Cumbria Designs T-1

High Performance SSB/CW Transceiver Sub-System

User Manual

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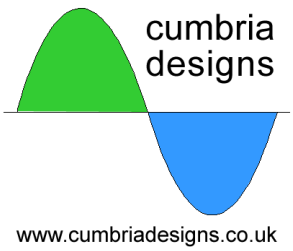

The Steading
Stainton
PENRITH
Cumbria
CA11 0ES
UK

1. Introduction

Thank you for purchasing the Cumbria Designs T1 high performance SSB/CW transceiver sub-system. We hope that you enjoy constructing this kit and find many uses for this feature rich design. This manual describes the assembly and operation of the T1, even if you are a seasoned constructor, we respectfully ask that you first read this manual and familiarise yourself with the instructions and kit contents before commencing construction. If assembled carefully, this unit will provide many years of reliable service.

The Cumbria Designs Team

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2. Preparation

2.1. Unpacking

The T-1 kit represents a reasonably complicated construction project which comprises over 270 parts, some of which are very small and may easily be mislaid. To reduce the risk of loss we suggest the following method of working;

- Keep all parts in a large clean container, preferably a tin with a lid.
- When unpacking the anti static bags check very carefully to ensure that no parts are trapped in the corners of the bags.
- The MMIC amplifiers are packaged in protective plastic strips. Do not unpack a MMIC until you are ready to solder it to the board.
- Resistors and diodes are generally supplied in bands. Cut the component from the band when you are ready to fit it to the board.
- Loose pins are provided for the header connector shells. During transit some of these may become lodged in the connectors. Check and if necessary remove carefully.
- Choose a well lit work area with a light neutral covering (e.g. white paper) to help you spot dropped parts.
- Don't attempt to solder too many parts at once, similarly limit your time spent soldering to a comfortable periods (of say an hour), taking breaks in between.

2.2. Tools

We recommend that the following tools are used during assembly and testing;

25W fine tipped soldering

60/40 Rosin cored solder

5" or smaller diagonal side cutters

Small pointed nosed pliers

Solder sucker (just in case!)

Tweezers (for SMDs)

Multimeter

Oscilloscope (40MHz)

Magnifier

2.3. Conventions

The following symbols are used within the assembly instructions to draw attention to critical steps such as component orientation and anti-static precautions. The associated narrative describes the action required.


Critical Step


Static Sensitive

3. Assembly

The production of a successful finished working kit is dependent upon care during component handling,

placement and good soldering! Don't be tempted to rush the construction, even though this is a relatively simple kit, a wrongly placed component can provide hours of frustrating fault finding. Also, as this kit uses a double sided Printed Circuit Board (PCB) with through plating, removal of a wrongly soldered part can be difficult. Follow the assembly instructions carefully to avoid mistakes.

3.1 *Component Identification*

All parts carry a coded identity to describe their values. It is important to be able to recognise these during assembly. Capacitors have their value printed numerically, e.g. 104 = 100nF, 103 = 10nF etc. Resistors have their values represented by coloured bands – this is a frequent source of confusion!

To simplify component identification, the parts list carries the identities of each component as it appears on the device. For resistors the colour coding is given. This should be referred to during assembly to ensure the right parts are placed in their respective positions on the PCB.

3.2 *Component Leads*

Many of the passive components will require their leads to be formed to align with the holes on the PCB. This mainly applies to the axial parts such as resistors and diodes. Forming component leads is easily done with a pair of pointed nose pliers and using the hole spacing on the PCB as a measure. Alternatively, small formers made from scrap off cuts of Vero board etc make ideal templates that produce consistent results. Some parts, such as the variable resistors, have preformed leads designed for machine assembly. These will require straightening to align with the board layout. Again, a pair of pointed nose pliers should be used to carefully flatten the factory performing to produce straight leads.

3.3 *Soldering*

Before applying solder **check carefully that the component you have placed is in the right position!** This is a through plated double sided board. Whilst some of the pads are very small, the area presented by the through plating is more than adequate to allow good solder flow to form mechanically strong good electrical joints. These can be difficult to undo, please double check!

The majority of problems are likely to be caused by soldering faults. These can sometimes be difficult to find. Here are some basic golden rules that will help you to avoid poor solder joints;

- **Clean Iron**

Make sure your soldering iron tip is in good condition and tinned. A small moistened pad for cleaning tips, regularly used to wipe off excess solder and flux, will ensure that your iron performs well. Remember to tin the iron immediately after each wipe.

- **Clean Leads and Pads**

All of the component leads and PCB pads in this kit are pre-tinned and should not need cleaning before soldering. Please ensure that parts are handled so as to avoid contamination with grease or fingerprints.

- **Soldering**

This is the bit that can trip up even experienced constructors. For the

solder to fuse with the surfaces to be joined it is necessary for them to be hot – but not so hot as to damage the parts! It's a simple as ***1-2-3***;

1. *Place the tip of the iron against the joint, hold it there briefly to bring the metal surfaces up to temperature.*
2. *Apply the solder allowing it to flow smoothly onto the surfaces.*
3. *Remove the iron and inspect the new joint.*

The finished joint should have a smooth shiny coating of solder. If the joint is dull grey or has formed a spherical "blob", apply the iron to the joint, remove the old solder with a solder sucker and re-solder.Mistakes
They do happen! Should you inadvertently solder a part in the wrong position, we recommend that you DO NOT attempt to remove it intact. To prevent damage to the plated through hole PCB through excessive over heating and mechanical strain, the wrongly placed part should be cut off the board leaving it's leads/pins exposed. These can then be removed carefully one by one and the PCB pads de-soldered and prepared for the replacement.

If you have difficulty in sourcing a replacement part, contact us. We hold high volumes of parts for our kits and can offer components at competitive rates.

4 Circuit Description

4.1 *General*

The Cumbria Designs T1 is a high performance sub-system designed to serve as the core of an SSB/CW transceiver for operation from 140 kHz to 400MHz. The T1 main PCB carries all of the IF, AF, DC and signal switching stages of a single conversion SSB/CW transceiver, from mixer to audio connectors. A simplified block diagram of the T1 is shown in fig1.

The design is broad band and features plug in filter modules and carrier crystals to allow easy configuration of IF and bandwidth options to suit the users application. The main filter module accommodates two filters, typically one for SSB and one for CW although if desired both filters could be configured for differing bandwidths of the same mode. A tail end filtering scheme is implemented to clean up the wideband noise.

All signal routing and DC switching controls are extended to a 16 pin interface to provide the greatest flexibility in operation. The controls can be operated by the users sequencing circuit or via the optional Cumbria Designs C-1 processor controlled sequencer module.

4.2 *Receive*

The RF input to the T1 is mixed to the IF frequency by M1, a TUF-3 diode ring mixer. The output of the mixer is routed via PIN diodes through IC1, a high IIP3 MMIC amplifier configured as a bilateral stage. Signal direction is set by the biasing of the PIN diode bridge. The output of the post mixer amplifier is presented on FL2 to the plug in filter module. The signal is routed on the filter module to the selected filter by steering diodes. Impedance matching from 50Ohms to the filter input impedance is performed by toroidal transformers. Each filter can have up to 6 poles (crystals) and parts placement allows for several different filter configurations to be realised. For good performance and repeatability we recommend that the minimum loss Cohn design is used.

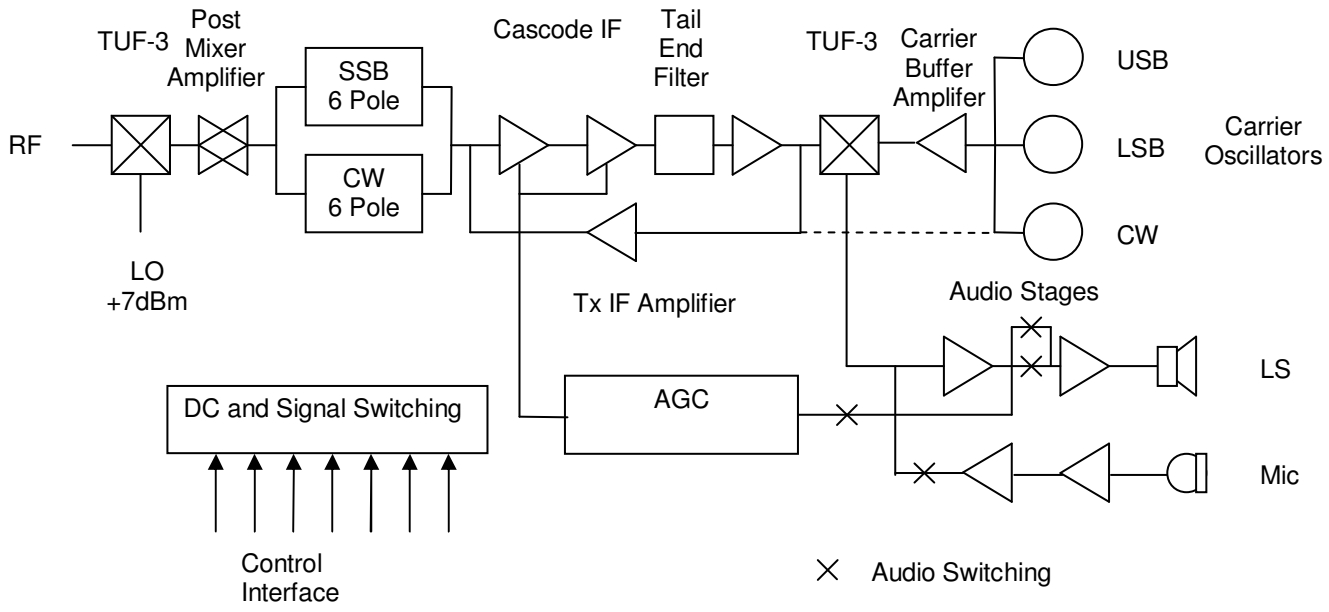


Fig.1 T-1 block diagram

The filter kit supplied with the T1 and its instructions has been produced on this basis.

The output from the crystal filter module is presented via FL1 to the gain controlled IF stages comprising of a two stage, JFET cascode amplifier. This provides a gain of about 50dB and an AGC range in excess of 90dB. The diode chain D11-D16 lifts the source voltages of the IF stage increasing the AGC range. The output from the IF stage is filtered by a two pole crystal filter to remove wideband noise before being amplified by Q8 which provides a fixed gain of about 15dB and matching into the TUF-3 product detector M2.

The IF signal is demodulated to audio by mixing in the product detector with the selected carrier oscillator. Two JFET Colpitts oscillators are used to generate LSB and USB carriers which are amplified by IC2, a MMIC Amplifier to around +7dBm to drive the diode ring mixer. The audio output is taken from the DC port of the TUF-3 and forms a common bus between the receive and transmit audio circuitry. Audio path selection is performed by a quad bi-lateral switch IC5.

The low noise pre-amplifier IC6 raises the audio to a level to drive the audio power amplifier IC7, an LM380N-8, to provide up to 800mW of audio output. The output of the pre-amplifier is presented on PL1, the AF gain pot connector. Additional connector pins allow access to the audio and provide +12v and ground for connection to an external DSP (or other) filter unit.

The AGC system is a high performance, full wave audio derived scheme. This approach was chosen over RF derived AGC to offer repeatable and predictable performance. Once adjusted, it works very well indeed. The AGC is switched on and off by the audio input switch IC3a. An adjustable gain, full wave audio rectifier is formed from two of the quad operational amplifiers, IC8c and IC8b. The demodulated audio is applied to IC8c, a non inverting gain stage that drives one of the detector diodes and provides the input to IC8b, a unity gain inverter that drives the second detector diode in anti-phase.

The combined output from the two diodes is filtered by the AGC time constant circuit to produce the DC AGC voltage which is amplified by IC8a and applied to the level shifter IC8d. VR7 sets the AGC gain and VR6 is adjusted set the quiescent (no signal) AGC voltage. The AGC system generates a decreasing AGC voltage for an increasing audio input. The resulting AGC voltage is applied to the control FET's in the gain controlled AGC stages. Manual IF Gain may be set by a 10K pot connected to the IF_GAIN connector.

4.3 *Transmit (SSB)*

The microphone input is matched and amplified by Q5 before being passed to IC4 a low noise amplifier which provides most of the gain. The transmit audio level is adjusted with VR2, microphone impedance matching is set by the Hi/Lo Z link, (open for medium/high impedance, closed for low impedance).

The transmit audio is routed via the transmit audio switch, IC5D to double balanced mixer M2. During transmit this serves as the balanced modulator. In SSB mode, the audio switches are configured such that only the transmit audio path is enabled. All other audio routes are disabled to prevent audio feedback and over driving of the AGC system. The carrier oscillator input, from the selected oscillator, is modulated by the audio to produce a double sideband output from the modulator. The receive IF amplifier is muted by turning on Q22. This holds the AGC line at ground setting the Rx IF gain to maximum attenuation, preventing RF feedback from the Tx IF path. The 50 Ohm output of the modulator is routed to the main crystal filter module by the transmit IF which comprises of switching diodes D5 and D4, and MMIC amplifier IC1. A facility to apply ALC is provided in the transmit IF path. A power diode D1 is biased to a act as a variable resistor offering about 15dB of gain variation over a 12V control range. The 50 Ohm output of the transmit IF is passed to the filter module where it is transformer matched to the filter impedance. The filter removes the unwanted sideband (determined by carrier oscillator frequency) and the resulting SSB signal at IF frequency is transformer matched to the 50 Ohm IF port of the bilateral post mixer amplifier IC2. Signal direction through this stage is set by the biasing of PIN diodes D2, D3, D8 and D9. On transmit D2 and D9 are 'on' whereas D3 and D8 are 'off'. In this condition, the filter output is amplified by IC2 and passed to the mixer M1. The choice of local oscillator frequency and filtering on the RF port of M1 translate the SSB signal to the desired transmission frequency.

4.4 *Transmit (CW)*

Broadly the transmit operation in CW mode is similar to SSB but there are some important differences in the routing of the audio signal paths. This is to provide sidetone during key down periods.

During CW operation, the audio switches are configured such that the receive audio route is enabled and the input to the audio power amplifier IC7 is taken from the sidetone switch IC5A. The transmit audio and AGC input switches are opened. This configuration allows sidetone, which is produced by M2 (now acting as a product detector), to be output from the loudspeaker.

With the transmit signal paths conditioned for CW, on key down the CW carrier oscillator is powered producing a carrier signal. The carrier signal is routed to the Tx IF path via buffer stage Q2 and diode switch D5. VR1 sets the drive level to the Tx IF, this should be set for minimum unwanted in band products at the front end mixer output. The CW carrier signal branches to both the Tx IF and to the M2. With one of the main carrier oscillators permanently running, M2

demodulates the carrier to produce the audio sidetone signal that is then coupled to the audio stages as described above. The other path via the Tx IF path, amplifies the CW carrier and passes it to the filter module. During CW transmit the narrow filter should be selected to ensure that any intermodulation products generated by the action of the sidetone and carrier are removed. The use of a narrow filter also provides further suppression of the main carrier oscillator. The choice of main carrier oscillator to use in CW mode is up to the user. The CW carrier frequency is adjusted to produce the sidetone frequency desired by the user, 800Hz being typical. As the transmitted CW carrier passes through the narrow filter on transmit, if this is used on receive then a "netted" CW signal will fall within the receiver passband without the need to offset the main tuning.

4.5 *Control Interface and switching*

One of the unique features of the T-1 is the provision on the main board of an interface to allow easy control of DC and signal switching. This allows the user to easily configure the module to suit their application. Each control input drives a 2N7000 FET. These devices are optimised for 5V logic levels and will switch on at about 2V input. The gates are held low with pull down resistors (RN4 and RN5) so that with no control voltage applied a FET is fully off. Taking the control input voltage above 2V turns the FET fully on activating that control. The maximum recommended control voltage is no higher than the nominal 12V supply. This allows the interface to be either driven by logic levels or switched supply voltage signals from relays etc. The choice of control system will depend upon the users application but for the fastest transceive operation a processor based sequencer is recommended.

The audio control inputs deserve special mention. Unlike the power or other signal switching controls these work in an inverse state. With no control voltage the associated audio path is active, with a high control voltage condition the path is disabled.

If the module is powered up without any control signals applied to the interface then all of the audio paths are active with the possibility of feedback between the loudspeaker and microphone if connected.

Should it be desired to use the T-1 module with a bespoke control circuit, a convenient way of converting the 16 interface to a 0.1" pitch linear presentation is to use a Cumbria

PL2 Pin	Function	High or Open	Low (Ground)
1	AGC system Signal Input	AGC OFF	AGC ON
2	Receive DC Control	RX DC ON	RX DC OFF
3	Microphone Audio path	MIC Audio OFF	MIC Audio ON
4	Transmit DC Control	TX DC ON	TX DC OFF
5	Main Receive Audio path	Main RX Audio ON	Main RX Audio OFF
6	Filter A select	Filter A Selected	Filter A de-selected
7	Sidetone Audio path	Sidetone Audio ON	Sidetone Audio OFF
8	Filter B select	Filter B Selected	Filter B de-selected
9	AGC Speed	AGC Fast	AGC Slow
10	CW Carrier	CW Carrier ON	CW Carrier OFF
11	Receive IF Mute	IF Muted	IF Normal Gain
12	LSB Carrier	LSB Carrier ON	LSB Carrier OFF
13	Spare	Spare	
14	USB Carrier	USB Carrier ON	USB Carrier OFF
15	Ground to sequencer		
16	+12V for sequencer		

Table 1 PL2 Functions

Designs LCDA kit. This was originally designed to simplify the connection of LCD's to micro controllers but it is also very well suited as a general adapter to provide conversion from 8x2 to linear 16 way formats. The function of each control interface pin is given in Table 1.

5 Assembly

The order of assembly is not particularly critical, even though this is a relatively complicated circuit it is perhaps easiest to test it in its complete state rather than to attempt to carry our individual stage testing as construction progresses. The key to success is simply to ensure that the right component is placed in each position. As this is a plated through hole board removal of a misplaced part is best done by cutting the part off the board and then carefully removing each residual lead/pin from the PCB. This results in the destruction of the part but overheating and possible damage to the PCB pads is avoided. *Please check very carefully the value and orientation of each part before soldering*. In the words of the carpenter, "Measure twice, cut once!"

The following recommended assembly sequence is based upon part profile and will allow parts to be held in place whilst the board turned over whilst soldering. Unless stated otherwise, all components are mounted on the top (silk screen) side of the board. You are strongly advised to check off each part number as it is installed to keep a track of progress.

PRECAUTIONS

Static sensitive components. Discharge yourself to ground before handling. Avoid wearing static generating clothing (e.g. wool, man made fibres etc) during assembly.

Critical step during installation such as orientation. Read associated note.

5.1 *Monolithic Microwave Integrated Circuits (MMICs)*

Three very small surface mount MMIC amplifiers are employed in the circuit. These devices provide excellent performance with a significant saving in components and complexity. To compensate for the small size of these parts large pads have been provided on the PCB to ease soldering. A magnifier is essential to identify part type and orientation.

Before opening the MMIC packaging you are advised to cover the work area with a large sheet of white paper so that should you drop a device you will be able to find it easily.

The three MMICs are identified as follows;

Device	Function	Device Marking
MAR-2SM	IC1 Tx IF Amplifier	02
MAR-3SM	IC3 Carrier Amplifier	03
ERA-4XSM	IC2 Post Mixer Amplifier	4

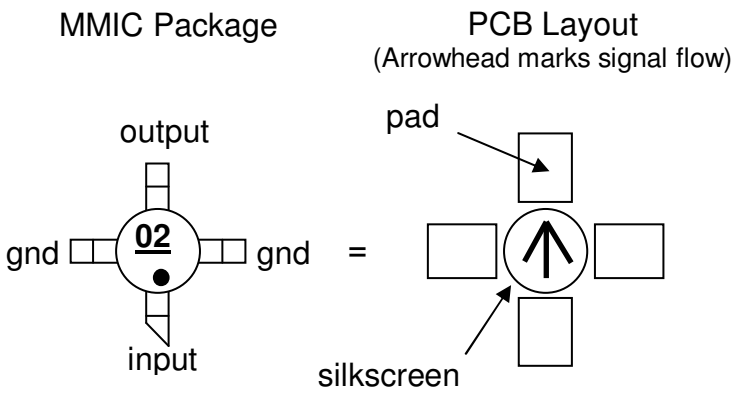


Fig 2 MMIC physical appearance and corresponding PCB layout

Soldering MMICs

With a little care and concentration, the MMIC devices are relatively easy to install;

a) Lightly tin each MMIC PCB pad removing excess with a solder sucker or solder wick.
b) Place the device onto it's mounting pads aligning it so that the leads fall centrally inside the respective pads. Check orientation!
c) Hold the MMIC gently in place with the end of a fine pointed tool such as the blade of a modelling knife and secure one pin by melting pad tinning with a lightly tinned soldering iron.
d) With the MMIC secured by one pin, check alignment adjusting if necessary by apply gentle sideways pressure.
e) Lightly solder each of the unsoldered pads and finally re-solder the first pad to ensure a good connection.

Fit all three MMICs as described above. *If this is the first time you've installed a Surface Mount Device congratulate yourself!*

5.2 *IC Sockets*

Ensure correct orientation! Match index cut out on socket to board printing. Tip; solder one pin only then check positioning before continuing. Heat solder and reposition if necessary.

a) Fit 8 Pin IC sockets in positions; IC4, IC6 and IC7.
b) Fit 14 Pin IC Sockets in positions; IC5 and IC8.

5.3 *Socket Strip*

Turned pin socket strip is used for mounting parts where a plug-in installation is required. Use a sharp scalpel or fine bladed modelling knife to cut the socket strip to length and fit as follows;

a) Crystal Sockets X1, X2 and X3. Cut strip to three lengths of three sockets, cut pin of centre socket and engage remaining two pins in crystal positions.
b) VXO Inductors L1 and L2. Cut strips to two lengths of 5 sockets. Cut off pins inside each strip leaving the end pins in place. Mount each strip in the inductor position.

c) AGC Time Constant resistors, R71,R73 and R77. Cut socket strip to two lengths of three sockets and mount each strip in resistor mounting holes in same axis as IC8.
d) Hi-Lo Z Microphone Impedance Selector. Cut a two socket length and solder in position next to microphone connector. To select low impedance bridge the sockets by inserting a short wire link.

5.4 *Resistor Networks*

It is essential that each type is correctly identified and installed for the correct operation of the control circuitry. Two types of resistor network are provided;

Commoned network identified by a "1" in the part number in the format; *No. of pinsX -1- Value* e.g. 6X-1-103 = 6 pins, common, 10K. Pin 1 marked by a dot is the common, the remaining 5 pins are the other ends of the commoned resistors. Orientation of this type of network is critical.

Isolated network identified by a "2" in the part number in the format; No. of pinsX -2-Value e.g. 10X-2-103 = 10pins, isolated, 10K. Orientation of this type of network is not critical although for aesthetic/maintenance purposes you may wish to adopt a standard orientation.

a) Fit 6 pin common network (6X-1-103) RN6 ensuring pin 1 is aligned to pin 1 on the PCB. (Note due to sourcing difficulties a 5 resistor package is supplied, use the 10K resistor provided to connect the vacant end position to the common.
b) Fit 10 pin isolated networks (10X-2-103) RN1 and RN2.
c) Fit 6 pin isolated network (6X-2-103) RN4
d) Fit 8 pin isolated networks (8X-2-103) RN3 and RN5

5.5 *Resistors*

Install all resistors mounting horizontal or vertical as required by PCB layout. For horizontally mounted resistors bend leads sharply at end of body to 90 degrees and insert into board. Solder and trim off excess leads.

Vertical

2	100R	Brown, Black, Black, Black, (Brown)	R17, R35
1	150R	Brown, Green, Black, Black, (Brown)	R37
2	1K	Brown, Black, Black, Brown, (Brown)	R12, R57
4	10K	Brown, Black, Black, Red, (Brown)	R59, R60, R61, R62
2	100K	Brown, Black, Black, Orange, (Brown)	R11, R38

Horizontal

2	2R7	Red, Mauve, Black, Silver, (Brown)	R47, R58
1	51R	Green, Brown, Black, Gold, (Brown)	R29
12	100R	Brown, Black, Black, Black, (Brown)	R1, R2, R3, R4, R20, R21, R24, R26, R31, R43, R53, R67
2	150R	Brown, Green, Black, Black, (Brown)	R49, R51
4	220R	Red, Red, Black, Black, (Brown)	R6, R18, R25, R45
1	390R	Orange, White, Black, Black, (Brown)	R8
8	560R	Green, Blue, Black, Black, (Brown)	R13, R14, R22, R23, R27, R28, R33, R39
9	1K	Brown, Black, Black, Brown, (Brown)	R7, R9, R19, R30, R34, R41, R42, R63, R75
2	2K2	Red, Red, Black, Brown, (Brown)	R48, R66
1	4K7	Yellow, Mauve, Black, Brown, (Brown)	R68
11	10K	Brown, Black, Black, Red, (Brown)	R5, R50, R54, R55, R64, R65, R70,

			R71*, R72, R76, R78
2	47K	Yellow, Mauve, Black, Red, (Brown)	R40, R56
11	100K	Brown, Black, Black, Orange, (Brown)	R10, R15, R16, R32, R36, R44, R46, R52, R69, R74, R79
1	220K	Red, Red, Black, Orange, (Brown)	R77*
1	4M7	Yellow, Mauve, Black, Yellow, (Brown)	R73*

*Note: R71, R73 and R77 plug into pin sockets to allow user optimisation.

5.6 *Diodes*

All diodes are polarity conscious. The cathode is marked by a band on the diode body, ensure orientation matches the PCB legend.

BAV21 Silicon Signal Diodes (Red glass bodies)

a) Install carrier oscillator steering diodes; D6 and D7.
b) Install IF signal steering diodes; D4, D5 and D10.
c) Install the six IF Bias diodes; D11, D12, D13, D14, D15 and D16.
d) Install AGC circuit diodes; D17, D18 and D19. **Note on V1.0 PCB, the silkscreen component numbering skips D18 to show D18 and D19 as D19 and D20, and D20 (Power Diode) as D21.**

1N4004 Silicon Power Diodes (Black plastic bodies)

a) Install ALC attenuator diode D1.
b) Install Reverse polarity protection diode D20 **(D21)**. Note, this mounts vertically with the cathode (band) towards the PCB.

5082-3081 PIN Diodes (Clear or black glass bodies)

Install the four post mixer amplifier signal steering diodes; D2, D3, D8 and D9.

5.7 *Ceramic Capacitors*

Insert leads into PCB such that the capacitor body is flush with the board surface. Bend the leads outwards slightly to hold the capacitor in place during soldering. Trim off excess leads.

3	33pF	33J	C6, C18, C19
3	120pF	121K	C14, C23, C24
2	1500pF	152	C49, C68
23	10nF	103	C13, C15, C16, C17, C20, C21, C22, C26, C27, C28, C29, C30, C31, C34, C35, C42, C45, C51, C52, C53, C54, C57, C58
28	100nF	104	C1, C2, C3, C4, C5, C7, C8, C9, C10, C11, C12, C25, C32, C33, C36, C39, C40, C41, C44,C47, C56, C59, C62, C63, C64, C69, C70, C73

5.8 *Transistors*

Polarity conscious components. Make sure that orientation is correct.

The J310 and 2N7000 are Static sensitive parts. Insert transistors so as to leave about 3mm of lead between the body and the board. Solder centre lead, check position and solder outside leads, trim off excess leads.

7	2N3906	PNP	Q12, Q13, Q14, Q15, Q16, Q17, Q18
10	J310	J-FETs	Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q10, Q11
13	2N7000	Power FETs	Q9, Q19, Q20, Q21, Q22, Q23, Q24, Q25, Q26,

Q27, Q28, Q29, Q30

5.9 *Variable Resistors*

The pre-formed leads will require to be straightened to fit.

6	10K	103	VR1, VR2, VR3, VR5, VR6, VR7
1	100K	503	VR4

5.10 *Variable Capacitors*

3	60pF	Yellow body	TC1, TC2, TC3

5.11 *Electrolytic Capacitors*

Polarity conscious Capacitors, the short lead marked '–', goes to ground.

10	10uF	C38, C43, C46, C48, C50, C55, C65, C67, C72, C74
4	100uF	C37, C60, C66, C71

5.12 *Polystyrene Capacitor*

1	0.47uF	C61

5.13 *Connectors*

a) Headers. Recommended Header Connector orientation is as marked on the PCB with rear locking tab facing into the centre of the board.

5	2 way headers	ALC, HI/LO-Z, LS, MIC, PWR, S-METER
1	3 way header	IF GAIN
1	6 way header	PL1
1	8x2 header	PL2

b) Pin Strip. Plug in filter connections are made by pin and socket strip. It is recommended that the pin strip part is fitted to the main PCB and the socket part (in filter kit) is fitted to the filter boards. Cut lengths of strip to suit, the broad end of the pin strip is inserted into the main PCB. Solder one pin, check connector sits correctly adjusting if necessary, solder remaining pin(s).

1	2 way pin strip	FL1
2	4 way pin strip	FL2 and FL3

5.14 *DIL Integrated circuits*

Static sensitive parts. Discharge yourself to ground before handling. Avoid wearing static generating clothing (e.g. wool, man made fibres etc) during assembly. Orientation is critical. Observe correct alignment of IC pins which will need to be gently formed for correct alignment before insertion into sockets.

IC pins can be pushed inwards by placing the device on its side on a firm surface, and gently pressing the body down against the pins. When inserting parts take care to check pin alignment.

2	NE5534N	IC4, IC6
1	4066N	IC5
1	LM380N-8	IC7
1	LM324N	IC8

5.15 *Packaged Mixers*

Static sensitive parts. Discharge yourself to ground before handling. Avoid wearing static generating clothing (e.g. wool, man made fibres etc) during assembly.

Fit TUF-3 Mixers in positions M1 and M2 taking care to observe marked orientation. The pin clearance may be tight, if this is the case gently work the device into position.

5.16 *Transformers*

Almost there! To provide increased gain at lower IF operating frequencies, T1 has been replaced by an axial 47uH choke; Yellow, Mauve, Black, (Gold) . Wind the three IF inductors (T2 –T4) onto FT34-43 cores as described in the table below. Trim the ends to fit the board. Before insertion, scrape the enamel away from the wire end and tin with a hot iron. Holding the iron on the exposed copper and applying solder will remove more enamel and tin the wire at the same time.

Inductor	Primary	Secondary	Orientation
T1	47uH	Use axial inductor	
T2	15 turns	5 turns	Secondary facing Q6
T3	16 turns	4 turns	Secondary facing M2
T4	3 turn	20 turns	Primary facing C29

Be sure to fit transformers with windings orientated correctly!

5.17 *Axial Inductors*

The three remaining 47uH axial chokes Yellow, Mauve, Black, (Gold) are installed as follows;

L3 Mount vertically next to M2
L1 and L2 Mount horizontally by trimming leads and plugging into socket strip.

5.18 *Connector Assemblies*

Connector shells and pins are supplied to allow connection of power, audio and controls to the T-1. The use of good quality, colour coded, heat resistant, multi stranded wire is recommended. To avoid accidents, a colour code convention should be chosen to represent function, e.g. Red +ve supply, Black ground, striped colours controls etc. Each connector assembly comprise of two component parts; the shell and the pins. To terminate a conductor first strip back about 2mm of insulation and tin the exposed wire. Place the tinned end of the wire into a pin such that the tinned wire sits inside the inner pair of tabs and the insulation sits within the outer tabs. With small pointed nose pliers carefully compress the outer tabs onto the insulation to hold the wire.

Repeat this with the inner tabs to grip the exposed conductor. Very carefully solder the exposed conductor in place taking care not to allow solder to flow onto the locking tab. Finally, insert the pin into the shell with the small locking tab orientated to the face of the shell with the small cut outs. Push home until the locking tab snaps into the cut out. Should you need to remove a pin, gently press the locking tab in with a small screwdriver or the end of some pointed nose pliers. The pin will be released and can be pulled out of the shell.

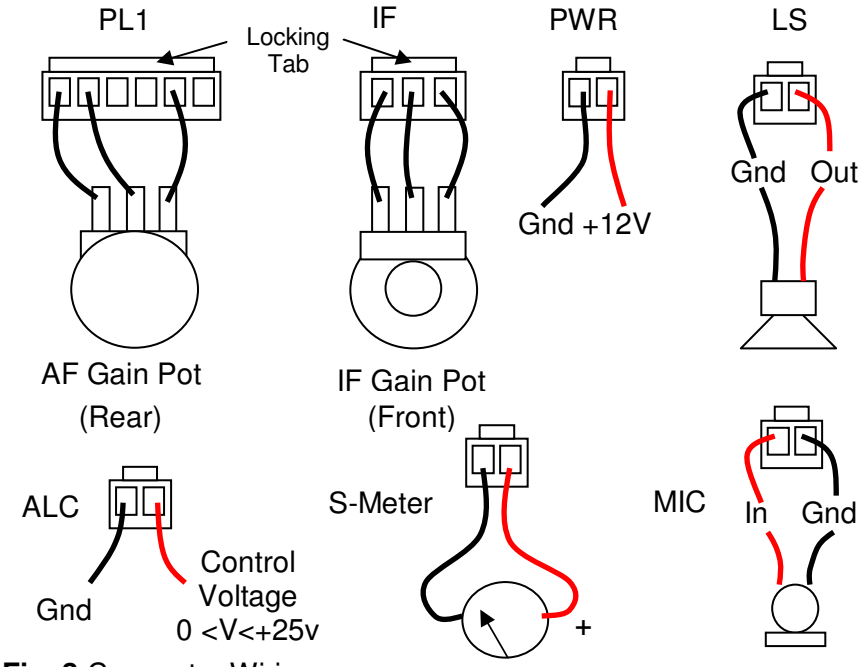


Fig. 3 Connector Wiring

Assembly complete, well done! Now carefully check your work for dry joints and bridges before moving on to testing.

6 TESTING

The testing sequence assumes that the filters and carrier crystals have been have been installed.

6.1 *DC Tests*

Before connecting the T-1 to your power supply for the first time, carry out these simple checks – just to be safe!

Using a multi-meter check for short circuits on the DC input and each of the switched supply rails downstream of the 2N3906 DC switching transistors. Depending upon the specification of you meter resistances in the order of 100 Ohms upwards should be seen. If you find less than this check the tracks for solder bridges or misplaced parts.

6.2 Power Up

With no control signals applied to PL2 all of the audio paths are active. **This means that if a microphone and speaker are connected "howl round" will occur.** The control states for typical LSB operation are shown in table 2 below. These may be adapted and used to control the T-1 in a simple Tx/Rx switching scheme. For fast break in operation the controls will require to be sequenced to reduce audio disturbances during transitions. The settings assume the following configuration; LSB Operation, Dual Filters fitted (A and B), Filter A SSB, Filter B CW, Fast AGC enabled

With the controls shown the T-1 will draw about 200mA from a 12V supply. A 1A supply fuse is recommended to protect the T-1. This will blow on reverse polarity or if a major short circuit occurs.

6.3 *Receive Set Up*

With 12V applied check that the current is in the region of 200mA. Disable the AGC input by taking pin 1 of PL2 high and advance the AF gain until a faint hiss is heard. With no IF Gain pot attached, adjust the AGC bias pot VR6 for maximum IF noise, this will be at an AGC voltage of about 8V. If no noise is heard, check that the carrier oscillator is functioning and that the right DC conditions have been applied to the control connector PL2.

Connect a +7dBm local oscillator source set to the desired receive frequency+/- IF frequency to the LO SMB connector. Connect and antenna or signal source and adjust the carrier oscillator by listening to the unwanted sideband suppression level. Change over sideband oscillators by grounding pin 12 and raising pin 14. Adjust USB carrier for good suppression and a similar passband sound to that of LSB operation.

Enable the AGC by grounding pin 1 of PL2 and set AGC gain by adjusting VR7. Note that too much gain may cause the AGC to "overshoot" indicated by a characteristic "pumping" of audio level. A smooth AGC operation across a wide range of receive signal levels should be obtained.

PL2 Pin	Function	Receive	Transmit SSB	Transmit CW
1	AGC system Signal Input	0	1	1
2	Receive DC Control	1	0	0
3	Microphone Audio path	1	0	1
4	Transmit DC Control	0	1	1
5	Main Receive Audio path	0	1	0
6	Filter A select	1	1	0
7	Sidetone Audio path	1	1	0
8	Filter B select	0	0	1
9	AGC Speed	1	1	1
10	CW Carrier (Keyed)	0	0	1
11	Receive IF Mute	0	1	1
12	LSB Carrier	1	1	0
13	Spare	0	0	0
14	USB Carrier	0	0	1

Table 2 PL2 Control States

Raising pin 11 of PL2 should mute the receiver. Grounding pin 9 should switch the AGC to slow. Note that without the "Hang" control provided by the T-1 Controller, the slow AGC setting may be too slow for most purposes. This can be changed by reducing the value of R73 to 1M.

6.4 *SSB Transmit Set Up*

Power off the T-1 and reconfigure the control inputs for transmit SSB operation. Connect a microphone setting the Hi/Lo Z impedance link to suit. Power on the T-1, with a receiver loosely coupled to the RF port of the T-1 it should now be possible to monitor the SSB output. The microphone gain is set by VR2. An oscilloscope (of suitable bandwidth) connected to the RF port should show a peak to peak output of approximately 150mV.

6.5 *CW Transmit Set Up*

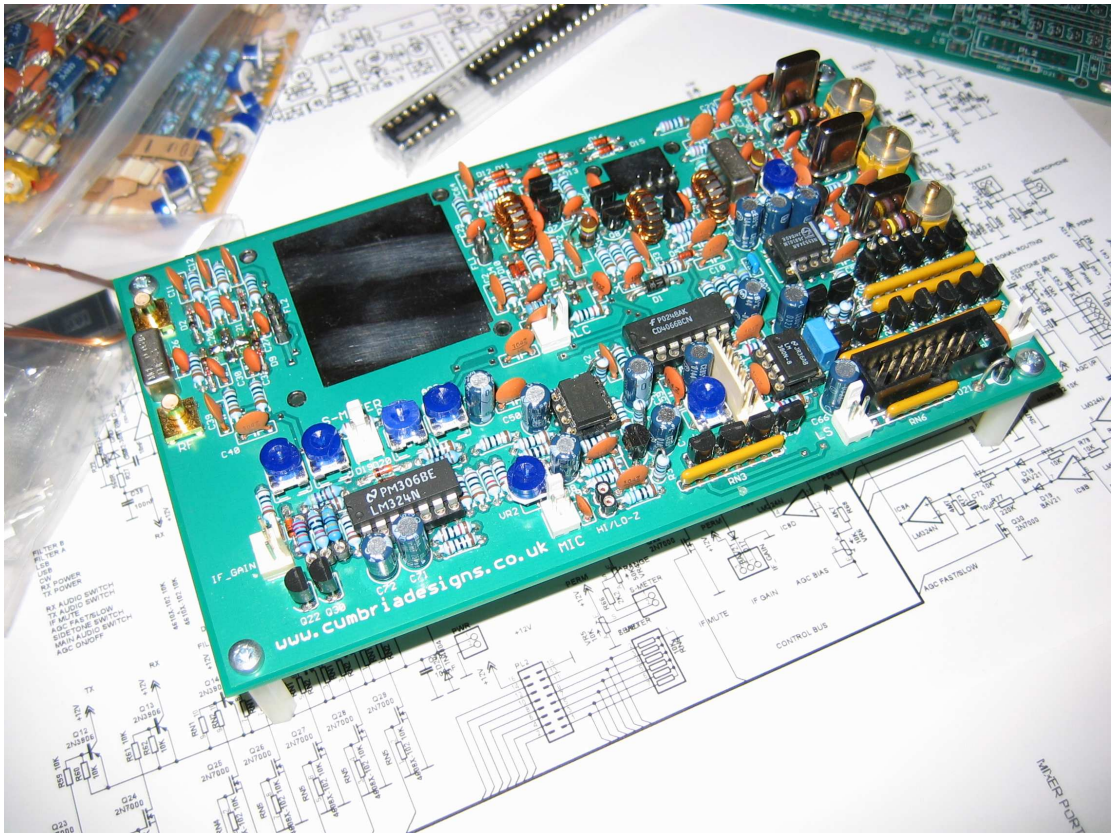
During CW it is recommended that a narrow filter is selected to reduce further low level bleed through of the sidetone signal. If the T-1 filter dual unit is used set the controls to select Filter B during transmit or during both transmit and receive. The CW filter on the T-1 filter board will favour operation with the USB carrier oscillator.

In transmit, with the narrow filter and USB selected, raise the CW Carrier control pin 10. This turns on the CW carrier oscillator. An audio sidetone signal will be heard from the loudspeaker. The sidetone level is adjusted by VR3. With the RF port connected to an oscilloscope, adjust the carrier level VR1 until no increase in amplitude is seen. At this level the output will contain low level intermodulation products, (especially if you are using the SSB filter in CW mode) back off the carrier level (VR1) until the amplitude just starts to fall. Any distortion products will now be reduced to an acceptable level. The RF output can be monitored on a loosely coupled receiver with a narrow filter (or better still a spectrum analyser if you have one!) to confirm the signal is clean. Re-adjust the sidetone level if necessary.

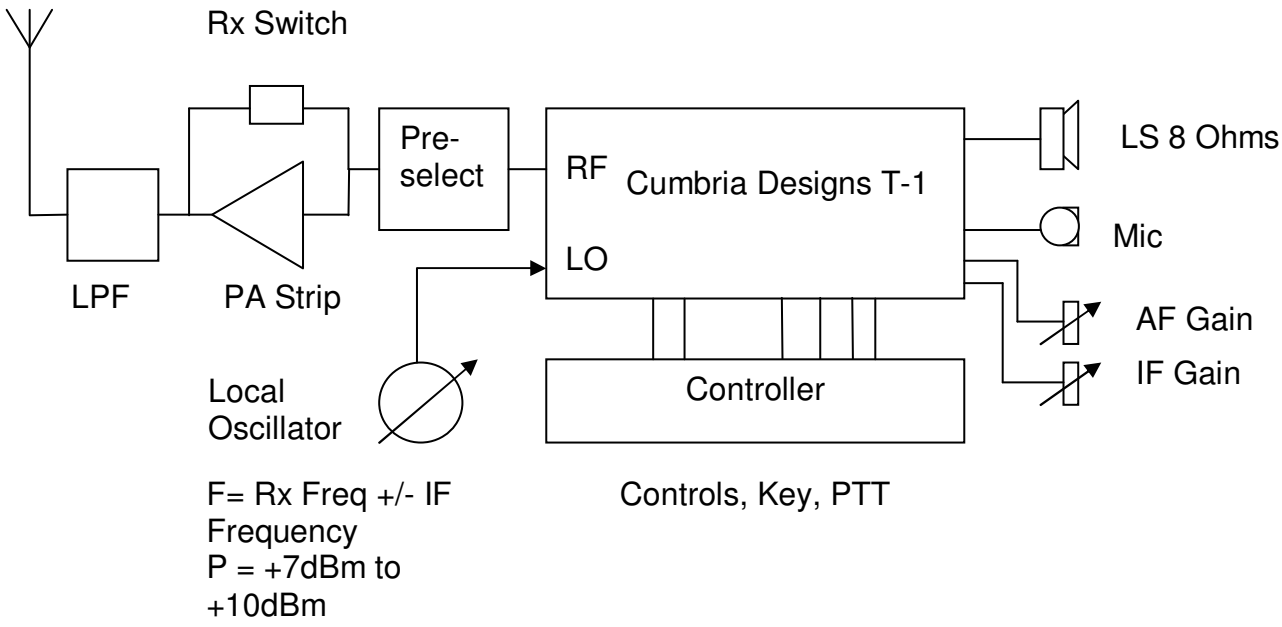
6.6 *Need Help?*

Hit a problem that you can't resolve? Don't worry, we're here to help! Contact us by letter or email at support@cumbriadesigns.co.uk for support.

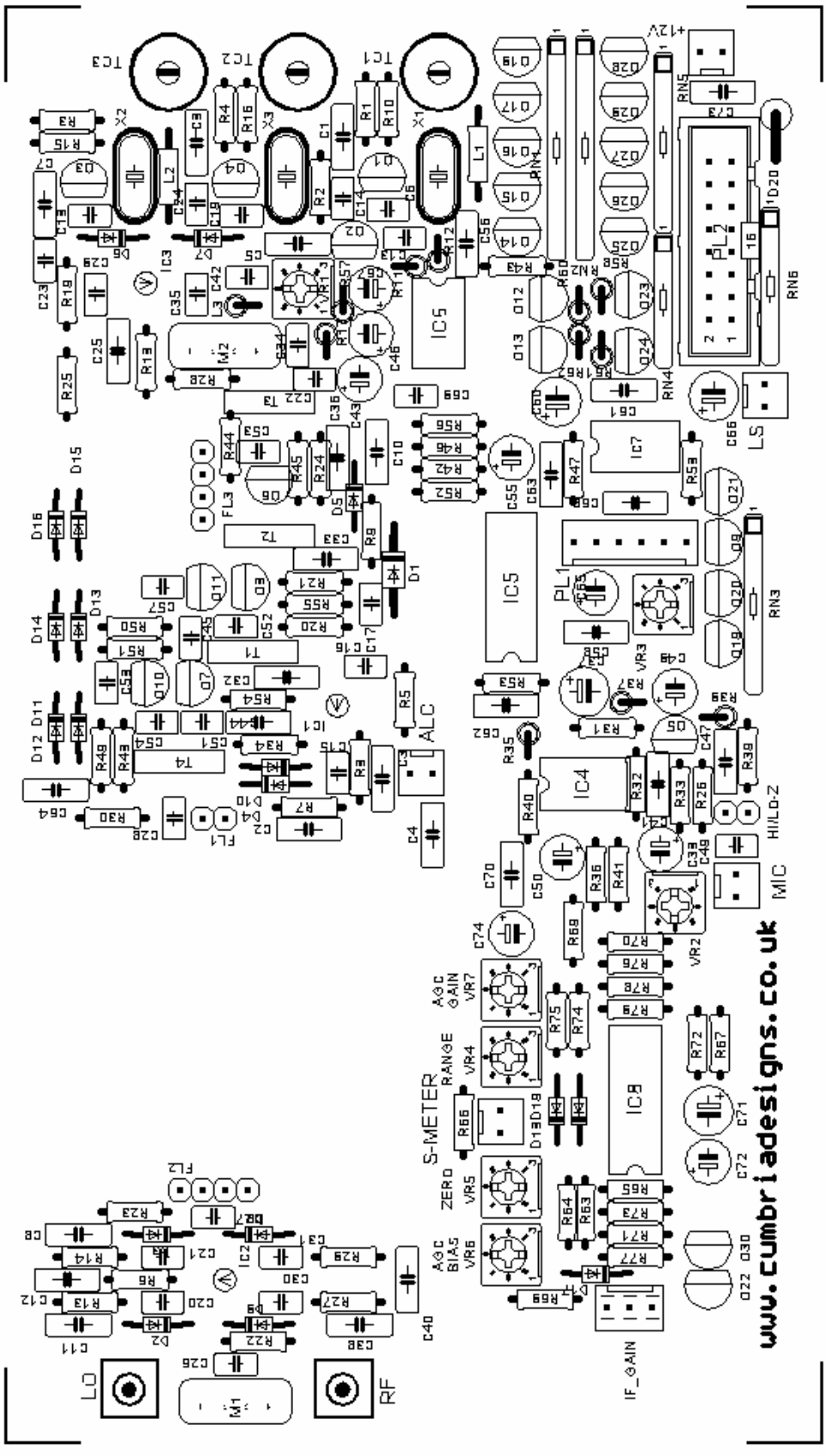
The Assembled T-1 with Filter Kit



Typical T-1 Application



Appendix A **T-1 Component Overlay**



Appendix B T-1 PCB VERSION 1.0 PARTS LIST

2	SMB	LO, RF
1	ML16	PL2
5	HEADER 2 WAY	ALC, LS, MIC, PWR, S-METER
5	SHELL 2 WAY	
1	HEADER 3 WAY	IF_GAIN
1	SHELL 3 WAY	
1	HEADER 6 WAY	PL1
1	SHELL 6 WAY	
20	CONNECTOR PINS	
1	PIN SOCKET 16 WAY	
ENAMELED COPPER WIRE		
T-1 PCB		

2	2R7	R47, R58
1	51R	R29
14	100R	R1, R2, R3, R4, R17, R20, R21, R24, R26, R31, R35, R43, R53, R67
3	150R	R37, R49, R51
4	220R	R6, R18, R25, R45
1	390R	R8
8	560R	R13, R14, R22, R23, R27, R28, R33, R39
11	1K	R7, R9, R12, R19, R30, R34, R41, R42, R57, R63, R75
2	2K2	R48, R66
1	4K7	R68
15	10K	R5, R50, R54, R55, R59, R60, R61, R62, R64, R65, R70, R71, R72, R76, R78
2	47K	R40, R56,
13	100K	R10, R11, R15, R16, R32, R36, R38, R44, R46, R52, R69, R74, R79
1	220K	R77
1	4M7	R73

1	10K	6X-1-103	RN6
1	10K	6X-2-103	RN4
2	10K	8X-2-103	RN3, RN5
2	10K	10X-2-103	RN1, RN2

6	10K TRIMPOT	VR1, VR2, VR3, VR5, VR6, VR7
1	100K TRIMPOT	VR4

3	33PpF	C6, C18, C19
3	120Pf	C14, C23, C24
2	1500pF	C49, C68
23	10nF CERAMIC	C13, C15, C16, C17, C20, C21, C22, C26, C27, C28,C29, C30, C31, C34, C35, C42, C45, C51, C52,C53, C54, C57, C58
28	100nF CERAMIC	C1, C2, C3, C4, C5, C7, C8, C9, C10, C11, C12, C25,C32, C33, C36, C39, C40, C41, C44, C47, C56, C59, C62, C63, C64, C69, C70, C73
1	0.47uF Poly	C61
10	10uF ELEC	C38, C43, C46, C48, C50, C55, C65, C67, C72,C74
4	100uF	C37, C60, C66, C71
3	60pF TRIMMER	TC1, TC2, TC3

3	FT34-43 CORES	T2, T3, T4
4	47uH	T1, L1, L2, L3 (Design change, T1 now axial inductor)

1	1N4004	D1
1	1N4004	D20 (Note on PCB 1.0, D20 is shown as D21)
4	5082-3081	D2, D3, D8, D9

14	BAV21	D4, D5, D6, D7, D10, D11, D12, D13, D14, D15, D16,D17, D18, D19 (Note on PCB 1.0, D18 and D19 are shown as D19 and D20)
7	2N3906	Q12, Q13, Q14, Q15, Q16, Q17, Q18
10	J310	Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q10, Q11
13	2N7000	Q9, Q19, Q20, Q21, Q22, Q23, Q24, Q25, Q26, Q27,Q28, Q29, Q30
1	MAR2-SM	IC1
1	ERA-4XSM	IC2
1	MAR-3SM	IC3
1	4066N	IC5
1	LM324N	IC8
1	LM380N-8	IC7
2	NE5534N	IC4, IC6
2	TUF-3 MIXERS	M1, M2

Additional Parts Required for operation

AF Gain	10K Log	With switch for transceiver power on/off
IF Gain	10K Lin	With optional switch for AGC on/off
Speaker	8 Ohm	2W

Microphone Low or High Impedance, strap impedance link to suit
SMB Plugs For Local Oscillator/RF connections
Filters and Carrier Crystals