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Dispersion in SiGe Devices Revealed by Fast Pulsed Measurements.

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1. Introduction

Dispersion in devices may arise from thermal effects, or from charge trapped in deep-levels. This paper describes work using variable length pulses to determine regions in which SiGe devices are dispersion free, and regions which are affected by thermal dispersion. An approximate thermal time constant is estimated from a transient response of the device.

2. Purpose

To be useful to circuit designers, semiconductor devices must be properly characterised at dc (which will determine the quiescent or bias point) and under large-signal RF excitation. Practical applications include knowing where a circuit simulator model will give accurate answers, the RF behaviour at high power, and time constants for pulse circuits.

3. Equipment Used

A commercial pulsed-measurement instrument allows measurements with pulse lengths from 100 ns up to 1 ms as well as dc measurements. The equipment is compact enough for cables to be kept short (less than 30cm), thereby reducing the effect of cable inductance and capacitance.The instrument provides synchronous pulses on two ports. A quiescent bias point may be set to any value within the measurement range.

4. Sample Devices

Results are given for a strained Si MOS device probed on-wafer. Results are given also for a SiGe HBT. As the sample is a packaged part, thermal behaviour is a combination of device and package effects.

5. Results

Figure 1 shows dc and pulsed results for a strained Si MOSFET. At the higher current levels the dc droop relative to the 100ns pulsed results. Figure 2 shows at higher power levels the dc current of the HBT droops while the pulsed curves (measured using 200ns pulses) are steeply rising.

6. Transient Behaviour

Figure 3 shows a plot of the transient current when the HBT is pulsed from a quiescent bias point set at V_{CE}=4V and i_B=0.2mA to a new point of V_{CE}=6V,i_B=1.4mA. The data of Figure 3 gives a time constant of 400 µs.

7. Conclusions

Though SiGe devices show very little dispersion if power levels are kept low, it is important to determine where dispersive effects take place and approximate time-constants associated with such dispersion.

To measure dispersion requires a large-signal measurement that is faster than the fastest time constant involved and which can be varied to give a transient response. Such measurements can only be obtained using a synchronous pulse system with a variable quiescent point setting.

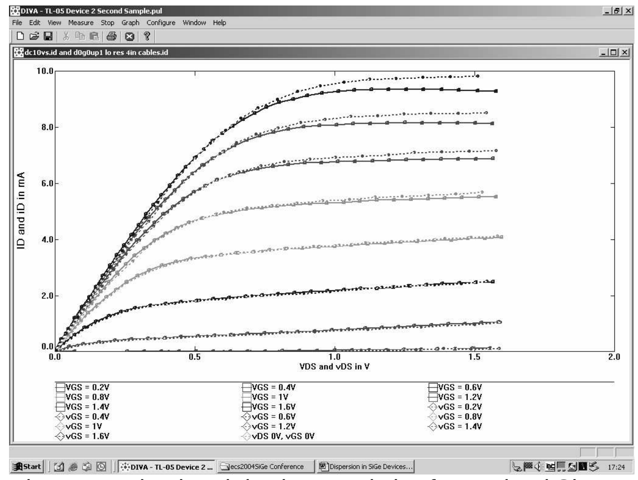

Figure 1: pulsed and dc characteristics for strained Si device

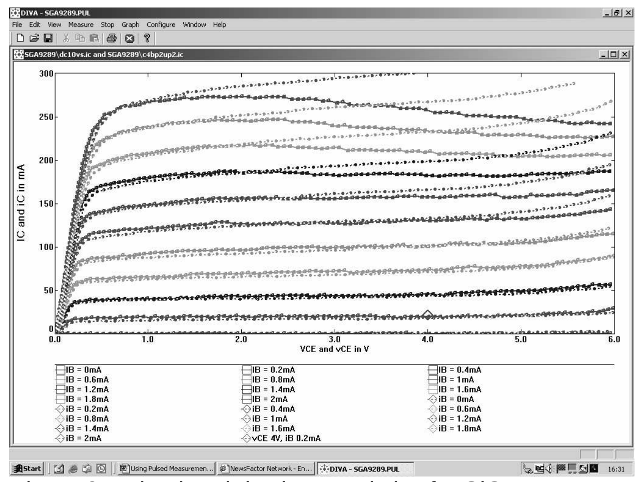

Figure 2: pulsed and dc characteristics for SiGe HBT

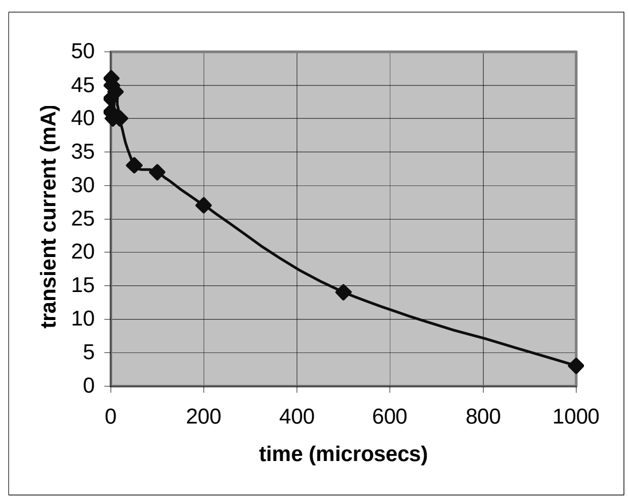

Figure 3: transient behaviour of HBT