Using the RF Probe

Before you start, a few precautions are in order. Don't use this 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).

N5FC 2001

TO RF TEST CKT — 0.01uF — 4.7M — TO VM +

TO VM -

TO CKT GND

1N34A
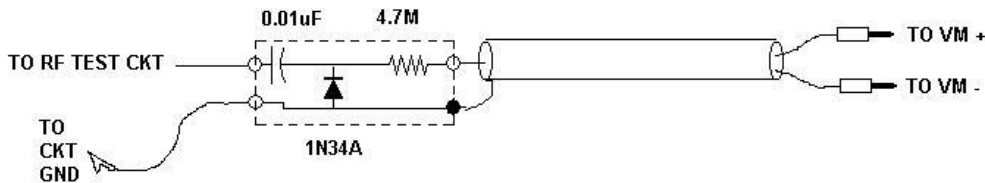
CLASSIC RF PROBE

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)

To use the RF Probe for signal tracing in a malfunctioning RF circuit or a homebrew circuit, connect the alligator 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.

We recently used the RF probe to troubleshoot a dead QRP Transceiver, which had suddenly quit transmitting in mid-QSO. We connected the rig to a dummy load, and then keyed it while probing. Using the probe, we were 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 are not 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, we 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:

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

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

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. Monty's 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 gesstimate. 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.

RF should be where the yellow arrows are.
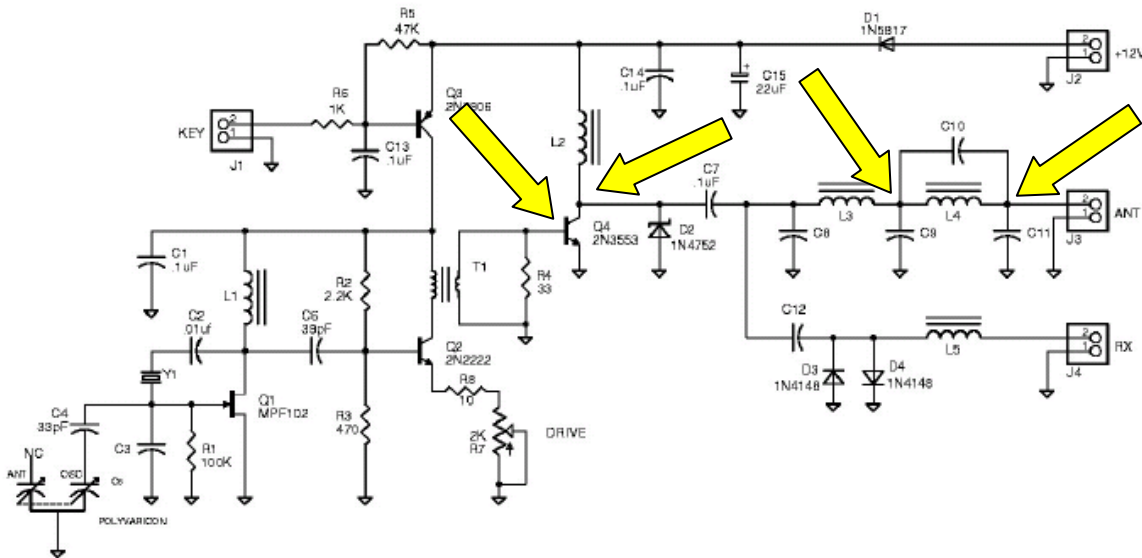
Remember, we are not talking high performance test equipment here, but we *are* talking very useful. Good luck. Dar W9HZC (Thanks again Monty!)

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One Note: If your multi-meter has a different input resistance than the
standard 10 to 11 Meg Ohm, for example, 22 Meg Ohms, You can figure out
the scaling resistor (Rs) value by multiplying  the multi-meter's input
resistance Rm by 0.414. For example: Rs = 22.00 x 0.414 = 9.018 Meg Ohm
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