INSTRUCTION MANUAL

for

V.S.W.R. INDICATOR
AND
SELECTIVE AMPLIFIER
TYPE 6593A

MARCONI INSTRUMENTS LIMITED
MICROWAVE PRODUCTS DIVISION

STEVENAGE HERTFORDSHIRE ENGLAND
A GEC-MARCONI ELECTRONICS COMPANY

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Contents

Chapter 1

General information

Fig. 1 Marconi Instruments V.S.W.R. Indicator Type 6593A

1.1 SPECIFICATION

AMPLIFIER

Inputs	2 channels, A and B. High impedance. 200Ω Bolometer input, bias current 4.5mA.
Functions	A,B, A-B, Bolometer.
Frequency range	800 Hz-1200 Hz variable.
Selectivity	20 Hz-100 Hz variable.
Sensitivity	0.5 μV R.M.S. for F.S.D. on channels A and B. 0.15 μV R.M.S. for F.S.D. on Bolometer input.
Noise level	Below −10 dB level on meter at maximum sensitivity and bandwidth with high impedance input terminated in 50Ω.
Output	Proportional to meter indication. 1 volt corresponding to F.S.D. Output impedance, 100 kΩ.

ATTENUATORS

Coarse	0 to 60 dB in steps of 10 dB ±0.1 dB/10 dB. From 0-10dB ±0.5 dB.
Medium	0 to 10 dB in steps of 1 dB ±0.05 dB/dB.
Fine	0 to 1 dB continuously variable.

METER SCALES

VSWR	1.0 to ∞ 3.16 to ∞
Expanded	1.0 to 1.3
dB range	0 to −10dB
Expanded dB range	0 to −2.2 dB
Battery check	Discharged/Charged
Meter calibration	For square law detector
Scale length	119,5 mm 4.7 in.

POWER REQUIREMENTS

A.C. mains	115 or 230V a.c. 50 to 60 Hz.

DIMENSIONS AND WEIGHT

Height	Width	Depth	Weight
140.5 mm	202 mm	284 mm	2.64 kg
5.53 in	7.95 in	11.2 in	5lb 13 oz

OPTIONAL ACCESSORY

2200186	Internal rechargeable battery pack. permits use up to 20 hours continuous operation.

INTRODUCTION

The V.S.W.R. indicator and selective amplifier is basically a low noise, high gain amplifier driving a meter output. The instrument is primarily intended for Laboratory use but its small size and robust construction make it equally suitable for use in the field.

Provision is made for two inputs from crystal detectors. These can be used indepentently or together for bridge measurements. A separate input is provided with a d.c. bias supply for bolometer operation.

The switched attenuators are adjustable from 0 to 70db in increments of 1db, and a continuously variable 0-1db attenuator is also provided. Attenuator calibration assumes that the input is from a square law detector.

Either a mains a.c. supply or optional internal batteries can be used to power the instrument which has a very low power consumption.

MAINS SUPPLY

Before connecting the mains supply check that the rear panel voltage switch is set to the appropriate value and that the correct fuse (160mA) is fitted.

Chapter 2

Operation

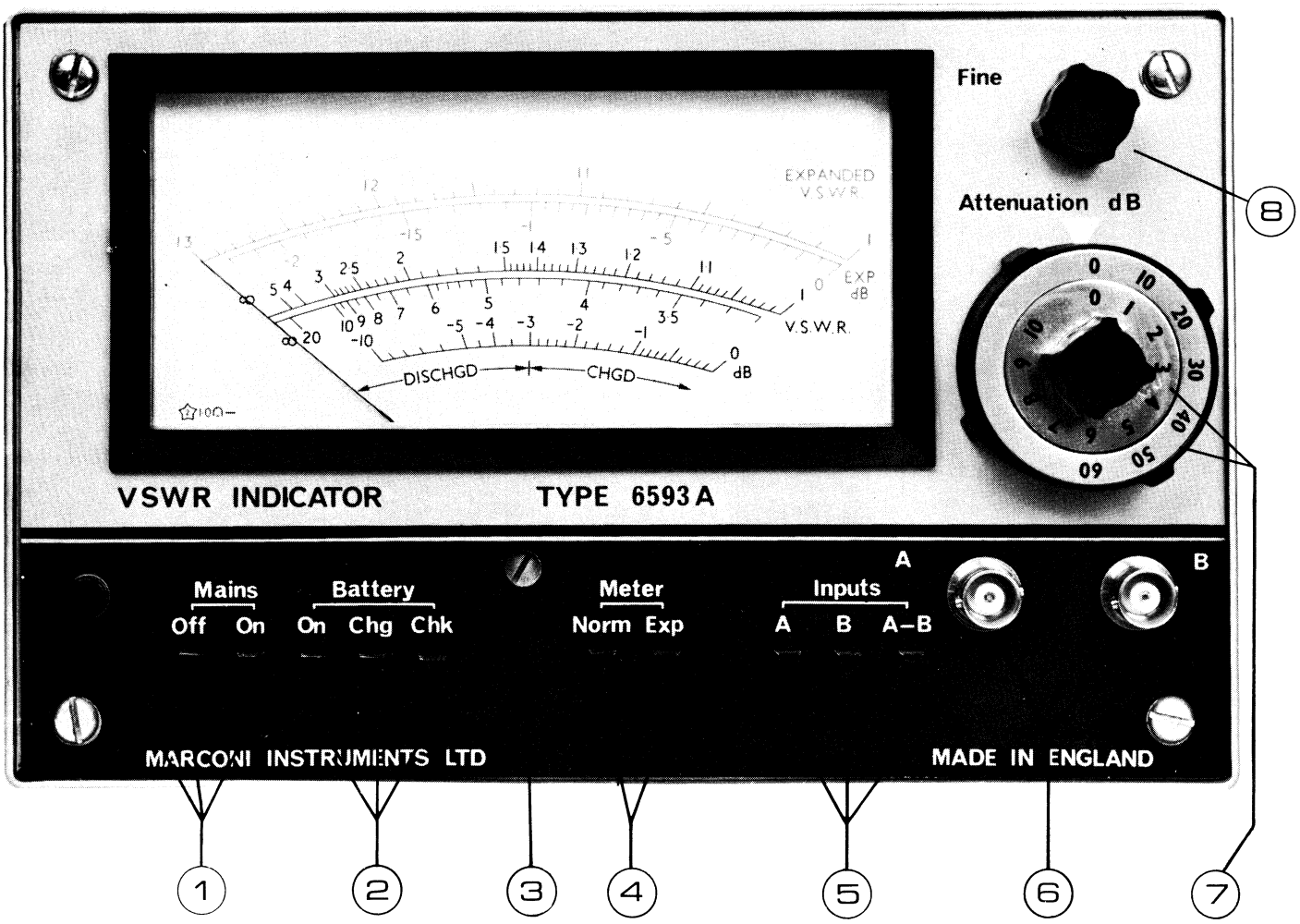


Fig. 2. Front Panel Controls

2.1 FRONT PANEL CONTROLS

1. MAINS SWITCH

Mains supply ON/OFF switch and associated indicator lamp. During battery charge, indicator lamp is lit.

2. BATTERY

A three-position push-button switch which energises the 6593A from the battery pack (optional). It also permits the condition of the battery pack to be checked (BAT CHK button) and charged (BAT CHG button). When the mains is on, a trickle-charge is applied to the battery pack and in the BAT CHG position the power is used for charging purposes with the indicator lamp glowing.

3. METER MECHANICAL ZERO

Set meter indication to zero when mains power is OFF.

4. METER RANGES

Selects normal or expanded meter ranges as indicated on meter.

5. INPUT SELECTOR SWITCHES

Selects alternative high impedance input channels A and B as well as A-B facility for bridge measurements.

6. INPUT SOCKETS

BNC sockets for channels A and B inputs.

7. STEP ATTENUATOR CONTROLS

Coarse 0 to 60dB in steps of 10dB ±0.1dB/10dB.
From 0-10dB ±0.5dB.
Medium 0 to 10dB in steps of 1dB ±0.05 dB/dB.

8. CONTINUOUSLY VARIABLE ATTENUATOR CONTROL

Fine 0 to 1 dB continuously variable.

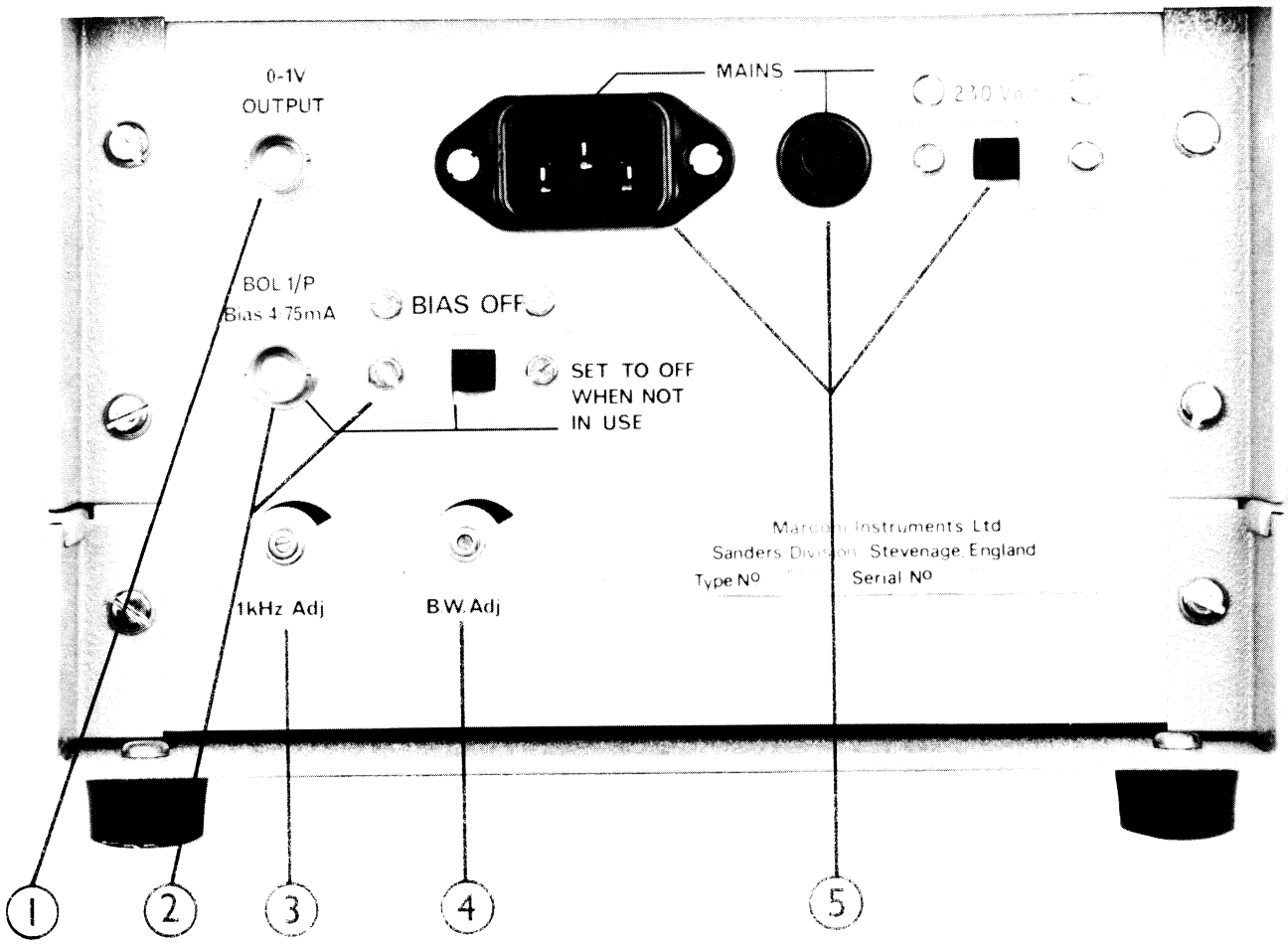


Fig. 3. Rear Panel Controls

2.2 REAR PANEL CONTROLS

1. OUTPUT

0-1V output proportional to meter indication. 1 volt corresponding to f.s.d. Output impedance 100kΩ.

2. INPUT

Bolometer input and associated bias ON/OFF switch.

3. AMPLIFIER TUNING

Tuned amplifier centre frequency adjustment. Clockwise rotation increases frequency.

4. AMPLIFIER BANDWIDTH

Amplifier bandwidth adjustment. Clockwise rotation increases bandwidth.

5. 115 - 230V MAINS

This switch permits the application of either 115V or 230V a.c. power. Insure that the switch position is properly set prior to the application of power to avoid equipment damage. If replacement of the associated fuse (160mA slow blow) becomes necessary, ensure that the replacement conforms with the description given in the Replaceable Parts list.

2.3 OPERATING INFORMATION

2.3.1. V.S.W.R.

For normal V.S.W.R. measurements the instrument is used in the conventional manner. Socket A or B may be used for connection to a crystal, the input selector switch being set appropriately.

BRIDGE APPLICATIONS

If two signals are available from the microwave bench, very small deviations in either of the signals can be accurately measured using bridge techniques. When the two inputs are connected to sockets A and B they complete a bridge network with two primary windings on the input transformer.

Having connected the signals to sockets A and B, proceed as follows:

1) Switching INPUT SELECTOR to A and B in turn, adjust attenuators on microwave bench until the two signals are indicated as being of approximately the same level on the V.S.W.R. Indicator.
2) Set INPUT SELECTOR TO A - B.
3) Switch out attenuation in amplifier to increase the reading to a convenient indication.
4) Adjust attenuators on microwave bench to obtain a null on the meter indication.

5) Re-adjust one of the microwave attenuators to a position at which the sensitivity of the indication is adequate for the measurement to be performed, at the same time ensuring that the working region for these measurements is confined to one side of the null. If necessary the meter indication can be calibrated against an attenuator in the arm in which variations are being measured.

A simpler, but slightly less accurate application of the bridge balance facility, particularly useful in measuring insertion losses above 0.1dB, is as follows:

1) Adjust the two signals, as described above, to obtain a null reading.
2) Insert or remove the component, whose insertion loss is to be measured in one arm of the microwave system.
3) Adjust the attenuator in that arm of the system to re-establish the null readings. The difference in the two readings of the attenuator is the insertion loss.

2.3.2. MEASUREMENT OF VERY LOW V.S.W.R.

When a V.S.W.R. of less than 1.3:1 is being measured, more accurate readings can be obtained by using the expanded scale facility as follows:-

1) Adjust microwave and/or amplifier attenuators to obtain a reading of approximately '1' for the standing wave maximum.
2) Depress 'Expand' Button.
3) Proceed as if normal V.S.W.R. measurement were being made but read the red EXPANDED V.S.W.R. scale.

2.3.3. MEASUREMENT OF LARGE V.S.W.R.

For measurement of a V.S.W.R. greater than 3.16:1 proceed as follows:-

1) Set the instrument inputs and controls for ordinary V.S.W.R. measurements and proceed to make the measurement.
2) When the null of the signal is obtained, reduce the attenuation by 10dB and take the V.S.W.R. reading from $3.16-\infty$ scale instead of the $1.0-\infty$ scale.

2.3.4. BOLOMETER OPERATION

To use a Bolometer with the 6593A proceed as follows:-

1) Connect Bolometer to Bol.I/P on the rear panel.
2) Set the Bolometer Bias switch to ON and select channel B on front panel. Proceed as with other mmmeasurements.
3) It is important to set the Bolometer Bias switch to OFF when not in use, or the input sensitivity on channel B will be degraded.

Chapter 3

Technical description

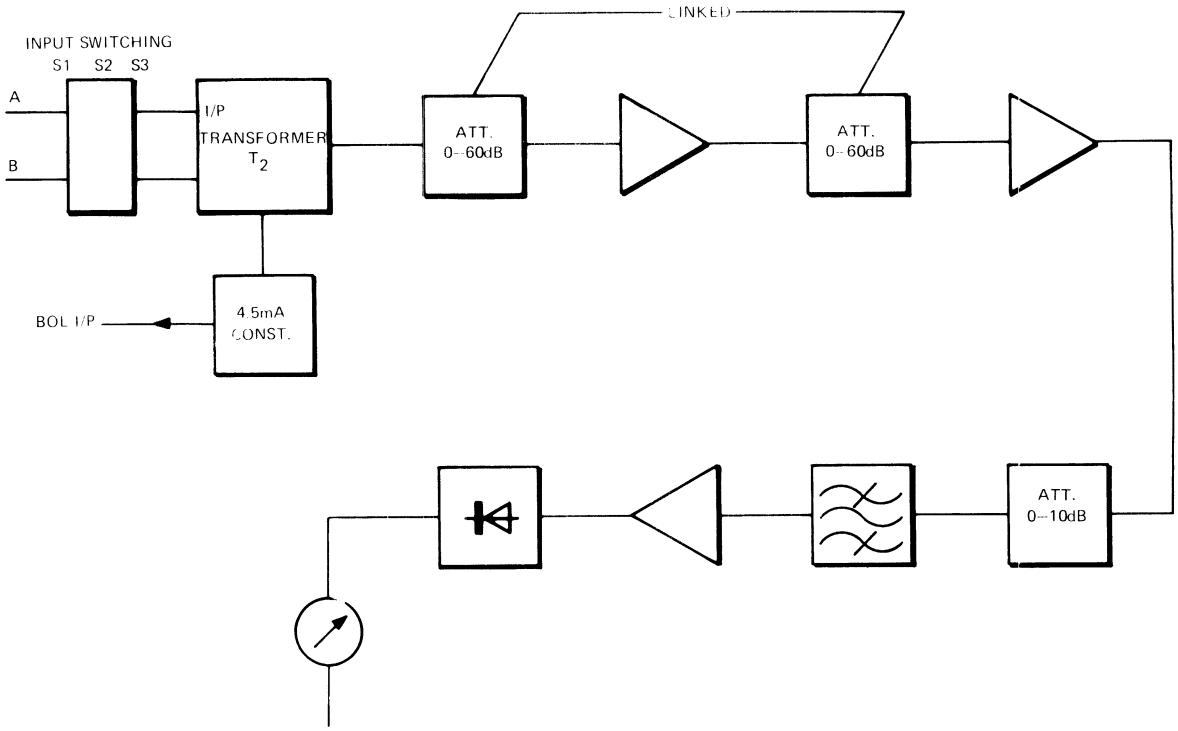


Fig. 4. Block Diagram of 6593A

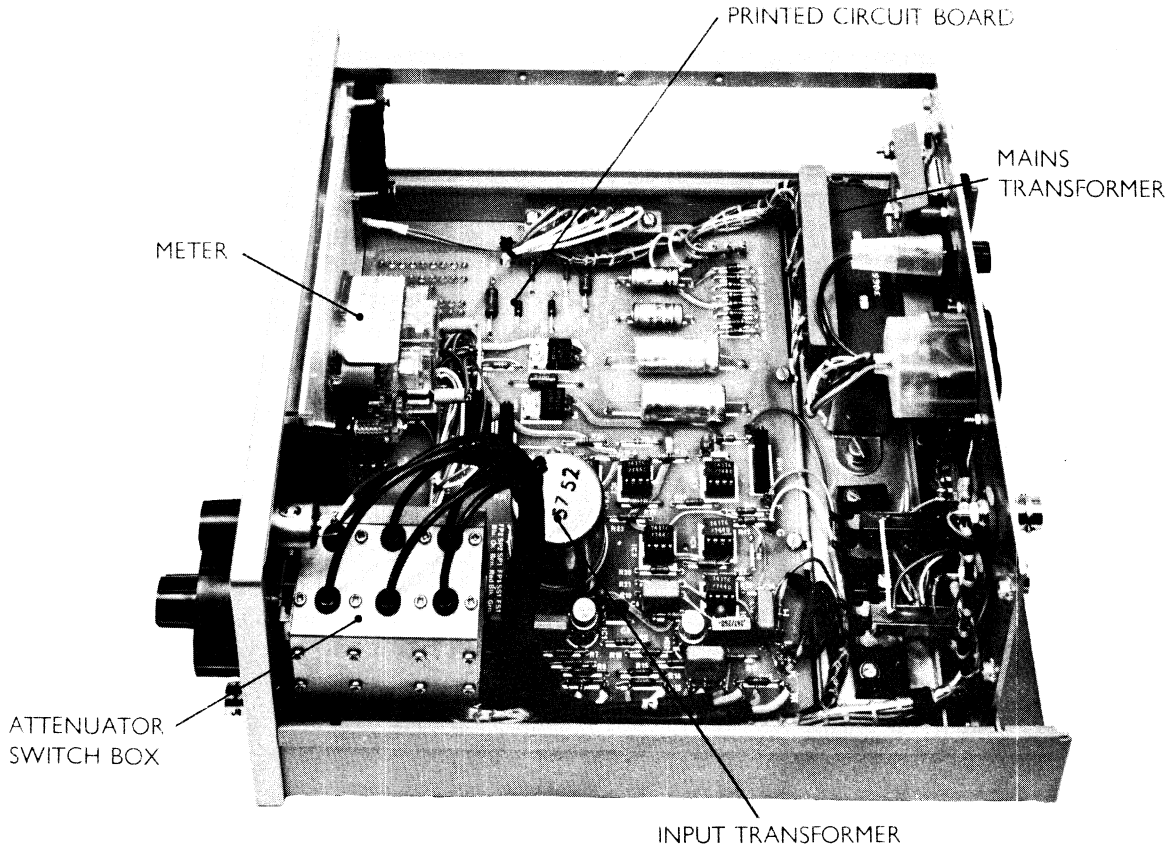


Fig. 5. General Internal Layout

3.1 PRINCIPLE OF OPERATION & CIRCUIT DESCRIPTION

Two front panel inputs A and B are provided which are both connected via switches S1, S2 and S3 to the primaries of the input transformer T2. (See Circuit Diagram Fig 7).

A Bolometer input is provided on the rear panel which is linked to one primary of T2 by S11 and C1. The bolometer bias is fixed at 4.5ma by TR1, R1, R2 and R3.

When the A-B button, S1, is depressed, both A and B inputs are connected to T2 primaries which are in antiphase hence the subtraction of B from A.

3.2 AMPLIFIERS AND ATTENUATORS

The input amplifier IC1 is a low-noise integrated circuit, part No. 6593 Item 212 Attenuator SW1 and SW2 are the 10db step attenuators and attenuator SW3 gives the 1db steps. These are located within the screened box shown in Fig. 5.

The first amplifier, IC1, operates at a gain of 330, IC2 operates at a gain of 100 and IC3 gain is variable. By fixing the gains of the operational amplifiers and using resistive attenuators, better stability and noise performance can be obtained. The attenuators are separated from one another by amplifiers to eliminate interaction and loading effects.

3.3 FILTER

To reduce the noise level at the detector to a minimum, it is necessary to filter the signal at this point. An active filter is used, composed of IC4 and IC5 whose frequency is controlled by RV6 and bandwidth by RV5.

IC6 provides more signal amplification and RV3 determines the gain of this stage. This preset potentionmeter is adjusted during test and no further adjustment should be necessary.

3.4 OUTPUT CIRCUITS

IC7 and IC8 form the output rectifier together together with D9 and D10. IC7 and IC8 amplify separately the positive and negative halves of the waveform. The negative half is inverted and added to the positive half, giving a full wave rectified output. Smoothing is achieved by C16. The output from IC8 is taken to the meter M1 via S4 and S5.

In the "Norm" position the meter is shunted with RV1 and R9. In the "Exp" position the shunt is removed and a backing-off current is provided from the –8 volt rail by RV2 and R11. RV2 is preset to give a backing-off current such that the 1.0 to 1.3 portion of the normal scale is expanded and aligned to cover the whole of the expanded V.S.W.R. scale.

3.5 POWER SUPPLIES

The amplifier operates from any 50 - 60Hz supply in the ranges 110-120V or 200-250 volts. The change-over switch S12 is located on the rear panel. Two supplies are necessary for the circuit, +8V and –8V. These are provided by the secondaries of T1, two bridge rectifiers D1-D8 and the two regulators VR1 and VR2. Switching is achieved by S9 and S10.

When the optional rechargeable battery pack is fitted this can be selected by S8, Battery 'ON' switch. N.B. The battery pack contains 2 independent batteries shown as BT1 and BT2 on the circuit diagram. The batteries are trickle-charged from the the mains via T1, D1-8, R34 and R36 when the instrument is operating from the mains. For a full charge, S7, Battery Charge, is selected and they are then fed via R35 and R37. Battery testing is accomplished with S6 which loads both batteries with R39 and measures the resulting voltage on the Meter M1 via R33.

Battery life will be of the order of 20 hours from one full charge.

Chapter 4

Maintenance

4.1 INTRODUCTION

Readily-available components are used in the manufacture of the 6593A wherever possible. The parts list show the replaceable parts available from MIMPD. Full instructions for re-ordering are given at the end of the replaceable parts list.

4.2 REMOVAL FROM CASE

To remove the instrument from its case it is necessary to undo the six chrome-head screws at the rear of the instrument. The top and bottom covers may then be removed.

4.3 SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be dis-connected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

4.4 EQUIPMENT REQUIRED FOR TEST

1 DMM, DANA 4600 or equivalent.
2 Signal Generator covering three frequencies 0.8, 1.0 and 1.2 kHz squarewave output with output filtered by 750Hz high pass filter, (For mains rejection). Output amplitude: 8V, p.p.
3 Precision attenuators covering:
  0 - 100dB in 10dB steps
  0 - 10dB in 1dB steps
4 Mains Variac.
5 Multimeter, AVO 8.

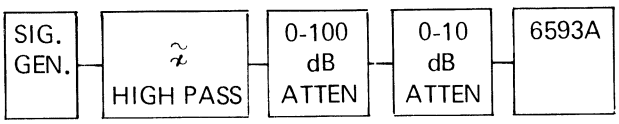
4.5 PERFORMANCE AND CALIBRATION CHECKS

1 Power Supplies

a) Connect 6593A to mains variac and set variac to 230V.
b) Using DMM measure voltage regulator supply outputs across C10 and C11.
c) Check these voltages are within 7.8 - 8.3 volts +ve and -ve respectively.
d) Using the variac adjust the supply voltage from 180V - 260V and observe the change in supply voltages. The change should be no greater than 0.1V on both supplies.
e) Set 6593A to OFF and set voltage selector to 115V (rear panel).
f) Repeat b) to d) for supply voltages 100 to 130V.

2 Meter Scale Calibration

a) Connector equipment as below:-



b) Set 6593A controls as follows:

ATTENUATOR 0-60	20dB
NORM/EXP	NORMAL
INPUT CHANNEL	A
BANDWIDTH CONTROL (Rear Panel)	FULLY C W

c) Switch mains ON and check meter deflection is zero.
d) Apply signal from signal generator at frequency 1.000kHz and peak the meter reading using frequency adjust pot. on rear panel of 6593A.
e) Set the meter to read f.s.d. (i.e. 1.0) by adjusting either the signal level or the attenuator controls.
f) Using DMM check the RECORDER output for 1.0 - 1.3V dc.
g) Switch to EXP and adjust RV2 to give full scale deflection.
h) If f.s.d. cannot be obtained then set the instrument to NORM and adjust RV1 by several turns, then set f.s.d. using attenuators. Repeat (g).
i) Switch to NORM and adjust attenuators to give a reading of 1.3 on the 1.0 VSWR scale.
j) Switch to EXP and check that a reading of 1.3 is obtained on the expanded scale. Adjust RV1 if necessary.
Progressive adjustment of RV1 and RV2 may be necessary to obtain correct results.

k) Having calibrated the meter scale, set the attenuator controls of the 6593A to minimum and set precision attenuators to setting of 70dB.

l) Adjust RV3 for f.s.d. on NORM.
N.B. Adjust RV3 only if meter is ON scale, leave if meter is upscale of f.s.d.

m) Set 6593A attenuator controls to 20dB and adjust output level from precision attenuators to give 1/2 f.s.d. on the meter.

n) Set signal generator frequency to 800Hz and adjust the frequency control on rear panel of 6593A to peak the reading on the meter.

o) Set signal generator frequency to 1.200KHz and adjust the frequency control on rear panel of 6593A to peak the reading on the meter.

p) Reset and repeat at 1.000kHz.

q) Check behaviour of bandwidth control set to fully CW and ACW, meter reading should vary. Reset bandwidth control to approx. mid-position.

r) Disconnect signal input to Input A and connect to Input B. With the 6593A attenuator set to 20dB there should be very little difference between readings on inputs A or B.

s) Disconnect signal input to 6593A and connect the output of a Marconi Instruments 6060 Detector to input A. With the attenuators set to minimum, the noise level should be less than -10dB on full scale as indicated on the dB scale on the meter.

t) Adjust RV3 if meter indicates upscale of -10dB.
N.B. This adjustment is to comply with para. (k) & (l).

3 Attenuator Checks

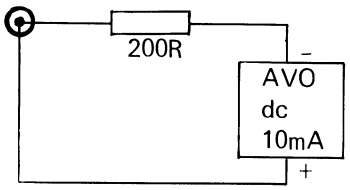
a) Reconnect 1.000kHz signal from precision attenuator output to input A of 6593A.

b) Using the 10dB step precision attenuator check each step on the 0-60dB attenuator in the 6593A, by increasing the precision attenuator whilst decreasing the attenuator of 6593A.
The error as seen on the dB scale of the 6593A should be no more than ±0.1dB per 10dB step except 0dB, ±0.5dB.

c) Repeat this process using the dB precision attenuator and the 0 - 10dB attenuator on the 6593A.
The error between steps should be no more than ±0.05dB.

4 Bolometer Bias Check

a) Connect an AVO 8 in series with a 200 ohm resistor and connect across BOLO bias socket as shown:-



b) Remove locking plate from Bolometer bias switch (on rear panel) and set to ON. Measured current output to be within 4.25 - 4.75mA.

Switch Bolometer Bias off when not in use.

Chapter 5

Replaceable parts

Circ. Ref.	Description	Total No. used.	Mfrs.	Part No.	Circuit Diag. Grid Ref.
C1	Capcitor, fixed, Met. Film, 0.1μF ±10%	6	Mullard or equiv.	C280	X7 – Y10
C2	Capacitor, fixed, Met. Film, 0.047μF ±10%	2	Mullard or equiv.	C280	X7 – Y9
C3	As C1				X7 – Y8
C4	As C1				X10 – Y10
C5	As C2				X10 – Y9
C6	As C1				X10 – Y8
C7	Capacitor, fixed, Tant. Bead, 2.2μF 35V	3	ITT or equiv.	TAG	X11 – Y9
C8	Capacitor, fixed, electrolytic, 470μF –10% to +50% @ 25V	2	ITT or equiv.	EN12.12	X16 – Y3
C9	As C8				X16 – Y2
C10	Capacitor, fixed, electrolytic. 100μF; –10% to +50% @ 16V	2	Erie or Equiv.		X18 – Y3
C11	As C10				X18 – Y1
C12	Capacitor, fixed, Tant. bead, 4.7μF 35V	1	ITT or Equiv.	TAG	X17 – Y9
C13	As C1				X15 – Y8
C14	Capacitor, fixed, ceramic, 1000pf	2	Erie or Equiv.		X15 – Y8
C15	As C14				X16 – Y7
C16	Capacitor, fixed, Tant. bead, 0.1 μF 35V	1	ITT or Equiv.	TAG	X20 – Y9
C17	As C7				X8 – Y9
C18	As C7				X5 – Y10
C19	As C1				X3 – Y6
C20	Capacitor, fixed, Tant. Bead, 3.3μF, 35V	1	ITT or Equiv.	TAG	X2 – Y5
C21	Capacitor, fixed, Tant. Bead, 0.47μF 35V	1	ITT or Equiv.	TAG	X21 – Y8
D1	Semiconductor, Diode, Type IN4003	4	Comm.		X15 – Y2
D5–8	Semiconductor Diode, Type IN4003	4	Comm.		X15 – Y3
D9	Semiconductor Diode, Type IN914	1	Comm.		X19 – Y9
D10	As D1		Comm.		X19 – Y8
D11	As D1		Comm.		X8 – Y3
D12	As D1		Comm.		X8 – Y5
FS1	Fuse 20mm 160mA	1	Comm.	23411/054	X3 – Y3

Circ. Ref.	Description	Total No. used.	Mfrs.	Part No.	Circuit Diag. Grid Ref.
IC1	Integrated circuit	1	P.M.I.	OP-06-CJ	X7 – Y9
IC2	Integrated circuit Type LM741CH	1	National Semiconductors or equiv.		X10 – Y9
IC3	Integrated circuit Type LM741CN	6	National Semiconductors or equiv.		X13 – Y9
IC4	As IC3				X15 – Y9
IC5	As IC3				X16 – Y7
IC6	As IC3				X17 – Y9
IC7	As IC3				X18 – Y8
IC8	As IC3				X20 – Y8
1LP1	Indicator Lamp	1	Boss Industrial Mouldings	Series M Lens A T/Red 125V	X14 – Y3
M	Meter, 100μa, Moving coil	1	Sangamo Weston	S819	X11 – Y4
PL1	Plug, Mains inlet	1	Marconi Instruments	3850/069	X2 – Y2
R1	Resistor fixed film 1/8 watt 1.2K ohms 2%	1	Comm.		X2 – Y4
R2	Resistor fixed film 1/8 watt 330 ohms 2%	1	Comm.		X2 – Y5
R3	Resistor fixed film 1/8 watt 1K ohms 2%	1	Comm.		X2 – Y4
R4	Resistor fixed film 1/8 watt 12 ohms 1%	1	Comm.		X5 – Y7
R5	Resistor fixed film 1/8 watt 150 ohms 1%	1	Comm.		X5 – Y7
R6	Resistor fixed film 1/8 watt 100 ohms 2%	1	Comm.		X6 – Y10
R7	Resistor fixed film 1/8 watt 100 ohms 2%	1	Comm.		X7 – Y9
R8	Resistor fixed film 1/8 watt 27 ohms 2%	1	Comm.		X7 – Y9
R9	Resistor fixed film 1/8 watt 47 ohms 2%	1	Comm.		X19 – Y7
R10	Resistor fixed film 1/8 watt 8K2 ohms 2%	1	Comm.		X21 – Y8

Circ. Ref.	Description	Total No. used.	Mfrs.	Part No.	Circuit Diag. Grid Ref.
R11	Resistor fixed film 1/8 watt 22K ohms 2%	1	Comm.		X19 – Y5
R12	Resistor fixed film 1/8 watt 33K ohms 2%	1	Comm.		X7 – Y10
R13	Resistor fixed film 1/8 watt 120 ohms 1%	1	Comm.		X8 – Y7
R14	Resistor fixed film 1/8 watt 1.5K ohms 1%	1	Comm.		X9 – Y7
R15	Resistor fixed film 1/8 watt 100 ohms 2%	1	Comm.		X9 – Y10
R16	Resistor fixed film 1/8 watt 100 ohms 2%	1	Comm.		X10 – Y9
R17	Resistor fixed film 1/8 watt 27 ohms 2%	1	Comm.		X10 – Y9
R18	Resistor fixed film 1/8 watt 10K ohms 2%	1	Comm.		X10 – Y10
R19	Resistor fixed film 1/8 watt 1K ohms 2%	1	Comm.		X13 – Y9
R20	Resistor fixed film 1/8 watt 1K ohms 2%	1	Comm.		X13 – Y8
R21	Resistor fixed film 1/8 watt 1K ohms 2%	1	Comm.		X13 – Y8
R22	Resistor fixed film 1/8 watt 20K ohms 2%	1	Comm.		X18 – Y9
R23	Resistor fixed film 1/8 watt 10K ohms 2%	1	Comm.		X18 – Y8
R24	Resistor fixed film 1/8 watt 20K ohms 2%	1	Comm.		X19 – Y9
R25	Resistor fixed film 1/8 watt 20K ohms 2%	1	Comm.		X19 – Y10
R26	Resistor fixed film 1/8 watt 10K ohms 2%	1	Comm.		X19 – Y8
R27	Resistor fixed film 1/8 watt 8.2K ohms 2%	1	Comm.		X16 – Y7
R28	Resistor fixed film 1/8 watt 8.2K ohms 2%	1	Comm.		X16 – Y7

Circ. Ref.	Description	Total No. used.	Mfrs.	Part No.	Circuit Diag. Grid Ref.
R29	Resistor fixed film 1/8 watt 1K ohms 2%	1	Comm.		X16 – Y8
R30	Resistor fixed film 1/8 watt 20K ohms 2%	1	Comm.		X20 – Y9
R31	Resistor fixed film 1/8 watt 5.1K ohms 2%	1	Comm.		X20 – Y9
R32	Resistor fixed film 1/8 watt 4.7K ohms 2%	1	Comm.		X20 – Y8
R33	Resistor fixed film 1/8 watt 390K ohms 2%	1	Comm.		X12 – Y3
R34	Resistor fixed film 1/8 watt 1.5K ohms 2%	1	Comm.		X8 – Y3
R35	Resistor fixed W/W 3 watt 51 ohms 5%	1	C.G.S.		X8 – Y3
R36	Resistor fixed film 1/8 watt 1.5K ohms 2%	1	Comm.		X8 – Y5
R37	Resistor fixed W/W 3 watt 51 ohms 5%	1	C.G.S.		X8 – Y5
R38	Resistor fixed film 1/8 watt 100K ohms 2%	1	Comm.		X21 – Y8
R39	Resistor fixed W/W 3 watt 220 ohms 5%	1	C.G.S.		X12 – Y4
R40	Resistor fixed film 1/8 watt 15K ohms 2%	1	Comm.		X14 – Y9
R41	Resistor fixed film 1/8 watt 10K ohms 2%	1	Comm.		X15 – Y7
R42	Resistor fixed film 1/8 watt 47 ohms 1%	1	Comm.		X11 – Y6
R101	Resistor fixed film 1/8 watt 100K ohms 1%	1	Comm.		X5 – Y9
R102	Resistor fixed film 1/8 watt 10K ohms 1%	1	Comm.		X5 – Y8
R103	Resistor fixed film 1/8 watt 1K ohms 1%	1	Comm.		X5 – Y8
R104	Resistor fixed film 1/8 watt 100 ohms 1%	1	Comm.		X5 – Y7
R105	Resistor fixed film 1/8 watt 10K ohms 1%	1	Comm.		X8 – Y9
R106	Resistor fixed film 1/8 watt 1K ohm 1%	1	Comm.		X8 – Y9
R107	Resistor fixed film 1/8 watt 100 ohms	1	Comm.		X11 – Y9
R108	Resistor fixed film 1/8 watt 82 ohms 1%	1	Comm.		X11 – Y9
R109	Resistor fixed film 1/8 watt 62 ohms 1%	1	Comm.		X11 – Y8

Circ. Ref.	Description	Total No. used.	Mfrs.	Part No.	Circuit Diag. Grid Ref.
R110	Resistor fixed film 1/8 watt 47 ohms 1%	1	Comm.		X11 – Y8
R111	Resistor fixed film 1/8 watt 39 ohms 1%	1	Comm.		X11 – Y8
R112	Resistor fixed film 1/8 watt 30 ohms 1%	1	Comm.		X11 – Y8
R113	Resistor fixed film 1/8 watt 24 ohms 1%	1	Comm.		X11 – Y7
R114	Resistor fixed film 1/8 watt 20 ohms 1%	1	Comm.		X11 – Y7
R115	Resistor fixed film 1/8 watt 15 ohms 1%	1	Comm.		X11 – Y7
R116	Resistor fixed film 1/8 watt 12 ohms 1%	1	Comm.		X11 – Y6
R117	Resistor fixed film 1/8 watt 1.2K ohms 2%	1	Comm.		X12 – Y3
R118	Resistor fixed film 1/8 watt 82K ohms 2%	1	Comm.		X21 – Y8
Resistors Variable					
RV1	Resistor Variable Cermet, 2K, ±10%	1	Spectrol or equiv.	43P	X19 – Y6
RV2	Resistor Variable Cermet, 50K, ±10%	1	Spectrol or equiv.	43P	X19 – Y5
RV3	Resistor Variable Cermet, 20K, ±10%	1	Spectrol or equiv.	43P	X17 – Y8
RV4	Resistor Variable Wirewound, 1K, ±10%	1	Spectrol or equiv.	CW05	X14 – Y8
RV5	Resistor Variable Cermet, 200K, ±10%	1	Bourns or equiv.	Type M	X14 – Y9
RV6	Resistor Variable Cermet, 50K ±10%	1	Bourns or equiv.	Type M	X14 – Y7
Switches					
S1	Switch, Push Button	5	Marconi Instruments	6593/048	X3 – Y10
S2	As S1				X3 – Y9
S3	As S1				X3 – Y7
S4	As S1				X20 – Y7
S5	As S1				X20 – Y6
S6	Switch, Push Button	5	Marconi Instruments	6593/049	X12 – Y5
S7	As S6				X9 – Y5
S8	As S6				X7 – Y5
S9	As S6				X6 – Y5
S10	As S6				X5 – Y5
S11	Switch, slide	2	Marconi Instruments	T/11040/004	X2 – Y6
S12	As S11				X14 – Y3
SW1	Switch, rotary	3	N.S.F.	MU117044MA3	X6 – Y8
SW2	As SW1				X9 – Y8
SW3	As SW1				X12 – Y8

Circ. Ref.	Description	Total No. used.	Mfrs.	Part No.	Circuit Diag. Grid Ref.
Sockets					
SK1	Socket B.N.C. G.E. 35063BN	4			X21 – Y8
SK2	As SK1				X1 – Y10
SK3	As SK1				X1 – Y8
SK4	As SK1				X1 – Y6
Transformers					
T1	Transformer, mains, step down	1	C.B.T.	T23458	X15 – Y3
T2	Transformer, screened, step up	1	Belclere	EN5752	X4 – Y10
Transistors					
TR1	Transistor Type ZN3053	1	Comm.		X1 – Y5
Voltage Regulators					
VR1	Voltage regulator, Type 7808UC	2	Fairchild or equiv.		X17 – Y3
VR2	As VR1				X17 – Y2
Optional Accessory					
BT1/ BT2	Battery, rechargeable	1	Marconi Instruments	2200186	X10 – Y3 X11 – Y3

SPARE PARTS ORDERING

All enquiries for spare parts should go to our Technical Services Department. Please specify the following information for each part required.

1. Type and serial number of the instrument.
2. Circuit reference
3. Full description as detailed in the replaceable parts list.

Orders should be sent to:-

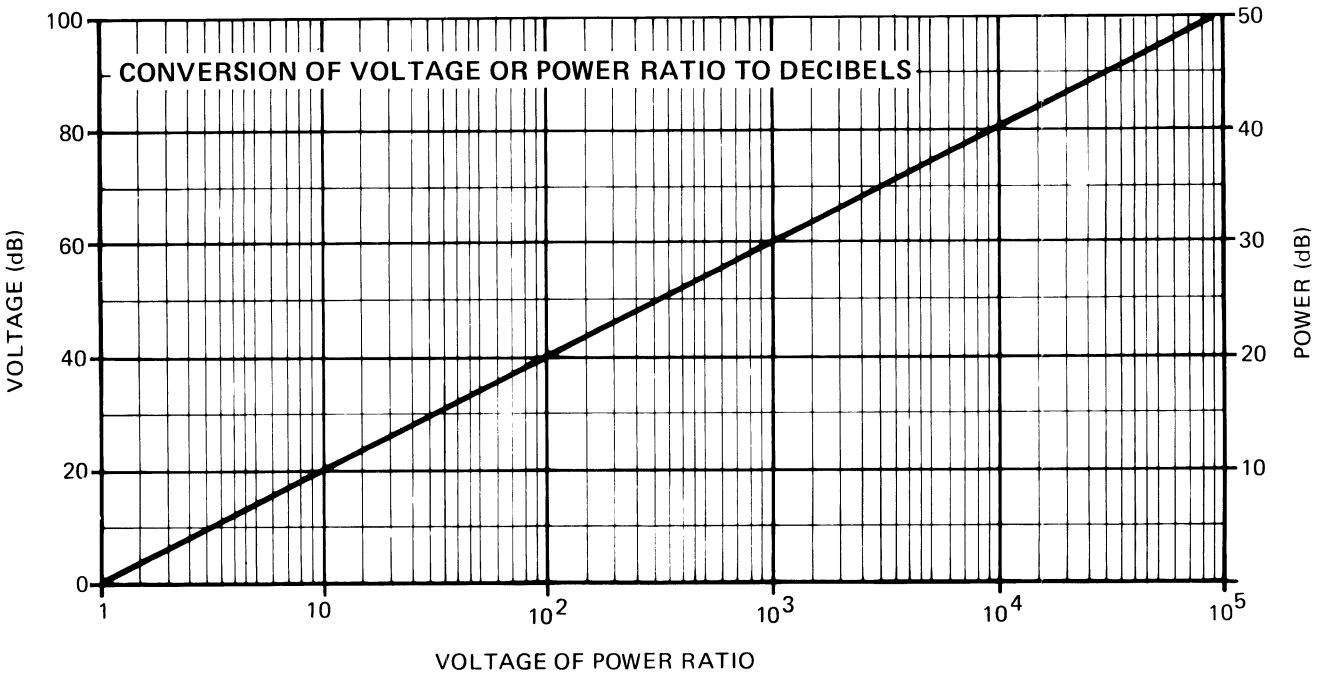
The Technical Services Department
Marconi Instruments Limited
Microwave Products Division
P. O. Box. 10
Stevenage, Herts. SG1 2AU
England

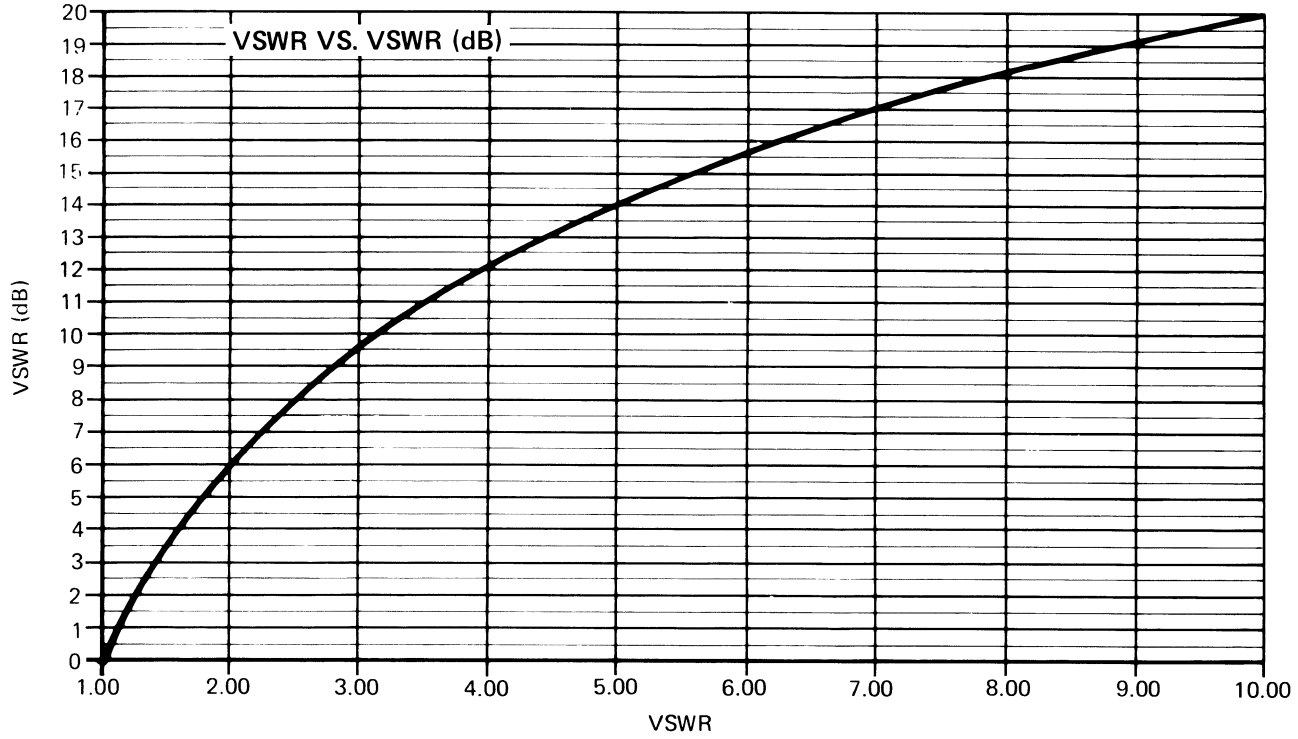
Telephone: Stevenage 2311

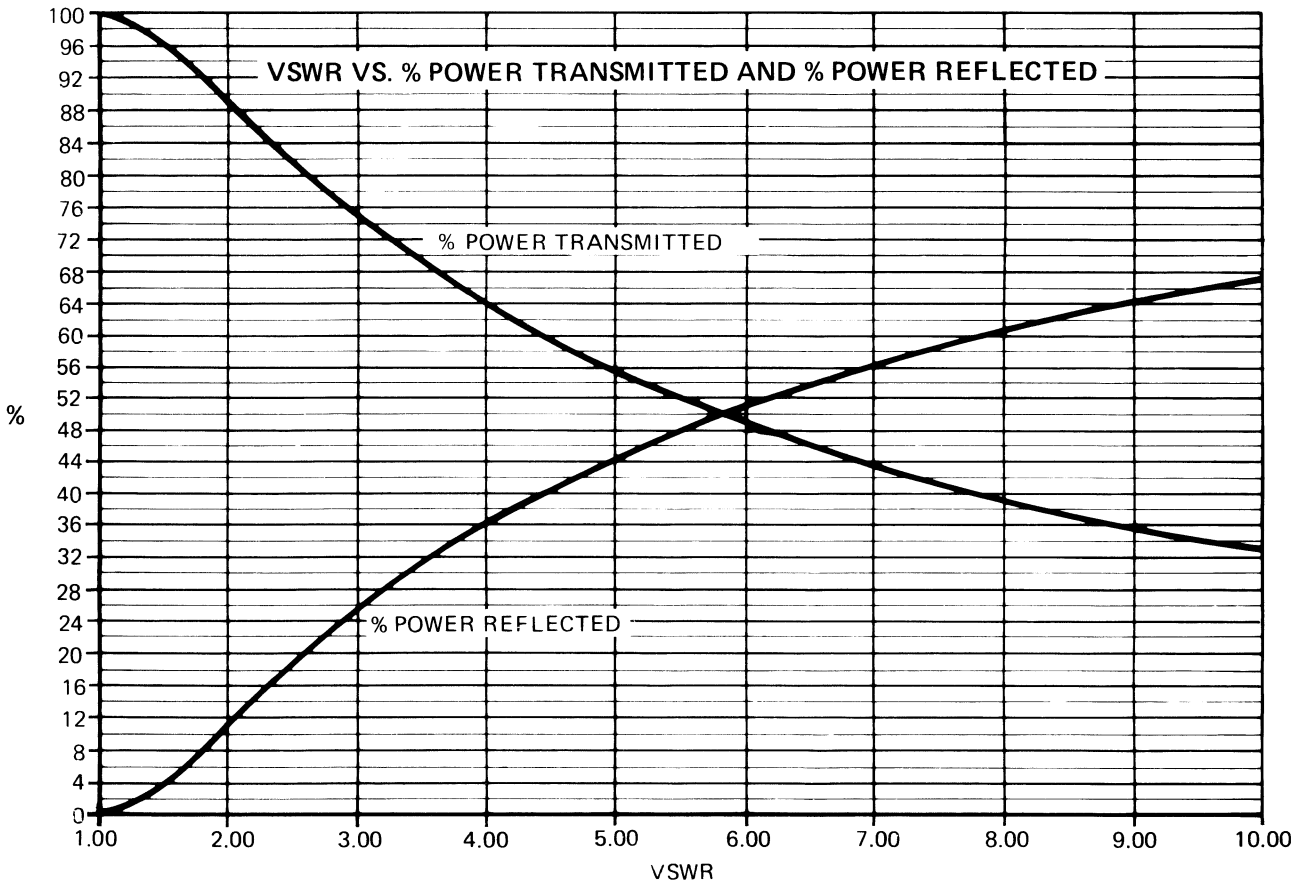
Or to your local distributor if outside the U.K.

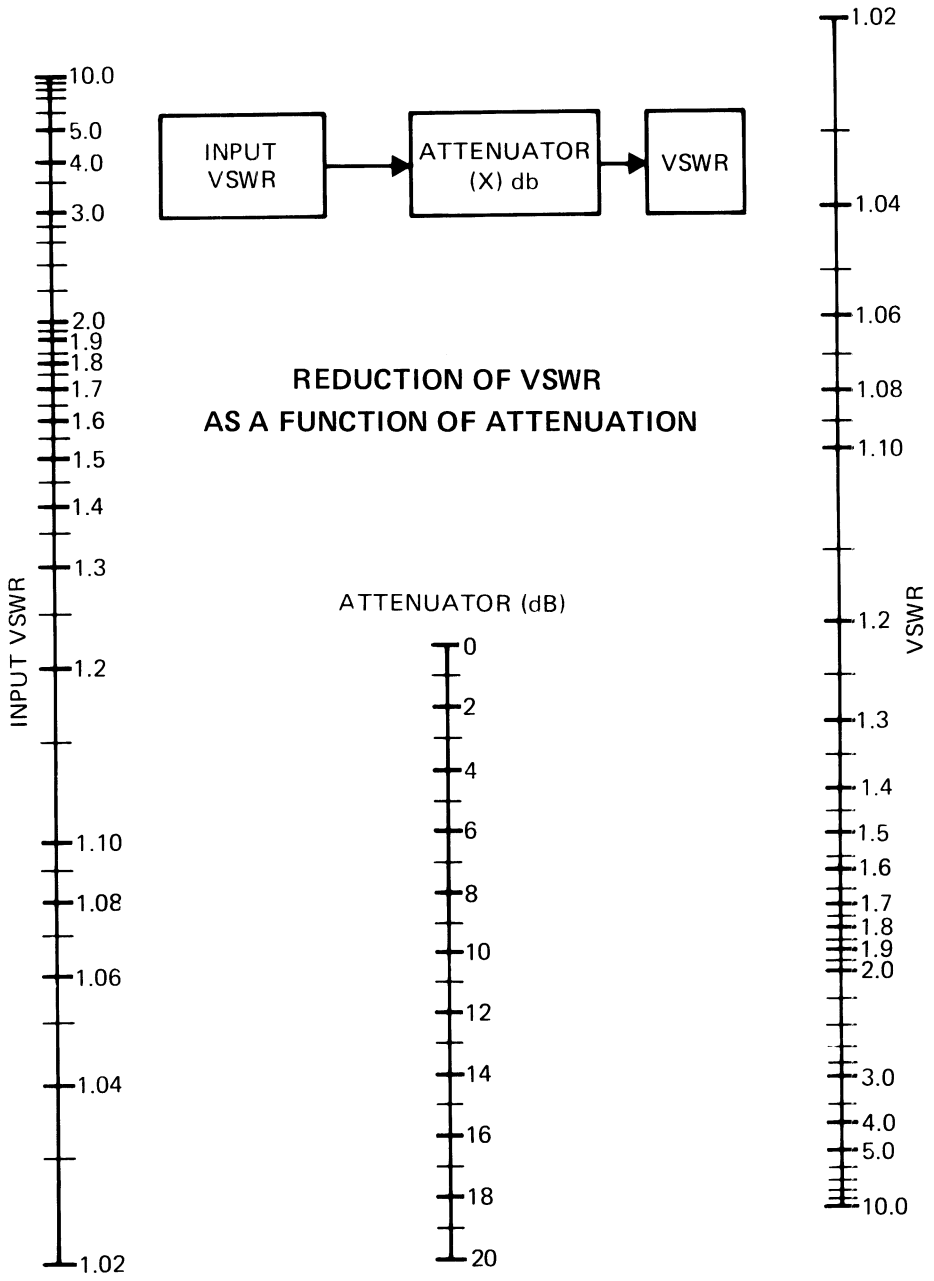
Chapter 6

Reference Tables




VSWR VS. VSWR (dB)
VSWR (dB)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
VSWR


VSWR VS. % POWER TRANSMITTED AND % POWER REFLECTED
% POWER TRANSMITTED
% POWER REFLECTED
%
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
72
76
80
84
88
92
96
100
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
VSWR



The Input V.S.W.R. resulting from the insertion of attenuation is found by laying a straight-edge from the original V.S.W.R. to the attenuator value and reading-off on the left-hand scale.

VSWR (<1) TO POWER REFLECTION COEFFICIENT

s	0	1	2	3	4	5	6	7	8	9	s
.00	1.000	.9960	.9920	.9881	.9841	.9802	.9763	.9724	.9685	.9646	.00
.01	.9608	.9570	.9531	.9493	.9455	.9418	.9380	.9343	.9305	.9268	.01
.02	.9231	.9194	.9158	.9121	.9085	.9048	.9102	.8976	.8940	.8905	.02
.03	.8869	.8833	.8798	.8763	.8728	.8693	.8658	.8624	.8589	.8555	.03
.04	.8521	.8487	.8453	.8419	.8385	.8352	.8318	.8285	.8252	.8219	.04
.05	.8186	.8153	.8121	.8088	.8056	.8023	.7991	.7959	.7927	.7896	.05
.06	.7864	.7833	.7801	.7770	.7739	.7708	.7677	.7646	.7615	.7585	.06
.07	.7554	.7524	.7494	.7464	.7434	.7404	.7374	.7345	.7315	.7286	.07
.08	.7257	.7227	.7198	.7169	.7141	.7112	.7083	.7055	.7026	.6998	.08
.09	.6970	.6942	.6914	.6886	.6858	.6831	.6803	.6776	.6749	.6721	.09
.10	.6694	.6667	.6640	.6614	.6587	.6560	.6534	.6507	.6481	.6455	.10
.11	.6429	.6403	.6377	.6351	.6326	.6300	.6275	.6249	.6224	.6199	.11
.12	.6174	.6149	.6124	.6099	.6074	.6049	.6025	.6000	.5976	.5952	.12
.13	.5928	.5904	.5880	.5856	.5832	.5808	.5785	.5761	.5738	.5714	.13
.14	.5691	.5668	.5645	.5622	.5599	.5576	.5553	.5531	.5508	.5486	.14
.15	.5463	.5441	.5419	.5397	.5374	.5352	.5331	.5309	.5287	.5265	.15
.16	.5244	.5222	.5201	.5180	.5158	.5137	.5116	.5095	.5074	.5053	.16
.17	.5033	.5012	.4991	.4971	.4950	.4930	.4910	.4889	.4869	.4849	.17
.18	.4829	.4809	.4789	.4770	.4750	.4730	.4711	.4691	.4672	.4652	.18
.19	.4633	.4614	.4595	.4578	.4557	.4538	.4519	.4500	.4482	.4463	.19
.20	.4444	.4426	.4408	.4389	.4371	.4353	.4335	.4317	.4299	.4281	.20
.21	.4263	.4245	.4227	.4210	.4192	.4174	.4157	.4139	.4122	.4105	.21
.22	.4088	.4071	.4053	.4036	.4019	.4003	.3986	.3969	.3952	.3936	.22
.23	.3919	.3902	.3886	.3870	.3853	.3837	.3821	.3805	.3789	.3773	.23
.24	.3757	.3741	.3725	.3709	.3693	.3678	.3662	.3646	.3631	.3615	.24
.25	.3600	.3585	.3569	.3554	.3539	.3524	.3509	.3494	.3479	.3464	.25
.26	.3449	.3435	.3420	.3405	.3391	.3376	.3361	.3347	.3333	.3318	.26
.27	.3304	.3290	.3276	.3262	.3247	.3233	.3219	.3206	.3192	.3178	.27
.28	.3164	.3150	.3137	.3123	.3110	.3096	.3083	.3069	.3056	.3043	.28
.29	.3029	.3016	.3003	.2990	.2977	.2964	.2951	.2938	.2925	.2912	.29
.30	.2899	.2887	.2874	.2861	.2849	.2836	.2824	.2811	.2799	.2787	.30
.31	.2774	.2762	.2750	.2738	.2726	.2714	.2702	.2690	.2678	.2666	.31
.32	.2654	.2642	.2630	.2619	.2607	.2595	.2584	.2572	.2561	.2549	.32
.33	.2538	.2526	.2515	.2504	.2493	.2481	.2470	.2459	.2448	.2437	.33
.34	.2426	.2415	.2404	.2393	.2382	.2372	.2361	.2350	.2340	.2329	.34
.35	.2318	.2308	.2297	.2287	.2276	.2266	.2256	.2245	.2235	.2225	.35
.36	.2215	.2204	.2194	.2184	.2174	.2164	.2154	.2144	.2134	.2125	.36
.37	.2115	.2105	.2095	.2085	.2076	.2066	.2057	.2047	.2037	.2028	.37
.38	.2019	.2009	.2000	.1990	.1981	.1972	.1963	.1953	.1944	.1935	.38
.39	.1926	.1917	.1908	.1899	.1890	.1881	.1872	.1863	.1854	.1846	.39
.40	.1837	.1828	.1819	.1811	.1802	.1793	.1785	.1776	.1768	.1759	.40
.41	.1751	.1743	.1734	.1726	.1718	.1709	.1701	.1693	.1685	.1676	.41
.42	.1668	.1680	.1652	.1644	.1636	.1628	.1620	.1612	.1605	.1597	.42
.43	.1589	.1581	.1573	.1566	.1558	.1550	.1543	.1535	.1527	.1520	.43
.44	.1512	.1506	.1497	.1490	.1483	.1475	.1468	.1461	.1453	.1446	.44
.45	.1439	.1432	.1424	.1417	.1410	.1403	.1396	.1389	.1382	.1275	.45
.46	.1388	.1361	.1354	.1347	.1340	.1334	.1327	.1320	.1313	.1307	.46
.47	.1300	.1293	.1287	.1280	.1273	.1267	.1260	.1254	.1247	.1241	.47
.48	.1235	.1228	.1222	.1215	.1209	.1203	.1196	.1190	.1184	.1178	.48
.49	.1172	.1165	.1159	.1153	.1147	.1141	.1135	.1129	.1123	.1117	.49
s	0	1	2	3	4	5	6	7	8	9	s

s	0	1	2	3	4	5	6	7	8	9	s
.50	.1111	.1105	.1099	.1093	.1088	.1082	.1076	.1070	.1065	.1059	.50
.51	.1053	.1047	.1042	.1036	.1030	.1025	.1019	.1014	.1008	.1003	.51
.52	.0997	.0992	.0986	.0981	.0976	.0970	.0965	.0960	.0954	.0949	.52
.53	.0944	.0938	.0933	.0928	.0923	.0918	.0913	.0907	.0902	.0897	.53
.54	.0892	.0887	.0882	.0877	.0872	.0867	.0862	.0858	.0853	.0848	.54
.55	.0843	.0838	.0833	.0829	.0824	.0819	.0814	.0810	.0805	.0800	.55
.56	.0796	.0791	.0786	.0782	.0777	.0773	.0768	.0764	.0759	.0755	.56
.57	.0750	.0746	.0741	.0737	.0733	.0728	.0724	.0720	.0715	.0711	.57
.58	.0707	.0702	.0698	.0694	.0690	.0686	.0681	.0677	.0673	.0669	.58
.59	.0665	.0661	.0657	.0653	.0649	.0645	.0641	.0637	.0633	.0629	.59
.60	.0625	.0621	.0617	.0613	.0610	.0606	.0602	.0598	.0594	.0591	.60
.61	.0587	.0583	.0579	.0576	.0572	.0568	.0565	.0561	.0557	.0554	.61
.62	.0550	.0547	.0543	.0540	.0536	.0533	.0529	.0526	.0522	.0519	.62
.63	.0515	.0512	.0509	.0505	.0502	.0498	.0495	.0492	.0488	.0485	.63
.64	.0482	.0479	.0475	.0472	.0469	.0466	.0463	.0459	.0456	.0453	.64
.65	.0450	.0447	.0444	.0441	.0438	.0435	.0432	.0429	.0426	.0423	.65
.66	.0420	.0417	.0414	.0411	.0408	.0405	.0402	.0399	.0396	.0393	.66
.67	.0391	.0388	.0385	.0382	.0379	.0377	.0374	.0371	.0363	.0366	.67
.68	.0363	.0360	.0357	.0355	.0352	.0350	.0347	.0344	.0342	.0339	.68
.69	.0337	.0334	.0331	.0329	.0326	.0324	.0321	.0319	.0316	.0314	.69
.70	.0311	.0309	.0307	.0304	.0302	.0299	.0297	.0295	.0292	.0290	.70
.71	.0288	.0285	.0283	.0281	.0278	.0276	.0274	.0272	.0269	.0267	.71
.72	.0265	.0268	.0261	.0259	.0256	.0254	.0252	.0250	.0248	.0246	.72
.73	.0244	.0242	.0239	.0237	.0235	.0233	.0231	.0229	.0227	.0225	.73
.74	.0223	.0221	.0219	.0217	.0216	.0214	.0212	.0210	.0208	.0206	.74
.75	.0204	.0202	.0200	.0199	.0197	.0195	.0193	.0191	.0190	.0188	.75
.76	.0186	.0184	.0182	.0181	.0179	.0177	.0176	.0174	.0172	.0171	.76
.77	.0169	.0167	.0166	.0164	.0162	.0161	.0159	.0158	.0156	.0154	.77
.78	.0153	.0151	.0150	.0148	.0147	.0145	.0144	.0142	.0141	.0139	.78
.79	.0138	.0136	.0135	.0133	.0132	.0130	.0129	.0128	.0126	.0125	.79
.80	.0124	.0122	.0121	.0119	.0118	.0117	.0115	.0114	.0113	.0112	.80
.81	.0110	.0109	.0108	.0106	.0105	.0104	.0103	.0101	.0100	.0099	.81
.82	.0098	.0097	.0095	.0094	.0093	.0092	.0091	.0090	.0089	.0087	.82
.83	.0086	.0085	.0084	.0083	.0082	.0081	.0080	.0079	.0078	.0077	.83
.84	.0076	.0075	.0074	.0073	.0072	.0071	.0070	.0069	.0068	.0067	.84
.85	.0066	.0065	.0064	.0063	.0062	.0061	.0060	.0059	.0058	.0058	.85
.86	.0057	.0056	.0055	.0054	.0053	.0052	.0052	.0051	.0050	.0049	.86
.87	.0048	.0048	.0047	.0046	.0045	.0044	.0044	.0043	.0042	.0042	.87
.88	.0041	.0040	.0039	.0039	.0038	.0037	.0037	.0036	.0035	.0035	.88
.89	.0034	.0033	.0033	.0032	.0031	.0031	.0030	.0030	.0029	.0028	.89
.90	.0028	.0027	.0027	.0026	.0025	.0025	.0024	.0024	.0023	.0023	.90
.91	.0022	.0022	.0021	.0021	.0020	.0020	.0019	.0019	.0018	.0018	.91
.92	.0017	.0017	.0017	.0016	.0016	.0015	.0015	.0014	.0014	.0014	.92
.93	.0013	.0013	.0012	.0012	.0012	.0011	.0011	.0011	.0010	.0010	.93
.94	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0007	.0007	.0007	.94
.95	.0007	.0006	.0006	.0006	.0006	.0005	.0005	.0005	.0005	.0004	.95
.96	.0004	.0004	.0004	.0004	.0003	.0003	.0003	.0003	.0003	.0003	.96
.97	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0001	.0001	.0001	.97
.98	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0000	.0000	.0000	.98
.99	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.99
s	0	1	2	3	4	5	6	7	8	9	s

VSWR (<1) TO VOLTAGE REFLECTION COEFFICIENT

s	0	1	2	3	4	5	6	7	8	9	s
.00	1.000	.9980	.9960	.9940	.9920	.9901	.9881	.9861	.9841	.9822	.00
.01	.9802	.9782	.9763	.9743	.9724	.9704	.9685	.9666	.9646	.9627	.01
.02	.9608	.9589	.9570	.9550	.9531	.9512	.9493	.9474	.9455	.9436	.02
.03	.9418	.9399	.9380	.9361	.9342	.9324	.9305	.9286	.9268	.9249	.03
.04	.9231	.9212	.9194	.9175	.9157	.9139	.9121	.9102	.9084	.9066	.04
.05	.9048	.9030	.9011	.8993	.8975	.8957	.8939	.8922	.8904	.8886	.05
.06	.8868	.8850	.8832	.8815	.8797	.8779	.8762	.8744	.8727	.8709	.06
.07	.8692	.8674	.8657	.8639	.8622	.8605	.8587	.8570	.8553	.8536	.07
.08	.8519	.8501	.8484	.8467	.8450	.8433	.8416	.8399	.8382	.8366	.08
.09	.8349	.8332	.8315	.8298	.8282	.8265	.8248	.8232	.8215	.8198	.09
.10	.8132	.8165	.8149	.8132	.8116	.8100	.8083	.8067	.8051	.8034	10
.11	.8018	.8002	.7986	.7970	.7953	.7937	.7921	.7905	.7889	.7873	.11
.12	.7857	.7841	.7825	.7809	.7794	.7778	.7762	.7746	.7731	.7715	.12
.13	.7699	.7684	.7668	.7652	.7637	.7621	.7606	.7590	.7575	.7559	.13
.14	.7544	.7529	.7513	.7498	.7483	.7467	.7452	.7437	.7422	.7406	14
.15	.7391	.7376	.7361	.7346	.7331	.7316	.7301	.7286	.7271	.7256	15
.16	.7241	.7227	.7212	.7197	.7182	.7167	.7153	.7138	.7123	.7109	.16
.17	.7094	.7079	.7065	.7050	.7036	.7021	.7007	.6992	.6978	.6964	17
.18	.6949	.6935	.6921	.6906	.6892	.6878	.6863	.6849	.6835	.6821	.18
.19	.6807	.6793	.6779	.6765	.6750	.6736	.6722	.6708	.6695	.6681	.19
.20	.6657	.6653	.6639	.6625	.6611	.6598	.6584	.6570	.6556	.6543	.20
.21	.6529	.6515	.6502	.6488	.6475	.6461	.6447	.6434	.6420	.6407	.21
.22	.6393	.6380	.6367	.6353	.6340	.6327	.6313	.6300	.6287	.6273	.22
.23	.6250	.6247	.6234	.6221	.6208	.6194	.6181	.6168	.6155	.6142	.23
.24	.6129	.6116	.6103	.6090	.6077	.6064	.6051	.6039	.6026	.6013	.24
.25	.6000	.5987	.5974	.5962	.5949	.5936	.5924	.5911	.5898	.5886	.25
.26	.5873	.5860	.5848	.5835	.5823	.5810	.5798	.5785	.5773	.5760	.26
.27	.5748	.5735	.5723	.5711	.5699	.5686	.5674	.5662	.5650	.5637	.27
.28	.5625	.5613	.5601	.5589	.5576	.5564	.5552	.5540	.5528	.5516	.28
.29	.5504	.5492	.5480	.5468	.5456	.5444	.5432	.5420	.5408	.5397	.29
.30	.5395	.5373	.5361	.5349	.5337	.5326	.5314	.5302	.5291	.5279	.30
.31	.5267	.5256	.5244	.5232	.5221	.5209	.5198	.5186	.5175	.5163	.31
.32	.5152	.5140	.5129	.5117	.5106	.5094	.5083	.5072	.5060	.5049	.32
.33	.5038	.5026	.5015	.5004	.4993	.4981	.4970	.4959	.4948	.4937	.33
.34	.4925	.4914	.4903	.4892	.4881	.4870	.4859	.4848	.4837	.4826	.34
.35	.4815	.4804	.4793	.4782	.4771	.4760	.4749	.4738	.4728	.4717	.35
.36	.4706	.4695	.4684	.4674	.4663	.4652	.4641	.4631	.4620	.4609	.36
.37	.4599	.4588	.4577	.4567	.4556	.4546	.4535	.4524	.4514	.4503	.37
.38	.4493	.4482	.4472	.4461	.4451	.4440	.4430	.4420	.4409	.4399	.38
.39	.4389	.4378	.4368	.4358	.4347	.4337	.4327	.4316	.4306	.4296	.39
.40	.4286	.4276	.4266	.4255	.4245	.4235	.4225	.4215	.4205	.4195	.40
.41	.4184	.4174	.4164	.4154	.4144	.4134	.4124	.4114	.4104	.4094	.41
.42	.4085	.4075	.4065	.4055	.4045	.4035	.4025	.4015	.4006	.3996	.42
.43	.3986	.3976	.3967	.3957	.3947	.3937	.3928	.3918	.3908	.3899	.43
.44	.3889	.3879	.3870	.3860	.3850	.3841	.3831	.3822	.3812	.3803	.44
.45	.3793	.3784	.3774	.3765	.3755	.3746	.3736	.3727	.3717	.3708	.45
.46	.3699	.3689	.3680	.3671	.3661	.3652	.3643	.3633	.3624	.3615	.46
.47	.3605	.3596	.3587	.3578	.3569	.3559	.3550	.3541	.3532	.3523	.47
.48	.3514	.3504	.3495	.3486	.3477	.3468	.3459	.3450	.3441	.3432	.48
.49	.3423	.3414	.3405	.3396	.3387	.3378	.3369	.3360	.3351	.3342	.49
s	0	1	2	3	4	5	6	7	8	9	s

s	0	1	2	3	4	5	6	7	8	9	s
.50	.3333	.3325	.3316	.3307	.3298	.3289	.3280	.3271	.3263	.3254	.50
.51	.3245	.3236	.3238	.3219	.3210	.3201	.3193	.3184	.3175	.3167	.51
.52	.3158	.3149	.3141	.3132	.3123	.3115	.3106	.3098	.3089	.3080	.52
.53	.3072	.3063	.3055	.3046	.3038	.3029	.3021	.3012	.3004	.2996	.53
.54	.2987	.2979	.2970	.2962	.2953	.2945	.2937	.2928	.2920	.2912	.54
.55	.2903	.2895	.2887	.2878	.2870	.2862	.2854	.2845	.2837	.2829	.55
.56	.2821	.2812	.2804	.2796	.2788	.2780	.2771	.2763	.2755	.2747	.56
.57	.2739	.2731	.2723	.2715	.2707	.2698	.2690	.2682	.2674	.2686	.57
.58	.2658	.2650	.2642	.2634	.2626	.2618	.2610	.2602	.2595	.2587	.58
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.60	.2500	.2492	.2484	.2477	.2469	.2461	.2453	.2446	.2438	.2430	.60
.61	.2422	.2415	.2407	.2399	.2392	.2384	.2376	.2369	.2361	.2353	.61
.62	.2346	.2338	.2331	.2323	.2315	.2308	.2300	.2293	.2255	.2278	.62
.63	.2270	.2262	.2255	.2247	.2240	.2232	.2225	.2218	.2210	.2203	.63
.64	.2195	.2188	.2180	.2173	.2166	.2158	.2151	.2143	.2136	.2129	.64
.65	.2121	.2114	.2107	.2099	.2092	.2085	.2077	.2070	.2063	.2056	.65
.66	.2048	.2041	.2034	.2027	.2019	.2012	.2005	.1998	.1990	.1983	.66
.67	.1976	.1969	.1962	.1955	.1947	.1940	.1933	.1925	.1919	.1912	.67
.68	.1905	.1898	.1891	.1884	.1877	.1869	.1862	.1856	.1848	.1841	.68
.69	.1834	.1827	.1820	.1813	.1806	.1799	.1793	.1786	.1779	.1772	.69
.70	.1765	.1758	.1751	.1744	.1737	.1730	.1723	.1717	.1710	.1703	.70
.71	.1696	.1689	.1682	.1675	.1669	.1662	.1655	.1648	.1641	.1635	.71
.72	.1628	.1621	.1614	.1608	.1601	.1594	.1583	.1581	.1574	.1567	.72
.73	.1561	.1554	.1547	.1541	.1534	.1527	.1521	.1514	.1508	.1501	.73
.74	.1494	.1483	.1481	.1475	.1468	.1461	.1455	.1448	.1442	.1435	.74
.75	.1429	.1422	.1416	.1409	.1403	.1396	.1390	.1383	.1377	.1370	.75
.76	.1364	.1357	.1351	.1344	.1338	.1331	.1325	.1319	.1312	.1306	.76
.77	.1299	.1293	.1287	.1280	.1274	.1268	.1261	.1255	.1249	.1242	.77
.78	.1236	.1230	.1223	.1217	.1211	.1205	.1198	.1192	.1186	.1179	.78
.79	.1173	.1167	.1161	.1155	.1148	.1142	.1136	.1130	.1124	.1117	.79
.80	.1111	.1105	.1099	.1093	.1082	.1080	.1074	.1068	.1062	.1056	.80
.81	.1050	.1044	.1038	.1031	.1025	.1019	.1013	.1007	.1001	.0995	.81
.82	.0989	.0983	.0977	.0971	.0965	.0959	.0953	.0947	.0941	.0935	.82
.83	.0929	.0923	.0917	.0911	.0905	.0899	.0893	.0887	.0881	.0876	.83
.84	.0870	.0864	.0858	.0852	.0846	.0840	.0834	.0828	.0823	.0817	.84
.85	.0811	.0805	.0799	.0793	.0788	.0782	.0776	.0770	.0764	.0759	.85
.86	.0753	.0747	.0741	.0735	.0730	.0724	.0718	.0712	.0707	.0701	.86
.87	.0695	.0690	.0684	.0678	.0672	.0667	.0661	.0655	.0650	.0644	.87
.88	.0638	.0633	.0627	.0621	.0616	.0610	.0605	.0599	.0593	.0588	.88
.89	.0582	.0576	.0571	.0565	.0560	.0554	.0549	.0543	.0537	.0532	.89
.90	.0526	.0521	.0515	.0510	.0504	.0499	.0493	.0488	.0432	.0477	.90
.91	.0471	.0466	.0460	.0455	.0449	.0444	.0438	.0433	.0428	.0422	.91
.92	.0417	.0411	.0406	.0400	.0395	.0390	.0384	.0379	.0373	.0368	.92
.93	.0363	.0357	.0352	.0347	.0341	.0336	.0331	.0325	.0320	.0315	.93
.94	.0309	.0304	.0299	.0293	.0288	.0283	.0278	.0272	.0267	.0262	.94
.95	.0256	.0251	.0246	.0241	.0235	.0230	.0225	.0220	.0215	.0209	.95
.96	.0204	.0199	.0194	.0189	.0183	.0178	.0173	.0168	.0163	.0157	.96
.97	.0152	.0147	.0142	.0137	.0132	.0127	.0122	.0116	.0111	.0106	.97
.98	.0101	.0095	.0091	.0086	.0081	.0076	.0071	.0065	.0060	.0055	.98
.99	.0050	.0045	.0040	.0035	.0030	.0025	.0020	.0015	.0010	.0005	.99
s	0	1	2	3	4	5	6	7	8	9	s

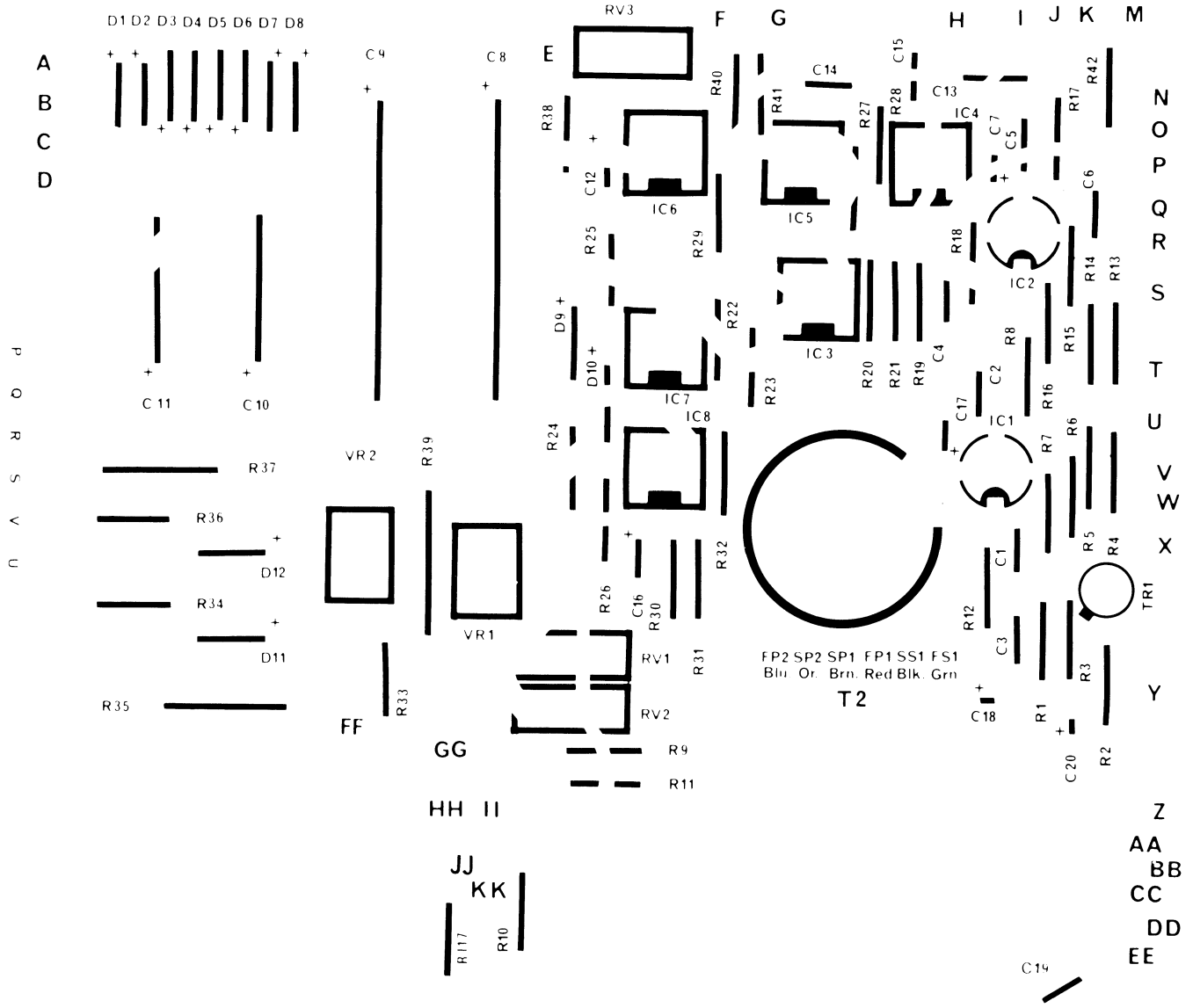

Fig. 6. Printed Circuit Board layout

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