Technical Manual

9475
Rubidium Frequency Standard

1978
THE QUEEN'S AWARD
FOR TECHNOLOGICAL ACHIEVEMENT
TO RACAL DANA INSTRUMENTS LTD.

RACAL
The Electronics Group

Racal-Dana Instruments Limited Duke Street, Windsor, Berks, England
Prepared by Group Technical Handbooks Department, Racal Group Services Limited.

Printed in England Ref. WOH 6171 Issue 3.4.80-50

Rubidium Frequency Standard 9475

HANDBOOK AMENDMENTS

Amendments to this handbook (if any), which are on coloured paper for ease of identification, will be found at the rear of the book. The action called for by the amendments should be carried out by hand as soon as possible.

'POZIDRIV' SCREWDRIVERS

Metric thread cross-head screws 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.

CONTENTS

ILLUSTRATIONS
(at the back of the book)

TECHNICAL SPECIFICATION

OUTPUT SIGNALS

Outputs:	Three isolated and protected outputs are provided.
Frequency:	1 MHz.
Amplitude:	Greater than 1V r.m.s. into 50Ω.
Impedance:	50Ω
Signal to Noise Ratio:	Greater than 100 dB measured in a 1 Hz band at 200 Hz from carrier.
Non-Harmonically Related Spurious:	Greater than 100 dB below carrier.
Hum Related Side-Bands:	Greater than 80 dB below carrier.
Harmonic Distortion:	Greater than 30 dB below carrier.

STABILITY

Long Term:	Average drift rate less than 1×10^{-10}/month.
Short Term:	Less than 5×10^{-11} over a sampling time of 1 second.
Warm-up Characteristics:	(a) 2×10^{10} of final frequency within 15 minutes. (b) 1×10^{-10} of final frequency within 1 hour. These times are after switch-on following 24 hours switched off, in the temperature range +5°C to +30°C.
Temperature Effect:	Less than 2.5×10^{-11} (typically less than 1.2×10^{-11}) per °C between 0°C and +45°C.

Effect of External Magnetic Field on Frequency Stability:	Less than 1×10^{-10} for 1 gauss d.c. change or 1 gauss peak a.c. 50 to 60 Hz.
Range of Frequency Adjustment:	Greater than 2×10^{-9}.

POWER SUPPLIES

Voltage:	100 to 120V ±6% or 200 to 250V ±6%.
Frequency:	50 to 60 Hz ±10%.
Consumption:	40 VA approximately.

MECHANICAL

Dimensions:

Height	Width	Depth
132 mm 5.2 in	232 mm 9.1 in	270 mm 10.6 in

Weight: 4.5 kg (9.9 lb).

ENVIRONMENTAL CONDITIONS

Operating Temperature Range:	0°C to +45°C.
Storage Temperature Range:	-40°C to +70°C.

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1.1 The Racal Rubidium Frequency Standard Type 9475 is a compact high grade fast-warm-up standard for use in electronic repair vehicles and field workshops and all applications where a very high stability standard of compact size is required. The instrument derives its performance from the rubidium 'atomic resonance' principle, using the Rubidium Standard Module 9474A.

1.2 The instrument gives three 1 MHz isolated and protected outputs of high spectral purity and with amplitudes greater than 1V r.m.s. into 50Ω. A 10 MHz square wave output is provided for monitoring purposes. Other monitoring facilities are included which indicate ageing of the internal oscillator crystal; the 'in lock' (atomic resonance) condition; functioning of the spectral lamp, and the presence of output signals.

POWER SUPPLY

1.3 The instrument operates from a.c. supplies of 100V to 120V or 200V to 250V r.m.s. 50 to 60 Hz. Voltage selection is by means of internal linking on the transformer. Rear panel fuse protection is provided in both line and neutral input leads. Interior fuses protect the +24V and +5V lines.

CALIBRATION

1.4 Provision is made for 'fine' adjustment of internal oscillator frequency and compensation for crystal ageing. Frequency adjustments can be carried out only if suitable calibrating equipment is available, such as a frequency difference meter and a master frequency reference source equivalent in accuracy to the 9475. Refer to Chapter 5.

MAINTENANCE

1.5 Maintenance should be confined to the procedures described in Chapter 5 and conventional fault location on the power supply and amplifier p.c.b. Provision is made for fitting a replacement spectral lamp in the rubidium module without any dismantling or switching off of the instrument.

1.6 If a fault is suspected in the Rubidium Module 9474A it is recommended that the complete instrument be returned to Racal Instruments Limited for repair. No attempt should be made to service the rubidium module in the field.

CHAPTER 2

PREPARATION AND OPERATING

POWER SUPPLY

Power Lead

2.1 Connect a suitable plug to the power lead supplied, the cable colour code is:-

Brown	Line
Blue	Neutral
Green/Yellow	Earth (Ground)

Fuses

2.2 Check that the rear panel anti-surge fuses have the correct rating for the a.c. supply voltage, as marked on the rear panel. Spare fuses are contained in the accessories bag supplied with the instrument.

Supply Voltage Selection

2.3 The instruments are normally dispatched with transformer link connected for 200V to 250V supply. To change or check the selection proceed as follows:-

(1) Disconnect the a.c. supply and remove the bottom cover of the instrument and perspex protective plate (see para. 5.1).

(2) For 200V to 250V operation connect the two primary windings in series by a single soldered link, as shown in the circuit diagram at the back of the book,

(3) For 100V to 120V operation the two 115V terminals must be linked, and the two 0V terminals, thus connecting the windings in parallel.

(4) Replace the perspex protective plate and bottom cover.

(5) Verify that the engraved plate on the rear panel indicates the selected voltage range. If necessary reverse the plate to reveal the alternative selection.

External Connections

2.4 Connect the driven equipment to the rear panel BNC output socket(s) A, B and C, as required. The cables should be terminated in 50Ω.

Switching On

2.5 (1) Connect the power lead to the rear panel plug. Connect the lead to the supply and set the front panel POWER switch to ON.

(2) Check that the LED indicator adjacent to the Power switch is illuminated and then continue with the Monitor checks in the next paragraph.

Monitoring

2.6 (1) Allow the 9475 to warm up until the green IN LOCK indicator illuminates, which shows that the crystal oscillator is under atomic resonance control. This normally occurs within 10 minutes of switching on.

(2) Set the front panel meter switch to the LAMP VOLTAGE position and verify a meter reading within the 6V to 12V range. An inoperative lamp is indicated by a reading of approximately 3V.

(3) Set the meter switch to the OSCILLATOR CONTROL VOLTAGE position and verify a meter reading within the range 1 to 17V.

NOTE: The oscillator control voltage reading is not valid until IN LOCK has occurred, as the voltage makes slow variations during the search period.

(4) Check that the front panel indicators A, B and C are illuminated, thus indicating that the output signal is available.

CHAPTER 3

PRINCIPLES OF OPERATION

POWER SUPPLY AND AMPLIFIERS

3.1 The power supply employs conventional rectifying and stabilizing circuits to provide +5V and +23.5V internal supplies. The 10 MHz reference signal from the rubidium module is divided by ten in an integrated circuit divider package and fed through conventional cascode amplifiers to the individual outputs. Detector circuits associated with the 1 MHz outputs illuminate the front panel light emitting diode (LED) indicators when output signals are present.

RUBIDIUM MODULE 9474A

3.2 The rubidium module is the heart of the instrument but a complete discussion of its operating principles is beyond the scope of this handbook.

3.3 Briefly, the module utilizes the atomic resonance of Rb 87 to control and lock the frequency of a quartz crystal oscillator. The light of a rubidium spectral lamp is passed through a rubidium vapour cell and applied to a photo detector. The vapour cell is contained within a microwave cavity which is excited at 6.834 GHz, the resonant frequency of rubidium. The 6.834 GHz signal is generated by a frequency synthesizer which is excited by a voltage controlled 10 MHz crystal oscillator (VCXO).

3.4 At a precise frequency, when the synthesizer is locked to the atomic resonance of the rubidium cell and the VCXO frequency is exactly 10 MHz, an absorption of light energy occurs and a null is obtained in the output of the photo detector. At opposite sides of resonance the detector will give a positive or negative signal. The detector signal is applied to a variable capacitance diode in the 10 MHz VCXO, causing the oscillator to search and lock to the atomic resonance frequency.

3.5 Over a period of time, crystal ageing will cause the VCXO control voltage to change, as indicated by the front panel meter reading. When the limit of the 1V to 17V range is reached, compensation adjustment should be carried out. (Refer to Chapter 5).

CHAPTER 4

CIRCUIT DESCRIPTION

INTRODUCTION

4.1 The 9475 is composed of the following major parts:-

(1) The Rubidium Module Type 9474A. In the event of a fault the customer is recommended to return this unit (or preferably the complete instrument) to Racal Instruments Limited for repair and re-calibration.

(2) The amplifier circuit p.c.b. (Part number 19-0820). This Assembly contains d.c. voltage stabilizers, signal dividers and output amplifiers.

(3) Various chassis mounted components which are associated with the power supply.

(4) Front panel meter, controls and LED indicators.

POWER SUPPLY

4.2 Reference should be made to the Overall Circuit diagram, Fig. 3 at the back of the book.

4.3 The instrument operated from a.c. mains of 100V to 120V or 200V to 250V r.m.s. 50 to 60 Hz. Power is applied via a mains cable assembly and a fixed plug and filter assembly at the rear panel. The line and neutral inputs are protected by anti-surge fuses FS50 and FS51 on the rear panel. The a.c. input to the transformer T50 is switched by the double-pole switch S51 mounted on the front panel.

4.4 Mains voltage selection is by means of wired link(s), the 115V windings being connected in series for 200V to 250V supplies and in parallel for 100V to 120V supplies. Access to the transformer link is by removal of the bottom cover of the instrument and a protective perspex plate.

4.5 The a.c. in the secondary of transformer T50 is rectified by the encapsulated diode D50 and the d.c. output is smoothed by capacitors C50 and C51. Fuse protection is provided by FS2 mounted on the p.c.b.

4.6 The nominal +24V supply is stabilized at 23.5V by the series regulator transistor Q50, controlled by the integrated circuit differential amplifier IC2 with a reference level provided by D10. Zener diode D8 protects IC2 against possible damage from excessive voltage on the d.c. line which might occur prior to setting up the stabilizer.

4.7 The level at IC2/2 is preset by R39 to provide exactly +23.5V on the supply to the Rubidium module. Any departure from this preset voltage will act via IC2 and Q15 to regulate the flow of current in Q50 such as to restore and maintain the +23.5V output level.

4.8 A +5V output is obtained from the emitter of Q14 via the fuse FS1. The stabilizing circuit is a differential amplifier IC1, with a feedback loop via Q14 emitter and fuse FS1 to IC1/2.

4.9 The LED indicator LP51, mounted on the front panel, is connected in series with resistor R34 across the +23.5V supply line and indicates when power is switched on (provided the d.c. supply circuit is functioning correctly).

Front Panel Metering

4.10 The meter M50 is connected in series with resistor R33 and transistor Q13. Transistors Q12 and Q13 form a high impedance buffer for the meter drive.

Meter Switch

4.11 The meter switch S50 has two positions. In the LAMP VOLTAGE position the voltage of the spectral lamp in the Rubidium module is monitored on the meter. For normal operation the meter reading is between 6V and 12V. An inoperative lamp is indicated by a level of approximately 3V.

4.12 The OSCILLATOR CONTROL VOLTAGE position of the switch monitors the control voltage on the crystal oscillator in the rubidium module. As the crystal ages the control voltage will automatically change in order to compensate. Eventually the indicated control voltage will approach one of the limits marked on the panel (1-17V). When this occurs the oscillator control voltage should be reset to 5V. (Refer to Chapter 5).

RUBIDIUM MODULE 9474A

4.13 The principles of the Rubidium module have been described in the previous chapter. No circuit information is provided as repair of this component calls for specialised techniques and equipment. Provision is made, however, for customer replacement of the rubidium spectral lamp, and for oscillator re-calibration (refer to Chapter 5).

DIVIDER AND OUTPUT CIRCUITS

4.14 The 10 MHz standard frequency output from pin 1 of the Rubidium module is fed via a coaxial lead to PL1/3 and PL1/4 on the amplifier p.c.b. This is a floating connection with both inner and outer of the coaxial lead biased to a mean level of +0.7V.

4.15 Transistor Q1 is switched on/off by the 10 MHz input, and thus provides a shaped input to the digital ÷ 10 stage IC3. This IC functions as ÷ 5 followed by ÷ 2, thus providing a 1 MHz signal with 1 : 1 mark/space ratio from IC3/12. A 10 MHz signal is fed from the collector of Q1 to the 10 MHz MONITOR socket on the rear panel.

4.16 From IC3/12 the rectangular signal is fed to the tuned filter L2/C7/C5/C9 which feeds a sine wave signal to the base of Q2. The bias on Q2 base is from the +5V line via the filter circuit L1/R8/C6.

4.17 The signal on the emitter of Q2 drives the three cascode amplifiers Q4/Q3, Q7/Q6 and Q10/Q9. The amplifier feed into separate rear panel BNC output sockets (Outputs C, B and A) via tuned transformers T1, T2 and T3.

4.18 The presence of an output signal is confirmed by the illumination of the LED indicators LP52, LP53 and LP54, mounted on the front panel. These indicators are driven by transistors Q5, Q8 and Q11 which function as output detectors in conjunction with diodes D2/D3, D4/D5 and D6/D7. The rectified signal voltage from the diode detector turns on the associated transistor which illuminates the LED indicator. A loss of signal output will extinguish the associated LED.

CHAPTER 5

MAINTENANCE

CAUTION: TAPTITE SCREWS

The main chassis assembly is threaded for the use of TAPTITE screws. The TAPTITE screws must be carefully retained and not mixed with machine-thread screws.

REMOVAL OF COVERS

WARNING: DANGEROUS A.C. VOLTAGES EXIST WITHIN THE INSTRUMENT WHEN COVERS ARE REMOVED WITH A.C. SUPPLY CONNECTED.

5.1 Each cover is retained by a single screw at the rear centre of the cover. Disconnect the mains supply, remove the retaining screw and slide the cover towards the rear until it can be lifted away.

CHANGING A RUBIDIUM SPECTRAL LAMP

NOTE: The lamp exchange can be done without switching off the instrument.

5.2 (1) Remove the large slotted screw accessible via the aperture in the centre of the rear panel.

(2) Using the special tool provided with the replacement lamp carry out the lamp exchange.

(3) Re-fit the slotted screw.

REMOVAL OF RUBIDIUM MODULE 9474A

CAUTION: The module base is made of relatively soft aluminium alloy. Care must be taken when removing and re-fitting the 8 screws which secure the base of the module to the rear panel, in order to avoid possible thread damage. Do not overtighten. The screws are metric M2,6 x 8.

Module Removal

5.3 (1) Disconnect the a.c. supply and remove the top cover (para. 5.1).

(2) Remove the top cover fixing block which projects from the mid-point of the rear panel upper edge.

(3) Place the instrument with underside uppermost.

(4) Remove the bottom cover.

(5) Unplug the coaxial connector, and the five coloured leads, from the module (These leads are adjacent to the transverse mounting bar).

(6) Carefully remove the 8 slot-headed screws (which engage the base of the module) from the rear panel.

(7) Place the instrument on its side.

(8) Grip the top of the module with one hand whilst with the other hand remove the two 'Pozidriv' retaining screws from the transverse mounting bar. These screws are 8-32 UNC x 3/8in.

(9) Carefully lift the module out of the instrument.

(10) Re-fitting is a reversal of the above procedure, but note the following:-

(a) The five leads removed in (5) carry numbered sleeves corresponding to module pin number.

(b) The two screws removed in (8) should not be tightened until all 8 screws into the base have been secured. Do not overtighten.

(c) Ensure that the top cover fixing block is correctly fitted.

ACCESS TO AMPLIFIER PCB

NOTE: This p.c.b. can be operated in a partially detached condition for servicing purposes, as follows:-

5.4 (1) Remove the top cover from the instrument.

(2) Remove the rubidium module from the instrument (para.5 3).

(3) Release the six screws which secure the p.c b. to the frame. Ease the p.c.b. away from its mounting and unplug the three 1MHz (A,B,C) output leads.

(4) Carefully withdraw the p.c.b. sideways, with the remaining leads still connected.

(5) Refit the rubidium module to the instrument.

(6) For servicing with power on, place a sheet of card beneath the p.c.b. to minimise the risk of short circuits to chassis.

(7) To completely remove the p.c.b. unplug the remaining leads.

(8) Re-assembly is the reverse of the above procedure. Re-connection of leads is assisted by the numbered sleeves which correspond to the pin numbers on the p.c .b.

TABLE 1

TEST EQUIPMENT REQUIRED

Item No.	Preferred Item	Remarks
1	Multimeter AVO Model 8.	20 kΩ/V, d.c. voltage ranges 0 - 250V ± 2%.
2	Oscilloscope BWD 525.	Bandwidth d.c. to 50 MHz. Sensitivity 50 mV/cm.
3	Frequency Standard.	1 MHz; accuracy ± 3 parts in 10^{11}. Output 1V r.m.s. nominal.
4	Frequency Difference Meter. Tracor 527A	1 MHz, giving $1 + 10^{4}\Delta f$ output.
5	Digital Frequency Meter Racal 9915 (Counter)	To measure 1 MHz with 0.1 Hz resolution.
6	Coaxial leads, 50Ω, quantity 4.	BNC to BNC. Length 3 ft (1 metre) approximately.
7	Coaxial lead, 50Ω	BNC to open end. Length 1 ft (30 cm) approximately.
8	Terminating connector, BNC, 50Ω	
9	Power Supply. 240V ± 2%, 50 Hz. Single phase, line neutral and earth.	

POWER SUPPLIES AND GENERAL TESTS

NOTE: If the accuracy of internal d.c. supply voltages is in doubt, the lead should be disconnected from pin 4 of the Rubidium Module 9474A before carrying out power supply adjustments or repairs.

5.5 (1) Remove the bottom cover (para. 5.1) and check the voltage selection as described in paragraph 2.1 to 2.3.

(2) Disconnect the lead from pin 4 of the Rubidium module (the lead has a numbered sleeve) as advised in the NOTE above.

(3) Connect the a.c. supply and switch POWER on.

(4) Connect a multimeter (25V range) between test points TP1 and TP3 on the amplifier p.c.b. 19-0820. Verify a reading of 24V ±0.5V. If necessary adjust R39 to obtain this reading.

(5) Switch POWER off. Reconnect the lead to pin 4 of the Rubidium module.

(6) Switch POWER on and check that the POWER indicator is illuminated immediately.

(7) Check that the output indicators A, B and C are illuminated within one minute.

(8) Check that the IN LOCK indicator becomes illuminated within 10 minutes from switch on.

(9) Allow at least 10 minutes from switching on, then repeat operation (4) to obtain a reading of 23.5V ± 0.25V.

(10) Connect the oscilloscope (Page 12, Table 1, item 2) to the output sockets A, B and C in turn, using a 50Ω test lead (Page 12, Table 2, item 7) terminated in 50Ω at the oscilloscope input. Check for an undistorted sinusoidal signal of not less than 2.8V p-p.

(11) Transfer the oscilloscope test lead to the 10 MHz Monitor output socket and verify that the amplitude is not less than 150 mV peak-to-peak.

(12) Disconnect the oscilloscope.

(13) Take the coaxial test lead (Page 12, Table 1, item 8) and apply a short circuit to the open end.

(14) Connect the test lead to output sockets A, B and C in turn and check that the associated output indicator is extinguished.

(15) Set the meter switch to the OSCILLATOR CONTROL VOLTAGE (up) position, and verify that the meter reading is between 1V and 17V.

(16) Set the meter switch to the LAMP VOLTAGE (down) position and verify that the meter reading is between 6V and 12V.

CALIBRATION

NOTES: 1. The 'Power Supplies and General Tests' must be satisfactorily completed before commencing calibration.

2. Immediately prior to calibration the 9475 must be in continuous operation, with covers fitted, for 24 hours in an ambient temperature of 22°C ± 0.5°C if the accuracy of calibration in the following procedure is to be achieved.

Equipment Required

5.6 Frequency Difference Meter (Page 12, Table 1, item 4).
1MHz Master Frequency Standard (Page 12, Table 1, item 3).
Digital Frequency Meter (Counter) (Page 12, Table 1, item 5).

Calibration Procedure

5.7 (1) Connect the 1MHz master frequency standard to the frequency difference meter and also to the external standard input of the counter.

(2) Set the frequency difference meter to maximum resolution N = 4, and connect to Output 'A' of the 9475.

(3) With the counter synchronised to the master frequency standard, connect the counter input to the $1 + 10^{N} \triangle f$ output of the frequency difference meter and select a 10 second gate time on the counter.

(4) Carefully adjust the FINE FREQUENCY ADJUST control (accessible via the rear panel aperture) until the counter reads exactly 1.0000000 ± 1 count. This is equivalent to a resolution of the difference to ± 1 part in 10^{11}.

(5) Remove the top cover of the 9475.

Calibration Procedure (Contd.)

(6) With meter switch set to OSCILLATOR CONTROL VOLTAGE position adjust the oscillator control voltage trimmer, via the aperture in the side of the Rubidium module, to an indicated 5V on the front panel meter. The Notes below give essential advice for this procedure:-

NOTES:

(a) Whenever the oscillator control voltage trimmer is adjusted it must be changed SLOWLY and the effect on the meter reading observed after an interval of approximately 5 minutes.

(b) Although in calibration an oscillator control voltage reading of 5V is called for, this is not a critical figure, and in normal use a reading within the range 2V to 16V is within specification.

(c) If adjustment of the oscillator control voltage fails to bring the unit into lock, the output frequency should be re-checked (operations (1) to (5)) and any large error corrected. If adjustment of the oscillator control voltage still fails to achieve lock the complete instrument should be returned to the service department of Racal Instruments Ltd, or Racal agent.

(7) Set the meter switch to LAMP VOLTAGE and verify a meter reading between 6V and 12V.

(8) Disconnect all test equipment and replace the top cover.

PARTS LIST

AMPLIFIER PCB ASSEMBLY 19-0820

Part No.	Description	Rat	Tol %	Value	Component Reference
	Resistors	**W**		**Ω**	
20-2100	Carbon Film	¼	5	10	R3
20-2101	Carbon Film	¼	5	100	R15,21,27
20-2102	Carbon Film	¼	5	1k	R2,10,46
20-2103	Carbon Film	¼	5	10k	R11,48
20-2123	Carbon Film	¼	5	12k	R1
20-2152	Carbon Film	¼	5	1.5k	R19,25,30,31,34
20-2153	Carbon Film	¼	5	15k	R12,17,23,29
20-2183	Carbon Film	¼	5	18k	R40
20-2203	Carbon Film	¼	5	20k	R33
20-2220	Carbon Film	¼	5	22	R47
20-2222	Carbon Film	¼	5	2.2k	R9
20-2330	Carbon Film	¼	5	33	R5
20-2331	Carbon Film	¼	5	330	R4,44
20-2333	Carbon Film	¼	5	33k	R32
20-2390	Carbon Film	¼	5	39	R14,20,26
20-2470	Carbon Film	¼	5	47	R13,18,24
20-2471	Carbon Film	¼	5	470	R7
20-2472	Carbon Film	¼	5	4.7k	R38,41,43
20-2560	Carbon Film	¼	5	56	R16,22,28,45
20-2561	Carbon Film	¼	5	560	R8
20-2681	Carbon Film	¼	5	680	R6
20-3101	Metal Oxide	½	5	100	R35
20-4075	Metal Oxide	¼	1	4.7k	R37
20-4108	Metal Oxide	¼	1	18k	R36
20-5060	Metal Oxide	2.5	5	100	R42
20-6544	Variable, linear	¼	20	3.3k	R39
	Capacitors	**V**		**F**	
21-0503	Electrolytic	63		47µ	C29
21-1003	Tantalum	20	20	15µ	C34
21-1041	Tantalum	35	20	1µ	C6,28
21-1038	Tantalum	6.3	20	47µ	C35
21-1514	Ceramic	500	10	33p	C7
21-1516	Ceramic	500	10	47p	C12,18,24
21-1528	Ceramic	500	10	470p	C5,9
21-1532	Ceramic	500	10	1n	C10,16,23
21-1538	Ceramic	500	25	3.3n	C8
21-1541	Ceramic	500	25	5.6n	C30
21-1543	Ceramic	500	25	8.2n	C4
21-1551	Ceramic	25	+80 -20	100n	C31,32,33
21-1616	Ceramic	12	+80 -20	100n	C1,2,3,11, 13,14,15,17, 19,20,21,22, 25,26,27
	Inductors				
23-7086	Choke			1mH	L1
23-7080	Choke			80µH	L2
17-3213	Transformer Assembly				T1,T2,T3
	Diodes				
22-1029	Silicon, general purpose				D1,D2,D3,D4 D5,D6,D7
22-1820	Voltage reg. 18V				D8
22-1809	Voltage reg. 5.6V				D10
	Transistors				
22-6009	Silicon, npn (2N4124)				Q13
22-6010	Silicon, pnp (2N4126)				Q12
22-6017	Silicon, npn (2N2369)				Q1,Q2
22-6041	Silicon, npn (BC109)				Q4,Q5,Q7, Q8,Q10,Q11
22-6081	Silicon, npn (MJE 520)				Q14
22-6112	Silicon, npn high current (ZTX 450)				Q3,Q6,Q9
22-6113	Silicon, pnp, high current (ZTX 550)				Q15
	Integrated Circuits				
22-4111	High performance Op. Amp. (741TC)				IC1,IC2
22-4049	Decade Counter (7490)				IC3
	Miscellaneous				
17-3213	Transformer assemblies				T1,T2,T3
23-0000	Fuselink, 5 x 20 mm, quick action,			60 mA	FS1
23-0008	Fuselink, 5 x 20 mm, quick action,			2A	FS2
17-1005	Straight header, 7-way				PL1
17-1006	Straight header, 15-way				PL2

FRONT PANEL COMPONENTS (11-1134)

17-1008	Meter	M50
23-4065	Switch, toggle, s.p.d.t.	S50
23-4087	Switch, toggle, d.p. on/off	S51
26-5007	LED, green	LP50
26-5005	LED, red	LP51
26-5006	LED, orange	LP52, LP53, LP54

REAR PANEL COMPONENTS AND ACCESSORIES (11-1135)

9474A	Rubidium frequency standard module	
23-0028	Fuselink, anti-surge (200-250V) 400 mA	FS50 & FS51
23-0023	Fuselink, anti-surge (100-120V) 750 mA	FS50 & FS51
23-0044	Fuseholder for FS50 and FS51	
23-3222	Mains Filter Connector	
23-3005	Sockets, coaxial BNC	A,B,C and MONITOR
23-3019	Plugs, free, for BNC sockets	
23-3227	Mains supply lead assembly	

SIDE PANEL (LEFT HAND) ASSEMBLY (11-1136)

21-0588	Capacitors, electrolytic 63V 2200µ	C50*, C51*
22-1662	Bridge rectifier, 200V, 6A	D50
17-4070	Transformer, mains	T50

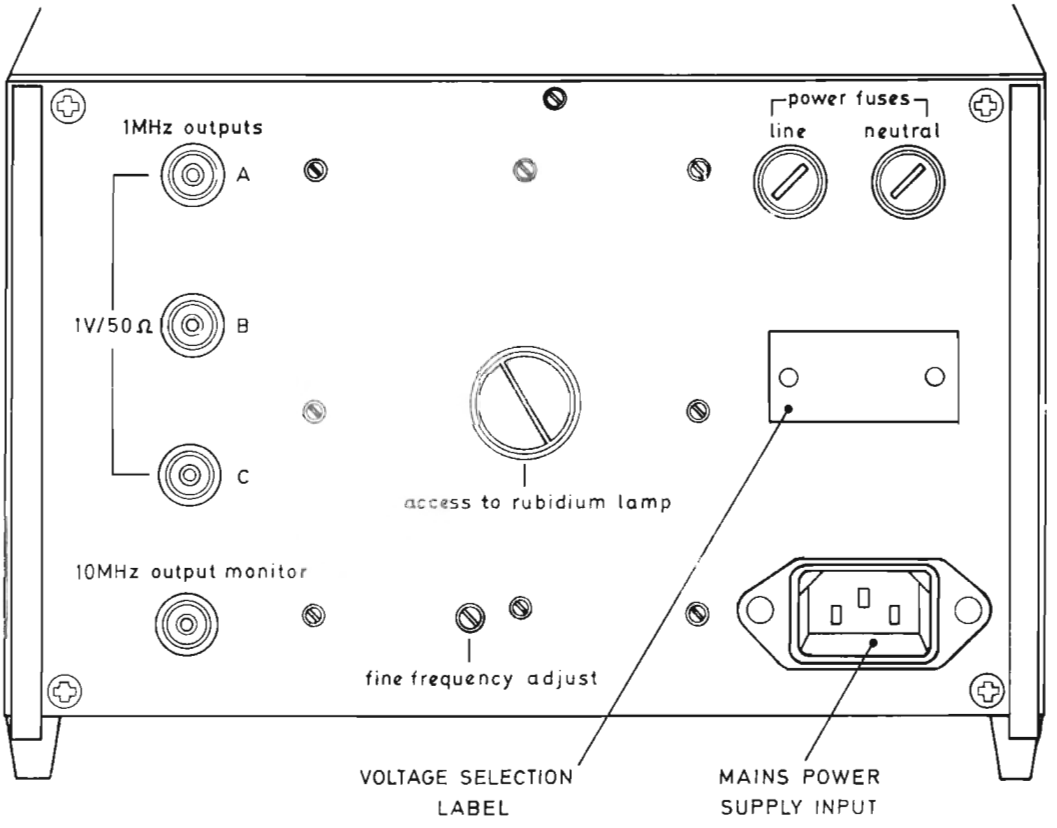
* C50 and C51 are mounted on Capacitor Plate Assembly II-1138

SIDE PANEL (RIGHT HAND) ASSEMBLY (11-1137)

19-0820	Amplifier PCB Assembly (see Parts List 19-0820)	
22-6104	Transistor, high power (MJE 3055)	Q50

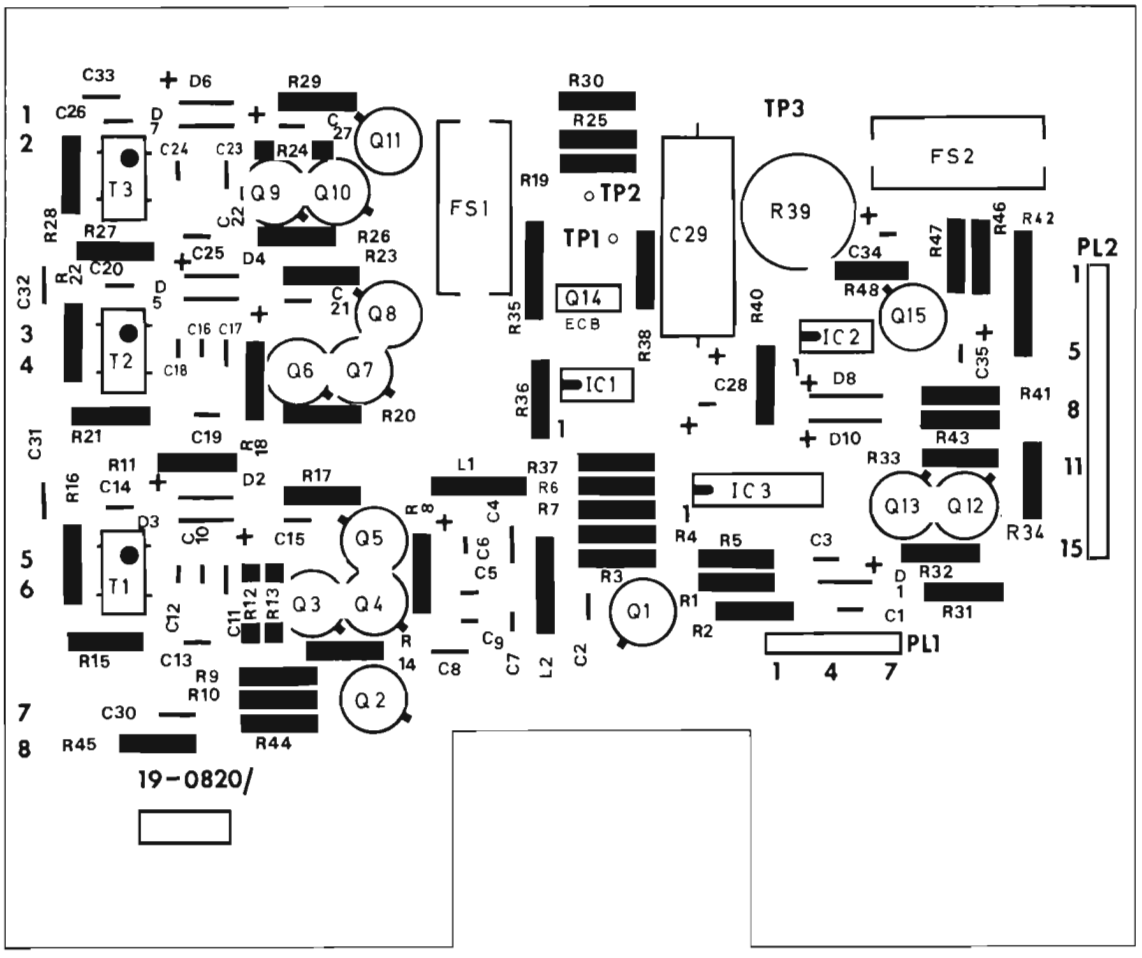
MISCELLANEOUS

21-6503	Feed-thru' capacitor (Filtercon)	FC1



Type 9475 : Rear Panel

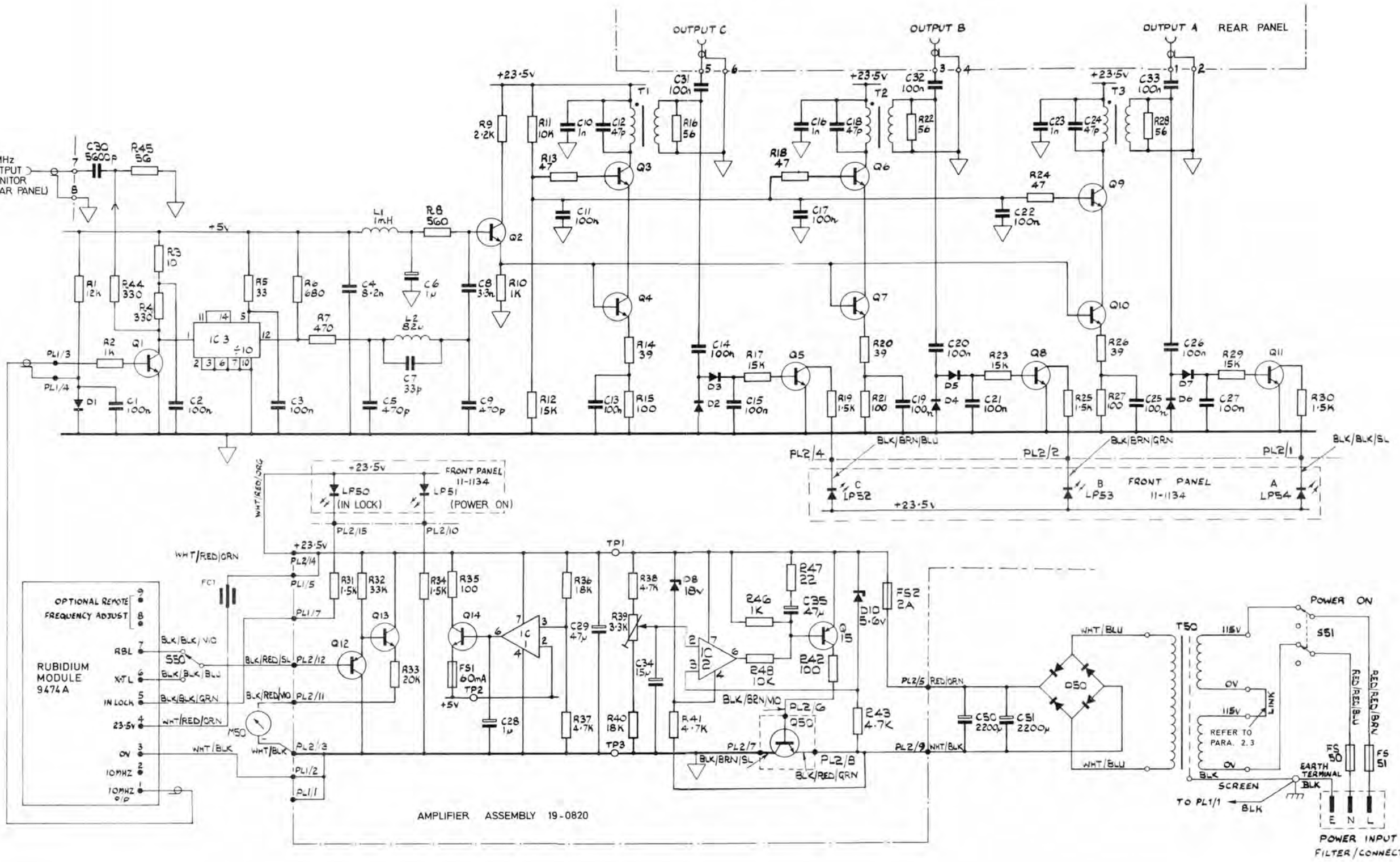
Fig. 1



Component Layout :
Amplifier Assembly 19-0820
(9475)

Fig. 2

WOH 6171	19-0820
1	



WOH 6171 | 9475
1

Circuit : Rubidium
Frequency Standard 9475

Fig. 3