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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TECHNOLOGY CONVENTION

Kevin, ZL1UJG

First, a big thank you to the Hamilton Amateur Radio Club for organising the 2003 Technology Convention, held at the Hamilton Astronomical Observatory. The venue was ideal for the size of the group attending, and included a lecture theatre with excellent facilities

The Observatory is only a few km from the hotels in Ulster St. The venue was ideal for the size of the group attending.It had a large reception area and a number of other rooms.

Adjacent to the Complex is the 10 m dish shown in the picture left. Unfortunately the feed to and from the dish was out of action due to some digging that had taken out the cable.

Ewan Wilson, Hamilton City Councillor, opened the convention on Saturday morning and invited those attending to view some of Hamilton's attractions such as the Hamilton Gardens, Museum, Restaurants, shops as well as many other attractions.

The first talk was given by Ian, ZL1AOX on AO40 and its YACE camera experiment. This outlined some of the uses that this camera was used for such as confirmation of sensor readings. Ian showed some pictures that the camera had taken. During the early part of AO40's life unfortunately some chemical has appeared on the imaging port that the camera is attached too and degraded the image quality.
The following talk by John Andrews, ZL2HD and other members of the Wellington VHF Group was about the Past, present and Future of the National System with ideas on expansion which would enable greater capacity.

After lunch (see how many people you can recognise) I gave a talk on parameters of transceivers, amplifiers and transverters. (A PDF can be obtained on this talk if you contact me) During lunch I had set up a test equipment demonstration in the reception area. (see image)

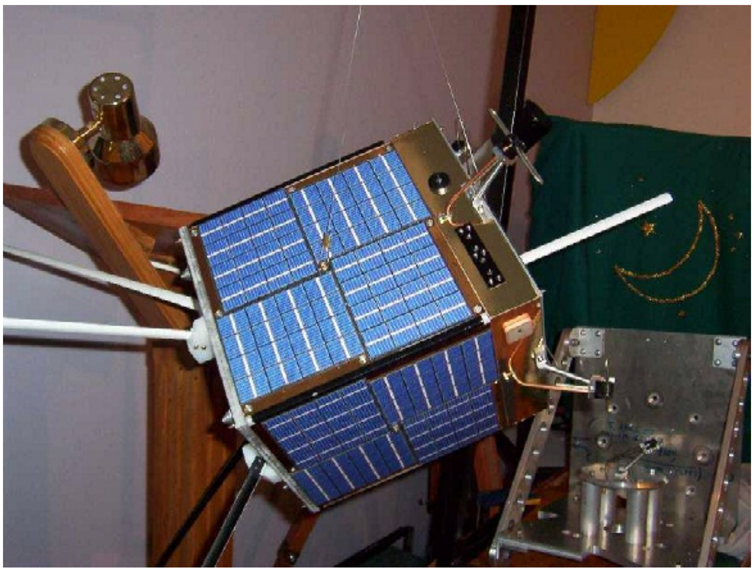
Grant ZL1WTT gave a very informative talk on developments in the ATV arena above 1 GHz. This outlined work in the 2.4 GHz and 10 GHz bands (10 GHz with multiple ATV FM signals) and also with CPU controlled modules.

Doug Ingham ZL2TAR gave a very informative talk on stubs and their uses both individually and for multiple signals (eg. duplexing AT V on 70 & 50 cm's or duplexing Txer's on the FM band.

After this talk some other amateurs bought their transverters out for measurements on the equipment setup.

The transverters were both commercial and home built units. The measurements were mainly on RX Noise figure and showed a variation from 0.7dB (2.4 GHz) to 12 dB (3.399 GHz) With the use of Peter ZL1UKG's Microwave signal generator we confirmed it's insensitivity. [Subsequent emails from the 12 dB NF unit indicated that the 1st RF stage was incomplete. The unit is now expected to be in the 2-3 dB region.]

Ralph, ZL1TBG also had his 122 GHz transceivers out for people to look at. The Auckland VHF Group had a small trading table which catered for component purchasing.



An Optical telescope was used later that evening to look planets and other phenomena.

On Sunday morning, Peter, ZL1UKG gave a talk on simple test equipment and techniques with a demonstration of measurements on dish feeds. Much of the equipment such as attenuators and couplers was obtained at bargain basement prices from markets in the USA. (He did say that the items were cheap but the travelling too and from the US put a dent in his wallet…)

I didn't attend the talk by Doug, ZL2TAR on Curing Intermodulation, as I looked at a 2M amplifier won by someone during the previous evening's raffle. The amp showed low noise figure and somewhat excessive TX gain (this is mentioned in previous issues of the newsletter.) The documention indicated it was a Linear AMP but was only to be used on FM… I had used a commercial Switch Mod e PSU made for RT's. This gave me incorrect results during a Noise Figure measurement until is was replaced with a linear type PSU!!

After lunch Fred, ZL1BYP gave a very informative talk on the status of some of the modules for KIWISAT with some of modules as part of the talk. (see picture on previous page)

Robin, ZL1IC gave a talk on the Observatory, its history and also on the technical side of Radio telescope measurements.

After afternoon tea there was a 6 M/ VHF/ UHF forum hosted by Vaughan ZL1TGC, at which many people discussed a number of important issues. One of the issues discussed was looking at having a measurement day in the future…

Some of the remaining attendees and their partners attended the final dinner at which a few items were still raffled (Yours truly won a LNA from the Auckland VHF group)

I certainly enjoyed the Convention and had a great time. I wish to thank the Hamilton Amateur Radio Club, the speakers, VHF groups and also the attendees for the support and for making this a great convention. The time just seemed to fly by and am looking at attending the next one.

GENERAL

The talk that I gave at the NZART Technology Convention, that was held in Hamilton over Easter , 2003 is at the following website http://www.netspace.net.au/~rpreston/newslett.htm

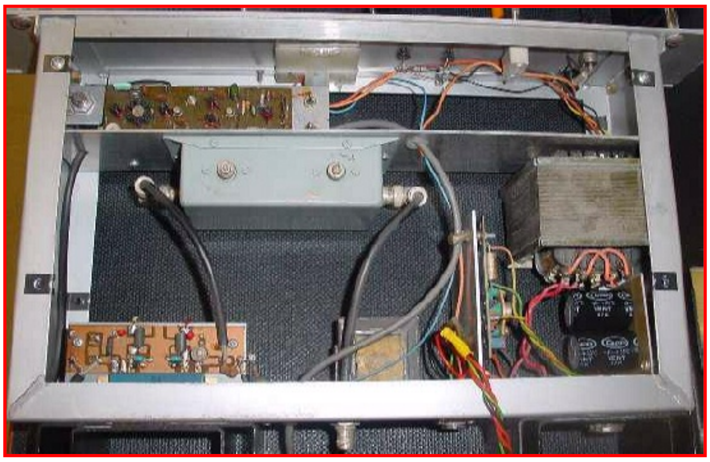
G8ACE has a good website with information on stable crystal oscillator circuits (G8ACE MKII OCXO) and LF crystal jitter(see investigations) These excellent articles have previously been published in the RSGB Microwave Newsletter. See http://www.microwaves.dsl.pipex.com/

The place for 2m, 70cm, 23cm, etc enthusiasts in the Australia, New Zealand & New Caledonia region, Real-time propagation spots & alerts, Activity reports & announcements, Weak Signal QSO co-ordination and ...any VHF/UHF chat! Go to http://www.vk4cp.com/vklogger.php

Will the newsletter reader who discussed a 1296 MHz homemade transverter & G4DDK004 Oscillator at the Cambridge Market day, please contact me.

Michael ZL1ABS has BFQ68's for sale @ NZ$35 plus P&P. They are useful for ATV (and other modes) from 432 thru 2400 MHz http://www.semiconductors.philips.com/acrobat/datasheets/BFQ68_CNV_2.pdf
Contact via zl1abs@xtra.co.nz

Break In "VHF Scene" Column
After discussions with Bob ZL3TY, I have offered to co-edit the column with Bob. Any input from the readers will be greatly appreciated on any VHF,UHF,SHF activity. (Operating Activity [Stations/Beacons you have worked or heard], constructional, Any mode, news, pictures, etc… My email address is rfman@xtra.co.nz and Bob's email is b.mcquarrie@minidata.co.nz

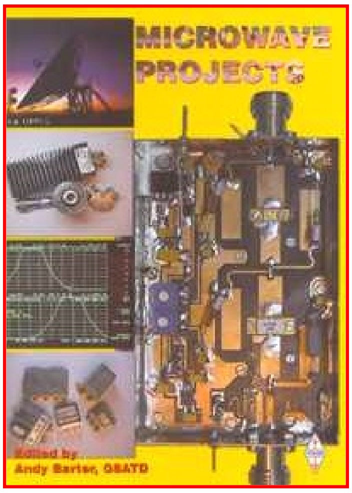


Beacons The pictures show the internal and external views of the Hamilton (Waikato) 144.256 MHz beacon which was temporarily removed from service during early June. This was due to hum present on the output (as mentioned in a previous newsletter). The main filter capacitors were replaced (the old capacitors being only about 20% capacity) The Beacon also had some realignment and should be in service for another 20 years (by which time I may be retired). The filter capacitors were previously replaced on the 432.256 MHz Beacon. (Waikato 144.256 MHz beacon expected to be back in service very soon)

I wonder if there are any operational beacons in the South Island so that DX operators can determine whether there is propagation into the Island?

Steve ZL1TPH mentioned that he has recently heard both the Hamilton 1296.256 MHz Beacon and the Wellington 1296.275 MHz Beacon from Moirs Hill. He stated that the Wellington Beacon was in fact stronger than the Hamilton Beacon (Wn Beacon was fully quieting on FM)

New Microwave book A new microwave projects book edited by Andy Barter G8ATD has hit the RSGB stands. I have ordered a copy so will review it when it arrives (see cover right)



UPGRADE OF DEM 2424 MHZ TRANSVERTER

Kevin ZL1UJG

The RX filters which are same as the TX 2.2 to 2.4 GHz filters (1st graph green) may improve slightly, by raising the response by 100 MHz. (by cutting 1.8mm off each hairpin… 0.9mm off each open end) This will reduce the loss slightly at 2424 MHz and improve image rejection.

The RX amplifiers, including filters, have a slope on the frequency response which is caused by gain of the MAR-1 and MAR-6's dropping off fast (~ 12 dB between 2-3 GHz). At 2424 MHz the filter response is also starting to drop. Higher gain could be obtained by fitting a NGA-386 or ERA-3 instead of one of the MAR devices.

The gain of the RX converter is +17 dB at 2399 MHz and +16 dB at 2424 MHz. The transverter RX noise figure (NF) was measured to be 6.5 –7 dB which was not unexpected. With the addition of a GaAsfet or HEMT preamp the NF will drop considerably. The unit had a ATF10135 GaAsfet preamplifier fitted which dropped the NF to ~1.9 dB.

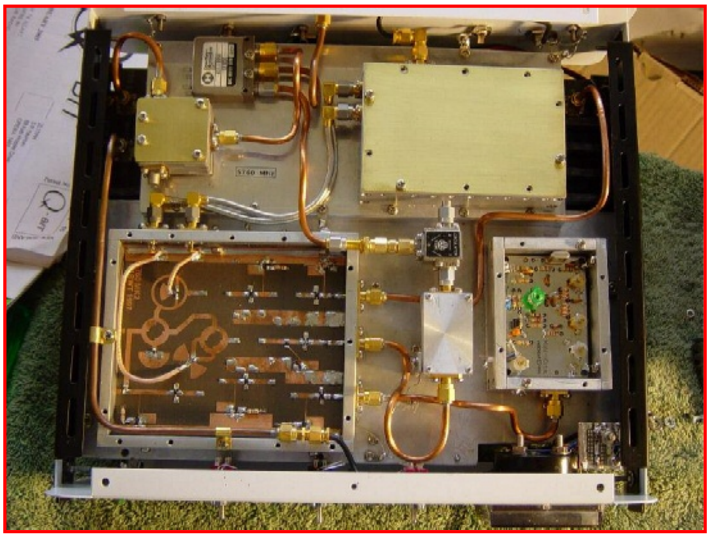
The 100 nF chip capacitors on the power feeds have a dielectric whose performance at 2424 MHz is debatable. To improve decoupling and stability at 2424 MHz an additional 100 pF chip capacitor is put across the 100 nF. (This could also be done to other DEM transverters such as the 1296 MHz one).

The instability problem in the LO (last newsletter) is also prevalent in the RX section, so an additional 100 pF capacitor is fitted in the centre of the DC feed. I have also added a 100 pF in the DC feed to the TX section for good measure.

TX gain. I had initially cut a small section out after the mixer so that signal could be fed in. This will be later used for fitting a 3 dB pad. I fed a –10 dBm 2424 MHz signal in and close to + 10 dBm appeared on the output. I used a MAR3 (since I same some) as the 1st MMIC amp and fitted a NGA-386 (ERA-3) on the output, although a ERA2 and NGA-586 (ERA-5) would provide slightly more output for similar drive levels at the IF. The resistors feeding the MMIC's were fed off and +8 volt supply and a single turn was placed on the resistor lead near each MMIC, so that the resistor didn't shunt RF away as their values were in the 100 Ω region. I initially estimated the overall gain from device figures and filter losses but the figures measured were slightly low, almost certainly due to imperfect grounding of the MMIC devices. The gain is probably reduced by ~ 1.5 dB/device.

I drove the transverter with about –3 dBm CW (0.5 mW) or(-3dBm PEP). At this input level +8 dBm (~6 mW) was obtained with intermodulation down about –38dB from each output tone. No gain compression was noticed at this drive level. The transverter was being driven by signal generator(s) through a 20 dB attenuator **[part of transverter]** The signal generator output maximum level was @ +17 dBm (50 mW) so no tests at increased levels were possible. However it is expected that the transverter will develop < +10 dBm with 0 dBm (1mW) into the mixer. At this output level the intermodulation products are expected to be around the –30-32 dB level.

The power amplifier is being fitted and since this requires ~ +7dBm drive, a long piece of coax to attenuate the RF level slightly is used. I decided to do it this way to increase the LO rejection (rather than attenuate the IF level further… ie; a lower RF/LO difference) Images to be in the next newsletter



MINIKIT'S 5760MHZ TRANSVERTER

Steve ZL1TPH. [See adjacent picture]

Steve ZL1TPH has completed another 5760 MHz transverter using modules from Minikits in Australia http://www.minikits.com.au/

The transverter pcb on the lower left of the picture is designed by Paul Wade N1BWT (W1GHZ) and uses copper pipe caps as the frequency selective elements. Amplification is done by ERA mmic's (Minicircuits) http://www.minicircuits.com/

The oscillator is produced by Minikits. These boards give excellent results and are highly recommended. The editor is acquiring some kits for building equipment for 3.399 GHz and 5.760 GHz.

Similar boards are available from DEM http://www.downeastmicrowave.com/

Steve had some problems with setting up of this equipment, which unfortunately resulted in some component fatalities. It was determined that his DVM was giving erron eous results (check that batteries are in good condition as some meters don't have battery warning indicators)

Analogue meters are less prone to RF , they could be used as an alternative.

Additional parts are also available from http://www.users.bigpond.com/graham.lewis/Module Man.htm

Editor:-I am sure existing microwave operators will assist those building equipment for microwave bands. This will help increase the number of NZ microwave stations

Bird 43 Inserts Steve ZL1TPH

A 25 watt D Element (200-500 MHz) is good for 100 milliwatts on 5760 MHz at full scale

A 25 watt C Element(100-200 MHz) is good for 8 to 12 watts at half scale on 3400 MHz

925 MHZ TRANSVERTER TOM ZL1THG

Tom ZL1THG is working on a 925 MHz transverter using a 65 MHz crystal ($5 from the Wellington VHF Group - Members only price). The oscillator is multiplied to 390 MHz where it feeds an antiparallel mixer The multiplies 390 MHz to the final frequency (780 MHz) as well as mixing with 145 MHz (TX).

The antiparallel mixer consisted of 2 semirigid coax striplines at $\frac{1}{2}$ λ long at final LO frequency & TX frequency. With only one Bandpass filter in the TX/RX chain (Waikato VHF group BPF PCB) results have been quite good. LO and TX image were significantly suppressed in the prototype.

VHF to Microwave measurements at low cost Peter Loveridge ZL1UKG

Judicious buying to assist with amateur research and development

This paper will set out to show some of the areas where being able to make measurements will enable the debugging of hardware designs so that they perform as predicted by that article or discussion that inspired you to buy the components and pick up the tools. It will cover the use of attenuators, power measurement, directional couplers and sweep generators. In this case the low cost is achieved by buying older commercial instruments, but accessories may have to be built to support them.

A short summary of Microwave Test Equipment can be found in Chapter 11 of the ARRL UHF/Microwave Experimenter's Manual.

Attenuators Attenuators can be found with the commonly used connector series BNC, N and SMA. The same frequency limitations apply to the connectors as they do for cable use ie BNC to 2 GHz, N to 18 GHz for precision made units, SMA typically to 18 GHz. Lower spec ratings will be found for any of these connectors due to the nature of the internal construction of the device.

The ARRL Handbook prints tables of Pi and T network attenuator values in the Reference section. These are a good start to checking on the accuracy of your latest purchase. Attenuators are rated from DC to an upper frequency. An ohm-meter will reveal whether the series and parallel combinations of internal elements agree with the markings on the case. Attenuators have a power rating. If this has been exceeded, the elements may have changed or be open circuit. Caveat Emptor!

Typical values are 3, 6, 10, 20 dB, but others may be found. Don't pass up the 4, 8, 16 values when preferred values are gone. 30, 40 dB may be found, but good cables and shielding becomes necessary to prevent leakage around the attenuator.

Good performing low power attenuators can be made with SMT resistors connecting PCB tracks on double-sided board. More than one link to the ground plane is required as the desired frequency of operation rises. A few cents worth does wonders at GPS frequencies (1.575 GHz) compared with a commercial unit @ NZ$30.

Examples of Use 1.1) A project to build the ultimate 2m backpack Yagi was begun. Backpack implies hilltop where front to back ratio becomes important, as stations on either side of the hill may not be able to hear each other and simultaneous operation of both may interfere with your QRP ability to work them. A suitable hilltop was chosen with visibility of a weak beacon. An attenuator is inserted in the antenna lead and the resulting signal to noise ratio (SNR) memorised. The antenna is rotated 180' and the attenuator removed. Chose attenuator values which make the attenuated direct and back lobe levels sound similar. Minor rear lobes and nulls can be checked in the same way. A protractor mounted on the mast will allow recording of the angles.

1.2) You are working on a 23cm antenna. You need a power source for measurements. You don't wish to stress the power block in the transverter so you insert attenuators in the IF radio input to the transverter. In this way you reduce heat generation and run the output stage in a less vulnerable manner when dealing with unknown antennas.

1.3) You are assessing your latest low noise creation with the help of the free signal generator in the day -time sky, using an AC scale multi-meter in the headphone socket and attenuators for an approximate result. With the antenna pointed at a cold region of the sky you set the volume control to give some convenient reading. Now point the antenna at the sun and as the reading on the meter increases, insert attenuators to bring the noise value back to the cold sky value. You have offset the value of "Sun Noise" with attenuators for a measure of performance. "Note that using noise of a narrow (voice) bandwidth will lead to more variability in amplitude with time than for a wide-band IF. Noise measuring instruments typically have a 1-6 MHz bandwidth. The increased bandwidth is necessary for repeatability and accuracy."

1.4) You have a Power Meter of unknown linearity. Insert attenuators between the source and sensor and see that the scale reading changes in keeping with the attenuator value. You may find that some of your attenuators have had a calibration certificate on them, and even frequency related results are recorded. Attenuators are amongst the least recognised pieces of precision test equipment.

2)The Power Meter When starting out in Amateur Radio, an SWR meter was one of the things you knew you needed to have for checking radios and antennas. They came in flavours like 3 -150 MHz, 20 or 200W full scale, or 140-525 MHz, with single or twin needle displays. Buying something useful above the 70 cm band wasn't possible. The fabled Bird 43 meter wasn't often seen and its plethora of slugs were like currency.

What is needed is a low power, wide band instrument like the HP 432A with 478A sensor head. This is a "Bolometer" instrument where the measurement is due to heating of a sensor element. The 432 contains a chopper stabilised amplifier to detect tiny changes in bridge balance due to RF heating. A superb meter movement is calibrated in mW linear with a logging scale below. Older instruments 430, 431 are not as stable as the 432. More recent instruments are more stable, and expensive.

The 10 mW level is no handicap. To measure higher power levels, just insert an attenuator in front of the sensor. "N" attenuators are typically rated at 1W max. A 20 dB attenuator will extend your meter to 1W from 10 mW. Power attenuators are now a useful luxury. 5 to 50W models can extend the range of the sensor accordingly. They will not be cheap! Power attenuators gene rally have lower frequency ratings as the size of the internal elements increase. They don't degrade gracefully in performance as frequency rises when parasitic values of the elements come into play.

It becomes progressively more difficult to generate pow er as frequency rises, so being able to measure low levels is highly desirable.

The simplest form of power meter is a diode detector. Diodes like the HP 5082 -2800 are usable to low microwave frequencies, but have a threshold below which they don't detect. Some MMIC gain in front of the diode can cope with this. Commercial diode mounts can also be found, with N, SMA or wave guide terminations usable up to 10 GHz or more.

Examples of Use 2.1) Your IF radio needs to be checked for input to a mixer that can t olerate 1 mW maximum. What amount of attenuation do you need before the mixer? The meter and power attenuator lets you measure 2.8W say, from a Yeasu FT290.

2.2) Someone says "lets run an antenna range at the next convention" with no idea of how to do it. It transpires that with the backpack yagi across the lawn from the clubrooms and 5W of carrier lets the antennas under test pick up a few mW, easily readable on the power meter. The results are relative to each other, but after measuring a dipole, some re asonable calculations can be done.

2.3) You have a collection of assorted coax relays. What project are they best for? Do they provide the isolation to prevent frying the GaAs Fet on the input to the transverter during transmit. With 1 -2W from the transverter at frequency of interest passing through the relay to a dummy load, how much is picked up on the other port? Some insurance is useful here in the form of an attenuator before the power sensor, in case more than 10mW would damage the sensor. Once safet y is determined, power down to 1-2uW can be detected, so that isolation of at least 60dB can be measured.

2.4) You must adjust the circularity of your 23 cm dish feed. You have two short helical antennas wound in opposite sense sitting in the garden drive n by a transverter, pointing at the dish feed. Connect the power meter to the receive probe. Adjust the polarising stub depths until minimum power is received at the probe (W2IMU design). Swap left and right circular feeds to check that the received power difference is more than 20 dB.

3) The Directional Coupler The directional Coupler can do two things for you. 1st it will extract a sample of the energy passing through the device with a known attenuation from the input signal of say 10 -20 dB. It can allow higher powers to be measured. 2nd it will take the sample from the input port, largely ignoring the output port returned power. The "directivity" of the coupler will typically be 15 -25 dB for a broadband unit and higher values are found in the more limite d range such as 1 octave couplers. You can now check on the matching of input circuits and antennas.

The SWR meters mentioned above are built around directional couplers. With a little ingenuity, some MMIC amplifiers might be placed inside them to increas e their sensitivity, but they don't extend into the microwave region. If not much power is available, a high attenuation at the sample port should be avoided when you can only detect down to 10uW. Power handling of up to 20W is typical of a small coupler. A set of adapters and short cables is required to insert a coupler into the circuit and connect to the power meter. The best results are obtained when the coupler is placed right at the device to be measured. Impedance transformations by cable lengths are thus avoided.

The author has found a particular broadband coupler that was not flat over its specified range. Until you can confirm this by checking against another coupler, the results can be very confusing. It appeared that the directivity reduced to a very low value at one frequency. There is an interesting table in the recently published International Microwave Handbook, p202 of the range of true return loss values likely to exist for a measured return loss. EG measured return loss 14 dB, directivity 2 0 dB True loss range 10.5 to 20 dB.

Examples of use 3.1) You have just assembled a Loop-Yagi kitset. Can your transverter live with it? Reduce the output of the transverter to 10-100mW. Measure the forward power sample into the antenna. Turn the coupler around. Measure the reflected power sample from the antenna. The "Return Loss" can be calculated from the two power levels. Some ARRL manuals contain tables to convert Return Loss to SWR. EG 10 db loss = SWR 1.9:1, 20 dB loss = SWR 1.2:1.

3.2) You notice that one 10 GHz dish feed is producing instability in the receiver while another one is fine. Measure as described above. Find Return Loss of 6-7 dB. Instability is being provoked in the amplifier. It is time to place 3 tuning stub screws to adjust the mat ching. Adjust for maximum Return Loss.

4 The Sweep Generator Many people will have a signal generator. They are fine test instruments, but very slow to use in some circumstances. Where filters and antennas are to be worked on and adjusted it helps a great deal to see the effect of a change on the whole range at once, to see if it has helped or hindered the overall result.

The ability to sweep the frequency used to mean lower "Q" frequency determining components. Instruments that are now affordable would have used mixing techniques from much higher frequencies down to the working frequency. The output from such an instrument will have lots more phase noise present than a similar signal generator. Setting the sweep to 144.2 MHz produced a rushing noise in the IF receiver rather than a pure tone. This does not matter as such narrow band measurements are not being made here. Dial setting accuracy is also compromised, but this is made up for with Markers being inserted on the display on multiples of a crystal oscillator. The main dial need only be settable closely enough to identify the markers.

An older instrument may cover 500 MHz in one band, with several overlapping bands to cater for needing to sweep past the band edge of a lower or higher band. The display will be an external oscilloscope, with the X axis sweep provided by a sawtooth wave from the sweep generator. Not all scopes have external input for the X axis. The Y axis is output from the sweep generator also, after insertion of the markers. A detector input is required on the front panel. This is where the making of accessories may be required.

To complete the set up a detector is required. This can be as simple as a diode, by convention with negative going output. The negative output is input to the sweep generator and appears on the scope with increased response = +ve y deflection. For passive components, the maximum output of the sweep generator may be only just enough for the diode to conduct. The detector needs a gain block in front of it. MMICs may be used for the purpose these days with total gain of 20-40 dB.

The POS series VCOs from Mini-Circuits may be candidates for making a sweep generator from scratch. Other forms of voltage tuned oscillators include YIG modules. Experience with sawtooth generators shows that plastic film capacitors are required to escape from dielectric storage effects seen with electrolytic capacitors. Op Amp buffering is required to keep real loads away from linear charging circuits. A simple example can be built with a constant current source and a UJT discharge device. Scour those ham fests for 10 turn pots for easily resetable tuning.

Examples of use 4.1) A US design no-tune transverter kitset for 902 MHz was purchased for use on 925 MHz. In order to scale the filters for a 23 MHz higher IF a calculation was made for the amount to cut from the legs of the printed filter. An investigation showed that the peak response of the LO chain filter was at 690 MHz where 780 MHz was required. The 7th harmonic at 682.5 MHz was passed much more strongly than 780 MHz. Result equals more cell phones than you could shake a stick at, on 826.5 MHz. Two small copper pads were joined to a Perspex rod to cause changes to the tuning of each individual filter. The changing peaks on the scope display could determine which filter leg was responsible for the different humps on the scope display. A Stanley Knife then trimmed the legs of the filters. Some of these were determined to now be too short, pieces of copper were soldered on to the ends of the filter legs and could be moved with a hot iron. Result : better filter shape overall, and on frequency.

4.2) The return loss and coupling between the RX and TX probes must be adjusted for a W2IMU horn. A directional coupler was mounted on the probes via an adapter. With gain block and detector in place, the effect of trimming the probe length had only slight effect on return loss. More effect was seen by moving the probe and its mounting in and out from the position of flush with the inside the feed h orn. I have been told that this form of adjustment is not strictly kosher. A position could be found where return loss was at least 20 dB. When later checked the result could not be improved on using an Anritsu "Site Master" costing many thousands of dollars.

5 Putting it all together A YIG tuned source covering 8-18 GHz at 1GHz per volt had been purchased cheaply at a US junk sale. A sawtooth generator as described above was applied to the tuning terminal. About 12 -14 dBm output was available. This is eno ugh for a simple diode detector. A directional coupler covering 2 -18 GHz was available. The scope could show best return loss for a ½ wave slot at 10.3 GHz after adjustment with a small file. The sheet metal with slot was placed across the end of a coax tr ansition to waveguide. Now having the means to investigate, an update on the Clavin Feed for deeper dishes of f/D 0.3 -0.4 could be investigated. It turns out that the original dimensions from UHF/Microwave Projects Vol 2 p1 -15 appear to call for dimensions suitable for a lower frequency than 10.3 GHz. I have measured my kitchen table and find that it is 60 * 90 wavelengths. This is enough for an indoor antenna range over the winter months ahead. Watch this space for an improved set of dimensions.

Having 12-14 dBm @ 10.3 GHz allows the power meter to be used to determine the pattern of a feed. A small horn from p1-7 of the same manual was folded up from copper sheet. It was driven by the YIG source and pointed at the feed under test. The feed was connected t o the power meter sensor. About 10 wavelengths separation could be used to get a full scale reading on the meter when beamed at the feed. The feed was rotated while received power at several angles was measured. This technique is described in the proceedin gs of Microwave Update 99. A small file was created for input to FEEDPATT, an evaluation program available from www.w1ghz.org. The efficiency of feed and f/D can be determined.

There are many other projects that could be tackled, depending on the needs of the occasion.

6 Summary On a limited power budget, a Spectrum Analyser would be a more sensitive detector. This lifts the equipment out of the "low cost" target of this paper. The devices described here have been pur chased for about US$500 at various US Ham Fests. This is not a great outlay until you include Air Fares and Accomodation, and some of the supporting equipment like a scope, adapters, cables, gain block….. It does show that a little test equipment can make the difference between guesswork and guided work, leading to a satisfying result. A literature search for an exact model to copy does not need to be found. Adaptions can be made and verified later. I hope that these ideas encourage people to spend a little bit on other than ready made radios and antennas.

Peter Loveridge ZL1UKG