RC generator 10Hz-100kHz PM 5109 / PM 5109 S

Instruction manual

9499 453 00602 82 08 01/1/01-02



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1. GENERAL

1.1. INTRODUCTION

The \underline{RC} generator \underline{PM} 5109 produces sine wave signals with very low distortion and square wave signals. The frequencies are adjustable in four sub-ranges from 10 Hz to 100 kHz.

Several outputs are available:

- For the sine wave signal a floating transformer output is available, which can be set to either low impedance (0.5 Ohm) or to 600 Ohm. The open circuit output voltage is continuously adjustable up to 3.16 Vrms, indicated by the front panel voltmeter.
- For the sine wave and square wave signal an asymmetrical output is available, which can be set to 600 Ohm or 50 Ohm.

 The open circuit output voltage is continuously adjustable up to 10 Vrms and can be attenuated in steps of 10 dB down to 60 dB. The open circuit output voltage is indicated by the front-panel voltmeter with additional range LED indication.

The generator can be set to LOW DISTORTION mode or to FAST SETTLING mode.

For TTL applications a separate output is available.

The RC generator PM 5109S is designed with all the facilities of the PM 5109 except the floating transformer output.

The two RC generators are ideal for general-purpose use in education and training, research and development, manufacture, quality control and service of audio equipment.

1.2. TECHNICAL DATA

General information:

On delivery from the factory, the instrument complies with the safety regulations of measuring and control equipment. The information and warnings contained in this instruction manual must be followed by the user to ensure safe operation and to maintain the instrument in a safe condition.

- Only data with indicated tolerances or limits are guaranteed; data without tolerances are given only for guidance.
- All specifications will be met after a warm-up time of 30 min. when keeping the instrument in a constant operating position.
- If not stated otherwise, relative or absolute tolerances relate to the set value.

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1.2.1. Frequency

frequency range

temperature coefficient

adjustments

10 Hz to 100 kHz

4 sub-ranges, decadal stepped

- 4 range pushbuttons;

x 10 Hz, x 100 Hz, x 1 kHz, x 10 kHz - dial with half-logarithmic scale

scale on the dial

frequency indication

setting error

short-term drift long-term drift temperature coefficient <5 % ±1 Hz

<0.05 % within 15 min <0.15 % within 7 h

<0.05 %/K

1.2.2 Wave forms sine wave square wave

1.2.3 Outputs PM 5109

outputs A and B

selected by pushbutton

output A~, LOW Z and 600 Ohm selected by pushbutton;

floating; two separate transformer outputs, not connected to earth; serially connected by link at the front plate

max.external d.c. current through transformer winding 100 mA

- LOW Z

- LOW Z + LOW Z, 0.5 Ohm (at 1 kHz) - 2 x LOW Z, 0.25 Ohm each (at 1 kHz) short-term short-circuit proof (1 min.)

- 600 Ohm

- 300 Ohm + 300 Ohm - 2 x 300 Ohm short-circuit proof

connection

four 4 mm banana sockets

one 4 mm banana socket for measuring

earth

output A, LOW Z /!\

LOW Z, 0.5 Ohm (at 1 kHz); floating,

earth-free;

as output A, LOW Z + LOW Z; serial link must be set

connection

DIN loudspeaker socket (rear side)

output B, 50 Ohm and 600 Ohm

selected by pushbutton; asymmetrical, related to earth; short-circuit proof

connection

BNC socket;

connection measuring earth - safety earth

via high-ohmic RC combination

PM 5109S

see output B for PM 5109;

output A is not available in PM 5109S

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open circuit voltage	all are Vrms voltages		
output A	O to 3.16 V, continuously adjustable		
<pre>output B - temperature coefficient - step attenuationtolerance</pre>	O.1 to 10 V, continuously adjustable <0.3 %/K O to 60 dB in steps of 10 dB <0.2 dB for all attenuations		
open circuit voltage display display error range indication signal wave form	analogue meter indication with 10 V, 3.16 V and dB scales <±5 % of f.s.d. 7 LEDs; 0.01 V to 10 V; fixed 3 V LED for output A		
output A	sine wave LOW DISTORTION sine wave FAST SETTLING; selected by pushbutton square wave not available		
output B	sine wave LOW DISTORTION sine wave FAST SETTLING square wave; selected by pushbutton		
for sine wave, output A,B:			
LOW DISTORTION	low distortion - slow amplitude settling		
FAST SETTLING	fast amplit. settling - normal distortion		
distortion (sine wave)			
output A, 600 Ohm			
- LOW DISTORTION - FAST SETTLING	<0.03 % (300 Hz to 20 kHz) <0.7 % (10 Hz to 100 kHz) 0.40.6 % (100 Hz to 100 kHz) <1.5 % (10 Hz to 100 kHz)		
output A, LOW Z			
 LOW DISTORTION, open circuit LOW DISTORTION, loaded with 4 Ohm FAST SETTLING, open circuit4 Ohm 	<0.03 % (300 Hz to 20 kHz) <0.7 % (20 Hz to 100 kHz) <0.15 % (20 Hz to 100 kHz) <0.6 % (100 Hz to 100 kHz)		
output B			
- LOW DISTORTION - FAST SETTLING	<0.03 % (300 Hz to 20 kHz) <0.7 % (10 Hz to 100 kHz) 0.40.6 % (20 Hz to 100 kHz) <1.5 % (10 Hz to 100 kHz)		

operating limits

power consumption

nominal frequency range

limit range of operation

```
amplitude response (sine wave;
       reference value 1 kHz)
       output A, 600 Ohm
                                      <0.2 dB, earth-free measurement
                                      <0.2 dB (10 Hz to 30 kHz) ) measurement with
                                      -O.5 dB (at 100 kHz)
                                                                 safety earth connec-
                                                                 ted to one winding
                                      (for details see chapter 3.1.4.)
       output A, LOW Z
                                      <0.2 dB
       - open circuit
       - load 4 Ohm
                                      <0.5 dB (10 Hz to 10 kHz)
                                      -6 dB
                                               (at 70 kHz)
                                      <0.2 dB
       output B
       square wave
       duty cycle
                                      50 %
       overshoot, ringing, tilt
                                      <2 % (f >20 Hz)
                                      <1 % (f >50 Hz)
       rise time, fall time
                                      <0.5 \mu s
                                      not for LOW DISTORTION
1.2.4. TTL output
                                      BNC socket
       connection
                                      PM 5109: rear side
                                      PM 5109S: front side
                                      inverse of output B
       output signal
                                      50 %
        duty cycle
                                      20 TTL inputs
       fan out
                                      standard TTL level: high >2.4 V, low <0.8 V
       level
                                      not proof against external voltage > 5 V
       external voltage
                                      ac mains
1.2.5. Power supply
                                      220 V
        reference value
                                      110 V/128 \ V/220 \ V/238 \ V, selectable by
       nominal values
                                                                solder links
       nominal operating range
                                      \pm 10 % of selected nominal value
```

±10 % of selected nominal value

50 - 100 Hz

17 W

47.5 - 105 Hz

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1.2.6. Environmental conditions

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 operation 10...90 % limits for storage and transport 0...90 %

Air pressure:

reference value 1013 mbar ($\stackrel{\triangle}{=}$ 760 mm Hg)

nominal working range 800...1066 mbar (≙ 600...800 mm Hg;

up to 2200 m height)

Air speed:

reference value 0...0.2 m/s nominal working range 0...0.5 m/s

Heat radiation direct sunlight radiation not allowed

Vibration:

limits for storage and transport $\begin{cases} max. 0.35 \text{ mm amplitude (10 to 60 Hz)} \\ max. 5 \text{ g} \end{cases}$ (60 to 150 Hz)

Operating position normally upright on feet or with handle

fold down

Warm-up time 30 min.

1.2.7. Cabinet

protection type (see DIN 40 050) IP 20

protection class (see IEC 348) class I, protective conductor

overall dimensions:

weight PM 5109: 6.5 kg PM 5109S: 5 kg

1.3. ACCESSORIES

1.3.1. Standard instruction manual fuse 315 mA delayed labels for power supply

1.3.2. Optional PM 9585: 50 Ohm termination 1 W PM 9581: 50 Ohm termination 3 W

PM 9075: Coaxial connection cable

BNC-BNC 75 Ohm

PM 9051: Adapter BNC (male)-Banana (female)

1.4. OPERATING PRINCIPLE

The block diagram, fig. 30, indicates the signal flow, signal processing and the pushbutton actions on the different blocks. For further details look into chapter 3.1., OPERATION, and chapter 4.1., CIRCUIT DESCRIPTION.

2. INSTALLATION

2.1. SAFETY REGULATIONS

Upon delivery, the instrument complies with the required safety regulations. To maintain this condition and to ensure safe operation, it is recommended to follow the instructions below.

2.1.1. Before connecting

Mains voltage

Check whether the instrument is adapted to the nominal mains voltage.

Protection

This instrument is protected according to class I (protective earth) of the IEC 348 or VDE 0411. The mains cable provides earth connection. Outside specially protected rooms, the mains plug must be connected only to sockets with earthed contact.

It is not allowed to interrupt the earth connection inside or outside the instrument.

2.1.2. 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.

Fuses

Only use the specified fuses.

Repair, replacing parts

Repairs must be made by trained personnel. Ensure that the construction of the instrument is not altered to the detriment of safety. Above all, leakage paths, air gaps and insulation layers must not be reduced.

When replacing, use only original parts. Other spare parts are only acceptable when the safety precautions for the instrument are not impaired.

2.2. MOUNTING

The instrument may be used in any desired position. With the handle fold down, the instrument may be used in sloping position; for this purpose press the buttons of the handle. Do not position the instrument on any surface which produces or radiates heat, or in direct sunlight.

2.3. EARTHING

Before switching on, the instrument must be earthed in conformity with the local safety regulations. The mains cable fixed to the instrument includes a protective conductor, which is connected to the earth contacts of the plug. Thus, when connected to an earthed mains socket, the cabinet of the instrument is consequently connected to the protective earth.

WARNING: Connect the mains cable plug only to a socket with protective earth contacts. This protection must not be made ineffective, e.g. by using an extension cable without earth protection!

The circuit earth potential applied to the external contacts of BNC sockets is connected to the cabinet by means of a parallel-connected capacitor and resistor. So correct HF-earthing of the circuit is obtained. The external contacts of the BNC sockets must not be used to connect a protective conductor.

2.4. DISMANTLING THE INSTRUMENT

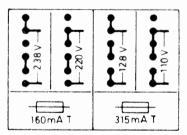
- Unplug the mains connector
- Fold up the handle to the top. For this push the buttons of the handle
- Loosen the central screw at the rear
- Remove the lead-through of the mains cable from the cabinet
- Dismantle the cabinet

2.5. MAINS CONNECTION

The instrument must be connected only to an AC supply. On delivery the instrument is set to 220 V. Before mains connection, ensure that the local mains voltage ranges within the set mains voltage range indicated on the plate at the rear of the instrument.

If the instrument is to be used on a different supply voltage proceed as follows:

- Unplug the mains connector
- Dismantle the instrument, see 2.4.
- Change connections of the mains transformer by means of solder links on the printed circuit board according to the connection diagram. See also below



- If necessary, insert the supplied fuse 315 mA delayed into the fuse holder instead of the one built-in.
- Change the mains voltage plate at the rear of the instrument in accordance with the mains voltage selected. The plates for the other supply voltages are inserted into a plastic cover, as the fuse just mentioned.
- Close the instrument

Mains connection must be made in accordance with the local safety regulations. This implies that the instrument is connected to mains sockets with protective earth contact (see para, 2.3.).

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3. OPERATING INSTRUCTIONS

3.1. OPERATION

3.1.1. Setting the frequency

Two controls are provided for setting the frequency:

- dial with half-logarithmic scale
- range selector FREQUENCY Hz, decadal stepped

The scale reading, multiplied by the factor of the range selector, represents the frequency (e.g. dial setting 1.9 x range selector 10 $k=19 \, \text{kHz}$ output frequency).

3.1.2. ISO frequencies

For acoustical and electro-acoustical measurements distinct geometrical frequency relations are often required, especially for filter testing and adjustment (octave filters, third octave filters). Those "Standard frequencies for acoustical measurements", according to ISO recommendations, published in DIN 45401, are marked on the dial: \blacktriangledown : 10/12.5/16/20/25/31.5/40/50/63/80/100/125/... Hz and repeated for the higher frequency ranges.

3.1.3. Low distortion, fast amplitude settling; bouncing

When turning the frequency dial and changing the frequency ranges, bouncing can be observed: due to the RC oscillator principle the amplitude of the sine wave signal alters.

For your convenience two operating modes are offered:

- LOW DISTORTION: low distortion of the sine wave signal,

but slow amplitude settling associated with

changes in frequency setting

- FAST SETTLING: fast amplitude settling,

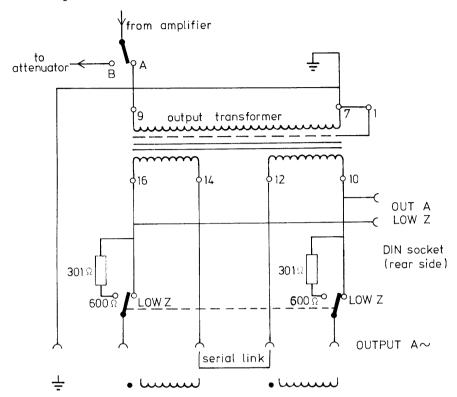
normal distortion of the sine wave signal

For high precision measurements the LOW DISTORTION mode is recommended, whilst the FAST SETTLING mode can be applied for fast, routine work. For extreme settings (low distortion mode at low frequencies) amplitude settling can last some seconds.

In LOW DISTORTION mode the TTL signal is switched off.

3.1.4. Output A

The figure below illustrates the connections of the output transformer to the output sockets.



So depending on the serial link the following output modes are available:

output	serial link	switch LOW Z 600	output at OUT A LOW Z
		_	
2 x LOW Z	open	 	
		L_	
LOW Z + LOW Z	closed	 -	LOW Z + LOW Z
2 x 300 Ohm	onon	.	
2 x 300 0/1m	open	 -	
300 Ohm + 300 Ohm	closed	Þ	LOW Z + LOW Z

On delivery state the serial link is closed.

When one of the frontplate output terminals A is connected to protective earth and the 2 x 300 Ohm or 300 Ohm + 300 Ohm mode is chosen, ground loops can effect additional amplitude response for frequencies above 30 kHz (see also chapter 1.2.3).

When selecting OUTPUT A the step attenuation is not effective.

A square wave signal is not available at output A. When selecting OUTPUT A and square wave mode, no range indication LED is lighting.

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3.1.5. TTL OUTPUT

In SINE WAVE / FAST SETTLING and SQUARE WAVE mode a TTL signal is available.

For PM 5109 the BNC socket is placed at the rear side, for the PM 5109S at the front side.

The TTL signal is inverse of the signal at OUTPUT B:

OUTPUT B (or sine wave)

TTL OUTPUT

6383

4.1. CIRCUIT DESCRIPTION PM 5109

4.1.1. Oscillator

The frequency determining RC network of the oscillator is a Wienbridge. The proper in-phase conditions for self-justained oscillations are satisfied at the frequency

$$f = \frac{1}{2\pi RC}$$

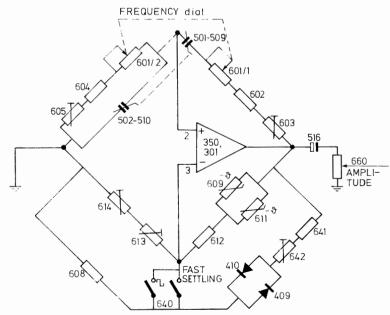
In this symmetrical arrangement R are the both ohmic total resistances and C are the total capacitances in the reactive branch of the Wien-bridge.

Continuously variable frequency control within the selected range is achieved by the tandem potentiometer 601 (FREQUENCY dial) connected in the series and parallel arms of the bridge circuit. The ranges can be selected by the four FREQUENCY range pushbuttons 801, which select the bridge tuning capacitors as follows:

PUSHBUT	ron	1
FREQ. RANGE	SWITCH	CAPACITORS
x 10	801/1	501,502
x 100	801/2	503,504
x 1k	801/3	505,506
x 10k	801/4	507//509, 508//510

The series arm of the bridge circuit consists of range capacitors 501 - 509, frequency potentiometer 601/1 and 602, 603. The parallel arm of the bridge consists of range capacitors 502 - 510, frequency potentiometer 601/2 and resistors 604, 605.

The amplifier within the Wien-bridge consists of the operational amplifier 350 and boosting transistor 301. The circuit including the ohmic feedback branch of the Wien-bridge has an overall voltage gain of 3. The high slew rate of >2 V/ μs makes the TAA 761 suitable for this application.



Amplitude control of the oscillator is achieved by thermistor 609. This thermistor, representing a resistor with high negative temperature coefficient, is heated by a portion of the oscillator amplitude. The resulting thermistor resistance together with resistors 611, 612, 613, 614 determine an amplifier voltage gain of 3. Steady state variations of the oscillator amplitude are eliminated, because an increasing amplitude causes a decreasing thermistor resistance by stronger heating and, vice versa, a decreasing amplitude effects a higher resistance and therefore amplifier gain.

By NTC resistor 611 the amplitude stability versus ambient temperature variations is improved.

The natural response of the previously described amplitude control circuit to disturbances of the oscillator loop, e.g. changes in frequency settings and amplitude variations, is mostly called amplitude bouncing. The amount of this amplitude bouncing mainly depends on the signal distortion factor.

The instrument PM 5109 offers the possibility to reduce the bouncing magnitude and duration by increasing the distortion factor. This is achieved by switching over to FAST SETTLING, so by-passing the ohmic path of the bridge with anti-parallel diodes 409/410 and resistors 641, 642 and 608.

In SQUARE WAVE mode this fast settling circuit is automatically switched in.

4.1.2. Square wave generator, TTL output

The square wave generator is active only in sine wave/fast settling or in square wave mode, as in these modes only the negative supply voltage is fed to the input stage.

The sine wave signals generated by the oscillator are fed via resistor 622 and decoupling emitter follower 317 to the Schmitt trigger circuit to produce a square wave signal. The separate output from the collector of transistor 301 provides isolation between the sine wave output taken from the emitter of 301 and the Schmitt trigger input circuit. The Schmitt trigger circuit comprises a coupled differential amplifier stage 302 and 303. Potmeter 620 in the collector circuit of 301 serves for duty-cycle adjustment of the square wave (1 : 1) by equalizing the d.c. level at collector 301 and the mean value of the switching levels of the Schmitt trigger (base 302).

The switching output levels of the Schmitt trigger are converted to TTL levels by transistor stages 304, 305.

4.1.3. Amplifier

The non-inverting amplifier mainly comprises two differential transistor stages and a complementary collector output stage.

The input stage consists of a differential FET amplifier 306 for low input current. Because of the high impedance of the amplitude potmeter 660 it is necessary to have low input bias current, resulting in low offset variations and so low premagnetization of the output transformer. The well-known ON561 (2 matched transistors BF 245) guarantees low offset drift.

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For sufficient open loop gain a second differential amplifier 309/310 is inserted. Within the current source of this stage potmeter 673 serves for setting the quiescent current of the output stage. The negative temperature coefficient of diode 421 serves for compensation of the negative temperature coefficient of the base-emitter voltage of transistor 308. The current source furthermore effects limitation of the output current swing during bouncing periods of the oscillator.

The output stage consists of the complementary darlingtons 313/315 and 314/316. The latter are directly controlled by the differential stage 309/310, while the first stage is controlled via current mirror 311/312.

Overall feedback of the amplifier is achieved by resistors 685, 670 to the input stage.

The d.c. offset is adjusted by potmeter 679.

4.1.4. Meter rectifier, range LED control, voltage indication

The meter rectifier is designed as full wave rectifier, operating as average detector. The meter is scaled for Vrms voltages. Different scale factors for sine wave and square wave form are taken into account by adding resistor 650 into the input current path of the amplifier 353.

The 7 range indication LEDs are directly switched according to the selected attenuation.

When OUTPUT A is selected, the step attenuation is not effective; in this case the 3 V range LED is lighting independent from the state of the attenuation pushbuttons.

When selecting OUTPUT A and square wave mode, the square wave generator is switched off by open switches 801/3 and 801/8; no range indication LED is lighting so indicating that no output signal is available.

4.1.5. Power supply

The required two supply voltages of +20V and -20 V are realized by means of the four-terminal adjustable voltage regulators 351 and 352. The positive voltage is adjusted by 642 and the negative voltage by means of 645 to an accuracy of $\pm 0.1V$.

4.2. ACCESS TO PARTS

Before dismantling the instrument, the safety regulations in accordance with para. 2.1. must be strictly observed.

4.2.1. Cabinet, see 2.4.

4.2.2. Knobs

- Remove the cap from the knob.
- Unscrew the nut and remove the knob.
- When replacing the knob, ensure that the white mark is correctly aligned with the text plate markings.

4.2.3. Text plate

- Remove the cabinet, see 2.4.
- Remove the turn-knobs, see 4.2.2.
- Remove the dial.
- Remove the plastic cover of the mains switch.
- The text plate can now be removed.

Be careful:

The textplate is fitted to the frontplate by double sided adhesive tape.

4.2.4. Pushbutton unit

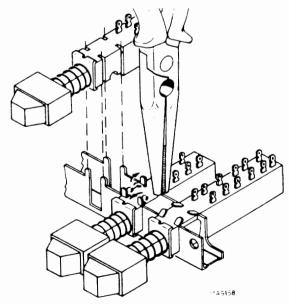
Replacing a pushbutton lever.

The single pushbutton lever can be replaced from the front.

- Push the spring towards the pushbuttons.
- Remove the wire strap and/or lift the plastic reed between the contacts.
- Carefully tear the pushbutton lever out of the pushbutton.

Replacing a switch of the pushbutton unit

- Straighten the 4 retaining lugs of the relevant switches as shown in the figure below.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering
 pins are then accessible.
- Remove the soldering pins and clean the holes in the printed circuit board (e. g. with a suction soldering iron).
- Bend the 4 retaining lugs back to their original positions.
- Solder the new switch on to the printed circuit board.



4.3. CHECK AND ADJUSTMENT

4.3.1. General

- The limits mentioned in this paragraph are valid only for a newly adjusted instrument and therefore might deviate from the values as stated in paragraph 1.2. "Technical Data".
- Adjustment of the instrument is only permitted after a warm-up time of at least 30 minutes at an ambient temperature of $(+23 \pm 3)^{\circ}$ C and when connected to a mains voltage of 220 V ± 5 %. The adjustment must be performed in normal operating position.
- If not explicitely stated otherwise, the voltage potentials refer to the relevant contact measured against measuring earth (\pm).
- The following abbreviations are used for seting and measuring instruments:

```
Button pressed
X
         Button not pressed/unlocked
         • extreme left-hand position
lh
         potentiometer setting
           outputs unloaded
         = outputs, terminated with indicated load of 600\%50\%4\Omega
            with 50\Omega, e.g. PM 9585
         $\hat{\text{e}}$ keep setting concerned
Vrms, Vdc - Digital multimeter for a.c. (rms) and d.c., e.g. PM 2517

    Oscilloscope,

                                       e.g. PM 3226, PM 3207
OSC
         e.g. PM 6622/02
C
         • Distortion analyzer
DA
                                        e.g. HP 334A

⇒ 50 Ohm terminating resistor, e.g. PM 9585
50 \Omega
```

4.3.2. Preparations

- All trimming potentiometers and capacitors in mid-position; (only for complete new adjustment).
- Solder joints A to F must be closed. To be opened for failure detection only.

4.3.3. General functional test

- Set the instrument to POWER ON
- Adjust power supply according to seq. 1.1. and 1.2. of the following table
- Actuate all controls for rough functional test of the generator and check all input and output sockets.

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4.4. CHECKS AFTER REPAIR AND MAINTENANCE

Checking the protective leads

The correct connection and condition is checked by visual control and by measuring the resistance between the protective-lead connection at the plug and the cabinet.

The resistance should be < 0.5 Ohm. During measurement the mains cable should be moved. Resistance variations indicate a defect.

Checking the insulating resistance

Measure the insulating resistance at $U_=500~V$ between the mains connections and the protective lead connections. For this purpose set the mains switch to ON. The insulating resistance should be > 2~MOhm.

4.5. PARTS LIST

4.5.1. Mechanical parts, miscellaneous, parts not on units

Item	Fig./unit	Quantity		Description
1		1	5322 447 44009	cover
2		4	5322 462 44174	foot (bottom side)
3	35	2	5322 520 34164	bearing bush
4	35	2	5322 530 84075	spring
5	35	2	5322 528 34101	ratchet
6	35	2	5322 532 54425	ring for handle
7	35	2	5322 498 54048	arm for handle
8		1	5322 498 54051	carrying handle
9	35	2	5322 414 64053	knob
10	36	1	5322 321 14048	mains cable 1850
11	36	1	5322 401 14275	cable clamp
12	36	1	5322 325 54067	lead through
13	36	1	5322 325 60119	pull relief
		1	5322 502 14164	<pre>coin-slot screw (rear side)</pre>
		1	4822 530 70124	locking washer (rear side)
		4	5322 462 44176	foot (rear side)
803	32	1	5322 276 14433	mains switch
851	32	1	4822 253 30009	fuse 160 mAT
		1	4822 253 30014	fuse 315 mAT
751	32	1	5322 146 20689	mains transformer
752	32	1	5322 140 60246	output transformer *
		2	5322 267 10004	BNC connector
		2	5322 532 51309	insulating bush for BNC connector
		2	5322 532 64214	insulating disk for BNC connector
	frontpl.	4	5322 267 34059	terminal grey *
	"	1	5322 267 34058	terminal blue *
	"	1	5322 290 30001	conducting link for terminal *
	rear side	1	5322 267 30424	DIN loudspeaker socket *
		3	5322 462 34125	print holder
		1	5322 414 40003	dial, mounted with knob
	frontpl.	1	5322 414 74047	locating mark
601	37/38	1	5322 102 34016	wire-wound tandem potm.2x50k0hm
660	37/38	1	4822 101 20417	potmeter 22 kOhm/LIN
		1	5322 414 34075	knob (pos. 660)
		1	5322 414 74031	cap for knob (pos. 660)
		1	5322 414 74042	cap for knob (dial)
545	37/38	1	5322 121 44028	0.01 MU 2x2N5 250 V, line filter
		3	5322 276 14394	pushb. switch 801/7, 802/1/7
		6	5322 276 14395	- " - 801/1-4,802/2/3
		2	5322 276 10961	- " - 802/5/6
	32	2	5322 276 34052	- " - 801/5/6
		1	5322 276 80246	- " - 802/4
			5322 414 25851	cap for pushbuttons 801, 802
821	unit 3	1	5322 344 60021	voltmeter
			5322 390 24013	silicon paste DC 340

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4.5.2. Electrical parts

Some parts are listed in chapter 4.5.1.

TRANSISTORS/	U	1
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301,304	4822	130	44197	BC558B
302,303,307	4822	130	40937	BC548B
305	5322	130	40417	BSX2O
306	5322	130	44302	ON561
308-310,313	4822	130	44197	BC558B
311,312,314,317	4822	130	40937	BC548B
315	4822	130	40824	BD140
316	4822	130	40823	BD139

INTEGRATED CIRCUITS/U1

350,353	5322	209	85193	TAA761A
351	5322	209	85565	78GCU1
352	5322	209	86349	79GCU1

DIODES/U1

401,402	5322	130	34321	1N4151
403,404	4822	130	34233	BZX79-C5V1
405	4822	130	34174	BZX79-C4V7
406	4822	130	34048	BZX75-C2V8
407	4822	130	30414	BY164, RECTIFIER
408,409	4822	130	34233	BZX79-C5V1
410-413	5322	130	34321	1N4 151
421	4822	130	34047	BZX75-C1V4

CAPACITORS/U1

ITEM	ORDERING	NUMBER	FARAD	TOL	VOLTS	REMARKS
				%/VAL		
501,502	5322 121	54171	3 3ONF	1	63	POLYSTYRENE FOIL
503,504	5322 121	54111	33NF	1	63	" "
505,506	5322 121	54049	3.3NF	1	63	11 11
507	5322 121	54059	220PF	1	500	11 11
508	5322 121	54047	270PF	1	500	11 11
509,518	4822 122	31316	100PF	2	100	CERAMIC PLATE
510	5322 125	54025	5.5-65PF		100	TRIMMER
511,512	4822 122	30043	10NF	-20/+80	63	CERAMIC PLATE
513	4822 122	31049	6.8PF	O.25PF	100	11 11
515	5322 122	30108	100NF	10	50	POLYESTER FOIL
516,520	4822 124	20731	22UF		40	ELECTROLYTIC
517	4822 122	31052	8.2PF	O.25PF	100	CERAMIC PLATE
519	4822 124	20693	220UF		16	ELECTROLYTIC
522	4822 121	41169	22ONF	10	250	POLYESTER FOIL
523,524	4822 124	20798	3300UF		40	ELECTROLYTIC
525,526	4822 124	20731	22UF		40	II
527,528	4822 124	20722	1UF		63	11
530	4822 122	31177	470PF	10	100	CERAMIC PLATE
531,532	4822 122	30043	10NF	-20/+80	63	и и
533	4822 124	20673	470UF		6.3	ELECTROLYTIC
540	4822 122	31175	1NF	10	100	CERAMIC PLATE
541,544	4822 124	20731	22UF		40	ELECTROLYTIC
542	4822 125	50045	2-22PF		100	TRIMMER
543	4822 122	31076	68PF	2	100	CERAMIC PLATE

(6386) 4–12

RESISTORS/U1

All metal film resistors not listed are of type MR25 \pm 1% O.4W (ordering code see end of this chapter).

ITEM	ORDERING I	NUMBER	ОНМ	TOL(%)	TYPE	REMARKS
603,605	4822 100		1K		LIN	POTM.TRIMMING
606	4822 100	10051	22K		LIN	" "
609	5322 116	34026	50K	20	3mW	NTC
611	5322 116	30215	4.7K	10	O.25W	NTC
614	4822 100	10254	1K		LIN	POTM.TRIMMING
620	5322 101	14047	470E		LIN	" "
627	4822 100	10019	220E		LIN	11 11
642,645	4822 100	10075	100E		LIN	11 11
656	4822 100	10036	4.7K		LIN	" "
673	5322 101	14011	100E		LIN	" "
679	4822 100	10079	47K		LIN	n n
686-689	4822 116	51093	15E	5	PR52	METAL FILM
CAPACITORS/U2						
521	5322 121	44138	47NF	10	250V	POLYESTER FOIL
RESISTORS/U2						
690	4822 116	51086	22E	5	PR52	METAL FILM
691	4822 116	51152	27E	5	PR52	METAL FILM
DIODES/U3						
414-420	4822 130	30914				CQY54, LED

LACQUERED METAL FILM RESISTORS MR25

style	resistance range		tol. ±%	serie	_	temperature coefficient ±ppm/ ^O C	limiting voltage (r.m.s.) V		service code no. 5322 116 5				
MR 25	4,99	Ω – 301 k Ω	1	E96	+	50 *	250		followed by				
				* For resistance values lower than 49,9 Ω : 100 ppm/ $^{ m O}$ C.									
4,99	0568		4109	5	4,9	4445	182	4493	604	4528			
5,11	4192	l .	0627	1	6,2		187	4494	619	4529			
5,23	4113	i .	4432	1	7,6	1	191	4495	634	4531			
5,36 5,49	4239 4102	1	0418	1	9	4448	196	0676	649	4532			
		į.	4083	i i	0,4	- 1	200	4496	665	4533			
5,62 5,76	4128 4413		0895 4104	•	1,9		205	0669	681	4534			
5,70	1064		4104 0473		3,4 4,9	1	210	4036	698	4037			
6,04	4114	1	1048		4,9 6,5		215 221	0457 4002	715 732	0571 4535			
6,19	1049	1	0678		8,1	4455	226	4497	750	4536			
6,34	0862	!	4433		9,8	i	232	4498	768	4537			
6,49	4112	1	0677		3,6 1,5	1	237	0679	787	4537 4538			
6,65	4414	1	0983		-,5 3,2		243	0437	806	4539			
6,81	4013	,	0491	7		4459	249	4499	825	4541			
6,98	4103	23,2	4434		6,8		255	4501	845	454 2			
7,15	4415	23,7	4014	7	8,7	0578	261	4502	866	4543			
7,32	4416	24,3	4435		0,6		267	4503	887	4544			
7,50	4417	1	0903		2,5		274	4504	909	4545			
7,68	4418	l	4436		4,5		280	4505	931	4546			
7,87	4046	ł	0876	8	6,6	4464	287	4506	953	4547			
8,06	4419	1	4067	L.	8,7		294	4507	976	4548			
8,25	4099		0493	1	0,9	1	301	4508	1 K	4549			
8,45	4421	l .	0623		3,1	4467	309	4509	1 K02	4551			
8,66	1051 4101		4068		5,3	1	316	4511 4512	1 K05 1 K07	4552 4553			
8,87		:	4084	1	7,6	i i	324	4512	į				
9,09 9,31	0863 4422	1	0904 4437		00	4469	332	4513 4514	1 K1 1 K13	4554 4555			
9,53	4258		4437 4034		02 05	4471 4472	340 348	4514 4515	1 K15	4555 0415			
9,76	4423	l	4105		07	4473	357	0603	1K18	4556			
10	0452		0527		10	4474	365	4516	1 K21	4557			
10,2	4111		4438	Į.	13	4475	374	4517	1K24	4559			
10,5	4071	1	4027		15	4476	383	4518	1K27	0555			
10,7	4424	l .	4439		18	4477	392	4006	1K3	0526			
11	4059	1	0409	1	21	4426	402	4519	1K33	45 61			
11,3	4425	37,4	4158	1	24	4478	412	4521	1K37	0628			
11,5	0838	38,3	0954	1	27	4479	422	0459	1K4	4562			
11,8	0738	1	4087	1	30	4481	432	4522	1K43	4563			
12,1	4069	40,2	092 6	1	33	4482	442	0592	1K47	0635			
12,4	4427		4108		37	4483	453	4523	1K5	4564			
12,7	4261	42,2	1052	1	40	4484	464	0536	1K54	0586			
13	4082		0519		43	i	475	4007	1K58	0622			
13,3	1047		0818		47	0766	487	0508	1K62	4565			
13,7	4428		0795	ı.	50		499	4524	1K65	4566 4567			
14	0839	1	0492	1	54		511 522	4525 4526	1K69 1K74	4567 0629			
14,3	4429		0952	1	58	i	523	4526	1				
14,7	0412		0511	1	62		536	0621	1K78	5015 4568			
15 15,4	0902	l	4441	1	65		549 563	0732	1K82 1K87	0728			
15,4 15,8	0925 0861		4442 4443	1	69 74		562 576	4009 4527	1K91	4569			
16,2	4431		4443 4444		178 178		570 590	0561	1K96	4571			
-,-		30,0		ł	. , 0	1102	000	2001					

	4==0	I 5140			(4-01/	4740
2K	4572	5K9	0583	17K4	4636	51K1	0672	150K	4713
2K05	0664	6K04	4601	17K8	4637	52K3	4673	154K	4714
2K1	4573	6K19	0608	18K2	4638	53K6	4674	158K	4715
2K15	0767	6K34	4602	18K7	0558	54K9	4675	162K	4716
2K21	4574	6K49	4603	19K1	4639	56K2	4676	165K	4717
2K26	0675	6K65	4604	19K6	4641	57K6	4677	169K	4718
2K32	4575	6K81	4012	20K	4642	59K	4678	174K	4719
2K32	4576	6K98	4605				4679		
		1		20K5	4643	60K4		178K	4721
2K43	4004	7K15	4606	21K	4644	61K9	0872	182K	4722
2K49	0581	7K32	4607	21K5	0451	63K4	4681	187K	4723
01/55	4533	71/5	4000				0.74		
2K55	4577	7K5	4608	22K1	4003	64K9	0514	191K	4724
2K61	0671	7K68	4609	22K6	0481	66K5	4682	196K	4725
2K67	4578	7K87	0458	23K2	4645	68K1	4683	200K	4726
2K74	0636	8K06	4611	23K7	4646	69K8	4684	205K	4727
2K8	4579	8K25	4558	24K3	4647	71K5	4685	210K	4208
2K87	0414	8K45	4612	24K9	4648	73K2	0666	215K	4728
2K94	4581	8K66	4613	25K5	4649	75K	4686	221K	4038
3K01	0524	8K87	4614	26K1	4651	76K8	4687	226K	4729
3K09	4582	9K09	4615	l .		1	0533	1	4731
		ł .		26K1	4652	78K7		232K	
3K16	0579	9K31	4616	27K4	0559	80K6	4688	237K	4732
21/24	4500	01/53	4047	0014	0007	001/5	4000	0.4014	4700
3K24	4583	9K53	4617	28K	0667	82K5	4689	243K	4733
3K32	4005	9K76	4618	28K7	4653	84K5	4691	249K	4734
3K4	4584	10K	4619	29K4	4654	86K6	4692	255K	4735
3K48	4585	10K2	4621	30K1	4655	88K7	4693	261K	4736
3K57	4586	10K5	0731	30K9	4656	90K9	4694	267K	4737
3K65	4587	10K7	4622	31K6	4657	93K1	4297	274K	4738
3K74	4588	11K	4623	32K4	4658	95K3	0567	280K	4739
3K83	4589	11K3	0668	33K2	0482	97K6	4695	287K	4741
3K92	4591	11K5	4624	34K	4659	100K	4696	294K	4742
4K02	4592	11K8	4625	34K8	4661	102K	4697	301K	4743
	1002		4025	3410	4001	1021	4037	3011	4740
4K12	4593	12K1	0572	35K7	4662	105K	4698	1	
4K22	0729	12K4		l .		1			
4K32		12K7	4626	36K5	0726	107K	4699		
	4594	1	0443	37K4	4663	110K	4701		
4K42	0556	13K	0522	38K3	0483	113K	4702		
4K53	0631	13K3	4627	39K2	4664	115K	4279		
41404									
4K64	0484	13K7	4628	40K2	4665	118K	4703	1	
4K75	4008	14K	4629	41K2	4666	121K	4704	1	
4K87	0509	14K3	4631	42K2	0474	124K	4705	1	
4K99	0523	14K7	4632	43K2	4667	127K	4706	1	
5K11	4595	15K	4001	44K2	4668	130K	4707		
		}							
5K23	4596	15K4	0479	45K3	4669	133K	4708		
5K36	4597	15K8	4633	46K4	0557	137K	4709	1	
5K49	4598	16K2	0593	47K5	4671	140K	4259		
5K62	4011	16K5	4634	48K7	0442	143K	4711		
5K76	4599	16K9	4635						
31170	7000	1010	4033	49K9	0674	147K	4712	1	