FLUKE®

PM5139

Function Generator 0.1 mHz - 20 MHz

Users Manual

Gebrauchsanleitung

Mode d'emploi

4822 872 10203
March 1997, Rev. 2, 2/99

CONTENTS

Users Manual

Limited Warranty & Limitation of Liability

Each Fluke product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is one year and begins on the date of shipment. Parts, product repairs and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer of a Fluke authorized reseller, and does not apply to fuses, disposable batteries or to any product which, in Fluke's opinion, has been misused, altered, neglected or damaged by accident or abnormal conditions of operation or handling. Fluke warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Fluke does not warrant that software will be error free or operate without interruption.

Fluke authorized resellers shall extend this warranty on new and unused products to end-user customers only but have no authority to extend a greater or different warranty on behalf of Fluke. Warranty support is available if product is purchased through a Fluke authorized sales outlet or Buyer has paid the applicable international price. Fluke reserves the right to invoice Buyer for importation costs of repair/replacement parts when product purchased in one country is submitted for repair in another country.

Fluke's warranty obligation is limited, at Fluke's opinion, to refund of the purchase price, free of charge repair, or replacement of a defective product which is returned to an Fluke authorized service center within the warranty period.

To obtain warranty service, contact your nearest Fluke authorized service center or send the product, with a description of the difficulty, postage and insurance prepaid (FOB Destination), to the nearest Fluke authorized service center. Fluke assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Fluke determines that the failure was caused by misuse, alteration, accident or abnormal condition of operation or handling, Fluke will provide an estimate of repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges (FOB Shipping Point).

This warranty is buyer's sole and exclusive remedy and is in lieu of all other warranties, express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose. Fluke shall not be liable for any special, indirect, incidental or consequential damages or losses, including loss of data, whether arising from breach of warranty or based on contract, tort, reliance or any other theory.

Since some countries or states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this Warranty is held invalid or unenforceable by a court of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

Fluke Corporation
P.O. Box 9090
Everett, WA
98206-9090
USA

Fluke Europe B.V.
P.O. Box 1186
5602 B.D. Eindhoven
The Netherlands

FLUKE®

DECLARATION OF CONFORMITY

for

FLUKE
Function Generator 20 MHz
PM 5139

Manufacturer
Fluke Industrial B.V.
Lelyweg 1
7602 EA Almelo
The Netherlands

Statement of Conformity
Based on test results using appropriate standards, the product is in conformity with
Electromagnetic Compatibility Directive 89/336/EEC
Low Voltage Directive 73/23/EEC

Sample tests
Standards used:

EN 50081-1 (1992)
Electromagnetic Compatibility Generic Emission Standard:
EN 55011 Group I Class B

EN 50082-1 (1992)
Electromagnetic Compatibility; Generic Immunity Standard:
EN 61000-4-2, -3 and -4

EN 61010 – (1994) CAT II Pollution Degree 2
Safety Requirements for Electronic Equipment for Measurement,
Control, and Laboratory Use.

The tests have been performed in a typical configuration.

This Conformity is indicated by the symbol CE, i.e. “Conformité européenne”.

CONTENTS

SHIPMENT NOTE

The following parts should be included in the shipment:

1 PM5139 function generator 0.1 mHz – 20 MHz

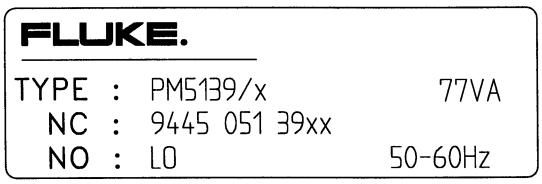
1 Users Manual 4822 872 10203

1 Power Cable

2 Fuses

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

Type plate



Type number
Code number
Serial number

Code number
9445 051 390xx

Power cable (see Section 1.1.4)

Options built-in:

0 No interface
2 IEEE-488 interface
3 RS-232 interface

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 Service organization to facilitate the repair or replacement of the instrument. Fluke addresses are listed in the back of this manual.

1 INSTALLATION AND SAFETY INSTRUCTIONS

1.1 SAFETY INSTRUCTIONS

Upon delivery from the factory the instrument complies with the required safety regulations, see Chapter 4. To maintain this condition and to ensure safe operation, carefully follow the instructions below.

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 considered to be unsafe when any of the following conditions exist:
- It shows physical damage.
- No longer functions.
- Has been 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.

1.1.2 Grounding

Before any other connection is made the instrument must be connected to a protective ground conductor via the three-wire power plug.
The power plug shall be inserted only into a grounded connector outlet with a protective ground contact.
Do not defeat the protective action by using an extension cord without a grounded conductor.
The external contacts of the BNC sockets must not be used to connect a protective conductor.

WARNING

Any interruption of the protective conductor inside or outside the instrument, or disconnection of the protective ground terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.

1.1.3 Connections

The circuit ground potential is applied to the external contacts of the BNC sockets and is connected to the cabinet by means of parallel-connected resistors and capacitors. This method ensures that ground loops are avoided and a clear RF grounding is obtained.

If the circuit ground potential in a measurement setup is different from the protective ground potential, it must be noticed,

- that the BNC sockets can be touched and that it must not be live (see the safety regulations on the subject).
- that all sockets marked with the sign ⊥ are internally interconnected.

1.1.4 Line Voltage Setting and Fuses

Before plugging in the line cord, make sure that the instrument is set to the correct line voltage.

WARNING

Changing fuses and modifying power cables to local power must be done by qualified service personnel who are aware of the hazards involved.

On delivery from the factory the instrument is set to one of the following line voltages.

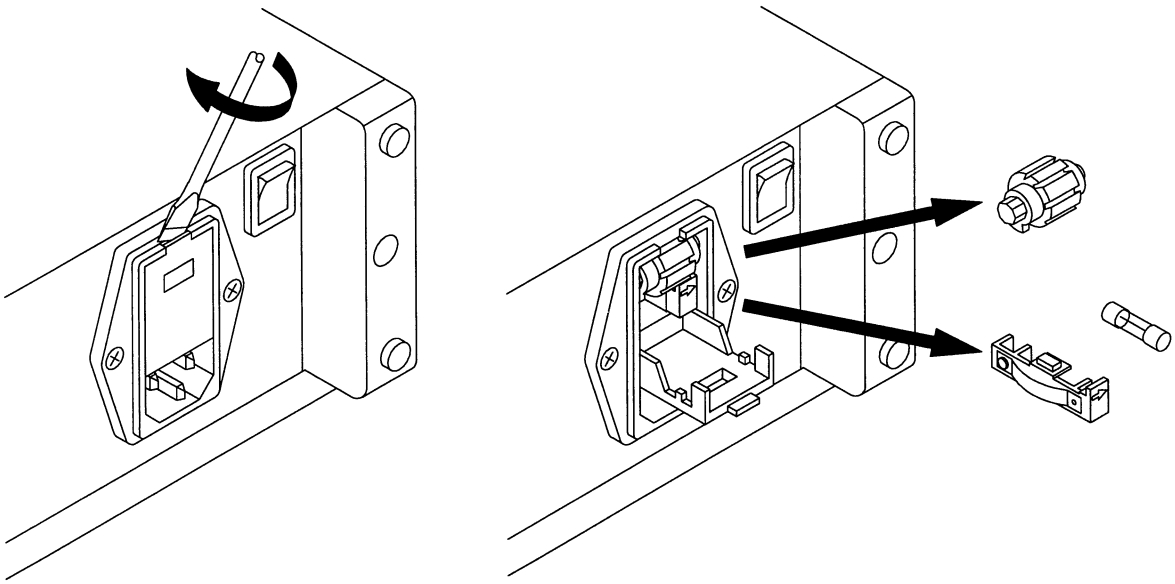
Instrument Version	Instrument Code No.	Line Voltage Setting	Delivered Power Cord
PM5139/0x1	9445 051 390x1	220 V	Universal Europe
PM5139/0x3	9445 051 390x3	120 V	North America
PM5139/0x4	9445 051 390x4	240 V	England (U.K.)
PM5139/0x5	9445 051 390x5	220 V	Switzerland
PM5139/0x8	9445 051 390x8	240 V	Australia

The voltage setting and the corresponding fuse are indicated on the rear panel.

Make sure that replacement fuses are of the specified type and current rating. The use of repaired fuses, and/or the short circuiting of the fuse holders are prohibited.

The instrument can be set to the following line voltages: 100 V, 120 V, 220 V and 240 V ac. These nominal voltages are selected by means of the voltage selector, located on the rear panel, next to the line voltage connector. The fuse is located in a holder at the same place. To select line voltage or replace the fuse, remove the power cord and pry open the compartment with a small screwdriver (see illustration).

Turn the selector to select the appropriate voltage range. If necessary, insert the specified fuse (T0.4A or T0.8A according to IEC127 or T0.5A or T1.0A 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 used in the position indicated in Chapter 4. With the handle folded down, the instrument may be used in a sloping position. The characteristics mentioned in Chapter 4 are guaranteed for the specified positions. Ensure that the ventilation holes in the cover 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 interference occurs in connection with other deficient suppressed instruments, further suppression activities may be required.

2 MAIN CAPABILITIES

2.1 INTRODUCTION

The PM5139 function generator introduces a new concept of menu-driven operation to waveform generation and frequency synthesis.
Microprocessor control enables simple and rapid operation and allows you to set parameters by stepping through the menu offered. One single control rotary knob allows you to make precise settings of all numeric values.

The large backlit LCD clearly displays the selected signal and gives a readout of vital parameters, such as frequency, waveform, amplitude, and modulation. Any invalid parameter selections are ignored and an error message shows the incorrect settings that have been made.

The PM5139 frequency range covers 11½ decades, from 0.1 mHz to 20 MHz. Ten waveforms are selectable, including standard functions, such as sine, triangle, square, as well as positive and negative sawtooth, different pulses, and haversine.

Seven modulation modes are available:

- Amplitude modulation (AM)
- Frequency modulation (FM)
- Phase Shift Keying (PSK)
- GATE
- Linear SWEEP
- Logarithmic SWEEP
- BURST

The 10-key section on the right of the front panel permits a versatile activation and control of such functions as single or continuous sweep or burst, sweep hold, and switching from internal to external modulation or trigger source; further asymmetrical waveforms with variable duty cycle, key for instant return to symmetrical waveform, store and recall keys for up to nine complete instrument settings, a DIAL LOCK key to disable the rotary control, and a key for switching the signal output impedance.

AC or DC amplitudes can be precisely set using the numeric setting rotary knob. DC offset is set independently of the AC output amplitude. The output signals phase noise and residual FM are very low, ensuring a clean and stable signal.

The instrument is optionally available under type number PM5139/02 with a built-in GPIB (IEEE bus) interface and under number PM5139/03 with built-in RS-232 interface. All instrument functions can be remotely activated from a PC or test system controller. It is also possible to upload settings and status data from the instrument for storage in the controller and later recall at any time. The facility IEEE bus makes PM5139 an integral part of an automated test system.

The PM5139 with interface also offers a user-definable "arbitrary" waveform ARB: the desired waveform may be programmed on the PC, and than downloaded to the generator via interface. Twenty-four arbitrary waveforms can be stored separately.

A test program is built in to provide customer support and to facilitate servicing.

The PM5139 is very much suited for applications in research and development, production monitoring, quality assurance, and for service purposes.

3 OPERATING INSTRUCTIONS

3.1 GENERAL INFORMATION

This chapter outlines the procedures and precautions necessary for operation. It identifies and briefly describes the functions of the front and rear panel controls and the display, and explains the practical aspects of operation to enable an operator to quickly evaluate the instrument's main functions.

3.2 TURNING THE INSTRUMENT ON

After the instrument is connected to the line voltage as described in Section 2.2.4, press POWER on the rear panel to ON.

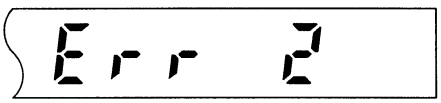
With normal installation in accordance with Section 2.3 and after a warm-up time of 30 minutes, the characteristics specified in Chapter 4 are valid.

After turning the power off, allow 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 routine that tests the PROMs, RAMs, and EEPROMs. After this the software version is indicated in the upper line of the display for about 1 second. All segments of the display field are shown for about 2 seconds, and the instrument is set to the operating mode to which it was set before POWER OFF.
The output signal with the corresponding parameters is now at the OUTPUT socket.

A possible fault is indicated as follows:

e.g. 

The digits mean:

1 program memory checksum
2 RAM processor
3 memory of actual settings
4 memory registers 1 to 9
5 reverse power protection at signal output
6 no frequency generation

For detailed information, see Section 3.5.9.

3.4 BRIEF CHECKING PROCEDURE

3.4.1 General Information

This procedure is intended to check the instrument's functions with a minimum of test steps and actions. It is assumed that the operator doing this test is familiar with the instrument and its characteristics.
If this test is started within a short period after switching on, test steps may be out of specification, due to insufficient warm-up time.

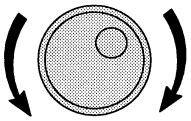
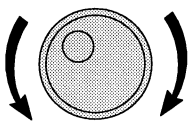
WARNING

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

3.4.2 Functional Test

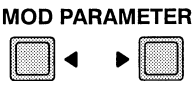
Immediately after power-on a self-test routine is performed (see Section 3.3). After that the instrument automatically recalls operating settings prior to the last power off.
If you prefer different operating settings, set new parameters now.

Example:

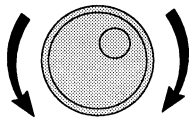
	input sequence
Prepare frequency setting.	
Coarse setting about 20 kHz.	
Fine setting to 20 kHz; if **DIAL LOCKED** lights up, push **DIAL LOCK** key.	
Select waveform (until e.g. ∿ symbol flashes); if **VAR SYMMETRY** lights up, push 50 % key.	
Select output amplitude.	
Set amplitude to 1 V.	

input sequence

Select modulation frequency (until **fMOD** symbol flashes).

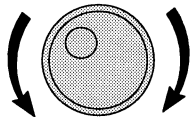


Set modulation frequency to e.g. 1 kHz.

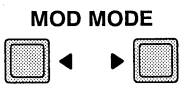


Select modulation depth (until **m** symbol flashes).

Set modulation depth to 50 %.



Select modulation mode (until **AM** symbol flashes).



Connect oscilloscope to socket OUTPUT (Zo 50 Ω) and check the signal. If it is correct the test is finished. If not, repeat the procedure with other settings. For input examples, see Section 3.5.

3.5 OPERATION

3.5.1 Design of Display Field and Keyboard (see section figures, Figure 1)

The display field consists of six horizontal sections for the following displays:

- frequency, max. 4½ digits
- start frequency for sweep
- unit **MHz**, **kHz**, **Hz**
- **REMOTE** for identification of remote operation
- **DIAL LOCKED** points to inhibited rotary knob

- waveform symbols
  (⎓ ∿ ∿ ⊓ ⊓ ⊓ ◿ ◺ ∧ ∧ ∧ **ARB** ★) ★ instruments with interface only

- output amplitude, peak value (**ACPP**) in **V**olt, max. 2½ digits
- DC offset voltage (**DC OFFSET**) in **V**olt, max. 2½ digits
- output impedance (**LOW Zo**)

- modulation parameter:
  - modulation frequency (**fMOD**), 2½ digits in **Hz** or **kHz**
  - modulation depth (**m**), 2½ digits in **%**
  - frequency deviation (**DEV**), 2½ digits in **%**, related to carrier
  - sweep stop frequency (**fSTOP**), 3½ digits in **MHz**, **kHz**, **Hz**
  - sweep time (**T**), 3½ digits in **s**econds
  - sweep modes, **–1–**, **–2–**, **–3–**
  - ON periods (**N**) for burst mode, 3½ digits
  - start-stop phase (φ) for burst mode, 2½ digits in degrees (**DEG**)
- duty cycle (**SYMMETRY**), 2 digits in **%**
- storage register number (**REG**), 1 ... 9
- device address for IEEE-488 (**ADDR**) or interface configuration for RS-232

- modulation mode (**MOD-OFF**, **AM**, **FM**, **PSK**, **GATE**, **LIN-SWP-LOG**, **BURST**)

- trigger state (**INT**, **EXT-TRIG**, **CONT**, **SGLE**, **NOT TRIG'D**)
- sweep and burst control (**CONT**, **SGLE**), signal interruption (**HOLD**)
- duty cycle not 50 % (**VAR SYMMETRY**)
- DC offset voltage (**VAR DC OFFSET**)

The symbol "▶" in front of the upper five sections shows that this section is ready for input or selection of data respectively parameters.

The keyboard is divided into four sections:

- keys for operation via interface (**LOCAL**, **ADDR**)
- special key for processor reset (**RESET**)

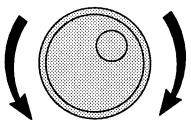
- selection for frequency input (**FREQUENCY**)
- selection of signal waveform (**WAVEFORM**)
- preparation for input of DC offset and output amplitude(**DC** and **AC**)
- selection for input of modulation parameter (**MOD PARAMETER**)
- selection of modulation mode (**MOD MODE**)

- keys to change numerical values in decade steps and for subrange selection (**÷10** **RANGE** **x10**)
- rotary knob to set values for:
  - frequency
  - DC offset voltage
  - output amplitude
  - modulation parameter
  - duty cycle
  - storage register number
  - device address for remote control (IEEE-488)
  - communication parameters (RS-232)

- keys to control sweep and burst (**SINGLE**, **CONT**, **HOLD**)
- key to select modulation or trigger signal source (**EXT**)
- keys to select duty cycle (**ASYM**, **50%**)
- keys for storage registers (**STORE**, **RECALL**)
- key to inhibit and release the rotary knob (**DIAL LOCK**)
- key to select the output impedance (**LOW Zo**)

3.5.2 Control Elements, Display and Connectors

3.5.2.1 Front Panel

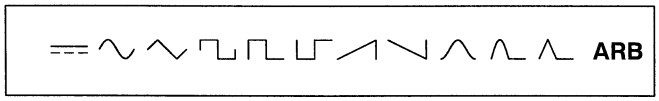
Description	Function
LOCAL 	Key to switch from remote control to keyboard operation.
ADDR 	Display and input of device address for remote control.
RESET 	Processor reset to initial state (use e.g. ball point pen).
FREQUENCY 	Keys to select frequency section and to select that digit which is to be altered by the rotary knob (resolution).
WAVEFORM 	Keys to select the signal waveform.
DC **AC** 	Key to prepare input of DC offset voltage respectively AC output amplitude. Pressing the same key twice sets the value to zero.
MOD PARAMETER 	Keys to select modulation parameter.
MOD MODE 	Keys to select modululation mode.
÷10 **x10** 	Keys for altering numerical values in decades, e.g., for frequency or output amplitude.
	Rotary knob for setting and alteration of values for: – frequency – output amplitude – DC offset voltage – modulation parameter – stop frequency for sweep – duty cycle – storage register number – device address (IEEE-488), interface configuration (RS-232)

Description	Function
SINGLE **CONT**	Keys to start a sweep or burst, pressing the same key once more resets the sweep respectively burst.
HOLD	Key to stop a sweep at the present frequency. In MOD-OFF the key also serves – to stop and to release the output amplitude at its present value in the frequency range from 0.1 mHz to 1 Hz – to set the output amplitude to zero and back again in the frequency range from 1 Hz to 20 kHz.
EXT	Key to switch to external modulation or trigger source, pressing the key once more switches back to internal signal.
ASYM **50%**	Key for selection of duty cycle.
STORE **RECALL**	Keys to store and to recall complete instrument settings (9 storage registers).
DIAL LOCK	Key to inhibit and to release the rotary knob.
LOW Zo	Key to select the output impedance (50 Ω or LOW Zo for amplitudes ≥ 2.0 V).

Display Section

"▶" points to the selected display section

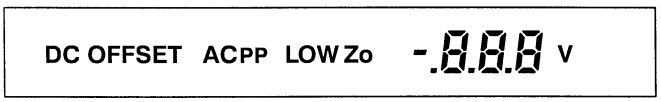
– **fSTART**: carrier frequency (also sweep start frequency) in MHz, kHz or Hz
– **DIAL LOCKED**: rotary knob inhibited
– **REMOTE**: remote control via interface



– signal waveforms
  ⎓ DC voltage
  ∿ sine
  ⩘ triangle
  ⊓ square
  ⊓ positive pulse
  ⊔ negative pulse
  ◿ positive sawtooth
  ◺ negative sawtooth
  ∩ haversine
  ∩ sine pulse
  ∧ triangle pulse
  ARB freely programmable (instruments with IEEE-488 or RS-232 only)

Description

Function



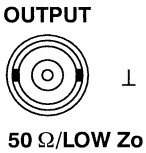
- **DC OFFSET** : DC offset voltage in volts
- **ACPP** : output amplitude in volts
- **LOW Zo** : output impedance

- Modulation parameter:
  - **fMOD** : modulation frequency in Hz or kHz
  - **m** : modulation depth AM in %
  - **DEV** : frequency deviation FM in %
  - **fSTOP** : stop frequency for sweep
  - **T** : sweep time in seconds sweep mode -1-, -2-, -3-
  - **N** : carrier periods per burst
  - φ : start and stop phase for burst
- **SYMMETRY** : duty cycle 50 %
- **REG** : storage register
- **ADDR** : device address

- Modulation modes:
  - **MOD-OFF** : modulation switched off
  - **AM** : amplitude modulation
  - **FM** : frequency modulation
  - **PSK** : phase shift keying
  - **GATE** : gating
  - **LIN-SWP** : linear sweep
  - **SWP-LOG** : logarithmic sweep
  - **BURST** : burst
  - **INT** : internal modulation
  - **EXT-TRIG** : external modulation or trigger signal source
  - **CONT** : continuous sweep or burst
  - **SGLE** : single sweep or burst
- **NOT TRIG'D** : trigger status
- **HOLD** : HOLD key pressed

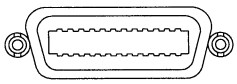
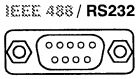
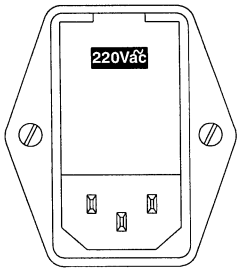
- **VAR SYMMETRY** : duty cycle not 50 %
- **VAR DC OFFSET** : DC voltage added to output signal

Connectors:



Signal output:
short-circuit proof, max. external voltage:
±15 V up to 3 min, Zo 50 Ω
±12 V up to 3 min, LOW Zo

3.5.2.2 Rear Panel

Description	Function
INPUTS **REFERENCE**  ⊥	External reference frequency input.
MOD/TRIG  ⊥	External modulation or trigger signal input.
IEEE 488 / RS232  or  **IEEE 488 / RS232**	IEEE-488 or RS-232 connector for remote control.
 220Vac	Mains input socket with fuse and voltage selector.
POWER OFF ○  ON —	Power switch
OUTPUTS **10MHz**  ⊥	10 MHz internal reference frequency output for synchronization purposes
MOD  ⊥	Internal modulation or keying signal output.
PEN LIFT  ⊥	Signal output, e.g. to control a plotter pen during sweep.
SWEEP  ⊥	Sweep voltage output (0 – 10 V, proportional to sweep frequency).
TTL  ⊥	TTL signal output (frequency as output signal).

3.5.3 Keyboard Input

The instrument can be controlled via the keyboard or via remote control. When you are working via the remote control, the keyboard is inhibited and REMOTE lights up on the display.

Operational errors will not cause damage to the instrument. Set values are carried out immediately. The instrument does not have an ENTER key. The signal output is short-circuit proof and is protected for up to 3 minutes against external voltages up to ±15 V. Any illegal input values or combinations are shown by the illegal parameters flashing on the display. The instrument automatically returns to the last valid setting.

Data can be input in any order. Values that have been input earlier and don't need to be changed do not need to be input again.

3.5.3.1 Input Formats

Frequency

Frequency Subranges	Maximum Resolution	Display
0.1 mHz ... 0.2 Hz	0.1 mHz	0 . X X X X Hz
1 mHz ... 2 Hz	1 mHz	★ . X X X Hz
10 mHz ... 20 Hz	10 mHz	★ X . X X Hz
100 mHz ... 200 Hz	100 mHz	★ X X . X Hz
1 Hz ... 2 kHz	1 Hz	★ . X X X kHz
10 Hz ... 200 kHz	10 Hz	★ X X . X X kHz
100 Hz ... 2 MHz	100 Hz	★ . X X X X MHz
1 kHz ... 20 MHz	1 kHz	(#) X . X X X MHz

Output Amplitude (Zo 50 Ω, open circuit)

Subranges	Resolution	Display
0 V ... 0.2 V	1 mV	. ★ X X V
0.2 V ... 2 V	10 mV	★ . X X V
2 V ... 20 V	100 mV	★ X . X V

DC offset voltage (Zo 50 Ω, open circuit)

Range	Resolution	Display
− 10.0 V ... + 10.0 V	0.1 V	(−)(1) X . X V

"★" = digits 0, 1, 2
"X" = digits 0 to 9
"#" = digits 1 or 2

The ranges of the modulation parameters are listed together with the examples of the modulation modes.

3.5.4 Frequency Setting

WAVEFORM	Symbol	Frequency Range	Amplitude Range (Zo 50 Ω, open circuit) max. resol. 1 mV
sine	∿	0.1 mHz – 20 MHz	0 – 20 V
triangle	⩘	0.1 mHz – 500 kHz	0 – 20 V
square	⊓	0.1 mHz – 20 MHz	0 – 20 V
pos. pulse 1)	⊓	0.1 mHz – 20 MHz	0 – 10 V
neg. pulse 1)	⊔	0.1 mHz – 20 MHz	0 – 10 V
pos. sawtooth	◿	0.1 mHz – 50 kHz	0 – 10 V
neg. sawtooth	◺	0.1 mHz – 50 kHz	0 – 10 V
haversine	∩	0.1 mHz – 50 kHz	0 – 10 V
sine pulse	∩	0.1 mHz – 50 kHz	0 – 10 V
triangle pulse	∧	0.1 mHz – 50 kHz	0 – 10 V
arbitrary 2)	**ARB**	0.1 mHz – 20 kHz	0 – 20 V
MODULATION			
amplitude modulation	**AM**	0.1 mHz – 20 MHz	0 – 20 V 3)
frequency modulation	**FM**	0.1 mHz – 20 MHz	0 – 20 V
phase shift keying	**PSK**	0.1 mHz – 20 MHz	0 – 20 V
gate	**GATE**	0.1 mHz – 20 MHz	0 – 20 V
sweep	**SWP**	1 mHz – 10 MHz 50 kHz – 20 MHz	0 – 20 V
burst 4)	**BURST**	0.1 mHz – 2 MHz	0 – 20 V

1) 10 MHz for LOW Zo
2) instruments with IEEE-488 or RS-232 only
3) carrier amplitude reduced by 6 dB
4) the lower frequency in continuous burst mode depends on ON-periods and repetition frequency

The frequency can be input when the symbol "▶" appears at the front of the frequency display section. If it is at the front of another field, press one of the FREQUENCY ◀ ▶ keys.

Example:

Key Operation	Display Shows
FREQUENCY ◀ ▶	▶ 1.63 15 MHz

When the " 3 " flashes, the rotary knob can be used to change the frequency at a resolution of 0.01 MHz within this frequency subrange.
If a different resolution is required, press one of the FREQUENCY ◀ ▶ keys until the digit in the required decimal place flashes,

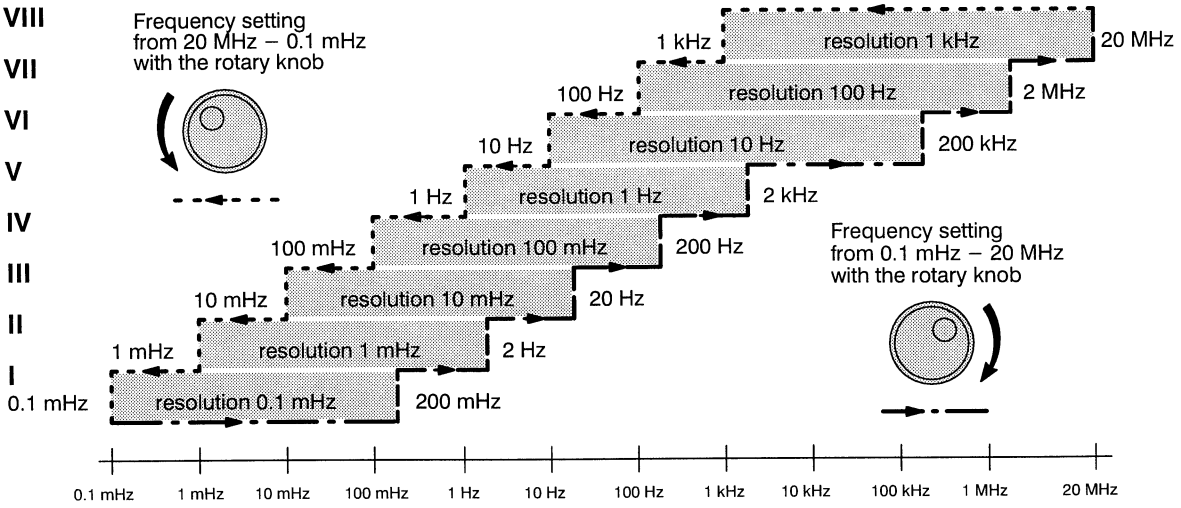
for example resolution 100 Hz (max. resolution in this range)

Key Operation	Display Shows
FREQUENCY ▶ 3 times	▶ 1.63 15 MHz

The subrange in which the instrument is operating is shown by the digits behind the decimal point in conjunction with the unit of measure. In this example it is the range 100 Hz to 2 MHz. See the Frequency Table under Section 3.5.3.1.

Frequency range 0.1 mHz – 20 MHz

Subranges:



If in a subrange the maximum resolution is chosen, e.g., 0.1 mHz (rightmost digit) in subrange I, the instrument automatically selects the maximum resolution of the next range when passing the limits to the next range.

Press the RANGE keys ÷10 x10 to divide or multiply the frequency by the factor 10. Use the rotary knob for fine frequency settings.

Example: 125.5 Hz

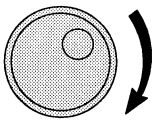
Key Operation		Display Shows
	e.g.	2.0000 MHz
÷10	4 times	200.0 Hz
FREQUENCY ◄ ►	press until the rightmost "0" flashes (max. resolution)	200.0 Hz
	fast	118.2 Hz
	slow	125.1 Hz
	stepwise	125.5 Hz

The key DIAL LOCK prevents the set value from being incidentally altered if the rotary knob is touched. The text DIAL LOCKED will appear in the display.
Pressing the key DIAL LOCK once more will release the knob again.

3.5.5 Setting Output Amplitude

Pressing the key AC will set the symbol "▶" in the third section of the display, and the present value will appear. The rotary knob can now be used to set another value.
The coarse setting is done as for the frequency setting using the keys ÷10 x10.

Example: Output amplitude 8.5 V

Key Operation	Display Shows
AC 	▶ ACPP 0.53 V
x10  (if required)	▶ ACPP 5.3 V
	▶ ACPP 8.5 V

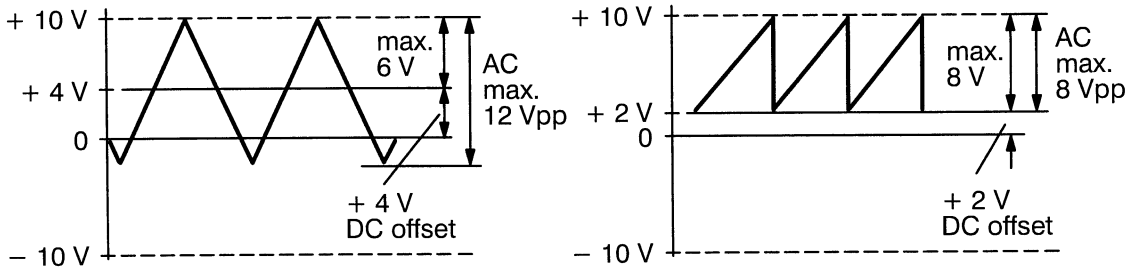
Operating the AC key several times sets the value to zero and back again to the value set; this corresponds with the function "AC OFF".

3.5.5.1 Input of the DC Offset Voltage

A DC voltage of −10 V to +10 V (Zo 50 Ω, open circuit) can be added to the AC signal.

The text VAR DC OFFSET appears in the display.

Please note that the total output voltage (AC and DC) cannot exceed ± 10 V.



If the permissible setting range is exceeded, "DC OFFSET" and "ACPP" will flash in the display. The instrument will automatically return to the last permissible setting.

The offset is input with the key DC in the same way as the output amplitude has been input (Section 3.5.5).

Pressing the DC key again sets the previously selected offset value to zero.

Example:

Key Operation	Display Shows
DC	▶ DC OFFSET 2.2 V VAR DC OFFSET
	▶ DC OFFSET - 3.2 V VAR DC OFFSET
DC	▶ DC OFFSET 0 V
DC	▶ DC OFFSET - 3.2 V VAR DC OFFSET

3.5.6 Selection of the Signal Waveform

Press WAVEFORM ◀ ▶ keys to set the symbol "▶" to the second section of the display; the symbols of the selectable waveforms appear, the waveform that is currently set flashes.
Continue to press the WAVEFORM ◀ ▶ key to select the required waveform. During selection the flashing waveform is available at the signal output.
The waveform flashes 10 times, then the display only shows the symbol of the selected waveform.

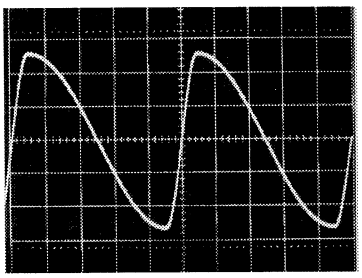
Note the frequency and amplitude limits of the waveforms in the tables in Section 3.5.3.1. Unallowed combinations are shown by flashing of the respective settings. The instrument then automatically returns to the last permissible selected waveform.

Example: Selection of positive pulses

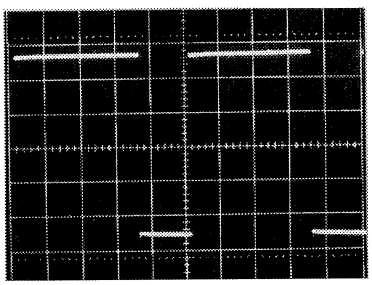
Key Operation	Display Shows
WAVEFORM ◀ ▶	▶ ARB
WAVEFORM ▶ 3 times	▶ ARB
after 10 flashes	

After pressing the ASYM key, the asymmetry (duty cycle) of all waveforms shown below can be set by the rotary knob.

sine triangle square square pulse	1 % to 99 % 1 % to 99 % 1 % to 99 % 1 % to 99 %	up to 20 kHz up to 20 kHz up to 20 kHz up to 20 kHz
additionally: square square pulse	 20 % to 80 % 20 % to 80 %	 20 kHz to 5 MHz 20 kHz to 5 MHz



sine, 10 kHz, 20 %



square, 1 MHz, 70 %

Reset to symmetrical waveform is done by the key 50 %.

3.5.7 Modulation Modes

The frequency and amplitude range limits of the modulated signal also apply to all modulation modes, except sweep and burst (see Section 3.5.4).

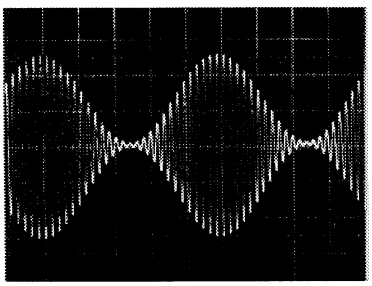
The operation is similar to that for the waveform selection.

Press the MOD MODE ◀ ▶ key to move the symbol "▶ " to the fifth section of the display. The abbreviations of the selectable modulation modes appear. The present one set or MOD-OFF flashes.

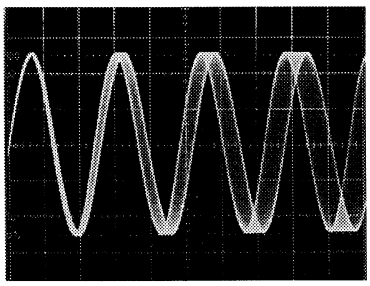
Continue to press the MOD MODE ◀ ▶ key to set the required mode; during selection the flashing mode is available at the signal output.
The symbol flashes 10 times, then the display shows the selected modulation mode.

The MOD PARAMETER ◀ ▶ keys are used to set the modulation parameters shown in the section above, which can be set to the required value by turning the rotary knob.

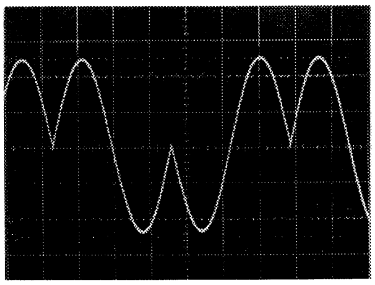
Modulation frequency range:	10 Hz	–	100 kHz	for AM, FM, PSK, GATE, BURST	
Subranges:	100 kHz	–	1 kHz,	resolution	100 Hz
	1 kHz	–	100 Hz,	resolution	10 Hz
	100 Hz	–	10 Hz,	resolution	1 Hz
Additional for BURST:	10 Hz	–	1 Hz,	resolution	0.1 Hz
	1 Hz	–	0.1 Hz,	resolution	0.01 Hz
	0.1 Hz	–	0.001 Hz,	resolution	0.001 Hz



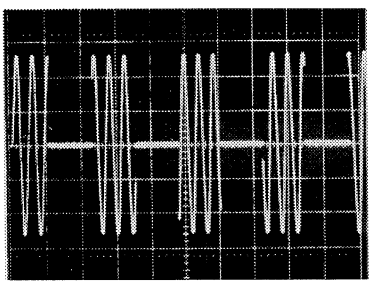
AM



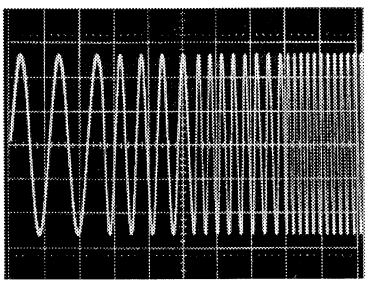
FM



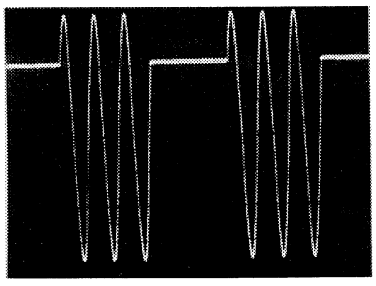
PSK



GATE



LIN SWEEP



BURST

3.5.7.1 Amplitude Modulation (AM)

internal:	modulation frequency	10 Hz – 100 kHz
	modulation depth (m)	0 – 100 %, resolution 1 %
external:	modulation frequency	0 – 200 kHz
	modulation depth	0 – 100 %
		(≙ external voltage 0 – 1 V)

Example: Amplitude modulation, internal, modulation frequency 2 kHz, mod. depth 30 %.
For frequency, waveform, and output amplitude settings, see Sections 3.5.4 to 3.5.6.

Key Operation	Display Shows
e.g.	MOD–OFF
MOD MODE	▶ MOD–OFF AM FM PSK GATE LIN–SWP–LOG BURST
MOD MODE	▶ MOD–OFF AM FM PSK GATE LIN–SWP–LOG BURST INT
MOD PARAMETER	▶ f MOD m DEV fSTOP T N φ 1.0 kHz
	▶ f MOD 2.0 kHz
MOD PARAMETER	▶ f MOD m DEV fSTOP T N φ 85 %
	▶ m 30 %

Turn off the modulation mode:

MOD MODE	▶ MOD–OFF AM FM PSK GATE LIN–SWP–LOG BURST INT
MOD MODE	▶ MOD–OFF AM FM PSK GATE LIN–SWP–LOG BURST
	MOD–OFF

To modulate the carrier by an external modulation signal, select AM, press the EXT key, and feed a signal via the MOD/TRIG socket on the rear panel.

Press the EXT key once more to switch the instrument back to the internal modulation signal source.

3.5.7.2 Frequency Modulation (FM)

Internal:	modulation frequency	10 Hz – 100 kHz
	frequency deviation (DEV)	0 – 2 %, resolution 0.01 %
External:	modulation frequency	10 Hz – 200 kHz
	frequency deviation	0 – 2 %
		(≙ external voltage 0 – 1 V)

Example: Frequency modulation, modulation frequency 150 Hz, internal, deviation 1.5 %.
For frequency, waveform, and output amplitude settings, see Sections 3.5.4 to 3.5.6.

Key Operation	Display Shows
e.g.	MOD–OFF
MOD MODE	▶ MOD–OFF AM FM PSK GATE LIN–SWP–LOG BURST
MOD MODE ▶ 2 times	▶ MOD–OFF AM FM PSK GATE LIN–SWP–LOG BURST INT
MOD PARAMETER	▶ f MOD m DEV fSTOP T N φ 2.0 kHz
	▶ f MOD 0.15 kHz
MOD PARAMETER ▶ 2 times	▶ f MOD m DEV fSTOP T N φ 2.00 %
	▶ DEV 1.50 %
Turn off the modulation mode:	
MOD MODE	▶ MOD–OFF AM FM PSK GATE LIN–SWP–LOG BURST INT
MOD MODE ◀ 2 times	▶ MOD–OFF AM FM PSK GATE LIN–SWP–LOG BURST
	MOD–OFF

To modulate the carrier by an external modulation signal, select FM, press the EXT key, and feed a signal via the MOD/TRIG socket on the rear panel.

Press the EXT key once more to switch the instrument back to the internal modulation signal source.

3.5.7.3 Phase Shift Keying (PSK)

Signal waveforms:		sine, triangle, square
Internal:	Keying frequency (fMOD)	10 Hz – 100 kHz
	duty cycle	50 %, fixed
External:	Keying frequency	0 – 200 kHz
	duty cycle	depends on external signal

Example: Carrier frequency 32 kHz, sine, with phase shift keying, keying frequency 1 kHz.
For frequency, waveform, and output amplitude settings, see Sections 3.5.4 to 3.5.6.

Key Operation	Display Shows
e.g.	▶ FM INT
MOD MODE	▶ MOD–OFF AM FM PSK GATE LIN–SWP–LOG BURST INT
MOD MODE	▶ MOD–OFF AM FM PSK GATE LIN–SWP–LOG BURST INT
MOD PARAMETER	▶ f MOD m DEV f STOP T N φ 0.15 kHz
	▶ f MOD 1.00 kHz
Turn off the modulation mode: MOD MODE	▶ MOD–OFF AM FM PSK GATE LIN–SWP–LOG BURST
Press and release until MOD-OFF flashes	MOD–OFF

For external signal keying select PSK, press the EXT key, and feed a TTL signal via the MOD/TRIG socket on the rear panel.

Press the EXT key once more to switch the instrument back to the internal keying signal source.

3.5.7.4 Modulation Mode GATE

Internal:	Keying frequency (fMOD)	10 Hz – 100 kHz
	duty cycle	50 %, fixed
External:	Keying frequency	0 – 200 kHz
	duty cycle	depends on external signal

Example: Carrier frequency 30 kHz, sine, with on/off keying, keying frequency 10 kHz.
For frequency, waveform, and output amplitude settings, see Sections 3.5.4 to 3.5.6.

Key Operation	Display Shows
e.g.	▶ PSK INT
MOD MODE ◀ ▶	▶ MOD–OFF AM FM PSK GATE LIN– SWP–LOG BURST INT
MOD MODE ▶	▶ MOD–OFF AM FM PSK GATE LIN– SWP–LOG BURST INT
MOD PARAMETER ◀ ▶	▶ f MOD m DEV f STOP T N φ 1.00 kHz
	▶ f MOD 10.0 kHz

Turn off the modulation mode:

MOD MODE ◀	▶ MOD–OFF AM FM PSK GATE LIN– SWP–LOG BURST
Press and release until MOD-OFF flashes	
	MOD–OFF

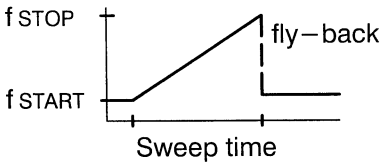
For external signal keying select GATE, press the EXT key, and feed a TTL signal via the MOD/TRIG socket on the rear panel.

Press the EXT key once more to switch the instrument back to the internal keying signal source.

3.5.7.5 Modulation Mode SWEEP

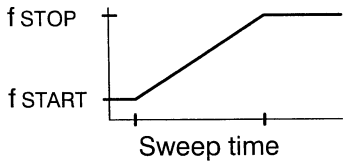
Max. sweep ranges: (fSTART to fSTOP)	1 mHz – 10 MHz 50 kHz – 20 MHz	
Sweep time:	10 ms – 1000 s	
Subranges:	10 ms – 10.00 s 10 s – 100.0 s 100 s – 1000 s	resolution 0.01 s resolution 0.1 s resolution 1 s
Sweep characteristic:	linear (LIN-SWP) logarithmic (SWP-LOG)	

Modes:



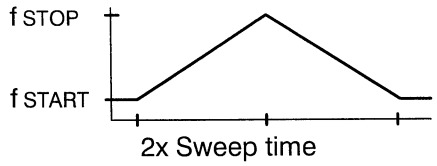
– 1 –

Sweep runs from fSTART to fSTOP fly-back to fSTART.



– 2 –

A single sweep runs from fSTART to fSTOP and remains at fSTOP. Pressing key SINGLE, CONT or HOLD resets the sweep to fSTART.



– 3 –

Sweep runs from fSTART to fSTOP and back to fSTART.

The start frequency is shown in the upper display section and set as explained in Section 3.5.4 (Frequency Setting).

The stop frequency is selected in the modulation parameter row using the MOD PARAMETER ◀ ▶ keys, then it is set by the rotary knob.

Frequency Subranges	Maximum Resolution	Display
1 mHz to 2 Hz	1 mHz	★ . X X X Hz
2 Hz to 20 Hz	10 mHz	★ X . X X Hz
20 Hz to 200 Hz	100 mHz	★ X X . X Hz
200 Hz to 2 kHz	1 Hz	★ . X X X Hz
2 kHz to 20 kHz	10 Hz	★ X . X X kHz
20 kHz to 200 kHz	100 Hz	★ X X . X kHz
200 kHz to 2 MHz	1 kHz	★ . X X X kHz
2 MHz to 20 MHz	10 kHz	# X . X X MHz

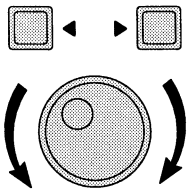
"★" = digits 0, 1, 2
"X" = digits 0 to 9
"#" = digits 1 or 2

The MOD PARAMETER ▶ key allows the sweep time (T) to be selected in the same row, then set by the rotary knob.

The MOD MODE ◀ ▶ keys allow the sweep characteristic to be selected in the lower section (LIN-SWP or SWP-LOG). The set sweep mode – 1 –, – 2 – or, – 3 – appears in the row above for about 5 seconds. It can be changed while being displayed using the rotary knob.

Example: fSTART 200 kHz, fSTOP 2 MHz, sweep time 3 s, linear, mode – 3 –

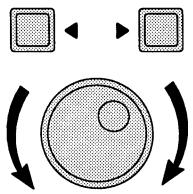
FREQUENCY



Prepare frequency input, select resolution.

Set start frequency (200 kHz).

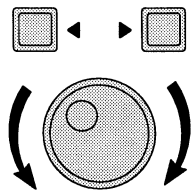
MOD PARAMETER



Select fSTOP.

Set stop frequency (2 MHz).

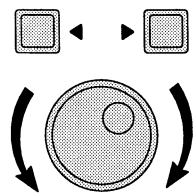
MOD PARAMETER



Select sweep time (T).

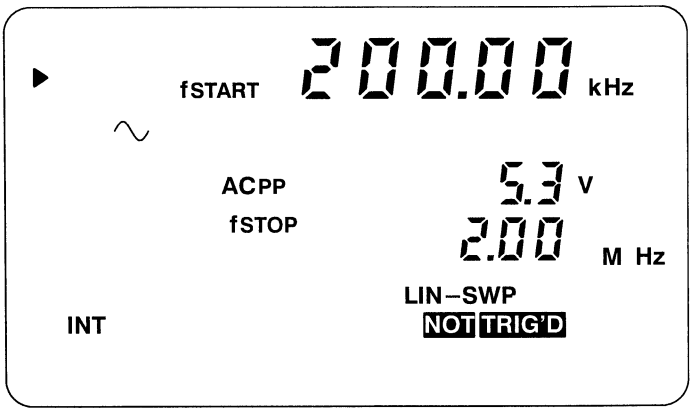
Set sweep time (3 s).

MOD MODE



Select sweep characteristic (LIN–SWP) and set sweep mode (– 3 –).

The display now shows:



Start the sweep with the SINGLE key for a single sweep, or with the CONT key for a continuous sweep.
The keyboard is inhibited during sweep so that no further input is possible.
Pressing the SINGLE or CONT keys once more resets the running sweep.
The letters "NOT TRIG'D" appear again.
To leave Sweep modulation mode, select MOD-OFF.

If the SINGLE key is pressed **during continuous sweep**, the frequency is reset to f_{START}, and a single sweep is started.
If the CONT key is pressed **during a single sweep**, the frequency will also be reset to f_{START}, and a continuous sweep is started.

The HOLD key stops the sweep at its present frequency.
This frequency is shown in the upper display section.
Press the HOLD key once more and the sweep continues.

For external triggering of the sweep, press the EXT key and feed a TTL signal via the MOD/TRIG socket at the rear panel.

The positive-going edge of the signal starts the sweep. When sweep is running, the external signal is ignored.
In **sweep mode – 2 –**, the sweep remains at the stop frequency after the sweep time has elapsed. The next positive-going edge of the signal sets the sweep back to the start frequency, and the following positive-going edge starts the sweep again.
If the TTL-signal is 'high' when the sweep reaches the stop frequency, the sweep is immediately reset.

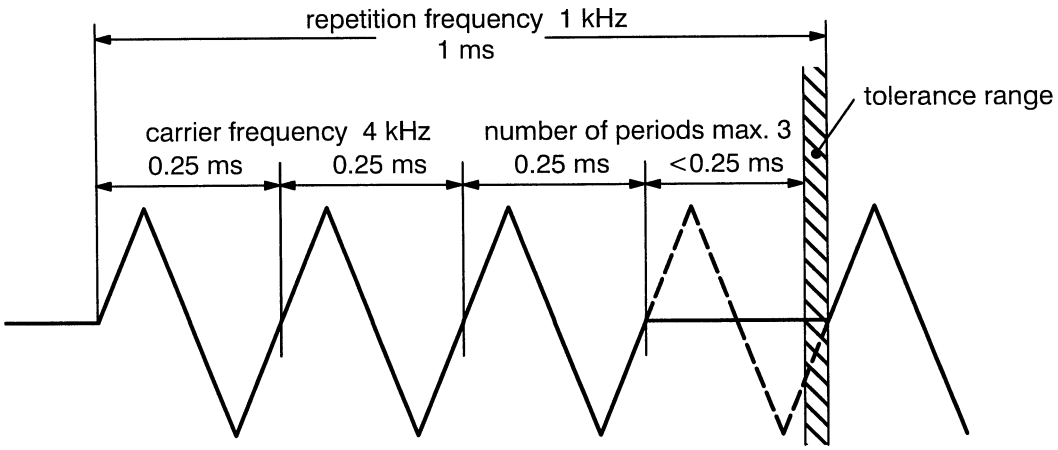
Pressing the SINGLE or CONT keys switches the instrument to the internal trigger signal source.

3.5.7.6 Modulation Mode BURST

Carrier frequency:	max. 2 MHz	
Start/stop phase:	-180° to $+180^\circ$, resol. 1°;	sine and triangle, ≤ 20 kHz
	0°	general
Carrier periods per burst:	1 – 2000	
Repetition frequency (f_{MOD})		
– internal:	1 mHz – 100 kHz	
– external:	0 – 200 kHz	

Note that when setting the carrier frequency respectively the repetition frequency for a continuous burst the last period of the burst packet must have come to an end before the next burst packet starts.

e.g.:	repetition frequency	500 Hz	(2 ms per burst)
	periods per burst	1000	(2 µs per period), i.e.
	carrier frequency	>500 kHz	(one period <2 µs)
or	repetition frequency	1 kHz	(1 ms per burst)
	carrier frequency	4 kHz	(0.25 ms per period)
	number of periods	max. 3	(duration of a burst packet <1 ms)

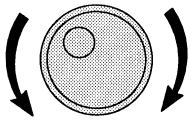


Example: carrier frequency 18 kHz, sine, repetition frequency (f_{MOD}) 1 kHz, periods per burst (N) 10, start-/stop phase (φ) 45 degrees.

For frequency, waveform, and output amplitude settings, see Sections 3.5.4 to 3.5.6.

MOD PARAMETER

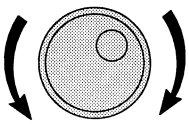
Select repetition frequency (f_{MOD})



and set to 1 kHz.

MOD PARAMETER

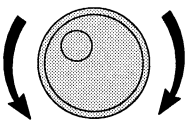
Select periods per burst (N)



and set to 10.

MOD PARAMETER

Select start–/stop phase (φ)

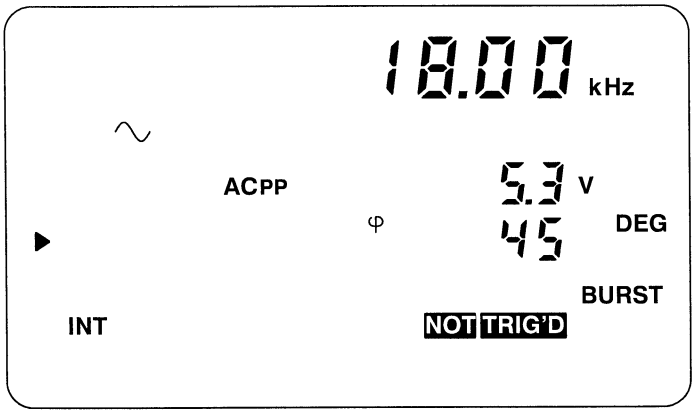


and set to 45 degrees (DEG).

MOD MODE

Select BURST

The display now shows:



The SINGLE key starts a single and the CONT key starts a continuous burst.
Parameters can be changed within the allowed ranges during running burst.
Pressing the SINGLE or CONT keys once more switches the burst off.
To leave the modulation mode burst, select MOD-OFF.
For external triggering select BURST, press the EXT key and feed a TTL signal via the MOD/TRIG socket at the rear panel. The negative-going edge starts the burst.
During running burst packets external trigger pulses are ignored.
Pressing the SINGLE, CONT, or EXT keys switches the instrument back to the internal trigger signal source.

3.5.8 Store and Recall of Instrument Settings

Nine complete instrument settings can be stored into storage registers 1 to 9. The actual operating mode is automatically stored separately. The registers are battery-buffered so that the settings are not lost when the instrument is turned off.

When the instrument is turned on again, it will run through its self-test routine, then return to the operating mode it was set to before it was turned off.

Store

Storage is done by pressing the STORE key. REG will appear in the display together with a digit from 1 to 9 for the storage register number. The rotary knob can now be used to select the register number where the displayed settings are to be stored.

Pressing the STORE key once more stores the settings into the selected register. Previous settings in that register are written over and thus are lost.

Recall

Stored settings are recalled by pressing the RECALL key. REG appears in the display with a register number. The entire display starts to flash. The settings stored in this register are shown but not yet carried out.

The rotary knob selects the register 1 to 9 and thus shows its contents. Press the RECALL key once more to activate the settings shown.

3.5.9 Error Messages, Operating Errors

When the instrument has been switched on it will automatically check the program memory, the processor RAM, the memory of actual settings and the storage registers 1 to 9 for the instrument settings. The data in the registers remain intact.

Next follows a test of the overload protection.

In instrument versions with the IEEE bus, the memory registers for the arbitrary waveforms (ARB) are also tested.

During operation the instrument checks the input of settings for their validity and range limits.

3.5.9.1 Error Messages when Switching on

Errors the instrument detects after power-on are shown in the upper display section by "Err" followed by one digit.

The messages mean as follows:

Err 1	checksum error, program memory (PROM)
Err 2	RAM error, processor
Err 3	defective memory of actual settings
Err 4	defective storage registers 1 to 9
Err 5	overload protection
Err 6	frequency generation does not work
Err 8	defective memory for arbitrary waveforms (ARB)
Err 9	error during data transfer scope – generator

Errors 1 and 2 do not permit further operation. For errors 3, 4, or 8 operation is possible after the error message has been reset by pressing any key except LOCAL. In this case, however, it is no longer possible to store data into the respective register.

3.5.9.2 Operating Hints, Operating Errors

Settings exceeding the permissible limits are shown by the respective parameters flashing. The instrument automatically returns to the last valid setting.

The error message "Err 5" during operation shows that the overload protection of the signal output has been activated. In this case remove the BNC cable from the output socket and check the measurement assembly.
Pressing any key except LOCAL resets the error message and releases the signal output again.

The error message "Err 9" shows data error in the data transfer from the storage oscilloscope to the generator for the arbitrary waveform (instruments with IEEE-488 or RS-232 only).

3.6 SPECIAL APPLICATION

Function generators with an IEEE-488 interface (PM5139/02) or RS-232 interface (PM5139/03) are able to read in a stored signal of a digital storage oscilloscope (DSO), store these in an internal EEPROM, and generate this signal as an output signal itself. Twenty-four different signals can be stored.

This allows you use the generator to reproduce single signals, such as spikes or contact bouncing when required for testing and measuring. You can also vary the frequency and / or the amplitude of the signal.

All that is needed for signal transfer is for the oscilloscope and the PM5139/02 or PM5139/03 to be connected together via an IEEE bus or a RS-232 cable. The transfer is carried out in the plotter language HPGL. A Fast Transfer Mode, depending on the oscilloscope, is possible via IEEE-488 interface. The DSOs PM 3382A, PM 3384A, PM 3392A, and PM 3394A also provide the Fast Transfer Mode via the RS-232 interface. You do not need a computer, nor do you need to set up programs or know special programming commands.

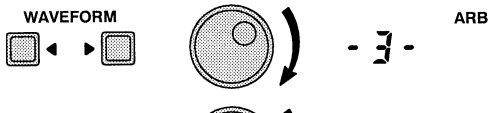
Example: Transfer of waveform data from a digital storage oscilloscope (PM 3350) to the PM 5139/02 via IEEE-488 bus.

Connect both instruments together using an IEEE bus cable and connect them to line power.

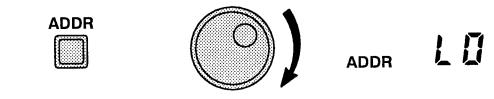
The oscilloscope as the Talker in the digital plot mode must be set to transfer the signal to plotter type PM 8153_6 via the IEEE interface.
Set the generator to the ARB waveform, and use the rotary knob to select the memory location (1 to 24) where the signal will be stored.
Set the generator to Listener Only by pressing the ADDR key and setting LO in the display.

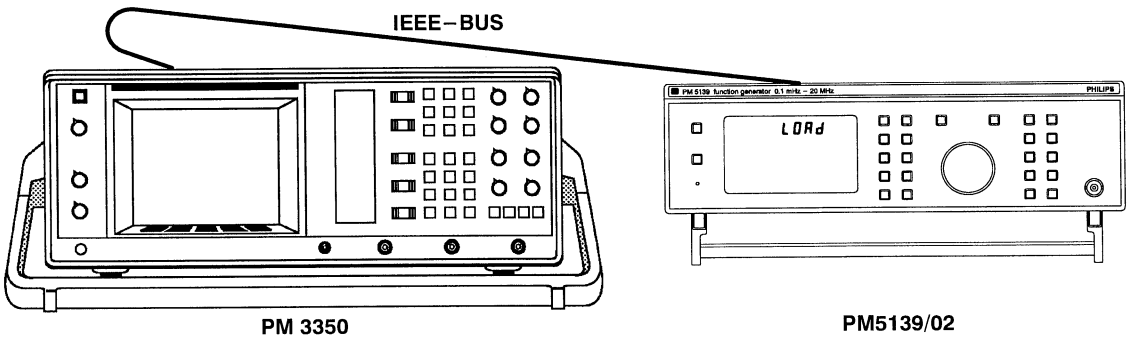
At the start of plotting (PLOT key on the scope), the generator shows the letters "LOAd" in the display as an indication that the transfer of data is in process. When the transfer of data is complete, the transferred signal is now available at the output of the generator. The amplitude and frequency of this signal can be altered within the permissible limits, whereby the relation of the maximum amplitude is proportional to the signal received from the screen of the scope. The full vertical range of the screen corresponds to the maximum voltage of 20 Vpp (open circuit voltage).

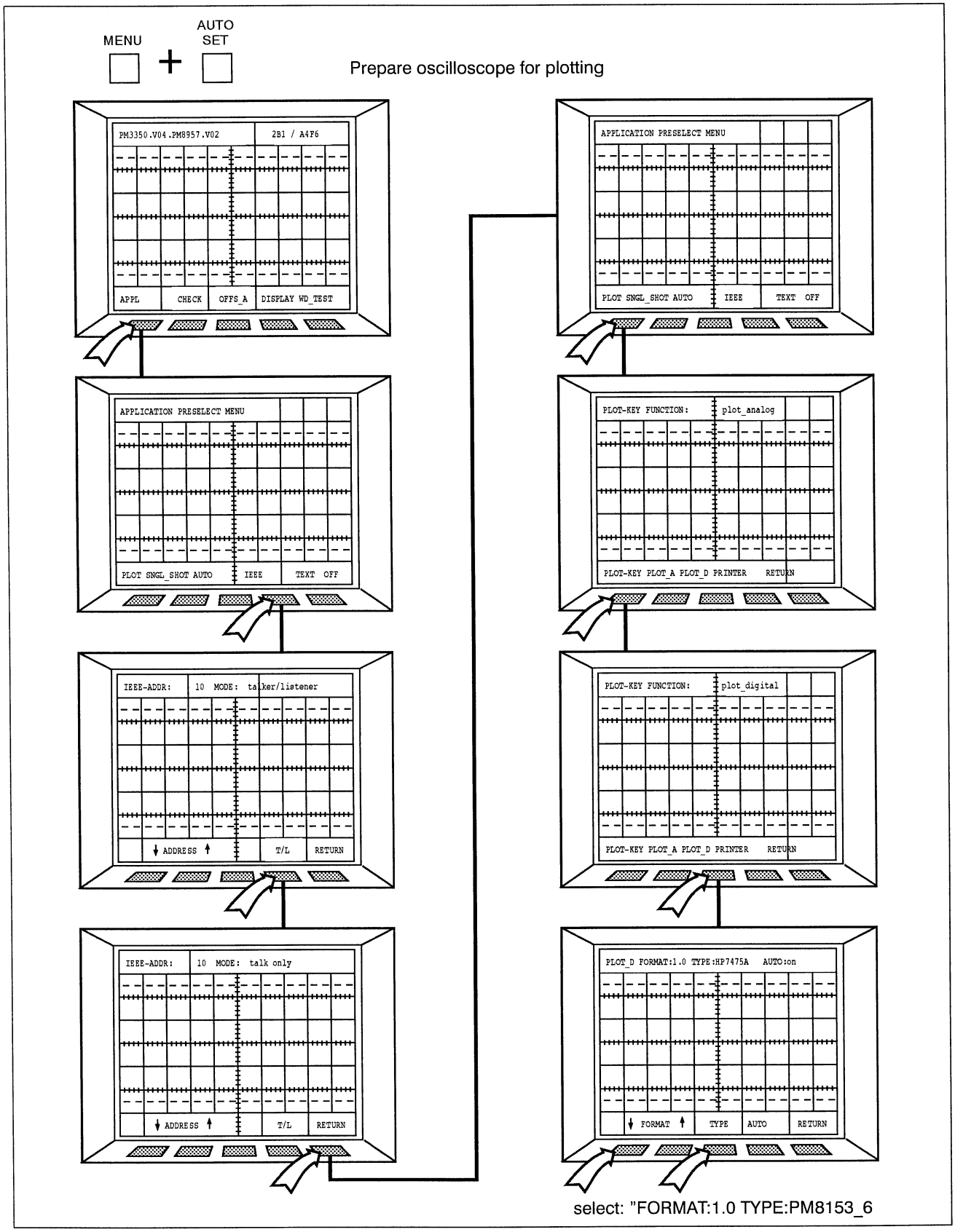
Select memory location:



Set device address of the generator to "LO":





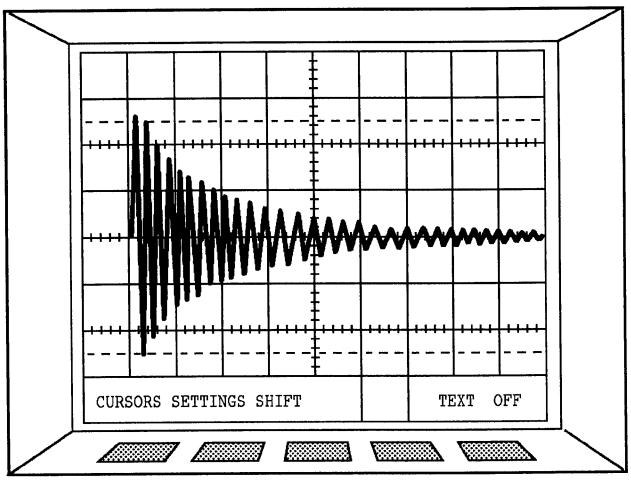

MENU
AUTO SET
Prepare oscilloscope for plotting
PM3350.V04.PM8957.V02
2B1 / A4F6
APPL
CHECK
OFFS_A
DISPLAY WD_TEST
APPLICATION PRESELECT MENU
PLOT SNGL_SHOT AUTO
IEEE
TEXT OFF
IEEE-ADDR:
10 MODE: talker/listener
ADDRESS
T/L
RETURN
IEEE-ADDR:
10 MODE: talk only
ADDRESS
T/L
RETURN
APPLICATION PRESELECT MENU
PLOT SNGL_SHOT AUTO
IEEE
TEXT OFF
PLOT-KEY FUNCTION:
plot_analog
PLOT-KEY PLOT_A PLOT_D PRINTER
RETURN
PLOT-KEY FUNCTION:
plot_digital
PLOT-KEY PLOT_A PLOT_D PRINTER
RETURN
PLOT_D FORMAT:1.0 TYPE:HP7475A
AUTO:on
FORMAT
TYPE
AUTO
RETURN
select: "FORMAT:1.0 TYPE:PM8153_6

Feed signal to the Oscilloscope

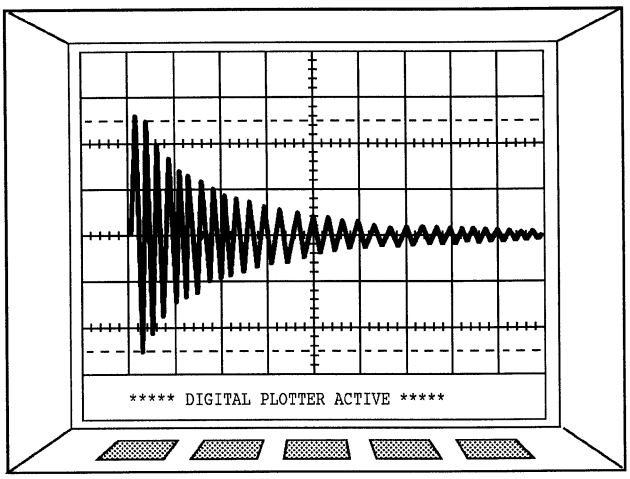
AUTO SET

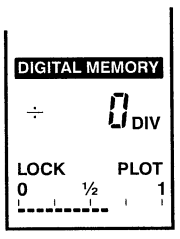
Set scope: trigger, timebase, amplitude, etc.

DIGITAL MEMORY LOCK



PLOT





The bargraph in the display of the oscilloscope shows the course of plotting, which in this case is the transfer of data to the generator. The display of the generator shows "LOAd" while the transfer is running. Once all data has been transferred, these letters are switched off and the generator returns to display the last setting. If the waveform ARB is selected now, the instrument will generate the signal transferred.

3.7 REMOTE CONTROL OF THE INSTRUMENT

3.7.1 Introduction

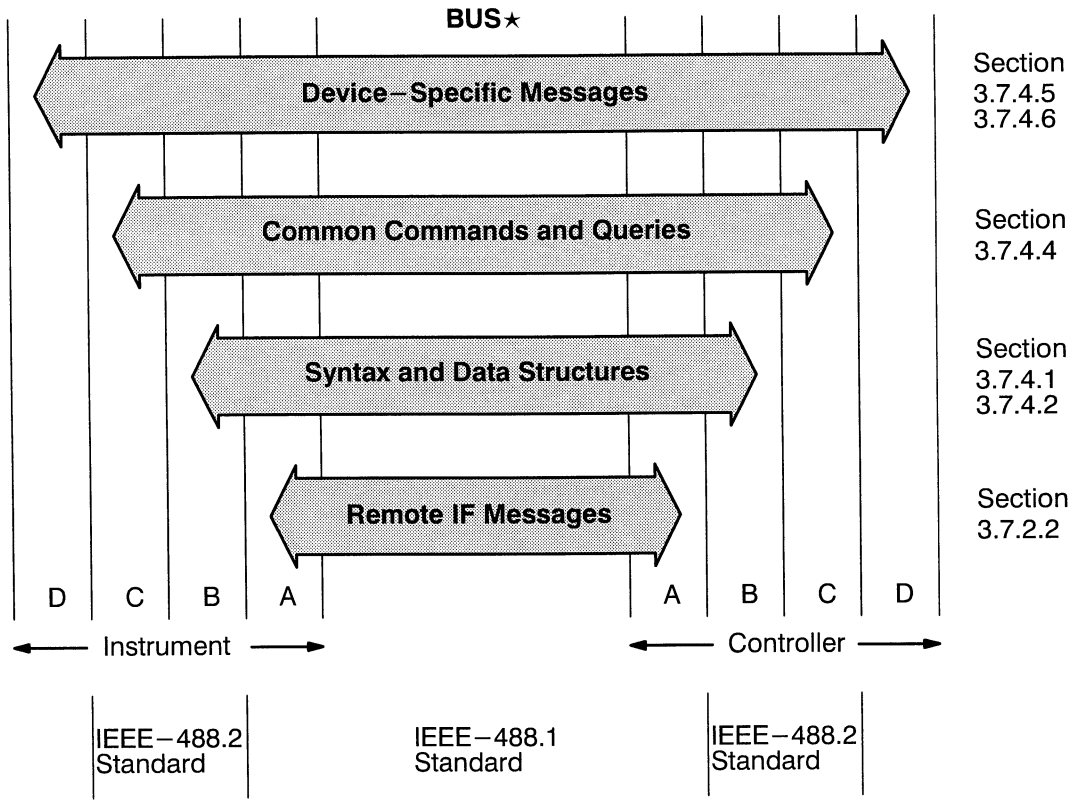
All instrument functions can be controlled via the IEEE-488 or RS-232 interface.

The information in this section assumes that you are acquainted with the operation of the instrument, modulation facilities, parameters, and limits. A detailed description with examples is included in Section 3.5.

In addition, data for a maximum of twenty-four arbitrary waveforms (ARB) can be sent to the generator by a controller, stored in EEPROMs. The arbitrary waveforms can be activated via remote control as well as directly via the generator keyboard.

3.7.2 IEEE-488 Interface

In the following section the functions of the IEEE-488 bus interface are described.
For commands, queries, syntax, and terminators, see Section 3.7.4.



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

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

3.7.2.1 Instrument Address

Remote control of the generator requires the instrument address to be known. Press the ADDR key to display the set address, and if necessary turn the rotary knob to select an address from 1 to 30 for remote control or LO for the "Listener Only mode" to transfer data from a Digital Storage Oscilloscope (DSO) directly to the generator without any PC or controller.

When the instrument is turned on, it is in 'local' mode (input via keyboard). When addressed as a listener by a controller, the text REMOTE appears in the display field. The rotary knob and all keys except LOCAL are locked and the instrument can now be operated in remote control. Return to local operation is done by the addressed command GTL (go to local) or by the LOCAL key. In order to avoid unintended return the LOCAL key can be disabled by the universal command LLO (local lockout).

3.7.2.2 Interface Functions

The following interface functions are implemented:

AH1:	acceptor handshake	SR1:	service request SRQ
SH1:	source handshake	DC1:	device clear function
L3:	listener function	DT1:	device trigger function
L1:	listener only	PP0:	no parallel poll
T6:	talker function	C0:	no control function
RL1:	local/remote with local lockout	E2:	tri-state drivers

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

3.7.3 RS-232 Interface

3.7.3.1 Instrument Configuration

In the following section the functions of the RS-232 interface are described.

For commands, queries, syntax, and terminators, see Section 3.7.4.

In addition you can send data from a Digital Storage Oscilloscope (DSO) directly to the generator without any PC or controller.

Remote control of the instrument requires an interface communication configuration that matches that of your PC.
With the **ADDR** key, the current configuration can be displayed and altered by the rotary knob.

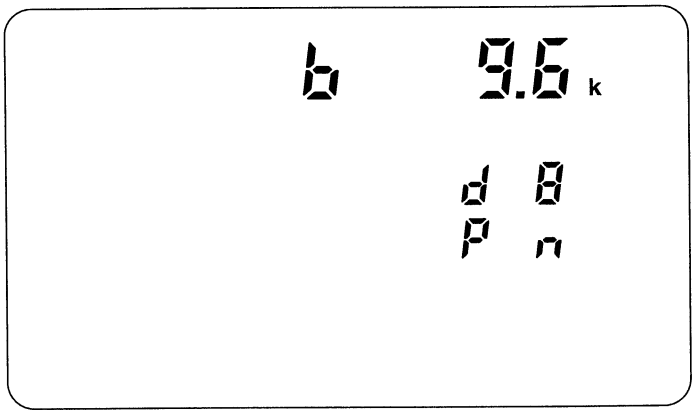
If you use the Fast Transfer Mode for data transfer from an oscilloscope 8 data bits must be set.

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

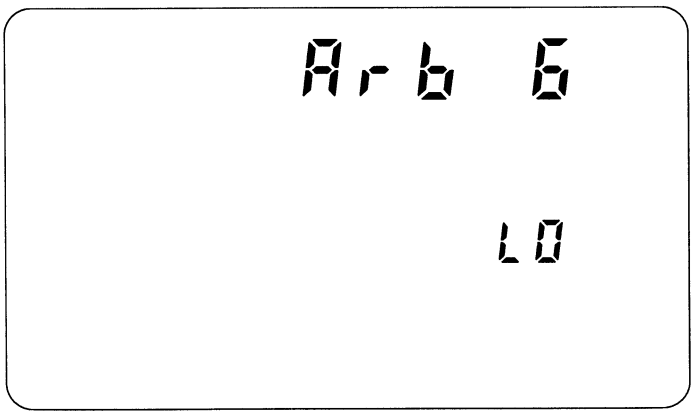
Key Operation	Display shows
ADDR 	Communication Mode (Co) or Listener Only Mode (LO).

With the rotary knob you can switch from Lo to Co.
From Co to Lo you can only switch if 8 data bits are selected.

After two seconds the
selected settings are displayed.



That means:
baud rate **9600**, **d**ata bits **8**, **p**arity **n**o.

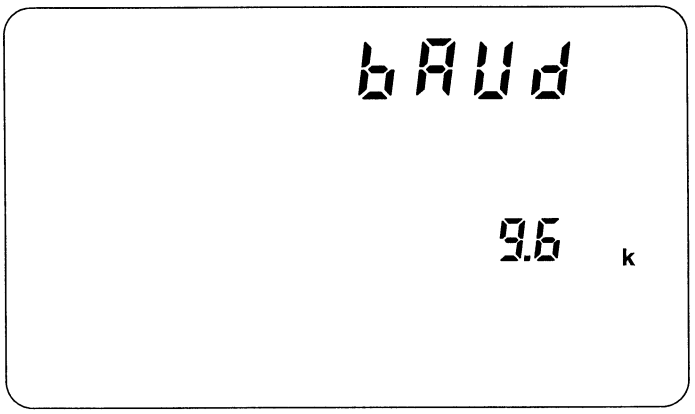
Key Operation	Display shows
In **L**istener **O**nly Mode the display shows after three seconds:	

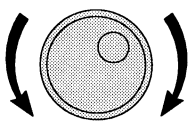
Arb 6 means data transferred will be stored in ARB memory number six.

The instrument remains in this mode until the data transfer has been finished or any key (except ADDR and LOCAL) has been pressed.

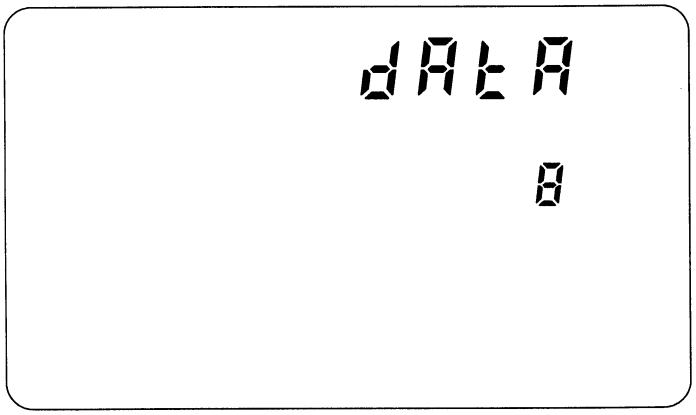
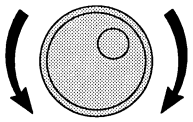
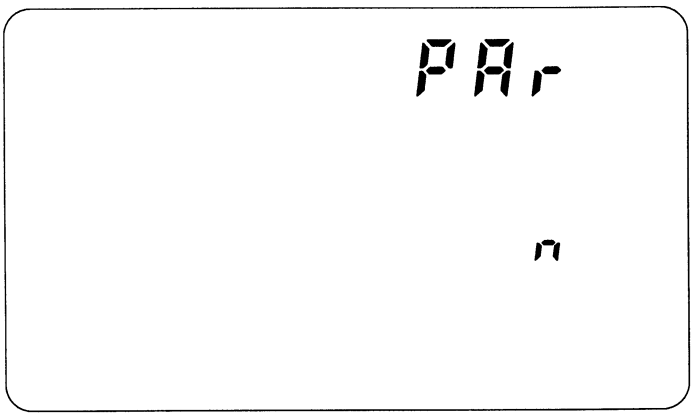
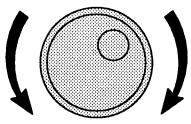
In Communication Mode the instrument shows the current settings and returns to normal display after three seconds.

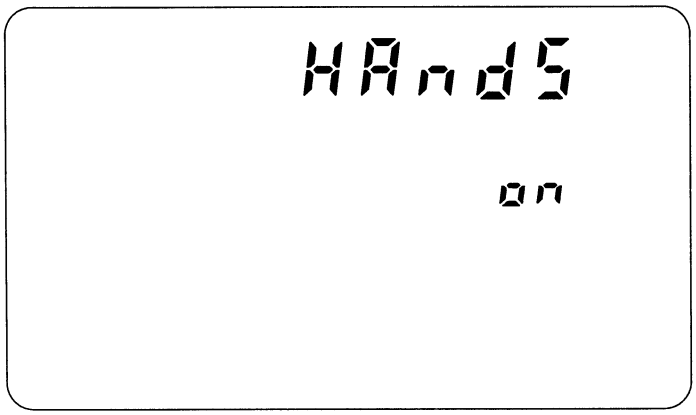
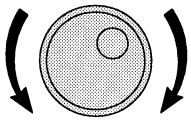
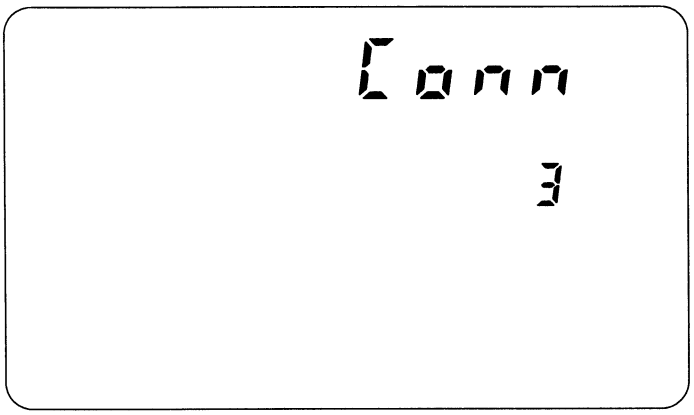
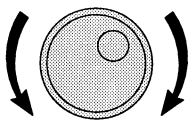
If you want different settings press the **ADDR** key again during display:





Select **baud** rate
110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200
for 110 baud 2 stop bits are set, otherwise 1 stop bit.

Key Operation	Display shows
ADDR 	
	Select **data** bits **7** or **8** 7 bits for parity **E**ven or **O**dd. Fast Transfer Mode needs 8 data bits.
ADDR 	
	Select **par**ity **E**ven, **O**dd or **no** (parity **no** for 8 data bits only).

Key Operation	Display shows
ADDR 	
	Select Xon/Xoff **hands**hake **on** or **oFF**. For data transfer of more than 64 byte the handshake Xon/Xoff should be set to **on**.
ADDR 	
	Select **3** or **7** wire **conn**ection.

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

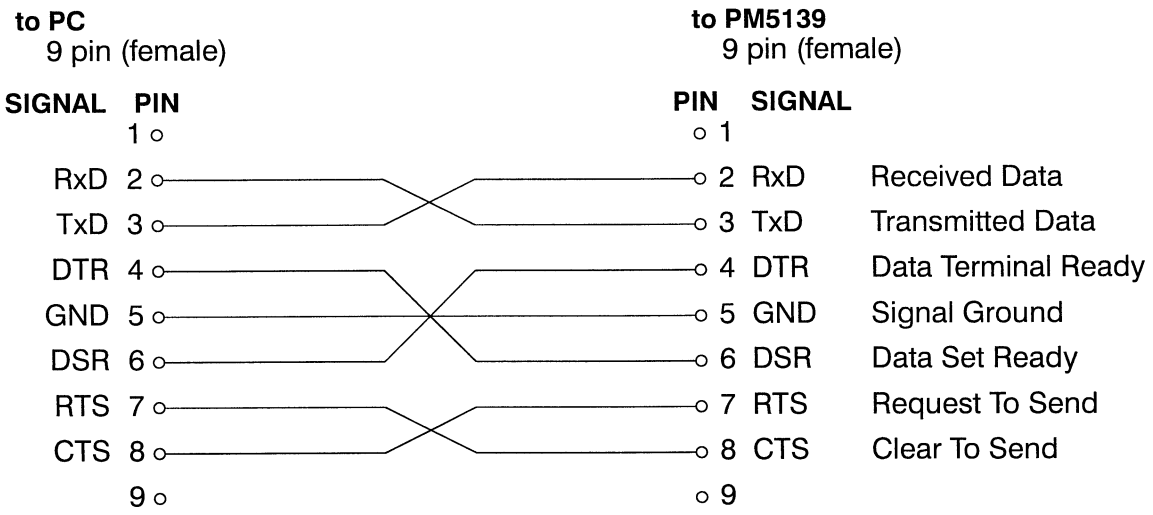
If no key is pressed within 3 seconds during configuration the instrument returns automatically to normal mode; the altered configurations are not stored.

On power up, the instrument is in 'local' mode (input via keyboard). When set to listener by PC with the command **ESC 2** the text REMOTE appears in the display field. 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. In order to avoid unintended local control the LOCAL key can be disabled by the command **ESC 5**.

3.7.3.2 Interface Functions and Wiring

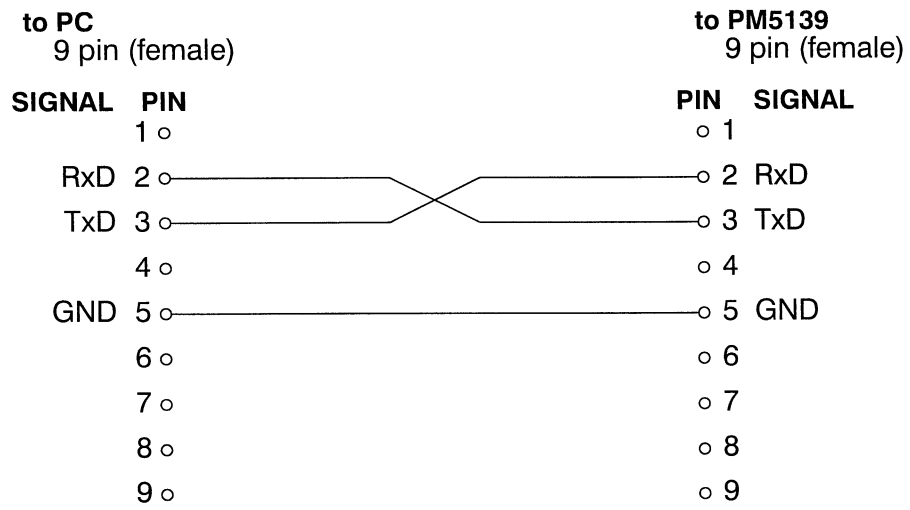
Operating modes:	Communication Mode (Co) / Listener Only Mode (LO)
Baud rates:	110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200
Data bits:	7 or 8
Stop bits:	1 (2 for 110 baud only)
Parity:	ODD EVEN NO (with 8 data bits)
Xon/Xoff Handshake:	ON or OFF
Hardware connection:	3 wires, no hardware handshake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

Because the PC as well the PM5139 are DTE (Data Terminal Equipement) following pin configuration for the RS-232 connection cable should be used. In general it is recommended to use a well shielded cable for adequate radio interference suppression.



This cable can be purchased from your local Fluke Organization, order number PM9536/041.

If you use a 3 wire connection set the PM5139 to software handshake.



3.7.3.3 Special Interface Functions

For communication with the RS-232 interface following commands are used (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 a application program, so they can be sent to the instrument by a PC.

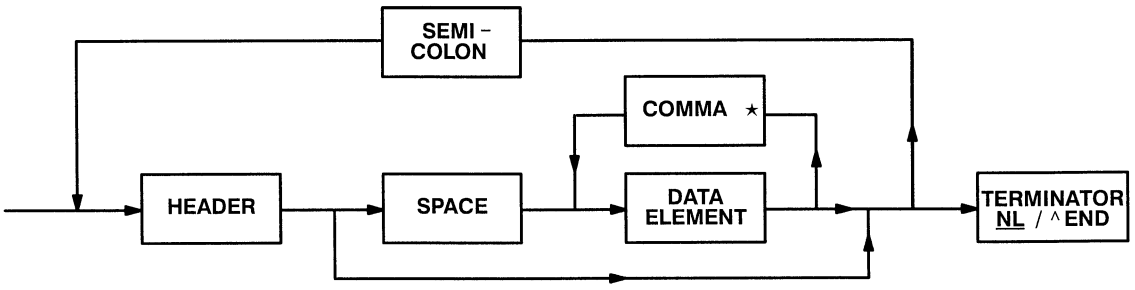
3.7.4 Remote Control Commands

In this section the commands are described related to the instrument functions and front panel keys, which are listed in Section 3.5. If not stated otherwise, following commands are used for IEEE-488 as well as for RS-232.

3.7.4.1 Program Message Syntax

Several commands can be combined in a message and sent to the generator, 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.



★ for arbitrary waveform data

3.7.4.2 Message Terminator

The instrument accepts ^ END or NL (ASCII 10 dec.) or both as the terminator for a program message via IEEE-488 interface.
The instrument also sets ^ END and NL as the terminator for a response message. To get compatibility to earlier controllers you can program terminators which 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 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 RS-232 interface uses only NL as the terminator.

3.7.4.3 Service Request (SRQ) and Status Registers

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'.

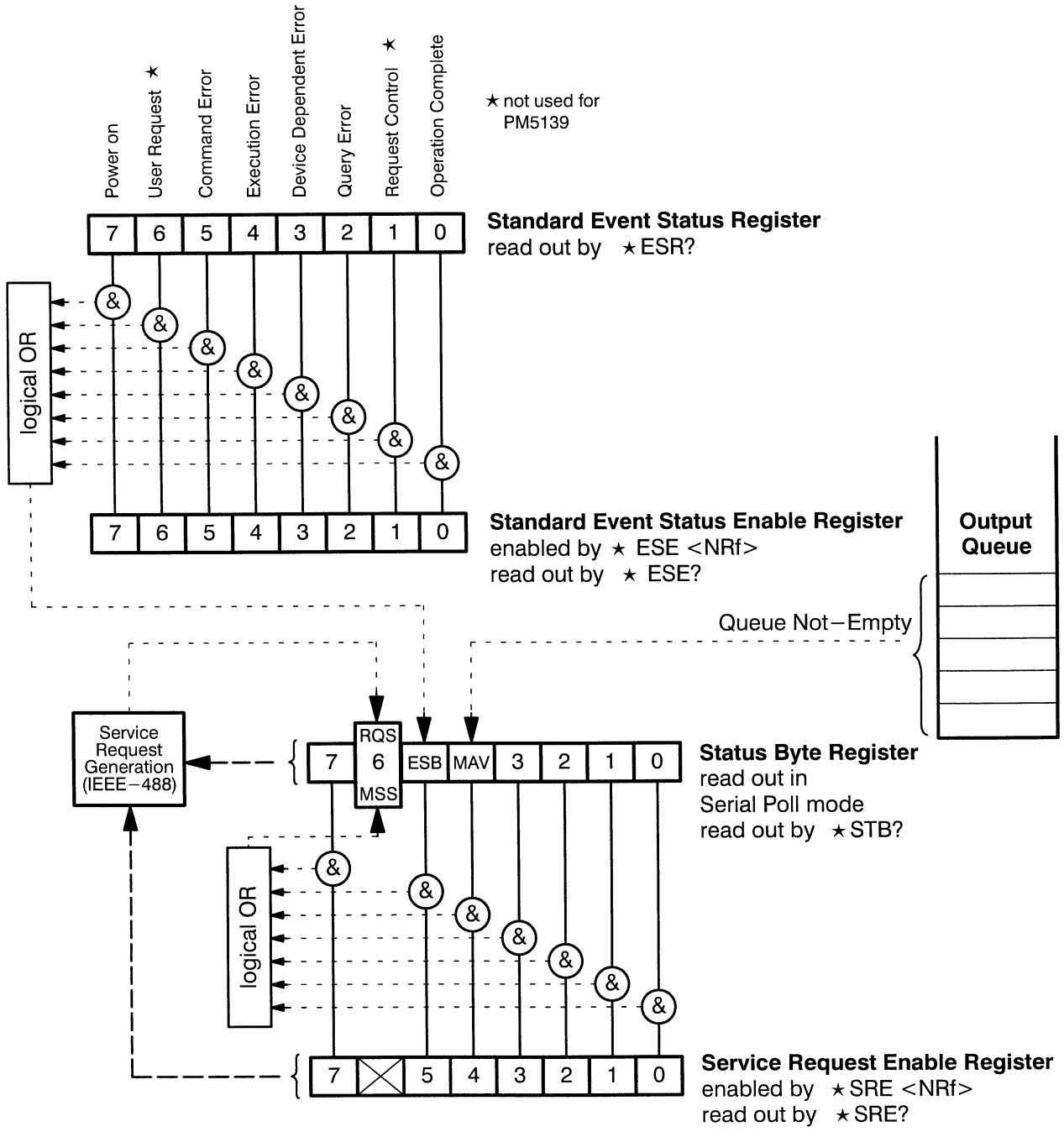
PM5139 'Status Byte Register':

Bit	Function	Decimal value
0	power protection	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 (RQS)	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'.

'Standard Event Status Register'



<NRf> represents a decimal value whose binary pattern sets the corresponding bits of the 'Enable Register' to 1. By this the assigned bits of the 'Standard Event Status Register' respectively the bits of the 'Status Byte Register' are enabled.

All bits of the 'Standard Event Status Enable Register' and of the 'Service Request Enable Register' are set to 0 when the instrument is turned on. Therefore, in a user program where Service Request is required, the required bits must be set to 1 after power on.

3.7.4.4 Common Commands and Queries (IEEE-488.2)

System data:

⋆IDN? Identification Query

After receiving this query, the instrument generates the following response message:

FLUKE,PM5139,0,Vx.x/0000 x.x = software status

⋆LRN? Learn Mode Query

After receiving the query ⋆LRN? the PM5139 generates a response message, which comprises the complete actual instrument setups. This message can be read in by the controller, stored in a program, and later on, it can be re-sent as a program command message to the generator. By this also manual keyboard inputs can be read into a program.

Example of an answer after receiving ⋆LRN?:

MODOFF;FREQ 20.00E3;SINE;AMPLT 2.00;DCOFFS 1.0;DUTYC 80;
ACON;DCON;LOIMP OFF;SYM ON;MODLN GATE;MODFRE 1.5E3;MODSRC INT

MODOFF	switches off previously set modulation
FREQ 20.00E3	carrier frequency 20 kHz
SINE	waveform sine
AMPLT 2.00	output amplitude 2.0 V
DCOFFS 1.0	DC offset voltage 1.0 V
DUTYC 80	waveform asymmetry 80 % selected
ACON	AC output signal on
DCON	DC offset voltage on
LOIMP OFF	output impedance 50 Ω
SYM ON	waveform symmetry on (80 % asymmetry not active)
MODLN GATE	modulation mode gate
MODFRE 1.5E3	keying frequency (f_{MOD}) 1.5 kHz
MODSRC INT	internal modulation signal

Internal operations:

⋆RST Reset Command

This command performs a device reset which sets the instrument to a defined status:

modulation	OFF	duty cycle	50 %
frequency	1 kHz	amplitude (AC)	ON
waveform	sine	offset (DC)	OFF
amplitude	1.1 V	LOW impedance	OFF (Zo 50 Ω)
DC-offset	0	symmetry	ON

The reset does not affect the internal memories of the generator or the enable or status registers of the interface.

⋆TST? Self-test Query

The instrument automatically checks the memory for the current settings, the storage registers 1 to 9, the memory for the arbitrary waveforms. The contents of the registers will not be destroyed, instrument settings remain unchanged. The test lasts approximately 1 second.

A zero in the response indicates that the self-test has completed without any errors detected.

1 means error during test of backup memory
2 means error during test of storage registers 1 to 9
4 means error during test of memory for ARB

Synchronization:

⋆OPC Operation Complete Command

For PM5139 this command is suggested for single sweep or burst. Selecting single sweep or burst via the interface, followed by the command ⋆OPC, sets bit 0 (operation complete) of the 'Standard Event Status Register' to 1 when the sweep or burst is finished. This bit activates bit 5 of the 'Status Byte Register' (event status bit); this generates Service Request (IEEE-488 interface only). This allows the controller to realize that the function is finished. Service Request, however, will be generated when the respective bits are enabled, see Section 3.7.4.3.

⋆OPC? Operation Complete Query

This command is also suggested for single sweep or burst. Sending the ⋆OPC? query to the generator during single sweep or burst causes the instrument to wait until the function is finished and to set a 1 into the output queue. The register can be read out by the controller without Service Request to continue in its user program.
Data in the output queue generally activate bit 4 of the 'Status Byte Register' (MAV, message available); this may generate a Service Request (IEEE-488 interface). To avoid this, bit 4 must not be enabled. Bit 0 (operation complete) of the 'Standard Event Status Register' is not affected by ⋆OPC?.

⋆WAI Wait-to-Continue Command

This command sent to the instrument in a message with further commands causes the generator to execute the command behind ⋆WAI only when the previous command is completed. This command acts as a terminator for the PM5139.

⋆TRG Trigger Command

When receiving this command the generator starts burst respectively sweep if one of these functions was selected before.

Status and event:

⋆CLS Clear Status Command

Sets the 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 additionally 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' which correspond to that decimal value to 1. This enables the assigned bits of the 'Standard Event Status Register', see Section 3.7.4.3.

⋆ESE? Standard Event Status Enable Query

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

Example: "255" = all bits are set to 1, that means 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 clears the register contents.

⋆SRE Service Request Enable Command

⋆SRE, followed by a decimal value, sets the bits of the 'Service Request Enable Register' which correspond to that decimal value to 1, except bit 6. This enables the assigned bits of the 'Status Byte Register', see Section 3.7.4.3.

⋆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.

Stored settings:

⋆SAV Save Command

This command followed by a decimal value from 1 to 9 stores the current instrument setting into the corresponding memory location. The memory contents are not affected by the ⋆RST command or by the instrument being turned off.

⋆RCL Recall Command

This command followed by a decimal value from 1 to 9 for the memory location calls up and executes the instruments settings stored in that memory location.

3.7.4.5 Device-Specific Messages

The following examples show which remote control commands are necessary to select operation modes and parameters and to set values.

"|" separates expressions which can be used by choice.

"NRf" (flexible numeric representation) value within the allowed range as integer, real or exponential value (NRf 1, 2 or 3 according to IEEE-488.2), whereby the number of digits is limited to 10 and to 1 for the exponent. The dimension is automatically set by the generator to **Hz**, **V**, **s**, **%** or **DEG** (degree). Numerical values exceeding the maximum resolution of a subrange are internally rounded.

Different from the keyboard input the resolution in the frequency range from 100 Hz to 10 MHz is 10 Hz in remote control, except for SWEEP. These high resolution digits are not displayed.

"," serves as separator between several data elements in the program data, when programming an arbitrary waveform.

Some headers can be sent as command headers to program the generator and they can also be sent as queries with a question mark. The instrument then generates an answer with its actual value.

Example:	**FREQ 10e6**	sets the frequency to 10 MHz
	FREQ?	answer: FREQ 10.000E6

In the following table the question mark of these headers is set into brackets, e.g., FREQ(?).

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

Example: **SYM**METRY **ON** in short form **SYM ON**

- **Frequency Setting**

Header/Query:	**FREQ**(**?**)	Frequency, carrier frequency (also start frequency for sweep)
	STARTFREQ(**?**) | **STFRE**Q(**?**)	Start frequency for sweep
	STOPFREQ(**?**)	Stop frequency for sweep
Data element:	NRf	
Remark:	Max. frequency depends on waveform.	
	Frequency ranges for sweep:	1 mHz – 10 MHz
		50 kHz – 20 MHz
Example:	**FREQ 10E6**	Sets the frequency to 10 MHz

■ **Waveform Setting**

Query: **WAVE**FORM**?**

Header:

SINE	sine
TRNGLE	triangle
SQUARE | **SQR**	square
POSPULSE | **PULS**E	positive pulse
NEGPULSE	negative pulse
POSSAWTOOTH | **SAW**TOOTH	positive sawtooth
NEGSAWTOOTH	negative sawtooth
HAVERSINE	haversine
SINEPULSE	sine pulse
TRNGLPULSE	triangle pulse
ARBITRARY | **ARB**ITRARY	free programmable (see Section 3.7.4.6)

Data element: none

Example: **TRNG**LE or **TRNG** sets the waveform to triangle

Remark: Apart from keyboard operation the amplitude value is not automatically set to half the value when selecting unipolar signals.

■ **Waveform Asymmetry Setting**

Header/Query: **DUTYC**YCLE(**?**) Sets the asymmetry

Data element: NRf

Remark: NRf for:

sine, square, square pulses	≤ 20 kHz:	1 to 99
square, square pulses	> 20 kHz to 5 MHz:	20 to 80

Header/Query: **SYM**METRY(**?**) Switches asymmetry on or off

Data element: **ON** | **OFF**

Remark: **SYM ON** means duty cycle 50 %

Example: **SQR;DUTYC 20;SYM OFF** sets square wave to 20 % duty cycle

■ **Output Amplitude Setting**

Header/Query:

AMPLTUDE(**?**)	AC setting
DCOFFSET(**?**)	DC setting

Data element: NRf

Remark: AC plus DC may not exceed a window of ±10 V

Header: **AC** | **DC** Switch AC or DC on or off

Data element: **ON** | **OFF**

Remark: **DCON** | **DCOFF** respectively **ACON** | **ACOFF** can also be used

■ **Modulation Mode Setting**

Header/Query:	**MODLN**(**?**)	No header for sweep
Data element:	**AM**|**FM**|**PSK**|**GATE**|**BUR**ST|**OFF**	
Remark:	**AM**|**FM**|**PSK**|**GATE**|**BUR**ST	Can be used as header alone
Header:	**MODOFF**	Can be used to switch modulation off
Data element:	none	
Header:	**BUR**ST	Starts burst if burst is selected (ON) or sets burst to not triggered (OFF)
Data element:	**ON**|**OFF**	
Header/Query:	**SWEEP**(**?**)	
Data element:	**LOG**|**LIN**|**ON**|**OFF**	LOG = logarithmic sweep LIN = linear sweep OFF = sweep not triggered ON = starts sweep, if sweep selected
Remark:	During running sweep, no device-specific message is accepted, except MODOFF, MODLN OFF, and SWEEP OFF. These commands also serve to reset a single sweep in mode – 2 – to f_{START}.	
Header:	**SINGL**E|**CONT**INUOUS	Starts a single or continuous burst or sweep
Data element:	none	
Header:	**AMSWE**EP	Combines AM with sweep
Data element:	**LIN**|**LOG**	
Examples:	**MODLN AM** or **AM**	Sets amplitude modulation
	MODLN FM or **FM**	Sets frequency modulation
	SWEEP LIN;CONT	Linear sweep, continuous
	BURST;BURST ON	Burst, continuous
	BURST OFF	Burst not triggered

■ **Modulation Parameter Setting**

Header/Query:	**MODFRE**Q(**?**) | **MODLNFRE**Q(**?**)	Modulation/repetition frequency
	AMDEPTH(**?**)	Modulation depth for AM in %
	FMDEVIATION(**?**)	Frequency deviation for FM in %
	SWEEPTIME(**?**)	Sweeptime in seconds
	SWEEPMODE(**?**)	Sweepmode – 1 –, – 2 – or – 3 –
	ONPERIODS(**?**)	ON-periods per burst
	STARTPHASE(**?**) | **STPHA**SE(**?**)	Start/stop phase for burst
Data element:	NRf	
Remark:	For these settings, the ranges and limits stated in Section 3.5 are valid.	

■ **Modulation/Trigger Signal Setting**

Header/Query:	**MODSRC**(**?**) | **TRIGS**RC(**?**) | **TRGS**RC(**?**)	Modulation/trigger signal source
Data element:	**INT** | **EXT**	
Header/Query:	**TRIGF**UNCTION(**?**) | **TRGF**UNCTION(**?**)	Trigger function
Data element:	**SINGL**E | **CONT**INUOUS	
Remark:	This command determines whether the command '*TRG' or an interface trigger function, for example, GET, starts a single or continuous burst respectively sweep.	

■ **Additional Commands**

Header:	**HOLD**	Stops the output signal at its present amplitude value (frequency 0.1 mHz ... 1 Hz). Sets the output amplitude to zero (frequency 1 Hz ... 20 kHz). Different from the 'HOLD' key, the command 'HOLD' is not effective during sweep.
	RELEASE	Releases the HOLD function
	ENABLE	Resets tripped power protection (RPP)
Query:	**OUTP**UT**?**	Output status query
Header/Query:	**LOWIMP**(**?**) | **LOIMP**(**?**)	Output impedance 50 Ω or LOW Zo
Data element:	**ON** | **OFF**	
Remark:	LOW Zo for amplitudes ≥ 2.0 V.	

Examples:

Internal amplitude modulation:

frequency 150 kHz	**FREQ 150E3**
waveform sine	**SINE**
output amplitude 4.5 V	**AMPLT 4.5**
amplitude modulation	**AM**
modulation frequency 1.5 kHz	**MODFRE 1.5E3**
internal modulation signal	**MODSRC INT**
modulation depth 50 %	**AMDEP 50**

Linear sweep with same start frequency and amplitude as above:

amplitude modulation off	**MODOFF**
linear sweep	**SWEEP LIN**
stop frequency 5 MHz	**STOPF 5E6**
sweep time 5 seconds	**SWEEPT 5**
mode – 3 –	**SWEEPM 3**
continuous sweep	**CONT**

Burst with 5 periods, carrier frequency 15 kHz, amplitude 5 V:
repetition frequency (f_{MOD}) 500 Hz, start-/stop phase 45°:

modulation off	**MODOFF**
frequency 15 kHz	**FREQ 15E3**
amplitude 5 V	**AMPLT 5**
modulation mode BURST	**BUR**
repetition frequency (f_{MOD}) 500 Hz	**MODFRE 500**
periods 5	**ONPER 5**
start-/stop phase 45°	**STPHA 45**
continuous burst	**CONT**

The commands in the examples can also be sent to the generator in a combined message:

FREQ 150E3;SINE;AMPLT 4.5;AM;MODFRE 1.5E3;MODSRC INT;AMDEP 50 (AM)

MODOFF;SWEEP LIN;STOPF 5E6;SWEEPT 5;SWEEPM 3;CONT (sweep)

MODOFF;FREQ 15E3;AMPLT 5;BUR;MODFRE 500;ONPER 5;STPHA 45;CONT (burst)

3.7.4.6 Arbitrary Waveform (ARB)

Data for twenty-four free programmable waveforms can be sent to the generator via the IEEE-488 or via the RS-232 interface. These data are stored in an EEPROM and can be recalled at any time or overwritten by new data. Values for the amplitude Y are assigned to the storage addresses on the time axis X of a system of coordinates.
When generating the arbitrary waveform, the instrument recalls the addresses and sets the output signal to the value corresponding to the storage contents.
The total signal can be repeated at a frequency up to 20 kHz; this means a maximum sample rate of the single addresses of 20.48 MS/s (mega samples per second).

Commands to select, program, and recall the arbitrary waveform

Header:	**ARBSEL**ECT(**?**)	Selects the memory location 1 to 24 to store data for an arbitrary waveform during a different signal is present at the output.
Data element:	**1** to **24**	
Header:	**ARBIT**RARY(**?**) | **ARB**(**?**)	Activates the programmed signal of the memory place 1 to 24, 'ARB' without a decimal value activates the signal of the memory place last selected.
Data element:	**1** to **24**	
Note:	If the command 'ARBSEL..' is sent to the generator in a combined message after 'ARB..' (e.g., ARB 2;ARBSEL 5;...), the waveform selected by 'ARBSEL..' is activated.	
Header:	**BEG**IN(**?**)	Defines the start address on the x-axis (0 to 1023) of the data for the amplitude; if this command is not sent, programming will start at the next free address.
Data element:	**0** to **1023**	
Header:	**COUNT**(**?**) | **CNT**(**?**)	Address increment (1 to 255) on the X-axis; if this command is not sent, the increment will be 1.
Data element:	**1** to **255**	
Header:	**DATA**	yy = number of subsequent data elements xx = amplitude data on Y-axis (−511..0..+511); the range −511 to +511 corresponds to 20 Vpp.
Data element:	**yy,xx,xx...**	
Header:	**FILL**	Sets all addresses from 0 to 1023 to the programmed value.
Data element:	**−511** to **0** to **+511**	
Header:	**CLEAR**	Erases the selected arbitrary waveform (corresponds to FILL 0).
Data element:	**ARB**IT	

The command FILL supports programming a wave form with DC component.
You can program a DC voltage, in which you can program a desired waveform in segments.

When you only program one value by FILL, this corresponds to a DC voltage. This voltage is present at the generator output. The display shows "AC 0".
It is not possible to make changes within the amplitude subranges.

When programming the maximum output amplitude Vmax the programmed Y-values are converted by the generator into volts.

for example: Ymax = 8, Ymin = – 6

$$Umax = \frac{Ymax - Ymin}{1022} \times 20\ V = \frac{8 - (-6)}{1022} \times 20\ V = 0.2739\ V$$

Digits behind the 1. position behind the decimal point are ignored as they surpass the resolution of 100 mV of this range (see Section 4.10);

i.e. Output amplitude and display: AC_{pp} 0.2 V

When you switch from a standard waveform to an "ARB" which doesn't cover the full amplitude range (– 511 to + 511), it is recommended to set the output amplitude to zero (AMPLT 0). This avoids range respectively subrange exceeding.

You use the following commands to select whether the arbitrary waveform is executed after data transmission or after sending the command 'ARB'.

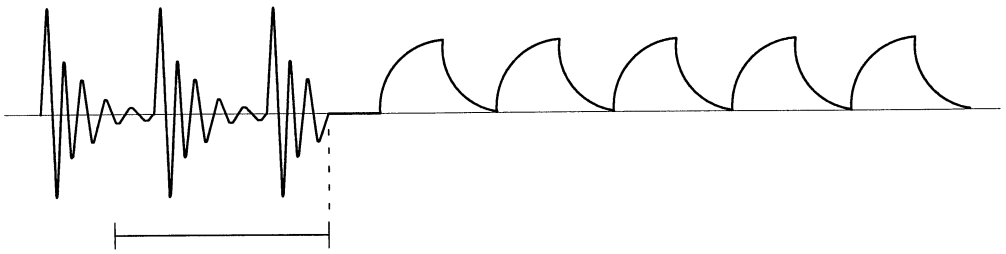
Header: **ARBITE**XECUTE(**?**) | **ARBE**XECUTE(**?**)

Data element: **ON** | **OFF**

The initial state of the instrument is 'ARBE ON'. The same applies after '★RST', power-on or after receiving the command 'CLEAR ARBIT'.

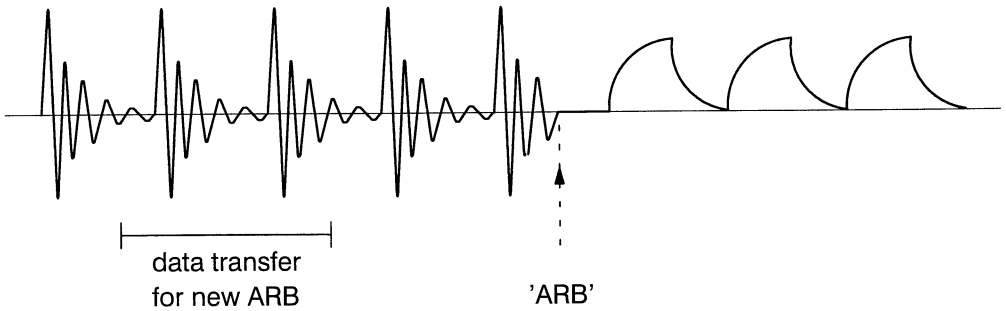
After receiving the 'ARBE ON' command, the instrument immediately generates a new arbitrary waveform and feeds it to the output after data transmission is finished.

waveform ARB



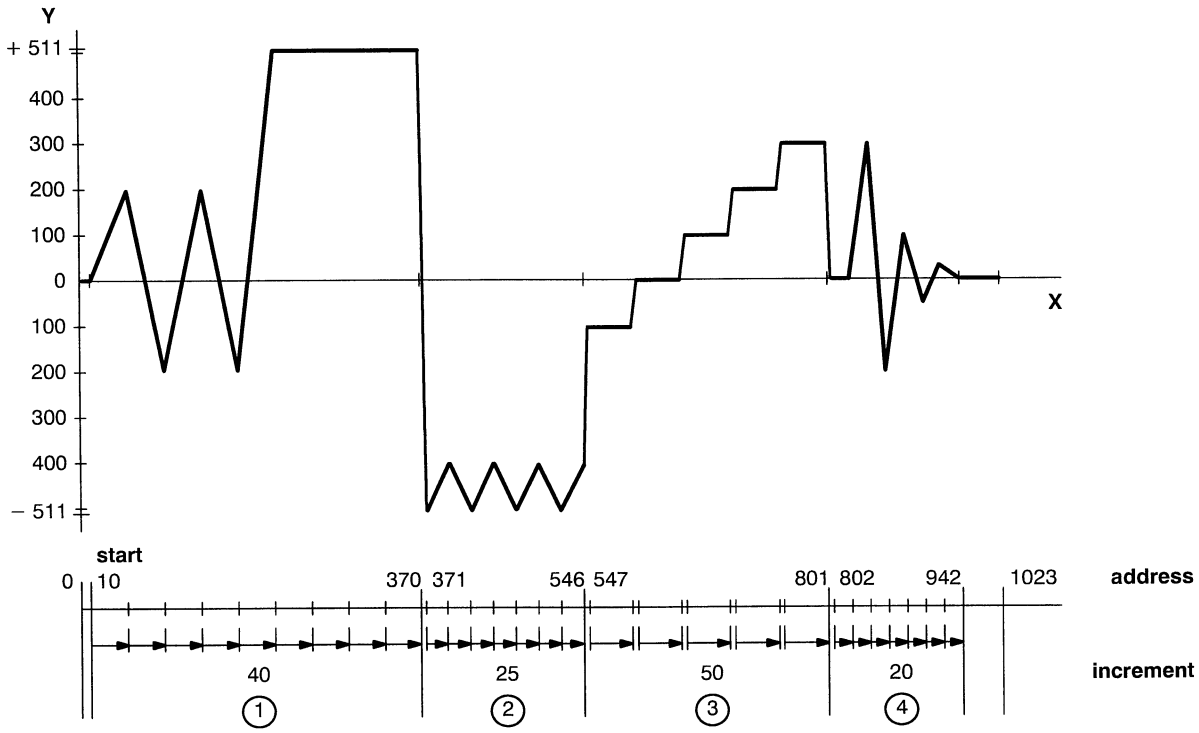
When the generator is programmed with 'ARBE OFF', the previous ARB waveform is still present at the output after data transfer of the new one until the 'ARB' command is sent.

waveform ARB



Example: Programming a waveform in four sections with different address increments

	CLEAR ARBIT	Erases the selected memory location of the EEPROM
	BEGIN 10	Start address 10
	CNT 40	Increment 40
1	DATA 10,0,200,–200, 200,–200, 511,511,511,511,511	Number of data (DATA 10,) and data input (0,200,...)
	CNT 25	Increment 25
2	DATA 8,–511,–400,–511,–400, –511,–400,–511,–400	Number of data (DATA 8,) and data input (–511,–400,...)
	CNT 50	Increment 50
	DATA 2,–100,–100	
	DATA 2,0,0	
3	DATA 2,100,100	Input of 2 data per group
	DATA 2,200,200	
	DATA 2,300,300	
	CNT 20	Increment 20
4	DATA 8,0,0,300,–200,100,–50,25,0	Input of 8 data



Samples within the count-steps are automatically interpolated and stored by the generator.

Programming in 16-Bit Hex Format (IEEE-488 interface only)

In addition to the programming with decimal values, values can also be sent in 16-bit hex format. This speeds up the transfer time.
The commands 'CNT' and 'BEGIN' remain unchanged. Instead of the decimal values 'DATA .....' in the message hexadecimal coded amplitude values are sent.

Positive values:	0 to +511 dec	=	0000 to 01FF hex
Negative values:	−1 to −511 dec	=	FFFF to FE01 hex

Before hexadecimal values are sent, the generator must get the information on how many bytes will be sent; this is similar to the information 'DATA yy,...' for the decimal transfer. At the end, the checksum (sum of the contents of all data bytes) is sent.

DATA #ZXXXX<Hy><Ly><Hy><Ly><Hy><Ly>.....<Hy><Ly><CHKS>

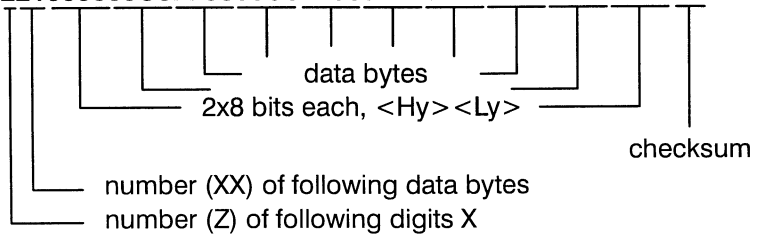
#	=	symbol to identify the data transfer in binary format
Z	=	number of following digits X
X	=	number of following data bytes including byte of the checksum
<Hy>	=	upper byte of the 16-bit data
<Ly>	=	lower byte of the 16-bit data
<CHKS>	=	checksum

The following example shows the first data set of the example on the previous page in decimal format:

DATA 10,0,200,−200,200,−200,511,511,511,511,511

16-bit hex format:

DATA #221000000C8FF3800C8FF3801FF01FF01FF01FF01FFFE



Contents of the data bytes:

Hex		Decimal
0000	=	0
00C8	=	200
FF38	=	−200
01FF	=	511

FE = lower byte of the sum of the contents of all single bytes (08FE)

3.7.5 Program Examples

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 operating system MS-DOS of the controller and the programming language QuickBasic (version 4.0 and onwards) in order to understand the examples that follow.

The programs allows to input commands via the controller keyboard and to send them via the interface to the generator.

- **Example for the IEEE-488 interface:**

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

    CLS
    PRINT " "
    PRINT " "
    PRINT "                ***** DEMO PROGRAMM FOR PM5139 *****"
    PRINT
    PRINT "                      PRESS 'RETURN' TO CONTINUE  "
    PRINT
    PRINT "              To leave running program type 'END' or 'end' "
    BEEP
    PRINT
    DO                                  'waiting for 'RETURN'
       B$ = ""
       DO UNTIL B$ <> ""
          B$ = INKEY$
       LOOP
    LOOP UNTIL B$ = CHR$(13)

    CLS                                 'clears screen
    Stp = 0
    BDNAME$ = "GEN1"                    'name of the device on the conf.table
    CALL IBFIND(BDNAME$, GEN%)          'open device
    CALL ErrChk(1, GEN%)                'check error


    IF Stp = 0 THEN
       CALL IBCLR(GEN%)                    '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 identity
            CALL SendStr(A$)                    'send command string

            WHILE Stp = 0
                 LINE INPUT "COMMAND :      ", A$    'reading keyboard input
                 IF A$ = "END" OR A$ = "end" THEN
                        CALL IBLOC(GEN%)            '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$)
    'Send command string to instrument via GPIB without response
    SHARED GEN%
    CALL IBWRT(GEN%, WR$)               'output command string
    CALL ErrChk(3, IBSTA%)              'check error
END SUB

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

    IF IBSTA% < 0 THEN
           CALL ErrChk(3, IBSTA%)          'check error
    ELSE
           Stat = 0
           CALL IBRSP(GEN%, 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(GEN%, 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$(MaxLen)            'clear response string
           CALL IBRD(GEN%, RD$)            '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(GEN%, WR$)    'output command string
               END IF
           END IF
    END IF
END SUB
```

■ Example for the RS-232 interface:

```
DECLARE FUNCTION TestCmd! (A$)
DECLARE SUB RecDat (St%)
DECLARE SUB SendCmd (Cmd%, Rsp%)
DECLARE SUB SendStr (WR$)
DECLARE SUB InitCom ()

    CLS
    PRINT " "
    PRINT " "
    PRINT "             ***** Demonstration Program for PM5139 *****"
    PRINT "             *****       with RS-232 Interface       *****"
    PRINT
    '            Enviroment : IBM AT or Compatible with Quick Basic 4.5
    Stp = 0
    A$ = ""
    CALL InitCom                        'open device

    ErrSts% = 0
    CALL SendCmd(4, 0)                  'send interface clear

    CALL SendCmd(2, 0)                  'sets instrument to remote

    A$ = "*ese 255"                     'initialize ESR register
    CALL SendStr(A$)                    'send command

    IF ErrSts% > 0 THEN                 'if no answer
       PRINT "Please check the connection and setting!"
    ELSE
       CLS                              'clears screen
       A$ = "*cls"                      'clear status register
       CALL SendStr(A$)                 'send command

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

       WHILE Stp = 0
             LINE INPUT "COMMAND :     ", A$    'reading keyboard input
             Cmd% = TestCmd(A$)           'test command
             SELECT CASE Cmd%
                CASE 0
                      CALL SendCmd(1, 1)     'set instrument to 'LOCAL'
                      CLOSE #1
                      CLS                    'clear screen
                      Stp = 1
                CASE 1 TO 8
                      CALL SendCmd(Cmd%, 1)  'send command
                CASE IS > 8
                      CALL SendStr(A$)       'send command string
             END SELECT
             PRINT
             PRINT
       WEND
    END IF
END
```

```
DATA END,end,GTL,gtl,GTR,gtr,GTR,gtr,DCL,dcl,LLO,llo,LLO,llo,STB,stb,DTR,dtr

SUB InitCom
    'Inilize serial communication channel
    PRINT "Please set the RS-232 parameters of the PM5139 to : "
    PRINT "          Baudrate  : 9600"
    PRINT "          Parity    : n"
    PRINT "          Data      : 8"
    PRINT "          Handshake : on"
    PRINT "          Wire      : 3"
    PRINT
    PRINT "Which communucation port of the PC do You use ? "
    PRINT "             COM1    [1]"
    PRINT "             COM2    [2]             please select : ";
    C$ = ""
    DO UNTIL (C$ = "1" OR C$ = "2")
       C$ = INKEY$
    LOOP
    PRINT C$
    ComStr$ = "COM" + C$ + ":9600,N,8,1,CS,DS,LF"
    PRINT
    OPEN ComStr$ FOR RANDOM AS #1
    PRINT "Special commands :         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 program type 'END' or 'end'.       Press a key to continue ";
    PRINT
    BEEP
    C$ = ""
    DO WHILE C$ = ""                        'waiting for a key
       C$ = INKEY$
    LOOP
    PRINT
    PRINT
END SUB

SUB RecDat (Rsp%)
   SHARED stb%, ErrSts%
   Tr = TIMER
   RD$ = ""
   C$ = ""
   DO UNTIL (C$ = CHR$(10) OR (TIMER - Tr > 3))
      IF LOC(1) > 0 THEN
            C$ = INPUT$(1, #1)
            IF C$ <> CHR$(10) THEN
               RD$ = RD$ + C$
               C$ = ""
            END IF
      END IF
```

```
   LOOP
   IF (TIMER - Tr > 3) THEN
      ErrSts% = 1
      PRINT "**** receive timeout ****"
      PRINT
   ELSE
      ErrSts% = 0
      IF Rsp% = 0 THEN
            stb% = VAL(RD$)
      ELSE
            PRINT
            PRINT "RESPONSE :     " + RD$   'response string
            PRINT
      END IF
   END IF
END SUB

SUB SendCmd (Cmd%, Rsp%)
    'Send command string to instrument via serial bus without response
    WR$ = CHR$(27) + CHR$(Cmd% + 48)
    PRINT #1, WR$                          'output command string
    IF Cmd% = 7 THEN                       'if statusbyte requested
       CALL RecDat(Rsp%)                   'get status byte
    END IF
END SUB

SUB SendStr (WR$)
    'Send command string to instrument via serial bus with response
    SHARED stb%
    qry = 0                                'query flag
    WR$ = WR$ + CHR$(10)                   'append LF
    PRINT #1, WR$                          'output command string

    IF INSTR(WR$, "?") > 0 THEN            'check if query command
          MaxLen = 164                        'max. length of response string
          RD$ = SPACE$(MaxLen)                'clear response string
          CALL RecDat(1)                      'get response string
    END IF

    stb% = 0
    CALL SendCmd(7, 0)                     'ask for status byte
    IF (stb% AND 16) THEN                  'checks whether MAV is set
       qry = 1
    END IF
    IF (stb% AND 32) THEN                  'checks whether ESB is set
       BEEP
       WR$ = "err?" + CHR$(10)             'error query
       PRINT #1, WR$                       'output command string
       qry = 1
    END IF
```

```
    IF qry = 1 THEN
           CALL RecDat(1)                  'get error string
           WR$ = "*cls" + CHR$(10)         'clear status register
           PRINT #1, WR$                   'output command string
    END IF
END SUB

FUNCTION TestCmd (A$)
   RESTORE
   Cmd% = 100
   i% = 0
   DO UNTIL Cmd% < 100 OR i% > 17
      READ b$
      IF A$ = b$ THEN
            Cmd% = i% \ 2
      END IF
      i% = i% + 1
   LOOP
   TestCmd = Cmd%
END FUNCTION
```

3.7.6 Error Messages

After receiving the query 'ERR?' the PM5139 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 Section
ERROR 0/NO ERROR	
ERROR 101/SYNTAX ERROR	3.7.4 / 3.7.7
ERROR 102/ILLEGAL HEADER	3.7.4 / 3.7.7
ERROR 103/BODY SYNTAX ERROR	3.7.4 / 3.7.7
ERROR 104/DATA OUT OF RANGE	3.7.4 / 3.7.7
ERROR 105/NO QUERY HEADER	3.7.4 / 3.7.7
ERROR 107/FREQUENCY OUT OF RANGE	3.5.4
ERROR 108/STOP FREQUENCY OUT OF RANGE	3.5.7.5
ERROR 109/AMPLITUDE OUT OF RANGE	3.5.5
ERROR 110/DC OFFSET OUT OF RANGE	3.5.5.1
ERROR 111/MOD.FREQUENCY OUT OF RANGE	3.5.7
ERROR 112/AM DEPTH OUT OF RANGE	3.5.7.1
ERROR 113/FM DEVIATION OUT OF RANGE	3.5.7.2
ERROR 114/SWEEP TIME OUT OF RANGE	3.5.7.5
ERROR 115/BURST PERIOD OUT OF RANGE	3.5.7.6
ERROR 116/BURST PHASE OUT OF RANGE	3.5.7.6
ERROR 117/DUTY CYCLE OUT OF RANGE	3.5.6
ERROR 118/ILLEGAL SWEEP MODE	3.5.7.5
ERROR 119/AMPLITUDE+DC OFFSET OUT OF RANGE	3.5.5.1
ERROR 120/INCOMPATIBLE FREQUENCY / WAVEFORM	3.5.4
ERROR 121/INCOMPATIBLE AMPLITUDE / WAVEFORM	3.5.4
ERROR 122/INCOMPATIBLE DUTY CYCLE / WAVEFORM	3.5.6
ERROR 123/INCOMPATIBLE DUTY CYCLE / FREQUENCY	3.5.6
ERROR 124/INCOMPATIBLE FREQUENCY / BURST PARAMETERS	3.5.7.6
ERROR 125/NO EXTERNAL MODULATION POSSIBLE	3.7.4.5
ERROR 127/NO EXTERNAL TRIGGER POSSIBLE	3.7.4.5
ERROR 128/ILLEGAL REGISTER ADDRESS	3.5.8 / 3.7.4.4
ERROR 129/NO DATA STORED	3.5.8
ERROR 130/OUTPUT OVERLOADED	3.5.9 / 3.7.4.5 / 4.7
ERROR 131/NO ARBITRARY DATA	3.7.4.6
ERROR 132/CHECKSUM ERROR	3.7.4.6
ERROR 133/VALUE OUT OF RANGE	3.7.4.6
ERROR 134/ADDRESS OUT OF RANGE	3.7.4.6
ERROR 135/TIME OUT	
ERROR 136/STOP SWEEP FIRST	3.7.4.5
ERROR 137/EEPROM ERROR	3.5.9.1
ERROR 138/AMPLITUDE OF ARBITRARY OUT OF RANGE	3.7.4.6 / 4.10.4
ERROR 139/AMPLITUDE CORRECTED	3.7.4.6 / 4.10.4
ERROR 140/HOLD NOT POSSIBLE	3.7.4.5
ERROR 141/NO SWEEP SELECTED	3.7.4.5
ERROR 142/NO BURST SELECTED	3.7.4.5
ERROR 143/EXTERNAL RAM ERROR	3.5.9
ERROR 144/BACKUP ERROR	3.5.9
ERROR 145/NO TRIGGER POSSIBLE	3.7.4.5
ERROR 146/NO OUTPUT DATA AVAILABLE	3.7.4.3
ERROR 147/OUTPUT DATA DESTROYED	3.7.4.3
ERROR 148/INCOMPATIBLE WAVEFORM / MODULATION	3.5.4
ERROR 149/INCOMPATIBLE MOD.FREQUENCY / MODULATION	3.5.4
ERROR 150/INCOMPATIBLE STOP FREQUENCY / WAVEFORM	3.5.7.5
ERROR 151/INCOMPATIBLE FREQUENCY / FM–DEVIATION	3.5.4
ERROR 152/INCOMPATIBLE FREQUENCY / STOP FREQUENCY	3.5.7.5
ERROR 153/ILLEGAL MEMORY ADDRESS	3.7.4.6
ERROR 199/UNKNOWN ERROR	

3.7.7 Commands in Alphabetic Order

Allowed abbreviations are printed in bold letters

3.7.7.1 Common Commands and Queries (IEEE-488.2):

Command/Query	Description	Page
★**CLS**	Sets 'Standard Event Status Register' and 'Status Byte Register' to zero	3 – 41
★**ESE** <NRf>	'Standard Event Status Enable' command	3 – 42
★**ESE?**	'Standard Event Status Enable' query	3 – 42
★**ESR?**	Reads 'Standard Event Status Register'	3 – 42
★**IDN?**	Identification query	3 – 40
★**LRN?**	Asks for instrument settings	3 – 40
★**OPC**	'Operation Complete' command	3 – 41
★**OPC?**	'Operation Complete' query	3 – 41
★**RCL 1** to **9**	Recall command	3 – 42
★**RST**	Reset command	3 – 40
★**SAV 1** to **9**	Save command	3 – 42
★**SRE** <NRf>	'Service Request Enable' command	3 – 42
★**SRE?**	'Service Request Enable' query	3 – 42
★**STB?**	Read status byte query	3 – 42
★**TRG**	Trigger command	3 – 41
★**TST?**	Self-test query	3 – 41
★**WAI**	Wait-to-Continue command	3 – 41

3.7.7.2 Device-Specific Commands:

Command/Query	Description	Page
AC ON|**OFF**	AC amplitude on/off	3 – 44
ACON	AC amplitude on	3 – 44
ACOFF	AC amplitude off	3 – 44
AM	Amplitude modulation	3 – 45
AMDEPTH(**?**) <NRf>	Modulation depth for AM	3 – 46
AMPLTUDE(**?**) <NRf>	Output amplitude	3 – 44
AMSWEEP **LIN**|**LOG**	AM combined with sweep	3 – 45
ARB(**?**) **1** to **24**	Free programmable waveform	3 – 48
ARBITRARY(**?**) **1** to **24**	Free programmable waveform	3 – 48
ARBITEXECUTE(**?**) **ON**|**OFF**	Execution of arbitrary waveform	3 – 49
ARBEXECUTE(**?**) **ON**|**OFF**	Execution of arbitrary waveform	3 – 49
ARBSELECT(**?**) **1** to **24**	Memory place 1 to 24 for ARB waveform	3 – 48
BEGIN(**?**) **0** to **1023**	Start address for ARB programming	3 – 48
BURST	Selects modulation mode burst	3 – 45
BURST **ON**|**OFF**	Starts burst respectively sets to not triggered	3 – 45

Command/Query	Description	Page
CLEAR ARBIT	Erases data of selected arbitrary waveform	3 – 48
CNT(?) **1** to **255**	Address increment for ARB programming	3 – 48
COUNT(?) **1** to **255**	Address increment for ARB programming	3 – 48
CONTINUOUS	Starts continuous burst respectively sweep	3 – 45
DATA ....,...,...	Data for free programmable waveform ARB	3 – 48
DUTYCYCLE(?) <NRf>	Asymmetry of output signal	3 – 44
DCOFFSET(?) <NRf>	DC offset	3 – 44
DC ON|**OFF**	DC offset on/off	3 – 44
DCON	DC offset on	3 – 44
DCOFF	DC offset off	3 – 44
ENABLE	Resets tripped power protection (RPP)	3 – 46
ERROR?	Error query	3 – 59
FILL **–511** to **+511**	Sets all data of ARB to the same value	3 – 48
FM	Frequency modulation	3 – 45
FMDEVIATION(?) <NRf>	Deviation for frequency modulation	3 – 46
FREQ(?) <NRf>	Carrier frequency	3 – 43
GATE	Gating	3 – 45
HAVERSINE	Haversine	3 – 44
HOLD	Stops amplitude at its present value	3 – 46
LOWIMP(?) **ON**|**OFF**	Output impedance 50 Ω or LOW Zo	3 – 46
LOIMP(?) **ON**|**OFF**	Output impedance 50 Ω or LOW Zo	3 – 46
MODOFF	Modulation off	3 – 45
MODFREQ(?) <NRf>	Modulation frequency	3 – 46
MODLNFREQ(?) <NRf>	Modulation frequency	3 – 46
MODLN(?) **AM**|**FM**|**PSK**|**GATE**|**BUR**ST|**OFF**	Modulation mode	3 – 45
MODSRC(?) **INT**|**EXT**	Modulation signal source	3 – 46
NEGPULSE	Negative square pulse	3 – 44
NEGSAWTOOTH	Negative sawtooth	3 – 44
ONPERIODS(?) <NRf>	Periods per burst	3 – 46
OUTPUT?	Output status query	3 – 46
POSPULSE	Positive square pulse	3 – 44
PULSE	Positive square pulse	3 – 44
POSSAWTOOTH	Positive sawtooth	3 – 44
PSK	Phase shift keying	3 – 45
RELEASE	Releases the HOLD function	3 – 46

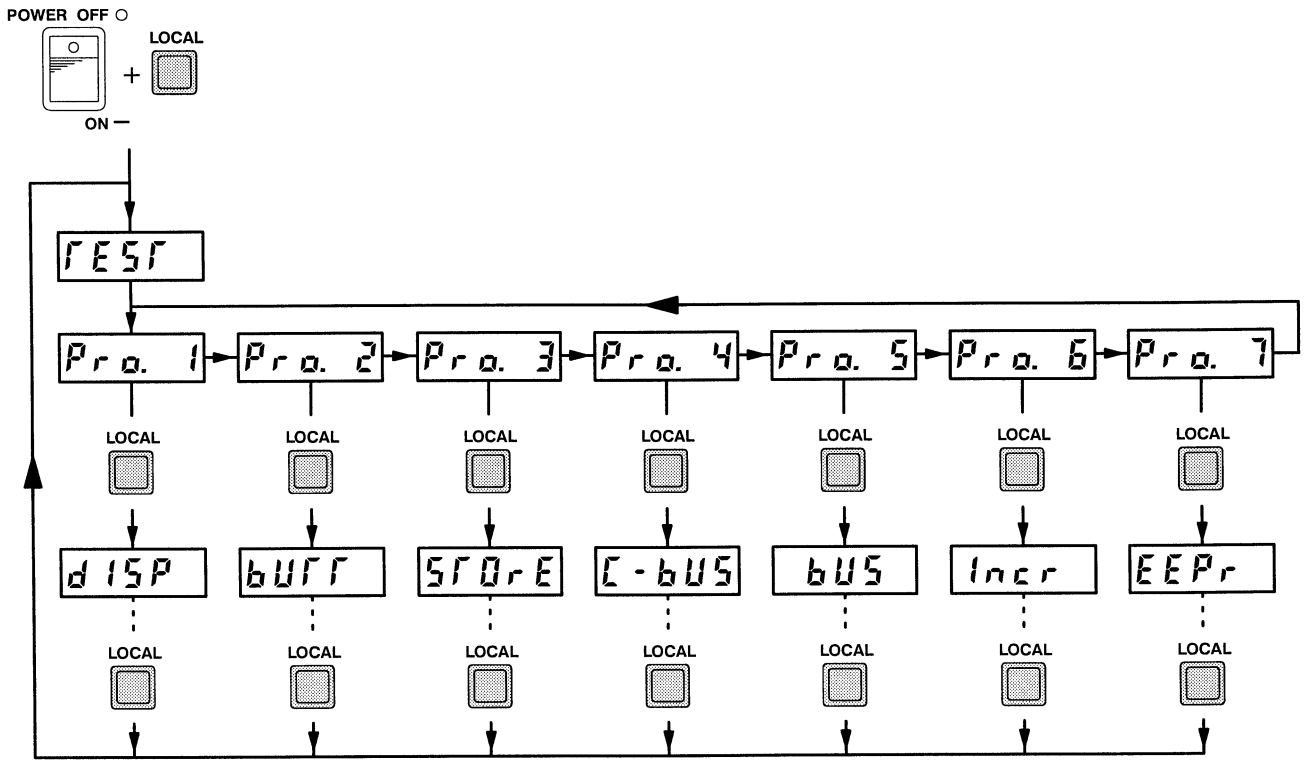
Command/Query	Description	Page
SAWTOOTH	Positive sawtooth	3 – 44
SINE	Sine wave	3 – 44
SINEPULSE	Sine pulse	3 – 44
SINGLE	Starts single burst respectively sweep	3 – 45
SQUARE	Square wave	3 – 44
SQR	Square wave	3 – 44
STARTPHASE(**?**) **–18o** to **+180**	Start/stop phase for burst	3 – 46
STPHASE(**?**) **–18o** to **+180**	Start/stop phase for burst	3 – 46
STARTFREQ(**?**) <NRf>	Start frequency for sweep	3 – 43
STFREQ(**?**) <NRf>	Start frequency for sweep	3 – 43
STOPFREQ(**?**) <NRf>	Stop frequency for sweep	3 – 43
SWEEP(**?**) **LIN**|**LOG**|**ON**|**OFF**	Sweep selection	3 – 45
SWEEPTIME(**?**) <NRF>	Sweeptime	3 – 46
SWEEPMODE(**?**) **1** to **3**	Sweep mode	3 – 46
SYMMETRY(**?**) **ON**|**OFF**	Symmetry on or off	3 – 44
TRIGFUNCTION(**?**) **CONT**|**SINGL**	Trigger function	3 – 46
TRGFUNCTION(**?**) **CONT**|**SINGL**	Trigger function	3 – 46
TRIGSRC(**?**) **INT**|**EXT**	Trigger signal source	3 – 46
TRGSRC(**?**) **INT**|**EXT**	Trigger signal source	3 – 46
TRM <NRf>	Sets message terminator	3 – 38
TRNGLE	Triangle wave	3 – 44
TRNGLPULSE	Triangle pulse	3 – 44
WAVEFORM**?**	Waveform query	3 – 44

3.8 TEST PROGRAM

The test program of the PM5139 contains the following seven subprograms:

1. Display test
2. Keyboard test
3. Memory register test
4. Strobe test (test of the internal interfaces)
5. Interface test (RS-232 or IEEE-488)
6. Rotary knob test
7. EEPROM test (PM5139/02 and PM5139/03 only)

The test program is activated by pressing the LOCAL key for about 3 seconds, while the instrument is being switched on, or by pressing the LOCAL key and pressing the concealed RESET key. The self-test routine is followed by the word "TEST" in the display followed by the menu of subprograms 1 to 7. Press the LOCAL key briefly to select and carry out the test required. Press LOCAL again for about 1 second to return to the subprogram menu. To leave the test program, either press RESET or turn off the instrument.



Program 1: Display Test

This test checks the operation of the liquid crystal display and the respective decoders/drivers.

When the text "Pro. 1" appears in the subprogram menu, press the LOCAL key to select the display test. The letters "dISP" appear in the display, whereupon each segment of the display is switched on one after the other. The generator waits with its total display lit up until either you press LOCAL to take it back to the program menu or until you leave the test program.

Program 2: Keyboard Test

This test checks the function of each key as well as those of the keyboard decoder.

Select this test and the letters "bUTT" (button) appear in the display. Press any key at random, except LOCAL, and the current number of this key will appear in the display together with a control number, e.g., 12–2 when key DC is pressed. This control number is generated by the keyboard decoder and can be changed to 0, 1, 2, or 3 by pressing this key again. The keys are numbered row by row from left to right. Thus, for example, the key SINGLE has the number 5 and the key ADDR the number 11.
To return to the program menu, press LOCAL.

Program 3: Memory Register Test

This test checks the memory registers 1 to 9 for the storage of the generator settings and register 0 which stores the last setting before the instrument is switched off. The contents of these registers are not written over or deleted during the test and can be used as normal when the test has been completed.

This test runs automatically. The display continually shows the numbers of the registers being tested. If the test is finished without detecting any errors, the display will read "PASS"; if it finds an error, then it will read "Error".
To return to the program menu, press the LOCAL key.

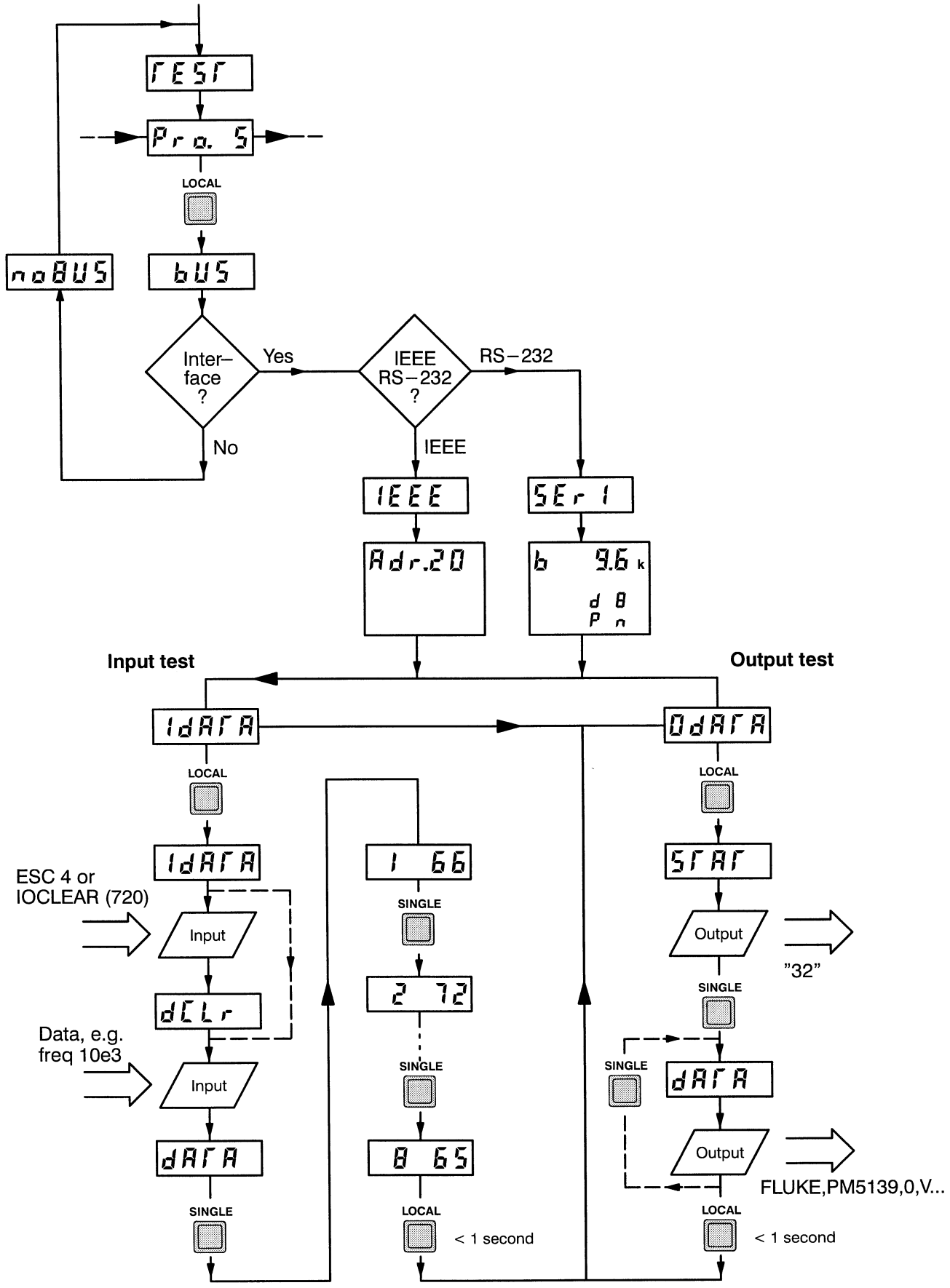
Program 4: Strobe Test (Test of the internal interfaces)

This test serves to test the internal data transfer to the shift registers whose outputs can be set to "High" or "Low" at the touch of a key. The purpose of the test is to help the Service Technician locate an error. Details are given in the Service Manual.

Program 5: Interface Test (RS-232 or IEEE-488)

This test checks the built-in interface, its input and output buffers, and the correct coding and decoding of the data transferred.

The test automatically checks which interface is actually available; if none, "noBUS" will appear in the display and the instrument returns to the program menu. In instruments with an interface, there is a choice between an input test ("IdATA") and an output test ("OdATA"). Selection is done by pressing the LOCAL key. For the IEEE-488 interface the device address is set to 20. The configuration for the RS-232 interface is: Baud rate 9600, data bits 8, parity no. Using the RS-232 Interface the instrument must be set with ESC 2 to remote.


rESr
Pro. 5
LOCAL
noBUS
bUS
Inter–face ?
Yes
No
IEEE RS–232 ?
RS–232
IEEE
IEEE
Adr.20
SEr 1
b 9.6 k
d 8
P n
Input test
Output test
IdArA
OdArA
LOCAL
LOCAL
IdArA
ESC 4 or IOCLEAR (720)
Input
dCLr
Data, e.g. freq 10e3
Input
dArA
SINGLE
1 66
SINGLE
2 72
SINGLE
8 65
LOCAL
< 1 second
SrAr
Output
"32"
SINGLE
SINGLE
dArA
Output
FLUKE,PM5139,0,V...
LOCAL
< 1 second

Input test:

The display shows "dCLr" when the interface command "IOCLEAR(720)" or "ESC 4" has been received. When data to set the instrument are received, the display will show "dATA", and the first eight figures of the string can be shown individually in hexadecimal form by pressing the SINGLE or CONT keys. The data input can be repeated as often as desired.

Press LOCAL for less than 1 second and the program will return to the selection between input and output test.

Output test:

The letters "STAT" appear. All bits of the Standard Event Status Register are set to "1". If the bits of the Standard Event Status Enable Register were set to "1" with the command ⋆ESE 255 the MAV bit of the Status Byte Registers will be set to "1". The controller can ask for the contents of the Status Byte with serial poll or with the query ⋆STB? (IEEE-488) respectively with ESC 7 for the RS-232 interface. The Standard Event Status Register can also be read out by a controller with query ⋆ESR?. The SINGLE or CONT keys set the bits to "0", the letters "dATA" appear in the display, and the controller can read in the identification string "FLUKE,PM5139,0,Vx.x" (x.x = software version).

Press LOCAL for less than 1 second and the program returns to the selection between the input and output test; press LOCAL longer, and the program returns to the test program menu.

Program 6: Rotary Knob Test

This test checks whether the direction of rotation is recognized (display "L" or "r"). The display also shows a number of pulses, dependent on the speed of rotation. "Error" shows that there may be an error.

Program 7: EEPROMs Test (PM5139/02 and PM5139/03 only)

This test checks the memory registers for the arbitrary waveforms. The contents of these registers are not written over or deleted during the test. If the test finishes without detecting any errors, the display reads "PASS"; if the test finds an error, the display reads "Error".
To return to the program menu, press the LOCAL key.

4 CHARACTERISTICS

4.1 SAFETY AND EMC REQUIREMENTS

The PM5139 Function Generator 0.1 mHz – 20 MHz is

in accordance with EN 61010-1 (safety requirements),
an instrument for measurement and test including accessories
- intended for professional, industrial process, and educational use.
- Overvoltage Category II, Pollution Degree 2.

in accordance with EN 55011 (radio interference suppression),
an ISM equipment (industrial, scientific, and medical RF-equipment)
- of Group I,
  which intentionally generates and/or uses conductively coupled radio frequency energy which is necessary for the internal functioning of the equipment itself.
- of Class B,
  suitable for use in domestic establishments and in establishments directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

in accordance with EN 50082-1 (radio frequency immunity)
an instrument for use in all locations which
- are characterized by being supplied directly at low voltage from the public mains.
- are considered to be residential, commercial or light-industrial, both indoor and outdoor.

4.2 PERFORMANCE CHARACTERISTICS, SPECIFICATIONS

Properties expressed in numerical values with stated tolerances are guaranteed by the manufacturer. Specified non-tolerance numerical values indicate those that could be nominally expected from the mean of a range of identical instruments.
This specification is valid after the instrument has warmed up for 30 minutes and the generator output terminated with a 50 ohm load. For reference conditions see Sections 4.14 and 4.15. If not stated otherwise, relative or absolute tolerances relate to the set value.

4.3 FREQUENCY, RESOLUTION

Frequency range		0.1 mHz	–	20 MHz	Depending on function and waveform	
Subranges	I	0.1 mHz	–	0.2 Hz	Resolution	0.1 mHz
	II	1 mHz	–	2 Hz		1 mHz
	III	10 mHz	–	20 Hz		10 mHz
	IV	100 mHz	–	200 Hz		100 mHz
	V	1 Hz	–	2 kHz		1 Hz
	VI	10 Hz	–	200 kHz		10 Hz
	VII	100 Hz	–	2 MHz		100 Hz
	VIII	1 kHz	–	20 MHz		1 kHz

Display	LCD: liquid crystal backlit display	
Setting	2 step keys, rotary knob	÷10 x10
Setting error limit	±2 ppm	
Temperature Coefficient limit	±0.2 ppm/K	
Short-term drift	±0.25 ppm	Within 15 min
Long-term drift	±0.3 ppm	Within 7 hours
Aging rate	±1 ppm	Within 1 year
Frequency noise	<10 ppm, typ. 1 ppm	f ≤ 10 MHz } meas. bandwidth
rms deviation	<100 Hz, typ. 13 Hz	f > 10 MHz } 10 Hz – 20 kHz

4.4 SYNCHRONIZATION

External frequency	10 MHz/N	N = 1, 2, 3 ... 10
Capture range	±0.2 %	
Lock-in time	<2 s	
Input terminal	REFERENCE INPUT	BNC connector
– Input impedance	50 Ω	
– Input waveform	Sine, square	
– Input level	0 – 20 dBm	
Output terminal	10 MHz OUTPUT	Short-circuit proof
– Output level	2 dBm, >0 dBm	at 50 Ω load
– Output impedance	50 Ω	
– Output frequency	10 MHz	Error limits and temperature coefficient as output frequency; several instruments can be synchronized by a single reference

4.5 WAVEFORMS

		Frequency range
Selectable waveforms	Sine	0.1 mHz – 20 MHz
	Triangle	0.1 mHz – 0.5 MHz
	Square	0.1 mHz – 20 MHz
	Pos. pulse	0.1 mHz – 20 MHz } 10 MHz
	Neg. pulse	0.1 mHz – 20 MHz } for LOW Zo
	Pos. sawtooth	0.1 mHz – 50 kHz
	Neg. sawtooth	0.1 mHz – 50 kHz
	Haversine	0.1 mHz – 50 kHz
	Sine pulse	0.1 mHz – 50 kHz
	Triangle pulse	0.1 mHz – 50 kHz
	Arbitrary (ARB)	0.1 mHz – 20 kHz (see Sect. 4.10)

Asymmetry	1 % – 99 % Resolution 1 %	≤20 kHz; sine, square, triangle, pos./neg. pulses
	20 % – 80 % Resolution 1 %	20 kHz – 5 MHz; square, pos./neg. pulses
Asymmetry	±0.1 %	<20 kHz
Absolute error limits	±1.0 %	20 kHz – 1 MHz
	±2.0 %	>1 MHz– 2 MHz
	±5.0 %	>2 MHz– 5 MHz

4.6 WAVEFORM CHARACTERISTICS

4.6.1 Sine Wave

	1 Hz – 0.5 MHz	> 0.5 – 5 MHz	> 5 MHz	> 10 MHz	Amplitude > 20 mV, MOD OFF
THD	< 0.4 %	–	–	–	Amplitude < 70 % of subrange maximum
Harmonics *	< –48 dBc	< –40 dBc	< –36 dBc	< –34 dBc	Amplitude < 70 % of subrange maximum
Sub-harmonics	< –60 dBc	< –60 dBc	< –38 dBc	< –38 dBc	–
Non-harmonics	< –37 dBc	< –37 dBc	< –37 dBc	< –37 dBc	30 kHz band centered on carrier and frequencies > 100 MHz excluded
Phase noise	< –80 dBc/Hz	< –80 dBc/Hz	< –80 dBc/Hz	< –80 dBc/Hz	At 1 kHz distance from carrier

* Add +6 dBc for amplitudes higher than 70 % of subrange maximum

4.6.2 Square Wave and Rectangular Pulses

Rise/fall time		For MOD OFF and 50 % symmetry setting
	≤30 ns	f ≤500 kHz
	≤20 ns	f >500 kHz
Aberration (overshoot, ringing, tilt)	±2 %	Amplitude >100 mV

4.6.3 Triangle and Sawtooth

Linearity error	<0.2 %	f <20 kHz

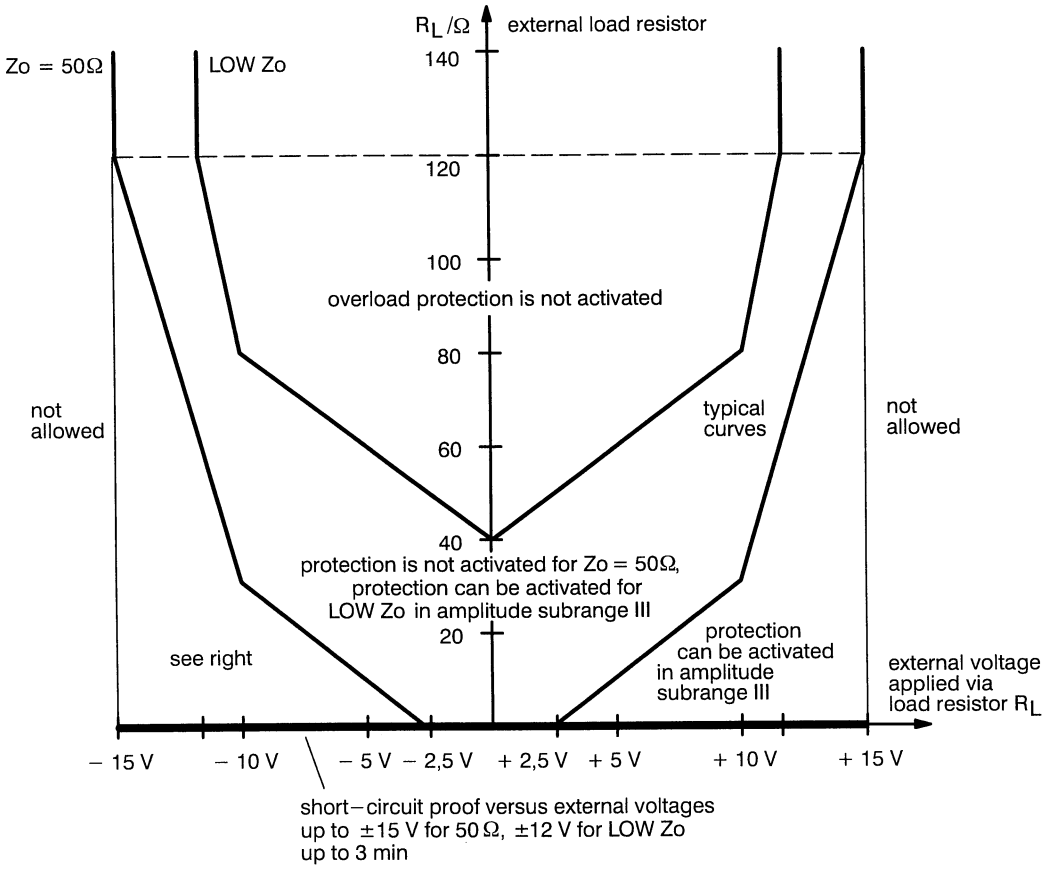
4.7 SIGNAL OUTPUT

Output Impedance	50 Ω LOW Zo	
LOW Zo		AC amplitude ≥2.0 V
Impedance	Zo = 0.36 Ω + 32 Ω x (f/20 MHz)	
Max. current range	−250 mA ... +250 mA	
Min. load resistor	40 Ω	AC amplitude ≥10 V
	V/250 mA	AC amplitude <10 V
	(≙ 40 Ω for 10 V)	
AC Output Amplitude	0 – 20 V	pp, open circuit voltage
Subrange I	0 – 0.200 V	Resolution 1 mV
II	0.20 – 2.00 V	10 mV
III	2.0 – 20.0 V	100 mV
	Half the amplitude values for pulses, sawtooth, haversine	

	<0.2 MHz	0.2 – 5 MHz	5 – 10 MHz	>10 MHz	Amplitude
Error limits for MOD OFF, FM, SWEEP	±2.0 %	±2.5 %	±4.0 %	±6 %	0.01 – 20 V
Amplitude flatness for MOD OFF, FM, SWEEP	±0.1 dB ±0.03 dB typ.	±0.2 dB ±0.07 dB typ.	±0.25 dB 0.1 dB typ.	±0.5 dB ±0.4 dB typ. ±0.15 dB typ.	0.01 – 20 V 2.0 – 20 V

Temp. coeff. limits for MOD OFF, FM, SWEEP	±0.1 %/K ±0.15 %/K	≤5 MHz >5 MHz
DC Offset Voltage	−10.0 V ... +10.0 V	Open circuit; resolution 0.1 V, can be set independently on the ac amplitude within a ±10 V window
Error limits	±2 % ±50 mV	
Temperature coeff.	±2.0 mV/K ±2.5 mV/K	For MOD OFF, FM, SWEEP For AM, PSK, GATE, BURST
Output Load Capability	Short-circuit proof	Max. external voltage ±15 V for Zo 50 Ω, ±12 V for LOW Zo, up to 3 min
Max. capacitive load, not activating the protector	100 nF 0.5 nF 1.0 nF	Zo 50 Ω LOW Zo, pos./neg. pulse LOW Zo, other waveforms

Overload Protection Can be activated in amplitude subrange III with respect to the conditions shown in the diagram; it protects the instrument



See also Section 3.5.9.2: Error 5

4.8 MODULATION

Carrier waveforms	all	Except PSK, see Section 4.8.3
Internal modulation frequency	10 Hz – 100 kHz	Sine wave for AM, FM TTL signal for PSK, GATE, BURST
Subranges	10 Hz – 100 Hz	Resolution 1 Hz
	100 Hz – 1 kHz	10 Hz
	1 kHz – 100 kHz	100 Hz
Additional for BURST	0.001 Hz – 0.1 Hz	0.001 Hz
	0.1 Hz – 1 Hz	0.01 Hz
	1 Hz – 10 Hz	0.1 Hz
Error limits	±0.1 %	

4.8.1 Amplitude Modulation (AM)

Carrier frequency range	Total range	Related to waveform
Carrier amplitude pp for m = 0	Reduced by 6 dB	
Envelope THD for m ≤90 %	<0.7 % <0.5 %; typ. 0.15 %	f ≤15 MHz

Amplitude Modulation, Internal

Modulation depth	m = 0 – 100 %	Resolution 1 %
Absolute error limits	±1 % ±2 % ±4 %	Mod. freq. ≤20 kHz, carrier ≤2 MHz Mod. freq. ≤20 kHz, carrier ≤5 MHz General

Amplitude Modulation, External

Mod. frequency range	0 – 200 kHz	
Modulation depth	m = 0 – 100 %	
Mod. input voltage, pp	1 V for m = 100 %	+0.5 V DC: 0 % of AC display 0 V DC: 50 % of AC display −0.5 V DC: 100 % of AC display

4.8.2 Frequency Modulation (FM)

Carrier freq. range	Complete ranges	Related to waveform
Modulation THD	<0.4 %, typ. 0.12 %	For 1 % deviation
Residual FM		As unwanted FM deviation, see Section 4.3

Frequency Modulation, Internal

Frequency deviation	0 – 2 %	Resolution 0.01 %
Absolute error limits	±0.03 % ±0.2 %	Mod. freq. ≤20 kHz General

Frequency Modulation, External

Mod. freq. range	10 Hz – 200 kHz	
Frequency deviation	0 – 2 %	
Mod. input voltage, pp	1 V	For 2 % frequency deviation

4.8.3 Phase Shift Keying (PSK)

The carrier phase is keyed between 0° and 180° (π); non-coherent

Carrier waveforms	Sine, triangle, square	
Carrier freq. range	Total range	Related to waveform

Phase Shift Keying, Internal

Keying frequency	10 Hz – 100 kHz	
Duty cycle	50 %	

Phase Shift Keying, External

Keying frequency	0 – 200 kHz	TTL signal
Phase difference OUTPUT to TTL OUTPUT	0° for f ≤ 20 kHz 180° for f > 20 kHz	MOD IN high MOD IN high

4.8.4 Gate

The modulating signal switches the carrier on and off; non-coherent

Carrier freq. range	Total range	Related to waveform

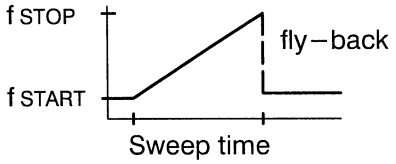
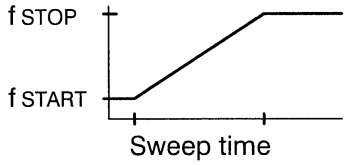
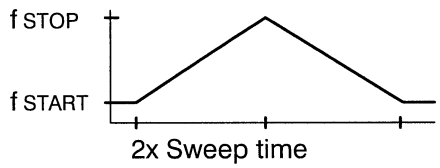
Gate, Internal

Keying frequency	10 Hz – 100 kHz	
Duty cycle	50 %	

Gate, External

Keying frequency	0 – 200 kHz	TTL signal
Relation OUTPUT/ MOD INPUT	Output signal blanked	For MOD INPUT high

4.8.5 Sweep

Sweep operating modes	SINGLE sweep CONTinuous sweep	
	HOLD/release	Stops and releases the sweep
	Reset to fSTART	By pressing SINGLE respectively CONT once more
Sweep characteristic	Linear Logarithmic	
	Up Down	fSTART < fSTOP fSTART > fSTOP
Mode – 1 –	Sweep runs from fSTART to fSTOP, fly-back to fSTART	
Mode – 2 –	Sweep runs from fSTART to fSTOP and remains at fSTOP	
		For CONT mode 1 and mode 2 are identical
Mode – 3 –	Sweep runs from fSTART to fSTOP and back to fSTART	
Carrier waveforms	all	
Max. sweep range	1 mHz – 10 MHz 50 kHz – 20 MHz	If fSTART or fSTOP >10 MHz
Sweep time T	10 ms – 1000 s	
Resolution for Sweep time	10 ms 100 ms 1 s	10 ms – 10 s 10 s – 100 s 100 s – 1000 s
Number of frequency steps	1000 per second = 1 step per 1 ms	

4.8.6 Burst

Carrier on/off switching with selectable ON periods per burst; phase-coherent

Burst modes	Internal burst External burst Single burst Continuous burst	
Carrier waveforms	All	

Carrier Frequency Range

– For INT CONT burst		Related to selected waveform, but max. 2 MHz and min. freq. >1.01 x (N + n) x f_{MOD} f_{MOD} = repitition frequency N = ON periods per burst n = 0; f ≤20 kHz n = 1; f >20 kHz
– For INT SINGLE burst and EXT burst		Related to selected waveform, but max. 2 MHz
ON periods per burst	N = 1 – 2000	
Start / Stop Phase (Φ)	–180° ... +180°, resol. 1° 0°	Sine, triangle, f ≤20 kHz General

Repetition Frequency

– For INT CONT burst	1 mHz – 100 kHz	Internal modulation frequency
– For EXT burst	0 – 200 kHz	
Trigger facility internal	SINGLE key CONT key	
Trigger facility external	Low-going edge of TTL signal at MOD INPUT; trigger pulses during ON periods are ignored	

4.9 STORAGE AND RECALL OF INSTRUMENT SETTINGS

Number of storage registers	10	Nonvolatile; in register 0 the actual setting is automatically stored
Storage time	Approximately 7 years (depends on the age of the battery)	
Battery	Lithium battery	

4.10 REMOTE CONTROL

All instrument functions can be remotely controlled except the sweep function HOLD. Additionally the instrument has twenty-four arbitrary waveform facilities.

The commands consists of header and data element, command set see Section 3.7.4.

Digits exceeding the resolution of the subranges are internally rounded. For frequency settings >200 kHz increased resolution of 10 Hz can be used; not for sweep.

4.10.1 IEEE-488 Interface (PM5139/02)

Galvanical insulation	opto-electronical	
Interface functions	AH1: acceptor handshake SH1: source handshake L3: listener function L1: listener only T6: talker function RL1: remote/local with local lockout	SR1: service request SRQ C0: no control function DC1: device clear function DT1: device trigger function PP0: no parallel poll E2: tri-state drivers
Device address	1 – 30, LO	LO (= 31) is reserved for listener only mode (L1)
Remote lock-out	LOCAL key	Can be disabled by LLO
Service request	Error messages, end message for single sweep or burst; Service request asks for operating by the controller	

4.10.2 RS-232 Interface (PM5139/03)

Galvanical insulation	opto-electronical
Operating modes	Communication Mode / Listener Only Mode
Baud rate	110, 150, 300, 600, 1200, 2400, 4800, 9600, or 19200 baud
Data bits	7 or 8
Stop bits	1, 2 for 110 baud
Parity check	odd, even or none (none for 8 data bits only)
X_{ON}/X_{OFF} handshake	on or off
Hardware handshake	DSR/DTR and CTS/RTS
Connector	9-pin D-connector (male)

4.10.3 Timing

Generator response time (approximately):

Frequency	7 ms
Amplitude	7 ms
Waveform	39 to 51 ms
Modulation mode	5 to 6 ms

Transfer time:

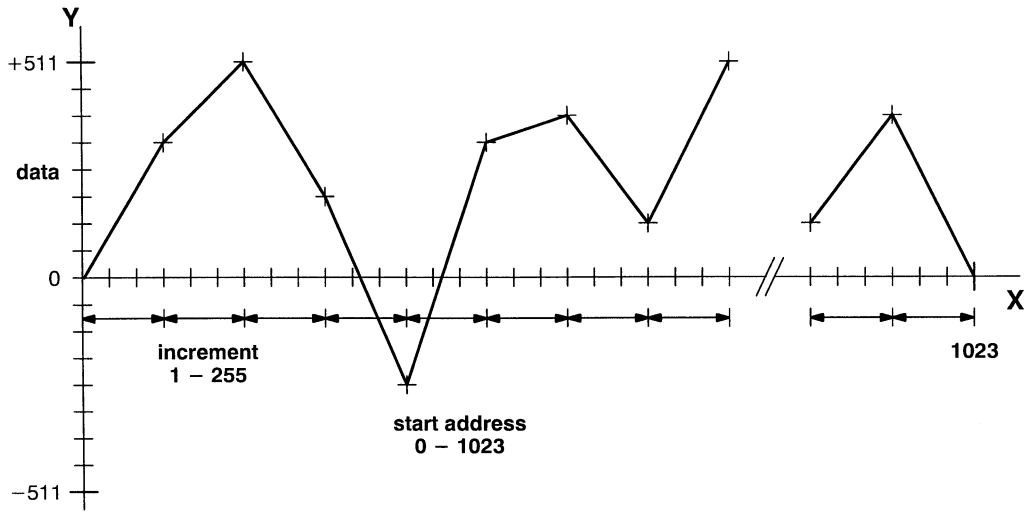
Per byte	IEEE-488	0.56 ms
	RS-232	depends on baud rate
Learn string		160 to 250 ms
Identification string		<52 ms

4.10.4 Arbitrary Waveforms

Up to twenty-four different arbitrary waveforms are defined by sample addresses (X-axis) with assigned waveform data (Y-value) which are sent as programming data to the internal generator RAM. This can be done by a controller via IEEE-488 or RS-232 interface. It can also directly be done in listener only mode by a digital storage oscilloscope using the graphic language HPGL or the Fast Transfer Mode, depending on the Philips/Fluke oscilloscope.

Start address	0 – 1023	
Address increment	1 – 255	Interval between two addresses
Waveform data	−511 to 0 to +511	Y-value
Frequency range	0.1 mHz – 20 kHz	Repetition rate of a complete ARB waveform
Max. sample rate	20.48 MS/s	For 20 kHz output frequency (MS/s = mega samples per second)
Max. output Amplitude pp, Vmax (open circuit)	$\frac{(Ymax-Ymin)}{1022}$ x 20 V	Ymax – Ymin ≥ 6 For conversion to Vpp all digits behind the 1st position behind the decimal point are ignored.

Subrange	I	0 – Vmax/100	Resolution	1 mV
	II	Vmax/100 – Vmax/10		10 mV
	III	Vmax/10 – Vmax		100 mV
Error limits		±2.0 % ±0.7 mV	Subrange	I
		±1.75 % ± 7 mV		II
		±1.5 % ± 70 mV		III



4.11 CONNECTORS

Front panel	OUTPUT	BNC connector, signal output Zo 50 Ω or LOW Zo
Rear panel	REFERENCE INPUT	BNC connector, for external synchronization, see Section 4.4.
	MOD/TRIG INPUT	BNC connector, for external modulation or trigger signal, see Section 4.8.
	10 MHz OUTPUT	BNC connector, reference output, Section 4.4.
	MODULATION OUTPUT	BNC connector, Zo = 600 Ω (1 kΩ for AM or FM int.), internal modulation signal 1 V(pp) sine wave for AM and FM INT; TTL signal for PSK, GATE and BURST, or feedthrough of MOD INPUT signal, see Section 4.8.
	PEN LIFT OUTPUT	BNC connector, electronic switch: closed 0 V / Zo = 200 Ω open +5 V / Zo = 20 kΩ
	SWEEP OUTPUT	BNC connector, sweep voltage proportional to frequency, 0 – 10 V (f_{START} – f_{STOP}), Zo = 10 kΩ
	TTL OUTPUT	BNC connector, Zo = 50 Ω, fan out 4 TTL inputs, in-phase with OUTPUT signal f >20 kHz, antiphase for f ≤20 kHz
	IEEE-488/RS-232	IEEE-488 interface connector, PM5139/02; 9-pin D-connector (male), PM5139/03

4.12 ERROR MESSAGES

Unallowed settings are indicated by flashing of the incompatible settings or their combinations.

4.13 SELF-TEST ROUTINE, DIAGNOSTIC PROGRAM

After POWER ON the instrument performs a self-test routine, which tests the PROMs, RAMs, and EEPROMs. After this the software version is indicated on the display. All segments of the display field are shown for a moment.
This program also contains a detailed diagnostic part for fault finding.

4.14 POWER SUPPLY

AC line voltage

Nominal values	100/120/220/240 V	Selectable at mains input connector
Reference Value	220 V ±2 %	
Nom. operating range	±10 %	Of nominal value
Operating limits	±10 %	Of nominal value
Nom. frequency range	50 – 60 Hz	
– operating limits	47.5 Hz, 63 Hz	
Power consumption	77 VA	

4.15 ENVIRONMENTAL CONDITIONS

The following environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the Fluke organization in your country.

Ambient temperature:	
Reference value	+23 °C ±1 K
Nominal working range	+ 5 °C ... +40 °C
Non-operating range	−40 °C ... +70 °C
Relative humidity:	
Reference range	45 % ... 75 %
Nominal working range	20 % ... 80 %
Limit range of use	10 % ... 90 %
Non-operating range	0 % ... 90 %
Air pressure:	
Reference value	1013 hPa
Nominal working range	800 ... 1060 hPa
Air speed:	
Reference range	0 ... 0.2 m/s
Nominal working range	0 ... 0.5 m/s
Heat radiation:	Direct sunlight radiation not allowed
Vibration:	
Limits for storage and Transport	Max. amplitude 0.35 mm (10 to 150 Hz), Max. 5 g
Bump accelleration limit:	10 g
Operating position:	Normally upright on feet or with bow fold down
Warm-up time:	30 min

4.16 SAFETY- AND QUALITY DATA; CABINET

Safety	According to Low Voltage Directive 73/23/EEC, EN 61010–1 CAT II Pollution Degree 2 CSA 22.2 no. 231
Protection type	IP 20 (IEC 529)
EMC	According to Electromagnetic Compatibility Directive 89/336/EEC. Emission according to EN 55 011, Group 1, Class B. Immunity according to EN 50 082-1, inclusive EN 61000–4–2, –3 and –4.
Call rate	<0.10 units per year
MTBF (calculated)	25,000 hours
Cabinet dimensions	– Width 315 mm (12.4") – Height 105 mm (4.13") – Depth 405 mm (15.9") – Weight 6.8 kg (15.2 lb)

4.17 ACCESSORIES

4.17.1 Standard

Users Manual	4822 872 10203
Power cord	
Fuses	

4.17.2 Optional

Service Manual	4822 872 15206
PM9074	Coax cable BNC – BNC, 50 Ω, 1 m
PM9051	Adapter BNC (male) / banana jack (female)
PM9585	50 Ω termination, 1 W
PM9581	50 Ω termination, 3 W
PM9563	19 inch rack mount adapter (3 E high)
PM9564	19 inch rack mount adapter (2 E high)
PM2295/10	IEEE bus cable, 1 m
PM2295/20	IEEE bus cable, 2 m
PM9536/041	RS-232 cable, 3 m

5 PERFORMANCE TEST

5.1 INTRODUCTION

The information in the following paragraphs describes the performance tests for the key parameters of the PM5139 Function Generator using the instrument specifications (Chapter 4) as the performance standard.

These performance tests may be used as an acceptance test upon receipt of the instrument, as an indication that repair and/or adjustment is required, or as a performance verification after repairs or adjustment of the instrument. The PM5139 must be warmed up with all covers in place for at least 30 minutes before starting the performance tests. For reference conditions, see Sections 4.14 and 4.15. The test result requirements in the tables of the following sections do not take into account the tolerances of the measuring equipment.
If not stated otherwise the output impedance of the generator must be set to Zo 50 Ω.

5.2 RECOMMENDED TEST EQUIPMENT

- 50 Ω feedthrough termination
- Wideband oscilloscope (tr <3.5 ns); PM 3295
- DC voltmeter, resolution <100 μV; PM 2535
- Counter/timer; PM 6654
- Spectrum analyzer; HP 8590 A
- RMS voltmeter; Fluke 8920 A
- Distortion meter, resolution 0.01 %; PM 6309
- Power meter; HP 436A with power sensor HP 8482A
- Modulation analyzer; Rohde & Schwarz FAM
- Reference synthesizer, accuracy $\pm 10^{-6}$; PM 5192

5.3 SELF-TEST ROUTINE

When turned on, the instrument performs a self-test that checks the PROMs, RAMs, and EEPROMs. After this the software version is indicated in the upper line of the display for about 1 second. All segments of the display field are shown for about 2 seconds and the instrument is set to that operating mode to which it was set before POWER OFF.

The output signal with the corresponding parameters is now available at the OUTPUT socket.

A possible fault is indicated by "Err" followed by a digit.
For detailed information, see Section 3.5.9.

5.4 PERFORMANCE VERIFICATION

5.4.1 Frequency

5.4.1.1 Frequency Accuracy Test

Test Equipment:

– Frequency counter

Procedure:

– Connect the PM5139 OUTPUT to the frequency counter.
– Set the counter to 10 seconds gate time.

Generator Settings:

Waveform	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	1 MHz	OFF	10 V	0	0.999998 MHz to 1.000002 MHz
∿	1 MHz	OFF	10 V	0	9.99998 MHz to 10.00002 MHz
∿	1 MHz	OFF	10 V	0	19.99996 MHz to 20.00004 MHz

5.4.1.2 Frequency Noise RMS Deviation

Test Equipment:

– Modulation analyzer

Procedure:

– Connect the PM5139 OUTPUT to the modulation analyzer.
– Set the modulation analyzer to the RMS measuring mode and LF-measuring bandwidth to 10 Hz to 20 kHz.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	5.000 MHz	OFF	10 V	0	<35 Hz
	10.000 MHz	OFF	10 V	0	<71 Hz
	10.199 MHz	OFF	10 V	0	<71 Hz
	15.715 MHz	OFF	10 V	0	<71 Hz
	20.000 MHz	OFF	10 V	0	<71 Hz

5.4.2 10 MHz Synchronization

5.4.2.1 Synchronization Capture Range

Test Equipment:

- Reference synthesizer
- Counter

Procedure:

- Connect the TTL-output of the reference synthesizer to REF INPUT of PM5139.
- Connect the PM5139 OUTPUT to the counter.
- Set the counter to 1 second gate time.
- Set the reference synthesizer to the frequencies in the following table.

Waveform	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Reference Frequency	Test Result Requirement
∿	1 MHz	OFF	10 V	0	0.998 MHz	0.998 MHz
∿	1 MHz	OFF	10 V	0	1.002 MHz	1.002 MHz

5.4.2.2 10 MHz OUTPUT Level

Test Equipment:

- RMS voltmeter
- 50 Ω feedthrough termination

Procedure:

- Connect RMS voltmeter to the 10 MHz OUTPUT of PM5139.
- Set RMS voltmeter to dBm and 50 Ω reference via 50 Ω feedthrough termination.

Test Result Requirement: 0 to 5 dBm

5.4.3 Waveform Asymmetry

Test Equipment:

– Counter/timer

Procedure:

– Connect the PM5139 OUTPUT to the counter input.
– Set the counter to 1 second gate time and time interval measurement ( ).

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Asymmetrie	Test Result Requirement
⊓⊔	1 kHz	OFF	10 V	0	10 %	99 to 101 µs
	1 kHz	OFF	10 V	0	50 %	499 to 501 µs
	1 kHz	OFF	10 V	0	90 %	899 to 901 µs
⊓⊔	1 MHz	OFF	10 V	0	20 %	190 to 210 ns
	1 MHz	OFF	10 V	0	50 %	490 to 510 ns
	1 MHz	OFF	10 V	0	80 %	790 to 810 ns
⊓⊔	2 MHz	OFF	10 V	0	20 %	90 to 110 ns
	2 MHz	OFF	10 V	0	50 %	240 to 260 ns
	2 MHz	OFF	10 V	0	80 %	390 to 410 ns
⊓⊔	5 MHz	OFF	10 V	0	20 %	30 to 50 ns
	5 MHz	OFF	10 V	0	50 %	90 to 110 ns
	5 MHz	OFF	10 V	0	80 %	150 to 170 ns

5.4.4 Sine Wave

5.4.4.1 Total Harmonic Distortion Test at 1 kHz

Test Equipment:

– Distortion meter

Procedure:

– Connect the PM5139 OUTPUT to 50 Ω feedthrough termination at the distortion meter input.

Generator Settings:

Waveform	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	1 kHz	OFF	14 V	0	<0.4 %

5.4.4.2 Harmonic Components

Test Equipment:

– Spectrum analyzer

Procedure:

– Connect the PM5139 OUTPUT to the spectrum analyzer; be careful not to overload the analyzer input. Overloading the analyzer causes it to generate harmonics, thus invalidating the test.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	0.5 MHz	OFF	14 V	0	< −48 dBc
	0.5 MHz	OFF	20 V	0	< −42 dBc
∿	5 MHz	OFF	14 V	0	< −40 dBc
	5 MHz	OFF	20 V	0	< −34 dBc
∿	10 MHz	OFF	14 V	0	< −36 dBc
	10 MHz	OFF	20 V	0	< −30 dBc
∿	20 MHz	OFF	14 V	0	< −34 dBc
	20 MHz	OFF	20 V	0	< −28 dBc

5.4.4.3 Subharmonic Components (level at ½ of carrier frequency)

Test Equipment:

– Spectrum analyzer

Procedure:

– Connect the PM5139 OUTPUT to the spectrum analyzer.

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	10 MHz	OFF	20 V	0	< −60 dBc
	11 MHz	OFF	20 V	0	< −38 dBc
	18 MHz	OFF	20 V	0	< −38 dBc
	20 MHz	OFF	20 V	0	< −38 dBc

5.4.4.4 Non Harmonic Components

Test Equipment:

– Spectrum analyzer

Procedure:

– Connect the PM5139 OUTPUT to the 50 Ω input of the spectrum analyzer.
– Measure the relative level of the non-harmonic components, >15 kHz distanced from the carrier.
– Measuring frequency range 0 to 100 MHz.

Generator settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	500 kHz	OFF	10 V	0	< –37 dBc
	500 kHz	OFF	20 mV	0	< –37 dBc
∿	5 MHz	OFF	10 V	0	< –37 dBc
	5 MHz	OFF	20 mV	0	< –37 dBc
∿	10 MHz	OFF	10 V	0	< –37 dBc
	10 MHz	OFF	20 mV	0	< –37 dBc
∿	18 MHz	OFF	10 V	0	< –37 dBc
	18 MHz	OFF	20 mV	0	< –37 dBc
∿	20 MHz	OFF	10 V	0	< –37 dBc
	20 MHz	OFF	20 mV	0	< –37 dBc

5.4.5 Square Wave and Rectangular Pulses

5.4.5.1 Rise and Fall Times

Test Equipment:

– Wideband scope; tr <3.5 ns

Procedure:

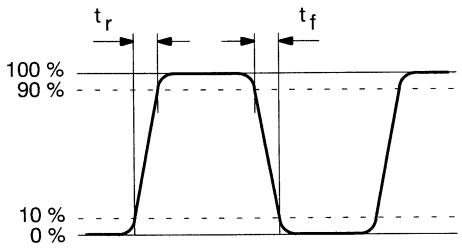
– Connect the PM5139 OUTPUT to the 50 Ω feedthrough termination at the scope.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
⊓⊔	20 kHz	OFF	20 V	0	tr,tf ★ < 30 ns
	20 kHz	OFF	100 mV	0	< 30 ns
⊓⊔	20.01 kHz	OFF	20 V	0	< 30 ns
	20.01 kHz	OFF	100 mV	0	< 30 ns
⊓⊔	50 kHz	OFF	20 V	0	< 30 ns
	50 kHz	OFF	100 mV	0	< 30 ns
⊓⊔	100 kHz	OFF	20 V	0	< 30 ns
	100 kHz	OFF	100 mV	0	< 30 ns
⊓⊔	200 kHz	OFF	20 V	0	< 30 ns
	200 kHz	OFF	100 mV	0	< 30 ns
⊓⊔	500 kHz	OFF	20 V	0	< 30 ns
	500 kHz	OFF	100 mV	0	< 30 ns
⊓⊔	501 kHz	OFF	20 V	0	< 20 ns
	501 kHz	OFF	100 mV	0	< 20 ns

Repeat these steps with positive and negative pulses, ⊓⊔ ⊔⊓, AC pp 10 V and 50 mV.

★ tr = rise time
tf = fall time
for 50 % symmetry setting



5.4.5.2 Overshoot, Ringing, Tilt

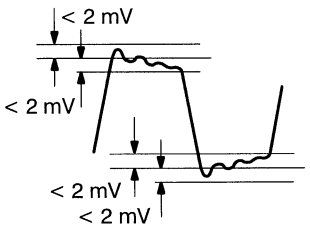
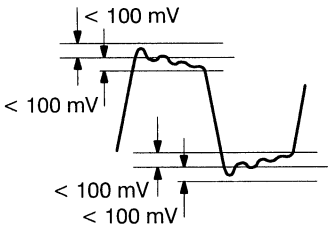
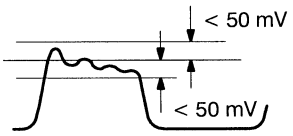
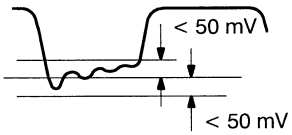
Test Equipment:

– Wideband scope

Procedure:

– Connect the PM5139 OUTPUT to the 50 Ω feedthrough termination at the scope.

Generator Settings:

Waveform	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
⎍	2 MHz	OFF	0.199 V	0	
⎍	2 MHz	OFF	10 V	0	
⎍	2 MHz	OFF	5 V	0	
⎍	2 MHz	OFF	5 V	0	

5.4.6 AC Output Amplitude

5.4.6.1 AC Voltage Accuracy Test in the Frequency Range ≤200 kHz

Test Equipment:

– RMS voltmeter

Procedure:

– Connect the PM5139 OUTPUT to the 50 Ω feedthrough termination at the RMS voltmeter input.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	10 kHz	OFF	150 mV	0	26.0 to 27.0 mV
	10 kHz	OFF	0.21 V	0	36.4 to 37.9 mV
	10 kHz	OFF	1.50 V	0	0.260 to 0.270 V
	10 kHz	OFF	2.00 V	0	0.347 to 0.360 V
	10 kHz	OFF	2.1 V	0	0.364 to 0.378 V
	10 kHz	OFF	10 V	0	1.733 to 1.803 V
	10 kHz	OFF	20 V	0	3.465 to 3.606 V
∿	200 kHz	OFF	150 mV	0	25.9 to 27.2 mV
	200 kHz	OFF	0.21 V	0	36.2 to 38.0 mV
	200 kHz	OFF	1.50 V	0	0.259 to 0.272 V
	200 kHz	OFF	2.00 V	0	0.345 to 0.362 V
	200 kHz	OFF	2.1 V	0	0.362 to 0.380 V
	200 kHz	OFF	10 V	0	1.725 to 1.812 V
	200 kHz	OFF	20 V	0	3.449 to 3.624 V
⊓	10 kHz	OFF	150 mV	0	36.8 to 38.2 mV
	10 kHz	OFF	0.21 V	0	51.5 to 53.5 mV
	10 kHz	OFF	1.50 V	0	0.368 to 0.382 V
	10 kHz	OFF	2.00 V	0	0.490 to 0.510 V
	10 kHz	OFF	2.1 V	0	0.515 to 0.535 V
	10 kHz	OFF	10 V	0	2.450 to 2.550 V
	10 kHz	OFF	20 V	0	4.900 to 5.100 V
⊓	10 kHz	OFF	150 mV	0	36.8 to 38.2 mV
	10 kHz	OFF	0.21 V	0	51.5 to 53.5 mV
	10 kHz	OFF	1.50 V	0	0.368 to 0.382 V
	10 kHz	OFF	2.00 V	0	0.490 to 0.510 V
	10 kHz	OFF	2.1 V	0	0.515 to 0.535 V
	10 kHz	OFF	10 V	0	2.450 to 2.550 V

5.4.6.2 AC Voltage Accuracy Test in the Frequency Range >200 kHz

Test Equipment:

- Power meter with power sensor
- 20-dB attenuator

Procedure:

- Calibrate and zero the power meter.
- Connect the probe to the PM5139 OUTPUT.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	5 MHz	OFF	1.50 V	0	1.34 to 1.48 mW
	5 MHz	OFF	2.00 V	0	2.38 to 2.63 mW
	5 MHz	OFF	2.1 V	0	2.63 to 2.89 mW
	5 MHz	OFF	10 V	0	59.5 to 65.6 mW
	5 MHz	OFF	20 V ★	0	237.5 to 262.6 mW
∿	10 MHz	OFF	1.00 V	0	0.58 to 0.68 mW
	10 MHz	OFF	1.50 V	0	1.30 to 1.52 mW
	10 MHz	OFF	2.00 V	0	2.30 to 2.70 mW
	10 MHz	OFF	2.1 V	0	2.55 to 2.98 mW
	10 MHz	OFF	10 V	0	57.8 to 67.6 mW
	10 MHz	OFF	20 V ★	0	231.2 to 270.4 mW
∿	20 MHz	OFF	1.00 V	0	0.56 to 0.70 mW
	20 MHz	OFF	1.50 V	0	1.25 to 1.58 mW
	20 MHz	OFF	2.00 V	0	2.23 to 2.80 mW
	20 MHz	OFF	2.1 V	0	2.46 to 3.01 mW
	20 MHz	OFF	10 V	0	55.7 to 70.2 mW
	20 MHz	OFF	20 V ★	0	222.5 to 280.9 mW

★ **Note:** To avoid damage to the power meter, insert a 20-dB attenuator and take into account a power factor of 0.01.

5.4.7 DC Voltage

5.4.7.1 DC Voltage Accuracy Test at AC OFF

Test Equipment:

– DC voltmeter

Procedure:

– Connect the PM5139 OUTPUT to the 50 Ω feedthrough termination at the DC voltmeter input.

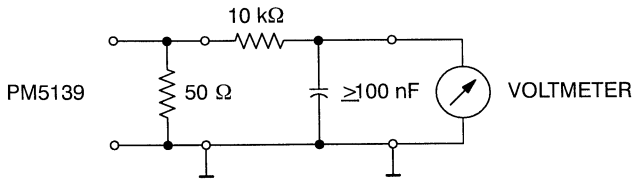
Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
⎓	1 kHz	OFF	1 V	−10 V	−4.850 to −5.150 V
	1 kHz	OFF	1 V	−9 V	−4.360 to −4.640 V
	1 kHz	OFF	1 V	−8 V	−3.870 to −4.130 V
	1 kHz	OFF	1 V	−7 V	−3.380 to −3.620 V
	1 kHz	OFF	1 V	−6 V	−2.890 to −3.110 V
	1 kHz	OFF	1 V	−5 V	−2.400 to −2.600 V
	1 kHz	OFF	1 V	−4 V	−1.910 to −2.090 V
	1 kHz	OFF	1 V	−3 V	−1.420 to −1.580 V
	1 kHz	OFF	1 V	−2 V	−0.930 to −1.070 V
	1 kHz	OFF	1 V	−1 V	−0.440 to −0.560 V
	1 kHz	OFF	1 V	−0.1 V	+0.001 to −0.101 V
⎓	1 kHz	OFF	1 V	0 V	−50 to +50 mV
⎓	1 kHz	OFF	1 V	+0.1 V	−0.001 to +0.101 V
	1 kHz	OFF	1 V	+1 V	+0.440 to +0.560 V
	1 kHz	OFF	1 V	+2 V	+0.930 to +1.070 V
	1 kHz	OFF	1 V	+3 V	+1.420 to +1.580 V
	1 kHz	OFF	1 V	+4 V	+1.910 to +2.090 V
	1 kHz	OFF	1 V	+5 V	+2.400 to +2.600 V
	1 kHz	OFF	1 V	+6 V	+2.890 to +3.110 V
	1 kHz	OFF	1 V	+7 V	+3.380 to +3.620 V
	1 kHz	OFF	1 V	+8 V	+3.870 to +4.130 V
	1 kHz	OFF	1 V	+9 V	+4.360 to +4.640 V
	1 kHz	OFF	1 V	+10 V	+4.850 to +5.150 V

5.4.7.2 DC Voltage Offset Error Test

Test Equipment:

- DC voltmeter
- Low-pass filter



Procedure:

- Connect the PM5139 OUTPUT to the 50 Ω feedthrough termination at the DC voltmeter input.

Note: Take care that the DC voltmeter does not respond on the AC portion of the tested voltage. If necessary, insert a low-pass filter.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	1 MHz	OFF	10 V	0	−50 to +50 mV
	2 MHz	OFF	10 V	0	−50 to +50 mV
	.	.	.	.	.
	1 MHz steps	.	.	.	.
	.	.	.	.	.
∿	19 MHz	OFF	10 V	0	−50 to +50 mV
	20 MHz	OFF	10 V	0	−50 to +50 mV

Repeat with ACpp = 20 V, test result requirement as above

5.4.8 Modulation

5.4.8.1 Modulation Frequency Accuracy Test

Test Equipment:

- Frequency counter

Procedure:

- Connect the PM5139 MODULATION OUTPUT (at the rear of the instrument) to the frequency counter.
- Set the counter to >1 second gate time.

Generator Settings:

Waveform	Frequency	Modulation Mode	Output Voltage f_{MOD}	Output Voltage m %	Test Result Requirement
∿	1 kHz	AM INT	11 Hz	50	10.989 to 11.011 Hz
∿	1 kHz	AM INT	1 kHz	50	999 to 1001 Hz

5.4.8.2 AM Envelope Distortion Test

Test Equipment:

– Modulation analyzer

Procedure:

– Connect the PM5139 OUTPUT to the modulation analyzer RF input.
– Set the analyzer to AM, DIST, and the filter to 30 Hz to 20 kHz.

Note: The modulation depth m of 90 % must be checked with the modulation analyzer. If necessary, change the generator setting.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Modulation Parameter		Output Voltage		Test Result Requirement
			f_{MOD}	m %	ACpp	DC	
∿	5 MHz	AM INT	1 kHz	90	5 V	0	<0.5 %
	10 MHz	AM INT	1 kHz	90	5 V	0	<0.5 %
	15 MHz	AM INT	1 kHz	90	5 V	0	<0.5 %
	20 MHz	AM INT	1 kHz	90	5 V	0	<0.7 %

5.4.8.3 Internal AM Modulation Depth (m) Accuracy Test

Test Equipment:

– Modulation analyzer

Procedure:

– Connect the PM5139 OUTPUT to the modulation analyzer.
– Set the analyzer to $\frac{P+P}{2}$ and the filter to 30 Hz to 200 kHz.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Modulation Parameter		Output Voltage		Test Result Requirement
			f_{MOD}	m %	ACpp	DC	
∿	2 MHz	AM INT	20 kHz	10	5 V	0	9 to 11 %
	2 MHz	AM INT	·	50	5 V	0	49 to 51 %
	2 MHz	AM INT	·	90	5 V	0	89 to 91 %
∿	5 MHz	AM INT	·	10	5 V	0	8 to 12 %
	5 MHz	AM INT	·	50	5 V	0	48 to 52 %
	5 MHz	AM INT	·	90	5 V	0	88 to 92 %
∿	20 MHz	AM INT	·	10	5 V	0	6 to 14 %
	20 MHz	AM INT	·	50	5 V	0	46 to 54 %
	20 MHz	AM INT	20 kHz	90	5 V	0	86 to 94 %

Note: Take into account the tolerances of the used modulation analyzer.

5.4.8.4 FM Distortion Test

Test Equipment:

– Modulation analyzer

Procedure:

– Connect the PM5139 OUTPUT to the modulation analyzer RF input.

– Set the modulation analyzer to FM, DIST, $\frac{P+P}{2}$, and the filter to 30 Hz to 20 kHz.

Generator Settings:

Waveform	Frequency	Modulation Mode	Modulation Parameter		Output Voltage		Test Result Requirement
			f_{MOD}	DEV	ACpp	DC	
∿	10 MHz	FM INT	1 kHz	1.00 %	5 V	0	<0.4 %

5.4.8.5 FM Deviation Accuracy Test

Test Equipment:

– Modulation analyzer

Procedure:

– Connect the PM5139 OUTPUT to the modulation analyzer.

– Set analyzer to FM, $\frac{P+P}{2}$, and the filter to 30 Hz to 200 kHz.

Generator Settings:

Waveform (for all)	Frequency	Modulation Mode	Modulation Parameter		Output Voltage		Test Result Requirement
			f_{MOD}	DEV	ACpp	DC	
∿	10 MHz	FM INT	1 kHz	2 %	5 V	0	197 to 203 kHz
	10 MHz	FM INT	·	1.8 %	5 V	0	177 to 183 kHz
	10 MHz	FM INT	·	1.6 %	5 V	0	157 to 163 kHz
	10 MHz	FM INT	·	1.4 %	5 V	0	137 to 143 kHz
	10 MHz	FM INT	·	1.2 %	5 V	0	117 to 123 kHz
	10 MHz	FM INT	·	1.0 %	5 V	0	97 to 103 kHz
	10 MHz	FM INT	·	0.8 %	5 V	0	77 to 83 kHz
	10 MHz	FM INT	·	0.6 %	5 V	0	57 to 63 kHz
	10 MHz	FM INT	·	0.4 %	5 V	0	37 to 43 kHz
	10 MHz	FM INT	1 kHz	0.2 %	5 V	0	17 to 23 kHz
∿	10 MHz	FM INT	100 kHz	2 %	5 V	0	180 to 220 kHz
	10 MHz	FM INT	·	1.8 %	5 V	0	160 to 200 kHz
	10 MHz	FM INT	·	1.6 %	5 V	0	140 to 180 kHz
	10 MHz	FM INT	·	1.4 %	5 V	0	120 to 160 kHz
	10 MHz	FM INT	·	1.2 %	5 V	0	100 to 140 kHz
	10 MHz	FM INT	·	1.0 %	5 V	0	80 to 120 kHz
	10 MHz	FM INT	·	0.8 %	5 V	0	60 to 100 kHz
	10 MHz	FM INT	·	0.6 %	5 V	0	40 to 80 kHz
	10 MHz	FM INT	·	0.4 %	5 V	0	20 to 60 kHz
	10 MHz	FM INT	100 kHz	0.2 %	5 V	0	0 to 40 kHz

5.4.8.6 Phase Shift Keying (PSK) Functional Test

Test Equipment:

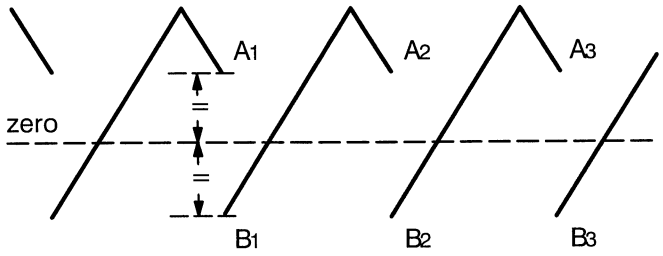
– Scope

Procedure:

– Connect the PM5139 OUTPUT to the 50 Ω feedthrough termination at the scope.
– Connect the PM5139 MODULATION OUTPUT to the external trigger input of the scope.
– Set the scope to external trigger and set the trace to the zero voltage line.

Generator Settings:

Waveform	Frequency	Modulation Mode	Modulation Parameter	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	1 kHz	PSK INT	f_{MOD} 1 kHz	5 V	0	See drawing



The pairs A,B of the transition points (showing varying distances A – B) must be symmetrical to the zero voltage line.

5.4.8.7 Gate Functional Test

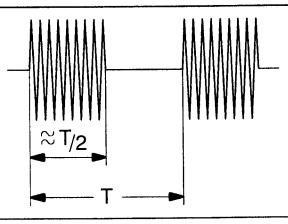
Test Equipment:

– Scope

Procedure:

– Connect the PM5139 OUTPUT to the 50 Ω feedthrough termination at the scope.

Generator Settings:

Waveform	Frequency	Modulation Mode	Modulation Parameter	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	100 kHz	GATE INT	f_{MOD} 1 kHz	5 V	0	

Note: Check the duty cycle of the gated output signal: approximately 50 % and voltage pp 2.5 V.

5.4.8.8 Sweep Functional Test

Test Equipment:

– Dual channel scope

Procedure:

– Connect the PM5139 OUTPUT to the 50 Ω feedthrough termination at the scope input channel A.
– Connect the PM5139 SWEEP OUT (at the rear of the instrument) to channel B of the scope.
– Set channel B to DC-coupling.
– Set the trigger to channel A.
– Set the scope to chopped mode.

Generator Settings:

Waveform	Frequency	Modulation Mode	Modulation Parameter	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	f_{START} 1 kHz f_{STOP} 10 kHz	LIN SWEEP CONT	T = 5 s mode 1	5 V	0	See following text

During the 5-second sweep period, the output frequency is swept from start to stop (channel A), and the SWEEP OUTPUT (channel B) is rising from 0 to +10 V open loop.

– Connect channel B to the PM5139 PEN LIFT OUTPUT (rear).
– Start single sweep by pressing the SINGLE key.

When sweep is running the PEN LIFT voltage (channel B) must be approximately 0 V; at the end of the sweep the PEN LIFT voltage is switched to approximately +5 V.

5.4.8.9 Burst Functional Test

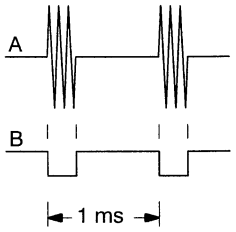
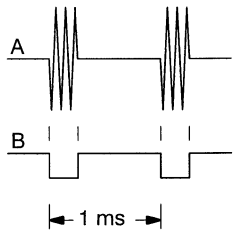
Test Equipment:

- Dual channel scope
- External TTL source of 1 kHz

Procedure:

- Connect the PM5139 OUTPUT to the 50 Ω feedthrough termination at scope channel A.
- Connect the PM5139 MODULATION OUTPUT (at the rear of the instrument) to channel B of the scope.
- Connect the external 1 kHz-TTL source to the PM5139 MODULATION INPUT (rear).

Generator Settings:

Waveform	Frequency	Modulation Mode	Modulation Parameter	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
∿	10 kHz	BURST INT CONT Repetition frequency (f_{MOD}) 1 kHz $\phi = 0°$	3 ON cycles	5 V	0	
∿	10 kHz	BURST EXT	3 ON cycles	5 V	0	Must be the same display
∿	10 kHz	BURST INT CONT Repetition frequency (f_{MOD}) 1 kHz $\phi = -180°$ $\phi = +180°$	3 ON cycles	5 V	0	
∿	10 kHz	BURST EXT	3 ON cycles	5 V	0	Must be the same display

5.4.9 TTL OUTPUT Level Test

Test Equipment:

– Scope

Procedure:

– Connect the PM5139 TTL OUT to the scope (without 50 Ω termination).

Generator Settings:

Waveform	Frequency	Modulation Mode	Output Voltage ACpp	Output Voltage DC	Test Result Requirement
–	1 kHz	OFF	–	–	low level: −0.3 to +0.3 V high level: +4.7 to +5.3 V

INDEX

— M —

— N —

— O —

— P —

— Q —

— R —

— S —

— T —

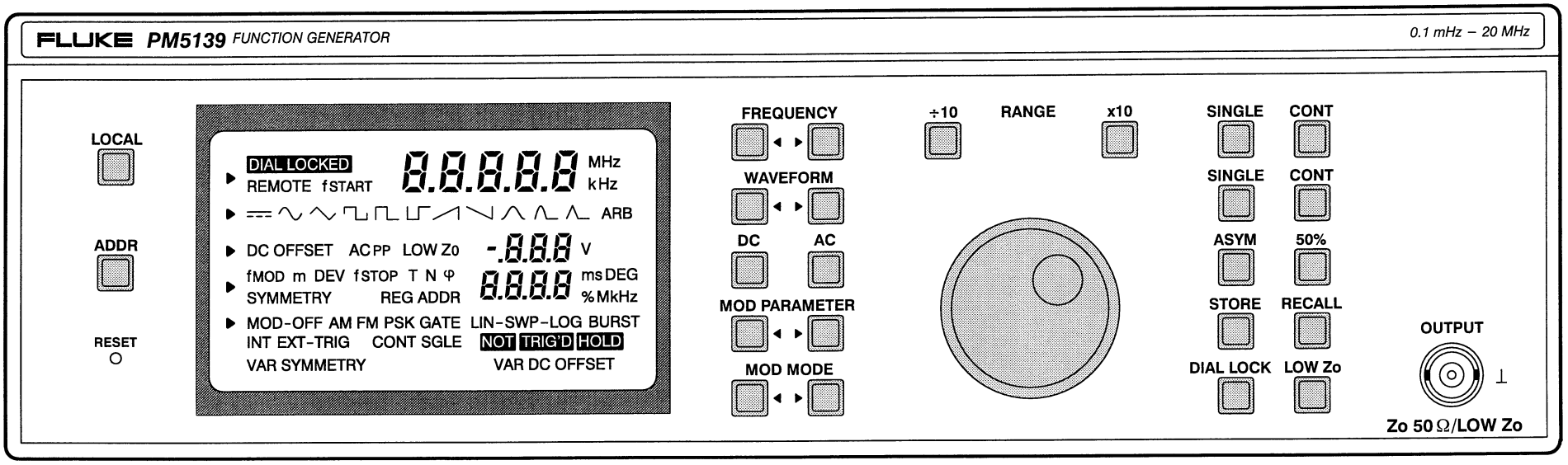
— W —

— X —

— Y —

FIGURES

Front View / Rear View
Frontansicht / Rückansicht
Vue avant / vue arrière



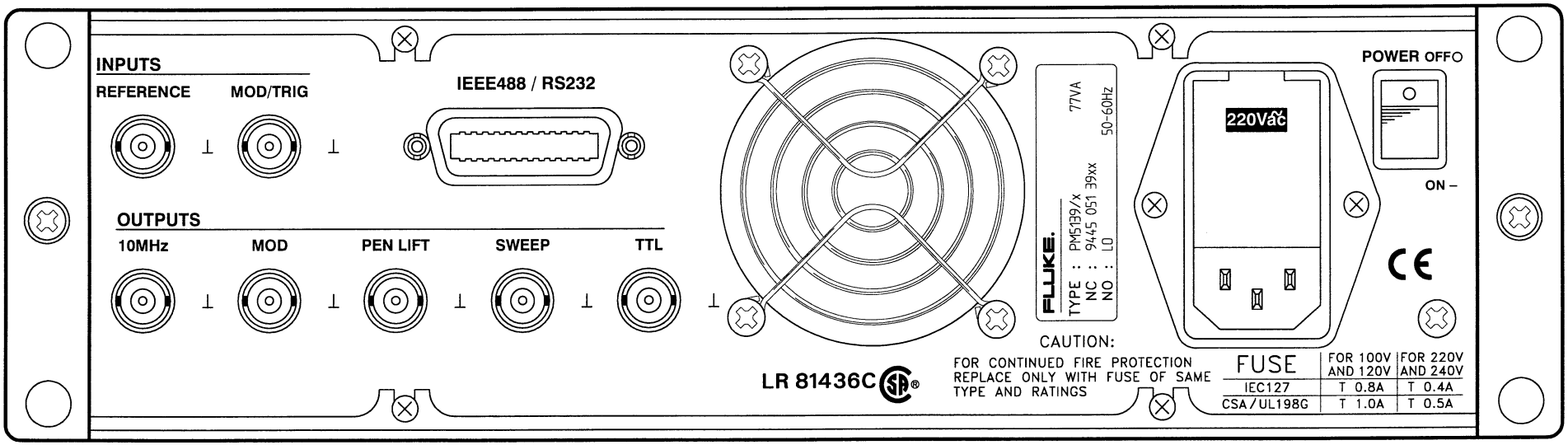


Fig. 1 Front View / Rear View
Frontansicht / Rückansicht
Vue avant / vue arrière

Argentina
Viditec S.A.
Lacarra 234
Buenos Aires CP 1407
Phone: +54-1-636-1200
Fax: +54-1-636-2185

Australia
Philips Scientific & Industrial, Pty., Ltd.
34 Waterloo Road
North Ryde, N.S.W. 2113
Phone: +61-2-888-8222
Fax: +61-2-888-0440

Austria
Fluke Vertriebsges GmbH
Südrandstraße 7
P.O. Box 10
A 1232 Wien
Phone: +43-1-61410-30
Fax: +43-1-61410-10

Bahrain
Mohammed Fakhroo & Bros.
P.O. Box 439 Bahrain
Phone: +973-253529
Fax: +973-275996

Belgium
N.V. Fluke Belgium S.A.
Sales & Service Department
Langeveldpark - Unit 5 & 7
P. Basteleusstraat 2 - 4 - 6
1600 St. Pieters-Leeuw
Phone: +32-2-331-2777
[Ext 218]
Fax: +32-2-331-1489

Bolivia
Coasin Bolivia S.R.L.
Casilla 7295
Calle Ayacucho No. 208
Edificio Flores, 5to. Piso
La Paz
Phone: +591-2-317531
Fax: +591-2-317545

Brazil
Sistest
Av. Ataulfo De Paiva
135 S/ 1117 - Leblon
22.449-900 - Rio De Janeiro
Phone: +55-21-259-5755
Fax: +55-21-259-5743

Brazil
Sigtron Instrumentos E. Servicos Ltda
Rua Alvaro Rodriques
269 - Brooklin
Sao Paulo
Phone: +55-11-240-7359
Fax: +55-11-533-3749

Brazil
Philips Medical Syst., Ltda.
Av. Interlagos North
3493 - Campo Grande
04661-200 Sao Paulo S.P.
Phone: +55-11-523-4811
Fax: +55-11-524-4873 (ID2148)

Bulgaria
Ac Sophilco
Customer Support Services
P.O. Box 42
1309 Sofia
Phone: +359-2-292-1815
Fax: +359-2-292-1915

Canada
Fluke Electr. Canada, Inc.
400 Britannia Road East,
Unit #1
Mississauga, Ontario
L4Z 1X9
Phone: +1-905-890-7600
Fax: +1-905-890-6866

Chile
Intronica
Instrumentacion Electronica S.A.C.I
Guardia Vieja 181 Of. 503
Casilla 16500
Santiago 9
Phone: +56-2-232-3888
Fax: 56-2-231-6700

China
Fluke Int'l Corporation
Room 2111 Scite Tower
Jianguomenwai Dajie
Beijing 100004, Prc
Phone: +86-10-512-3436
Fax: +86-10-512-3437

China
China Academy Of Science
Guangzhou Institute Of Ele. Researc
100 Xian Lie Road Central
Guangzhou
Phone: +86-20-776-9464
Fax: +86-20-776-9464

Colombia
Sistemas E Instrumentacion, Ltda.
Calle 83, No. 37-07 Barrio Patria
Ap. Aereo 29583 Bogota
Phone: +57-1-635-7266
Fax: +57-1-623-3334

Costa Rica
Electronic Engineering, S.A.
Carretera De Circunvalacion
Sabanilla Av. Novena
P.O. Box 4300-1000
San Jose
Phone: +506-*-253-3759
Fax: +506-*-225-1286

Countries not listed
For Eastern Europe And Middle East
Export Sales
Science Park Eindhoven 5110
5692 EC Son
The Netherlands
Phone: +31-402-678 265
Fax: +31-402-678 260

Croatia
Kaltim - Zagreb
Fluke Sales & Service
Draga 8
41425 Sveta Jana
Phone: +385-41-837115
Fax: +385-41-837237

Cyprus
D. Ouzounian, M. Soultanian & Co.
P.O. Box 1775
Nicosia
Phone: +357-2-442220
Fax: +357-2-459885

Czech Republic
Elso
NA. Berance 2
16000 Prague 6
Phone: +42-2-316-4810
Fax: +42-2-364-986

Czech Republic
Elso
Branch Office
Optatova 17a
63700 Brno
Phone: +42-5-41220263
Fax: +42-5-524742

Denmark
Fluke Danmark A/S
Ejby Industrivej 40
DK 2600 Glostrup
Phone: +45-43-44-1900
Fax: +45-43-43-9192

Ecuador
Proteco Coasin Cia., Ltda.
Av. 12 de Octubre 2449 y Orellana
P.O. Box 17-03-228-A
Quito
Phone: +593-2-230283
Fax: +593-2-561980

Egypt
EEMCO
Nasr City
19 Shararah Bldgs.
Hassan Mamoun Street
Cairo
Phone: +20-2-2718873
Fax: +20-2-2718873

Finland
Fluke Finland Oy
Sinikalliontie 5
P.L. 151
SF 02631 Espoo
Phone: +358-0-61525-620
Fax: +358-0-61525-630

France
Fluke France S.A.
37, rue Voltaire
B.P. 112
93700 Drancy
Phone: +33-1-4896-6310
Fax: +33-1-4896-6330

Germany
Fluke Deutschland GmbH
Oskar Messter Straße 18
85737 Ismaning
Münich
Phone: +49-89-99611-260
Fax: +49-89-99611-270

Germany
Fluke Deutschland GmbH
Meiendorfer Straße 205
22145 Hamburg
Phone: +49-40-67 960 434
Fax: +49-40-67 960 421

Greece
George D. Zis & SIA O.E.
Fluke Sales & Service
Zacharitsa 27
117 41 Athens
Phone: +30-1-922 1581
Fax: +30-1-924 9087

Hong Kong
Schmidt & Co., Ltd.
1st Floor
323 Jaffe Road
Wanchai
Phone: +852-2223-5623
Fax: +852-2834-1848

Hungary
Mta-Mmsz Kft.
Etele Ut. 59 - 61
P.O. Box 58
H 1502 Budapest
Phone: +361-203-4319
Fax: +361-203-4328

Hungary
MTA-MMSZ Kft.
Etele Ut. 59 - 61
P.O. Box 58
H 1502 Budapest
Phone: +361-203-4298
Fax: +361-203-4353

Iceland
Taeknival Hf
P.O. Box 8294
Skeifunni 17
128 Reykjavik
Phone: +354-550-4000
Fax: +354-550-4001

India
Hinditron Services Pvt., Ltd.
204-206 Hemkunt Tower
98 Nehru Place
New Delhi 110 019
Phone: +91-11-641-3675
Fax: +91-11-642-9118

India
Hinditron Services Pvt., Ltd.
Castle House, 5th Floor
5/1 A, Hungerford Street
Calcutta 700 017
Phone: +91-33-247-9094
Fax: +91-33-247-6844

India
Hinditron Services Pvt., Ltd.
Emerald House, 5th Floor
114 Sarojini Devi Road
Secunderabad 500 003
Phone: +91-40-844033
Fax: +91-40-847585

India
Hinditron Services Pvt., Ltd.
Hinditron House, 23-B
Mahal Industrial Estate
Mahakali Caves Road,
Andheri East
Mumbai 400 093
Phone: +91-22-836-4560
Fax: +91-22-836-4682

India
Hinditron Services Pvt., Inc.
33/44A 8th Main Road
Raj Mahal Vilas Extension
Bangalore 560 080
Phone: +91-80-334-8266
Fax: +91-80-334-5022

Indonesia
P.T. Daeng Brothers
Philips House
J/n H.R. Rasuna Said Kav. 3-4
Jakarta 12950
Phone: +62-21-520-1122
Fax: +62-21-520-5189

Israel
R.D.T Equipment & Systems
(1993) Ltd.
P.O. Box 58072
Tel Aviv 61580
Phone: +972-3-645-0745
Fax: +972-3-647-8908

Italy
Fluke Italia S.R.L.
Viale Delle Industrie, 11
20090 Vimodrone (MI)
Phone: +39-2-268-434-203
Fax: +39-2-250-1645

Japan
Fluke Corporation Japan
Sumitomo Higashi Shinbashi
Bldg.
1-1-11 Hamamatsucho
Minato-ku, Tokyo 105
Phone: +81-3-3434-0181
Fax: +81-3-3434-0170

Jordan
Jordan Medical Supplies and
Services
P.O. Box 140415
Amman 11814
Phone: +962-6-699353
Fax: +962-6-663556

Korea
Fluke Korea Co., Ltd.
5th Floor, Juan Bldg
646-14, Yuksam-Dong
Kangnam-Ku
Seoul 135-080
Phone: +82-2-539-6311
Fax: +82-2-539-6311

Kuwait
Yusuf A. Alghanim & Sons
W.L.L.
P.O. Box 223 Safat
Alghanim Industries
Airport Road Shuwaikh
13003 Kuwait
Phone: +965-4842988
Fax: +965-4847244

Lebanon
DC Electronics S.A.R.L.
Autostrada Dora
Hayek Building
P.O. Box 90
1388 Beirut
Phone: +961-1-884271
Fax: +961-1-898842

Macedonia
Tehnokom
Koco Racin 42
91000 Skopje
Phone: +389-91-236817
Fax: +389-91-236851

Malaysia
Cnn Sdn. Bhd.
17D, 2nd Floor
Lebuhraya Batu Lancang
Taman Seri Damai
11600 Jelutong Penang
Phone: +60-4-657-9584
Fax: +60-4-657-0835

Malta
Cam Services Ltd.
Cam Centre
Triq 1 - Industrija
Qormi QRM 09
Phone: +356-484640
Fax: +356-447174

Mexico
Metrologia Y Calibraciones Ind.,
S.A. De C.V.
Industrial S.A. De C.V.
Calle Diagonal No. 27 - 4 Piso
Colonia Del Valle
Mexico 03100 D.F.
Phone: +52-5-682-8040
Fax: +52-5-687-8695

Netherlands
Fluke Nederland B.V.
Customer Support Services
Science Park Eindhoven 5108
5692 EC Son
Phone: +31-402-678 310
Fax: +31-402-678 321

New Zealand
Philips Scientific & Industrial,
Pty., Ltd.
Private Bag 41904
St. Lukes, 2 Wagener Place
Mt. Albert
Auckland 3
Phone: +64-9-849-4160
Fax: +64-9-849-7814

Norway
Fluke Norge A/S
Customer Support Services
P.O. Box 6054
Etterstad
N 0601 Oslo
Phone: +47-22-65-3400
Fax: +47-22-65-3407

Pakistan
Philips Electrical Industries Of
Pakistan Ltd.
Islamic Chamber of Commerce
St-2/A, Block 9
KDA Scheme 5, Clifton
Karachi 75600
Phone: +92-21-587-4641
Fax: +92-21-577-0348

Peru
Importaciones &
Representaciones
Jr. Pumacahua 955
Lima 11
Phone: +51-14-235099
Fax: +51-14-310707

Philippines
Spark Electronics Corporation
P.O. Box 610, Greenhills
Metro Manila 1502
Phone: +63-2-700621
Fax: +63-2-721-0491

Poland
Electronic Instrument Service
(E.I.S.)
UL. Malechowska 6
60 188 Poznan
Phone: +48-61-681998
Fax: +48-61-682256

Portugal
ARESAGANTE Representacoes
Estudos e
Servicos, Lda.
Rua Oliveira Gaio, 333 R/C,
Esq.
4465 S.Mamede Infesta
Phone: +351-2-906.00.22
Fax: +351-2-901.68.72

Qatar
Darwish Trading Co.
P.O. Box 92
Doha
Phone: +974-422781
Fax: +974-417599

Rep. of Belarus
Component & Systems Ltd.
7, Melnikaite Str.
220004 Minsk
Phone: +375-172-292103
Fax: +375-172-292110

Romania
RONEXPRIM S.R.L.
Str. Transilvaniei Nr. 24
70778 Bucharest - I
Phone: +40-1-6143597
Fax: +40-1-6594468

Russia
Swemel Innovation Enterprise
15, 4-Th Likhachevskiy Lane
125438 Moscow
Phone: +7-095-154-5181
Fax: +7-095-154-0201

Russia C.I.S.
Infomedia
Petrovsko Razumovsky
Proezd. 29
103287 Moscow
Phone: +7-095-2123833
Fax: +7-095-2123838

Saudi Arabia
A. Rajab & Silsilah Co.
Sales & Service Department
P.O. Box 203
21411 Jeddah
Phone: +966-2-6610006
Fax: +966-2-6610558

Singapore
Fluke Singapore Pte., Ltd.
#27-03 PSA Building
460 Alexandra Road
Singapore 119963
Phone: +65-*-276-5161
Fax: +65-*-276-5929

Slovak Republic
Elso
Stef nikova 20
911 01 Trencin
Phone: +42-8313-1410
Fax: +42-8313-1592

Slovenia
Micom Electronics d.o.o.
Resljeva 34
61000 Ljubljana
Phone: +386-61-317830
Fax: +386-61-320670

Slovenia
Elacss d.o.o.
Medvedova 28
61000 Ljubljana
Phone: +385-61-317178
Fax: +385-61-301595

South Africa
Spescom Measuregraph Pty.,
Ltd.
SPESCOM Park
Crn. Alexandra Rd. & Second St.
Halfway House
Midrand 1685
Phone: +27-11-315-0757
Fax: +27-11-805-1192

Spain
Fluke Ib,rica S.L.
Centro Empresarial Euronova
C/Ronda De Poniente, 8
28760 - Tres Cantos
Madrid
Phone: +34-1-804-2301
Fax: +34-1-804-2496

Sultanate Of Oman
Mustafa & Jawad Science &
Industry Co. LLC.
P.O. Box 1918
112 Ruwi - Muscat
Phone: +968-602009
Fax: +968-607066

Sweden
Fluke Sverige AB
P.O. Box 61
S 164 94 Kista
Phone: +46-8-751-0235
Fax: +46-8-751-0480

Switzerland
Fluke Switzerland A.G.
Rütistrasse 28
CH 8952 Schlieren
Phone: +41-1-730-3310
Fax: +41-1-730-3720

Taiwan, R.O.C.
Schmidt Scientific Taiwan, Ltd.
6f, No. 109, Tung Hsing St.
Taipei
Phone: +886-2-767-8890
Fax: +886-2-767-8820

Thailand
Measuretronix Ltd.
2102/31 Ramkamhang Road
Bangkok 10240
Phone: +66-2-375-2733
Fax: +66-2-374-9965

Turkey
Pestas Prof. Elektr. Sistemler
Tic. ve San. A.S.
Meydan Sokak
Meydan Apt. No. 6/23
Akatlar 80630
Istanbul
Phone: +90-212-2827839
Fax: +90-212-283-0987

U.A.E.
Haris Al-Afaq Ltd.
P.O. Box 8141
Dubai
Phone: +971-4-283623
Fax: +971-4-281285

U.S.A.
Fluke Corporation
Service Center - Palatine
1150 W. Euclid Avenue
Palatine, IL 60067
Phone: +1-847-705-0500
Fax: +1-847-705-9989

U.S.A.
Fluke Corporation
Service Center - Paramus
West 75 Century Road
Paramus, NJ 07652-0930

U.S.A.
Fluke Corporation
Service Center - Everett
P.O. Box 9090
Everett, WA 98206-9090
Phone: +1-206-356-5531
Fax: +1 206 356 6390

U.S.A.
Fluke Calibration Center
C/o Flw Service Corporation
3505 Cadillac Ave., Bldg E.
Costa Mesa, Ca 92626
Phone: +1-714-863-9031
Fax: +1-714-751-0213

U.S.A.
Fluke Corporation
Service Center
42711 Lawrence Place
Fremont, CA 94538
Phone: +1-510-651-5112
Fax: +1-510-651-4962

U.S.A.
Fluke Corporation
Service Center - Dallas
2104 Hutton Drive
Suite 112
Carrollton, TX 75006
Phone: +1-214-406-1000
Fax: +1-214-247-5642

United Kingdom
Fluke United Kingdom Ltd.
Colonial Way
Watford
Hertfordshire WD2 4TT
Phone: +44-1923-240511
Fax: +44-1923-212157

Uruguay
Coasin Instrumentos S.A.
Acevedo Diaz 1161
11200 Montevideo
Montevideo
Phone: +598-2-492-436
Fax: +598-2-492-199

Venezuela
Coasin C.A.
Calle 9 Con Calle 4
Edif Edinurbi Piso - 3
La Urbina
Caracas 1070-A
Phone: +58-2-242-7466
Fax: +58-2-241-1939

Vietnam
Schmidt-Vietnam Co., Ltd.
8/f. Schmidt Tower
Hanoi International Technology Ctr
Km8, Highway 32, Cau Giay
Tu Liem, Hanoi
Phone: +84-4-8346-186
Fax: +84-4-8346-188

All other countries
Fluke Corporation
P.O. Box 9090
Mail Stop 268C
Everett, WA 98206-9090
USA

SERVICE CENTERS

To locate an authorized service center, visit us on the World Wide Web:

http://www.fluke.com

or call Fluke using any of the phone numbers listed below:

+1-888-993-5853 in U.S.A. and Canada

+31-402-678-200 in Europe

+1-425-356-5500 from other countries

SERVICE-ZENTREN

Wenn Sie die Adresse eines authorizierten Fluke-Servicezentrums brauchen,

besuchen Sie uns doch bitte auf dem World Wide Web:

http://www.fluke.com

oder rufen Sie uns unter einer der nachstehenden Telefonnummern an:

+1-888-993-5853 in den USA und Canada

+31-402-678-200 in Europa

+1-425-356-5500 von anderen Ländern aus

CENTRES DE SERVICE APRES-VENTE

Pour localiser un centre de service, visitez-nous sur le World Wide Web:

http://www.fluke.com

ou téléphonez à Fluke:

+1-888-993-5853 aux U.S.A. et au Canada

+31-402-678-200 en Europe

+1-425-356-5500 pour les autres pays