

PHYSICS

CHEMISTRY  
BIOLOGY

ENGINEERING



LD DIDACTIC

# FUNDAMENTALS OF ELECTRONICS



CATALOG T6

**LEYBOLD®**

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## STE 6

# FUNDAMENTALS OF ELECTRONICS

### *Training in Electronics using the LD Plug-in System STE*

From a simple resistor to a highly integrated microchip, advanced training in electronics requires that the basic underlying principles are mastered completely. It is also necessary to establish the link between theory and practice as soon as possible. Bridging this gap is an important task, especially when it comes to mastering such complex technologies as those in the field of modern electrical engineering and electronics.

Such demanding subject matter requires well structured training programs with clearly defined teaching aims, as well as a sound curriculum. Furthermore, technical training can only be effective when suitable teaching aids, equipment and training systems are used. **LD DIDACTIC** produces such training systems.

Experience acquired over many years of close cooperation with teachers, educators and lecturers, together with **LD DIDACTIC's** desire to achieve the highest quality and performance, provide the background for the development of the STE plug-in system training concept for electrical engineering and electronics.

Using this system a wide range of experiments and circuits can be investigated in the areas of

- microcomputer technology
- telecommunications technology
- instrumentation and automatic control technology
- electric power engineering, control and drive technology

These areas are divided into topic groups and arranged to prepare the student for progressively higher training goals (see flow chart). Each topic group is accompanied by an set of the same name for conducting experiments.

See for yourself the advantages of this modular system by choosing the appropriate set for your training needs.

For further details concerning more advanced training systems in the different fields of electrical engineering and electronics, a complete program of professional training systems such as the training panel system, electrical machines, the microcomputer training system and the **LD DIDACTIC** laboratory equipment system for the planning and installation of complete laboratories, are available.

### *Components of the Plug-in System (STE)*

#### **The Universal Plug-in Board**

The universal plug-in board is necessary for all experiments and circuits used in the STE training system for electrical engineering and electronics. It is available in sizes 297 x 300 mm and 400 x 634 mm. The symmetrical arrangement of the socket areas, containing 9 electrically interconnected 4-mm sockets, makes possible the use of plug-in elements of different sizes with pin spacings of 19 mm, 50 mm and 100 mm. Contact resistance is less than  $5 \times 10^{-3}$  Ohm, permitting currents up to 10 A. Because of the low capacitance of 1.5 pF between adjoining areas, the universal boards are also suitable for experiments with high frequency circuits well into the MHz range.

#### **The Plug-in Elements**

The 2- and 4-terminal plug-in elements consists of a transparent housing with a detachable front plate, and specially designed long-life plugs. Thus the built-in components are visible and can be easily

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replaced should they be damaged. The component symbols on the front allow for a close correspondence between circuit diagram and assembled circuit.

The plug-in elements are available in the following sizes:

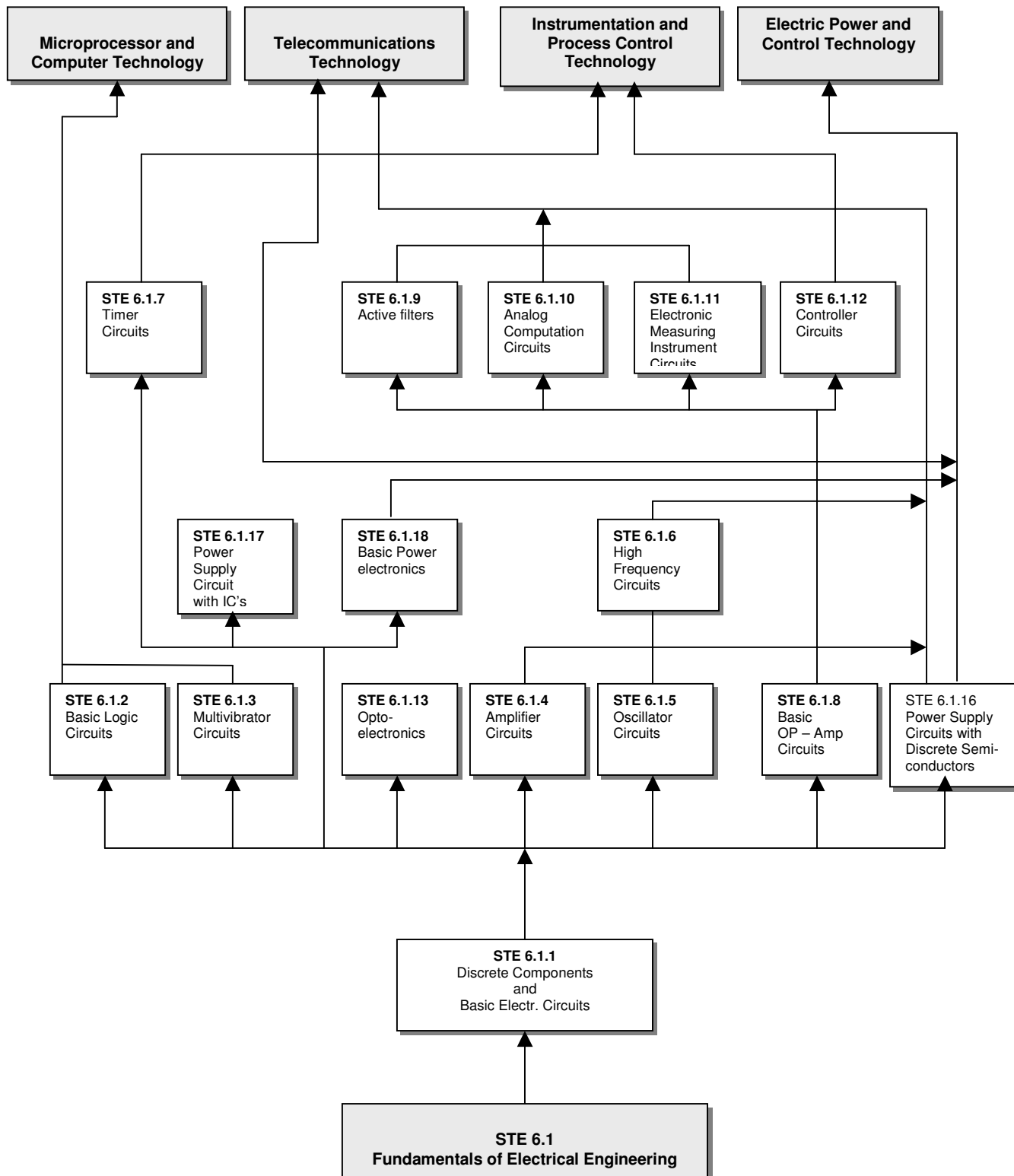
- Plug-in element 2/19 with 2 pins
- Plug-in element 2/50 with 2 pins
- Plug-in element 4/50 with 4 pins
- Plug-in element 4/100 with 4 pins

This facilitates the transition from circuit diagrams in instruction books to self-designed circuits, as well as the listing of experiment set-ups, and encourages thinking, learning and experimenting in terms of circuit diagrams.

To aid the successful performance of experiments on electricity and electronics, detailed experiment descriptions for students and accompanying information for instructors are available.

### **Literature**

The manuals for each topic group begin with a description of components, units and abbreviations used, as well as an introduction, to the topics. The experiments are described according to well proven didactical principles in the form of student's work sheets and teacher's notes. In addition, solution sheets are available to the teacher.



### *Plug-in System STE*

The plug-in system for electricity and electronics is especially suited to meet the many and varied demands of technical education and technical training. For the student using this system it is not only possible to become acquainted with a large number of basic electronic circuits, but he may also make measurements on the circuits which provide in-depth information on the underlying operating principles. The main features of the plug-in system for electricity and electronics are:

- ✓ Quick mounting plug-in units containing single components which make good contact with the rastered socket panel, thus minimising work which is not directly connected with the matter to be studied.
- ✓ The assembled circuit corresponds visually and electrically to the circuit diagram in the text book or the circuit developed by the teacher or student.
- ✓ Single components are contained in the plug-in units, thus enabling step by step assembly of discretely built up circuits.
- ✓ Due to the discrete assembly any point within the circuit is easily accessible for either measurements or modifications.
- ✓ All components used in the plug-in system are mutually compatible.
- ✓ Each kit may be extended by adding single plug-in units - which are separately available - or by supplementary kits, so that individual requirements can be met by the system.
- ✓ Compatibility for overlapping subjects such as digital electronics and control techniques.
- ✓ Identical components are used for both demonstration experiments and student's practical work, the difference being the size of the plug-in units containing the components. Thus demonstration and students experiments can be carried out in parallel.

## Basic Equipment

### 727531N: Basic equipment T 6.1.1

Basic set - *Discrete Components and Basic Electronic Circuits* -, consisting of:

(1) Resistor 10 $\Omega$ , 2 W	(1) Voltage dependent resistor	(1) Z diode ZPD 6.2
(1) Resistor 100 $\Omega$ , 2 W	(1) Capacitor 100 pF, 160 V	(1) LED1, green, top, STE 2/19
(1) Resistor 330 $\Omega$ , 2 W	(1) Capacitor 22 pF, 100 V	(1) LED1, green, top, STE 2/50
(1) Resistor 470 $\Omega$ , 2 W	(1) Capacitor 0.1 $\mu$ F, 100 V	(1) LED red, lateral
(1) Resistor 1 k $\Omega$ , 2 W	(1) Capacitor 1 $\mu$ F, 100 V	(1) Diac BR 100
(1) Resistor 1.5 k $\Omega$ , 2 W	(1) Capacitor 2.2 $\mu$ F, 63 V	(1) Photo-diode BPX 43
(1) Resistor 2.2 k $\Omega$ , 2 W	(2) Capacitors 4.7 $\mu$ F, 63 V	(1) Transistor BD 137 (NPN), e.b.
(1) Resistor 3.3 k $\Omega$ , 2 W	(1) Capacitor 10 $\mu$ F, 35 V	(1) Fe-transistor BF 244
(1) Resistor 10 k $\Omega$ , 0.5 W	(1) Capacitor 47 $\mu$ F, 40 V	(2) Thyristors TYN 1012
(1) Resistor 47 k $\Omega$ , 0.5 W	(1) Capacitor 100 $\mu$ F, 35 V	(1) Triac BT 137/800
(1) Resistor 100 k $\Omega$ , 0.5 W	(1) Capacitor 470 $\mu$ F, 16 V	(1) Inductance 33 mH
(1) Resistor 1 M $\Omega$ , 0.5 W	(1) Light emit. Diode infrared, lat.	(2) Lamp holders E10, top
(1) Potentiometer 1 k $\Omega$ , 1 W	(1) Ge diode AA 118	(1) Key switch, single-pole
(1) Potentiometer 10 k $\Omega$ , 1 W	(4) Si diodes 1N 4007	(1) Set 10 incand. Lamps 12 V/3 W, E10
(1) Potentiometer 100 k $\Omega$ , 1 W	(1) Z diode ZPD 9.1	(1) Tray STE

### Alternative to 727531N (Basic equipment T 6.1.1)

### 727510N: Complete Equipment Set DC/AC/EL

Optimized equipment set to carry out experiments from the following topic groups:

- T2.2 *DC Technology*
- T2.3 *AC Technology*
- T 6.1.1 *Discrete Components and Basic Electronic Circuits* consisting of:

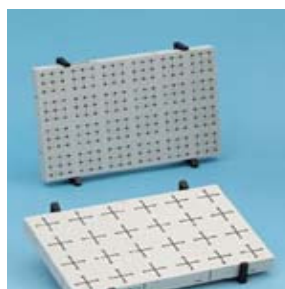
(1) Resistor 0.1 $\Omega$ , 2 W	(1) VDR-Resistor	(1) Photo-diode BPX 43
(1) Resistor 0.22 $\Omega$ , 2 W	(1) Photoresistor LDR 05	(1) Transistor BD 137 (NPN), e.b
(1) Resistor 1 $\Omega$ , 2 W	(1) NTC-Resistor 150 $\Omega$ , 1 W	(1) FET-transistor BF 244
(2) Resistors 10 $\Omega$ , 2 W	(1) PTC-Resistor 150 $\Omega$ , 1 W	(2) Thyristors TYN 1012
(1) Resistor 47 $\Omega$ , 2 W	(1) Capacitor 100 pF, 160 V	(1) Triac BT 137/800
(2) Resistors 100 $\Omega$ , 2 W	(1) Capacitor 22 pF, 100 V	(1) Inductance 33 mH
(1) Resistor 150 $\Omega$ , 2 W	(1) Capacitor 0.1 $\mu$ F, 100 V	(2) Lamp holders E10, lateral
(1) Resistor 220 $\Omega$ , 2 W	(1) Capacitor 1 $\mu$ F, 100 V	(2) Lamp holders E10, top
(1) Resistor 330 $\Omega$ , 2 W	(1) Capacitor 2.2 $\mu$ F, 63 V	(2) Key switches, single-pole
(1) Resistor 470 $\Omega$ , 2 W	(2) Capacitors 4.7 $\mu$ F, 63 V	(2) Change-over switches, single-pole
(1) Resistor 1 k $\Omega$ , 2 W	(1) Capacitor 10 $\mu$ F, 35 V	(1) Relay w. single-pole change-over
(1) Resistor 1.5 k $\Omega$ , 2 W	(1) Capacitor 47 $\mu$ F, 40 V	(1) Coil 500 turns
(1) Resistor 2.2 k $\Omega$ , 2 W	(1) Capacitor 100 $\mu$ F, 35 V	(1) Coil 1000 turns
(1) Resistor 3.3 k $\Omega$ , 2 W	(2) Capacitors 470 $\mu$ F, 16 V	(1) Transformer core, demountable
(1) Resistor 10 k $\Omega$ , 0.5 W	(1) Light emit. diode red, LED 2, top	(2) Plug-in battery holder
(1) Resistor 47 k $\Omega$ , 0.5 W	(1) Light emit. diode infrared, lat.	(2) Mono cells 1.5 V
(1) Resistor 100 k $\Omega$ , 0.5 W	(1) Light emit. diode green, LED 1, top	(1) Magnet with core
(1) Resistor 330 k $\Omega$ , 0.5 W	(1) Light emit. diode red, lateral	(1) Set 10 incand. Lamps 4 V/ 0.16 W, E10
(1) Resistor 1 M $\Omega$ , 0.5 W	(1) Ge diode AA 118	(1) Set 10 incand. Lamps 12 V/ 3 W, E10

(1) Potentiometer 220 $\Omega$ , 3 W	(4) Si diodes 1N 4007	(1) Set 10 incand. Lamps 2.5 V/ 0.25 W, E10
(1) Potentiometer 1 k $\Omega$ , 1 W	(1) Z diode ZPD 6.2	(1) Set 10 incand. Lamps 6 V/ 3 W, E10
(1) Potentiometer 10 k $\Omega$ , 1 W	(1) Z diode ZPD 9.1	(1) Glow lamp 110 V, E10
(1) Potentiometer 100 k $\Omega$ , 1 W	(1) Diac BR 100	(2) Trays STE

### Essential accessories

#### (2) 57674: Rastered socket panel DIN A4

for clearly arranged assembly of electrical circuits with plug-in units (STE). 24 symmetrically arranged socket areas with 24 conducting crosses and 120 4-mm sockets on the front side, as well as 24 conducting squares and 216 4-mm sockets on the rear side  
Dimensions: 30 cm x 20 cm x 2.4 cm



#### (1) 521485: AC/DC Power supply 0...12 V / 3 A

with variable and regulated output voltage and analog display instrument, additional 4 AC voltage outputs. AC and DC voltage outputs electrically isolated, therefore especially suitable for students and practical experiments.

Technical Data:

Output voltages:

DC: 0 - 12 V, continuously adjustable

Stabilization: < 1 %

Residual ripple: approx. 2 mV

AC: 3, 6, 9, 12 V

Output current: max. 3 A

Overload protection, short circuit-proof,  
safe from external voltage

Connections: 4-mm safety sockets

Connection voltage: 230 V, 50/60 Hz

Primary fuse: T 1

Dimensions : 23 cm x 12 cm x 19 cm

Weight : 5.2 kg



### (1) 522621: Function generator S 12

With built-in power amplifier, continuous variable in six decade ranges, ideal for students' experiments, including 12 V DC plug-in power supply.

Signals: sine, triangle and squarewave

Frequency range: 0.1 Hz to 20 kHz

Power output: 0 to 12 V<sub>pp</sub> across 8 W continuously adjustable

Distortion (sine-wave): < 3% (1 kHz)

Mark-to-space ratio (square wave): 1 : 1

Rise time (square wave): 2 μs

Dimensions: 16 x 12 x 7 cm

Weight: 0.5 kg

Plug-in power supply:

primary 230 V AC, 50/60 Hz/secondary 12 V AC, 20 VA



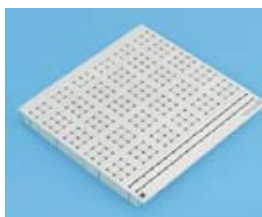
### Alternative to 57674, 521485 and 521621

### (1) 72650: Plug-In Board 297 x 300 mm \*

for panel frames, for clear and comprehensive understanding of the assembly of an electric circuit with plug-in elements (STE); with 4 mm-sockets for STE-type.

Pin no./spacing: 2/19, 2/50, 4/50 or 4/100

Dimensions: 297 x 300 x 24 mm



\* In combination with the Panel frame (Cat. no. 72619)

### (1) 72688: AC/DC Stabilizer \*

Lab power supply unit with DC and AC voltage.

Outputs, equipped with:

- Illuminated mains switch

DC Outputs:

- fixed voltage: 5 V / 3 A floating ground

residual ripple: 1 mV RMS

- tracking stabilizer: ± 0...15 V / 1 A

floating ground

- residual ripple: < 3 mV RMS

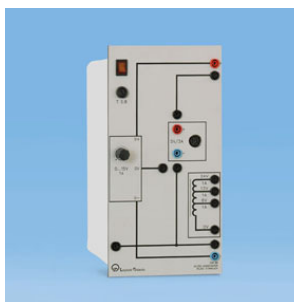
AC Outputs:

- AC voltage: 6/12/24 V / 1 A floating

ground

Output: via 4 mm sockets and 6pin DIN-socket

Mains connecting cable with euro plug



\* In combination with the Panel frame (Cat. no. 72619)



**(1) 72619: Panel Frame-SL85, One Level**

- 1-level frame for training panels in DIN A4 equivalent height; design with approx. 30° angle
- 2 aluminum profile rails with 2 brush strips
- 2 L-bases of rectangular steel tubing
- mounted to bench top with 2 M8 wing screws
- Width: 895 mm, height: 380 mm, depth: 250 mm



**(1) 726961: Function Generator 200 kHz, 230 V\***

Microprocessor-controlled signal generator.  
Functions: sine/triangular/square-wave/DC  
Square-wave signal: duty cycle 10 %...90 %,  
adjustable in steps of 5 %  
Frequency range: 1 Hz...200 kHz  
Resolution: 1 mHz...100 Hz, frequency-dependent  
Output voltage: 0...20 Vpp continuous  
DC offset:  $\pm 10$  V  
Display: 4-digit LC display for signal parameters and functions  
Attenuator: 0 dB, -20 dB, -40 dB  
Output: Impedance 50 Ohm  
Trigger output: TTL level  
Output: via 4-mm safety sockets  
Supply voltage: 230 V, 50/60 Hz with mains connection cable and earthing-pin plug



\* In combination with the Panel Frame (Cat. no. 72619).

**(2) 575231: Probe 100 MHz, 1:1 10:1**

Switchable; including spring loaded hook tip, trimmer key, BNC adapter, probe tip, insulating covering, ground lead and 4-mm plug.  
Input impedance: 1 MOhm / 10 MOhm  
Bandwidth: 10 MHz / 100 MHz  
Connection: BNC plug  
Cable length: 1.2 m



**(1) 575212: Two-channel oscilloscope  
400**

Bandwidth: 0...40 MHz (-3dB)  
 Input impedance: 1 MOhm, 15 pF, max.  
 400V.  
 Screen: 8 x 10 cm with internal graticule.  
 Vertical deflection: 1mV/cm...20V/cm (14 steps).  
 Time base: 0.1µs/cm...0.2s/cm (20 steps),  
 with X-magnification x10 to 10ns/cm.  
 Trigger sources: Ch1, Ch2, line, ext.  
 Operating modes: Ch1, Ch2, Ch1+Ch2  
 (alternate or chopped), Ch1/Ch2 sum or  
 difference, Ch2 inv., XY-Mode.  
 Built-in component tester.  
 Dimensions (WxHxD): 28.5 x 12.5 x 38.0cm  
 Mains supply: 105...253 V, 50/60 Hz ±10%,  
 Cat II.  
 Without probes



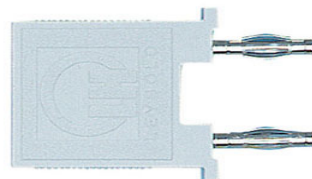
**(1) 531172: Multimeter DMM120**

Compact multimeter with large digital display, 3¾ digits; automatic or manual range selection, illuminated digital display. Automatic display of function symbols and low battery state. Automatically switching off. With 1 protective coating and 1 set of leads with probe tips red/black.  
 DC voltage ranges: 0.1 mV to 600 V (5 ranges)  
 AC voltage ranges: 0.1 mV to 600 V (5 ranges)  
 DC current ranges: 0.1 µA to 10 A (5 ranges)  
 AC current ranges: 0.1 µA to 10 A (5 ranges)  
 Input resistance: 10 MW DC/AC  
 Resistance ranges: 0.1 W to 40 MW (6 ranges)  
 Capacitance: 0.01 nF to 100 µF (5 ranges)  
 Frequency: 0.01 Hz to 20 MHz (6 ranges)  
 Continuity/diode tester: yes  
 Measured value storage HOLD: yes  
 Accuracy (DC voltage): ±0.5 % +2 digits  
 Accuracy (AC voltage): ±1.0 % + 4 digits  
 Accuracy (DC current): ±1.2 % + 2 digits  
 Accuracy (AC current): ±1.5 % + 4 digits  
 Battery type: 2 x 1.5 V/IEC R6  
 Overload capacity for voltage: 500 Vrms  
 Fuses: 500 mA/250 V (5 x 20 mm) and 10 A/HP600 V  
 Vmax CAT II: 600 V  
 Dimensions: 16.5 cm x 8.5 cm x 4.0 cm  
 Weight: 260 g



**(3) 50148: Set of 10 Bridging Plugs**

for extra-low voltage circuits with 4-mm  
plugs in storage block.  
Pin spacing: 19 mm  
Current: 25 A max.



**(1) 501532: Set of 30 Connecting Leads 1  
mm<sup>2</sup>**

4-mm laboratory plugs with 1 mm<sup>2</sup> cable,  
max. current 19 A.

*Consisting of:*

- 2 each, connecting leads, red 100 cm
- 2 each, connecting leads, blue 100 cm
- 2 each, connecting leads, black 100 cm
- 4 each, connecting leads, red 50 cm
- 4 each, connecting leads, blue 50 cm
- 4 each, connecting leads, black 50 cm
- 3 each, connecting leads, red 25 cm
- 3 each, connecting leads, blue 25 cm
- 6 each, connecting leads, black 25 cm



**(1) 565712: (Book) Discrete  
Components and Basic Circuits of  
Electronics T 6.1.1**

28 experiments, with an introduction to  
the equipment. DIN A4, in english.



### Additionally accessories to

Supplementary Set T 6.1.6 "High Frequency Circuits"

#### (1) 747202: Sweep Function Generator 0.2 Hz...2 MHz

Professional function generator with integrated frequency counter and sweep function. The set frequency is also shown on the 6-digit LED display. External signals can also be measured with the integral frequency counter.

The generator section provides sine, square and triangle waves. The square wave is available with CMOS-TTL and variable amplitude. The impulse width infinitely variable.

Generator section:

Output frequency: 0.2 Hz to 2 MHz in 7 ranges

Impedance:  $50\ \Omega \pm 5\%$

Amplitude: up to 20 Vpp

Attenuation: 20 dB

Frequency variable: 100:1 or more

Symmetry variable: 10:1 to 1:10

DC offset: 10 V

Sine wave: distortion  $< 1\%$  (at 100 kHz)

Square wave: rise time  $< 140\ \text{ns}$

Triangle wave: linearity  $\pm 1\%$  (up to 2 MHz)

TTL level:

Rise time  $< 25\ \text{ns}$  (1 kHz)

Amplitude  $> 2.4\ \text{V}/< 0.4\ \text{V}$

CMOS output:

Rise time  $< 140\ \text{ns}$

Amplitude 4 to 15 V

Sweep section:

Sweep time: 20 ms to 2 s

Bandwidth: from 1:1 to 100:1

External sweep function via VFC input

VFC input:

Input voltage: 0 to 10 V

Input impedance: approx. 10 k $\Omega$

Frequency counter:

Display: 6 digit, green LED

Frequency range: 2 Hz to 10 MHz

Sensitivity: 100 mVrms

Max. input voltage: 250 Vpp

General:

Power supply: 100/120/220/240 V AC, 48 - 66 Hz

Dimensions (W x D x H): 240 x 280 x 90 mm

\* Supplied with mains cable, BNC cable and instructions and 2 adapters BNC/4 mm, 2-pole



## Supplementary sets to T 6.1.1 or Compact Sets

### 727632N: Supplementary Set T 6.1.2

"Logic Circuits", (Supplement to T 6.1.1),  
consisting of:

(9) Resistors 100 $\Omega$ , 2 W	(2) Light emit. diodes red, LED2, top	(1) Output unit
(1) Resistor 330 $\Omega$ , 2 W	(3) Transistors BC 550 (NPN), e.b.	(1) IC socket, 14 pin
(1) Resistor 15 k $\Omega$ , 0.5 W	(2) Transistors BC 560 (PNP), e.b.	(1) IC socket, 16 pin
(1) Resistor 20 k $\Omega$ , 0.5 W	(1) Transistor BC 140	(1) Steppingmotor-modell
(1) Resistor 40.2 k $\Omega$ , 0.5 W	(2) Transistors 3N 163	(1) IC digital SN74 LS02N
(1) Resistor 47 k $\Omega$ , 0.5 W	(1) Incand. Lamp 15 V/ 1.5 W/ E10	(1) IC digital SN74 LS00
(1) Resistor 80.6 k $\Omega$ , 0.5 W	(1) Key switch n.c, single-pole	(1) IC digital 74 LS47
(1) Potentiometer 22 k $\Omega$ , 0.5 W	(1) Relay w. single-pole switch	(1) IC digital 74 LS194
(4) Light emit. diodes red, top	(1) Input unit	(2) Trays STE

### 727633N: Supplementary Set T 6.1.3

"Multivibrator Circuits", (Supplement to T 6.1.1),  
consisting of:

(1) Resistor 47 $\Omega$ , 2 W	(1) Capacitor 2.2 nF, 160 V	(2) Transistors BC 140
(3) Resistors 470 $\Omega$ , 2 W	(1) Capacitor 0.22 $\mu$ F, 250 V	(1) Transistor BC 160
(1) Resistor 1.5 k $\Omega$ , 2 W	(1) Capacitor 0.47 $\mu$ F, 100 V	(1) Relay w. single-pole switch
(3) Resistors 15 k $\Omega$ , 0.5 W	(1) Capacitor 0.47 $\mu$ F, 35 V	(2) Incand. Lamps 15 V/ 1.5 W/ E10
(1) Potentiometer 22 k $\Omega$ , 0.5 W	(1) Capacitor 220 $\mu$ F, 16 V	(1) DC moror 12 V, 4 W, with gear
(1) Photo-resistor LDR 05	(1) Light emit. diode red, LED 2, top	(1) Tray STE
(1) NTC-resistor 2.2 k $\Omega$	(1) Transistor BC 550 (NPN), e.b.	

### 727641N: Supplementary Set T 6.1.4

"Amplifier Circuits", (Supplement to T 6.1.1),  
consisting of:

(1) Resistor 10 $\Omega$ , 2 W	(1) Resistor 5.6 k $\Omega$ , 2 W	(2) Resistors 330 k $\Omega$ , 0.5 W
(1) Resistor 22 $\Omega$ , 2 W	(1) Resistor 10 k $\Omega$ , 0.5 W	(2) Potentiometers 4.7 k $\Omega$ , 1W
(1) Resistor 47 $\Omega$ , 2 W	(1) Resistor 15 k $\Omega$ , 0.5 W	(1) Capacitor 10 nF, 100 V
(1) Resistor 150 $\Omega$ , 2 W	(1) Resistor 22 k $\Omega$ , 0.5 W	(1) Capacitor 47 nF, 100 V
(1) Resistor 220 $\Omega$ , 2 W	(1) Resistor 27 k $\Omega$ , 0.5 W	(1) Capacitor 0.47 $\mu$ F, 100 V
(1) Resistor 680 $\Omega$ , 2 W	(1) Resistor 33 k $\Omega$ , 0.5 W	(1) Capacitor 1 $\mu$ F, 100 V
(1) Resistor 820 $\Omega$ , 2 W	(1) Resistor 47 k $\Omega$ , 0.5 W	(1) Capacitor 2.2 $\mu$ F, 63 V
(1) Resistor 4.7 k $\Omega$ , 2 W	(1) Resistor 68 k $\Omega$ , 0.5 W	(2) Transistors BC 140
(1) Transistor BC 160	(1) Transformer 1:1, 40 mW	
(1) Transistor BD 138 (PNP9, e.t.	(1) Tray STE	

### 727642N: Supplementary Set T 6.1.5

"Oscillator Circuits", (Supplement to T 6.1.1),  
consisting of:

(1) Resistor 220 $\Omega$ , 2 W	(1) Potentiometer 100 k $\Omega$ , 1 W	(1) Capacitor 1 $\mu$ F, 100 V
(1) Resistor 1 k $\Omega$ , 2 W	(1) Potentiometer 100 M $\Omega$ , 1 W	(1) Varicap diode BB 212
(1) Resistor 2.7 k $\Omega$ , 2 W	(1) Capacitor 4.7 pF, 500 V	(2) Transistors BC 140
(3) Resistors 4.7 k $\Omega$ , 2 W	(1) Capacitor 10 pF, 160 V	(1) Ferrite core transformer 1:2
(2) Resistors 10 k $\Omega$ , 0.5 W	(2) Capacitors 22 pF, 160 V	(1) LC oscillary circuit
(2) Resistors 15 k $\Omega$ , 0.5 W	(1) Capacitor 47 pF, 160 V	(2) Variable capacitors 500 pF
(1) Resistor 22 k $\Omega$ , 0.5 W	(1) Capacitor 100 pF, 160 V	(1) PLL Module
(1) Resistors 47 k $\Omega$ , 0.5 W	(2) Capacitors 220 pF, 160 V	(1) RF coil 2.2 $\mu$ H
(2) Resistors 82 k $\Omega$ , 0.5 W	(2) Capacitors 470 pF, 160 V	(1) RF coil 140 $\mu$ H
(1) Resistor 100 k $\Omega$ , 0.5 W	(3) Capacitors 1 nF, 100 V	(1) Reactance coil 10 mH
(1) Resistor 150 k $\Omega$ , 0.5 W	(3) Capacitors 2.2 nF, 160 V	(1) Pot type core coil 33 mH
(1) Resistor 220 k $\Omega$ , 0.5 W	(2) Capacitors 3.3 nF, 100 V	(1) Quartz 100 kHz, screened
(1) Resistor 470 k $\Omega$ , 0.5 W	(1) Capacitor 10 nF, 100 V	(1) Quartz 3.2 MHz, screened
(2) Potentiometers 4.7 k $\Omega$ , 1 W	(1) Capacitor 0.22 $\mu$ F, 250 V	(1) Tray STE

### 727643N: Supplementary Set T 6.1.6

"High Frequency Circuits", (Supplement to T 6.1.1 and T 6.1.5),  
consisting of:

(1) Resistor 47 $\Omega$ , 2 W	(3) Resistors 470 k $\Omega$ , 0.5 W	(2) Operational amplifiers LM 741
(1) Resistor 100 $\Omega$ , 2 W	(1) Resistor 1 M $\Omega$ , 0.5 W	(2) Transformers 1:1, 40 mW
(1) Resistor 470 $\Omega$ , 2 W	(1) Potentiometer 470 $\Omega$ , 1 W	(1) Ferrite core transformers 1:2
(1) Resistor 680 $\Omega$ , 2 W	(1) Potentiometer 10 k $\Omega$ , 1 W	(1) Prog. Frequency divider
(3) Resistors 1 k $\Omega$ , 2 W	(1) Potentiometer 47 k $\Omega$ , 1 W	(2) Ceramic filters
(1) Resistor 3.9 k $\Omega$ , 2 W	(1) Capacitor 4.7 nF, 100 V	(1) Ring modulator
(2) Resistors 5.6 k $\Omega$ , 2 W	(2) Capacitors 10 nF, 100 V	(1) Double gate BF 961
(1) Resistor 6.8 k $\Omega$ , 2 W	(3) Capacitors 47 nF, 100 V	(1) Reactance coil 3.3 mH
(1) Resistor 27 k $\Omega$ , 0.5 W	(1) Capacitor 0.47 $\mu$ F, 100 V	(1) Coil 150 $\mu$ H
(1) Resistor 33 k $\Omega$ , 0.5 W	(6) Capacitor 1 $\mu$ F, 100 V	(1) Earphone 2000 $\Omega$
(1) Resistor 39 k $\Omega$ , 0.5 W	(1) Capacitor 2.2 $\mu$ F, 63 V	(1) Tray STE
(1) Resistor 68 k $\Omega$ , 0.5 W	(1) Ge diode AA 118	
(1) Resistor 330 k $\Omega$ , 0.5 W	(1) FET transistor BF 244	

### 727645N: Supplementary Set T 6.1.7

"High Frequency Circuits", (Supplement to T 6.1.1 and T 6.1.5),  
consisting of:

(1) Resistor 1 k $\Omega$ , 2 W	(2) Potentiometers 10 k $\Omega$ , 1W	(1) Timer unit IC 555
(1) Resistor 2.2 k $\Omega$ , 2 W	(1) Potentiometers 47 k $\Omega$ , 1W	(1) Key switch (n.o), single pole
(1) Resistor 4.7 k $\Omega$ , 2 W	(1) Potentiometer 10 M $\Omega$ , 1W	(1) Toggle switch, single pole
(2) Resistors 10 k $\Omega$ , 0.5 W	(1) Photoresistor LDR 05	(1) Change-over switch, double pole
(2) Resistors 22 k $\Omega$ , 0.5 W	(1) Capacitor 10 pF, 160 V	(1) Relay with single-pole switch
(1) Resistor 47 k $\Omega$ , 0.5 W	(2) Capacitors 10 nF, 100 V	(1) Earphone 2000 $\Omega$
(2) Resistors 100 k $\Omega$ , 0.5 W	(1) Capacitor 47 nF, 100 V	(2) Incand. Lamps 12 V/ 1.2 W, E10
(1) Resistor 220 k $\Omega$ , 0.5 W	(1) Capacitor 470 $\mu$ F, 16 V	(1) Tray STE
(1) Resistor 470 k $\Omega$ , 0.5 W	(1) Transistor BC 140	

### 727646N: Supplementary Set T 6.1.8

"Basic Op-Amp Circuits", (Supplement to T 6.1.1),  
consisting of:

(1) Resistor 220 $\Omega$ , 2 W	(1) Resistor 47 k $\Omega$ , 0.5 W	(1) Capacitor 10 nF, 100 V
(1) Resistor 2.2 k $\Omega$ , 2 W	(3) Resistors 100 k $\Omega$ , 0.5 W	(1) Capacitor 1 $\mu$ F, 100 V
(1) Resistor 4.7 k $\Omega$ , 2 W	(1) Resistor 470 k $\Omega$ , 0.5 W	(1) Z diode ZPY 5.6, 1.3 W
(1) Resistor 10 k $\Omega$ , 0.5 W	(1) Variable resistor 1 k $\Omega$ , 1 W	(1) Transistor BC 140
(1) Resistor 15 k $\Omega$ , 0.5 W	(1) Variable resistor 4.7 k $\Omega$ , 1 W	(1) Operational amplifier LM 741
(1) Resistor 22 k $\Omega$ , 0.5 W	(1) Variable resistor 10 k $\Omega$ , 1 W	(1) Tray STE
(2) Resistors 33 k $\Omega$ , 0.5 W	(1) Potentiometer 100 k $\Omega$ , 1 W	
(1) Resistor 39 k $\Omega$ , 0.5 W	(2) Capacitors 2.2 nF, 160 V	

### 727647N: Supplementary Set T 6.1.9

"Active Filters", (Supplement to T 6.1.1 and T 6.1.8),  
consisting of:

(1) Resistor 6.8 k $\Omega$ , 2 W	(1) Capacitor 0.22 $\mu$ F, 250 V	(1) Tray STE
(5) Resistors 10 k $\Omega$ , 0.5 W	(1) Capacitor 0.47 $\mu$ F, 100 V	
(2) Capacitors 1 nF, 100 V	(1) Operational amplifier LM 741	

### 727649N: Supplementary Set T 6.1.11

"Electronic Measuring Instrument Circuits", (Supplement to T 6.1.1 and T 6.1.8),  
consisting of:

(1) Resistor 5.1 $\Omega$ , 2 W	(1) Resistor 20 k $\Omega$ , 0.5 W	(1) Capacitor 1 nF, 100 V
(1) Resistor 68 $\Omega$ , 2 W	(1) Resistor 68 k $\Omega$ , 0.5 W	(1) Capacitor 47 nF, 100 V
(3) Resistors 1 k $\Omega$ , 2 W	(4) Resistors 100 k $\Omega$ , 0.5 W	(1) Capacitor 0.47 $\mu$ F, 100 V
(1) Resistor 2.7 k $\Omega$ , 2 W	(1) Resistor 150 k $\Omega$ , 0.5 W	(1) Capacitor 47 $\mu$ F, 40 V
(1) Resistor 3.3 k $\Omega$ , 2 W	(2) Resistors 220 k $\Omega$ , 0.5 W	(3) Ge diodes AA 118
(1) Resistor 3.9 k $\Omega$ , 2 W	(2) Resistors 330 k $\Omega$ , 0.5 W	(1) Transistor BC 140
(1) Resistor 4.7 k $\Omega$ , 2 W	(1) Resistor 470 k $\Omega$ , 0.5 W	(2) OP-Amps LM 741
(1) Resistor 6.8 k $\Omega$ , 2 W	(1) Resistor 10 M $\Omega$ , 0.5 W	(1) Tray STE
(2) Resistors 10 k $\Omega$ , 0.5 W	(1) Potentiometer 4.7 k $\Omega$ , 1W	
(1) Resistor 15 k $\Omega$ , 0.5 W	(1) Capacitor 470 pF, 160 V	

### 727653N: Supplementary Set T 6.1.16

"Power Supply Circuits with Discrete Semiconductors", (Supplement to T 6.1.1),  
consisting of:

(1) Resistor 0.68 $\Omega$ , 2 W	(1) Resistor 1.2 k $\Omega$ , 2 W	(1) Si power diode SKN 2.5/0.8
(4) Resistors 1 $\Omega$ , 2 W	(1) Resistor 4.7 k $\Omega$ , 2 W	(1) Transistor 2N 3055 (NPN), e.b.
(3) Resistors 5.1 $\Omega$ , 2 W	(1) Variable resistor 1 k $\Omega$ , 1 W	(1) Transistor BC 550 (NPN), e.b.
(1) Resistor 10 $\Omega$ , 2 W	(1) Potentiometer 470 $\Omega$ , 1 W	(1) Transistor BC 550 (NPN), e.t.
(4) Resistors 22 $\Omega$ , 2 W	(1) Potentiometer 4.7 $\Omega$ , 1 W	(1) Transistor BC 560 (PNP), e.t.
(4) Resistors 47 $\Omega$ , 2 W	(1) Capacitor 10 nF, 100 V	(1) Transistor BC 140
(1) Resistor 62 $\Omega$ , 2 W	(1) Capacitor 0.47 $\mu$ F, 100 V	(1) Transistor BC 160
(3) Resistors 100 $\Omega$ , 2 W	(1) Capacitor 47 $\mu$ F, 35 V	(1) Darlington transistor TIP 162
(2) Resistors 220 $\Omega$ , 2 W	(1) Z-diode ZY 3.9	(1) Operational amplifier LM 741
(1) Resistor 330 $\Omega$ , 2 W	(1) Z-diode ZY 6.2	(1) Coil 500 turns
(2) Resistors 470 $\Omega$ , 2 W	(1) Z-diode ZPD 3.3	(1) Coil 1000 turns
(1) Resistor 510 $\Omega$ , 2 W	(1) Z-diode ZPD 18	(1) Transformer core, demountable
(1) Resistor 1 k $\Omega$ , 2 W	(1) Light emit. diode red, LED2, top	(1) Tray STE

### 727655N: Supplementary Set T 6.1.17

"Power Supply Circuits with IC's", (Supplement to T 6.1.1), consisting of:

(1) Resistor 1 $\Omega$ , 2 W	(1) Resistor 1 k $\Omega$ , 2 W	(1) PNP-Transistor BD 138, e.b.
(2) Resistors 5.1 $\Omega$ , 2 W	(1) Resistor 1.2 k $\Omega$ , 2 W	(1) Transistor BC 140
(1) Resistor 10 $\Omega$ , 2 W	(1) Resistor 1.8 k $\Omega$ , 2 W	(1) Operational amplifier LM 741
(2) Resistors 22 $\Omega$ , 2 W	(1) Resistor 4.7 k $\Omega$ , 2 W	(1) IC socket, 14 pole
(2) Resistors 47 $\Omega$ , 2 W	(1) Resistor 10 k $\Omega$ , 0.5 W	(1) Regulator LM 723
(1) Resistor 100 $\Omega$ , 2 W	(1) Potentiometer 470 $\Omega$ , 1 W	(1) Regulator LM 7805
(2) Resistors 220 $\Omega$ , 2 W	(1) Potentiometer 4.7 k $\Omega$ , 1 W	(1) Regulator LM 7905
(1) Resistor 330 $\Omega$ , 2 W	(2) Capacitors 10 nF, 100 V	(1) Regulator LM 317
(1) Resistor 510 $\Omega$ , 2 W	(2) Capacitors 0.47 $\mu$ F, 100 V	(1) Tray STE
(1) Resistor 680 $\Omega$ , 2 W	(1) Capacitor 47 $\mu$ F, 40 V	

### 727657N: Supplementary Set T 6.1.18

"Basic Power Electronics", (Supplement to T 6.1.1), consisting of:

(1) Resistor 10 $\Omega$ , 10 W	(1) Capacitor 10 nF, 100 V	(1) Pulse width generator
(1) Resistor 100 $\Omega$ , 2 W	(1) Capacitor 47 nF, 100 V	(2) Pulse isolate. Transformers 1:1, 400 mW
(1) Resistor 220 $\Omega$ , 2 W	(1) Capacitor 1 $\mu$ F, 100 V	(1) Ignition pulse generator, surface triggered
(1) Resistor 680 $\Omega$ , 2 W	(1) Capacitor 100 $\mu$ F, bipolar	(1) Key-switch, (n.c.) single-pole
(1) Resistor 1 k $\Omega$ , 2 W	(1) Z-diodes ZPY 8.2	(1) Change-over switch, two-pole
(1) Resistor 3.3 $\Omega$ , 2 W	(1) Transistor BD 137 (NPN), e.b.	(1) Coil 1000 turns
(1) Resistor 4.7 k $\Omega$ , 2 W	(1) Transistor BD 138 (PNP), e.b.	(1) Incandescent lamp 24 V/ 3 W/, E10
(1) Resistor 10 k $\Omega$ , 0.5 W	(1) Transistor BSV 81 (MOS-FET)	(1) Tray STE
(1) Variable resistor 47 k $\Omega$ , 1 W	(1) Diac MBS 4991	
(1) Capacitor 1 nF, 100 V	(1) Thyristor trigger unit TCA 785	

## Literature

#### 565712 Book: Discrete Components and Basic Circuits of Electronics T 6.1.1

28 experiments, with an introduction to the equipment. DIN A4, in English.

#### 565722 Book: Basic Logic Circuits, T 6.1.2

Instructions for 10 experiments for plug-in-system, with worksheets and solutions for the teacher. DIN A4, in English.

#### 565732 Book: Multivibrator Circuits T 6.1.3

12 sets of experiment instructions for the STE system with worksheets and solutions for the teacher. DIN A4, in English.

#### 565752 Book: Amplifier Circuits T 6.1.4

Basic information, exercises and worksheets additional information and solution sheets for the teacher. DIN A4, in English.

#### 565762 Book: Oscillator Circuits T 6.1.5

16 experiment instructions for STE with worksheets and solutions for the teacher. DIN A4, in English.

#### 565772 Book: High Frequency Circuits T 6.1.6

39 experiment instructions for STE with worksheets and solutions for the teacher. DIN A4, in English.

#### 565782 Book: Timer Circuits T 6.1.7

10 sets of experiment instructions for the STE system with worksheets and solutions for the teacher. DIN A4, in English.

#### 565822 Book: Basic Op-Amp Circuits T 6.1.8

Thirteen sets of experiment instructions for the STE system with worksheets and solutions for the teacher. DIN A4, in English.



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**565832 Book: Active Filters  
T 6.1.9**

DIN A4, in English

**565852 Book: Electronic Measuring  
Device Circuits T 6.1.11**

18 experiment instructions for STE with worksheets and solution sheets for teacher. DIN A4, in English.

**565952 Book: Power Supply Circuits with  
Discrete Semiconductors T 6.1.16**

20 sets of experiment instructions for the STE system with worksheets and solutions for the teacher. DIN A4, in English

**565962 Book: Power Supply Circuits with  
IC's T 6.1.17**

DIN A4, in English

**565982 Book: Basic Power Electronics T  
6.1.18**

DIN A4, in English

**565622 Book: DC Circuits T 2.2**

30 experimental arrangements for exercises and demonstration with solutions. DIN A4 in English

**565632 Book: AC Technology T 2.3**

basic information, exercises and worksheets additional information and solution sheets for the teacher. 31 experiment topics, DIN A4, in English

### Compact set 'Basics of electronics' DC/AC/EL



- ✓ **(1) 727510KOF: Compact set 'Basics of electronics' in the case DC/AC/EL**  
 consisting of:  
 1 Complete Equipment DC/AC/EL: Optimized equipment set to carry out experiments from the following topic groups:  
 T 2.2 DC Technology  
 T 2.3 AC Technology  
 T 6.1.1 Discrete components and basic electronic circuits

(1) Resistor 0.1 $\Omega$ , 2 W	(1) VDR-Resistor	(1) Photodiode BPX 43
(1) Resistor 0.22 $\Omega$ , 2 W	(1) Photoresistor LDR 05	(1) Transistor BD 137 (NPN), e.b.
(1) Resistor 1 $\Omega$ , 2 W	(1) NTC-Resistor 150 $\Omega$ , 1 W	(1) FET-Transistor BF 244
(2) Resistors 10 $\Omega$ , 2 W	(1) PTC-Resistor 150 $\Omega$ , 1 W	(2) Thyristors TYN 1012
(1) Resistor 47 $\Omega$ , 2 W	(1) Capacitor 100 pF, 160 V	(1) Triac BT 137/800
(2) Resistors 100 $\Omega$ , 2 W	(1) Capacitor 22 pF, 100 V	(1) Inductance 33 mH
(1) Resistor 150 $\Omega$ , 2 W	(1) Capacitor 0.1 $\mu$ F, 100 V	(2) Lamp holders E10, lateral
(1) Resistor 220 $\Omega$ , 2 W	(1) Capacitor 1 $\mu$ F, 100 V	(2) Lamp holders E10, top
(1) Resistor 320 $\Omega$ , 2 W	(1) Capacitor 2.2 $\mu$ F, 63 V	(2) Kex switches, single-pole
(1) Resistor 470 $\Omega$ , 2 W	(2) Capacitors 4.7 $\mu$ F, 63 V	(2) Change-over switches, single-pole
(1) Resistor 1 k $\Omega$ , 2 W	(1) Capacitor 10 $\mu$ F, 35 V	(1) Relay w. single-pole change-over
(1) Resistor 1.5 k $\Omega$ , 2 W	(1) Capacitor 47 $\mu$ F, 40 V	(1) Coil 500 turns
(1) Resistor 2.2 k $\Omega$ , 2 W	(1) Capacitor 100 $\mu$ F, 35 V	(1) Coil 1000 turns
(1) Resistor 3.3 k $\Omega$ , 2 W	(2) Capacitors 470 $\mu$ F, 16 V	(1) Transformer core, demountable
(1) Resistor 10 k $\Omega$ , 0.5 W	(1) Light emit. diode red, LED2, top	(2) Plug-in batteryholder
(1) Resistor 47 k $\Omega$ , 0.5 W	(1) Light emit. diode infrared, lateral	(2) Mono cells 1.5 V
(1) Resistor 100 k $\Omega$ , 0.5 W	(1) Light emit. diode green, LED1, top	(1) Magnet with core
(1) Resistor 300 k $\Omega$ , 0.5 W	(1) Light emit. diode red, lateral	(1) Set of 10 incand. Lamps 4 V/ 0.16 W, E10
(1) Resistor 1 M $\Omega$ , 0.5 W	(1) Ge diode AA 118	(1) Set of 10 incand. Lamps 12 V/ 03 W, E10
(1) Potentiometer 220 $\Omega$ , 3 W	(4) Si diodes 1 N 4007	(1) Set of 10 incand. Lamps 2.5 V/ 0.25 W, E10
(1) Potentiometer 1 k $\Omega$ , 1 W	(1) Z diode ZPD 6.2	(1) Set of 10 incand. Lamps 6 V/ 3 W, E10



(1) Potentiometer 10 k $\Omega$ , 1 W	(1) Z diode ZPD 9.1	(1) Glow lamp 110 V, E10
(1) Potentiometer 100 k $\Omega$ , 1 W	(1) Diac BR 100	

✓ (1) Large Case , with following Equipment:

(1) Rastered socket panels DIN A3	(3) Sets of Bridging Plugs	(1) Book: AC Technology T 2.3
(1) AC/DC Stabilizer	(1) Set of 30 Connecting Leads 1 mm <sup>2</sup>	(1) Book: Discrete components and basicelctronic circuits T 6.1.1
(1) Functio generator 200 kHz	(1) Book: DC Technology T 2.2	

### *Demonstration Equipment*

(1) Resistor 10 $\Omega$ , 2 W	(1) Voltage dependent resistor	(1) Z diode ZPD 6.2
(1) Resistor 100 $\Omega$ , 2 W	(1) Capacitor 100 pF, 160 V	(1) LED1, green, top
(1) Resistor 330 $\Omega$ , 2 W	(1) Capacitor 22 pF, 100 V	(1) LED red, lateral
(1) Resistor 470 $\Omega$ , 2 W	(1) Capacitor 0.1 $\mu$ F, 100 V	(1) Diac BR 100
(1) Resistor 1 k $\Omega$ , 2 W	(1) Capacitor 1 $\mu$ F, 100 V	(1) Photodiode BPX 43
(1) Resistor 1.5 k $\Omega$ , 2 W	(1) Capacitor 2.2 $\mu$ F, 63 V	(1) Transistor BD 137 (NPN), e.b.
(1) Resistor 2.2 k $\Omega$ , 2 W	(2) Capacitors 4.7 $\mu$ F, 63 V	(1) Fe-Transistor BF 244
(1) Resistor 3.3 k $\Omega$ , 2 W	(1) Capacitor 10 $\mu$ F, 35 V	(2) Thyristors TYN 1012
(1) Resistor 10 k $\Omega$ , 0.25 W	(1) Capacitor 47 $\mu$ F, 35 V	(1) Triac BT 137/800
(1) Resistor 47 k $\Omega$ , 0.5 W	(1) Capacitor 100 $\mu$ F, 40 V	(1) Inductance 33 mH
(1) Resistor 100 k $\Omega$ , 0.25 W	(1) Capacitor 470 $\mu$ F, 35 V	(2) Lamp holders E10, top
(1) Resistor 1 M $\Omega$ , 0.5 W	(1) Light emit. diode infrared, lat.	(1) Kex switch, single-pole
(1) Potentiometer 1 k $\Omega$ , 1W	(1) Ge diode AA 118	(1) Set 10 incand. lamps 12 V/ 3 W, E10
(1) Potentiometer 10 k $\Omega$ , 1W	(4) Si diodes 1N 4007	(2) Trays STE
(1) Potentiometer 100 k $\Omega$ , 1W	(1) Z diode ZPD 9.1	

## Experiment Topics

### ***STE 6.1.1: Discrete Components and Basic Electronic Circuits***

#### **Diode**

- The diode in the DC and AC circuit
- Displaying the diode characteristics on the oscilloscope
- The half-wave rectifier circuit
- The bridge rectifier circuit

#### **Z-Diode**

- Characteristics of a Z-diode

#### **Optosemiconductor**

- Characteristics of an LED
- Photodiode

#### **Bipolar transistors**

- The diode properties of transistors
- Input characteristic of a transistor
- Output characteristic of a transistor
- Transfer characteristic of a transistor
- Measurement of the current amplification of a transistor
- The transistor in a common emitter circuit
- The transistor in a common collector circuit
- The transistor in a common base circuit
- Electronic switch with a transistor
- Time delay switch

#### **The field effect transistor (FET)**

- Characteristic of the Field effect transistor
- The field effect transistor as a controlled resistor and switch

#### **MOSFET**

- MOSFET characteristic
- Sensor dimmer with MOSFET

#### **Diac/Triac/Thyristor**

- Characteristic of a diac
- Characteristic of a thyristor
- Characteristic of a triac
- Thyristor as a switch
- Phase control with triac and diac

### ***STE 6.1.2: Basic Logic Circuits***

#### **Diode gate**

- AND
- OR

#### **Inverters**

- NOR
- NAND

#### **Storage factor**

- Bistable multivibrator

#### **TTL Logic**

- Logic families

#### **Signal input**

- Changeover switch
- Pushbutton
- Bounce-free pushbutton with IC 7400

#### **Signal output**

- LED's
- Indicator
- Relay (driver)

#### **Seven-segment display**

- Discrete as component

#### **EX-OR**

### *STE 6.1.3: Multivibrator Circuits*

#### **Switch function of a transistor**

- Open, closed, reserve current/saturation voltage, current amplification
- Switching amplifier for relays
- with 1 transistor
- with 2 transistors
- Free-wheeling diode

#### **Bistable multivibrator**

#### **Astable multivibrator**

- Blinking light
- Square-wave generator

#### **Monostable multivibrator**

- Timing element (delay)
- Pulse shaper

#### **Schmitt trigger as threshold value switch**

- Switch with potentiometer
- Switch with photoresistor and NTC

#### **Schmitt trigger as pulse shaper**

#### **Discrete optocoupler with phototransistor**

#### **Blocking oscillator**

### *STE 6.1.4: Amplifier Circuits*

- Single-step amplifier in emitter circuit
- Bootstrap circuit
- Darlington circuit, simple and complementary
- Two-stage inductively coupled amplifier
- Two-stage capacitively coupled amplifier
- Two-stage directly coupled amplifier
- Amplifier with feedback
- Differential amplifier
- Push-pull output stage, operating modes
- Fault finding in two-stage amplifier
- amplification factor of the junction-gate FET in various basic circuits

### *STE 6.1.5: Oscillator Circuits*

- Meissner oscillator with NPN
- Meissner oscillator with FET
- Hartley oscillator with NPN transistor
- Hartley oscillator with FET
- Colpitts oscillator with FET
- RC high-pass generator
- RC low-pass generator
- Wien bridge generator
- Clapp oscillator
- Quartz oscillator with parallel resonance
- Quartz oscillator with series resonance
- Oscillator with capacitive feedback (FM oscillator)
- Pierce oscillator
- Voltage controlled LC oscillator (VCO)
- Voltage controlled IC oscillator (VCO)

### *STE 6.1.6: High Frequency Circuits*

#### **Passive filters**

- Series oscillator circuit, characteristics, transmission behaviour
- Parallel oscillator circuit, characteristics, transmission behaviour
- RC low-pass, frequency response
- LC low-pass and high-pass filter
- Band pass
- Band stop
- Ceramic filter as series tuned wave trap
- Ceramic filter as stopper circuit
- RC pulse shaping

#### **Frequency modification**

- Frequency divider
- Frequency doubler, frequency multiplier
- PLL circuit

#### **High-frequency amplifier**

- Single-stage resonance amplifier
- RF input stage
- Two-stage selective amplifier
- Amplification control with regulating transformer
- Threshold value control, delayed control

#### **Amplitude modulation**

- AM modulation with diode
- AM modulation with transistor
- AM modulation with dual gate MOSFET
- Ring modulator
- Balanced modulator
- Collins modulator

### **Amplitude demodulation**

- AM demodulation with diode
- AM demodulation with transistor

### **Frequency modulation**

- FM modulation with tuning diode
- FM modulation with VCO

### **Frequency demodulation**

- Slope detector
- Differential discriminator
- Ratio detector, ratio discriminator
- Phase discriminator

### **Mixing circuits**

- Additive mixing
- Multiplicative mixing

### ***STE 6.1.7: Timer Circuits***

- Astable multivibrator
- Monostable multivibrator
- Bistable multivibrator and Schmitt-trigger
- Hand-triggered timer
- Alternating flasher
- Metronome
- Pulse generators

Needle-pulse generator

Square-wave generator

Sawtooth generator

- Automotive circuit applications
- Turn-signal indicator circuit
- Prolonged auto interior lighting
- Interval switch

Automatic illumination application

- Tone generator circuits
- Tone generator 1 kHz
- Multi-frequency tone generator
- Modulated tone generator

### ***STE 6.1.8: Basic Op-Amp Circuits***

- The comparator
- The inverting amplifier and the voltage follower
- Frequency compensation
- The summing amplifier
- The analog subtractor
- Constant current source (with floating load)
- Integrating circuits
- Differentiating circuits
- Sine wave generator with Wien bridge

### ***STE 6.1.9: Active filters***

- Calculations on first-order active filters
- Calculations on second-order active filters:
  - critical damping, Bessel, Tschebysheff, Butterworth, with single positive feedback loops
- Second-order filter with single negative feedback loops
- Filters with multiple negative feedback loops
- Higher order filters
- Band pass filters and resonance circuits composed of active filters
- Selective peak filter with single positive feedback loops
- Selective filter with multiple negative feedback loops
- Active double-T notch filter
- Active Wien notch filter
- The NIC (Negative Impedance Converter)
- The Gyrator

### ***STE 6.1.11: Electronic measuring instrument circuits***

This set provides the components for investigating the individual circuit blocks of a modern analog electronic voltmeter, consists of a frequency-compensated input divider with overload protection, high input impedance amplifier for A.C., and the precision rectifier circuit.

### ***STE 6.1.16: Power Supply Circuits with discrete Semiconductors***

#### **General introduction**

- Smoothing, sieving
- Constant voltage source
- Constant current source
- Characteristics of stabilization
- Parallel stabilization
- Series stabilization
- Current limiting
- Current stabilization
- Semiconductor data sheets

#### **Parallel stabilization**

- Smoothing, sieving
- Stabilization with the zener diode
- Precision stabilization
- Stabilization with zener diode and transistor in parallel
- Parallel stabilization for higher output power
- Parallel stabilization with an op-amp

#### **Series stabilization**

- Stabilization with zener diode and transistor in series
- Stabilization with zener diode and Darlingtonstage
- Power supply with adjustable voltage 0 – 15 V
- Power supply with adjustable voltage 0 – 15 V and adjustable current limiting
- Stabilization with zener diode and op-amp
- Stabilization with control amplifier
- Stabilization with differential amplifier
- Stabilization with hum compensation
- Stabilization with control amplifier, variable output voltage and current limiting
- Power supply with improved stabilization and high output power
- Fold-back characteristic current regulation

#### **Current stabilization**

- Current source with bipolar transistor
- Current source with field effect transistor
- Current source with op-amp
- Current source for higher currents

### ***STE 6.1.17: Power Supply Circuits with IC's***

#### **General introduction**

- Integrated fixed-voltage regulators of the 78xx series
- Universal voltage regulator  $\mu$ A723
- adjustable voltage regulator LM 317

#### **Experiment section**

- Positive voltage regulator IC 7805
- Negative voltage regulator IC 7905
- Increasing the output power of the IC 7805 using a series transistor
- Increasing the output power of the IC 7805 using a series transistor and current limiting
- Changing the output power of the IC 7805
- Adjustable output voltage from 8-25 V with IC 7805 and op-amp
- Adjustable output voltage from 2 – 25 with IC  $\mu$ A723
- Adjustable output voltage from 2 – 25 V with IC  $\mu$ A723 and series transistor
- Voltage regulator IC  $\mu$ A723 as constant current source
- Adjustable output voltage from 2 – 25 V with IC LM 317 for currents up to 1.5 A

### ***STE 6.1.18: Basic Power Electronics***

#### **Components of Power Electronics**

- Thyristor characteristic
- Thyristor in the DC circuit
- Characteristic of a triac
- Switching performance of a diac

#### **Thyristor as a DC Switch and Chopper Converter**

- Thyristor as DC switch
- Thyristor with auxiliary arm as chopper converter
- Thyristor-chopper converter with ring-around circuit

- GTO-Thyristor with control circuit Pulse Generators and Trigger Circuits for Thyristor Gate Triggering
- Measurement circuit for thyristor gate triggering circuit
- Basic setting of a thyristor triggering IC TTIC

### **Phase Controls**

- Thyristor in the AC circuit
- Horizontal control with thyristor
- Phase angle control with diac and triac
- Triac suppressor (snubber) circuit
- Zero voltage switch
- Lift dimmer with FET

### **Circuits with thyristor Gate Triggering IC**

- Controlled half-wave rectifier with ohmic load
- Trigger circuit for inductive-ohmic load
- Half-controlled bridge circuit B2Hz
- Phase control: gate control triac and anti-parallel connection of thyristors
- Full-wave control

### **Circuits with Dimmer IC**

- Touch dimmer







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