Optoelectronics

Products, Packaging & Engineering Services
Teledyne Ruggedized Optical Devices

- **International Space Station**
  - 125 Mbps, FDDI suite of devices
  - All data-audio-video communications go thru Teledyne devices

- **F22**
  - 500 Mbps, MM Fiber
  - Very Low Profile (0.140”)
  - Over 15,000 devices to date
  - 52 Tx & 53 Rx per aircraft

- **F35, Joint Strike Fighter**
  - 2.5 Gbps per Channel, MM fiber
  - Miniature footprint (1” x 1” x 0.200”)
  - Over 5,000 devices to date
  - 55 Quad Transceivers per aircraft
Optical Networking

Push the envelope in next generation optical networks

Optical Routers & Transponders
- OC768, 16 channels
- Multiple rates to 44 Gbps
- Highly integrated single chip modules
- High frequency and noise isolation
- Solder bump flip chip
- High Temperature Co-fired Ceramic (HTCC)
- BGA substrate
- Utilizing stripline and microstrip provisions

TOSA/ROSA
- Up to 11 Gbps & 80 Km
- TDM & DWDM, 1550 nm
- Sonet/SDH, Ethernet
- High speed gain chip
- Planar wave guide
Application Experience

- 2 Gbps Quad Channel Transceiver
- 10 Gbps Receiver
- 10 Gbps TOSA
- Wavelength locked light source
- MEMS mirror array (n x n) optical switch
- Laser Pump Module for Raman Amplifier
- Tunable wavelength laser source
- DWDM Tx/Rx
- Mach-Zehnder waveguide modulator
- High power laser sources (up to 10W)
- MEMS HUD
- MEMS F-P interferometer based navigation grade accelerometer
- Fiber Bragg grating array for optical gain control
- Fiber optic pressure sensors
Optoelectronics Advanced Design & Packaging
Ruggedized Fiber Optics Transmitters, Receivers and Transceivers

Custom Design & Packaging
- High Reliability
- Hermetic
- MIL-PRF-38534 Class H

Standard Devices
- Up to 4.25 Gbps, -40°C to +95°C, soon 105°C
- High Reliability Industrial Packaging & Components
- Extended shock and vibration, moisture resistant
- Standard connector interface: LC/MT/FC and others
- Single mode, Multimode, Ethernet, Duplex, Multiplex

8 Optical Rx & Tx
500 Mbps, 1.5” x 1” x 0.15” ea

Quad Optical Transceiver
2.5 Gbps per channel, 1” x 1” x 0.2”

SFF: 1.9” x 0.5”
MINI: 0.8” x 0.5”
Micro Form Factor (MFF): 0.375” x 0.375”
Teledyne Optical Device Roadmap

- **Phase 1: Currently available**
  - TX004-SFF: 4.25 Gbps SFF MM Dual Transmitter
  - RX004-SFF: 4.25 Gbps SFF MM Dual Receiver
  - TR004-SFF: 4.25 Gbps SFF MM Transceiver
  - TR004-MINI: 4.25 Gbps MM Transceiver
  - TX004-MFF: 4.25 Gbps MFF MM Transmitter
  - RX004-MFF: 4.25 Gbps MFF MM Receiver
  - TXSM4-MFF: 4.25 Gbps MFF SM Transmitter
  - RXSM4-MFF: 4.25 Gbps MFF SM Receiver

- **Phase 2: 10 Gbps**
  - Moisture resistant
  - MINI, MFF

- **Phase 3: 4.25 & 10 Gbps**
  - Hermetically sealed
  - MINI, MFF

- **Phase 4: 4.25 & 10 Gbps Arrays**
  - 4 to 8 channels per device

- **Phase 5: Space Qualified Transceivers**
Nano/MicroTechnology
Comprehensive Design Tools

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

● Processes
  – Alignment, single and multi-mode fiber
  – Fusion splicing regular and PM fibers
  – Multi-channel fiber (array)
  – Alignment for high power (up to 10 W)
  – Hermetically sealed fiber packaging
    • Single fiber and multi-fiber array
    • In-house fiber metallization
  – V-Groove fabrication (2 Ch – 128 Ch)
  – Optical bench fabrication
  – Single and Multi-mode fiber tip lensing
  – Multiple fiber termination technologies
  – Beam profile characterization

● Optical Design and Analysis
  – Optical Modeling
    • Near field (BeamProp)
    • Free-space (ZEMAX)

● Fiber Lensing
  • Micro-lens array
  • Fiber tip lens (SM&MM)
  • Free-space collimation and focusing
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
Substrate Capabilities

- Thin Film Ceramic
  - Nickel & Gold Plating
  - Nichrome, TaN, Gold & TiW 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
Enabling Manufacturing Technologies

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

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

Packaging & Testing:
- Cover Seal
- Encapsulation
- Test Systems
Process Validation & 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

XRF (X-Ray Fluorescence) Tester
Fiber Optics Test Stations
Automatic Alignment Station

6 degrees of freedom alignment station
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
Teledyne Solution

- Defense, Aviation, Space, and Ruggedized Industrial
  - Requires high performance fiber optic devices
  - Increased data rates, small size, EMI immunity, ease of scalability, lightweight

- Existing Standard Commercial Fiber Optic Suppliers
  - Devices do not meet ruggedized environmental requirements
  - Not willing to provide custom devices

- Teledyne fills the need
  - HRIP design for ruggedized applications
  - Long history with optical devices in these markets
Teledyne

Aerospace & Defense

Circuit Modeling

Industrial

Analysis & Simulation

Assembly & Test

RF/Microwave & Optoelectronics

Design

Full service microelectronics manufacturing

Medical