Frequencies VHF, UHF, and SHF Newsletter NZ

This newsletter is compiled by Kevin Murphy ZL1UJG to promote operational and construction activity on the VHF, UHF and SHF Amateur Radio allocations in New Zealand...(and overseas).

Articles for this Newsletter can be sent via email to rfman@xtra.co.nz or by post to K Murphy, 8 Tamar Place, Hamilton. Ph 07 8470041

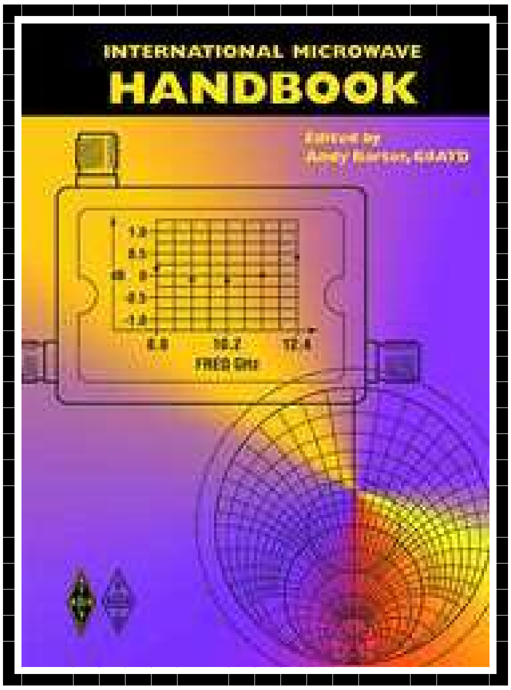
Issue 4 June 2002

New subscribers to this newsletter if you wish to have previous issues please email me.

Contents

The International Microwave Handbook

edited my Andy Barter G8ATD (VHF Communications Magazine) and produced by the ARRL and RSGB is now on sale.



Being a subscriber to the RSGB Microwave newsletter has enabled me to get an early copy. Hey, it was that hot off the press that it had a back cover a picture of the VHF Communications 1/2002 Issue which appeared in the letter box a day later.
It is a compendium of excellent articles from all round the world covering from 1296 MHz to 24 GHz and above.

Many of the articles are from DUBUS,QEX,RSGB Microwave Newsletter and VHF Communications.

Unfortunately the images from an excellent W1GHZ 5.6 GHz transverter appear to be printed inside out (or is that back to front).(Hopefully corrected in the next reprint). There was no coverage of transverter articles for 3.4 GHz which is an underutilized band

There was good coverage of crystal oscillator and multiplier circuits, however there was no reference to the Butler Emitter Follower Oscillator (as used in Downeast Microwave Oscillators and other USA circuits) and a minimal reference to keeping the crystal thermally stable.

I find it an excellent reference book to cover many topics and will prove an invaluable source of information

The editor apologizes for the late production of this newsletter and will endeavour to produce more frequent issues
Kevin

PROPOSED VK/ZL METEOR SCATTER TESTS WITH FAST HELL AND WSJT

Rex Moncur, VK7MO

The recent Leonids event produced a number of VK/ZL SSB contacts on 2 meters using Meteor scatter. However, a large Leonids shower at this level is a very rare event. This proposal aims to see if we can achieve regular VK/ZL contacts on 6 and 2 meters via meteor scatter throughout the year.

A group or some 15 VK amateurs are experimenting with Fast Hellshreiber (FAST HELL) and WSJT on meteor scatter on six and two meters with the objective of making meteor scatter QSOs on random meteors at any time of the year. While it is still early days it seems that one can readily achieve a distance of 2000 kms if one is prepared to spend an hour and use abbreviated coding to make a QSO. Thus regular VK/ZL meteor scatter contacts on two meters seem to be possible.

WSJT stands for Weak Signal communications by K1JT, a computer sound card program written by Joe Taylor K1JT. FAST HELL is produced with computer sound card program written by Nino Porcino IZ8BLY. Both programs use the same hardware set-up as PSK31 - so any station set up for PSK31 can join in by downloading the software at the following URLs.

FAST HELL: http://home.wanadoo.nl/nl9222/software.htm download IZ8BLY HELL 3.8
WSJT: http://pulsar.princeton.edu/~joe/K1JT/

The programs have pros and cons. WSJT is the faster program working at 147 characters per second while FAST HELL at 5xHell speed works at around 18 characters per second. WSJT can produce false decodes where-as FAST HELL is decoded by eye and is less susceptible to false decoding. WSJT works on a 100 % duty cycle and may make your rig hot where-as FAST HELL works at around 15% duty cycle and can be run for hours as a beacon.

The proposal is for a number of VK stations to transmit in beacon mode with FAST HELL and to see what is received by a number of ZL stations. The results would be reported by e-mail. Depending on the results we could move to two way tests. Tests could be on 6 or 2 meters depending on interest although six is easier and probably the best place to start. The best time is around 1900 to 2000 UTC. Large antennas are not required, 3 to 5 element beams work well on six and 5 to 10 element beams work well on two. Power is a factor and it is best to have 100 watts. Any ZL stations interested in such testing are invited to signify their interest to:
Rex.Moncur@bigpond.com

Let us know:

1. The times when you are available and whether weekends or weekdays
2. Whether you prefer six or two meters
3. Antennas and power output

More detailed information will be sent to those who signify an interest.

WANTED

Tom Bevan ZL1THG is looking for a non working Icom IC22S Contact rfman@xtra.co.nz
Leon Toorenburg ZL2AOC, is after miscellaneous test equipment such as a Spectrum analyzer and RF signal generator . If you know of any for sale or of suitable local contacts contact Leon at bee@paradise.net.nz
Suitable internet sites are Milcom @ www.milcom.co.nz/

COMPONENTS

Vaughan Henderson ZL1TGC as the Auckland VHF Group Trading Table Manager can send the component list out as an email . Contact vaughanh@ww.co.nz

RELAYS FOR TRANSVERTER USE

Peter Loveridge ZL1UKG

An assessment of suitable types for UHF/Microwave bands

Readers are referred to the ARRL UHF/Microwave experimenters manual on p 7-48 for an article with good photos and diagrams of the internals of some different designs. A number of people have recently imported transverters for 23cm and higher bands. They are complete except for the antenna change over relay, and some glue components such as a sequencer for the order of switching actions to insure that Tx output power is not applied to Rx inputs, and switching does not occur while RF power is present at the relay.

The first test can be done with an ohm meter. What is the resistance between the contacts of the relay ports? A good relay should show 0-0.2 ohm for closed contacts. Values greater than 1-2 ohms have probably been retired from active service and turned up at swap meets cheaply. Check that the coil is intact and note the polarity of any transient suppression diode. Some cases have them built in.

RELAYS FOR TRANSVERTER USE

Peter Loveridge ZL1UKG

An assessment of suitable types for UHF/Microwave bands

Do not be put off by 115v AC markings. They generally have a series diode for halfwave rectification and will pull in with 25-30v DC of the correct polarity. 26-28 v DC is the most common marking. They will just pull in over the range 14-18 v but will take some time to do it at a marginal voltage. This can lead to later contact damage if the power has come on the contacts, or the relay coil heats up and resistance rises, slowing down operation.

Measurements were made using a transverter as a source of RF, and looking at the isolation from Tx port to Rx port. They will be assisted by having a sensitive power meter. 1.3 GHz output is usually around 2-3 W and 2.4 GHz output is around 1 W for the recent imports. Using an HP 432 power meter, as little as 1uW will cause a deflection on the meter, but it is waving around a bit making accuracy limited. To prevent accidents, measurements were made with power applied to the common port, the Rx port was terminated in a dummy load, and the Tx port feeds the power meter.

The most commonly available designs may have RG58 terminated in the relay or have the common port at one end and opposed ports at the far end (T configuration). The next cheapest category has the common port on one side and 2 or 3 ports parallel on the other side of the body (Y or fork configuration). The "fork" configuration allows you to terminate the unused port, increasing isolation. The more desirable configuration for UHF/Microwave use has all ports parallel on the same side (E configuration).

Results @ 1296 MHz	Isolation	Comments
Coax termination	31 dB	Use up to 432, lower power
T configuration (N)	30 dB	Use for Antenna selection
Y configuration (N)	35 dB	Use up to 432, higher power
Fork configuration (BNC)	25 dB	Older design
Fork terminated 50 ohm	31 dB	Not enough improvement, use up to 432
Fork configuration	35 dB	Amphenol, better than older design
Fork configuration termination contact open circuit, caveat emptor		
E configuration	>60 dB	Use anywhere, depends on quality

A short circuit was not as good as a 50 ohm terminator for isolation for the fork configuration. Other configurations may be seen. You may see UHF, BNC, N, SMA for relay terminations. UHF is used up to 144 MHz, BNC up to 1.3 GHz but may start to introduce losses above this. SMA becomes very convenient at higher bands but may introduce power limits over 10-20 W.

The dummy load had an N thread inside a small rod and showed –27 dB return loss at 1.3 GHz, -16 dB @ 2.4 GHz, measured with a directional coupler. It should not have interfered with the isolation calculation.

The results above were from a very small number of samples. It is likely that there are better made units available than the ones I have purchased cheaply. SMA relays have two flavours. Unmarked units seem to be intended for use up to 3.3-5.7 GHz. Above this specification the relay will generally be marked with an intended upper limit, such as 12 GHz. For the E configuration relays I could detect no change at 2.4 GHz. I have been unable to measure above this as I have insufficient RF power available or lack of detector sensitivity.

The relay article was previously published in SPECTRUM The Newsletter of the Auckland VHF Group

IMPORTANT TECH NOTES

Kevin Murphy ZL1UJG

UNSTABLE AMPLIFIERS A two stage 1296 MHz preamp using NE72084 GaAsfet and ERA3 MMIC was built on a filter pcb. During alignment the amplifier was unstable, which was traced to the earth plane area around the WVHF/pcb details on the reverse of the pcb. I suspect it was acting like an antenna. Covering the area with copper tape and soldering that to the pcb removed the instability. **On the AMP & FILTER PCB'S, COVER WITH COPPER TAPE the area with writing, , THEN SOLDER.**

AMPLIFIERS WITH LOW GAIN During construction and testing of a 1st stage 1296 MHz TX AMP I accidentally left the earth wires/pins off near the NGA-386 MMIC (the earth return was via the tape over the edge of the PCB. The NGA-386 MMIC gain was +17.6 dB. Running 4 wires (2 U links) through the PCB right at the MMIC leads increased the gain to +19.4 dB (Gain increase of 1.8 dB). Sirenza Microdevices quote ~20 dB gain @ 1300 MHz

Short earth return paths for MMIC devices is important for GAIN & STABILITY and Short earth return paths for DECOUPLING is important for STABILITY.

TECH NOTES CORRECTION to MIXER/AMP levels

Kevin Murphy ZL1UJG

In the previous issue during TECH NOTES I stated the mixer/amplifier had -1 dB compression point of +4 dB in for +8 dBm out WRONG.These results were taken during testing when the mixer was strapped with the LO /RF ports swapped.This gives a higher compression point, as each diode was on alternately and the LO cancellation was worse

The correct level is +2 dBm into the mixer for +6.4 dBm out of the amplifier (@ 1 dB compression. With the addition of the (A) preceding 144 MHz IF PIN diode switch (0.7 dB loss) (B) and following1296 MHz filter (3 dB loss) following the 1st TX AMP. The losses of (A)&(B) change this first to + 2.7 dBm in /+6.4 dBm out @ 1 dB compression first, then to +2.7 dBm in/+ 3.4 dBm out.

The requirement for driving the following 2 Tx stages is 0 dBm so the RF input to the mixer can be reduced. Typically -1.3 dBm is needed at the 144 MHz PIN diode switch input to achieve this. This is 4 dB below the -1 dB compression level. Even at this level there is 0.25 dB compression. Remember that compression is cumulative Gain/Loss Compression is a very good reason why mixer and low level amplifier stages should not be overdriven. The linearity of the system degrades and intermodulation occurs and your signal deteriorates both close in (your transmitted signal) and also wideband (rejection of spurious mixing products [generated in mixer and amplifier stages]). A review of an older commercial transverter noted 8 dB compression at its rated output!

Non Linearity in Digital Radio Systems is very important causing errors and spreading of the transmitted signal. The Final RF Amplifiers are often run ~7 dB below their compression points!

1296 MHz Transverter Progress.

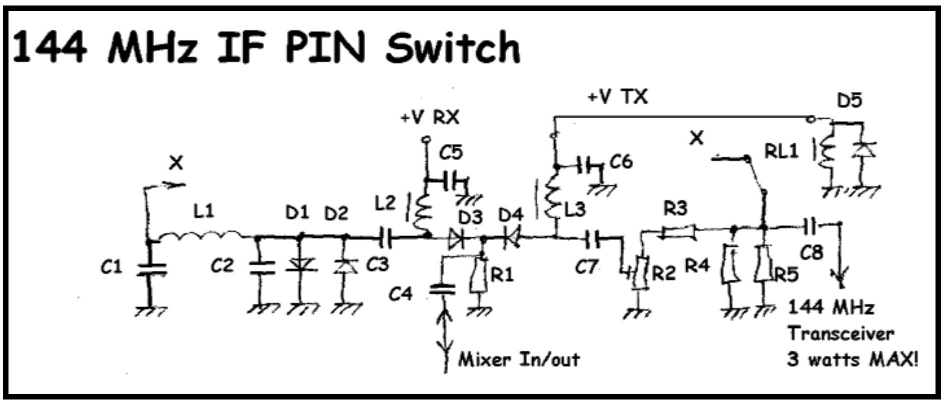
However best spurious performance is obtained when the mixer PCB was screened and tightly screwed down to the Box. The 1152 MHz LO is in a external diecast box. There was considerable RF on the DC leads from the LO and this led to poorer LO rejection so extra decoupling was with feedthrough capacitors and ferrite beads .Each PCB screwed down with M2 hardware (4 per pcb).

144 MHZ PIN SWITCH FOR TRANSVERTER USE

Kevin Murphy ZL1UJG

A prototype PIN switch for 144 MHz has been made as part of the IF interface between the 2M transceiver and the mixer. It exhibits 0.7 dB loss (TX) (from C4 to C7) and <35 dB isolation. (+V TX OFF) It has diode protection so that during TX/RX switch over any transient RF power is limited so that the TX/RX mixer is not damaged. The 2M transceiver is fed permanently into a 50 ohm termination for two reasons 1) to provide the front end of an attenuator to reduce the TX power level for the mixer 2) Some transceivers may be damaged or exhibit instability if no load/ high VSWR is seen on initial TX as in the case of a relay switching over. This instability may continue during the TX cycle. The load resistors are 2 * 100 ohm 2 watt resistors.

The TX high power signal is fed through a PI type attenuator to a 100 ohm preset resistor so that the TX level to the mixer can be optimized. This is fed into one side of the PIN switch. The RX signal coming from the transverter goes into the common port of the PIN switch then feeds out via antiparallel diodes to protect the diode mixer and then via a low pass filter and relay.



If a TX signal is seen at the C1 end, then diodes D1, D2 turn on clamping the power to ~ 50 mW (3 watts TX). C2 is shorted out and the L1 and C1 resonate at 144 MHz. The C1 end of the filter feeds to relay which is attached to the top of the 50 ohm attenuator resistors. This adds isolation on TX so that the TX attenuation is not made up of two paths (limiting the range of attenuation available). The relay may be switched from a PTT signal, + volts from transceiver during TX.

Parts List Note All components used were leaded not SMD

C1	22 pF	**C2**	18pF	**C3,4,5,6,6,8**	1 nF	**L1**	55 nH (5t 5mm diameter)
L2,L3	1 uH	**D1,D2**	1N4148	**D3,D4**	BA379 PIN diode (Auckland VHF Group)		
D5	1N4002	**R1,R3**	820 R	**R2**	100R Preset	**R4,R5**	100R 2 Watt
RL1	12V Miniature relay			Filter PCB			

G4DDK004 OSCILLATOR UPGRADE

Kevin Murphy ZL1UJG

I did some improvements to the last G4DDK004 Oscillator that I built (PCB's are available from the RSGB Microwave Components service). I also noted the reason that I did each modification.

1) Fit a 330 nH axial inductor across the crystal (1nF series capacitor Cx must be fitted to prevent DC flowing between the TR1 and TR2 emitters. Reason This gives a stable pulling range due to the crystal capacitance (~ 7pF) being cancelled

2) Ground TR3, TR4 and TR5 emitters directly. R11,R15,R19,C12,C17,C22,C24 not fitted.The holes for TR3,4 and TR5 were filed carefully with a small round needle file so that the collector and base leads would fold down in little notches while the transistors emitters were soldered directly to the earthplane. The PCB areas where the emitter C's and R's were,are covered with copper tape and soldered . Reason This gives a direct path for the emitters and reduces potential problems with emitter bypassing.

3) The 1st striplines in Tr4 and Tr5 collectors are directly grounded now with copper tape and the transistors outputs are fed via small chip capacitors (33pF 0805 capacitors used.) TR4 has its collector volts fed via a 100 nH 1206 size chip inductor. TR5 has the PCB stripline extended with a small wire. C21,C25 and C29 not fitted. Reason This increases the Q of the striplines by grounding them directly.

4) The collector resistors R12,R16 and R20 associated with TR3 , TR4 and TR5 are increased to 150 ohms and the collector's side of the resistors are fed to the base bias circuits. Reason This is called a saturated multplier circuit that is self regulating. (The collector voltage reduces under drive and reduces the base bias). Values other than 150 ohm were not tried. Increased power may be obtained by reducing the resistors to 120 or 100 ohm.

5) A 3 terminal regulator 78L08 is fitted on pcb with associated Tantalum capacitors 10 uF on o/p and 1uF on i/p. Note 4 holes ~ 1mm drilled with clearance pads. (Use an offboard 7808 1 Amp regulator if a crystal heater is fitted and run off 8 volts) Reason This reduces the effects of the operating point of TR3,4 and TR5 changing due to supply variations. This reduces chirp and other random variations

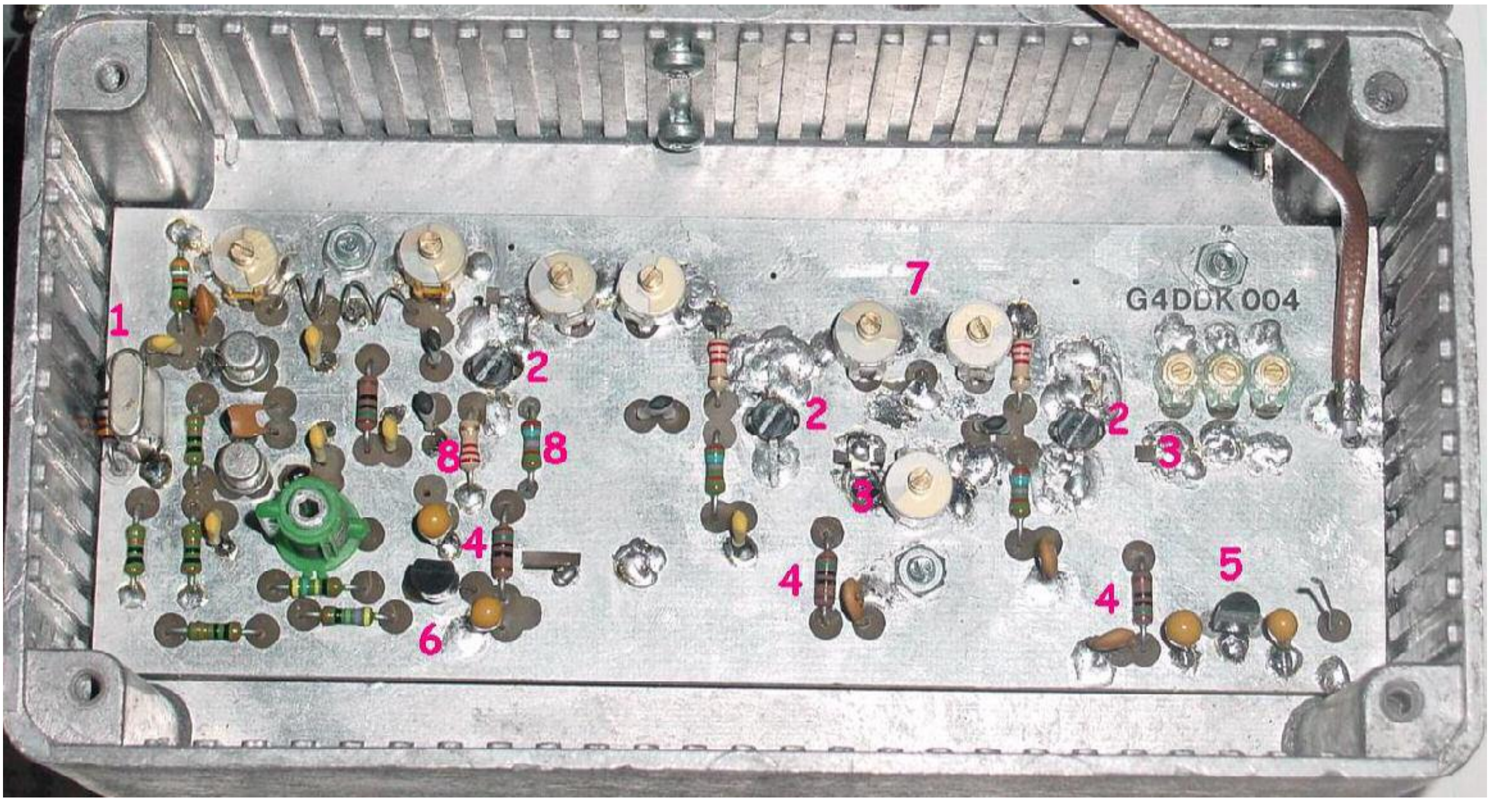
6) The small 3 terminal regulator (IC1) already fitted to the PCB for TR1 and TR2 is removed . A new NPN transistor (eg BC547 or 2N2222) is fitted (Collector to +8 volts, Base to centre hole, Emitter towards Butler oscillator). A 1k ohm from the 8 volts to the base of the transistor and a 10 uF Tantalum capacitor from base to ground is used. Note the middle hole must now have a clearance pad so the base lead doesnt short out. Reason This reduces the regulator noise feeding into TR1 and TR2 circuitry. See previous newsletter or WA1MBA.org site for pictures of regulator noise

7) I fitted low cost and more common Philips 1.4 - 5 pF trimmers for the 1200 MHz multplier by reversing the middle trimmer (like an interdigital filter). Reason Availability & the trimmers are overcoupled causing the middle trimmer not to tune

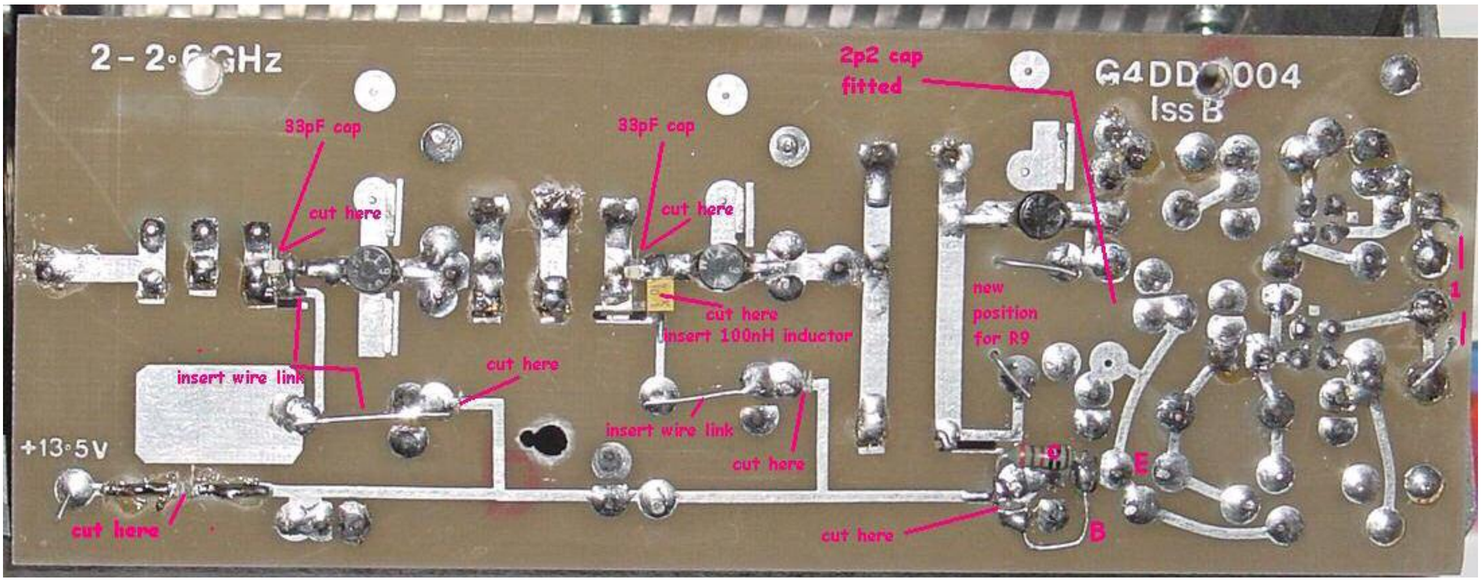
8) An extra 2.2 pF NP0 ceramic capacitor is fitted on TR3 's base and position of R9 moved. Two holes need to be drilled with clearance pads. Reason to improve multiplier performance (increased collector current)

Note Where Tantalum capacitors are mentioned on the original G4DDK004 documentation and on these modifications it is very important that they are used due to their superior filtering characteristics (See previous newsletter or www.WA1MBA.org website) . Even if you are not doing these modifications to an existing pcb it is still recommended that an additional 10 uF tantalum capacitor is fitted on the output of IC1 to suppress noise.

The level of crystal harmonic products on the output (eg ~1200 MHz) is better than -45 dBc.
The board runs at ~60 mA
MRF901 transistors were used for TR3,4 and TR5 multipliers and +7dBm (5mW) output was obtained.
R8 18 ohms was changed to 100 ohms but is not a necessary modification



The image is of the top of the G4DDK004 PCB with all components fitted.The numbers are associated with the list of modifications.



This picture underneath the pcb shows notes where to cut tracks and add components.
Overall the modifications are made to improve the **<u>keying charcteristics, stability and noise charcacteristics</u>** of the G4DDK004 oscillator. I am upgrading 4 other units to this standard so that their performance is enhanced for transverter and beacon use.
Since the crystal is sensitive to temperature it is recommended that a heater is fitted (available from RSGB Microwave Component Service, Downeast Microwave or VK5EME Minikits). Failing that some sort of thermal jacket from foam or a polystyrene packing bead is fitted over the crystal at minimum.
For even superior stability an external oscillator such as that from G8ACE may be fitted and fed into the first stage of the Butler Oscillator after removing the crystal and choke. For matching reasons it is recommended that a J310 FET is fitted instead of TR1 and R2 changed to 220ohms. TR2 emitter in this case can have the 22pF NP0 capacitor replaced with a 1nF

New Zealand VHF/UHF/SHF Records July 2001

John Wysocki ZL2TWS

The following is the up-dated records table since printing of the 2000/2001 Call Book.

Please refer to page 4-32 of Call Book,the changes are as follows.

1) **New 5cm CW Record.** 5cm 5760MHz ZL1TBG/p-ZL1TPH/p 18/03/2001 CW distance 317kms.

New Zealand VHF/UHF/SHF Records July 2001

Band/Frequency	Type	Stations	Date	Mode	Distance(kms)
6M------50MHz	O/seas	ZL1MQ-ZB0T	17/04/1981	SSB	*18,250
6M------50MHz	EME	ZL2BGJ-WA4NJP	08/09/1988	CW	13,256
2M-----144MHz	Int.	ZL2ARW/p-ZL1BJB/P	03/02/1982	SSB	1,069
2M-----144MHz	O/seas	ZL1HH-VK5ZEE	15/01/1986	SSB	3,467
2M-----144MHz	EME	ZL2BGJ-G3POI	26/05/1985	CW	18,821
70cm---432MHz	Int.	ZL2ARW/p-ZL1BJB/p	03/02/1982	SSB	1,069
70cm---432MHz	O/seas	ZL2TPY-VK4ZSH/p	13/01/1988	SSB	2,402
70cm---432MHz	EME	ZL3AAD-G3SEK	12/03/1989	CW	18,970
70cm---425MHz	Int.	ZL2TWS/p-ZL2ASF/p	31/01/1982	VIDEO	373
50cm---610MHz	Int.	ZL2UGR/p-ZL2AJI/p	23/04/1988	SSB/FM	302
32cm---925MHz	Int.	ZL3VTV/p-ZL1AVZ/p	06/12/1998	SSB/FM	154
23cm--1281MHz	Int.	ZL1TBG/p-ZL1WTT	05/07/1998	FM/ATV	76
23cm--1296MHz	Int.	ZL2ARW/p-ZL1THG/p	30/01/1982	SSB	687
23cm--1296MHz	O/seas	ZL1AVZ-VK2FZ/4	30/11/1995	SSB	2,317
23cm--1296MHz	EME	ZL3AAD-PA0SSB	13/06/1983	CW	18,657
13cm--2304MHz	Int.	ZL2ARW/p-ZL1THG/p	31/01/1982	NBFM	687
13cm--2304MHz	EME	ZL2AQE-W3IWI/8	18/10/1987	CW	13,931
9cm---3456MHz	Int.	ZL2AQE/p-ZL2ARW/p	06/03/1983	NBFM	547
5cm---5760MHz	Int.	ZL1TBG/p-ZL1TPH/p	18/03/2001	CW	317
3cm--10368MHz	Int.	ZL1THG/p-ZL2BFC/p	25/01/1981	WBFM	390
3cm--10368MHz	EME	ZL1GSG/p-DJ7FJ	12/03/1997	CW	18,340
1.25cm--24Ghz	Int.	ZL2AQE/p-ZL2AZQ/p	20/03/1988	MCW	126

Notes:

1) NZ 70cm band has now been reduced from 420-450MHz to 430-440MHz.The Video (TV) Record of 31/01/1982 on 425MHz stays as a 70cm Record.

2)NZ 13cm band has now been reduced from 2300-2450MHz to 2396MHz-2450MHz. The Records of 31/01/1982 and 18/10/1987stay as a 13cm Record. This band now known as 12cm band.

3)NZ 50cm band has now been reduced and changed from 610-620MHz to 614-622MHz.The Record of 23/04/1988 stays as a 50cm Record.

4)/p means portable operation. 5)/# means operating in another state or district.
6)* 50MHz contact ZL1MQ-ZB0T, Long Path.

For a copy of the rules to follow and how to claim a record contact:

The VHF/UHF/SHF Records Co-ordinator
C/- NZART
P.O. Box 40-525,Upper Hutt, New Zealand
or vhfrecords@nzart.org.nz
or www.nzart.org.nz/nzart/vhf
or see PDF file accompanying newsletter

Terrestrial WORLD VHF/UHF/SHF/EHF DX RECORDS July 2001

Frequency	Stations	Date	Dist.km	Mode	Propagation
50 MHz	(Note-1)				
50 MHz	ZS6Y-ZS1AGF	24/10/1999	1,238		Tropo
50 MHz	ES2QN-TF3MLT	12/09/2000	2,335	SSB	Aurora
50 MHz	9H1CG-K7KV	26/06/1989	9,765	CW	Sporadic-E
50 MHz	G4IGO-SV1OE	12/08/1990	2,542		Meteor
50 MHz	EA7KW-ZL2TPY	29/03/1999	19,815	SSB	F2
50 MHz	9H1CG-VP6BR	21/03/2000	16,428		Transequatorial
50 MHz	SM3EQY-VE8HL	14/06/1995	4,018	SSB	Aurora/Spor-E
70 MHz	GJ3YHU-GM3WOJ	09/08/1998	960	CW	Tropo(Europe)
70 MHz	G3SHK-GM3WOJ/p	11/08/1982	904	CW	Aurora
70 MHz	GW4ASR/p-5B4AZ	07/06/1981	3,465	CW	Sporadic-E
70 MHz	GJ3YHU-GM3WOJ/p	12/08/1982	1,083	SSB	Meteor
144 MHz	GN0KAE-EA8BML	09/09/1988	3,264	SSB	Tropo (Europe)
144 MHz	PA3EKK-UA4ANV	10/05/1992	2,724	CW	Aurora
144 MHz	OE1SSB-RI8TA	21/07/1989	4,281	SSB	Sporadic-E
144 MHz	GW4CQT-UW6MA	12/08/1977	3,101	CW	Meteor
144 MHz	I4EAT-ZS3B	30/03/1979	7,784	CW	Transequatorial
144 MHz	DF9PY/p-SM2EKM	09/06/1989	1,947	CW	Iono-Scatter
144 MHz	JX7DFA-SM1BSA	05/08/1996	1,959	CW	Aurora/Spor-E
144 MHz	YU7EW-EB4TT	02/06/1995	2,084	CW	Field Aligned Irregularities
222 MHz	KP4EOR-LU7DJZ	09/03 1983	5,905		Transequatorial
432 MHz	KH6HME-XE2/N6XQ	15/07/1989	4,142		Tropo(Pacific
432 MHz	PA0FRE-RA3LE	13/03/1989	1,851	CW	Aurora
432 MHz	SM3AKW-UA9FAD	12/08/1999	2,141	CW	Meteor
903 MHz	KH6HME-N6XQ	13/07/1994	4,061		Tropo(Pacific)
1296 MHz	KH6HME-XE2/N6XQ	15/07/1989	4,142		Tropo(Pacific)
2304 MHz	KH6HME-N6CA	14/07/1994	3,973		Tropo(Pacific)
2304 MHz	IW4CJM-I1TEX	16/04/2000	427	SSB	Rain-scatter
3456 MHz	KH6HME-N6CA	28/07/1991	3,973		Tropo(Pacific
3456 MHz	PA0WWM-DG1KJG	25/08/1997	240	SSB	Rain-scatter

Terrestrial WORLD VHF/UHF/SHF/EHF DX RECORDS July 2001

Frequency	Stations	Date	Dist.km	Mode	Propagation
5760 MHz	KH6HME-N6CA	29/07/1991	3,973		Tropo(Pacific)
5760 MHz	SM7ECM-PA0EZ	03/07/1999	646	CW	Rain-scatter
5760 MHz	TK2SHF-F/HB9RXV/p 1	5/06/1999	216	ATV	
10 GHz	4X/DJ4AM-I/DJ3KM	25/06/2000	2,079	SSB	Tropo
10 GHz	PA6C-OE5VRL/p	04/07/1990	754		Rain-scatter
10 GHz	EA/F1AAM/p- I5/HB9AFO/p	17/06/1999	1,320	ATV	
24 GHz	IW3EHQ/3-I0LVA/3	18/06/2000	461	CW+SSB	Tropo
47 GHz	F6BVA/p-F5CAU	26/12/1998	286	SSB	Tropo
75 GHz	W0EOM/6-KF6KVG/6	01/02/2001	145	SSB	Tropo
120 GHz	KF6KVG/6-W0EOM/6	19/10/1999	11.7		Tropo
145 GHz	W2SZ/4-WA4RTS/4	01/01/2001	61	CW	Tropo
241 GHz	DB6NT/p-DF9LN/p	26/06/1995	2	SSB	LOS
474 THz	KC7AED/p-WB7VVD/p	21/09/1997	192.6		LOS(red)
678 THz	WA7LYI-KY7B/7	08/06/1991	248		LOS(green)

Notes: 1) Some 6m contacts are left out on this list because long-path QSO's (those exceeding approximately 20,000kms) have been reported during solar cycles 19 and 21.

2) /p means portable operation. 3) /# means operating in another state or district.

MOONBOUNCE (EME) RECORDS 2000

Frequency	Stations	Date	Mode	Distance(km)
50 MHz	ZL2BGJ-WA4NJP	08/09/1988	CW	13,256
144 MHz	K6MYC/KH6-ZS6ALE	18/07/1984		19,287
222 MHz	K1WHS-KH6BFZ	17/11/1983		8,154
432 MHz	ZL3AAD-G3SEK	12/03/1989		18,970
902 MHz	K5JL-AF1T	27/05/1990		2,384
1296 MHz	ZL3AAD-PA0SSB	13/06/1983	CW/SSB	18,773
2304 MHz	NU7Z-ZS6AXT	13/06/1999		16,480
3456 MHz	WB5LUA-DL9EBL	04/06/1995		8,531
5760 MHz	WB5LUA-JA7BMB	12/11/1997		10,246
10368 MHz	ZL1GSG/p-DJ7FJ	12/03/1997	CW	18,340

Notes: 1) /p means portable operation 2) /# means operating in another state or district.