Receiver Protectors
DEO RG-2000 vs. DXE RG-5000
Jim Galm W8WTS

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Comparison: DEO RG-2000M and DXE RG-5000 Receiver Protectors

Any high power multi transmitter station like PJ2T must take particular precautions to prevent damage to sensitive receivers from destructive voltages on receive antenna circuits. These voltages can originate from static electrical charge build-up, high voltage pulses from nearby lightning discharge, or transmitted signals being intercepted by receive antennas. Station Manager Jeff, K8ND, has been a proponent of the DEO RG-2000M Receiver Guards for many years. When DX Engineering introduced their RG-5000 Receiver Guard, the natural question is, which one is better?

To answer the question, I did a thorough product review of both the traditional DEO RG-2000M (available from Universal Radio) and the new DX Engineering RG-5000.

Dealer: DX Engineering RG-5000 $75

Dealer: DEO RG-2000M (Universal Radio) $39

First, let us examine the circuits. Inside the RG-2000M, we find these components soldered to a through-hole PCB.

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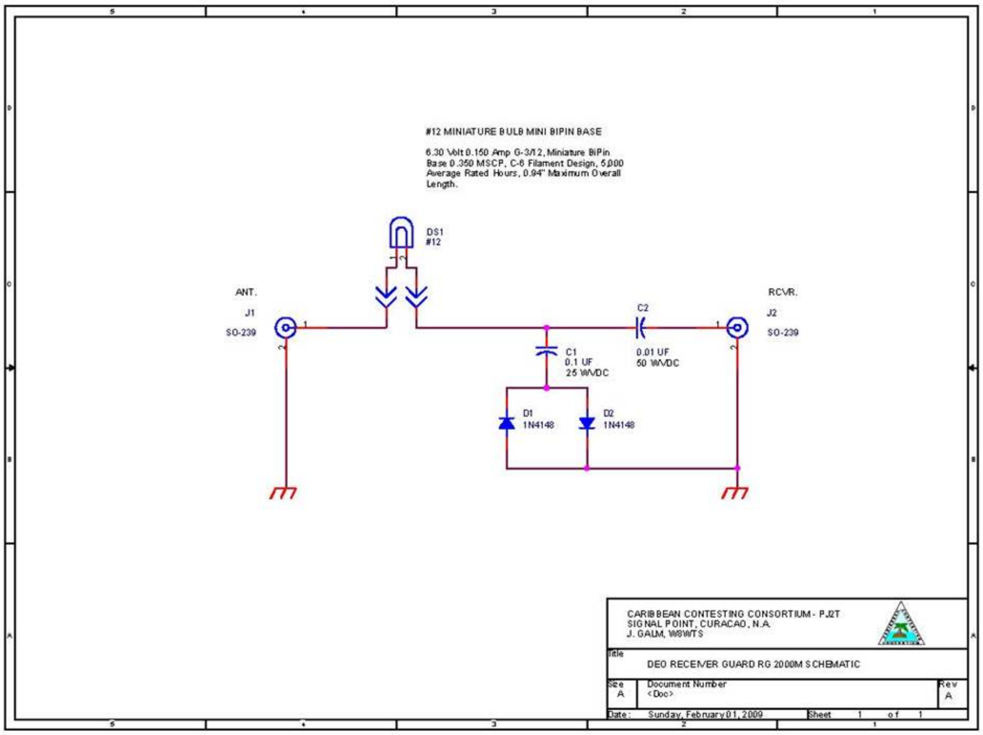
I was able to identify all of the parts in the RG-2000M. The RG-2000M circuit schematic is shown below.

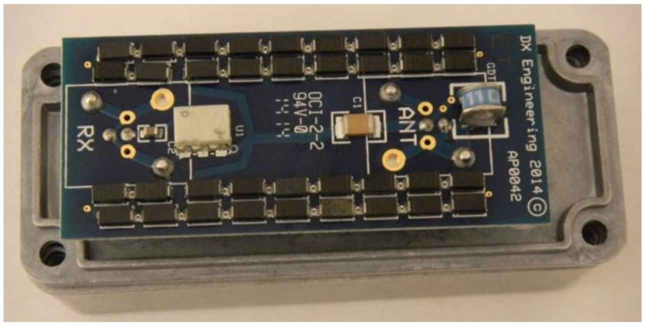


The RG-2000M uses a 6.3 V light bulb as the primary protective element. The idea is that as the tungsten filament heats from current flow, the resistance increases. Increasing resistance reduces the current flow, hopefully reaching a stable operating point where the resistance and current balance each other. This is the principle upon which all incandescent lamps operate. If that were not the case, light bulb filaments would simply vaporize when a voltage source is connected.

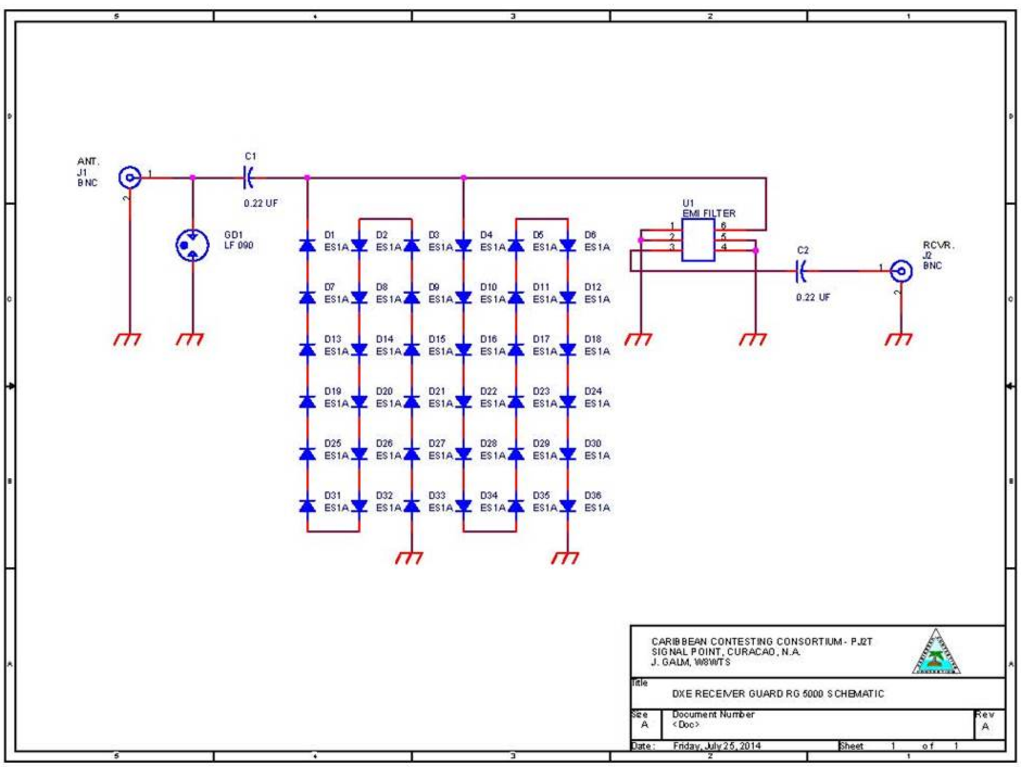
The light bulb is followed by a diode clipper that is capacitively coupled to the antenna circuit. Only AC voltage will reach the diodes, since the coupling capacitor will block any DC voltage. Another coupling capacitor connects the lamp and diode clipper to the receiver input. This is important, since static charge buildup on the antenna can reach amazingly high voltages. C2 prevents the receiver input from being exposed to the potentially very voltage from static charge buildup.

There are three main deficiencies in this circuit. First, the lamp has a very slow time constant due to the relatively high thermal mass of the lamp filament. By the time that the lamp filament resistance increases to a significant level, it might be too late to save the receiver. Second, there is no means to discharge high DC voltage due to static charge buildup. Should the DC input voltage rise to a high level, the only mechanism to discharge it is for one of the capacitors to break down. If C1 shorts first, no signals will get to the receiver. If C2 shorts first, the receiver is toast. Finally, the diodes will begin to clip at about 1.4 V P-P, which is only 6 dBm. This could cause some non-linear products to be created, spoiling the linearity of the receiver.

Next up the new DX Engineering RG-5000, shown below.



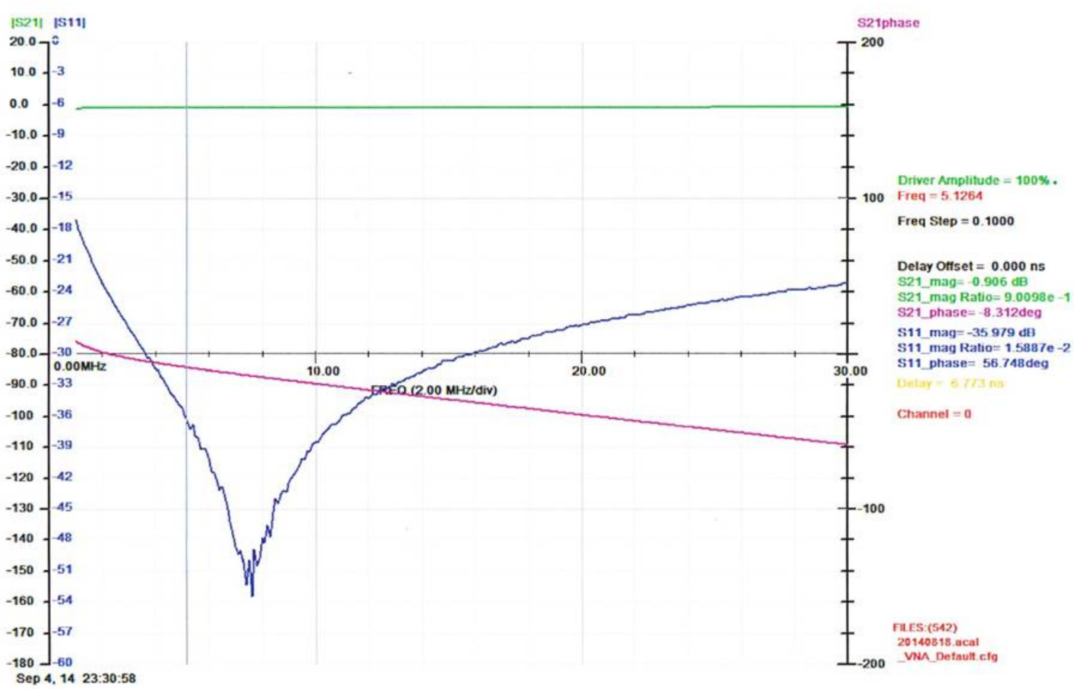
I was able to identify all of the parts in the RG-5000 except for the white, six pin gull wing surface mount device marked U1. The top of the package was filed off, removing all traces of the part markings. The RG-5000 circuit is as follows.



GD1 is a gas filled discharge tube. It is manufactured by Littlefuse, and is designed to change from insulating to conducting state when the terminal voltage rises about 90 V. Below 90 V, GD1 presents a very high resistance (several megohms) and a few picofarad of capacitance. The gas filling in discharge tubes at this voltage range is usually a mixture of Helium, Argon and Neon. When the electric field density across the gas mixture reaches a critical point, Townsend discharge begins, ionizing the gas and causing the resistance of GD1 to switch to a low value (several ohms). Once the voltage drops, the plasma recombines and the gas mixture returns to an insulating state.

C1 prevents static charge buildup on the antenna from reaching the receiver or diode strings. Should the DC antenna voltage rise about 90 V, GD1 will fire and drain off the charge buildup. The diode strings clip any AC voltage exceeding 24 V P-P, which corresponds to approximately 30 dBm. That is about the limit of what most receivers will tolerate, but it is enough voltage that received signals are unlikely to be clipped under normal operation. U1 is probably some type of EMI/RFI filter, meant to soften any very high frequency components that might appear. If anyone knows more about this component, let the editor know.

The author's Array Solutions VNA-2180 vector network analyzer makes it easy to sweep the receiver protectors for S21 (forward gain) and S11 (return loss). S21 and S11 for the RG-2000M follows.



Forward gain S21 is nearly constant and close to 0 dB. This is as expected, since there is no filter or impedance in series with the signal path from antenna to receiver. In terms of impedance matching, the Antenna port is quite poor. S11 varies with frequency from -20 dB to less than -50 dB at some frequencies.

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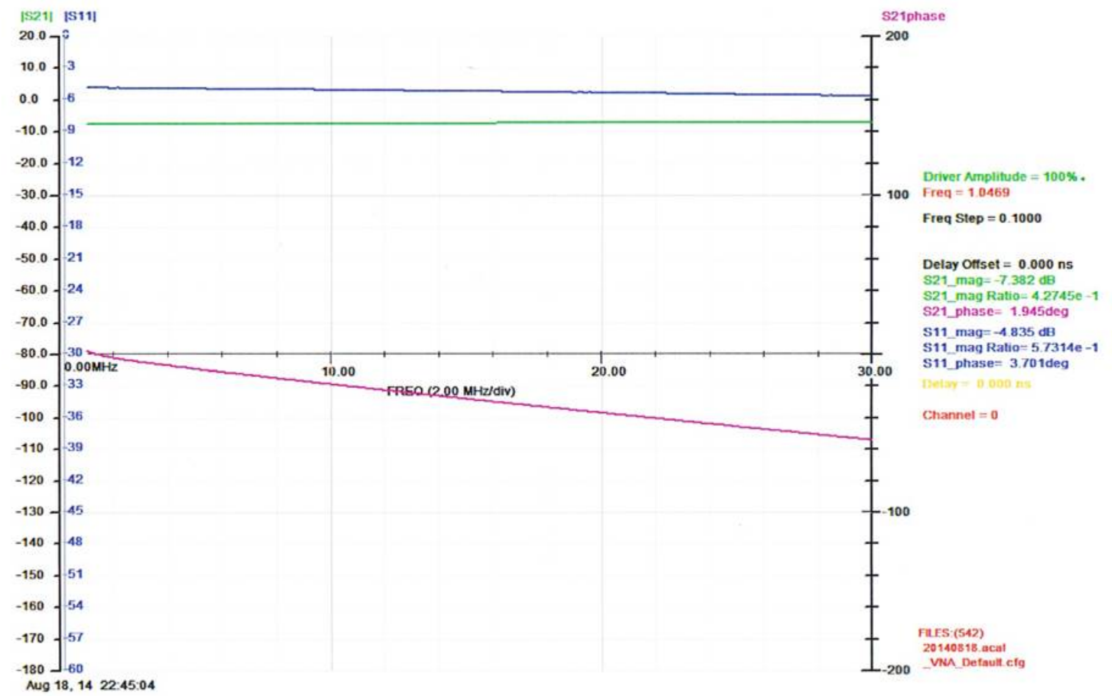
A similar forward gain and return loss sweep of the DX Engineering RG-5000 shows a very different picture.



The RG-5000 does have a forward gain less than unity, generally about -8 dB. This would not be noticeable unless one was working with weak signals at VHF or higher. The return loss, a measure of impedance matching, is very good in the RG-5000. At approximately 5 dB, the input SWR is 3.5:1. This is very reasonable for a receive device.

The RG-5000 addresses the three main deficiencies of the earlier RG-2000M. The gas discharge tube provides a DC path to ground should static voltage buildup exceed 90 V. The diode clipper has a sufficiently high clip voltage that it will not introduce non-linear products into the receiver front end. Furthermore, both the gas tube and the diodes react very quickly (on the order of microseconds or faster), so that high voltages will be stopped before they reach the receiver. The measured S21 (forward gain) of the RG-5000 is comparable to the RG-2000M, but the input impedance of the RG-5000 is much more constant with respect to frequency.

SUMMARY

In summary, the editor finds the DX Engineering RG-5000 to be a superior solution for receiver protection with respect to the older RG-2000M circuit. There is an RG-5000 installed on the W8WTS CW Skimmer receiver at this moment.