CONTENTS

1 General Information

1.1 ⚠ Safety Instructions

☞	**Note**	**Wherever you see this sign ⚠ you will find information on potential hazards. Please read these sections with particular care!**
⚠	**Warning!**	Before opening the RLC 300 disconnect the mains plug!
⚠	**Attention!**	Our instrument fuses are dimensioned in such a way that optimum protection is guaranteed for the instrument and the user. In industrial power supplies, which are extremely strongly loaded, the instrument fuses could respond sporadically due to high voltage peaks. If the fuse has to be changed, use only G fuse-link 5 × 20 according to IEC 127 (See p. 12, Para. 4.1)!
⚠	**Attention!**	The replacement fuses T125 contained in the accessories are determined for a mains voltage of 115 V and may not be used at mains voltage of 230 V!

1.2 Measuring Conditions

⚠	**Attention!**	Direct or alternating voltages and direct or alternating currents must not be connected to the measuring sockets of the RLC 300.
⚠	**Attention!**	Capacitors must be discharged before connection to the measuring sockets. If not, the RLC 300 could be damaged!
⚠	**Attention!**	The maximum admissible limit of the external polarization voltage V_{max} = 30 V at the BIAS sockets must not be exceeded. Take note of the polarity of the external polarization voltage.

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

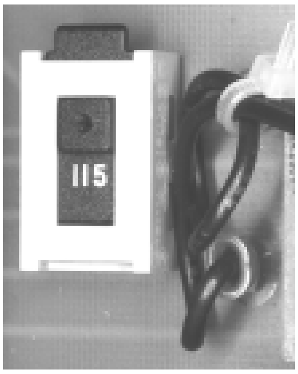
Note

Your RLC 300 left the factory set to 230 V~. Switching to 115 V~ requires the RLC 300 to be opened, which should only be done by trained personnel.

Setting the operating voltage 115 V~

1. Disconnect the RLC 300 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 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

1.4 ⚠ Mains Connection

Protective measures

The design of the unit meets the requirements of safety class I according to EN 61010-1.
Power is supplied via a mains cable with earthing contact.

1.5 Installing the RLC 300

⚠ **Attention!**

Dewfall can cause damage at the RLC 300. If the RLC 300 was stored in a cold surrounding, allow it to acclimatize at room temperature.
The RLC 300 should not be operated close to equipment that develops heat.
The ventilation slots on the case of the RLC 300 must not be covered and no liquid may enter.

1.6 Switching on

Note

The RLC 300 is switched on using the power switch at the front. The power switch separates the RLC 300 completely from the primary side of the transformer.
The LED *I/O* serves as a status indicator.

1.7 EMC

Interference suppression

The RLC 300 is interference-free according to the EN 55011 Class B in agreement with the recommendations IEC CISPR No. 34.

Prerequisite for EMC

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:

– After opening and closing the RLC 300 check that all the fixing elements are installed as before and that all the screws have been tightened.

1.8 Inspection and Maintenance

Note

If service is needed, due attention should be paid to the regulations according to VDE 0701. The RLC 300 should only be repaired by trained personnel.

1.9 Warranty

Conditions for warranty

digimess guarantees the perfect working order of the RLC 300 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.

Returning the RLC 300

If a fault occurs please contact or send your RLC 300 to:

The RLC 300 should be returned 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 serial number.

Identification

Kindly verify warranty cases by enclosing your 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 300 as per our General Terms Of Assembly And Service.

1.10 Accessories Supplied

Contents

1 mains cable

1 fine-wire fuse T100L250V (230 V~)

2 fine-wire fuses T200L250V (115 V~)

1 four-terminal configuration RLC adapter for radial and axial components

1 SMD adapter
1 adapter with Kelvin terminals
1 measuring earth cable
1 operating instructions
1 label for indicating the switch-over to 115 V

2 Application

Performance features

The automatic RLC 300 is a microprocessor-controlled measuring instrument for precise and fast evaluation of impedance parameters of passive and active components and circuits within a broad measuring range. Basic accuracy is 0.1 %.
The frequencies of the internal measuring signal are 50 Hz, 100 Hz, 1 kHz and 10 kHz.
Two measuring signal levels can be selected and allow for measurements of components with semiconductor transitions, too.
The internal or external polarization voltage can be selected alternatively and serves to measure electrolytic capacitors and semiconductor components.

Connection of the measured object

The objects to be measured are connected to the RLC 300 by a four-terminal configuration with Kelvin terminals and measuring adapters. The effect of stray capacitances, lead inductances and contact resistance is thus substantially reduced. The residual parameters of the measuring terminals can be compensated.

Measuring principle

In response to the connected impedance, the RLC 300 automatically recognises the object being measured and the measuring range and allows the parameters to be determined using the series and parallel equivalent circuit diagram of the object being measured.

Performance features

The comprehensive equipment level of the RLC 300 ensures a wide range of features:

- Automatic determination of the object being measured
- Automatic selection of measuring range
- Correction of the residual parameters
- Automatic or manual triggering of the measurements
- Indication of the measuring voltage, the measuring current or the polarization voltage (monitor function)
- Increase of the measuring precision (averaging function)
- Tolerance measurements
- Comparison measurements
- User-oriented functions

Operation via RLC 300

All functions and parameters can be set with eight buttons via menus.
The chosen parameters and functions as well as the measurements are clearly depicted on a two-line alphanumeric LC matrix display.

Remote control via PC

The RLC 300 is equipped, as standard, with the interfaces GPIB and RS-232C for communication with a PC.

- All functions and parameters can be set.
- Set values and states of the RLC 300 can be transmitted.

3 Configuration and Functional Description

3.1 Block Diagram

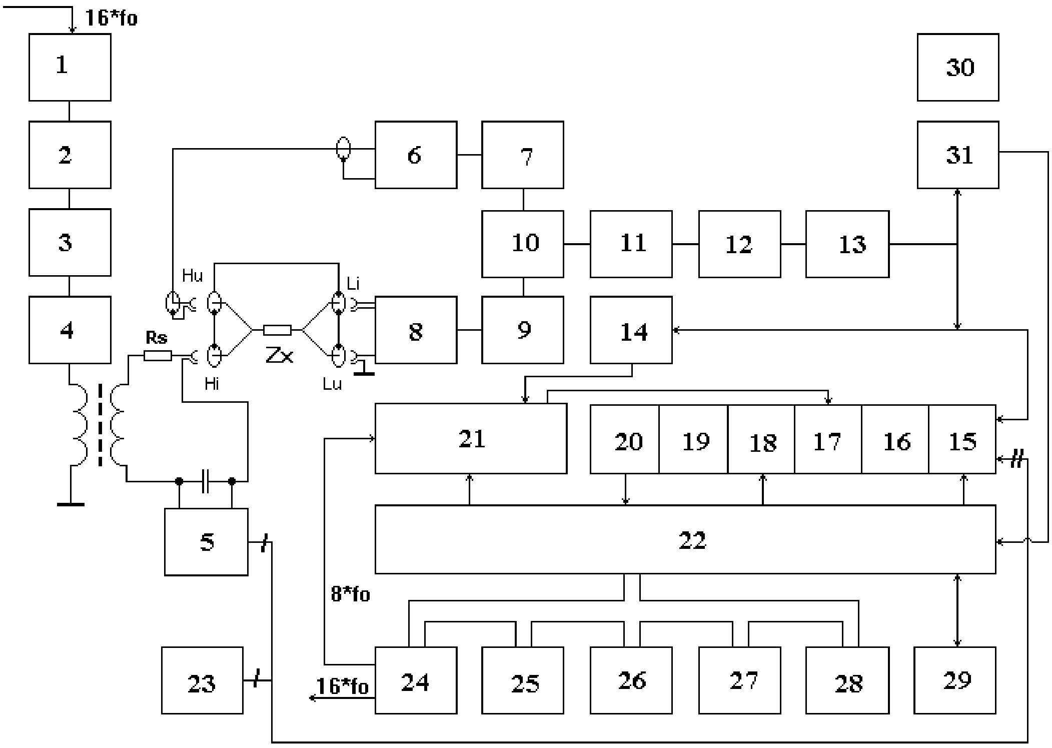


Fig. 1 *Block diagram of the RLC 300*

(1) Measuring signal generator
(2) Amplitude control
(3) Lowpass
(4) Output amplifier
(5) Switch for the generation of the polarization voltage
(6) Amplifier
(7) Adjustable amplifier
(8) I/V converter
(9) Amplifier
(10) Switchover for the voltage and current channels
(11) Separation amplifier
(12) Attenuator
(13) Amplifier
(14) Comparator
(15) Switch for the input signals of the A/D converter
(16) Voltage amplifier and inverter
(17) Sync detector
(18) Integrator
(19) Amplifier
(20) Comparator
(21) Control logic
(22) Microprocessor
(23) Source of the reference voltage for the A/D converter
(24) Timer
(25) Keyboard
(26) LCD display
(27) EPROM memory
(28) EEPROM memory
(29) Interfaces GPIB and RS-232C
(30) Power supply
(31) Comparator of the analogous overload

3.2 Description

Measuring principle	The measuring impedance Z_X is determined with the help of the voltage at the measured object (impedance Z_X) and from the current passing through the measured object. The vector division of the voltage and the current result in four components. The selected parameters are calculated mathematically from the components.
Supply of the generator signal	The generator signal is defined supplied to the measured object Z_X via the oscillator with amplitude control (1), (2), (3), (4), the separating transformer, and the series resistor R_S.
Picking off the measuring signal	The voltage picked off by the measured object Z_X, is determined directly with the help of the operating amplifier (6). The voltage, which is proportional to the current passing through the measured object Z_X is supplied by the I/V converter (8). The signals are further processed in the component groups (7), (9) and led to the switch (10).
Processing of the measuring signal	The voltage amplification of the component groups (11), (12), (13) is set according to the measured impedance value. The adjusted measuring signal is led to the sync detector (17) via the input circuits of the A/D converter (15), (16). The sync detector evaluates the real and imaginary components of the voltage and current vectors (U_{re}, U_{im}, I_{re}, I_{im}) of the measured object Z_X. The evaluated voltages are transformed by the A/D integration converter.
A/D conversion	A/D conversion takes place with the help of the integrator (18), the amplifier (19), the comparator (20), the control logic (21) and the voltage reference source (23). Synchronisation takes place via the comparator (14). The numeric values of the A/D converter are saved in the internal memory of the microprocessor (22) for further processing.
Determination of the measuring impedance	At the auto mode the error message of the comparator (31) and the numeric overflow of the A/D converter control the measuring range selection after the connection of the measuring impedance Z_X. The microprocessor (22) determines the character of the measuring impedance in response to the phase shift of the voltage and current vectors.
Internal control unit	The internal measuring sequence is controlled by the one-chip microprocessor MCS-51 (22) with the help of additional circuits, e. g., program memory EPROM (27), data memory EEPROM (28) and timer (24).
Operating the RLC 300	The RLC 300 can be operated locally via the keyboard (25) and via the LC display (26). Remote control by a PC takes place via the interfaces GPIB and RS-232C (29).
Power supply	The modules are supplied by the internal power supply (30).

4 Technical Data

4.1 General Data

Nominal temperature:	+ 23 °C ± 2 °C
Operating temperature:	+ 5 ... + 40 °C
Relative humidity:	20 ... 80 %
Atmospheric pressure:	70 ... 106 kPa
Operating position:	horizontal or inclined by ± 15 °
Operating voltage:	sinusoidal alternating voltage, distortion factor < 5 % 115/230 V (+ 10 %/– 15 %), internally switchable 47 ... 63 Hz
Power consumption:	max. 20 W
Fuses:	T100L250V (230 V~) T200L250V (115 V~)
Safety class:	I, according to EN 61010 Part 1
Radio interference suppression:	EN 55011 Class B
Dimensions (L × H × D):	291 mm × 120 mm × 259 mm
Dimensions of packing:	418 mm × 155 mm × 355 mm
Weight of	
RLC 300:	approx. 3.5 kg
incl. packing and accessories:	approx. 5.2 kg

4.2 Specifications

4.2.1 Measuring Functions

Measuring parameters:

|Z| - absolute value of the impedance (amount)
R - resistance
L - inductance
C - capacity
D - dissipation factor
Q - quality factor
φ - phase shift

Combinations of the measuring parameters:

<table>
<tr><th rowspan="3">Main parameters</th><th colspan="4">Secondary parameters</th></tr>
<tr><th colspan="4">Measuring function</th></tr>
<tr><th>AUTO</th><th colspan="3">MANUAL</th></tr>
<tr><td>R</td><td>Q</td><td>Q</td><td>D</td><td>L, C</td></tr>
<tr><td>L</td><td>Q</td><td>Q</td><td>D</td><td>R</td></tr>
<tr><td>C</td><td>D</td><td>Q</td><td>D</td><td>R</td></tr>
<tr><td>Z</td><td>|Z|</td><td colspan="3">φ</td></tr>
</table>

Table 1 *Combinations of the measuring parameters*

Tolerance measurement:	Δ	- absolute deviation of the measured value from the entered reference value
	δ	- relative deviation of the measured value from the entered reference value
	COMP	- function for sorting the component elements according to set tolerance limits

4.2.2 Operating Parameters

Equivalent circuit of the measured object:	series connection parallel connection
Selection of measuring range:	automatic manual (fixed range)
Selection of measuring function:	automatic manual
Triggering of the measurements:	automatic manual (single)
Measuring time:	(valid for fixed range or after selection of the measuring range) approx. 300 ms for measuring signal level of 1 V approx. 400 ms for measuring signal level of 50 mV
Averaging:	10 times
Connection of the measured object:	four-terminal configuration with ground terminal
Correction of the residual parameters:	at short-circuit of the measuring terminals (Z_X < 10 Ω) at idling of the measuring terminals (Z_X > 100 kΩ)
Warm-up time:	20 min

4.2.3 Measuring Signal Parameters

Measuring frequencies:	50 Hz, 100 Hz, 1 kHz, 10 kHz
Levels of the measuring signal:	1 V (normal) 50 mV (low)
Output impedance:	100 Ω
Polarization of the measured object:	2 V (internal) 0 ... 30 V (external)

Indication of the measuring signal parameters:

Parameter	Range	Accuracy
Voltage	0.001 mV ... 1.000 V	± (3 % + 0.1 mV)
Current	0.1 nA ... 10.00 mA	± (3 % + 10 nA)
BIAS	0 ... 30.00 V	± (1 % + 10 mV)

Table 2 *Indication of the measuring signal parameters*

4.2.4 Measuring Ranges

Measuring parameter	Measuring range	Resolution
|Z|, R	0.01 mΩ ... 199.9 MΩ	0.01 mΩ
L	0.001 µH ... 635.5 kH	0.001 µH
C	0.001 pF ... 399.9 mF	0.001 pF
D	0.0000 ... 9.999	0.0001
Q	0.0000 ... 199	0.0001
φ	– 179.99 ° ... + 180.00 °	0.01°
δ	– 99.99 % ... + 199.9 %	0.01 %

Table 3 *Measuring ranges and resolution of the display values*

4.2.5 Measuring Accuracy

The specifications are valid under the following conditions:

- Warm-up time of t ≥ 20 min
- Connection of the measured object with supplied measuring adapters (See p. 7, Para. 1.10)
- Max. capacity of C ≤ 200 pF of the measuring sockets Li and Lu against ground
- Correction of the residual parameters of the measuring terminals (See p. 39, Para. 6.4.3)

4.2.5.1 Measuring Errors during /Z/, R, L, C Measurement

- For $|Z|$ measurement and R measurement with $\mathbf{Q_m \leq 0.1}$ and L/C measurement with $\mathbf{D_m \leq 0.1}$ the measuring error is the result of the following equation:

$$\mathbf{A = \pm\,(A_b + K_s + K_p) \times K_l \times K_t} \quad [\%]$$

where:
$\mathbf{A_b}$ - basic error (See p. 16, Table 4)
$\mathbf{K_s}$ - additional error for low impedances (See p. 16, Table 5)
$\mathbf{K_p}$ - additional error for high impedances (See p. 16, Table 5)
$\mathbf{K_l}$ - coefficient of the measuring signal level (See p. 16, Table 6)
$\mathbf{K_t}$ - temperature coefficient (See p. 17, Table 7)

- For R measurement with $\mathbf{Q_m > 0.1}$ the measuring error results from the product:

$$\mathbf{A \times \sqrt{1 + Q_m^2}} \quad [\%]$$

where: $\mathbf{Q_m}$ - measured value of the quality Q

- For L/C measurement with $\mathbf{D_m > 0.1}$ the measuring error results from the product:

$$\mathbf{A \times \sqrt{1 + D_m^2}} \quad [\%]$$

where: $\mathbf{D_m}$ - measured value of the dissipation factor D

- Conversion of the impedance Z with the parameters L and C can be carried out with the nomogram (See p. 16, Table 4) or with the following equations:

$$\mathbf{Z = \omega L} \qquad \text{or} \qquad \mathbf{Z = \frac{1}{\omega C}}.$$

4.2.5.2 Measuring Errors during D Measurement

- For D measurement with $D_m \leq 0.1$ the measuring error results from the following equation:

$$\pm A_D / 100 \qquad \text{[absolute value D]}$$

- For D measurement with $0.1 < D_m \leq 1$ the measuring error results from the product:

$$\pm \frac{A_D}{100} \times (1 + D_m) \qquad \text{[absolute value D]}$$

- For D measurement with $D_m > 1$ the measuring error results from the product:

$$\pm \frac{A_D}{100} \times D_m \times (1 + D_m) \qquad \text{[absolute value D]}$$

where: $A_D = A \times (1 + \frac{f}{10000})$

A - measuring error of the main parameter in [%]
(See p. 14, Para. 4.2.5.1)
f - frequency of the measuring signal in [Hz]
D_m - measured value of the dissipation factor D

4.2.5.3 Measuring Errors during Q Measurement

- For Q measurement with $Q_m \leq 0.1$ the measuring error results from the following equation:

$$\pm A_D / 100 \qquad \text{[absolute value Q]}$$

- For Q measurement with $0.1 < Q_m \leq 1$ the measuring error results from the product:

$$\pm \frac{A_D}{100} \times (1 + Q_m) \qquad \text{[absolute value Q]}$$

- For Q measurement with $1 < Q_m \leq 10$ the measuring error results from the product:

$$\pm \frac{A_D}{100} \times Q_m \times (1 + Q_m) \qquad \text{[absolute value Q]}$$

- For Q measurement with $Q_m > 10$ the measuring error results from the product:

$$\pm \frac{A_D}{100} \times Q_m^2 \qquad \text{[absolute value Q]}$$

where: Q_m - measured value of the quality Q

4.2.5.4 Measuring Errors during φ Measurement

- The measuring error results from the following equation:

$$\frac{180}{\pi} \times \frac{A_D}{100} \qquad \text{[deg]}$$

4.2.5.5 *Additional Errors and Coefficients*

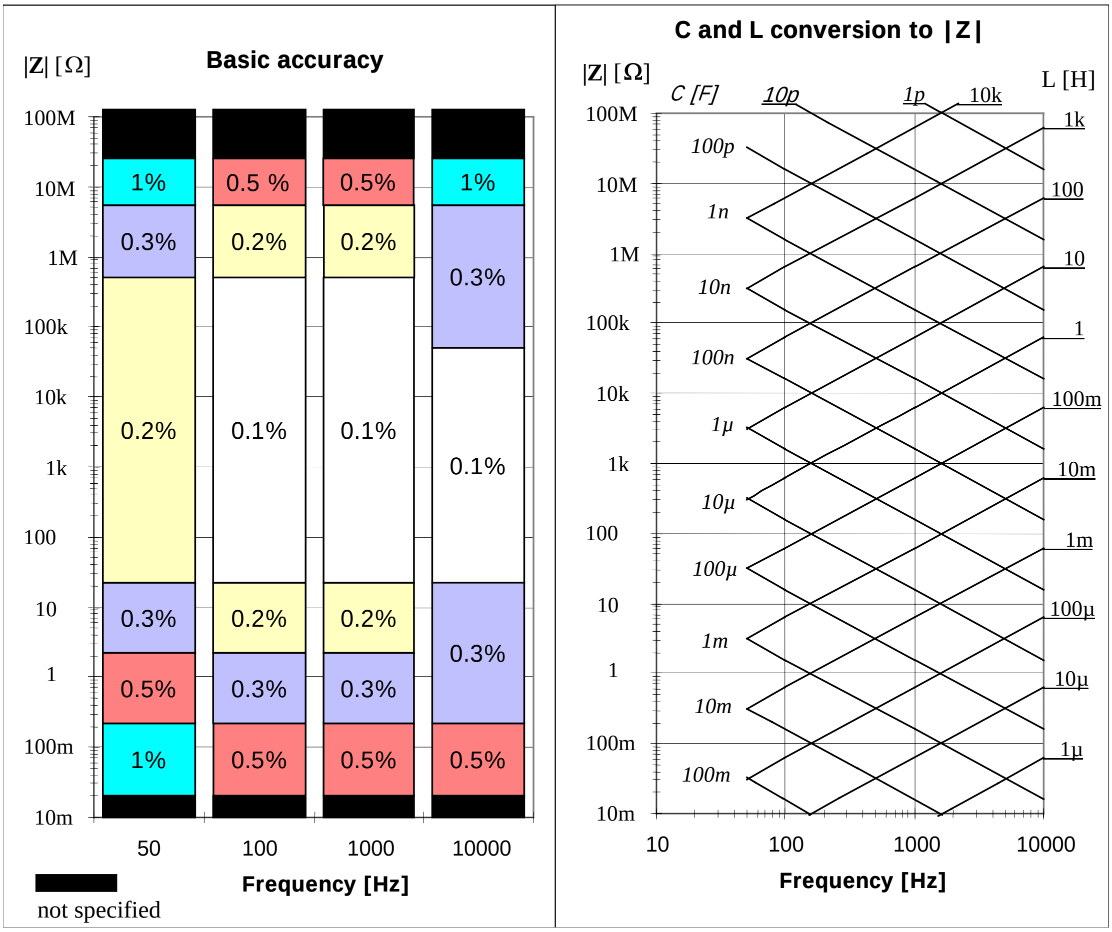


Table 4 *Basic error*

Frequency	K_s [%]	K_p [%]
50 Hz	$2 \times \frac{0,1}{\lvert Z_m \rvert}$	$2 \times \lvert Z_m \rvert \times 10^{-7}$
100 Hz ... 10 kHz	$\frac{0,1}{\lvert Z_m \rvert}$	$\lvert Z_m \rvert \times 10^{-7}$

where: $\lvert Z_m \rvert$ - measuring impedance [Ω]

Table 5 *Additional error*

☞ **Note** The influence of the additional error K_s is negligible at high frequencies, the influence of the additional error K_p is negligible at low frequencies.

Measuring signal level	NORMAL (1 V)	LOW (50 mV)
K_l	1	2

Table 6 *Coefficient of the measuring signal level*

Temperature [° C]	5	11	21	25	35	40	
K_t	-	2	1.5	1	1.5	2	-

Table 7 *Temperature coefficient*

4.3 Display

Set-up and display contents

The RLC 300 is equipped with a 16-digit alphanumerical LC matrix display with background lighting.
It indicates measuring results, error messages or the menu-controlled functions and system messages.

4.4 System Interfaces

Performance range

The RLC 300 is equipped, as standard, with the interfaces GPIB and RS-232C for communication with a PC. All functions and parameters can be set. Set values and states of the RLC 300 can be transmitted.

4.4.1 Interface GPIB

Interface standards:	ANSI/IEEE Std 488.1-1987 and IEEE Std 488.2-1992
Interface functions:	SH1, AH1, SR1, T5, L4, RL1, PP0, DC1, DT1, E2
Length of input buffer:	64 characters
Length of output buffer:	256 characters
General commands:	*CLS, *ESE, *ESE?, *ESR?, *SRE, *SRE?, *STB?, *IDN?, *RST, *TST?, *TRG, *OPC, *OPC?, *WAI

4.4.2 Interface RS-232C

Font:	ASCII
Baud rate (eligible):	1200, 2400, 4800, 9600 Bd
Length of data character:	8 Bit
Number of STOP bits:	1
Parity:	none
Protocol:	RTS/CTS, without (NONE)
Length of input buffer:	64 characters
Length of output buffer:	256 characters
End character on receiving:	LF (10 dec.)
End characters on transmission:	CR + LF (13 dec. + 10 dec.)

4.4.2.1 Plug Connections of Cable

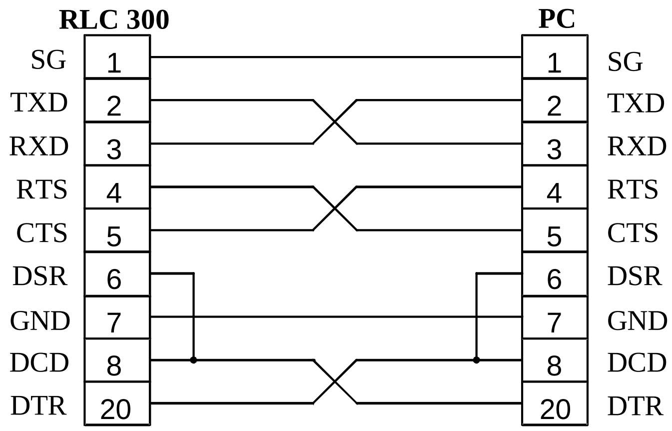


Fig. 2 *Plug connections of cable RS-232C*

5 Instrument Setting

5.1 Connection of the Measured Objects

☞ **Note**	Connecting the measuring cable or the measuring adapter wrongly to the measuring sockets Hi, Hu, Lu, Li leads to incorrect measuring results but not to operational disturbances.

Connecting the measured object with the adapter	Connect the measured object Z_X to the RLC 300 via one of the supplied measuring adapters (See p. 7, Para. 1.10). The effect of the stray capacitances, line inductances and transition resistors is thus strongly reduced. The measuring sockets are marked with the symbols Hi, Hu, Lu and Li. The ground terminal is used for the galvanic connection between the shield of the measured object which may be needed and the earth of the RLC 300.
Connecting the measured object without the adapter	Should you wish to connect the measured object only via the measuring cable (four-terminal) abide by the measuring directions according to Fig. 3 (See p. 19). Hu and Lu connections must be at the shortest distance possible from the measured object. The shield of the measuring cable must also be connected.

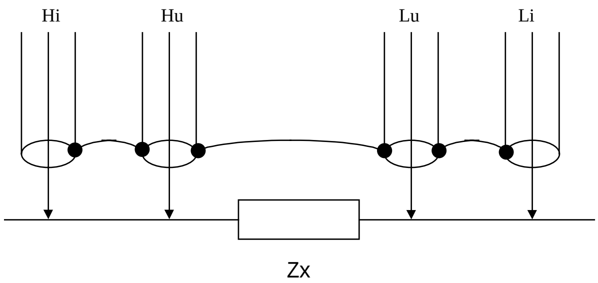


Fig. 3 *Connecting the measured object without the adapter*

5.2 Control Elements

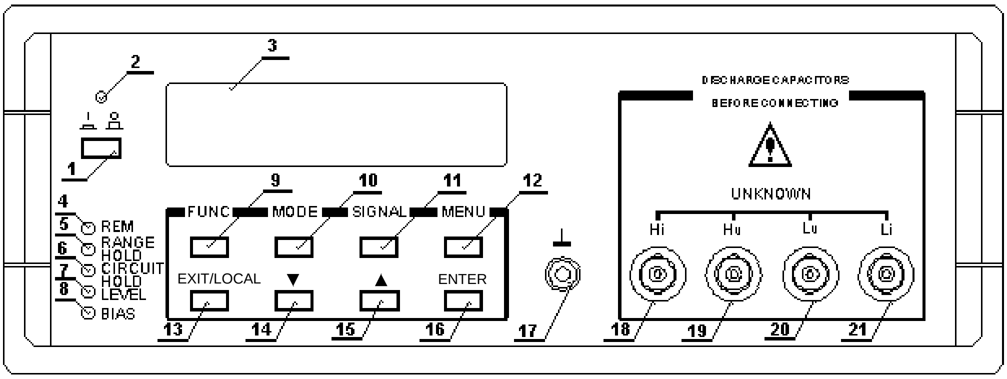


Fig. 4 Front side of the RLC 300

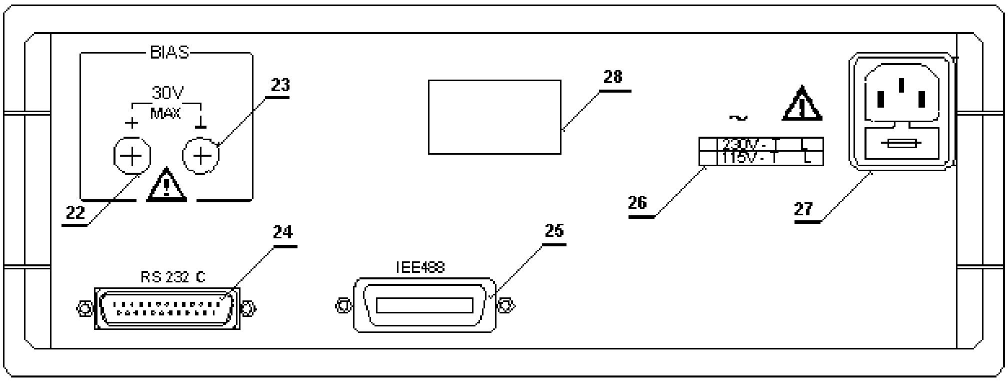


Fig. 5 Rear side of the RLC 300

[1] Power switch

[2] LED *I/O*
The LED indicates whether the unit is ready for operation.

[3] Display
See p. 17, Para. 4.3.

[4] LED *REM*
The LED lights up if the RLC 300 is being remote controlled via the PC.

[5] LED *RANGE HOLD*
The LED lights up if the automatic measuring range selection is blocked.

[6] LED *CIRCUIT HOLD*
The LED lights up if the automatic selection of the equivalent circuit is blocked.

[7] LED *LEVEL*
The LED lights up if the low level of the measuring signal is switched on.

[8] LED *BIAS*
The LED lights up if the polarization voltage is switched on.

[9] F1 button (function button with multiple allocation)
FUNC - The button opens the menu FUNC to set the measuring function.
... - The button has different meanings at the menu levels.

[10] F2 button (function button with multiple allocation)

MODE - The button opens the menu MODE to set the mode of operation of the RLC 300.

... - The button has different meanings at the menu levels.

[11] F3 button (function button with multiple allocation)

SIGNAL - The button opens the menu SIGNAL to set the parameters of the mesuring signal.

... - The button has different meanings at the menu levels.

[12] F4 button (function button with multiple allocation)

MENU - The button opens the menu MENU to set further parameters of the RLC 300.

... - The button has different meanings at the menu levels.

[13] EXIT/LOCAL button

EXIT - The button starts the measurement with the current settings from every menu level.

LOCAL - On remote control the RLC 300 changes to local control.

[14] Cursor button DOWN

⇩ - The cursor is moved downwards in the menu.

[15] Cursor button UP

⇧ - The cursor is moved upwards in the menu.

[16] ENTER button

ENTER - With this button the new parameter setting is confirmed and the previous menu level is selected.

[17] Ground terminal

[18] BNC socket - measuring socket Hi

[19] BNC socket - measuring socket Hu

[20] BNC socket - measuring socket Lu

[21] BNC socket - measuring socket Li

[22] Input socket of the external polarization voltage (positive measuring terminal)

[23] Input socket of the external polarization voltage (negative measuring terminal)

[24] Plug of RS-232C interface

[25] Plug of GPIB interface

[26] Operating voltage indication

The indication shows which operating voltage is to be used.

[27] Fused plug for non-heating appliances

The RLC 300 is protected by a fuse of T100L250V for 230 V~ or T200L250V for 115 V~ net voltage respectively.

[28] Type plate

5.3 Starting

☞ **Note**

When the RLC 300 is operated remotely via PC the connecting cable of the system interface must be connected before switching on the operating voltage. (See p. 51, Para. 7.1.1 and see p. 53, Para. 7.2.1).

Switching on the RLC 300

1. Connect the RLC 300 [27] with the mains cable to the mains system.

2. Press the **power switch** [1].
– The LED *I/O* [2] lights up and the following message appears on the display [3]:

```
<RLC300>
Version:1.01
```

Starting the initialization test

An internal initialization test starts up. The components and the calibrating data are checked.
The following message appears on the display [3]:

```
<RLC300>
PowerUp SelfTest
```

The individual test procedures are accompanied by the following messages:

```
Testing: UNIT
........ PASSED
```

The variable **UNIT** stands for the unit which has just been tested:

- processor (**CPU**)
- RAM memory (**RAM**)
- ROM memory (**EPROM**)
- EEPROM memory (**EEPROM**)
- display (**DISPLAY**)
- keyboard (**KEYBOARD**)
- whole system (**SYSTEM**)

Fault-free test

On error-free conclusion of the test the following confirmation and current software version appear, e. g.:

```
<RLC300>
Version:1.01
```

☞ **Note**

The initialization test can be switched off (See p. 47, Para. 6.5.2.3).

Check of the calibrating data

If the initialization test is switched off the calibrating data of the EEPROM memory are checked only after switching on. On error-free conclusion the following message appears on the display [3]:

```
<RLC300>
Ready!
```

In the event of a fault the following message appears on the display [3]:

```
<RLC300>
Calibration OFF!
```

Operating state	After fault-free testing the parameters of the RLC 300 correspond to the following initial state:

Measuring the main parameters:	automatic
Measuring range selection:	automatic
Selection of the equivalent connection of the measured object:	automatic
Triggering of the measurements:	automatic
Frequency of the measuring signal:	1 kHz
Level of the measuring signal:	NORM (1 V)
Polarization voltage:	is switched off
Monitor function:	is switched off
Averaging function:	is switched off
Correction of the residual parameters:	is switched off
Residual parameters:	are deleted
Tolerance measurement:	is switched off
Reference and tolerance values:	are deleted
Interface parameters:	user-defined
Test to the self-diagnosis:	user-defined

The RLC 300 is in the measuring mode and carries out automatic identification and measurement of the measured object. If a measuring impedance is not connected the following message appears on the display [3], e. g.:

```
Cp:    0.31  pF
 D:    0.04
```

☞ **Note**

After switching on the RLC 300 is basically ready to start measurements. But the specified parameters are only fully set after a warm-up time of approx. 20 minutes.

Faulty test

Should a system error occur during the internal test, the RLC 300 interrupts the test until the error is eliminated. The following message appears on the display [3]:

```
Testing:  UNIT
........  ERROR
```

The variable **UNIT** stands for the unit which has just been tested (See above). If errors which have no direct effect on the function of the RLC 300 occur in the component circuits, the test will continue.

6 Operation of the RLC 300

6.1 Introduction

Keybord

The RLC 300 is operated via eight buttons which are assembled in two rows.
The **upper four buttons** are function buttons F1 to F4 with multiple functions. In response to the state of operation of the RLC 300 and the menu-driven settings, the function buttons perform different tasks (See p. 20, Para. 5.2).
The **lower four buttons** are direct-selection buttons. The cursor buttons ⇩ [14] and ⇧ [15] are used for scrolling with menu-driven settings and the buttons EXIT [13] and ENTER/LOCAL [16] are used to carry out instrument functions quickly.

Menu-driven operation via display

After activating the function buttons F1 to F4, menus and also menu-points for settings are opened.
After opening a menu, the name of the menu is displayed in the top line of the display [3]. The function buttons F1 to F4 have the function as displayed in the bottom line of the display.
The cursor buttons ⇩ [14] and ⇧ [15] serve to set the desired parameters. The request for using the cursor buttons is signalised in the display [3] with the symbol ⇳.

Parameter input and measurement

After opening a menu, the measurements are interrupted until the menu is exited either by pressing the EXIT button [13] or by repeatedly pressing the ENTER button [16] (according to the menu level which has been selected).
Pressing the EXIT button [13] immediately closes the menu-driven settings and starts the measurement. All parameters which have already been set are activated.
The ENTER button [16] selects the previous menu level, or measurement is started.

6.2 Measuring Signal Parameters

6.2.1 Frequency of the Measuring Signal

Introduction

The frequency of the internal measuring signal can be switched between 50 Hz, 100 Hz, 1 kHz and 10 kHz and thus make optimal measurement results possible when determining the various measuring impedances.

6.2.1.1 Setting the Frequency

Calling up the menu point

1. Press the **F3 button SIGNAL** [11] when the RLC 300 is in the measuring mode.
   – The menu for the parameter setting of the measuring signal appears on the display [3].

```
- - - -  S i g n a l  - - - -
F R E Q  L V L       B I A S
```

2. Press the **F1 button FREQ** [9].
– The current value of the measuring frequency appears on the display [3], e. g.:

```
F r e q u e n c y :
⇳                5 0   H z
```

Changing the parameter

3. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], set the desired measuring frequency **50 Hz**, **100 Hz**, **1 kHz** or **10 kHz**.

Completing the settings

4. Change to the menu for the parameter setting of the measuring signal with the **ENTER button** [16].

Starting the measurement

5. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

6.2.2 Level of the Measuring Signal

Nominal and actual value level

Measurements with two different levels of the measuring signal are possible with the RLC 300:

- Measuring voltage NORMAL (1 V)
- Measuring voltage LOW (50 mV)

The nominal value of the measuring voltages can be measured at the load-free measuring socket Hi.
The actual value of the voltage via the measured object is always smaller than the nominal value because of the generator‘s inner resistance (approx. 100 Ω).
The actual value of the voltage via the measured object and the actual value of the current flowing through the measured object can be measured and displayed with the help of the monitor function (See p. 44, Para. 6.5.1).

Application of the LOW level

The LOW level is particularly suitable for measuring semiconductor components such that the semiconductor transition remains blocked.
Furthermore the LOW level is suited to measuring spools with highly permeable cores because the inductance is heavily dependent on the saturation of the core.

6.2.2.1 Setting the Level

Calling up the menu point

1. Press the **F3 button SIGNAL** [11] when the RLC 300 is in the measuring mode.
– The menu for the parameter setting of the measuring signal appears on the display [3]:

```
- - - -   S i g n a l   - - - -
F R E Q   L V L       B I A S
```

2. Press the **F2 button LVL** [10].
– The current value of the measuring frequency appears on the display [3], e. g.:

```
L e v e l :
⇳             N O R M A L
```

Changing the parameter	**3.** With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], set the desired measuring level **NORMAL** (1 V) or **LOW** (50 mV).
Completing the settings	**4.** Change to the menu for the parameter setting of the measuring signal with the **ENTER button** [16].
Starting the measurement	**5.** Start the measuring mode of the RLC 300 with the **EXIT button** [13]. – The active LOW level of the measuring signal is indicated with the LED *LEVEL* [7].

6.2.3 Polarization Voltage

☞ **Note**	Note the connection polarity with applied polarization voltage. There must be no short-circuit between the measuring sockets.

Application	The use of the polarization voltage is particularly suited to measuring electrolytic capacitors and voltage-dependent semiconductor components.
Connection conditions	The polarization voltage is applied internally from a voltage source of approx. 2 V or externally via the input sockets [22] and [23] at the rear panel of the RLC 300. The negative pole of the polarization voltage is at the ground of the RLC 300 and the positive pole of the polarization voltage is at the Hi socket of the RLC 300. When measuring with Kelvin terminals, the positive pole is marked red.

6.2.3.1 Setting the Polarization Voltage

Calling up the menu point	**1.** Press the **F3 button SIGNAL** [11] when the RLC 300 is in the measuring mode. – The menu for the parameter setting of the measuring signal appears on the display [3]:

```
- - - -   S i g n a l   - - - -
F R E Q   L V L         B I A S
```

2. Press the **F4 button BIAS** [12].
– The current state of the polarization voltage appears on the display [3], e. g.:

```
B i a s :
⇳                         O F F
```

Changing the parameter	**3.** With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the current state of the polarization voltage: ▪ **INTERNAL** - The internal dc voltage source of approx. 2 V is switched on. ▪ **EXTERNAL** - An external dc voltage source of 0 to 30 V is connected. ▪ **OFF** - The polarization voltage is switched off.

Completing the settings

4. Change to the menu for the parameter setting of the measuring signal with the **ENTER button** [16].

Starting the measurement

5. Start the measuring mode of the RLC 300 with the **EXIT button** [13].
 – The switched polarization voltage is indicated with the LED *BIAS* [8].

6.3 Measuring Functions

6.3.1 Automatic Measurement of the Main Parameters

Application

Automatic measurement of the impedance parameters allows for the main parameters R, L and C as well as a dominant secondary parameter Q (R, L) or D (C) to be determined.
Should you wish to have a different combination of main and secondary parameters, select the specific measurement of the impedance parameters (See p. 28, Para. 6.3.2).

6.3.1.1 Performing the Automatic Measurement

Calling up the menu point

1. Set the automatic measuring range selection (See p. 37, Para. 6.4.2).

2. Press the **F1 button FUNC** [9] when the RLC 300 is in the measuring mode.
 – The menu for the selection of the measuring functions appears on the display [3]:

```
- -  F u n c t i o n  1  - -
A U T O  M A N  M O N  < >
```

Changing the parameter

3. Select the automatic detection and measurement of the main parameters R, L and C by pressing the **F1 button AUTO** [9].
 – The following message appears on the display [3]:

```
A u t o :            R L C
```

Completing the settings

4. Change to the menu for the selection of the measuring functions with the **ENTER button** [16].

Starting the measurement

5. Start the measuring mode of the RLC 300 with the **EXIT button** [13].
 – The format of the measuring results corresponds to the connected measured object Z_X. The magnitude and the sign of the phase shift of the impedance vector (See p. 28, Fig. 6) serve as deciding criteria for determination of the measuring impedance R, L or C.

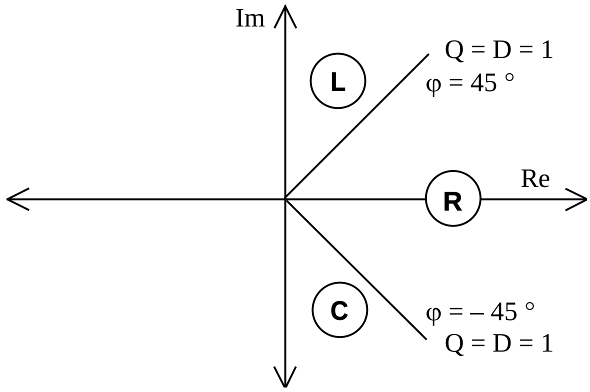


Fig. 6 *Definition of the RLC parameters in the complex plane*

6.3.2 Specific Measurement of the Impedance Parameters

Application

The specific measurement of the impedance parameters makes the determination of the main and secondary parameters possible in arbitrary combination.

6.3.2.1 Performing the Specific Measurement

Calling up the menu point

1. Press the **F1 button FUNC** [9] when the RLC 300 is in the measuring mode.
   – The menu for the selection of the measuring functions appears on the display [3]:

```
- -   F u n c t i o n   1   - -
A U T O   M A N   M O N   < >
```

2. Press the **F2 button MAN** [10].
   – On the display [3] appears:
     - in the first line the main and secondary parameters wich are set for the measurement, e. g. **C - D**
     - in the second line the menu for the selection of the main parameters, e. g.:

```
M a n u a l :          C - D
    R       L       C   | Z | φ
```

Changing the parameter

3. Select the desired main parameters R, L, C or |Z| φ with the **function buttons F1-F4** [9-12].
   – If the main parameter |Z| φ is selected, the following message appears on the display [3]:

```
M a n u a l :          | Z | φ
    R       L       C   | Z | φ
```

   – If the main parameter **X** (R, L oder C) is selected, the menu for the selection of the secondary parameters **Y** (Q, D, L, C, R) appears in the display [3]:

```
M a n u a l :
⇳                       X - Y
```

4. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], select the desired secondary parameter **Y** according to Table 8 (See p. 29).

Main parameter X	Secondary parameter Y		
R	Q	D	L, C
L	Q	D	R
C	Q	D	R

Table 8 *Combinations of the displayed parameters*

Completing the settings

5. Change to the menu for the selection of the measuring function with the **ENTER button** [16].

Starting the measurement

6. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

– If the selected main parameter of the measurement does not correspond to the measured object, a negative display result can occur.

6.3.3 Tolerance Measurement

Introduction

The RLC 300 can determine the absolute (Δ) and relative (δ) deviation of the measuring parameters in relation to a reference value or can carry out a reference measurement with limiting values. The reference and limiting values must be entered before measurement.

6.3.3.1 Input of Reference and Limiting Values

Introduction

When entering the reference and limiting values, the RLC 300 automatically evaluates the set main parameter and sets the corresponding type of reference value which is to be entered.
The reference values are saved separately in the RLC 300 for each main parameter. The limiting values are valid for the same types of the reference values.

Selecting the menu

1. Press the **F1 button FUNC** [9] when the RLC 300 is in the measuring mode.

– The menu for the selection of the measuring functions appears on the display [3]:

```
-- Function 1 --
AUTO MAN MON <>
```

2. Press the **F4 button < >** [12].

– The second part of the menu for the selection of the measuring functions appears on the display [3]:

```
-- Function 2 --
TRIM DEV PAR <>
```

3. Press the **F3 button PAR** [11].

– The menu for entering the reference and limiting values appears on the display [3]:

```
- Ref & Limits -
REF MIN MAX DLIM
```

6.3.3.1.1 Entering the Reference Value

Preparation

1. Set the desired main parameter which serves as the basis for entering the reference value. (See p. 28, Para. 6.3.2).
   – If the automatic measurement of the main parameters is selected the type of the main parameter and the reference value according to the character of the attached measured object is defined.

Calling up the menu point

2. Select the menu for entering the reference and limiting values (See p. 29, Para. 6.3.3.1).

3. Press the **F1 button REF** [9].
   – The menu for entering the reference value appears on the display [3], e. g.:

```
Ref:    0.000  pF ⇳
CLR   <      >  MEAS
```

4. Enter the reference value with the variants **a)** or **b)**.

a) Measuring the reference value

5a. Connect the measuring impedance, which is to serve as a reference value, to the RLC 300.

6a. Press the **F4 button MEAS** [12].
   – The RLC 300 carries out a measurement. The measuring result is saved as a reference value of the set main parameter and appears on the display [3].

☞ **Note**

If the measured value lies outside the measuring range, the message **Overflow** appears briefly on the display [3] and **no** reference value is saved.

---

b) Entering the reference value

5b. With the help of the **F2 button** ⇦ [10] and **F3 button** ⇨ [11], select the position of the reference value to be changed.
   – If the cursor moves to the left or right outside of the displayed range, the power of the reference value is decreased or increased respectively.

6b. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the value displayed at the position of the cursor.
   – The reference value can be entered in the value range according to Table 9 (See p. 32).

☞ **Note**

The **F1 button CLR** [9] has a special function. After pressing this button, the mantissa of the reference value is cleared, but the power is preserved. This simplifies entering reference values of the same power.

Completing the settings

7. Change to the menu for entering the reference and limiting values with the **ENTER button** [16].

Starting the measurement

8. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

6.3.3.1.2 Entering the Positive and Negative Limiting Values

Preparation

1. Enter the reference value which serves as base for the input of the limiting values (See p. 30, Para. 6.3.3.1.1).

Selecting the menu

2. Select the menu for entering the reference and limiting values (See p. 29, Para. 6.3.3.1).

Entering the neg. limiting value

3. Press the **F2 button MIN** [10].
– The menu for the input of the negative limiting value appears on the display [3], e. g.:

```
M i n :        0 . 0 0   %  ⇳
C L R     <       >
```

4. With the help of the **F2 button** ⇦ [10] and **F3 button** ⇨ [11], select the position of the limiting value to be changed.

5. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the value displayed at the position of the cursor.
– The limiting value can be entered in the range of values according to the Table 9 (See p. 32).

Completing the settings

6. Change to the menu for entering the reference and limiting values with the **ENTER button** [16].

Entering the pos. limiting value

7. Press the **F3 button MAX** [11].
– The menu for the input of the positive limiting value appears on the display [3], e. g.:

```
M a x :        0 . 0 0   %  ⇳
C L R     <       >
```

8. With the help of the **F2 button** ⇦ [10] and **F3 button** ⇨ [11], select the position of the limiting value to be changed.

9. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the value displayed at the position of the cursor.
– The limiting value can be entered in the range of values according to the Table 9 (See p. 32).

Completing the settings

10. Change to the menu for entering the reference and limiting values with the **ENTER button** [16].

Starting the measurement

11. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

6.3.3.1.3 Entering the Limiting Value of the Dissipation Factor

Preparation

1. Enter the reference value which serves as base for the input of the limiting values (See p. 30, Para. 6.3.3.1.1).

Selecting the menu

2. Select the menu for entering the reference and limiting values (See p. 29, Para. 6.3.3.1).

3. Press the **F4 button DLIM** [12].
   – The menu for entering the limiting value of the dissipation factor appears on the display [3], e. g.:

```
Dlim:    0.0000  ⇳
CLR  <    >  MEAS
```

4. Enter the limiting value with the variants **a)** or **b)**.

a) Measuring the limiting value of the dissipation factor

5a. Connect the measuring impedance, which is to serve as a limiting value of the dissipation factor to the RLC 300.

6a. Press the **F4 button MEAS** [12].
   – The RLC 300 carries out a measurement. The measurement result is saved as limiting value of the dissipation factor and appears on the display [3].

☞ **Note**

If the measured value is out of the measuring range, the error message **Overflow** appears on the display [3] briefly. **No** limiting value is saved.

b) Entering the limiting value of the dissipation factor

5b. With the help of the **F2 button** ⇦ [10] and **F3 button** ⇨ [11], select the position of the limiting value to be changed.

6b. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the value displayed at the cursor position.
   – The limiting value can be entered in the range of values according to the Table 9 (See p. 32).

Completing the settings

7. Change to the menu for entering the reference and limiting values with the **ENTER button** [16].

Starting the measurement

8. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

6.3.3.1.4 Range of Values of Reference and Limiting Values

Parameter	Minimum value	Maximum value
R, Z	0.00 mΩ	199.99 MΩ
L	0.000 µH	635.51 kH
C	0.000 pF	399.99 mF
MIN	0.00 %	– 99.99 %
MAX	0.00 %	99.99 %
DLIM	0.0000	9.9999

Table 9 *Range of values of reference and limiting values*

☞ **Note**

The maximum reference values of the inductance and the capacitance are valid for the measuring frequency of 50 Hz.

6.3.3.2 Performing the Tolerance Measurement

Preparation

1. Enter the reference value for the corresponding main parameter (See p. 29, Para. 6.3.3.1.1).
2. Enter the limiting values for the comparison measurement (See p. 30, Para. 6.3.3.1.2 and see p. 31, Para. 6.3.3.1.3).

Calling up the menu point

3. Press the **F1 button FUNC** [9] when the RLC 300 is in the measuring mode.
   – The menu for the selection of the measuring functions appears on the display [3]:

```
- -  F u n c t i o n  1  - -
A U T O  M A N  M O N  < >
```

4. Press the **F4 button < >** [12].
   – The second part of the menu for the selection of the measuring functions appears on the display [3]:

```
- -  F u n c t i o n  2  - -
T R I M  D E V  P A R  < >
```

5. Press the **F2 button DEV** [10].
   – The current setting of the tolerance measurement appears on the display [3], e. g.:

```
D e v i a t i o n :
⇳                     A B S
```

Changing the parameter

6. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], set the mode of the tolerance measurement:
   - **ABS** - measurement of the absolute deviation
   - **REL** - measurement of the relative deviation
   - **COMP** - comparison measurement

6.3.3.2.1 Measuring the Absolute Deviation

Setting the mode of tolerance measurement

1. Select the menu for setting the tolerance measurement (See p. 33, Para. 6.3.3.2).
2. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], select the setting **ABS**.

Completing the settings

3. Change to the menu for the selection of the measuring functions with the **ENTER button** [16].

Starting the measurement

4. Start the measuring mode of the RLC 300 with the **EXIT button** [13].
   – The displayed value results from the equation:

$$\Delta = M - R$$

where: Δ - absolute deviation of the measurement
M - measured value
R - reference value

– The result is indicated on the display [3] in the following format, e. g.:

```
∆Rp:    -0.02   Ω
 Q :   0.0002
```

Completing the settings

3. Change to the menu for the selection of the measuring functions with the **ENTER button** [16].

☞ **Note**

The correction of the residual parameters of the measuring terminals is taken into account when the processing the measurement.

6.3.3.2.2 Measuring the Relative Deviation

Setting the mode of tolerance measurement

1. Select the menu for setting the tolerance measurement (See p. 33, Para. 6.3.3.2).

2. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], select the setting **REL**.

Completing the settings

3. Change to the menu for the selection of the measuring functions with the **ENTER button** [16].

Starting the measurement

4. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

– The displayed value results from the equation:

$$\delta = \left(\frac{\mathbf{M}}{\mathbf{R}} - \mathbf{1}\right) \times \mathbf{100}$$

where: δ - relative deviation of the measurement
M - measured value
R - reference value

– The result is indicated on the display [3] in the following format, e. g.:

```
δRp:    -0.01   %
 Q :   0.0002
```

☞ **Note**

The correction of the residual parameters of the measuring terminals is taken into account when processing the measurement.

6.3.3.2.3 Comparison Measurement

Application

The comparison measurement is suited, for example, to sorting same components with similar parameters. The criteria of the comparison measurement are determined with the help of the reference value R and the limiting values MIN, MAX and DLIM. (See p. 29, Para. 6.3.3.1).

Setting the mode of tolerance measurement

1. Select the menu for setting the tolerance measurement (See p. 33, Para. 6.3.3.2).

2. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], select the setting **COMP**.

Completing the settings

3. Change to the menu for the selection of the measuring functions with the **ENTER button** [16].

Starting the measurement

4. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

– In response to the reference value R and the limiting values MIN, MAX the absolute tolerance limits Rmin and Rmax are set in the RLC 300:

$$R_{min} = R \times (1 + MIN) \quad \text{and} \quad R_{max} = R \times (1 + MAX)$$

where:
- R_{min} - lower tolerance limit
- R_{max} - upper tolerance limit
- **R** - reference value
- **MIN** - negative limiting value (relative deviation from the reference value)
- **MAX** - positive limiting value (relative deviation from the reference value)

– The result of the comparison measurement is the states **LOW**, **IN**, **HIGH**, which result from the following dependencies:

LOW	- for	$M < R_{min}$	and	$D < DLIM$
IN	- for	$R_{min} \le M \le R_{max}$	and	$D < DLIM$
HIGH	- for	$M > R_{max}$	and simultaneously	$D < DLIM$
	- for	$M < R_{max}$	and simultaneously	$D > DLIM$
	- for	$M > R_{max}$	and simultaneously	$D > DLIM$

where:
- **M** - measured value
- **D** - dissipation factor of the measured object
- **DLIM** - limit of the dissipation factor

☞ **Note**

If parameter **DLIM = 0**, it is not considered in the comparison measurement.

– The result is indicated on the display [3] in the following format:

```
Compare X:
LOW  <
```

or

```
Compare X:
     < IN >
```

or

```
Compare X:
         > HIGH
```

where: **X** - type of the main parameter R, L, C, Z

6.4 Operating Parameters

6.4.1 Selection of the Equivalent Circuit of the Measured Object

Series and parallel connection

The measured object generally has a complex character. The equivalent circuit can be depicted as series or parallel connection of the real and imaginary components. (See p. 36, Fig. 7).
The RLC 300 uses this approach to determine the measuring parameters.
The equivalent circuit (E circuit) can be set automatically by the RLC 300 or manually by the user.

Fig. 7 *Series or parallel connection of the measuring impedance*

Automatic selection of the E circuit

With regard to optimum measuring conditions, the unit measures high impedances at constant voltage V_P (parallel connection) and low impedances at constant current I_S (series connection).
After instrument setting, the RLC 300 sets itself to measurements with automatic selection of the equivalent circuit.

Manual selection of the E circuit

For evaluation of a specific parameter of the connected measuring impedance, the equivalent circuit must be set. The desired parameter is calculated from the measured parameters with the help of the mathematical relations (See p. 36, Table 10) and displayed.

Measuring function	Series connection (SERIES)		Parallel connection (PARALLEL)	
	R - C	**R - L**	**R - C**	**R - L**
R	R_S	R_S	R_P	R_P
L	$-\frac{1}{\omega^2 C_S}$	L_S	$-\frac{1}{\omega^2 C_P}$	L_P
C	C_S	$-\frac{1}{\omega^2 L_S}$	C_P	$-\frac{1}{\omega^2 L_P}$
Q	$\frac{1}{\omega R_S C_S}$	$\frac{\omega L_S}{R_S}$	$\omega R_P C_P$	$\frac{R_P}{\omega L_P}$
D	$\omega R_S C_S$	$\frac{R_S}{\omega L_S}$	$\frac{1}{\omega R_P C_P}$	$\frac{\omega L_P}{R_P}$

$\omega = 2\pi f$, f = measuring frequency

Table 10 *Mathematical definition of the measuring parameters*

6.4.1.1 *Setting the Equivalent Circuit*

Calling up the menu point

1. Press the **F2 button MODE** [10] when the RLC 300 is in the measuring mode.
   – The menu for setting the operating mode appears on the display [3]:

```
- - - - -   M o d e   - - - - -
R N G   C I R   T R I G   A V G
```

2. Press the **F2 button CIR** [10].
   – The current selection of the equivalent circuit appears on the display [3], e. g.:

```
C i r c u i t :
⇳                      A U T O
```

Changing the parameter

3. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the current setting of the equivalent circuit:
   - **AUTO** - automatic selection of the equivalent circuit
   - **SERIES** - series connection of the measuring impedance
   - **PARALLEL** - parallel connection of the measuring impedance

Completing the settings

4. Change to the menu for setting the operating mode with the **ENTER button** [16].

Starting the measurement

5. Start the measuring mode of the RLC 300 with the **EXIT button** [13].
   – The manual selection of the equivalent circuit is indicated with the LED *CIRCUIT HOLD* [6].

6.4.2 Measuring Range Selection

Automatic measuring range selection

The RLC 300 is particularly suitable for measurements involving automatic measuring range selection.
In order to yield optimum measuring results, the measuring range with the highest measuring resolution is set in response to the connected measuring impedance.
After instrument setting, the instrument sets itself for automatic measuring range selection.

Manual measuring range selection

On repeated measurements of the object 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 optimum measuring range does not take place. The RLC300 works internally with ten measuring ranges.

6.4.2.1 Setting the Measuring Range

Calling up menu point

1. Press the **F2 button MODE** [10] when the RLC 300 is in the measuring mode.
– The menu for setting the operating mode appears on the display [3]:

```
- - - - -   M o d e   - - - - -
R N G   C I R   T R I G   A V G
```

2. Press the **F1 button RNG** [9].
– The current measuring range selection appears on the display [3], e. g.:

```
R a n g e :             H O L D
A U T O   H O L D
```

Changing the parameter

3. With the help of **function buttons F1** [9] und **F2** [10] select the automatic (**AUTO**) or manual (**HOLD**) measuring range selection.
– If the automatic measuring range selection is selected, the following message appears on the display [3]:

```
R a n g e :             A U T O
A U T O   H O L D
```

– If the manual measuring range selection is selected, the menu for the measuring range selection appears on the display [3], e. g.:

```
R a n g e :             H O L D
⇳                           0 6
```

4. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], select the desired measuring range from **01** to **10**.

Completing the settings

5. Change to the menu for setting the operating mode with the **ENTER button** [16].

Starting the measurement

6. Start the measuring mode of the RLC 300 with the **EXIT button** [13].
– The manual measuring range selection is indicated with the LED *RANGE HOLD* [5].
– When setting the measuring range, errors can occur which are displayed with the corresponding messages. (See p. 38, Para. 6.4.2.2).

6.4.2.2 Error Messages

OVERLOAD

The connected measuring impedance causes an overload of the RLC 300 analog component (voltage or current channel) during measurement. The following error message appears on the display [3]:

```
* *   E r r o r :   3 0     * *
        O v e r l o a d
```

OUT OF RANG

With the manual measuring range selection the connected measuring impedance does not correspond to the set measuring range (See p. 37, Para. 6.4.2). The component, which is used for synchronisation of the measurement is too small. The following error message appears on the display [3]:

```
** Error:  20 **
  Out of range
```

OVERFLOW

The value of the connected measuring impedance has exceeded the set (manual measuring range selection) and the maximum (automatic measuring range selection) measuring range. The following error message appears on the display [3], e. g.:

```
 Rp: 10.000 kΩ
 D : Overflow
```

or

```
 Rp: Overflow
 D :    0.01
```

☞ **Note**

If the set measuring range at the manual measuring range selection deviates from the correct measuring range and no error message appears, then the specified measuring accuracies (See p. 14, Para. 4.2.5) for the measuring result do **not** apply.

6.4.3 Residual Parameters of the Measuring Terminals

Residual parameters

The measuring signals are tapped off by a four-terminal configuration 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 of the measuring terminals becomes apparent.

The residual parameters can be measured in the case of load-free measuring terminals and also in the case of a short-circuit of the measuring terminals.

Compensation of the residual parameters can be carried out with the help of the correction function.

6.4.3.1 Measuring the Residual Parameters

Selecting the menu

1. Press the **F1 button FUNC** [9] when the RLC 300 is in the measuring mode.
   – The menu for the selection of the measuring functions appears on the display [3]:

```
- -  F u n c t i o n  1  - -
A U T O  M A N  M O N  < >
```

2. Press the **F4 button < >** [12].
   – The second part of the menu for the selection of the measuring functions appears on the display [3]:

```
- -  F u n c t i o n  2  - -
T R I M  D E V  P A R  < >
```

3. Press the **F1 button TRIM** [9].
   – The menu for the measurement and correction of the residual parameters appears on the display [3]:

```
T r i m :
O P E N  S H O R T   C A L C
```

☞ **Note** After switching off the RLC300 the correction values are deleted.

6.4.3.1.1 Residual Parameters at Load-free Measuring Terminals

Preparation

1. Switch the measuring terminals to the load-free state.

Selecting the menu

2. Select the menu for the measurement and correction of the residual parameters (See p. 39, Para. 6.4.3.1).

Measuring the residual parameters

3. Press the **F1 button OPEN** [9].
   – Measurement for all frequencies of the measuring signal is carried out. In the display [3] the actual frequency value appears. The measured residual parameters are saved in the RLC 300.
   – If the residual impedance of the load-free measuring terminals is smaller than 100 kΩ then the measured value is not saved and the following message appears briefly on the display [3]:

```
T r i m  O P E N :
         O v e r f l o w
```

   – After completion of the measurement of the residual parameters the RLC 300 changes to the menu for the measurement and correction of the residual parameters.

6.4.3.1.2 Residual Parameters at Short-circuited Measuring Terminals

Preparation

1. Short-circuit the measuring terminals.
   – For the measuring adapter with Kelvin terminals, the short-circuit has to be generated at the outermost ends of the treminals.

Selecting the menu

2. Select the menu for the measurement and correction of the residual (See p. 39, Para. 6.4.3.1).

Measuring the residual parameters

3. Press the **F2 button SHORT** [10].
- Measurement is carried out for all frequencies of the measuring signal. In the display [3] the actual frequency value appears. The measured residual parameters are saved in the RLC 300.
- If the residual impedance of the short-circuited measuring terminals is smaller than 10 Ω then the measured value is not saved and the following message appears briefly on the display [3]:

```
Trim SHORT:
     Overflow
```

- After completion of the measurement the RLC 300 changes to the menu for the measurement and correction of the residual parameters.

6.4.3.2 Correcting the Residual Parameters

Application

After measuring the residual parameters of the measuring terminals the measured values are saved in the memory of the RLC 300 and can be used during impedance measurement for the correction of the measuring results.

Calling up the menu point

1. Select the menu for the measurement and correction of the residual parameters (See p. 39, Para. 6.4.3.1).

2. Press the **F4 button CALC** [12].
- The current state of the correction function appears on the display [3]:

```
Trim calcul.:
⇳          DISABLED
```

Changing the parameter

3. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the current state of the correction function:
- **ENABLED** - automatic correction of the residual parameters
- **DISABLED** - The correction function is switched off.

Completing the settings

4. Change to the menu for the measurement and correction of the residual parameters with the **ENTER button** [16].

Starting the measurement

5. Start the measuring mode of the RLC 300 with the **EXIT button** [13].
- The active correction function is identified in the display [3] at the end of the upper line with the symbol **T**, e. g.:

```
 Rp: 100.00   Ω T
 Q : 0.0002
```

6.4.4 Trigger Function

Introduction

The RLC 300 allows for continual and single (manually controlled) triggering of the measurements.

6.4.4.1 Setting the Trigger Mode

Calling up the menu point

1. Press the **F2 button MODE** [10] when the RLC 300 is in the measuring mode.

– The menu for setting the operating mode appears on the display [3]:

```
- - - - -   M o d e   - - - - -
R N G   C I R   T R I G   A V G
```

2. Press the **F3 button TRIG** [11].

– The current selection of the triggering appears on the display [3], e. g.:

```
T r i g g e r :
⇳           C O N T I N U O U S
```

Changing the parameter

3. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the current setting of the triggering:

- **CONTINUOUS** - continuous triggering of the measurement
- **SINGLE** - single triggering of the measurement

Completing the settings

4. Change to the menu for setting the operating mode with the **ENTER button** [16].

Starting the measurement

5. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

– With the trigger function **SINGLE** one single measurement is started each time the **ENTER button** [16] is pressed. The end of the previous measurement (measuring result) must be waited for. Otherwise the active measurement is stopped.

6.4.5 Averaging Function

Introduction

The averaging function allows the measuring result to be displayed with a higher accuracy. Ten measurements are carried out, mathematically evaluated and the end result is displayed.

Application

The use of the averaging function is suited for measurements close to the measuring range limits where the measuring results can be unstabler.

6.4.5.1 *Switching on/off the Averaging Function*

Calling up the menu point

1. Press the **F2 button MODE** [10] when the RLC 300 is in the measuring mode.
– The menu for setting the operating mode appears on the display [3]:

```
- - - - -  M o d e  - - - - -
R N G  C I R  T R I G  A V G
```

2. Press the **F4 button AVG** [12].
– The current setting of the averaging function appears on the display [3], e. g.:

```
A v e r a g e :
⇳                          1
```

Changing the parameter

3. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the current setting of the averaging function:
- **1** - The averaging function is switched off.
- **10** - The averaging function is switched on.

Completing the settings

4. Change to the menu for setting the operating mode with the **ENTER button** [16].

Starting the measurement

5. Start the measuring mode of the RLC 300 with the **EXIT button** [13].
– At the active averaging function the measurement result appears after approx. 3 to 4 s.

6.5 Additional Functions

6.5.1 Monitor Function

Introduction

The RLC 300 allows mesurement and display of the measuring voltage present at the measured object and the current flowing through the measured object or the polarization direkt voltage connected to the measured object.

Selecting the menu

1. Press the **F1 button FUNC** [9] when the RLC 300 is in the measuring mode.
   – The menu for the selection of the measuring functions appears on the display [3]:

```
-- Function 1 --
AUTO MAN MON <>
```

2. Press the **F3 button MON** [11].
   – The current setting of the monitor function appears on the display [3], e. g.:

```
Monitor:
⇳               OFF
```

Changing the parameter

3. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the current setting of the monitor function:
   - **V - I** - The measuring signal parameters are measured and displayed.
   - **BIAS** - The polarizing voltage is measured and displayed.
   - **OFF** - The monitor function is switched off.

6.5.1.1 Measuring and Displaying the Measuring Signal Parameters

Application

This function is suiteble e. g., for controlling voltage- or current-loading of the measured object.

Calling up the menu point

1. Select the menu for setting the monitor function (See p. 44, Para. 6.5.1).

2. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], select the setting **V - I**.

Completing the settings

3. Change to the menu for setting the monitor function with the **ENTER button** [16].

Starting the measurement

4. Start the measuring mode of the RLC 300 with the **EXIT button** [13].
   – The measurement result appears on the display [3] in the following format, e. g.:

```
 Rp: 100.00  Ω
 500.0mV 5.000mA
```

6.5.1.2 Measuring and Displaying the Polarization Voltage

Application

With the help of this function, the voltage dependence of the capacitance from semiconductor components can be measured.

Calling up the menu point

1. Select the menu for setting the monitor function (See p. 44, Para. 6.5.1).

2. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], select the setting **BIAS**.

Completing the settings

3. Change to the menu for setting the monitor function with the **ENTER button** [16].

Starting the measurement

4. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

– The measurement result appears on the display [3] in the following format, e. g.:

```
  Cp:    10.00  pF
Bias:    0.000   V
```

6.5.2 User Functions

Contents

The RLC 300 is equipped with a series of special functions which support user-oriented control and measurement.

Selecting the menu

1. Press the **F4 button MENU** [12] when the RLC 300 is in the measuring mode.

– The main menu appears on the display [3]:

```
----- Menu -----
INT USER SERVICE
```

2. Press the **F2 button USER** [10].

– The menu of the user functions appears on the display [3]:

```
-- User  Menu --
STO RCL TEST LCD
```

6.5.2.1 Saving the Current Instrument Settings

Application

If measurements with certain instrument settings are repeated, there is the possibility of saving up to four parameter configurations in the RLC 300.

Preparation

1. Set the desired parameter configuration:

- Automatic or specific measurement of the impedance parameters incl. the combination of the main and secondary parameters
- Monitor function
- Correction of the residual parameters of the meas. terminals
- Tolerance measurement incl. the reference and limiting values
- Mode of the meas. range selection incl. the current meas. range
- Selection of the equivalent circuit
- Averaging function
- Frequency of the measuring signal
- Levels of the measuring signal
- Source of the polarization voltage

Calling up the menu point

2. Call up the menu of the user functions (See p. 45, Para. 6.5.2).

3. Press the **F1 button STO** [9].
– The selection of the memories appears on the display [3]:

```
Store  user  Nr.
 0   1   2   3
```

Changing the parameter

4. With the help of the **function buttons F1-F4** [9-12] select the memory space **0**, **1**, **2** or **3**.
– If the **memory space is free**, the actual instrument setting is saved. The following message appears on the display [3]:

```
Store  user  Nr.X
........  OK!
```

X is the number of the selected memory space.
The RLC 300 changes to the menu of the user functions.

– If the **memory space is occupied**, the question if the memory content should be replaced appears on the display [3]:

```
Store  user  Nr.X
Rewrite? YES  NO
```

5.a) Press the **F3 button YES** [11].
– The current instrument setting is saved. The following message appears on the display [3]:

```
Store  user  Nr.X
........  OK!
```

The RLC 300 reverts to the menu of the user functions.

5.b) Press the **F4 button NO** [12].
– The RLC 300 changes to the menu of the user functions without saving.

Starting the measurement

6. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

6.5.2.2 Loading the Saved Instrument Setting

Calling up the menu point

1. Call up the menu of the user functions (See p. 45, Para. 6.5.2).

2. Press the **F2 button RCL** [10].

– The selection of the memories appears on the display [3]:

```
Recall user Nr.
 0   1   2   3
```

Loading the parameter

3. With the help of the **function buttons F1-F4** [9-12] select the memory space **0**, **1**, **2** or **3**.

– If the **memory space is occupied**, the current instrument setting is loaded. The following message appears on the display [3]:

```
Recall user Nr.X
........ OK!
```

X is the number of the selected memory space.
The RLC 300 reverts to the menu of the user functions.

– If the **memory space is not occupied**, the following message appears on the display [3]:

```
Recall user Nr.X
is not defined!
```

The RLC 300 changes to the menu of the user functions.

Starting the measurement

4. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

6.5.2.3 Switching on/off the Initialization Test

Calling up the menu point

1. Call up the menu of the user functions (See p. 45, Para. 6.5.2).

2. Press the **F3 button TEST** [11].

– The current state of the initialization test appears on the display [3]:

```
PowerUp SelfTest
⇳         ENABLED
```

Changing the parameter

3. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the current state of the initialization test:

- **ENABLED** - The initialization test is switched on.
- **DISABLED** - The initialization test is switched off.

Completing the settings

4. Change to the menu of the user functions with the **ENTER button** [16].

Starting the measurement

5. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

6.5.2.4 Settings at the Display

Contents

With the RLC 300, it is possible to adjust the brightness and contrast settings of the display according to user preferences.

Calling up the menu point

1. Call up the menu of the user functions (See p. 45, Para. 6.5.2).

2. Press the **F4 button LCD** [12].
– The menu for setting the display appears on the display [3]:

```
-- LCD Adjust --
CONTR     BRIGHT
```

Changing the contrast

3. Press the **F1 button** [9] or **F2 button CONTR** [10].
– The current contrast setting appears on the display [3], e. g.:

```
Contrast Adjust:
⇳            90 %
```

4. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the current contrast setting in the range of 0 to 100 % in 5 % steps.

Completing the settings

5. Change to the menu for setting the display with the **ENTER button** [16].

Changing the brightness

6. Press the **F3 button** [11] or **F4 button BRIGHT** [12].
– The current brightness setting appears on the display [3]:

```
Bright Adjust:
⇳            80 %
```

7. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the current brightness setting in the range of 0 to 100 % in 5 % steps.

Completing the settings

8. Change to the menu for setting the display with the **ENTER button** [16].

Starting the measurement

9. Start the measuring mode of the RLC 300 with the **EXIT button** [13].
– After switching off the RLC 300 the last settings of the display is kept.

6.5.3 Service Functions

Contents

The RLC 300 contains diagnostic tests for self-diagnosis and special functions for service and calibration work.

Selecting the menu

1. Press the **F4 button MENU** [12] when the RLC 300 is in the measuring mode.
   – The main menu appears on the display [3]:

```
- - - - -  M e n u  - - - - -
I N T  U S E R  S E R V I C E
```

2. Press the **F3 button** [11] or **F4 button SERVICE** [12].
   – The menu of the service functions appears on the display [3]:

```
-  S e r v i c e  M e n u  -
T E S T        S P E C I A L
```

6.5.3.1 Self-diagnosis of the RLC 300

☞ **Note** — For the successful testing sequence test equipment is necessary.

Calling up the menu point

1. Call up the menu of the service functions (See p. 48, Para. 6.5.3).

Starting the self-diagnosis

2. Press the **F1 button TEST** [9].
- Internal diagnostic test routines are started.
- After successful completion of the test the RLC 300 returns to the menu of the service functions.

Starting the measurement

3. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

6.5.3.2 Special Functions of the RLC 300

Calling up password input

1. Call up the menu of the service functions (See p. 48, Para. 6.5.3).

2. Press the **F3 button** [11] or **F4 button SPECIAL** [12].
- The field for the input of the password appears on the display [3]:

```
Password:          ⇳
 <    >    00000000
```

Entering the password

3. With the help of the **F1 button** ⇦ [9] and **F2 button** ⇨ [10], select the position of the password to be changed.

4. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the value displayed at the position of the cursor.

5. Press the **ENTER button** [16] after completion of the password input.
- The special menu is opened to the authorized user (service technicians) for service and calibration work.

Wrong password input

Upon wrong input of the password the following message appears on the display [3] and the RLC 300 changes to the menu of the service functions:

```
Password:          ⇳
Invalid  password
```

6. Press the **ENTER button** [16].
- The RLC 300 changes to the measuring mode.

7 Remote Control by Program

☞ **Note**	For remote control of the RLC 300 the connecting cable of the respective system interface GPIB or RS-232C has to be connected before switching on the operating voltage.

7.1 Remote Control via GPIB (IEEE 488.2)

7.1.1 Connection of the RLC 300 to the System

Prerequisite

The connecting cable must correspond to the standard IEEE 488.1 when the RLC 300 is connected to a system with an interface to IEEE 488.1.

Joining the connecting cable

1. Join the connecting cable to the RLC 300 [25] and the system (PC, measuring system, printer).

2. Screw in tight the connections.

☞ **Note**	Make sure that the phase of the mains voltage at the RLC 300 and the system is the same, the earth connection was removed and the EMC/ESD regulations are observed.

Switching on the RLC 300

3. Switch on the RLC 300.
– After the initialization test the RLC 300 can receive commands.

7.1.2 Selection of the Interface Type

Selecting the menu

1. Press the **F4 button MENU** [12] when the RLC 300 is in the measuring mode.
– The main menu appears on the display [3]:

```
- - - - -  M e n u  - - - - -
I N T  U S E R  S E R V I C E
```

2. Press the **F1 button INT** [9].
– The menu for the configuration of the interface appears on the display [3]:

```
- -  I n t e r f a c e  - -
T Y P E  S E T
```

Calling up the menu point

3. Press the **F1 button TYPE** [9].
– The current interface type appears on the display [3], e. g.:

```
I n t e r f a c e  T y p e :
⇳                   R S 2 3 2
```

Changing the parameter

4. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the interface type:
- **GPIB** - The interface GPIB is active.
- **RS-232C** - The interface RS-232C is active.

Completing the settings

5. Change to the menu for the configuration of the interface with the **ENTER button** [16].

Starting the measurement

6. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

7.1.3 Interface Parameters

Selecting the menu

1. Press the **F4 button MENU** [12] when the RLC 300 is in the measuring mode.
   – The main menu appears on the display [3]:

```
----- Menu -----
INT USER SERVICE
```

2. Press the **F1 button INT** [9].
   – The menu for the configuration of the interface appears on the display [3]:

```
-- Interface --
TYPE SET
```

3. Press the **F2 button SET** [10].
   – The menu for setting the interface parameters appears on the display [3]:

```
--- Set GPIB ---
ADDRESS TON
```

7.1.3.1 Setting the GPIB Address

Calling up the menu point

1. Select the menu for setting the interface parameters (See p. 51, Para. 7.1.3).

2. Press the **F1 button** [9] or **F2 button ADDRESS** [10].
   – The current GPIB address appears on the display [3], e. g.:

```
GPIB Address:
⇳             07
```

Changing the parameter

3. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the GPIB address within the range of **00** to **31**.

Completing the settings

4. Change to the menu for setting the interface parameters with the **ENTER button** [16].

Starting the measurement

5. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

7.1.3.2 Operation without Control Unit - TON

Application

In operating mode TON (TALK ONLY) it is possible to connect a device (printer) in the operating mode LON (LISTEN ONLY) to the RLC 300. With it the reporting of readings is possible.

Calling up the menu point

1. Select the menu for setting the interface parameters (See p. 51, Para. 7.1.3).

2. Press the **F3 button TON** [11].
   – The current state of the operating mode TON appears on the display [3], e. g.:

```
Talk ONly:
⇳            OFF
```

Changing the

3. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change

parameter	the state of the operating mode TON: ▪ **ON** - The operating mode TON is switched on. ▪ **OFF** - The operating mode TON is switched off.
Completing the settings	**4.** Change to the menu for setting the interface parameters with the **ENTER button** [16].
Starting the measurement	**5.** Start the measuring mode of the RLC 300 with the **EXIT button** [13]. – After every measurement the measured value is filed in the output buffer and is sent in the following format: ▪ **<UNIT> <TX.XETZX><CR><END>** to **<UNIT> <TYXX.XXXETZX><CR><END>** where: **UNIT** - measuring unit of the current measuring function (See p. 70, Para. 7.5.3) **E** - exponent **X** - character from **0** to **9** **Y** - character from **1** to **9** **Z** - character **0** or **1** **T** - character **+**, **–** or **“Blank”** **CR** - character **CR** (13 dec.) **END** - end signal **LF** (10 dec.) + **END** (EOI true)

☞ **Note** If there is no active device (printer) in operating mode LON connected to the RLC 300, error 171 **No listener** appears.

7.2 Remote Control via RS-232C

7.2.1 Connection of the RLC 300 to the PC

Prerequisite	Remote control of the RLC 300 with a personal computer (PC) is possible via the serial interface RS-232C. The interface of the personal computer must be configured as described in paragraph 4.4.2 (See p. 17). The connecting cable of the type DTE-DTE must not be longer than 15 m.
Joining the connecting cable	**1.** Join the connecting cable to the RLC 300 [24] and the PC. **2.** Screw in tight the connections.

☞ **Note** Make sure that the phase of the mains voltage at the RLC 300 and PC is the same, the earth connection was removed and the EMC/ESD regulations are observed.

Switching on the RLC 300	**3.** Switch on the RLC 300. – After the initialization test the RLC 300 can receive commands.

7.2.2 Selection of the Interface Type

Reference	Set the interface type **RS-232C** (See p. 51, Para. 7.1.2).

7.2.3 Interface Parameters

Selecting the menu	**1.** Press the **F4 button MENU** [12] when the RLC 300 is in the measuring mode.

– The main menu appears on the display [3]:

```
- - - - -  M e n u  - - - - -
I N T  U S E R  S E R V I C E
```

2. Press the **F1 button INT** [9].

– The menu for the configuration of the interface appears on the display [3]:

```
- -  I n t e r f a c e  - -
T Y P E  S E T
```

3. Press the **F2 button SET** [10].

– The menu for setting the interface parameters appears on the display [3]:

```
- -  S e t  R S  2 3 2  - -
B D - R A T E  P R O T O C O L
```

7.2.3.1 Setting the Baud Rate

Calling up the menu point

1. Select the menu for setting the interface parameters (See p. 53, Para. 7.2.3).

2. Press the **F1 button** [9] or **F2 button BD-RATE** [10].

– The current baud rate appears on the display [3], e. g.:

```
B a u d  R a t e :
⇳                  9 6 0 0
```

Changing the parameter

3. With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the baud rate (**1200**, **2400**, **4800** or **9600** Bd).

Completing the settings

4. Change to the menu for setting the interface parameters with the **ENTER button** [16].

Starting the measurement

5. Start the measuring mode of the RLC 300 with the **EXIT button** [13].

7.2.3.2 Setting the Transmission Protocol

Calling up the menu point	**1.** Select the menu for setting the interface parameters an (See p. 53, Para. 7.2.3). **2.** Press the **F3 button** [11] or **F4 button PROTOCOL** [12]. – The current setting of the transmission protocol appears on the display [3], e. g.:

```
P r o t o c o l :
⇳                N O N E
```

Changing the parameter	**3.** With the help of the **cursor buttons** ⇩ [14] and ⇧ [15], change the setting of the transmission protocol: ▪ **NONE** - communication without transmission protocol ▪ **RTS/CTS** - communication with RTS/CTS protocol
Completing the settings	**4.** Change to the menu for setting the interface parameters with the **ENTER button** [16].
Starting the measurement	**5.** Start the measuring mode of the RLC 300 with the **EXIT button** [13].

7.2.4 Transmission Protocol

Contents	The communication between RLC 300 and PC can be carried out with RTS/CTS protocol or without transmission protocol (NONE).

7.2.4.1 Communication with RTS/CTS Protocol

Data received from PC	Signal **RTS=ON** – RLC 300 can receive data. Signal **RTS=OFF** – RLC 300 cannot receive data.
Data transmitted to PC	Signal **CTS=ON** – RLC 300 transmitting data. Signal **CTS=OFF** – RLC 300 not transmitting data.

7.2.4.2 Communication without RTS/CTS protocol

Data received from PC	Signal **RTS=ON** – RLC 300 can always receive data, on overloading of the input buffer the error 181 **Inp. Buffer Full** is reported.
Data transmitted to PC	Signal **CTS=ON** – RLC 300 can always transmit data.

☞ **Note**	The signal at the output DTR is identical with the signal at the input DSR (The connections DTR and DSR of the plug [24] are connected together).

7.3 Local Control ⇔ Remote Control

Activating the remote control	Send the command **REN** via the control unit (PC, measuring system). – The RLC 300 is in the REMOTE CONTROL status. This is indicated by the LED *REM* [4]. Afterwards control of the RLC 300 by the local control elements is not possible (except with the **LOCAL button** [13]). – After the transition to the remote control the current measurement is ended. The RLC 300 is set in the operating mode **SINGLE** (single triggering of the measurement).
☞ **Note**	Block the **LOCAL button** [13] with the help of the command **LLO**. Then all the commands of the PC are processed completely.
Activating the local control	– There are several ways of switching from remote control to local control: ▪ By transmitting command **GTL** (Go To Local) from the PC ▪ By pressing the **LOCAL button** [13] at the RLC 300 if the keyboard has not been locked by the command **LLO** (Local Lock Out) ▪ By switching the **power switch** [1] off and on – The button field is ready for use again after the transition for the local control. The LED *REM* [4] goes out.
Remote control at local control	– The following commands and signals can also be transmitted and received by the control unit when the RLC 300 is on local control: ▪ ***IDN?**, ***CLS**, ***ESR?**, ***ESE**, ***ESE?**, ***STB?**, ***SRE**, ***SRE?**, **ERR?**, **DER?**.
☞ **Note**	For local control, transmission of commands and messages is slow. If commands other than those described above are transmitted error 132 **Not Ex. in Local** appears.

7.4 Messages of the RLC 300 on Remote Control

7.4.1 Description of the Unit Status

Introduction

The current status of the operating conditions of the RLC 300 can be interrogated at any time via the EVENT STATUS REGISTER and the STATUS BYTE REGISTER.

7.4.1.1 ESR - EVENT STATUS REGISTER

Reading and deleting the register

By transmitting the command ***ESR?** the contents of the ERS register **XXX** within the range of **0** to **255** are saved in the output buffer and deleted.

The ESR register can set on **Ø** after the following operations (except bit 7):

- Switching on the RLC 300
- Transmitting the command ***CLS**
- Changing the interface parameters

Contents of the ESR register

Bit 7: (PON) Power On
Operating readiness and interface activities are displayed on **1**.

Bit 6: (URQ) User Request
Is not used, is always set on **Ø**.

Bit 5: (CME) Command Error
Is set on **1** at instruction errors.

Bit 4: (EXE) Execution Error
Is set on **1** at query errors and execution errors.

Bit 3: (DDE) Device Dependent Error
Device errors are displayed on **1**.

Bit 2: (QYE) Query Error
Is set on **1** at query errors.

Bit 1: (RQC) Request Control
Is not used, is always set on **Ø**.

Bit 0: (OPC) Operation Complete
Is set on **1** by transmitting the command ***OPC**.

7.4.1.1.1 ESE - EVENT STATUS ENABLE REGISTER

Meaning of the register

Various statuses and settings of the RLC 300 can be checked. For this the contents of the ESR register are called with the help of a mask. The single bits are compared and evaluated by the following logical equation:

- $ESB = (ESR7 \wedge ESE7) \vee (ESR6 \wedge ESE6) \vee (ESR5 \wedge ESE5) \vee (ESR4 \wedge ESE4) \vee (ESR3 \wedge ESE3) \vee (ESR2 \wedge ESE2) \vee (ESR1 \wedge ESE1) \vee (ESR0 \wedge ESE0)$

The result ESB (Event Summary Bit) is entered in the STB register.

Describing the register

The command ***ESE <XXX>** offers the possibility of initializing the ESE register with any mask. The value **XXX** has to be within the range of **0** to **255**. Otherwise the error 134 **Val. Out of Range** is reported.

Reading and deleting the register

The current contents **XXX** are saved in the output buffer by transmitting the command ***ESE?**.

The ESE register can set on **Ø** after the following operations:

- Switching on the RLC 300
- Transmitting the command ***ESE 0**

Changing the interface parameters

7.4.1.2 STB - STATUS BYTE REGISTER

Reading and deleting the register

By transmitting the command ***STB?** the contents of the STB register **XXX** within the range of **0** to **255** are saved in the output buffer.

The STB register can set on **Ø** after the following operations (except bit 4 - MAV):

- Switching on the RLC 300
- Transmitting the command ***CLS**
- Changing the interface parameters

Contents of the STB register

Bit 7: Is not used, is always set on **Ø.**

Bit 6: (MSS) Master Summary Status Bit
Result during checkup of the STB register with a mask (SRE register, see below).
Used for setting the RQS Bit. The RQS Bit is dependent on the contents of the STB register and therefore also on the operating requirements (only for GPIB interface – report SRQ).

(RQS) Request Service
Operating requirements (only for GPIB interface).
State of the bit is derived from the state of the MSS bit according to IEEE 488.2 and can be read in the serial mode of operation (Serial Poll) according to IEEE 488.1 only as part of the STB registers with the request ***STB?**.

Bit 5: (ESB) Event Summary Bit
Result during checkup of the ESR register with a mask (ESE register).

Bit 4: (MAV) Message Available
Is set on 1 if a current message of the RLC 300 is requested at the output buffer.

Bit 3: Is not used, is always set on **Ø**.

Bit 2: Is not used, is always set on **Ø**.

Bit 1: Is not used, is always set on **Ø**.

Bit 0: Is not used, is always set on **Ø**.

☞ **Note**

With remote control via the GPIB interface, the contents of the STB register, including the RQS bit for the control unit in serial mode of operation is accessible according to IEEE 488.1. This is not possible when using the RS-232C interface.

7.4.1.2.1 SRE - SERVICE REQUEST ENABLE REGISTER

Meaning of the register

Various statuses and settings of the RLC 300 can be checked. For this the contents of the STB register are called with the help of a mask. The single bits (except SRE bit 6, which is always set on **Ø**) are compared and evaluated by the following logical equation:

- $MSS = (STB7 \wedge SRE7) \vee (STB5 \wedge SRE5) \vee (STB4 \wedge SRE4) \vee (STB3 \wedge SRE3) \vee (STB2 \wedge SRE2) \vee (STB1 \wedge SRE1) \vee (STB0 \wedge SRE0)$

The result MSS (Master Summary Status) is entered in the STB register.

Describing the register

The command ***SRE <XXX>** offers the possibility of initializing the SRE register with any mask. The value **XXX** has to be within the range of **0** to **255**. Otherwise the error 134 **Val. Out of Range** is reported.

Reading and deleting the register

The current contents **XXX** are saved in the output buffer by transmitting the command ***SRE?**.

The SRE register can set on **Ø** after the following operation:

- Switching on the RLC 300
- Transmitting the command ***SRE 0**
- Changing the interface parameters

7.4.2 Description of Errors

Contents of the error register

When errors occur in the remote-controlled settings and measurements, they are saved with a code in the error register (See p. 60, Para. 7.4.2.2).

Reading and deleting the register

The contents of the error register can be called and deleted at any time by transmitting the command **ERR?**.

If several errors arise only the error codes of the first and last error are saved. On repeating transmission of the command **ERR?** the contents of the error codes are filed in the output buffer and initialized (deleted).

The initializing of the error register is also started by transmitting the command ***CLS** (initializing of the state register).

☞ **Note**

Before transmission of the command **ERR?** the interface command **DCL** has to be transmitted.

7.4.2.1 DER - DEVICE ERROR REGISTER

Meaning of the register	The contents of the DER register specify the device error filed in the error register.
Reading and deleting the register	The contents of the register **XXX** within the range of **0** to **255** are filed in the output buffer by transmitting the command **DER?**. The DER register can set on **Ø** after the following commands: ▪ Setting of the measuring function ▪ Changes of the operating mode ▪ Start of the measurements (***TRG**, **OPEN**, **SHORT**, **REF**) ▪ Initialization of the instrument functions (***RST**)
☞ **Note**	The DER register is updated after the completion of a measurement (errors 20 and 30) or after interrogation of the measuring parameter (error 10).
Contents of the DER register	**Bit 7**: Is not used, is always set on **Ø**. **Bit 6**: Is not used, is always set on **Ø**. **Bit 5**: Is not used, is always set on **Ø**. **Bit 4**: Is not used, is always set on **Ø**. **Bit 3**: Is set on **1** at device error **Overflow** (error code 10) **Bit 2**: Is set on **1** at device error **Out of Range** (error code 20) **Bit 1**: Is set on **1** at device error **Overload** (error code 30) **Bit 0**: Is not used, is always set on **Ø**.
☞ **Note**	When a device error occurs the bit 3 (DDE) of the ESR register is set on **1**.

7.4.2.2 Error Messages

Indication of the error message	The indication of the error messages is dependent on the operating status (local control or remote control) and the type of error (device or interface error): ▪ On local control interface errors are displayed for only a short time. On remote control of the RLC 300 interface errors are displayed until the contents of the error register are queried or deleted. ▪ Device errors are displayed until the next measuring result is transmitted or the next interface error appears.

List of Error Messages

Error code	Text of messages	Meaning of text
0	-	Faultless operation
	DEVICE DEPENDENT ERROR	**Device error**
10	Overflow	Overflow error
20	Out of Range	Exceeding the measuring range
30	Overload	Overload error
	INTERFACE ERROR	**Interface error**
	Query Error	**Query error**
111	Unterminated	Is not programmed, but read access
114	Interrupted	Is programmed, but no read access
117	Deadlocked	Is programmed, but is blocked
120	Bad using query	Used query is wrong
	Execution Error	**Execution error**
131	No Execution	Command cannot be executed
132	Not Ex. in Local	Is not executable at local control
133	No valid data	Data are incorrect
134	Val. Out of Range	Value is out of range
	Command Error	**Command error**
151	Illegal command	Unknown command
	GPIB Error	**Error of the GPIB interface**
171	No listener	No instrument is connected in the operating mode TON
	RS 232 Error	**Errors of the RS-232C interface**
181	Inp. Buffer Full	Input buffer is full

Table 11 *List of error messages*

7.5 List of Commands on Remote Control

7.5.1 General Commands

7.5.1.1 Interface commands

REN
(Remote)

– Transition from local control to remote control

	ASCII	Character (dec.)
GPIB	Command according to IEEE 488.1	
RS-232C	HT	9

LLO
(Local Lock Out)

– Locking of the LOCAL button [13]

	ASCII	Character (dec.)
GPIB	Command according to IEEE 488.1	
RS-232C	EM	25

GTL
(Go To Local)

– Transition from remote control to local control

	ASCII	Character (dec.)
GPIB	Command according to IEEE 488.1	
RS-232C	SOH	1

DCL
(Device Clear)

– Initializing for the communication protocol of the interface
– Resetting or initializing of the partial circuits#

	ASCII	Character (dec.)
GPIB	Command according to IEEE 488.1	
RS-232C	DC4	20

☞ **Note**

The command **DCL** has no influence on the functions of the device. These have to be initialized by the general command ***RST**.

GET

– The measurement is started and the measured results are filed in the output buffer of the RLC 300.

	ASCII	Character (dec.)
GPIB	Command according to IEEE 488.1	
RS-232C	BS	8

☞ **Note**

This command must be at the end of a command line. Otherwise the error 151 **Illegal command** is reported.

7.5.1.2 *Initializing the Instrument Settings*

*RST (Reset)
– Resetting the RLC 300 in the operating state

Measurement of the main parameters:	automatic
Measuring range selection:	automatic
Selection of the equivalent circuit of the measured object:	automatic
Frequency of the measuring signal:	1 kHz
Level of the measuring signal:	NORM (1 V)
Polarization voltage:	is switched off
Monitor function:	is switched off
Averaging function:	is switched off
Correction of the residual parameters:	is switched off
Residual parameters:	are deleted
Tolerance measurement:	is switched off
Reference and tolerance values:	are deleted

☞ **Note**
After switching on the RLC 300 the commands ***RST** und ***CLS** are executed automatically and the contents of the ESE and SRE registers are reset. Bit 7 (PON) of the ESR register is set on **1**.

7.5.1.3 *Self-Diagnosis of the RLC 300*

*TST? (Test)
– Start of internal test and saving of result
where: **0** - test is successful
1 - test is not successful

7.5.1.4 *Identification of the RLC 300*

*IDN? (Identification)
– Identification ***digimess*,RLC300,X,Y**
where: **X** - production number or **0**
Y - software version or **0**

☞ **Note**
The query ***IDN?** should be written at the end of the command line because subsequent data can be lost before transmission. Otherwise the error120 **Bad using query** is reported.

7.5.1.5 *Initializing the Error Register*

*CLS (Clear Status Byte)
– Resetting of ESR and STB register (except bit 4 - MAV)
ESE and SRE registers are not deleted.
– Initializing of the error structure (See p. 59, Para. 7.4.2)

7.5.1.6 *Synchronization Commands*

*WAI (Waiting)
– The following commands are executed only after completion of current operation.

*OPC (Operation Complete)
– After completion of current operation bit **0** (OPC) in the ESR register is set on **1**.

∗OPC?	– After completion of current operation the number **1** is saved in the output buffer.

☞ **Note**	In the RLC 300 all commands are executed sequentially. The execution of the next command starts only when the current operation is ended. While the commands **∗OPC** and **∗OPC?** are executed, the command **∗WAI** does not have any effect.

7.5.1.7 Query of the Instrument Status

ERR? (Error)	– Reading and resetting of the error messages (See p. 59, Para. 7.4.2)
DER?	– Contents of the DER register are filed in the output buffer.
∗ESR? ∗ESE <XXX> ∗ESE?	– Reading of the ESR register (See p. 57, Para. 7.4.1.1)
∗STB? ∗SRE <XXX> ∗SRE?	– Reading of the STB register (See p. 58, Para. 7.4.1.2)

7.5.2 Instrument Settings and Messages

7.5.2.1 Frequency of the Measuring Signal

FREQ <X...X>	– Frequency setting [Hz] with the numeric argument: ▪ **50**, **100**, **1000** orr **10000** (in the free format) The value is rounded up.

☞ **Note**	If the value is out of range the error 134 **Val. Out of Range** is reported.

FREQ?	– The set frequency value [Hz] is filed in the output buffer with the following format: ▪ **HZ 50**, **HZ 100**, **HZ 1000** or **HZ 10000**

7.5.2.2 Levels of the Measuring Signal

LEVEL_NORM	– Level setting [V] on 1 V (NORM)
LEVEL_LOW	– Level setting [V] on 50 mV (LOW)
LEVEL?	– The current setting of the output level is filed in the output buffer with the following format: ▪ **LEVEL_NORM** (1 V) or **LEVEL_LOW** (50 mV)

7.5.2.3 Polarization Voltage

BIAS_OFF – The polarization voltage at the measuring sockets is switched off.

BIAS_INT – The internal polarization voltage at the measuring sockets is switched on.

BIAS_EXT – The external polarization voltage at the measuring sockets is switched on.

BIAS? – The current state of the polarization voltage at the measuring sockets is filed in the output buffer:

- **BIAS_OFF**, **BIAS_INT** or **BIAS_EXT**

7.5.2.4 Automatic Measurement of the Main Parameters

AMODE_ON – The automatic measurement of the main parameters is switched on.

AMODE_OFF – The automatic measurement of the main parameters is switched off.

AMODE? – The current state of the automatic measurement of the main parameters is filed in the output buffer:

- **AMODE_ON** or **AMODE_OFF**

7.5.2.5 Specific Measurement of the Impedance Parameters

MODE_RQ – Resistance measurement [Ω] and measurement of the quality of the measuring impedance [-].

MODE_RD – Resistance measurement [Ω] and measurement of the dissipation factor of the measuring impedance [-].

MODE_LR – Inductance measurement [H] and resistance measurement [Ω].

MODE_LQ – Inductance measurement [H] and measurement of the quality of the measuring impedance [-].

MODE_LD – Inductance measurement [H] and measurement of the dissipation factor of the measuring impedance [-].

MODE_CR – Capacitance measurement [F] and resistance measurement [Ω].

MODE_CQ – Capacitance measurement [F] and measurement of the quality of the measuring impedance [-].

MODE_CD – Capacitance measurement [F] and measurement of the dissipation factor of the measuring impedance [-].

MODE_ZFI – Measurement of the measuring impedance [Ω] and of the phase shift [deg].

MODE? – At the specific measurement of the impedance parameters the current combination of the main and secondary parameters is filed in the output buffer:

- **MODE_RQ**, **MODE_RD**, ... **MODE_ZFI**

7.5.2.6 Automatic Selection of the Equivalent Circuit of the Measured Object

ACIRC_ON – The automatic selection of the equivalent circuit is switched on. The LED *CIRCUIT HOLD* [6] goes out.

ACIRC_OFF – The automatic selection of the equivalent circuit is switched off. The current equivalent circuit is fixed. The LED *CIRCUIT HOLD* [6] shines.

ACIRC? – The current state of the automatic selection of the equivalent circuit is filed in the output buffer:

- **ACIRC_ON** or **ACIRC_OFF**

7.5.2.7 Manual Selection of the Equivalent Circuit of the Measured Object

CIRC_SER – The series equivalent circuit of the measured object is set. The LED *CIRCUIT HOLD* [6] shines.

CIRC_PAR – The parallel equivalent circuit of the measured object is set. The LED *CIRCUIT HOLD* [6] shines.

CIRC? – The current setting of the equivalent circuit of the measured object is filed in the output buffer with the following format:

- **CIRC_SER** or **CIRC_PAR**

7.5.2.8 Automatic Measuring Range Selection

ARANGE_ON – The automatic measuring range selection is switched on. The LED *RANGE HOLD* [5] goes out.

ARANGE_OFF – The automatic measuring range selection is switched off. The current measuring range is kept. The LED *RANGE HOLD* [5] shines.

ARANGE? – The current state of the automatic measuring range selection is filed in the output buffer with the following format:

- **ARANGE_ON** or **ARANGE_OFF**

7.5.2.9 Manual Measuring Range Selection

RANGE <XX> – Manual measuring range selection in the range of **1** bis **10** (in the free format). The value is rounded up. The LED *RANGE HOLD* [5] shines.

☞ **Note** If the value is out of range the error 134 **Val. Out of Range** is reported.

RANGE? – The oriented measuring range is filed in the output buffer with the following format:

- **1**, **2**, **3**, ... **10**

7.5.2.10 Residual Parameters of the Measuring Terminals

OPEN	– Measurement of the residual parameters at load-free measuring terminals
SHORT	– Measurement of the residual parameters at short-circuited measuring terminals
TRIM_ON	– The correction of the measuring parameters is switched on.
TRIM_OFF	– The correction of the measuring parameters is switched off.
TRIM?	– The current state of the correction of the measuring parameters is filed in the output buffer with the following format: ▪ **TRIM_ON** or **TRIM_OFF**

7.5.2.11 Monitor Function

MON_OFF	– The monitor function is switched off.
MON_VI	– The voltage at the measured object or the current passing through the measured object is measured and displayed.
MON_BIAS	– The polarization voltage at the measuring sockets (BIAS) is measured and displayed.
MON?	– The current setting of the monitor function is filed in the output buffer with the following format: ▪ **MON_OFF**, **MON_VI** or **MON_BIAS**

7.5.2.12 Averaging function

AVG <XX>	– Setting of the averaging function with the numeric argument (in the free format): ▪ **1** - The averaging function is switched off. ▪ **10** - The averaging function is switched on. The value is rounded up.

☞ **Note** If the value is out of range the error 134 **Val. Out of Range** is reported.

AVG?	– The current state of the averaging function is filed in the output buffer with the following format: ▪ **1** or **10**

7.5.2.13 Tolerance Measurement

DEV_OFF	– The tolerance measurement is switched off.
DEV_ABS	– The measurement of the absolute deviation in relation to a reference value is switched on.
DEV_REL	– The measurement of the relative deviation in relation to a reference value is switched on.
DEV_COMP	– The comparison measurement is switched on.
DEV?	– The current state of the tolerance measurement is filed in the output buffer with the following format: ▪ **DEV_OFF**, **DEV_ABS**, **DEV_REL** or **DEV_COMP**

Input of the Reference and Tolerance Values

REF – An automatic measurement of the connected measuring impedance is started and the measuring result is saved as a reference value. The type of reference value is set in accordance with the value of the measured main parameter.

REF_R <X...X> – The numeric argument is set as a reference value for the resistance measurement.
The valid range of values [Ω] is from **0.01E–3** to **199.99E6** (in the free format).
The value is rounded up.

REF_L <X...X> – The numeric argument is set as a reference value for the inductance measurement.
The valid range of values [H] is from **0.001E–6** to **635.51E3** (in the free format).
The value is rounded up.

REF_C <X...X> – The numeric argument is set as a reference value for the capacitance measurement.
The valid range of values [F] is from **0.001E–12** to **399.99E–3** (in the free format).
The value is rounded up.

REF_Z <X...X> – The numeric argument is set as a reference value for the impedance measurement.
The valid range of values [H] is from **0.01E–3** to **199.99E6** (in the free format).
The value is rounded up.

COMP_MIN <X...X> – The numeric argument is set as a lower tolerance limit for the comparison measurement.
The valid range of values [%] is from **0.00** to **-99.99** (in the free format).
The value is rounded up.

COMP_MAX <X...X> – The numeric argument is set as an upper tolerance limit for the comparison measurement.
The valid range of values [%] is from **0.00** to **99.99** (in the free format).
The value is rounded up.

COMP_DLIM <X...X> – The numeric argument is set as the limit of the dissipation factor for the comparison measurement.
The valid range of values [-] is from **0.0000** to **9.9999** (in the free format).
The value is rounded up.

☞ **Note** When the averaging function is active the resolution of the displayed values increases by a factor of ten. If a value is out of range the error 134 **Val. Out of Range** is reported.

Query of the Reference and Tolerance Values

REF_R? – The set reference value for the resistance measurement is filed in the output buffer with the following format:

- **OHM <TX.XETZX>** to **OHM <TYXX.XXXETZX>**
  where: **E** - exponent
  X - character from **0** to **9**
  Y - character from **1** to **9**
  Z - character 0 or 1
  T - character **+**, **–** or **"Blank"**

REF_L? – The set reference value for the inductance measurement is filed in the output buffer with the following format:

- **H <TX.XETZX>** to **H <TYXX.XXXETZX>**

REF_C? – The set reference value for the capacitance measurement is filed in the output buffer with the following format:

- **F <TX.XETZX>** to **F <TYXX.XXXETZX>**

REF_Z? – The set reference value for the inpedance measurement is filed in the output buffer with the following format:

- **OHM <TX.XETZX>** to **OHM <TYXX.XXXETZX>**

COMP_MIN? – The set lower tolerance limit for the comparison measurement is filed in the output buffer with the following format:

- **PCT <TX.XXE+00>** to **PCT <TYX.XXXE+00>**

COMP_MAX? – The set upper tolerance limit for the comparison measurement is filed in the output buffer with the following format:

- **PCT <TX.XXE+00>** to **PCT <TYX.XXXE+00>**

COMP_DLIM? – The set limit of the loss faktor for the comparison measurement is filed in the output buffer with the following format:

- **<TX.XXXXXE+00>**

7.5.2.14 Trigger Function

*TRG – The measurement is started and the measured values are filed in the output buffer of the RLC300.

7.5.2.15 Saving and Loading of the Instrument Setting

*SAV <X> – The current instrument setting is filed in the memory space of **<X>**.
The numeric argument is valid within the range of **0** to **3** (in the free format). The value is rounded up.

*RCL <X> – The instrument setting is loaded from the memory **<X>**.
The numeric argument is valid within the range of **0** to **3** (in the free format). The value is rounded up.

☞ **Note** If the value is out of range the error 134 **Val. Out of Range** is reported.
If no value is available, the error 133 **No valid data** is reported.

7.5.3 Transmitting the Results

7.5.3.1 Measurement of the Main Parameters

R? – The real resistance of the measured impedance is filed in the output buffer with the following format:

- **OHM <TX.XETZX>** to **OHM <TYXX.XXXETZX>**
  where: **E** - exponent
  X - character from **0** to **9**
  Y - character from **1** to **9**
  Z - character **0** or **1**
  T - character **+**, **–** or **“Blank”**

L? – The inductance of the measured impedance is filed in the output buffer with the following format:

- **H <TX.XETZX>** to **H <TYXX.XXXETZX>**

C? – The capacitance of the measured impedance is filed in the output buffer with the following format:

- **F <TX.XETZX>** to **F <TYXX.XXXETZX>**

Z? – The measured impedance is filed in the output buffer with the following format:

- **OHM <TX.XETZX>** to **OHM <TYXX.XXXETZX>**

FI? – The phase displacement of the measured impedance is filed in the output buffer with the following format:

- **DEG <TX.XXE+00>** to **DEG <TYXX.XXXE+00>**

Q? – The quality factor of the measured impedance is filed in the output buffer with the following format:

- **<TX.XXXXE+00>** to **<T1XXE+00>**

D? – The dissipation factor of the measured impedance is filed in the output buffer with the following format:

- **<TX.XXXXE+00>** to **<TX.XXXXXE+00>**

7.5.3.2 Tolerance Measurement

☞ **Note** Before transmitting the following commands, a given function mode of tolerance measurement must be set. Otherwise error 131 **No Execution** is reported.

DEV_R? – The deviation of the real resistance of the measuring impedance in relation the reference value is filed in the output buffer.

DEV_L? – The deviation of the inductance of the measuring impedance in relation the reference value is filed in the output buffer.

DEV_C? – The deviation of the capacitance of the measuring impedance in relation the reference value is filed in the output buffer.

DEV_Z? – The deviation of the measuring impedance in relation the reference value is filed in the output buffer.

Measurement of the absolute deviation
– The result has the same format as that which is transmitted when measuring the main parameters **R?**, **L?**, **C?** or **Z?** (See p. 70, Para. 7.5.3).

Measurement of the relative deviation
– The result has the format:
- **PCT <TX.XXE+00>** to **PCT <TYXX.XXE+00>**
  where: **E** - exponent
  X - character from **0** to **9**
  Y - character from **1** to **9**
  T - character **+**, **–** or **“Blank”**

Comparison measurement
– The result has the format:
- **<TX>**
  where: **–1** - result for **LOW**
  0 - result for **IN**
  1 - result for **HIGH**

7.5.3.3 Measuring Parameters at Active Monitor Function

☞ **Note** Before transmitting the following commands an arbitrary monitor function must be set. Otherwise the error 131 **No Execution** is reported.

MON_V?
– The measuring voltage at the measured object is filed in the output buffer with the following format:
- **V <TX.XXXETZX>** to **V <TXXX.XETZX>**
  where: **E** - exponent
  X - character from **0** to **9**
  Z - character **0** or **1**
  T - character **+**, **–** or **“Blank”**

MON_I?
– The current passing through the measured object is filed in the output buffer with the following format:
- **A <TX.XETZX>** to **A <TX.XXXETZX>**

MON_B?
– The polarization voltage connected at the measuring terminals is filed in the output buffer with the following format:
- **V <TX.XXXE+00>** to **V <TYX.XXXE+00>**
  where: **E** - exponent
  X - character from **0** to **9**
  Y - character from **1** to **9**
  T - character **+**, **–** or **“Blank”**

☞ **Note** If the setting of the RLC 300 is changed during the request for the measuring parameter and thus if no measurement can be started, error 133 **No valid data** appears.

7.6 Programming Notes

Command line

Single commands can be written one after the other in one command line, the length of which must not exceed 64 characters. In case errors occur, the command sequence is ignored and error 181 **Inp. Buffer Full** is indicated.

Separator characters

A separator character has to be between the single commands (PC → RLC 300) or messages (RLC 300 → PC):

	ASCII	Character (dec.)
GPIB, RS-232C	;	59

End characters

An end character is at the end of every command line.

- During transmission of commands (PC → RLC 300):

	ASCII	Character (dec.)
GPIB	„Last character“	„Last character“ + END (EOI true)
	LF	10
	LF	10 + END (EOI true)
RS-232C	LF	10

- During receiving of messages (RLC 300 → PC):

	ASCII	Character (dec.)
GPIB	LF	10 + END (EOI true)
RS-232C	CR+LF	13 + 10

Parameter separator characters

Certain commands or messages may contain parameters or results which are separated from the command by a parameter separator characters.

- During transmission of commands (PC → RLC 300):

	ASCII	Character (dec.)
GPIB	SP	32
	NUL to HT	0 to 9
	VT to US	11 to 31
RS-232C	SP	32

- During receiving of messages (RLC 300 → PC):

	ASCII	Character (dec.)
GPIB, RS-232C	SP	32

7.7 Program Examples (Q Basic)

7.7.1 Remote Control via Interface GPIB

```
100 REM *****************************************************
110 REM THE EXAMPLE IN Q BASIC OF USING RLC 300
120 REM WITH GPIB BOARD AT-GPIB/TNT AND SOFTWARE NI-488.2(NI)
130 REM Its GPIB primary address is 7.
140 REM Instrument settings - frequency: 10 kHz
150 REM                     - level: LOW
160 REM                     - mode: C-D
170 REM                     - monitor: V-I
180 REM Merge this code with DECL.BAS (when using NI-488.2)
190 REM *****************************************************
200 CLS
210 REM *** Setup interface AT-GPIB/TNT ***
220 DIM ADDRLIST%(31):ADDRLIST%(0)=7:ADDRLIST%(1)=NOADDR%
230 BDINDEX%=0:PAD%=7
240 CALL SENDIFC (BDINDEX%)
250 REM
260 REM *** Setup RLC 300 ***
270 CALL ENABLEREMOTE (BDINDEX%,ADDRLIST%(0))
280 CALL DEVCLEAR(BDINDEX%,PAD%)
290 WRT$="*RST;*CLS"
300 CALL SEND (BDINDEX%,PAD%,WRT$,NLEND%)
310 REM
320 REM *** Measuring signal settings (frequency, level) ***
330 WRT$="FREQ 10000;LEVEL_LOW"
340 CALL SEND (BDINDEX%,PAD%,WRT$,NLEND%)
350 REM
360 REM *** Mode settings ***
370 WRT$="MODE_CD;MON_VI"
380 CALL SEND (BDINDEX%,PAD%,WRT$,NLEND%)
390 REM
400 REM *** Start of measurements ***
410 WRT$="*TRG;C?;D?;MON_V?;MON_I?"
420 CALL SEND (BDINDEX%,PAD%,WRT$,NLEND%)
430 REM
440 REM *** Receive response message ***
450 RD$=SPACE$(100)
460 CALL RECEIVE (BDINDEX%,PAD%,RD$,STOPEND%)
470 CLS:PRINT "Response message: ",RD$
480 REM
490 REM *** Setup RLC 300 and set local mode ***
500 WRT$="*RST;*OPC?"
510 CALL SEND (BDINDEX%,PAD%,WRT$,NLEND%)
520 RD$=SPACE$(20)
530 CALL RECEIVE (BDINDEX%,PAD%,RD$,STOPEND%)
540 REM
550 CALL ENABLELOCAL (BDINDEX%,ADDRLIST%(0))
560 REM
570 REM *** Disable the software and hardware ***
580 V%=0
590 CALL IBONL (BDINDEX%,V%)
600 END
```

7.7.2 Remote Control via Interface RS-232C

```
100 '********************************************************
110 ' THE EXAMPLE IN MICROSOFT Q BASIC
120 ' OF USING RLC 300 WITH RS232C INTERFACE
130 ' Serial port is com2 and baud rate is 9600
140 ' Instrument settings - output frequency:     10 kHz
150 '                      - output level:         LOW
160 '                      - parameter indication: C-D
170 '                      - monitor function:     V-I
180 '********************************************************
190 '
200 CLS
210 '
220 '**** Setup interface ****
230 IDCL$ = CHR$(20): IREN$ = CHR$(9): ILLO$ = CHR$(25):
    IGTL$ = CHR$(1)
240 '
250 '**** Opening communication file ****
260 OPEN  "COM1:9600,n,8,1,CS15000,LF" FOR RANDOM AS #1
270 '
280 '**** Setup RLC 300 ****
290 PRINT #1, IDCL$; IREN$; ILLO$; "*RST;*CLS"
300 '
310 '**** Measuring signal settings (frequency, level) ****
320 PRINT #1, "FREQ 10000;LEVEL_LOW"
330 '
340 '**** Mode settings ****
350 PRINT #1, "MODE_CD;MON_VI"
360 '
370 '**** Start of measurements ****
380 PRINT #1, "TRG;C?;D?;MON_V?;MON_I?
390 '
400 '**** Receive response message
410 INPUT #1,A$
420 PRINT "Response message:";A$
430 '
440 '**** Setup RLC 300 and set local mode****
450 PRINT #1, "*RST;*OPC?"
460 INPUT #1, A$
470 PRINT #1, IGTL$
480 '
490 '**** Close statement ****
500 CLOSE #1
510 '
520 END
```

8 Maintenance

☞ **Warning!**	The RLC 300 must be separated from all power sources before maintenance work is carried out and before parts or fuses are repaired or replaced.

Care

Only use a soft wet rag with some soap suds or a soft rinse liquid for cleaning. Avoid acrid cleanser and solvents.

Maintenance

The RLC 300 does not require special maintenance if it is used and handled correctly.
Service work should only be done by trained personnel.
In case of repairs it is vital to ensure that the design features of the RLC 300 are not changed, resulting in a reduction in operational safety, and that replacement parts match the original ones and are installed properly (original state).

9 Appendix

9.1 List of all Instrument Messages

Display	Description
<RLC300> Ready!	– Version of the firmware
<RLC300> Calibration OFF!	– Warning with fault characteristics (See p. 22, Para. 5.3)
<RLC300> PowerUp SelfTest	– Internal test starts
Testing: UNIT .... PASSED	– Faultless test, **UNIT** describes the just tested unit (See p. 22, Para. 5.3)
Testing: UNIT .... ERROR	– Error during test, **UNIT** describes the just tested unit (See p. 22, Para. 5.3)
<RLC300> READY Version:1.01	– Operational readiness of the instrument
Password: ⇳ Invalid password	– Invalid password (See p. 50, Para. 6.5.3.2)
Store user Nr.X .... OK!	– Invalid password (See p. 50, Para. 6.5.3.2)
Store user Nr.X Rewrite? Yes No	– Inquiry at the saving of the instrument setting No. **X**, if the storage is occupied (See p. 45, Para. 6.5.2.1)
Recall user Nr.X .... OK!	– Loading the instrument setting No. **X**
Recall user Nr.X is NOT difined!	– The instrument setting No. **X** is not defined (See p. 46, Para. 6.5.2.2)

9.2 Declaration of Conformity

digimess	**Konformitätserklärung** **Declaration of Conformity / Déclaration de Conformité** 101/98	CE

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

digimess **Instruments**
Test- und Meßsysteme GmbH
Test and Measuring Systems GmbH

Anschrift / Address / Adresse

Würzburger Straße 150
90766 Fürth
Germany

erklärt hiermit eigenverantwortlich, daß das Produkt:
declare under their sole responsibility that the product / déclare, que le produit:

Bezeichnung / Name / Description

Programmierbares automatisches RLC-Meter
Programmable automatic RLC Meter
RLC-mètre automatique programmable

Type / Model / Type

RLC 300

Bestell-Nr. / Order-No. / N° de réf.

H.UC 35-00

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

DIN EN 61010-1
DIN EN 50081-1, DIN EN 50081-2
EN 55011, EN 55022 Class B

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, 23.1.98

Henninger
Leiter Qualitätsmanagement
Q-Manager / Directeur Contrôle de Qualité