ANGUS McKENZIE TESTS

MUTEK TVVF144A

2m transverter

muTek have already acquired a very good name for the quality of their VHF and UHF pre-amps, front end boards and more recently, their 50MHz transverters. Chris Bartram, their designer, has been working on a 2m transverter for over a year, and whilst I looked at the prototype a few months ago, only in late July did a production sample arrive for review.

The transverter contains only one functional switch: dc on/off. The front panel has LEDs to indicate Tx/Rx, and four separate Tx power levels: 1.5, 3.75, 6 and 9W output, the final one glowing more brightly when full power of just over 10W is reached. On the back panel there are 50 ohm BNC sockets for 28-30MHz in and out, and a 50 ohm N-socket for the 144MHz antenna or linear connection.

Sockets

A 5-pin power socket (270 degree DIN) contains pins for ±13V dc, hard PTT, ALC return to the main transceiver and a pin which provides 30 ohm impedance to deck on Tx and open circuit on Rx. This is operated by a transistor switching circuit which can draw up to 30mA or so from 13V, although the manufacturers state that it can switch a 30V line provided this is not too low an impedance.

The hard PTT line is of a fairly high impedance, so it does not require much current to pass through an external relay control.

The ALC level is intended to reach a sufficient negative voltage to cut down the RF power output from most transceivers currently on the market, and the circuit was further improved in late July to cope with Trio rigs which require around −6.5V to turn the RF drive back by at least 10dB.

There are some important presets accessible internally. The Tx drive input goes through an RF sensing circuit so that the input BNC can be used for transceive connection. Approximately 5mW power is required here to pull the rig over to Tx, but there is some hysteresis so that it will not drop back until the level is below 1mW. The signal passes through a relay and then into a Tx input preset gain, which should be adjusted appropriately for the required sensitivity.

Input levels from well below 100μW to 300mW can produce full output. The receive converter gain can also be preset to achieve a maximum of around 22dB, down to 8dB when fully backed down. This last position is not quite so silly as you might think, for if you are regularly using a very good masthead cable losses, could be around 20dB (12dB in the masthead pre-amp etc, and 8dB in the converter). 20dB system gain is about ideal in front of a good HF transceiver which has good sensitivity and a good RF input intercept point on the 28MHz band.

Circuit description

As normally supplied, the transverter employs separate Tx and Rx BNCs at 28MHz, but an internal link can be changed so that the Tx drive socket gives transceive operation. The RF sensing circuit is driven from the Tx input line both before and after the relay, the line from after the relay being around 6dB more sensitive, thus holding the transceiver over to Tx with a hysteresis effect. This helps to prevent incredibly strong received signals from putting the transverter into the Tx mode!

A pin diode ALC attenuator follows the drive preset and the ALC internal attenuation range is 25dB maximum, which gives plenty of headroom. The output from this attenuator is taken to a BF199 amplifier provided to give sufficient amplification to cope with the modern low output transverter drives from Icom and Yaesu equipment. Heavy negative feedback is provided around this amplifier which also acts as a fuse to prevent the mixer being blown up with a grossly excessive input drive level. The amplifier is followed by a pin switching diode and a 28MHz filter (2-pole band-

The ring diode mixer, muTek type HLRM200, incorporates four matched diodes. The same mixer is used for Tx and Rx with pin diode switching. The 144MHz output is impedance matched via the pin switch into a MosFET amplifier type 3SK74. This is followed by a 2-pole bandpass filter driving a 2N3866 in class A with negative feedback. A 2SC1947 in class AB drives the PA which is a 2SC1946a, also in class AB. The PA output is filtered with a 7-pole Tchebyshev low-pass filter which feeds a directional coupler, provided to give an ALC feed and to give reverse power protection. The RF output feeds through a broadband matched open frame relay.

The local oscillator uses a fifth overtone 116MHz crystal in a very low noise J310 oscillator, feeding another J310 buffer, which is matched into the ring mixer to give a drive level of 10mW. The Rx converter path from the input relay is protected by an inductance and back to back diodes. The RF pre-amp consists of two BF981s in the same configuration that muTek uses in one of their masthead pre-amps.

The output feeds through a 3-pole bandpass filter and a pin diode switch and is then impedance matched into the mixer. The mixer output with matching passes through a 2-pole bandpass filter, then a pin diode switch into the IF amplifier, a BFR96 with negative feedback. A variable attenuator is provided

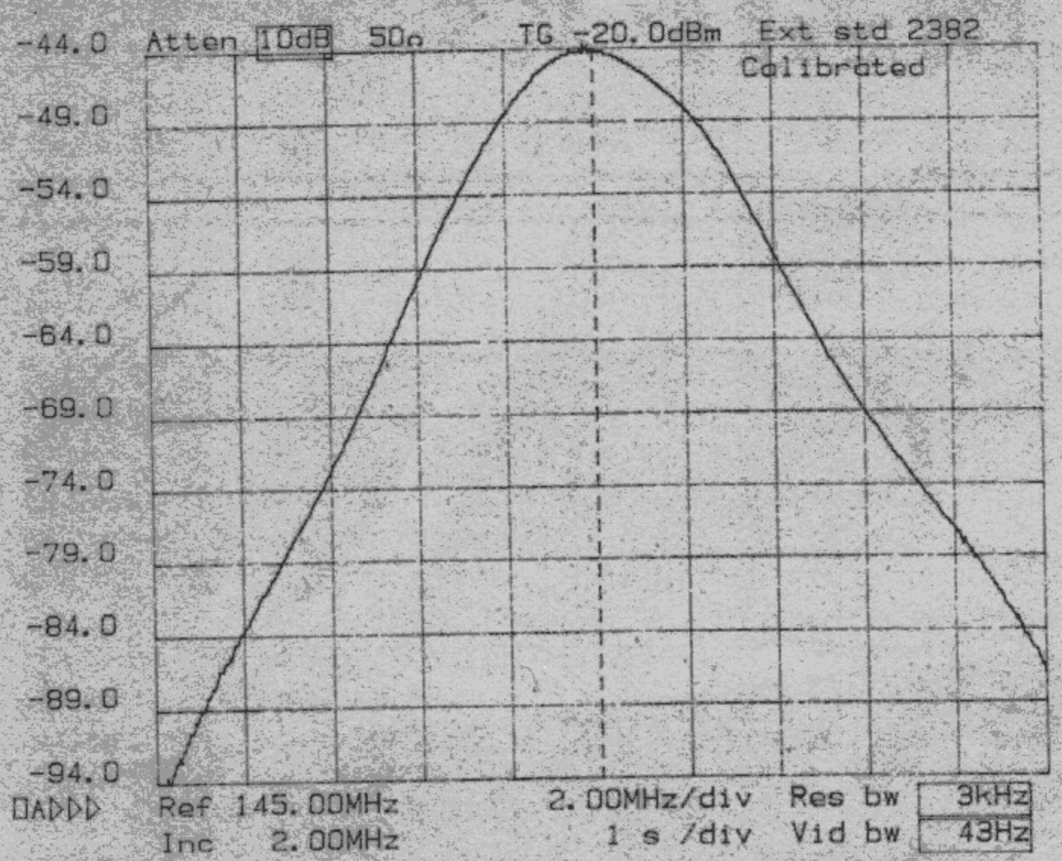

Fig1
Rx response plot

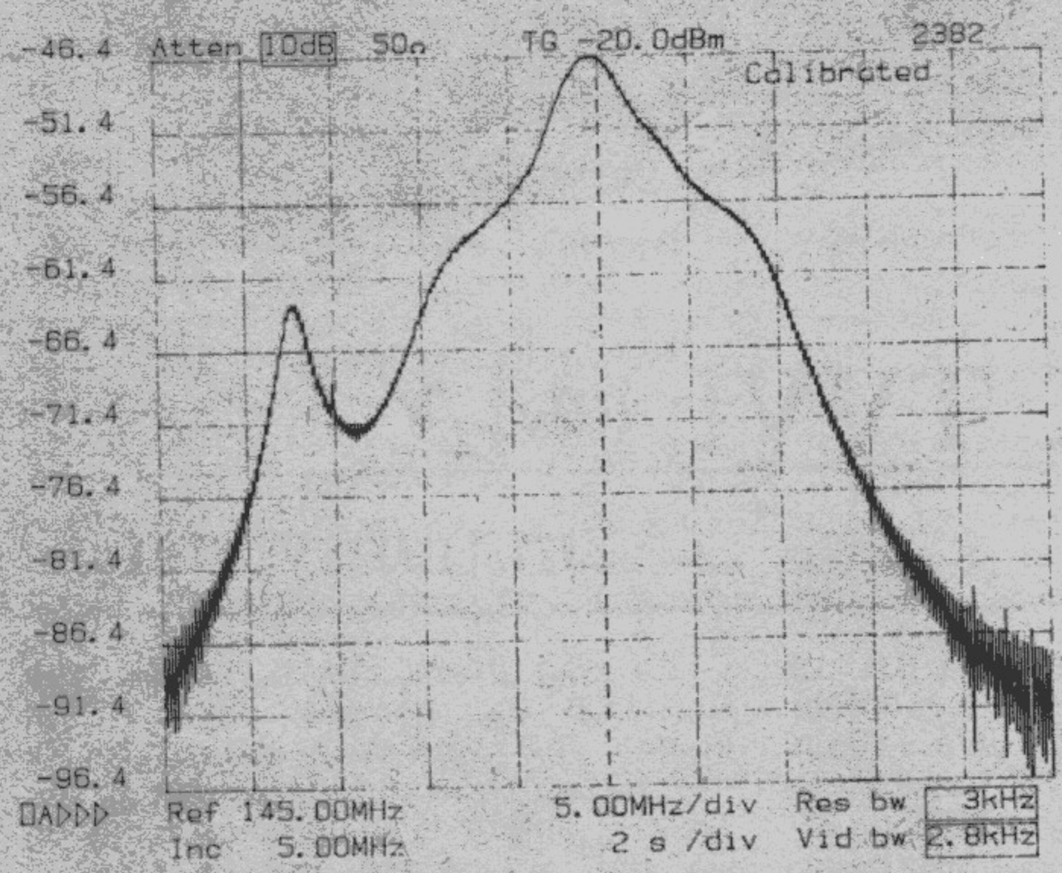

Fig 2
Rx pre-amp response at mixer plot

The ALC loop takes the rectified RF from the directional coupler, processes it with carefully designed attack and decay times and feeds it back to the input pin diode attenuator. The ALC also feeds a separate ALC drive, cunningly designed to provide a negative going voltage for feeding back to transceivers, despite the fact that the rig requires no negative dc voltage from an external source! The power LEDs are also driven from voltages derived from the directional coupler.

Subjective tests

I have tried so many transverters in my time and I have absolutely no doubt that the receive section on this one is far superior to any other one that I have ever used.

In the London area there are some mighty strong signals from stations transmitting at least 10kW ERP, and very strong out of band signals give the majority of black boxes and transverters such an almighty headache that there is a sort of crackly background audible right across the band for much of the time. This background noise reaches horrendous proportions in a contest!

crackle seems to vanish, to be replaced by what I would describe as a fairly constant hiss until the local thermostats come on, or old bangers pass nearby. I have to admit that strong stations sound that bit cleaner if the transmissions are well controlled, and thus a bad transmission stands out all the more clearly!

There seems to be a remarkable absence of spurii caused by out of band intermodulation products, and when I investigated one or two whistles or pulsing noises they came from in band computer rubbish, or even ambassador telephones!

The frequency stability was remarkable and as good as I have known from any transverter. The gain seems just about right with the masthead pre-amp switched off and the provision of a gain preset is very welcome if you regularly want to use a masthead. I tried switching in and out my muTek GaAsFET masthead amplifier and there was only a very marginal difference on the received signal to noise ratios. The loss between the masthead and the transverter input, in my installation, is around 2.5dB or so, and I would only want to put on the masthead for winkling out the very

The transmitter section performed extremely well after the input drive level was appropriately set. The ALC time constants were just about right and we found that we could use around 10dB of ALC backing off around the transverter to good effect. As originally designed the external ALC did not back off the Trio TS940S, but the prototype that I checked in June worked very well with the 940. muTek have now redesigned the external ALC circuit so that it will derive at least −6.5V to back off Trio rigs which require more negative dc than most others. This double protection of internal and external ALC control will make this transverter almost idiot proof.

The power output LEDs are very useful, and can allow you to set up the drive level very accurately as well as reassuring you that you are putting out a reasonable amount of power. Although the rig is RF sensed, the use of hard PTT is essential if low drive transceivers are used as these will not give sufficient output to pull the RF sensing circuits over.

Good reports

I obtained some very good quality reports from many stations around the London area, one station commenting that when I was driving the transverter into the Dressler, running at 400W PEP output, I was still only just over 4kHz wide, even when he was receiving me on the end stop of his S-meter.

One station however complained bitterly when I was beaming at him and it was very obvious that the problem was in his receiver, which must have been jumping up and down rather violently whenever I spoke! The transmission was said to be cleaner than many when I was running the linear, and it was of course very clean indeed running barefoot.

The transverter is supplied in the usual muTek brown metal case, a rural colour which some might say is appropriate to a Devonshire manufacturer!

Laboratory tests

We had to apply some very esoteric testing techniques to show how good this transverter actually is. Having obtained an overall response plot of the receive converter from 2m input to 10m output (*Figure 1*) which showed an extremely narrow, virtually ideal bandpass response, we felt it important to establish how sharp the front end response was in order to show the degree to which strong out of band signals were rejected before they could hit the mixer.

Figure 2 therefore shows the response at the mixer input and it was necessary to use a Hewlett-Packard active probe with a 10 times divider on the tip to provide a very low capacity. The probe tip was placed across the mixer input resistor. You will see that the front end response at 140MHz is already 10dB down, whilst the 150MHz level is −8dB. By 130MHz the response is around −25dB, whilst at

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We did note however that the response humps up again to be −17dB at around 127MHz, below which it attenuates very rapidly. I consider this to be an extremely good front end response which should greatly help in attenuating strong local annoying signals from aircraft and PMR.

The front end sensitivity is very good, the noise figure being just over 2dB. The RF input intercept point, when measured for a 60dB ratio, was at +2dBm, improving to +3.5dBm when checked at lower ratios, ie higher levels still.

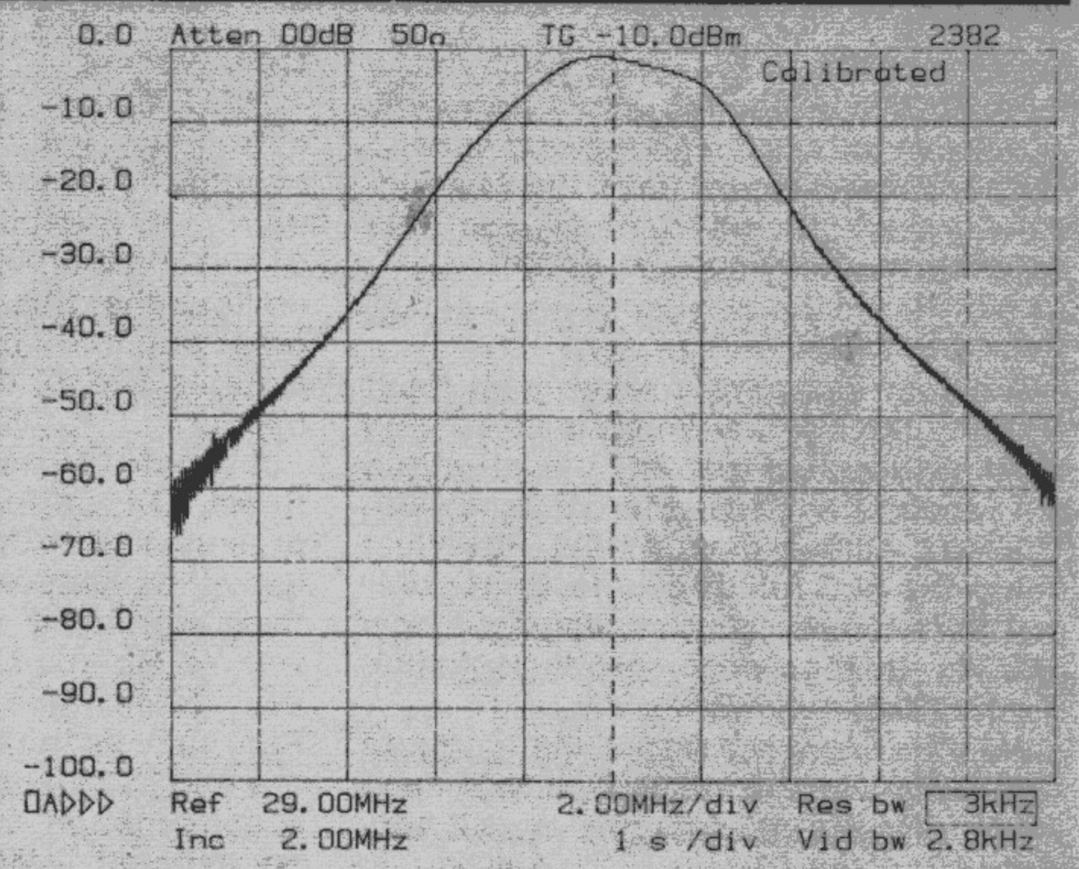


Fig 3 *Tx passband response plot*

Into perspective

To put this into perspective, the input intercept point is some 15dB better than on the new Microwave Modules transverter and 22dB higher than that of their older model. This will mean that intermodulation products developed will be perhaps 30dB lower in practice, and you are therefore not likely to detect any at all.

The overall gain plot shows the maximum gain of 22dB in midband, but this can be substantially reduced if required. Local oscillator breakthrough on the output was at only 400μV, which is not likely to cause a problem to any receiver. The image response around 261MHz (145 + 116) was below −77dB and immeasurable! One awkward spurious which sometimes develops in poor transverters is (4 x LO) − (3 x RF) which can be in-band.

An input signal of −20dBm (22mV!) was required to develop a spurious in-band signal which was at −70dB and can be virtually ignored, thus proving the mixer distortion to be extremely low. We allowed the muTek to warm up for five minutes before measuring the transversion frequency accuracy and the 28MHz output was a mere 50Hz low. Over a period of two hours testing on Tx and Rx the frequency accuracy was always within 100Hz, which really is superb.

For testing the transmitter section we used two Marconi 2019 signal generators, locked to the Rugby standard where appropriate and combining in a hybrid coupler before the signals entered the 28MHz input drive socket. The PA output on 2m fed a Bird Thruline wattmeter and then a 30dB power attenuator into the Marconi 2382 spectrum analyser.

On single carrier tests we noted that around 4mW input drive was required to pull over the RF sensing circuits, but the muTek did not fall back to Rx until drive was reduced to below 1mW.

As supplied, using hard PTT, −7dBm was required (100mV) for a full output of 11W. The input preset, however, had many dB gain to spare so that even the lowest output transverter drives from modern rigs should provide enough drive power.

We plotted an overall Tx response from input to output *(Figure 3)*, which shows once again a very narrow passband. Therefore, unwanted transmitter spurii in the main transceiver are not likely to

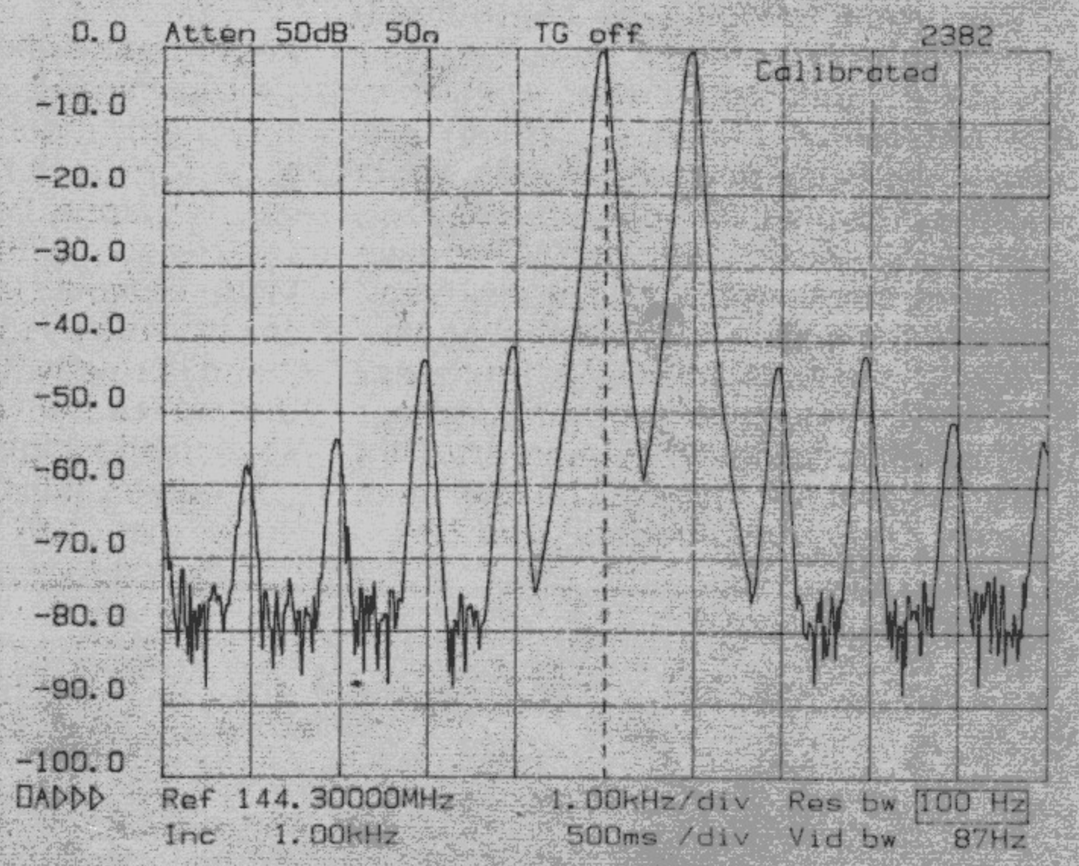


Fig 4 *10W PEP plot*

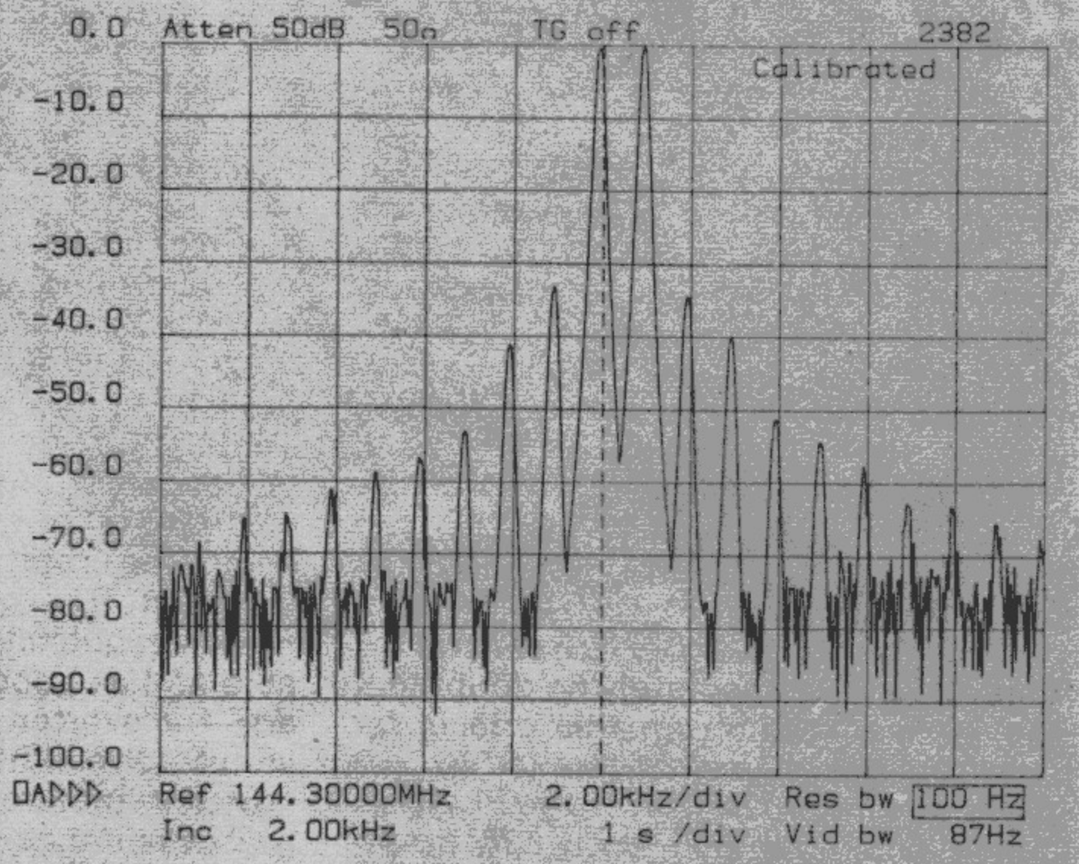


Fig 5 *12.5W PEP into ALC plot*

Local oscillator breakthrough on the output was between 94dB and 89dB below full output, depending on whether the transverter was being driven or not. The ALC loop coped with at least 20dB excess drive and the gain recovery time was around 1s or so, which seems ideal. We tried to look for an output image signal just below 88MHz when the rig was

not detect any image whatsoever, which must therefore be below −100dB!

I don't like being defeated but it is a credit to Chris Bartram that he has indeed defeated me here! We also looked for other spurii and gave up after a while, so I feel fairly sure that you are not likely to find any significant ones. For example, we looked for five-times input

below –75dB, so we gave up hunting further! We checked the harmonic outputs at full output power and second harmonic was below –70dB, third harmonic was at –60dB and fourth at –65dB. No other harmonics could be detected.

Two-tone tests

Two-tone tests were taken with input carriers 1kHz apart, which is stretching the measurement system but well within the capabilities of the Marconi analyser. The plot shows that at 10W PEP, just below the ALC full threshold, third order products were at astonishingly low levels with high order products falling down reasonably well.

We then drove the rig around 10dB into ALC, achieving 12.5W PEP output maximum, and the products were still very good.

The products would be contributed, almost entirely, by the PA stage itself and these are significantly better at 10W than the Microwave Modules performance was at the same power: a model that is designed to give 25W output. However, this is not to say that the Microwave Modules transverter is in any way poor, but that the muTek is extremely good.

We did not note any Tx/Rx frequency drift and an examination of various other factors indicates that this transverter is a very fine product indeed. The maximum current drawn on full output was 2.3A.

Conclusions

This superb product is not only extremely well engineered but is beautifully made and proved to be extremely reliable. I cannot criticise any of the measured parameters and it is obvious that this transverter, above any other one that I have tested, is the most suitable one for the most discriminating users.

It would be ideal for obtaining the finest DX performance, even in the presence of strong local signals, but to use all its features fully you will need to have a good HF transceiver, preferably with an RF input attenuator to optimise the system gain under all conditions. Rigs such as the latest Icom models and the Trio TS930 and 940 would be ideal and a combination of these will provide a magnificent 144MHz station.

Recommendation

I recommend this muTek transverter very highly indeed for it sets a standard of performance that is not easily equalled, let alone beaten. Quite clearly, a comparison with the new Microwave Modules model is appropriate. The latter can provide up to 25W output if you need it and is relatively clean on Tx, whereas the muTek delivers 12.5W maximum on speech and slightly less on CW/FM.

However, most valve linears need no more than 10W input and often less power for full output and I strongly recommend a valve linear rather than a solid-state one in order to preserve a good intermodulation performance. When we come to the receiver sections, you are buying a bomb proof machine with the muTek, whereas the Microwave Modules model is a lot inferior, although it should be adequate unless you live in a very 'hot' area.

The choice is yours

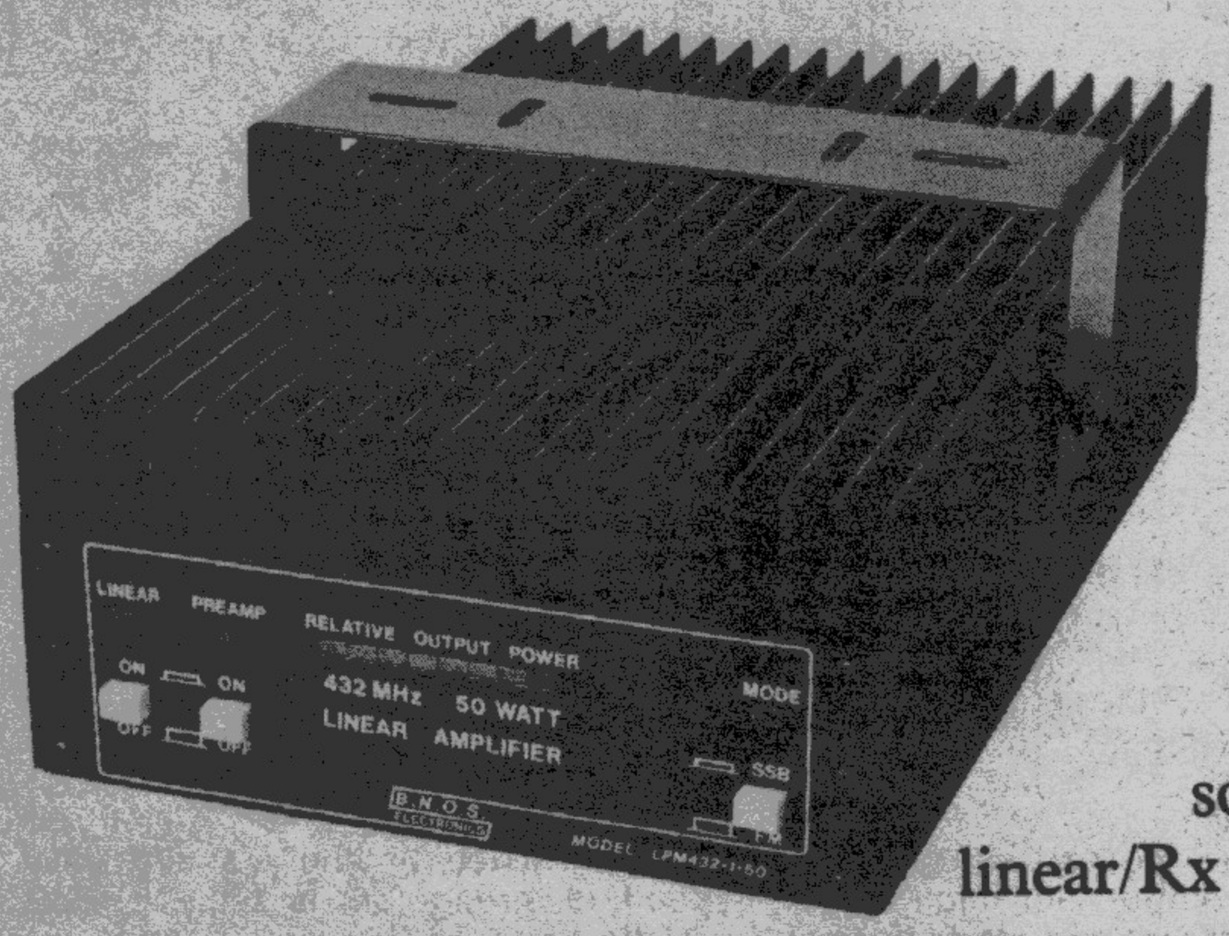
The Microwave Modules does have a repeater shift facility which could be useful for FM if your HF transceiver has only a single VFO, and the muTek is around £20 more expensive than the Microwave Modules, which seems relatively little extra to pay for such an outstanding product.

Of course you will have to make your own mind up, but what more can I say than I have purchased the review sample after many years of using a Microwave Modules transverter and the improvement in the Rx performance is astonishing and well worthwhile.

Chris Bartram has been so helpful in providing me with an early prototype and the first production sample for evaluation and I find muTek so receptive when discussing technical details. I would like to thank Nigel G1LSA and Mark G4RCD for helping me with all the measurements and subjective evaluations.

BNOS LPM432-1-50

solid-state linear/Rx pre-amp



Some time ago in *Amateur Radio* I gave a very favourable review to the BNOS 2m linear in the 3W input and 180W output version. This new model for 70cm is specified at 1W in and 50W out and can be used for all normal modes. The unit is supplied in an attractively designed metal case with an enormous heatsink right across the top. A mobile mounting bracket is supplied with it with locking nuts either side allowing the linear to be withdrawn from the mount.

and captive high current dc power leads for 13V interconnection fused in the positive line only at 10A. This fuse value is rather near the wind, although it did not blow at all, for the amplifier actually takes 10A when giving full output on FM.

A 3.5mm jack socket on the back panel is fitted for hard PTT and this is strongly recommended when the linear is used for SSB or CW operation. Most helpfully, the PTT line is high impedance, which means that when shorted to ground it

that are not suitable for low impedance interconnections. The linear worked quite well with the FT790, a rig which goes very well with it in all respects.

Three push-buttons on the front panel select linear on/off, Rx pre-amp on/off and SSB/FM, this last switch altering the hold time on Tx when RF auto switching is used. Three LEDs indicate the functions being switched on. A row of eight LEDs indicates relative power output, most useful to show you how much you are driving out of the linear.

The RF sensing hold time is unfortunately a little on the short side at around 0.5s on SSB and it is particularly for this reason that I prefer to recommend use of the external PTT input. No problems were experienced with the RF sensing sensitivity, however, and the rig would change over on quite low input powers. On the FM position changeover is almost instantaneous. I used the rig with my own FT790, which was set to give 1W PEP and transmission quality reports were all good except for the fact that some synthesiser whine was noted from the FT790, obviously not the fault of the linear.

The RF pre-amp worked well and gave