LUCAS-NÜLLE

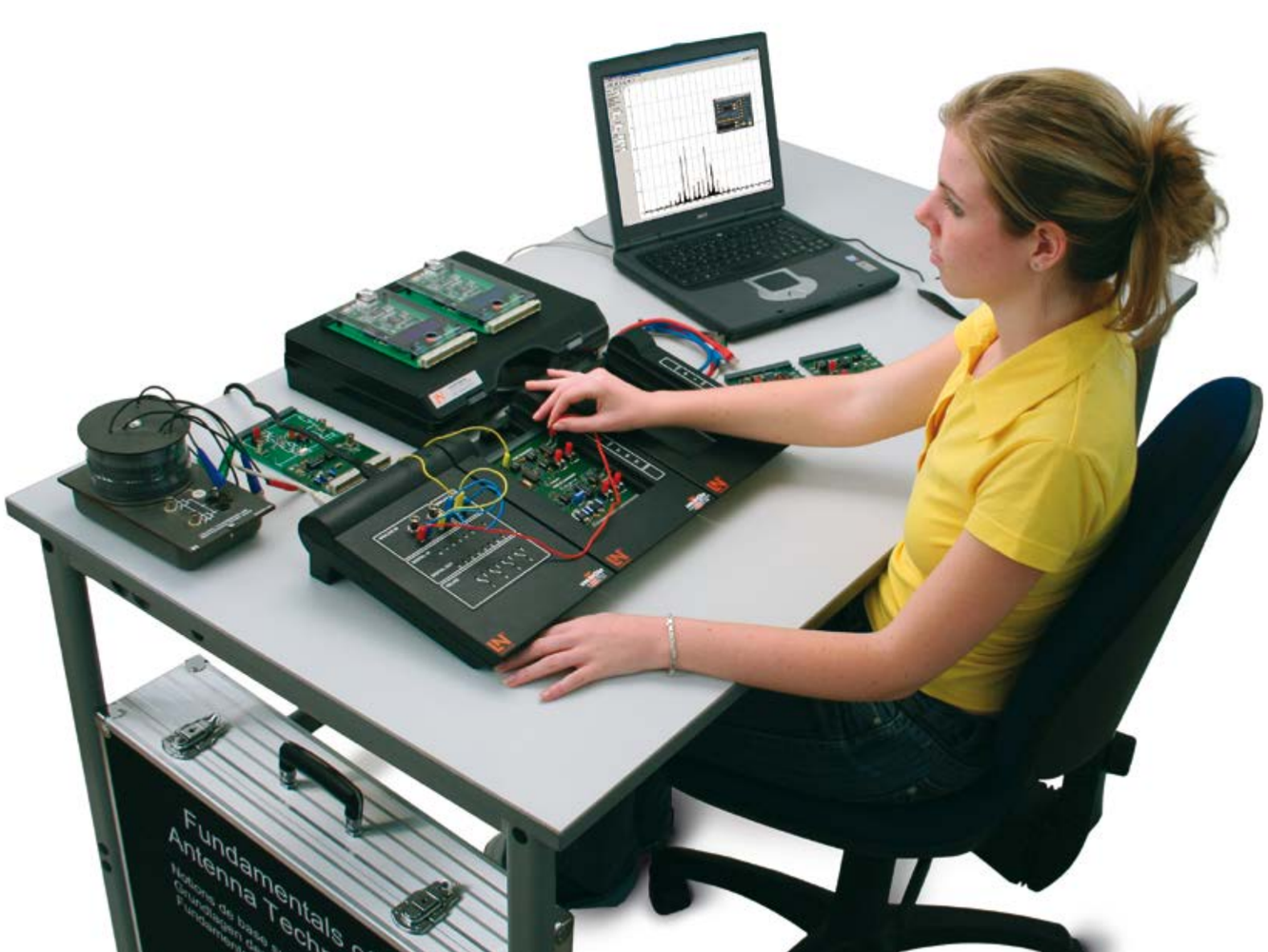
Communications Technology

Including Transmission, RF and Network Technology

Acquiring Practical and Project-oriented Expertise

2nd Edition

Contents



Contents

Qualifications Through Quality

Training Systems for Telecommunications Engineering

Technological Progress ...

The ever-increasing amount of information being transmitted is pushing development in telecommunications engineering toward higher and higher operating frequencies, which permit considerably greater bandwidths and thus make faster data processing possible.
The information itself is being conveyed via radio links, copper cables, fibre-optic cables, waveguides and microstrips.

Lucas-Nülle

... Is Having a Huge Impact on Training and Education

Due to the fact that telecommunications technology is becoming more and more complicated and sophisticated, it is necessary to find a way of dealing with this in training and education. This is the only way to ensure that trainees and students are constantly being prepared for tomorrow's complex world of work using state-of-the-art technology.

Lucas-Nülle

The UniTrain-I System – Combining Theory and Practice at the Same Time and Place

UniTrain-I – Multimedia Laboratory with 30 Communications Technology Courses

The multimedia-based experiment and training system UniTrain-I guides the student through experiments and theoretical sections with clearly structured course navigation and software that also includes texts, graphics, animations and tests.

In addition to the training software, the courses also contain experiment cards on which practical exercises are performed. Courses are included on such topics as “transmission lines”, “antenna technology” and “digital signal processing” which convey all of the knowledge and skills needed for the understanding, configuration, trouble-shooting and deployment of modern telecommunications technology. With the aid of animations and a host of experiments on real modules and systems, the various courses explore the fundamentals, principles and component properties used in transmission and receiving technology, modulators and demodulators, AD and DA converters and permit the required measurements to be carried out.

Your benefits

- All the topics involving communications technology are available
- Theory and practice are combined at the same time and place
- High student motivation thanks to PC and modern media work environment
- Rapid learning success thanks to structured course navigation
- Quick understanding thanks to theory-supporting animation
- Acquisition of skills through own experimenting
- Continuous feedback thanks to comprehension questions and tests
- Guided trouble-shooting using an integrated fault simulator
- Safety guaranteed thanks to the use of extra-low voltage
- Sample solutions

UniTrain-I system

- Complete, portable laboratory
- Multimedia courses
- High-tech measurement and control interface
- Combines theory and practice at the same time

UniTrain-I interface with USB

- Oscilloscope with 2 analog differential inputs
- Sampling rate 40 Msample/s
- 9 measurement ranges 100 mV – 50 V
- 22 time ranges 1 µs – 10 s
- 16 digital inputs and outputs
- Function generator up to 1 MHz
- 8 relays for fault simulation

UniTrain-I experimenter

- Receptacle for experiment cards
- Experimenter voltage ± 15 V, 400 mA
- Experimenter voltage 5 V, 1 A
- Variable DC and three-phase source 0 ... 20 V, 1 A
- IrDa interface for multimeter
- Additional serial interface for cards

Integrated measuring instruments and power supplies

- Multimeter, ammeter, voltmeter
- 2-channel storage oscilloscope
- Function and waveform generator
- Spectrum analyser
- Bode plotter
- ... and many more instruments besides

Training and experiment software LabSoft

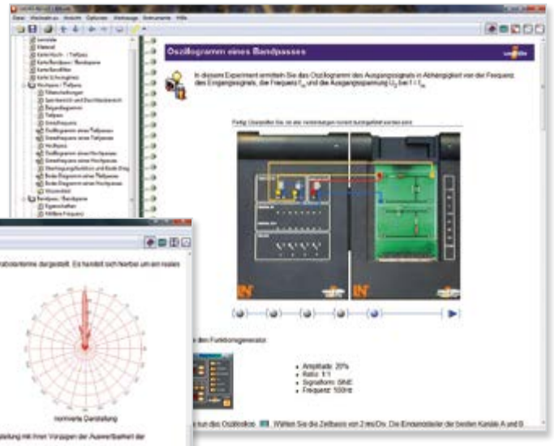
- Large selection of courses
- Comprehensive theory
- Animations
- Interactive experiments with instructions
- Free navigation
- Documentation for measurement results
- Test

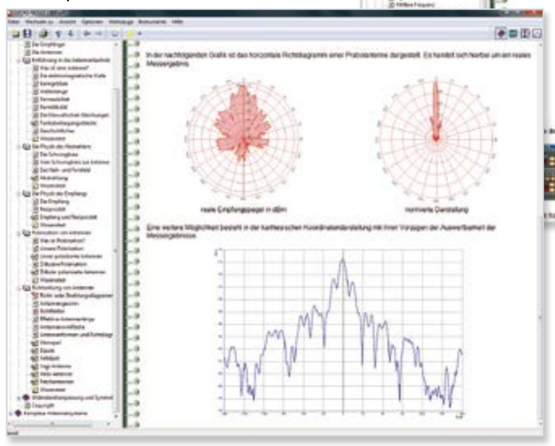
Animated Presentation of Complex Training Content

Project-oriented Training Media – Adaptable to Any Training System

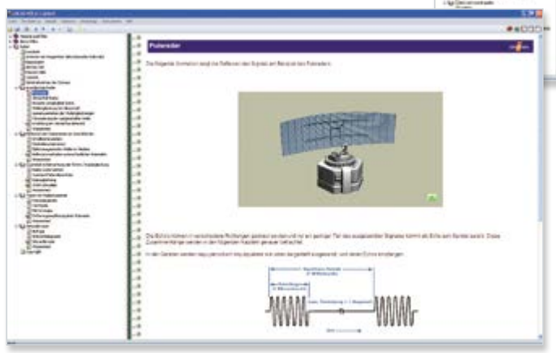
Multimedia courses
Many experiment instructions are available as multimedia courses. These allow direct access to the measurement results from a variety of equipment. Multimedia courses contain the following:

- Questions to monitor knowledge level and learning
- Interactive experiment set-ups
- Navigation bars
- Animated sections devoted to theory



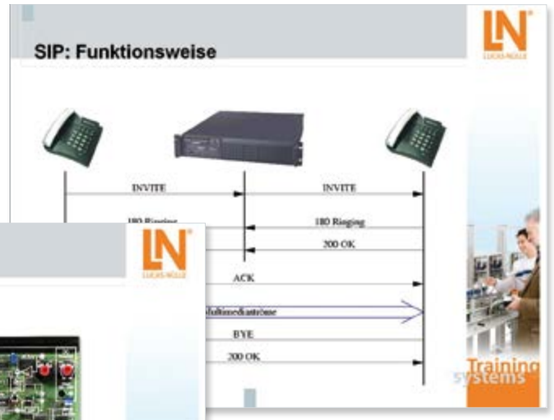


ILA – Interactive Lab Assistant
ILA courses are interactive manuals containing all the necessary theoretical content and step-by-step instructions for experiments and tests of knowledge, which make our equipment an educational medium of the utmost efficiency.



ILA

Presentation slides
Presentation slides can provide support for your lessons, e.g. supplying background information, block circuit diagrams, physical fundamentals, specific standard characteristics, special modifications and application examples. The set of slides is provided in PowerPoint format.



QuickCharts
QuickCharts are illustrated sets of brief instructions, laminated and rugged, which provide a quick overview of specific areas of learning and work processes. They explain how technical aspects fit together clearly and concisely.

Entire System at a Glance

Practical Work on VoIP	**Equipment set TVP 1** VoIP Lite training system		**Equipment set TVP 2** VoIP-ISDN-POTS PRO training system	
Practical Work on WLAN/WiFi Systems	**Equipment set TWT 1** SOHO WLAN training system		**Equipment set TWT 2** Bridgelink WLAN microwave training system	
Practical Work in Telecommunications	**Equipment set TTT 6P** Private exchange (PBX) systems	**Equipment set TTT 4P** ISDN basic access systems	**Equipment set TTT 1P-2P** Analog connection using TAE and modular systems	**Equipment set TPN1** CAT5 wiring technology
Network Technology				
Radar	**Equipment set CO3538-6A** Radar training system			
Transmission and Receiving Technology	**Course SO4204-9X** Antenna systems			
	Course SO4204-9W Complex antenna systems			
Modulation Methods and Multiplexing Technology	**Course SO4204-9J** Pulse modulation methods PAM/PCM/Delta modulation, AMI/HDB3 coding		**Course SO4204-9K** Pulse modulation methods – PWM, PPM	
Transmission Lines				
	Course SO4204-9F Four-wire lines		**Course SO4204-9D** Coaxial cables	
Basic Modules for Communications Engineering	**Course SO4204-9A** Quadripoles and filters		**Course SO4204-9B** Active filters with operational amplifiers	

			Equipment set TTN1 ISDN wiring	**Equipment set TTK1** PBX systems in offices panel system
			Course SO4204-9R Network technology – client integration	
			Course SO4204-9Q Network technology – TCP/IP	
			Course SO4204-9S Data acquistion with RFID	**Course SO4204-9N** Transmission and receiving technology
			Course SO4204-9L Modem methods - ASK, FSK, PSK	**Course SO4204-9M** Analog modulation – AM, DSB, SSB, FM
				Course SO4204-9V Hohlleiterbauelemente
			Course SO4204-9E Fibre-optic waveguides	**Course SO4204-9Y** Microstrip lines
			Course SO4204-5M Operational amplifiers	**Course SO4204-6F** A/D and D/A converters

More Than Just a Training System

The Communications Technology Laboratory is a Complete Solution

Animated presentation of complex training content using modern media

Laboratory communication systems with networked workstations

Microwave technology

Multimedia-based training and education using UniTrain-I

Practical technical expertise Telecommunications technology

Antenna technology

LUCAS-NÜLLE

Basic Modules for Tele-communications Engineering

Basic Modules for Telecommunications Engineering

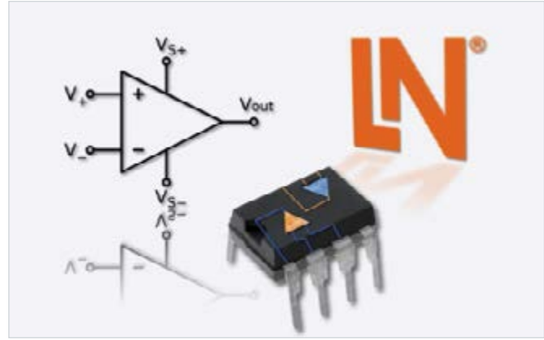
Basic Modules for Telecommunications Engineering

Basic Practice-oriented Know-how

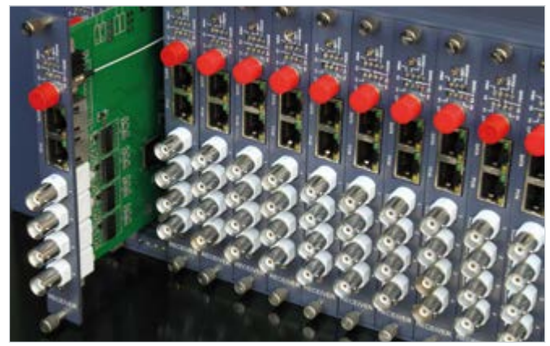
A well-grounded training in the fundamentals of telecommunications is the prerequisite for understanding complex relationships found in various application areas. Our training systems are especially designed for the needs of practice-oriented training of both technicians and engineers. The fundamentals of telecommunications engineering are explored and graphically depicted using many examples, explanations, exercises and practical assignments.

Signal Processing and Conditioning
Modern signals in telecommunications technology consist of a broad spectrum of frequencies and are often subject to noise. In order to be able to recover the information from the signal, it has to be processed with filters and subsequently amplified.

Analog-digital and Digital-analog Conversion
Information transmission and processes normally take place in an analog world. The signals being transmitted and processed by modern telecommunications systems are for the most part digital. These systems need analog-digital and digital-analog converters to convert these signals.



Equipment Operates in a Reciprocal Context
More and more varied telecommunications equipment and modules are being used in ever more restricted space. This can lead to system interference and distortion.



Quadripoles and Filters

High-pass/Low-pass – Bandpass/Bandstop – Band Filters – Series and Parallel Resonant Circuits

In telecommunications technology, filter or filtering circuits are used in a wide range of applications in suppressing or attenuating frequency ranges in the signal. In expressing transfer response it is primarily the two quadripole parameters, transfer function and phase response, which are of interest.

Training contents

- Transfer function phase response and cut-off frequency
- Transfer function in the complex plane
- Transfer function, phase response and cut-off frequency of high- and low-pass filters with Bode plot
- Transfer function, bandwidth and medium frequency of band filters with Bode plot
- Resonant circuit: transfer function, bandwidth, determining quality and resonance frequency
- Analysis of resonant circuits with the aid of Bode diagrams
- Parallel resonant circuit with capacitance diode tuning

Active Filters with Operational Amplifiers

2nd and 4th order low-pass and high-pass filters – 2nd order band-pass and band-stop filters

An active filter is usually composed of an operational amplifier in a circuit containing a network of components consisting of capacitors and resistors. One benefit of active filters is that the use of op-amps decouples the output of the filter from its input. This makes it possible to cascade multiple filter stages to implement a higher-order filter. By contrast with passive filters, active ones can be used not only to attenuate signals but also to boost specific frequency ranges.

Training contents

- Definition of active and passive filters
- Representation of frequency and phase response using a Bode plot
- Types of filters: high-pass, low-pass, band-pass and band-stop
- Filter order, slope, maximum phase-shift
- Tolerance schemes: upper and lower cut-off frequencies, ripple, attenuation
- Various filter approximations: Bessel, Butterworth and Chebyshev filters
- Characteristics in the time domain: delay, rise time, transient response, steady-state response range
- Measurement of frequency and phase response, determination of cut-off frequency and slope of 2nd and 4th order low-pass and high-pass filters
- Measurement of resonant frequency, band-width, quality and resonance gain of 2nd order band-pass and band-stop filters

Operational Amplifiers

Basic Circuitry – Precision Power Supply Sources – Active Filters

Operational amplifiers have come to play a significant role in analog electronics. As highly integrated and multi-functional components they constitute a critical component in electronics training.

Training contents

- Design and operation of operational amplifiers
- Circuit diagram and basic types of operational amplifier circuits
- Determination of the parameters and limiting values of an operational amplifier by means of measurement: frequency response, gain
- Investigation of typical analog computation circuits: adders, subtractors, integrators and differentiators
- Set-up and measurements on precision voltage sources and constant current sources
- Set-up and measurements on typical application circuits: impedance converter, precision rectifier, comparator and Schmitt trigger
- Investigation of active filter circuits
- Fault simulation

Converter Circuits

A/D and D/A Converters – f/U and U/f Converters

A/D and D/A converters form the interface between the real world and the world of digital data processing. They are deployed in almost every area of electrical engineering and electronics and thus have an important role in training and education.

Training contents

- Design and operation of D/A converters (R-2R network, weighted resistors)
- Static and dynamic recording of D/A converter characteristics
- Investigation of a D/A converter circuit of loudness control
- Design and operation of A/D converters (pulse-counting methods, dual-slope methods)
- Design and operation of U/f and f/U converters
- Measuring the internal signals and recording their characteristics
- Tuning the reference voltage for U/f and f/U converters
- Fault simulation

LUCAS-NÜLLE

Transmission Lines

Transmission Lines

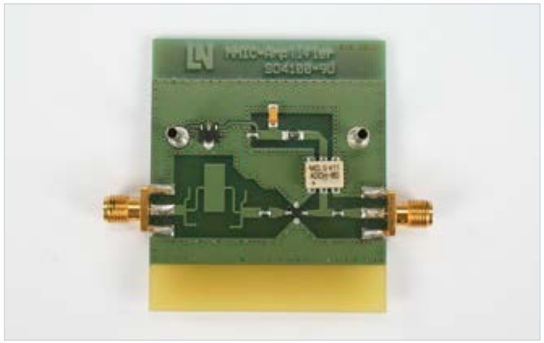
Are You Wired?

Transmission lines are the arteries of telecommunications systems. The technically appropriate design and the correct choice of components in a transmission line are paramount for the proper operation of the entire system. The functions and application areas of transmission lines are explored here with didactically adapted training systems using typical components as well as conventional cables and waveguide operating elements.

Copper Lines
Coaxial and four-wire lines are still very widely used and are often the best solution in terms of price for a transmission link. Our UniTrain-I course explores and explains what makes such transmission media so outstanding and in which applications optimum use can be made of them.

Optical Fibres
Ever-rising bandwidths and increasing clock frequencies require suitable transmission lines to be found. For these cases, clear preference goes to fibre-optic waveguides.

Radio Frequency Technology
The higher the frequency of a signal, the smaller the wavelength becomes and thus makes the deployment of conventional components and cables more complicated. Microstrip lines are being used more and more in efforts to pack integrated functionality onto the increasingly smaller spaces of printed circuit boards. Normally waveguides are used in order to convey signals of higher frequency at high power levels.



Four-wire Lines

Four-wire Lines – Backbone of Every Telecommunications Network – Quantities per Unit Length – Near and Crosstalk – Matching

The classic two- and four-wire line is still the most commonly used line for the connection and cabling of telecommunications networks. As a rule, be it an analog or a digital connection terminal, the last mile to the end user is a four-wire line.

Training contents

- Measuring the quantities of unit length at various frequencies using a measurement bridge
- Measuring pulse transit on the conductor pair as well the individual wires with respect to ground
- Demonstration of the pulse transmission or distortion in the case of faulty line termination
- Measuring the line's pulse reflection factor when the line has been incorrectly terminated

Coaxial Cables

Quantities per Unit Length – Characteristic Impedance – Matching – Reflections

By far the biggest volume of signal and data transmission goes via terrestrial media, i.e. via cables. In spite of relatively low technical complexity in comparison to wireless transmission, practical usage is still not free of problems which arise due to the wrong choice of cable materials or faulty matching at the coupling points.

Training contents

- Resistance, capacitance and inductance per unit length and characteristic impedance of a coaxial cable
- Determination of:
  - Resistance per unit length using a Wheatstone bridge
  - Capacitance per unit length using a Wien bridge
  - Inductance per unit length using a Maxwell bridge
  - Characteristic impedance of a coaxial cable
- Investigating reflections on a coaxial cable as a function of the line termination
- Terminating a line correctly so that no more reflections occur

Fibre-optic Waveguides

Optical Transmission Links – Fibre-optic Waveguides – Attenuations

The constantly expanding availability of information and data calls for ever-greater transmission rates. The result is that more and more fibre-optic transmission links are coming into use both in industrial applications as well as in communications engineering networks.

Training contents

- Principles of optical telecommunications
- Components used in optical telecommunications
- Advantages and disadvantages of optical transmission links
- Characteristics and frequency response of infra-red emitting diodes
- Modulation methods for analog and TTL signals
- Influence of different wavelengths on the transmission response
- Configuring a fibre-optic waveguide
- Influence of the receiver diode on signal recovery
- Determining the bandwidth of a fibre-optic transmission link
- Influence of the input capacitance on the bandwidth and the wavelength on attenuation
- Comparing properties of step index fibres and gradient index fibres

Microstrip Lines

From Outer Space to Your Cell Phone

The manufacture of integrated RF circuits on a semiconductor basis was only made possible by advances in microstrip technology. Planar waveguides have established themselves in a plethora of applications over the last two decades.

Training contents

- Design and operation of planar microstrip lines
  - Substrate materials
  - Calculation of line parameters
  - Line forms
  - Field distribution on the lines
- Microstrip components
  - Directional coupler and Wilkinson divider
  - Dispersion matrix
  - Standardisation
  - Recording the transfer function
- 90° and 180° hybrid coupler
  - Investigation of the transfer function
  - Measurement of the reflection factor
- Microstrip line filter
  - Low-pass of the 3rd and 5th order
  - Bandpass (edge-coupled filter)
  - Bandstop (butterfly element)
- Investigation of complex microstrip circuitry
  - Amplifier designed in MMIC technology
  - Low-noise FET amplifier

Microwave Technology

Simple to Operate Thanks to the Integrated Instrumentation

Whether it be radar technology, satellite technology or even in mobile radio, microwaves are critical to signal transmission. The signal feed to the transmission and receiving antenna is carried out for the most part using waveguides.

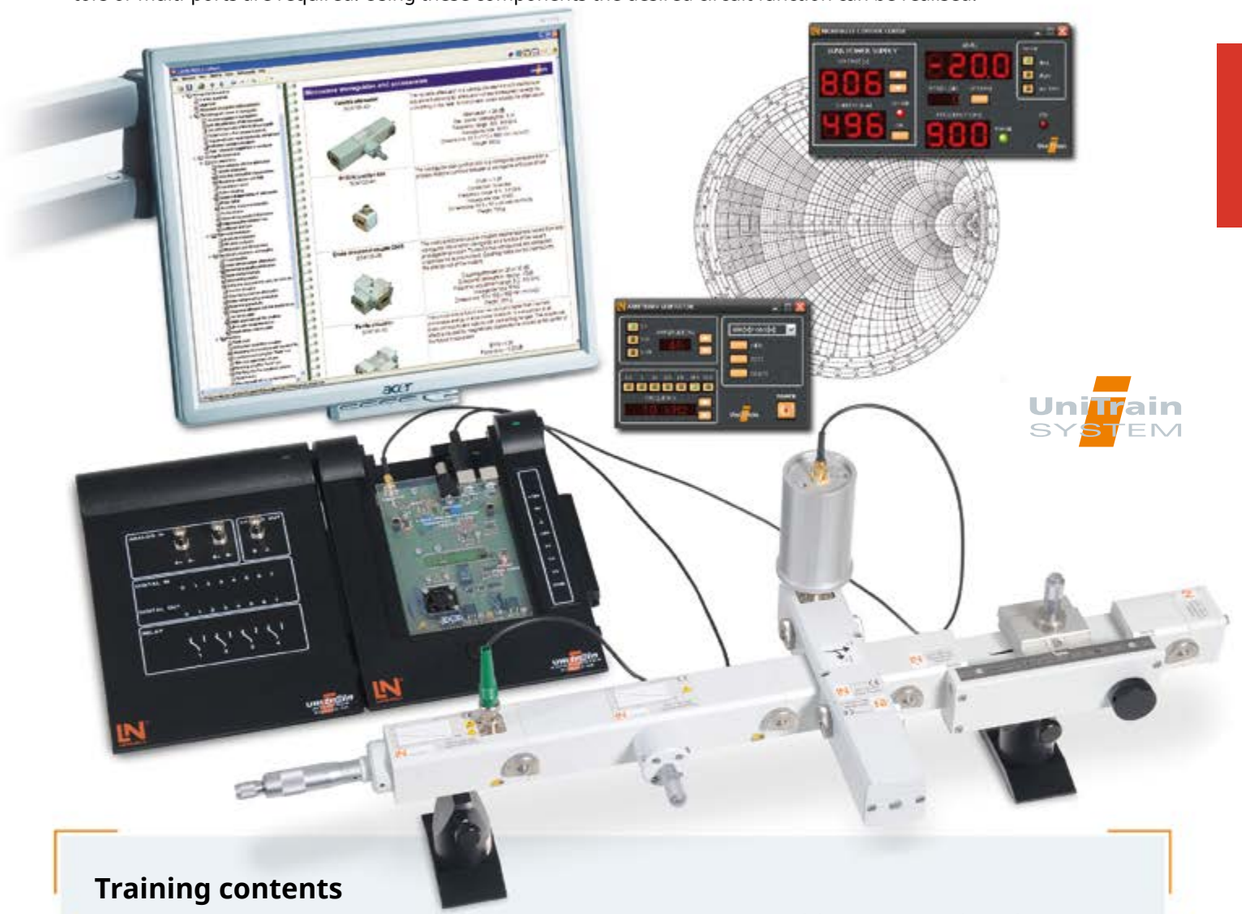
Training contents

- Line propagation theory and line parameters
- Gunn oscillator: recording the current-voltage characteristic
- Slotted lines
- Reflection, standing wave ratio and matching
- Measurement of wave propagation inside the waveguide, standing wave diagrams
- Waveguide dimensioning and operating frequency
- Shorting the waveguide termination, wavelengths
- Measuring the effects of dielectrics

Waveguide Components

Experimenting with Different Waveguide Components

To assemble the complex microwave circuits found in waveguide technology, special components such as couplers, circulators or multi-ports are required. Using these components the desired circuit function can be realised.



Training contents

- Become familiar with waveguide elements for changing direction: rotary coupling, E- and H-plane bends
- Determine the characteristic of a variable attenuator
- Design and operation of a waveguide phase shifter
- Measurement of the phase shift in the waveguide
- Measurement of the attenuation and insulation of a ferrite valve
- Measurement of the attenuation and reflection of cross-couplers, directional couplers and ferrite circulator
- Measurement of the insertion and coupling attenuation
- Modulation and demodulation of microwaves in waveguides
- Examining a PIN modulator by means of measuring instruments
- Line characterisation using the Smith chart
- Line matching using a slotted impedance adapter
- Investigating the microwave signal at the waveguide's open end

Modulation Methods and Multiplexing Technology

Modulation Methods and Multiplexing Technology

Analog and Digital Modulation – Coding – Time Division Multiplexing

Modulation methods and various types of signal coding form the basics of virtually every system in telecommunications. The most important of these are the digital forms of modulation. They have gone on to dominate a vast number of the most varied of areas – from wireless to radio transmission – satellite transmission or mobile radio.

Analog Modulation
Useful analog signals include, for example, voice, music or video signals. An essential property of analog modulation technologies is the continuity of the modulation both in terms of time as well as signal value. This is because analog modulation methods process the useful signal continuously, i.e. there is no digitisation of the transmitted signal into discrete values. Analog modulation methods can be broken down into two main groups: amplitude modulation and angle modulation (phase and frequency modulation or PM and FM)

Digital Modulation
Some digital modulation technologies correspond to their analog counterparts or have been derived therefrom. However, there are a multitude of digital modulation methods, which feature no direct analog equivalents, such as pulse width modulation, to name one example, which constitutes a special digital angle modulation and can be used to perform dynamic sampling of an analog signal.

Multiplexing
Multiplexing procedures are methods used in signal and message transmission in which several signals are bundled and transmitted simultaneously via a medium. The transmission media might take the form of a line, a cable or wireless link. Frequently, multiplexing methods are also combined to achieve even higher efficiency levels.

PAM / PCM / DELTA
Pulse Modulation Methods

PAM/PCM/Delta Modulation – Time Multiplexing – AMI/HDB3 Encoding

There are a host of benefits associated with the transmission of digital rather than analog data via communications channels. In addition to the higher quality and improved immunity to interference comes the added benefit of multiplexing several channels at once, which was a decisive advantage in getting this technique assimilated so quickly into telecommunications and signal transmission technologies.

Training contents

- Function of PAM/PCM/Delta modulation and time multiplexing methods
- Shannon’s sampling theorem
- Signal curve measurements of PAM- and PCM-modulated signals
- Optimum filtering, anti-aliasing
- Quantisation of analog signals and determination of the quantisation interval
- Companding methods using A law and μ law; recording transmission characteristics
- Line codes: signal characteristic measurements of line-coded signals: AMI, HDB3 and modified AMI
- Clock signal recovery and phase jitter
- ISDN layer 1: investigating position and function in data frames and bits

PTM Pulse Modulation Methods

Pulse Width Modulation – Pulse Phase Modulation

In addition to pulse code modulation, pulse width modulation also plays a not insignificant role in transmission technology.

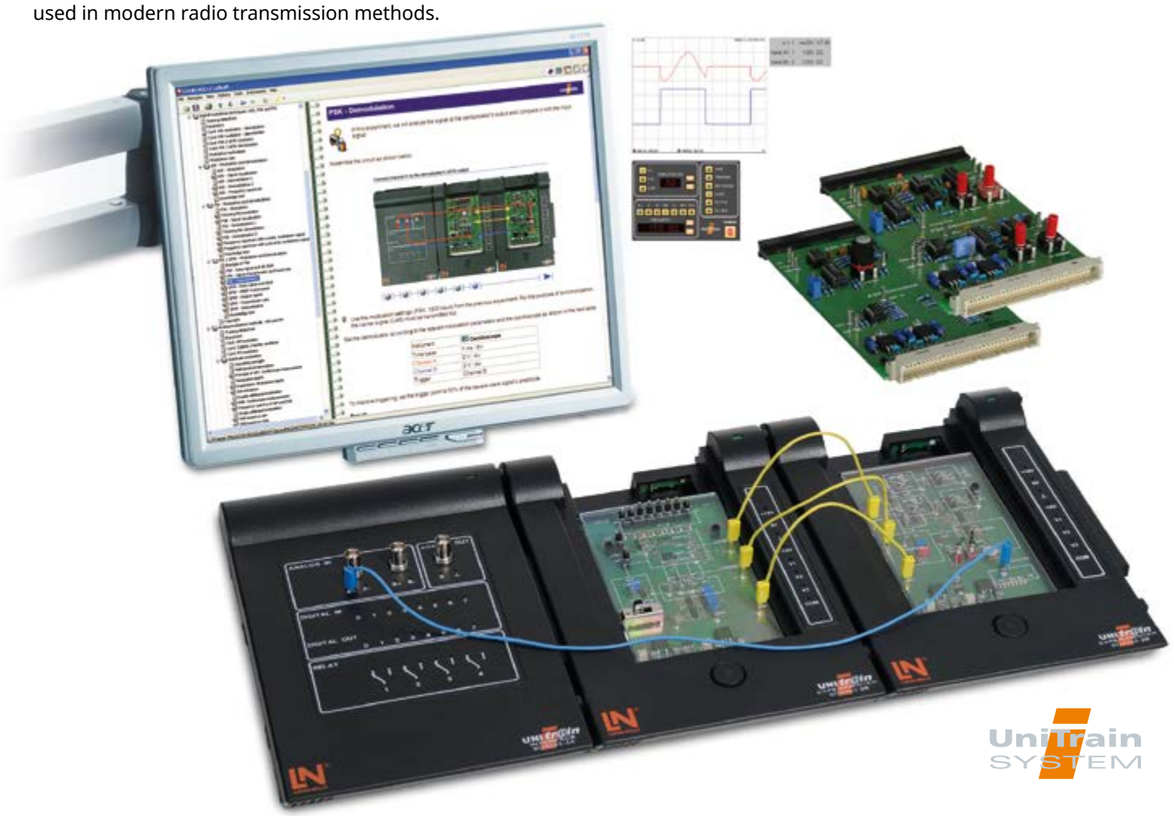
Training contents

- Principle of PWM modulation and demodulation
- Recording the signal characteristic at the output of the PWM modulator
- Investigating the output signal of the PWM demodulator and the influence of input signal’s bandwidth
- Listing the advantages and disadvantages of PWM
- Become familiar with the principle of PPM modulation and PPM demodulation
- Recording the signal characteristic at the output of the PPM modulator
- Signal characteristic measurements of the demodulator’s internal signals
- Listing the advantages and disadvantages of PPM

ASK / FSK / PSK Modem Methods

Amplitude Shift-keying – Frequency Shift-keying – Phase Shift-keying

When analog channels are utilised to transmit digital data, then this mostly involves performing so-called shift-keying on the sinusoidal carrier's parameters. This transmission method is standard for cable modems or telefax devices, but is also used in modern radio transmission methods.



Training contents

- Principle of ASK/FSK modulation for the transmission of digital signals via analog transmission lines
- Spectrum of an ASK-modulated signal
- Relationship between data transfer rates and required bandwidth
- Investigation of the spectrum of an FSK-modulated signal using measuring instruments
- Demodulation of FSK signals with the aid of a PLL loop
- Principle of PSK (DPSK) modulation, formation of a 2-PSK signal with different baud rates
- Principle of QPSK and DQPSK modulation
- Formation of Dibits
- Signal characteristic measurements at the output of the modulator and demodulator (ASK, FSK, (Q)PSK)

Modulation

Amplitude Modulation – Double-sideband Modulation DSB – Single-sideband Modulation SSB – Frequency Modulation

Thanks to their use in radio broadcasting, AM and FM modulation are by far the most widespread modulation methods for the radio transmission of audio signals.

Training contents

- Demonstrating the principle of amplitude modulation
- Recording the modulation trapezoidal at various modulation depths
- Demodulation of the signal: the diode detector
- Single-sideband modulation (SSB) and double-sideband modulation (DSB)
- Signal recovery using the integrated double balance mixer (SSB)
- Demonstrating the principle of FM modulation and demodulation
- Explanation of the terms "instantaneous frequency", "frequency deviation" and "modulation index" on the basis of the modulation signal
- Effect of LF amplitude and LF frequency
- Recovery of a modulation signal with the phase demodulator

Transmission and Receiving Technology

Transmission and Receiving Technology

Transmission and Receiving Technology

Transmitters and Receivers for Wireless Transmission Links – Complex Antenna Systems – RFID Technology

Radio transmission links are playing an ever-greater role in modern telecommunications. With mobile radio's coverage having spread across the entire globe during the Nineties, wireless communication to mobile terminal devices has become the biggest challenge of all in the telecommunications industry. Here, the huge increase in the number of users, and data volumes as well as ever-growing number of new applications such as RFID or Bluetooth demand highly efficient transmission and receiving systems to guarantee reliable and secure data transmission. Accordingly, adaptive antennas which point their signals in the direction of their users are indispensable for the interference-free operation of modern broadband wireless networks.

Antenna Technology
Wherever signals are transmitted without a line, then in the broadest sense we are talking about wireless transmission links. Accordingly, this is a transmission form in which the signal propagates to us freely through the surrounding space without having to use a line or cable. This requires special technical equipment that first radiates the desired signal into space and equipment that receives it from free space and ultimately converts it into a line-bound signal.

AM Transmission and Receiving Technology
Although it is primarily digital modulation methods which predominate today, an understanding of how classic analog transmission and receiving technology works provides a solid footing for entry into the complex modern world of communications engineering.

RFID
Nowadays, RFID applications are encountered almost every day: electronic article surveillance in department stores, door security in buildings, animal ID using transponder implants under the skin or electronic immobilisers in motor vehicles are just some examples of RFID system applications.

Antenna Technology

Three Frequency Variations Permit Simultaneous Operation of Several Workstations

Day-to-day existence without radio transmission lines and their associated antennas is inconceivable, ranging from radio and mobile telephony through to satellite navigation or air-space tracking. The three different frequency variants available for the simultaneous operation of several workstations lie between 8.5 and 9.5 GHz.

UniTrain SYSTEM

Training contents

- Antenna types and examples
- Physics of signal beams and reception
- Antenna impedance as well as matching
- Symmetry (Balun)
- Radiation characteristic in the near and far fields
- Formation of directional gain diagrams
- Measurement of directional gain diagrams of various antennas
- Investigation of:
  - Monopole and dipole antennas
  - Yagi antennas
  - Helix antennas
  - Patch and microstrip antennas

Antenna Rotary Platform with Wireless Transmission Link

There are three different frequency variants available between 8.5 and 9.5 GHz for the simultaneous operation of several work-stations in a single room.

Yagi

Yagi

Dipole

Helix

Linear patch

Folded dipole

Monopole

Circular patch

Complex Antenna Systems

Investigation of the Properties of Professional Antennas

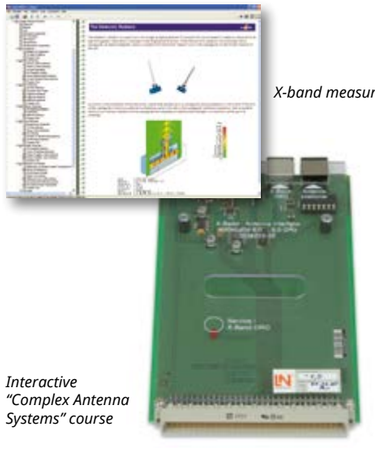
This antenna technology course focuses our deliberations on the parameters and attributes of antennas, their properties as well as measurement configurations up to and including the recording of their directional gain characteristics.

UniTrain SYSTEM

Training contents

- Investigating how various antennas work
- Measurement of the directional gain diagrams of various antennas
- Distant field conditions
- Parabola reflectors
- Primary radiators
- Antenna arrays
- Phase relations in array antennas
- Reflections in radio transmission links
- Secondary radiation
- Passive radar transponder, Lüneberg lens

Broadband Measurement Interface and Professional Antennas



X-band measurement interface

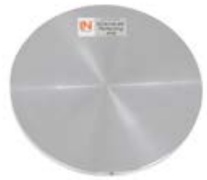
Interactive "Complex Antenna Systems" course

Horn antenna, 20 dB

Horn antenna, 15 dB

Horn antenna, 10 dB

Passive radar transponder (Lüneberg lens)



Reflection disc

Microstrip antenna

Parabola antenna

Dielectric antenna

Configurable slotted antenna

Helix antennas

Patch antennas

Transmission and Receiving Technology

Oscillators – Modulators and Modulation Depth – Transmitters – Superheterodyne Receivers

Transmitters and receivers for radio transmission links continue to play a dominant role in communications engineering. This is equally true for both traditional radio transmission as well as for modern wireless transmission methods.

Training contents

- Design and operation of high-frequency oscillators: Hartley and Colpitts oscillators
- Investigation of oscillation condition (self-excitation)
- Design and investigation of an AM transmitter and receiver
- Tuned radio frequency receivers and superhet receivers
- Automatic gain control (AGC) and automatic frequency correction (AFC)
- Investigation of a phase discriminator
- Image selection (far-off selection) and close-in selection
- Determination of the image frequency in superhet receivers
- Investigating filter curves of RF input stages and IF amplifiers
- Design of a medium-wave AM single-stage superhet with full-range tuning

RFID

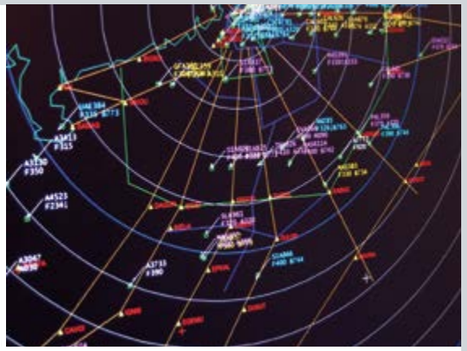
Non-contact Data Acquisition

Today RFID technology is being deployed in more and more systems and application areas. This technology permits the transfer of data to the most diverse objects without the need for physical contact.

Training contents

- Survey of RFID technology
- System components and variants
- Transformer principle
- Electrical resonant circuit
- Power link and range
- Auxiliary carrier modulation
- ISO 15693 standard
- Data encoding and transmission
- Standard commands
- Application potential

Radar



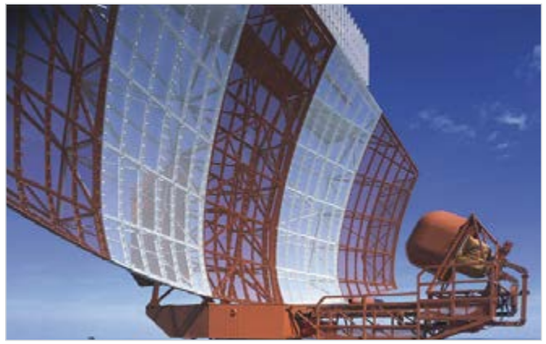
Radar

Radar

Radio Detection and Ranging

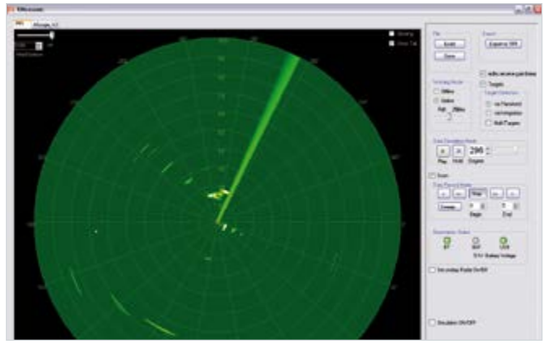
“Radio Detection and Ranging” is more commonly known by its acronym, radar. It represents a method of locating objects and determining how far away they are using electromagnetic (radio) waves and measuring how long it takes them to be reflected from the object in question. Originally developed as a purely military application, radar technology has advanced and is now used for air traffic control, coast-guard monitoring, road traffic control, safety and other related areas.

The LN radar training system
Use of a radar system based on ultrasonic waves rather than radio provides for a training platform which closely mirrors authentic practice in radar. Students can use the radar system to locate one or more objects in the classroom and it is also possible to interact with objects which are active. The technical fundamentals and the experiments are taught with the help of an accompanying multimedia course, which also demonstrates how typical radar software functions.



Flight transponder
When an aircraft is detected by radar, it automatically responds with certain additional information. This may include the plane’s altitude or an identification code. Without such information it would be impossible to guide aircraft safely along their well defined flight paths and corridors.

Training system
Thanks to the modular design and the use of modern components, our training systems are extremely versatile and allow for countless fascinating experiments on the topic of radar.



Radar

Radar Training System

System Components, Radar Equation, Passive and Active Targets

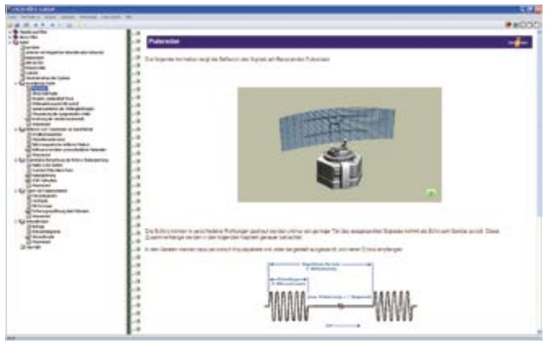
The radar training system is designed for the training of technicians, engineers and other users in the fields of air traffic control, coast-guard monitoring, road traffic control, safety and other related areas. The ILA course conveys the fundamentals of radar, right up to the use of the latest technology, combining both theory and practical exercises. The key component of the training system is a radar base station using a rotating beam antenna. Echoes of ultrasonic pulses are digitalised and transmitted to a computer via a wireless interface so that targets can be displayed on the computer monitor in real time. The secondary radar transponder system supports Mode A (identification) and Mode C (altitude).

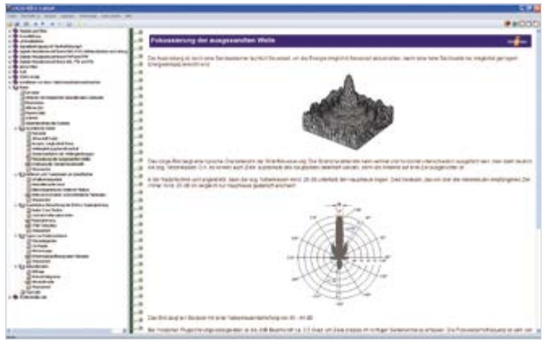
Training contents

- Basic principle of radar: comparison between pulse radar and ultrasonic radar
- Reflection and transmission at boundaries: characteristic impedance to sound, characteristic wave impedance, waves in a medium, reflection methods in conjunction with various materials
- Radar equation: RCS, CFAR
- Types of radar systems: pulse radar, continuous wave (CW) radar, frequency modulated continuous wave (FMCW) radar
- Secondary radar: squawking, squawk response

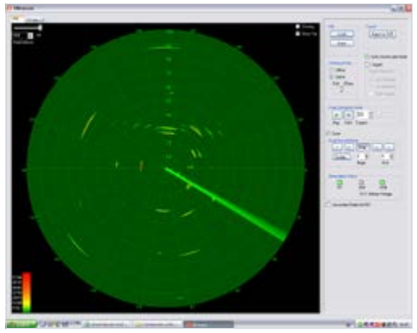
Interactive Course Software

The blended learning course teaches the fundamentals of radar with all the necessary theoretical content accompanied by animated graphics. For reproducible results, the course features precise and well tested experiment instructions. Experiments are conducted interactively, i.e. the results of measurements are copied to specially provided fields and the program also checks whether the results are correct and provides feedback. The course is completed by interactive tests of knowledge.



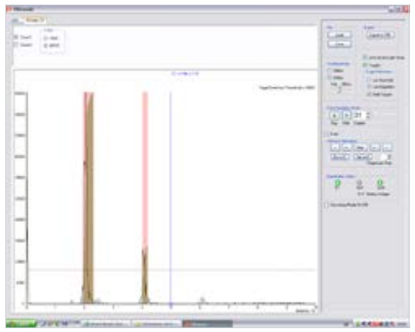


The combination of a training program and experiment-based work allows students to learn quickly and successfully, while giving them an in-depth knowledge of radar technology. The virtual instruments show the results of measurements in real time on realistic displays, including PPI and A-scope views. It is also possible to control the experiment set-up remotely.



PPI scope functions

- 360° representation of measurements
- Display of active and passive targets
- Detection of target ID and altitude of active targets
- Adjustable 0° position
- Continuous rotation of antenna
- Rotation through a specific angle
- Step-wise operation

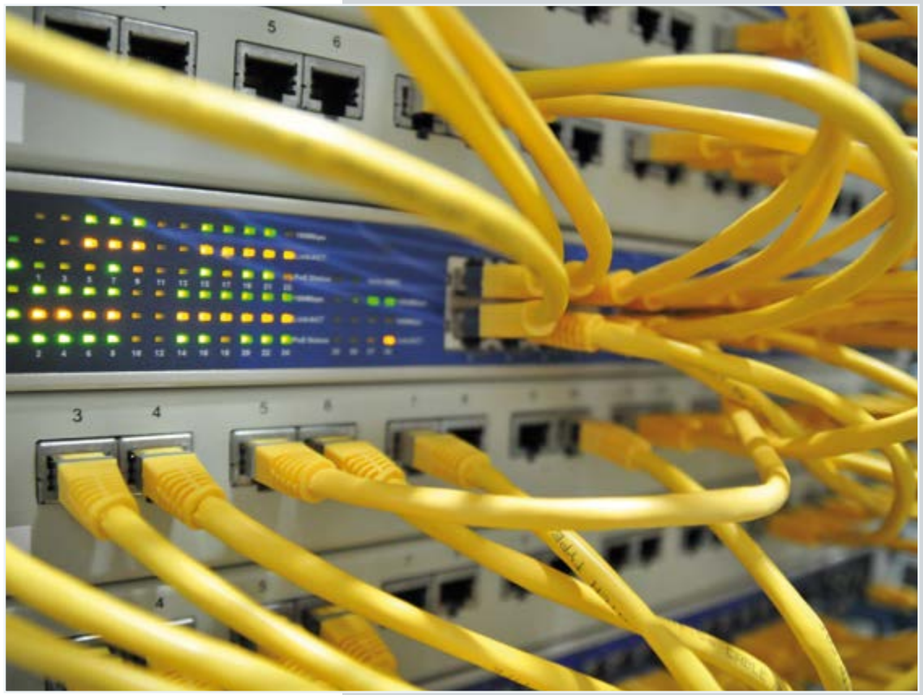


A scope functions

- Display of signal amplitude as a function of distance
- Adjustable thresholds
- Measurement of target distance data

All measurements can be recorded and played back at a later date. This allows for typical situations to be saved and investigated later on, even without the hardware.

Network Technology



Network Technology

Network Technology

Network Structures – Addressing – Protocols

The advantages of a network are the virtually unlimited communication, data exchange and messaging between the participants, centralised administration as well as the possibility to jointly access resources and data. Just how computer networks are assembled is shown step by step in our UniTrain-I courses.

Mini Network
To network two computers you only need a crossover cable. In order to configure a mini-network like this it is imperative to know what an IP address is, a sub-network mask and a gateway. If more than two computers are to be networked, an additional Ethernet switch comes into play.

Tabletop Server-Client System
The client-server model describes the possibility of distributing tasks and services within a network. The tasks are performed by programs, which are subdivided into clients and servers. For many reasons it is the so-called dedicated server model that is used most in practice.

Integrated Web Server
A web server is a computer which transmits documents to clients such as a web browser for example. Web servers are deployed locally, in company networks and primarily as WWW service in the internet. Documents can thus be created locally according to the purpose at hand and then made available inside the company and worldwide.

TCP/IP Network Technology

Ethernet – Network Structures – Protocols – Addressing

The triumph of the internet is thanks first and foremost to the associated transmission protocols and their pre-eminent importance for network technology. Without them computer networks simply do not work.

Training contents

- Network standards and the differences between LAN, MAN, WAN, GAN, OSI layered models
- Network interfaces and their tasks
- Network structures: Ethernet, TokenRing, TokenBus
- Assembly and individual components of an Ethernet network
- Principle of addressing (MAC addresses) in the local network
- Design and testing of a computer network in client-server and peer-to-peer configuration
- Become familiar with TCP/IP internet protocol family
- Addressing the IP, changing the network addresses of a computer
- Design of a sub-network with the aid of a sub-network mask
- Integration of several courses in an existing LAN possible

Network Technology Client-Integration

Network Connection – Configuration – Network Services

Today virtually every single computer is networked. Consequently, to connect up a new computer also means integrating it into a network and setting up interfaces and services.

Training contents

- Integration of a network adapter into a PC
- Line-side connection, cable
- OSI-layer 1, Manchester code
- Configuration of the network adapter (hardware) into the Windows XP operating system
- Configuration of the network interface and the corresponding drivers
- Integration into an existing network
- Utilising tools to test operation
- DHCP
- Name resolution in Windows networks (Host file, LMHOST file, WINS)
- Use of services (http, ftp)
- Creating releases

Practical Work in Telecommunications

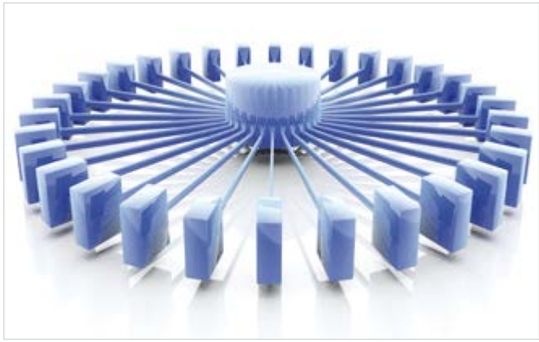
Practical Work in Telecommunications

Planning – Installation – Configuration – Customer Handover

Whether it be POTS, ISDN or an Ethernet network with VoIP, you can decide for yourself! What would you prefer? Copper, fibre-optics, WLAN? We can satisfy your heart's desire, no matter what it is. This is where you put into actual practice the fundamentals learned using the UniTrain courses.

Practical Work in Telecommunications

Virtualisation
The primary objective here is to make an abstraction level available to the user, which isolates him/her from the actual hardware, computer power and memory. A logical layer is introduced between the user and the resources in order to conceal the physical realities of the hardware. In the process each user has the impression that he/she is the sole user of a resource. Several hardware resources are merged into a homogeneous platform.



Network convergence
By network convergence we mean the dissolution of single, individually separated networks into a larger system which takes over their tasks. Network convergence can be observed for example in telephony: classic telephone networks are increasingly being dissolved into so-called Next Generation Networks or Voice over IP networks.

Bridgelink
Laying cables is the most conventional method of connecting and networking computers and their peripheries – but this is frequently not the most economical and certainly not the most flexible solution. Particularly when offices are spread across several buildings or an external warehouse is being operated. In this case cable-bound networks are time-consuming to implement and consequently not economically viable.

PBX Systems in Offices Panel System

Customer Order:
Planning and Setting up a Telecommunications System in an Office

This training system allows you to set up, commission, configure and troubleshoot the infrastructure of a typical office telecommunications system. The equipment set can either be used stand-alone or integrated into an existing telephone installation or local network.

Training contents

- Installation and configuration
- Commissioning
- Installation and configuration of analog terminal devices
- Installation and configuration of ISDN terminal devices
- Installation and configuration of VoIP terminal devices
- Troubleshooting
- Handover and instructions to customers

Technical Practice on Networks

Customer Order:
Installation of a CAT5 Network

The content of this practice-oriented project is the learning of practical skills needed to install networks. This includes selecting the right components, materials and tools for the installation as well as acquiring knowledge of the topology to be implemented.

A focal point is the selection and operation of both straightforward as well as more complex testing instruments for checking functionality and performing fault finding in the communication system.

Training contents

- Components used for network installation
- Cables, plugs and sockets, design, deployment and function
- Use of general tools and measuring instruments needed for installation
- Network topology and importance for practical use of equipment

Practical Work with PBX Systems

Customer Order: Installation of Analog and Digital Telephone Equipment for Small Offices and Homes (SOHO)

This set of experiments describes the modular and TAE telephone connection systems. Students learn how the system components work and how to install them in the form of practical exercises. The exercises are set up to resemble authentic situations for customer-specific installations. They therefore cover the three typical steps in a job: customers' requirements, suggested installation and installation.

Training contents

- Planning for a SOHO private exchange (PBX) system
- Installation and configuration of ISDN equipment
- Installation and configuration of POTS equipment
- Installation and configuration of VoIP equipment
- Installation of door intercom system

Equipment set TTT1P-6P
Lucas-Nülle

SOHO WLAN Training System

Customer Order: Installation of a WLAN/WiFi Network

This practical work covers training of practical skills in installation and security of wireless networks. This also involves selection of the right components, materials and tools for an installation, as well as knowledge of the encoding system to be used. One key aspect is the choice of both simple and complex test equipment for checking functionality and finding faults in a telecommunications system.

Training contents

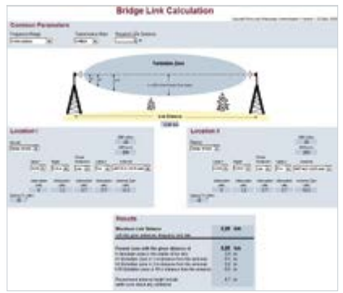
- Installation of network components
- Configuration of WLAN router
- Use of hand tools and measuring instruments during installation
- Network topologies and equipment for implementing them

Equipment set TWT1
Lucas-Nülle

WLAN Bridgelink Radio Trainer

Customer Order:
Network Several Company Locations

With all new 802.11n technology the advantages of higher data transfer rates or greater distances can be exploited also for bridgelinks, simply by having two data streams transmitted separately. To do this you need to use – in addition to N-Access Points – dual-polarising antennas, which can transmit two separate partial streams from one location to another.



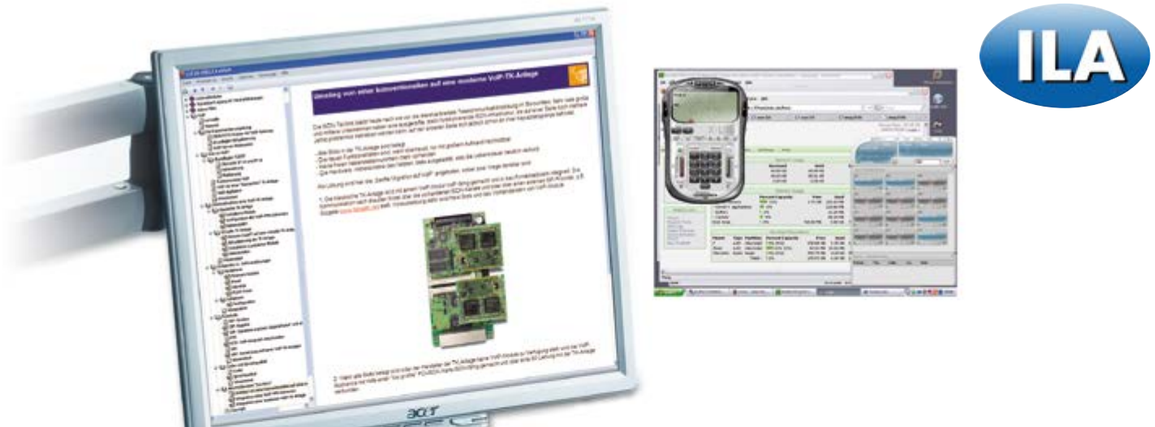
Training contents

- Planning
- Calculating maximum radio bridge lengths, Fresnel zone and determining antenna height
- Installation of network components
- Configuration of WLAN routers
- Use of standard tools and measuring instruments for installation
- Network topology and importance for practical use of equipment

Voice over IP

Quick and Reliable Introduction to VoIP

The Internet has made it possible for modern telecommunications networks to be merged with networks for data communication.
One of the results is VoIP – the new generation of telephony – a packet-switched service based on TCP/IP.



Training contents

- TCP/IP
- Fundamentals of virtualisation
- SIP, RTP, RTCP and RTSP protocols
- Design and function of VoIP-Soft PBX system
- Configuration of PBX system
- Installation and configuration of VoIP terminal devices
- Installation and configuration of a “soft-phone”
- Investigation of data packets

VoIP-LITE

Measurements and Troubleshooting in a VoIP network

All investigations during the course of the protocols, as well as diagnostics and troubleshooting, are carried out with the help of various software tools. They enable processes occurring in the network to be traced in detail during establishment, communication and closure of a VoIP call, including editing and highly detailed analysis of packets exchanged during the process.

As an option, we can offer an advanced measuring instrument housed in a rugged hand-held case, designed to make the daily work of a network technician much easier.

Training contents

- SIP packet structure
- Design and function of RTP
- Diagnostics and troubleshooting using software tools
- Diagnostics and troubleshooting using network analyser
- Security of VoIP

VoIP-PRO

Customer Order: Migration from a Conventional PBX System to VoIP

The training system makes it possible to incorporate telecommunications systems perfectly into the training lab. There are two possible procedures: setting up a VoIP PBX system using only Ethernet infrastructure or making use of existing ISDN or POTS infrastructure to allow smooth migration to VoIP.

ILA

This module allows for up to 18 groups (virtual VoIP PBX systems) to be implemented in your project at the same time.

Training contents

- Customer order: Planning and installation of infrastructure for a company
  - Commissioning a VoIP PBX system
  - Installation and configuration of additional modules:
- Answering machine, IVR, CLIP, CLIR, music-on-hold, conference calls etc.
  - Installation and configuration of VoIP terminal devices
  - Handover and customer instruction
- Customer order: Planning and installation of a VoIP PBX system for multiple decentralised locations
- Installation project: Setting up a network with multiple PBX systems
- Customer order: Setting up a conventional PBX system
  - Setting up an ISDN network with up to 32 subscribers
  - Setting up an analog network with up to 16 subscribers
- Customer order: Migration from analog and ISDN telephony to VoIP

Decisive Product Benefits

… Ensure Long-term Customer Satisfaction

Vladimir I. Schepelew, Director of the State College in Moscow:

“The training systems from Lucas-Nülle play an important role in the training and educational activities of our college.

Both the faculty as well as our students appreciate the technical detail of the LabSoft courses and the elegant way in which it integrates the control and measurement interface of UniTrain-I.

Among other things, we are currently using a series of courses on the subject of microwave technology. With the aid of the multimedia-based teaching and training platform, we are providing instruction on the basics of analog and digital modulation, antenna systems and signal processing.

Apart from the system’s high quality level, both in didactic and technical terms, they are also attractive because of their reliability and realistic measurement accuracy. For us it is a great advantage that the systems are also designed to be compact and flexible.

The software as well as the hardware components consist of modules that are connectible and interchangeable, and it has been our experience that they also incorporate state-of-the-art technology. Our students are therefore able to get a taste of industrial areas of application.

Thanks to these positives we opted for the Lucas-Nülle training systems, which in actual day-to-day practice never cease to prove that we really made the right decision.”

The Whole is Greater than the Sum of its Parts

Individual consultation with Lucas-Nülle

Do you require comprehensive advice or a firm offer?

Please contact us using any of the following means:

Tel.: +49 2273 567-0

Fax: +49 2273 567-39

E-Mail: export@lucas-nuelle.com

Lucas-Nülle is a byword for custom occupational training courses in all of the following areas:

- Electrical Wiring
- Electropneumatics and Hydraulics
- Electrical Power Supply Technology
- Measurement and Instrumentation Technology
- Renewable Energies
- Refrigeration and Air-conditioning Technology
- Power Electronics, Electrical Machines, Drive Technology
- Microcomputers
- Fundamentals of Electrical Engineering and Electronics
- Automation
- Communications Technology
- Automotive Technology
- Control Technology
- Laboratory Systems

Ask us for detailed information.

Our employees will be happy to advise you.

Further information on our products can be found at the following web address:

www.lucas-nuelle.com

Ref. No.: P5151
Communications Technology
13/08-2GB (Printed in Germany)
Subject to technical alterations.

Lucas-Nülle GmbH
Siemensstraße 2 · D-50170 Kerpen-Sindorf
Telephone: +49 2273 567-0 · Fax: +49 2273 567-39
www.lucas-nuelle.com · export@lucas-nuelle.com

LUCAS-NÜLLE

Communications Technology