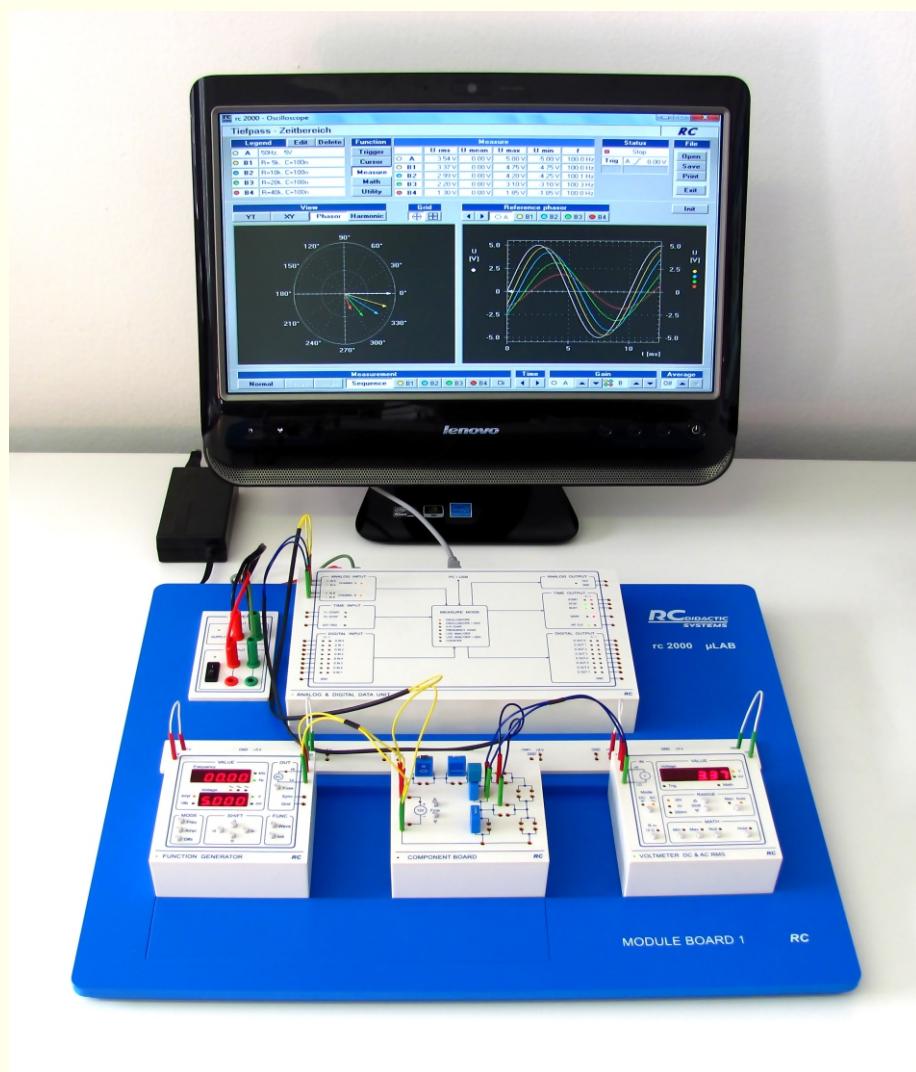


Teaching System rc2000 - μ LAB

Modules



RC společnost s r. o.
přístroje pro vědu a vzdělání
Cholupická 38
CZ - 142 00 Praha 4

Tel./Fax: 00420-244 464 176
Mobile: 00420-603 158 544
E-mail: info@rcdidactic.cz
Web: www.rcdidactic.cz

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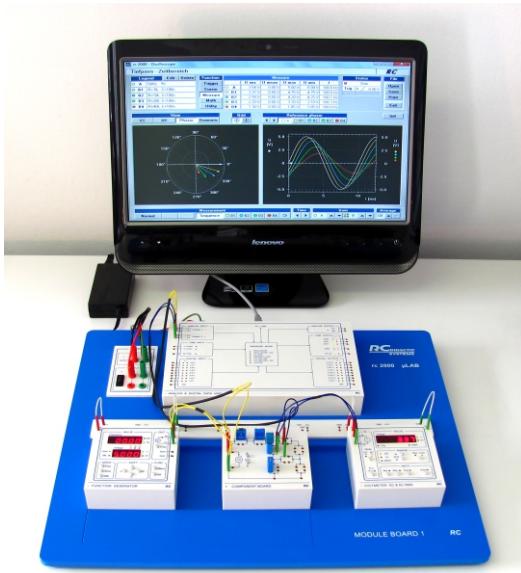
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System rc2000

0.1

Features and Use of the System rc2000

Workplace



Features

- Modular design with full compatibility of all modules
- Standard rates according to subject area, individual sets on customer request possible
- A single supply voltage of 5V (with the exception of the motor-generator set)
- Intuitive change of a variable or mode by keys
- Robust buttons with micro switches and metal buttons
- Gold plated contacts with high quality, 1.5 mm type HYPCON
- Display of values by 7-segment LED display
- Ideal input and output parameters
- High accuracy of measurement
- Protection against damage due to incorrect wiring, polarity reversal
- Protection of all connections against voltage up to ± 15 V
- Protection of all outputs against overload
- Overview of circuit configuration
- Connection of the system to any PC via USB interface

Philosophy of the System

The rc2000 - µLAB Teaching System includes a variety of electronic modules that enable the construction of many different electrical and electronic circuits.

High accuracy of the individual modules results in an exact agreement between the practical experiments and the theoretical calculations, which means that the measurements are "ideal". Thus, it is possible to study the effect of defined errors in the examined circuits. The conditions, which are often not ideal in practice, can be generated and investigated in a defined way by the ideal system.

Through the use of precise components and the robust construction of the individual modules, the high reliability is ensured even under the experimental conditions in the laboratory application. For this purpose, mechanically resistant, gold-plated contacts, fuses against fault voltages and an operating voltage of only 5V contribute. The long-term stability of the modules over 10 years has been proven in practice in many cases. Rare cable breaks can be easily repaired.

The system rc2000 is suitable for teaching at secondary schools and universities with an electrotechnical focus, especially in the following areas:

- Electrical engineering
- Electronics
- Measuring technology
- Digital technology
- Control engineering
- Mechatronics

More than 300 medium and high schools in the Czech Republic, Slovakia, Poland, Austria, Germany, Belgium, Romania and Iceland use our system.

The main task of the system is a clear explanation of the fundamentals of electrical engineering and electronics. Therefore, great attention is paid to the didactic features of the system, in particular to the methods of the representation of the measurements.

The measurement results can be displayed on the PC screen or with a beamer using the measuring unit ADDU and the program rc2000. Images and data can be printed, saved or exported.

General parameters

		Value	
		min	max
The whole system	Supply voltage (V)	(1)	4,8 5,5
	Ambient temperature for use (°C)		15 35
	Dimensions of small Modules (mm)		50 x 100 x 42
	Dimensions of bigger Modules (mm)		100 x 100 x 42
	Dimensions of big Modules (mm)		250 x 150 x 42
Analog components	Voltage range of the measurement (V)		± 10
	Frequency (Hz)	0	10 k
	Input resistance (Ω)	(2)	100 k 10 G
	Output resistance (Ω)		< 0,1
Digital components	Clock speed (Hz)	-	1 M
	Input resistance (Ω)	(2)	> 10 k
	Output resistance (Ω)		> 2 k < 360

(1) With the exception of the motor-generator set, which is fed by a +24 V source.

(2) Depending on the module type.

Usage guidelines

- The system does not require any special maintenance
- The specified function of the system is only guaranteed with the switching power supply supplied by the manufacturer
- Do not disassemble the components, do not open the modules, and do not perform any repairs yourself
- If an error occurs return the product to us and we shall do everything necessary
- Avoid contact with alcohol or similar solvents for cleaning
- Clean the system with a soft damp cloth

Customer service

- 3 years full warranty
- Free upgrades of the rc2000 program
- Development and production of your "own" new modules upon request possible
- Exercise book for System rc2000
- Individual advice and support according to customer requirements

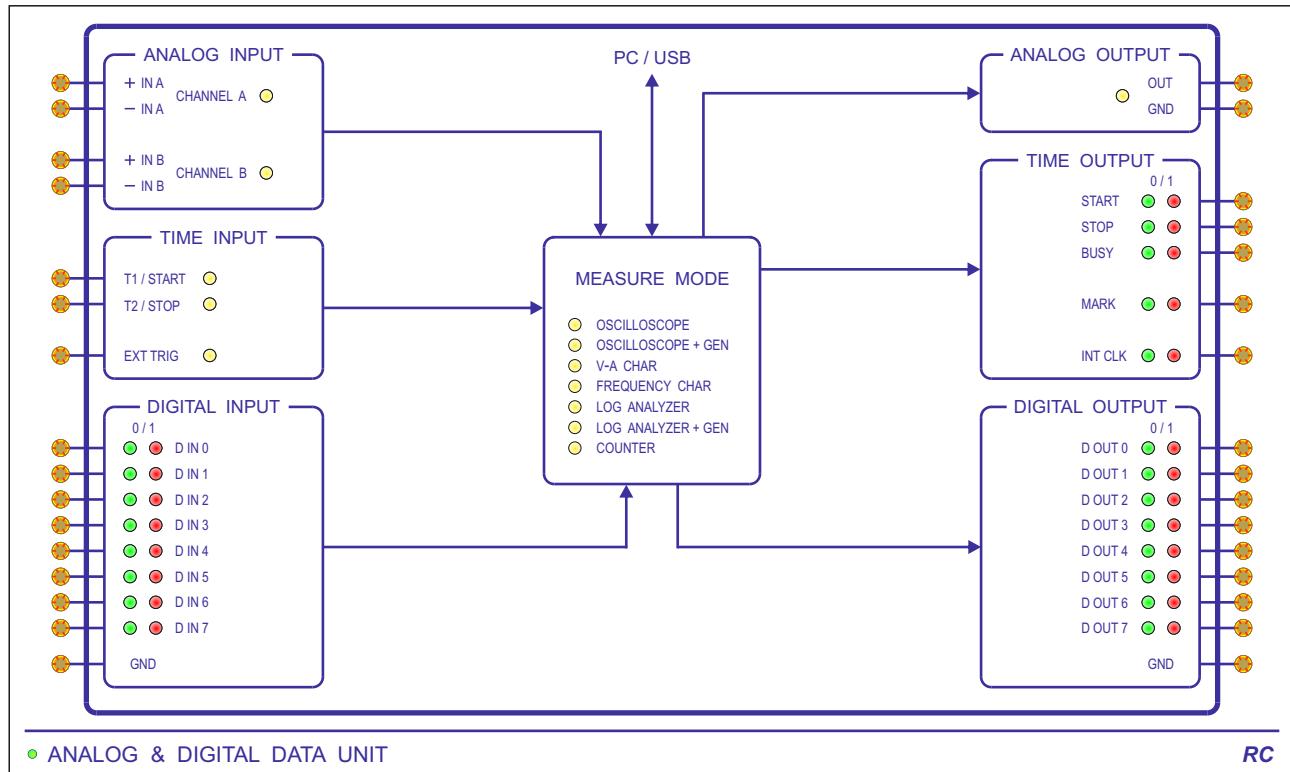
Instrument Modules

1.1

Measuring Unit

ADDU

Panel



Features

- The module enables the generation, measurement and display of analog and digital signals on a PC with the program rc2000 (module connected to PC via USB)
- The PC program allows the selection of seven measurement modes
- The memory location for the measurements can be preset
- For analog signals, two differential input channels and a channel for generating signals are available
- For digital signals, there are eight inputs and outputs (TTL standard)
- Measuring modes:

OSCILLOSCOPE	Dual-channel differential voltage measurement
OSCILLOSCOPE + GEN	Single-channel voltage gen. and single-channel diff. - Voltage measurement
V-A CHARACTERISTICS	U-I characteristics
FREQUENCY CHARACTERISTICS	Amplitude and phase measurement
LOGIC ANALYZER	Eight-channel measurement of logic signals
LOGIC ANALYZER + GEN	Eight-channel logical generator and eight-channel logical analyzer
COUNTER	Two-channel counter

- Dimensions (250 x 150 x 42) mm. Weight 740g

Accessories

- USB cable, power supply cables (2Pcs.)

Parameter**OSCILLOSCOPE**

		Values	
		min	max
ANALOG INPUT	CHA, CHB	Z_{in} / MΩ; C_{in} / pF	10 ; 50
		Voltage range / V	± 100m ± 10
		Scaling / V/div	50m 5
		Frequency range / Hz	0 ... 10k (1)
		Sampling rate / Sa/s	1 1M
		Time base / s/div	100μ 100
		Trigger	CHA, CHB, EXT Level, Edge

(1) For decrease 0,1 dB

OSCILLOSCOPE + GEN

		Values	
		min	max
ANALOG INPUT	CHB	Z_{in} ; C_{in}	10 MΩ / 50 pF
		BIP	± 100m ± 10
		UNI	0 - 100m 0 - 10
		BIP	50m 5
		UNI	25m 2,5
		Frequency range / Hz	0 - 10k (1)
		Sampling rate / Sa/s)	1 1M
ANALOG OUTPUT	OUT	Time base / s/div	100μ 100
		I_{MAX} / mA	20
		R_{OUT} / Ω	< 0,1
		BIP	± 100m ± 10
		UNI	0 - 100m 0 - 10
		BIP	50m 5
		UNI	25m 2,5
		Frequency range / Hz)	0 ... 10k (1)
		Sampling rate / Sa/s	1 1M
		Samples in the cycle / Sa	500

(1) For decrease 0,1 dB

*Parameter***V-A CHARACTERISTICS**

			Werte	
			min	max
ANALOG INPUT	CHA	Voltage range (V)	± 100m	± 10
		Amplification (V/div)	50m	5
		Frequency range (Hz)	0 - 10k (1)	
	CHB	Measuring resistor (Ω)	1, 10, 100, 1k, 10k	
		1 Ω	± 100m	± 10
		10k	± 10 μ	± 1m
		1 Ω	50m	5
		10k	5 μ	500 μ
	Frequency range (Hz)		0 - 10k (1)	
ANALOG OUTPUT	OUT	Voltage range (V)	± 10	
		Sampling (s/div)	0,5m	500

(1) For decrease 0,1 dB

FREQUENCY CHARACTERISTICS

			Values	
			min	max
ANALOG INPUT, ANALOG OUTPUT	OUT, CHB	Frequency range (Hz)	10 - 100	10 - 10k
		Transmission (dB)	± 15	± 45
		Phase range (°)	± 45	± 180
		U_{OUT} (Sinus) (V)	100m	10

LOGIC ANALYZER

			Values	
			min	max
DIGITAL INPUT	D IN 0 - D IN 7	Mode	Time analysis	
		U_{in}	TTL	
		R_{in} (Ω)	> 10k	
		Trigger	8 bit	
		Sampling (Sa/s)	1	1M
		Time base (s/div)	100 μ	100

LOGIC ANALYZER + GEN

			Values	
			min	max
DIGITAL INPUT	D IN 0 - D IN 7	(See LOGIC ANALYZER)		
DIGITAL OUTPUT	D OUT 0 - D OUT 7	U_{out}	TTL	
		R_{out} (Ω)	330	
		Sampling (Sa/s)	1	1M

Parameter —**COUNTER**

			Values	
			min	max
TIME INPUT	T1, T2	U _{in}	TTL	
		Measuring range N _{MAX} (-)	300	60 000
		Measuring time (s)	5	500
		Time base (s/div)	1	100
		Pulse width (ns)	50	-
		Trigger	T1, T2, EXT	

Controls —**1. FUNCTION BLOCKS**

MEASURE UNIT	Selected measurement mode
ANALOG INPUT	Inputs of the differential voltage measurement
TIME INPUT	Trigger inputs, counter inputs
DIGITAL INPUT	Inputs of the logical analyzer
ANALOG OUTPUT	Output of the analog signal generator
TIME OUTPUT	Synchronization outputs
DIGITAL OUTPUT	Outputs of the generator of the logic signals

2. INITIAL CONDITIONS

The initial conditions can be set by the control program according to the selected measuring mode

3. CONTROL ELEMENTS

All Blocks	Selected measuring mode or active input / output
	0/1 ● ●	Displays the status of the respective digital input / output

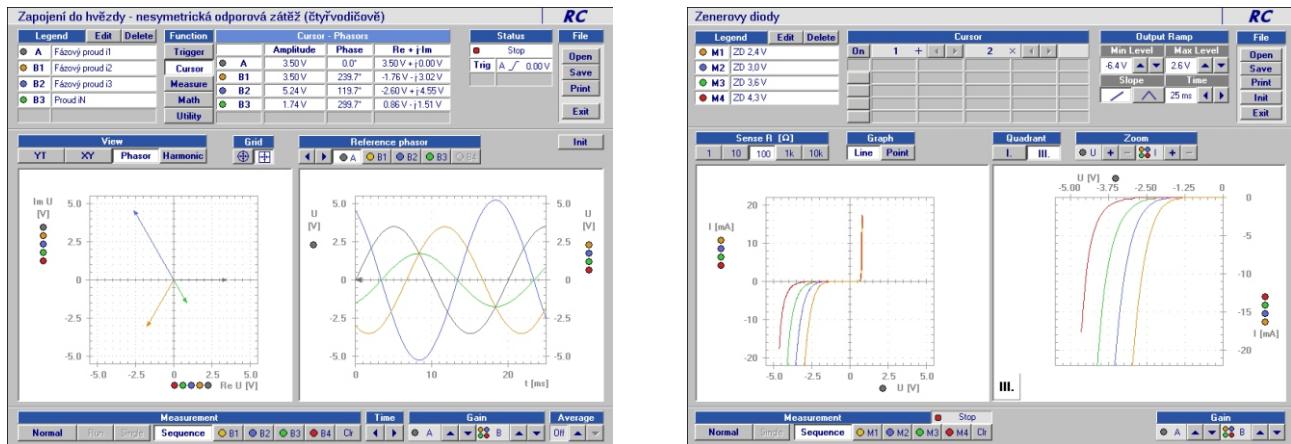
Instrument Modules

1.2

Software rc2000

SWRC

Screen



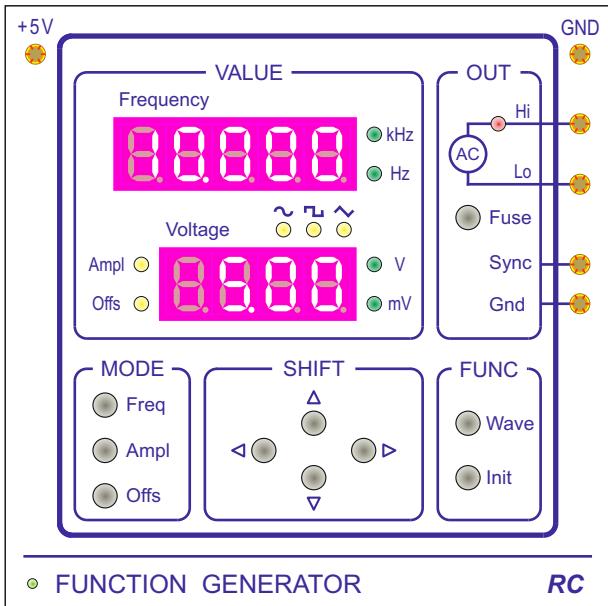
Features

- The PC program rc2000 and the measuring unit ADDU enable the generation and measurement of the analog and digital signals
- Choice of seven measurement areas (the start page)
- Intuitive control
- Clear and intuitive display in different ways (time diagrams, measuring marks, pointer diagrams, XY mode, ...)
- Harmonic analysis, sequence measurement with variation of parameters in one image (trend measurement)
- Possibility of using the projector, simple printing function and storage of the measurement results and settings
- Separate program for setting the communication between measuring unit ADDU and PC
- Measurement areas:

OSCILLOSCOPE	Dual-channel differential voltage measurement
OSCILLOSCOPE + GEN	Single-channel function generator and single-channel oscilloscope
V-A CHARACTERISTICS	Measurement of U-I characteristics
FREQUENCY CHARACTERISTICS	Amplitude and phase frequency responses
LOGIC ANALYZER	Eight-channel logical analyzer
LOGIC ANALYZER + GEN	Eight-channel logical analyzer and eight-channel logical generator
COUNTER	Two-channel counter

- HW and SW requirements:

PC with MS Windows (all versions), USB

Panel*Features*

- Adjustable function generator (sine, triangle and square wave). Precise and stable frequency setting (Direct Digital Synthesis Method)
- Accurate incremental setting of all parameters, such as frequency, amplitude, and offset
- Potential-free generator output AC
- Output resistance $R_{\text{OUT}} < 100\text{m}\Omega$ (Generator behaves as an ideal source)
- Output protected against overload. The control unit switches off the output voltage in the event of an error
- Synchronisationsausgang Sync dient zum Triggern (Starten) der Messung
- Dimensions 100 x 100 x 42 mm. Weight 240g

Parameter

	Value		Precision (1)
	min	max	
Frequency / Hz	0,01	10 000	$\pm 0,001 \%$
Amplitude / V	0,05	10	$\pm 1,0 \%$
Offset / V	-8,0	8,0	$\pm (1\%A + 1\%O + 2\text{mV})$ (2)
Waveform	\sim	\square	-
I_{OUT} / mA	-	22	-
R_{OUT} / Ω	$< 0,1$		-

(1) Temperature range 15°C - 35°C. Warm-up time 15 min.

(2) A - set amplitude, O - set offset.

Controls**1. FUNCTION BLOCKS**

VALUE	Adjustment and voltage display
OUT	Output with protection against overload
MODE	Parameter selection
SHIFT	Change of position and values
FUNC	Function selection and setting of initial conditions

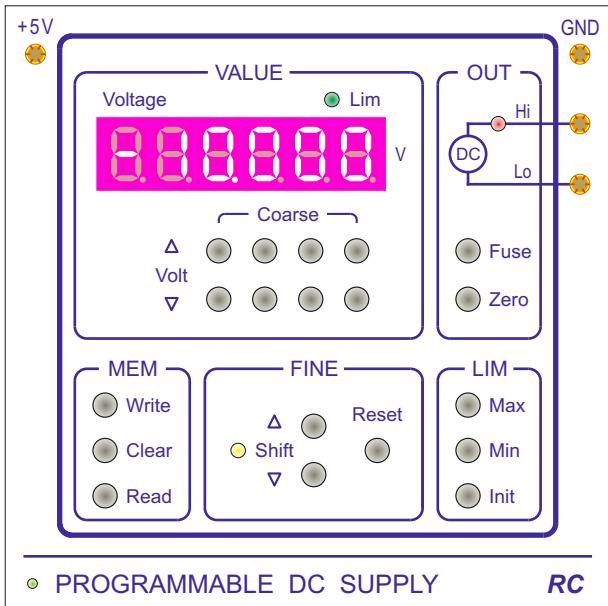
2. Standard settings / INITIAL CONDITIONS

After the + 5V connection or after pressing the Init key the following parameters are set:

Frequency	Amplitude	Offset	Function
100 Hz	5,00 V	0,00 V	Sinus

3. CONTROL ELEMENTS

VALUE	kHz	Display unit. When flashing, the value shifts by one order
	Hz	
	V	Display unit. When flashing, the value shifts by one order
	mV	
	~ □ ~	Display of the output signal
	○ ○ ○	
	Ampl	Display of the amplitude
MODE	Offs	Display of the offset
	Freq	Display and adjustment of the frequency
	Ampl	Display and adjustment of the amplitude
SHIFT	Offs	Display and setting of the offset
	◀ ○ ○ ▶	Selection of the setting position.
FUNC	^ ○ ○ ▾	Value change by ± 1.
	Wave	Choice of the form of the output signal
OUT	Init	Reset to default settings
	—●—	Red LED indicates that the output is switched off by short circuit or overload
	Fuse	Reset the overload protection

Panel*Features*

- Microprocessor-controlled source for high-stable low-noise DC voltage
- Very exact and stable setting of the output voltage (by keypad "Coarse", fine adjustment in block "FINE")
- Potential-free output of the voltage source (DC)
- Low output resistance $R_{OUT} < 100\text{m}\Omega$ (behaves like an ideal voltage source)
- The output is protected against overload by electronic fuse.
- Memory (MEM) for eight typical values of the output voltage
- Dimensions 100 x 100 x 42 mm. Weight 230g

Parameter

	Range		Precision (1)
	min	max	
Voltage / V	-10,000	10,000	$\pm (0,02 \% + 0,5 \text{ mV})$
Step / mV	1,00		$\pm 5 \%$
Step of fine tuning / μV	80		$\pm 10 \%$
I_{OUT} / mA	-22	22	$\pm 5 \%$
R_{OUT} / Ω	< 0,1		-

(1) Temperature range 15°C - 35°C. Warm-up time at least 15 min.

*Controls***1. FUNCTION BLOCKS**

VALUE	Setting and display of the output voltage
FINE	Fine tuning of the voltage
OUT	Output + fuse
MEM	Memory for 8 voltage values
LIM	Limiting the voltage to protect components

2. Standard settings / INITIAL CONDITIONS

After connecting to +5V or after pushing the Zero button, the output is set to 0.000V

3. CONTROL ELEMENTS

VALUE	● Lim	At least one limit is active
	Coarse ▲ ○ ▲ ○ ▲ ○ ○ ○ ○ ○ ▼ ▽ ▽ ▽ ▽	Changes the voltage value in the selected decimal place by +/- 1
FINE	●	Adjustment is not ZERO. It is always lower than 1 mV and adds to the value on display
	▲ ○ ○ ○ ▼	Shift Changes the output value by +/- 1 step of the fine adjustment
	○ Reset	Reset the fine adjustment
OUT	—●—	Output is switched off due to overload
	○ Fuse	Reset the overload protection
	○ Zero	Sets 0.000 V at the output
MEM	○ Write	Stores the value in the next memory cell
	○ Clear	Clears all stored voltage values
	○ Read	Reads the stored value. Press the button repeatedly to select the desired memory
LIM	○ Max	Sets the current voltage value as the upper limit (Upper Limit)
	○ Min	Sets the current voltage value as the lower limit (Lower Limit)
	○ Init	Disabling the limits, full voltage range is available

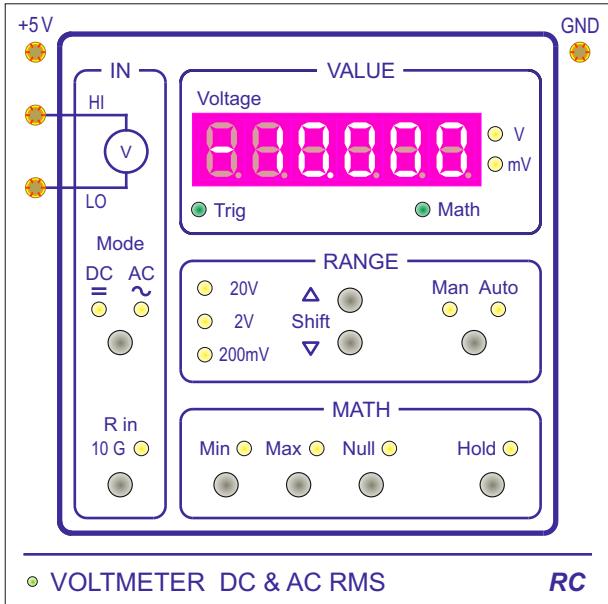
Instrument Modules

1.5

Voltmeter DC & AC RMS

VDAR

Panel



Features

- DC 4,5 - digit voltmeter
- AC 3,5 - digit True RMS voltmeter, 10 Hz - 10 kHz
- DC input resistance
 $R_{in} = 10 M\Omega$ (Range: 200 mV, 2 V, 20 V)
 Switchable for the measuring ranges
 $R_{in} = 10 G\Omega$ (Range: 200 mV, 2 V)
- AC input impedance
 $Z_{in} = 10 M\Omega / 50 pF$
- Automatic or manual selection of the range
- Mathematical functions
- Dimensions 100 x 100 x 42 mm. Weight 260g

Parameter

		Range		Precision (1)
		min	max	
DC	Display	4,5 - digit		-
	Measuring range	200 mV		$\pm (0,05 \% + 5 \text{ digit})$
		2 V		$\pm (0,04 \% + 3 \text{ digit})$
		20 V		
	$R_{in} (\Omega)$	10 M		-
AC	$R_{in} 10G (\Omega)$	> 10 G (2)		-
	Display	3,5 - digit		-
	Measuring ranges	200 mV		$\pm (1,0 \% + 5 \text{ digit})$
		2 V		$\pm (0,8 \% + 5 \text{ digit})$
		20 V		
Z_{in}		10 M Ω / 50 pF		-
Frequency range / Hz		10	10 k	-

(1) Temperature range 15°C - 35°C. Warm-up time 15 min.

(2) Function available for DC ranges 200 mV and 2 V.

Controls**1. FUNCTION BLOCKS**

IN	Input of the voltmeter, measuring mode setting
VALUE	Display of the measured value
RANGE	Range selection
MATH	Mathematical functions and function Hold

2. INITIAL CONDITIONS

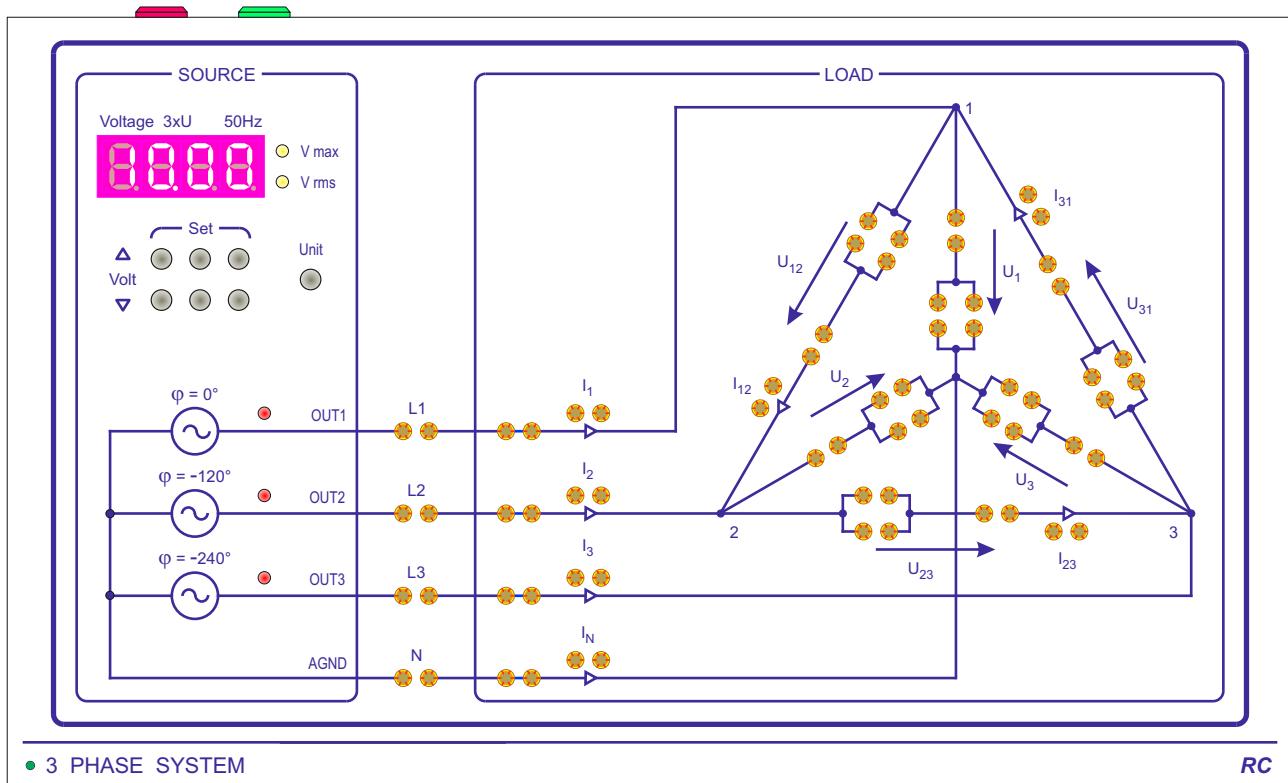
After connecting the module to the supply the following initial conditions are set:

Measuring mode	DC	Range	Auto	R_{in}/Ω	10 M
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3. CONTROL ELEMENTS

IN	Mode DC AC ○	Selection and display of the activated measuring mode (DC or AC)
	○ R in 10G	Input resistance 10 GΩ (for DC ranges 200mV and 2V)
VALUE	● V	Unit display
	● mV	
	● Math	Mathematical function is active
	● Trig	Flashes at sampling time
RANGE	● 20V	Display of the selected measuring range
	● 2V	
	● 200mV	
	△ ○ Shift ▽	Switch to higher or lower voltage range
	Man Auto ● ○	Switch between manual and automatic selection of the range
MATH	● Min ○	Display of the minimum measured value
	● Max ○	Display of the maximum measured value
	● Null ○	Selection of the reference value of the measurements
	● Hold ○	Freezing the display

Panel



Features

- The module allows to study the characteristics of the three-phase system
- It contains two basic parts: a voltage source part (SOURCE) and a load part (LOAD). Both parts can be connected as desired.
- A processor controls the generator which outputs three phase-shifted sinusoidal voltages.
- Incremental setting of the output voltage
- Optionally displays the peak value U_{\max} or the effective value (RMS) U_{rms} of voltage (switch with the key UNIT).
- Potential-free generator outputs, i.e. no problems with loops during measurement.
- Thanks to low output resistances the generator acts as an ideal voltage source.
- Outputs are electronically secured against overload. Overload is indicated by a red LED.
- The connection field allows the star or delta connection with symmetrical or unsymmetrical load.
- Currents in the individual branches are measured by means of I / U converters and the multimeter or oscilloscope.
- Dimensions 250 x 150 x 42 mm. Weight 690g

Accessories

- Power cables (2 Pcs)
- Set of elements (100 Ω : 3 Pcs, 500 Ω : 3 Pcs, 1 k Ω : 3 Pcs, 2 k Ω : 3 Pcs, coupling: 7 Pcs)

Parameter

		Value		Precision (1)
		min	max	
Generator		Frequency / Hz		± 0,05 %
		Voltage U_{MAX} / V		0,10 10,00
		Voltage U_{RMS} / V		0,07 7,07
		Offset / V		± 2,0 mV
		Phase shift / °		± 1,0 °
		I_{OUT} / mA	- 8,0	-
Converter I/U		R_{OUT} / Ω		< 0,1
		Constant / V/mA		± 1,0 %
		Offset / V		± 10,0 mV
		Load R_L / k Ω	10 -	-

(1) Temperature range 15°C - 35°C. Warm-up time 15 min.

Controls**1. FUNCTION BLOCKS**

SOURCE	Three-phase voltage source with frequency 50 Hz
LOAD	Load part, allows the star or delta connection

2. INITIAL CONDITIONS

After connecting the module to the voltage supply, the amplitude of the output voltage is set to $U_{max} = 5,00$ V.

3. CONTROL ELEMENTS

SOURCE	Set ▲ ▲ ▲ ○ ○ ○ ○ ○ ○ ▼ ▼ ▼	Changes the voltage value in the selected decimal place +/- 1
	○ Unit	Change the display between V_{max} and V_{rms}
	● V_{max}	Displays the peak value of the generated voltage
	● V_{rms}	Displays the effective value (RMS) of the generated voltage
	— ● —	Overload, current $I > 8$ mA

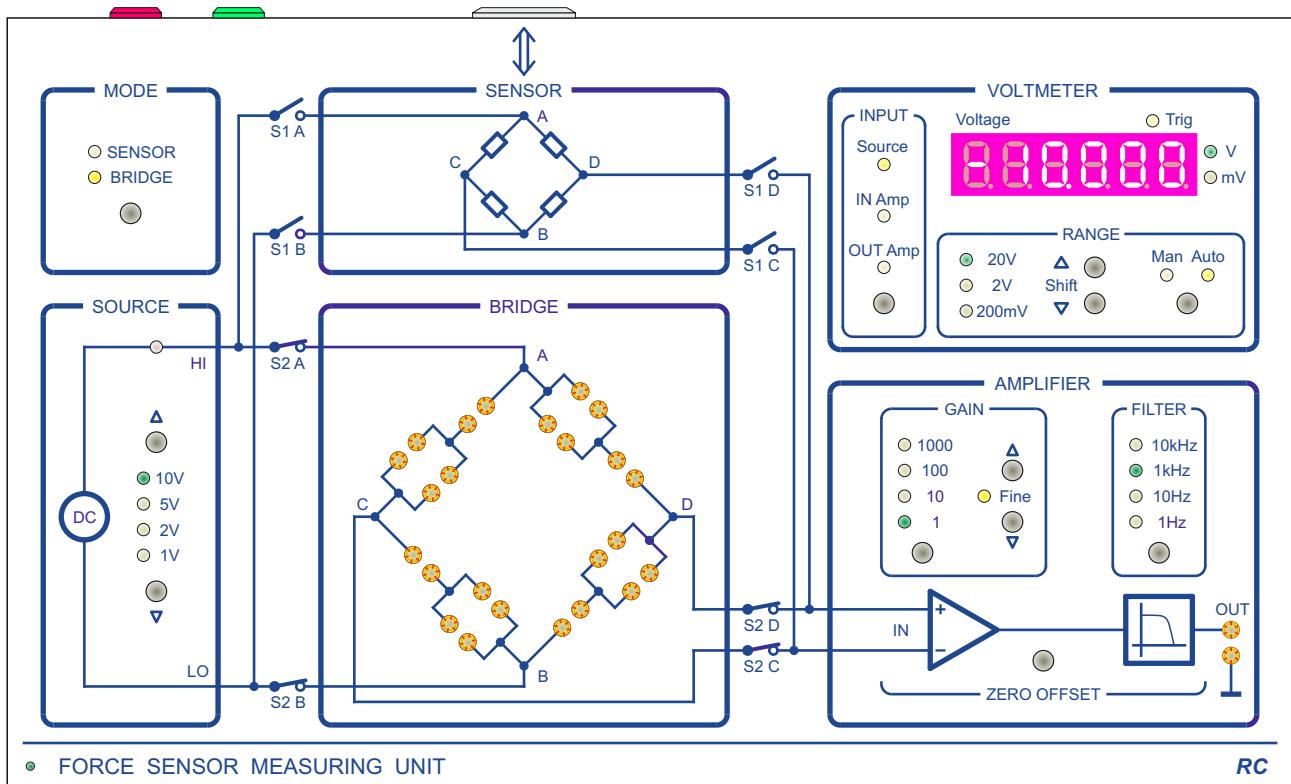
Instrument Modules

1.7

Force Sensor Measuring Unit

FSMU

Panel



Features

- The module allows to study the characteristics of the bridge sensors
- The module contains the basic parts: Source (SOURCE), Wheatston Bridge (BRIDGE), Amplifiers (AMPLIFIER) and voltmeter (VOLTMETER), which allow any mutual connection
- Processor-controlled source of four precise reference voltages
- Amplification setting in the range 1-1000 in ± 512 steps
- The source voltage, bridge output voltage and amplified voltage are displayed
- Floating voltage source output
- Negligible output resistance of the source
- Output protected by electronic fuse, overload is indicated by the red LED
- The connection field allows the connection of different bridge types
- Adjustable filter behind the amplifier to eliminate noise
- Dimensions 250 x 150 x 42 mm. Weight 560g

Supplied accessories

- Power cables (2 Pcs)
- Set of elements (1k Ω : 4 Pcs, 9k Ω : 2 Pcs, 19k Ω : 2 Pcs, 49k Ω : 2 Pcs, 99k Ω : 2 Pcs, 10 Ω : 2 Pcs, 20 Ω : 2 Pcs, 50 Ω : 2 Pcs, 100 Ω : 2 Pcs, 200 Ω : 2 Pcs, couplings: 4 Pcs)

Parameter

		Value		Precision (1)
		min	max	
Reference Source DC	U _{1V} (V)	1.000		± 500 μ V
	U _{2V} (V)	2.000		± 750 μ V
	U _{5V} (V)	5.000		± 1mV
	U _{10V} (V)	10.000		± 2mV
	I _{OUT} (mA)	-50	50	± 2mA
	R _{OUT} (Ω)	< 0,1		-
Amplifier	Amplification [V/V]	0,8	1200	± 1,0 %
	Steps of fine adjustment	1024		-
	Offset (μ V)	±200		-
	R _{OUT} (Ω)	< 0,1		-
	Filter (Hz)	1, 10, 1000, 10000		-
Voltmeter	Display	4,5 - digital		-
	Measuring Range	200 mV		± (0,05 % + 5 digit)
		2 V		± (0,04 % + 3 digit)
		20 V		
	R _{in} (Ω)	10 M		-

(1) Temperature range 15°C - 35°C. Warm-up time 15 min.

*Controls***1. FUNCTION BLOCKS**

MODE	External or internal Wheatstone bridge
SOURCE	Setting the voltage of the source
SENSOR	Connection of an external sensor
BRIDGE	Connection of the bridge
VOLTMETER	Setting the range and location of the voltage measurement
AMPLIFIER	Sets the gain and the filter characteristic for the voltage measurement

2. INITIAL CONDITIONS

After connecting the module to the power supply, these initial conditions are set:

SOURCE	1V	RANGE	Auto	GAIN	1.00
MODE	BRIDGE	INPUT	Source	FILTER	1Hz

Controls**3. CONTROL ELEMENTS**

SOURCE		Increases or decreases the voltage value
		Display of the set voltage
		Max. supply current exceeded > 50 mA
MODE		External sensor is active
		Block BRIDGE is active
VOLTMETER INPUT		Voltmeter displays source voltage
		Voltmeter displays the input voltage of the amplifier
		Voltmeter displays the output voltage of the amplifier
VOLTMETER VOLTAGE		Display the selected unit
		Flashes at sampling time
VOLTMETER RANGE		Display of the selected measuring range
		Switching of the measuring range
		Switches between manual and automatic selection of the range
AMPLIFIER GAIN		Display of the set amplification
AMPLIFIER FILTER		Display of selected filter
ZERO OFFSET		Automatically resets the amplifier input

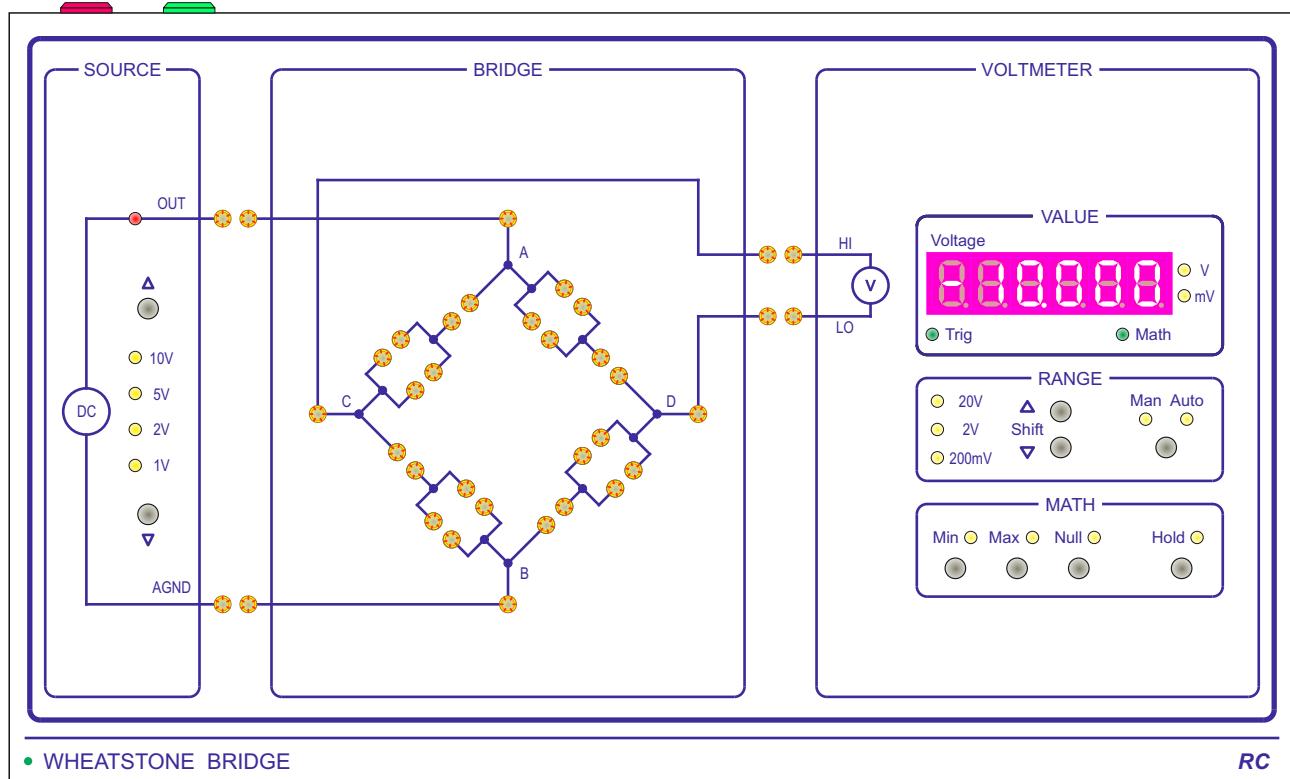
Instrument Modules

1.8

Wheatstone Bridge

WHBR

Panel



Features

- The module contains three basic parts: Source (SOURCE), Wheatston Bridge (BRIDGE), and Voltmeter (VOLTMETER), which allow any mutual connection
- Processor-controlled source for four precise reference voltages
- Potential-free voltage source output
- Negligible output resistance of the source
- Output protected by electronic fuse, overload is indicated by the red LED
- The circuit field allows the construction of different bridge types
- Dimensions 250 x 150 x 42 mm. Weight 570g

Supplied accessories

- Power cables (2 Pcs)
- Set of elements (1k Ω : 4 Pcs, 9k Ω : 2 Pcs, 19 k Ω : 2 Pcs, 50 k Ω : 2 Pcs, 100 k Ω : 2 Pcs, 10 Ω : 2 Pcs, 20 Ω : 2 Pcs, 50 Ω : 2 Pcs, 100 Ω : 2 Pcs, 200 Ω : 2 Pcs, coupling: 4 Pcs)

Parameter

		Value		Precision (1)
		min	max	
Reference Source DC	U_{1V} (V)	1.000		$\pm 500\mu V$
	U_{2V} (V)	2.000		$\pm 750\mu V$
	U_{5V} (V)	5.000		$\pm 1mV$
	U_{10V} (V)	10.000		$\pm 2mV$
	I_{OUT} (mA)	-50	50	$\pm 2mA$
	R_{OUT} (Ω)	< 0,1		-
Voltmeter	Display	4,5 - digital		-
	Measuring Range	200 mV		$\pm (0,05 \% + 5 \text{ digit})$
		2 V		$\pm (0,04 \% + 3 \text{ digit})$
		20 V		
	R_{in} (Ω)	10 M		-

(1) Temperature range 15°C - 35°C. Warm-up time 15 min.

*Controls***1. FUNCTION BLOCKS**

SOURCE	Setting the voltage of the source	
BRIDGE	Connection of the bridge	
VOLTMETER	VALUE	Display of the measured value
	RANGE	Setting the range
	MATH	Mathematical Functions and Function Hold

2. INITIAL CONDITIONS

After connecting the module to the power supply, these initial conditions are set:

SOURCE	1V	RANGE	Auto
--------	----	-------	------

Controls

3. CONTROL ELEMENTS

SOURCE		Increases or decreases the voltage value
		Display of the set voltage
		Max. supply current exceeded > 50 mA
VOLTMETER VALUE		Display the selected unit
		Flashes at sampling time
VOLTMETER RANGE		Display of the selected measuring range
		Switching of the measuring range
		Switches between manual and automatic selection of the range
VOLTMETER MATH		Display of the minimum measured value
		Display of the maximum measured value
		Selection of the zero value. The display refers to this value
		Freezes the current value on the display

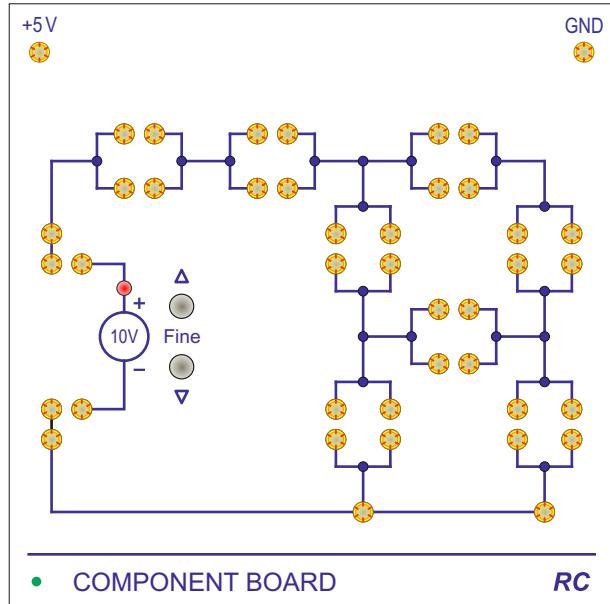
Active Components

2.1

Component Board

COBO

Panel



Features

- Universal board for building DC and AC circuits
- The distribution of the leads and sockets allows the parallel and serial combination of the components
- Reference source 10V DC with potential-free output
- Adjustment of the voltage in steps of 0.4 mV
- Output resistance of the source $R_{OUT} < 100\text{m}\Omega$ (ideal source)
- Output of the source is protected against overload with the electronic fuse
- Dimensions 100 x 100 x 42 mm. Weight 195g

Parameter

		Range		Precision (1)
		min	max	
Reference source 10V DC	U_{nenn} / V	10,000		$\pm 2 \text{ mV}$
	Voltage change range / mV	-12,5	+12,5	10%
	Step / mV	0,4		10%
	I_{MAX} / mA	22		$\pm 5\%$
	R_{OUT} / Ω	< 0,1		-

(1) Temperature range 15°C - 35°C. Warm-up time 15 min.

Description

1. INITIAL CONDITIONS

After connecting the module to the power supply, the output voltage of the 10V source is set to 10,000 V.

2. CONTROLS

Source 10V	Fine ▲ ○ ▼	Changes the voltage of the source by +/- 1 step, i.e. about 0,4 mV
	—●—	Overload, Current $I > 22 \text{ mA}$

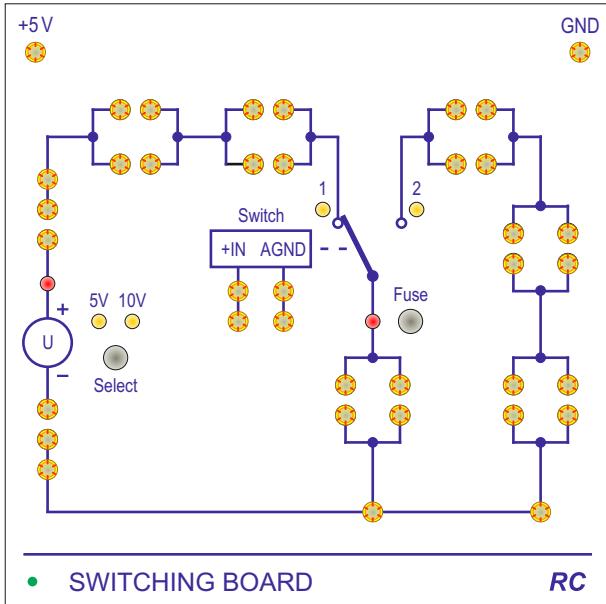
Active Components

2.2

Switching Board

SWBO

Panel



Features

- Universal board for building circuits with the switch
- Suitable for measuring switching operations with storage elements (L, C) and resistors R
- The distribution of the leads and sockets allows the parallel and serial combination of the components
- Reference source 5V, 10V DC with potential-free output
- Output resistance of the source $R_{OUT} < 100m\Omega$ (The source behaves as an ideal voltage source)
- Output of the source is protected against overload with the electronic fuse
- Dimensions 100 x 100 x 42 mm. Weight 195g

Parameter

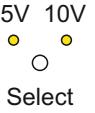
		Range		Precision (1)
		min	max	
Reference source 5V, 10V DC	U_{10V} / V	10,0		$\pm 2 \text{ mV}$
	U_{5V} / V	5,0		$\pm 1 \text{ mV}$
	I_{MAX} / mA	22		$\pm 5\%$
	R_{OUT} / Ω	< 0,1		-
Switch contact	Input level	TTL		-
	R_{on} / Ω	< 2,0		-
	$R_{off} / M\Omega$	> 200		-
	I_{OUT} / mA	± 250		$\pm 5\%$
	$t_{toggle} / \mu\text{s}$	< 1,0		-

(1) Temperature range 15°C - 35°C. Warm-up time 15 min.

Controls**1. INITIAL CONDITIONS**

After connecting the module to the supply, the output voltage of the source is set to 5V and the switch is in the "position" 1.

2. CONTROL ELEMENTS

Source 5V, 10V	5V 10V 	Selects the output voltage of the source
		LED lights when the source is overloaded with current > 22 mA
Switch		Indication of the position of the closed contact of the changeover switch
		LED lights - The circuit is opened if the load is overloaded with current > 250 mA
		Resetting the fuse to overload the switch

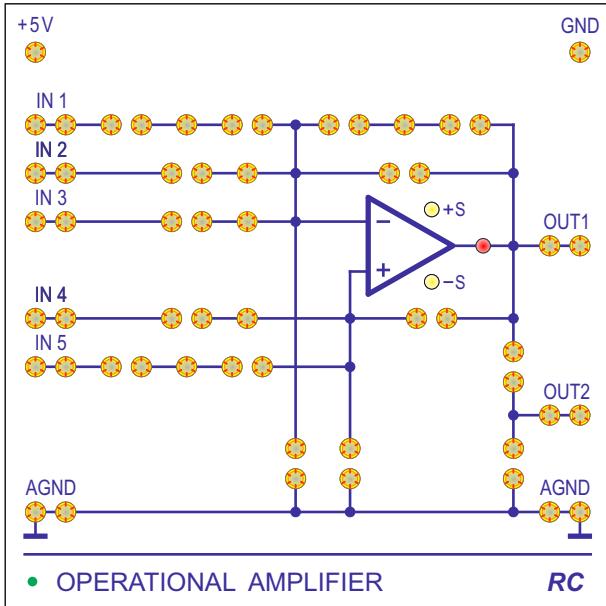
Active Components

2.3

Operational Amplifier

OPAM

Panel



Features

- Fast operational amplifier and circuit field
- The module allows the clear and descriptive construction of the basic circuits of the operational amplifier
- Operational amplifier (Type OPA 132)
- Output voltage ± 11 V (Load resistance $R_L = 500 \Omega$)
- Output current ± 22 mA
- FET inputs, low input current
- Low input voltage offset and CMRR > 100 dB
- Amplification of the open loop 130 dB
- Dimensions 100 x 100 x 42 mm. Weight 205g

Parameter

	Value		Precision (1)
	min	max	
Saturation voltage (V)	-11,0	11,0	± 5 %
I_{OUT} (mA)	-22	22	± 5 %
Input voltage Offset (μ V)	< 50		-
Input current (pA)	< 50		-
Amplification of the opened loop (dB)	130		-
CMRR (dB)	>100		-

(1) Temperature range 15°C - 35°C. Warm-up time 15 min.

Description

OPAM output	● +S ● -S	Positive, negative saturation of the output
	—●—	LED lights - Current overload (Current > 22 mA)

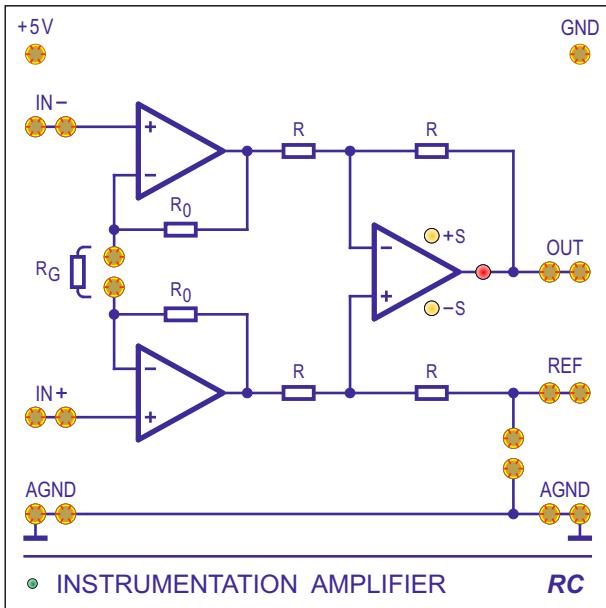
Active Components

2.4

Instrumentation Amplifier

INAM

Panel



Features

- Modul des Instrumentenverstärkers
- Provides an input for an external reference voltage
- Instrumentation amplifier INA 121
- Output voltage ± 11 V (Load $R_L = 2\text{k}\Omega$)
- Output current ± 6 mA
- Amplification $A = 1 + \frac{2R_o}{R_G}$
- FET inputs, low input current
- Low input voltage offset and CMRR > 80 dB
- Dimensions 100 x 100 x 42 mm. Weight 200g

Parameter

	Value		Precision	(1)
	min	max		
Saturation voltage (V)	-11,0	11,0	± 5 %	
I_{OUT} (mA)	-6	6	± 5 %	
Input voltage offset (mV)	< 1		-	
Output voltage offset (mV)	< 1		-	
Input current (pA)	< 50		-	
R_0 ($k\Omega$)	25		$\pm 0,1$ %	
R ($k\Omega$)	40		$\pm 0,1$ %	
Amplification (-)	1	10 000	$\pm 0,1$ %	$\pm 0,5$ %
CMRR (dB)	80	106		-

(1) Temperature range 15°C - 35°C. Warm-up time 15 min.

Description

Output OPA	● +S ● -S	Positive, negative saturation of the output
	—●—	LED lights - current overload (Output current > 6 mA)

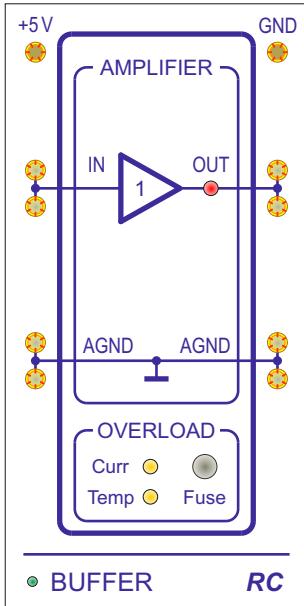
Active Components

2.5

Buffer

BUFF

Panel



Features

- Module of the power amplifier with amplification $A = 1$
- Suitable for feeding the transformer and for measuring the U-I characteristics of some components, etc.
- Output resistance $R_{OUT} < 0,1 \Omega$
- Module output current up to 220 mA. Indication of overload and decoupling of the output
- Module protected against thermal overload with indication and decoupling of the output
- Dimensions 50 x 100 x 42 mm. Weight 160g

Parameter

	Range		Precision (1)
	min	max	
Amplification (-)	1		$\pm 0,5 \%$
Offset (mV)	± 10		-
Frequency range (kHz)	0	10	-
Output voltage (V)	- 12	12	-
$R_{IN} (\Omega)$	100 k		$\pm 1 \%$
$R_{OUT} (\Omega)$	< 0,1		-
I_{OUT} (mA)	- 220	220	$\pm 5 \%$

(1) Temperature range 15°C - 35°C.

Controls

AMPLIFIER	— ● —	LED lights, output decoupled by overload
OVERLOAD	● Curr	Current overload, output current $> \pm 220$ mA
	● Temp	Temperature overload of the amplifier
	○ Fuse	Restart of the overload protection

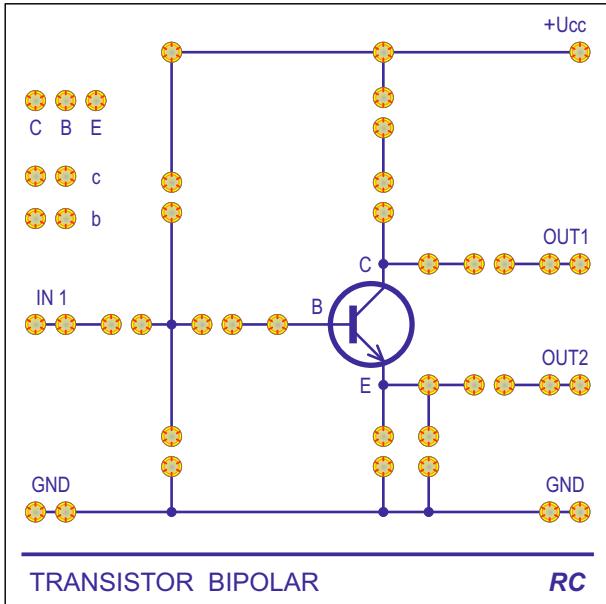
Active Components

2.6

Transistor Bipolar NPN

TRBN

Panel



Features

- Circuit field for bipolar transistor NPN
- The module allows the basic circuits of the transistor to be constructed in a clear and descriptive way
- Type BC 546 or similar one
- Transistor is inserted as an independent component on a 3-pin connector. Easy change of the transistor type
- Transistor protection (possibility of bridging):
 - Crossing BE: $R_B = 200 \Omega$ Bridging b
 - Collector: $R_C = 120 \Omega$ Bridging c
- The bridging of the protective resistor is used for example for transistor characteristic measurements
- Dimensions 100 x 100 x 42 mm. Weight 175g

Parameter

1. Module

	Value		Precision
	min	max	
Protection $R_B (\Omega)$ (1)	200		-
Protection $R_C (\Omega)$ (2)	120		-
Voltage $+U_{cc}$ (V)	-	15	-

- (1) Bridging the socket b turns off the protection
- (2) Bridging the socket c turns off the protection

2. Transistor BC 546

	Value		Precision
	min	max	
Amplification factor β (-)	120	220	- (1)
I_C (mA)	-	100	-
Threshold voltage (V)	< 0,6		- (2)

- (1) For $U_{CE} = 5$ V, $I_C = 2$ mA.
- (2) For $I_C = 100$ mA, $I_B = 5$ mA.

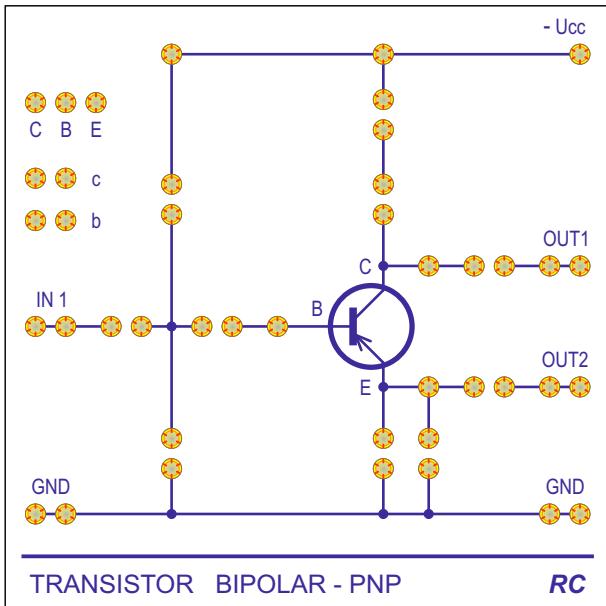
Active Components

2.7

Transistor Bipolar PNP

TRBP

Panel



Features

- Circuit field for bipolar transistor PNP
- The module allows the basic circuits of the transistor to be constructed in a clear and descriptive way
- Type BC 556 or similar one
- Transistor is inserted as an independent component on a 3-pin connector. Easy change of the transistor type
- Transistor protection (possibility of bridging):

Crossing BE:	$R_B = 200 \Omega$	Bridging <i>b</i>
Collector:	$R_C = 120 \Omega$	Bridging <i>c</i>
- The bridging of the protective resistor is used for example for transistor characteristic measurements
- Abmessungen 100 x 100 x 42 mm. Gewicht 170g

Parameter

1. Module

	Value		Precision
	min	max	
Protection $R_B (\Omega)$ (1)	200		-
Protection $R_C (\Omega)$ (2)	120		-
Voltage $+U_{cc}$ (V)	-	15	-

- (1) Bridging the socket *b* turns off the protection
- (2) Bridging the socket *c* turns off the protection

2. Transistor BC 556

	Value		Precision
	min	max	
Amplification factor β (-)	120	220	- (1)
I_C (mA)	-	100	-
Threshold voltage (V)	< 0,6		- (2)

- (1) For $U_{CE} = - 5$ V, $I_C = - 2$ mA.
- (2) For $I_C = - 100$ mA, $I_B = - 5$ mA.

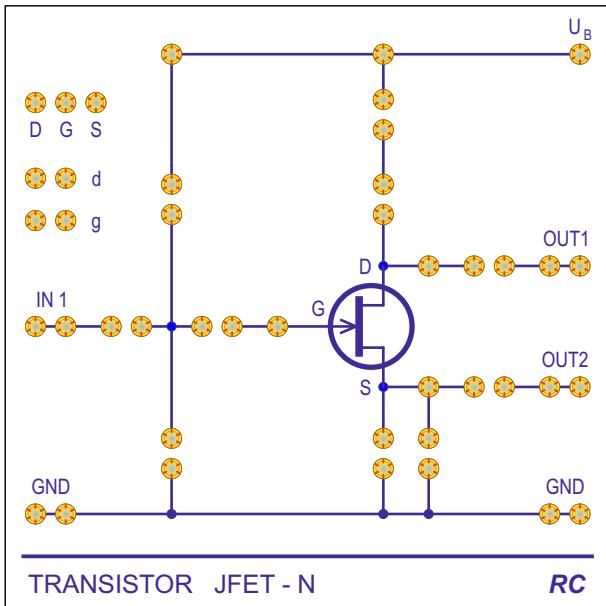
Active Components

2.8

Transistor Unipolar JFET - N

TRJN

Panel



Features

- Circuit field for unipolar transistor JFET - N
- The module allows the basic circuits of the transistor to be constructed in a clear and descriptive way
- Type BF 245 or similar one
- Transistor is inserted as an independent component on a 3-pin connector. Easy change of the transistor type
- Transistor protection (possibility of bridging):

Gate:	$R_g = 1 \text{ k}\Omega$	Bridging g
Channel:	$R_d = 120 \Omega$	Bridging d
- The bridging of the protective resistor is used for example for transistor characteristic measurements
- Dimensions 100 x 100 x 42 mm. Weight 175g

Parameter

1. Module

	Value		Precision
	min	max	
Protection R_g (Ω) (1)	1k		-
Protection R_d (Ω) (2)	120		-
Voltage $+U_{cc}$ (V)	-	15	-

(1) Bridging the socket g turns off the protection

(2) Bridging the socket d turns off the protection

2. Transistor BF 245

	Value		Precision
	min	max	
y_{21s} (mS)	3,0	6,5	- (1)
I_{DS} (mA)	-	25	-
Threshold voltage $U_{GS(off)}$ (V)	- 8,0	- 0,5	- (2)

(1) For $U_{DS} = 15$ V, $U_{GS} = 0$ V, $f = 1$ kHz.

(2) For $U_{DS} = 15$ V, $I_D = 10$ nA.

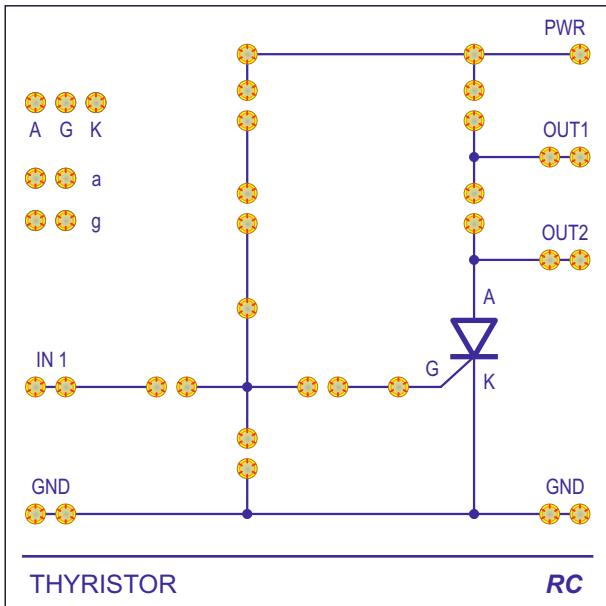
Active Components

2.9

Thyristor

THYR

Panel



Features

- Circuit field for thyristor
- The module allows the basic circuits of the thyristor to be constructed in a clear and descriptive way
- Designed for type 2N5060 or similar
- Thyristor is inserted as an independent component on a 3-pin connector. Easy change of the type
- Protection of the thyristor (possibility of bridging):

Anode:	$R_A = 20\Omega$	Bridging a
Gate:	$R_G = 1\text{k}\Omega$	Bridging g
- Bridging the protective resistor is used for example in the measurement of the U-I characteristics of the thyristor
- Dimensions 100 x 100 x 42 mm. Weight 170g

Parameter

1. Module

	Value		Precision
	min	max	
Protection R_A (Ω) (1)	20		-
Protection R_G ($\text{k}\Omega$) (2)	1		-
Voltage $+U_{cc}$ (V)	-	15	-

- (1) Bridging the socket a turns off the protection
 (2) Bridging the socket g turns off the protection

2. Thyristor 2N5060

	Value (1)		Precision
	min	max	
Anode current (mA)	-	800	-
Holding current (mA)	5		-
Switching current (mA)	0,2		-
Switching voltage U_{GK} (V)	0,8		-
Breakdown voltage U_{AK} (V)	30		-

- (1) Temperature 25 °C.

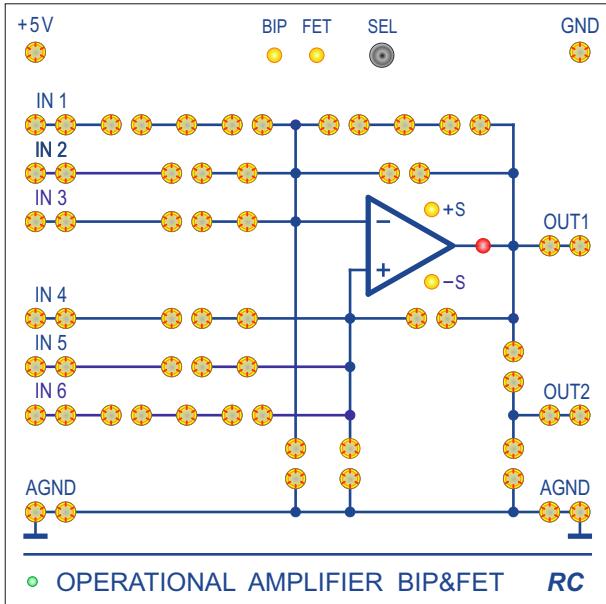
Active Components

2.10

Operational Amplifier BIP&FET

OABF

Panel



Features

- Fast operational amplifier and circuit field
- The module allows the clear and descriptive construction of the basic circuits of the operational amplifier
- Bipolar operational amplifier OPA27
- Unipolar operational amplifier OPA132
- Output voltage ± 11 V (load $R_L = 500 \Omega$)
- Output current ± 22 mA
- Inputs in bipolar or FET technology, low input current
- Low input voltage offset and CMRR > 100 dB
- Open-loop amplification 115 dB
- Dimensions 100 x 100 x 42 mm. Weight 210g

Parameter

	Value		Precision (1)
	min	max	
Saturation voltage (V)	-11,0	11,0	$\pm 5\%$
I_{OUT} (mA)	-22	22	$\pm 5\%$
Input voltage offset (μ V)- OPA27	< 100		-
Input voltage offset (mV)- OPA132	< 5,0		-
Input current (nA) - OPA27	< 100		-
Input current (pA) - OPA132	< 50		-
Open-Loop Amplification (dB)	> 115		-
CMRR (dB)	> 100		-

(1) Temperature range 15°C - 35°C. Warm-up time 15 min.

Controls

Output OA	• +S • -S	Positive, negative saturation of the OA output
	—●—	Current overload, output current over ± 22 mA
Setting OA	• BIP • FET	Display of the active operational amplifier
	○ SEL	Switching of the operational amplifier type

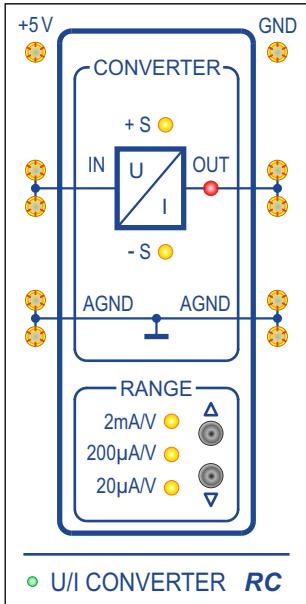
Aktive Module

2.11

U/I Converter

UIMO

Panel



Features

- Precise voltage-to-current converter for three ranges
- Advantageous for measuring the U / I characteristics of components
- Input resistance $R_{IN} > 10 \text{ G}\Omega$
- Output current in range 0.2 μA to 22 mA
- Monitoring the range limits of input and output
- Dimensions 50 x 100 x 42 mm. Weight 160g

Parameter

	Value		Precision (1)
	min	max	
Conversion	20, 200, 2000		$\pm 1 \%$
Offset (V)	0		$\pm 10 \text{ mV}$
Frequency range (Hz)	0	10 k	-
Output voltage (V)	- 11	11	$\pm 5 \%$
$R_{IN} (\Omega)$	>10G		-
$R_{OUT} (\Omega)$	100		$\pm 1 \%$
$I_{OUT} (\text{mA})$	- 22	22	$\pm 5 \%$

(1) Temperature range 15°C - 35°C.

Controls

OVERLOAD	—●—	The current is outside the permissible range
	● +S	Exceeding the positive current limit
	● -S	Exceeding the negative current limit
RANGE	△○ ▽○	Switching the converter constant 20-200-2000 $\mu\text{A/V}$

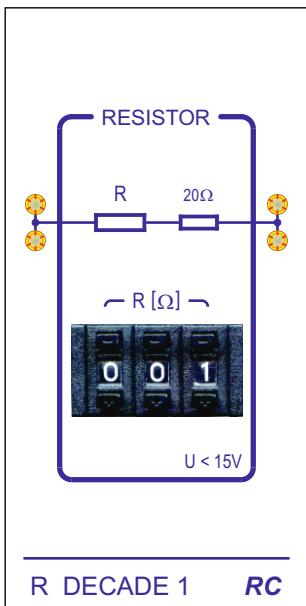
Passive modules

3.1

Resistor Decade 1 (20-1019 Ohm)

R1DE

Panel



Features

- Precise resistor decade with choice of value by switch
- Range: 20Ω - 1019Ω, Step: 1Ω
- Protection with audible alarm:
 - when the voltage 15 V is exceeded
 - when the current 250 mA is exceeded
- Precision (Temperature 15°C - 35°C):

$R < 50\Omega$	1,0 %
$R < 100\Omega$	0,5 %
$R \geq 100\Omega$	0,1 %
- Temperature coefficient 25 ppm/°C
- Dimensions 50 x 100 x 42 mm. Weight 120g

Parameter

	Value		Precision (1)
	min	max	
Range R (Ω)	20	1019	± 1,0 / 0,5 / 0,1 % (2)
Step (Ω)		1	-
Temperature coefficient (ppm/°C)		25	-
U _{MAX} (V)		15	-
I _{MAX} (mA)		250 mA	-

(1) Temperature range 15°C - 35°C.

(2) Precision for values $R < 50\Omega$ / $50 \leq R < 100$ / $R \geq 100\Omega$.

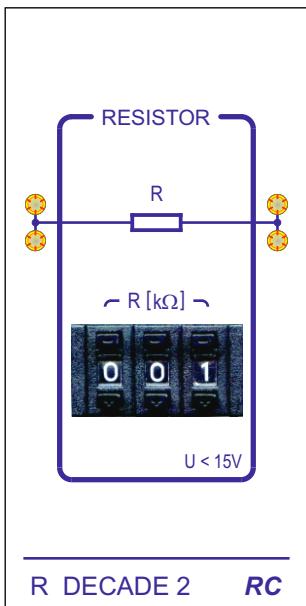
Passive Components

3.2

Resistor Decade 2 (1-999 kOhm)

R2DE

Panel



Features

- Precise resistor decade with choice of value by switch
- Range: 1 kΩ - 999 kΩ, Step: 1 kΩ
- Protection with audible alarm:
 - when the voltage 15 V is exceeded
 - when the current 250 mA is exceeded
- Precision: 0,1 %
(Temperature 15°C - 35°C)
- Temperature coefficient 25 ppm/°C
- Dimensions 50 x 100 x 42 mm. Weight 120g

Parameter

	Value		Precision (1)
	min	max	
Range R (Ω)	1 k	999 k	± 0,1 %
Step (Ω)	1 k		-
Temperature coefficient (ppm/°C)	25		-
U _{MAX} (V)	15		-
I _{MAX} (mA)	250 mA		-

(1) Temperature range 15°C - 35°C.

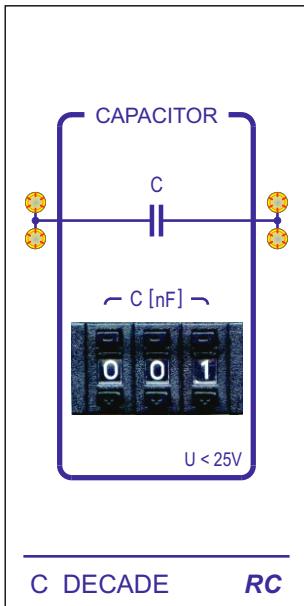
Passive Components

3.3

Capacitor Decade

CDEC

Panel



Features

- Precise capacitor decade with choice of value by switch
- Range: 1 nF - 999 nF, Step: 1 nF
- High quality polypropylene capacitors
- Precision: 0,8 %
(Temperature 15°C - 35°C)
- Temperature coefficient <200 ppm/°C
- Maximum voltage 25 V
- Dimensions 50 x 100 x 42 mm. Weight 120g

Parameter

	Value		Precision (1)
	min	max	
Range C (nF)	1	999	± 0,8 %
Step (nF)		1	-
Temperature coefficient (ppm/°C)		< 200	-
U _{MAX} (V)		25	-

(1) Temperature range 15°C - 35°C.

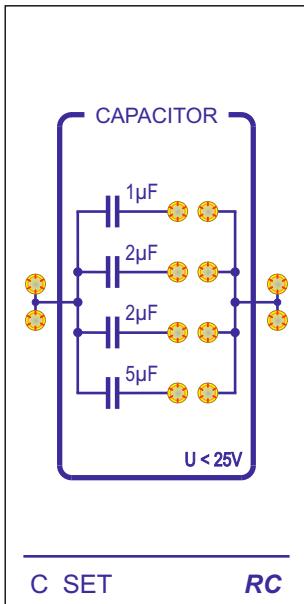
Passive Components

3.4

Capacitor Set

CSET

Panel



Features

- Capacitor set with values 1 μF , 2 μF (2x), 5 μF with the choice of parallel connection to the output clips
- High quality propylene capacitors
- Precision: 0,8 % (Temperature 15°C - 35°C)
- Temperature coefficient < 200 ppm/°C
- Maximum voltage 25 V
- Dimensions 50 x 100 x 42 mm. Weight 120g

Parameter

	Value		Precision (1)
	min	max	
Range C (μF)	1	10	-
Step C (μF)		1	-
Capacity of individual capacitors (μF)	1,0		± 0,8 %
	2,0		± 0,8 %
	5,0		± 0,8 %
Temperature coefficient (ppm/°C)	< 200		-
U _{MAX} (V)	25		-

(1) Temperature range 15°C - 35°C.

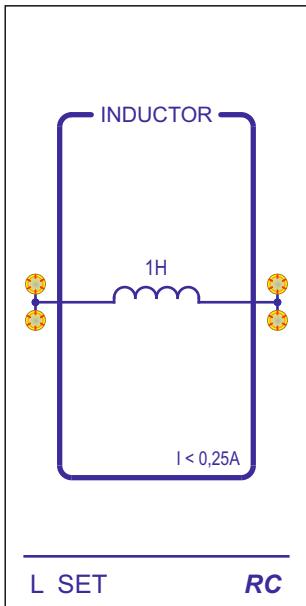
Passive Components

3.5

Inductor

LSET

Panel



L SET

RC

Features

- Module of the precise inductance
- Value: 1 H
- If interested, we can also supply the values 100 mH, 200 mH, 500 mH, 2H.
(Parameter valid for the value 1 H)
- Precision: 0,8 %
(10 Hz - 10 kHz, 15°C - 35°C)
- Coil resistance $r_L \sim 35 \Omega$
- Ferrite core
- Protection against direct current overload with acoustic alarm
- Maximum current 0,25 A
- Dimensions 50 x 100 x 42 mm. Weight 215g

Parameter

	Value		Precision (1)	
	min	max		
Inductance (H)	1		$\pm 0,8 \%$	(2)
Coil resistance (Ω)	35		-	
I_{MAX} (A)	0,25		-	

(1) Temperature range 15°C - 35°C.

(2) Frequency range 10 Hz - 10 kHz.

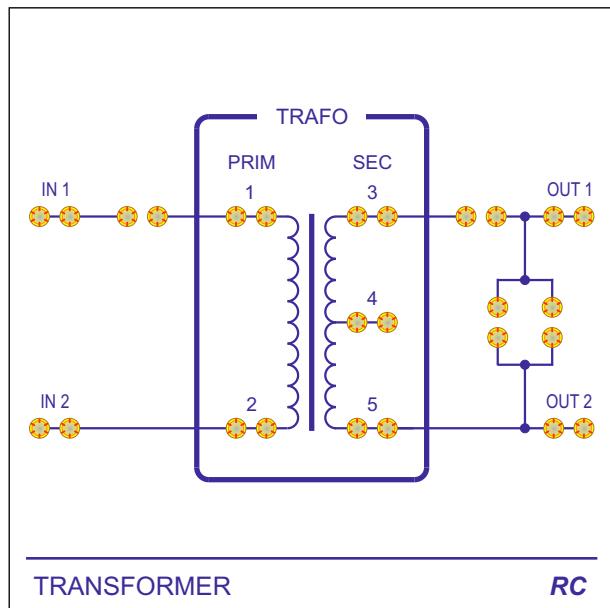
Passive Components

3.6

Transformer

TRFO

Panel



Features

- Transformer module with protection system

- Ratio of coil: 1: 1

- Tapping at half of the secondary winding

- Transformer parameters:

Primary coil number 170

Secondary coil number: 2x 85

Core: Sheets M111-35N

Coil resistance $R_{12} = R_{35} = 5\Omega$

- Protection against current and voltage overload

- Maximum current 0,25 A, maximum voltage 10 V

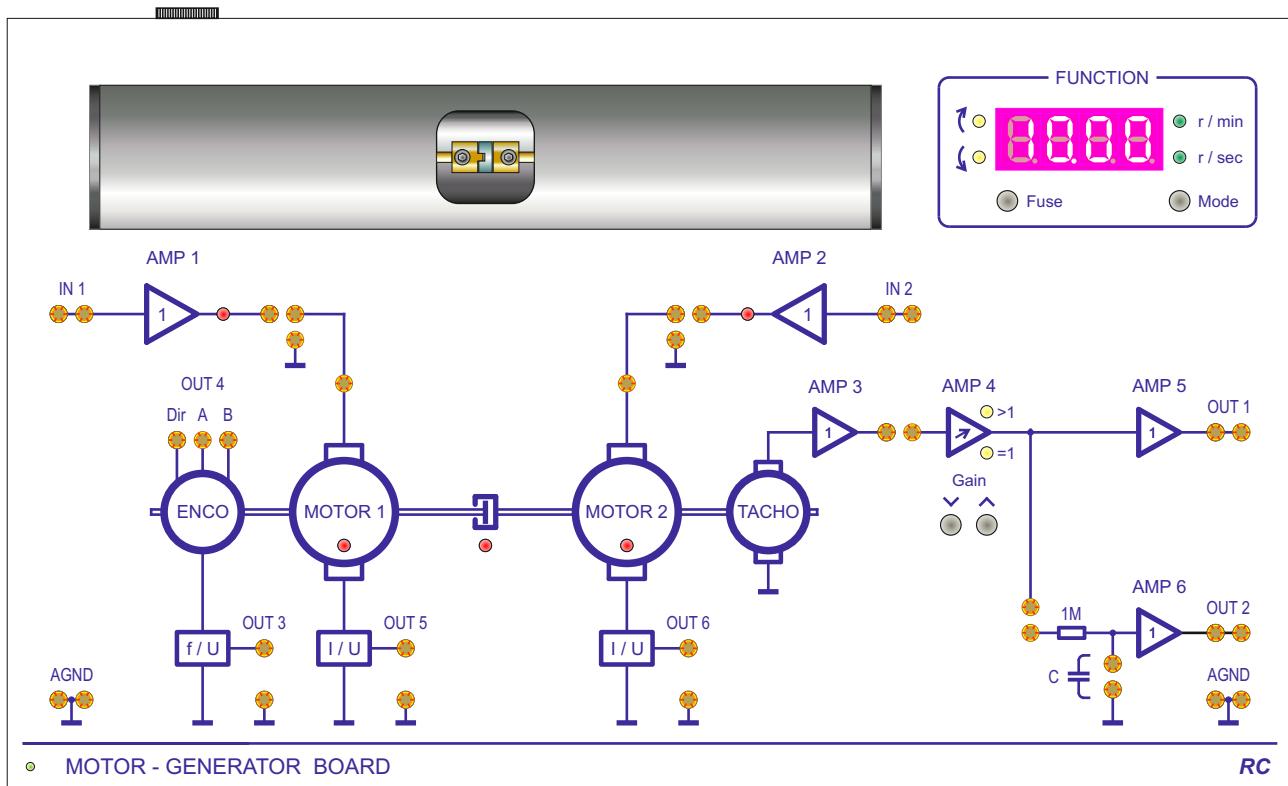
- Dimensions 100 x 100 x 42 mm. Weight 170g

Parameter

		Value		Precision (1)
		min	max	
Primary coil	Coil number	170		-
	R_{12} (Ω)	5		$\pm 20\%$
	U_{MAX} (V)	10		-
	I_{MAX} (A)	0,25		-
Secondary coil	Coil number 3-4 4-5	85		-
		85		-
	R_{34} (Ω)	2,5		$\pm 20\%$
	R_{45} (Ω)	2,5		$\pm 20\%$
	U_{MAX} (V)	10		-
	I_{MAX} (A)	0,25		-
Core	Core material	sheets M111-35N		
	Permeability (mH/m)	-	5,0	-
	Cross-section (mm^2)	100		
	Middle field line (mm)	65		

(1) Temperature 25°C.

Panel



Features

- Controlled system with two DC motors
- Ironless high-tech motors that have low friction and low starting voltage as well as high efficiency and good thermal characteristics
- A very accurate OLDHAM coupling ensures the perfect connection of the two motors
- Motor M1 is connected to the incremental encoder ENCO, whose output also leads to a frequency / voltage converter. Motor M2 is connected with the linear tachodynamo TACHO with very small moment of inertia
- The evaluation of the tachodynamos can be done in two ways:
 - a) via isolation amplifier AMP 3
 - b) via a variable-gain filter AMP 4, which allows the normalization of characteristic curves
- Both motors are controlled by precise operational amplifiers AMP 1 and AMP 2, which are protected against overload
- The independent control of the motor M2 allows any load on the motor M1
- Speedblock (FUNCTION) indicates the motor speed in two ways - RPM or RPS. LED diodes indicate the direction of rotation. The display also shows the error messages (see table Error Diagnostics)
- In addition to a broad application in control technology, the module also allows the measurement of the characteristics of small DC motors
- Dimensions 250 x 150 x 42 mm. Weight 880g

Supplied accessories

- Two long measuring probes (2pcs)

Parameter

		Value		Precision (1)
		min	max	
Motor 1	Type	DC ironless		
	Rated power (W)	4,05		-
	Voltage (V)	0,2 (2)	12,0	-
	Revolutions(r/min)	-	7 800	-
	I _{DURATION POWER} (A)	-	0,52	-
	Diameter (mm)	22,0		± 0,1
	Weight (g)	46		-
Motor 2	Type	DC ironless		
	Rated power (W)	3,69		-
	Voltage (V)	0,2 (2)	12,0	-
	Revolutions (r/min)	-	8 200	-
	I _{DURATION POWER} (A)	-	0,43	-
	Diameter (mm)	22,0		± 0,1
	Weight (g)	61		-
Motor-Generator Set	Power (W)	-	3,5	-
	Revolutions (r/min)	-	5 000	-
	Time constant (ms)	16		± 2
	Starting voltage (V)	0,5		-
Revolutions-sensor	Constant (n/r)	512		-
	Digital outputs	A, B, DIR (Alles TTL)		-
Converter f/U	Constant	1 V/1000r/min		± 2,0 %
	R _{OUT} (Ω)	< 0,1		-
Tachodynamo	Constant	1 V/1000r/min		± 2,0 %
	R _{OUT} (Ω)	< 0,1 (3)		-
Amplifier AMP 4	Amplification (-)	1,00	2,12	± 1 %
	Step (-)	0,01		± 20 %
	R _{OUT} (Ω)	< 0,1		-
Converter I/U	Constant	5 mV/mA		± 2,0 %
	R _{OUT} (Ω)	< 0,1		-

(1) Temperature range 15°C - 35°C. Warm-up time 15 min

(2) Starting voltage of the motor

(3) Output resistance of the AMP3 amplifier

*Controls***1. FUNCTION BLOCKS**

FUNCTION	Display of the speed, restart interlock
AMP 1, 2	Driver of the first or second motor
MOTOR 1, 2	Ironless DC motors
I/U	Converter of the current in the winding voltage
ENCO	Speed sensor
f/U	The frequency / voltage converter of the pulses of the speed sensor
TACHO	Tachodynamo with a small moment of inertia
AMP 3	Signal follower of output of tachodynamo
AMP 4	Amplifier for normalization of the transient response
AMP 5	Isolation amplifier of the output AMP 4
AMP 6	A filter enables the processing of the signal of the tachodynamo

2. INITIAL CONDITIONS

After connecting the module to the power supply, the speed is displayed in rpm and the amplification of AMP 4 is set to 1.65.

3. CONTROLS

FUNCTION	↑ ●	Display of the direction of rotation of the controlled system
	↓ ●	
	● r / min	Display of the unit of presentation
	● r / sec	
	○ Mode	Switching the unit of the presentation, switching off the display
	○ Fuse	Restart of all fuses in module
AMP 1, 2	—●—	Temperature overload of the amplifier, output switched off
MOTOR 1, 2	● MOTOR	Motor switched off due to voltage or power overload
	—■— ●	Motor switched off by exceeding the speed
AMP 4	● >1	Amplification AMP 4 is greater than 1
	● =1	Amplification AMP 4 is equal to 1
	Gain ▼ ▲ ○ ○	Gradually changing the amplification of AMP 4

*Controls***4. ERROR DIAGNOSTICS**

E-01	MOTOR 1	Load > 3,5 W
E-02	MOTOR 1	Voltage on the motor > 14 V
E-03	AMP 1	Temperature overload
E-04	Coupling	Revolutions > 4000 r/min
E-05	MOTOR 2	Load > 3,5 W
E-06	MOTOR 2	Voltage on the motor > 14 V
E-07	AMP 2	Temperature overload
E-08	Supply	Positive supply voltage < 14 V
E-09	Supply	Negative supply voltage > -14 V

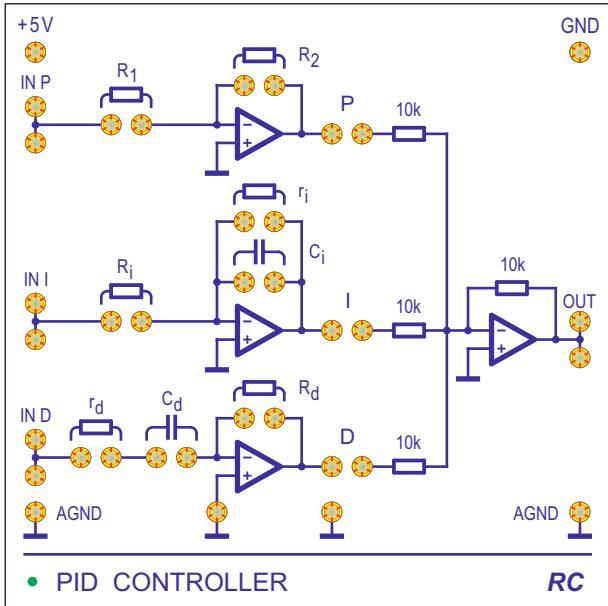
Control Modules

4.2

PID Controller

RPID

Panel



Features

- Regulators P, I and D
- Three - channel adder, each with amplification 1
- Possibility of the parallel and cascade arrangement of the cells
- Independent setting of parameters of the individual links (amplification and time constant)
- Max / min values of the output voltage ± 12 V
- Outputs of the cells and the adder are short-circuit-proof
- Dimensions 100 x 100 x 42 mm. Weight 175g

Parameter

		Value		Precision (1)
		min	max	
P, I, D elements	Offset (mV)		0	$\pm 1,0$
	I _{OUT} (mA)	-22	22	-
	R _{OUT} (Ω)	< 0,1		-
Adder	Offset (mV)		0	$\pm 1,0$
	Amplification (-)		1	$\pm 0,2 \%$
	U _{OUT} (V)	-12,0	12,0	-
	I _{OUT} (mA)	-22	22	-
	R _{OUT} (Ω)	< 0,1		-

(1) Temperature range 15°C - 35°C. Warm-up time 15 min.

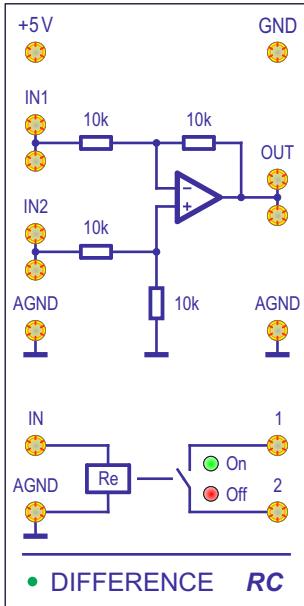
Control Modules

4.3

Difference Module

RDIF

Panel



Features

- Differential amplifier for obtaining control deviation
- Separate ground of the amplifier
- Output voltage range greater than ± 13 V
- The output of the amplifier is short-circuit proof
- Relay with the switching contact, used e.g. for setting the initial conditions of the I-link in the PID controller
- TTL input of the relay
- The output of the relay is protected against current load
- Dimensions 50 x 100 x 42 mm. Weight 110g

Parameter

		Value		Precision (1)
		min	max	
Differential element		Offset (mV)		± 1,0
		Amplification (-)		± 0,2 %
		U _{OUT} (V)		-1
		I _{OUT} (mA)		13
		R _{OUT} (Ω)		< 0,1
Relay		U _{IN} (V)		TTL
		I _{MAX} (A)		0,5
		R _{OUT} (Ω)		< 5

(1) Temperature range 15°C - 35°C. Warm-up time 15 min.

Controls

Relay	● On	LED is lit - contact is closed
	● Off	LED is lit - contact is opened

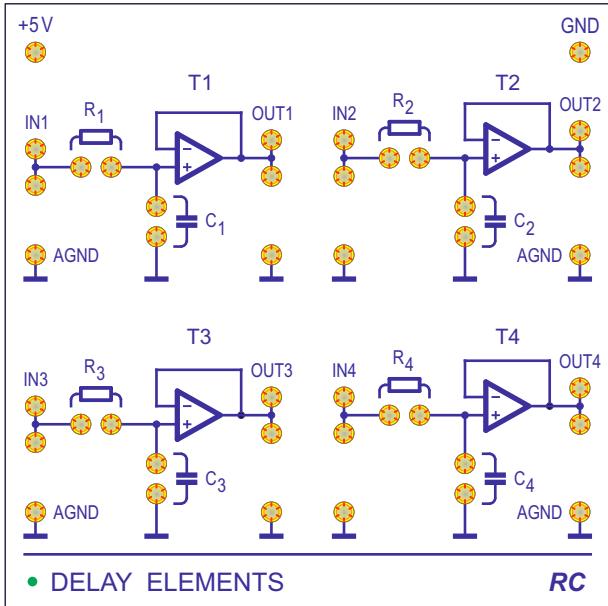
Control Modules

4.4

Delay Elements

RDEL

Panel



Features

- Four independent elements of the first order
- The individual elements are decoupled by amplifiers in order to prevent mutual interference
- Possibility of parallel and series connection of individual elements
- Independent setting of the time constants of the individual elements
- Max / min values of the output voltage ± 13 V
- Outputs of the elements are short-circuit proof
- Dimensions 100 x 100 x 42 mm. Weight 175g

Parameter

	Value		Precision (1)
	min	max	
Offset (mV)	0		$\pm 1,0$
U_{OUT} (V)	-13	13	-
I_{OUT} (mA)	-22	22	-
R_{OUT} (Ω)	< 0,1		-

(1) Temperature range 15°C - 35°C. Warm-up time 15 min.

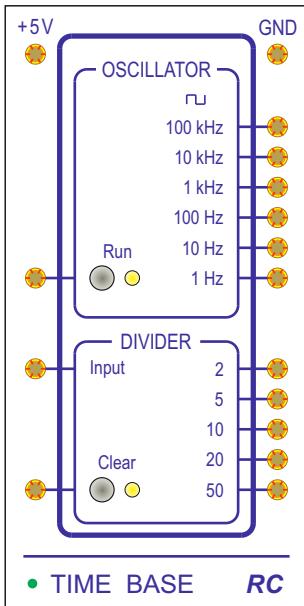
Digital Modules

5.1

Time Base

TIBA

Panel



Features

- Crystal oscillator and frequency divider
- TTL level
- Frequency range 1 Hz - 100 kHz
6 divider - outputs in logarithmic graduation
- Function Start (key or TTL input RUN)
- Frequency divider as an independent part of the module
- Dividing ratios (5 separate outputs):
2, 5, 10, 20, 50
- Technology HCT – Fan-Out > 10
- Dimensions 50 x 100 x 42 mm. Weight 110g

Controls

1. FUNCTION BLOCKS

OSCILLATOR	Oscillator with 6 outputs
DIVIDER	Divider with 5 continuous partial ratios

2. INITIAL CONDITIONS

After connecting the module to the supply, the oscillator is stopped and the outputs are set to logic zero.

3. CONTROL ELEMENTS

OSCILLATOR	○ ●	Run	Starts and stops the oscillator
			Indication of the oscillator's run
DIVIDER	○ ●	Clear	Restart of the counter in divider, pulse counting starts again from 0
			Indication that the restart of the divider is necessary

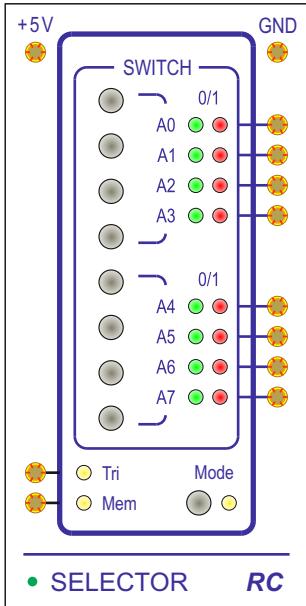
Digital Modules

5.2

Logic Selector

LOSE

Panel



Features

- Eight-channel selector of logic level TTL
- Protected outputs
- Button selection of the logic levels with debouncing
- Display of the logic level by LED
- Two modes of control - switch and switch-over mode
- Input Mem - simultaneous "freezing" of the logic levels on the selector output with the possibility of setting new logic levels
- Input TRI - selector outputs in tristate output (state of high impedance) - Possibility of switching to µP bus
- Technology HCT – Fan-Out > 10
- Dimensions 50 x 100 x 42 mm. Weight 115g

Controls

1. FUNCTION BLOCKS

SWITCH	Keys of control of outputs with indication of the logical state
MAIN BLOCK	Control inputs, change of the buttons mode

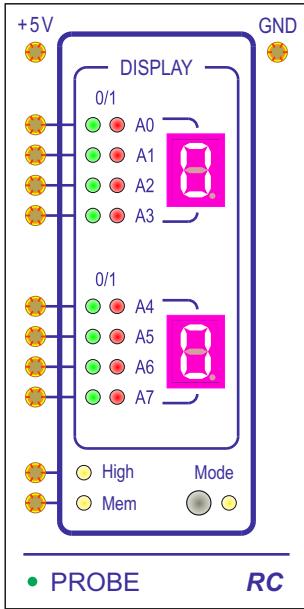
2. INITIAL CONDITIONS

After connection of the module to the supply, the keys operate in the switching mode and outputs are set to logic zero.

3. CONTROL ELEMENTS

SWITCH	○ A0 - A7	Switches the output level - when the switching mode is active only for a time when the key is pressed
	0/1 ● ●	Indication of the selected state of the relevant digital output
MAIN BLOCK	○	Switching between switch and switch-over mode
	● Mode	Switch mode is active
	○ Tri	Outputs are "tristate" (high impedance)
	○ Mem	Outputs keep their states independent of the state selected by the keys. Selected values are not changed until the input Mem to logic 0 or in Tristate

Panel



Features

- Eight-channel logical tristate probe TTL
- LED does not light up: Tristate or input not switched on
- Display of the logic levels
binary (green and red LED)
hexadecimal seven-segment display
- Two modes of the display
Tristate: not shown
Bisters: Tristate is considered as a log. 0
- Input High: Inputs of the probe are internally set to log. 1
- Input Mem: allows storage of the current state
- Technology HCT – Fan-Out > 10
- Dimensions 50 x 100 x 42 mm. Weight 110g

Controls

1. FUNCTION BLOCKS

DISPLAY	Display of measured state, binary and hexadecimal
Main block	Control inputs, switching of the display mode

2. INITIAL CONDITIONS

After connection of the module to the supply the display is in the tristate mode

3. CONTROL ELEMENTS

DISPLAY	0/1 ● ●	Displays the state of the relevant digital input. With Tristate, none of the LEDs is lit.
Main block	○	Switch between tristate and bistate display
	●	Bistate mode: tristate is considered logical 0
	● High	Inputs are internally on log. 1
	● Mem	The values shown correspond to the moment of the last positive edge of the input Mem

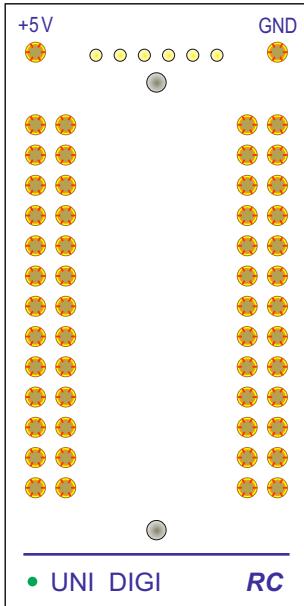
Digital Modules

5.4

Universal Module 74xxx

UNDI

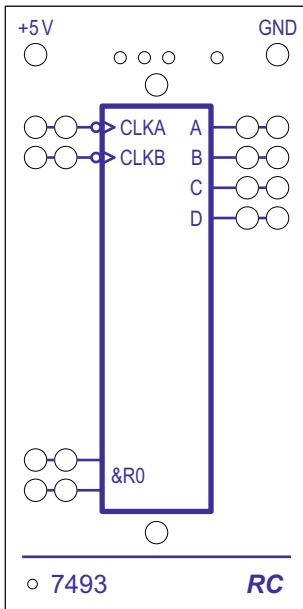
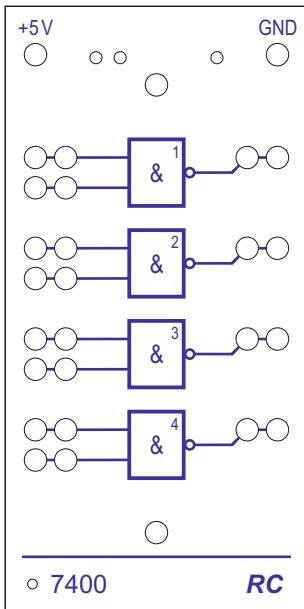
Panel



Features

- Universal module for digital technics - 74-series
- Realizes 24 different circuits of the 74 series
- Selection of the circuit by magnetic code on the replacement board with the respective schematic diagram
- Protected inputs TTL (up to 13)
- Protected outputs TTL (up to 13)
- Technology HCT – Fan-Out > 10
- 2 sockets each for all inputs and outputs
- Dimensions 50 x 100 x 42 mm. Weight 125g

Cards



CIRCUIT CARDS

7400	7490
7402	7493
7404	74112
7408	74138
7410	74151
7420	74153
7430	74157
7432	74164
7474	74193
7475	74194
7485	74283
7486	74373

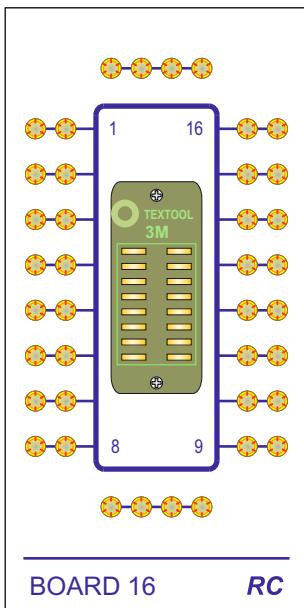
Socket Modules

6.1

Module with Socket 1x16

BO16

Panel



Features

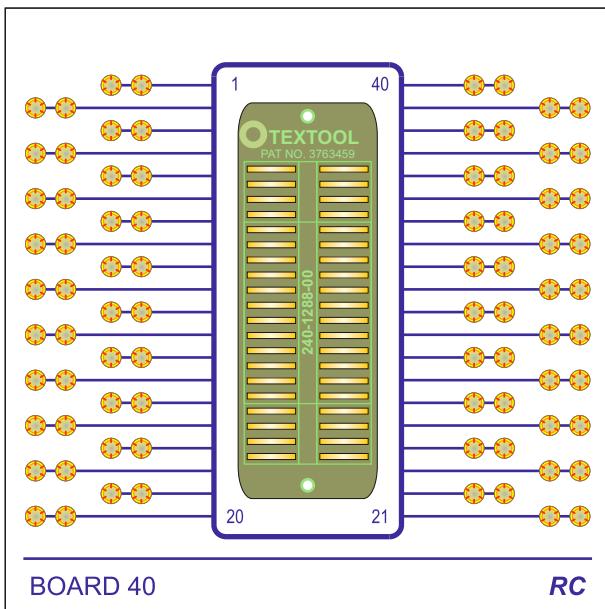
- Module with 16pin socket ZIF from the company Textool
- High quality socket with zero mechanical force and gold plated contacts
- 2 sockets each for all pins
- Dimensions 50 x 100 x 42 mm. Weight 125g

6.2

Module with Socket 1x40

BO40

Panel



Features

- Module with 40pin socket ZIF from the company Textool
- High quality socket with zero mechanical force and gold plated contacts
- 2 sockets each for all pins
- Dimensions 100 x 100 x 42 mm. Weight 215g

Connection Modules

7.1

Supply +5V

Z05V

Description



Features

- The external power supply unit for the supply voltage 5 V (4.0 A)
- The source complies with safety standards En60950, IEC950, EN55022, EN61000-3-2 class A
- Two-core supply cable with plug according to IEC 320-C8 standard
- Hardwired output cable, 40 cm long, with gold plated 2 mm safety plugs
- Output-side fuse against short circuit and overvoltage with automatic reset
- Dimensions 110 x 50 x 20. Weight 155g

Parameter

	Values		Precision
	min	max	
Voltage (V)	5,0		± 6 %
Current (A)	0	4,0	-
Noise (%)	1		-
Effectiveness (%)	73		-

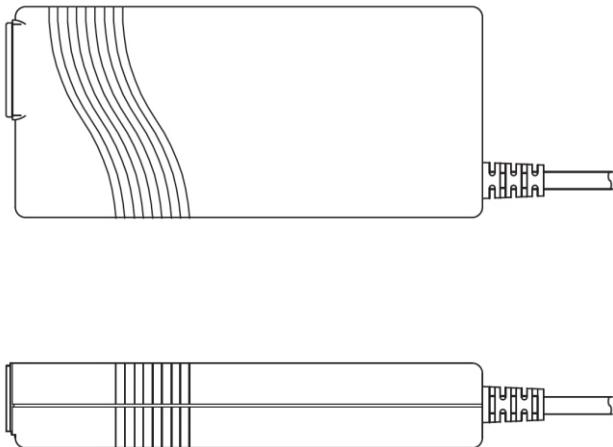
Connection Modules

7.2

Supply +24V

Z24V

Description



Features

- The external power supply unit for the supply voltage 24 V (1.5 A)
- The source complies with safety standards EN60950-1, EN55022, EN61000-3-2 class A
- Two-core supply cable with plug according to IEC 320-C8 standard
- Hardwired output cable, 120 cm long, with gilded low voltage plug (DC jack - inner diameter 2.1 mm, outer diameter 5.5 mm)
- Output-side fuse against short circuit and overvoltage with automatic reset
- Dimensions 110 x 50 x 20mm. Weight 155g

Parameter

	Values		Precision
	min	max	
Voltage (V)	24,0		± 2 %
Current (A)	0	1,5	-
Noise (%)	1		-
Efficiency (%)	81		-

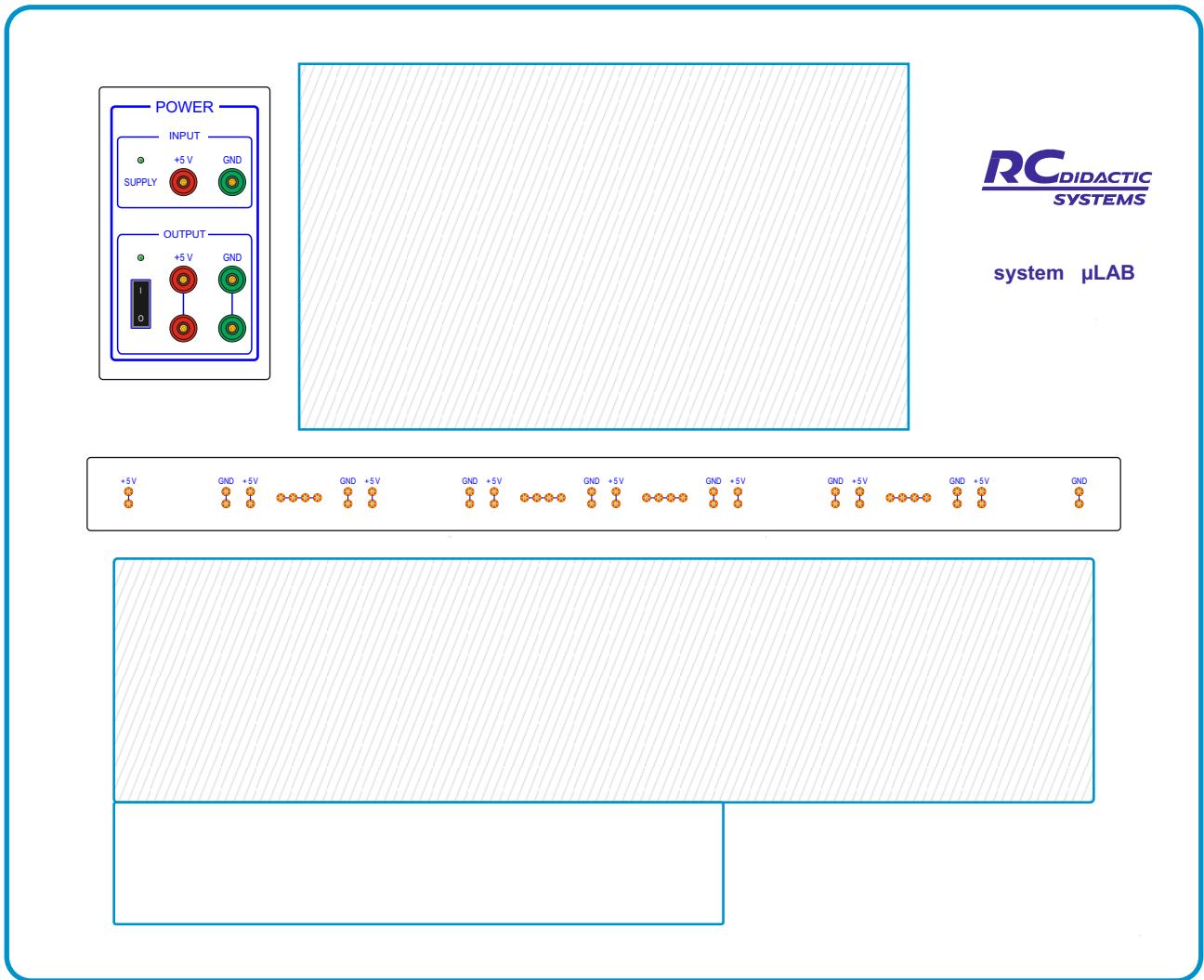
Connection Modules

7.3

Module Board 1

MOB1

Description



Features

- Voltage distribution trough with recesses for placing the modules on the table, especially suitable for all tasks with PC support
- Contains a room for modules and separate room for the measuring unit (ADDU)
- Room for 4 (10x10cm) or 8 (5x10cm) modules
- An alternative is a room for modules of the three - phase system or motor - generator controlled set and up to 3 other 5x10cm modules. For control engineering tasks we recommend the additional module plate 2 for 8 modules size 5x10cm
- Power supply by gold-plated 2 mm plug, switch with LED display
- Dimensions 490 x 400 x 45 mm. Weight 2200g



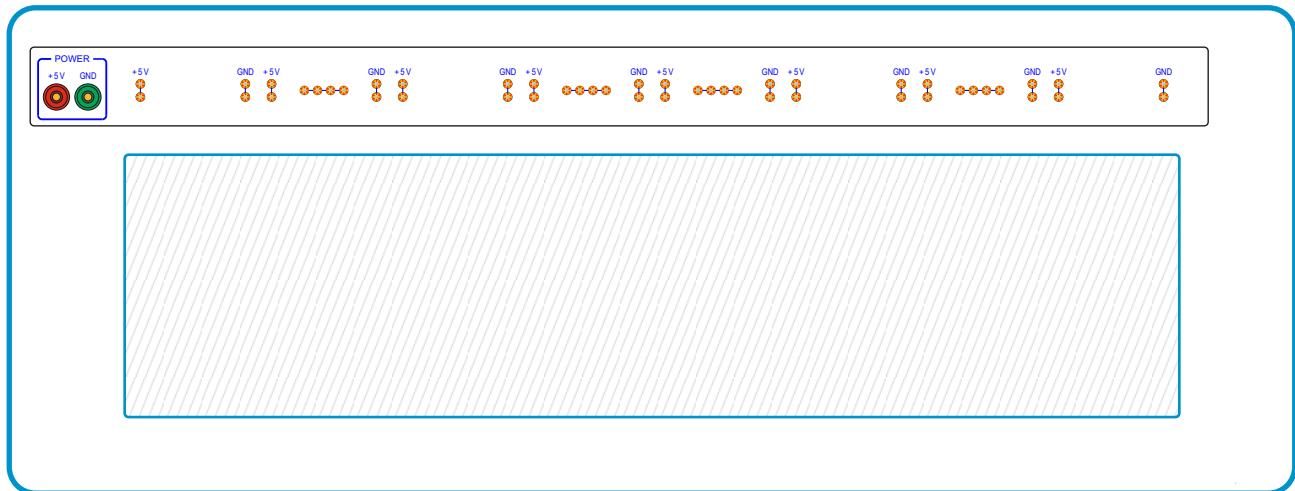
Connection Modules

7.4

Module Board 2

MOB2

Description



Features

- Voltage distributor for placing the modules on the table
- Provides space for 4 modules size 10x10cm or 8 modules size 5x10cm
- Suitable for all tasks without measuring unit (ADDU), or together with module board 1 for the tasks of control technology
- Powered by gold plated 2mm plugs
- Dimensions 490 x 185 x 35 mm. Weight 730g

Cables

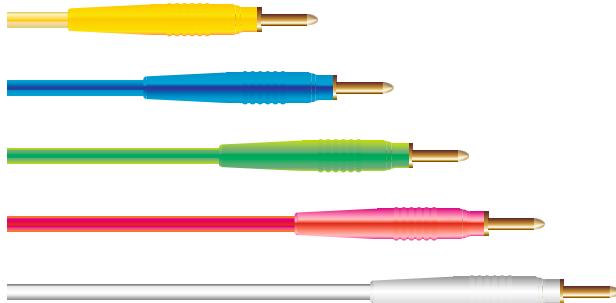
8.1

Connection Cables

CAS1

Connection Cables

Description _____



Features _____

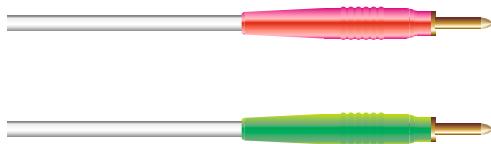
- Flexible cable with silicone insulation
- Cross section of the copper core 0.25 mm^2
- Different length with different colors of isolation
- Gold-plated connectors with a diameter of 1.5 mm

List _____

Color	Length (mm)	Set No. 1 (pcs)	Set No. 2 (pcs)
yellow	150	10	10
blue	200	10	10
green	300	8	10
red	400	4	10
white	500	2	4

Cables to power supply modules

Description _____



Features _____

- Flexible cable with silicone insulation
- Cross section of the copper core 0.25 mm^2
- Gold-plated connectors with a diameter of 1.5 mm

List _____

Color	Length (mm)	Set No. 1 (pcs)	Set No. 2 (pcs)
red	150	8	8
green	150	8	8

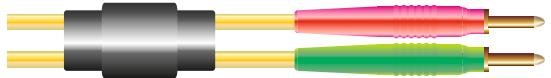
Cables

8.2

Double and Transition Cables

Double Cables

Description



Features

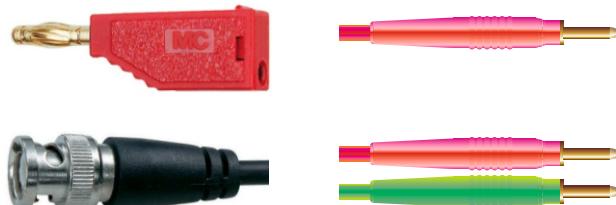
- Flexible double cable with silicone insulation
- Cross section of the copper core 0.25 mm^2
- Long and short measuring cables
- Gold-plated connectors with a diameter of 1.5 mm
- Color of the cables yellow and blue, color of the extension red and green

List

Color	Length (mm)	Set No. 1 (pcs)	Set No. 2 (pcs)
yellow	250	1	-
blue	250	1	-
yellow	550	2	-
blue	550	1	-

Transition Cables

Description



Features

- Flexible cable with silicone insulation
- Cross section of the copper core 0.25 mm^2
- Adapter 4 mm system or BNC plug to 1.5 mm
- Gold-plated connectors with a diameter of 1.5 mm

List

Color	Lenght (mm)	Set No. 1 (pcs)	Set No. 2 (pcs)
red, 4mm	500	-	-
green, 4mm	550	-	-
black, BNC	900	-	-

Cables

8.3

Power Supply Cables

Power Supply Cables 2mm

Description



Features

- Flexible power cable with silicone insulation
- Cross section of the copper core 0.50 mm^2
- Different length and colors on request
- Gold plated plug with diameter 2 mm
- High reliability and mechanical strength

List

Color	Lenght (mm)	Set No. 1 (pcs)	Set No.2 (pcs)
red	150	-	1
green	150	-	1
red	300	1	1
green	300	1	1
red	600	-	1
green	600	-	1

Supply Cables 4mm

Description



Features

- Flexible cable with silicone insulation
- Cross section of the copper core 0.75 mm^2
- Nickel connectors with diameter 4 mm
- High reliability and mechanical strength

List

Different combinations of colors and lengths of cables to be supplied.

Discrete Elements

8.4

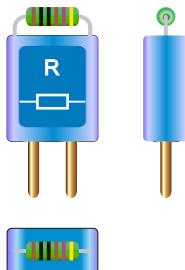
2-pin Elements

SCO 1-2

Resistors

Description _____

Features _____



- High Precision
- High stability of the parameters
- Very good parasitic properties
- Gold plated connectors with 5 mm spacing
- Available separately or in complete sets
- Other values on request
- Dimensions of the base
(without element and plug) 12 x 14 x 6 mm

List _____

RESISTORS			1	
Value (Ω)	Precision (%)	Temperature dependency (ppm/ $^{\circ}$ C)	Set No. 1 (pcs)	Set No. 2 (pcs)
1	0,5	100	•	••
10	0,2	50	••	••
20	0,2	50		
50	0,2	25		
100	0,1	25	••	••
200	0,1	25	•	•
500	0,1	25	•	•
1k	0,1	25	••	••
2k	0,1	25	•	•
5k	0,1	25	•	•
10k	0,1	25	••	••
20k	0,1	25	•	•
50k	0,1	25	•	•

RESISTORS			100k	
Value (Ω)	Precision (%)	Temperature dependency (ppm/ $^{\circ}$ C)	Set No. 1 (pcs)	Set No. 2 (pcs)
100k	0,1	25	••	••
200k	0,1	25	•	•
500k	0,1	25	•	•
1M	0,1	25	••	••
2M	0,1	50		
5M	0,1	50		
10M	0,1	50	•	••

120R	0,1	50		
350R	0,1	50		
505R	0,1	50		
82K	0,5	50		

Discrete Elements

8.5

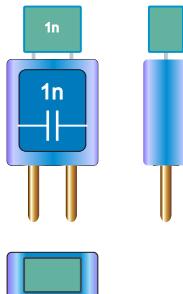
2-pin Elements

SCO 1-2

Capacitors

Description _____

Features _____

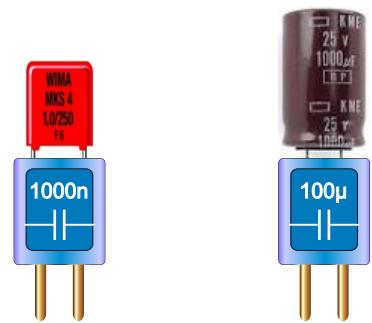


- High precision
- High stability of the parameters
- Very good parasitic properties
- Gold plated connectors with 5 mm spacing
- Available separately or in complete sets
- Other values on request
- Dimensions of the base (without element and plug) 12 x 14 x 6 mm

List _____

Polypropylene capacitors				
Value (F)	Precision (%)	Temperature dependency (ppm/°C)	Set No. 1 (pcs)	Set No. 2 (pcs)
100p	1	200		
330p	1	200		
1n	1	200
2n2	1	200		
3n3	1	200	.	.
6n8	1	200		
10n	1	200
22n	1	200		
33n	1	200	.	.
68n	1	200		
100n	1	200
330n	1	200		
1000n	5	200		

Bipolar electrolytic capacitors				
Value (F)	Precision (%)	Voltage (V)	Set No. 1 (pcs)	Set No. 2 (pcs)
1μ	10	50	•	•
3μ3	10	50	•	•
10μ	10	50	•	•
33μ	10	35	•	•
100μ	10	35	•	•
330μ	20	35		



Discrete Elements

8.6

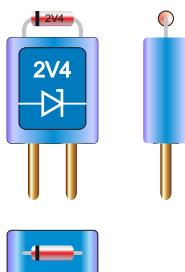
2-pin Elements

SCO 1-2

Elements

Description

Features



- High precision
- High stability of the parameters
- Very good parasitic properties
- Gold plated connectors with 5 mm spacing
- Available separately or in complete sets
- Other values on request
- Dimensions of the base (without element and plug) 12 x 14 x 6 mm

List

Diodes			D	
Designation	Description	Type	Set No. 1 (pcs)	Set No. 2 (pcs)
D	Si	1N4148	••••	••••
SD	Schottky	BAT48	•	•
GD	Germanium	1N60		•
2V4	Zener	BZX55C 2V4	•	•
3V0	Zener	BZX55C 3V0	•	•
3V6	Zener	BZX55C 3V6	•	•
4V3	Zener	BZK55C 4V3	•	•
5V1	Zener	BZX55C 5V1		
5V6	Zener	BZX55C 5V6		•
6V2	Zener	BZX55C 6V2		
6V8	Zener	BZX55C 6V8		•
7V5	Zener	BZX55C 7V5		
8V2	Zener	BZX55C 8V2		•

LEDs			R	
Designation	Description	Cross-section (mm)	Set No. 1 (pcs)	Set No. 2 (pcs)
R	LED red	3	••	••
G	LED green	3	••	••
Y	LED yellow	3	•	•
B	LED blue	3	•	•
W	LED white	3		
IR	LED infra	3		•

Special Elements				
Designation	Description	Type	Set No. 1 (pcs)	Set No. 2 (pcs)
—	Bridge	—	•••• •••• ••••	•••• •••• ••••
NTC	NTC 1k0	NTC 1k	•	•
PTC	PTC 50 mA	RXE 005	•	•

Discrete Elements

8.7

2-pin Elements

SCO 1 - 2

Summary

Set No. 1 _____

- Standard set - 60 elements
- 23 precise resistances
- 8 precise capacitors
- 5 bipolar capacitors
- 9 diodes
- 6 LED diodes
- 1 special element
- 8 bridges

Set No. 2 _____

- Extended set - 75 elements
- 25 precise resistors
- 11 precise capacitors
- 5 bipolar capacitors
- 16 diodes
- 6 LED diodes
- 2 special elements
- 10 bridges

Containers

Mars _____



Plastic Box _____

