Marconi
Instruments

6910 and 6911

RF POWER SENSORS

Instruction Manual

Instruction Manual
H 6910
2nd Edition

RF POWER SENSORS
6910 and 6911

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CONTENTS

PREFACE

WARNINGS, CAUTIONS AND NOTES

These terms have specific meanings in this manual:-

WARNINGS contain information to prevent personal injury.
CAUTIONS contain information to prevent damage to the equipment.
Notes contain important general information.

HAZARD SYMBOLS

The meaning of symbols that appear on the equipment is as follows:-

Symbol	Type of hazard	Reference in manual
	Static sensitive component	Page iv
 *on front plate*	Dismantling may cause unrepairable damage to this unit.	Page 5-5
 *on casing*	Precision type N connector	Page iv

SYMBOLS IN THE MANUAL

The meaning of symbols used in this manual is as follows:-

(1) Sequence of steps in a procedure.

■ List of topics or items.

[1] Topics or items keyed to the same number on a diagram.

CAPS Capitals are used to identify names of controls and panel markings.

[ ] Square brackets are used to distinguish push-button keys.

MANUAL AMENDMENT STATUS

Each page bears the date of the original issue or the code number and date of the latest amendment (Am. 1, Am. 2 etc.).

Any changes subsequent to the latest amendment state of the manual are included on inserted sheets coded C1, C2, etc.

OPERATING PRECAUTIONS

This sensor, when used with the 6950 or 6960 Series RF Power Meter, is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 148 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition.

CAUTION – AVOIDANCE OF MEASUREMENT ERRORS

To prevent stray radiation being detected and displayed on the power meter, this sensor should be properly terminated in 50 Ω.

Because the detection process involves the conversion of RF power to thermal power, time should be allowed for the sensor to take up the ambient temperature of the measuring environment before zeroing and operating the meter. Rapid temperature changes should be avoided while operating.

CAUTION – STATIC SENSITIVE COMPONENTS

Components identified with the symbol ⚠ on the circuit diagrams and/or parts lists are static sensitive devices. Certain handling precautions must be observed to prevent these components being permanently damaged by static charges or rapid charge surges.

If a printed board containing static sensitive components is removed, it must be temporarily stored in a conductive plastic bag.

If a static sensitive component is to be removed or replaced the following anti-static equipment must be used.

A *work bench* with an earthed conductive surface.

Metallic tools earthed either permanently or by repeated discharges.

A low-voltage earthed *soldering iron*.

An earthed *wrist strap* and a conductive earthed *seat cover* for the operator, whose *outer clothing* must not be of man-made fibre.

As a general precaution, avoid touching the leads of a static sensitive component. When handling a new one, leave it in its conducting mount until it is required for use.

CAUTION – PRECISION CONNECTOR

⚠ The precision type N connector fitted to this sensor may be damaged by mating with general purpose type N connectors.

WARNING – TOXIC HAZARD

Many of the electronic components used in this sensor employ resins and other chemicals which give off toxic fumes on incineration. Appropriate precautions should therefore be taken in the disposal of these items.

Chapter 1

GENERAL INFORMATION

FEATURES

RF Power Sensor 6910 is used with Marconi Instruments RF Power Meters 6950 (analogue) and 6960 series (digital). It provides the meter with an accurate chopped DC analogue of RF power over a 50 dB dynamic range from –30 dBm to +20 dBm (1 μW to 100 mW) at frequencies from 10 MHz to 20 GHz.

The 6911 sensor differs from 6910 in having an APC7 RF connector instead of a type N. In all other respects the two sensors are identical.

Each sensor has an individual label showing a graph of 'calibration factor' and a 'linearity factor' figure. The calibration factor appropriate to the measurement frequency may be entered into both the 6950 and 6960 meters to enhance accuracy. The linearity factor may also be entered into the 6960 to compensate for non-linearity at higher powers (compensation is switch-selectable in the 6950).

A 'calibration data chart' which lists calibration and linearity factors to two decimal places is also provided with each sensor.

Fig. 1–1 RF Power sensor type 6910

VSWR and uncertainty values are low across the entire frequency range of the sensor.

Zero drift due to temperature changes is less than 2.0 μW over the range 0°C to 60°C. Gain changes caused by fluctuations in ambient temperature are rapidly corrected by a compensating circuit.

The sensor provides high level signals to the power meter so that the possibility of significant RF interference when measuring is negligible. A high damage level threshold minimizes the possibility of damage to the RF unit. Should this unit be damaged, however, it may be easily replaced by the user - see Chap. 5.

Its small, light, rugged construction allows the sensor to be used confidently in bench or field applications without the need of any mechanical support.

PERFORMANCE DATA

Power range:	-30 dBm (1 μW) to +20 dBm (100 mW).
Maximum RF input:	+24.8 dBm (300 mW) average. Peak power 15 W for 2 μs.
Frequency range:	10 MHz to 18 GHz, usable to 20 GHz.
VSWR:	10 MHz - 30 MHz : 1.25 30 MHz - 2 GHz : 1.1 2 GHz - 6 GHz : 1.18 16 GHz - 18 GHz : 1.28 18 GHz - 20 GHz : 1.4 (typical)
Drift:	10 nW (typical, 1 hour after 24 hour warm-up at constant temperature).
Linearity factor:	Provided with sensor . Accuracy ±0.5% at 25°C.
Calibration factor:	Provided with sensor.
RF connector:	6910 : Precision N-type male, 50 Ω. 6911 : Type APC7, 50 Ω.
Output connector:	Multiway. Mates with sensor cable assembly (supplied with power meter).
Size:	87 mm long (including connectors). 33.5 mm dia.
Weight:	140 g.

Chapter 2

INSTALLATION

UNPACKING AND REPACKING

Retain the packing materials and the packing instruction note (if included) in case it is necessary to reship the sensor.

If the sensor is to be returned for servicing attach a label indicating the service required, type number, serial number and your return address.

If the original container or materials are not available use a strong double-wall carton packed with shock absorbing material around all sides of the sensor to hold it firmly.

Chapter 3

OPERATION

PREPARATION FOR USE

Before making measurements, the power meter must be matched to the individual characteristics of the sensor. This entails the following procedures:-

- Zeroing the meter.
- Calibration, that is, entering the sensor's calibration factor and linearity factor.

Note...

If the sensor has been stored at a temperature different from that of the measurement environment, allow sufficient time for thermal equilibrium to be established before zeroing or calibration.

WITH POWER METER 6950

Zeroing

(1) Connect the sensor to the SENSOR INPUT socket of the 6950 using the sensor cable supplied with the power meter.

(2) With no power applied to the sensor, select the most sensitive range (–25 dBm) by turning the RANGE switch fully counter-clockwise.

(3) Adjust the ZERO preset control for zero reading on the meter, using the special tool provided with the power meter.

Hint...

It may be helpful in setting zero to adjust the RESPONSE TIME control on the rear panel to reduce noise. You may also find it easier to set zero first on a less sensitive range, as slight adjustments of the ZERO control have considerable effect on the most sensitive range.

Calibration

(1) Connect the sensor to the POWER REFERENCE output of the 6950.

(2) Set the RANGE switch to 0 dBm.

(3) Set the CAL FACTOR control to 100%.

(4) On the rear panel, switch POWER REF to ON and the LIN F : 6%/8% switch to the setting which is nearest to the value of the linearity factor shown on the sensor label or its calibration data chart. (If the LIN F switch positions on your 6950 are designated 75 Ω and 50 Ω, these should be interpreted as 6% (75 Ω) and 8% (50 Ω) and the switch set accordingly as above.)

(5) Adjust the GAIN preset control for full-scale meter reading.

(6) Switch POWER REF off and disconnect the sensor from the POWER REFERENCE socket.

(7) Determine the calibration factor for the measurement frequency, either from the graph on the sensor label or from its calibration data chart. Set the CAL FACTOR control to the same value.

The power meter can now be used for measuring RF power. For full instructions and uncertainty calculations, refer to the 6950 Operating Manual, Chapter 3.

WITH POWER METER 6960 Series

Zeroing

(1) Connect the sensor to the SENSOR INPUT of the 6960, using the sensor cable supplied with the power meter.

(2) With no power applied to the sensor, press [AUTO ZERO]. Five dashes appear on the display, representing the power meter's five ranges. When the last of these disappears, all five ranges have been zeroed.

Calibration

(1) Determine the linearity factor, either from the label on the sensor or from its calibration data chart. Press [LINEARITY FACTOR] and enter this value in the 6960.

(2) Connect the sensor to the POWER REFERENCE output of the 6960.

(3) Press [CAL FACTOR] and note that the display reads 100%.

(4) Press [AUTO CAL]. Note that the POWER REFERENCE LED comes on and 'CAL' is displayed.

(5) When calibration is completed, you can check that it has been successful by pressing [POWER REF]. This switches the power reference signal on, and 0 dBm (1 mW) should be displayed.

(6) Press [POWER REF] again to switch off the power reference signal and disconnect the sensor from the POWER REFERENCE socket.

(7) Determine the calibration factor for the measurement frequency, either from the graph on the sensor label or from its calibration chart. Press CAL FACTOR and enter this value in the 6960.

The power meter can now be used for measuring RF power. For full instructions and uncertainty calculations, refer to the 6960 Operating Manual, Chapter 3.

Chapter 4

TECHNICAL DESCRIPTION

OVERALL CIRCUIT DESCRIPTION – see Fig. 4-1

The RF sensor gives a small DC output voltage when power is applied. This DC voltage is converted to an AC signal by the signal chopper. The chopped signal is fed to the amplifier which is divided into two parts, the first part being the power sensor and the other in the power meter. The signal is then processed by the power meter to give a power reading. A Zener diode in the power sensor provides sensor type information for the power meter.

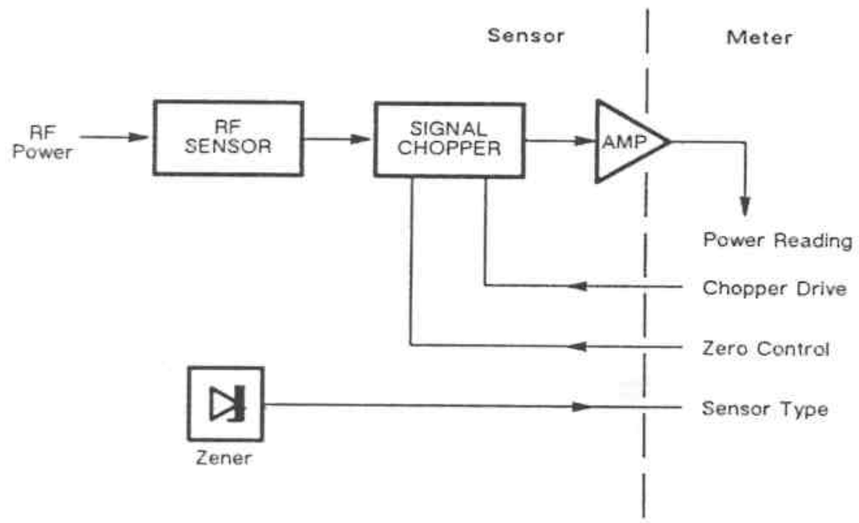


Fig. 4-1 Block diagram of RF power sensor

DETAILED DESCRIPTION – see Fig. 7-1

RF sensor

The RF sensor consists of a monolithic semiconductor thermocouple element. This element provides a good 50 Ω match to the RF power and an output voltage proportional to the RF power.

Signal chopper

The signal chopper consists of two field-effect transistors which act as a sampling gate. The sampling rate is controlled by a 925 Hz squarewave signal from the power meter. The output of the signal chopper is a 925 Hz square wave with amplitude proportional to the RF input power.

A zero control signal from the power meter is introduced at the input of the signal chopper. This allows the power meter to cancel any residual output that occurs with no RF power applied.

Amplifier

The amplifier is divided between the power sensor and the power meter. A simplified circuit is shown in Fig. 4-2.

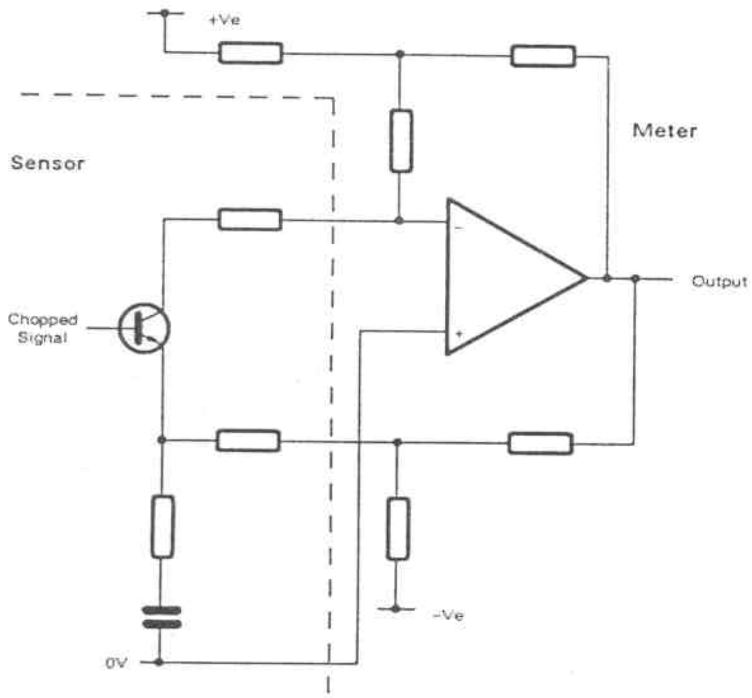


Fig. 4-2 Simplified diagram of amplifier

The amplifier has a gain of approximately 1000 and a band-pass characteristic centred at the sampling rate of 925 Hz. For a full description of the amplifier refer to the 6950 or 6960 Service Manuals.

A Zener diode is mounted in the sensor to provide head select information for the power meters. For the 6910 type sensor head a 5.6 V diode is used.

Chapter 5

MAINTENANCE

CAUTIONS...

- It is important that the dismantling and re–assembling detailed in this chapter is performed in the order specified. This is because the gold wires which connect the RF assembly to the body assembly (see Fig. 5–1) are of extremely delicate construction and may easily be damaged if over–stressed. For this reason also, care should be taken when measuring voltages across or in the vicinity of the gold wires.
- Ensure that all parts are free from dirt, grease or moisture as these might impair the performance of the sensor.

TEST EQUIPMENT

Description	Specification
6950 or 6960 Power Meter (with sensor lead)	
Digital voltmeter	Resolution: 10 μV and 1 Ω.
Power supply	Capable of producing ±5 V DC.
Allen key	1.5 mm
Slot–head screwdriver	

SERVICING POLICY AND MAINTENANCE INFORMATION

For customer-servicing purposes, the sensor is considered in two parts (see Fig. 5-1).

The RF assembly. This is not customer-servicable, but replacement RF assemblies may be quickly and easily fitted by the customer. See later in this chapter for testing and replacement instructions.

The body assembly. This contains the PCB assembly on which the FET chopper and part of the amplifier are mounted. The procedure for testing the chopper is given later in this chapter.

The chopper is not customer-serviceable but is available as a replacement part. The parts list in Chap. 6 and circuit diagram in Chap. 7 detail those components of the amplifier which are contained in the sensor. The remainder of the amplifier circuit is in the Power Meter 6950 or 6960, and limited fault-finding information for this circuit is contained in the Service Manuals for these instruments.

The complete sensor may, of course, be returned to Marconi Instruments Service Division for repair (address at rear of manual).

FAULTY OPERATION

If the sensor is connected to a 6950 or 6960 Power Meter and sensor lead which are known to be working, and either zeroing or calibration (as described in Chap. 3) cannot be successfully accomplished, then the sensor can be assumed to be faulty.

BASIC ACCESS

(1) Remove the sensor cable from the 12 pin connector on the sensor.

(2) Remove the rear plate retaining screws [1] and [2] using a 1.5 mm allen key.

(3) Remove the rear plate and slide the casing from the sensor.

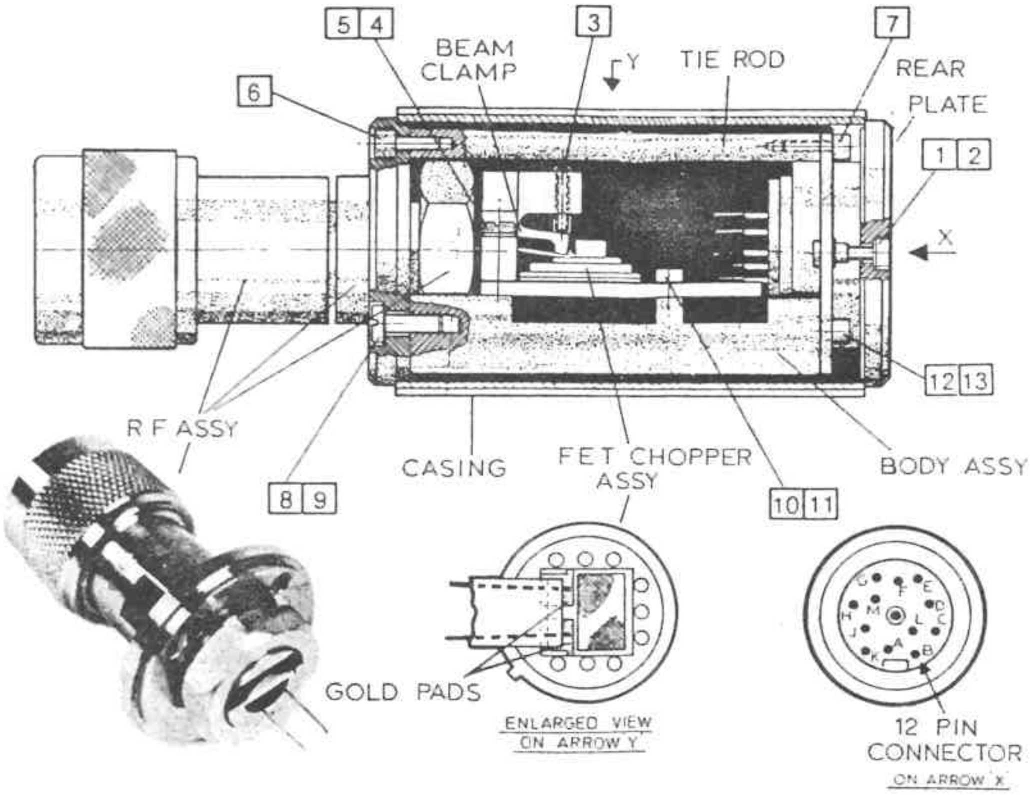


Fig. 5–1 Access and layout diagram

FAULT FINDING

Reconnect the sensor cable and power meter. Connect the input to the 1 mW 50 MHz reference output of the power meter. Switch on the reference signal.

Testing the RF assembly

(1) Carefully measure the voltage across the gold pads on the FET chopper assembly (see inset, Fig. 5-1).

(2) If the voltage is 100 µV or greater, the RF assembly is functioning correctly. In this case, test the FET chopper assembly as described in the next section.

(3) If the voltage is less than 100 µV, remove the sensor from the 1 mW reference. Remove the tie rod by removing screws [6] and [7] with the allen key.
Remove the beam clamp, by first loosening the clamp screw [3], then removing the beam clamp fixing screws [4] and [5]. Remove the beam clamp and carefully lift the two gold wires from the RF assembly clear of the gold pads.

(4) Reconnect the sensor to the 1 mW reference signal and carefully measure the voltage across the gold wires. If the voltage is now greater than 100 µV, it can be concluded that there is a fault on the chopper/amplifier PCB or in the 12 pin connector. If the voltage is still less than 100 µV, the RF assembly is faulty and must be replaced as described in "Replacement of RF assembly".

Testing the FET chopper assembly

(1) Disconnect the sensor from the 1 mW reference and remove the sensor cable. Remove the beam clamp as described in step (3) of "Testing the RF assembly".

(2) Connect together sockets B, G and H of the 12 pin connector (see Fig. 5-1 inset) to turn both of the chopper's FETs on.

(3) Measure the resistance between the two gold pads. This should be approximately 100 - 200 Ω.

(4) Disconnect the link between sockets B/G and socket H. Apply -5 V to socket H. This will turn off the parallel FET of the chopper. The resistance measured across the gold pads should now be greater than 10 kΩ.

(5) Disconnect the link between sockets B and G. Connect socket H to socket B and apply -5 V to socket G. This will turn off the series FET of the chopper. The resistance measured across the gold pads should be greater than 10 kΩ.

If the applied signals are getting through to the FET chopper but any of the above measurements are not achieved then the assembly is faulty and should be replaced as described in "Access to chopper/amplifier PCB".

SERVICING (see Fig. 5-1)

Replacement of RF assembly (code 6910-008)

(1) Dismantle the sensor as described in "Testing the RF assembly", step (3), on page 5-4.

(2) Carefully remove the two RF assembly fixing screws [8] and [9] using a screwdriver. Carefully separate the RF assembly from the body assembly without damaging the gold wires.

(3) Offer up the replacement RF assembly to the body assembly so that the fixing screw holes in the RF assembly flange match with those in the body assembly. Be careful not to damage the gold wires.

(4) Fit the fixing screws [8] and [9] . Align the gold wires centrally over the gold pads on the chopper assembly.

(5) Ensure that the clamp screw [3] is not in contact with the lower part of the plastic clamp and fit the beam clamp in position using the fixing screws [4] and [5] .

(6) Tighten the clamp screw [3] to firmly clamp the gold wires. The top of the clamp should just begin to bend upwards. If a torque screwdriver is available, tighten to 2 Ncm.

(7) Connect the partly assembled sensor to a power meter and check that zeroing and calibration can be successfully accomplished.

(8) Fit the tie rod in position using screws [6] and [7] .

(9) Fit the casing and rear plate followed by the rear plate screws [1] and [2] .

Access to chopper/amplifier PCB (chopper code 6910-004)

(1) Separate the RF assembly from the body assembly as described in steps (1) and (2) of "Replacement of RF assembly".

(2) Remove the PCB fixing screws [10] and [11] . Remove the 12 pin connector fixing screws [12] and [13] . The PCB and 12 pin connector are now free of the body assembly.

(3) To replace the chopper/amplifier PCB and the 12 pin connector, reverse the above procedure.

Chapter 6

REPLACEABLE PARTS

ABBREVIATIONS

The components are listed in alphanumerical order of the complete circuit reference using abbreviations from the following list:

C	:	capacitor	MF	:	metal film
Carb	:	carbon	MO	:	metal oxide
Cer	:	ceramic	R	:	resistor
D	:	semiconductor diode	Tant	:	tantalum
Elec	:	electrolytic	TR	:	transistor
FET	:	field effect transistor	WW	:	wirewound

COMPONENT VALUES

One or more of the components fitted in this instrument may differ from those listed in this chapter for any of the following reasons:

- Components indicated by a * have their values selected during test to achieve particular performance limits.
- Owing to supply difficulties, components of different value or type may be substituted provided the overall performance of the instrument is maintained.
- As part of a policy of continuous development, components may be changed in value or type to obtain detail improvements in performance.

When there is a difference between the component fitted and the one listed, always use as a replacement the same type and value as found in the instrument.

ORDERING

When ordering replacements, address the order to the Service Division (address on rear cover) or nearest agent and specify the following for each component required:

(1) Type and serial number of equipment.
(2) Circuit reference.
(3) Description.
(4) Part number.

COMPONENTS

Circuit ref.	Description	Manufacturer/Part No.
	Power sensor, complete assy.	6910-001
	N type RF assy. replacement kit	6910-008
	Body assy. (includes Amplifier PCB and Connector assy. SK1)	6910-002
	Connector assy, SK1	6910-052
	Amplifier PCB assy.	6910-003
C1	Cer 0.01μF 20% 100V	ITT B111 MZ5U
C2	Tant 4.7μF 20% 50V	STC 39479A
C4	Tant 1μF 20% 35V	26486-209F
C5	Chip 100pF 10% 100V	STC 0805 FX7R
C6	Chip 100pF 10% 100V	STC 0805 FX7R
C7	Tant 2.2μF 20% 50V	STC 42310X
D1	Zener BZX79C5V6	28371-417X
R1	RES MF 348kΩ 0.5% 1/8W	Holco H8
R2	RES MO 330Ω 2% 1/8W	Corning NK3
R3	RES MO 2.2kΩ 2% 1/8W	Corning NK3
R4	RES MO 10kΩ 2% 1/8W	Corning NK3
R5	RES WW 100Ω 2% 1/8W	6910-043
	FET Chopper assy. ⚠	6910-004
TR1	BC414	Motorola

Mechanical parts

Description	Manufacturer/Part No.
Beam clamp	6910-048
Fixing screws (2 off)	21821-211W
Centre fixing screw (1 off)	21815-359X
Casing	6910-018
Rear plate	6910-019
Tie rod	6910-028

Chapter 7

SERVICING DIAGRAMS

Component values

The letter in the component value code replaces the decimal point and indicates the multiplier and unit as follows:-

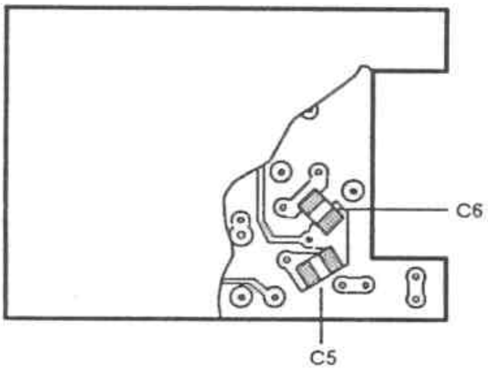
Resistors : Code letter R = ohms,
k = kilohms (10^3),
M = megohms (10^6).

Capacitors : Code letter m = millifarads (10^{-3}),
μ = microfarads (10^{-6}),
n = nanofarads (10^{-9}),
p = picofarads (10^{-12}).

Inductors : Code letter H = henrys,
m = millihenrys (10^{-1}),
μ = microhenrys (10^{-6}),
n = nanohenrys (10^{-9}).

* SIC : value selected during test, nominal value shown.

Components are marked normally with two, three or four figures according to the accuracy limit ±10%, ±1% or ±0.1%.



PART VIEW - TRACK SIDE

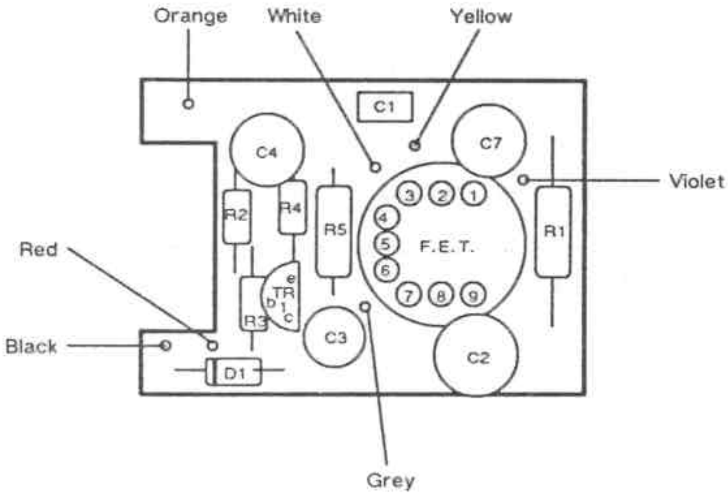


Fig. 7-1a Amplifier PCB layout

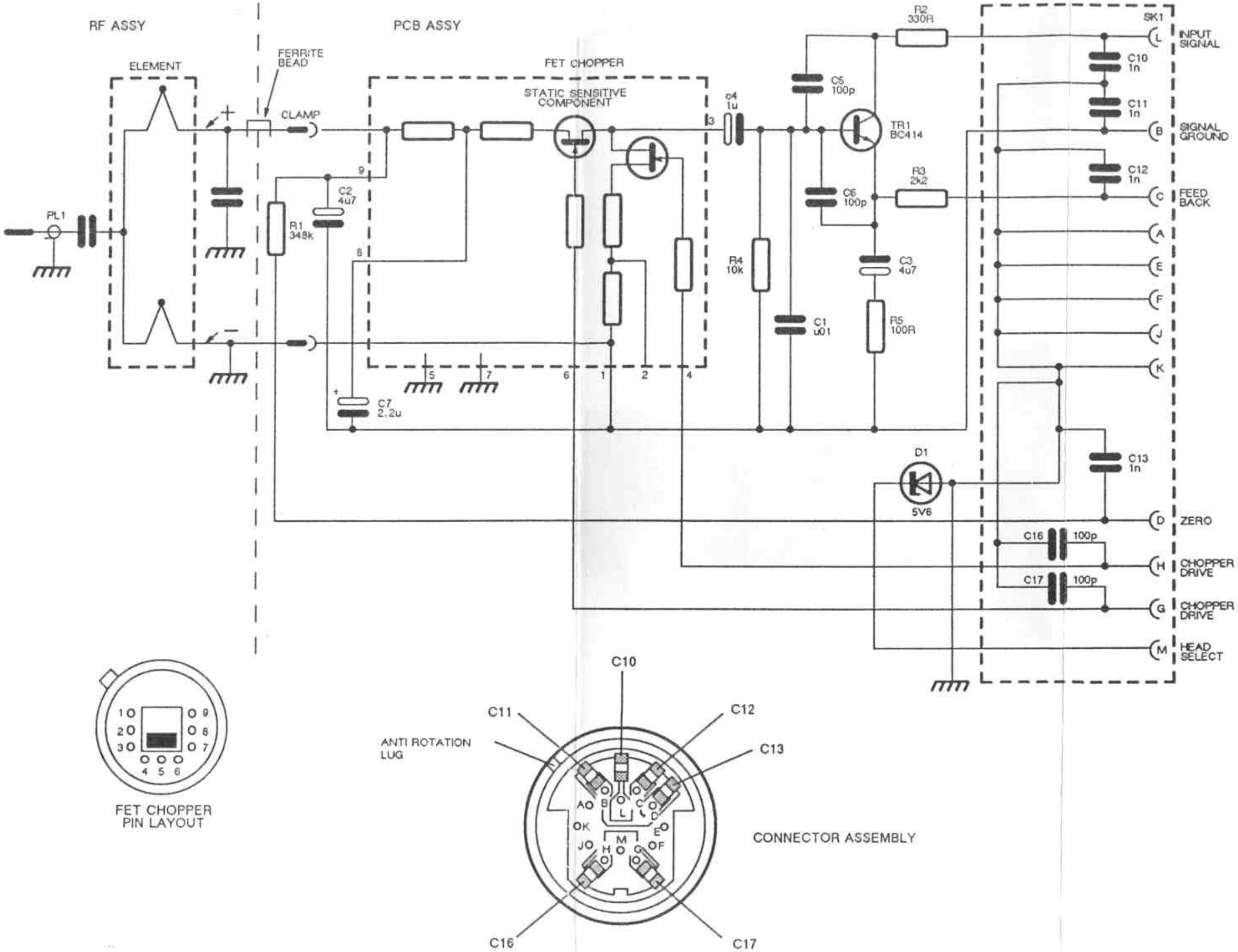


Fig. 7-1 Circuit diagram

6910 and 6911

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