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GaN/Si MMIC process for mmW applications

Marc Rocchi

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- **OMMIC profile and strategy**
- **100nm GaN MMIC processes**
- **Design kit and Foundry service**
- **Conclusions**

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Founded by Philips Semiconductors

OMMIC : French & independent III/V MMIC foundry

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Strategy

- **Offer High added value , Unique III/V MMIC solutions to complement Si solutions up to 400GHz for the following professional markets :**
  - Aviation
  - Cellular Infrastructure
  - Space
  - Defence
  - Security
  - Automotive
  - Optical fiber
  - Instrumentation
  - Radio astronomy

- **Offer foundry services based on long term partnership**

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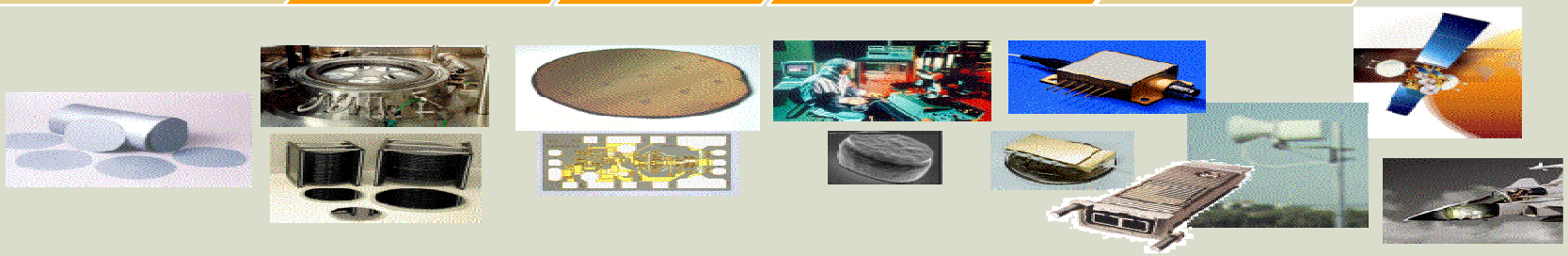
Value chain and FAB+ services

Substrate Supply → Epitaxy → IC Fab → Back-End → System → End User



- Epitaxial growth
- Process development
- Custom MMIC design
- Foundry service and MPW
- MMIC Production
- Packaging
- Modules with MC2
- HiRel Test & Qualification

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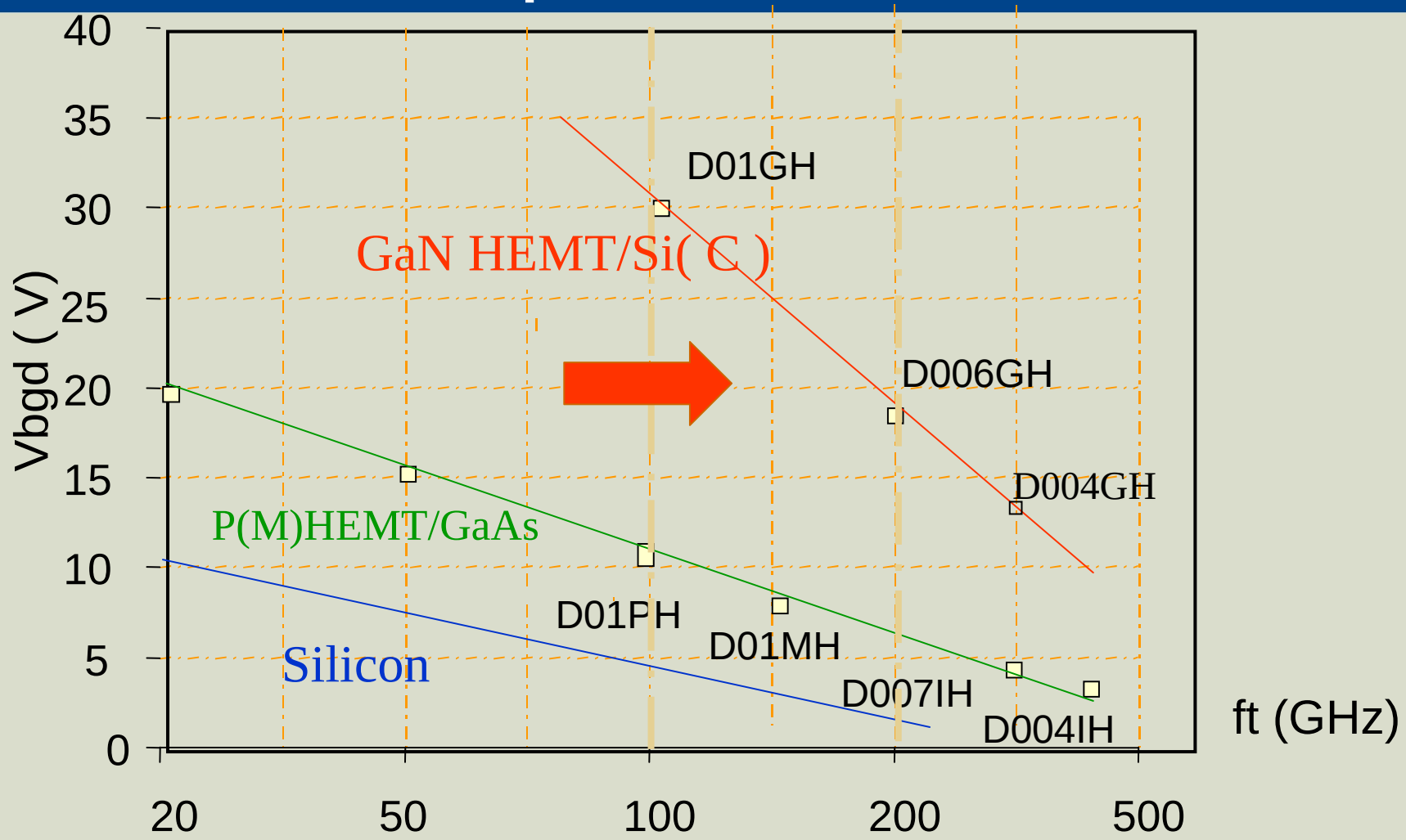
Process Roadmaps



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100nm GaN/Si process For mmW MMICs

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GaN processes and applications

Power electronics :

Replacement of SI solutions Si to improve the DC efficiency of DC power converters

- Switching Transistors
- Schottky Diodes

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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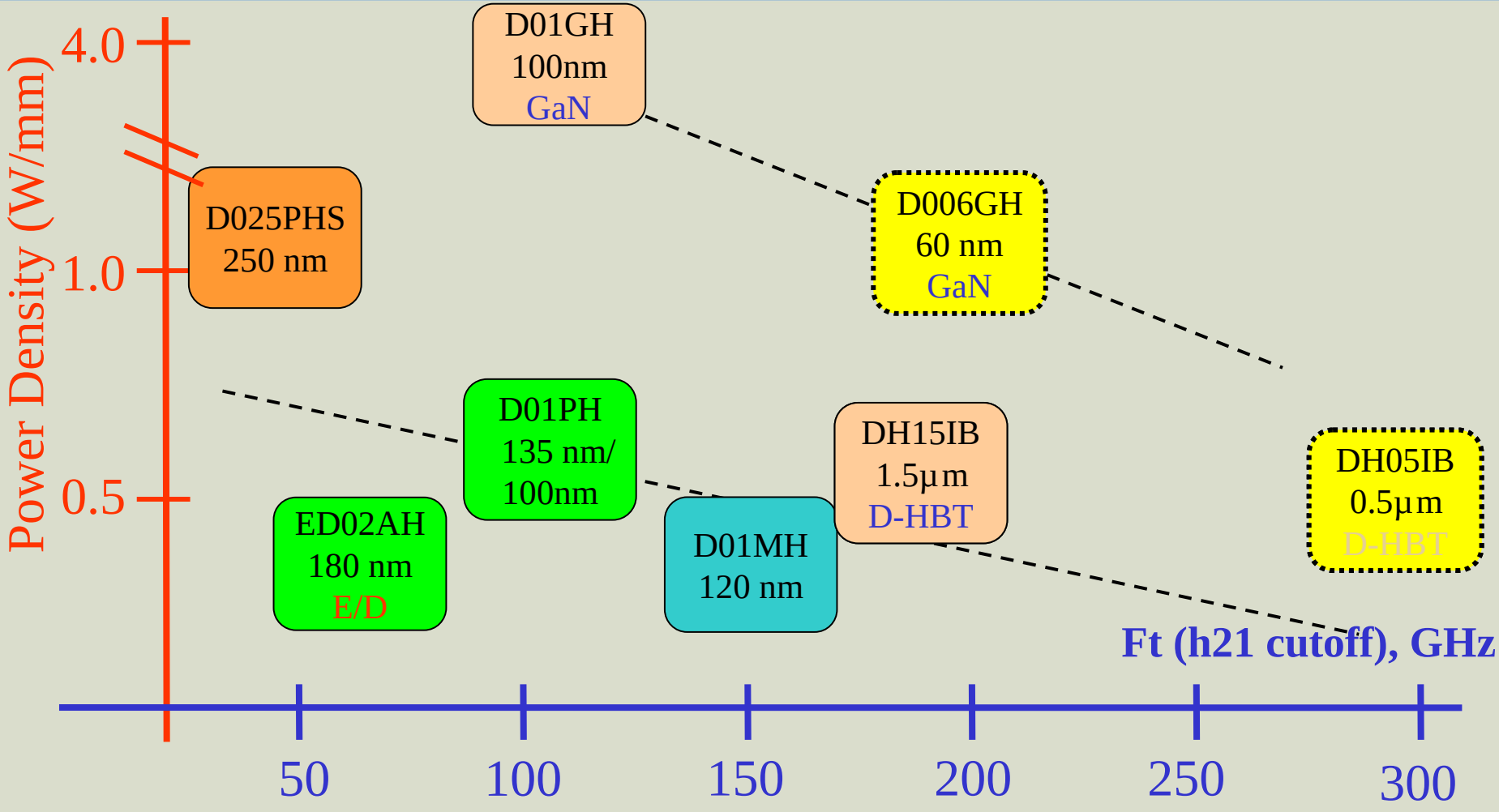
Power density/process



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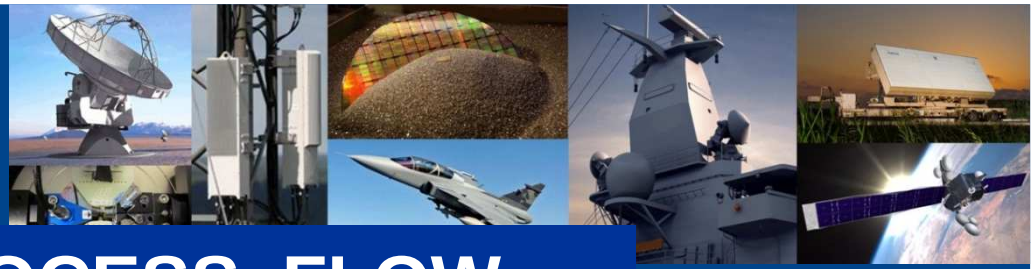
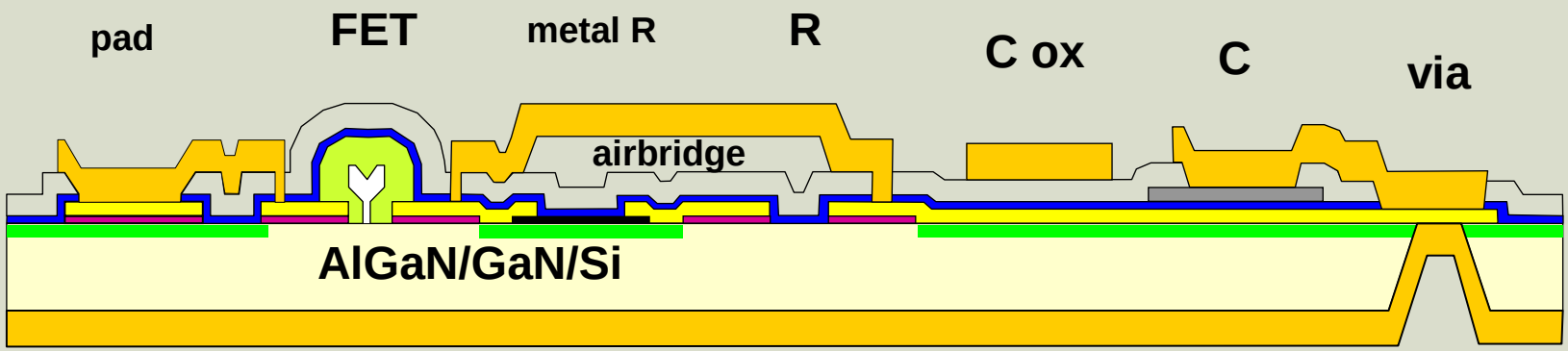


D01GH : MMIC « PROCESS FLOW «



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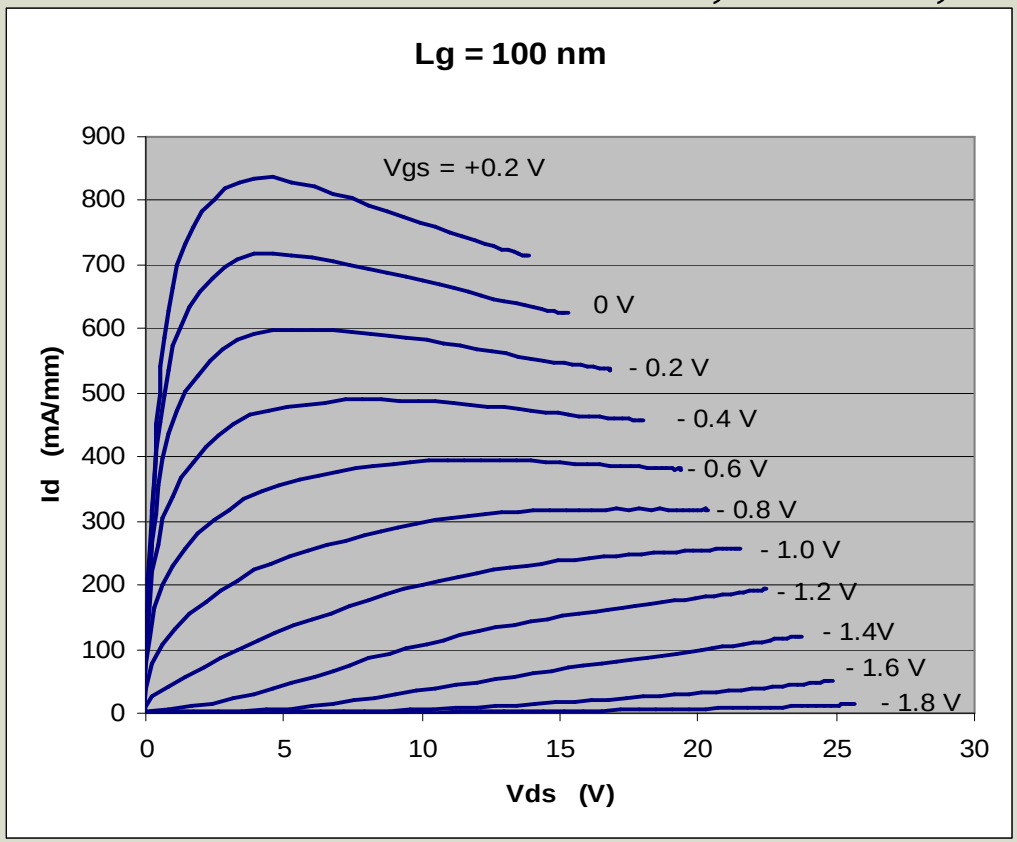
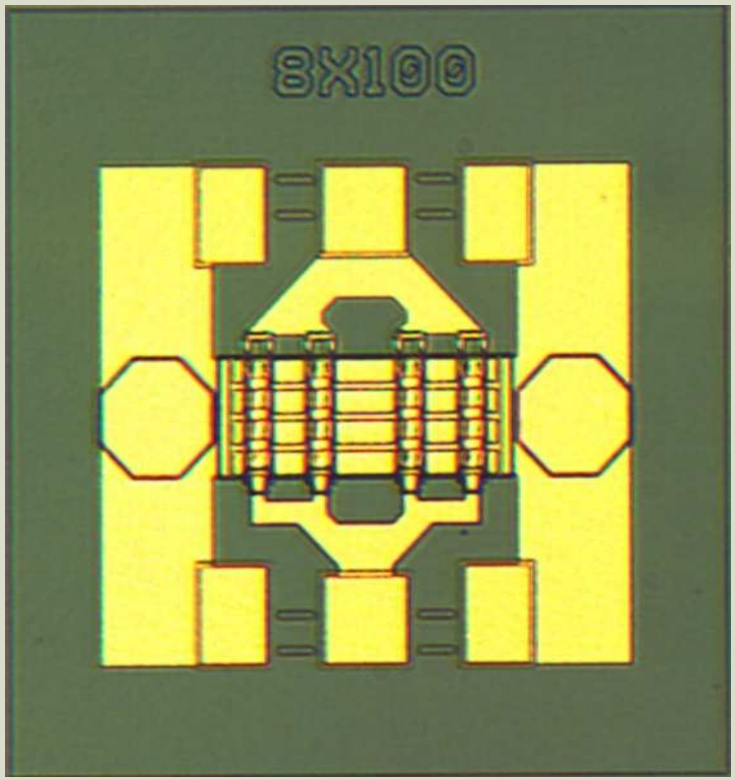
D01GH : I/V curves

Gm max = 650 mS/mm; Ron =0,8 ohms *mm





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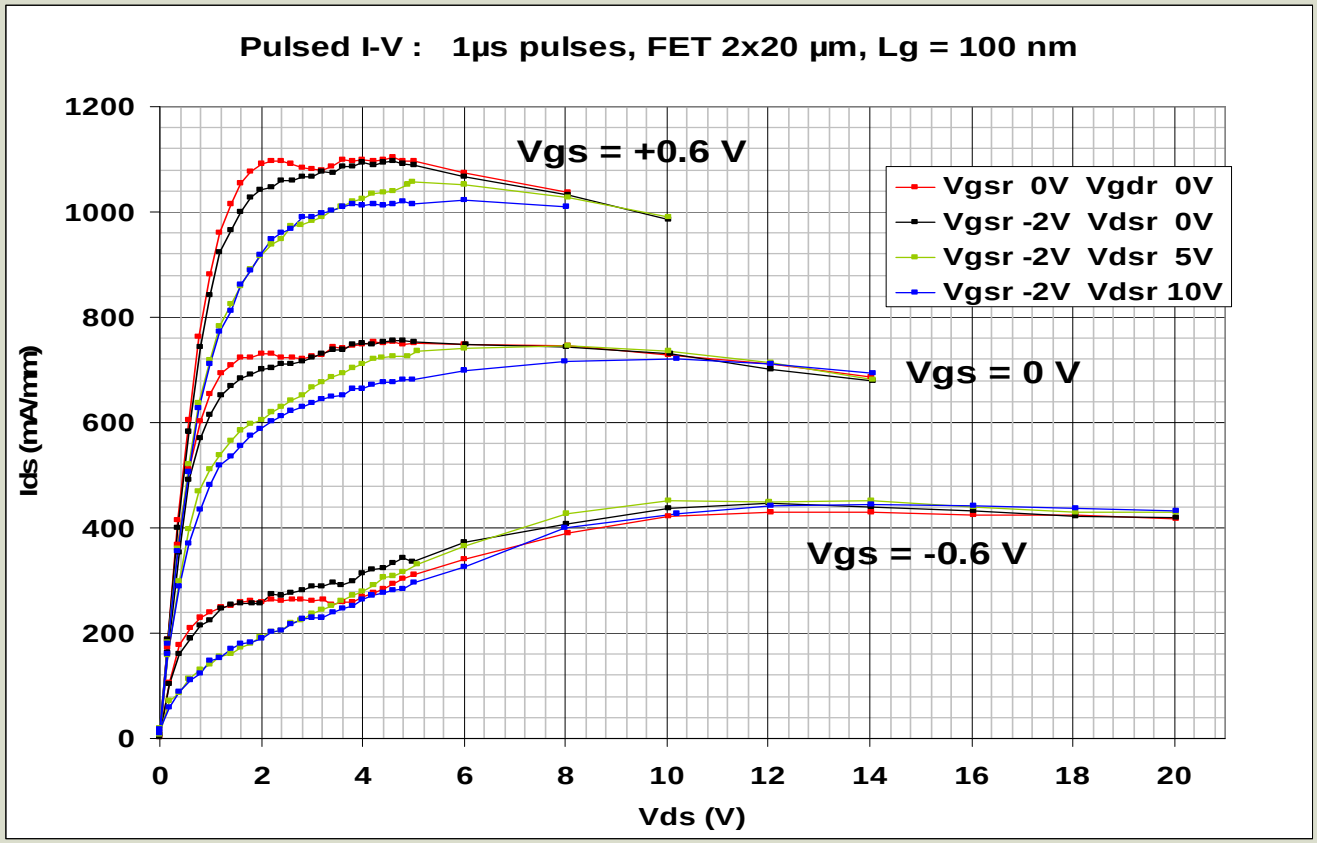
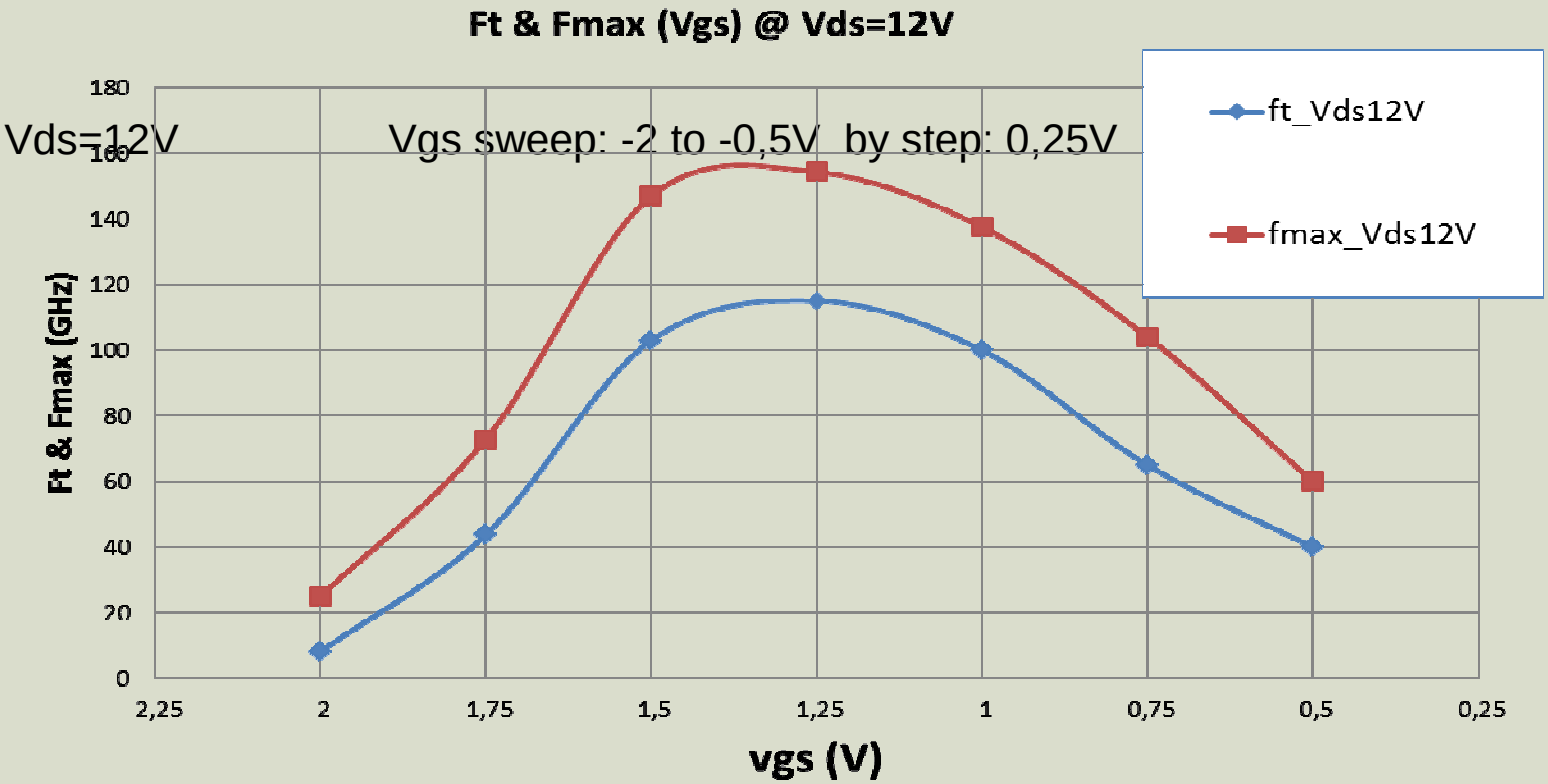
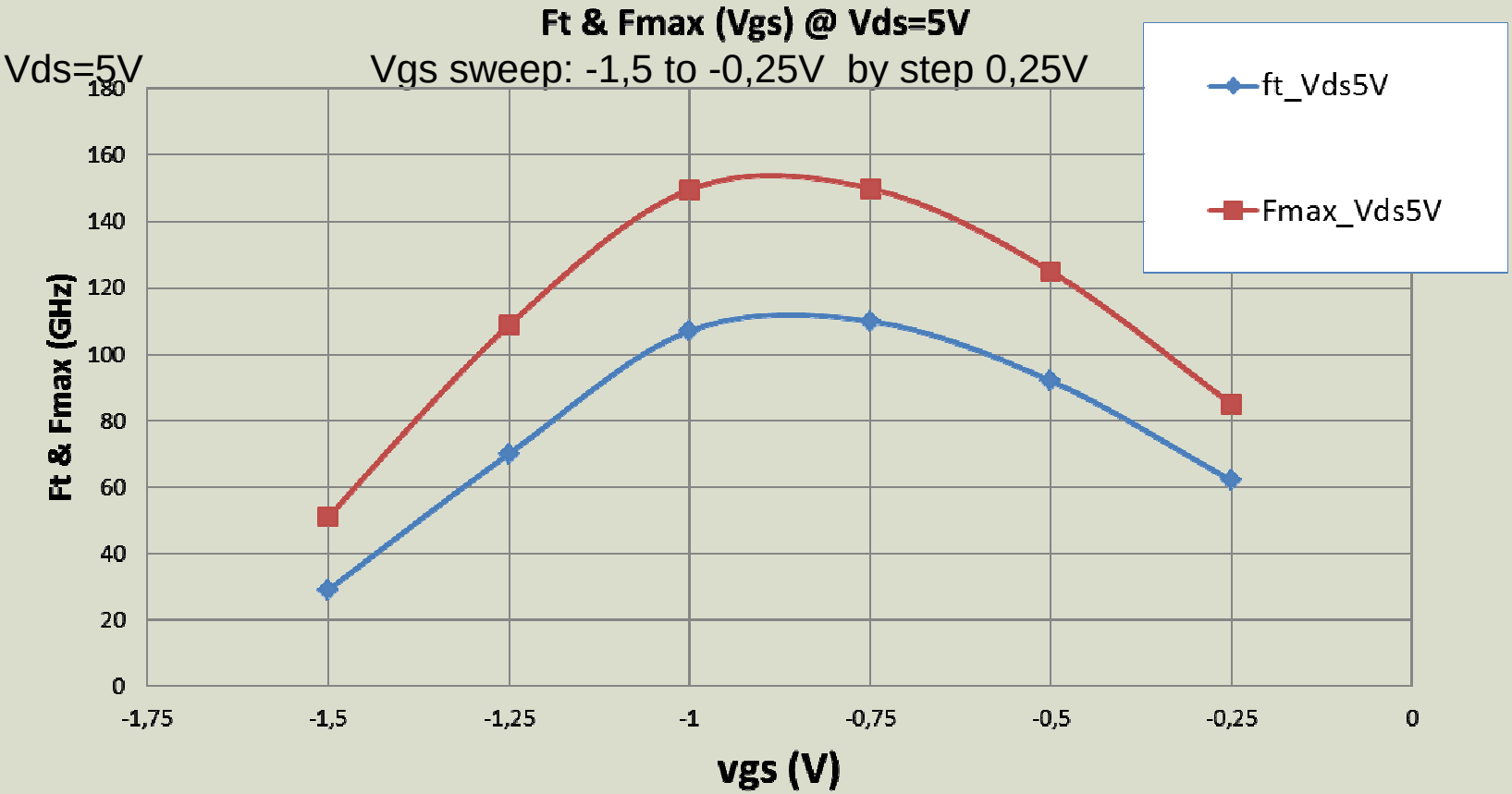
Pulsed IV curves



D01GH_trans 4x50µm _Vds 12V



D01GH_trans 4x50µm _Vds 5V



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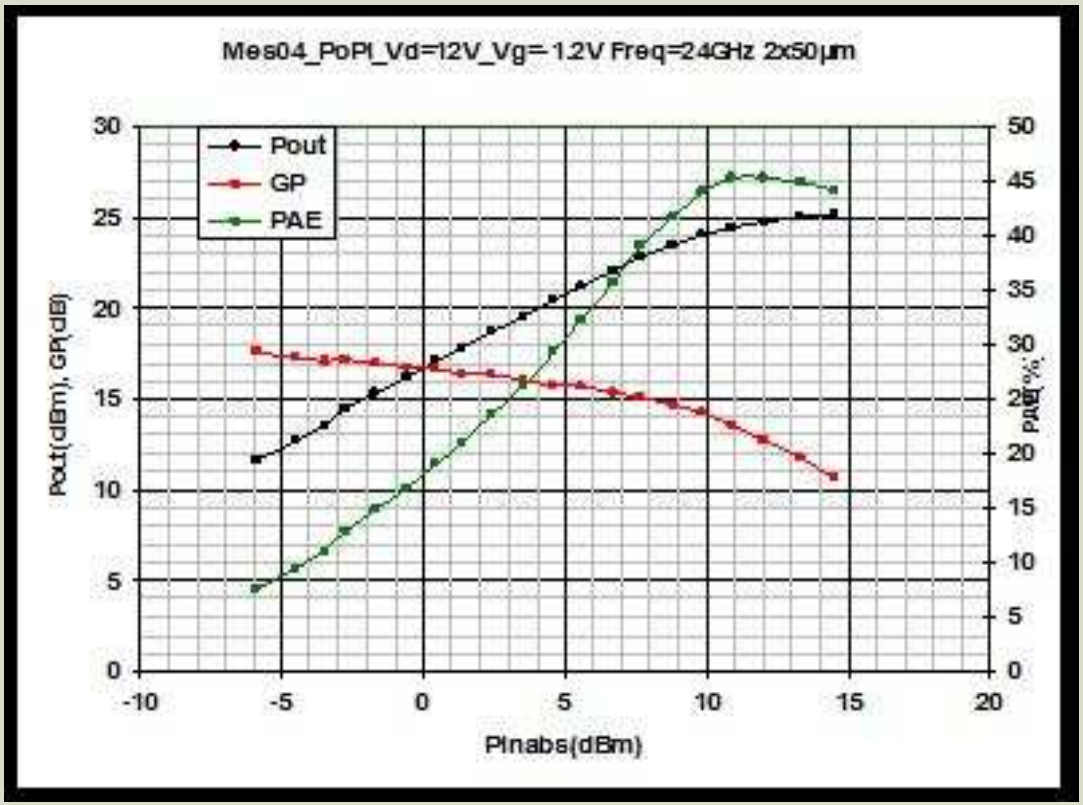
Loadpull results at 24GHz

2*50µm
12V
3.5W/mm
17dB gain
24GHz
46%PAE
CW



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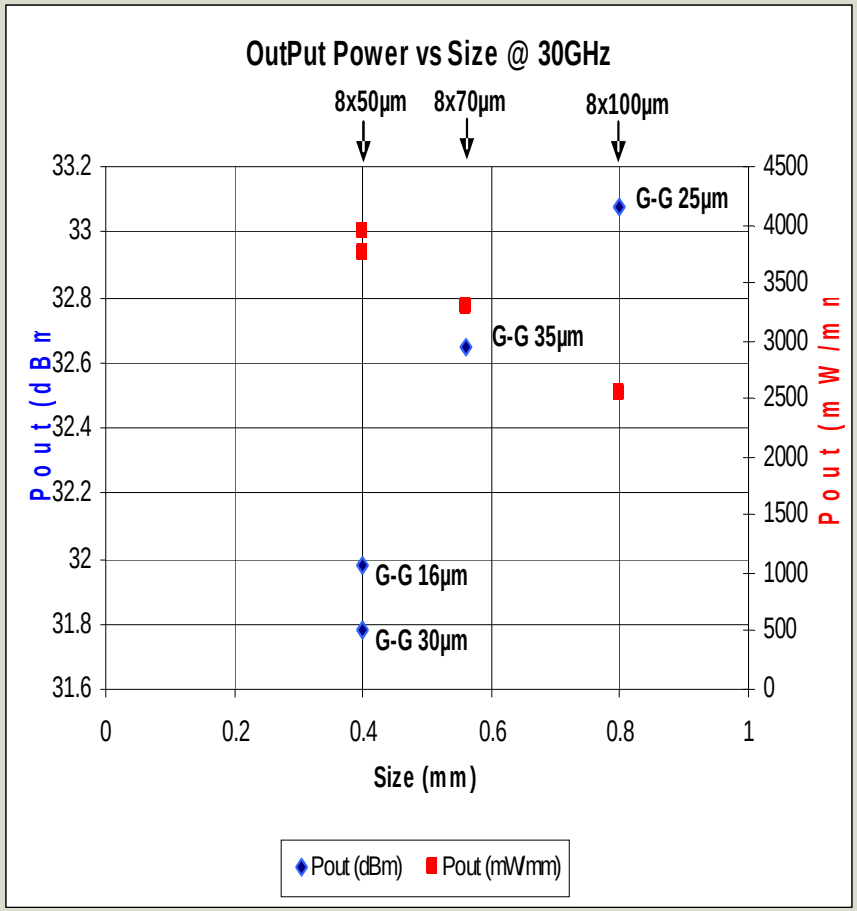
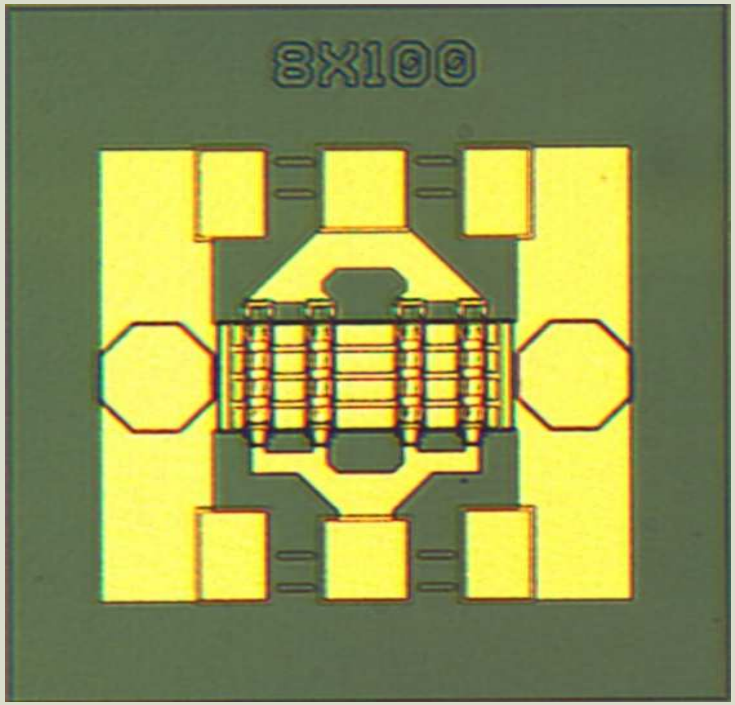
D01GH mini power bars at 30GHz





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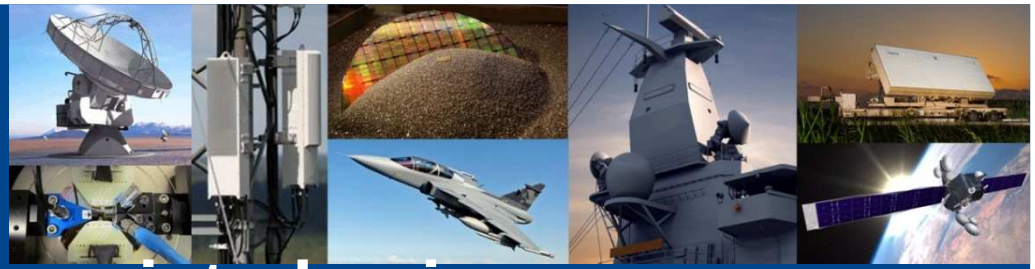
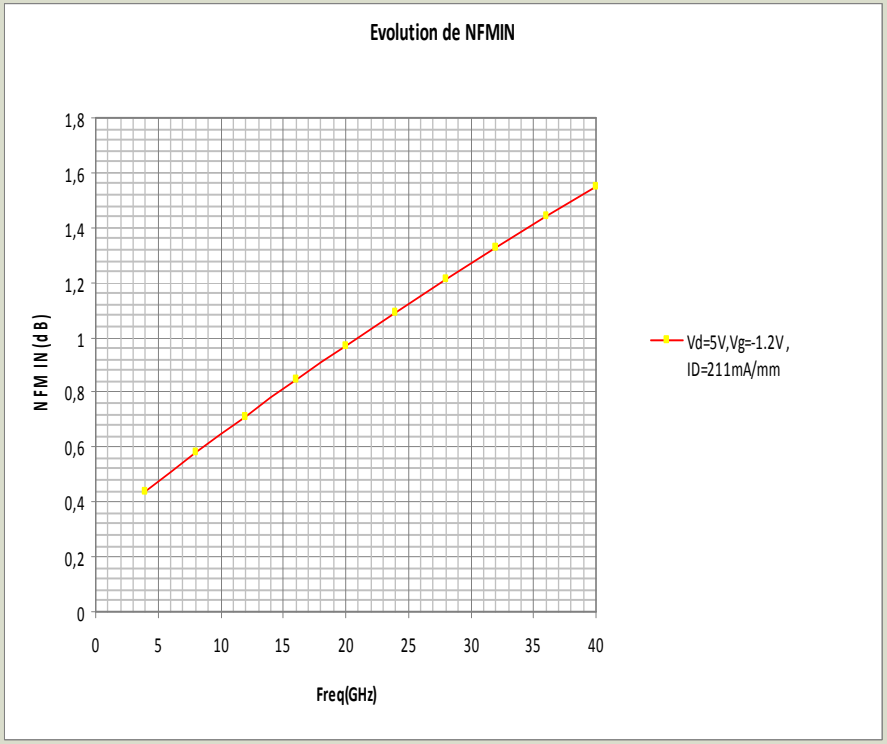
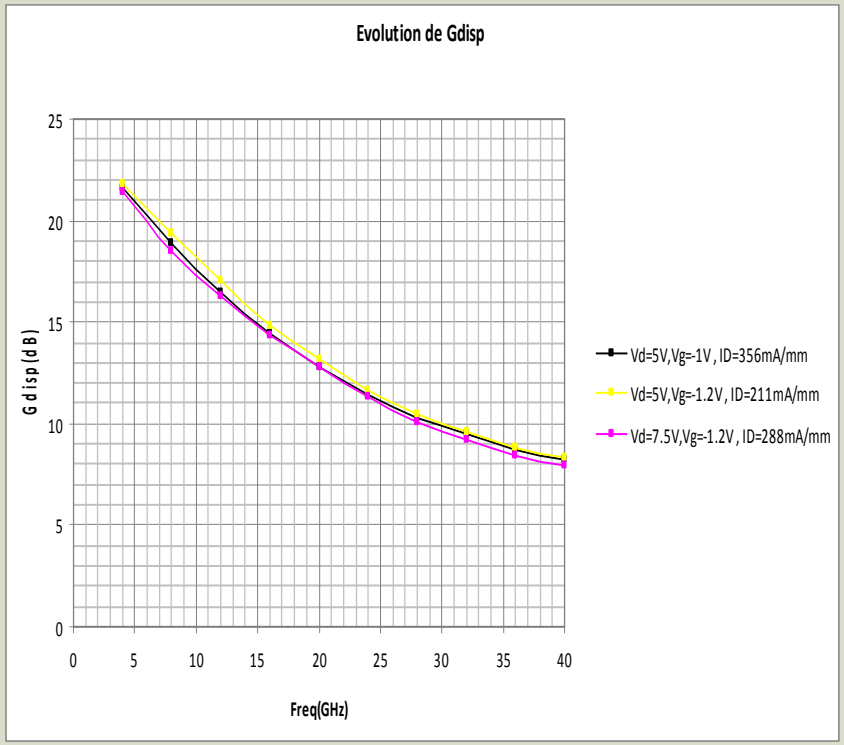


Measured NF min and associated gain

4*50µm , 40GHz , 5V, 42mA, NF =1, 54 dB, 8dB Asssociated gain





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Measured NF min and associated gain at 40GHz

4*50µm	D01PH (**135nm GaAs PHEMT)**	D01GH **(100nm GaN/Si HEMT**)	D01MH **(120nm GaAs MHEMT)**
Vds (Volt)	3V	5V	1V
Ids(mA)	15	42	30mA
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

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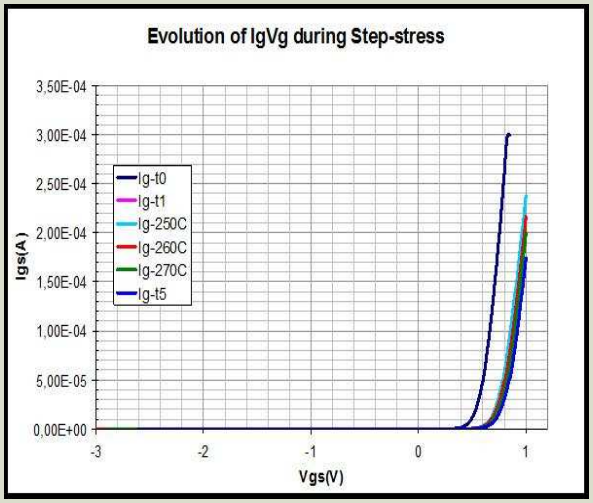
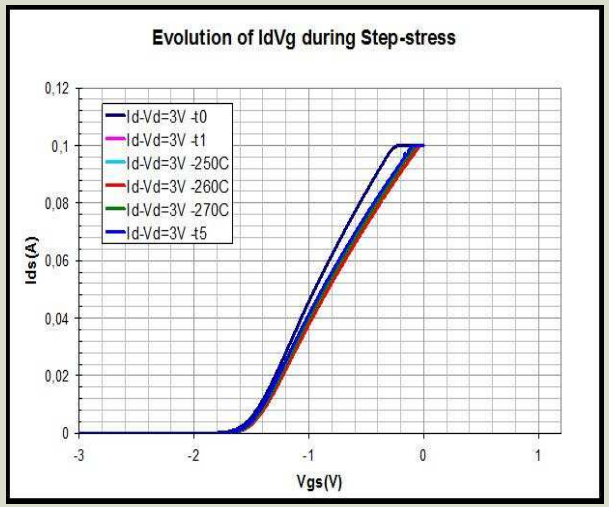
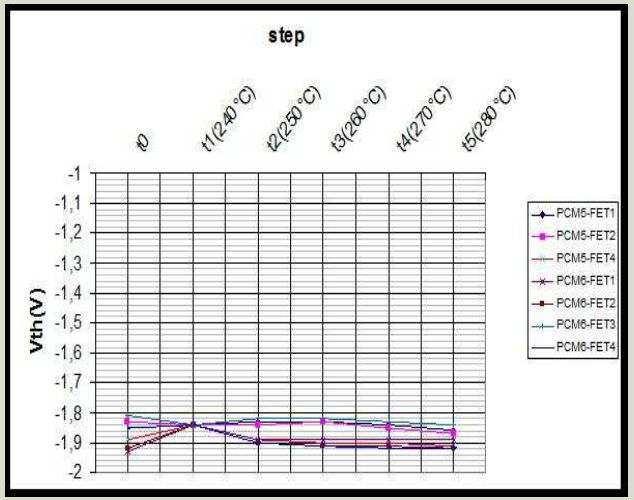
DC « Step stress » results







IG(Vgs) ID(Vgs) Vth

250C, 270C, 280C, 1000h (no drift after burn-in)

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D01GH :specifications and RF performances

- Idss (0V) = 650 mA/mm
- Vt= - 1.6VGm max ext= 650 mS/mm
- Ft= 115 GHz, Fmax =155 GHz @ up to Vds = 12 V
- MSG(2*50µm) = 14 dB @ 30 GHz
- Vbgd min =30V, typical = 40V (Vds max= 25V)
- Vdd =12V
- Psat> 3.5 W/mm at 24 GHz (Vds =12V)
- NFmin (30GHz) : 1.3 dB

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D01GH design kit

- Important Notice
- Your contact points
- Maximum Ratings
- Thermal calculations
- Data Files
- Summary of Changes
- Working with the Foundry
- Processing
- PCM and guarantees
- General Layout considerations
- Layout example Library
- C.A.D. libraries
- DEVICE INDEX

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Conclusions

- **End of 2014, project,,OMMIC opened its GaN/Si foundry service based on the 100nm D01GH process up to 50GHz**
- **Customer foundry runs:**
  - **May 2015**
  - **June 2015**
  - **September 2015**
- **This process is a full replacement of D01PH**