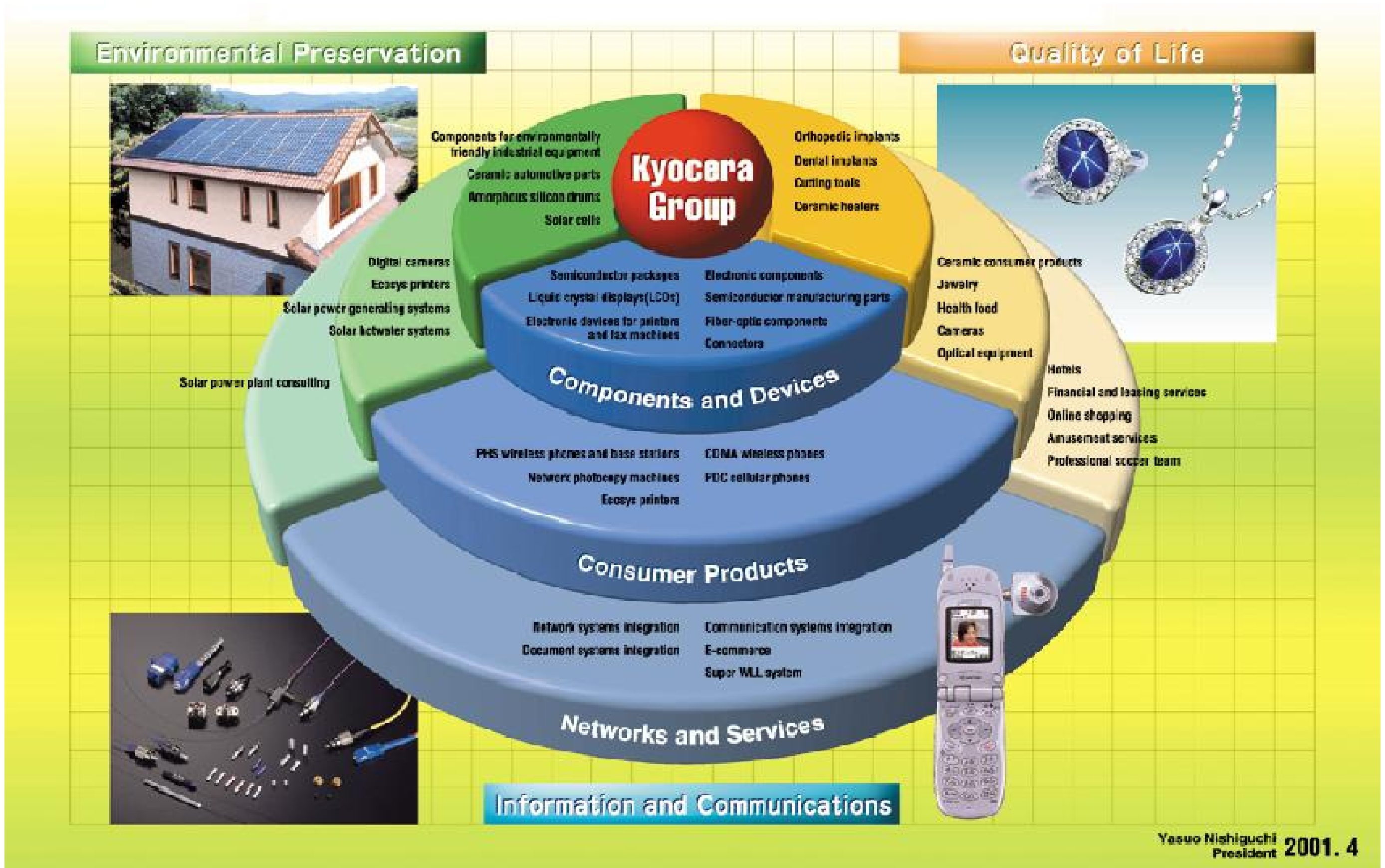
Kyocera Corporation 3 Strategic Markets in the 21st Century…



…Overall Enterprise ~ $30B

Kyocera Corporation

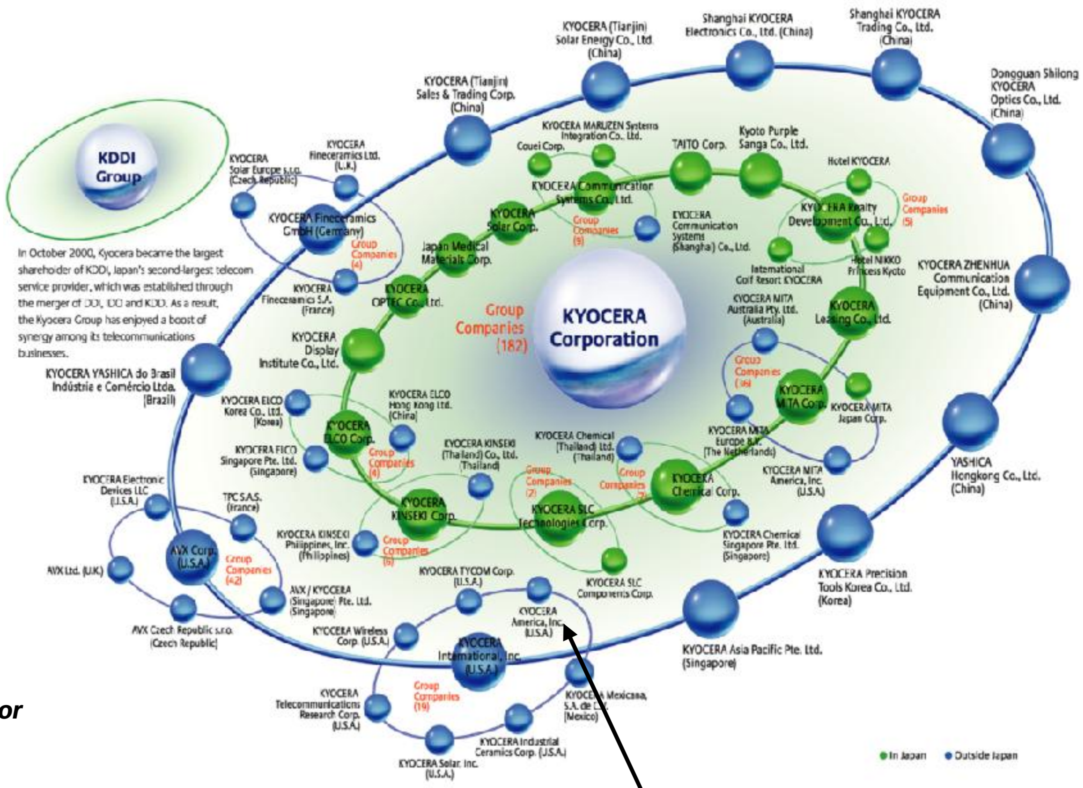
Established: 1959

Consolidated Sales: $ 10.7 billion

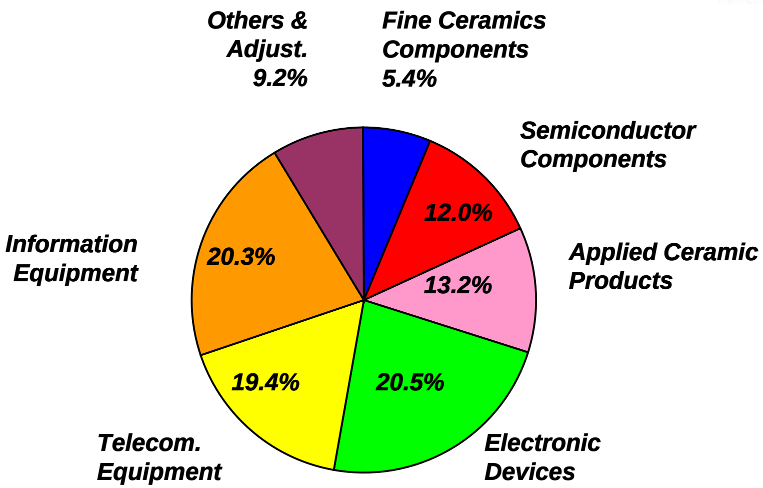
Group Companies: 211 companies

Employees: 59,500

Headquarters: Kyoto, Japan



Kyocera America, Inc.



Kyocera America, Inc.

Part of Kyocera's Semiconductor Components Group

Headquarters : San Diego, CA

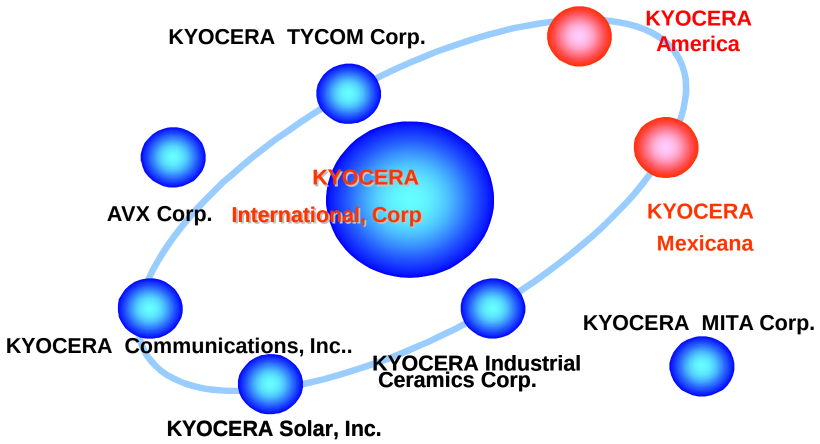
Established in SD : 1971

SD Employees : 500 + 80 Temps

Tijuana Employees: 750

KYOCERA America, Inc., San Diego

KYOCERA Mexicana, Tijuana



KAI is ISO Certified

QUALITY SYSTEM CERTIFICATIONS

ISO 9001 - SAN DIEGO
ISO 9002 - KMX

Certificate of Registration

Certificate Number FM 27921

KYOCERA AMERICA, INC.

8611 BALBOA AVENUE
SAN DIEGO, CALIFORNIA 92123
USA

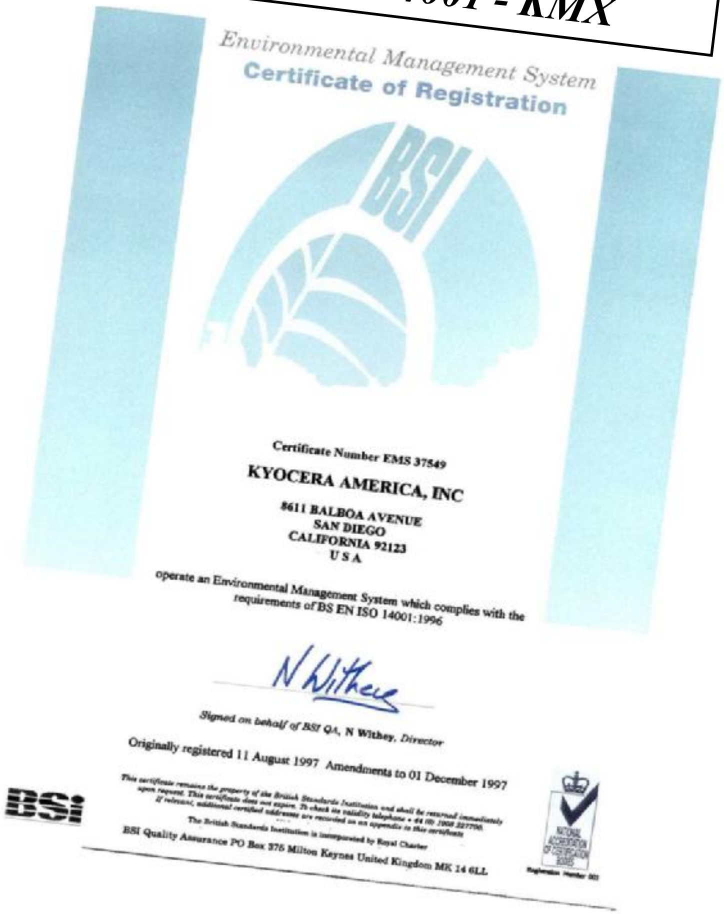
operate a quality management system which complies with the requirements of BS EN ISO 9001:1994

Signed on behalf of BSI, Mark Freeman,
General Manager, Technical and Certification Services

Originally registered 19 April 1994 Amended on 21 December 1998

British Standards Institution · 389 Chiswick High Road · London W4 4AL

ISO14001 - SAN DIEGO
ISO14001 - KMX



Environmental Management System
Certificate of Registration

Certificate Number EMS 37549

KYOCERA AMERICA, INC

8611 BALBOA AVENUE
SAN DIEGO
CALIFORNIA 92123
USA

operate an Environmental Management System which complies with the requirements of BS EN ISO 14001:1996

Signed on behalf of BSI QA, N Withey, *Director*

Originally registered 11 August 1997 Amendments to 01 December 1997

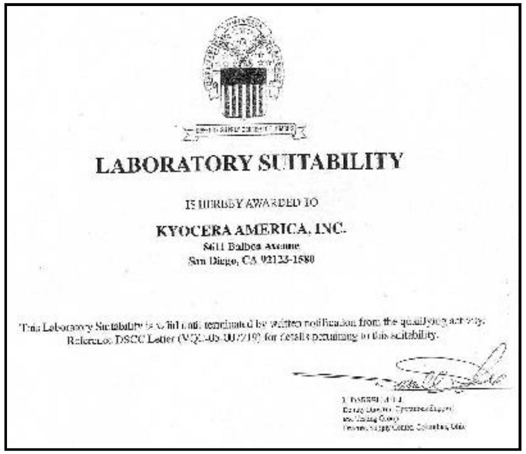
BSI Quality Assurance PO Box 375 Milton Keynes United Kingdom MK 14 6LL

Certifications

- ITAR registered & compliant
- DSCC / QML Class S, K certified
- ISO 9001:2000 certified San Diego/Tijuana
- ISO 14001:2004 certified San Diego/Tijuana

MIL-PRF-38535
CUSTOM MICROCIRCUIT CERTIFICATION

KYOCERA AMERICA, INC.
8611 Balboa Avenue
San Diego, CA 92123-1580



LABORATORY SUITABILITY

IS HEREBY AWARDED TO

KYOCERA AMERICA, INC.
8611 Balboa Avenue
San Diego, CA 92123-1580

Certificate of Registration

QUALITY MANAGEMENT SYSTEM - ISO 9001:2000

This is to certify that:

Kyocera America Inc.
8611 Balboa Avenue
San Diego
California
92123
USA

Holds Certificate No: FM 27921

and operates a Quality Management System which complies with the requirements of ISO 9001:2000 for the following scope:

The design, development, production and sale of custom microelectronic products, including multi-layer, metallized products, sub-contract chip assembly and plating processes for the electronics industry.

For and on behalf of BSI:

President, BSI Management Systems (Americas)

Originally registered: 04/19/1994 Latest Issue: 04/25/2006 Expiry Date: 04/24/2009

Page: 1 of 2

Certificate of Registration

ENVIRONMENTAL MANAGEMENT SYSTEM - ISO 14001:2004

This is to certify that:

Kyocera America Inc.
8611 Balboa Avenue
San Diego
California
92123
USA

Holds Certificate No: EMS 37549

and operates an Environmental Management System which complies with the requirements of ISO 14001:2004 for the following scope:

The design and manufacture of semi-conductor chip packaging and components.

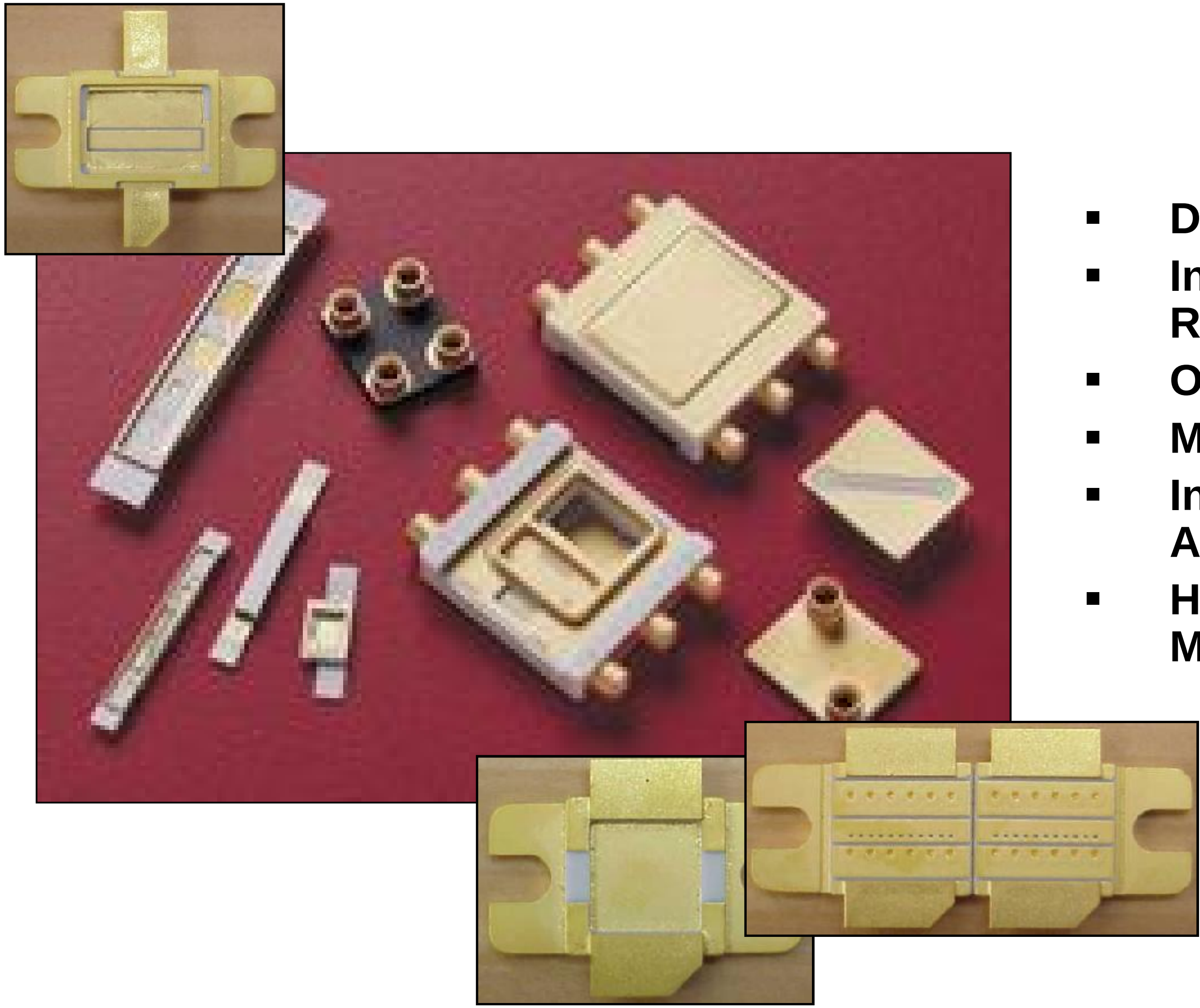
For and on behalf of BSI:

President, BSI Management Systems (Americas)

Originally registered: 08/11/1997 Latest Issue: 04/14/2006 Expiry Date: 04/13/2009

Page: 1 of 2

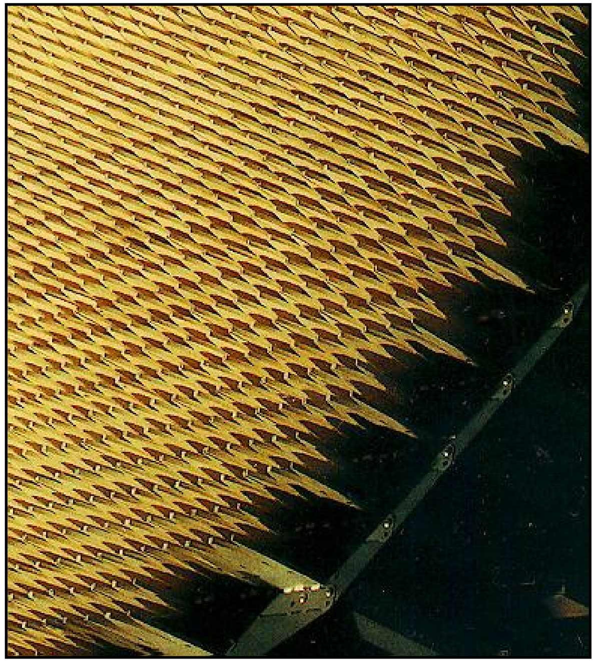
KAI Packaging Products – DC through Light



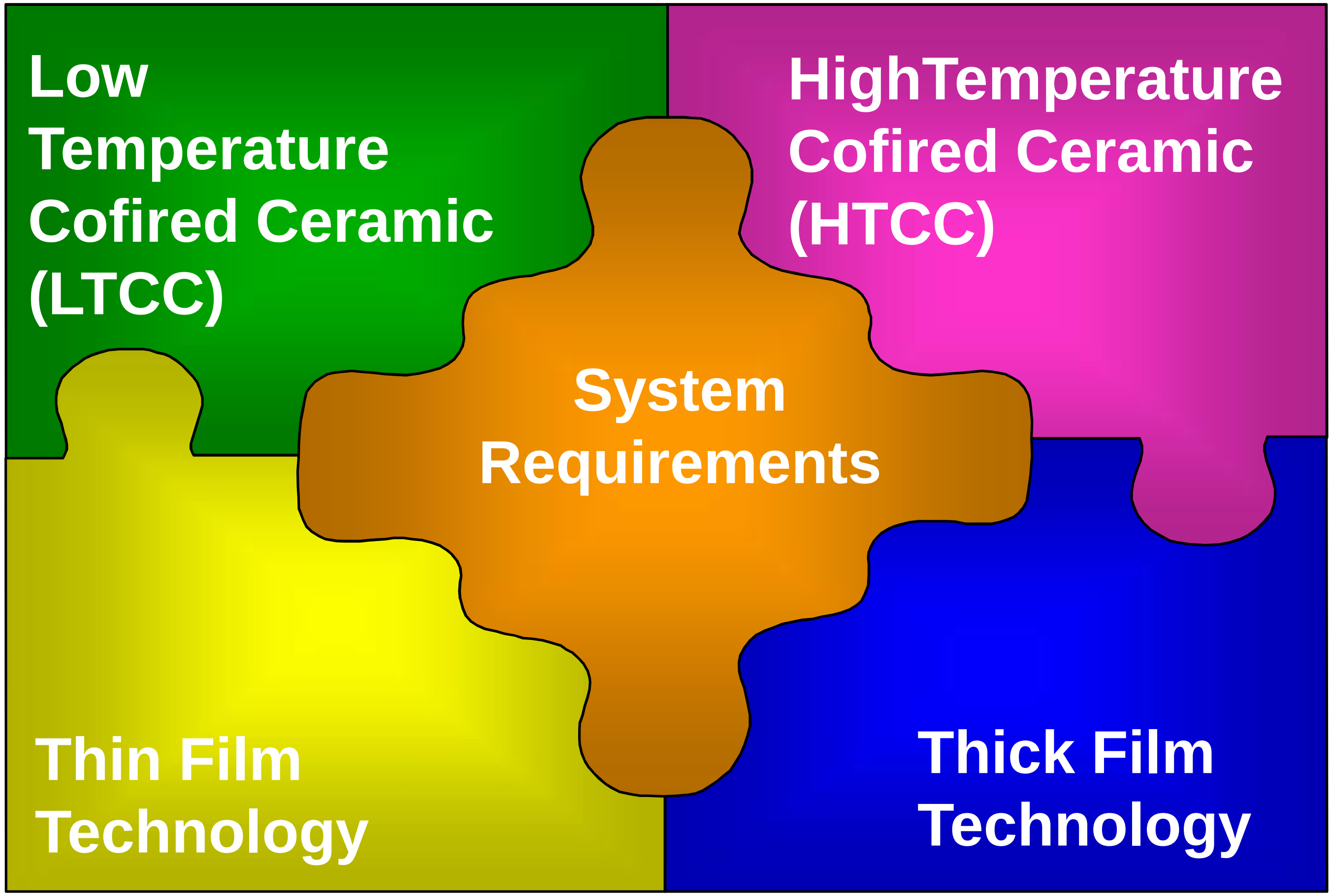
- DC to 50 GHz
- Integrated Multilayer RF Modules
- Optical Packages
- Mixed Signal MCM's
- Integrated Passive and Antenna Components
- HTCC and LTCC Materials

KAI Module Technology Used in Complex RF and Optical Systems

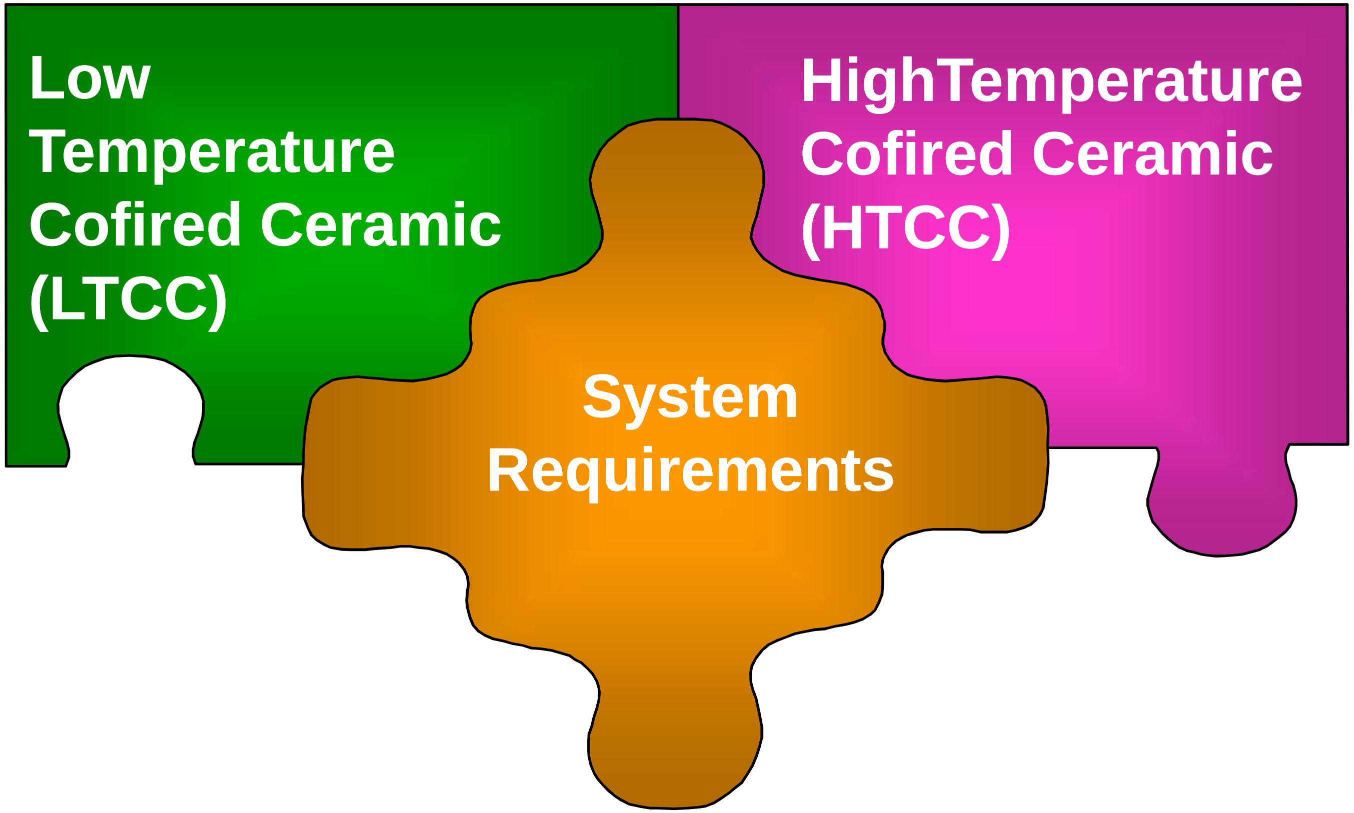
- RF/MMW *(ALL WEATHER)*
  - Phased Array Radars
  - Phased Array Electronic Warfare (EW) Systems
  - Phased Array Electronic Surveillance
  - Phased Array Communication Systems
  - Software Defined Radios
- IR/Optical/UV *(FAIR WEATHER)*
  - LWIR Forward Looking Infrared (FLIR) Systems
  - MWIR Imaging Systems
  - SWIR Imaging Systems
  - Visible Imaging Systems
  - UV Passive Detection
  - Laser Targeting



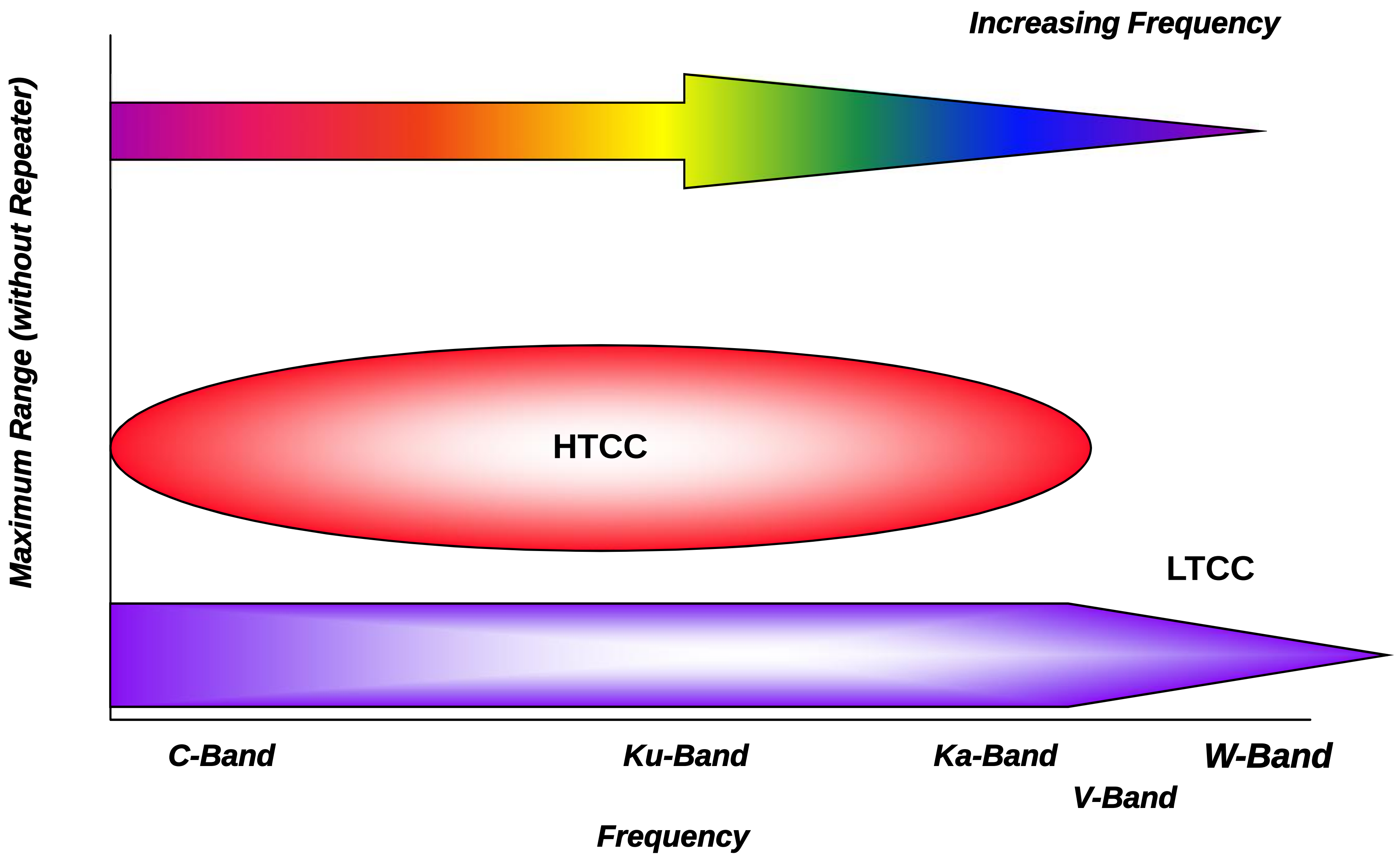
Several Packaging Options



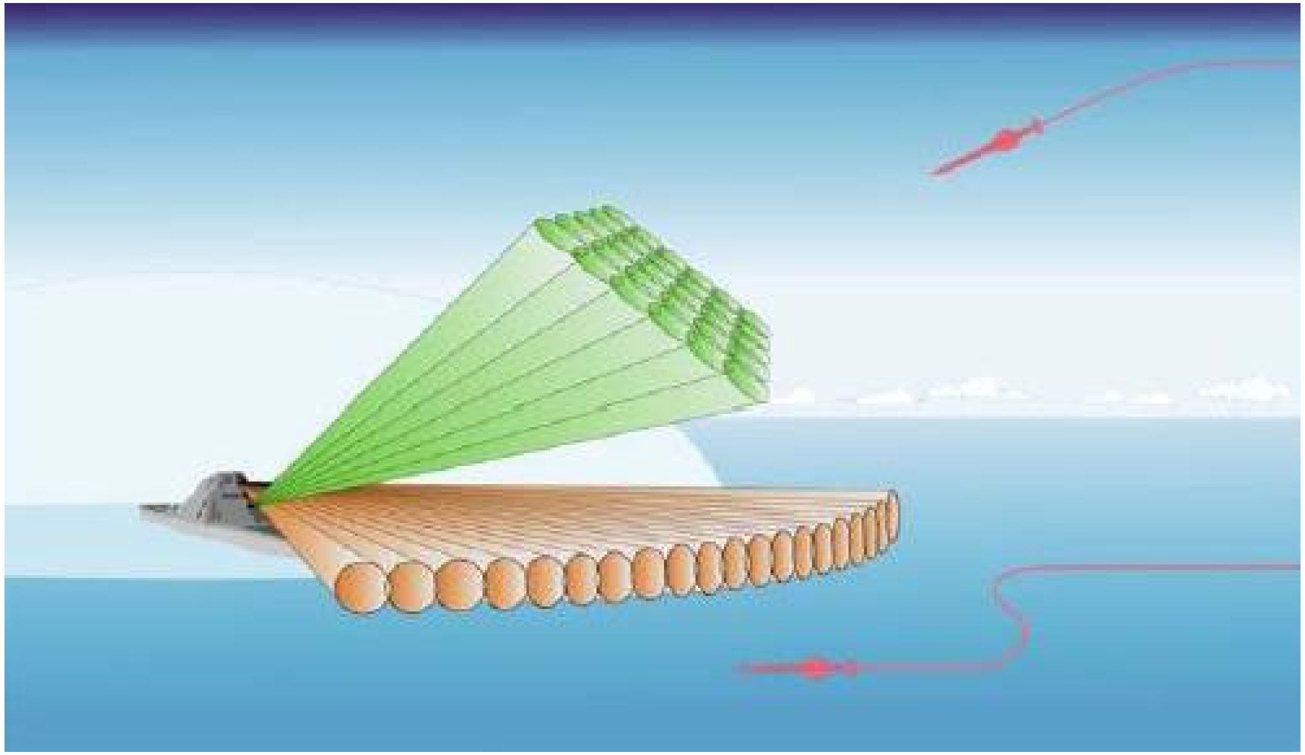
Cofired Ceramic Mainstay of KAI Packaging...



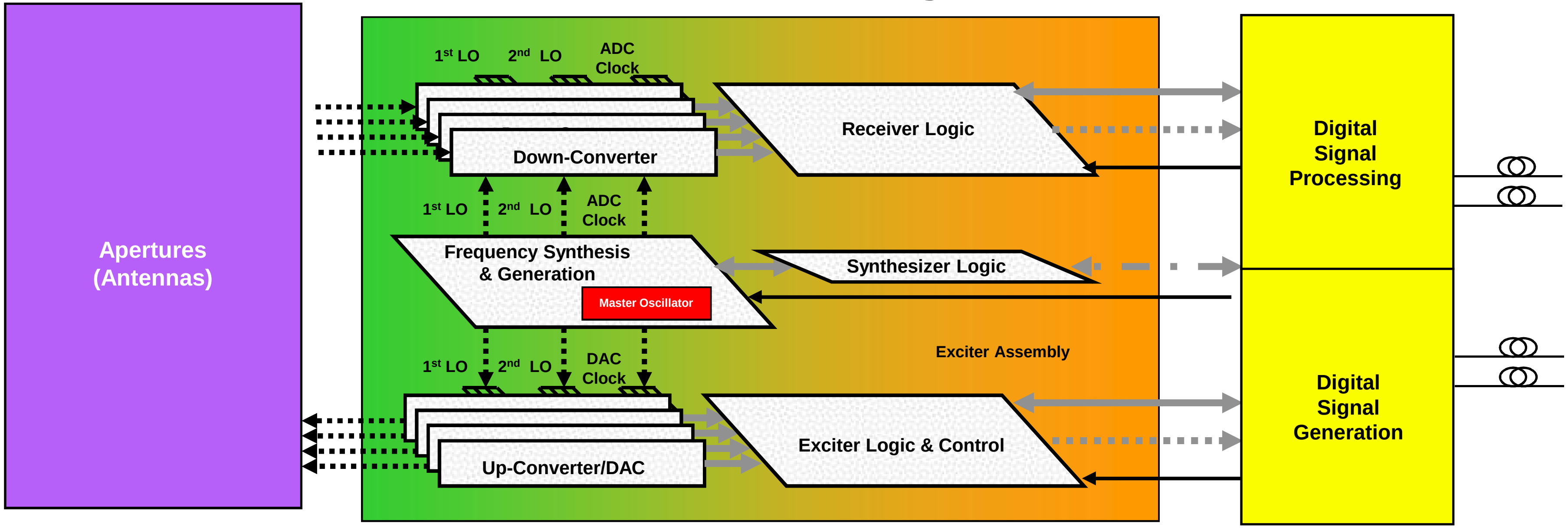
Basic Trend Packaging - Lower Dielectric Constant with Increasing Frequency



…Enables Multiple Simultaneous Beams

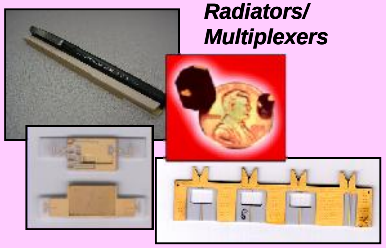


KAI Module Technology Enabling Advanced RF/Microwave Systems



Digital Receiver/Exciter (DREX)

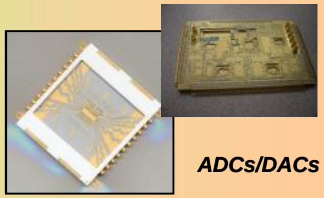
Radiators/ Multiplexers



Dense Antenna Manifolds

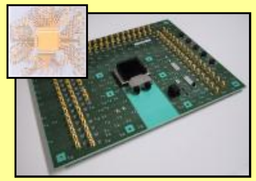
T/R Modules (Next Slides)

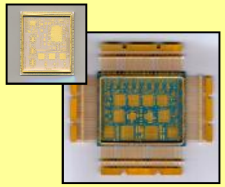
Synthesizers/Frequency Converters



ADCs/DACs

Parallel Optical Interfaces

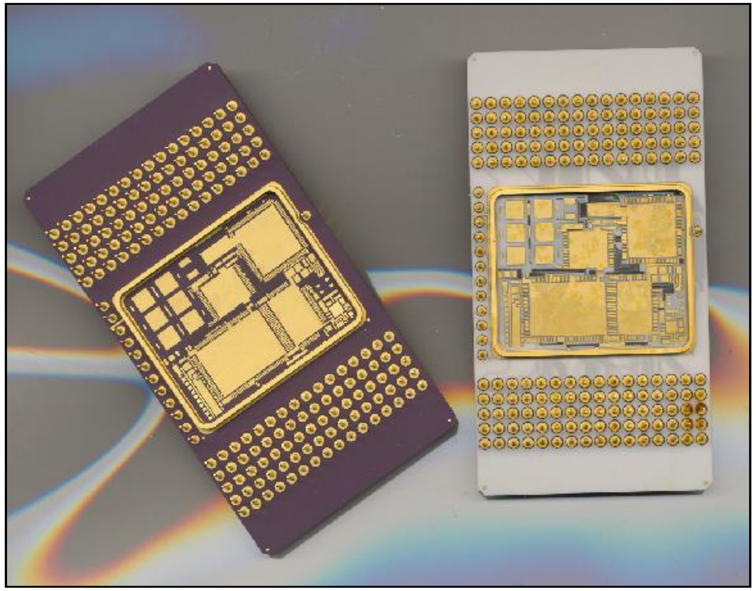




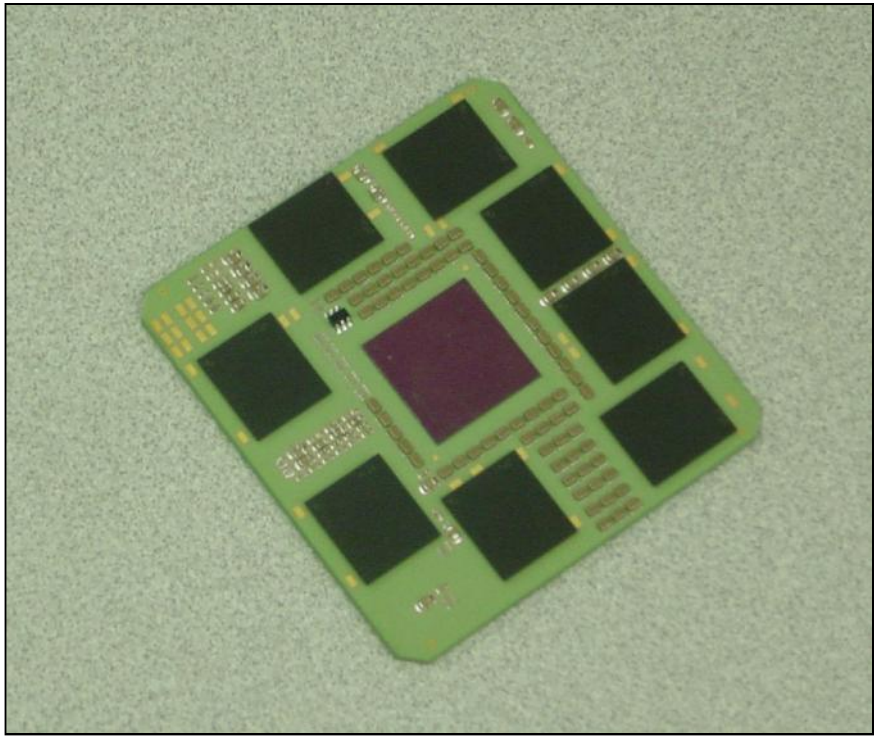
Advanced Processing Elements

General Trends Driven by Power and Bandwidth

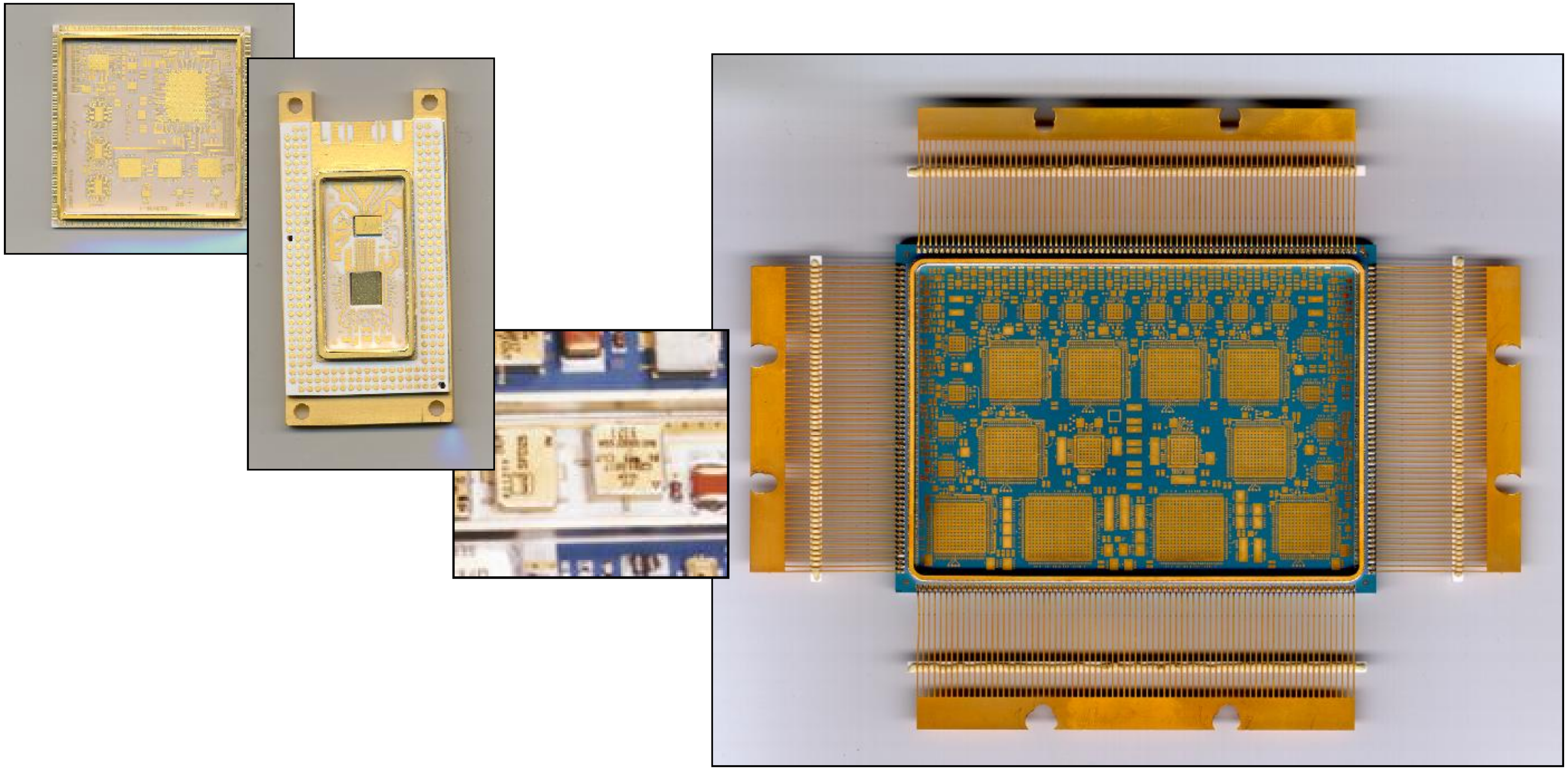
- **Transitions from Black Alumina to White Alumina**
  - **Wide Bandwidth RF Components: WiMAX, UWB etc.**
  - **T/R Modules Increasing BW and Power**
  - **High Voltage Medical Implants**
- **Trend toward Lower Dielectric Constants**
- **Increasing Power and Bandwidth Needs:**
  - **Need to Avoid Silver due to Electromigration**
  - **High Field Densities**
  - **Higher Power Interfaces – RF and DC**



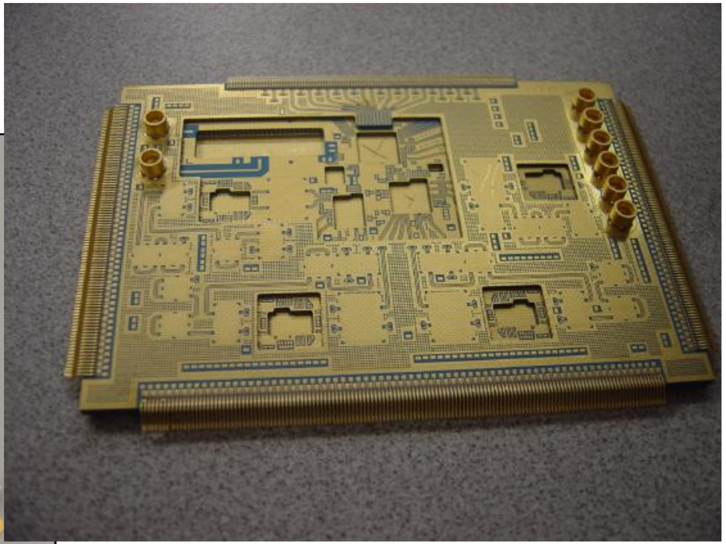
High Bandwidth Si and SiGe Devices on HiTCE Ceramic for DoD Application



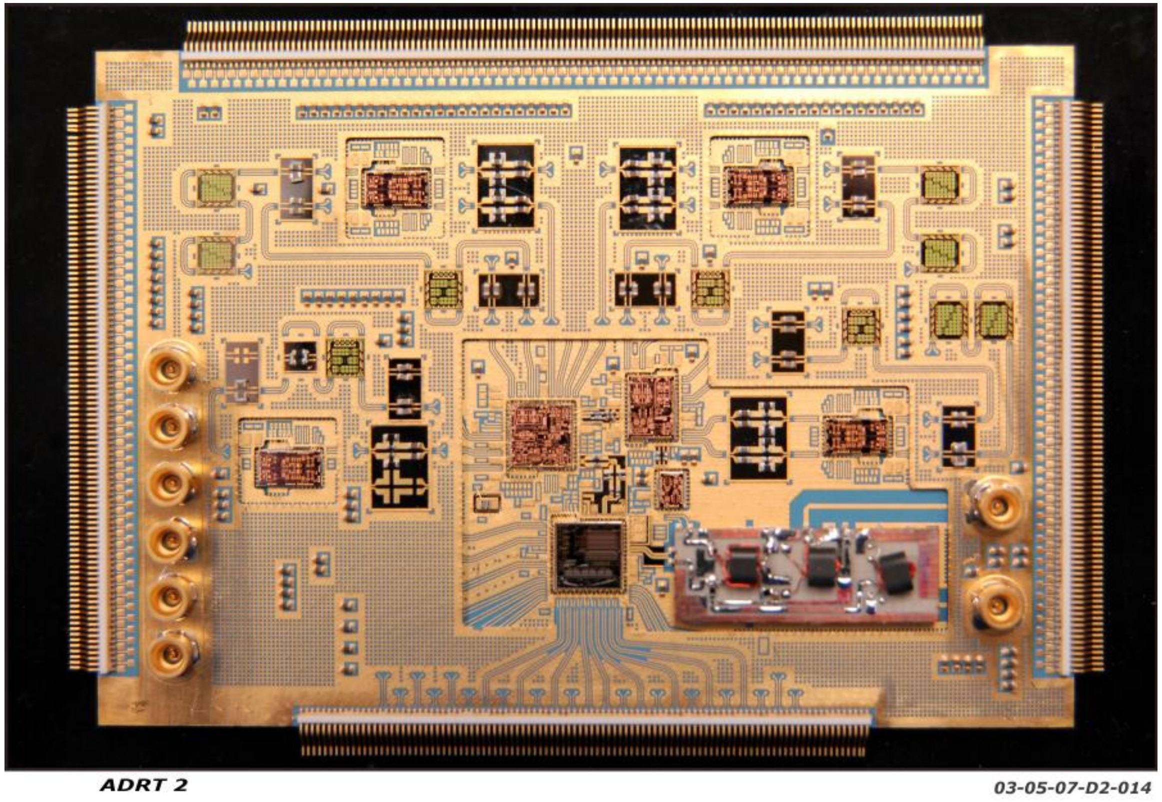
KAI Supports Non-Antenna Packaging



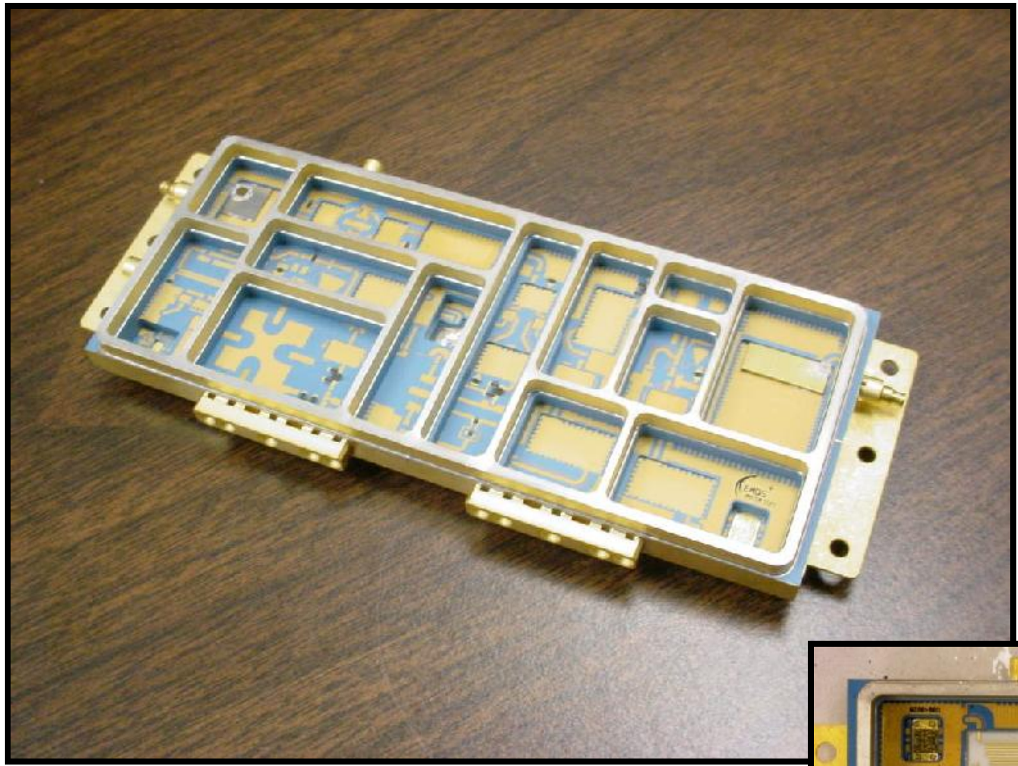
Next Generation ADCs and DACs Capitalize on Mixed Signal and RF Experience

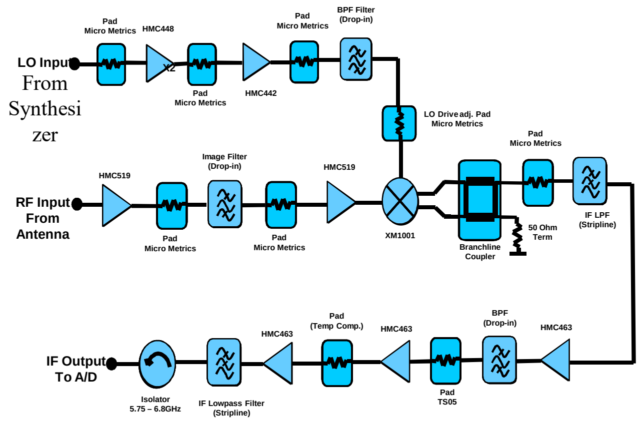


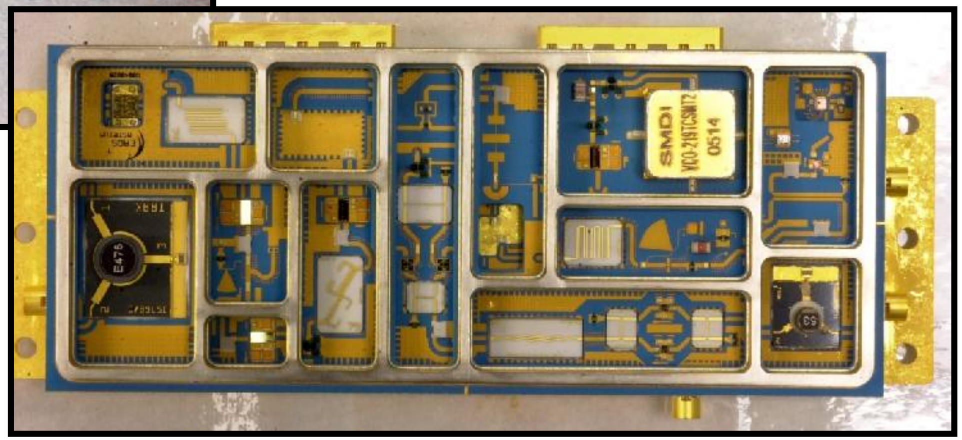
Assembled A/D



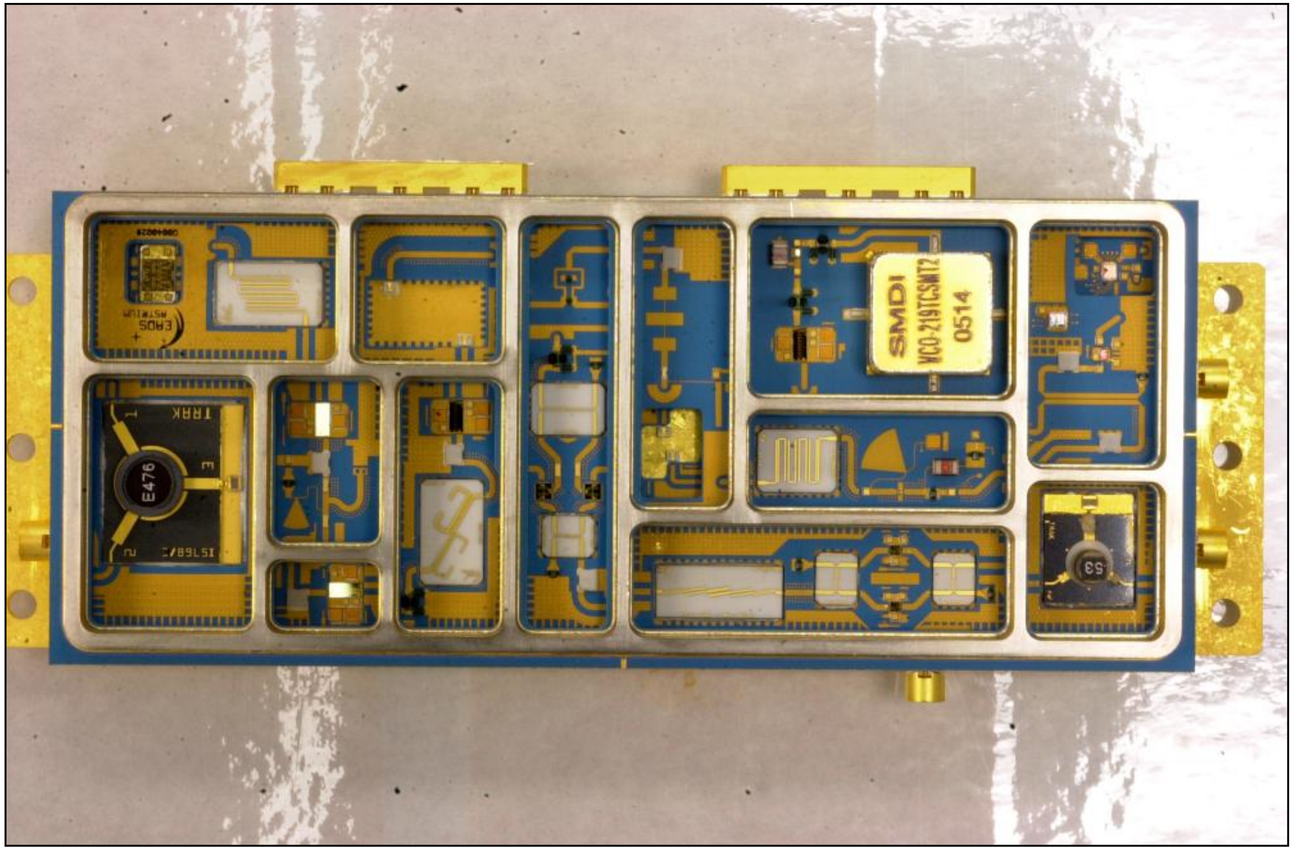
= Highly Integrated Frequency Converters



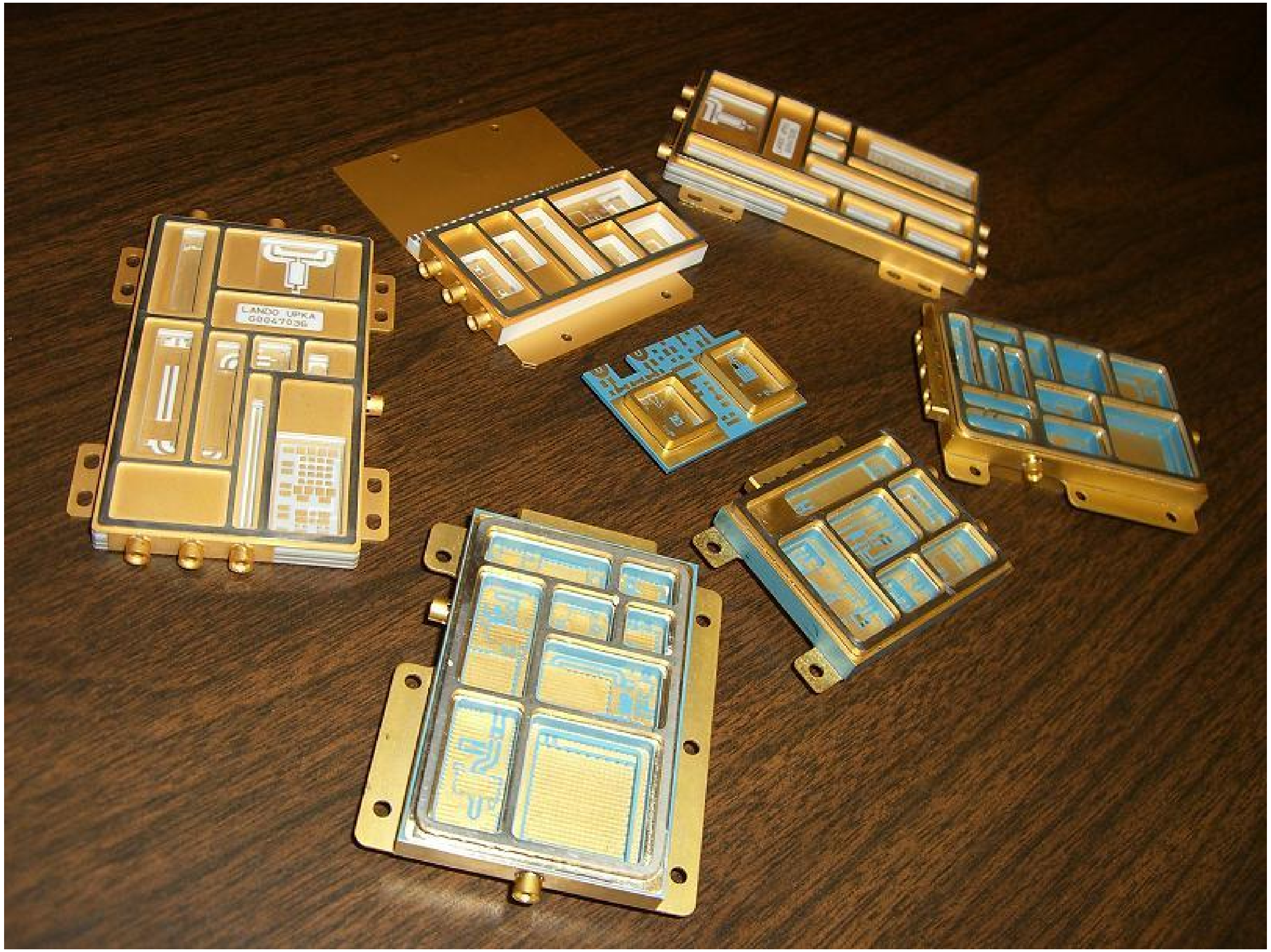




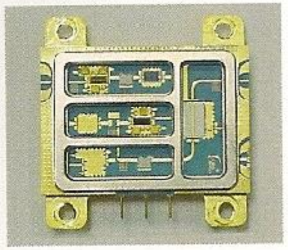
Fully Assembled Downconverter



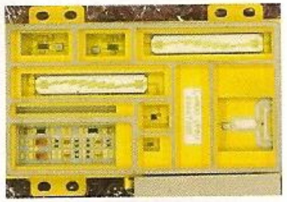
Variety of Up/Down Converters Manufactured…



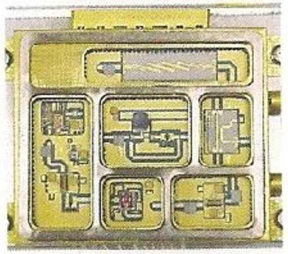
Ku-Ka Band Frequency (UP & DOWN) Converters

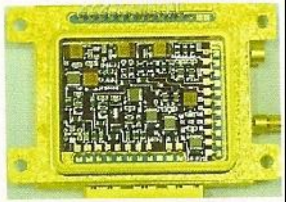


18GHz LNA

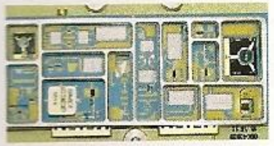


Agile Ku band Downconverter

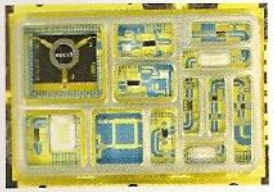




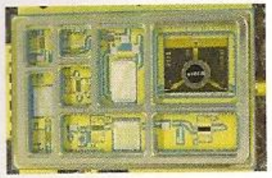
Agile Ku-band LO (RF & Bias sides)



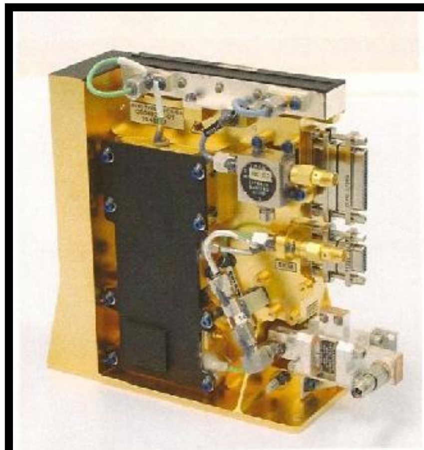
14 - 6GHz Downconverter with integral LO

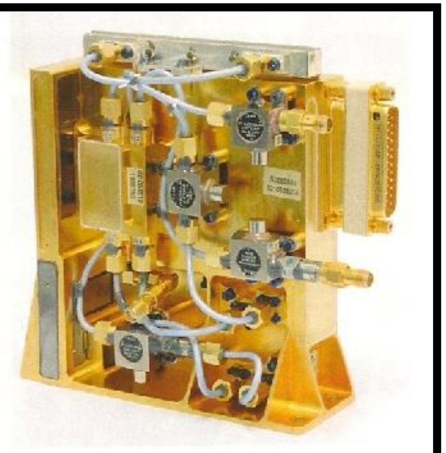


Ka/C-band Downconverter

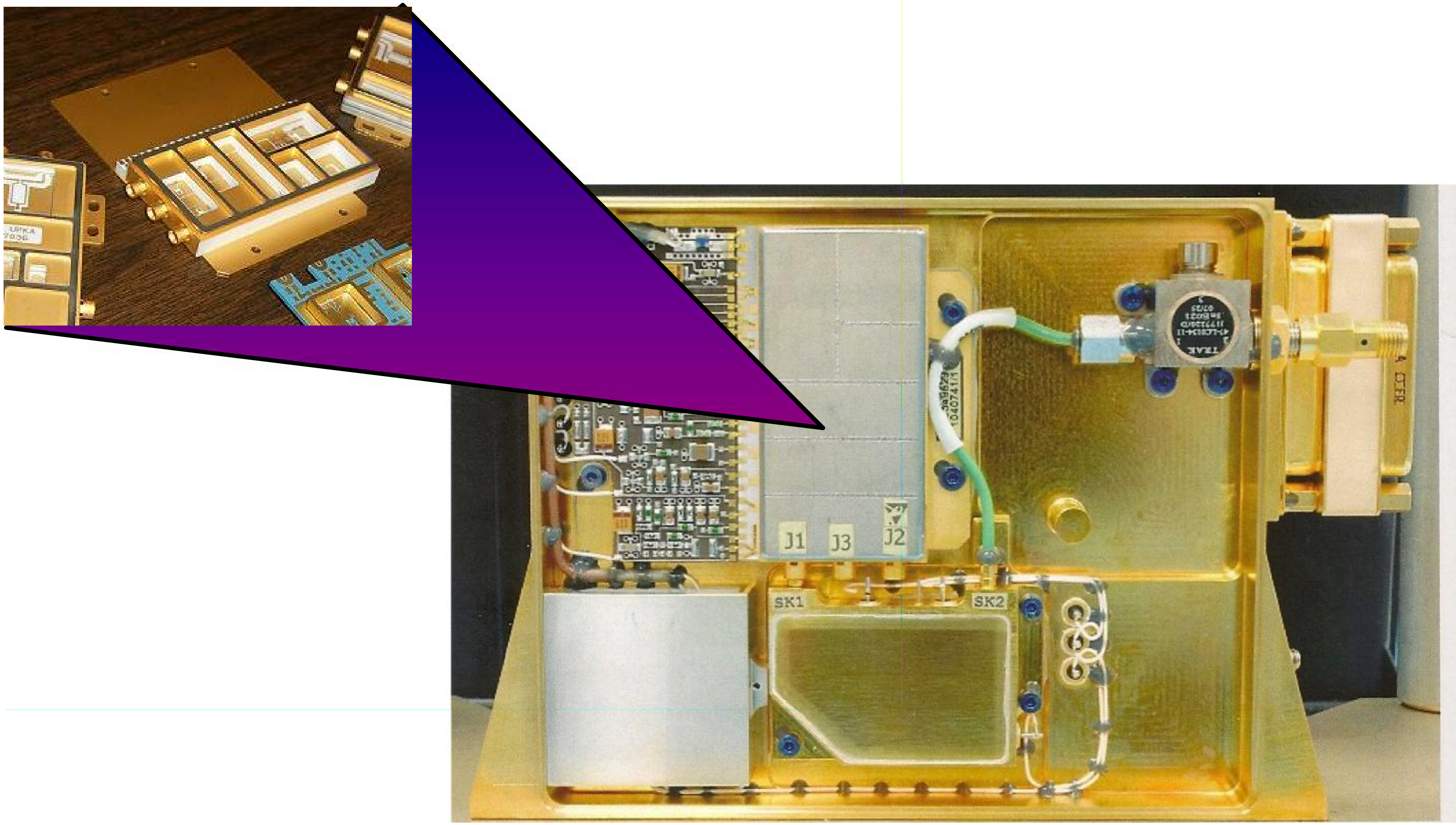


Ku-band Downconverter

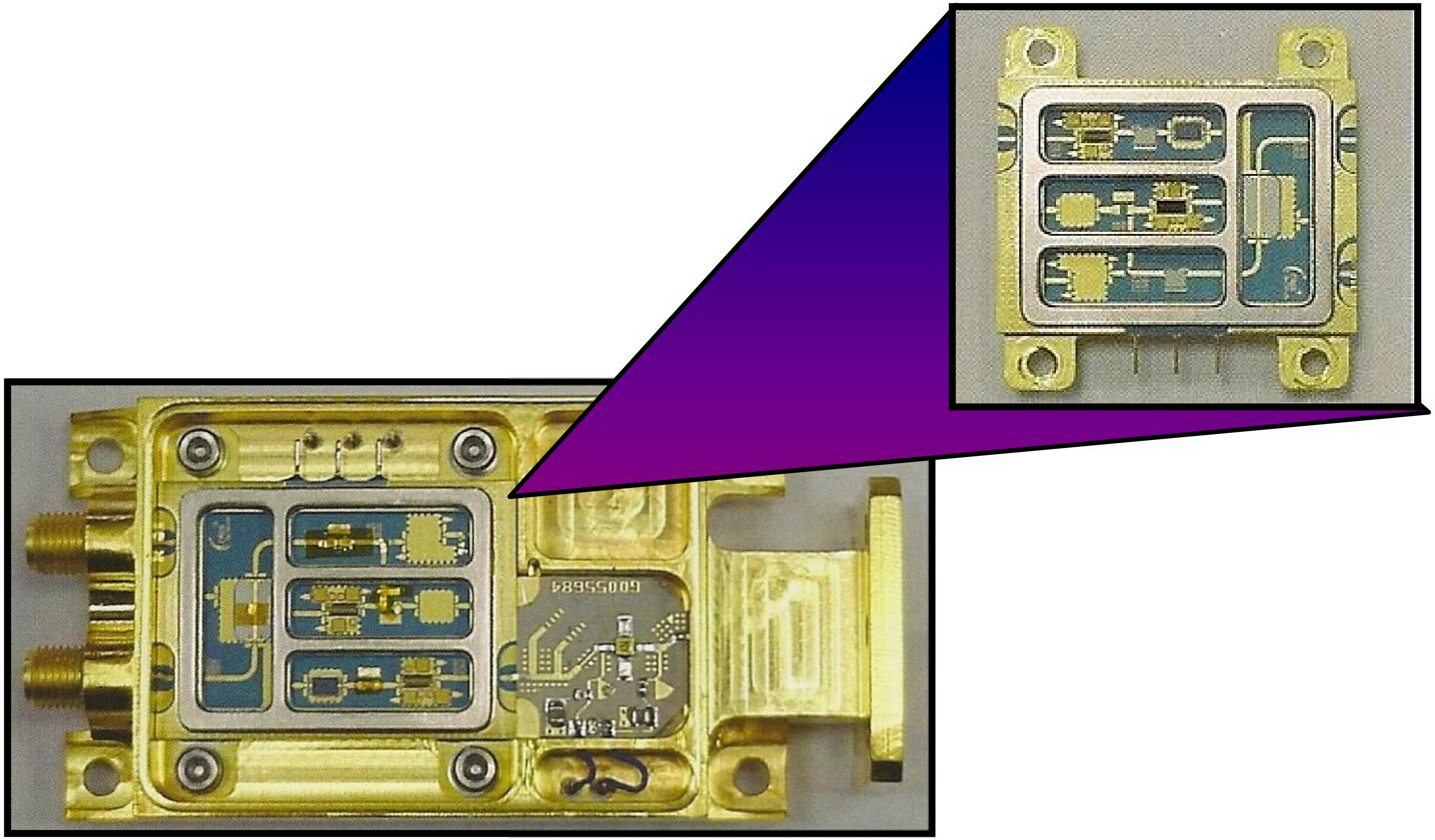




Upconverter Synthesizers in HTCC



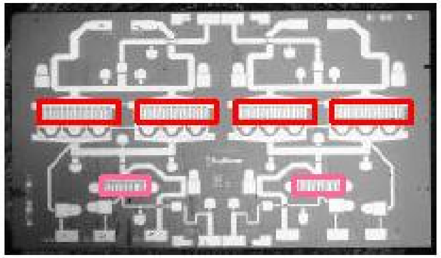
Wideband LNAs



GaN Performance Impressive

10 W X-band GaAs PHEMT amp

5.7mm x
3.3 mm

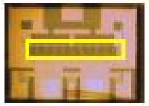


7V @ 75 mA/mm 40% ? pa
~ 20mm total gate periphery
output resistance ~ 4.6?

Best in Class GaAs Amplifier

Same power at >10x the impedance

10 W X-band GaN HEMT Device



1.6mm x
1.2 mm

30V@ 223 mA/mm 46% ? pa
2mm gate periphery
output resistance ~ 67?

Higher impedance enables high efficiency and wide bandwidth

5-10x the power in same transistor size

Higher power at same dimension maintains manufacturability

40 W (pulsed) X-band GaN HEMT Device

0.7mm x 4mm
(~1/2 GaAs
output stage)

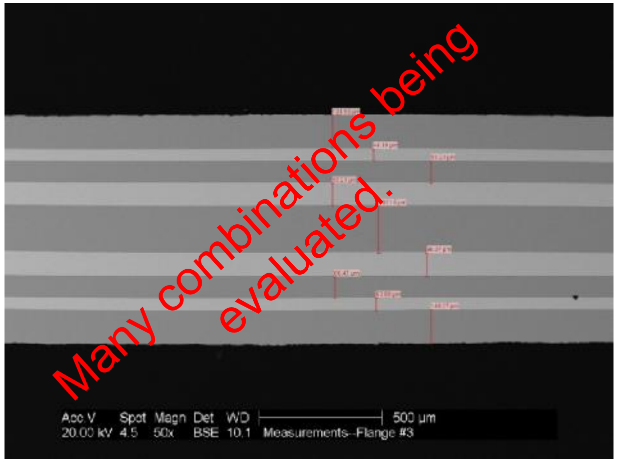
55V@ 283 mA/mm 20% ? pa
12mm gate periphery
output resistance ~ 16?

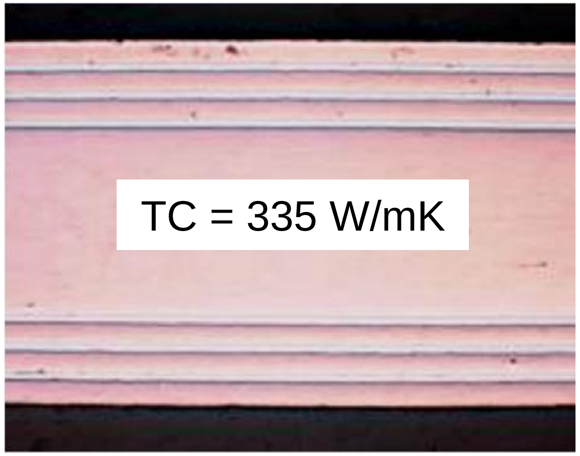
9

AlGaN HEMT work supported ONR and AFRL

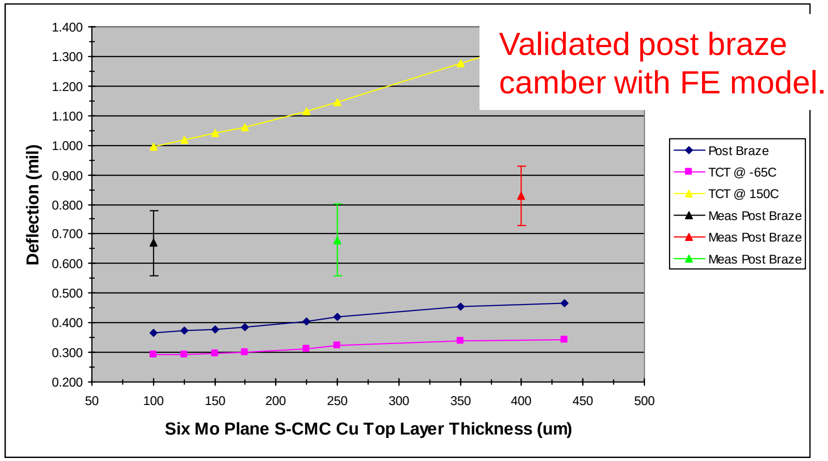
Advanced Heat Spreaders: Super CMC or SCMC Migrating into Modules

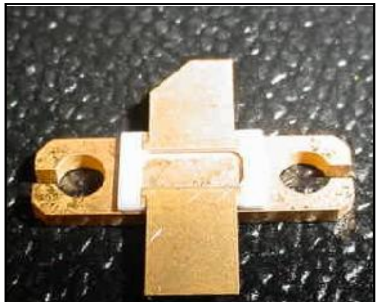
Patent pending material set being evaluated by numerous WBG customers.
Caveat, many challenges remain and typically we use thermomechanical finite element analysis to optimize the heat spreader stackup based on package geometry.





Stiffness bands



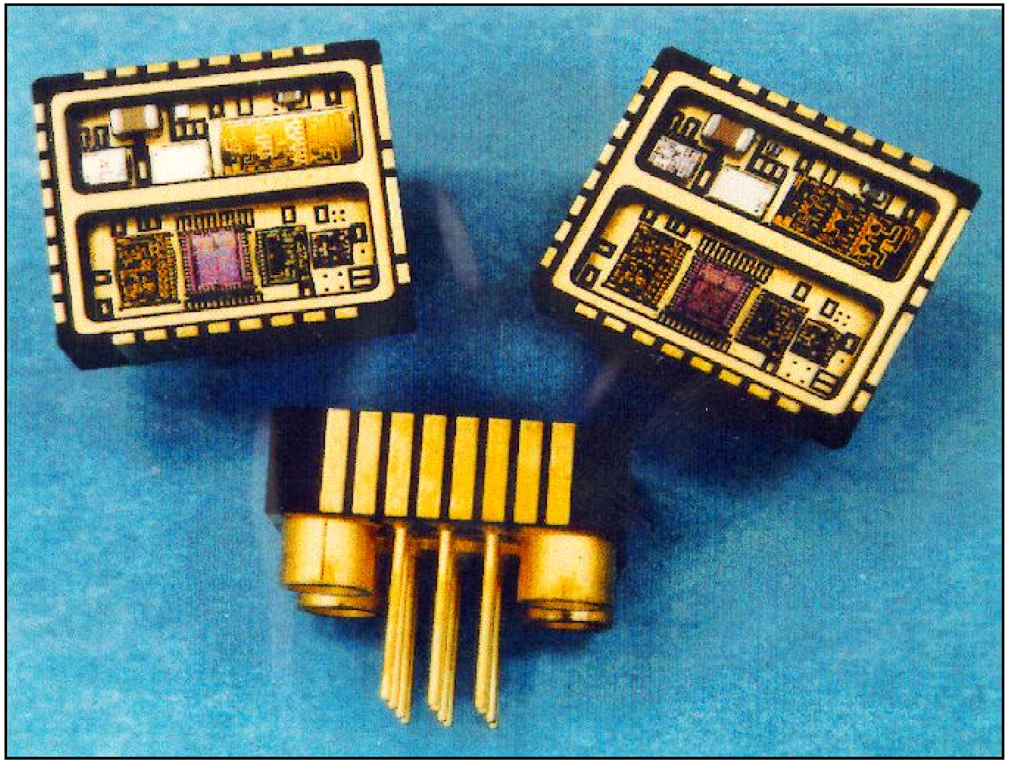


GaN LDMOS Pkg Prototype

Conventional T/R Module Packaging: Packages and Many Substrates

- **Packages:**
  - Metal
  - Metal + Ceramic
  - Composite
- **Sustrates**
  - Multilayer Ceramic
  - Multilayer Organic
  - Single Layer Ceramic

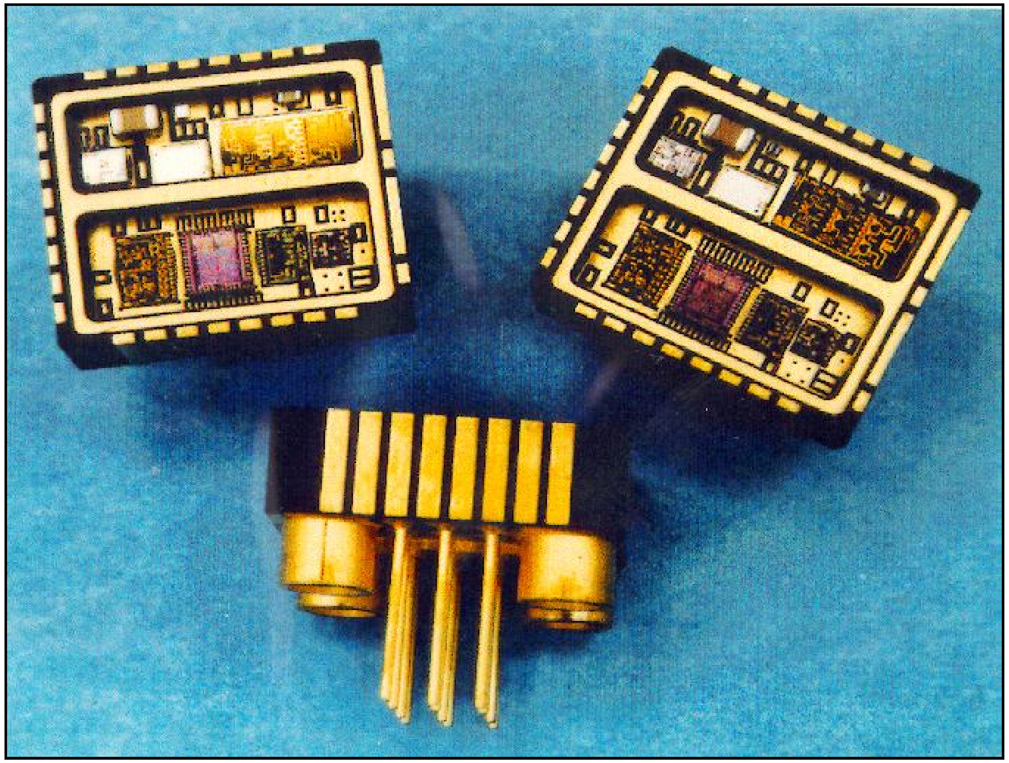
Initial T/R Module Work Initiated in 1991 with Westinghouse…



…Initial Test Pieces Started in ’89/’90

Image from Advancing Microelectronics April 1996

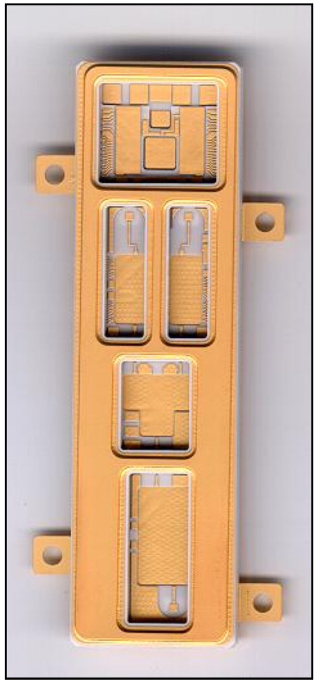
Initial T/R Module Work Initiated in 1990's with Westinghouse…

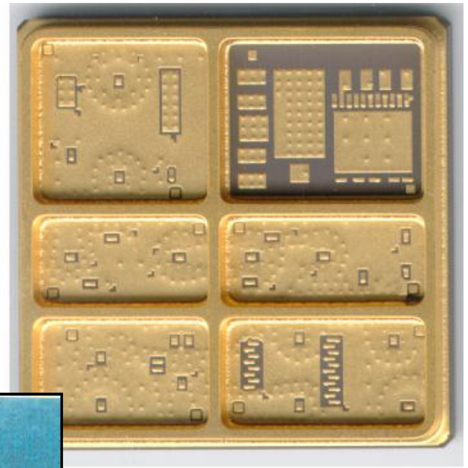


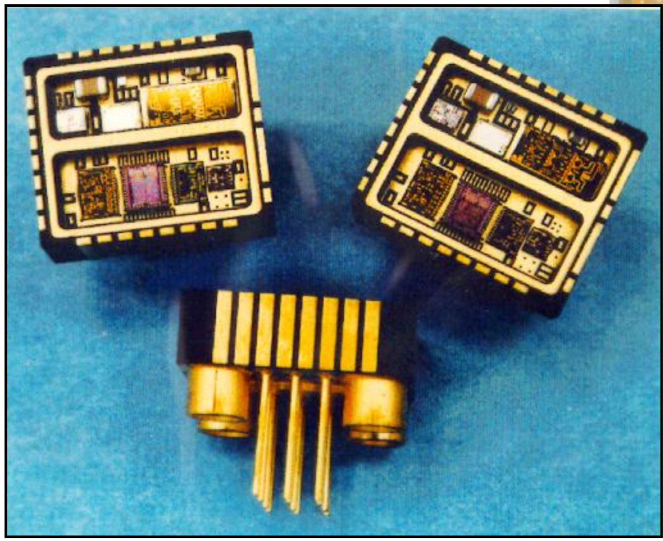
…Initial Test Pieces Started in '89/'90

Image Owned and Shown Courtesy of Advancing Microelectronics April 1996

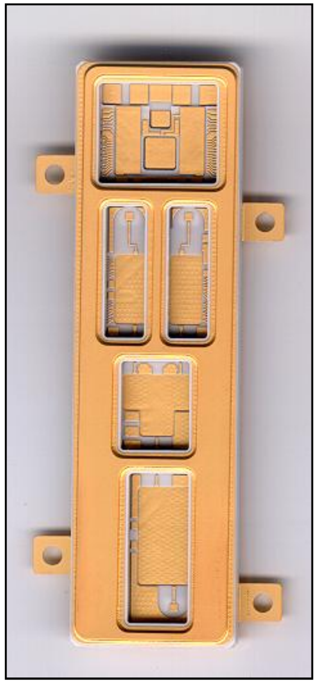
CURRENT TRENDS: Integration!!

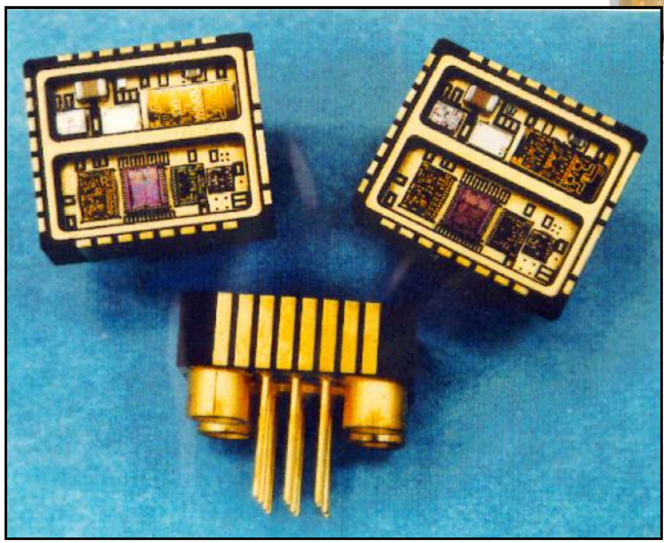


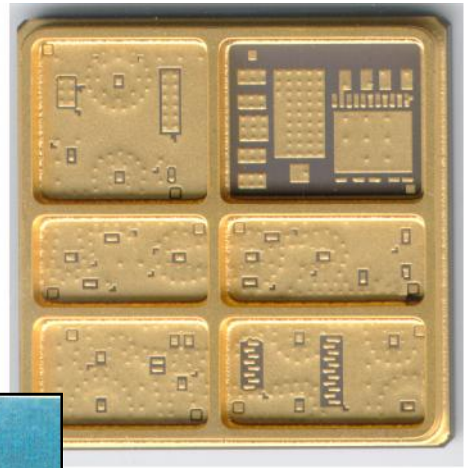




…Housing Integration…



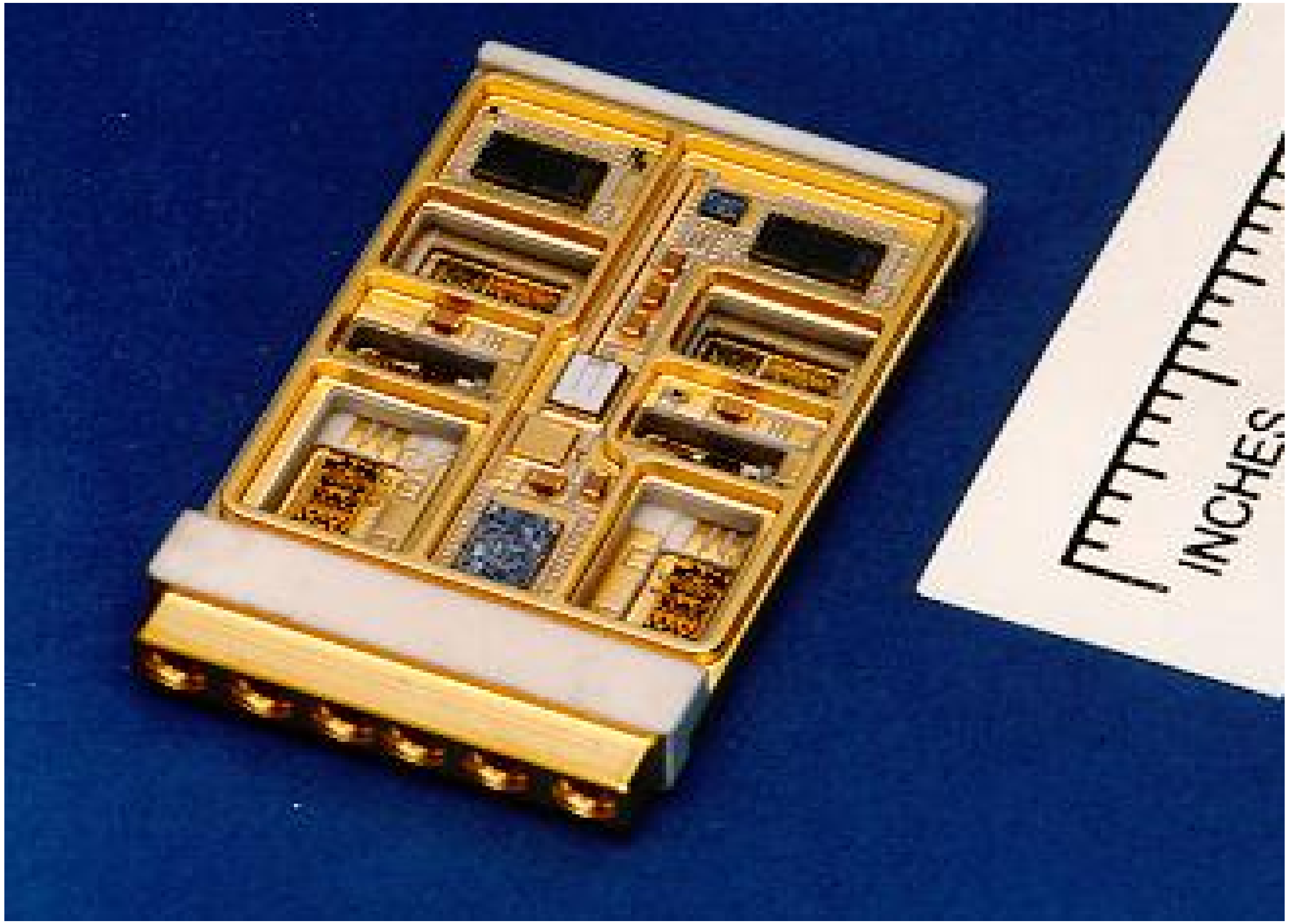




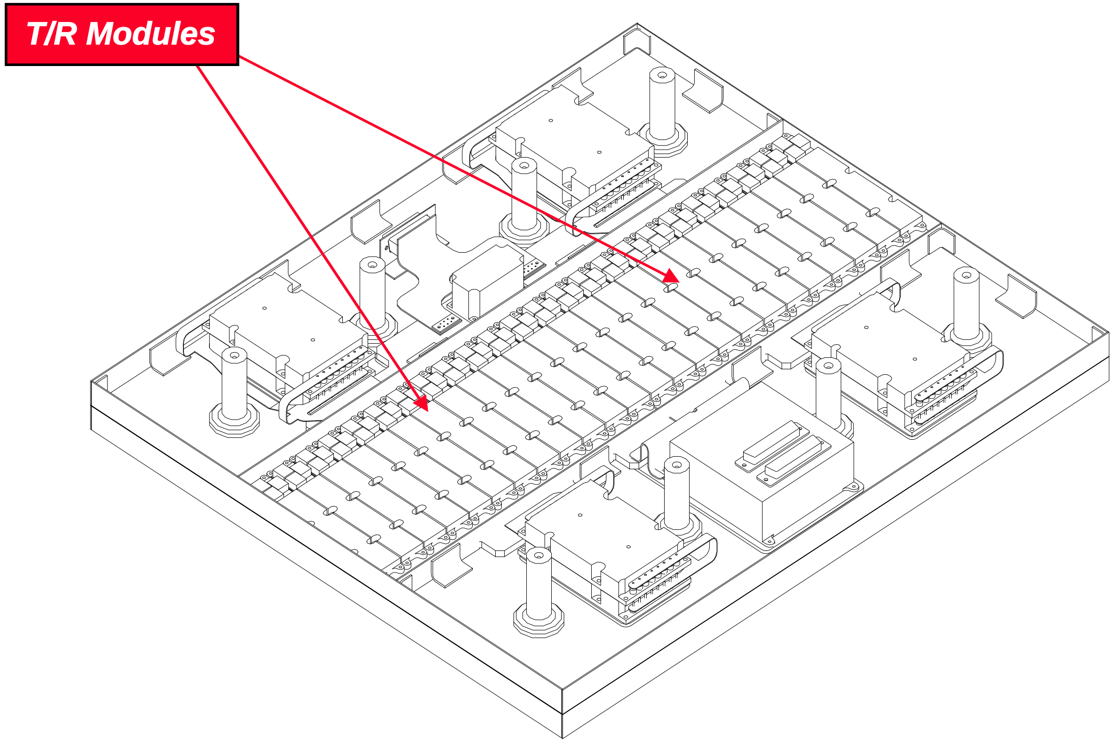
Low Cost Microwave T or R Modules for Active Antennas

- **4 Layer Alumina**
- **Simple Brazing**
- **Simple Metal Components**

Published X Band T/R Module



X-SAR 1D AESA Back View



TREND: Complex Electrical Simulations Typical in Complex Housings

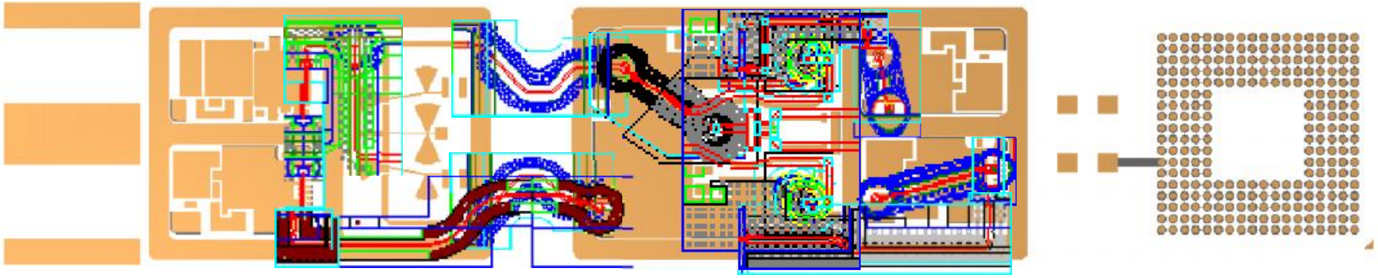
2. PA output

7&8. Calibration to GPPO

1. PA in

5. Output to Cinch connector short and long versions

4. 3dB coupled line



3. Polarization switches to Circulators

9. -16.5dB coupler calibration line

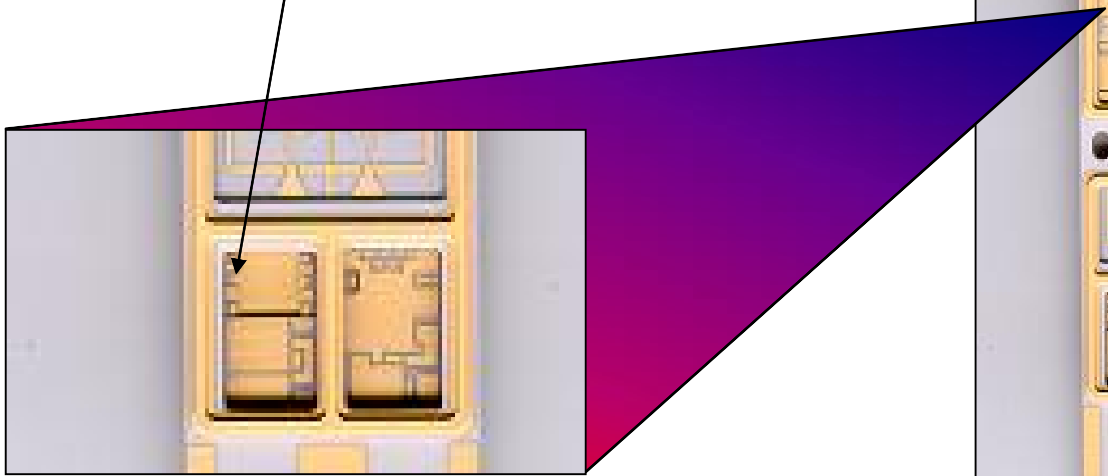
6. 3dB coupled line

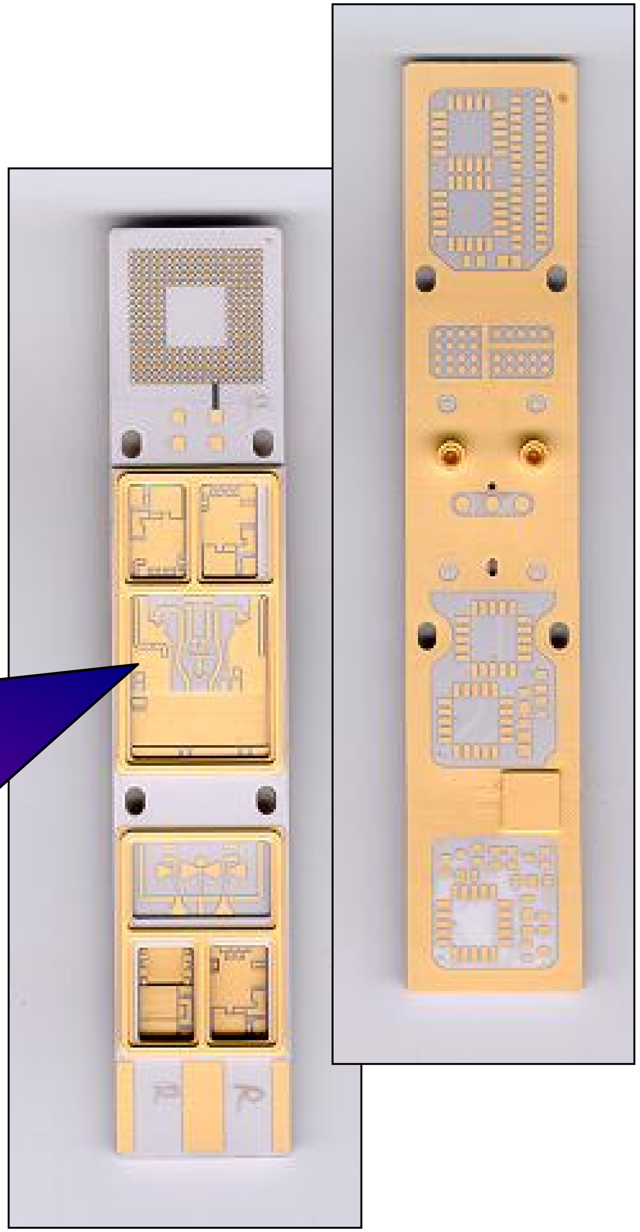
10. GPPO to Long Stripline

11. Overall combined model

EX: Power Amp Output

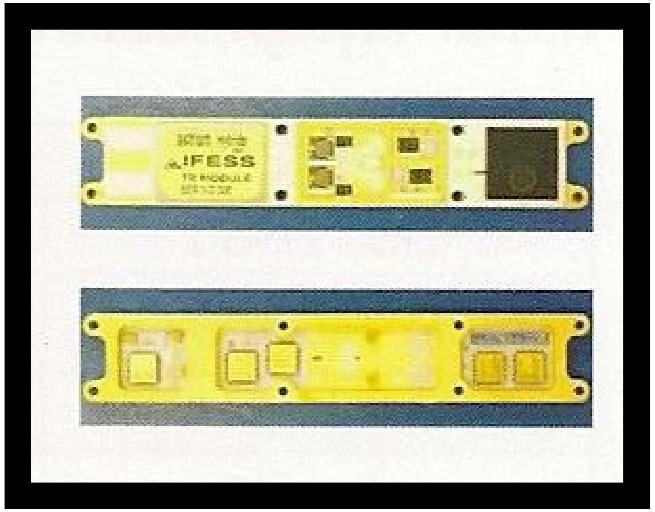
PA Output



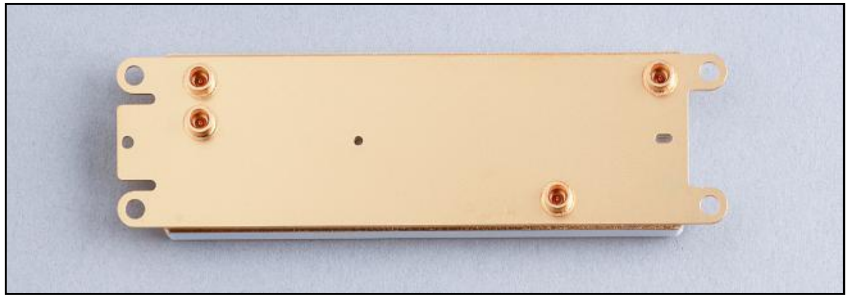


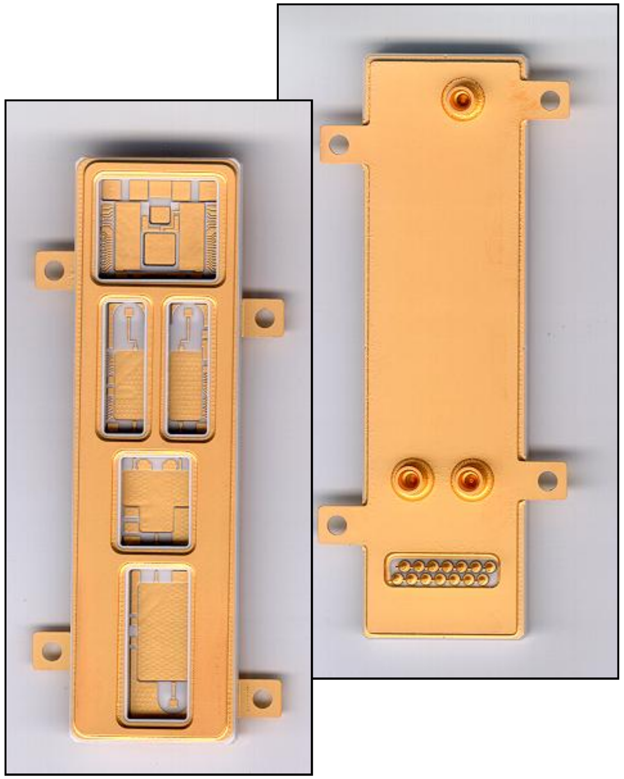
X-Band T/R Module used to Map UK Coast

<2m Resolution

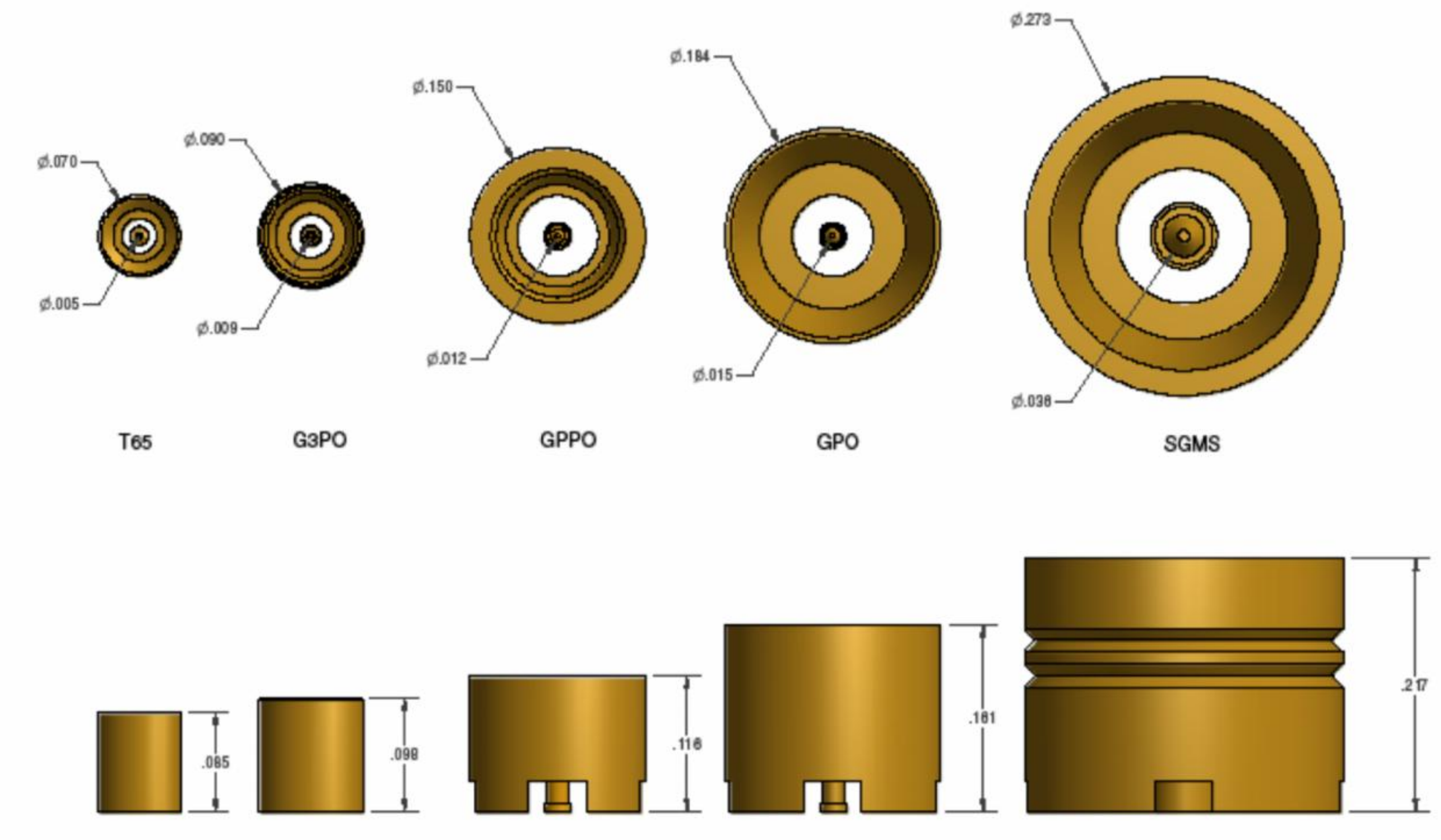


…Integration of Connectors…

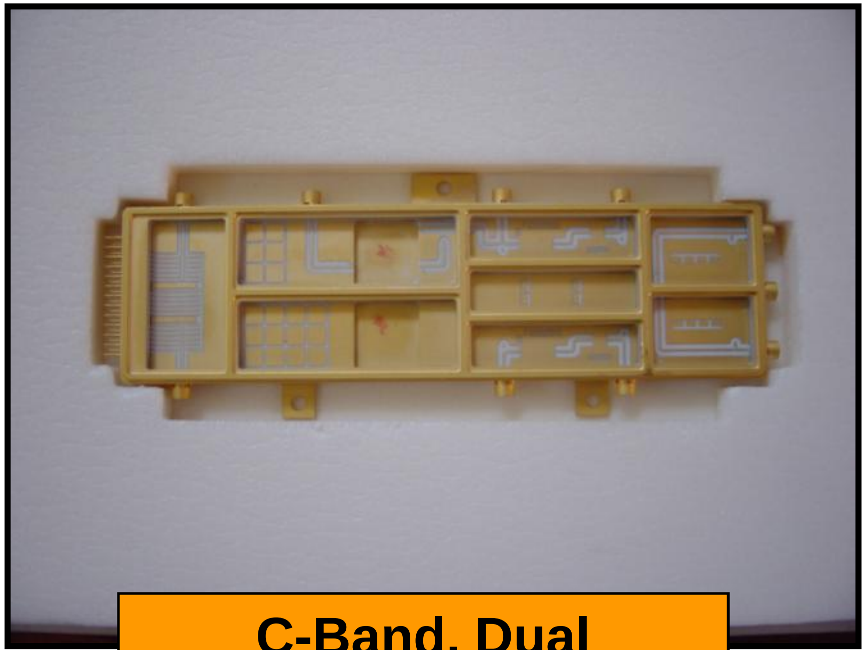




5 Blindmate Connector Types Available

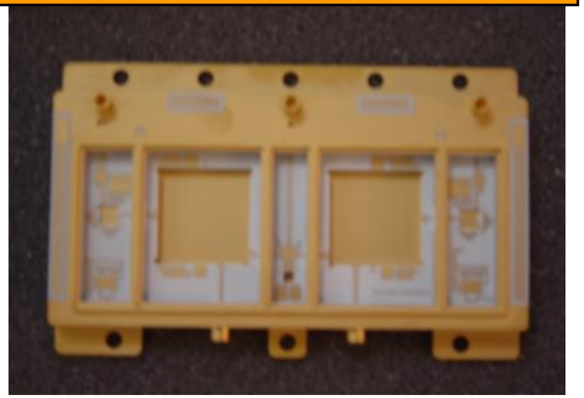


Complex Integration of Connectors



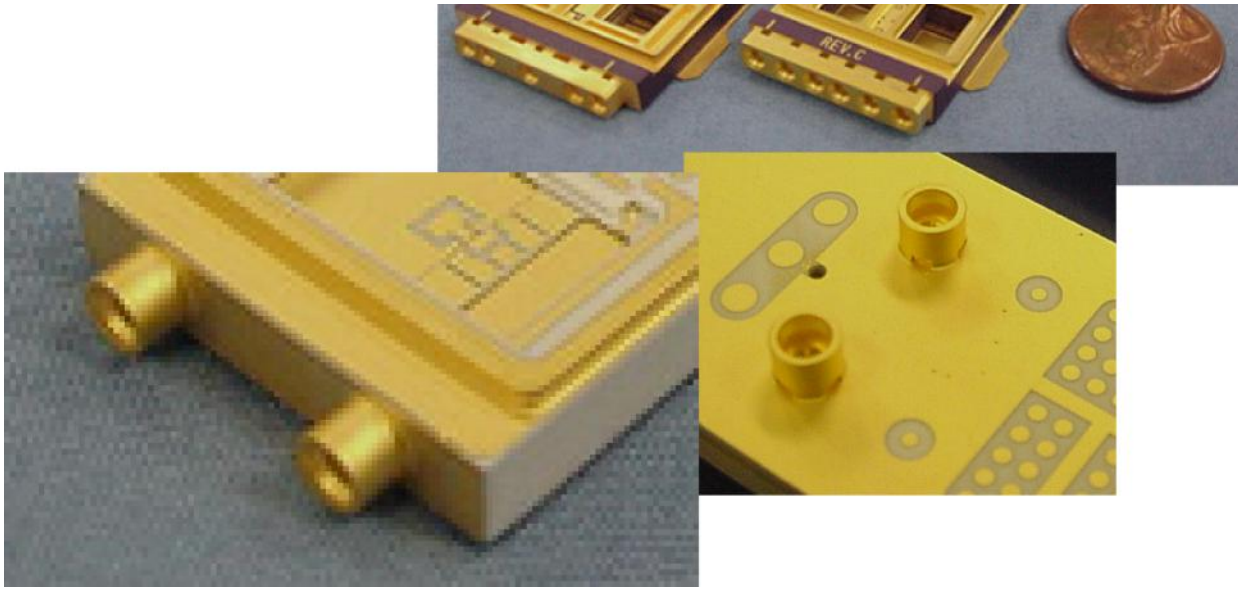
C-Band, Dual Polarized T/R Module

GPS III Module

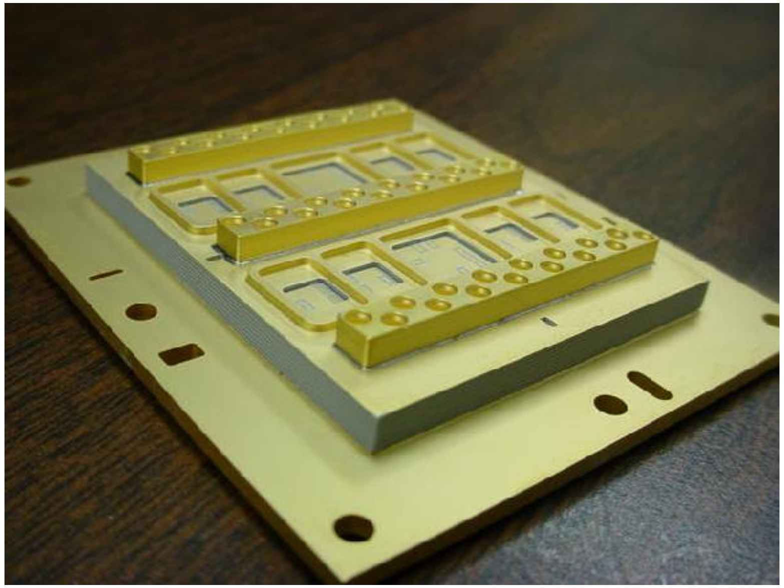


Most T/R Modules in Production have Integrated GPPO Connectors

- **Side Brazed**
  - ***Individual***
  - ***Grouped***
- **Bottom and/or Top Brazed**

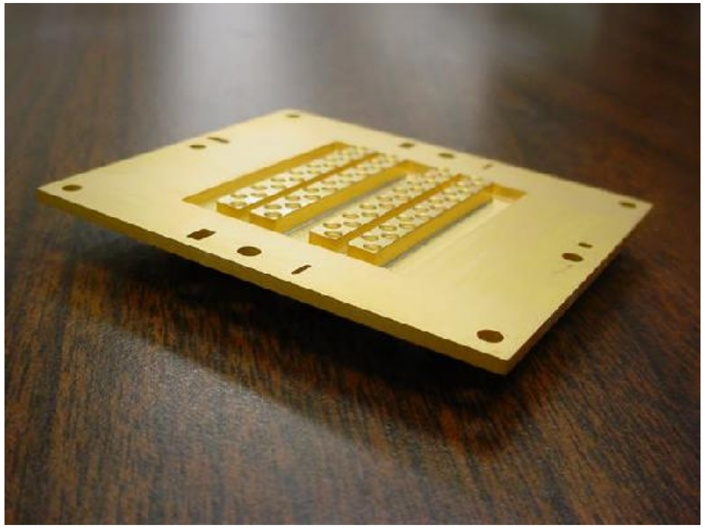


AZ/EL Array Combiner – Widescale Implementation of G3PO Connectors



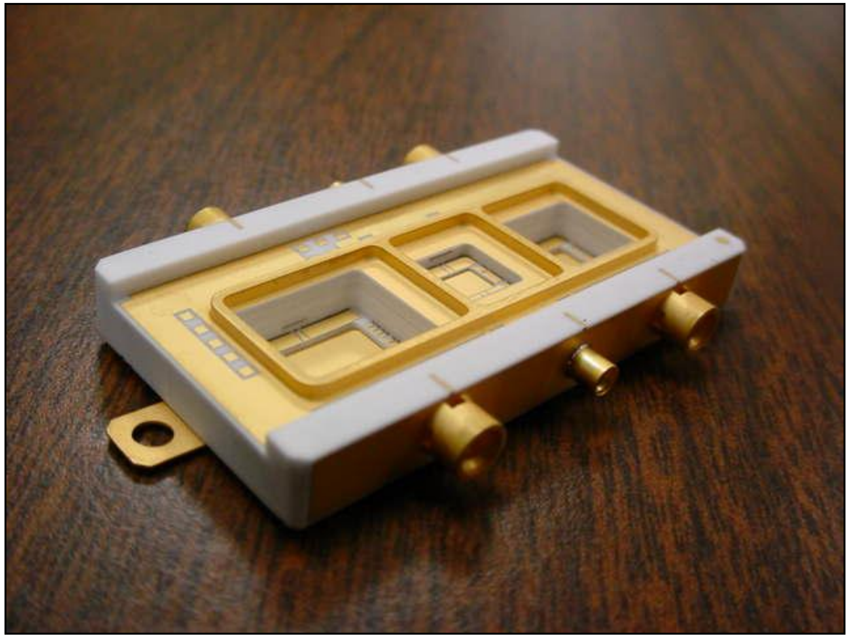
Top

Bottom

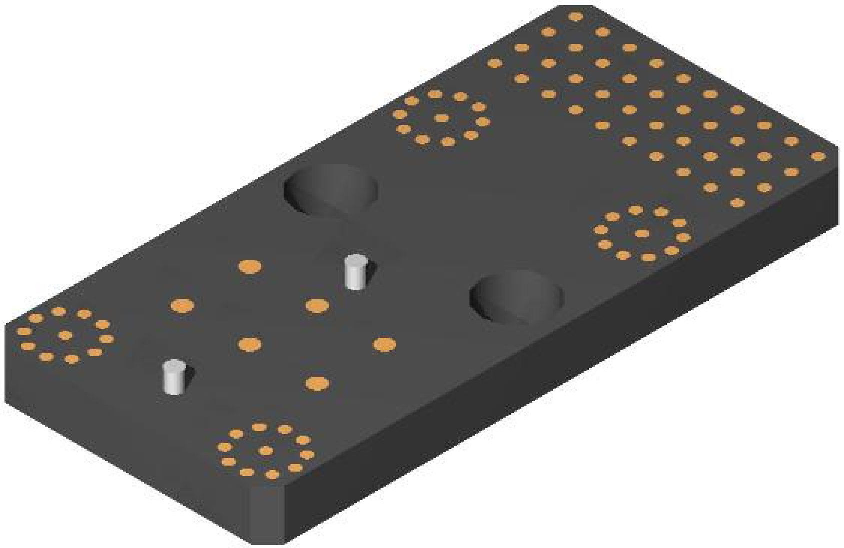


Package Characteristics…

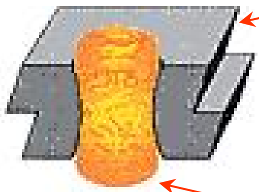
- **White Alumina HTCC**
  - **Dielectric Constant (e_r) = 8.8 @ X-Band**
  - **Tan**d **= 0.0009 @ X-Band**
  - **This Material Chosen for Brazing Maturity**
- **CuMo, Cu-Graphite and CuDiamond Heatsinks Delivered**
  - **CuMo ~ 180W/mK**
  - **CuGr ~ 430 W/mK**
  - **CuDiamond ~ >600W/mK**



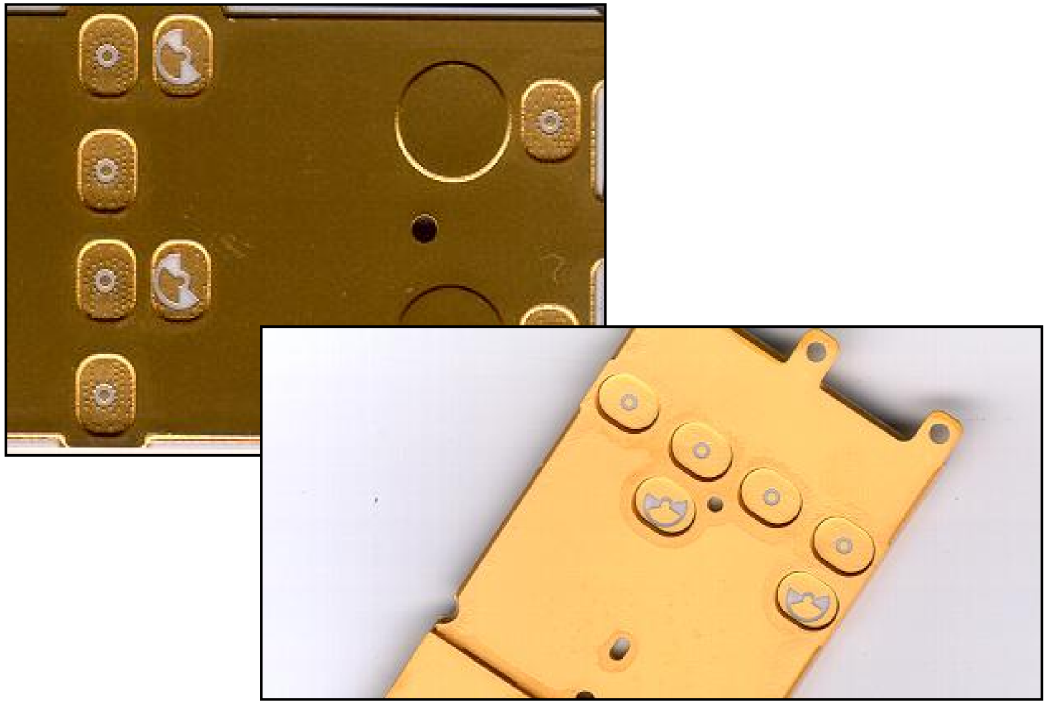
Cinch CIN::APSE Inerfaces Demonstrated



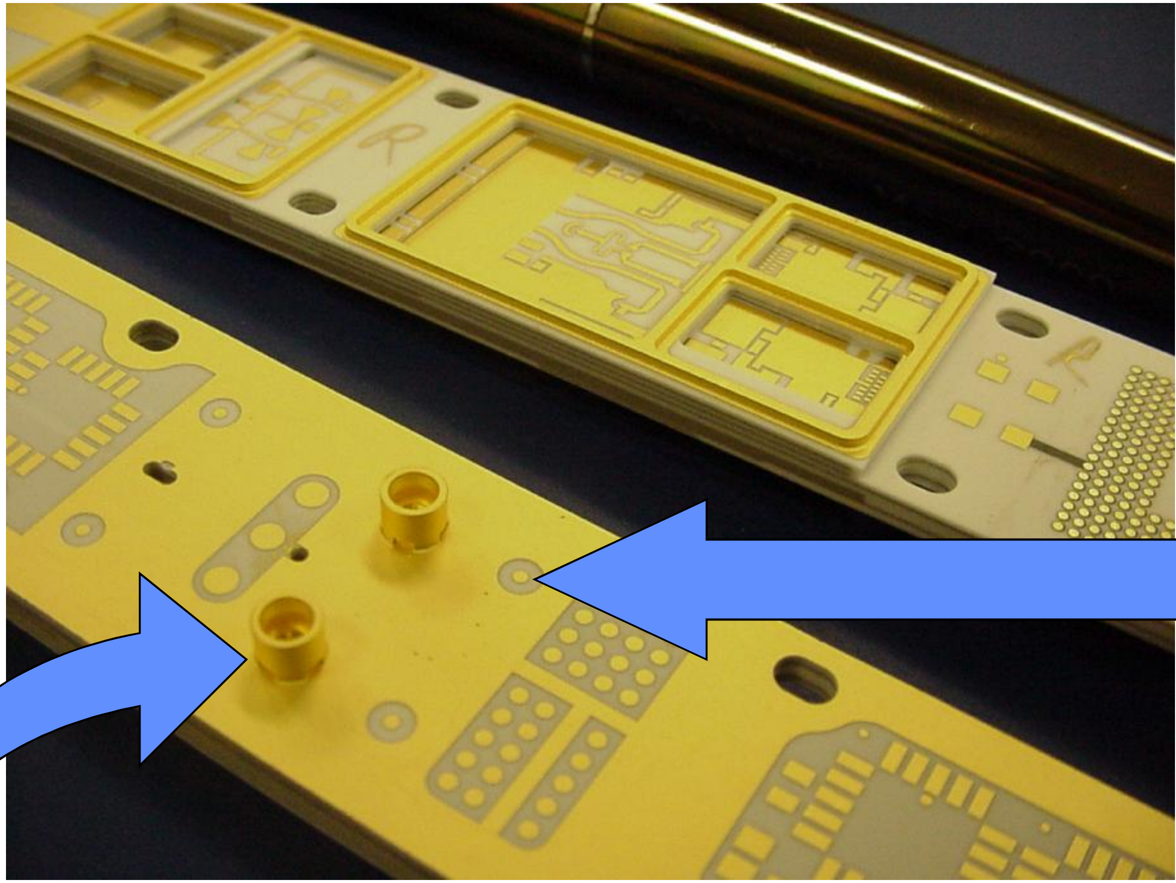
- ***Solderless compression connector.***
- ***DC – 20GHz.***
- ***Custom pad patterns.***
- ***25,000 cycles.***



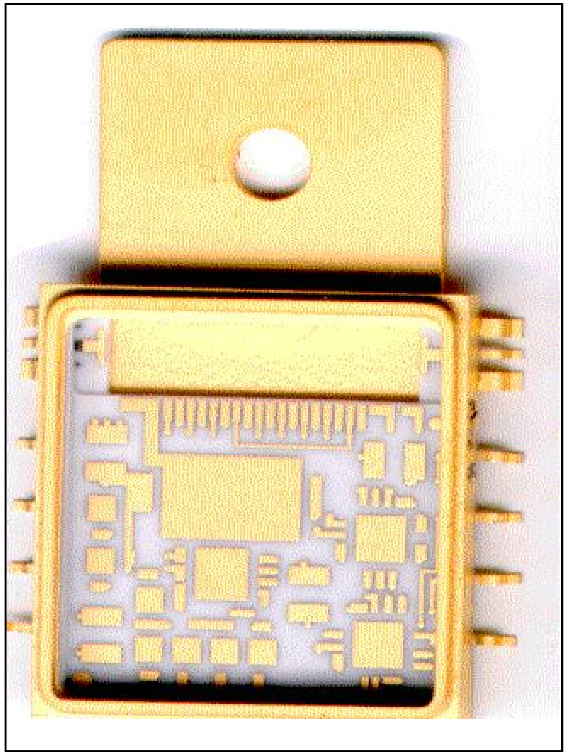
CIN::ASPE RF Interface for RF and DC



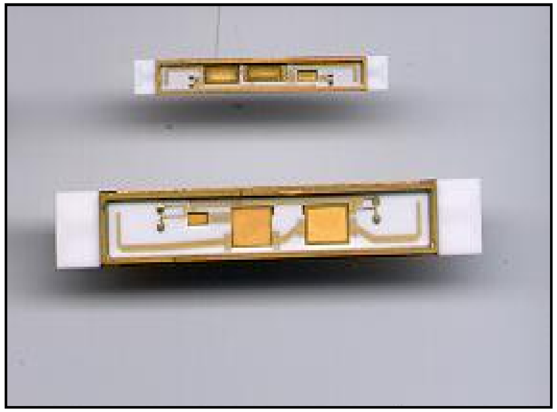
Some T/R Modules Contain both GPPO and CIN::APSE

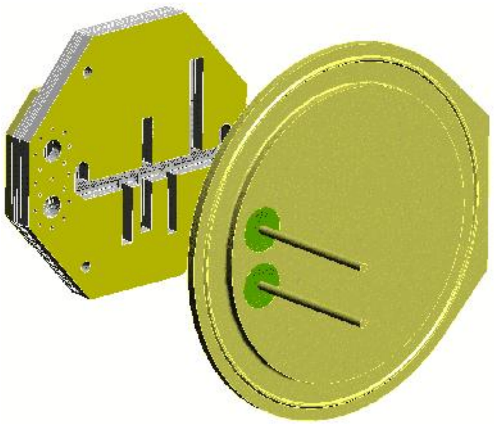


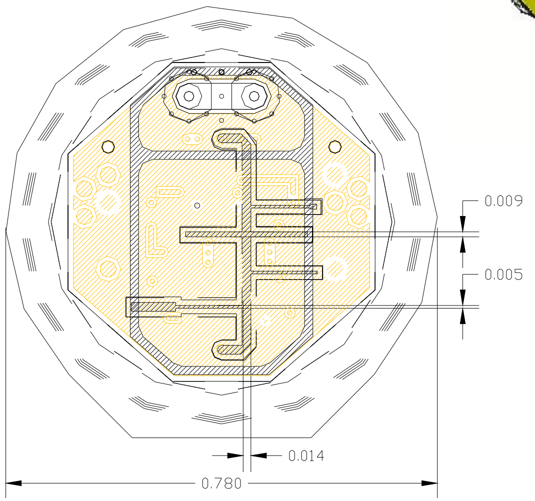
SMT Interfaces being Pursued for some T/R Modules

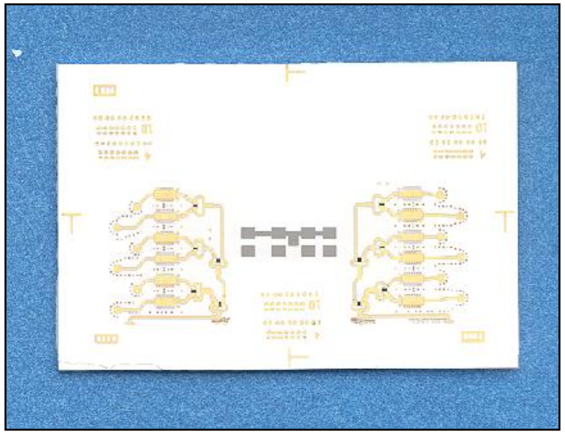


INTEGRATION TREND: Passive Components

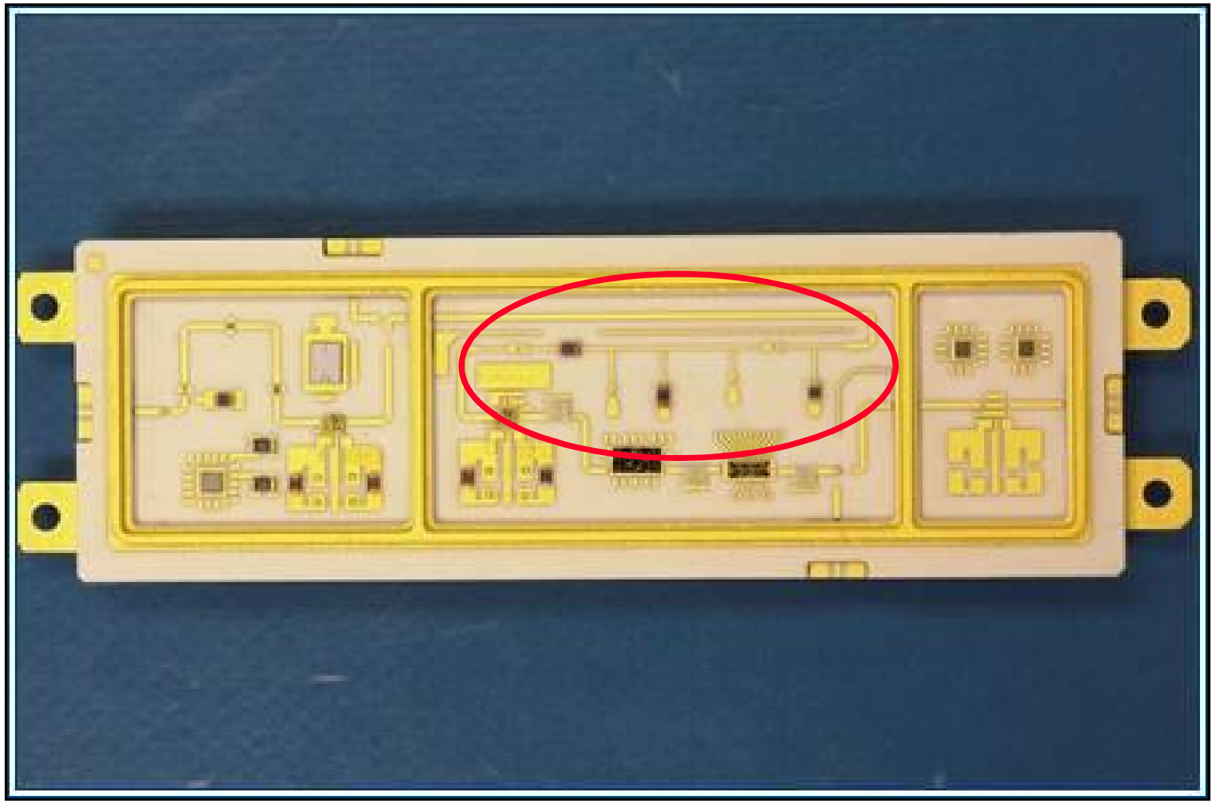




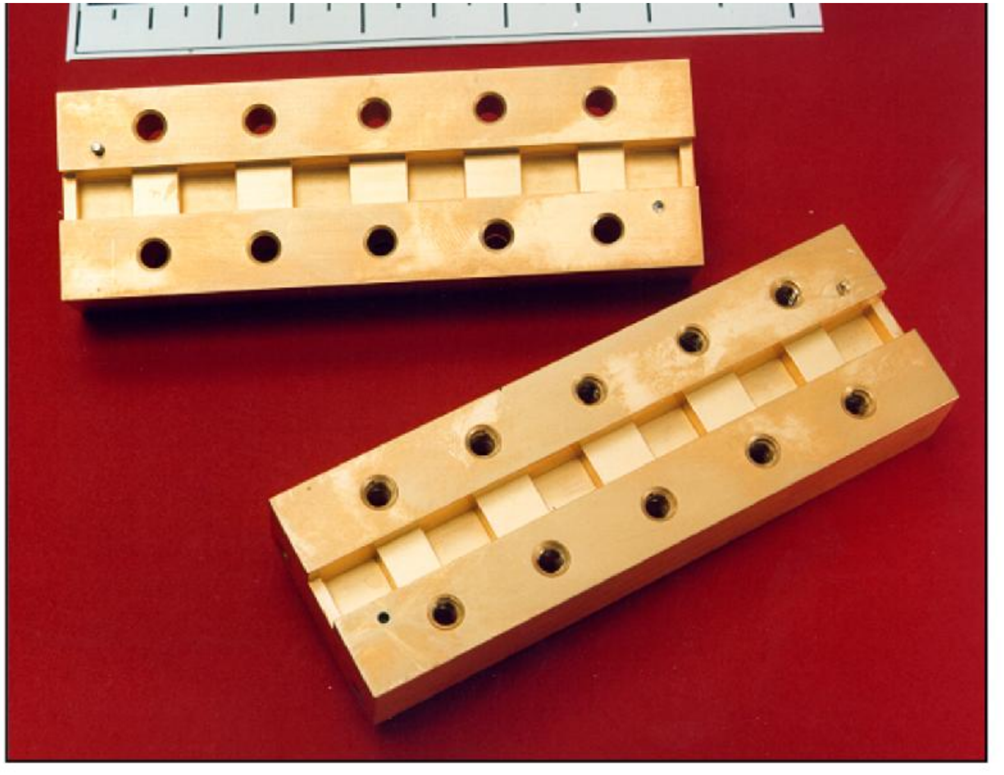




…L-Band Lumped Element Filter, Package & Discrete Combination

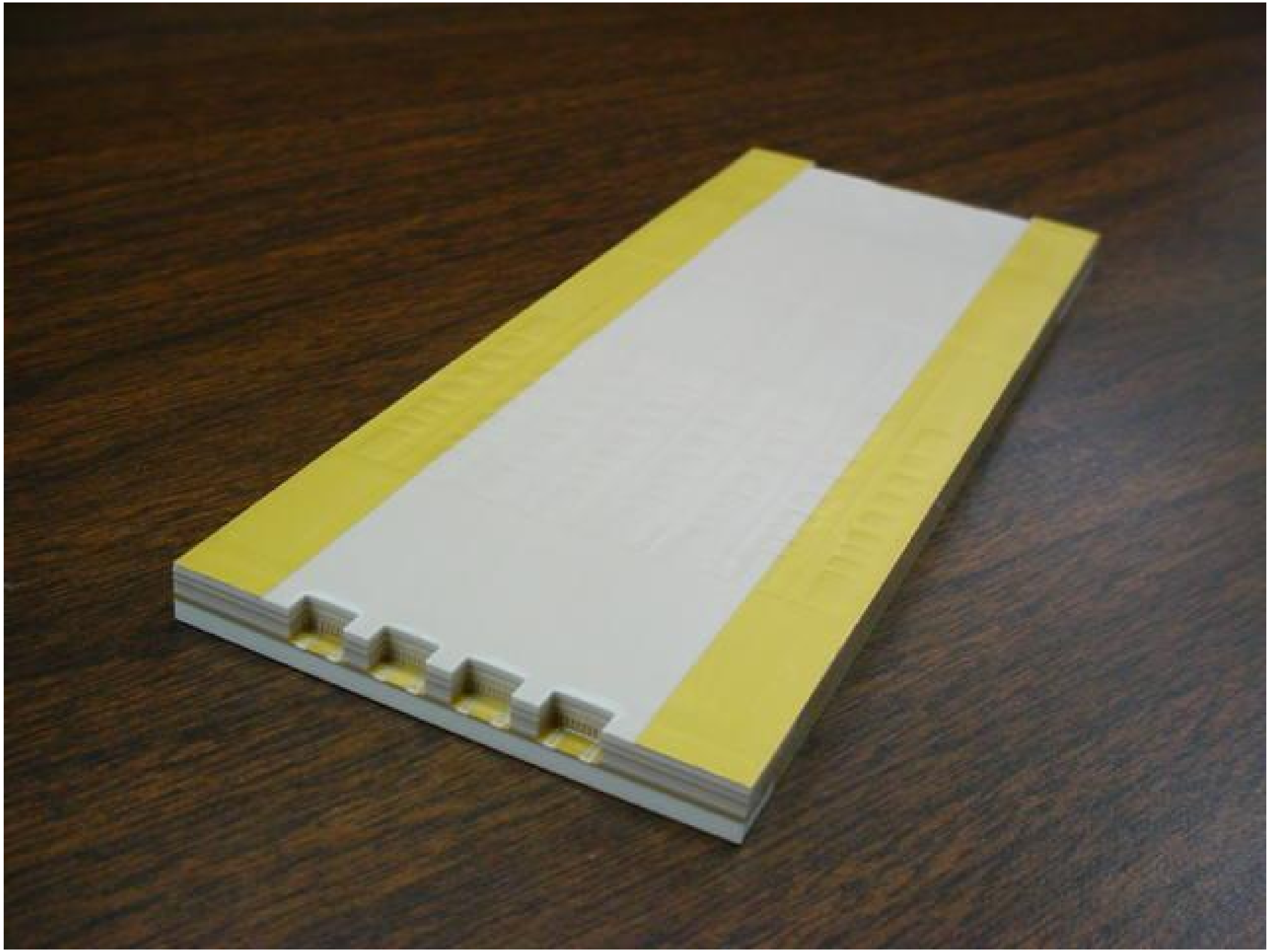


Waveguide Filters are the Lowest Loss but the Largest and Most Costly…

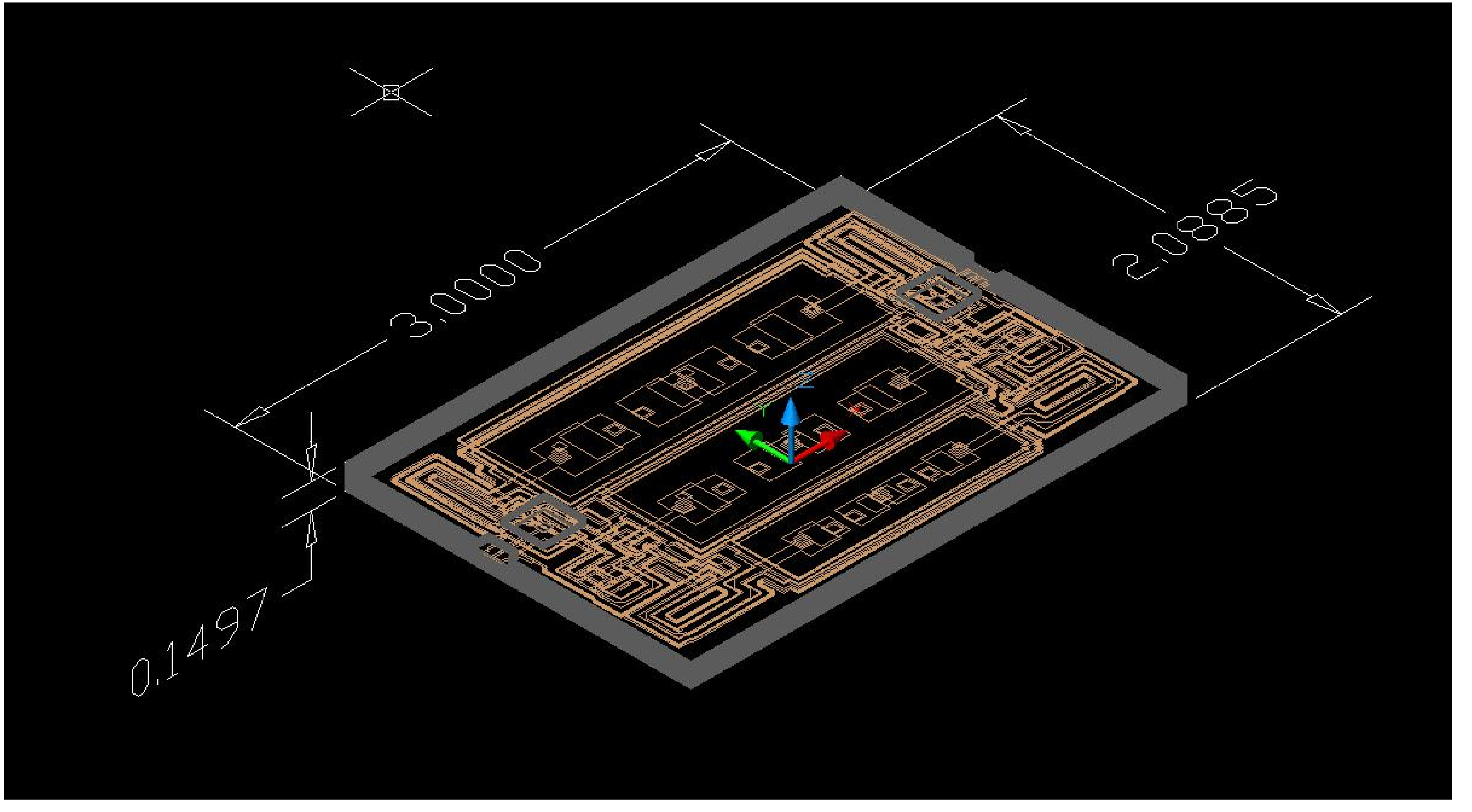


…Desire to Integrate Filter into Package

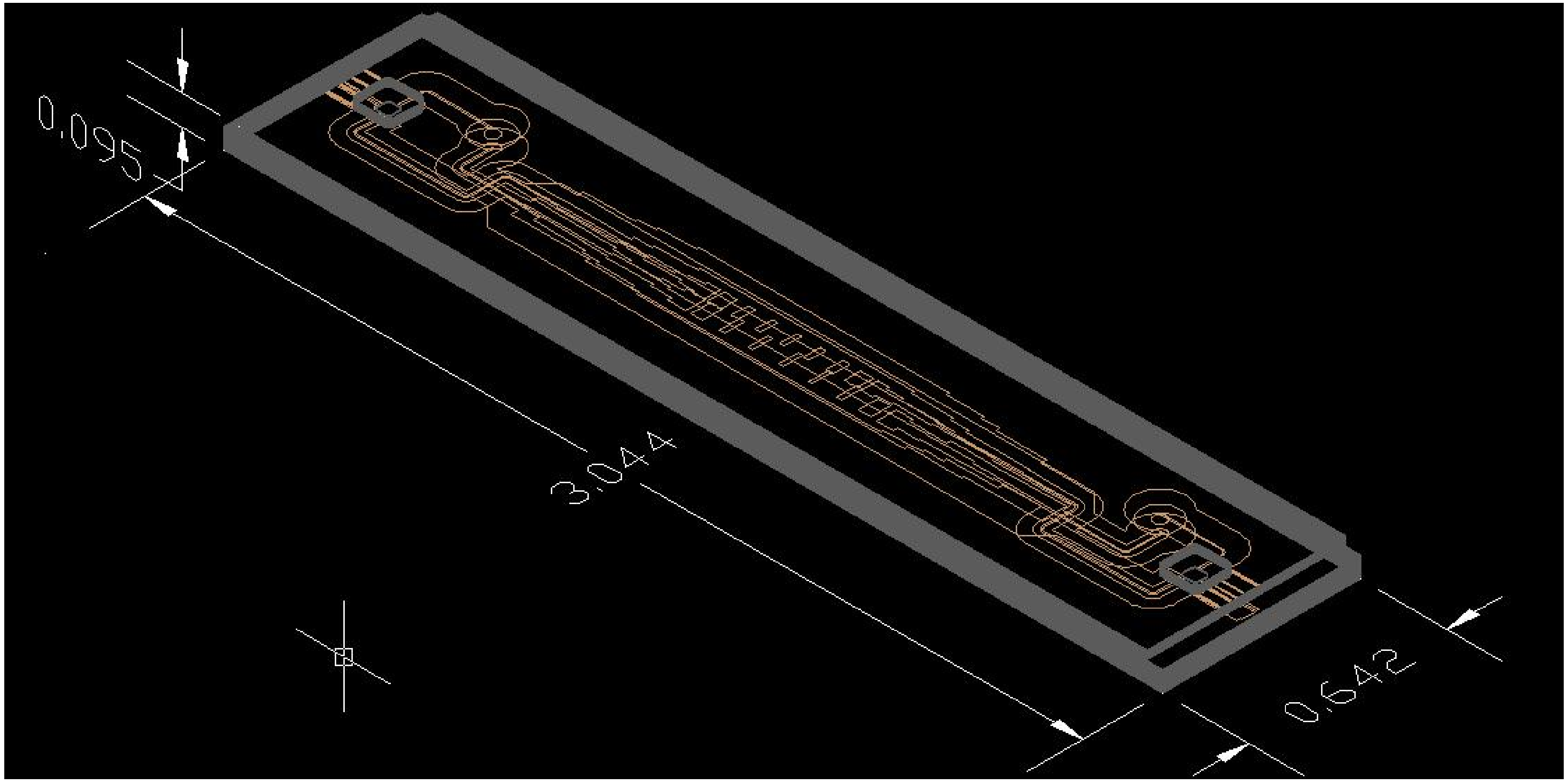
Eight (8) Triplexers = One (1) Multiplexer



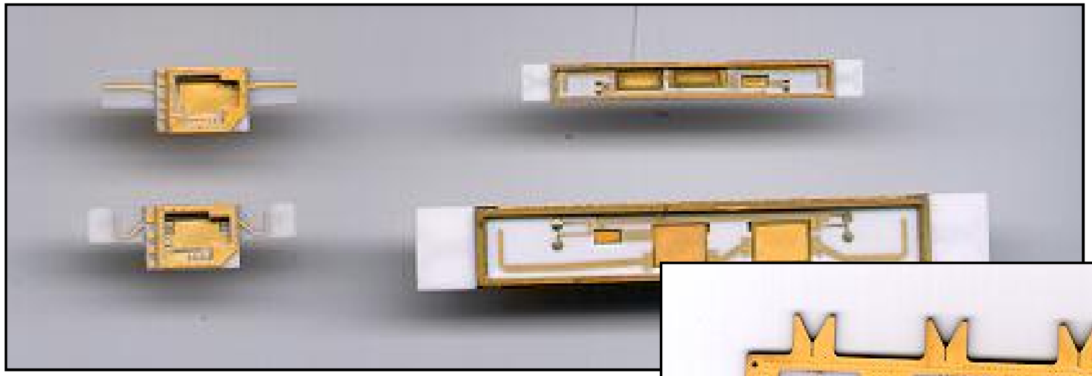
Filterbank 1 FINAL: 0.938 in^3

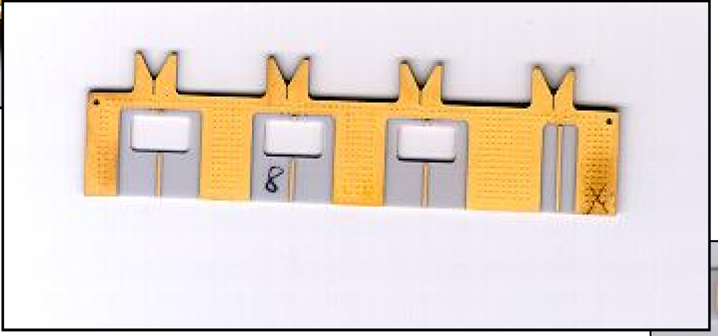


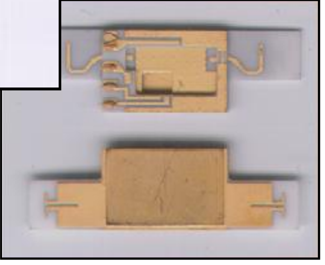
FINAL Filterbank 5: 0.1857 in^3



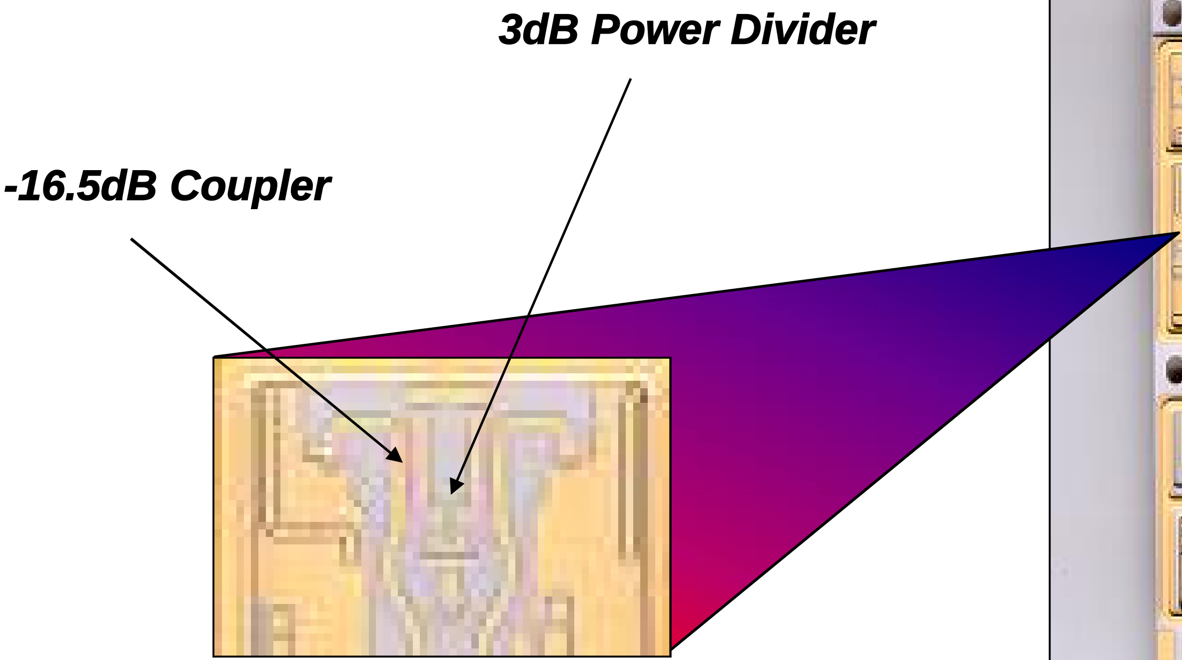
Some Modules Integrate Radiators

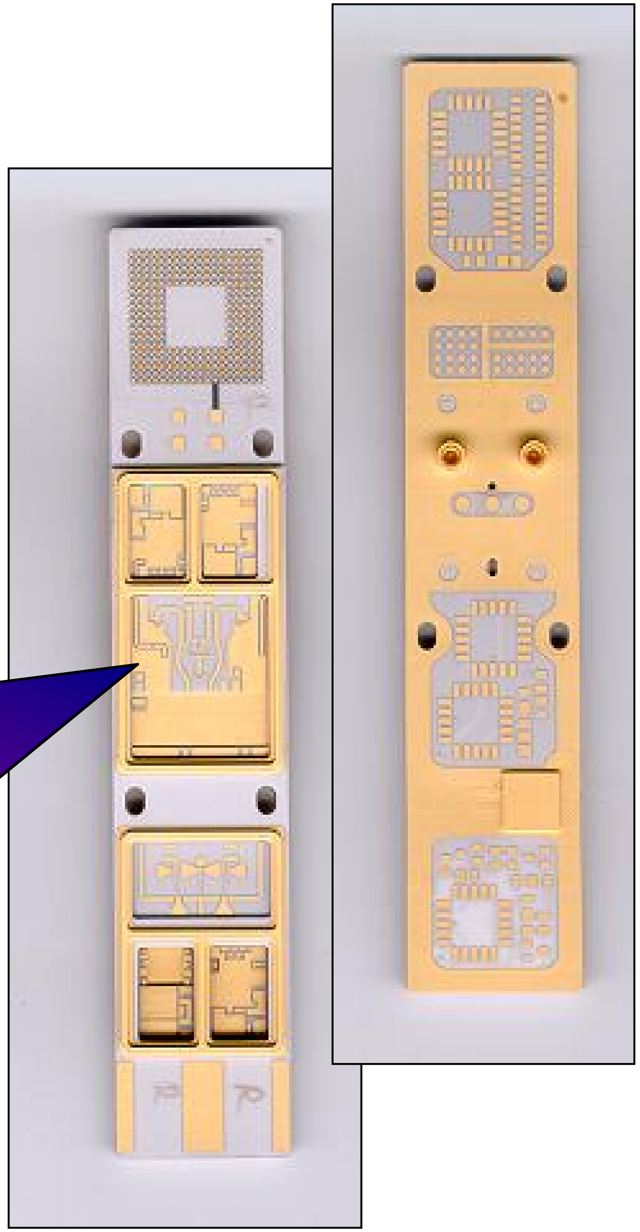




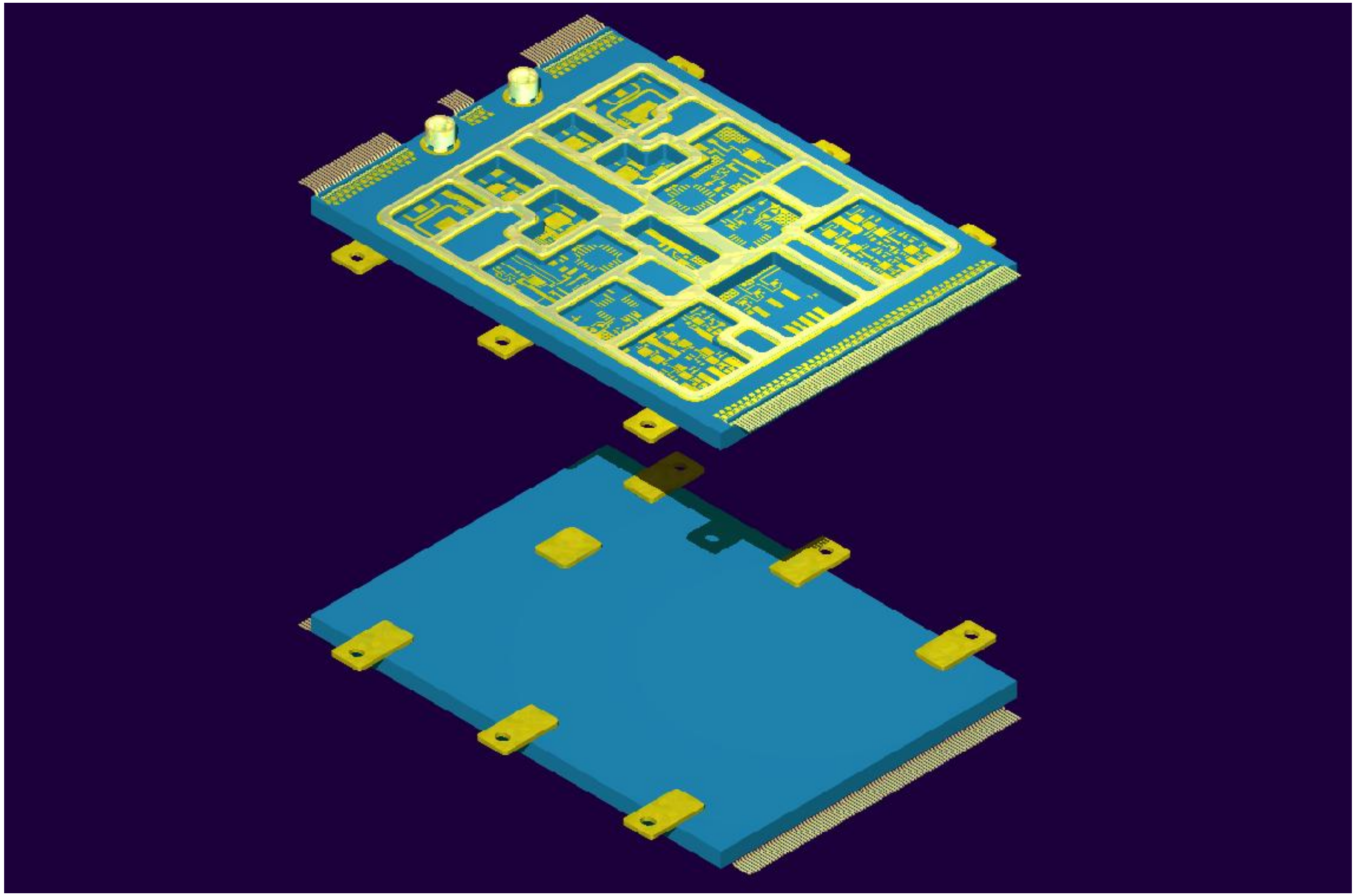


…Power Dividers Combined with Couplers…



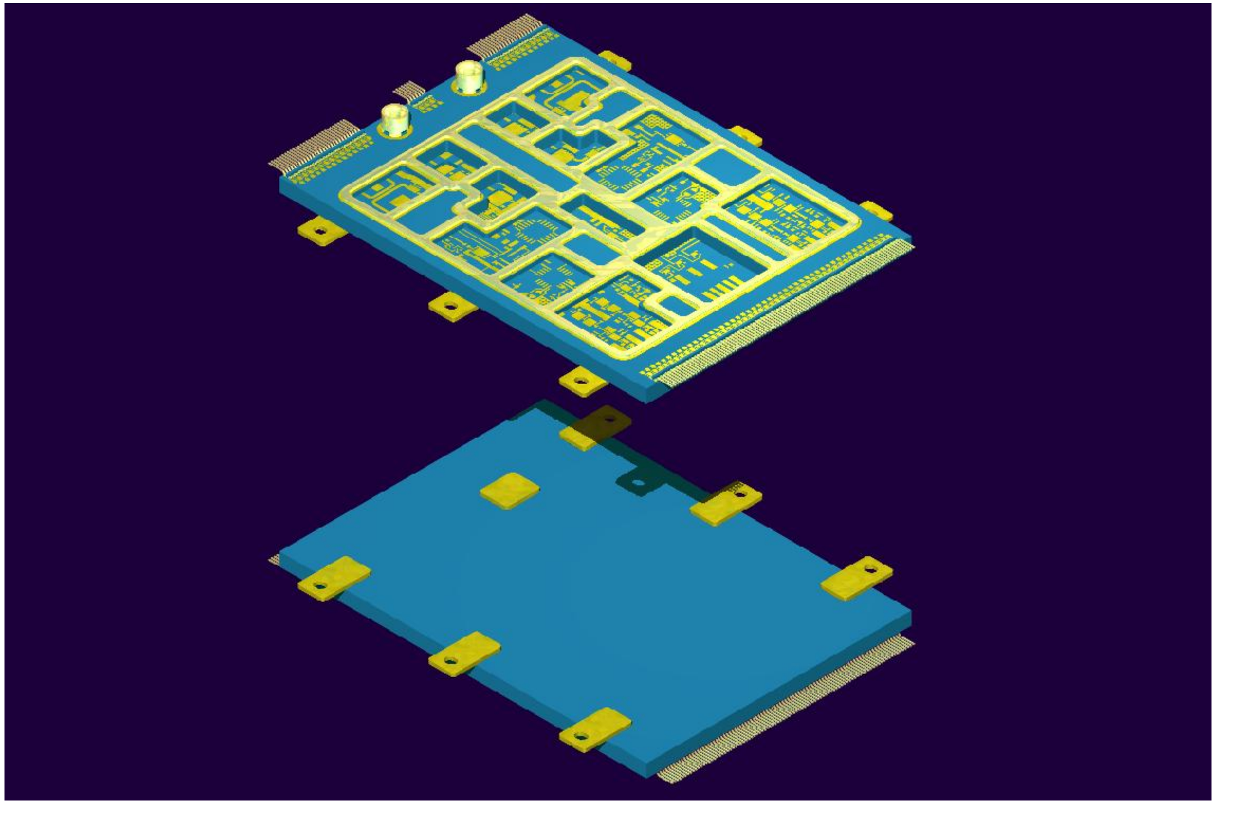


T/R Module, UP/DOWN Converter, Synthesizer: Transponder already in Development…

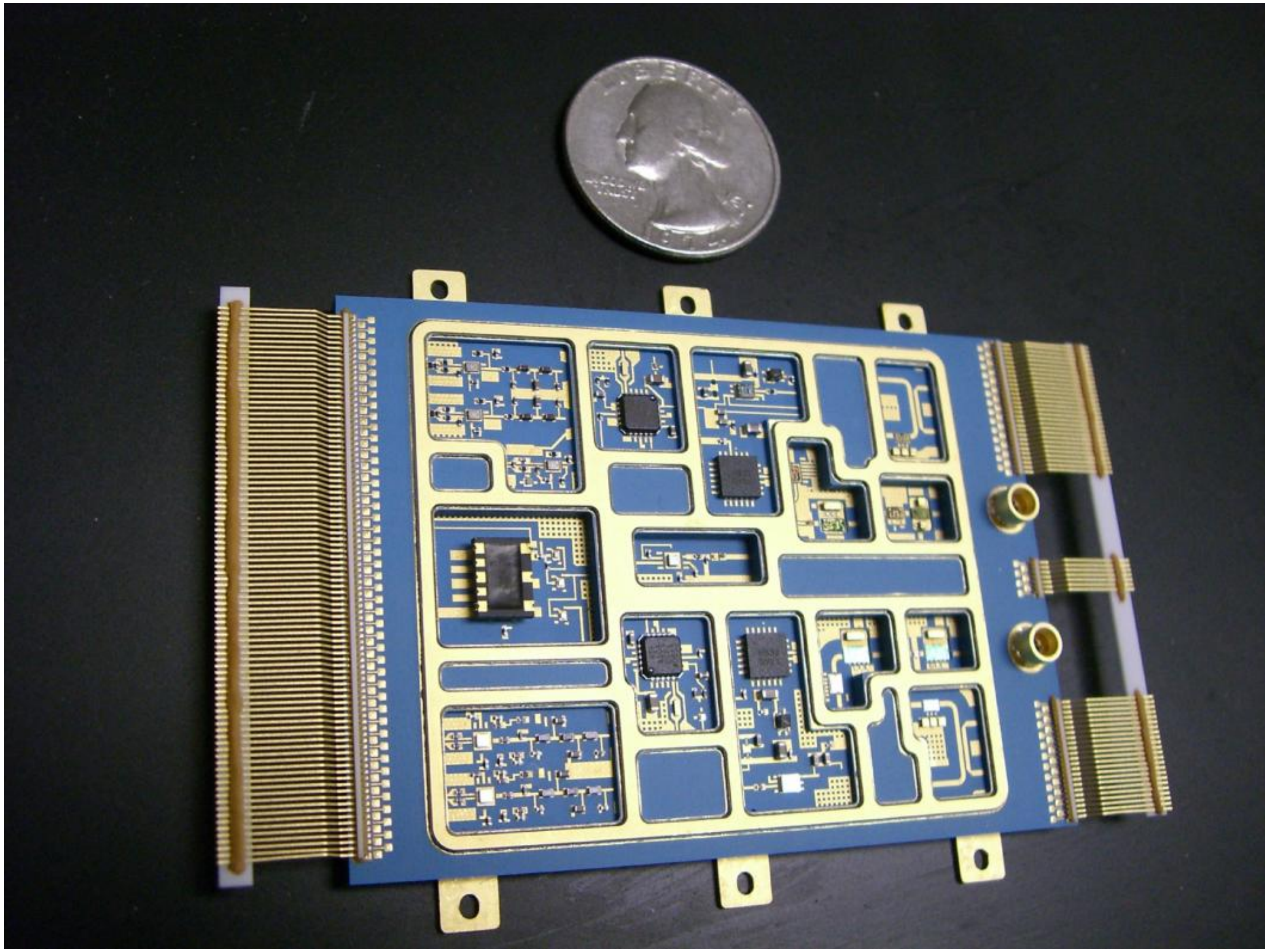


T/R Module, UP/DOWN Converter, Synthesizer: Transponder already in Development…

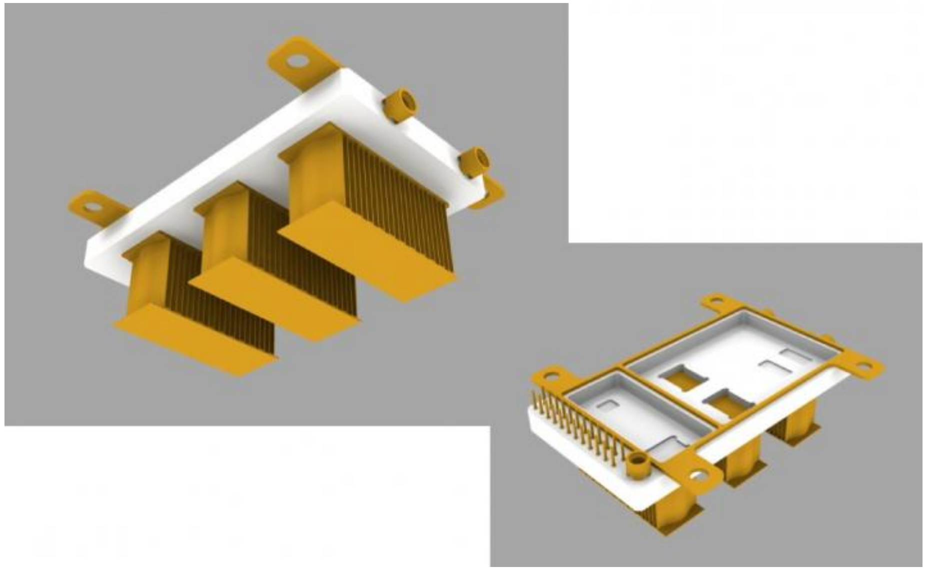
- **Integrated High Dielectric Constant Paste to Tailor Transmission Lines**
- **Integrated Capacitors**
- **Integrated Resistors**
- **Integrated Connectors**
- **Highly Isolated Tx from Rx for Full Duplex Operation**

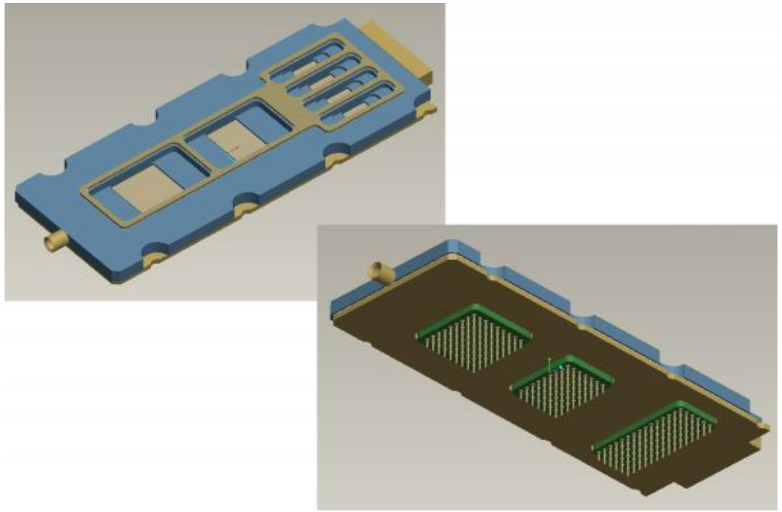


Assembled, Transponder



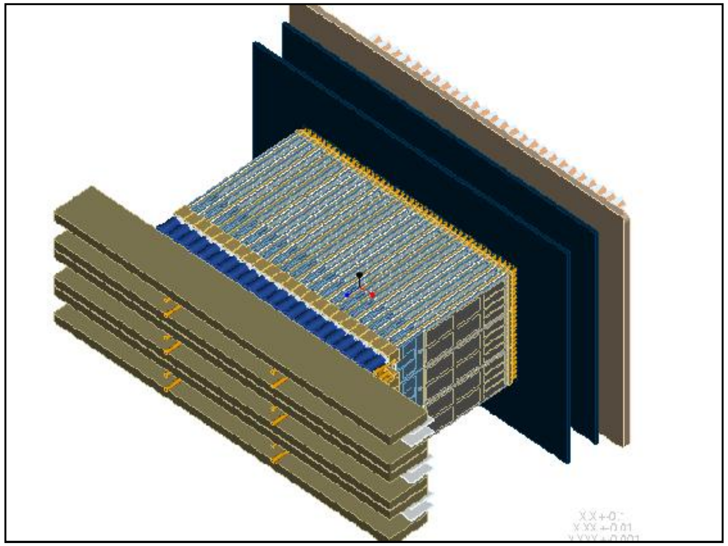
Convective Heatsink will Integrate Fins and/or Pins for Improved Cooling





Current Module Activities

- 35 +/- 1 GHz Tx Module with Integrated Radiator
- 35 GHz, 29% BW, Tx Module with GaN Amp with Integrated Liquid Heatsink (shown to the right)
- Wide X-Band T/R Module
- Multiple S-Band T/R Modules
- Diplexing S-Band T/R Module
- Ka/C-Band DREX
- 2-18 GHz Digital Rcvr Preselector Filterbank
  - In Design with GL-330/1
- 900 MHz Self-Equalized Filter
  - In Design with GL-330/1
- SDR T/R Module
  - Interest in Migrating to GL-330/1 or AO600
- C-Band Dual Polarized T/R Module
- Others



THE END