TELEDYNE
MICROELECTRONIC TECHNOLOGIES
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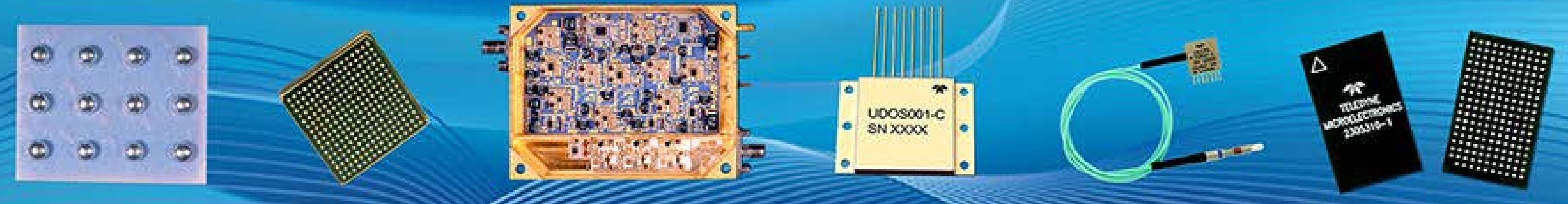
Teledyne Microelectronic Technologies



1425 Higgs Road, Lewisburg, TN 37091 | 931.359.4531 | microelectronics@teledyne.com | teledynemicro.com

TELEDYNE ADVANCED ELECTRONIC SOLUTIONS
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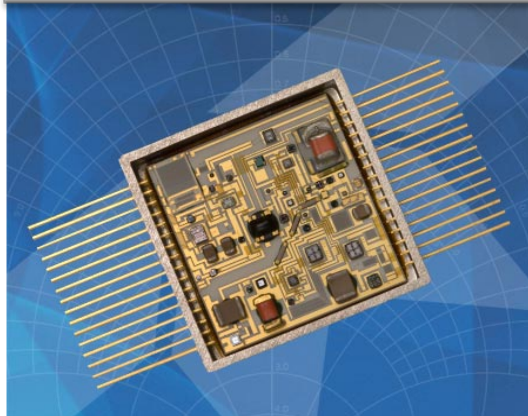
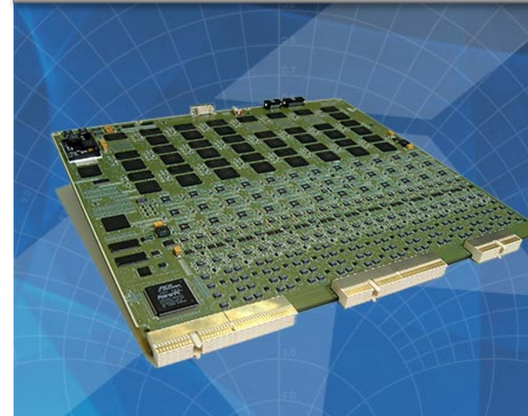
Teledyne Advanced Electronic Solutions



Microelectronic Hybrid Manufacture/Test



Complex Circuit Card Module and Box Assembly Manufacture/Test

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Teledyne Microelectronics Overview

- Established in 1964
  - Lewisburg, Tennessee
- From prototype to production
  - Enhance design for manufacturability
  - Miniaturize size and reduce weight
  - Improve performance and reliability
  - Comprehensive testing and screening
  - Obsolescence management
- Microelectronics Trusted Source
  - Packaging, Assembly and Test Services
  - DoD Accredited to
    - Mission Assurance Category 1
    - Trusted Category 1A

ACCREDITATION OF TRUST

Microelectronics Trusted Source
CATEGORY 1A

By these presents the undersigned expresses the confidence of the Department of Defense, Defense Microelectronics Activity (DMEA) in the ability of the organization known as

Teledyne Microelectronic Technologies

to deliver trusted foundry microelectronic goods and services to end users within the United States Government that correspond to Trusted Category 1A which meets Mission Assurance Category 1 as defined by Instruction 8500.2 of the Department of Defense Directives, effective this date.

108	16170	11 Jan 2012	11 Jan 2014	Ted Glum
Site Accreditation Number	Cage Code	Effective Date	Renewal Date	Director, Defense Microelectronics Activity

TELEDYNE
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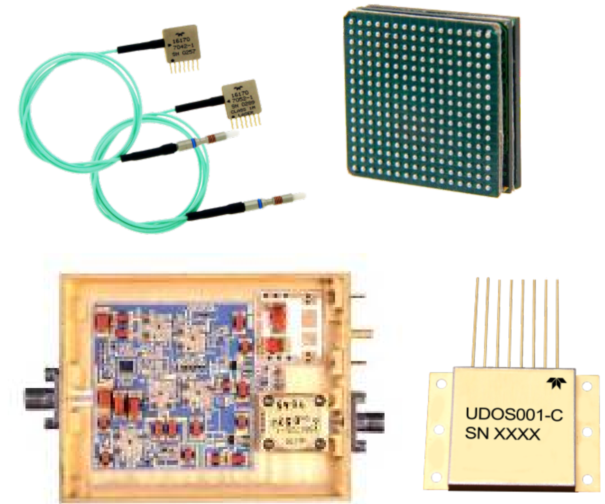
Teledyne Microelectronics Capabilities

- Microelectronic Packaging & Products
  - COTS to Class K
  - Prototypes to fully qualified production
- Technologies
  - RF & Microwave
  - Optoelectronics
  - High Speed Digital and Mixed Signal
  - Secure Communications
- Markets
  - Defense (Class H certified)
  - Avionics
  - Space (Class K certified)
  - Secure Communications
  - Ruggedized Industrial



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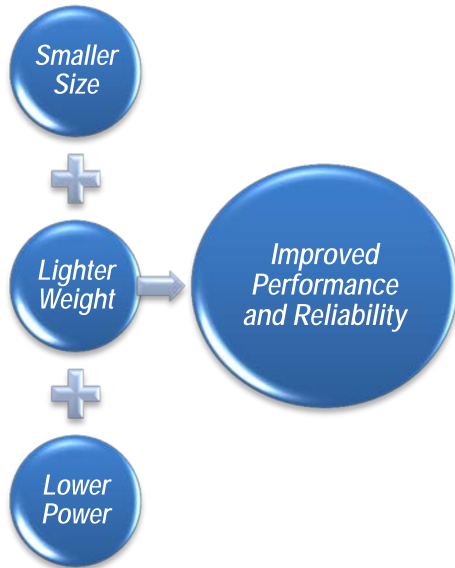
Major Customers & Technologies



Mixed Signal

- Boeing
- DRS
- Goodrich
- Exelis
- L-3 Communications
- Maxwell
- Northrop Grumman
- Raytheon
- Semtech
- St. Jude

RF/Microwave

- Boeing
- Comtech PST
- Exelis
- L-3 Communications
- Lockheed Martin
- National Instruments
- Raytheon
- Rockwell Collins
- Semtech

Optoelectronics

- Boeing
- Goodrich ISR
- Harris
- Honeywell
- L-3 Communications
- Raytheon
- RIO
- Rockwell Collins

Secure Communications

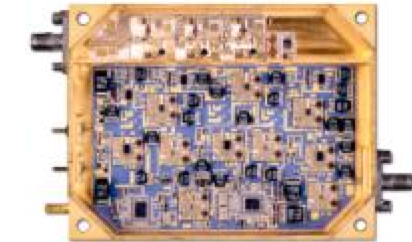
- BAE Systems
- Boeing
- Exelis
- L-3 Communications
- NSA (MPO)
- Raytheon
- SafeNet
- Sandia
- SPAWAR
- Trimble
- VIASAT

Space

- Aerojet
- Astrium
- Boeing
- Harris
- Exelis
- JPL
- L-3 Communications
- Lockheed Martin
- Moog
- Northrop Grumman

RF & Microwave Technologies

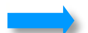
- Housing: Aluminum LTCC, Kovar
- GPPO, GPO, SMA connectors
- Substrates/Laminates
  - Thick/thin film microstrip, stripline, coplanar
  - LTCC, PTFE (Teflon), Rogers, FR4 with embedded Rogers
  - Multiple substrate construction: thick film substrate with thin film daughter boards
- Active or passive laser trim
- Surface mount assembly (mixed mode)
- Die Attach
  - Eutectic
  - Epoxy
  - Flip chip
- Wire Bonding
  - 0.7, 1 mil gold
  - Manual ribbon
- Microwave, thermal/mechanical modeling analysis and simulation
- Testing to 65 GHz



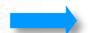
Optoelectronics Advanced Design & Packaging

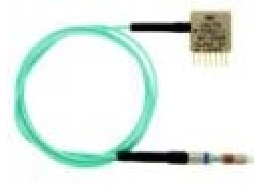
- Standard Ruggedized Fiber Optic RX, TX and XCVRs
  - Up to 10 Gbps, -40°C to +95°C, soon 105°C
  - High Reliability Industrial Packaging & Components
  - Extended shock and vibration, moisture resistant
  - Standard connector interface: LC/MT/FC and others
  - SM, MM, Ethernet, Duplex, Multiplex

SFF: 1.9" x 0.5"



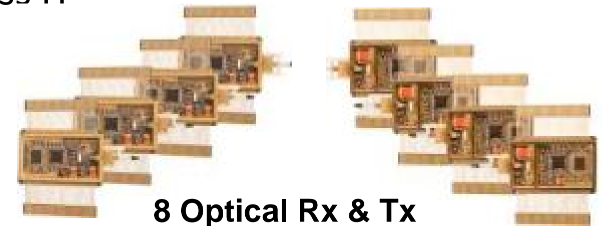
MINI: 0.8" x 0.5"



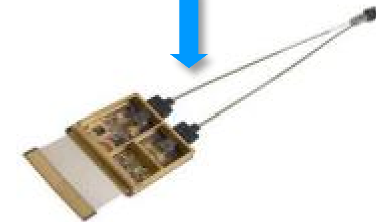


Chip-Scale: 0.375" x 0.375"

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



8 Optical Rx & Tx
- 500 Mbps
- 1.5" x1"x 0.15" ea



Quad Optical Transceiver
- 2.5 Gbps per channel
- 1" x 1" x 0.2"

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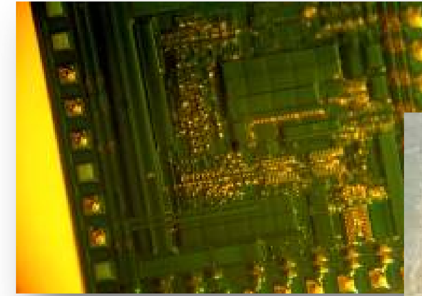
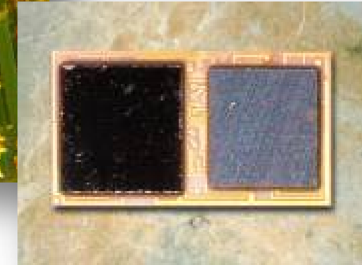
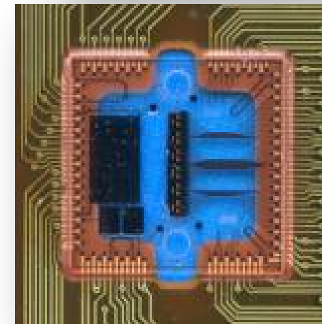
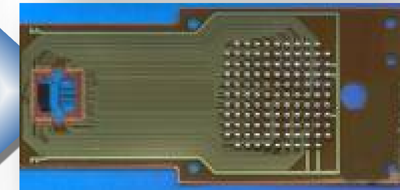
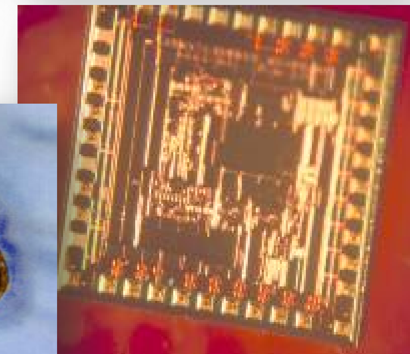
Teledyne Flip Chip Technologies

- Flip Chip
  - Solder FC Technology
  - Diffusive FC Technologies
  - Conductive Adhesive FC
  - Copper Pillar FC
- Substrate Materials
  - Si on Alumina/Organic/Flex
  - GaAs on Alumina/Si/ Sapphire
- Processes
  - Non conductive adhesive
  - Re-flow/localized re-flow
  - Thermocompression
  - Thermosonic
- Equipment
  - 2 Panasonic FCBII machines
  - Delvotec 6200 wirebonder
  - MRSI pick & place
  - Delvotec automatic die bonder
  - Okamoto 8” wafer dicing saw
  - Underfill dispenser Sonoscan
  - High Resolution Real-Time X-ray



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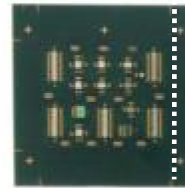
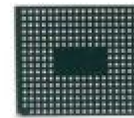
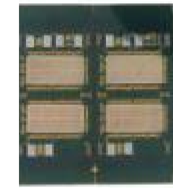
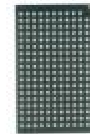
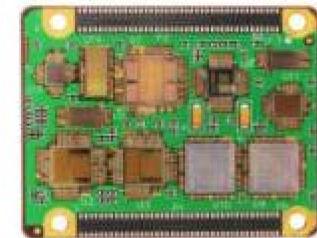
Mixed SMT with Chip-n-Wire

- Multi-Chip Modules on Laminate
  - Defense, Industrial, Space Applications
- Developed custom Qualification Profile
- Preconditioning per JESD22-A113B (to JEDEC Level 3)
  - Encapsulation examination with Sonoscan
  - Bake out: 24 hours at 125°C, unbiased
  - Humidity soak: 192 hours at 30°C and 60% relative humidity, unbiased
- 84 hour High-pressure Steam Autoclave per JESD22-A102C
  - Temperature: 121°C
  - Relative humidity: 100%
  - Vapor pressure: 29.7 psia
- Temperature Cycling per JESD22-A104B
  - Temperature range: –55°C to +150°C
  - Cycles: 500
  - Transition rate: 10°C/minute
  - Soak time at extremes: 5 minutes
- 44 hour Highly-Accelerated Stress Test (HAST) per JESD22-A110B
  - Temperature: 130°C
  - Relative humidity: 85%
  - Vapor pressure: 29.7 psia



Defense Mixed Technology SMT and Wirebonding

Space Mixed Technology SMT and Wirebonding

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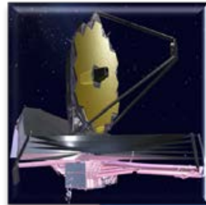
Pioneers in Space

Spacecraft

- ISSI
- Voyager
- Viking
- Mars Observer
- Galileo
- Susei
- Magellan
- Giotto
- MESUR
- Ulysses
- Spacelab
- Sakigake
- Cassini
- Hugyens
- Clementine
- GLAST
- Hubble Space Telescope
- James Webb Space Telescope
- Mars Global Surveyor
- Mars Science Laboratory



Satellite

- Tiros
- DOT
- ANIK
- INTELSAT
- Galaxy
- Palapa
- ERS
- Westar
- Brazilsat
- SBS
- GOES
- DRIRU
- OAO
- Landsat
- Solarmax
- Globalstar
- HS601/701
- Spaceway
- Satcom4000/5000

Launch & Reentry Vehicles

- Titan
- Delta
- IUS
- Centaur
- Atlas
- MK12A
- Space Shuttle
- Scout
- MX
- Minuteman
- Trident
- D5

Military Spacecraft

- DSCS
- PMALS
- Milstar
- GPS
- DMS
- PMS
- TDRSS
- PRISM
- Zodiaque
- SDI
- Crosslink
- Classified

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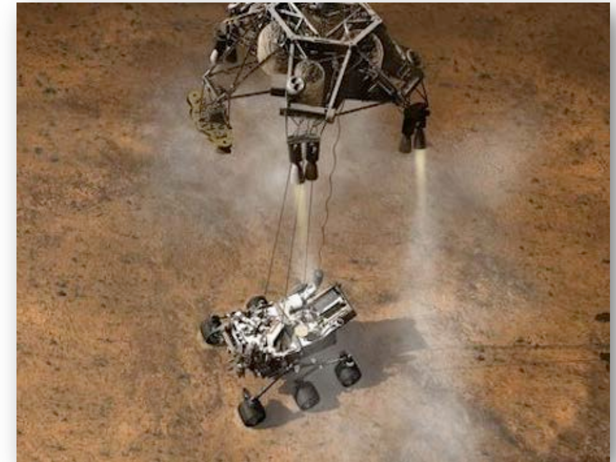
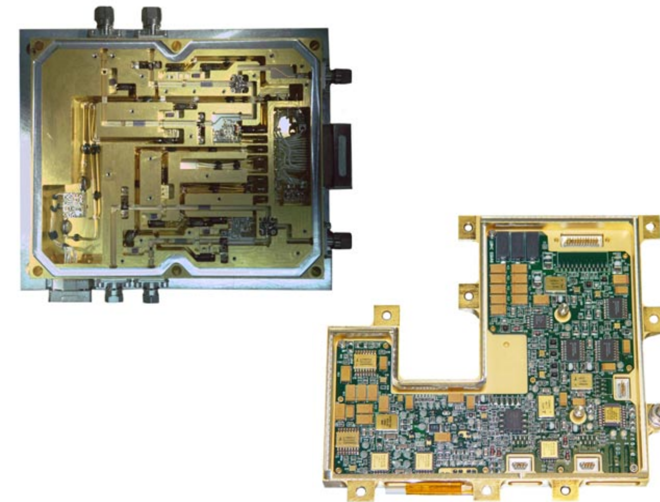
Mars Science Laboratory Curiosity Rover RF Modules

- 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





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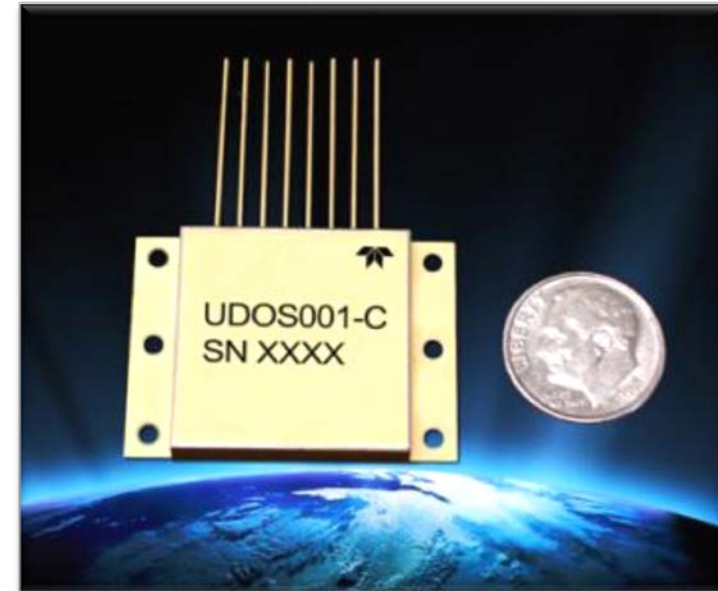
World's Smallest Radiation Dosimeter

- Space, Defense Nuclear and Medical radiation measurement
- Total ionizing dose measurement
- Alert for hazardous conditions or hostile action
- Diagnose anomalies
- Improve system design and life estimates
- Improve future radiation models
- Plug & play connectivity



1.4" x 1.0"
20 grams

COMSEC Modules

- Secure Communications since 1988
  - COMSEC and SAASM products
  - Anti-Tamper Coatings
  - Approved to load Encryption Protection software
- 40+ Customers
  - U.S. Government Agencies
  - Defense & Aerospace OEMs
- GPS SAASM Module
- CDH Cryptographic Hybrid
- KGV-68B Cryptographic MCM
- EPLRS Cornfield Cryptographic MCM
- 50,000+ complex MCM's shipped

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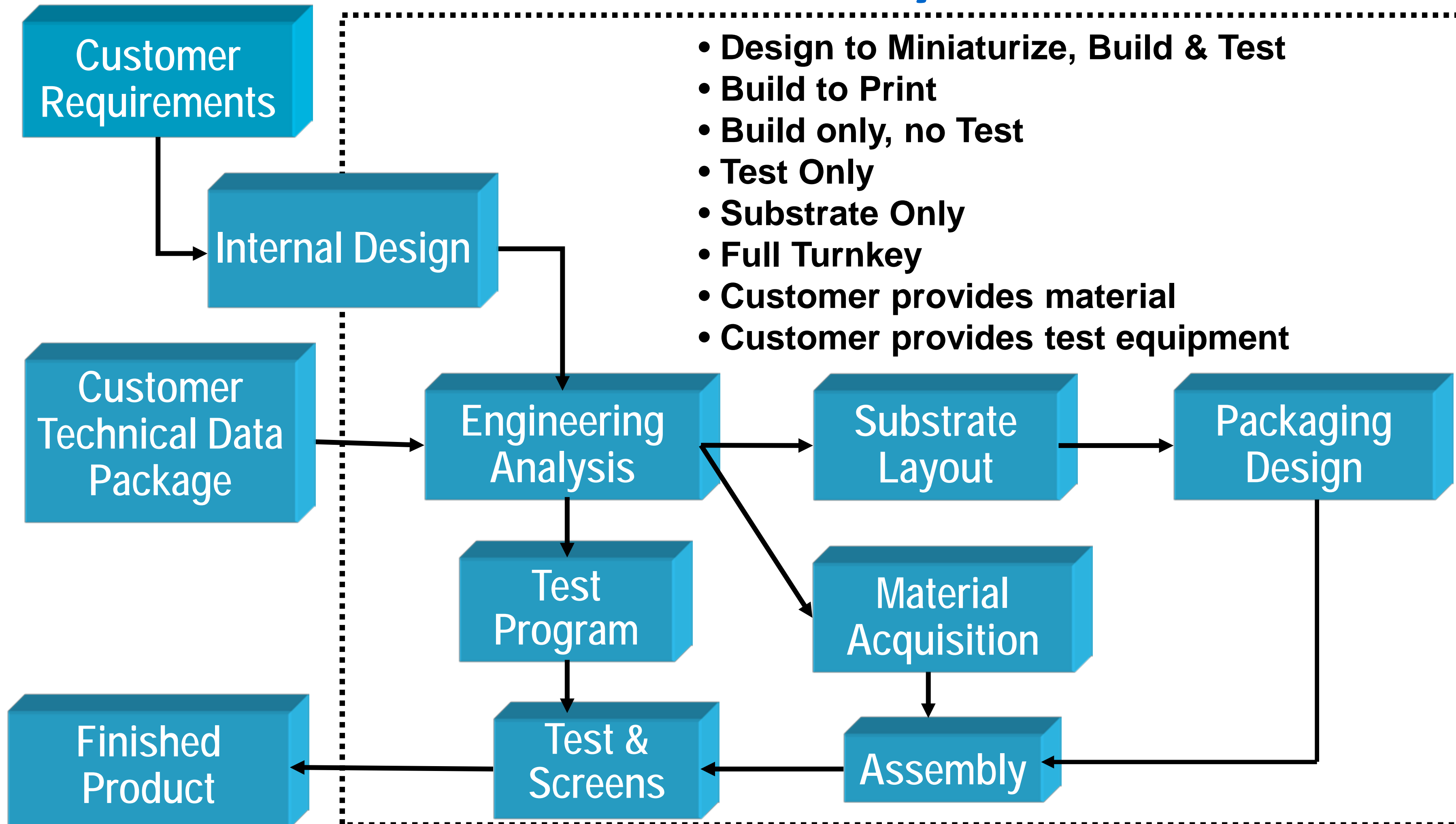
A to Z Flexibility



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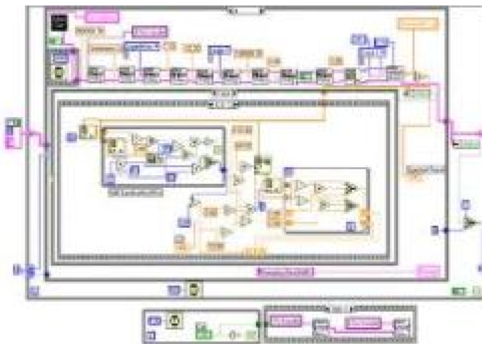
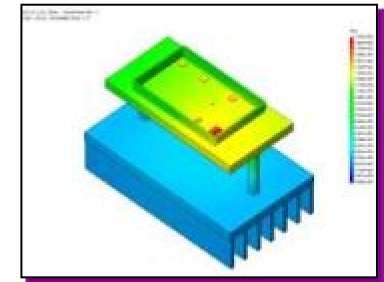
Design Tools

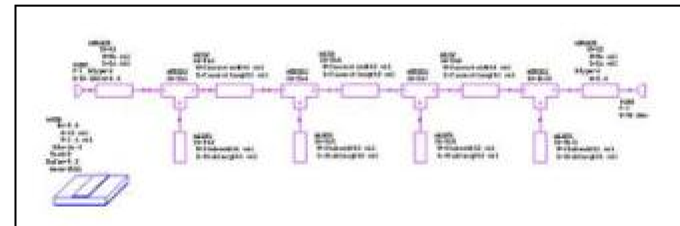
- 2D Microwave - EEsof, Microwave Office
- 3D Microwave - Ansoft, HFSS
- Photonic Design and Simulation
  - Zemax – Far Field Optics
  - RSoft – Near Field Optics
- Mentor Graphics MCM Station
  - Schematic Capture
  - Autorouting
  - High Speed/Crosstalk Analysis
  - Idea - Schematic Capture, Digital 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



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Substrate Technologies

- Laminates
  - FR4
  - Polyimide
  - Rigid-Flex
  - Insulated Metal
  - Proprietary High Tg (BT, BN)
  - PTFE (Teflon, Rogers™)
- Thick Film
  - Au/Ag on Al2O3, BeO, AlN
  - Diffusion Patterning™, Fodel®, Etchable
  - 2”x2” wafers standard (up to 6.5”)
  - 0.002” lines/spaces
  - Integral resistors and capacitors
  - Hi-frequency process ≥ 20 (40) GHz
- Thin Film
  - Ti-W, Au, Ni, NiCr, TaN on Al2O3, BeO, AlN
  - Thermal evaporation and sputter deposition
  - 2”x2” wafers
  - 0.001” (0.0006) lines/0.0005” spaces
  - 50-200 ohms/sq.
- LTCC
  - Ferro
  - DuPont
- HTCC

TELEDYNE
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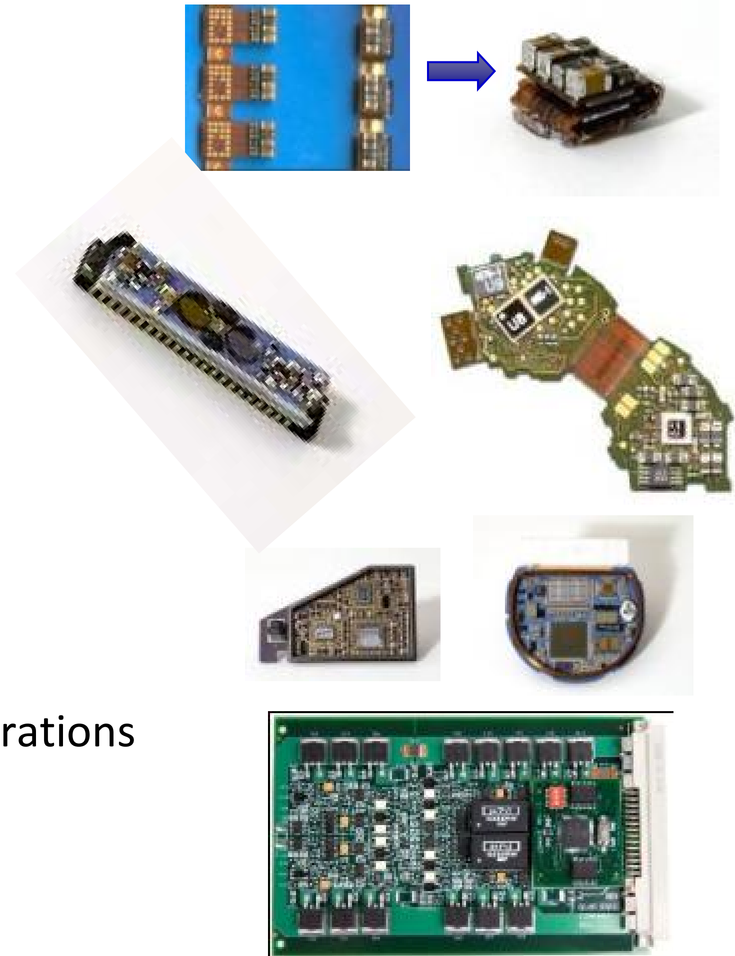
Surface Mount Packaging

- Market Focus
  - Mixed Technology on a single circuit
    - SMT, Chip-n-Wire, Flip-Chip BGA
  - Multiple substrates
    - Laminate, Rigid-Flex, Ceramic
  - Low to mid-range volume
    - up to 25K circuits per month
  - High level of Traceability
    - Trusted Source
  - High Reliability
- Up to 18” x 18” panels
- Up to 8,000 modules per month
- Simultaneous board placement of different configurations
- 010-005 up to 55 mm^2 component sizes
- Fine pitch, down to 15 mil
- Offline set up & programming



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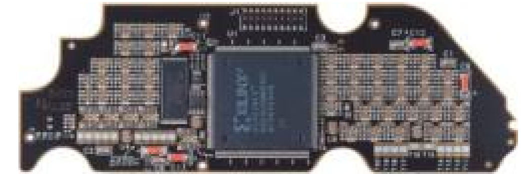
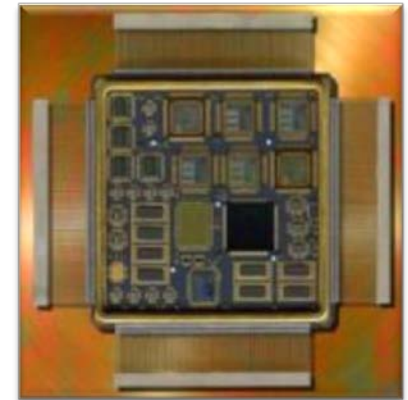
Mixed Signal/Mixed Assembly Technologies





- Combined chip & wire and SMT assembly
- High density substrates/laminates
  - Thick/thin film microstrip, stripline, coplanar
  - LTCC, FR4, PTFE, Rogers materials
  - Multiple substrate construction
- Automated SMT assembly
  - Solder and epoxy dispense/screening
  - High speed pick & place
    - Siemens D1 (010-005 and larger)
    - Mydata My12E (0201's and larger)
  - Solder reflow: 5 zone Vitronics system
  - Aqueous cleaning
  - Over 200,000 components per day/single shift
- Advanced thermal/mechanical modeling analysis and simulation
- High speed functional, parametric and dynamic testing

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Manufacturing Technologies

Microelectronic Interconnection:

Dispensing

Die Attach

Wire Bonding

Flip Chip

SMT:

Stenciling/Screen Printing

SMT Pick & Place

Solder Reflow

Packaging:

Cover Seal

Encapsulation

TELEDYNE MICROELECTRONIC TECHNOLOGIES
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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

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Test Technologies

VLSI Tester

Multifunction Test Stations

Custom ATE Station

Fiber Optic Test Stations

Fiber Optic Tx/RX Tester

RF Test Bench

Cryptologic Tester

As if someone's life depends on it

Boeing, Airbus

- Avionics
- Environmental Control System
- Fuel Indicator Display
- De-Icing System
- Fuel Management
- Landing Lights
- Power Distribution & Management
- Cargo Handling System
- Landing Gear Control
- Slats & Flaps Control
- Engine Control

F-35, F-22, F-18, F16, F-15, B1B, C17, C130, EFA, Tornado, Rafale, Mirage, Hawk , Harrier

- Cockpit Hatch Controls
- Heads Up Display
- Avionics
- Flight Control Computers
- FO Databus Communications
- EW Systems
- Slats & Flaps Controls
- Landing Gear Computers
- Braking Control System
- Stores Management
- Armament Control
- Power Distribution
- Digital Engine Control Unit
- Oxygen Regeneration System

Apache, Comanche, Seahawk, Blackhawk

- Infrared Night Vision Systems
- Avionics
- Power Distribution & Management
- Armament Control
- Head Mounted Display
- Environmental Control System
- FO Databus Communications
- EW Systems

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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 TECHNOLOGIES
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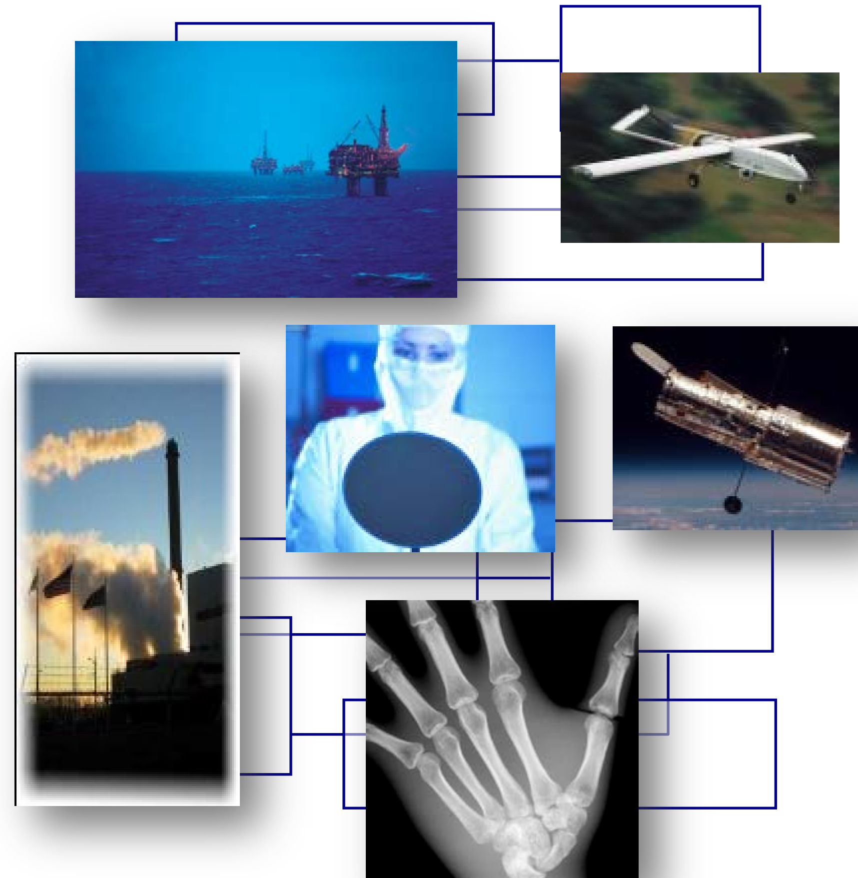
Teledyne Technologies

Enabling Technologies for Industrial Growth Markets

Markets

- Offshore energy & global infrastructure
- Analytical and electronic test & measurement
- Machine vision, imaging and factory automation
- Aircraft information management
- Defense, security and satellite communications



TELEDYNE TECHNOLOGIES
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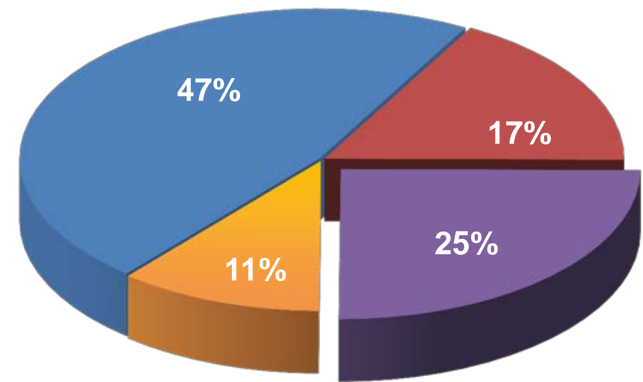
Continuous Growth

($ in millions)

$2,500
2,000
1,500
1,000
500
0

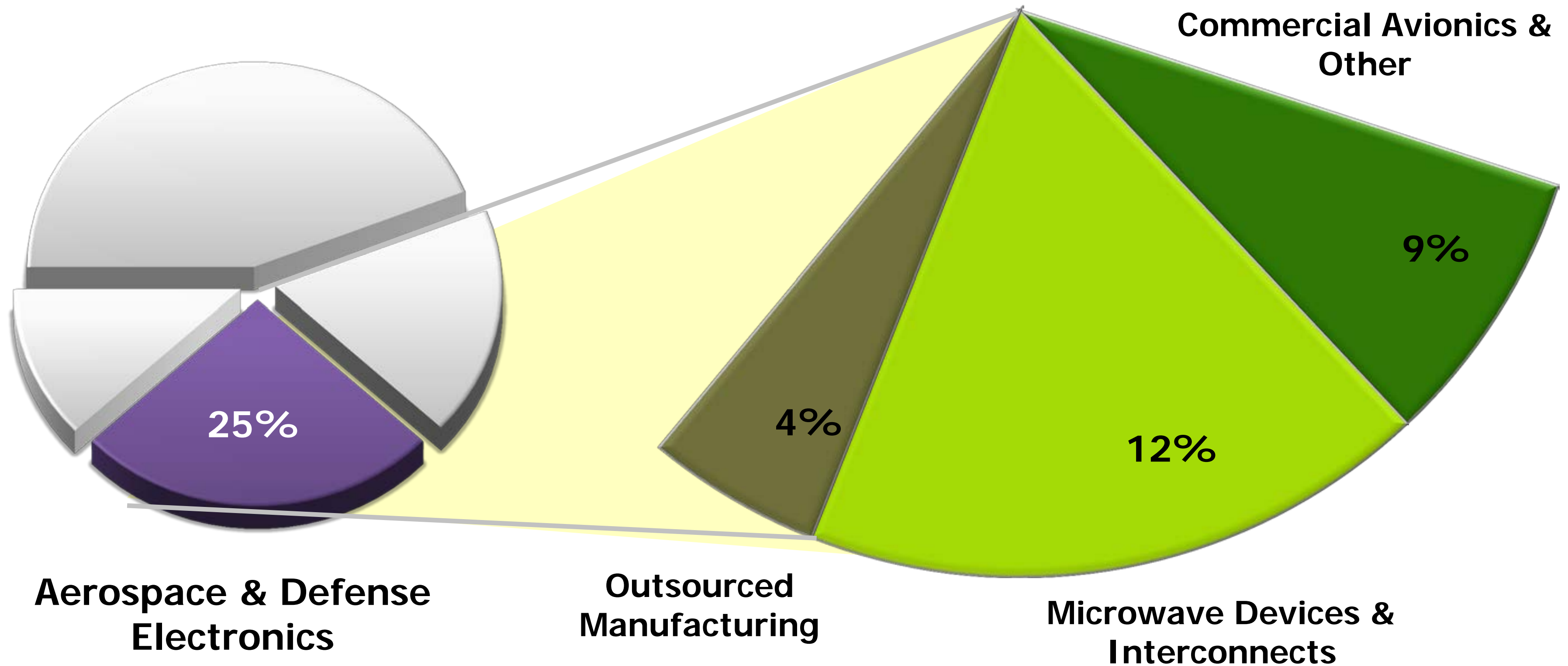
$875 $1,055 $1,252 $1,442 $1,722 $1,652 $1,644 $1,942 $2,127 $2,339 $2,394 $2,298

2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015



- Instrumentation
- Digital Imaging
- Aerospace & Defense Electronics
- Engineered Systems

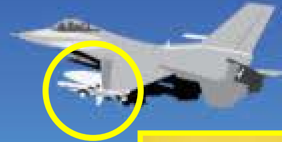
Aerospace & Defense Electronics Markets



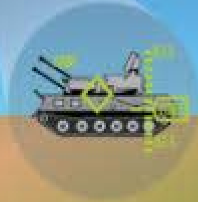
Defense Electronics Products

Infrared Imaging

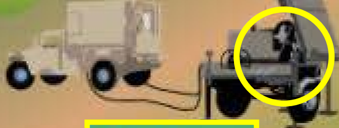
Standoff Jamming



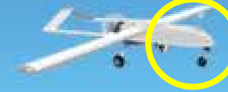
Helmet Mounted Targeting



Battlefield Radar

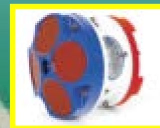


UAV Datalinks

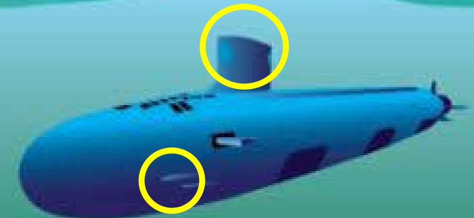


Communication Subsystems

Autonomous Underwater Vehicles (AUVs)



Subsea Interconnects



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TELEDYNE TECHNOLOGIES
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Corporate Headquarters

✪ Teledyne Technologies Incorporated

Defense & Aerospace Electronics

1. Teledyne Coax Switches
2. 3. 4. Teledyne Controls
5. 6. Teledyne Cougar
7. Teledyne Defence Limited
8. Teledyne Electronic Manufacturing Services
9. Teledyne Electronic Safety Products
10. Teledyne Imaging Sensors
11. Teledyne Interconnect Devices
12. Teledyne Judson Technologies
13. Teledyne MEC
14. Teledyne Microelectronic Technologies
15. Teledyne Microwave
16. Teledyne Printed Circuit Technology
17. Teledyne Relays
18. Teledyne Reynolds
19. Teledyne Scientific Company
20. Teledyne Storm Products

Marine Instrumentation

21. Teledyne Benthos
22. Teledyne Geophysical
23. Teledyne RD Instruments
24. Teledyne TSS Limited
25. Teledyne Webb Research

Marine Interconnect

26. Teledyne DG O'Brien
27. Teledyne Impulse
28. ODI
A Teledyne Majority Owned Company

Engineered Systems

29. Teledyne Brown Engineering
30. Teledyne Solutions
31. Teledyne CollaborX

International Manufacturing Facilities

32. Teledyne Limited
33. Teledyne Geophysical Instruments
34. 35. Teledyne Reynolds
36. 37. 38. Teledyne Controls
39. Ensambles de Precisión, S.A. de C.V.

TELEDYNE MICROELECTRONIC TECHNOLOGIES
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