

# MAINTENANCE MANUAL

9081 AND 9082

SYNTHESIZED  
SIGNAL GENERATORS

**RACAL-DANA**

**RACAL**  
The Electronics Group

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# 9081 AND 9082

## SYNTHESIZED SIGNAL GENERATORS

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The RACAL logo consists of the word "RACAL" in a bold, italicized, sans-serif font. Each letter is contained within a rectangular border, and the letters are slightly shadowed to give a three-dimensional effect.

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## LETHAL WARNING

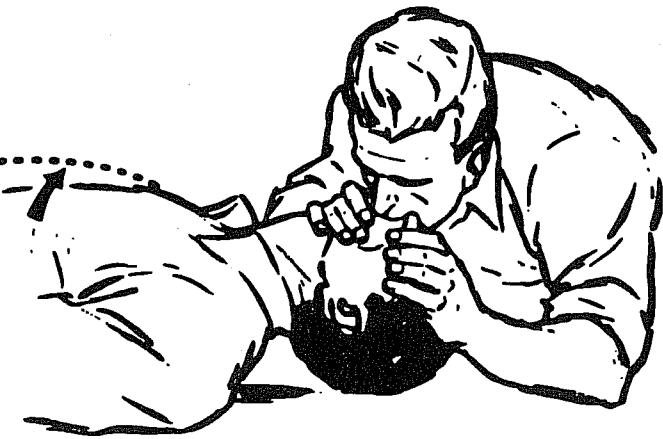
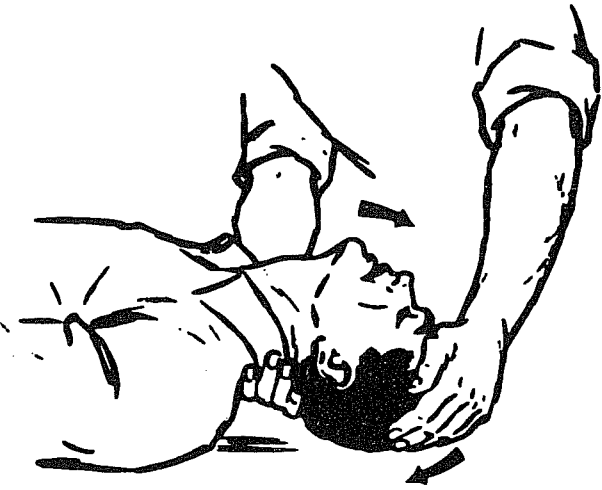
Voltages within this equipment are sufficiently high to endanger life.

Covers are NOT to be removed except by persons qualified and authorised to do so and these persons should always take extreme care once the covers have been removed.

Resuscitation instructions are given overleaf.

## FIRST AID

### in case of Electric Shock



1. Lay victim on his back.
2. Clear victim's mouth and throat.
3. Tilt victim's head back as far as possible and raise his head.
4. Pinch victim's nostrils.
5. Take a deep breath.
6. Cover the victim's mouth with yours and blow, watching his chest rise. Note: Blow forcefully into adults, but gently into children.
7. Move your face away to allow victim to breathe out, watching his chest fall.
8. Repeat first five to ten breaths at a rapid rate; thereafter, take one breath every three to five seconds.
9. Keep victim's head back as far as possible all the time.

Have someone else send for a Doctor  
Keep patient warm and loosen his clothing

**DO NOT Give liquids  
until patient is conscious**

SYNTHESIZED SIGNAL GENERATOR 9082

The changes listed below have been made on some instruments having serial numbers above 4010.

Changes found to apply to the instrument with which this manual is to be used should be incorporated in the manual by manuscript amendment.

PARTS LIST 4

Resistors            20-2103 Delete '86'  
                      20-2223 Delete '87'

                     Add new components:

'20-2123	Carbon Film	1/4	5	12k	R87'
'20-2332	Carbon Film	1/4	5	3.3k	R86'
'20-1521	Carbon Film	0.1	5	1k	Ra'

Capacitors           21-1512 Delete '64'

                     Add new component:

'21-1764	Ceramic	100	2	1n	Ca'
----------	---------	-----	---	----	-----

FIG. 9

R86                    Amend value to 3.3k  
 R87                    Amend value to 12k  
 C64                    Delete all details

                     Add new components Ra (1k) and Ca (1n) in series between pins 2 and 3 of IC5.

PARTS LIST 3b

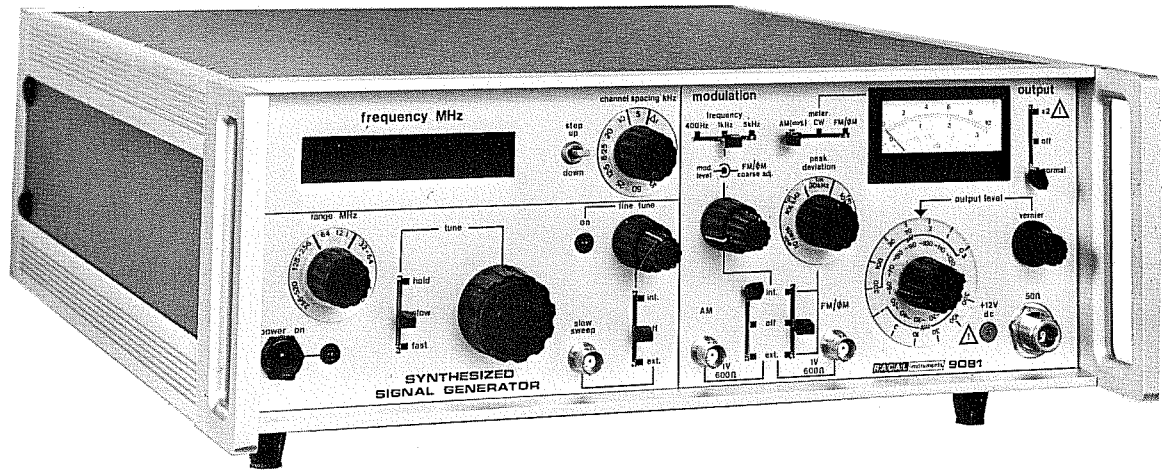
Capacitors           21-1677 Add 'Ca'

FIG. 7

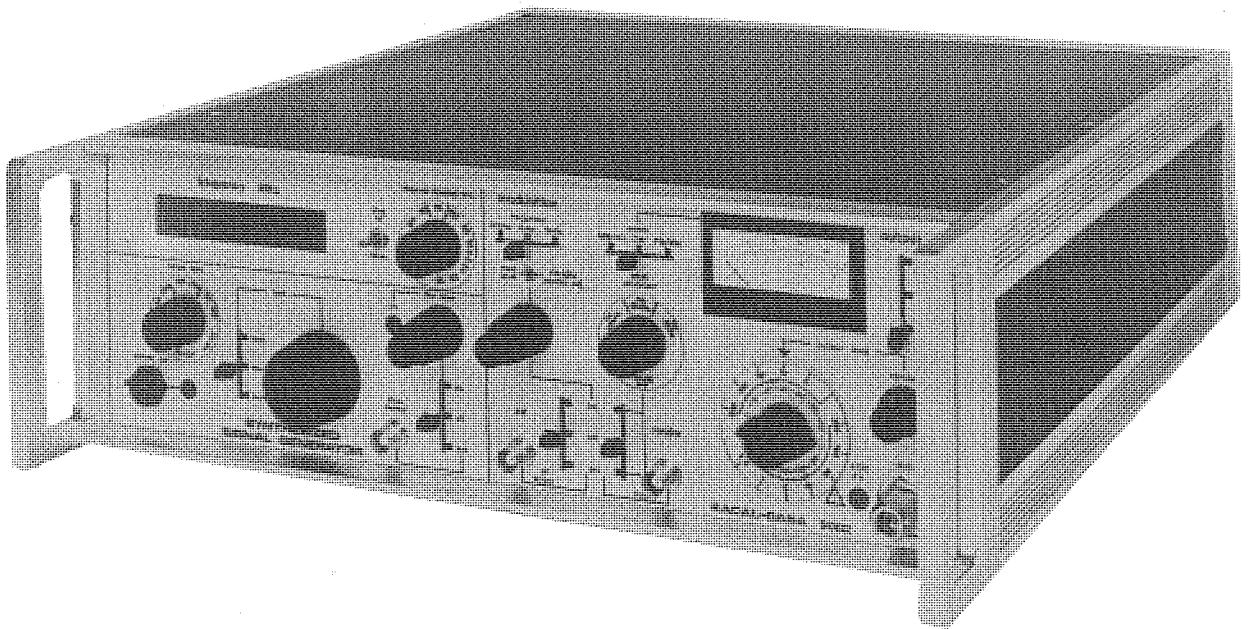
Add Ca (5.6p) between IC3 pin 6 and 0V.

## 'POZIDRIV' SCREWDRIVERS

Metric thread cross-headscrews fitted to Racal equipment are of the 'Pozidriv' type. Phillips type and 'Pozidriv' type screwdrivers are not interchangeable, and the use of the wrong screwdriver will cause damage. POZIDRIV is a registered trade mark of G.K.N. Screws and Fasteners Limited. The 'Pozidriv' screwdrivers are manufactured by Stanley Tools Limited.



Synthesized Signal Generator 9081



**RACAL**

**Synthesized Signal Generator 9082**



## IMPORTANT NOTES

1. This manual is applicable to Model 9081, 9081H, 9082 and 9082H instruments.
2. The most significant differences between the models are:-
  - (a) The frequency range for Models 9081 and 9081H is 5 to 520 MHz while that for Models 9082 and 9082H is 1.5 to 520 MHz.
  - (b) The frequency range for external AM is d.c. to 100 kHz for Models 9081 and 9081H, and d.c. to 20 kHz for Models 9082 and 9082H.
3. Models 9081H and 9082H incorporate a modular r.f. amplifier which increases the maximum r.f. output to +13 dBm into 50  $\Omega$ . To maintain the same minimum output level an additional 10 dB step is provided on the output attenuator.

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SECTION 1

TECHNICAL SPECIFICATION

*Base Division*



## TECHNICAL SPECIFICATION

### RF CHARACTERISTICS

Frequency Range:	1.5 MHz (5 MHz for 9081) to 520 MHz in five bands:-  Band 1      1.5 MHz (5 MHz for 9081) to 35 MHz Band 2      31 MHz to 67 MHz Band 3      61 MHz to 134 MHz Band 4      122 MHz to 268 MHz Band 5      244 MHz to 520 MHz
Channel Spacing (kHz): (Step Size)	Ten channel spacings are provided, and these are grouped to serve different national requirements as follows:-  (1)    5, 10 and 20 kHz. (2)    6.25, 12.5, 25 and 50 kHz. (3)    15, 30 and 60 kHz.  The frequency increments in $\Delta f$ mode are given in Chapter 2, page 2-6.
Frequency Indication:	The output frequency is continuously measured and displayed on an 8-digit LED display. The resolution is 100 kHz in FAST TUNE, 1 kHz in SLOW TUNE and 10 Hz in HOLD.
Accuracy of Frequency Indication:	$\pm 1$ count $\pm$ frequency standard accuracy.
Frequency Stability:	(1) FINE TUNE off:- the step frequencies are phase-locked to the internal frequency standard.  (2) FINE TUNE on:-  (a) Band 1: less than 100 Hz change per 10 minutes after 30 minutes.  (b) Bands 2 to 5: less than 1 ppm change per 10 minutes after 30 minutes.

## FREQUENCY STANDARD

Type:	Racal-Dana Type 9442:-
Frequency:	5 MHz.
Ageing Rate:	$\pm 3$ parts in $10^9$ per day after 3 months continuous operation.
Warm-Up Time:	Better than $\pm 2$ part in $10^7$ within 6 minutes from cold.
Temperature Stability:	Better than $\pm 3$ parts in $10^9$ per $^{\circ}\text{C}$ over the range $-10^{\circ}\text{C}$ to $+45^{\circ}\text{C}$ .
Alternative Standard:	See Optional Accessories.
External Frequency Standard Input:	
Frequency:	1 MHz.
Minimum Level:	100 mV r.m.s.
Maximum Level:	10V r.m.s., 100V d.c.
Input Impedance:	Approximately $1\text{ k}\Omega$ (a.c. coupled).

## SPECTRAL PURITY

Harmonics:	At least 30 dB below carrier for frequencies between 5 and 520 MHz.  At least 20 dB below carrier for frequencies between 1.5 and 5 MHz (9082 only).
Sub-Harmonically Related Signals:	More than 40 dB below carrier: typically 55 dB below carrier.
Discrete Spurious:	Bands 2-5:- At least -70 dB at 20 kHz or more off carrier.  Band 1:- At least -70 dB at 20 kHz or more off carrier in the frequency range 5 to 120 MHz for carrier frequencies from 5 - 35 MHz.  At least -50 dB at 20 kHz or more off carrier for carrier frequencies from 1.5 to 5 MHz (9082 only).

Residual FM on CW:	Less than 50Hz r.m.s. deviation in 300Hz to 3kHz bandwidth.
AM on FM:	1% for deviations of 100kHz and less.
Carrier Leakage:	The e.m.f. induced in a 2-turn 25mm diameter loop 25mm away from any surface is significantly less than 1 $\mu$ V into a receiver 50 $\Omega$ input.
SSB Phase Noise:	Better than -105dB/Hz at 20kHz removed from carrier.

### RF OUTPUT

Output Level:	<ol style="list-style-type: none"> <li>(1) The maximum output level is +3dBm (+13dBm for models 9081H and 9082H) into 50<math>\Omega</math>. The minimum output level is -130 dBm into 50<math>\Omega</math> (71nV).</li> <li>(2) The stepped output level switch provides attenuation from 0dB to 120dB (130dB for models 9081H and 9082H) in 10dB steps. The switch is calibrated in dBm into 50<math>\Omega</math> and in voltage units.</li> <li>(3) The Vernier control provides continuous output level variation from -10dB to + 3dB relative to the output level switch setting.</li> </ol>
Attenuator Accuracy:	$\pm 0.1$ dB per 10dB step (cumulative with reference to 0dB) $\pm 0.2$ dB.
Output Level Flatness:	<ol style="list-style-type: none"> <li>(1) Within <math>\pm 0.7</math>dB relative to 50MHz level over frequency range 5 to 520MHz.</li> <li>(2) Within <math>\pm 2.5</math>dB relative to 50MHz level over frequency range 1.5 to 5MHz (9082 only).</li> </ol>

Output Level Accuracy:

As indicated on the meter to the following tolerances with attenuator (OUTPUT LEVEL) controls in 'straight through' condition and OUTPUT switch in NORMAL position:-

- (1) For carrier frequencies from 5 to 520MHz  
 $\pm 0.8\text{dB}$  at  $+25^{\circ}\text{C}$   $\pm 5^{\circ}\text{C}$   
 $\pm 1.5\text{dB}$  at  $0^{\circ}\text{C}$  and  $+55^{\circ}\text{C}$
- (2) For carrier frequencies from 1.5 to 5MHz  
(9082 only)  
 $\pm 3.3\text{dB}$  at  $+25^{\circ}\text{C}$   $\pm 5^{\circ}\text{C}$   
 $\pm 4\text{dB}$  at  $0^{\circ}\text{C}$  and  $+55^{\circ}\text{C}$

When Reverse Power Protection Unit 11-1405 or 11-1390 is fitted add  $\pm 0.7\text{dB}$  to the above figures.

Output Impedance:

$50\Omega$  Type 'N' connector.

Output VSWR:

Ratio 1.1 to 1 (1.2 to 1 if the Reverse Power Protection Unit is fitted) with not less than 10dB attenuation selected.

Output Protection:

The output withstands reversed r.f. inputs up to 1W. A protection unit giving protection up to 50W is available as an optional extra.

Output Meter:

The front panel meter is calibrated in dBm into  $50\Omega$  and in volts.

## FREQUENCY MODULATION

Frequency Ranges:

- (1) Using the internal oscillators: 400Hz, 1kHz and 5kHz.
- (2) Using an external source: 20Hz to 100kHz ( $\pm 3\text{dB}$ ).

Distortion:

Less than 5% at maximum deviations using internal oscillator.

Deviation Ranges and Modulating Frequency Ranges:

External Modulation frequency response:-  
within 3dB from 20Hz to 100kHz for all ranges.

FSD Deviation	Front Panel Meter frequency response within 3dB
3kHz	20Hz - 5kHz
10kHz	20Hz - 20kHz
30kHz	20Hz - 100kHz
100kHz	20Hz - 100kHz

An external input of 1V r.m.s. into 600Ω gives full scale deviation.

Accuracy:

±5% of full-scale reading (f.s.d.).

### AMPLITUDE MODULATION

Frequency Ranges:

- (1) Using the internal oscillators: 400Hz, 1kHz and 5kHz.
- (2) Using external source d.c. up to 100kHz (9081) or 20kHz (9082).

Modulation Depth:

- (1) Up to 90% at a modulation frequency of 30kHz or less, decreasing to 50% at 100kHz. Adjustment (internal source) is by MODULATION LEVEL control.
- (2) Using an external input 800mV into 600Ω gives 80% modulation depth.

Distortion:

At 80% modulation depth, using internal oscillator:-

for carrier frequencies from 5 to 520MHz,  
 $\leq$  5%

for carrier frequencies from 1.5 to 5MHz,  
 $<$  15% (9082 only).

Accuracy:

For modulation depth below 80%:-

for carrier frequencies from 5 to 520MHz,  
 $\pm$ 3% f.s.d.  $\pm$ 2% of reading

for carrier frequencies from 1.5 to 5MHz,  
 better than  $\pm$ 5% f.s.d.  $\pm$ 10% of reading  
 (9082 only).

## PHASE MODULATION ( $\phi$ M)

Frequency Ranges:

400Hz to 5kHz from internal oscillators or external source.

Phase Range:

- (1) Internal and external range 10 radians at full-scale reading.
- (2) Phase range from internal source is adjustable by MODULATION LEVEL control.
- (3) Using an external input 1V r.m.s. into 600 $\Omega$  gives 10 radians phase modulation.

Distortion:

Less than 5% at 100 radians using internal oscillator.

Accuracy:

$\pm 5\%$  of f.s.d.

## MULTIPLE MODULATION

Facilities:

Simultaneous modulation by AM and either FM or  $\phi$ M is available, using one internal and one external oscillator, or two external oscillators.

## MODULATION OSCILLATOR

Frequencies:

400Hz, 1kHz and 5kHz.

Accuracy:

$\pm 5\%$

Distortion:

Less than 1% total harmonic distortion.

Output:

An output level of 1V r.m.s. from a 600 $\Omega$  source is available at the rear panel AUDIO OUTPUT (BNC) socket.

## POWER SUPPLY

AC Voltage Ranges:

Four ranges selected by rear panel switches:-  
94V to 110V                      188V to 220V  
110V to 130V                     220V to 260V

Frequency:

45 to 440Hz.

Power Consumption:

Approximately 25 VA.

## ENVIRONMENTAL CONDITIONS

Operating Temperature Range:	0°C to +55°C (but internal frequency standard 0°C to +45°C).		
Storage Temperature Range:	-40°C to +70°C.		
Specification:	Meets IEC 68.		
Safety:	Designed to meet IEC 348 (BS.4743).		
Dimensions:	<u>Height</u>	<u>Width</u>	<u>Depth</u>
	133mm (5 $\frac{1}{4}$ in)	408mm (15 7/8 in)	445mm (17 $\frac{1}{2}$ in)
Weight:	Approximately 13 kg (29 lb).		

## ACCESSORIES

Accessories Supplied:	(1) Power supply lead. (2) Power supply fuse for 94V to 130V supply.
-----------------------	---

### Optional Accessories

#### (1) Racal-Dana Frequency Standard Type 9420M

Frequency:	5MHz
Ageing Rate:	$\pm 5$ parts in $10^{10}$ per day after 3 months continuous operation.
Warm-Up Time:	Better than $\pm 1$ part in $10^7$ within 20 minutes from cold.
Temperature Stability:	Better than $\pm 6$ parts in $10^{10}$ per °C over the range 0°C to +45°C.

(2) 50 - 75Ω Adaptor (10dB Attenuation) Part No. 23-3174.

(3) Protector Muff.

(4) Reverse Power Protection Unit to 25W.

(5) Reverse Power Protection Unit to 50W.

(6) Rack Mounting Kit Part No. 11-1272

(Part No. 11-1354 for Model 9081 instruments with serial numbers up to 2159)

(7) Frequency Doubler Part No. 11-1356

SECTION 2

DESCRIPTION

OPERATION & MAINTENANCE

*Blue D. 11*



## CHAPTER 1

### GENERAL DESCRIPTION

#### INTRODUCTION

1.1 The 9081 and 9082 are synthesized signal generators designed primarily for the testing of radio communications equipment. Although providing the precision of a synthesizer system locked to a high-stability frequency standard they retain the versatility of analogue-type tuning.

#### RF TUNING

1.2 A major feature of the instruments is their 'single-knob' tuning allied to a channelized mode of operation. This enables the instruments to be tuned in steps according to the channel spacing required. The r.f. tuning automatically locks into the centre frequency of the particular channel. Selection of the HOLD position on the front panel switch then electronically disconnects the spin wheel.

1.3 A fine tune facility provides for interpolation between channels, and this can also be carried out by an external slow sweep voltage if desired. The carrier frequency is displayed on an 8-digit LED readout in which the resolution is varied to suit the particular tuning mode (Fast, Slow or Hold) in use.

1.4 The Channel Spacing switch provides ten different frequency spacings which conform to the internationally agreed requirements of different authorities. A continuous tuning facility ( $\Delta f$ ) is provided in which the frequency increments are reduced to a minimum value when using SLOW tune mode.

#### RF OUTPUT

1.5 Automatic levelling maintains the output typically within  $\pm 0.5$ dB over the entire frequency range. A switched attenuator and vernier control provide an output range from  $-130$ dBm to  $+3$ dBm, ( $+13$ dBm for models 9081H and 9082H), calibrated in both dBm and voltage units. An output switch provides a multiply-by-two facility which permits a doubling of the normal output levels in CW, FM and Phase Modulation modes.

#### MODULATION FACILITIES

1.6 AM, FM and Phase Modulation ( $\phi M$ ) facilities are provided. Three spot modulation frequencies (400Hz, 1kHz and 5kHz) are available from an internal oscillator. External modulation can also be used, the maximum frequencies permitted being 100kHz for FM, 5kHz for  $\phi M$ , 100kHz for AM on Model 9081 and 20kHz for AM on Model 9082.

1.7 The meter indicates both external and internal modulation, and, as these can be applied simultaneously, various arrangements of multiple modulation are feasible (see para 2.4).

### POWER SUPPLY

1.8 The instruments operate from nominal 110V or 220V a.c. supplies, 45 to 440Hz. Mains voltage selection is by means of two rear panel switches which provide four possible voltage selections and can be locked to the chosen positions by a screwed plate, which allows the selected voltage range markings to be seen. Refer to para. 5.1.

### HANDBOOK NOTES

#### Frequency Range

1.9 Although the signal generators have a specified operating range extending to 520MHz, the design capability is at least 540MHz. This higher figure with its range subdivisions is used in the technical descriptions except when referring to the actual operating ranges.

## CHAPTER 2

### OPERATING INSTRUCTIONS

#### INTRODUCTION

- 2.1 Until familiar with the instrument the user is recommended to refer to the description of controls commencing on page 2-4.

#### POWER SUPPLY AND FREQUENCY STANDARD

- 2.2 (1) If using the instrument for the first time, or at a new location, verify that the a.c. (mains) voltage selection is correct. Refer to para. 5.1.
- (2) Connect the a.c. (mains) supply lead to the rear panel three-pin plug.
- (3) Set the front panel POWER switch to ON. Verify that the adjacent LED illuminates.
- (4) Set the rear panel STANDARD switch to the required position, according to whether internal, or external, frequency standard is to be used.
- (5) From cold switch-on, the approximate warm-up time for the internal frequency standard to reach operating accuracy is:-
- (a) Six minutes (with standard 9442 unit).
  - (b) With the optional 9420M allow 10 minutes to reach  $1$  in  $10^6$ , or 20 minutes to reach optimum accuracy.

#### OPERATING

##### 2.3. RF Tuning

- (1) Set the RANGE MHz switch to the required frequency band.
- (2) Set the TUNE lever switch to FAST and the FINE TUNE lever switch to OFF.
- (3) Set the CHANNEL SPACING (kHz) switch according to the type of operation required as follows:-

- (a) For a channelized output set the switch to the particular kHz spacing required (5kHz through to 60 kHz).
- (b) For non-channelized output the red  $\Delta f$  position may be selected to obtain the smallest frequency increments on each band (see page 2-6 Table 1.).
- (4) For large changes in frequency set the TUNE lever switch to FAST and rotate the TUNE (spin-wheel) control. Complete the channel tuning with the TUNE lever switch in the SLOW position.
- (5) To hold the tuned channel, set the TUNE lever switch to HOLD. The TUNE spin-wheel control is then electronically disengaged.
- (6) Having tuned to particular channel, rapid changes to another channel can be made by operating the biased STEP switch to UP (for higher frequency) or DOWN for a lower frequency. Each operation of the switch moves the tuning by one channel, and can be repeated until the required channel is reached.
- (7) The FINE TUNE control provides infinitely variable tuning between frequency increments. Set the FINE TUNE lever switch to INT (or to EXT if external fine tuning is to be used). Check that the adjacent ON indicator illuminates. To disconnect the FINE TUNE facility set the lever switch to OFF and note that the ON indicator extinguishes.

#### Output Level Setting

- (8) Set the METER switch to CW.
- (9) Set the OUTPUT switch to NORMAL or to X2 as required (see description of switch functioning on page 2-8). In the X2 position of the switch the meter will indicate half the true output level. All facilities are available in X2 except AM.
- (10) Set the METER switch to CW and set the OUTPUT LEVEL (Attenuator) control to the desired output level range. The switch markings are coloured black, green and red, which correspond to the colours of the associated meter scales.
- (11) Fine adjustment of output level can be made by the VERNIER control which has a range of 13 dB (+3 dB and -10 dB relative to the 0 dB datum on the red meter scale). For example to obtain a setting of -25 dBm select -20 dBm on the OUTPUT level control and adjust the VERNIER for a meter reading of -5dB.

### Modulation Mode Selection

- (12) Set the METER switch to the required mode (AM or FM/ $\emptyset$ M)
- (13) Depending on the modulation mode required, set the AM or the FM/ $\emptyset$ M lever switch to INT (for internal modulation), or EXT (for external modulation). The unwanted modulation facility must be switched to OFF.
- (14) Set the MODULATION FREQUENCY lever switch to the required modulating frequency (unless external modulation is in use).
- (15) If on AM, set the MODULATION LEVEL control to obtain the required percentage modulation on the meter 10 scale (internal modulation only).
- (16) If using FM/ $\emptyset$ M mode, set the PEAK DEVIATION selector as required. The switch settings are coloured black or green to indicate the appropriate meter scale, and the peak deviation frequencies correspond to full scale readings. Note that in the  $\emptyset$ M (10 Rads) position the frequency range is 400 Hz to 5 kHz.

### FM Deviation Setting

- (17) The f.m. deviation is adjusted manually as follows:-
- (18) If using internal modulation set the MODULATION LEVEL (inner) control to maximum clockwise position and then adjust the FM COARSE (outer) control to give full scale reading on the meter.
- (19) Adjust the MODULATION LEVEL control for the required deviation reading on the meter. Readjustment will be required when substantial changes of carrier frequency are made.

### Multiple Modulation

- 2.4. Simultaneous modulation by AM and either FM or  $\emptyset$ M is available, using the following oscillator combinations:-
- (1) One internal and one external oscillator.
  - (2) One internal frequency applied to both AM and FM/ $\emptyset$ M modes.
  - (3) Two external oscillators.

The AM and FM/ $\emptyset$ M lever switches should be set to the appropriate positions, according to the oscillator combination in use.

## DESCRIPTION OF CONTROLS INDICATORS AND CONNECTIONS

2.5 The following items are numbered to correspond with those in the front panel illustration Fig. 2.1. The power supply and r.f. tuning control are described first, followed by those for modulation and output control.

### POWER SUPPLY AND RF TUNING CONTROL

2.6

① POWER ON/OFF Switch.

This double pole toggle switch is in the a.c. mains input. In the OFF position the a.c. supply is disconnected from all except the mains fuse.

In the ON position the instrument is fully operational and the adjacent POWER ON l.e.d. indicator is illuminated. This l.e.d. is supplied from the +12V line.

② RANGE MHz Switch.

The five position rotary switch selects the five r.f. frequency ranges which are referred to by range numbers as follows:-

<u>Range No.</u>	<u>Frequency Range *</u>
1	1.5 (5 for 9081) to 35MHz
2	31 to 67 MHz
3	61 to 134 MHz
4	122 to 268 MHz
5	244 to 520 MHz

③ FREQUENCY MHz Display.

The carrier frequency is measured by the internal digital frequency meter and displayed on the digital LED readout. For ease of operation there is a four digit display (100 kHz resolution) in FAST tune. This is increased to six digits (1kHz resolution in SLOW tune and to the maximum eight digit, 10 Hz resolution, in HOLD mode.

\* These frequency ranges are those normally obtainable and slightly exceed the ranges shown by the front panel markings.

④ TUNE (lever) Switch.

- (1) In the FAST position of the switch the TUNE spin-wheel provides rapid tuning (approximately 30 revolutions per band) with a four-digit frequency display.
- (2) In the SLOW position the TUNE spin-wheel is de-sensitized to approximately 20 channels per revolution, with a six-digit display.
- (3) The HOLD position electronically disengages the TUNE spin-wheel and gives an eight-digit display.

⑤ TUNE (Spin-Wheel) Control.

This control provides frequency tuning in the FAST and SLOW positions of the associated TUNE switch, as described above.

6 CHANNEL SPACING Switch.

The setting of the CHANNEL SPACING switch depends upon the type of operation required as follows:-

- (1) For a channelized type of operation the switch is set to the particular kHz spacing required.
- (2) For a non-channel operation the red  $\Delta f$  position can be used. With the TUNE switch set to SLOW, this gives the lowest possible value of frequency increment (steps) for each frequency band, as shown in Table 1. Precise tuning can be completed in HOLD mode. When FAST tune mode is selected, however, the channel spacing reverts to the maximum possible for the band in use.

TABLE 1.

Frequency Increments in  $\Delta f$  Mode.

Range Switch Position.	Frequency Increments (Slow Tune).	Remarks.
1.5-32 (5-32 for 9081) 32-64 64-128 128-256 256-512	2.5kHz 0.625kHz 1.25kHz 2.5kHz 5.0kHz	These are the $\Delta f$ frequency increments with SLOW TUNE selected. On FAST TUNE the instrument tunes in 40kHz increments.

7 STEP Switch

This is a centre-biased three-position toggle switch in which each movement of the switch shifts the r.f. tuning by one channel (UP for a higher frequency and DOWN for a lower). This step selection can be repeated until the desired channel is reached.



- 8 FINE TUNE (Lever) Switch and SLOW SWEEP Socket
- This switch connects the required fine tuning source as follows:
- (1) INT position: the ON indicator illuminates and the adjacent FINE TUNE control is operative.
  - (2) OFF position; both internal and external fine tuning is disabled. The ON indicator extinguished.
  - (3) EXT position: the ON indicator will illuminate and an external fine tuning voltage can be applied via the SLOW SWEEP socket. A ramp voltage with an excursion of 0 to 10V and frequency not exceeding 2Hz is suitable.
- 9 FINE TUNE Control
- The control is operative when the adjacent lever switch is set to INT.
- 10 AM (lever) Switch
- This switch selects the amplitude modulation mode. The INT position connects the internal modulation oscillator to the modulation system. The EXT position permits the application of external modulation via the adjacent 600Ω BNC Input Socket.
- 11 FM/ØM (lever) switch
- This switch selects frequency and phase modulation modes, otherwise its description is similar to that of the AM switch described above.
- 12 MODULATION LEVEL and FM COARSE (Concentric) Controls
- The MODULATION LEVEL control adjusts the amplitude of the selected internal modulation oscillator and thus sets the meter reading for the chosen modulation mode. The FM COARSE control adjusts the level of the modulating audio applied to the main oscillator on FM and ØM.
- 13 PEAK DEVIATION (Rotary) Switch
- This switch selects the four FM peak deviation ranges as shown by the switch markings, and a single (10 radians) phase modulation range. The switch markings are coloured to correspond with the appropriate meter scale.

- 14 MODULATION FREQUENCY (Lever) Switch. This switch provides a choice of three internal modulation frequencies.
- 15 METER (Lever) Switch. This switch connects the meter to the appropriate function and thus ensures the correct type of indication for the mode in use.
- 16 OUTPUT LEVEL (Rotary) Switch. This switch selects the 10dB steps of an attenuator, calibrated in both dBm and mV. The switch markings are coloured to correspond with the scales on the meter. Each switch setting corresponds to 0dB on the red meter scale, with 13dB variation available by means of the VERNIER control.
- 17 VERNIER Control. This potentiometer provides variation of +3dB to -10dB on any setting of the OUTPUT LEVEL switch.
- 18 OUTPUT Switch.
- (1) NORMAL: in this position the maximum output is +3dBm (+13dBm for models 9081H and 9082H) into 50Ω.
  - (2) OFF: in this position the r.f. source (the synthesizer) is inhibited. There is no output and the display reads 'all zeros', but the remainder of the instrument remains in operation.
  - (3) X2: in this position the true output is twice the reading shown on the meter. Full CW and FM/ØM facilities are available but the AM mode is not operative. The symbol  $\triangle$  advises the user to consult the handbook for operational details.
- 19 Meter. The meter displays the output information corresponding to the function selected by the adjacent METER switch. In the X2 position of the OUTPUT switch the meter reading on CW must be doubled to obtain the true value.
- 20 50Ω Output Socket. The output socket is a 50Ω Type 'N'.
- 21 +12V Socket. Provides a +12V supply output for the reverse power protection option.

## REAR PANEL ITEMS

### Mains (AC) Voltage Selector.

2.7 This comprises two slide switches, with a screwed locking plate, for selection of the appropriate a.c. supply voltage. Instructions for voltage selection are given in para.5.1.

### Standard Switch.

2.8 This toggle switch connects the internal or external frequency standard, as required. If the switch is inadvertently in the EXTERNAL position, with no external standard connected, the frequency display will be blank.

### Internal Standard Output Socket (BNC).

2.9 A 1MHz reference output, derived from the internal frequency standard, is available when the STANDARD switch is set to INTERNAL.

### External Standard Input Socket (BNC).

2.10 This socket accepts a 1MHz external frequency standard input. The input characteristics are given on page Tech.Spec.(2).

### Audio Output Socket (BNC).

2.11 The output from the internal modulation oscillators is available at this socket. The level is nominally 1V r.m.s. from a 600 $\Omega$  source.

### Frequency Standard and Adjustment.

2.12 Two apertures are provided, marked COARSE and FINE, for calibration of the internal frequency standard. The FINE aperture is for use with the 9442 unit. The optional 9420M uses both COARSE and FINE adjustments. A calibration procedure is given in para.5.41.

### Power Fuse.

2.13 A 5 x 20mm, glass cartridge, anti-surge, type fuse must be used. The fuse ratings are marked on the panel. The instrument is despatched with the 188V/260V fuse fitted and a spare 94V/130V fuse is supplied in the Accessories bag.

SECTION 3

PARTS LIST

CIRCUIT DIAGRAMS

AND

LAYOUTS

ORDERING OF SPARE PARTS

1. To be assured of satisfactory service when ordering replacement parts, the customer is requested to include the following information.
  - (a) Instrument type and serial number.
  - (b) The type reference of the Assembly in which the particular item is located.
  - (c) The Part number and circuit reference of each item being ordered.

It should be noted that a minimum charge of £10 sterling is applicable to all U.K. orders.

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## CHAPTER 3

### PRINCIPLES OF OPERATION

#### BRIEF DESCRIPTION

##### Introduction

3.1 Fig. 3.1 shows a simplified block diagram of the signal generator. A more detailed block diagram is Fig.3.2 at the end of the chapter. The carrier source is a 240MHz to 540MHz voltage controlled oscillator (VCO1) operating in a phase-locked loop and feeding a bank of four dividers and one mixer which provide the five frequency ranges. The dividers operate continuously, the selected range being chosen by appropriate logic signals on the inputs to the succeeding combiner stage. From the combiner stage the selected signal is fed through an AM modulator stage and level setting attenuator to the output amplifier.

##### Carrier Tuning

3.2 Variable tuning of the r.f. source is carried out by an optical type shaft encoder, manually rotated by the tuning (spin-wheel) control, from which a series of pulses is fed into the 'N' counter. The 'N' counter data is used to programme a variable divider which divides the VCO r.f. signal by the number 'N' loaded in from the 'N' counter. This divided signal is then compared, in a phase sensitive detector, with the selected channel spacing reference frequency (see para.3.4). Any phase difference produces an 'error' voltage which tunes the VCO to bring the carrier frequency into phase lock with a multiple of the channel spacing frequency.

3.3 It is essential to bear in mind that all carrier frequency changes are incremental, i.e. the VCO frequency is moved up or down in steps, the step size being determined by the channel spacing selection and whether FAST or SLOW tune mode is in use. In FINE TUNE mode, however, the channel spacing reference frequency is variable, thus providing continuous tuning over a few channels (see para.3.5).

##### Channel Spacing Reference Frequencies

3.4 The channel spacing reference frequencies are derived from a 300kHz reference, which is itself derived from the master frequency standard. The 300kHz is divided down to 37.5kHz which is then fed to a programmable divider, whose division ratios are  $\div 10$ ,  $\div 12$  or  $\div 15$ , thus giving reference frequencies of 3.75kHz, 3.125kHz and 2.5kHz respectively. These basic channel spacing reference frequencies are used as references in the phase sensitive detector, as described in para.3.2.

3.5 In Fine Tune mode a variable 300kHz reference is used. This is obtained by mixing a 5MHz master reference with the 5.3MHz from a voltage controlled crystal oscillator (VCXO). The FINE TUNE control, 'pulls' the frequency of the 5.3MHz VCXO, thus permitting a small variation in the mixer output frequency and hence in the channel spacing reference frequencies.

Fig. 3.1

Whole page

Page 3-2

### Amplitude Modulation and Automatic Level Control (ALC)

- 3.6. The carrier level at the output amplifier is peak detected and compared with a d.c. reference voltage which is determined by the setting of the front panel VERNIER control. The resulting a.l.c. voltage automatically maintains a constant carrier amplitude in CW mode. Amplitude modulation is obtained by varying this a.l.c. feedback voltage at an audio frequency supplied by the modulating tone.
- 3.7. The modulation oscillator provides three fixed audio frequencies for amplitude (a.m.) frequency (f.m.) and phase modulation ( $\phi$ M). External modulation frequencies can be used up to 100 kHz on a.m. and f.m., and 5kHz on  $\phi$ M.

### Frequency Modulation

- 3.8. Frequency modulation is obtained by modulating the main VCO (240-540MHz) varactor tuning with an a.c. voltage related to the audio modulating tone. Because of the non-linear voltage-frequency characteristic of the varactor-tuned VCO, provision is made for monitoring the actual deviation on the carrier and displaying it on the meter. The user can then set any desired level of deviation by use of the FM COARSE and MODULATION LEVEL controls.
- 3.9. The f.m. monitoring referred to above is carried out by feeding the Range 2 carrier signal into a mixer operating in a frequency locked loop, giving an i.f. output of 400 kHz. The deviation on this 400 kHz is demodulated, filtered, and the audio component fed to the meter as a display of actual deviation obtained. In models with serial numbers up to 1409 the f.m. peak deviation level is controlled automatically. That system is described in Issue 1 of the Manual.

### Phase Modulation ( $\phi$ M)

- 3.10 Phase modulation uses the same circuitry as for f.m., except that the basic concept of phase modulation is that deviation increases linearly with increase of modulation frequency. This is achieved by providing amplifier roll-off which is compensated by increased modulation levels.

### Frequency Counter and Display

- 3.11 The frequency counter monitors the r.f. output of the signal generator. Frequencies up to 32 MHz are counted directly. For the remaining frequency coverage the same input range is used but the counter time base frequency is automatically adjusted (by the Range logic) in accordance with the division ratio in use for each range, thus giving a frequency readout from 5 MHz to 540 MHz (1.5MHz to 540MHz for 9082).



### Tune (Spin Wheel) Encoder

3.12. The spin wheel shaft encoder is an optical displacement transducer of the incremental type. A graticule, of a transparent material with opaque stripes, is attached to the encoder spindle and is made to rotate between two pairs of l.e.d's and photo-transistors. As the graticule rotates, the photo-transistors are alternatively darkened and illuminated, thereby producing two output waveforms. The two photo-transistors are physically aligned and there are two tracks on the transparent graticule which are printed with a phase difference of 90 degrees, thus the two output waveforms are 90° out of phase, with output A leading output B for one direction of rotation and lagging output B for the reverse direction of rotation. The two outputs are applied to the Logic Assembly.

Fig. 3-2

Whole page (R30)

Page 3-5

## CHAPTER 4

### TECHNICAL DESCRIPTION

#### INTRODUCTION

- 4.1 This chapter describes the significant features of the circuit design and functions. The reader should have a clear understanding of the functional principles described in Chapter 3 and a basic knowledge of solid state theory and logic.
- 4.2 The circuits are mounted on printed circuit board (p.c.b.) assemblies and these will be described individually. The circuit diagrams at the back of the book are arranged in order of Assembly reference number (19-0841 to 19-0849) applicable to the model 9081. The circuits for assemblies 19-0842, 19-0843 and 19-0846 carry the necessary notes to enable them to be used for assemblies 19-0948, 19-0949 and 19-0950 which are applicable to model 9082. Other assemblies are common to both models. It will be useful also to refer to the block diagram Fig. 3.2 at the end of Chapter 3 to observe the theoretical relationship between the different circuits. The practical (interconnection) relationships are shown in the overall block diagram (Fig. 22 at the back of the book).

#### LOGIC CIRCUIT SYMBOLS

- 4.3 Extensive use is made of integrated circuits (IC's) and these are identified by a number and suffix letter. In the circuit description a particular IC pin will be identified by a reference such as 'IC2b/4' which indicates pin 4 on that particular gate or amplifier. The logic symbols used in the circuits are those found in most manufacturers IC data sheets to which reference should be made if detailed information is required.

#### MAIN OSCILLATOR (VCO1) ASSEMBLY 19-0841 (Fig. 3)

- 4.4 This is the r.f. source shown as VCO1 on the block diagram Fig. 3.2. Referring to the circuit diagram, Fig. 3, the resonant element of the oscillator is the strip-line, with voltage variable capacitance (varactor) diodes D1 and D2. This line is r.f. decoupled from the modulation input by Ferrite bead FX1 and inductor L1. Oscillator d.c. tuning voltage is applied via pin 5 and R6. Components R4, R6, C3 and C4 provide filtering and shaping on the d.c. tuning and the f.m. modulation inputs.
- 4.5 The oscillator transistor is Q4 which is coupled to the resonant line by strip-lines connected to emitter and collector. The oscillatory output is tapped from a point close to the end of the resonant element via R16 and is fed to pin 6 of the board. Transistors Q1 and Q2 stabilize the d.c. supply rails.
- 4.6 The oscillator output level is controlled by Q3, the base of which is held at the required potential by the divider R14, R15 and the forward volt drop in D3, 4 and 5. D6 prevents the D3, R15 junction going positive.

LOGIC PCB ASSEMBLY 19-0842 (9081) AND 19-0948 (9082) FIG. 5Introduction

- 4.7 The Logic Assembly receives information from the following sources and processes it to provide appropriate commands to the succeeding circuits:-

- Divider and Phase Detector Assembly.
- Channel Spacing Switch S4.
- Range Switch S2.
- Tune Control Switch S6.
- Single Step Switch Up/Down information.
- Fine Tune Control Switch.
- Fine Tune potentiometer/and external fine tune.
- Tuning spin wheel encoder.
- Reference frequency.

Diagrams for reference are Figs. 5, 20 and 22 at the back of the book and Fig.3.2 at the end of Chapter 3.

300kHz Reference Frequency

- 4.8 Referring to Fig.5, a fixed 300kHz reference frequency (derived in 19-0849 from the frequency standard) is fed in via socket SK1 and shaper Q10 to the gate IC1d/13. This gate is enabled by a '0' on IC1d/12 when the Fine Tune Control switch (S7, Fig.20) is at OFF, thus allowing the fixed 300kHz reference to pass via IC1a to the divide-by-eight package IC2 which feeds 37.5kHz as a channel spacing reference to the channel spacing dividers in the Divider and Phase Detector Assembly.

- 4.9 When the FINE TUNE switch S7 is set to INT or EXT, gate IC1d is disabled by +12V from S7, and gate IC1c is enabled via IC1b. At the same time +12V is applied, via R58, to the Fine Tune oscillator Q3 to Q6 and mixer Q7/Q8 and Q9 which supply a tunable 300kHz reference via IC1c and IC1a to IC2.

Fine Tune Reference

- 4.10 For fine tuning purposes a variable 300kHz reference is produced via the mixer Q8/Q9, as follows.
- 4.11 Transistor Q3 is a crystal oscillator operating in a Colpitts-type circuit, the frequency being determined by the 5.3MHz crystal XL1 and voltage variable capacitance (varactor) diode D3. The oscillator frequency can be 'pulled' over a limited range by the front panel FINE TUNE potentiometer, or by an external slow-sweep input, which applies a positive d. c. voltage to the junction of XL1 and D3.

- 4.12 The oscillator signal is fed via amplifiers Q4 and Q6 to the mixer Q7 and Q8. Oscillator a.g.c. and output limiting is provided by Q5 and associated components. Q11 regulates the collector supply voltage to the oscillator section. When the Fine Tune control switch is set to OFF, the positive supply via R58 is disconnected, thus disabling the Fine Tune reference circuit and mixer.
- 4.13 The mixer Q7/Q8 is fed with the variable 5.3MHz described above, and a fixed 5MHz reference from the frequency standard. The resultant (tunable) 300kHz 'difference' frequency is fed via the shaper/amplifier Q9 to the gate IC1c.

#### Tuning (Spin Wheel) Input

- 4.14 Rotation of the Fine Tune spin wheel encoder (described in para 3.12) applies a train of pulses in phase quadrature to pins 11 and 12 of the Logic board. The pulses at pin 11 lead those on pin 12 by  $90^\circ$  for one direction of rotation and lag by  $90^\circ$  for the opposite rotation. These input pulses are shaped by the Schmitt triggers IC3 and IC4, and fed via IC5a to the pulse multiplier circuit.

#### Pulse Multiplier and Up/Down Detector

- 4.15 The pulse multiplier IC5a and IC5d receives the tune pulse train from the Schmitt triggers IC3 and IC4, and IC4, and by forming a pulse from each edge effectively multiplies the spin wheel signal by four, thus increasing its sensitivity.
- 4.16 A delayed version of the spin wheel signal is fed to IC8a/5 and is clocked through by the x4 pulse train applied to IC8a/3. This enables IC8a to detect the direction of rotation of the spin wheel. When turned in one direction such that IC5a/1 leads IC5a/2 by  $90^\circ$ , then the 'Q' output of IC8a stays high, conversely the opposite rotation reverses the phase relationship and the 'Q' output then goes low. The state of IC8a/1 is fed through IC8b (except when operating the step switch) to the Up/Down line.

#### Step Switch

- 4.17 When the biased step switch (Fig.20, S3) is operated it applies an earth to the appropriate Set or Reset pin of IC8b thus forcing the Up/Down detector to the required state, according to the step direction required.

#### Pulse Divider

- 4.18 The pulse divider IC13 receives information from the Range switch, the Tune Control switch (Fast, Slow, Hold) and the tuning spin wheel. Its function is to provide different 'gearing' for the fast and slow tuning modes, as follows:-
- (1) In fast tune mode the tuning rate is such that each frequency range is covered in 30 turns of the spin wheel. By acting as a variable divider IC13 maintains this 30 turn relationship despite the widely differing frequency coverages of the various ranges.

- (2) In slow tune mode IC13 acts as a fixed divider because the tuning rate has a constant number of channel changes per revolution of the spin wheel.
- 4.19 The pulse divider functions as follows. Tuning signals from the spin wheel are fed into IC13 via inverter IC9a. With the Tune Control switch S6b set to FAST the line to pin 24 is open circuit which enables IC9b and allows the 'carry' output at IC13/7 to be fed into the 'preset enable' at IC13/1, thus converting IC13 to a programmable divider, with an output fed via IC10b/6 to IC7a/3.
- 4.20 Division ratio commands are applied to the A, B, C and D lines of IC13 from the four upper bands of the Range switch S2. Range 5, for example, commands division by one whereas Range 2 commands division by eight.
- 4.21 When the Tune Control switch S6 is set to HOLD or SLOW, a '1' is applied via pin 24 to IC9b/6. This disables IC9b, which cuts off the carry output loop and converts IC13 to a fixed division by 16. Thus a constant number of channels is obtained for each revolution of the spin wheel.
- 4.22 In the HOLD position of the Tune Control switch an open circuit is applied from switch S6a which turns on Q1 and clamps IC10b/6 to +12V, which inhibits the output of IC13, thus electronically dis-engaging the spin wheel. IC10b/5 receives an input from the biased Step Up/Down switch when this is operated for single step channel shifting. The tuning information received by IC10b is fed to IC7a/3 where it is processed by the range and channel spacing control circuitry described below.

#### Principles of Channel Spacing Control

- 4.23 The function of the pulse multiplier is to detect the direction of rotation of the Fine Tune encoder and from this information control the direction of counting (up or down) in the variable divider in the main oscillator loop (Divider and Phase Detector Assembly 19-0846). At the same time it allows the magnitude of the  $\div N$  number set into that divider to be changed, to achieve the required channel spacing. The system operates as follows.
- 4.24 The channel spacing is determined by gating a certain number of 300kHz pulses through IC9d. This is controlled by the pulse multiplier, the channel spacing switch and the Range switch in conjunction with the channel spacing control circuitry shown in the upper right hand corner of Fig.5.
- 4.25 For example, if operating on Range 5 and channelized mode, a 5kHz channel spacing is selected, then each pulse from the spin wheel on slow tune causes one pulse to be released through IC9d, this clocks the 'N' counter by one, which instructs the 'N' divider to change the instrument output frequency by 5kHz. If the channel spacing is changed to 10kHz, then two pulses will be released through IC9d giving a 10kHz change of output frequency. Similarly for 20kHz channel spacing, 4 pulses will be released for each pulse from the spin wheel.

4.26 Operation of the Range switch downwards from Range 5 also causes a doubling of the number of pulses released for each range, to obtain a given output frequency step, because of the  $\div 2$  stages introduced by the Range switch into the main oscillator output. Table 2 shows the relationship between channel spacing, range selection and pulses released.

TABLE 2  
Channel Spacing Control

CHANNEL SPACINGS (kHz)	Number of 300kHz pulses released for each Spin Wheel Pulse on different frequency ranges.				
	Ranges				
	5	4	3	2	1
5 } 6.25 }	1	2	4	8	2
10 } 12.5 }	2	4	8	16	4
15 } 20 }	4	8	16	32	8
25 } 30 }	8	16	32	64	16
50 } 60 }					

Channel Spacing Control Circuit

4.27 Consider first the operation in Slow Tune mode with  $\Delta f$  selected. In  $\Delta f$  mode one pulse at pin 18 is obtained for each pulse from the spin wheel (or each movement of the Step switch in Hold mode) irrespective of range selection.

4.28 With Channel Spacing switch S4 at  $\Delta f$  the line from pin 27 is open circuited, which turns off Q2 and puts a '0' on IC15b/5. With switch S6 on Slow Tune, the '1' on pin 24, inverted in IC10d, sends IC15b/4 and hence IC10c/8 to '0', which disables IC10 and inhibits any output from the channel spacing circuit IC6, IC11 and IC14. The '1' at IC10c/10 sets the 'Q' output of IC7b to '1' via the 'K' input on the positive edge of the clock pulse.

4.29 Meanwhile each pulse at the output of IC10b clocks IC7a, giving a '1' into the 'J' input of IC7b. This allows IC7b to change state on the positive transition of the 300kHz reference input at IC7b/13. The resulting change of state at the 'Q' output of IC7b (from '0' to '1') resets IC7a; at the same time the '0' produced at the  $\bar{Q}$  output of IC7b enables the gate IC9d/13, and allows the 300kHz reference signal to pass to the 'pulse'

output at pin 18, but only for the time that it takes for IC7a to reset; therefore only one 300kHz pulse will be allowed to pass for each pulse into IC7a/3.

4.30 The effect of introducing channel spacing and range information will now be considered. On all settings of the Channel Spacing switch except  $\Delta f$ , IC15b/4 will be at '1' level, thus enabling IC10c which allows IC11, IC6 and IC14 to be operative. IC11 introduces channel spacing data and IC14 introduces range data. The two dividers operate in series.

4.31 Assume that the Range switch is set to the highest range and the Channel Spacing switch to single channel (5kHz or 6.25kHz). The next tuning spin wheel pulse via IC10b clocks IC7a which changes the states of IC7a and IC7b as described in para.4.29. The '1' at IC7b/15 is applied via IC10a to the preset enable of IC11 and sets it to divide by one. The Range switch line RA will already have set IC6 and IC14 to divide by one. Thus the 300kHz allowed to pass through IC9d will be fed to the clock input at IC11/15 and fed through to IC10c/10, without division, to reset IC7a as described in para.4.29. As previously described, only one 300kHz pulse will be allowed to pass to pin 18.

4.32 If the Channel Spacing switch is set to a double channel spacing (10kHz or 12.5kHz, for example) IC11 will be set via IC15d to  $\div 2$ . An incoming 'tuning' pulse from IC10b will set IC7a/IC7b as previously described, IC9d will be enabled but two 300kHz reference pulses will pass to pin 18 before the reset of IC7a/IC7b occurs and closes IC9d.

4.33 Similarly, a channel spacing selection of 25 will change the division ratio of IC11 to  $\div 4$ , allowing four reference pulses to pass to IC14. A channel spacing of 50 will allow eight pulses to pass, and so on.

4.34 Range information is introduced by changing the division ratio of IC14 by the lines RA, RB, RC and RD. For example, on Range 4 IC14 divides by eight. Thus a combination of Range 4 with single channel spacing (6.25kHz) will result in successive divisions by eight, giving an effective multiplication by 64.

4.35 Fast Tune. When FAST is selected on switch S6, a '0' is applied to pin 24 and via inverter IC10d puts a '1' on IC15a, IC15d/13 and IC15c/8 which effectively disconnects the channel spacing switch and sets IC11 to the maximum division ratio ( $\div 8$ ), thus giving the fastest tuning rate.

4.36 On model 9082 (assembly 19-0948), a Read Only Memory (ROM) IC16, IC's 17 to 24, Q12 and resistors R64 to 68 are mounted on the Logic Assembly p.c.b. This circuitry does not form part of logic circuitry, and its operation is described in the section relating to the Divider and Phase Detector Assembly.

## DIVIDER AND PHASE DETECTOR ASSEMBLY 19-0846 (9081) AND 19-0950 (9082) FIG. 13

### Introduction

4.37 The principal functions are shown in the block diagram (Fig. 3.2) at the end of Chapter 3. These are:-



- (a) Division of the Range 4 signal by a factor 'N'.
- (b) The storing of a number 'N', determined by the range and channel logic, which instructs the programmed divider.
- (c) Phase detection of channel spacing data and tuning data to provide a frequency control (varactor) signal to the main oscillator, with fast or slow response according to tuning mode.
- (d) A read-only memory (ROM) which, from channel spacing and 'N' counter data, provides a ( $\frac{1}{2}$  octave) logic output which selects the appropriate filter bandwidths in the Output Assembly. The ROM also provides 'end stop' logic to prevent the main oscillator from tuning beyond the end of each range.

Note:- In model 9082 the extension of the frequency range requires modification to the logic provided by the ROM. Space for the additional circuitry is not available on the Divider and Phase Detector Assembly, so it is mounted on the Logic Assembly (19-0948). Connections to the circuit are made via a 24-way cable and two leads as shown in Figs. 5, 13 and 22.

#### 'N' Counter

4.38 The 'N' counter consists of the binary counter IC4 decade counter IC7 and binary counters IC20, IC13 and IC23. The clock input to the divider is a controlled number of 300kHz pulses from the Logic Assembly which is derived from tuning (spin wheel) information. The Up/Down signal on pin 16 of the p.c.b. commands the 'N' counter to count up or down, according to the direction of tuning. The outputs from the 'N' counter are fed direct (or via the digit blanking gates described in succeeding paragraphs) to the data inputs of IC5, IC9, IC21, IC14 and IC25, which operate in conjunction with the h.f. divider.

#### Digit Blanking

4.39 The instrument always tunes to a channelized frequency which is determined by the channel spacing selection. For example, the selected channel spacing could be the basic spacing for a group (e.g. 5kHz) or a multiple of this spacing (10kHz or 20kHz). When operating on a multiple of the basic channel spacing provision is made for inhibiting the redundant digit from the 'N' counter, otherwise the 'N' divider would receive ambiguous data causing the instrument to settle between channels. This digit blanking is performed by the network of gates in the Q1, Q2, Q3 and Q4 output lines from IC4 and the Q1 and Q2 outputs from IC7.

4.40 For example, assume that the VCO is operating on the highest range and that a basic channel spacing (5kHz, 6.25kHz or 15kHz) is in use. The pulse input to the p.c.b. at pin 15 clocks the binary counter IC4 with a single pulse which provides an output pulse via IC1e and IC6a to the 'N' divider. If, however, the first multiple of the channel spacing is in use (e.g. 10, 12.5 or 30kHz) IC4 will be clocked by two pulses, providing an output from Q2 of IC4 which is fed via IC/a and IC2c to the 'N' divider. Because the Q1 output of IC4 will have been clocked back to its original state, its data could cause a false offset to be applied. It is therefore inhibited by the closing of IC6a by the channel selection logic applied via R28 and R29.

- 4.41 The digit blanking is progressive with both channel selection and range selection. When 20, 25 or 60kHz channel spacing is in use an inhibit is applied to IC2c. On 50kHz channel spacing the inhibit is applied to IC6b. When operating on one of the divided VCO ranges (Range 4 to Range 2) however, the digit blanking is also applied progressively to compensate for the frequency division which has occurred. For example when Range 4 (120-270MHz) is in use, the Q1 output from IC4 is blanked by a logic signal applied via line RL, even though the lowest channel spacing is in use. Thus when a 'divided' frequency range is selected, the digit blanking occurs at an earlier point than it would when the top range (240-540MHz) is in use.
- 4.42 Digit blanking of the Q2 output of IC7 occurs when the widest channel spacing is in use at the same time as the 32-64MHz frequency range, but as IC7 is a decade counter the associated circuitry is more complex. Range information is provided via line RS and NOR gate IC2b.
- 4.43 When IC7 reaches a count of ten the Q2 outputs of IC7 and IC20 change state. This is detected by the gating network IC12a-d. If the Q2 output of IC4 goes to a '0' no action occurs, but if it changes to '1' and the Q1 of IC20 is also a '1', the gating network will force Q2 of IC4 back to a '0'.

#### HF Divider

- 4.44 The Range 4 oscillator signal is fed via socket SK6 into the HF Divider, which is formed by the  $\div 10$  or  $\div 11$  divider IC30 feeding a chain of four  $\div 2$  binaries, IC29b, IC29a, IC28b and IC28a, all of which are ECL packages.
- 4.45 Divider IC30 can divide by either eleven or ten, thus enabling the particular circuitry (para. 4.48) to divide by either 161 or 160. IC30 divides by 11 if pins 2 and 3 (PE1 and PE2) are both low, but if either of these pins rises to logic '1', then division by 10 will occur. This logic state is controlled by part of the 'N' divider, as follows.
- 4.46 Binary divider IC5 and decade divider IC9, with IC8a, IC15a and associated gates, form a swallow counter with zero detector. The output of the h.f. divider is fed from IC28a/2 via transistors Q1, Q6 and Q7 to the clock inputs at IC5/15 and IC9/15. Each clock pulse causes the divider to count down by one.
- 4.47 Assume that a count of 4 is loaded into IC5, and IC9 is at zero. Until a digital zero is reached the output of the zero detector at IC8a/1 remains low, which holds transistor Q4 non-conducting and applies a low to IC30/3, thus maintaining  $\div 11$  mode in IC30 and hence an overall  $\div 161$  mode in the h.f. divider.
- 4.48 When the count in IC5 reaches zero this is detected and IC8a/1 goes high, which turns on Q4 and sends IC30/3 high thus changing the division ratio in IC30 to 10 and the overall division to  $\div 160$ . Thus, division by 161 lasts for the duration of the count down in IC5/IC9. The zero detection at IC8a/1 also turns off Q7, which cuts off the clock pulses from IC5 and IC9, thus preventing any further change in the h.f. divider ratio.

- 4.49 The  $\div 160$  signal via Q1 and Q5 clocks IC21, IC14 and IC25 downwards from the numbers stored in them from the 'N' counter. When a count of 2 is reached this is detected via the gates IC8b, IC15b, IC24b, IC16d, IC22c and IC22d, causing IC8b to change state and apply a '1' to the 'J' input of IC10.
- 4.50 The next clock pulse from the h.f. divider clocks the 'N' divider down to one and transfers the 'J' input of IC10 to the Q output, which turns on Q8. This applies a '1' to the 'K' of IC10 and enters 'N' back into the divider via the preset enable.
- 4.51 The next clock pulse (via IC10/13) resets IC10, which feeds a carry output pulse from IC10/14 to the phase detector. Simultaneously the 'Q' output of IC10 turns off Q8, thus ending the preset pulse and enabling the divider to begin another count down. Q3 is turned off which sends IC30/3 low, thus setting IC30 to the  $\div 11$  mode in readiness for the next sequence.
- 4.52 The pulse recurrence frequency fed from IC10/14 via TP9 to the clock input of IC3b is the Range 4 frequency (128MHz to 256MHz) divided by the number loaded into the 'N' divider by the tuning system. It now remains to bring this divided frequency into coincidence with the appropriate channel spacing reference frequency. This is done by the phase detector IC3a/IC3b.

#### Phase Detector

- 4.53 The basic phase detector is IC3a and IC3b with the NOR gate IC2a. The clock input to IC3a/3 is a reference frequency received via the programmed divider IC19. The clock input to IC3b/11 is the tuning information from the 'N' divider. When these two clock frequencies are identical the main VCO loop will be in lock. If, however, they are not identical the VCO varactor line will adjust the d.c. tuning voltage as described in para.4.55.
- 4.54 The 37.5kHz reference at pin 18 (which is a fixed frequency except when Fine Tune is in use) clocks the divider IC19. This divider is programmed by the Channel Spacing switch to divide by 10, 12 or 15, thus providing a clock reference of 2.5kHz, 3.125kHz or 3.75kHz at IC3a/3. The selected division ratio determines the channel spacing. As described in the Logic circuit description (para.4.10) the 37.5kHz reference is variable when in Fine Tune mode, thus providing analogue tuning within a particular channel spacing.
- 4.55 The voltage on the VCO varactor tuning line is normally determined by the charge on the dominant capacitor network C25, C26 with R59. If, for example, the tuning frequency at IC3b/11 is lower than the reference at IC3a/3, an output at the  $\bar{Q}$  of IC3a will turn on Q9 and, via the constant current generator Q10 feed current into C25/C26, thus tuning the VCO in the appropriate direction.
- 4.56 If, on the other hand, the tuning frequency at IC3b/11 is higher than the reference, then Q12 will be turned on by the Q output of IC3b. This will draw current out of C25/C26 and thus reverse the tuning direction.

4.57 When the spin wheel is rotated rapidly, the varactor line is forced to follow a faster time constant (C23, C24 and R57) by turning on a low output impedance buffer Q15a. The key components of the fast time constant circuit are Q13, Q14, Q15a, Q15b, Q16, C23, C24 and R57. The system operates as follows.

4.58 Operation of the spin wheel provides a train of pulses at pin 15 of the p.c.b. As well as clocking the 'N' counter these are peak detected by D10/R64. If spin wheel rotation is sufficiently rapid, the detected pulse train will produce a negative level at IC26/6 which is sufficient to turn off Q17 and thus turn on Q16, which allows the charge on C23/C24 to dominate the varactor tuning. The difference in value between C23 and C25 indicates the relative speed of response. During fast tuning the voltage on C25 is forced to follow that of C23 so that when reverting to slow tuning, with Q16 turned off, the varactor line does not experience an abrupt change of voltage.

#### Read Only Memory (ROM)

4.59 The ROM is IC16. With IC11 and, in the case of model 9082, IC's 17 to 24 and Q12, it has two main functions:-

- (1) It provides oscillator 'end stop' control, detecting when the tuning has driven the main VCO to either extremity of its tuning range. When this occurs a low appears on either the step-up or step-down lines to the Logic Assembly. This simulates operation of the STEP switch, and prevents any further change in the 'N' counter state in the direction which would drive the VCO out of range.
- (2) It provides half octave information by detecting (when on ranges 2 to 5) whether the instrument is tuned to the upper or lower half of the selected frequency range. This half octave output (at pin 17) selects the appropriate filter bandwidth in the Output System Assembly and also selects the appropriate oscillator in the FM Loop Assembly.

4.60 The address data for the ROM is provided by the most significant outputs of the 'N' counter, obtained from IC20, IC13 and IC23 and fed into IC16 at pins 13 to 20. Additional information is supplied to IC11 pins 14 and 2 from the Channel Spacing switch and a reference frequency (also dependent on channel spacing selection) is supplied from the programmed divider IC19 to IC11 pin 1.

4.61 In the case of model 9082 the information supplied to pins 13 to 20 of the ROM, augmented by additional information from IC20, is also supplied, via IC's 21, 23 and 24, to the NAND gates IC's 19, 20 and 22. The outputs of these gates modify the ROM outputs at pins 4, 5 and 6 of IC17. The overall logic is thus made to suit the requirements of the extended frequency range whilst retaining the original ROM.

4.62 Transistor Q20 with zener diode D12 provides a regulated +7V supply to IC16, and the diode connected transistor Q21 provides temperature compensation in the negative supply.

- 4.63 Half Octave Output. IC11 is a 4 : 1 multiplexer which, from the tuning data detected in IC16, and the channel spacing data, provides an output at IC11/9 which turns on Q22 when operating in the lower half of the selected range.
- 4.64 On Range 1 the half octave output at pin 17 is held in the low condition by a positive level supplied by the Range switch on line RE, which via diode D14 turns off Q22.
- 4.65 End Stop Control. Half octave data at IC11/9 is used to turn Q19 on or off, according to which end of the tuning range has been reached. This is detected by the gates IC17a, b and d, in conjunction with the state of Q18 and inverter IC17c and a logic signal is fed out on the appropriate Step Up or Down line. If, for example, the VCO has reached the bottom end of its range, Q19 will be turned off and IC17b will be turned on, thus putting a 'low' on the Step Up line from pin 12.
- 4.66 On the instrument's 'mixer' range (Range 1) the 'end stop' information required is different from the divided ranges 2 to 5. Thus, on the 'mixer' range, pin 14 goes high causing the 'mixer' range input to the ROM to go low via IC18c. Thus the ROM selects the appropriate new end stops.

## OUTPUT SYSTEM ASSEMBLY 19-0843(9081) AND 19-0949(9082), FIG 7.

### Introduction

- 4.67 Referring to circuit diagram Fig. 7, the ECL circuitry on the left hand side of the diagram is concerned with division and filtering of the main oscillator signal to produce the five frequency ranges. The TTL circuitry on the right is concerned with amplitude modulation, a.g.c. level setting and output metering.

### R.F. Input

- 4.68 The 240MHz to 540MHz signal from the main oscillator assembly is fed via socket SK11 to the buffer amplifier Q1. From Q1 the collector output is fed via C4 to the Range 5 filtering system, and the emitter output via Q2 to the Range 4 divider IC3. The collector voltage for Q1 and Q2 is connected via the Output switch S12 (Fig. 20) in the X2 and NORMAL positions. In the OFF position this collector supply line is earthed, which inhibits the r.f. input to the range dividers and filters.

### Range Switching

- 4.69 Range selection is obtained by applying a +12V level from the Range switch (Fig. 20, S2 via the appropriate range lines RA, RE, RG, RC and RD),

### Range 5 Filtering and Half Octave Selection

- 4.70 The 240-540MHz signal is fed via C4 to two alternative filter paths, selected by forward biasing either D1 or D2, the control information being supplied via the  $\frac{1}{2}$  octave input (pin 8). The  $\frac{1}{2}$  octave data is obtained by interrogation of the Read Only Memory (ROM) in the Divider and Phase Detector Assembly, in order to establish which half of the Range 5 frequency band is in use. This  $\frac{1}{2}$  octave logic is employed in all the range filters except Range 1.

4.71 For example, on Range 5, if the  $\frac{1}{2}$  octave logic signal (pin 8) is high, Q5 will be turned on and also Q4, thus reverse biasing D4 and forward biasing D1. This allows the r.f. signal to pass through the filter formed by the stubs 17 and 18, with C13, C14 and C15. Since Q3 will be off, diode D2 is reverse biased, which blocks the path through the stub filters 19 and 20.

4.72 A change of logic state on the  $\frac{1}{2}$  octave line will reverse the above arrangements, causing D2 to be forward biased and D1 reversed, thus inserting the filter formed by stubs 19 and 20 with C9, C10 and C11. The filter outputs are fed via D5 and D6 to the common output via the combiner diode D7.

#### Range 4 Division and Filtering

4.73 The Range 4 divider IC3 is fed from Q2 and the divided signal drives the Range 1 mixer via Q10 and the Range 3 divider IC2 via Q9. The Range 4 filter is fed via Q9 and Q10, which drive the input transformer T3 in antiphase. Range switching is obtained by biasing the diodes D18 and D19 via the range line RG.

4.74 When Range 4 is selected a positive voltage forward biases D18 and D8, and reverse biases D19, allowing the signal to pass through the filter formed by stubs 15 and 16, with C42, C43 and C46. When the  $\frac{1}{2}$  octave level (pin 8) is high it will apply forward bias to D21, thus connecting C44 which extends the filter pass band to a lower frequency. The r.f. output signal is fed via D8 to the common output line via the combiner diode D7.

#### Range 3 Division and Filtering

4.75 The Range 3 divider is IC2 which feeds the Range 2 divider via Q11 and the Range 3 filter from Q12 collector via diode D23, which is forward biased by the positive logic from the range selection. The filter is a conventional LC network with an extension of the lower passband whenever D26 is forward biased by the  $\frac{1}{2}$  octave logic, thus inserting C58 in parallel with C59. The output is fed via D9 to the common line at the combiner diode D7.

#### Range 2 Division and Filtering

4.76 The Range 2 divider is IC1b which feeds the Range 2 filter from IC1b/15. The  $\overline{Q}$  output from IC1b/14 is fed to another divider (IC1a) which provides a 16 to 32MHz signal to the Display Counter Assembly.

4.77 The Range 2 filter is similar to that of Range 3. A positive range signal forward biases D27 and D10 and allows the r.f. signal to pass through the filter. The lower passband is extended when  $\frac{1}{2}$  octave logic forward biases D30, thus inserting C70 in parallel with C71.

Range 1 Mixer and Filtering

4.78 The Range 1 frequency band is obtained by mixing a 120 MHz reference with a portion of the Range 4 spectrum. This restricted portion of the range is determined by the ROM in the Divider and Phase Detector Assembly, which limits the tuning range on this band.

4.79 The 120MHz reference is applied to T1 in the mixer, via R19, R20 and the filter L3/L4/C16/C17/C18. The Range 4 signal from Q10 collector is fed into the opposite side of the mixer at T3. The mixer output is fed via Q6 to a low pass filter L5/L6 and associated components which removes unwanted mixer frequencies. The output is enabled when Q7 is turned on by a logical '0' on line RE, applying a positive supply to the collectors of Q6 and Q8, and forward biasing the combiner diode D17.

RF Output Amplifier

4.80 The r.f. signal from the selected range is fed via the combiner diode D7, or D17, and C74 to the modulator preamplifier Q13, which has an overall gain of approximately  $\times 4$ . The r.f. signal is then buffered in Q14 and fed via the components of the modulator stage to Q15, which is the driver for the balanced output power amplifier Q16/Q17. Amplifier bias is preset by R94. The output is fed via C94 to the output attenuator. The diode D36 with R107 and C97 forms a peak detector on the output waveform which provides a d.c. level for automatic level control and meter information.

Output Metering

4.81 The r.f. output is peak detected by D36 and the information stored on C97, this level being applied via the filter L22/C98 and R128 to the operational amplifier IC7 which operates in a conventional circuit, with the addition of diode D38 for temperature compensation. Meter calibration is by potentiometers R134 and R136. The output is fed to the meter via pin 31 through the Output switch S12 to the meter switch S11. (see Fig.20).

Amplitude Modulator Stage

4.82 The modulator operates on the principle that the impedance of the p.i.n. diodes D33, D34 and D35 varies according to the applied bias current. If this bias current is varied at an audio frequency then amplitude modulation of the r.f. signal will occur. Similarly, the r.f. carrier level can be controlled automatically, or manually, by a d.c. level applied to the p.i.n. diodes, as described below. The modulation process is described in para. 4.87.

ALC and Carrier Level Setting

4.83 The automatic level control (ALC) comparator is IC9, which compares the peak detected signal level on C97 with an adjustable reference level applied to the other input (IC9a/2). The output at IC9/7 is fed via L19, R89 and R90 to the p.i.n. diodes D33/D34 and D35. The diode attenuation, and hence the carrier level is thus controlled at a

point which produces a balance between the two inputs of comparator IC9.

4.84 The carrier level (in c.w. mode) is manually adjusted by the front panel Vernier potentiometer, which is fed with a d.c. reference level provided by IC4, zener diode D40, and associated components.

4.85 The reference d.c. level from IC4/6 is fed via R151 to Q20. In the absence of any audio input at pin 23 this reference will set the carrier level via the d.c. coupled stages Q20 and Q19, manual adjustment being made via the Vernier potentiometer connected between pins 25 and 21. The modulation depth is adjusted by R143 and R153 to be the same at both extremes of the Vernier setting.

4.86 From the Vernier potentiometer the carrier reference (and audio signal if on AM) are fed through the shaper buffer IC8, R118 and D37 to one input of the a.l.c. comparator IC9, thus providing the reference described in para. 4.83. The purpose of D37 is to provide temperature compensation in the peak detector circuit and for this reason D36, D37 and D38 are mounted in physical contact.

#### X2 Output

4.87 A d.c. carrier reference voltage is fed via pin 27 and line RN3a to tag 'c' of the Output switch S12/1F. (Fig.20). In the X2 position of the switch this voltage is fed via line RN3 to the modulation input at pin 23 of the p.c.b., thus setting the carrier level as described in the previous paragraph. At the same time the other half of S12/1F inserts the attenuating resistor R26 into the meter drive path, causing the meter to read half the true output level. The X2 facility is not operative in a.m. mode.

#### AM Audio Input

4.88 The audio signal from the internal oscillator (or external modulation source) is fed via switches S8 and S12/1F(Fig.20) to pin 23 on the Output System p.c.b. It is then fed via the carrier reference path to the a.l.c. comparator IC9.

4.89 ALC information is provided via the peak detector diode D36 which tends to be non-linear near the trough of the modulation envelope when modulating to a high percentage at relatively low carrier levels. The function of the AF Shaper IC6, and the transistors in the package IC5, is to introduce sufficient a.f. shaping over a wide temperature range to compensate for any non-linearity in D36 and thus ensure an undistorted modulating waveform at the output of the comparator IC9. The shaper is calibrated by adjustment of R109.

#### OUTPUT AMPLIFIER 11-1404 (9081H and 9082H ONLY)

4.89a The increased maximum output level of models 9081H and 9082H is achieved by means of an additional amplifier between the output system assembly and the attenuator, (see Fig. 22). The amplifier module is mounted adjacent to the attenuator. No parts list or repair information for the amplifier is given in this manual. In the event of failure the complete module should be replaced.



120MHz LOOP ASSEMBLY 19-0849 (Fig.18)Introduction

4.90 Referring to the block diagram Fig.3.2., this assembly contains a voltage controlled oscillator (VCO2) operating in a phase locked loop, synchronized to the master frequency standard and providing the following facilities:-

- (1) A 120MHz reference frequency for the Range 1 mixer process.
- (2) A 10MHz reference for the display counter.
- (3) A 300kHz reference for use in the logic assembly.

The circuitry to the left of Q4 and Q5 in Fig.18 is ECL and that to the right is TTL.

120MHz Oscillator

4.91 Referring to Fig.18 the 120MHz Oscillator is Q3 and associated components, voltage tuned by the loop 'error' voltage supplied from the phase detector IC4 pin 8, via L1 and R8, to the varactor diode D1.

The oscillator output is inductively coupled to the base of amplifier Q1 via L1 and the printed wiring inductor. An output is obtained from Q1 when Q2 is turned on by the Range 1 logic at pin 15. The signal is fed out via C1 to SK8. (The range logic at pin 15 is an inverted level obtained via Q8 in the Counter Assembly).

4.92 The output at Q3 source drives the  $\div 4$  package IC8a/IC8b. From IC8b a 30MHz signal is fed to the phase detector path via IC8b/15 and to the 300kHz divider path via IC8b/14.

Phase Detector Path and Display Blanking

4.93 The 30MHz signal is divided by 3 in IC1a/IC1b and the resulting 10MHz is fed through the ECL-to-TTL level converter Q5 to the output at pin 14, and to the divider IC5 which provides a 5MHz reference output at pin 4 and a 1MHz input to the phase detector IC4. The phase detector compares the 1MHz oscillator signal with the 1MHz master reference signal at IC4/1, and any frequency difference produces an 'error' voltage which tunes the oscillator Q3 to bring the two frequencies into lock. The error voltage is also fed via R35 to pin 10 to blank the digits in the counter display if the 120MHz loop goes out of lock (para. 4.118).

300kHz Reference Output

4.94 The 30MHz oscillator signal from IC8b/14 is fed through the ECL-to-TTL level converter Q4 to drive the  $\div 100$  stage IC3/IC2, which provides a 300kHz reference output at SK95.

Master Reference Inputs

- 4.95 The phase detector reference is provided by the 5MHz internal frequency standard, or, alternatively by an external 1MHz standard, selected by a rear panel switch and fed to the p.c.b. at pin 9. The reference input is fed via shaper Q6 and buffer Q7 to the divider IC7.
- 4.96 The  $\div 5$  package IC7 operates when internal standard is selected and feeds a 1MHz reference via gate IC6b, R44 and C33 to the internal standard output socket on the rear panel, and also via IC6c to the phase detector IC4.
- 4.97 When the rear panel Standard switch is set to EXTERNAL the divider IC7 is inhibited, and gate IC6d is enabled, by a logic signal applied via D4, thus feeding the 1MHz external standard direct to the phase detector. If the Standard switch is set to EXTERNAL but with no external standard applied the display blanking will operate because the phase detector cannot lock.

COUNTER ASSEMBLY 19-0845 (Fig, 11)

Introduction

- 4.98 A portion of the carrier frequency spectrum is applied to the digital counter and by means of binary and decade control of the timing process this data provides a readout of the whole frequency range. For ease of viewing certain (trailing) digits are blanked out, according to the position of the TUNE switch. This gives a four digit display (100kHz) resolution) in FAST tune, a six digit (1kHz resolution) display in SLOW tune, and the full eight digit display (10Hz resolution) in HOLD mode. At frequencies below 100MHz the leading zero is blanked out and below 10MHz two leading zeros are blanked out.

Logic Voltage Levels

- 4.99 The power supply voltages to the Counter Assembly are +12V and -6V. Both TTL and CMOS logic levels are used, as follows:-

TTL logic levels are:-

'0' = -5V = 'low'  
'1' = 0V = 'high'

CMOS logic levels are:-

'0' = 0V = 'low'            ) IC10 and  
'1' = +12V = 'high'        ) IC11

COUNTER PRINCIPLES

4.100 The following paragraphs describe the basic principles of the counter and display system. The circuit description commences at para.108. In a conventional digital counter the unknown frequency is fed via a main gate into a chain of decade counters. The main gate is opened for a defined period controlled by the time base, during which the signal is counted and the accumulated b.c.d. data is stored. At the end of the gate time the measurement is terminated and the counting circuits are automatically reset. At the same time the stored data is transferred to update the readout, which is displayed while a new count is in progress.

4.101 Fig.4.1 is a theoretical block diagram of the Counter p.c.b. in which most of the functions are performed in the large scale integration CDI Chip IC12. The Chip is operated in the 'frequency ratio' mode, in which the frequency of the time base drive is not a fixed reference, but is variable in binary steps by the Range switch and decadic steps by the Tune switch. This technique allows the full 1.5MHz to 512MHz frequency range to be displayed from measurements of binary related frequencies in the 16 to 32MHz range (1.5 to 32MHz when on Range 1). Table 3 gives full details of the binary and decade division and main gate periods.

Reference Frequency

4.102 A 10MHz reference frequency from the 120MHz Loop Assembly is fed into the CDI Chip where it is divided down to 1MHz and fed out via pin 6 to the binary divider controlled by the Range switch. Following binary division the reference is fed back to the CDI Chip, where it drives the variable time base divider which provides decade division determined by the coding on the x-y-z lines. The time base outputs control the main gate.

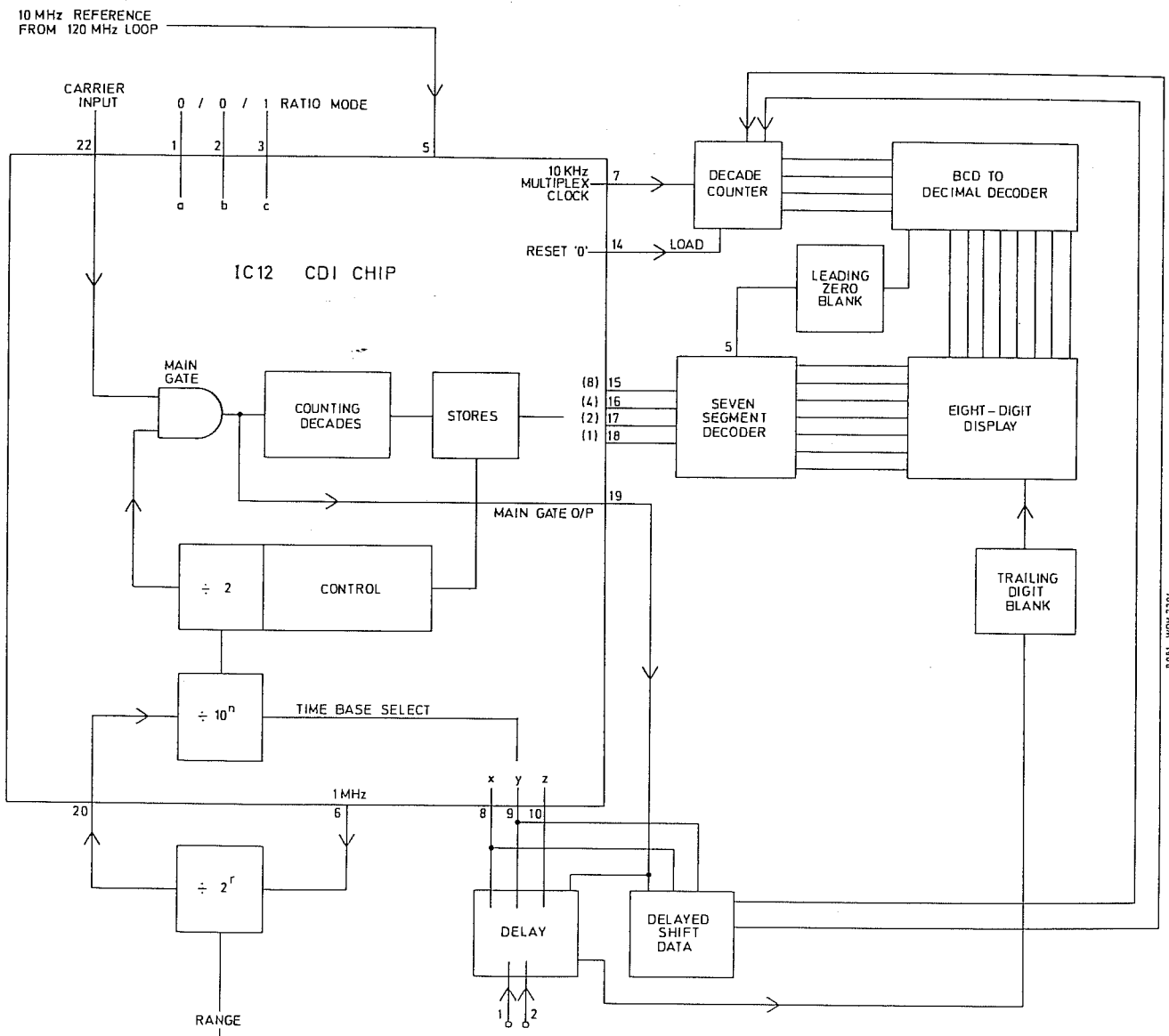
Time Base and Shift Data Delay

4.103 A delay circuit, interposed between the Tune switch and the x-y-z inputs of the CDI Chip, ensures that when the Tune switch is moved to a new position the time base data is not updated until the measurement in progress has been completed. Similarly, certain shift operations in the display (para.4.113) are inhibited until a new measurement has commenced. The delay circuit also provides the data for blanking out unwanted (trailing) digits in the FAST and SLOW positions of the Tune switch.

Multiplex Readout

4.104 The readout data is fed from the CDI Chip to the display decode via a single four-wire b.c.d. connection. To permit this simple interconnection a parallel-to-serial (multiplex) system is used. The principles are shown in Fig.4.2 although it should be noted that part of the system is in the CDI Chip.

# COUNTER ASSEMBLY



- 4.105 In the CDI Chip the data stores feed in parallel into a common b.c.d. four-line output. The store outputs are enabled in turn for approximately 100µs by a 10kHz reference signal, derived from the 10MHz reference frequency.
- 4.106 The b.c.d. data is fed to a 7-segment decoder (IC12) which offers the decoded data to the bank of LED digital indicators. The 10kHz reference is fed via a presettable decade counter IC4 to a BCD to Decimal decoder IC3 which enables each display LED in turn for 100µs. A reset pulse (Ro) ensures that the display data is synchronised with the data store readout. The function of the presettable decade counter IC4 is described in the next paragraph.

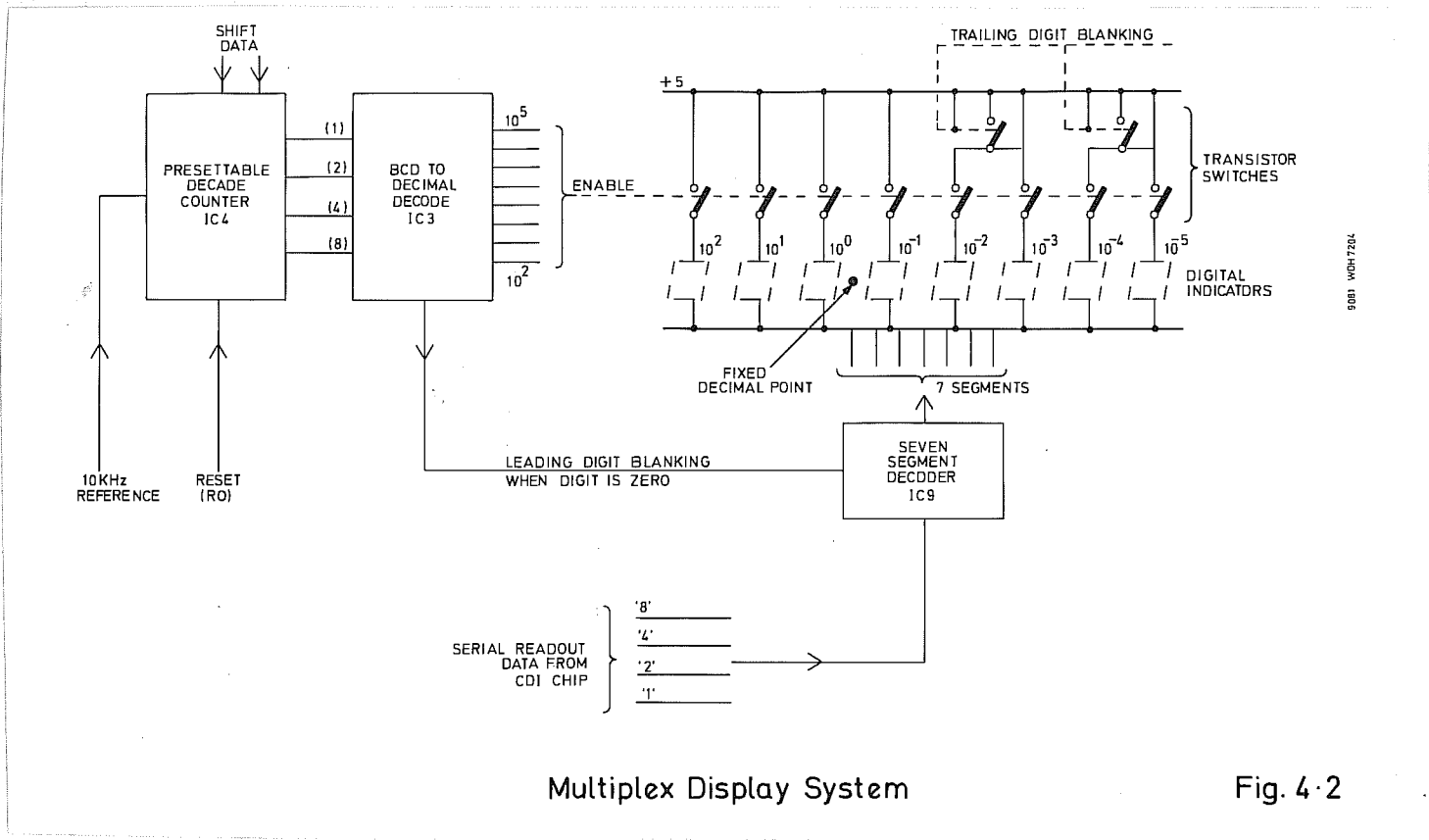


Fig. 4-2

Shift Data

4.107 Reference to Table 3 shows that the main gate time is decreased by a factor of 10 as the Tune switch is moved from HOLD through SLOW to FAST. The effect of this would be to shift the display one place to the right for each switch movement were it not counteracted by providing an equivalent shift to the left. This is done by changing the reset point in the counter IC4 as follows:-

- HOLD mode ... reset to '0'
- SLOW mode ... reset to '1'
- FAST mode ... reset to '2'

The reset is determined by the shift data applied to pins 4 and 10 of IC4.

TABLE 3

COUNTER ASSEMBLY DATA

Tune Control	Time Base Control Code			Display Shift*	Ratio Multiplier $10^n$	Binary Multiplier $2^r$	Time Base Input Freq $\frac{1\text{MHz}}{2^r}$ (B)	Main Gate Time ms	Counter Input Freq MHz(A)	Carrier Freq Range MHz	
	x	y	z								
FAST	1	1	0	to left	$10^3$	1	1MHz	1	16-32	5-32 <sup>†</sup>	5-32 <sup>†</sup>
						2	500kHz	2		32-64	
						4	250kHz	4		64-128	
						8	125kHz	8		128-256	
						16	62.5kHz	16		256-512	
SLOW	0	0	1	to left	$10^4$	1	1MHz	10	16-32	5-32 <sup>†</sup>	5-32 <sup>†</sup>
						2	500kHz	20		32-64	
						4	250kHz	40		64-128	
						8	125kHz	80		128-256	
						16	62.5kHz	160		256-512	
HOLD	1	0	1	No Shift	$10^5$	1	1MHz	100	16-32	5-32 <sup>†</sup>	5-32 <sup>†</sup>
						2	500kHz	200		32-64	
						4	250kHz	400		64-128	
						8	125kHz	800		128-256	
						16	62.5kHz	1600		256-512	

\* Display shift is described in para. 4.107.

† 1.5 - 32 for model 9082.

CIRCUIT DESCRIPTIONCarrier Input

4.108 Referring to the circuit diagram Fig.11, the carrier signal to be measured is applied to the 'A' input (pin 22) of the CDI Chip. This signal is in the 16 to 32MHz spectrum on all ranges except Range 1, and is fed in via transistor Q2 and the enabled gates IC13c/IC13b.

4.109 When operating on Range 1, however, IC13c is disabled by a logic level from the 'Range 1 Select' line (see next paragraph) inverted in IC13d. At the same time IC13a is enabled, thus allowing the Range 1 spectrum to pass via IC13b to the CDI Chip.

Range 1 Select

4.110 The 'Range 1 Select' logic level is the inverse of the Range switch logic on line RE. This Range 1 logic is fed via zener diode D4 to the base of Q8, the inverted level at Q8 collector being used in the Counter Assembly and also fed out via pin 15 to the 120MHz Loop Assembly.

Time Base Drive

4.111 The 10MHz reference signal from the 120MHz Loop Assembly is fed in at pin 5 of the CDI Chip and internally divided, supplying a 1MHz output at pin 6 of the Chip which is fed via amplifier Q5 to the clock input of the binary divider network formed by the CMOS packages IC11, IC10a and IC10b.

4.112 The division ratio of the binary divider is programmed by the logic on the Range switch lines RA, RE, RF, RC and RG. No division occurs on Range 1 (line RA). Table 3 gives details of the binary division for each range, and the corresponding effect on the main gate time in the CDI Chip. The binary divided reference signal is fed via IC10a, Q4 and Q3 to the 'B' input at pin 20 of the CDI Chip, for further decade division in the time base chain within the CDI Chip.

Time Base Encoding and Delay

4.113 The decadic division of the time base divider in the CDI Chip is determined by the coding of the x-y-z lines (pins 8,9 and 10 of IC12) under the control of the TUNE switch via the delay circuit Q23, Q24, IC1a and IC1b. The truth table for the TUNE switch is shown in Figure 11. The clock inputs at IC1a/3 and IC1b/11 are fed with the main gate timing waveform from pin 19 of the CDI Chip and this inhibits any change in the x-y-z coding (caused by operation of the Tune switch) until the main gate has closed at the end of a measurement.

- 4.114 To correspond with the delay described in the previous paragraph the shift delay is introduced by IC2a and IC2b. The  $\overline{Q}$  output of IC2a and the Q output of IC2b are fed to the respective A and B inputs of the presetable decode counter IC4. This inhibits any update of the display data until the next main gate period has been completed.

#### Trailing Digit Blanking

- 4.115 The trailing digit blanking is achieved by switching off the anode supply to the appropriate numerical display LED's. The relevant transistors are Q9 and Q13 which control these anode supplies. Transistor Q9 is switched by the voltage at the collector of Q25 which is controlled by the Tune switch logic at input TC1 via Q24. Similarly Q13 is switched by the logic at TC2 via Q23 collector.

#### Leading Digit Blanking

- 4.116 At frequencies below 100MHz the leading digit of the display data is a zero, but provision is made for blanking this leading zero by applying a 'low' to the ripple blanking input (pin 5) of the seven segment decoder IC9. The data for this operation being obtained from IC3 pins 7 and 9, encoded by the OR gate network IC5a, b, c, d.
- 4.117 On the lowest frequency range two leading zeros will occur below 10MHz. The most significant digit on this range is blanked off by applying the Range 1 Select' logic to turn off Q19, while the next most significant digit is blanked via IC5 and I9/5 whenever it becomes a zero.

#### Complete Display Blanking

- 4.118 For complete display blanking pin 4 of IC9 must be held 'low'. In normal operation both Q22 and Q21 are conducting, giving a 'low' at Q21 collector and a 'high' at IC9/4. If the 120MHz Loop goes out of lock (para. 4.93) the resultant error signal applies a 'low' via pin 10 of the Counter p.c.b. which turns off Q22, and also Q21, thus applying a blanking 'low' to IC9/4 which extinguishes the whole display, thereby indicating an 'out of lock' fault.
- 4.119 A brief blanking pulse is applied at the end of each main gate period to allow the display multiplex to resynchronise with the CDI Chip. The main gate waveform for this purpose is fed via inverter IC6c and the trailing edge produces a narrow pulse in R50, C21 and Q21, which blanks the display for approximately one millisecond.
- 4.120 The circuitry of IC7a, b, c, d and IC6b is included in the blanking system for future development, but has no operational function at present.



## AUDIO OSCILLATOR ASSEMBLY 19-0847 (Fig.15)

### Introduction

4.121 The Audio Oscillator Assembly provides three fixed frequencies of 400Hz, 1kHz and 5kHz, together with ancillary amplifiers in the meter circuit. For an understanding of the circuit operation and functions it is necessary to refer to the front panel switching diagram, Fig.20, as well as to the circuit Fig.15.

### Audio Oscillator Circuit

4.122 Referring to Fig.15, transistors Q4, Q5 and Q7, together with R15/C9 and R11/C4 form a 400Hz Wien Bridge oscillator. Frequencies of 1kHz and 5kHz are obtained by shunting R15 and R11 by resistors on the Modulation Frequency Switch Assembly S10 (Fig.20). To obtain 1kHz R23/R24 are switched in parallel with R15 and R19/R20 with R11. For 5kHz, the parallel switched resistors are R21/22 and R17/18 respectively.

4.123 Transistors Q8, Q9 and Q6 provide a feedback loop for automatic level control with potentiometer R20 providing a bias control for output level setting. The oscillator output is fed via the amplifier Q10, and the back-to-back electrolytic capacitors C16 and C17, to the front panel Modulation Level potentiometer (Fig.20) via pin 11. An output is also fed via C14/C15 and resistors R25/R26 to give a 600 $\Omega$  output at the rear panel Audio Output socket.

4.124 Referring to Fig.20, the audio signal at the slider of the Modulation level control R33b is fed to switch S8/1R for use on AM (internal) modulation. The signal is also fed back into the Audio Oscillator Assembly at pin 18 where it is buffered by Q11 and fed out via pin 20 to the FM/DM Control switch (Fig.20, switch S9).

4.125 With switch S9 at INT the audio signal is fed via tag 12 to the Range Switch S2/3R where it is attenuated by the network R2-R6, according to the frequency range selected. From tag 18 of S2/3R it is fed via the FM COARSE potentiometer R33a to pin 5 of the Audio Oscillator p.c.b. (Fig.15) where it is buffered by Q1 and then fed via pin 6 to the Peak Deviation switch S5/1R for appropriate ranging by the network R8-R10.

4.126 From S5/1R the audio is fed via tag 22 to pin 11 of the FM Loop p.c.b. (Fig.9) where it is buffered and fed to the modulating line of the main oscillator, VCO1, when FM mode is in use.

4.127 Pin 15 of the Audio Oscillator p.c.b. receives the meter drive signal on AM and FM, as follows:-

- (1) AM. The output signal described in para 4-80 is fed via meter switch S11F/1F tags C and E.
- (2) FM. The demodulated f.m. audio (see para 4.129) is fed via S11F/1F tags F and E.

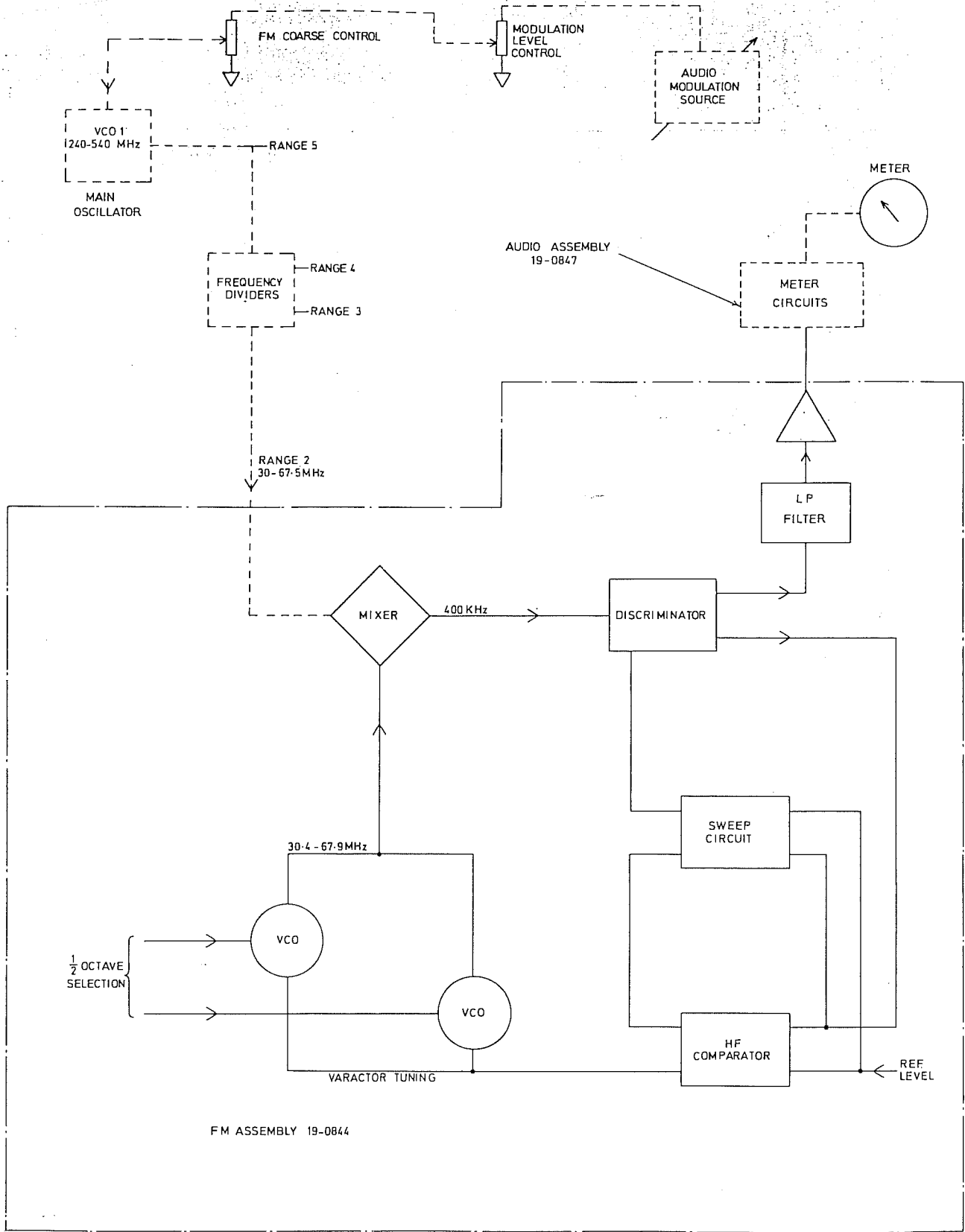
The signal entering the p.c.b. at pin 15 is fed via C2 to the operational amplifier IC1 and Q2, from which an output via the meter setting potentiometer R8 is fed to the Meter Switch S11/1R, and thence to the meter.

FM LOOP ASSEMBLY 19-0844 (Fig. 9)Principles of the System

- 4.128 Frequency modulation is obtained by modulating the main (240-540MHz) oscillator varactor line with a voltage derived from the audio input. This type of oscillator has, however, a non-linear voltage/frequency characteristic, therefore provision is made for monitoring the actual deviation on the oscillator output.
- 4.129 Referring to the block diagram, Fig. 4.3 on the next page, the system operates by converting the Range 2 (30-67.5 MHz) main oscillator signal to 400kHz in a frequency locked loop. The deviation on this 400 kHz is demodulated by a discriminator and the audio component fed to the meter as a display of deviation, which can be manually set using the FM COARSE and MODULATION LEVEL controls.

Circuit Description : 400kHz Loop

- 4.130 Referring to the circuit diagram, Fig. 9, the frequency modulated 30-67.5MHz signal derived from the main oscillator is mixed in IC2 with a signal from the loop oscillator Q9/Q14. The difference frequency 400kHz when the loop is locked, is fed via emitter followers Q37 and Q40 to Q3 and Q1, which with Q2, form a limiter stage and also drive a pair of Schmitt triggers IC1a and IC1b in anti-phase.
- 4.131 Each Schmitt trigger feeds a pump-type frequency discriminator, Q6 and Q8, via driver stages Q5 and Q7. The stable voltage supply, essential for this type of discriminator, is provided via Q4 which is temperature compensated by D2, D3 and D4. The output from discriminators Q6 and Q8 is fed via C44 to the a.f. loop and via TP3 to the 400 kHz loop.
- 4.132 Continuing the description of the 400kHz loop, the unfiltered discriminator output is fed via TP3 to pin 2 of comparator IC3. This comparator attempts to maintain identical levels at pins 2 and 3 and provides an inverted output level at pin 6 which tunes the oscillators Q14 and Q9 by means of varactor diodes D11 and D9 respectively.
- 4.133 Two oscillators (Q9 and Q14) cover the frequency range, the appropriate oscillator being switched on when the control transistor in the emitter circuit (Q10 or Q13) is turned on by the half octave signal from the ROM in the Divider and Phase Detector Circuit. Transistor Q12 acts as a logic inverter.



NOTE: THIS DIAGRAM SHOWS MANUAL DEVIATION SETTING INTRODUCED FROM SERIAL N° 1410 ONWARDS.

Functional Block Diagram  
FM Loop Assembly

Fig. 4-3

4.134 Potentiometer R50 on IC3/3 provides a reference voltage for calibrating the loop frequency. The procedure is described in Chapter 5. If, when switching on, the i.f. is outside the capture range of the comparator circuit a sweep circuit comes into operation, as follows:

4.135 The elements of the sweep circuit are:-

- (1) The sweep transistors Q15 and Q16.
- (2) A circuit to detect when the oscillators are far off tune and generate the sweep action (Q21, Q22, Q23 with bistable IC4d/IC4d).
- (3) A circuit to detect when the i.f. is within the capture range of the loop (Q18, Q19, Q20) and inhibit the sweep action.
- (4) A means of switching the sweep action on and off (gates IC4a/IC4b).

4.136 Sweep Circuit . The sweep waveform is a sawtooth in which the oscillator varactor tuning is swept rapidly upwards and slowly downwards, with the object of achieving lock when the oscillator frequency is above that of the input signal. Due to the inverting action of IC3 the sweep direction on pins 2 and 3 is opposite to the direction of oscillator sweep, thus Q15 with R51 pulls IC3/2 slowly upwards (oscillator tuning downwards) and Q16 provides an opposite, but faster, sweep in IC3. These sweep transistors are controlled as follows:

4.137 The conductivity of Q15 and Q16 is determined by the bistable IC4c/IC4d and the gates IC4a/IC4b. If the loop frequency is within the capture range of IC3 then the sweep transistors are turned off. This is done by using the output from the Schmitt trigger IC1b, which is fed via C38, emitter-follower Q18 and low pass filter L1, with associated capacitors, to a diode detector D14. If the loop frequency is within the capture range of the comparator, the level of the detected signal will be sufficient to turn on Q19/Q20, which is a long-tailed pair with positive feedback via R66 giving a rapid Schmitt trigger action. This output from Q19 inhibits the gates IC4a and IC4b and thus prevents the bistable IC4c/IC4d from driving the sweep transistors Q15 and Q16. If, however, the loop frequency is outside the capture range, there will be little or no detected signal from D14 and IC4a/IC4b will be enabled, thus allowing the sweep to operate.

4.138 The sweep generator operates by applying the varactor line voltage to the emitters of Q21 and Q23 via diodes D16 and D17 respectively. If, for example, the varactor line is sufficiently positive, the p.n.p. transistor Q21 will turn on and the n.p.n. Q23 will turn off, thus causing bistable IC4c/IC4d (via gates IC4a/IC4d) to turn on Q15 and sweep the oscillator slowly downwards.

4.139 If lock is not achieved the varactor line will go negative, thus reversing the conductivity of Q21 and Q23 and changing the state of the bistable, which will turn off Q15 and (via Q17) turn on Q16 for a rapid upward sweep. This action will continue until an in-band signal is detected at D14, causing Q19 to inhibit the gates IC4a/IC4b.

Deviation Monitoring

Note: Model 9081 instruments with serial numbers from 1710 to 1909 and Model 9082 instruments with serial numbers from 3010 to 3109 are fitted with a 'piggy back' board 19-0953. This board carries Q44, Q45, Q46, Q25 and R1A. The circuit and interconnections are shown in Fig.9a. The operation of the circuit is identical to that for the later models, which is described below.

4.140 The common output from discriminators Q6 and Q8 is fed via C44 and Q24 to the low pass filter L2, L3 with associated capacitors which eliminates the 400kHz and 800kHz ripple. The demodulated audio is then routed via the Set Deviation potentiometer R85 to an amplifier formed by Q38, Q39, Q26 and Q27.

4.141 The overall gain of the amplifier between Q38 and Q27 is partially determined by a resistor/capacitor network on the Peak Deviation switch (Fig.20). This switch is connected to pins 18 and 15 (marked 'Gain Select 1' and 'Gain Select 2'), and in  $\emptyset$ M mode causes the gain of the amplifier to roll off with increasing frequency, thus ensuring a relatively constant phase modulation level.

4.142 From Q27 the demodulated f.m. is fed to Amplifier IC5, whose gain depends upon the selected carrier range, as follows:

<u>Carrier Range</u>	<u>Amplifier Gain</u>
5	x 8
4	x 4
3	x 2
2	x 1
1	x 4

4.143 The difference in gain is determined by C66 with either R112, R113 or R114 in series, depending on whether Q31, Q32 or Q33 is switched on by the Range Switch via IC6a, IC6b or IC6c.

4.144 The demodulated f.m. is fed from IC5 via Q30 and R1A-1 to the meter switch (Fig.20) whence it is routed via the FM contacts to the Audio Oscillator Assembly 19-0847. Here the signal is fed through meter input circuitry to provide a reading on the meter of the actual deviation on the carrier. This deviation can be adjusted by the operator by combined use of the MODULATION LEVEL and FM COARSE controls.

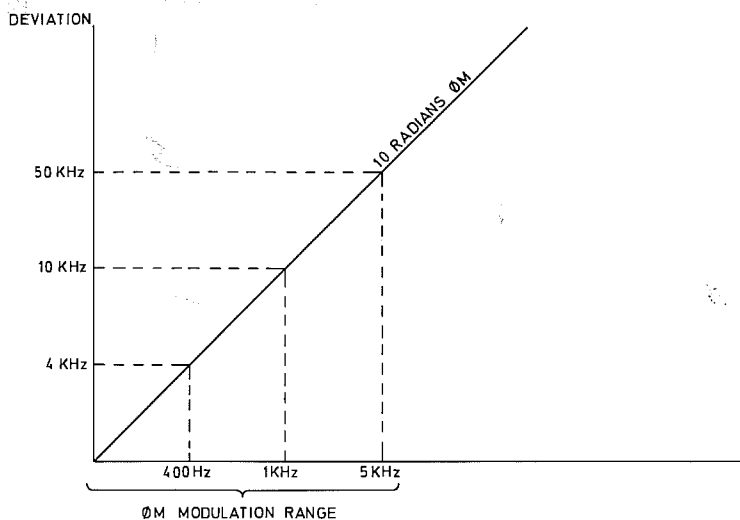
4.145 When the equipment is being tuned by spinwheel or Step Switch pulses are fed to pin 16. With the OUTPUT switch at NORMAL or X2 pin 21 is at +12V and Q45 is turned off. The pulses are passed by Q44 to pin 2 of IC7 which changes state and turns on Q29. Q25 is turned off and R1A-1 breaks the FM audio line. With the OUTPUT switch at OFF Q46 is turned off and Q45 turns on. This provides a low at IC7/2 to operate the muting circuit. R1A-1 is remade approximately 1 second after tuning ceases or the OUTPUT switch is moved from the OFF position.

Modulation Audio for FM

4.146 The audio modulating signal for the main oscillator (VCO1) is fed via a small high impedance buffer stage, on the FM Loop p.c.b., formed by Q42 and Q43 with power supply regulator and buffer Q41.

Phase Modulation ( $\phi M$ )

4.147 Phase modulation is effectively achieved by applying pre-emphasis to the audio modulating signal. Fig 4.4 illustrates the principle, assuming 10 radians of  $\phi M$ .



Phase Modulation Principle

Fig. 4-4

4.148 When  $\phi M$  is selected S5/1 F and R connect C1 and R7 into the line carrying the VCO audio modulating signal. This provides the necessary pre-emphasis. In order that the meter shall give a constant reading of modulation level when the modulating frequency is changed the demodulated FM audio is de-emphasised by R12 and C3. These are connected into the feedback path of the amplifier Q38 to Q27 to control the amplifier gain.

FM Switching

4.149 Referring to the front panel switching diagram, Fig. 20, the Range switch S2 and the Peak Deviation switch S5 provide the following switching facilities for the FM system.

(1) Range Switch

Range switch S2/3R receives the internal or external audio signal via switch S9/1R when on FM. This is fed through the attenuating chain R2, R3, R4, R5 and R6, and the appropriate level (in the ratio 1-2-4-8) is picked off by the switch according to the frequency range selected (see para. 4.143). The audio at tag 18 of the switch is fed via the FM COARSE potentiometer R33a\* to a buffer in p.c.b. 19-0847, thence via pin 6 to the Peak Deviation switch S5 for routing to the modulation line of the main oscillator.

(2) Peak Deviation switch

(a) Wafer S5/1R: The attenuating network R8, R9, R10 and R11 with switch S5/1R taps down the audio modulating level according to the deviation selected. In the 100kHz deviation position the signal is fed via tags 18 and 22 to the FM audio line at the highest level, but in the remaining deviation positions the signal is attenuated in the ratio of 3, 10 and 30 to 1 respectively. In the  $\emptyset$ M position C1 and R7 provide a small amount of roll off on the audio signal.

(b) Wafer S5/2R. The resistor network R13, R14, R15 and R16 is connected to amplifier Q38-Q27 in the FM Loop p.c.b. 19-0844, and defines the amplifier gain in the ratio of 3, 10 and 30 to 1, relative to the 100kHz deviation position. R12 and C3 provide roll off in the amplifier gain when in  $\emptyset$ M mode (para 4.148).

POWER SUPPLY (Fig.19)

4.150 The instrument operates from the following a.c. supply ranges:-

94V to 110V	118V to 220V
110V to 130V	220V to 260V

The required supply range is selected by removing a screwed locking plate on the rear panel and setting two slide switches as instructed in para. 5.1.

4.151 Almost all components of the power supply are mounted on the inner face of the rear panel as shown in the chassis view drawing, Fig.1, at the rear of the book.

4.152 The external a.c. supply is fed into the instrument via the rear panel combined mains plug and filter unit, thence via the surge resisting fuse FS1, the power on/off switch S1 and the voltage selector switches S14 and S15 (see para 5.1) to the primary of the mains transformer T1. The instrument is dispatched with fuse FS1 rated for the 188V to 260V supply range. A higher rated fuse for a 94V to 130V supply is supplied in the accessories bag supplied with the instrument.

4.153 The three secondary windings of T1 feed the encapsulated bridge rectifiers D1, D2 and D3, which provide nominal outputs of +24V, +12V and -6V respectively. The +24V and +12V supplies are regulated by the integrated circuit regulator packages IC1 and IC2 in the positive output lines.

4.154 The -6V circuit uses the discrete transistor Q1 as the series regulator under the control of IC3, with a limiting zener diode D4 across the output. D4 is mounted on the inner face of the rear chassis wall (see chassis view Fig.1). The circuit is protected by a quick action type fuse (FS2) mounted in a clip holder on the inner face of the rear panel.

4.155 The 'Power On' l.e.d. indicator LP1 is shown in Fig.20. It is supplied from the +12V line via a limiting resistor R1.

4.156 A +12V supply is available at a front panel socket (Fig.20 SK96) for the Reverse Power Protection Assembly (Option). This supply is given polarity protection by D3 and filtering by L1/C5/C6.



## CHAPTER 5

### MAINTENANCE

#### POWER SUPPLY (MAINS) VOLTAGE SELECTION

- 5.1 AC supply voltage selection is by means of two slide switches with locking plate on the rear panel.
- (1) Observe the voltage range marking shown in the cutaway portion of the locking plate. If this is not correct for the local supply, proceed as follows.
  - (2) Unplug the power cable from the supply and extract the two screws securing the locking plate and remove the plate.
  - (3) Refer to Table 4 below and set the slide switches to the positions for the required voltage range. The switches are referred to as left hand and right hand as seen when viewing the rear of the instrument.
  - (4) Ease the plate over the slide switches such as to align the screw holes. Secure the plate with the two screws previously removed.
  - (5) Verify that the cut-away in the plate allows the required voltage range marking to be seen.

TABLE 4

Mains Voltage Selection Switches

Switch Settings		Instrument Voltage Range For Local AC Supply
Left Hand Switch*	Right Hand Switch*	
Down	Up	94V to 110V
Up	Up	110V to 130V
Down	Down	188V to 220V
Up	Down	220V to 260V

\*Left and right are as seen when looking at the rear of the instrument.

TABLE 5  
LIST OF TEST EQUIPMENT REQUIRED

Item	Description	Requirements	Preferred Type
1	Digital Multimeter	Range 0 - 20V Resolution 10mV Accuracy better than 0.5%	Racal 9076
2	Millivoltmeter		Racal 9301
3	Modulation Meter		Racal 9009
4	Modulation Meter		Marconi TF2300
5	Spectrum Analyser:1250MHz		HP.8554L with HP.8552 IF Section
6	Audio Distortion Analyser		HP.333A
7	Millivoltmeter (True RMS)	Freq Range 50Hz-1MHz Input Impedance 100k $\Omega$ Range 50mV - 2V r.m.s	
8	Millivoltmeter (Audio)		HP.400E or HP.3400A
9	Audio Signal Generator	10Hz-100 kHz Less than 0.5% third harmonic distortion.	
10	Frequency Counter	Range 10Hz - 560MHz	Racal 9915
11	Power Meter		HP.435A with Sensors 8481A and 8482H
12	Power Supply	240V ov 120V, 50Hz Single phase.	
13	Modulation Meter	Freq range 1.5 - 10MHz with AF output	Racal 9008 (Required for 9082 only).
14	Signal Generator	0dBm in 50 $\Omega$ at 100MHz	
15	Power Amplifier	1W at 100MHz into 50 $\Omega$	
16	Oscilloscope	Bandwidth 10MHz	
	<u>Miscellaneous</u> Length of RG213U cable fitted with type 'N' connectors Length of RG223/11 cable fitted with SMA and Type 'N' connectors. Type 'N' to BNC Adaptor Shorting Link.		Required for 9081H and 9082H only).

## REMOVAL OF COVERS

**WARNING:** DANGEROUS AC VOLTAGES ARE EXPOSED WHEN COVERS ARE REMOVED WITH AC SUPPLY CONNECTED. COVERS SHOULD BE REMOVED BY AUTHORISED PERSONS ONLY.

- 5.2
- (1) Switch the instrument POWER switch to STANDBY and switch off the a.c. supply at the bench outlet. Unplug the power lead from the rear panel of the instrument.
  - (2) Remove the six screws from the particular cover (top or bottom) which is to be removed.
  - (3) Remove the two rubber plugs (located near to the rear end) from both side panels of the instrument and slacken, by about two turns, the screws revealed.
  - (4) Grip the rear panel assembly and ease it back from the main case to the maximum extent available (about 5mm).
  - (5) The rear edge of either cover can now be lifted and the cover withdrawn outwards and rearwards. Take care not to displace or damage the RF gasket material when removing or replacing covers.

## POWER SUPPLY TESTS

- 5.3
- (1) Do not connect the a.c. mains supply. Check that the mains fuse is correctly rated for the supply voltage range, as marked on the rear panel.
  - (2) Check that the 6V d.c. supply fuse on the inner face of the rear panel is a 2A quick action type (to remove top cover see para. 5.2)
  - (3) Set the front panel POWER switch to ON and remove the locking plate of the rear panel voltage selector switches (see para. 5.1)
  - (4) Set the multimeter to read 'ohms' and connect between the line and neutral pins of the rear panel mains input plug. Set the mains voltage selection switches to the positions in Table 6 and verify satisfactory resistance readings.
  - (5) Set the voltage selector switches to the correct positions for the local a.c. supply (page 5-1 Table 4) and secure the locking plate.
  - (6) Do not connect the mains supply, but with the front panel POWER switch at ON, set the OUTPUT switch to NORMAL.

TABLE 6

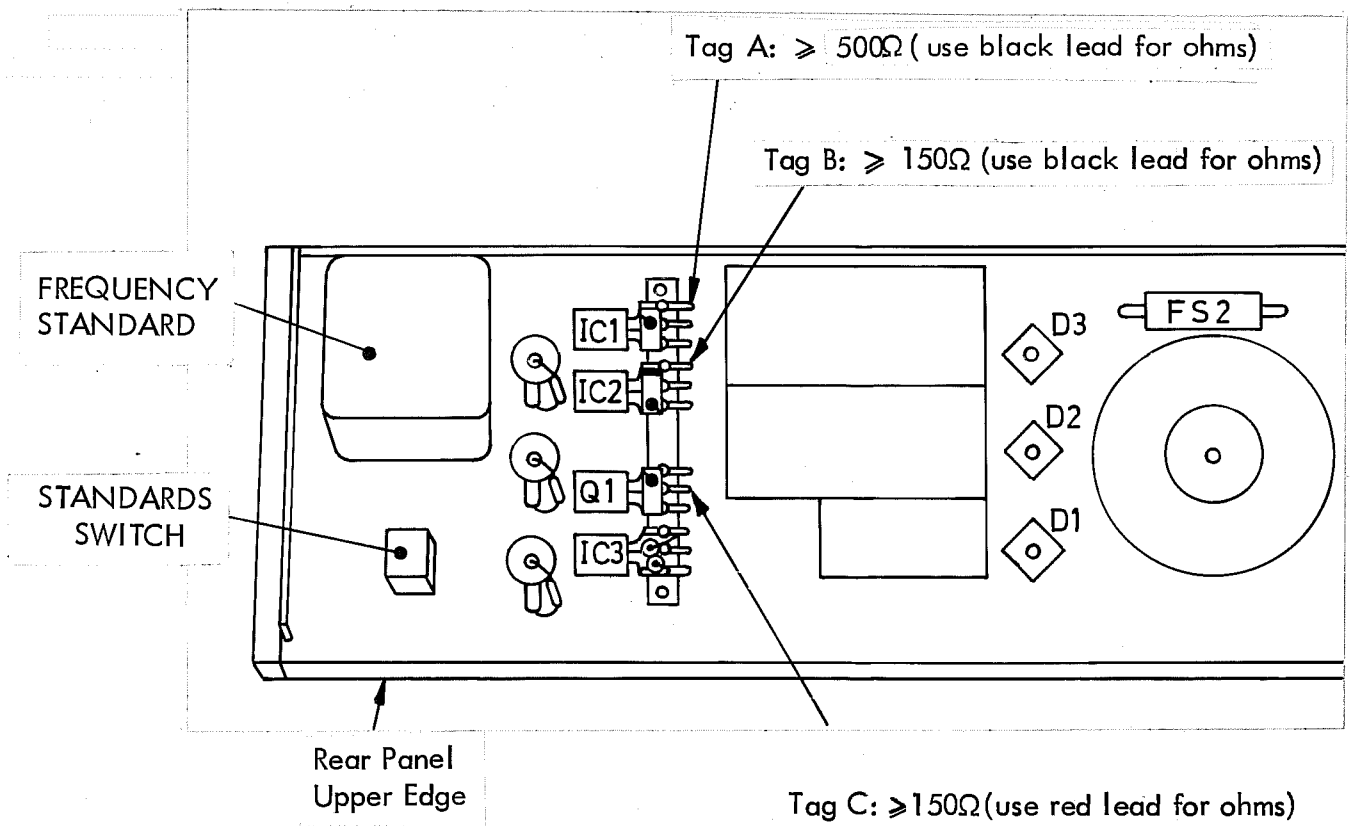
Mains Input Resistance Readings

Left Hand Switch*	Right Hand Switch*	Mains Plug Resistance Readings
Down	Up	11.5 - 15.5Ω
Up	Up	14.5 - 19.5Ω
Down	Down	45 - 61Ω
Up	Down	57 - 77Ω

\*Left hand and right hand are as seen when looking at the rear panel.

- (7) Refer to Fig. 5.1, and with the multimeter set to measure ohms, measure the resistance between the tags A, B and C on the rear panel tag strip and chassis. Note the correct connection of the ohmmeter leads as shown in Fig. 5.1.
- (8) Set the POWER switch to OFF and the rear panel STANDARD switch to INTERNAL.
- (9) Finally, connect the a.c. mains supply lead to the rear panel plug.
- (10) Plug in the a.c. mains supply.
- (11) Switch POWER to ON. Check that the Power indicator illuminates and the digital display comes on.
- (12) Refer to Fig. 5.1 and, with a multimeter, measure the d.c. voltages relative to chassis, on the rear panel tag strip, at points A, B and C as follows:-

Tag A	+24V ± 1V
Tag B	+12V ± 0.5V
Tag C	-6V ± 0.25



Tag Strip Test Points

Fig. 5.1

### OUTPUT TEST POINT, MODELS 9081H and 9082H

5.4 For models 9081H and 9082H the SMA connector between the casting and the 10dB amplifier should be disconnected at the casting. The SMA to Type N test lead should be connected at the casting. The Type N connector should be used instead of the instrument RF OUTPUT connector for all tests up to and including that in paragraph 5.38.

### TUNING CHECKS

#### 5.5 Test, Equipment Required

Digital Multimeter (d.v.m.)  
Coil Trimming tool.  
1MHz External Standard.

Table 5

Item 1

## 5.6 Procedure

- (1) Firstly, set up the 120MHz Loop as follows:-
- (2) Using the multimeter set to a d.c. voltage range, monitor link LK1 on p.c.b. 19-0849 (Fig. 18). Verify a reading (to chassis) of  $-2.0V \pm 0.2V$ .  
If necessary adjust the core of inductor L2 to obtain this reading.
- (3) Disconnect the multimeter.
- (4) Note the frequency reading on the display. Set the rear panel STANDARD switch to EXTERNAL and check that the frequency display extinguishes.
- (5) Connect a 1MHz external standard to the external standard input socket, the 1MHz output from a counter is suitable, and check that the display is restored and the frequency reading has not changed.
- (6) Set the STANDARD switch to INTERNAL.
- (7) Set the TUNE switch to FAST, SLOW and HOLD in turn and verify that the resolution on the display is:-

Fast:	100kHz
Slow:	1kHz
Hold:	10Hz
- (8) Set the modulation selector switches and the FINE TUNE selector switches to OFF.  
Check that the OUTPUT switch is at NORMAL.
- (9) Set the TUNE switch to FAST and CHANNEL SPACING kHz to '5'.
- (10) Starting with the 256-512 range, set the RANGE MHz switch to each range in turn and, by operating the TUNE spin wheel and observing the display, verify that the frequency coverages, in Table 7 are obtained.

TABLE 7

Carrier Frequency Ranges

<u>Range</u>	<u>Coverage</u>
5	240.0 - 540.7MHz
4	120.0 - 270.3MHz
3	*60.0 - 135.1MHz
2	*30.0 - *67.5MHz
1	**4.8 - *36.7MHz(9081) **1.5 - *36.7MHz Channel spacings ) at 6.25, 12.5, 25 ) and 50KHz ) 9082 **1.2 - *36.7MHz remaining channel ) spacings )

\*Digits blanked.

- (II) Set the TUNE switch to HOLD.  
Refer to Table 8. Operate the STEP UP/DOWN switch, while observing the display, and verify that the correct frequency steps are obtained for the ranges and channel spacings in table 8.

TABLE 8

Channel Spacing Check

Frequency	Channel Spacing to check
400MHz	All. $\Delta f$ (= 5kHz)
200MHz	10kHz and $\Delta f$ (= 2.5kHz)
100MHz	60kHz and $\Delta f$ (= 1.25kHz)
50MHz	6.25, 12.5 and $\Delta f$ (= 625Hz) 25, 50k Hz

- (12) Select range 2 and tune to 50 MHz. Select 6, 25 kHz channel spacing, and operate step up switch once.  
Select 12.5kHz channel spacing and check that the display returns to 50 MHz.
- (13) Repeat the procedure of sub para (II) stepping up by 12.5kHz and then selecting 25 kHz channel spacing and stepping up by 25 kHz and then selecting 50kHz channel spacing.

(14) With HOLD still selected, turn the spin wheel and check that the frequency does not change.

NOTE: If the channel spacing is changed from 20kHz to 6.25kHz, or from 50 to 15kHz, the carrier frequency will change.

(15) Set:-  
Carrier frequency to 390MHz.  
FINE TUNE switch to INT.  
TUNE switch to SLOW.

(16) Rotate the FINE TUNE coarse (outer) control and verify that frequencies of 389.9MHz and 390.1MHz can be obtained. Check that the fine tune ON indicator lights.

(17) Centralize the FINE TUNE outer control and then rotate the fine (inner) control. Verify that the frequency display changes by at least 10kHz.

(18) Set the FINE TUNE switch to EXT.

(19) Connect the internal +12V rail (tag 12 on wafer 1 rear of either the TUNE or FINE TUNE switches) to a flying lead. Alternately apply and remove this voltage at the pin of the front panel SLOW SWEEP socket. At a carrier frequency of approximately 390 MHz verify that the frequency changes by a least 300kHz.

(20) Set the FINE TUNE switch to OFF.

(21) Select Range 5 and tune to 540MHz.  
Note the displayed frequency.

(22) Operate the OUTPUT switch several times rapidly through its NORMAL/OFF/X2 positions and check that the frequency display returns to its original value. Repeat this operation, pausing each time in the OFF position.

(23) Set the OUTPUT switch to NORMAL.

## PRELIMINARY SYSTEM CHECKS

### Output System

5.7 Test Equipment Required Page 5-2 Table 5

Millivoltmeter (True RMS) Item 2

5.8 Procedure

(1) Connect the unit under test (UUT) 50 $\Omega$  output socket to the 9301 50 $\Omega$  input socket.



- (2) Select the top frequency range and tune the UUT to 240 MHz. Check that the OUTPUT switch is in the NORMAL position.
- (3) Set the OUTPUT LEVEL switch to the 0dBm position. Check that the VERNIER control can vary the meter reading over the -10dBm to +3dBm range.
- (4) Without changing the tuning repeat operation (3) on the other frequency ranges.
- (5) Select the top range again, tune to 362MHz, and repeat operation (4).
- (6) Disconnect the millivoltmeter.

### FM System

#### 5.9 Test Equipment Required Page 5-2 Table 5

Modulation Meter 9009  
Type 'N' to BNC Adaptor

Item 3

#### 5.10 Procedure

- (1) Set:-  
FM/ $\emptyset$ M switch to INT  
METER switch to FM/ $\emptyset$ M  
MODULATION FREQUENCY switch to 1kHz position.  
PEAK DEVIATION switch to 100kHz position.
- (2) Vary the MODULATION LEVEL control and check that the UUT meter responds.
- (3) Connect the modulation meter (set to 100kHz FM) to the UUT 50 $\Omega$  output socket, using Type 'N' to BNC adaptor.
- (4) Tune the UUT to 300MHz and vary the MODULATION LEVEL control until the 9009 modulation meter reads 80kHz deviation.
- (5) Repeat (4) at 450MHz.
- (6) Disconnect the test equipment

## CALIBRATION

**NOTE:-** Tests must be carried out in the order given, with satisfactory completion of each test before proceeding to the next. Do not make any adjustments other than those referred to in this Chapter. If satisfactory results cannot be obtained the relevant p.c.b. Assembly should be replaced by a pre-tested p.c.b. from the manufacturer, or authorized spares holding.

### OUTPUT SYSTEM ASSEMBLY 19 - 0843 (9081) and 19- 0949 (9082)

#### 5.11 Test Equipment Required Page 5-2 Table 5

Multimeter	Item 1
Spectrum Analyser	Item 5
Millivoltmeters True RMS (Two)	Items 2 and 7
Modulation Meter	Item 3
Distortion Analyser	Item 6
Audio Signal Generator	Item 9
Shorting link	
Length of RG .213U cable with 'N' connectors.	

#### 5.12 Procedure

- (1) On the UUT set the following controls:-  
OUTPUT switch to NORMAL  
AM and FM/ $\emptyset$ M modulation switches to OFF  
METER switch to CW  
OUTPUT LEVEL control to OdBm position  
FINE TUNE switch to OFF
- (2) Connect the spectrum analyser to the 50 $\Omega$  Output socket of the UUT. Select 30 dB of input attenuation.
- (3) Tune UUT to 400 MHz. Adjust R94 to minimise the second and third harmonics, as displayed on the spectrum analyser, at +9dBm output.
- (4) On p.c.b. connect link LK1(in the ALC loop) to chassis, using the shorting link.
- (5) Tune the UUT to 135MHz and adjust L11 on the p.c.b. for maximum amplitude on the spectrum analyser
- (6) Tune to 130MHz. Connect the +12V rail to pin 8 on the p.c.b. (thus simulating  $\frac{1}{2}$  octave logic '1') and adjust inductor L12 for minimum amplitude on the spectrum analyser.

- (7) Tune the UUT to 65MHz on range 2.
- (8) Adjust inductor L16 on the p.c.b. for minimum amplitude on the spectrum analyser.
- (9) Disconnect the +12V link from pin 8.
- (10) Tune to 67MHz and adjust L15 on the p.c.b. for maximum amplitude on the spectrum analyser.
- (11) Disconnect the spectrum analyser and connect the millivoltmeter to the 50 $\Omega$  output, using RG213U cable with 'N' connectors.
- (12) Remove the earthing link from LK1.
- (13) Tune the UUT to 50MHz.
- (14) Adjust the UUT VERNIER control to give a reading of +2dBm on the millivoltmeter.
- (15) Adjust R136 on the p.c.b. until the UUT meter reads +2dBm.
- (16) Adjust the UUT VERNIER control to obtain a reading of -9dBm on the millivoltmeter.
- (17) Adjust R134 on the p.c.b. until the UUT meter reads -9 dBm.
- (18) Repeat adjustments (14) to (17) until the UUT and the millivoltmeter give identical readings at +2dBm and -9dBm.
- (19) Disconnect the millivoltmeter and connect a modulation meter to the UUT 50 $\Omega$  output socket.
- (20) Connect a distortion analyser to the modulation meter audio output.
- (21) Set the AM switch to EXT.
- (22) Connect a 1kHz low distortion audio generator to the AM 600 $\Omega$  socket of the UUT.
- (23) Monitor the level of the applied 1kHz audio, using the HP.400E millivoltmeter, and level until the HP400E reads 800 mV.
- (24) Set the UUT VERNIER control to read +3dBm on the meter.
- (25) Adjust R153 on the p.c.b. until the modulation meter reads 80%.

~~± 0.2 dB~~  
see below

- (26) Set the UUT VERNIER to give -9dBm on the meter.
- (27) Adjust R143 on the p.c.b. until the modulation meter reads 80%, and adjust R109 for minimum distortion on the distortion analyser.
- (28) Repeat adjustments (24) to (27) until the modulation depth is 80% at the +3dBm and -9dBm output levels.
- (29) Tune UUT to 520MHz and check that modulation depth is 80% at +3dBm and -9dBm.
- (30) Disconnect the modulation meter from the UUT output and re-connect the millivoltmeter. Re-check operations (14) to (17).
- (31) Tune the UUT to 50MHz. Set the UUT VERNIER control to read +3dBm on the UUT meter.
- (32) Set the OUTPUT switch to X2. Verify that the millivoltmeter reading is +9dBm  $\pm 0.3$ dB, and that the UUT meter reading is within  $\pm 0.2$ dB of the millivoltmeter reading. If necessary change the value of R42 on the output switch to achieve this.
- (33) Operate the UUT VERNIER control and verify that readings of at least +3dB and -10dB can be obtained on the UUT meter.
- (34) Tune the UUT to 1.5MHz (5MHz for 9081) on range 1.
- (35) Set the multimeter to the 10V d.c. range. Connect the positive lead to link LK1 on the p.c.b. (ALC loop) and the negative lead to chassis.
- (36) With OUTPUT switch on X2 adjust R19 on the p.c.b. (Range 1 mixer input) to give a reading of 2.0V on the multimeter. (2.8V for 9081).
- (37) Tune the UUT through the frequency range 5MHz to 36MHz and verify that the multimeter reading does not exceed 2.8V. Tune the UUT through the remaining frequency ranges using 60kHz step size and verify that the multimeter reading does not exceed +6V.
- (38) Disconnect the multimeter and connect the UUT 5 $\Omega$  output socket to a spectrum analyser which has 30dB of input attenuation selected.
- (39) On the UUT set:-
  - The AM switch to OFF
  - The OUTPUT switch to X2
- (40) Tune the UUT across the full frequency range and adjust R94 on the p.c.b. (output amplifier bias) for minimum 2nd and 3rd harmonic distortion on the analyser display which must be at least 30dB below carrier level.

AUDIO OSCILLATOR ASSEMBLY 19-0847

(Fig.14, Fig. 15)

5.13

Test Equipment Required

Page 5-2 Table 5

Millivoltmeter (HP.400E)	Item 7
Audio Signal Generator (1kHz)	Item 9
Digital Frequency Meter (Counter)	Item 10

5.14

Procedure

- (1) On the UUT set the following controls:-  
OUTPUT switch to NORMAL.  
AM switch to EXT.  
METER switch to AM 100%.
- (2) Connect the 1kHz audio generator to the AM 600Ω external input socket of the UUT
- (3) Using the HP.400E millivoltmeter monitor the level of the audio generator and adjust for an input of 0.8V r.m.s.
- (4) Adjust R8, on p.c.b. 19-0847, for reading of 8 on the top scale of the UUT meter.
- (5) Set the UUT AM switch to INT and the MODULATION FREQUENCY switch to 1kHz.
- (6) Monitor the UUT rear panel audio output socket, using the HP.400E millivoltmeter, and adjust R20 on p.c.b. 19-0847 to give a reading of 1.00V, ±0.01V, on the millivoltmeter.
- (7) Select the 400Hz and 5kHz internal modulation frequencies in turn and verify that the reading on the millivoltmeter does not change by more than ±0.5dB.
- (8) Connect a digital frequency counter to the UUT rear panel audio output socket. Select each of the internal modulation frequencies in turn and verify the following counter readings:-

400Hz	(380 - 420Hz)
1kHz	(950 - 1050Hz)
5kHz	(4750 - 5250Hz)
- (9) Disconnect the audio signal generator and millivoltmeter.

5.13	<u>Test Equipment Required</u>	<u>Page 5-2 Table 5</u>
	Millivoltmeter (HP.400E)	Item 7
	Audio Signal Generator (1kHz)	Item 9
	Digital Frequency Meter (Counter)	Item 10

5.14 Procedure

- (1) On the UUT set the following controls:-  
 OUTPUT switch to NORMAL.  
 AM switch to EXT.  
 METER switch to AM 100%.
- (2) Connect the 1kHz audio generator to the AM 600Ω external input socket of the UUT
- (3) Using the HP.400E millivoltmeter monitor the level of the audio generator and adjust for an input of 0.8V r.m.s.
- (4) Adjust R8, on p.c.b. 19-0847, for reading of 8 on the top scale of the UUT meter.
- (5) Set the UUT AM switch to INT and the MODULATION FREQUENCY switch to 1kHz.
- (6) Monitor the UUT rear panel audio output socket, using the HP.400E millivoltmeter, and adjust R20 on p.c.b. 19-0847 to give a reading of 1.00V,  $\pm 0.01V$ , on the millivoltmeter.
- (7) Select the 400Hz and 5kHz internal modulation frequencies in turn and verify that the reading on the millivoltmeter does not change by more than  $\pm 0.5dB$ .
- (8) Connect a digital frequency counter to the UUT rear panel audio output socket. Select each of the internal modulation frequencies in turn and verify the following counter readings:-
 

400Hz	(380 - 420Hz)
1kHz	(950 - 1050Hz)
5kHz	(4750 - 5250Hz)
- (9) Disconnect the audio signal generator and millivoltmeter.

5.15 Test Equipment Required

Page 5-2 Table 5

Multimeter	Item 1
Millivoltmeter (HP.400E)	Item 8
Audio (1kHz) Signal Generator	Item 9
Modulation Meter	Item 3
Frequency Counter	Item 10
Oscilloscope	Item 16

5.16 Procedure

- (1) Set the UUT controls as follows:-  
RANGE MHz '256 - 512' range.  
AM switch to OFF.  
FM/ØM switch to OFF.  
PEAK DEVIATION switch to '100kHz'.  
TUNE switch to FAST.  
OUTPUT switch to NORMAL.
- (2) Tune the UUT to 240MHz
- (3) Connect the multimeter to link LK1 on the FM loop p.c.b. (19-0844, Fig.8) and (if necessary) adjust the core of T1 on the p.c.b. to give a reading of  $+2.5V \pm 0.1V$  on the multimeter.
- (4) Tune the UUT to 362 MHz and adjust T2 on the p.c.b. to give a reading of  $+2.5V \pm 0.1V$  on the multimeter.
- (5) Disconnect the multimeter from LK1. Monitor TP2 on the p.c.b. with a frequency counter and, if necessary, adjust R50 on the p.c.b. for a reading of  $370kHz \pm 5 kHz$ .
- (6) Monitor TP3 using the oscilloscope. Adjust R145 until the waveform is as shown in Fig.5.2.

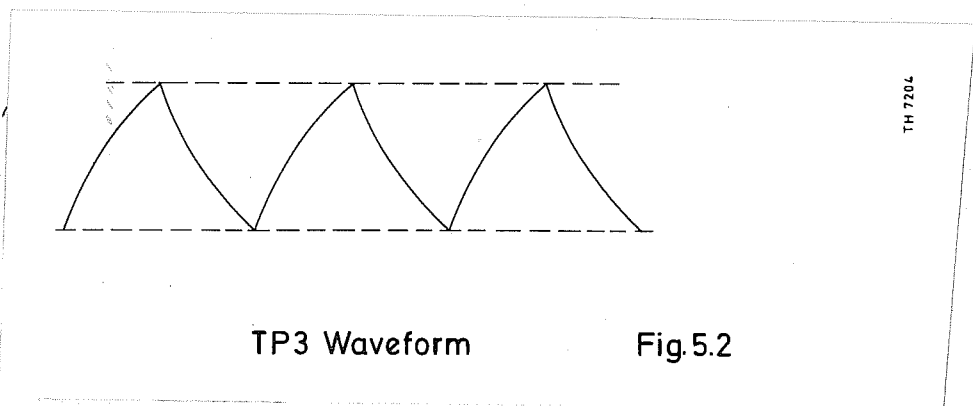
5.15 Test Equipment Required

Page 5-2 Table 5

Multimeter	Item 1
Millivoltmeter (HP.400E)	Item 8
Audio (1kHz) Signal Generator	Item 9
Modulation Meter	Item 3
Frequency Counter	Item 10
Oscilloscope	Item 16

5.16 Procedure

- (1) Set the UUT controls as follows:-  
 RANGE MHz '256 - 512' range.  
 AM switch to OFF.  
 FM/ØM switch to OFF.  
 PEAK DEVIATION switch to '100kHz'.  
 TUNE switch to FAST.  
 OUTPUT switch to NORMAL.
- (2) Tune the UUT to 240MHz
- (3) Connect the multimeter to link LK1 on the FM loop p.c.b. (19-0844, Fig.8) and (if necessary) adjust the core of T1 on the p.c.b. to give a reading of  $+2.5V \pm 0.1V$  on the multimeter.
- (4) Tune the UUT to 362 MHz and adjust T2 on the p.c.b. to give a reading of  $+2.5V \pm 0.1V$  on the multimeter.
- (5) Disconnect the multimeter from LK1. Monitor TP2 on the p.c.b. with a frequency counter and, if necessary, adjust R50 on the p.c.b. for a reading of  $370kHz \pm 5 kHz$ .
- (6) Monitor TP3 using the oscilloscope. Adjust R145 until the waveform is as shown in Fig.5.2.





- (7) Set the FM/ØM switch to EXT and the METER switch to FM/ØM.
  - (8) Select 128-256 MHz range and tune the UUT to 270MHz.
  - (9) Connect the audio (1kHz) signal generator to the FM/ØM EXT socket and connect the millivoltmeter to monitor this audio input. Adjust the audio source for 1.00V r.m.s. input level.
  - (10) Connect a modulation meter to the 50Ω output of the UUT.
  - (11) Observe the modulation meter and adjust the front panel FM/ØM COARSE adjust control to give 100kHz peak deviation, ± 1%.
  - (12) Adjust R85 on p.c.b. 19-0844 to give 100kHz peak deviation indication on UUT meter.
- 
- (13) Operate the PEAK DEVIATION switch on the UUT and verify that 30kHz (±3%) 10kHz (±3%) and 3kHz (±3%) deviations are observed on the modulation meter for the corresponding positions on the PEAK DEVIATION switch.
  - (14) Disconnect the test equipment. Check that all p.c.b. assemblies are tightly screwed down. Replace the casting covers, checking carefully that the r.f. gasket is correctly positioned and not damaged. Screw the covers down tightly, but avoid using excessive force which might strip the threads.

## DISTORTION CHECK

### 5.17 Test Equipment Required

Page 5-2 Table 5

Spectrum Analyser

Item 5

### 5.18 Procedure

- (1) Set the UUT controls as follows:-  
 OUTPUT switch to NORMAL.  
 OUTPUT LEVEL control to 0dBm position.  
 RANGE MHz switch to '256 - 512' position.  
 FM/ØM and AM INT/EXT switches to OFF  
 METER switch to CW position.
- (2) Tune the UUT to 250MHz and adjust the VERNIER control for 0dBm reading on the UUT meter.

(3) Set the Spectrum Analyser controls as follows:-

Input attenuation	30dB
Log. ref.	+10dB
Vernier	-7dB
Scanwidth	0-1250MHz on red control.
Video filter	Off
Bandwidth	300kHz

(4) Tune the UUT from 240 to 540MHz and, by observing the spectrum analyser, verify that all harmonics are at least 30dB below carrier level, and that sub-harmonically related signals are at least 40dB below carrier.

(5) Tune the UUT through each range in turn and verify that the harmonics and sub-harmonics meet the limits in Table 9. The spectrum analyser setting for each range are given in Table 9.

TABLE 9

Distortion Check

Tuning Range MHz	Analyser		UUT	
	Centre freq.	Scanwidth	Harmonic Level	Sub-Harmonically Related Signals
256-512	-	0-1250MHz )		
128-256	500 MHz	100MHz/div )	At least	At least
64-128	500MHz	100MHz/div )	30dB	40db below
32-64	500MHz	100MHz/div )	below	carrier
5-32	50MHz	10MHz/div )	carrier	
1.5-5 (9082 only)	8MHz	2MHz/div )	At least 20dB below carrier	At least 30dB below carrier

(6) On the UUT set the OUTPUT switch to X2 position and adjust the VERNIER control for a meter reading of +3dB.

(7) On the spectrum analyser set 30dB input attenuation and the Log. Ref, vernier to -1dB.

(8) Repeat operation (5) and verify that all harmonics are at least 24dB below carrier for frequencies between 5 and 540MHz and at least 18dB below carrier for frequencies between 1.5 and 5MHz (9082 only).

(9) Disconnect the spectrum analyser.

## LEVEL ACCURACY CHECK

5.19 Test Equipment Required Page 5-2 Table 5

Millivoltmeter (True RMS)                      Item 2  
Cable with N-N connectors

5.20 Procedure

(1) Set the UUT controls as follows:-

AM switch to OFF.

FM/OM switch to OFF.

FINE TUNE switch to OFF

CHANNEL SPACING switch to '10 kHz'.

TUNE switch to FAST.

OUTPUT switch to NORMAL.

METER switch to CW.

OUTPUT LEVEL switch to 0dBm position (Models 9081 and 9082)

(2) Connect the True RMS Millivoltmeter to the 50Ω output socket of the UUT using appropriate cable.

(3) Tune the UUT to 50 MHz and adjust the VERNIER control for a reading of 0dB on the UUT meter. Verify that the millivoltmeter reads 0dBm ± 0.25 dB (± 0.35 dB when the Reverse Power Protection Option is fitted).

(4) Tune the UUT slowly over its entire frequency range from 5MHz to 520MHz and verify that the millivoltmeter reading does not change by more than ± 0.6dB (± 1.1 dB if the Reverse Power Protection Option is fitted), and the UUT meter by more than ± 0.2dB. In the range 1.5 to 5MHz (9082 only) the millivoltmeter reading should not change by more than ± 1.5dB and the UUT meter by more than ± 0.5dB.

(5) Set the UUT OUTPUT switch to 'X2'.

(6) Tune the UUT to 50MHz on the appropriate range and operate the VERNIER control for a reading of +3dB on the UUT meter. Verify that the millivoltmeter now reads 9dBm ± 0.6dB.

(7) Repeat operation (4) but keeping the OUTPUT switch at 'X2' position.

(8) The millivoltmeter should now read +9dBm ± 0.6dB and the UUT meter +3dB ± 0.5dB over the frequency range 5MHz to 520 MHz. In the frequency range 1.5MHz to 5MHz (9082 only) the millivoltmeter reading should not change by more than ± 2dB and the UUT meter by more than ± 1dB.

(9) Disconnect the millivoltmeter.

## SPURIOUS CHECK

5.21 Test Equipment Required Page 5-2 Table 5

Spectrum Analyser Item 5

5.22 Procedure

- (1) Check that all UUT modulation control switches are at OFF and set the OUTPUT switch to 'X2'.
- (2) Tune the UUT to 25MHz and operate the VERNIER to give a 3dB reading on the meter.
- (3) Connect the spectrum analyser to the UUT 50Ω output and set the analyser controls as follows:-

Input attenuator	20dB
Log. ref.	+10
Vernier	- 1
Bandwidth	100kHz
Scanwidth	10MHz/div.
Video filter	Off
Scan time	5ms

- (4) Tune the spectrum analyser from 0 - 1000MHz and check that any spurious frequencies are below the following levels, relative to carrier:-

<u>Frequency Spectrum</u>	<u>Spurious Level (Maximum)</u>
0-120MHz	-70dB
120-540MHz	-65dB
Above 540 MHz	-60dB

- (5) Repeat (4) but with the UUT tuned to the following frequencies:-
  - (a) 50MHz
  - (b) 520MHz

- (6) Verify that spurious frequencies are at least 70dB below carrier level. Tune the analyser to 50MHz and slowly tune the UUT throughout range 1. Check that any spurious are at least 70dB below carrier in the range 5MHz to 35MHz and at least 55dB below carrier in the range 1.5MHz to 5MHz (9082 only).

(7) Tune the UUT to 30.005MHz and set the spectrum analyser as follows:-

Centre freq.	30MHz
Bandwidth	10kHz
Scanwidth	200kHz/div.

(8) Check for sidebands, at 300kHz and 400kHz off carrier, which must be at least 70dB below carrier.

(9) Reset analyser controls as follows:-

Bandwidth	1kHz
Scanwidth	10kHz/div.

Check for sidebands, at 20kHz or more off carrier, which should be at least 70dB below carrier.

(10) Retain the spectrum analyser connection for the next test.

## FAR-OFF AND CLOSE-IN NOISE CHECKS

5.23 Test Equipment Required Page 5-2 Table 5

Spectrum Analyser Item 5

5.24 Procedure

(1) Check that all UUT modulation control switches are at OFF and the OUTPUT switch at 'X2'. Tune UUT to 400 MHz.

(2) For far-off noise set the analyser controls as follows and verify that the noise is on, or below, the 70dB graticule line:-

Input attenuator	0dB
Centre freq.	425MHz
Log. ref.	-20
Vernier	-1
Scanwidth	1kHz/div.
Bandwidth	3kHz
Video filter	10Hz

- (3) For close-in noise tune the analyser to 400MHz and set the controls thus:-

Input attenuator	10dB
Scanwidth	10kHz/div.
Bandwidth	1kHz
Video filter	10Hz
Log. ref.	+10dB

- (4) Adjust the analyser vernier control to bring the carrier to the top graticule line. Verify that the noise at 20kHz off carrier is on or below the 70dB graticule line and that no spurious frequencies are visible.
- (5) Disconnect the spectrum analyser.

### RESIDUAL FM CHECK

5.25 Test Equipment Required Page 5-2 Table 5

Modulation Meter (9009)	Item 3
Millivoltmeter (True RMS)	Item 7
Cable with N-N connectors	

5.26 Procedure

- (1) Check that all UUT modulation control switches are at OFF.
- (2) Connect the UUT 50Ω output socket to the modulation meter input.
- (3) Connect a True RMS Millivoltmeter to the audio output of the modulation meter.
- (4) Select the 1.5kHz f.s.d. range and FM mode on the modulation meter (9009).
- (5) Refer to Table 10 and verify that the modulation meter (9009) and millivoltmeter readings are within the limits given at several points in the range 360MHz to 420MHz and at 520MHz.

TABLE 10

Residual FM Check

9081 Carrier freq.	9009 audio filter	9009 reading	Millivoltmeter reading
360MHz to 420MHz	Out	$\leq 350\text{Hz}$	-
	In	-	$\leq 50\text{mV}$
520MHz	Out	$\leq 350\text{Hz}$	-
	In	-	$\leq 50\text{mV}$

FM DEVIATION CHECK

5.27 Test Equipment Required Page 5-2 Table 5

Modulation Meter (9009)	Item 3
Millivoltmeter	Item 8
Audio (1kHz) signal generator	Item 9

5.28 Procedure

(1) Set the UUT controls as follows:-

OUTPUT switch to NORMAL  
METER switch to FM/ $\emptyset$ M  
FM/ $\emptyset$ M switch to INT  
AM switch to OFF  
PEAK DEVIATION switch to 100kHz  
MODULATION FREQUENCY control to 1kHz.

(2) Connect the modulation meter (9009) to the UUT 50 $\Omega$  output.

- (3) Adjust the concentric FM/AM COARSE and MOD level controls on the UUT for 100kHz peak deviation on UUT meter.
- (4) Tune the UUT to the carrier frequencies in Table 11. Set the PEAK DEVIATION switch and monitor 9009 and UUT meter readings in the table. At each carrier frequency repeat operation (3) for 100kHz peak deviation.

TABLE 11

FM Deviation Check

Range	Carrier freq. MHz	9081 Peak Dev. switch setting	9009 reading kHz dev.	9081 meter reading
5	520	100	100± 2%	10
		30	30± 3%	3
		10	10± 3%	10
		3	3± 5%	3
5	360	100	100± 2%	10
		3	3± 5%	3
5	240	100	100± 2%	10
		3	3± 5%	3
4	265	3	3± 5%	3
4	120	3	3± 5%	3
3	132	3	3± 5%	3
3	60	3	3± 5%	3
2	67	100	100± 2%	10
		3	3± 5%	3
2	30	100	100± 2%	10
		3	3± 5%	3

- (5) Retain the test equipment for the next test.



## FM DISTORTION CHECK

### 5.29 Test Equipment Required Page 5-2 Table 5

Distortion Analyser	Item 6
Modulation Meter (9009)	Item 3

### 5.30 Procedure

- (1) Connect the distortion analyser to the AF output socket of the modulation meter.
- (2) Set the UUT controls as in para. 5.28 (1).
- (3) Tune the UUT to 67MHz on the 32-64MHz range.
- (4) Adjust the FM/ØM COARSE and MOD LEVEL controls on the UUT to give 100kHz peak deviation reading on the 9009. Verify that the total harmonic distortion indicated on the distortion analyser does not exceed 4%.
- (5) Retain the test equipment for the next test.

## PHASE MODULATION CHECK

### 5.31 Test Equipment Required Page 5-2 Table 5

Modulation Meter	Item 3
Audio Signal Generator (400Hz -5kHz)	Item 9
Millivoltmeter	Item 8
Distortion Analyser	Item 6
Frequency Counter	Item 10

### 5.32 PROCEDURE

- (1) Set the UUT controls as follows:-
  - OUTPUT switch to NORMAL
  - METER switch to FM/ØM
  - FM/ØM switch to EXT
  - AM switch to OFF
  - PEAK DEVIATION switch to 100kHz.

- 5.32 (2) Connect:-
- (a) Audio generator to FM/ØM EXT 600Ω socket
  - (b) Modulation meter to UUT 50Ω output
  - (c) Millivoltmeter and frequency counter to monitor the output of the audio generator.
  - (d) The distortion analyser to the AF output of the modulation meter.
- (3) Tune the UUT to 520 MHz.
- (4) Apply the external audio modulating frequencies as in Table 12. Monitor the audio frequencies with the counter and maintain the audio level at 1.00V r.m.s. on the millivoltmeter. Check deviation on the modulation meter and distortion (not exceeding 4%) on the analyser.

TABLE 12

Phase Modulation Check

Audio freq.	Deviation	Distortion
400Hz	4kHz ± 5%	≤ 4%
1000Hz	10kHz ± 5%	≤ 4%
5000Hz	50kHz ± 5%	≤ 4%

- (5) Retain the test equipment for the next check.

AM DEPTH and DISTORTION CHECK

5.33 Test Equipment Required

As in para. 5.31, except frequency counter.  
Modulation Meter Item 13 of Table 5 (9082 only).

5.34 Procedure

- (1) Connect the test equipment as in 5.32 (2) but with the audio generator connected to the AM EXT 600Ω socket.

- (2) On the UUT set the FM/OM switch to OFF, the AM switch to EXT and the METER switch to CW.
- (3) Set the external audio generator to 1kHz and the audio level to 800mV r.m.s. on the millivoltmeter.
- (4) Select 'AM 100%' on the modulation meter control.
- (5) Refer to Table 13. Tune the carrier frequencies and adjust the UUT VERNIER control to the required +10dB or +3dB readings. Verify that the modulation meter indicates 80% AM depth ( $\pm 3\%$ ), and that the analyser indicates not more than 4% total harmonic distortion. (T.H.D).

TABLE 13

AM Depth and Distortion Check

Range	Carrier frequency	Set UUT Carrier Level with Vernier	Mod Depth	T.H.D.
5	520MHz	( + 3dB	80% $\pm 3\%$ on all frequencies	Not greater than 4% on any frequency
	240MHz	( - 10dB + 3dB		
4	260MHz	+ 3dB		
	120MHz	+ 3dB		
3	130MHz	+ 3dB		
	60MHz	+ 3dB		
2	65MHz	+ 3dB		
	30MHz	+ 3dB		
1	32MHz	+ 3dB		
	10MHz	+ 3dB		

- (6) For 9082 only.  
Disconnect the 9009 modulation meter and replace it with the 9008.
- (7) Check at a carrier frequency of 1.5MHz to ensure that with the UUT adjusted to +3dB, the modulation depth as shown on the modulation meter is  $80 \pm 4\%$  and that THD is  $\leq 6\%$ .

## FM FREQUENCY RESPONSE CHECK

### 5.35 Test Equipment Required Page 5-2 Table 5

Modulation Meter (TF2300)	Item 4
Millivoltmeter	Item 8
Audio Signal Generator	Item 9

### 5.36 Procedure

- (1) Set the UUT controls as in 5.32 (1).
- (2) Connect the audio generator to the FM/ØM EXT 600Ω socket with the millivoltmeter as monitor. Set the audio frequency to 1kHz.
- (3) Connect the modulation meter (TF2300) to the UUT 50Ω output socket.
- (4) Tune the UUT to 520MHz.
- (5) Refer to Table 14. Apply the audio frequencies at 1.00 V r.m.s., and adjust the front panel FM/ØM COARSE control to give a 100 kHz peak deviation reading on the UUT meter. Verify the corresponding peak deviation readings on the modulation meter.

TABLE 14

### FM Frequency Response Check

Audio freq.	Millivoltmeter reading	Modulation meter reading
20Hz	1.00V	100kHz ± 30 kHz
100Hz	1.00V	100kHz ± 10kHz
10kHz	1.00V	100kHz ± 5kHz
100kHz	1.00V	100kHz ± 30kHz

## AM FREQUENCY RESPONSE CHECK

### 5.37 Test Equipment Required Page 5-2 Table 5

As in the preceding test, plus:-

Digital Multimeter	Item 1
Power Meter	Item 11

### 5.38 Procedure

- (1) Transfer the audio generator and monitor millivoltmeter to the AM EXT 600 $\Omega$  socket. The modulation meter remains connected to the UUT 50 $\Omega$  output.
- (2) On the UUT set the FM/ $\phi$ M switch to OFF and the AM switch to EXT. Adjust OUTPUT LEVEL controls for 3dBm level.
- (3) With the UUT tuned to 520MHz, refer to Table 15. Apply the external audio frequencies, monitored at 800mV, and verify the specified modulation depth on the modulation meter.

TABLE 15

AM Frequency Response Check

Audio freq.	Millivoltmeter reading	Modulation meter reading
20 Hz	800 mV	80% $\pm$ 3%
100 kHz	800 mV	80% $\pm$ 3%
1 kHz	800 mV	80% $\pm$ 3%
10 kHz	800 mV	80% $\pm$ 3%
30 kHz	800 mV	80% $\pm$ 3%
(20 kHz for 9082)		

- (4) Set the external audio generator frequency to 1kHz and adjust the audio level until the modulation meter reads 50%AM. Note the reading on the monitor millivoltmeter at the AM EXT input socket.
- (5) Disconnect the modulation meter and connect the Power Meter in its place.
- (6) Monitor the d.c. output voltage of the power meter using the digital multimeter (d.v.m.)
- (7) Adjust the UUT OUTPUT LEVEL controls to give a reading of 1.000V on the d.v.m.

- (8) Set the audio generator frequency to 100kHz and adjust the audio level to the same monitor level as noted in (4).
- (9) Verify that the d.v.m. reading is within the range 0.94V to 1.06V.

NOTE: Paragraphs 5.39 to 5.43 relate to 9081H and 9082H only.  
The tests applicable to models 9081 and 9082 resume at paragraph 5.44.

### RECONNECTION OF HIGH LEVEL AMPLIFIER

5.39 For models 9081H and 9082H remove the SMA to type N test lead which was connected as instructed in paragraph 5.4. Reconnect the SMA connector between the casting and the 10dB amplifier. Use the front panel RF OUTPUT connector where required for the remaining tests.

### LEVEL ACCURACY CHECK

5.40	<u>Test Equipment Required</u>	<u>Page 5-2 Table 5</u>
	Millivoltmeter (True RMS) Cable with N-N connectors	Item 2

5.41 Procedure

- (1) Set the UUT controls as follows:-

AM switch to OFF  
 FM/ØM switch to OFF  
 FINE TUNE switch to OFF  
 CHANNEL SPACING switch to '10kHz'  
 TUNE switch to FAST  
 OUTPUT switch to NORMAL  
 METER switch to CW  
 OUTPUT LEVEL switch to +10dBm position

- (2) Connect the True RMS Millivoltmeter to the 50Ω output socket of the UUT using appropriate cable.
- (3) Tune the UUT to 50MHz and adjust the VERNIER control for a reading of 0dB on the UUT meter. Verify that the millivoltmeter reads +10dBm ±0.4dBm.

- (4) Tune the UUT slowly over its entire frequency range from 5MHz to 520MHz and verify that the millivoltmeter reading does not change by more than  $\pm 1$ dB, and the UUT meter by more than  $\pm 0.2$ dB. In the range 1.5 to 5MHz (9082H only) the millivoltmeter reading should not change by more than  $\pm 2.75$ dB and the UUT meter by more than  $\pm 0.5$ dB.
- (5) Set the UUT OUTPUT switch to 'X2'.
- (6) Tune the UUT to 50MHz on the appropriate range and operate the VERNIER control for a reading of +3dB on the UUT meter. Verify that the millivoltmeter now reads +19dBm  $\pm 1$ dBm.
- (7) Repeat operation (4) but keeping the OUTPUT switch at 'X2' position.
- (8) The millivoltmeter should now read +19dBm  $\pm 1$ dBm and the UUT meter +3dB  $\pm 0.5$ dB over the frequency range 5MHz to 520 MHz. In the frequency range 1.5MHz to 5MHz (9082H only) the millivoltmeter reading should not change by more than  $\pm 2.75$ dB and the UUT meter by more than  $\pm 1$ dB.
- (9) Disconnect the millivoltmeter.

#### DISTORTION CHECK

5.42 Repeat the tests detailed in paragraphs 5.17 and 5.18.

#### AM DEPTH AND DISTORTION CHECK

5.43 Repeat the tests detailed in paragraphs 5.33 and 5.34

#### ATTENUATOR CHECK

5.44 Test Equipment Required Page 5-2 Table 5

Spectrum Analyser Item 5

5.45 Procedure

- (1) On the UUT set:-  
Range to '256-512' position.  
OUTPUT LEVEL Control to the 0 dBm position.  
OUTPUT switch to X2.
- (2) Connect the spectrum analyser to the UUT 50 $\Omega$  output socket and set the analyser controls as follows:-

Centre Frequency	500MHz
Input attenuation	20dB
Bandwidth	1kHz
Scanwidth	5kHz/div.
Video filter	Off
Scan time	10 msec/div.
Log. ref.	+10dB
Vernier	-1dB

- (3) Tune the UUT to 500MHz. Adjust the UUT VERNIER to bring the signal to the top graticule line of the analyser display. The UUT meter should read +3 dB.
- (4) Operate the UUT OUTPUT LEVEL control in 10dBm steps and observe 10dB steps on the analyser as far as -60dBm.
- (5) Reset the following analyser controls:-  
Input attenuation: 0dB  
Log Reference: -50dB
- (6) Repeat operation (4) up to -120dB on the analyser.
- (7) Disconnect the spectrum analyser.

#### INTERNAL STANDARD OUTPUT CHECK

- 5.46
- (1) Connect a True RMS Millivoltmeter to the rear panel standard output socket, using a 50ΩBNC load and 'T' piece.
  - (2) Check that the STANDARD switch is set to INTERNAL and verify a reading of 125mV ± 25mV on the Millivoltmeter.
  - (3) Disconnect the test equipment.

#### INTERNAL FREQUENCY STANDARD CALIBRATION

5.47 The 'cycle drift' method of frequency calibration, described below, is suitable for oscillators which have temperature stability characteristics of up to 1 part in  $10^7$ . With higher stability oscillators, such as the Racal 9421 and 9442, specialised equipment such as the Tracor Frequency Difference Meter Type 527A should be used if the optimum calibration is to be achieved.

#### 5.48 Equipment Required

1MHz external frequency standard with accuracy better than one part in  $10^7$ .

Oscilloscope.

#### 5.49 Procedure

- (1) Allow a suitable warm-up period (not less than one hour for a temperature-controlled oscillator).
- (2) Set the oscilloscope time base to 1 microsecond/cm.
- (3) Connect the 1MHz external standard to the External Trigger input of the oscilloscope.



- (4) Connect the oscilloscope lead to the inner pin of the Internal Standard Output socket on the rear panel of the UUT (screen to chassis).
- (5) Set the UUT frequency standard switch to INTERNAL.
- (6) Observe the oscilloscope display and check that in a period of 10 seconds not more than one cycle of displayed waveform moves past a fixed point on the oscilloscope face. This is equivalent to an accuracy of 1 in  $10^7$ .
- (7) If necessary, adjust the mechanical tuning via the aperture in the rear panel to obtain a stationary trace.

#### INTERNAL REVERSE POWER PROTECTION UNIT OPTION

5.50	<u>Test Equipment Required</u>	<u>Page 5-2 Table 5</u>
	Power Meter	Item 11
	Signal Generator	Item 14
	Power Amplifier	Item 15
	Cable with N-N connectors	

#### 5.51 Procedure

- (1) Set the UUT controls as follows:  
 OUTPUT switch to NORMAL  
 METER switch to CW  
 OUTPUT LEVEL to -20 dBm  
 Modulation controls OFF
- (2) Tune the UUT to 6 MHz and adjust the VERNIER control to give a reading of 0dB on the UUT meter.
- (3) Connect the Signal Generator to the RF Amplifier. Set the Signal Generator to give an output from the amplifier of 100 MHz at a level of -30 dBm.
- (4) Connect the amplifier output to the 50  $\Omega$  RF output socket of the UUT. Slowly increase the Signal Generator output level until the UUT protection unit buzzer sounds.
- (5) Disconnect the amplifier output from the UUT 50  $\Omega$  RF output socket. The buzzer should stop sounding.
- (6) Measure the amplifier output, using the Power Meter. The level should be within the range 0.2W to 1W.
- (7) Disconnect the test equipment.

PARTS LIST FOR FIG. 3

OSCILLATOR ASSEMBLY 19-0841

Part No.	Description	Rating	Tol %	Value	Component Reference
<u>Resistors</u>					
		<u>W</u>		<u>Ω</u>	
20-1531	Carbon Film	0.1	5	47	R16
20-2101	Carbon Film	$\frac{1}{4}$	5	100	R3,5,7,8
20-2102	Carbon Film	$\frac{1}{4}$	5	1k	R1,2,6
20-2103	Carbon Film	$\frac{1}{4}$	5	10k	R14
20-2123	Carbon Film	$\frac{1}{4}$	5	12k	R15
20-2150	Carbon Film	$\frac{1}{4}$	5	15	R10
20-2181	Carbon Film	$\frac{1}{4}$	5	180	R9
20-2222	Carbon Film	$\frac{1}{4}$	5	2.2k	R4
<u>Capacitors</u>					
		<u>V</u>		<u>F</u>	
21-0514	Electrolytic	10		470 $\mu$	C2
21-0596	Electrolytic	16		47 $\mu$	C1
21-1520	Ceramic	500	10	100p	C3
21-5507	Polycarbonate	100	20	1 $\mu$	C4
21-1616	Ceramic	12	-20+80	100n	C5,7
21-1684	Ceramic	63	2	22p	C9
21-1686	Ceramic	63	2	33p	C6
<u>Diodes</u>					
22-1029	Silicon, general purpose (1N4149)				D3,4,5,6
22-1065	Variable capacitance, 20pF hyper abrupt (DKV6520B)				D1,2
<u>Transistors</u>					
22-6017	Silicon, npn (2N2369)				Q1
22-6041	Silicon, npn (BC.109)				Q3
22-6008	Silicon, pnp (2N3906)				Q2
22-6123	Silicon, npn, u.h.f. amp (BFR90)				Q4
<u>Inductors</u>					
				<u>H</u>	
23-7060	Choke, r.f. sub min			0.22 $\mu$	L1
23-8000	Ferrite Bead (FX1242)				FX1
23-8053	Toroid, Ferrite, G63V (GREY)				

PARTS LIST FOR FIG. 5

LOGIC ASSEMBLY 19-0842 OR 19-0948

Part No.	Description	Rat	Tol %	Value	Component Reference	Part No.	Description	Rat	Tol %	Value	Component Reference
	<u>Resistors</u>	<u>W</u>		<u>Ω</u>			<u>Transistors</u>				
20-2100	Carbon Film	$\frac{1}{4}$	5	10	R63	22-6017	Silicon, npn metal con (2N2369)				Q3,4,5,6,7,8,10,11
20-2101	Carbon Film	$\frac{1}{4}$	5	100	R58,61	22-6110	Silicon, pnp gen purpose (BFX48)				Q1,2,9
20-2102	Carbon Film	$\frac{1}{4}$	5	1k	R8,20,25,26,41,49,51,54,57,59,60,62						
20-2103	Carbon Film	$\frac{1}{4}$	5	10k	R3,4,16,34,35,36,39,43,47,64*		<u>Integrated Circuits</u>				
20-2104	Carbon Film	$\frac{1}{4}$	5	100k	R1,2,5,6,10,13,30,31,32,33,66*,67*,68*	22-4111	Op Amp high performance (741)				IC3,4
20-2105	Carbon Film	$\frac{1}{4}$	5	1M	R23,24	22-4129	Triple 3 Input NAND (7411)				IC17*
20-2123	Carbon Film	$\frac{1}{4}$	5	12k	R17	22-4700	Quad 2 Input NAND (HF4011)				IC12
20-2153	Carbon Film	$\frac{1}{4}$	5	15k	R38	22-4710	Dual J-K Bistable (4027)				IC6,7
20-2221	Carbon Film	$\frac{1}{4}$	5	220	R46	22-4711	Dual-D Bistable (4013)				IC8
20-2222	Carbon Film	$\frac{1}{4}$	5	2.2k	R48,50,52,55	22-4712	Binary/Decade Up/Down Counter (4029)				IC2,11,13,14
20-2223	Carbon Film	$\frac{1}{4}$	5	22k	R9,21,22,37,40,42,56,70	22-4713	Quad 2 Input NOR (4001)				IC1,9
20-2332	Carbon Film	$\frac{1}{4}$	5	3.3k	R44,45	22-4716	Quad 2 Input OR (4071)				IC15,23*
20-2333	Carbon Film	$\frac{1}{4}$	5	33k	R7,11	22-4729	Quad Exclusive - OR (HEF4030P)				IC5
20-2472	Carbon Film	$\frac{1}{4}$	5	4.7k	R12,69	22-4715	Hex Inverter (4069)				IC21*
20-2473	Carbon Film	$\frac{1}{4}$	5	47k	R14,15,29	22-4717	Hex Buffer/Converter (4050)				IC18*
20-2683	Carbon Film	$\frac{1}{4}$	5	68k	R27,28,53,65*	22-4727	8 Input NAND (4068)				IC19*,20*,22*
						22-4728	Triple 3 Input AND (4073)				IC24*
						22-4752	Quad 2 Input NAND (HEF4011P)				IC10
						22-8700	ROM 512 x 8 bit (3515)				IC16*
	<u>Capacitors</u>	<u>V</u>		<u>F</u>			<u>Miscellaneous</u>				
21-1006	Tantalum	35	20	4.7μ	C19	17-2108	Crystal 5.3MHz				XL1
21-1002	Tantalum	20	20	10μ	C17,25	23-7056	Inductor			100μH	L3
21-1041	Tantalum	35	20	1.0μ	C11	23-7086	Coil Assembly			1mH	L1,L2
21-0596	Electrolytic	16		47μ	C29,30,33						
21-1508	Ceramic	500	10	10p	C22,32						
21-1520	Ceramic	500	10	100p	C9,10,28						
21-1524	Ceramic	500	10	220p	C8						
21-1527	Ceramic	500	10	390p	C3,4						
21-1531	Ceramic	500	10	820p	C5,6						
21-1535	Ceramic	500	20	1.8nF	C34						
21-1545	Ceramic	500	-20+80	10n	C14,15,18,20,21,24,26						
21-1533	Ceramic	500	10	1.2n	C7						
21-1616	Ceramic	12	-20+80	100n	C1,2,16,27						
21-2586	Silver Mica	350	2	220p	C13						
21-2587	Silver Mica	350	2	470p	C12						
21-2630	Silver Mica	125	5	270p	C31						
21-3041	Silver Mica	200	2	270p	C23						
	<u>Diodes</u>						<u>Notes:</u>				
22-1029	Silicon, gen purpose (1N4149)				D1,2,4,5	*	These components are fitted for Model 9082 only.				
22-1038	Variable capacitance, 22pF (MV1634) D3					**	For Model 9081 this component is fitted to Divider and Phase Detector Assembly 19-0846 (Fig. 13).				

PARTS LIST FOR FIG 7

OUTPUT SYSTEM ASSEMBLY 19-0843 AND 19-0949

Part No.	Description	Rat	Tol %	Value	Component Reference	Part No.	Description	Rat	Tol %	Value	Component Reference
	<u>Resistors</u>	<u>W</u>		<u>Ω</u>			<u>Resistors</u>			<u>Ω</u>	
20-1513	Carbon Film	0.1	5	39	R100	20-2684	Carbon Film	$\frac{1}{4}$	5	680k	R129
20-1521	Carbon Film	0.1	5	1k	R89	20-2820	Carbon Film	$\frac{1}{4}$	5	82	R46, 47
20-1523	Carbon Film	0.1	5	120	R92	20-2821	Carbon Film	$\frac{1}{4}$	5	820	R49, 64, 75, 140
20-1526	Carbon Film	0.1	5	22	R84, 102	20-4018	Metal Oxide	$\frac{1}{4}$	2	10k	R139
20-1527	Carbon Film	0.1	5	270	R86	20-4071	Metal Oxide	$\frac{1}{4}$	2	3.3k	R138
20-1529	Carbon Film	0.1	5	33	R105	20-6543	Variable, linear	$\frac{1}{4}$	20	2.2k	R136
20-1531	Carbon Film	0.1	5	47	R101	20-6544	Variable, linear	$\frac{1}{4}$	20	3.3k	R94
20-1532	Carbon Film	0.1	5	470	R95	20-6547	Variable, linear	$\frac{1}{4}$	20	22k	R109, 134
20-1533	Carbon Film	0.1	5	5.6k	R158	20-6550	Variable, linear	$\frac{1}{4}$	20	100k	R143, 153
20-1542	Carbon Film	0.1	5	4.7k	R88	20-6596	Variable, linear	$\frac{1}{4}$	20	50	R19
20-1534	Carbon Film	0.1	5	82	R83						
20-1546	Carbon Film	0.1	5	56	R98		<u>Capacitors</u>	<u>V</u>		<u>F</u>	
20-1547	Carbon Film	0.1	5	2.7k	R90						
20-1548	Carbon Film	0.1	5	3.9k	R91						
20-1554	Carbon Film	0.1	5	680	R156						
20-2101	Carbon Film	$\frac{1}{4}$	5	100	R5, 8, 33, 42, 44 53, 60, 63, 107						
20-2102	Carbon Film	$\frac{1}{4}$	5	1k	R11, 12, 122, 142	21-0627	Electrolytic	16	-10+50	220 $\mu$	C123
20-2103	Carbon Film	$\frac{1}{4}$	5	10k	R15, 17, 18, 36, 115, 117, 124, R128, 132	21-1038	Tantalum	6.3	20	47 $\mu$	C22, 117, 120
20-2104	Carbon Film	$\frac{1}{4}$	5	100k	R3	21-1039	Tantalum	16	20	22 $\mu$	C1, 62, 75, 115
20-2121	Carbon Film	$\frac{1}{4}$	5	120	R52, 68, 79, 133	21-1041	Tantalum	35	20	1 $\mu$	C126, 127, 128, 129, 130, 131, 132, 133, 1 135, 136
20-2122	Carbon Film	$\frac{1}{4}$	5	1.2k	R113						
20-2123	Carbon Film	$\frac{1}{4}$	5	12k	R1, 54, 69, 81, 123	21-0596	Electrolytic	16		47 $\mu$	C21
20-2151	Carbon Film	$\frac{1}{4}$	5	150	R28, 57, 59, 61, 70, 71, 72, 73	21-1505	Ceramic	500	0.5p	5.6p	C5
20-2152	Carbon Film	$\frac{1}{4}$	5	1.5k	R58, 127	21-1512	Ceramic	500	10	22p	C103
20-2153	Carbon Film	$\frac{1}{4}$	5	15k	R16, 50, 66, 77	21-1514	Ceramic	500	10	33p	C114
20-2181	Carbon Film	$\frac{1}{4}$	5	180	R149	21-1516	Ceramic	500	10	47p	C111
20-2182	Carbon Film	$\frac{1}{4}$	5	1.8k	R116	21-1520	Ceramic	500	10	100p	C121
20-2183	Carbon Film	$\frac{1}{4}$	5	18k	R110, R121, 131	21-1522	Ceramic	500	10	150p	C102, 106
20-2184	Carbon Film	$\frac{1}{4}$	5	180k	R32, 34, 35, 39, 40, 96, 104	21-1532	Ceramic	500	20	1n	C4, 6, 7, 31, 32, 35, 36, 37, 38, 40, 49, 51 53, 63, 65, 10E, 110
20-2220	Carbon Film	$\frac{1}{4}$	5	22	R4, 7, 22, 24, 43	21-1533	Ceramic	500	20	1.2n	C82
20-2221	Carbon Film	$\frac{1}{4}$	5	220	R150, 151	21-1537	Ceramic	500	-20+40	2.7n	C116, 140
20-2223	Carbon Film	$\frac{1}{4}$	5	22k	R144	21-1545	Ceramic	25	-20+80	10n	C19, 24, 29, 30, 41, 47, 48, 50, 52, 54, 61 56, 73
20-2225	Carbon Film	$\frac{1}{4}$	5	2.2M	R82, 85, 87						
20-2271	Carbon Film	$\frac{1}{4}$	5	270	R29, 41	21-1616	Ceramic	12	-20+80	100n	C8, 12, 20, 23, 64, 71 91, 100, 101, 104, 10 109, 112, 118, 119,
20-2272	Carbon Film	$\frac{1}{4}$	5	2.7k	R135						
20-2273	Carbon Film	$\frac{1}{4}$	5	27k	R108						
20-2274	Carbon Film	$\frac{1}{4}$	5	270k	R23, 25, 106 30	21-1672	Ceramic	63	0.25p	2.2p	C10, 90, 92
20-2330	Carbon Film	$\frac{1}{4}$	5	33	R120, 145, 148	21-1674	Ceramic	63	0.25p	3.3p	C56
20-2331	Carbon Film	$\frac{1}{4}$	5	330		21-1675	Ceramic	63	0.25p	3.9p	C9, 11
20-2332	Carbon Film	$\frac{1}{4}$	5	3.3k		21-1677	Ceramic	63	0.25p	5.6p	C16, 18, 68
20-2390	Carbon Film	$\frac{1}{4}$	5	39	R103	21-1678	Ceramic	63	0.25p	6.8p	C13, 15
20-2391	Carbon Film	$\frac{1}{4}$	5	390	R97	21-1679	Ceramic	63	0.25p	8.2p	C44
20-2393	Carbon Film	$\frac{1}{4}$	5	39k	R152	21-1680	Ceramic	63	0.25p	10p	C42, 46, 59, 142
20-2394	Carbon Film	$\frac{1}{4}$	5	390k	R159	21-1682	Ceramic	63	2	15p	C14, 26, 58
20-2470	Carbon Film	$\frac{1}{4}$	5	47	R9, 26, 125, 147	21-1683	Ceramic	63	2	18p	C17, 25, 60, 71
20-2471	Carbon Film	$\frac{1}{4}$	5	470	R10, 48, 65, 76 80, 118, 146	21-1684	Ceramic	63	2	22p	C43, 55, 125, 137,
20-2472	Carbon Film	$\frac{1}{4}$	5	4.7k	R13, 14, 51, 67, 78, 119	21-1685	Ceramic	63	2	27p	C57
20-2473	Carbon Film	$\frac{1}{4}$	5	47k	R112	21-1686	Ceramic	63	2	33p	C70, 72, 124
20-2560	Carbon Film	$\frac{1}{4}$	5	56	R2, 55, 56, 126	21-1687	Ceramic	63	2	39p	C67
20-2561	Carbon Film	$\frac{1}{4}$	5	560	R31	21-1688	Ceramic	63	2	47p	C28, 69, 84
20-2562	Carbon Film	$\frac{1}{4}$	5	5.6k	R141, 154, 157	21-1690	Ceramic	63	2	68p	C27
20-2680	Carbon Film	$\frac{1}{4}$	5	68	R6, 20, 21, 99						
20-2681	Carbon Film	$\frac{1}{4}$	5	680	R37, 38, 137						
20-2682	Carbon Film	$\frac{1}{4}$	5	6.8k	R93, 111, 155						
20-2683	Carbon Film	$\frac{1}{4}$	5	68k	R114						

PARTS LIST FOR FIG. 7

OUTPUT SYSTEM ASSEMBLY 19-0843 AND 19-0949

Part No.	Description	Rat	Tol %	Value	Component Reference	Part No.	Description	Rat	Tol %	Value	Component Reference
	<u>Capacitors</u>	<u>V</u>		<u>F</u>		<u>FOR 19-0843 (Model 9081) ONLY</u>					
21-1697	Ceramic	63	2	270p	C122		<u>Resistors</u>	<u>W</u>		<u>Ω</u>	
21-1708	Ceramic	50	20	100n	C74, 76, 78, 80, 81, 93, 95	20-2101	Carbon Film	$\frac{1}{4}$	5	100	R62
21-1738	Ceramic	100	20	10n	C2, 3, 33, 34, 39, 87, 88, 89, 94	20-2820	Carbon Film	$\frac{1}{4}$	5	82	R74
21-1716	Ceramic	250	20	1n	C77		<u>Capacitors</u>	<u>V</u>		<u>F</u>	
21-1740	Ceramic	100	10	2.2n	C138	21-1503	Ceramic	500	0.5p	3.0p	C98
21-4548	Polyester	400	10	100n	C113	21-1508	Ceramic	500	10	10p	C99
	<u>Diodes</u>					21-1515	Ceramic	500	10	39p	C97
22-1029	Silicon, general purpose (1N4149)				D15, 16, 20, 22, 25, 29, 39	21-1524	Ceramic	500	10	220p	C83
22-1053	Silicon, u.h.f. switch (BA244)				D21, 26, 30	21-1528	Ceramic	500	10	470p	C107
22-1056	Hot carrier, matched quad (HP5082-2815)				D11, 12, 13, 14	21-1531	Ceramic	500	10	820p	C96
22-1058	PIN diode v.h.f./u.h.f. (HP5082-3379)				D1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 17, 18, 19, 23, 24, 27, 28, 32	21-1688	Ceramic	63	2	47p	C86
22-1046	PIN diode (HP 5082.3080)				D33, 34, 35	21-1697	Ceramic	63	2	270p	C85
22-1084	Hot carrier, matched set (ZC2811)				D36, 37, 38		<u>Inductors</u>			<u>H</u>	
22-1927	Voltage reg. 5.6V (BZY88-C5V6)				D40	23-7014	Choke r.f. sub. miniature			10μ	L20
	<u>Integrated Circuits</u>					23-7084	Coil Assembly			200μ	L22
						<u>FOR 19-0949 (Model 9082) ONLY</u>					
							<u>Resistors</u>	<u>W</u>		<u>Ω</u>	
22-4111	Op. Amp high performance (741)				IC4, 6	20-2121	Carbon Film	$\frac{1}{4}$	5	120	R74
22-4121	Op. Amp (301)				IC7, 8	20-2182	Carbon Film	$\frac{1}{4}$	5	1.8k	R130
22-4213	Transistor Array (CA3046)				IC5	20-2680	Carbon Film	$\frac{1}{4}$	5	68	R62
22-4214	Wideband Amp (702)				IC9		<u>Capacitors</u>	<u>V</u>		<u>F</u>	
22-4539	600MHz ÷ 2 PECL (SP8607B)				IC3	21-1500	Ceramic	500	0.5p	2.2p	C98
22-4541	400MHz ÷ 2 PECL (SP8603B)				IC2	21-1512	Ceramic	500	10	22p	C99
22-4542	Dual-D Bistable MECL (MC10231P)				IC1	21-1520	Ceramic	500	10	100p	C97
	<u>Transistors</u>					21-1530	Ceramic	500	10	680p	C139
22-6017	Silicon, npn (2N2369)				Q5, 6, 8, 11, 12, 18	21-1532	Ceramic	500	20	1n	C83
22-6039	Silicon, npn 1000MHz (BFY90)				Q1, 2, 9, 10	21-1533	Ceramic	500	20	1.2n	C85, 107
22-6041	Silicon, npn (BC109)				Q20, 21	21-1545	Ceramic	25	-20±80	10n	C96
22-6113	Silicon, npn, gen purpose (ZTX550)				Q3, 4, 7	21-1696	Ceramic	63	2	220p	C86
22-6123	Silicon, npn, u.h.f. (BFR90)				Q15, 16, 17		<u>Inductors</u>			<u>H</u>	
22-6134	Silicon, npn (BFW92)				Q13, 14	23-7018	Choke, r.f. sub. miniature			47μ	L20
22-6110	Silicon, pnp (BFX48)				Q19	23-7086	Coil Assembly			1n	L22
	<u>Inductors</u>										
23-7004	Choke, r.f. sub. min			220nH	L1, 2, 3, 4						
23-7006	Choke, r.f. sub- min			470nH	L7, 8						
23-7007	Choke, r.f. sub. min			680nH	L5, 6						
23-7010	Choke, r.f. sub. min			2.2μH	L10, 23						
23-7012	Choke, r.f. sub. min			4.7μH	L9, 14						
23-7014	Choke, r.f. sub. min			10μH	L13, 17, 18, 21						
23-7077	Coil Assembly			33μH	L19						
17-3159	Transformer Assembly				T1, T2						
17-3216	Transformer Assembly				T3						
23-7126	Ferrite coil 60/120MHz, (red)				L12						
23-7127	Ferrite coil 60/120MHz (orange)				L11						
23-7128	Ferrite coil 60/120MHz (yellow)				L16						
23-7129	Ferrite coil 60/120MHz (green)				L15						
23-8000	Ferrite Bead				FX1						
23-8055	Ferrite Bead				FX2						

PARTS LIST FOR FIG. 9

FM LOOP ASSEMBLY 19-0844

Part No.	Description	Rat	Tol %	Value	Component Reference	Part No.	Description	Rat	Tol %	Value	Component Reference
	<u>Resistors</u>	<u>W</u>		<u>Ω</u>			<u>Capacitors</u>	<u>V</u>		<u>F</u>	
20-2101	Carbon Film	$\frac{1}{2}$	5	100	R1, 2, 6, 31, 32, 35, 36, 37, 47, 48, 90, 91, 94, 96, 104, 111, 125, 127, 142, 143, 144	21-0620 21-0780 21-1003 21-1006	Electrolytic Electrolytic Tantalum Tantalum	10 50 25 35	-10+50 20 20 20	1000 $\mu$ 10 $\mu$ 15 $\mu$ 4.7 $\mu$	C74 C16 C69 C12, 32, 46, 57, 63
20-2102	Carbon Film	$\frac{1}{2}$	5	1k	R3, 4, 18, 39, 44, 46, 62, 126, 129	21-1029	Tantalum	35	20	1.5 $\mu$	C44, 56
20-2103	Carbon Film	$\frac{1}{2}$	5	10k	R30, 40, 41, 42, 45, 53, 56, 59, 60, 61, 64, 65, 68, 70, 74, 75, 76, 86, 88, 98, 99, 103, 134, 135	21-0596	Electrolytic	16		47 $\mu$	C7, 23, 27, 30, 54, 56, 60, 66, 67, 75, 78, 80
20-2184	Carbon Film	$\frac{1}{2}$	5	180k	R79	21-1694	Ceramic	63	2	150P	C72, 73
20-2104	Carbon Film	$\frac{1}{2}$	5	100k	R69, 72, 78, 101, 102, 106, 118, 119, 120, 121, 122, 123, 124, 130, 131, 132, 133, 136	21-1512 21-1514 21-1519 21-1518 21-1520 21-1522	Ceramic Ceramic Ceramic Ceramic Ceramic Ceramic	500 500 500 500 500 500	10 10 10 10 10 10	22p 33p 82p 68p 100p 150p	C64, 76 C33, C26, C40 C21, 53, 70, C29, 49
20-2105	Carbon Film	$\frac{1}{2}$	5	1M	R9, 100, 115, 116, 117	21-1528 21-1530	Ceramic Ceramic	500 500	10 10	470p 680p	C62 C39, 42
20-2122	Carbon Film	$\frac{1}{2}$	5	1.2k	R34, 93	21-1532	Ceramic	500	20	1n	C86
20-2152	Carbon Film	$\frac{1}{2}$	5	1.5k	R13, 14, 51, 105	21-1545	Ceramic	25	-20+80	10n	C1, 2, 3, 4, 25, 28, 30, 59, 85
20-2153	Carbon Film	$\frac{1}{2}$	5	15k	R22, 28, 71						
20-2221	Carbon Film	$\frac{1}{2}$	5	220	R10, 11, 128						
20-2222	Carbon Film	$\frac{1}{2}$	5	2.2k	R19, 33, 57, 58, 77	21-1551	Ceramic	30	-20+80	100n	C13, 15, 36
20-2223	Carbon Film	$\frac{1}{2}$	5	22k	R16, 87	21-1616	Ceramic	12	-20+80	100n	C5, 6, 10, 17, 18, 19, 23, 38, 41, 43, 55, 61, 68
20-2224	Carbon Film	$\frac{1}{2}$	5	220k	R55						
20-2271	Carbon Film	$\frac{1}{2}$	5	270	R20						
20-2225	Carbon Film	$\frac{1}{2}$	5	2.2M	R138						
20-2333	Carbon Film	$\frac{1}{2}$	5	33k	R108	21-1693	Ceramic	63	2	120p	C71
20-2391	Carbon Film	$\frac{1}{2}$	5	390	R80, 82	21-2586	Silver Mica	350	2	220p	C14, 20
20-2392	Carbon Film	$\frac{1}{2}$	5	3.9k	R5, 7, 8, 17, 25	21-3065	Silver Mica	350	2	1500p	C47, 50
20-2470	Carbon Film	$\frac{1}{2}$	5	47	R24, 81, 92	21-3865	Polystyrene	30	1	4750p	C48
20-2471	Carbon Film	$\frac{1}{2}$	5	470	R12, 23, 29, 63	21-5504	Polycarbonate	100	20	330n	C80
20-2472	Carbon Film	$\frac{1}{2}$	5	4.7k	R67, 89, 110	21-5509	Polycarbonate	100	20	2.2 $\mu$	C35
20-2473	Carbon Film	$\frac{1}{2}$	5	47k	R54, 73	21-5501	Polycarbonate	100	20	100n	C8
20-2475	Carbon Film	$\frac{1}{2}$	5	4.7M	R66	21-1738	Ceramic	100	20	10n	C24, 31
20-2560	Carbon Film	$\frac{1}{2}$	5	56	R38, 43, 107						
20-2681	Carbon Film	$\frac{1}{2}$	5	680	R21, 27						
20-2822	Carbon Film	$\frac{1}{2}$	5	8.2k	R49	22-1029	<u>Diodes</u> Silicon, general purpose (1N4149)				D1, 4, 5, 16, 17
20-4952	Metal Film	$\frac{1}{2}$	0.5	1.43k	R112						
20-4953	Metal Film	$\frac{1}{2}$	0.5	3.32k	R113	22-1033	Hot Carrier (HP 5082.2811)				D13, 14
20-4954	Metal Film	$\frac{1}{2}$	0.5	10k	R109, 114	22-1032	Variable Capacitance (ZC714)				D9, 11
20-6543	Variable	$\frac{1}{2}$	20	2.2k	R85	22-1810	Voltage reg 6.2V				D2, 3
20-6545	Variable	$\frac{1}{2}$	20	4.7k	R50	22-1817	Voltage ref 12V				D10
20-2332	Carbon Film	$\frac{1}{2}$	5	3.3k	R15, 84	22-1819	Voltage reg 15V				D12
20-1538	Carbon Film	0.1	5	10k	R137	22-1809	Voltage reg 5.6V				D20
20-1514	Carbon Film	0.1	5	100	R95, 97, 139, 140	22-1856	Voltage reg 5.7V				D19
20-2562	Carbon Film	$\frac{1}{2}$	5	5.6k	R52, 141						
20-7058	Variable	$\frac{1}{2}$		470	R145						
	<u>Transistors</u>						<u>Integrated Circuits</u>				
22-6008	Silicon, pnp (2N3906)				Q6, 8, 15, 21	22-4083	Dual NAND Schmitt Trigger (7413)				IC1
22-6017	Silicon, npn (2N 2369)				Q5, 7, 9, 10, 11, 12, 13, 14, 18, 22, 23, 28, 29, 35, 37, 40, 41	22-4091 22-4102 22-4203 22-4206	Balance Mod/Demod. (MC 1496) Hi-perf op. Amp. (709) Selected op. Amp. (301) Precision Timer (555)				IC2 IC5 IC3 IC7
22-6038	Silicon, pnp (BCY71)				Q26	22-4700	Quad 2 i/p NAND CMOS (4011)				IC4
22-6041	Silicon, npn (BC109)				Q19, 20, 25, 27, 38, 39, 44, 45, 46	22-4725	Triple 3 i/p NOR CMOS (4025)				IC6
22-6068	Silicon, npn (NC107)				Q4, 24, 30						
22-6101	Silicon, FET. N (W300A)				Q43						
22-6110	Silicon, pnp (BFX48)				Q1, 2, 3, 17, 34, 36, 42	23-7124 23-7125	30-60MHz ferrite coil (blue) 30-60MHz ferrite coil (orange)				T1 T2
22-6158	FET, N Channel (J110)				Q31, 32, 33	23-7055	Inductor				L1
22-6112	Silicon, npn (ZTX450)				Q16	23-7107	Inductor				L2, 3
	<u>Miscellaneous</u>										
23-7517	Relay, 8 pin DIL, 500 $\Omega$ coil				RLA						

PARTS LIST FOR FIG. 9a

FM Mute Assembly 19-0953

Part No.	Description	Rating	Tol %	Value	Component Reference
	<u>Resistors</u>	<u>W</u>		<u>Ω</u>	
20-2103		$\frac{1}{4}$	5	10k	R134, 135
20-2104		$\frac{1}{4}$	5	100k	R133, 136
	<u>Diodes</u>				
22-1029	Silicon, general purpose (IN4149)				D18
	<u>Transistors</u>				
22-6041	Silicon, npn (BC 109)				Q25, 44, 45, 46
	<u>Relay</u>				
23-7517	8 pin DIL reed relay, 500Ω coil				RLA

PARTS LIST FOR FIG 11

COUNTER ASSEMBLY 19-0845

Part No.	Description	Rat	Tol %	Value	Component Reference	Part No.	Description	Rat	Tol %	Value	Component Reference
	<u>Resistors</u>	<u>W</u>		<u>Ω</u>			<u>Diodes</u>				
20-2006	Carbon Film	$\frac{1}{4}$	5	3.3	R31	22-1029	Silicon, general purpose (1N4149)				D1, 2, 3, 5, 6
20-2008	Carbon Film	$\frac{1}{4}$	5	4.7	R64	22-1814	Voltage regulator 9.1V				D4, 7, 8
20-2100	Carbon Film	$\frac{1}{4}$	5	10	R38						
20-2101	Carbon Film	$\frac{1}{4}$	5	100	R11, 50						
20-2102	Carbon Film	$\frac{1}{4}$	5	1k	R3, 8, 14 25, 28, 41, 42, 43, 45, 48						
							<u>Integrated Circuits</u>				
20-2103	Carbon Film	$\frac{1}{4}$	5	10k	R20, 22, 26, 30, 34 44, 49, 52, 55, 59, 60, 61	22-4044	Quad 2 Input Pos. NAND (7400)				IC8
						22-4045	Quad 2 Input Pos. NOR (7402)				IC5, 7
20-2104	Carbon Film	$\frac{1}{4}$	5	100k	R12, 13, 15, 16, 17, 66	22-4048	Dual D Bistable (7474)				IC1, 2
20-2123	Carbon Film	$\frac{1}{4}$	5	12k	R21	22-4060	Quad 2 Input NAND (7403)				IC6
20-2150	Carbon Film	$\frac{1}{4}$	5	15	R32, 33, 46	22-4123	BCD/Decimal Decoder (74145)				IC3
20-2180	Carbon Film	$\frac{1}{4}$	5	18	R2	22-4128	BCD/7 Segment Decoder (74247)				IC9
20-2181	Carbon Film	$\frac{1}{4}$	5	180	R35	22-4505	Quad NAND Schottky TTL (74S00)				IC13
20-2220	Carbon Film	$\frac{1}{4}$	5	22	R57	22-4521	Presetable Decade Counter (74196)				IC4
20-2221	Carbon Film	$\frac{1}{4}$	5	220	R7	22-4601	Racal CDI Chip 1018E				IC12
20-2222	Carbon Film	$\frac{1}{4}$	5	2.2k	R4, 9, 23, 24, 29, 36, 54	22-4721	Dual 4 Input NOR HEF4002(LOC MOS)				IC10
20-2223	Carbon Film	$\frac{1}{4}$	5	22k	R51, 53	22-4723	Binary/Decade Up/Down Counter HEF4029 (LOC MOS)				IC11
20-2270	Carbon Film	$\frac{1}{4}$	5	27	R63						
20-2332	Carbon Film	$\frac{1}{4}$	5	3.3k	R65						
20-2470	Carbon Film	$\frac{1}{4}$	5	47	R1						
20-2472	Carbon Film	$\frac{1}{4}$	5	4.7k	R18, 19, 37, 56						
20-2561	Carbon Film	$\frac{1}{4}$	5	560	R5, 10						
20-2562	Carbon Film	$\frac{1}{4}$	5	5.6k	R58	22-6009	Silicon, npn (2N4124)				Q8, 21, 23, 24
20-2822	Carbon Film	$\frac{1}{4}$	5	8.2k	R27	22-6017	Silicon, npn (2N2369)				Q1, 2, 3, 4, 5, 6, 25
20-5500	D.I.L. Array 7 x 56Ω				R62						Q22
20-5501	D.I.L. Array 8 x 220Ω				R39	22-6038	Silicon, pnp (BCY71)				Q7, 9, 10, 11, 12
20-5502	D.I.L. Array 13 x 1kΩ				R40	22-6113	Silicon, pnp High current (ZTX550)				13, 14, 15, 16, 17, 18, 19, 20
20-5503	D.I.L. Array 13 x 10k				R47						
20-2680	Carbon Film	$\frac{1}{4}$	5	68	R6						
							<u>Transistors</u>				
	<u>Capacitors</u>	<u>V</u>		<u>F</u>							
21-0598	Electrolytic	10	20	470μ	C12, 22						
21-1041	Tantalum	35	20	1μ	C25						
21-0596	Electrolytic	16	20	47μ	C9, 11, 18, 19, 24						
21-1520	Ceramic	500	10	100p	C5						
21-1532	Ceramic	500	20	1n	C1, 2, 14						
21-1589	Ceramic	10	-20+80	220n	C15						
21-1616	Ceramic	12	-20+80	100n	C3, 4, 7, 8, 10 13, 16, 17, 20, 21, 23						
21-1545	Ceramic	25	-20+80	10n	C26						





PARTS LIST FOR FIG. 15

AUDIO OSCILLATOR ASSEMBLY 19-0847

Part No.	Description	Rat	Tol %	Value	Component Reference	Part No.	Description	Rat	Tol %	Value	Component Reference
<u>Resistors</u>						<u>Transistors</u>					
		<u>W</u>		<u>Ω</u>							
20-2101	Carbon Film	$\frac{1}{4}$	5	100	R9, 13, 32, 36	22-6017	Silicon, npn (2N2369)				Q2
20-2102	Carbon Film	$\frac{1}{4}$	5	1k	R3, 7, 12, 29, 33, 35	22-6041	Silicon, npn (BC. 109)				Q4, 5, 7, 10, 11, 12
20-2103	Carbon Film	$\frac{1}{4}$	5	10k	R17	22-6101	FET, N Channel (W300A)				Q1
20-2122	Carbon Film	$\frac{1}{4}$	5	1.2k	R16, 25, 26	22-6102	FET, N Channel (W300D)				Q6
20-2151	Carbon Film	$\frac{1}{4}$	5	150	R22	22-6110	Silicon, npn (BFX48)				Q8, 9
20-2152	Carbon Film	$\frac{1}{4}$	5	1.5k	R23						
20-2154	Carbon Film	$\frac{1}{4}$	5	150k	R27						
20-2181	Carbon Film	$\frac{1}{4}$	5	180	R21						
20-2184	Carbon Film	$\frac{1}{4}$	5	180k	R28						
20-2221	Carbon Film	$\frac{1}{4}$	5	220	R24						
20-2222	Carbon Film	$\frac{1}{4}$	5	2.2k	R14						
20-2223	Carbon Film	$\frac{1}{4}$	5	22k	R5, 10	23-8000	Bead, Ferrite				FX1, 2
20-2224	Carbon Film	$\frac{1}{4}$	5	220k	R6, 30, 31	23-7086	Inductor		1mH		L1
20-2225	Carbon Film	$\frac{1}{4}$	5	2.2M	R1, 2						
20-2393	Carbon Film	$\frac{1}{4}$	5	39k	R19						
20-2473	Carbon Film	$\frac{1}{4}$	5	47k	R18						
20-4024	Metal Oxide	$\frac{1}{4}$	2	1.2k	R11, 15						
20-4068	Metal Oxide	$\frac{1}{4}$	2	1k	R4						
20-7001	Variable, cermet			500	R8						
20-7022	Variable, cermet			10k	R20						
<u>Capacitors</u>						<u>Miscellaneous</u>					
		<u>V</u>		<u>F</u>							
21-0598	Electrolytic	10	20	470 $\mu$	C3						
21-1000	Tantalum	35	20	3.3 $\mu$	C1						
21-1002	Tantalum	20	20	10 $\mu$	C14, 15, 16, 17						
21-1006	Tantalum	35	20	4.7 $\mu$	C13, 19						
21-1039	Tantalum	16	20	22 $\mu$	C5						
21-1041	Tantalum	35	20	1 $\mu$	C2						
21-1045	Tantalum	16	20	47 $\mu$	C23						
21-1511	Ceramic	500	10	18p	C22						
21-1520	Ceramic	500	10	100p	C6						
21-1545	Ceramic	25	-20+80	10n	C8, 21						
21-1616	Ceramic	12	-20+80	100n	C10, 11, 18, 20, 24						
21-4536	Polyester	160	1	330n	C4, 9						
21-0596	Electrolytic	16		47 $\mu$	C7, 12, 25, 26						
<u>Diodes</u>											
22-1029	Silicon, general purpose (1N4149)				D1, 2, 3						
<u>Integrated Circuits</u>											
22-4229	JFET Operational Amplifier (TL081CP)				IC1						

PARTS LIST FOR FIG 18

120MHz LOOP ASSEMBLY 19-0849

Part No.	Description	Rat	Tol %	Value	Component Reference	Part No.	Description	Rat	Tol %	Value	Component Reference
	<u>Resistors</u>	<u>W</u>		<u>Ω</u>			<u>Diodes</u>				
20-2101	Carbon Film	$\frac{1}{4}$	5	100	R1, 20	22-1029	Silicon, gen purpose (1N4149)				D2,3,4
20-2102	Carbon Film	$\frac{1}{4}$	5	1k	R18, 22, 24, 34 36,39	22-1038	Variable capacitance 22pF (MV.1634)				D1
20-2104	Carbon Film	$\frac{1}{4}$	5	100k	R9						
20-2105	Carbon Film	$\frac{1}{4}$	5	1M	R32						
20-2122	Carbon Film	$\frac{1}{4}$	5	1.2k	R7		<u>Integrated Circuits</u>				
20-2150	Carbon Film	$\frac{1}{4}$	5	15	R3,15,19,23	22-4044	Quad 2 Input Pos. NAND (7400)				IC6
20-2152	Carbon Film	$\frac{1}{4}$	5	1.5k	R12	22-4049	Decade Counter (7490)				IC2,3,5,7
20-2182	Carbon Film	$\frac{1}{4}$	5	1.8k	R37	22-4200	Phase/Frequency Detector (MC4044)				IC4
20-2220	Carbon Film	$\frac{1}{4}$	5	22	R42	22-4507	Dual Master/Slave D-Type Bistable (MC.10131L)				IC8
20-2221	Carbon Film	$\frac{1}{4}$	5	220	R26	22-4544	Dual J-K Bistable MECL (MC.10135P)				IC1
20-2223	Carbon Film	$\frac{1}{4}$	5	22k	R35						
20-2272	Carbon Film	$\frac{1}{4}$	5	2.7k	R33		<u>Transistors</u>				
20-2333	Carbon Film	$\frac{1}{4}$	5	33k	R5	22-6017	Silicon, npn metal can (2N2369)				Q4,5,6,7
20-2391	Carbon Film	$\frac{1}{4}$	5	390	R28	22-6041	Silicon, npn (BC.109)				Q2
20-2470	Carbon Film	$\frac{1}{4}$	5	47	R29	22-6079	Silicon, npn, high speed (ZTX313L)				Q1
20-2471	Carbon Film	$\frac{1}{4}$	5	470	R4,44	22-6102	FET, N channel				Q3
20-2472	Carbon Film	$\frac{1}{4}$	5	4.7k	R13,21,30,31,38,40 43						
20-2473	Carbon Film	$\frac{1}{4}$	5	47k	R6,8		<u>Inductors</u>				
20-2561	Carbon Film	$\frac{1}{4}$	5	560	R2,25,41	23-7014	Choke, sub-min 10 10μH				L1
20-2681	Carbon Film	$\frac{1}{4}$	5	680	R10,11	23-7127	Ferrite coil 60/120MHz (orange)				L3
20-2682	Carbon Film	$\frac{1}{4}$	5	6.8k	R27	23-7128	Ferrite coil 60/120MHz (yellow)				L2
20-2821	Carbon Film	$\frac{1}{4}$	5	820	R14,16,17,45						
	<u>Capacitors</u>	<u>V</u>		<u>F</u>			<u>Thermistar</u>				
21-0598	Electrolytic	10		470μ	C26	22-3003	Thermistar G53C				TH1
21-1006	Tantalum	35	20	4.7μ	C2,5,23,24						
21-1045	Tantalum	16	20	47μ	C12						
21-1512	Ceramic	500	10	22p	C35						
21-1508	Ceramic	500	10	10p	C34						
21-1527	Ceramic	500	10	390p	C1,3						
21-1530	Ceramic	500	10	680p	C14,15,17,18						
21-1532	Ceramic	500	20	1n	C16,19,31						
21-1542	Ceramic	500	20	6.8n	C27						
21-1545	Ceramic	500	-20+80	10n	C4,6						
21-1589	Ceramic	10	-20+80	220n	C28						
21-1616	Ceramic	12	-20+80	100n	C10,20,22,25,30, 32,33						
21-1684	Ceramic	63	2	22p	C8						
21-1686	Ceramic	63	2	33p	C13						
21-1708	Ceramic	50	20	100n	C7,11						
21-0596	Electrolytic	16		47μ	C9,21,29						

## PARTS LIST FOR FIG 19

### POWER SUPPLY

NOTE: Power supply components are mounted on the rear panel assembly except for D4 which is mounted on the chassis rear bulkhead (See Fig. 1).

Part No.	Description	Rated	Tol %	Value	Component Reference
<u>Resistors</u>					
		<u>W</u>		<u>Ω</u>	
20-5036	Wire Wound	2.5	5	47	R1
<u>Capacitors</u>					
		<u>V</u>		<u>F</u>	
21-0581	Electrolytic	40		2 200μ	C1
21-0654	Electrolytic	63		4.7μ	C2
21-0582	Electrolytic	25		6 800μ	C3
21-1006	Tantalum	35		4.7μ	C4,6,7
21-0583	Electrolytic	16		15 000μ	C5
<u>Diodes and Transistors</u>					
22-1650	Bridge Rectifier 2A (VS.248)				D1,2
22-1662	Bridge Rectifier 6A (VH.248)				D3
22-1846	Voltage Reg 6.8V (1S.6006RA)				D4
22-6104	Silicon, npn high power (MJE. 3055)				Q1
<u>Integrated Circuits</u>					
22-4220	Regulator, +24V (MC.7824CP)				IC1
22-4219	Regulator, +12V (MC.7812CP)				IC2
22-4218	Regulator, -6V (MC.7906CP)				IC3
<u>Miscellaneous Power Supply Items</u>					
23-0032	Fuselink 315mAT surge-resisting (for 188V-260V supply)				FS1
23-0060	Fuselink 630mAT surge-resisting (for 94V-130V supply )				FS2
23-0008	Fuselink 2A (quick action)				FS2
23-0044	Fuseholder, panel mounting for FS1				
23-0040	Fuseholder, chassis mounting for FS2				
23-4091	Switches, slide, Voltage selectors				S14, S15
23-3005	Socket, BNC				SK84,85,86
23-3222	Mains input filter/connector				
17-4076	Transformer, mains				T1

PARTS LIST FOR FIGS. 20 & 21

Part No.	Description	Rat	Tol %	Value	Component Reference	Part No.	Description	Rat	Tol %	Value	Component Reference
<u>SPIN WHEEL ASSEMBLY (11-1212)</u>						<u>MISCELLANEOUS COMPONENTS</u>					
20-2681	Resistor, carbon film	$\frac{1}{2}$	5	68 $\Omega$	R28, 29	<u>Resistors</u>		<u>W</u>	<u><math>\Omega</math></u>		
20-2222	Resistor, carbon film	$\frac{1}{2}$	5	2.2k $\Omega$	R38, 39	20-3471	Carbon Film	$\frac{1}{2}$	5	470	R1, 30
22-7000	Photo Dorlington Amplifier (ZM100)				Q1 and Q2	20-6028	Variable, dual, linear		20	50k	R31a, 3
26-5008	LED, size T13/4 (HP.5082.4658)				LP2, LP3	20-2224	Carbon Film	$\frac{1}{2}$	5	220k	R32
21-0788	Capacitor		16V	47 $\mu$ F	C5	20-6027	Variable, linear	2	2	5k	R34
23-7014	Choke			10 $\mu$ H	L1	20-2122	Carbon Film	$\frac{1}{2}$	5	1.2k	R35, 36
						20-2271	Carbon Film	$\frac{1}{2}$	5	270	R37
						20-7045	Variable, dual, linear		10	50k+5k	R33a, 3
<u>RANGE SWITCH ASSEMBLY (11-1213)</u>											
20-4909	Resistor, metal film	25ppm	0.25	75 $\Omega$	R5, 6	<u>Capacitors</u>		<u>V</u>	<u>F</u>		
20-4911	Resistor, metal film	25ppm	0.25	150 $\Omega$	R2, 3, 4	21-1610	Ceramic	100	-20+80	10n	C5*
17-0096	Switch, rotary, to Racal drawing				S2	21-1694	Ceramic	63	2	150p	C6*
<u>OUTPUT SWITCH ASSEMBLY (11-1214)</u>											
20-2822	Resistor, carbon film	$\frac{1}{2}$	10	8.2k $\Omega$	R42	<u>Solid State Items</u>		<u>Type</u>			
20-4921	Resistor, metal film	50ppm	0.5	1k $\Omega$	R25	22-1602	Diode, silicon, rectifier			1N4002	D5
20-4922	Resistor, metal film	50ppm	0.5	1.2k $\Omega$	R26, 27	26-5003	Light emitting diodes (l.e.d.) red			(HP5082-4850)	LP1, LP
21-0566	Capacitor, electrolytic	25V	+80-20	1000 $\mu$ F	C4						
17-0100	Switch, to Racal drawing				S12						
<u>MODULATION FREQUENCY SWITCH ASSEMBLY (11-1215)</u>											
20-4056	Resistor, metal oxide	$\frac{1}{2}$	2	47 $\Omega$	R17, 21	<u>Miscellaneous</u>					
20-4046	Resistor, metal oxide	$\frac{1}{2}$	1	56 $\Omega$	R18, 22	23-4090	Switch, toggle				S1
20-4020	Resistor, metal oxide	$\frac{1}{2}$	2	680 $\Omega$	R19, 24	23-4084	Switch, toggle, s.p.				S3
20-4001	Resistor, metal oxide	$\frac{1}{2}$	2	120 $\Omega$	R20, 23	17-0099	Switches to Racal drawing				S6, 7
17-0100	Switch, to Racal drawing				S10	17-0100	Switches to Racal drawing				S8, 9, 1
<u>PEAK DEVIATION SWITCH ASSEMBLY (11-1217)</u>											
20-2224	Resistor, carbon film	$\frac{1}{2}$	5	220k $\Omega$	R40	23-3236	Plug, SMA, straight				SK96
20-2225	Resistor, carbon film	$\frac{1}{2}$	10	2.2M $\Omega$	R41	23-3030	Socket BNC				SK97, 9
20-4956	Resistor, metal oxide	$\frac{1}{2}$	5	365k $\Omega$	*R12	17-3166	Choke, to Racal drawing				L1*
20-4916	Resistor, metal film, 25ppm	0.25		46.4k $\Omega$	R8	17-1010	Meter, to Racal drawing				M1
20-4915	Resistor, metal film, 25ppm	0.25		13.3k $\Omega$	R9	23-7010	Choke, sub miniature, RF			2.2 $\mu$ H	L2, 3, 4
20-4913	Resistor, metal film, 25ppm	0.25		2k $\Omega$	R10						
20-4914	Resistor, metal film, 25ppm	0.25		4.64k $\Omega$	R11						
20-4918	Resistor, metal film, 25ppm	0.25		36.5k $\Omega$	R7, 15						
20-4917	Resistor, metal film, 25ppm	0.25		3.65k $\Omega$	R13						
20-4919	Resistor, metal film, 25ppm	0.25		12.1k $\Omega$	R14						
20-4920	Resistor, metal film, 25ppm	0.25		121k $\Omega$	R16						
* NOTE: R12 may be two 732k (20-4955) in parallel.						* NOTE: On later equipment L1, C5 and C6 are replaced by 21-6503 FILTERCON, RFI suppression.					
21-2823	Capacitor, silver mica	350V	2	174pF	C1						
21-2590	Capacitor, polystyrene	200V	2	4.150nF	C3						
17-0098	Switch, to Racal drawing				S5						
<u>CHANNEL SPACING SWITCH ASSEMBLY (11-1256)</u>											
22-1029	Diode, General purpose				D1, D2						
17-0097	Switch, to Racal drawing				S4						

PARTS LIST FOR FIG. 22

NOTE: For location of items to Fig. 1, chassis view.

ITEMS MOUNTED ON REAR PANEL

<u>Part No.</u>	<u>Description</u>	<u>Component Reference</u>
23-4043	Switch, toggle	S13
9442/12	Frequency standard	
9420M	Optional frequency standard	
20-4854	Resistor, metal film                      0.5%    10kΩ	R1,3
20-6029	Resistor, variable wire wound            10%    10kΩ	R2

For other rear panel mounted items in the power supply refer to Fig.19 and Parts List 10.

ITEMS MOUNTED ON MAIN CHASSIS  
(other than p.c.b. assemblies)

11-1237	Manual Attenuator Assembly (Model 9081 with serial number up to 2109)	
11-1364	Manual Attenuator Assembly (Model 9082 and model 9081 with serial numbers after 2109).	
11-1414	Manual Attenuator Assembly (Models 9081H and 9082H)	
11-1404	Amplifier (Models 9081H and 9082H).	
14-1499	Coaxial connectors	
21-1508	Capacitor, Ceramic, 500V, 10%                      10pF	C2
21-6501	Capacitor, feed-through                                      1000pF	
21-6502	Capacitor, feed-through                                      500pF	
21-6503	Filtercon	
22-1846	Diode, voltage regulator, 6.8V	D4 (Fig.19)
23-3193	Conhex Adaptor	PL2,3,4,5,6, PL8,9,10,11,95
23-3234	SMA Connector, straight, bulkhead	SK19
23-3235	SMA plug, straight	
23-3239	Type N plug	
23-3280	SMA plug, right-angled.	
23-7008	Choke, r.f., sub-miniature                                      1μH	L5,6,7,8
23-7010	Choke, r.f., sub-miniature                                      2.2μH	L9
23-9101	Ring RFI (for attenuator shaft)	
23-3165	Socket, Type N, bulkhead mounting	

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SYNTHESIZED SIGNAL GENERATORS 9081 & 9082AMENDMENTS

The following amendments are necessary to the 9081 and 9082 Vol.2 manual to render it suitable for the 9082C version of the instrument.

INTRODUCTORY PAGE

After the LETHAL WARNING insert the attached PREFACE, 1 page.

REPLACEMENT PAGES

Remove existing pages 4-13/4-14 and insert new pages 4-13/4-14.

Remove existing pages 5-3/5-4, 5-11/5-12, 5-15/5-16 and substitute new pages 5-3/5-4, 5-11, 5-11(a)/5-12 and 5-15/5-16.

After existing page 5-25 insert new page 5-25(a).

Remove Parts List pages 3a, 3b/Fig.6, 7/Fig. 14, 10, 11, 12 and substitute new pages 3a, 3b/Fig. 6, 7/Fig. 14, 10, 11, 12.

Remove existing Figs. 7, 15, 19, 20 and 22 and substitute new Figs. 7, 15, 19, 20 and 22.

MANUSCRIPT AMENDMENTS

Page Tech Spec. (3)

RF OUTPUT:

Output Level (1): Fourth line - amend '-130 dB' to read '-129 dB'.

Output Level (3): Second line - amend '-10 dB' to read '-9 dB'.

Attenuator Accuracy: Under existing para. add: '±0.02 dB per 1 dB step (cumulative with reference to 0 dB) ±0.1 dB.'

Output Level Flatness (1): Amend '±0.7 dB' to read '±1.2 dB'.

Output Level Flatness (2): Amend '±2.5 dB' to read '±3 dB'.

Page Reference:

Amend to read '9082C Vol. 2'.

Page Tech. Spec (4)

RF OUTPUT: Output Level Accuracy (1): Amend ' $\pm 0.8$  dB' to read ' $\pm 1.3$  dB' and ' $\pm 1.5$  dB' to read ' $\pm 2$  dB'.

Page Reference: Amend to read '9082C Vol.2'.

Page Tech Spec. (5)

AMPLITUDE MODULATION: Modulation Depth (2): Amend '800 mV' to read '400 mV'.

After 'Accuracy': add new heading and text:

Stability:

At fixed carrier frequency, variation of output level gives change in mod. depth of  $\leq \pm 0.5\%$  relative to mod. depth at full output level.

Page Reference: Amend to read '9082C Vol.2'

Page Tech Spec. (7)

ACCESSORIES: Optional Accessories (1): After '9420M' add '(Not available on the 9082C)'

Page 1-1

Paragraph 1.5: First line - amend ' $\pm 0.5$  dB' to read ' $\pm 1$  dB'

Third line - amend '-130 dB' to read '-129 dB'

Page Reference: Amend to read '9082C Vol. 2'

Page 2-2

Paragraph 2.3 (11): Second line - amend '13 dB, +3 dB and -10 dB' to read '12 dB, +3dB and -9dB'

Page Reference: Amend to read '9082C Vol. 2'

Page 5-2

Table 5

Item 1. Amend the following columns:

Description - to read 'Multimeter'

Requirements - to read 'Range 0 to 30 V d.c.

0 to 2 k $\Omega$  resistance

Sensitivity 20k $\Omega$ /Volt.

Preferred Type - to read 'AVO 8'

Item 13. After this item insert the following details in their respective columns:

Item	Description	Requirements	Preferred Type
14	1 dB Step Attenuator	-	HP355C

Item 14: Amend this to read '15'

Page Reference: Amend to read '9082C Vol. 2'

Page 5-8 Paragraph 5.6 (16)	After present sentence add new sentence 'Check that FINE TUNE ON indicator lights'.
Page 5-9 Paragraph 5.8 (3)	Second line - amend '-10 dB' to read '-9 dB'.
Page Reference:	Amend to read '9082C Vol. 2'.
Page 5-10 Paragraph 5.11	'Shorting link'. Delete reference to 'Item 13'.
Paragraph 5.12 (1)	Second line - amend 'NORMAL' to read 'X2'. Third line - insert the missing slash ( / ) from 'ØM'.
Page Reference	Amend to read '9082C Vol. 2'.
Page 5-13 Paragraph 5.14 (3)	Amend '0.8 V' to read '0.4 V'.
Page Reference:	Amend to read '9082C Vol. 2'.
Page 5-14. Paragraph 5.16 (5)	Amend '380 kHz' to read '370 kHz'.
Page Reference:	Amend to read '9082C Vol. 2'.
Page 5-17 Paragraph 5.19	'Cable with N-N connectors' - delete 'Item 13'.
Paragraph 5.20 (4)	Third line - amend '±0.6 dB' to read '±1.1 dB'. Fifth line - amend '±1.5 dB' to read '±2.0 dB'
Page Reference:	Amend to read '9082C Vol. 2'.
Page 5-20 Paragraph 5.25	'Cable with N-N connectors'. Delete reference to 'Item 13'.
Page 5-23 Paragraph 5.32 (1):	Last line - amend '100 kHz' to read 'ØM 10 rads'.
Page 5-24 Paragraph 5.32 (4)	After this paragraph add: NOTE: Adjust COARSE control for full scale deflection on UUT meter at each measurement.

Page 5-25

Paragraph 5.34 (3):

Amend '800 mV' to read '400 mV'.

Page Reference:

Amend to read '9082C Vol. 2'.

Page 5-27

Paragraph 5.38 (3)

Second line - amend '800 mV' to read '400 mV'.

Table 15 - amend all '800 mV' to read '400 mV'.

Page Reference:

Amend to read '9082C Vol. 2'.

Page 5-30

Paragraph 5.45 (3)

Amend paragraph to read:

Tune the UUT to 500 MHz. Adjust the UUT Vernier to bring signal to the top graticule line of the analyser display. The UUT meter should read +3 dBm.

### RECORDING

Insert this amendment sheet at the rear of the manual for record purposes.

## PREFACE

This manual has been amended for use on the Avionics Signal Generator Model 9082C. Where the information contained is relevant ONLY to the 9082C, such pages are identified by the reference '9082C Vol.2' in the bottom left hand corner. All remaining text is applicable to all instruments.

The Avionics Signal Generator 9082C has improved AM sensitivity and better AM depth stability with carrier-level change.

An improved vernier control of output level attenuation has been incorporated, comprising an eleven-times-1 dB-step attenuator (ungraduated) with a concentrically-mounted potentiometer of approximately 1 dB. This vernier provides a continuously variable attenuation range of 12 dB (+3 dB to -9 dB with reference to the Output Level switch position), giving a total instrument attenuation range of +3 dBm to -129 dBm.

Range 1 Mixer and Filtering

4.78 The Range 1 frequency band is obtained by mixing a 120 MHz reference with a portion of the Range 4 spectrum. This restricted portion of the range is determined by the ROM in the Divider and Phase Detector Assembly, which limits the tuning range on this band.

4.79 The 120 MHz reference is applied to T1 in the mixer, via R19, R20 and the filter L3/L4/C16/C17/C18. The Range 4 signal from Q10 collector is fed into the opposite side of the mixer at T3. The mixer output is fed via Q6 to a low pass filter L5/L6 and associated components which removes unwanted mixer frequencies. The output is enabled when Q7 is turned on by a logical '0' on line RE, applying a positive supply to the collectors of Q6 and Q8, and forward biasing the combiner diode D17.

RF Output Amplifier

4.80 The r.f. signal from the selected range is fed via the combiner diode D7, or D17, and C74 to the modulator preamplifier Q13, which has an overall gain of approximately x4. The r.f. signal is then buffered in Q14 and fed via the components of the modulator stage to Q15, which is the driver for the balanced output power amplifier Q16/Q17. Amplifier bias is preset by R94. The output is fed via C94 to the output attenuator. The diode D36 with R107 and C97 forms a peak detector on the output waveform which provides a d.c. level for automatic level control and meter information.

Output Metering

4.81 The r.f. output is peak detected by D36 and the information stored on C97, this level being applied via the filter L22/C98 and R128 to the operational amplifier IC7 which operates in a conventional circuit, with the addition of diode D38 for temperature compensation. The output is fed to the meter via pin 31 through the Output switch S12 to the Meter switch S11 (see Fig. 20). Meter ranging is by a bank of resistors on the 1 dB Step Attenuator switch and selected by it. Meter calibration is by resistors R134 and R136 for zero and full scale deflections respectively.

Amplitude Modulator Stage

4.82 The modulator operates on the principle that the impedance of the p.i.n. diodes D33, D34 and D35 varies according to the applied bias current. If this bias current is varied at an audio frequency then amplitude modulation of the r.f. signal will occur. Similarly, the r.f. carrier level can be controlled automatically, or manually, by a d.c. level applied to the p.i.n. diodes, as described below. The modulation process is described in para. 4.87..

ALC and Carrier Level Setting

4.83 The automatic level control (ALC) comparator is IC9, which compares the peak detected signal level on C97 with an adjustable reference level applied to the other input (IC9a/2). The output at IC9/7 is fed via L19, R89 and R90 to the p.i.n. diodes D33/D34 and D35. The diode attenuation, and hence the carrier level is thus controlled at a point which produces a balance between the two inputs of comparator IC9.



- 4.84 The carrier level (in c.w. mode) is manually adjusted by the front panel Vernier potentiometer, which is fed with a d.c. reference level provided by IC4, zener diode D40, and associated components.
- 4.85 The reference d.c. level from IC4/6 is set by AOT resistor R161. The reference d.c. level is fed via R151 to Q20. In the absence of any audio input at pin 23, this reference will set the carrier level via Q20 and Q19, manually adjusted by the Vernier potentiometer between terminals 25 and 21. Potentiometers R153 and R143 set the a.m. depth to be the same at the extremes of the Vernier control.
- 4.86 From the Vernier potentiometer the carrier reference (and audio signal if on AM) are fed through the shaper buffer IC8, R118 and D37 to one input of the a.l.c. comparator IC9, thus providing the reference described in para. 4.83. The purpose of D37 is to provide temperature compensation in the peak detector circuit and for this reason D36, D37 and D38 are mounted in physical contact.

#### X2 Output

- 4.87 A d.c. carrier reference voltage is set by AOT resistor R159 and fed to tag 'C' of the Output switch S12/1F (Fig. 20) via line RN3a. In switch position 'X2' this voltage is fed to the modulation input at pcb pin 23, setting the carrier level as previously described. Simultaneously, wafer S12/1F inserts attenuating resistance R26 into the meter path, causing the meter to read half the true output level. The 'X2' facility is inoperative in the a.m. mode.

#### AM Audio Input

- 4.88 The audio signal from the internal oscillator (or external modulation source) is fed via switches S8 and S12/1F (Fig. 20) to pin 23 on the Output System p.c.b. It is then fed via the carrier reference path to the a.l.c. comparator IC9.
- 4.89 ALC information is provided via the peak detector diode D36 which tends to be non-linear near the trough of the modulation envelope when modulating to a high percentage at relatively low carrier levels. The function of the AF Shaper IC6, and the transistors in the package IC5, is to introduce sufficient a.f. shaping over a wide temperature range to compensate for any non-linearity in D36 and thus ensure an undistorted modulating waveform at the output of the comparator IC9. The shaper is calibrated by adjustment of R109.

#### OUTPUT AMPLIFIER 11-1404 (9081H and 9082H ONLY)

- 4.89a The increased maximum output level of models 9081H and 9082H is achieved by means of an additional amplifier between the output system assembly and the attenuator, (see Fig. 22). The amplifier module is mounted adjacent to the attenuator. No parts list or repair information for the amplifier is given in this manual. In the event of failure the complete module should be replaced.

## REMOVAL OF COVERS

WARNING: DANGEROUS AC VOLTAGES ARE EXPOSED WHEN COVERS ARE REMOVED WITH AC SUPPLY CONNECTED. COVERS SHOULD BE REMOVED BY AUTHORISED PERSONS ONLY.

- 5.2
- (1) Switch the instrument POWER switch to STANDBY and switch off the a.c. supply at the bench outlet. Unplug the power lead from the rear panel of the instrument.
  - (2) Remove the six screws from the particular cover (top or bottom) which is to be removed.
  - (3) Remove the two rubber plugs (located near to the rear end) from both side panels of the instrument and slacken, by about two turns, the screws revealed.
  - (4) Grip the rear panel assembly and ease it back from the main case to the maximum extent available (about 5mm).
  - (5) The rear edge of either cover can now be lifted and the cover withdrawn outwards and rearwards. Take care not to displace or damage the RF gasket material when removing or replacing covers.

## POWER SUPPLY TESTS

- 5.3
- (1) Do not connect the a.c. mains supply. Check that the mains fuse is correctly rated for the supply voltage range, as marked on the rear panel.
  - (2) Check that the 6V d.c. supply fuse on the inner face of the rear panel is a 2A quick action type (to remove top cover see para. 5.2)
  - (3) Set the front panel POWER switch to ON and remove the locking plate of the rear panel voltage selector switches (see para. 5.1)
  - (4) Set the multimeter to read 'ohms' and connect between the line and neutral pins of the rear panel mains input plug. Set the mains voltage selection switches to the positions in Table 6 and verify satisfactory resistance readings.
  - (5) Set the voltage selector switches to the correct positions for the local a.c. supply (page 5-1 Table 4) and secure the locking plate.
  - (6) Do not connect the mains supply, but with the front panel POWER switch at ON, set the OUTPUT switch to NORMAL.

TABLE 6

Mains Input Resistance Readings

Left Hand Switch*	Right Hand Switch*	Mains Plug Resistance Readings
Down	Up	11.5 - 15.5Ω
Up	Up	14.5 - 19.5Ω
Down	Down	45 - 61Ω
Up	Down	57 - 77Ω

\*Left hand and right hand are as seen when looking at the rear panel.

- (7) Refer to Fig. 5.1, and with the multimeter set to measure ohms, measure the resistance between the tags A, B and C on the rear panel tag strip and chassis. Note the correct connection of the ohmmeter leads as shown in Fig. 5.1.
- (8) Set the POWER switch to OFF and the rear panel STANDARD switch to INTERNAL.
- (9) Finally, connect the a.c. mains supply lead to the rear panel plug.
- (10) Plug in the a.c. mains supply.
- (11) Switch POWER to ON. Check that the Power indicator illuminates and the digital display comes on.
- (12) Refer to Fig. 5.1 and, with a multimeter, measure the d.c. voltages relative to chassis, on the rear panel tag strip, at points A, B and C as follows:-

Tag A	+24V ± 1V
Tag B	+12V ± 0.5V
Tag C	-6 V ± 0.25V

- (13) Check that the d.c. voltage at pin 2 on the side panel regulator is +12V ± 0.5V with respect to chassis.
- (14) Check that the 1 dB step attenuator on the VERNIER control operates by rotating the control and listening for the solenoid action.

- (7) Tune the UUT to 65 MHz on range 2.
- (8) Adjust inductor L16 on the p.c.b. for minimum amplitude on the spectrum analyser.
- (9) Disconnect the +12V link from pin 8.
- (10) Tune to 67MHz and adjust L15 on the p.c.b. for maximum amplitude on the spectrum analyser.
- (11) Disconnect the spectrum analyser and connect the millivoltmeter to the 50 $\Omega$  output, using RG213U cable with 'N' connectors.
- (12) Remove the earthing link from LK1.
- (13) Set the OUTPUT LEVEL switch to NORMAL and tune the UUT to 50MHz.
- (14) Set R153 to approximate mid position.
- (15) Set the 1 dB STEP ATTENUATOR to give maximum output and turn the VERNIER control fully clockwise.
- (16) Connect the modulation meter, TF2300 to the UUT output. Connect the distortion analyser to the audio output from the TF2300 and the multimeter to its d.c. output.
- (17) Select AM switch to EXT on the UUT. Connect a 1 kHz low distortion audio source to the AM 600 $\Omega$  socket of the UUT and monitor the level of this audio input with a HP400E millivoltmeter.
- (18) Set the level of audio input to read 400 mV on the millivoltmeter and adjust R153 until the modulation meter reads 80%.
- (19) Set VERNIER control on UUT fully anticlockwise and adjust R143 until the modulation meter reads 80%. Adjust R109 for minimum distortion on analyser.
- (20) Disconnect the mod. meter from UUT and connect the millivoltmeter 9301.
- (21) Turn VERNIER control fully clockwise and select an AOT resistor (R161) in parallel with R145 (nominal 27k $\Omega$ ) such that its value is the minimum which allows > 3dBm to be obtained on the 9301.
- (22) Adjust VERNIER control to give 3dBm on the 9301 and adjust R134 until the UUT meter reads +3dBm.

- (23) Reset the 1 dB STEP ATTENUATOR to give -8 dBm on the 9301 and adjust R134 until the UUT meter reads -8 dBm. Repeat operation (21) and (22) until the UUT meter and 9301 agree at +3 dBm and -8 dBm levels.
- (24) Recheck modulation depth and distortion, operations (16) through (19) and adjust if necessary. If circuit has been adjusted, repeat operation (20) to evaluate continued suitability of AOT resistor R161.
- (25) Remove the 9301 and reconnect the mod. meter. Check that audio input is still 400 mV and tune UUT to 520 MHz. Ensure that at +3 dBm and +2dBm (use VERNIER to control the output levels) the modulation depth is 80%.
- (26) Reset 1 dB STEP ATTENUATOR and VERNIER control to give maximum output (operation 15). Remove the mod. meter and connect the 9301. Set VERNIER to give +3 dBm on the 9301.
- (27) Select X2 on OUTPUT LEVEL switch and adjust value of AOT resistor R159 so that the 9301 millivoltmeter reads +9 dBm  $\pm 0.2$  dB. On the OUTPUT LEVEL switch solder AOT resistor (33k $\Omega$  nominal) across R27 to bring the UUT meter reading within  $\pm 0.1$  dB of the 9301 reading.
- (28) Operate the 1 dB STEP ATTENUATOR and ensure that steps of 1 dB are obtained on the UUT meter.
- (29) Select NORMAL on the OUTPUT LEVEL switch and set 3 dBm on the UUT meter. Reduce level using the 1 dB STEP ATTENUATOR and check that level drops in 1 dB steps.
- (30) Tune UUT to 1.5 MHz, select X2 on the OUTPUT LEVEL switch and set level to +9 dBm. Monitor LK1 on 19.0949 with the AVO on +10 V d.c. range (positive lead to link and negative to chassis). Adjust R19 to obtain a reading of 3.5 V d.c.
- (31) Tune the UUT from 1.5 MHz to 36 MHz and ensure AVO reading does not exceed 4 V.
- (32) Tune the UUT over the remaining ranges using the 60 kHz CHANNEL SPACING selection and ensure AVO reading does not exceed 6 V.

NOTE: It may be necessary to re-adjust R19 slightly to achieve low harmonic distortion and/or minimum spurious specification on Band 1. However, adjustment of R19 must NOT be to the detriment of the output level specification.

- (33) Disconnect the multimeter and connect the UUT 50 $\Omega$  output socket to a spectrum analyser which has 30dB of input attenuation selected.
- (34) On the UUT set:-  
The AM switch to OFF  
The OUTPUT switch to X2  
The RANGE MHz switch to 256-512 position.
- (35) Tune the UUT across the range and adjust R94 on the p.c.b. (output amplifier bias) for minimum 2nd and 3rd harmonic distortion on the analyser display which must be at least 30dB below carrier level.

- (12) Operate the PEAK DEVIATION switch on the UUT to the 30 kHz, 10 kHz and 3 kHz positions, adjusting each by means of the FM/ØM COARSE control. Check that identical indications appear on the modulation meter,  $\pm 3\%$  to the UUT settings and readings.
- (13) Disconnect the test equipment. Check that all p.c.b. assemblies are tightly screwed down. Replace the casting covers, checking carefully that the r.f. gasket is correctly positioned and not damaged. Screw the covers down tightly, but avoid using excessive force which might strip the threads.

### DISTORTION CHECK

#### 5.17 Test Equipment Required

Page 5-2 Table 5

Spectrum Analyser

Item 5

#### 5.18 Procedure

- (1) Set the UUT controls as follows:-

OUTPUT switch to NORMAL.

OUTPUT LEVEL switch to 0 dBm position.

Set UUT meter to 0 dBm using VERNIER control

RANGE MHz switch to '256-512' position.

FM/ØM and AM INT/EXT switches to OFF.

METER switch to CW position.

- (2) Tune the UUT to 250 MHz and adjust the VERNIER control for 0dBm reading on the UUT meter.

- (3) Set the Spectrum Analyser controls as follows:-

Input attenuation	30dB
Log. ref.	+10dB
Vernier	-7dB
Scanwidth	0-1250MHz on red control.
Video filter	Off
Bandwidth	300kHz

- (4) Tune the UUT from 240 to 540MHz and, by observing the spectrum analyser, verify that all harmonics are at least 30dB below carrier level, and that sub-harmonically related signals are at least 40dB below carrier.
- (5) Tune the UUT through each range in turn and verify that the harmonics and sub-harmonics meet the limits in Table 9. The spectrum analyser setting for each range are given in Table 9.

TABLE 9

Distortion Check

Tuning Range MHz	Analyser		UUT	
	Centre freq.	Scanwidth	Harmonic Level	Sub-Harmonically Related Signals
256-512	-	0-1250MHz )		
128-256	500 MHz	100MHz/div)	At least	At least
64-128	500MHz	100MHz/div)	30dB	40db below
32-64	500MHz	100MHz/div)	below	carrier
5-32	50MHz	10MHz/div )	carrier	
1.5-5 (9082 only)	8MHz	2MHz/div )	At least 20dB below carrier	At least 30dB below carrier

- (6) On the UUT set the OUTPUT switch to X2 position and adjust the VERNIER control for a meter reading of +3dB.
- (7) On the spectrum analyser set 30dB input attenuation and the Log. Ref. vernier to -1dB.
- (8) Repeat operation (5) and verify that all harmonics are at least 24dB below carrier for frequencies between 5 and 540MHz and at least 18dB below carrier for frequencies between 1.5 and 5MHz (9082 only).
- (9) Disconnect the spectrum analyser.



## A.M. ACCURACY CHECK

### 5.34(a) Test Equipment Required

Page 5.2 Table 5

1dB Step Attenuator	Item 15
Modulation Meter (Racal 9009)	Item 3
Multimeter (AVO8)	Item 1
Distortion Analyser (HP333A)	Item 6
Audio Signal Generator	Item 9
Millivoltmeter (Audio) HP400E	Item 8

- (1) Connect the UUT output to the low level input of the modulation meter 9009 via the 1dB step attenuator unit. Select 100% range on mod. meter.
- (2) Connect the AVO8 multimeter to the d.c. output of the mod. meter with its audio output taken to the distortion analyser.
- (3) Connect the audio signal generator to the 600Ω BNC and monitor the signal input voltage with the HP400E.
- (4) Set the UUT controls  
FM/ØM to 'OFF'  
AM to 'EXT'  
METER to read 'CW'
- (5) Tune UUT to 520 MHz and adjust the attenuator controls of the UUT to give 3dBm on the UUT meter. Select 12dB on external attenuator.
- (6) Record mod. depth and T.H.D. (using distortion analyser) this should be 80% ±3% with T.H.D. ≤ 4%. Let mod. depth be 'A'%.
- (7) Reduce output level of UUT in 1dB steps, at the same time reducing the value of external attenuation by 1 dB each step and check the resulting values of mod. depth and T.H.D. This should be AM 'A'% ±0.5%, T.H.D. ≤ 4%.
- (8) When the maximum attenuation available from the 1dB attenuator of the UUT is reached, use the VERNIER control to reduce the output by a further 1dB. Reduce the external attenuator to 0dB and check mod. depth and T.H.D. This should be AM 'A'% ±0.5%, T.H.D. 4%.
- (9) Disconnect the mod. meter, 9009.

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PARTS LIST FOR FIG 7

OUTPUT SYSTEM ASSEMBLY 19-1004

Part No.	Description	Rat	Tol %	Value	Component Reference	Part No	Description	Rat	Tol %	Value	Component Reference
	<u>Resistors</u>	<u>W</u>		<u>Ω</u>			<u>Resistors</u>	<u>W</u>		<u>Ω</u>	
0-1513	Carbon Film	0.1	5	39	R100	20-2684	Carbon Film	1/2	5	680k	R129
0-1521	Carbon Film	0.1	5	1k	R89	20-2820	Carbon Film	1/2	5	82	R26, 46, 47
0-1523	Carbon Film	0.1	5	120	R92	20-2821	Carbon Film	1/2	5	820	R49, 64, 75, 135, 140
0-1526	Carbon Film	0.1	5	22	R84, 102	20-4018	Metal Oxide	1/2	2	10k	R139
0-1527	Carbon Film	0.1	5	270	R86	20-4071	Metal Oxide	1/2	2	3.3k	R138
0-1529	Carbon Film	0.1	5	33	R105	20-6542	Variable, linear	1/2	20	1k	R134, 136
0-1531	Carbon Film	0.1	5	47	R101	20-6544	Variable, linear	1/2	20	3.3k	R94
0-1532	Carbon Film	0.1	5	470	R95	20-6547	Variable, linear	1/2	20	22k	R109, 153
0-1533	Carbon Film	0.1	5	5.6k	R158	20-6550	Variable, linear	1/2	20	100k	R143
0-1542	Carbon Film	0.1	5	4.7k	R88	20-6596	Variable, linear	1/2	20	50	R19
0-1534	Carbon Film	0.1	5	82	R83						
0-1546	Carbon Film	0.1	5	56	R98						
0-1547	Carbon Film	0.1	5	2.7k	R90						
0-1548	Carbon Film	0.1	5	3.9k	R91						
0-1554	Carbon Film	0.1	5	680	R156		<u>Capacitors</u>	<u>V</u>		<u>F</u>	
0-2101	Carbon Film	1/2	5	100	R5, 8, 33, 42, 44	21-0617	Electrolytic	10	-10+50	220μ	C123
					53, 60, 63, 107	21-1038	Tantalum	6.3	20	47μ	C22, 117, 120
0-2102	Carbon Film	1/2	5	1k	R11, 12, 122, 137	21-1039	Tantalum	16	20	22μ	C1, 62, 75, 115
0-2103	Carbon Film	1/2	5	10k	R15, 17, 18, 36, 115	21-1041	Tantalum	35	20	1μ	C126, 127, 128, 130, 131, 132, 133, 134, 135, 136
					117, 124						
0-2104	Carbon Film	1/2	5	100k	R128, 132						
0-2121	Carbon Film	1/2	5	120	R3, 74	21-1045	Tantalum	16	20	47μ	C21
0-2122	Carbon Film	1/2	5	1.2k	R52, 68, 79,	21-1500	Ceramic	500	0.5p	2.2p	C98
0-2123	Carbon Film	1/2	5	12k	R113	21-1505	Ceramic	500	0.5p	5.6p	C5
0-2151	Carbon Film	1/2	5	150	R1, 54, 69, 81, 123	21-1512	Ceramic	500	10	22p	C99, 103
0-2152	Carbon Film	1/2	5	1.5k	R28, 57, 59, 61, 70,	21-1514	Ceramic	500	10	33p	C114
					71, 72, 73	21-1516	Ceramic	500	10	47p	C111
0-2153	Carbon Film	1/2	5	15k	R58, 127	21-1520	Ceramic	500	10	100p	C97, 121
0-2181	Carbon Film	1/2	5	180	R16, 50, 66, 77	21-1522	Ceramic	500	10	150p	C102, 106
0-2182	Carbon Film	1/2	5	1.8k	R149, 130	21-1530	Ceramic	500	10	680p	C139
0-2183	Carbon Film	1/2	5	18k	R116	21-1532	Ceramic	500	20	1n	C4, 6, 7, 31, 32, 35, 36, 37, 38, 40, 49, 51, 53, 63, 65, 83, 108, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000

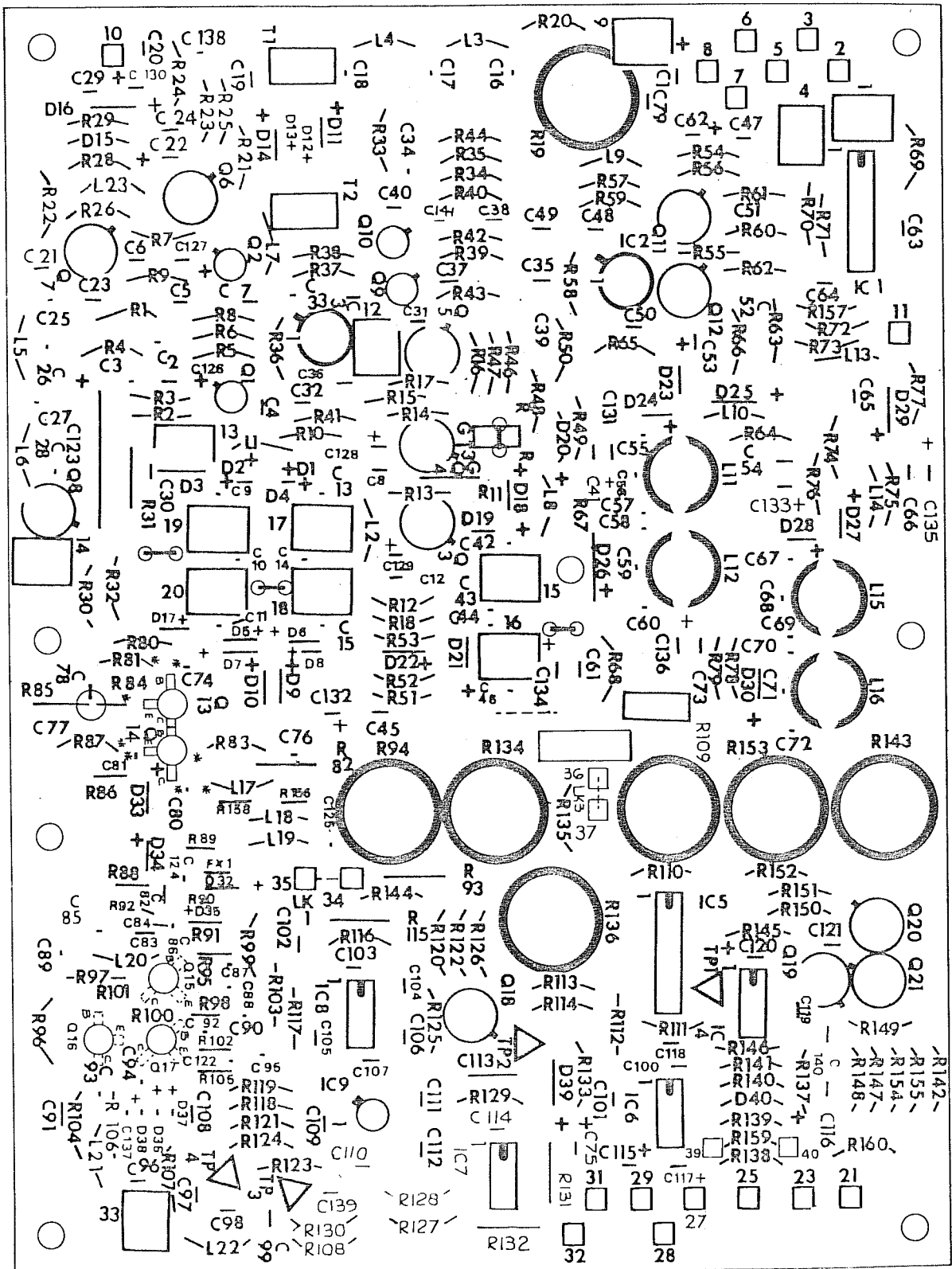
R159 is AOT. The nominal value is 68kΩ

R161 is AOT. The nominal value is 27kΩ

PARTS LIST FOR FIG. 7

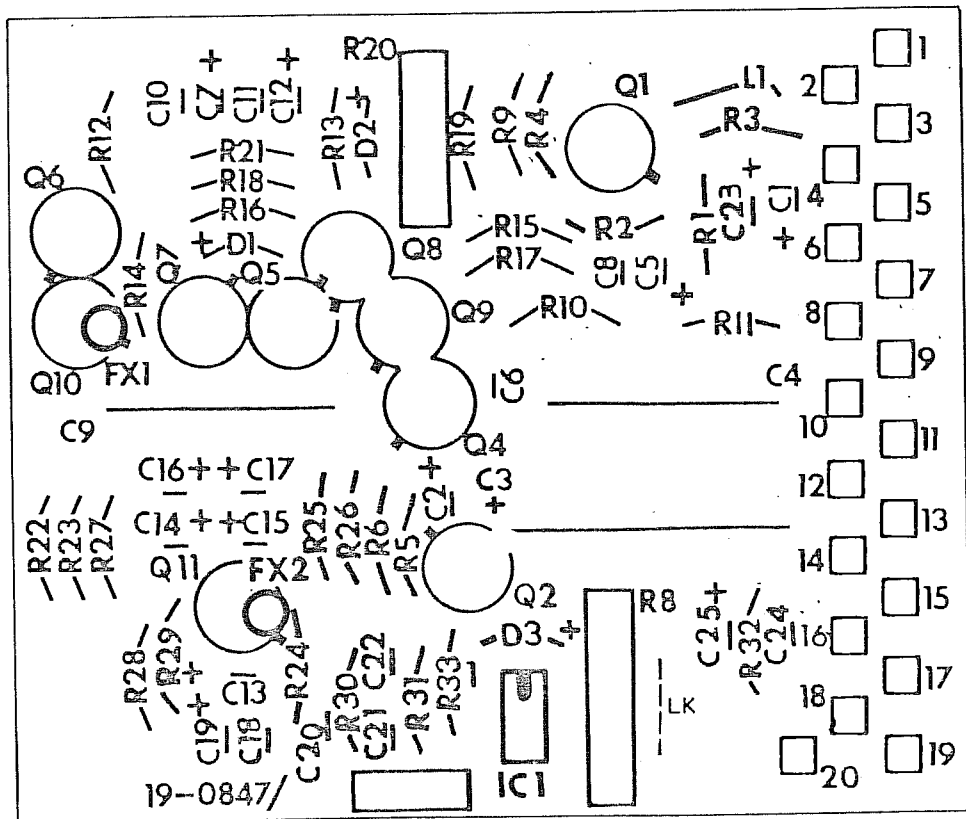
OUTPUT SYSTEM ASSEMBLY 19-1004

Part No.	Description	Rat	Tol %	Value	Component Reference	Part No.	Description	Rat	Tol %	Value	Component Reference
	<u>Ceramics</u>						<u>Inductors</u>				
21-1709	Ceramic	100	-20+80	10n	C74, 76, 78, 80, 81, 93, 95	23-7006	Choke, r.f.sub. min			470n	L7, 8
21-1716	Ceramic	250	20	1n	C2, 3, 33, 34, 39, 87, 88, 89, 94	23-7007	Choke, r.f.sub. min			680n	L5, 6
21-1740	Ceramic	100	10	2.2n	C77	23-7010	Choke, r.f.sub. min			2.2μ	L10, 23
21-4548	Polyester	400	10	100n	C138	23-7012	Choke, r.f.sub. min			4.7μ	L9, 14
					C113	23-7014	Choke, r.f.sub. min			10μ	L13, 17, 18, 21
						23-7018	Choke, r.f.sub. min			47μ	L20
						23-7077	Coil Assembly			33μ	L19
						23-7086	Coil Assembly			1n	L22
						17-3159	Transformer Assembly				T1, T2
						17-3216	Transformer Assembly				T3
						23-7126	Ferrite coil 60/120MHz, (red)				L12
22-1029	Silicon, general purpose (1N4149)				D15, 16, 20, 22, 25, 29, 39	23-7127	Ferrite coil 60/120MHz, (orange)				L11
22-1053	Silicon, u.h.f. switch (BA244)				D21, 26, 30	23-7128	Ferrite coil 60/120MHz, (yellow)				L16
22-1056	Hot carrier, matched quad (HP5082-2815)					23-7129	Ferrite coil 60/120MHz, (green)				L15
058	PIN diode v.h.f./u.h.f. (HP5082-3379)				D11, 12, 13, 14	23-8000	Ferrite Bead				FX1
					D1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 17, 18, 19, 23, 24, 27, 28, 32, 33, 34, 35,						
22-1066	Hot carrier, E line (ZC2811)				D36, 37, 38						
22-1809	Voltage reg. 5.6V (BZY88-C5V6)				D40						
	<u>Integrated Circuits</u>										
22-4111	Op. Amp high performance (741)				IC4, 6						
22-4121	Op. Amp (301)				IC7, 8						
22-4213	Transistor Array (CA3046)				IC5						
22-4214	Wideband Amp (702)				IC9						
22-4539	600MHz ÷ 2 PECL (SP8607B)				IC3						
22-4541	400MHz ÷ 2 PECL (SP8603B)				IC2						
22-4542	Dual-D Bistable MECL (MC10231P)				IC1						
	<u>Transistors</u>										
22-6017	Silicon, npn (2N2369)				Q5, 8, 11, 12, 18						
039	Silicon, npn 1000MHz (BFY90)				Q1, 2, 9, 10						
22-6041	Silicon, npn (BC109)				Q6, 20, 21						
22-6110	Silicon, pnp, gen purpose (BFX48)				Q3, 4, 7, 19						
22-6123	Silicon, npn, u.h.f. (BFR90)				Q15, 16, 17						
22-6134	Silicon, npn (BFW92)				Q13, 14						



## AUDIO OSCILLATOR ASSEMBLY 19-0847

Part No.	Description	Rat	Tol %	Value	Component Reference	Part No.	Description	Rat	Tol %	Value	Component Reference
<u>Resistors</u>						<u>Transistors</u>					
20-2101	Carbon Film	$\frac{1}{2}$	5	100	R9, 13, 32	22-6017	Silicon, npn (2N2369)				Q2
20-2102	Carbon Film	$\frac{1}{2}$	5	1k	R3, 7, 29, 33	22-6041	Silicon, npn (BC109)				Q4, 5, 7, 10, 11
20-2103	Carbon Film	$\frac{1}{2}$	5	10k	R17	22-6101	FET, N Channel (W300A)				Q1
20-2104	Carbon Film	$\frac{1}{2}$	5	1.2k	R16, 28, 34	22-6102	FET, N Channel (W300D)				Q6
20-2151	Carbon Film	$\frac{1}{2}$	5	150	R22	22-6110	Silicon, npn (BFX48)				Q8, 9
20-2152	Carbon Film	$\frac{1}{2}$	5	1.5k	R23						
20-2154	Carbon Film	$\frac{1}{2}$	5	150k	R27						
20-2181	Carbon Film	$\frac{1}{2}$	5	180	R21						
20-2184	Carbon Film	$\frac{1}{2}$	5	180k	R28						
20-2221	Carbon Film	$\frac{1}{2}$	5	220	R24						
20-2222	Carbon Film	$\frac{1}{2}$	5	2.2k	R14	23-8000	Bead, Ferrite				FX1, 2
20-2223	Carbon Film	$\frac{1}{2}$	5	22k	R5, 10	23-7086	Inductor			1mH	L1
20-2224	Carbon Film	$\frac{1}{2}$	5	220k	R6, 30, 31						
20-2225	Carbon Film	$\frac{1}{2}$	5	2.2M	R1, 2						
20-2393	Carbon Film	$\frac{1}{2}$	5	39k	R19						
20-2473	Carbon Film	$\frac{1}{2}$	5	47k	R18						
20-4024	Metal Oxide	$\frac{1}{2}$	2	1.2k	R11, 15						
20-4044	Metal Oxide	$\frac{1}{2}$	1	430	R12						
20-4068	Metal Oxide	$\frac{1}{2}$	2	1k	R4						
20-7001	Variable, cermet			500	R8						
20-7022	Variable, cermet			10k	R20						
<u>Capacitors</u>						<u>Miscellaneous</u>					
21-0514	Electrolytic	10		470 $\mu$	C3						
21-1000	Tantalum	35	20	3.3 $\mu$	C1						
21-1002	Tantalum	20	20	10 $\mu$	C14, 15, 16, 17						
21-1006	Tantalum	35	20	4.7 $\mu$	C13, 19						
21-1039	Tantalum	16	20	22 $\mu$	C5						
21-1041	Tantalum	35	20	1 $\mu$	C2						
21-1045	Tantalum	16	20	47 $\mu$	C7, 12, 23, 25						
21-1511	Ceramic	500	10	18p	C22						
21-1520	Ceramic	500	10	100p	C6						
21-1545	Ceramic	25	-20+80	10n	C8, 21						
21-1616	Ceramic	12	-20+80	100n	C10, 11, 18, 20, 24						
21-4536	Polyester	160	1	330n	C4, 9						
<u>Diodes</u>											
22-1029	Silicon, general purpose (1N4149)				D1, 2, 3						
<u>Integrated Circuits</u>											
22-4229	JFET Operational Amplifier (TL081CP)				IC1						



Component Layout  
Audio Oscillator Assembly 19-1005

Fig.14

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PARTS LIST FOR FIG. 19

POWER SUPPLY

Part No.	Description	Rat	Tol %	Value	Component Reference
	<u>Resistors</u>	<u>W</u>		<u>Ω</u>	
20-5036	Wire Wound	2.5	5	47	R1
	<u>Capacitors</u>	<u>V</u>		<u>F</u>	
21-0560	Electrolytic	25		3 300μ	C8
21-0581	Electrolytic	40		2 200μ	C1
21-0582	Electrolytic	25		6 800μ	C3
21-0583	Electrolytic	16		15 000μ	C5
21-0654	Electrolytic	63		4.7μ	C2
21-1006	Tantalum	35		4.7μ	C4,6,7,9
	<u>Diodes and Transistors</u>				
22-1650	Bridge Rectifier 2A (VS.248)				D1,2
22-1662	Bridge Rectifier 6A (VH.248)				D3
22-1846	Voltage Reg 6.8 V (1S.6006RA)				D4
22-6104	Silicon, npn high power (MJE.3055)				Q1
	<u>Integrated Circuits</u>				
22-4220	Regulator, +24 V (MC.7824CP)				IC1
22-4219	Regulator, +12 V (MC.7812CP)				IC2,4
22-4218	Regulator, -6 V (MC.7906CP)				IC3
	<u>Miscellaneous Power Supply Items</u>				
23-0019	Fuselink 160mA surge resisting for 188 V- 260 V supply				FS1
23-0032	Fuselink 315mA surge resisting for 94 V - 130 V supply				
23-0008	Fuselink 2A (quick action)				FS2
23-0044	Fuseholder, panel mounting for FS1				
23-0040	Fuseholder, chassis mounting for FS2				
23-4086	Switches, slide, Voltage selectors				S14, S15
23-3005	Socket, BNC				SK84,85,86
23-3222	Mains input filter/connector				
17-4094	Transformer, mains				T1

Part No.	Description	Rat	Tol %	Value	Component Reference	Part No.	Description	Rat	Tol %	Value	Component Reference
<u>SPIN WHEEL ASSEMBLY (11-1212)</u>						<u>VERNIER ASSEMBLY (11-1444)</u>					
0-2681	Resistor, carbon film	$\frac{1}{4}$	5	680 $\Omega$	R28, 29	17-0115	Switch				S16
0-2222	Resistor, carbon film	$\frac{1}{4}$	5	2.2k $\Omega$	R38, 39	17-1021	Resistor, variable, Racal Dana pattern			4.7k $\Omega$	R34
0-7000	Photo Darlington Amplifier (ZM100)				Q1 and Q2	20-4111	Resistor, metal oxide	$\frac{1}{4}$	2	187 $\Omega$	R46
0-5008	LED, size T 13/4 (HP.5082.4658)				LP2, LP3	20-4112	Resistor, metal oxide			215 $\Omega$	R45
0-1045	Capacitor	16V		47 $\mu$ F	C5	20-4113	Resistor, metal oxide			237 $\Omega$	R44
0-7014	Choke			10 $\mu$ H	L1	20-4114	Resistor, metal oxide			261 $\Omega$	R43
<u>RANGE SWITCH ASSEMBLY (11-1213)</u>						<u>MISCELLANEOUS COMPONENTS</u>					
0-4909	Resistor, metal film	25ppm	0.25	75 $\Omega$	R5,6	20-4115	Resistor, metal oxide			301 $\Omega$	R47
0-4911	Resistor, metal film	25ppm	0.25	150 $\Omega$	R2,3,4	20-4116	Resistor, metal oxide			332 $\Omega$	R48
0-7006	Switch, rotary, to Racal drawing				S2	20-4117	Resistor, metal oxide			383 $\Omega$	R50
<u>OUTPUT SWITCH ASSEMBLY (11-1214)</u>						<u>Solid State Items</u>					
0-2822	Resistor, carbon film	$\frac{1}{4}$	5	8.2k $\Omega$	R42	22-1602	Diode, silicon, rectifier			(1N4002)	D5
0-4198	Resistor, metal film	50ppm	0.5	1.47k $\Omega$	R26	26-5003	Light emitting diodes, red			(HP5082-4850)	LP1, LP4
0-4921	Resistor, metal film	50ppm	0.5	1k $\Omega$	R25	<u>Miscellaneous</u>					
0-4299	Resistor, metal film	50ppm	0.5	1.2k $\Omega$	R27	23-4090	Switch, toggle				S1
0-0566	Capacitor, electrolytic 25V +80-20			1000 $\mu$ F	C4	23-4084	Switch, toggle, s.p.				S3
<u>MODULATION FREQUENCY SWITCH ASSEMBLY (11-1215)</u>						17-0099 Switches to Racal drawing					
0-4056	Resistor, metal oxide	$\frac{1}{4}$	2	47 $\Omega$	R17,21	17-0100	Switches to Racal drawing				S6,7
0-4046	Resistor, metal oxide	$\frac{1}{4}$	1	56 $\Omega$	R18,22	23-3236 Plug, SMA, straight					
0-4020	Resistor, metal oxide	$\frac{1}{4}$	2	680 $\Omega$	R19,24	23-3030	Socket BNC				SK97,98,99
0-4001	Resistor, metal oxide	$\frac{1}{4}$	2	120 $\Omega$	R20,23	17-1010	Meter, to Racal drawing				M1
0-70100	Switch, to Racal drawing				S10	23-7010	Choke, sub miniature, RF			2.2 $\mu$ H	L2,3,4
<u>PEAK DEVIATION SWITCH ASSEMBLY (11-1217)</u>						21-6503 Filtercon, RFI suppression					
0-2224	Resistor, carbon film	$\frac{1}{4}$	5	220k $\Omega$	R40						
0-2225	Resistor, carbon film	$\frac{1}{4}$	10	2.2M $\Omega$	R41						
0-4956	Resistor, metal oxide	$\frac{1}{2}$	5	365k $\Omega$	*R12						
0-4916	Resistor, metal film,	25ppm	0.25	46.4K $\Omega$	R8						
0-4915	Resistor, metal film,	25ppm	0.25	13.3k $\Omega$	R9						
0-4913	Resistor, metal film,	25ppm	0.25	2k $\Omega$	R10						
0-4914	Resistor, metal film,	25ppm	0.25	4.64k $\Omega$	R11						
0-4918	Resistor, metal film,	25ppm	0.25	36.5k $\Omega$	R7,15						
0-4917	Resistor, metal film,	25ppm	0.25	3.65k $\Omega$	R13						
0-4919	Resistor, metal film,	25ppm	0.25	12.1k $\Omega$	R14						
0-4920	Resistor, metal film,	25ppm	0.25	121k $\Omega$	R16						
NOTE: R12 may be two 732k (20-4955) in parallel.											
0-1-2823	Capacitor, silver mica 350V	2		174pF	C1						
0-1-2590	Capacitor, polystyrene 200V	2		4.150nF	C3						
0-7008	Switch, to Racal drawing				S5						
<u>CHANNEL SPACING SWITCH ASSEMBLY (11-1256)</u>											
0-2-1029	Diode, General purpose				D1,D2						
0-7-0097	Switch, to Racal drawing				S4						

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PARTS LIST FOR FIG. 22

ITEMS MOUNTED ON REAR PANEL

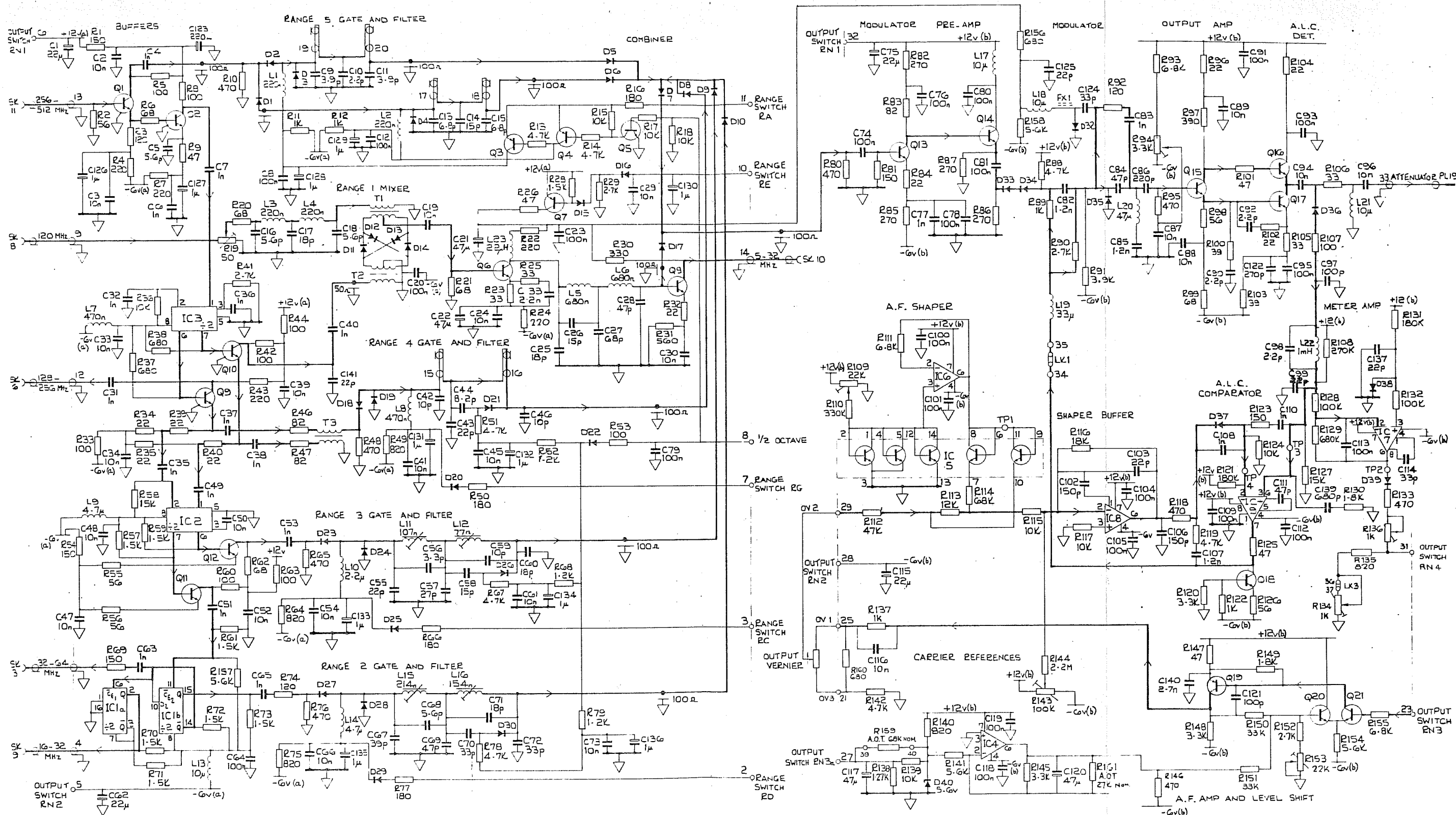
<u>Part No.</u>	<u>Description</u>	<u>Component Reference</u>
23-4043	Switch, toggle	S13
9442/12	Frequency standard	
20-4854	Resistor, metal film	0.5% 10k $\Omega$ R1,3
20-6029	Resistor, variable wire wound	10% 10k $\Omega$ R2

For other rear panel mounted items in the power supply refer to Fig. 19 and Parts List 10.

ITEMS MOUNTED ON MAIN CHASSIS

(other than p.c.b. assemblies)

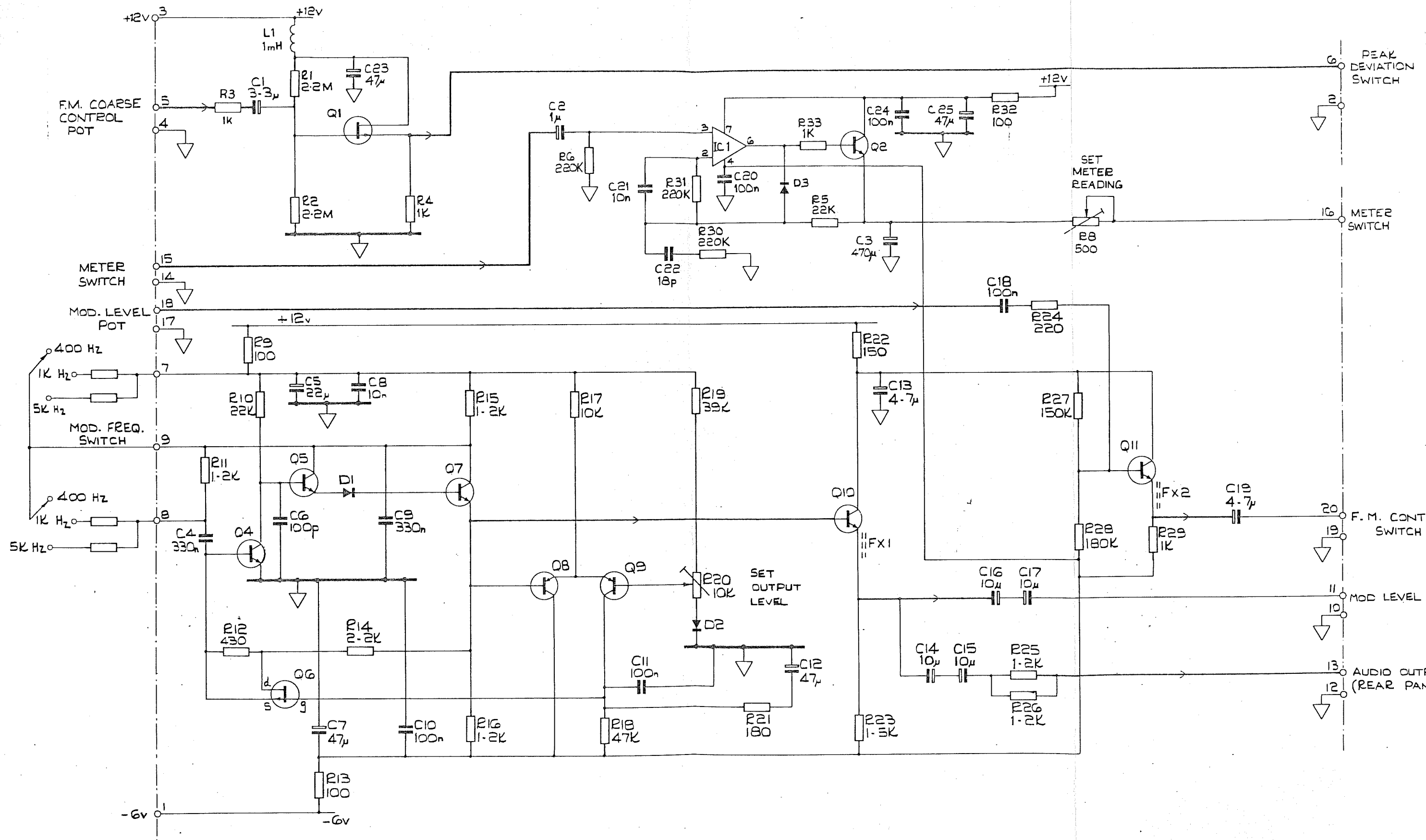
11-1364	Manual Attenuator Assembly (10 dB steps)	
11-1440	Attenuator Assembly (1 dB steps)	
14-1499	Coaxial connectors	
21-1508	Capacitor, Ceramic, 500 V, 10%	10pF C2
21-6501	Capacitor, feed-through	1000pF
21-6502	Capacitor, feed-through	500pF
21-6503	Filtercon	
22-1846	Diode, voltage regulator, 6.8 V	D4 (Fig. 19)
23-3193	Conhex Adaptor	PL2, 3, 4, 5, 6, PL8, 9, 10, 11, 95 SK19
23-3234	SMA Connector, straight, bulkhead	
23-3239	Type N plug	
23-7008	Choke, r.f., sub-miniature	1 $\mu$ H L5, 6, 7, 8
23-7010	Choke, r.f., sub-miniature	2.2 $\mu$ H L9



S2 RANGE SWITCH

RANGE	RA	RC	RD	RE	RG
5	1	0	0	1	0
4	0	0	0	1	1
3	0	1	0	1	0
2	0	0	1	1	0
1	0	0	0	0	0

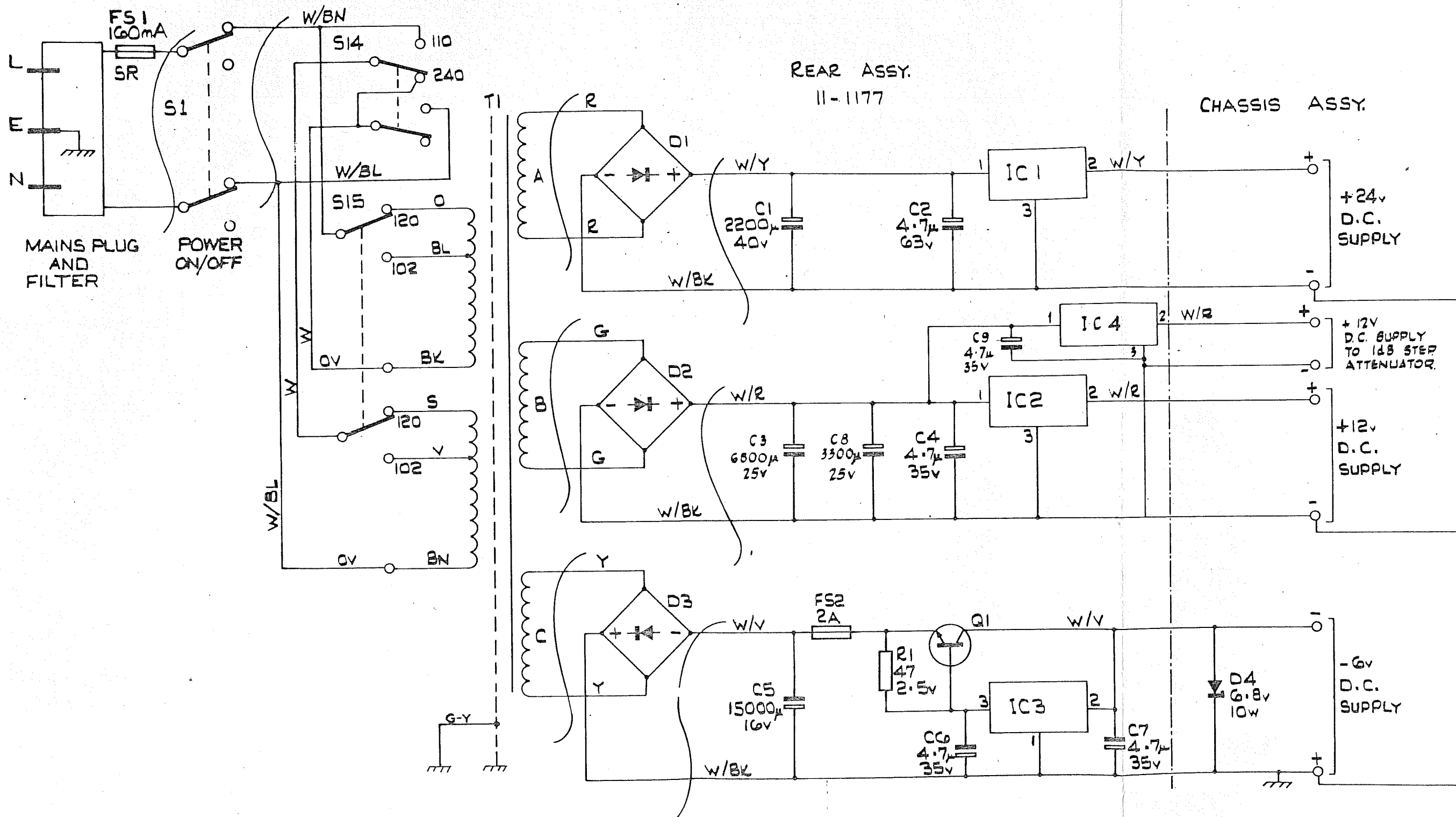
Circuit: Output System Assembly 19-1004 Fig.7



Circuit: Audio Oscillator  
 Assembly 19-1005

Fig.15

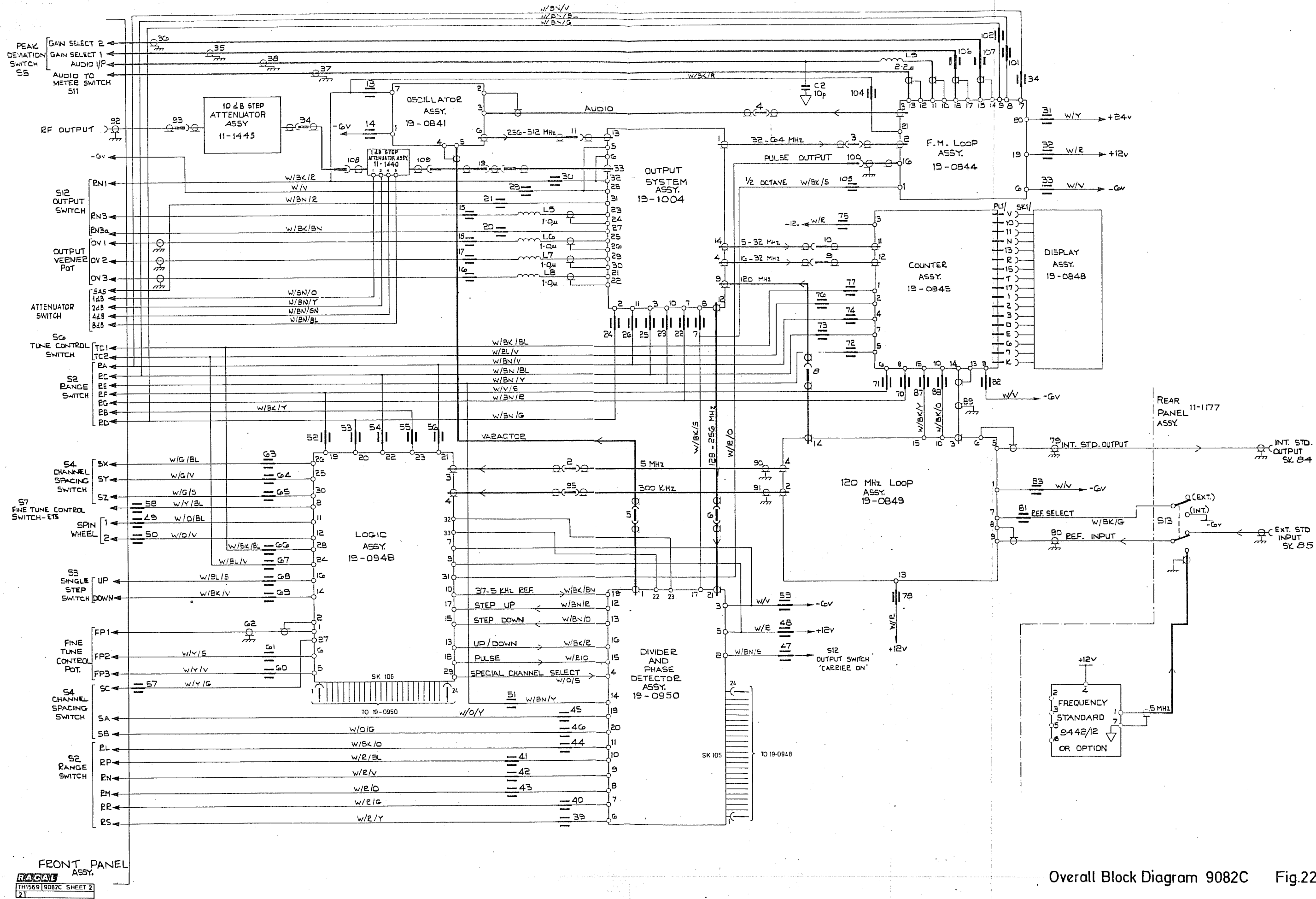




TH 1569	9082C SHEET 4
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Circuit: Power Supply Fig. 19





TH1569 9082C SHEET 2  
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Overall Block Diagram 9082C Fig.22