KONGSBERG SPACE & SURVEILLANCE FAMILY

- Launcher and satellite mechanisms, electro optics
- Satellite electronics
- Ground station equipment
- Ground station services
- Maritime surveillance
- AIS payloads
- GPS systems

KONGSBERG MARITIME

Launch and satellite mechanisms, electro optics
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Maritime surveillance
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GPS systems
Kongsberg Space Electronics – At Glance

- Workforce: 130 (80 Engineering)
- On-Board Satellite Electronics Since 1984
- All Major Primes
- All Major Satcom Operators
- Kongsberg Group Since 2011
- 200 satellites
- RF Units
- TTC/TCR Subsystems
- SAW/Components
- Located in Horten, Norway
Manufacturing facilities

- SAW crystal wafer and Thin film substrate manufacture
  - Class 100-1000
  - 140 m²

- Printed Wire Board Assembly and Unit Integration
  - Automation planned
  - Class 100 000
  - 240 m²

- SAW and Hybrid Assembly, inspection and test
  - Automation ongoing
  - Class 10 000
  - 270 m²

- Electrical Test & Tune
  - Temp/TVAC cycling
  - Class 100 000
  - 650 m²
Satellite Communication

- Broadband /mobile phones everywhere
- Fixed communication links
- Navigation Signals
- Search and Rescue Signals
- Earth observation
Satellites – big babies!

Source: Airbus (Astra 3B)
Galileo - European Navigation system

- Navigation Signals
- Search and Rescue Service
- Kongsberg Deliveries to 4 + 22 + 12 satellites
  - Two units (~15 kg) in each satellite

Search and Rescue Transponder

Frequency Generator and Upconverter unit
Inmarsat 6 – Satellites for mobile communications
Frequency Converter Assemblies
14 units (~10kg each) x Two flighsets
Inmarsat Beam hopping – flexible capacity

With the ability to generate thousands of
Telemetry Tracking & Command

- Remote control of the Satellite
  - Command Receiver ➔ reception of command signals
  - Telemetry Transmitter ➔ Status signals from Satellite and Payload
  - Beacon ➔ Tone generator (Satellite position, Antenna pointing)
Requirements for Space
“It simply must work!”

- **Mechanical Environments**
  - Launch / deployment: Vibration and Shock

- **Superb performance in harsh environments**
  - EMC (Electro Magnetic Compatibility)
  - Radiation hard designs
  - Thermal flow management in Vacuum
  - Mass optimization
  - World Class Performance

- **Reliability and Product Assurance Analysis**
  - Designs for 18 Years Lifetime
  - Qualified processes and materials
  - Reliability Analysis (Calculate Failures In Time)
  - Simulations and Design Analysis
Technology platform – Space Electronics

- SAW filter technology
- RF - Hybrid technology
- RF PCB Technology
- Equipment technology
- Advanced testing
Qualification testing

- Soldering, adhesive bonding, wire-bonding, crimping, painting/coating, plating, hermetic sealing, //gap welding

- Typical qualification test flow:
  - Sample assembly
  - Inspection (visual, x-ray)
  - Reference test (electrical, die shear, bond pull, tape test, peel test)
  - Environmental test
    - Vibration
    - Mechanical shock
    - Thermal cycling
    - Heat storage
  - Final test (electrical, die shear, bond pull tape test, peel test)
  - Final inspection (visual, x-ray, micro-section)
Environmental testing

- X-, Y-, Z-axis,

- Typical qualification parameters:
  - Sine vibration
    - 5 Hz – 100 Hz
    - 20 g – 30 g amplitude
  - Random vibration
    - 20 Hz – 2000 Hz
    - 30 g\text{RMS}

- "Slow" cycling, ECSS-Q-ST-70-08C:
  - 500 cycles, -55 °C to +100 °C, max 10 °C /min

- Shock cycling, MIL-STD-883
  - 100-200 cycles -55 °C to +125 °C
X-ray inspection

- Detect voids and cracks
- 3D scan
SEM of Transistor
Micro-section inspection

- Epoxy-molded sections → Grinding & Polishing
- Inspection using optical microscopy or SEM
- Evaluation of solder joint integrity according to ECSS-Q-ST-70-38C
Micro-section inspection

- Cracks in components and solder fillets
  - Stand off
  - Thermal shock
Qualification of wirebonding

Transistor, ca 600 µm x 500 µm

µ-section of gold bonding wire 25 µm
Wirebonding with wrong parameters
Conclusion

It simply must work