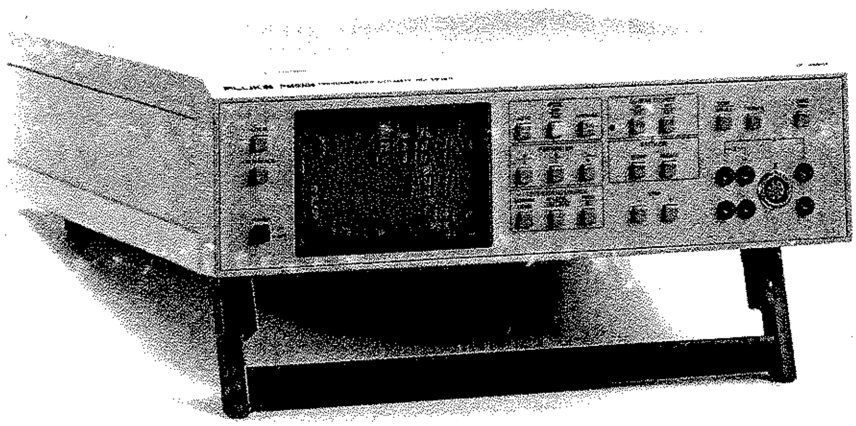
Programmable Automatic RCL Meter

PM6304

Programmers Manual



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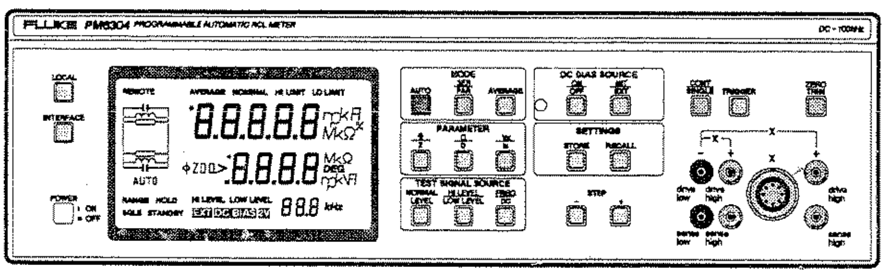

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PM6304 PROGRAMMABLE AUTOMATIC RCL METER DC–100kHz **Programming Card**

4822 872 10168
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IEEE-488 INTERFACE

AH1	acceptor handshake
SH1	source handshake
L4	listener function
T6	talker function
RL1	local/remote with local lockout
SR1	service request (SRQ)
DC1	device clear
DT1	device trigger
PPO	no parallel poll
CO	no controller function
E2	tri-state drivers

Addresses: 1 to 30

RS-232 INTERFACE

to PC 9 pin (female) — **RS-232 cable** — **to PM6306** 9 pin (female)

SIGNAL	PIN	PIN	SIGNAL	
	1 n.c.	n.c. 1		
RxD	2	2	RxD	Received Data
TxD	3	3	TxD	Transmitted Data
DTR	4	4	DTR	Data Terminal Ready
GND	5	5	GND	Signal Ground
DSR	6	6	DSR	Data Set Ready
RTS	7	7	RTS	Request To Send
CTS	8	8	CTS	Clear To Send
	9 n.c.	n.c. 9		

Baud rate: 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200
Data bits: 7 or 8
Parity: odd, even or no
Hardware connection: 3 or 7 wires
Stop bits: 1 (2 for 110 baud only)
Xon/Xoff handshake: on or off
Hardware handshake: DSR/DTR or CTS/RTS

Special Interface Functions

IEEE-488		**RS-232**
GTL	go to local	**ESC 1**
GTR	go to remote control	**ESC 2**
DCL	device clear	**ESC 4**
LLO	local lockout	**ESC 5**
⋆STB?	read status byte query	**ESC 7**
DTR	device trigger	**ESC 8**

Common Commands and Queries in Accordance with IEEE-488.2

⋆CLS	Clear Status Command
⋆ESE	Event Status Register Enable
⋆ESR?	Standard Event Status Register Query
⋆IDN?	Identification Query
⋆LRN?	Learn Mode
⋆OPC	Operation Complete Command
⋆RCL	Recall Command
⋆RST	Reset Command
⋆SAV	Save Command
⋆SRE	Service Request Enable
⋆STB?	Read Status Byte
⋆TRG	Trigger Command
⋆TST?	Selftest Query
⋆WAI	Wait-to-Continue

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Device Specific Commands

Normal operation:

MODE?	asks for measurement mode
AUTO	automatic measurement mode
SER	sets series measurement mode
PARAL	sets parallel measurement mode
PARAM?	asks for selected parameter
PARAM QUA	quality factor is displayed
PARAM DISS	dissipation factor is displayed
PARAM PHA	phase angle is displayed
PARAM IMP	impedance is displayed
PARAM VOL	voltage is displayed
PARAM CUR	current is displayed
PARAM AUTO	switches to measurement mode selected before
FRE	sets test signal frequency
FRE?	asks for test signal frequency
LEV?	asks for test signal voltage
LEV LO	test signal 50 mV AC or 300 mV DC
LEV HI	test signal 2 V
LEV NO	test signal 1 V
DC_BIAS?	asks for DC bias
DC_BIAS OFF	DC bias off
DC_BIAS INT	DC bias internal
DC_BIAS EXT	DC bias external
AVG?	asks for averaging
AVG ON	increased averaging
AVG OFF	r[illegible] averaging

TEST_SIG?	asks for test signal
TEST_SIG AC	AC test signal
TEST_SIG DC	DC test signal
COM?	asks for dominant/secondary parameter
RESI?	asks for resistance value
CAP?	asks for capacitance value
INDU?	asks for inductance value
IMP?	asks for impedance value
QUAL?	asks for quality factor value
DISS?	asks for dissipation factor value
PHA?	asks for phase angle value
VOL?	asks for measured voltage
CUR?	asks for measured current
TRIM	open/short-circuit trimming
CON	continuous measurements
SIN	single measurement
TRIG	starts single measurement
MEA_FAST?	asks for fast measurement
MEA_FAST ON	fast measurement on
MEA_FAST OFF	fast measurement off
RNG_HOLD?	asks for hold function
RNG_HOLD ON	gain factor is fixed
RNG_HOLD OFF	internal gain factor is automatically determined
ERR?	asks for error message

Binning:

BIN ON	binning mode on
BIN OFF	normal measurement mode
BIN	allocates data to selected bin
BIN?	asks for the bin the component is allocated to
BIN_DISABLE	disables selected bin
BIN_ENABLE	enables selected bin
BIN_SET?	asks for selected bin set
BUF_BIN?	asks for the selected bin from the buffer for editing
BUF_CLR	deletes buffer for editing
BIN_ERA	deletes selected bin set
BIN_STO	stores bin set
BIN_RCL	loads bin set into register 0 for binning
BUF_RCL	loads bin set into buffer for editing
BIN_ABS	input of absolute value
BIN_REL	nominal value, tolerance in %
RESI <NRf>	resistances, nominal
CAP <NRf>	capacitances, nominal
INDU <NRf>	inductances, nominal
IMP <NRf>	impedances, nominal
QUAL<NRf>	quality factor, normal
DISS <NRf>	dissipation factor, nominal
PHA <NRf>	phase angle, nominal

for input of absolute values skip <NRf>
<NRf> means flexible numeric representation,
e.g. RESI 1000 or RESI 1000.0 or RESI 1.0E3 for 1 kOhms

LIM_HI	[illegible]per limit
LIM_LO	[illegible]wer limit

Please note

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

Bitte beachten

Bei Schriftwechsel über dieses Gerät wird gebeten, die Typennummer und die Gerätenummer anzugeben. Diese befinden sich auf dem Typenschild an der Rückseite des Gerätes.

Noter s.v.p.

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez toujours indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Important

As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

Wichtig

Da das Gerät ein elektrisches Betriebsmittel ist, darf die Bedienung nur durch eingewiesenes Personal erfolgen. Wartung und Reparatur dürfen nur von geschultem, fach- und sachkundigem Personal durchgeführt werden.

Important

Comme l'instrument est un équipement électrique, le service doit être assuré par du personnel qualifié. De même, l'entretien et les réparations sont à confier aux personnes suffisamment qualifiées.

Printed in Germany

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INSIDE THIS MANUAL

This PROGRAMMERS MANUAL contains information about how to control the PM6304 / PM6304C by a Personal Computer or Controller via IEEE-488 or RS-232.

The manual is organized into the following chapters:

Chapter 1 IEEE-488 Interface

This chapter describes the function of the IEEE-488 interface and how to set the instrument address.

Chapter 2 RS-232 Interface

This chapter describes the RS-232 interface and the steps necessary for configuration.

Chapter 3 Remote Control Commands

This chapter contains information about the Message Syntax and describes all commands necessary for operation via IEEE-488 as well as via RS-232.

Chapter 4 Programming Examples

This chapter shows programming examples for IEEE-488 and RS-232.

Chapter 5 Printing of Measurement Results

This chapter shows a setup for direct printing of measurement results without PC.

Chapter 6 Error Messages

This chapter lists error messages with references to chapters in this manual and to the Service Manual where the topic is described.

Chapter 7 Commands in Alphabetical Order

This chapter shows all commands and queries in a short form. It serves as a reference for correct syntax.

Using the Programmers Manual requires that you are acquainted with the functions of the instrument, measurement setups, parameters and limits.

For detailed information about:

- Characteristics

see **REFERENCE MANUAL**

For detailed information about:

- Safety Precautions
- Getting Started
- How to Use the Instrument
- Function Reference

see **USERS MANUAL** (English)
GEBRAUCHSANLEITUNG (German)
MODE D'EMPLOI (French)

CONTENTS

Chapter 1

IEEE-488 INTERFACE

1 IEEE-488 INTERFACE

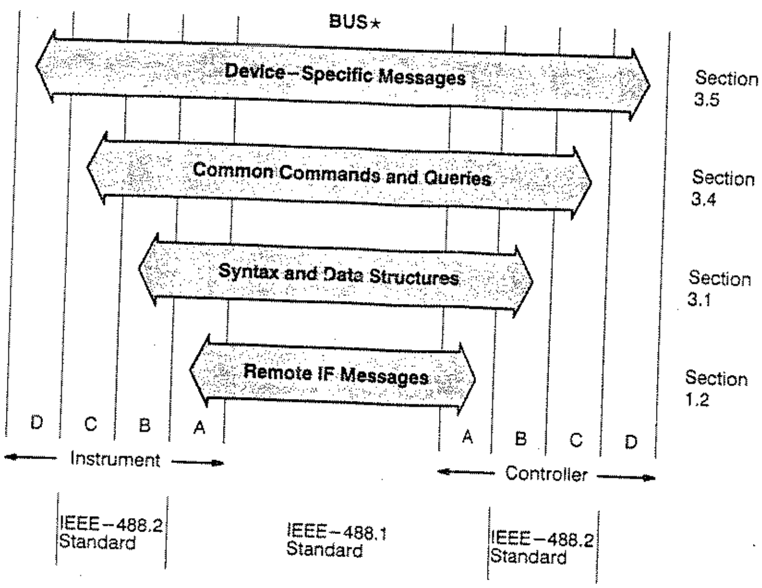
1.1 INSTRUMENT ADDRESS

All instrument functions can be controlled via the IEEE-488/IEC interface.

Before learning the remote interface command set, first get acquainted with the functions of the instrument, measurement setups, parameters, and limits. A detailed description with examples is in the USERS MANUAL or GEBRAUCHSANLEITUNG or MODE D'EMPLOI.

The following chapter describes the functions of the IEEE-488 bus interface.

For commands, queries, syntax, and terminators see Chapter 3.



A = Interface functions
B = Message communication functions
C = Common system functions
D = Device functions

★ this figure is in accordance with "IEEE-488 Standard Codes, Formats, Protocols, and Common Commands" (ANSI/IEEE-488 Std 488.2-1987).

Remote control of the instrument requires the instrument address to be known. On delivery from the factory the address is set to 20. You can display the set address by pressing the INTERFACE key. You can change the address from 1 to 30 by pressing the step keys.

On power up the instrument is in 'local' mode (input via keyboard). When addressed as listener by a controller, the text REMOTE appears in the display field. All keys except LOCAL are locked and you can now operate the instrument in remote control. To return to local operation, use the addressed command GTL (go to local) or press the LOCAL key. To avoid unintended local control, you can disable the LOCAL key by using the universal command LLO (local lockout).

1.2 INTERFACE FUNCTIONS

The following interface functions are implemented:

AH1: acceptor handshake
SH1: source handshake
L4: listener function
T6: talker function
RL1: local/remote with local lockout

SR1: service request SRQ
DC1: device clear function
DT1: device trigger function
PP0: no parallel poll
C0: no controller function
E2: tri-state drivers

Hardware, connections, and the handshake procedure are in accordance with IEEE-488.1.

Chapter 2

RS-232 INTERFACE

2 RS-232 INTERFACE

2.1 INSTRUMENT CONFIGURATION

All instrument functions can be controlled via the RS-232 interface.

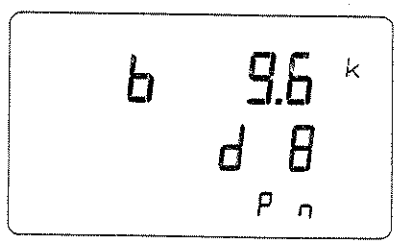
Before learning the remote interface command set, first get acquainted with the functions of the instrument, measurement setups, parameters, and limits. A detailed description with examples is in the USERS MANUAL (also in the GEBRAUCHSANLEITUNG or MODE D'EMPLOI).

The following chapter describes the functions of the RS-232 bus interface. Chapter 3 contains information about commands, queries, syntax, and terminators.

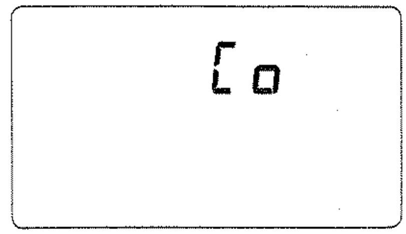
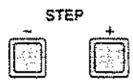
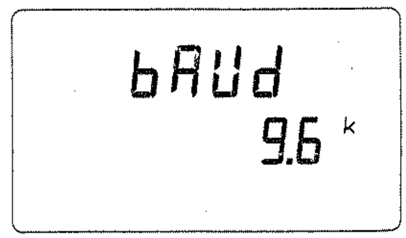
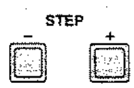
You can also send measurement results directly to a printer via the interface without any PC or controller. This mode is described in Chapter 5.

Remote control of the instrument requires an interface communication configuration that matches that of your PC. Press the **INTERFACE** key to display the current configuration. Press the step keys to change the displayed configuration.

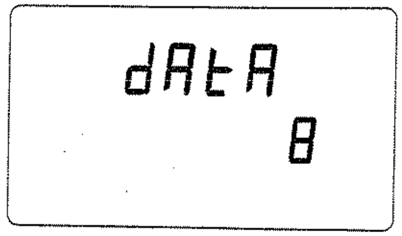
Pressing the **INTERFACE** key shows the current configuration:

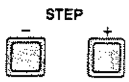
Function and Key Operation	Display
INTERFACE 	Communication or Printer mode (**Co** or **Pr**)
and after 2 seconds	
	That means: baud rate 9600, data bits 8, parity no

If you want different settings press the **INTERFACE** key again during display:

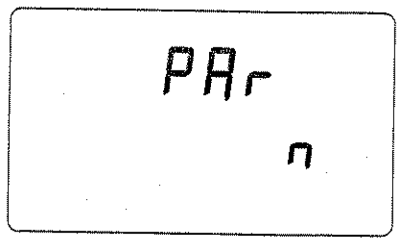
Function and Key Operation	**Display**
	
	select operating mode **Pr** Printer mode or **Co** Communication mode
	
	select baud rate **110, 150, 300, 600,** **1200, 2400, 4800, 9600, 19200** for 110 baud 2 stop bits are set, otherwise 1 stop bit

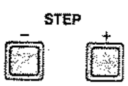
Function and Key Operation	Display





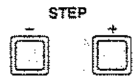
select data bits **7** or **8**
(7 bits for parity **E**ven or **O**dd)



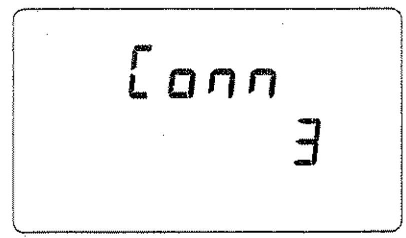


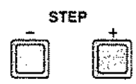
select parity **E**ven, **O**dd or **no**
(parity **no** for 8 data bits only)

Function and Key Operation | **Display**



select Xon/Xoff handshake
on or **oFF**





select **3** or **7** wire connection

Press the **INTERFACE** key again to leave the mode.

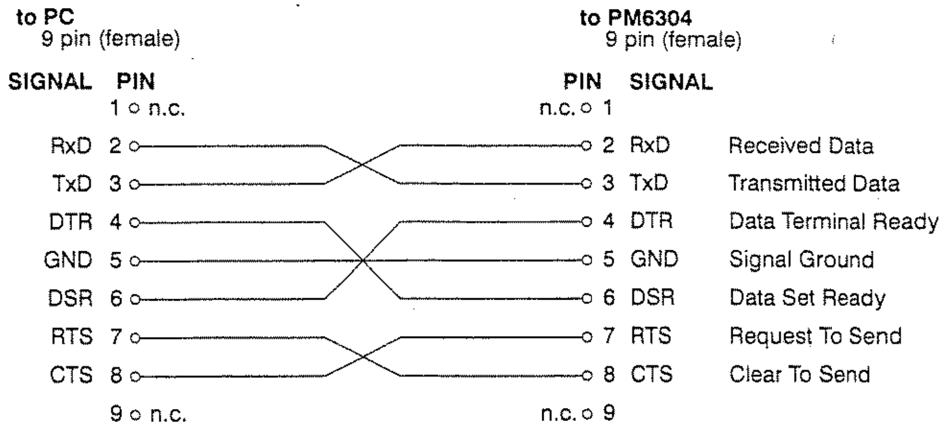
If you do not press any key within 3 seconds during configuration, the instrument automatically returns to measuring mode, and the altered configurations are not stored.

On power up, the instrument is in 'local' mode (input via keyboard). When you set the instrument to listener mode by sending the command **ESC2** via PC, the REMOTE text appears on the display. All keys except LOCAL are locked and the instrument can now be operated in remote control. Return to local operation is done by the command **ESC 1** or by the LOCAL key. To avoid unintended local control, you can disable the LOCAL key by using the command **ESC 5**.

2.2 INTERFACE FUNCTIONS AND WIRING

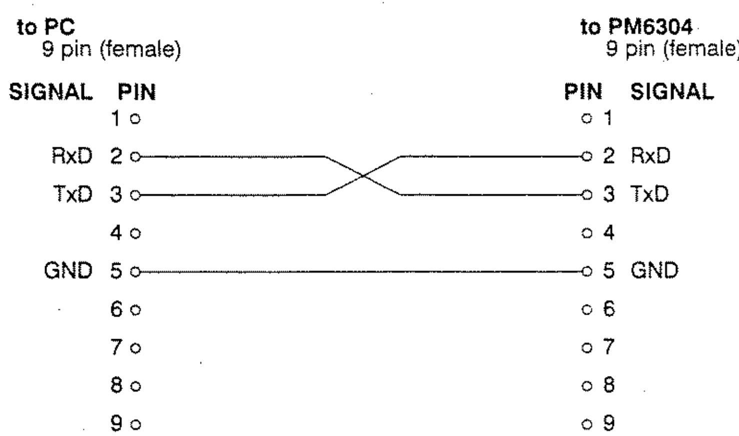
Operating modes:	Communication mode, talk only mode (Printer mode)
Baud rates:	110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200
Data bits:	7 or 8
Stop bits:	1 (2 for 110 baud only)
Parity:	ODD EVEN NO (with 8 data bits)
Xon/Xoff Handshake:	ON or OFF
Hardware connection:	3 wires, no hardware handshake 7 wires, with hardware handshake
Hardware handshake:	DSR/DTR and CTS/RTS
Connector:	9-pin D-connector (male)

Because the PC and the RCL Meter are DTE (Data Terminal Equipment) you should use the following pin configuration for the RS-232 connection cable. In general it is recommended that you use a well shielded cable for adequate radio interference suppression.



This cable can be purchased from your local Fluke organization, order number PM 9536/041.

If you use a 3-wire connection, set the PM6304 to software handshake.



2.3 SPECIAL INTERFACE FUNCTIONS

For communication with the RS-232 interface, use the following commands (similar to the addressed and unaddressed interface commands for IEEE-488):

RS-232	Function	similar to IEEE-488
ESC 1	go to local	GTL
ESC 2	go to remote control	GTR
ESC 4	device clear	DCL
ESC 5	local lock out	LLO
ESC 7	asks for status byte	⋆STB?
ESC 8	device trigger	DTR

These commands should be implemented in an application program, so they can be sent to the instrument by a PC.

Chapter 3

REMOTE CONTROL COMMANDS

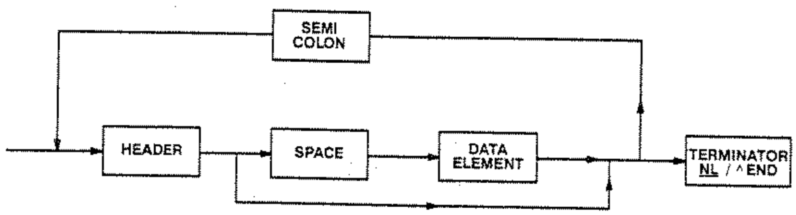
3 REMOTE CONTROL COMMANDS

In this section the commands are described as they relate to the instrument functions and front panel keys, which are listed in the Users Manual, Chapter 5, Function Reference. If not stated otherwise, following commands are used for IEEE-488 as well as for RS-232.

3.1 PROGRAM MESSAGE SYNTAX

You can combine several commands in a message and send them to the instrument, using the semicolon ";" as a separator between the commands.

Header and data element must be separated by a space; the end of a message must be terminated by NL (new line), ^END or both for the IEEE-488 interface and by NL for the RS-232 interface.



3.2 MESSAGE TERMINATOR

The instrument accepts ^END or NL (ASCII 10 dec.) or both as the terminator for a program message via the IEEE-488 interface.
The instrument also sets ^END and NL as the terminator for a response message. For compatibility to earlier controllers, you can program terminators that depart from the IEEE-488.2 standard. Use the command TRM followed by the decimal value of the required ASCII character.

Example: **TRM 13,10** sets CR NL as terminator for a response message

The command TRM without the decimal value, ⋆RST or the interface functions SDC/DCL sets the initial terminator again. The initial terminator is also set after power on.

Programming via the RS-232 interface uses only NL as the terminator.

3.3 SERVICE REQUEST (SRQ) AND STATUS REGISTERS

A Service Request will be generated if one or more bits of the 'Status Byte Register' are set to 1 and if the corresponding bits are enabled by the 'Service Request Enable Register' (IEEE-488 interface only). The controller asks the contents of the 'Status Byte Register' in 'Serial Poll Mode.'

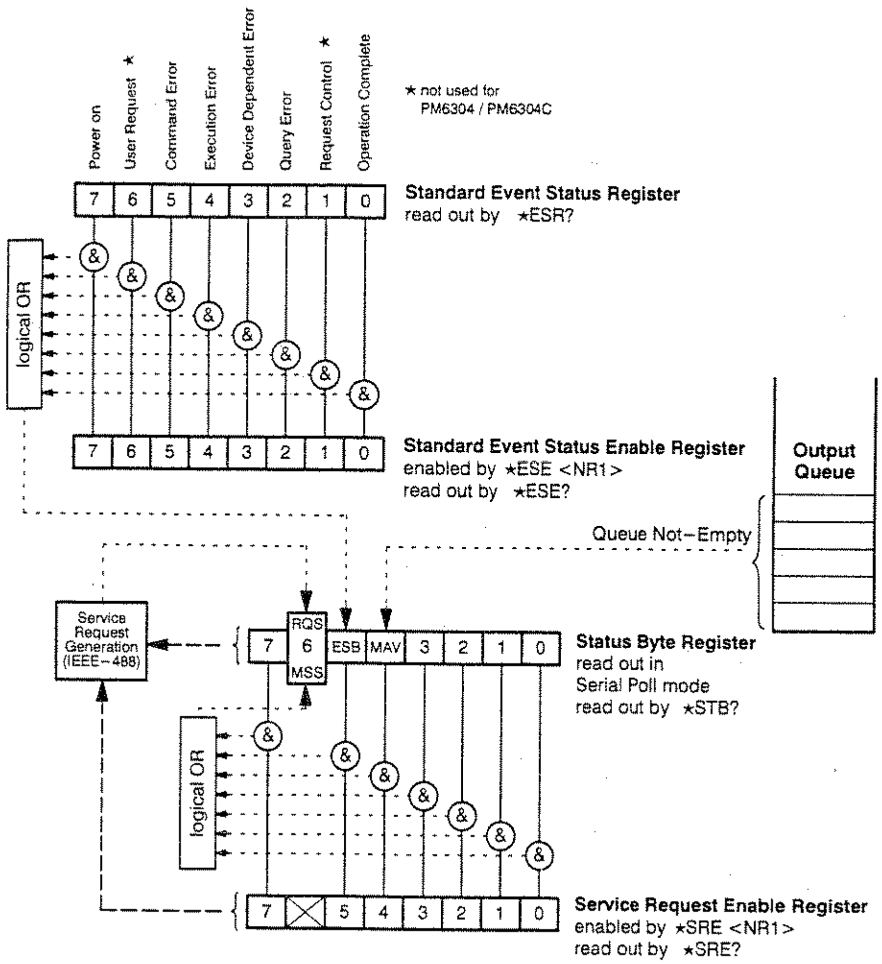
PM 6304 'Status Byte Register':

Bit	Function	Decimal value
0	not used	1
1	not used	2
2	not used	4
3	not used	8
4	message available (MAV)	16
5	bit of the 'Standard Event Status Register' high	32
6	request for service (RSQ)	64
7	not used	128

To get the information via Service Request that bits of the 'Standard Event Status Register' are set, those bits must have been enabled by ⋆ESE, **and** bit 5 of the 'Status Byte Register' must have been enabled by ⋆SRE.

Direct readout without Service Request is possible for the IEEE-488 as well as for the RS-232 interface by using the ⋆ESR? query for the 'Standard Event Status Register' and by the ⋆STB? query for the 'Status Byte Register.'

PM6304 / PM6304C 'Standard Event Status Register'



<NR1> represents a decimal value. The binary pattern of the decimal value sets the corresponding bits of the 'Enable Registers' to 1, which enables the bits of the 'Status Registers'.

All bits of the 'Standard Event Status Enable Register' and the 'Service Request Enable Register' are automatically set to 0 when powering up the instrument. Therefore, in a user program it is necessary that the required bits are set to 1 after power-on, if Service Request is required.

Example: **TRIG;⋆OPC**
causes the instrument to set bit 0 of the 'Standard Event Status Register' to 1 when the operation (single measurement) is completed.
When the instrument is externally triggered, it is recommended you send ⋆OPC alone. Bit 0 is set to 1 when the externally triggered measurement is finished.
If ⋆OPC is sent when the operation is already finished bit 0 is not set to 1.

⋆OPC? Operation Complete Query
This command also works well for single measurements, trimming, and calibration. Sending the query ⋆OPC? to the generator during a running function causes the instrument to wait until the function is finished, and then set a 1 in the output queue. The register can be read out by the controller without a Service Request. When a 1 is returned, your user program can then continue.

Data in the output queue activates bit 4 of the 'Status Byte Register' (MAV, message available), which may generate Service Request. To avoid generating an SRQ, disable bit 4 (set it to 0). Bit 0 (operation complete) of the 'Standard Event Status Register' is not affected by ⋆OPC?

Contrary to ⋆OPC, the query ⋆OPC? is more convenient for the RS-232 interface because the 1 is directly sent; a separate read-out is not necessary as it would be for the IEEE-488 interface.
If ⋆OPC? is sent when the operation is already finished, bit 0 is not set to 1.

⋆WAI Wait-to-Continue Command
This command sent to the instrument in a message string with other commands causes the instrument to execute the command following ⋆WAI only when the previous command is completed.

Example: **TRIG;⋆WAI;COMP?**
In single measurement mode this message causes the instrument to wait until the measurement is finished; after that it sends the result. This avoids a readout of the stored values of the previous measurement.
The message SINGL;⋆WAI;COMP? is only applicable for external trigger; the command TRIG via interface is not accepted in this case.
Sending ⋆WAI alone or at the end of a string could stop the communication via the interface.

⋆TRG Trigger Command

When receiving ⋆TRG, the instrument starts a measurement in single measurement mode (see page 3 – 14 to set instrument for single measurement mode).

Status and Event:

⋆CLS Clear Status Command

Sets bits of the 'Standard Event Status Register' and of the 'Status Byte Register' to zero. Sending ⋆CLS as a single command or as the first command of a string also clears the contents of the Output Queue.

⋆ESE Standard Event Status Enable Command

⋆ESE, followed by a decimal value, sets the bits of the 'Standard Event Status Enable Register'. For more detail on the assigned bits of the 'Standard Event Status Register,' see Section 3.3.

⋆ESE? Standard Event Status Enable Query

This query asks the instrument for the contents of the 'Standard Event Status Enable Register'. The response is a decimal value.

Example: "255 = all bits are set to 1: all events of the 'Standard Event Status Register' are enabled.

⋆ESR? Standard Event Status Register Query

Asks for the contents of the 'Standard Event Status Register.' The response is a decimal value. This query also clears the register contents.

⋆SRE Service Request Enable Command

⋆SRE, followed by a decimal value, sets the bits to 1 of the 'Service Request Enable Register,' except bit 6. For more detail on the assigned bits of the 'Status Byte Register', see Section 3.3.

⋆SRE? Service Request Enable Query

Asks for the contents of the 'Service Request Enable Register.' The response is a decimal value.

⋆STB? Read Status Byte Query
Asks for the contents of the 'Status Byte Register.' The response is a decimal value.

Sending this query via IEEE-488 interface causes the PM 6304 to set bit 4 (MAV) of the Status Byte Register. The output is 16 dec if no further bits are set.

Save and Recall Instrument Settings:

⋆SAV Save Command
This command, followed by a decimal value from 1 to 9, stores the current instrument setting including trimming data into the corresponding internal memory register. The contents of the memory are not affected by the command ⋆RST or when the instrument is turned off.

⋆RCL Recall Command
This command followed by a decimal value from 1 to 9 for the memory place calls up and executes the instrument setting stored in that memory register. Trim data are also recalled.

3.5 DEVICE SPECIFIC MESSAGES

This section contains the remote programming commands necessary to select operation modes and parameters and to read out measurement values.

Numeric entry
<NRf> flexible numeric representation
Under the IEEE-488.2 standard, numeric values can be given to the instrument in integer <NR1>, real <NR2>, or exponential <NR3> forms. The number of digits is limited to 10 for mantissa and 2 for the exponent. The dimension (**Hz, F, H, Ω, V, I**, or **degrees**) is automatically set by the instrument.

You can set the test frequency, for example, to 1 kHz with following inputs for <NRf>:

FREQUENCY 1.000e3	
FREQUENCY 1000	
FREQUENCY 1000.0	
FREQUENCY 1E3	
FREQUENCY 1000.1	instrument rounds to its nearest available frequency which is 1 kHz

Some headers can be sent as command headers to program the instrument and also as queries by adding a question mark. The instrument returns its actual setting in response to the query.

Example:	FREQUENCY 1E3	sets the test signal frequency to 1 kHz
	FREQUENCY?	response: FREQ 1.0E3

Sending several queries in a single string could cause an error message if the answer exceeds 31 characters.

Most headers can be used in short form, marked with bold letters in the table.

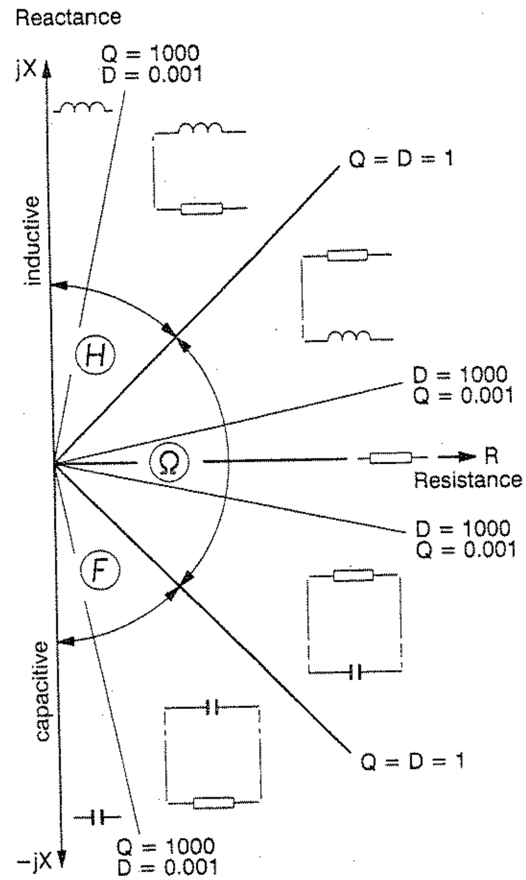
Example: **AVERAGE ON** in short forms **AVG ON**

3.5.1 Instrument Settings and Measurements

3.5.1.1 Measuring Modes

In most cases, you will be interested in the dominant parameter of the component. This is automatically determined in the AUTO mode. The display shows AUTO, the value of the dominant parameter in the upper line, the value of the secondary parameter in the lower line and the appropiate equivalent circuit symbol.
If you want to determine a parameter that differs from the automatically determined by the instrument, select SERIAL or PARALLEL MODE.

Auto Mode Desicion Diagram



Commands: MODE **AUTO**
MODE **SER**IAL
MODE **PARAL**

Query: **MODE?**

Response: MODE AUTO
MODE AUTO SER
MODE AUTO PAR
MODE SER
MODE PAR

3.5.1.2 Parameters

You also can select certain parameters to be displayed, for example, phase angle, quality factor, impedance, etc.

Commands:	**PARAM QUAL**ITY	quality factor
	PARAM DISSIPATION	dissipation factor
	PARAM PHASE	phase angle
	PARAM IMPEDANCE	impedance
	PARAM VOLTAGE	measured voltage
	PARAM CURRENT	measured current
	PARAM AUTO	measurement selected before (AUTO, SER or PARAL)
Query:	**PARAM**ETER?	
Response:	PARAM QUA	
	PARAM DISS	
	PARAM PHA	
	PARAM IMP	
	PARAM VOL	
	PARAM CUR	
	PARAM AUTO	

To read out measured values see Section 3.5.1.7.

3.5.1.3 Zero Trim

If you measure low-resistance components (i.e., less than 100 Ω), or small inductances (i.e., less than 100 nH) short circuit the connection sockets and perform trimming.

For measuring small capacitances (i.e. less than 200 pF) or high resistances, perform trimming with open connection sockets.

For detailed information see the Users Manual, Section 4.3.

Commands: **TRIM**

Query: none

Response: none

If the trim fails, the instrument generates an error message.

3.5.1.4 Test Signal

You can select an AC test signal with different frequencies or a DC test signal (option). If you want to send a query for measurement results after you change the test signal, allow the instrument to set the new settings, see ⋆OPC(?) and ⋆WAI, Section 3.4.

Test signal AC/DC

Commands: **TEST_SIGNAL AC**
TEST_SIGNAL DC

Query: **TEST_SIGNAL?**

Response: TEST_SIG AC
TEST_SIG DC

Test signal frequency

You can select following frequencies:

50 Hz, 60, 100, 120, 200, 300, 400 Hz ... 19.9 kHz, 20 kHz, 100 kHz

If you select different values, the instrument automatically rounds to the next valid frequency value.

Commands:	**FREQ**UENCY <NRf>	NRf = values see above
Query:	**FREQ**UENCY**?**	
Response:	FREQ <NR1> or <NR3>	

Test signal level

You can select following test signal voltages:

AC voltage	2 V,	400 Ω internal resistance	(HIGH LEVEL)
	1 V,	100 Ω internal resistance	(NORMAL LEVEL)
	50 mV,	100 Ω internal resistance	(LOW LEVEL)
DC voltage	2 V,	400 Ω internal resistance	(HIGH LEVEL)
	1 V,	100 Ω internal resistance	(NORMAL LEVEL)
	300 mV,	100 Ω internal resistance	(LOW LEVEL)

Commands:	**LEV**EL **HI**GH **LEV**EL **NO**RMAL **LEV**EL **LO**W
Query:	**LEV**EL**?**
Response:	LEVEL HI LEVEL NO LEVEL LO

3.5.1.5 DC Bias

You can add an internal 2 V bias voltage or an external one of maximum 40 V to the AC test signal voltage.

Commands: **DC_BIAS OFF**
DC_BIAS INT
DC_BIAS EXT

Query: **DC_BIAS?**

Response: DC_BIAS OFF
DC_BIAS INT
DC_BIAS EXT

3.5.1.6 Measuring Types

For normal measurement you should select continuous measurement.

For binning or using the instrument for checking in automatic systems you should select single measurements. This allows you to remove or to insert components and to start a measurement at a defined moment.

You can increase the measurement speed up to 10 measurements per second. The measurement results are returned via remote interface only. The display shows FAST, and the measured values can be read out by the controller (IEEE-488 interface). When you use the RS-232 interface, the value is sent directly to the computer.

In FAST mode different tolerances are valid. See Reference Manual, Chapter 1.

The following test signal frequencies are available in fast mode:
200 Hz, 400 Hz ... 19.6 kHz, 19.8 kHz, 20 kHz, 100 kHz, or DC.

If you select a different frequency via interface or keyboard the instrument sets to the next lower frequency.

Continuous or single measurements

Commands: **CONT**IN
SINGLE

Query: **TRIG?**

Response: CONTIN
SINGLE

Start a single measurement

Commands: **TRIG**GER

Query: **TRIG**GER?

Response: CONTIN
SINGLE

Fast measurement

Commands: **MEAS_FAST ON**
MEAS_FAST OFF

Query: **MEAS_FAST?**

Response: MEAS_FAST ON
MEAS_FAST OFF

Note:

- FAST measurement is possible only in SINGLE mode.
- The instrument measures the value of the dominant parameter or of the parameter selected by PARAM ... .
- The measured value and the bin number can be read out by a controller without query when the measurement is finished.
- Instrument settings cannot be stored.
- The command TRIM or BIN_RCL <NRf> switches off FAST measurement.
- When you switch to LOCAL, the instrument returns to FAST measurement OFF. When you combine FAST measurement and Binning, the instrument remains in this mode when you switch to LOCAL; so you can bin in FAST measurement mode without a PC.
- In FAST measurement mode the bin 0 output of the Handler Interface provides a timing signal for an external component handler; see Reference Manual, Section 1.6.
- If you trigger externally in FAST measurement mode, avoid contact bouncing.

3.5.1.7 Queries for measured values

Query:	**COMP**ONENT?	askes for dominant and secondary parameter shown in the display
	RESISTANCE?	
	CAPACITANCE?	
	INDUCTANCE?	
	IMPEDANCE?	
	QUALITY?	
	DISSIPATION?	
	PHASE?	
	VOLTAGE?	
	CURRENT?	

Responses for COM?

Dominant ; secondary parameter in Auto mode in accordance with the Auto Mode Decision Diagram, Section 3.5.1.1.
If a certain parameter has been selected with the LOCK command, this parameter is shown at first, regardless of whether or not it is the dominant one.

L <NRf>
L <NRf>;R <NRf>
R <NRf>;L <NRf>
R <NRf>
R <NRf>:C <NRf>
C <NRf>;R <NRf>
C <NRf>

Response for selected parameter:

R <NRf>	for resistances in Ohms
C <NRf>	for capacitances in Farads
L <NRf>	for inductances in Henrys
Z <NRf>	for impedances in Ohms
Q <NR2>	for quality factor
D <NR2>	for dissipation factor
P <NR2>	for phase angle in degrees
V <NRf>	for measured voltage in Volts
I <NRf>	for measured current in Amperes

Exceeds a parameter of the component under test the measurement range, the response is OVER, or >, or <; for example:
C 22E-9;R OVER or Q>1000

3.5.1.8 Store/Recall of Instrument Settings

Nine complete instrument settings including trim data can be stored in nonvolatile registers 1 to 9; the measured values are not stored. Already existing data will be overwritten. Register 0 contains the current instrument settings.

Commands: Common Commands in accordance with IEEE-488.2

⋆**SAV** <NR1>
⋆**RCL** <NR1>

3.5.2 Binning

Binning means sorting components into separate boxes or containers to get tighter tolerances or match like values.
During binning with the RCL Meter, single items of similar components are allocated to defined sorting fields based on their measured value. These fields are called bins.

3.5.2.1 Programming of Bin Tolerances

You can define ten different bins (bin 0 to 9). The instrument checks in the sequence bin 1, bin 2 ... to bin 9 and then bin 0. If the greatest tolerance is programmed for bin 1, then all components lying within this tolerance are immediately allocated to bin 1.

A different parameter can be defined for bin 0 than that for bin 1 to bin 9.

For example, bins 1 to 9 can be used to check the tolerance of a capacitor while bin 0 checks its quality factor.

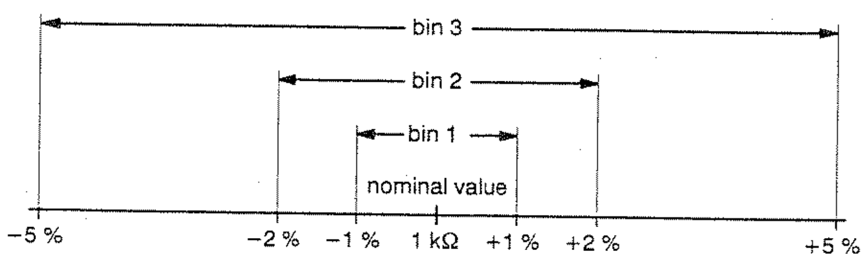
The test sequence for binning is as follows:

Component meets tolerance defined in: bin 1 to 9	bin 0	Display
YES	YES	bin 1 to 9
NO	do not care	FAIL
YES	NO	bin 0

In FAST measurement mode bin 0 is ignored.

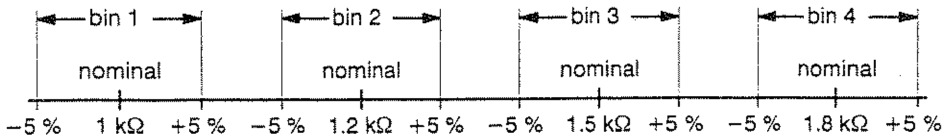
The limits of the bins can be defined in several ways according to various application requirements:

- Binning components with certain value according to different tolerance class, e.g., for quality control or incoming inspection.



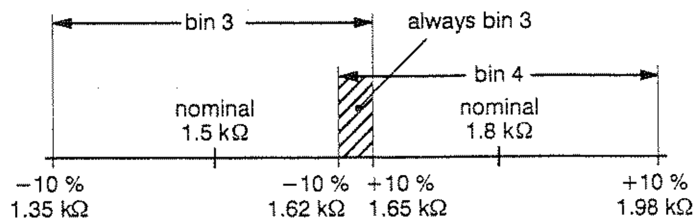
Nested limits with reference to a nominal value.

- Binning components according to certain values, e.g. resistors according to the series E12, here with ±5 %.

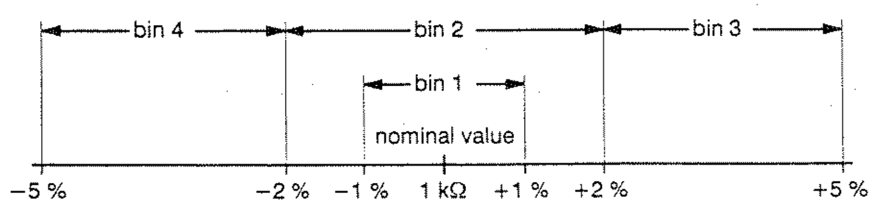


Sequential limits with reference to nominal values.

If limits overlap, a component lying within this overlapping area is always allocated to the bin with the lower number.

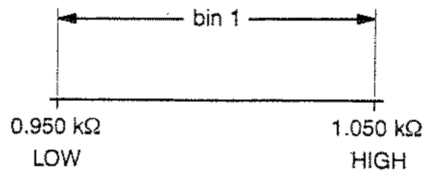


- Nested and sequential limits can be combined



Sequential and nested limits.

The limits can be programmed directly as absolute values instead of a nominal value with an upper and lower limit in percent.



Commands:	**BIN**NING_**REL**ATIV	input with reference to a nominal value
	BINNING_**ABS**OLUT	input of absolute values
	LIMIT_**LO**W <NRf>	lower tolerance limit
	LIMIT_**H**IGH <NRf>	upper tolerance limit
	BIN <NR1>	defines the bin number which programmed values are valid for

Parameter for bins:

RESISTANCE <NRf>	resistances in Ohms
CAPACITANCE <NRf>	capacitances in Farads
INDUCTANCE <NRf>	inductances in Henrys
IMPEDANCE <NRf>	impedanze in Ohms
QUALITY <NRf>	quality factor
DISSIPATION <NRf>	dissipation factor
PHASE <NRf>	phase angle in degrees

<NRf> is necessary only when you are programming nominal values and tolerances in percent. For input of absolute LOW and HIGH LIMIT values, skip <NRf>.

Examples:

The following example shows a complete binning set for capacitors of 100 nF with tolerances of ±0.5 %, ±1 %, ±2 %, ±3 %, ±4 %, ±5 %, ±6 %, ±7 %, ±10 %, programmed with nominal value and tolerances in percent.
Bin 0 checks if the quality factor is within 300 to 600.

```
BIN_REL;CAP 100E−9; LIM_LO −.5;LIM_HI .5;BIN 1;
                    LIM_LO −1;LIM_HI 1;BIN 2;
                    LIM_LO −2;LIM_HI 2;BIN 3;
                    LIM_LO −3;LIM_HI 3;BIN 4;
                    LIM_LO −4;LIM_HI 4;BIN 5;
                    LIM_LO −5;LIM_HI 5;BIN 6;
                    LIM_LO −6;LIM_HI 6;BIN 7;
                    LIM_LO −7;LIM_HI 7;BIN 8;
                    LIM_LO −10;LIM_HI 10;BIN 9;
           QUAL 400;LIM_LO −25;LIM_HI +50;BIN 0 <LF>
```

Same values and tolerances are programmed with absolute values.

```
BIN_ABS;CAP;LIM_LO 99.5E−9;LIM_HI 100.5E−9;BIN 1;
            LIM_LO 99E−9;LIM_HI 101E−9;BIN 2;
            LIM_LO 98E−9;LIM_HI 102E−9;BIN 3;
            LIM_LO 97E−9;LIM_HI 103E−9;BIN 4;
            LIM_LO 96E−9;LIM_HI 104E−9;BIN 5;
            LIM_LO 95E−9;LIM_HI 105E−9;BIN 6;
            LIM_LO 94E−9;LIM_HI 106E−9;BIN 7;
            LIM_LO 93E−9;LIM_HI 107E−9;BIN 8;
            LIM_LO 90E−9;LIM_HI 110E−9;BIN 9;
BIN_ABS;QUAL;LIM_LO 300;LIM_HI 600;BIN 0; <LF>
```

3.5.2.2 Store/Recall of Bin Sets

Nine complete bin records (bins 0 to 9), including selected instrument settings can be stored into registers 1 to 9 of the instrument. Storage register 0 contains the bin set for current binning. These registers are independent of those mentioned in Section 3.5.1.8.

Commands:	**BIN**NING_**STO**RE <NR1>	stores binning set into selected register (1 to 9)
	BUFFER_RECALL <NR1>	loads binning set from selected register into a buffer for editing
	BINNING_**RECALL** <NR1>	transfers binning set from selected register into register 0 for binning
	BUFFER_CLEAR	deletes buffer for editing
	BINNING_**ERA**SE <NR1>	deletes binning set of selected register
Query:	**BIN**NING_**SET?** <NR1>	asks for the complete bin set of selected register

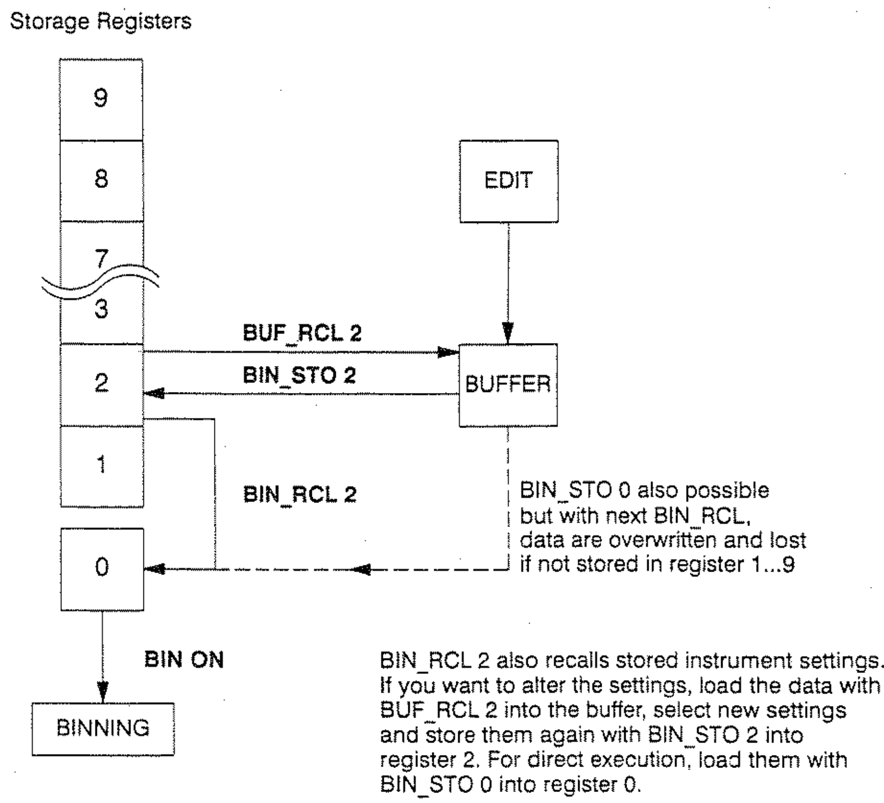
Response: BIN_REL;RESI 1E3;LIM_LO -5;LIM_HI 5;BIN 1;
LIM_LO -10;LIM_HI 10;BIN 2;
LIM_LO -15;LIM_HI 15;BIN 3;
LIM_LO ......

Query:	**BUFFER_BIN?** <NR1>	asks for the selected bin in the buffer for editing

Response: e.g. LIM_LO -10;LIM_HI 10; BIN 2

3.5.2.3 Operation Mode Binning

Select desired bin set and transfer it into register 0 for binning.
If you do not need all the bins for sorting, you can disable bins not needed, except bin 1. To do this, load the set into the buffer for editing, disable the bins, and load the set into register 0.



Commands: **BIN**NING **ON**
BINNING **OFF**

BIN_DISABLE <NR1>
BIN_ENABLE <NR1>

When you select binning mode, the instrument is set to single measurement mode.

Insert the component to be measured and start the measurement.

The display shows the bin number the component is allocated to or FAIL (see table in Section 3.5.2.1).
This information can also be asked by the controller.

Commands: **TRIG**

Query: **BIN?** or **COMP?**

Response: BIN <NR1> or BIN FAIL respectively
R <NR3>; BIN <NR1> or BIN FAIL

3.5.3 Additional Commands

Average

During continuous measurements, the instrument performs an exponential average from the individual measurements before the value is shown in the display. The time factor of the averaging can be increased to reduce any fluctuations in the display.

Commands: **AVERAGE ON**
AVERAGE OFF

Query: **AVERAGE?**

Response: AVG ON
AVG OFF

Range Hold

When you measure components the instrument checks voltage and current and internally selects an appropriate gain factor. If you measure similar components with slightly different values, perform one measurement and set the instrument to Range Hold. This prevents the instrument from setting a new gain factor for each component.

Range Hold increases the measurement speed because the instrument no longer needs to check current and voltage for selecting the gain factor. Range Hold is particularly valuable in the Fast Measurement Mode (Section 3.5.1.6).

Commands: **RANGE_HOLD ON**
RANGE_HOLD OFF

Query: **RANGE_HOLD?**

Response: RNG_HOLD ON
RNG_HOLD OFF

RANGE_HOLD ON is applicable only in SINGLE mode.
After receiving one of the following commands, the instrument automatically returns to Range Hold OFF:
TRIM, BIN ON, BIN OFF, BIN_RCL <NR1>, ⋆RCL, TEST_SIG DC, TEST_SIG AC, LEV HI, LEV NO, LEV LO, or FRE <NRf>.

LOCK Function

When the instrument measures components with a quality factor of about Q = 1 either a resistance or a capacitance, respectively a resistance or an inductance is determined as the dominant parameter, see Auto Mode Decision Diagram, Section 3.5.1.1. With the LOCK function you can define which parameter shall be displayed as the dominant parameter.

The function is applicable for the modes AUTO, SER, PAR, and FAST. It cannot be stored with *SAV into the internal memory registers. The instrument returns to LOCK OFF when different setting are called up or when the instrument is turned off.

Commands:	**LOCK R**	sets resistance as dominant parameter
	LOCK C	sets capacitance as dominant parameter
	LOCK L	sets inductance as dominant parameter
	LOCK OFF	switches the LOCK function off
Query:	**LOCK?**	
Response:	LOCK R	
	LOCK C	
	LOCK L	
	LOCK OFF	

Calibration

The instrument was calibrated in the factory prior to shipment.
The calibrating data are stored in an EEPROM and are referenced for each measurement.

It is necessary to calibrate again after loss of data (replacing the EEPROM), after changing components during repair which influence the measuring results, or when the instrument does not meet the technical specifications.

In normal operation recalibration once a year is sufficient.
Details on calibration can be found in the SERVICE MANUAL.

Query: **CAL**IBRATE**?**

Response: CAL OFF (means calibration data not valid or lost)
CAL ON; NO.<NR1>,YY/MM/DD

<NR1> = number of calibrations since first delivery
YY/MM/DD = Year/Month/DAY
is the date of last calibration via interface

Chapter 4

PROGRAMMING EXAMPLES

4 PROGRAMMING EXAMPLES

4.1 IEEE-488 INTERFACE

The following examples are related to an IBM-compatible PC. The first one uses a built-in IEEE-488 interface, the second one uses the standard serial port of the controller and the RS-232 interface. You should have a basic knowledge of the MS-DOS operating system of the controller and the programming language QuickBasic (version 4.0 and above) to understand the examples that follow. The program allows you to input commands via the controller keyboard and to send them to the RCL meter via the interface.

```
DECLARE SUB SendCmd (WR$)
DECLARE SUB SendStr (WR$)
DECLARE SUB ErrChk (Cs!, Sts%)
REM $INCLUDE: 'qbdecl4.bas'

    CLS
    PRINT " "
    PRINT " "
    PRINT "                ***** DEMO PROGRAM FOR PM6304 ******"
    PRINT
    PRINT "                     PRESS 'RETURN' TO CONTINUE  "
    PRINT
    PRINT "              To leave running program type 'END' or 'end' "
    BEEP
    PRINT
    B$ = ""
    DO                               'waiting for 'RETURN'
      B$ = INKEY$
    LOOP UNTIL B$ = CHR$(13)

    CLS                              'clears screen
    Stp = 0
    BDNAME$ = "RCL1"                 'name of the device on the conf.table
    CALL IBFIND(BDNAME$, RCL%)       'open device
    CALL ErrChk(1, RCL%)             'check error

    IF Stp = 0 THEN
      CALL IBCLR(RCL%)             'send interface clear
      CALL ErrChk(2, IBSTA%)       'check error
    END IF

    IF Stp = 0 THEN
      A$ = "*ese 255"                'initialize ESR register
      CALL SendCmd(A$)               'send command

      A$ = "*cls"                    'clear status register
      CALL SendCmd(A$)               'send command

      A$ = "*IDN?"                   'ask for identiti
      CALL SendStr(A$)               'send command string
```

```
     WHILE Stp = 0
          INPUT "COMMAND :     ", A$    'reading keyboard input
          IF A$ = "END" OR A$ = "end" THEN
            CALL IBLOC(RCL%)          'set instrument to 'LOCAL'
            CLS                       'clear screen
            Stp = 1
          ELSE
            CALL SendStr(A$)          'send command string
          END IF
          PRINT
          PRINT
     WEND
   END IF
END

SUB ErrChk (Cs, Sts%)                'Error handler
    SHARED Stp
    SELECT CASE Cs
      CASE 1
          IF Sts% < 0 THEN
            PRINT
            PRINT
            PRINT "IBFIND ERROR"
            PRINT "Check the configuration of the bus interface with IBCONF.EXE"
            PRINT
            Stp = 1              'terminate program
          END IF
      CASE 2
          IF Sts% < 0 THEN
            PRINT
            PRINT
            PRINT "     BUS ERROR!"
            PRINT
            PRINT "     Please check connections and start program again"
            PRINT
            Stp = 1              'terminate the program
          END IF
      CASE 3
          IF Sts% < 0 THEN
            PRINT
            PRINT
            PRINT "GPIB ERROR"
            PRINT
          END IF
          IF Sts% > 16383 THEN
            PRINT
            PRINT
            PRINT "TIME OUT ERROR"
            PRINT
          END IF
    END SELECT
END SUB
```

```
SUB SendCmd (WR$)
    'Send command string to instrument via GPIB without response
    SHARED RCL%
    CALL IBWRT(RCL%, WR$)              'output command string
    CALL ErrChk(3, IBSTA%)             'check error
END SUB

SUB SendStr (WR$)
    'Send command string to instrument via GPIB with response
    SHARED RCL%
    qry = 0                            'query flag
    qer = 0                            'error query flag
    CALL IBWRT(RCL%, WR$)              'output command string

    IF IBSTA% < 0 THEN
      CALL ErrChk(3, IBSTA%)         'check error
    ELSE
      Stat = 0
      CALL IBRSP(RCL%, Stat%)        'get status byte from instrument
      CALL ErrChk(3, IBSTA%)         'check error
      IF (Stat% AND 16) THEN         'checks whether MAV is set
           qry = 1
      END IF
      IF (Stat% AND 32) THEN         'checks whether ESB is set
           BEEP
           WR$ = "err?"             'error query
           CALL IBWRT(RCL%, WR$)  'output command string
           qry = 1
           qer = 1
      END IF
    END IF

    IF INSTR(WR$, "?") > 0 OR qry = 1 THEN 'check if query command
      MaxLen = 164                   'max. length of response string
      RD$ = SPACE$(MaxLen)           'clear response string
      CALL IBRD(RCL%, RD$)           'get response string
      IF IBSTA% < 0 THEN
          CALL ErrChk(3, IBSTA%)     'check error
      ELSE
          PRINT
          PRINT "RESPONSE :     " + RD$  'response string
          IF qer = 1 THEN
            WR$ = "*cls"           'clear status register
            CALL IBWRT(RCL%, WR$)  'output command string
          END IF
      END IF
    END IF
END SUB
```

4.2 RS-232 INTERFACE

```
DECLARE SUB SndCmd (WR$)
DECLARE SUB SndMsg (WR$)
DECLARE FUNCTION ChkCmd$ (WR$)
DECLARE SUB ClrBuf (COMFILE)
DECLARE FUNCTION IniPrg (COMFILE)
DECLARE FUNCTION RecMsg$ (COMFILE)
DECLARE SUB SetDTR (Cnt)

COMMON SHARED COMFILE, MCREG, Chk
    COMFILE = 1                                     'file buffer handle
    MCREG = IniPrg(COMFILE)                         'inilize program
    Stp = 0
    WHILE (Stp = 0)
       SEND$ = CHR$(27) + "2"
       CALL SndCmd(SEND$)                           'send goto remote
       SEND$ = "*cls;*ese 255"
       CALL SndCmd(SEND$)                           'send status clear
       SEND$ = "*idn?"
       CALL SndCmd(SEND$)                           'send identifikation query
       REC$ = RecMsg$(COMFILE)                      'get identifikation
       IF LEN(REC$) = 0 THEN                        'if buffer empty
          PRINT
          PRINT "No answer! Please check the connection and setting!"
          CLOSE COMFILE
          Stp = 1
       ELSE
          CLS
          PRINT "connected instrument : "; REC$     'display identity string
          PRINT
       END IF
       '
       '****** main loop ********************************************
       WHILE (Stp = 0)
          PRINT
          PRINT
          LINE INPUT "COMMAND : "; SEND$         'command input
          SEND$ = ChkCmd(SEND$)                  'checks the command
          IF Chk = 0 THEN
             SEND$ = CHR$(27) + "1"
             CALL SndCmd(SEND$)                  'sets instrument to local
             CLOSE COMFILE
             Stp = 1
             CLS
          ELSE
             CALL SndMsg(SEND$)                  'send message
          END IF
       WEND
    WEND
END
```

```
FUNCTION ChkCmd$ (WR$)
    '****** command check ******************************************
    Chk = 2
    IF LEN(WR$) = 3 THEN
       IF WR$ = "END" OR WR$ = "end" THEN Chk = 0
       IF WR$ = "GTL" OR WR$ = "gtl" THEN WR$ = CHR$(27) + "1"
       IF WR$ = "GTR" OR WR$ = "gtr" THEN WR$ = CHR$(27) + "2"
       IF WR$ = "DCL" OR WR$ = "dcl" THEN WR$ = CHR$(27) + "4"
       IF WR$ = "LLO" OR WR$ = "llo" THEN WR$ = CHR$(27) + "5"
       IF WR$ = "dtr" OR WR$ = "DTR" THEN WR$ = CHR$(27) + "8"
       IF WR$ = "STB" OR WR$ = "stb" THEN
          WR$ = CHR$(27) + "7"
          Chk = 3
       END IF
    ELSE                                        'no special command
       Chk = 1
       WR$ = WR$ + CHR$(10)                     'append terminator
    END IF
    ChkCmd$ = WR$
END FUNCTION

SUB ClrBuf (COMFILE)
    '******** clear buffer *************************************
    CALL SetDTR(1)                              'set DTR on
    WHILE (LOC(COMFILE) > 0)                    'if buffer not empty
       C$ = INPUT$(1, #COMFILE)                 'read one character
       CALL SetDTR(1)                           'set DTR on again
    WEND                                        'next character
END SUB

FUNCTION IniPrg (COMFILE)
    CLS
    PRINT "       ***************************************************************"
    PRINT "       *********    Demonstration program for PM6304    ***************"
    PRINT "       *********       with RS-232 interface            ***************"
    PRINT "       ***************************************************************"
    PRINT
    PRINT
    PRINT
    '****** list of special commands ************************************
    PRINT "Special commands : "
    PRINT
    PRINT "            GTL  : go to local"
    PRINT "            GTR  : go to remote"
    PRINT "            DCL  : device clear"
    PRINT "            LLO  : local lock out"
    PRINT "            STB  : get status byte"
    PRINT "            DTR  : device trigger"
    PRINT
    PRINT
    PRINT "To leave running programm type 'END' "
    PRINT
    PRINT
    PRINT "                        press a key to continue ";
    C$ = ""
    WHILE (C$ = "")
       C$ = INKEY$
    WEND
    CLS
```

```
PRINT
'****** Enviroment : IBM AT or Compatible  *********
'****** Initialisation of PM6304 / serial interface *********************
PRINT "         Please set the RS-232 interface parameters of the PM6304 to : "
PRINT "                    Mode      : COmmunication "
PRINT "                    Baudrate  : 9600"
PRINT "                    Parity    : off"
PRINT "                    Data      : 8"
PRINT "                    Handshake : on"
PRINT "                    Wire      : 7"
PRINT
PRINT
'
'****** Initialisation of PC communication port ***************
 PRINT "        Which communication port of the PC do you use ?"
 PRINT
 PRINT "                    COM1   [1]"
 PRINT "                    COM2   [2]                        please select "
 PRINT
 PORT = 0
 WHILE (PORT = 0)
    C$ = INKEY$                       'get key code
    IF C$ = "1" THEN PORT = 1
    IF C$ = "2" THEN PORT = 2
 WEND
 MCREG = &H3FC
 IF PORT = 2 THEN MCREG = &H2FC     'modem control register address
 SER$ = "COM" + CHR$(48 + PORT) + ":9600,N,8,1,CS,DS,CD,RS"
 OPEN SER$ FOR RANDOM AS #COMFILE
 WIDTH #COMFILE, 255
 CALL ClrBuf(COMFILE)               'clear input buffer
 IniPrg = MCREG
END FUNCTION

FUNCTION RecMsg$ (COMFILE)
   '******** receive message from instrument ******************
   Del = 1                                     'communication delay
   REC$ = ""                                   'clear response string
   DO
      TR! = TIMER                               'start timeout timer
      DO
         IF TIMER < TR! THEN TR! = TR! - 86400!    'adjust 24.00h
      LOOP UNTIL (LOC(COMFILE) > 0) OR (TIMER - TR! > Del)

      IF LOC(COMFILE) = 0 THEN                 'if there no characters
         PRINT "***** receive timeout *****"
         Stp = 1
      ELSE
         C$ = INPUT$(1, #COMFILE)               'read one character
         CALL SetDTR(1)                         'set DTR on
         IF NOT C$ = CHR$(10) THEN
            REC$ = REC$ + C$                    'append character
         END IF
      END IF
   LOOP UNTIL ((C$ = CHR$(10)) OR (Stp = 1))
   RecMsg$ = REC$
END FUNCTION
```

```
SUB SetDTR (Cnt)
    '******** buffer size check ********************************
    IF Cnt = 0 THEN
     'if input buffer becomes full then reset DTR to stop transmission
        IF LOC(COMFILE) > 200 THEN
           OUT MCREG, INP(MCREG) AND 254            'set DTR off
        END IF
     ELSE
     'if input buffer has enough space then  continue transmission
        IF LOC(COMFILE) < 100 THEN
           OUT MCREG, INP(MCREG) OR 3               'set DTR on
        END IF
     END IF
END SUB

SUB SndCmd (WR$)

    '******** send command to instrument **********************
     IF NOT LEFT$(WR$, 1) = CHR$(27) THEN
        WR$ = WR$ + CHR$(10)                   'append terminator
     END IF
     PRINT #COMFILE, WR$;                      'send command string
END SUB

SUB SndMsg (WR$)
    PRINT #COMFILE, WR$;                        'send command string

    T1 = TIMER
    WHILE (T1 + .1 > TIMER)                     'delay 100ms
    WEND
    IF (INSTR(WR$, "?") > 0) OR Chk = 3 THEN    'if a query
       REC$ = RecMsg$(COMFILE)                  'get response message
       PRINT
       PRINT "RESPONSE :  "; REC$
    END IF
    WR$ = CHR$(27) + "7"
    CALL SndCmd(WR$)                            'sends get status byte
    Sts% = VAL(RecMsg$(COMFILE))
    IF (Sts% AND 32) THEN                       'checks wether ESB is set
       BEEP
       WR$ = "err?"
       CALL SndCmd(WR$)                         'sends command
       REC$ = RecMsg$(COMFILE)
       PRINT
       PRINT " ERROR : "; REC$
       WR$ = "*cls"
       CALL SndCmd(WR$)                         'clear status register
    END IF
END SUB
```

Chapter 5

PRINTING OF MEASUREMENT RESULTS

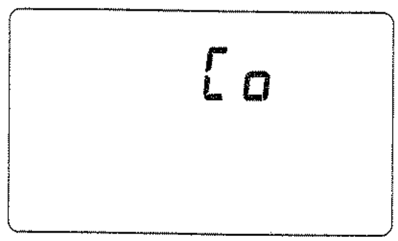
5 PRINTING OF MEASUREMENT RESULTS

The PM6304 / PM6404C RCL Meter can send measurement results directly to a printer without any special program or PC.

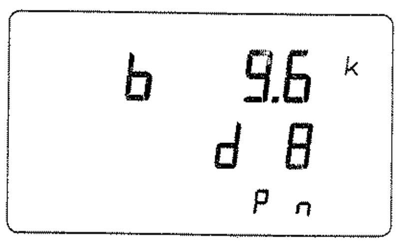
- Select an appropiate measurement setup;
  select required instrument settings for measurement.
- Set the interface configuration in accordance with your printer, see Chapter 2.1, and refer to your printer manual if necessary.
- Connect the RCL meter to the printer via the RS-232 cable as shown on Page 5 – 3.
- Set the Operating Mode of the interface to Printer Mode (**Pr**) by pressing the **INTERFACE** and **STEP** keys. The instrument is automatically set to single measurement mode.

Function and Key Operation | **Display**

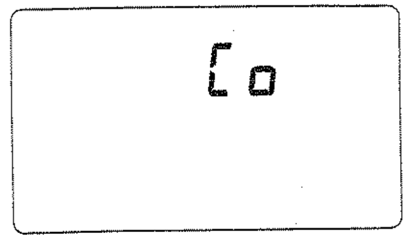
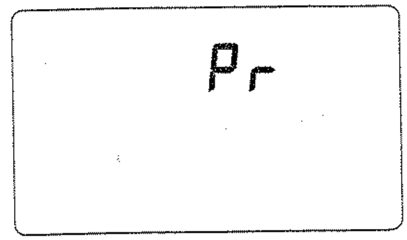
INTERFACE



INTERFACE

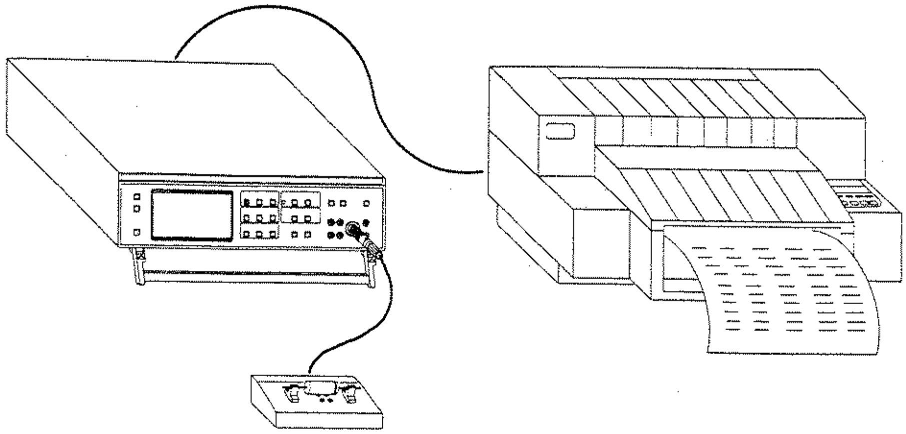


display shows
current configuration

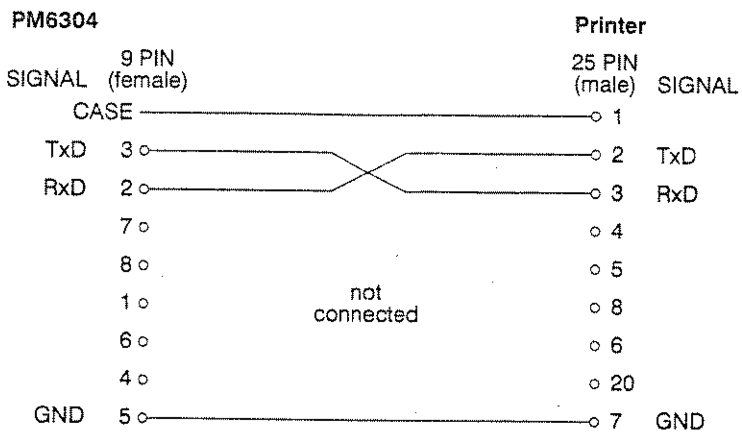
Function and Key Operation	Display
INTERFACE	
STEP – + select printer mode	

If you do not press the **INTERFACE** key within 3 seconds, the instrument returns automatically to measurement mode, the altered settings are not stored.

Press the **INTERFACE** key to step completely through the menus until the normal display appears.



Connection cable



Xon/Xoff software handshake must be switched on.

- The printer prints the first header line.
- Insert a component and press the **TRIGGER** key to start a measurement.
- The printer prints the second header line and the measurement result.
- Insert a different component, and press the **TRIGGER** key.
- The printer prints the result, etc.

Example of a print:

PM6304 RCL METER : TEST PROTOCOL FLUKE

NO	DOMINANT	SECOND	CIRCUIT	MODE	FREQ	LEVEL	BIAS
1	R=79.13 kOhm	C=10.08 nF	Par	Auto	100 Hz	Norm	Off
2	C=10.059 nF	R=78.34 kOhm	Par	Auto	1.0 kHz	Norm	Off
3	C=10.062 nF	R=78.3 kOhm	Par	Auto	10.0 kHz	Norm	Off
4	C=10.070 nF	R=35.5 kOhm	Par	Auto	100 kHz	Norm	Off
5	C=10.059 nF	Z=15.51 kOhm	Par	Par	1.0 kHz	Norm	Off
6	C=10.059 nF	0=-78.5 deg	Par	Par	1.0 kHz	Norm	Off
7	C=10.060 nF	D=.202	Par	Par	1.0 kHz	Norm	Off
8	C=10.059 nF	Q=4.95	Par	Par	1.0 kHz	Norm	Off
9	C=10.470 nF	R=3.070 kOhm	Ser	Ser	1.0 kHz	Norm	Off
10	R=79.144 kOhm	----	----	----	DC	Norm	Off
11	R=19.937 kOhm	C=4.83 uF	Ser	Ser	1.0 kHz	Norm	Off
12	R=19.938 kOhm	C=13.5 pF	Par	Auto	1.0 kHz	Norm	Off
13	R=19.940 kOhm	Z=19.94 kOhm	Par	Par	1.0 kHz	Norm	Off
14	R=19.941 kOhm	D=591	Par	Par	1.0 kHz	Norm	Off
15	R=19.941 kOhm	Q=.002	Par	Par	1.0 kHz	Norm	Off
16	R=19.96 kOhm	Q=.002	Par	Par	1.0 kHz	Low	Off
17	R=19.96 kOhm	Q=.002	Par	Par	1.0 kHz	Low	Off
18	R=19.946 kOhm	Q=.002	Par	Par	1.0 kHz	High	Off
19	R=19.951 kOhm	C=13.0 pF	Par	Auto	1.0 kHz	Norm	Off
20	R=120.91 kOhm	C=21.5 pF	Par	Auto	1.0 kHz	Norm	Off
21	R=120.86 kOhm	C=80.4 nF	Ser	Ser	1.0 kHz	Norm	Off
22	R=120.89 kOhm	Z=120.9 kOhm	Par	Par	1.0 kHz	Norm	Off
23	R=120.90 kOhm	D=61.5	Par	Par	1.0 kHz	Norm	Off
24	R=120.91 kOhm	Q=.016	Par	Par	1.0 kHz	Norm	Off
25	R=120.89 kOhm	Q=.016	Par	Par	1.0 kHz	Norm	Off

To leave the Printer Mode set the PM6304 to Communication Mode by pressing the **INTERFACE** and **STEP** keys as mentioned before.

Chapter 6

ERROR MESSAGES

6 ERROR MESSAGES

After receiving the query **ERR?** the instrument generates a response message with an error number and an error description in clear text, which can be read in by the controller.

Error Message	**see Chapter/ Section**
ERROR0/NO ERROR	
ERROR101/PROM CHECKSUM ERROR	SM
ERROR102/INTERNAL RAM ERROR	SM
ERROR103/EXTERNAL RAM ERROR	SM
ERROR104/BACKUP ERROR	SM
ERROR105/EXTERNAL MEMORY ERROR	SM
ERROR107/EEPROM ERROR	SM
ERROR108/EEPROM ERROR: TRIMM DATA	SM
ERROR109/EEPROM ERROR: CAL.DATA	SM
ERROR110/EEPROM ERROR: BINNING DATA	SM
ERROR111/HARDWARE ERROR	SM
ERROR112/DISPLAY ERROR	SM
ERROR113/TIME OUT ERROR	
ERROR114/ERROR DURING TRIMMING	UM 4.3
ERROR115/TRIMMING RESISTANCE OUT OF RANGE	UM 4.3
ERROR117/OVERLOADED	UM 4.7
ERROR118/BINNING SET IS EMPTY	PM 3.5.2
ERROR120/CALIBRATION ERROR	SM
ERROR140/REFERENCE RESISTANCE OUT OF RANGE	SM
ERROR142/ILLEGAL REGISTER ADDRESS	PM 3.5
ERROR143/ILLEGAL BINNING NUMBER	PM 3.5.2
ERROR144/DATA INCOMPLETE	PM 3.5.2
ERROR145/BINNING SET IS EMPTY	PM 3.5.2
ERROR146/BINNING SET IS NOT CONSISTENT	PM 3.5.2
ERROR150/SYNTAX ERROR	PM 3.1

7 COMMANDS IN ALPHABETICAL ORDER

7.1 COMMON COMMANDS AND QUERIES (IEEE-488.2)

Command/Query	Description	Page
⋆CLS	Sets 'Standard Event Status Register' and 'Status Register' to zero	3 – 7
⋆ESE <NRf>	'Standard Event Status Enable' Command	3 – 7
⋆ESE?	'Standard Event Status Enable' Query	3 – 7
⋆ESR?	Reads 'Standard Event Status Register'	3 – 7
⋆IDN?	Identification Query	3 – 4
⋆LRN?	Learn Device Setup Query	3 – 4
⋆OPC	'Operation Complete' Command	3 – 5
⋆OPC?	'Operation Complete' Query	3 – 6
⋆RCL 1...9	Recall Command	3 – 8 / 18
⋆RST	Reset Command	3 – 4
⋆SAV 1...9	Save Command	3 – 8 / 18
⋆SRE <NRf>	'Service Request Enable' Command	3 – 7
⋆SRE?	'Service Request Enable' Query	3 – 7
⋆STB?	Reads Status Byte	3 – 8
⋆TRG	Trigger Command	3 – 7
⋆TST?	Self-test Query	3 – 5
⋆WAI	Wait-to-Continue Command	3 – 6

7.2.2 Commands for Binning

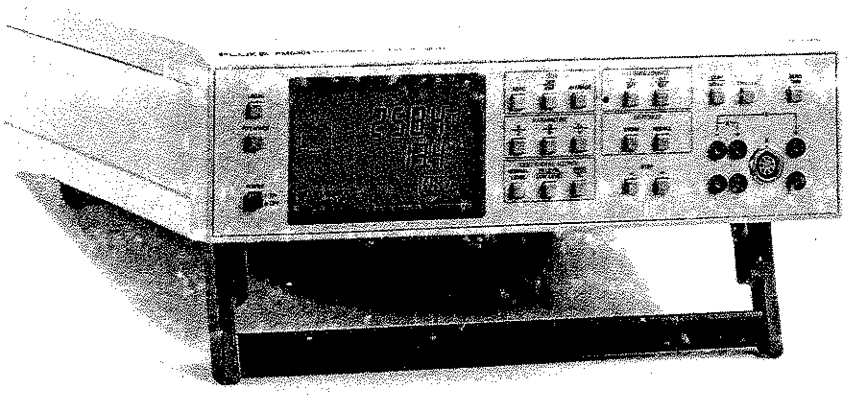
Command/Query	Description	Page
BIN <NR1>	Allocates data to bins 0 to 9	3 – 21
BIN?	Asks for the bin the component is allocated to	3 – 25
BIN OFF	Normal measuring mode	3 – 24
BIN ON	Binning mode	3 – 24
BIN_ABS	Input af absolute values	3 – 21
BIN_DISABL <NR1>	Disables selected bin	3 – 24
BIN_ENABL <NR1>	Enables selected bin	3 – 24
BIN_ERA <NR1>	Deletes selected bin set	3 – 23
BIN_RCL <NR1>	Loads bin set into register 0	3 – 23
BIN_REL	Input of tolerances in percent	3 – 21
BIN_SET? <NR1>	Asks for selected bin set	3 – 23
BIN_STO <NR1>	Stores bin set into register 1 to 9	3 – 23
BUF_BIN? <NR1>	Asks for the selected bin from the buffer for editing	3 – 23
BUF_CLR	Deletes buffer for editing	3 – 23
BUF_RCL <NR1>	Loads selected bin set into buffer for editing	3 – 23
CAP	Capacitance; absolute	3 – 21
CAP <NRf>	Capacitance; nominal	3 – 21
DISS	Dissipation factor; absolute	3 – 21
DISS <NRf>	Dissipaton factor; nominal	3 – 21
IMP	Impedance; absolute	3 – 21
IMP <NRf>	Impedance; nominal	3 – 21
INDU	Inductance; absolute	3 – 21
INDU <NRf>	Inductance, nominal	3 – 21
LIM_HI	Upper tolerance limit	3 – 21
LIM_LO	Lower tolerance limit	3 – 21
PHA	Phase angle; absolute	3 – 21
PHA <NRf>	Phase angle; nominal	3 – 21
QUA	Quality factor; absolute	3 – 21
QUA <NRf>	Quality factor; nominal	3 – 21
RESI	Resistance; absolute	3 – 21
RESI <NRf>	Resistance; nominal	3 – 21

4822 872 10167

Programmable Automatic RCL Meter

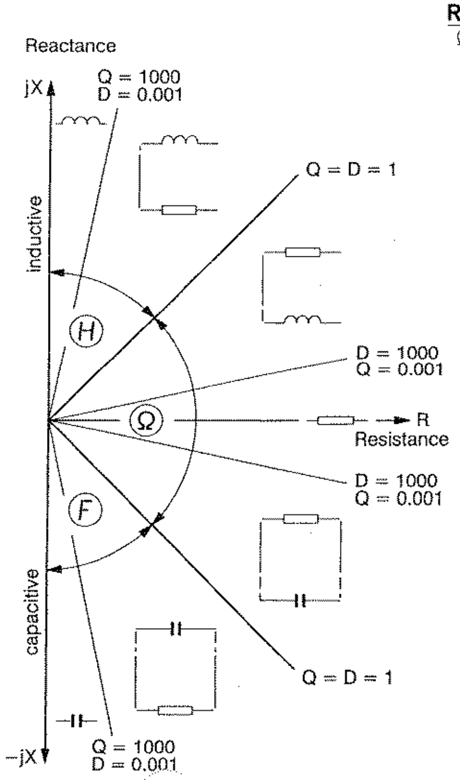
PM6304

Users Manual

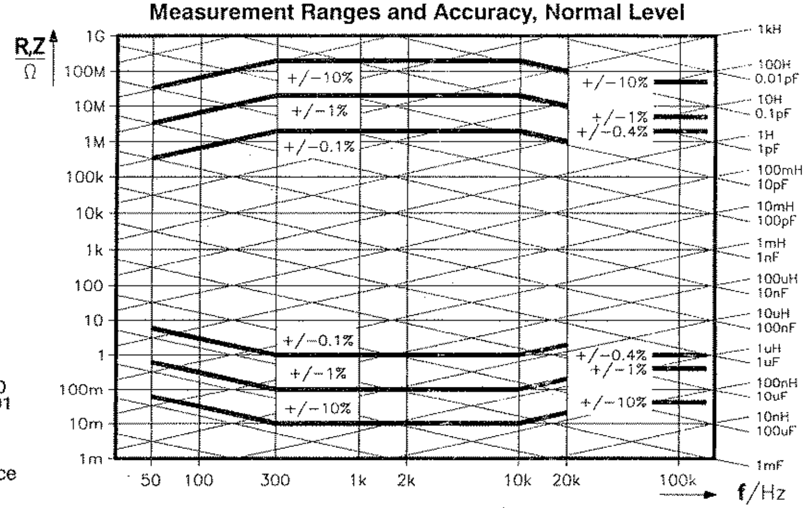


Now incorporating Philips T&M... FLUKE®

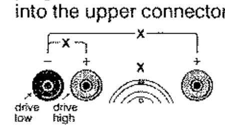
Auto Mode Decision Diagram



Measurement Ranges and Accuracy, Normal Level



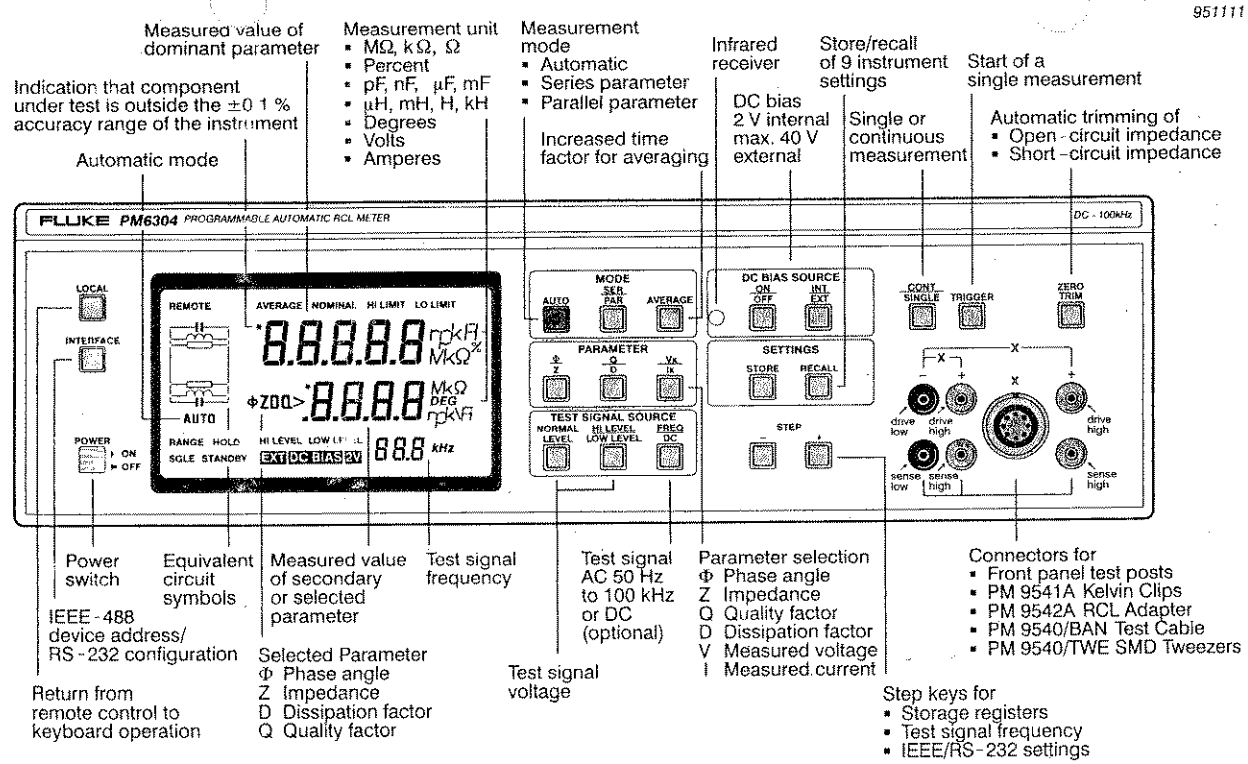
- For SMD components use PM 9542 SMD Adapter or PM 9540/TWE SMD Tweezers.
- For larger components use PM 9542A RCL Adapter.
- For in-circuit measurement of components use PM 9541A Kelvin Clips Test Cable.
- For two-wire measurements plug two normal test leads into the upper connectors.



- Center segments of digits flash when component exceeds measurement range:
  R >200 MΩ
  C >32 F at 50 Hz, >16 mF at 100 kHz
  L >637 kH at 50 Hz, >318 H at 100 kHz.
- Asterisk flashes if component is outside basic accuracy of the instrument. Select appropriate test signal frequency.
- Discharge capacitors before connecting.
- **ZERO TRIM** compensates:
  - Contact and line resistances (up to 10 Ω in short circuit).
  - Stray capacitances in open-circuit.
- Test sigr uency 50 Hz to 100 kHz.

PM6304 PROGRAMMABLE AUTOMATIC RCL METER DC - 100KHZ

Operating Card
4822 872 10165
951111



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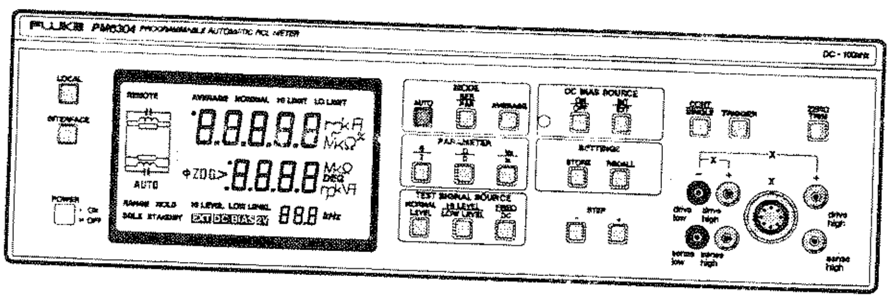
Programmable Automatic RCL Meter

PM6304

Users Manual

951111



FLUKE.

Please note
In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

Bitte beachten
Bei Schriftwechsel über dieses Gerät wird gebeten, die Typennummer und die Gerätenummer anzugeben. Diese befinden sich auf dem Typenschild an der Rückseite des Gerätes.

Noter s.v.p.
Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez toujours indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Important
As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

Wichtig
Da das Gerät ein elektrisches Betriebsmittel ist, darf die Bedienung nur durch eingewiesenes Personal erfolgen. Wartung und Reparatur dürfen nur von geschultem, fach- und sachkundigem Personal durchgeführt werden.

Important
Comme l'instrument est un équipement électrique, le service doit être assuré par du personnel qualifié. De même, l'entretien et les réparations sont à confier aux personnes suffisamment qualifiées.

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CONTENTS

INSIDE THIS MANUAL

This USERS MANUAL contains information on all features of the PM6304 and PM6304C instruments.
It starts with a shipment note and an initial inspection.

The manual is organized into the following chapters:

Chapter 1 Installation and Safety Instructions

This chapter should be read before unpacking, installing, and operating the instrument. It describes grounding, power cables, and line voltage settings.

Chapter 2 Main Capabilities

This chapter describes the main features of the instrument, its functions, operation modes, measurement possibilities and its options.

Chapter 3 Getting Started

This chapter starts with general procedures and precautions necessary for operation followed by a short functional test. It contains a description of the display, a summary of controls and connectors on the front and rear panels, and a description of accessories and measurement setups.

Chapter 4 How to Use the Instrument

This chapter provides the user with detailed explanations of the measurement principle and the measurement of different components.

Chapter 5 Function Reference

This chapter contains a description of each function in alphabetical order. Each description includes an explanation of local and remote control functions.

Included in the shipment you find an additional REFERENCE MANUAL.

The REFERENCE MANUAL contains:

- CHARACTERISTICS
- PRINCIPLE OF OPERATION
- BRIEF CHECKING PROCEDURE
- PERFORMANCE TEST
- PREVENTIVE MAINTENANCE
- APPENDIX
- SERVICE CENTERS

CONTENTS

SHIPMENT NOTE

The following parts should be included in the shipment:

1 PM6304 / PM6304C Progammable Automatic RCL Meter DC – 100 kHz

1 Users Manual

1 Reference Manual

1 Programmers Manual

1 Power Cable

2 Fuses

2 Single Test Posts

For built-in options, see the type plate on the rear panel:

Type plate

FLUKE.

Type number	TYPE : PM6304/xxx	31VA
Code number	NC : 9452 063 04xxx	
Serial number	NO : LO	50-60Hz

Code number:
9452 X63 04X X X

- Power cable (see Section 1.1.4)

Options built-in:

2 IEEE-488 interface
3 RS-232 interface
4 DC Unit
6 DC Unit and IEEE-488 interface
7 DC Unit and RS-232 interface
0 No option

5 Handler interface
0 No Handler interface

0 PM6304
1 PM6304C

INITIAL INSPECTION

Check that the shipment is complete and note whether any damage has occurred during transport. If the contents are incomplete or there is damage, file a claim with the carrier immediately, and notify the Fluke Sales or Service organization to facilitate the repair or replacement of the instrument. The addresses are listed in the back of this manual.

The performance of the instrument can be tested by using the Performance Test in the Reference Manual.

Chapter 1

INSTALLATION AND SAFETY INSTRUCTIONS

1 INSTALLATION AND SAFETY INSTRUCTIONS

1.1 SAFETY INSTRUCTIONS

Upon delivery from the factory the instrument complies with the required safety regulations (see Reference Manual, Chapter 1). To maintain this condition and to ensure safe operation, the instructions below must be followed carefully.

1.1.1 Maintenance and Repair

Failure and excessive stress:
If the instrument is suspected of being unsafe, remove it from operation immediately and secure it against any unintended operation. The instrument is considered to be unsafe when any of the following conditions exist:
- It shows physical damage.
- It does not function anymore.
- It is stressed beyond the tolerable limits
  (e.g., during storage and transportation).

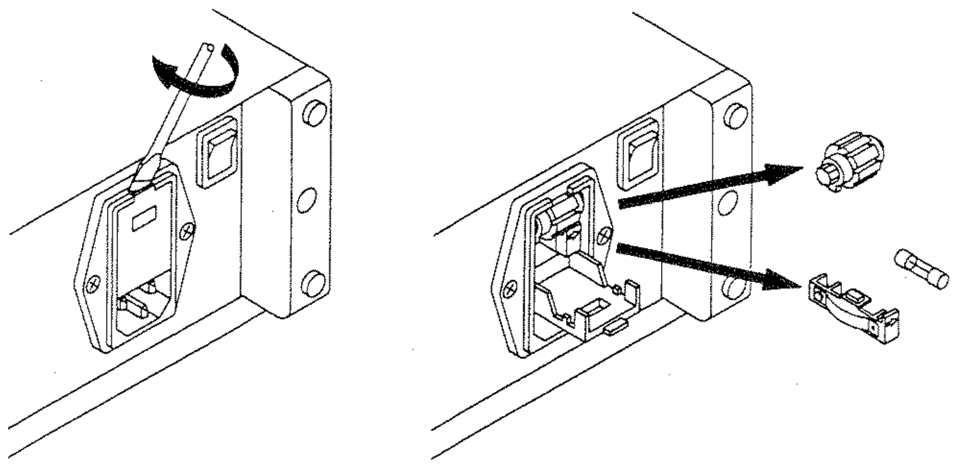
Disassembling the Instrument:

WARNING

Calibration, maintenance, and repair of the instrument must be performed only by trained personnel who are aware of the hazards involved. To avoid electric shock, do not remove the cover unless you are qualified to do so.

Before removing the cover, disconnect the instrument from all power sources. The capacitors in the instrument may remain charged for several seconds after all power has been disconnected.

Turn the selector to select the appropriate voltage range. If necessary, insert the specified fuse (T0.2A or T0.4A according to IEC127 or T0.25A or T0.5A according to CSA/UL198G) that matches the line voltage setting into the fuse holder.



1.2 OPERATING POSITION OF THE INSTRUMENT

The instrument can be operated on a horizontal surface in a flat position or with the tilt bale extended. Ensure that the ventilation holes are free of obstruction. Do not position the instrument in direct sunlight or on any surface that produces or radiates heat.

1.3 RADIO INTERFERENCE SUPPRESSION

Radio interference of the instrument is suppressed and checked carefully. If radio frequency interferences occurs in connection with deficiant suppressed other instruments, further suppression actions may be required.

Chapter 2

MAIN FEATURES

2 MAIN FEATURES

The **PM6304 Programmable Automatic RCL Meter** is used for precise measurements of resistance, capacitance, and inductance. Its basic accuracy is 0.1 %. The **PM6304C Programmable Automatic RCL Meter** has a higher accuracy of 0.05 % at test signal frequencies up to 2 kHz. The instrument provides an auto-function and autoranging feature. It allows fast and high precision measurements and diagnostic of passive components over a wide range.

The component to be measured is connected to the instrument via front panel posts, the PM 9541A four-wire test cable, or the PM 9542A four-terminal test adapter. The Adapter PM 9542SMD or the PM 9540/TWE SMD Tweezers for surface-mounted components are also available.

Measurements are performed using a four-wire system.
The test frequency is selectable in the range from 50 Hz to 100 kHz.
Three test voltages are available: 2 V, 1 V, and 50 mV rms.

The measurement result, the numerical value, dimension, and the equivalent circuit symbol, are all displayed on the large five-digit liquid-crystal display (LCD), which is updated at a rate of approximately two measurements per second.

A microprocessor controls the measurement process, computes the measurement value, and transfers the result to the display.

In the AUTO mode the dominant and the secondary parameter, either R, C, or L of the component under test is automatically selected for display.
For example, for an inductance with a quality factor Q between 1 and 1000, the instrument indicates the measurement value of the series inductance and the series resistance and as the equivalent-circuit symbol, the series connection of an inductance and a resistance.

In addition to AUTO mode, the following modes can be selected:

- series respectively parallel components
- impedance Z
- phase angle Φ
- quality factor Q, dissipation factor D
- component voltage V_x, component current I_x

An internal DC BIAS voltage (2 V dc) can be added to the measurement voltage for electrolytic capacitors.
An external DC BIAS voltage can also be selected, up to 40 V dc.

DC resistance measurements without an ac test signal can be made by using the optional PM 9565 DC Unit.

The instrument can be programmed and can transfer its measurement data via the optional PM 9548 Interface for IEEE-488, or via the PM 9549 Interface for RS-232. Ten measurements per second are also possible. The RS-232 Interface also allows output of measurement results directly to a printer with no controller needed.

For sorting and binning of components, the optional infrared remote control, the PM 9559 Bin Programmer, and the PM 9566 Handler Interface are available.

Nine complete instrument settings can be stored and recalled for fast and convenient setup.

Chapter 3

GETTING STARTED

3 GETTING STARTED

3.1 GENERAL INFORMATION

This section outlines the procedure and precautions necessary for operation. It identifies and briefly describes the functions of the front and rear panel controls and the display.

3.2 TURNING THE INSTRUMENT ON

After the instrument has been connected to the line voltage in accordance with Section 1.1.4, it can be turned on by setting the **POWER** switch on the front panel to **ON**.

The specifications given in the Reference Manual, Chapter 1, are valid when the instrument is installed in accordance with the instructions in Chapter 1 of this manual and a warm-up period of 5 minutes is allowed.

After turning the power off, wait at least 5 seconds before turning it on again. This allows all power to completely discharge and the instrument to reset.

3.3 SELF-TEST ROUTINE

After power on, the instrument performs a self-test of the PROM, processor RAM, and external RAM. After this, the software version is indicated in the upper line of the display for approximately 1 second. All segments of the display field are shown for approximately 2 seconds, and the instrument automatically recalls its instrument state before power off.

If a fault is found during self-test, this fault is indicated as follows,

for example: Err 2

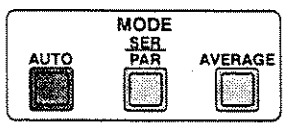
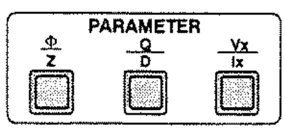
For detailed information see Section 4.7.

3.4 OPERATION AND APPLICATION

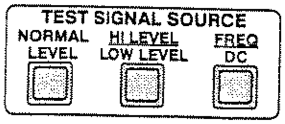
3.4.1 Control Elements, Display and Connections

3.4.1.1 Front Panel

Keyboard:

Description	Function
	Key used to switch from remote control to keyboard operation.
	Key used to display and to select • Instrument address for remote control via IEEE-488 interface • Setup for remote control via RS-232 interface.
	Power switch
	Keys used to select the required measurement function **AUTO** • Automatic measurement mode: the dominant and secondary parameters are automatically determined **SER/PAR** • Select series or parallel mode **AVERAGE** • Alteration of averaging function to reduce fluctuation of measured value
	**Φ/Z** • Phase angle or impedance (complex impedance) **Q/D** • Quality factor (tan ϕ; Q = 1/D) Dissipation factor (tan δ; D = 1/Q) **Vx/Ix** • Test voltage or current at the component terminals.

Description | **Function**

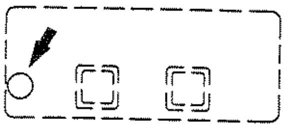


Measurement source voltage

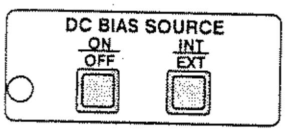
NORMAL LEVEL
- NORMAL: 1 V ac rms or 1 V dc

HI LEVEL LOW LEVEL
- HI LEVEL: 2 V ac rms or 2 V dc
- LOW LEVEL: 50 mV ac rms or 300 mV dc

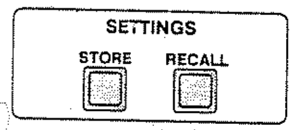
FREQ DC
- Test signal frequency 50 Hz to 100 kHz or dc (optional)



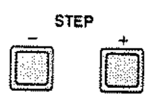
Infrared receiver for PM 9559 Bin Programmer.



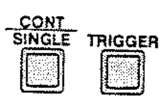
Internal 2 V dc bias on or off or external bias voltage (maximum 40 V dc), e.g., to measure electrolytic capacitors.



Keys used to store or to recall instrument settings (9 registers).



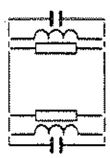
Keys used to step the test signal frequency up or down and to select the storage registers.



Keys used to
- select single or continuous measurement **CONT SINGLE**
- trigger a single measurement (**TRIGGER**).

Key used for automatic trimming of
- open-circuit impedance (>100 kΩ)
- short-circuit impedance (< 10 Ω).

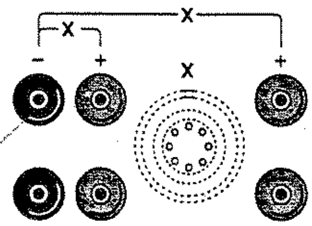
Display:

Description	Function	
REMOTE AVERAGE NOMINAL HI LIMIT LO LIMIT	**REMOTE**	Instrument in remote control via RS-232 or IEEE-488 Interface.
	AVERAGE	Increased time factor for averaging to reduce fluctuation of measured value.
	NOMINAL **HI LIMIT** **LO LIMIT**	Tolerance limits and value using the PM 9559 Bin Programmer.
	Equivalent circuit symbols: In AUTO mode the dominant parameter is shown in the upper section; the secondary parameter is shown in the lower section.	
*8.8.8.8.8	Maximum of five digits for the measured value of the dominant parameter. The asterisk indicates that the component is outside the basic accuracy range of the instrument.	
	Units for: ***nF, pF, μF, mF*** ***μH, mH, H, kH*** ***MΩ, kΩ, Ω*** **%**	 for capacitances for inductances for resistances for tolerance limits in binning mode
ΦZDQ	Display of selected parameter: **Φ** Phase angle **Z** Impedance **D** Dissipation factor **Q** Quality factor	

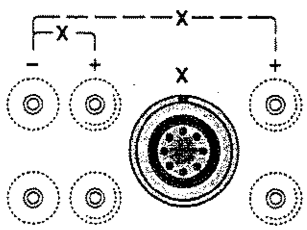
Description	Function
*8.8.8.8	Maximum of four digits for the measured value of the selected parameter or of the series/parallel parameter in **AUTO** mode. The asterisk indicates during impedance measurements (**Z**) that the component is outside the basic accuracy range of the instrument.
MkΩ DEG npk\H	Units for: ***MΩ, kΩ, Ω*** for resistances ***DEG*** (Degree) for phase angle ***nF, pF, µF, mF*** for capacitances ***µH, mH, H, kH*** for inductances ***V, mV*** for voltage ***mA, µA*** for current
AUTO	AUTO mode enabled: Automatic selection of dominant and series/parallel parameter.
RANGE HOLD HI LEVEL LOW LEVEL SGLE STANDBY EXT DC BIAS 2V	**RANGE HOLD** Fixes the current internal measuring range (via remote control only). **HI LEVEL LOW LEVEL** Test signal voltage **SGLE STANDBY** Ready for single measurement (normal level is not displayed). **EXT DC BIAS** External bias voltage enabled. **DC BIAS 2V** Internal 2 V bias enabled.
88.8 kHz	Test signal frequency in Hz or kHz for ac or dc (**dc**).

Description	Function

Connector on the front panel:

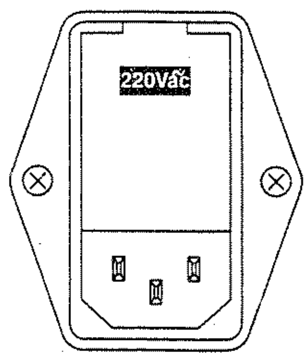


Connectors for
- Test posts for four-wire measurement.
- PM 9542SMD, SMD Adapter

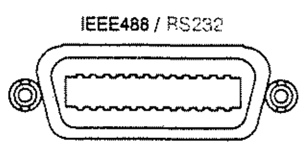


Connector for
- PM 9541A 4-wire test cable with Kelvin Clips
- PM 9542A RCL Adapter
- PM 9540/TWE, SMD Tweezers
- PM 9540/BAN, 4-wire test cable with banana plugs

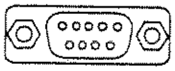
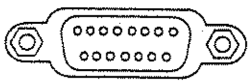
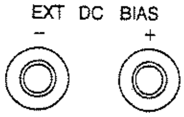
3.4.1.2 Rear Panel



Input power module with fuse and voltage selector.
– ac (alternating current).
For details, see Section 1.1.4: Line Voltage Setting and Fuses.



IEEE-488 bus connector for remote control.

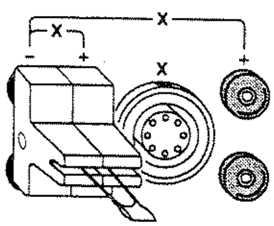
Description	Function
IEEE488 / RS232 	RS-232 connector.
HANDLER INTERFACE 	Component handler interface connector.
EXT DC BIAS  MAX 40V	External dc bias voltage input (maximum 40 V dc).

3.4.2 Measurement Setup and Accessories

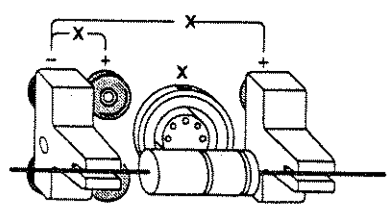
For best accuracy, you should perform ZERO TRIM (see Section 4.3) when you change the measurement setup, the test signal frequency, or the test signal voltage when test signal frequency is ≥ 10 kHz.
You should not change the setup after trimming if you use test signal frequencies ≥ 10 kHz with the PM 9541A Test Cable with Kelvin Clips, the PM 9542A RCL Adapter, the PM 9540/TWE SMD Tweezers, or the PM 9540/BAN Test Cable.

Test posts

Most common components can be measured with the supplied test posts plugged into the front panel connectors.



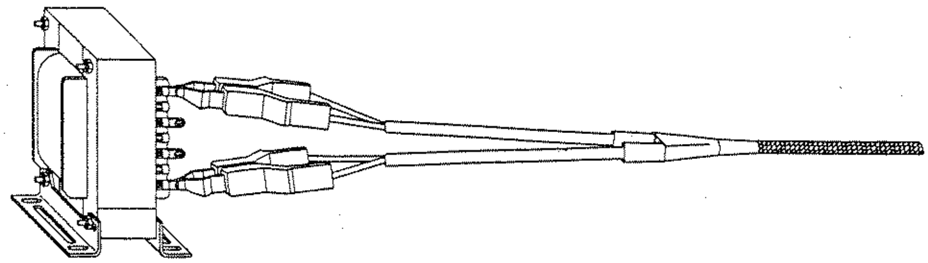
Radial-lead Component



Axial-lead Component

PM 9541A Test Cable with Kelvin Clips

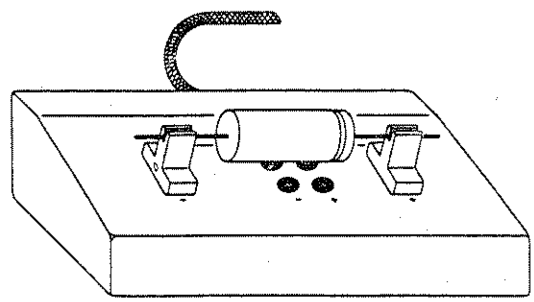
Use the test cable to measure in-circuit components or components of large size.



The test cable is connected to the instrument via the round plug (red markings face to face). The plug locks automatically. To unlock the plug, pull on the ridged part.

PM 9542A RCL Adapter

The RCL adapter allows you to make component measurements away from the front panel of the instrument. The RCL adapter can also handle larger components than the front panel connector can.



The RCL adapter is connected to the instrument via the round plug on the front panel (red markings face to face).

The supplied single test posts and the double test post can also be directly inserted into the front panel connector of the instrument.

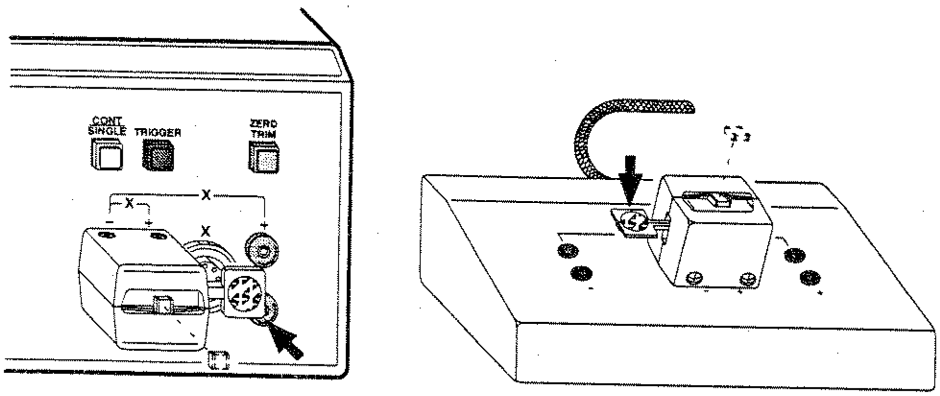
Note: For accurate measurements you should insert only the test posts, cable, or adapter, that you need for the actual measurement.

SMD Adapter PM 9542SMD

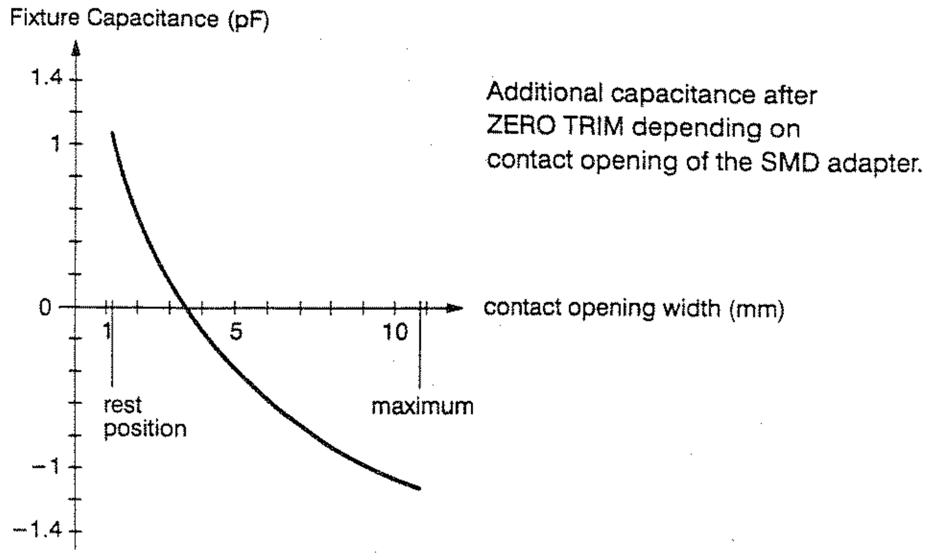
The SMD adapter can be used to measure SMD components with a length of 2 to 10 mm, depth >1 mm, height >0.5 mm, or a diameter >1 mm.

For easy and quick insertion and removal of components, insert the SMD adapter into the PM 9542 RCL adapter.

You can also insert the SMD adapter directly into the front panel connector of the instrument. To ease insertion of components, set the instrument in a sloping position (handle folded down)

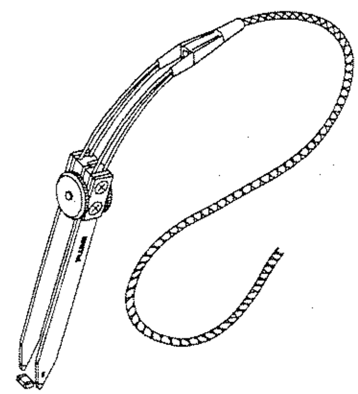


When you use the SMD adapter to measure very small capacitances especially below 100 pF, you must take into account the alteration of the stray fixture capacitances, depending on the separation of the contacts.



PM 9540/TWE SMD Tweezers

Use the SMD Tweezers to measure single SMD components or in-circuit SMD components.

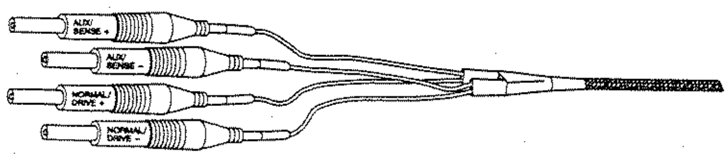


The SMD Tweezers are connected to the instrument via the round plug on the front panel (red marking face to face).

For open-circuit trimming when you are measuring small capacitances, set the opening of the tweezers to the size of the component.
The two-wire measuring technique and the pressure applied by the tips of the tweezers can cause a measuring error in addition to the basic error of the RCL Meter, due to the additional serial resistance (typical 0.02 Ω). The presence of dirt or contaminants on the tips of the tweezers can also affect measurements. The tips may be periodically cleaned with alcohol and a non-abrasive cloth.

PM 9540/BAN Test Cable with Banana Plugs

Use the test cable if you need banana plugs for your own special applications.

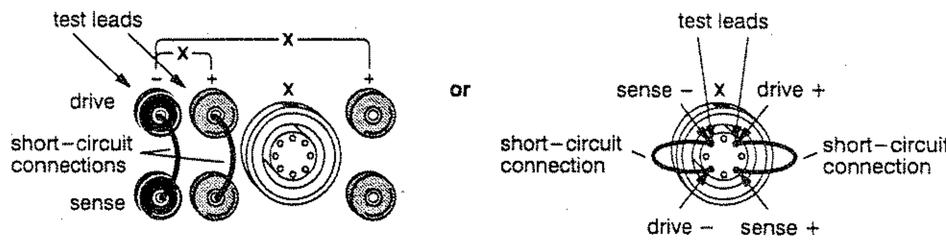


The test cable is connected to the instrument via the round plug on the front panel (red marking face to face).

When you perform ZERO TRIM short-circuit DRIVE+ with SENSE+ and DRIVE– with SENSE– for the open-circuit trimming. Short-circuit all four plugs for the short-circuit trimming.

Two-Wire Measurements

You can measure components with two test leads in two-wire mode by using the plus and minus connectors. For this, it is necessary to short-circuit the drive and sense lines at the instrument. To reduce stray capacitances and interferences, use short leads.
You also can use the eight-pole round connector.



The technical specifications given in Chapter 1 of the REFERENCE MANUAL are valid for four-wire measurements. Four-wire measurements are particularly important for high impedance components at high test signal frequencies and for low impedance components.

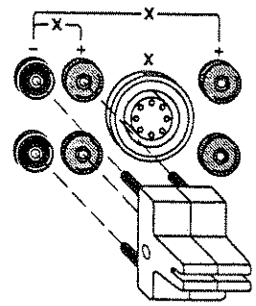
3.4.3 Example of a Measurement

WARNING

Before turning the instrument on, ensure that it has been installed in accordance with the instruction in Chapter 1.

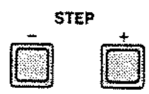
Immediately after power on a self-test routine is performed. Then the instrument automatically recalls measurement settings prior to the last power off. (see Section 3.3).

Insert the test posts supplied into the connector on the front panel (Logos face to face).



If the display shows dc, press the $\frac{\textbf{FREQ}}{\textbf{DC}}$ key.

Select an appropriate measurement frequency, for example, 1 kHz.



Press the green **AUTO** key.

The display shows: AUTO

Press the **ZERO TRIM** key for 2 seconds.

For open-circuit trimming
the display shows:

bUSY
Oct

For short-circuit trimming short circuit
the test posts with a short wire or
similar object and press the ZERO TRIM key;
the display shows:

bUSY
Sct

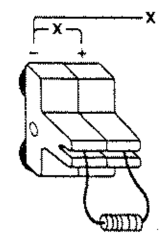
If the ZERO TRIM operation is
unsuccessful, the diplay shows:
Refer to Section 4.7.

FAIL

If the ZERO TRIM operation was
successful, the diplay shows:

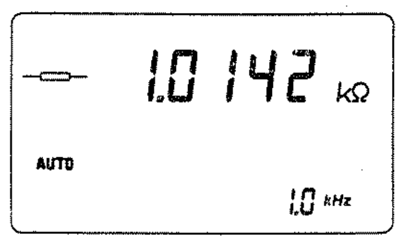
PASS

Insert a known component
into the test posts,
e.g., a 1 kΩ resistor.



The display shows:

The test is finished.
See Chapter 4 for detailed
information about measurement
of components and
measurement principles.



Chapter 4

HOW TO USE THE INSTRUMENT

4 HOW TO USE THE INSTRUMENT

4.1 THE PRINCIPLE OF MEASUREMENT

The component measurement is based on the current and voltage technique. The component voltage and the component current are measured and converted into binary values. From these values the CPU calculates the electrical parameters of the component. According to the front panel parameter selection different parameters are displayed. Via AUTO mode or by pressing the SER/PAR key when AUTO mode was selected, the dominant and secondary parameters (resistance, capacitance, or inductance) are displayed. In addition manually selected parameter can be displayed (Q, D, Z, Φ, V_x, or I_x).

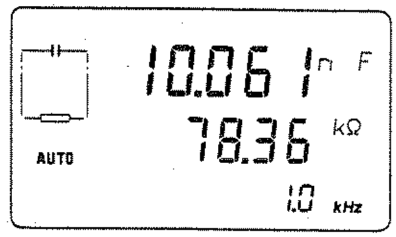
Each measurement cycle lasts approximately 0.5 seconds. For AC measurements one cycle consists of seven single measurements, the results of which are stored and arithmetically evaluated. Finally the result is transferred to the display. The seven single measurements are as follows:

1. **Voltage Measurement: 0°**
   and internal gain factor setting
2. **Voltage Measurement: 90°**
3. **Reference Measurement: 0°**

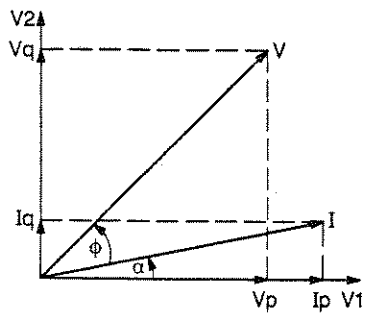
	Gain factor >1		Gain factor = 1	
4.	**Reference Measurement:**	**90°**	**Current Measurement:**	**0°**
5.	**Current Measurement:**	**0°**	**Current Measurement:**	**90°**
6.	**Current Measurement:**	**90°**	**ReferenceMeasurement:**	**0°**
7.	**Reference Measurement:**	**0°**	**Reference Measurement:**	**90°**

The seven measured values are stored at the end of the single measurements. The microprocessor uses the measured values to calculate the equivalent series resistance Rs, the equivalent series reactance Xs, and the quality factor Q = Xs/Rs of the component. In AUTO mode the microprocessor determines the dominant and secondary parameter, calculates its value, and displays it together with the equivalent circuit symbol. If one of the other parameters is manually selected, this parameter is calculated and displayed. After that the next measurement cycle starts with the seven single measurements.

The display shows:



The following phase diagrams and formulas show the mathematic basics for internal calculation of the component value.



V: voltage
I: current
V1, V2: 0°-voltage, 90°-voltage

The phase angle between I and V is ϕ.
The phase angle between I and V1 is α.

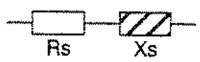
In the diagram the phase relation between I and V happens to be a lossy inductance.
In each measurement cycle, the following components are determined:

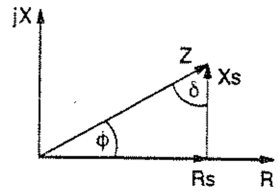
Vp, Vq, Ip, Iq.

The series resistance and reactance are calculated from these components.

$$\boxed{Rs = \frac{VpIp + VqIq}{Ip^2 + Iq^2}} \quad (1) \qquad \boxed{Xs = \frac{VqIp + VpIq}{Ip^2 + Iq^2}} \quad (2)$$

The following equivalent circuit is valid:





Quality factor: $Q = \tan\phi = 1/D = \dfrac{|Xs|}{Rs}$ (3)

Dissipation factor: $D = \tan\delta = 1/Q = \dfrac{|Rs|}{Xs}$ (4)

The magnitude of Q and the sign of Xs determine which parameter of the component is dominant.

Xs positive = inductive
Xs negative = capacitive

The formulas for the various parameters are as follows:

$Q = \dfrac{|Xs|}{Rs}$ see equation (3)

$D = \dfrac{1}{Q}$

$Rp = (1 + Q^2) \times Rs$

Rs see equation (1)

$Z = \sqrt{Rs^2 + Xs^2}$

$Cp = \dfrac{1}{\omega(1 + 1/Q^2)|Xs|}$ if $Xs < 0$

$Lp = \dfrac{(1 + 1/Q^2)|Xs|}{\omega}$ if $Xs > 0$

$Cs = \dfrac{1}{\omega|Xs|}$ if $Xs < 0$

$Ls = \dfrac{|Xs|}{\omega}$ if $Xs > 0$

Impedance $Z = R + jX$
Admittance $Y = 1/Z$

Example:

By using the seven measurements, the instrument has calculated Rs and Xs in accordance with formulas 1 and 2, for example,

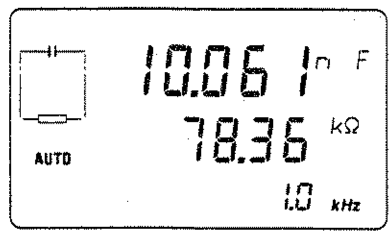
$$Rs = 3.068\ k\Omega$$
$$Xs = -15.199\ k\Omega$$

From this the instrument calculated:

$$Q = \frac{|Xs|}{Rs} = 4.954$$

The instrument displays the corresponding equivalent circuit symbol with the dominant and the secondary parameter, according to the criteria of the Auto Mode Decision Diagram (see Section 4.4.1); in this case, as Xs is negative and $1 < Q < 1000$:

The display shows:



The calculation of the dominant parameter Cp was done according to the following formula:

$$Cp = \frac{1}{\omega(1 + 1/Q^2)|Xs|}$$

$$Cp = \frac{1}{2\pi \times 1\ kHz\ (1 + 1/4.954^2) \times 15.199\ k\Omega} = 10.061\ nF$$

The maximum display is five digits ±1 digit tolerance.

Calculation of the other selectable parameters are performed as follows:

$$D = \frac{1}{Q} = \frac{1}{4.954} = 0.202$$

$$Rp = (1 + Q^2) \times Rs = (1 + 4.954^2) \times 3.068\ k\Omega = 78.36\ k\Omega$$

$Rs = 3.068\ k\Omega$ (calculated by the instrument according to formula 1)

$$Z = \sqrt{Rs^2 + Xs^2} = \sqrt{(3.068\ k\Omega)^2 + (15.199\ k\Omega)^2} = 15.51\ k\Omega$$

$$Cs = \frac{1}{\omega|Xs|} = \frac{1}{2\pi \times 1\ kHz \times 15.199\ k\Omega} = 10.471\ nF$$

Φ : The instrument calculates

$$\tan\Phi = \frac{|Xs|}{Rs} = \frac{15.199\ k\Omega}{3.068\ k\Omega} = 4.954$$

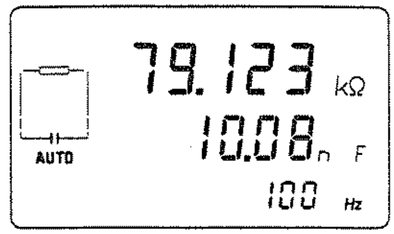
and gets Φ from an internal tangent table similar to a calculator

$\Phi = -78.6$ DEG

For accurate measurement, you should select an appropriate test signal frequency; see Section 4.2.
If you measure the same component mentioned in the preceding example, with a test signal frequency that is too low, the resistive part of the capacitive component dominates.
So the instrument determines a resistor as the dominant parameter.

Example: Test signal frequency 100 Hz

The display shows:



The instrument determined:
Rs = 63.248 kΩ
Xs = −31.680 kΩ

and calculated:

$$Q = \frac{|Xs|}{Rs} = 0.501$$

Because Q<1, the display shows a resistor as the dominant parameter.

Calculation of the other parameter is performed by the same formulas:

$$D = \frac{1}{Q} = 2.00$$

$$Rp = (1 + Q^2) \times Rs = 79.123 \text{ k}\Omega$$

$$Cp = \frac{1}{\omega(1 + 1/Q^2)|Xs|} = 10.08 \text{ nF}$$

$Rs = 63.248$ kΩ (calculated according to formula 1)

$$Cs = \frac{1}{\omega|Xs|} = 50.23 \text{ nF}$$

$$Z = \sqrt{Rs^2 + Xs^2} = 70.74 \text{ k}\Omega$$

$$\tan \Phi = \frac{|Xs|}{Rs} = 0.501$$

$$\Phi = -26.6 \text{ DEG}$$

If you are interested in mathematics, the appendix of this guide shows the phasor diagrams and formulas for the various components.

4.2 MEASURING COMPONENTS

4.2.1 Test Signal Frequency and Voltage

Resistors, inductors, and capacitors are not ideal electrical components. They all have secondary effects that limit their performance. Understanding the effects is important in understanding the results displayed on the RCL meter. For example, a resistor has shunt capacitance and lead inductance. Inductors have shunt capacitance and resistance in their windings.
The differing reaction of these components, which depends on the frequency and test signal voltage, requires methods of measurement adapted to each situation.

To this end, the PM6304 / PM6304C has a frequency range from 50 Hz to 100 kHz.
Resolution: 50, 60, 100, 120, 200, 300, 400 Hz to 19.9 kHz, 20 kHz, 100 kHz

The analog-to-digital converter (ADC), used for digitizing the measured values, is basically insensitive to hum interfered into the measurement setup. Hum interference may degrade measurement accuracy using test frequencies of 60 Hz or 120 Hz at 50 Hz AC power or 50 Hz test frequency at 60 Hz AC power.

The following can be selected as the test signal voltage:

AC voltage:		**DC voltage (option):**	
2 V,	400 Ω internal resistance	2 V,	400 Ω internal resistance
1 V,	100 Ω internal resistance	1 V,	100 Ω internal resistance
50 mV,	100 Ω internal resistance	300 mV,	100 Ω internal resistance

An internal 2 V dc bias voltage or an external bias of maximum 40 V dc can be added to the AC voltage signal. The external voltage must be free of hums, particularly if test signal frequency is 50 Hz or 60 Hz (line frequencies).

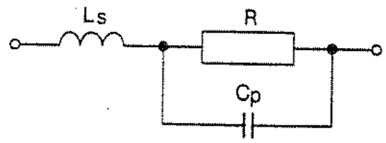
If you measure components with Z >10 kΩ and if you use an external bias source with an impedance >50 Ω, perform open-circuit trimming with bias voltage applied.

WARNING

A 40 volt external bias can charge a capacitor to a high enough voltage that it can cause injury if it is accidentally discharged. Verify that polarized capacitors are installed with the correct polarity before applying a bias voltage.

4.2.2 Resistors

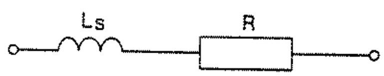
In principle in addition to its purely resistive component, a resistor has capacitive and inductive components.



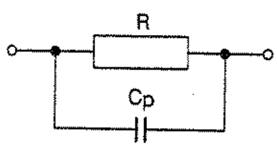
R = DC resistance.
L_S = Inductance of any winding/coiling and of the components leads.
C_P = Shunt capacitance across the resistive component.

In the case of wire-wound resistors, C and L are relatively high due to the winding. In the case of film resistors, these values are considerably smaller.

With low-valued resistors (<1 kΩ), the series inductive component dominates.



With high-valued resistors (>1 kΩ), C predominates.



The effect of C and L limits the high frequency performance of the component.

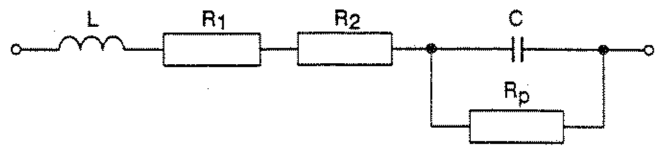
Measurement Conditions:

Select a low test signal frequency, i.e., 1 kHz or measure with DC voltage (option). In the case of resistors in the megohm range, the instrument might recognize the shunt capacitor as the dominant component if the measurement frequency is too high.

4.2.3 Capacitors

Several components, which depend on the type of capacitor, determine the electrical characteristics of a capacitor.

Foil Capacitor:



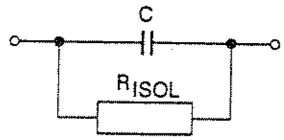
L = Inductance of the lead wires, the bonding and the winding (mainly in the nH area).
R_1 = Resistance of the bonding (5 to 10 ohms in unfavorable cases).
R_2 = Resistance of the foils, which increases as frequency increases.
R_P = Dissipation in dielectric, which can be ignored as frequency increases.
C = Capacitance.

Electrolytic Capacitors:

With AC voltage

L = Inductance of the connections and of the winding.
ESR = Equivalent series resistance:
Resistance of the electrolytes, the dielectric, DC resistance of the mechanical structure. The ESR depends on the frequency.
C = Overall capacitance.

With DC voltage



C = Overall capacitance.
R_{ISOL} = Insulating resistance, it determines the leakage current of the component.

Electrolytic capacitors operate at lower frequencies (usually <10 kHz).

Measurement Conditions:

The frequency for the test signal should not be selected too high as otherwise a capacitance that is too high is measured when the resonant frequency is approached.

$$f_o = \frac{1}{2\pi\sqrt{LC}} \qquad f_o = \text{self-resonant frequency}$$

If the frequency is too low, the ohmic and inductive components falsify the result. A test frequency lower than $f_o/30$ should be taken as the approximate value.

For example:
Typical self-resonant frequency for a 100 µF capacitor is 50 kHz; select test signal frequency less than 1.6 kHz.

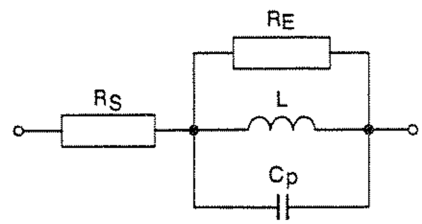
Electrolytic capacitors used for smoothing in power supplies should be measured at their operating frequency (100 Hz or 120 Hz).

In order to determine the real dissipation components, a high test frequency is selected for the serial losses and a low one for the parallel losses.

Use DC voltage for measuring the insulating resistance.

4.2.4 Inductances

Coil with iron core



R_S = DC resistance of the copper winding
R_E = Core loss
C_P = Capacitance of the winding
L = Inductance

Measurement Conditions:

As in the case of the capacitor, the test frequency (f_{TEST}) should lie far below the self-resonant frequency (f_0). The f_0 frequency can be very low because of the relatively high capacitance of the winding.

$$f_o = \frac{1}{2\pi\sqrt{LC}} \qquad f_o = \text{self-resonant frequency}$$

Approximate value: $f_{TEST} = f_o/30$

It is advisable to measure the coil close to its operating frequency if the reaction of the coil under operating conditions is to be determined.

A voltage level that is not too high must be selected for coils because of the saturation effect caused by the iron core. For this purpose, the PM6304 offers a voltage reduced to 50 mV.

Use DC voltage to measure the resistance of the winding.

4.3 AUTOMATIC ZERO TRIM

When pressing the **ZERO TRIM** key for approximately 2 seconds the instrument performs an impedance measurement of the measurement setup and stores the value determined. The display shows ***PASS***. For all further measurements this value will be taken into consideration. **To ensure best measuring accuracy you should perform ZERO TRIM when you change the measurement setup, the test signal frequency, or the test signal voltage when the test signal frequency is ≥ 10 kHz.**

If you press the **ZERO TRIM** key with a component connected with an impedance of <10 Ω or >100 kΩ, the value of the component will be taken into consideration. At open or short-circuited contacts of the measurement setup the instrument now indicates a negative resistance value, for instance, or an inductance in case of a connected capacitance (or a capacitor in case of a an inductance.) Please perform ZERO TRIM once again without any component connected in order to obtain correct values.

The TRIM data are stored in a memory and will persist even if the instrument is switched off.

Note: If you use the test cable with PM 9541A Kelvin Clips, the PM 9542A RCL Adapter, or the PM 9540/TWE, SMD Tweezer for test signal frequencies ≥ 10 kHz, you should not change the setup after trimming.
To avoid measurement errors, do not touch the contacts during measuring.

Short-Circuit Trimming

For measuring low impedances, below 100 Ω in particular, please short-circuit the contacts of the measurement setup and press the **ZERO TRIM** key for approximately 2 seconds. The display shows ***bUSY*** and ***Sct*** (short-circuit). The instrument now performs a measurement and stores the value determined, which is the short circuit impedance. The display shows ***PASS***. For all further measurements this value is taken into consideration, including the line and contact impedances. If during short circuit trimming the measured impedance is >10 Ω, ***FAIL*** will be displayed.

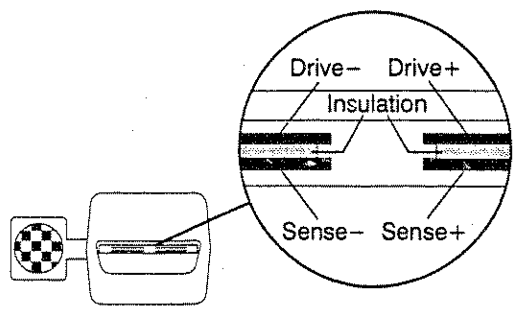
Open-Circuit Trimming

When you measure low capacitances with high test signal frequency the open-circuit impedance of the measurement setup may affect the result. Remove any connected component and press the **ZERO TRIM** key for approximately 2 seconds. The display shows ***bUSY*** and ***Oct*** (open-circuit). The instrument performs a measurement considering the value determined, which is the open-circuit impedance, for all following measurements. The display shows ***PASS***.
If the impedance measured during open-circuit trimming is <100 kΩ, the diplsay shows ***FAIL***.

For the ZERO TRIM the contacts DRIVE+ and SENSE+ as well as DRIVE– and SENSE– should be connected. As far as the adapters available from Fluke are concerned, this is normally ensured automatically, except for the PM 9540/BAN cable and for the PM 9542SMD SMD Adapter.

If you use the PM 9540/BAN cable in your own special application short-circuit DRIVE+ with SENSE+ and DRIVE– with SENSE– for the open-circuit trimming. Short-circuit all four plugs for the short-circuit trimming.

As far as the SMD Adapter is concerned the contacts are insulated from each other. The contacts are only closed when a component is inserted.



Contacts of the PM 9542SMD, SMD Adapter

To perform ZERO TRIM at an open adapter with the DRIVE/SENSE contacts connected, the SMD Adapter is equipped with SMD components with an impedance of Z → ∞. Please use this component for open-circuit trimming. For short-circuit trimming you can use one of the attached components with an impedance of Z → 0 Ω. These components have a real resistance of typical 4 mΩ. You should take into account this value if you measure low impedances.

If you need spare sets you can order them via your Service Organization with the following number: 5322 310 32275.

Z → 0 Ω Z → ∞

4.4 MEASURING MODES

After power on, the instrument automatically recalls the mode that was set before power off.

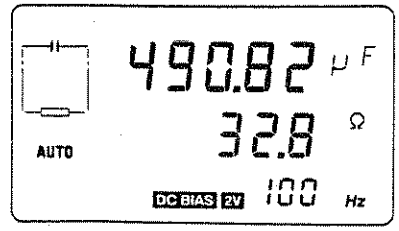
- Select a suitable measurement setup.
- Select the matching test signal frequency and voltage (refer to Sections 3.4.2 and 4.2).
- Execute ZERO TRIM if necessary.
- Insert the component.

Galvanic nonconducting components, e.g., electrolytic capacitors, should be measured with the internal bias voltage activated. To do this

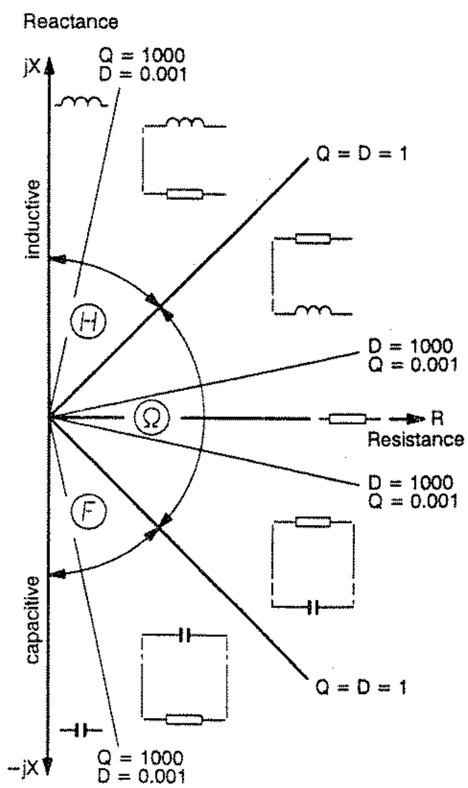
- Press the **DC BIAS ON/OFF** key.
- The display shows DC BIAS 2V.

4.4.1 Automatic (AUTO)

In most cases, you will be interested in the dominant parameter of the component. This is automatically determined and displayed in the AUTO mode. Press the green **AUTO** key. The display shows ***AUTO***, the value of the dominant parameter in the upper line, the value of the secondary parameter in the lower line, and the appropriate equivalent circuit symbol.

Function and Key Operation	Display
	

The decision criterion for selecting the dominant parameter is Q = D = 1. Refer to Section 4.1. The values Q and D not only depend on the component but also on the test signal frequency used.

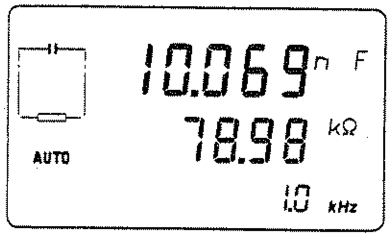


AUTO MODE DECISION DIAGRAM

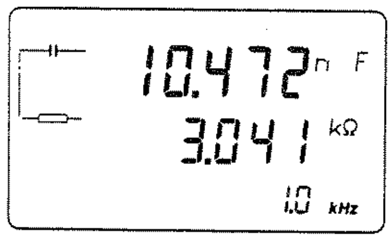
4.4.2 Manual

If you want to determine a parameter that differs from the one automatically calculated by the instrument, press the appropriate function key:

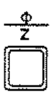
Function and Key Operation	Display

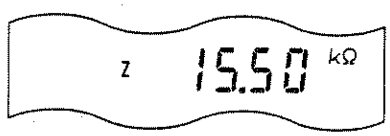


Series or parallel parameter

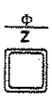


Impedance



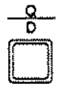


Phase angle

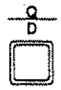


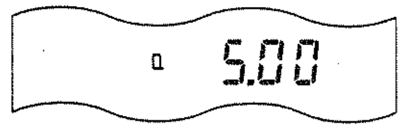
Function and Key Operation	**Display**

Dissipation factor

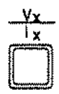


Quality factor

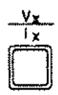




Current measured ★



Voltage measured ★

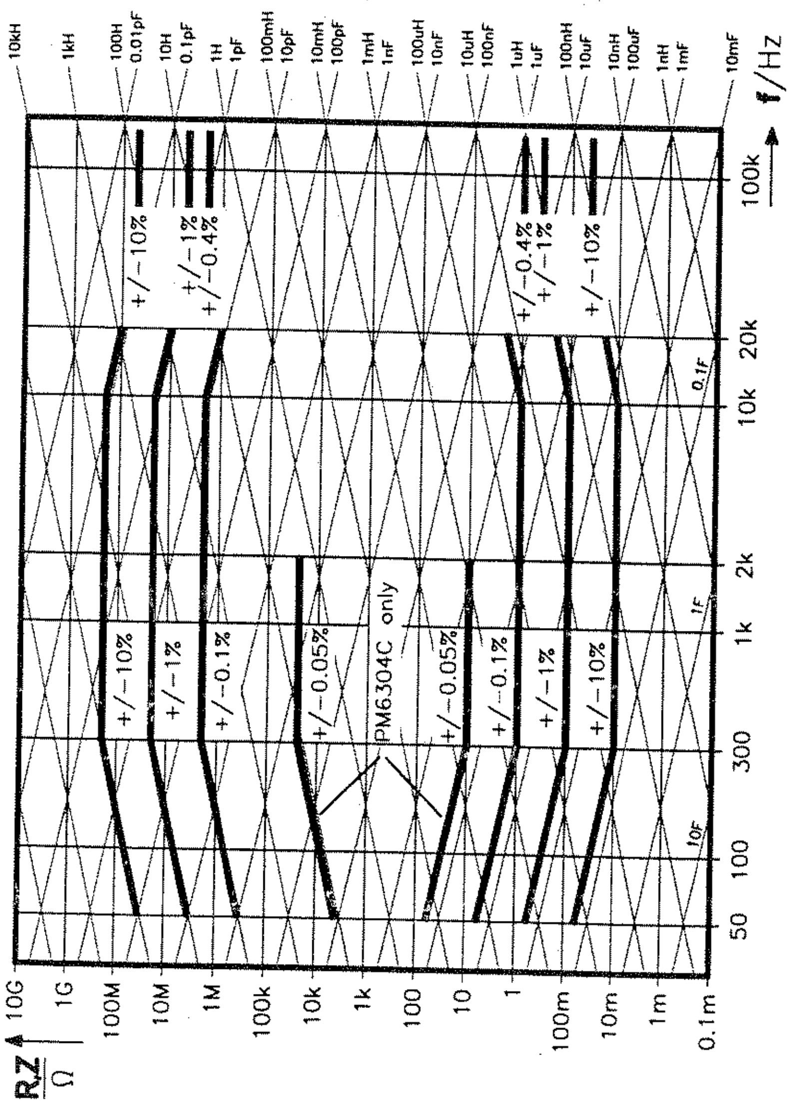


★ Current or voltage is displayed for approximately 3 seconds. The instrument then returns automatically to the parameter you selected beforehand.

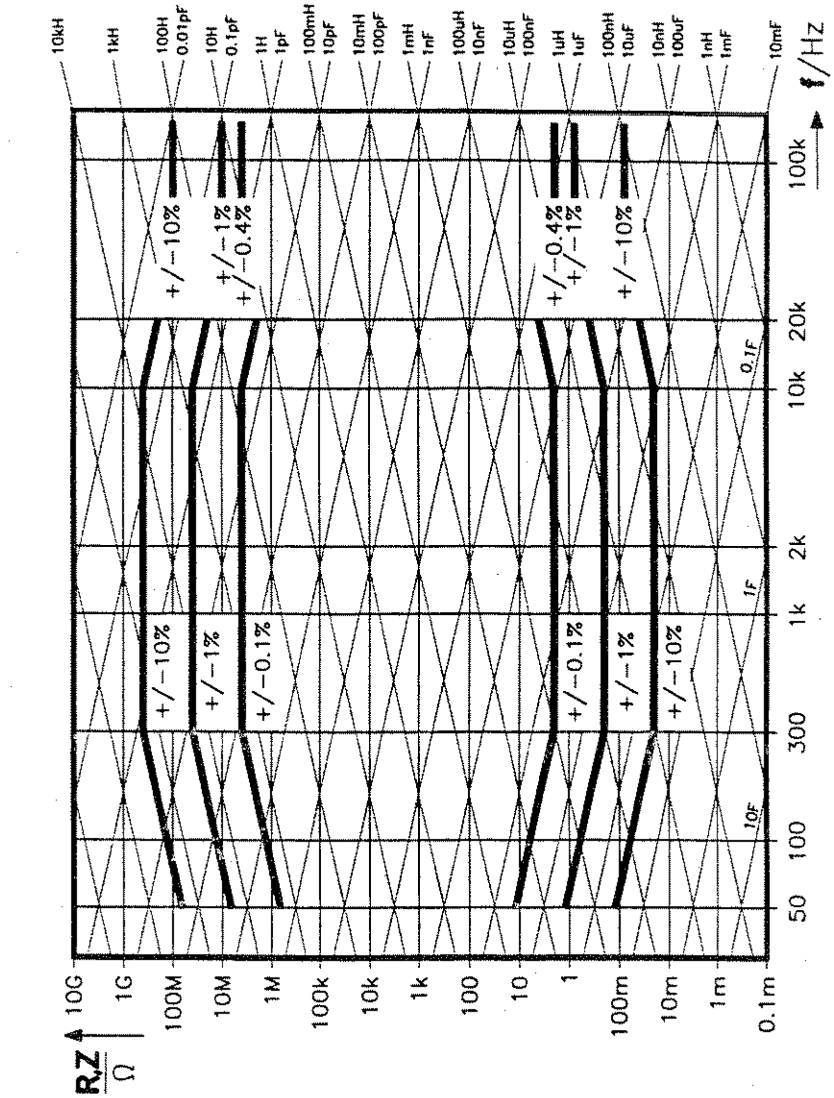
The values displayed for the selected parameter are calculated by the instrument. They are based on the values measured for the series reactance and the series resistance (refer to Section 4.1).

4.4.3 Accuracy

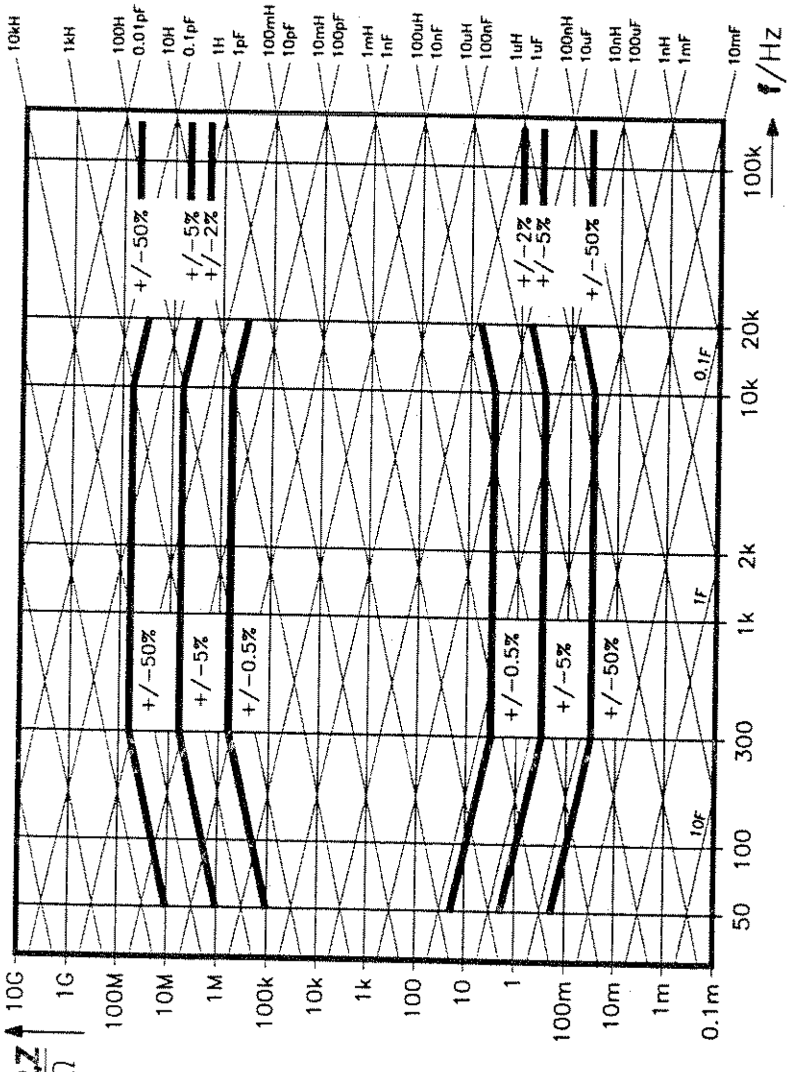
The following diagrams show the measuring range and accuracy of the instrument as a function of test signal frequency and voltage.



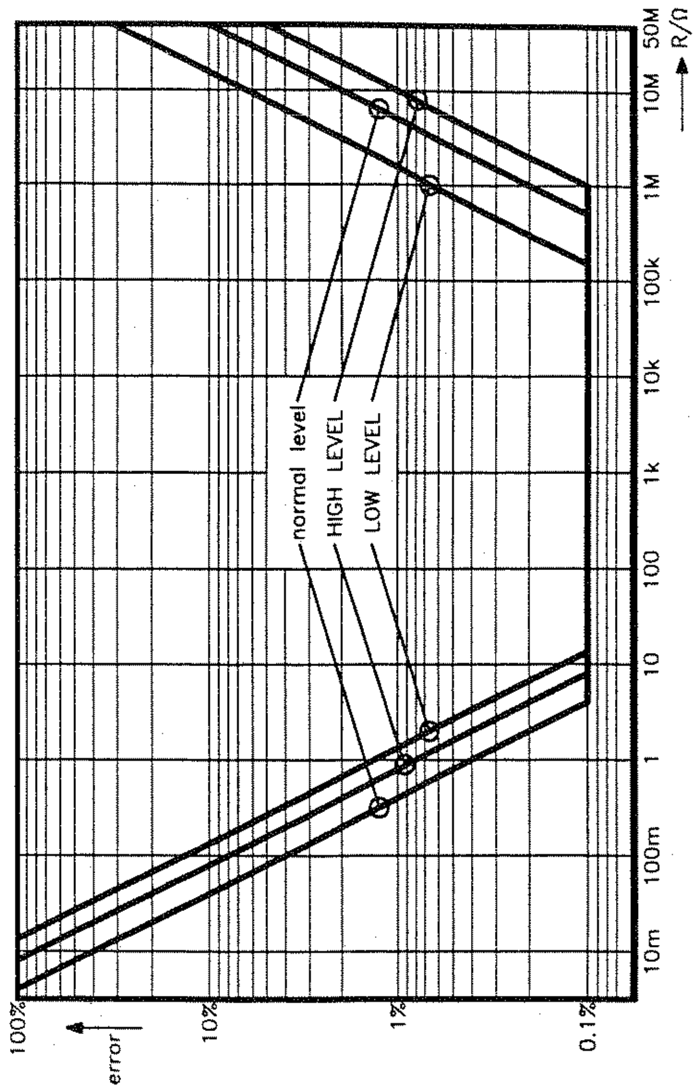
Accuracy with 1 V (NORMAL LEVEL)



Accuracy with 2 V (HIGH LEVEL)



Accuracy with 50 mV (LOW LEVEL)



Accuracy with DC voltage

For detailed information see REFERENCE MANUAL, Chapter 1.

4.5 STORE/RECALL OF INSTRUMENT SETTINGS

Nine complete instrument settings including trim data can be stored in memory registers 1 to 9. The current mode is automatically saved separately. The memories are buffered by battery so that the data are retained even after the instrument is turned off.

After power on, the instrument runs through its start routine, and then goes to the mode that was last set.

Store

Data are stored by pressing the STORE key. The display shows ***Sto*** and a digit from 1 to 9 for the memory register number. This number under which the settings are to be stored can now be selected by using the +/– step keys; the measured values are not stored.

Pressing STORE once again saves the settings under the register number selected. Any values that may exist there already are overwritten and lost in the process.

Recall

Stored settings are called up by pressing the RECALL key. The display shows ***rCL*** and a memory register number. The display panel starts to flash. The data from this memory register are only displayed but not yet called up.

You can use the +/– step keys to select memory register numbers 1 to 9 to display their contents. When you press the RECALL key again, the stored setting displayed is called up.

4.6 BINNING

4.6.1 Introduction

Binning means sorting components by their measured value into boxes or similar containers.
During the binning process with the PM6304, similar component values are allocated to defined sorting fields known as bins to obtain better tolerances, closer matching or pass/fail sorting.

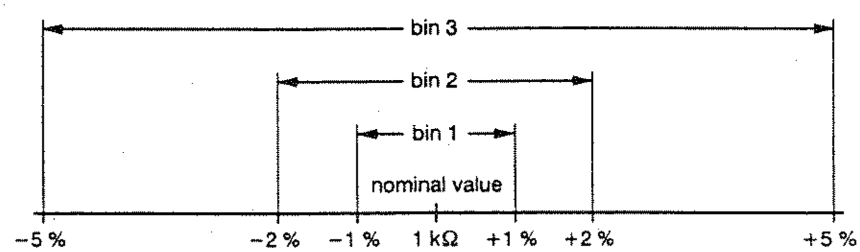
You can define a maximum of 10 bins. For this purpose, you can use an interface for remote control with a PC (IEEE-488 or RS-232 as an option) or an infrared remote control, the PM 9559 Bin Programmer (option).
The instructions for programming with the PC are described in detail in the PROGRAMMERS MANUAL and in brief form in Chapter 5. This section describes binning using the PM 9559 infrared remote control.

The PM6304 checks the component according to the criteria of bins 1 to 9, last of all according to bin 0, and displays the bin the component is allocated to. If none of these requirements are met, the display shows ***FAIL***.

Values and limits (tolerances) for 10 complete bin records, each record for a maximum of ten bins (bins 0 to 9), including the selected instrument settings can be stored in registers of the PM 6304. These registers are independent of those that contain the instrument settings typed in at the front panel.

The limits of the bins can be defined in the following ways according to the various demands:

- Binning components can be defined with a certain value according to different tolerance classes, for example, for quality control or incoming inspection.



Nested limits with reference to a nominal value.

The instrument checks in the sequence bin 1, bin 2 ... to bin 9 and then bin 0. the greatest tolerance is programmed for bin 1, then **all components** lying within this tolerance are immediately allocated to bin 1.

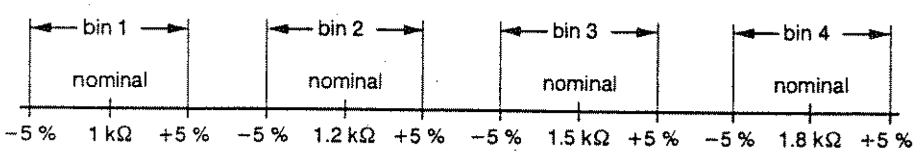
A different parameter than that for bin 1 to 9 can be defined for bin 0.

For example, bins 1 to 9 check the tolerance of a capacitor and bin 0 checks at last the quality factor of the capacitor.

The display is as follows:

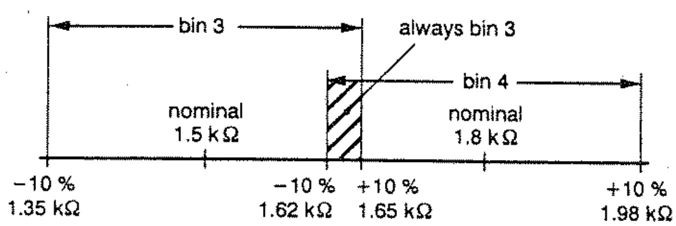
Component meets tolerance defined in:		
bin 1 to 9	bin 0	Display
YES	YES	bin 1 to 9
NO	do not care	FAIL
YES	NO	bin 0

- Binning components can be defined according to certain values, e.g. resistors according to the series E12, here with ±5 %.

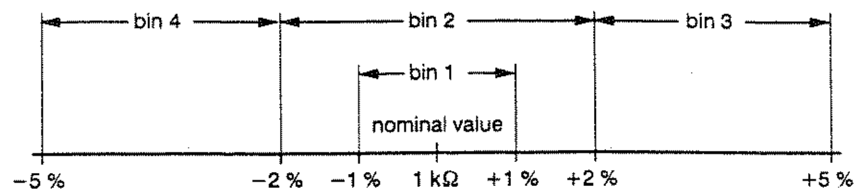


Sequential limits with reference to nominal values.

If limits overlap, a component lying within this overlapping area is always allocated to the bin with the lower number.

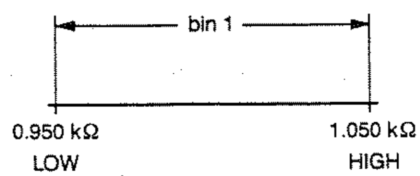


- Nested and sequential limits can be combined.



Sequential and nested limits.

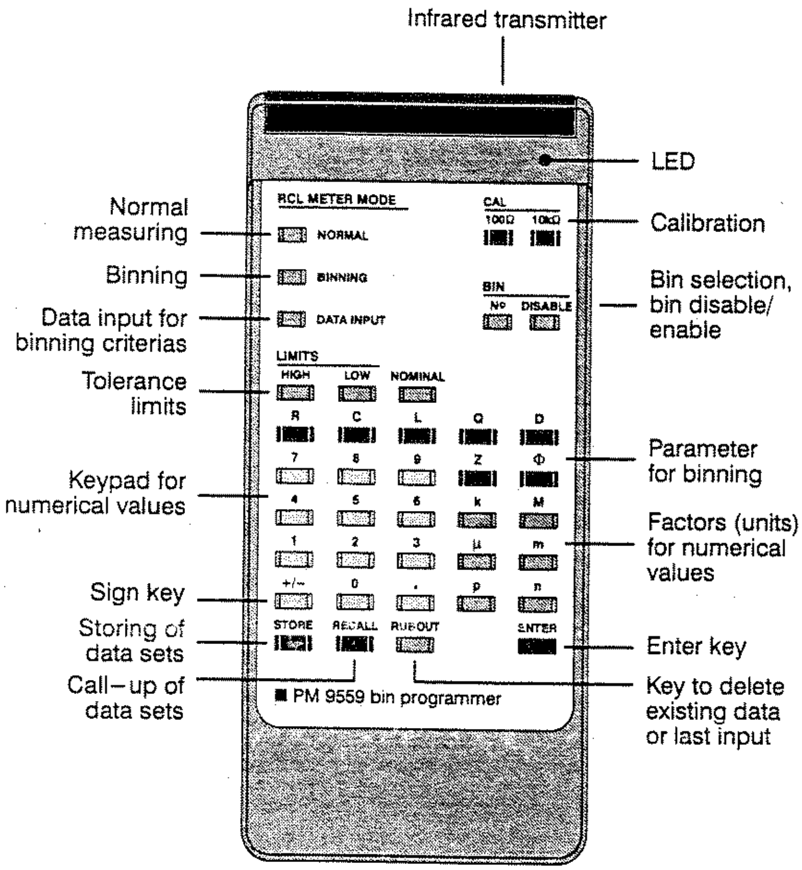
The limits can be programmed directly as absolute values instead of a nominal value with an upper and lower limit in percent:



When storing, the instrument checks the values entered for plausibility. A nominal value with an upper limit of +5 % and a lower limit of +5% or a value without limits would not be accepted. The instrument displays ***Error*** and the number of the bin concerned.
No check is made whether the tolerances selected lie in the accuracy range of the instrument. This accuracy depends on the type and the value of the component to be measured and on the test signal frequency and voltage. Refer to Section 4.4.3.

4.6.2 PM 9559 Bin Programmer (Infrared Remote Control)

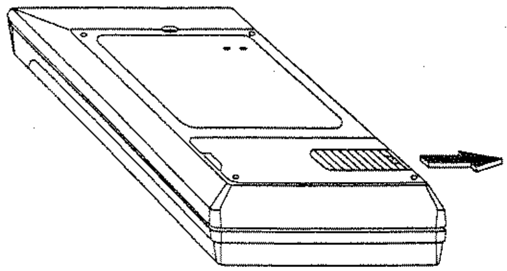
4.6.2.1 Keyboard



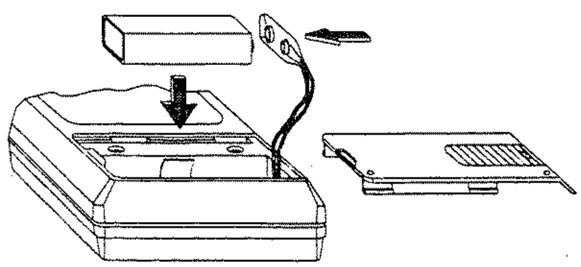
4.6.2.2 Battery Replacement

The remote control is supplied with power by means of the accompanying 9 V block battery.

Inserting the battery:



Pry open the battery compartment at the back of the remote control.

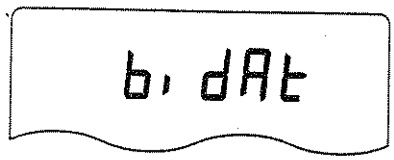
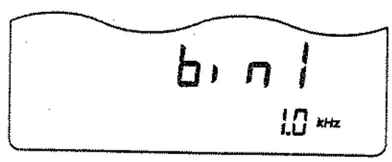
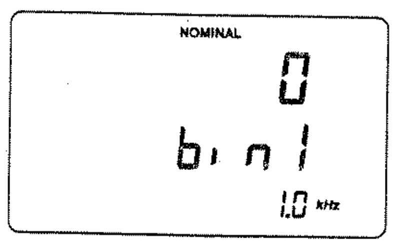
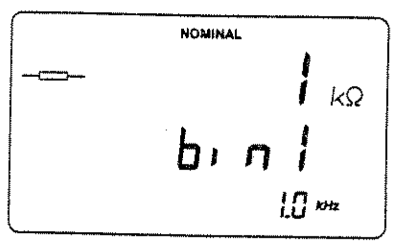


Attach battery terminals and insert the battery. The battery is protected from falling out by a retaining clip.
Close the compartment.

Operational check:	Press any key; the pilot light must flicker. If necessary, check the battery.
NOTE:	Remove dead batteries and dispose of them according to local regulations.
CAUTION:	To prevent the remote control from being damaged, use only leak-proof batteries of the type 6F22G or similar for replacement.

4.6.2.3 Programming with the Infrared Remote Control

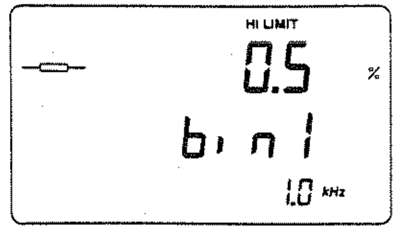
You can define a set of bins by using the following steps.
The examples are based on empty memory locations. If values are contained there, delete the old values with the **RUBOUT** key before entering new ones.
Pressing the **RUBOUT** and the **ENTER** key after selecting a bin number deletes **all values** of the bin.

Function and Key Operation	Display
Set the instrument to data input. DATA INPUT	
Select the bin. BIN No 1	
Set to nominal value. NOMINAL	
Define the parameter and set the value. R 1 k	

Function and Key Operation	**Display**

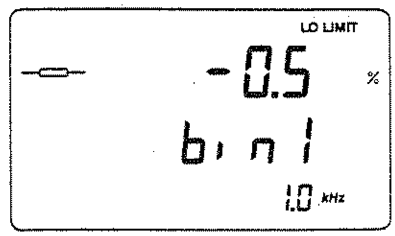
Set the upper limit ★.

HIGH . 5



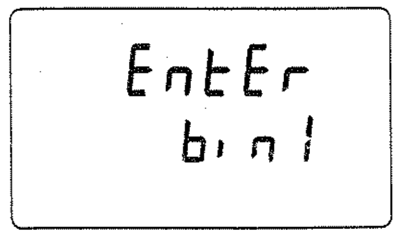
Set the lower limit ★.

LOW . 5 +/–

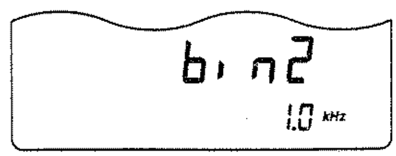


enter

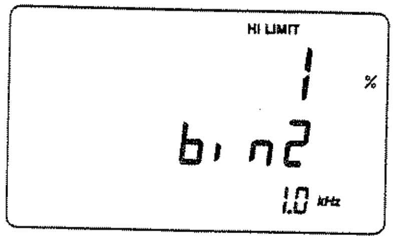
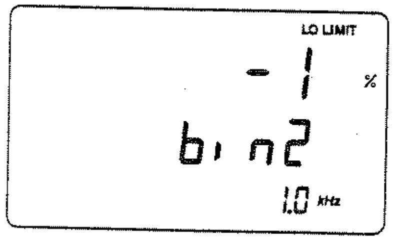
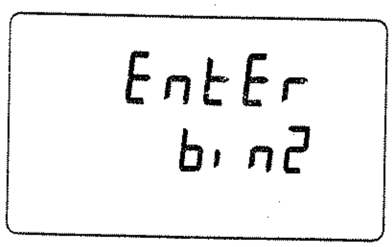
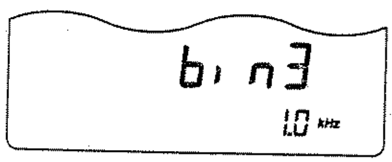
ENTER



The instrument automatically selects the next bin.



If the nominal values selected for the next bins are to remain the same as in bin 1, then the tolerances for these bins refer to this nominal value.

Function and Key Operation	**Display**
Set the upper limit ⋆. HIGH 1	
Set the lower limit ⋆. LOW 1 +/−	
Enter ENTER	
The instrument automatically selects the next bin.	

⋆ It is also possible to set only the upper or lower limit. The instrument automatically inserts the same value with the appropriate sign for the other limit. However, if values are already stored here, these remain unchanged.

A maximum of 10 bins can be defined.

This example referred to nested bins with tolerances in percent.
Other input types, as described in Section 4.6.1, are possible as follows.

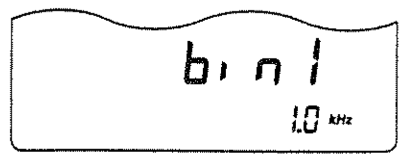
Function and Key Operation	**Display**

Input as an absolute value:

Set the instrument to data input.
Select the bin.

DATA INPUT

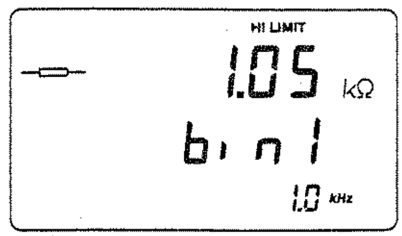
BIN No   1



Select the upper limit.
Define the parameter.
Set the absolute value.

HIGH   R

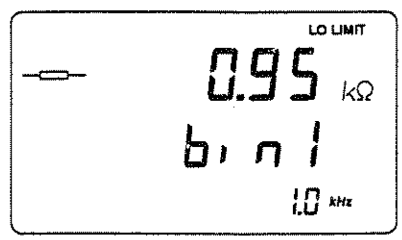
1   .   0   5   k



Select the lower limit.
Define the parameter
(the same as for the upper limit).
Set the absolute value.

LOW   R

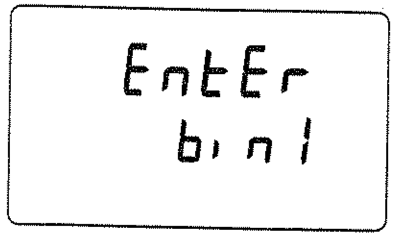
.   9   5   k



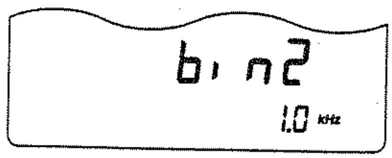
Function and Key Operation | **Display**

Enter

ENTER

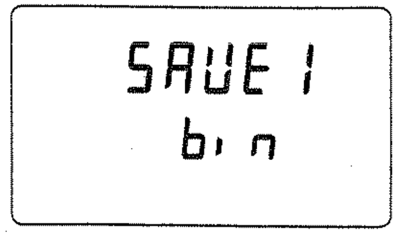
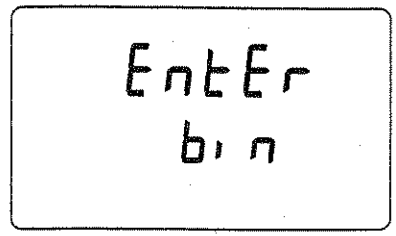


The instrument automatically selects the next bin.



If ***Error*** appears when pressing the **ENTER** key, please check to see whether the data record contains a nominal value programmed at an earlier stage (**NOMINAL** key).

Note: The data for a bin are stored in a buffer after every acknowledgment (**ENTER**). These data are lost when the instrument is turned off or when leaving bin programming by pressing a front panel key. After the **STORE** function the data are stored in memories buffered by battery (memory locations **0** to **9**).

Function and Key Operation	**Display**
Store STORE 1	
Enter ENTER	

In addition to the data of the bin set, the instrument settings selected, such as test signal frequency and voltage, measuring mode, DC bias etc. are also stored. Any data found in the storage register are overwritten.

Stored sets are called up by pressing the **RECALL** key, the desired storage register number (**1** to **9**) and the **ENTER** key.

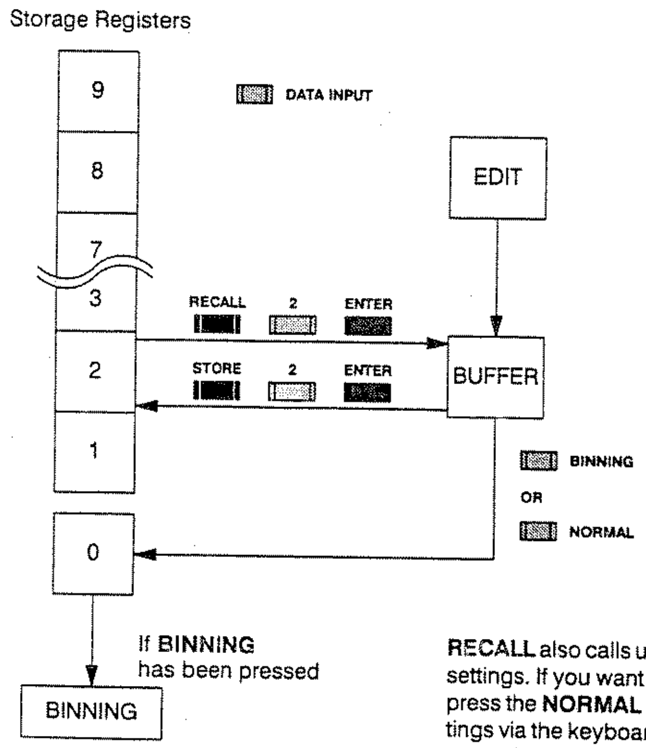
If some programmed bins from a set are not to be taken into account during binning, they can be deactivated by pressing the **DISABLE** key (except for bin 1).
Pressing the **ENTER** key now shows only the active bins. A deactivated bin is activated again by pressing the **BIN N°** key and the relevant number.

A table in the appendix has been provided for your notes on assignment of the storage register contents. You can make a copy of the table and fill in the programmed values.

4.6.2.4 Binning

Select the measurement setup and, if necessary, execute trimming (**ZERO TRIM**).

Press the **DATA INPUT** key on the infrared remote control and call up the bin record desired by pressing **RECALL**. If no data have been stored yet, enter the parameters and tolerances according to which binning is to take place. Refer to Section 4.6.2.3.



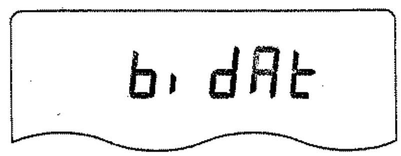
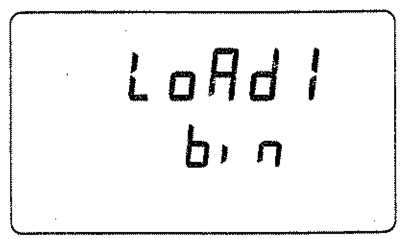
RECALL also calls up stored instrument settings. If you want to alter the settings press the **NORMAL** key, select new settings via the keyboard of the RCL meter, press the **DATA INPUT** key, and press the **BINNING** key to start binning.

The instrument is set to the bin mode by pressing the **BINNING** key. The instrument settings stored in the memory are adopted. The instrument switches automatically to single measurement to avoid measuring errors when inserting or removing the components to be measured.

The display shows maximum five digits. The instrument calculates with a higher resolution. For example, the upper limit for bin 1 is 100 Ω, the instrument measures 100.004 Ω; in this case the display shows 100.00 Ω, but the component is correctly allocated to bin 2.

Insert the component and start measuring by pressing the **TRIGGER** key.
The PM6304 checks the component according to the criteria of the individual bins and shows in what bin the component is and its value. If none of the criteria of bin 1 to 9 are met, the display shows ***FAIL***, see table on Page 4 – 25.

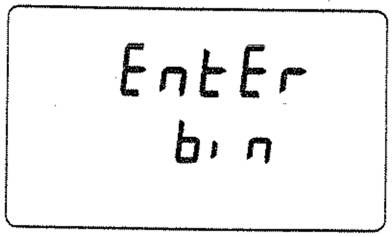
Example:

Function and Key Operation	**Display**
Set the instrument to data input. DATA INPUT	
Call up the stored data. RECALL 1	

Function and Key Operation | **Display**

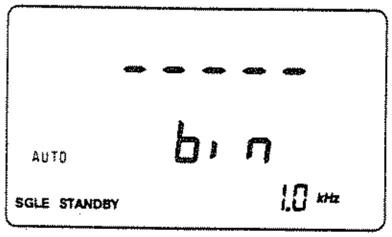
Enter

ENTER



Set the instrument to binning.

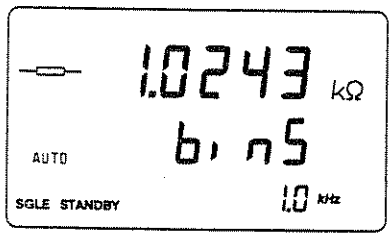
BINNING



Insert the component.

Start the measurement.

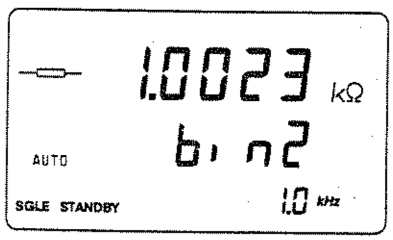
TRIGGER



Remove the component and insert the next one.

Start the measurement.

TRIGGER

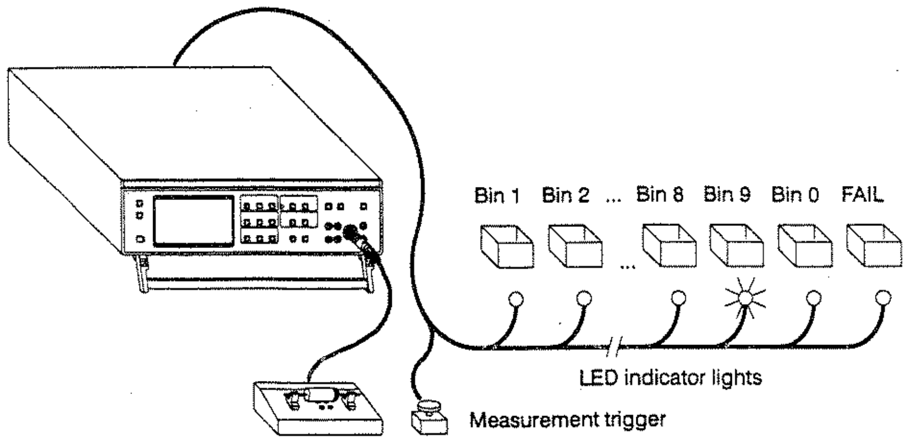


Press the **NORMAL** key to switch back to normal mode.

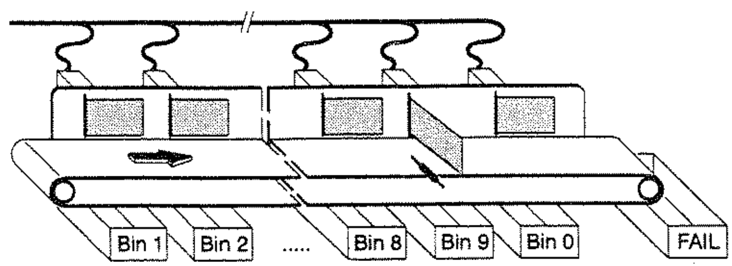
4.6.3 PM 9566 Handler Interface

To make further handling of the checked components easier, you can connect appropriate control lines to the bin numbers by means of the **HANDLER INTERFACE** (option). For example, LEDs that can identify the bin where the component is placed can be connected by means of these control lines. This process can also be automated by means of the appropriate application (conveyor and electromagnetic flaps).

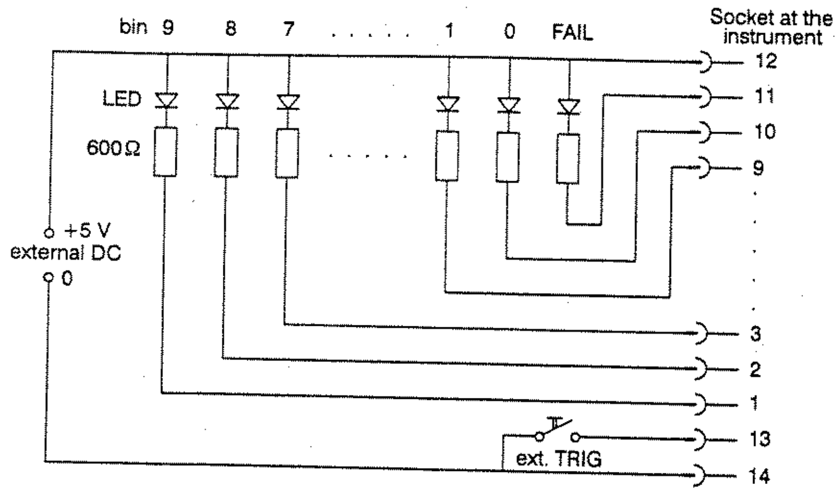
Identification by LEDs (principle)



Automatic handling (principle)

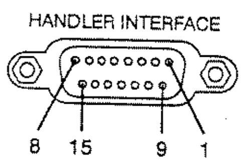


Connection Example:



The internal driver stages have open collector outputs.
External operating voltage max. +24 V DC voltage.
Maximum collector current 200 mA.

Pin assignment:



View of the rear

1	=	Bin 9
2	=	Bin 8
3	=	Bin 7
4	=	Bin 6
5	=	Bin 5
6	=	Bin 4
7	=	Bin 3
8	=	Bin 2
9	=	Bin 1
10	=	Bin 0
11	=	FAIL
12	=	+ DC
13	=	TRIGGER
14	=	Ground
15	=	Shielding (screen)

4.7 OUT-OF-RANGE AND ERROR MESSAGES

The middle segments of the digits are displayed when the following limits are exceeded:

▪ Resistance	>200 MΩ at AC,			
	> 50 MΩ at DC			
▪ Capacitance	> 32 F	at 50 Hz,	> 16 mF	at 100 kHz
▪ Inductance	>637 kH	at 50 Hz,	>318 H	at 100 kHz

The asterisk in front of the upper digits indicates that the measured component is outside the measurement range of the basic error limit.
Select a different appropriate test signal frequency and check that the measurement is within the basic accuracy; see tables in Section 4.4.3.
The asterisk in front of the lower digits only indicates when impedance is being measured that the value is outside the basic error limit. Other parameter values displayed by this digits are secondary parameters and generally not within the basic accuracy range of 0.1 %; for these no asterisk is displayed.

After power on, the instrument checks the PROM, the processor RAM, and the external RAM. Additionally the instrument generates error messages if there are faults during measurements or trimming or if there is a fault during data transfer to a printer.

Errors are indicated as follows:

Err 1	Program memory checksum error
Err 2	Processor RAM defective
Err 3	External RAM defective
Err 4	External RAM, backup (current instrument settings) destroyed
Err 5	External RAM, stored instrument settings 1 to 9 destroyed
Err 6	Error during analog to digital conversion of the test signal

Err 7	EEPROM defective
Err 8	Error in trim data (EEPROM)
Err 9	Error in calibration data (EEPROM)
Err 10	Error in binning data (EEPROM)
Err 11	Error during line frequency detection
Err 14	Test signal out of limits during trimming
Err48	Communication error to the printer (time-out)

Errors 19 to 41 are errors during recalibration.
A detailed description is given in the Service Manual, Chapter 9.

During measurement with the bias voltage activated, the display shows ***oVer*** if there is excessive DC current flow from the bias source.

If the values entered for binning do not match each other, the instrument displays ***Error*** when an attempt is made to store them.

If the instrument cannot compensate the short-circuit or open-circuit impedance during trimming, it displays ***FAIL***. Check the contacts and try it again.

Chapter 5

FUNCTION REFERENCE

5 FUNCTION REFERENCE

In Section 5.1, all functions of the instrument that can be called up at the key panel are described in alphabetical order. Each function description contains:
- A detailed explanation of the function.
- The key sequence for setting or calling up via the keyboard and the relevant display.
- The commands for remote control.

The Programmers Manual contains detailed information about the interfaces for the remote control, the program message syntax, and the complete set of remote control commands.

Some functions are possible only with the appropriate options:

For example, binning components according to tolerance class requires the PM 9559 Bin Programmer or an interface for remote control. Measuring components with DC voltage only requires an integrated DC unit.

These functions are identified in the description by 'option'.

Section 5.2 describes the functions of the PM 9559 Bin Programmer for programming tolerance ranges for binning components.

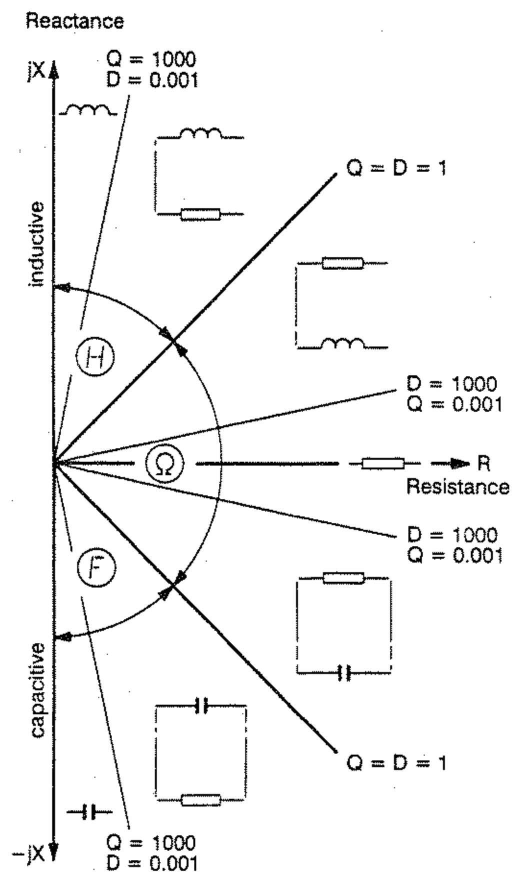
5.1 FUNCTIONS OF THE FRONT PANEL OF THE INSTRUMENT

AUTO Mode

In this mode, the instrument automatically determines the dominant parameter of the component measured and displays the appropriate equivalent circuit symbol. The value of the dominant component is displayed in the upper line, and the value of the secondary parameter is displayed in the line below.

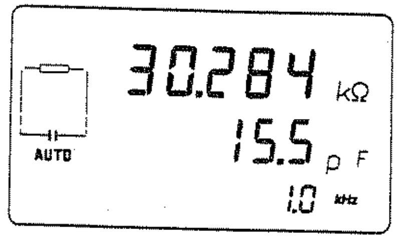
The decision criterion for defining the dominant component is Q=D=1, with Q and D not only dependent on the features of the component but also on the test signal frequency used (see Sections 4.1 and 4.2).

Decision criteria for defining the dominant parameter and for the equivalent circuit symbol in the sectors of the phase level:



AUTO MODE DECISION DIAGRAM

e.g.

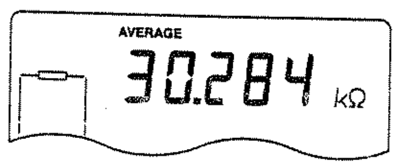


Remote control commands:

Setting:	AUTO
Query for dominant and secondary component:	COM?

AVERAGE

With continuous measurement, the instrument performs an exponential average from the individual measurements before the value is shown in the display. The time factor of the average is increased by pressing the **AVERAGE** key. This reduces fluctuations in the display.
The original time factor reappears when the key is pressed again.



Remote control commands:

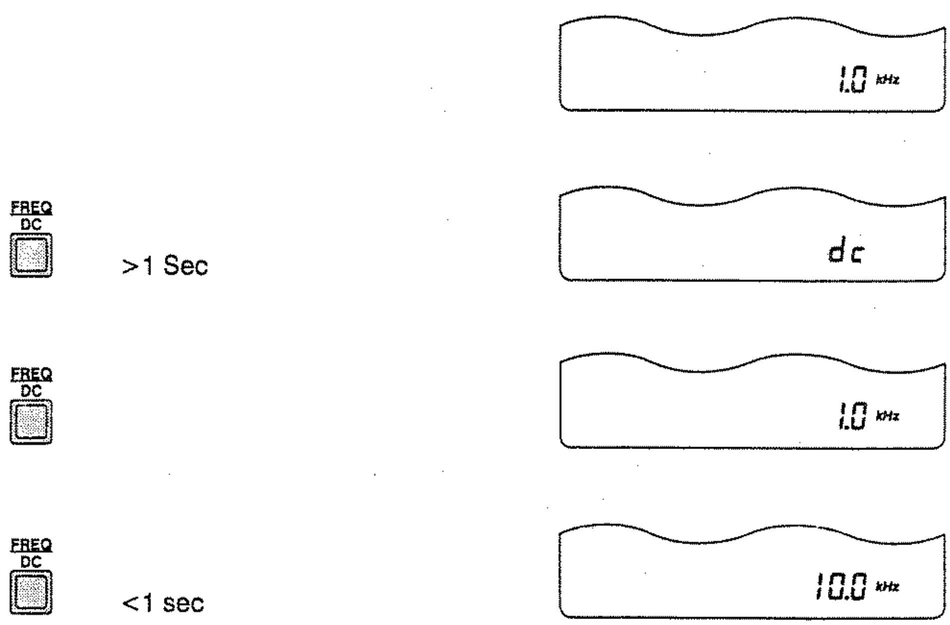
Activate:	AVG ON
Deactivate:	AVG OFF
Query:	AVG?

EXT External

Refer to **DC BIAS SOURCE**.

FREQ/DC Test Signal Frequency

Press the **FREQ/DC** key longer than 1 second to change from an AC voltage signal to a DC voltage signal (option).
Press the key briefly (less than 1 second) to changes the frequency step by step: 100 Hz, 1 kHz, 10 kHz, 100 kHz, 100 Hz, 1 kHz, 10 kHz, 100 kHz ...



Remote control commands:

Selecting the test signal:	TEST_SIG AC or TEST_SIG DC
Setting the AC frequency:	FRE x

x = Frequencies possible:
50 Hz, 60 Hz, 100 Hz, 120 Hz, 300 Hz, 400 Hz to 20 kHz, 100 kHz

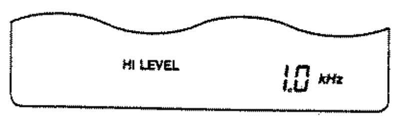
Queries:	TEST_SIG? FRE?

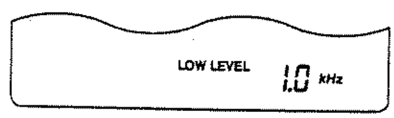
HI LEVEL/LOW LEVEL — Voltage of the Test Signal

Key used to select a voltage for the test signal higher or lower than 1 V:

HI LEVEL: 2 V AC voltage or DC voltage;
400 Ω internal resistance

LOW LEVEL: 50 mV AC voltage, 300 mV for DC voltage;
100 Ω internal resistance





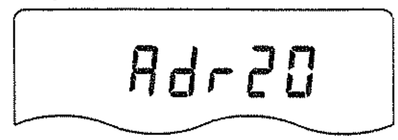
Remote control commands:

Setting:	LEV LO or LEV HI or LEV NO (normal)
Query:	LEV?

INTERFACE (Option)

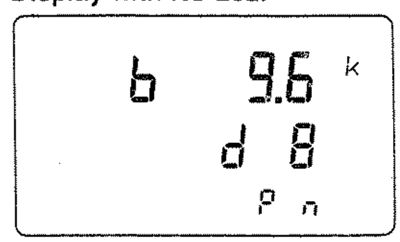
Depending on the internal interface, the instrument address (IEEE-488 Interface) is displayed when you press the **INTERFACE** key. Press the **STEP** keys to select a different address. With a built-in RS-232 interface, the display shows ***Co*** or ***Pr*** (Communication Mode or Printer Mode) and then the current configuration. Press the **INTERFACE** key again to step through a menu to select mode of transmission, baud rate, data bits, parity, and handshake. If more than 3 seconds passes and no key has been pressed, the instrument returns to normal display; altered settings are not stored. To store the settings, press the **INTERFACE** key several times until the normal display appears.

Display with IEEE-488:



Address 20

Display with RS-232:



Baud rate 9600, data bits 8, parity none.

The Programmers Manual contains a detailed description about the configuration setting.

INT/EXT Internal/External

Refer to **DC BIAS SOURCE**.

I_x Current Measured

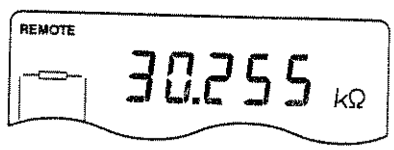
Refer to V_x/I_x (Voltage/Current).

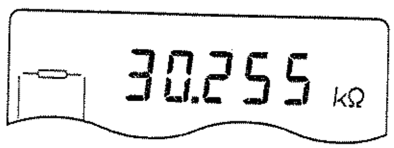
LEVEL Test Signal Voltage

Refer to **HI LEVEL/LOW LEVEL.**

LOCAL

Press this key to switch back from remote control to keyboard operation. You can lock the key with a remote control command to prevent inadvertent or unauthorized use.





Remote control commands: No device-specific message

Common commands, e.g., with the PM 2201 Interface:

Reset to local:	IOLOCAL
Lock key:	IOLLOCKOUT

LOW LEVEL Lower Voltage for Test Signal

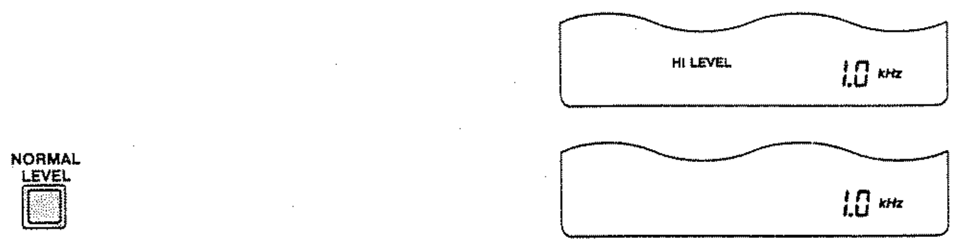
Refer to **HI LEVEL/LOW LEVEL.**

MODE of Measurement

Refer to **AUTO, SER/PAR, AVERAGE.**

NORMAL LEVEL Test Signal Voltage

Press this key to return to a test signal voltage of 1 V with an internal resistance of 100 Ω, if HI LEVEL or LOW LEVEL was selected.



Remote control commands:

Setting:	LEV NO
Query:	LEV?

PAR Parallel Parameter

Refer to **SER/PAR.**

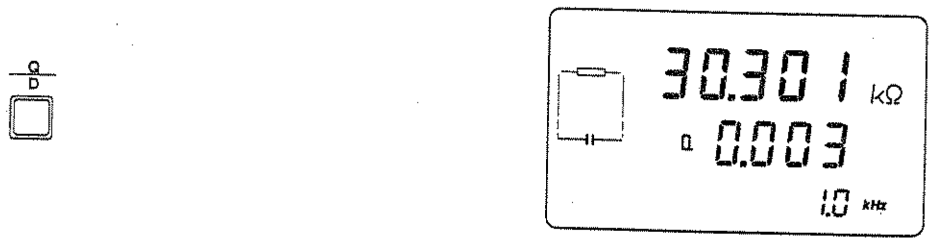
PARAMETER

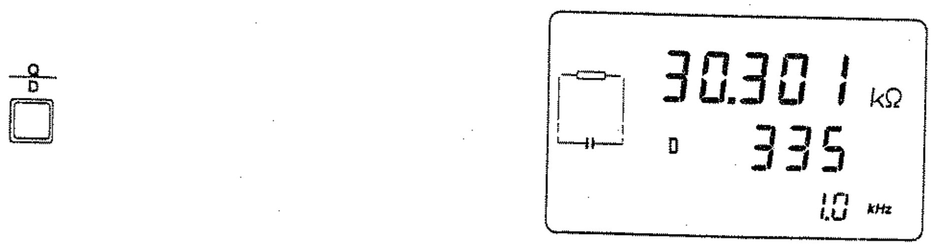
Refer to **Φ/Z**, **Q/D**, **V_x/I_x**.

Q/D Quality/Dissipation Factor

Press this key to display the quality factor Q or the dissipation factor D calculated by the instrument for the component up to 1000 or 0.001.

Q and D not only depend on the features of the component but also on the test signal frequency used. Refer to Chapter 4 and to the appendix at the end of these operating instructions.



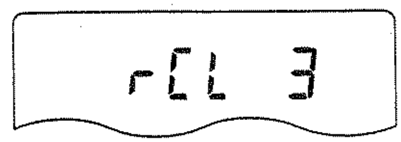


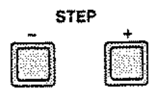
Remote control commands:

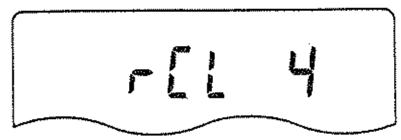
Setting:	PARAM QUA or PARAM DISS
Query for setting:	PARAM?
Query for value:	QUAL? or DISS?

RECALL

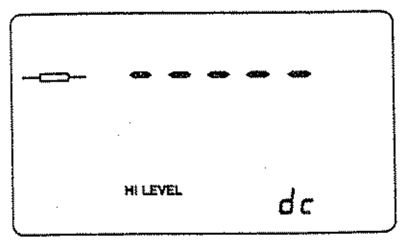
Press the **RECALL** key. The display shows ***rCL***, the present storage register number and the stored instrument settings. Press the **STEP** keys to select registers 1 to 9. Press the **RECALL** key again to load the settings displayed including trim data.







e.g.



Remote control commands: *RCL x

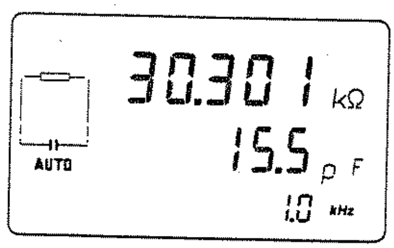
x = Storage registers 1 to 9

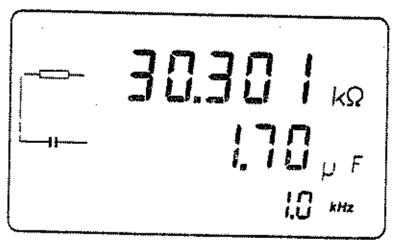
SER/PAR Series or Parallel Parameter

In the **AUTO** mode when the instrument has determined a resistance as the dominant parameter with a shunt capacitance and when it displays the relevant equivalent circuit symbol, you can display the calculated series resistance and capacitance of the component by pressing the **SER/PAR** key; the sign **AUTO** is switched off. Press the key once again to display the shunt parallel parameters again.
This function applies to all components whose equivalent circuit symbols are shown under the keyword for **AUTO** mode.

The instrument uses the phase diagrams and formulas listed in the appendix of these users manual as the basis for the calculations.

e.g.





Remote control commands:

Setting:	SER or PARAL
Query for value of the serial/parallel parameter:	CAP? or RESI? or INDU?

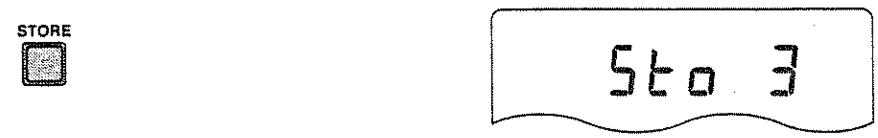
SINGLE Single Measurement

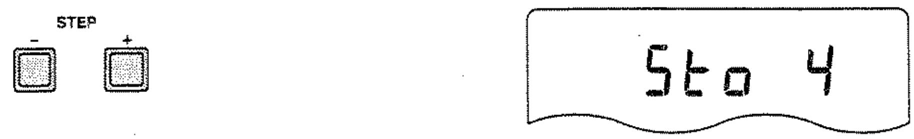
Refer to **CONT/SINGLE**.

STEP +/− Step Keys

These keys have two functions:

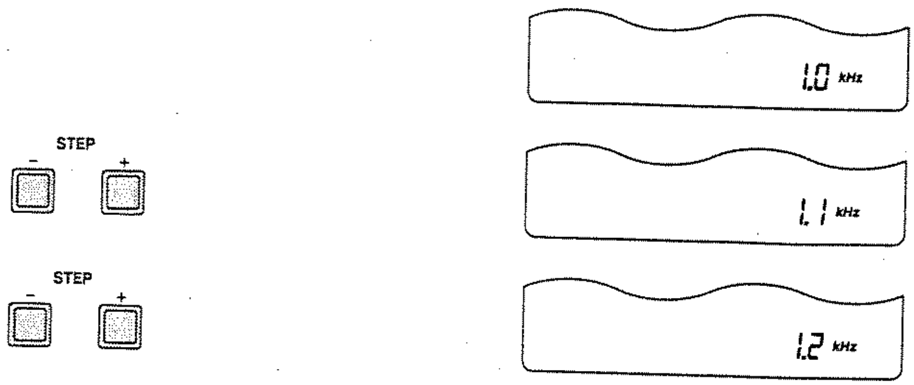
1. If **STORE** or **RECALL** was pressed beforehand, these keys are used to select storage registers 1 to 9 for storing or calling up instrument settings.





2. If no key was pressed beforehand, these keys change the frequency of the test signal step by step:

   50 Hz, 60 Hz, 100 Hz, 120 Hz, 300 Hz, 400 Hz to 20 kHz, 100 kHz



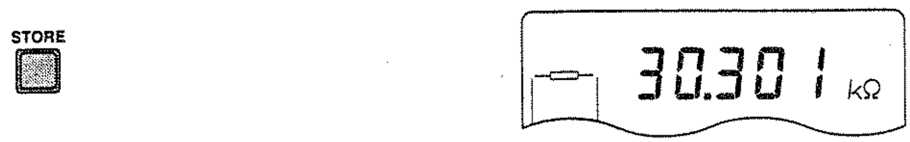
Remote control commands: None

STORE

You can store nine different instrument settings including trim data of the measurement setup. The settings are retained even after power off of the instrument.

Select the mode desired and press the **STORE** key. The display shows ***Sto*** with the present storage register number. Press the **STEP** keys to select a location between 1 and 9. Press the **STORE** key again to save the instrument settings (not the measuring results). The last setting prior to power-off of the instrument is automatically stored in register 0.

To recall the settings, refer to **RECALL**.



Remote control commands: *SAV x
x = Storage register 1 to 9

TEST SIGNAL SOURCE

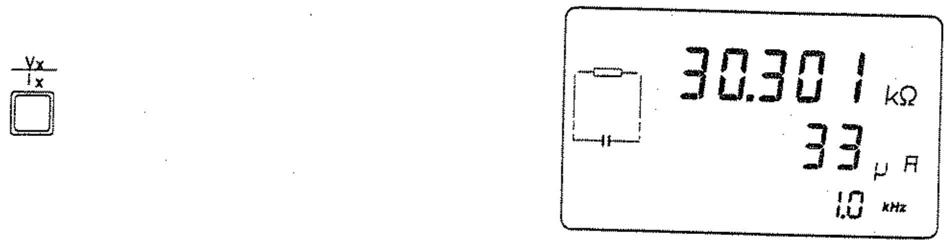
Refer to **NORMAL LEVEL, HI LEVEL/LOW LEVEL, FREQ/DC.**

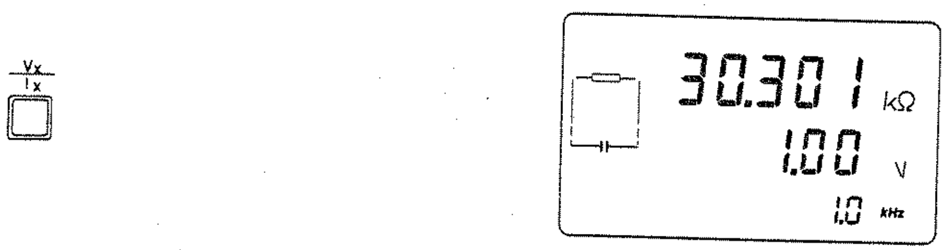
TRIGGER Starting a Single Measurement

Refer to **CONT/SINGLE** (continuous/single measurement).

V_x/I_x Voltage/Current

Press this key to display the voltage V_x or current I_x measured at the component. After approximately 3 seconds, the display jumps back to the parameter selected beforehand (not in remote control operation).





Remote control commands:

Setting:	PARAM VOL or PARAM CUR
Query for setting:	PARAM?
Query for value:	VOL? or CUR?

Z Impedance

Refer to Φ/Z at the end of the list.

ZERO TRIM Open-circuit Trimming / Short-circuit Trimming

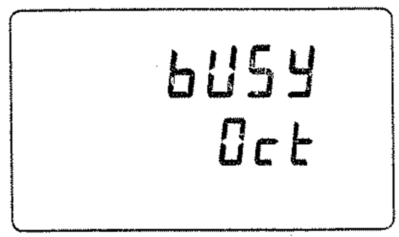
When you are measuring components of low impedance, line and contact impedances can falsify the measuring result. When you are measuring high impedances, this can also be the case due to the parallel impedance of the measurement setup.

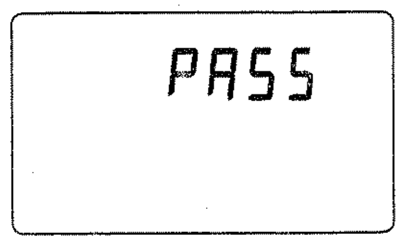
When you press the **ZERO TRIM** key for 2 seconds when there is a short-circuit input, the line and contact impedances are determined and considered for the subsequent measurements.

When you press the **ZERO TRIM** key for 2 seconds when there is an open input, the impedance of the measurement setup is determined and considered for the subsequent measurements.

The display shows ***bUSY*** and ***Sct*** respectively ***bUSY*** and ***Oct*** during trimming. After trimming it shows ***PASS***. If the display shows ***FAIL***, the short-circuit impedance is too high (>10 Ω) to be trimmed by the instrument or the open-circuit impedance is <100 kΩ.

with open input

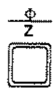


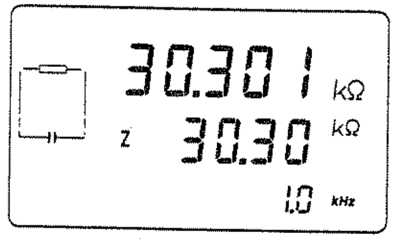


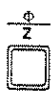
Remote control commands: TRIM

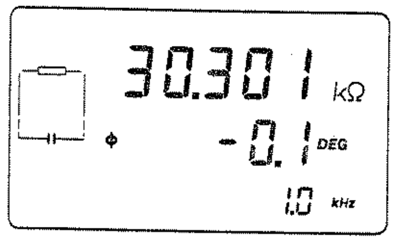
Φ/Z Phase Angle Phi / Impedance

Press this key to display the impedance of the component. Press it again to display the phase angle between the current and the voltage measured at the component.









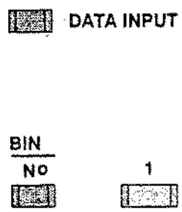
Remote control commands:

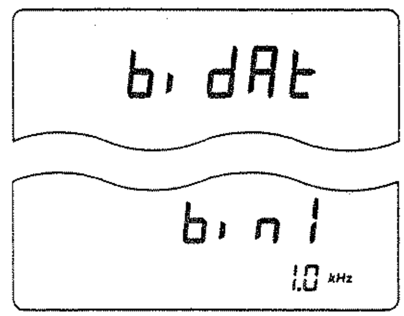
Setting:	PARAM IMP or PARAM PHA
Query for setting:	PARAM?
Query for value:	IMP? or PHA?

5.2 FUNCTIONS OF THE PM 9559 BIN PROGRAMMER (OPTION)

BIN

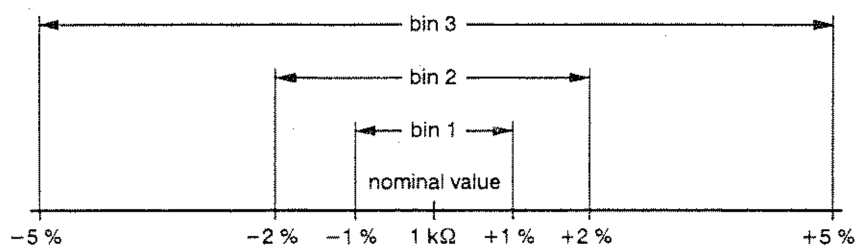
Press the **DATA INPUT** key to set the bin to data input, then press the **N°** key to call up the desired bin. Next press a digit **0** to **9** to check the data in the bin or to enter a new data.
Press the **DISABLE** key to deactivate the bin displayed (bin 1 cannot be disabled). In this case, the data are not taken into account during binning, but are retained in the memory. Press the **N°** and **0** to **9** keys to reactivate disabled bins.





The bins can be defined as follows to meet different requirements.

- Nested limits can be set with reference to a nominal value ⋆ to bin components according to tolerance classes:



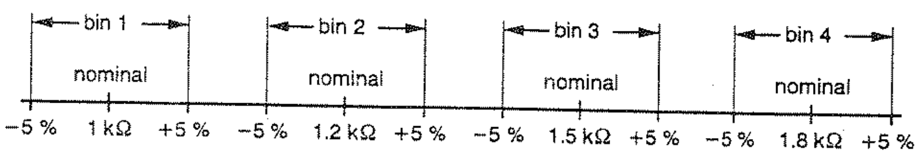
Bear in mind that the instrument checks the criteria of the bins in the sequence 1 to 9, ending with bin 0. If bin 1 contains the largest tolerance (±5 %), then each component with a tolerance <5 % is immediately allocated to bin 1.

For example, bins 1 to 9 check the tolerance of a capacitor and bin 0 checks the quality factor of the capacitor.

The display is as follows:

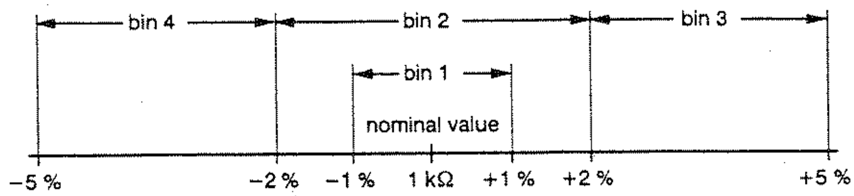
Component meets tolerance defined in:		
bin 1 to 9	bin 0	Display
YES	YES	bin 1 to 9
NO	do not care	FAIL
YES	NO	bin 0

- Sequential limits can be set with reference to a nominal value ⋆ to bin components according to values.



Ensure that the limits do not overlap. If a component lies within an overlapping area, it is always allocated to the bin with the lower number.

- Combined nested and sequential limits



★ Instead of a nominal values with +/− limits in percent, the limits can also be entered directly as absolute values. Refer to **LIMITS** keyword.

Remote control commands:

Parameter	As nominal value: BIN_REL	
	In absolute limits: BIN_ABS	
Resistance	RESI	
Capacitance	CAP	
Inductance	INDU	
Impedance	IMP	
Quality factor	QUAL	
Dissipation factor	DISS	
Phase angle	PHA	
Upper limit:	LIM_HI xx	
Lower limit:	LIM_LO xx	xx = numerical value
Bin number:	BIN x	x = 0 ... 9

Nominal value and tolerance in percent:

```
BIN_REL;RESI 1E3;LIM_LO -.5;LIM_HI .5;BIN 1;
                 LIM_LO -1;LIM_HI 1;BIN 2;
                 LIM_LO -1.5;LIM_HI 1.5;BIN 3;
```

Input as absolute value:

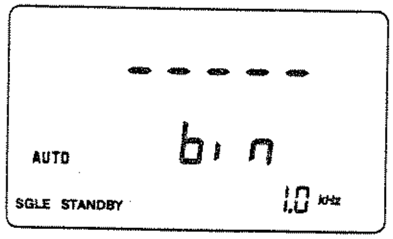
```
BIN_ABS;RESI;LIM_LO 0.95E3;LIM_HI 1.005E3;BIN 1;
             LIM_LO 0.90E3;LIM_HI 1.010E3;BIN 2;
             LIM_LO 0.85E3;LIM_HI 1.015E3;BIN 3;
```

BINNING

In this mode, the instrument checks the component to be measured according to the criteria for the bins entered beforehand; for instrument settings, see Section 4.6.2.4. If the component meets the criteria of a bin, that means, it is within a defined tolerance, the display shows the number of the bin. If the component cannot be allocated to any bin, the display shows ***FAIL*** .

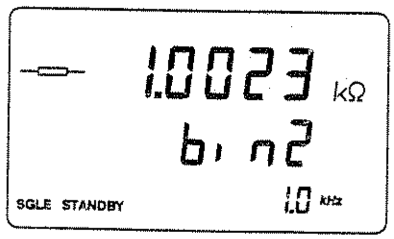
External control lines can be connected by means of a handler interface (option). This enables an automatic binning device to be operated or an optical display with LED indicator lights.

BINNING



Insert component

TRIGGER



Remote control commands: BINNING ON

C Capacitance

Refer to **Parameter**.

CAL Calibrate

The instrument was calibrated in the factory prior to shipment. The calibrating data are stored in an EEPROM and are taken into account during every measurement.
It is necessary to calibrate again after loss of data (replacing the EEPROM), after changing components during repair which might influence the measuring result or when the instrument does not comply with the technical specifications. In normal operation, recalibration once a year is sufficient. More details on this can be found in the SERVICE MANUAL.

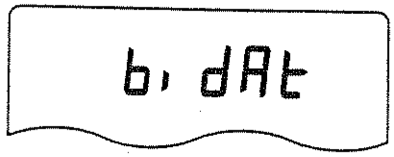
The calibrating data are protected by a code number.
Pressing the keys inadvertently does not have any effect on the stored data. The display shows ***CAL–1*** or ***CAL–2***. Press the **NORMAL** key to switch back to normal mode again.

D Dissipation Factor

Refer to **Parameter**.

DATA INPUT

Press this key to set the instrument to the input mode for binning data.



DATA INPUT

To select a bin, refer to **BIN**.
To enter data for the bin, refer to **LIMITS**.

Remote control commands:

No direct command. Data can be entered directly via the interface.

Decimal Point

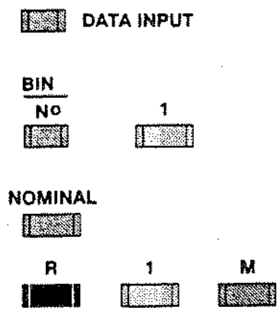
Refer to **Numerical Keypad**, end of the list.

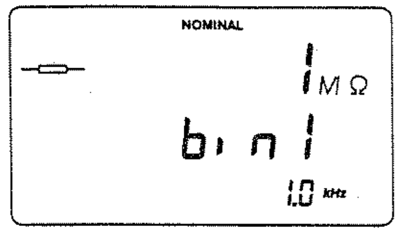
Dimension

When the parameter which is to be used for binning has been selected, the instrument automatically sets the unit of measurement. When the number has been entered, the multiplier desired can be selected with key **k**, **M**, μ, **m**, **n** or **p**.

Resistances	(R, Z):	10^3 (k),	10^6 (M)		
Capacitances	(C):	10^{-3} (m),	10^{-6} (μ),	10^{-9} (n),	10^{-12} (p)
Inductances	(L):	10^3 (k),	10^{-3} (m),	10^{-6} (μ)	

Q and D are factors without a unit of measuremment.
With Φ (phase angle), the unit of measurement, degree, is not displayed.

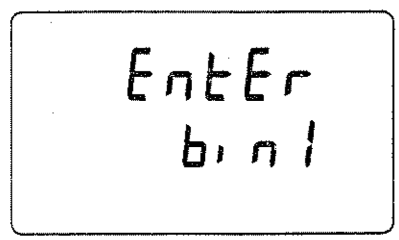




Remote control commands:
No direct command; the unit of measurement is automatically set according to the programmed parameter. The multiplier can be entered in exponential form: 1E3 = 1 kΩ with resistances, 10E−6 = 10 μF with capacitances

ENTER

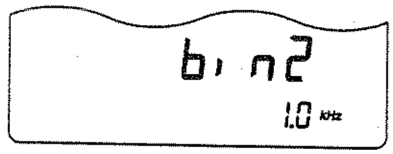
You must press the **ENTER** key to acknowledge when data sets are changed or new ones entered. The data are now stored in a buffer. They are lost when the instrument is turned off or when leaving bin programming by pressing a front panel key or by pressing the **BINNING** or **NORMAL** key. They have to be saved beforehand via the **STORE** function.



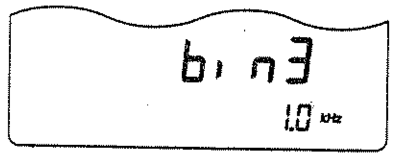
Remote control commands:

None; the terminator of a string is equivalent to an acknowledgment.

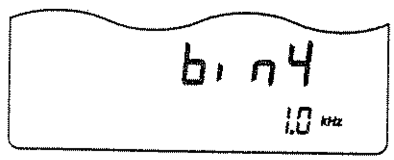
If a bin was selected, press the **ENTER** key to move step by step to other bins without having to press the **Nº** key and a digit.



ENTER



ENTER



HIGH Upper Tolerance Limit

Refer to **LIMITS**.

---

k kilo

Refer to **Dimension**.

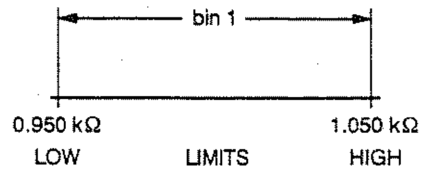
L Inductance

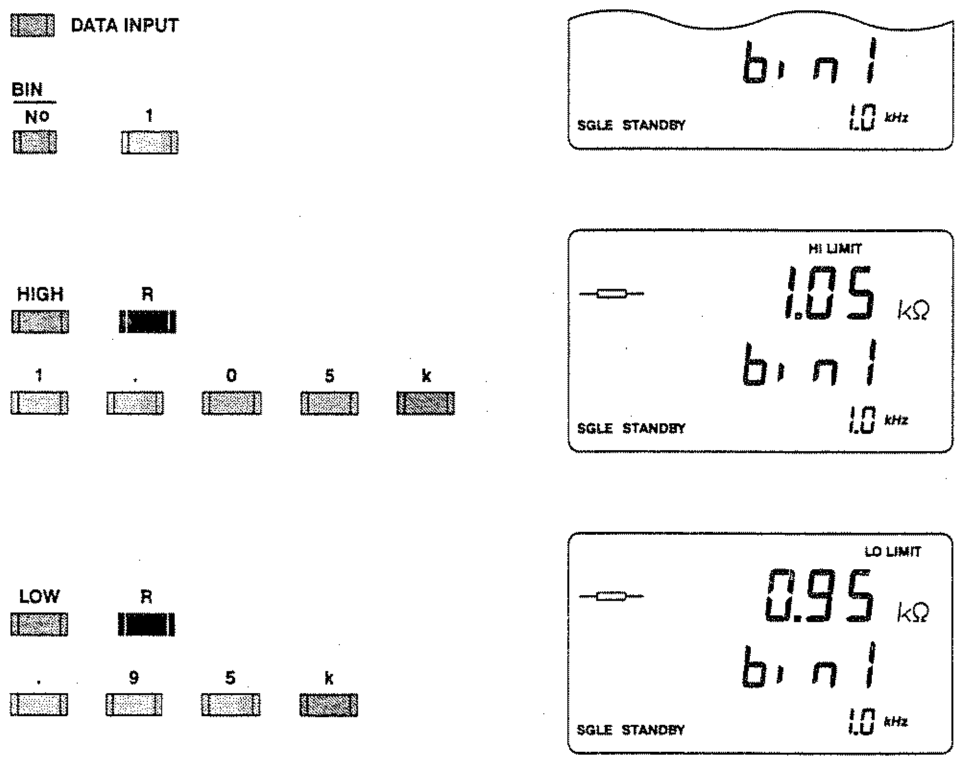
Refer to **Parameter**.

LIMITS Ranges for Binning

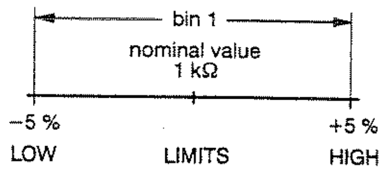
There are various methods for defining the limits for a bin:

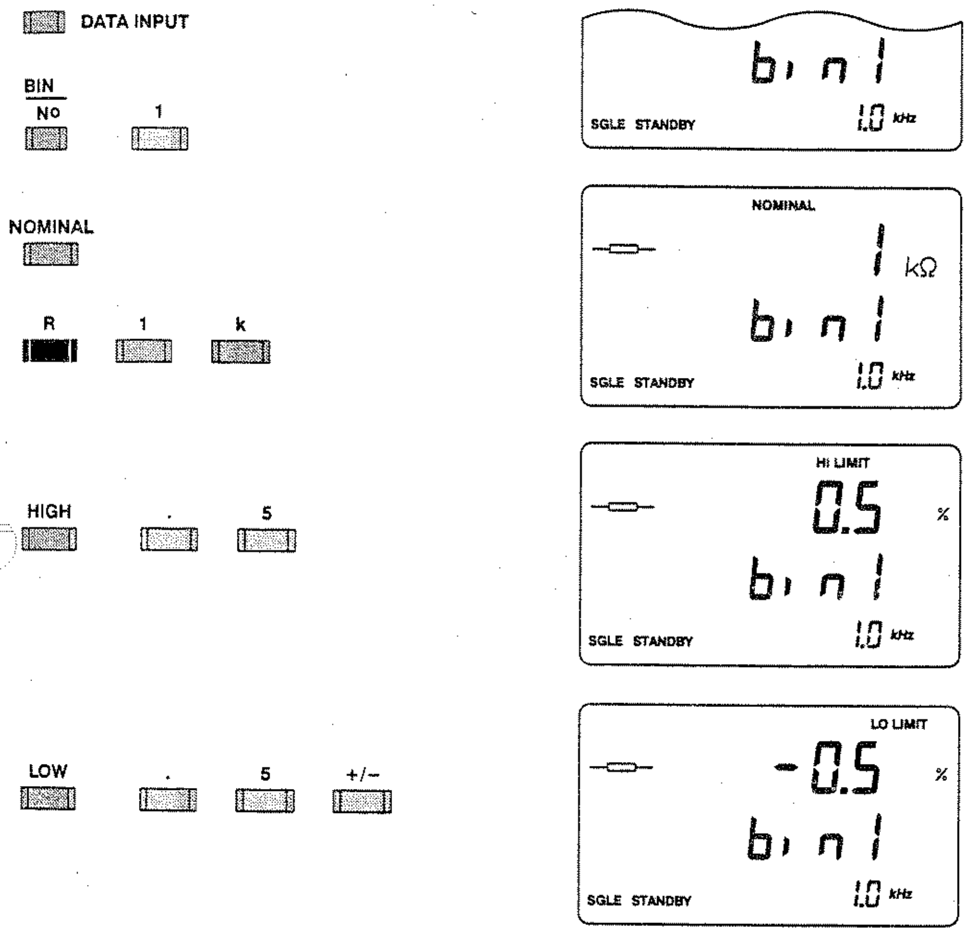
Upper and lower limit as absolute values, for example:





A nominal value and the upper and lower limit as a relative offset of the nominal value:





Remote control commands:

Input as absolute values:
BIN_ABS;RESI;LIM_LO 0.95e3;LIM_HI 1.005E3;BIN 1;

Nominal value and tolerance in percent:
BIN_REL;RESI 1E3;LIM_LO –.5;LIM_HI .5;BIN 1;

LOW Lower Tolerance Limit

Refer to **LIMITS**.

M Mega

Refer to **Dimension.**

---

m milli

Refer to **Dimension.**

---

n nano

Refer to **Dimension.**

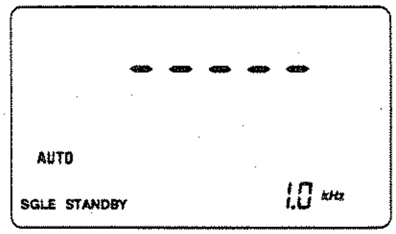
NOMINAL Nominal Value

Refer to **LIMITS.**

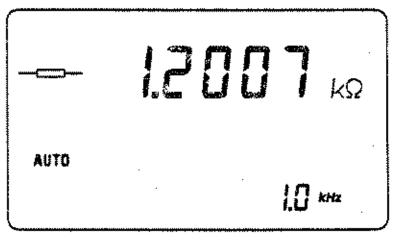
NORMAL Normal Mode

You can return to normal mode by pressing this key if data input or binning was selected.


NORMAL



CONT
SINGLE

Remote control commands: BIN OFF

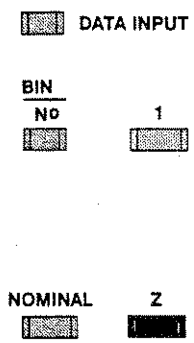
p piko

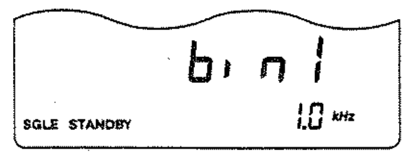
Refer to **Dimension.**

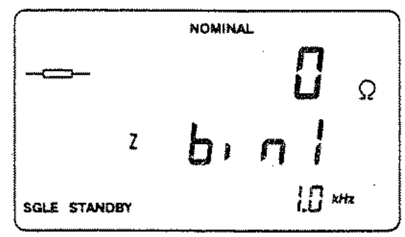
Parameter

Before you enter the values for the binning limits, you must define to which parameter they must refer by pressing the appropriate key. This parameter must be used for the complete bin set, with the exception of bin 0.

R Resistance	**Q** Quality factor	**Z** Impedance
C Capacitance	**D** Dissipation factor	Φ Phase angle
L Inductance		







Remote control commands:

Resistance	RESI
Capacitance	CAP
Inductance	INDU
Impedance	IMP
Quality factor	QUAL
Dissipation factor	DISS
Phase angle	PHA

Q Quality Factor

Refer to **Parameter.**

R Resistance

Refer to **Parameter.**

RCL METER MODE Operating Mode

Keys **NORMAL**, **BINNING**, **DATA INPUT** are used to select the operating mode of the RCL Meter.

NORMAL: Normal measuring functions with operation via the keyboard of the instrument

BINNING: Instrument in the binning mode, components are classed according to limiting values entered beforehand

DATA INPUT: Instrument is ready for data input for binning criteria

The functions are described under the appropriate keyword.

Remote control commands:

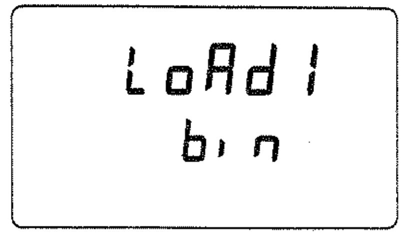
Normal:	BIN OFF
Binning:	BIN ON
Data input:	None; data can be entered directly

RECALL

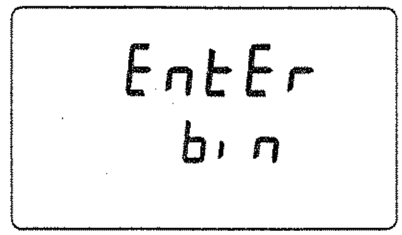
Press the **RECALL** key and then a storage register number (**0** to **9**) to call up the stored data of a complete bin set including instrument settings.

DATA INPUT

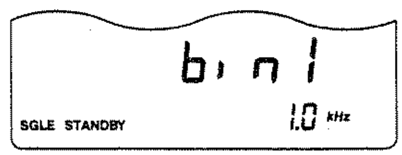
RECALL 1



ENTER



after 2 seconds

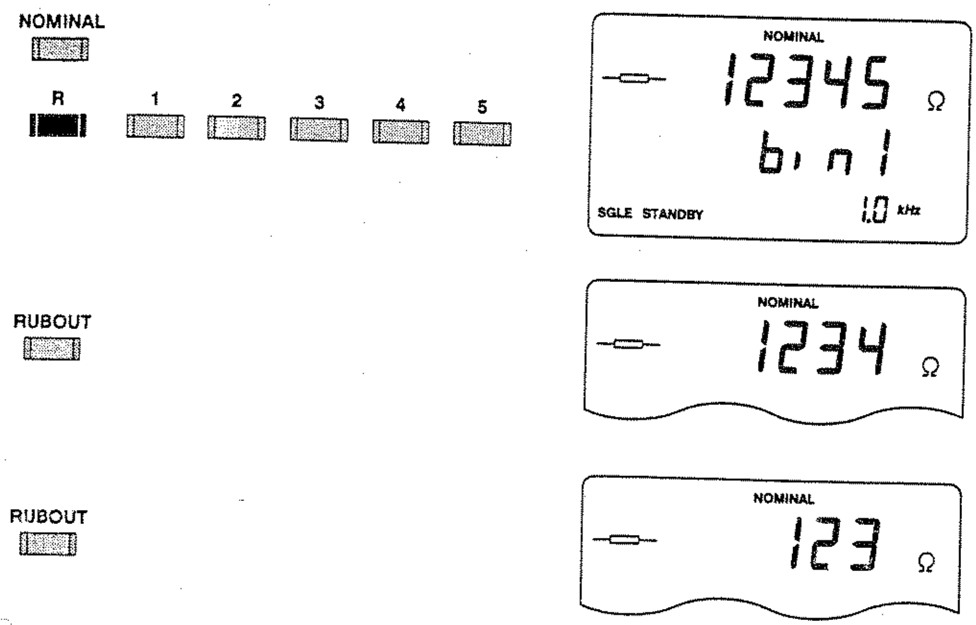


Remote control commands:

BUF_RCL x	x = 0 ... 9	loads contents of register x into a separate buffer for editing
BIN_RCL x	x = 1 ... 9	loads contents of register x into register 0 for binning

RUBOUT

You can delete inadvertently or erroneously entered digits individually by pressing the **RUBOUT** key.



Press the **RUBOUT** and the **ENTER** key after selecting a bin number to delete **all values** of the bin.

Remote control commands:

No direct ones;

BIN_ERA x	deletes the data set x
BUF_CLEAR	deletes the input buffer

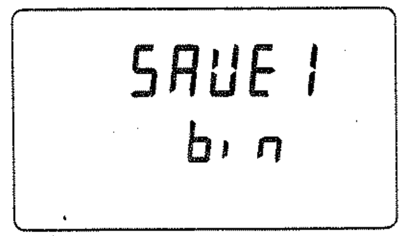
STORE

You can store ten data sets in storage registers 0 to 9. A data set contains the data of bins 1 to 9 and the selected instrument setting. These storage registers are not the same as those where the instrument settings are stored during keyboard operation.

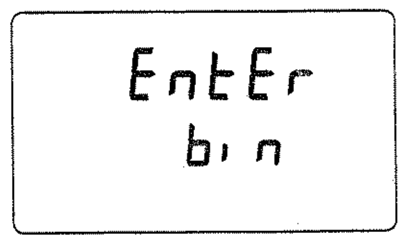
Newly entered data for binning must be stored into registers 0 to 9 via the **STORE** function or by pressing the **BINNING** or **NORMAL** key into register 0. The **ENTER** key alone does not store the data.

To recall the data, refer to **RECALL**.

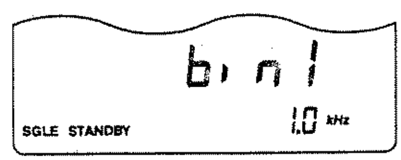
STORE 1



ENTER



after 2 seconds



Remote control commands: BIN_STO x x = 0 ... 9

Z Impedance

Refer to **Parameter**.

Numerical Keypad

- Keys **0** to **9** are used for:
  - Selecting a bin.
  - Inputting values for the bins.
  - Selecting a memory location for calling up or storing data sets.
- Decimal point for input of decimal values.
- The +/– key is used for inputting negative percentages for the bin limits or a negative phase angle.

Remote control commands: Numerical values in the data element of a program message

Φ Phase Angle Phi

Refer to **Parameter**.

μ micro

Refer to **Dimension**.

+/– Sign Key

Refer to **Numerical Keypad**.

INSTALLATION AND SAFETY INSTRUCTIONS IN FOREIGN LANGUAGES

INSTRUCCIONES DE INSTALACION Y DE SEGURIDAD (E)

ISTRUZIONI PER LA MESSA IN FUNZIONE E NORME DI SICUREZZA (I)

INSTRUCTIES MET BETREKKING TOT DE INSTALLATIE EN VEILIGHEID (NL)

INSTALLATIONSANVISNINGAR OCH SÄKERHETSFÖRESKRIFTER (S)

INSTALLATION AND SAFETY INSTRUCTIONS IN FOREIGN LANGUAGES

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1 **INSTALLATION AND SAFETY INSTRUCTIONS** (GB)

See Chapter 1 of the English part.

1 **INSTALLATIONS- UND SICHERHEITSANWEISUNGEN** (D)

Siehe Kapitel 1 des deutschen Teils.

1 **INSTRUCTIONS POUR L'INSTALLATION ET DE SECURITE** (F)

Voir le chapitre 1 de la partie francaise.

1 INSTRUCCIONES DE INSTALACION Y DE SEGURIDAD

1.1 INSTRUCCIONES DE SEGURIDAD

El aparato sale de fábrica, técnicamente, en perfectas condiciones de seguridad (ver cap. 1, Reference Manual). Para que se conserven estas condiciones, y para evitar riesgos en el uso, hay que seguir cuidadosamente las indicaciones siguientes.

1.1.1 Reparación y mantenimiento

Defectos y esfuerzos extraordinarios:
Si se piensa que el aparato ya no puede funcionar sin riesgo, hay que apagarlo y asegurarse de que no se ponga en funcionamiento inadvertidamente. Este es el caso:

- cuando el aparato presenta daños visibles,
- cuando el aparato ya no funciona,
- luego de haber sido sometido a esfuerzos excesivos de cualquier tipo (p.e. en el almacenaje o el transporte) que sobrepasan los límites permitidos.

Abrir el aparato:
Al abrir algunas tapas o al desmontar piezas con herramientas pueden quedar al descubierto partes bajo tensión eléctrica. También puede haber tensión en los puntos de conexión. Antes de abrir el aparato hay que desconectarlo de todas las fuentes de alimentación.

Si es inevitable realizar un **calibrado, mantenimiento o reparación con el aparato abierto** que se encuentra bajo tensión, sólo debe hacerlo un técnico cualificado que conozca los riesgos que existen. Los condensadores del aparato pueden seguir estando cargados aún cuando esté haya sido desconectado de todas las fuentes de alimentación.

1.1.2 Puesta a tierra

Antes de hacer alguna conexión hay que conectar el aparato a un contactor de protección mediante el cable de alimentación de tres conductores.
El enchufe de la red debe ser insertado sólo en tomacorrientes con contacto de seguridad de tierra.
No se deben anular estas medidas de seguridad, p.e. usando un cable de extensión sin contactor de protección.
La puesta protectora a tierra a través de los contactos de medición en la placa frontal, a través de los 4 contactos de la toma a la cual se aplica el potencial de tierra del circuito o a través del contacto exterior de la toma o de la clavija es inadmisible.

ADVERTENCIA: Toda interrupción del contactor de protección dentro o fuera del aparato, o la separación de la conexión de la puesta protectora a tierra es peligrosa.
Se prohíbe hacer la interrupción expresamente.

1.1.3 Contactos y conexiones

El potencial de tierra del circuito se aplica a 4 de los 8 contactos de la toma, estando éste conectado en paralelo a la carcasa del aparato por medio de condensadores y resistencia; el contacto exterior de la toma está unido a la carcasa del aparato. De esta forma se evitan zumbidos y se obtiene una clara puesta a tierra de HF.

Si al efectuar una medición se observa que el potencial de tierra del circuito eléctrico difiere del potencial de tierra de protección, se ha de tener en cuenta que los 4 contactos de la toma no deban estar conectados a tensiones que sean peligrosas al menor contacto.

1.1.4 Ajuste de la tensión de la red y fusibles

Antes de enchufar el aparato a la red hay que verificar si éste está ajustado a la tensión de la red local.

ADVERTENCIA: Si hay que adaptar el enchufe de la red a las circunstancias del lugar, este trabajo debe realizarlo sólo un técnico cualificado.

Al salir de fábrica el aparato está ajustado a una de las tensiones de red siguientes:

Tipo de aparato	Nro. de código	Tensión de red	Cable suministrado
PM6304 o PM6304C	9452 x63 04xx1	220 V	Europa
PM6304 o PM6304C	9452 x63 04xx3	120 V	Norteamérica
PM6304 o PM6304C	9452 x63 04xx4	240 V	Inglaterra (U.K.)
PM6304 o PM6304C	9452 x63 04xx5	220 V	Suiza
PM6304 o PM6304C	9452 x63 04xx8	240 V	Australia

En la parte trasera del aparato se indica la tensión de red ajustada y el valor del fusible correspondiente.

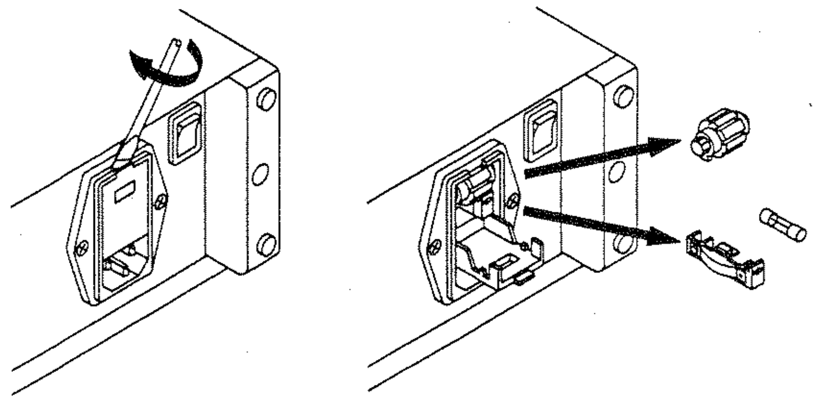
Hay que tener en cuenta de emplear solamente fusibles con la tensión nominal indicada y del tipo especificado para recambio. Se prohíbe el empleo de fusibles reparados o cortocircuitar el porta-fusibles. El cambio del fusible sólo deberá realizarlo un técnico cualificado, que conozca los riesgos que existen.

ADVERTENCIA: Cuando se cambia un fusible y cuando se ajusta el aparato a otra tensión, éste debe ser desconectado de todas las fuentes de alimentación.

El aparato se puede ajustar a las tensiones de red siguientes: 100 V, 120 V, 220 V y 240 V en corriente alterna. Se puede hacer la regulación de estas tensiones nominales con el selector de tensión (combinado con el enchufe en la pared trasera del aparato).

El fusible se encuentra en un soporte en el mismo sitio. Para ajustar la tensión de la red o para sustituir el fusible hay que desconectar el aparato de la red y abrir con un destornillador la tapa (ver dibujo).

La tensión adecuada se elige girando el selector de tensión. Si hace falta, se debe montar el fusible correspondiente en lugar del que está instalado en el soporte del fusible – T0.2A o T0.4A (IEC127) o T0.25A o T0.5A (CSA/UL198G).



1.2 POSICION DE FUNCIONAMIENTO DEL APARATO

El aparato puede funcionar en las posiciones indicadas en el capítulo 1, Reference Manual. Si la horquilla de soporte está cerrada, el aparato puede utilizarse en posición inclinada. Los datos técnicos del capítulo 1, Reference Manual, se refieren a las posiciones indicadas. Se ha de tener cuidado de no cubrir las aberturas de ventilación del aparato. El aparato no se debe colocar nunca sobre una superficie que produzca o irradie calor ni exponerlo a los rayos directos del sol.

1.3 SUPRESION DE INTERFERENCIAS

En el aparato se han suprimido cuidadosamente todas las interferencias, habiéndose sometido éste también a prueba. Al conectarlo a unidades básicas o a otras unidades periféricas cuyas interferencias no se han suprimido correctamente, pueden generarse interferencias que en algunos casos exigirán medidas adicionales para suprimirlas.

1 ISTRUZIONI PER LA MESSA IN FUNZIONE E NORME DI SICUREZZA

1.1 NORME DI SICUREZZA

L'apparecchio viene fornito dalla fabbrica perfettamente sicuro e funzionante dal punto di vista tecnico (vedi Cap. 1, Reference Manual). Per preservarlo in condizioni ottimali e garantirne un corretto funzionamento, attenersi scrupolosamente alle seguenti istruzioni.

1.1.1 Riparazione e manutenzione

Funzionamento anomalo e sollecitazioni eccessive:
Qualora il funzionamento non risultasse regolare, spegnere subito l'apparecchio e prevenirne ogni accensione accidentale.
Le precauzioni di cui sopra vanno adottate nei seguenti casi:

- se l'apparecchio mostra dei danni visibili,
- se l'apparecchio non funziona più,
- se l'apparecchio è stato sottoposto a sollecitazioni (ad esempio durante il magazzinaggio, il trasporto, ecc.) oltre i limiti di tolleranza ammessi.

Apertura dell'apparecchio:
Se i coperchi o alcune parti dell'apparecchio vengono rimossi con appositi attrezzi, può darsi che risultino esposti dei componenti sotto tensione. Anche i punti di connessione possono essere sotto tensione. Prima di aprire l'apparecchio occorre quindi disinnestarlo dalle relative prese di corrente.

Se fosse necessario eseguire interventi di **calibrazione, manutenzione o riparazione con l'apparecchio aperto** e sotto tensione, rivolgersi a personale specializzato che conosca bene i probabili rischi nelle procedure da adottare. Potrebbe darsi che i condensatori dentro all'apparecchio siano ancora carichi anche se l'apparecchio è stato disinnestato dalle relative prese di corrente.

1.1.2 Messa a terra

Prima di eseguire un qualsiasi collegamento, mediante il cavo di alimentazione tripolare l'apparecchio deve essere allacciato ad un conduttore di protezione.
La spina del cavo di alimentazione deve essere inserita soltanto in una presa munita di contatto di messa a terra.
Questa norma resta comunque valida, anche se si utilizza un cavo di prolunga senza conduttore di protezione.
I contatti di misura sulla piastra anteriore o i quattro contatti della presa su cui viene applicato il potenziale di terra del circuito di alimentazione, o il contatto esterno della presa/spina, o le prese alla piastra posteriore non devono essere utilizzati per collegare un conduttore di terra protettivo.

ATTENZIONE: E' estremamente pericoloso interrompere il conduttore di protezione interno o esterno all'apparecchio o i contatti di messa a terra. Evitare quindi di farlo intenzionalmente.

1.1.3 Contatti e collegamenti

Il potenziale di terra del circuito di alimentazione viene applicato a quattro degli otto contatti della presa e condotto alla carcassa dell'apparecchio tramite condensatori e una resistenza collegati in parallelo; il contatto esterno della presa viene collegato alla carcassa dell'apparecchio. In tal modo, viene realizzato un collegamento di messa a terra RF univoco esente da interferenze.

Se il potenziale di terra del circuito all'interno di una determinata configurazione fosse differenziato dal potenziale di messa a terra di protezione, occorre accertarsi che i quattro contatti della presa non siano sotto tensione.

1.1.4 Predisposizione della tensione di alimentazione e fusibili

Prima di collegare la spina di alimentazione alla presa, controllare che l'apparecchio sia predisposto per la tensione di rete locale.

ATTENZIONE:	L'eventuale adattamento della spina di alimentazione alle condizioni locali va effettuata esclusivamente da personale specializzato.

L'apparecchio fornito dalla fabbrica è predisposto per uno dei seguenti valori di tensione di rete:

Tipo di apparecchio	N° di codice	Tensione	Cavo di alimentazione fornito in dotazione
PM6304 op. PM6304C	9452 x63 04xx1	220 V	Europa
PM6304 op. PM6304C	9452 x63 04xx3	120 V	Norteamérica
PM6304 op. PM6304C	9452 x63 04xx4	240 V	Inglaterra (U.K.)
PM6304 op. PM6304C	9452 x63 04xx5	220 V	Suiza
PM6304 op. PM6304C	9452 x63 04xx8	240 V	Australia

Il valore della tensione di rete predisposto e la portata del fusibile sono indicati sul retro dell'apparecchio.

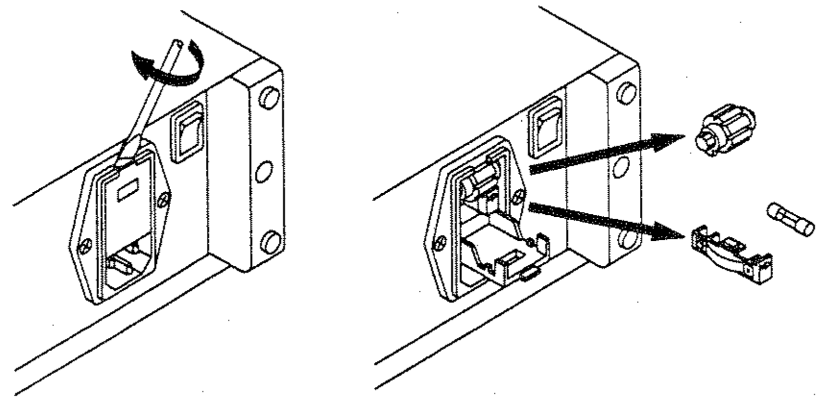
Si un fusibile deve essere sostituito, fare attenzione a utilizzarne uno caratterizzato dalla portata nominale prescritta e di tipo idoneo. Non è consentito utilizzare fusibili riparati e/o cortocircuitare il porta-fusibile. Il fusibile può essere sostituito solo da personale specializzato che conosca bene i potenziali rischi esistenti negli interventi di questo tipo.

ATTENZIONE:	Per sostituire un fusibile o predisporre un diverso valore della tensione di alimentazione occorre disinserire l'apparecchio dalle relative presa di corrente.

L'apparecchio può essere predisposto per i seguenti valori della tensione di alimentazione: 100 V, 120 V, 220 V e 240 Vca. Questi valori nominali di tensione possono essere predisposti con il selettore della tensione (in corrispondenza della presa di alimentazione sul retro dell'apparecchio).

Il fusibile è collocato in un supporto nello stesso posto. Per impostare il valore della tensione di rete o per sostituire il fusibile, occorre disinnestare il cavo di alimentazione e aprire con un cacciavite l'aletta di chiusura (vedere il disegno).

Selezionare il valore di tensione richiesto girando la rotella di regolazione. Se necessario, sostituire il vecchio fusibile con uno nuovo – T0.2A oppure T0.4A (IEC127) oppure T0.25A oppure T0.5A (CSA/UL198G).



1.2 POSIZIONE DI FUNZIONAMENTO DELL'APPARECCHIO

L'apparecchio può essere installato nelle posizioni indicate nel Capitolo 1, Reference Manual. Abbassando la squadretta di supporto, l'apparecchio può essere usato in posizione inclinata. I dati tecnici riportati nel Capitolo 1, Reference Manual, valgono per le posizioni indicate. Attenzione che le aperture di ventilazione dell'apparecchio non vengano coperte. L'apparecchio non deve essere mai collocato su una superficie surriscaldabile o che produca irradiazioni, né essere esposto ai raggi diretti del sole.

1.3 INTERFERENZE

L'apparecchio è stato realizzato per garantire un funzionamento esente da interferenze. Se viene utilizzato congiuntamente a unità base e a unità periferiche non dotate delle stesse protezioni, ne possono derivare interferenze che richiederanno ulteriori interventi.

1 INSTRUCTIES MET BETREKKING TOT DE INSTALLATIE EN VEILIGHEID

1.1 VEILIGHEIDSINSTRUCTIES

Het apparaat heeft de fabriek in een onberispelijke veiligheidstechnische toestand verlaten (zie hoofdstuk 1, Reference Manual). Voor het behoud van deze toestand en het risicoloze gebruik dienen de onderstaande instructies nauwkeurig te worden opgevolgd.

1.1.1 Reparatie en onderhoud

Storingen en uitzonderlijke omstandigheden
Wanneer verondersteld moet worden dat een risicoloos gebruik niet meer mogelijk is, dient het apparaat buiten gebruik gesteld en tegen een ongewenst gebruik beveiligd te worden. Deze situatie doet zich voor

- wanneer het apparaat zichtbare beschadigingen vertoont,
- wanneer het apparaat niet meer functioneert,
- na blootstelling aan excessieve omstandigheden van welke aard dan ook (bij voorbeeld bij opslag, transport) die de toelaatbare grenzen overschrijden.

Openen van het apparaat
Bij het openen van afdekkingen of bij het met behulp van gereedschap verwijderen van onderdelen, kan het risico van contact met spanningvoerende delen ontstaan. Ook kan er spanning op aansluitpunten aanwezig zijn. Het apparaat mag pas geopend worden nadat het van alle spanningsbronnen losgenomen is.

Wanneer **ijk-, onderhouds- of herstelwerkzaamheden aan een open en onder spanning staand apparaat** onvermijdelijk zijn, mogen deze slechts worden uitgevoerd door een vakman die weet met welke gevaren dit gepaard gaat. In het apparaat aanwezige condensators kunnen nog geladen zijn, ook wanneer het apparaat van alle spanningsbronnen is losgenomen.

1.1.2 Aarding

Alvorens men een verbinding tot stand brengt, dient men het apparaat met behulp van een drieaderige kabel met een veligheidsaarddraad te verbinden.
De netsteker mag slechts op een stopcontact met randaarde worden aangesloten.
Deze veiligheidsmaatregel mag niet onwerkzaam gemaakt worden, bij voorbeeld door het gebruik van een verlengsnoer dat niet van een veiligheidsaarddraad voorzien is.
Een beschermde aarde aansluiting via de meetansluitingen aan de voorkant, over de 4 steker contacten welke op schakelnulpunt-potentiaal liggen, via het externe contact van de steker (stekerhuis) of van de steker, of via de stekers aan de achterkant is niet toegestaan.

WAARSCHUWING:	Elke onderbreking van de beschermende aardleiding, hetzij binnen of buiten het apparaat, of de scheiding ten opzichte van de aardleiding zijn gevaarlijk. Een opzettelijke onderbreking is verboden.

1.1.3 Aansluitingen en verbindingen

Het aardpotentiaal van de stroomkringen wordt aan 4 van de 8 contacten van de steker verbonden, en is met het huis verbonden via parallel aangesloten condensators en weerstand; het externe contact van de steker (stekerhuis) is met de behuizing verbonden.
Op deze manier wordt een duidelijke bromvrije HF-aarding tot stand gebracht.

Wanneer in een meetopstelling het schakelnulpunt-potentiaal van een stroomkring afwijkt van het beschermde aardpotentiaal, dan dient men er op bedacht te zijn, dat de 4 contacten van de steker geen gevaarlijke spanningen mogen voeren!

1.1.4 Netspanningsinstelling en zekeringen

Alvorens men de netsteker op het lichtnet aansluit, dient men zich ervan te vergewissen dat het apparaat op de plaatselijke netspanning is afgesteld.

WAARSCHUWING:	Wanneer de netsteker aan de plaatselijke situatie moet worden aangepast, mag deze aanpassing slechts door een vakman worden uitgevoerd.

Bij het verlaten van de fabriek is het apparaat op een van de volgende netspanningen afgesteld:

Type apparaat	Codenummer	Netspanning	Meegeleverde netkabel
PM6304 of PM6304C	9452 x63 04xx1	220 V	Europa
PM6304 of PM6304C	9452 x63 04xx3	120 V	Noord-Amerika
PM6304 of PM6304C	9452 x63 04xx4	240 V	Engeland (U.K.)
PM6304 of PM6304C	9452 x63 04xx5	220 V	Zwitserland
PM6304 of PM6304C	9452 x63 04xx8	240 V	Australië

Op de achterwand van het apparaat zijn de netspanning waarop het apparaat is afgesteld en de hierbij behorende zekering vermeld.

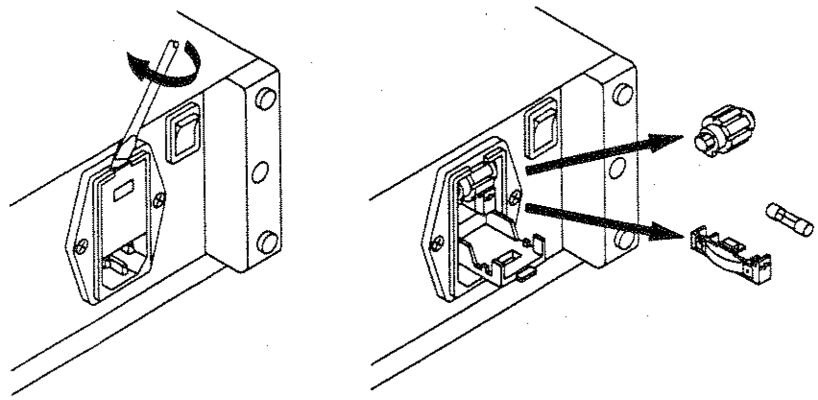
Men dient erop te letten dat men bij het vervangen van een zekering slechts een exemplaar met de gespecificeerde nominale stroomsterkte en van het gespecificeerde type mag gebruiken. Het gebruik van gerepareerde zekeringen en/of het kortsluiten van de zekeringhouder zijn verboden. De zekering mag slechts vervangen worden door een vakman die weet met welke gevaren dit gepaard gaat.

WAARSCHUWING:	Bij het vervangen van een zekering en bij het instellen op een andere netspanning moet het apparaat van alle spanningsbronnen worden losgenomen.

Het apparaat kan op de volgende netspanningen worden ingesteld: 100 volt, 120 volt, 220 volt en 240 volt wisselspanning. Deze nominale spanningen kunnen met de spanningskiezer (die gecombineerd is met de netaansluitbus op de achterwand) worden ingesteld.

De zekering bevindt zich in een houder op dezelfde plaats. Voor het instellen van de netspanning of het vervangen van een zekering moet de voedingskabel losgenomen worden en het afdekplaatje met een schroevedraaier worden verwijderd. (zie tekening).

Men kiest de juiste spanning door het verdraaien van het instelwiel. Indien nodig moet de bijbehorende zekering in plaats van de reeds aanwezige zekering worden aangebracht – T0.2A of T0.4A (IEC127) of T0.25A of T0.5A (CSA/UL198G).



1.2 GEBRUIKSPOSITIE VAN HET APPARAAT

Het apparaat mag in de in hoofdstuk 1, Reference Manual beschreven posities gebruikt worden. Wanneer de stelvoet naar beneden geklapt is, kan het apparaat in een schuingeplaatste positie gebruikt worden. De technische specificatie in hoofdstuk 1, Reference Manual is van toepassing op de gespecificeerde gebruiksposities. Het erop dat de ventilatieopeningen van het apparaat niet afgedekt worden. Het apparaat nooit installeren op een oppervlak dat warmte genereert of uitstraalt, en het evenmin aan rechtstreekse zonnestraling blootstellen.

1.3 RADIO-ONTSTORING

Wat radio-ontstoring betreft is het apparaat zorgvuldig ontstoord en gecontroleerd. Bij het schakelen in combinatie met basisunits die niet correct onstoord zijn en met andere perifere apparatuur, kan radiostoring optreden. In de desbetreffende gevallen maakt dit aanvullende maatregelen op radio-ontstoringsgebied noodzakelijk.

1 INSTALLATIONSANVISNINGAR OCH SÄKERHETSFÖRESKRIFTER

1.1 SÄKERHETSFÖRESKRIFTER

Detta instrument uppfyllde gällande säkerhetsföreskrifter (se kapitel 1, Reference Manual) när det lämnade fabriken. Följ nedanstående säkerhetsföreskrifter så förblir instrumentet säkert under normal drift.

1.1.1 Reparation och underhåll

Är instrumentet är trasigt eller har utsatts för onormal förhållanden?
Om du misstänker att det inte går att använda instrumentet på ett säkert sätt, sluta använda det och förhindra även andra att använda det.
Detta skall göras då:

- det finns synliga skador på instrumentet
- instrumentet inte längre fungerar
- när instrumentet utsatts för förhållanden som går utanför specifikationen, till exempel. vid lagring eller transport.

Öppning av instrumentet
Om du tar av kåpan på instrumentet eller tar bort delar som måste demonteras med verktyg, så blir spänningsförande delar direkt åtkomliga. Drag alltid ur nätsladden och koppla bort alla andra spänningskällor innan du öppnar instrumentet.

När det är nödvändigt att **kalibrera, underhålla eller reparera ett instrument** med spänningen inkopplad, måste detta göras av behörig personal som känner till riskerna med arbetet. Kom ihåg att även om du kopplat ifrån alla spänningskällor så kan kondensatorer i instrumentet behålla sin laddning i några sekunder.

1.1.2 Skyddsjordning

Innan du ansluter några andra kablar till instrumentet, jorda det genom att ansluta den trepoliga nätkabeln till en jordad nätkontakt. Instrumentet får aldrig anslutas till en ojordad kontakt! Bryt inte heller jordningen genom att använda ojordade skarvsladdar. Skyddsjorden får endast anslutas via nätkabeln som är ansluten till nätbrunnens jordstift.

VARNING: Om du bryter skyddsjorden i eller utanför instrumentet blir det farligt att använda. Att avsiktligt bryta skyddsjorden är absolut förbjudet.

1.1.3 Anslutningar

Signaljorden är ansluten till fyra stift i den åttapoliga kontakten. Dessa stift är anslutna till kåpan via parallellkopplade kondensatorer och motstånd. Kontaktdonets ytterhölje är direktanslutet till kåpan. På detta sätt undviks brum och instrumentet får god RF-jordning.

Om mätobjektets signaljord inte är på samma potential som skyddsjorden, måste du se till att det inte finns någon spänning mellan de fyra signaljordsstiften och skyddsjorden, till exempel genom att använda skyddstransformator.

1.1.4 Nätspänningsomkoppling och säkringar

Innan du ansluter nätsladden till vägguttaget måste du kontrollera att instrumentet är inställt för rätt nätspänning.

VARNING: Om kontakt på nätsladden måste bytas, överlåt detta till behörig elektriker.

När instrumentet lämnar fabriken är spänningsomkopplaren inställd enligt följande:

Typnummer	Beställnings-nummer	Nät-spänning	Medievererad nätkabel
PM6304 och PM6304C	9452 x63 04xx1	220 V	Europeisk
PM6304 och PM6304C	9452 x63 04xx3	120 V	Nordamerikansk
PM6304 och PM6304C	9452 x63 04xx4	240 V	Brittisk (U.K.)
PM6304 och PM6304C	9452 x63 04xx5	220 V	Schweizisk
PM6304 och PM6304C	9452 x63 04xx8	240 V	Australiensisk

Du kan se inställd nätspänning och säkringsvärde på bakpanelen.

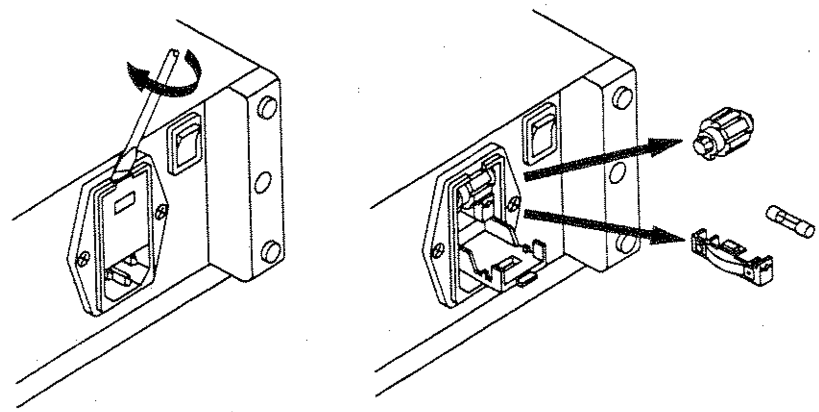
Om säkringen måste bytas, använd endast säkringar av specificerad typ och med rätt strömstyrka. Det är absolut förbjudet att reparera säkringen eller att kortsluta säkringshållaren. Säkringsbyte får endast utföras av kvalificerad personal som är medveten om riskerna.

VARNING: Koppla alltid ur nätsladden och alla andra spänningskällor innan du ändrar nätspänningsomkopplaren eller byter säkring.

Instrumentet kan ställas in för 100 V, 120 V, 220 V och 240 V växelström. Både spänningsomkopplaren och säkringshållaren sitter i nätbrunnen på bakpanelen.

Om du skall ändra spänningsområde eller byta säkring, så drar du ur nätkabeln ur nätbrunnen och öppnar sedan skyddslocket med en skruvmejsel (se bild).

Välj rätt nätspänning genom att ta ut rullen, vända den så att den spänning du vill ha visas utåt och sedan sätta in den igen. Du kan vara tvungen att byta säkring vid val av ny spänning. Drag ut säkringshållaren och byt till rekommenderad säkring – T0.2A resp. T0.4A (IEC127) och T0.25A resp. T0.5A (CSA/UL198G).



1.2 DRIFTSLÄGE

I kapitel 1, Reference Manual, kan du se vilka lägen instrumentet får användas i. Instrumentet kan vinklas upp till en bekväm betraktningsvinkel genom att handtaget fälls ned. Specifikationspunkterna i kapitel 1, Reference Manual, garanteras i alla godkända driftslägen. Se till att ventilations hållen inte är bockerade. Ställ aldrig instrumentet på en yta som avger värme, inte heller i direkt solljus.

1.3 RADIOAVSTÖRNING

Radiostörningar som genereras av instrumentet är noggrant dämpade och avstörningen är noggrant kontrollerad. Om instrumentet kopplas samman med dåligt avstörda basenheter eller andra enheter, kan det genereras radiostörningar som behöver yttre avstörning.

FIGURES