all the way to automatic control on a single equipment set.

Scope of equipment

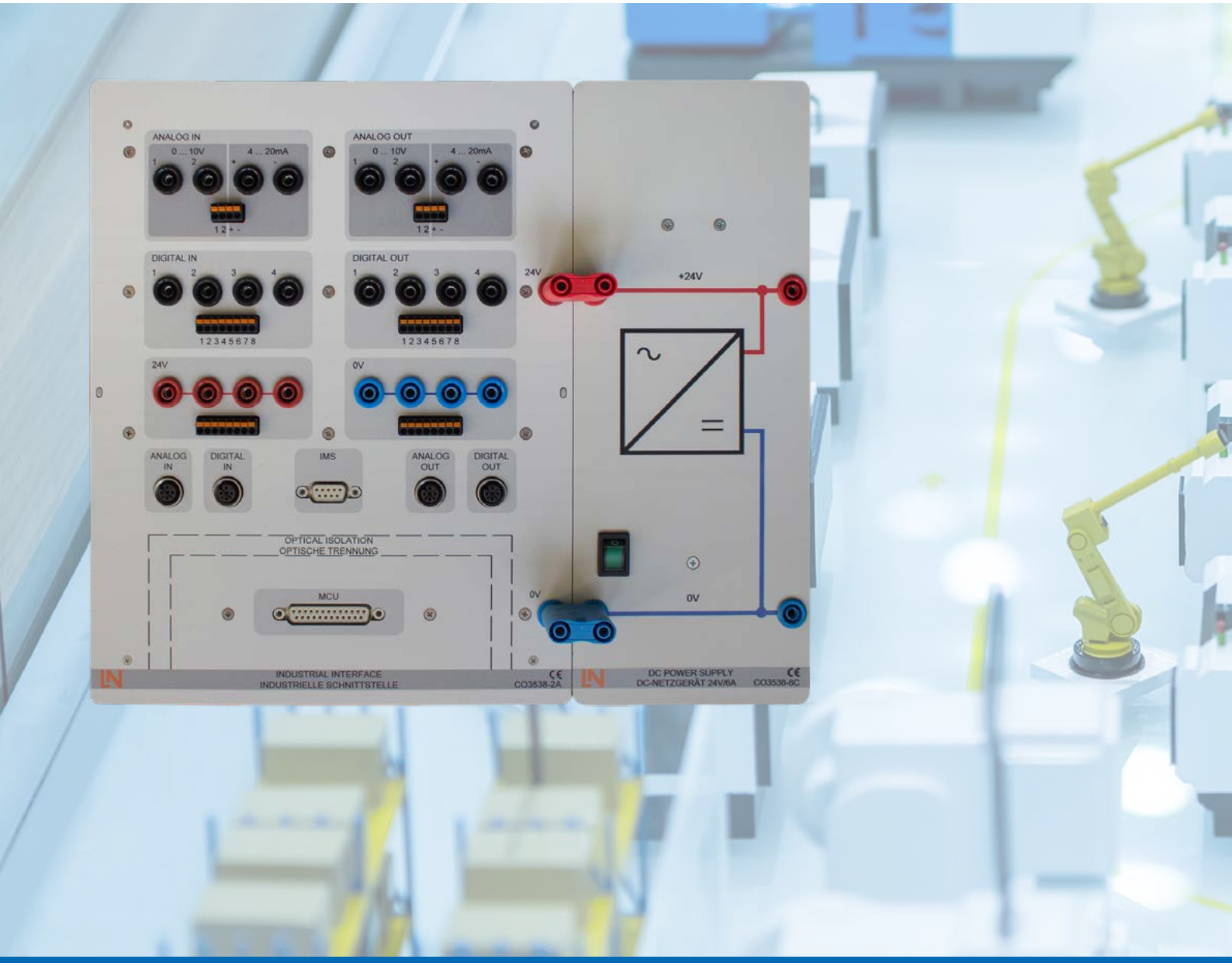
- Microcontroller programming module
- Adapter sub-D9 / sub-D24
- "Industrial interface" module
- "Power supply for industrial interface" module
- "Conveyor belt" module
- Additional units on request

Training contents

- Putting a mechatronic system into operation
- Voltage signal conversion
- Electrical decoupling
- Controlling an industrial machine
- Monitoring using sensor technology
- Programming with Flowcode (C code integration also possible)

The CPS includes a variety of components

SUPPLEMENTARY EQUIPMENT SET – INDUSTRIAL INTERFACE



The "Industrial interface" module can also be ordered on its own, separately from the CPS equipment set. It creates the link connecting the microcomputer world to the world of industry.

With this powerful tool, any given industrial component like conveyor belts, motors or lifts can be safely controlled and operated by all the microcontrollers from our program.

Technically one step further

- Total optical decoupling of all inputs and outputs
- Signal level conversion of digital signals from 3.3 V or 5 V to 24 V
- Signal level conversion of analog signals from 1 V to 10 V
- Measurement interface 4 to 20 mA
- Digital outputs load capability up to 0.5 A (total 5 A)
- 8x digital inputs/outputs, 2x analog inputs/outputs
- 4-mm safety sockets, terminal strips, M12 connector plug
- IMS connection terminal

Art. no. CO4205-7Z

INTERNET OF THINGS – AN INTELLIGENT HUB

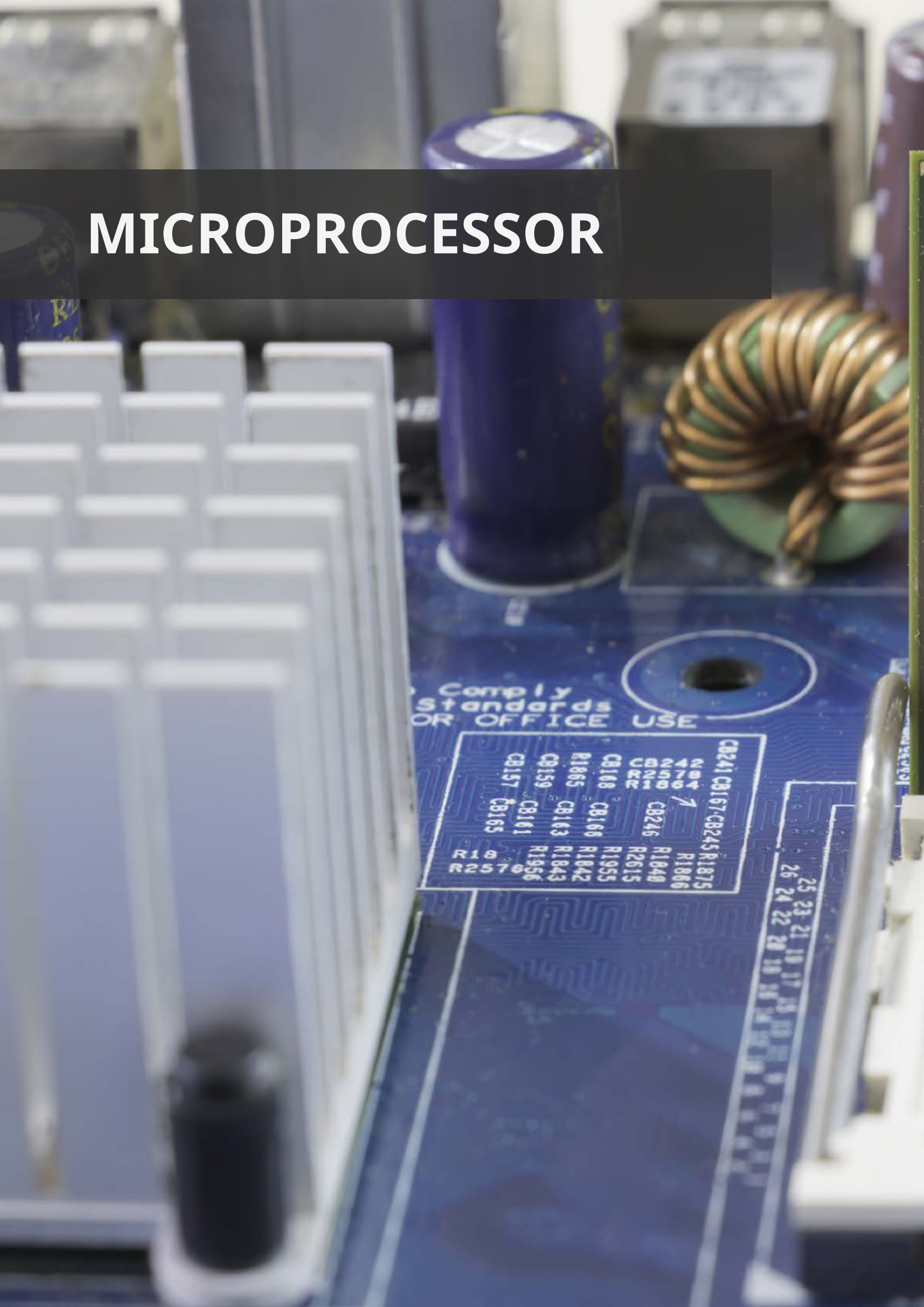
A so-called "Ethernet" and a "WiFi interface" make this supplementary set to the CPS project into a fully fledged participant in the "Internet of things".

Data detected by sensors and processed using microcontrollers are transmitted wirelessly or via cable. A database in the cloud permits the collated data to be processed centrally. Important aspects of data security are also explained here.

Training contents

- Ethernet interface
- WiFi interface
- Cloud storage
- Cyber security

Art. no. CO4205-7X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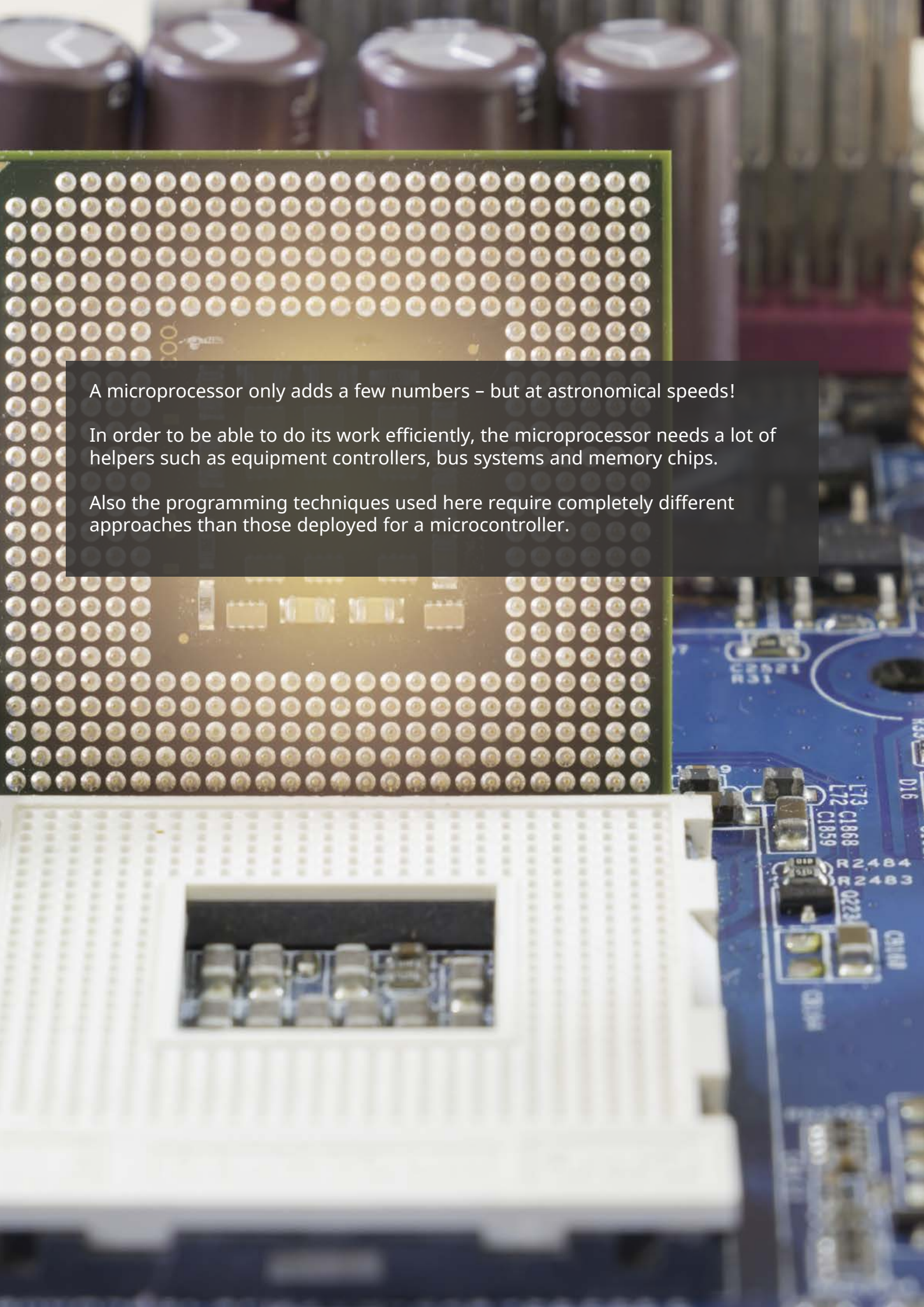
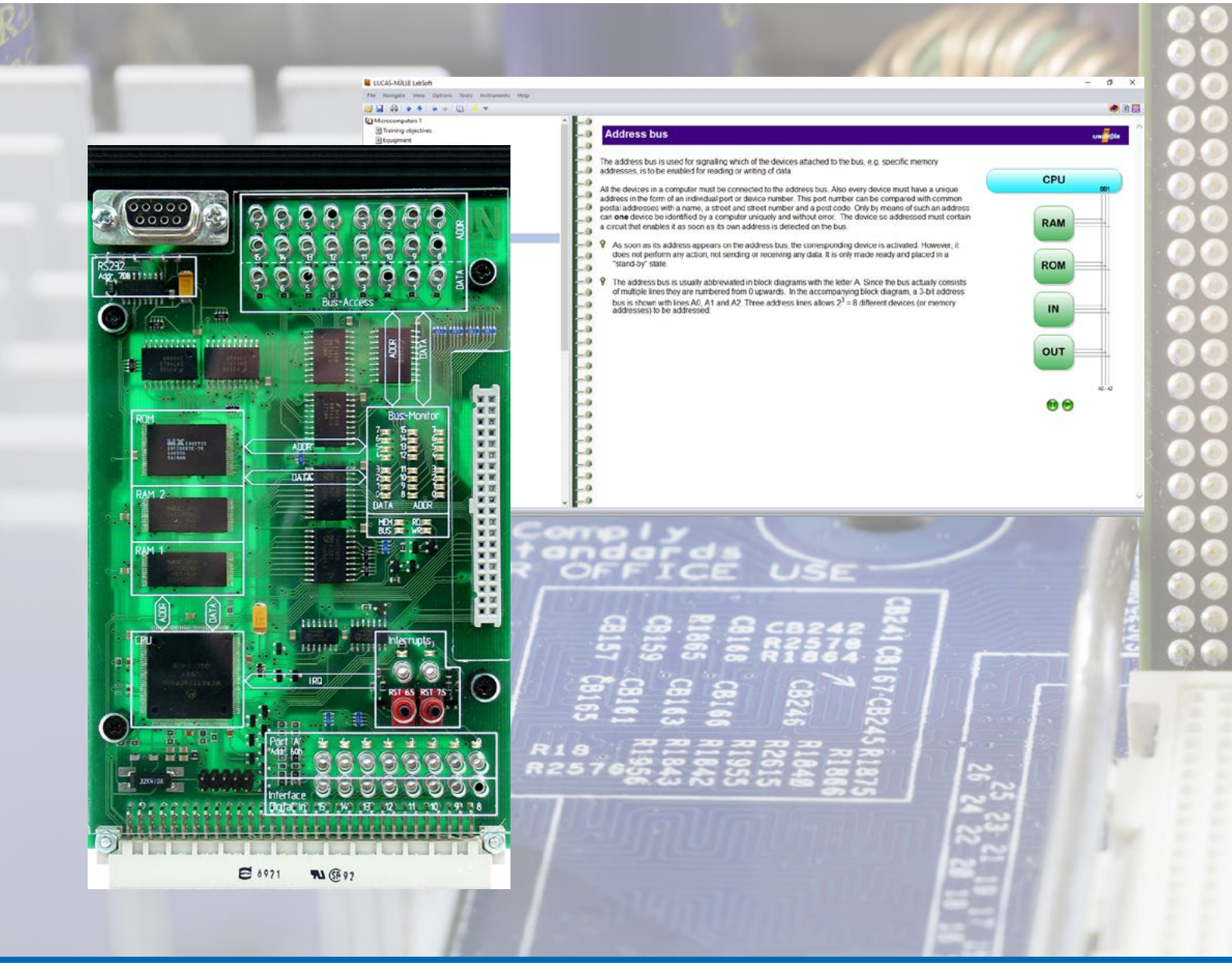


A microprocessor only adds a few numbers – but at astronomical speeds!

In order to be able to do its work efficiently, the microprocessor needs a lot of helpers such as equipment controllers, bus systems and memory chips.

Also the programming techniques used here require completely different approaches than those deployed for a microcontroller.

BASIC EQUIPMENT SET – FUNDAMENTALS OF COMPUTER TECHNOLOGY



Know-how involving the entire spectrum of "microprocessors" both in theory and practice. In addition to the basics of the individual components and functional units of a microcomputer, also its control functions will be graphically demonstrated using certain commands.

Training contents

- Introduction to the design of a microcomputer system
- Insight into a CPU's set of instructions
- Knowledge of the various input and output times
- Experiment-based exploration of program routines and sequences
- Monitoring how commands are executed
- Become familiar with the history of the technology

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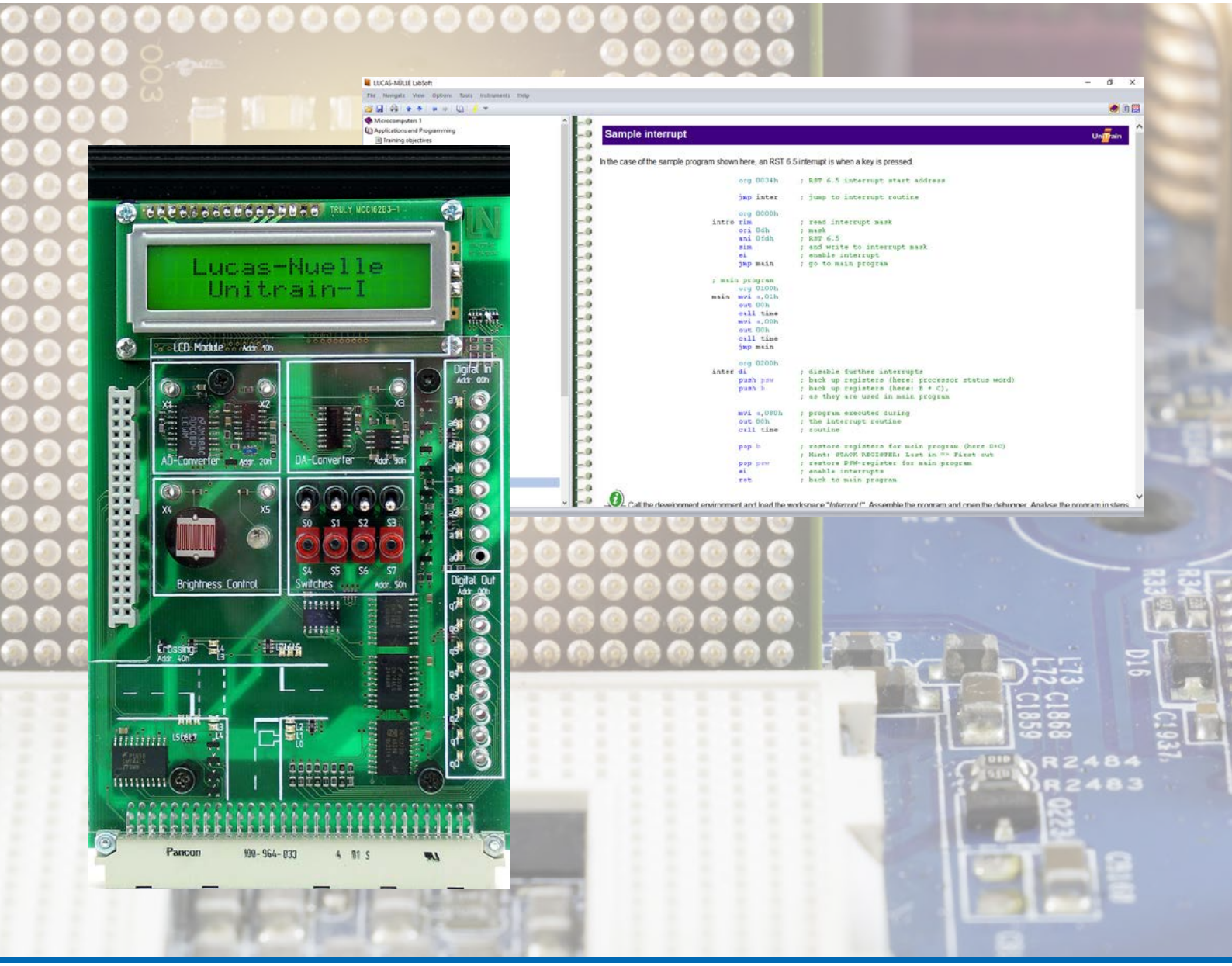
SUPPLEMENTARY SET – APPLICATIONS AND PROGRAMMING



In this equipment set, the focus is on program development for deploying the microcomputer as a control unit in the process control of technical applications.

With selected examples, a variety of applications such as AD conversion or the process control of a traffic light are explored with hands-on training.

Training contents

- Types of instructions and commands
- Creating and evaluating assembler programs
- Investigating program run times
- Programming times, loops, subroutines and interrupts
- Creating programs for the processing of analog values and alphanumerical output on the display unit
- Analyzing and programming traffic light controls
- Creating programs for serial data transmission
- Becoming familiar with and applying trouble-shooting techniques and analysis

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