CENTRAL INSTITUTE OF TECHNOLOGY

SCHOOL OF ELECTRONIC ENGINEERING

MICROWAVE EXPERIMENTAL TEST BENCH

GUIDELINES

Safety
The level of radiation from the test generators in the laboratory is less than 10 mW/m^2. However in the interests of developing safe working habits, **DO NOT LOOK INTO OPEN SECTION OF RADIATING WAVEGUIDES OR CARRY OUT ADJUSTMENTS WHERE THE EYE IS PLACED CLOSE TO OR AT THE FOCAL POINT OF RADIATION**

Handbooks
The equipment handbooks and component data are located in cupboard adjacent to the mains switch panel.

Microwave Components
Microwave components are located :

a) Set up as part of an existing test bench
b) Surplus items held in cupboards

Equipments can be identified from equipment handbooks.

Basic Test Bench
An attached sheet shows a typical layout. Note that some components can be placed towards or away from the generator depending on the nature of the experiment.

Ferrite isolator is a non-reciprocating attenuator that acts as a buffer on the oscillator to minimise changes in oscillator frequency due to loading (ie high VSWR).
Typical attenuation in the forward direction is <1 dB and in the reverse direction it will be in the vicinity of >20 dB depending upon type selected.
NOTE THE ARROW FOR FORWARD DIRECTION

Cross Couplers permit examination of forward and reverse energy within the waveguide. Each arm is terminated in a diode-detector mount, or termination mount if detector is not used.
There are three types of couplers available; identify the one you will use and note the attenuation between main waveguide and each arm and between arms.

Wavemeters (absorption) enable an indirect measurement of the free-space wavelength and hence frequency of the oscillator. The adjustment is via a micrometer movement and resonance is indicated by a reduction of energy in the main waveguide (a dip will occur on the meter, monitoring the main waveguide energy. The dip is steep for the precision wavemeters because they have low loss and a high Q).

Transfer of the micrometer reading to the appropriate <u>calibration chart for that wavemeter</u> will identify the oscillator's frequency. Also, from the accompanying tabulations, the free-space and waveguide wavelengths can be ascertained. Note that resonance of the rectangular types is calibrated for H_{102} modes, however, resonance will also occur in the H_{101} mode when the generator's frequency is lower than that for which the wavemeter is calibrated. If the waveguide wavelength is twice that calculated, readjust the oscillator to a higher frequency. A limited range of frequencies may also occur where no dip is possible; operation is now outside the range of the wavemeter.

<u>Attenuators</u> are used to control the energy level within the waveguide. Maximum attenuation occurs when the strip is at the centre point of the waveguide. The range of adjustment is >40 dB.

<u>NOTE</u> the difference(s) between the attenuator and the variable phase shifter.

<u>Variable Phase shifter</u> is used to change the <u>electrical length</u> of the waveguide. This change in length permits the exact positioning of measuring or test points on the waveguide.

<u>Standing Wave Indicator</u> is used in conjunction with a **<u>SLOTTED LINE</u>** section to observe the behaviour of the energy within the waveguide.

The slot is non-radiating (H_{10} mode) and via a tuned probe, which has a fixed amount of penetration to cause minimum disturbance to the main waveguide, energy is extracted and rectified via the diode detector producing a relative level dc to drive the standing wave indicator meter via level controlled amplifiers.

The standing wave indicators used in the laboratory are calibrated for square-law detection (the output is directly proportional to the power level).

Note that filters are used to mask the noise level. Ensure alignment between generator modulating frequency and filter by adjusting the modulating frequency. The Marconi 6593A permits a small adjustment via rear panel controls; ~~the TA3 has a switchable bandwidth~~.

Also, ~~the TA3 and Marconi-Sanders SWI permit VSWR and corresponding reflection coefficient to be read directly off the scales;~~ the Marconi 6593A show VSWR/dB calibrations.

<u>Terminations</u>. The waveguide may be terminated in a variety of loads. However, an open ended waveguide is NOT a true open circuit. At midband frequencies the open ends present a load of approximately 500 ohms in a shunt with a capacitor. The open-ended waveguide coupled to the "free-space" load (377 ohms) will show that it is an effective widebeam radiator.

Matched terminations are available to absorb all incident energy.

Chapter 2

Operation

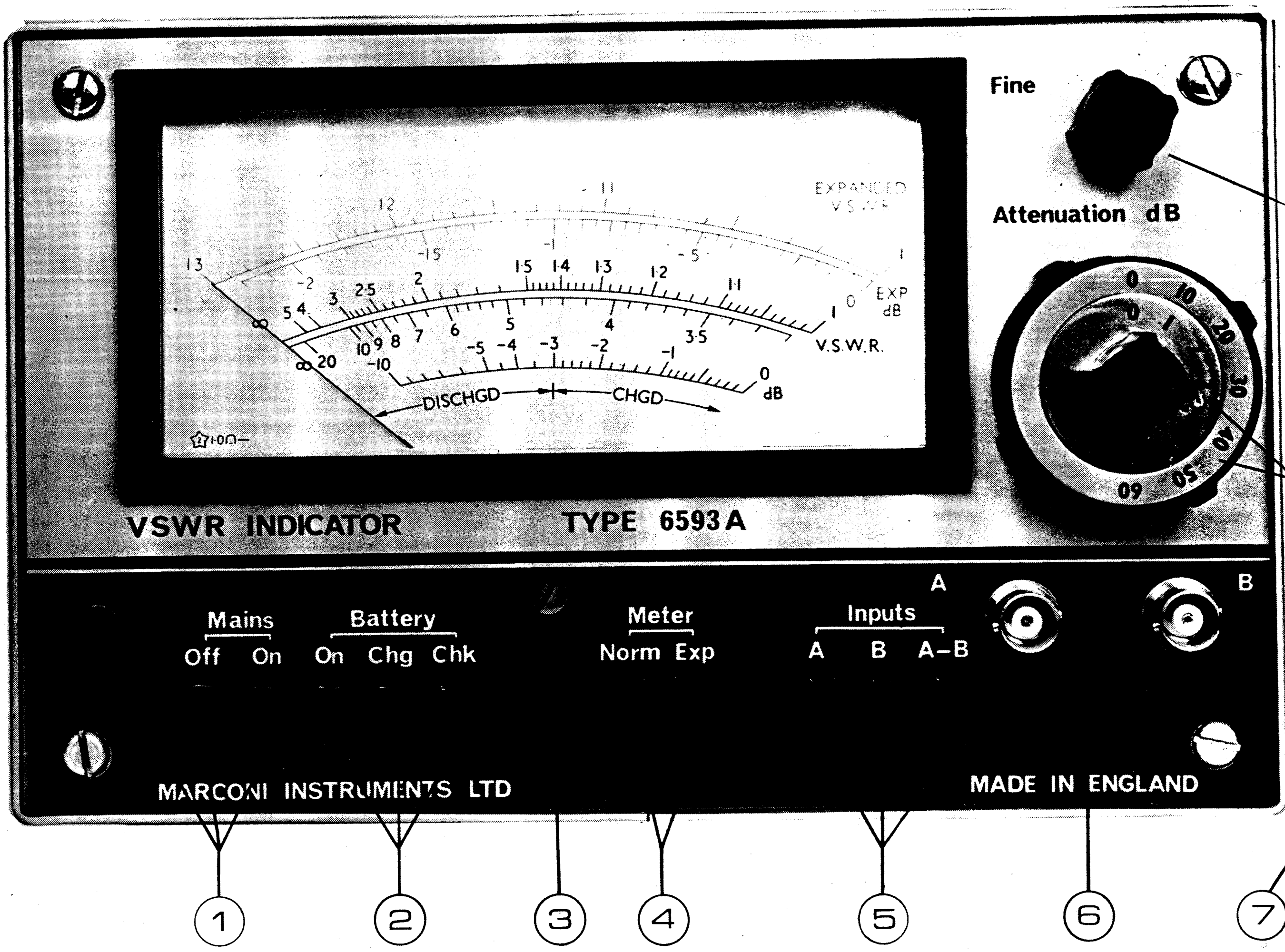

Fig. 2. Front Panel Controls

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.

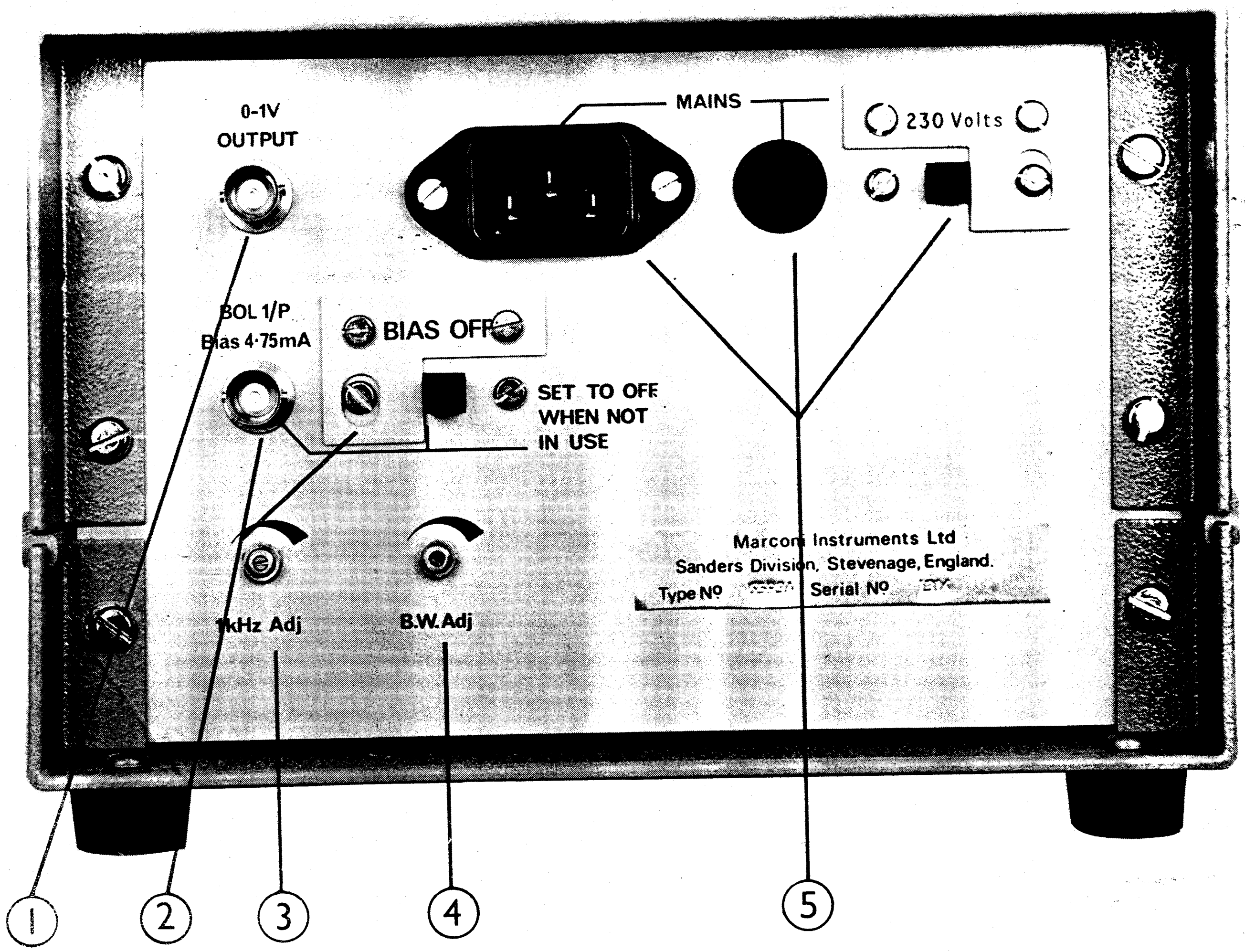

Fig. 3. Rear Panel Controls

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—∞ scale instead of the 1.0—∞ 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 1

GENERAL INFORMATION

CONTENTS

INTRODUCTION

1. This range of electronically tuned signal sources is a development of the previous range of electronically tuned sources manufactured by Marconi Instruments Microwave Products Division. These new A-series units use improved YIG oscillators to provide a compact, versatile electronically tuned signal source with a wide range of applications.

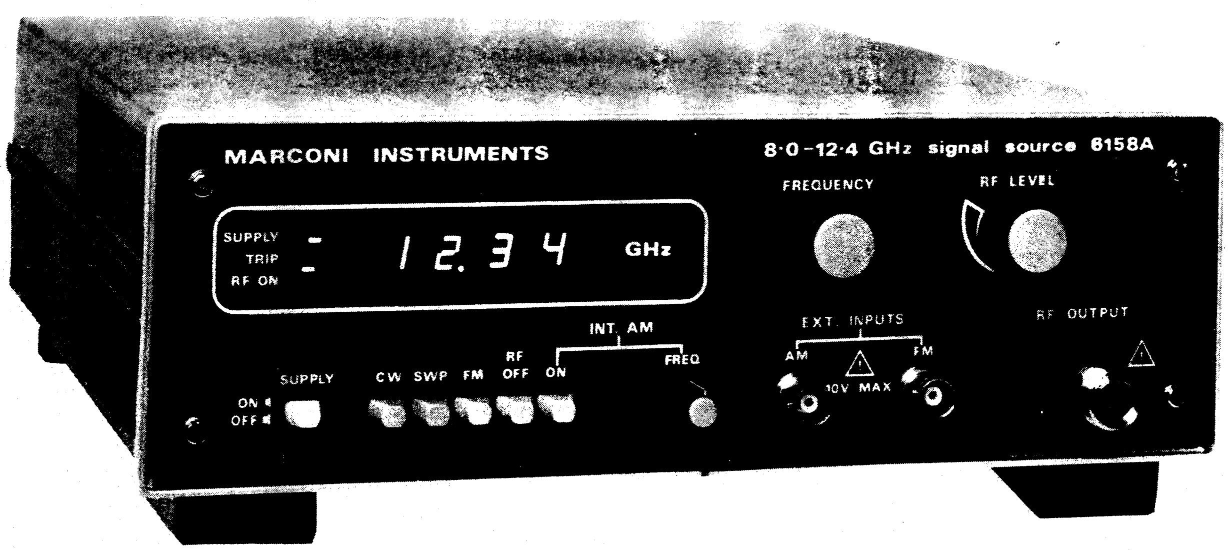

Fig.1 8.0 - 12.4 GHz AM-FM Signal Source type 6158A

2. A wide range of modulation facilities are provided and the 6150A Series may be operated in several modes by selecting the appropriate front panel push button switches and providing the necessary drive inputs.

CW	- Single frequency tuned using front panel knob. Low residual f.m. mode.
SWP	- Enables swept frequency when a 0 to +10V drive is applied (for full range) to the rear panel auxilliary or BNC sockets.
CW + SWP	- Enables slow sweeps (100Hz) or steps between frequencies with low residual f.m. using rear panel sockets and external drive.
FM	- Fast frequency modulation up to ±20MHz deviation for ±10V input to front panel BNC socket at up to 100kHz rate for -3dB response. This enables fine tuning or external locking about a centre frequency.
RF OFF	- RF output disabled.
INT AM ON	- Internal modulator switches RF amplitude at 1kHz rate adjustable ±200Hz with depth up to 18dB.

3. All AM functions are performed using a PIN modulator and so total AM depth specified is the summation of internal AM, external AM (if any) and front panel RF Level control. This is a 10 turn potentiometer allowing fine control of output power. An external levelling circuit may be used for swept frequency testing by incorporating a coupler, detector and the 6587 Levelling Amplifier. AM and FM functions are independent allowing full control of the 6150A Series.

4. The frequency display is by seven segment, 4 digit LED readout. Manual frequency control is via a multiturn potentiometer. A fifth LED provides an indication of mains on and RF on. A third segment lights to indicate power supply trip should the instrument be operated at an excess ambient temperature.

5. The rear panel auxiliary socket enables remote control of

* centre frequency
* output power
* 1kHz internal modulation
* RF on/off
* display blanking

These may be conveniently controlled via the IEEE-488 or IEC Interfaces by the 6140 GPIB Adaptor. A pin on the auxiliary socket also provides a dc output voltage (0 to 10V) proportional to centre frequency. This may be used to drive external recording devices such as X-Y pen recorders or display oscilloscopes.

6. The 6150A Series operates from either 110V or 240V mains supply via a changeover switch. The internal temperature rise is kept low for short warm up time and good stability. However should the instrument be inadvertently operated in an excessive ambient temperature a thermal trip operates in the power supply circuitry.

7. Typical uses of the 6150A Series include testing microwave components, antennas, radar receivers and systems. Used with the 6140 they provide compact, economical and versatile GPIB controlled microwave oscillators with the ability to generate both swept power and frequency. As a low harmonic oscillator the 6158A provides a convenient RF source for measurements with the 6500 Automatic Amplitude Analyser.

8. Accessories Supplied: Mains Lead
Handbook
Mating connector 'D' 15 way for
Auxiliary socket.

MODEL	6155A	6158A
FREQUENCY RANGE	1.0-2.0GHz	8.0-12.4GHz
RF POWER OUTPUT Minimum	15mW	10mW
FREQUENCY ACCURACY AT 20°C AND MAXIMUM RF POWER	±1%	±0.75%
FREQUENCY PULLING External Internal	±2MHz DUE TO 2:1 VSWR ±2MHz DUE TO 10dB CHANGE IN LEVEL CONTROL	±2MHz DUE TO 2:1 VSWR ±2MHz DUE TO 10dB CHANGE IN LEVEL CONTROL
FREQUENCY STABILITY Warm up time(1)(2) Temperature Coefficient(1)	< 15 min ±0.05%/°C (at 22°C nominal)	< 15 min ±0.01%/°C (at 22°C nominal)
SPECTRAL PURITY (1) (3) AT MAXIMUM RF POWER Residual f.m. Harmonic Content Spurious Output	< 35kHz rms -35dBc (5) -60dBc	< 35kHz rms -40dBc -60dBc
RF LEVEL CONTROL (Internal & External (4)	20dB	18dB
AMPLITUDE MODULATION Internal Depth (4) (1kHz ±200Hz min) External Depth (4) Rise and Fall Time	20dB 20dB For +10V or +50mA Input < 600ns	18dB 18dB For +10V or +50mA In < 600ns
FM CAPABILITY Deviation Maximum Rate (-3dB)	±20MHz for ±10V Input 100kHz	±20MHz for ±10V Input 100kHz
SWEEP CAPABILITY Input -3dB Bandwidth(1) Tuning Voltage Output	0 to +10V > 100 Hz 0 to +10V for full sweep, reduced for narrow band	0 to +10V > 100 Hz 0 to +10V for full sweep, reduced for narrow band
OUTPUT CONNECTOR	Precision Stainless Steel 'N' Type Female 50 ohm	Precision Stainless Steel 'N' Type Female 50 ohm
POWER REQUIREMENTS	100-125 or 200-250V, 50-60 Hz, 60VA	100-125 or 200-250V, 50-60 Hz, 60VA
DIMENSIONS AND WEIGHT	Height Width Depth Weight 98mm 270mm 254mm 6.1kg 3⅞ in 10½ in 10 in. 13½ lb	Height Width Depth Weig 98mm 270mm 254mm 6.1k 3⅞ in 10½ in 10 in 13½
ENVIRONMENTAL: TEMPERATURE	10+35°C meets specification 0,+50°C operating -40,+70°C storage	10,+35°C meets specification 0, +50°C operating -40,+70°C storage

(1) Typical values
(2) To be within frequency accuracy
(3) In CW and FM modes
(4) AM depth is dependent on R.F. level control settings and external modulation input. As only one modulator is used for all AM functions it therefore has a summation capab
(5) Below 1.5GHz carrier frequency, this may rise to -15dBc.

Chapter 3

OPERATION

CONTENTS

OPERATING MODES

1. The 6150A series Signal Sources can be operated in the following modes:

(a) As a CW source of microwave power

(b) As a 1kHz ±20% internally A.M.modulated square wave source

(c) As an externally AM modulated source

(d) As an externally FM modulated source

(e) As an externally swept frequency source

(f) Under GPIB control using Marconi Instruments type 6140 GPIB Adaptor

All modulation facilities are independant and may be operated simultaneously with the proviso that total AM capability is limited to level shown in specifications.

CONTROLS AND CONNECTORS

2. <u>Front Panel</u>

(1) MAINS SWITCH. Depress to turn instrument ON; depress again to turn instrument OFF. Supply indicator (9) (1st LED Segment) should light.

(2) FUNCTION SWITCH

(a) For Manual frequency control push CW button. CW and SWP buttons are inter linked but may be depressed together for slow sweeps at low f.m.

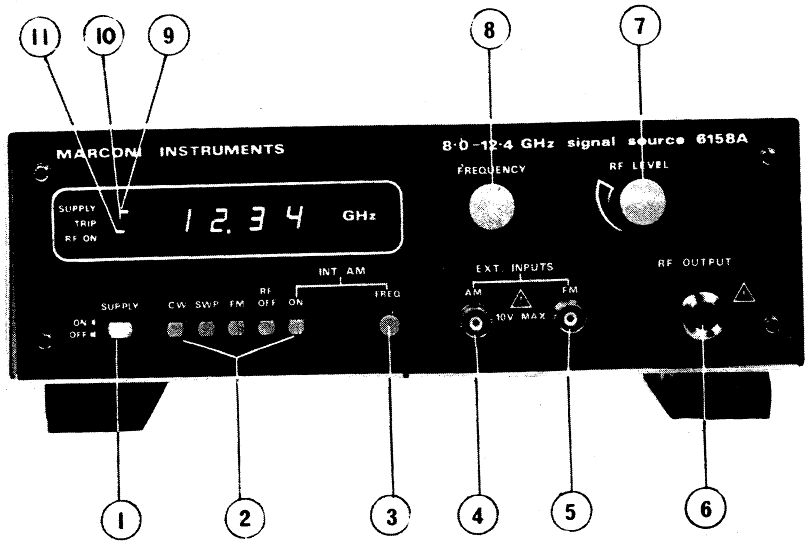

Fig.1 Front Panel

(b) For external sweep push SWP button (See Chapter 1 paragraph 3)

(c) For external FM push FM button (See Chapter 1 paragraph 3)

(d) For internal squarewave AM push INT AM ON button

(e) For complete switching-off of output push RF OFF, (3rd LED segment) (11) extinguished

(3) MODULATING FREQUENCY CONTROL. Sets the internal modulation frequency between 800Hz and 1200Hz.

(4) EXTERNAL AM INPUT. A 0 to +50mA input applied will produce attenuation, but refer to RF LEVEL control (7).

(5) EXTERNAL FM INPUT. A ±10V input will produce ±20MHz deviation; maximum rate (-3dB) 100 kHz.

(6) RF OUTPUT CONNECTOR. Precision Type N(f), 50 ohm.

(7) RF LEVEL CONTROL. This is at maximum range with minimum RF output when fully counter clockwise. AM depth is dependent on RF LEVEL control settings and external modulation input. Only one modulator is used for all AM functions and therefore it has a summation capability of 20dB 6155A or 18dB 6158A.

(8) FREQUENCY CONTROL. This multi-turn potentiometer, which allows very good frequency resettability, is used to set the RF output frequency in the CW mode of operation. Frequency is indicated on the LED Display.

(9) SUPPLY ON. 1st LED segment illuminated when mains applied and Supply switch (1) depressed.

(10) TRIP 2nd LED segment illuminated if power supply trip occurs.

(11) RF ON 3rd LED segment illuminated when RF output present at (6).

General information

Fig. 1 Marconi Instruments Signal Source Type 6058B

1.1 SPECIFICATION

FREQUENCY	
Range	8.0 to 12.5 GHz in one continuous band
Scale Accuracy	±1%
Stability (Typical) (After one hour warm up in stable environment)	
Short Term (5 min)	0.003% (Allowing settling time of 15 min after frequency change)
Long Term (1 hour)	0.008%
Line stability	0.001% per 10V change in range 200 to 260V
With Temperature	0.006%/°C in range 10 to 50°C

Pulling (Typical) (Frequency pull due to mismatch of 50:1)	
at 8.0 GHz	0.09%
at 10.0 GHz	0.06%
at 12.0 GHz	0.09%
Output Power	Not less than 20 mW in 50Ω
Attenuator	Internally and externally fully variable over at least 15 dB
Impedance	50Ω
Output Connector	Precision stainless steel female 'N' Type
SIGNAL PURITY	
Harmonic Content	Not greater than −20 dB relative to fundamental
Residual F.M.	Typically 10 p.p.m.
Amplitude Modulation	
Internal	15 dB depth modulation, variable over at least 100 Hz either side of a nominal 1 kHz squarewave.
External	Up to 17 dB depth for a 100 mA input. Rise time being faster than 5 μs.
Output Levelling	Compatible with levelling amplifier Type 6587, to level output within 0.1 dB (excluding detector and coupler variations).
Power Requirements	
Supply Voltage	100 to 120 or 200 to 260V 50 to 60 Hz.
Input Power	20 VA
Dimensions	Height: 98 mm (3.7/8 in) Width: 203 mm (8 in) Depth: 286 mm (11.1/4 in) Weight: 4.0 kg
Accessories	A wide range of precision coaxial components is available for use with this instrument.

1.2 INTRODUCTION

The Marconi Instruments Signal Source Type 6058B is one in a range of solid state replacements for low power triode and klystron oscillators.

This model employs a Gunn effect device operating in a fundamental mode coaxial cavity. The cavity is tuned by means of a non-contacting short circuit plunger which is driven by a linearising cam and linked through a gear train to the front panel FREQUENCY control. The output frequency is displayed on a four digit mechanical counter. The effects of load variations on the oscillator are minimised by the incorporation of a miniature ferrite isolator.

Adjustment of the r.f. power level is accomplished by means of an electrically variable P.I.N. diode attenuator, which may be operated by the use of the front panel LEVEL control. The r.f. power can also be modulated internally by a 900 to 1100 Hz (or 2.9 to 3.1 kHz) squarewave applied to the P.I.N. diode unit.

The P.I.N. diode is also accessible via a BNC socket on the front panel, for use with a variety of external modulation signals. For example, the attenuator may be employed to level the r.f. output if an error signal is fed back from an external coupler and detector system.

The attenuation range available using the LEVEL control is greater than 15 dB. With this control set to MAX and an Ext input of 100 mA then attenuation of greater than 17.0 dB is available.

A facility which increases the usefulness of the source is the output voltage which is proportional to frequency. The relevant output connector is mounted on the rear panel of the unit and is labelled S2 on Fig.14. This voltage, which is approximately a 10V change over the frequency range, can be applied to the X traverse input of an X–Y recorder to enable broadband or manual swept-frequency measurements to be carried out.

Residual f.m. is of the order of 0.001% for the unit and is comparable with that of a conventional triode or klystron microwave source. Harmonic frequency components in the output of the unit are kept to a level of at least 20 dB below that of the fundamental, typically −30 dB, by the use of multi-section low-pass filter in the output line of the oscillator.

The oscillator is completely self-contained with its own built-in integrated circuit power unit suitable for operation from a.c. mains supplies of 110 or 230V.

1.3 INSTALLATION

Before connecting to the mains supply check that the rear panel voltage switch is set to the appropriate value and that the correct fuse ([illegible]mA) is fitted.
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The unit can be mounted in any position, but care should be taken to allow air to circulate freely over the rear panel.

Chapter 2 Operation

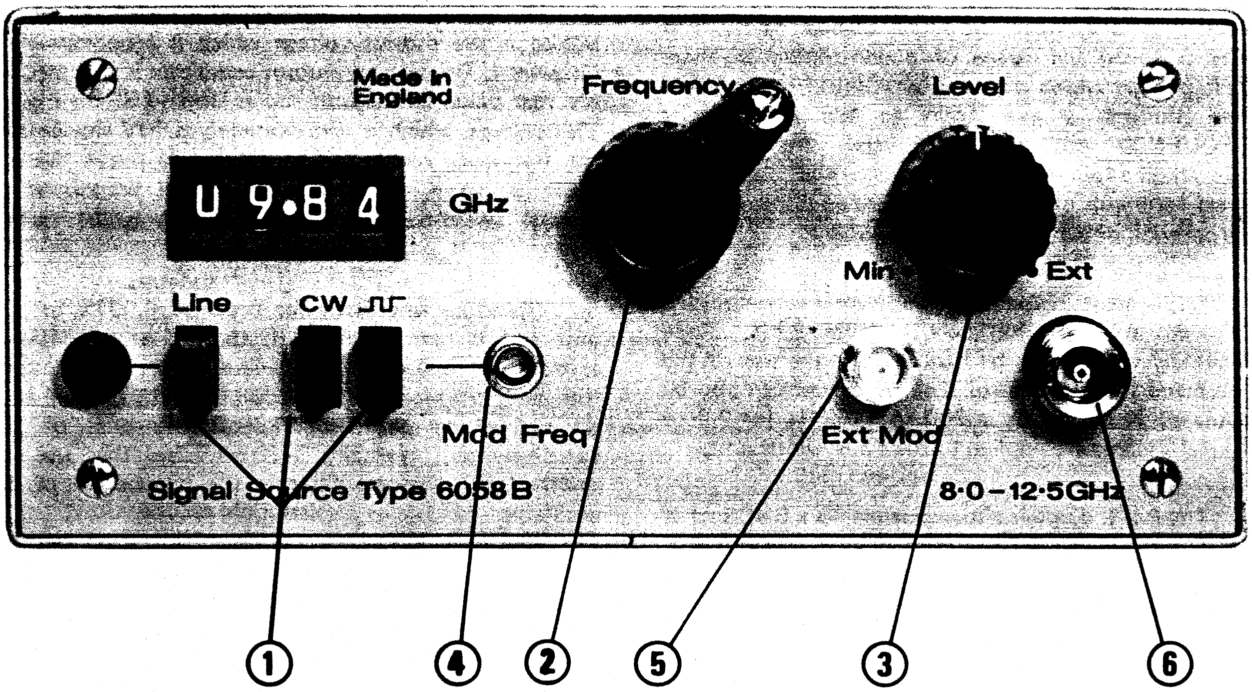


Fig. 2 Control Panel

2.1 OPERATING INSTRUCTIONS

The Type 6058B Signal Source can be operated in the following modes:

a) As c.w. source of microwave power.

b) As 900 to 1100 Hz or 2.9 to 3.1 kHz internally modulated squarewave source.

c) As externally modulated source with a rise time faster than 5 μs.

The control functions of the unit are shown in Fig.2.

1. FUNCTION SWITCH

For c.w. output push LINE and C.W. buttons.

For squarewave modulated output push LINE and ⎍⎍ buttons.

The panel lamp indicates a.c. power in each case.

2. FREQUENCY CONTROL

Set the desired frequency as indicated on the front panel counter.

3. R.F. LEVEL CONTROL

This can be used to set the r.f. output level. The minimum r.f. output is obtained when the control is set fully counterclockwise.

4. MODULATING FREQUENCY CONTROL

This control is used to set the internal modulation frequency between 900 to 1100 Hz or 2.9 to 3.1 kHz depending on the internal connection.

5. EXTERNAL MODULATION INPUT

The front panel BNC socket allows access to the internal P.I.N. diode attenuator, directly, when the

LEVEL switch is set to EXT. For maximum attenuation an input of 100 mA is required. Details of the attenuator performance are given by Fig.5.

6. R.F. OUTPUT

The r.f. output is connected via a miniature ferrite isolator, P.I.N. diode modulator and low-pass filter to the front panel 'N' type connector. In addition there is a rear panel BNC connector which provides an output voltage directly proportional to frequency. (Typically a 10V change over the full r.f. frequency range.) This can be used to drive the X axis of an X–Y recorder when making broadband measurements.

2.2 OUTPUT LEVELLING

The 6058B Signal Source produces an output in excess of 20 mW over the range 8.0 to 12.5 GHz.

Typical variation of output power with frequency is shown in Fig.3.

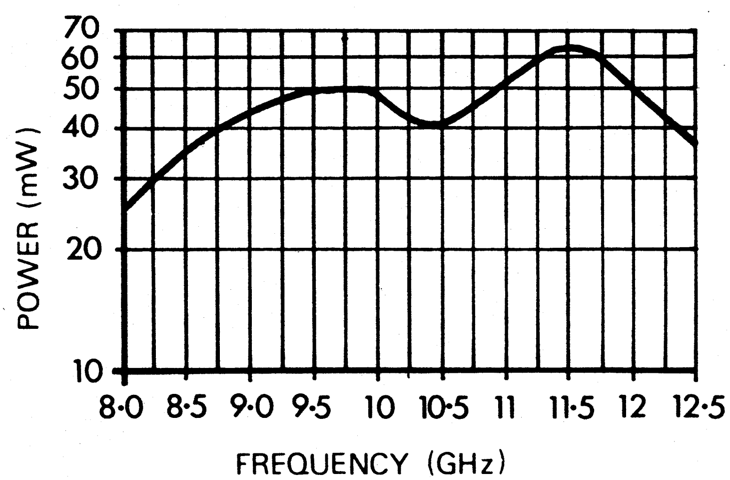


Fig. 3 Output Power As A Function Of Frequency

The power output can be levelled to 20 mW over the range using the internal modulator. The circuit required is shown in Fig.4.

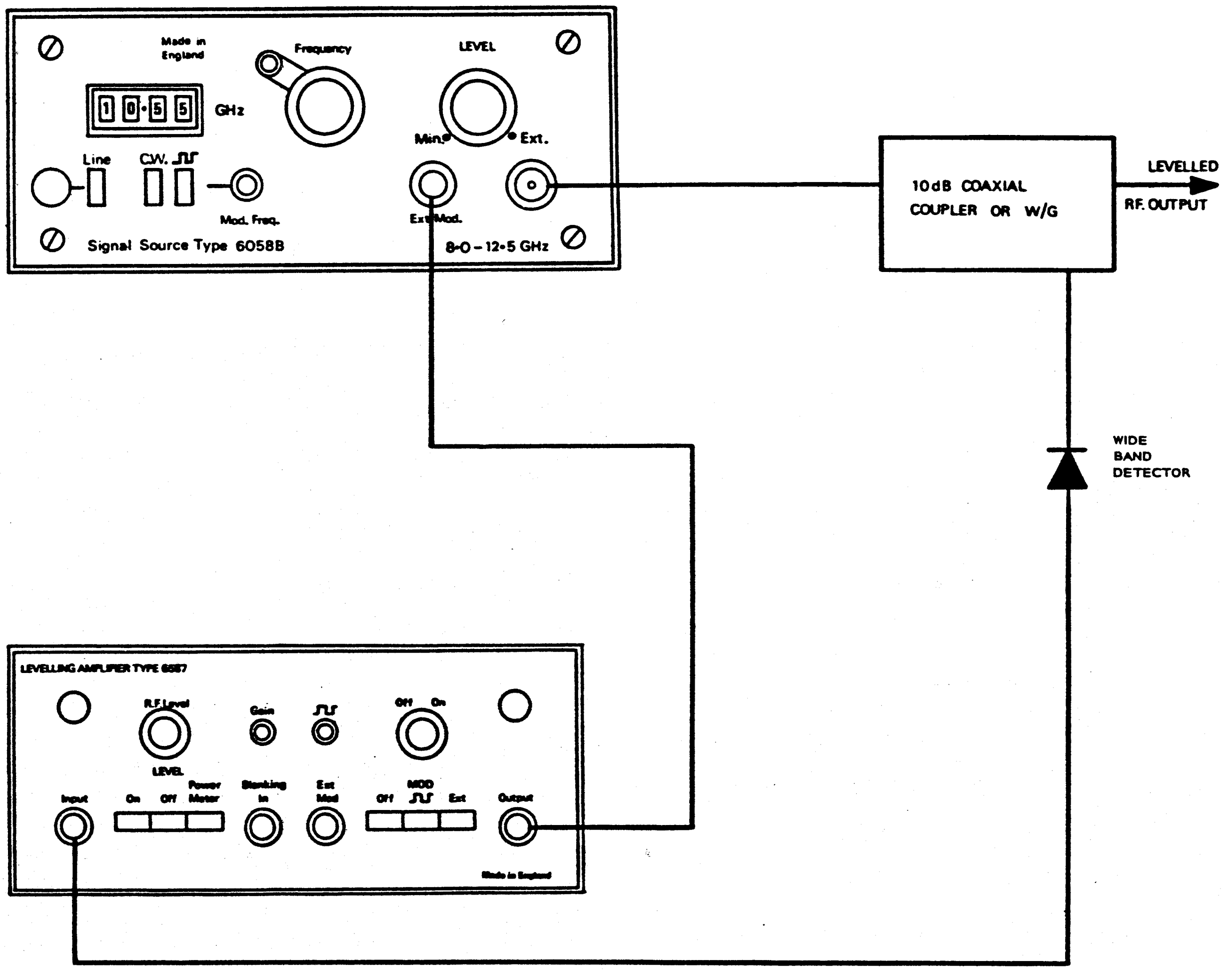


Fig. 4 Levelling Circuit With Type 6587 Levelling Amplifier

2.3 BROADBAND MEASUREMENTS

The Signal Source 6058B, can be used in conjunction with an X–Y recorder to provide a permanent record of broadband measurements. When used in this mode the source is operated in a similar way to the Microwave Sweeper Type 6600A with the rear panel BNC socket providing the sweep voltage. Reflectometer and insertion loss measurements can be made in the usual way see Figs.A1 and B1. The output voltage is zero at 8 GHz and approximately 10V at 12.5 GHz. As it is intended for high impedance input circuits (100 kΩ) heavier loading than this will degrade the linearity. This output can also be used in conjunction with network analyser systems.

Maximum accuracy will be achieved if the FREQUENCY control is always rotated in the same direction during the sweep. This will avoid errors due to residual backlash in the system.

2.4 EXTERNAL MODULATION

The front panel 'Ext. Mod.' socket provides direct access to the P.I.N. diode attenuator. This attenuator requires a positively increasing current to increase its attenuation, i.e. to decrease the r.f. output. When using the external modulation facility of this unit the LEVEL control is turned fully clockwise, i.e. maximum r.f. output and then any positive signal applied to the 'Ext. Mod.' socket will reduce the r.f. output. To adjust the maximum level of the r.f. output turn the LEVEL control counterclockwise until the required level is reached.

The logarithmic characteristic of the P.I.N. diode attenuator is shown by Fig.5. Do not exceed 100 mA input current. If necessary include series resistor (470Ω) to limit input current when driving from voltage source.

The frequency response of the modulator is limited by the rise time of the input circuitry. The rise time when driven from a high impedance source is less than 5 μs. Faster rise times can be achieved by driving the diode with shaped pulses. The basic requirement for achieving faster rise times is to remove the charge stored in the P.I.N. diode junction capacitance by applying higher potentials at the leading and trailing edges of the applied pulse. In the case of short pulses of r.f. power it is usual to arrange that the P.I.N. diode is biased slightly positive during the r.f. pulse in order to improve the pulse shape.

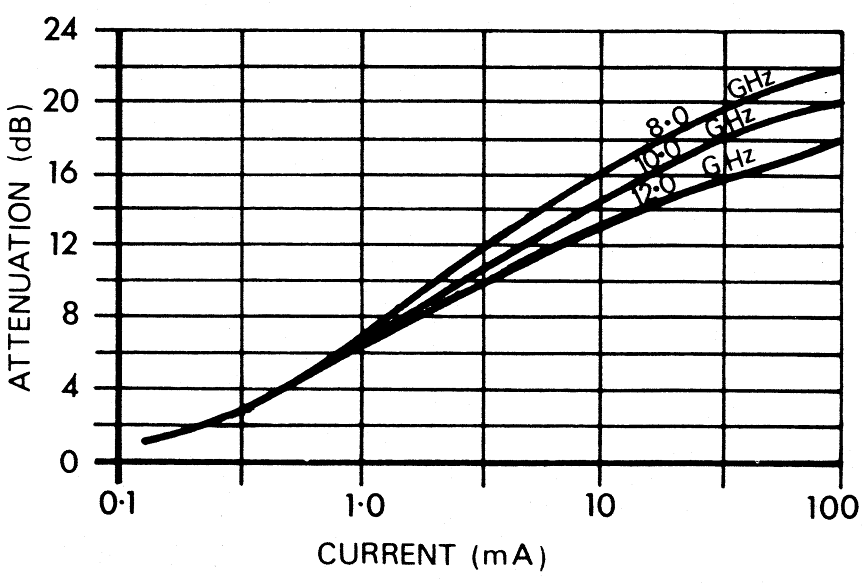


Fig. 5 Typical Modulator Performance

The P.I.N. diode attenuator represents a severe mismatch above about 3 dB attenuation with a result that some frequency pulling must be expected. This pulling has been reduced to approximately 0.1% by the use of an internally fitted miniature ferrite isolator.

In applications where it is necessary to achieve even better frequency stability with a varying load, about 10 dB of attenuation should be introduced by the front panel LEVEL control. This will reduce the pulling to an insignificant level. Alternatively another isolator or large value attenuator may be put in series with the r.f. signal.

2.5 TYPICAL APPLICATIONS

A. Manual Swept Frequency Measurements of V.S.W.R.

A. **Manual Sweep Frequency Measurements of V.S.W.R. Using the equipment as shown in Fig.A1 a permanent record of test results can be obtained over the complete frequency range of the instrument. If greater sensitivity is required a Ratiometer can be connected and used with the signal source operated in the squarewave modulated mode.**

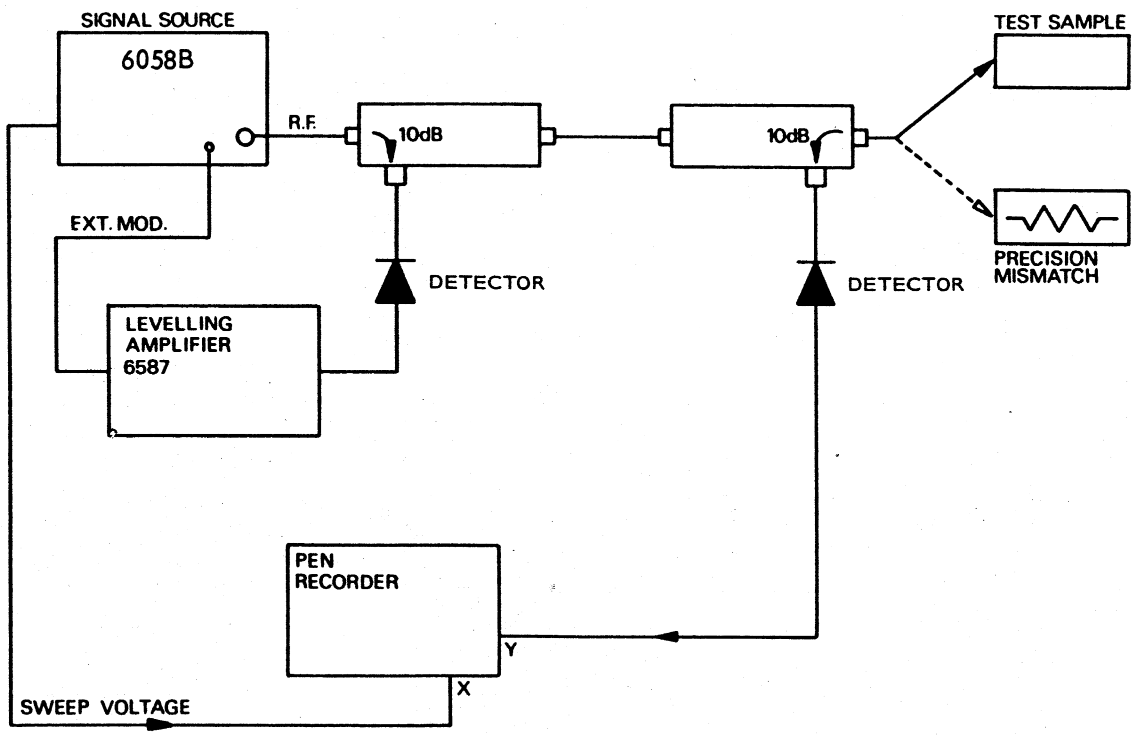


Fig. A1 V.S.W.R. Measurements

B. Broadband Transmission Loss Measurement

B. Manual Swept Frequency Measurement of Transmission Loss. Using the equipment as shown in Fig.B1 it is possible to make transmission loss measurement over the complete frequency range of the signal source. The signal source is suitable for carrying out the same measurements in a waveguide system although coaxial systems are shown in the example.

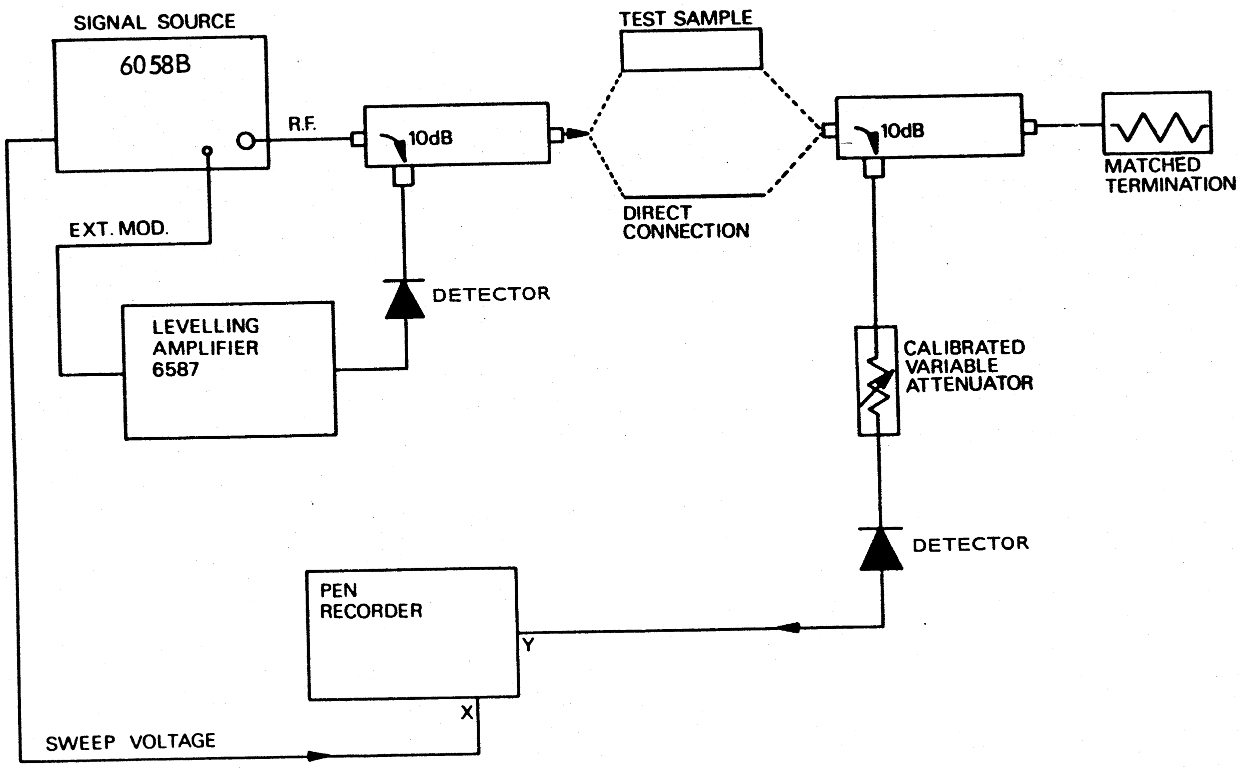


Fig. B1 Transmission Loss Measurements

C. Superheterodyne System For High Attenuation Measurement

C. Superheterodyne System for High Attenuation Measurement. Using the equipment as shown in Fig.C1 attenuations of 80 dB can be measured. The system requires that the signals from the signal source and the local oscillator be 45 MHz different in frequency. The most reliable method of setting up is to set the local oscillator to the required frequency for the test and then adjust the output frequency of the signal source until a maximum reading is achieved on the calibration receiver.

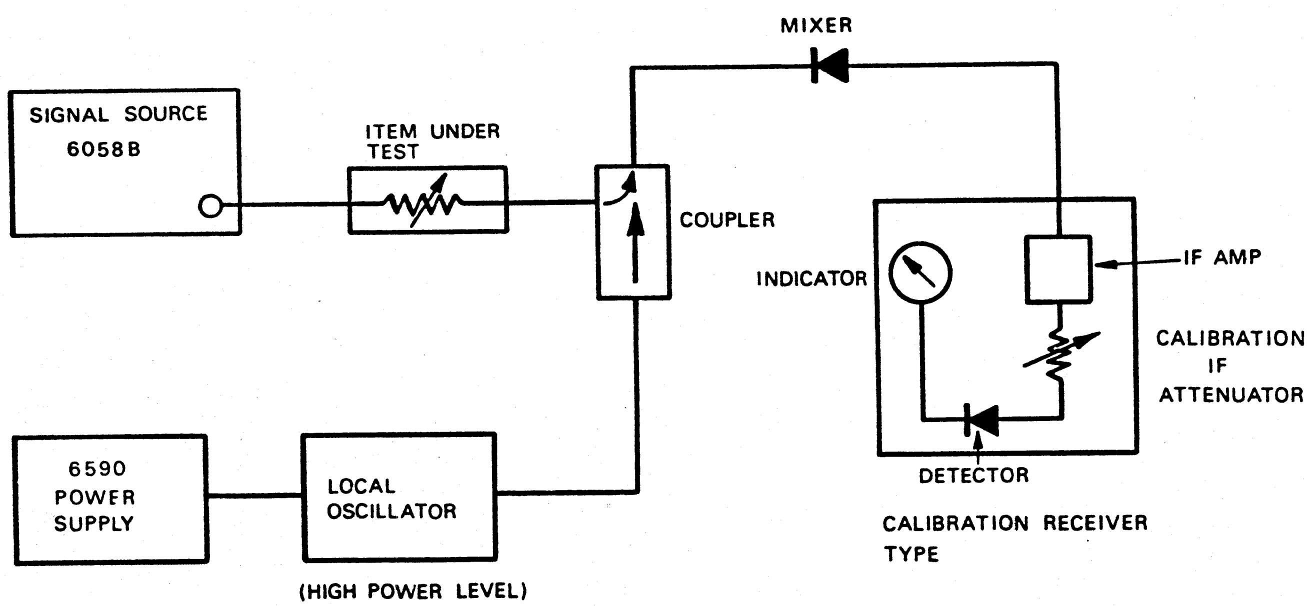


Fig. C1 High Attenuation Measurement

NOTE: With item under test removed power level from 6058B should be 20 dB below level of local oscillator, i.e. with 10 dB coupler, 10 dB down.

Chapter 3

Technical description

3.1 MICROWAVE OSCILLATOR

The microwave generator consists of a Gunn effect device operating in a fundamental mode coaxial cavity; the resonant frequency of which is varied by means of a non-contacting short circuit plunger driven by a cam. By using a suitable cam profile a linear relationship between the angular position of the cam spindle and r.f. output frequency can be acheived, this allows a direct frequency reading to be displayed on the front panel digital counter.

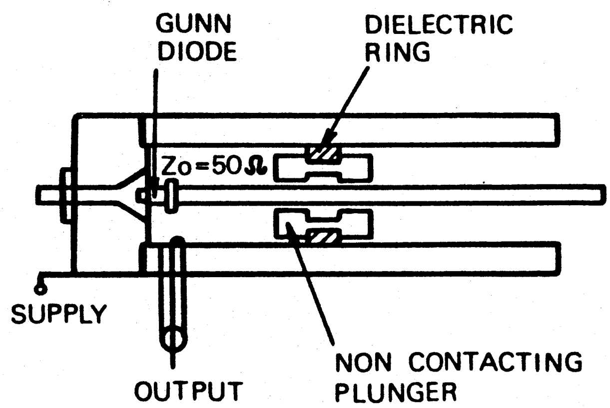


Fig. 6 Microwave Oscillator Schematic

3.2 P.I.N. DIODE ATTENUATOR

The P.I.N. diode attenuator unit mounted in the 50Ω output line is used to control the output signal level.

The operation of this unit depends on the fundamental factor that the shunt resistance of the diode is a function of the current passing through it. Reference to Fig.7 shows the relationship between insertion loss and shunt resistance in a 50Ω line.

The maximum attenuation which can be introduced depends on the parasitic resistance of the diode. In this case the residual resistance is about 1Ω corresponding to about 30 dB attenuation for 100 mA forward bias current.

This is modified somewhat due to the compensating elements used to keep the diode impedance resistive. The main consequence of these elements is to cause the attenuation to vary with frequency.

C. Superheterodyne System For High Attenuation Measurement

C. Superheterodyne System for High Attenuation Measurement. Using the equipment as shown in Fig.C1 attenuations of 80 dB can be measured. The system requires that the signals from the signal source and the local oscillator be 45 MHz different in frequency. The most reliable method of setting up is to set the local oscillator to the required frequency for the test and then adjust the output frequency of the signal source until a maximum reading is achieved on the calibration receiver.

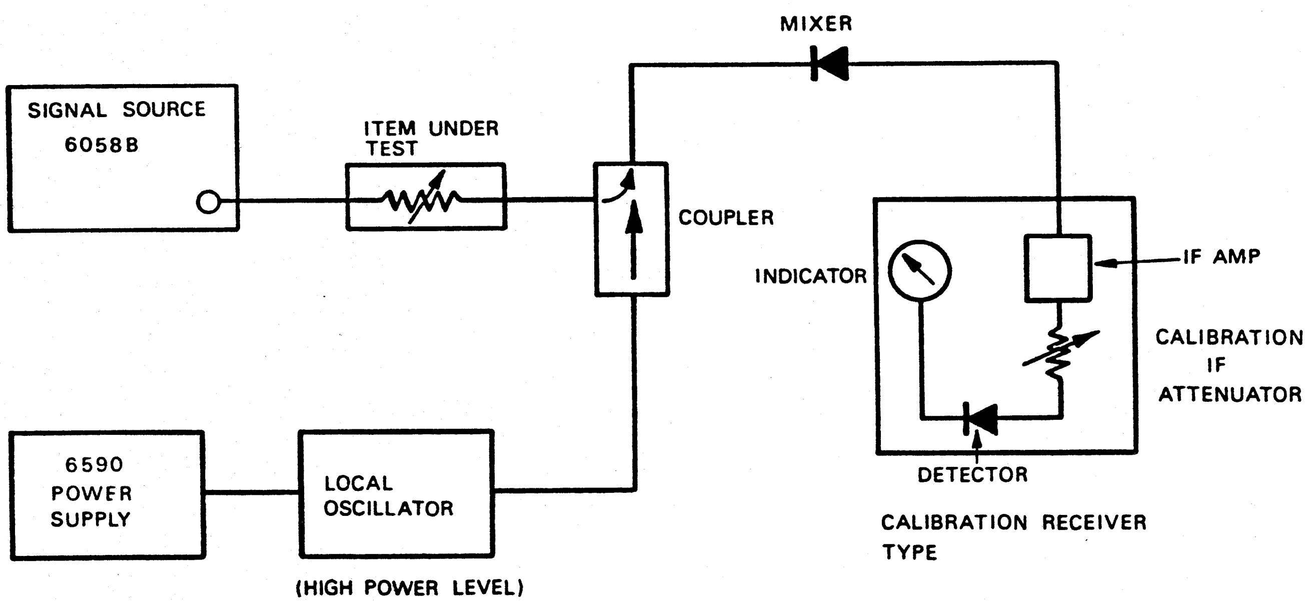


Fig. C1 High Attenuation Measurement

***NOTE:** With item under test removed power level from 6058B should be 20 dB below level of local oscillator, i.e. with 10 dB coupler, 10 dB down.*

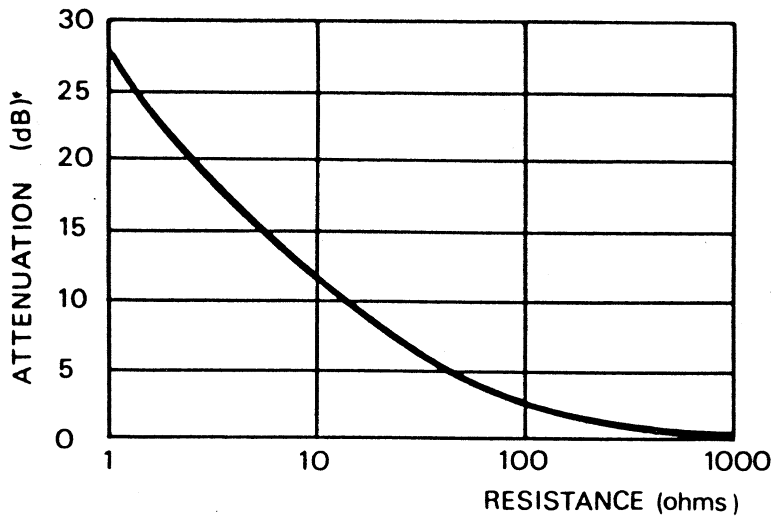


Fig. 7 Insertion Loss as a Function of Shunt Resistance in a 500 Line

3.3 POWER SUPPLY

TRANSFORMER, PRIMARY SMOOTHING

Transformer T1 has two primary windings which can be connected in series or parallel by the operation of switch S1 on the rear panel, for operation on either 230 or 110V a.c. supply. The secondary consists of 22V and 15V supplies each employing a bridge rectifier with capacitive smoothing to provide a.c. lines of 29V and 20V respectively.

GUNN DIODE BIAS SUPPLY

The variable voltage supply for biasing the Gunn diode is derived from an integrated circuit stabilized power supply.

The reference voltage for the control-integrated circuit IC–4 is derived from the hybrid integrated circuit, IC–1, this contains a constant current supply and a temperature compensated zener diode. The output of IC–1, is reduced by the potential divider consisting of R2 and R3, the output of which is decoupled by C4. Current amplification of the output of IC–4 is provided for by TR4. The Gunn diode bias voltage is determined by the ratio of the potential divider consisting of R17, RV5 and RV6 with the voltage tracking over the frequency range controlled by the setting of RV2A. As IC–4 has a very high gain the voltage at the inverting input, pin 2, is always maintained within a few millivolts of the reference voltage, pin 3. Hence the output voltage is varied by changing the dividing ratio of the output potential divider.

The potentiometers RV5 and RV6 are preset during calibration, to set the required level of bias for the particular Gunn diode, and any adjustment after this will certainly put the instrument out of frequency calibration and probably prevent the diode from oscillating at certain frequencies.

SHORT CIRCUIT PROTECTION

When the voltage across R16 is increased, by excess output current flowing, to the V_{BE} of TR3, that transistor conducts and grounds the base voltage of TR4, hence reducing the output voltage to zero. Removal of the short circuit will result in the resumption of normal operation.

OVER VOLTAGE PROTECTION

This is a basic crowbar circuit, where RV7 determines the voltage at which CRS1 clamps down. The circuit is set to operate at the maximum Gunn diode voltage rating, and when the voltage between the positive end of C8 and the wiper of RV7 equals the zener voltage plus V_{BE} of TR7, that transistor will conduct and cause an IR drop across R22, which in turn fires CRS1, thus shorting out the power supply. Hence the power supply is shut down by the action of R16/TR3 previously described.

MODULATOR POWER SUPPLY

This consists of two independent supplies, IC–3 with its constant reference voltage derived from D10 and R4 with TR2 as a current amplifier, provides a stabilized positive voltage. Likewise IC–2, D9, R1 and TR1 provide an equivalent negative voltage. The mark/space ratio of the squarewave is varied by RV4 which controls the negative rail voltage.

MULTIVIBRATOR CIRCUIT

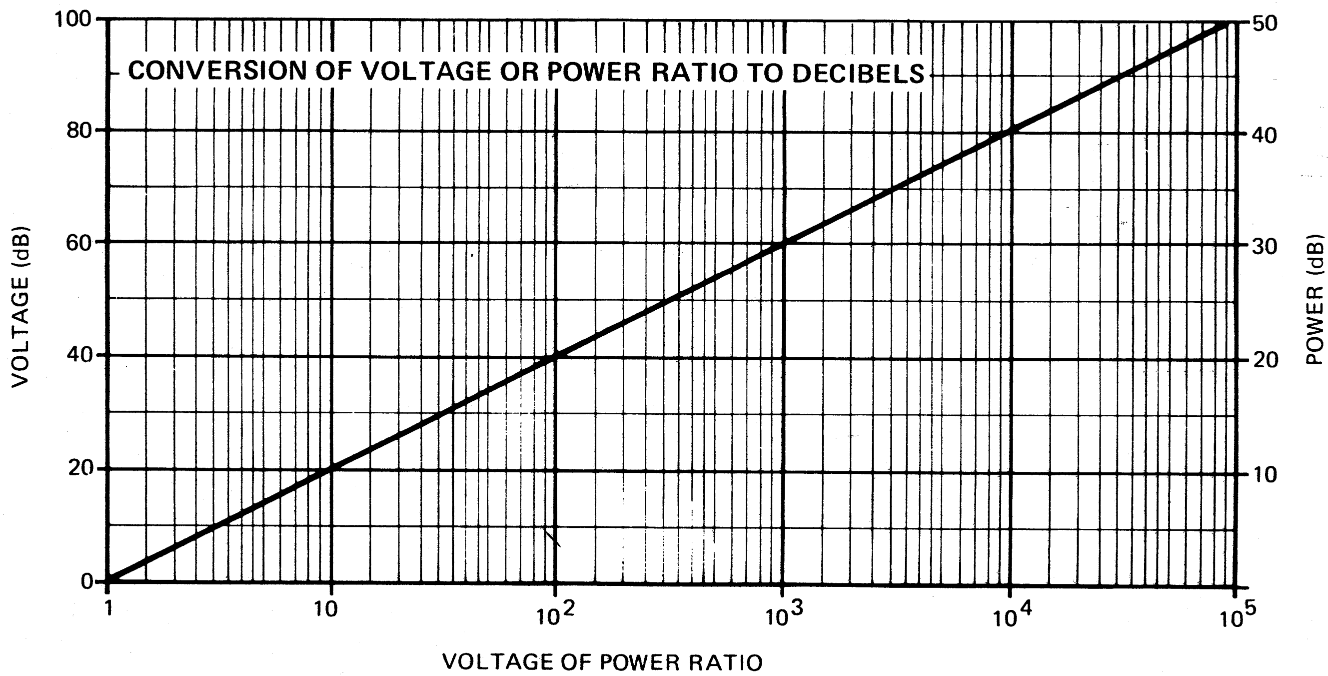
The free-running multivibrator again employs an integrated circuit. This has two states, one in which the output is at its positive saturation level, the other is the corresponding negative saturation state. The necessary feedback to ensure saturation is supplied by R14, R12 and R13 whereas the switching frequency is determined by C7, RV1 and either R10 or R11. Variation in the value of RV1 results in a change in the charged voltage of C7 hence affecting the frequency of oscillation. Switching occurs when the voltage at the inverting and non-inverting inputs are equal and remains so until C7 charges or discharges to a state determined by R2 and R3 then again switching occurs and process repeats itself. Diodes D11 and D12 protect IC–5 against input breakdown.

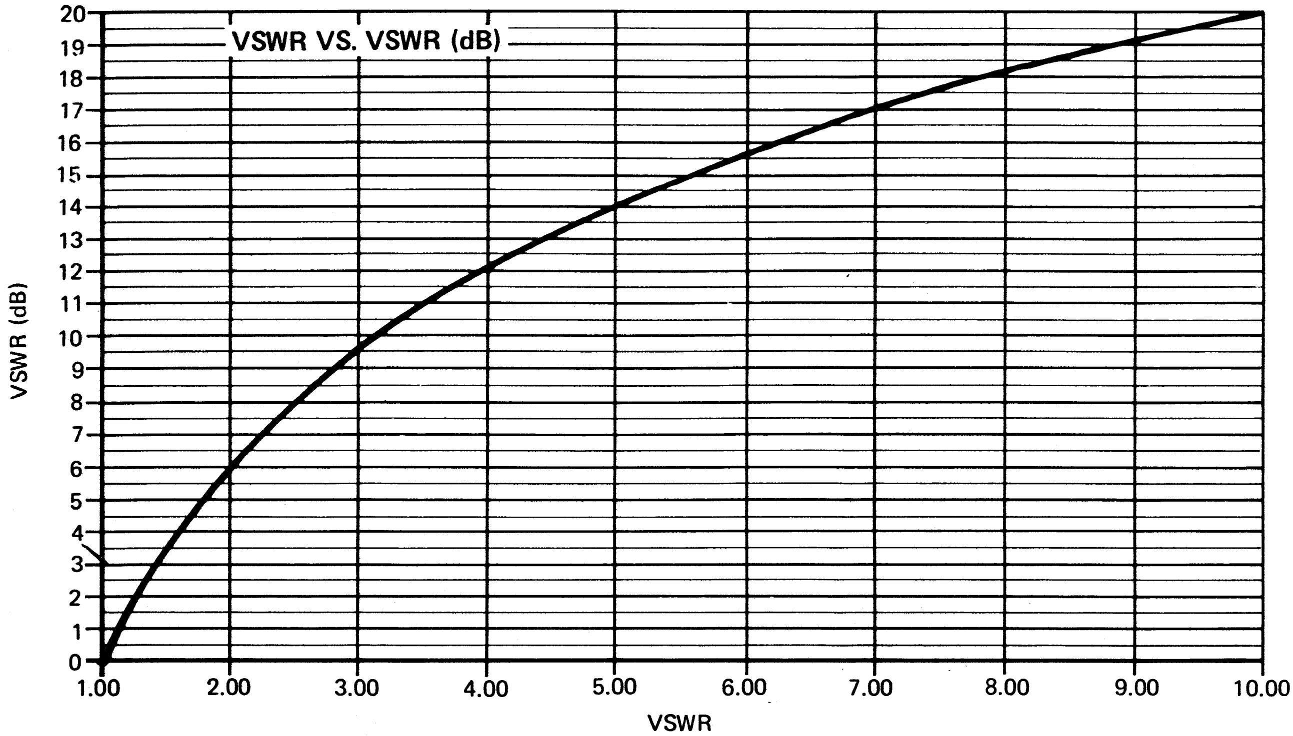
The multivibrator produces a squarewave having good rise and fall times and excellent frequency stability.

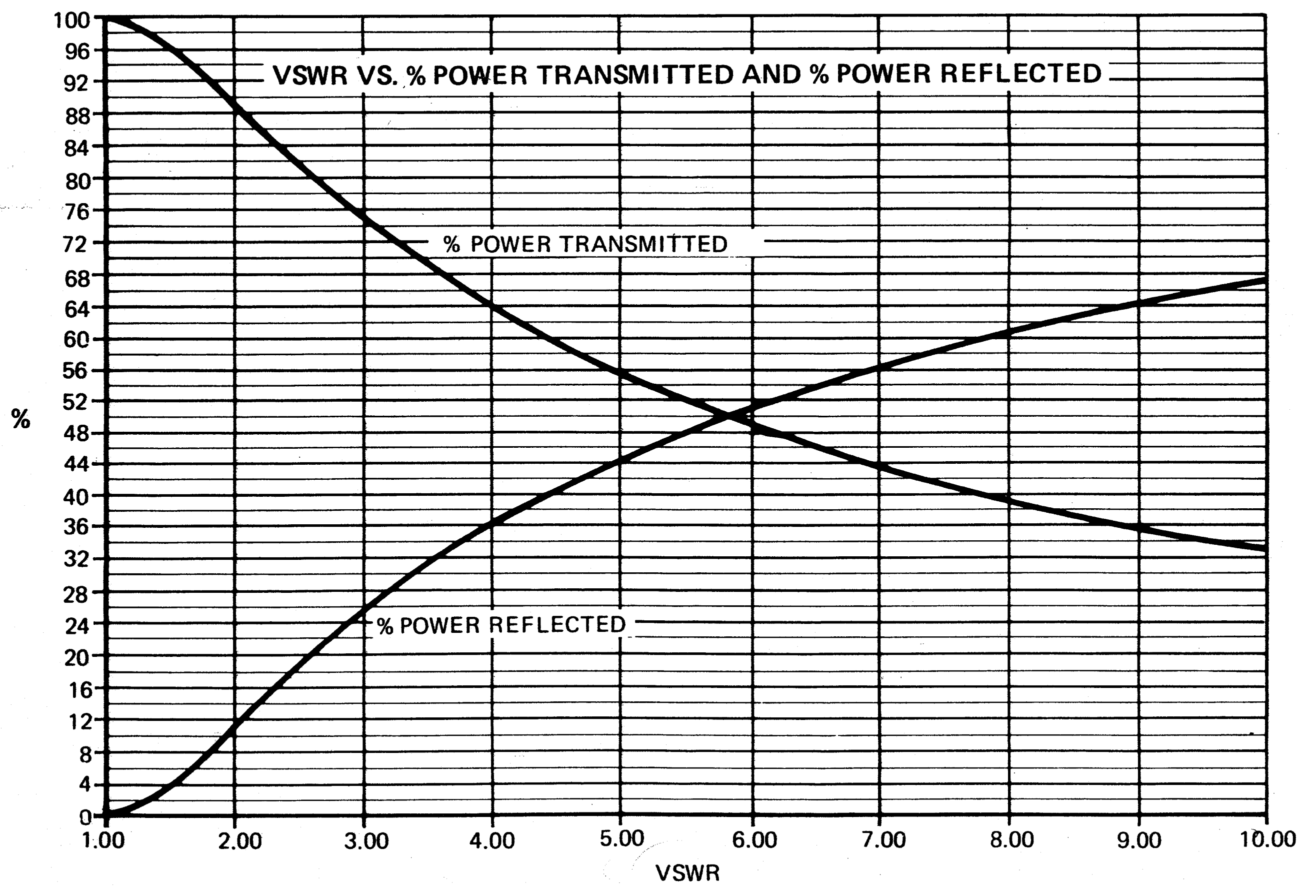
The output has a mark/space ratio of approximately 1:1 and a repetition frequency of either 1 kHz or 3 kHz depending on whether R10 or R11 is connected to terminal 'K'. The ratio is adjusted by varying RV4 so that the voltage across C5 is the same as that across C6 (approximately 12V).

Internal r.f. level control is achieved by biasing the P.I.N. diode modulator with current derived from the positive voltage rail and set by the value of RV3.

Reference Tables

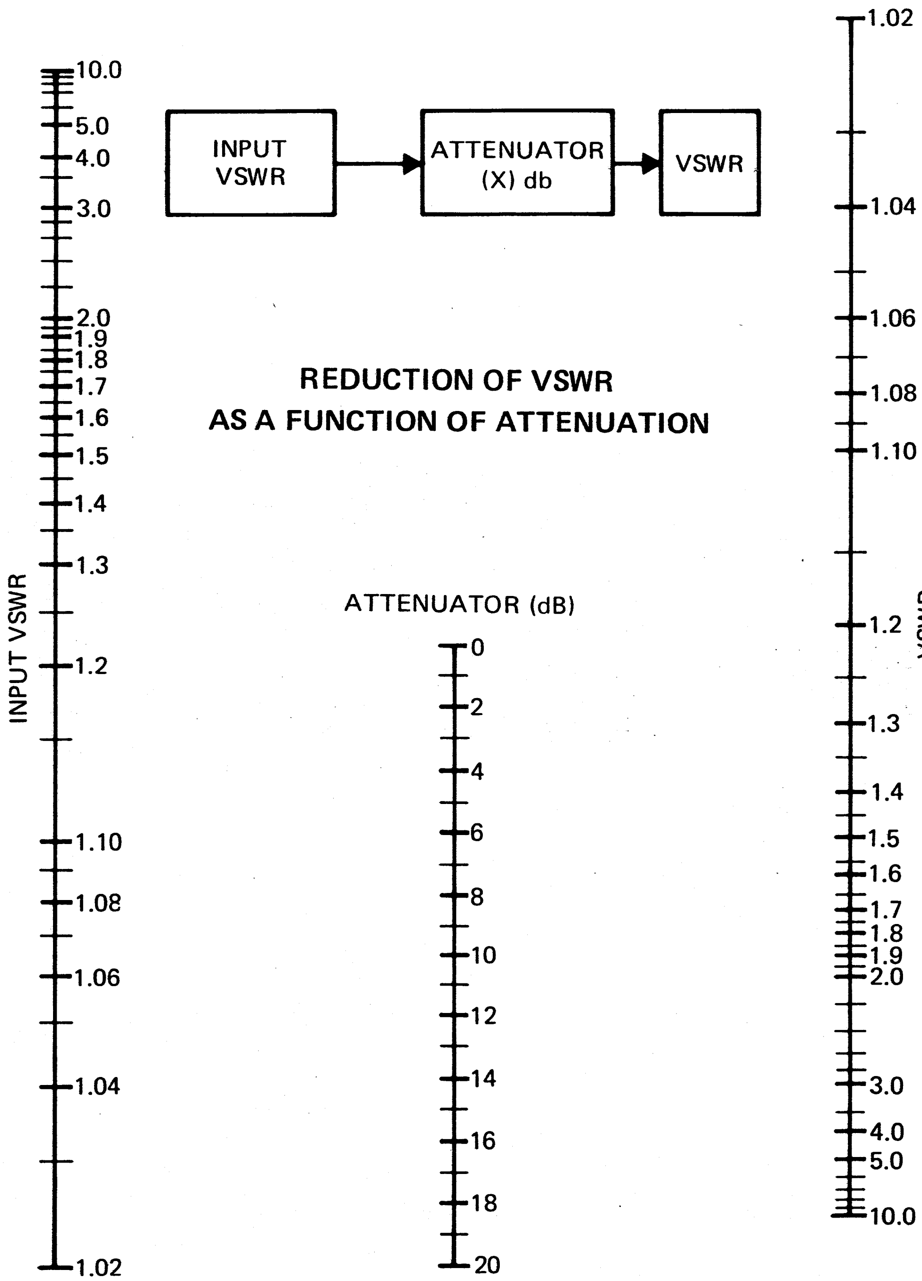






$\lambda = \frac{c}{f}$

REDUCTION OF VSWR AS A FUNCTION OF ATTENUATION



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.