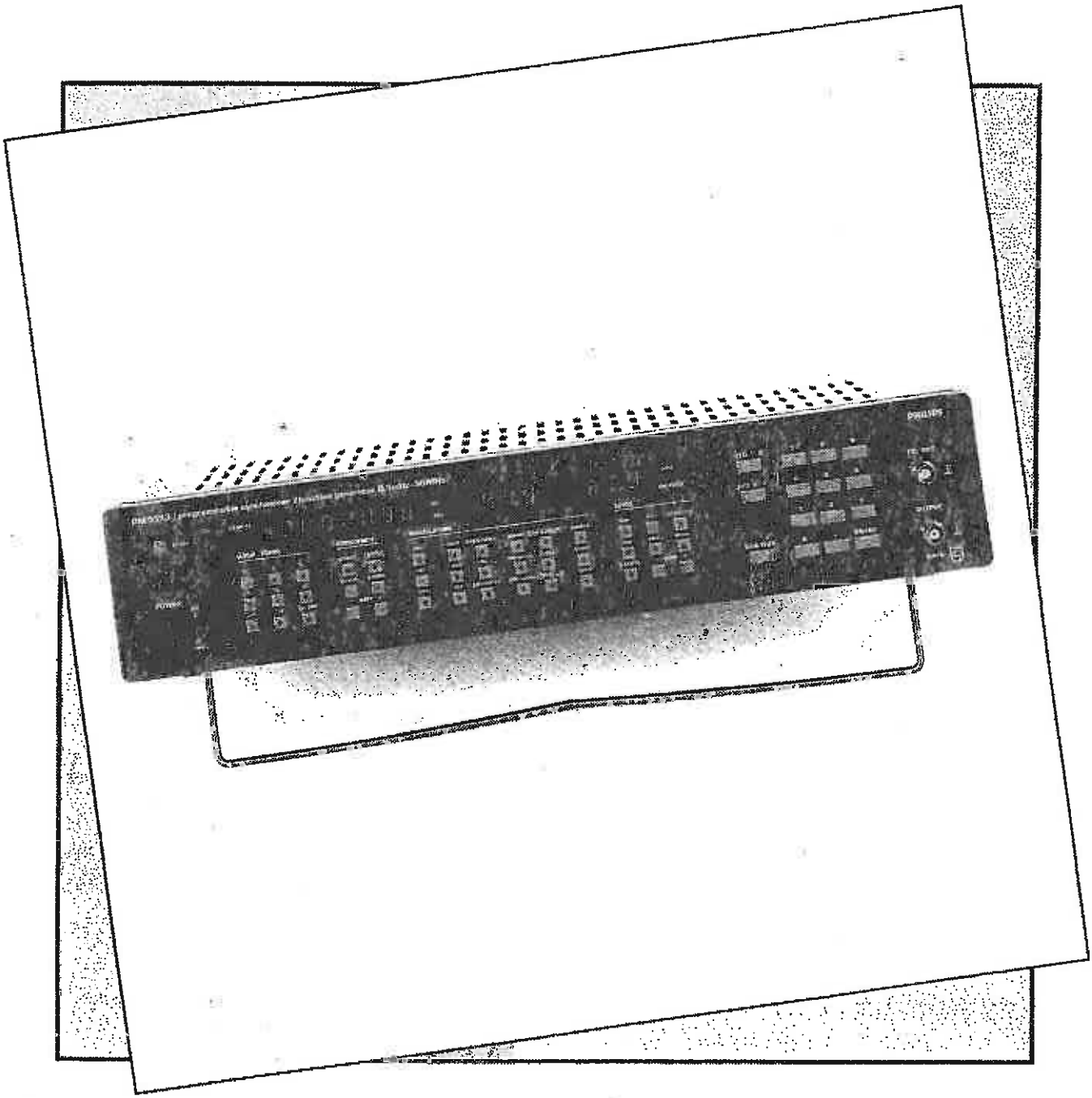
PHILIPS

Synthesizer / function generator 50 MHz
PM 5193

Operating manual

TEST & MEASUREMENT CUSTOMER SUPPORT



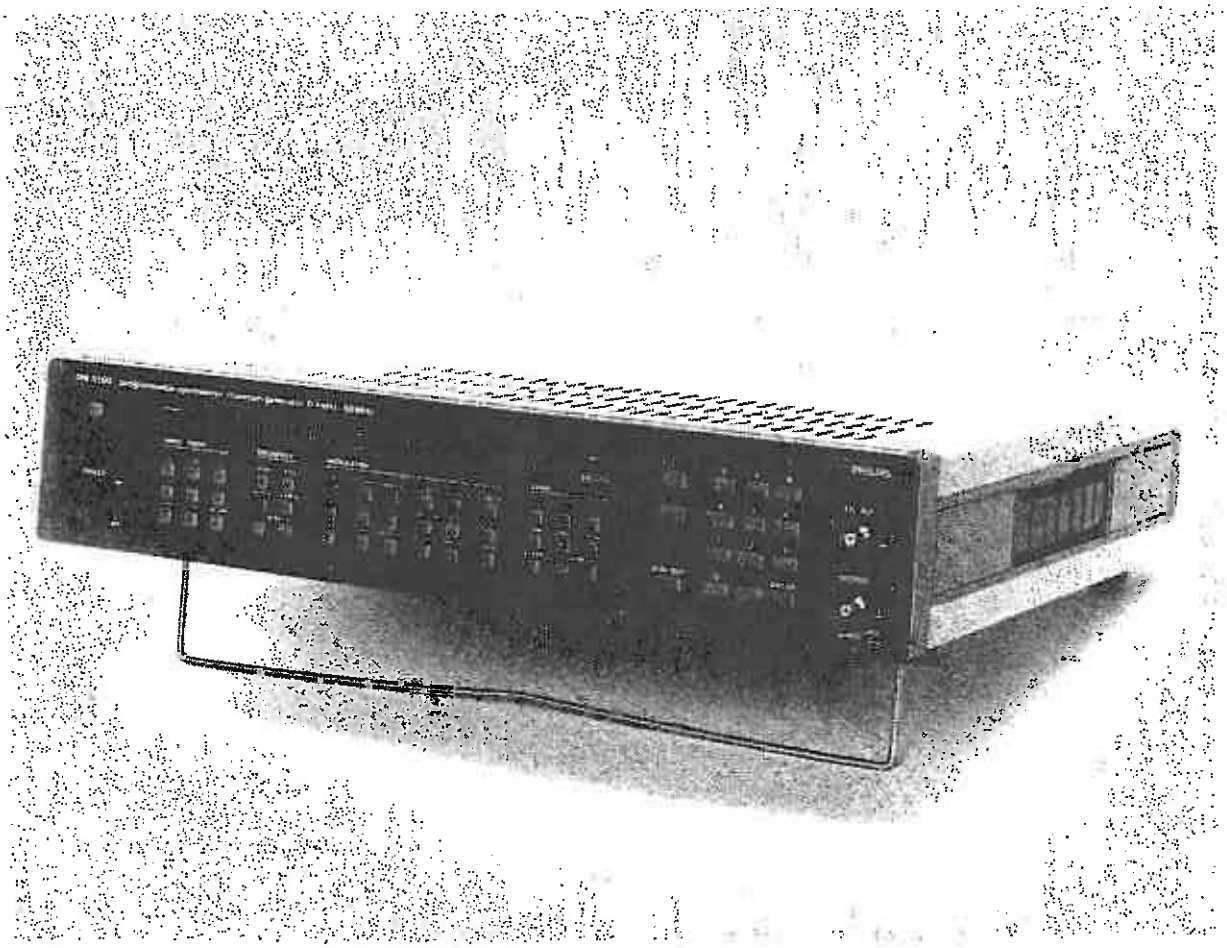
9499 450 08801
Third Edition
900101

Synthesizer / function generator 50 MHz
PM 5193

Operating manual
Gebrauchsanleitung
Notice d'emploi

9499 450 08801
Third Edition
900101

This operating manual is also valid for
PM 5193 S
PM 5193 M
PM 5193 SM
PM 5193 V.. (combined with an additional manual)



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Please note

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

Bitte beachten

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

Noter s.v.p.

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

Important

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

Wichtig

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

Important

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

Him

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3rd edition 3. Ausgabe 3me tirage

CONTENTS

1. GENERAL

1.1. INTRODUCTION

PM 5193 is a cost-effective multifunctional combination of programmable frequency synthesizer and function generator. The microprocessor control enables simple and rapid operation and allows parameter sets to be stored and recalled. Up to 10 set-ups may be stored in non-volatile registers, each of them containing parameters to set wave form, frequency, amplitude, dc-offset and modulation modes like AM, FM, SWEEP, BURST and GATING.

PM 5193 frequency range covers 11 1/2 decades, from 0,1 mHz to 50 MHz. And to make working with this high precision instrument as simple as possible 8 different wave forms are directly selectable. That includes standard functions like sine, square wave, sawtooth and ramps, as well as important extras like rectangular pulses – positive and negative – and haversine.

Precision and stability are essential factors in this instrument. With a crystal oscillator that serves as a reference standard for all generated frequencies, a high standard of accuracy is achieved. Together with outstanding long-term stability, ensuring that today's signals can always be reproduced precisely.

Frequency resolution is 8 digits, so that full advantage can be taken of the instruments high precision, for example in the identification and measurement of phenomena occuring at precisely defined frequencies.

IEEE/IEC bus compatibility adds an important extra dimension to PM 5193's versatility. All functions are remotely selectable, and all settings and status data can be transmitted to a remote controller and recalled whenever required.

Completing its impressive specification, PM 5193 combines powerful user features with operation that could not be simpler. The front panel is divided into clear, separate keypad areas, and three LED displays show together with the key LEDs frequency, modulation parameters, output level and status.

In addition to this manual please find attached an operating/programming card for short-form operating instruction of the instrument.

For adequate customer support and in order to facilitate the service, a test program is built in. Service is done on component level, so no complete module must be exchanged.

For verification of the technical data a performance test is incorporated, chapter 4.

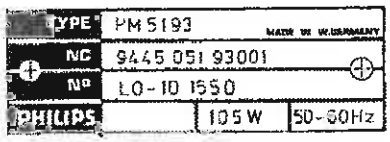
Instrument versions

Type	code number on type plate	external reference frequency for synchronisation	mains voltage on delivery
PM 5193	9445 051 93001	8.58 ... MHz	220 V
PM 5193 S	9445 051 93701	10 - 5 - 3 1/3 - 2.5 - 2 - . . . - 1 MHz*	220 V
PM 5193 SM	9445 051 93708	10 - 5 - 3 1/3 - 2.5 - 2 - . . . - 1 MHz*	120 V

* 10 MHz subharmonics

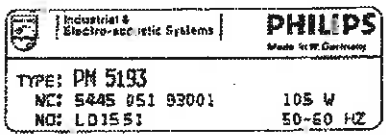
Identification on the type plate at the rear of the instrument

old type plate



type number
code number
series/serial no.

new type plate



last instrument:

LO-10 1550

serial no.
series no.
factory code

first instrument:

LO 1551

serial no.
without series no.
factory code

1.2. CHARACTERISTICS

1.2.1. Safety Characteristics

This apparatus has been designed and tested in accordance with safety class I requirements of IEC-Publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. This manual contains some information and warnings which must be followed by the user to ensure safe operation and to retain the apparatus in a safe condition.

1.2.2. Performance Characteristics, Specifications

Properties expressed in numerical values with stated tolerance are guaranteed by the manufacturer. Specified non-tolerance values indicate those that could be nominally expected from the mean of a range of identical instruments.
These specifications are valid after a warming-up time of 30 minutes (reference temperature 23° C) and for a termination of the signal output with 50 Ohm.
If not stated otherwise, relative tolerances relate to the set value.

1.2.3. Frequency

frequency range	0.1 mHz – 50 MHz	depending on function and wave form
setting range		
– sine wave	0.1 mHz – 50 MHz	
– square wave	0.1 mHz – 20 MHz	
– pos. pulses	0.1 mHz – 50 MHz	
– neg. pulses	0.1 mHz – 50 MHz	
– triangular wave	0.1 mHz – 200 kHz	
– haversine	0.1 mHz – 50 kHz	
– pos. sawtooth	0.1 mHz – 20 kHz	
– neg. sawtooth	0.1 mHz – 20 kHz	
setting		numerical keys decimal point key dimension key Hz/kHz step function
measuring unit	Hz, kHz	selectable with key Hz/kHz. When controlling via IEC/IEEE bus frequency values can only be entered in Hz.
indication	8 digits	7-segment LED-display; decimal point free selectable
max. resolution	0.1 mHz	
setting error limit	$\pm 1 \times 10^{-6}$	
temperature coefficient	< 0.2 ppm/K	
long term drift	< 0.3 ppm within 7 hours	
aging	< 1 ppm/year	
phase noise	< -80 dBc/Hz	1 kHz from carrier, $f < 2$ MHz
frequency jitter rms	< 0.02 %, < 1200 Hz	$f \geq 2$ MHz, LF bandwidth 10 Hz – 20 kHz

	PM 5193	PM 5193 S, PM 5193 SM
phase jitter rms	< 3 mrad, $f < 2$ MHz	< 3 mrad, $f \leq 0.1$ MHz; < 30 f/MHz mrad, $f = 0.1 - 2$ MHz
signal/noise ratio (SNR)*	≥ 55 dBc, $f < 2$ MHz	≥ 55 dBc, $f \leq 0.1$ MHz; $\geq 55 - 20 \log (10\ f/\text{MHz})$ dBc, $f = 0.1 - 2$ MHz

* for a 30 kHz band centered on the carrier excluding ± 1 Hz about the carrier

1.2.4. Signal Output — BNC-connector OUTPUT at the front plate

impedance	50 Ω	
wave forms	sine wave 	indication with LEDs in the keys
	square wave 	
	pos. pulses 	
	neg. pulses 	
	triangular wave 	
	haversine 	
	pos. sawtooth	
	neg. sawtooth	
amplitude setting		numerical keys, decimal point key, step function
indication	max. 2 1/2-digits	7-segment display
measuring unit	V	amplitude pp or rms, dc-voltage
	dBm	ac-level, indication of the measuring unit with LEDs in the keys

1.2.4.1. Sine Wave

frequency range		0.1 mHz – 50 MHz	
voltage pp			
setting range		0 – 20 V	
– subranges	I:	2.1 – 20 V	resolution 0.1 V
	II:	0.21 – 2.00 V	resolution 0.01 V
	III:	0 – 0.200 V	resolution 0.001 V

error limits of the output voltage pp with 50 Ω termination
(nominal value = 1/2 open circuit voltage)

subranges of open circuit voltage	FREQUENCY RANGES			
	0.1 mHz – 1 Hz	1 Hz – 200 kHz	200 kHz – 10 MHz	10 MHz – 50 MHz
I 15.1 – 20.0 V	± 2.5 %	± 2.0 %	± 3.5 %	+6/–12 % (+0.5/–1 dB)
I 2.1 – 15.0 V		(± 0.1 dB)	(± 0.25 dB)	± 8 % (± 0.5 dB)
II 1.51 – 2.00 V	± 3 %	± 2.5 %	± 4 %	+10/–13 % (+0.7/–1.1 dB)
II 0.21 – 1.50 V		(± 0.1 dB)	(± 0.3 dB)	± 12 % (± 0.7 dB)
III 0.151 – 0.200 V	± 3.5 %	± 3.0 % ± 0.15 mV	± 5 % ± 0.25 mV	± 15 % (± 1.2 dB)
III 0 – 0.150 V		(± 0.1 dB ± 0.1 mV)	(± 0.4 dB ± 0.25 mV)	(± 30 % ± 0.25 mV)

The values in brackets specify the flatness of the amplitude response related to the corresponding lower limit of the frequency subrange.

voltage rms open circuit

setting range		0 – 7.1 V	
– subranges	I:	1.1 – 7.1 V	resolution 0.1 V
	II:	0.11 – 1.00 V	resolution 0.01 V
	III:	0 – 0.100 V	resolution 0.001 V

error limits of output voltage rms with 50 Ω termination (nominal value = 1/2 open circuit voltage)

subranges of open circuit voltage		FREQUENCY RANGES			
		0.1 mHz – 1 Hz	1 Hz – 200 kHz	200 kHz – 10 MHz	10 MHz – 20 MHz
I	5.1 – 7.1 V	± 3.0 %	± 2.5 %	± 4.0 %	+ 7 / – 13 %
	1.1 – 5.0 V	± 3.5 %	± 3.0 %	± 4.5 %	+ 8 / – 9 %
II	0.51 – 1.00 V	± 5.5 %	± 5.0 %	± 6.0 %	+ 11 / – 14 %
	0.11 – 0.50 V	± 4.0 %	± 3.5 %	± 4.0 %	± 11 %
III	0.051 – 0.100 V	± 5.5 %	± 5.0 %	± 7.5 %	+ 11 / – 16 %
	0 – 0.050 V	± 5.5 % ± 0.1 mV	± 5.0 % ± 0.1 mV	± 7.5 % ± 0.1 mV	+ 11 / – 18 % ± 0.15 mV

level with 50 Ω termination

setting range – 45 . . . + 24 dBm resolution 1 dB

error limits of the output level dBm

subranges		FREQUENCY RANGES			
		0.1 mHz – 1 Hz	1 Hz – 200 kHz	200 kHz – 10 MHz	10 MHz – 50 MHz
I	22 . . . 24 dBm	± 0.2 dB	± 0.2 dB	± 0.3 dB	+ 0.6 / – 1.0 dB
	5 . . . 21 dBm	± 0.4 dB	± 0.3 dB	± 0.5 dB	+ 0.8 / – 0.9 dB
II	2 . . . 4 dBm	± 0.3 dB	± 0.3 dB	± 0.4 dB	+ 1.0 / – 1.3 dB
	–15 . . . +1 dBm	± 0.4 dB	± 0.4 dB	± 0.5 dB	± 1 dB
III	–30 . . . – 16 dBm	± 0.4 dB	± 0.4 dB	± 0.6 dB	+ 1.0 / – 1.3 dB
	–45 . . . – 31 dBm	± 0.6 dB	± 0.8 dB	± 1.2 dB	+ 2.0 / – 2.5 dB

temperature coefficient	< 0.1 %/K	f ≤ 2.146 MHz
	< 0.25 %/K	f < 10 MHz
	< 0.45 %/K	generally

spectral purity

total harmonic distortion		open circuit voltage > 10 mVpp
	typ. 0.2 %, < 0.5 %	f = 1 Hz – 200 kHz
	typ. 0.4 %, < 0.7 %	f = 200 kHz – 2 MHz
harmonics		f = 2 MHz – 50 MHz
	< – 31 dBc	open circuit voltage ≥ 10 mVpp
	< – 20 dBc	open circuit voltage < 10 mVpp
	< – 37 dBc	open circuit voltage ≥ 10 mVpp, f ≤ 10 MHz
non-harmonics		distance from carrier > 15 kHz
	< – 40 dBc	open circuit voltage ≥ 100 mVpp
	< – 23 dBc	open circuit voltage ≥ 10 mVpp
	< – 6 dBc	open circuit voltage < 10 mVpp

phase jitter rms
signal/noise ratio (SNR) } see chapter 1.2.3.

1.2.4.2. Square Wave

frequency range		0.1 mHz – 20 MHz	
duty cycle		50 %	
rise-/fall time		typ. 10 ns, < 11.5 ns	
aberration limits (overshoot, ringing, tilt)		± 2 % ± 20 mVpp ± 2 % ± 3 mVpp	related to amplitude pp and termination with 50 Ω subrange I subrange II
voltage pp open circuit			
setting range		0.2 – 20 V	
– subranges	I:	2.1 – 20 V	resolution 0.1 V
	II:	0.20 – 2.00 V	resolution 0.01 V
error limits (50 Ω termination)		± 2 % ± 3 %	subrange I, f < 5 MHz subrange II, f < 5 MHz
temperature coefficient		< 0.15 %/K	
voltage rms open circuit			
setting range		0.1 – 10 V	
– subranges	I:	1.1 – 10 V	resolution 0.1 V
	II:	0.10 – 1.00 V	resolution 0.01 V
error limits (50 Ω termination)		± 2 % ± 3 %	subrange I, f < 2 MHz subrange II, f < 2 MHz
level			with 50 Ω termination
setting range		– 13 . . . + 27 dBm	resolution 1 dB
– subranges	I:	+ 9 . . . + 27 dBm	
	II:	– 13 . . . + 8 dBm	
error limits		± 0.25 dB ± 0.40 dB	subrange I, f < 2 MHz subrange II, f < 2 MHz

1.2.4.3. Pulses

positive or negative rectangular pulses alternatively selectable

frequency range	0.1 mHz – 50 MHz	
duty cycle	50 %	
rise-/fall time	typ. 3 ns, < 4.5 ns	
aberration limits (overshoot, ringing, tilt)	± 2 % ± 40 mVpp	related to amplitude pp and 50 Ohm termination

voltage pp open circuit

setting range		1 – 10 V	resolution 0.1 V
error limits		± 2 % ± 40 mV	f < 5 MHz
temperature coefficient		< 0.1 %/K ± 2 mV/K	

voltage rms open circuit

setting range		0.5 – 5.0 V	resolution 0.1 V
error limits		± 2 % ± 40 mV	f < 2 MHz
level			with 50 Ohm termination
setting range		+ 1 . . . + 21 dBm	
– subranges	I:	+ 9 . . . + 21 dBm	resolution: 1 dB
	II:	+ 1 . . . + 8 dBm	resolution: 1 dB
error limits		± 0.25 dB	subrange I, f < 2 MHz
		± 0.50 dB	subrange II, f < 2 MHz

1.2.4.4. **Triangular wave**

frequency range		0.1 mHz – 200 kHz	
linearity error		< 1 %	related to amplitude pp
voltage pp open circuit			
setting range		0 – 20 V	
– subranges	I:	2.1 – 20 V	resolution 0.1 V
	II:	0.21 – 2.00 V	resolution 0.01 V
	III:	0 – 0.200 V	resolution 0.001 V
error limits		as sine wave	refer to tolerance table sine wave amplitude pp
temperature coefficient		< 0.1 %/K	
voltage rms open circuit			
setting range		0 – 5.7 V	
– subranges	I:	1.1 – 5.7 V	resolution 0.1 V
	II:	0.11 – 1.00 V	resolution 0.01 V
	III:	0 – 0.100 V	resolution 0.001 V
error limits		as sine wave	refer to tolerance table sine wave amplitude rms
		additionally ± 1 %	subrange I
		additionally ± 2.5 %	subranges II + III

level			with 50 Ω termination
setting range		– 45 . . . + 22 dBm	resolution 1 dB
error limits		as sine wave	refer to tolerance table sine wave amplitude dBm
		additionally ± 0.1 dB	subrange I
		additionally ± 0.2 dB	subrange II
		additionally ± 0.3 dB	subrange III

1.2.4.5. **Haversine**

this wave form is only significant in combination with the modulation mode BURST. When programming a single ON-cycle haversine pulses are generated which are approximating the Gaussian curve. When using another operation mode, the haversine waveform gives a sinewave with a positive dc-offset.

frequency range		0.1 mHz – 50 kHz	
dc-portion		1/2 open circuit amplitude pp	positive
distortion		< 0.8 %	open circuit amplitude > 10 mVpp
voltage pp open circuit			
setting range		0 – 10 V	
– subranges	I:	1.1 – 10 V	resolution: 0.1 V
	II:	0.11 – 1.00 V	resolution: 0.01 V
	III:	0 – 0.100 V	resolution: 0.001 V
error limits		as sine wave	refer to tolerance table
		additionally ± 1 %	sine wave amplitude pp
voltage rms open circuit			
setting range		0 – 3.5 V	
– subranges	I:	1.1 – 3.5 V	resolution: 0.1 V
	II:	0.11 – 1.00 V	resolution: 0.01 V
	III:	0 – 0.100 V	resolution: 0.001 V
error limits		as sine wave	refer to tolerance table
		additionally ± 1 %	sine wave amplitude rms
level			with 50 Ohm termination
setting range		– 45 . . . + 18 dBm	resolution 1 dB
error limits		as sine wave	refer to tolerance table
		additionally ± 0.1 dB	sine wave amplitude dBm

1.2.4.6.	**Sawtooth Voltage**			unipolar positive or negative going ramps selectable
	frequency range		0.1 mHz – 20 kHz	
	linearity error		< 1 %	related to amplitude pp
	fly-back time		< 1 µs	
	voltage pp open circuit			
	setting range		0 – 10 V	
	– subranges	I:	1.1 – 10 V	resolution 0.1 V
		II:	0.11 – 1.00 V	resolution 0.01 V
		III:	0 – 0.100 V	resolution 0.001 V
	error limits		as sine wave additionally ± 1 %	refer to tolerance table sine wave amplitude pp
	temperature coefficient		< 0.1 %/K	
	voltage rms open circuit			
	setting range		0 – 2.8 V	
	– subranges	I:	1.1 – 2.8 V	resolution 0.1 V
		II:	0.11 – 1.00 V	resolution 0.01 V
		III:	0 – 0.100 V	resolution 0.001 V
	error limits		as sine wave additionally ± 1 %	refer to tolerance table sine wave amplitude rms
	level			with 50 Ω termination
	setting range		– 48 . . . + 16 dBm	resolution 1 dB
	error limits		as sine wave	refer to tolerance table sine wave amplitude dBm
			additionally ± 0.1 dB	subrange I
			additionally ± 0.2 dB	subrange II
			additionally ± 0.3 dB	subrange III
1.2.4.7.	**DC Voltage (offset)**			adjustable independently of the ac-voltage within a window of ± 10 V
	open circuit voltage			
	setting range		– 10 . . . + 10 V	resolution 0.1 V
	error limit		± 2 % ± 30 mV	with 50 Ω termination
	additional error voltage		max. ± 50 mV	subrange I
	– temperature coefficient		< 5 mV/K < 1 mV/K	subrange I subrange II + III

1.2.5.	**Modulation Modes**		
1.2.5.1.	**Amplitudemodulation (AM)**	AM internal, AM external	the voltage setting and indication is related to twice the carrier amplitude
	carrier wave forms	all, except pulses	
	carrier frequency range	0.1 mHz – 50 MHz	
	AM internal		
	modulation frequency range	10 Hz – 200 kHz	sine wave
	– subranges I:	0.01 – 0.99 kHz	resolution 10 Hz
	II:	1.0 – 9.9 kHz	resolution 100 Hz
	III:	10 – 200 kHz	resolution 1 kHz
	– error limits	± 3 % ± 2 Hz	modulation frequency ≤ 50 kHz
		+ 5 % / – 10 %	modulation frequency > 50 kHz
	– temperature coefficient	< 0.02 %/K	
	modulation depth	0 – 100 %	resolution 1 %
	– absolute error limit	± 3 %	carrier frequency < 40 MHz modulation frequency ≤ 50 kHz
		+ 5 % / – 10 %.	modulation frequency > 50 kHz
	AM distortion (THD)	< 2 %	modulation depth ≤ 98 %;
		< 1.5 %	modulation depth ≤ 50 %, fm = 100 Hz – 20 kHz;
		< 1 %	modulation depth ≤ 50 %, fm = 100 Hz – 20 kHz and carrier frequency ≤ 30 MHz
	MODULATION OUTPUT	0 – 1 Vrms	proportional to the modulation depth
	AM external		including static amplitude control
	modulation frequency range	0 – 200 kHz	
	modulation wave form	any wave form possible	
	modulation depth	0 – 100 %	
	MODULATION INPUT-voltage	+ 1.4 V	for doubling the carrier amplitude
		– 1.4 V	for zero carrier amplitude
	AM distortion (THD)	< 1.5 %	modulation depth ≤ 98 %, imp. of mod. signal source ≤ 50 Ω;
		< 1 %	modulation depth ≤ 50 %, imp. of mod. signal source ≤ 600 Ω;
		< 0.7 %	modulation depth ≤ 50 %, imp. of mod. signal source ≤ 600 Ω, carrier frequency ≤ 30 MHz

1.2.5.2. Frequency Modulation (FM) — FM internal, FM external

carrier frequency			
— range		2 — 50 MHz	
— lock-in time		< 10 s	
carrier waveforms		sine wave, square wave, pulses	

FM internal

modulation frequency range		10 Hz — 200 kHz	sine wave
— subranges	I:	0.01 — 0.99 kHz	resolution 10 Hz
	II:	1.0 — 9.9 kHz	resolution 100 Hz
	III:	10 — 200 kHz	resolution 1 kHz
— error limits		± 3 % ± 2 Hz	modulation frequency ⩽ 50 kHz
		+ 5 % / — 10 %	modulation frequency > 50 kHz
— temperature coefficient		< 0.02 %/K	
frequency deviation		10 — 200 kHz	resolution: 1 kHz
— error limit		± 20 %	carrier frequency ⩽ 30 MHz
FM distortion (THD)		< 2 %	generally
		< 1 %	frequency deviation ⩽ 100 kHz, modulation frequency 200 Hz — 50 kHz, carrier frequency ⩽ 30 MHz
MODULATION OUTPUT		0 — 1 V	sine wave voltage rms, proportional to frequency deviation

FM external

modulation frequency range	10 Hz — 200 kHz	any waveform possible
frequency deviation	max. 200 kHz	with modulation waveform sine
FM distortion (THD)	< 1 %	carrier frequency ⩽ 30 MHz, frequency deviation ⩽ 100 kHz, impedance of the modulation signal source ⩽ 50 Ω
MODULATION INPUT	1 V	sine wave voltage rms for 200 kHz deviation

1.2.5.3. Gate — gate internal, gate external — non phase-coherent signal keying

carrier wave forms	all, except pulses
carrier frequency range	0.1 mHz — 50 MHz

gate internal

duty cycle		50 %	
modulation frequency range		10 Hz – 200 kHz	
– subranges	I:	0.01 – 0.99 kHz	resolution 10 Hz
	II:	1.0 – 9.9 kHz	resolution 100 Hz
	III:	10 – 200 kHz	resolution 1 kHz
– error limits		± 3 % ± 2 Hz	modulation frequency ≤ 50 kHz
		+ 5 % / – 10 %	modulation frequency > 50 kHz
– temperature coefficient		< 0.02 %/K	
MODULATION OUTPUT		1 V	sine wave voltage rms

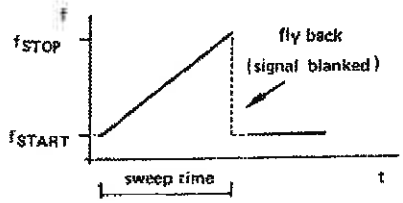
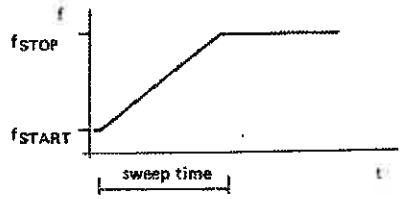
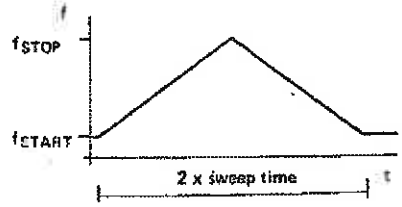
gate external

modulation frequency range	0 – 500 kHz	
MODULATION INPUT		
– modulation waveform	any waveform possible	
– max. peak value	± 10 V	
– threshold	2.5 ± 1 V	above this threshold the output signal is blocked
– minimal on/off keying time	2 µs	

1.2.5.4. **Sweep**

sweep operating modes	SINGLE sweep CONT sweep	
	sweep up sweep down	refer to start/stop frequency setting

sweep, operating mode SINGLE

mode 1	sweep runs from f_{START} to f_{STOP}. Fly back to f_{START}	
mode 2	sweep runs from f_{START} to f_{STOP} and remains at f_{STOP}	
mode 3	sweep runs from f_{START} to f_{STOP} and runs back again to f_{START}	

carrier waveforms		all	
sweep range		1 mHz – 50 MHz	resolution max. 1 mHz
start/stop frequency		any frequency independently adjustable within the sweep range	the upper range limit depends on the selected waveform
sweep time		10 ms – 999 s	
– subranges	I:	0.01 – 9.99 s	resolution: 0.01 s
	II:	10.0 – 99.9 s	resolution: 0.1 s
	III:	100 – 999 s	resolution: 1 s
– error limits		± 0.1 ms ± 45 ms	sweep time $\leqslant$ 4.09 s sweep time $\geqslant$ 4.1 s
sweep characteristic		linear, logarithmic	alternatively selectable
MODULATION INPUT			trigger pulse for external triggering
– voltage level		TTL-level	
– duration		$\geqslant$ 1 ms 'high'	
– repetition rate		max. 33 Hz max. 20 Hz	in 'lin' mode in 'log' mode
start frequency persisting time cont sweep, mode 1 and 2		$\approx$ 15 % of sweep time, $>$ 2 ms	sweep time $<$ 10 s
		$\approx$ 1.6 s	sweep time $>$ 10 s
frequency steps per sweep range		$\frac{\text{sweep time}}{1\text{ ms}}$	sweep time $\leqslant$ 4.09 s
		4096	sweep time $\geqslant$ 4.1 s
SWEEP OUT-voltage		0 – 10 V	proportional to the frequency for LIN SWEEP proportional to log (f) for LOG SWEEP 0 $\triangleq$ fstart; + 10 V $\triangleq$ fstop
PEN LIFT		electronic switch to ground; closes: at start of sweeps	
		opens: mode 1 and 2 SINGLE, CONT	when reaching f_{STOP}
		mode 3, SINGLE	after return to f_{START}
		mode 3, CONT	at leaving this mode
– switch-off time		$\approx$ 5 % of sweep time; min. 1.8 ms, max. 0.5 s	
function key HOLD		stops the sweep with indication of the actual frequency	The sweep will be continued by pressing HOLD again.

1.2.5.5. Burst

carrier waveforms	all	phase-coherent signal on/off keying with programmable number of signal periods per burst
frequency range	0.1 mHz – 2 MHz	the upper range limit depends on the selected waveform
ON-cycles	1 – 200	number of signal periods per burst
OFF-cycles	1 – 200	number of suppressed signal periods between the bursts in CONT burst mode
burst modes	INT: SINGLE burst CONT burst	manually triggered
	EXT: SINGLE burst	electronically triggered at the connector MODULATION INPUT
trigger pulse EXT SINGLE burst – voltage	TTL-level	a burst is released by the positive edge of a trigger pulse
– repetition rate	max. 1 kHz	
start/stop level	zero crossings for: – sine wave – triangular wave – square wave	
	neg. peaks for: – Haversine – pos. sawtooth – pos. pulses	
	pos. peaks for: – neg. sawtooth – neg. pulses	

1.2.6.	**Step- and HOLD-Functions**		
1.2.6.1.	**frequency step function**		these functions can only be used manually via the keyboard
	– indication	5 digits	
	– control keys	Δ FREQ + STEP	altering the frequency in programmable steps
1.2.6.2.	**amplitude step function**		
	– control keys	Δ LEVEL + STEP – STEP	altering the amplitude in programmable steps
1.2.6.3.	**HOLD-Function**		
		HOLD	sweep function stop and release; stop and release of the output voltage at the momentary value (f ≤ 1 Hz)
1.2.7.	**Connectors**		all signal in- and outputs are BNC connectors
1.2.7.1.	**Outputs**		
	front panel:		
	OUTPUT	main signal output	short-circuit proof, max. external voltage ± 12 V (< 3 min)
	– impedance	50 Ω	
	TTL OUT – fan out	TTL-output 5 TTL-standard inputs	phase difference of pos. edge to OUTPUT

0°	f ≤ 2.147 MHz,
90°	f > 2.147 MHz
– 90°	
180°	

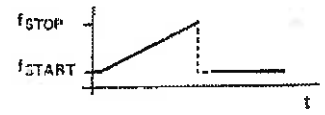
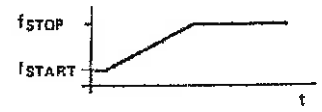
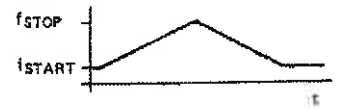
	rear:	
	INT CLOCK (PM 5193) – frequency – fan out	internal clock signal 8.589935 MHz (2^{33} mHz) 5 TTL-standard inputs
	10 MHz (PM 5193 S + SM)	short-circuit proof, max. external voltage ± 10 V
	– frequency – level – impedance	10 MHz typ. 2 dBm, > 0 dBm 50 Ω
	MODULATION – voltage	square wave internal modulation voltage 0 – 1 Vrms 1 Vrms TTL-level
	– impedance	1 kΩ

PEN LIFT	electronic switch to ground	
— max. current	200 mA (output voltage 0.7 V)	switch closed
— voltage	+ 20 V (impedance 100 kΩ)	switch open
SWEEP		sweep voltage proportional to the frequency for LIN-SWEEP or to log (f) for LOG-SWEEP
— voltage	0 — 10 V	0 ≙ fstart, 10 V ≙ fstop
— impedance	10 kΩ	

1.2.7.2. Inputs

EXT CLOCK (PM 5193)	external TTL-signal	for synchronisation purposes; the external clock supply is automatically switched on when clock signal is fed to EXT CLOCK.
— frequency (fc)	7.5 — 10 MHz 8.6 ± 0.5 MHz	fp ≤ 2.147 MHz fp > 2.147 MHz resulting generator output frequency $f = fp \cdot fc \cdot 2^{-33} \cdot 10^{9}$ (fc in MHz) fp = programmed frequency
— impedance	10 kΩ	
EXT REF (PM 5193 S + SM)	max. external voltage ± 5 V	sine or square wave
— frequency	$\frac{10\ MHz}{N}$, N = 1, 2, 3 . . . 10	for synchronisation purposes
— — lock-in time	< 2 s	
— — lock-in range	± 0.1 %	a relative frequency offset of the reference frequency results in the same relative offset of the output frequency
— level	0 — 20 dBm	
— impedance	50 Ω	
MODULATION	input of external modulation voltages for the modulation modes: GATE, AM, FM; input of external trigger pulses for SWEEP and BURST	
— input voltage	max. ± 10 V	
— impedance	> 50 kΩ	

1.2.8.	**IEEE/IEC-Bus**		all generator functions can be remotely controlled
	interface functions	AH1	acceptor handshake
		SH1	source handhake
		L4	listener function
		T6	talker function
		RL1	local/remote with local lockout
		SR1	service request
	address range	Ø – 3Ø	address adjustment with key ADDRESS, stored in a battery buffered RAM, initial value = 2Ø
	remote control commands	consisting of – header – numerical extension – numerical value	 not for all commands
	frequency headers	F	basic frequency, carrier frequency
		FS (or F)	SWEEP start-frequency
		FF	SWEEP stop-frequency
		FM	modulation frequency
		FD	frequency deviation (FM)
	amplitude headers	LA	amplitude pp
		LR	amplitude rms
		LL	dBm-level
		LD	DC-level
		LM	modulation depth (%)
	period number headers	NB ..	number of signal periods per BURST
		NO ..	number of suppressed signal periods per BURST (CONT)
	modulation headers	these commands – except MO – require a numerical extension (x) or (y) to sub-specify the modulation mode	
		MA x	amplitude modulation
		MF x	frequency modulation
		GC x	continuous gate
		BS x	single burst
		BC x	continuous burst
		SS x	single sweep
		SC x	continuous sweep
		SM y	sweep mode
		MO	modulation off
	numerical extension 'x'	Ø	'off'; reset to f_{START}, mode 2
		1	internal
		2	external
		3	linear
		4	logarithmic
		5	wait for BURST

numerical extension 'y'	1	sweep mode 1 
	2	sweep mode 2 
	3	sweep mode 3 
store/recall functions	RL x RR y	register store (x = 1 . . . 9) register recall (y = Ø . . . 9)
sweep time header	TS	
wave form header	WS WT WQ WH RP RN PP PN ACØ AC1	sine wave triangular wave square wave haversine pos. sawtooth neg. sawtooth pos. pulses neg. pulses AC 'off' AC 'on'
dimensions	V dBm s Hz	for voltages for levels for sweep time for frequencies
format of the numerical values	integers, reals or exponentials; the sign may be left out if mantissa or exponent is positive	
string format	a complete string may consist of one or more commands. Spaces and separators are ignored.	
string delimitor	CR or LF or ETX or ETB	decimalcode ASCII: 13 or 1Ø or 3 or 23
string length	not limited	
transfer time	appr. 5.9 ms appr. 3.Ø ms appr. 2.6 ms appr. 1.Ø ms appr. 7.2 ms appr. 2.6 ms	wave form frequency modulation parameters modulation mode amplitude dc-voltage
execution time	5 ms typ.	

status byte	Bit 6: request for service: SRQ Bit 5: error message Bit 4: busy (BURST or SWEEP) Bit 3: (not used) Bit 2: syntax error Bit 1: out of range Bit Ø: incompatibility between parameters	
masking for SRQ	MSR 'n'	'n' = decimal value which binary pattern masks the status byte. The individual bit of the status byte is activated for SRQ if the corresponding bit of the binary pattern is '1'.
learn-mode-command	IS?	When receiving this command the PM 5193 emits a string to the controller defining the complete generator setting. This string is formatted in a way that it can directly be used for a new setting.
identification-mode-command	ID?	When receiving this command the PM 5193 emits a string to the controller which contains the type number and the software status identification.

1.2.9. Storage of Parameter Settings

number of storage registers	1Ø	the registers 1 — 9 are free selectable for storing purposes, register Ø serves only for storing of the actual manual setting
control keys	STO x RCL x ENTER	store into register (x) recall from register (x) transfer parameters to the working memory
storage time	appr. 5 years	if the instrument is always switched off; with power switched on, the RAMs will be supplied from power supply — this increases the storage time.
battery	Lithium battery	

1.2.10. Diagnostic Program

When power is switched on, the voltage display field shows the software status for approx. 1 s. After this the processor checks the PROM(s) and the RAM chip and switches on all display segments and LEDs in the keys for approx. 2 — 3 s.

Beside this the program contains a very detailed diagnostic part to ease the fault finding.

1.2.11. Overflow, Misoperating

In case of incorrect or insufficient inputs the relevant part of the display and the key-LEDs start flashing.

1.2.12. Power Supply

ac mains

nominal values	100/120/220/240 V (selectable by wiring)
nominal operating range	± 10 % of selected nominal value
operating limits range	± 10 % of selected nominal value
nominal frequency	50/60 Hz
— tolerance range	± 5 % of nominal frequency range
power consumption	105 W

1.2.13. Environmental Capabilities

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 PHILIPS organization in your country or by PHILIPS International B.V., Industrial & Electro-acoustic Systems Division, EINDHOVEN, THE NETHERLANDS.

ambient temperature:	
reference value	+ 23° C ± 1 K
nominal working range	+ 5° C . . . + 40° C
limits for storage and transport	−40° C . . . + 70° C
relative humidity:	
reference range	45 % . . . 75 %
nominal working range	20 % . . . 80 %
limit range of use	10 % . . . 90 %
limit range for storage and transport	0 % . . . 90 %
air pressure:	
reference value	1013 hPa (≙ 760 mm Hg)
nominal working range	800 hPa . . . 1060 hPa (≙ 600 . . . 800 mm Hg; up to 2200 m height)
air speed:	
reference value	0 m/s . . . 0.2 m/s
nominal working range	0 m/s . . . 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
operating position	normally upright on feet (horizontal position) or with bow fold down
warm-up time	30 min.

1.2.14. Safety- and Quality Data; Cabinet

protection type (see DIN 40 050)	IP 20
protection class (see IEC 348)	class I, protective conductor
line connection	mains connector
radio interference voltage radio interference radiation	according to VDE 0871 class B (Grenzwertklasse B)
call rate	≤ 0.15
overall dimensions	19", 2 E high
width	440 mm
height	105 mm
depth	430 mm
weight	10 kg (22 lbs)

1.3. ACCESSORIES

1.3.1. Standard

operating manual	9499 450 08801
with operating/programming card	9499 450 08911

mains cable
fuses
adapters for 19"-rack mounting (see Appendix 2)
labels for mains voltage
4 foot rubbers

1.3.2. Optional

PM 9074	coaxial cable BNC-BNC / 50 Ω (1 m)
PM 9051	adapter BNC (male)/banana jack
PM 9585	50-Ohm-termination 1 W
PM 9581	50-Ohm-termination 3 W
PM 2295/10	IEEE-Bus-cable (1 m)
PM 2295/20	IEEE-Bus-cable (2 m)
PM 2296/50	IEEE/IEC-adapter
PM 2296/60	IEC/IEEE-adapter
PM 9613	Rack-mount slide kit
	Service-Manual, order no. 9499 455 00311; Philips Instrumentation Systems
	Reference Manual, order no. 9499 997 01111

1.4. OPERATING PRINCIPLE, Fig. 2 (Block diagram)

1.4.1. General Operating Principle

The basic functional units, performing the generation, processing and conditioning of the generator output signals, are named

- DFS, Digital Frequency Synthesizer, on unit 2
- PLL, Phase Locked Loop, on unit 1
- MODULATOR on unit 1
- PULSE GENERATOR on unit 1
- AMPLIFIER on unit 1

These functional units are under control of the CPU (Central Processing Unit), consisting of a microprocessor and its peripheral components on unit 2. Primary control data for the CPU is derived from the front-end KEYBOARD & DISPLAY on unit 3 or from an external controller via the IEEE/IEC bus interface. The output-signal parameters are displayed numerically on a 7-segment-LED display. Key LEDs are provided for operating mode indication. Subsequently a brief description of the over-all block diagramm (fig. 2) of the generator is given.

1.4.2. Description of the Block Diagram

DFS

In the frequency range up to 2147 kHz the primary signals – sine, triangular, positive and negative sawtooth waves – are generated by direct digital signal synthesis.

Binary samples of the wave are created in the SIGNAL SYNTHESIZER section and converted to analogue voltages by a fast DAC at the clock rate fc. The output frequency fo is directly related to fc, according to

$$fo = 0.1 \cdot N \cdot 2^{-33} \cdot fc = N \cdot 10^{-4}\ Hz$$

where N is the decimal equivalent of the binary frequency word, routed to the SIGNAL SYNTHESIZER from the CPU via U2-CONTROL BUS.

The PM 5193 generates f_c by a crystal oscillator, the 8.59 MHz CLOCK on unit 2.
The PM 5193 S + SM derive f_c from a PLL/VCO on unit 5 which gets the reference frequency from an 10 MHz crystal oscillator or from an external signal via connector EXT REF. An AUTOMATIC SWITCH on unit 5 is routing the frequency of the 10 MHz crystal oscillator or the external reference frequency, if applied, via frequency divider and phase detector to the VCO of the PLL.
The PM 5193 uses the AUTOMATIC SWITCH on unit 2 to route either the external clock frequency or the internal 8.59 MHz CLOCK to the SIGNAL SYNTHESIZER.

The DAC output signal is smoothed by the 3 MHz LPF, an anti-aliasing low-pass filter. The BURST CONTROL LOGIC section generates the carrier on/off keying control signals in the burst mode of the generator.

PLL

In the frequency range above 2147 kHz the primary sine wave is generated in the PLL. The PLL consists of a broad-band VCO, Voltage-Controlled Oscillator, – with a triangular-wave output signal fed to the SINE SHAPER – the FREQUENCY DIVIDER, the PHASE DETECTOR and the LOOP FILTER. By the PLL the PLL REF frequency – generated in the DFS – is multiplied by a factor of 4096 in FM mode and 32 otherwise. For fast phase-locking response the VCO is preset roughly by the DAC to the programmed frequency.

MODULATOR

By the VOLTAGE CONDITIONER the DFS sawtooth wave or the sine wave – if haversine is selected – are halved in amplitude and shifted in dc, resulting in unipolar signals. The sine wave – if sine waveform is programmed – and the triangular wave are routed without change through the VOLTAGE CONDITIONER. In the BURST-mode the output signal of the VOLTAGE CONDITIONER is keyed on/off by the DIODE SWITCH 1 and routed to the AMPLIFIER. In NON-BURST-mode the signal from DIODE SWITCH 1 is fed either directly or through the AMPLITUDE MODULATOR to the AMPLIFIER. In the frequency range above 2147 kHz the RF SINE wave is routed from the PLL to DIODE SWITCH 2 and to the AMPLITUDE MODULATOR or directly to the AMPLIFIER. Both diode switches are served by the SWITCH CONTROL, which evaluates the accurate control signal from the outputs SQUARE BURST and BURST for the DFS, the 2 MHz SWITCH control signal from the CPU and the GATE signal from the SWITCHING CIRCUITRY in the gate mode of the generator.

In internal GATE, AM or FM mode the modulating signal is derived from the MODULATION OSCILLATOR output. The output sine wave is scaled in amplitude by the AMPLITUDE CONTROLLER to give the accurate AM or FM modulation depth. The modulating sine wave is fed to the AMPLITUDE MODULATOR in AM mode or to the PLL in FM mode through the SWITCHING CIRCUITRY. Alternatively – in the external modulation modes – the modulating signal is supplied from the generator MODULATION INPUT.

PULSE GENERATOR

The PULSE GENERATOR basically represents an electronical switching circuitry, creating a TTL signal and either a square wave or a positive respectively negative rectangular pulse train, each signal with a 50 % duty cycle. The instants of the positive and negative edges of these signals are determined by the zero-crossings of the reference input signal. In the frequency range up to 2147 kHz the DFS signal, e. g. a sine wave, fed to the ZERO CROSSING DETECTOR serves as reference. Above 2147 kHz the TTL output signal of the PLL, named RF TTL, directly determines the switching points.

By the CONTROL CIRCUITRY either the TTL output of the ZERO CROSSING DETECTOR or the RF TTL combined with one of the burst switching signals in burst mode – the POSITIVE PULSE BURST, the BURST or the SQUARE BURST – are routed to the switching output of the signal conditioners. The TTL OUTPUT STAGE and the SQUARE WAVE CONDITIONER are creating the TTL output voltage of the generator and the primary square wave with accurate amplitude and waveform. The PULSE TRAIN CONDITIONER generates a square wave with extra steep positive and negative edges and a programmable amplitude, controlled by the dc output of the DAC. At the generator output this square wave is shifted to unipolar positive or negative pulses by the DC GENERATOR in the AMPLIFIER.

AMPLIFIER

The vernier setting of the generator output amplitude is performed by the AMPLITUDE CONTROLLER. After amplification by the POWER AMPLIFIER the signal either directly or after 20 dB respectively 40 dB attenuation by the STEP ATTENUATOR is routed to the OUTPUT socket. The DC GENERATOR adds the programmed dc voltage.

CPU

An 8-bit microprocessor (8031) and a 10 MHz clock are the constituents of the PROCESSOR & CLOCK. The PROGRAM MEMORY is a 16 Kbyte EPROM. In an external data memory, the 256 byte RAM, the 10 storage register contents of the generator are stored. By the CONTROL BUS DRIVER the required load capability of the U1- and U2 CONTROL BUS serial data linie (SDA), and the clock line (SCL), is achieved. The device selecting strobe signals STR1...15 — used for CPU components and latching-data — shift registers in the various functional units controlled by the CPU — are derived from 4 ports of the PROCESSOR by the STROBE DECODER.

By the DIRECT PORT LATCH two output port signals — 2 MHz SWITCH and PLL CNTL — are derived from three address/data bus lines of the CPU. The SWEEP VOLTAGE DAC is generating a voltage ramp during a frequency sweep. The PEN LIFT SWITCH serves for lifting the writing pen of an x-y plotter during frequency sweep fly-backs.

The IEEE/IEC bus interface of the generator consists of the IEC BUS CONTROLLER, the DEVICE ADDRESS LATCH & SHIFT REGISTER and the 3-STATE GATE & LATCH.

2. INSTALLATION INSTRUCTIONS

2.1. INITIAL INSPECTION

Check the contents of the shipment for completeness and note whether any damage has occurred during transport. If the contents are incomplete, or there is damage, a claim should be filed with the carrier immediately, and the Philips Sales or Service organisation should be notified in order to facilitate the repair or replacement of the instrument.

2.2. SAFETY INSTRUCTIONS

Upon delivery from the factory the instrument complies with the required safety regulations, see para. 1.2. To maintain this condition and to ensure safe operation, the instructions below must carefully be followed.

2.2.1. Maintenance and Repair

Failure and excessive stress:
If the instrument is suspected of being unsafe, take it out of operation permanently.
This is the case when the instrument

- shows physical damage
- does not function anymore
- is stressed beyond the tolerable limits (e.g. during storage and transportation)

Dismantling the instrument: When removing covers or other parts by means of tools, live parts or terminals could be exposed. Before opening the instrument, disconnect it from all power sources.

If the open live instrument needs calibration, maintenance or repair, it must be performed only by trained personnel being aware of the risks. After disconnection from all power sources, the capacitors in the instrument may remain charged for some seconds.

2.2.2. Earthing (grounding)

Before any other connection is made the instrument shall be connected to a protective earth conductor via the three-core mains cable. The mains plug shall be inserted only into a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor.

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

2.2.3. Connections

The circuit earth potential is applied to the external contacts of the BNC sockets and is connected to the cabinet by means of parallel-connected capacitors. By this means hum loops are avoided and a clear HF earthing is obtained.

If the circuit earth potential in a measurement set-up is different from the protective earth 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 (VDE 0411),
- that all sockets marked with the sign ⊥ are internally interconnected.

2.2.4. Mains Voltage Setting and Fuses

Before inserting the mains plug into the mains socket, make sure that the instrument is set to the local mains voltage.

The instrument shall be set to the local mains voltage only by a qualified person who is aware of the hazard involved.

WARNING: If the mains plug has to be adapted to the local situation, such adaption should be done by a qualified person only.

On delivery from the factory the instrument is set to a mains voltage which is indicated on the rear panel as well as the corresponding fuse:

PM 5193 + PM 5193 S	220 V	630 mAT
PM 5193 M + PM 5193 SM	120 V	1.25 AT

For modification to other local mains voltages please use the "Appendix" of this manual or the service manual.

Make sure that only fuses of the required current rating, and of the specified type are used for renewal. The use of repaired fuses, and/or the short-circuiting of fuse holders, are prohibited.

The fuse is located in a holder on the rear panel above the mains socket.

100 V	1.6 AT
120 V	1.25 AT
220 V / 240 V	630 mAT
	DIN 41571 Slow blow

WARNING: The instrument shall be disconnected from all voltage sources when a fuse is to be renewed.

2.3. OPERATING POSITION OF THE INSTRUMENT

The instrument may be used in the positions indicated in clause 1.2.13. For use in sloping position erect the tilting support at the bottom. The characteristics mentioned in section 1.2. are guaranteed for the specified positions.
Ensure that the ventilation holes are free of obstruction.
Do not position the instrument on any surface which produces or radiates heat, or in direct sunlight.

2.4. RADIO INTERFERENCE SUPPRESSION

Radio interference of the instrument is suppressed and checked carefully. In connection with deficient suppressed base units and further units radio interference can be generated, which have to be suppressed by means of additional activities.

3. OPERATING INSTRUCTIONS

3.1. GENERAL INFORMATION

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

3.2. SWITCHING ON THE INSTRUMENT

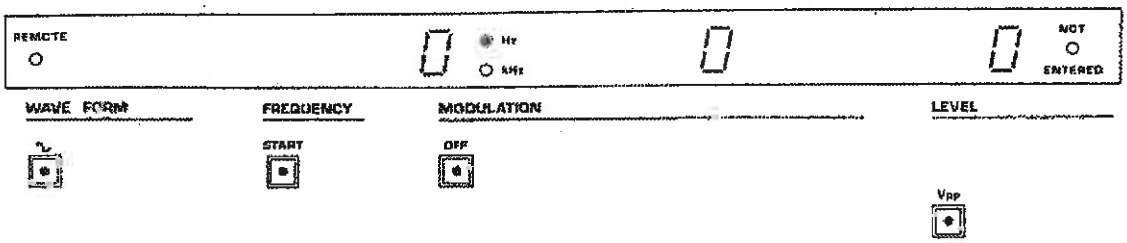
After the instrument has been connected to the mains voltage in accordance with clauses 2.2.4., it can be switched on by operating the mains switch POWER. The white circle on the POWER switch mechanically indicates that the instrument is switched on.

Having switched on the instrument, it is immediately ready for use. With normal installation in accordance with section 2.3. and after a warming-up time of 30 minutes, the characteristics specified in section 1.2. are valid.

After switching power off a time interval of at least 5 s should pass by — allowing the capacitors of the power supply to discharge — before the device is switched on again. This measure is necessary to set the internal logic circuitry to its correct initial condition.

3.3. SELFTEST ROUTINE

When switched on, the instrument first carries out a selftest whereby the PROMs and RAMs are checked. If the instrument is in order all the segments and decimal points of the figures and all LEDs light up for approx. 3 s. The instrument then passes to its default status, indicated by a zero in each of the three sectors of the display, the LED Hz in the display and the LEDs in the keys SINE, START, OFF and Vpp.



An error is represented as follows:

Err 1	PROM	checksum error
Err 2	RAM (processor)	read/write error
Err 3	RAM (CPU)	operation possible but memory contents is destroyed

For further examples see chapter 3.5.6. Error Messages.

3.4. BRIEF CHECKING PROCEDURE

3.4.1. General

The purpose of this operation is to check the functions of the PM 5193 with the least amount of time and effort.

It is assumed that the operator is familiar with the PM 5193 and its characteristics. If the test is carried out shortly after being switched on, the individual testing steps could lead to incorrect results owing to the warming-up time being inadequate.

WARNING: Before switching on ensure that the equipment has been put into operation in accordance with chapter 2.

3.4.2. Operations Test

Immediately upon being switched on, a self-test is carried out. The instrument then automatically returns to its basic status (see chapter 3.3.). The equipment's last operational status prior to being switched off can be recalled from memory 0 as follows:

[RCLO-9] [0] [ENTER]

If you prefer a different operation mode, then just input new parameters.

example:	wave form	sine
	frequency (fstart)	150 Hz
	modulation	off
	level: amplitude (Vpp)	1 V
	DC offset (Vdc)	0 V

– Earlier settings that remain unchanged do not need to be entered again.

[∿] [START] [1] [5] [0] [Hz/kHz] * frequency

[OFF] modulation

[Vpp] [1] [Vdc] [0] [ENTER] level

* (press key Hz/kHz only if LED "Hz" doesn't lit)

– connect the oscilloscope to socket OUTPUT (see chapter 3.5.2.1.) (Zo = 50 ohm) and check the signal. If it is correct, the operations test is finished. If not, repeat the procedure with other settings. For input examples see the concise form of the operating instructions "Operating Card" and chapter 3.5.

3.5. OPERATION AND USE

3.5.1. Configuration of the display and control panel (Fig. 1)

This display (3) consists of 3 sectors for the following indications (from left to right):

- frequencies (8 digits):
  basic or sweep start frequency, or sweep stop frequency or frequency increment.
- modulation parameters (3 digits)
- output voltage/address (4 digits)
  output voltage or level, or voltage or level increment, or remote control address.

The keyboard is subdivided into five functional main sectors:

- WAVE FORM (16)
  direct setting of the wave form
- FREQUENCY (14)
  setting of the basic (= sweep start frequency), the sweep stop frequency, and frequency interval for the frequency STEP-function
- MODULATION (13)
  setting one of the modulation modes using the corresponding modulation parameters.
- OUTPUT SIGNAL (12)
  setting and stepping of the output voltage or level as well as setting the remote addresses.
- NUMERIC KEYBOARD (5, 6, 9, 10)
  input of figures and decimal point, erasing the last figure entered for correction purposes, recalling one of the 10 storage registers, transferring one of the parameter sets into one of the storage registers and the ENTER function (implementation of the numeric input values).

LEDs in the respective keys on the control panel indicate the actual parameters.

There are two kinds of keys:

- keys having a direct effect on the output signal.

keyboard WAVE FORM:	all
keyboard FREQUENCY:	Hz/kHz, STEP–, STEP+
keyboard MODULATION:	OFF, AM, FM, GATE, EXT, INT, SINGLE, CONT and HOLD
keyboard LEVEL:	STEP–, STEP+

  These keys have direct effect on the output if their respective parameters are complete and within the correct range.

- keys with a „pre-selection" character.

keyboard FREQUENCY:	START, STOP and ΔFREQ
keyboard MODULATION:	FREQ (kHz), %, DEV (kHz), LIN SWEEP, LOG, BURST, ON cycles, OFF cycles and TIME(s)
keyboard LEVEL:	Vpp, dBm, Vrms, Vdc, ΔLEVEL and ADDRESS

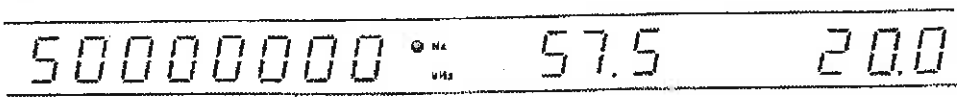
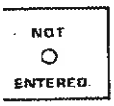
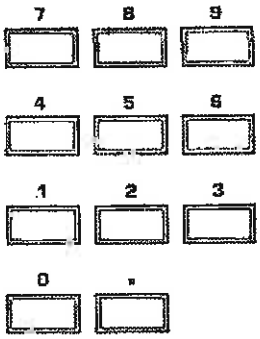
The „pre-selection" keys (except LIN SWEEP, LOG and BURST) have a dual function:

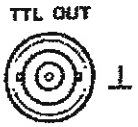
- when pressed once the respective display is blanked and ready for a numeric entry.
- when operated twice, the respective display is blanked and then the actual numerical value is displayed. This way every parameter not already being shown can be displayed.

When the display is blanked by operating one of the pre-selection keys once and during the following numerical input, the unit is in a NOT ENTERED state, i. e. the input parameter value has not yet been activated and can be corrected using the key RUB OUT. This state is recognised by the NOT ENTERED LED flashing at the right-hand side of the display. The input value is implemented after the ENTER key has been pressed.

3.5.2. Display, Control Elements and Connectors

3.5.2.1. Controls and Indicators at the Front Panel

Controls/Indicators	Function
	Key (1). This allows the equipment to be switched over from „remote operation" to local operation
	LED (2) indicating remote operation via IEEE/IEC bus.
	LEDs and display (3) for: — frequency (8 digits) and frequency dimension (LED) — modulation parameter (3 digits) — output level (2 digits) or output voltage (3 digits) or remote operation address (2 digits).
	LED (4) flashes if the input operation parameters have not yet been entered out or in the case of an input error.
 	Keys (5) to — store up to 9 sets of parameters (STORE) — recall settings from the 10 storage registers (RECALL)
	Numeric keyboard (6) with decimal point to input the parameter values. When the ENTER key is pressed, the input values are transferred from the input store to the working memory.



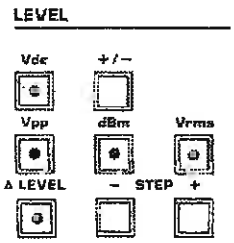
Output socket (7) for TTL signal

Output socket (8)

Key (9) to execute the data input

Correction key (10) to cancel the input in reverse order.

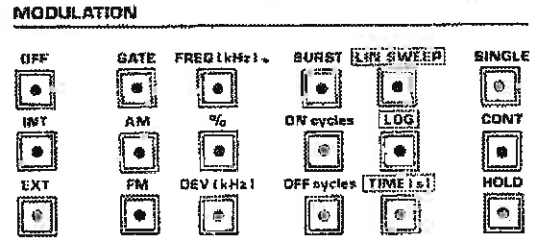
Key (11) to input the device address (0 . . . 30).



Keyboard (12) to input the output level and offset voltage

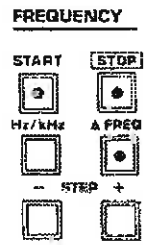
Additional functions:

- conversion of Vpp/dBm/Vrms
- changing the output amplitude stepwise either in a positive or negative direction with the keys STEP+ or STEP−
- changing the sign of the offset voltage (Vdc) and the LEVEL (dBm) with the key +/−.



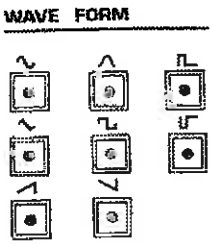
Keyboard (13)

- to select the modulation mode (internal: AM, FM, SWEEP LOG/LIN, BURST, GATE; external: AM, FM, BURST, GATE),
- to select one of the modulationparameters for numerical entries (%, DEV, FREQ (kHz), ON cycles, OFF cycles, TIME),
- to control the SWEEP and BURST (SINGLE, CONT, HOLD)

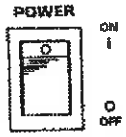


Keyboard (14) to set the frequency.
(Key STOP only used for SWEEP)

Key (15) to switch the AC output signal on and off without influence on the offset voltage.



Keyboard (16) to select the wave form.
(The wave form 'Haversine' (⌒) is significant in combination with the BURST-mode to produce an approximating 'Gaussian curve'. See chapter 3.5.4.4.).



Mains switch (17). The white circle shows that the equipment is switched off.

3.5.2.2. Rear Connections

Output socket (18) for synchronisation purposes (PM 5193: 8.59 MHz, PM 5193 S + SM: 10 MHz)
Output socket (19) for the modulation frequency.
Output socket (20) for x-y plotter pen control.
Output socket (21) for the sweep voltage (0–10 V)
Fuse (22).
Mains socket (23).
IEEE/IEC bus for remote operation (24).
Input socket (25) for modulating the carrier in AM, FM or GATE mode or for triggering of SWEEPs, as well as BURST.
Input socket (26) for external reference frequencies.

3.5.3. Manual Input Procedure

The PM 5193 can be controlled either via the keyboard or via the IEEE/IEC bus. The keyboard is inhibited when controlling via the bus and the REMOTE LED lights.

In LOCAL mode, the maximum number of digits that can be entered is identical with the number of positions in the display. If too many digits are entered or decimal points entered at illegal positions, these are ignored.

Illegal input or values are shown by flashing of key LEDs and display. The PM 5193 does not accept illegal inputs so that no damage can be caused by such wrong operations.

Numerical inputs have to be terminated using the key ENTER. Not terminated inputs are indicated by the flashing NOT ENTERED LED.

The parameters can be entered in any sequence. Previously entered values that remain unchanged do not need to be entered again. (See chapter 3.5.4.).

Corrections can be made during input by using the key RUB OUT or by starting this parameter input again.

Formular signs:

fo	=	frequency, carrier frequency
Δf	=	frequency steps
fm	=	modulation frequency
m	=	modulation depth (degree of modulation)
Vpp	=	output amplitude peak-peak
Vdc	=	DC offset

Input formats:

FREQUENCY		
start-/stop frequency	x.x.x.x.x.x.x.x.	Hz/kHz
Δfrequency	x.x.x.x.x.	Hz/kHz
MODULATION		
modulation frequency	x.x.x.	kHz
modulation depth	x x x	%
deviation	x x x	kHz
sweep time	x.x.x.	s
sweep mode	1 . . . 3	
ON-/OFF-cycles	x x x	
LEVEL		
Vpp, Vrms, ΔVpp, ΔVrms	x.x.x.	
Vdc, ΔVdc (+ is not shown) +/–	x.x.	
dBm, ΔdBm (+ is not shown) +/–	x x	
address (external control)	0 . . . 30	

Example: sine wave, fo = 150 kHz, Vpp = 0.1 V, Vdc = 0 V

∿	START	1	5	0	Hz/kHz
OFF					
Vpp	.	1	Vdc	0	ENTER

3.5.3.1. Frequency Input

By pressing the START key the instrument is set to accept frequency inputs in the following ranges:

WAVE FORM	symbol	frequency range	amplitude (open circuit)
sine wave	∿	50 MHz	
triangular wave	⩘	200 kHz	
square wave	⊓	20 MHz	
pos. pulse	⊓	50 MHz	
neg. pulse	⊔	50 MHz	
pos. sawtooth	◿	20 kHz	
neg. sawtooth	◺	20 kHz	
haversine	∩	50 kHz	
MODULATION			
sine wave	AM*)	50 MHz	
sine wave	FM	2 MHz – 50 MHz	
sine wave	SWEEP	50 MHz	
sine wave	BURST	2 MHz	
sine wave	GATE	50 MHz	
		0.1 1m 1 1k 1M 100 M → Hz	0..1m 10m 0.2 1 2 10 20 → Vpp

*) carrier amplitude reduced by 6 dB

- The FREQUENCY display is blanked.
- A new frequency value of max. 8 digits can now be entered.
- When the first digit of the new value has been input the LED NOT ENTERED starts flashing to indicate that the number not yet has been executed. At this moment input errors can still be corrected by operating the key RUB OUT.
- By actuating the ENTER key the frequency value just input is executed. This value can now only be changed by inputting new data.

The frequency can be input either in 'Hz' or 'kHz'. The frequency dimension currently operative is indicated by the LEDs 'Hz' or 'kHz'. Key Hz/kHz is used to change the dimension.

The numeric values are entered from left to right, whereby leading zeros in front of the decimal point are omitted, with the exception of the units column. For the 'Hz' frequency dimension a maximum of 4 digits is permissible behind the decimal point, for the 'kHz' dimension 7 are allowed.

Example: fo = 169 kHz.

START | Hz/kHz | 1 | 6 | 9 | ENTER

Frequency steps (ΔFREQ)

After the key ΔFREQ has been actuated a frequency step can be defined by which the indicated frequency (start or stop frequency) can be increased or decreased (keys +STEP, −STEP).

Continuously pressing the STEP keys results in a continuous sequence of steps.

Example: Δf = 5 kHz

ΔFREQ | 5 | ENTER

+STEP frequency rising

−STEP frequency falling

Using the frequency step function please note that the signal-frequency at the socket OUTPUT can only be altered when the start frequency is indicated, i. e. the LED in the key START lights.

3.5.3.2. Input of the Output Level

The output level can be input either in the dimensions Vpp, dBm or Vrms. Selection is done with the keys on the LEVEL keyboard.

During the input of the output level care should be taken to ensure that the amplitude (Vpp) and the offset (Vdc) together do not exceed the value +/– 10 V. The output levels that can be set for the different wave forms are:

WAVE FORM	symbol	max. frequency	output level		
			Vpp	Vrms	dBm (R_L = 50 Ω)
sine wave	∿	50 MHz	1 m . . . 20	1 m . . . 7.1	– 45 . . . + 24
triangle	∿	200 kHz	1 m . . . 20	1 m . . . 5.7	– 45 . . . + 22
square	⊓	20 MHz	0.2 . . . 20	0.1 . . . 10	– 13 . . . + 27
pos. pulse	⊓	50 MHz	1 . . . 10	0.5 . . . 5	+ 1 . . . + 21
neg. pulse	⊓	50 MHz	1 . . . 10	0.5 . . . 5	+ 1 . . . + 21
pos. sawtooth	◺	20 kHz	1 m . . . 10	1 m . . . 2.9	– 48 . . . + 16
neg. sawtooth	◿	20 kHz	1 m . . . 10	1 m . . . 2.9	– 48 . . . + 16
haversine	∿	50 kHz	1 m . . . 10	1 m . . . 3.5	– 45 . . . + 18

Vpp or Vrms values are open circuit voltages.

The keys Vpp, Vrms and dBm allow the conversion between these measuring units by pressing the according key twice:

Example:

Input: sine wave, 10 Vpp	display shows 10 (Vpp)
pressing 2 x [Vrms]	display shows 3.5 (Vrms)
pressing 2 x [dBm]	display shows 17.9 (dBm)

Key Vdc on the LEVEL keyboard allows the input of a DC offset that can be added to the AC voltage; the polarity of the offset voltage can be selected using key +/–.

Stepping of the Output Level (ΔLEVEL)

The output level can be altered into discrete steps using keys +STEP, –STEP. The smallest step ΔLEVEL that can be programmed corresponds with the resolution of the output level in the respective range (see table).

	range	resolution ΔLEVEL
Vpp	1 mV . . . 0.200 V	1 mV
	0.21 V . . . 2.00 V	10 mV
	2.1 V . . . 20.0 V	100 mV
Vrms	1 mV . . . 0.100 V	1 mV
	0.11 V . . . 1.00 V	10 mV
	1.1 V . . . 10.0 V	100 mV
dBm	resolution 1 dBm across the entire range	

Example: ΔVpp = 0,5 V

Vpp	display is blanked		Vpp	actual value (Vpp) is displayed.	
ΔLEVEL	0	.	5	ENTER	0,5 V step width is entered. (the input of ΔLEVEL is related to the actual displayed output value.)
+STEP	Vpp rising				
−STEP	Vpp falling				

The increments for LEVEL, Vpp, Vrms and Vdc must be entered separately. Using the keys +STEP or −STEP the just displayed parameter, indicated by LED in the respective key, will be altered.

3.5.4. Modulation Modes

Table of Modulation Modes

Modulation mode	Modulation parameters
AMPLITUDE MODULATION	carrier waveforms: all, except pulse carrier frequency: 0,1 mHz . . . 50 MHz
internal	modulation depth: variable von 0 . . . 100 %, resolution: 1 % modulation frequency: 10 Hz . . . 200 kHz, resolution 10 Hz max.
external	modulation frequency range: 0 . . . 200 kHz
FREQUENCY MODULATION	carrier waveforms: sine/square/pulses carrier frequency: 2 . . . 50 MHz
internal	modulation frequency: 10 Hz . . . 200 kHz, resolution 10 Hz max. deviation: 10 . . . 200 kHz, resolution 1 kHz
external	modulation frequency: 10 Hz . . . 200 kHz deviation: max. 200 kHz
SWEEP	carrier waveforms: all sweep range: 1 mHz . . . 50 MHz sweep time: 10 ms . . . 999 s, resolution: 3 digits sweep functions include: linear/logarithmic up/down, single/continuous, hold/release and triggered externally
BURST	carrier waveforms: all carrier frequency: max. 2 MHz phase-coherent signal keying BURST-functions: single-shot, continuous or standby ON-/OFF-cycles: 1 . . . 200 independently programmable
GATING	carrier waveforms: all, except pulses carrier frequency: 0,1 mHz . . . 50 MHz non-phase coherent signal keying
internal	modulation frequency: 10 Hz . . . 200 kHz, resolution 10 Hz max., duty cycle 50 %
external	modulation frequency: 0 . . . 500 kHz

NOTE: If the numerical and operational inputs are incompatible, actuating the ENTER key does not lead to implementation of the inputs.

- The NOT ENTERED LED continues flashing.
- The LEDs of those keys corresponding with the incompatible parameters are flashing or in case of unallowed values the display is flashing, this necessitates a correction by inputting permissible parameters.

Incompatibilities of the inputs can be derived from the tables in chapters 3.5.3.1. and 3.5.3.2.

3.5.4.1. Modulation Mode AM (Amplitude Modulation)

This modulation mode is switched on by operating the key AM.

carrier frequency = start frequency

One can choose between internal and external modulation. External modulation is performed by an external modulation signal at INPUT MODULATION at the rear. The change-over is carried out using keys INT and EXT.

Modulation frequency and depth:

internal: 10 Hz . . . 200 kHz, resolution max. 10 Hz, modulation depth 0 . . . 100 %, resolution 1 %
external: 0 Hz . . . 200 kHz, modulation depth depends on the amplitude of the modulation signal

Example: Amplitude Modulation (AM), internal

intended settings		key operations
wave form	: sine	∿
frequency (carrier)	: 25 kHz	START 2 5 Hz/kHz *
amplitude	: 1.7 V	Vpp 1 . 7
offset voltage	: 0.5 V	Vdc . 5
modulation frequency	: 2 kHz	FREQ (kHz) 2
modulation depth	: 54 %	% 5 4 ENTER
modulation mode	: internal, AM	INT AM
		* (press key Hz/kHz only if LED "kHz" doesn't lit)

The modulation mode AM is switched off using key OFF.

To alter single parameters it is only necessary to operate the according keys, all other parameters remain unchanged.

e. g. Vdc = 0.1 V instead 0.5 V

key operation:

Vdc . 1 ENTER

or modulation depth 100 % instead 54 %

key operation:

% 1 0 0 ENTER

3.5.4.2. Modulation Mode FM (Frequency Modulation)

This modulation mode is switched on by operating the key FM.

carrier frequency = start frequency (2 – 20 MHz)

One can choose between internal and external modulation. The change-over is carried out using keys INT and EXT. For external modulation, the modulation signal is supplied to the INPUT MODULATION socket at the rear.

Modulation frequency and deviation:

internal: 10 Hz . . . 200 kHz, resolution 10 Hz max.,
frequency deviation (DEV) variable 10 . . . 200 kHz, resolution 1 kHz
external: 10 Hz . . . 200 kHz, frequency deviation depends on the amplitude of the modulation signal.

Example: Frequency Modulation (FM), internal

intended settings		key operations
wave form	: sine	∿
frequency (carrier)	: 3 MHz	START 3 0 0 0 Hz/kHz *
amplitude	: 1.2 V	Vpp 1 . 2
offset voltage	: 0 V	Vdc 0
modulation frequency	: 10 kHz	FREQ (kHz) 1 0
deviation	: 60 kHz	DEV (kHz) 6 0 ENTER
modulation mode	: internal, FM	INT FM
		* (press key Hz/kHz only if LED "kHz" doesn't lit)

The modulation mode FM is switched off using the key OFF.

To alter single parameters refer to example in chapter 3.5.4.1..

3.5.4.3. SWEEP

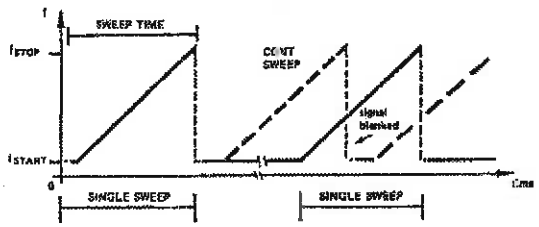
The following data has to be entered before a sweep is started:

- start frequency (key START)
- stop frequency (key STOP). This value is input in the same way as for the start frequency (start frequency > stop frequency is possible). Frequency range for the sweep function: 1 mHz . . . 50 MHz. The stop frequency is used to control the SWEEP function, it can only be measured at the OUTPUT socket, in sweep mode 2, SINGLE sweep
- sweep time (key TIME(s)), 10 ms . . . 999 s
- linear or logarithmic sweep characteristic (key LIN SWEEP or LOG).
- sweep mode 1, 2 or 3 (key 1, 2 or 3 after pressing key LIN SWEEP or LOG during 4 seconds). The selected sweep mode is displayed in the display section of the modulation parameters for max. 4 seconds by -1-, -2- or -3-. After POWER ON sweep mode 1 is programmed as standard.

The sweep is started using either key SINGLE (for single sweep) or key CONT (for continuous sweep).

A single sweep can also be triggered externally by a trigger pulse at the socket INPUT MODULATION at the rear; it is not necessary to press the key EXT. This trigger pulse must last for at least 1 ms; its maximum repetition rate is 33 Hz in case of a linear sweep and 20 Hz for a logarithmic one.

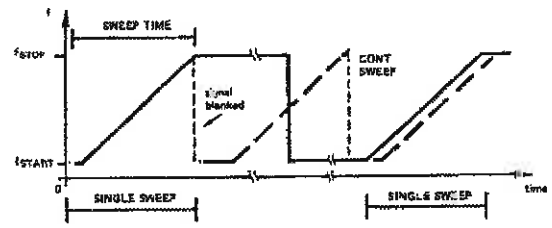
Mode 1



SINGLE: Sweep starts at f_{START}
runs to f_{STOP}
flies back to f_{START}

CONT: Sweep is continuously repeated

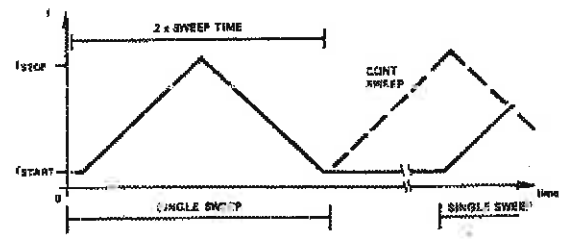
Mode 2



SINGLE: Sweep starts at f_{START}
runs to f_{STOP}
remains at f_{STOP}.
Pressing SINGLE again
resets the sweep to f_{START}

CONT: mode 1 and 2 are identical

Mode 3



SINGLE: Sweep starts at f_{START}
runs to f_{STOP}
runs to f_{START} (in the same time as from f_{START} to f_{STOP})

CONT: Sweep is continuously repeated

Example: Modulation Mode SWEEP, internal, sweep mode 3

intended settings		key operations
wave form	: triangle	∿
start frequency	: 2 kHz	START 2 Hz/kHz *1
stop frequency	: 100 kHz	STOP 1 0 0 Hz/kHz *1
amplitude	: 1.2 V	Vpp 1 . 2 *2
offset voltage	: 0 V	Vdc 0 *2
sweep time	: 5 s	TIME(s) 5 ENTER
modulation mode: continuous logarithmic sweep, mode 3		LOG 3 CONT
		*1 (press key Hz/kHz only if LED "kHz" doesn't lit)
		*2 (if these values are entered in the example before, it is not necessary to press keys.)

The sweep can be stopped by operating the keys SINGLE or CONT or by operating the OFF key.

If the sweep is to be stopped and then continued again operate key HOLD. The frequency value during the hold is displayed.

HOLD — sweep stops

HOLD — sweep continues

SINGLE — sweep runs to fstop, returns to fstart and stops (during continuous sweep) or
sweep stops, returns to fstart and stops (during single sweep)
sweep is set from f_{STOP} to f_{START} (mode 2, single sweep)

CONT — sweep continues

CONT — sweep stops and returns to fstart (during continuous sweep),
sweep changes without interruption from single to continuous mode during single sweep

The alteration of the sweep modes is possible during 4 seconds after pressing key LIN SWEEP or LOG again, the alteration of other parameters is possible as described in the example in chapter 3.5.4.1. but not during a running sweep or if the sweep is interrupted by the key HOLD.

3.5.4.4. Modulation Mode BURST

Carrier frequency = start frequency: max. 2 MHz

Phase-coherent signal keying

ON-periods: 1 . . . 200; programmable using key ON-cycles
OFF-periods: 1 . . . 200, programmable using key OFF-cycles

In internal mode choosing between continuous (CONT) and single BURST (SINGLE) is possible.

Single periods can be started too by an external trigger pulse via the socket INPUT MODULATION at the rear (repetition rate max. 1 kHz). Key EXT has to be pressed.

BURST combined with waveform 'Haversine' can produce an approximate 'Gaussian curve'. Therefore it is necessary to program a single ON-period and to press key CONT or SINGLE.

Using other operation modes, the 'Haversine' gives a sine wave with a positiv dc-offset.

Example: Modulation Mode BURST, internal

intended settings			key operations
waveform	:	triangle	∿
frequency (carrier)	:	10 kHz	START 1 0 Hz/kHz *1
amplitude	:	1.2 V	Vpp 1 . 2 *2
offset voltage	:	0 V	Vdc 0 *2
ON-cycles	:	10	ON-cycles 1 0
OFF-cycles	:	3	OFF-cycles 3 ENTER
modulation mode	:	BURST, continuous	BURST CONT

*1 (Press key Hz/kHz only if LED "kHz" doesn't lit)

*2 (If these values are entered in the examples before it is not necessary to press keys.)

To interrupt the continuous BURST press key CONT.

The modulation mode BURST is switched off using the key OFF.

3.5.4.5. Modulation Mode GATE

This modulation mode is switched on using key GATE.

Carrier frequency = start frequency.

Modulation frequency and duty cycle:

- internal modulation: 10 Hz . . . 200 kHz, resolution 10 Hz max., duty cycle 50 %
- external modulation: 0 . . . 500 kHz, duty cycle depends on the modulation signal

The change-over is carried out using keys INT and EXT.
The external modulation signal is supplied to the INPUT MODULATION socket at the rear.

Example: Modulation Mode GATE, internal

intended settings			key operations
wave form	:	sine	∿
frequency (carrier)	:	119 kHz	START 1 1 9
amplitude	:	1.2 V	Vpp 1 . 2 *
offset voltage	:	0 V	Vdc 0 *
modulation frequency	:	20 kHz	FREQ(kHz) 2 0 ENTER
modulation mode	:	internal, GATE	INT GATE

* (If these values are entered in the examples before, it is not necessary to press keys.)

The modulation mode GATE is switched off using key OFF.
To alter single parameters refer to example in chapter 3.5.4.1..

3.5.5. Storing/Recalling of Instrument Settings

Up to 9 complete sets of settings (contents of the entire display unit incl. the key settings) can be stored. This is done using key STO 1-9 and entering a number between 1 and 9, defining the storage register address.

In addition to these 9 registers, there is another register with the address „0". This automatically stores the latest settings of the PM 5193.

Example: STORING
The current setting is to be stored in register 3: STO 1-9 3

Example: RECALLING
The setting stored in register 5 is to be recalled: RCL 0-9 5 ENTER

By using the RECALL function all stored parameters in registers 0 . . . 9 can be displayed in desired sequence. Only when key ENTER was pressed the parameters just shown are executed.

By recalling

RCL 0-9 0 ENTER

after switching on the instrument, it is set to that state to which it was set before power off.

The STORE and RECALL functions are disabled during SWEEP.

3.5.6. Error Messages, Operating Errors

3.5.6.1. Error Messages when Switching on

Apart from the normal service routines, the program memory of the PM 5193 contains a selftest routine that starts automatically when the instrument is switched on. The selftest routine checks the battery buffered RAM, the microprocessor RAM and the contents of the program memory (PROM).

Then all LEDs and segments of the numeric displays are switched on for approx. 3 s – any errors in the decoders and drivers can then be recognised instantly.

If the selftest routine discovers an error, then one of the following error messages will appear in the display:

Err 1 This is a PROM checksum error. The PROMs have to be replaced.

Err 2 The processor containing the working memory RAM has to be replaced.

Err 3 This is a checksum error of the battery buffered RAM, it lost its data since last being switched off. This can be caused either by a defective battery, a defective RAM chip or a RAM test (see diagnostic program).
Before servicing it is recommended to create new storage-register data and to repeat the initial selftest.

3.5.6.2. Operating Instructions, Operating Errors

If the required setting of the equipment cannot be attained, then try once more using the examples given (chapter 3.5.3. and 3.5.4.1. to 3.5.4.5.).

Operating errors are indicated by a flashing display:

- FREQUENCY or LEVEL display flashes:
  In step operation (working with the keys +STEP or –STEP) the permissible frequency or level range is left (see chapters 3.5.3.1. and 3.5.3.2.). The display flashes three times and stops at the last value.

- FREQUENCY display flashes continued:
  Frequency is greater or smaller than the permissible frequency range of the selected wave form. (See chapter 3.5.3.1.).

- MODULATION display flashes continued:
  Modulation parameter is greater or smaller than the permissible range (see chapter 3.5.4. and chapter 1.2.5.).

- LEVEL display flashes continued:
  The input value exceeds the permissible range or Vpp + Vdc exceed + 10 V or – 10 V. (See chapter 3.5.3.2.).

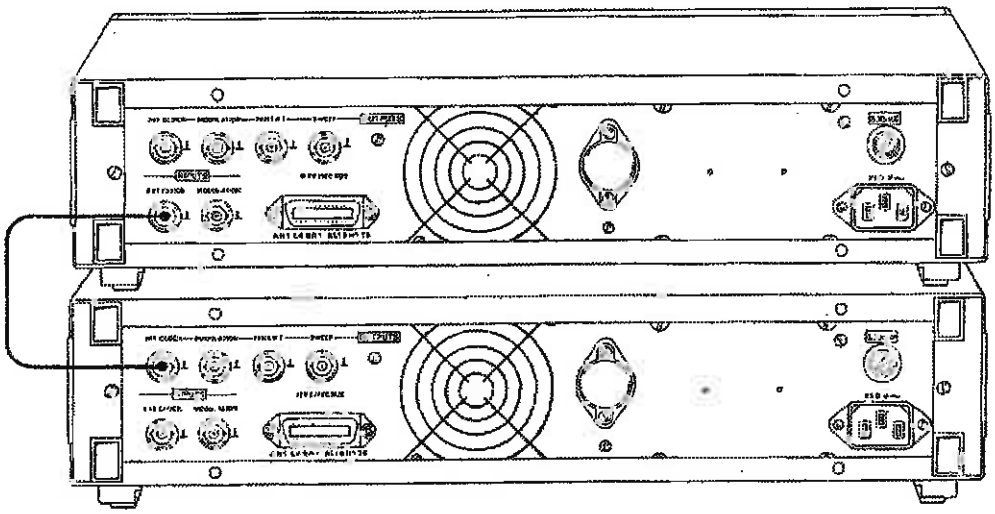
3.6. SPECIAL APPLICATIONS

The high versatility of the PM 5193 allows applications in many measurement sectors, as well as a table-top model or installed in a system with remote control by IEEE/IEC-bus.

Another facility is the possibility to connect several instruments via the CLOCK INPUTs/OUTPUTs for frequency synchronisation.

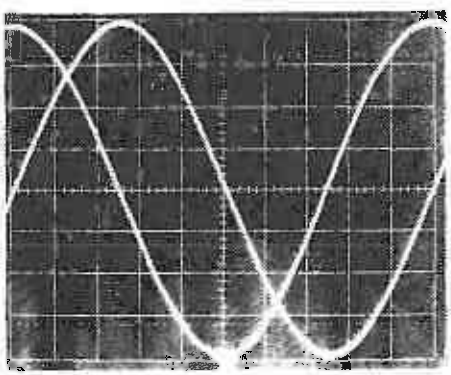
Example 1:

The following example shows the connection of two instruments to generate a sine wave and a cosine wave. The synchronisation is realized by a connection between the INT CLOCK OUTPUT of the first and the EXT CLOCK INPUT of the second instrument. (Using two PM 5193 S or . . SM connect 10 MHz OUTPUT with EXT REF INPUT.)



Settings:

According to the required function, both instruments must be set to the same frequency. In order to reach the desired phase angle between the signals, one of the instruments must be programmed with a frequency increment ΔFREQ of e. g. 0.01 Hz, which must be executed with the key +STEP. This frequency difference effects a phase shift between the two signals of $2\pi\,\Delta$FREQ, i. e. one of the two signals shifts within the time of $\frac{1}{\Delta\text{FREQ}} = \frac{1}{0.01\ \text{Hz}} = 100\ \text{s}$ over 2π. By pressing the key –STEP at the right moment, the frequency difference will be = 0 and the phase shift stops. The phase angle between the two signals remains fixed.



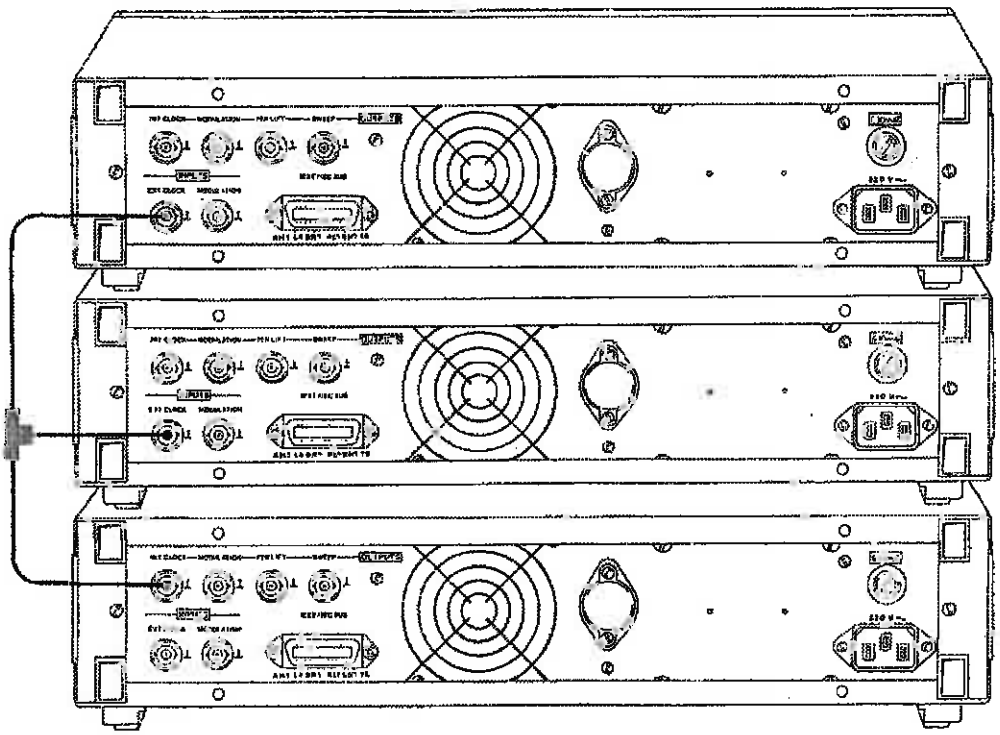
—— B = cosine wave

—— A = sine wave

Example 2:

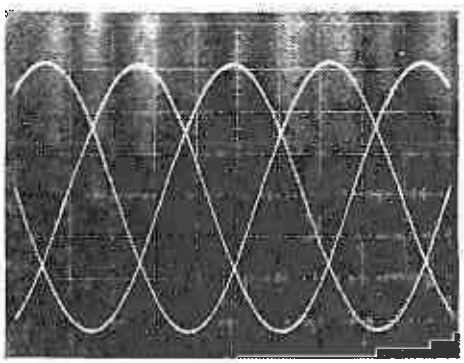
The second example shows three PM 5193s generating the same signals with a fixed phase angle as shown in the example before.

In this case there are three sine waves with phase displacements of 120° (2/3 π). The generators are synchronized by two connections from INT CLOCK OUTPUT of the first to EXT CLOCK INPUT of the second instrument and to the EXT CLOCK INPUT of the last one.



Settings:

All instruments are set to the same frequency. Two of the three instruments must be programmed with a frequency increment ΔFREQ, which value is relevant for the speed of the phase shift. By pushing the key +STEP the phase of this generator starts to shift with the speed 2 π ΔFREQ. By pushing –STEP, at the right moment, the phase shift stops at the desired point and remains fixed. The phase angle of the third generator output is adjusted in the same way.



—— B = sine wave with
– 120° phase difference to A

—— C = sine wave with
– 240° phase difference to A

—— A = reference sine wave

3.7. REMOTE CONTROL OF THE INSTRUMENT

Apart from using the keyboard, all operations of the function generator PM 5193 with the exception of the 'STEP' operation and 'HOLD' functions can also be controlled via the IEC/IEEE interface. The following table shows which interface functions are implemented:

AH 1: acceptor handshake
SH 1: source handshake
L4: listener function
T6: talker function
RL 1: local/remote with local lockout
SR 1: service request SRQ

Control of the PM 5193 synthesizer requires knowledge of the device address. When first using the equipment as well as when the contents of the memory have been destroyed (e. g. after a RAM test), the default address 2Ø is set. Using the 'ADDRESS' key on the 'LEVEL' keyboard this address can be checked and altered. The permissible range for the IEC/IEEE device address is Ø – 3Ø.

The following tables show which remote control commands are necessary to enter parameters and to control the operation mode and the storage register functions.

Remote control headers for the waveforms

WS	sine
WT	triangular
WQ	square wave
WH	haversine
RP	sawtooth positive
RN	sawtooth negative
PP	positive pulses
PN	negative pulses
ACØ	AC off; switches off AC voltage
AC1	AC on; switches on AC voltage

Remote control headers for frequency setting

F	basic frequency start frequency carrier frequency	(≙ key START)
FS or F	start frequency for sweep	(≙ key START)
FF	stop frequency for sweep	(≙ key STOP)

Remote control headers for amplitude and DC offset setting

LA	amplitude (Vpp)	(≙ key Vpp)
LR	amplitude (Vrms)	(≙ key Vrms)
LL	amplitude (dBm)	(≙ key dBm)
LD	DC offset (V)	(≙ key Vdc)

Remote control headers for modulation parameter setting

FM	modulation frequency	(≙ key 'FREQ (kHz)')
FD	frequency deviation for FM	(≙ key 'DEV (kHz)')
LM	modulation depth for AM	(≙ key '%')
TS	sweep time	(≙ key 'TIME (s)')
NB ..	number of signal periods switched on (BURST)	(≙ key 'ON cycles')
NO ..	number of signal periods switched off (BURST)	(≙ key 'OFF cycles')

Input dimensions are:

Hz	for frequency
V	for amplitude
dBm	for level
s	for time

Parameters can be sent to the device either as integer, real or exponential values.

Examples: F1ØØØ = frequency input 1 kHz
F3.125 = frequency input 3.125 Hz
F2ØE6 = frequency input 2Ø MHz

If the parameter is input in the exponential form, then please note that only the first digit of the exponent is considered; further digits are accepted but ignored.
The frequency value F 4E23, for example, is identified as F4E2 = 4ØØ Hz. The size of the mantissa in exponential values, of integers and reals are restricted to the largest possible number of digits on the corresponding display panel, i. e. 8 digits for frequency inputs, 3 digits for the input of levels or sweep times, etc.. More digits can be entered than are actually possible, but only the first digits of the input string will be recognised.

Remote control headers for modulation modes

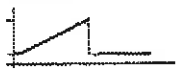
MA (x) amplitude modulation
MF (x) frequency modulation
BS (x) single burst
BC (x) continuous burst
GC (x) continuous gate function
SS (x) single sweep
SC (x) continuous sweep
SM (y) sweep mode
MO "modulation off" = switch-off of the modulation operation

A number from 1 — 5 for 'x' and from 1 — 3 for 'y' must be sent in addition to the above commands (except MO) in order to transmit the required additional information; the figure Ø for 'x' switches the function off, resp. resets the frequency to f_{START} in sweep mode 2.

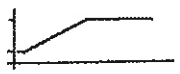
Numeric extensions for modulation modes

x = Ø switches off the operation;
reset of the frequency to f_{START},
single sweep, mode 2 (≙ key SINGLE)
= 1 internal modulation (≙ key INT)
= 2 external modulation (≙ key EXT)
= 3 linear sweep (≙ key LIN SWEEP)
= 4 logarithmic sweep (≙ key LOG)
= 5 wait for BURST

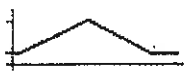
y = 1 sweep mode 1



y = 2 sweep mode 2



y = 3 sweep mode 3



Example: SM 1 SC 4 ≙ start of a continuous logarithmic sweep, sweep mode 1
GC 1 ≙ start of a continuous internal gating

Remote control headers for storage registers

Store or recall of parameter sets is carried out using the following remote control commands:

'RL x' = register load ≙ (key 'STO 1-9')
'RR y' = register recall ≙ (key 'RCL 0-9')

whereby the memory address x can have the value 1 — 9 and y Ø — 9.

Data in storage register "Ø" correspond with the setting in the last local state of the generator and are not changed during remote control. The other storage registers (1 — 9) can be used in the same way when controlled by the bus as when using the keyboard, i. e. when operating the key 'STO 1-9' and inputting a figure 1 — 9, or when sending the remote command 'RLx' via the bus the latest device setting is stored in the register selected. This instrument setting includes not only the frequency, amplitude and offset values but also all the modulation parameters necessary to set a preselected type of modulation.

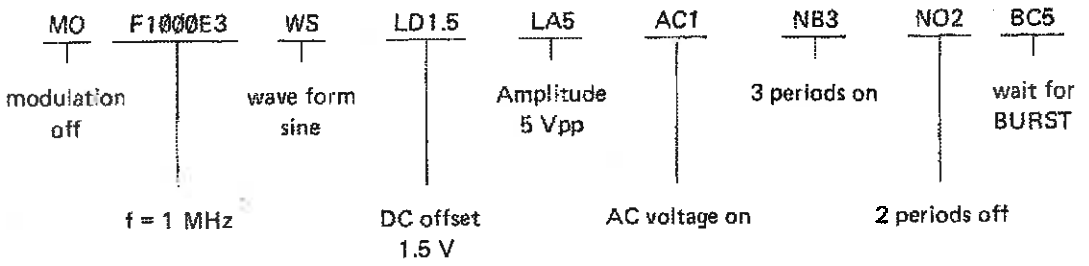
Note: Only if a modulation mode is switched on the corresponding modulation parameters are stored by the command 'RLx'.

Bus learn mode

In addition to the remote control commands described above, the IEC/IEEE bus also allows the respective parameters to be read out of the working store. This so-called 'learn mode' is called up using the command 'IS?' and, when the generator is addressed as talker, it emits a string to the computer. This string contains all information of the generator setting and can be used for re-establishing this setting lateron.

Example 1: Command 'IS?' is sent to the PM 5193, the following string of data is accepted:

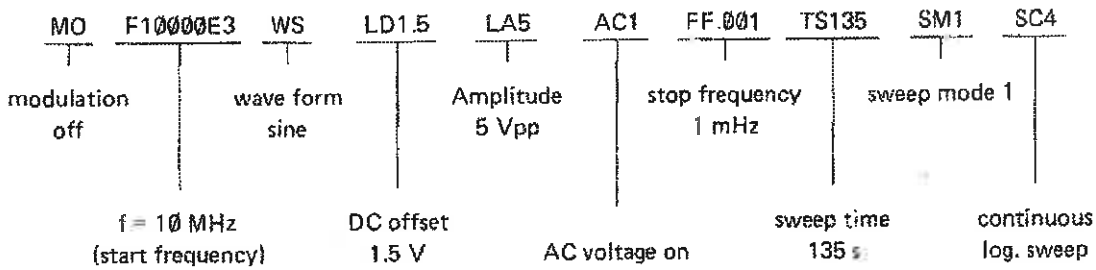
MOF1ØØØE3WSLD1.5LA5AC1NB3NO2BC5



Note: Every string sent to the controller after 'IS?' begins with 'MO' (modulation off) to ensure safe acceptance of the string in every operation mode.
During a running sweep sending 'IS?' causes termination of the function.

Example 2: The following string is received by the controller after 'IS?' has been sent

MOF10000E3WSLD1.5LA5AC1FF.ØØ1TS135SM1SC4



Identification mode

Another remote control command permits identification of the device by a controller. When the comman 'ID?' is sent to the PM 5193 this reflects e. g. the following string to the controller:

PM 5193/V 2.2
- sub-version of the program
- main version of the program

Status byte

When the remote control commands or the data has been received by the instrument, this is checked for syntax as well as for its validity with regard to the specifications. The result of this check is written into the status byte and can be called up by the IEC controller at any time when in serial poll.

6	5	4	3	2	1	Ø	Bit
SRQ	error message	busy (sweep, burst)	not used	syntax error	range exceeding	incompatibility of parameters	status byte PM 5193
64	32	16	8	4	2	1	value (dec.)

The status byte can be taken by the IEC controller either with or without a service request. If there is no service request the computer has to carry out a serial poll. In the course of this polling, the IEC controller sends the talker address to the PM 5193 for the output of the status byte.

Example for HP 85:

S = SPOLL (7Ø5)

When this Basic command has been executed, the variable S contains the sum of the decimal values of the individual bits set in the status byte. For example, if the variable S has the value 33 (decimal value), then this is the sum of the individual values 32 + 1 that means bit 5 = '1' and bit Ø = '1'.

If the status byte is to be entered using SRQ, then the read out and evaluation is precisely the same as described above.

Activating of SRQ and masking the status byte is performed by 'MSR x' command, where 'x' is a decimal value sent to the PM 5193. The individual bit of the status byte is activated for SRQ if the corresponding bit of the binary pattern of the sent decimal value is '1'.

Example 1: masking with 'MSR 65';
i. e. bit 6 and bit Ø (dec. 64 + 1) of the status byte are activated.
When the instrument sets one of these bits in the status byte, a SRQ is initiated.

Example 2: masking using 'MSR 1Ø3';
i. e. bits Ø, 1, 2, 5 and 6 (dec. 64 + 32 + 4 + 2 + 1) are activated.
When the instrument sets one or several of these bits, a SRQ is initiated.

The status byte is accepted in the serial poll mode.

The purpose of the busy bit in the status byte is to signal the end of the sweep operation. If this status bit (bit 4) was activated, then service request is initiated at the end of the single sweep. The remaining bits Ø 1, 2, and 5 serve to indicate erroneous data; if one of these bits is set, this corresponds with the flashing of one or more LEDs on the keyboard. In this case, the SRQ initiates an error output (status byte).

Use

When sending commands from the IEC controller to the PM 5193, the basic procedure is such that

1. the IEC computer sends the listener address of the PM 5193 via the bus, thus addressing the device as listener.

2. the IEC computer begins to send commands and data to the PM 5193.

The procedure for the transfer of data from the PM 5193 to the IEC computer, e. g. in the learn mode, is as following:

1. The IEC computer sends the talker address to the PM 5193, thus addressing the device as talker.

2. The IEC computer receives data from the PM 5193.

Attention:
If the PM 5193 is not prepared by 'ID?' or 'IS?' before addressing as talker the interface function is blocked. No further communication with the PM 5193 is possible until the device has been de-addressed, i. e. when the 'untalk' command has been sent by the computer. In this situation it would be advisable to make use of the 'time out' functions of the IEC computer.

1. Programming examples using the Philips P 2000 C computer

The following program is one example of how easily the frequency, amplitude and wave form can be set by a Philips P 2000 C computer.

device address = 4

```
10 IEC INIT
20 INPUT " BASIC FREQUENCY";  A$
30 INPUT " AMPLITUDE       ";  B$
40 INPUT " WAVEFORM        ";  C$
50 D$="F"
60 E$="LA"
70 F$=D$+A$+E$+B$+C$
80 IEC PRINT #4,F$
90 GOTO 10
100 IEC END: END
```

In lines 20, 30 and 40 the values for the frequency, amplitude and wave form characters are entered via the computer's keyboard. Together with the two headers D$ = F for frequency and E$ = LA for amplitude in Vpp, these values are linked together in line 70 to form a common string (F$) and sent to the PM 5193 in line 80. In this example, the device address must be set to '4'.

The following example shows the control of the PM 5193 by the Philips P 2000 C computer using a service request for error messages. This program also permits the intake of data strings for the learn and identification modes of the instrument.

```
                                                    device address = 5

10 DIM A$(50)
20 DIM B$(50)
30 B$=""
40 IEC INIT
50 IEC REMOTE
60 IEC LOCAL LOCKOUT                                A initialisation
70 IEC PRINT #5,"MSR 103"
80 IEC TIMEOUT 1
90 ON ERROR GOTO 240
100 IEC ON SRQ GOSUB 220
110 REM
120 REM --------------------                        ------------------------
130 REM
140 INPUT "COMMAND= ";A$
145 IF A$="//" THEN 195
150 IF A$="ID?" THEN 170
155 IF A$="IS?" THEN 170
160 IEC PRINT #5,A$:GOSUB 250                       B command received
165 GOTO 140                                          from keyboard,
170 IEC PRINT #5,A$                                   sent to PM 5193
175 IEC INPUT #5,B$
180 PRINT B$
185 B$=""
190 GOTO 140
195 IEC LOCAL
200 STOP
205 GOTO 140
210 REM ----------------------                      ------------------------
215 REM INTERRUPT ROUTINE
220 IEC POLL #5,S                                   C interrupt routine
225 PRINT "INPUT ERROR  S= ";S
230 RETURN
235 REM ----------------------                      ------------------------
240 IEC UNT
245 RETURN                                          D time out error routine
250 FOR I=1 TO 250
255 NEXT I
260 RETURN
265 IEC END:END
```

Lines 10 – 100 of this program serve to initialize the IEC interface of both devices as well as to set the dimensions of the two string lengths A$ and B$.

In line 140 A$ picks up the command for the PM 5193. In the following lines 145, 150 and 155 the program checks on whether this command is 'IS?' for the learn mode, 'ID?' for the identification of the device, or '//' to switch back to local. If one of the two strings 'ID?' and 'IS?' is keyed in, the output of the command is followed immediately by taking in the string B$ with the consequent output on the VDU (lines 175 and 180). In case of an error the status byte is output using the service request (SRQ); bits 0, 1, 2, 5 and 6 were activated in line 70 using command 'MSR 103'. If an SRQ occurs, the program branches out at line 220 and carries out a serial poll there; the decimal value of the entered status byte is displayed as the variable 'S' in line 225.

If the PM 5193 is controlled by the P 2000 C via the IEEE interface, it should be taken into account that the respond time of the PM 5193 at the IEC bus is considerably slower than that of the P 2000 C. It is for this reason that line 160 calls up a short waiting loop using GOSUB 250 after the command (string A$) has been sent to the PM 5193. If an error occurs, then SRQ can be received before the next INPUT is started in line 140.

2. Programming example using an HP85 computer

This example shows a possibility of controlling the PM 5193 via the IEC/IEEE bus using an HP 85. With this program all commands can be sent to the instrument, strings accepted and error messages (status byte) received after a SRQ.

```
 10 DIM A$[30]                          device address = 5
 20 DIM B$[30]
 30 B$=""
 40 REMOTE 705
 50 LOCAL LOCKOUT 7
 60 OUTPUT 705 ;"MSR 103"
 70 ON TIMEOUT 7 GOSUB 360
 80 SET TIMEOUT 7;100                   A
 90 ON INTR 7 GOSUB 280
100 CONTROL 7,1 ; 8
110 REM
120 REM ----------------------
130 REM
140 DISP "COMMAND =";
150 INPUT A$
160 IF A$="//" THEN 220
170 OUTPUT 705 ;A$
180 ENTER 705 ; B$
190 DISP B$
200 B$=""                               B
210 GOTO 140
220 LOCAL 705
230 STOP
240 GOTO 140
250 REM
260 REM ----------------------
270 REM
280 CONTROL 7,1 ; 0
290 S=SPOLL(705)
300 DISP "INPUT ERROR ! S=";S
310 CONTROL 7,1 ; 8                     C
320 RETURN
330 REM
340 REM ----------------------
350 REM
360 ABORTIO 7
370 RETURN
380 END
                                        D
```

A) Initialization is carried out in this part of the program. Lines 70 and 80 prepare the call-up instruction for the error routine (D) that is called up in case of a time out. Timeout time is 100 milliseconds.

The line 40 switches the device to 'remote' and prevent the keyboard from being used manually. Line 50 disables the function of the LOCAL key. In line 60 of the program the masking command 'MSR 103' is sent to the PM 5193, thus permitting error messages and status information to be sent with a service request (SRQ). Line 90 of the program determines the address of the service routine that is called up when the interrupt appears; the command in line 100 means interrupt (SRQ) enable to the computer.

B) In this part of the program the commands for the PM 5193 are given by the computer's keyboard (line 150) and sent to the device via the IEC bus (line 170). The ENTER command in line 180 permits data strings to be taken up in the learn mode (command 'IS?') as well as identification of the device (command 'ID?') and for this to be indicated (line 190). Line 160, 220 and 230 of the program serve only to switch back to local after '//' has been entered.

C) This is the service routine called up by the program as soon as the PM 5193 has set the SRQ sequence. The command in line 280 blocks any further interrupts, line 290 carries out a serial poll and passes the value (decimal value) of the status byte received from the generator to the variable 'S'. In line 300 of the program this variable 'S' is shown together with the commend 'INPUT ERROR' at the VDU of the computer. And finally the command in line 310 enables the interrupts for the computer again.

D) Timeout routine.

3.8. TEST-PROGRAM PM 5193

This test program contains 5 submodules:

TEST 1: Display and LED test
TEST 2: Keyboard test
TEST 3: Storage register test
TEST 4: Strobe test (test of the internal interfaces)
TEST 5: Test for the IEEE/IEC-BUS interface

To activate this test program, press the key MODULATION OFF while power is switched on and keep it pressed for about 3 seconds.

The return to the main operating mode is only possible by switching power OFF and ON again.

When the test program is activated, the display shows "TEST x" where 'x' is a number from 1 to 5. This number changes continuously and slowly, and by pressing the key MODULATION OFF at the right moment, the respective test-submodule will be started.

To leave the test submodules, press the key MODULATION OFF for about 2 seconds.

TEST 1 : Display and LED test

Step 1: 7-segment-display

All display segments and LEDs are switched on for about 2 seconds.
After this the program starts to switch on one segment after the other for four display positions simultaneously. Finally, the decimal points of these four positions remain lit and the program starts to do the same with the next four display positions.
After the last four digits were tested, the program switches on all segments and LEDs and remain in this state until the key MODULATION OFF was pressed once again.

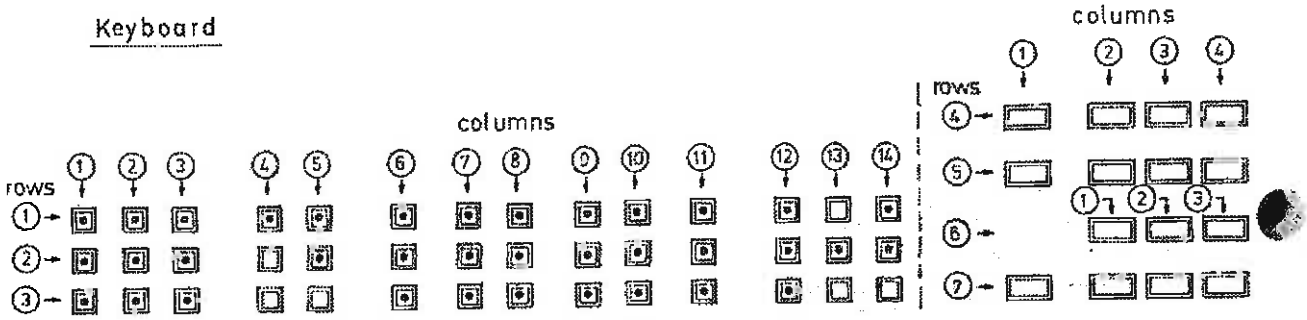
Step 2: LEDs

All LEDs will be switched on sequentially, one after the other, for approx. 0.5 seconds beginning with the uppermost left one (inside the key sine wave). When the last LED was switched on the indication "End" appears at the display until the key MODULATION OFF was pressed. Then the program returns to the test-menu.

TEST 2: Keyboard test

The display shows the indication: 1 – Ø1 – – – –

Now you must press the first key of the first row: 1 – Ø1 – – – –
(row 1) – (column 1)



When the right key was pressed, the display shows

1 – Ø1 1 1 1 1

for about 1 second and changes then to

1 – Ø2 – – – –

as a request to press the second key in the first row. In case of a failure, the display would show

Err 1 – Ø1 x – xx

where x – xx indicates the wrong code (row and column). This error indication will only be reset by pressing the requested key – in case of a hardware failure at the keyboard unit it would not be possible to get the right code and thus to reset the error message.

When the last key was pressed, the keyboard test is finished and the display indicates "End". To leave this diagnostic submodule and to get back to the test menue, the key MODULATION OFF must be pressed.

TEST 3 : Storage register test

Attention:
This memory test damages the register contents. When the instrument is switched on after the storage register test was executed, the display indicates "Err 3" which means that there are now no parameters in the storage register – the complete contents (parameters) are destroyed.

The display indicates

MEMO 1 –

and the program starts to write a test pattern into each location of memory chip 1, reads it again, and checks this value for correctness. When no failure was detected, the same will be done with a second pattern. In case that there is no failure, the display shows

MEMO 1 – 1

and in case of a failure

MEMO 1 – Ø

Now the program waits until the key MODULATION OFF is pressed and starts then to check the memory chip 2 in the same way as described above. When this is terminated successfully, the display indicates

MEMO 2 – 1

or in case of a failure

MEMO 2 – Ø

With MODULATION OFF the program returns to the test menu.

TEST 4 : Strobe test

The display indicates

STRO x

where x is a number from 6 to 15. This number changes continuously and slowly. By pressing the key "MODULATION OFF" at the right moment the required strobe line will be selected. The display shows then e. g.:

STRO Ø8 -- 1

which means that the output lines of the shift registers controlled by strobe line 8 show a specific bit-pattern. If MODULATION OFF was pressed once for a short moment all output lines of the shift registers change their state. Now the display shows:

STRO Ø8 -- Ø

Each time the MODULATION OFF-key is pressed for a short moment, the states of these output lines will be inverted. If MODULATION OFF is pressed for longer than about 1 second, this subprogram will be left and the display shows again:

STRO x

If the key MODULATION OFF is pressed again for longer than about 1 second, the program will return to the test menu.

This strobe test serves fault finding in the internal C-bus system. More detailed information, e. g. measuring points, positions of ICs and measuring values are described in the service manual.

TEST 5 : IEC-Bus test

The display shows the indication

IEC BUS

Each character sent from the controller via the IEC (IEEE)-Bus will be decoded and displayed with its hexadecimal code, e. g.

ASCII 'A' indication 41 H
ASCII '3' indication 33 H
etc.

The device address of the PM 5193 is fixed to 2Ø.

With the key MODULATION OFF the program returns to the test menu.

4. PERFORMANCE TEST

4.1. INTRODUCTION

The information in the following chapters describes the performance tests for the key parameters of the PM 5193 using the instrument specifications (chapter 1.2) 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 PM 5193 must be warmed up with all covers in place for at least 30 minutes before starting the performance tests (reference temperature 23° C).

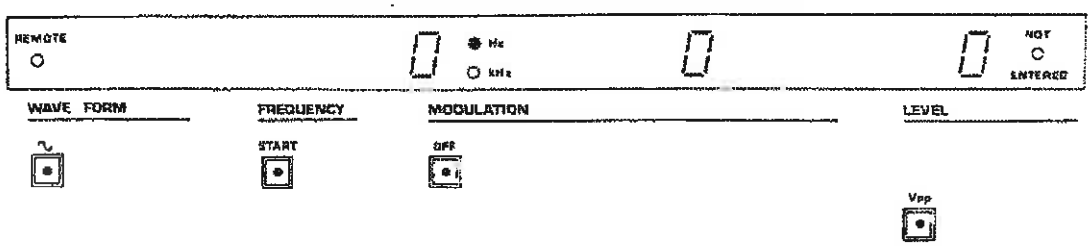
The test result requirements in the tables of following sections don't take the tolerances of the measuring instrument into account.

4.2. RECOMMENDED TEST EQUIPMENT

- 50 Ohm feed-through termination ±0.25 Ohm
- wide band oscilloscope ($t_r < 1$ ns); e.g. PM 3340
- DC-voltmeter, resolution $< 100\ \mu V$; e.g. PM 2528
- counter 50 MHz, 8 digits resolution; e.g. PM 6665
- spectrum analyzer; e.g. HP 8590 A
- rms voltmeter, max. resolution $1\mu V$; e.g. Fluke 8920 A, PM 2535.
  The insertion loss of the 50 Ohm-coax cable to the voltmeter must be < 0.05 dB.
- distortion meter; e.g. PM 6309
- power meter; e.g. HP 436A with power sensor HP 8482A
- modulation meter; e.g. Rhode+Schwarz FAM

4.3. SELFTEST ROUTINE

When switched on, the instrument first carries out a selftest whereby the PROMs and RAMs are checked. If the instrument is in order all segments and the decimal points of the figures and all LEDs light up for approx. 3 seconds. The instrument then passes to its default status, indicated by a zero in each of the three sectors of the display, the LED Hz in the display and the LEDs in the keys SINE, START, OFF and V pp.



An error is represented as follows:

Err 1	PROM	checksum error
Err 2	RAM (processor)	read/write error
Err 3	RAM (CPU)	operation possible but memory contents is destroyed

4.4. PERFORMANCE VERIFICATION

4.4.1. Frequency

4.4.1.1. Frequency Accuracy Test

Test equipment:
– Frequency counter

Procedure:
– Connect PM 5193 OUTPUT to frequency counter
– Set counter to 10 s gate time

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∿	1 MHz	OFF	–	10 V	0	0.999999 MHz .. 1.000001 MHz
∿	10 MHz	OFF	–	10 V	0	9.999999 MHz .. 10.000001 MHz

4.4.1.2. RMS Frequency Jitter Test

Test equipment:
– Modulation analyzer

Procedure:
– Connect PM 5193 OUTPUT to modulation analyzer
– Set modulation analyzer to rms measuring mode and LF-measuring bandwidth 10 Hz – 20 kHz

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∿	4 MHz	OFF	–	10 V	0	<800 Hz
∿	40 MHz	OFF	–	10 V	0	<1100 Hz
∿	50 MHz	OFF	–	10 V	0	<1000 Hz

4.4.2. Sine wave

4.4.2.1. Sine Wave Voltage Accuracy Test in the Low and Medium Frequency Range

Test equipment:
– rms-voltmeter

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at rms-voltmeter input

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∿	10 kHz	OFF	–	12.8 V	0	2.217 . . 2.308 V
∿	10 kHz	OFF	–	6.4 V	0	1.109 . . 1.154 V
∿	10 kHz	OFF	–	3.2 V	0	0.554 . . 0.577 V
∿	10 kHz	OFF	–	3.1 V	0	0.537 . . 0.559 V
∿	10 kHz	OFF	–	1.28 V	0	0.221 . . 0.232 V
∿	10 kHz	OFF	–	0.128 V	0	21.9 . . 23.3 mV
∿	200 kHz	OFF	–	12.8 V	0	2.217 . . 2.308 V
∿	200 kHz	OFF	–	6.4 V	0	1.109 . . 1.154 V
∿	200 kHz	OFF	–	3.2 V	0	0.554 . . 0.577 V
∿	200 kHz	OFF	–	3.1 V	0	0.537 . . 0.559 V
∿	200 kHz	OFF	–	1.28 V	0	0.221 . . 0.232 V
∿	200 kHz	OFF	–	0.128 V	0	21.9 . . 23.3 mV

4.4.2.2. Sine Wave Voltage Accuracy Test in the Higher Frequency Range

Test equipment:
– Power meter with power sensor

Procedure:
– Calibrate and zero the power meter
– Connect probe to PM 5193 OUTPUT

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∿	2 MHz	OFF	–	10 V	0	58.3 . . 66.9 mW
∿	10 MHz	OFF	–	10 V	0	58.3 . . 66.9 mW
∿	50 MHz	OFF	–	10 V	0	48.4 . . 70.3 mW

4.4.2.3. Total Harmonic Distortion Test at 1 kHz

Test equipment:
– Distortion meter

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at distortion meter input

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∿	1 kHz	OFF	–	20 V	0	<0.5 %

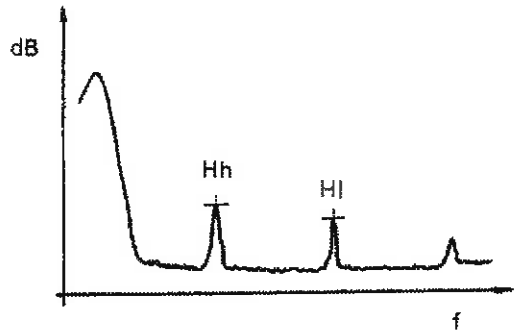
4.4.2.4. Harmonic Components in the Frequency Range < 2 MHz

Test equipment:
– Spectrum analyzer

Procedure:
– Connect PM 5193 OUTPUT to spectrum analyser;
be careful not to overload the analyzer input. Overloading the analyzer causes it to generate harmonics, thus invalidating the test.

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∿	200 kHz	OFF	–	20 V	0	*
∿	2 MHz	OFF	–	20 V	0	*



* Measure 2nd and 3rd harmonics, define the larger one (Hh) and the smaller one (Hl)

Hh < –43 dBc if Hl < –66 dBc
Hh < –44 dBc if Hl < –50 dBc
Hh < –45 dBc if Hl < –47 dBc
Hh < –46 dBc if Hl = Hh

4.4.2.5. Harmonic Components in the Frequency Range > 2 MHz

Test equipment:
– Spectrum analyzer

Procedure:
– Connect PM 5193 OUTPUT to spectrum analyser;
be careful not to overload the analyzer input. Overloading the analyzer causes it to generate harmonics, thus invalidating the test.

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∿	10 MHz	OFF	–	20 V	0	< –37 dBc
∿	20 MHz	OFF	–	20 V	0	< –31 dBc
∿	20 MHz	OFF	–	9 mV	0	< –20 dBc
∿	30 MHz	OFF	–	9 mV	0	< –20 dBc
∿	50 MHz	OFF	–	9 mV	0	< –20 dBc

4.4.2.6. **Non Harmonic Components**

Test equipment:
– Spectrum analyzer

Procedure:
– Connect PM 5193 OUTPUT to spectrum analyser
– Measure relative level of the non-harmonic components > 15 kHz distanced from the carrier
– Measuring frequency range 0–100 MHz

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∿	20 MHz	OFF	–	100 mV	0	< –40 dBc
∿	20 MHz	OFF	–	10 mV	0	< –23 dBc
∿	30 MHz	OFF	–	100 mV	0	< –40 dBc
∿	30 MHz	OFF	–	10 mV	0	< –23 dBc
∿	50 MHz	OFF	–	100 mV	0	< –40 dBc
∿	50 MHz	OFF	–	10 mV	0	< –23 dBc

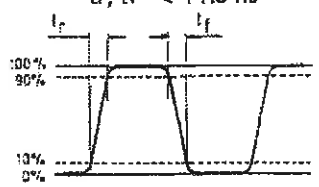
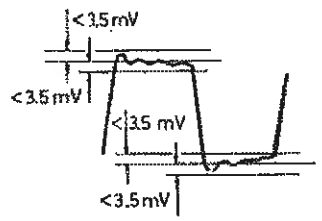
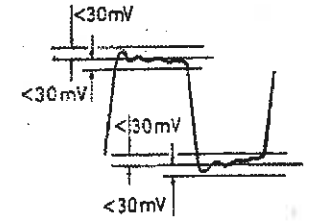
4.4.3. **Square Wave**

4.4.3.1. **Square Wave Performance Test**

Test equipment:
– Wide band scope; tr < 1 ns

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at scope

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
⎍	5 MHz	OFF	–	20 V	0	tr, tf < 11.5 ns 
⎍	5 MHz	OFF	–	200 mV	0	
⎍	5 MHz	OFF	–	2.1 V	0	

4.4.3.2. Square Wave Voltage Test

Test equipment:
– rms voltmeter

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at rms voltmeter input
– Set rms voltmeter to AC-coupling

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
⊓	1 MHz	OFF	–	20 V	0	4.90 . . . 5.10 V
⊓	1 MHz	OFF	–	10 V	0	2.45 . . . 2.55 V
⊓	1 MHz	OFF	–	2 V	0	485 . . . 515 mV
⊓	1 MHz	OFF	–	1 V	0	242.5 . . . 257.5 mV
⊓	1 MHz	OFF	–	0.2 V	0	48.5 . . . 51.5 mV

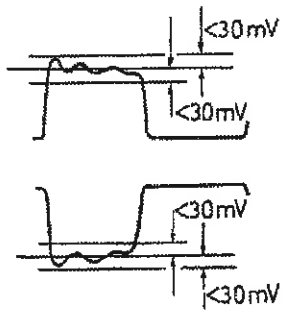
4.4.4. Positive and Negative Pulses

4.4.4.1. Positive and Negative Pulses Performance Test

Test equipment:
– Wide band scope; tr $<$ 1 ns

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed through termination at scope

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage Ac pp	Output voltage DC	Test result requirement
⊓	5 MHz	OFF	–	10 V	0	tr $<$ 4.5 ns
⊓	5 MHz	OFF	–	10 V	0	tf $<$ 4.5 ns
⊓	5 MHz	OFF	–	1 V	0	
⊓	5 MHz	OFF	–	1 V	0	
⊓	5 MHz	OFF	–	10 V	0	same as above
⊓	5 MHz	OFF	–	10 V	0	but ± 120 mV

4.4.4.2. Positive and Negative Pulses Voltage Test

Test equipment:
– rms voltmeter

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at rms voltmeter input
– Set rms voltmeter to AC-coupling

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
⊓	1 MHz	OFF	–	10 V	0	2.45 . . . 2.55 V
⊔	1 MHz	OFF	–	10 V	0	2.45 . . . 2.55 V
⊓	1 MHz	OFF	–	1 V	0	235 . . . 265 mV
⊔	1 MHz	OFF	–	1 V	0	235 . . . 265 mV

4.4.5. Triangular Wave

4.4.5.1. Triangular Wave Voltage Test

Test equipment:
– rms voltmeter

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at rms voltmeter input
– Set rms voltmeter to AC-coupling

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∿	10 kHz	OFF	–	20 V	0	2.829 . . . 2.944 V
∿	100 kHz	OFF	–	20 V	0	2.829 . . . 2.944 V
∿	10 kHz	OFF	–	2.1 V	0	297 . . . 309 mV
∿	100 kHz	OFF	–	2.1 V	0	297 . . . 309 mV
∿	10 kHz	OFF	–	2 V	0	281 . . . 295 mV
∿	100 kHz	OFF	–	2 V	0	281 . . . 295 mV
∿	10 kHz	OFF	–	200 mV	0	28.0 . . . 29.7 mV
∿	100 kHz	OFF	–	200 mV	0	28.0 . . . 29.7 mV

4.4.6. Haversine

4.4.6.1. Haversine THD Test

Test equipment:
– Distortion meter

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at distortion meter input

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∧	1 kHz	OFF	–	10 V	0	< 0.8 %

4.4.6.2. Haversine Voltage Test

Test equipment:
– rms voltmeter

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at rms voltmeter input
– Set rms voltmeter to AC-coupling

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∧	50 kHz	OFF	–	10 V	0	1.715 . . 1.821 V
∧	50 kHz	OFF	–	1.1 V	0	188.6 . . 200.3 mV
∧	50 kHz	OFF	–	1 V	0	170.6 . . 182.9 mV
∧	50 kHz	OFF	–	0.1 V	0	16.97 . . 18.38 mV

4.4.7. Positive and Negative Sawtooth

4.4.7.1. Sawtooth Fly-Back Time Test

Test equipment:
– Scope

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at scope

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
⟋	20 kHz	OFF	–	10 V	0	<1 µs
⟍	20 kHz	OFF	–	10 V	0	<1 µs

4.4.7.2. Sawtooth Voltage Test

Test equipment:
– rms voltmeter

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at rms voltmeter input
– Set rms voltmeter to AC-coupling

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
⟋	20 kHz	OFF	–	10 V	0	1.400 . . . 1.487 V
⟋	20 kHz	OFF	–	10 V	0	1.400 . . . 1.487 V
⟋	20 kHz	OFF	–	1.1 V	0	154.0 . . 163.5 mV
⟋	20 kHz	OFF	–	1.1 V	0	154.0 . . 163.5 mV
⟋	20 kHz	OFF	–	1 V	0	139.3 . . 149.4 mV
⟋	20 kHz	OFF	–	1 V	0	139.3 . . 149.4 mV
⟋	20 kHz	OFF	–	0.1 V	0	13.86 . . 15.01 mV
⟋	20 kHz	OFF	–	0.1 V	0	13.86 . . 15.01 mV

4.4.8. DC-Voltage

4.4.8.1. DC-Voltage Test at AC OFF

Test equipment:
– DC-voltmeter

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at DC-voltmeter input

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
AC OFF	1 kHz	OFF	–	1 V	–10 V	–4.87 . . . –5.13 V
AC OFF	1 kHz	OFF	–	1 V	–9 V	–4.38 . . . –4.62 V
AC OFF	1 kHz	OFF	–	1 V	–8 V	–3.89 . . . –4.11 V
AC OFF	1 kHz	OFF	–	1 V	–7 V	–3.40 . . . –3.60 V
AC OFF	1 kHz	OFF	–	1 V	–6 V	–2.91 . . . –3.09 V
AC OFF	1 kHz	OFF	–	1 V	–5 V	–2.42 . . . –2.58 V
AC OFF	1 kHz	OFF	–	1 V	–4 V	–1.93 . . . –2.07 V
AC OFF	1 kHz	OFF	–	1 V	–3 V	–1.44 . . . –1.56 V
AC OFF	1 kHz	OFF	–	1 V	–2 V	–0.95 . . . –1.05 V
AC OFF	1 kHz	OFF	–	1 V	–1 V	–460 . . . –540 mV
AC OFF	1 kHz	OFF	–	1 V	0 V	–30 . . . +30 mV

Generator settings:

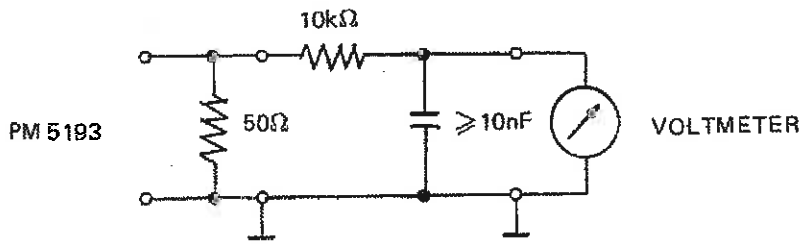
Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
AC OFF	1 kHz	OFF	—	1 V	+1 V	+460 . . . + 540 mV
AC OFF	1 kHz	OFF	—	1 V	+2 V	+0.95 . . . +1.05 V
AC OFF	1 kHz	OFF	—	1 V	+3 V	+1.44 . . . +1.56 V
AC OFF	1 kHz	OFF	—	1 V	+4 V	+1.93 . . . +2.07 V
AC OFF	1 kHz	OFF	—	1 V	+5 V	+2.42 . . . +2.58 V
AC OFF	1 kHz	OFF	—	1 V	+6 V	+2.91 . . . +3.09 V
AC OFF	1 kHz	OFF	—	1 V	+7 V	+3.40 . . . +3.60 V
AC OFF	1 kHz	OFF	—	1 V	+8 V	+3.89 . . . +4.11 V
AC OFF	1 kHz	OFF	—	1 V	+9 V	+4.38 . . . +4.62 V
AC OFF	1 kHz	OFF	—	1 V	+10 V	+4.87 . . . +5.13 V

4.4.8.2. DC-Voltage Offset Error Test

Test equipment:
– DC-voltmeter

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at DC-voltmeter input

Remark: Take care that the DC-voltmeter doesn't respond on the AC portion of the tested voltage.
If necessary insert LOW PASS FILTER.



Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∼	1 MHz	OFF	—	3 V	0	–80 mV . . . +80 mV
∼	2 MHz	OFF	—	3 V	0	–80 mV . . . +80 mV
	step width 1 MHz					
∼	49 MHz	OFF	—	3 V	0	–80 mV . . . +80 mV
∼	50 MHz	OFF	—	3 V	0	–80 mV . . . +80 mV
∼	1 MHz	OFF	—	20 V	0	–80 mV . . . +80 mV
∼	2 MHz	OFF	—	20 V	0	–80 mV . . . +80 mV
	step width 1 MHz					
∼	49 MHz	OFF	—	20 V	0	–80 mV . . . +80 mV
∼	50 MHz	OFF	—	20 V	0	–80 mV . . . +80 mV

4.4.9. Modulation

4.4.9.1. Modulation Frequency Accuracy Test

Test equipment:
– Frequency counter

Procedure:
– Connect PM 5193 MODULATION OUTPUT (at the rear of the instrument) to frequency counter
– Set counter to > 1 s gate time

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter fmod	Modulation parameter m %	Output voltage AC pp	Output voltage DC	Test result requirement
∿	1 kHz	AM INT	10 Hz	50	–	–	8 . . . 12 Hz
∿	1 kHz	AM INT	990 Hz	50	–	–	959 . . . 1021 kHz
∿	1 kHz	AM INT	1 kHz	50	–	–	969 . . . 1031 kHz
∿	1 kHz	AM INT	9.9 kHz	50	–	–	9.6 . . . 10.4 kHz
∿	1 kHz	AM INT	10 kHz	50	–	–	9.5 . . . 10.5 kHz
∿	1 kHz	AM INT	200 kHz	50	–	–	180 . . . 210 kHz

4.4.9.2. Internal AM Modulation Depth (m) Accuracy Test

Test equipment:
– Modulation analyzer

Procedure:
– Connect PM 5193 OUTPUT to modulation analyzer

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter fmod	Modulation parameter m %	Output voltage AC pp	Output voltage DC	Test result requirement
∿	4 MHz	AM INT	1 kHz	50	5 V	0	47 . . . 53 %
∿	40 MHz	AM INT	1 kHz	50	5 V	0	47 . . . 53 %
∿	4 MHz	AM INT	50 kHz	50	5 V	0	47 . . . 53 %
∿	40 MHz	AM INT	50 kHz	50	5 V	0	47 . . . 53 %
∿	4 MHz	AM INT	200 kHz	50	5 V	0	40 . . . 55 %
∿	40 MHz	AM INT	200 kHz	50	5 V	0	40 . . . 55 %

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

4.4.9.3. AM Envelope Distortion Test

Test equipment:
- Modulation analyzer
- Distortion meter

Procedure:
- Connect PM 5193 OUTPUT to modulation analyzer RF input
- Connect modulation analyzer AF output to distortion meter

Remark: The modulation depth (m) of 50 % resp. 98 % must be checked with the modulation analyzer. If necessary the generator setting must bei changed.

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter fmod	Modulation parameter m %	Output voltage AC pp	Output voltage DC	Test result requirement
∿	30 MHz	AM INT	1 kHz	50	5 V	0	< 1 %
∿	30 MHz	AM INT	1 kHz	98	5 V	0	< 2 %
∿	50 MHz	AM INT	1 kHz	50	5 V	0	< 1.5 %
∿	50 MHz	AM INT	1 kHz	98	5 V	0	< 2 %

4.4.9.4. FM Deviation Accuracy Test

Test equipment:
- Modulation analyzer

Procedure:
- Connect PM 5193 OUTPUT to modulation analyzer

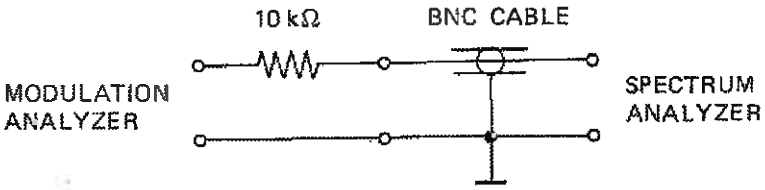
Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter fmod	Modulation parameter DEV	Output voltage AC pp	Output voltage DC	Test result requirement
∿	5 MHz	FM INT	1 kHz	200 kHz	5 V	0	160 . . . 240 kHz
∿	10 MHz	FM INT	1 kHz	200 kHz	5 V	0	160 . . . 240 kHz
∿	15 MHz	FM INT	1 kHz	200 kHz	5 V	0	160 . . . 240 kHz
∿	20 MHz	FM INT	1 kHz	200 kHz	5 V	0	160 . . . 240 kHz
∿	25 MHz	FM INT	1 kHz	200 kHz	5 V	0	160 . . . 240 kHz
∿	30 MHz	FM INT	1 kHz	200 kHz	5 V	0	160 . . . 240 kHz
∿	5 MHz	FM INT	1 kHz	50 kHz	5 V	0	40 . . . 60 kHz
∿	10 MHz	FM INT	1 kHz	50 kHz	5 V	0	40 . . . 60 kHz
∿	15 MHz	FM INT	1 kHz	50 kHz	5 V	0	40 . . . 60 kHz
∿	20 MHz	FM INT	1 kHz	50 kHz	5 V	0	40 . . . 60 kHz
∿	25 MHz	FM INT	1 kHz	50 kHz	5 V	0	40 . . . 60 kHz
∿	30 MHz	FM INT	1 kHz	50 kHz	5 V	0	40 . . . 50 kHz

4.4.9.5. **FM Distortion Test**

Test equipment:
- Modulation analyzer
- Spectrum analyzer

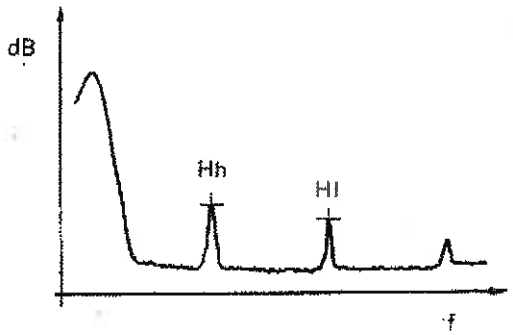
Procedure:
- Connect PM 5193 OUTPUT to modulation analyzer RF input
- Connect modulation analyzer AF output to spectrum analyzer
- Insert serial resister to avoid overloading of the modulation analyzer AF output



Remark: If you use a modulation analyzer with 50 Ohm load capability of the AF output or a spectrum analyzer with high-impedance input the resistor is not required.

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter fmod	Modulation parameter DEV	Output voltage AC pp	Output voltage DC	Test result requirement
∿	30 MHz	FM INT	50 kHz	100 kHz	5 V	0	see table



Measure 2nd and 3rd harmonics,
define the larger one (Hh)
and the smaller one (Hl)

Hh < −40 dBc if Hl < −60 dBc
Hh < −41 dBc if Hl < −47 dBc
Hh < −42 dBc if Hl < −44 dBc
Hh < −43 dBc if Hl = Hh

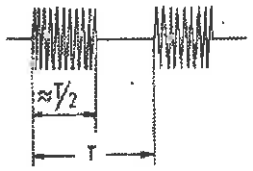
Wave form	Frequency	Modulation mode	Modulation parameter fmod	Modulation parameter DEV	Output voltage AC pp	Output voltage DC	Test result requirement
∿	50 MHz	FM INT	50 kHz	200 kHz	5 V	0	2nd and 3rd < −37 dBc

4.4.9.6. Gate Functional Test

Test equipment:
– Scope

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at scope

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∿	100 kHz	GATE INT	fmod 1 kHz	5 V	0	

Remark: Check duty cycle of gated output signal: appr. 50 % and voltage pp 2.5 V

4.4.9.7. Sweep Functional Test

Test equipment:
– Dual channel scope

Procedure:
– Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at scope input channel A
– Connect PM 5193 SWEEP OUT (at the rear of the instrument) to channel B of the scope
– Set channel B to DC-coupling
– Set trigger to channel A
– Set scope to chopped

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∿	fstart 1 kHz, fstop 10 kHz	LIN SWEEP CONT	T = 5 s mode 1	5 V	0	see following text

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

– Connect channel B to PM 5193 PEN LIFT OUTPUT (rear)
– Start single sweep (key SINGLE)

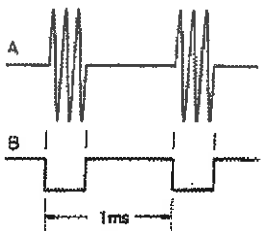
During running sweep the PEN LIFT voltage (channel B) must be appr. 0 V; at the end of the sweep the PEN LIFT voltage is switched to appr. +20 V.

4.4.9.8. BURST Functional Test

Test equipment:
- Dual channel scope
- External TTL source of 1 kHz

Procedure:
- Connect PM 5193 OUTPUT to 50 Ohm feed-through termination at scope channel A
- Connect PM 5193 MODULATION OUTPUT (at the rear of the instrument) to channel B of the scope
- Connect external 1 kHz-TTL source to the PM 5193 MODULATION INPUT (rear)

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
∿	10 kHz	BURST INT	3 ON cycles, 7 OFF cycles	5 V	0	
∿	10 kHz	BURST EXT	3 ON cycles, 7 OFF cycles	5 V	0	must be the same display

4.4.10. TTL Output Level Test

Test equipment:
- Scope

Procedure:
- Connect PM 5193 TTL OUT to scope (without 50 Ohm termination)

Generator settings:

Wave form	Frequency	Modulation mode	Modulation parameter	Output voltage AC pp	Output voltage DC	Test result requirement
–	1 kHz	OFF	–	–	–	low level: – 0.1 . . . +0.1 V high level: +4.0 V . . . +5 V