# PS-10
# Level Generator

## Service Manual

BN 0904/00.83

Wandel & Goltermann
Electronic Measurement Technology

---

LEVEL GENERATOR PS-10

for the frequency range
200 Hz to 4 kHz

Service Manual BN 904; series A...

Order No. BN 0904/00.83
Edition 3664/5.89 (replaces 3046)

I.2.84 VBS/sl
0.1.5.89

Subject to change without notice
Printed in the Federal Republic of Germany
© Wandel & Goltermann GmbH & Co, Eningen u. A., 1989

**Wandel & Goltermann** Electronic Measurement Technology

---

## Addresses

### International Sales and Service

**Head office**

Wandel & Goltermann GmbH & Co
Postfach 12 62
D-7412 Eningen u.A.
Federal Republic of Germany
Tel. +49-71 21-86-0
tlx. 7 29 833 wug d
FAX +49-71 21-8 84 04

**Affiliated companies**

**Argentina**
Wandel & Goltermann & Co
Montaneses 2599
1428 Buenos Aires
Tel. 1-7 84 66 42, tlx. 24 543 wglas ar

**Australia**
Wandel & Goltermann Pty Ltd.
42 Clarendon Street,
South Melbourne, Victoria 3205
(P.O.Box 419, World Trade Centre
Melbourne, Victoria 3005)
Tel. 03-6 90 67 00, tlx. 34 801 AA
FAX 03-6 90 67 50

**Austria**
Wandel & Goltermann Ges.m.b.H.
Postfach 13, A-2500 Baden
Tel. 22 52-8 55 21-0, tlx. 14 375 wgo a
FAX 22 52-8 55 21 20

**Belgium / Luxembourg**
Wandel & Goltermann bv
Technical office
Schrikheidestraat 69
B-3580 Koersel, Tel. 011-43 24 12
FAX 011-43 24 01

**Brazil**
Wandel & Goltermann Instr. Ltà & Cia
Rua da Assembleia 10, Sala 2711
20011 Rio de Janeiro – RJ
Tel. 0055 21 221-3731, tlx. 2 137 438 wg la br
FAX 21242-8 662

**Canada**
Wandel & Goltermann Inc.
21, Rolark Drive
Scarborough, Ontario M1R 3B1
Tel. 416-291 71 21, tlx. 610-492-2712 wg inc tor
FAX 416-2 91 26 38

**France**
Wandel & Goltermann France
46 bis, rue Pierre Curie
B.P. 53 · Z.I. Les Gâtines
F-78372 Plaisir Cedex
Tel. (1) 30 55 81 90, tlx. 698 955
FAX (1) 30 55 87 75
Telefax 933-130 55 94 29

**Great Britain**
Wandel & Goltermann Ltd.
Progress House, 412 Greenford Road
Greenford, Middlesex, UB6 9AH
Tel. 1-5 75 30 20/4, tlx. 934 489 waguk g
FAX 1-5 75 56 29

**Guatemala**
Servicio Y Telecomunicaciones S.A.
SERTELSA
22 Av. "A" 11-63, Zona 6
Apartado Postal 117
Guatemala City
Tel. 22-56 07 40, 56 65 90

**Hong Kong**
Wandel & Goltermann Ltd.
1905 Bond Centre, West Tower
89 Queensway, Central
Hong Kong
Tel. 5-868 31 13, tlx. 81 590 wago hx
FAX 5-868 54 82

**Japan**
Wandel & Goltermann
Liaison Office Japan
German Industry Center 207
Hakusan-cho 616-1, Midori-ku,
Yokohama-shi, 226
Tel. 45-931-57 25
FAX 45-931-57 28

**The Netherlands**
Wandel & Goltermann bv
Monnickskamp 8-B
1273 JS Huizen
Tel. 02152-66 122, tlx. 43 348 wango nl
FAX 02152-6 79 37

**Singapore**
Wandel & Goltermann
151 Chin Swee Road, Room 14-11
14-4 Manhattan House, Singapore 0316
Tel. 7 33 07 22, tlx. 38 133 wandel rs
FAX 7 32 89 09

**Spain**
Wandel & Goltermann S.A.
Apartado Postal 48008
Arturo Soria, 95, 2° Planta
E-28080 Madrid
Tel. 0 03 41-4 08 60 12, tlx. 052 27 224 wugb e
FAX 0 03 41-4 07 37 15

**Sweden**
Wandel & Goltermann AB
Box 6044, S-126 04 Haegersten-Stockholm
Tel. 8-88 04 80, tlx. 17 783 wgab s
FAX 8-88 38 90

**Switzerland**
Wandel & Goltermann (Schweiz) AG
Postfach 254, CH-3000 Bern 25
Tel. 31-42 66 44, tlx. 912 350 wgch
FAX 31-42 61 33

**USA**
Wandel & Goltermann, Inc.
1030 Swabia Court,
Imperial Center
Research Triangle Park, NC 27 709-3585
P.O.B. 13585
Tel. 919-941-57 30, tlx. 810-621-0 002
FAX 919-941-57 51
E. Link 62 61 56 40

---

FIGURES





# 6 PRELIMINARY REMARKS

## 6.1 INTRODUCTION TO THE SERVICING METHOD

Maintenance and repairs are the two main tasks involved in the servicing of a measuring instrument. The Instrument Manual which comprises the Operating Manual, the Service Manual and the Appendix provides all the necessary information in this respect.

The Operating Manual provides all the necessary basic information about the instrument. Section 5 contains a description of all the non-electrical maintenance work such as cleaning and lubricating moving parts, should this be necessary.

The Service Manual provides all the specialist information required for repairs. Section 8 "Re-checking important specifications" describes maintenance and repairs.

The range of information provided was selected so that an experienced technician is in a position to carry out all the usual types of repair work. Work which, as a rule, only occurs when the instrument is being manufactured has not been included.

The Appendix contains all block diagrams, circuit diagrams, parts lists and p.c.b. layout plans. It also provides all the information for reading the circuit diagrams and for ordering spare parts. A German/English/French glossary gives translations for all the important terms that appear in the Appendix.

## 6.2 TEST EQUIPMENT

The measuring instruments listed here, which are essential for performing the tests that follow, are only recommendations. Equivalent instruments from other manufacturers may also be used.



| Instrument | Requirements | Rec. type | Manufacturer | For applications see Sec. |
|---|---|---|---|---|
| Milliwatt Power Meter with options | 10 Hz to 300 MHz | EPM-1 | W&G | 8.2, 8.3, 8.4.1 |
| Selective Level Meter | 15 Hz to 200 kHz | SPM-11 | W&G | 7.7.3, 8.4.2, 8.5 |
| Oscilloscope with test probe | $Z_{in} \geq 10$ MΩ | | | 7.6.1<br>7.6.2<br>7.6.3<br>7.6.4<br>7.6.5<br>7.6.6 |
| Digital voltmeter | 4 1/2 digits $Z_{in} > 10$ MΩ | 8600 A | Fluke | 7.6.2, 7.6.3<br>7.6.5, 7.6.6<br>7.6.7, 7.7.2<br>7.7.4, 8.4.2 |
| Universal frequency counter | 10 Hz to 520 MHz | PM 6614 | Philips | 8.6 |
| "T"-Adaptor | 3 pole (CF) | S 833 | W&G | 8.5 |
| Terminating impedance | 600 Ω/1 % 2.5 W | | | 7.6.1, 7.6.7, 8.5 |
| Power supply | Adjustable between 30...50 V 60 mA, $Z_{out}$ < 5 Ω to 200 Hz | | | 7.6.7 |

Figure 6-1 Measuring instruments

| Instru-ment | Require-ments | Rec. type | Manu-fac-turer | For app-lications see Sec. |
|---|---|---|---|---|
| Power supply | Adjustable between 12...18 V 10 mA | | | 7.6.2 |
| Ammeter | 100 mA | | | 7.6.7 |

Figure 6-1 Measuring instruments (continued)



# 7 NOTES ON TROUBLESHOOTING AND REPAIRS

## 7.1 SAFETY PRECAUTIONS

### 7.1.1 CHECKING THE ISOLATION IMPEDANCE AFTER REPAIRS AND MAINTENANCE

The isolation impedance between the measurement outputs (a and b wire) and the casing (c wire) is checked with 700 V d.c. or with 500 V a.c. The impedance must be greater than 2 MΩ. There must be no spark-overs.

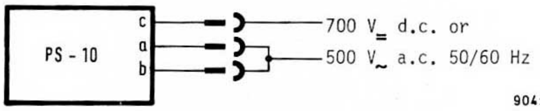



Figure 7-1 Checking the isolation impedance

### 7.1.2 HOW TO PREVENT DAMAGE TO THE PS-10's CIRCUITS

Take care when working with MOS components!

Some MOS components are used in this instrument. These components are easily destroyed by static charges, hum from devices that are not earthed, and other types of interference potentials. The following rules should be obeyed to prevent destruction by static charges:

- MOS components should be left in the manufacturer's packaging until they are required. All MOS connections must be shorted together until they are required for use (use the black, conductive plastic foam).
- Before removing MOS components from their packing, or before removing p.c.b.s with MOS components from their packing, the electrically conductive part of the packing must be brought into contact with a con-



ductive working-surface or with the ground of the instrument to be repaired surface. The ground of the instrument acts as a reference potential.

- Always touch the reference potential before handling MOS components.
- All tools, other devices used, the part of the instrument to be repaired and the person carrying out the repair must be at the same potential as the conductor which defines the reference potential (e.g. the conductive working-surface, or failing this, the ground of the instrument which is to be repaired). For similar reasons always bring tools which will come into contact with MOS components to the same potential as the reference potential. Under no circumstances must tools have insulating handles.
- If a p.c.b., or any other part of the instrument, is removed to be repaired or maintained, and a conductive work-surface is not available, the ground of the p.c.b. or other parts must be connected to the reference potential.

When soldering MOS components p.c.b.s or other instrument parts, a permanent connection should be made between the ground of the board, or part, and the soldering iron to prevent destruction by mains hum.

MOS components can be recognised in the parts list from the letters MOS, CMOS or MOSFET which appear in the component code.

## 7.2 SOLDERING INSTRUCTIONS

The use of thin solder with a little flux is recommended. The following points should be noted:

- The soldering times for all components must be $\leq$ 5 s.
- Soldering temperatures must be $\leq$ 260°C.



- Do not let flux creep or splash onto switch contacts: Be especially careful with the contact paths of the frequency selector switch.

Notes on unsoldering components with many connections:

By far the best method of unsoldering components of this type is to use a special desoldering tool to suck the solder from each connection. When unsoldering a component, gently move it from side to side to check that each connection is free. On no account use force! Through-plated holes are sensitive to pulling during soldering. In the case of dual-in-line components the p.c.b. can be spared damage by first of all cutting through the connections on the component side and unsoldering each connection separately.

## 7.3 INSTRUMENT MARKINGS

Should you have any enquiries, should you want to order spare parts or check that this Service Manual is the right one for the instrument that you are repairing, it is essential to note the following instrument markings:

Type marking, special version marking, series index and instrument number.

Figure 7-2 shows where each marking is to be found.

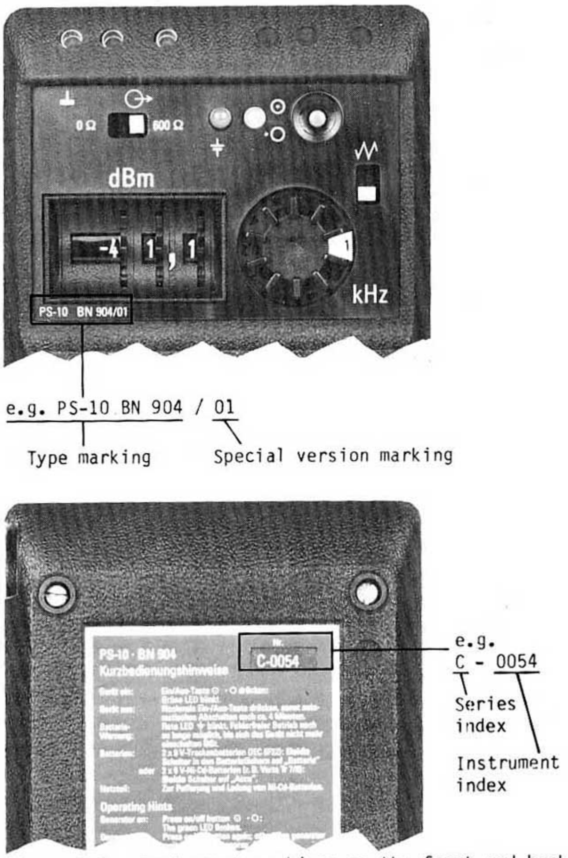



Figure 7-2 Instrument markings on the front and back panels



## 7.4 DISMANTLING THE INSTRUMENT

Undo the four screws on the bottom of the instrument, separate the upper and lower halves of the casing:

Now all the alignment elements and test points on the printed circuit boards are easy to get at.

> Caution!
>
> Be careful not to rip off the connecting leads for the mains/charger connector in the lower half of the casing.

Gaining access to the components on the middle printed circuit board [904-B]:
Remove the four screws in the lowest printed circuit board [904-C], and take out the printed circuit board together with the thumbwheel switch.

The two topmost printed circuit boards ([904-A] und [904-B]) can be operated together without the lowermost printed circuit board; see Section 7.6.1.

Separating the upper printed circuit boards:
Undo the four hexagonal nuts near the battery compartment and either unsolder the connecting leads to the battery compartment or unscrew the hexagonal bolts.



## 7.5 LOCATION OF THE SUB-ASSEMBLIES, ALIGNMENT ELEMENTS AND TEST POINTS

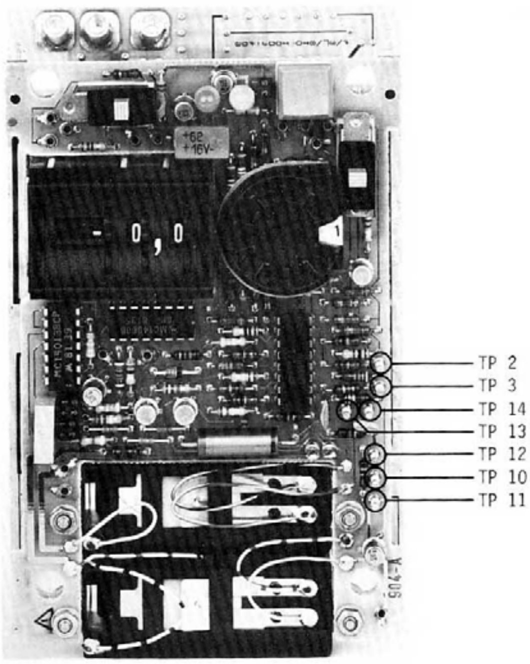



Figure 7-3 "Sweep generator" p.c.b. [904-A]



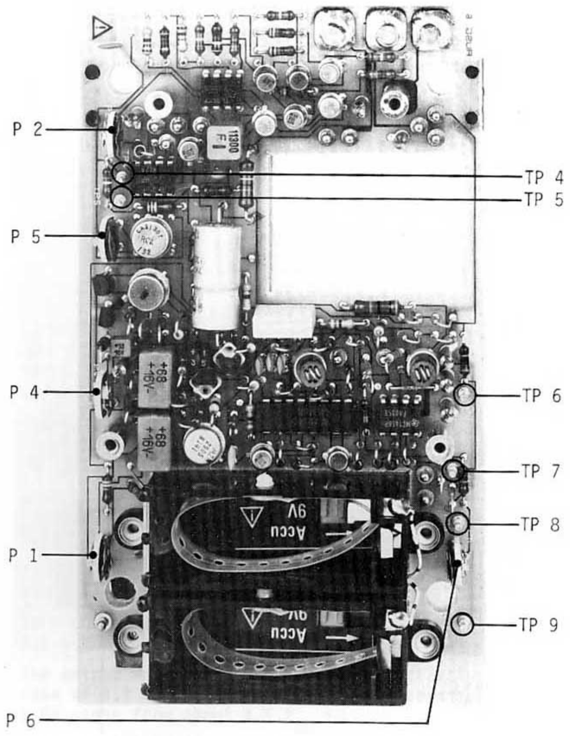



Figure 7-4 "Oscillator and output amplifier" p.c.b. [904-B]

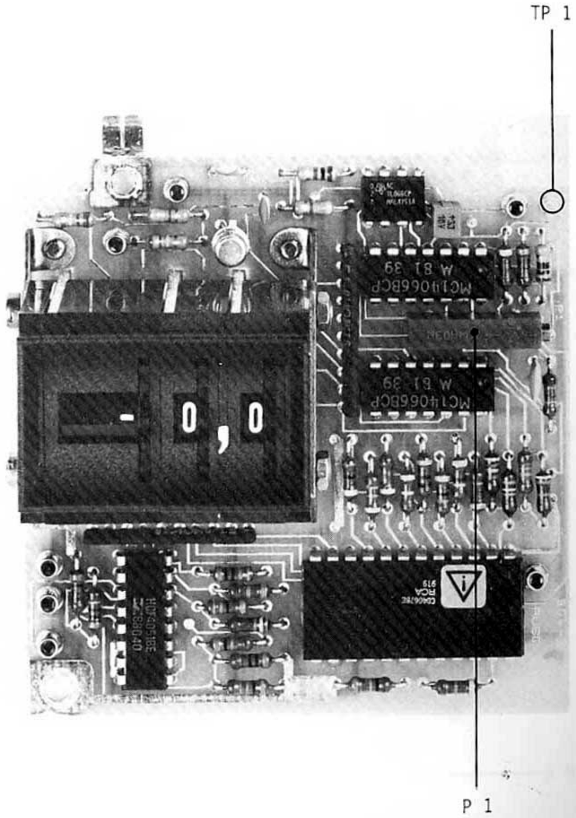



Figure 7-5 "Level conditioning " p.c.b. [904-C]



## 7.6 NOTES ON TROUBLESHOOTING

### 7.6.1 METHOD FOR FAULT LOCALISATION

The following sections describe a simple function test which can be carried out without opening the casing. Using this test the source of the fault can be localised. A section describing the exact trouble-shooting procedure is given for each case. Before carrying out troubleshooting always check the operating voltages using the methods described in Section 7.6.2!

Function check:

Connect an oscilloscope without a test probe to the output of the PS-10.
Set the PS-10 to 0.0 dB, 1 kHz (sweep "off"), 600 Ω.
Press on/off button:
The green LED flashes every two seconds, and a sinusoidal signal with approx. 4.4 $V_{pp}$ appears at the output.

Does the LED not flash? Does the sinusoidal signal only appear <u>when</u> the button is <u>being</u> pressed?

If so the possible causes are:

A flat battery or too much current is being taken. Defective on/off switch or power supply (see Section 7.6.2).

If the LED flashes but no signal is present see Section 7.6.3.

Turn the thumbwheel switch consecutively through the 0.1 dB, 1 dB, and 10 dB settings:

The output voltage should decrease constantly; in the case of 0.1 dB steps this is barely recognizable, for 1 dB steps from about 4.4 $V_{pp}$ to about 1.6 $V_{pp}$ (-9 dB), for 10 dB steps from about 4.4 $V_{pp}$ to about 14 $mV_{pp}$ (-50 dB).



Carry out troubleshooting as indicated in Section 7.6.6.

Set the PS-10 to -0.0 dB again: terminate output with 600 Ω, switch to "$R_i$ = 600 Ω/$R_i$ = 0 Ω":

The output voltage must remain constant at approx. 2.2 $V_{pp}$.
Carry out troubleshooting as indicated in Section 7.6.3: Level conditioning or output amplifier.

Set the PS-10 to 0.0 dB, 600 Ω, and terminate with 600 Ω.

Turn the test frequency switch, setting by setting, through the whole range:

The signal must be present at all settings (if not see Section 7.6.5). The signal must not be distorted (troubleshoot as indicated in Section 7.6.3).

Switch the PS-10 to "sweep":

The frequency sweep must be continuous.
If not troubleshooting as indicated in Section 7.6.5.

### 7.6.2 ON/OFF SWITCH AND VOLTAGE SUPPLY

The following checks can be performed without the lowest printed circuit board [904-C].

<u>Checking the operating voltage</u>

Switch on the PS-10.

Connect the millivolt meter to TP 8 and TP 9 (printed circuit board [904-B]:

The voltage must be 12 V ± 10 mV.

Connect the millivolt meter to TP 8 [904-B] and TP 10 (printed circuit board [904-A]).

N.B.
Series A PS-10s do not have TPs 8 and 9.



The voltage must be 6 V ± 100 mV.

Is the 12 V voltage too low?

Can a voltage only be measured when the on/off button is pressed?

Can a voltage only be measured when the on/off button is pressed?

Measure the battery voltage and the current taken:

Nominal value 18 V (> 13.5 V) at 5 mA (< 7.5 mA). If the battery is flat or a voltage drop is caused by a too high current being taken, the PS-10 is automatically switched off by the battery monitoring circuit (3 IC 4/3)!

Is it impossible to switch the PS-10 on?
Check the switch itself and transistors 3 T 2 and 3 T 3.

Does the PS-10 only remain on when the button is being pressed?

First check:
If the voltage supply is sufficient, pin 4 of 3 IC 2/2 connected via 3 R 34 must be at -6 V (see battery monitoring circuit).

Further checks:
The signal states at 3 IC 1, pin 3; 3 IC 2, pins 13 and 1 should be as indicated in Fig. 7-6.

<u>Checking the battery monitoring circuit</u>

Connect the PS-10 to an external power supply that can be adjusted between 12 and 18 V. Adjust the voltage to about 18 V and switch on the PS-10:

The green LED flashes.
Set the slide-switch in the battey compartment to "Akku", set the voltage to 17.4 V:

The red LED should not flash yet: output pin 1 on 3 IC 4/2 is at approx. 36 V.

Set the voltage to 16.6 V:

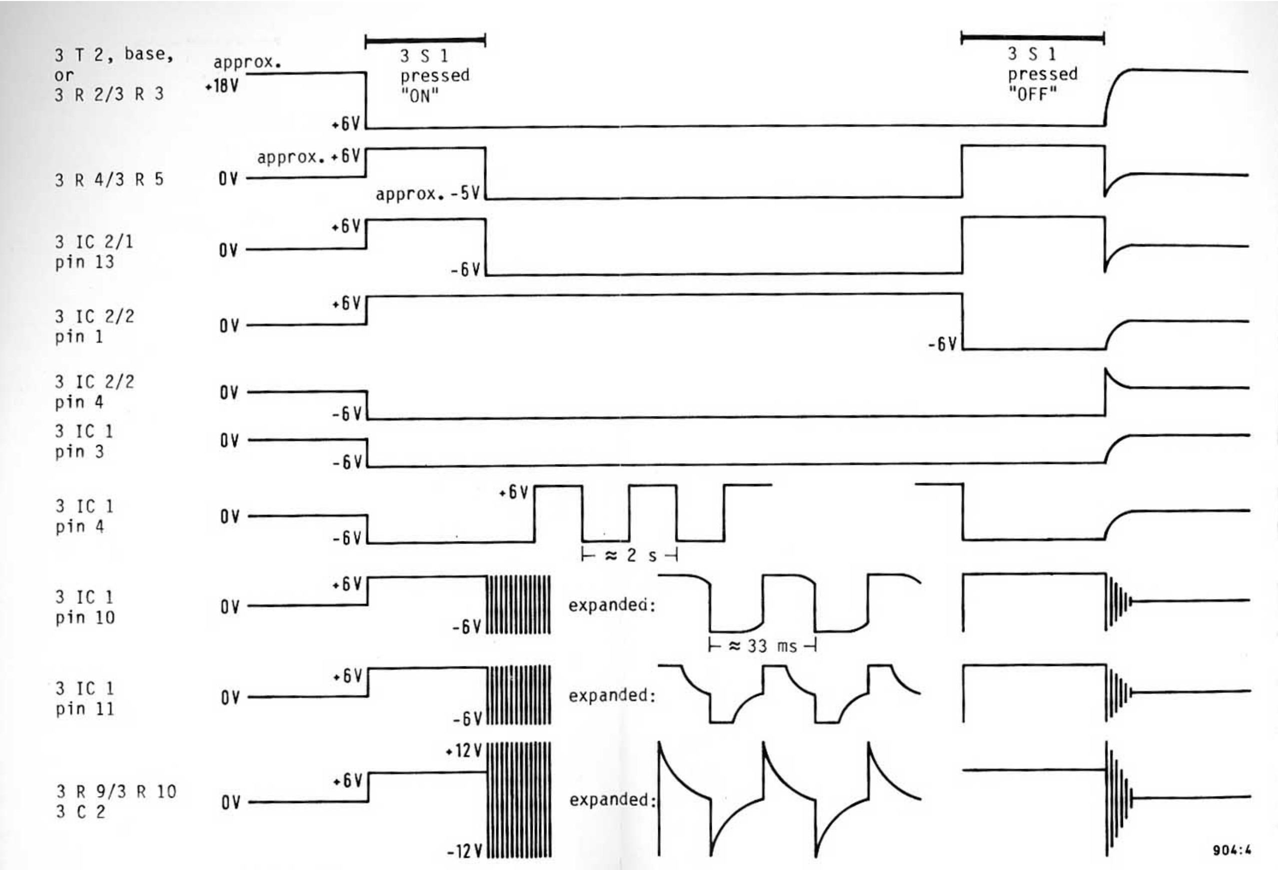



Figure 7-6 ON/OFF switching

Checking the On-Off Switch using Fig. 7-6 - Oscilloscope ground to 0V (TP10 on p.c.b. (904-A1))

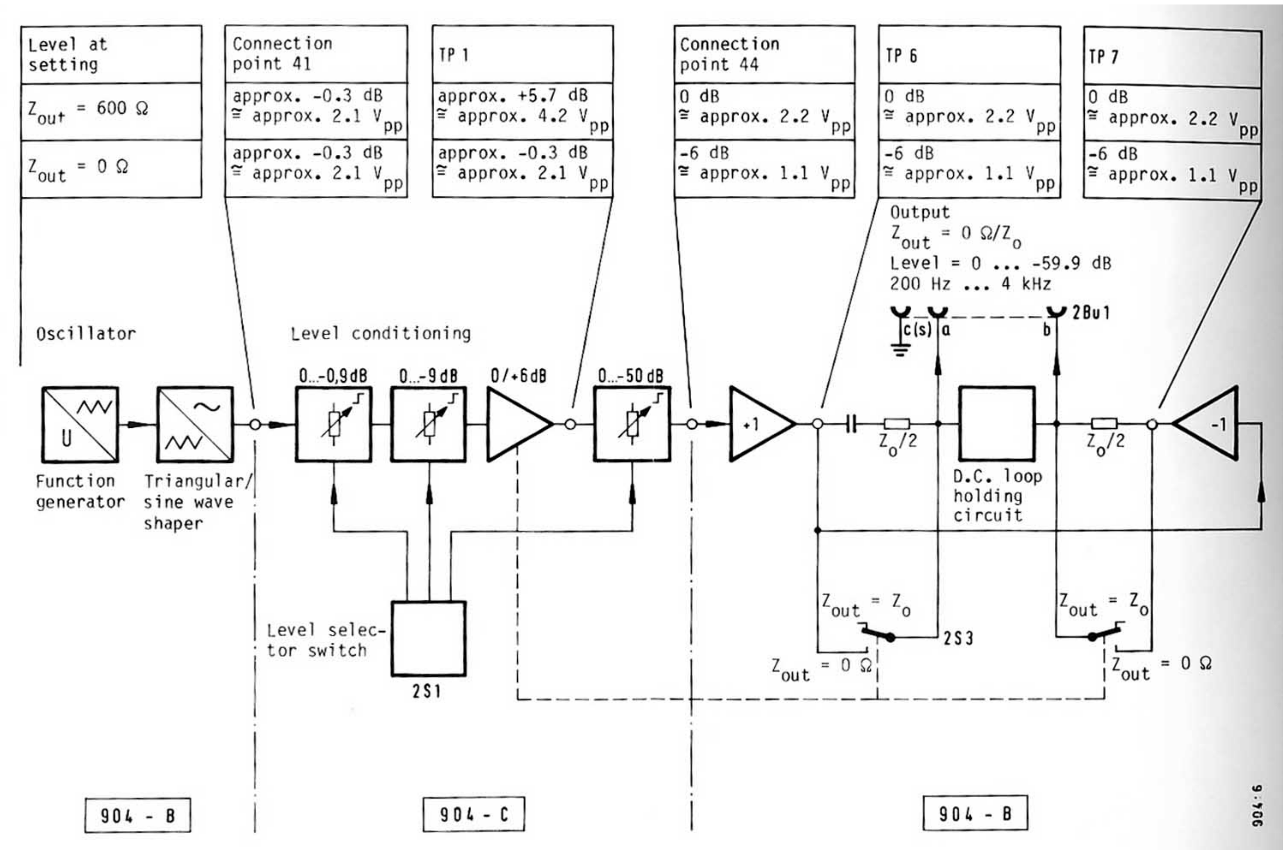



Figure 7-7 Internal levels

The red LED flashes: output pin 1 on 3 IC 4/2 is at approx. -6 V. Set the slide-switch in the battery compartment to "Batterie" and set the voltage to 15.0 V:

The red LED should not flash.

Set the voltage to 14.3 V:

The red LED flashes.

Set the voltage to 13.2 V:

The PS-10 switches off because of the positive output voltage at pin 7 on 3 IC 4/3.

### 7.6.3 INTERNAL LEVELS

The levels can be checked as indicated in Fig. 7-7 with the aid of an oscilloscope, and if need be together with millivolt meter ($Z_{in} \geq 10$ MΩ).



For troubleshooting purposes, the lower printed circuit board [904-C] can be replaced by the following circuit.

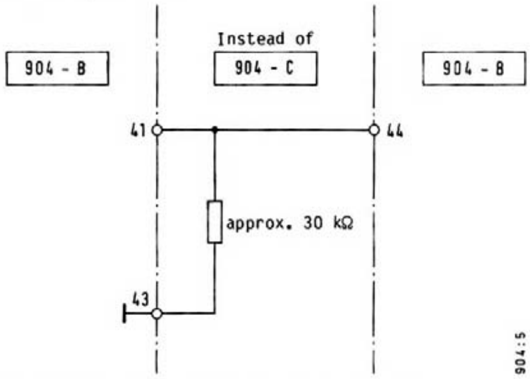



Figure 7-8 Equivalent circuit for [904-C]

In this case the levels for $Z_{out}$ = 500 Ω are approximately correct!



### 7.6.4 OSCILLATOR

The lowermost printed circuit board [904-C] can be removed for the following checks.
Check the signals from the function generator with an oscilloscope to see whether they are clean or not (dynamic check):

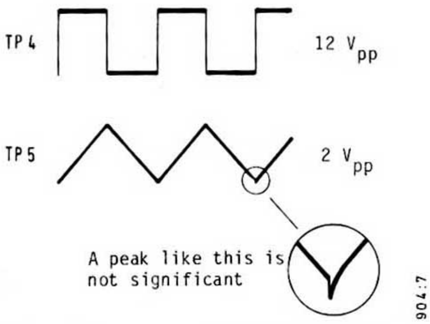



Figure 7-9 Signals at TP 4 and TP 5

If the generator will not oscillate (static check)

1. Check the control voltages:

   Setting 1 kHz (sweep "off")

   +4.50 V at connection point 24 and 4.05 V at connection point 25.

   Otherwise see Section 7.6.5.

2. Check generator blanking:

   Transistor 1 T 11 must not be conducting.

   (If 1 T 11 is on, the output of 1 IC 4, pin 6 goes to +6 V).



3. Check the current source 1 IC 2 and 1 T 5:

   The voltage difference between pins 2 and 3 on 1 IC 2 must not be greater than a few millivolts.

4. Check current sink 1 IC 3/1 and 1 T 10:

   The voltage at pin 3 on 1 IC 3 must be about 0 V. (If transistor 1 T 9 is defective this will cause an incorrect voltage at pin 3).

5. Check buffer amplifier 1 IC 3/2:

   The voltage difference between pins 5 and 6 must not be greater than a few millivolts.

6. Check comparator 1 IC 4:

   Alternately apply voltages of +6 V and -6 V to pin 2 on 1 IC 4;
   the output voltage at pin 6 must be -6 V and +6 V respectively.

7. If all the preceding checks have been o.k., there is probably a fault in one of the switching transistors 1 T 6 to 1 T 9.

Check the sine shaper:

The triangular voltage at the base of 1 R 12 is about 0.4 $V_{pp}$.
The sinusoidal voltage at the collector of 1 T 12' is about 3.5 $V_{pp}$ when the sine shaper is <u>not</u> loaded (printed circuit board [904-C] has been removed), this sinusoidal voltage is superimposed on a d.c. voltage:

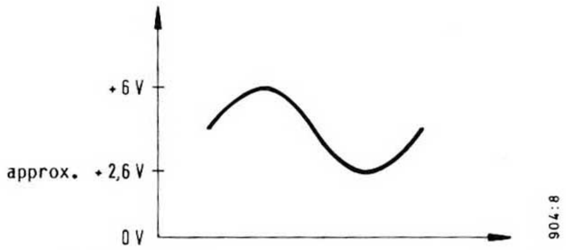



Figure 7-10 Collector voltage of 1 T 12'

### 7.6.5 FREQUENCY SELECTOR SWITCH AND SWEEP GENERATOR

Checking the frequency selector switch:

Set switch 1 S 2 to sweep "off".
Turn rotary switch 1 S 1 through all its positions one at a time. The following voltages must be produced:

| Frequency setting | Voltage at connection point 25 referred to 0 V | Connection point 25 referred to +4.5 V at connection point 24 |
|---|---|---|
| 200 Hz | 4.410 V | -0.090 V |
| 300 Hz | 4.365 V | -0.135 V |
| 400 Hz | 4.320 V | -0.180 V |
| 600 Hz | 4.230 V | -0.270 V |
| 800 Hz | 4.140 V | -0.360 V |
| 1 kHz | 4.050 V | -0.450 V |
| 1.6 kHz | 3.780 V | -0.720 V |
| 2.4 kHz | 3.420 V | -1.080 V |
| 3.4 kHz | 2.970 V | -1.530 V |
| 4 kHz | 2.700 V | -1.800 V |
| Lower sweep | 4.410 V | -0.090 V |
| Upper limit | 2.925 V | -1.575 V |

Figure 7-11 Fixed frequency voltage divider



A rough check can be carried out with an oscilloscope (voltage to 0 V). A more accurate check is carried out by connecting the digital voltmeter between connection points 24 and 25.

Checking the sweep generator:
Set switch 1 S 2 to sweep "on".
Connect the ocsilloscope to TP 2 and TP 10 (0 V). The voltage trace should be approximately the same as the curve shown below:

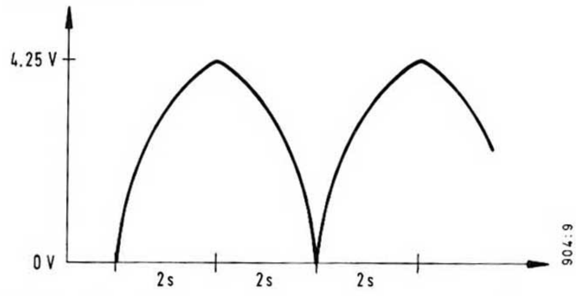



Figure 7-12 Sweep generator voltages

Determine the sweep limits:

Connect TP 10 to TP 11, and TP 13 to TP 14.
The voltage across connection points 24 and 25 must be 1.575 V $\pm 30$ mV (see the Table in Fig. 7-11 for the upper sweep limit).

Connect TP 10 and TP 12, and TP 13 to TP 14. The voltage across connection points 24 and 25 must now be 90 mV $\pm 3$ mV (lower sweep limit).



### 7.6.6 LEVEL CONDITIONING

Check the 0.1 dB settings:

| Switch setting | BCD code, weighting 8 4 2 1 | Switched in resistors |
|---|---|---|
| - .0 | 0 0 0 0 | |
| - .1 | 0 0 0 1 | R4 |
| - .2 | 0 0 1 0 | R3 |
| - .3 | 0 0 1 1 | R3 // R4 |
| - .4 | 0 1 0 0 | R2 |
| - .5 | 0 1 0 1 | R2 // R4 |
| - .6 | 0 1 1 0 | R2 // R3 |
| - .7 | 0 1 1 1 | R2 // R3 // R4 |
| - .8 | 1 0 0 0 | R1 |
| - .9 | 1 0 0 1 | R1 // R4 |

Figure 7-13 0.1 dB settings

A "1" indicates that the thumbwheel switch contact has been connected to +6 V and consequently to a closed contact in 2 IC 1. A "0" indicates an open switch contact; the relevant input of 2 IC 1 is pulled down to -6 V via 2 R 40.
Carry out this check with an oscilloscope or digital voltmeter.

Checking the 1 dB settings:

| Switch setting | BCD code, weighting 8 4 2 1 |
|---|---|
| - 0 | 0 0 0 0 |
| - 1 | 0 0 0 1 |
| - 3 | 0 0 1 1 |
| - 4 | 0 1 0 0 |
| - 5 | 0 1 0 1 |
| - 6 | 0 1 1 0 |
| - 7 | 0 1 1 1 |
| - 8 | 1 0 0 0 |
| - 9 | 1 0 0 1 |

Figure 7-14 1 dB settings



A "1" indicates that the thumbwheel switch contact is connected to +6 V. A "0" indicates an open contact; the relevant input of 1 IC 2 is pulled down to -6 V via 2 R 41.

Checking the 10 dB settings:

| Switch setting | BCD code, weighting 4 2 1 | Switch contact - ∞ |
|---|---|---|
| - 0 | 0 0 1 | 0 |
| - 10 | 0 1 0 | 0 |
| - 20 | 0 1 1 | 0 |
| - 30 | 1 0 0 | 0 |
| - 40 | 1 0 1 | 0 |
| - 50 | 1 1 0 | 0 |
| - ∞ | 1 1 1 | 1 |

Figure 7-15 10 dB settings

A "1" indicates that the thumbwheel switch contact is connected to +6 V.

### 7.6.7 D.C. LOOP HOLDING CIRCUIT

Test setup:

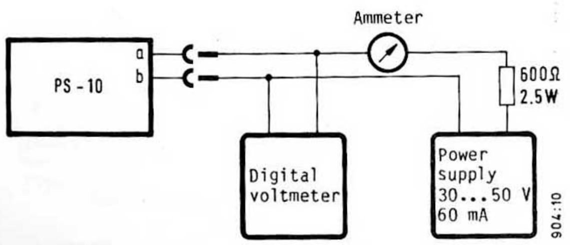



Figure 7-16 Checking the loop holding circuit

Special requirements:
The load resistor must be reasonably constant with temperature. The power supply must have a low impedance at signal frequencies of 200 Hz (< 5 Ω).

Check:
Set the PS-10 to -0.0 dB, 200 Hz (sweep "off"), $Z_{out}$ = 600 Ω. Digital voltmeter to a.c. range.

Switch on the PS-10. Switch on the power supply and starting at about 30 V slowly increase the voltage until a current of about 60 mA is being taken.

Read off the voltage on the power supply; nominal value 35 ... 50 V. N.B. The current taken will vary slightly as the load resistor and the holding circuit warm up. The output voltage of the PS-10 will also vary as the load resistor varies.

Measure the output voltage of the PS-10 (approx. 0.775 V). Now switch off the power supply and measure the output voltage again: The voltage difference must be, at most, 2 mV.

Carry out the measurement again with the polarity of the power supply reversed.

Does the holding circuit only function with one polarity? Fault in the diode bridge 2 Gl 9 to 2 Gl 12.

Is the current taken too low?

Check the following transistors:
Base-emitter voltage of 2 T 10 approx. -0.7 V;
Base-emitter voltage of 2 T 8 and 2 T 9 (Darlington pairs) approx. +1.4 V.

Check the d.c. voltages:
The collector-emitter voltage drop of 2 T 8 and 2 T 9 must be approximately the same. If this is not the case check the dividers 2 R 68/2 R 71 and 2 R 67/-2 R 70.

Impermissible variations in the output voltage?
Check capacitors 2 C 12 and 2 C 13.

The remaining signal voltage across the capacitors should be 1 mV at 200 Hz.



## 7.7 A L I G N M E N T   I N S T R U C T I O N S

### 7.7.1 OVERVIEW

| Alignment | Alignment | Section |
|---|---|---|
| 1 P 2 | frequency | 8.6 |
| 1 P 4 | distortion factor k3 | 7.7.3 |
| 1 P 5 | distortion factor k2 | 7.7.3 |
| 2 P 1 | 0 dBm send level | 8.2 |
| 2 P 6 | output offset voltage | 7.7.4 |
| 3 P 1 | 12 V supply voltage | 7.7.2 |

Figure 7-17 List of all alignment elements

Alignments to be carried out when a subassembly is replaced

| Subassembly | Alignment | Section |
|---|---|---|
| [904-A] sweep generator | 1 P 2 | 8.6 |
| | 1 P 4 | 7.7.3 |
| | 1 P 5 | 7.7.3 |
| | 2 P 6 | 7.7.4 |
| [904-B] oscillator | 3 P 1 | 7.7.2 |
| | 1 P 4 | 7.7.3 |
| | 1 P 5 | 7.7.3 |
| | 2 P 6 | 7.7.4 |
| | 2 P 1 | 8.2 |
| | 1 P 2 | 8.6 |
| [904-C] level conditioning | 2 P 1 | 8.2 |

Figure 7-18 Alignments to be carried out when a subassembly is replaced



When a complete new alignment of the PS-10 is to be carried out, e.g. when the subassembly [904-B] is replaced, the order of alignment as set out in Sections 7.7.2 to 7.7.6 must be strictly followed. The same applies to Sections 8.2 and 8.6.

### 7.7.2 12 V SUPPLY VOLTAGE

Connect the digital voltmeter to TPs 8 and 9.
Adjust the potentiometer 3 P 1 to get a voltage of 12 V ± 5 mV.

### 7.7.3 DISTORTION FACTORS

Connect the output of the PS-10 to the selective level meter (SPM-11).
Set the PS-10 to -0.0 dB, 0 Ω, 1.6 kHz.
Adjust 1 P 5 so that the distortion factor k2 (3.2 kHz) is a minimum (< -60 dB).
Adjust 1 P 4 so that the distortion factor k3 (4.8 kHz) is a minimum (< -50 dB).

### 7.7.4 OUTPUT OFFSET-VOLTAGE

Connect the output of the PS-10 to the digital voltmeter set the PS-10 to -∞, 0 Ω.
Adjust 2 P 6 for an output offset-voltage of 0 V ± 1 mV.

### 7.7.5 SEND LEVEL

See Section 8.2.

### 7.7.6 FREQUENCY

See Section 8.6.



# 8 R E C H E C K I N G   I M P O R T A N T   S P E C I F I C A T I O N S

## 8.1 I N T R O D U C T I O N

The following Sections describe methods for rechecking the most important specifications of the PS-10. Wherever possible commercially available test aids have been recommended.

If nothing to the contrary is stated, the tests sould be carried out within the rated ranges of use for temperature and a.c. line voltage.
If a warm-up time is stated in the specifications, the test should only be commenced after this time has elapsed.

The purpose of rechecking the most important specifications is to determine whether the displayed measured value lies within the guaranteed error limits. The rechecking procedures are only completely valid when the intrinsic errors of the test setup used can be neglected.

If the intrinsic errors cannot be neglected the following rules apply:

If the error of the test setup used is m, and the guaranteed error limits for the item under test are ±e
- a transgression of the limits ±(e + m) indicates that the guaranteed error limits have certainly been exceeded;
- a transgression of the limits ±(e - m) indicates that the guaranteed error limits have certainly not bee exceeded.

Values for e and m are stated in every measurement procedure. The value m depends on the test equipment used and if a test device which is not specified in the measurement procedure is used, the value of m must be redetermined.

If a systematic check of the specifications of to be carried out, the order of the checks given in this Manual must be followed.

The item under test should only be aligned when the limit ±(e + m) is transgressed.

The purpose of the tests in Sections 8.2 to 8.4 is to determine important partial errors in the send level. If each partial error value is met, one can be sure that the value for the overall error has not been transgressed.

## 8.2 ERROR LIMIT OF THE SEND LEVEL AT 0 dBm, f = 1 kHz

The check must be carried out at a temperature of 23°C ± 3 K.

Required equipment:

| | | |
|---|---|---|
| 1 Milliwatt Power Meter with accessories: | EPM-1 | W&G |
| 1 Test Probe | TKS-10 | W&G |
| 1 Test Probe Adaptor | TKSA-600 | W&G |
| 1 Calibration Adaptor | TKSE-600 | W&G |

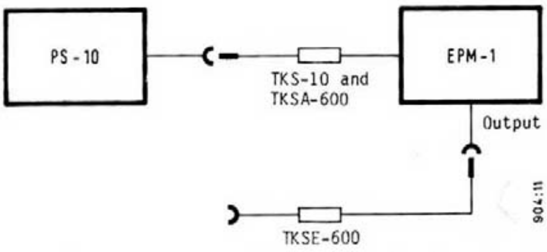



Figure 8-1 Test setup for 0 dBm send level



Device settings:

PS-10:

| | |
|---|---|
| Output impedance | : 600 Ω |
| Frequency | : 1 kHz |
| Level | : -0.0 dBm |

EPM-1:

| | |
|---|---|
| Measurement range | : 0 dBm ± 0.2 dBm |
| Calibration level switch | : 0 dB, $Z_{in}$ = 75 Ω |

Calibrating the EPM-1 Milliwatt Power Meter:

Connect up the test setup using the Calibration Adaptor. Adjust the calibration potentiometer so that the meter display reads zero.

Measurement:

Connect the PS-10 with the Test Probe. Read off the value shown on the EPM-1. Switch the output impedance of the PS-10 to 0 Ω and read the send level again.

| | | |
|---|---|---|
| Error limit (e): | for $Z_{out}$ = 600 Ω | ± 0.06 dB |
| | for $Z_{out}$ = 0 Ω | ± 0.09 dB |
| Error of the test setup (m): | | ± 0.02 dB |

Aligning 2 P 1 (output impedance of the PS-10: 600 Ω):

Adjust 2 P 1 so that the display on the calibrated EPM-1 reads exactly 0 dBm.

## 8.3 FREQUENCY RESPONSE

The measuring equipment, the test setup and settings are the same as those in Section 8.2.

Adjust the calibration potentiomenter on the EPM-1 so that its display reads zero (reference point). Read the value displayed by the EPM-1 at the following frequencies: f = 200, 300, 2400, 4000 Hz.



Set the output impedance of the PS-10 to 0 Ω and repeat the measurement.

| | |
|---|---|
| Error limit (e): | for f = 300 Hz to 4 kHz ±0.1 dB |
| | for f = 200 Hz to 4 kHz ±0.15 dB |

Test setup error (m): can be neglected

## 8.4 PARTIAL ERRORS

### 8.4.1 PARTIAL ERROR ON THE 0.1 dB STEPS

The measuring equipment, the test setup and settings are the same as those given in Section 8.2

Adjust the calibration potentiometer on the EPM-1 so that its meter reading is zero (reference point).

Set the following send levels on the PS-10: -0.1, -0.2 ... -0.9 dBm. Read off the deviation from the nominal value on the EPM-1 (change the measurement range when required).

| | |
|---|---|
| Error limit (e): | ±0.03 dB |
| Error on test setup (m): | ±0.02 dB |



### 8.4.2 PARTIAL ERRORS ON THE 1 dB AND 10 dB STEPS

Required measuring equipment:

| | | |
|---|---|---|
| 1 Selective Level Meter | SPM-11 | W & G |
| 1 Digital voltmeter | 8600 A | Fluke |

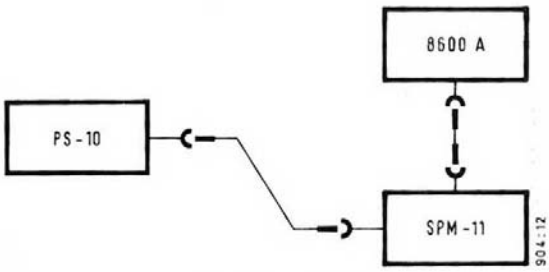



Figure 8-2 Test setup for partial errors

Equipment settings:

PS-10:

| | |
|---|---|
| Output impedance | : 0 Ω |
| Frequency | : 1 kHz |
| Level | : -0.0 dBm |

SPM-11:

| | |
|---|---|
| Measurement range | : 0 dB |
| Drive mode | : low noise |
| Bandwidth | : 40 Hz |
| Display | : slow |

8600 A:

| | |
|---|---|
| Measurement range | : D.C. V, 20 V |

Set the SPM-11 to the send frequency of the PS-10. Adjust the calibration potentiometer on the SPM-11 so that the digital voltmeter shows a voltage of 4 V ± 5 mV (reference point).

Alter the send level of the PS-10 and the range of the SPM-11 as shown in the following Table. Read off the deviation from the nominal value on the digital voltmeter.



| Send level PS-10/ dBm | Range SPM-11/ dB | Nominal value | Error limit (e) | Test setup error (m) |
|---|---|---|---|---|
| -0.0 | 0 | 0 dB ≅ 4000 mV ± 5 mV | Reference point | ——— |
| -1.0 | 0 | -1 dB ≅ 3565 mV | ±2.5 mB ≅ ±10 mV | ±3.9 mB ≅ ±16 mV |
| -2.0 | ↓ | -2 dB ≅ 3177 mV | ±2.5 mB ≅ ±9 mV | ±4.1 mB ≅ ±15 mV |
| -3.0 | ↓ | -3 dB ≅ 2832 mV | ±2.5 mB ≅ ±8 mV | ±4.6 mB ≅ ±15 mV |
| -4.0 | ↓ | -4 dB ≅ 2524 mV | ±2.5 mB ≅ ±7 mV | ±4.8 mB ≅ ±14 mV |
| -5.0 | ↓ | -5 dB ≅ 2249 mV | ±2.5 mB ≅ ±6 mV | ±5.4 mB ≅ ±14 mV |
| -6.0 | ↓ | -6 dB ≅ 2005 mV | ±2.5 mB ≅ ±6 mV | ±6.0 mB ≅ ±14 mV |
| -7.0 | ↓ | -7 dB ≅ 1787 mV | ±2.5 mB ≅ ±5 mV | ±6.3 mB ≅ ±13 mV |
| -8.0 | ↓ | -8 dB ≅ 1592 mV | ±2.5 mB ≅ ±5 mV | ±7.1 mB ≅ ±13 mV |
| -9.0 | ↓ | -9 dB ≅ 1419 mV | ±2.5 mB ≅ ±4 mV | ±7.9 mB ≅ ±13 mV |
| -10.0 | -10 | 0 dB ≅ 4000 mV | ±2 mB ≅ ±9 mV | ±11 mB ≅ ±52 mV |
| -20.0 | -20 | ↓ | ↓ | ↓ |
| -30.0 | -30 | ↓ | ↓ | ↓ |
| -40.0 | -40 | ↓ | ↓ | ↓ |
| -50.0 | -50 | ↓ | ↓ | ↓ |

Figure 8-3 Table for checking partial errors



NOTE: The error can only be determined to certain limits with the test setup used. The PS-10 is checked in the factory with test instruments that have been specially designed for the purpose. The method indicated is, however, quite adequate for finding the large deviation which would be expected in the case of a fault.

## 8.5 INTRINSIC HARMONIC RATIO

Required test equipment:

| | | |
|---|---|---|
| 1 Selective Level Meter | SPM-11 | W & G |
| 1 Terminating impedance | 600 Ω/1 % | |
| 1 T Adaptor, 3 pole | S 833 | W & G |

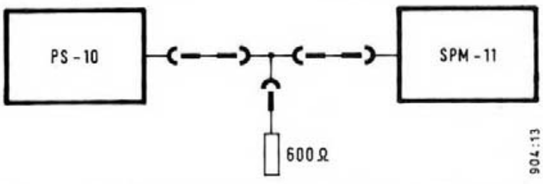



Figure 8-4 Test setup for intrinsic harmonic ratio

Settings:

PS-10:

Output impedance : 0 Ω
Level : -0.0 dBm

SPM-11:

Range : 0 dB
Drive mode : low distortion
Bandwidth : 40 Hz
Display : fast



Tune the SPM-11 to the send frequency $f_0$ of the PS-10. Adjust the calibration potentiometer on the SPM-11 so that the display is exactly 0 dB (reference point).

Then increase the sensitivity of the SPM-11 by 40 dB. Tune the SPM-11 to 2 x $f_0$ and 3 x $f_0$ and read off the intrinsic harmonic distortion on the meter.

Carry out measurement at $f_0$ = 200, 1000, and 4000 Hz.

Error limit (e): ≤ 40 dB
Test setup error (m): ±0.5 dB

## 8.6 ERROR LIMITS ON THE SEND FREQUENCY

Required test equipment:

1 Universal counter PM 6614 Philips

Test setup:
Connect the output of the PS-10 with input A of the counter.

Settings:

PS-10:
Output impedance : 0 Ω
Level : -0.0 dBm

PM 6614:
Frequency range : < 100 kHz
Resolution : 1 Hz

Set the frequency to be checked on the PS-10 and read off the value on the universal counter.

Error limit (e): for f = 800 Hz : ±2%
for f = 200 Hz to 4 kHz : ±3%
Test setup error (m): : ±1 Hz

Aligning 1 P 2 (at f = 4 kHz):

Using 1 P 2 set a frequency of 4 kHz.

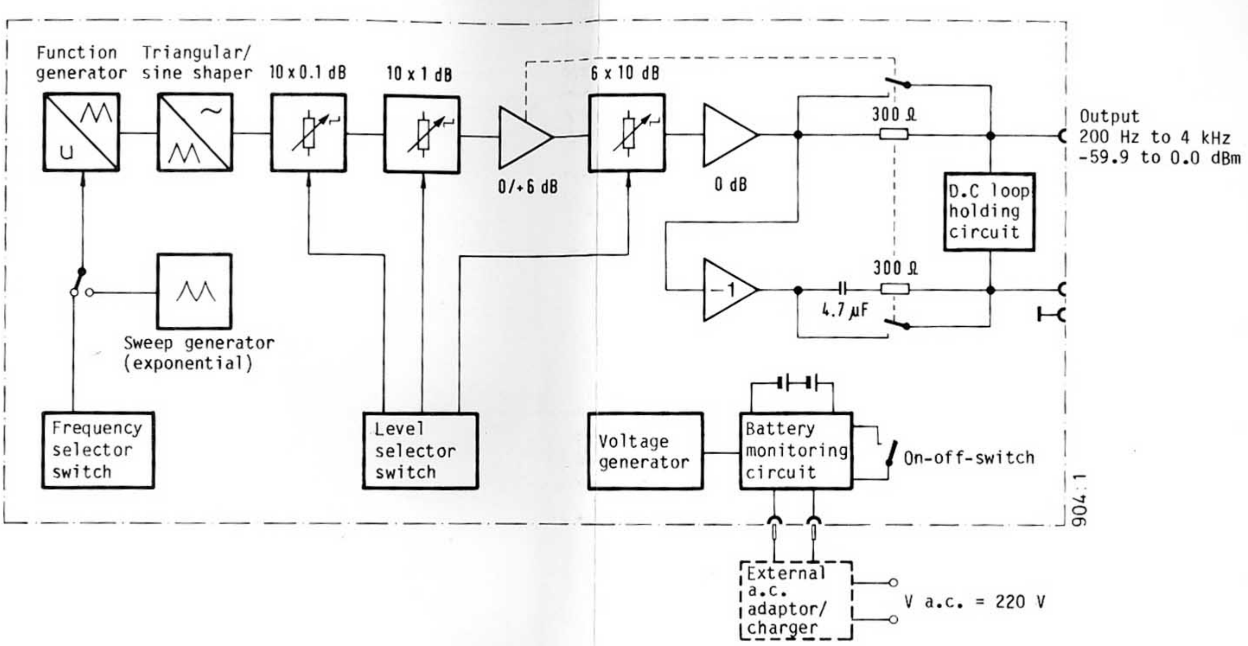



Figure 9-1 Simplified block diagram of the PS-10



# 9 FUNCTION AND CIRCUIT DESCRIPTION

## 9.1 FUNCTIONAL DESCRIPTION OF THE PS-10

### 9.1.1 SIGNAL GENERATION

The oscillator in the PS-10 is a function generator that first of all produces a triangular signal which is then passed through a shaper to give a good approximation of a sine wave.

The frequency of the oscillation is solely determined by the control voltage which is fed to the function generator. A constant control voltage is fed from the frequency selector switch and a varying voltage from the sweep generator. The latter voltage varies exponentially with time. This means that the frequency interval swept through per unit time is constant and that the sweep corresponds to the logarithmic frequency scale on, for example, the VDU (x-deflection).

### 9.1.2 LEVEL CONDITIONING

The level selector switch controls the electronic switchover of three attenuators which reduce the level in steps of 10, 1, and 0.1 dB.

In the setting "600 Ω" a buffer amplifier generates an additional gain of +6 dB. This is necessary because when operated with $Z_{out} = Z_L = 600\ \Omega$, half of the output power is dissipated in the PS-10 itself (2 x 300 Ω).



### 9.1.3 OUTPUT STAGE

The output stage is constructed from an inverting and a non-inverting amplifier. After these two components come two 300 Ω resistors for power matching ($Z_{out} = Z_L = 600\ \Omega$) and a capacitor which blocks off external d.c. voltages, e.g. from the loop holding circuit, from the output stage. The resistors and the capacitor are by-passed by means of a switch in the low output impedance setting ("0 Ω"); in this case no external d.c. voltage may be applied to the PS-10.

### 9.1.4 D.C. LOOP HOLDING CIRCUIT

This circuit presents a low impedance to d.c. voltages and a high impedance to a.c. voltages. This means that the circuit will pass the current of a d.c. holding loop (≤ 60 mA) without attenuating the a.c. output voltage.

### 9.1.5 SUPPLY VOLTAGE

The PS-10 Level Generator is powered by two 9 V dry batteries or by two NiCads. These are used to generate a voltage of ±6 V internally, i.e. 12 V with a stabilised centre point.

The PS-10 is switched on and off by means of a single pushbutton. This button is connected to a flip-flop circuit. A time switch switches off the PS-10 after 4 min when it is powered by dry batteries or NiCads; when powered by an a.c. adaptor/charger this function is disabled so making continuous operation possible.

A green LED flashes when then PS-10 is functioning. If the battery voltage sinks below a certain threshold, a red LED also flashes indicating that the batteries will be flat in a short period of time. The PS-10 switches itself off automatically before the battery voltage sinks so low that the PS-10 would no longer function correctly.

## 9.2 CIRCUIT DESCRIPTION OF THE SUBASSEMBLIES

### 9.2.1 SIGNAL GENERATION

#### 9.2.1.1 Oscillator

The triangular function generator works on the following principle:

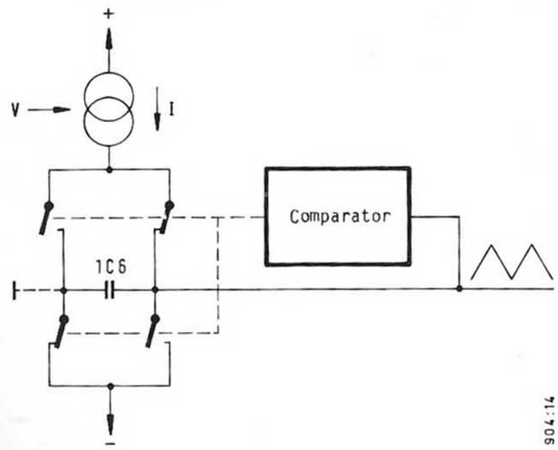



Figure 9-2 Operation of the triangular generator

A constant current is used to charge capacitor 1 C 6 alternately in one polarity direction and then the other; a comparator switches over the charging direction at a voltage of +1 V or -1 V. The triangular voltage, which can be measured at TP 5, is therefore 2 V peak to peak.



In reality the voltage controlled current source in realised by means of the op-amp 1 IC 2 with the transistor 1 T 5 and the resistors 1 R 40 and 1 P 2. The control voltage passes via contact pin 25 and is referred to the voltage of +4.5 V at pin 24, and not to a voltage of 0 V. The four transistors 1 T 6, 1 T 7, 1 T 8, and 1 T 9 act as a switch for changing the polarity of the charging device. The operational amplifier 1 IC 3/1 forms a control loop with 1 T 10 via 1 T 8. This control loop holds one of the terminals of capacitor 1 C 6 at a voltage that is approximately equal to the centre point voltage.

The second operational amplifier acts as a buffer amplifier. Therefore 1 IC 4 is connected up as a comparator whose threshold is held at a value of 0.5 V by the resistors 1 R 53 and 1 R 54. As this voltage divider is switched to +6 V or -6 V by the output of 1 IC 4 the comparision is valid in both voltage directions.

#### 9.2.1.2 SINE SHAPER

A differential amplifier is used as the sine shaper:

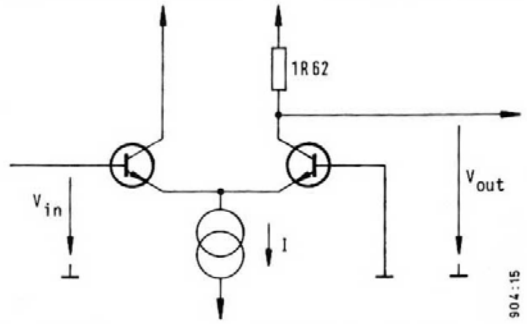



Figure 9-3 Basic circuit of the sine shaper



If the input voltage increases linearly the output voltage is as shown in the graph below (tanh function)

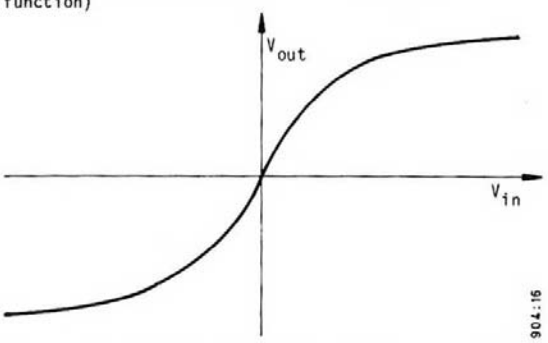



Figure 9-4 Input/output characteristic of the sine shaper

When the input voltage is triangular and varies along a suitable section of the above curve, the output of the shaper is a good approximation to a sine curve.

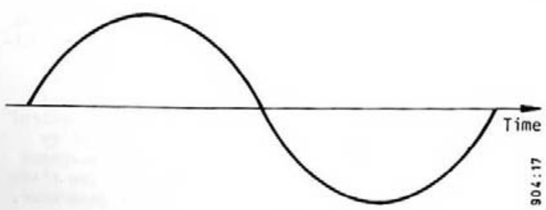



Figure 9-5 Output voltage of the sine shaper



The amplitude of the triangular not only determines the amplitude of the sine signal, it also fixes the magnitude of the odd harmonic distortion factors (k3, k5 ...). For this reason k3 is reduced to a minimum by adjusting 11 P 4. The d.c. offset voltage of the triangular signal determines the even harmonic distortion factors (k2, K4 ...) on the other hand. The even harmonic content can be reduced to a minimum by adjusting the offset of 1 IC 4 with 1 P 5. Theoretically the even harmonc content could be reduced to zero. The small kink at the voltage peaks indicates that a "natural" amount of odd harmonics remains however.

The differential amplifier is realised with the transistor pair 1 T 12 and 1 T 12. Two additional emitter resistors 1 R 61 and 1 R 64 produce current feedback, and so optimise the approximation to a pure sinusoidal signal. The original triangular voltage is divided down to a peak to peak voltage of approximately 400 mV by means of 1 R 57 ad 1 R 60. the high-valued resistor 1 R 59 is an adequate current sink for the differential amplifier. The temperature dependent resistors 1 R 59 and 1 R 66 compensate for the temperature related behavior of the base emitter diode in 1 T 12.

#### 9.2.1.3 Frequency selector switch and sweep generator

The control voltages for the triangular signal function generator are referred to a voltage of +4.5 V as was mentioned in Section 9.2.1.1. This reference voltage is generated by the operational amplifier 1 IC 1/1. The largest voltage difference of 1.8 V (i.e. +2.7 V referred to the centre point voltage) produces that highest frequency of 4 kHz. The control voltages for the fixed frequencies are produced by simple division via 1 R 18 to 1 R 28. These voltages are fed through the rotary switch 1 S 1 and the slide switch 1 S 2/2 to the control input of the generator.

The sweep should be carried out over the frequency range so that equal time intervals give a logarithmic frequency scale (on a display unit for example).

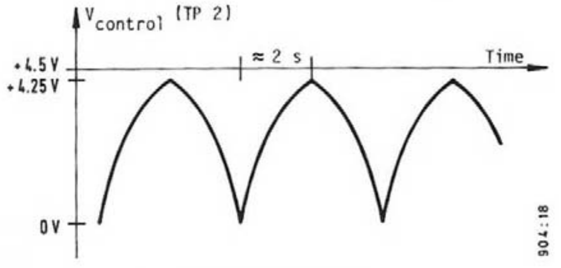



Figure 9-6 Control voltage at TP 2



THe sweep generator produces a signal like the one shown in the preceding Figure with the following circuit:

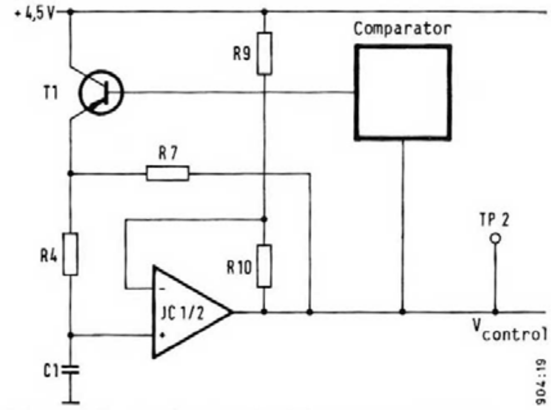



Figure 9-7 Basic circuit of the sweep generator

When the PS-10 is switched on or switch 1 S 2 is switched over to the sweep mode, capacitor 1 C 1 is discharged, transistor 1 T 1 comes on, and 1 C 1 is recharged via 1 R 4. The charging and discharging of a capacitor is exponential with time. The charging current decreases as the voltage across 1 C 1 increases.

When a threshold voltage is reached, the comparator stops the transistor 1 T 1 from conducting and 1 C 1 is discharged by the operational amplifier via 1 R 4 and 1 R 7. This is also an exponential function of time. The discharge current increases as the voltage across 1 C 1. When the lower threshold voltage is reached, 1 T 1 conducts again and the charging process is repeated.



The capacitor 1 C 1 and the resistors 1 R 4, 1 R 7, 1 R 9 and 1 R 10 are so dimensioned that the charge and discharge times are both about 2 s.

The operational amplifier 1 IC 1/3 functions as the comparator, which itself switches over the charge and discharge thresholds via transistor 1 T 2. While 1 C 1 is charging, 1 T 2 does not conduct and the threshold is fixed at about +4.25 V by 1 R 13 and 1 R 15. During the discharge phase, 1 R 15 is short-circuited by 1 T 2 and so the lower threshold is 0 V.

The control voltage at 1 TP 2 is divided down to the generator control voltage by means of 1 R 11 and 1 R 12, as the generator accepts values between +2.925 V and +4.410 V, or, referred to the reference voltage of +4.5 V, values between 1.575 and 0.090 V. This means the sweep limits lie between 3.5 kHz and 200 Hz.

### 9.2.2 LEVEL CONDITIONING

#### 9.2.2.1 Level settings

The 0.1 level steps are realised by loading the output impedance of the sine former (1 R 62, also see Sec. 9.2.1.2) with the resistors 2 R 1 to 2 R 4. These resistors can be connected together in various combinations by means of the 4 way switch 2 IC 1. The switch 2 IC 1 is controlled by one gang of the thumbwheel switch. The various combinations correspond to BCD code.

The 1 dB level steps are realised by switched the divider 2 R 9 to 2 R 18 via the multiplexer 2 IC 2, whose inputs are selected by one gang of the thumbwheel switch in BCD code.

Like the 1 dB steps, the 10 dB steps are realised by means of a divider, in this case 2 R 25 to 2 R 32. The tapping points of this divider are switched by the multiplexer 2 IC 5. The selection is carried out using one gang of the thumbwheel switch; BCD code is used. In switch position "-∞" a positive voltage is applied



to the base of transistor 1 T 11 which is located in the triangular wave generator, while at the same time the output stage of 1 IC 4 (triangular generator) is connected to a negative potential, so interrupting the oscillator.

#### 9.2.2.2 "$Z_{out}$ = 600 Ω/$Z_{out}$ = 0 Ω" switchover

When the PS-10 is operated under matched conditions with $Z_{out} = Z_L$ = 600 Ω, or in the switch position $Z_{out}$ = 0 Ω the output voltage must be the same: 0 dB = 0.775 $V_{r.m.s.}$. When $Z_{out}$ = 600 Ω, half of the output power will be dissipated in the output impedance of the PS-10, but this will not be the case when $Z_{out}$ = 0 Ω. Therefore when the output impedance is 600 Ω the output stage must deliver an output voltage that is twice as high as the voltage when $Z_{out}$ = 0 Ω.
The necessary gain switchover is carried out in the level conditioning circuit. In the switch position "$Z_{out}$ = 600 Ω" (2 S 3) the base of the transistor connected via 2 R 34 lies at a medium potential. Therefore 2 T 1 is on, the switches 2 IC 9/3 and 2 IC 9/2 are closed and 2 IC 9/1 is open: the operational amplifier 2 IC 3 operates with a gain of +6 dB.

When 2 S 3 is switched to "$Z_{out}$ = 0 Ω", the base of 2 T 1 is pulled up to a positive potential by means of resistor 2 R 33. This causes 2 T 1 to go off; the switches 2 IC 9/2 and 2 IC 9/3 open, and switch 2 IC 9/1 closes: now 2 IC 3 is working as an amplifier with full negative feedback and has a gain of 0 dB.

The resistor 2 R 24 and the potentiometer 2 P 1 are connected between the amplifier and the following 10 dB attenuator. Together they cause an attenuation of about 6 dB. The level of the whole instrument is adjusted with 2 P 1.

## 9.2.3 OUTPUT STAGE

The output stage is balanced and comprises a noninverting amplifier (2 IC 10/1) and an inverting amplifier (2 IC 10/2). As the gains are +1 and -1 the voltage between test points 6 and 7 is two times bigger than the input voltage, which is produced by the level conditioning circuit; when the output impedance is 0 Ω this is also true for the output voltage.

N.B. The balanced output does not float with respect to the internal 0 V operating voltage!

When the switch 2 S 3 is in the position

$Z_{out}$ = 0 Ω, the resistors 2 R 65 and 2 R 66 are connected into the signal path and produce external d.c. voltages, e.g. from a holding loop, from the output amplifiers. In the switch position $Z_{out}$ = 0 Ω, the resistors 2 R 65, 2 R 66 and the capacitor 2 C 11 are by-passed. Only the residual impedance of the switch remains this is about 2 Ω, the maximum possible value is 3 Ω. In this switch position no d.c. voltages may be applied externally, the amplifiers are, however, protected from destruction by external voltages by means of the diodes 2 Gl 5 to 2 Gl 8.

The chokes 2 L 1 and 2 L 2 suppress the tendency of the circuit to oscillate when capacitative loads are connected.

The d.c. offset voltage of the output stage can be adjusted to zero by means of the potentiometer 2 P 6.

## 9.2.4 LOOP HOLDING CIRCUIT

The holding circuit must fulfil two requirements: it must present a low resistance to a d.c. holding current of up to 60 mA and at the same time present a very high impedance to a.c. signals so that the output stage is not overloaded. The holding circuit behaves approximately like an inductance of about 25 H and so fulfils these requirements.



The circuit works in the following manner:

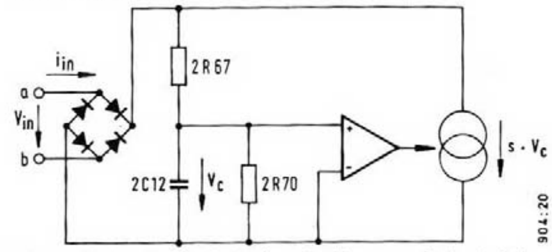



Figure 9-8 Simplified circuit diagram of the holding circuit

If a d.c. voltage $V_{in}$ is applied across the points a and b - the polarity is immaterial because of the diode bridge - a current first of all flows into the capacitor 2 C 12 via the high value resistor 2 R 67. The greater the voltage across 2 C 12, $V_c$, becomes, the greater the input current accepted by the controlled current source becomes. This means that the whole circuit presents a low resistance to d.c. voltages. However for superimposed a.c. voltages there is always a high input impedance given by 2 R 67 = 3.3 MΩ.

The differential amplifier comprises two darlington transistors connected in cascade (2 T 8 and 2 T 9). The transistor with the greater power rating is used as the controlled current source. The bias for 2 T 8 is reduced by passing via the divider 2 R 68 and 2 R 71 to the capacitor 2 C 13. The current control response s of the whole arrangement is determined by current coupling via the resistor 2 R 69.



## 9.2.5 POWER SUPPLY

### 9.2.5.1 On/off flip-flop and the time switch

The voltage from the dry battery or the NiCads and a.c. adaptor/charger passes via the diodes 3 Gl 1 and 3 Gl 3 which prevent damage to the circuit. The diode 3 Gl 2 stops the battery discharging when the a.c. adaptor/charger connector is short-circuited. Switch 3 S 2/1 (in the battery compartment) is open when dry batteries are used because this type of battery should not be charged.

The transistor 3 T 2 is switched through via 3 T 3 by means of button 3 S 1. At the same time the Q outputs of the flip-flops 3 IC 2/1 and 3 IC 2/2 go to +6 V and keep 3 T 2 open via 3 T 3, even if the button is released again. The Q output of the second flip-flop 3 IC 2/2 therefore goes into its higher voltage state because during the switch-on, a positive voltage is applied to the S (set) input via the capacitor 3 C 3. The capacitor 3 C 3 is discharged to the negative voltage via the resistor 3 R 11 with a time constant of about 0.5 s; therefore if button 3 S 1 is pressed again after this time, the lower input voltage state at the D input is transferred to the Q output of 3 IC 2/2 because of the positive voltage at the Q output of 3 IC 2/2 and at the CLK (clock) input f 3 IC 2/2.: 3 T 2 is blocked via 3 T 3 and so the PS-10 is switched off.

3 IC 1 functions as an oscillator and multiple divider. The oscillator frequency is determined by 3 R 10 and 3 C 2 and has a value of about 33 Hz which corresponds to a period of about 30 ms; the frequency is divided down by a factor of $2^6$ and so the frequency here is equal to 33 Hz/$2^6$ = 0.5 Hz, at the output Q 14 the frequency is divided down by a factor of $2^{14}$. The output of Q 6 is used to flash the LED approximately every 2 s, Q 14 switches the PS-10 off via the D input of 3 IC 2/1, when it goes into the lower voltage state, i.e. after approximately



30 ms x $2^{14}/2$ = 30 ms x $2^{13}$ = $2^{13}$ = 246 seconds or about 4 minutes.

### 9.2.5.2 Voltage and centre point stabilisation

The operational amplifier 3 IC 4/1 compares the operating voltage, which has been divided down by 3 R 25, 3 P 1 and 3 R 24, with the voltage at reference diode 3 Gl 6 and controls transistor 3 T 5 correspondingly as a setting element. As 3 T 5 does not conduct when the PS-10 is switched on first, resistor 3 R 20 is required so that a voltage can build up at the reference diode.

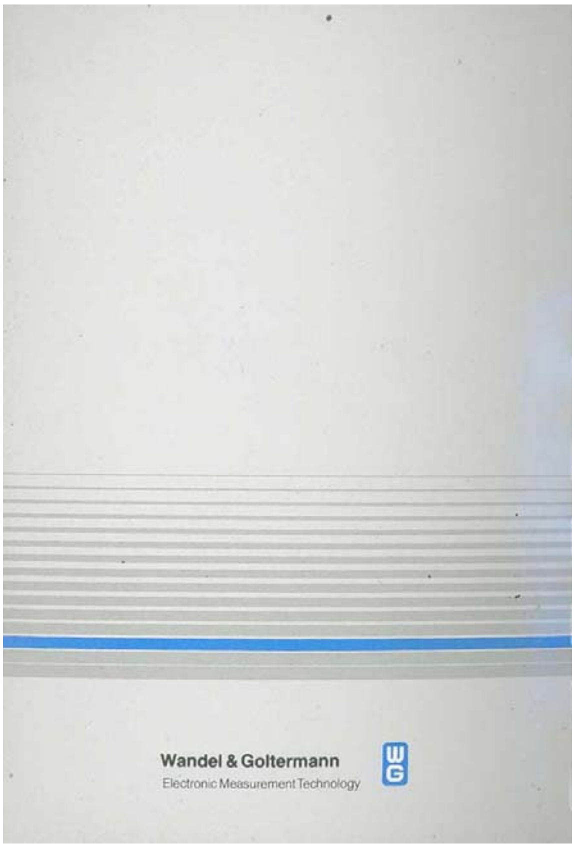
The centre point voltage is produced by means of the divider 3 R 40 and 3 R 41, and is stabilised by 1 IC 1/4 which is part of a negative feedback loop.

### 9.2.5.3 Battery monitoring circuit

The unregulated supply voltage is applied across the divider 3 R 28, 3 R 31 and 3 R 32, and is monitored by the two comparators 3 IC 4/2 and 3 IC 4/3.

As a reference the stabilised centre point voltage is applied to the inverting input of 3 IC 4/3. If the supply voltage sinks below about 13.2 V its output goes positive and switches the PS-10 off via the R (reset) input of the flip-flop 3 IC 2/2.

A reference voltage is applied to the non-inverting input of 3 IC 4/2. This reference voltage can be switched over by means of the switch 3 S 2/2 in the battery compartment because dry batteries and NiCads have different charging, characteristics. If the supply voltage sinks below about 14.5 V (dry batteries) or 17.0 V (NiCads), the output of 3 IC 4/2 goes negative and blocks transistor 3 T 6. This causes the second red LED to flash every two seconds.




This Digital edition of the

W&G PS-10 Level Generator

Service manual

was prepared in Australia

by

Gary Edwards

On 18th September 2006

Note:- This manual should be read in conjunction with the Description and Operating Manual, which contains the schematics and parts lists