Modern

High-Performance

Equipment for 10GHz

Part 2 The G3WDG-002 Receive Converter

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Modern High-performance Narrowband Equipment for 10GHz

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Designed by

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Modern high-performance narrowband equipment for 10GHz

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Part 2 - The G3WDG-002 10GHz receive converter

Introduction

Over the past few years there has been a trend away from traditional waveguide techniques for amateur narrowband equipment at 10GHz. Equipment using GaAs FETs in microstrip circuits offers higher power levels, better receiver performance and is arguably easier to build. Construction techniques follow lower frequency practice rather than "plumbing", although care and attention to detail are still required if good results are to be obtained.

A number of GaAs FET-based designs for 10GHz have appeared in amateur literature, for example [1]. These have tended to use relatively expensive GaAs FETs and the cost of construction has been too high for many amateurs. Recently a large quantity of GaAs FETs have become available on the UK surplus market at a fraction of the cost of "new" devices. The GaAs FETs in question were manufactured by the Plessey 3-5 Group for use in 11GHz satellite TV LNBs and have excellent performance. The low cost of these led the authors to develop a number of new designs for 10GHz.

The designs are intended for home construction without the need for either difficult construction methods or elaborate test equipment. They have all been duplicated with relatively little difficulty by a number of independent constructors. Wherever possible, low cost components have been identified and designed-in, but in some cases it has been necessary to use more expensive components. The specified parts MUST be used throughout or the hard work put in by the designers to make the designs reproducible will have been wasted! All the special components, with the exception of the GaAs FETs, are available from the RSGB Microwave Committee Components Service. Problems were encountered during the design-proving phase when some constructors had not used the correct grade of GaAs FETs in some locations. The different surplus GaAs FETs available are NOT interchangeable!

Like the G3WDG-001 multiplier/amplifier described in Part 1, this module also requires a drive input of approximately 5-10mW in the 2.5 to 2.6GHz region. The exact frequency of the drive depends on the particular application. A suitable oscillator/multiplier, the G4DDK-004 design [2] has already been described, giving the required level of output in this range, and PCBs for that design are available through the RSGB Microwave Committee Components Service (G4DDK PCB 004). Subsequent to the original article, a number of minor modifications were made to some of the circuit values [3] which raised the output to 10mW or more, sufficient to drive the present designs. The modifications have been incorporated into the PCBs currently available (Issue B).

The three designs are:

1. A x4 multiplier/amplifier chain (G3WDG-001) which can provide 50 to 100mW output anywhere in the 10 - 10.5GHz band. It can be used as the basis of a simple CW/FM narrowband transmitter, a beacon or personal signal source, as an ATV transmitter or as a packet radio link transmitter. This was described in Part 1.

2. The present design, a down-converter (receiver), G3WDG-002, to 144 - 146MHz incorporating a x4 multiplier chain to generate the local oscillator signal, a dual-diode mixer and two stages of low-noise pre-amplification before the mixer. The design also incorporates a low-noise post-mixer amplifier at the intermediate frequency. The front-end noise figure of several prototypes has been measured at less than 3dB . It is possible to improve this figure by using an external pre-amplifier.

3. Part 3 which describes a linear up-converter (transmitter), G3WDG-003, from 144 -146MHz to any 2MHz segment in the 10GHz band. It incorporates a x4 multiplier chain, a GaAs FET mixer and four amplifier stages to reach an output power of at least 50mW. A further power amplifier stage is under development using a Mitsubishi MGF1601 GaAs FET and the prototype is giving over 200mW output.

By providing the 002 and 003 modules with a common 2.556GHz local oscillator source and suitable transmit/receive changeover arrangement, the result is a complete "state-of-the-art" linear transverter.

It is a good idea, for those not yet skilled in the art of microwave PCB construction, to work through these module designs in the order described since this represents a steady progression from a relatively simple to quite a complex design. If you can successfully build and align the G3WDG-001 design, then you are well on the way to building your own state-of-the-art high performance receive converter or linear transverter at a fraction of the cost of comparable commercial equipment.

General circuit features and components.

All three designs are built on ptfe-glass board and, in the main, surface-mount "chip" devices (SMDs) are used, although some more familiar "ordinary" components are also used. The "heart" of the units is the widespread use of GaAs FETs as active multipliers, amplifiers and, where required, as mixers. Microstrip circuitry is used to provide the correct operating impedances for the GaAs FETs and the circuits have been designed to cover the whole of the 10GHz band from 10.0 to 10.5GHz. A reliable method for grounding the source leads of the GaAs FETs was developed to ensure that the designs would be reproducible. Earlier attempts using copper foil "wrap-arounds" failed because the inductance of such connections was too variable.

Where high selectivity is required, to discriminate between harmonics or to reject image frequencies, this is provided by the use of small "pill-box" tuned cavity resonators soldered to the board. Coupling from the microstrip lines into and out of the resonators is accomplished by the use of probes. This technique has been common in German amateur microwave designs for some time, for example [4], and avoids the use of critically dimensioned and spaced printed microstrip filters which are almost impossible to make with enough accuracy. It will be noted that a high drive oscillator frequency has been chosen (around 2.5GHz), also in order to minimise the stringency of filtering. The drive source chosen gives output at the required level, with all unwanted products at least -40dBc or better: this minimises the filtering requirement at the final signal frequency and makes the use of single, simple cavity resonators possible wherever such selectivity is needed.

Similar principles have been adopted for all three designs, each GaAs FET amplifier stage providing a gain of about 10dB. Matched input and output circuits are realised by the use of microstrip lines. Rather than attempt to etch very narrow (high impedance) microstrip lines, where these are necessary, easier construction results from the use of short lengths of thin wire soldered to the lines and pads on the surface of the board.

It is recommended that the PCBs available from the RSGB Microwave Committee's Components Service be used for these designs. Both the board material and the dimensions of the microstrip lines are critical to the success of this type of circuit. The other critical components, such as the ceramic chip capacitors, resistors and the resonators, are also available. Virtually all the other components are available from easily accessible amateur sources.

ONLY the recommended components should be used and only first-grade KNOWN components employed - substitution from the "junk-box" or components "salvaged" from other microwave equipment is just not acceptable!

It is strongly recommended that, whichever module is to be constructed, the PCB is installed in a tin-plate box or an alternative, specially made sheet-metal (brass or copper) enclosure of similar size and form. By so-doing, not only is the somewhat flexible board housed rigidly, but is also well screened and thermally insulated to some degree. The finished, boxed unit(s) should be housed in a rigid outer case to provide mechanical and thermal stability - the "boxes within boxes" approach which has been advocated for high performance microwave equipment, almost regardless of frequency.

The use of other than SMA connectors for input and output is not recommended. The 12V power supply (or any other ingoing supplies) should be well decoupled by 1nF to 10nF solder-in feedthrough capacitors or Filtercons. The power supplies must be stabilised to the voltages given in the circuit diagrams: if these voltages are exceeded, or the gate bias voltage fails, the GaAs FETs can be damaged, if not instantaneously destroyed. By incorporating resistors in the drain circuits a degree of current -limiting protection is afforded. Nevertheless, it is well worth spending time on this aspect of the circuits, using only generously rated and reliable components in the bias circuits.

Care and attention to detail is essential AND your soldering techniques must be good! Components should be mounted in the order given and the GaAs FET devices should always be the last components to be soldered into place, taking the usual precaution of grounding together the constructor, the body of the soldering iron and the case/groundplane of the PCB whilst soldering them in place. In this way the risk of damage by static discharge is minimised or eliminated.

The G3WDG-002 receive converter: circuit description and operation.

The circuit is shown in Fig. 1, the layout of the board and components in Fig. 2 and their values in Table 1.

Referring to the circuit diagram of the G3WDG-002 receive converter, Fig. 1, the 2556MHz LO input signal is fed to F1 which acts as a frequency multiplier producing a few milliwatts at 10224MHz. The multiplier circuit is identical to that used in the G3WDG-001 module. The input signal is fed to the gate of the FET via a lumped element matching network L1/L2. The cold end of L2 is decoupled via C2 and negative gate bias is applied via L2. The output of the FET is matched to 50 ohms via microstrip elements, and drain bias is fed via a quarter-wave line L4 which is decoupled at 10GHz by a low impedance quarter-wave stub. L3 and the chamfered element (a microstrip shunt capacitor) form a series resonant circuit at the input frequency (2556MHz) to improve the efficiency of the multiplier. Wideband stability is provided by decoupling elements R1, C3 and C4. A number of harmonics are present in the output from the FET. The wanted fourth harmonic is selected by the cavity filter FL1 and passed to the LO port of the hybrid ring mixer via a microstrip matching network.

The mixer uses a series diode pair, D1, connected between the ends of a folded three-quarter wave line. This configuration gives good rejection of the LO signal at the RF port and vice-versa. L9 is a shorted quarter wave line to provide the required low impedance IF return path, while having no effect at the LO frequency. The conversion loss of the mixer including the matching networks is about 6-7dB.

A two stage low noise amplifier (LNA) is provided to reduce the noise figure of the unit to a more acceptable level. The amplifier is of conventional design and uses "Birkett" FETs. It is very similar to the power amplifier used in the G3WDG-001, except that a low noise FET can be used in the input stage as an option. F2 can be either a red or black Birkett FET according to the level of performance required. Noise figures of 2.6dB with a red FET and 3.2dB with a black FET are typical, but note the comments on stability below. The input circuit of F2 has an "optional" stub which in some cases, when connected, can reduce the noise figure by a small amount. It is usually not required. The overall gain of the LNA is about 19-20dB and its own inherent noise figure is in the region of 1.9 to 2.5dB.

The output from the LNA goes to the RF port of the mixer via a microstrip matching network and a high-pass filter (C11) after passing through filter FL2 which provides about 20dB of image rejection (with a 144MHz IF). Note that FL2 can easily be tuned to the wrong image (10,080MHz), so care should be taken when tuning up (see later). The IF output from the mixer is fed to a low noise amplifier via a low-pass filter consisting of L10, a quarter-wave line, and

L11, to prevent 10GHz energy from reaching the IF amplifier. The IF amplifier is a well-proven design from another application [6], constructed in surface mount form to save space.

The board layout is shown in Fig. 2. Note that C12, the negative rail decoupling capacitor, is not shown as it is fitted on the reverse side of the board. It can been seen in Fig. 8, which shows how the power supply board is fitted.

The negative bias generator used to supply the gate bias for the FETs uses the same PCB as that used in the G3WDG-001 module (G4FRE-023). Two modifications have been made for this application - the use of a 7805 regulator and the omission of the Zener diode. The circuit is shown in Fig.3 and the board layout in Fig. 4.

Construction of the G3WDG-002 receive converter.

It is strongly recommended that the following procedures are followed in detail, and in the order described for both this and the subsequent design:-

1. Fit grounding PCB pins and filter locating pins (see later) and solder in place. Lightly tin around the edge of the groundplane.

2. Locate the PCB into its box and trim to a neat fit if needed, particularly in the corners of the box where there are joints. The PCB material will cut quite easily with a sharp scalpel blade and straight-edge. Locate the groundplane 17mm from the top of the open box and mark its position. Locate and mark the SMA socket centre-pin clearance holes. Drill the holes and de-burr. Locate, drill and de-burr holes for any feedthrough components needed for power supplies. Tack-solder the corner seams of the box and make sure that the lids are a neat fit. Adjust as necessary. Check also that the board will fit neatly. When satisfied, solder the corner seams fully. Solder the SMA connectors and the feedthroughs in position.

3. Relocate the PCB so that the input and output tracks touch their respective socket spills, tack-solder the PCB in place and, when satisfied that it is correctly located, solder all round the groundplane and solder the SMA socket spills to their respective tracks.

4. Solder the filters into position. Leave the tuning screws and lock nuts in position to avoid unwanted debris accidentally falling into the cavities. This completes the mechanical construction of the module.

5. Fit inductors L1 - L11, as specified in the parts list (Table 1), into position, ensuring that the wires lie flat to the board.

6. Fit all chip components using the mounting techniques described later. You will need a pair of fine-pointed tweezers to handle these small devices and, maybe, the assistance of a magnifier!

7. Fit all components which have leads, ensuring that static-sensitive devices (ICs, FETs, etc) are put on the board last of all to minimise the risk of damage to the devices.

Note:- it is best to apply the supply voltage to the board BEFORE fitting the FETs, to check that both the +5V and -2.5V voltages are present and correct on the respective tracks/pins. On completion of this test, disconnect power and solder in the devices only if everything checks out correctly.

Individual "build" techniques.

1. PCB-pin grounds.

Place the PCB-pins in the holes with the pin heads on the track side and the body of the pins sticking up through the groundplane, with the exception of the six filter-locating pins (see below). Place the head of a pin on something hard and flat and press the board until the head butts up against the track side of the board.

Solder by starting with the iron at the top of the pin; tin the pin generously and, while applying more solder to the joint, flow the solder down the pin and onto the groundplane to ensure good pin to groundplane contact. Trim the pin back using flush-cut cutters. Repeat until all grounding pins are fitted.

2. Fitting the filters

This is potentially the most difficult soldering operation on the board! Details of the cavities are given in Fig. 5(a), together with the dimensions of the coupling probe pins. First prepare the PCB by fitting the six PCB-pins which mark the filter cavity positions. These pins are fitted from the groundplane side through to the track side. Solder the pins to the pads provided on the track side and cut off excess pin length after soldering. The board is now ready to take the cavity filters.

Pre-heat each cavity in turn, with its tuning screw and locknut assembly in position. Heat it by placing on a hot plate (eg. a 3 to 6mm thick sheet of aluminium placed over a gas ring) and heat until 60/40 tin/lead solder melts easily on touching it to the cavity wall near the base (open end). Quickly transfer the hot cavity, using pliers to grasp the tuning screw, to the board, position it between the three guide-pin heads on the groundplane side of the board and apply fine (22 SWG or finer) solder at the junction of the board and filter to fix the cavity in place. Ensure the cavity does not jump outside the guide pins whilst soldering, ensure a continuous small fillet of solder all round the cavity, but do not apply too much solder. Allow the cavity to cool without disturbing it. When it has cooled fully, fit the PCB-pins which probe through the board and into the cavity, having pre-cut them to the length shown in Fig. 5(a). Note that the lengths are significantly different for the LO and signal filters: make sure you fit the right pins in the right places!

3. Inductors

For inductors using enamel covered wire (ECW), cut the required length of wire then scrape/chip the enamel from the last 1-2mm of each end using a scalpel blade. Tin each end.

For inductors using one strand of a standard multi-strand wire, tin one end and fit to the board as shown in Fig. 5(d): solder first at position 1, then at position 2 as close as possible to the apex of the triangle, then at position 3. If any excess wire remains at 1 or 3, trim off carefully with a scalpel blade.

4. Chip components

To fit chip components across two circuit tracks or pads, adopt the following procedure for best results: (see Fig. 6)

a. Lightly tin one of the tracks or pads. b. Fit component and reflow solder to make a solder fillet at the tinned side - the tip of the tweezers may be used to hold the chip in position whilst the solder solidifies. Use as little solder as possible to form a very small fillet. c. The component should now be secure: tin the other track and make a solder fillet on the second side of the chip component to complete the mounting. d. Resolder the first joint if required, using a little fresh solder.

This procedure ensures that the components are flat to the board, good contact is made and the best circuit performance is achieved.

5. Static-sensitive components

Components such as ICs and FETs should always be fitted last to minimise the risk of static damage. The GaAs FETs have the gate lead bevelled for identification, as shown in Fig. 5(b). Grounding of the two FET source leads is via PCB-pin ground "pads " fitted as shown in Fig. 7. Cut the source leads to minimum length, but note that before handling static-sensitive devices, you should make sure that you and the handling implements (eg. tweezers) are grounded together: it is often a good idea to work on a grounded sheet of aluminium foil spread on the work surface, resting the wrists on the foil, with the board and implements also on the foil when not in use. You may find, if using surplus GaAs FETs, that one source lead is already trimmed short. Cut the other to a similar length. Lightly tin the source grounding-pins and the ends of the lines - the same remarks about cleanliness and minimum amounts of solder apply here also!

Place the trimmed FET as shown in Fig. 7 and reflow the solder on one of the source leads, then the other. Push the gate and drain leads down flat onto the board as close to the FET as possible, cut off excess lead length carefully with a sharp scalpel blade, then solder them down to the respective tracks, making sure that the device is orientated the right way round!

Alignment with simple test-gear

Once completed, the PCB should be carefully examined for poor joints, accidental solder bridges and other forms of short circuit. Once satisfied that all is well, the alignment procedure may begin. You should already have checked before mounting the FETs and other semiconductors that the correct supply voltages will appear on the positive and negative supply rails when a 12V supply is connected to the input feedthrough capacitor.

1. Preset the FL1 and FL2 tuning screws as shown in Fig. 5a. Note that the 7.5mm dimension shown is the length of screw protruding from the locknut.

2. Turn the bias potentiometers RV1, RV2 and RV3 fully clockwise so that full negative bias will be applied to the gates of the three GaAs FETs when power is applied.

3. Insert a multimeter in series with the +5V supply between the regulator output and the +5V rail and set initially to, say, 500mA full scale deflection.

4. Connect some form of matched load to the 10368MHz input socket, such as a 10GHz-rated termination, attenuator or SMA-to-waveguide transition with a horn or similar well matched (low VSWR) antenna connected.

5. With no oscillator drive applied, apply +12v to the power input feedthrough. The indicated current should be no more than a few microamps. Switch the range of the multimeter as necessary. If considerably more current is measured look for short-circuits or misconnected components.

6. Adjust RV1 to give an indicated current of about 1mA on the meter.

7. Apply the LO signal (approx. 10mW at 2,556MHz). The indicated current should rise to approximately 7mA. The absolute level is not critical.

8. Connect a 144MHz ssb receiver to the IF output socket and tune C15 for a noise peak. This should be quite a significant peak if the IF amplifier is working correctly.

9. Carefully adjust the FL1 tuning screw a turn or so either side of the preset position. A small but clear drop in the 144MHz noise level should be heard at the correct tuning point. Lock the tuning screw in this position.

10. Adjust RV2 to cause the indicated current to rise by approximately 12mA, and RV3 to cause a further increase of 15mA. The total current shown should now be in the order of 34mA. The LNA is now powered up at approximately the optimium bias currents for the two FETs.

12. Preliminary alignment is completed by tuning FL2 for a peak in the noise level. Careful tuning will show that two peaks can be heard. The correct one is with the tuning screw at the smaller penetration. Lock the screw in this position.

13. If a signal source is available (maybe your, or your friends', G3WDG-001 personal beacon?), check that this can be heard satisfactorily. It is worth reconfirming that FL2 is set to the correct image by tuning it for maximum signal. If no such signal source is available, try listening for other local signals on the band, perhaps harmonics from lower frequency equipment.

14. Remove the test meter and make good the connection.

15. Final alignment can be done using a noise figure meter or weak signal to optimise the performance. Adjust RV1, RV2, RV3, FL1, FL2 and C15 for best results. If a noise figure meter has been used, recheck with a signal source or generator that FL2 is on the correct frequency, as the noise figure meter will not tell you if you are tuned to the wrong image!

After alignment, the converter should have a noise figure below 3.5dB. Prototypes have varied from 2.4dB to 3.3dB. The overall gain should be in the region of 27-30dB.

Stability

During the initial tuning-up phase, the module should be operated with both top and bottom lids off. Under these conditions the module should be perfectly stable with either a red or black FET in the front end. However, problems with stability were encountered in some of the prototypes when the lid was put on the component/microstrip side of the box. Note that the module works perfectly well without a lid and can be operated like this with no problems unless mounted close to another metal surface. In one of the prototypes the impedance connected to the rf input socket had an effect too. Quality of construction, particularly how well the groundplane of the board is soldered to the box, may also have an effect. Prototypes using black FETs seemed to be more stable than those with red FETs.

A common cure for lid-induced oscillations (often used in LNBs) is to mount a piece of lossy material to the lid above the LNA section of the unit. The choice of material is quite important and the material supplied in the kit is the same as that used professionally in many similar microwave applications. Black anti-static IC foam was tried initially but was not nearly as effective as the proper material. The lossy rubber should be glued to the inside surface of the lid above the 2 stage amplifier and should be as flat as possible. Note that lossy rubber on the lid does not degrade the performance; the author has often seen an improvement in noise figure of up to 0.2dB with the lid in place!

The approach to solving oscillation problems, which will be evident as excessive noise, burbling or crackly noises as the lid is squeezed etc, is left to the individual constructor. No doubt the safest approach is to use a black FET in the first stage and to use the lossy rubber right from the outset. This has been a total cure for all the prototypes built so far, although if you are after every tenth of a dB of performance (and have the means to measure it!) then building with a red FET and perhaps operating "lid free" may be best for you. Please do not hestitate to contact the author if you are in difficulties - I will do my best to help.

Other Applications

As described above, the application is for narrow-band use at 10,368MHz. However, the design has been made sufficiently wideband so that the unit can be used anywhere in the 10,000-10,500MHz band with virtually the same performance. All that has to be done is to choose the appropriate LO frequency and tune FL1 and FL2 to the desired LO and RF frequencies. Two particular applications might be in the 10,450-10,500MHz band for receiving future amateur satellites, and, lower down in the band, for ATV.

A large amount of flexibility also exists with the choice of the IF frequency, limited only by the tuning range of the "144MHz" tuned circuit. However, IFs below 144MHz are not recommended for high performance applications as the image rejection will be insufficient and the noise performance will suffer. (You will not see this on a noise figure meter, though, so beware!) Higher IF frequencies should be possible by modifying the IF amplifier, although this has not been tried by the authors. However, the mixer on its own has good performance with IFs up to at least 1.3GHz. For ATV use, it should be possible to accommodate a standard amateur fm tv signal within the FL2 bandwidth, but the IF bandwidth might be too narrow. A damping resistor across L12 should increase the bandwidth, but this has not been tried. A better solution would be to use a higher IF, eg 480, 612 or 1240MHz with a modified IF amplifier to suit. If a higher IF frequency is used, the bandwidth of FL2 could be increased by using longer probes. The authors would be pleased to hear of work done to use the G3WDG-002 for 10GHz ATV.

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Typeset

G3PFR, **R.Mudhar(SWL)**

Graphics

G4DDK, G4FRE and G3PFR

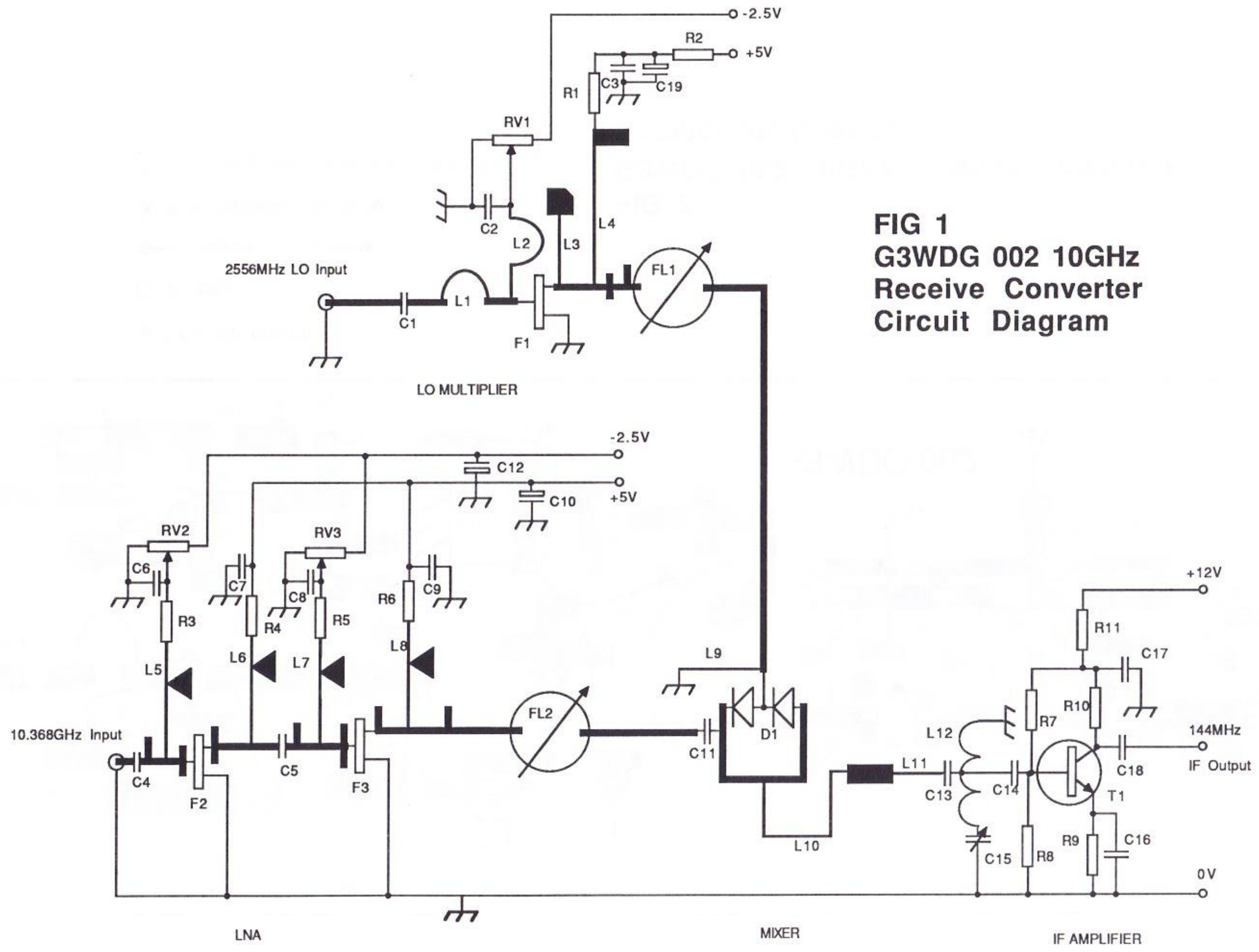
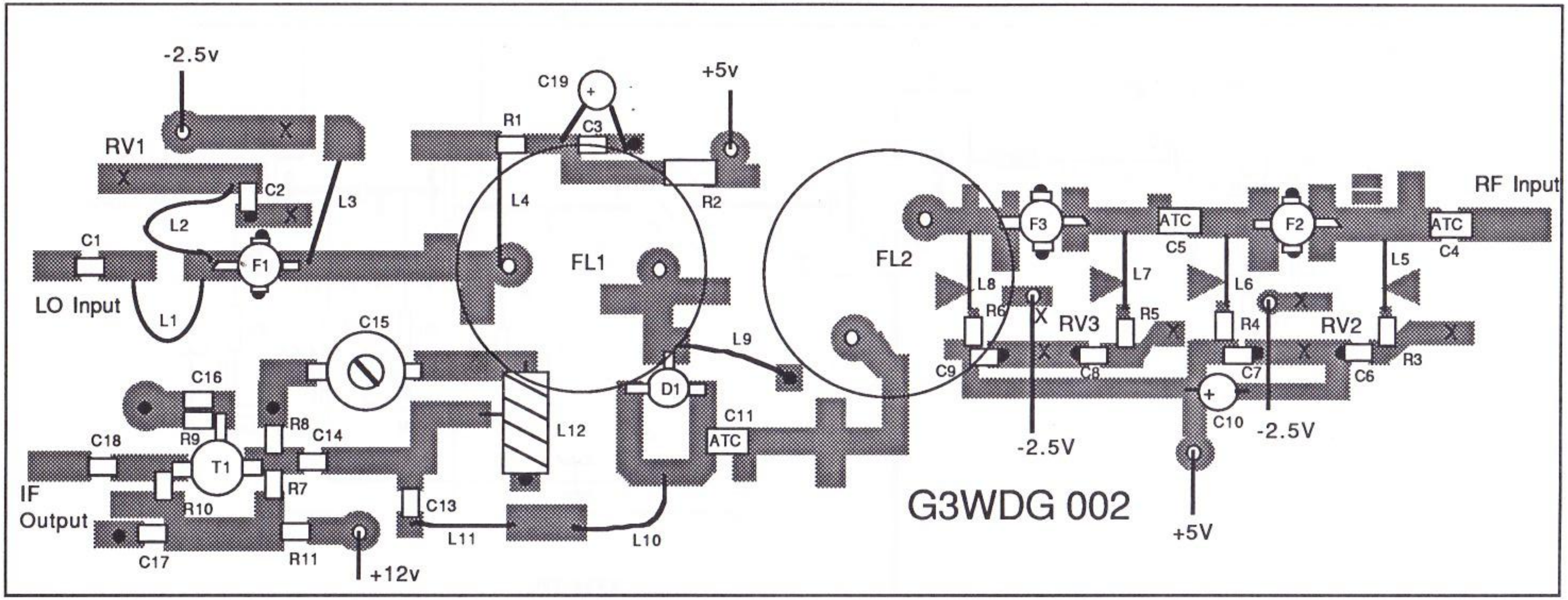


FIG 1
G3WDG 002 10GHz
Receive Converter
Circuit Diagram



- Vero pin ground
- O Probes
- Supply connections
- X Potentiometer mounting

C12 on the groundplane side of the PCB

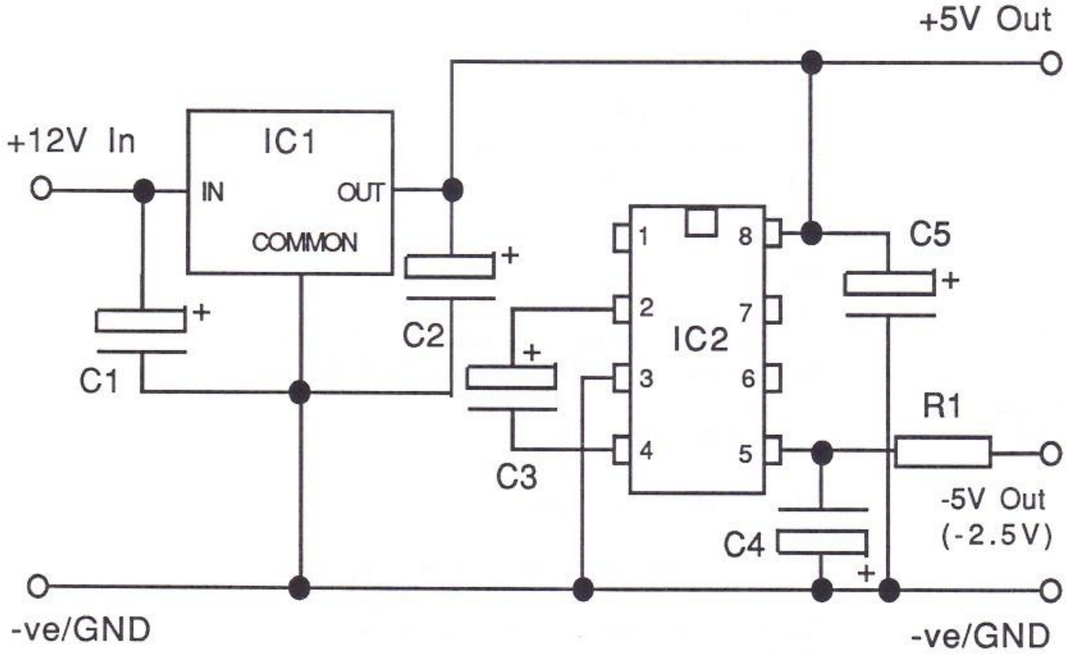
FIG 2
G3WDG 002 10GHz Receive Converter
Component Overlay

TABLE 1

COMPONENT LIST FOR THE G3WDG002 RECEIVE CONVERTER

Semiconductors	
F1,3	Birkett black spot P1108
F2	Birkett red spot P1145 or black spot P1108 (see text)
D1	Alpha series dual diode
T1	BFR90/91
Resistors	
R1,3,4,5,6	47R SMD 0805 Size
R2	220R SMD 1206 Size or 1/4W leaded
R7	18k SMD 0805 Size
R8	4k7 "
R9	270R "
R10	100R "
R11	560R "
RV1,2,3	2k2 Horizontal preset. eg Allen Bradley 90H, Bourns VA05H or 3309, Philips OCP10H etc
Capacitors	
C1,2,3,6,7 8,9	220pF SMD 0805 Size
C13,14,16 17,18	1000pF SMD 0805 Size
C4,5,11	2p2 ATC Chip capacitor, 100 or 130 series
C12	22 to 47uF Tantalum bead, 10V Wkg
C10,19	2u2 to 10uF Tantalum bead capacitor, 10V Wkg
C15	30pF trimmer, 5mm diameter. eg Murata TZ03Z300. (Green)
Inductors	
L1	16mm length of 0.315mm diameter ecw, formed into a hairpin. 1mm each end to be tinned and soldered to the tracks as shown.
L2	As L1, but 19.5mm long.
L3 (8mm)	Straight length of 0.315mm diameter ecw, tinned 1mm either end as above. The wire should be soldered to the edge of the stub and as close to the drain connection of F1 as possible.
L4	Straight length of 0.315mm diameter ecw, tinned 1mm either end as above. Solder between the stub edge and the probe connection to FL1.
L5,6,7,8	Straight length of 0.2mm (not too critical) tinned or silver plated copper wire. Solder between the track, stub point and terminal pad as shown.
L9	10mm length of 0.2mm diameter wire as L5. *Bend* to fit between earth pin and mixer connection.
L10,11	20mm length of 0.2mm diameter wire as L5. Solder between mixer centre, stub and C13 as shown.
L12	4 Turns of 0.6mm diameter tinned or silver plated copper wire. Wound to 5mm inside diameter, turns spaced half wire diameter. Centre tapped. Mount 1mm above the board.

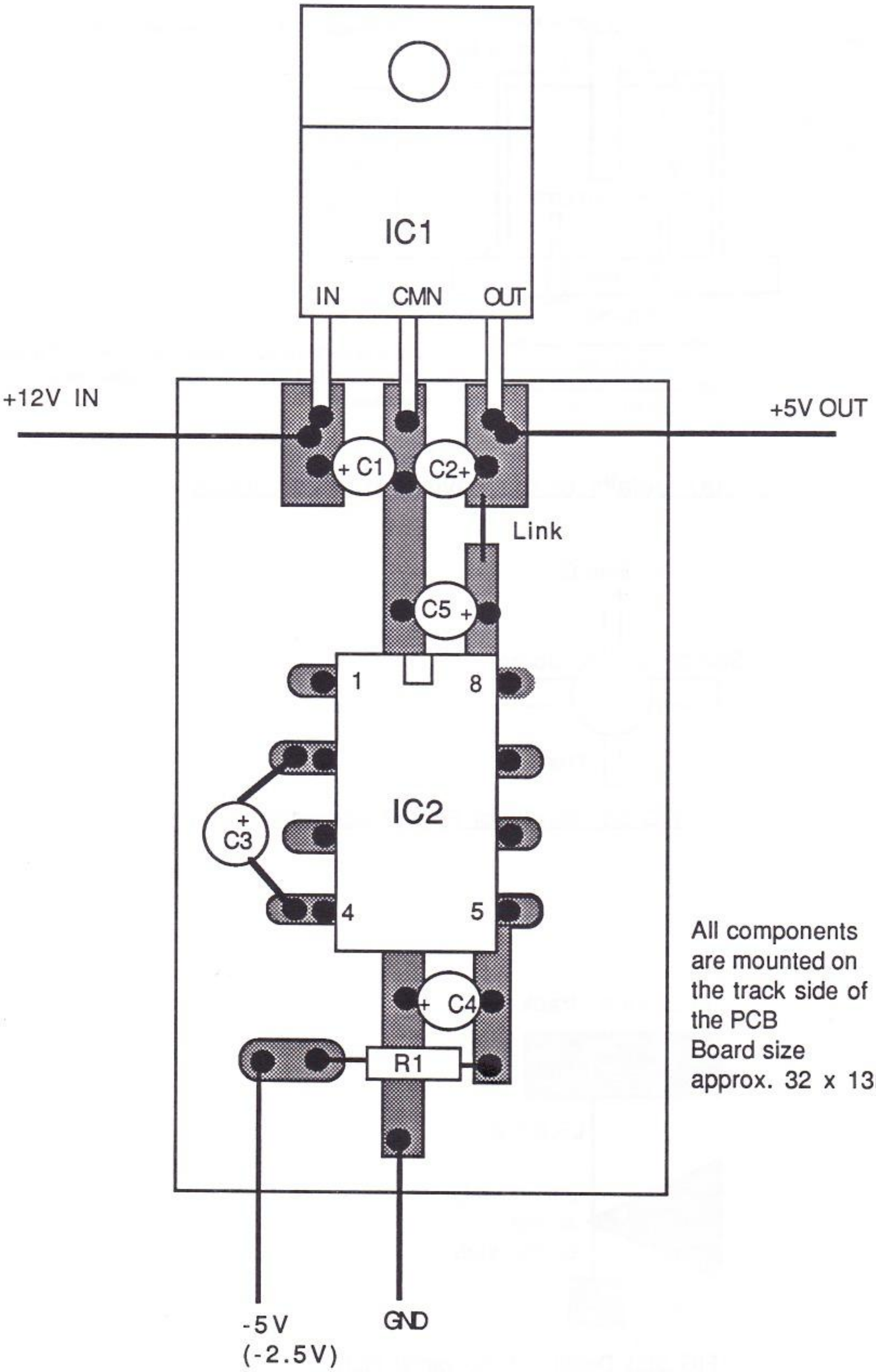
Miscellaneous Tinplate box type 7754 (37 x 111 x 30mm): 33 off 1mm diameter Veropins (RS 433-854): 2 off SMA flange mount sockets: 1 off SMB/C Flange mount socket (for IF): FL1/2 Cavity resonators. See text and diagrams for details: 1000pF feedthrough capacitor: G4FRE regulator board and components (see fig 4).



<u>Component list for the regulator circuit</u>

IC1	uA7805
IC2	ICL7660CPA
R1	680R 1/4W metal film
C1	1uF Tantalum bead, 16V Wkg
C2	0.1uF Tantalum bead,10V Wkg
C3	22uF Tantalum bead,10V Wkg
C4	22uF Tantalum bead,10V Wkg
C5	10uF Tantalum bead, 10V Wkg
PCB	G4FRE-023

Fig 3 Regulator circuit



All components are mounted on the track side of the PCB
Board size approx. 32 x 13mm

FIG 4 Regulator layout

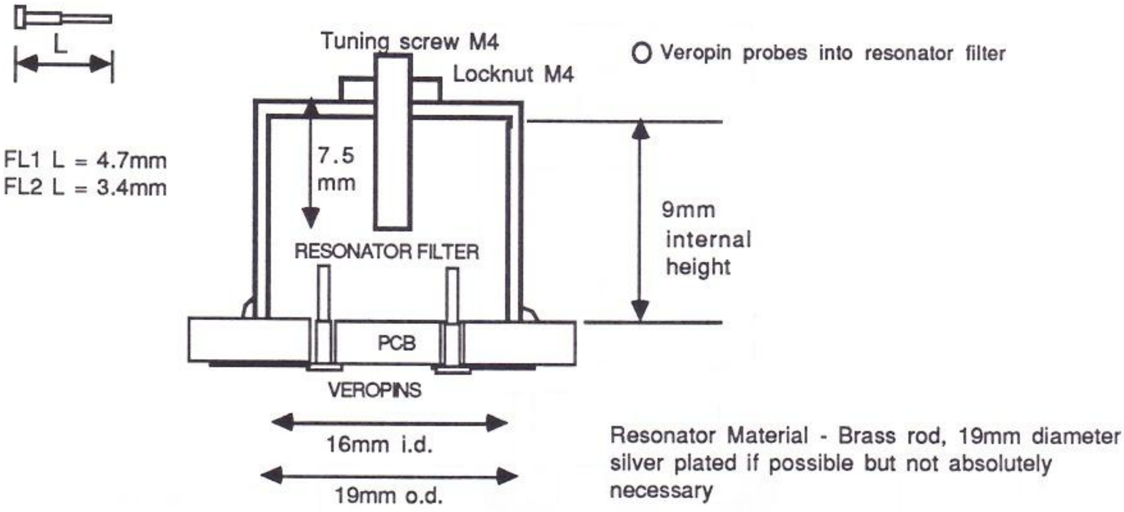


FIG 5(a) Details of the cavity resonator filters

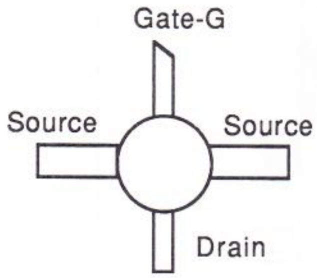


FIG 5(b) Details of F1,2,&3 connections

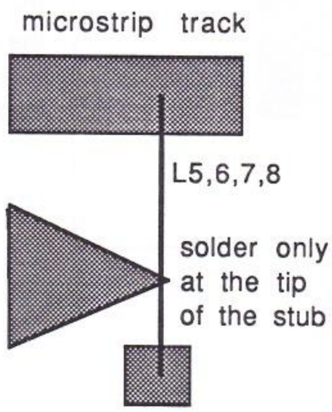
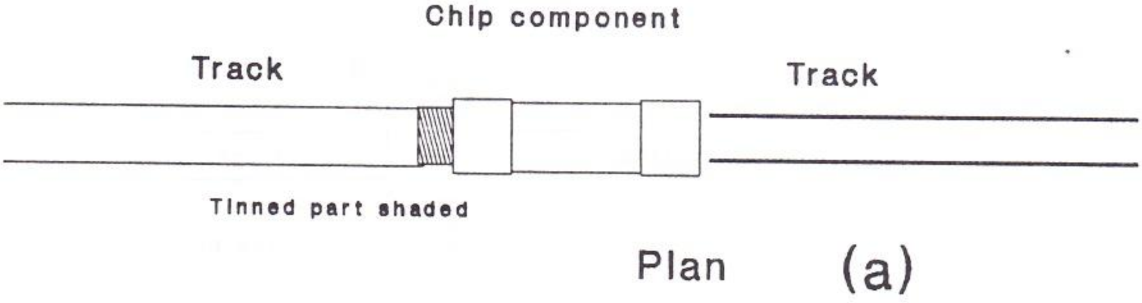


FIG 5(c) Details of the radial stub connections to the bias chokes



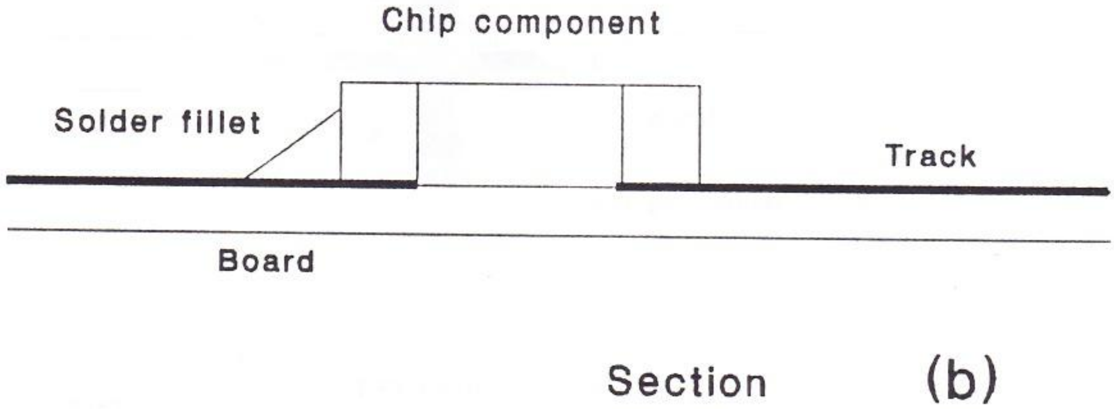


Fig. 6 Fitting chip components

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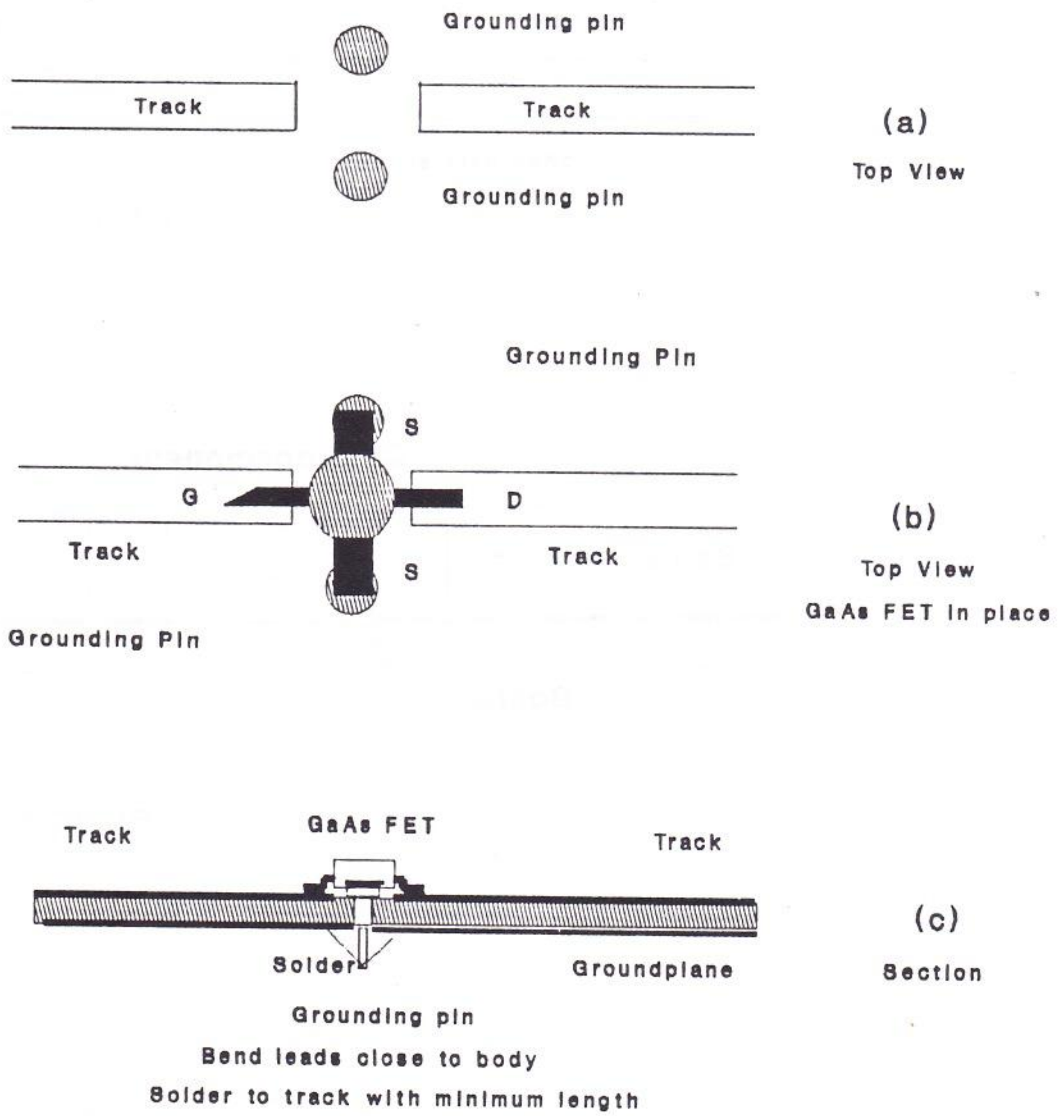

Fig. 7 Mounting GaAs FETs

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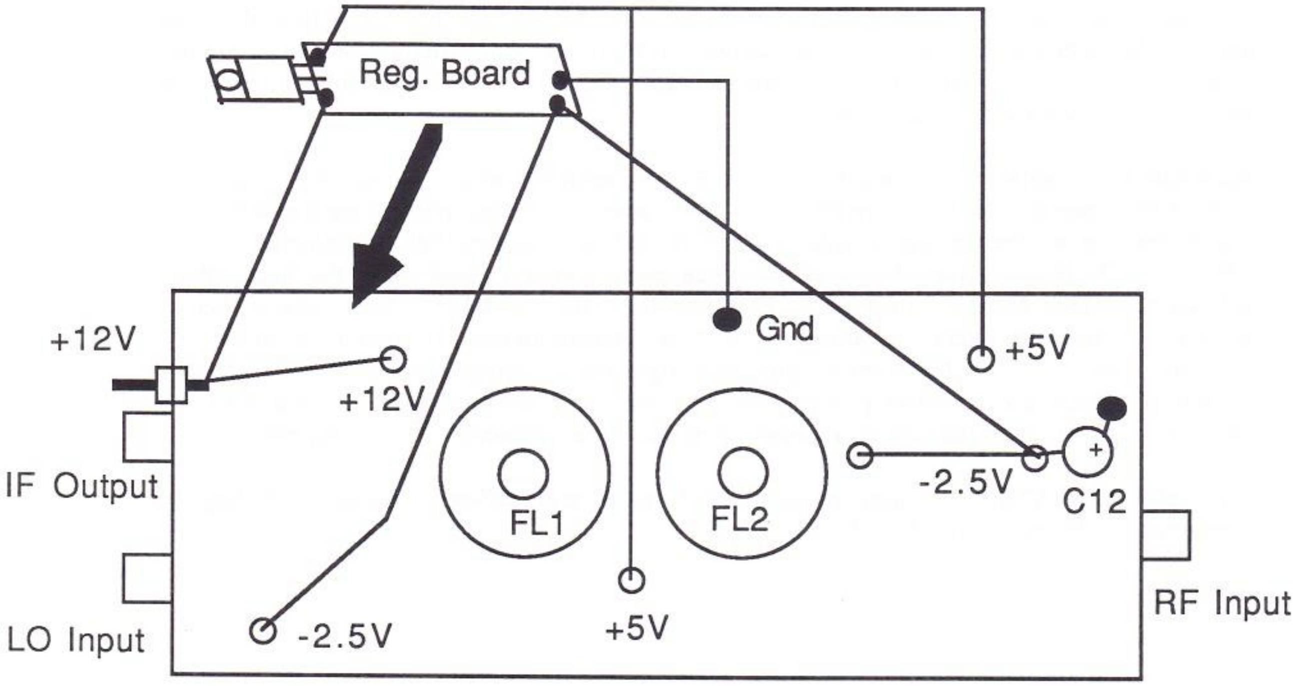

FIG 8
Wiring arrangement for the G3WDG002 receive converter

Appendix 1

G4FRE023 Regulator

Figure 3 shows the recommended regulator circuit for the receive converter. The circuit consists of a 5V integrated circuit regulator to provide +5V for FET drain bias, and a negative voltage inverter circuit consisting of an ICL 7660 and associated components to provide the -5V gate bias.

The regulator may be built-up in any convenient form, but the G3WDG002 short kit includes a G4FRE023 regulator PCB. This may conveniently be housed within the upper part of the specified tin-plate box as shown in figure 8. Construction of the regulator is a little unusual in that the components are all mounted on the track side of the PCB. *No holes are required in the PCB.*

Although the regulator provides both +5 and -5V outputs, when connected to the G3WDG003 board the -5V is reduced to -2.5V across the bias potentiometers RV1,2 and 3 because of the voltage divider formed by R1 and the parallel combination of RV1,2 and 3. If the value of any of the three potentiometers is changed the bias voltage will change. This can be remedied by changing the value of R1 on the regulator board so that it equals the parallel value of the three potentiometers. It should be noted however that the ICL7660 inverter produces significant voltage spikes at the switching frequency. These are effectively suppressed by the filter consisting of R1 and C12. If the value of R1 is significantly reduced then the filter becomes less effective!

ICL 7660 and uA7805 ICs may be obtained from several different sources including RS Components, Farnell, and Maplin.

Appendix 2

Components

The "Modern High Performance Equipment for 10GHz" series of modules were designed specifically to use the surplus series of GaAs FETs available from Birketts of Lincoln. There are two devices available. The black spot device is designed for use in the oscillator stage of an LNB and the red spot as the low noise amplifier (LNA) stage. It may be possible to use alternative devices but this has not been tried by the authors and no guarantee can be made for performance if components are substituted. Please note that the "3 for £1.99" devices from the same source are not suitable for this application.

The RSGB microwave component service short kit consists of:-

ITEM	QUANTITY
RF printed circuit board G3WDG002	1
DC printed circuit board G4FRE023	1
Veropins	33
Cavity filter	2
Mixer diode	1
2.2pF chip capacitor (loose)	3
220pF chip capacitor	7
1000pF chip capacitor	5
47R chip resistor (dark green)	5
18k chip resistor (blue)	1
4k7 chip resistor (green)	1
270R chip resistor (orange)	1
560R chip resistor (red)	1
100R chip resistor (no colour)	1
0.315mm wire	1
Lossy rubber	1
Booklet	1

To complete construction of the receive converter you will need to obtain ALL of the remaining components in table 1, including the regulator components.

Many of the other components such as BFR91, tin plate box, feedthrough capacitor etc, are available from Piper Communications, Didcot, Oxon.

Other useful suppliers are:-

Maplin

RS Components

Farnell