Gunn Diode Oscillator Minutes

Mick Gaskill

2004-04-29 10:00

Attendance

- Fourth year students:
  - MP Gaskill.
  - AJ Nelms.
- UMIST staff:
  - WS Truscott.
- e2v personnel:
  - N Priestley.
  - P Norton.

Initial discussions

After meeting Phil Norton and signing in the team went to the conference room.

- The oscillator is working temperature in the range of 48°C; Phil stated that more power can be obtained while warm.
- It was recommended that we should experiment with the oscillator using shims of 0.1 mm. These can be made using kitchen tin foil.

- The graphs were shown to Phil and Nigel, it was stated that the UMIST test equipment did have a 3 dB loss. The frequency is pulled by resonance. 6.1v bias seemed a lot to Phil may be in danger of blowing Gunn diodes up.

Testing

The team at this point attended the test laboratory to see the oscillator working.

- Phil had made a second backshort which had a slightly small diameter to the original piece. Approximately 3.4 mm this value was an educated guess. Phil seemed to think the fundamental was escaping out of the back.
- Phil photocopied the results from his note book.
- Four Gunn housing sections were set up; 1, 2, 3 and 4, each section producing 50 mW.
- Each section had a different bandwidth 300–400 MHz apart.
- Phil experimented with various combinations of the sections and the best combination was 2 and 3 with 3 nearest the backshort. There are several combinations although Phil has not tried all of these. It will be up to the testing team to try all of these combinations.
- Each section was separately biased and tuned individually.
- When switching on the oscillator it is important to switch on 2 first then 3. Work from the front to back. The first one was set at 5.03 V then the second was at 4.85 V. This device was "tweaked" to gave 100 mW. Although it had previously run at 112 mW at 54.6°C.
- The circuit has a high Q value.
- It was suggested to shim one section.
- If the third oscillator was added this would be hard to setup, the frequency would be altered but would add about another 50 mW to the output. This was another challenge for the testing team to investigate.

A series of measurements were then taken at an optimised backshort distance of 7.17 mm.

Gunn 2 (V)	Gunn 3 (V)	Power (mW)	Frequency (GHz)
5.20	4.85	85	84.5424
5.20	4.80	73	84.5200
5.20	4.85	87	84.5300
5.20	4.90	70	84.5800
5.20	4.95	56	84.6300
5.25	4.85	100	84.5150
5.25	4.80	51	84.5700
5.25	4.90	84	84.5650
5.25	4.95	70	84.6960
5.30	4.85	77	84.5539
5.30	4.80	38	84.6100
5.30	4.85	76	84.5500
5.30	4.90	96	84.5600
5.30	4.95	84	84.5800

- It shows that it has very narrow bandwidth, although tunability was a bonus.
- Tuning range 5.2–5.3 V for G2 and 4.8–4.9 V for G3. This indicated that the accuracy of the power supply is crucial e.g. steps of 0.05 V. Note take account of volt drops however small.
- At 5.25 V and 4.8 V for G2 and G3 respectively the backshort was altered to 82 mW with a frequency of 84.56 GHz.
- The Q of the circuit can be reduced by altering the radial disc.
- The switch on voltages for each device were required.
- G2 on first at 5.27 V, G3 required 4.76 V. With G3 on first at 4.8 V, G2 required 5.08 V.
- With G2 on at 4.48 V and G3 off this gave a power of 50 mW.
- With G3 on at 3.56 V and G2 off this gave 12 mW, This is because of the diode in front of its output.
- If a third diode was present it would be hard to tune the one in the middle, the use of a tuning screw could be the answer.

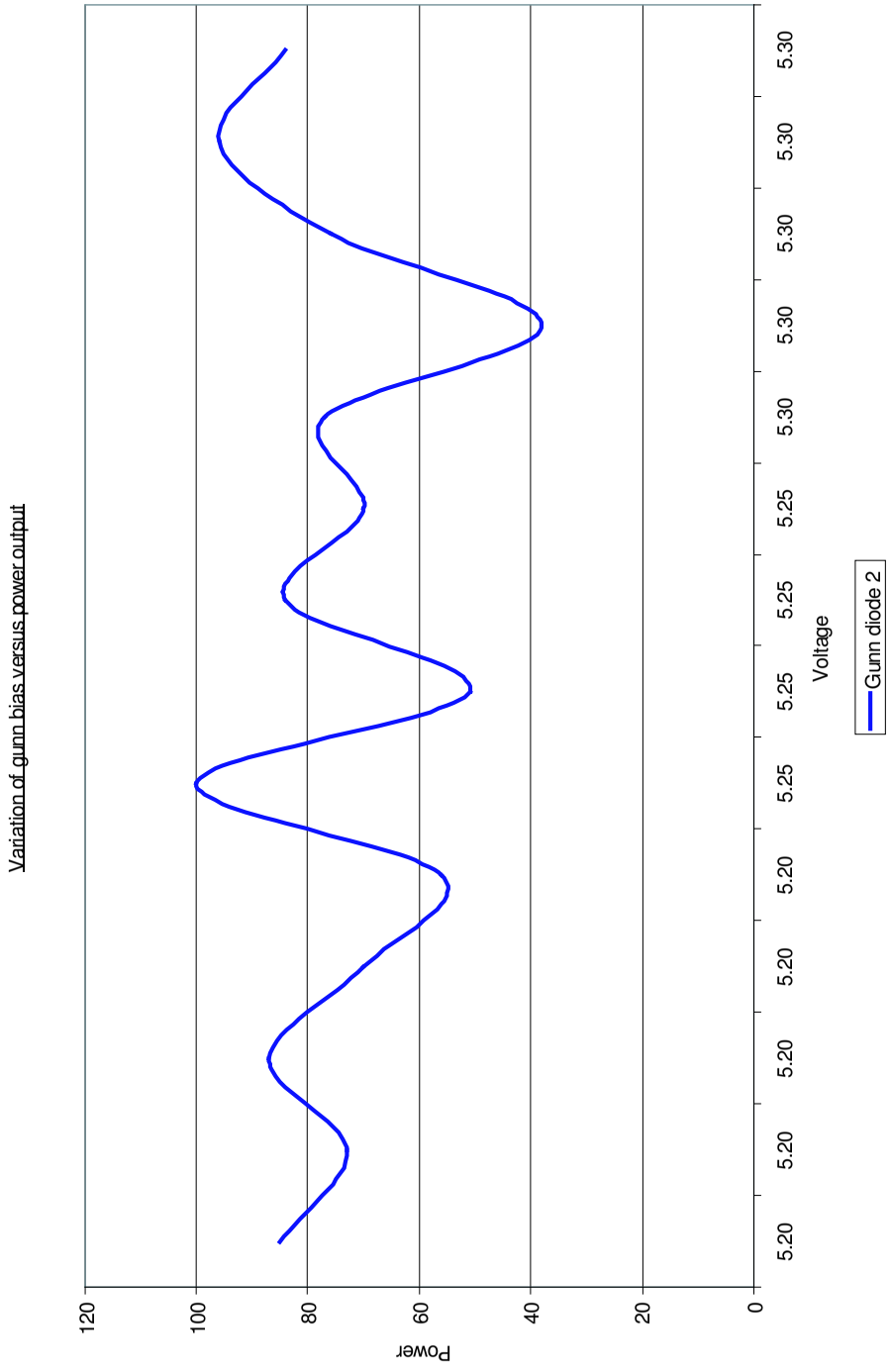

Figure 1: Power output for G2 as the bias is varied

- The backshort of 3.4 mm diameter was tested this resulted in hardly any change in the results but Phil said it is easier to the second Harmonic with this.
- The results conducted proved that two Gunn diodes at 55 mW each could combine to achieve 100 mW. Therefore 90% efficiency and proves the principle.
- The device is safe to operate up to 75°C.
- The final part was to set up the oscillator to its optimised performance: G2=5.26 V, G3=4.88 V, power output=94 mW, Frequency=84.5289 GHz. The first test back at UMIST is clarify these values before altering any component as top ensure the calibration of the UMIST test setup.
- One question was raised why did it not attain the goal frequency?

It possibly could be due the inductor post, the Gunn housing cavity calculations did not take account of this therefore the frequency would be slightly reduce by 2–3 GHz. May be recalculate using a goal frequency of 90 GHz?

A second possibility because of the fringing fields in the radial disc may affect this value.

Proposed actions

RE Irwin	Send Nigel the exact detail of the time of demonstration and location as soon as its available he will ensure Gunn diode model is with the team for demonstration.

Next meeting

Time Friday 30 April 2004, 10:00.

Place D2c coffee room.

Meeting adjourned, 14:30.