Overview

Cobham RAD Solutions
1/1/15

Presenter: Malcolm Thomson

Commercial in Confidence
Overview

- Cobham At A Glance

- Cobham RAD Solutions
  - Extensive Radiation Effects Testing, History and background
  - Radiation Testing Services and Capabilities
  - Cobham RAD Solutions Assembly & Screening Services
  - Cobham RAD Solutions Products, MOSFETS, BJTs and ADCs
  - Partial Listing of Customers

- Summary
At a Glance

What we do

• Cobham protects lives and livelihoods with its differentiated technology and know-how, operating with a deep insight into customer needs and agility. The Group offers an innovative range of technologies and services to solve challenging problems in harsh environments across commercial, defence and security markets, from deep space to the depths of the ocean, specialising in meeting the growing demand for data, connectivity and bandwidth.

• Employing more than 12,000 people on five continents, the Group has customers and partners in over 100 countries, with market leading positions in: wireless, audio, video and data communications, including satellite communications; defence electronics; air-to-air refuelling; aviation services; life support and mission equipment.

Some numbers

• Annual revenue £1.8bn* in 2013
• £88m* company funded R&D in 2013 (6% revenue)
• Employ more 12,000 people on five continents

*excludes Aeroflex acquisition
This Sector delivers outsourced aviation services for military and civil customers worldwide through military training, special mission flight operations, outsourced commercial aviation and aircraft engineering.

**Capabilities**
- Air Traffic Display Systems
- Electronic Warfare Training
- Fly-In Fly-Out Services for the Natural Resource Industry
- Helicopter Services
- Maritime Surveillance and Border Protection
- Regional Airline Services for Qantas

This Sector provides: end-to-end avionics; law enforcement and national security solutions; wireless communication and test equipment for public safety and building infrastructure; and satellite communication equipment for land, sea and air applications.

**Capabilities**
- Antenna Systems for Communication, Navigation, Electronic Warfare and Radar
- Cockpit and Cabin Communications
- Composite Technologies
- Public Safety and Wireless Communications for Infrastructure
- Satcom Equipment for Aerospace, Land and Maritime
- Wireless Surveillance Technology
- Wireless and Radio Test Solutions

This Sector provides safety and survival systems for extreme environments, nose-to-tail refuelling systems and wing-tip to wing-tip mission systems for fast jets, transport aircraft and rotor craft, and remote controlled robots and fully-equipped bomb disposal vehicles for homeland security and military applications.

**Capabilities**
- Advanced Restraint Systems
- Air-to-Air Refuelling Systems
- On Board Inert Gas Generation Systems (OBIGGS)
- On Board Oxygen Generation Systems (OBOGS)
- Unmanned Systems
- Weapons Carriage and Release
Sector Overview

Integrated Electronic Solutions

- Antenna and Radome Solutions for Airborne Communications, Navigation & Identification (CNI), Ground mobile, Launch vehicles & missiles/munitions
- Electronic Warfare (EW) / Electronic Support Measures (ESM)
- Multi-function Assemblies
- Precision Gimbals
- Microwave Components
- Waveguides
- Antennas
- Rotary joints
- Cables

Microelectronic Solutions

Integrated Microwave Assemblies (IMA) and Line-Replacable Units (LRU) for:
- Electronic Warfare and Electronic Support Measures
- Radar (Land, Sea, Air) including AESA panels and DREX
- Tactical Missile Systems
- Space (Launch, Bus, Payload)
- Force Protection
- Data Links
- Precision Guided Weapons

Motion Control Solutions

High reliability motion control products including:
- Slip Rings
- Twist Capsules
- Actuators
- Stabilized Platforms
- DC Motors
- Controllers

Applications:
- Spacecraft
- Aircraft
- UAV/RPV payloads
- Missiles
- Shipboard
- Ground Vehicles
- Homeland Defense

RFMW Solutions

Microwave & RF Devices, Components, Modules and Subsystems, including:
- Signal Attenuation products
- Microwave Diodes
- Integrated Microwave Assemblies
- JAN Military Discretes
- Synthesizers and Interconnect Subsystems

Product Brands:
- Cobham Inmet
- Cobham Metalics
- Cobham Weinschel
- Cobham Signal & Control Solutions

Semiconductor Solutions

- Standard HiRel ICs to include: Memory, µProcessor, Interconnect & Power
- Application Specific Integrated Circuits (ASIC) for Space, Commercial and Industrial Markets
- Application Specific Standard products (ASSP) & ASICs for Medical Market
- Electronic Manufacturing Services (EMS) to include: Build-To-Print (BTP) CCA & MCM; Build-To-Specification (BTS) MCM, Single Board Computer (SBC) & Microwave Filter; Systems Engineering; Supply Chain; Radiation Services
New Location for Radiation Testing

5030 Centennial Blvd., Colorado Springs, Colorado 80919
(719)531-0800, www.aeroflex.com/RAD
Cobham RAD Solutions
History & Key Milestones...

• Cobham RAD Solutions business and capabilities were originally known as “Longmire Laboratory” and has existed for over 20 years. The timeline below highlights some of the lab’s history:
  - September of 2014 - Cobham purchased Aeroflex which owed the Aeroflex RAD, Inc.

  - October 2013 – Outgrew the older offices and relocated to this 36,000 sq. ft. facility. This new facility allows for more efficient testing, better servicing the needs of our customers for the foreseeable future. The new space is twice the size of our previous facility and became operational 10/2013.

  - September 2013 – Announced the opening of a European division to support the radiation testing needs of our customers outside of the U.S.A. Tests will be planned, managed and conducted within the U.K thereby providing an ITAR free option for our customers. This new facility will be headed by Dr. Richard Sharp.

  - July of 2010 - Aeroflex purchased Radiation Assured Devices and is now known as Aeroflex RAD, Inc.

Cobham RAD Solutions
History & Key Milestones Continued…

- September 2007 – RAD began developing a custom device manufacturing capability with associated assembly and test methods for the space and commercial HiRel markets.

- November 2006 – Certified to ISO 9001:2000

- Jan 2004 – Alliant Tech Systems, Inc. (ATK) purchased Longmire Laboratory from MRC

- Early 1990s – Longmire Laboratory founded to focus on radiation testing

• Cobham RAD Solutions has established itself as the premier radiation test and qualification facility within the United States and recently announced new facilities in Europe to provide the same services and support to our European customers.

• Cobham RAD Solutions provides these services to most of the major satellite prime contractors and high-rel component users and integrators for commercial and government programs.
Facilities Overview – Administration Area
Facilities Overview – Radiation Test

- Cobalt-60 High Dose Rate Source 4,000 Curie
- Flash X-Ray Source Prompt Pulse Testing
- Cobalt-60 Low Dose Rate Source 1 100 Curie
- Neutron Source
- Cobalt-60 Low Dose Rate Source 2 360 Curie
- Krypton-85 F/G Leak Detection
- Electrical Test Expansion Area
- Data Center
- Electric Test Expansion Area
- Electrical
- Locker Room
- Locker Room
- Comm. Janitorial
Facilities Overview – Assembly & Screening

- Krypton-85 F/G Leak Detection
- Assembly & Screening Area
- Class 100 Clean Room Assembly & Screening

Aeroflex RAD, Inc.
Facilities Overview – Electrical Test & Engineering

- Center
- Electrical Test Expansion Area
- Plant Equipment: Chillers, Boilers, Compressed Air, Dryers, Vacuum, Air Handlers etc.
- Electrical Test
- 15KVA UPS
- NICS / Cryo. Laboratory
- Liquid Nitrogen Storage
- Storage
- Engineering
- Break
- Conf.
In House Radiation Test Capabilities

- MIL-STD DLA compliant radiation effects testing available for all DLA radiation test methods.
- High dose rate (HDR), 50-300 rad(Si)/s, panoramic Co-60 source for device and box/system level testing
- Low dose rate (LDR) panoramic Co-60 source (Cell 1). Dedicated for Enhanced Low Dose Rate Sensitivity (ELDRS) testing at 1, 10 and 100 mrad(Si)/s. Custom dose rates are also available upon request.
- Low dose rate panoramic Co-60 ELDRS (Cell 2). Capabilities same as cell 1 above.
- Pulserad 112A Flash X-ray Source up to $10^{11}$ rad(Si)/s, 20 ns FWHM for prompt dose testing
- 14 MeV neutron source for Single Event Upset (SEU) and displacement damage testing
- Cs-137 Gamma Source available
- Focal Plane Array (FPA) development and testing
- 1 MeV Pelletron electron beam source
- Cryogenic irradiation and testing to 20 Kelvin
Cobham RAD Solutions has gained lab suitability for all Defense Logistic Agency’s radiation test methods. The table below lists DLA test methods and companies that offer testing to show compliance with those test methods set by DLA.

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Source Type</th>
<th>Aeroflex RAD</th>
<th>BREL (Boeing Radiation Effects Lab)</th>
<th>DMEA *</th>
<th>Honeywell (Clearwater)</th>
<th>Intersil Corporation</th>
<th>Raytheon (El Segundo)</th>
<th>Silicon Radiation Effects Lab</th>
<th>U.S. Army White Sands *</th>
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* US Army White Sands and DMEA are not authorized to perform commercial work without special application and authorization.

Single Event Effects Testing & Experience

- Cobham RAD Solutions has extensive experience (100+ man years) in the highly specialized field of heavy ion, single event effects (SEE) testing. We offer our clients turnkey services to characterize SEE on electronic components.

These services include:

- Project Management of a custom, complete test cycle from the receipt of test devices to the delivery of detailed final test reports.
- Development of custom hardware and software as necessary, leveraging our extensive library and experience utilized on our standard test platform, saving time and expense.
- Test support for single event latch-up (SEL), single event functional interrupt (SEFI), single event upset (SEU), single event burnout (SEB), single event gate rupture (SEGR), and transient (SET) characterization tests.
- Complex device types such as FPGA, ASIC’s and Microcontrollers are supported.
- Efficient and reusable test methodology results in customer savings. Costs such as travel and cyclotron facility rental are shared among several clients with multiple device tests conducted on a single visit to the cyclotron facility.
- Devices can be “de-processed” or packaged and verified at in house prior to direct exposure of the silicon in the heavy ion beam.
- See www.aeroflex.com/SEE for further details.
Cyclotron Testing Facilities...

Texas A&M University
Cyclotron Testing Facilities…

Lawrence Berkeley National Laboratory
Radiation Capabilities & Experience

- **High Dose Rate, Total Ionizing Dose (HDR)**
  - Cobham RAD Solutions has tested thousands of analog and digital devices. Numerous tests are conducted, onsite, every month.

- **Low Dose Rate, Total Ionizing Dose (LDR) or ELDRS.**
  - Again, Cobham RAD Solutions has tested thousands of analog and digital devices. These tests are conducted, onsite, every month. Due to the low dose rate and amount of time necessary to get sufficient total dose on a part, Cobham RAD Solutions has added a second ELDRS cell and both cells are now panoramic.

- **14 MeV Neutron Irradiation**
  - Cobham RAD Solutions also conducts, onsite, many neutron irradiation tests for SEE or displacement damage. Fluence levels from $10^8$ neutrons/cm$^2$/s to $10^{12}$ neutrons/cm$^2$ achievable.

- **Flash X-ray Irradiation (Prompt Dose Test)**
  - Tests are conducted on site with up to 100 pulses per day and up to $10^{11}$ rad(Si)/s, 20 ns FWHM pulse. Many tests are conducted every month.

- **Heavy Ion and proton Single Event Effects (SEE) testing**
  - All preparation, including hardware and software design and pretesting is conducted in house. The exposure testing is conducted primarily at either LBNL or TAMU.
High Dose and ELDRS TID Test Cells
ELDRS Gamma Test Cells

ELDRS Panoramic Cobalt-60, Dose rate ~ 1, 10, 100 mrad(Si)/s
Enhanced Low Dose Rate Sensitivity Characterization and Qualification
High Dose Rate Gamma Test Cells

HDR Cobalt-60, Dose rate up to 400 rad(Si)/s
High Dose Rate Characterization and Qualification, Component and System Level
High Dose Rate Gamma Test Cells

Cesium-137
Dose rate ~ 20 rad(Si)/s
Cryo System compatible
14 MeV Neutron Generator and Test Cell

14 MeV Neutron Generator Neutron for Displacement Damage and Single Event Upset (SEU) Testing
Flash X-Ray Source

Pulserad 112A Flash X-ray used for Prompt Dose Testing and Qualification. High Duty Cycle. Max Dose Rate: $10^{11} \text{ rad(Si)/s}$, Pulse width: 20ns full width.
FPA High-Speed Data Acquisition System (HDAS)

- Low noise FPA test capability <100 µV noise
- 20 Kelvin test capability
- Monolithic IC Cryogenic Testing
- Programmable biases and clocks

Focal Plane Array Test System

Focal Plane Array Cryogenic Test Head
Nuclear Infrared Clutter Simulator (NICS) Laboratory
Focal Plane Array Qualification
A few of the devices tested...

We have test programs and hardware in place to test over 1000 different devices. Device types include memories, A/D Converters, D/A Converters, Microcontrollers, Pulse Width Modulators, Voltage References, Op Amps, Regulators, Clock Chips, Transistors, Diodes and much more.
Assembly/Screening Overview

• Cobham RAD Solutions has established a highly specialized manufacturing capability to support radiation testing, internal product line requirements and to offer screening and assembly services to our clients.

• Production, quick-turn and prototyping, specialty assembly, radiation characterization and qualification preparation
  – Die Qualifications, Element Evaluations
  – State of the art assembly, test, and screening equipment

• DLA lab suitability to many MIL-STD-750 & 883 test methods.

• Assembly, screening and QCI compliant to MIL-PRF-19500, & 38535.

• Package thinning and re-packaging for SEE heavy ion testing.
• In-house PCB design and assembly for die or package Qualification and testing.

• COTS Component up-screening and qualification.

• Support for RLAT – Radiation Lot Acceptance Test.
Class S Flow Example

- **Wafer Lot Acceptance**
  - Method 5007

- **Electrical Test**

- **Incoming Inspection**

- **Assembly**

- **Non-Destruct Bond Pull**
  - Method 2023

- **Internal Visual**
  - Method 2010, Cond. A

- **Seal**
  - Method 1014

- **Serialization**
  - Method 1010, Cond. C

- **Temp Cycle**

- **Constant Acceleration**
  - Method 2020, Cond. A

- **PIND**
  - Method 2012, Y1 View

- **Radiography**
  - Method 2009

- **Lead Trim**

- **Pre Burn In Electrical**

- **Static Burn In**
  - Method 1015

- **Interim Post Burn In**
  - Electrical

- **Dynamic Burn In**
  - Method 1015

- **Post Burn In Electrical**
  - +25°C

- **Post Burn In Electrical**
  - Hot

- **Post Burn In Electrical**
  - Cold

- **Cold**
  - Groups A, B, D & E

- **QCI Testing**

- **PDA Calculation**

- **Delta Calculation**

- **Seal Test**
  - Method 1014

- **External Visual**
  - Method 2009
<table>
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<tr>
<th>Test Description</th>
<th>MIL-STD 883</th>
<th>MIL-STD-750</th>
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<tr>
<td>Adhesion of Lead Finish</td>
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<td>Bond Strength</td>
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<td>Burn-in</td>
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<td>Internal Water Vapor *</td>
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* = other divisions/labs
Green background = DLA Lab Suitability

Lab Suitability - Certified
Wafer Dicing: Mount, Saw and Wash
Class 100 Clean Room

Assembly & Screening
Krypton 85 Fine & Gross Leak Detection
Digital Real Time X-Ray
Burn In and Life Test
Temperature Cycle and PIND
Mechanical Shock and Variable Frequency Vibration
Cobham offers a family of Analog to Digital Converters ideal for military, aerospace and high reliability space applications.

The first offering from Cobham RAD Solutions is the RAD1419A, a 14-bit sampling ADC. This device can be built to your custom flows (SCD/VID) or purchased from inventory to our SCD. The RAD1419A uses a specially processed Linear Technology LTC1419A Die. LTC1419A is a well proven, highly reliable design.

RAD1419A key features:
- 100 krad(s), Latch up immune (LET < 55 MeV-cm²/mg)
- 800ksps/825ksps available
- 150mW power dissipation
- Typical performance: 81.5dB S/(N+D) 93dB THD
- No missing pipeline delays or missing codes
- Nap and shutdown modes
- 28-lead hermetic ceramic flat pack

Inventory available: Prototype, Electromechanical or Class S compliant.

Product datasheet and example SCD is available at www.aeroflex.com/rad
Cobham RAD Solutions has been developing family of Radiation Tolerant Bipolar Transistors that include:

- **RAD2N2222A & RAD2N3700**
  - 100 krad(Si) TID
  - JANS & JANSR available now
  - Die available
  - ECCN EAR99 for International sales

- **RAD2N2484**, 100 krad(Si) TID, JANS and JANSR, in qualification and life test.
  - JANS & JANSR available Q1 2015
  - Die available

- **RAD2N2907A**, 100 krad(Si) TID, HC/KC Die, in qualification and life test.
  - Protos available in Q2 2015

- **During 2015 Cobham RAD Solutions will expand the transistor family to include up to 20+ radiation tolerant, commonly used transistors.**
Cobham RAD Solutions has also developed a family of Radiation Tolerant IR Compatible (form, fit and function) MOSFETS

- Part numbering system compatible/similar with IR P/N’s. For example, RAD7110-NFS = IRHF7110.

- Device currently available in 4 voltages: 100V, 150V, 200V, and 250V.

- Designed for low power losses through a unique combination of low RDS(on) and gate charge while also optimizing the die size for maximum current rating.

- Available in die form for MCM manufacturers.

- Available in 7 different package types.

- Available as Prototypes, EMs or “Class S” compliant flow based upon customer’s SCD.

- Development of select “P” Channel devices in 2015.
MOSFETS Cont…

- Cobham RAD Solutions MOSFETs have better SEE immunity than the industry standard and is consistent throughout the product line. All MOSFETs pass a LET of 60 MeV-cm²/mg over full drain potential.

- Working design in’s with various customers for the RAD7110, 7034, 7264.

- Looking for Beta customer opportunities in the 250-2500 pcs range. Already sold 250 and 2200 pcs orders in packaged and die form.

- Manufactured to MIL-PRF-19500 flow, provided to a Vendor Identification drawing (VID) and custom Source Control Drawing (SCD).

- Quad version, RAD7214-NQS, ordered by large satellite OEM and currently in production.

www.aeroflex.com/mosfets
Partial Listing of Customers

- AFRL
- Analog Devices
- ASIC Advantage
- ATK
- Austin Semiconductor
- Ball Aerospace
- BF Goodrich
- Boeing
- Crane Interpoint
- EADS
- Emerson
- General Dynamics
- Harris
- Honeywell
- International Rectifier
- ITT
- JPL
- L3
- Linear Technologies
- Lockheed Martin
- Loral
- Los Alamos National Labs
- Moog
- NASA
- National Semiconductor
- Northrop Grumman
- Orbital Sciences
- Ramtron
- Pratt & Whitney Rocketdyne
- Rockwell Collins
- RT Logic
- Sandia Labs
- Scientific Inc.
- SEAKR
- SNCorp
- Space Dev
- Teledyne
- Tesat
- Texas Instruments
- Trident
- Univ. of Colorado
- Vectron
- Viasat
- And many others…
Summary of Cobham RAD Solutions

- The preeminent, comprehensive commercial radiation effects testing laboratory in the United States with Lab Suitability for all DLA radiation test methods.

- Highly experienced staff and consistent test methodology allows for cost effective testing of electronic components, from the more simple Total Ionizing Dose (TID) test to complex Single Event Effects (SEE) tests. Complete turnkey services are available.

- DLA suitability for radiation test methods 1019, 1017, 1020, 1021.

- Product and service focused with screening, assembly and radiation testing services.

- Able to quickly identify and develop new product offerings for space, commercial HiRel, military and aircraft-borne market segments. Will partner with customers to bring new products to market quickly and cost effectively.

The most important thing we build is trust
Aeroflex RAD, Inc. doing business as Cobham RAD Solutions
www.aeroflex.com/RAD
info-ams@aeroflex.com

Phone: 719 531-0800
5030 Centennial Blvd. Colorado Springs, CO 80919