PHILIPS

INSTRUCTION MANUAL
ANLEITUNG
NOTICE D'EMPLOI ET D'ENTRETIEN

PULSE GENERATOR 1 Hz - 50 MHz
IMPULSGENERATOR 1 Hz - 50 MHz
GENERATEUR D'IMPULSIONS 1 Hz - 50 MHz

PM5712

9446 057 12..1

9499 460 06601

730430

Important

In correspondance concerning this instrument, please quote the type number and the serial numbers as given on the type plate at the rear of the instrument.

Wichtig

Beim Schriftwechsel über dieses Gerät geben Sie bitte die Typennummer und die Serienummer an, die auf dem Typenschild an der Rückseite des Gerätes stehen.

Important

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 fixée à la paroi arrière de l'appareil.
Lorsque l'appareil doit être retourné à notre Dépt. Service pour réparations importantes, il doit être muni d'une étiquette comportant, outre les indications de série et le nom du propriétaire, les renseignements indispensables, concernant les défauts constatés; ceci permet une immobilisation plus réduite de l'appareil et diminue considérablement le prix de revient de la réparation. Emballer l'appareil avec précaution si possible dans son emballage d'origine.

CACHET DU SERVICE TECHNIQUE

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I. Introduction — General information

The PM 5712 generates high-quality pulses between 1 Hz and 50 MHz at a fixed rise time of 4 ns.

Except the general purpose facilities such as variable d.c. offset and pulse inverting possibility, the PM 5712 provides a TTL matched signal from a second output. Square wave pulse generation and a pulse shaping facility extend the application range further.

Testing and simulating TTL circuits (even TTL's with high noise immunity), testing semiconductor devices and coaxial lines are some important applications in which the PM 5712 can be used to good advantage.

II. Technical data

Properties expressed in numerical values with statement of tolerances are guaranteed by the factory. Numerical values without tolerances are intended for information purposes only and indicate the properties of an average instrument. The numerical values hold good for nominal mains voltage.

A. ELECTRICAL

1. Internal triggering

Repetition rate	1 Hz ... 50 MHz. Variable in 8 ranges with continuous control within the ranges
Jitter	$\leqslant$ 0.1 % or 50 ps whichever is greater
Temperature coefficient	$<$ 0.3 %/°C

2. External triggering

Triggering: input voltage	$>$ +1 V to trigger the generator
max. voltage	+12 V
frequency input	0 ... 50 MHz
impedance	approx. 1 kΩ In mode T/2 the pulse duration is determined by the drive input. In mode single or double the delay, double pulse and pulse duration are set by front panel controls.
Synchronous gating: input voltage	$>$ +1 V to gate the generator
impedance	approx. 1 kΩ Gating signal turns generator "off". First pulse coincides with trailing edge of the gating pulse.
Delay from trigger (or gate) input pulse to main pulse output with pulse delay set to 10 ns	approx. 50 ns

3. Single shot operation

Single shot facility by means of push-button

4. Sync. output

Square wave, amplitude +1.5 V into 50 Ω (+3 V open circuit).
Source impedance: 50 Ω
Pulse occurs approx. 40 ns ahead of the main pulse when pulse delay is set to 10 ns.

5. Pulse delay

Range	10 ns ... 100 ms. Variable in 7 ranges with continuous control within the ranges.
Jitter	⩽ 0.1 % or 50 ps whichever is greater
Temperature coefficient	< 0.3 %/°C

6. Pulse duration

Range	10 ns ... 100 ms. Variable in 7 ranges with continuous control within the ranges
Duty cycle	Approaching 100 % using inverted-pulse output (limited only by minimum duration) Greater than 50 % in normal operation.
Jitter	⩽ 0.1 % or 50 ps whichever is greater
Temperature coefficient	< 0.3 %/°C

7. Modes of operation

T/2, single pulse or double pulse.
Double pulse mode provides "twin" pulses at set delay with simultaneously controlled pulse duration.

8. Auxiliary output

Amplitude +2.5 V into 50 Ω (+4.5 V open circuit).
Source impedance: 50 Ω
Pulse occurs approx. 12 ns ahead of main pulse.
Pulse delay and duration are set with the controls delay and duration in all operation modes.
Provides single pulse or double pulse but not T/2 or inverted pulse.

9. Main pulse output

Amplitude	+0.2 V ... +10 V into 50 Ω Variable in 4 ranges, (10 V, 5 V, 1.5 V and 0.5 V) with continuous control within the ranges.
Polarity	Normal or inverted
Source impedance	Position 10 V: current source (max. 200 mA) Positions 5 V, 1.5 V, 0.5 V: internally terminated with 50 Ω
Transition times at 5 V and lower positions	⩽ 4 ns with internal and external 50 Ω terminations.
Waveform aberration	⩽ ±5 % of set amplitude
Protection	Short and open circuit safe

10. D.C. offset

Continuously variable from
+2 V to −5 V into 50 Ω
Pulse amplitude plus d.c.-offset max. +10 V

11. Mains supply

Mains voltage	100 ... 130 V and 200 ... 260 V, switchable 85 ... 115 V and 170 ... 230 V, solderable
Mains frequency	50 ... 400 Hz
Power consumption	70 VA

12. Temperature range

0 ... +40 °C

B. MECHANICAL

Dimensions	Depth	275 mm
	Width	210 mm
	Height	130 mm
Weight	4 kg	

III. Accessories

Standard accessories (supplied with the instrument)

- 1 manual
- 1 mains flex
- fuse 400 mA, delayed action
- fuse 800 mA, delayed action

Optional accessories (to be ordered separately)

Termination, 50 Ω, 3 W	PM 9581
Termination, 50 Ω, 1 W	PM 9585
Mixing piece, 50 Ω	PM 9584
Coaxial cable set, 50 Ω	PM 9588 *)

*) contains following cables, type RG58A/U with BNC connectors:

	Delay	Length (mm)	Separately available under service codenumber
5x	1 ns	200	5322 320 10009
4x	2 ns	400	5322 320 10011
3x	3 ns	600	5322 320 10012
3x	10 ns	1980	5322 320 10013

IV. Block diagram description

Note: figures in brackets refer to the waveforms shown in Fig. IV-1.

Astable multivibrator

The astable multivibrator generates square wave pulses from which all internal pulses are derived.
Switch REPETITION TIME, SK1, and its vernier, R1, enable adjustment of the repetition time between 1 s and 20 ns. The multivibrator is inoperative when switch REPETITION TIME is set to position EXT.

Trigger circuit

In the EXT. mode the pulse generator can be triggered by an external signal applied at connector TRIGG./GATE IN, BU1.
The triggering signal is fed to a Schmitt trigger producing an appropriate signal for the remaining circuits of the generator. With no triggering signal applied, a single pulse is generated by the Schmitt trigger when push-button switch SINGLE SHOT is depressed.

With switch REPETITION TIME set to one of the time positions, the astable multivibrator can be gated by a signal applied at input TRIGG./GATE IN. Bursts of pulses which are synchronized with the gating signal are then obtained.

Gate, sync. amplifier and first pulse shaper

The output of the gate is available at front panel connector SYNC. OUT, BU2. The repetition frequency and the duty cycle of this signal is determined by the astable multivibrator, or, at external operation, by the triggering signal.
The pulse shaper is controlled by the leading edge of the output signal (1) from the gate. The shaper provides a needle pulse (2) which is controlling the delay circuit.

Delay circuit, second pulse shaper and duration circuit

The delay circuit delivers pulses (3) whose width is adjusted with the DELAY control, SK2, and its vernier, R2. The trailing edge of these pulses controls the next pulse shaper which feeds a needle pulse (4) to the duration circuit.
Similar to the delay circuit, the duration circuit produces pulses whose width is set with the DURATION control, SK3, and its vernier, R3.

In the DOUBLE mode, a needle pulse (5) derived from the leading edge of the delay pulse is gated to the input of the duration circuit. Double pulses are then generated.
The output of the duration circuit is available at front panel connector AUX. OUT, BU3. This signal having a fixed amplitude occurs approximately 12 ns ahead of the main signal at front panel connector PULSE OUT, BU4. Normal or inverted mode of the signal at PULSE OUT can be selected with switch NORMAL/INV, SK10.

Switch T/2, SK8

When the T/2 switch, SK8, is depressed, the delay and duration circuits are separated from the output stage. The signal (1) produced by the internal multivibrator, or the Schmitt trigger, is fed directly to the output stage. However, the AUX. OUT connector still provides the signal with adjustable delay and duration.
In the EXT. position of switch REPETITION TIME and with switch T/2 depressed, the triggering signal applied at input TRIGG./GATE IN is fed only through the output stage and is available at connector PULSE OUT with the same repetition time and duty cycle as the original signal, but with a rise time, shape and amplitude in conformance with the specification of the PM 5712.

Output stage, attenuator and d.c.-offset

From switch T/2 the pulses are fed via a differential amplifier to the output stage in which the pulse amplitude can be continuously adjusted with AMPLITUDE vernier R5.
Next, the signal is fed to a resistive attenuator, which is controlled by the AMPLITUDE switches SK11...SK14.

As set with the DC OFFSET control R4, a positive or negative current is added to the output line, thus providing a baseline shift.

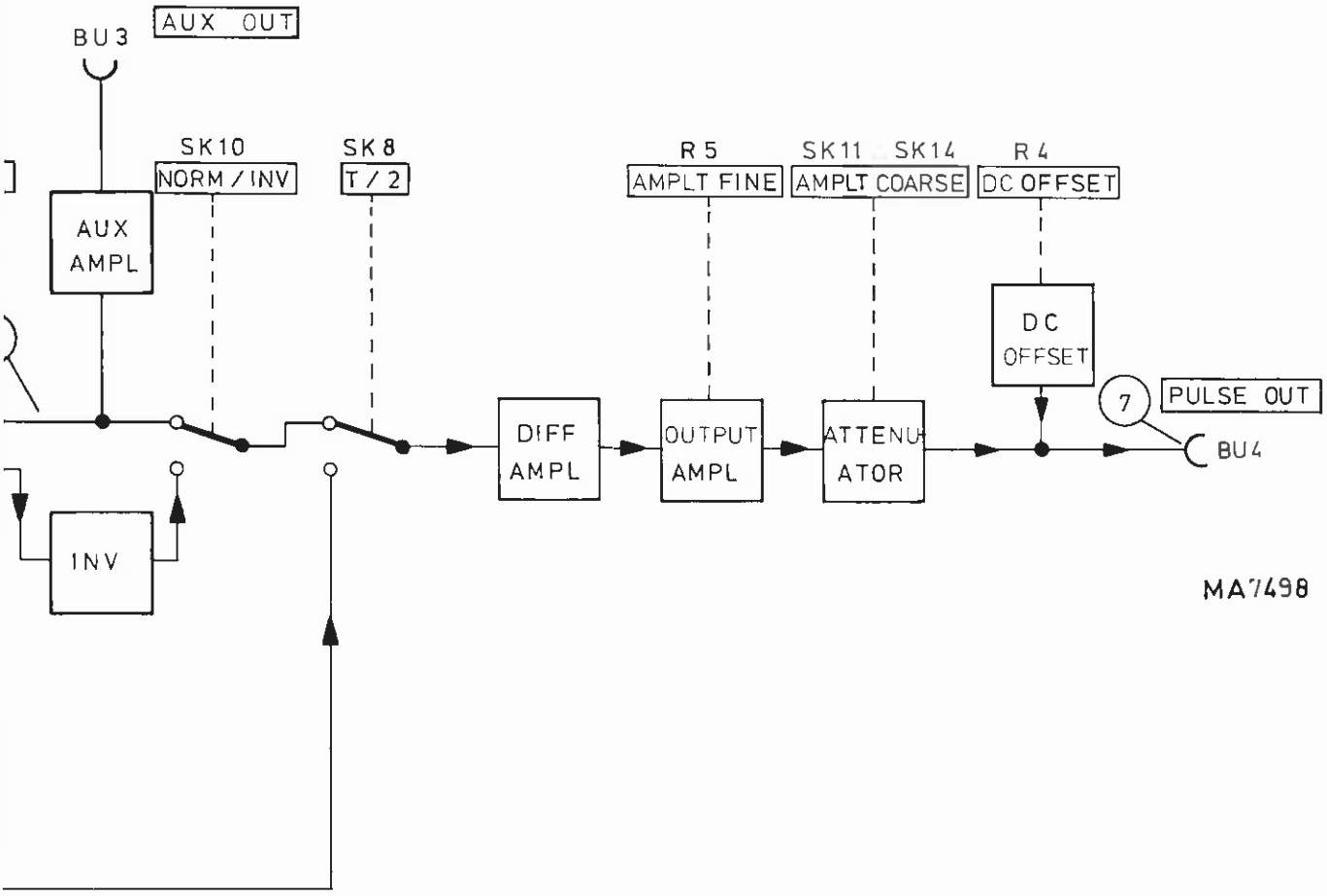

Fig. IV-1. Block diagram

V. Installation

Directions for use

A. SETTING UP

Always place the instrument so that the air circulation through the airvents in the bottom plate and the top cover is not impeded. The ambient temperature should be between 0 °C to +40 °C for operating within the specification.

The handle can be used as a tilting bracket to use the instrument in a sloping system.
To place the handle in its carrying position pull both round plastic covers a little sideways and turn simultaneously the handle in the horizontal position.

B. ADJUSTMENT TO THE LOCAL MAINS VOLTAGE

The mains voltage selector SK21 at the rear of the generator can be set to two ranges:

Position	Voltage range	
110 V	100...130 V	Frequency 50 Hz...400 Hz
220 V	200...260 V	

Two other ranges, 85...115 V and 170...230 V can be achieved by changing the connection of the mains transformer as described in the Service Manual (chapter X).

C. EARTHING

The generator should be earthed according to the local safety regulations. This may be effected as follows:
– Via the 3-core mains flex
– Via the earthing terminal BU22 at the rear panel
Double earth connection should be avoided because they may cause hum!

D. SWITCHING ON

The instrument is switched on by depressing push-button POWER ON, SK15. The indicator lamp in the push-button will then light up.

E. FUSE

For 220 V mains voltage, a 400 mA fuse with delayed action is used. For 110 V, a delayed 800 mA fuse is required.
The fuse is available at the rear panel of the generator.
The fuse-holder can be unscrewed for replacement of the fuse.

F. CONTROLS, INPUT AND OUTPUT CONNECTORS

Control or connector	*Designation*	*Purpose*
SK1	REPETITION TIME	Selection of the repetition time in 8 steps
	EXT	Selection of single shot operation or external triggering
R1	VERNIER	Fine control of repetition time, provides overlap between ranges
SK2	DELAY	Selection of delay time in 7 steps
R2	VERNIER	Fine control of delay time, provides overlap between ranges
SK3	DURATION	Selection of pulse duration in 7 steps
R3	VERNIER	Fine control of duration time, provides overlap between ranges
R4	DC OFFSET	Continuous baseline shift from +2 V to –5 V
SK11 SK12 SK13 SK14	10 V 5 V 1.5 V 0.5 V } AMPLITUDE	Selection of output amplitude
R5	VERNIER	Continuous control of output amplitude. Provides overlap between ranges
SK5	SINGLE SHOT	When SK1 is set to EXT., and no triggering signal is applied to BU1, TRIGG/GATE IN, a single pulse is produced when SK5 is depressed
SK6 SK7	SINGLE DOUBLE }	Selection of single or double pulse
SK8	T/2	Internal operation: Selection of an output pulse train with duty cycle ≈ 50 % External operation: Shaping of the applied triggering signal. Set delay and duration do not influence
SK10	NORM./INV.	Selection of normal or inverted output pulses
SK15	POWER ON	Mains switch
BU1	TRIGG./GATE IN	Accepts triggering or gating signals
BU2	SYNC. OUT	Provides synchronizing signal with fixed amplitude (+1.5 V into 50 Ω) derived from internal square wave source or from triggering signal. Typical risetime 10 ns, fall time 5 ns.
BU3	AUX. OUT	Provides auxiliary signal with fixed amplitude +2.5 V into 50 Ω. Typical risetime 10 ns, falltime 5 ns. Variable repetition time, delay and duration. No inverted pulses
BU4	PULSE OUT	Provides main pulses
BU21 (rear)		Input connector for mains supply
BU22 (rear)		Earthing clamp
SK21 (rear)		Mains voltage selector

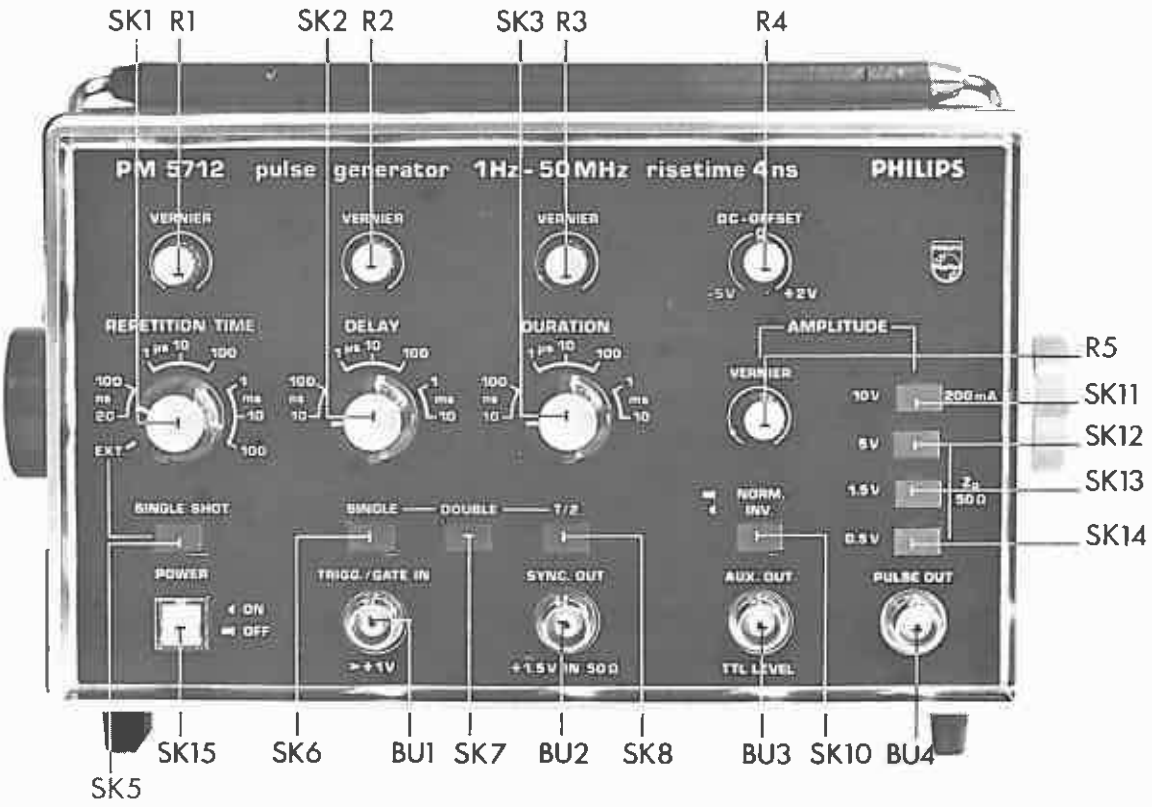

Fig. V-1. Indication of controls, input/output sockets at the front

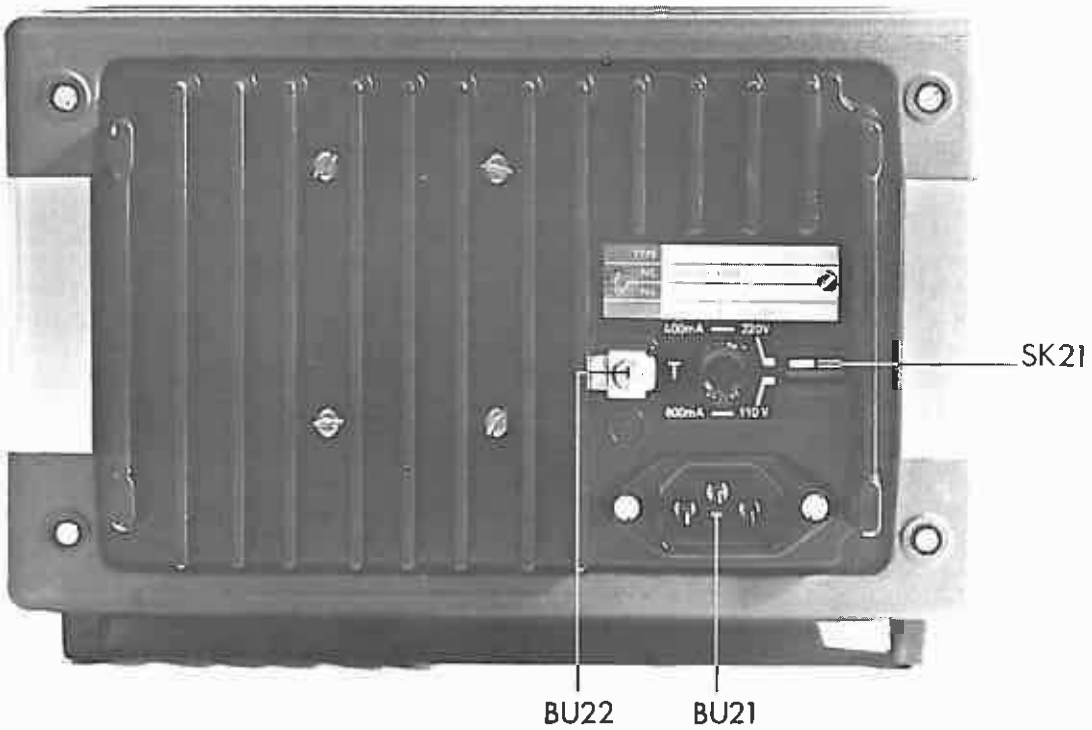

Fig. V-2. Indication of controls, input socket at the rear

VI. Operation

A. GENERAL

When exercising the use of the PM 5712 or employing the generator in practical set-ups it is recommended to use the Philips 200 ps oscilloscope PM 3400 as displaying unit.
This oscilloscope enables error-free presentation of the 4 ns transition time of the PM 5712 and high resolution close-ups of minor pulse details. A conventional oscilloscope with slower rise time can be used, but at the expense of the pulse characteristics.

B. PULSE OUT OUTPUT, AMPLITUDE CONTROL AND DC OFFSET

The PULSE OUT output can stand open circuit and short circuit conditions. In the lowest amplitude ranges, 0.5 V, 1.5 V and 5 V, the output is internally terminated with 50 Ω.
In the 10 V range, a current source provides a maximum current output of 200 mA. Higher current can be taken out, however at the expense of pulse amplitude.
If the device under test is not terminated with 50 Ω, it is recommended to use the Philips 50 Ω terminations PM 9581, 3 W, or PM 9585, 1 W, which are available as optional accessories.

Continuous setting of the pulse amplitude within each of the four ranges is made with the amplitude VERNIER, from 0.2 V to 10 V.
The DC OFFSET control provides a baseline shift from +2 V to −5 V. The control is mechanically locked in the zero position, thus preventing any offset voltage to be introduced by accident.
The total sum of d.c.-offset and pulse amplitude is maximum 10 V.
Consequently, at the highest amplitude position, positive d.c.-offset is added at the expense of pulse amplitude.

C. OUTPUTS AUX. OUT AND SYNC. OUT

Output AUX. OUT provides an auxiliary signal at a fixed amplitude of +2.5 V into a 50 Ω load. A high-ohmic load makes the amplitude increase to maximum +4.5 V at open circuit. The AUX. OUT output is always connected to the delay and duration circuits of the generator, even in the T/2 mode, but remains unaffected by the DC OFFSET and NORM./INV. controls.
The typical rise time of the output pulse is 10 ns; typical fall time is 5 ns. The signal occurs approximately 12 ns before the main signal at the PULSE OUT connector and can be fed directly into TTL circuits.

The output SYNC. OUT is connected to the internal square wave multivibrator or, in the EXT. position, to the trigger circuit.
In the internal mode the signal is a square wave with the set repetition time but unaffected by the set delay, duration or other settings. In the EXT. position, the triggering signal determines the repetition time and duty cycle of the SYNC. OUT signal.
This signal occurs approximately 40 ns before the main signal at the PULSE OUT connector when the DELAY control is set to 10 ns.
The amplitude is fixed to +1.5 V into a 50 Ω load (+3 V open circuit).
Typical rise time is 10 ns; typical fall time is 5 ns.
The signal can be used to trigger external equipment, e.g. an oscilloscope.

D. SINGLE PULSE MODE

Repetition time, pulse delay, and pulse duration are defined in Fig. VI-1, which also shows the relationship between these parameters.

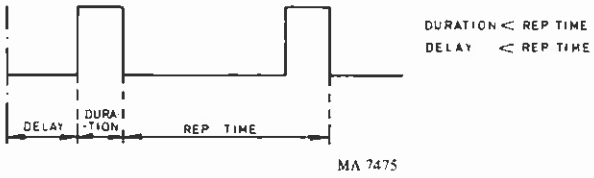

Fig. VI-1. Time setting at single-pulse mode

– Set controls REPETITION TIME and DURATION to the desired value.
– Set control DELAY to 10 ns or to a position required to show the leading edge of the pulse on the oscilloscope.
– Depress push-button switch SINGLE.
– Set the AMPLITUDE switches and vernier to required value.
– Select normal or inverted pulses with switch NORM./INV.

Note that when the verniers of controls REPETITION TIME, DELAY, and DURATION are set to the white dot, the setting approximately corresponds to the value indicated by the switch knob.
The white dot, however, does not coincide with the extreme position of the vernier, thus enabling a sufficient overlap range.

E. DOUBLE PULSE MODE

Proceed as with SINGLE pulse mode, but depress button DOUBLE.
Note, however, the relationship between repetition time, pulse delay and pulse duration shown in Fig. VI-2.
Use the DELAY controls to change the spacing between the twin pulses.

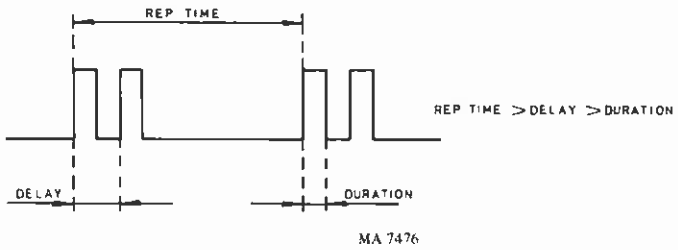

Fig. VI-2. Time setting at double-pulse mode

F. SQUARE-WAVE MODE (T/2)

– Set switch REPETITION TIME to the desired position.
– Depress button T/2.

At the PULSE OUT connector a T/2 square-wave signal is available. Amplitude and d.c.-offset are variable. At the two fastest positions of the REPETITION TIME switch, the duty factor is 50 % ± 20 %.
Note that the output AUX. OUT provides a signal with the same repetition time but with variable delay and duration (Fig. VI-3).

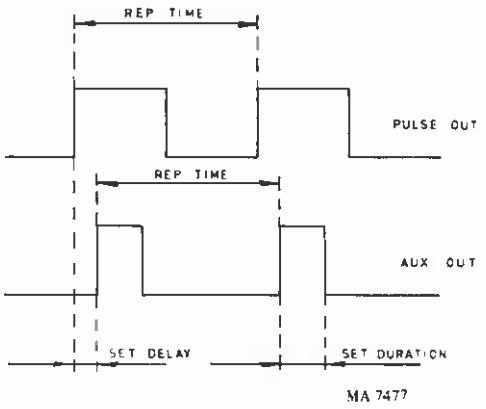

Fig. VI-3. Time setting at T/2-pulse mode

G. GATED SINGLE OR DOUBLE PULSES

Connect the gating signal to input TRIGG/GATE IN. The amplitude of the gating signal should exceed +1 V. Maximum amplitude is +12 V.
The positive-going edge of the gating signal turns the generator off. The generator can be gated both in the single and double pulse mode. Select the proper relationship between repetition time, gating pulse duration, internal pulse delay and duration as described in paragraphs D and E, and as shown in Figs. VI-4 and VI-5.

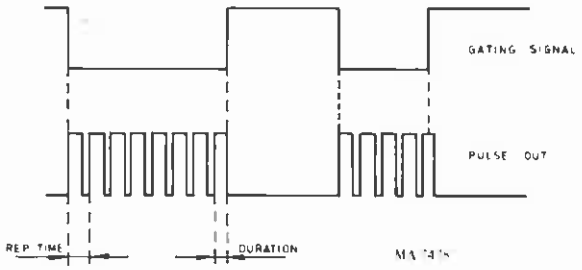

Fig. VI-4. Time setting at gating, single-pulse mode

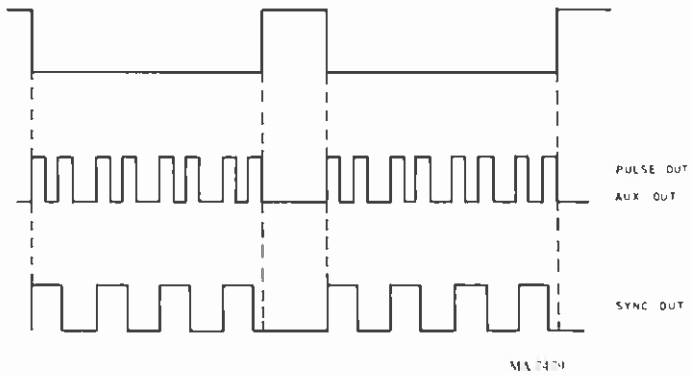

Fig. VI-5. Time setting at gating, double-pulse mode

The gating is synchronous which means that the first pulse coincides with the trailing edge of the gating pulse. The last pulse maintains the set duration even if the gating pulse ends during the pulse.

The overall delay from input TRIGG/GATE IN to output PULSE OUT is approximately 50 ns when switch DELAY is set to 10 ns.

H. EXTERNAL TRIGGERING

– Set switch REPETITION TIME to position EXT.
– Connect a triggering signal with amplitude > +1 V, (max. +12 V) frequency 0 - 50 MHz, to connector TRIGG./GATE IN.
  The internal multivibrator is now inoperative.
– Depress buttons SINGLE or DOUBLE and set DELAY accordingly (See paragraphs D and E).

Outputs PULSE OUT and AUX. OUT provide signals with the same repetition time as the triggering signal but with delay and duration as set with the front panel controls.
The SYNC. OUT output provides a square wave with the same repetition time and duty cycle as the triggering signal.

J. PULSE SHAPING

– Set switch REPETITION TIME to position EXT.
– Apply the signal to be shaped to input TRIGG/GATE IN (amplitude +1 V to +12 V).
– Depress button T/2.
– Select suitable amplitude and d.c.-offset.

The PULSE OUT connector now provides a signal with the same repetition time and duty cycle as the input signal, but shaped (waveform aberration, transition time) according to the generator's specification (Fig. VI-6). Pulse delay and duration can be varied on the signal available at AUX. OUT.

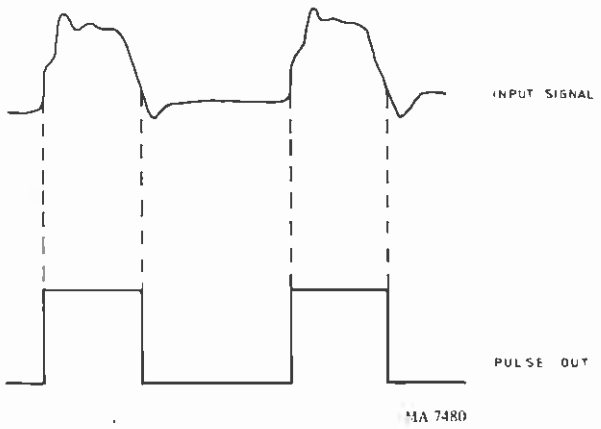

Fig. VI-6. Pulse shaping

K. SINGLE SHOT

– Set switch REPETITION TIME to position EXT.
– Set DURATION and DELAY to desired values.
– Select NORMAL or INVERTED mode, amplitude and d.c.-offset.
– Depress the SINGLE SHOT button.

One and only one pulse is now generated having a duration as set with the front panel controls.
Electronic switching circuits ensure bounce-free switching.
Outputs SYNC. OUT and AUX. OUT also provide the single pulse (Fig. VI-7).
By depressing switch T/2 the delay and duration circuits are disconnected from output PULSE OUT.
The pulse generated remains at PULSE OUT as long as switch SINGLE SHOT is depressed.
The AUX. OUT connector, however, still provides a single pulse whose duration is set with the front panel controls (Fig. VI-8).

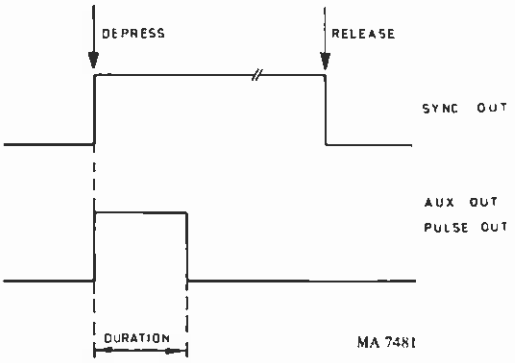

Fig. VI-7. Single shot at single-pulse mode

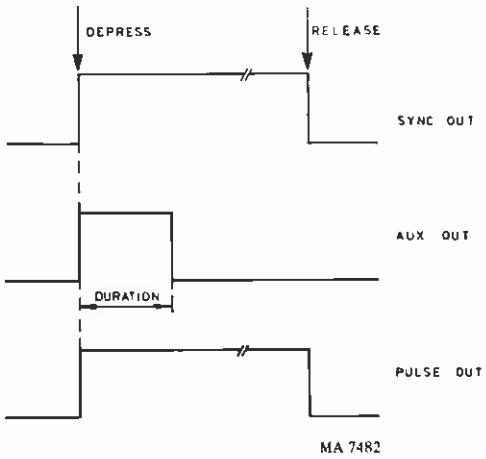

Fig. VI-8. Single shot at T/2-pulse mode

L. NEGATIVE POLARITY OF OUTPUT PULSE

Primarily, the PM 5712 generates a pulse train with positive polarity.
A negative polarity can, however, be simulated by adding a sufficient amount of negative d.c.-offset voltage and using the normal/inverted facility.

The negative baseline shift can be −5 V which means that pulses having an amplitude of 5 V or less can be taken out with negative polarity, see Figs. VI-9 and VI-10.

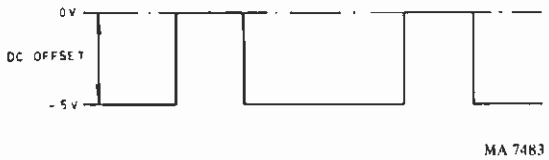

Fig. VI-9.
Simulating 5 V negative inverted pulse.
Generator set to NORMAL, amplitude to 5 V, and DC-OFFSET to −5 V

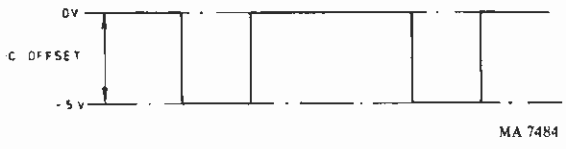

Fig. VI-10.
Simulating 5 V negative normal pulse.
Generator set to INVERTED, amplitude to 5 V, and DC-OFFSET to −5 V

M. DUAL CHANNEL ARRANGEMENT

By combining two PM 5712 a true dual channel generator is achieved.
The one generator can be placed on top of the other to save bench space (Fig. VI-11).

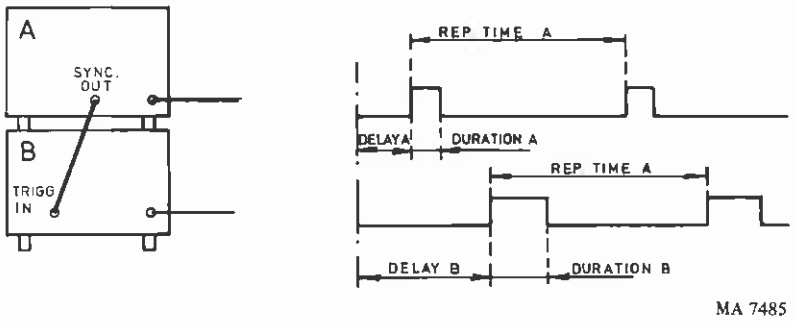

Fig. VI-11. Dual channel arrangement

Set the controls of generator A:

REPETITION TIME > DURATION and DELAY
Connect SYNC. OUT of generator A to TRIGG./GATE IN of generator B.

Set the controls of generator B:

REPETITION TIME to EXT.
Controls DURATION and DELAY to values less than the repetition time of generator A.

The delay and duration of the two pulses A and B can be varied independently as well as selection of single or double pulse mode, amplitude, d.c.-offset, normal or inverted mode.
The repetition time is determined by generator A.

N. MIXING THE OUTPUTS OF TWO GENERATORS

To generate more complex pulse patterns it is feasible to interconnect two PM 5712 and mix their output signals (Fig. VI-12).
The pulse waveform is best preserved by using a resistive 50 Ω T-piece, e.g. Philips type PM 9584. One can also mix the outputs via a normal BNC T-piece if the pulse distortion can be tolerated.
The cables from the outputs should be of equal length and kept as short as possible.

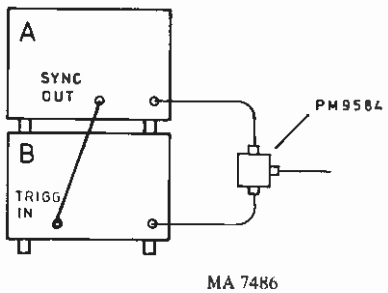

Fig. VI-12. Mixing two outputs

However, because of the direct connection between the outputs of the generators, some precautions as regards amplitude and duty cycle must be taken to avoid damage to the output stage.
Two alternatives are described below.

1. **Mixing when at least one output is at or below 5 V**

   When at least one of the generators is set to 5 V or lower amplitude there is no risk of any damage.

2. **Mixing when both outputs exceed 5 V**

   This combination is **NOT** 100 % open circuit safe.
   If the load is disconnected and the duty cycle exceeds 50 % the output transistors dissipate more power than in normal short-circuit conditions. These three rules, therefore, must be followed:

   1. Make sure that the 50 Ω load is connected **before** the generators are switched on.
   2. Check the time settings so that each generator does not deliver more than 50 % duty cycle. Special care must be taken when switching over from NORMAL to INVERTED. A duty cycle of 30 % in the NORMAL mode becomes 70 % in the INVERTED mode.
   3. Avoid such conditions when pulses overlap eachother. When pulses are of the same polarity, the output stages will be saturated.
      Although harmless, this is no real operating condition.
      If pulses are of opposite polarity (see paragraph L) the output currents cancel each other only at the load.

Service manual

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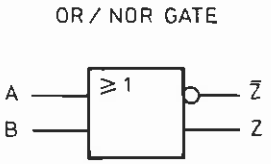
VII. Circuit description

A. TIMING CIRCUIT, UNIT PM 5712-1

Refer to the circuit diagram Fig. XII-2 or Fig. XII-4.

1. Oscillator, Schmitt-trigger and gating circuits

The oscillator consists mainly of transistors TS103, 105, 108 and 109. Its repetition frequency is determined by capacitor network C105, C107 ... C113, which are connected to the oscillator with front panel switch SK1, REPETITION TIME. Continuous setting of the frequency is achieved with constant current generator TS104, TS107, TS106 and TS109, which is operated with front panel control VERNIER, R1.
The output of the oscillator is connected to input terminal 10 of OR/NOR gate IC101, whose second input terminal 9 must be low to enable the signal to pass through (Fig. VII-1).



A	B	Z	Z̄
0	1	1	0
1	1	1	0
1	0	1	0
0	0	0	1

MA7962

Fig. VII-1. Truth table OR/NOR gate

When switch SK1 is set to anyone of the time coefficients, the oscillator is free-running and can only be inhibited by a positive gating pulse applied at connector BU1, TRIGG./GATE IN, or if the SINGLE SHOT push-button, SK5, is depressed. A positive gating pulse affects Schmitt-trigger TS101, TS102 via diodes GR101, GR102.
The Schmitt-trigger produces a positive pulse which cuts off current source TS104 via R111 and GR105. This makes that the oscillator stops because no current is supplied to TS103. When the gating pulse goes negative, the oscillator starts and remains operative until the gating pulse goes positive again.
Similarly, the oscillator will be stopped if the SINGLE SHOT push-button SK5 is depressed. This makes that the −22.5 V supply is disconnected from the diode GR102 causing the Schmitt-trigger to switch and cut off current generator TS104.
In the external triggering mode, switch SK1 occupies the EXT. position which disconnects the timing capacitors C107 ... C113 from the oscillator that stops.
Input terminal 10 of OR/NOR gate IC101 then goes low.
Gate control transistor TS110 starts conducting causing transistor TS111 to be cut off. A triggering signal applied to input BU1 will switch the Schmitt-trigger whose output signal is fed to input terminal 9 of IC101 via diode GR110. Without an external triggering signal, the Schmitt-trigger generates one single pulse when push-button SINGLE SHOT, SK5, is depressed.

2. SYNC. OUT, pulse shaper and interface circuits

NOR gate IC101 provides the oscillator or shaped triggering signal at output terminal 7 and its complementary pulse at output terminal 6.
Both signals are fed to differential amplifier TS112 and TS113, that provides the synchronizing signal available at front panel output SYNC. OUT BU2.

The complementary output terminal 6 feeds a pulse shaper which produces a 5 ns pulse derived from the trailing edge of the pulse.
The signal is fed directly to input terminal 4 of IC101, but is also delayed about 5 ns before it reaches input terminal 5 of the same gate. When both inputs are low during 5 ns, complementary output 3 provides a positive needle pulse which is fed to TS114, as shown in the pulse diagram Fig. VII-2.
At the same time, gate output feeds TS115 with a negative needle pulse. These two transistors serve as an interface circuit between the ECL gate and the following delay circuit. The needle pulse at the collector of TS115 is shown in the oscillogram for testpoint TP103.

3. Delay circuit

The 5 ns pulse from interface transistor TS115 controls the delay circuit, consisting of differential stage TS116, TS117, emitter follower TS119, timing capacitors C123 ... C130, switching diode GR112, and constant current generator TS118.
The positive pulse is applied to the base of TS116 which cuts off TS117. The negative step at the emitter of TS119 is coupled through the timing capacitor selected and keeps TS117 in the non-conductive state and cuts off diode GR112. The current generated by TS118 is set with VERNIER control R2 and will now charge capacitor C123 and one of capacitors C124 ... C130 as set with the DELAY switch SK2.
When the charging level has reached zero, TS117 and GR112 start conducting and TS116 cuts off. The timing capacitors will now discharge through GR112. At the collector of TS117 a pulse occurs, whose duration is determined by the selected value of the timing capacitors (DELAY switch) and the value of the charging current (VERNIER control). This pulse is shown in the oscillogram recorded at testpoint TP104.

4. Pulse shaper, double pulse gating, interface circuits

The "delay" pulse at output terminal 15 of OR/NOR gate IC102 is fed to input terminal 4 of IC102. This pulse is also delayed about 5 ns before it reaches the second input terminal 5 of the same gate.
The output result is a 5 ns pulse at terminals 3 and 2, occurring at the same time as the trailing edge of the "delay pulse" (see pulse diagram Fig. VII-3).

In the DOUBLE mode, that is, when switch SK7 is depressed, a 5 ns pulse derived from the leading edge of the "delay" pulse is produced at the output terminals 6 and 7 of the OR/NOR gate IC103 (see the pulse diagram Fig. VII-3).

In the SINGLE mode, as indicated in the circuit diagram, this gate is inhibited because input terminal 9 of IC103 is permanently high.
In the DOUBLE mode, however, input 9 is low and thus the gate is enabled.
Interface circuit TS120 and TS122 provide the 5 ns pulse controlling the duration circuit. In the DOUBLE mode, interface circuit TS121 and TS123 are also operative.

5. Duration circuit

The principles of function of the duration circuit are the same as for the delay circuit (see paragraph 3.).

TS124, TS125 form the differential amplifier, TS126 is the constant current source charging timing capacitors C138...C145, GR114 is the switching diode discharging the capacitors, and TS127 the emitter follower providing the negative step to TS125 and GR114.

Fig. VII-2. Pulse diagram

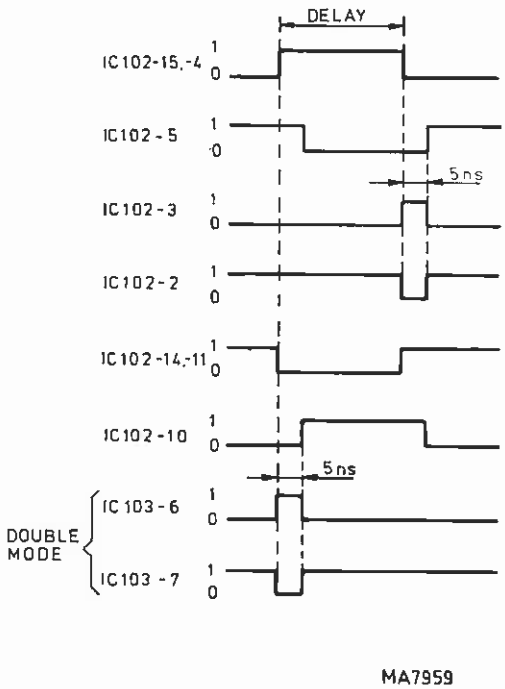


Fig. VII-3. Pulse diagram

6. Auxiliary output, driver stage

The pulse now having a duration as set with the front panel controls is fed to input terminal 5 of OR/NOR gate IC103 which acts as an inverter with one inverted and one non-inverted output.
One of the outputs is selected with the NORMAL/INVERTED switch SK10.

An amplifier network TS128 ... TS131 shapes the signal and provides the TTL matched auxiliary signal available at output BU3, AUX. OUT.

From the NORMAL/INVERTED switch SK10 the signal passes the T/2 switch SK8 to input terminal 13 of OR/NOR gate IC103 whose output terminals 14 and 15 provide the normal and inverted pulse, driving the output stage on unit PM 5712-2.

When switch T/2, SK8 is depressed, the delay and duration circuits are disconnected from the output stage and the oscillator or triggered signal from output terminal 7 of OR/NOR gate IC101 is fed directly to the output stage via the driver.

B. OUTPUT CIRCUIT, UNIT PM 5712-2

Refer to the circuit diagram Fig. XII-6 or Fig. XII-8.

1. Differential amplifiers and amplitude control

Two identical signals with opposite polarity and with set repetition time, delay and duration enter the output circuit at terminals BU206 and BU207. The signals are fed to the inputs of differential amplifier TS201 and TS202.

The next differential amplifier TS203 and TS204 is fed with the collector signal of TS201 and a reference level obtained from the difference between the both collector signals at TS201 and TS202.

The TS203 - TS204 configuration is controlled by constant current source TS206 and emitter follower TS205. The voltage indications around TS205 and TS206 apply when the amplitude VERNIER, R5, is set to maximum amplitude. When the vernier is set to a lower amplitude position, the emitter voltage of TS205 is decreased, and the current supply from TS206 is also reduced.
The pulse amplitude at the collector of TS204 is then decreased but the baseline level is maintained.

2. Driver and output stage

The output of the differential amplifier is fed to emitter follower TS207 which in turn feeds two transistors, TS208 and TS209, that provide the drive current for the both output transistors TS210 and TS211.

These transistors supply the signal to the front panel connector PULSE OUT, BU4. A trimming capacitor C206 in the emitter circuit of TS209 sets the pulse shape. The pulse amplitude can be preset with trimmer R230 that is biasing emitter follower TS212.

In the 10 V position of the attenuator switch AMPLITUDE, that is, when switch SK11 is depressed, the output signal is fed directly to the PULSE OUT connector BU4. The output line is then not terminated with 50 ohm, but can be considered as a current source output of maximum 200 mA. In the remaining amplitude positions, the signal passes a resistive attenuator network, providing a 50 ohm output impedance.

3. DC offset

A baseline offset from +2.5 V to −5 V can be introduced by adding a positive or negative current to the output line via L201.
This function is performed by transistors TS213 ... TS216, those are controlled with front panel potentiometer DC OFFSET, R4, being connected between the +22.5 V and −22.5 V supply.
In the 10 V position, the offset current is reduced by one half, because switch SK11 connects resistor R247 in series with R246.

C. POWER SUPPLY, UNIT PM 5712/15-3

Refer to the circuit diagram Fig. XII-10 or Fig. XII-12.

This unit provides three stabilized and overload protected supply voltages: +22.5 V, +6 V, and −22.5 V.

The +22.5 V, that is presettable with potentiometer R313, also serves as the reference voltage for the other two stabilizing circuits. Since the principles of function are the same for all three circuits, only the +22.5 V portion will be described here.

The raw d.c. voltage from rectifier bridge GR301 is fed to the collectors of series regulator TS302 and its current driver TS301.

Operational amplifier IC301 controls the current driver TS301 via zener diode GR304. Zener diode GR305 provides the reference voltage for the operational amplifier, which senses and counteracts the variations of the supply voltage.

Overload and short-circuit protection is achieved with resistor R308 and transistor TS305, that is normally cut off. An increased load current will increase the voltage drop across R308 and bias TS305 into conduction. This will reduce the current output of series regulator TS302.

VIII. Replacing parts

A. COVER PLATES

The top and bottom covers are secured to the rear panel with 2 screws each. Remove the screws and pull up the cover.

B. KNOBS AND PUSH-BUTTONS

1. Knobs

1. Pull out cap of knob.
2. Loosen nut and pull off knob.
3. When fitting the knob, ensure that the white indications are positioned as before removal.

2. Push-buttons

1. Pull out the button using a pair of pliers.

C. HANDLE

1. Remove the two screws securing the handle caps to the side strips.
2. Remove handle caps and pull out handle.

D. TEXT PLATE ASSEMBLY

1. Remove top and bottom covers.
2. Remove all knobs.
3. Snap off text plate together with ornamental frame.

E. PRINTED-CIRCUIT CARDS

1. Unit PM 5712-1

1. Loosen unit PM 5712-2 (refer to 2. steps 1 and 3).
2. Remove all fast-on connections.
3. Loosen flexible card PM 5712-4 from connector.
4. Remove knobs and text plate assembly.
5. Remove nuts securing rotary switches to front panel.
6. Remove screws securing side profiles to front panel.
7. Pull up front panel and take out circuit card.

2. Unit PM 5712-2

1. Remove 2 screws securing card to rear panel.
2. Remove 1 screw securing card to front panel.
3. Loosen card from connector on unit PM 5712-1.
4. Pull up and take out the card.

3. Unit PM 5712-3

1. Remove handle and its bearing bushes.
2. Remove both ornamental strips covering the side profiles.
3. Loosen 2 screws securing unit PM 5712-2 to rear panel.
4. Remove fast-on connections between units PM 5712-3 and PM 5712-2.
5. Remove screws securing rear panel to side profiles.
6. Pull rear panel backwards.

7. Remove the screws fixing the three power transistors TS302 ... TS304 to rear panel.
8. Remove 4 screws securing card to rear panel and take out card.

F. OUTPUT TRANSISTORS TS210-TS211 ON UNIT PM 5712-2

Note: These transistors are placed in lead spring sockets.
No soldering is required!

1. Remove circuit card PM 5712-2 (refer to E.2.).
2. Loosen screw and remove leaf spring.
3. Pull up transistors using a pair of pliers.

G. IC's 101, 102, 103 ON UNIT PM 5712-1

1. Remove the top portion of the IC housing using a cutter.
2. Remove the bottom portion until the leads of the IC remains.
3. Unsolder the leads one by one.

H. FRONT PANEL POTENTIOMETERS R1 ... R5

1. Remove text plate assembly (refer to D).
2. Remove nuts securing potentiometers to front panel.
3. Disconnect the flexible card PM 5712-4 and take out the assembly.
4. Unsolder potentiometer to be replaced. Avoid excessive heating.

J. PUSH-BUTTON SWITCHES

1. SK6 ... SK10 (unit PM 5712-1)

1. Remove push-buttons.
2. Slightly bend 4 tags securing switch to rail (Fig. VIII-1).
3. Unsolder switch and remove from card.

2. SK11 ... SK14 (unit PM 5712-2)

1. Remove circuit card PM 5712-2 (refer to E.2.).
2. Proceed as in J.1., steps 2 and 3.

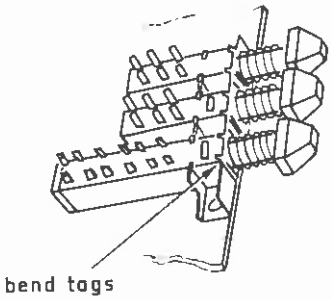


Fig. VIII-1. Removing push-button switches

K. ROTARY SWITCHES SK1 ... SK3

1. Remove circuit card PM 5712-1 (refer to E.1.).
2. Break connection pins of switch to be replaced.
3. Unsolder pins one by one at the soldering side of the card.

Note: Use a sucking device. Avoid excessive heating.

L. MAINS TRANSFORMER

1. Unsolder green wire at contact 13 of transformer.
2. Remove 4 screws securing transformer to rear panel.
3. Pull out transformer and unsolder remaining connections.

M. LAMP IN MAINS SWITCH

1. Cut lamp leads.
2. Pull out lamp.
3. Remove push-button.
4. Install a new lamp. Ensure that the lamp protrudes about 3 mm from front panel.

N. MAINS SWITCH

Instruments of version —/01 and some of version —/02 are provided with a single-pole mains switch.
The Central Service Department however, delivers a mains switch of the double-breaking type as spare part.
It is therefore necessary to change the wiring of the mains switch when replacing it in the above-mentioned versions.
The wiring diagram is shown in Fig. XII-16.

IX. Calibration

A. SURVEY OF CALIBRATION POINTS AND REQUIRED TEST INSTRUMENTS

Calibration point	*Calibration*	*Refer to paragraph*	*Test instruments and devices*
R313	+22.5 V	B	Digital voltmeter, PM 2421
R502	Start oscillator	C	
C206	Pulse shape	D	Sampling oscilloscope, PM 3400
R230	Pulse amplitude	D	20 dB attenuator, 50 Ω

B. POWER SUPPLY, UNIT PM 5712/15-3

1. General

Allow the PM 5712 to warm up for at least 10 minutes before calibrating. The voltages mentioned apply at nominal mains voltage.

2. Equipment required

Digital voltmeter, e.g. PHILIPS PM 2421.

3. +22.5 V

1. Connect the DVM to terminal BU309 on the power supply unit PM 5712/15-3.
2. Set the trimmer R313 until the DVM reads +22.5 V ±1 %.
3. Check that the voltage at terminal BU307 is −22.5 V ±1 %.
4. Check that the voltage at terminal BU310 is +6 V ±1 %.

C. TIMING CIRCUIT, UNIT PM 5712-1

1. Equipment required

- Sampling oscilloscope, e.g. PHILIPS PM 3400
- 50 ohm attenuator, 20 dB

2. Oscillator

1. Set the PM 5712 controls as follows:
   REP TIME 20 ns
   VERNIER fully clockwise
2. Connect the SYNC. OUT output to the oscilloscope via 20 dB attenuator.
3. Set trimmer R502 on unit PM 5712-1 until the oscillator runs properly.
4. Rotate the rep time VERNIER fully counter-clockwise.
5. Check that the oscillator runs properly. If not, readjust R502 and repeat steps 3 through 5.

D. OUTPUT CIRCUIT, PM 5712-2

1. Equipment required

- Sampling oscilloscope, e.g. PHILIPS PM 3400
- 50 ohm attenuator, 20 dB

2. Pulse shape

1. Set the controls of the PM 5712 as follows:
   REP TIME 1 μs
   VERNIER fully counter-clockwise
   T/2 mode

DC OFFSET 0 V
AMPLITUDE fully clockwise

2. Connect the PULSE OUT output to the oscilloscope via 20 dB attenuator.
3. Set trimming capacitor C206 until output pulse shows no overshoot or rounding (refer to Fig. IX-1).

3. Pulse amplitude

1. Set the PM 5712 controls as described in paragraph D.2.1.
2. Set R230 until pulse amplitude is 5.2 V.
3. Check the pulse shape and repeat, if necessary, step D.2.3.

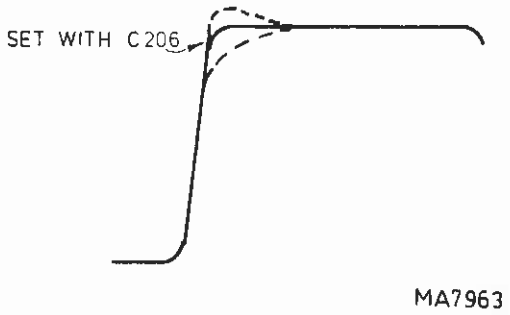


Fig. IX-1. Pulse adjustment

X. Mains transformer connection for 100 V or 200 V mains supply

1. Move wire from contact 1 to contact 2 of mains transformer.
2. Move wire from contact 6 to contact 5 of mains transformer.

Mains supply 100 V: set voltage selector SK21 to **110 V** (fuse 800 mA)
Mains supply 200 V: set voltage selector SK21 to **220 V** (fuse 400 mA)

This parts list does not contain multi-purpose and standard parts. These components are indicated in the circuit diagram by means of identification marks. The specification can be derived from the survey below.

Diese Ersatzteilliste enthält keine Universal- und Standard-Teile. Diese sind im jeweiligen Prinzipschaltbild mit Kennzeichnungen versehen. Die Spezifikation kann aus nachstehender Übersicht abgeleitet werden.

In deze stuklijst zijn geen universele en standaardonderdelen opgenomen. Deze componenten zijn in het principeschema met een merkteken aangegeven. De specificatie van deze merktekens is hieronder vermeld.

La présente liste ne contient pas des pièces universelles et standard. Celles-ci ont été repérées dans le schéma de principe. Leurs specifications sont indiquées ci-dessous.

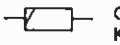
Esta lista de componentes no comprende componentes universales ni standard. Estos componentes están provistos en el esquema de principio de una marca. El significado de estas marcas se indica a continuación.

Carbon resistor E24 series
Kohleschichtwiderstand, Reihe E24
Koolweerstand E24 reeks
Résistance au carbone, série E24
Resistencia de carbón, serie E24
0,125 W 5%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
1 W ≦ 2,2 MΩ, 5%
> 2,2 MΩ, 10%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
0,25 W ≦ 1 MΩ, 5%
> 1 MΩ, 10%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
2 W 5%



Carbon resistor E24 series
Kohleschichtwiderstand, Reihe E24
Koolweerstand E24 reeks
Résistance au carbone, série E24
Resistencia de carbón, serie E24
0,5 W ≦ 5 MΩ, 1%
> 5 ≦ 10 MΩ, 2%
> 10 MΩ, 5%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
0,4 – 1,8 W 0,5%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
0,5 W ≦ 1,5MΩ, 5%
> 1,5MΩ, 10%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
5,5 W ≦ 200 Ω, 10%
> 200 Ω, 5%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
10 W 5%

Tubular ceramic capacitor
Rohrkondensator
Keramische kondensator, buistype
Condensateur céramique tubulaire
Condensador cerámico tubular
500 V

Polyester capacitor
Polyesterkondensator
Polyesterkondensator
Condensateur au polyester
Condensador polyester
400 V

Tubular ceramic capacitor
Rohrkondensator
Keramische kondensator, buistype
Condensateur céramique tubulaire
Condensador cerámico tubular
700 V

Flat-foil polyester capacitor
Miniatur-Polyesterkondensator (flach)
Platte miniatuur polyesterkondensator
Condensateur au polyester, type plat
Condensador polyester, tipo de placas planas
250 V

Ceramic capacitor, "pin-up"
Keramikkondensator "Pin-up" (Perltyp)
Keramische kondensator "Pin-up" type
Condensateur céramique, type perle
Condensador cerámico, versión "colgable"
500 V

Paper capacitor
Papierkondensator
Papierkondensator
Condensateur au papier
Condensador de papel
1000 V

"Microplate" ceramic capacitor
Miniatur-Scheibenkondensator
"Microplate" keramische kondensator
Condensateur céramique "microplate"
Condensador cerámico "microplaca"
30 V

Wire-wound trimmer
Drahttrimmer
Draadgewonden trimmer
Trimmer à fil
Trimmer bobinado

Mica capacitor
Glimmerkondensator
Micakondensator
Condensateur au mica
Condensador de mica
500 V

Tubular ceramic trimmer
Rohrtrimmer
Buisvormige keramische trimmer
Trimmer céramique tubulaire
Trimmer cerámico tubular

For multi-purpose and standard parts, please see PHILIPS' Service Catalogue.
Für die Universal- und Standard-Teile siehe den PHILIPS Service-Katalog.
Voor universele en standaardonderdelen raadplege men de PHILIPS Service Catalogus.
Pour les pièces universelles et standard veuillez consulter le Catalogue Service PHILIPS.
Para piezas universales y standard consulte el Catálogo de Servicio PHILIPS.

B. ELECTRICAL

Capacitors

No.	*Ordering number*	*Value*	*Voltage (V)*	*Tolerance (%)*	*Description*
C1, C2	4822 121 20067	5 nF	–	–	
C101	4822 124 20362	22 µF	25	–	Electrolytic
C102	4822 122 30022	22 pF	–	2	Ceramic
C103	5322 121 40323	0.1 µF	100	–	Polyester
C104	4822 122 30043	10 nF	40	–	Ceramic
C105	4822 122 30013	39 pF	–	2	Ceramic
C107	5322 121 50029	220 pF	500	1	Polystyrene
C108	4822 121 50389	3.3 nF	63	–	Polystyrene
C109	4822 121 40054	33 nF	250	–	Polyester
C110	5322 124 14026	0.33 µF	35	10	Electrolytic (Roederstein ETR-1)
C111	5322 124 14052	3.3 µF	16	10	Electrolytic (Roederstein ETR-1)
C112	5322 124 14053	33 µF	10	10	Electrolytic (Roederstein ETR-3)
C113	5322 124 14054	330 µF	6.3	10	Electrolytic (Roederstein ETR-5)
C115, C116	5322 121 40323	0.1 µF	100	–	Polyester
C117	4822 122 30006	10 pF		2	Ceramic
C118	5322 121 40323	0.1 µF	100	–	Polyester
C119	4822 122 30019	3.3 pF	–	2	Ceramic
C120, C121	4822 122 30043	10 nF	40	–	Ceramic
C122	5322 121 40323	0.1 µF	100	–	Polyester
C123	4822 122 31076	68 pF	–	2	Ceramic
C124	4822 122 30006	10 pF	–	2	Ceramic
C125	5322 121 50367	680 pF	125	–	Polystyrene
C126	4822 121 50442	6.8 nF	63	–	Polystyrene
C127	4822 121 40057	68 nF	100	–	Polyester
C128	5322 124 14039	0.68 µF	35	10	Electrolytic (Roederstein ETR-1)
C129	5322 124 14055	6.8 µF	6.3	10	Electrolytic (Roederstein ETR-1)
C130	5322 124 14056	68 µF	16	10	Electrolytic (Roederstein ETR-4)
C131, C132	5322 121 40323	0.1 µF	100	–	Polyester
C133	4822 122 30006	10 pF	–	10	Ceramic
C134	4822 122 30019	3.3 pF	–	2	Ceramic
C135, C136	4822 122 30043	10 nF	40	–	Ceramic
C138	4822 122 31076	68 pF	–	2	Ceramic
C139	4822 122 30006	10 pF	–	2	Ceramic
C140	5322 121 50367	680 pF	125	–	Polystyrene
C141	4822 121 50442	6.8 nF	63	–	Polystyrene
C142	4822 121 40057	68 nF	100	–	Polyester
C143	5322 124 14039	0.68 µF	35	10	Electrolytic (Roederstein ETR-1)
C144	5322 124 14055	6.8 µF	6.3	10	Electrolytic (Roederstein ETR-1)
C145	5322 124 14056	68 µF	16	10	Electrolytic (Roederstein ETR-4)
C146	5322 121 40323	0.1 µF	100	–	Polyester
C147, C148	5322 121 40323	0.1 µF	100	–	Polyester
C149	4822 124 20575	100 µF	25	–	Electrolytic
C150	4822 124 20573	220 µF	10	–	Electrolytic
C151	4822 124 20575	100 µF	25	–	Electrolytic
C152	5322 121 40323	0.1 µF	100	–	Polyester
C153	4822 122 31058	15 pF	–	2	Ceramic
C154, C155, C156	4822 122 30043	10 nF	40	–	Ceramic

No.	Ordering number	Value	Voltage (V)	Tolerance (%)	Description
C157	4822 122 30043	10 nF	40	–	Ceramic, from version –/03
C158	4822 122 30043	10 nF	40	–	Ceramic, from version –/03
C201, C202	5322 121 40323	0.1 µF	100	–	Polyester
C203	4822 122 30043	10 nF	40	–	Ceramic
C204, C205	5322 121 40323	0.1 µF	100	–	Polyester
C206	5322 125 50051	2...18 pF	–	–	Trimmer
C207	4822 122 30006	10 pF	–	2	Ceramic
C208	5322 121 40323	0.1 µF	100	–	Polyester
C209	4822 124 20575	100 µF	25	–	Electrolytic
C210	4822 122 30016	33 pF	–	2	Ceramic
C211, C212	4822 122 30043	10 nF	40	–	Ceramic
C213, C214	5322 121 40323	0.1 µF	100	–	Polyester
C215, C216	4822 124 20362	22 µF	25	–	Electrolytic
C217	4822 124 20575	100 µF	25	–	Electrolytic
C301	4822 124 70215	1000 µF	63	–	Electrolytic
C302	4822 124 20419	1000 µF	25	–	Electrolytic
C303	4822 124 70215	1000 µF	63	–	Electrolytic
C304	4822 124 20396	220 µF	63	–	Electrolytic
C307	4822 122 30043	10 nF	100	–	Ceramic
C308	5322 121 40323	0.1 µF	100	–	Polyester
C310	5322 121 40323	0.1 µF	100	–	Polyester
C311, C312 C313	4822 122 30043	10 nF	100	–	Ceramic
C314	4822 124 20468	33 µF	16	–	Electrolytic

Resistors

No.	Ordering number	Value (Ω)	Tolerance (%)	Description
R1, R2, R3 R4, R5	5322 101 24029	5 k	20	Potentiometer lin. (Allen Bradley, type 70A1 G056 R5024)
R114	5322 116 54001	15 k	1	Metal film
R115	5322 116 50781	1.82 k	1	Metal film
R116	5322 116 54286	1.21 k	1	Metal film
R117	5322 116 54011	5.62 k	1	Metal film
R118	5322 116 50752	1.5 k	1	Metal film
R124	5322 116 50752	1.5 k	1	Metal film
R125	5322 116 54292	1.69 k	1	Metal film
R128	5322 116 50752	1.5 k	1	Metal film
R134	5322 116 54082	13	1	Metal film
R144	5322 116 50417	162	1	Metal film from version –/03
R146	5322 116 54002	221	1	Metal film
R148	5322 116 50752	1.5 k	1	Metal film
R152	5322 116 54001	15 k	1	Metal film
R154	5322 116 50842	1.1 k	1	Metal film
R155	5322 116 54748	1.2 k	5	Metal film
R167	5322 116 50417	162	1	Metal film from version –/03
R168	5322 116 54002	221	1	Metal film
R170	5322 116 50752	1.5 k	1	Metal film
R174	5322 116 54001	15 k	1	Metal film
R176	5322 116 50842	1.1 k	1	Metal film
R177	5322 116 54748	1.2 k	5	Metal film
R179	5322 116 50863	9.09 k	1	Metal film
R181	5322 116 50757	51.1	1	Metal film

No.	Ordering number	Value (Ω)	Tolerance (%)	Description	
R183	5322 116 50762	5.11 k	1	Metal film	
R199	5322 116 54269	20 k	1	Metal film	versions —/01 and —/02 only
R199	5322 116 50522	13.0 k	1	Metal film	from version —/03
R213	5322 116 54397	56	5	Metal film	
R214	5322 116 50603	357	1	Metal film	
R215	5322 116 54393	150	5	Metal film	
R216	5322 116 50781	1.82 k	1	Metal film	versions —/01 and —/02 only
R216	5322 116 50629	1.74 k	1	Metal film	from version —/03
R217	5322 116 50949	1.62 k	1	Metal film	
R219, R220	5322 116 54004	2.43 k	1	Metal film	
R221	5322 116 54398	680	5	Metal film	
R222	5322 116 50689	511	1	Metal film	
R225, R226	5322 116 54391	33.2	1	Metal film	
R227	5322 116 50974	432	1	Metal film	
R230	5322 101 14049	470	5	Potentiometer	
R231	5322 116 54395	330	5	Metal film	
R233, R234 R235, R236	5322 116 54392	100	5	Metal film	
R239, R240	5322 116 54392	100	5	Metal film	
R241	5322 116 54396	68	5	Metal film	
R242	5322 116 54397	56	5	Metal film	
R243	5322 116 54393	150	5	Metal film	
R245	5322 116 50659	511	1	Metal film	
R246, R247	5322 116 50417	162	1	Metal film	versions —/01 and —/02 only
R246, R247	5322 116 54462	82.5	1	Metal film	from version —/03
R248, R249	5322 116 54392	100	5	Metal film	
R251	5322 116 50545	475	1	Metal film	
R252	5322 116 50608	6.19 k	1	Metal film	versions —/01 and —/02 only
R252	5322 116 50572	12.1 k		Metal film	from version —/03
R253	5322 116 54064	2 k	1	Metal film	
R308	5322 113 44131	1.6	10	Wire wound	
R309	5322 113 60082	0.62	10	Wire wound	
R310	5322 113 44131	1.6	10	Wire wound	
R312	5322 116 50979	8.25 k	1	Metal film	
R313	5322 101 14047	470	20	Potentiometer	
R314	5322 116 54171	2.21 k	1	Metal film	
R315	5322 116 54191	30.1 k	1	Metal film	
R316	5322 116 51056	11 k	1	Metal film	
R317, R318	5322 116 54148	9.09 k	1	Metal film	
R502	5322 101 14048	47 k	20	Potentiometer	versions —/01 and —/02 only
R502	5322 100 10118	22 k	20	Potentiometer	from version —/03
R504	4822 116 40007	3-20 k		PTC thermistor	

Diodes

No.	*Type*	*Ordering number*	*Remarks*
GR101, GR102, GR103 GR104, GR105	BAX13	5322 130 40182	
GR106, GR107	BA220	5322 130 34221	
GR108	BAX13	5322 130 40182	
GR109	FD777	5322 130 34045	Fairchild
GR110, GR111	BAX13	5322 130 40182	
GR112	FD777	5322 130 34045	Fairchild
GR113	BAX13	5322 130 40182	
GR114	FD777	5322 130 34045	Fairchild
GR115, GR116	BAX13	5322 130 40182	
GR201	BZX79-C4V1	5322 130 30773	Zener
GR301, GR302, GR303	BY164	5322 130 30414	Rectifier diode
GR304, GR305	BZX79-C5V1	5322 130 30767	Zener

Transistors

No.	*Type*	*Ordering number*	*Remarks*
TS101, TS102, TS103	BFX89	5322 130 40542	
TS104	MPSL08	5322 130 44215	Fairchild
TS105	BFX89	5322 130 40542	
TS106	2N2369*	5322 130 40407	
TS107	MPSL08	5322 130 44215	Fairchild
TS108	BFX89	5322 130 40542	
TS109	2N2369*	5322 130 40407	
TS110	BC177	4822 130 40522	
TS111, TS112, TS113 TS114, TS115	MPSL08	5322 130 44215	Fairchild
TS116, TS117	BFX89	5322 130 40542	
TS118	BC177	4822 130 40522	
TS119	BFX89	5322 130 40542	
TS120, TS121 TS122, TS123	MPSL08	5322 130 44215	Fairchild
TS124, TS125	BFX89	5322 130 40542	
TS126	BC177	4822 130 40522	
TS127	BFX89	5322 130 40542	
TS128, TS129 TS130, TS131	MPSL08	5322 130 44215	Fairchild
TS201, TS202	2N2369	5322 130 40407	
TS203, TS204	BFW30	5322 130 40379	
TS205	2N2905A	5322 130 40468	
TS206	BC109C	5322 130 40144	
TS207, TS208, TS209	BFW16A	5322 130 44015	
TS210, TS211	2N5160	5322 130 44136	
TS212	2N2219	5322 130 40496	
TS213	BD132	5322 130 40753	
TS214	BC109C	5322 130 40144	
TS215	BC177	4822 130 40522	
TS216	BD131	5322 130 40752	
TS301	2N2219	5322 130 40496	
TS302	BD207	5322 130 44213	Motorola
TS303	BD175	5322 130 44214	Motorola
TS304	BD207	5322 130 44213	Motorola

* From version −/03, in versions −/01 and −/02 BFX89 has been used.

No.	Ordering number	Value (Ω)	Tolerance (%)	Description	
R183	5322 116 50762	5.11 k	1	Metal film	
R199	5322 116 54269	20 k	1	Metal film	versions −/01 and −/02 only
R199	5322 116 50522	13.0 k	1	Metal film	from version −/03
R213	5322 116 54397	56	5	Metal film	
R214	5322 116 50603	357	1	Metal film	
R215	5322 116 54393	150	5	Metal film	
R216	5322 116 50781	1.82 k	1	Metal film	versions −/01 and −/02 only
R216	5322 116 50629	1.74 k	1	Metal film	from version −/03
R217	5322 116 50949	1.62 k	1	Metal film	
R219, R220	5322 116 54004	2.43 k	1	Metal film	
R221	5322 116 54398	680	5	Metal film	
R222	5322 116 50689	511	1	Metal film	
R225, R226	5322 116 54391	33.2	1	Metal film	
R227	5322 116 50974	432	1	Metal film	
R230	5322 101 14049	470	5	Potentiometer	
R231	5322 116 54395	330	5	Metal film	
R233, R234 R235, R236	5322 116 54392	100	5	Metal film	
R239, R240	5322 116 54392	100	5	Metal film	
R241	5322 116 54396	68	5	Metal film	
R242	5322 116 54397	56	5	Metal film	
R243	5322 116 54393	150	5	Metal film	
R245	5322 116 50659	511	1	Metal film	
R246, R247	5322 116 50417	162	1	Metal film	versions −/01 and −/02 only
R246, R247	5322 116 54462	82.5	1	Metal film	from version −/03
R248, R249	5322 116 54392	100	5	Metal film	
R251	5322 116 50545	475	1	Metal film	
R252	5322 116 50608	6.19 k	1	Metal film	versions −/01 and −/02 only
R252	5322 116 50572	12.1 k		Metal film	from version −/03
R253	5322 116 54064	2 k	1	Metal film	
R308	5322 113 44131	1.6	10	Wire wound	
R309	5322 113 60082	0.62	10	Wire wound	
R310	5322 113 44131	1.6	10	Wire wound	
R312	5322 116 50979	8.25 k	1	Metal film	
R313	5322 101 14047	470	20	Potentiometer	
R314	5322 116 54171	2.21 k	1	Metal film	
R315	5322 116 54191	30.1 k	1	Metal film	
R316	5322 116 51056	11 k	1	Metal film	
R317, R318	5322 116 54148	9.09 k	1	Metal film	
R502	5322 101 14048	47 k	20	Potentiometer	versions −/01 and −/02 only
R502	5322 100 10118	22 k	20	Potentiometer	from version −/03
R504	4822 116 40007	3·20 k		PTC thermistor	

Diodes

No.	*Type*	*Ordering number*	*Remarks*
GR101, GR102, GR103 GR104, GR105	BAX13	5322 130 40182	
GR106, GR107	BA220	5322 130 34221	
GR108	BAX13	5322 130 40182	
GR109	FD777	5322 130 34045	Fairchild
GR110, GR111	BAX13	5322 130 40182	
GR112	FD777	5322 130 34045	Fairchild
GR113	BAX13	5322 130 40182	
GR114	FD777	5322 130 34045	Fairchild
GR115, GR116	BAX13	5322 130 40182	
GR201	BZX79-C4V1	5322 130 30773	Zener
GR301, GR302, GR303	BY164	5322 130 30414	Rectifier diode
GR304, GR305	BZX79-C5V1	5322 130 30767	Zener

Transistors

No.	*Type*	*Ordering number*	*Remarks*
TS101, TS102, TS103	BFX89	5322 130 40542	
TS104	MPSL08	5322 130 44215	Fairchild
TS105	BFX89	5322 130 40542	
TS106	2N2369*	5322 130 40407	
TS107	MPSL08	5322 130 44215	Fairchild
TS108	BFX89	5322 130 40542	
TS109	2N2369*	5322 130 40407	
TS110	BC177	4822 130 40522	
TS111, TS112, TS113 TS114, TS115	MPSL08	5322 130 44215	Fairchild
TS116, TS117	BFX89	5322 130 40542	
TS118	BC177	4822 130 40522	
TS119	BFX89	5322 130 40542	
TS120, TS121 TS122, TS123	MPSL08	5322 130 44215	Fairchild
TS124, TS125	BFX89	5322 130 40542	
TS126	BC177	4822 130 40522	
TS127	BFX89	5322 130 40542	
TS128, TS129 TS130, TS131	MPSL08	5322 130 44215	Fairchild
TS201, TS202	2N2369	5322 130 40407	
TS203, TS204	BFW30	5322 130 40379	
TS205	2N2905A	5322 130 40468	
TS206	BC109C	5322 130 40144	
TS207, TS208, TS209	BFW16A	5322 130 44015	
TS210, TS211	2N5160	5322 130 44136	
TS212	2N2219	5322 130 40496	
TS213	BD132	5322 130 40753	
TS214	BC109C	5322 130 40144	
TS215	BC177	4822 130 40522	
TS216	BD131	5322 130 40752	
TS301	2N2219	5322 130 40496	
TS302	BD207	5322 130 44213	Motorola
TS303	BD175	5322 130 44214	Motorola
TS304	BD207	5322 130 44213	Motorola

* From version −/03, in versions −/01 and −/02 BFX89 has been used.

No.	Type	Ordering number	Remarks
TS305, TS306, TS307	BC107B	5322 130 40332	

Integrated circuits

No.	Type	Ordering number	Remarks
IC101, IC102, IC103	MC10105	5322 209 84338	Motorola
IC301, IC302, IC303	SN72741P	5322 209 84163	

Miscellaneous

No.	Item	Qty	Ordering number	Description
	VL1	1	5322 253 30016	Fuse, 400 mA (delayed action)
	L1, L2	2	5322 526 14007	FXC bead
	L3, L103, L104 L105, L106 L202, L301	7	5322 526 10025	FXC bead
	L101, L102	2	5322 158 10052	Coil
	L201	1	5322 158 14052	Choke, 1 mH
	T1	1	5322 146 34023	Mains transformer
	BU121...BU130	1	5322 264 54017	Pin connector, AMP 163740-8
	BU141...BU147	1	5322 264 54016	Pin connector, AMP 163749-5
	BU201...BU210	1	5322 266 44008	Female connector, AMP 163680-8
	BU401...BU407	1	5322 266 44009	Female connector, AMP 163683-5
	–	31	5322 268 10072	"Fast-on" male contact pins
XI-2	–	1	5322 216 64063	Printed-wiring board, timing circuit
XI-2	–	1	5322 216 64064	Printed-wiring board, output circuit
XI-2	–	1	5322 216 64065	Printed-wiring board, power supply (without TS302, TS303 and TS304)
	–	1	5322 466 14077	Flexible P.C. board (without components)