1 Introduction

The low frequency generator SG66 is one of a series of Advance Signal Generators and provides both sine and square waves from 5c/s to 125kc/s, with low hum and noise content at all signal levels.

Frequency selection is provided by a range switch, selecting one of five ranges, and a calibrated dial that is easy to read. The output level is indicated by the reading on a calibrated meter and the setting of a 50dB decade attenuator.

When using the sine wave output, alternative impedances of 600Ω floating and 5Ω unbalanced are available with output levels that are continuously variable from 0 to 30V r.m.s. and from 0 to 1W, respectively. A square wave output is also available at separate terminals and is adjustable from 0 to 30V peak to peak. The maximum rise and fall time of the square wave is 0·75μs over the whole frequency range.

2 Specification

Frequency Range 5c/s to 125kc/s in five ranges:
5c/s to 50c/s
50c/s to 500c/s
500c/s to 5,000c/s
5kc/s to 50kc/s
50kc/s to 125kc/s

Frequency Accuracy ±1% or ±1c/s whichever is the greater.

Hum and Noise Level Less than 0·25% of maximum output.

Sine Wave Output impedance 600Ω approximately, floating unbalanced, 5Ω unbalanced.

Output Levels 0 to 30V r.m.s. into 600Ω. Level indicated by calibrated meter and setting of 50dB decade attenuator. Meter calibrated −10dB to +2dB relative to 1mW into 600Ω. 0 to 1W into 5Ω.

Output Voltage Accuracy Decade attenuator ±2%. Meter ±5% F.S.D.

Distortion Less than 1% at 1W.

Square Wave Output impedance varies up to 5kΩ with level setting. Output level 0 to 30V pk.pk. Rise and fall times 0·75μs maximum. (Sine wave output available at same time with some distortion.)

Power Supply 100, 110, 120, 130V ±7%
200, 220, 240, 260V ±7% a.c. supply 40 to 60c/s.

Power Consumption Approximately 100W.

Accessories Supplied One red 4mm plug, Part No. 12178. One black 4mm plug, Part No. 12179. One Instruction Manual, Part No. 2894.

Dimensions

Width	*Height*	*Depth*
16½in.	10½in.	8¾in.
(42cm)	(27cm)	(22cm)

Weight 32¼lb (14·6kg).

Finish Dark blue metal case with light grey front panel and medium grey surround. All colours to B.S.2660; case tint No. 7–086, front panel tint No. 9–093, front panel surround tint No. 9–095.

3 Operation

3.1 A.C. Supply Voltage

Check that the transformer T3 is set for the correct nominal a.c. supply voltage before connecting the instrument to the local a.c. supply.

Carefully lay the instrument on its face and remove the four screws at the rear. Lift the case clear and locate the supply transformer adjacent to the a.c. supply switch and indicator lamp. Early versions of the instrument have a supply transformer label with different voltage tap designations than those listed below. Refer to T3 on the circuit diagram (*fig.2*) where both types of designation are used including the start (S), finish (F) and the nominal voltage of each input winding.

Ensure that the soldered connections to the supply transformer correspond to those given in the following tables, appropriate to the nominal voltage of the local supply.

(a) *Voltage Range 195V to 265V*

Connect A to fuse F1 and strap B to C. Other connections as in table.

Supply Voltage	*Connections* *Inter Winding*	*To Switch S1 From*
265	D–E	H
260	D–F	H
250	D–G	H
245	D–E	G
240	D–F	G
235	D–E	F
230	—	D
225	D–F	E
220	D–G	F
215	D–G	E
210	D–H	G
200	D–H	F
195	D–H	E

(b) *Voltage Range 100V to 130V*

Connect A to fuse F1 and strap A to C, B to D. Other connections as in table.

Supply Voltage	*Connections* *Inter Winding*	*To Switch S1 From*
130	D–E	G
125	D–F	G
120	D–E	F
115	—	D
110	D–F	E
105	D–G	F
100	D–G	E

3.2 Warming Up Period

A warming up period of 30 minutes should normally be allowed in order to obtain maximum frequency accuracy, i.e. ±1%. For less exacting requirements the warming up period may be reduced to approximately five minutes.

After a long period in storage the warming up period should be extended to two hours.

3.3 Frequency Selection

The desired signal frequency is selected using the five-position range switch and the FREQUENCY control, in conjunction with the appropriate frequency scale.

The five frequency ranges are as follows:

5 to 50c/s	Top black scale
50 to 500c/s	Top black scale
500 to 5,000c/s	Top black scale
5 to 50kc/s	Lower red scale
50 to 125kc/s	Top red scale

3.4 Sine Wave Output

Two sine wave outputs are available with the output selector switch at SINE. One is from the nominal 600Ω output which is floating and unbalanced, the other is from the unbalanced 5Ω output which has one terminal earthed.

(a) *600Ω Output*

This output can be adjusted using both the ADJUST VOLTS control and the 50dB decade attenuator. The signal level into the attenuator can be read directly off the meter up to a maximum of 30V, when the output is correctly terminated. When the termination is a high impedance, the output voltage level is approximately double the indicated value in attenuator positions −20dB to +20dB. The blue terminal is preferred for earthing purposes.

(b) *5Ω Output*

A maximum output of 1W is obtainable from the 5Ω terminals and may be adjusted using the ADJUST VOLTS control. This output is independent of the setting of the decade attenuator and has no direct relation to the voltmeter reading.

3.5 Square Wave Output

An additional square wave output is available at separate terminals when the output selector switch is in the SINE AND SQUARE position. The rise and fall times of the square wave do not exceed 0·75μs and the output level may be adjusted between 0 to 30V peak to peak. The output impedance using the square wave varies with the output setting, being a maximum of 5kΩ at high output levels.

Although the meter now indicates the square wave output level, sine wave outputs with some distortion are also available and could be monitored with an external meter.

NOTE *If the square wave is set on the 30V range, a much higher voltage will exist at the 600Ω sine wave output terminals when these are terminated in a high impedance. If the output selector switch is now moved to* SINE, *maximum voltages approximating to 100V r.m.s. will exist at the 600Ω terminals, possibly damaging any external circuit components which may be connected.*

It is recommended that the voltage level is reduced to a minimum on any particular range before moving the output selector switch from SINE AND SQUARE *to* SINE.

4 Circuit Description

4.1 General

The basic circuit of the instrument is illustrated in the functional diagram (*fig.1*) and the full circuit diagram in *fig.2*. It is seen that a Wien Bridge Oscillator forms the source of both sine and square wave signals. The square wave output is obtained using a Schmitt trigger circuit and clipper circuits, as described in later paragraphs.

4.2 Wien Bridge Oscillator

The valves V2A and V2B form the basis of the oscillator circuit and, together with the associated cathode followers V1A and V1B, are connected to that part of the h.t. supply which is stabilised by the neons NS1, NS2.

The high impedance grid circuit of the cathode follower V1A is connected to the mid-point of the potential divider formed by R1/R3, R2/R4 etc. which is connected in parallel with C25 and forms one arm of the bridge. The other bridge arm is formed by the series elements R8/RV1, R9/RV2 etc. connected in series with C26 and the fixed trimmer C27, and preset trimmers C1 to C5.

The drive to the bridge is derived from the low impedance circuit of the cathode follower V1B. C7 forms a negative feedback path between V2B cathode and V1A grid circuits. Other forms of negative feedback are derived from the negligible decoupling in the cathode circuit of V2A (C9 is only effective on the highest frequency range) and by the absence of decoupling across R24 in the cathode circuit of V2B.

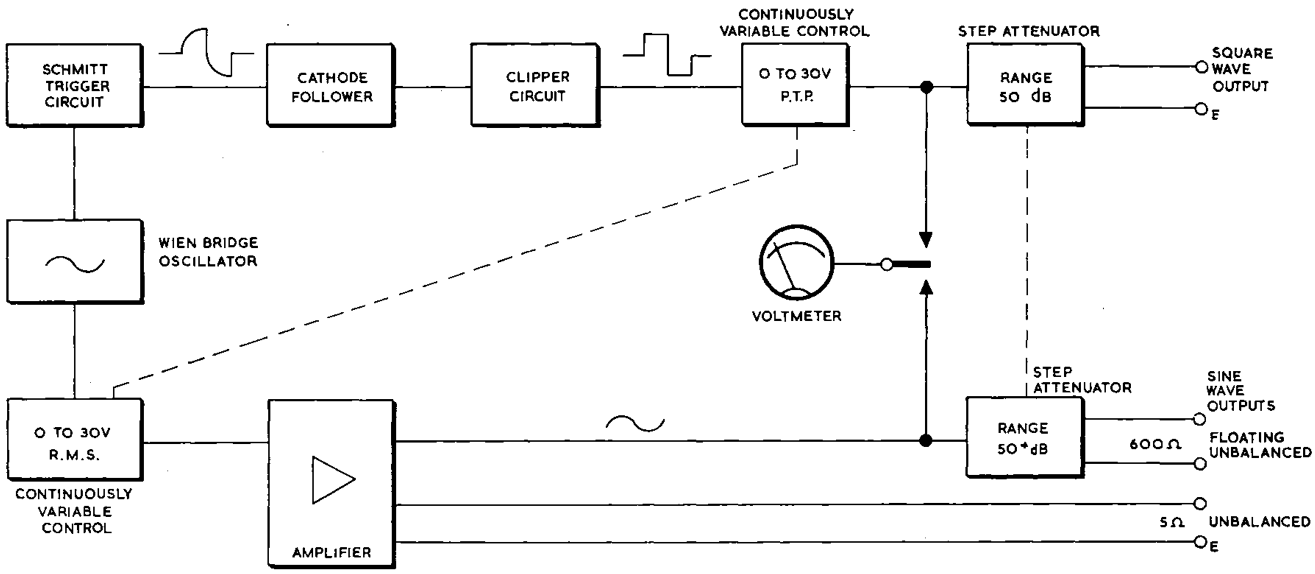


Fig.1. Functional Diagram SG66

4.3 Sine Wave Output

The oscillator output is passed via C14 to the sine wave level control RV7 (ADJUST VOLTS) which is located in the grid circuit of the triode V4B. This triode forms a straight-forward driver stage for the single ended push–pull circuit formed by the series coupled valves V5 and V6. Negative feedback is provided via the loop C19, R41 and by the lack of decoupling in the cathode circuit of V4B.

The sine wave signals are fed to one of two output transformers via capacitor C31. Transformer T1 is used on the two lower frequency ranges from 5c/s to 500c/s, and T2 on the three higher frequency ranges from 500c/s to 125kc/s.

One output is floating with an impedance of 600Ω and is monitored by the output level meter VM1. The level meter monitors the input to the decade attenuator, and the attenuator output is connected direct to the 600Ω output terminals. The alternative 5Ω sine wave output is taken from a separate winding on transformer T1 or T2 and is unbalanced to earth.

4.4 Square Wave Output

The input to the Schmitt trigger circuit V3 is earthed when the output selector switch is in the SINE position. Moving this switch to the alternative SINE/SQUARE position removes this earth connection, and passes part of the sinusoidal signal across R28 to the grid of the trigger valve V3.

When the input signal is positive, and with the earth connection removed from the grid, V3A will conduct. The input signal going negative at V3A grid will cause reduction in current through the valve, resulting in an increased positive potential at the anode which is passed to the grid of V3B via R51. Thus V3A will tend to cut-off and V3B will now conduct. Therefore, the application of the sinusoidal signal to the grid of V3A will result in a waveform from the anode of V3B that is approximately square in shape (*fig.1*).

The cathode follower V4A acts as a buffer stage between the high impedance output of the trigger circuit and the relatively low impedance of the following clipper circuit. In this way the pulse shape of the trigger output is preserved.

From V4A the signal is passed to the clipper circuit formed by zener diodes MR1 and MR2, where the output of the trigger circuit is shaped into an improved square wave. The square wave output level is controlled by the potentiometer RV10 (ADJUST VOLTS) and the decade attenuator formed by R57 to R62. The output level meter VM1 indicates the signal level immediately preceding the attenuator except in the +30dB position of the attenuator, when the meter indicates the level at the output terminals. In positions +20dB to −20dB the output of the attenuator is connected to the square wave output terminals.

4.5 Power Supply Circuit

The d.c. supply for the signal generator is derived from a.c. supplies (100 to 130V or 195 to 265V) via transformer T3 and a conventional voltage doubler circuit consisting of C24, MR4, MR3 and C23. The components R45 and C22 form a simple smoothing circuit. The h.t. supply to oscillator valves V2A and V2B is stabilised by neons NS1 and NS2.

The valve heaters are supplied from a separate winding on T3. A centre-tap earth connection is provided by the slider of RV8 which may be adjusted to produce minimum hum in the output signal.

The supply indicator lamp ILP1 is connected directly across one 115V winding of T3.

5 Maintenance

5.1 Removal of Instrument Case

Place the instrument carefully face downwards on a bench and remove the four coin-slotted screws at the rear. The case can now be lifted clear of the chassis and front panel.

5.2 Fuse Replacement

N.B. *Switch* OFF *and disconnect the instrument from the a.c. supply.*

The supply fuse FS1 is located on the inside of the lower half of the chassis adjacent to T3 and is accessible when the case has been removed (para. 5.1). The fuse fitted as standard is the Belling Lee type L1055, 1A rating.

5.3 Valve Replacement

With the case removed, all valves except V1 and V2 are readily accessible on the printed board immediately behind the output level meter VM1. Valves V1 and V2 become accessible after removing the screening can secured by six screws. It is recommended that the recalibration procedure of para. 5.5 is followed after the replacement of either V1 or V2, and the procedure of para. 5.6 followed after replacement of any of the valves V3 to V6.

The valve types are as follows:

V1 12AT7	V4 6BQ7A
V2 ECF80	V5 EL86
V3 12AT7	V6 EL86

5.4 Adjustment for Minimum Distortion

Correctly terminate the 600Ω terminals and, with the output selector switch at SINE, set the output frequency to approximately 5kc/s. Adjust RV6 on the oscillator board, protruding through the screening can, until the current through thermistor TH1 is 1mA a.c. This will be indicated by a 1·8V r.m.s. voltage drop across R26 measured with a valve voltmeter or millivoltmeter. The required voltage may be measured as a difference between the two readings from either side of the resistor to earth, or directly across R26 using a valve voltmeter with a floating input.

Using a distortion factor meter across the 600Ω terminated terminals, check that the total distortion is less than 1% with an output level of 1W at a frequency of 5kc/s.

5.5 Frequency Calibration

It will be necessary to check the SG66 output against a frequency standard having an accuracy better than ±0·1% by means of a Lissajous display on an oscilloscope or by observing beats using a simple detector circuit.

Set the SG66 to the highest frequency range and using the dial set the instrument to a convenient frequency at the bottom end of the scale at an approximate level of 25V. Select an output from the frequency standard at the same nominal frequency and adjust RV1 until the two frequencies coincide. RV1 is accessible through a hole in the right hand end plate (viewed from the front).

The correct adjustment is indicated by a stationary Lissajous display or by a zero beat from a detector.

Set the SG66 by means of the dial to a convenient frequency at the higher end of the same frequency range and adjust for maximum accuracy using C5. C5 is accessible through a hole in the right hand end plate (viewed from the front).

Check both ends of the scale in turn until no further adjustment is required.

Proceed similarly on each frequency range using the preset components indicated below until the frequency calibration check of the instrument is complete.

Range	*Adjust alternately*
50 to 125kc/s	RV1 and C5
5 to 50kc/s	RV2 and C4
500 to 5,000c/s	RV3 and C3
50 to 500c/s	RV4 and C2
5 to 50c/s	RV5 and C1

5.6 Output Calibration Procedure

(a) *600Ω Output Impedance Adjustment*

Select the SINE position of the output selector switch and adjust to a frequency of approximately 200c/s. Adjust the level on the highest voltage range to 30V using an external meter with the 600Ω terminals unterminated. Correctly terminate the 600Ω terminals and note the meter reading. Adjust RV12 (on printed board underneath main chassis) so that the indicated voltage when terminated is half the unterminated voltage.

Select a frequency of approximately 6kc/s and repeat the procedure using RV11 (on printed board underneath main chassis) to obtain the required voltage condition.

The output impedance at the 600Ω terminals will have now been correctly adjusted when connected to either output transformer T1 or T2.

(b) *Sine Wave Voltage Calibration*

Terminate the 600Ω output terminals using a suitable resistor. At a frequency of 1kc/s set the output level to 25V using an external meter having an accuracy of at least ±1%. Adjust RV13 on the printed board underneath the main chassis to obtain a reading of 25V on the level meter VM1.

At a frequency of 100kc/s set the output level to 25V using the external meter. Adjust C34 on the printed board underneath the main chassis to obtain a reading of 25V on the level meter VM1.

(c) *Square Wave Mark Space Ratio*
Select the SINE AND SQUARE position of the output selector switch and adjust the output frequency to approximately 10kc/s. Connect the square wave output to an oscilloscope, adjust the output voltage to a maximum level and obtain a steady display. Adjust RV9 at the bottom of the printed board to the rear of VM1 so that the mark space ratio is 1 : 1 within the limits 60 : 40 to 40 : 60.

(d) *Square Wave Voltage Calibration*
Switch to SINE AND SQUARE and adjust to a frequency of approximately 1kc/s. Obtain a steady display on a calibrated oscilloscope and, using the oscilloscope graticule, set a level of 30V peak to peak. Set the internal voltmeter to 30V using potentiometer RV14 located on the right hand side of the chassis immediately to the rear of the front panel.

5.7 Hum Balance Control

Set the instrument to the frequency of the local supply (either SINE or SINE AND SQUARE) using the bottom range wherever possible. Adjust RV8 and RV15 alternately to obtain a minimum beat on the internal meter, repeating the adjustment as often as required. RV8 is located on the oscillator printed circuit board that protrudes from the screen at the rear. RV15 can be adjusted through the hole in the rear of the chassis.

6 Components List

Resistors

Ref.	Description		Part No.
R1	2·77K	Welwyn C21 1%	2380
R2	45K	Welwyn C21 1%	2374
R3	1·23K	Welwyn C21 1%	2379
R4	20K	Welwyn C21 1%	2378
R5	200K	Welwyn C21 1%	2377
R6	2M	Welwyn C21 1%	2376
R7	20M	Welwyn C23 1%	2375
R8	3·6K	Welwyn C21 1%	2371
R9	60K	Welwyn C21 1%	2370
R10	600K	Welwyn C21 1%	2369
R11	6M	Welwyn C21 1%	2368
R12	60M	Welwyn C14/C25 1%	2367
R13	4·5M	Welwyn C21 1%	2372
R14	450K	Welwyn C21 1%	2373
R15	4·5M	Welwyn C21 1%	2372
R16	20M	Welwyn C14/C25 1%	2375
R17	1M	5SWD33 5%	2069
R18	56K	5SWD33 5%	2359
R19	3·3K	5SWD33 5%	2524
R20	47K	5SWD33 5%	2358
R21	10K	5SWD33 5%	2353
R22	680K	5SWD33 5%	2874
R23	15K	5SCD4 5%	2051
R24	200Ω	5SWD33 5%	2881
R25	12K	5SWD33 5%	2880
R26	1·8K	5SWD33 5%	2523
R27	220K	5SWD33 5%	2066
R28	15K	5SCD4 5%	2051
R29	2·2K	RRC LG75	599
R30	180K	5SWD33 5%	2885
R31	180K	5SWD33 5%	2885
R32	1M	5SWD33 5%	2069
R33	47K	5SWD33 5%	2358
R34	1·5K	5SWD33 5%	2352
R35	2·2K	5SWD33 5%	2351
R36	470Ω	RRC LG 75	231
R37	1K	5SWD33 5%	2060
R38	120Ω	5SCD4 5%	2362
R39	1K	5SWD33 5%	2060
R40	1M	5SWD33 5%	2069
R41	27K	5SWD33 5%	2054
R42	120Ω	5SCD4 5%	2362
R43	5·6K	5SCD4 5%	2363
R44	5·6K	5SCD4 5%	2363
R45	470Ω	RRC LG 75	231
R46	150K	5SWD33 5%	2884
R47	56K	5SWD33 5%	2359
R48	15K	5SCD4 5%	2054
R49	10K	5SCD4 5%	2882
R50	2·2K	5SCD4 5%	2883
R51	33K	5SWD33 5%	1242
R52	56K	5SWD33 5%	2359
R53	6·8K	5SCD4 5%	2053
R54	22K	5SWD33 5%	2356
R55	20K	Welwyn AW3111 2%	2220
R56	1K	5SWD33 5%	2060
R57	6·8K	RRC 2HS2 1%	2039
R58	2·2K	RRC 2HS2 1%	2038
R59	680Ω	RRC 2HS2 1%	2035
R60	220Ω	RRC 2HS2 1%	11502
R61	68Ω	RRC 2HS2 1%	2350
R62	30Ω	RRC 2HS2 1%	1862
R63	397Ω	Welwyn C22 1%	10330
R64	4Ω	RRC 2HS3 5%	2892
R65	15K	5SWD33 5%	2354
R66	180K	5SWD33 5%	2885
R67	27K	5SWD33 5%	2054
R68	1297Ω	RRC 2HS3 1%	2046
R69	5·4K	RRC 2HS4 1%	2047
R70	18·37K	RRC 2HS2 1%	2042
R71	59·45K	RRC 2HS2 1%	2887
R72	189·5K	RRC 2HS2 1%	2888
R73	600Ω	RRC 2HS2 1%	2030
R74	600Ω	RRC 2HS4 1%	2048
R75	278Ω	RRC 2HS2 1%	2029
R76	66·7Ω	RRC 2HS2 1%	2028
R77	19·6Ω	RRC 2HS2 1%	2027
R78	6·06Ω	RRC 2HS2 1%	2026
R79	1·9Ω	RRC 2HS2 1%	2025
R80	20M	1% Welwyn	2375
R81	2M	1% Welwyn	2376
R82	33K	5% RRC 5SWD33	1242
R83	330KΩ	5% 5SWD33	2361

Potentiometers

Ref.	Description		Part No.
RV1	1K	Plessey MPD	1054
RV2	10K	Plessey MPD	2262
RV3	100K	Plessey MPD	2383
RV4	1M	Plessey MPD	2382
RV5	5M	Plessey MPD	2384
RV6	1K	Plessey MPD	1054
RV7	250K (+20K)	Dual Pot	2891
RV8	1K	Plessey MPD	1054
RV9	56K	Plessey MPD	1758
RV10	20K	Pot (part of RV7)	
RV11	100Ω	DC1/1/P	2697
RV12	100Ω	DC1/1/P	2697
RV13	56K	Plessey MPD	1758
RV14	50K	Morgan Miniature	1699
RV15	250K	Plessey type 'E'	3230

Capacitors

Ref.	Description		Part No.
C1	6–30pF	Trimmer	2097
C2	6–30pF	Trimmer	2097
C3	6–30pF	Trimmer	2097
C4	6–30pF	Trimmer	2097
C5	6–30pF	Trimmer	2097
C6	220pF	Lemco 1%	11587
C7	50μF	15V Wkg. Wima Elect.	2750
C8	1μF	125V Wkg. Wima Elect.	2364
C9	100pF	5% Lemco	12277
C10	16μF + 16μF 350V Wkg. Elect.		11863
C11	16μF + 32μF (+32μF) 350V Wkg. Elect. Plessey		2071
C12	0·15μF	400V Wkg. Wima	2366
C13	Selected on Test		
C14	1μF	125V Wkg. Wima	2364
C15	0·15μF	400V Wkg. Wima	2366
C16	100μF	350V Wkg (part of 60μF+100μF Elect.)	12054
C17	0·47μF	400V Wkg. Wima	2365
C18	60μF + 100μF 350V Wkg. Elect. Plessey		2072
C19	16μF + 16μF 350V Wkg. Elect. Plessey		11863
C20	200μF + 100μF 25V Wkg. Elect. Plessey		2073
C21	32μF	350V Wkg. Elect. (part of C11)	
C22	100μF	350V Wkg. Elect. (part of 60μF + 100μF Elect.)	12054
C23	60μF	(Part of C16)	
C24	60μF	(Part of C22)	
C25, C26	532μF + 532μF 2 Gang Variable		2299
C27	15pF	Lemco 5%	12913
C28	270pF	Lemco 1%	2889

Ref.	Description	Part No.
C29	150pF Lemco 1%	11572
C30	60μF+100μF 350V Wkg.	2072
C31	100μF 200V Wkg. Elect. Plessey	2318
C32	2,200pF Mullard 10%	773
C33	22,000pF Mullard 10%	788
C34	0–60pF Trimmer Mullard	1866
C35	500μF 3V Wkg. Elect.	1742
C36	30pF Lemco	2151
C37	47pF Lemco	2336

Rectifiers

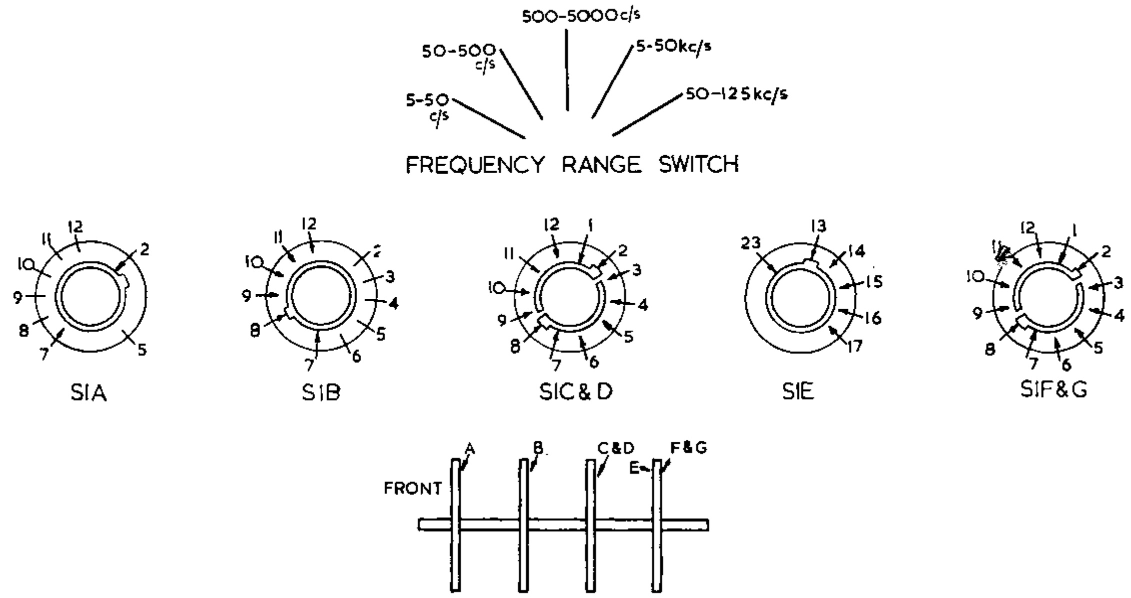
Ref.	Description	Part No.
MR1	15V Zener Diode	2347
MR2	15V Zener Diode	2347
MR3	SD94 Silicon Diode	489
MR4	SD94 Silicon Diode	489
MR5	CG 46/H	5871
MR6	CG 46/H	5871
MR7	CG 46/H	5871
MR8	CG 46/H	5871

Valves

Ref.	Description	Part No.
V1	12AT7	7106
V2	ECF80	11005
V3	12AT7	7106
V4	6BQ7A	12339
V5	EL86	2070
V6	EL86	2070

Miscellaneous

Ref.	Description	Part No.
NS1	90C1 Mullard Voltage Stabiliser	431
NS2	108C1 Mullard Voltage Stabiliser	2890
VM1	Voltmeter	15196
ILP1	Neon Pilot Lamp	1165
FS1	Fuse Belling Lee L1055, 1A	4732
S1	Range Switch	15225
S2	Attenuator Switch	15226
S3	Square Wave Switch	16168
S4	Supply Switch NSF	332
T1	L.F. Output Transformer	MT404
T2	H.F. Output Transformer	MT405
T3	Supply Transformer	MT403
TH1	Thermistor A15	6719
	Red 4mm Plug	12178
	Black 4mm Plug	12179
	Instruction Manual	2894


500-5000c/s
50-500 c/s
5-50kc/s
5-50 c/s
50-125kc/s
FREQUENCY RANGE SWITCH
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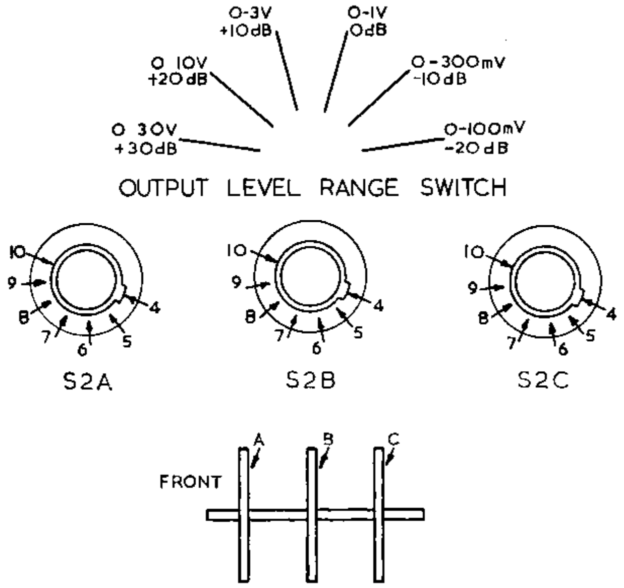
0-3V +10dB
0-1V 0dB
0 10V +20 dB
0-300mV -10 dB
0 30V +30dB
0-100mV -20 dB
OUTPUT LEVEL RANGE SWITCH
S2A
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S2C
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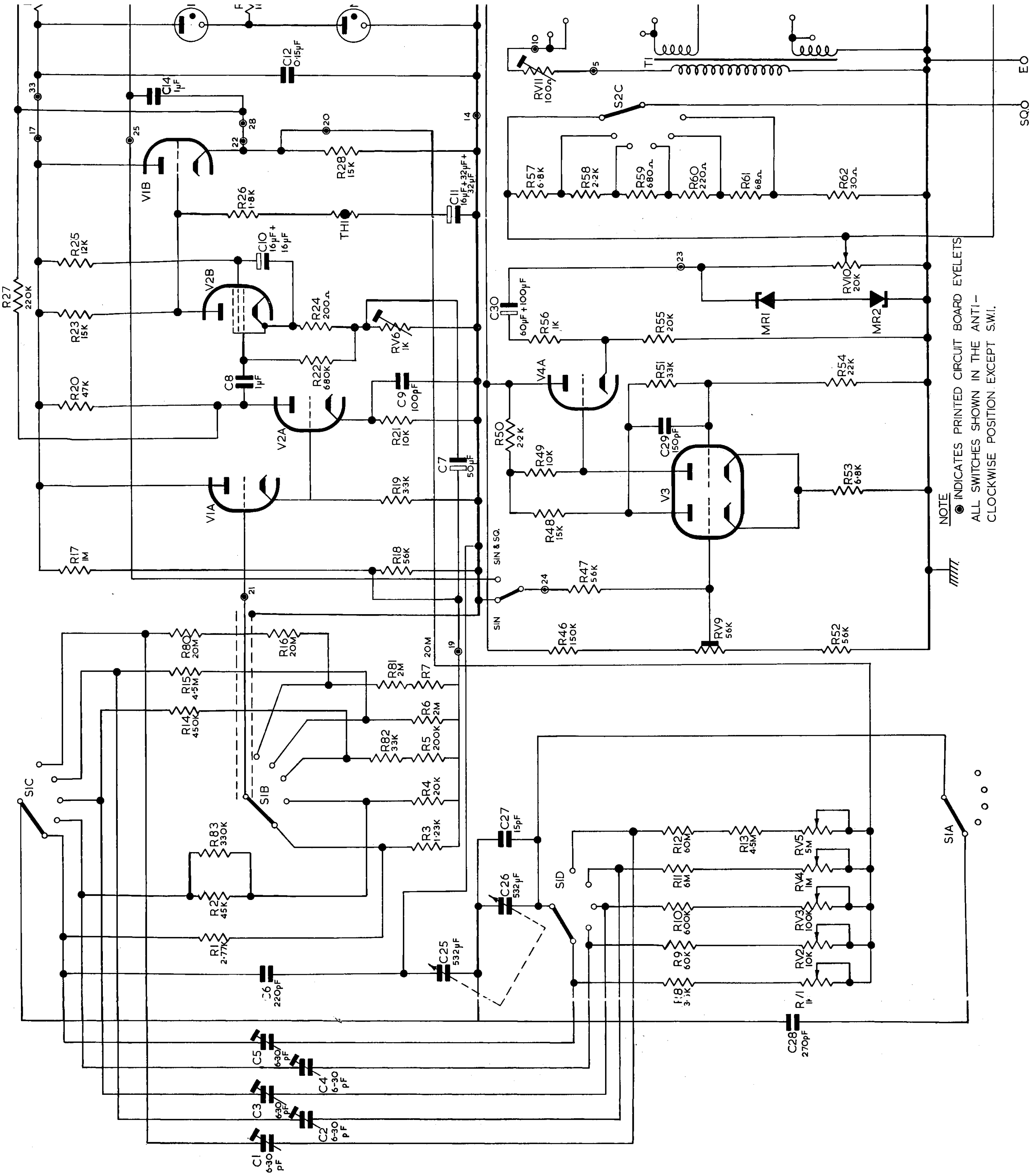
NOTE
◉ INDICATES PRINTED CIRCUIT BOARD EYELETS
ALL SWITCHES SHOWN IN THE ANTI-CLOCKWISE POSITION EXCEPT S.W.I.