CHAPTER 4

FAULT FINDING

INTRODUCTION

1. The information given in this chapter will, in the majority of cases, allow the fault to be localised to a stage or ancillary component with the minimum use of test equipment. When the faulty stage is determined, the faulty component can be found by checking static voltages at individual components. A table of typical voltages is given at the end of this chapter.

INITIAL PROCEDURE

2. It is advisable to commence fault finding with a battery voltage check, or, if available, to operate the equipment from the test set CA.470. The test set can be used to indicate r.f. power output.

3. The next operation should be to check the ancillary equipment such as headsets, p.t.t. switches, keys and antenna, as this equipment can receive severe handling under operational conditions. The easiest method of checking is by substituting equipment known to be functional in place of the suspect item.

4. A final check prior to internal investigation can be made by checking ancillary equipment connected in turn to both of the two audio sockets on the front panel of the manpack.

FAULT LOCATION PROCEDURE

5. If the foregoing procedure does not locate a fault then the internal circuitry of the unit must be suspected. Prior to removing the equipment from its case a deductive procedure should be adopted on the following lines.

6. Check whether the fault is in the transmit or receive circuits, or in both. If the fault is in only one circuit the common stages can be eliminated. A study of the block diagram fig. 2, will show that, amongst others, this will eliminate the channel frequency input, the antenna circuit, the power supply and, if a mode other than VOICE A.M. is chosen, the 10.7 MHz frequency input (this input is absent in VOICE A.M. reception). The u.s.b., l.s.b. and a.m. filters and switches can also be eliminated.

7. If, say, reception only is possible, the transmitter should be checked in all modes. The inability to transmit in any mode will eliminate the input pre-amplifier and the speech compressor circuit of the transmitter, as these are not in use

during keying modes. The operation of both relays (in HIGH power) should be checked.

8. The output of the tone oscillator can be heard in the a.f. circuits during tuning, this provides a simple method of checking the tone oscillator and the receiver a.f. circuits.

9. Further transmitter checks could consist of checking whether an output is given during tuning, using the test set; if for example an output was available during tuning but not at any other time, the VT37 buffer stage would need checking, followed by the modulator D24a, D24b (which is unlikely to be faulty in this particular instance) and the 'Unbalancing Gate' incorporating RV6 (which would cause a failure during VOICE A.M. working).

10. The above procedure is not intended to be exhaustive, but to illustrate how, with a few simple tests carried out without dismantling the equipment, it may be possible to determine the stage or stages that are faulty.

11. The faulty stages can now be checked by taking voltage measurements at the appropriate points listed in the Table, or by injecting a signal at the input of the suspect stage. If a signal is injected, the signal level should not be excessive.

STATIC VOLTAGE CHECKS

12. The voltages given in the following table are typical values, and were measured with an Avometer Model 8 multimeter (20 kΩ per volt) under the condition stated, with no input signal and an 18V power supply. All readings are positive with respect to ground.

TABLE OF STATIC VOLTAGES

Test Point	D.C. Voltage		Condition
VT1 collector	7.9	)	
VT1 emitter	1.0	)	
VT1 base	1.6	)	
VT2 collector	7.9	)	RECEIVE, VOICE L.S.B.
VT2 emitter	1.0	)	
VT2 base	1.6	)	
R5/D2 junction	0.7	)	
D5/L2 junction	7.0	)	
D5/L2 junction	8.2		TRANSMIT, VOICE L.S.B., HIGH POWER
VT4/VT6 base	0.9		RECEIVE OR TRANSMIT, VOICE L.S.B.
VT10/VT12 base	0.9		RECEIVE OR TRANSMIT, VOICE L.S.B.
VT3/VT5 base	0.9		RECEIVE OR TRANSMIT, VOICE U.S.B.
VT9/VT11 base	0.9		RECEIVE OR TRANSMIT, VOICE U.S.B.
VT7/VT8 base	0.9		RECEIVE OR TRANSMIT, VOICE A.M.
T4/R15 junction	4.2		RECEIVE , VOICE L.S.B.
T4/R15 junction	6.8		TRANSMIT, VOICE L.S.B., HIGH POWER
VT13 collector	8.9	)	
R20/R21 junction	1.3	)	
R25/26 junction	1.3	)	
VT14 collector	9.0	)	
VT15 collector	8.7	)	
VT15 emitter	1.4	)	
VT16 emitter	8.4	)	
VT17 collector	7.5	)	
VT17 emitter	0.2	)	
VT19 collector	4.4	)	
VT19 emitter	0.9	)	RECEIVE, VOICE L.S.B.
VT20 base	0.9	)	
VT21 collector	8.8	)	
VT21 emitter	4.0	)	
VT21 base	4.6	)	
VT22 collector	0.3	)	
VT22 emitter	4.0	)	
VT22 base	3.4	)	
VT23 collector	18.0	)	
VT23 emitter	9.3	)	
VT23 base	9.8	)	

TABLE OF STATIC VOLTAGES (CONTINUED)

Test Point	D.C. Voltage	Condition
VT24 collector	19.0	)
VT24 base	0.6	)
VT25 collector	19.0	)
VT25 base	0.6	)
D3/R67 junction	0.7	)
VT26 collector	19.0	)
VT26 emitter	0.6	) TRANSMIT, VOICE L.S.B. HIGH POWER
VT27 collector	19.0	)
VT27 emitter	0.6	)
VT28 collector	7.1	)
VT28 emitter	1.4	)
VT28 base	2.0	)
VT29 collector	1.3	TRANSMIT, VOICE L.S.B., HIGH POWER
VT29 collector	9.1	TRANSMIT, VOICE L.S.B., LOW POWER
VT29 emitter	1.3	TRANSMIT, VOICE L.S.B., HIGH POWER
VT29 emitter	1.0	TRANSMIT, VOICE L.S.B., LOW POWER
VT29 base	1.9	TRANSMIT, VOICE L.S.B., HIGH POWER
VT29 base	0	TRANSMIT, VOICE L.S.B., LOW POWER
VT30 emitter	0.3	)
VT30 base	1.1	)
VT31 collector	6.8	)
VT31 emitter	0.6	)
VT31 base	1.1	)
VT32 collector	6.8	)
VT32 emitter	0.6	) TRANSMIT, VOICE L.S.B., HIGH POWER
VT32 base	1.2	)
VT33 collector	6.0	)
VT33 emitter	3.2	)
VT34 collector	8.6	)
VT34 emitter	1.9	)
VT35 base	0.8	)
VT35 base	0	TRANSMIT, VOICE L.S.B., LOW POWER
VT36 collector	8.9	)
VT36 emitter	1.5	) TRANSMIT, VOICE L.S.B., HIGH POWER
VT37 collector	9.1	)
VT37 emitter	3.0	)
VT38 collector	0	) TUNE, LOW POWER
VT38 base	0.6	)

TABLE OF STATIC VOLTAGES (CONTINUED)

Test Point	D.C. Voltage	Condition
RV8/D25 junction	0.6	TRANSMIT, VOICE A.M., LOW POWER
VT39 collector	4.4)	TRANSMIT, VOICE L.S.B., HIGH POWER
VT39 emitter	0.6)	
VT39 base	1.2)	
VT40 base	0.6)	
VT41 collector	8.3)	TUNE, LOW POWER
VT41 emitter	4.8)	
VT41 base	5.1)	
R153/D27 junction	0.7)	

DYNAMIC VOLTAGE CHECKS

13. The voltages given in the following table are typical values and were measured using an electronic voltmeter, under the conditions stated, with no signal input.

Test Point	R.F. Voltage	Condition
TP1	250 mV	RECEIVE, VOICE L.S.B.
TP2	370 mV	TRANSMIT, VOICE L.S.B., HIGH POWER
TP3	85 mV	TRANSMIT, KEY L.S.B., HIGH POWER
TP5	215 mV	RECEIVE, VOICE L.S.B.
TP7	100 mV	TRANSMIT, KEY L.S.B., HIGH POWER
TP8	420 mV	TRANSMIT, KEY L.S.B., HIGH POWER
TP9	115 mV	TRANSMIT, KEY L.S.B., HIGH POWER

CHAPTER 5

DISMANTLING AND RE-ASSEMBLY

INTRODUCTION

1. Dismantling and re-assembly procedures are, in general, self-evident. The following instructions should be noted to prevent damage to the equipment during these procedures.

WARNING: DO NOT APPLY GREASE OR ANY FORM OF SEALING COMPOUND TO THE SEAL RETAINING GROOVES OR THE RUBBER SEALING RINGS WHEN RE-ASSEMBLING THIS EQUIPMENT.

Front Panel/Main Case Assembly

2. Under no circumstances should grease or any other sealing compound be used on the plastic cases or front panels for sealing purposes as this may induce stress cracks.

Battery Box

3. The sealing rings of the retaining screws on the battery case should be lightly lubricated. Under normal operating conditions the grease applied to these rings during manufacture will last the life of the equipment. In the event of the replacement of the rings, the recommended lubricant is silicone grease Part No.917814.

Pressure Testing

4. During manufacture a sealing test at an internal pressure of 2 psi (0.9 kg/cm^2) is carried out, it is normally necessary to repeat this test. If however a pressure test is required internal pressures greater than 10 psi (4.5 kg/cm^2) must be avoided to prevent distortion of the main case.

REMOVAL FROM, AND REPLACEMENT INTO HAVERSACK

5. Remove antenna, headsets etc. from the unit. Loosen the two screws in the bottom of the haversack and remove the manpack from the haversack. Replacement is self-evident.

REMOVAL AND REPLACEMENT OF BATTERY PACK

6. After removal from the haversack the two screws in the base of the battery

container can be loosened and the container removed. Prior to replacement the seal at the underside of the case must be examined for damage and renewed, if necessary.

NOTE: The battery can be charged, via an audio socket, without removing it from the manpack.

REMOVAL AND REPLACEMENT OF MAIN UNIT

7. Remove sixteen screws from the underside of the front panel and slide out the main unit until access can be gained to the terminal block to which the power supply connectors are screwed. Remove connectors and remove main unit.

8. Prior to replacement of main unit check the seal at the underside of the front panel for damage, and renew if necessary. Re-connect power supplies, slide the main unit into the case and replace sixteen securing screws.

NOTE: Do not over tighten screws. The torque wrench type BA 700449 should be used.

OPERATIONS ON MAIN UNIT

9. The transceiver and synthesizer or 49 channel crystal oscillator units are housed in light alloy cases. Removal of the covers from the case is self evident, and only the outer covers need to be removed unless components are to be changed. The transceiver case is hinged, and can be swung away from the synthesizer or oscillator case when a clamp, at the base of the unit is unscrewed and the a.t.u. plug removed. Care must be taken to ensure that the hinged panel does not cause damage by being allowed to swing freely.

RELAYS

10. The two relays are plug-in units and can easily be changed after a clamp has been removed.

KNOBS

11. It is not necessary to remove knobs unless a switch or variable component has to be changed. The knob is removed by first removing the cap at the top of the knob, then loosening the collet screw.

ORDERS FOR SPARE PARTS

In order to expedite handling of spare part orders, please quote:-

(1) Type and serial number of equipment .

(2) Circuit reference, description, Racal part number.

(3) Quantity required.

NOTE: If the equipment is designed on a modular basis, please include the type and description of the module for which the replacement part is required.

CHAPTER 6

LIST OF COMPONENTS

(MA.924)

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part No.
Resistors	ohms		watts		
R1	100	Carbon film	1/3	±10	914938
R2	6.8k	Carbon film	1/3	±10	914947
R3	18k	Carbon film	1/3	±10	915153
R4	150	Carbon film	1/3	±10	914939
R5	2.2k	Carbon film	1/3	±10	914944
R6	120	Carbon film	1/3	±10	915132
R7	220	Carbon film	1/3	±10	914940
R8	390	Carbon film	1/3	±10	915145
R9	1k	Carbon film	1/3	±10	914943
R10	1k	Carbon film	1/3	±10	914943
R11	1k	Carbon film	1/3	±10	914943
R12	1k	Carbon film	1/3	±10	914943
R13	1k	Carbon film	1/3	±10	914943
R14	1k	Carbon film	1/3	±10	914943
R15	1k	Carbon film	1/3	±10	914943
R16	220	Carbon film	1/3	±10	914940
R17	10k	Carbon film	1/3	±10	911914
R18	3.3k	Carbon film	1/3	±10	914945
R19	220	Carbon film	1/3	±10	914940
R20	150	Carbon film	1/3	±10	914939
R21	1k	Carbon film	1/3	±10	914943
R22	10k	Carbon film	1/3	±10	911914
R23	3.3k	Carbon film	1/3	±10	914945
R24	220	Carbon film	1/3	±10	914940
R25	NOT USED				
R26	1k	Carbon film	1/3	±10	914943
R27	10k	Carbon film	1/3	±10	911914
R28	3.3k	Carbon film	1/3	±10	914945
R29	220	Carbon film	1/3	±10	914940
R30	1k	Carbon film	1/3	±10	914943

Alternative values of R26 may be 680Ω Racal Part Number 914942
470Ω Racal Part Number 914941

Cct. Ref.	Value	Description	Rat	Tol. %	Racal Part No.
Resistors (contd)	ohms		watts		
R31	150	Carbon film	1/3	±10	914939
R32	10k	Carbon film	1/3	±10	911914
R33	100k	Carbon film	1/3	±10	915112
R34	10k	Carbon film	1/3	±10	911914
R35	3.3k	Carbon film	1/3	±10	914945
R36	12k	Carbon film	1/3	±10	915151
R37	150	Carbon film	1/3	±10	914939
R38	560	Carbon film	1/3	±10	915146
R39	47k	Carbon film	1/3	±10	914950
R40	82k	Carbon film	1/3	±10	915154
R41	5.6k	Carbon film	1/3	±10	915150
R42	1k	Carbon film	1/3	±10	914943
R43	12k	Carbon film	1/3	±10	915151
R44	15k	Carbon film	1/3	±10	915152
R45	2.7k	Carbon film	1/3	±10	915148
R46	560	Carbon film	1/3	±10	915146
R47	4.7k	Carbon film	1/3	±10	914946
R48	3.9k	Carbon film	1/3	±10	915149;
R49	1.2k	Carbon film	1/3	±10	915108
R50	680	Carbon film	1/3	=10	914942
R51	100k	Composition	1/10	±10	902532
R52	120	Carbon film	1/3	±10	915132
R53	10Ω	Composition	1/3	±10	902411
R54	150	Carbon film	1/3	±10	914939
R55	100	Carbon film	1/3	±10	914938
R56	5.6k	Carbon film	1/3	±10	915150
R57	39	Composition	1/4	±10	902418
R58	39	Composition	1/4	±10	902418
R59	39	Composition	1/4	±10	902418
R60	39	Composition	1/4	±10	902418
R61	820	Carbon film	1/3	±10	915144
R62	820	Carbon film	1/3	±10	915144
R63	820	Carbon film	1/3	±10	915144
R64	820	Carbon film	1/3	±10	915144
R65	18	Carbon film	1/3	±10	915138

Cct. Ref.	Value	Description	Rat	Tol. %	Racal Part No.
Resistors (contd)					
	ohms		watts		
R66	18	Carbon film	1/3	±10	915138
R67	2.2k	Carbon film	1/3	±10	914944
R68	100	Carbon film	1/3	±10	914938
R69	100	Carbon film	1/3	±10	914938
R70	100	Carbon film	1/3	±10	914938
R71	100	Carbon film	1/3	±10	914938
R72	3	Wirewound	1½	±10	915155
R73	22	Carbon film	1/3	±10	915139
R74	22	Carbon film	1/3	±10	915139
R75	220	Carbon film	1/3	±10	914940
R76	68	Carbon film	1/3	±10	915135
R77	68	Carbon film	1/3	±10	915135
R78	1.2k	Carbon film	1/3	±10	915108
R79	1.2k	Carbon film	1/3	±10	915108
R80	220	Carbon film	1/3	±10	914940
R81	12	Carbon film	1/3	±10	915136
R82	12	Carbon film	1/3	±10	915136
R83	1k	Carbon film	1/3	±10	914943
R84	10k	Carbon film	1/3	±10	911914
R85	47	Carbon film	1/3	±10	914937
R86	820	Carbon film	1/3	±10	915144
R87	39	Carbon film	1/3	±10	915120
R88	560	Carbon film	1/3	±10	915146
R89	2.2k	Carbon film	1/3	±10	914944
R90	3.3k	Carbon film	1/3	±10	914945
R91	33	Carbon film	1/3	±10	915140
R92	1k	Carbon film	1/3	±10	914943
R93	33k	Carbon film	1/3	±10	915111
R94	56	Carbon film	1/3	±10	915134
R95	180	Carbon film	1/3	±10	915143
R96	220	Carbon film	1/3	±10	914940
R97	1k	Carbon film	1/3	±10	914943
R98	15	Carbon film	1/3	±10	915137
R99	15	Carbon film	1/3	±10	915137
R100	4.7k	Carbon film	1/3	±10	914946

Cct. Ref.	Value	DescriptionT	Rat	Tol. %	Racal Part No.
Resistors (contd)	ohms		watts		
R101	NOT USED				
R102	1k	Carbon film	1/3	±10	914943
R103	560	Carbon film	1/3	±10	915146
R104	220	Carbon film	1/3	±10	914940
R105	NOT USED				
R106	47	Carbon film	1/3	±10	914937
R10	820	Carbon film	1/3	±10	915144
R108	820	Carbon film	1/3	±10	915144
R109	10	Carbon film	1/3	±10	914936
R110	1k	Carbon film	1/3	±10	914943
R111	820	Carbon film	1/3	±10	915144
R112	3.3k	Carbon film	1/3	±10	914945
R113	220	Carbon film	1/3	±10	914940
R114	390	Carbon film	1/3	±10	915145
R115	150	Carbon film	1/3	±10	914939
R116	180	Carbon film	1/3	±10	915143
R117	6.8k	Carbon film	1/3	±10	914947
R118	3.3k	Carbon film	1/3	±10	914945
R119	2.2k	Carbon film	1/3	±10	914944
R120	NOT USED				
R121	100k	Carbon film	1/3	±10	915112
R122	15k	Carbon film	1/3	±10	915152
R123	NOT USED				
R124	820	Carbon film	1/3	±10	915144
R125	100	Carbon film	1/3	±10	914938
R126	100	Carbon film	1/3	±10	914938
R127	220	Carbon film	1/3	±10	914940
R128	220	Carbon film	1/3	±10	914940
R129	1k	Carbon film	1/3	±10	914943
R130	10k	Carbon film	1/3	±10	911914
R131	3.5k	Carbon film	1/3	±10	914945
R132	220	Carbon film	1/3	±10	914940
R133	2.7k	Carbon film	1/3	±10	915148
R134	47k	Carbon film	1/3	±10	914950
R135	33k	Carbon film	1/3	±10	915111

Cct. Ref.	Value	Description	Rat	Tol. %	Racal Part No.
Resistors (contd)	ohms		watts		
R136	47k	Carbon film	1/3	±10	914950
R137	33k	Carbon film	1/3	±10	915111
R138	100k	Carbon film	1/3	±10	915112
R139	47k	Carbon film	1/3	±10	914950
R140	15k	Carbon film	1/3	±10	915152
R141	100k	Carbon film	1/3	±10	915112
R142	1.5k	Carbon film	1/3	±10	915109
R143	220	Carbon film	1/3	±10	914940
R144	2.7k	Carbon film	1/3	±10	915148
R145	47	Carbon film	1/3	±10	914937
R146	330	Carbon film	1/3	±10	915107
R147	2.2k	Carbon film	1/3	±10	914944
R148	220	Carbon film	1/3	±10	914940
R149	680	Carbon film	1/3	±10	914942
R150	12k	Carbon film	1/3	±10	915151
R151	33k	Carbon film	1/3	±10	915111
R152	12k	Carbon film	1/3	±10	915151
R153	1k	Carbon film	1/3	±10	914943
R154	1.5k	Carbon film	1/3	±10	915109
R155	1.5k	Carbon film	1/3	±10	915109
R156	1.5k	Carbon film	1/3	±10	915109
R157	1.5k	Carbon film	1/3	±10	915109
R158	1k	Carbon film	1/3	±10	914943
R159	Not Used				
R160	Not Used				
Potentiometers	ohms				
RV1	100	Linear, preset			919513
RV2	5k	[illegible]			711054
RV3	220	Linear, preset			919518
RV4	100	Linear, preset			919513
RV5	NOT USED				

Cct. Ref.	Value	Description	Rat	Tol. %	Racal Part No.
Potentiometers (contd)					
	ohms				
RV6	4.7k	Linear, preset			919511
RV7	470	Linear, preset			919514
RV8	1k	Linear, preset			919516
RV9	100k	Linear, preset			919512
RV10	4.7k	Linear, preset			919511
RV11	100	Linear, preset			919513
RV12	100	Linear, preset			919513
RV13	4.7k	Linear, preset			919511
Capacitors					
	F		Volts		
C1	33p	Ceramic	4k	±5	915127
C2	33p	Ceramic	4k	±5	915127
C3	33p	Ceramic	4k	±5	915127
C4	.01μ	Ceramic	63	±20	916187
C5	.01μ	Ceramic	63	±20	915173
C6	.01μ	Ceramic	63	±20	915173
C7	.01μ	Ceramic	63	±20	916187
C8	.01μ	Ceramic	63	±20	916187
C9	.01μ	Ceramic	63	±20	915173
C10	NOT USED				
C11	68p	Polystyrene	30	±2½	908321
C12	150p	Polystyrene	30	±2½	908331
C13	.01μ	Ceramic	63	±20	915173
C14	4.7μ	Electrolytic	35	±20	914026
C15	.01μ	Ceramic	63	±20	915173
C16	NOT USED				
C17	NOT USED				
C18	.01μ	Ceramic	63	±20	916187
C19	.01μ	Ceramic	63	±20	916187
C20	.01μ	Ceramic	63	±20	915173
C21	.01μ	Ceramic	63	±20	915173
C22	.01μ	Ceramic	63	±20	916187
C23	.01μ	Ceramic	63	±20	916187
C24	.01μ	Ceramic	63	±20	916187
C25	150p	Polystyrene		±5	916514

Cct. Ref.	Value	Description	Rat	Tol. %	Racal Part No.
Capacitors (contd)	F		Volts		
C26	470p	Polystyrene		±20	916870
C27	.01μ	Ceramic	63	±20	915173
C28	.01μ	Ceramic	63	±20	916187
C29	.01μ	Ceramic	63	±20	916187
C30	.01μ	Ceramic	63	±20	916187
C31	150p	Polystyrene		±5	916514
C32	470p	Polystyrene		±20	916870
C33	.01μ	Ceramic	63	±20	915173
C34	.01μ	Ceramic	63	±20	916187
C35	.01μ	Ceramic	63	±20	916187
C36	270p	Polystyrene	30	±2½	913452
C37	.01μ	Ceramic	63	±20	915173
C38	.01μ	Ceramic	63	±20	916187
C39	.01μ	Ceramic	63	±20	916187
C40	.01μ	Ceramic	63	±20	916187
C41	.47±	Electrolytic	35	±20	915168
C42	.01μ	Ceramic	63	±20	916187
C43	.01μ	Ceramic	63	±20	916187
C44	22μ	Electrolytic	15	±20	915169
C45	.47μ	Electrolytic	35	±20	915168
C46	4.7μ	Electrolytic	35	±20	914026
C47	150p	Polystyrene	30	±2½	908331
C48	100μ	Electrolytic	3	±20	915170
C49	.22μ	Polycarbonate		±20	917205
C50	.01μ	Ceramic	63	±20	916187
C51	4.7μ	Electrolytic	35	±20	914026
C52	.01μ	Ceramic	63	±20	916187
C53	.01μ	Ceramic	63	±20	916187
C54	4.7μ	Electrolytic	35	±20	914026
C55	.47μ	Electrolytic	35	±20	915168
C56	.01μ	Ceramic	63	±20	916187
C57	.01μ	Ceramic	63	±20	916187
C58	150p	Polystyrene	30	±2½	908331
C59	.01μ	Ceramic	63	±20	916187
C60	22μ	Electrolytic	15	±20	915169

Cct. Ref.	Value	Description	Rat	Tol. %	Racal Part No.
Capacitors (contd)	F		Volts		
C61	.001μ	Polystyrene	30	±2½	908583
C62	4.7μ	Electrolytic	35	±20	914026
C63	100μ	Electrolytic	3	±20	915170
C64	NOT USED				
C65	22μ	Electrolytic	15	±20	915169
C66	22μ	Electrolytic	15	±20	915169
C67	4.7μ	Electrolytic	35	±20	914026
C68	~~250μ~~ 220μ	Electrolytic	25	+50-10	~~910911~~ 921536
C69	.1 μ	Ceramic		+40-20	906675
C70	.1 μ	Ceramic		+40-20	906675
C71	.1 μ	Ceramic		+40-20	906675
C72	.1 μ	Ceramic		+40-20	906675
C73	.1 μ	Ceramic		+40-20	906675
C74	.1 μ	Ceramic		+40-20	906675
C75	560p	Ceramic	500	±10	915128
C76	560p	Ceramic	500	±10	915128
C77	.01μ	Ceramic	~~63~~ 250v	~~±20~~ +40 -20	~~900067~~ 916187
C78	.01μ	Ceramic	63	±20	915173
C79	.01μ	Ceramic	63	±20	915173
C80	.0015 μ	Ceramic	500	±20	911850
C81	.0015 μ	Ceramic	500	±20	911850
C82	250 μ	Electrolytic	25	+50-10	910911
C83	250 μ	Electrolytic	25	+50-10	910911
C84	.01 μ	Ceramic	63	±20	915173
C85	.01 μ	Ceramic	63	±20	916187
C86	.01 μ	Ceramic	63	±20	915173
C87	.01 μ	Ceramic	63	±20	915173
C88	NOT USED				
C89	~~470p~~	~~Polystyrene~~	~~30~~	~~±2½~~	~~908317~~
C90	.01 μ	Ceramic	63	±20	916187
C91	.01 μ	Ceramic	63	±20	915173
C92	.01 μ	Ceramic	63	±20	915173
C93	.01 μ	Ceramic	63	±20	915173
C94	.01 μ	Ceramic	63	±20	915173
C95	NOT USED				

Cct. Ref.	Value	Description	Rat	Tol. %	Racal Part No.
Capacitors (contd)	F		Volts		
C96	.01 μ	Ceramic	63	±20	916187
C97	.01 μ	Ceramic	63	±20	916187
C98	.01 μ	Ceramic	63	±20	915173
C99	.01 μ	Ceramic	63	±20	916187
C100	.01 μ	Ceramic	63	±20	916187
C101	.01 μ	Ceramic	63	±20	915173
C102	.01 μ	Ceramic	63	±20	915173
C103	470p	Polystyrene		±20	916870
C104	150p	Polystyrene		±5	916514
C105	22 μ	Electrolytic	35	±20	915169
C106	.01 μ	Ceramic	63	±20	915173
C107	.01 μ	Ceramic	63	±20	915173
C108	.01 μ	Ceramic	63	±20	915173
C109	.01 μ	Ceramic	63	±20	916187
C110	.01 μ	Ceramic	63	±20	916187
C111	NOT USED				
C112	.01 μ	Ceramic	63	±20	916187
C113	2.10p	Var.ceramic			918716
C114	2.7p	Ceramic	500	±0.5	909889
C115	.47 μ	Electrolytic	35	±20	915168
C116	.01 μ	Ceramic	63	±20	915173
C117	.01 μ	Ceramic	63	±20	916187
C118	.01 μ	Ceramic	63	±20	916187
C119	.01 μ	Ceramic	63	±20	916187
C120	.01 μ	Ceramic	63	±20	916187
C121	4.7 μ	Electrolytic	35	±20	914026
C122	.001 μ	Polystyrene	30	±2½	908583
C123	4.7 μ	Electrolytic	35	±20	914026
C124	4.7 μ	Electrolytic	35	±20	914026
C125	4.7 μ	Electrolytic	35	±20	914026
C126	.01 μ	Ceramic	63	±20	916187
C127	4.7 μ	Electrolytic	35	±20	914026
C128	22 μ	Electrolytic	15	±20	915169
C129	.47 μ	Polycarbonate		±10	915172
C130	.47 μ	Polycarbonate		±10	915172

Cct. Ref.	Value	Description	Rat	Tol. %	Racal Part No.
Capacitors (Contd)	F		Volts		
C131	.01 μ	Ceramic	63	±20	916187
C132	.001 μ	Polystyrene	30	±2½	908583
C133	.002 μ	Polystyrene	30	±2½	915167
C134	4.7 μ	Electrolytic	35	±20	914026
C135	4.7 μ	Electrolytic	35	±20	914026
C136	.01 μ	Ceramic	63	±20	916187
C137	.47 μ	Electrolytic	35	±20	915168
C138	4.7 μ	Electrolytic	35	±20	914026
C139	.01 μ	Ceramic	63	±20	916187
C140	.01 μ	Ceramic	63	±20	916187
C141	.01 μ	Ceramic	63	±20	916187
C142	.01 μ	Ceramic	63	±20	916187
C143	.01 μ	Ceramic	63	±20	916187
C144	.01 μ	Ceramic	63	±20	916187
Inductors	H				
L1					BT 710023
L2	NOT USED				
L3	330 μ	Choke, sub miniature		±10	911593
L4	330 μ	Choke, sub miniature		±10	911593
L5	330 μ	Choke, sub miniature		±10	911593
L6	330 μ	Choke, sub miniature		±10	911593
L7	330 μ	Choke, sub miniature		±10	911593
L8	68μ	Choke			915848
L9					CT 710024
L10					CT 710024
L11	330 μ	Choke, sub miniature		±10	911593
L12	330 μ	Choke, sub miniature		±10	911593
L13	330 μ	Choke, sub miniature		±10	911593
L14					CT 710024
L15					CT 710025
L16	330 μ	Choke, sub miniature		±10	911593

Cct. Ref.	Value	Description	Rat	Tol. %	Racal Part No.
Transformers					
T1					BT 710034
T2					BT 710029
T3					BT 710030
T4					BT 710027
T5					BT 710028
T6					CT 710008
T7					CT 710035
T8					CT 710035
T9					BT 710026
T10					BT 710026
T11					BT 710032
T12					BT 710034
T13					BT 710033
T14					BT 710032
Switches					
SA		Rotary			BD 700219
SB		Lever			900265
Transistors					
VT1		SX 407 or T1 407K			915117
VT2		SX 407 or T1 407K			915117
VT3	NOT USED				
VT4	NOT USED				
VT5	NOT USED				
VT6	NOT USED				
VT7	NOT USED				
VT8	NOT USED				
VT9	NOT USED				
VT10	NOT USED				
VT11	NOT USED				
VT12	NOT USED				
VT13		SX 407 or T1 407K			915117
VT14		2N 4996			916493
VT15		2N 4996			916493

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part No.
Transistors (contd)					
VT16		SX 3711 or 2N 3711K			915119
VT17		2N 4996			916493
VT18		SX 3711 or 2N 3711K			915119
VT19		SX 3711 or 2N 3711K			915119
VT20		SX 3711 or 2N 3711K			915119
VT21		2N 5450			915133
VT22		2N5448			915118
VT23		2N 3054			911951
VT24*		U 14630/3			915130
VT25*		U 14630/3			915130
VT26		BSX61			916632
VT27		BSX61			916632
VT28		BSX61			916632
VT29		SX3711 or 2N3711K			915119
VT30		SX407 or T1 407K			915117
VT31		SX407 or T1 407K			915117
VT32		SX407 or T1 407K			915117
VT33		SX407 or T1 407K			915117
VT34		SX407 or T1 407K			915117
VT35		SX407 or T1 407K			915117
VT36		SX407 or T1 407K			915117
VT37		SX3711 or 2N 3711K			915119
VT38		SX3711 or 2N 3711K			915119
VT39		SX3711 or 2N 3711K			915119
VT40		SX3711 or 2N 3711K			915119
VT41		SX3711 or 2N 3711K			915119

* VT24 and VT25 must be replaced as a matched pair by selecting devices with identical colour code spots. The colour may be red, green, brown or black.

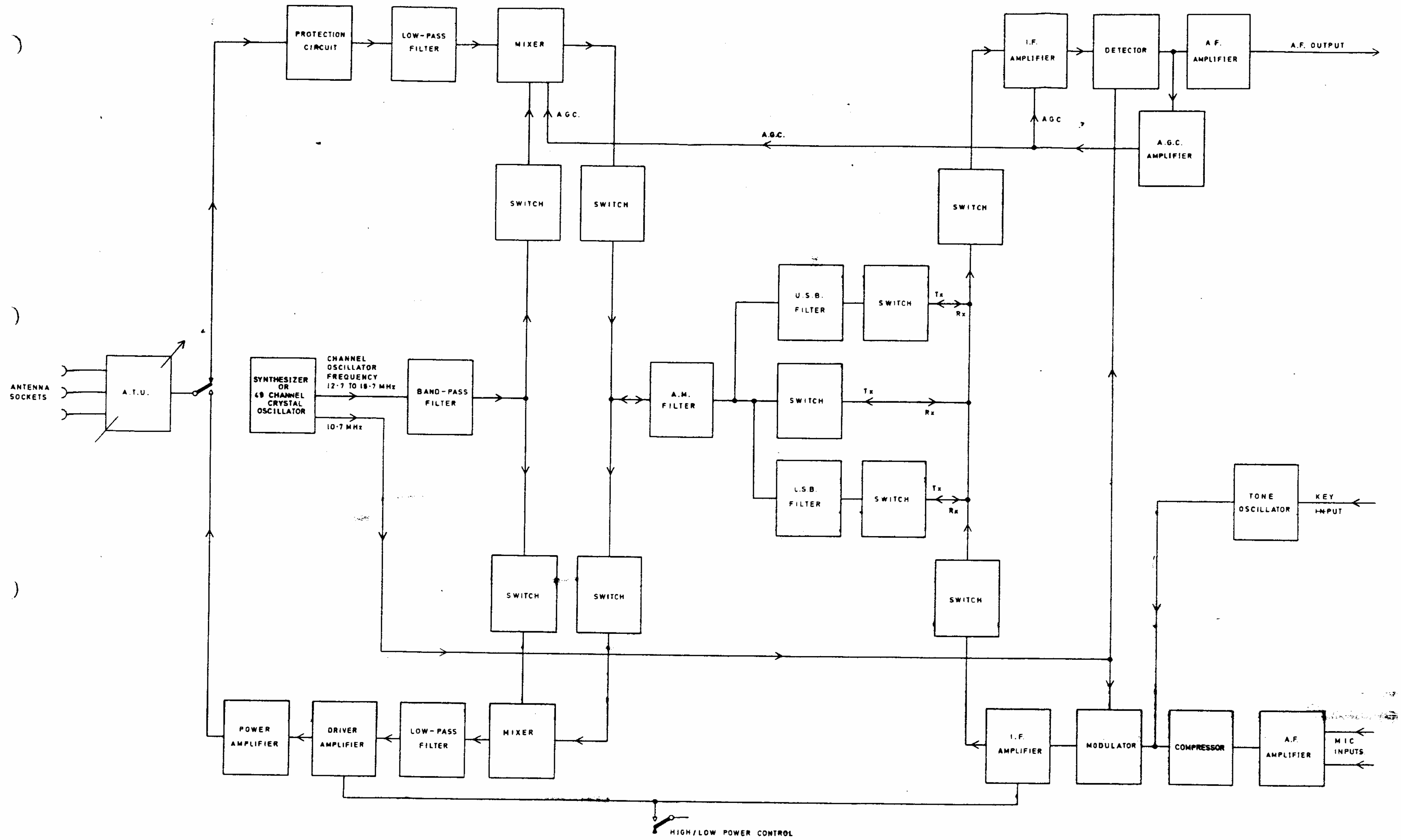
Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part No.

Diodes

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part No.
D1a/b		1N4149			914898
D2		1N4149			914898
D3		1N419			914898
D4a/b		BAV10			918130
D5		1N4149			914898
D6		1N4149			914898
D7		1N4149			914898
D8		1N4149			914898
D9		1N4149			914898
D10		1N4149			914898
D11		1N4149			914898
D12		1N4149			914898
D13		1N4149			914898
D14a/b		1N4149			914898
D15a/b		1N4149			914898
D16		1S2100A			909902
D17		BZY93-C27R			918084
D18		1N4149			914898
D19		0A91			900071
D20		1N4149			914898
D21		1N4149			914898
D22		10D1			909879
D23a/b		1N4149			914898
D24a/b		BAV10			918130
D25a		1N4149			914898
D26a/b		1N4149			914898
D27		1N4149			914898
D28		BA182			921781
D29		BA182			921781
D30		BA182			921781
D31		BA182			921781
D32		BA182			921781

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part No.
D33		BA182			921781
D34		BA182			921781
D35		BA182			921781
D36		BA182			921781
D37		BA182			921781
Plugs and Sockets					
PL1					906391
PL2					906391
PL6					916884
SKT1					905449
SKT2					905449
SKT3					BD 70007
SKT4					909908
SKT5					909908
SKT6					916885
Relays					
RLA					909880
RLB					909880
Fuses					
FS2		Size 00 350 mA			907842
Miscellaneous					
ME1		Meter			AR711005
		Terminal (ground)			901399
		Dessicator, black			909909
TB1		Terminal Block, 2 way			906882
		Knob (Gain and Tune)			915125
		Knob (Mode Switch)			915126
FL1		Filter			AR 711041
FL2		Filter			BR 711046
FL3		Filter			AR 711050
FL4		Filter			BR 711031
FL5		Filter			BR 711030
FL6		Filter			AR 711041

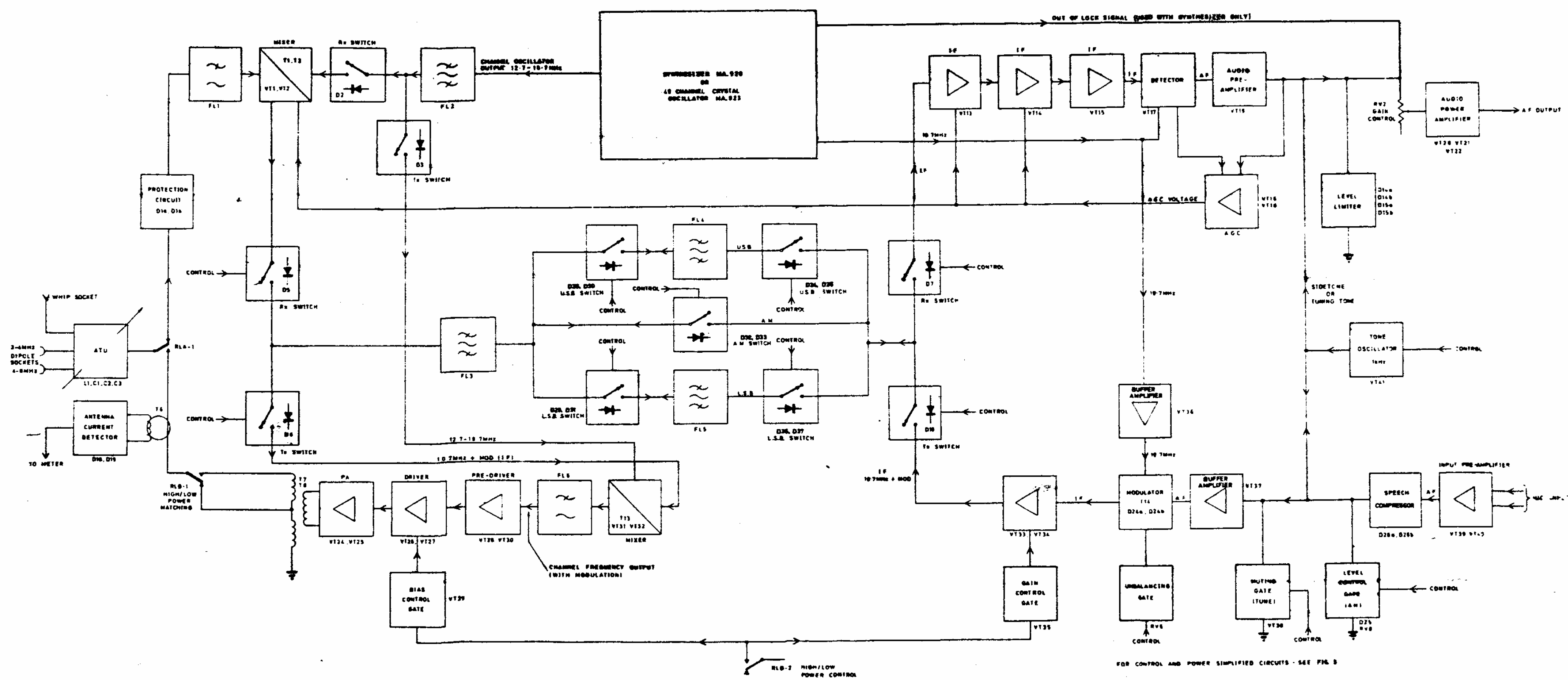
Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part No.
		Heat sink			915176
		Mounting pad for transistors			915177
		Mounting pad for transistors (T05)			909933
		Socket (test points)			915179
		Fuse Holder, Size 00			900412
		Socket for relay			909881
		Clamp for relays			AD 700414



H610/1-2
Part 2

Simplified Block Diagram: Transceiver MA.924

Fig.1



Block Diagram : Transceiver MA.924

Fig. 2

53. VT42 and VT43 are separate amplifiers driven by VT44. The output via VT43 is fed to the mixer in the tuning loop (Fig. 5) and that via VT42 drives the main output buffer VT45/VT46 and also the oscillator a.g.c. circuit.

54. Oscillator A.G.C. The amplitude in each oscillator circuit is controlled by the conductivity of VT41. If the amplitude of the oscillatory feedback into the emitters of VT39/VT40 tends to increase, a lower impedance is automatically developed by a -ve bias applied to VT41, which drains the excess current sufficiently to stabilise the oscillator gain. The a.g.c. bias on the base of VT41 is derived from the main output via peak detector D53, which charges C74 negatively in proportion to the output amplitude.

SUMMING AMPLIFIER Fig. 6

55. The summing amplifier is designed to maintain a linear relationship between oscillator frequency and changes of input current. The input to the summing amplifier is a combination of the coarse bias selected by the MHz switch (Fig. 3) and the error information from the phase and frequency comparators; the output is fed to the junctions of the varactors in the main oscillators. A varactor is most sensitive at low junction voltages, and less gain is then required from the summing amplifier. On the other hand. an increased voltage applied to the varactors will increase the main oscillator frequency, but due to the lower sensitivity of the varactors at higher voltages, it is necessary for the summing amplifier to provide higher gain to maintain tuning linearity.

56. The summing amplifier comprises transistors VT35 and VT36. and VT37. The tuning information is in the form of currents flowing into a virtual earth at the base of VT35. The overall gain of the summing amplifier varies according to the output level at pin 84 and is determined almost entirely by the impedance of the nonlinear feedback network D46, D47, R72 and R74. If the impedance of the feedback path is high, the gain is high. If the feedback impedance is reduced, the overall gain is correspondingly lower. The main feedback path is via R74 to the base of VT35 with a parallel path via D47/D46/R72.

57. At higher frequency settings the feedback path is via R74 alone. At the lower frequency settings of the MHz switch, the coarse bias is increased, and the resulting -ve voltage at the collector of VT37 will cause D47 and D46 to conduct, thereby lowering the resistance of the feedback path and reducing the amplifier gain, as required. The output from VT37 is fed to the oscillator tuning circuits via the low-pass filter formed by R75 with R76, C59 and C65. The diodes D55/D56 and D57/58 provide a path of lower resistance to abrupt changes of voltage, thus ensuring that the oscillator rapidly approaches the correct frequency whenever the MHz tuning switch is operated.

CHAPTER 3

TEST AND MAINTENANCE EQUIPMENT

Power Supply

NOTE: For testing purposes the MA. 920 can be powered from the Manpack battery or from a suitable 18 volt source such as the Test Set Type CA. 470. The load is approximately 100 mA irrespective of the supply voltage. If, however, the covers are removed and the boards hinged outwards (see Chapter 6) for testing, there is a considerable risk of accidental short-circuits to chassis which could damage the series regulator transistor in the power section. Such damage can be prevented by the use of a 30-volt d.c. power source connected to the MA. 920 via a 120 ohm resistor rated at 1½ watts or higher. The voltage on the +18V terminal must not exceed 25 volts.

Power Unit

Test Set CA. 470 or a dual 30V d.c. power supply unit with 120 ohm, 1½ watt wirewound resistor. (See NOTE above).

Multimeter — 20 000 ohms per volt.

Example:	AVO 8.

Digital Frequency Meter

Frequency:	100 Hz to 20 MHz with resolution to one Herz.
Sensitivity:	100 mV r.m.s.
Input:	High impedance, or a high impedance active probe must be available.
Example:	Racal Type 806.

Electronic Voltmeter (not essential if suitable oscilloscope available).

A. C. Input Impedance:	Not less than 1 megohm.
Frequency Range:	Up to 20 MHz.
Measurement Range:	10 mV to 250 mV.
Example:	Airmec 301.

Oscilloscope (not essential if electronic voltmeter is available, but is useful for fault location).

Bandwidth:	20 MHz or better.
Sensitivity:	100 mV/cm when used with high impedance probe.

Cambion Trimming Tool	Type 2375-4.
Screwdriver	1/16 inch (1.6 mm) shaft
Terminating Resistor	50 ohm, ± 10% ¼ watt.

CHAPTER 4

ADJUSTMENTS

NOTE: The setting-up procedures in this chapter are intended for use in an overhaul schedule. Do not make random adjustments in an attempt to improve performance. Under normal conditions of serviceability the only adjustment likely to need attention is the trimmer of the 5 MHz reference oscillator. If a fault condition is suspected refer to the next Chapter.

CAUTION: The two printed circuit boards will remain attached to the synthesizer unit with normal interconnections. Care must be taken to prevent short-circuits between any part of the board and the chassis. To reduce the risk of damage from accidental short-circuits, it is recommended that the Manpack battery supply should be disconnected from the synthesizer and a 30-volt d.c. supply be connected through a 120 ohm $1\frac{1}{2}$ watt resistor in series with the 18V terminal.

IDENTIFICATION OF BOARDS AND DISMANTLING

1. When the synthesizer unit and the trans/receiver unit are in their normal positions the PM1 (or PM2) board is on the outer side adjacent to the Manpack container and the PM3 board is on the opposite side, adjacent to the tran/receiver unit. For dismantling instructions refer to Chapter 6.

ACCESS TO ADJUSTMENTS

2. After removing the synthesizer covers the potentiometer adjustments are accessible via holes in each board without further dismantling. Coil trimming can be done only from the component (inner) side of each board. The access to the trimmer capacitor of the reference frequency oscillator is via a hole in the main frame.

POWER UNIT ADJUSTMENTS (PM3 Board)

Equipment Required

3. 30 volt d.c. Power Unit with 120Ω $1\frac{1}{2}$ watt resistor.
Multimeter 20 000 ohms per volt.

Procedure

4. (1) Connect up the d.c power supply to terminal 1 (+ve) and the earth tag (0 volts).

(2) Connect the multimeter +ve lead to pin 72 on the PM3 board, the -ve lead to chassis. Switch on the power supply and check that the multimeter indicates approximately 18 volts. (The synthesizer will function satisfactorily from supply voltages within the range 13.3V to 25V but the nominal 18V input is desirable for setting up).

(3) Transfer the +ve lead of the multimeter to pin 64 and check for an indication of 13 volts plus or minus 100 mV. If necessary adjust potentiometer RV3 to obtain the correct level.

(4) Transfer the +ve lead of the multimeter to pin 65 and check for an indication of 8 volts plus or minus 100 mV. If necessary adjust potentiometer RV1 to obtain the required level.

(5) Transfer the +ve lead of the multimeter to pin 66 and check for an indication of 4 volts plus or minus 100 mV. If necessary adjust potentiometer RV2 to obtain the required level.

(6) Switch off the power supply and disconnect the testmeter.

REFERENCE FREQUENCY OSCILLATOR (PM1 or PM2 Board)

CAUTION: Normal production of the MA. 920 is fitted with the discrete component oscillator (PM2 board). Alternatively sealed 5 MHz Oscillator unit can be provide (PM1 board). If a sealed unit is fitted the user should adjust only if absolutely necessary and replace the unit if a large frequency error exists.

NOTE: The most satisfactory check on the frequency reference is to measure the 10.7 MHz frequency at the outlet SKT1. The limits at this point are 10.7000 000 plus or minus 40 Hz within the temperature range 0°C to 40°C. If possible checks and adjustment should be made at an ambient temperature of approximately 25°C (77°F). It is essential that the synthesizer covers are screwed into position during this test.

Equipment Required

5. Digital Frequency Meter.
Screwdriver with 1/16 inch (1.6mm) shaft.

Adjustment of Discrete Component Reference Oscillator (PM2 Board)

6. (1) Disconnect the 10.7 MHz outlet, SKT1, from the trans/receiver and connect a digital frequency meter to this outlet.

(2) Switch on and allow the synthesizer to run for a few minutes. Check that the digital frequency meter indicates within the limits 10 700 000 plus or minus 40 Hz.

(3) If necessary, adjust the oscillator trimmer (C42 in Fig. 2) via the hole in the main frame to obtain an indication as close to 10 700 000 Herz as possible. This adjustment must be done with the synthesizer covers screwed into position.

(4) Disconnect the test equipment and reconnect the 10.7 MHz output lead.

Adjustment of Sealed 5 MHz Oscillator Unit (PM1 Board)

7. (1) Check the 10.7 MHz frequency as instructed in operations (1) and (2) of the previous paragraph.

(2) Insert the 1/16" Screwdriver into the aperture in the oscillator unit, via the hole in the synthesizer main frame, and very carefully adjust the variable capacitor for an indication as close to 10 700 000 Herz as possible.

(3) Disconnect the test equipment. Re-connect the 10.7 MHz output lead.

MAIN OSCILLATORS SETTING-UP (PM3 Board)

Equipment Required

8. 30 volt d.c. Power Unit with 120Ω $1\frac{1}{2}$ watt resistor.
Digital Frequency Meter.
Multimeter.
Electronic Voltmeter.
Variable d.c. supply 1 volt to 11 volts.
50 ohm $\frac{1}{4}$ watt terminating resistor.
Shorting link.
Cambion Trimming tool

Procedure

9. (1) Check that the power supply is switched off and disconnect the coaxial lead from the OUTPUT socket (SKT2).

(2) Terminate the OUTPUT socket with a 50 ohm resistor to chassis.

(3) On the PM3 board fix a temporary link from pin 83 to chassis (earth) in order to turn off VT37.

(4) Connect the +ve side of an 11 volt d.c. supply to pin 85, The -ve side to chassis. Check with the multimeter that this supply is 11 volts plus or minus 100 mV.

(5) Connect a digital frequency meter to the synthesizer OUTPUT socket (SKT2).

(6) Set the synthesizer MHz switch to position 3 and check that the digital frequency meter indicates 16.2 MHz plus or minus 20 kHz. If necessary adjust transformer T8 to obtain this reading. To do this, slacken the locking nut on T8 assembly (6BA spanner) and adjust the core using the slotted end of the Cambion trimming tool. Finally re-tighten the locking nut.

(7) Move the MHz switch to positions 2 and 4 and check that the frequency indication does not change.

(8) Set the MHz switch to position 6 and check that the digital frequency meter indicates 19.2 MHz plus or minus 20 kHz. If necessary, adjust transformer T9 to obtain this reading. The method of adjustment is described in (6) above.

(9) Move the MHz switch to positions 5 and 7 and check that the frequency indication does not change.

(10) Reduce the level of the d.c. source connected to pin 85 from 11 volts to 1 volt ± 100 mV. Check that the frequency at the OUTPUT socket is less than 12.400 MHz on the lower range (MHz switch set to 2, 3 or 4) and less than 15.400 MHz on the higher range (MHz switch set to 5, 6 or 7).

(11) Set the MHz control to position '3' and adjust the level of the d.c. source connected to pin 85 so that the frequency at the OUTPUT socket is 14.2 MHz plus or minus 200 kHz. With the electronic voltmeter check that the level is 200 mV plus or minus 5 mV. If necessary adjust RV5 to obtain this reading.

(12) Set the MHz control to position '6'. Check that the frequency at the OUTPUT socket is 17.2 MHz plus or minus 200 kHz and the output level 200 mV plug or minus 5 mV. If necessary adjust RV6 to obtain this reading.

(13) Remove the temporary link from between pin 83 and chassis fitted in (3).

(14) Remove the 50 ohm termination from the OUTPUT socket and disconnect the test equipment.

10.7 MHz OUTPUT (PM1 or PM2 Board)

10. (1) To check the 10.7 MHz generator the 10.7 outlet on the case must be driving a 50 ohm load, either the trans/receiver, an electronic voltmeter or a 50 ohm resistor connected to chassis.

(2) Switch on the synthesizer and check that the level at the 10.7 MHz outlet is not less than 100 mV r.m.s. or 280 mV peak-to-peak if using an oscilloscope.

(3) If necessary adjust the core of transformer T2 on the PM1/PM2 board to obtain a peak response. (Use the screwdriver end of the Cambion tool).

(4) Connect a digital frequency meter to SKT1 and check that the frequency is 10 700 000 plus or minus 32 Herz.

(5) If the frequency is not correct the reference frequency oscillator unit may require adjustment. Refer to paragraphs 6 or 7.

(6) Switch off and disconnect the 50 ohm load (if fitted) and the test equipment.

PHASE COMPARATOR OUTPUT (PM1 or PM2 Board)

NOTE: This test describes the adjustment of potentiometer RV1 on the PM1 or PM2 board. This adjustment should normally be required only if an M.O.S.T. or a component has been changed in the area of VT54 or VT56.

Equipment Required

11. Oscilloscope.
Multimeter.

Procedure

12. (1) Switch on the power supply and connect the oscilloscope probe to pin 54 on the PM1 (or PM2) board (collectors of VT50/51) observe the slightly distorted triangular waveform and check that the amplitude is 8 volts plus or minus 1 volt, peak-to-peak. The mean d.c. voltage should be 6.7V plus or minus 0.6V.

(2) Disconnect the link between pins 32 and 33.

(3) Connect the +ve lead of the multimeter to pin 36 (emitter of VT58), -ve lead to chassis.

(4) Adjust potentiometer RV1 to obtain an indication of 4.8 volts plus or minus 100 mV on the multimeter. If the voltage is too high a resistor of 1.5 kΩ ± 5%(R155) should be connected between pins 46 and 47 in place of the link.

(5) Finally, switch off and re-connect the link between pins 32 and 33.

CHAPTER 5

TESTING AND FAULT FINDING

INTRODUCTION

1. This chapter provides a series of tests which will assist fault location. The first part, headed "Overall Unit Tests" can be performed with the covers in position and will quickly establish the serviceability of the synthesizer. The second part headed "Board Tests" will assist in locating a fault to a particular board or part of a board. It is assumed that the user has a thorough knowledge of the circuit principles. The data in this chapter conforms to the specification standard of the synthesizer. It is assumed that tests will not be carried out in extreme conditions of either heat or cold.

NOTE: Do not remove the covers from the synthesizer unit.

EQUIPMENT REQUIRED

2. Digital Frequency Meter (20)MHz with high impedance input).
Electronic Voltmeter (frequency range up to 20 MHz).
50 ohm ¼ watt terminating resistor.
Universal Test Meter (Multimeter)
Headphones.

OVERALL UNIT TESTS

MAIN OUTPUT CHECK

3. (1) Disconnect the lead from the OUTPUT socket on the synthesizer case, and terminate this outlet with the 50 ohm resistor.

(2) Set the synthesizer controls to 3.500.

(3) Connect a digital frequency meter across the 50 ohm termination at the OUTPUT socket.

(4) Switch on and check that the digital frequency meter indicates a frequency 10.7 MHz higher than the settings of the synthesizer controls, within a tolerance of 3 parts in 10^6. In this example the output frequency should be 14 200 000 plus or minus 42 Hz. This checks the lower frequency oscillator output.

(5) Disconnect the digital frequency meter and connect an electronic voltmeter in its place. Check that the output level is 200mV ± 10 mV.

NOTE: A lower output level will cause some reduction in transmitter output power. Refer to Chapter 4 for information on the adjustment of oscillator output voltage.

(6) To check the high frequency oscillator set the synthesizer controls to 6.500 and check that the output level is 200 mV ± 10 mV (See also NOTE above).

(7) Disconnect the electronic voltmeter and connect the digital frequency meter in its place. Check that the output frequency is 17 200 000 plus or minus 51 Hz.

(8) Select various settings of the synthesizer MHz and kHz controls and check that the digital frequency meter indicates a frequency 10.7 MHz higher than the control settings in each case.

(9) Disconnect the test equipment and remove the 50 ohm load resistor.

<u>10.7 MHz OUTPUT CHECK</u>

4. (1) Disconnect the coaxial lead from the 10.7 MHz outlet SKT1. Terminate this outlet with the 50 ohm resistor.

(2) Measure the frequency at the 10.7 MHz outlet which should be 10 700 000 plus or minus 32 Hz.

(3) Check the voltage across the 50 ohm termination which should be in the range 100 to 200 mV.

(4) Refer to Chapter 4 for adjustment information.

(5) Do not remove the 50 ohm termination until the Mute test is completed.

<u>10.7 MUTE</u>

5. (1) If the synthesizer is connected to the trans/receiver the mute operation can be checked by switching the Manpack Mode switch through its various settings. The 10.7 MHz output level measured across the 50 ohm termination at the 10.7 socket (see para. 4) should fall to less than 10 mV whenever the Mode switch is set to A.M.

(2) If the trans-receiver is not connected, the following method of activating the mute may be used:-

(i) Disconnect the lead from the MUTE terminal on the synthesizer.

(ii) With a jumper lead briefly connect the MUTE terminal to the adjacent 18 volt terminal. At the same time note the electronic voltmeter reading across the terminated 10.7 MHz outlet. This should fall to less than 10 mV as the jumper lead is connected.

NOTE: Ideally this test should be made by connecting a +ve 9 volt d.c. supply to the disconnected MUTE terminal, but the +18V connection is a convenient alternative.

(3) Disconnect the test equipment. Remove the 50 ohm termination.

(4) Re-connect the lead to the MUTE terminal (if it has been disconnected).

OUT OF LOCK INDICATION

NOTE: For this test the headphones should be connected to the synthesizer between the out-of-lock (O.L.I.) terminal and the chassis, or an oscilloscope may be used. If the synthesizer is connected in the Manpack the normal phones outlet should be used.

6. (1) Make the synthesizer go out-of-lock by setting the MHz control midway between two adjacent settings.

(2) Switch on and listen for the interrupted 1 kHz out-of-lock tone, or connect an oscilloscope to the out-of-lock terminal and observe the 1 kHz waveform.

(3) Set the MHz control correctly so that the synthesizer is in lock. Connect the +ve lead of a multimeter to the out-of-lock terminal.

(4) Set the multimeter to the 25 volt d.c. range (do not use a lower range because the circuit resistance is 22 kΩ).

(5) Set the synthesizer kHz x 100 control to position '5'. Provided the unit is correctly locked, the multimeter should then indicate between 4.0 and 5.0 volts.

(6) Check that with the unit "in lock", the out of lock tone disappears.

BOARD TESTS

CAUTION: For board testing the covers must be removed with a consequent risk of accidental short circuits while testing. The use of a 30 volt d.c. power supply connected via a 120Ω $1\frac{1}{2}$ watt resistor is strongly advised to avoid the risk of damage to the series regulator transistor in the power section.

GENERAL DIAGNOSIS

PM1 (or PM2) Board Diagsosis

7. (a) Reference Frequencies Generator Fault

A fault in this section may cause the main oscillator output frequency to be very low. In this case there will be no out-of-lock tone, only a clicking sound in the phones. Check the 10.7 MHz at the 10.7 MHz outlet (SKT1) and check the 1 kHz reference at pin 32 on the PM1 board.

(b) 12-17 MHz Generator Fault

If the unit works correctly except in one position of the MHz switch, check the 12-17 MHz generator. A fault in the generator affecting all switch positions can be found only by testing, but will normally cause the frequency to too high.

(c) 10.7 MHz Generator Fault

The 10.7 MHz output is not used in the synthesizer, but can be used to check the accuracy of the 5 MHz reference. Refer to Chapter 4.

(d) Frequency Comparator Fault

No distinct fault indications, but a tendency to lock on the wrong frequency indicates a frequency comparator fault.

(e) Phase Comparator

A fault in the Phase Comparator will cause the main oscillator output frequency to be unstable. (Hunting around the correct frequency but failing to lock).

PM3 Board Diagnosis

8. (a) Main Oscillator and Summing Amplifier

If the synthesizer is satisfactory in positions 2 to 4 of the MHz switch but not in 5 to 7 - or vice versa - it is probably a main oscillator fault. If the frequency from both main oscillators is seriously in error, or does not change with movements of the MHz switch, check the summing amplifier section and coarse bias. Also check the links to pins 86, 87. It is possible for these links to be disturbed by careless re-fitting of the boards.

(b) Mixer Fault

Main oscillator frequencies will be high because the frequency comparator will see an apparently low frequency output from the programmed divider and will attempt to correct this. (Similar symptoms to complete failure of 12-17 MHz Generator).

(c) Programmed Divider

The most likely indications are that the main oscillator frequency is too high or is locking on to the wrong frequency.

(d) Power Supply

A power supply fault may cause a complete failure of the synthesizer indicated by no outputs from SKT1 (10.7 MHz) or main oscillators OUTPUT (SKT2) and no out-of-lock tones.

TESTING PM1 (or PM2) BOARD

NOTE: To avoid repetition of tests described elsewhere the user will be referred to Chapter 4 where appropriate.

Equipment Required

9. 30 volt d.c. power supply with 120Ω $1\frac{1}{2}$ watt resistor.
Digital Frequency Meter with high impedance input or with active high impedance probe.
Electronic Voltmeter.
Oscilloscope with 10 MΩ probe.
Multimeter.
50 ohm $\frac{1}{4}$ watt resistor.
Soldering iron.

Board Tests

10. (1) The boards should remain in the unit with covers removed, but with all interconnections as normal. Unscrew the board under test but do not undo any connections. When folding the board outwards take great care to prevent contact between the track and any metal work. Place a sheet of thick paper or polythene beneath the board.

(2) Disconnect the Manpack power supply from the synthesizer and connect the +ve side of the 30 volt d.c. power supply in series with a 120 ohm $1\frac{1}{2}$ watt resistor to the 18 volt terminal. Connect the 0 volt terminal to the -ve side of the supply.

(3) Check that all the wire links on the board are connected, and in good order as follows:

Pins 20/21, 30/31, 32/33, 35/36, 43/44
(43/44 may have a resistor link).

(4) Check the supply voltages coming from the other board using a multimeter. (Note the different polarity on pin 34) 0 volt pins are 17 and 23.

Supply Voltages

Pin	D.C. Voltage Relative to 0 volt
15	+ 13.0v ± 100 mV
18	+ 8.0v ± 100 mV
16	+ 4.0v ± 100 mV
34	- 5.3v ± 1V

(5) To check the 5 MHz reference, disconnect the link between pins 20 and 21. Connect the digital frequency meter (high impedance input) to pin 20 (Fig. 2). The frequency should be 5 MHz plus or minus 15 Hz. If adjustment is necessary refer to Chapter 4 paragraph 6 or 7.

(6) Re-connect the link between pins 20 and 21.

(7) Reduce the sensitivity of the digital frequency meter to between 0.5 and 1.0 volt. Measure the frequency at pin 32 (Fig. 4) which should be 1 kHz plus or minus 1 Hz. An oscilloscope should display a square wave of approximately 2 volts amplitude peak-to-peak, at this pin.

(8) Repeat test (7) at pin 41 (Fig. 4).

(9) To check the 10.7 MHz generator and Mute facility refer paragraphs 4 and 5 in this chapter.

(10) If satisfactory, the above tests fully check the reference frequencies generator.

12-17 MHz Generator

11. (1) Connect the oscilloscope probe to the case (collector) of transistor VT11 (Fig. 9, Fig. 3). The waveform amplitude should be approximately 2 volts peak-to-peak.

(2) Connect the digital frequency meter (high impedance input essential) and in each setting of the synthesizer MHz switch check the frequency to a tolerance of plus or minus 50 Hz as follows:

TABLE 1

MHz Switch Setting	Frequency at VT11	
2	12.0)	
3	13.0)	
4	14.0)	All ± 50 Hz
5	15.0)	
6	16.0)	
7	17.0)	

Disconnect the frequency meter and oscilloscope.

(3) Test point pins 11 and 48 (Refer to Fig. 3, collector of VT6 and junction of R60/T1) should be checked with the multimeter (10v d.c. range) in each setting of the MHz switch. This may provide useful information if a fault condition exists.
Pin 11 (a.g.c.) should normally read higher than 1 volt. The level at pin 48 is satisfactory if it is between 0.25V and 5V.

(4) If the synthesizer is faulty on only one setting of the MHz switch, refer to Fig. 3 and check the switch wiring. Check that the relevant channel wire (pins 1 to 6) is at 0 volts. Try by-passing the appropriate diode D9 to D14. If necessary check resistor R11-R19 for correct resistance.

Phase Comparator Check (Fig. 9 Fig. 4)

12. (1) With an oscilloscope check at pin 54 (collectors of VT50/VT51). Observe a 1 kHz slightly distorted triangular waveform with an amplitude of 8V plus or minus 1V peak-to-peak. The mean d.c. voltage should be 6.7V plus or minus 0.6V.

(2) The setting-up of RV1 is described in Chapter 4 paragraph 12. If necessary refer to those instructions.

Frequency Comparator Checks (Fig. 9 Fig. 4)

NOTE: Three methods are available depending upon the test equipment available. The principle in each case is to check the operation with an input frequency which is in turn higher, lower and equal to the reference input. The methods are:

12. (a) Alternative Connection Method

This requires no specialised test equipment but has the slight disadvantage that the out of lock indication is checked only on the higher frequency side.

(b) Pulse Generator Method

This is a very satisfactory method provided that a suitable pulse generator is available.

(c) Variable Voltage Method

This method provides a complete check on the phase lock loop by manual variation of the main oscillator frequency. Its disadvantages are the need for a regulated variable d.c. supply and the necessary assumption that the mixer and programmed divider are working correctly.

Alternative Connection Method (Frequency Comparator Check)

13. (1) Disconnect the links between pins 30/31 and 41/42 on the PM1 board, thus removing both inputs from the frequency comparator (Fig. 1).

(2) Connect a jumper wire from pin 31 to pin 41, thus feeding the 1 kHz reference in lieu of the programmed divider signal. This simulates the condition 'programmed input high'.

(3) Connect the +ve lead of the multimeter (25V d.c. range) to pin 51 and 53 in turn (-ve lead to chassis). Check that the voltages are 13V and 8V ± 0.5V respectively (see Table 2 below, Input High).

(4) Retain the jumper wire linking pins 31 and 41 and re-connect the link between pins 41/42, thus feeding the 1 kHz reference to both inputs (Inputs equal).

(5) Connect the +ve lead of the multimeter (10V d.c. range) to pins 51 and 53 in turn and check that voltages are 8V and 8V respectively (see Table 2 Input Equal).

(6) Remove the jumper wire from pin 31 and 41 thus simulating input low. Again check the voltages at pins 51 and 53 which should be 8V and 4V respectively (Table 2 Input Low).

TABLE 2

Frequency Comparator Measurements

Pins Linked	Input State	Pin 51	Pin 53	Limits
31/31	High	13V	8V	±0.5V
31/41 } 41/42 }	Equal	8V	8V	±0.5V
41/42	Low	8V	4V	±0.5V

(7) Finally, reconnect the link between pins 30 and 31.

Pulse Generator Method (Frequency Comparator Check)

NOTE: The measurements in Table 2 above also apply to a pulse generator test provided the input signals in each mode differ by more than 200 Hz.

14. (1) The pulse generator output should be a square wave variable in frequency from 500 Hz to 2000 Hz. The amplitude should be approximately 3 volts peak-to-peak with rise and fall times of less than 200 nanoseconds.

(2) Disconnect the link between pins 30 and 31 and connect the pulse generator output to pin 31 with its earth lead to pin 29.

(3) Set the pulse generator to the following frequency settings in turn. Refer to Table 2 in the previous paragraph and check the voltage measurements according to each input state as follows:

Frequency	Input State in Table 2
Greater than 1200 Hz	High
Exactly 1000 Hz	Equal
Less than 800 Hz	Low

(4) Check that the out-of-lock indication is obtained with the 'High' and 'Low' inputs.

(5) Finally, disconnect the test equipment and re-connect the link between pins 30 and 31.

Variable Voltage Method (Frequency Comparator Check)

NOTE: For this test the 12-17 MHz generator, main oscillator, mixer and programmed divider must be working correctly. A variable d.c. voltage source (0 to 11 volts) may be used or alternatively a 10 kΩ potentiometer connected between the +18V and EARTH terminals on the case can provide a suitable voltage. Check that the voltage taken from the potentiometer slider does not exceed 12 volts.

15. (1) Set the Synthesizer kHz controls to 300.

(2) On the PM3 board link pin 83 directly to earth. This prevents excessive current in VT37 (Fig. 6).

(3) On the PM3 board connect a regulated d.c. voltage source to pin 85 (+ve) and pin 82 (-ve). The applied voltage must not at any time exceed 12 volts.

(4) With the d.c. voltage source set to approximately 10 volts check the voltage at pins 51 and 53 on the PM1 board in accordance with Table 2 in paragraph 13 (Input State High). At the same time an out of lock indication should be obtained.

(5) Reduce the d.c. voltage source to 1 volt and repeat the measurements of (4) which should be in accordance with Input State Low. Check that an out-of-lock indication is obtained.

(6) Slowly vary the d.c. voltage source from 1 volt through to 10 volts and check that the out-of-lock tone output goes through the sequence of 'on' - 'off' - 'on'. The phones or oscilloscope can be connected between the out-of-lock terminal and chassis. An oscilloscope will disply a 1 kHz waveform, approximately triangular (with some interference superimposed) with an amplitude between 0.5V and 1.0V peak-to-peak.

PM3 BOARD TESTS

CAUTION: The advice previously given concerning the use of a 30V d.c. power supply connected via a 120 ohm $1\frac{1}{2}$ watt resistor should be noted.

Power Supply

16. (1) Check that correct d.c. voltages are present on the following pins of the PM3 board:

Pin 64	+ 13V ± 100 mV
Pin 65	+ 8V ± 100 mV
Pin 66	+ 4V ± 100 mV

If voltages are not correct refer to Chapter 4 for adjustment instructions.

(2) Measure the voltage on pin 70 which should be +10V plus or minus 1.5V. This monitors the current in the 8-volt line by measuring the volts drop across resistor R47. (Fig. 5).

(3) Measure the voltage on pin 71 which should be +5 volts plus or minus 0.5V. This monitors the current in R48 for the 4-volt line. (Fig. 5).

Main Oscillator Setting-Up

17. This is described in Chapter 4.

Main Oscillators Output Check

18. Refer to paragraph 3 in this chapter.

Mixer and Programmed Divider Check

NOTE 1 : The 12-17 MHz generator in the PM1 board should be working correctly for this test. If it is not, a signal generator (12 MHz) will be required. This 12 MHz can be injected at pin 1 on the PM3, but first disconnect the coaxial lead from pins 1 and 2 because this lead carries 8V d.c.

NOTE 2 : The following procedures refer to the later production versions fitted with binary coded KHz switches.

19. (1) With both the PM1 and PM3 boards connected, set the synthesizer controls to 2.500. The two frequencies entering the mixer should now be 12.0 MHz and 13.2 MHz.

NOTE: If the 12-17 MHz generator is not working disconnect the coaxial inner and outer from pins 1 and 2 on the PM3 board. Connect a signal generator output to pin 1 on the PM3 board (Fig. 5). Set the signal generator to 12 MHz c.w. 70 mV r.m.s.

(2) Connect a digital frequency meter to the main oscillator OUTPUT socket and check that the frequency indication is 13 200 000 approximately The actual reading depends upon the accuracy of the signal generator frequency.

(3) Check the frequency at pin 7 of the PM3 board. This should be 1 kHz. An oscilloscope connected to pin 7 will display the 1 kHz waveform which should have the following approximate parameters.

Up for 800 microseconds.
Down for 200 microseconds.
Amplitude 3 volts peak-to-peak.

(4) If the above waveform is not obtained, check the integrated-circuit elements LG1, LG2 and LG3. Check for an input at pin 8 on the element and an output at pins 5 and 12. The output waveform is typically 3 volts peak-to-peak and should not be less than 2V p-p.

(5) If an integrated-circuit element is faulty a recognizable square waveform will be obtained at pin 8 of the faulty element but nil output at the output pins 5, 12 etc.

(6) With a multimeter measure the voltage on pin 10 which should be -ve 5.3V plus or minus 1.0V. This is the negative bias for the phase comparator.

(7) Measure the voltage at pin 9 which should be +8 volts relative to chassis. This is the binary 0 volt reference applied to the kHz control switches.

kHz Switching Faults

20. (1) A faulty contact in one of the kHz control switches may be the cause of an erratic change of the kilohertz frequency of the main oscillator. This frequency can be measured at the OUTPUT socket, using a digital frequency meter. For example if one of the kHz, switches, when rotated from 0 to 9, causes the corresponding digits in the main oscillator output frequency to have an erratic sequence such as 1-2-3-4-8-6-7-8-9, then the binary levels at the pins on the relevant integrated circuit LG1, LG2 or LG3 should be checked. Refer to the Switch Sequence tables on page 2-13, bearing in mind that '0' reference is +8 volts and the '1' level is approximately +13V.

(2) If an output reading of "600" is obtained in every combination of switch settings it suggests a break in the '0' reference line between pin 9 on the Programmed Divider and the common lead to tag 10 on the switches. It may be noted that the disconnection of a single wire to a kilohertz switch will normally cause an erroneous digit indication in several positions of that switch.

POWER UNIT FAULTS

21. Series Regulator Fault

(1) If the series transistor VT27 (Refer to Fig. 5) is open-circuit, current can continue to flow through the parallel resistor R56. The effect is that the 4 volt, 8 volt and 13 volt lines will all show low-voltage readings. The extent of the reduced voltage on these lines would depend upon the battery voltage. If the battery supply is only 15 volts, then the fall in voltage levels resulting from this fault would be substantial (certainly more than 50 percent). With an 18 volt battery the drop would be slightly less.

Broken Connections

(1) The voltage regulation system depends upon a correct balance of currents in the 4V, 8V and 13V lines. It is essential that the 4 volt line carries a slightly higher current than the other two. A broken connection could upset this balance, but the actual effect depends upon where the break occurs. The test points at pins 70 and 71 on the PM3 board provide a check on the correct balance in the voltage regulator circuit. The following voltages should be measured on the PM3 board with a good quality testmeter.

(i) First check that the voltage at pin 64 is 13 volts ± 0.1V relative to chassis. If this reading is not correct check the adjustment of RV3 (Chapter 4 para. 4).

(ii) Assuming that pin 64 is at 13 volts, check that pins 70 and 71 show the following readings relative to chassis.

Pin 70	between 8.5V and 11.5V
Pin 71	between 4.5 V and 5.5V.

VOLTAGE MEASUREMENTS

22. Typical Voltage readings are given on the following pages. These were taken on a good quality 20 000 ohms per volt instrument and are provided as a general guide to serviceability.

TABLE OF STATIC VOLTAGE MEASUREMENTS

NOTES 1: All measurements are relative to chassis (0 volt)

2: All readings are positive (+) unless otherwise indicated

3: These readings are provided as a guide and do not represent a specification. Variations of ±10% may be expected. The measurements were made with an AVO Type 8 (20 kΩ/volt) multimeter using the 10V or 25V range, as appropriate.

4: The Frequency selecting switches of the manpack may be in any in-lock position except where specific instructions are given.

PM2 (or PM1) BOARD

Test Point	D.C. Volts	
VT1e	9.5	MHz Switch set to 2
	10.8	MHz Switch set to 3
	12.5	MHz Switch set to 4
	10.0	MHz Switch set to 5
	11.2	MHz Switch set to 6
	12.7	MHz Switch set to 7

Test Point	D.C. Volts	Test Point	D.C. Volts
VT5 b	5.6	VT14 b	7.1
e	5.0	VT18 e	6.2 (PM2 only)
c	7.7	VT20 e	5.5
VT9 e	0.2	VT21 c	5.0
c	1.2	Pin 11 between	1V and 5V
VT11 e	1.6	Pin 9 between	0.5V and 5V
b	2.3	VT22 c	4.9
VT16 e	4.6	VT23 c	4.8
c	5.7	VT24 e	4.8
VT15 b	6.4	VT24 c	7.8
c	7.2	VT26 c	4.4

Test Point	D.C. Volts	Test Point	D.C. Volts
VT27 e	5.1	VT51 e	1.0
c	8.0	b	1.2
VT40 e	4.5	VT52 b	1.2
c	6.5	c	1.3
VT41 e	5.2	VT53 e	5.0
b	5.9	b	4.7
VT43 e	8.0	c	-1.8
b	8.7		
VT44 e	4.0	Pin 40	8.0
b	3.8	VT63c	2.0
VT48 c	0.2	VT66c	2.0
VT49 c	4.0	Pin 51, 53	8.0
VT50 e	11.5	Pin 34	-5.3
b	10.3	Pin 54	6.8
c	6.8		

	In Lock	Out of Lock	(Set MHz switch between positions)
VT73 c	0.2	0.7	
VT75 c	3.6	0.8	
VT76 c	0.1	1.7	
VT77 e	0.1	1.3	

PM3 BOARD

(See Next Page)

PM3 BOARD

Test Point	D.C. Volts	Test Point	D.C. Volts
Pin 70	10.0	VT39 b	4.0 } MHz SW in positions 5, 6 and 7.
71	5.0	VT40 b	3.1 }
VT1 e	3.4	VT44 e	0.5
VT5 e	8.0	c	4.1
b	8.7	VT42 e	4.4
c	9.3	b	5.1
VT6 c	10.5	c	7.5
VT8 c	12.8	Pin 83	7.9
VT9 c	8.3	Junction D54-R99	4.5
VT10 c	12.0	Pin 91	3.1
VT12 c	9.1	VT43 e	4.5
VT11 e	11.3	b	5.2
VT13 c	2.7	c	8.0
VT14 e	4.0	VT46 e	1.0
VT39 b	3.1 } MHz Sw in positions 2, 3, 4	b	1.7
VT40 b	4.0 }	c	5.0
VT41 e	3.7	VT45 b	5.7

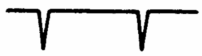
TABLE OF TYPICAL WAVEFORMS

PM2 (or PM1) Board

Pin 12 Sinusoidal 12-17 MHz 300 mV p.p.

VT11 c Sinusoidal 12-17 MHz 2.4 V p.p.

VT2 c  p.r.f. = 1 MHz, width = 30 nS, amplitude = 3V.

VT3 c  p.r.f. = 1 MHz, width = 30 nS, amplitude = 4V.

Pin 10  p.r.f. = 1 MHz, width = 20 nS amplitude = 13V.

Note VT2c, VT3c, Pin 10 need fast scope, - 80 MHz or higher.

VT15 c Normally shows a complex waveform of 12-17 MHz together with feedback from mixer, therefore it is not a useful one to observe.

NOTE To check frequency of 12-17 MHz generator, connect oscilloscope probe to VT11 collector and connect probe output to digital frequency meter input. (Racal 806R).

VT18 e Sinusoidal 5 MHz 300 mV p.p. (PM2 only)

VT20 c Sinusoidal 5 MHz 2 V p.p. (PM2 only)

Pin 20 PM2 (a) with no link to pin 21: same as VT20 c

(b) with link to pin 21:....1.6 V p.p.

PM1 with link connected:.... 1V p.p.

VT22 c  5 MHz 3.5 p.p.

	Waveform	p.m.f.	width	amplitude
VT25 c		1 MHz	= 100 nS	= 3.5V
D24 a	Waveform as VT25C	1 MHz	= 80 nS	= 2.2V