PM 5109
Philips

1. GENERAL

1.1. INTRODUCTION

The RC generator 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

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.

Performance characteristics, specifications

Properties expressed in numerical values with stated tolerance are guaranteed by the manufacturer. Specified non-tolerance numerical values indicate those that could be nominally expected from the mean of a range of identical instruments.
This specification is valid after the instrument has warmed up for 30 minutes (reference temperature 23 ^{o}C).
If not stated otherwise, relative or absolute tolerances relate to the set value.

1.2.1. Frequency

frequency range	10 Hz to 100 kHz
sub-ranges	4 sub-ranges, decadal stepped
adjustments	- 4 range pushbuttons; x 10 Hz, x 100 Hz, x 1 kHz, x 10 kHz - dial with half-logarithmic scale
frequency indication	scale on the dial
setting error	< 5 % ± 1 Hz
short-term drift	< 0.05 % within 15 min
long-term drift	< 0.15 % within 7 h
temperature coefficient	< 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

open circuit voltage	all are Vrms voltages
output A	0 to 3.16 V, continuously adjustable
output B	0.1 to 10 V, continuously adjustable
- temperature coefficient	< 0.3 %/K
- step attenuation	0 to 60 dB in steps of 10 dB
--tolerance	< 0.2 dB for all attenuations
open circuit voltage display	analogue meter indication with 10 V, 3.16 V and dB scales
display error	< ±5 % of f.s.d.
range indication	7 LEDs; 0.01 V to 10 V; fixed 3 V LED for output A
signal wave form	
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	< 0.03 %	(300 Hz to 20 kHz)
	< 0.7 %	(20 Hz to 100 kHz)
- FAST SETTLING	0.4...0.6 %	(100 Hz to 100 kHz)
	< 1.5 %	(20 Hz to 100 kHz)
output A, LOW Z		
- LOW DISTORTION, open circuit	< 0.03 %	(300 Hz to 20 kHz)
	< 0.7 %	(20 Hz to 100 kHz)
- LOW DISTORTION, loaded with 4 Ohm	< 0.15 %	(20 Hz to 100 kHz)
- FAST SETTLING, open circuit...4 Ohm	< 0.6 %	(100 Hz to 100 kHz)
output B		
- LOW DISTORTION	< 0.03 %	(300 Hz to 20 kHz)
	< 0.7 %	(10 Hz to 100 kHz)
- FAST SETTLING	0.4...0.6 %	(20 Hz to 100 kHz)
	< 1.5 %	(10 Hz to 100 kHz)

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 -0.5 dB (at 100 kHz) } safety earth con } ted to one windi
	(for details see chapter 3.1.4.)
output A, LOW Z	
- open circuit	<0.2 dB
- load 4 Ohm	<0.5 dB (10 Hz to 10 kHz) -6 dB (at 70 kHz)
output B	<0.2 dB

square wave

duty cycle	50 %
overshoot, ringing, tilt	<2 % (f >20 Hz) <1 % (f >50 Hz)
rise time, fall time	<0.5 µs

1.2.4. TTL output — not for LOW DISTORTION

connection	BNC socket PM 5109: rear side PM 5109S: front side
output signal	inverse of output B
duty cycle	50 %
fan out	20 TTL inputs
level	standard TTL level: high >2.4 V, low< 0.8 V
external voltage	not proof against external voltage >5 V

1.2.5. Power supply — ac mains

reference value	220 V
nominal values	110 V/128 V/220 V/238 V, selectable by solder links
nominal operating range	±10 % of selected nominal value
operating limits	±10 % of selected nominal value
nominal frequency range	50 - 100 Hz
limit range of operation	47.5 - 105 Hz
power consumption	17 W

1. CIRCUIT DESCRIPTION PM 5109

1.1. Oscillator

The frequency determining RC network of the oscillator is a Wien-bridge. The proper in-phase conditions for self-justained oscillations are satisfied at the frequency $f = 1 / 2\pi RC$.

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.

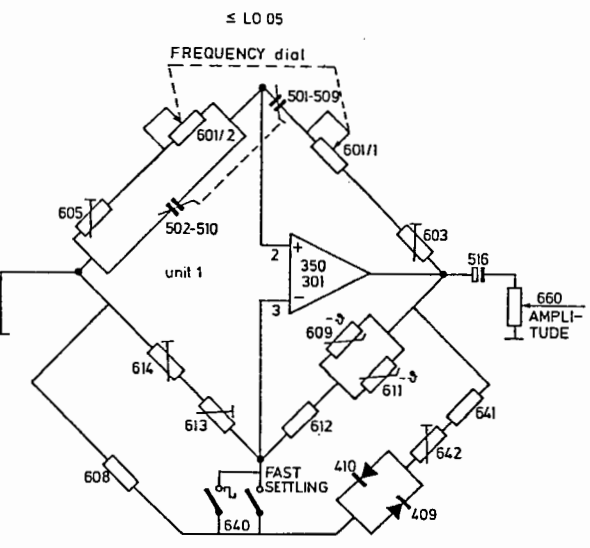
Continuously variable frequency control within the selected range is achieved by the tandem potentiometer 601 (FREQUENCY dial) connected in the series and parallel arms of the bridge circuit. The ranges can be selected by the four FREQUENCY range pushbuttons 801, which select the bridge tuning capacitors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

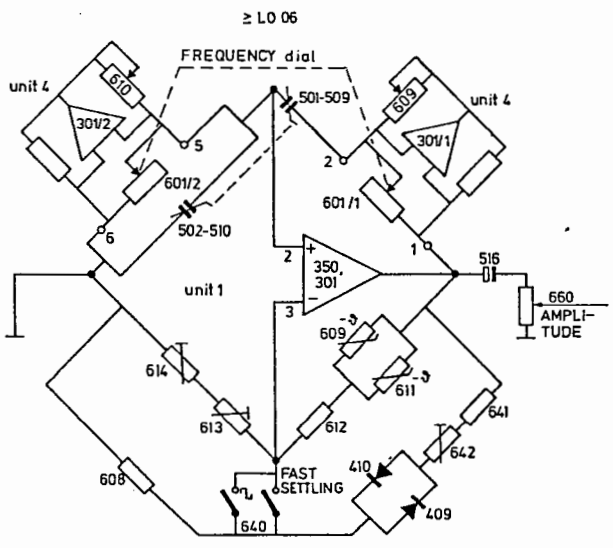
FREQ. RANGE	PUSHBUTTON SWITCH	CAPACITORS
x 10	801/1	501,502
x 100	801/2	503,504
x 1k	801/3	505,506
x 10k	801/4	507//509, 508//510

In instruments until LO 05 the series arm of the bridge circuit consists of range capacitors 501 - 509, frequency potentiometer 601/1 and potmeter 603. The parallel arm of the bridge consists of range capacitors 502 - 510, frequency potentiometer 601/2 and potmeter 605.

Because of too high price and delivery problems the frequency potmeter is replaced by a different one, 601 on the additional unit 4, LO 06 onwards. In combination with IC 301 on unit 4 the potmeter acts as "electronic" potmeter.

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.

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.

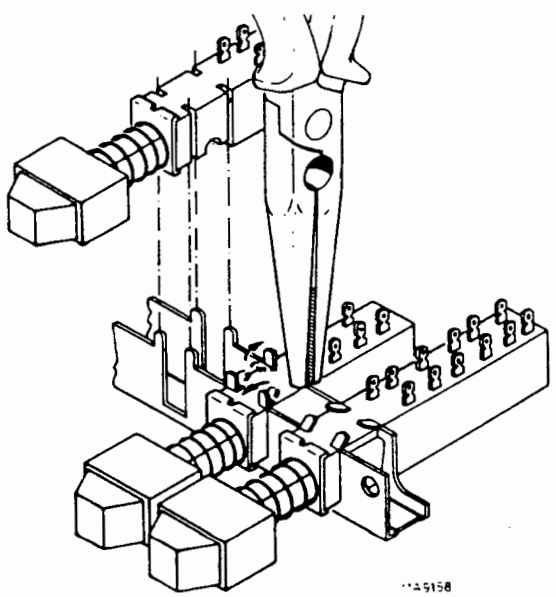
4.2.4. Pushbutton unit

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 ±3)°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 (⊥).

- The following abbreviations are used for seting and measuring instruments:

X	≙	Button pressed
-	≙	Button not pressed/unlocked
rh	≙	extreme right-hand position
lh	≙	extreme left-hand position
Ω	≙	potentiometer setting
o—	≙	outputs unloaded
•—	≙	outputs, terminated with indicated load of 600Ω/50Ω/4Ω with 50Ω, e.g. PM 9585
⊤	≙	keep setting concerned

Vrms,Vdc	≙	Digital multimeter for a.c. (rms) and d.c., e.g. PM 2517
OSC	≙	Oscilloscope, e.g. PM 3226, PM 3207
C	≙	Counter, e.g. PM 6622/02
DA	≙	Distortion analyzer e.g. HP 334A
50Ω	≙	50 Ohm terminating resistor, e.g. PM 9585

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.

4. SAFETY INSPECTION AND TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT

4.1. General directives

- Take care that creepage distances and clearances have not been reduced
- Before soldering, wires:
- should be bent through the holes of solder tags, or wrapped round the tag in the form of an open U, or, wiring ridigity shall be maintained by cable clamps or cable lacing.
- Replace all insulating guards and -plates.

4.2. Safety components

Components in the primary circuit may only be renewed by components selected by Philips, see also chapter 4.5.1.

4.3. Checking the protective earth connection

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/frame. The resistance shall not be more than 0.5 Ω. During measurement the mains cable should be moved. Resistance variations indicate a defect.

4.4. Checking the insulation resistance

Measure the insulation resistance at U = 500 Vdc between the mains connections and the protective lead connections. For this purpose set the mains switch to ON. The insulation resistance shall not be less than 2 MΩ.

Note:
2 MΩ is a minimum requirement at 40 °C and 95 % relative humidity. Under normal conditions the insulation resistance should be much higher (10 to 20 MΩ).

5. SPARE PARTS

5.1. General

Standard parts

Electrical and mechanical parts replacement can be obtained through your local Philips organisation or representative. However, many of the standard electronic components can be obtained from other local suppliers. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

NOTE:
Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.

Special Parts

In addition to the standard electronic components, some special components are used:

- Components, manufactured or selected by Philips to meet specific performance requirements.
- Components which are important for the safety of the instrument, marked with 'S' in the parts list.

ATTENTION:
Both type of components may only be replaced by components obtained through your local Philips organisation.

4.5.2. PARTS LIST PM 5109

Mechanical parts, miscellaneous, parts not on units

Item	Fig./unit	Quantity	Order number	Description	
1		1	5322 447 94324	cover, grey	
1		1	5322 447 90395	cover, brown	
2		4	5322 462 44174	foot (bottom side), grey	
2		4	5322 462 10222	foot (bottom side), brown	
3	36	2	5322 520 34164	bearing bush	
4	36	2	5322 530 84075	spring	
5	36	2	5322 528 34101	ratchet	
6	36	2	5322 532 54425	ring for handle, grey	
6	36	2	5322 532 51481	ring for handle, brown	
7	36	2	5322 498 54048	arm for handle	
8		1	5322 498 54051	carrying handle	
9	36	2	5322 414 64053	knob, grey	
9	36	2	5322 414 30043	knob, brown	
10	38	1	5322 321 14048	mains cable 1850	*S
11	38	1	5322 401 14275	cable clamp	*S
12	38	1	5322 325 64068	lead through	*S
13	38	1	5322 325 60119	pull relief	*S
		1	5322 502 14164	coin-slot screw (rear side)	
		1	4822 530 70124	locking washer (rear side)	
		4	5322 462 44176	foot (rear side)	
803	32	1	5322 276 14393	mains switch	*S
851	32	1	4822 253 30009	fuse 160 mAT	*S
			4822 253 30014	fuse 315 mAT	*S
751	32	1	5322 146 20689	mains transformer	*S
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 54056	insulating disk for BNC connector	
14	37	4	5322 267 34059	terminal grey	*
14	37	4	5322 414 30042	terminal brown	*
14	37	1	5322 267 34058	terminal blue	*
15	37	5	5322 325 24002	feedthrough terminal, grey	*
15	37	5	5322 267 30528	feedthrough terminal, brown	*
16	37	5	5322 532 64081	ring	*
	frontpl.	1	5322 290 30001	conducting link for terminal	*
	rear side	1	5322 267 30424	DIN loudspeaker socket	*
		3	5322 405 94178	print holder	
		1	5322 414 40003	dial, mounted with knob, grey, ≤L003	
		1	5322 414 40034	dial, mounted with knob, brown, L004/05	
		1	5322 414 40037	dial, mounted with knob, brown, ≥L006	
	frontpl.	1	5322 414 74047	locating mark, grey	
	frontpl.	1	5322 414 70044	locating mark, brown	
601	40/42	1	5322 102 34016	wire-wound tandem potm.2x50kOhm, ≤L005	
601	35	1	5322 103 60036	wire-wound tandem potm.2x10kOhm, ≥L006	
660	39-42	1	4822 101 20417	potmeter 22 kOhm/LIN	
		1	5322 414 34075	knob (pos. 660), grey	
		1	5322 414 74031	cap for knob (pos. 660), grey	
		1	5322 414 70032	cap for knob (pos. 660), brown	

*S = safety component
* = PM 5109 only

Item	Fig./ unit	Quan- tity	Order number	Description
		1	5322 414 74042	cap for knob (dial), grey
		1	5322 414 70043	cap for knob (dial), brown
545	37/38	1	5322 121 44028	0.01 MU 2x2N5 250 V, line filter
		3	5322 276 14221	pushb. switch 801/7, 802/1/7
		6	5322 276 14271	- " - 801/1-4, 802/2/3
		2	5322 276 10961	- " - 802/5/6
	32	2	5322 276 10961	- " - 801/5/6
		11	5322 276 80246	- " - 802/4
		11	5322 414 25851	cap for pushbuttons 801/802 grey
		1	5322 414 20033	cap for pushbuttons 801/802 brown
821	unit 3	1	5322 344 60021	voltmeter
			5322 390 24013	silicon paste DC 340

Electrical parts

Some parts are listed in chapter 4.5.2.

TRANSISTORS/U1		
301,304	4822 130 44197	BC558B
302,303,307	4822 130 40937	BC548B
305	5322 130 40417	BSX20
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	5322 130 32031	RECTIFIER SKB2/08/L5
408,409	4822 130 34233	BZX79-C5V1
410-413	5322 130 34321	1N4151
421	4822 130 34047	BZX75-C1V4
422,423	5322 130 34605	BAX12A

Item	Order number	Farad	TOL %/VAL	Volts	Remarks
CAPACITORS/U1					
501,502	5322 121 54171	330NF	1	63	POLYSTYRENE FOIL
503,504	532 121 54111	33NF	1	63	" "
505,506	5322 121 54049	3.3NF	1	63	" "
507	5322 121 54059	220PF	1	500	" "
508	5322 121 54047	270PF	1	500	" "
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

Item	Order number	Farad	TOL %/VAL	Volts	Remarks
513	4822 122 31049	6.8PF	0.25PF	100	CERAMIC PLATE
514	4822 122 31063	22PF	2	100	" "
515	5322 122 30108	100NF	10	50	POLYESTER FOIL
516,520	4822 124 20731	22UF		40	ELECTROLYTIC
517	4822 122 31052	8.2PF	0.25PF	100	CERAMIC PLATE
519	4822 124 20693	220UF		16	ELECTROLYTIC
521	5322 122 31795	22NF		63	CERAMIC PLATE
522	4822 121 41169	220NF	10	250	POLYESTER FOIL
523,524	4822 124 20798	3300UF		40	ELECTROLYTIC
525,526	4822 124 20731	22UF		40	"
527,528	4822 124 20722	1UF		63	"
530	4822 122 31177	470PF	10	100	CERAMIC PLATE
531,532	4822 122 30043	10NF	-20/+80	63	" "
533	4822 124 20673	470UF		6.3d	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

RESISTORS/U1

All metal film resistors not listed are of type MR25 ±1% 0.4W (ordering code see end of this chapter).

ITEM	ORDERING NUMBER	OHM	TOL(%)	TYPE	REMARKS
603,605	4822 100 10037	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	0.25W	NTC
614	4822 100 10254	1K		LIN	POTM.TRIMMING
620	5322 101 14047	470E		LIN	" "
627	4822 100 10019	220E		LIN	" "
642,645	4822 100 10075	100E		LIN	" "
656	4822 100 10036	4.7K		LIN	" "
673	5322 101 14011	100E		LIN	" "
679	4822 100 10079	47K		LIN	" "
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

INTEGRATED CIRCUITS/U4 (U4 LO 06 onwards)

301	4822 209 80921				NE5538N

DIODES/U4

401,402	4822 130 34174				BZX79-B4V7

POTMETERS/U4

609,610	5322 101 14047	470E		LIN	POTM.,CARBON