Gunn Diode Oscillator Minutes

Mick Gaskill

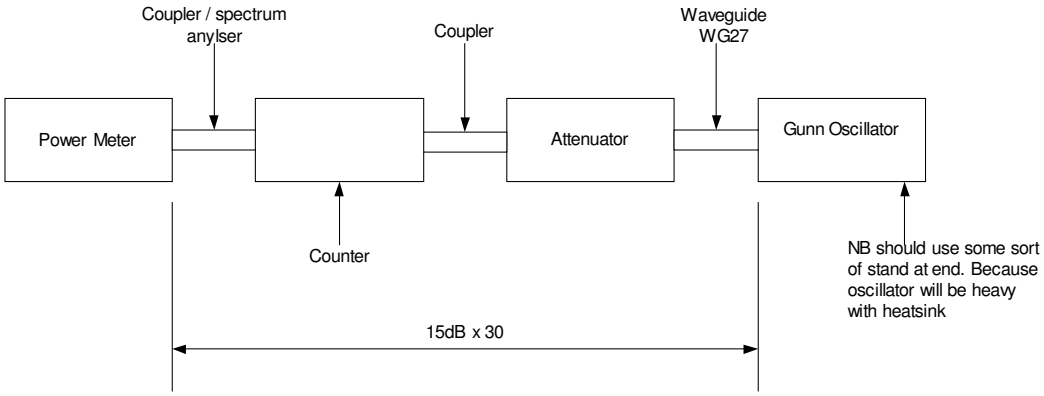
2004-03-23 09:35

Attendance

- Fourth year students:
  - JM Higginbotham.
  - AJ Nelms.
  - MP Gaskill.
- e2v personnel:
  - Nigel Priestley.
  - Philip Norton.
  - Bernard Whitworth.

Testing laboratory

* Phil Norton explained the test equipment he was using and a sketch was made.



- Phil had an accurate power supply — it is important to take account of volt drop.
- The oscillator has a $1\,\mu$F capacitor mounted at the biasing point this can be between 1–$10\,\mu$F. The leads connecting from the oscillator to the supply should be short as possible to reduce any inductance.
- The connections to the oscillator were then soldered.
- The oscillator was then mounted on the waveguide WG27 but not tightened. The power was then switched on, the oscillator was then firmly secured by tightening the screws individual, constantly looking at the power meter. This is to gain the optimum power output and reduces any air gaps, note that losses can be as much as 20 mW!
- The initial frequency was 85.8991 GHz with 35 mW of power, using 5.402 V and taking 0.785 A.
- Phil mentioned using the "frequency pushing method". This means to alter the frequency of the Gunn while keeping the power flat over that region.
- At this point Phil explained that it would be a important to take some measurements on this working system before the team got their hands on it.
- The parameters taken were voltage, current, frequency, power, over different backshort distances. It was suggested that these figures could be used in the report testing section. A plot of power versus voltage would be interesting. A set of Vernier were used to measure the backshort distance.

Backshort (mm)	Bias (C)	Current (A)	Power (mW)	Frequency (GHz)
13.0	4.5	0.776	21.5	85.69
13.0	5.0	0.773	16.5	85.83
13.0	5.5	0.771	12.0	85.94
13.0	6.0	0.772	9.0	86.00

Backshort (mm)	Bias (C)	Current (A)	Power (mW)	Frequency (GHz)
13.5	4.5	0.771	4.0	85.63
13.5	5.0	0.770	5.0	85.80
13.5	5.5	0.770	5.0	85.91
13.5	6.0	0.771	6.0	85.98

Backshort (mm)	Bias (C)	Current (A)	Power (mW)	Frequency (GHz)
14.0	4.5	0.775	16.0	85.62
14.0	5.0	0.773	19.0	85.79
14.0	5.5	0.773	19.0	85.90
14.0	6.0	0.773	17.0	85.96

Backshort (mm)	Bias (C)	Current (A)	Power (mW)	Frequency (GHz)
14.5	4.5	0.771	7.0	85.59
14.5	5.0	0.769	5.5	85.76
14.5	5.5	0.770	10.0	85.87
14.5	6.0	0.771	11.5	85.94

Backshort (mm)	Bias (C)	Current (A)	Power (mW)	Frequency (GHz)
15.0	4.5	0.778	40.0	85.61
15.0	5.0	0.774	35.0	85.77
15.0	5.5	0.772	32.0	85.87
15.0	6.0	0.771	25.0	85.93

Backshort (mm)	Bias (C)	Current (A)	Power (mW)	Frequency (GHz)
15.5	4.5	0.768	5.0	85.52
15.5	5.0	0.766	4.0	85.69
15.5	5.5	0.776	4.0	85.80
15.5	6.0	0.768	4.5	85.87

- It was seen that not much variation of frequency versus backshort.

- During these tests it was noted that the device was getting hot, Phil stated that the could run to approximately 115°C. But this would result in a reduced power, therefore its important to keep the device cool.

- Phil then recommended it would be beneficially to the group to take the device apart and look inside and re-set it back up ourselves.

- Insulation is placed round the radial line transformer pin, a length of this tape was given to the group and is wrapped around a pencil. The tape $\varepsilon_r = 2.2$. As an estimate the length of tape to put round each radial line pin is $1\frac{1}{4}$ turns. A washer is on the top of the radial line transformer pin this is at ground potential. The dimension of the pin were approximately 2.5 mm diameter and 1.5 mm thick. A sketch was made.

- Andrew replaced the Gunn diode with an alternative, the diode sits within a housing and sits flat to the floor in the cavity, the flange of the diode sits on the floor of the waveguide.

- The Gunn diode was tweaked. Rotating the Gunn while connected to the supply is a way of optimising the potential output, although if the contact is loss with the radial line this can cause the Gunn diode to be destroyed if the contact is made back again instantly. Phil demonstrated this.

- The spring keeps the contact in position, this can be used to lock the diode at the highest power.

- Optimum performance was at 85.05 GHz with 50 mW of power, although he stated that he could not get the goal frequency 87 GHz. Phil stated that it was not the package design, it would likely to be the oscillator design. Mick provided a solution to the problem by having a extra shim that could be implemented, Bernard made one.

- It was suggested that a second harmonic backshort slide could be used to optimise the second harmonic frequency. Bernard had produce four different backshorts set at different lengths: 0 mm, 0.5 mm, 1.0 mm, 1.5 mm. These results showed that little was to gain from this line of design.

Distance (mm)	Power (mW)	Frequency (GHz)
0.00	44.0	85.68
0.50	45.0	85.70
1.00	45.5	85.74
1.50	25.5	85.61

- Phil showed the group of a second example of this sort of design produced by a old employee of e2v. This looked fairly similar although the spacing between the diodes has various numbers of shims at different sizes, this was to gain the optimum performance.

- Again Phil suggested that the paper by H.Barth was lacking the full truth.

- Jamie went to discuss the simulation he has been doing with Keith Newsome (senior engineer).

- Mick went to discuss with Bernard Whitworth (machinist) about some points with the manufacturing of the device.

- Bernard explained that he would be extremely busy with customers and would be unlikely be able to spend much time on this project. Mick suggested that we did not need the full version to be built a more feasible solution would be just to build the Gunn diode housings. He agreed this would reduce the turnover time although expressed that his other jobs were a priority but would be happy to do our work but Nigel would have the final approval.

- At this point we all met back up in the meeting room to discuss the days findings and actions required from both parties.

- It was suggested that it would be more feasible to aim for using two Gunn diodes as this would be solving the design requirements of power combining. Due to the performance of the single device it would be hoped to get about 80 mW with two. Then we could add on a third device if possible.

- A heatsink and fan was provided by Nigel for us to use.

- It was expressed that the Gunn diodes should be manufactured at very latest for the first week in May, Bernard and Nigel agreed that this job should be prioritised with the other impending customer jobs.

Proposed actions

RE Irwin	Send Nigel the exact detail of the time of demonstration and location as soon as its available, reminder to bring the full scale Gunn model.
MPG, JMH	Report back to team with findings.
MP Gaskill	Send details of the exact lengths of the Gunn diodes housing ASAP to Bernard.

Next meeting

Time	Thursday 25 March 2004, 10:00.
Place	D2c coffee room.

Meeting adjourned, 15:00.