The West Rand Amateur Radio Club

The Anode

Volume 10 Issue 1

Editors Comments

Well this is a first in several ways. First of all I am not in South Africa, I am in London. Its been fairly wet but has had some sunny periods. Edith and I went to Paris for three days. Where, believe it or not, I spotted an amateur radio station. It was on a hill in Montmartre. The picture is on Picasa.

http://picasaweb.google.co.uk/brockjk/Holiday2008Paris

What is the Anode?

Google search for "The Anode" amateur radio turns up on page 9 of 4319 hits :-

The Anode is the club magazine of the West Rand Amateur Radio Club. It was started sometime in the 20th century by enthusiastic radio amateurs who typed it ...

www.jbcs.co.za/ham_radio/the_anode.php - 5k - Cached - Similar pages

Amateur radio is going down the "drain".

Can you remember the last time you saw an actual anode? With all the MosFETs being used in the radio construction kits, maybe the Anode should be called the drain?

For those who are interested in electronics

I found some articles on a “Signal tracer and injector”. I also searched for a 'HowTo' article but did not find any that could be inserted, legally or otherwise into the Anode. This follows the discussion we had at the clubhouse on the last Electronic Enthusiasts meeting. Stuart was a proponent of this rather useful device and waxed eloquent about how useful it was. It is one of the simplest test gadgets you can build and can find a tricky fault in a receiver within minutes.

So the upshot is that we will have to discuss ways and means of using the signal injector. The signal tracer is just as useful and features in some articles. It also doesn't seem to have found favour with some modern 'techies'.

Listen to radio amateurs on/via the Internet

Use VLC and open the playlist. Connect to shoutcast. Search for "ham".

Found on the Internet

This paper appears in: **100 Years of Radio, 1995.**, International Conference on

Publication Date: 5-7 Sep 1995 On page(s): 44-50

Meeting Date: 09/05/1995 – 09/07/1995 Location: London, UK

ISBN: 0-85296-649-0 References Cited: 18

INSPEC Accession Number: 5119107

Date Published in Issue: 2002-08-06 19:54:10.0

Abstract

The Boer War in South Africa (1899-1902) was the first occasion in which wireless communications were used in a military conflict. The paper traces the history from the point of view of both the British and the Boer forces: both of whom had intentions to use this latest invention on the field of battle. Marconi's apparatus, in its most elementary form, went with the British Army to the front, but failed. The Boer's German equipment was captured and never saw service. The Army soon rejected wireless but the Royal Navy acquired the apparatus and made it work. No doubt circumstances and personalities played their part but by far the major factor in determining success and failure was the natural electromagnetic environment. All these components of a fascinating saga are discussed.

[To download the original document, you have to pay the IEEE for subscription rights.]

Signal Tracer and Injector

Circuit : Andy Collinson

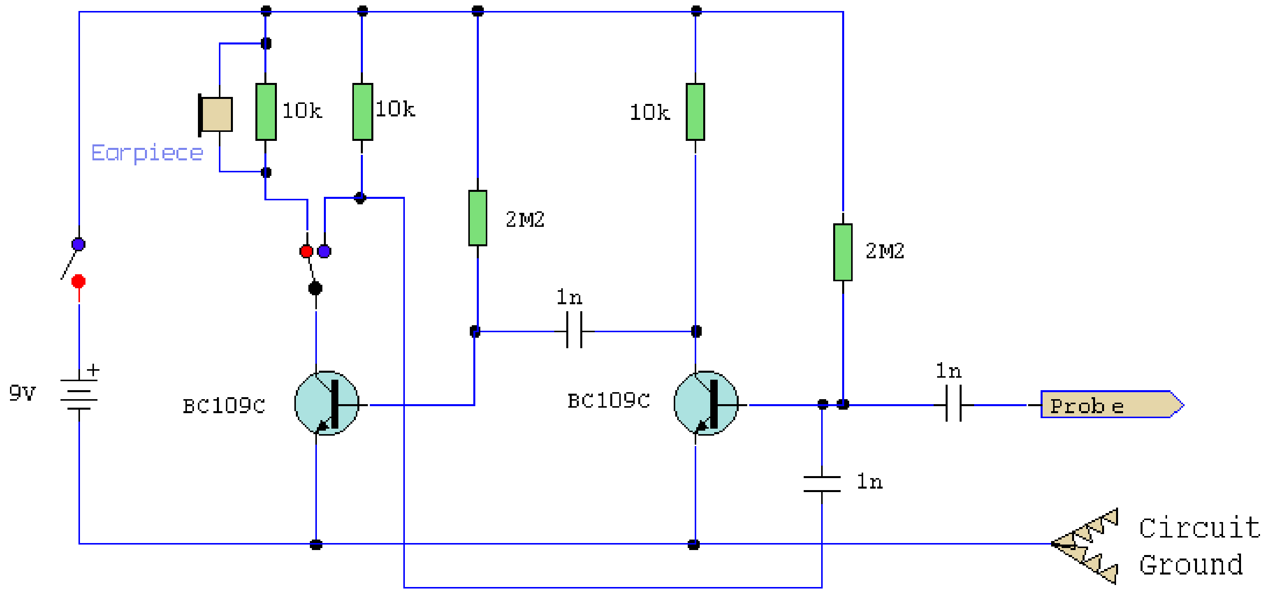
Email: anc@mitedu.freeserve.co.uk

Description:
A simple test circuit to fault find audio and radio equipment. Can be used to inject a square wave signal, rich in harmonics, or used with headphones as an audio tracer.

Notes:
A single pole double throw switch is used to switch between inject and trace modes. The diagram is drawn in trace mode, the earpiece being connected to the collector of the last transistor. Both transistors are wired as emitter followers, providing high gain. DC blocking is provided by the 1n capacitor at the probe end, and the two stages are capacitively coupled.

When the switch is thrown the opposite way (to the blue dot) both transistors are wired as an astable square wave generator. This provides enough harmonics from audio up to several hundred kilohertz and is useful for testing AM radio Receivers.

Circuit diagram



Notes

It goes without saying the transistors are general purpose silicon types and can be substituted by almost any other type. Examples are 2N3904, 2N2222 and lots of others. The 2 Megohm resistors may be hard to find, so I suggest two 1 Megohm resistors in series. The earpiece can also be replaced with a high impedance noise maker taken from a modem.

How To use a signal tracer

Don Wilhelm a écrit :

Jean-Francois,

Signal tracing can be quite effective - I applaud your goals.

Signal tracing of a transmitter path can usually be done with only an RF probe since the signal levels are usually large enough to measure easily, although a 'scope is more informative because you can see the relative frequencies involved. For the K2, just follow the steps detailed in the Transmit Signal Tracing section of Appendix E in the manual.

Receive Signal Tracing is a bit more 'iffy' - although the method in Appendix E of the K2 manual works well, one must use a relatively strong signal source (such as the oscillator shown in the manual) to have a large enough signal in the receiver to measure (very small readings are likely just noise picked up by the probe). One must remember that in the RF and IF stages, a signal that can be observed on a 'scope or RF probe is much greater than the normal signal levels handled by the receiver - none-the-less, the procedure can be informative in identifying a failing stage, but it cannot be used to evaluate distortion levels since the stages are being overdriven by the generator with this elementary test. If one uses a normal receiver input level signal, there are devices to effectively measure those small signal levels (Spectrum Analyzer for instance), but the signal path must usually be broken and the signal level transformed to 50 ohms to do proper measurements.

A more effective method of troubleshooting a receiver is to use a signal generator to do 'signal injection' at each stage of the receiver - for the audio stages, that requires a generator that will produce audio frequencies, and for the IF stages it requires a signal generator that can produce a frequency equal to the IF frequency. The RF stages require a signal generator at the receiver tuning frequency. This generator should have a controllable output level so the levels can also be evaluated. Normally one would start at the audio stages and move toward the antenna one stage at a time, injecting the level and frequency that each stage should respond to.

Using that procedure, it is sufficient to measure the ouput of the receiver either with an AC Voltmeter or just the ears listening to the speaker.

There ued to be 'signal injectors' available that produced an audio square waveform that was very rich in harmonics that could be used as a relative indicator of functioning receiver stages - if you can hear a good response when moving from the audio stages toward the antenna, it can quickly identify a failing stage.

Bottom line - receiver signal tracing begins at the antenna and works toward the receiver audio stages, signal injection works the other way around.

Both methods verify the operation of each stage in turn until the failure point is found.

The generator that you referred to is a Function Generator which is great for evaluating audio and low frequency IF stages, but if you are using a K2 for this 'education', the IF is at 4915 KHz and that generator will not go above 3000 kHz.

As I indicated, if you are just trying to isolate a failing stage, the large signal injected at the antenna (tune the receiver to the signal generator frequency) will usually suffice, but if the problem is more subtle than just a failing stage (distortion for example), the controlled level signal injection at each stage is required - along with a good knowledge of 'what is normal'.

73, Don W3FPR

-----Original Message-----

I would like to learn and explore more «signal tracing» procedure and technique. I actually have a Fluke 196C. But I don't have a signal generator.

A friend of mine have his signal generator for sale. The model is an Instek GFG-8216A. I would like to know if the device will be good for signal tracing or the specification of this device is not enough for this purpose??? I know that I could build the one in the K2 building manual or at least use the technique «Cheap'n Dirty» from N0SS... but that's not my point.... ;-)

The specification can be viewed at

http://www.instek.com/pdf/Generator/GFG-8216A8215A.pdf

Thanks for all your advice.

Best 73

J-F VA2VYZ

Thanks Don.

Again, I will keep and print this email has a reference in my shack. Clear explanation... very instructive. I am actually building the signal generator found in the K2 manual. Now it works ! I

I will now experiment using this device. I also found a good explanation the ARRL handbook, in the section «troubleshooting», chapter 27. I really want to use more my scope and learn on how to use it... and how to read it. A good practice.....

Best 73 and thanks again for your time !!!!

J-F VA2VYZ

N5ESE's Classic RF Probe

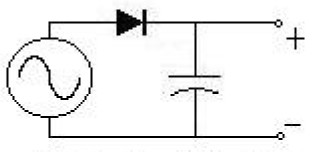
NOTE: 'N5FC' is my former call.

This project was constructed while that call was valid, and you may observe references to it.

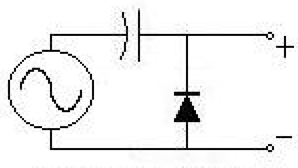
The RF Probe is one of the handiest accessories you can have around the shack. Using only 3 electronic components, it may rank as one of the simplest and cheapest homebrew projects. The one featured here cost about $10 in parts and supplies, not counting the wire, which I scrounged. When used with a high-impedance DC Voltmeter, it can be used to measure RF voltage (and power), trace RF signals in a new design, and troubleshoot malfunctioning RF circuits. It has its limits, of course, and we'll discuss those here. But once you understand how it's used, and how easy it is to build, you'll wonder why you never built one before.

What's an RF probe, and how does it work?

You might think of an RF probe as a special test lead that converts your regular ol' DC voltmeter to a RF reading voltmeter. Why not just read it using your trusty voltmeter, set on AC? Well, because most voltmeters wont read AC signals having a frequency above 10 or 100 KHz, and RF is way above that. [You can buy special RF-reading voltmeters, but they're very expensive... a homebrew RF probe is dirt-cheap]. Let's examine how an RF Probe works.



Classic Peak Rectifier



Simplified RF Probe

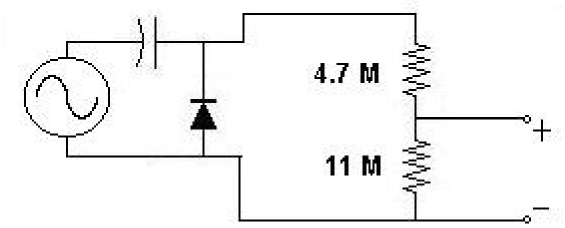
Above left, we see the schematic of a classic half-wave peak rectifier, commonly seen in power supplies. It's pupose is to take an AC signal at the input (usually from a transformer or the AC line), rectify it, and charge a capacitor. If you don't take a lot of power from the circuit (i.e., if your load doesn't draw a lot of current), the capacitor charges up to the peak voltage of the AC signal, and stays pretty much constant. Notice the simplicity of the circuit: not counting the load, we see it is an AC Source, a diode, and a capacitor in series.

Above right, we see a simplified schematic of the RF Probe. At first glance, it looks quite different from the circuit at the left. But notice: just like the first, it consists of an AC Source, a diode, and a capacitor in series. It's purpose is to take an AC signal at the input (usually from a circuit under test), rectify it, and charge a capacitor. And just like the first circuit, If you don't take a lot of power from the circuit (i.e., if your load doesn't draw a lot of current), the capacitor charges up to the peak voltage of the AC signal, and stays prettty much constant.

What's the difference between these two circuits, then? One small little thing, really. In the first circuit (the half-wave peak rectifier), any positive DC component gets added to the voltage at the output. In the second circuit (the RF Probe), the circuit is insensitive to positive DC components. This is good for an RF probe, because we're going to be testing circuits with DC biases applied, and we don't want those biases to affect our readings (we're interested in the AC only, i.e., the RF)

In both these circuits, if we place a DC (not AC) voltmeter at the place where it says "+" and "-" we'll read a DC voltage that is approximately equal to the peak of the applied AC voltage. If we knew our applied AC was a sinusoidal signal (or sine wave), then we could divide our reading by 1.414 to obtain the RMS value, which is the way we usually measure AC voltages. Even if it's not a sinusoid, at least we know what the peak voltage is, and that's something we didn't know before we started.

We'll do one more little trick to make the RF Probe more useful, and it will only cost us the addition of a 2-cent resistor. So that we don't have to manually divide our readings by 1.414, we'll use a resistor to create a voltage divider that will do it for us. Here's a classic voltage divider, added to our RF Probe circuit:

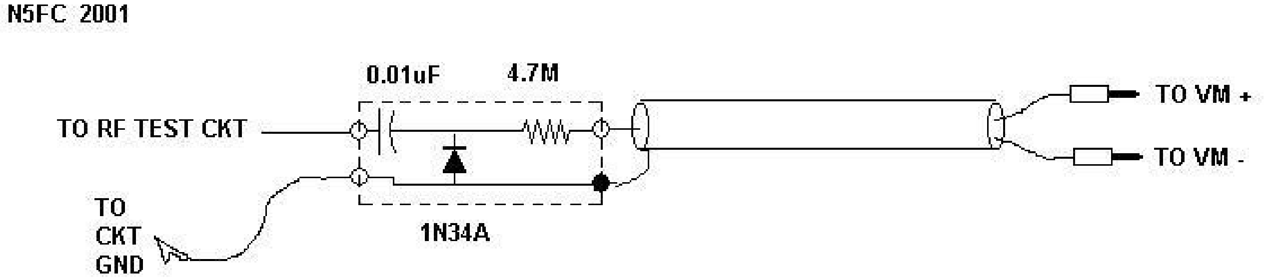


As we know from elemental electronic theory, the voltage across the second resistor (where it says "+" and "-") is equal to the applied voltage multiplied times the ratio of the second resistance divided by the total resistance in series. In our case, for a sinusoidal input, we know the applied DC voltage is equal to the PEAK of the AC voltage. We would like the resistor divider to divide by 1.414, which means that the total resistance in series (including the second resistor) needs to be equal to 1.414 times the second resistance. In our example circuit, shown above, the second resistor is 11 Megohms, and the total series resistance is 11 Megohms PLUS 4.7 megohms, or 15.7 Megohms. Is this ratio 1.414? Pretty close, about 1.427, closer than the typical resistor tolerances.

But wait! I said we would add one resistor, not two! What's up with that? Well, the 11 Megohms is the typical input resistance of a high-impedance voltmeter, like an electronic VTVM or a digital voltmeter. As long as it's 10-11 Megohms, it'll give results close enough for government work (HI). Obviously, it's important to know what your voltmeter's input resistance is, and you can find this out in your voltmeter's specifications, or measure it (I wont get into that). And really, accuracy is often not that important, especially when you're signal-tracing.

Enough! Let's get real... let's build something!

Here's a complete schematic of the classic RF Probe. Simple, eh?



CLASSIC RF PROBE

Reads RMS Equivalent Voltage in test circuit, if Voltmeter is 10-11 Meg Input Impedance;
Reads 4X RMS Equiv Voltage if VM is 1Meg Input Impedance (Set VM to measure DCV)

We've added a few things from our theoretical discussion that we'll make short note of. Obviously, for "probing" we need a "probe". (Hey! No wonder I get paid the big bucks...). We add a SHORT lead with an alligator clip. The alligator clip goes to our circuit "ground" and the probe goes to our test circuit, where we're probing. Brilliant! We don't want either of these to be long leads, because we're talking RF here, and long leads = antennas, and we don't want to be picking up stray signals or broadcasting them. 10-12 inches for our ground lead is sufficient for circuits to up to 30 MHz.

As shown in the schematic, we'll need to shield the RF Probe circuit, or else our hand and body will pick up stray RF and couple it into the circuit, causing erroneous readings. We'll also shield our leads all the way back to the Voltmeter, as shown, for the same reason. At the far end of the shielded wire, we'll mount banana plugs (or whatever will fit our DC Voltmeter).

In case you're tempted, don't make poor substitutions for the diode. We chose the 1N34A because it had the following key characteristics: Reverse Breakdown Voltage greater than 40 Volts, forward voltage (barrier potential) of less than 0.3 Volts, and good RF qualities. Any diode with these qualities (example, the 1N458A) would work as well, but the 1N34A is readily available (at Radio Shack and others). Silicon and Shottky (hot-carrier) diodes, while good RF devices, have higher barrier voltages, and will not work as well at low RF voltages. The 1N34A is a germanium device, and with a barrier voltage of around 0.25 V, provides about the best performance you can get with this simple circuit.

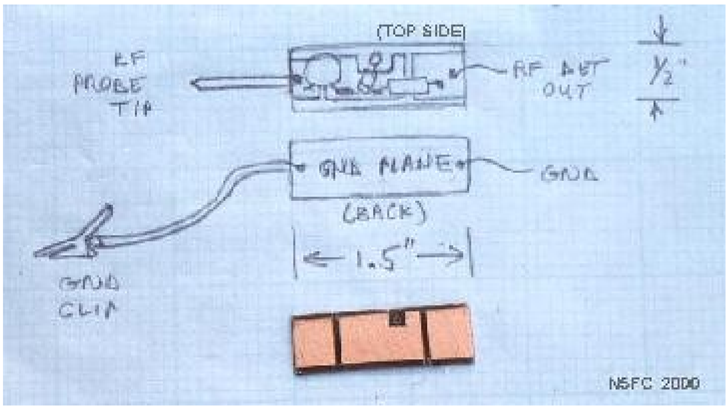
For best accuracy, size the resistor to match your DC Voltmeter's input impedance:

R = 4.7 Meg for Zin = 11-Meg;

R = 4.3 Meg for Zin = 10-Meg;

R = 430 K for Zin = 1-Meg;

Here's one cheap-and-easy approach to building the RF Probe:



Take a small piece of scrap double-sided printed-circuit board, about 1-1/2 x 1/2 inches, Groove it on one side only, similar to the image above, to create pads for soldering, but leave the back side as a "ground plane". Mount your diode, capacitor, and resistor as shown, soldering to the pads you made. One side of the diode (the non-banded isde) gets connected to the ground plane (drill a hole through to the other side and solder it). Try to fit all the components neatly inside the edges of the pc board. Solder the braid of the shielded wire (3-4 ft long) to the ground plane, and the centre conductor to the pad with the resistor. Also, solder a 10-12 inch hook-up wire to the ground plane. Check that there are no shorts between the centre conductor and the ground-plane. Solder the probe tip to the pad with the capacitor (I used a discarded probe tip from a broken test probe).

Here's where we get creative: packaging! One way or another, whatever method we use, it's important to shield the probe circuit, yet without shorting any part of the circuit to our shield (except the ground plane). I was on a kick of using copper pipe, which is very cheap, so I built my shield out of 1/2-inch copper pipe and end caps, commonly available at your local hardware store. I drilled a hole in the end of each end-cap, to pass the shielded cable and the probe tip. I used a shouldered washer to insulate the probe tip from the end cap, but a small rubber grommet would have worked as well. Stuff the assembly inside the copper pipe, and you end up with a completed probe that looks like the following:

RF Probe

So, how do we use this thing?

Before we use it, a few precautions are in order. Don't use the probe in any circuit where the highest DC supply voltage is greater than the diode's reverse-breakdown voltage. For the 1N34A, this is 50 Volts. Same goes for the capacitor, which should be rated at least 50 Volts. This probably means that the probe cannot be used in most tube circuits. Also, don't try to measure RF power in circuits where the peak voltage will exceed 50 Volts. What will happen if you exceed these voltages by a little? Well, probably nothing; possibly, the diode or capacitor will fail open or short.

The first thing you'll always do in using the RF Probe is to connect the banana-plug end to the +/- jacks of your DC Voltmeter; set the Voltmeter to DC-Volts (not AC).

To use the RF Probe for signal tracing in a malfunctioning RF circuit or a homebrew circuit, connect the aligator clip to a convenient "ground" or "common" point in your circuit. Often this is the chassis. Most of the time, you'll be probing at the base/gate, emitter/source, or collector/drain of a transistor, one either side of a coupling capacitor or transformer, or at the input or output of an IC. Because the circuit's RF must overcome the diode's barrier potential (of 0.25V, for our 1N34A), voltages much less than that won't read at all, and voltages less than about a volt won't read very accurately. Typically, RF and post-mixer-amps in receivers don't have enough RF voltage, unless you inject a very strong signal at the input.

I recently used my RF probe to troubleshoot my dead TenTec Scout, which had suddenly quit transmitting in mid-QSO. I connected the rig to a dummy load, then keyed it while probing. Using the probe, I was able to follow a steadily increasing RF signal through the transmit chain, from the oscillator through the transmit mixer, to the pre-driver, and the driver. The actual voltage measurements weren't important, just that they were increasing from stage to stage where expected. Then, (whoops!) the driver's base circuit had 6 Volts, but the collector circuit only had only 0.1 Volts! The driver transistors had gone south!

You can also use the RF probe to measure RF power with reasonable accuracy, up to about 50 watts in a 50-ohm circuit. By 50-ohm circuit, I mean a 50-ohm antenna system at 1:1 SWR (higher SWRs are not 50 ohms), or a 50-ohm dummy load. Assuming the resistor in your RF probe is sized to match your DC Voltmeter's input impedance (as explained above), you will get quite reasonably accurate measurements using the following formula:

$$\mathrm{PWR} = \frac{(V_{(\mathrm{read})} + 0.25)^2}{R_{(\mathrm{load})}}$$

For example, I want to measure the power out of my TenTec 1340 40-Meter QRP transceiver. I place it on a 50-ohm dummy load, and key down. I generally use a BNC-Tee adapter to gain access to the output line, but I could as easily pop the cover off. Using the RF probe (alligator clip to chassis ground), I measure12.2 Volts (DC) (and the same RF RMS Volts). Plugging this into the formula above I have PWR= (12.2 + 0.25) * (12.2 + 0.25) / 50 = 3.1 Watts. The rated power for this rig is 3 Watts, so I've verified everything is hunky-dorey.

We've added the potential barrier to the measured voltage above, but that little trick doesn't work so well when you get down around a volt, and for voltages less than about a volt, the measurement accuracy suffers greatly. Also, the diode's response is severely non-linear below the barrier potential, and will generally read much less than expected in circuits where the RF voltage is less than 1/4 volt. So if you see tiny readings in circuits where it's normal to have voltages less than 1/4 volt RF, don't get too spun-up about the low readings... it may mean everything is normal. My rule of thumb for guessing at this is as follows: For collector/drain circuits in oscillators or transmit-chain amplifiers in key-down, expect RF Voltages about

20-50% of the applied DC (supply) voltage. This depends on the circuitry, of course, but it's a reasonable 'guesstimate'. Base/gate and emitter/source circuits will generally be much less, maybe 5-10%. Circuit impedance will affect this too.

How good is this thing?

Well, we're not talking high performance test equipment here, but we are talking very useful. If you account for the barrier voltage, the readings can be quite accurate when measuring most low-impedance circuits (20-200 ohms), provided that the voltage is above 1 or 2 volts. How accurate? +/-10% from 200 KHz to 150 MHz would be a reasonable expectation. Also, the voltage divider is only accurate for sinusoidal signals. If you want "peak" measurements, simply multiply your reading by 1.414. The "peak" measurement should be good regardless of whether the waveform is sinusoidal. Regarding ultimate accuracy, your results may vary, and you may want to compare it to a laboratory instrument at the frequency of interest if you're really interested in accuracy. If you shield it well, and keep the ground clip lead reasonably short, it should be good in low-impedance circuits up into the VHF region, and down into the upper-audio region. In higher-impedance circuits, the junction capacitance of the diode may cause a low-pass effect at higher frequencies, and you're most likely to see this as a loss of measurement accuracy (i.e., low readings) at frequencies above 30 MHz. This doesn't mean it's not useful; it just means it reads low. Also, the capacitance of the probe may affect some sensitive RF circuits. For example, if you're probing a LC-tuned oscillator circuit, it may stop oscillating or change frequency or become unstable. Actually, most any probe will do this. Also, as we said before, the barrier voltage becomes a bigger part of the measurement error as the circuit voltage drops below a volt or so, and becomes dominant as you approach the barrier voltage. Just keep this in mind as one of it's limits.

Enjoy, good luck, and 73!

monty N5ESE

[from Monty's web page]

The West Rand Amateur Radio Club

26.14122 South - 27.91870 East

Bulletins (Sundays at ...)

11h15 Start of call in of stations

11h30 Main bulletin start

Frequencies

439.000MHz 7.6MHz split Input: 431.4MHz (West Rand Repeater)

145,625 MHz (West Rand Repeater)

10,135 MHz (HF Relay)

We need your input! Email us articles, comments and suggestions please.

West Rand members - we need your input!

To make this the best ham radio magazine in South Africa we need your input. Please submit articles, comments, suggestions etc.

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