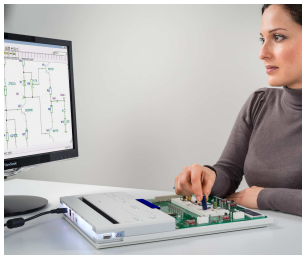
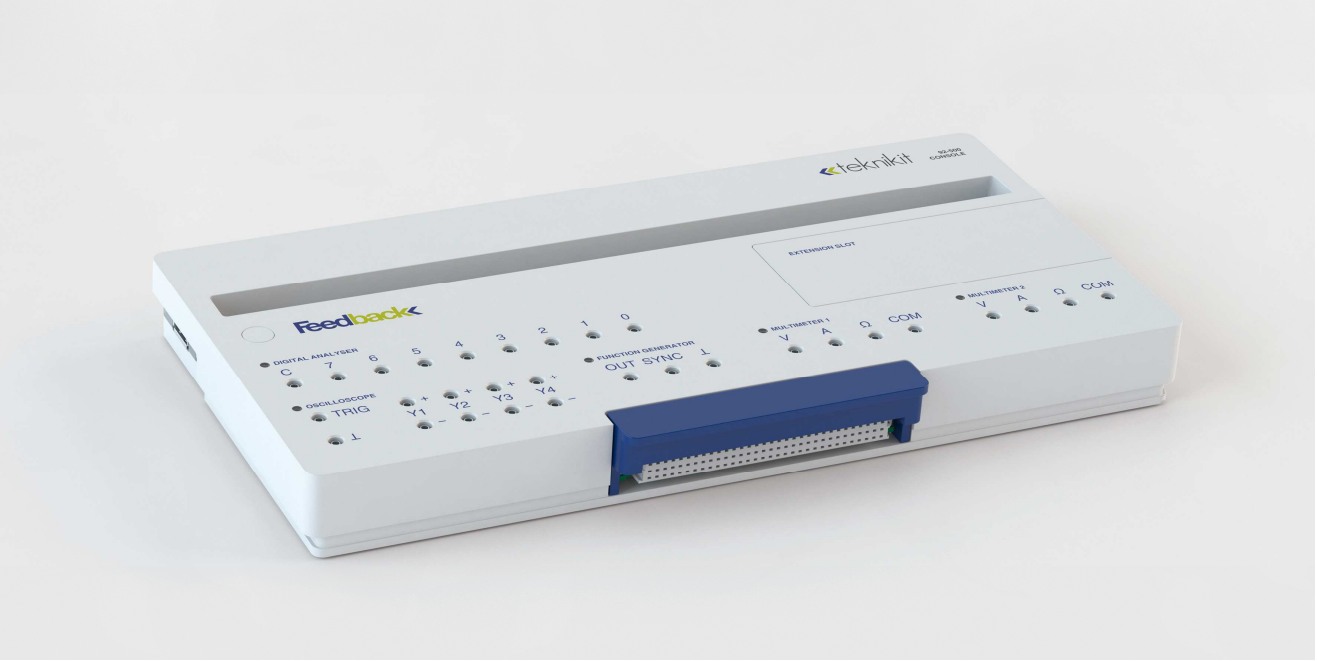
TEKNIKIT

Compact, Modular, Electronics Teaching System



92-500 Console

The TEKNIKIT CONSOLE is the multifunctional, compact measuring interface. It is used for the operation and the power supply to the TEKNIKIT multimedia experiment boards 14-106 to 14-136. The Console is connected to the PC via USB Port, Wi-Fi or Ethernet for the recording of measurements and for remote control of its built-in functions. The Console can be quickly attached to an experiment board and experiment board carrier and its clear and structured design results in easy operation.

Characteristics:

- 4-channel oscilloscope
- Digital multi-meter (x2)
- Digital Analyser
- Function Generator
- Frequency Counter
- Integrated USB interface for external measuring instruments
- USB charging socket for tablets
- Light strip and LEDs for status display
- two separate audio outputs so that two school children can work with the Console at the same time (suitable for inclusion)
- Interfaces: Network interface 100 MBits RJ45, WiFi, USB
- Security lock for fastening the experimentation boards
- Anti-theft protection (Port for Kensington lock)

Software Support

- Windows 8 / 8.1 32/64 Bit
- Windows 7
- Windows Vista

Experiment boards

The experiment boards are as follows:

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Integrated Measuring Instruments & Functions:

- Two digital multi-meters:
  Voltage: AC / DC / AD + DC 2/20 V Current: AC/DC 0,2/2 A
  Resistance: 2/20/200 kΩ, 2 MΩ
  Auto-ranging for all measurement ranges
  Digital Function generator: digitally generated signal types Sinusoidal, square-wave, triangular, DC
  0.5 Hz...100 kHz
  Max. ±10 V, max. 250 mA
- Digital 4-Channel Oscilloscope:
  4 differential inputs
  Sampling rate: 2 MSamples per channel
  Resolution: 12 Bit per channel
  Memory depth: 2 K Samples per channel
- Digital Analyser:
  9 digital inputs, TTL-compatible
  Sampling frequency: 200 Hz to 2 MHz
  Triggering on any combination of the input statuses
  Memory depth 2048 words with 9 Bits
  The real measuring instruments can be read out and operated via the software

Items Included:

- Console (main unit)
- USB Cable
- Ethernet Cable
- Power Supply DC 15V 6A 90W

14-101 Set of Safely Cables (2mm)

For use with TEKNIKIT boards and console, comprising:

2 x 150mm red
2 x 150mm blue
6 x 150mm black
2 x 300mm red
2 x 300mm blue
2 x 300mm black

14-103 Low-noise Compressor

High-quality, low-noise compressor with a layered and hence corrosion-resistant 25-liter tank. Equipped with two handles for easy transport.

Characteristics:

- Network voltage: 230 V/50 Hz; 0.18 kW
- max. pressure: 8 bar
- Tank volume: 25 l
- FAD @ 8 bar: 26 ltr/min
- Sound emissions: 45 dB(A)/1 m
- Dimensions: 380 x 380 x 542 mm
- Weight: 25 kg

14-106 DC Technology I

Comprises a board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course in the fundamentals of direct current technology using 13 different circuits wired using 2mm safety cables (14-101 set of 2mm cables supplied separately). Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Circuits with switches
- Switches in series
- Switches in parallel
- Change-over switches
- Polarity reversing circuit
- Relays
- Conductivity
- Ohm's law
- Colour codes and IEC series
- Series-connected resistors
- Kirchhoff's law
- Voltage dividers
- Voltage dividers under load
- Wheatstone bridge

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Ordering information:

- 14-106 DC Technology I
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-107 DC Technology II

Comprises a board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course in the fundamentals of direct current technology using 11 different circuits wired using 2mm safety cables (14-101 set of 2mm cables supplied separately).
Characteristics can be recorded and the basic types of electrical circuit can be mastered. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Incandescent lamp characteristic
- VDR characteristic
- Diode characteristic
- LDR characteristic
- NTC characteristic
- PTC characteristic
- Capacitors
- Capacitors connected in parallel
- Capacitors connected in series
- RC circuits
- Inductance
- Moving coil instrument
- Batteries
- Two batteries connected in parallel
- Two batteries connected in series

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Ordering information:

- 14-107 DC Technology II
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-108 AC Technology I

Comprises a board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course in the fundamentals of alternating current technology using 11 different circuits wired using 2mm safety cables (14-101 set of 2mm cables supplied separately). This course covers the production of AC voltage, transformers and rectifier circuits. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Step voltage
- Continuous AC voltage
- Electronic generation of AC voltage
- Function generators and oscilloscopes
- Induction
- Principle of transformers
- Short-circuited transformers
- Transformers under load
- Transformer losses
- Diodes used as current valves
- M1 rectifiers
- M2 rectifiers
- B2 rectifiers
- Symmetrical output voltage

Virtual lab:

- Oscilloscope
- Function generator
- Multimeter (2x)
- Digital analyser

Additional functions:

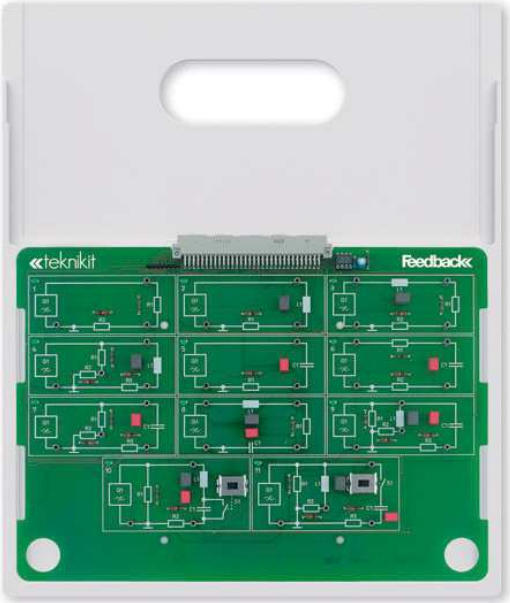
- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Ordering information:

- 14-108 AC Technology I
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-109 AC Technology II

Comprises a board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course in the fundamentals of alternating current technology using 11 different circuits wired using 2mm safety cables (14-101 set of 2mm cables supplied separately).
This course covers the behaviour of resistance, coil and capacitor in an AC circuit. Course content, experiment instructions and tasks are taught through course-specific software.



Topics:
- Generating alternating voltages
- Key parameters of AC technology
- Ohmic resistance in an AC circuit
- Coils in an AC circuit
- Inductive reactance
- Series RL circuits
- Parallel RL circuits
- Capacitors in an AC circuit
- Capacitive reactance
- Series RC circuits
- Parallel RC circuits
- Series RLC circuits
- Parallel RLC circuits
- Series compensation
- Parallel compensation
- Voltage resonance
- Current resonance

Virtual laboratory:
- Oscilloscope
- Function generator
- Multimeter (2x)
- Digital analyser

Additional functions:
- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Ordering information:
- 14-109 AC Technology II
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-110 Electronic Components I

Comprises a board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course on Electronic components using 12 varying circuits wired using 2mm safety cables (14-101 set of cables supplied separately). This course provides the behaviour of diodes and transistors. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Diode characteristics
- Characteristic of a Z diode
- Characteristic of an LED
- Diode branches in a transistor
- Input characteristic of the transistor
- Output characteristics of the transistor
- Control characteristic of the transistor
- Power dissipation of a transistor
- Characteristic of a phototransistor
- Darlington circuit
- Operating point of a transistor
- Transistor in a common emitter circuit
- Transistor in a common collector circuit
- Transistor in a common base circuit
- Transistors in timer circuits

Virtual laboratory:

- Oscilloscope
- Function generator
- Multimeter (2x)
- Digital analyser

Additional functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Ordering information:

- 14-110 Electronic Components I
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-111 Electronic Components II

Comprises a board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course on electronic components using 12 varying circuits wired using 2mm safety cables (14-101 set of 2mm cables supplied separately). This course explains the behaviour of FETs, MOSFETs and IGBTs. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Design of the FET
- Transfer characteristic of the JFET
- Output characteristic family of a JFET
- JFET as a switch
- Characteristics of the MOSFET
- The MOSFET as a switch
- Characteristics of the IGBT
- The IGBT as a switch
- Characteristic of the DIAC
- Characteristic of the thyristor
- Thyristor in the DC circuit
- Phase angle control with a thyristor
- Characteristic of the TRIAC
- Phase angle control with a TRIAC

Virtual lab:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Ordering information:

- 14-111 Electronic Components II
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-112 Digital Technology I

Comprises a board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course on the basics of digital technology (circuits) with numerous components and logic gates, experiments being wired by using 2mm safety cables (14-101 set of 2mm cables supplied separately). The course examines the principles and laws in digital technology. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- TTL AND gates
- TTL OR gates
- TTL NOT gates (inverters)
- TTL XOR gates
- Boolean operations
- De Morgan's law
- TTL NAND gates
- Associative law
- Distributive law
- Karnaugh maps
- Coding
- Seven-segment displays
- Half- and Full -adders
- Multiplexers / demultiplexers
- Fault simulation

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:

- 4 x AND, 3 x OR, 2 x XOR, 2 x NOR, 3 x NAND
- Full adder
- 7 Segment display
- Multiplexers, Demultiplexers
- 4 command switches, 2 sensors, 2 LEDs

Ordering information:

- 14-112 Digital Technology I
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-113 Digital Technology II

Comprises a board, housed with a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course on the basics of digital technology (switching networks) by forming various circuits wired using 2mm safety cables (14-101 set of 2mm cables supplied separately). The course deals with the operation and use of flip-flops. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Flip-flops
- RS flip-flops
- RS flip-flops with clock input
- Monostable and astable multivibrators
- Schmitt triggers
- D flip-flops
- JK flip-flops
- JK master-slave flip-flops
- Frequency dividers
- Counters
- Shift registers
- Parallel-serial converters

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:

- 2 x AND, 2 x NOR, 4 x NAND
- 2 Inverter
- 1 Schmitt trigger
- 1 7-segment display
- 4 JK flip-flop
- 1 Universal shift register
- 4 command switches, 2 sensors, 4 LEDs

Ordering information:

- 14-113 Digital Technology II
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-114 Three-Phase Technology

Comprises a board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course investigating the behaviour of three-phase system, experiments being wired using 2mm safety cables (14-101 set of 2mm cables supplied separately). Practical exercises show the generation of the rotary fields or the function of the transformer.
Furthermore, passive components in different circuits are discussed. Coils, capacitors and resistors are analysed and evaluated in different circuits. An 8-channel oscilloscope enables the simultaneous measurement of all voltages and currents in the three-phase system. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:
- Characteristics of a three-phase system
- Representation of line diagrams and phase relationships
- Star- and delta circuits with different loads
- Measurement of phase and line voltage/current
- Ohmic load
- Symmetrical and unsymmetrical charges
- Measurement of power in the three-phase system

Virtual Laboratory:
- Spectrum analyser (FFT module)
- Frequency counter
- Multi-meter (x2)
- Function generator
- Digital memory oscilloscope
- Multiplexer for recording four voltages and four currents

Additional Functions:
- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:
- Star circuit with resistors
- Delta circuit with resistors
- Capacitors
- Load resistors

Ordering information:
- 14-114 Three-Phase Technology
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-115 Sensor Technology

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching the basics of the measurements of non-electric quantities, experiments being wired using 2mm safety cables (14-101 set of 2mm cables supplied separately). With many examples, explanations and practical tasks, the function and operation of sensors and measuring circuits are investigated. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Electronic circuits for temperature measurement function and characteristics of different temperature sensors: Pt100, NTC, KTY and thermocouple.
- Function and characteristics of pressure sensors.
- Force measurements with strain gauges.
- Force measurement with bending bar.
- Displacement-, angle- and speed measurement.
- Measurements with optical encoder.
- Hall sensors.

Virtual Laboratory:

- Frequency counter
- Multi-meter (x2)
- Function generator
- Digital memory oscilloscope

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:

- Torque measurement using strain gauges on beams
- Temperature sensors: Pt 100,NTC, KTY, Thermocouple element
- Peltier element for recording the temperature characteristics of approx. 0° to 50°
- Differential pressure sensor
- Ohmic displacement transducer
- Capacitive displacement transducer
- Inductive displacement transducer
- Positioning using hall sensor and Reed contact
- Ultrasonic sensor with receiver
- Brightness measurement using photo diode
- Hall sensor
- Optical sensor:
  Adjustable current source
  Measuring procedure with compensated lines: three-wire measurement, four-wire measurement
- 1 universal measurement amplifier
- 1 pressure sensor with pressure display
- 1 force gauge

Ordering information:

- 14-115 Sensor Technology
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-116 Photovoltaics

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course investigating the structure and the function of solar cells, experiments being wired using 2mm safety cables (14-101 set of 2mm cables supplied separately). Animations and illustrations give a descriptive introduction into photovoltaic systems. On basis of real experiments, the course describes the functioning of solar modules. The micro-controlled charge controller pursues the solar generator in the Maximum Power Point (MPP). Theory and experiments are accompanied and checked by the photovoltaic interactive training program. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Solar cell (Properties, function, etc)
- Solar module (Properties, function, etc)
- Different circuits of solar modules
- Solar characteristic
- Influence of temperature
- Influence of shadow
- Charge controller
- Solar charger controller
- Photovoltaic systems
- Applications

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:

- 1 x Halogen lamp 230 V /100 W with holder and dimmer
- 4 x Solar cells 4 V / 35 mA
- 1 x Solar charger 2.4 V / 60 mAh
- 1 x Solar controller with microcontroller
- 1 x Solar controller with IC
- 1 x Temperature sensor
- 1 x Fan 12 V
- 1 x Step-up converter
- 1 x Frequency converter
- 2 x Current/Voltage converter
- 1 x Motor
- 1 x LED 12 V
- 2 x Storage capacitors
- 1 x Ohmic load

Ordering information:

- 14-116 Photovoltaics
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-117 Operational Amplifier

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a course on operational amplifier circuits, experiments being wired using 2mm safety cables (14-101 set of cables supplied separately). Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- The comparator
- Features of the operational amplifier
- Inverting op amp
- Non-inverting op amp
- Fault simulation in inverting op amps
- Adder
- Integrator
- Differentiator
- Active filters
- Stabilised voltage source
- Stabilised current source
- Schmitt trigger
- Astable multi-vibrator
- Wien bridge oscillator
- Function generator

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser
- FFT Spectrum analyser
- Frequency counter
- Bode module

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Ordering information:

- 14-117 Operation Amplifier
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-118 Control Technology I

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course on the fundamentals of automatic control technology, experiments being wired using 2mm safely cables (14-101 set of cables supplied separately). Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Introduction
- Open-loop control
- Closed-loop control
- Analysis of controlled systems
- Controlled systems with/without compensation
- Controlled systems of a higher order
- Types of controllers
- P, I, PI, PID and PD control
- Automatic digital control
- Performance criteria for automatic controls
- Optimization guidelines for PID controllers
- Automatic temperature control
- Automatic speed control
- Automatic light control
- Automatic control of systems without compensation
- Automatic control with discontinuous controllers
- Fault simulation

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser
- Static characteristic plotter
- Step response plotter
- DDC plotter
- Controller design calculator (for optimum controller parameters)

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:

- Analogue controller
- Summation points with disturbance inputs
- Digital controller
- Lag element
- DC signal sources 1V, 5V, 10V
- P-action element
- PT-1 elements (2 x)
- I-action element, resettable
- Nonlinear characteristic element
- Speed controlled system with optical speed sensor
- Temperature controlled system with KTY-temperature sensor
- Light controlled system with photodiode sensor and external light source (disturbance source)
- Operating system: Windows XP/Vista/7/8
- Support for unguided, free experimentation

Ordering information:

- 14-118 Control Technology I
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-119 Control Technology II

This provides a supplementary course on the fundamentals of control technology including a dongle for use with, and requires, the Control Technology I experiment board 14-118. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Introduction
- Stability of automatic control systems
- Controller design using the Ziegler/Nichols method
- Systems with lag time
- Limiting the manipulated variable
- Cascade control
- Introduction to frequency response
- Frequency response of single basic elements
- Frequency response of combined elements
- Controller design in the frequency domain
- Fuzzy control
- Adaptive control
- Experiments with external controlled systems

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter
- Digital Analyser
- Static characteristic plotter
- Step response plotter
- DDC plotter
- Controller design calculator (for optimum controller parameters)

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Ordering information:

- 14-119 Control Technology II
- 14-118 Control Technology I (required)
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-120 Automation and Bus Technology

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching the basics of a programmable logic controller (PLC) and showing it's networking capability including the use of sensors and actuators by means of the PROFIBUS. With many examples, explanations and practical tasks, the base and mode of operation of the PLC and PROFIBUS are represented.
Experiments are wired using 2mm safety cables (14-101 set of 2mm cables supplied separately). Course content, experiment instructions and tasks are taught through course-specific software.

Topics:
- Basics and basic terms (IEC 1131) of the PLC
- Logic connections, times, counters, data processing and program editing
- Simple sensors and signal conditioning with analogue digital transformers and multiplexers
- Projecting of an automatization system
- Programming and initiation of the PLC
- Data transfer structures and protocols
- Transfer and error analysis
- Connection of external components
- Link of PROFIBUS users (GSD)

Virtual Laboratory:
- Oscilloscope
- Function generator
- Multi-meter (x2)
- PROFIBUS analyser
- PLC Control
- PLC Program
- Process In/Out

Additional Functions:
- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:
- 24 digital inputs
- 8 analogue inputs
- Sensors: Temperature sensor, Photo transistor
- 20 digital outputs
- 2 analogue outputs
- 1 Motor
- Dimmable incandescent lamp
- 4 mm sockets for external application
- Connection for external Profibus components
- PROFIBUS (1 Master, 2 Slaves)

Ordering information:
- 14-120 Automation and Bus Technology
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-121 Power Electronics I

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a course on various phase-commutated and self-commutated converter circuits, experiments being wired by using 2mm safety cables (14-101 set of cables supplied separately). Course content, experiment instructions and tasks are taught through course-specific software.

Topics:
- Semiconductors in power electronics
- Wiring and triggering
- Switching processes and commutation
- Uncontrolled rectifier circuits
- Parameters for periodic signals Controlled line-commutated static converters
- M1C circuit
- M3C-circuit
- B2C circuit
- B6C semi-controlled rectifiers

Virtual Laboratory:
- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser
- Characteristic curve plotter
- Converter analyser
- Converter control unit

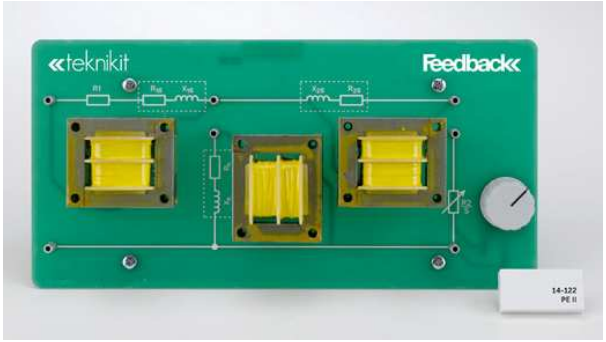
Additional Functions:
- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:
- 1 three-phase network generator in 50 and 60 Hz
- Self-commutated and line-commutated static converter (E1 to B6 circuit) with TSE protection
- H6-MOSFET frequency converter from 1 to 120 Hz
- Three independent ampere meters
- Three incandescent lamps as ohmic load
- Inductive and capacitive loads
- 4-channel multiplexer

Ordering information:

- 14-121 Power Electronics I
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-122 Power Electronics II



For use with the 14-121 Power Electronics I (required and supplied separately), this is a supplementary course on power inverters, DC choppers, converters and drive technology, consisting of a dongle and a circuit board with the equivalent circuit of a three-phase induction machine, including a rotating field indicator. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Self-commutated converters (power inverters)
- Semiconductor switches and controllers (bidirectional static converters)
- Switches and controller for DC
- Converters
- Static converters in automatic control technology
- Static converters in drive technology

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser
- Characteristic curve plotter
- Converter analyser
- Converter control unit

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Ordering information:

- 14-122 Power Electronics II
- 14-121 Power Electronics I (required)
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-123 Electrical Machines I

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course concerning the connection methods and the recording of characteristics for electric motors and generators, experiments being wired by using 2mm safety cables (14-101 set of cables supplied separately). With the integrated machine test system, a multitude of experiments can be carried out, e.g. the recording of torque, power and current-locus curves. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Forces in a magnetic field
- Measurement of Lorentz force
- Drives
- Torque-speed characteristic
- Machine test system
- DC machines
- Speed and induced voltage with DC machines
- Torque and armature voltage with DC machines
- Torque and excitation voltage with DC machines
- DC machines with external excitation
- Reversible of direction
- Characteristics with variable armature voltage
- Characteristics with variable excitation voltage
- Shunt-wound DC machines
- Characteristics with variable operating voltage
- Series-wound DC machines
- Reversal of direction with DC machines
- Characteristics with variable operating voltage
- Generator operation of DC machines
- Drive and generator with a resistive load
- Power output of generator
- Rotating field (three-phase) machines
- Three-phase windings
- Rotating fields
- Direction of rotation with periodic swapping of phase conductors
- Direction of rotation when phase conductors are swapped
- Voltage and current in star (Y) circuits
- Voltage and current in delta circuits
- Resistance in stator winding
- Reactance of an AC winding
- Synchronous machines
- Equivalent circuit diagram for synchronous machines and how they are used
- Permanently excited synchronous machines
- Step operation of synchronous machines
- Determining rotor position in star configuration
- Determining rotor position in delta configuration
- Synchronous machine at variable speed (run-up)
- Speed measurement
- Speed setting using frequency converter
- Asynchronous machines
- Block and equivalent circuit diagrams for asynchronous machines
- Determination of slip
- Star-delta starting
- Measurement of torque and line currents during run-up
- Changing direction of asynchronous machines
- Recording of torque-speed characteristic for asynchronous machines
- Three-phase drives
- Changing speed of asynchronous machines
- How speed depends on slip
- How speed depends on stator frequency
- Stepper motors
- Full-step operation
- Half-step operation
- Changing the direction of a stepper motor

Virtual Laboratory:

- Multi-channel oscilloscope
- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser

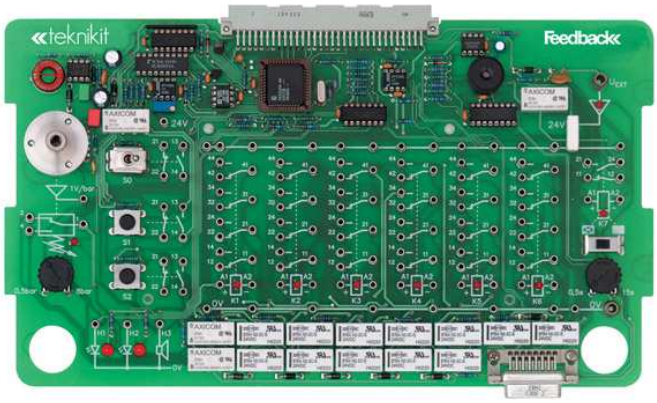
Additional functions:
- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:
- Synchronous machine with optical rotary field indicator and strobe for speed determination
- Induction motor with star-delta switch
- Optical tachogenerator
- DC motor
- DC generator
- Current-torque converter
- Thermometer
- Electronic load
- Three phase generator, phase voltage: 0 V. .. 10 V,
- Frequency converter, Frequency: 1 Hz - 80 Hz
- DC supplies
- Stepper motor
- Electrodynamic force meter
- Multichannel oscilloscope

Ordering information:
- 14-123 Electrical Machines I
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-124 Electro Pneumatics

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course on pneumatics and electro pneumatics. In order to perform experiments, this board can either be connected with industry standard valve technology or with the 14-125 Pneumatics Board (supplied separately) to perform all the experiments. The wiring of the experiments is carried out over 2 mm safety cables (14-101 set of 2mm cables supplied separately). Course content, experiment instructions and tasks are taught through course-specific software.



Topics:

- Basics of pneumatics / electro pneumatics
- Pneumatic and electric circuit diagrams
- Pilot control of a single-acting cylinder
- Pilot control of a double-acting cylinder
- Holding element control
- Basic circuit with AND function
- Basic circuit with OR function
- Basic circuit with electric latching circuits
- Displacement-dependent control
- Time-dependent control, switch-on and switch-off time delay
- Pressure-dependent control
- Sequential controls

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

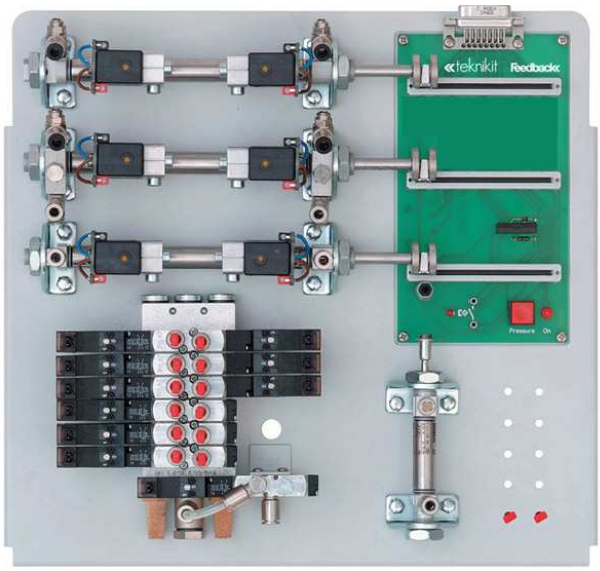
Technical Specifications:

- 6 relays, 4 changeover contacts
- 1 time relay (switch-on and switch-off time delay)
- 1 Pressure transducer
- 1 Pressure sensor 0 - 10 bar
- Operating and monitoring elements
- 24 V voltage supply

Ordering information:

- 14-124 Electro Pneumatics
- 14-125 Pneumatics Board (recommended)
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-125 Pneumatics Board



Selected by users of the 14-124 Electro Pneumatics board as an optional item, this board will monitor the components with the integrated displacement sensors of the cylinders.

In addition to the Pneumatics Board itself, the 14-125 comprises:

- 1 x PU Plastic hose 5m long and 2.5 mm thick
- 6 x adapter cables 2 mm on socket connectors
- 20 x blanking elements
- 10 x 2 mm cables in blue, 4 cm long
- 20 x 2 mm cables in blue, 15 cm long
- 12 x 2mm cables in red/black, different lengths
- 1 x screwdriver

A compressor is required which is supplied separately. We recommend our 14-103 Low Noise Compressor.

If you are supplying your own compressor, the minimum requirements are:

- Connection Power : 15 W
- Pressure: 500 kPa
- Feed rate: 2 l/min

Technical Specifications:

- 1 x single-acting cylinder, spring return with capacitive end switch
- 3 x double-acting cylinder with displacement sensor and cylinder switch
- 4 x throttle valves
- 3 x 5/2 electric displacement impulse valves
- 3 x 5/2 electric displacement valves with spring return
- 1 x central switch-on valve for pressure supply, controlled by TEKNIKIT
- 3 x displacement sensor for double-acting cylinders

Ordering information:

- See ORDERING INFORMATION on 14-124
- 14-103 Low Noise Compressor (recommended, or some other compressor required)

14-126 Protoboard II

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by the 92-500 Console (92-500 console supplied separately) and expands the Console into a development platform for electronic circuits. Any type of circuit with electronic components (not included) can be set up and tested on the breadboard with 1-mm contacts. The fixed voltage outputs and the function generator output are connected via 2-mm sockets and can be switched using slide switches. There are 2 change-over switches for any desired connections located on the prototyping board. Furthermore, standard European printed circuit boards can be connected using a 64-pin VG terminal strip.
8 relay switchover contacts are located on the VG terminal strip. 8 digital outputs can be tapped using the VG strip or via 2-mm sockets. The relay and digital outputs can be switched using software. The power supply, the multi-meter and the function generator of the Console can be operated without the PC.

Items Included:

- Experiment board & boards carrier
  Software for the display of the integrated measuring instruments (multi-meter, function generator, memory oscilloscope, logic analyser, frequency counter) under Windows
- 2 European grid matrix printed circuit boards with VG plug for soldering exercises and for the assembly of special circuits
- 50 wire jumpers, 1 mm, for interconnecting the components
- 20 adapter leads, 1 mm/2 mm for the connection of the measuring points to the inputs of the measuring instruments
- 5 probe tips with 2-mm terminal socket

Ordering information:

- 14-126 Protoboard II
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-127 Automotive Electrics

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) and provides a practical course teaching the basics of automotive electrics / electronics, experiments being wired using 2mm safety cables (14-101 set of 2mm cables supplied separately). Course content, experiment instructions and tasks are taught through course-specific software.

Topics:
- Electricity in the vehicle: current - voltage - resistance
- Calculating with parameters: Ohm's law - Power
- Circuits
- Series and parallel circuits - forward slope resistances

Virtual Laboratory:
- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser

Additional Functions:
- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:
- Circuit and relay
- Analog multimeter
- Resistances
- Solar cell
- Diodes
- On-board electrical system and lighting

Items Included:
- Experiment board & board carrier
- 1 x Wire wrap panel
- 1 x Chrome nickel wire (d=0.2mm/d=3m)
- 1 x Constantan wire (d=0.2mm/l=3m)
- 1 x Iron wire (d=0.2mm/l=3m)
- 2 x Adapter cables (2 to 4 mm)
- 1 x set of connecting cables (2 mm)

Ordering information:

- 14-127 Automotive Electrics
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-128 Automotive Sensor Technology

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course on the advanced principles of automotive electrics / electronics, experiments being wired using 2mm safety cables (14-101 set of cables supplied separately). The course results in a comprehensive understanding of the electrical processes and events in vehicles. Measuring technology, troubleshooting and fault correction complete the learning content. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Components: switches, resistors, capacitors, diodes and Zener diodes, relays.
- Schematics: reading vehicle schematics
- Sensors: inductive sensors, magnetic-field sensors.
- Batteries and accumulators: Interconnecting cells, accumulator types.
- Ignition: capacitors, relays, induction, ignition coil.
- Generators and motors: rectification, three-phase generator, permanent magnet generator.
- Transistors in the vehicle: transistor, checking transistors,
- Monitoring features in vehicles, amplifier circuits, application circuits.

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser

Additional functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:

- Components: diodes, coil,
- Capacitor, circuit, transistor
- Adjustable fan, rev counter
- Transistor circuits
- Bridge rectifier circuit
- Motor / Generator

Ordering information:

- 14-128 Automotive Sensor Technology
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-129 Automotive Data Buses

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course on the interconnected electronic systems in automotive technology, experiments being wired using 2mm safety cables (14-101 set of 2mm cables supplied separately). At the forefront of this is getting to know the various bus systems and their application areas. Here, action-oriented tasks lead to a comprehensive understanding of the connections in the vehicle, including troubleshooting and fault correction. Course content, experiment instructions and tasks are taught through course-specific software.

In conjunction with the CAN data bus adapter USB, 739 581USB and the LIN bus PC interface USB, 739 588 the following topics can be covered:

- Digital technology: Basics of the digital technology
- Bus systems: CAN, LIN, SENT
- Measuring technology: physical signals, protocols, fault analysis
- Connection with external components feasible
- Other applications and system components

Ordering information:

- 14-129 Automotive Data Buses
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-130 Automotive Digital Technology I

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (console supplied separately) teaching a practical course on switch algebra are dealt using logic links, experiments being wired by using 2mm safety cables (14-101 set of cables supplied separately). Course content, experiment instructions and tasks are taught through course-specific software.

Topics:
- TTL-AND
- TTL-OR
- TTL-NOT
- TTL-XOR
- TTL-NAND
- Boolean operations
- Coding
- Multiplexer
- Fundamentals CAN Bus

Virtual Laboratory:
- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser

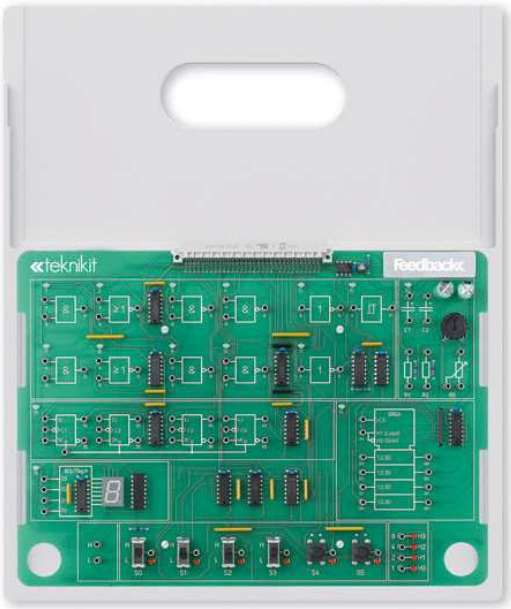
Additional Function:
- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:
- 4 x AND, 3 x OR, 2 x XOR, 2 x NOR, 3 x NAND
- Full adder
- 7-segment display
- Multiplexer, De-multiplexer
- 4 command switch
- 2 sensors, 2 LEDs

Ordering information:

- 14-130 Automotive Digital Technology I
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-131 Automotive Digital Technology II



Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course in digital technology for vehicle occupations, the fundamentals of switch algebra are dealt with using logic links. Animations and interactions make the fundamentals of modern bus systems clear. The topic areas are practical and adapted to the automotive technology in terms of application. Experiments are wired using 2mm safety cables (14-101 set of 2mm cables supplied separately). Course content, experiment instructions and tasks are taught through course-specific software.

Topics:
- Flip-flop
- RS flip-flop
- JK flip-flop
- Shift register
- Counter
- Multi-vibrators
- Impulse diagram

Virtual Laboratory:
- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser

Additional Function:
- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:
- 2 x AND, 2 x NOR, 4 x NAND
- 2 Inverter
- 1 Schmitt trigger
- 1 7-segment display
- 4 JK flip-flop
- 1 Universal shift register
- 4 Command switch,
- 2 sensors, 4 LEDs

Ordering information:

- 14-131 Automotive Digital Technology II
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-132 Transmission Technology TX433

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (console supplied separately) teaching a practical course on the fundamentals and applications of radio transmission technology and analogue modulation technology, experiments being wired by using 2mm safety cables (14-101 set of 2mm cables supplied separately). Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Introduction;
- Measuring techniques, spectrum and network analysis;
- Design of transmitters;
- Beats;
- Double sideband AM;
- Single sideband AM;
- Frequency modulation;
- Stereophonics and RDS;
- Coding; shift-keying ASK, FSK, PSK;
- Matching;
- The transmitting antenna, SWR measurements;
- Digital data;
- Fault simulation

In conjunction with an additional Console and the receiving technology course the following experiments can also be performed:

- Signal transmission;
  - transmission of alpha-numeric data;
  - telematics,
  - telemetry,
  - cryptography

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser
- Spectrum analyser (FFT-module)
- Network analyser with Bode module
- SWR meter
- Frequency counter
- Data transfer module

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Note: Runs under Windows 2000/XP/Vista/7/8 (32 Bit only)

Technical Specifications:

- Signal generator, Summing output stage
- Carrier oscillator, Product modulator (AM), ESB filter
- Matching element
- Stereo / Mono converter
- VCO with pre-emphasis (FM)
- Stereocoder, RDS coder
- FM transmitter in Hybrid module technology (SMD)
  - Transmission frequency: 433,75 MHz, approval-free ISM frequency
  - Power: 10 mW
- Frequency hub: adjustable, max. 75 kHz
  - Telescopic aerial, Directional coupler
  - Evaluation electronics (SWR)
  - Calibration element: 50 Ω BNC

Ordering information:

- 14-132 Transmission Technology TX433
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-133 Reception Technology RX433

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course on the fundamentals and applications of radio receiving technology and analogue demodulation technology. The experiments are performed with the board of the transmitter and the receiver. The wiring of the experiments is carried out by 2 mm safety cables (14-101 set of 2mm cables supplied separately). Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Receiver concepts
- Measurement techniques
- Sound equalizing
- Radio receiver
- Applications of RDS, service features and information types
- Stereo reproduction
- Synchronous demodulation
- Envelope curve demodulation
- PLL
- De-emphasis
- Encoding
- Data security
- Fault simulation

In conjunction with an additional Console and the transmission technology course the following experiments can also be performed:

- Demodulation of AM and FM signals
- How squelch works
- Signal transmission
- Transmission of alphanumeric data
- Telematics, telemetry, cryptography

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser
- Spectrum analyser (FFT-module)
- Network analyser with Bode module
- Data transfer module

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Note: Runs under Windows 2000/XP/Vista/7/8 (32 Bit only)

Technical Specifications:

- FM tuner 88...108 MHz with RDS function
- Stereo decoder
- Superhet in hybrid module technology (SMD)
- Reception frequency: 433,75 MHz, approval-free ISM frequency
- Audio bandwidth: 20 kHz
- Synchronous demodulator
- Band filter for carrier regeneration
- Variable phase shifter
- Envelope demodulator
- Demodulator low-pass
- PLL, De-emphasis
- Audio stage with sound corrector
- Output stage with loudspeaker
- Data processing unit
- Telescopic aerial

Ordering information:

- 14-133 Reception Technology RX433
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-134 Digital Communication Technology

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course on digital signal processing, experiments being wired using 2mm safely cables (14-101 set of 2mm cables supplied separately). Additional attention is paid to the realisation and function of fibre optic transmission systems. Emphasis is laid upon the applications of PCM technology, e.g. Transmission of voice and signals with real telephones, sound cards, CD-players etc. Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Characteristics of pulse carriers
- Generation of PAM
- PAM (natural)
- PAM (S&H)
- PAM spectrum
- Over sampling / under sampling
- Aliasing
- Shannon theorem
- Pulse code modulation (PCM)
- Quantisation linear and nonlinear
- Compression / expanding
- Code errors
- Time division multiplexing (TDM)
- Synchronisation
- Quantisation noise
- Difference pulse code modulation (DPCM)
- Optical signal transmission
- Signal transmission by wire (coaxial line / two-wire line)
- Simplex / duplex communication

Options

- Transmission of voice (requires external signals, CD player, telephones etc.)
- Influence of the trigger and type of quantisation on the speech intelligibility
- Duplex communication (requires 2 x TEKNIKIT Course PCM technology, as well as external signal sources)

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser
- Spectrum analyser (FFT-module)
- Frequency counter

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:

- 2 x PAM Modulator
- 2 x PCM Modulator
- Clock-pulse generator
- 2 x PAM Demodulator
- 2 x PCM Demodulator
- Signal source Sinus, 1 kHz
- Signal source Sinus, 2 kHz
- RJ-12 socket with hybrid termination circuit
- Jack bush for connecting external signal sources
- Jack bush for connecting external active speakers
- Optical transmitter
- Optical receiver
- Fibre-optic cable with plugs, 3m

Ordering information:

- 14-134 Digital Communication Technology
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-135 Modem Technology

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course on the fundamentals and applications of shift keyed signals and modems, experiments being wired using 2mm safety cables (14-101 set of 2mm cables supplied separately). Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Introduction
- Amplitude shift keying (ASK)
- Frequency shift keying
- 2-Phase shift keying (2PSK)
- 4-Phase shift keying (4PSK)
- Difference phase coding
- Shift keyed signals in the time domain
- Shift keyed signals in the frequency domain
- Estimation of the bandwidth
- Modulation rate / data rate
- SNR and bandwidth
- Hardware of the modulators
- Hardware of the demodulators
- Carrier recovery and synchronisation of the demodulators
- Error correction
- Error detection
- Operational modes: simplex half duplex, full duplex
- NRZ Line code
- Fault simulation

Options:

- Communication of 2 PCs using modems
  A 2nd workstation with a PC with Console and modem technology course (14-xxx) is necessary, as well as other accessories (coaxial cable, star quad cable etc.)

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser
- Spectrum analyser (FFT-module)
- Frequency counter
- Data transfer module

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:

- Data source for baseband signal
- ASK Modulator
- FSK Modulator
- 2PSK Modulator
- 4PSK Modulator
- Carrier generator
- Modulation multiplexer
- Audio stage with piezo loudspeaker
- Channel level adapter
- Signal detector
- ASK demodulator
- FSK demodulator
- 2PSK demodulator
- 4PSK demodulator
- Carrier recovery

Ordering information:

- 14-135 Modem Technology
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

14-136 Telecommunication Lines

Comprises an experiment board, housed within a board carrier, for use in conjunction with, and powered by, the 92-500 Console (92-500 console supplied separately) teaching a practical course on the fundamentals and applications of various telecommunication line types, experiments being wired using 2mm safety cables (14-101 set of 2mm cables supplied separately). Course content, experiment instructions and tasks are taught through course-specific software.

Topics:

- Frequency responses of two-wire lines
- Determination of the characteristic wave impedance
- Measurement of near and far-end crosstalk
- Impulse behaviour of coaxial lines
- Mismatching
- Hybrid and phantom circuit
- Duplex transmission and remote supply
- Characteristic curves of LEDs in the optical communications engineering
- Attenuation at fibre optic lines
- Measurement of the optical power
- Coupling losses
- Bending losses

Virtual Laboratory:

- Oscilloscope
- Function generator
- Multi-meter (x2)
- Digital analyser
- FFT Spectrum analyser
- Frequency counter
- Bode module

Additional Functions:

- Word processing
- Printer
- Pocket calculator
- Free experimentation
- Glossary

Technical Specifications:

- Equivalent circuits of two-wire lines
- Equivalent line of four-wire lines
- Star quad with phantom circuit
- Hybrid termination circuit
- Pulse generator
- Module for echo pulse evaluation
- Optical transmitter
- Optical level meter
- Shift unit for longitudinal offset on fibre-optic cable
- Signal sources 1 kHz / 2 kHz

Ordering information:

- 14-136 Telecommunication Lines
- 92-500 Console (required)
- 14-101 Set of Safety Cables (2mm) (required)

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