Playing with Gunn diodes

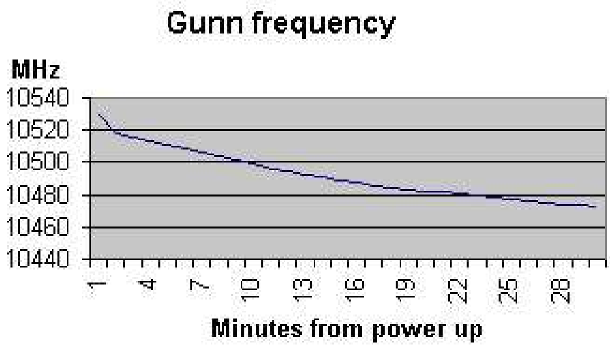
You need to know how Gunn diodes work if you want to get the most of them. Gunn diodes are devices from the 70's but they are quite useful these days. They are the cheapest and maybe the easiest way to get some microwave power. This is the test I made to one of these units trying to characterize its behavior.

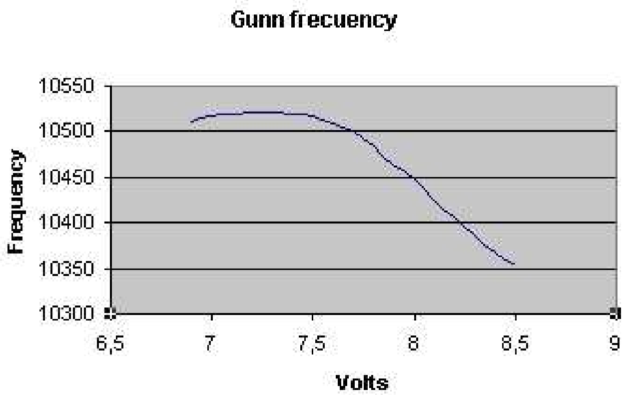
This is the Gunn unit I tested. It's the one inside a burglar alarm system. It has a microwave Doppler module and a infrared sensor. The microwave module is rated at 10.550 MHz. It consists on a 10 mW Gunn diode and a mixer diode. The Gunn diode is supplied with 8 volts DC. You can find these units on flea markets or security systems vendors. Pay attention! Older types work on 2.4 GHz band, but there are also newer units with Doppler modules working at **24 GHz** (Quite interesting!). At least in Spain, the most common unit is the 10 GHz one, working at 10550 MHz, but 24 GHz can be found also.

This is the measure system I used. It consists on a Alps universal LNB, with a local oscillator of 9.75 GHz, and a Aceco FC1002 3 GHz frequency counter connected as described here. In the photo, you can see the Gunn diode working at 10527.46 MHz , this is, 777.46 + 9750 = 10527.46 MHz. There is no need to place the LNB and the Gunn cavity near. If they are both in the same room, signal is quite strong, you can see half scale on frequency meter field strength meter. LNBs have very high gain, and this is quite useful here.

This is a general view of the workbench during tests. The main goal was to characterize the Gunn behavior against supply voltage and temperature. Gunn diodes varies its frequency with the supply voltage (and its output power), but this frequency is also dependant of ambient temperature. Gunn diodes are really bad devices if we see its efficiency. A 10 mW Gunn diode drawn more than a watt for only 10 mW output. Less than 1% efficiency. So Gunn diodes get quite hot. Fortunately, they are placed in a metal cavity that acts also as heat sink, but this cavity gets also hot, so Gunn diodes drift in frequency until they gets its operating temperature. Once they reach it, a small variation of the temperature is reflected as a frequency drift. This is quite important in base mounted Gunn diodes or in portable use. Wind, rain and snow will make de Gunn drift several MHz. This can reduce the possibilities of a QSO almost to zero!.

This graph shows the variation of the Gunn frequency with time. This variation is caused by the increment of temperature. Supply voltage to the diode was 8.0 volts. As noticed before, Gunn diodes drawn a lot of power from the supply source, but only a small fraction is converted into microwaves, the rest turn into heat. The cavity acts as a heat sink, and it gets warm. While it gets warm, the frequency decreases. You must wait about one hour to get a stable frequency, but wind or other causes can produce a change in cavity temperature, and therefore, in operation frequency. Gunn diodes also varies its frequency with the load. This means, if your cavity has waveguide output and a matching device in it, the frequency will vary a bit with its adjustment. Also, moving objects in front of the cavity will produce frequency variations.





This graph shown the variation of the Gunn frequency versus supply voltage. This graph is quite interesting, because with it, you can determine the right supply voltage for a optimum FM modulation. You can also determine your frequency range of actuation, useful for AGC circuits or similar. For this unit, the optimum supply voltage seems to be 8.0 volts. Supply voltages around 7 - 7.5 volts will produce a poor or even distorted modulation, because the horizontal trace on the graph. Under 6.9 volts the Gunn doesn't oscillate, and over 8.5 volts the Gunn could be damaged. For typical FM voice, supplies between 7.75 and 8.5 volts will produce nice FM modulation and a tuning range about 150 MHz, not so bad.

Another important measurement you must made is the output power versus the supply voltage. Gunn diodes are mounted on resonant cavities with their own resonant frequency, and the Gunn frequency is dependent on supply voltage. These two frequencies can be (and they will be) different, so you will not radiate the most from your Gunn unit. Thanks to the field strength meter built into the frequency counter, I could see easily, the output power peaked with 7.25 volts, around 10520 MHz. This is the resonant frequency of the cavity. Cavities should have and adjusting screw. You can play a bit with supply voltage and this screw to get the most radiated power on the desired working frequency.

Don't forget this measurements where made on a specific unit. Your Gunns will have different curves and/or values. It is a good idea to characterize your Gunn units individually, so you can the get the best from them.

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