CONTENTS

1 General Information

1.1 ⚠ Safety Instructions

Wherever you see this sign ⚠ you will find information on potential hazards. Please read these sections with particular care!

⚠ **Warning!** Before opening the RLC 200 disconnect the mains plug!

⚠ **Attention!** If the fuse has to be changed, use only G fuse-link 5 × 20 according to IEC 127 (see 4.1)!

1.2 ⚠ Switching the Operating Voltage 230 V~/115 V~

Your RLC 200 left the factory to 230 V~. Switching to 115 V~ requires the RLC 200 to be opened, which should only be done by trained personnel.

Setting the Operating Voltage 115 V~

1. Disconnect the RLC 200 from the mains.
2. Remove upper caps and loosen the screws below.
3. Identify the mains voltage switch with the following illustration.
4. Switch the voltage mains voltage switch (slide switch) located under the power switch to the indication “115”.
5. Remove safety cover at the mains plug and replace the fuse with the fuse for 115 V supplied with the instrument.
6. Fasten upper caps and put the sticker supplied with the instrument for marking the switch-over to 115 V on to the type label.

Mains Voltage Switch

115 V Position

230 V Position

1.3 ⚠ Mains Connection

The design of the unit meets the requirements of safety class I according to EN 61010-1, i.e. all metal parts accessible from outside and exposed to contact are connected with the protective conducto of the supply network.
Power is supplied via a mains cable with earthing contact.

1.4 Installing the Instrument

The RLC 200 should not be operated close to equipment that develops heat.

1.5 Switching on

The RLC 200 is switched on using the power switch at the front. The power switch separates the RLC 200 completely from the primary side of the transformer.

1.6 EMC

The RLC 200 is interference-free according to EN 50081-1 and EN 50081-2. In order to fulfil the limiting values in line with present standards, it is absolutely essential that only cables which are in perfect condition be connected to the unit. The following information applies here:

- Metallic or metallized socket cases must be used for the serial interface RS-232C. The socket cases and the braided screen of the cables must be connected at the shortest distance possible. The signal earth must not be connected to the braided screen.
- After opening and closing the RLC 200 it should be checked that all the fixing parts and contact springs are installed as before that all the screws are fixed tightly.

1.7 Inspection and Maintenance

If service is needed, due attention should be paid to the regulations according to VDE 0701. The RLC 200 should only be repaired by trained personnel.

1.8 Warranty

GRUNDIG guarantees the perfect working order of the RLC 200 for 12 months as from delivery.
There is no warranty for faults arising from improper operation or from changes made to the unit or from inappropriate application.
If a fault occurs please contact or send your RLC 200 to:

The RLC 200 should be sent in appropriate packing - if possible in the original packing. Please enclose a detailed fault report (functions working incorrectly, deviating specifications and so on) including unit type and series number.
Kindly verify warranty cases by enclosing your supply delivery note. Any repairs carried out without reference to a valid warranty will initially be at the owner's expense.
Should the warranty have expired, we will, of course, be glad to repair your RLC 200 as per our General Terms Of Assembly And Service.

1.9 Accessories

1 mains cable
2 fine wire fuses (T 160 mAL/250 V and T 80 mAL/250 V)
1 4-line RCL adapter for radial and coaxial components
1 4-line SMD adapter
2 2-line measuring cables with Kelvin terminals
2 voltage measuring cables with integrated test points
1 cable for external polarization voltage
1 measuring earthing cable
1 operating instruction
1 label for indicating the switch-over to 110 V

2 Application

The automatic RLC meter is a measuring unit controlled by a micro-processor that is suitable for the R, G, C, L, D and Q parameters of passive and active components and for measuring d.c. voltages. In addition to the mentioned parameters component tolerances can be measured absolutely or percantel (Δ/Δ%). The basic error is 0.2 %.

The test objects are connected to the RLC 200 via four lines. The effect of stray capacities, lead inductances and crossing resistances is thus substantially reduced.

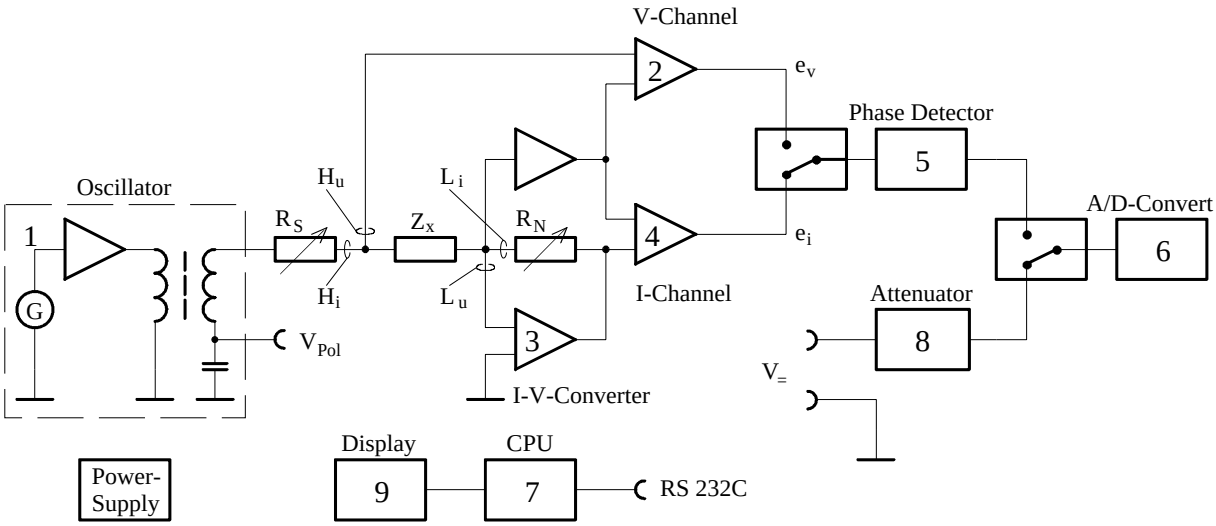
The RLC 200 automatically recognizes the object and allows the parameters to be determined using the series and parallel equivalent circuit of the measuring object. A manual selection of the measuring mode is also possible.

The RLC 200 has two internal measuring frequencies: 100 Hz and 1 kHz. Measurements can be carried out with a 50 mV or 1 V measuring signal level. The 1 V measuring level is mainly used for standard measurements and the 50 mV measuring level is for measuring semiconductor connections.
It is possible to connect an internal (+ 5 V) and external (≤ + 30 V) polarization voltage.

The measuring results and relevant units are indicated on an 8-digit display.
All functions can be remote controlled via the serial interface RS-232C.

3 Set-up and Functional Description

3.1 Block Diagram



3.2 Description

The system parameters R, G, C, L, D and Q are derived from the voltage at the measuring object Z_X and the current passing through the measuring object. The real and imaginary components of the voltage and current vectors are led to the internal processor which determines the parameters with the help of mathematical operations.
After being defined the measuring signal voltage is supplied via the oscillator [1] and the resistance R_S. The voltage e_u is determined directly with the help of the operation amplifier (OA) [2]. The voltage e_i, which is proportional to the current passing through the measuring object Z_X, is supplied by the I/O converter [3]. The appropriate measuring range is set using the standardized resistance R_N and the amplification of the OA [4]. The voltage values e_u and e_i are led in turns to the phase detector [5] which determines the real and imaginary components of the voltage and current vectors. The following A/D converter [6] feeds the processor [7] with the data necessary for evaluating the system parameters.
A polarization voltage V_{Pol} (e. g. for electrolyte capacitors) can be supplied by an internal (+ 5 V) or an external (≤ + 30 V) source of voltage.

When measuring d.c. voltages the input signal is adjusted by a voltage divider [8] and is led to the A/D converter [6] which supplies the processor [7] with the digital signals.

The results are displayed in figures and units [9].

4 Technical Data

4.1 General Data

Rated temperature:	+ 23 °C ± 1 °C
Operating temperature:	+ 0 to + 50 °C
Relative humidity:	40 to 80 %
Atmospheric pressure:	86 to 106 kPa
Operating position:	horizontal or inclined by ±10 °
Operating voltage:	sinusoidal alternating voltage 110/220 V ± 10 % (internal switchable) 50 to 60 Hz (± 5 %)
Power input:	16 VA
Fuses:	T 80 mAL/250 V (220 V~) T 160 mAL/250 V (110 V~)
Safety class:	1, according to IEC 348
Radio interference suppression:	EN 55011 Class B
Dimensions (L × H × D):	291 mm × 108 mm × 259 mm
Dimensions of packing:	338 mm × 138 mm × 408 mm
Weight	
of RLC 200:	approx. 2.8 kg
incl. packing and accessories:	approx. 4.5 kg

4.2 Specifications

Measuring parameters:	R, G, C, L, D, Q, $U_{=}$, Δ/Δ%
Connection:	series or parallel connection with four-pair arrangement of measuring terminals
Measuring frequencies:	100 Hz, 1 kHz
Measuring voltages:	50 mV, 1 V
Polarization of the measuring object	
internal voltage source:	+ 5 V
external voltage source:	≤ + 30 V
Selection of measuring range:	automatically or within fixed range
Input resistance of d.c. voltmeter:	> 9 MΩ
Triggering:	internal, manually, external via RS-232C
Measuring time:	200 ms
Display:	3 1/2-digit (measuring value and unit)
Interface:	RS-232C
Remote controllable functions:	R, G, C, L, D, Q, $V_{=}$, automatic determination of measuring parameters, measuring modes, measuring frequencies, measuring signal levels, automatic selection of the measuring range or fixed range absolute and percentage deviation (Δ/Δ%) with input of reference value, triggering and acustic short circuit indication
Data output:	measuring parameters, measuring mode, measuring value

4.3 Measuring Ranges of the Parameters

Parameter	Measuring Ranges from		to	Accuracy/dig
R	1 mΩ	-	100 MΩ	1 mΩ
G	1 nS	-	10 S	1 nS
C	0.1 pF	-	20 mF	0.1 pF
L	0.1 µH	-	20 kH	0.1 µH
D	0.001	-	2	0.001
Q	0.1	-	500	0.1
$V_=$	0.1 mV	-	400 V	0.1 mV
Δ %	- 999 %	-	+ 999 %	0.1 %

4.3.1 Permissible Measuring Tolerances of the Measuring Ranges

The following measuring tolerances are valid for a reference temperature of 23 °C ± 1 °C. The tolerance increases by 50 % per 10 °C on deviations from the reference temperature.

4.3.2 Measuring Tolerances for R or G (Q < 1, D > 1) Respectively and for L or C (Q > 1, D < 1) Respectively

The following equation determines the measuring tolerance T_{meas}:

$$T_{meas} = \left[\pm \left(A\sqrt{1 + P_m^2} \right) \pm K \right] K_t$$

A - basic accuracy in %
P_m - parameter Q (for R, G measurements) or parameter D (for L, C measurements) respectively
K - additional error of the last digit (dig)
K_t - error of the temperature coefficient

For converting from R, G, C, and L to the impedance |Z| the following equations apply:

$$|Z| = R = 1/G \qquad |Z| = 2\pi f L \quad \text{and} \quad |Z| = \frac{1}{2\pi f C}.$$

Basic Accuracy A + Additional Error K on V_{meas} = 1 V
(all percentages refer to the measured values indicated)

Impedance $\lvert Z \rvert$	Measuring Frequency f_{meas}	
	100 Hz	1 kHz
100 mΩ ≤ |Z| < 2 Ω	± 0.5 % ± 2 dig	± 0.5 % ± 2 dig
2 Ω ≤ |Z| < 20 Ω	± 0.3 % ± 2 dig	± 0.3 % ± 1 dig
20 Ω ≤ |Z| < 200 Ω	± 0.2 % ± 2 dig	± 0.2 % ± 1 dig
200 Ω ≤ |Z| < 2 kΩ	± 0.2 % ± 2 dig	± 0.2 % ± 1 dig
2 kΩ ≤ |Z| < 20 kΩ	± 0.2 % ± 2 dig	± 0.2 % ± 1 dig
20 kΩ ≤ |Z| < 500 kΩ	± 0.2 % ± 2 dig	± 0.2 % ± 1 dig
500 KΩ ≤ |Z| < 5 MΩ	± 0.3 % ± 3 dig	± 0.3 % ± 2 dig
5 MΩ ≤ |Z| < 20 MΩ	± 1.0 % ± 5 dig	± 1.0 % ± 2 dig

The measuring tolerance is specified with the conductance deviation G = ± 2 nS on impedances of $\lvert Z \rvert \geq 20$ MΩ (0 < G ≤ 50 nS), V_{meas} = 1 V and for both measuring frequencies.

The measuring tolerance is specified with the resistance deviation R = ± 2 mΩ on impedances of $\lvert Z \rvert < 100$ mΩ (0 < R < 100 mΩ), V_{meas} = 50 mV and for both measuring frequencies.

Basic Accuracy A + Additional Error K on V_{meas} = 50 mV
(all percentages refer to the measured values indicated)

Impedance $\lvert Z \rvert$	Measuring Frequency f_{meas}	
	100 Hz	1 kHz
100 mΩ ≤ |Z| < 2 Ω	not specified	± 0.8 % ± 3 dig
2 Ω ≤ |Z| < 20 Ω	± 0.5 % ± 3 dig	± 0.5 % ± 2 dig
20 Ω ≤ |Z| < 200 Ω	± 0.3 % ± 3 dig	± 0.3 % ± 2 dig
200 Ω ≤ |Z| < 2 kΩ	± 0.3 % ± 3 dig	± 0.3 % ± 2 dig
2 kΩ ≤ |Z| < 20 kΩ	± 0.3 % ± 3 dig	± 0.3 % ± 2 dig
20 kΩ ≤ |Z| < 500 kΩ	± 0.3 % ± 3 dig	± 0.3 % ± 2 dig
500 KΩ ≤ |Z| < 5 MΩ	± 0.5 % ± 5 dig	± 0.5 % ± 3 dig
5 MΩ ≤ |Z| < 20 MΩ	not specified	± 3.0 % ± 3 dig

The measuring tolerance is specified with the conductance deviation G = ± 3 nS on impedances of $\lvert Z \rvert \geq 20$ MΩ (0 < G ≤ 50 nS), V_{meas} = 50 mV and for the measuring frequency 1 kHz.

The measuring tolerance is specified with the resistance deviation R = ± 3 mΩ on impedances of $\lvert Z \rvert < 100$ mΩ (0 < R < 100 mΩ), V_{meas} = 50 mV and for the measuring frequency 1 kHz.

4.3.3 Measuring Tolerance of the Dielectric Loss Factor D

The measuring tolerance T_{meas} of the dielectric loss factor D results from the relation:

$$T_{meas} = 0.1\ D_m \pm D$$

D_m - measured value D
D - additional error

Additional Error D for f_{meas} = 1 kHz

Capacity C	Measuring Level V_{meas}	
	50 mV	1 V
10 pF ≤ C < 100 pF	not specified	± 0.005
100 pF ≤ C < 10 nF	± 0.005	± 0.005
10 nF ≤ C < 100 µF	± 0.004	± 0.003
100 µF ≤ C < 1 mF	± 0.010	± 0.005

Additional Error D for f_{meas} = 100 Hz

Capacity C	Measuring Level V_{meas}	
	50 mV	1 V
10 pF ≤ C < 1 nF	not specified	± 0.005
1 nF ≤ C < 10 nF	± 0.005	± 0.005
10 nF ≤ C < 100 µF	± 0.003	± 0.003
100 µF ≤ C < 1 mF	± 0.005	± 0.003
1 mF ≤ C < 10 mF	not specified	± 0.010

4.3.4 Measuring Tolerances of the Quality Factor Q

The tolerance for R respectively G is ± 0.2 within the impedance range of 100 mΩ ≤ |Z| < 20 MΩ. The following equation is used to calculate the measuring tolerance:

$$T_{meas} = 0.1\ Q_m \pm Q$$

Q_m - measured value Q
Q - additional error

Additional Error Q for f_{meas} = 1 kHz

Inductance L	Measuring Level V_{meas}	
	50 mV	1 V
100 µH ≤ L < 1 mH	± 0.5	± 0.4
1 mH ≤ L < 100 H	± 0.3	± 0.3
100 H ≤ L < 1 kH	± 1.5	± 0.5
1 kH ≤ L < 2 kH	not specified	± 0.5

Additional Error Q for f_{meas} = 100 Hz

Induktivität L	Measuring Level V_{meas}	
	50 mV	1 V
1 mH ≤ L < 10 mH	not specified	± 0.3
10 mH ≤ L < 2 H	± 0.7	± 0.3

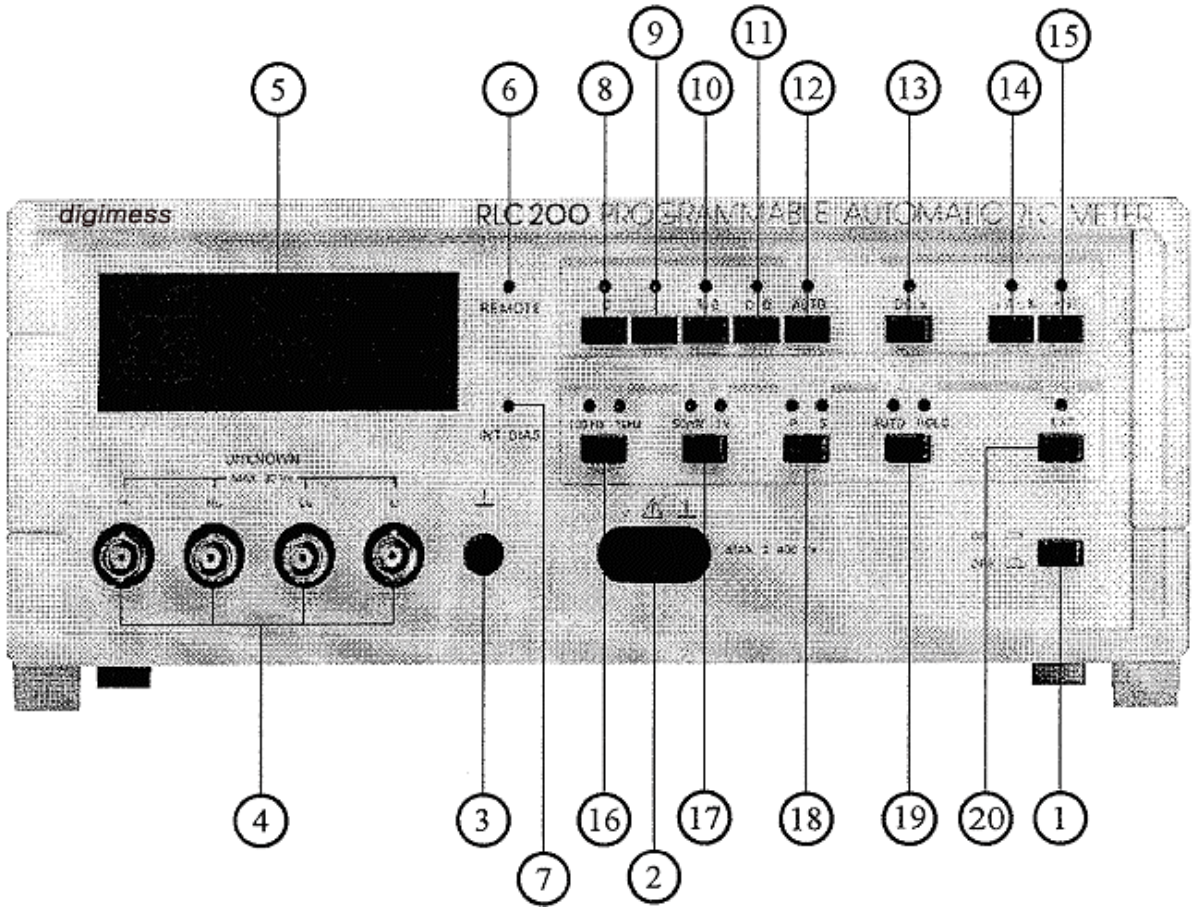
4.3.5 Measuring Tolerance on D.C. Voltage Measurement

The measuring tolerance on d.c. voltage measurement in all ranges is:

$$T_{meas} = 0.2\ \% \pm 1\ dig$$

The display can fluctuate by a maximum of ±0.2 mV on short circuit input.
The percentage refers to the measured value indicated. The given values are valid for a reference temperature of 23 °C ± 1 °C. The tolerance increases by 50 % per 10 °C on deviations from the reference temperature.

5 Control Switches



(1) **power switch "ON/OFF"**

(2) **input sockets of the voltmeter**
d.c. voltages of up to 400 V can be led to this input.

(3) e**arthing terminal**
External circuits or devices can be switched to a common reference potential via this zero-potential terminal.

(4) **BNC input socket "UNKNOWN"**
The measuring signals for determining the system parameters (R, G, C, L, D, Q, Δ/Δ%) of components and circuits can be led to this input.

(5) **8-digit LCD display**
The display is used to indicate measured values with measuring units and condition messages.

(6) **indication "REMOTE"**
The LED lights up if data are transmitted via the serial interface RS-232C.

(7) **indication "INT BIAS"**
The lighting up of the LED signalizes that the internal polarization voltage has been connected.

Function Buttons and Indications

After switching on the operation mode "AUTO" is automatically set and the current measuring mode is indicated (see 6.2.1.). By actuating the relevant button the measuring mode can be selected, directly, the function of which is indicated by the LED above the button.

(8) **"C" button**
By actuating this button the capacity measurement is activated.

(9) **"L" button**
By actuating this button the inductance measurement is activated.

(10) **"R/G" button**
After actuating this button once a resistance measurement is executed by the RLC 200 with the LED "R/G" lighting up red.
By actuating the button twice the conductance measurement is activated and the LED "R/G" lights up green.

(11) **"D/Q" button**
After actuating this button once a dielectric loss factor D measurement is executed by the RLC 200 with the LED "D/Q" lighting up red.
By actuating the button twice the quality measurement is activated and the LED "D/Q" lights up green.

(12) **"AUTO" button**
By actuating this button a measurement with automatic detection of the measuring parameters is started (see 6.2.1).

(13) **"DC V" button**
By actuating this button the d.c. voltage measurement of up to 400 V is started.

(14) **"Δ/Δ%" button**
After actuating this button once an absolute tolerance measurement is realized by the RLC 200 with the LED "Δ/Δ%" lighting up red.
By actuating this button twice a percentage tolerance measurement is activated and the LED "Δ/Δ%" lights up green.

(15) **"·))" button**
By actuating this button the emittance of a continous tone is effected to indicate resistance measurement of values under 2 Ω.

Parameter Settings and Displays (see 6.3)

(16) **"FREQ" button**
This button is for selecting the measuring frequency of 100 Hz or 1 kHz.

(17) **"LEVEL" button**
By actuating this button the measuring level is switched from 50 mV to 1 V and vice versa.

(18) **"MODE" button**
The measuring mode is set with this button where MODE "P" stands for parallel and MODE"S" stands for series equivalent circuit of the measuring object.

(19) **"RANGE" button**
Repeated actuating of this button alternately switches on the operation mode "RANGE AUTO" (automatic selection of the measuring range) and "RANGE HOLD" (holding the last current measuring range).

(20) **"TRG" button**
Every time this button is actuated a measurement is carried out once.

The **power** is supplied by a 3-pole cable with protection contact. The RLC 200 is provided with a fuse of T 80 mAL/250 V for 220 V and T 160 mAL/250 V for 110 V net voltage respec-tively.
The serial interface **RS-232C** is used for data transmission on remote control by external devices.
All connections as well as the **change-over switch "BIAS"** for selecting (internal/external) the polarization voltage and the **input socket** for the external polarization voltage can be found on the back of the RLC 200.

6 Realization of Measurements

6.1 Starting

After switching the RLC 200 on internal tests are carried out which are indicated by the message "CHECK". Errors within the data memory are signalized with the display "CHECK D" and errors in the program memory are signalized with the display "CHECK P". After the test run has been completed successfully the RLC 200 switches to the automatic measuring operation.

⚠ Wrong connection of the measuring cables at the measuring sockets H_i, H_u, L_i and L_u will lead to wrong measuring results but not operating breakdown.

6.2 Measuring Functions

6.2.1 RLC Measurement

After switching on and by actuating the button "AUTO" [12] the measuring unit switches to automatic RLC measurement. The respective measuring mode is determined internally and carried out depending on the measuring object Z_X. The result with the highest place value is the criterion for determining the measuring type. This process is indicated by the LED "AUTO" [12] and the LED of the measuring mode determined.
On direct selection by actuating the buttons "C" [8], "L" [9], "R/G" [10] and "D/Q" [11] the automatic measuring operation is stopped and the selected measuring function is carried out. Then only the LED of the active measuring type lights up.
The following applies to measuring resistance/conductance "R/G" and dielectric loss factor/quality "D/Q":
By actuating the button once the first mentioned measuring mode "R" or "D" is activated respectively and indicated by the LED lighting up red. By actuating the button twice the other measuring function is activated with the LED lighting up green.
Several measuring settings can be changed with the help of the operation parameters (see 6.3).
Measuring results and relevant measuring units are shown on the 3 1/2-digit display [5].

6.2.2 D.C. Voltage Measurement

The RLC 200 is switched to functioning as d.c. voltmeter by actuating the button "DC V" [13]. The measuring cables have to be connected at the input sockets [2].
The buttons "RANGE" [19], "TRG" [20] (see 6.3) and "Δ/Δ%" [14] are the only ones functioning in this mode.
The voltages are shown with measuring units on the display [5].

6.2.3 Tolerance Measurement

The RLC 200 allows the determination of absolute and percentage deviations from a reference value. After actuating the button "Δ/Δ%" [14] once (LED lights up red) the RLC 200 saves the present measured value as reference value and displays the absolute tolerance with the measuring unit. Actuating the button "Δ/Δ%" [14] again (LED lights up green) the tolerance value is calculated in percent and is indicated on the display [5].
This function can be started for the measuring types "C", "L", "R", "G", "D", "Q" and "DC V".

6.2.4 Transit Test

A transit test (test of conductive paths) can be carried out within the measuring type "R" (actuating the button "R/G" once [10]) by actuating the button "·))" [15]. In addition to the displayed value an accustic signal is emitted if the resistance value is $R \leq 2\ \Omega$.

6.3 Operating Parameters

6.3.1 Selection of the Measuring Frequency

The measuring frequencies f_{meas} = 100 Hz and 1 kHz are available for the measurements. The switch over is done with the button "FREQ" [16]. The present measuring frequency is indicated by the corresponding LED.
After switching the RLC 200 on the frequency f_{meas} = 1 kHz is preset automatically.

6.3.2 Selection of the Measuring Voltage

The RLC 200 measures with two different measuring voltage levels V_{meas} = 50 mV and 1 V. The selection of these values is done with the button "LEVEL" [17] (indication by the LEDs). The values are valid for loadfree measuring lines. Due to a series resistance the measuring voltage is lower at the measuring object Z_X.
After switching the RLC 200 on the measuring voltage V_{meas} = 1 V is preset automatically.

6.3.3 Parallel or Series Connection

The measuring object Z_X generally has a complex character and the alternative connection can be depicted as parallel or series connection of the real and imaginary components. With regard to optimal measuring conditions the RLC 200 measures high impedances with constant voltage (parallel mode) and low impedances with constant current (series mode). The measuring mode is selected outside the automatic measuring operation with the help of the button "MODE" [18] whereby MODE "P" stands for parallel equivalent circuit and MODE "S" for series alternative connection of the measuring sample.

6.3.4 Measuring Ranges

After switching on the RLC 200 the measurement with automatic extension of the measuring range "RANGE AUTO" is preset.
In case of repeated measurements of elements with approximately the same values and using a polarization voltage it is advisable to use the same measuring range. Here, the measuring time is shortened as the automatic selection of the measuring range does not take place. This operation mode "RANGE HOLD" can be selected for the measuring functions "C", "L", "R", "G", "D", "Q" and "DC V".
Repeated actuating of the button "RANGE" [19] alternately switches on the operation mode "RANGE AUTO" and "RANGE HOLD" which is indicated by the corresponding LED lighting up.

6.3.5 Triggering

The button "TRG" [20] serves for the manual triggering of the measurement. A measurement is carried out once after every actuation of this button. The operation state is indicated by a LED.
After switching on the RLC 200 automatically switches to internal triggering.

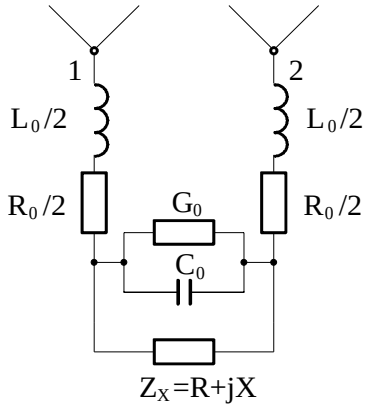
⚠ **Negative display of the unit**

A negative display occurs on measurements of objects Z_X with a predominant reactance component (capacitors, inductances) or if the selected measuring function is indirectly connected to the object to be measured. So, for instance, if a capacitor C is connected to the measuring lines for the measuring function "L", the RLC 200 displays an equivalent reactance according to the equation $L = -1/\omega^2 C$.

6.4 Residual Parameters of the Terminals

The measuring signals are tapped off by four-wire lines in order to minimize the influence of the residual parameters. However, a complete elimination of the residual parameters is impossible as the influence of the contact points becomes apparent between the cable terminals and the object to be measured. When the measuring lines are load free the RLC 200 indicates a residual capacity C_0 and the conductance G_0, in the case of a short circuit it indicates the residual resistance R_0 and the inductance L_0 respectively.
The four-wire line is connected to a two-wire line (connection points 1 and 2). The residual parameters R_0, G_0, C_0, and L_0 can be combined with the sought parameters of the measuring object Z_X as series or parallel connection.

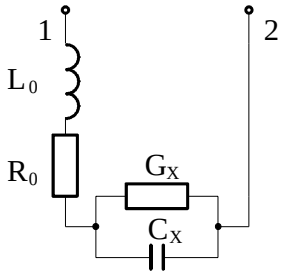
Transformed Impedance $R_m + jX_m$ at the Connection Points 1 and 2:



$$R_m = \frac{R\left(1+RG_0\right)+G_0X^2}{\left(1-\omega C_0X+RG_0\right)^2+\left(\omega RC_0+G_0X\right)^2}+R_0$$

$$X_m = \frac{X\left(1-\omega C_0X\right)-\omega C_0R^2}{\left(1-\omega C_0X+RG_0\right)^2+\left(\omega RC_0+G_0X\right)^2}+\omega L_0$$

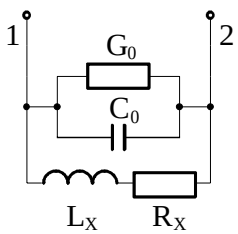
Influence of the Residual Parameters of the Measuring Lines on the C and G Measurement:



$$C_m \approx C_X\left(1+\omega^2L_0C_X-2R_0G_X-L_0G_X^2/C_X\right)$$

$$G_m \approx G_X\left(1+2\omega^2L_0C_X-R_0G_X+\omega^2R_0C_X^2/G_X\right)$$

Influence of the Residual Parameters of the Measuring Lines on the L and R Measurement:



$$L_m \approx L_X\left(1-2G_0R_X+\omega^2C_0L_X-C_0R_X^2/L_X\right)$$

$$R_m \approx R_X\left(1-G_0R_X+2\omega^2C_0L_X+\omega^2L_X^2G_0/R_X\right)$$

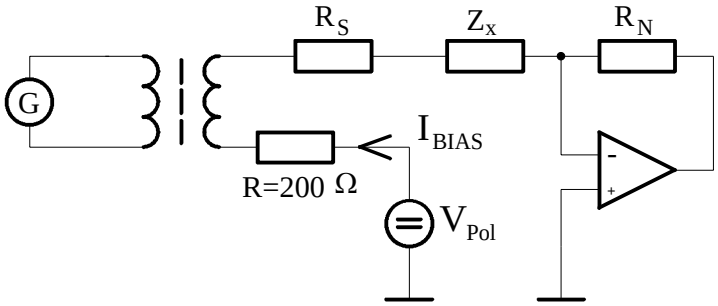
6.5 Polarization of the Measuring Object

6.5.1 Voltage Polarization (Capacitors, Semiconductors)

The polarization voltage V_{Pol} can be supplied internally from a voltage source (+ 5 V) or externally (max. + 30 V) via the input sockets on the back of the RLC 200. The internal voltage is connected to the measuring circuit via the change-over switch on the back of the RLC 200.

6.5.2 Current Polarization (Inductances)

Measurements with a current polarization (bias) on objects with an inductive character are also possible with an external source of power.
The permissible polarization current I_{BIAS} results from the characteristics of the measuring circuit, the maximum loss of the resistances R, R_S and the real component of the complex load Z_X as well as the fed polarization voltage V_{Pol}:



$$I_{BIAS} = \frac{V_{Pol}}{R + R_S + R_X}$$

⚠ **Caution!** Care should be taken to ensure that the measuring object's maximum voltage load is not exceeded as a result of the polarization voltage.
A short circuit between the measuring terminals "H" and "L" must be prevented when measuring with polarization voltage.
The external polarization voltage of + 30 V must not be exceeded.

6.6 Error Messages

In the case of faulty operation on corresponding object to be measured Z_X the RLC 200 displays a message which describes the faulty reaction of the RLC 200.

OVERLOAD	overload of analogous part
OVFL	overflow of counting decades or upper range limit exceeded
UNFL	lower range limit exceeded
REF OVER	input of reference value which is higher than the permissible limit value (on remote control only)

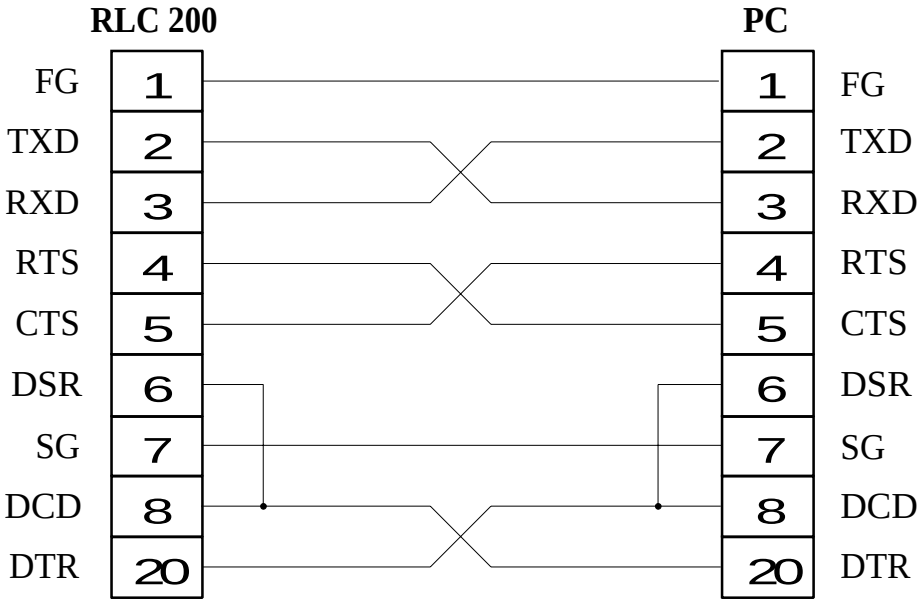
7 Remote Control by Program

7.1 General Information

The serial interface RS-232C allows the RLC 200 to be remote controlled by a personal computer (PC). All parameter settings, measuring functions and outputs of measuring values are realizable by remote control.
The data transfer is based on the ASCII character set. The interface of the PC must have the following configuration.

Data transmission rate:	2400 Bd
Length of data word:	8 Bit
Number of STOP bits:	1
Parity:	none

Plug arrangement:



After starting the RLC 200 is ready to receive commands. On receiving the first instructions the remote control mode is indicated by the REM "REMOTE" lighting up.

7.2 Data Transmission

7.2.1 Command Input

The RLC 200 can be remote controlled by commands which correspond to the ISO-7 code. Single instructions can be started successively within a sequence of commands, the maximum length of which can be 11 characters. Any further character is ignored.
The possible instructions and the corresponding codes are listed in the following table.

Statements		Code	Dec.	Hex.	Note
FUNCTION:	C	C	67	43	
	L	L	76	4C	
	R	R	82	52	
	G	G	71	47	
	Q	Q	68	44	
	D	D	81	51	
	AUTO	A	65	41	
	DC V	V	86	56	
	Δ	*	42	2A	
	Δ%	%	37	25	short-circuit meter
		B	66	42	
FREQ:	100 Hz	F∅	7∅48	463∅	
	1 kHz	F1	7∅49	4631	
LEVEL:	50 mV	U∅	8548	553∅	
	1 V	U1	8549	5531	
MODE:	P	M∅	7748	4D3∅	
	S	M1	7749	4D31	
RANGE:	AUTO	N∅	7848	4E3∅	
	HOLD	N1	7849	4E31	
TRIGGER:		T	84	54	single measurment
other:		W	87	57	data entry
		;	59	3B	end character
		<DC1>	17	11	request-to-send

Simple command lines: RF1U1N∅T;

R	resistance measurement
F1	measuring frequency: 1 kHz
U1	measuring level: 1 V
N∅	measuring range: AUTO
T	triggering: single measurement

CF1U∅<DC1>;

C	capacity measurement
F1	measuring frequency: 1 kHz
U∅	measuring level: 50 mV
<DC1>	readiness to receive

Beside the standard instructions the reference value for the absolute or the percentage tolerance measurement can be entered with the code "W". The reference value remains in the memory of the RLC 200 until a new one is transmitted. The transmission format for a value can be chosen as desired. For the value 1234 the following formats, for example, are possible:

W1.234+03, W1.234E3 or W1234.

7.2.2 Data Output

After receiving the code for the readiness to receive (<DC1>) the RLC meter transmits data to the PC with the following format:

CSF±X.XXXE±YY

with:

- C - connection mode of the measuring object
  - P - parallel connection
  - S - series connection
  - - space character
- S - status of the measurements
  - * - absolute tolerance
  - % - percentage tolerance
  - # - transit tester
  - - space character
- F - active measurement function
  - C - capacity
  - L - inductance
  - R - resistance
  - G - conductance
  - D - dielectric loss factor
  - Q - quality
  - V - voltage
- ± - sign of the mantisse or exponent, can also be a space character
- E - exponent announcement
- X.XXX - four digit value with sliding decimal point
- YY - exponent

If an error is detected by the RLC 200, the sign "!" is transmitted instead of the measuring value.

7.3 Triggering

Unless the instruction "T" for single triggering was received, the RLC 200 triggers interally. In the case of single triggering the instruction "T" has to be transmitted before the readiness to receive "<DC1>".

7.4 TRG Button on Remote Control

The button TRG has two functions. Pressing the button "TRG" causes the function described in 6.3.5 in the local control mode. In the case of remote control pressing the button "TRG" switches the RLC meter back to local control mode.

7.5 Error Messages

If the RLC 200 cannot operate due to incorrect keyboard operation, false commands in remote control mode, faulty connection of the measuring object or internal source of error, a error message flashed on to the display.

OVERLOAD	overload of analogous part
OVFL	overflow of counting decades or upper range limit exceeded
UNFL	lower range limit exceeded
ERR MODE	false selection of connection mode
ERR MEMO	error in the data register or the processor
ERR SYNT	faulty syntax of instruction in remote control mode
REF OVER	input of reference value which is higher than the permissible limit value (on remote control only)

7.6 Program Example (Q Basic)

```
 10 CLS
 20 PRINT
 30 PRINT"program for remote control of RLC 200 by PC"
 40 PRINT"-----------------------------------------"
 50 PRINT"              Ctrl_Break → end of program]"
 60 PRINT
 70 OPEN "com1:2400,n,8,1,CS30000,LF" FOR RANDOM AS #1
 80 REM rate 2400 bd, without parity, 8 data bits, 1 stop bit
 90 COM(1) ON
100 ON COM(1) GOSUB 500
110 K$=INKEY$
120 IF K$="1" THEN PRINT #1, CHR$(17);
130 IF K$="2" THEN GOSUB 200
140 REM key <1> data receiving, key <2> data transmission
150 GOTO 100
200 REM ***** message transmission *****
210 INPUT "input a message ?", A$
220 PRINT #1, A$, CHRS(17);
230 RETURN
500 REM ***** message reception *****
510 A$=INPUT$ (1,#1)
520 PRINT A$;
530 IF A$ <> CHR$ (10) THEN GOTO 500
540 PRINT
550 RETURN
```

8 Maintenance

The RLC 200 does not require special maintenance if it is used and handled correctly. Only use a soft wet rag with some soap-suds or a soft rinse liquid for cleaning. Avoid acrid cleanser and solvents.
Service-work should only be done by trained personnel.
In case of repairs it is vital to ensure that the constructive characteristics of the RLC 200 are not changed thus reducing the safety and that replacement parts match the original ones and are installed properly (original state).

⚠ **Warning!** The RLC 200 must be separated from all power sources before maintaining, repairing or replacing parts or fuses.

9 Appendix

9.1 List of all Display Messages

a) Messages after switching on the RLC 200

CHECK	- internal tests
CHECK D	- error in data memory
CHECK P	- error in program memory

b) Error messages

OVERLOAD	- overload of analogous part
OVFL	- overflow of counting decades or upper range limit exceeded
UNFL	- lower range limit exceeded
ERR MODE	- false selection of connection mode
ERR MEMO	- error in the data register or the processor
ERR SYNT	- faulty syntax of instruction in remote control mode
REF OVER	- input of reference value which is higher than the permissible limit value (on remote control only)

9.2 Declaration of Conformity

digimess	**Konformitätserklärung** **Declaration of Conformity / Déclaration de Conformité** 131/**95**	CE

Der Hersteller/Importeur
The manufacturer/importer
Le producteur/importateur

digimess
Professional Electronics GmbH

Anschrift / Address / Adresse

Würzburger Straße 150
90766 Fürth
Germany

erklärt hiermit eigenverantwortlich, daß das Produkt:
hereby declares, that the product: / déclare, que le produit:

Bezeichnung / Name / Description

Automatisches RLC-Meter
Automatic RLC Meter
LCR-mètre automatique

Type / Model / Type

RLC 200

Bestell-Nr. / Order-No. / N° de réf.

H.UC 30-00

folgenden Normen entspricht:
is in accordance with the following specifications: / correspond aux normes suivantes:

EN 61010-1 (1994)

DIN EN 50081-1 (1993)DIN EN 50081-2 (1994)

EN 55011 (1991) Class B

EN 55022 (1987) Class B

IEC 801-2 (1991) / prEN 55024-2 (1992) *3* kV

IEC 801-4 (1988) / prEN 55024-4 (1993) 2 kV Burst

IEC 801-3 (1984) *3V/m ; 0,15-150 MHz*

Das Produkt erfüllt somit die Forderungen folgender EG-Richtlinien:
Therefore the product fulfils the demands of the following EC-Directives:
Le produit satisfait ainsi aux conditions des directives suivantes de la CE:

73/23/EWG **Richtlinie betreffend elektrische Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen**
Directive relating to electrical equipment designed for use within certain voltage limits
Directive relatives au matériel électrique destiné à être employé dans certaines limites de tension

89/336/EWG **Richtlinie über die elektromagnetische Verträglichkeit**
Directive relating to electromagnetic compatibility
Directive relatives à la compatibilité électromagnétique

Fürth, 7.8.1995

Henninger
Leiter Qualitätsmanagement
Q-Manager / Directeur Contrôle de Qualité