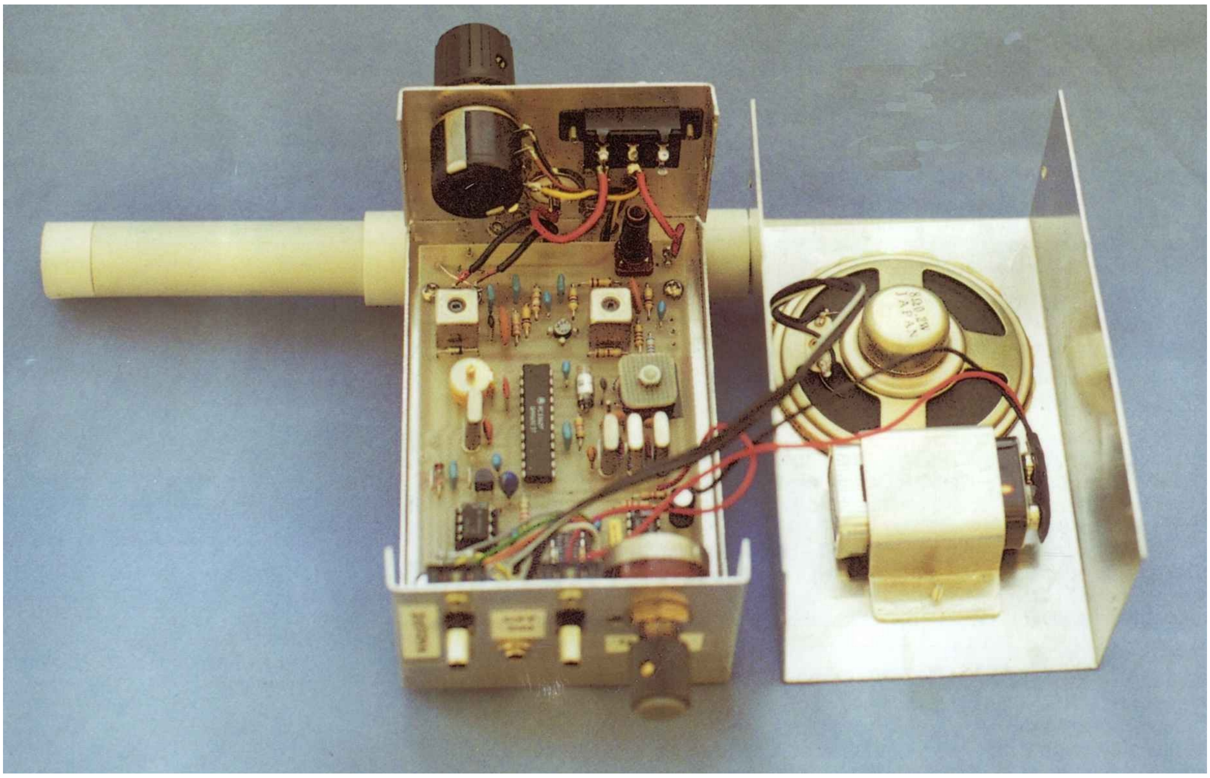
VK3MZ 80M Receiver for ARDF

***Please note:** this is a copy of an article that appeared in Amateur Radio Magazine December 1997 The Picture from the font cover is below while another similar photo has been omitted. The article was scanned and OCR'd so the format varies from the original. Photos and diagrams are copies of the magazine article. The article is only here for reference as there are a large number of these in use in VK3. Some of the major components are no longer available – do not contact the author for boards etc as he no longer has any. Although kits are not available for it, details of an updated version from Bryan VK3YNG can be seen at:*
http://www.foxhunt.com.au/80m_sniffer/80m_sniffer.html



Ian Stirling VK3MZ describes a receiver and directional antenna combination that is suitable for direction finding on the 80 m band.

The receiver is a single conversion SSB receiver and the antenna is of the ferrite rod or "loop-stick" style.

The Melbourne fox-hunting group are very active in vehicle based hidden transmitter events. We are now expanding this interest into pedestrian style events (our partners and families would probably describe it as an obsession rather than an interest!). The pedestrian style fox-hunting is known as ARDF (Amateur Radio Direction Finding) and is very popular throughout the world, particularly in Japan, Korea, China and Germany.

Many of the Melbourne fox-hunting fraternity have been competing in our monthly vehicle based fox—hunts for fifteen or more years and feel like a new challenge. The sudden interest in ARDF was precipitated by an ARDF competition held in Townsville last year. Australia was the host nation for an international ARDF event that spanned five days and attracted competitors from many countries. A group of VK3s went to Townsville and had a fabulous time. The VK3 participants have spread the word south about what a great activity ARDF is. We have since held several ARDF style events which were well attended with up to 14 competitors taking part.

At the conclusion of the Townsville competition the VK4s offered a loan of a set of transmitting gear to the VK3s. This generous offer was quickly accepted by Mark Diggins VK3JMD. Four excellent transmitters built by Ron Graham VK4BRG were transported down to Melbourne and they have helped us get this exciting radio sporting activity off the ground in VK3.

ARDF is conducted under a strict set of international rules. The rules describe the type of transmissions, course length and protocol for competitors. The amateur bands used for ARDF are 2M and 80M. The 2M band is very well established as a fox-hunting band in VK3; however. we are not very experienced at 80 in fox-hunting.

The aim of this article is to stimulate interest and facilitate the construction of 80M sniffers and increase the number of people able to participate in 80M ARDF style events.

The performance of this sniffer with the loopstick antenna in the unidirectional mode is not unlike that of a two metre sniffer with a three element beam. However, when the antenna is switched to the bi-directional mode. very accurate DFs can be taken and this makes 80M a very attractive band for direction finding.

How It Works

The ferrite rod "loop-stick" antenna is switchable from a "figure of eight" pattern (bi-directional) to a cardioid pattern (unidirectional). The loop-stick and vertical sense antenna combination is based on a design in the ARRL handbook. Minor changes have been made to allow easy reproduction with locally available parts.

Refer to the circuit, Fig 1. The receiver has one stage of RF amplification at 3.5 MHz. The signal is then converted up to an intermediate frequency of 8.00 MHz; this takes place within the MC3362. Although intended for FM applications. the Motorola MC3362 IC makes a very effective SSB receiver chip. Only the two mixers, two oscillators and varactor diodes are put to use in this receiver. The IF is selected by a simple crystal filter on the first mixer output. This is followed by a product detector which gives an audio output.

The RF amplifier associated with QI provides a gain of approximately 20dB. The control voltage on gate 2 of Q1 allows this stage to also function as a signal attenuator. which is important when DFing up close to the transmitter.

The 3.5 MHz output from the RF amplifier goes to the first active mixer in the MC3362 and combines with the 4.5 MHZ VFO. Potentiometer RVI tunes the VFO by varying the bias on a pair of varactor diodes within the 3362 IC. The specified VFO tank circuit produces a tuning range of about l00 kHz and I used a ten-turn pot to allow easy tuning of sideband signals. A buffered VFO output is available from the 3362 and this is used in the tune-up procedure.

The 8.00 MHz IF component of the first mixer output is selected by the simple ladder crystal network of XI -X3. Capacitors C21 to C24 set the filter bandwidth to approximately 4 KHz when typical computer crystals are used. A fairly wide IF bandwidth has been chosen to facilitate tuning while on the run.

The 8.00 MHz IF signal passes directly to the second mixer in the MC3362 which works as a product detector and gives an audio output. There is no IF amplification. The RF amplification of QI and the gain of the active mixers in the 3362 provide more than adequate gain for the 80 m band. X4 sets the BFO frequency which, in this application, is tuned to the high side of the IF pass-band to allow reception of LSB signals.

The stage associated with IC2 is a gain variable audio amplifier. The gain is adjustable from about 0 to 20 db. The RF gain of` QI and the audio gain of IC2 are both controlled by RV2. The audio from IC2 may pass directly to the LM386 audio PA, or it can be switched to the "whoopie" VCO.

Diodes D3, D4, and the following RC network, produce a DC signal on pin 9 of IC3 which is proportional to received signal strength. The VCO in IC3 is set to operate in the audio range and produces a "whooping" sound as the antenna is pointed towards or away from the signal being tracked.

The "whoopie" mode is now widely used in ARDF and generally allows a bearing on transmitter location to be more easily discerned than by judging received audio loudness. An '"S meter" could be used. however the operator would need to stop and read the meter, whereas an ear piece, together with "whoopie" mode, can be used while on the run.

Receiver Specifications

Single 9 V battery, current drain 50 mA. Sensitivity better than 0.2 uV. Single conversion 8 MHZ IF. Bandwidth 4 kHz approx. Tuning range l00 KHz approx. Receive modes of LSB and "whoopie" signal strength.

Construction Notes

The circuit board is single sided. and board population and soldering is straight forward. The loop-stick antenna is made by winding 20 turns over the centre of a l0 mm diameter, 200 mm long ferrite rod. The loop-tick is housed in an electrical tee-junction box which as short lengths of conduit protruding from each end.

The antenna tuning capacitor C1 is located in the junction box cavity. The junction box is mounted directly on to the back of the metal housing box, as near as possible to the part of the box which will become the "top".

The sense antenna is a straight piece of brazing rod soldered into a PL-259 plug. An S0-259 socket is mounted on top of the metal box to provide secure but removable connection. The cardioid pattern is achieved by switching the sense antenna "in" and then adjusting RV5 and L5 for a single null. Mount RV5 on the underside of the PCB. Drill holes on the metal box to align with RV5 and L5. This will facilitate easy adjustment of the vertical signal to achieve the cardioid pattern.

Receiver Tune Up

Set RV1 to the mid-position and connect a frequency counter to the VFO monitoring point on the PCB. Note that the VFO frequency is 8.00 MHz; minus the desired 80M frequency (eg to tune 3.850 MHz the VFO must run at 4.150 MHz). Experiment with the values of C18 and C19 until the desired VFO frequency is achieved. For good VFO stability use only silver mica, polystyrene or NPO capacitors for the selected values of C18 and C19.

The tuning range can be reduced by increasing the value of R9. To increase the tuning range. increase the number of turns on L4 and decrease C18. The value of the 10- turn potentiometer is not critical; any value between 10 k and 100 k will be fine. A single turn pot may be used if only a small segment of the 80 m band is required. R9 must be increased accordingly.

Use a signal generator or a strong local signal to tune L2 and L3 for maximum received signal strength. Adjust RV2 for a comfortable listening volume. Switch to "whoopie" mode and adjust RV3 so that the "whoopie" signal is a fairly low frequency purr in the absence of a received signal. When a strong signal is received the "whoopie" tone should rise in pitch considerably.

Antenna Tune Up

This should be done during the day to avoid sky wave effects. Run a low power signal of about 10 W and locate the receiver 0.5 to 1.0 km from the transmitter. Set the system to bidirectional mode by disconnecting the sense antenna with SW3. Peak the loop-stick antenna by adjusting C1 for maximum received signal. Set RV5 and L5 to their mid positions. Connect the vertical antenna with SW3. One of the peaks will now be larger than the other. Orientate the unit so that it is on the weaker peak. Adjustment of RV5 will now reduce this peak even further. Now adjust L5 (the effect of adjusting L5 and RV5 is to create a single null opposite a single broad peak). RV5 and L5 interact and some back and forth adjustment will be required to achieve a single null with the correct orientation.

If the null is off the front of the unit instead of the back. the position of the null may be moved 180 degrees by simply reversing the link connection from the antenna to the receiver input. For further description of the antenna set-up procedure refer to the ARRL Handbook. Look up "Direction Finding" in the index.

Component Supplies

*(Note: this section no longer valid – **do not contact Author**)* Drilled circuit boards. pre-wound TOKO coils for L2. L3 and some of the other hard to get components are available from the author. Write to Ian Stirling VK3MZ, 169 Glenvale Rd, Ringwood North. VIC 3134. Phone 03 9876 3643

Parts List

Metal Box 130 x 75 x 55 mm (Dick Smith Electronics Cat H-2325).

Sense antenna, 360 mm of 2 mm diameter brazing rod, trimmed during adjustment procedure.

LI - 20 turns of 0.7 mm wire wound on ferrite aerial rod 200 mm long, 10 mm dia (DSE Cat R-5105). Spacing of one wire diameter between turns wound over centre of ferrite rod. One and a half coupling turns. Tuned to resonance by C1 shunted with a fixed 27 pF capacitor.

L2, L3 - pre-wound TOKO coils, available from author.

L4 - 55 tums of 0.2 wire on AMIDON toroid T-50-49 (red mix) (Truscott's Electronic World). Secured to PCB with 3 mm nylon screw and nut with 14 x 14 mm bare PCB with a 3 mm hole used as top securing plate.

L5 - double layer of 0.2 mm wire, close wound over 12 mm of Neosid 4.8 mm former (DSE Cat R-5020). FI6 slug (DSE Cat R-5025).

RVI - 20 k I0 turn pot (or single turn pot, see text).

RV2 - 50 k linear pot.

RV3 - carbon trim-pot 50 k horizontal adjust.

RV4 - carbon trim-pot 50 k horizontal adjust.

RV5 - 5 k cermet, vertical adjust.

DI - 3V3 Zener, 400 mW

D2, D3, D4 - OA95 etc.

QI - BF98I etc.

Q2 - 2N38I9

IC1 - MC3362

IC2 - 74I

IC3 - 4046

IC4 - LM386

IC5 - 78L05

X1 , X2, X3, X4 - 8.000 MHz computer crystals.

S1 , S3 - single pole double throw switch.

S2 - double pole, double throw switch.

Resistors are all 0.25 W.

R1 - 220 k

R2 - 100 k

R3 - I k

R4 - 39 k

R5 - I00 k

R6 - I00 R

R7 - Ik5

R8 - I0 k

R9 - 4k7

R10 - I k

R11 - 4k7

R12 - 330R

R13 - 2k7

R14 - 10k

R15 - 10k

R16 - 100k

R17 - 100k

R18 - 330R

R19 - 2M2

R20 - 100k

R21 - 6R8

Capacitors are disk ceramic or mono- block unless otherwise specified.

C1 -5-55 pf Philips

C2 - 33pf

C3 - 10n

C4 - 10n

C5 - 10n

C6 - 10n

C7 - 47 n

C8 - 33pf

C9 - 47n

C10 - 150p

C11 - 68pf

C12 - 5-55 pf Philips

C13 - 100n

C14 - 10 μ tantalum

C15 - 100n

C16 - 100n

C17 - 100n

C18 - 100 pf polystyrene or SM

C19 - 2p2 NPO

C20 - 1 n

C21 - 470p

C22 - 68p

C23 - 68p

C24 - 470p

C25 - 10n

C26 - 100n

C27 - 100n

C28 – 100μ electro 16V

C29 - 10μ electro16V

C30 - 100n

C31 - 100n

C32 - 1 n

C33 - 100n

C34 - 100n

C35 - 47 n

C36 - 100μ electro 16V

C37 - 100μ electro 16V

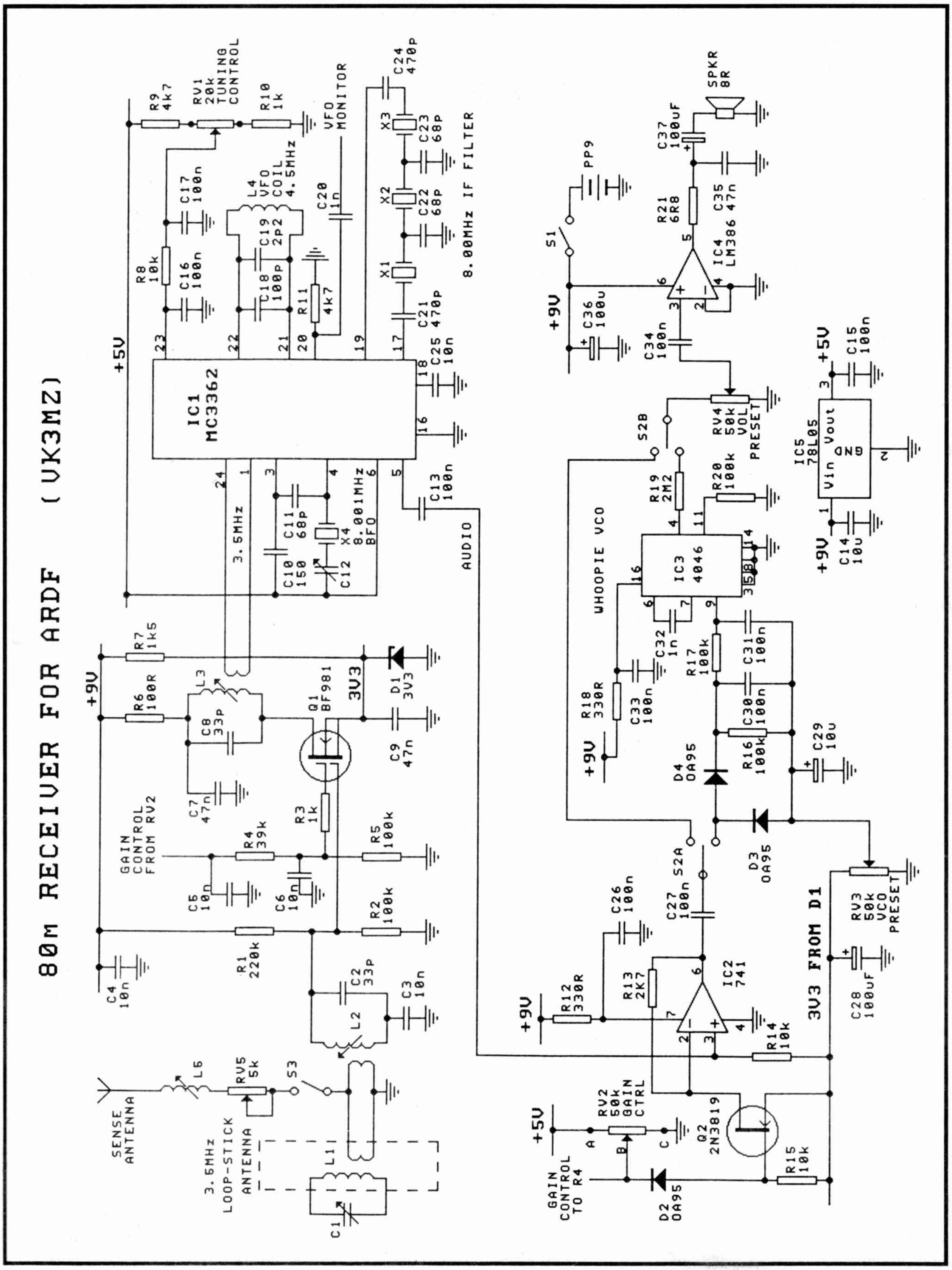


Fig 1 – Schematic of the 80 m ARDF receiver.

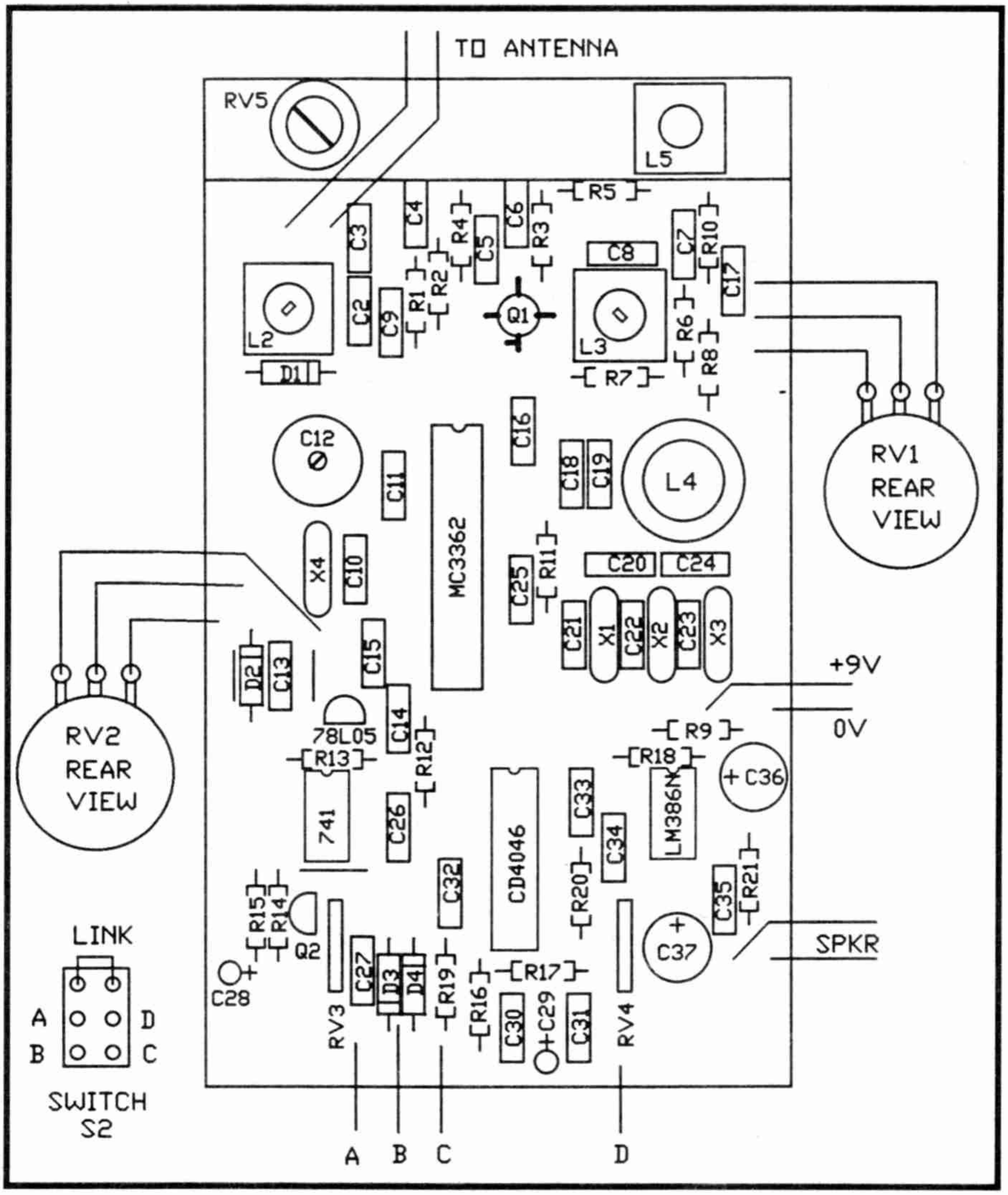


Fig 2 – Circuit board layout of the 80 m ARDF receiver.