OMMIC *Innovating with III-V's*

100nm GaN on Si:

A Pioneering Technology to Enable High RF Power in Millimeter Wave Bands

NEW ENGLAND IMAPS SYMPOSIUM

MAY 5, 2015

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Sales & Application Team Manager, OMMIC

PRESENTED By Tom Terlizzi
VP, GM Systems LLC

OMMIC Overview

Europe's Leading III-V Foundry

- **OMMIC S.A. created in January 2000 based on 30+ years of III-V background**
- **Over 30 years of experience in III-V compounds including GaAs and InP**

Europe's Only Foundry to offer a truly complete service :

- **Epitaxial Growth**
- **Process Development**
- **MMIC Design**
- **MMIC Fabrication**
- **Test & Product Qualification**

ISO9001 version 2000, ISO14001 version 2004 Registered Company

OMMIC Customers Base

- **2013 →2014 revenues growth +22%**
- **106 Active customers over the world**

Military (44%) / Space (33%) / Civil application (23%)

- **Sales representative network**

•GM Systems USA East Coast

Booth 105

Agile Microwave Technology Inc
SAC
Selex ES A Finmeccanica Company
RFHIC
RUAG Aerospace Defence Technology
ASTRIUM AN EADS COMPANY
SHF Communication Technologies
THALES
NASA JPL
SPACE SYSTEMS LORAL
ERICSSON
SAAB Defense and Security

ISO9001 version 2000, ISO14001 version 2004 Registered Company

Key Market Segments and Positioning

Wireless Local Networking and Cellular Infrastructure

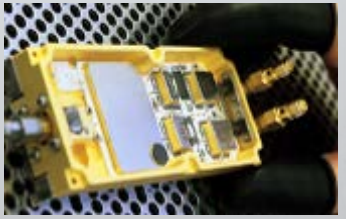
LNAs and Power Amplifiers

Defense, Civil Radars, Guidance systems

Control Functions and Integrated Core-chips

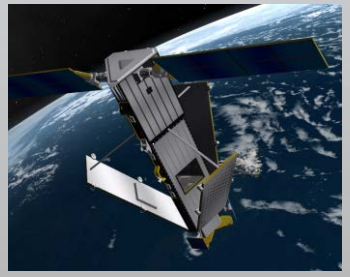
Security Scanners and Space Observation

94 GHz LNAs, Diodes and Integrated Solutions



Electronic Warfare and SATCOM

Power amplifiers, Switches, LNA



Hi-Rel Devices for Space and Defence

Qualified MMICs and Packaged Devices

OMMIC Key Numbers

- **3 inches III-V Wafer Fab**
- ***6 inches program for 2017***

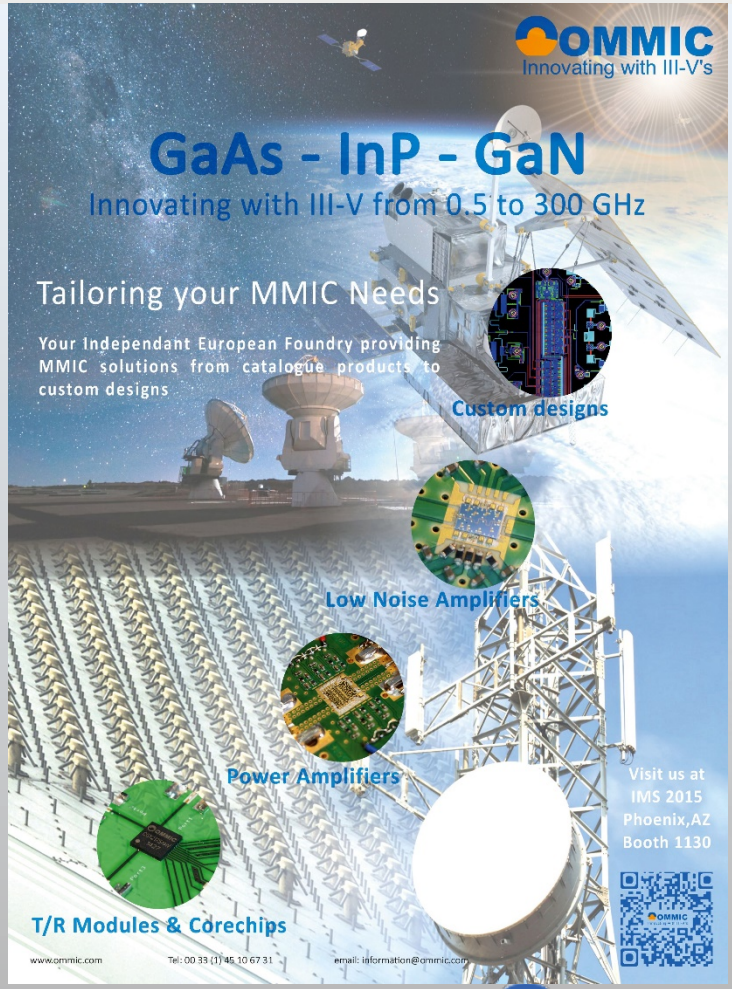
3 separate clean room areas :

- Production foundry line
- Process development line
- Epitaxial reactors line

2000 m^2 of clean rooms
3000 wafers / year

- **In-House Process development center**
  PHEMT,MHEMT and InP DHBT technologies

- **Custom MMIC Design center**



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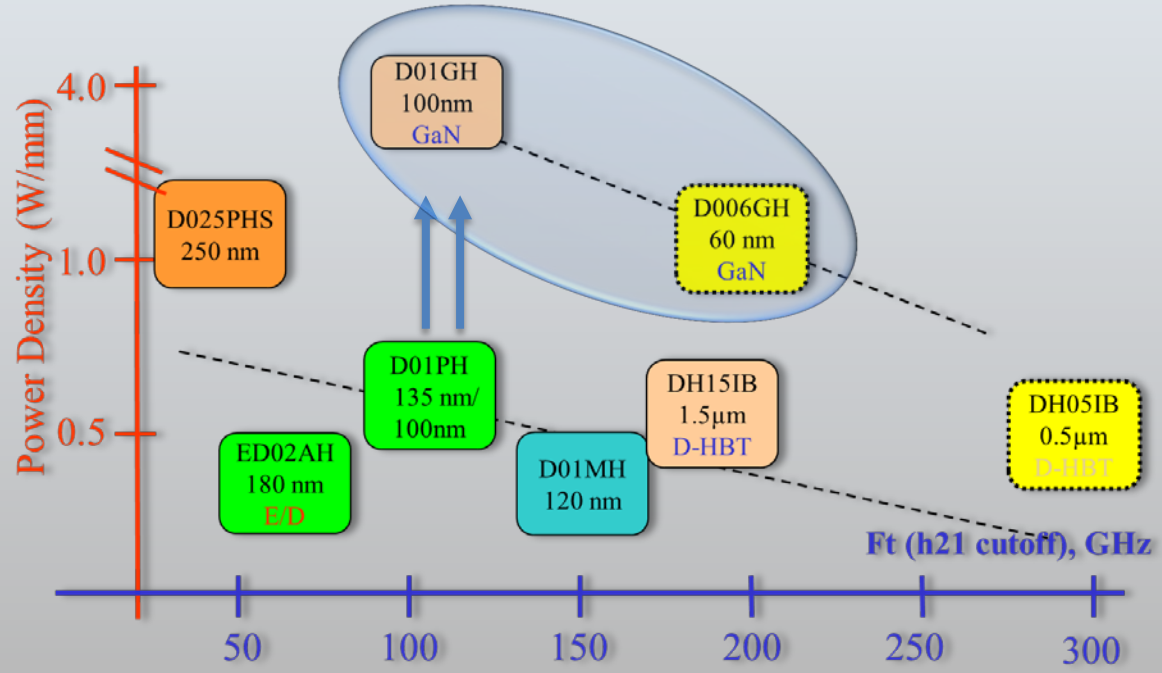
GaN processes and applications

RF Transistors and MMICs

- 0.5µm and 0.25µm HEMTs to replace high power LDMOS (> 100W)
- **100nm et 60nm GaN HEMTs to replace GaAs PHEMTs thanks to higher breakdown voltage and even better NF and gain**



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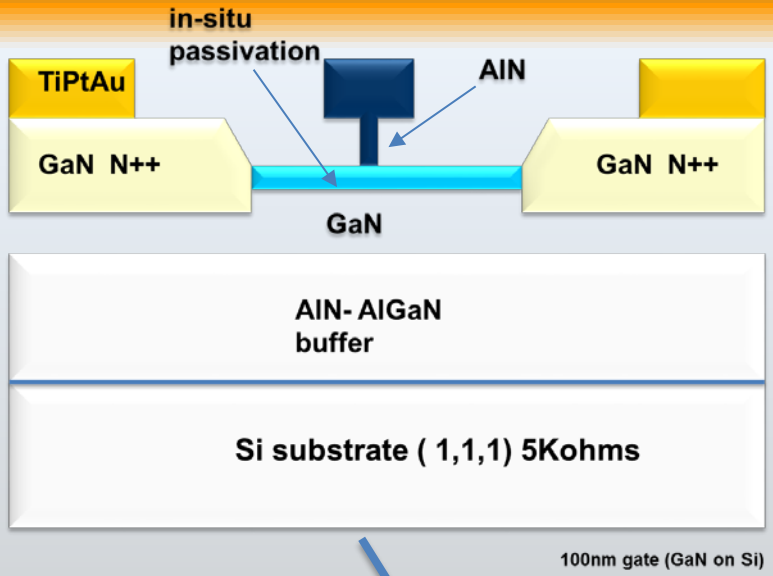
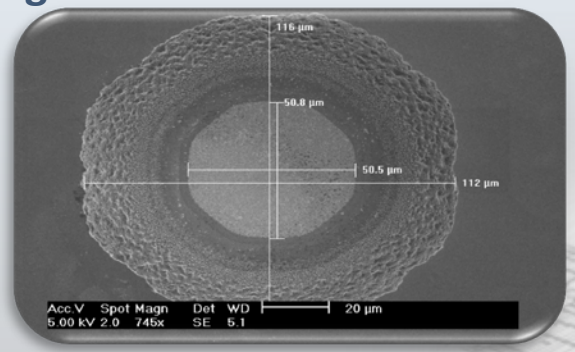
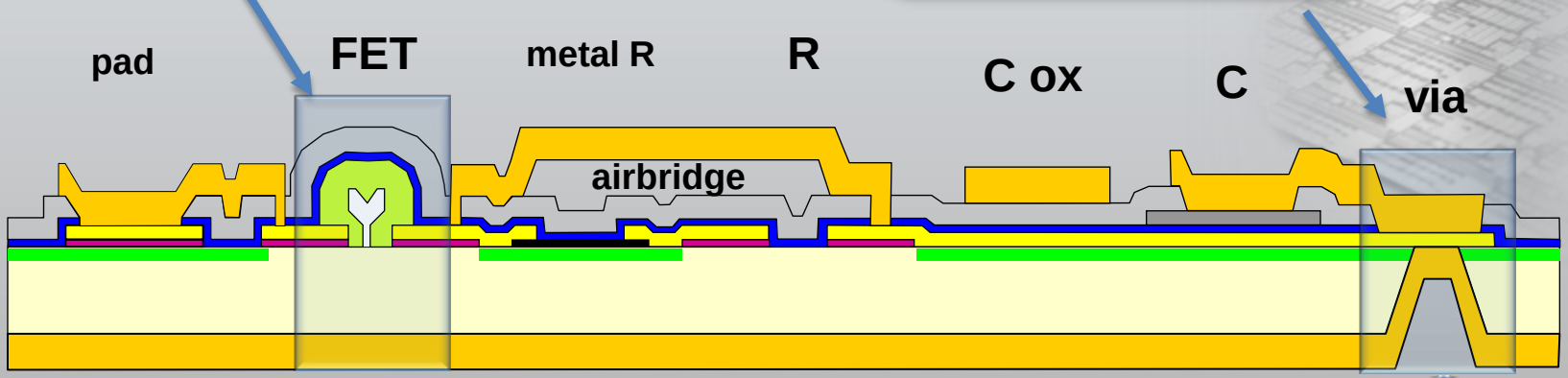
GaN/Si process features



- European epitaxy with in-situ passivation (EPIGaN) to get very sharp Ohmic interface.
- Regrown Ohmics (high gm , low noise: OMMIC)
- Mushroom gate





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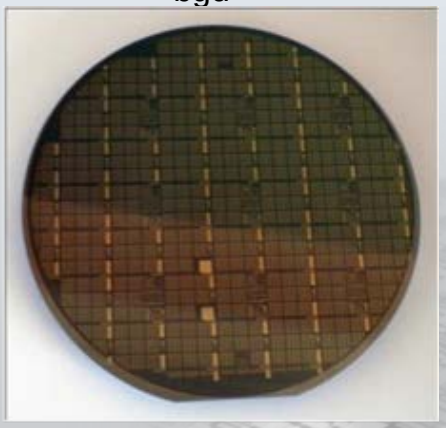
GaN/Si process features

Design Kit available under ADS or AWR
Pizza mask foundry run every 3 months starting June 2015

D01GH : f_{max} : 180 GHz , f_t : 100 GHz, Gate length : 100nm, V_{bgd} : 30 V

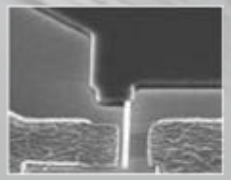


Preliminary on Wafer Measurements

- PW @ 30 GHz : 3.5 W/mm
- PAE : 48 %

Applications :

- High frequency Power Amplifiers *15GHz to 60 GHz*
- Robust Low Noise Amplifiers (< 40 GHz)
  up to 35dBm PinCW for radar application
- Instrumentation Wideband Amplifier DC-54GHz
- High Linearity Mixers

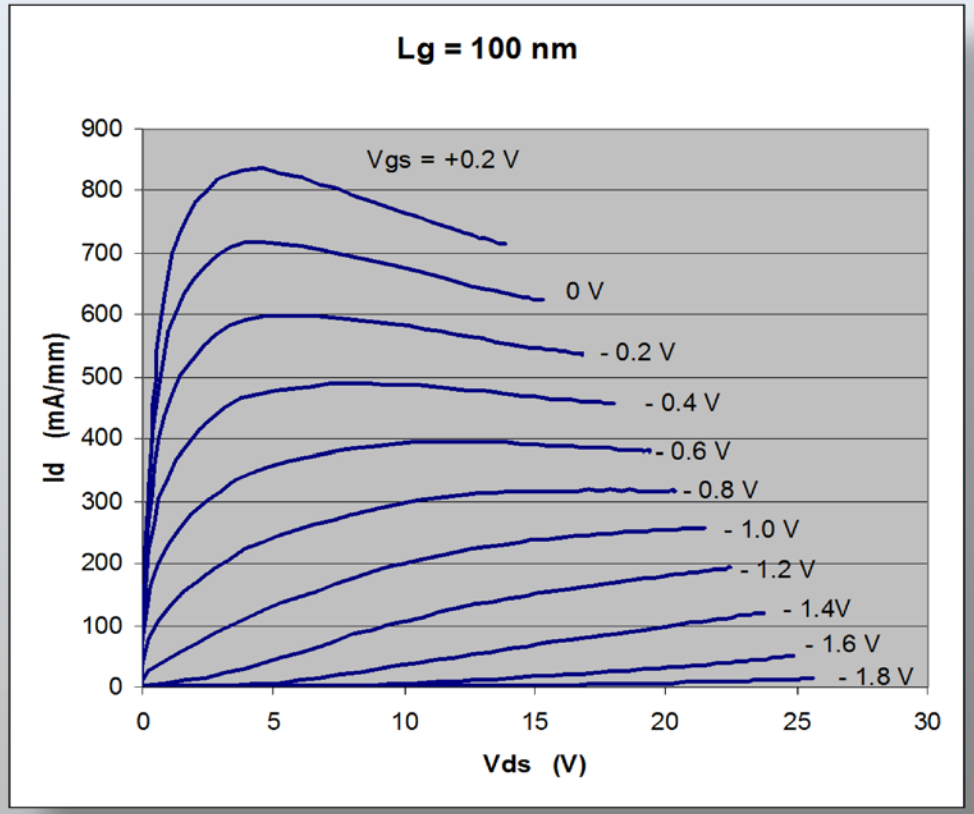


100nm gate (GaN on Si)

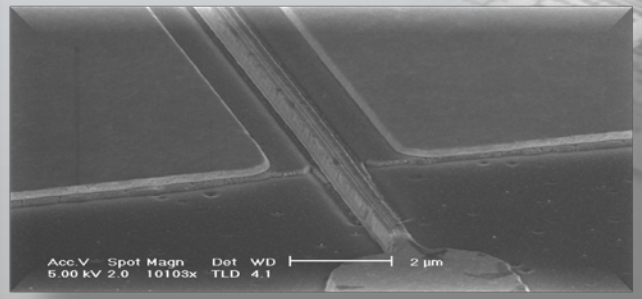
ISO9001 version 2000, ISO14001 version 2004 Registered Company

D01GH I/V characteristics and specifications

Gm max = 620 mS/mm; Ron =0,8 ohms *mm



- Idss (0V) = 700 mA/mm
- Vt= - 1.5V (@10V Vds)
- Gm max ext= 620 mS/mm
- Ft= 100 GHz, Fmax =180 GHz @ Vds = 3 V
- MSG = 18 dB @ 24 GHz
- Vbgd min =30V, typical = 40V (Vds max= 24V)
- Vdd =15V
- Psat> 3.3 W/mm at 24 GHz (Vds =12V)
- Nfmin<1dB @30GHz



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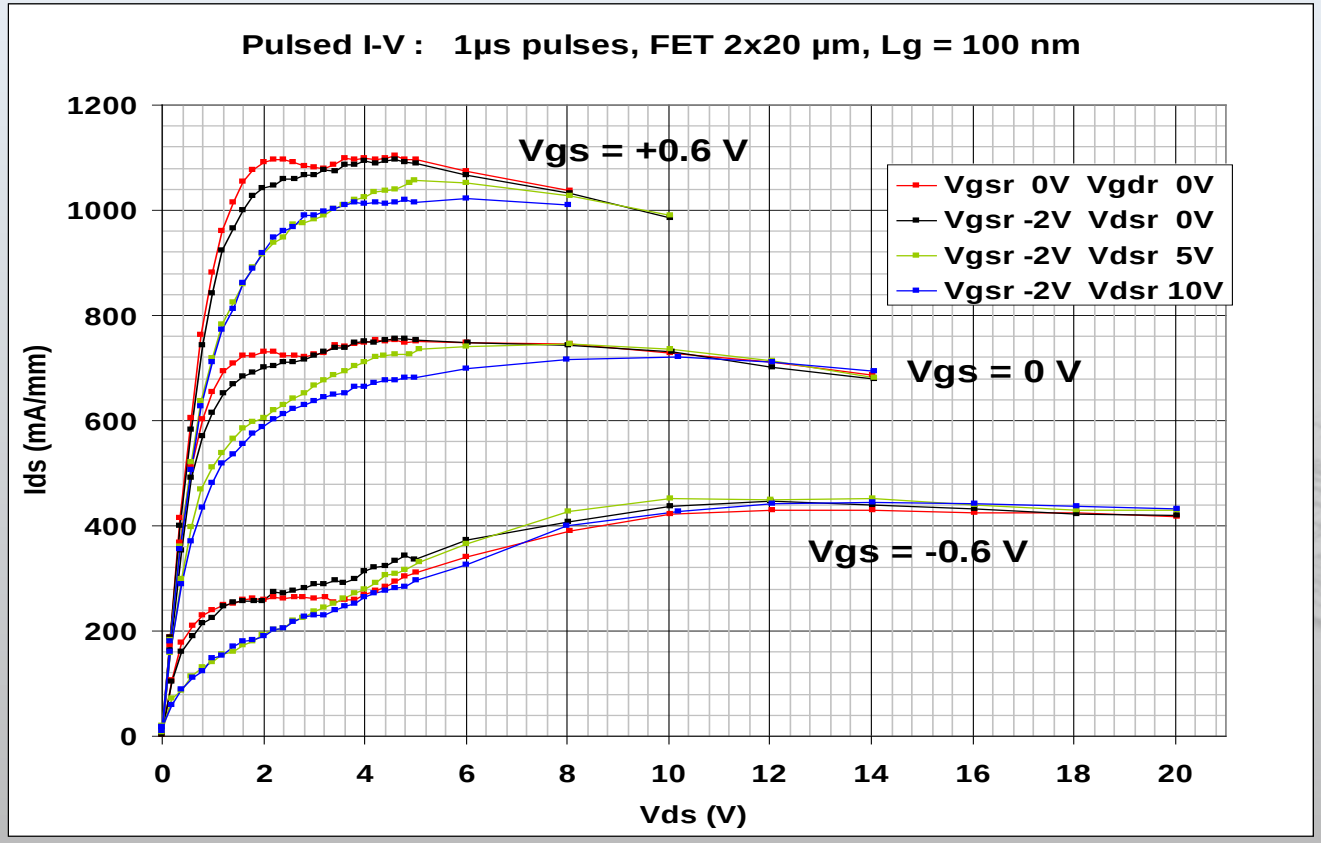
Pulsed IV curves

Reduced low frequency traps (<10%) thanks to in situ passivation



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CW Load Pull D01GH

FET 2x50 µm

Lg = 100 nm

Vdd = 12 V

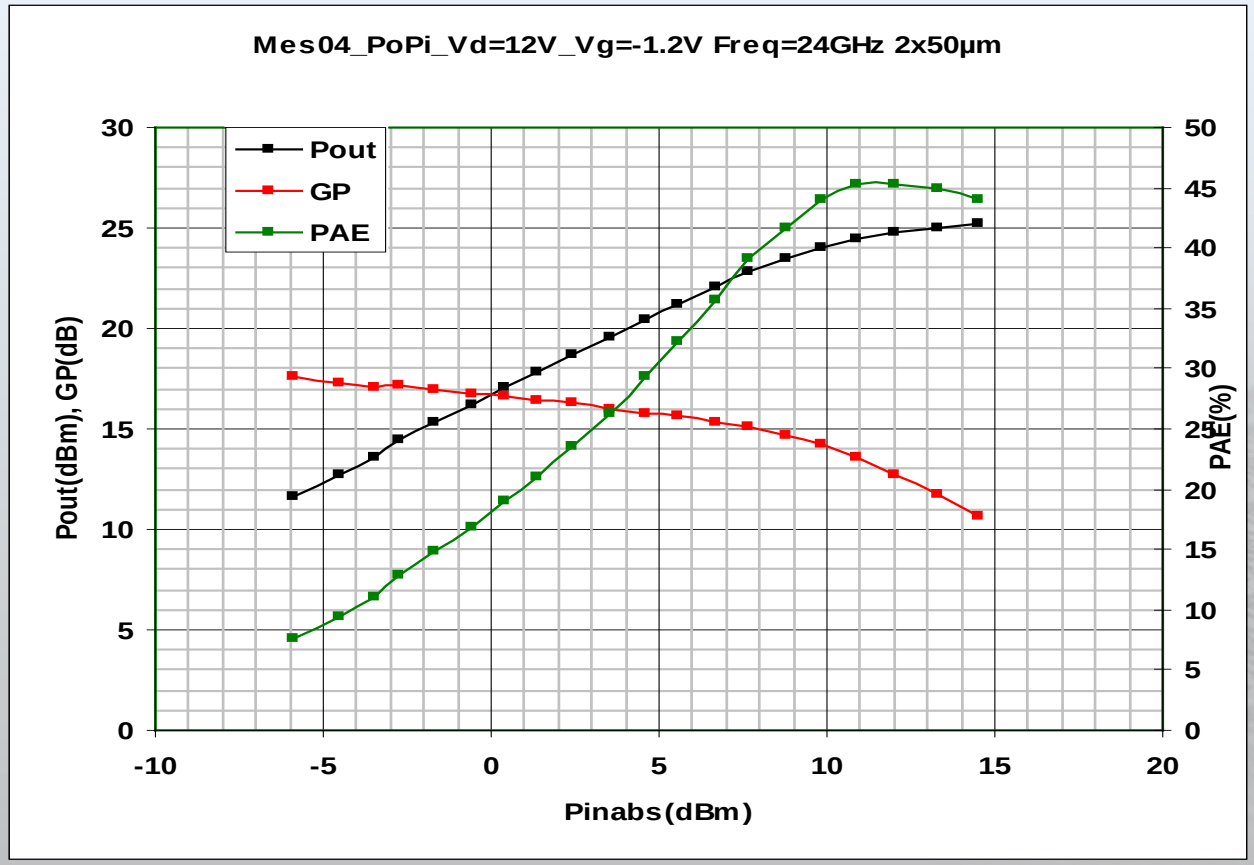
Vgs = -1.2 V

F = 24 GHz

Class AB

PAE =46%

Pmax = 3.5 W/mm



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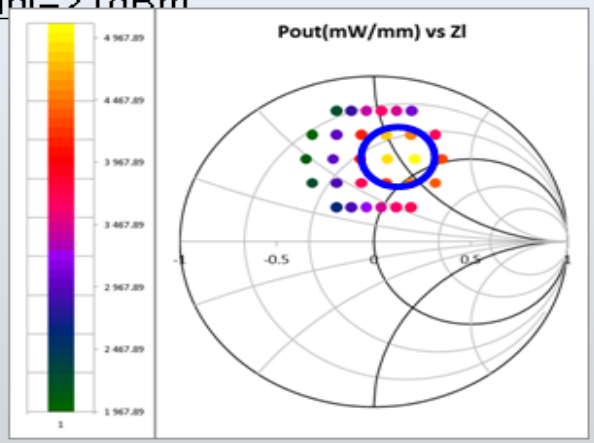
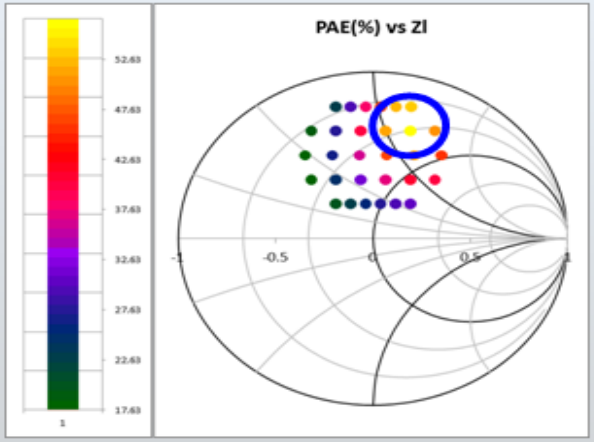
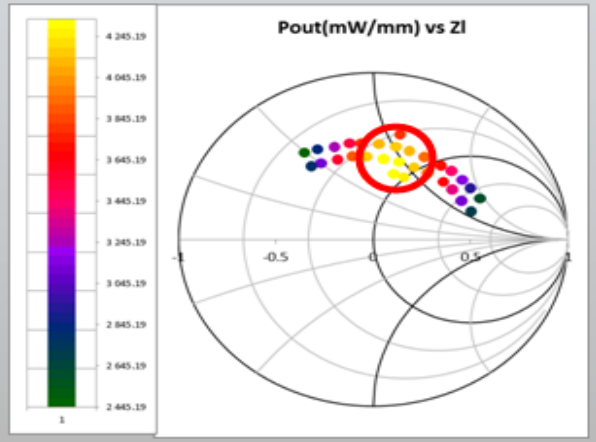
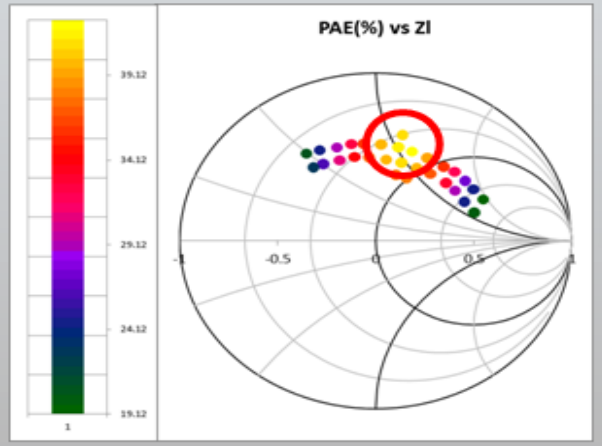
D01GH Load pull results

Wtot=2x50um / Vds=12V, Vgs=-1.5V (PDC=1.75W/mm) / Freq=26GHz / Pini=21dBm





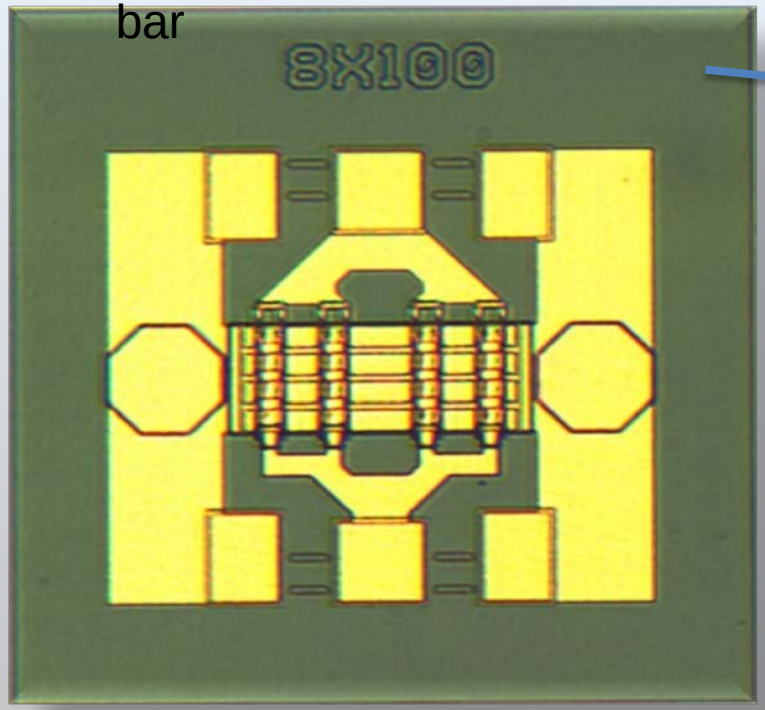


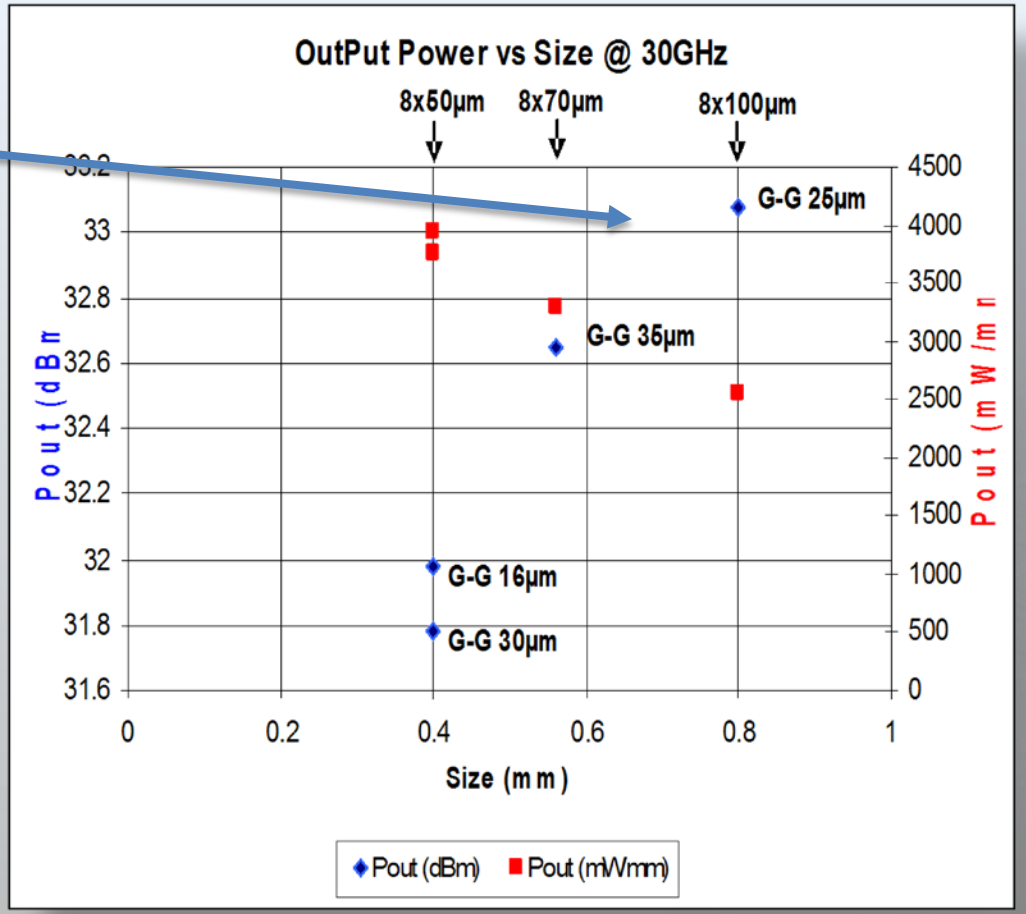


- Scalable Model, ADS Load-Pull simulations
- Load-Pull Measurement
- Good agreement Model/Measure for Pout and PAE optimum load impedance area

D01GH Load pull results

8 fingers of 100um power bar





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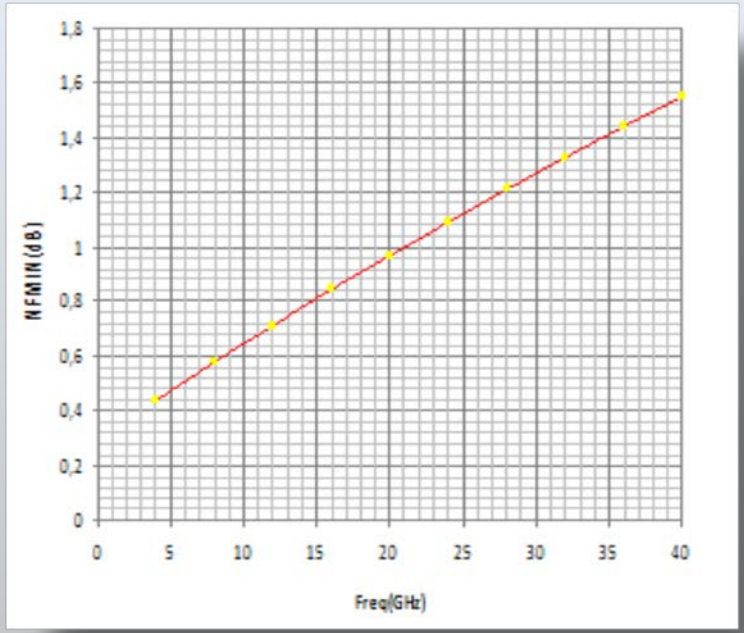
Noise figure measurements

Nfmin D01GH vs Freq



4*50µm @ 40GHz	D01PH 135nm GaAs PHEMT	**D01GH 100nm GaN/Si HEMT**	D01MH 120nm GaAs MHEMT
Vds (Volt)	3V	**5V**	1V
Ids(mA)	15	**42**	30
Rs(Ohm)	1,0	**1,2**	0,8
Rg(Ohm)	0,65	**0,70**	0,7
NFmin	1.72 dB	**1.54 dB**	1,13 dB
Associated gain	4.5 dB	**8 dB**	12,4dB

ISO9001 version 2000, ISO14001 version 2004 Registered Company

D01GH Key applications and targets

Ka Band SATCOM

27-31GHz 10W PA

E band Backhaul

56-64GHz 2W PA

Instrumentation

DC-46GHz 30dBm WBPA

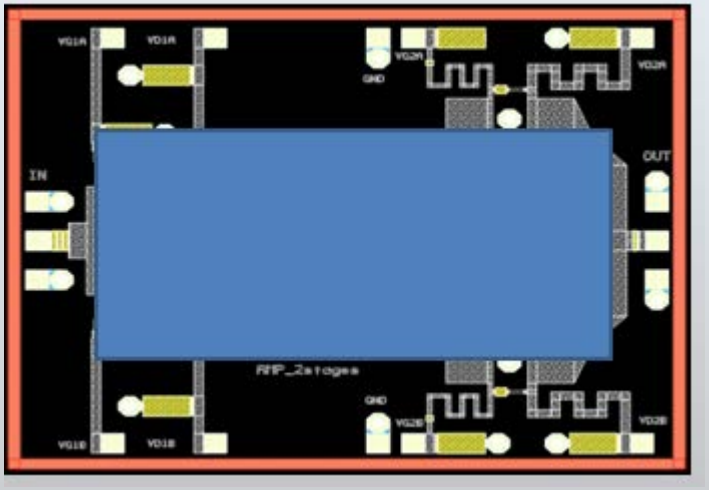
X band radar

8-12GHz 33dBm Pin CW LNA

ISO9001 version 2000, ISO14001 version 2004 Registered Company

D01GH already realized design

Two stage 4W 43GHz power amplifier



- P3dB =36dBm
- 23%PAE
- 17dB Gain

X=2,9 mm Y=2,35 mm.

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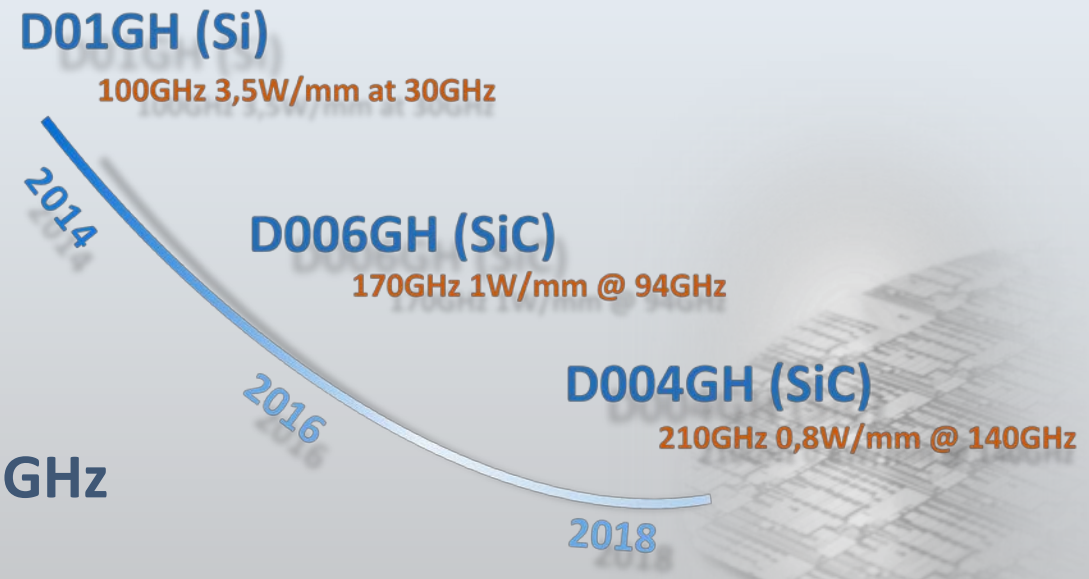
ROAD MAP
D006GH GaN/Si(C) 60nm and beyond

D006GH /SiCprocess

- Gatelength : 60 nm
- Imax = 1.1 A/mm
- gm = 700 mS/mm
- Ft : 170 GHz
- Fmax : 250 GHz
- Pmax = 1 W/mm @ 94 GHz
- Vbdg > 30 V
- NFmin : 1 dB @ 50 GHz



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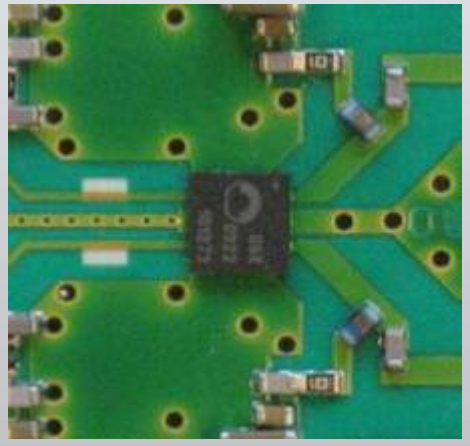
Packaging OMMIC

More and More customers are requesting packaged solution

OMMIC invest a significant R&D $ to develop packaged LNA and Corechip

LNA :

CGY2105XHV /06XHV /07HV /09HV

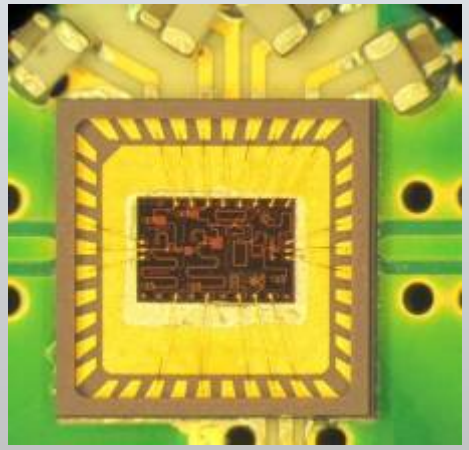


LNA 500MHz – 6GHz 0.5dB NF

Plastic QFN 4x4 16pin

> 130.000 unités en 2013

CGY2124HC

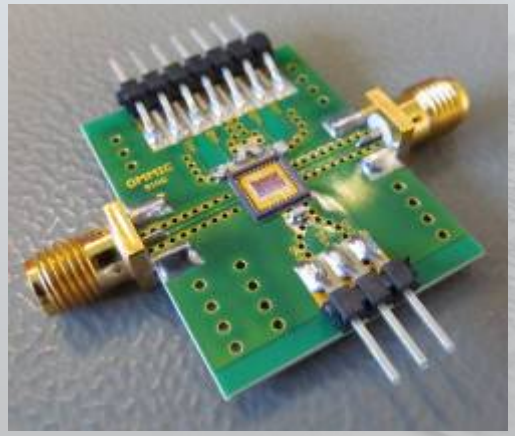


LNA 8 – 12GHz 1.4dB NF

HTCC QFN 5x5 32pin

Single supply

Custom OMM9106HC



LNA 8 – 12GHz 1.1dB NF

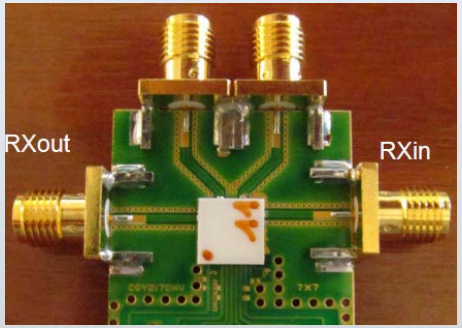
HTCC QFN 5x5 32 pin

OMMIC *Innovating with III-V's*

Packaging OMMIC

Corechip and control function :

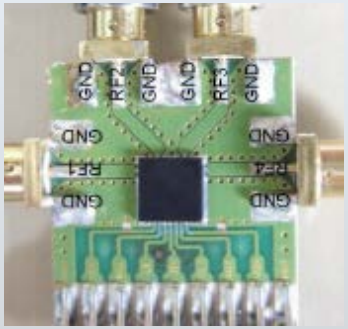
CGY2170HC/C2



Corechip bande X

HTCC QFN7x7 44pin

CGY2170XHC/C1

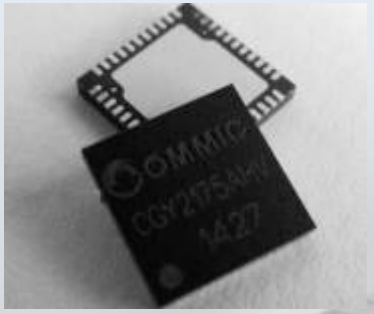


Corechip Bande X

HTCC QFN 6x6 40pin

NEW

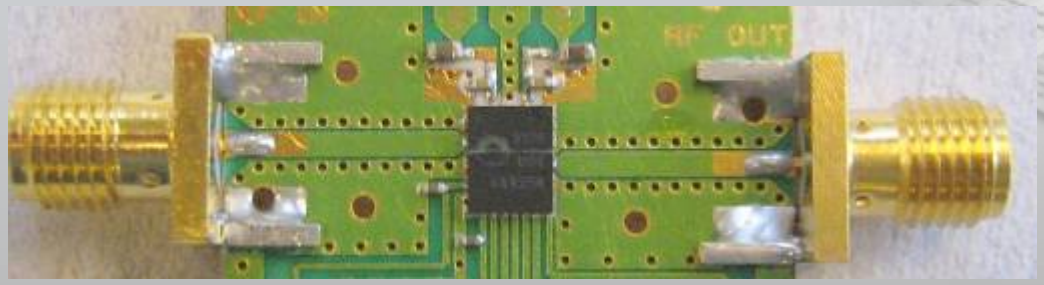
CGY2175AHV



Corechip Bande C

Custom plastic QFN 7x7 44pin

CGY2179HV



LNA+phase shifter

Plastic QFN4x5 28pin

OMMIC *Innovating with III-V's*

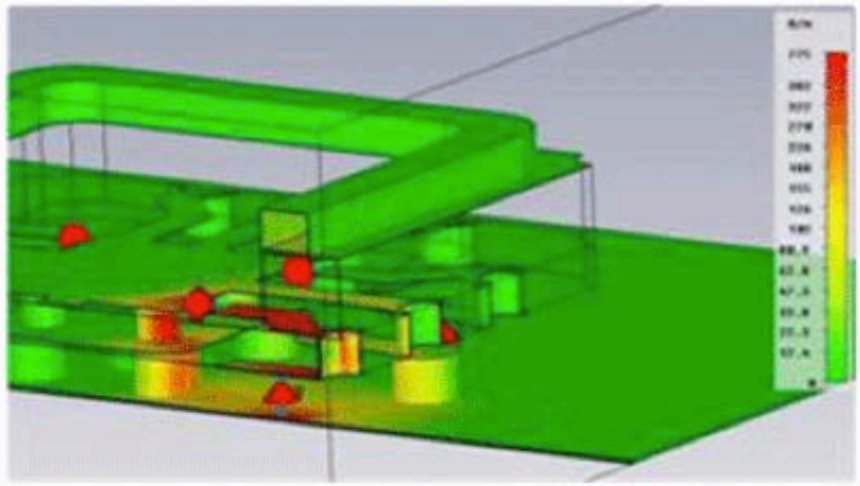
U.S. PACKAGING PARTNER

High Frequency Surface Mount Technology (SMT) packages

Cost effective solutions for Hermetic and Non-hermetic packages
Custom impedance matching for MMICs

Technology enabling smaller RF modules

- High Frequency Multilayer RF Boards
  - RF Impedance matched material (i.e. RO4003)
  - Using blind, buried and thru vias
  - Our proprietary grounding and shielding designs
- Heat spreading material integration
- HTCC and Thick/Thin film ceramic materials
- LTCC
  - Buried components
  - Cavities for MMIC/die and passives



Surface Current flow of package mounted on a Rogers Board

Contact us with your requirements and our highly experienced team of engineers can quickly identify and implement innovative solutions using latest technology to improve performance and reduce cost.

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Jay Chudasama jayc@agilemwt.com

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