



Optoelectronics

Products, Packaging & Engineering Services

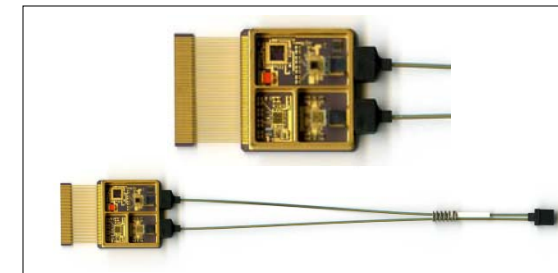
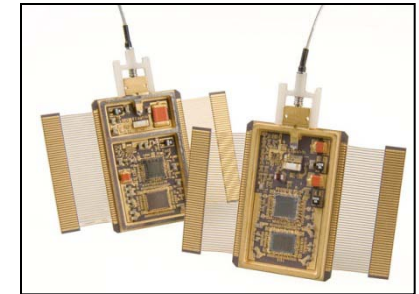
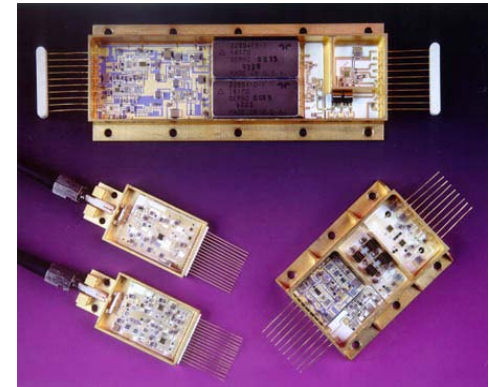
COMPANY PROPRIETARY

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Export
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Teledyne Ruggedized Optical Devices

Prototype to full scale production of complex, mixed technology and miniaturized assemblies

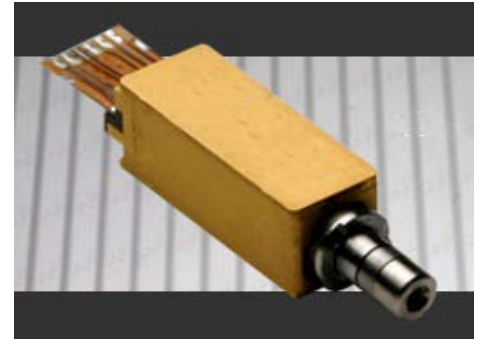
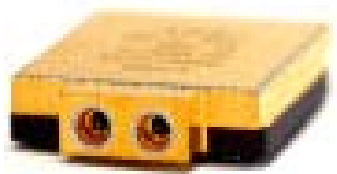
- ◆ International Space Station
 - 125 Mbps, FDDI suite of devices
 - All data-audio-video communications go thru Teledyne devices
- ◆ F22
 - 500 Mbps, MM Fiber
 - Very Low Profile (0.140")
 - Over 15,000 devices to date
 - 52 Tx & 53 Rx per aircraft
- ◆ F35, Joint Strike Fighter
 - 2.5 Gbps per Channel, MM fiber
 - Miniature footprint (1" x 1" x 0.200")
 - Over 5,000 devices to date
 - 55 Quad Transceivers per aircraft



Optical Networking

Prototype to full scale production of complex, mixed technology and miniaturized assemblies

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

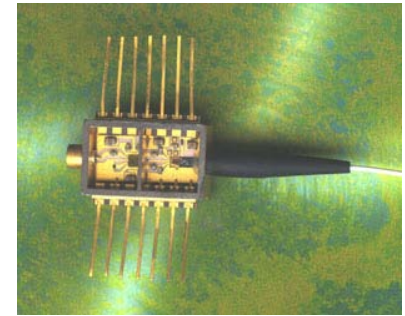
TOSA/ROSA

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

Application Experience

Prototype to full scale production of complex, mixed technology and miniaturized assemblies

- ◆ 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

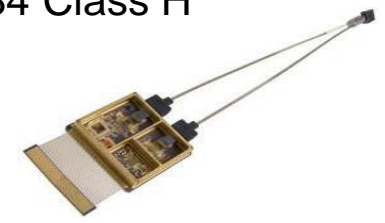
Prototype to full scale production of complex, mixed technology and miniaturized assemblies

- ◆ Custom Ruggedized Fiber Optics RX, TX and XCVRs
 - High Reliability, Hermetic, MIL-PRF-38534 Class H



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"

- ◆ Standard Ruggedized Fiber Optic RX, TX and XCVRs



SFF: 1.9" x 0.5"



MINI: 0.8" x 0.5"



Chip-Scale: 0.375" x 0.375"

- 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
- SM, MM, Ethernet, Duplex, Multiplex

Teledyne Optical Device Roadmap

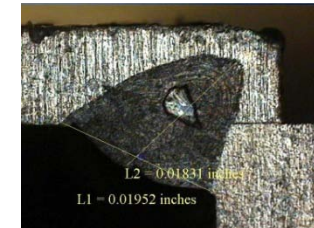
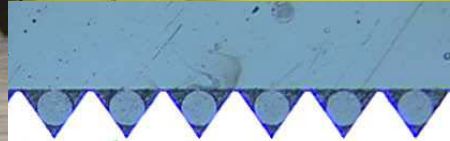
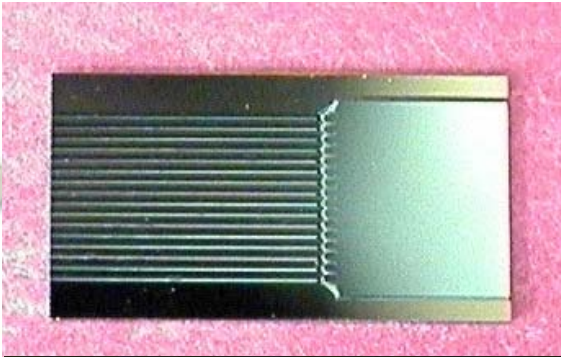
Prototype to full scale production of complex, mixed technology and miniaturized assemblies

- ◆ Phase 1: Currently available
 - TX004-SFF: 4.25 Gbps SFF Dual Transmitter
 - RX004-SFF: 4.25 Gbps SFF Dual Receiver
 - TR004-SFF: 4.25 Gbps SFF Transceiver
 - TR004-MINI: 4.25 Gbps VSFF Transceiver
 - TX004-CSP: 4.25 Gbps CSP Transmitter
 - RX004-CSP: 4.25 Gbps CSP Receiver
- ◆ Phase 2: 10 Gbps
 - Moisture resistant
 - MINI, CSP
- ◆ Phase 3: 4.25 & 10 Gbps
 - Hermetically sealed
 - MINI, CSP
- ◆ Phase 4: 4.25 & 10 Gbps Arrays
 - 4 to 8 channels per device
- ◆ Phase 5: Space Qualified Transceivers



Nano/MicroTechnology

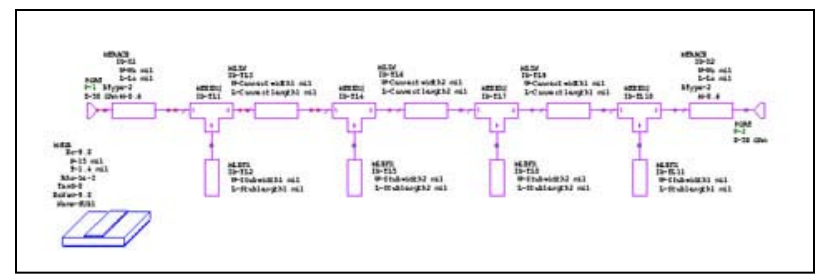
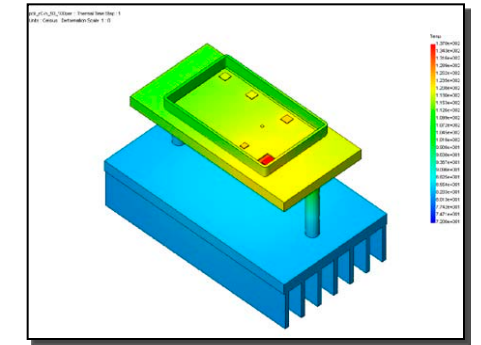
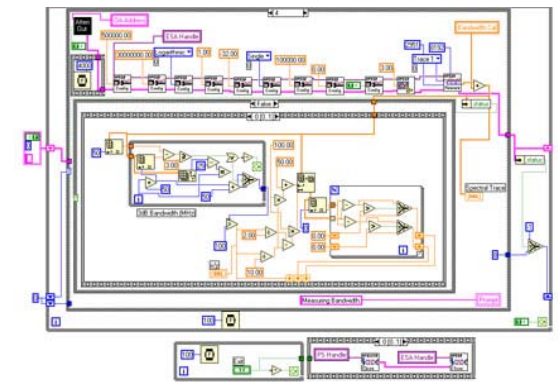
Prototype to full scale production of complex, mixed technology and miniaturized assemblies



Comprehensive Design Tools

Prototype to full scale production of complex, mixed technology and miniaturized assemblies

- ◆ 2D Microwave - EEsof, Microwave Office
- ◆ 3D Microwave - Ansoft, HFSS
- ◆ Photonic Design and Simulation
 - Zemax – Far Field Optics
 - RSoft – Near Field Optics
- ◆ Pro Engineering, Pro Mechanical, 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

Prototype to full scale production of complex, mixed technology and miniaturized assemblies

◆ Processes

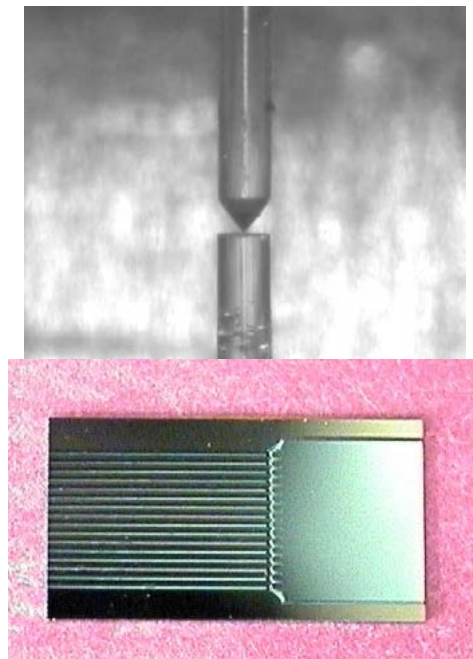
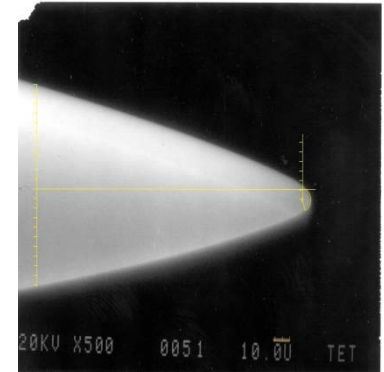
- Alignment, single and multi-mode fiber
- Fusion splicing regular and PM fibers
- Multi-channel fiber (array)
- Alignment for high power (up to 10 W)
- Hermetically sealed fiber packaging
 - Single fiber and multi-fiber array
 - In-house fiber metallization
- V-Groove fabrication (2 Ch – 128 Ch)
- Optical 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

Prototype to full scale production of complex, mixed technology and miniaturized assemblies

◆ Substrates

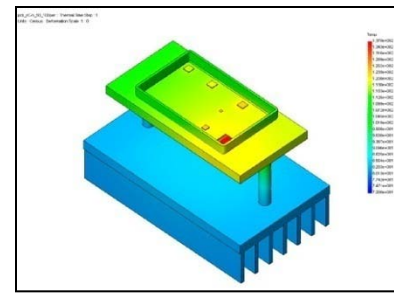
- Ceramics
 - Al₂O₃, BeO, AlN
 - Multi-layer thick film
 - ◆ Standard
 - ◆ Photo-etchable
 - ◆ High Frequency
 - Single-layer thin film
 - Cofired (LTCC, HTCC)
- Laminates
 - FR-4
 - Polyimide
 - Rigid-Flex
 - Insulated Metal
 - Proprietary High Tg

◆ 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

Prototype to full scale production of complex, mixed technology and miniaturized assemblies

- ◆ 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

Prototype to full scale production of complex, mixed technology and miniaturized assemblies

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

Prototype to full scale production of complex, mixed technology and miniaturized assemblies



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



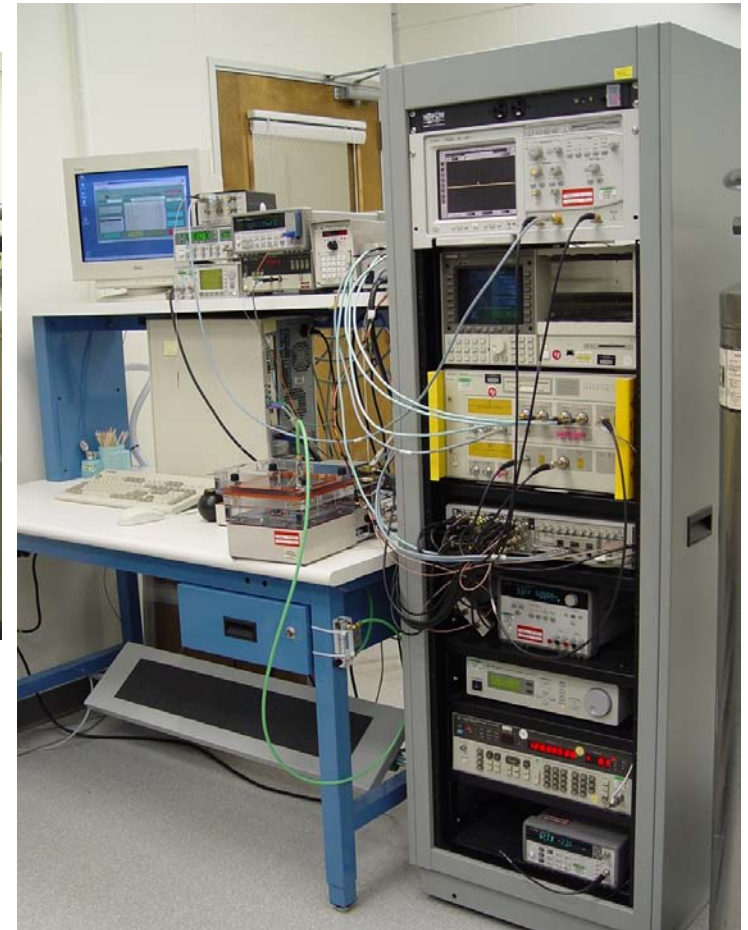
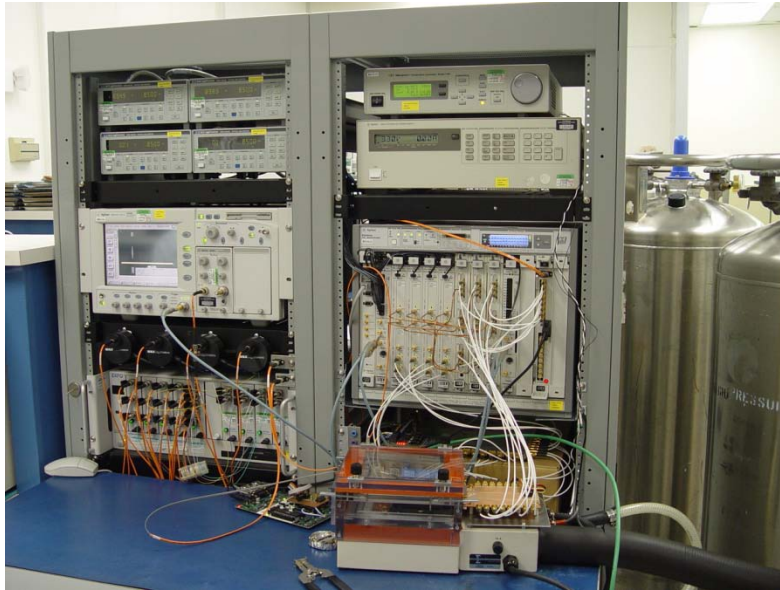
Mechanical Shock



XRF (X-Ray Fluorescence) Tester

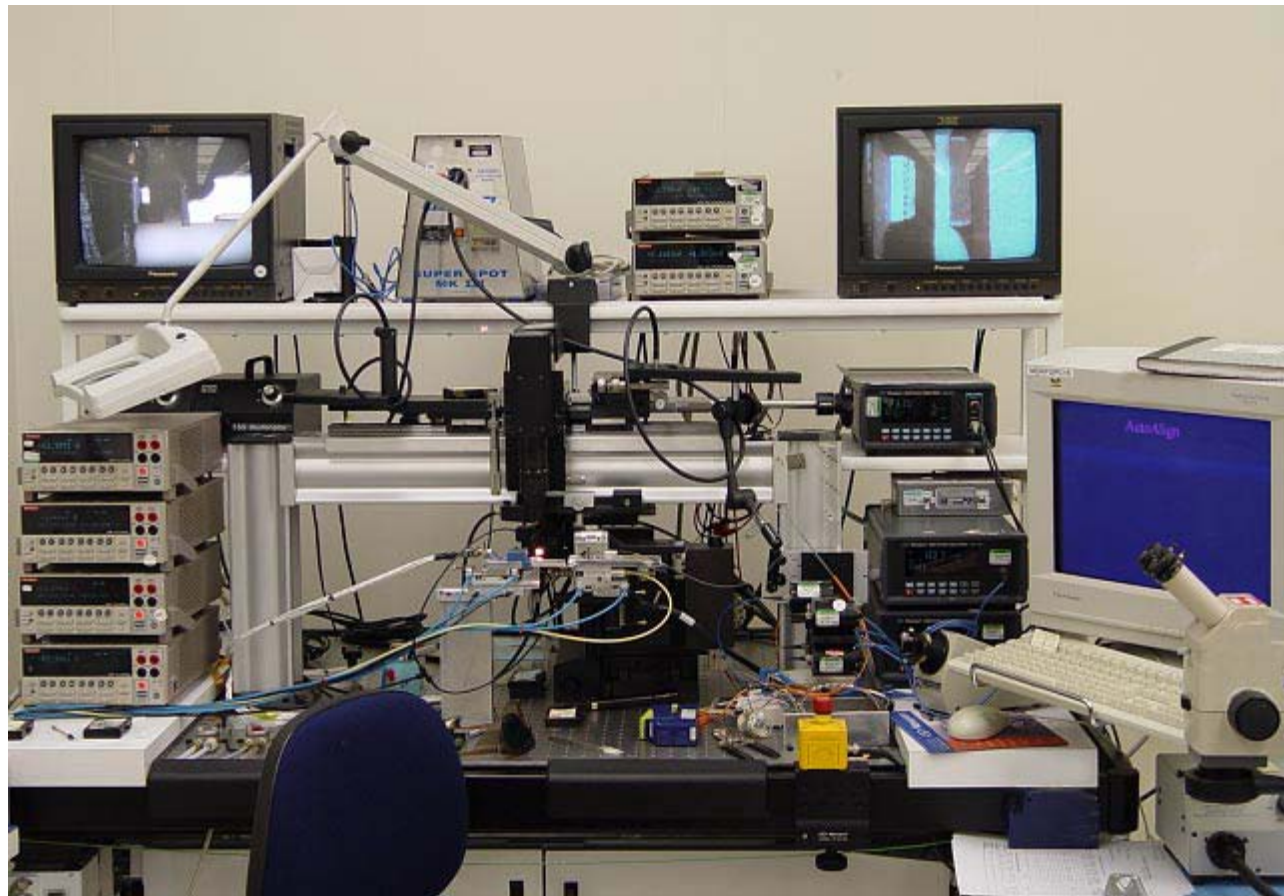
Fiber Optics Test Stations

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Automatic Alignment Station

Prototype to full scale production of complex, mixed technology and miniaturized assemblies



6 degrees of freedom alignment station

Certifications and Qualifications

Prototype to full scale production of complex, mixed technology and miniaturized assemblies

- ◆ 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 9100 Revision B/Section 1
- ◆ 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

Prototype to full scale production of complex, mixed technology and miniaturized assemblies

- ◆ 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 Microelectronic Technologies

Prototype to full scale production of complex, mixed technology and miniaturized assemblies



Teledyne	Assembly & Test	Medical
Aerospace & Defense Circuit Modeling	RF/Microwave & Optoelectronics	Design
Analysis & Simulation	Industrial	full service microelectronics manufacturing