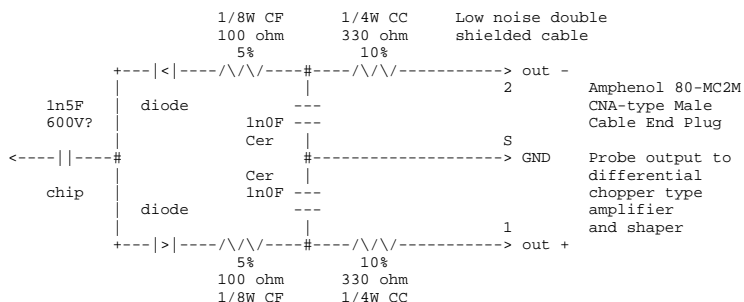


The old Boonton RF Millivoltmeter or Boonton RF Microwattmeter or Ballantine Labs RF Millivoltmeter you bought on eBay likely came without an RF probe or RF Power Sensor. The probe and sensor is not well documented in the service manual so here is the probe schematic and sensor schematic with relevant info. Feel free to share this info or to post it on your own web site. [HOME](#)

Boonton 952001 RF Probe - 10KHz to 1.2GHz with 1.5pF loading



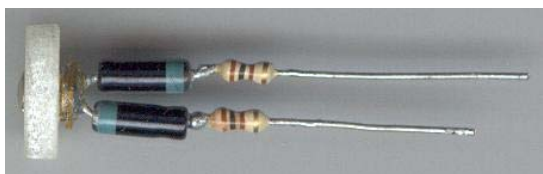
Below is the schematic diagram of my probe serial number 10091. Please see the last section of this web page for more info about the special diodes, and do email me with your successes and failures. Please also help me identify the mysterious factory selected diodes as to manufacturer and part number.



The unmarked diodes are almost certainly Low Barrier Silicon Schottky Detector Diodes. I have measured the original diodes to expose the following characteristics:

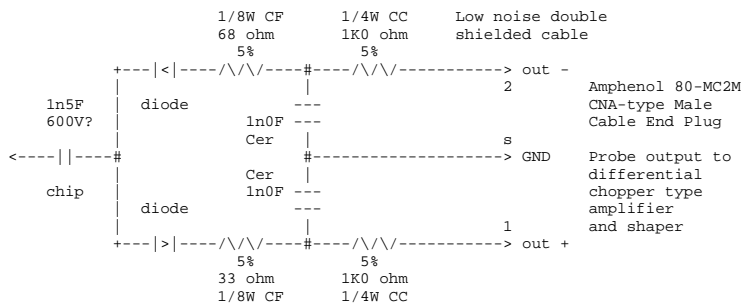
If	Vf	Measured at 20 degrees Celsius	Ir	Vr
10uA	140mV		10uA	41.5V
100uA	210mV		1uA	15.5V
1mA	320mV		100nA	0.4V

Pictured below are some of the innards I pulled out of the probe. Notice the thin chip capacitor soldered between the two diodes and the probe tip header. The secretive diodes have no markings. No I did not destroy my probe, but would you like to buy it on eBay now that I've autopsied it a few times? Just kidding.

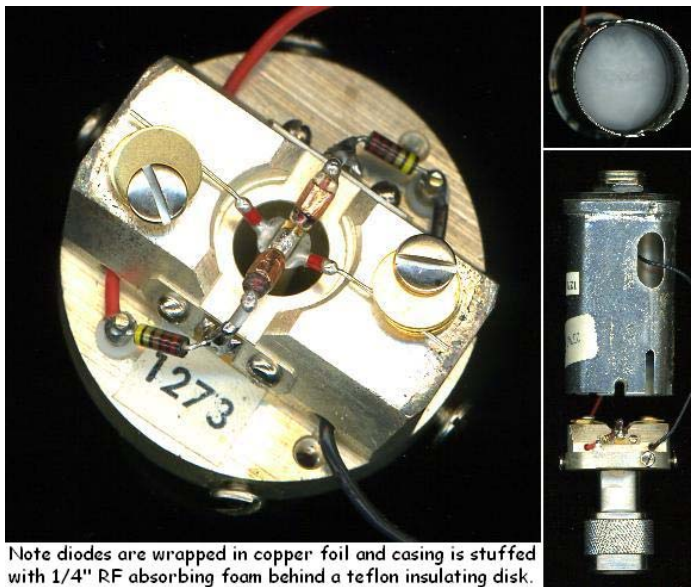


Later revisions of the probe use 1K0 resistors at the output, and the resistors at the diodes are selected during manufacturing to match individual diode characteristics. The resistor values and picture for probe serial number 16364 shown below are courtesy of Ray M.



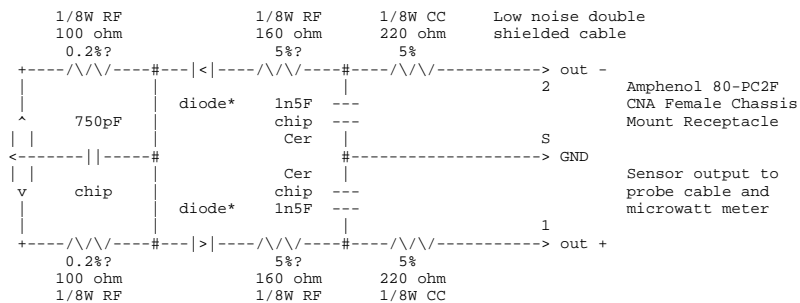


Boonton 51013 (aka 4E) RF Power Sensor - 100KHz to 18GHz with built in 50 ohm termination



Note diodes are wrapped in copper foil and casing is stuffed with 1/4" RF absorbing foam behind a teflon insulating disk.

Below is the schematic diagram of my sensor serial number 51013. The thin rectangular 750pF chip capacitor is soldered directly to the N connector center post, between the two red termination resistors. The white 160 ohm RF resistors are soldered directly in series with each diode. The termination is adjustable by loosening the screws and rotating the brass disks. Please see the last section of this web page for more info about the special diodes, and do email me with your successes and failures. Please also help me identify the mysterious factory selected diodes as to manufacturer and part number.

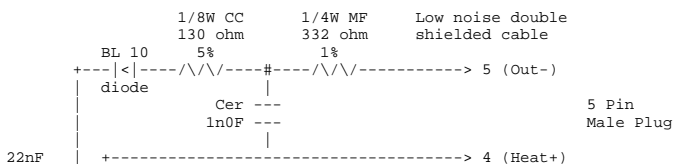


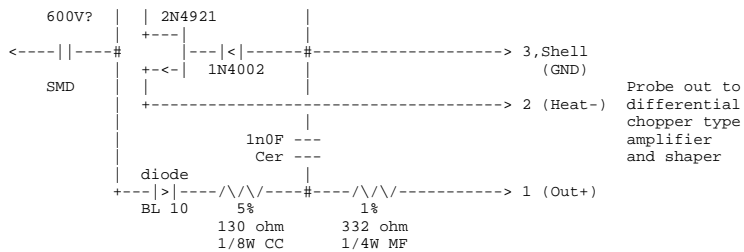
The unmarked diodes are almost certainly Low Barrier Silicon Schottky Detector Diodes. I have measured the original diodes to expose the following characteristics:

If	Vf	Measured at 20 degrees Celsius	Ir	Vr
10uA	? mV		10uA	? V
100uA	? mV		1uA	? V
1mA	? mV		100nA	? V

Ballantine Labs 3440A Standard RF Probe - 10KHz to 1.2GHz with 2.5pF loading

Below is schematic diagram of the probe circuit. Please see the last section of this web page for more info about the special diodes, and do email me with your successes and failures. Please also help me identify the mystery diodes as to manufacturer and part number. Note that the 2N4921 power transistor simply heats the diodes at a constant temperature in order to prevent drift.



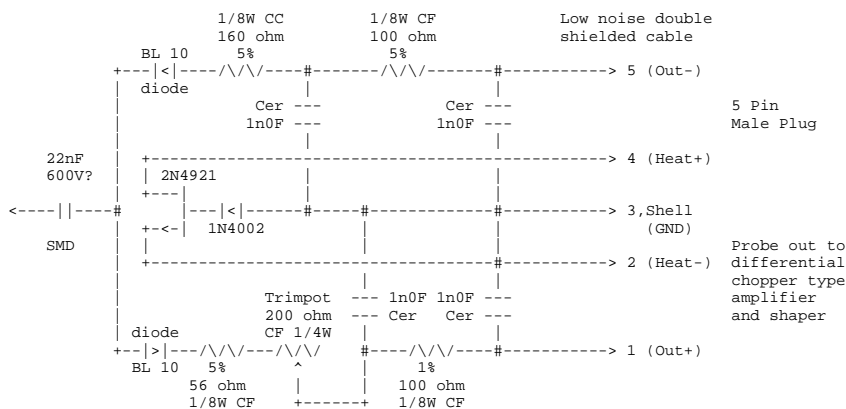


The unmarked diodes are almost certainly Low Barrier Silicon Schottky Detector Diodes. I have measured the original diodes to expose the following characteristics:

If	Vf	Measured at 20 degrees Celsius	Ir	Vr
10uA	? mV		10uA	? V
100uA	? mV		1uA	? V
1mA	? mV		100nA	? V

Ballantine Labs 34403A Precision RF Probe - 10KHz to 1.2GHz with 2.5pF loading

Below is schematic diagram of the probe circuit. Please see the last section of this web page for more info about the special diodes, and do email me with your successes and failures. Please also help me identify the mystery diodes as to manufacturer and part number. Note that the 2N4921 power transistor simply heats the diodes at a constant temperature in order to prevent drift.

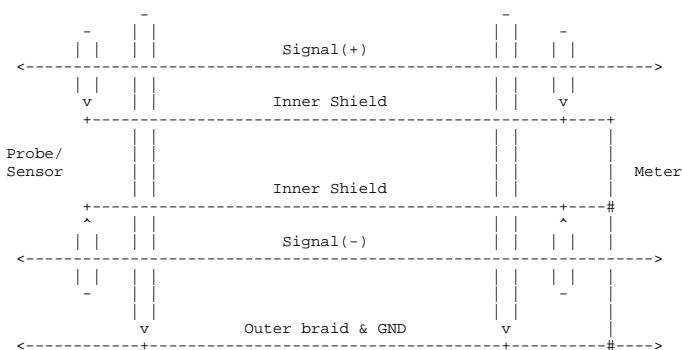


The unmarked diodes are almost certainly Low Barrier Silicon Schottky Detector Diodes. I have measured the original diodes to expose the following characteristics:

If	Vf	Measured at 20 degrees Celsius	Ir	Vr
10uA	? mV		10uA	? V
100uA	? mV		1uA	? V
1mA	? mV		100nA	? V

Connecting cable for Sensors and Probes - Shielding arrangement

The cable consists of two individually insulated coaxial shielded wires in a twisted pair configuration which is additionally shielded by an outer braid. The two inner shields and the outer braid attach to the connector shell/GND at the meter side, but at the probe/sensor side only the outer braid connects to the housing/GND leaving the inner shields totally unconnected. Be mindful that the cable carries a small DC voltage proportional to the amplitude of the RF signal, and that impedances rise extremely high when measuring microvolt or nanowatt levels, making the cable susceptible to leakage and interference.



Square Law Detector Diodes - Details and general information

A diode detector continues to produce a DC output even when the AC input falls orders of magnitude below the diode junction threshold voltage. This is called square-law region operation and here the DC output voltage is proportional to the square root of the peak AC input voltage. Ordinary PN junction silicon diodes and ordinary Schottky hot carrier diodes have an extremely high video resistance when biased to mere microvolt levels, making it difficult to separate a meaningful DC output signal from the noise. Such diodes typically also have way too much junction capacitance and this loads down the signal source at megahertz or higher frequencies. Therefore you must use one of the special types of hot carrier diodes

listed below, many of which are already configured as back to back matched pairs in a single SMD package. In any case you will need to recalibrate your millivoltmeter in order to obtain correct readings with your choice of diodes.

1) Zero Bias Silicon Schottky Detector Diodes. These have a reverse breakdown voltage of only around 3V so they are only good for measuring signals of 1 volt or less, but they work fantastically well in the microvolt and nanowatt ranges, and they exceed the 1.2GHz upper limit original spec of the Boonton probes.

www.agilent.com HSMS-2852
www.micrometrics.com MZB600
www.calmstech.com CMS-825x
www.skyworksinc.com SMS7630
www.mpulsemw.com MP20xx

2) Zero Bias GaAs Schottky Detector Diodes. These have a reverse breakdown voltage around 10V and are good to about 100GHz but they are expensive and a bit hard to find. They also don't come as back to back connected matched pairs within a single package. This is your only option if you want to maintain or exceed the original 18GHz spec of your Boonton power sensor.

www.agilent.com HSCH-9161

3) Low Barrier Silicon Schottky Detector Diode: These have a reverse breakdown voltage of 7V so you will need to use them if you intend to measure at the upper end of the 3V range on your boonton millivoltmeter. Unfortunately they don't turn on enough to measure well in the low microvolt and nanowatt ranges.

www.agilent.com HSMS-2862
www.infineon.com BAT62
www.skyworksinc.com SMS7621

4) Old Germanium Point Contact Microwave Detector or Mixer Diode: These are obsolete, large, thermally unstable, mechanically fragile, and electrically fragile, but their junction capacitance is low enough that they can be used at UHF and beyond. These too don't turn on enough to measure well in the low microvolt and nanowatt ranges.

1N23 or 1N21 microwave diodes.

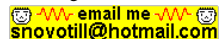
5) Common old Germanium Point Contact Detector or Mixer Diode: These are obsolete, thermally unstable, and have high parasitic capacitance, but you can easily find these in old gear or in old UHF TV tuners. It's the poor mans solution, and definitely at the bottom of the list.

1N34A or 1N48 or OA91 or K3A diodes

6) For more information and application notes regarding detector diodes, just google the phrase shown below. Note that Zero Bias Schottky Detector Diodes in differential configuration as above make a decent crystal radio detector, but don't ask me about it because I didn't spend much time on it.

square-law Schottky detector diode application

I do not guarantee the accuracy or safety of any information herein.



HOME



Do not experiment with or build any of the above circuits.