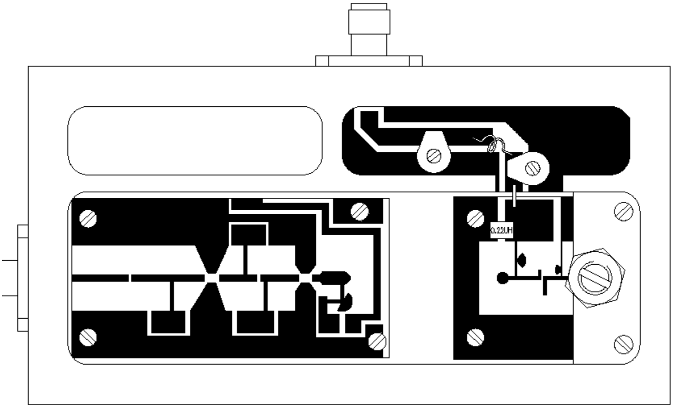
Chapter 7

Transverters and Converters

Improved I.F Matching at 1296MHz for the DB6NT 47GHz Transverter

Paul Widger, G0HNW and Martin Farmer, G7MRF



Following early tests on 47GHz, with the matching network (see figure 1 above) as described in the last issue of the Microwave Newsletter, our "group" in the North West decided that, whilst the circuit did work, it was not very good on receive. This was evident when David,G8VZT/P and Martin, G7MRF/P, were at the Stiperstones in Shropshire during the 24/47GHz contest. Signals from David, G0IVA/P, at Merryton Low were very strong on the transverter that had been modified as described below but on the transverter with the original matching circuit G0IVA's signal could not be heard! Paul, G0HNW, did some bench work on the original matching network and found it would not perform to his liking – so out came the knife and Paul's theory about the pad on the IF being too big at 1296MHz was put to the test.

The pad and the coil seem to be resonant at about 139MHz in their original configuration (figure 2) so

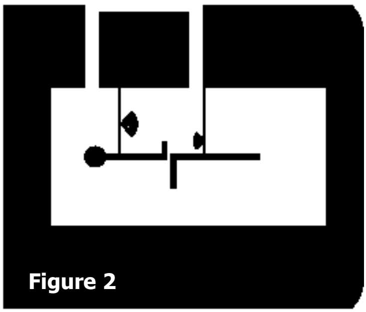


Figure 2

G0HNW cut the pad on his PCB to suit the direct attachment of.085 semi-rigid coax cable. The modified pad is shown in figure 3 on the next page.

As can be seen in figure 4, the semi-rigid cable passes through the wall of the machined case and is held in position by a small, thin piece of brass shim soldered to the outer casing of the cable and then fastened down with the PCB screw. Paul used a small solder tag to achieve the same result.

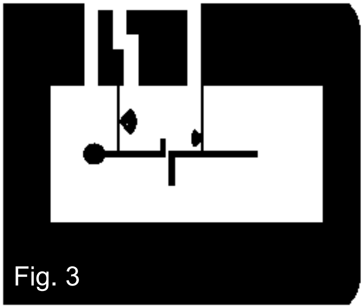
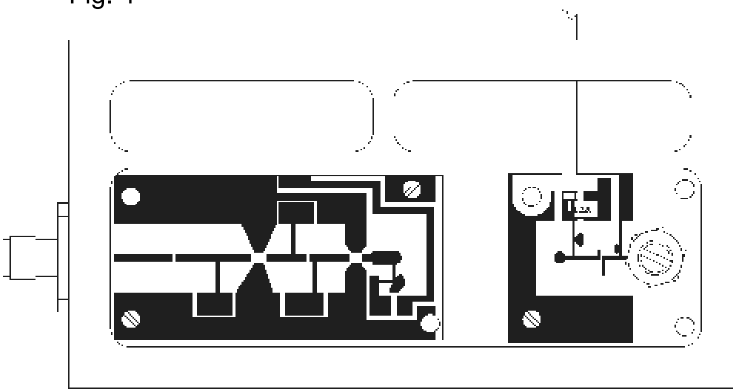


Fig. 3

It was thought that the 15 milliwatts of 1296MHz drive required in the DB6NT design was too high a level for the new layout. After some tests by G0HNW, a value of 1.5milliwatts
was arrived at.

G7MRF has also modified his transverter in line with this and also ended up by reducing the drive level, down to 4.5miliwatts. This was achieved by G0IVA/P watching the S-meter on his receiver over the 90km path being worked at the time while a variable attenuator was used on the IF transmit line to determine the best level.
The original matching circuit will be returned to for further investigation in the future when time allows.
Following the modification, G8VZT was able to take signals over a 133K path whereas before, over 90Km, nothing could be heard!

Fig. 4



G3WDG040 S-Band Downconverter

Charlie Suckling, G3WDG

Introduction

The G3WDG040 S-Band downconverter is a very low noise figure downconverter from 2.4GHz to 144MHz. It incorporates a HEMT LNA and modamp second RF stage, an image rejection filter, sub harmonic mixer, IF amplifier and local oscillator.

The design is based on two already well-proven designs, the WDG010 2.3GHz transverter and WDG016 local oscillator, the latter being a development of the G4DDK001 design. The HEMT LNA is based closely on the excellent DJ9BV preamp. The HEMT preamp stage is unusual in that the HEMT operated with zero volts on the gate.

It has been found that, with the WDG010 transverter (and WDG025 and 026 preamps), the optimum noise figure for the HEMT at this frequency occurs when the gate voltage is only very slightly negative and that the NF with 0V on the gate is only a few hundredths of a dB higher. Therefore it was decided to dispense with the negative voltage generator used in the other designs to save complexity and reduce cost. The prototype converters have an overall noise figure of about 0.65dB, with a conversion gain of about 38dB. The high gain will allow a reasonable amount of cable loss between the converter and the 144MHz receiver without significantly degrading the system noise figure. In case it is felt that this gain is excessive, it ought to be possible to leave out the modamp IF amplifier, and bridge the input to output with a piece of wire. Be prepared for a possible loss in overall receiver sensitivity if this is done, however, depending on individual circumstances.

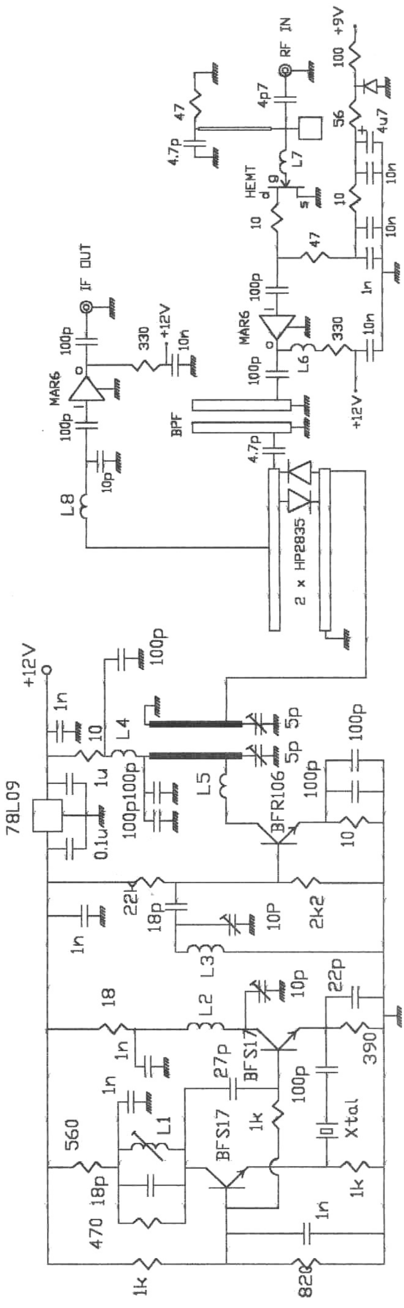
Provision is made on the board for the DC power to be fed up the cable. A bulletin to anyone interested in trying this on request. The extra components to do this will be provided separately.

Construction

The circuit diagram and the parts layout is shown on the following page. Construction follows the general methods used for previous WDG modules . Special points to note are that coils L2 and L3 need to be wound and shaped so that when fitted to the board they are nearly touching, in line, at the same height and with closely spaced turns. It is best to shape the coils and bend the leads before soldering them in place as the tracks may be lifted off the board if too much mechanical force is used later. Also, locate the two 5pF trimmers so that they are touching and position the oscillator coil so that the indent in the top plastic is to the right (i.e. nearest the voltage regulator).

The crystal is mounted through the board and the can is not to be soldered to ground or touching the ground plane. The leads of the oscillator coil and the trimmer capacitors are bent outwards so that the components sit flat on the board.

The choice of RF connectors is left to the constructor. The prototypes used gold plated SMA types soldered to the box. SMA types have the advantage of being not only first-class RF connectors but also do not require much mechanical force to mate. This avoids the possibility of flexing the box excessively when mating/de-mating connections, leading to possible damage to the unit (e.g. cracked chip capacitors). If the unit is to be mounted in a waterproof box later, it may be


78L09
+12V
1n
10
L4
1u
0.1u
100p
100p100p
5p
5p
L5
BFR106
100p
10
22k
18p
10P
2k2
1n
L3
L2
18
10p
22p
1n
27p
BFS17
BFS17
390
100p
560
1n
L1
BFS17
1k
Xtal
470
18p
1k
1n
1k
820
L8
10p
100p
MAR6
100p
IF OUT
330
+12V
10n
BPF
4.7p
2 x HP2835
100p
L6
MAR6
100p
330
10n
+12V
1n
47
10
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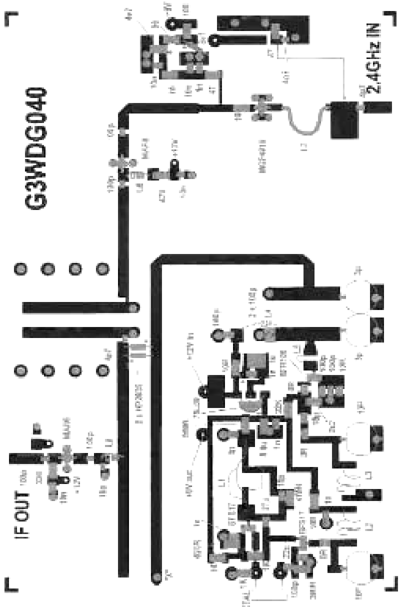
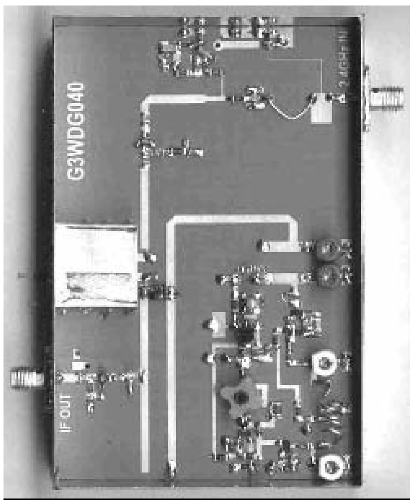

G3WDG040
IF OUT
2.4GHz IN


G3WDG040
IF OUT

worth considering connecting coaxial cables directly to the unit. Suitable cables would be thin semi-rigid or ptfe dielectric flexible. These can be connected with the inner passing through a hole in the wall of the box, with the outer folded back at 90 degrees to the cable, strand by strand (to form a disc not twisted together as one) and soldered to the outer of the box. Suitable chassis-mounting connectors fixed to the walls of the waterproof box are then fitted to the other end(s) of the cables.

A photo of the track side showing the components and a component placement diagram are shown alongside the circuit diagram.

Tuning-up

The first step is to tune up the LO chain. Preset the core in the oscillator coil to be level with the top of the former. Take care not to crack the core. Proper trimming tools for these cores are very expensive. I use a ceramic bladed screwdriver which has a blade which just fits across the diagonal of the square hole, and have only broken one core to date. Preset the trimmers to the positions shown in the photo (note the white blobs in the figure correspond with the square indentations in the top of the trimmer where it is adjusted). Apply +12V to the input of the voltage regulator, leaving all other power wiring as yet not connected. The current drawn will probably be in the region of 25-30mA. Adjust the left hand white trimmer (the one connected to L2) slightly to peak the current, followed by the other white trimmer and then the oscillator coil core.

It should be possible, after retuning a few times, to get the current up to near 50mA. We recommend using a ceramic bladed trimming tool to adjust the trimmers to avoid detuning by the trimming tool. If such a tool is not available it may be possible to trim a matchstick or similar insulating material to fit the top of the trimmer. The use of a metal-bladed tool will cause severe detuning. If 50mA current is not achieved, try adjusting the spacing between L2 and L3 (keeping the turn spacing tight) followed by readjusting the 10pF trimmers to peak the current as far as it will go.

Switch off and complete all the underside wiring. Connect the 144MHz receiver to the IF out socket and a good 50 ohm load (matched load, 10dB or greater attenuator or a long length of lossy cable) to the RF input. On switch on, there should be a considerable increase in noise at 144MHz.

Some or all of this will be coming from the IF amplifier. Next, adjust the blue trimmers slightly to peak the noise. This should get the output filter in the LO on tune. Once the LO is running properly there should be a lot more noise than with the LO off tune, and the noise should drop very noticeably if you put your finger on top of the RF filter lines. If a noise figure meter is available, the noise figure of the unit can be optimised by bending L7 up and down (careful not to lift the tracks), or by adding tuning tabs to the wide line in the input, on the opposite end to where L7 is joined.

Tuning adjustments are unlikely to improve the NF by more than .05dB, so don’t be too concerned if you are not able to do this!

This completes the adjustment of the unit. If things don’t work out, don’t despair! Troubleshooting methods might include using an FW radio to check that the 94MHz oscillator is running, loop/diode detectors to look for RF around L2/L3 and possibly the output LO filter. For reference, the crystal runs at 94MHz, L2 and L3 are tuned to 282MHz, and the final filter is tuned to 1128MHz. The final doubling takes place in the mixer. The BFR106 thus acts as a x4 multiplier and produces (in the two prototypes at least) about -1dBm output power at 1128MHz. The mixer needs -3dBm to 0dBm for best operation, although it will probably work well over a wider range of LO levels. It is hoped that the -1dBm level the LO seems to generate will leave enough margin to make this a relatively uncritical design. The most likely cause of poor performance is low LO power. If suitable test equipment is available, the first stage in diagnosing problems is to check out the actual LO level being generated.

The easiest way to do this is to break the track leading from the final LO filter to the mixer by cutting a small gap with a scalpel blade and solder a piece of thin coax (flexible, or 085 semi-rigid) to the microstrip line connected to a power meter. The ground is provided by drilling one or two holes in the ground plane no more than 2mm away from the line, and inserting Vero pins or similar soldered to the ground plane. Later revisions of the PCB have this ground pad in place. After checking the LO level and making adjustments to bring it to the correct level, the coax is removed and the gap repaired with a piece of thin brass or copper foil.

Final Checks

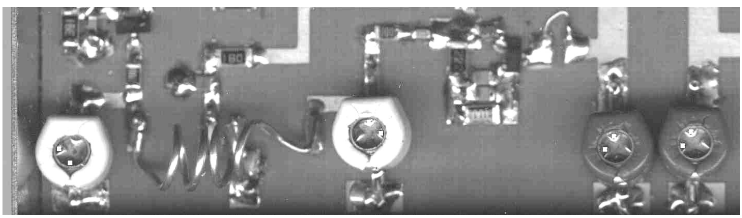
The best way of checking that the downconverter is working is to test it on air. There are two ways of doing this which do not require any specialised test equipment. Both require the use of an antenna.

The first way of checking the unit only needs a low-gain antenna such as a small helix (e.g. G3RUH dish feed). Take the downconverter and receiver outside where you have a good clear view of the sky overhead. Connect the antenna to the downconverter and listen for a change in receiver noise level as the antenna is pointed first towards the ground (the antenna should be kept a few feet above ground level to prevent detuning) and then towards the sky. If all is working correctly, there should be a very noticeable drop in noise when the antenna points skywards (5-dB). If little or no change is heard, there is probably something needing investigation. The second way of checking the receiver is to look for sun noise, but this requires a larger antenna such as 60cm (2ft) dish or larger. With this size of dish, a small increase in noise should be heard when the antenna is pointed at the sun compared to at clear sky. Sun noise may be used to optimise the antenna, for example to find the best position for the feed. The sun noise signal level is more constant than from a satellite, albeit a lot weaker. With dishes around 1.2m (4ft) the sun noise should rise to about the same level as the ground noise.

Coil Details

L1 Toko coil (supplied in kit)
L2, 3 2t 0.65mm wire, 4mm inside diameter, approx 2.5mm above board
L4 6t 0.25mm wire, 2mm inside diameter, approx 2mm above board
L5 hairpin of 0.25mm wire, flat on board, size as per photo – no longer than shown!
L6 4t 0.25mm wire, 2mm inside diameter, approx 2mm above board
L7 15.5mm length 0.5mm silver plated wire, ends bent down approx 0.5mm, approx 0.5mm
above board (adjusted for best NF). Note: wire supplied is LONGER than this and needs to be cut!
L8 as L6

Note: The easiest way of achieving the correct internal diameter for a coil is to wind it on a former (e.g. a drill bit) with a diameter the same as the required internal diameter.

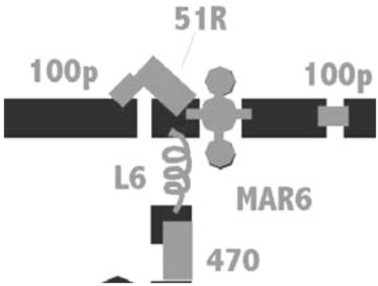


WDG040 Update Bulletin 1 - High Gain "MAR-6"

We have recently come across one example of a WDG040 which had unusually high conversion gain (47dB instead of the usual 39-40dB). This is not a problem in itself, but did lead to lid-induced oscillation problems, requiring the LNA screen described in the Appendix to the construction notes to be fitted. The converter was then stable, but still had the very high gain. [Lid-induced oscillations can manifest themselves as either a large increase or decrease in noise when the lid is fitted, usually accompanied by a very large drop in overall sensitivity].

We have traced the high gain to the MAR-6 device used in the RF amplifier section. After contacting the manufacturer (Mini-Circuits), it seems that the die used in the MAR-6 has been replaced with a different type, which has a lot more gain at 2.4GHz than the previous one. They did this without telling any or all of their customers (thanks Mini- Circuits!). The new MAR-6 have (difficult to read) laser markings on the top of the package, while the previous ones with normal gain have white paint markings. Thus the two types are easily distinguishable.

As noted above, the fitting of the extra screen over the LNA (as well as the one over the filter, which should be fitted as standard) should cure the problem. The screen needs to be soldered to the sidewalls of the box in several places per the photo in the write up. Insufficient soldering points may render the screen ineffective. We have found a simple way of reducing the extra gain back to nominal, should this be required. The "fix" is to add a series 51 ohm 1206 chip resistor to the output of the MAR-6 in the RF amplifier section. By orienting the 100pF and 51R resistors at an angle, the pcb does not need to be modified. The arrangement is shown in the diagram below.



Screens in WDG040 / MAR-6 and MSA06

Someone asked if the "51 ohm resistor" means that the small screen over the filter will not then be required.
The little screen over the filter is still a requirement.
The extra screen over the LNA section noted at the end of the booklet hopefully will then not be needed but be prepared to fit it if the unit is difficult about working with the lid on!

Measurements and Enhancements to the G3WDG 13cm Transverter

Bryan Harber, G8DKK

Background
I have a WDG010, 13cm transverter that has a beta version board. The measured performance of the receiver is excellent: 1.2dB NF (Adastral Park Round Table 1999). On transmit, the beta version board delivers 1mW maximum from the single MAR6 MMIC that follows the mixer + filter combination. Later versions of the board have a second MAR6 to increase the output level to around 3-5mW.

I have the companion WDG035 PA, also the earlier IC based version (now obsolete), that is specified to deliver 1W output from 5mW of drive. The output power of the transmit converter/amplifier combination measured with my professional microwave power meter is 500mW. This indicates the amplifier gain of 27dB is about 4dB greater than predicted. During the process of measuring the 1W output, a disturbing feature was observed: with no 144MHz drive applied the power meter was showing an output power of –7dBm, 34dB below the wanted output power. The 144MHz source had been disconnected and the transverter manually set into the transmit mode to confirm the problem.

Further Measurements
The transverter was taken into my place of work and the transmit output observed on a microwave spectrum analyser. The source of the unwanted output was the 2176MHz LO component that was indeed at –7dBm at the PA output.

The output spectrum is shown in **Figure 1**.

Removing the PA and measuring directly at the transmit output of the transverter module showed the 2176MHz signal was now at –34dBm as expected. A further unwanted component was also observed at 1088MHz but this is more than 50dB below the wanted output and some 20dB below the level of the 2176MHz signal.

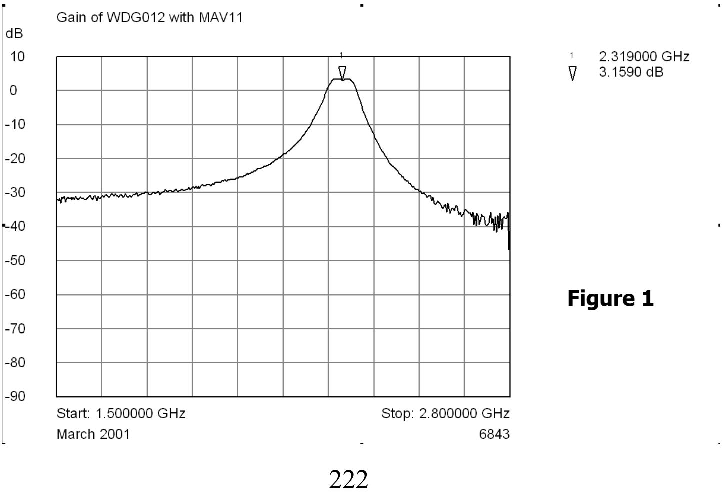


Figure 1

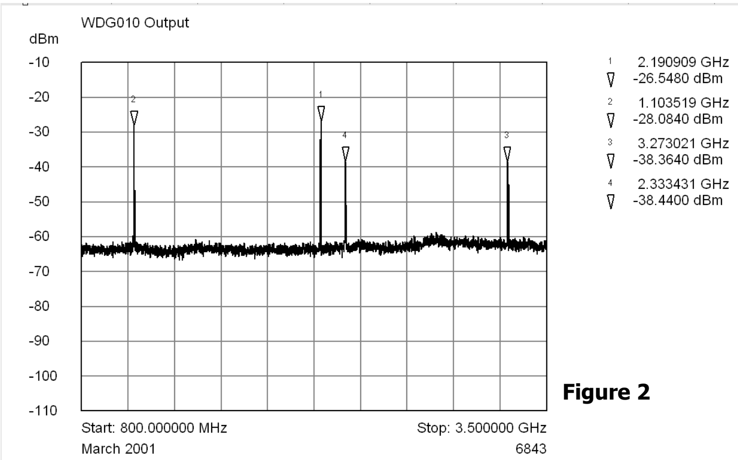


Figure 2

These results were entirely compatible with the design that uses just a single filter, consisting of 2 coupled lines, following the mixer.

Enhancement Solution

A few dB of extra gain is required to drive the PA to full power and an additional 20dB of filtering of the LO signal would reduce the LO leak signal.

Still in the Microwave Components Committee development list is the WDG012 filter/amplifier module. This module is configured with a filter identical to that in the transverter followed by a MMIC amplifier, an MAV11, contained in the smallest (37mm x 37mm) tin-plate box. I obtained one of these modules and completed it in 2 hours.

The measured response is shown in **Figure 2** above. A gain of 3.15dB was obtained with an input power of approximately 1mW that represents an output power of +3.5dBm or 2.25mW. As can be seen in the plot the marker at 2176MHz shows that the filter provides a rejection of some 20dB compared with the level at 2320MHz. The filter also gives around 50dB rejection at the LO sub-harmonic frequency of 1088MHz. Connecting the WDG012 module to the transmit output of the transverter provides a much improved spectrum, in fact I was now unable to measure the 1088MHz signal and the 2176MHz signal has dropped to a very satisfactory 35dB below the wanted signal level.

In the spectrum shown in **Figure 3**, the spectral line at 2.320GHz (marker value 2.333431GHz) is shown with the applied drive level 30dB lower than that normally applied by the 144MHz transceiver.

Further Enhancement

All looked good but I was surprised that the MAV11 provided only just more than 3dB of gain until I studied the manufacturer's data for this device. It is rated to only 1GHz and although I may not have an ideal grounding of the device it explains why the gain is lower than expected, although adequate in this application. The output power and output –1dB gain compression point are also satisfactory at 2.25mW and +12dBm respectively.

I had recently come by some of the newer ERA series of MMIC amplifiers and decided to try the ERA4. This

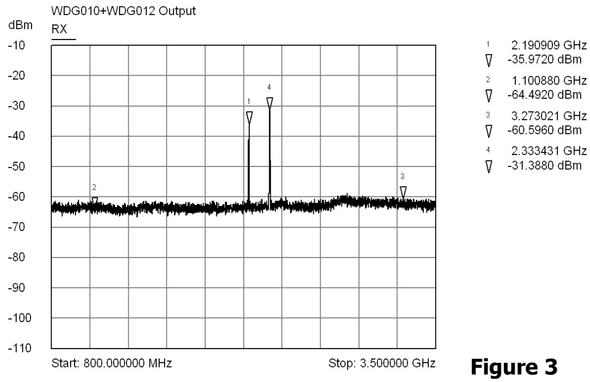


Figure 3

device is rated up to 4GHz with a –1dB compression point of +15dBm. I exchanged the MAV11 for an ERA4 and re-measured the amplifier with the following results:

Gain is now 9dB at 0dBm (1mW) of drive giving an output power of 8mW and the –1dB output gain compression point measured as +15dBm (30mW) with an input power of +7dBm (5mW). All of the filter characteristics remain unchanged and no sign of spurious oscillation was observed on the spectrum analyser. The measured response of the WDG012 with ERA4 is shown overleaf in **Figure 4**.

Final Results

The completed modules are now assembled in a waterproof ABS box that is mounted just below my 13cm Yagi antenna. The completed transverter consists of: WDG010 transverter module, WDG012 amplifier/filter fitted with ERA4, WDG035 PA (early IC based version, now obsolete). The final output power of the combination of transmit converter + amplifiers measured with my microwave power meter is 1.1W.

Conclusion

The WDG012 module provides worthwhile additional filtering to the WDG010, 13cm transverter in that
it reduces the output levels of unwanted products that will otherwise be amplified by the following broadband amplifier stage (s). Fitting the ERA4 in place of the MAV11 seems to give a worthwhile, although not essential, improvement in the performance of the WDG012 module.

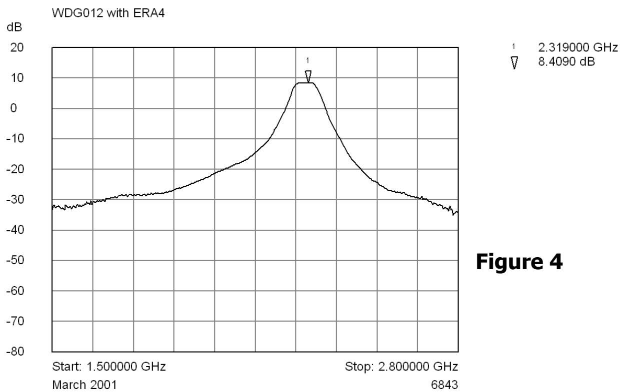


Figure 4

Experiences with the DB6NT 5.7GHz Transverter

Paul Marsh, M0EYT

After having a few years of operation during the 10GHz cumulative contests and being asked, repeatedly, if I was QRV on 5.7GHz, I decided that it would be a good idea to get on with building up a transverter for this band.

I had tried in vain to tidy out the junk in my garage and decided that, before skipping the stuff, it should go on EBay. Amazingly, the 'rubbish' that I'd cleared sold at good prices and amounted to enough to purchase a 5.7GHz transverter kit. Our local radio club (**www.frars.org.uk**) and another local radio amateur were also interested in getting some Kuhne Electronics (DB6NT) hardware, so we put in a combined order for 4 transverters covering 2.3GHz and 5.7GHz. After placing the order with Kuhne, it was only a few days before the large box arrived, very well packed and complete with a few of the new catalogues. I started the 5.7GHz transverter construction at once. The instruction / build manual is very straightforward and is well worth a couple of passes before gluing all the hardware together.

The tin plate box needed to be drilled and tapped to accommodate the 3 SMA connectors and 4 DC feed through capacitors. In my transverter I added another SMA socket for external LO input as I was intent on using an external G8ACE type local oscillator. The mechanics took about an hour to complete, including soldering the two halves of the tin plate box together and installing the RO4003 Duroid PCB. If you've not seen a DB6NT transverter kit before, they are nicely presented with all components being supplied in compartmentalised plastic boxes with all values printed on the lid of the boxes. Two boxes are supplied for the 5.7GHz transverter, one containing all the Rs and Cs, the other containing semiconductors, sockets and other mounting hardware. The transverter was built up as per the directions in the manual, starting with the two resonator cavities, helical filters and the discrete components. The power supply semiconductors were installed next, and a DC check performed to make sure the voltages looked right, which they all did.

The MMICs and FETs were added without problem – well almost with out any problem! Two transistors in the multiplier chain caught me out with the orientation of the writing on top of them being 180 degrees out compared to the component placement diagram but it was simple to rectify. I should have read the note on the component placement diagram which says "Don't use the orientation of the writing as a guide!!!"

I found it useful to use a good temperature controlled soldering iron for all the steps. The iron and work area was prepared to minimise the possibility of static build up, which could damage the devices.

The next step was the tune up as per the manual. The local oscillator is fairly straight forward, with several multiplication steps from the temperature-stabilised crystal of 117MHz up to the local oscillator of 5.616GHz. The tune up steps recommended measuring voltages at various points along the chain, and peaking for maximum / minimum. This was done and the results checked on a spectrum analyser only to find that no further improvement could be obtained. The remaining cavity filters were tuned as per the instruction – connect a 144MHz receiver and listen for a peak in the noise. The transmit side was pretty similar; apply 144MHz RF and peak for maximum power output, using the built in power monitoring facility. The transverter was checked on air and the local GB3SCC beacon could be heard on about the right frequency.

The next stage was to integrate the transverter into a complete system that I could take out on the local hills. For my portable systems, most of the transverters are housed in lightweight plastic boxes, with an aluminium chassis inside. The boxes used are made in the UK by Gewis (**www.gewiss.com**) and are of type GW44208 IP56.

Before getting the transverter kit, I had purchased a 5.7GHz power amplifier strip from another UK amateur – it was a TWT replacement and as such had a pretty high gain set of amplifier stages. This PA (see Fig. 1 below) was to be incorporated into the final transverter design, so the first two stages were removed, giving a PA that needed about 100mW in for 5W out – I built up a simple protected power supply circuit as a module and put that to one side whilst I concentrated on the rest of the transverter integration. As with any 'high power' microwave transverter, sequencing is recommended to avoid having to replace front-end devices repeatedly. I chose to use the VK5EME EME66 sequencer which has 4 sequenced outputs, and given the current £ to AU$ exchange rate, they are very cheap to import.

The sequencer has an output for a receive preamp which gives me the flexibility to add one in the future. The other outputs drive the NMS1212 dc-dc converter for the 24V relay, the antenna change over relay and finally the supply volts to the PA – this was via another small relay to avoid the voltage drop when switched through the sequencers output transistor. I used a latching 4 port transfer relay in my 5.7GHz transverter – it's an R566433 type, brand new from EBay for a "fiver" – the specification seems pretty good and the isolation is sufficient between the ports.

The other addition was a DF9LN local oscillator module that I bought from the 'flea market' at a Crawley microwave round table meeting – this really has improved the stability of the transverter. The picture below shows the completed transverter with the temporary (!) wiring that was installed just to test it.

I had my first 5.7GHz QSO only a couple of days after completing the transverter; I worked Dave G0RRJ via rain scatter on the 2/10/2004. So far, the system has been used in a few cumulative contests and some of the other

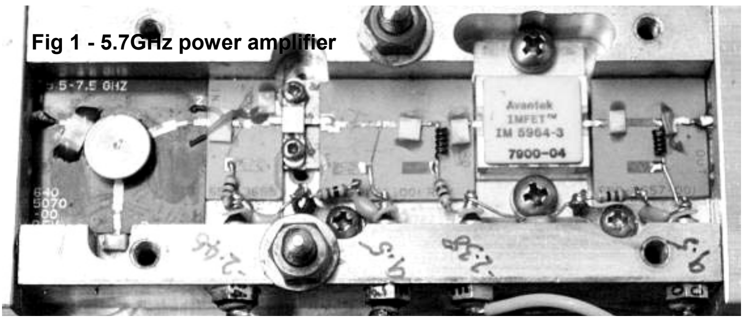


Fig 1 - 5.7GHz power amplifier

VHF/UHF/SHF contests that either FRARS or I participate in. I get the feeling that 5.7GHz seems to go better over paths that you might struggle on when working 10GHz. I've had a few QSOs from home with just a feed-horn propped out of the window, successfully working G0RRJ and G4LDR via some scattering mechanism – tree / rain / other at a guess. Certainly rain scatter effects seem to be more pronounced at 5.7GHz that 10GHz – all we need now are a few more 5.7GHz beacons in the UK with which to test.

Overall, I can thoroughly recommend the DB6NT transverter kits, they are easy to build and guarantee very good results on the microwave bands. Have a look at **www.db6nt.de** for more information on the 5.7GHz transverter – you can buy either a ready built one that has been professionally aligned, or save a bit of money and buy the kit, and have a few enjoyable hours building it up and testing it out on the air.

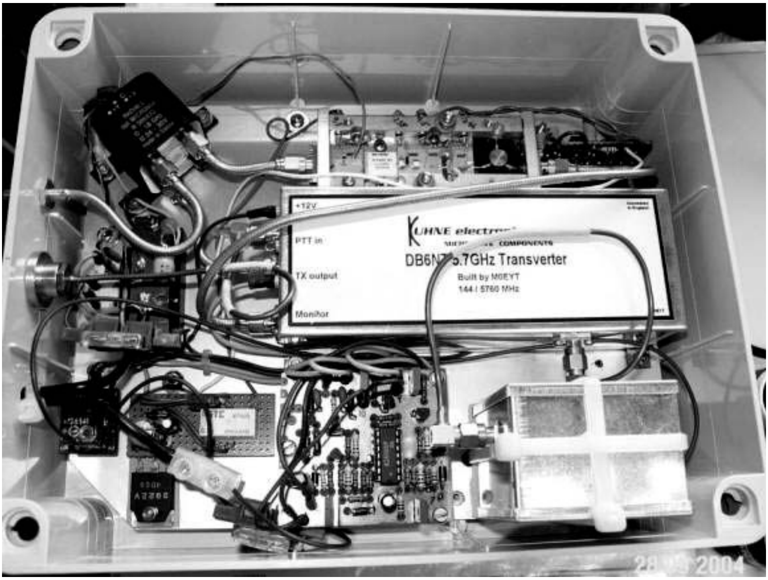


Fig 2 – Completed 5.7GHz transverter

Six Centimetres in two Days!

by Peter Day, G3PHO

I don't know what it was that encouraged me to email Michael Kuhne, DB6NT for one of his 5.7GHz transverter kits but I'm very glad I did! The kit arrived within a few days of ordering and it literally took only two days to build into its tinplate box! A further day was spent making a suitable enclosure for the complete transverter (i.e. including c/o relay, metering and IC202 interface).

On opening the parcel from Kuhne Electronic, I was immediately impressed by the high standard of presentation. There were two plastic, compartmentalised cases containing the components. Each compartment was labelled with the component value.

The construction manual is in English and the circuit, pcb layout and other diagrams, including photographs are beautifully presented. Most of the components are very small SMD types and are a very good test of one's eyesight! The transverter is of single board construction on RO4003 substrate. The DB6NT catalogue guarantees an RF output of more than 200mW. I found it easily did that and much more. A receiver noise of 1dB is claimed but I have not had the opportunity to check this yet. I will have to wait for the next Martlesham (Adastral Park) Microwave Round Table for that! The pc board is of excellent quality, gold flashed on the ground plane side and with plated-through ground connections from the circuit side. It fits into a tinplate enclosure 33 x 55 x 150mm. SMA connectors are used for IF input and the separate antenna connections to RX and TX. Feedthroughs are used for the 12V DC input line, PTT, power monitor and the +12V output for external relay control. Everything is provided except for the external c/o relay at 5.7GHz. As received from DB6NT, the transverter is configured for a 144MHz IF but, with some slight component changes, it can be used with a 432MHz IF. State which you want if you order the kit.

The circuit has an onboard Butler type local oscillator which I found to be very stable once the warm-up period had expired. The crystal uses a 40 degree PTC heater to make this period as short as possible. An external, high accuracy 117MHz source such as the DF9LN LO, can also be fed in if need be. The 117MHz is tripled in a BFR92A and then doubled in a BFP196 to 702MHz. A second BFP196 doubles again to 1404MHz and an MGF1902 quadrupler stage takes it to 5616MHz. Helical filters are used at 351MHz, 702MHz and 1404MHz to provide very good rejection of spurii. A microstrip edge coupled filter selects the 5616 signal to drive an ERA 2 MMIC to 5mW out put. The mixer is a single balanced diode type (BAT15-99 double array). Pin diode switching takes care of the TX/RX side of things apart from the antenna changeover, where a coax relay is required. The Receiver section uses a two stage HEMT amplifier

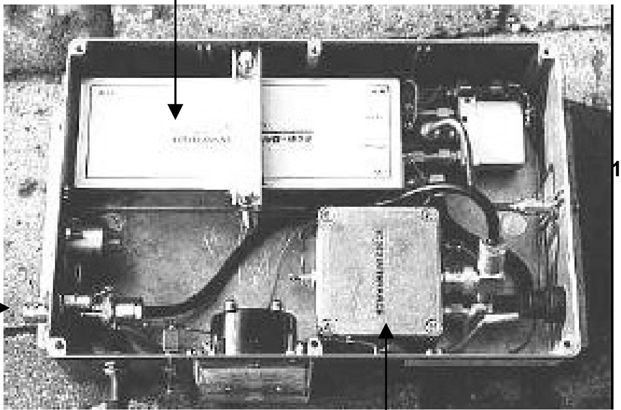
(2 x NE32584C) followed by an ERA3. A Wilkinson divider couples this to the mixer. The Transmitter has two stages of MGF1902s after the Wilkinson divider to drive an MGF1601 to over 200mW out. A simple power monitor or using a BAT15-03W diode gives a good indication of RF out. Cavity filters are used to provide the necessary LO and image rejection for the RX and TX. It had been some time since I had tackled a job of this nature, though in recent years I have been experimenting with SMT devices and smaller microwave modules such as the DB6NT 24GHz mixer and various WDG kits. Michael states in the manual that this kit is NOT a beginner's project and he is quite correct. However, anyone who has built up WDG and DDK modules in the past should have few, if any, problems. Essential equipment, in my view, is a temperature-controlled soldering iron (a Vann Draper SL20 in my case) with a fine tip, binocular headset magnifier (RS part no. 606-589 in my case) or large magnifying glass, a good pair of fine tip tweezers and good lighting! It goes without saying that modern surface mount components are very small and easily lost if allowed to snap out of your tweezers! Of course, you must also take the usual ESD precautions when handling the static sensitive devices. The actual construction presented no problems. Before the active devices were installed the pcb was checked for soldering errors. The voltage regulators were then installed and checked for the correct output. Then the bipolar devices were fitted and voltages checked. The LO was checked against my frequency counter and adjusted to 117MHz. Finally, the GaAsFETs were installed and bias levels checked. After that the tune up was very straight forward since Michael provides clear instructions with relevant voltage levels for the various test points. The filters tuned up beautifully. No one was more surprised than I was when the marker from my Adret 5401 synthesiser/diode multiplier arrangement was heard very loud and clear at T9, bang on 5760.100MHz! I use IC202s for my microwave IFs. Both have been modified to give 120mW out

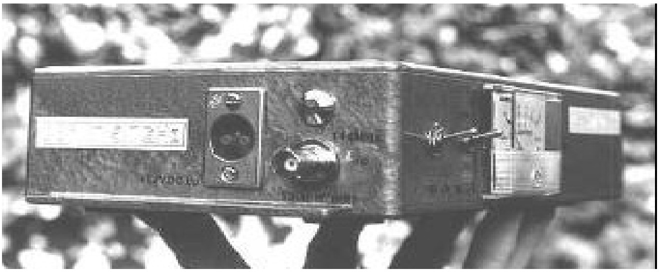
instead of the more usual 3 watts. Since the DB6NT kit comes with an IF input attenuator for a 3W input, I had to modify this to allow the lower input value to drive the unit. This meant reducing the 470 ohm resistor in the PI-attenuator to 100 ohms.

The fitted variable 100 ohm pot could then be adjusted for correct IF drive to the mixer.

The DB6NT transverter, as it stands, is configured to use an FT290 prime mover where +9 volts or so is present on the coax during transmit. This voltage switches a keying transistor into TX mode. I decided to leave the DB6NT intact and to make a simple two transistor keying interface for the IC202 so that, on pressing the microphone switch, the interface would ground the DB6NT PTT terminal, thus switching the module to TX. The IC202 has around +4.5 volts present on the coax inner on RX mode rather than the TX mode of the FT290. The interface was built into a small die cast box.

The tinplate box housing the transverter, the IC202 interface module and the microwave coaxial change-over relay were then installed into an Eddystone die cast box (220mm x 145mm x 55mm) which had been pre - drilled and sprayed with silver hammer finish paint. Switches, input and output connectors plus a meter to monitor both the 12 volt DC input and the TX RF output where also fitted. The photographs on the following page show the details. The 12 volt change-over relay came from a Teletra 23GHz TX/RX unit.





The DB6NT Module makes for a very compact transverter … almost a handheld!