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36 mA w/o PLG board
76 mA with " "
160 mA with fan

The Sutton Receiver

Introduction

This rig is a direct conversion multi-band receiver; in its simplest form, it is for 80m only but when fitted with optional plug in cards, it can do any of the other traditional harmonically related bands. It has double tuned RF filters and switch selectable audio filters for phone and CW. The VFO uses two ceramic resonators for ease of setting up; they will normally cover the bottom 200 KHz of 80m. The LO signal (for the other bands) is achieved by mixing the 80m VFO signal with special crystals for each band – hence they also have 200 KHz coverage, generally upwards from the bottom band edge. There are two alternative matching transmitters; a) the Mallet 1.5 Watt CW transmitter which it is anticipated will also be suitable for phone amplitude modulation (using the Audio Amplifier kit and a modulation transformer), and b) the Montis 1.5 Watt double sideband suppressed carrier phone transmitter. Both transmitters automatically work on whatever band is selected for the receiver, using either their own 80m low pass filter, or the TX low pass filter on the band card. Either transmitter can also drive the 10W Linear amplifier. There are also several other optional extra kits.

The main PCB is 100 mm square and is supplied with a small drilled PCB front panel. The kit includes all parts to make it open style as shown in the photographs but you can easily box it if you prefer. Please read through these instructions thoroughly before starting construction. The parts are numbered:-

Sutton receiver parts from 100
Receiver band card parts from 150
Mallet CW transmitter parts from 200
Transmitter band card parts from 250
Montis transmitter parts from 300

Technical Description

The Block Diagram is shown in Fig 1. The basic 80m receiver is in the middle and lower part of the diagram, the upper section is for the extra LO mixing parts required for the optional plug in band cards shown on the left. The full circuit diagram is shown in Fig 3.

Supply aspects: The supply voltage can be in the range 8.5 to 22 volts. A power diode is included to provide reversed supply protection. An 8 volt low drop out regulator IC101 provides a stable supply for the mixers, oscillator and Fine tuning controls.

Audio stages The audio output stage IC104 uses a LM380-8 which can drive a LS or phones. It has a voltage gain of 50. It is fed by the AFG pot RV101, with provision for muting by any associated transmitter, and the ability to accept sidetone from a CW transmitter. Depending on the filter switch S103, the AFG pot is fed either direct from the audio pre-amp IC103B, that has a voltage gain of 100 and a 3 KHz bandwidth for phone (and CW), or from the following CW filter IC103B, which is a unity gain third order 750 Hz low pass filter. Both sections of IC103 derive their DC bias from the product detector output on pin 5 of IC102. Because this is a direct conversion RX, it is the audio bandwidths selected by S103 that defines the selectivity of the RX.

Product detector The relay contacts RL100/A select either the 80m VFO signal for the local oscillator input to the product detector IC102 (an SA602/612 chip), or that from the output of the LO bandpass filter on the band card. The other set of relay contacts switches the antenna input from the 80m RF bandpass filter (which is on the main PCB) over to the RF filter on the band card. Both these RF BPFs are permanently connected to the balanced inputs of the product detector chip; this allows the second resonator of the band/filter *not* in use to effectively ground that input so providing maximum gain for wanted band. Thus, when the rig is used on 80m, either any band card should be plugged in; or if you don't have any band cards, then pin 5 of the band card should be shorted to 0 volts. The RF bandpass filters are double tuned to reduce the chances of BCI. The inputs to the product detector chip are tapped down the coils to maintain high Q and a good match to the chip's input impedance. C127, with the output impedance of IC102, provides the first section of audio filtering for the rig. A buffered output of the LO signal is available on point C for driving any associated transmitter and or a frequency counter.

Variable Frequency oscillator A separate oscillator is provided so that it can drive either the LO mixer chip IC100 or the product detector. TR101 is a Pierce oscillator with S101 selecting one of the two ceramic resonators whose nominal frequencies are near the bottom of 80m. By altering the capacity 'across' the resonator (principally C106 and CV100), each can be tuned down about 100 KHz from their nominal value. S100 divides the 100 KHz of each into two segments using the second section of the PolyVaricon tuning capacity and the trimmer CT100 - so as to ease the tuning rate on the variable tuning capacitor CV100. The capacitance across the resonator is also varied with the varactor diode D101 under the influence of the Fine tuning control RV100; this is arranged to provide a few KHz of tuning either side of that set by the main Tuning control CV100. When used with a CW transmitter, the Fine control becomes an RIT control setting the optimum beat note for either sideband and is switched off automatically during transmission by a short across RV100.

Non 80m bands For all other bands, the normal 80m LO is mixed with a crystal suited to each band to provide the necessary LO – which is of course the actual frequency of that band. These parts are included with the 80m RX kit but do not have to be fitted for 80m only operation. For all bands above 80m the crystal frequency is added to the 80m VFO, but for 160m, they are subtracted to avoid a special expensive low frequency crystal. The LO mixer, which uses another SA602/612 chip, has to be followed by a bandpass filter to ensure the correct mixer product is selected. Because the output from the LO mixer IC100 is fairly high impedance a buffer stage TR100 is used to match to the low Z input of the LO BPF. In principle this scheme can work on any band, but only the traditional harmonically related bands are offered as standard to avoid very expensive special crystals.

Band cards These are 50 x 80mm single sided cards that plug into the rear of the main PCB using a robust 10 way connector. There are 7 signal lines and three for 0 volts. The band card carries a crystal, double tuned LO filter and a double tuned RF filter – both filters use two TOKO cans each. In addition, the band card has a 50 R transmitter low pass filter. This arrangement allows the Sutton, with or without a band card, to work with either of the nominal 1.5 W transmitters, on whatever band the RX is equipped for. The transmitter filter parts are supplied with the RX parts of the band card. A single set of parts (excepting the crystal) is supplied for the 20 and 40m band card kits – the band card design permits the tuning capacitors to be connected in parallel for 40m or in series for 20m; hence there are connection pads and holes for both options – take care!

A single band card track layout is used with three different TOKO coils for the receiver filters, some of which have tapped main resonator windings. The early Issue 1A band card had an error that did not matter for all bands except from 160m owing to the differences between the TOKO coils; hence 160m requires the issue 2 band card, all other bands can use issue 1A or 2 cards.

General Construction Advice

Not all of the points below maybe applicable to your particular kit but in general you should sort the parts into different types and check against the parts list to make sure all are present and can be identified. If some parts come in a separate band bag do not mix them with the rest! The electrolytic capacitors supplied may have a higher voltage rating than stated in the parts list - this is quite in order - their polarity is indicated by the minus sign on one side of their body. If necessary, use a magnifying glass to read the value of small ceramic plate capacitors or, if possible, measure them. The number printed on capacitors is the value and does not indicate the temperature characteristics. Comparing the actual number of each size with the parts list can also help. The smaller the capacitance value, the smaller will be the physical size - examine them very carefully because small changes in size will help identify them. If there is any doubt about the colour code of resistors, check their value with a meter. When resistors are mounted on end, put them into the board as shown in the layout diagram since the top end maybe used as a test point. There are also pads for additional test points into which you can solder 10mm off cuts of stiff wire or Vero-pins. Turn all presets fully anti clockwise now as a safety precaution.

The PCB is etched on one side, with a continuous ground plane on the other top or component side, so beware of pushing parts in too far and shorting unintentionally to the ground plane at the edge of the countersinking; take particular care with chokes, integrated circuits and the leads of transistors which are more prone to touching the countersinking of non-earthy holes. The PCB has been lacquered to resist oxidation; it is specially designed to be soldered through so do not attempt to remove it! Only insert parts with the power off. Follow the layout diagram *very* carefully and it is a good habit to compare the circuit with the track pattern as you insert parts so as to check for correct part location and to help understanding of the circuit. If you have difficulty finding a particular part on the layout diagram, use the circuit to identify its 'role' and hence to find its general position on the PCB. The layout diagram shows large black "blobs" on the earthy end of some components (usually resistors or disc capacitors) which are connected to 0 volts; you have to solder these points on the top of the board as well as on the track side in order to make the ground connections. *Failure to make these ground connections is the most common source of trouble.* For these ground connections, disc capacitors may need to be soldered in place with their earthy lead slightly high to be sure of enough lead length to obtain good solder adhesion close to their body. Make all these ground plane top-side connections as you insert each part or you will miss some out! In the construction sequence later, they are marked with an E in brackets. The PCB is arranged so that you only need to solder those parts on the top side of the board that can easily be soldered on both sides. Do not attempt to solder other earthy parts to the ground plane as their shape is not suitable. For each table, do the left column first as this usually contains the earthy parts which are best fitted before others. Earth/0 volt tracks are shown with 'hairs' similar to those of a chassis symbol. Use an 18 Watt iron with 60:40 tin/lead resin cored solder; you may find that the protective lacquer requires the iron to be applied for slightly longer than normal to obtain a good joint – this will not damage the parts. Some transistors and integrated circuits are static sensitive, so it is desirable to use a proprietary personal earthing strap - especially if your shack is dry and has a synthetic carpet! Keep the semiconductors in the black static conducting bag until needed. Make sure your iron is earthed and connecting your PSU 0 volt terminal to mains earth through a 1M resistor is sensible. The layout diagram shows the position of individual parts as viewed from on top of the component side; the transistors are drawn as though you could see all of their leads to help get their orientation correct, in reality part of their leads will be obscured by the transistor's body. Take particular care with the orientation of transistors and integrated circuits which can easily be put in the wrong way round. Some transistors may need their central lead bending the opposite way to that done by the manufacturer. All parts should be on the ground plane side of the PCB. Load the PCB in the order suggested and test each stage as you go. As you insert parts, cross them off in the construction sequence. This approach much increases the chances of it working properly from the start! Do not build the whole thing and hope it will work! Spares for all parts are normally readily available from Walford Electronics.

Mechanical Assembly

If you are going to build this 'open style' using the supplied PCB front panel, it is probably best to do the assembly of the front panel before starting the electrical assembly. If you intend to install the whole project in your own case, it might be prudent to first build it open style and then decide what case it requires - allowing for any extras. Any associated transmitter must be mounted immediately to the rear of the receiver adjacent to the plug-in band cards. Other 'extras' should be mounted behind the transmitter or to one side.

The PCB front panel is soldered on its back lower edge to the front topside ground plane edge of the main PCB so that this joint is just concealed by the front panel – if it overlaps too much then the main tuning knob will acts as a wheel, and the sockets will not fit either! The two PCB side cheeks are then soldered (on their ground plane sides) at the outside ends of the front panel/main PCB joint. Before soldering offer them up together and make certain you understand this arrangement. Tack solder the front panel to the main PCB in two places about 5 mm from the outside ends, then tack solder the side checks to both the front panel and main PCB. Check everything is square and offer up the front panel items to ensure they have enough room when arranged as shown in Fig 4; if everything is all right, then make the proper solid joints, either running in a small solder fillet along their whole length or making spot joints about every 30 mm as shown on the parts layout diagram. Photo 1 shows the arrangement with all the front panel controls installed and partly connected, which is the next task. Install:-

- Four rubber feet underside in corners of the main PCB.
- LS socket. Bend sleeve contact down and solder to the back of the front panel.
- Mike/key socket if available from TX kit. Solder sleeve contact to front panel.

CV100 PolyVaricon tuning capacitor. Take care here! Before fitting adjust both trimmers on its rear for least overlap of their plates. A special long shaft extension (and 2.5 mm pan head bolt) for the PolyVaricon has been included courtesy of Andy Howgate G7WHM. When tightening this shaft extension bolt, make certain you grip the shaft/extension with your pliers so that **NO** strain is applied to the capacitor rotation end stops. A dab of super-glue between shaft and its extension will make this joint less likely to undo if rotated too abruptly! Check that the two small holes are properly located to allow the two short 2.5 mm capacitor mounting bolts to engage without stressing the capacitor body, ease with a file if necessary; the two small countersunk bolts should have a washer put under each head before inserting through the front panel to prevent them reaching too far into the capacitor body and damaging its plates. Solder the central earthy common lead of the capacitor directly to the back of the front panel. The other two capacitor leads should be slightly shortened so that they will be more rigid when their leads are attached later. The large main tuning knob is fitted so the pointer indicates 3 and 9 o'clock at its end stops.

Filter switch S103 – inside nut tight up against its body, discard the plain washer, then insert through the panel, and fit crinkle washer and front nut.

Band switch S102 – if plug-in band cards might be used - same mounting arrangement as above.

Segment switch S100 – same mounting arrangement as above.

Section switch S101 - same mounting arrangement as above.

AFG Pot RV101 – 4K7 Log. Shorten its shaft and break off the anti-rotation lug. Fit to panel and bend back its anticlockwise tag, which is then soldered direct to the back of front panel. Fit its knob.

Fine tuning pot RV100 – 10K Lin. Shorten its shaft and break off the anti-rotation lug. Offer up to the front panel, gingerly bending the key/mike socket tags if necessary, then secure to the panel and fit its knob.

Make the following front panel connections with short single strand stiff wires:-

Clockwise tag of AFG pot RV101 to central tag of Filter switch S103

Central tag of Segment switch S100 to central tag of Section switch S101

65 pF tag (right from rear) of tuning cap CV100 to lower tag of Segment switch S100

150 pF tag (left from rear) of tuning cap CV100 to upper tag of Section switch S100

Solder a short lead from the central tag of the Band switch S102 to the back of the front panel.

Assembling the 80m receiver

Using the parts layout diagram - Fig 4 - fit some large parts whose position is unambiguous:-

Four screw power and antenna connector			L102	TOKO 3334	(E)
RL100	12v DPCO relay		CT100	65 pF YL trimmer	
L101	TOKO 3334	(E)			

Now fit the supply parts:-

C101	10 nF disc – 103	(E)	R105	3K3 – OR,OR,RD	
C113	10 nF disc	(E)	R106	3K3	(E)
C114	100 uF 35v electro	Check polarity	D102	21DQ06 diode	Check orientation
C111	10 nF disc	(E)	IC101	LM2930-T8	Check orientation
C112	100 uF 35v electro	Check polarity			

Slightly tilt the body of IC101 towards the centre of the board to move it away from the sensitive VFO switch tags. Connect one of the point Y holes by wire to the anticlockwise tag of Fine tune pot RV100; connect point W to the clockwise tag of the Fine tune pot RV100. Keep these wires close up against the ground plane/front panel and away from the VFO switches and PolyVaricon wires. Carefully connect your positive supply lead to the V terminal of the four screw connector, and the negative lead to the adjacent E terminal. Switch on and measure the D voltage on point 8 with respect to 0 volts – it should be very close to 8 volts. Measure the DC voltage on the slider of RV100 – it should be adjustable between about 1.6 and 6.4 volts with the Fine tuning pot RV100. Switch off and fit the audio output amplifier:- 8.25 1.55 – 6.7

R118	1R – BN,BK,GLD	(E)	C138	10 uF 35v electro	
R117	3K3		C139	100 nF Polyester	
C135	10 nF Polyester		C140	100 uF 35v electro	Check polarity
C136	10 nF Polyester		IC104	LM380-8	Check orientation
C137	100 nF Polyester				

Connect point O by a wire to the tip contact of the LS socket. Connect point R by wire to the slider of the AFG pot RV101. Turn the AFG pot fully clockwise. Plug in your loud speaker or phones and switch on. You might just be able to hear a faint hiss. Do the screwdriver and finger hum test by applying you finger to the shaft of a metallic screwdriver while touching it to the clockwise tag of the AFG pot RV101 – there should be noises of some sort – probably a rough sounding hum. Switch off and fit the audio pre-amp chip which also needs the product detector for its biasing:-

R110	180R – BN,GY,BN		R116	100K	
R112	100K – BN,BK,YL		IC102	SA602/612	Check orientation
R114	3K3		IC103	TL072	Check orientation
R115	100K				

Switch on. Check the biasing of these parts by measuring the DC voltage on pins 1 and 2 of IC103; it should be near 6 volts. If not, check that the DC voltage on pin 5 of IC102, and pin 7 of IC103 are all about 6 volts. Switch off and fit the other parts of the pre-amp stages:- 6.6

R113	1K – BN,BK,RD	(E)	C130	100 nF Polyester	
C133	470 pF disc	(E)	C131	100 nF Polyester	
C127	10 nF Polyester		C132	10 nF Polyester	
C128	470 pF disc – 471		C134	100 nF Polyester	
C129	10 uF 35v electro	Check polarity			

Connect point J by wire to the lower tag of the Filter switch S103, connect point Q to the upper tag of Filter switch S103. Set S103 to the Wide position. Set the AFG pot RV101 to mid position. Switch on, you may be able to hear background hiss, then gingerly repeat the screwdriver finger hum test, this time on the hot end of C127 – be prepared for it possibly being somewhat louder. Change S103 to the Narrow position and check that the noises are still present although they should sound as though they are coming from a drain pipe! In both cases their level should be controllable by the AFG pot. Switch off and fit the other detector parts and 80m RF bandpass filter:-

More hiss than expected

R111	10K – BN,BK,OR	(E)	C123	330 pF disc – 331	(E)
C122B	10 nF disc	(E)	C124	15 pF cer plate	
C120	10 nF disc		C125	330 pF disc	(E)
C121	10 nF disc		C126	10 nF disc	
C122A	100 uF 35v electro	Check polarity			

The only checks that can be done here are DC checks on IC102, most of which have been done before by implication! Switch on and measure the DC voltage on point C – it should be near 6.25 volts. Switch off and fit the 80m local oscillator:-

6.65

R102	100K	(E)	X100	3.58 MHz cer res	
R103	1K – on end		X101	3.68 MHz cer res	
C107	470 pF disc	(E)	R104A	3K3 – on end	
C109	10 nF disc	(E)	D100	1N4148 – on end	Check polarity
C106A	56 pF cer plate		TR101	2N3819 – C/L Back	Check orientation

Connect point T with the stiff single strand wire to the already joined central tags of S100 and S101. Connect point U by another short stiff single strand wire to the upper tag of the Segment switch S100. Connect point H to the lower tag of Section switch S101, and point L to the upper tag of Section switch S101. Set CT100 for least overlap of its plates. Switch on and measure the DC voltage on the hot end of R103; if the oscillator is working, then shorting point T to 0 volts with a screwdriver (to stop the oscillator) should cause the voltage across R103 to increase – typically from about 1 to 1.25 volts. You should be able to find the strong carrier from the VFO in the bottom 200 KHz of 80m on another receiver whose aerial is draped across the rig. (The tuning range will be limited at this stage.)

Switch off and fit the remaining Fine tuning parts-

R104B	100K		C108	470 pF disc	
C110	10 nF disc	(E)	D101	B204 varactor – C/L back	Check orientation

Connect point F wire by wire to the slider of the Fine tuning pot RV100. For use on 80m without any band card fitted, make a temporary short between band card connector pin 5 and 0 volts. Check that altering the Fine tuning pot RV100 does alter the tuning by a few KHz.

with new resonators in PII.

CW	L	3480 – 3438	
CW	H	3515 – 3610	
PH	L	3662 – 3712	3638 – 3686
PH	H	3692 – 3753	3670 – 3740
		3 res	2 res

Setting up the 80m RX

Firstly peak up the 80m RF band pass filter. This is done using a signal that is steady in frequency and amplitude, ideally from a source such as a signal generator or dip oscillator, both of which are likely to need some form of attenuator to prevent overloading of the front end, or from a harmonic marker generator which usually provide weaker signals. It can also be done with off air signals but this makes finding the peaks on L101/102 rather harder! The signal source frequency should be about 3.6 MHz. This steady test signal is tuned in with a comfortable beat note using the Wide audio filter and then the two cores are adjusted for maximum signal. Because this is a direct conversion RX which responds to either sideband, there will be two settings of the tuning controls that produce this beat note – either side of zero beat which is where the signal source and local oscillator are on exactly the same frequency. (As you tune across the steady signal, the beat note first appears at high pitch then gets lower in tone till it disappears at zero beat, reappearing again at low pitch and then disappearing at high pitch.) Use a plastic tool on L101/102 as the cores are brittle. You can sharpen up the tip of a plastic knitting needle, or the clip of a cheap ball point pen, or even a matchstick if desperate! If possible use some form of AC voltmeter to detect the settings which give maximum audio output – your ordinary multi-meter set for AC should work on audio frequencies – this will give more accurate settings of the cores than trying to do it by ear.

Adjusting the tuning is more complex since the 0.5% frequency tolerance on the ceramic resonators means there will be variations between rigs. Measurements are best done with a counter if you can borrow one, or another 80m RX. A counter should be connected using a scope type divide by 10 probe across C107 or to point C. First check that you can find the tuning limits of all combinations of S100/101 and CV100 on the counter/other RX, with the Fine tuning pot RV100 set to mid position – it should achieve most of the bottom 200 KHz of 80m. Generally the ceramic resonators will tune up to the intended Section upper limits of 3.60 and 3.70 MHz but may need extra capacity to get down to the lower limits of 3.50 and 3.60 MHz. If these lower limits are *only just not achieved* with max capacity of CV100 and about half capacity from CT100, then change the 65 pF section of CV100 to the central tag of S100 so that it is always connected to point T. If these lower limits are *some way off*, then C106 needs to be increased by fitting the second spare 56 pF cer plate capacitor C106B. This will have more impact at the low frequency end but will also slightly reduce the upper end. The main use for the trimmer CT100 is to set the upper frequency limit of the Low frequency segments set with S100 – read that twice if necessary! I suggest CT100 is set to give about 3.540 and 3.640 MHz when S100 is set for the Lower segment on each section; you will then find that there is plenty of overlap because it will tune below these figures when set for the Higher sections. You can also use the trimmers on CV100 to set a higher minimum capacity for either or both the 65 & 150 pF sections of CV100. There is plenty of scope for experimentation! A 330 pF air variable with slow motion drive would be an excellent but very expensive alternative!

The tuning 'scales' that you achieve by the above process will apply to all the *higher* frequency traditional harmonically related bands that are available with the plug in band cards, since the 80m frequency is added to the crystals for other bands. These higher bands will have bottom band edge marker birdies – see later. Top band (160m) tunes backwards to avoid a very expensive low frequency crystal! (Thus when the VFO is on 3.6 MHz, the rig would be on 1.9 MHz.) The WARC bands are possible but require special expensive crystals.

Original with 1 resonator:

The 80m receiver is now complete! See Photo 2 and imagine the band card is not plugged in!

	Slot Section	Slot Seg		low	high	
6	PH	H		3622	3690	68
5	PH	L		3599	3676	77
4	CW	H		3611	3517	96
3	CW	L		3485	3591	116

CW	L	3482 – 3540
CW	H	3517 – 3612
PH	L	3597 – 3640
PH	H	3623 – 3687

Extending the 80m RX for the plug-in bands

First install the LO mixer stage IC100 and buffer, noting that TR100 needs to be close to the board to avoid fouling the band-card when it is fully inserted.:-

C102	10 nF disc	(E)	C103	56 pF cer plate	
C104	56 pF cer plate	(E)	C100	10 nF disc	
C105	10 nF disc	(E)	D103	1N4148	Check polarity
R100	1K	(E)	TR100	2N3819 – C/L fwd	Check orientation
R101	180R		IC100	SA602/612	Check orientation

At this stage only DC checks can be made. Switch on and measure the DC voltage on pins 1 and 2 of IC100; they should be equal at close to 1.25 volts. The DC voltage on pins 4 and 5 of IC100 should be the same as each other at near 6 volts; this means that the DC voltage across R100 should be near 6 volts. Switch off and do the remaining things for the band card:-

Remove the temporary link between band card connector pin 5 and 0 volts.

Install the 10 pin connector in the row of holes at the rear of the main PCB (long pins upwards), carefully pushing it down till the plastic strip is flush with the main PCB ground plane. Solder all 10 pins underside. Make certain all pins are parallel – bend them carefully if necessary.

Insert sections of short stiff wire through the three holes adjacent to the connector which join pins 3, 6 and 9 to 0 volts. Solder all three wires both sides and clip off the excess.

Connect point B on the PCB by wire to the lower tag of the Band switch S102.

Assembling the plug-in band cards

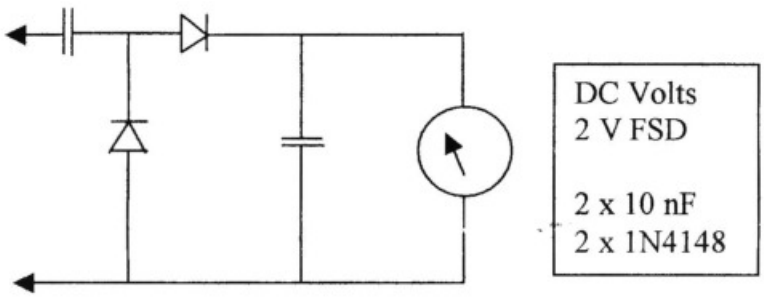
If you have more than one plug-in band start with the lowest frequency one since it will be easier to get going! First fit the 10 way socket to the band card PCB; this requires the 10 pins of the socket to be bent through 90° so they are on the same side as the two 'clips' of the socket, which will allow them to go through the band card PCB. These contact pins might be slightly tight in their PCB holes - if so, squeeze them gingerly with pliers to reduce their diameter; then clip the connector over the edge of the PCB and nudge each pin into the PCB. The body of the connector should be on the non-copper side of the PCB along with the other parts of the band card. A dab of glue under the connector might be advisable. Start with only the receiving parts – ignoring L250, L251 and C250 - C253. See Photo 3. Install the parts following the band card parts layout diagram Fig 2 using the part values given in Table 1 for the band being built. Fit the four TOKO cans first, then the crystal and then the 'six' nominal capacitors for both filters. Note that the band card PCB has provision for the fitting of a single actual capacitor or two in series, or parallel, for all 'six' of the main capacitors labelled C150 to C155 on the circuit – hence there will be unused holes on all bands so take care! (This is to allow a common set of filter parts for the 20 and 40m bands.) When complete, apart from the transmitter's low pass filters, plug the card in with the parts facing rearwards. Check that it does not foul TR100 - if necessary bend this transistor forward slightly. Switch the RX to the band card by raising the Bandswitch S102.

The LO crystal oscillator is first checked. You can connect a counter through a scope type divide by 10 probe to point X on the main PCB or listen for the oscillator on another RX. The frequency should be that shown for the band being assembled. (Do not use a plain screened lead on point X to connect to a counter.)

The LO BPF tuning needs a little care to make certain you get the right output frequency and the best output amplitude. You need some form of RF voltage measuring device; ideally a scope which can indicate amplitude and frequency of the LO bandpass filter output on pin 4 of the band card connector. Alternatively, use some form of RF voltmeter and check the frequency with a counter or another RX. If you do not have any form of RF voltmeter, then make up the circuit shown on the next page for use with your DC voltmeter. Connect these initially to pin 4 of the band card to find the peak but do the final adjustments using point C since IC102 acts as a buffer and will avoid the extra capacitive loading on L152. This does of course mean that IC102 has to be working!

Take care adjusting the cores of all the TOKO inductors (L150 - L153) since they are brittle. Start by slowly screwing them out anti-clockwise in case very little inductance is required and find the marked peak in output level. There should be over about 0.25 volts p-p on pin 4 of the band card connector. Then check it is the right frequency – that of your chosen band! Both cores should be in roughly the same position relative to their can. On 10m, it may be just possible to unintentionally also tune the cores for the unwanted difference mixer product (near 21 MHz) so use the higher frequency peak with less inductance. If the cores are not quite fully out when set for the peak, you can try screwing them right in and finding the peak again as this will keep them in their proper place! Change one core first to the 'screwed in position', find the peak again and then do the other core. Do the final adjustments using point C. The LO waveform may have some 'fuzz' when viewed with a scope due to unwanted strong harmonics (of the VFO usually) so you may need to experiment with the cores to obtain a good compromise between output level and lack of harmonics. Adjusting the LO BPF is the most difficult aspect of setting up the Sutton, so if you need help please ask.

Peak reading RF voltmeter



Next peak up the RF BPF cores of L150/1. This is done using a signal that is steady in frequency and amplitude in the same manner as you did for 80m. Use a test instrument source rather than off air signals if possible - the frequency must be within the bottom 200 KHz of the chosen band. Do NOT use the steady bottom band edge birdie that should be present on all the traditional harmonically related bands (except for 160m). Although annoying, the birdie is an inevitable consequence of the simple LO frequency mixing scheme, and it does have the advantage of providing a band edge frequency calibration marker! It arises when N x 3.50 MHz from the VFO is the same as the band's crystal frequency. The steady test signal is tuned in with a comfortable beat note using the Wide audio filter and then the two cores are adjusted for maximum signal. As before, use a plastic tool on L150/151.

Since the transmitter low pass filter parts are included with each band card, you might wish to add them while doing the receiving aspects. Follow the data in Table 2 which is the same for all transmitters that can be used with the Sutton. Fit the filter capacitors first noting that as before, the PCB has provision for a single actual capacitor, or two in series or in parallel for each of C250 to C253. They are yellow high voltage disc ceramics. Finally fit the filter toroids. The table suggests the length of wire required for each winding. Each time the wire goes through the middle of the toroid it counts as one turn. Thread the wire onto the toroid and slide it halfway along the wire. This is the first turn! Put on the rest of half the winding with one end, winding the turns tight and spaced around about a third of the circumference. Then put on the rest of the winding with the other end of the wire, around another third of the circumference so that there is a gap between the ends of the winding. Trim the ends to about 1 cm long, tin them with a hot iron (Do not breath the fumes) and fit to the PCB. Repeat for the second inductor. Finish any other cards and the RX is then complete!

Getting the best out of the Sutton

Aerial, earthing and supply arrangements can make a big difference to its performance and no two situations will be the same so there is plenty of opportunity to experiment! As a sweeping generality, it is best to get out as much wire as possible for the antenna and get it up as high as possible! Better results will generally be obtained if an Antenna Matching Unit (AMU) is used since this will improve the impedance match to the nominal 50R input of the RX. It will also help to remove interference from out of band broadcast stations (BCI). Balanced antenna schemes with symmetrical lengths in each arm are preferred but by all means start with a random length long wire connected directly to the rig for initial receiving experiments. However, almost all antennas will work better when feeding an AMU and you will almost certainly need one when you add a TX! Provided the matching unit is able to tune out the reactance, it is not essential for the arm lengths to be resonant. A link, or RF transformer, coupled AMU is recommended since this separate the rig's 0 volts (which might be connected to mains earth) from the real RF earth of the antenna system. If possible, avoid simple L matching networks as these often act as low pass filters that will still pass any troublesome lower frequency broadcast stations – especially from large antennas.

Direct conversion rigs are more prone to hum problems, associated with the RF aspects, so if you do have this trouble, experiment with different antenna and earthing arrangements such as connecting (or not) the RF earth to mains earth – the metal case of a mains powered appliance or water pipes. Using a transformer coupled AMU to definitely isolate mains earth from the RF earth may help. Check there is no hum when earth and antenna connections are absent or altered. See if running on a battery, to remove any potential mains earth loop, helps things with or without an 'intended' mains earth connection.

You may find that with a large antenna, that interference is present due to broadcast stations (BCI) that are just outside the amateur band. It is easily recognised as weak mushy voice/music signals which are *independent* of the rig's tuning. Careful adjustment of the receiver's RF bandpass filters, AMU, and earthing arrangements can all affect it. A link or transformer coupled resonant AMU will help to attenuate the unwanted signals. Sometimes a small amount of attenuation of the wanted as well as unwanted RF signals will eliminate the interference. For weak interference, this can be done by slightly mistuning the receiver's RF bandpass filter away (in a frequency sense) from the offending broadcast stations(s) so they get weaker but hardly make any difference to the wanted amateur signals.

When built for multi-band use, the absence of a band card will reduce the actual sensitivity on 80m – hence keep one plugged in!

For receiving SSB phone (or DSB or AM) signals, select the Wide audio bandwidth with S103. They are most likely to be in the higher frequency Section of the receiver's coverage so set S101 to PH (except for 160m where the tuning is backwards). Then tune for best intelligibility of the wanted signal; this will be when the local oscillator in the Sutton is tuned to almost exactly the same frequency as the other station. Consequently there is only one optimum tuning position. Under some strong interference conditions you might find that using the Narrow audio bandwidth helps improve readability. Normally one would tune to approximately the right spot with the main tuning CV100 and then make further minor adjustments for best clarity with the Fine tuning pot RV100.

For receiving CW signals, change to the Narrow bandwidth with S103 and generally use the CW section with S101 (not for 160m). You will be able to read each signal in two different tuning positions either side of zero beat for that signal – use whichever has least interference. You may find it helpful to search for signals using the Wide audio bandwidth with S103 initially and change to narrow when you have found something of interest. The same tuning technique of approximate tuning with CV100 and then Fine tuning with RV100 is fine for receiving purposes. (If you are going to add a CW transmitter later, you will then have to use a slightly different technique, so it might be best to get used to that now. The Fine control becomes a Receiver Incremental Tuning (RIT) control whose offset is automatically removed during transmission – requiring you to tune during reception for zero beat with the main tuning CV100 while the Fine/RIT control is centered, or turned off; and to then tune for the best beat note (or least interference) on either sideband with the RIT control RV100.)

Options!

There are several and many can be used together!

Boxing the rig This is easily done! Mount the main PCB by four screws in the spaces for the feet. Allow access for changing the band cards. Remember to allow space for additions such as a TX (not less than 80 x 100), 10W Linear (80 x 100), or other accessories. If adding a CW TX, there is not space on the supplied PCB front panel for the RIT switch, so allow for this if required. The new front panel should be near the main PCB with short leads - especially those associated with the tuning aspects. Use plenty of earthing points to connect the front panel to the main PCB. Do not let the LS socket and AFG pot RV101 share a single earth lead!!

Transmitters The Mallet 1.5W CW TX, or the Montis 1.5W phone DSB TX can be added. Both are 80 x 100 mm PCBs and both can work drive the 10W Linear amp. TR aerial changeover etc is included. Both transmitters have their own 80m output low pass filters, but for other bands, they use the LPF on the RX band card. The RX band switch also controls the TX band relay. The key or mike socket can be fitted to the bottom right of the RX front panel. It is hoped that the CW TX will also be able to do AM phone using the normal audio amp kit (50 x 80) and a modulation transformer.

Other bands Non 80m bands are added with plug-in cards. The WARC bands are technically feasible but are not offered due to the prohibitive cost of low quantities of special crystals. Ask me if you need any advice for the WARC bands. 30m is easier than the others!

Tuning As explained earlier, the tolerance on the ceramic resonators makes it very difficult to generalise but if you have a suitable air spaced variable capacitor of about 150 to 300 pF with a slow motion drive, then its worth a try to avoid the complication of S100 and its trimmers! Minimum tuning capacity should get both Sections above the nominal frequency for that ceramic resonator; high capacity will usually drag them down over 100 KHz.

Counters It is suggested the three digit counter is the most appropriate for this rig – it will show only the KHz part of the rig's tuned frequency for any of its bands. (You can use the 5 digit counter to also show the MHz part but it's more expensive!) The logic part of the 3 digit counter's PCB can be mounted anywhere convenient and close to the RX PCB. The displays (three occupy 0.9 x 0.5 inches) would normally be mounted directly behind the front panel with the segment resistors either behind the displays, or added to the counter PCB as described in the counter kit instructions. Either counter should be fed from the RX point C.

Meter kit This can be added to provide audio controlled receive AGC. It is connected just before the AFG pot RV101. Muting from any associated transmitter is changed to the input of the Meter kit, to ensure the AGC loop returns to full gain during transmission – as well as muting the receiver. The mute input from the transmitter is connected to the junction of R2 100K and the C4 220 nF in the Meter kit. For the TX, the kit includes a resistive antenna matching bridge and RF output indication.

Variable bandwidth filter This kit can be added to provide an adjustable audio bandwidth for CW purposes. It provides a much narrower band pass filter centred on 725 Hz. It is normally connected after the existing CW filter.

RF Gain control The best way to add one is to connect a 500R or 1K pot, connected as a variable resistor, directly in the antenna lead. This is particularly useful where BCI is a problem, because a small amount of RF attenuation can often eliminate the interference. When either TX is fitted, this pot is connected in series with the lead going to point A in the RX.

I must thank Andy Howgate for triggering the idea of a simple multi-band RX, and also Keith Woodward, Jim Gearey, Nick Phillips and Richard Booth for helping with the evaluation and proving of early models. As ever, I shall be delighted to hear how you have got on! The next page shows what mine looks like!

Tim Walford G3PCJ Jan 18th updated Feb 3rd, May 6th 2005

Sutton Photos

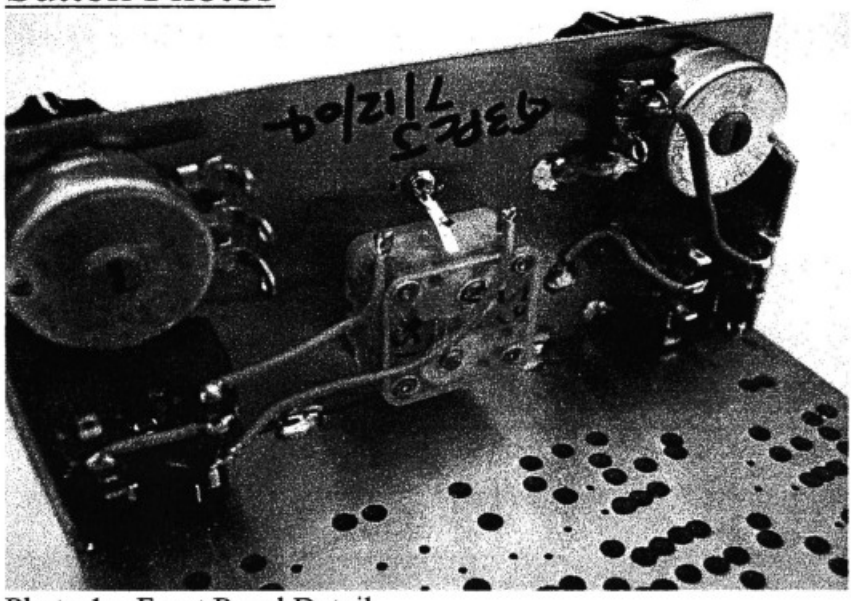


Photo 1 – Front Panel Detail

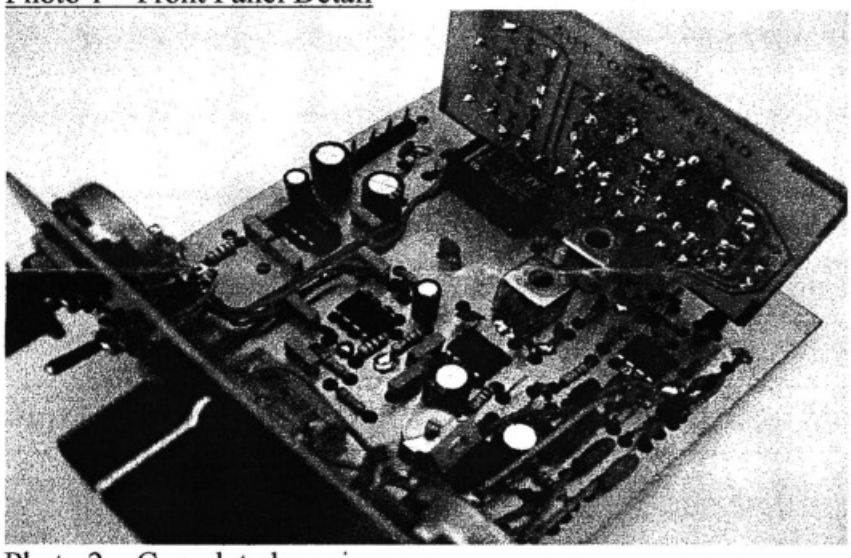


Photo 2 – Completed receiver

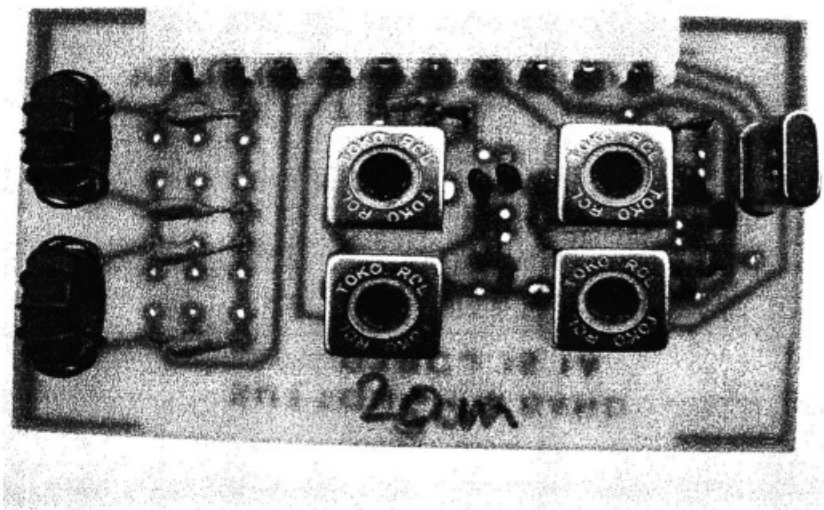


Photo 3 – 20m Band Card (note series connected BPF capacitors)

Parts List for the basic Sutton RX

Resistors			Capacitors		
1	1R	R118	1	15 pF cer plate	C124
2	180R	R101,110	4	56 pF cer plate	C103,104,106A 106B
3	1K	R100,103,113	2	330 pF cer disc - 331	C123,125
5	3K3	R104A,105,106, 114,117	5	470 pF cer disc – 471	C107,108,128, 128,133
1	10K	R111	12	10 nF disc - 103	C100,101,102, 105,109,110, 111,113,120, 121,122B,126
			4	10 nF Polyester	C127,132,135, 136
5	100K	R102,104B,112, 115,116	5	100 nF Polyester	C130,131,134, 137,139
			2	10 uF 35v electro	C129,138
			4	100 uF 35v electro	C112,114,122A, 140
1	10K Lin pot	RV100	1	65 pF YL trimmer	CT100
1	4K7 Log pot	RV101	1	65/150 pF Poly-Varicon	CV100
	R107/8/9 not used			C115 –119 not used	
Inductors			Miscellaneous		
1	12v DPCO	RL100	4	Rubber feet	
2	TOKO 3334	L101,102	1	Four screw connector	
1	3.58 MHz cer res	X100	1	10 pin connector	
1	3.69 MHz cer res	X101	1	3.5mm mono socket	For LS
			4	SP toggle switches	S100,101,102, 103
Semiconductors - in anti-static bag			2	Small knobs	For RV100/1
1	B204 varactor	D101	1	Large knob	For CV100
1	21DQ06 Schotky	D102	200 mm Length of stiff single core wire		
2	1N4148	D100, 103	300 mm Length of multi-core wire		
2	2N3819	TR100,101			
2	SA602/612	IC100,102			
1	LM2930-T8	IC101	2	PCB side braces	
1	TL072	IC103	1	PCB front panel	
1	LM380-8	IC104	1	DS etched main PCB	Issue 2
1	2.5mm long pan head bolt	For CV100			
1	Shaft extension	For CV100			
2	2.5 mm x 6mm	CSK bolts			
2	2.5 mm flat washers		The parts for bands other than 80m are listed in Tables 1 and 2.		
			TRN Walford G3PCJ		Feb 10th 2004

Table 1 — Sutton RX Band card LO and RF Bandpass Filter data

Band	Inductors TOKO cans RF BPF L150	L151	LO BPF L152	L153	Crystal X150 MHz	Frequency Mixing Sum	Band
160m	3333	3333	3333	3333	5.5	Subtract	160m
40m	3334	3334	3334	3334	3.5	Add	40m
20m	3334	3334	3334	3334	10.5	Add	20m
15m	3335	3335	3335	3335	17.5	Add	15m
10m	3335	3335	3335	3335	24.5	Add	10m

A blank in both these tables means that nothing is fitted in that location.

Each band card kit contains these band parts plus:-
Single sided Sutton band card PCB - Issue 1 or 2
10 way clip on socket
Length of 24 guage enam wire

G3PCJ April 18th 2005

These parts can be used with either Issue 1 or 2 band cards.

Band	Filter Resonating Capacitors All ceramic plate capacitors Nom Val pF	Form	RF BPF C150		152		LO BPF C153		C155		Coupling Capacitors Nom Val pF	Form	RF BPF C151	All ceramic plate capacitors LO BPF C154			Band
160m	150 pF	Single	150 pF		150 pF		150 pF		150 pF		15 pF	Single	15 pF		15 pF		160m
40m	78 pF	Parallel	39 pF	39 pF	39 pF	39 pF	39 pF	39 pF	39 pF	39 pF	4p4	Parallel	2p2	2p2	2p2	2p2	40m
20m	19 pF	Series	39 pF	39 pF	39 pF	39 pF	39 pF	39 pF	39 pF	39 pF	1p1	Series	2p2	2p2	2p2	2p2	20m
15m	39 pF	Single	39 pF		39 pF		39 pF		39 pF		2p2	Single	2p2		2p2		15m
10m	22 pF	Single	22 pF		22 pF		22 pF		22 pF		2p2	Single	2p2		2p2		10m

Table 2 — Low Pass Filter data for all transmitters that go with Sutton

Band	Filter Capacitors All yellow high voltage disc capacitors Nom Val pF	Form	C250		C251		C252		C253		Filter Inductors Nom Val microH	Wire Length	L250 Turns on T50-2	L251 Turns on T50-2	Band
160m	1600 pF	Parallel	1000 pF	680 pF	1000 pF	680 pF	1000 pF	680 pF	1000 pF	680 pF	4	0.75m	28	28	160m
40m	400 pF	Parallel	220 pF	220 pF	220 pF	220 pF	220 pF	220 pF	220 pF	220 pF	1	0.4m	14	14	40m
20m	200 pF	Single	220 pF		220 pF		220 pF		220 pF		0.5	0.3m	10	10	20m
15m	150 pF	Single	150 pF		150 pF		150 pF		150 pF		0.35	0.25m	8	8	15m
10m	100 pF	Single	100 pF		100 pF		100 pF		100 pF		0.25	0.2m	7	7	10m

Sutton RX - Page 14

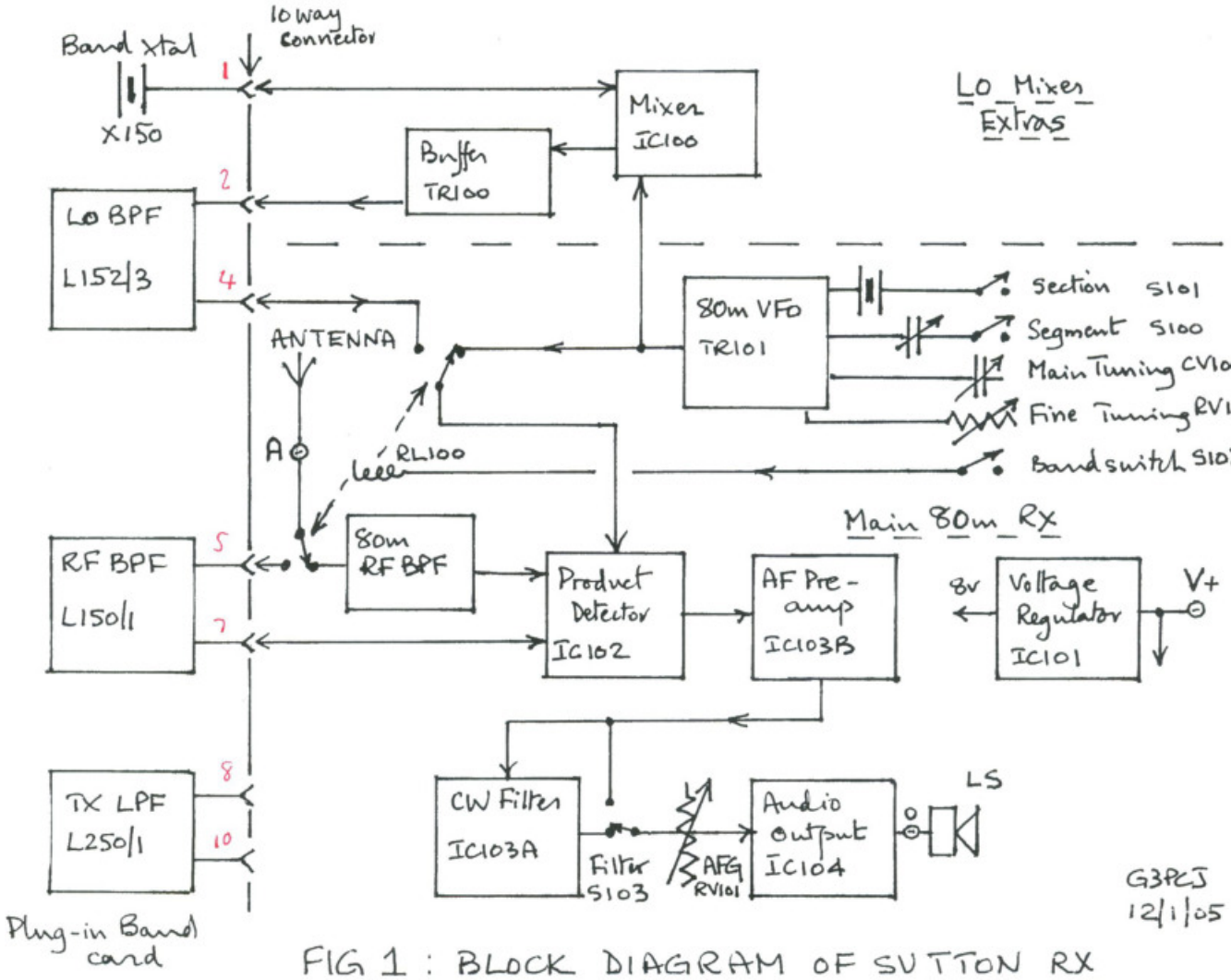


FIG 1 : BLOCK DIAGRAM OF SUTTON RX

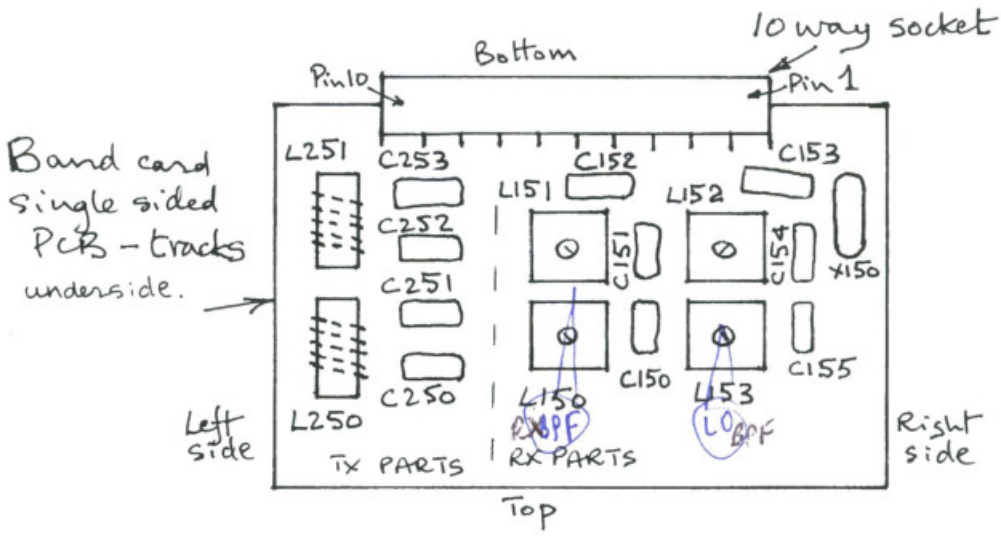


FIG 2 : PARTS LAYOUT OF SUTTON BAND CARD

- Top View – component side
- Plugged into RX with parts facing rearwards.
- All band card capacitors shown may actually be single or two in series or parallel

G3PCJ 12/1/05

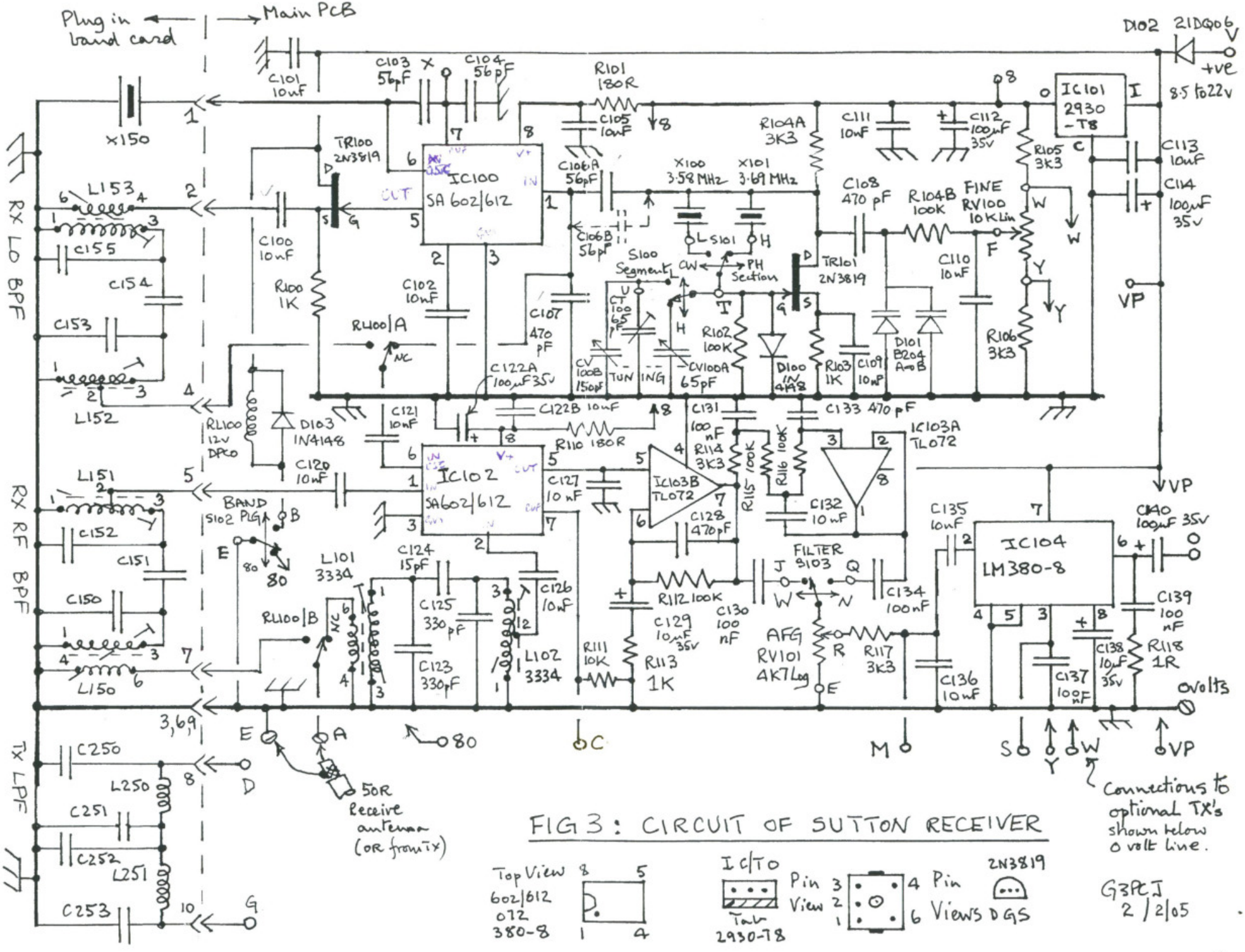


FIG 3 : CIRCUIT OF SUTTON RECEIVER

G3PCJ 2/2/05

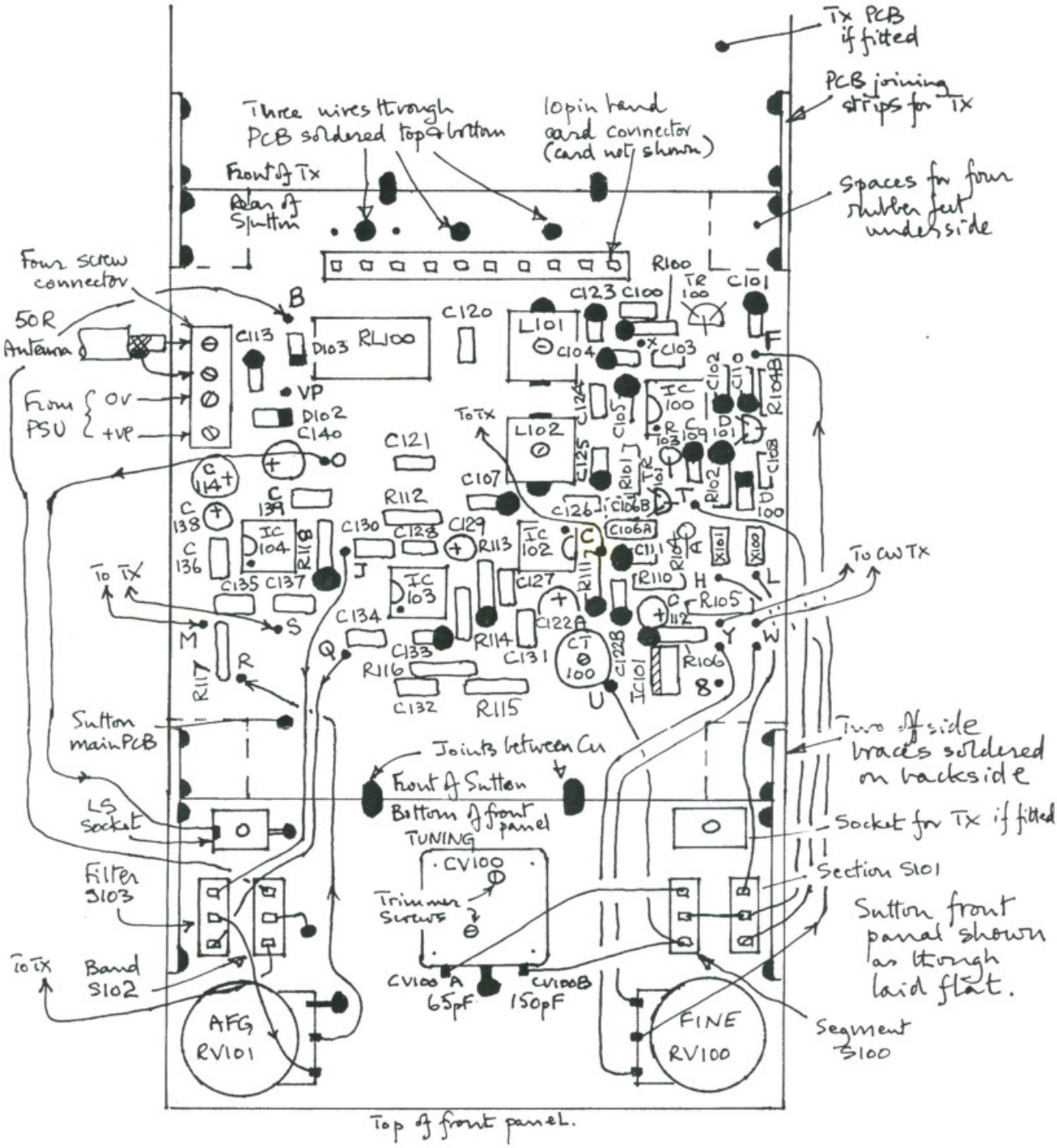


FIG 4 : PARTS LAYOUT OF SUTTON — top side view

● These large black blobs are topside solder points

Drawn as though front panel were laid flat.

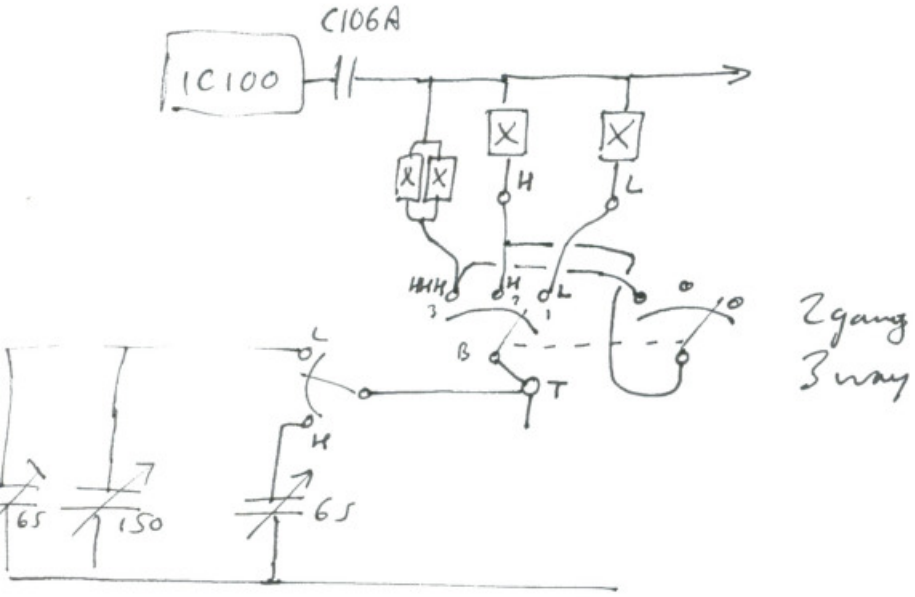
G3PCJ
2/2/05

Redesign for 3 band ranges

Based on

Low (CW)	med (PH)	high (70pf)
1 res	1 res	3 res.
3580	3680	3680

3482	3597	3662
| 3517	| 3623	| 3692
3540 |	3640 |	3712 |
3612	3687	3753



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Proprietor Tim Walford BSc MIEE CEng G3PCJ

Sutton Band Cards

Gentlemen,

Band Cards

I regret that a small error has crept into the track layout of the Issue 1A Sutton band cards. It arises from my getting the pin numbers mixed up on the TOKO coils for pins 1/3 and 4/6 when doing the track layout. For the untapped L150 and L153 it does not matter but for the others, the tapping point is closer to the hot end than it should be - depending on band; it is hardly worth altering for 20 and 40m upwards using the 3334, and for 10/15 using the 3335 it does not matter - but for 160m (using the 3333) you should modify the card by interchanging the connections to pins 1 and 3 of L151 using wire links/cut tracks. It will reduce the chance of BCI and very slightly reduce sensitivity. Changing L152 on 160m is hardly necessary.

I will supply the new/correct layout from now onwards for 160m; for the other bands, I will change to the new design when the current stock of PCBs is used up. The capacitor values etc. are not affected.

As a consequence of this track error, the circuit diagram has the wrong TOKO pin numbers on L150 and L153. (Pins 1 and 3 should be swapped, also swap pins 4 and 6.)

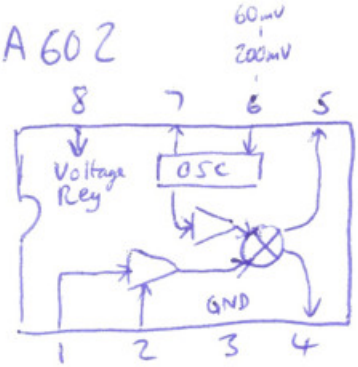
80m Sensitivity

Some of you have noted that the sensitivity on 80m is appreciably less than on other bands. I have now traced this to the ordinary medium K ceramic disc capacitors supplied originally for C123 and C125. Replacements higher quality 330 pF capacitors are enclosed for substitution! The circuit is correct and the better ones will be supplied in future.

Let me know if you have any other problems please.

Many thanks, Tim Walford April 14th 2005

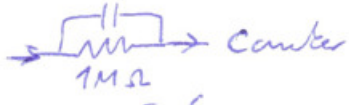
SA602



typical voltage 5-6v max 8v.

Input on 1 and 2 (interchangable symetrical)

Output on 4 and 5 (" " " ")

Counter on pin 7. 

Oscillator tuned input on pin 6.