COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF CIVIL AVIATION

HANDBOOK

FOR

MODEL 205

SIGNAL GENERATOR

D.C.A. IDENT No. Y10/591

MANUFACTURED BY

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ISSUE 1

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SECTION 1 — BRIEF DESCRIPTION AND SUMMARISED ELECTRICAL SPECIFICATION

1.1 Classification:

The Model 205 Signal Generator has been designed as a general purpose instrument to facilitate performance testing of communication equipment, particularly that of receivers operating at frequencies between 45 and 180 Mc/s.

The equipment is suitable for use in tropical areas.

1.2 Brief Description:

1.2.1 Operational Features:

Fundamentally the apparatus comprises a stable master oscillator whose output frequency is amplified, multiplied, and fed to a calibrated inductive piston attenuator. The output signal may be modulated to a depth of 50% from either a built-in 400 cps oscillator, or from an external source.

The R.F. Circuits are heavily shielded and this together with the attenuator allows sensitivity measurements to be taken in the range between 0.1 volt and 0.1 microvolt.

Considerable care has been taken in the design of the Model 205 to minimize frequency drift after a 45 minute warm-up period, and to minimise spurious frequency modulation of the output signal.

1.2.2 Mechanical Arrangements:

The Model 205 is housed in a steel carrying case fitted with a detachable cover lid which houses accessories such as Instruction Book, Power Cord, and Output Cable.

Mechanically the instrument is divided into three basic sections:

(a) Power Supply

(b) R.F. Amplifier and Oscillator Casting

(c) Modulator Chassis.

All the above units are mounted on a suitably engraved 3/16" aluminium front panel fitted with protective handles.

All controls required for normal operation are brought to the front panel as shown in photograph No. 1.

1.3 Power Requirements:

Power to the instrument is applied via a detachable 3 wire power cord 9' long fitted with a 3 pin plug and socket.

Provision is made within the instrument to accommodate line voltages between 220 and 260 volts 50 cps. Power consumption is approximately 30 watts.

1.4 Summarised Electrical Specification:

1.4. 1 FREQUENCY RANGE:	Continuously tuned between 45 and 180 Mc/s. covered in two ranges, namely 45 to 90 and 90 to 180 Mc/s.
1.4. 2 FREQUENCY CONTROL:	Master Oscillator operating in the range 22.5 to 45 M/cs.
1.4. 3 FREQUENCY CALIBRATION ACCURACY:	Better than ± 0.25% after ½ hour warm up.
1.4. 4 TIME REQUIRED TO REACH OPERATING TEMPERATURE:	For most purposes may be used after 5 minute warm up. After 45 minutes operation frequency remains constant within 0.02% for the next 15 minutes. Frequency stability improves for longer periods of operation.
1.4. 5 OUTPUT VOLTAGE:	Variable between 0.1 volt and 0.1 microvolt.
1.4. 6 OUTPUT ATTENUATOR DETAILS:	Calibrated inductive piston. Impedance looking into generator 50 ohms. S.W.R. less than 1.5 to 1. Calibrated to indicate microvolts across a 50 ohm resistor at the end of a 3' 50 ohm cable. Accuracy of calibration ± 1dB for all output levels below 10,000 microvolts and ± 2dB between 10,000 microvolts and 0.1 volt.
1.4. 7 SPURIOUS COMPONENTS IN OUTPUT SIGNAL:	The spurious outputs are harmonically related and are at least 30 dB below the carrier level.
1.4. 8 R.F. LEAKAGE:	Negligible at a distance of 6" from the case and allows measurements to be taken at a level of 0.1 microvolt.
1.4. 9 FREQUENCY CHANGE DUE TO ATTENUATOR LOADING:	Zero for all values of output below 10,000 microvolts, and less than 0.001% of operating frequency for output levels between 0.1 volt and 10,000 microvolts.
1.4.10 METERING FACILITIES:	A meter provides continuous monitoring of the output level and may be switched to indicate modulation %.
1.4.11 MODULATION FACILITIES:	Internal 0 to (50 ± 5)% at 400 cps. External 0 to (50 ± 5)%. Response 50 cps. to 10 Kc/s. within 0.5 dB. Approximately 3.5 volts required for 30% modulation.
1.4.12 MODULATION ENVELOPE DISTORTION:	Less than 5% total harmonic distortion at 30% modulation and maximum output, improves with lower output levels.

1.4.13 NOISE LEVEL: At least 50 dB below 30% modulation.

1.4.14 SPURIOUS F.M.: Less than ± 2 Kc/s. at 30% modulation and carrier frequency of 180 Mc/s. Improved as carrier frequency is decreased.

1.4.15 CLIMATIC CONDITIONS FOR NORMAL OPERATION: COMPLEMENT: The Signal generator will operate over a temperature range of — 5 to ± 55° C. with humidity of 95% and 55% respectively.

1.4.16 ELECTRON TUBE

Qty.	*Type*	*Description*	*Cir. Ref.*	*Function*
1	QS/150/15	Voltage regulator	V1	Voltage regulator
2	6AK5	R.F. Pentode	V2 & V3	R.F. Oscillator R.F. Amplifier
1	6AU6	R.F. Pentode	V4	400 cps. Oscillator
1	6CK6	High Gm Pentode	V5	Mod. Amplifier
3	STV8	Silocon Diode	D1 D2 D5	P.S. Rectifier P.S. Rectifier Relay Rectifier
2	OA95	Germanium Diode	D3 D4	Metering Rectifiers Metering Rectifiers

1.4.17 DIMENSIONS, WEIGHT AND FINISH: 14" long x 11½" high x 9½" deep overall. Weight 32 lbs. Finish — Case grey brocade and panel grey enamel to B.S.S. 381.

SECTION 2 — TECHNICAL DESCRIPTION

2.1 Principal of Operation:

The Model 205 is primarily a Signal generator constructed on conventional lines. The unit comprises a power supply, a variable frequency oscillator whose output frequency is multiplied, amplified, and applied to a calibrated piston attenuator.

2.2 Valve Functions:

The following valves are used in the equipment and their functions are listed below:

Circuit No.	*Valve Type*	
Voltage Regulator		*Function*
V1	QS/150/15	Voltage Regulator
V2	6AK5	R.F. Oscillator
V3	6AK5	R.F. Amplifier and Frequency Doubler
V4	6AU6	Audio Oscillator
V5	6CK6	Modulator
D1 and D2	STV8	H.T. Rectifiers
D3 and D4	OA95	Meter Rectifiers
D5	STV8	Relay Rectifier

2.3 Power Supply Details:

The power to operate the above valves enters the equipment through the main switch S1 and a 1 amp. fuse. F1. The Power Transformer T1 is provided with one 6.3 volt filament winding together a centre tapped H.T. winding delivering 235 volts per side at 40 milliamps to the silicon diodes D1 and D2.

D.C. filtering is provided in the positive lead by means of the 4 μF capacitor C1 together with the power choke L1 and the H.T. capacitors C2 and C3.

The main H.T. is delivered to the equipment at 280 volts except to circuits whose operation is voltage dependent, in which case the supply is regulated by the QS150/15 valve V1 at 150 volts.

2.3.1 Line Voltage Adjustment:

CARE SHOULD BE TAKEN TO DISCONNECT THE EQUIPMENT FROM THE POWER SOURCE BEFORE MAKING LINE VOLTAGE ADJUSTMENTS.

The power supply chassis mounted on the right hand side of the equipment carries a terminal strip which allows the input to be adjusted to suit mains voltages between 220 and 260 volts 50 cps. as required.

The terminal strip is readily accessible after the instrument is withdrawn from its carrying case.

2.4 The Master Oscillator:

The Master Oscillator is housed in a shielded compartment and consists of a type 6AK5 valve V2 and its associated components. The Oscillator is of the Hartley type, oscillation taking place between the control grid and screen of the tube. The inductance L3 in conjunction with the tuning capacitor C6A controls the frequency of oscillation which is variable between 22.5 and 45 Mc/s.

In order to reduce frequency drift due to tube input capacity change during the warm-up period, the grid coupling capacitor C8 is made small, C8 is also chosen to have a highly negative temperature co-efficient (N4,700 parts per million) which compensates to a large extent the positive temperature co-efficient of the other components of the circuit.

The screen of the oscillator is bypassed for R.F. by C9, and is fed through the resistor R7 which limits the screen dissipation, and also serves as a decoupling resistor.

The output of the oscillator is taken from the anode of the tube which is electron coupled to the oscillator circuit. L8 is tuned by C6B to the second harmonic of the oscillator frequency thus providing drive to the amplifier at double the oscillator frequency, i.e. 45 to 90 Mc/s.

In order to reduce frequency modulation of the oscillator due to change of input impedance of V3 under modulated conditions, L8 is heavily damped by the 2,200 ohm shunt resistor R11, whilst the output is taken across half of L8. Under these conditions the impedance of the drive source for V3 can never exceed $\frac{2{,}200}{4}$ ohms = 550 ohms.

The arrangement reduces spurious F.M. of the signal to less than 2,000 cps. or approximately one part in 10^5 at the highest operating frequency, obviously the spurious F.M. decreases as the operating frequency is lowered due to the increased value of the capacitor's C6A, C6B, and C6C.

2.5 The R.F. Amplifier and Doubler:

C20 couples the output of the oscillator to the grid of V3 which is driven in class C condition, bias being developed across the 33K grid resistor R13. The stage is operated under reduced anode and screen voltage conditions to improve the modulation characteristics.

Modulation is applied to the screen of the amplifier tube and the output level is controlled by adjusting the screen voltage by means of the potentiometer R12. The arrangement allows the output level to be adjusted throughout the operating range without adversely affecting the modulation percent calibration.

From a D.C. point of view the anode circuit of V3 is shunt fed through the resistor R15, which also serves to decouple the stage and prevent R.F. currents entering the H.T. line.

C26 couples the output of V3 to the final tank circuit consisting of L9 and C6c. The circuit tunes over a frequency range of either 45 to 90 Mc/s. or 90 to 180 Mc/s. depending on the position of RL1/1, which in turn is controlled by the relay RL1 and the range switch S3B, it will be seen therefore that V3 operates as an amplifier on the low range 45 to 90 Mc and a frequency doubler on the high range 90 to 180 Mc/s.

The output circuit is lightly loaded to preserve its selectivity, thereby reducing spurious components in the output to a level at least 30 dB below the desired signal.

2.6 R.F. Output Level Metering:

An R.F. volt meter consisting of the germanium diode D4, load resistors R16 and R18 and an 0 to 100 microamp meter M1, is coupled to the output tuned circuit by means of a 2.2 pF Capacitor C27. The arrangement continuously measures the output level in order that the attenuator may be calibrated.

Because the ratio of L9 to L10 changes by 4 : 1 when the frequency is changed 2 : 1 by means of RL1/1, the voltage across the tank required to give 0.1 volt output in the low range is approximately twice that to give 0.1 volt on the high range (Sec. 2.7 output attenuator formula 1). The switch S3 removes R18 from the circuit on the high range.

2.7 Output Attenuator:

The output signal is taken from the final amplifier tank circuit via the mutual inductance type piston attenuator having an internal impedance of 50 ohms. To provide continuous adjustment of the output voltage the pick-up loop L10 is movable along the axis of the attenuator barrel by means of a rack and pinion drive.

The voltage e' induced in the pick-up loop L10 is given by

$$e' = IWM$$

$$= \frac{E}{WL9} \times WK \sqrt{L9 \times L10}$$

$$= E \times K \sqrt{\frac{L10}{L9}} \quad \text{.....(1)}$$

where e' = the voltage induced in the pick-up loop L9
W = 2 π x frequency
K = co-efficient of coupling between L9 and L10
M = mutual inductance between L9 and L10
E = voltage across the tank coil L9
I = current flowing in the tank coil L9

Equation (1) indicates that the voltage induced in the pick-up loop is a function of the tank voltage E, and the co-efficient of coupling only, since L9 and L10 are constants fixed by design. The co-efficient of coupling is controlled by the law of the piston, and the tank voltage is continuously monitored by the output volt meter. The calibration is therefore independent of operating frequency provided the reactance of the pick-up loop at the operating frequency is small compared with the resistance of R19.

When the output cable is terminated at the far end with a load resistance of 50 ohms. the voltage e across the terminating resistor is given by

$$e = \frac{e' \times 50}{(50 + 50) + JW\ L10}$$

$$= \frac{50e'}{\sqrt{100^2 + WL10^2}}$$

and since L10 has a value in the order of 0.01 microhenry $(WL10)^2$ can be neglected by comparison with 100^2 at the highest operating frequency and hence the voltage across the terminating resistor is given by

$$e = \frac{50e'}{100} = \frac{e'}{2}$$

The attenuator is calibrated in terms of the voltage across a 50 ohms. resistor at the end of the output cable, and is direct reading between 0.1 volt and 0.1 microvolt.

2.8 R.F. Filtering:

Because the R.F. voltage on the oscillator, and amplifier plate, is high compared with the minimum useful output voltage (the voltage ratio being in excess of 100 million to 1) considerable care has been necessary in the design of the equipment to prevent stray leakage fields short circuiting the attenuator system.

For the above reason the entire R.F. circuits including V2 and V3 are mounted on a cast aluminium base, and are totally enclosed by a seamless aluminium shield cover. In addition all leads entering the R.F. unit are passed through a shielded R.F. filter system, consisting of the filter coils L4, L5, L6 and L7 and the associated R.F. bypass capacitors.

All the above components are mounted concentrically in a brass tube located in the R.F. compartment.

2.9 Modulation Amplifier:

The final stage of the Model 205 is amplitude modulated, and the modulating voltage is directly coupled from the anode of V5 to the screen of V3 via the potentiometer R12. The modulating signal derived either from an internal, or external source, is amplified by V5. A high Gm type 6CK6 tube is chosen in order that the necessary amplification can be achieved in one stage, and that sufficient negative feedback can be applied by means of the unbypassed cathode resistor R6. The negative feed-back halves the harmonic distortion of the stage and also reduces variations due to tube ageing or replacement.

2.10 Modulation Metering:

The audio voltage developed across R6 is coupled via C13 to the diode D3 and thence via S4 to the meter M1. S4 is spring-loaded, so that in its normal position the meter reads carrier voltage, and reads modulation voltage when the switch is held in position 1.

The meter M1 is calibrated in terms of modulation % and is adjusted to give a correct reading at the 30% point by means of the "adjust on test resistor" R10A, when the R.F. signal is set to 140 Mc/s. For other values of modulation % and carrier frequency the reading will be correct within ± 5 of the indicated value. (See Section 4.4.)

2.11 The Audio Oscillator:

A 400 cps. audio oscillator consisting of a 6AU6 valve V4, inductance L2, and their associated components, supply the voltage for internal modulation. The oscillator is of conventional Hartley design the tube being connected as a triode. L2 is tuned by C4 to 400 cps., fine adjustment of frequency is made by means of the adjustment slug of L2.

The unbypassed cathode resistor R1 controls both the output voltage and distortion of the oscillator. The value of R1 being chosen to give adequate output voltage with a total harmonic distortion in the order of 1.5%.

The output of the audio oscillator is applied across the modulation adjustment potentiometer R4 when selected by the switch S2A. When not required the oscillator is stopped by shorting V4 grid to ground by S2A.

2.12 External Modulation Facilities:

Provision is made to externally modulate the Model 205 when an audio voltage is applied to EXT. MOD. terminals, and selected by S2B. Approximately 3.5 volts are required to modulate the generator to a depth of 30% for all frequencies between 50 cps and 10,000 cps. The impedance looking into the external modulation terminals is approximately 50,000 ohms.

SECTION 3 — INSTALLATION AND ADJUSTMENT

3.1 Packing:

The Model 205 Signal Generator is packed complete with accessories in a wooden packing case suitable for rail or air transport.

The accessories comprise —

(a) The Instruction Book

(b) The Power Cord

(c) The Output Cable

all contained in a removable cover lid attached to the front of the instrument case.

3.2 Unpacking and Inspection:

The equipment is shipped with all valves mounted in their respective sockets and ready to operate from a mains power supply of 240V AC 50 c/s. Upon receipt the Signal Generator should be removed from its carrying case (by removing the panel thumb screws) and inspected for damage in transit and that the transformer (T1) tappings agree with the local mains power supply. If not refer to section 2.3.1.

After inspection replace the instrument and refit the panel thumb screws. Fit the power cord to the socket provided, and attach the output cable to the "R.F. Output" socket.

3.3 Controls:

The operator should now become familiar with the controls which may be listed as follows:—

(a) Power Switch

(b) Fuse and Pilot Lights

(c) Frequency Range Selector and Main Tuning Dial

(d) Meter Reads Switch

(e) Modulation Selector Switch

(f) Modulation Adjustment Control

(g) R.F. Output Level Control

(h) R.F. Output Attenuator

3.4 Operating Procedure:

Allow a period of at least 5 minutes after switch on for the valves to reach operating temperature before setting the controls. In the event of the signal generator being used to measure highly selective receivers the warm-up period should be extended to 45 minutes after which time the frequency drift will be less than 0.02% of the operating frequency during the following 15 minutes.

3.4.1 Frequency Selection:

The operating frequency may be selected by means of the main tuning dial used in conjunction with the range switch. Two ranges are available, namely 45 to 90 Mc/s. and 90 to 180 Mc/s.

3.4.2 Modulation Adjustment:

Set the modulation selector switch to either INT. or EXT. modulation position as required. Hold the meter read switch in the MOD.% position and adjust the MOD.% ADJ. control until the meter reads the desired modulation level, allow the meter read switch to return to normal position.

When using the EXT. MOD. the impedance looking into the generator terminals is approximately 50,000 ohms. and 3.5 volts are required to produce 30% modulation for all frequencies between 50 cps. and 10,000 cps.

3.4.3 R.F. Output Level Adjustment:

The R.F. output level may be adjusted by firstly adjusting the R.F. level control until the carrier meter reads at the red line at centre scale.

Output levels between 0.1 volt and 0.1 microvolt may now be set with the R.F. attenuator dial. The attenuator dial is directly reading in terms of the voltage appearing across a 50 ohm. load at the end of the output cable. See Section 2 para. 7.

3.4.4 Connection to Receiver Under Test:

When the impedance looking into the input circuit of a receiver under test is 50 ohms the signal generator may be directly connected to the receiver input socket.

When measuring stage gains of a receiver, when the impedance of the circuit under test may be considerably higher than 50 ohms. a 50 ohms. resistor should be used to terminate the output cable, and connection to the circuit under test should be made via the shortest possible wires.

A series blocking capacitor must be used between the signal generator and any circuit where direct and low frequency alternating voltages are present. Neglect of this precaution may result in damage to R19.

Damage to R19 may also result if the R.F. output of transmitter equipment is allowed to enter the attenuator.

If R19 is damaged it will be necessary to recalibrate the signal generator.

"It should be noted that since spurious outputs from the signal generator are in the worst case only 30 dB below the carrier level, caution should be used when examining the spurious response of a receiver with this signal generator."

SECTION 4 — MAINTENANCE

4.1 General Maintenance:

Because of few moving parts and the low operating temperatures involved, it is not envisaged that regular maintenance will be necessary. However, in the event of failure or when it becomes necessary to change a valve the following information may be of assistance.

In general, replacement of valves will cause only second order calibration changes.

To gain access to the R.F. compartment it will be necessary to remove the spun aluminium shield cover by gently tapping the shield from side to side, thus releasing the cover from its taper fit in the cast base.

4.2 Alignment Procedure:

It is not envisaged that the equipment should need realignment throughout its normal life, however, in the event of mechanical damage or wear the R.F. unit should be aligned as follows:—

1. Set the tuning capacitor to its maximum capacity and set the tuning dial to the end stop at the low frequency end of the dial. Tighten all shaft and knob grub screws.

2. Set Tuning Dial to 45 Mc/s. on the low range and adjust the tuning slug of the oscillator coil until the oscillator frequency is 22.5 Mc/s. equivalent to an output frequency of 45 Mc/s.

3. Turn the tuning dial to read 90 Mc/s. on the low range and adjust the oscillator trimmer capacitor C7 until the oscillator frequency is 45 Mc/s. equivalent to an output frequency of 90 Mc/s.

4. Check to see that the calibration at the 70 Mc/s. point on the low band is correct within 0.25% and if not slightly alter the tuning capacitor end plate spacing until the calibration is correct.

   Note 1: The above procedure may have to be repeated several times because of slight interaction between the adjustments.

   Note 2: The presence of the shield cover will slightly influence the calibration at the high frequency end of the dial and C7 should be readjusted to correct any error when the cover is replaced.

Having aligned the dial calibration check to see that the oscillator grid current in R5 is correct. The grid current will vary between 700 and 900 microamps over the tuning range.

5. Check the tracking of C6B by connecting a meter in series with R13 and noting the grid current of V3 which will vary between 160 and 250 microamps, depending on the setting of the frequency dial.

   It is important that the maximum drive be available at the low frequency end of the tuning range and the grid current at this point should be at least 160 microamps. It is possible that the grid current will be in excess of that required at the high frequency end of the band and the trimmer C17 may be "backed off" until the PA grid current varies as follows:—

H.F. end of band	175 microamps
Middle of band	200 microamps
L.F. end of band	160 microamps

6. Check the tracking of the final tank circuit by noting the deflection of the output meter which should always be above the red "set carrier line" when the R.F. level control is set to maximum. The circuit is adjusted firstly on the low frequency end of the high range by adjusting the spacing of the top two turns of L9 for maximum output indicated on the meter M1. Check the tracking at mid-range of the high band and adjust for maximum output by slightly moving the end plate of C6C. The range switch is now turned to the low range and the frequency dial set to 45 Mc/s. Adjust the spacing of the bottom two turns of L9 to give maximum output. The remainder of the range should now track satisfactorily.

4.3 Attenuator Calibration Adjustment:

In the event of it becoming necessary to change the attenuator resistor R19 it will be necessary to recalibrate the attenuator and this is done as follows:—

1. Remove the attenuator dial and loosen the stop clamp.

2. Withdraw the pinion so that it clears the rack and also the front panel.

3. Loosen the attenuator barrel clamp screw.

4. Withdraw the attenuator barrel and if necessary replace R19.

5. Re-fit the plunger into the attenuator barrel and push forward until the pick-up loop L10 protrudes past the end of the barrel.

6. Insert the attenuator barrel into the hole in the casting and move forward until the pick-up loop almost touches L9 and lies parallel and adjacent to the second turn from the top of L9. Check to see that the pinion spindle is aligned with the hole in the front panel, and if not, change the angle of the pick-up loop until both conditions are satisfied.

7. Set the frequency of the signal generator to 140 Mcs. on the high range and the R.F. level to maximum. Note the voltage across a 50 ohm. load resistor at the end of the output cable, which should be considerably in excess of 0.1 of a volt. Slightly rotate the loop for maximum output.

8. Reassemble the attenuator drive spindle, tighten the barrel holding screw, and check to see that the same high voltage output is still available. If not, repeat step 6 and 7 until the maximum output is obtained. Under the above condition small changes in the pick-up loop angle will cause comparatively large output level changes.

9. When satisfied that maximum output is being obtained, "back off" the plunger until approximately 0.1 of a volt appears across the load resistor when the carrier meter is set to the red line. Tighten the stop clamp on the drive spindle and also set the dial to read 0.1 of a volt.

10. Check the output level at 70 Mc/s. on the low range with the carrier level set to line which should also read 0.1 of a volt.

    It may be necessary to move the pick-up loop sideways and forward by a small amount to obtain 0.1 of a volt on both ranges. The forward movement will be made by loosening and re-setting the drive spindle clamp.

11. The output level should now be checked at the 10,000 microvolt point on both ranges and if necessary adjusted to the correct value by moving the dial position slightly and re-setting the stop clamp on the high range and altering the value of R18 on the low range.

    When the output has been corrected at 10,000 microvolts on both ranges all lower output voltages will be correct. However, it will be found that the 0.1 volt position may be 10% high or low depending on the adjustments made.

4.4 Modulation Calibration Adjustment:

To check the modulation calibration set the frequency dial to 140 Mc/s. on the high range and the modulation meter to read 30%. Using either a separate modulation measuring equipment or a C.R.O. together with a suitable frequency converter (to Heterodyne the carrier down to a suitable low frequency) measure the actual modulation % being obtained. If the reading is not 30% alter the value of R10 until the signal generator meter agrees with the true value. Re-check at several points throughout the frequency spectrum to see that the modulation is correct within ± 5%, i.e. 25% to 35% modulation.

4.5 Voltage Chart:

TUBE	SOCKET PIN No.								
CIRCUIT No.	1	2	3	4	5	6	7	8	9
V1	0	—	0	150v	150v	—	150v	—	—
V2	—12v*	0	0	6.3AC	150	125v	0	—	—
V3	—8v*	0	0	6.3AC	115v	90	0	--	—
V4	0	250v	0	6.3AC	250v	250v	7.5v	—	—
V5	250v	0	9.5v	0	6.3AC	9.5v	90v	N.C.	N.C.

* Calculated value.

NOTE 1: All voltages measured between valve pin and ground with A.V.O. Model 8 20,000 ohms. per volt.

NOTE 2: Line voltage 240 volts.

NOTE 3: Meter reads switch set to carrier.

NOTE 4: R.F. level control set to maximum.

NOTE 5: Frequency dial set to 140 Mc/s. high range.

4.6 Select On Test Resistors:

The resistors R1, R10A, R17 and R18 are selected on test and the values may be either 10% higher or lower than the value shown on the circuit diagram.
For further details refer as follows:—

R1 — See Section 2 para. 11.

R10A — See Section 2 para. 10.

R18 — See Section 4 para. 3.11.

R17 — Used on prototype, may not be used in production models.

SECTION 5

5.1 List of Manufacturers and/or Suppliers:

The following list includes the names and addresses of manufacturers mentioned in the attached parts list under Maker's Key Number, and may be of assistance in obtaining spare parts quickly.

KEY No.			PHONE:
1.	R. A. RATCLIFFE	35 Chilton Parade, Warrawee	48-2914
2.	PHILIPS MINIWATT PTY. LTD.	20 Herbert Street, Artarmon	43-2171
3.	DUCON CONDENSER LTD.	Christina Road, Villawood	72-0133
4.	PATON ELECTRIC PTY. LTD.	90 Victoria Street, Ashfield	71-5266
5.	COMMONWEALTH ELECTRONICS PTY. LTD.	James Street, Baulkham Hills	639-4261
6.	MANUFACTURERS' SPECIAL PRODUCTS PTY. LTD.	47 York Street, Sydney	2-0233
7.	TRANSMISSION PRODUCTS PTY. LTD.	Denison Street, North Sydney	92-4018
8.	MORGAN CRUCIBLE PTY. LTD.	65-67 Bourke Road, Alexandria	67-1371
9.	SIEMENS HALSKE SIEMENS SCHUCKERT ASIA, PTY. LTD.	8 Mount Street, North Sydney	92-0966
10.	UNITED CAPACITOR PTY. LTD.	433 Punchbowl Road, Belfield	53-3511
11.	W. J. McLELLAN PTY. LTD.	The Crescent, Kingsgrove	50-0111
12.	WATKIN WYNNE PTY. LTD.	21 Falcon Street, Crows Nest	43-2107
13.	SIMPLEX PRODUCTS PTY. LTD.	Christina Road, Villawood	72-0133
14.	AERONAUTICAL SUPPLY PTY. LTD.	Fifth Street, Mascot Airport	67-1488
15.	ACKLAND PTY. LTD.	321 Princes Highway, St. Peters	51-4256
16.	E. C. GALLARD PTY. LTD.	137 Princes Highway, Arncliffe	59-4457
17.	GENERAL ELECTRONIC SERVICES PTY. LTD.	5 Ridge Street, North Sydney	929-8453