TECHNICAL INFORMATION

BEACON MONITOR RECEIVER

TYPE IA8509

Technical Handbook 664

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TECHNICAL SUMMARY

BEACON MONITOR RECEIVER TYPE IA8509

FREQUENCY RANGE:	200 to 535 kHz.
FREQUENCY CONTROL:	Crystal, CR25U or similar.
FREQUENCY STABILITY:	+0.01% or better over full environmental range.
CRYSTAL FREQUENCY:	200 to 395 kHz: frequency of required signal plus 70 kHz (fc + 70 kHz). 395 to 535 kHz: frequency of required signal minus 70 kHz (fc - 70 kHz).
TYPES OF RECEPTION:	AO/A1: interrupted CW. AO/A2: double side band (DSB) amplitude modulation. A2H: compatible AM either upper or lower side band.
INTERMEDIATE FREQUENCY:	70 kHz.
INPUT IMPEDANCE:	50 Ω.
USEABLE SIGNAL AT AERIAL SOCKET:	5 μV to 10 mV r.m.s. 30% modulated.
SELECTIVITY:	6 dB bandwidth > + 1.25 kHz. 40 dB bandwidth < + 4.5 kHz.
IMAGE REJECTION:	Greater than 50 dB.
OTHER SPURIOUS RESPONSES:	Greater than 60 dB rejection.
INTERMODULATION:	Not exceeding - 60 dB for two 5 mV signals.
AUDIO OUTPUT:	(a) 200 mW into 35 Ω front panel loudspeaker controlled by front panel volume control. (b) 200 mW available from screw terminal block for external 35 Ω loudspeaker. (c) 0 dBm into balanced 600 Ω line. Adjustable down to zero by internal present potentiometer.

LEVEL ATTENUATION:	80 dB overall provided by:- (a) 20 turn internal r.f. gain potentiometer with 40 dB range. (b) Alternative low sensitivity aerial socket incorporating 40 dB attenuation.
CARRIER ALARM:	"Carrier On" lamp on front panel and one set of changeover relay contacts for external use. Threshold 3 dB. Tolerance ± 0.5 dB. Alarm delay nil.
CODING ALARM:	"Coding On" lamp on front panel and one set of changeover relay contacts for external use. Threshold 5 ± 1 dB or keying failure on mark or space. Alarm delay adjustable between 0.2 and 70 seconds.
EXTERNAL GROUP ALARM:	Operation when with either carrier or coding alarm is activated. Consisting of two sets of relay contacts, one set normally open and the other set normally closed.
EXTERNAL RELAY RATING:	1A maximum current or 30W switched power.
ENVIRONMENTAL LIMITS:	Temperature 0°C to 50°C operating. -20°C to 70°C storage. Humidity 0 to 97%.
POWER:	(a) 100-125V or 200-250V 50/60 Hz 10VA at 250V. (b) 12-20V d.c. 300 mA. (c) 20-28V d.c. 500 mA.
SIZE:	48.3 mm (19 inches) rack mounting. Height : 88 mm (3.5 inches). Depth : 181 mm (7.125 inches). Depth with mounting kit 359 mm (14.125 inches).
WEIGHT:	4.5 kg.

CHAPTER 1

GENERAL INFORMATION

INTRODUCTION

1. The Beacon Monitor Receiver Type IA8509 is a crystal controlled, single channel superheterodyne receiver designed to monitor aeronautical navigation transmissions in the L.F./M.F. band 200 to 535 kHz. The receiver can monitor AO/A1, AO/A2 or A2H upper or lower sideband. The equipment is entirely solid state with integrated circuits and silicon transistors ensuring high operational reliability and economy. The calculated mean time between failures (M.T.B.F.) figure is between 10 000 and 20 000 hours. The receiver meets the recommendations of I.C.A.O. under the Annex 10 document.

2. The operating frequency is determined by a plug-in local oscillator crystal. A tunable front end r.f. amplifier provides ample rejection of out of band signals and a three stage stagger-tuned i.f. provided high overall selectivity.

3. Separate fail alarm facilities are provided for carrier failure and modulation/ coding failure with independent alarm level setting circuits activated by an internal test button. A front panel push-button provides an alarm test facility. The modulation failure alarm has a time delay adjustable from 0.2 to 70s to cover different beacon transmitter coding. The carrier alarm operates virtually instantaneously.

4. Local alarm conditions are given by front panel mounting indicator lamps, which are normally lighted and which extinguish if the signal levels fall or the coding fails. Additionally, changeover relay contacts associated with the lamps provide the facility for remote status indication. Local aural indication is provided by a front panel loudspeaker. There is provision for an external loudspeaker and a 600 Ω line output for remote use.

5. For typical mounting of a locator beacon at a distance of up to 6 km, a 3 m whip aerial would normally be adequate. Facilities are available for connecting an active aerial to the receiver.

6. The receiver can be operated from either mains or d.c. supplies the choice being by means of soldered links.

MECHANICAL DESCRIPTION

7. The receiver is a single complete unit suitable for standard rack mounting. Alternatively, it could be mounted in a free standing cabinet. The receiver consists of a front panel, a chassis, a printed circuit board (P.C.B.) and top and bottom covers. The majority of the components on the receiver are fitted to the chassis mounted P.C.B. Those not fitted to the chassis consist of the chassis mounted mains transformers, the aerial input socket, the mains input plug and the tuning capacitors.

8. The front has fitted to it or accessible from it:-

(a) a 'mains on' push-button switch, is also connected to the P.C.B.
(b) a 'mains on', press-fit, indicator lamp that is wired to terminals on the P.C.B.
(c) 'carrier' and 'coding', press-fit, indicator lamps that are wired to P.C.B. terminals.
(d) 'alarm test' push-button that is directly connected to the P.C.B.
(e) loudspeaker and volume control connected to the P.C.B. via wiring.
(f) 'external meter' test sockets connected to the P.C.B. via wiring.
(g) a 'frequency' label holder.

9. The P.C.B. is fitted with a screen around the r.f. circuit components. A tuning tool clips onto the side of this screening. An insulated cover over the components connected to mains ensures safety should the top cover be removed from the chassis with the a.c. mains supply still connected to the receiver.

CHAPTER 2

CIRCUIT DESCRIPTION

BASIC SYSTEM DESIGN

1. The system design follows the basic principles of a superheterodyne receiver. It may be considered as consisting of six sections plus power supply. These sections being the r.f. section, the local oscillator and mixer, the i.f. amplifier, and detector, the audio amplifier, the carrier alarm circuit and the coding alarm circuit.

CIRCUIT DESCRIPTION

Fig. 1

Power Supply

2. The power requirements of the receiver are 12V d.c., 8V d.c. stabilised and 4V d.c. derived from the 8V supply. These may be obtained from the a.c. mains or from a d.c. supply such as a station battery of up to 28V d.c. The mains supply can be 100 to 125V or 200 to 250V 50/60 Hz.

3. When the external power supply is the a.c. mains, this is routed to the step down mains transformer T6 via plug PL3, links LK5 and 6, fuse F1 and the on/off push-button switch S3 and links LK7 and 13. The rating of fuse F1 depends upon the a.c. supply, refer to the Parts Lists. The primaries of the transformer are series or parallel linked by means of links LK7, 12, 13 and 14 for 200 to 250V or 100 to 125V working.

4. The 12.5V r.m.s. output from the secondary of transformer T6 is connected to the bridge rectifier D1, the d.c. output of which (nominal 12V) is connected to the reservoir and smoothing capacitor C32, and via voltage dropper R68 to the 'mains on' indicator D4 (light emitting diode). The stabilised 8V supply is derived from the 12V supply via the integrated circuit, voltage regulator IC3 which is mounted on the front panel of the receiver for adequate heat removal. Capacitor C33 provides a.c. decoupling. The 4V supply is taken from the potentiometer R25 and R26 with capacitor C34 providing a.c. decoupling.

5. When the external power supply is from a d.c. supply links LK5, 6, 7, 8, 9, 10, 11, 12, 13 and 14 are omitted and links LK1, 2 and 4 are fitted if the supply is 12 to 20V d.c. If the supply is between 20 and 28V link LK4 is omitted and resistors R21 and 69 are fitted. These form a potential divider on the supply circuit. It should be noted that the chassis earth is disconnected from the 0V line. This permits the use of a d.c. supply with either leg earthed.

Receiver

6. The receiver is a superheterodyne with a 70 kHz i.f. frequency. Most of the receiver circuitry is contained within integrated circuit IC1 which consists of the r.f. amplifier, the mixer and the first i.f. amplifier stages. Additional i.f. amplification is provided by transistors TR10 and TR1. Transistor TR2 acts as the detector.

R.F. Amplifier

Fig. 1

7. The signal from the aerial is connected via socket SK1, the low sensitivity input, or socket SK2, the high sensitivity input. Resistors R84 and 83 form a 40 dB attenuator. Transformer T1 matches the 50 Ω aerial input to the 1 kΩ input impedance of the r.f. amplifier. It is also parallel resonant with capacitors C2 and 46 (winding 1-2) at the carrier frequency, providing rejection of out of band and image frequency. Winding 3-4 provides the input to the r.f. amplifier. The output of the r.f. amplifier is matched to the mixer via transformer T2 which is parallel resonant at the carrier frequency by winding 1-2 and capacitors C4 and 47.

8. The gain of the r.f. amplifier is determined by the voltage across resistor R3 and the current through the r.f. gain control R72 which form part of the circuit of the long tailed pair TR14 and 15. If the d.c. current through the r.f. amplifier tends to increase the voltage at the base of transistor TR15 becomes more negative than the base of transistor TR14 which reduces the current through that transistor and the voltage across resistor R3, which in turn reduces the current through the r.f. amplifier. The r.f. gain control R72 is adjusted for the required r.f. amplifier current level and thus its gain level.

9. Transistor TR16, diode D5 and resistor R89 form a 1.2V voltage source which when added to the stabilised 8V supply provides a stable +9.2V source for the current of the long tailed pair.

Local Oscillator

10. Transistors TR12 and 13 form a long tailed pair with 'in phase' gain between the base of transistor TR12 and the collector of transistor TR13. Positive feedback is applied via crystal X1 which causes the circuit to oscillate at its series resonant frequency. The output of the oscillator is built up across inductor L2 and resistor R9 and fed to the mixer of integrated circuit IC1.

Mixer

11. The mixer is contained in integrated circuit IC1, its r.f. input being taken from winding 3-4 of r.f. transformer T2 and its output being connected to winding 1-2-6 of i.f. transformer T3. The latter is parallel resonated with capacitors C9 and C18 at 70 kHz.

L.F. Amplifier

12. The i.f. amplifier is a band pass amplifier centred on 70 kHz with a -6 dB bandwidth at ± 1.25 kHz and a -40 dB bandwidth at ± 4.5 kHz. To obtain this response the three parallel resonant transformers T3, 4, and 5 are respectively stagger-tuned to 70 kHz 68.75 kHz and 71.25 kHz. The amplification is provided by the i.f. amplifier of integrated circuit IC1 and transistors TR10 and 1. Resistors R11, 14 and 15 form a potential divider across transformer T4. Operation of switch S1a reduces the i.f. output from transformer T4 by 3 dB, whereas operation of switch S2a reduces it by 5 dB.

13. Capacitor C8 is a short circuit to i.f. currents but a blocker to d.c. currents and ensures that the internal d.c. bias circuit of the i.f. amplifier of integrated circuit IC1 is not earthed.

Detector

14. The detector, transistor TR2, is an emitter follower with a time constant, which is long compared with the i.f. frequency but short compared with the modulation frequency formed by capacitor C19 and resistors R31 and R73. The base emitter junction of transistor TR2 has the characteristics of a diode and the signal at the emitter follows the positive modulating envelope of the i.f. signal.

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Any i.f. signal remaining on the demodulated waveform is filtered off by the filter networks resistor R18 and capacitor C20 and resistor R19 and capacitor C22.

15. The output of the detector is taken via resistor R18 to the 'carrier' alarm circuit, and where the signal is A2 or A2H via capacitor C23 to the audio amplifier and the 'coding' alarm circuit.

Audio Amplifier

16. Audio amplification of the detected signal is provided by integrated circuit IC2, the voltage gain of which between pins 6 and 8 is 34 dB. The amplified audio is routed via d.c. blocker C26 and volume control R74 to the front panel loudspeaker, via the line level control R75, resistor R30 and transformer T7 to the 600 Ω output terminals of the receiver, and directly from pin 8 of the integrated circuit and earth to provide an external 35 Ω loudspeaker output. The external loudspeaker must have a series capacitor of at least 33 μF to function as a d.c. blocker. In addition an unbalanced 600 Ω audio output is taken from earth and the junction of capacitor C50 and the primary of transformer T7.

17. Because the output impedance of the amplifier is low it functions as a constant voltage generator, and changes in the setting of the audio control R74 have little effect on the level of a signal fed to line or an external speaker.

Carrier Alarms

18. Transistors TR3, 4 and 5, integrated circuit IC4d and their associated components form the carrier alarm circuit where transistors TR3 and 4 are peak detectors and transistor TR5 is a low impedance amplifier to drive an external meter and the comparator IC4d.

19. The signal from the detector is the demodulated envelope with a d.c. level that varies with the carrier level. With no modulation present the carrier level is the monitored d.c. level. With modulation present the carrier level is the monitored d.c. level midway between the positive and negative peaks of the envelope. This corresponds to the carrier level for both A2 and A2H modulation.

20. Transistors TR3 and 4 function as peak detectors where transistor TR3 charges capacitor C37 to a d.c. level corresponding to the positive modulation peaks. Resistors R57 and 58 function as a potential divider to give a voltage at the base of transistor TR5 equal to the midway voltage between the positive and negative peaks of the envelope.

21. The carrier level voltage from the emitter of transistor TR5 is fed to integrated circuit IC4d where it is compared with the reference voltage at the junction of resistors R60 and 61. Normally, the signal input is a nominal +1.3V and the reference voltage is +1V respectively at the non-inverting and inverting input of the comparator, and its output is +4.3V. Transistor TR6 and relay RLA are operated. If the signal input falls 3 dB (nominal +0.45V) the output of the comparator will fall to 0V causing transistor TR6 to cease conducting and relay RLA to fall out. Positive feedback via resistor R64 provides a 0.7 dB hysteresis effect to comparator IC4d, and capacitor C41 and resistor R66 form a 'miller integrator' which reduces the rise or fall of current through the relay coil thus minimising voltage transients on the +12V rail.

22. Once the output of the comparator has fallen to 0V, the signal input has to rise to greater than -2.3 dB to bring the output of the comparator to +4.3V. This avoids the circuit chattering on noise when near the threshold level.

23. When transistor TR6 conducts its current not only flows through relay RLA but through the front panel mounted light emitting diode (LED) D2. This lights to show the normal state. The current through the coil of relay RLA is greater than that required to operate diode D2, resistor R67 in parallel shares this current. If relay RLA is not fitted resistor R90 is fitted so that the carrier lamp still operates.

Coding Alarm

24. Transistors TR17, 7, 8, 9 and 11, integrated circuits, IC4a, b and c, and their associated components form the coding alarm. The function of each major components is as follows:-

(a) transistor TR17 is an amplifier with thermistor gain control.
(b) transistor TR7 is an amplifier.
(c) transistor TR8 is an envelope detector.
(d) integrated circuit IC4a is a Schmitt trigger.
(e) integrated circuit IC4b is a buffer.
(f) transistor TR9 provides the delay.
(g) integrated circuit IC4c is a comparator.
(h) transistor TR11 is a relay driver.

25. With a normal signal applied to the coding alarm the following conditions prevail with the modulation on:-

(a) the output of integrated circuit IC4a is high.
(b) the output of integrated circuit IC4b is high.
(c) the output of integrated circuit IC4c is high.
(d) transistor TR11 is conducting.
(e) relay RLB is operated and diode D3 (LED) is lighted.

26. Transistor TR7 amplifies the detected signal from transistor TR2 and has a voltage gain of approximately 12. The output from transistor TR7 is fed to the envelope detector TR8, the time constants in its emitter circuit are long compared to the modulating frequency but short compared with the keying waveform of the modulation. Resistor R41 and capacitor C49 form a noise averaging integrator. At high temperatures the amplification of the modulation envelope decreases. This is compensated for by the inclusion of transistor TR17, which has a thermistor (R95) in its emitter bias circuit. An increase in temperature decreases its resistance and the gain of transistor TR17 increases. Note that transistor TR17, resistor R94 and thermistor R95 are not fitted to the Issue 1 P.C.B. See Fig. 1a at the far left of Fig. 1.

27. The Schmitt trigger IC4a has the detected envelope at its non-inverting input and the d.c. level of the collector of amplified IC7 at its inverting input. If the modulation amplitude falls by more than 6 dB the output of the trigger rapidly falls towards zero volts, the speed of action being increased by the positive feedback via resistor R37. The use of the d.c. level from amplifier TR7 to determine the trigger point ensures that any change in d.c. level at the amplifier will be followed by both inputs of IC4a and therefore stabilises the trigger point on the waveform. Buffer IC4b causes the potential at the junction of resistors R39 and 50 to fall towards 0V.

28. During the keying period of the signal being monitored the Schmitt trigger output will follow the changes in signal level, each fall in amplitude will cause the output of the buffer to fall towards 0V and each rise will cause the output of the buffer to rise towards +8V.

29. Each time the output of the buffer goes positive, it switches on transistor TR9 for a period determined by the time constant formed by resistors R39 and 50 and capacitor C30. When transistor TR9 is switched on capacitor C31 discharges and when transistor TR9 switches off capacitor C31 slowly charges up via the delay potentiometer R76.

30. Comparator IC4c compares the potential across capacitor C31 and that from the +4V rail via resistor R44. If no keying occurs to keep capacitor C31 in a discharged state and permits it to exceed the reference voltage the output of the comparator will fall towards 0V, transistor TR11 will cease to conduct, relay RLB will drop out and diode D3 will be extinguished.

31. Capacitor C42, with resistor R47 and transistor TR11, form a 'miller integrator' which reduces the rise and fall of current through the relay coil thus minimising transients on the supply rail. The current through the relay coil is greater than that required to operate the LED. Resistor R48 shares the current.

32. If the beacon being monitored is operating in the keyed carrier mode (A0/A1) there will be no audio to operate the coding alarm. Link LK19 is made connecting the collector of transistor TR6 to the base of transistor TR9 via resistor R49 and capacitor C21. The drive from the carrier alarm current is detected by the coding delay circuit and operates the coding alarm circuit if there is an absence of keying.

Principle of Setting Alarm Levels

Fig. 1

33. Alarm indications are required when the carrier level is reduced by 3 dB or the modulation level by 6 dB. The principle used to set the alarm levels is to artificially reduce the signal to the alarm level and then to adjust the 'carrier' and 'coding' gain of the receiver to alarm threshold level. The signals are reduced by the internal 'set alarms' switch S1. This reduces the i.f. gain by 3 dB (S1a), the modulation gain by 6 dB (S1c) and the coding alarm delay (S1b). The accuracy of the alarm settings is then only dependant upon the accuracy of the internal attenuator networks, which reduce the gains when the 'set alarms' switch is operated.

34. Reducing the delay is useful when the 'set alarms' switch is operated. The 'coding normal' lamp D3 switches on and off with the keying and the coding gain is set by potentiometer R73 ('coding gain') to the point where the lamp just fails to light.

Alarm Test Switch

Fig. 1

35. Operation of the front panel 'alarm test' switch S2 reduces the i.f. gain (S2a), shorts out the signal to the coding alarm (S2b) and reduces the coding alarm delay (S2c). The front panel 'carrier' and 'coding' lamps extinguish until switch S2 is released.

Active Aerials

36. Where an active aerial is used in conjunction with the receiver power is supplied to it via inductor L1 and resistor R54. Inductor L1 decouples the r.f. signal from the supply and resistor R54 limits the current that may be taken from the receiver in the event of a short circuit in the active aerial or the coaxial cable to it. Resistor R54 is a 40 mA filament lamp. Under normal conditions this is off, but in the event of a short circuit it will glow and its resistance will rise limiting the maximum current to 40 mA.

37. The supply to the active aerial may be +8V via link LK15 or 0V via link LK18. The 0V supply may be required when the receiver is run from a d.c. supply with a positive earth. The 0V is then depressed to the negative supply voltage.

CHAPTER 3

INSTALLATION

SUPPLIES

1. To gain access to the links to set up the receiver for a.c. or d.c. operation remove the top and bottom covers of the receiver and then remove the isolated cover from the upper face which is held four screws to four pillars. Do not remove covers with power connected to the receiver. Replace covers before connecting to supplies. When soldering links to the printed circuit board the soldering iron should not be rated at more than 15W unless it has a constant temperature bit.

Mains Supplies

2. If the receiver is to operate from an a.c. mains supply check before connecting it to the mains that it is adjusted to suit the local supply. For 220-250V operation links LK5, 6, 7, 8 and 12 should be fitted on the primary side of the mains transformer and links LK9, 10 and 11 on the secondary side of the transformer. For 110-125V operation the secondary links are the same as for 220-250V but the primary taps are links LK5, 6, 7, 14, 13 and 8. If an Active Aerial is used in conjunction with the receiver link LK15 must be made and LK18 disconnected to supply it with 8V d.c.

D.C. Supplies

3. If the receiver is to operate from a d.c. supply ensure that links LK5, 6, 7, 8, 9, 10, 11, 12, 13 and 14 are not connected. Then check that links LK1, 2 and 3 are connected. Then proceed as detailed below:-

(a) If the supply is from a 12V battery, whether connected to a charger or not connect link LK4, check that resistor R69 is not fitted and the bridge rectifier is removed from circuit and replaced by two links shown by dotted lines on the P.C.B.

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(b) If the supply is between 12 and 20V d.c. connect link LK4 and ensure that resistor R69 is not fitted.

(c) If the supply is between 16 and 24V d.c. check that link LK4 is not fitted and that resistors R21 is fitted, where R21 18 Ω 5% 6W.

(d) If the supply is between 20 and 28V d.c. check that link LK4 is not fitted, and that resistors R21 and 69 are fitted. Where R21 is 33Ω 6W and R69 is 330R 2.5W.

(e) If the supply is between 28 and 32V d.c. check that link LK4 is not fitted and that resistors R21 and 69 are fitted, where R21 is 47 Ω 5% 9W and R69 is 220 Ω 5% 6W.

* (f) Link LK18 is normally made unless an Active Aerial is in use.

*4. It should be noted that the d.c. supply is not connected to the chassis of the receiver permitting either the positive or negative lead of the d.c. supply to be earthed. It is recommended that the d.c. supply be externally fused in the lead that is not fused with a 1A fuse. If the receiver is used in conjunction with an Active Aerial link LK18 is removed and link LK15 is made. If the receiver is operated from a d.c. supply with the positive earthed it will be necessary to connect link LK18 and disconnect link LK15. This will route the negative d.c. supply to the active aerial (see paragraph 37 of Chapter 2). The aerial screen, which is held by three screws, must be removed to gain access to these links. *

RACK OR CABINET MOUNTING

5. The receiver is designed for standard (19 inch) rack or cabinet mounting where it can be directly mounted in the racking or mounted with runners which should be fitted to the receiver and the cabinet with reference to Figure 2.

EXTERNAL RECEIVER CONNECTIONS

6. The aerial is connected to either socket SK1 or 2 at the rear of the receiver. The sockets are a 50 Ω BNC type for which a mating plug is provided. The aerial should be connected to the socket using a 50 Ω coaxial cable such as the Type UR43.

7. Normally the aerial is connected to the high sensitivity input socket SK2, and then transferred to socket SK1 if the signal is too great. No damage will result to the receiver if the wrong socket is used.

8. The aerial should be sited as far as is practicable from any man-made r.f. interference. If an Active Aerial is used remove link LK18 and connect link 15 as detailed in paragraph 4. For distances up to 6 km between the non-directional beacon and the receiver a 3 m whip aerial should be adequate. For greater distances a larger whip aerial or a long wire aerial can be used. If the aerial used is directional it should if possible be oriented for the best signal.

Alarm Outputs

9. Relay contact connections are brought out to the rear terminal blocks for connections to external alarms. The top cover of the receiver must be removed to gain access to these terminal blocks. Changeover contacts are provided that combine both alarms such that an alarm is given when either alarm operates. The printed circuit board has printed on it, adjacent to the terminal blocks, diagramatic representation of the contacts in the 'alarm' condition.

10. The alarm contacts are rated at 1A maximum current or 30W switched power whichever is the greater and neither may be exceeded.

11. Examples of connecting external warning indicators are shown on Figure 3.

600 Ω Outputs

12. Both 600 Ω balanced and unbalanced outputs are available from the rear terminal blocks of the receiver, the balanced output from terminals 16 and 19 with terminals 17 and 18 linked, and the unbalanced output from terminals 20 and 23 (earth). Figure 3 shows the normal connection of 600 Ω lines and the connections for phantoming the alarms over the 600 Ω lines.

External Loudspeaker

13. An external 35 Ω loudspeaker may be connected between terminals 24 and 23 (0V) of the rear terminal block of the receiver, where a nominal 200 mW of audio power is available. WARNING: The 33 μF 20V d.c. working capacitor must be connected between terminal 24 and the external loudspeaker. If an electrolytic capacitor is used the positive terminal should be towards pin 24.

External Meter

14. An external d.c. voltmeter can be connected to terminals 21 (positive) and 22 (earth) of the rear terminal block of the receiver. These terminals are in parallel with the receiver's front panel meter sockets. Currents up to 100 μA can be drawn to drive an external meter. Under normal operating conditions the terminal voltage is 1.25V and varies approximately 100 mV per dB change in carrier level. With no signal present there is a standing reading of approximately 0.5V.

SETTING UP

15. If the operating frequency was specified at the time of ordering the receiver it will be ready-for-use except for the adjustments detailed in paragraph 16 to 30. If the receiver is to be tuned up on site, proceed first as detailed in paragraphs 31 to 33. If the receiver is fitted with runners it can be set up whilst in the cabinet otherwise it should be set up on a test bench.

Final Tuning to Carrier Frequency

16. Connect a voltmeter to the front panel EXTERNAL METER terminals observing the marked polarity. The meter terminals are short circuit proof and no damage will occur if they are accidentally shorted. The voltmeter need only be a normal moving coil meter with 5 kΩ/V or better.

17. Withdraw the receiver on its runners from the racking and remove its top cover.

18. Refer to Figure 4 which shows the positions of the internal controls mentioned in the instructions that follow.

19. Set the meter to read about 2.5V full scale deflection (F.S.D.). The voltage at the METER TERMINALS is limited to approximately 3.5V and no damage should result if the meter is driven over F.S.D.

20. Connect the aerial to the high sensitivity socket SK2. Switch on the receiver and check that the SUPPLY L.E.D. lights. Adjust the r.f. gain control R72 for a mid-scale meter reading. If the signal is very strong it may be necessary to transfer the aerial to the low sensitivity socket SK1 to achieve a mid-scale reading.

21. Adjust the variable capacitors C2 and 4 for a maximum reading on the meter. These two controls have quite a coarse action. Fine tuning is by adjusting the slugs of transformers T1 and T2. A special tool for the adjustment of these is clipped to the r.f. screen of the receiver.

22. Final tuning should be with the meter adjusted to approximately 1.3V by the r.f. gain control R72.

Setting the Carrier Alarm Level

23. If the beacon is transmitting A0/A2 or A0/A2H increase the AUDIO control and listen to check that the beacon is being received. If the transmission is A0/A1 no audio will be heard except perhaps a change in noise level during keying.

24. Set the SET ALARMS switch S1 to the SET position. Reduce the r.f. gain by turning control R72 anticlockwise until the CARRIER NORMAL lamp just goes out. With noisy signals there may be some 'chattering' of the alarm circuit at the threshold point.

Setting the Coding Alarm Level (A2 and A2H Modulation Only)

25. Listen for the modulation. Set the SET ALARMS switch S1 to the SET position. Set the coding gain control R73 fully clockwise and note that the CODING NORMAL LED flashes with the keying of the modulation.

26. Turn the coding gain control R73 anti-clockwise to the point where the CODING NORMAL LED just fails to flash with the keying of the modulation.

Setting the Coding Gain (Keyed Carrier, A0/A1, Operation)

27. Where the receiver monitors an AO/A1 beacon the coding gain control R73 is set to its mid-position.

Setting the Coding Delay

28. Set the SET ALARMS switch S1 to the SET position. Set the delay control R76 fully anticlockwise. Listen to the coding at the loudspeaker. Advance delay control R76 clockwise to the point where the CODING NORMAL LED just stays on during the pause between coding repeats. Then advance the delay control R76 one tenth of a turn clockwise.

29. The receiver is now set up ready for operation. Set the SET ALARMS switch S1 to the NORMAL position. Replace the receiver's top cover. Slide or replace the receiver in the rack.

Receiver Sensitivity

30. After the receiver has been set up as detailed above it is recommended that its input sensitivity be measured and recorded, so that if at a later date it appears that the received signal has changed in level it is easy to check whether this is due to the gain of the receiver having changed or due to the output power of the beacon changing. The procedure for recording the receiver sensitivity is as follows:-

(a) Disconnect the aerial and feed in a signal from a generator set to the carrier frequency.
(b) Connect a voltmeter set to about 2.5V F.S.D. to the EXTERNAL METER terminals.
(c) Adjust the output of the signal generator for a reading of 1.25V on the meter.
(d) Record the output e.m.f. of the signal generator.
(e) Switch off and disconnect the signal generator and meter. Reconnect the aerial to the receiver.

Tuning Receiver to Operating Frequency

Crystal Frequency

31. To avoid the possibility of the image frequency coming in the broadcast bands where very high signals may cause interference the crystal frequency is selected as follows:-

(a) 200 to 395 kHz operating frequency (fc).

Crystal frequency = fc + 70 kHz.

(b) 395 to 535 kHz operating frequency (fc).

Crystal frequency = fc - 70 kHz.

R.F. Stage Linking

32. The r.f. stage should be linked as detailed below depending upon the operating frequency.

(a) 200 to 350 kHz.

(i) Resistor R80 to be 470 Ω.
(ii) Links LK16 and 17 to be fitted.

(b) 351 to 535 kHz.

(i) Resistor R80 to be 150 Ω.
(ii) Links LK16 and 17 not to be fitted.

R.F. Tuning

33. Because of the selectivity of the receiver the r.f. tuning cannot be initially tuned from a beacon transmitter. A high level signal from a signal generator is required. The procedure is as follows:-

(a) Connect a d.c. voltmeter to the EXTERNAL METER sockets at the front of the receiver set for a F.S.D. of about 2.5V.
(b) Connect the output of the signal generator to the receiver's high sensitivity aerial socket. Adjust the signal generator to the operating frequency and for MCW operation.

(Cont'd.......

33. Cont'd..........

(c) Adjust the output of the signal generator to a level such that the signal can be heard.

(d) Tune capacitors C2 and 4 for maximum meter reading of 1.3V when finally tuned.

(e) Proceed as detailed in paragraphs 16 to 30 after disconnecting the signal generator.

CHAPTER 4

OPERATION

ALARM OPERATION

A2 and A2H Modulation

1. Under normal conditions the CARRIER NORMAL and CODING NORMAL lamps (light emitting diodes) are on. The CARRIER NORMAL lamp goes off if the carrier level reduces by more than 3 dB. The CODING NORMAL lamp goes off if the modulation depth reduces by more than 6 dB or if the keying stops in either the mark or space condition for longer than the preset delay period.

Keyed Carrier Operation

2. On keyed carrier transmissions the CARRIER NORMAL lamp is on when the carrier is present and goes off when the carrier is keyed off. The CODING NORMAL lamp stays on under normal conditions but goes off if the keying stops with the carrier in either the mark or space condition for longer than the preset delay period.

LOUDSPEAKER OPERATION

3. With A2 or A2H operation the keyed tone is heard from the loudspeaker. On keyed carrier operation there is no tone to be heard. All that can be heard is a change in noise level as the carrier is keyed on and off. The loudspeaker output level is controlled by the panel AUDIO control.

ALARM TEST BUTTON

4. Depressing the front panel ALARM TEST push-button activates the alarms by reducing the receiver's gain by 5 dB, by cutting off the signal to the coding alarm and by reducing the delay period.

5. Depressing the push-button therefore causes both the CARRIER NORMAL and CODING NORMAL lamps to go out and also causes any external alarms to be activated. Because of the internal time constants it takes a few seconds for both lamps to go out after depressing the push-button. During the first few seconds lamps may go out and then come on again before finally setting in the off condition.

6. If the carrier lamp fails to go off, it may mean that the beacon power has risen by more than 2 dB from when the receiver's alarms were set. This can be checked by measuring the d.c. voltage at the front panel EXTERNAL METER sockets and comparing the reading with that previously recorded.

EXTERNAL METER

7. The EXTERNAL METER terminals are used when tuning the receiver and can also be used as a periodic check of changes in the carrier level of the gain of the receiver.

8. Any voltmeter with a range of approximately 2.5V d.c. F.S.D. and a resistance of 5 kΩ/V or greater may be connected to the EXTERNAL METER terminals. Under normal operating conditions the reading will be 1.25V $\pm$ 10%. The reading changes approximately 100 mV per dB change in carrier level. It is recommended that the same type of meter, if not the same meter, is used when checking the reading.

CHAPTER 5

MAINTENANCE

PERIODIC MAINTENANCE

1. Periodic maintenance, that is the removal of the receiver to a test bench to check tuning etc., is not recommended unless a fault occurs or it is thought that the receiver's gain has altered.

2. It is recommended that at regular intervals, say weekly initially, then monthly, as experience is built up, the ALARM TEST push-button is operated and the voltage reading at the EXTERNAL METER sockets is measured and recorded. See Chapter 4.

SETTING UP

Test Equipment

3. The following test equipment is recommended for bench setting up the receiver:-

(a) A.M. Signal Generator, frequency range 68 to 535 kHz: for example Marconi Instruments Type TF144H.
(b) Oscilloscope, bandwidth greater than 1 kHz sensitivity better than 50 mV per division: for example Telequipment D67.
(c) Frequency Counter, frequency range greater than 535 kHz, sensitivity better than 100 mV r.m.s., resolution better than 10 Hz: for example Racal 9835.
(d) General Purpose Multirangemeter, 5 kΩ/V or better: for example AVO 8.
(e) Divide by 10, 10 MΩ Oscilloscope Probe: for example Tektronix P6006.
(f) Power Supply (for d.c. operated receiver only) 28V, 0.5A d.c. isolated from earth: for example IE50/0.5.

Connection of Test Equipment

4. Normally, all measurements are taken with respect to the 0V line which, when the receiver is a.c. mains operated, is the receiver's chassis. The earth of the test equipment may then be connected to the receiver's chassis or 0V line.

5. When the receiver is set to operate from a d.c. supply the 0V line is not necessarily at chassis potential, particularly if the d.c. supply has a positive earth in which case the 0V line is depressed by the negative supply voltage. This makes the connection of the test equipment difficult. It is therefore recommended that when the receiver is set for d.c. operation, the problem is overcome by disconnecting it from its normal supply and connecting it to a test bench supply (see paragraph 3(f).) which has a floating output. The receiver 0V line may then be earthed to chassis by connecting link LK11 during the tests.
WARNING: This link must be disconnected before connecting it to its normal d.c. supply.

Crystal Oscillator

6. If the crystal is changed the oscillator should be checked for any tendency to slow starting or oscillating at twice its fundamental frequency. If either of these conditions occur resistor R5 needs to be changed in value.

7. Monitor the waveform at the end of inductor L2 nearest to transformer T3 on the P.C.B. Switch the supply on and off several times and check that the oscillator starts satisfactorily and runs at the correct frequency.

8. Resistor R5 is normally 220 Ω. If the starting is slow this should be changed to 330 Ω. If there is a tendency to run at twice frequency resistor R5 should be changed to 150 Ω.

9. For correct operation the waveform at inductor L2 should be a clipped sine wave of 0.8 to 1.5V peak-to-peak amplitude.

10. The frequency of the crystal oscillator can be checked by connecting a counter to inductor L2. The frequency should be within ± 0.015% of the nominal crystal frequency. Switch off the counter when it is not in use and disconnect from the receiver.

I.F. Amplifier Tuning

11. WARNING: The i.f. amplifier is tuned to 70 kHz and has three stages each stagger tuned to give a response curve with a nominally flat top and steep sides. There is a stray feedback path around the i.f. amplifier via the crystal oscillator circuit which causes the i.f. response to change when there is no crystal in the receiver. A crystal must always be fitted when checking or setting up the i.f. stages.

12. The signal generator frequencies require to be adjusted to those detailed in the test below and must be set up using a frequency counter. Because the receiver is sensitive and because the counter may radiate signals that could interfere with the receiver, the counter should always be disconnected from the signal generator and switched off when taking measurements or setting up the receiver's i.f. circuits.

13. Before attempting to tune the i.f. transformers, remove the black tape that covers the tops of them levering off with a screwdriver. This tape is factory fitted after setting up the i.f. stages so that when setting up the r.f. stages on the site the i.f. stages are not accidentally offset. Note that all slugs are adjusted from the chassis, never from below, using the tool clipped to the side of the r.f. screen. Check that the SET ALARM switch S1 is in the NORMAL position.

14. Connect a d.c. voltmeter set to about 2.5V F.S.D. to the EXTERNAL METER terminals on the front panel. Connect the output of the signal generator via a 500 Ω coaxial lead to test points TP3 and 4, with the centre of the lead to test point TP3 and the screen to TP4.

15. Adjust the signal generator to exactly 70 kHz in the CW mode. Adjust the slug of transformer T3 for maximum on the meter reducing the output of the signal generator until with transformer T3 correctly tuned the meter reads between 1.2 and 1.6V.

16. Adjust the signal generator to exactly 68.75 kHz and adjust the slug of transformer T4, reducing the output of the signal generator until with transformer T4 correctly tuned the meter reads between 1.2 and 1.6V.

17. Adjust the signal generator to exactly 71.25 kHz and adjust the slug of transformer T5, reducing the output of the signal generator until with transformer T5 correctly tuned the meter reads between 1.2 and 1.6V.

18. Slowly sweep the signal generator from 68 to 72 kHz noting the response on the meter. Three peaks in the response will be noted. The amplitude of the two outer peaks should not differ by more than 100 mV. If they do tune the signal generator to the frequency of the higher peak and adjust the slug of transformer T3 to reduce the meter reading to half the difference in peak amplitudes. For example if the outer peak readings differed by 220 mV, the slug of transformer T3 is adjusted to reduce the difference to 150 mV. Sweep the signal generator between 68 and 72 kHz and note that the response shows more equal amplitude of the outer peaks.

I.F. Sensitivity

19. When the i.f. stages are tuned set the signal generator to 70 kHz using the counter. Adjust the output of the signal generator for a reading of 1.25V on the meter. Record the output of the signal generator which should be 70 mV r.m.s. ± 10 dB (between 221 and 22.1 mV).

R.F. Tuning

20. The R.F. stages should be tuned as detailed in Chapter 3, paragraph 33.

FAULT FINDING

21. The data that follows is included as an aid to fault finding.

Power Supply

Unregulated +12V Line Voltage

22. Table A overleaf lists the voltage across capacitor C32 for various values of a.c. mains input.

(Cont'd.......

22. Cont'd...........

MAINS INPUT V r.m.s.	d.c. VOLTAGE across C32
110 or 220	15.3 ± 10%
115 or 230	16.0 ± 10%
120 or 240	16.8 ± 10%
125 or 250	17.6 ± 10%

TABLE 'A'

Ripple Voltage

23. The ripple voltage measured on the d.c. supply when derived from the a.c. mains supply is:-

(a) on +12V line, measured across capacitor C32, typically 0.5V peak to peak 100 Hz. Limits 0.25 to 1V peak-to-peak.

(b) on +8V line, measured across capacitor C33, less than 1 mV peak-to-peak.

Resistance Measurements

24. Low power supply voltages and high ripple may be caused by excessive loading of supplies. The resistance measurements that follow are measured with a multirangemeter set to read ohms. The supply to the receiver must be disconnected when carrying out any resistance measurements.

(a) Across capacitor C82, +12V line.

(i) Meter positive to positive terminal of capacitor - 25 Ω.
(ii) Meter negative to positive terminal of capacitor - 6 kΩ.

(b) Across capacitor C33, +8V line.

(i) Meter positive to positive terminal of capacitor - 700 Ω.
(ii) Meter negative to positive terminal of capacitor - 700 Ω.

(c) Across capacitor C34, +4V line,

(i) Meter positive to positive terminal of capacitor - 700 Ω.
(ii) Meter negative to positive terminal of capacitor - 700 Ω.

R.F. Amplifier Voltages

25. Table B below lists the voltages at various points of the r.f. amplifier with no r.f. input at the aerial and with the local oscillator crystal removed. All voltages are with respect to the 0V line unless otherwise stated.

TEST POINT	d.c. VOLTAGES min.	typical	max.	REMARKS
IC1 -11	0.4	0.7	1.0	d.c. bias generated inside IC1
IC1 -12	0.4	0.7	1.0	
IC1 -10	0.1	0.7	1.0	Depends on setting on r.f. gain.
TR14 or TR15 base with respect to +8V line	-0.4	-0.5	-0.7	R80 = 470 Ω
TR14 or TR15 emitter with respect to +8V line.	-0.1	-0.0	+0.2	R80 = 470 Ω
TR14 or TR15 base with respect to +8V line.	-0.1	-0.2	-0.3	R80 = 150 Ω
TR14 or TR15 emitter with respect to +8V line.	+0.1	+0.3	+0.5	R80 = 150 Ω
TR16 collector with respect to +8V line.	+0.9	+1.2	+1.5	
TR16 base with respect to +8V line.	+0.4	+0.6	+0.75	

TABLE 'B' R.F. Amplifier Voltages

Gain of R.F. Amplifier

26. Table C overleaf lists the output of the r.f. amplifier at terminal 4 of transformer T2 with respect to the 0V line for various carrier frequencies. An unmodulated signal is fed in at aerial SK2 at a level of 2.5 mV r.m.s. at that socket. This means an output of 5 mV e.m.f. at the 50 Ω output of the signal generator. Capacitors C2 and 4 are adjusted for maximum signal at terminal 4 of transformer

(Cont'd......

26. Cont'd........

T3 and with the r.f. gain control R72 set for maximum gain. The measurement at transformer T3 is taken using a 10 MΩ probe in the oscilloscope.

FREQUENCY kHz	OUTPUT T2-4
200	0.6V peak-to-peak ± 10%
250	1.0V peak-to-peak ± 10%
300	1.4V peak-to-peak ± 10%
535	1.0V peak-to-peak ± 10%

TABLE 'C' R.F. Amplifier Output

Local Oscillator Voltages

27. Table D below lists the d.c. voltages of the local oscillator. These voltages are quiescent, that is with no crystal fitted. Unless otherwise specified the voltages are measured with respect to the 0V line.

TEST POINT	d.c. VOLTAGE			REMARKS
	min.	typical	max.	
TR13 collector with respect to +8V line	-0.1	-0.5	-0.9	
TR13 base	3.5	4.0	4.5	
TR12 and TR15 emitter	2.8	3.4	4.0	
TR12 base	3.5	4.0	4.5	
TR12 collector	5.5	6.8	7.5	Depends upon IC1 internal zener diode connected to IC1 pin 3

TABLE 'D' Local Oscillator Voltages

Local Oscillator Output

28. Refer to paragraphs 6 to 10 inclusive for details of checking the output of the local oscillator.

Mixer

29. Table E below lists the d.c. voltages of the mixer. These voltages are quiescent, that is with no r.f. input at the aerial socket and with no crystal fitted.

TEST POINT	d.c. VOLTAGE			REMARKS
	min.	typical	max.	
IC1 -1 with respect to junction R10/L2	-1.5	-2.0	-2.5	d.c. bias generated inside IC1 reference to internal zener diode voltage connected to IC1-3.
IC1 -4 with respect to junction R10/L2	-1.5	-2.0	-2.5	

TABLE 'E' Mixer Voltages

I.F. Amplifier and Detector Voltage

30. Table F overleaf lists the d.c. voltages of the i.f. amplifier and detector stages. The voltages are quiescent, that is with no r.f. input at the aerial socket and with no crystal fitted. Unless otherwise specified all are with respect to the 0V line.

(Cont'd......

30. Cont'd.........

TEST POINT	d.c. VOLTAGES			REMARKS
	min.	typical	max.	
IC1 -7	0.4	0.7	1.0	Bias generated in IC1
IC1 -6	7.5	8.0	8.4	
Junction R14 and 15	7.5	8.0	8.4	Same voltage as measured on +8V line
Junction R14 and 11	7.5	8.0	8.4	
TR10 emitter	-1.65	-1.85	-12.1	With respect to the +8V line
TR1 emitter	-1.0	-2.1	-1.4	
TR2 emitter	0.8	1.0	1.2	
TR2 collector	1.0	1.2	1.4	With respect to the +8V line

TABLE 'F' I.F. Amplifier and Detector Voltages

Gain of I.F. Amplifier

31. Refer to paragraph 19 for details of the i.f. gain measurement. With a reading of 1.25V at the EXTERNAL METER terminals, the signal measured at test point TP7 using an oscilloscope with a 10 MΩ probe should be 2V peak-to-peak.

Audio Amplifier Voltages

32. Table G below lists the d.c. voltages of the audio amplifier under quiescent conditions that is with no r.f. signal input. All readings are with respect to the 0V line.

TEST POINT	d.c. VOLTAGES			REMARKS
	min.	typical	max.	
IC2 - 6		0V		
IC2 - 8	4.0	8.0	12.0	Approx. half supply at IC2-14.

TABLE 'G' Audio Amplifier Voltages

Audio Amplifier Gain

33. The voltage gain of the audio amplifier is 50 (limits 40 to 60). This is measured by feeding in a r.f. signal tuned to the receiver's operating frequency, modulated 80% either at 400 or 1 000 Hz. Adjust the output of the signal generator to obtain 150 mV peak-to-peak at IC2 pin 6. The signal at IC2 pin 8 should then be 7.5V peak-to-peak (limits 6.0V to 9.0V).

Carrier Alarms

34. Table H below lists the d.c. voltage of the carrier alarm circuit. Two sets of figures are quoted, one for the alarm state with no r.f. input to the receiver and the second for a normally operating receiver with an r.f. input sufficient to give 1.25V at the EXTERNAL METER terminals. All voltages are with respect to the 0V line.

TEST POINT	d.c. VOLTAGES						REMARKS
	ALARM STATE			NORMAL STATE			
	min.	typical	max.	min.	typical	max.	
TR3/TR4 base	0.8	1.0	1.2	1.7	1.9	2.1	
TR3 emitter	0.2	0.45	0.8	1.1	1.35	1.7	
TR4 emitter	1.4	1.7	2.0	2.3	2.6	2.9	
TR5 base	0.7	1.0	1.3	1.6	1.8	2.2	
IC4 -10	0.8	1.0	1.2	0.8	1.0	1.2	d.c. reference level
IC4 -11	0.2	0.45	0.8	1.0	1.3	1.7	
IC4 -13	0	0.15	0.4	3.9	4.3	4.7	
TR6 base	0	0.15	0.4	0.5	0.8	1.0	
TR6 collector	10.5	16.0	20.0	0	0.2	0.5	Equals +12V supply in alarm state
Across D2		0		1.4	1.7	2.0	

TABLE 'H' Carrier Alarm Voltages

Coding Alarms

35. Table I that follows, lists the d.c. voltage of the coding alarm circuit. Two sets of figures are quoted, one for the alarm state which are measured with no r.f. signal input, and the other for the normal state with a r.f. signal input 80% modulated at 400 Hz with the signal level adjusted for a reading of 1.25V at the EXTERNAL METER terminals.

36. With an EXTERNAL METER reading of 1.25V the 'coding gain' control R73 is adjusted for a reading of 150 mV peak-to-peak at the junction of resistor R27 and capacitor C27. The 'set alarms' switch S1 must be in the 'normal position'.

37. In the 'normal state' table the a.c. peak-to-peak voltage is quoted for the collector of transistor TR7 as this is more meaningful that quoting the d.c. level because the latter is nominally the same for both the alarm and normal states.

38. When taking the normal state measurements from integrated circuit IC4 pin 9 onwards in Table I, it will be necessary to periodically key the modulation in order to keep the circuit in the normal state, otherwise when the delay period has finished the circuit will change to the alarm state. It is recommended that the 'delay' control R76 be set fully clockwise for maximum delay which will be 70 seconds or more. The delay period can then be re-started every minute or so by switching off the signal generator modulation and then switching it on again.

39. When checking the alarm state measurements it will be found that circuit disturbances, such as connecting test equipment to the circuit, may trigger the circuit into the normal state, where it will remain for the delay period. It is recommended that the 'delay' control R76 be set fully anti-clockwise for the shortest delay to minimise the time that the circuit stays in the normal state.

40. The voltage on the base of transistor TR9 is always zero except for a period of about three seconds after the modulation comes on. During this period the voltage rises to about 0.5V then decays back to zero on a time constant determined by capacitor C30 and resistor R50 and 39.

41. The collector of transistor TR9 is a high impedance point and can only be monitored with an oscilloscope connected via a 10 MΩ probe. The oscilloscope should be set to be d.c. coupled. The d.c. voltage is then 0V (limits 0 to 0.5V) at the start of the delay period rising exponentially to +8V. The delay period can be triggered to the starting point by switching the modulation off and then on again.

Table I follows this page.

TEST POINT	ALARM STATE			NORMAL STATE			REMARKS
	min.	typical	max.	min.	typical	max.	
TR7 base	0.4	0.55	0.7	0.4	0.55	0.7	
TR7 collector	3.5	5.0	6.5	1.2	1.8	3.3	peak-to-peak
TR8 emitter	2.5	4.0	5.5	3.5	5.0	6.5	
IC4 -5	2.5	4.0	5.5	3.5	5.0	6.5	
IC4 -4	2.7	4.2	5.7	2.7	4.2	5.7	
IC4 -7	0	0.05	0.4	7.0	7.6	8.4	
IC4 -6	3.5	4.0	4.5	3.5	4.0	4.5	+4V line
IC4 -1	0	0.1	0.5	7.4	8.0	8.4	
TR9 base	0	0	0				See para. 40
TR9 collector		8.0					See para. 41
IC4 -9	1.8	2.0	2.4	3.5	4.0	4.6	
IC4 -14	0	0.1	0.5	3.8	4.4	4.8	
TR11 base	0	0.1	0.4	0.5	0.7	1.0	
TR11 collector	10.5	16.0	20.0	0	0.2	0.5	Equals +12V line in alarm state.
Across D3		0		1.4	1.7	2.0	

TABLE 'I' Coding Alarm Voltages

CHAPTER 6

PARTS LISTS

CONTENTS

ORDERING OF SPARE PARTS

To avoid delays and possible errors in the supply of spare parts the following should be quoted in all orders.

(a) Code number.
(b) Part description.
(c) Circuit reference, where there is one.
(d) The description and type number of the unit for which the component is required.

The right is reserved to provide spare parts that differ from those ordered in the light of future development or as replacements for those that are no longer manufactured.

PARTS LIST FOR BEACON MONITOR RECEIVER IA8509

IAL Code No.	Description	Ref. No.	Qty.
P851	Spacer M3 x 19 mm		4
P803	Spacer		4
P898	Spacer		2
Q245	Knob, 6 mm		1
Q189	Knob Cap		1
Q204	Knob Nut Cover		1
Q254	Knob		3
P853	Tag 7/16" I.D.		2
P110	Tag 2BA		2
O652	Grommet		1
P443	Clip		2
J432	Label, Self Adhesive	"Danger Mains Volts"	3
G181	Loudspeaker $2\frac{1}{2}$" square 35 Ω tropicalised		1
Q259	Adjusting Tool	DT2452	1
Q266	Adjusting Tool	B63399-B0004 X000	1
Select on Test from following values:-			
	Resistor, 47R 6W W22		1
	Resistor, 33R 6W W22	R21	1
	Resistor, 18R 6W W22		1
Select on Test from following values:-			
	Resistor, 220R 6W W22	R69	1
R1471	Resistor 330R $2\frac{1}{2}$W W21		1
	Resistor 180R $2\frac{1}{2}$W W21	R90	1
R1481	Resistor 56R 1/4W CR25	R83, 91, 92	3

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PARTS LIST FOR BEACON MONITOR RECEIVER IA8509 Cont'd.......

IAL Code No.	Description	Ref. No.	Qty.
R1149	Resistor 4K7 1/4W CR25	R84	1
R1479	Resistor, Variable, 100R	R74	1
K723	Capacitor 33 μF 16V	C26	1
or	Capacitor 33 μF 35V EN12 1233/35	C26	1
K472	Capacitor, Variable 150 pF	C2, C4	2
L575	Diode (L.E.D.)	D2, 3, 4	3
V587	Integrated Circuit	IC3	1
S525	Switch	S3	1
U380	Transformer	T6	1
P846	Socket, 2 mm L1737 BLACK	TP1, TP2	2
or	Socket, 2 mm 450-3381-1-0310	TP1, TP2	
P689	Socket	SK1, SK2	2
P777	Plug	PL1, PL2	2
P843	Socket P430/SE	SK3	1
P447	Plug Type P429	PL3	1
P842	Washer, Plug Type 6455	PL3	1
P441	Socket L1436	SK3	1
P442	Plug L1436B/S	PL3	1
	Crystal Type CR25U Tol. ± 0.01%	X1	1
Select from following:-			
	Freq. fc + 70 kHz (For fc = 200-395 kHz)		
	Freq. fc - 70 kHz (For fc = 395-535 kHz)		
L581	Fuse 160 mA, 20 mm TDC 123	F1 (Select required rating)	1
L591	Fuse, 315 mA, 20 mm TDC 123		
L592	Fuse 1A 20 mm, TDC 13		

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PARTS LIST FOR BEACON MONITOR RECEIVER IA8509 Cont'd.......

IAL Code No.	Description	Ref. No.	Qty.
N1117	Screw M4 x 12 mm M.S. Cad. and Pass.	Unit Fixing Kit	4
N1254	Screw M6 x 20 mm	Unit Fixing Kit	4
N1179	Nut, Plain 6 mm M.S. Cad. and Pass.	Unit Fixing Kit	4
N1253	Nut, Captive 6 mm	Unit Fixing Kit	4
N1235	Washer, Crinkle 4 mm St. Stl.	Unit Fixing Kit	4
N1260	Washer, Crinkle 6 mm St. Stl.	Unit Fixing Kit	4
K540	Capacitor 0μ1 400V	C53, C54	2
Q248	Inductor 10 μH	L3	1
or Q232	Inductor 10 μH	L3	1

PARTS LIST FOR BEACON MONITOR RECEIVER P.C.B.

IAL Code No.	Description	Ref. No.	Qty.
R1468	Resistor 2R7 ± 10%	R23	1
R1469	Resistor 56R ± 5% CR25	R48, 67	2
R1486	Resistor 150R ± 5% CR25	R6	1
R1168	Resistor 220R ± 5% CR25	R9, 5, 82	3
R1470	Resistor 330R ± 5% CR25	R16, 94*	2
R1471	Resistor 330R ± 5% W21	R68	1
R1472	Resistor 470R ± 5% CR25	R17, 30, 80	3
R1264	Resistor 680R ± 5% CR25	R78, 87	2
R1144	Resistor 1K0 ± 5% CR25	R7, 14, 18, 19, 25, 26, 35, 41, 42, 50, 59, 61 62, 63, 77, 81, 88, 89, 93	19
R1475	Resistor 2K0 ± 1% FC65	R15	1
R1147	Resistor 2K2 ± 5% CR25	R3	1
R1474	Resistor 3K9 ± 1% FC65	R11	1
R1149	Resistor 4K7 ± 5% CR25	R29, 39, 46, 47, 49, 55, 56, 65 and 66	9
R1476	Resistor 6K8 ± 5% CR25	R79, 60	2
R1150	Resistor 10K ± 5% CR25	R8, 22, 27, 33, 34, 36, 38, 44, 45, 51, 57, 58	12
R1153	Resistor 33K ± 5% CR25	R28	1
R1155	Resistor 100K ± 5% CR25	R13, 37	2
R1235	Resistor 150K ± 5% CR25	R64	1
R1260	Resistor 220K ± 5% CR25	R12, 32, 40	3
R1503	Resistor 330K ± 5% CR25	R2	1
R1495	Resistor 680K ± 5% CR25	R1, R71	2
R1275	Resistor 1M0 ± 5% CR25	R20	1
R1477	Variable Resistor 470R	R75	1
R1485	Resistor 33R 1/4W	R96	1

(Cont'd.......

PARTS LIST FOR BEACON MONITOR RECEIVER P.C.B. Cont'd.......

IAL Code No.	Description	Ref. No.	Qty.
R1484	Variable Resistor 25K B5W or 3252W	R72	1
R1477	Variable Resistor 470R C10 or 90H	R73	
R1478	Variable Resistor 470K C10 or 90H	R76	1
R1492	Resistor 100R ± 5% CR25	R10	1
K725	Capacitor 3m3 μF 25V 07116472 or WB35 D332 F02 S02	C32	1
K722	Capacitor 22 pF ± 10% C333 CC/C22E or AD/N150	C18	1
K729	Capacitor 47 pF ± 10% C333 CC/C47E or AD/N750	C14	1
K718	Capacitor 100 pF ± 2% C333 CC/C100E	C39	1
K720	Capacitor 560 pF ± 1% 30V EXF or MIAL 617	C9, 13, 17	3
K534	Capacitor 100n 160V 34425104 or 344-21104 - 1K100	C6, 19, 20, 22, 23, 25, 27, 41, 42, 45, 51, 52, 53	13
	Capacitor 1μ0	C36	1
K526	Capacitor 10 μF 15V TAG 10/15 or K10E16	C1, 8, 12, 16, 24, 28, 33, 34, 43, 44, 48, 50	12
K723	Capacitor 33 μF 16V 015-15339 or EN12.12 33/355	C49	1
K715	Capacitor 100 μF 25V 016101-120102-100-0101-AF0150	C21, 29, 30, 37, 38, 40	6
K724	Capacitor 220 μF 8V 402/1/50726/020 or 69 F215	C31	1
K721	Capacitor 33 pF ± 10% AD/N470 or 831/N750	C46, C47	2
Q193	Choke 1 mH 58/10/0023/10 or Nytronics Wee	L1, L2	2

(Cont'd......

PARTS LIST FOR BEACON MONITOR RECEIVER P.C.B. Cont'd.......

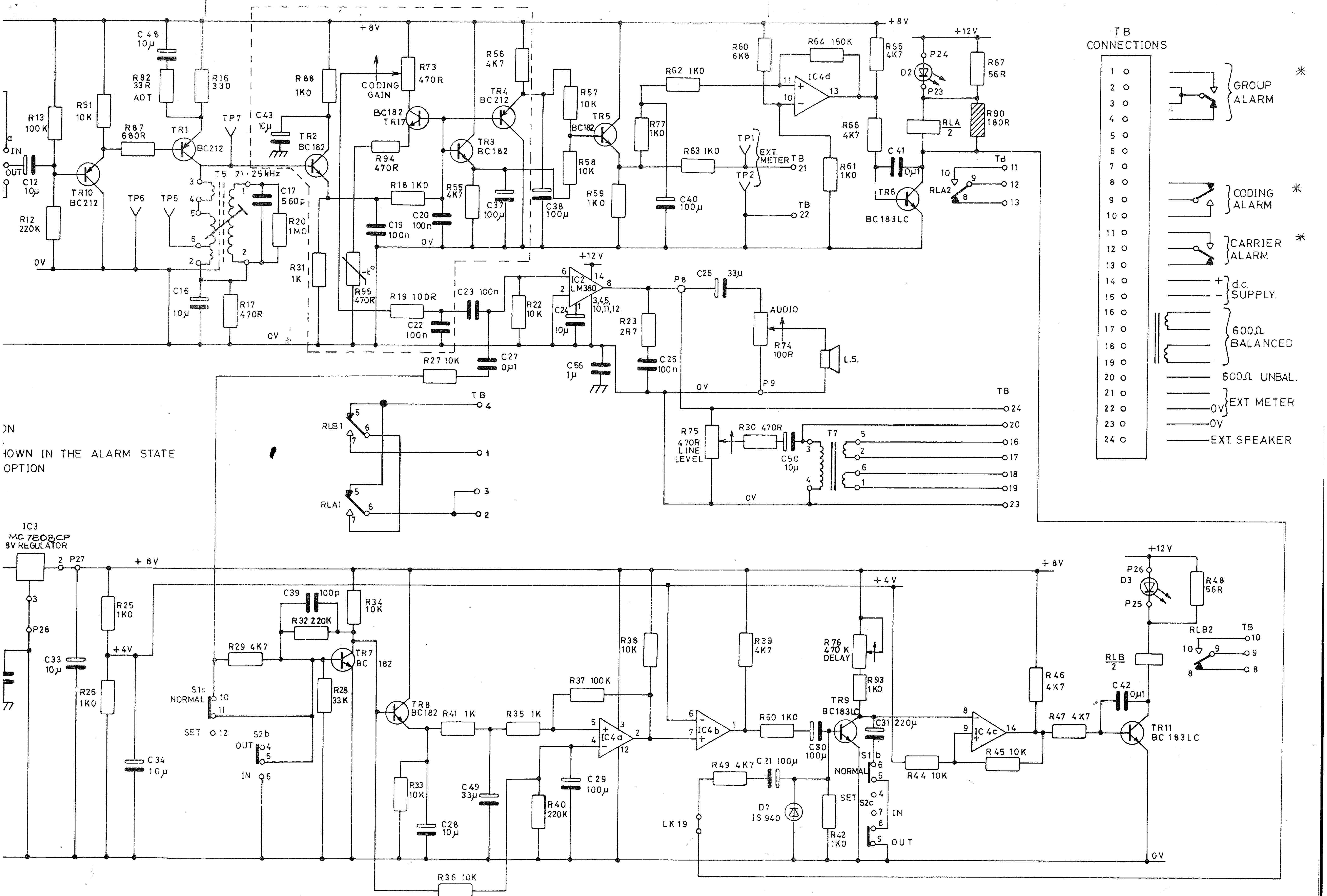
IAL Code No.	Description	Ref. No.	Qty.
V585	Integrated Circuit LM1820 or CA3123E or NE546A	IC1	1
V586	Integrated Circuit LM380N or ULN 2280A	IC2	1
V588	Integrated Circuit LM339 or MC3302P	IC4	1
V578	Diode ISB10A or OSHO1-100	D1	1
V659	Diode IS940	D5, D7	2
V523	Transistor BC182L or BC108 (N.B. Pin connections different)	TR2, 3, 5, 7, 8, 9, 12, 13, 16, 17*	10
V525	Transistor BC212L or BCY71 (N.B. Pin connections different)	TR1, 4, 10, 14 and 15	5
V524	Transistor BC183LC	TR6, 11	2
P520	Transistor Pad		16
P406	Crystal Socket	X1	1
U381	Line Transformer 600 Ω - IA1002/90	T7	1
U382	R.F. Transformer IA8509/26	T1, T2	2
U383	I.F. Transformer IA8509/25	T3, 4, 5	3
P844	Terminal Block P.C. Mounted R447958800012000 or L1795A	TB1, TB2	2
L580	Fuseholder P.C. Mounted F330 or FAS 0313501	F1	1
S519	Switch 4 c/o Alternate Action	S1, S2	2
S526	Push-Button BLACK 400/3	S1, S2	2
S494	Relay 12V 2 c/o T20/20A	RLA, RLB	2
S442	Relay Socket	RLA, RLB	2

* Not fitted to Issue 1 P.C.B.

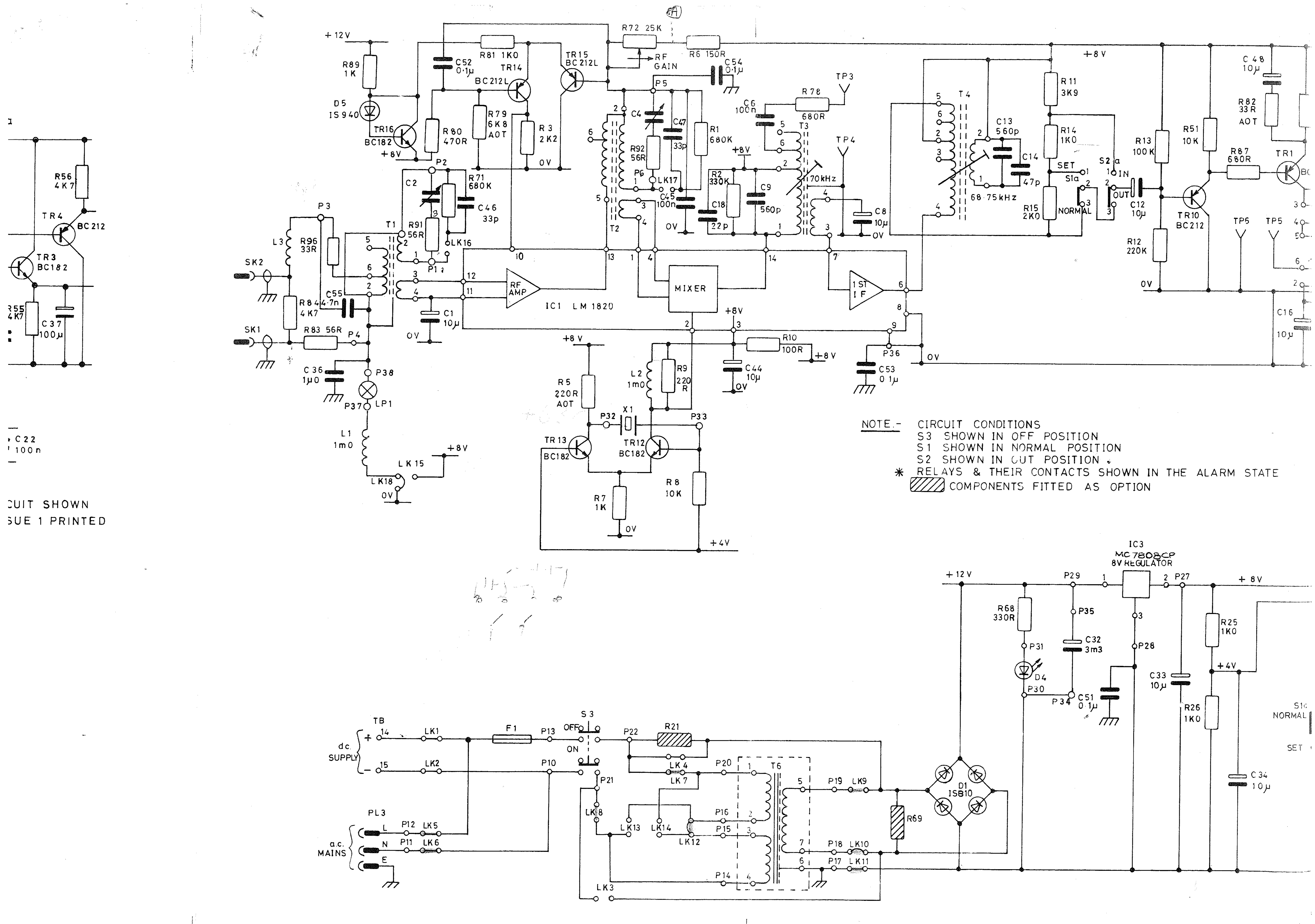
(Cont'd.......

PARTS LIST FOR BEACON MONITOR RECEIVER P.C.B. Cont'd.....

IAL Code No.	Description	Ref. No.	Qty.
P899	P.C. Pins H2101B	P1 to 6, 8 to 31, 34 to 38, TP1, 3, 4, 5, 6 and 7	41
H172	Ceramic Bead	R68	2
O643	Cable Ties	C32	2
L595	Filament Lamp 28V 40 mA	LP1	1
*R1510	Thermistor 470R KR471CW	R95	1
K622	Capacitor 1µ0 100V	C36, 56	2
K739	Capacitor 4n7	C55	1
R1485	Resistor 33 Ω 1/4W	R56	1
P847	P.C. Pins H2101A	P32, 33	2

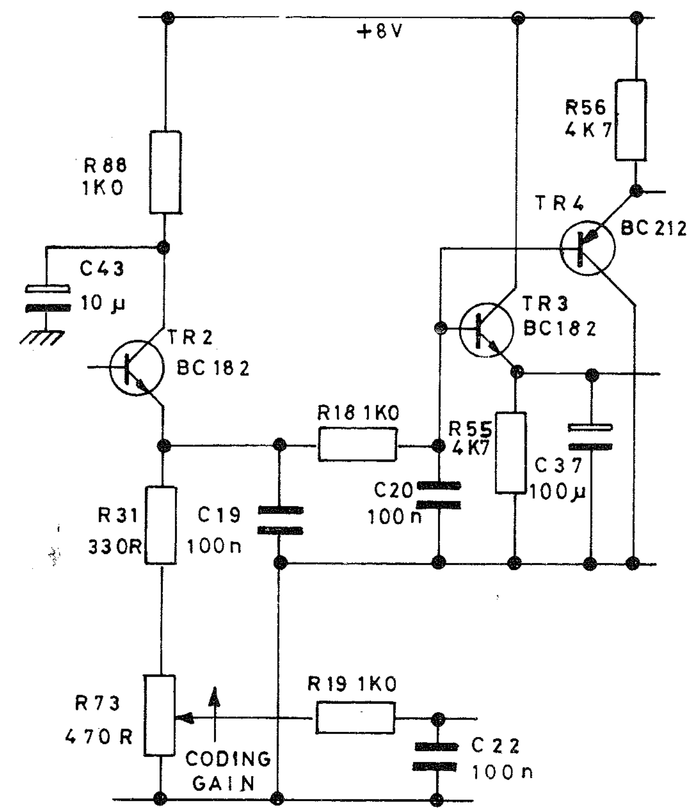


Circuit Beacon Monitor Receiver IA8509 Fig 1

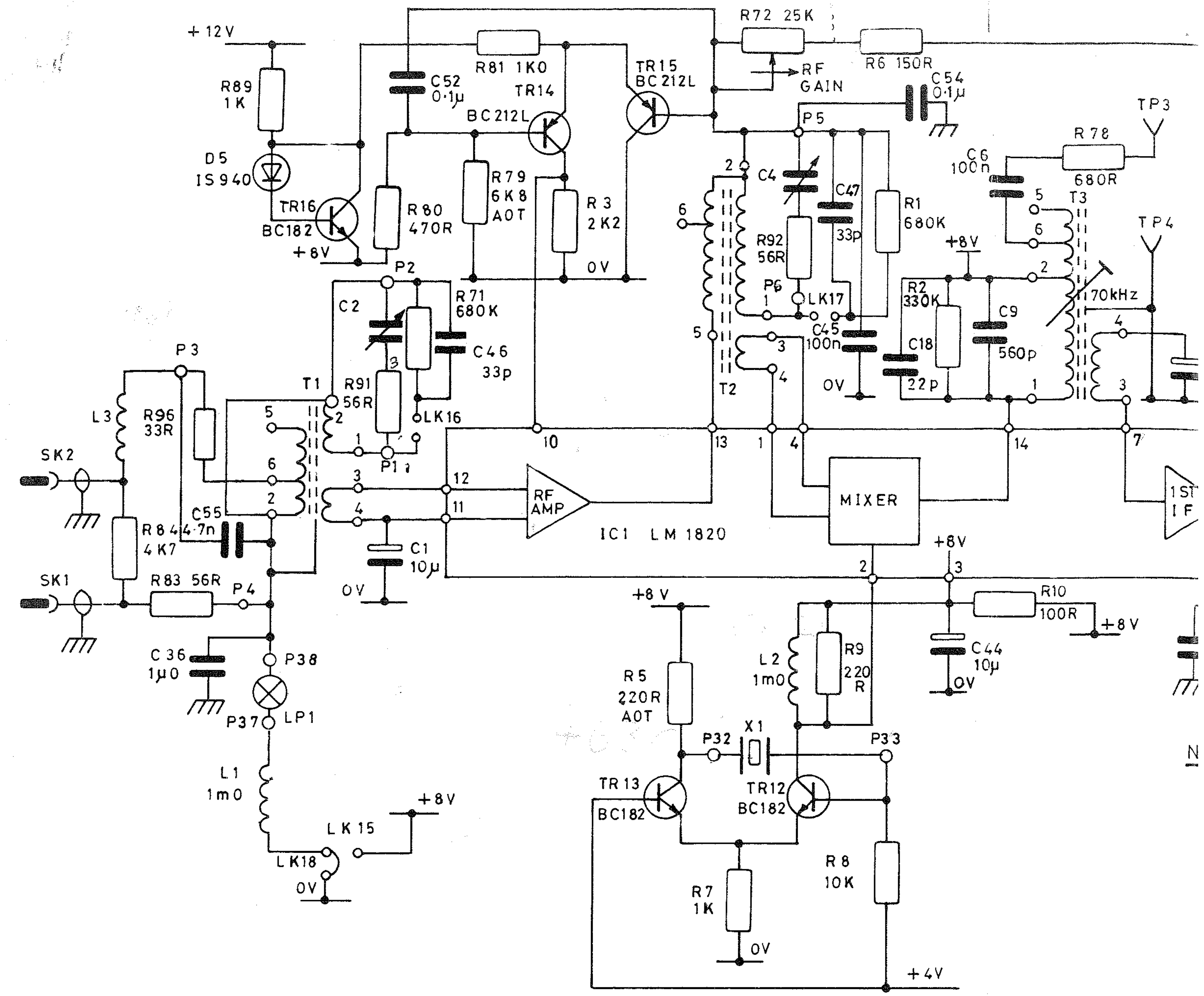


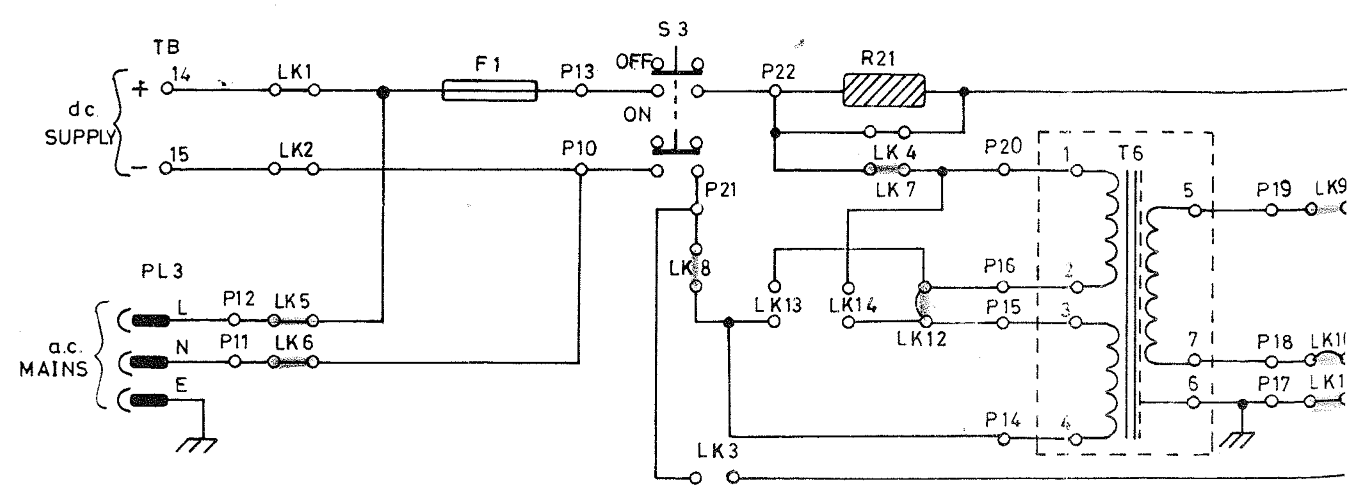
+12V
R89 1K
D5 IS940
TR16 BC182
R80 470R
C52 0·1μ
R81 1K0
TR14 BC212L
R79 6K8 AOT
R3 2K2
TR15 BC212L
R72 25K
RF GAIN
R6 150R
C54 0·1μ
+8V
P5
C4
C47 33p
R1 680K
R92 56R
P6
LK17
C45 100n
T2
C6 100n
R78 680R
TP3
TP4
T3
170kHz
R2 330K
C18 22p
C9 560p
C8 10μ
T4
C13 560p
C14 47p
68·75kHz
R11 3K9
R14 1K0
R15 2K0
SET
NORMAL
S1a
S2a
IN
OUT
C12 10μ
R13 100K
R12 220K
R51 10K
R87 680R
TR10 BC212
TR1
C48 10μ
R82 33R AOT
TP5
C16 10μ
P2
C2
R71 680K
C46 33p
R91 56R
LK16
P1
T1
P3
L3
R96 33R
R84 4K7
C55 4·7n
SK2
SK1
R83 56R
P4
C1 10μ
RF AMP
IC1 LM 1820
MIXER
1ST IF
C36 1μ0
P38
LP1
P37
L1 1m0
LK15
LK18
0V
R10 100R
C44 10μ
C53 0·1μ
P36
R5 220R AOT
L2 1m0
R9 220R
P32
X1
P33
TR13 BC182
TR12 BC182
R7 1K
R8 10K
+4V
R56 4K7
TR4 BC212
TR3 BC182
R55 4K7
C37 100μ
C22 100n
CUIT SHOWN
SUE 1 PRINTED
NOTE.- CIRCUIT CONDITIONS
S3 SHOWN IN OFF POSITION
S1 SHOWN IN NORMAL POSITION
S2 SHOWN IN OUT POSITION
✱ RELAYS & THEIR CONTACTS SHOWN IN THE ALARM STATE
COMPONENTS FITTED AS OPTION
IC3 MC7808CP 8V REGULATOR
P29
P27
R68 330R
P35
C32 3m3
P31
D4
P30
P34
C51 0·1μ
P28
C33 10μ
R25 1K0
R26 1K0
C34 10μ
S1c NORMAL
SET
TB
dc SUPPLY
LK1
F1
P13
S3 OFF ON
P22
R21
LK2
P10
LK4
LK7
P20
T6
P19
LK9
D1 ISB10
R69
P21
LK8
PL3
P12
LK5
P11
LK6
a.c. MAINS
LK13
LK14
P16
P15
LK12
P18
LK10
P17
LK11
P14
LK3

FIG. 1a



THIS CIRCUIT REPLACES CIRCUIT SHOWN WITHIN DOTTED LINE ON ISSUE 1 PRINTED CIRCUIT ONLY.





DRG. IA 8509/3 ISSUE 4 DATE 9-8-76.

INTERNATIONAL AERADIO LTD.
HAYES ROAD,
SOUTHALL MIDDX.