RF & Microwave

Packaging Capabilities & Engineering Services
RF & Microwave Applications

- Detector Log Video Amplifier (DLVA)
- Detector Video Compression Amplifier (DVCA)
- Low Noise Amplifiers (LNA)
- Medium Power Amplifiers (MPA)
- Successive Detection Log Amplifier (SDLA)
- Amplifier Controls (Pre, Variable, Gain, Driver, MMIC)
- Converters (Up, Down, High Band, Low Band)
- Detectors (Bit, RF, Log)
- Diplexers
- Filters (Bandpass, Low, High)
- Frequency Discriminators
- Frequency Doubler and Frequency Synthesizer
- GPS RF Processors
- Modulator (PFM)
- Multi-channel Video Module
- Multi-throw Switch Assembly
- Receivers (Wideband, Crystal Video)
- Ripple Counters
- Switch Combiners
- Tracking Converters and Processors
- Transmitters & Receivers
RF & Microwave Technologies

- Surface mount assembly (mixed mode)
- Eutectic and epoxy die attach
- Auto die attach
- Flip chip
- 0.7, 1 mil gold wire bonding
- Manual ribbon bonding
- Testing to 65 GHz
- Active or passive laser trim
- Hermetic construction with replaceable SMA connectors
- -55°C to +125°C electrical
- Burn-in capability
- Thin film microstrip subassemblies
- Multiple substrate construction: thick film substrate with boards
- SPC monitoring
Downconverter

- Airborne Radar System
- Multiple substrate construction
- Broadband
  - RF: 2-8 GHz
  - IF: 650 - 1250 MHz
  - LO: 240 MHz
  - Temperature compensated
MMIC Chip Evaluation, Packaging & Test

- Amplifiers, Splitters, Filters, Combiners, Mixers, etc.
  - Up to 43 GHz
  - 24 part types
  - Eutectic or Epoxy Die Attachment
  - Au Wire Bonds
  - Low Cost Ceramic SMT Packages (JEDEC)
MMIC Chip Evaluation, Packaging & Test

- Amplifiers, Detectors, Switches
  - Up to 3.3 GHz
  - 6 circuits
  - Eutectic or Epoxy Die Attachment
  - Au Wire Bonds
  - Hermetic Ceramic Flat Packs
  - Plastic Encapsulated Leadless Carriers (JEDEC)
High Frequency Flip Chip

- A prototype built for C-band Power amplifier, including 2 by-pass capacitors
- Preserves microstrip structure
  - Can be applied to virtually all existing dies
  - Placement accuracy is not very critical.
- Heat transfers in the classical way, from the back of the die
  - Well suitable for power devices
- Solid grounding to avoid common problems
  - Eliminates problem of radiation from the flipped die
- Plastic DIP packages
Mars Science Laboratory Curiosity Rover RF Modules

- Two RF modules on the terminal descent and landing unit of the MSL Curiosity Rover
  - Transmit /Receive Module (TRM)
    - Combines a channelized portion with a surface mount PWB
    - 35 GHz frequency band
    - 5” square x 1.5” thick
    - Hermetically sealed via laser sealing
  - Up/Down Microwave Module (UDMM)
    - Channelized design utilizing a chain of substrates connected by ribbons and wirebonds
    - 35 GHz frequency band
    - 5” square x 1.5” thick
    - Hermetically sealed via laser sealing
- Both modules designed by JPL with extensive manufacturing design inputs from Teledyne
- 7 EDU and 14 flight UDMM’s and 12 EDU and 20 flight TRM’s were delivered and tested by the customer
Optical Mux, DeMux, Transponder

- OC768 for Optical Routers & Transponders
- 16 channels, multiple rates to 44 Gbps
- High frequency and noise isolation
- Solder bump flip chip
- High Temperature Co-fired Ceramic (HTCC) BGA substrate
- Utilizing stripline and microstrip provisions
RF/Microwave & Optoelectronics Design Tools

- 2D Microwave - EEsof, Microwave Office
- 3D Microwave - Ansoft, HFSS
- Photonic Design and Simulation
  - Zemax – Far Field Optics
  - RSoft – Near Field Optics
- Mentor Graphics MCM Station
  - Schematic Capture
  - Autorouting
  - High Speed/Crosstalk Analysis
  - Idea - Schematic Capture, Digital Simulation
  - Quick Fault - Test Vector Generation
- Pro Engineering, Pro Mechanica, COSMOS, SolidWorks
  - 3D Mechanical Design
  - FEA, Stress Analysis, Thermal Analysis, Dynamic Analysis
- OrCad
  - Schematic Capture
  - Autorouting
- AutoCAD
  - Substrate layout
  - Hybrid packaging design
  - Microelectronic interconnection
- PSPICE
  - Design, Analysis and Simulation
Test Technologies

- VLSI Tester
- Multifunction Test Stations
- Custom ATE Station
- Fiber Optic Test Stations
- Fiber Optic Tx/RX Tester
- RF Test Bench
- High Power Tester
- Solid State Power ATE
- Cryptologic Tester
Diversified Packaging Technology Portfolio

- **Substrates**
  - Ceramics
    - Al2O3, BeO, AlN
    - Multi-layer thick film
      - Standard
      - Photo-etchable
      - High Frequency
    - Single-layer thin film
    - Cofired (LTCC, HTCC)
  - Laminates
    - FR-4
    - Polyimide
    - Rigid-Flex
    - Insulated Metal
    - Proprietary High Tg

- **Assembly**
  - Chip and wire
  - Flip Chip
  - SMT
  - Mixed Technologies
  - Chip Scale Packaging

- **Technical Expertise**
  - Multi-disciplinary product engineering
  - Routing and layouts
  - Circuit simulation, design, analysis
  - Established processes, SPC monitored
  - Concurrent Engineering Teams
RF & Microwave Substrates

- Thin Film Ceramic
  - Nickel & Gold Plating
  - Nichrome, TaN, Gold & TiWn Sputtering
  - Fine line capability (0.001” lines w/0.0005” spacing)
  - Nichrome & TaN resistors

- Thick Film Fine Line Ceramic
  - FODEL
  - Photo-Etchable
  - Low-K Dielectric
High Frequency Thick Film

● DuPont Fodel
  – Characterized to 19 GHz
  – Metallization - Au, Ag
  – 2 mil lines and spaces, 3 mil vias
  – Uses standard thick film manufacturing techniques
  – 2” x 2” wafers standard
  – Resistors - 20 x 20 mil to 40 x 40 mil

● Etchable
  – Characterized to 50+ GHz
  – Metallization - Au, Ag
  – 1.5 mil lines and spaces, 2 mil vias
  – Resistors - 10 x 10 mil
Enabling Packaging Technologies

- Ball Grid Array (BGA & micro BGA)
- Ceramic Quad Flat Pack (CQFP)
- Chip & Wire and Surface Mount Assembly (SMT)
- Chip on Board (COB)
- Chip Scale Packaging (CSP)
- Detachable Fiber Optic (DFO) connector
- Direct Bonded Copper (DBC)
- Flip Chip die attach/interconnect (FC)
- Flip Chip on flex
- Laminate: Flex, Stacked/folded/encapsulated
- Laminate: FR4 Epoxy, PTFE, Polyimide
- Land Grid Array (LGA)
- Multi-Chip Scale Packaging (MCSP)
- Optics: for High Brightness LEDs
- Stud Bumping (Gold & Solder)
- Substrates: Thin & Thick film, LTCC, HTCC
Manufacturing Technologies

Microelectronic Interconnection:
- Dispensing
- Die Attach
- Wire Bonding
- Flip Chip

SMT:
- Stenciling/Screen Printing
- SMT Pick & Place
- Solder Reflow

Packaging:
- Cover Seal
- Encapsulation
Process Validation & Environmental Screening

Wire Bond Pull and Shear Tester

Sonoscan

Pressurizing Helium Chamber

Temp Cycling

Fine Leak Test

Gross Leak Test

Real Time X-Ray

HAST

Centrifuge

Vibration

Mechanical Shock

X-Ray Fluorescence Tester
Test Technologies

VLSI Tester
Multifunction Test Stations
Custom ATE Station
Fiber Optic Test Stations
Fiber Optic Tx/RX Tester
RF Test Bench
High Power Tester
Solid State Power ATE
Cryptologic Tester
## Test Capabilities

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Description</th>
<th>Speed/Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agilent</td>
<td>8722ES</td>
<td>Network Analyzer</td>
<td>50 MHz – 40 GHz</td>
</tr>
<tr>
<td></td>
<td>8753C</td>
<td>Network Analyzer</td>
<td>300 KHz – 3 GHz</td>
</tr>
<tr>
<td></td>
<td>4195A</td>
<td>Network / Spectrum Analyzer</td>
<td>10 MHz – 500 MHz</td>
</tr>
<tr>
<td></td>
<td>N8975A</td>
<td>Noise Figure Analyzer with Frequency Conversion Measurement Capabilities</td>
<td>10 MHz – 26.5 GHz</td>
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<tr>
<td></td>
<td>70820A</td>
<td>Microwave Transition Analyzer</td>
<td>DC – 40 GHz</td>
</tr>
<tr>
<td></td>
<td>70340A</td>
<td>Signal Generator</td>
<td>1 – 20 GHz</td>
</tr>
<tr>
<td></td>
<td>70341A</td>
<td>Frequency Extension Module</td>
<td>0.01 – 1 GHz</td>
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<tr>
<td></td>
<td>86100A</td>
<td>Digital Communication Analyzer</td>
<td>12 GHz</td>
</tr>
<tr>
<td></td>
<td>8482A</td>
<td>Power Sensor</td>
<td>100 KHz – 4 GHz</td>
</tr>
<tr>
<td></td>
<td>83484A</td>
<td>Dual Channel 50 GHz Electrical Plug-in/Measurement Module</td>
<td>50 GHz</td>
</tr>
<tr>
<td></td>
<td>83485B</td>
<td>30 GHz optical/40 GHz electrical Plug-in/Measurement Module</td>
<td>30 GHz / 40 GHz</td>
</tr>
<tr>
<td></td>
<td>8703B</td>
<td>Optical Spectrum Analyzer</td>
<td>50 MHz – 20 GHz</td>
</tr>
<tr>
<td></td>
<td>8702D</td>
<td>Optical Spectrum Analyzer</td>
<td>3 KHz – 3 GHz</td>
</tr>
<tr>
<td></td>
<td>8703A</td>
<td>Lightwave Component Analyzer</td>
<td>130 MHz – 20 GHz</td>
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<tr>
<td></td>
<td>86030A</td>
<td>Lightwave Component Analyzer</td>
<td>50 GHz</td>
</tr>
<tr>
<td></td>
<td>83433A</td>
<td>Lightwave Transmitter</td>
<td>10.7 GHz</td>
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<tr>
<td></td>
<td>86100A</td>
<td>Digital Communication Analyzer</td>
<td>12 GHz</td>
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<tr>
<td></td>
<td>71612</td>
<td>Error Performance Analyzer</td>
<td>12 GHz</td>
</tr>
<tr>
<td></td>
<td>86140B</td>
<td>Optical Spectrum Analyzer</td>
<td>600 to 1700 nm</td>
</tr>
<tr>
<td></td>
<td>86142B</td>
<td>Optical Spectrum Analyzer</td>
<td>600 to 1700 nm</td>
</tr>
<tr>
<td></td>
<td>71501C</td>
<td>Jitter Analysis System</td>
<td>40 GHz</td>
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<tr>
<td></td>
<td>8504B</td>
<td>Precision Reflectometer</td>
<td>1300 to 1500 nm</td>
</tr>
<tr>
<td></td>
<td>E4407B</td>
<td>Spectrum Analyzer</td>
<td>9 KHz – 26.5 GHz</td>
</tr>
<tr>
<td></td>
<td>E8362B</td>
<td>Performance Network Analyzer with Frequency Conversion Measurement</td>
<td>10 MHz – 20 GHz</td>
</tr>
<tr>
<td></td>
<td>E8257C</td>
<td>Signal Generator</td>
<td>250 MHz – 20 GHz</td>
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<td>E4418B</td>
<td>Power Meter</td>
<td>18 GHz</td>
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<tr>
<td>Anritsu</td>
<td>E4412A</td>
<td>Power Sensor</td>
<td>18 GHz</td>
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<td></td>
<td>54845A</td>
<td>4 Channel Oscilloscope</td>
<td>1.5 GHz</td>
</tr>
<tr>
<td></td>
<td>83651B</td>
<td>Synthesized Signal Source / Sweeper</td>
<td>10 MHz – 50 GHz</td>
</tr>
<tr>
<td></td>
<td>83752A</td>
<td>Synthesized Signal Source / Sweeper</td>
<td>10 MHz – 20 GHz</td>
</tr>
<tr>
<td></td>
<td>93000</td>
<td>VLSI Tester, 512 pins</td>
<td>400 MHz</td>
</tr>
<tr>
<td></td>
<td>HP82000</td>
<td>VLSI Tester, 480 pins</td>
<td>200 MHz</td>
</tr>
<tr>
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<td>MS9710B</td>
<td>Optical Spectrum Analyzer</td>
<td>600 to 1750 nm</td>
</tr>
<tr>
<td></td>
<td>69047B</td>
<td>Synthesized Signal Source / Sweeper</td>
<td>10 MHz – 20 GHz</td>
</tr>
<tr>
<td>Takeda Riken</td>
<td>T3340</td>
<td>VLSI Tester, 256 pins</td>
<td>40 MHz</td>
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<tr>
<td>GEN RAD</td>
<td>2225</td>
<td>Static Functional, 192 pins</td>
<td>17 KHz</td>
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<tr>
<td>LTX</td>
<td>MTS-77</td>
<td>Analog, 48 pins</td>
<td>100 KHz</td>
</tr>
</tbody>
</table>
Certifications and Qualifications

- MIL-PRF-38534, General Specification for Hybrid Microcircuits
  - Facility and Manufacturing process certified and qualified by DSCC for Class “H” and “K” devices
  - Laboratory Suitability to MIL-STD-883 for 21 test methods
- ISO 9001:2008, Quality Management System
- SAE AS/EN/JISQ9100:2009 Revision C
- D6-82479 Appendix A, Advanced Quality Systems
  - Facility certification to Boeing D1-9000 updated in June 2002 to include AS 9100
- MIL-STD-790, Product Assurance Program for Electronic and Fiber Optic Parts Specification
- MIL-PRF-28750, Qualified Products List - Solid State Relay
- DOD DMEA (Defense Microelectronics Activity) Microelectronics Trusted Source