ACTIVE ANTENNAS AE.3001 and AE.3002

INSTALLATION MANUAL

RACAL

Please note that page numbers 9 and 10 were not used in the original document

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CONTENTS

TECHNICAL SPECIFICATION

	AE.3001	AE.3002
Frequency Range	Version A: 15 kHz to 100 MHz. Version B: 100 kHz to 100 MHz. Version C: 1MHz to 100 MHz with 15 dB attenuation at 200 kHz.	Version A: Not used. Version B: 170 kHz to 100 MHz. Version C: 1 MHz to 100 MHz with 15 dB attenuation at 200 kHz.
Effective length (= output EMF / field strength)	0.3m	0.4m
Intermodulation		
With two signals:	55 mV/m	60 mV/m
Second Order:	-75 dB	-80 dB
Third Order:	-100 dB	-100 dB
Power Consumption	45 mA	90 mA
Weight	1.1 kg (2.4 lb) approximately, excluding mountings	1.5 kg (3.3 lb) approximately, excluding mountings.

Output Impedance	50 to 75 ohms.
Output Connector	BNC (weather protected).
Maximum Signal before Gain Reduction	10 V/m
Maximum Safe Signal	50 V/m
Noise Figure	8 dB nominal above 3 MHz
Power Supply	+31 volts d.c. from external power supply PU.1167. 'A' versions require separate power supply cable and type TNC socket provided on antenna for d.c.input. 'B' and 'C' versions use the RF feeder as d.c. supply line.

Environmental Conditions	The units are designed to meet certain requirements of the British Defence Specification DEF.133 table L3. Temperature range (Operating): -40 degrees C to +70 degrees C. Maximum wind speed: 160 km/h (100 mph), noise. Suitable for vehicle mounting.
Extras	AC power supply unit PU.1167. Operates from 108-132V or 215-264V 48-65 Hz and delivers 31V d.c. at 500 mA. Overload protection is provided.
Weight (PU.1167)	3.3 kg (7.3 lb) approximately

ACTIVE ANTENNAS AE.3001 and AE.3002

INSTALLATION MANUAL

GENERAL

1. The AE.3001 and AE.3002 active antennas are designed to fulfil the need for compact broadband, omnidirectional receiving antennas, suitable for quick installation.

2. Broadband matching between a conventional passive antenna and the feeder cable necessitates the use of a physically large antenna structure; this often results in a received signal level far in excess of the level required for satisfactory reception and attenuation has to be introduced at the associated receiver. The physically smaller AE.3001 and AE.3002 active antennas produce a flat signal response over the spectrum whilst the internal active amplifier provides the broadband impedance match between the antenna element and the feeder cable. As the levels of received signals produced by the short element are more constant over the frequency range than for conventional antennas, the degree of intermodulation within the associated receiver is reduced.

3. The levels of signal produced by the AE.3001 and AE.3002 active antennas are considerably lower than those produced by conventional passive antennas. However, by utilisation of the available sensitivity of the associated receiver, the design of the antenna is such that a satisfactory, in many cases improved, signal to noise ratio can be obtained.

VERSIONS

4. The versions are listed in Table 1;only two versions are supplied for the AE.3001, namely/A and/C. The/B version is obtained by removal of a link in the /C version (para.15). Only one version of the AE.3002 (/C) is supplied. The /B version is obtained in a similar manner to the AE.3001.

USAGE

5. The monopole is intended for the reception of vertically polarized signals where the antenna can be fitted either close to the ground (using a ground-plane) or to a metal roof which acts as a ground plane. The dipole is used for the reception of either horizontally or vertically polarized signals, and does not require a ground plane. The dipole should be mounted vertically or horizontally to suit polarization. Both the AE.3001 and the AE.3002 are suitable for use as elements for phased arrays, even for very low frequencies.

Table 1: Antenna Versions

Version	Description
AE.3001/A	Monopole covering the range 15kHz to 100MHz. A separate power supply cable is required.
AE.3001/B	Monopole covering the range 100kHz to 100MHz. The d.c. supply is via the RF feeder cable.
AE.3001/C	Monopole covering the range 1MHz to 100MHz. The d.c. supply is via the RF feeder cable.
AE.3002/A	Version not used.
AE.3002/B	Dipole covering the range 170kHz to 100MHz. The d.c. supply is via the RF feeder cable.
AE.3002/C	Dipole covering the range 1MHz to 100MHz. The d.c. supply is via the RF feeder cable.

HORIZONTAL DIPOLE HEIGHT

6. In common with all dipoles, the AE.3002 should be mounted above a certain optimum height when used horizontally. The height, which is measured from the ground or other reflecting surface (such as the metal roof of a factory) is calculated as follows:

If f is the lowest operating frequency in MHz, and h min is the optimum height above the reflecting surface in metres.

$$h\ min = \frac{60}{f}\ metres$$

MONOPOLE AND GROUND PLANE

7. A method of installation is shown in fig.1. In order to retain the characteristics of the antenna, the base must be RF earthed. If mounted close to the ground, the support column should be embedded in the ground to at least 1m depth if the ground conductivity is good. In poor ground conductivity conditions a ground plane of 4 to 6 radial wires should be provided. If the antenna is to be mounted higher than 1.5m above ground a counterpoise should be provided. This may be a metal sheet of $3m^2$ area (conveniently a 1m radius disc) or radial wires 2m long or a wire mesh or a metal roof, provided that electrical connection can be made to it. These are minimum dimensions. The purpose of the counterpoise is to supress RF potentials at the base of the antenna.

MOUNTING

8. Fig.2 shows various other methods of mounting. The antenna stem is zinc-plated aluminium and is therefore electrolytically compatible with a wide range of materials. The cable should be secured with clips so that strain is removed from the connector. Fit whip antenna element securely (15 mm A/F). The base lock nut ensures correct orientation in the case of the dipole. The dipole should be mounted on a support tube not less than 2m long in order to space it sufficiently from mast or building, and to achieve cable spacing requirements (fig.4). Where two or more dipoles form a directive array, correct phasing will be achieved by ensuring that the red spots (one on each dipole) are in the same orientation (fig.4).

INSTALLATION

Siting

9. The antenna should be sited at a location as free as possible from interfering RF signals and man-made noise. Low-loss RF feeder cable should be used for long runs. A short cable (tail) may be required to link the low-loss cable to the BNC socket on the antenna.

10. An optional 0.75 m whip extension is available which, when fitted, doubles the effective length of the antenna. Details of the extension are given on page 10. The extension should only be used where discrete signals greater than 28mV/m (89dB μV/m) are not present. This is usually in 'radio quiet' locations, greater than 100 km from a broadcast transmitter.

NOTE: No advantage is gained by using more than one extension for a monopole (or 1 pair for a dipole).

Height

11. As with all antennas the height required for maximum efficiency is affected by frequency of operation, distance between transmitter and receiver, and the interaction of the sky and ground waves. For fixed frequency working the nomograph given on the centre page may be a useful guide to determine the optimum mounting height. This nomograph is based on a F_2-layer height of 300 km and assumes single-hop propogation.

Use of Nomograph

12. To use the nomograph, first determine the frequency of operation in MHz and the distance, in km, between the transmitter and the active antenna. Next place a rule or straight edge on the nomograph to line up the frequency (scale 'a' or 'b' as appropriate) with the distance on scale 'c'. The optimum mounting height may now be read from scale 'd' or 'e' where scale 'a' was used, or scale 'f' or 'g' where scale 'b' was used. Some worked examples are given on the next page.

Examples

13. (1) A horizontally-mounted dipole is used for the reception of 27MHz horizontally-polarized signals over a range of 600 km. Place the rule to line-up 27 on scale 'b' with 600 on scale 'c' to obtain a height of 4m from scale 'f'. If a height of 4m is impracticable, due to building height or other considerations, it may be multiplied by 3,5,7,9, etc. without affecting the performance of the antenna.

(2) A vertically-mounted dipole or monopole is required to work at 7MHz at a distance of 1400 km from the transmitter antenna. Line up 7 on scale 'a' with 1400 on scale 'c' to obtain (by interpolation) from scale 'd' a height of 66m. Where an impracticable height is obtained for a vertically mounted dipole or monopole (using scale 'd' or 'g') it may be multiplied by 2,3,4,5, etc. without affecting the performance of the antenna.

Power Supply

14. A 31 volt d.c. supply is required (dipole 90mA, monopole 45mA) and this is normally provided by a PU.1167 power supply unit. The PU.1167 operates from 108-132V or 215-264V, 48 to 65Hz; prior to operation, remove the cover and check that the internal soldered links are correctly set to suit the local source of supply. The PU.1167 is capable of supplying up to ten monopoles or five dipoles connected in parallel. A suitable distribution arrangement for /B or /C versions can be supplied.

NOTE: Where space is limited, the PU.1167 may be installed with the front panel removed.

Internal Link

15. The antenna versions AE.3001/B and C and AE.3002/B and C differ only in the connection or otherwise of an internal link. When a /C version is to be converted to /B proceed as follows:-

(1) Remove antenna element (two in the case of the dipole).

(2) Remove coin slot screw(s) holding cover(s).

(3) Remove cover(s) and disconnect link(s) LK1 on printed circuit board(s).

(4) Replace disturbed items. Do not over-tighten coin slot screw. Tighten only sufficiently to slightly compress the sealing ring.

(5) Amend serial number plate to /B.

Interconnections

16. The antenna, power supply unit and receiver are interconnected as shown in fig.3. Suitable cable types for the tail (between the antenna and the low-loss coaxial feeder) are UR(M)43 UR(M)76 or RG58U, and a suitable connector is supplied. If required, a connector can be supplied to allow the use of UR(M)67, UR(M)57 or RG213(U) cables.

17. For /A versions of the antenna a separate coaxial d.c. supply cable is required, terminating in a TNC connector. This cable can be joined to a two-core supply cable (examples in Table 2), using a suitable junction box, for connection to the power supply. The maximum d.c. loop resistance of this cable must not exceed 10 ohms.

Table 2: Examples of 2-Core PVC Insulated Cable

Cross-Sectional Area of Core (nominal)	Loop Resistance Per 100 metre	N.A.T.O. number
1.0 mm^2	3.6 ohms	6145-99-015-1863
1.5 mm^2	2.4 ohms	6145-99-015-1864
2.5 mm^2	1.4 ohms	6145-99-015-1865

AMPLIFIER PERFORMANCE CHECK

18. Two methods for checking the performance of the internal amplifier (two in the case of the dipole) are given. Remove the whip antenna element (two in the case of the dipole) before connecting the test equipment; the interconnecting leads may now be firmly attached to the antenna element socket(s) using M6 screw(s). Ensure that all interconnecting leads are kept as short as possible.

Test Equipment

19. The items of test equipment listed on page 6 are required for the performance checks.

(1) Signal Generator

Frequency: HF range
Output level: Between 1 and 50 millivolts

(2) Valve voltmeter, high impedance (Method A only).

NOTE: The valve voltmeter must be capable of accepting a 31V d.c. component when used with /B and /C versions.

(3) General purpose HF communications receiver (Method B only) with built in or externally connected signal strength meter.

(4) 50 or 75 ohm (to suit system and signal generator impedance) fixed resistor, 5% tolerance.

Method A: Quantity 2
Method B: Quantity 1

(5) Balun transformer, ratio 1:2 (AE.3002 only).

(6) Tee connector, 50 or 75 Ohm.(Method A only).

(7) Step attenuator, 0 to 20dB in 1dB steps, 50 or 75ohms (Method B only).

Method A

20. (1) Connect the test equipment to the antenna in accordance with fig.5a or 5b.

(2) Set the signal generator to a frequency between 5 and 20MHz.

(3) Connect the valve voltmeter between point E1 and earth (fig.5) and set the signal generator output level for a convenient meter reading between 10 and 50 millivolts (reference level).

(4) Transfer the valve voltmeter connections to point E2 and earth (fig.5). Check that the valve voltmeter indication (with respect to E1) is in accordance with Table 3.

Table 3: E2 measurement

Antenna	System Impedance	E2 ± 1dB
AE.3001	50 ohms	-6dB
AE.3001	75 ohms	-5dB
AE.3002	50 ohms	-4dB
AE.3002	75 ohms	-2.5dB

Method B

21. (1) Connect the test equipment in accordance with fig.6a.

(2) Set the step attenuator to 20dB.

(3) Set the signal generator to a frequency between 5 and 30MHz, and an output level to suit the receiver.

(4) Set the receiver AGC to OFF (or gain control to manual) and the mode switch to CW.

(5) Tune the receiver to the signal generator for maximum output.

(6) Adjust the receiver gain control (or signal generator output level) to obtain a convenient reference level on the receiver meter.

NOTE: Do not adjust the signal generator or receiver controls for the remainder of this check.

(7) Reconnect the test equipment in accordance with fig.6a.

(8) Reduce the step attenuator setting, in 1dB steps, until the receiver meter again indicates the reference level.

(9) Check that the difference between the two settings of the step attenuator is in accordance with Table 3.

REPLACEMENT PARTS LIST

Item	Racal Part Number	NATO Part Number
Whip antenna element	FG847	5985-99-772-0032
Whip antenna socket	A6096	5985-99-752-9390
Plastic cover	FG848	5985-99-752-9391
Whip antenna socket sealing ring, square section	A6108	5330-99-543-8114
Whip antenna socket sealing ring, round section	A6106	5330-99-543-8116
Antenna base sealing ring	A6107	5330-99-543-8115
RF amplifier PCB P5603	FG881	5985-99-742-5051
Balun transformer PCB (dipole only) PS619	FG1568	5985-99-753-1121
Mounting tube and U-bolt assembly	A6153	5985-99-752-9392
BNC bulkhead socket	A6103	5935-99-754-6590
Mating BNC plug	A6130	5935-99-768-7912
TNC bulkhead socket (/A versions only)	A6625	
Mating TNC plug	A6193	
Pillar Cheek	A6092	5985-99-752-7172
Pillar block	A6094	5985-99-752-7173
Special hexagon nut	A6098	5310-99-752-7174
Special washer	A6100	5310-99-763-8016
Active antenna base (AE3001C)	A6091	5985-99-752-9389
Washer saddle (AE3002C)	A7656	5310-99-752-7176
Active antenna base (AE3002C)	A7658	5985-99-752-9393
PCB support sub-assembly (AE3002C)	A7659	5989-99-752-9271
Support block (AE3002C)	A7671	5985-99-752-7180
Clamping strip (AE3002C)	A7673	5985-99-752-7181
Body assembly active antenna (AE3001A)	A8258	
Body assembly active antenna (AE3001C)	A8259	
Body assembly active antenna (AE3002C)	A8260	

Optional Item

Antenna Whip extension 0.75m (one required for monopole, two required for dipole)	A8451	

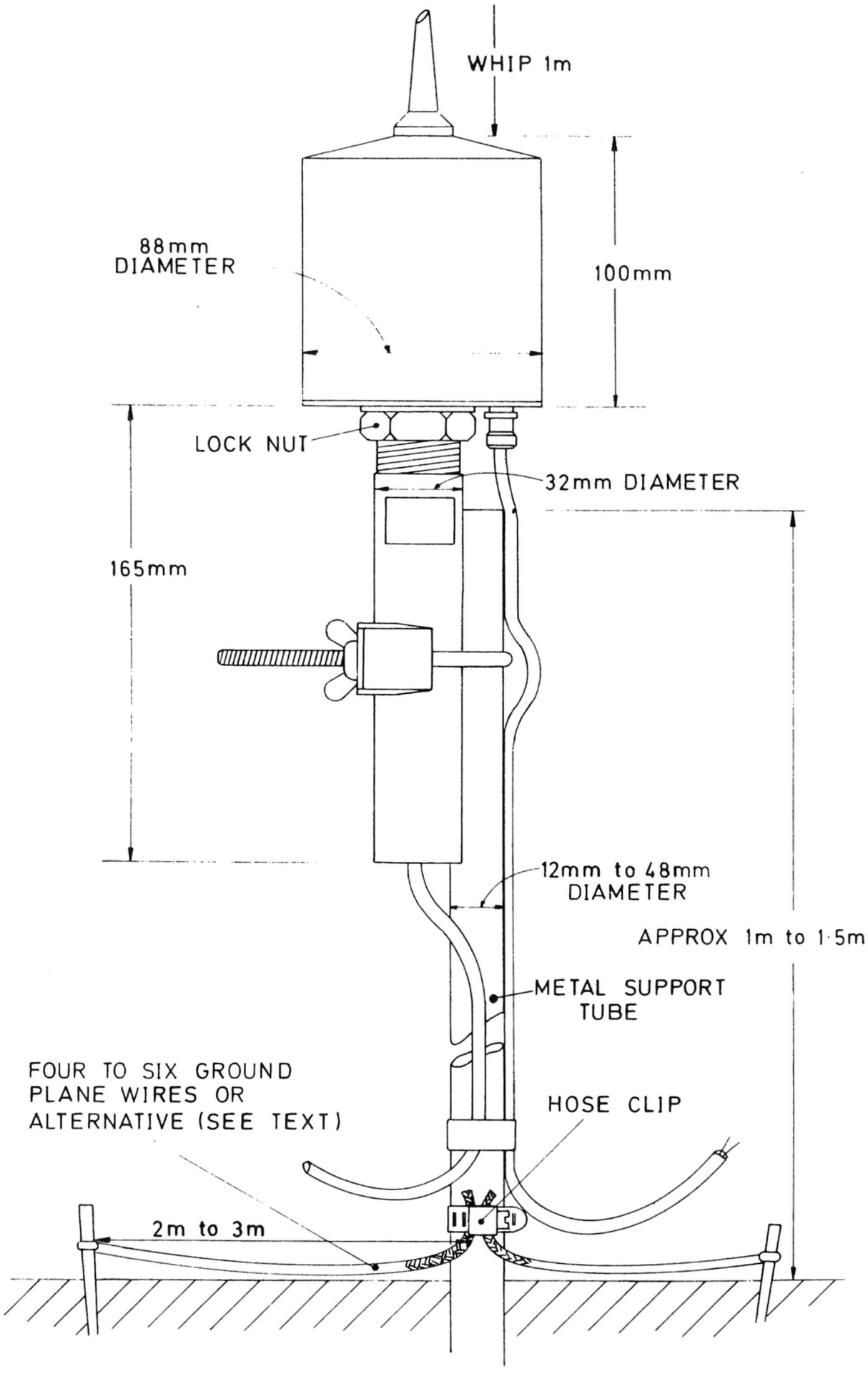
POWER SUPPLY ASSEMBLY

Item	Racal Part Number	NATO Part Number
Unit Power Supply	A7301	
Fuseholder	A7302	
Fuselink 1A	A7303	
Connector bulkhead male Suhner 12 BNC	A7325	
Connector bulkhead Suhner 22 BNC	A7326	5939-99-634-4715
Terminal Red	A7304	5940-99-620-1591
Terminal Black	A7305	
Connector plug Suhner 11 BNC	A7327	5935-99-945-9134
Connector jack Suhner 21 BNC	A7328	
Capacitor 0.22µF ±20%	A7310	5910-99-654-5351
Choke	A7311	5950-99-753-0636

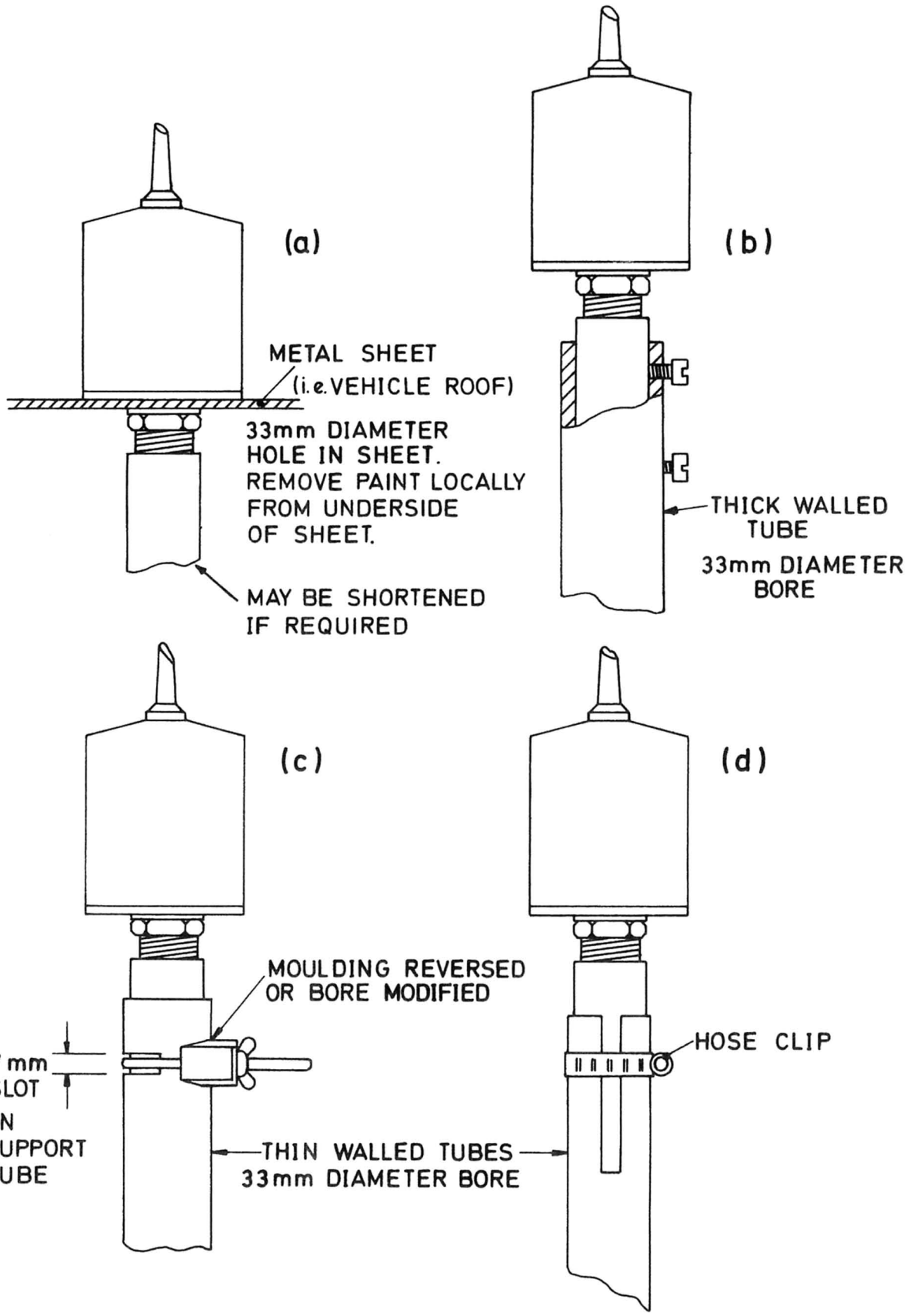
RF AMPLIFIER PCB PS603

Cct. Ref.	Value	Description	Rat	Tol. %	Racal Part No.	NATO Part No.
Resistors			W			
R1	8.2k	Fixed	1/4	2	A6114	
R2	820k	Fixed	1/2	2	A6116	
R3	68k	Fixed	1/4	2	A6115	
R4	10k	Fixed	1/4	2	A6112	
R5	330	Fixed	1/4	2	A6113	
R6	330	Fixed	1/2	2	A6118	
R7	47	Fixed	1/4	2	A6110	
R8	47	Fixed	1/4	2	A6110	
R9	56	Fixed	1/4	2	A6111	
R10	10M	Fixed	1/4	1	A6117	
Capacitors			V			
C1	470p	Polystyrene	160	2	A6119	
C2	0.1	Ceramic Disc	30	+50-25	A6121	5910-99-656-4045
C3	0.1	Ceramic Disc	30	+50-25	A6121	5910-99-656-4045
C4	0.1	Ceramic Disc	30	+50-25	A6121	5910-99-656-4045
C5	0.1	Polyester	100	20	A6120	
C6	0.22	Polyester	100	20	A6122	5910-99-654-5351

Cct. Ref.	Value	Description	Rat.	Tol. %	Racal Part No.	NATO Part No.
Transistors						
TR1		2N6660 (Siliconix only)			A6263	
TR2		BFW17A			A6124	
Diodes						
D1		BZY88C9V1			A6125	
D2		BZY88C9V1			A6125	
Inductors						
L1	220µH	Choke		5	A6126	
Miscellaneous						
FB1		Ferrite Bead			A6129	
		Transistor Pad			A6127	
		Heat Sink			A6128	
		Balun Transformer PCB PS619				
Resistors						
R1	56	Fixed		2	A6111	
R2	56	Fixed		2	A6111	
Capacitors			V			
C1	0.22		100	20	A6122	5910-99-654-5351
Transformer						
T1					A7633	5985-99-753-1862



WOH 5136 Mast Mounting of Monopole Fig. 1



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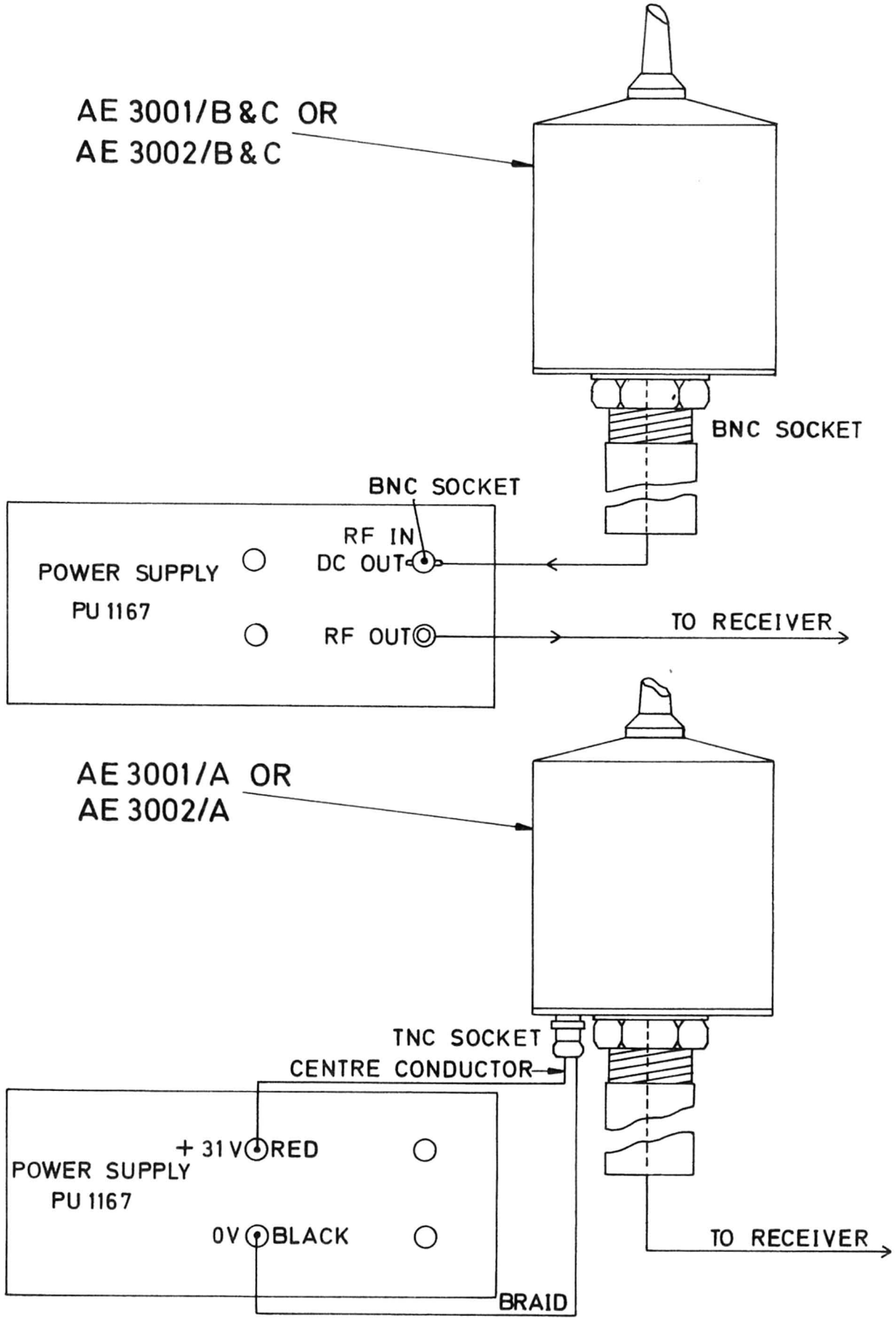
Alternative Mounting Method

Fig. 2



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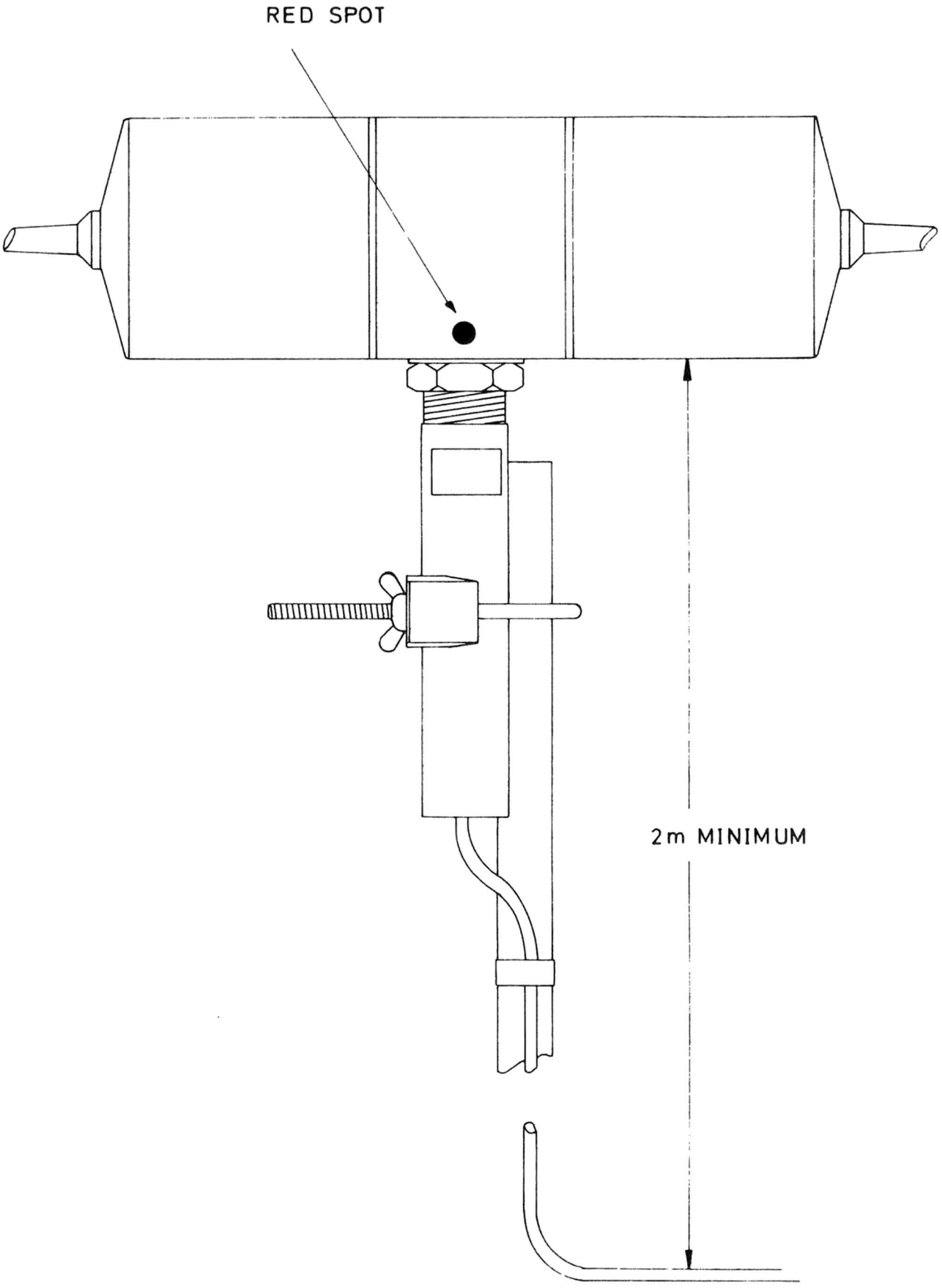
Interconnections

Fig. 3



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Dipole RF Cable Run

Fig. 4

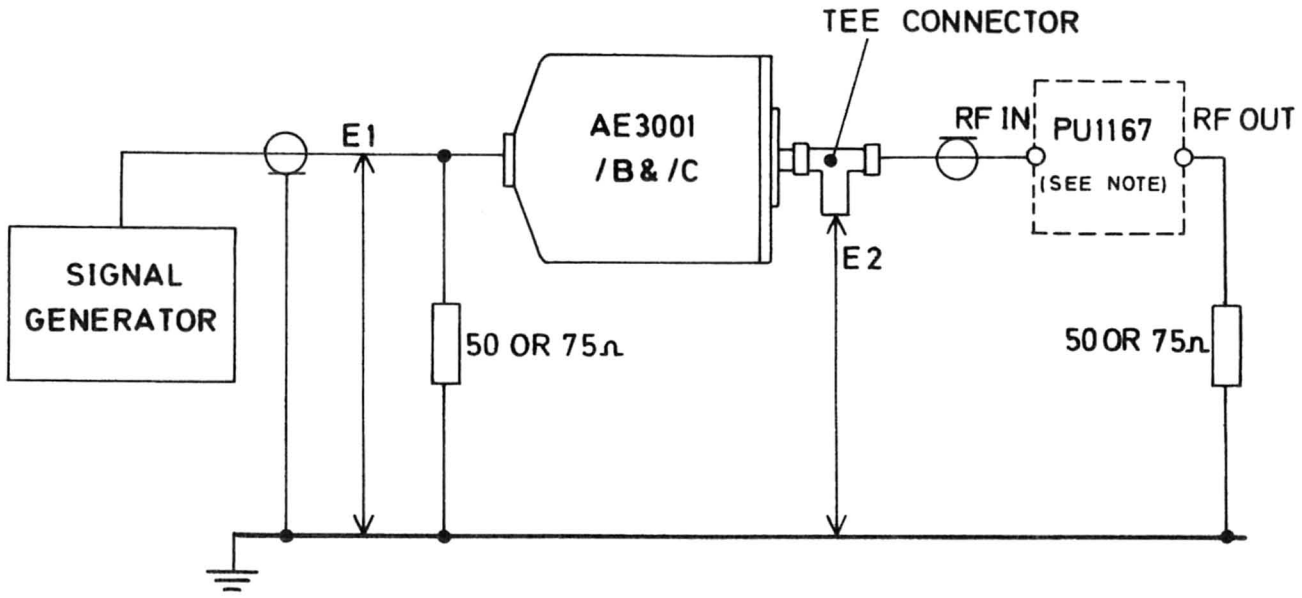


Fig. 5a

NOTE: ALTERNATIVE POWER SUPPLY ARRANGEMENT GIVEN IN FIG. 3

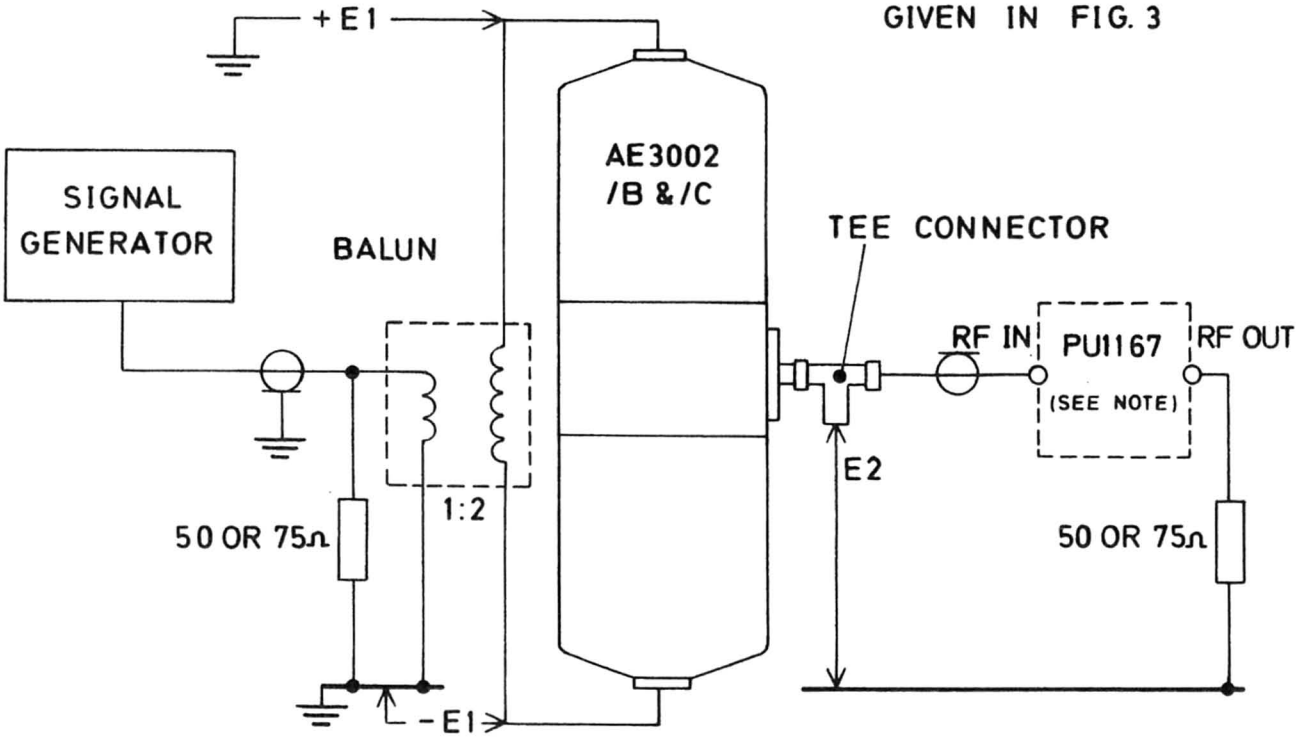


Fig. 5b

Test Equipment Configuration (Method A)

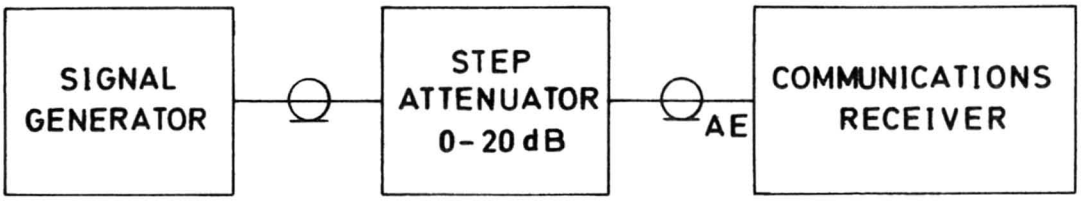


Fig. 6a

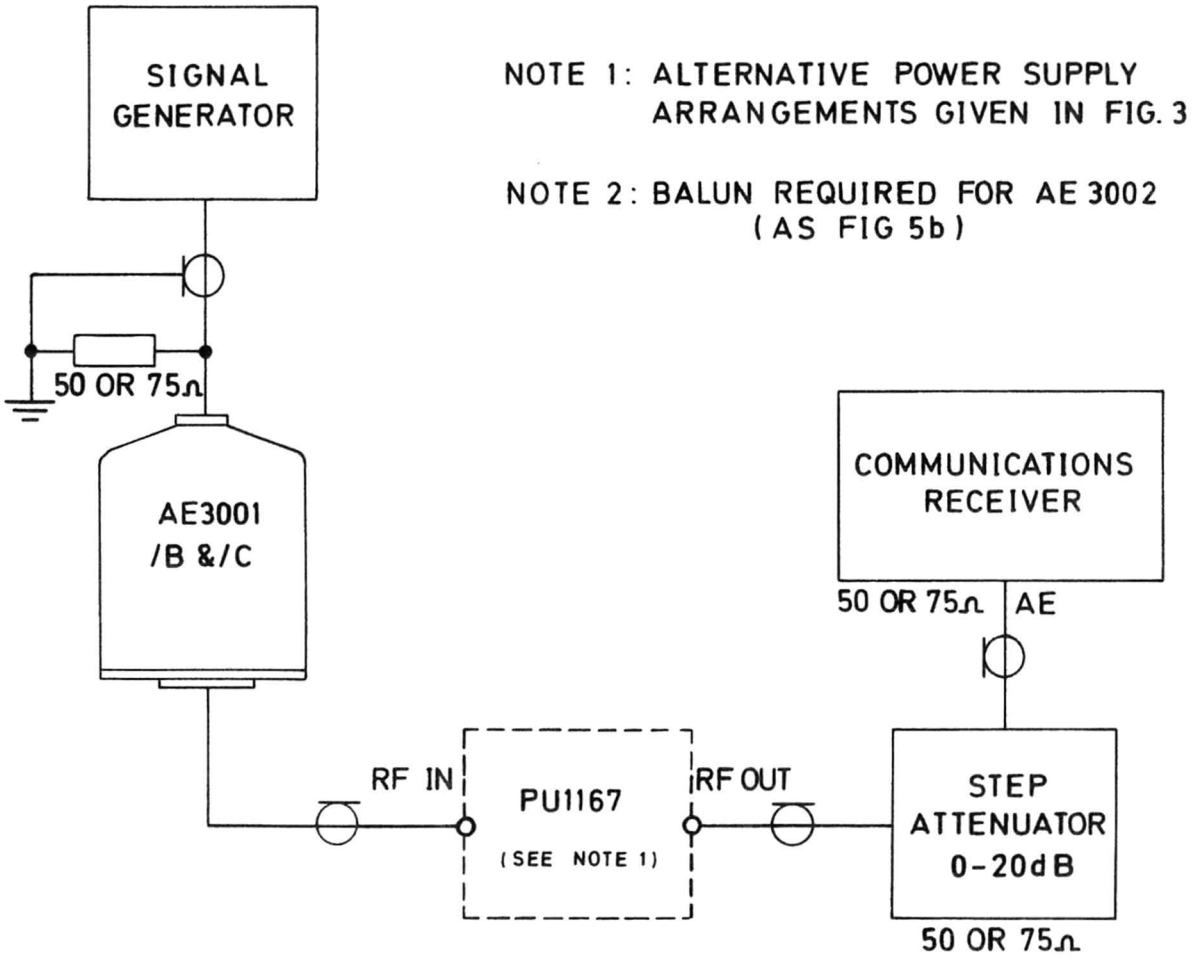
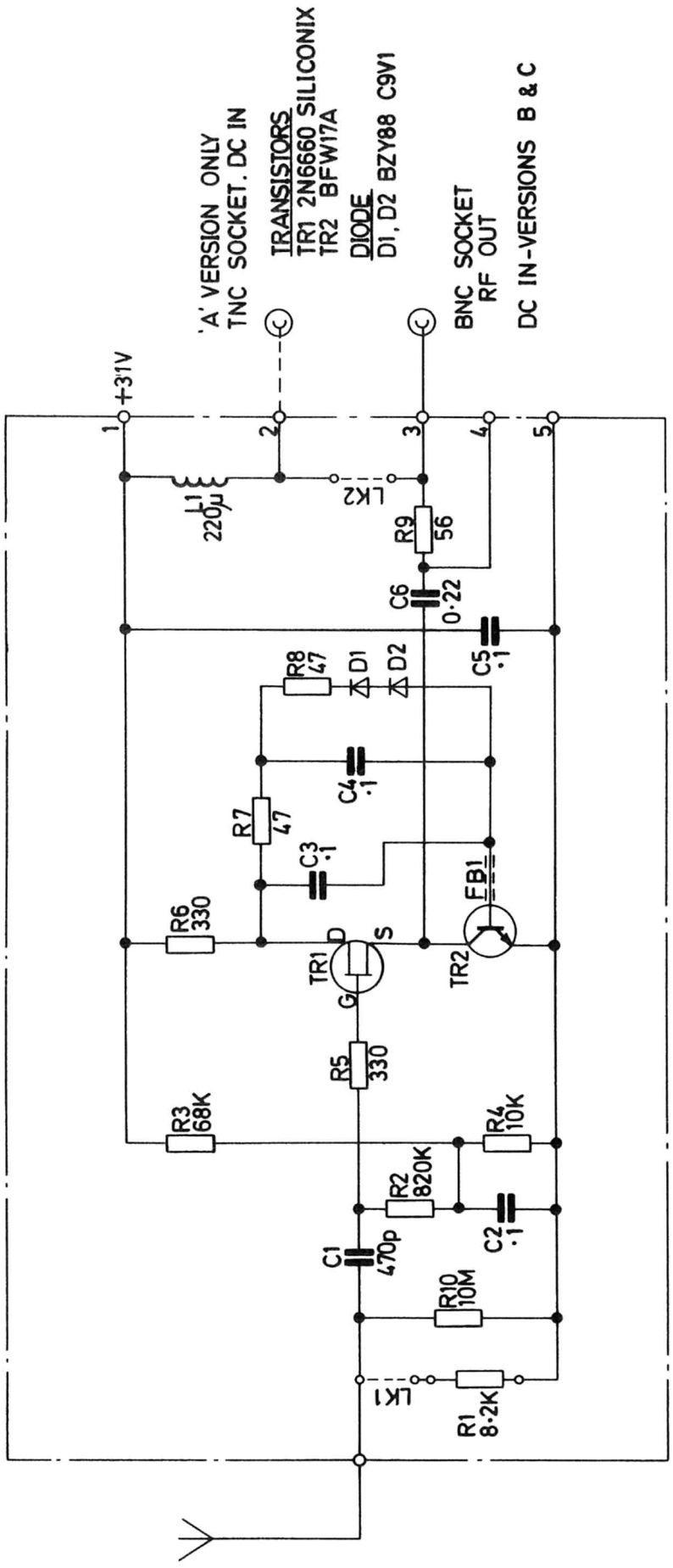


Fig. 6b

Test Equipment Configuration (Method B)



VERSION	LINK 1	LINK 2
A	OPEN	OPEN
B	OPEN	CLOSED
C	CLOSED	CLOSED

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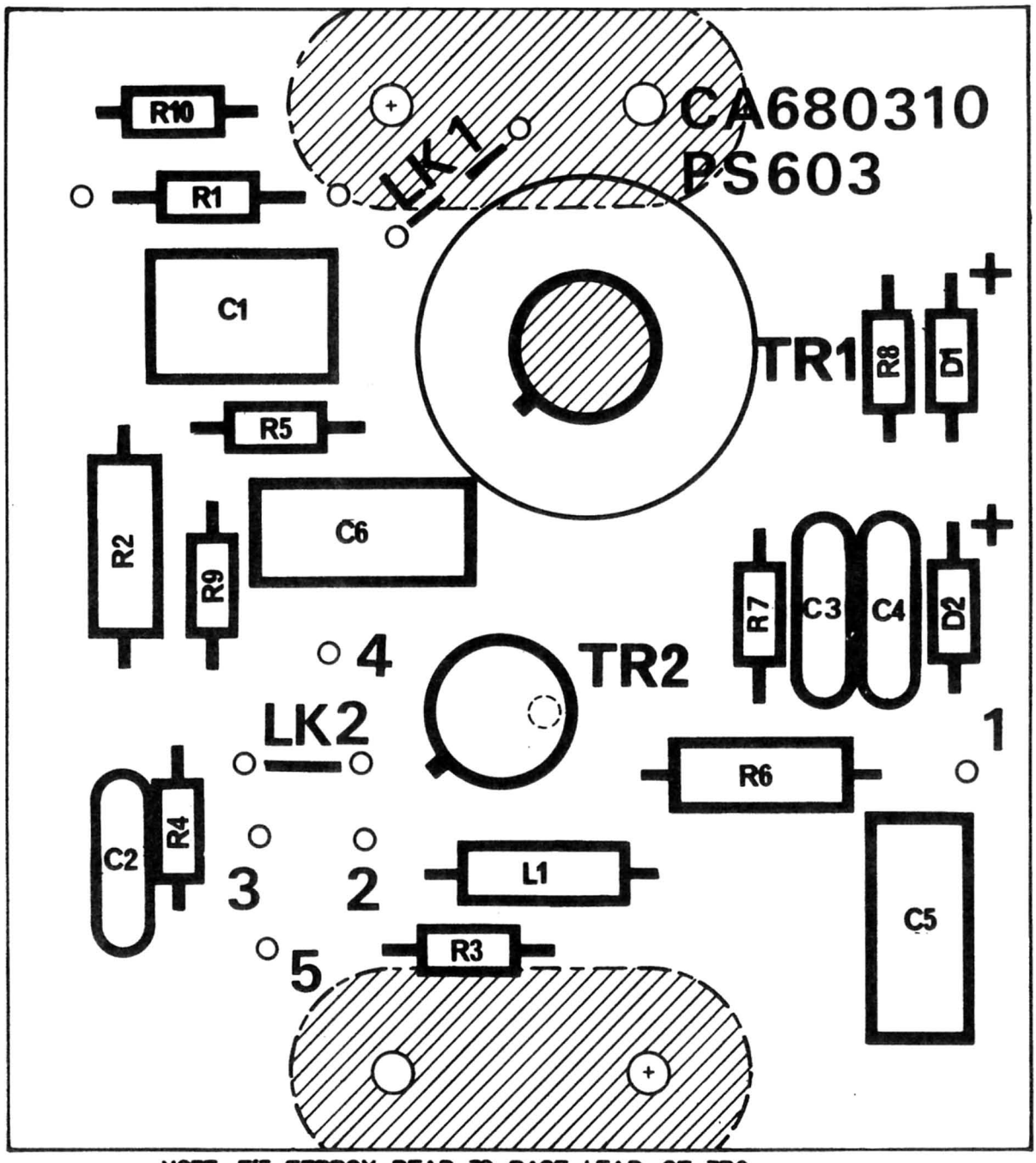
Circuit: Amplifier P.C.B. AE3001.

Fig. 7



NOTE : FIT FERROX BEAD TO BASE LEAD OF TR2

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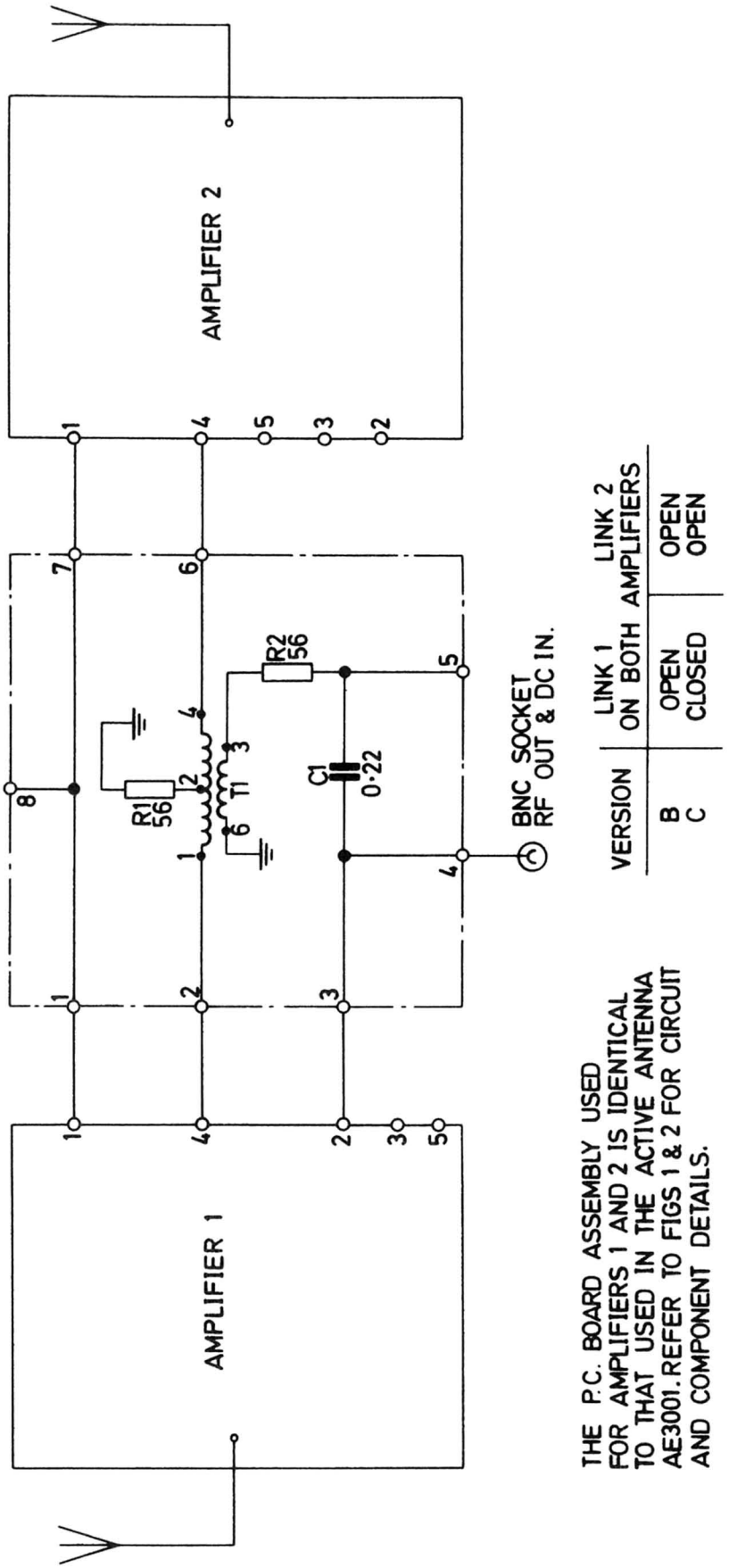
Layout : Amplifier PCB AE3001/3002 Fig.8



VERSION	LINK 1 ON BOTH	LINK 2 AMPLIFIERS
B	OPEN	OPEN
C	CLOSED	OPEN

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Circuit : Active Antenna AE3002.

Fig. 9

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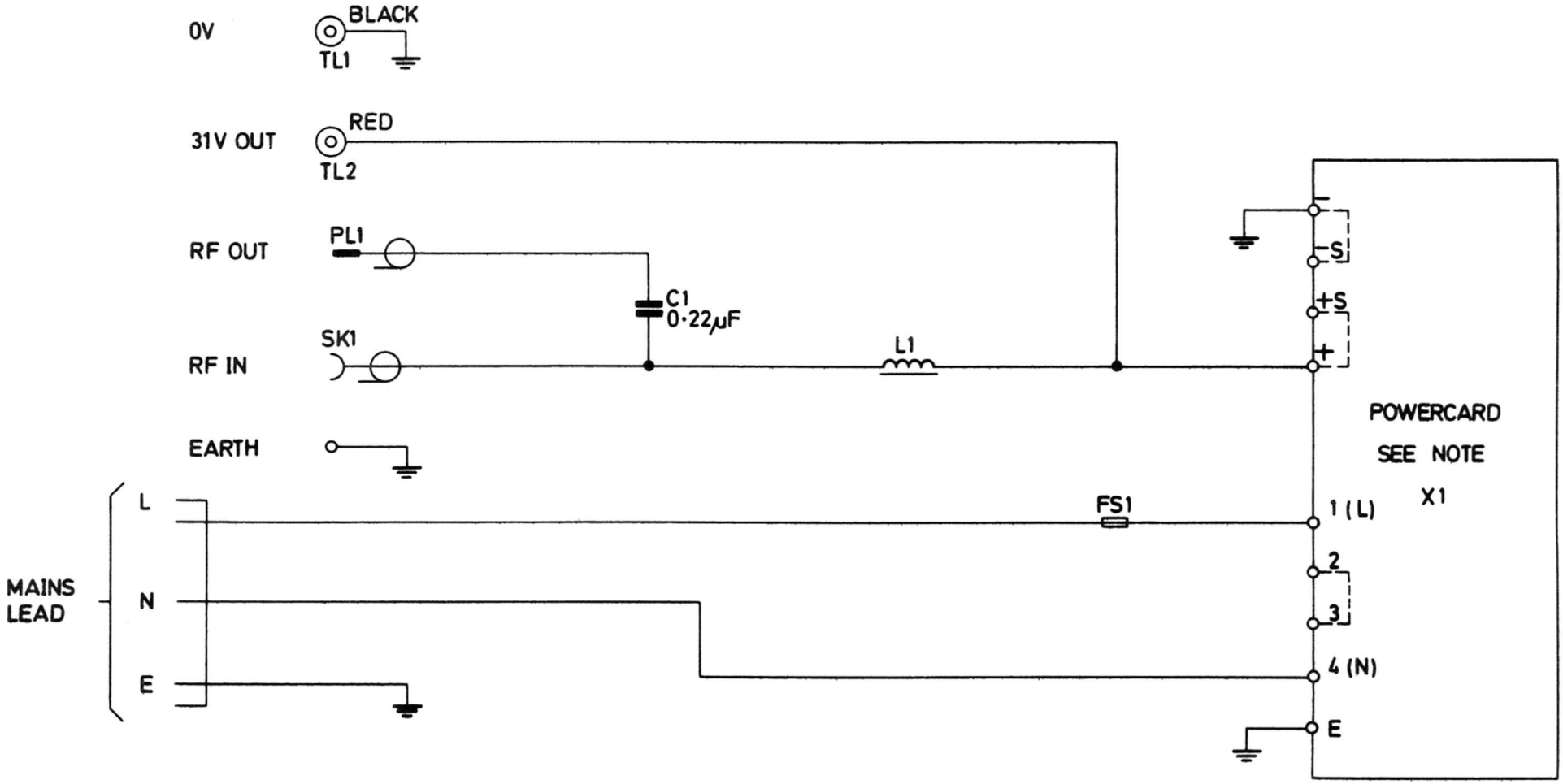
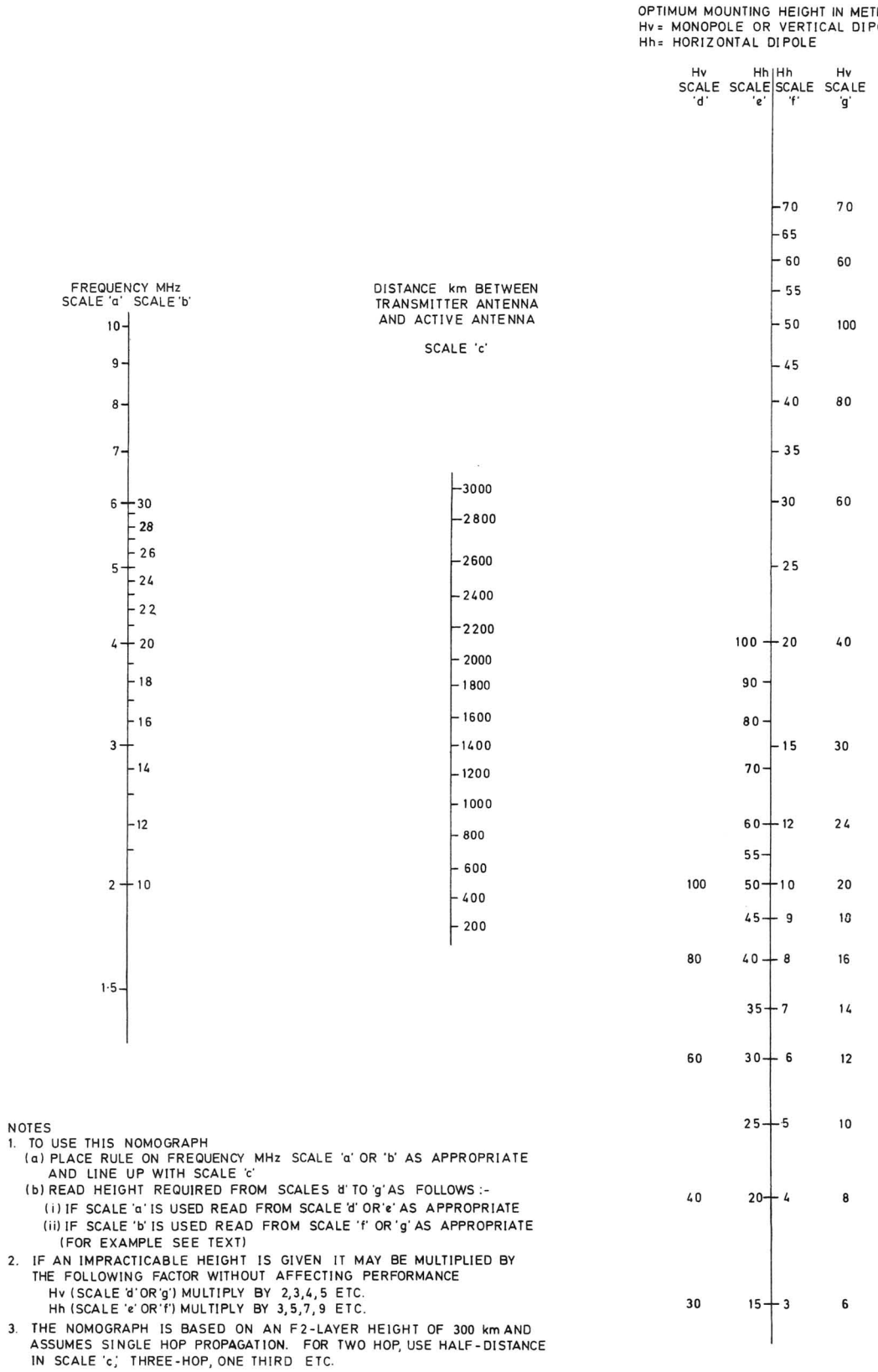


NOTE LINKS SHOWN ARE AS SUPPLIED FOR 215-260 VOLT OPERATION FOR 110V. OPERATION, REMOVE LINK BETWEEN PINS 2 & 3 AND CONNECT LINKS BETWEEN PINS 1 & 2 AND 3 & 4.
LINKS BETWEEN PINS –&–S AND BETWEEN PINS +&+S ARE NOT TO BE REMOVED.

Circuit : PU1167

Fig.10



NOTES

1. TO USE THIS NOMOGRAPH
   (a) PLACE RULE ON FREQUENCY MHz SCALE 'a' OR 'b' AS APPROPRIATE AND LINE UP WITH SCALE 'c'
   (b) READ HEIGHT REQUIRED FROM SCALES 'd' TO 'g' AS FOLLOWS :-
      (i) IF SCALE 'a' IS USED READ FROM SCALE 'd' OR 'e' AS APPROPRIATE
      (ii) IF SCALE 'b' IS USED READ FROM SCALE 'f' OR 'g' AS APPROPRIATE
      (FOR EXAMPLE SEE TEXT)
2. IF AN IMPRACTICABLE HEIGHT IS GIVEN IT MAY BE MULTIPLIED BY THE FOLLOWING FACTOR WITHOUT AFFECTING PERFORMANCE
   Hv (SCALE 'd' OR 'g') MULTIPLY BY 2,3,4,5 ETC.
   Hh (SCALE 'e' OR 'f') MULTIPLY BY 3,5,7,9 ETC.
3. THE NOMOGRAPH IS BASED ON AN F2-LAYER HEIGHT OF 300 km AND ASSUMES SINGLE HOP PROPAGATION. FOR TWO HOP, USE HALF-DISTANCE IN SCALE 'c,' THREE-HOP, ONE THIRD ETC.

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Nomograph: Antenna Mounting Height HF Band