FREQUENCIES VHF, UHF, 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).

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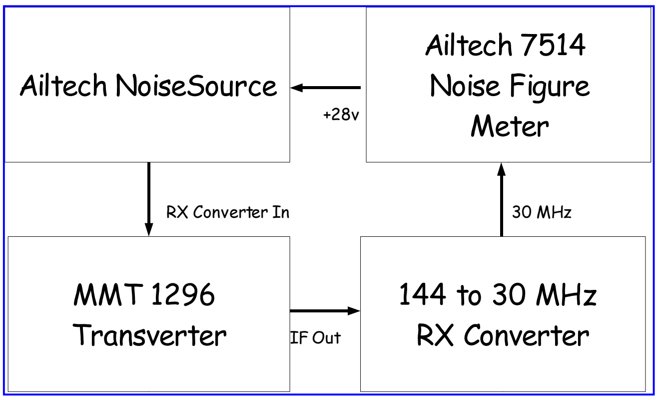
Editors note I have activated Truetype fonts on the latest version of Global Graphics PDF Creator. This will allow copying (cut and paste) of the newsletter. Note however, that some special symbols that I import into the original MS Word document may not appear correctly after copying. These symbols such as the Ω or ohm symbol can normally be accessed through the "Insert/Symbol" Menu in MS Word for reinsertion.

MICROWAVE MODULES TRANSVERTER MMT1296

This is not a step-by-step blow of the transverter modifications, just an overview of areas that required improvements.

The MMT1296 Transverter comes in a number of versions. There are some issues with the earlier versions that can be resolved. The RF section is a 2 stage bipolar amplifier, which comes in 2 versions:- Standard and Low noise. The standard RX preamplifier uses a NE57835 and BFR34a, while the Low noise version has a NE64535 in the 1st stage.



The transverter I acquired from the UK was fitted with the standard RF Section. After I gave the transverter a full alignment, the Noise Figure of the RX converter was 4.5 dB as measured on my Noise figure (NF) setup (as shown in the block diagram). The NF would be in excess of 5 dB via the RF PIN diode switch.

I decided to replace the Bipolar preamp with a GaAsfet preamplifier/ filter using a surplus Plessey Black Spot GaAsfet (similar to MGF1302/ MGF1402). The new stages were built on the Waikato VHF Group Amplifier and Filter PCB's. The FET is self biased using bypassed source resistors. These changes resulted in a new converter noise figure of 1.6 dB and just over 2 dB via the PIN diode switch.

The image left shows the preamp/ filter after conversion. The amplifier alone gives ~ 18 dB gain with a noise figure of ~ 0.5 dB.

Other modifications to the RX converter include a 22uF tantalum capacitor across the 78L08 regulator which powers the local oscillator. Also the 2nd stage IF preamp had its source resistor lifted and the amplifier was bypassed with a coax to reduce the gain (Original gain was in excess of 40 dB as it was

designed for use with a 10 watt IF and an additional 15dB attenuator)
The power output is rated at 1.2 watts output and there was compression starting at ~ 500 mW.. This is also apparent on the 2 watt version according to an early review by Angus McKenzie, G3OSS in the out of print book of "A Buyer's Guide to Amateur Radio". Angus stated that there was ~ 8 dB compression at 2 watts!
The TX converter circuitry was predominantly DC powered via a NPN Power transistor, which drops the input DC voltage significantly. There is also overheating of some associated resistors. Later versions had a relay instead of this circuitry.
During testing, I intentionally shorted out the DC power transistor and achieved a dramatic increase in gain/power. I decided to use a P- channel FET such as a MTP2955 or a similar device. I removed the Power transistor and its associated components and fitted the other device. Unfortunately this is not an easy fit and one leg has to be twisted. The change resulted in a RF power around 1.2 watts (at –1 dB compression) as a result of having ~ 13.8V on the devices rather than 11.5V
I also amended the bias on the driver transistor on the main board. There could be a tendency for the driver to thermally run away, as there is no DC feedback on its bias network. Additional resistance common to the collector and base circuits was added (18 and 22 Ω in parallel)
A further gain/power increase was achieved by extra grounding on the PA stage. I have also noticed this effect on the MMT432/28 transverter Power amplifier.
This resulted in a power of 1.6 watts (+32 dBm) at the 1 dB compression point, rather than the original 500 mW (+27 dBm). Further alignment was done after the modifications, due to changes in supply voltages.
Another additional modification was to add a series capacitor (from the IF connector to the board) and a 10 kΩ resistor from the IF connector to the TX/RX control circuits, giving the ability for the transverter DC switching to be controlled from the 2M IF rig rather than from the RF detector. Suitable rigs are FT290 Mk1 or a modified IC202 (control volts on antenna are normally for RX) or a modified Ft290R2.
If there is interest in more details of these changes, let me know.

I have also done some measurements on the MMT144 and MMT432 transverters.
There is a failure of the DC bias of the Final RF Amplifier to stay constant with RF drive. This is noticable on both of these transverters and may occur on other versions such as the 6 metre transverter and certainly occurs in transceivers, transverters from other sources and transistor linear (!) amplifiers as well.
The MMT144/28 base bias on the final RF Amplifier drops to about 150 mV DC at 10 watts output, while the MMT432/28 bias actually goes negative. (noticable from about 400 mW output!).
There is a side effect that the non linearity causes increased spurious levels, due to mixing action.
Changing the bias circuitry would increase linearity dramatically.
There is no low pass filtering on the outputs of the MMT144 and MMT432 transverters so harmonic levels are expected to be high.
I measured the gain of the MMT144/28 RX converter to be in excess of 40 dB after alignment. A touch excessive, as gain in the region of 20-25 dB is more than enough. Noise figure was 2.4 dB, not bad considering the vintage.
The MMT432/28 RX converter's gain is 38 to 40 dB depending on version. The noise figure is 3 to 3.5 dB. An additional problem here, is that the image rejection on RX is only of the order of 8 to 10 dB! (measured on a late model).
Some small changes to these units, such as done on the MMT1296/144 would improve performance in a number of areas.
There must be 1000's of these units, all over the world. Transverters are an alternative way to getting on the sharp end of the VHF/UHF bands, using simple/older 28 MHz transceivers (144 MHz for 1296 tvtrs) and for those with limited budgets. (Note that transverters by DEM, DB6NT and SSB Products are used extensively overseas with high performance HF transceivers to provide superior performance over most VHF/UHF rigs.)

VHF SCENE JULY 2004
Source:- NZART/ BREAK IN/ ISSUE SEPTEMBER/OCTOBER, 2004

Again, a very quiet few weeks. I hope a number of readers have built the simple detector. Later in this column is information on a Return Loss Bridge

DX

In July, Bob ZL3TY had EME contacts with W5UN, RA3AQ, RK3FG, UA4AQL, and a few meteor scatter QSOs with VK7MO.

Chris, ZL2DX, Martinborough, has 80 watts on 2m to a 10 element Yagi, while on 70cm he runs 100 watts to a 21 element Yagi. He also has preamps on both bands Chris also has 6m capability and is developing a FET Power Amplifier.

A recent article "Aircraft Enhancement" by VK7MO in the Fall 2003 issue of CQ VHF magazine describes a propagation mode widely used in Australia for VHF/UHF contacts in the 400 to 800km range, primarily on 144MHz. Typically, for a few minutes it produces enhanced signals that are 20 to 30dB stronger than would be expected, based on radar reflection or tropo scatter. The key difference between aircraft enhancement and normal radar reflections is that the aircraft must be closely in line between the two stations to achieve the enhancement. The article gives information on the construction of a simple model based on a map, tracing paper, and a drawing pin that allows the prediction of aircraft enhancement from known flight paths. Here in ZL we have many flights daily running up and down the country which suggests that opportunities may exist to exploit this interesting mode. Is there anyone who has tried this, or is interested in running tests? (Bob ZL3TY)

There was an article by Gordon MacDonald VK2ZAB in November December 2003 Break In.

MICROWAVE

Dave, ZL1AKW, Tauranga is working on increasing his ERP on 1296 MHz by using Stacked M^2 Yagi antennas. Simon, ZL1SWW, Auckland has added a 1 watt amplifier and a MMIC RX preamplifier to his 1296 MHz equipment. Some Auckland stations are working on oscillator/ multipliers for 13cm

Chris, ZL2DX, Martinborough is looking for contacts on 1296 MHz. He has about 10 watts to a double Quad antenna and is organising a homemade PHEMT preamp. Although there are mountain ranges on some paths, knife-edge scatter can give enhancements up to 20 dB.

Bob, ZL3TY, Greymouth and James, ZL3TJZ, Hokitika are both looking at working some stations on 1296 MHz. The coastal paths to the north, scatter paths across the Alps and ducting paths to VK will be closely monitored. During the ZL openings of the last DX season, there was a 70 cm contact from Greymouth to a station north of Auckland. Perhaps a similar contact may occur this season, but on 1296 MHz.

Steve ZL1TPH and Brian ZL1AVZ are doing some experiments on 10368 MHz in the Auckland Region.

While the NZ 122 GHz record stands at 32m (0.032 km), using WBFM (ZL1TBG and ZL1TPH), Will W0EOM and KF6KVG extended the US record to 24.88 km on August 27th. TX powers were of the order of 0.005mW (or -23 dBm) with 1 foot dishes. CW was able to be used due to the use of highly stable oscillators. Contacts were made over Silicon Valley in California.

CONFERENCES AND MARKET DAYS

While on a visit to the USA in August Bob, ZL3TY attended the 11th International EME Conference. The programme covered many aspects of EME activity, much of it applicable to VHF/UHF weak signal activities in general. The proceedings were provided on CD as well as hard copy, anyone interested in a copy of the CD please contact Bob ZL3TY. The SETI League Conference was run concurrently in an adjacent room. SETI stands for Search for Extra Terrestrial Intelligence and is looking for people interested in joining a world-wide listening network. The SETI League runs a beacon on 1296.000 for receiving system testing. They are running 100W and aim the signal at the moon, resulting in a suitably weak signal. There is a picture of their antenna at **www.qsl.net/w2eti/** , where there is also information about the SETI project. (Bob ZL3TY email b_mcquarrie@minidata.co.nz)

The scribe also attended the Hamilton Amateur Radio Club Market Day, in early September. The day provided good bargains for many. The event also provides an opportunity to have a good chat with others of similar interests. I also remember in previous years going to technical talks in the afternoon. (Kevin ZL1UJG)

GENERAL

Well-known radio astronomer, antenna designer, cosmic explorer and author John D. Kraus,W8JK, of Delaware, Ohio, died Sunday, July 18. He was 94. Full story: http://www.arrl.org/news/stories/2004/07/21/1/?nc=1

Moonbounce Anniversaries

July has seen the anniversaries of a number of Moonbounce milestones.

24 July marked the 50th anniversary of the first voice transmission received on Earth via moonbounce. James Trexler, an engineer (and radio amateur), working at the US Naval Research Laboratories in Maryland, heard his

own voice reflected from the Moon on 24 July 1954. The frequency was 198 MHz. See http://history.nasa.gov/SP-4217/ch2.htm
21 July is the 44th anniversary of the first-ever amateur moonbounce QSO. This was achieved on 1296 MHz by Sam Harris W1FZJ operating W1BU, who worked Orrin "Hank" Brown W6HB.(1960)
30th July 2004, marks the 32nd anniversary of the first 50 MHz amateur moonbounce QSO, between W5WAX (now K5SW) and K5WVX (now K5CM) on one team and WA5HNK plus W5SXD on the other team.(1972)
The very first successful moonbounce transmission was on 10 January 1946, at 111.5 MHz, from the US Army's Evans Signal Laboratory in New Jersey, accomplished by lab director John H. DeWitt Jr, also a radio amateur.
The first successful radio amateur moonbounce transmission happened in 1953, accomplished on 144 MHz by the duo of Ross Bateman, W4AO, and William L. Smith, W3GKP.
http://www.arrl.org/news/features/2002/01/21/1/

There are many designs for VHF and UHF valve amplifiers, such as those presented at www.nd2x.net and www.nd2x.net/ur4ll.html. Dr Alex Gavva, UR4LL sells Russian Amplifier valves, such as the GS15b Tetrode, suitable for a 300W 23cm Final. (only US$25 for the valve!!). He has many other valves and parts and has dealt with VK and ZL stations previously. Contact Alex at ur4ll@bk.ru

Tom ZL1THG mentions that some Intermediate and Secondary schools teach electronics to children. They may have a requirement for surplus components or you may be able to assist. Contact your local schools.

SYSTEM SENSITIVITY

A technique often used by EME, Satellite and DX stations to check system sensitivity is a Ground /Sky noise test.
Objects assume a level of noise partly depending on their temperature. Local terrestrial objects, such as the ground, a shrub or tree would be at the ground temperature of say 17° C or 290° Kelvin (0°C = +273° Kelvin), whereas looking into the sky (not the sun and moon), then that area may appear at a few degrees (~10°) above absolute zero (Absolute zero = -273°C or 0°K). This is generally called Cold Sky. If you point your antenna and SSB/CW/AM VHF/UHF receiver, converter towards the ground, shrub or tree and then towards the Cold sky, then the difference will indicate how sensitive the equipment is. You do not require a high gain antenna to do this! The antenna may be a small yagi, a simple dipole/reflector or a dish feed. Unfortunately at 144 MHz and below, atmospheric noise makes this technique less useful. Note that some areas of sky may have a little more noise than other areas, due to unseen noise sources.
Monitor the receiver for an audible or measurable change in noise (if the noise is below AGC threshold), or look for an increase in S-meter reading. Alternatively use an attenuator to make comparative measurements. If you can't hear or see any difference then your receive system is missing out on valuable signals!
I have used this technique with a dual dipole feed at 1400 MHz Radio Astronomy RX and see about 5 dB difference. Improvements in the antenna and RX improvements are expected to increase this figure further.
When your antenna is pointing towards the cold sky, the antenna side and back lobes will also pick up the noise radiated from the ground. Pointing your antenna towards the sun will increase the noise in your receiver, but in that case more antenna gain = more sun noise. Another important note is that when the antenna is pointed to the horizon, about half of the antenna sees the ground, while the other half sees the sky. Some stations elevate their antenna by a few degrees, which may increase system sensitivity.

Contest Dates

Microwave Contest
All Bands 614 MHz and up. 1st weekend in October.
VHF Field Day
All Bands 50 MHz and up. 1st weekend in December
Contest periods occur from 1600 to 2200 hrs on the Saturday and 0800 to 1400 hrs on the Sunday
For further VHF/UHF/SHF/EHF contest information go to
http://www.nzart.org.nz/nzart/Update/Contests/vhfcontestrules.html

RETURN LOSS BRIDGE
VHF-UHF Version 50 to 622 MHz
HF-UHF Version 1-500 MHz

A common way of looking at the SWR of objects (such as antennas) is to use a VHF/UHF SWR Meter. These are most commonly built as a coupler. At HF, this may be via a RF toroidal transformer, while at VHF/UHF adjacent parallel lines are coupled to a primary line. One end of the parallel lines is terminated in a load and the other end is coupled to a detector such as a diode. The VHF/UHF coupler has an optimum frequency for best performance. As the frequency increases, the parallel lines take more power while at the lower frequencies the lines take less. The Osker HF/VHF SWR Meter, CB type meters and many other VHF/UHF SWR meters use this principle. Amateur VHF/UHF SWR meters give an indication of SWR only (Especially if the meters use SO239 connectors!) Professional units may extend the flat frequency response by modifying the physical construction of the coupler. So disadvantages are:- They require significant power for coupling into the detector.(typically Watts if diode detectors are used) and frequency response is not flat. Advantage:- Can be left in circuit

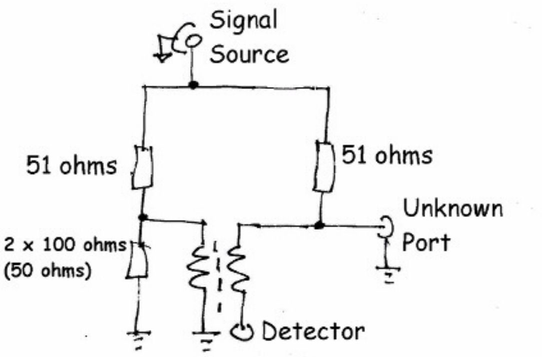
An alternative of looking at SWR is to use a Return Loss Bridge (RLB). Their advantage is that the response may be quite flat from a few MHz and may extend up to 1 GHz or more The signal required for operation is low. However the disadvantage they cannot be left in circuit due to losses associated with the bridge design.

The RLB is useful for checking impedances in circuitry, tuning filters, antennas and a whole myriad of other tests

The unit may have a internal detector (diode) or rely on an external detector, such as a diode, receiver, level meter or analyser.

The signal applied to the bridge, may be from a signal generator, such as for use with a receiver or other level indicator, or a low power TX (eg An FM transceiver on low power ~ 500mW max) for use with a diode detector, such as that in the previous VHF Scene column. An alternative signal would be a noise source.(similar to that in a noise bridge)

The unit typically consists of a 4 resistor bridge circuit, detector and signal source. Three resistors are of the circuit impedance (such as 50 or 75 ohms). One of these resistors is a reference, which may be part of the bridge, or as an separate external resistor. One of the resistors is of course the unknown load. The signal source feeds the top of the bridge. This may be from a signal generator, low power TX, oscillator or a noise generator. The detector is coupled across the centre of the bridge. At balance (ie SWR= 1:1, return loss is INFINITE) the voltage appearing between the resistors is 0. Whereas if the unknown port is shorted (ie the SWR is INFINITE and Return loss is 0 dB (If the connector is left open there may be some radiation from the connector). Return loss is a measure of how much power is reflected from the load. If the load is perfectly matched (SWR = 1:1) then no power is reflected from it, so the returned signal is infinitely small, or has a infinite loss. The return loss is normally measured in dB. A small chart accompanies this article A complete chart relating return loss to VSWR can be found at http://www.wenzel.com/pdffiles/losschrt.pdf.



Block diagram of Return Loss Bridge

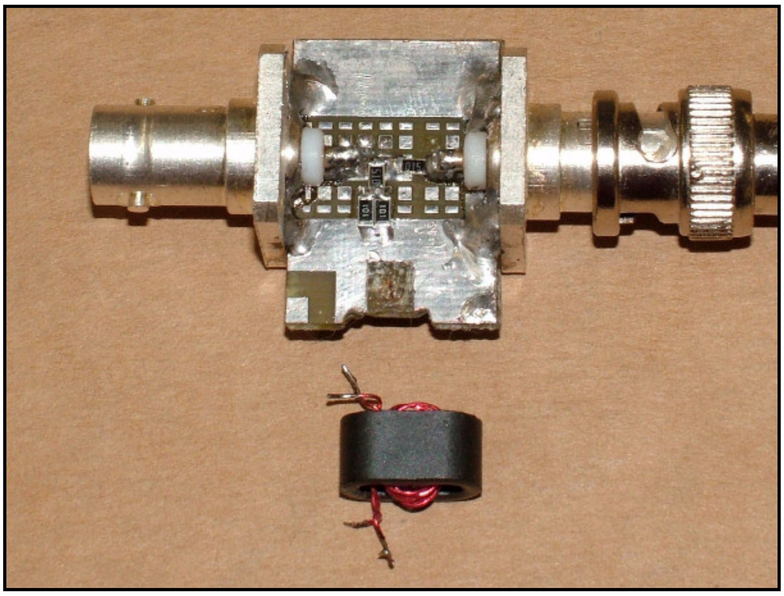
In practice a Return loss of 13 to 15 dB (VSWR ~ 1.6 to 1.4) is more than adequate as only 3 to 5 % of the power is reflected.

When the unknown port is shorted. The signal fed to the detector is typically –12 dB (1/16) of the input power.

The detector may consist of a sensitive diode detector across the two points mentioned before. Alternatively it may consist of a external power indicator such as a sensitive power meter, spectrum analyser or a Receiver. If you have a modulated signal source, then the demodulated signal may be fed to an indicator such as an oscilloscope or a selective AF voltmeter (such as a HP 415 or a homemade unit).

If a diode detector is used the Return loss can be calculated using the formula 20 x $\log_{10}$ (V Shorted/V unknown load)

The external indicators are generally connected via a Balanced to Unbalanced transformer (Balun) so that the bridge retains its balance.. This balun may consist of the wires being feed through a number of ferrite beads or via a ferrite transformer suitable for the frequency of interest. The return loss bridge may be also used in this format as a signal combiner or splitter (such as combining two signal sources) If external detectors are used then the frequency range is somewhat dependent on the properties of the Balun.



Use

Apply your signal source to the Input port of the bridge. Short circuit the unknown port with either a homemade s/c coax connector (or carefully place a screwdriver across the connector shorting the pin to the outside body). This will give the maximum signal into the detector. If you are using a detector calibrated in dB, such as a power meter or other relative indicator, then Return loss may be read directly. Apply the unknown load (such as a antenna) and then read the difference.

With a prototype 50 to 622 MHz RLB (as seen in the image), a professional 50 ohm termination indicated a return loss of ~ 28 dB at 50 and 622 MHz, while at 144 and 432 MHz this figure exceeded 30 dB. A 50 ohm PC LAN termination (DSE) indicated ~ 20 dB across the same frequency range.

Deterioration of the return loss at the low frequencies is due to insufficient inductance in the balun, while stray capacitance limits the high frequency end

Parts List

General Purpose Double sided PCB board, from Waikato VHF Group. (PO Box 606 Hamilton, NZ) Alternatively the bridge may be built on a scrap piece of PCB.

Resistors 100 ohm SMD 1206 (Qty 2) (In parallel for reference load) Farnell 420-141
Resistors 51 ohm SMD 1206 (Qty2) Farnell 420-074
For a 75 ohm bridge use 75 ohm SMD 1206 resistors Qty 3. Farnell 420-116

A 50 ohm prototype was built using ¼ watt 100 ohm leaded resistors (very short leads) and exhibited good performance to 500 MHz. See list below of associated values and part numbers.
Resistors 51 ohm axial 250mW (Qty 2) Farnell 543-070.
Resistors 100 ohm axial 250mW (Qty 2) Farnell 543-147
For 75 ohm use 75 ohm axial 250 mW (Qty 3) Farnell 543-111 . (All leaded resistors also available from Jaycar)

Ferrite Balun Core:- For 50 to 622 MHz coverage, use tv balun core, from an old TV balun, Wellington and Auckland VHF Groups or Jaycar/Sicom LF1222
For 1 to 500 MHz use B-202-73 or B-2402-73 Balun from CWS Bytemark or BN-73-202 and BN-73-2402 from Amidon
Enamelled Wire 0.4 to 0.63mm sourced from DSE or Jaycar
Twisted ~ 6 TPI (turns per inch) with hand or battery drill. Passed through core 3.5 times (ie 3.5 "U" turns)

Return Loss (dB)	VSWR	Power to load
0	∞	0%
6	3:1	75%
10	1.9	90%
13	1.6	95%
15	1.43	97%
20	1.22	99%
25	1.12	99.7%
30	1.07	99.9%
35	1.04	99.97%
40	1.02	99.99%

Suitable coaxial connectors. BNC, N, SMA. (Not SO239!).
The connectors may be soldered directly onto the PCB as shown in the prototype or may be installed in a suitable enclosure with care taken with the coax terminations especially at the unknown port
Component sources, www.dse.co.nz, , www.jaycar.co.nz www.sicom.co.nz www.cwsbytemark.com www.amidoncorp.com www.farnell.com, Radiospares, Wellington and Auckland VHF Groups,etc

Thank you those who have sent information for the column
Input for the column may be sent to Kevin ZL1UJG at rfman@xtra.co.nz

END OF VHF SCENE COLUMN