Raytheon Systems Limited

A bit of everything + SiC

Birth of Silicon Glen

Raytheon Systems Limited in Glenrothes, Scotland is part of the US$25B+ Raytheon Company. The facility was first established in Scotland in 1960 and pioneered the semiconductor revolution in Europe. They were the first to settle in what later became known as Silicon Glen.

The design and manufacturing capability includes semiconductor fabrication, substrate and microcircuit manufacture, printed circuit board assembly, and unit build—a complete production resource for high-quality electronic subsystems, from wafer and chip to fully packaged units.

Flexible Foundry

Raytheon has lots of experience in the development and manufacturing transfer of a range of silicon and non-silicon processes. This includes mixed signal and digital CMOS, NVM, Bipolar, SOS, SOI, NMOS FET sensors, and SiC.

It has a long history in the support of technology start-ups through post incubation to commercialization. As important, it understands the significance of supporting the very long product lifecycles seen in industrial, automotive, and defense applications without diminishing the highest levels of product reliability.

Raytheon products comply with strict mission assurance requirements, as reliability and precision are essential to the performance of any system that relies on electrical actuation, from missile flight control to systems for radar, armored vehicles and artillery. In short, wherever product quality is paramount.

Raytheon Glenrothes Facility

Fast Facts

Location:	Glenrothes, Scotland, UK
Web Site:	www.raytheon.co.uk
Site Established:	1960
Employees:	560
Major Markets:	Power, Control, Defense, Aerospace & Green Industries
Technologies:	Silicon, Silicon Carbide
Parametric Testers:	Reedholm

High Temp CMOS SiC Devices

Raytheon's power solutions are a technology success story. The latest development is High Temperature Silicon Carbide (HiTSiC). This technology has potential applications in aerospace, energy and green-related industries, as it enables IC's and transistors to operate in temperatures between 300°C and 400°C.

Through advances in SiC wafer processing and individual device design technology, the HiTSiC program has demonstrated the first CMOS transistors operating at more than 300°C. The team demonstrated 10 times higher logic complexity and significantly faster processing than earlier generation technologies.

This game-changing technology will enable new products and processes to be developed to ensure components capable of withstanding exceptional G-forces and extreme temperatures.

Significant technical challenges are being addressed in the creation of a MOS integrated circuit process operating in temperature extremes where all other existing integrated circuit technologies do not function.

By manufacturing integrated circuits on thin wafers of silicon carbide, the temperature at which integrated circuits can operate will be increased by more than 200°C. This, combined with the fact that devices can be CMOS-based, not NMOS-based, will lead to power consumption benefits, and products that exist in a designer and customer friendly CMOS-based world.

Process Monitoring & DC Final Test

There are two main process flows at Raytheon. At first glance, they have nothing in common, save for the fact that both are tested on a Reedholm system.

In CMOS applications, the Reedholm is used as a standard process control monitor test system, mostly for commercial NVM ASIC's. Between 3 and 5 sites are tested per wafer, and each site has two or more in-tradie steps. Data is taken on 120+ parameters, with hard pass/fail limits on more than half the tests. Parametric results correlate to final test reasonably well. Most MOS test conditions are <|100V| and <|200mA|.

Getting the Right Answer is Work

PCM test is one of the responsibilities of David Clark—the engineer in charge of parameter test/pull. Dave joined Raytheon in 1993, after interning for a couple of summers, and has been there ever since.

David Clark

The thing that would most surprise others is just how much work it is to get the right answer when it comes to parametric test. "It's more of an art to set up tests correctly to get the right, repeatable result," per Clark, "and since test plans and testers are often used for a long time, it makes sense to do the job right the first time."

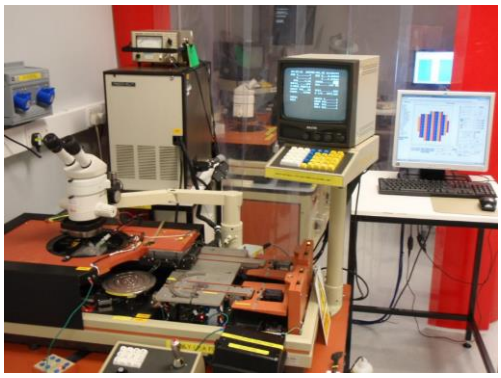
Value of 100% Sampling

Discrete power devices are a significant part of the silicon carbide foundry work performed at Raytheon. One hundred percent die sort testing ties up a considerable portion of Reedholm parametric tester time.

At Raytheon, all wafers are subjected to test. By changing to 100% sampling and fully automated probing, Raytheon catches rogue wafers. All sites are measured, even if sufficient pass/fail information has been obtained before the final site is tested. David notes that "we identified during PFMEA's that wafers could fail PCM testing, but pass final product test, so wafers are 100% PCM tested to pass/fail limits and failing wafers scrapped, thus ensuring the integrity of the devices we ship."

Crossing Boundaries w/SiC and CMOS

As Clark noted, Raytheon might have been old school with their 4" CMOS fab, but they are on the leading edge in providing CMOS-based SiC devices for high power and high temperature applications.



Reedholm SiC Test System

The Reedholm system does double duty. During wafer processing, the system makes drop-in/PCM measurements. After processing, wafer-level product data is taken before the devices are sent off for packaging. Lots of sweep data is collected as Raytheon comes up the learning curve. Eventually, this will evolve to faster single-point dc measurements.

This has the PCM and final test engineers and SiC and CMOS engineers talking and sharing information in ways never done before. Clark terms this mixing of disciplines and expertise "crossing boundaries," which keeps the fab and the test function interesting.

System Upgrade for SiC Requirements

SiC devices require far higher currents and voltages than available from typical parametric test systems. For this reason, Raytheon upgraded its hardware to handle 2kV and 5A devices, and its software to match that used by a Raytheon technology partner. A modified EG2001 prober also had to be ordered—one that could handle catastrophic breakdown of devices without causing the prober electronics to lock up.

Since Reedholm software is forward compatible, Raytheon test plans were ported for use in the Intranet software. The new software also included transistor test capabilities for use at 5A and 2kV. As Raytheon SiC devices are extended to 10kV and 20A or more, Raytheon knows it can look to Reedholm for new systems, upgrades and extensions.

Maker of High Reliability Devices

It is a bit of a misnomer that Glenrothes is "just a defense supplier." It is more correct to term them a maker of high reliability devices for commercial markets such as automotive.

Raytheon is betting that customers will pay more for reliable power devices that work for sustained lengths of time at high temperatures.