

Teledyne Microelectronic Technologies



Teledyne Microelectronic Technologies

- Microelectronic Packaging & Products

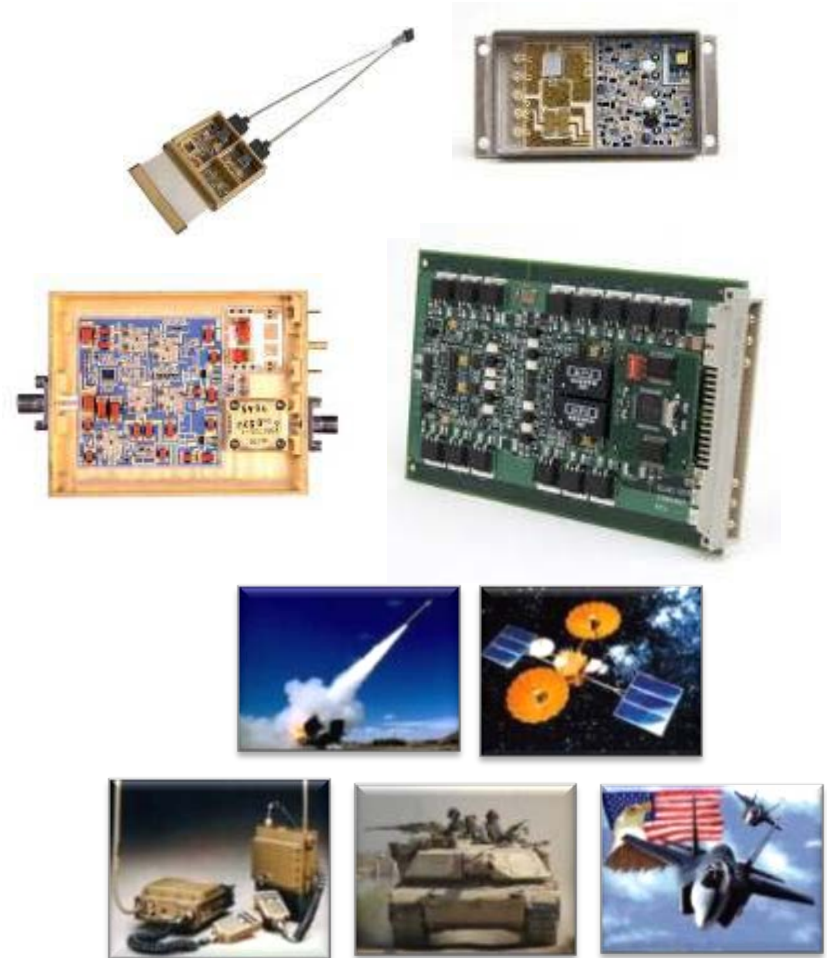
- COTS to Class K
- More than 250,000 single die to multichip packages per year

- Technologies

- RF & Microwave
- Optoelectronics
- Secure Communications
- Power and Mixed Signal
- LED Backlights & Light Engines
- Ultra-high Speed Communications

- Markets

- Defense (Class H certified)
- Avionics
- Space (Class K certified)
- Secure Communications
- Ruggedized Industrial

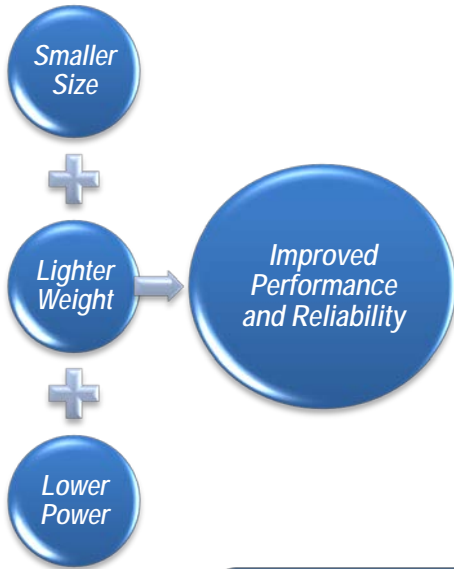


Teledyne Microelectronic Technologies

- World Class Facility, established in 1964
 - Los Angeles, California
 - 126,000 ft.2 total
 - 90,000 ft.2 manufacturing floor (65,000 ft.2. clean room)
- 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

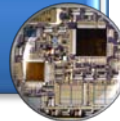


Major Customers & Technologies



- Boeing
- DRS
- Goodrich
- ITT
- L3 Communications
- Maxwell
- Northrop Grumman
- Raytheon
- Semtech
- St. Jude

Mixed Signal



- Boeing
- Comtech PST
- ITT
- L3 Communications
- Lockheed Martin
- National Instruments
- Raytheon
- Rockwell Collins
- Semtech

RF/Microwave



- Boeing
- Goodrich ISR
- Harris
- Honeywell
- L3 Communications
- Raytheon
- RIO
- Rockwell Collins
- Zephyr Photonics

Optoelectronics



- Airbus
- BAE Systems
- Boeing
- Borisch
- Curtiss Wright
- Diehl
- GE Aviation
- Hamilton Sundstrand
- Honeywell
- Lockheed Martin

Power



- BAE Systems
- Boeing
- ITT
- NSA (MPO)
- Raytheon
- SafeNet
- Sandia
- SPAWAR
- Trimble
- VIASAT

Secure Communications



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

Space



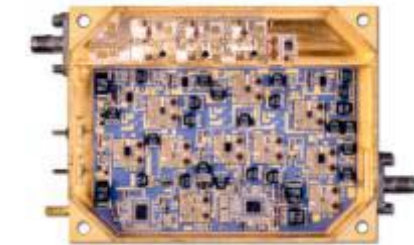
- Fourth Dimension
- Intervac Photonics
- Kopin
- NVIS
- Red Digital Cinema
- Rockwell
- Schott

LED Backlights & Illuminators



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

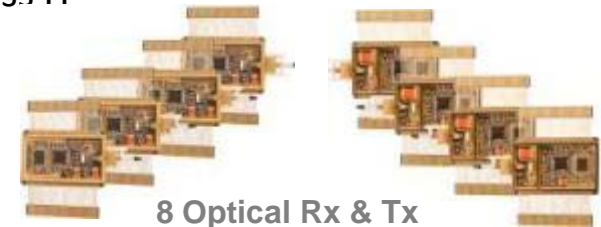
- Standard Ruggedized Fiber Optic RX, TX and XCVRs
 - Up to 10 Gbps, -40°C to +95°C, soon 105°C
 - High Reliability Industrial Packaging & Components
 - Extended shock and vibration, moisture resistant
 - Standard connector interface: LC/MT/FC and others
 - SM, MM, Ethernet, Duplex, Multiplex
- Custom Ruggedized Fiber Optics RX, TX and XCVRs
 - High Reliability, Hermetic, MIL-PRF-38534 Class H



SFF: 1.9" x 0.5"

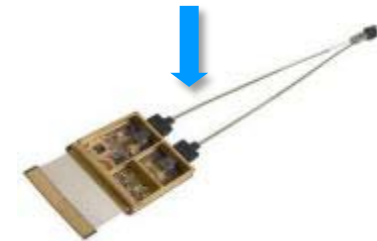
MINI: 0.8" x 0.5"

Chip-Scale: 0.375" x 0.375"



8 Optical Rx & Tx

- 500 Mbps
- 1.5" x 1" x 0.15" ea

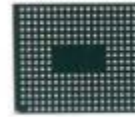
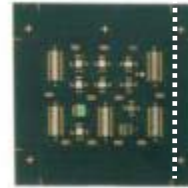


Quad Optical Transceiver

- 2.5 Gbps per channel
- 1" x 1" x 0.2"

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



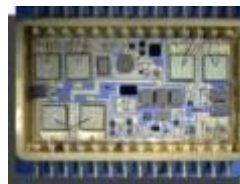
Defense Mixed Technology
SMT and Wirebonding



Space Mixed Technology
SMT and Wirebonding

Solid State Power Modules

- M1A2 Tank
 - DC/DC Converter
 - Up to 50 watts output power
 - EMI filtering
 - Overload, over-under voltage, short circuit protection
 - 16,000+ devices shipped to date
- M2A3 Fighting Vehicle
 - Family of Power Controllers
 - 3,000+ devices shipped to date
- F35, JSF
 - Family of Power Controllers
 - 16,000+ controllers will be required
- Solid State Relays & Power Devices
 - Shipping 12,000+ per month
- Quad SSPC Card



Single, Hermetic
SSPC



Quad SSPCs
On VME Card



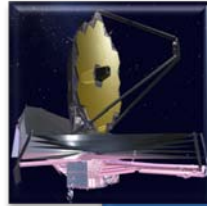
Power Distribution
& Control Chassis

Pioneers in Space



Spacecraft

- ISSI
- Voyager
- Viking
- Mars Observer
- Galileo
- Susei
- Magellan
- Giotto
- MESUR
- Ulysses
- Spacelab
- Sakigake
- Cassini
- Huygens
- 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

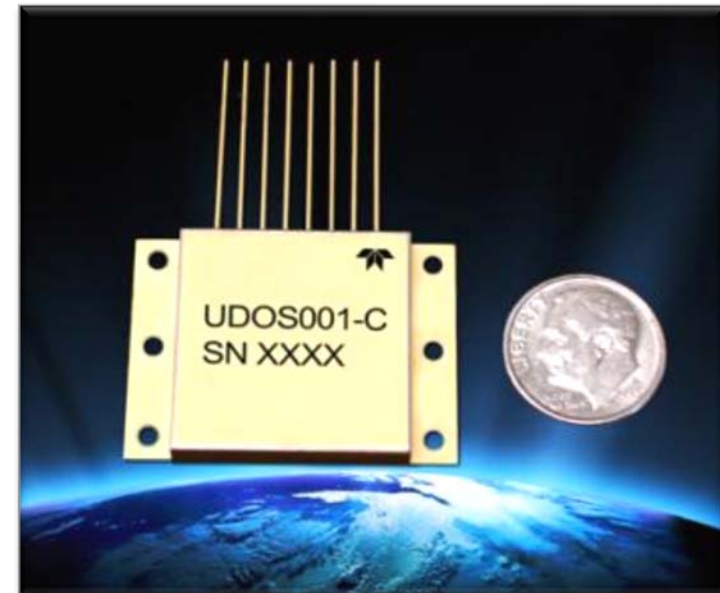


Military Spacecraft

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

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

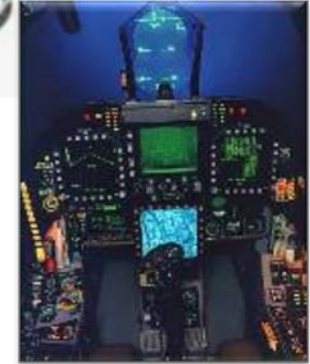
COMSEC Modules

- 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



LED Backlights & Illumination

- LED Backlights for Custom Displays
 - 0.25" to 5.0" Custom Backlights
 - NVIS & Thermal Scopes and Displays
 - Infrared Displays & Imaging Systems
 - Custom wavelengths, including NVIS Green, Red, and near IR
 - Polarized Brightness Enhancement Films
 - Custom filters to shift or cut-off at specific wavelengths
- High-intensity Collimating LED Light Engines
 - Biomedical (Photodynamic Therapy, Microscopy and Dental)
 - Machine Vision (Infrared)
 - Aviation, Naval, Mass Transit Lighting (RGB, White)

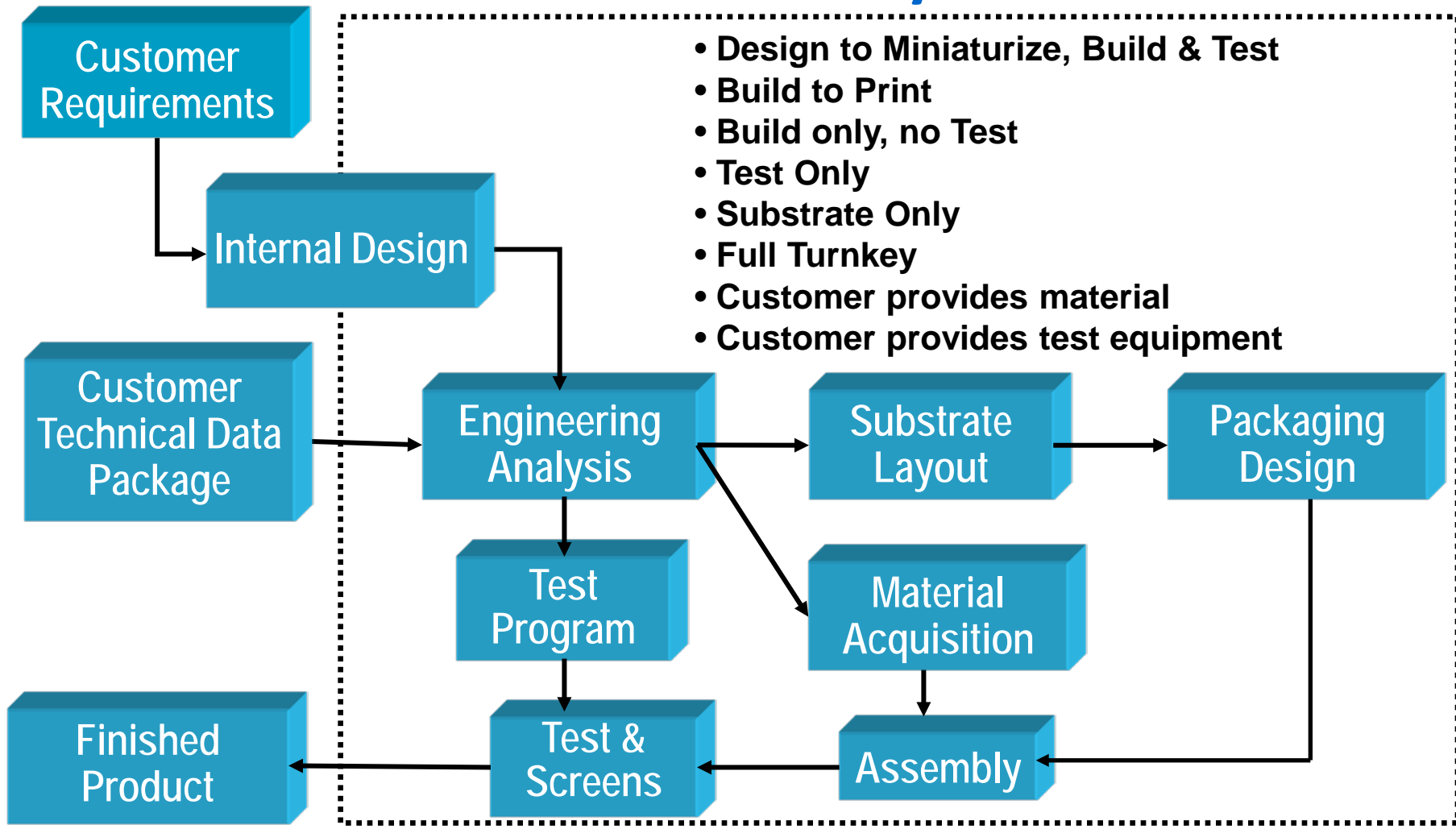


AL0505 VGA
18x14 mm



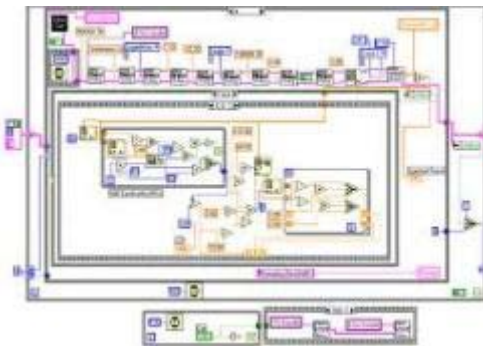
Photo Courtesy of U.S. Army

A to Z Flexibility

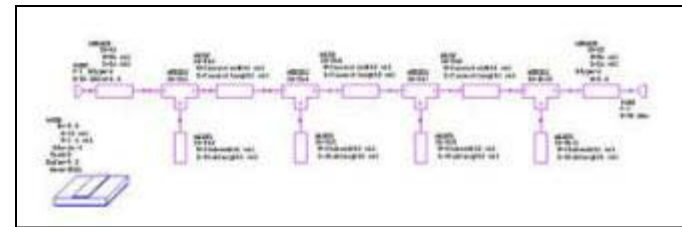
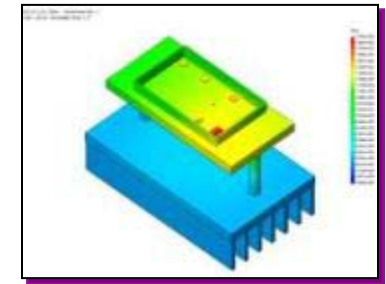


Design Tools

- 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 Mechanical, 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



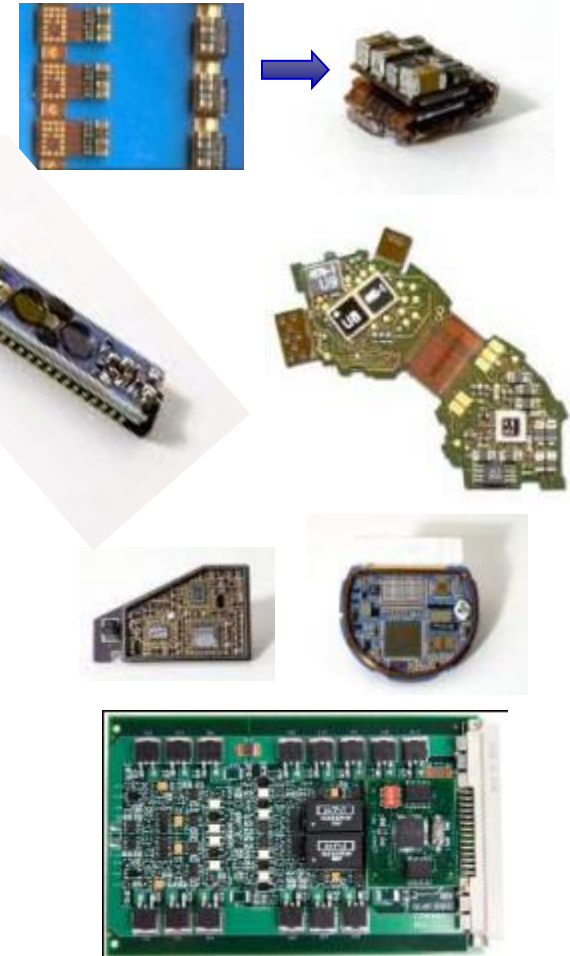
Substrate Technologies

- 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



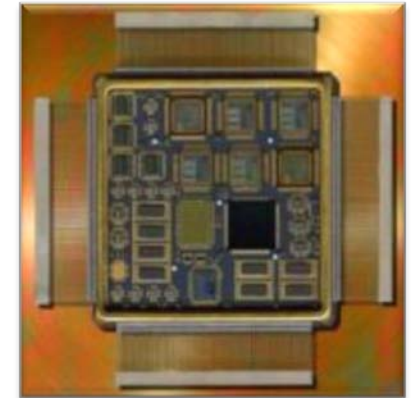
Surface Mount Packaging

- 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 mm² component sizes
- Fine pitch, down to 15 mil
- Offline set up & programming



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



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

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

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 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

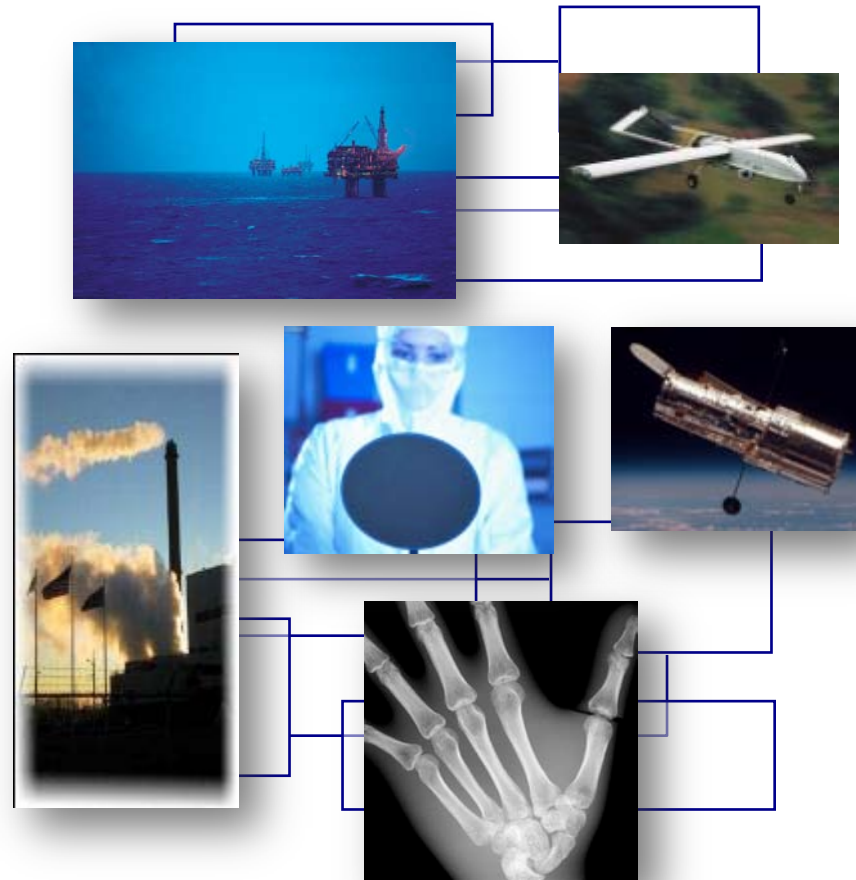


Teledyne Technologies

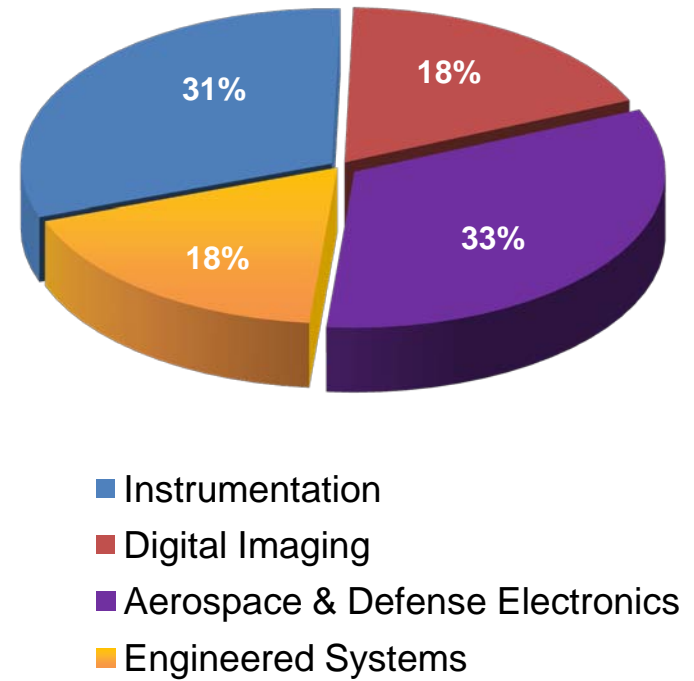
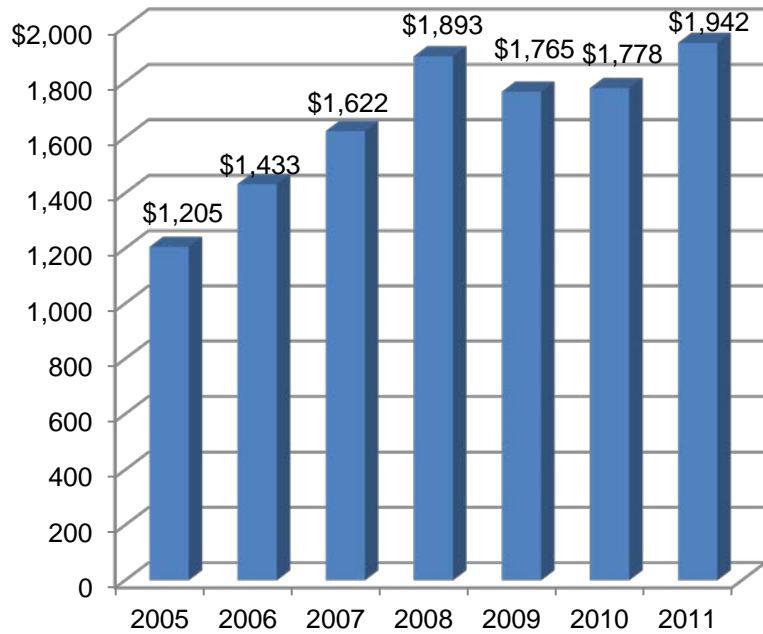
Technology for a challenging world

Demanding Markets

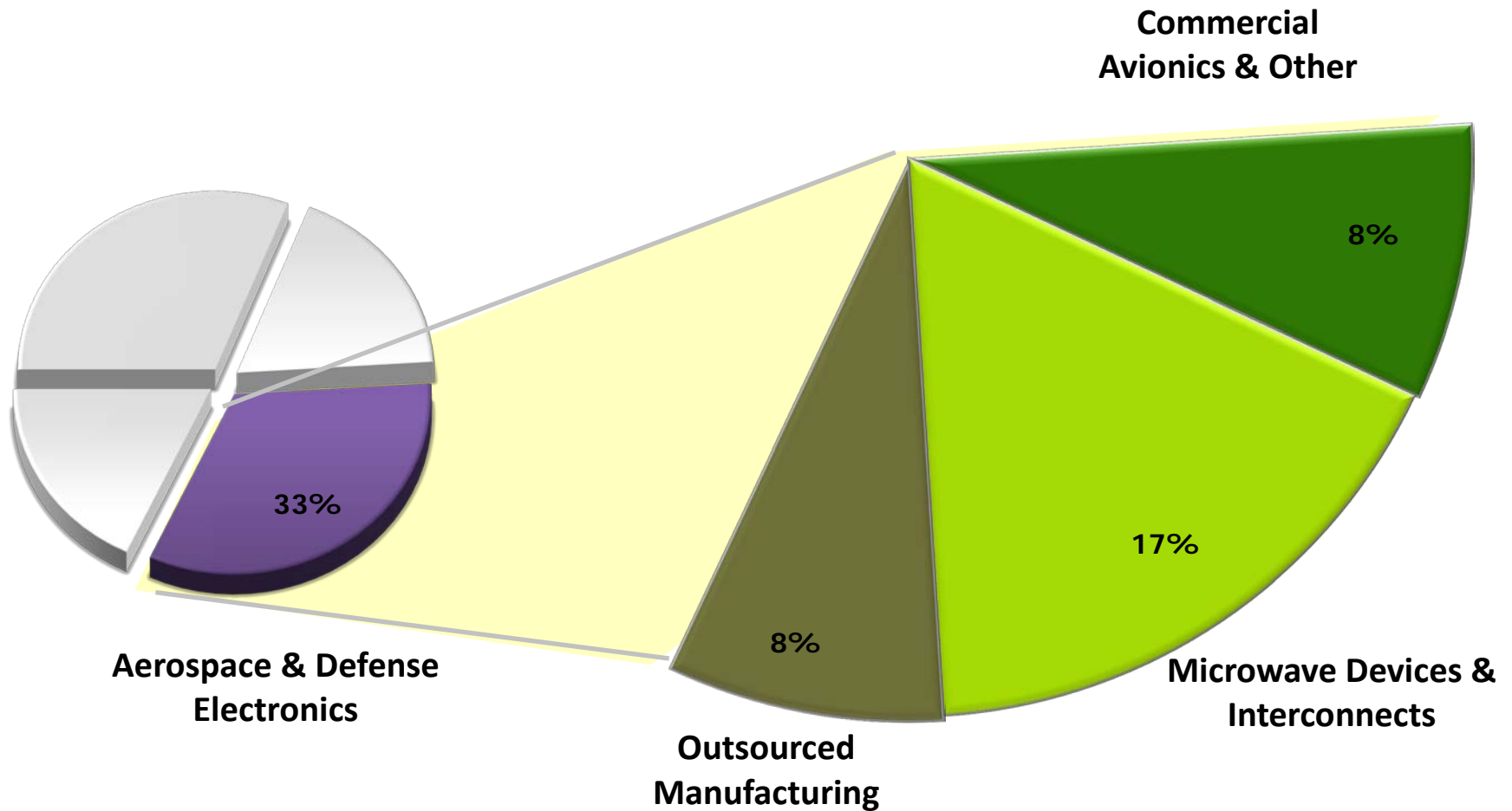
- Offshore exploration and production
- Infrared and visible imaging
- Defense communications
- Environmental monitoring
- Commercial aviation



(\$ in millions)



Aerospace & Defense Electronics Markets



Defense Electronics Products



Standoff Jamming

Infrared Imaging

Helmet Mounted Targeting



UAV Datalinks



Battlefield Radar



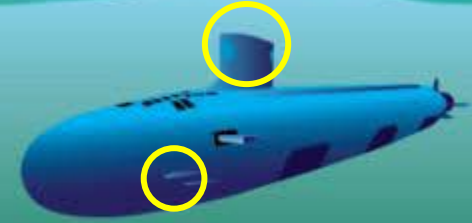
Communication Subsystems



Autonomous Underwater Vehicles (AUVs)



Subsea Interconnects





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

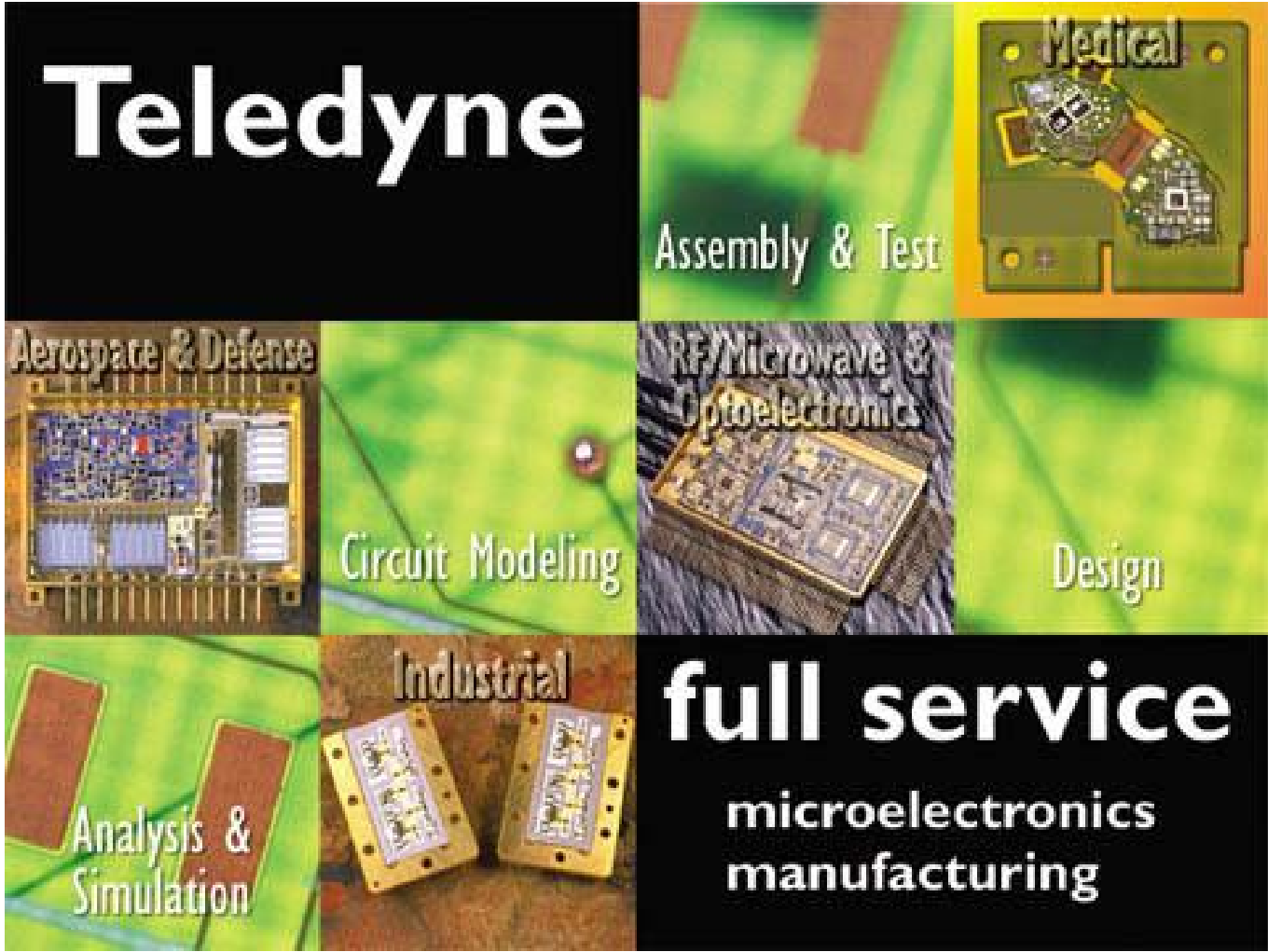
Engineered Systems

- 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. Ensamblés de Precisión, S.A. de C.V.





Teledyne

Assembly & Test

Medical

Aerospace & Defense

Circuit Modeling

RF/Microwave & Optoelectronics

Design

Analysis & Simulation

Industrial

full service
microelectronics
manufacturing

The image is a 3x3 grid of service areas. The top-left cell is black with the word 'Teledyne' in white. The top-right cell shows a green background with a red component and the text 'Assembly & Test'. The middle-right cell shows a yellow background with a medical device and the text 'Medical'. The middle-left cell shows a blue background with a circuit board and the text 'Aerospace & Defense'. The middle-center cell shows a green background with a circuit board and the text 'Circuit Modeling'. The middle-right cell shows a grey background with a circuit board and the text 'RF/Microwave & Optoelectronics'. The middle-right cell also has the text 'Design' on a green background. The bottom-left cell shows a green background with two red components and the text 'Analysis & Simulation'. The bottom-center cell shows a brown background with two gold components and the text 'Industrial'. The bottom-right cell is black with the text 'full service microelectronics manufacturing' in white.