Gunn Diode Oscillator Minutes

David Headland

2003-11-04 09:00

Attendance

- Fourth year students
  - DP Headland [Navigator going, driver return]
  - AJ Nelms [Driver going, navigator return]
  - RE Irwin
  - R Wan
  - JM Higginbotham
  - MP Gaskill
- UMIST staff
  - WS Truscott
  - R Sloan
- e2v Technologies staff
  - N Priestley
  - P Norton
  - Martin

Introduction from e2v

- The company was part of GEC.
- This split half into BAE Systems and half into Marconi.
- This company was sold to venture capitalists 3I.
- 3I don't dictate markets and technologies as Marconi did, this is left to e2v to decide upon.
- e2v can buy and sell businesses within the company.
- The Lincoln site is almost entirely dedicated to microwave products.
- 94 GHz radars developed there are to be used on the Brimstone missile system.
- A lot of the business is geared towards defence.
- The company started with free electron technology.
- Nowadays the main business concentrates on solid state technology.
- Power output is an advantage for free electron devices.

Our presentation to e2v

- The presentation was carried out as practised.
- Notes were taken by e2v staff during the presentation.
- A laugh was raised when it was suggested that "planar circuits are quite simple".
- A planar circuit in a heatsink was shown when we mentioned it.
- Reasoning for wanting an 87 GHz device was asked for. The response was that three would be combined to form a 260 GHz oscillator.

Comments by e2v

- GaAs vs InP
  - There is probably only one group of people in the world manufacturing InP Gunn diodes, based in France.
  - A company in the USA has many.
  - e2v will provide contact details for the USA company who may be willing to send some free samples.
  - InP is very temperature dependant and brittle.
  - GaAs will require operation in the second harmonic mode for our frequency.
  - The current spike in Gunn diodes is very short so produces many harmonics.
  - The second and subsequent harmonics can then easily be extracted.
- Waveguide vs planar
  - Suggested giving up on the planar approach.
  - There would be too many problems anticipated.
  - Planar circuits have a very bad Q value.
- Waveguide manufacture
  - A small waveguide was shown to the group.
  - Waveguides can be mass machined to the required tolerances.
  - Waveguide 27 will be required for us ($2.54 \times 1.27\,\mathrm{mm}$).
  - Working under a microscope will be required.

Questions to e2v

- What would they use for simulations?
  - Momentum.
  - HFSS.

- Can you supply Gunn diodes?
  - Yes.
  - Packaged ready for waveguides (F8).
- Can they produce resonant caps?
  - Yes.
  - Design is very empirical.
  - Simulation will be very difficult.
  - 94 GHz caps have a diameter of approximately 2 mm.
  - 77 GHz caps have a diameter of approximately 2.5 mm.
- Will heat be a problem in waveguide?
  - Probably not.
  - It certainly won't be a major issue in a prototype.
- What tests would e2v perform whilst developing a device?
  - Power measurements.
  - Spectrum analysis.
  - Voltage vs frequency relationship (should be positive).
  - Phase noise (should be approximately 75–80 dB/Hz at 100 kHz offset).
    - This is the peak sharpness on the spectrum analyser.
    - We may have difficulty measuring it.
  - For this project, only measure thermal effects as an academic exercise.
- Will e2v machine cavities?
  - Yes.
  - They will require a mechanical drawing.
  - The machinist is flexible, so perfect drawings are not completely essential.
  - Aluminium or brass can be used.

  - Waveguides do not need to be gold plated.

- Do you have any good device models?
  - Not for waveguide simulations.
  - Different engineering approaches are apparent within the company.
  - There are no models of the Gunn diode that work correctly.
  - Simulation may be a good idea for the multiple Gunn diode approach.
  - e2v will help us to get started.
  - Power combining in the second harmonic will be covering completely new ground.

- Do you have any general practical advice?
  - They will write a target specification.
  - This will attempt to reduce the number of unknown in the project to make it more achievable.
  - The fundamental issues should be sorted out at the start.
  - Allow time for hardware to be built later on in the project.

Points made by e2v

- Attention must be paid to the biasing circuit PCB as it is key to the operation of waveguide Gunn diode oscillators.
- Don't just assume this is generally metal work — burrs can cause major problems, and joints must be very tight.
- A tour of the factory was given.
- A decision should be made during the planning stage on the waveguide type : a single block, clamped or soldered waveguide.
- Philip Norton's email address was obtained: `philip.norton@e2vtechnologies.com`
- e2v will provide a list of recommended papers.
- WS Truscott and R Sloan discussed test equipment.
- Advice to get hands on experience was reiterated by e2v.

Next meeting

Time Tuesday, 11 November 2003, 10:00

Place D floor coffee room

Meeting adjourned, 18:30.