



Research Consortium in Speckled Computing

# Low power Radio Design

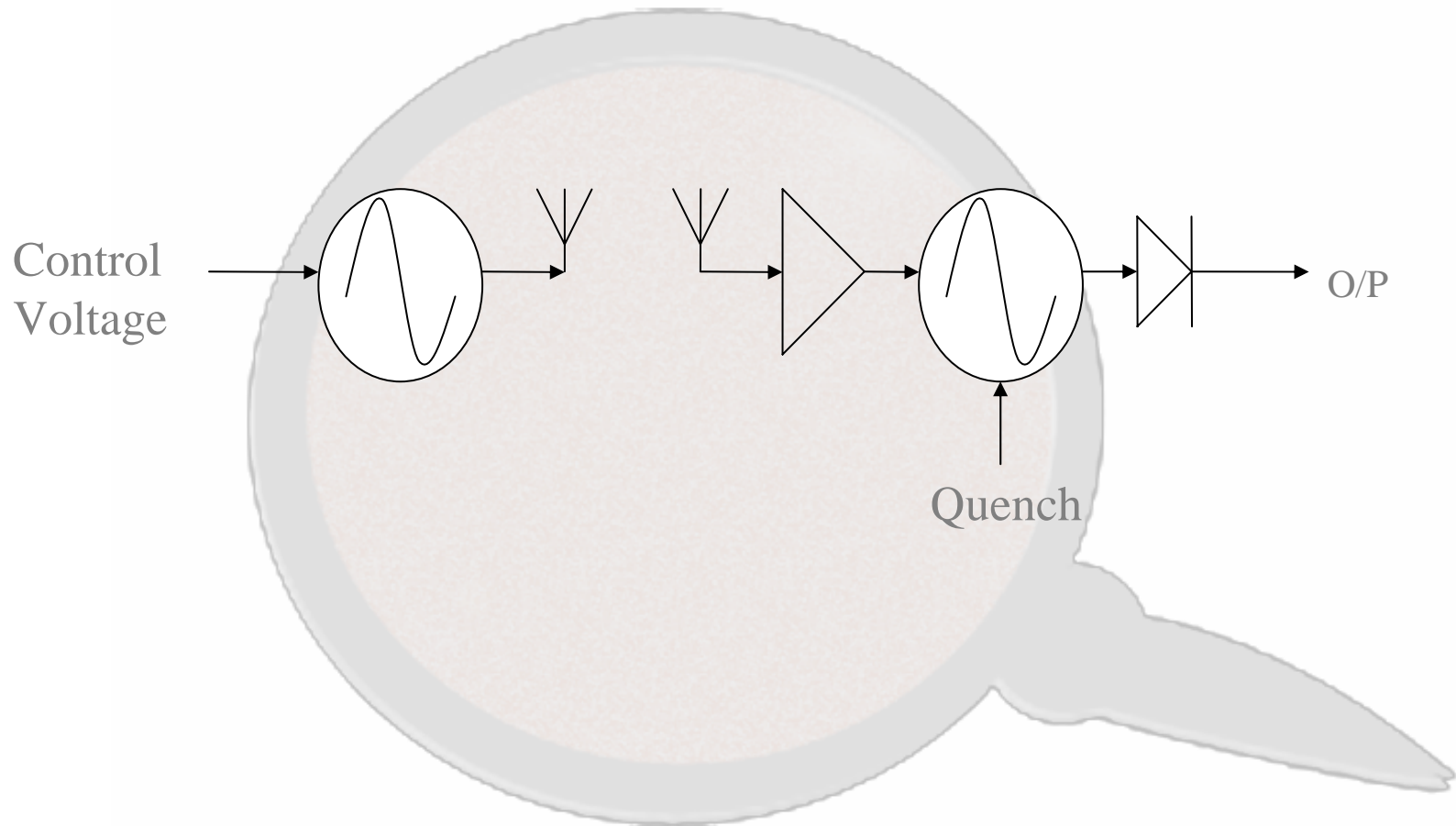
Ian McGregor

University of Glasgow

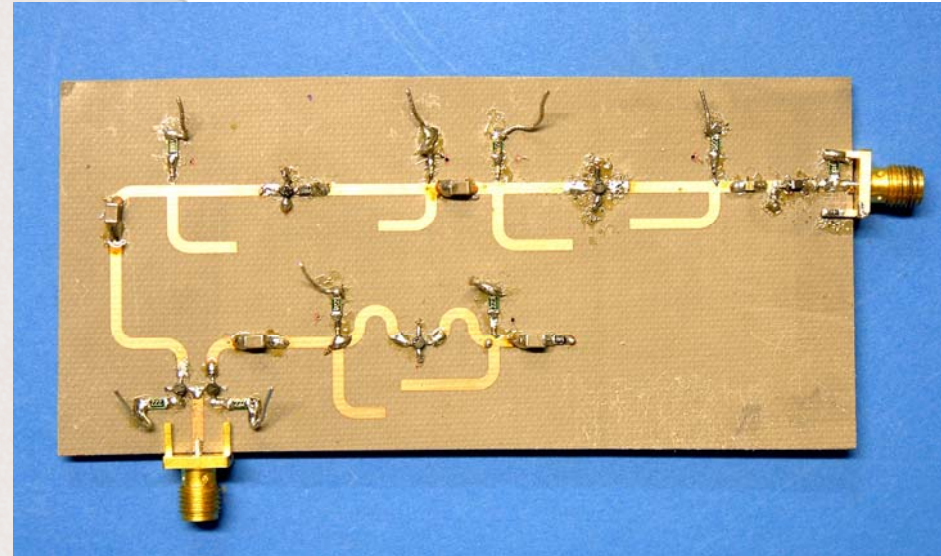
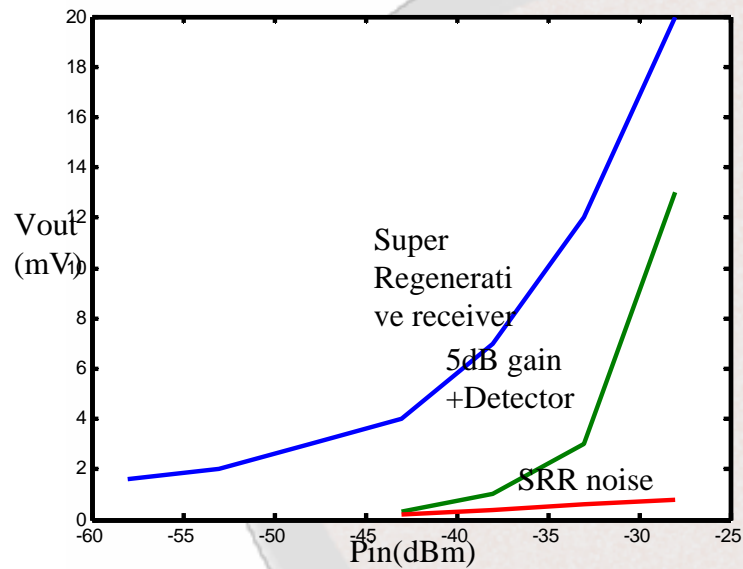
Supervisors: Edward Wasige and Iain Thayne



# Basic RF front end Block Diagram



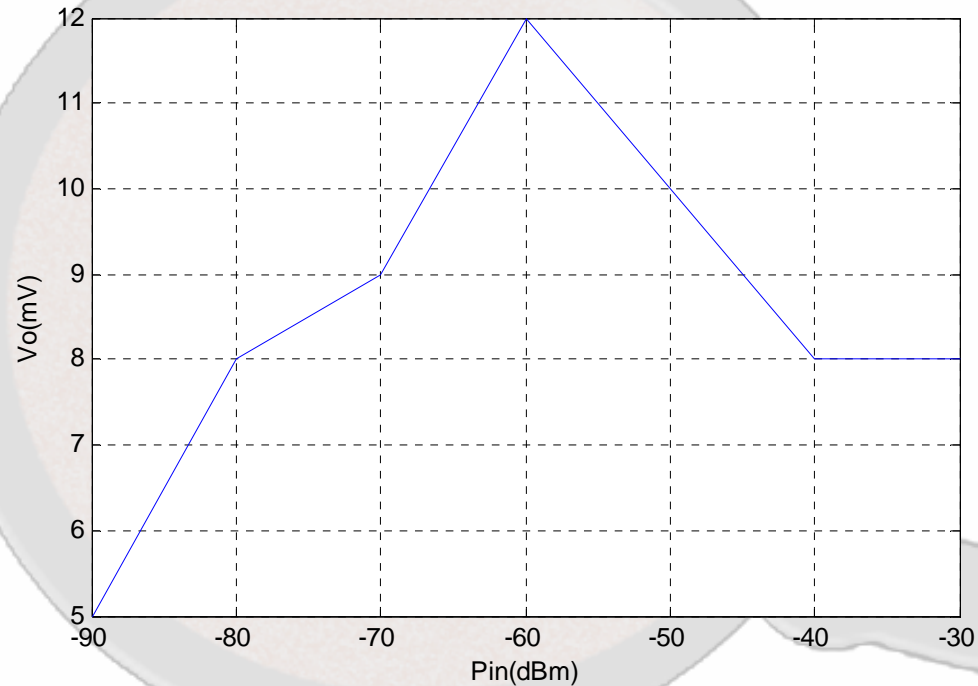
# Hybrid Prototype of Transceiver



Output Voltage vs. Input Power

- **'A 400uW Tx/380uW Rx 2.4GHz Super - Regenerative GaAs Transceiver'**  
Mcgregor, I.; Whyte, G.; Elgaid, K.; Wasige, E.; Thayne, I.;  
[Microwave Conference, 2006. 36th European](#)  
10-15 Sept. 2006 Page(s):1523 - 1525

# Hybrid Prototype designed to have large o/p voltage



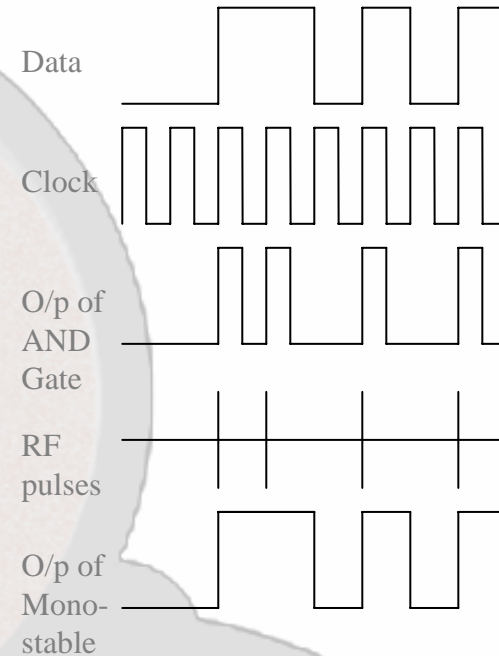
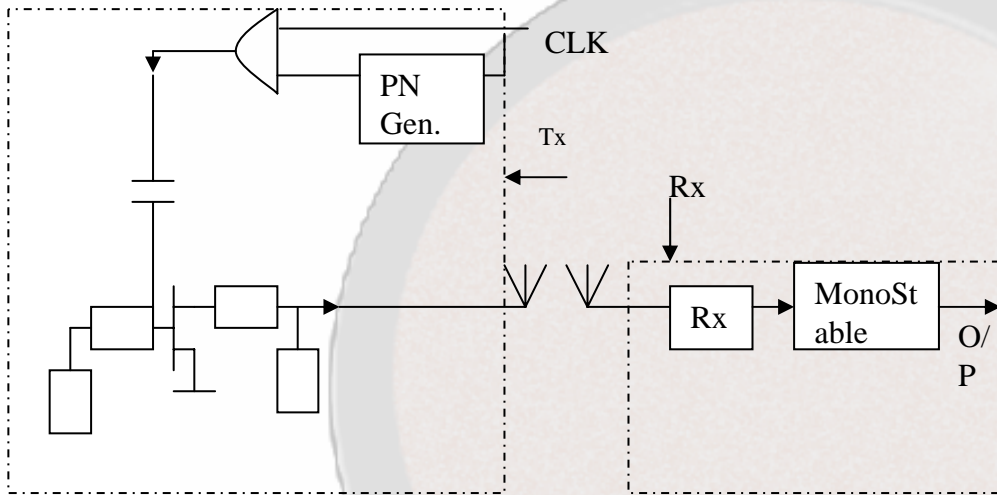
6  
Sub-50 $\mu$ W, 2.4 GHz Super-Regenerative Transceiver with Ultra Low Duty Cycle and a high impedance 650  $\mu$ W transceiver'

I. McGregor, E. Wasige and I. Thayne

Accepted for Publication at the 37th European Microwave Conference, 2007

# Low Duty Cycle Transmitter

- No loss in output voltage
- Power reduced from 400  $\mu$ W to 10  $\mu$ W

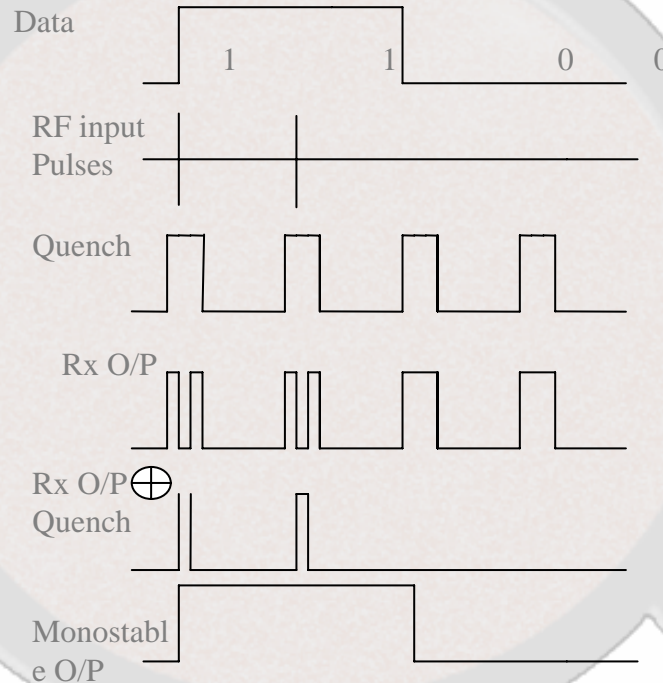


Measurement set-up to test Low duty cycle Tx

- 'Sub Milli-Watt, 2.4 GHz, Super-Regenerative Transceiver with Ultra Low Duty Cycle'
- I. McGregor, E. Wasige and I. Thayne  
[Microwave Conference Proceedings, 2006. APMC 2006. Asia-Pacific Conference Proceedings](#)  
 Volume 1, 4-7 Dec. 2006 Page(s):3 pp.

# Low Duty Cycle Receiver

- Power Reduced from 380  $\mu\text{W}$  to approx 30 $\mu\text{W}$
- Some reduction in output voltage



'Sub-50 $\mu\text{W}$ , 2.4 GHz Super-Regenerative Transceiver with Ultra Low Duty Cycle'  
I. McGregor, E. Wasige and I. Thayne

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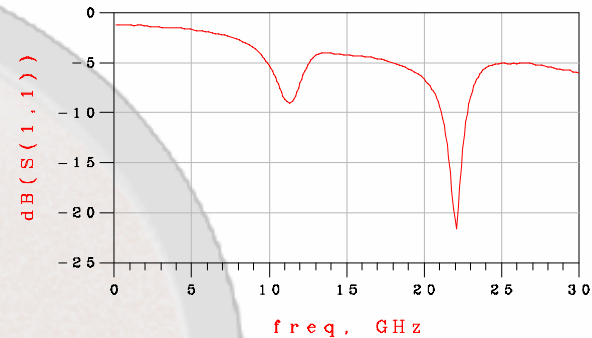
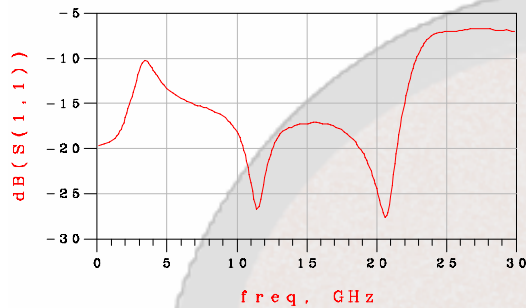


# MMIC Implementation

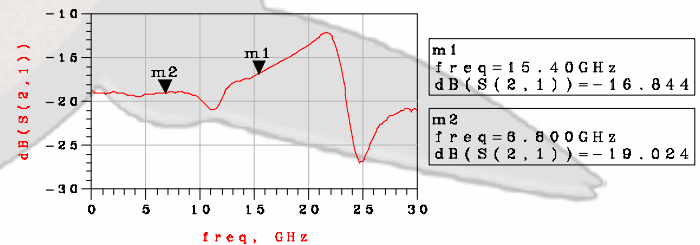
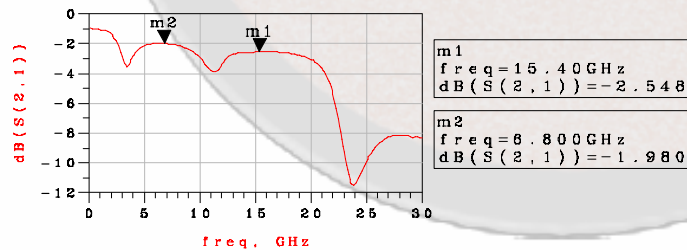
# Switch ON state

# Switch OFF state

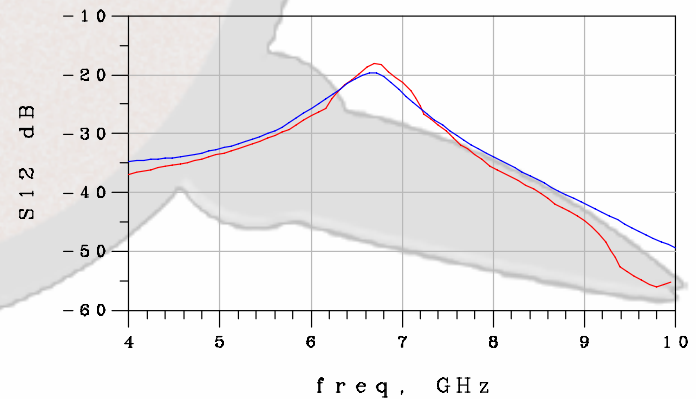
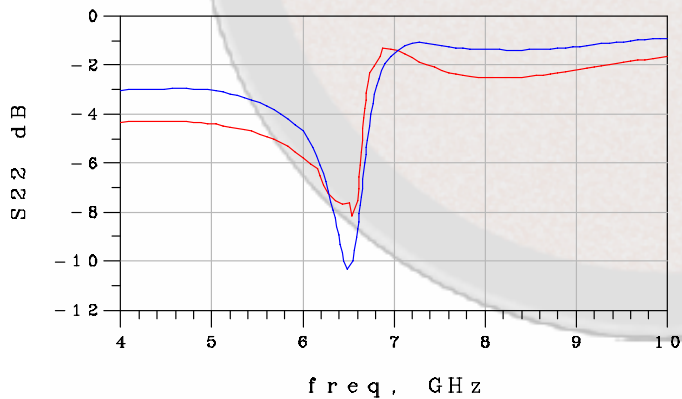
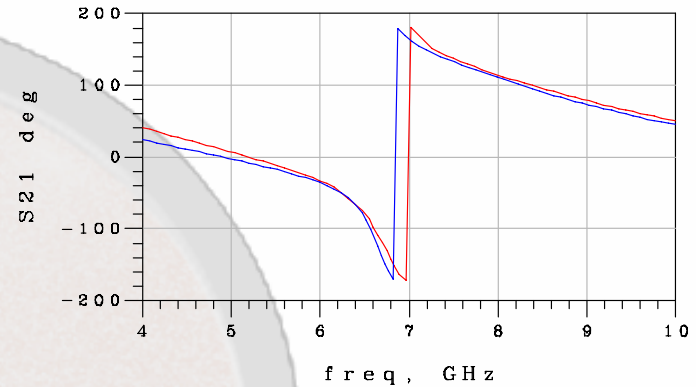
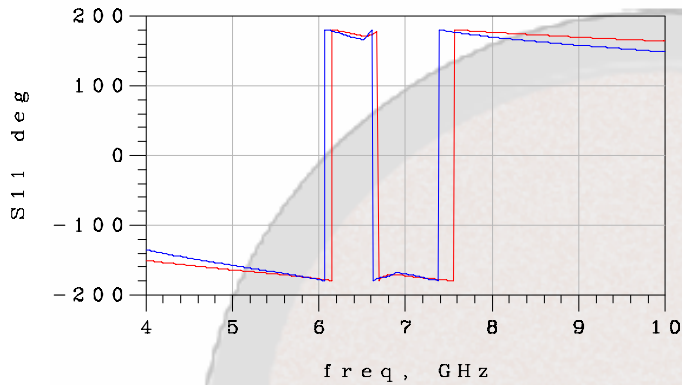
## Measured Match to 50 Ohm



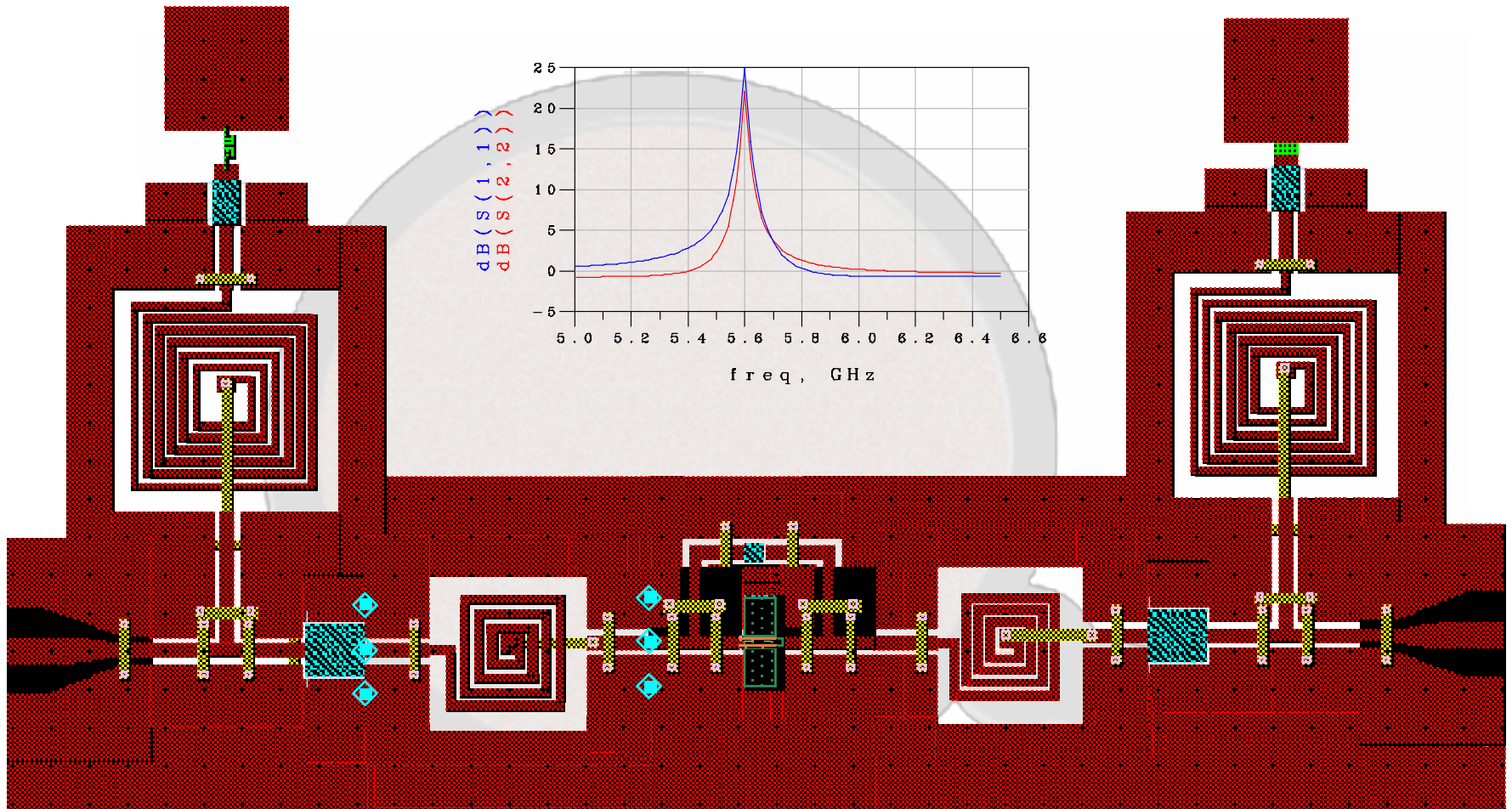
## Measured Power Transmission From i/p to o/p



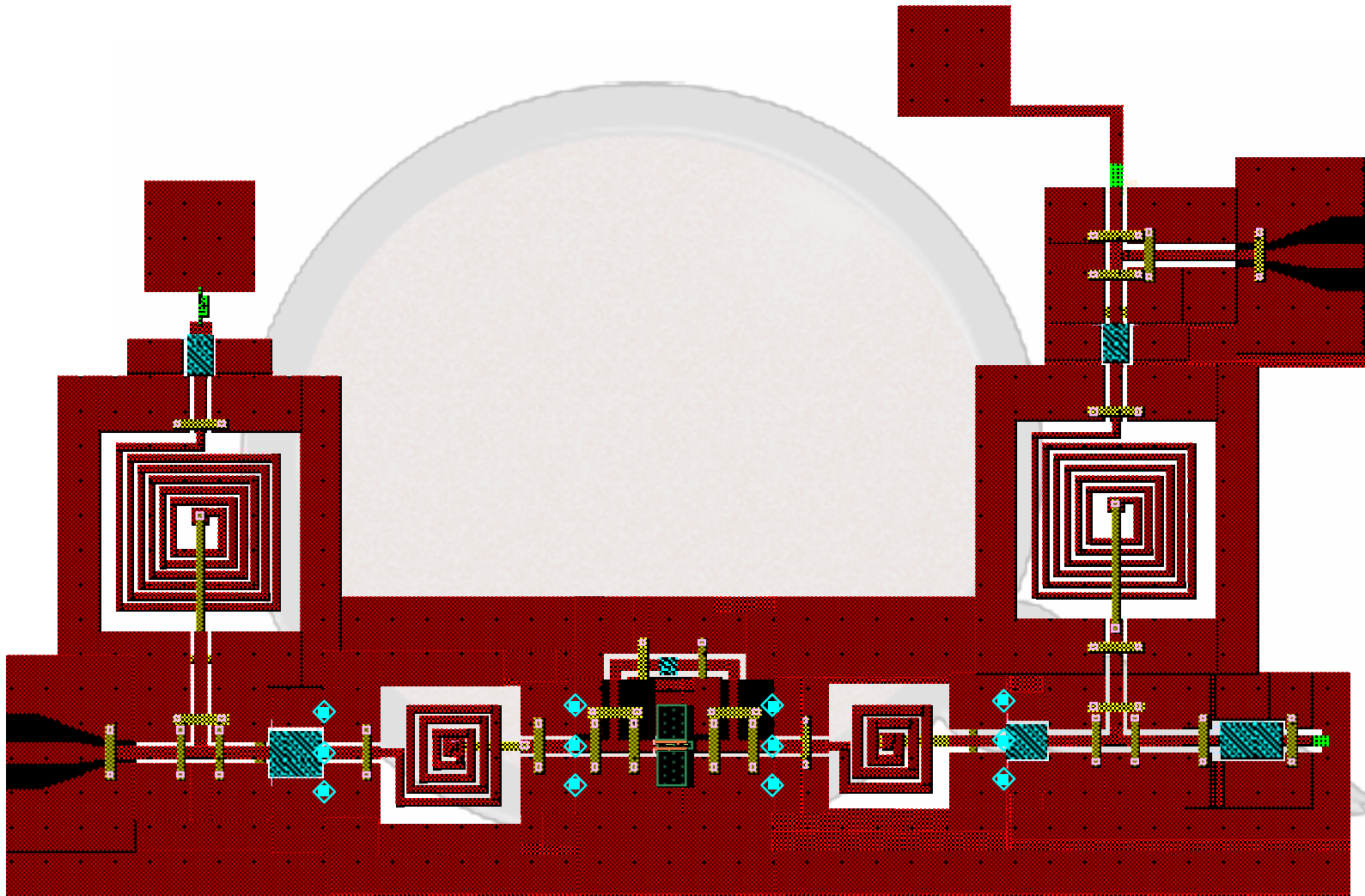
# Comparison Between Measured and Simulated Circuit



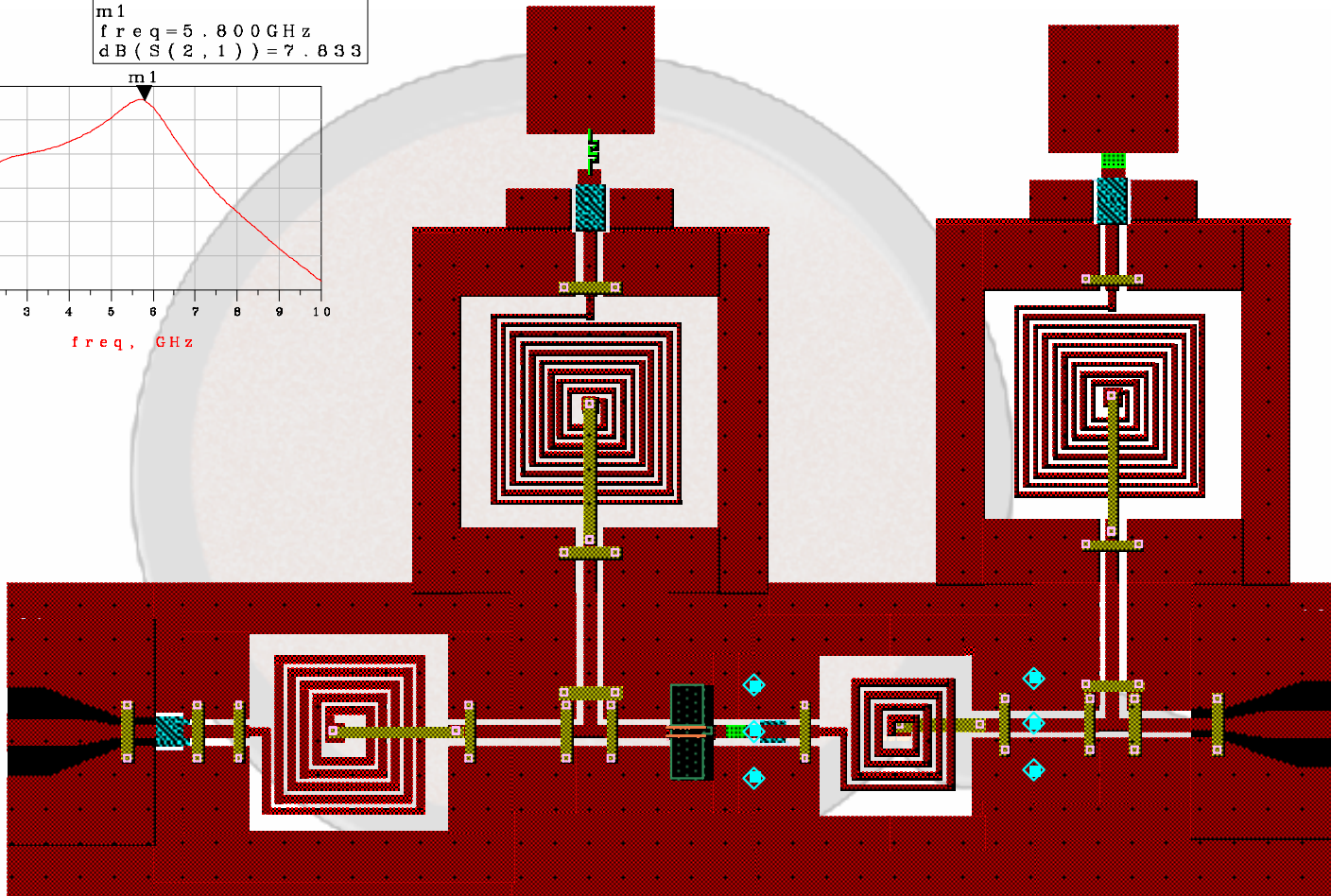
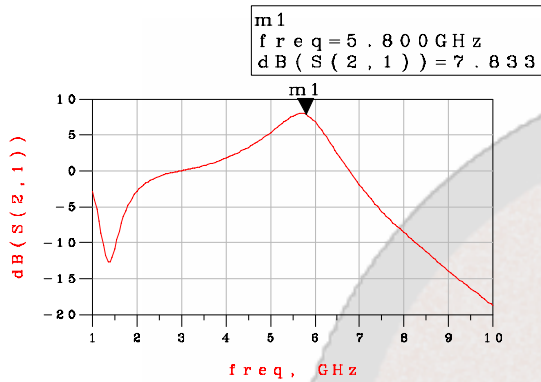
# Oscillator – 2.2x 1mm (predicted performance)



# Super-Regenerative Detector 2.3x 1.1 mm

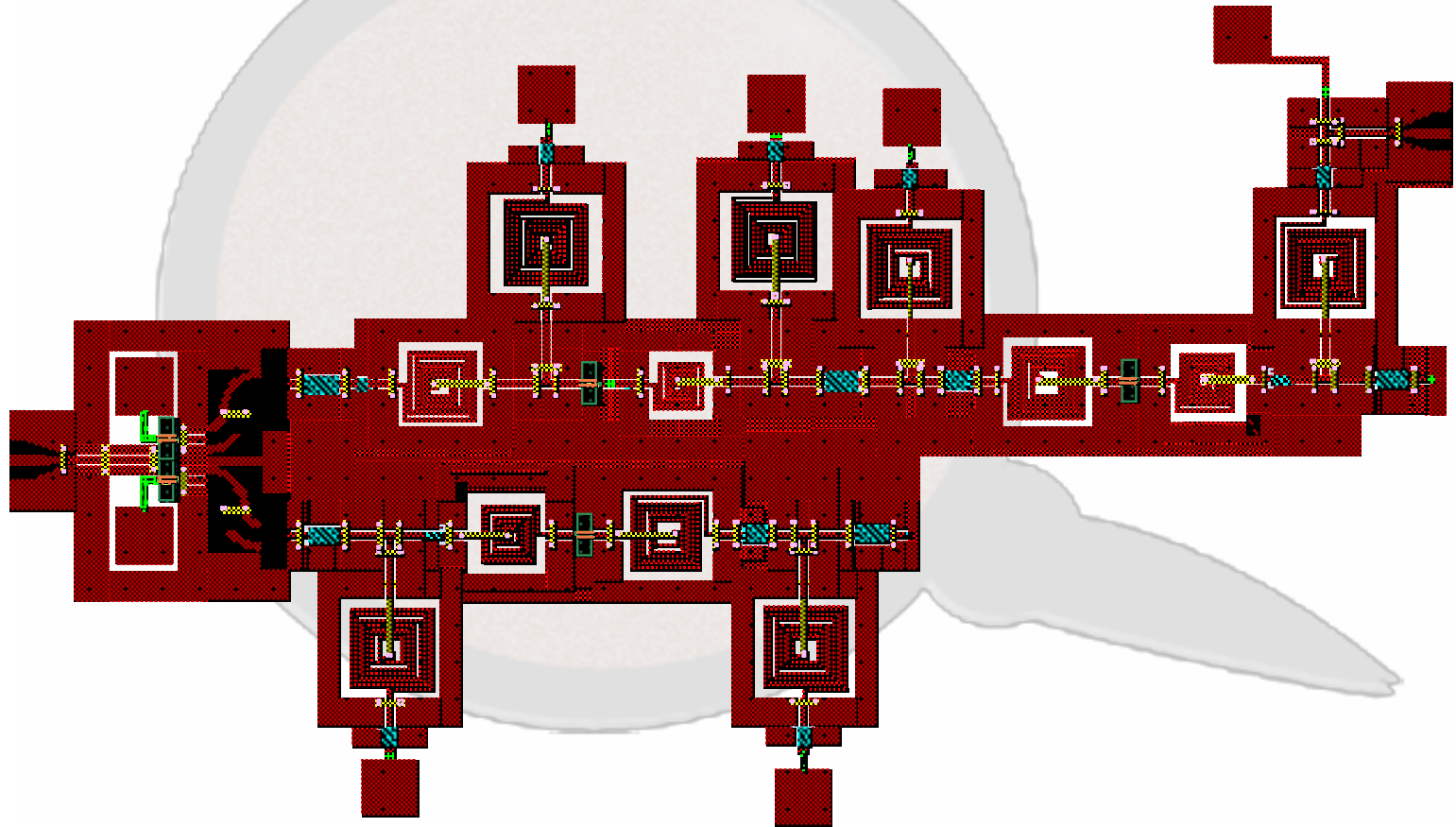


# Amplifier – 2 x 1.4 mm (predicted performance)



# Transceiver Layout : 4.9 x 2.5 mm, power = 0.56mW Rx and 0.28mW Tx

- Can be made smaller – Spacious layout is to reduce any mutual coupling



# Conclusions

- Sub 50  $\mu\text{W}$  power consumption possible
- MMICs in last process step: expected any day

