Complete Characterization of LF and RF Dynamics at Device Terminals within Microwave Circuits

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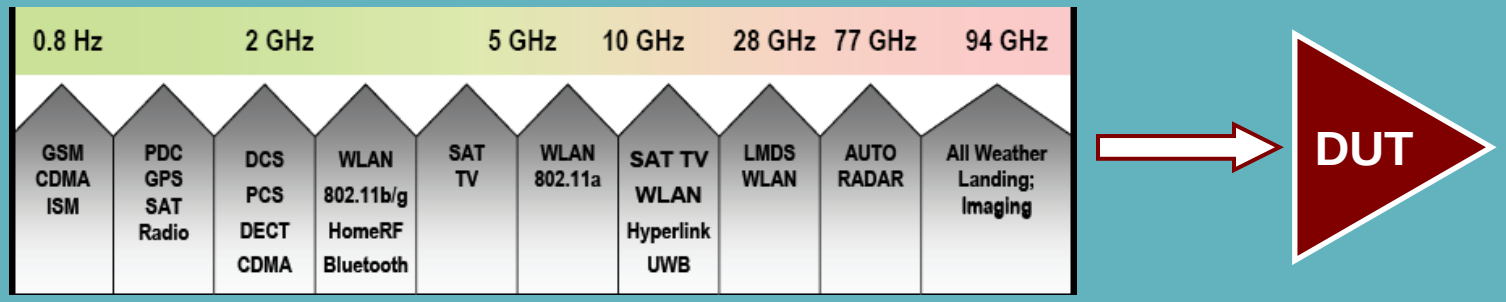
LEADING BEYOND S-PARAMETERS

Outline

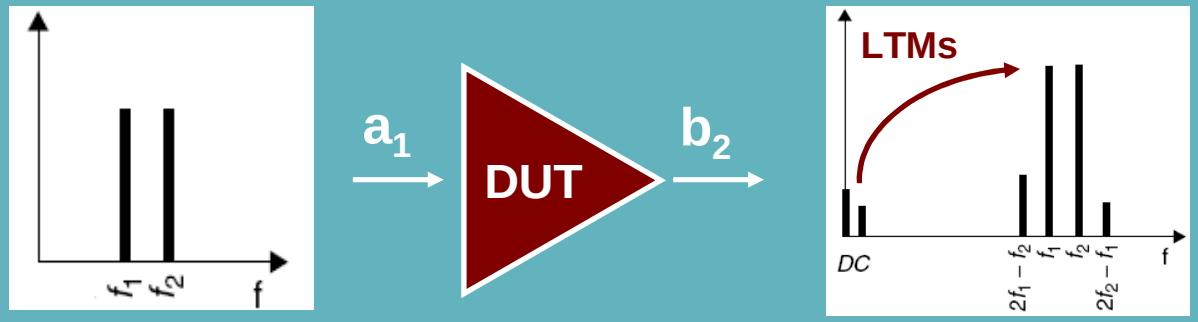
- ✓ **Introduction**
- ✓ Measurement set-up
- ✓ Case study
- ✓ Conclusions

Wireless Systems: trend



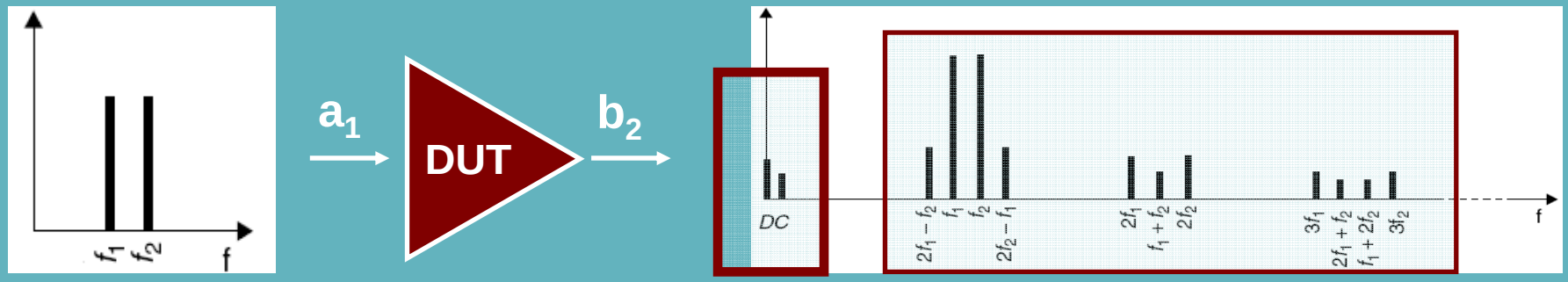
- Multi-carrier capability
- Complex Modulation Schemes

Issues



High frequency response depending on frequency offset (Long Term Memory Effects)

Aim



DYNAMIC BIAS

LSNA

RF dynamic: LSNA measurement (600 MHz-50GHz)

LF dynamic: Dynamic Bias (10 kHz-24 MHz)

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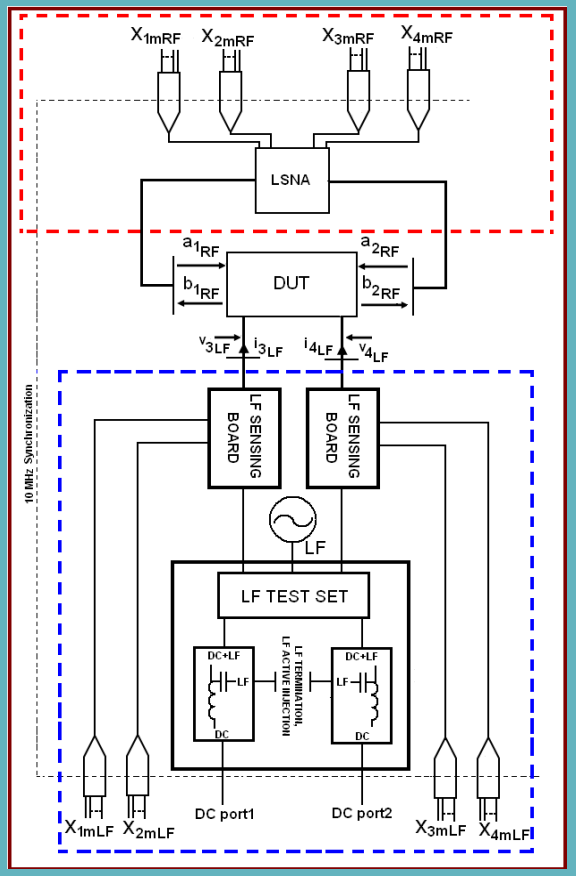
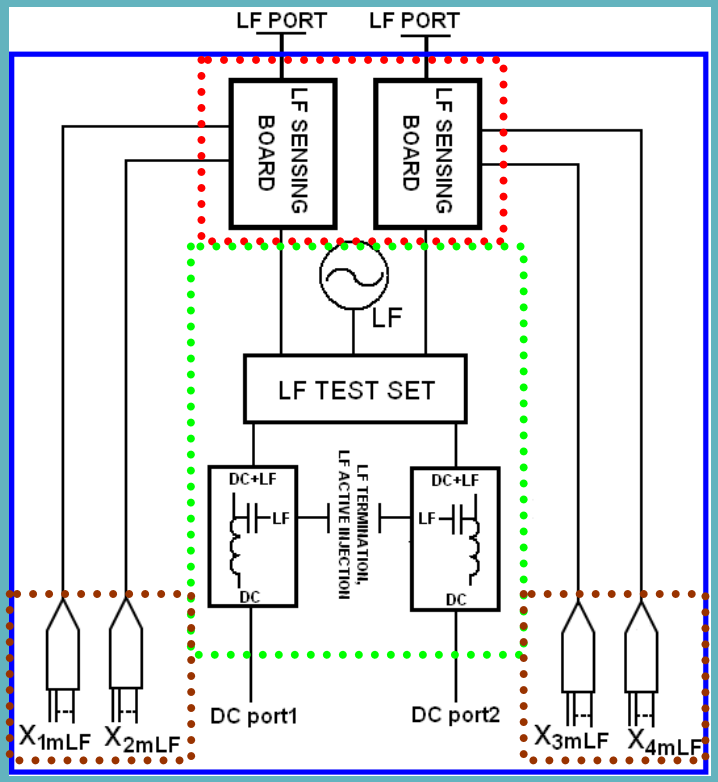
Set-up


X1mRF
X2mRF
X3mRF
X4mRF
LSNA
a1RF
a2RF
b1RF
DUT
b2RF
v3LF
i3LF
i4LF
v4LF
10 MHz Synchronization
LF SENSING BOARD
LF SENSING BOARD
LF
LF TEST SET
DC+LF
LF
DC
LF TERMINATION
LF ACTIVE INJECTION
DC+LF
LF
DC
X1mLF
X2mLF
DC port1
DC port2
X3mLF
X4mLF

Set-up



- Four additional ADC channels to sample Low Frequency Voltage/Current
- LF Test Set
- LF Sensing Board to 'probe' Low Frequency Components

Calibration

LF path

- SOLT
- Power & Phase

RF path

- SOLT
- Power & Phase

Phase alignment

Compensation for the different length of RF and LF path

last calibration step

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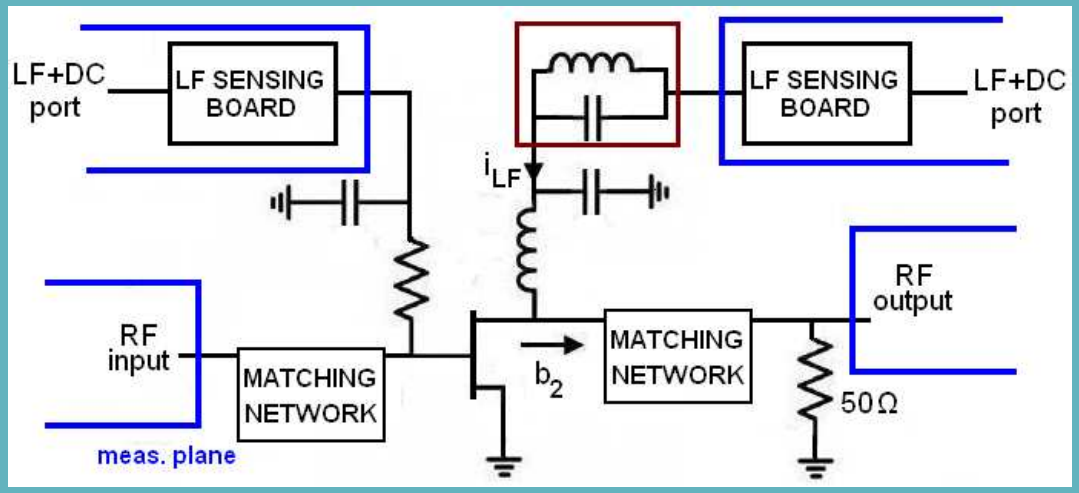
DUT

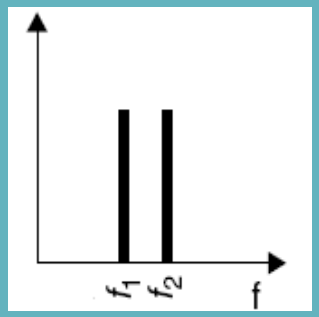


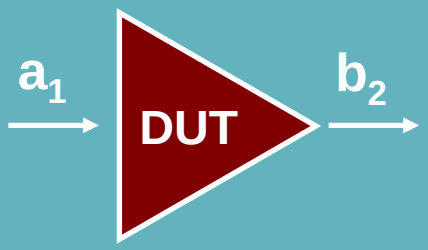
PCB Mounted GaAs PA*

f_c = 950 MHz

*J. Santiago, J. Portilla, and T. Fernández, "Nonlinear and Memory Characterisation of GaAs FET Devices and FET-Based Power Amplifier Circuits,"*1st European Microwave Integrated Circuits Conference,Manchester*, United Kingdom, pp. 99 - 102, Sept. 2006

Experiment



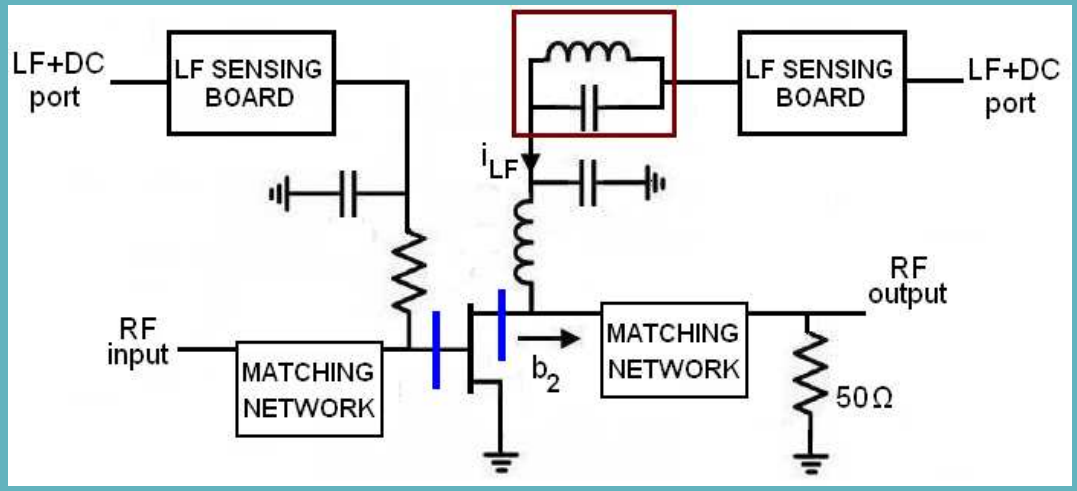


?

Two-Tone Measurement:

- P_{in} =0 dBm (for each input tone)
- Δf = 10 kHz - 450 kHz
- DC bias conditions (-0.5V,3V)
- Short termination at LF ports and 50 ohm termination at RF port

De-embedding



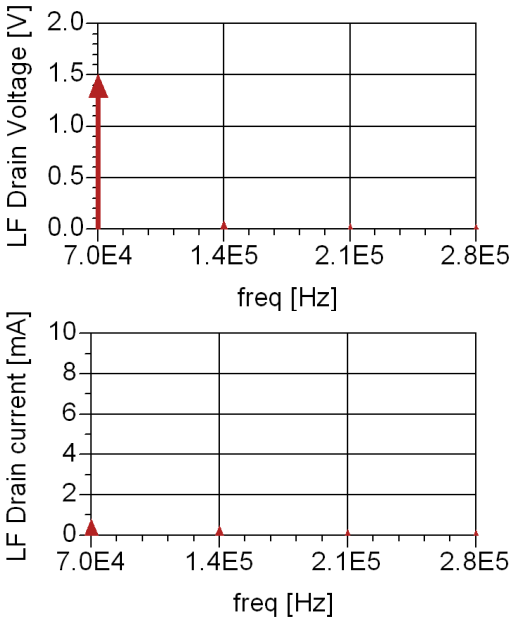
Measured voltages/currents shifted to DUT terminals

by means of ABCD transformation

Experimental results (I)

Frequency domain

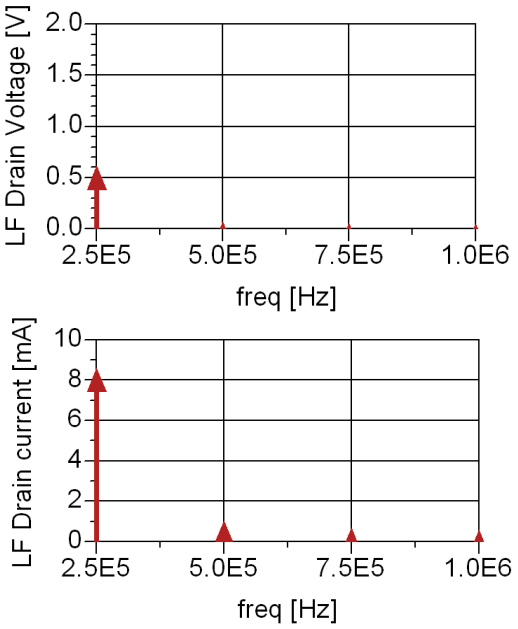
Δf=70kHz



measured LF voltage/current at drain side

V_{DDC}~3V I_{DDC}~430 mA

Δf=250kHz

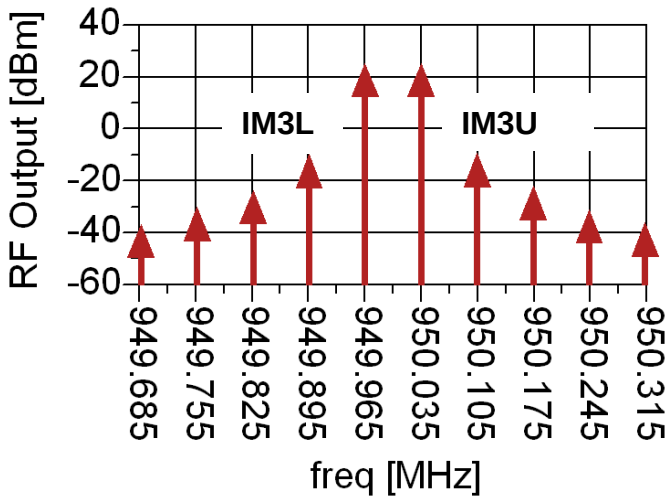


Influence of Frequency Dependent Bias Network

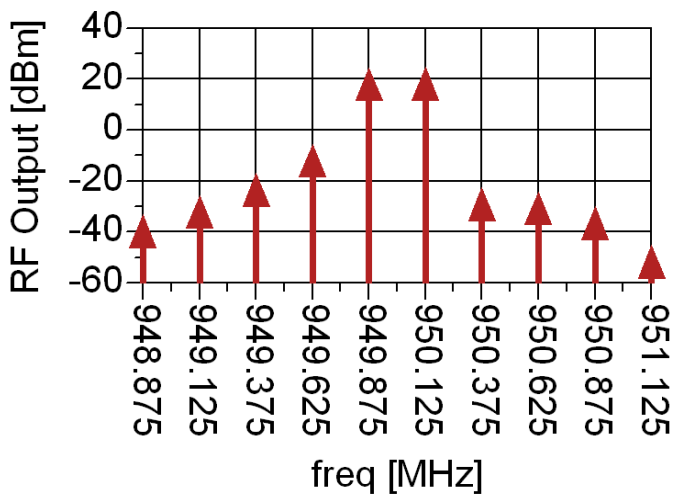
Experimental results (II)

Frequency domain

Δf=70kHz



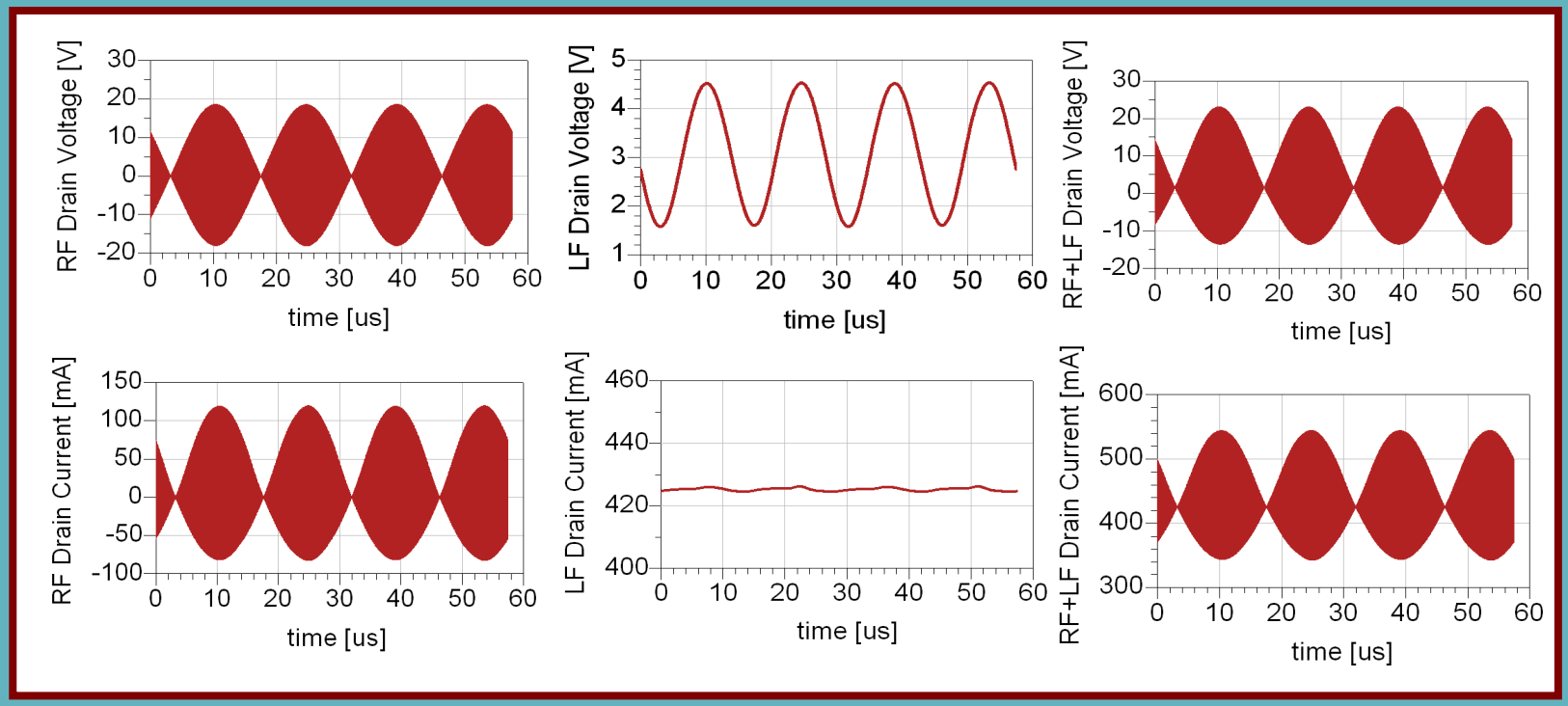
Δf=250kHz



Asymmetry ($IM3_U \neq IM3_L$) dependent on tone-spacing

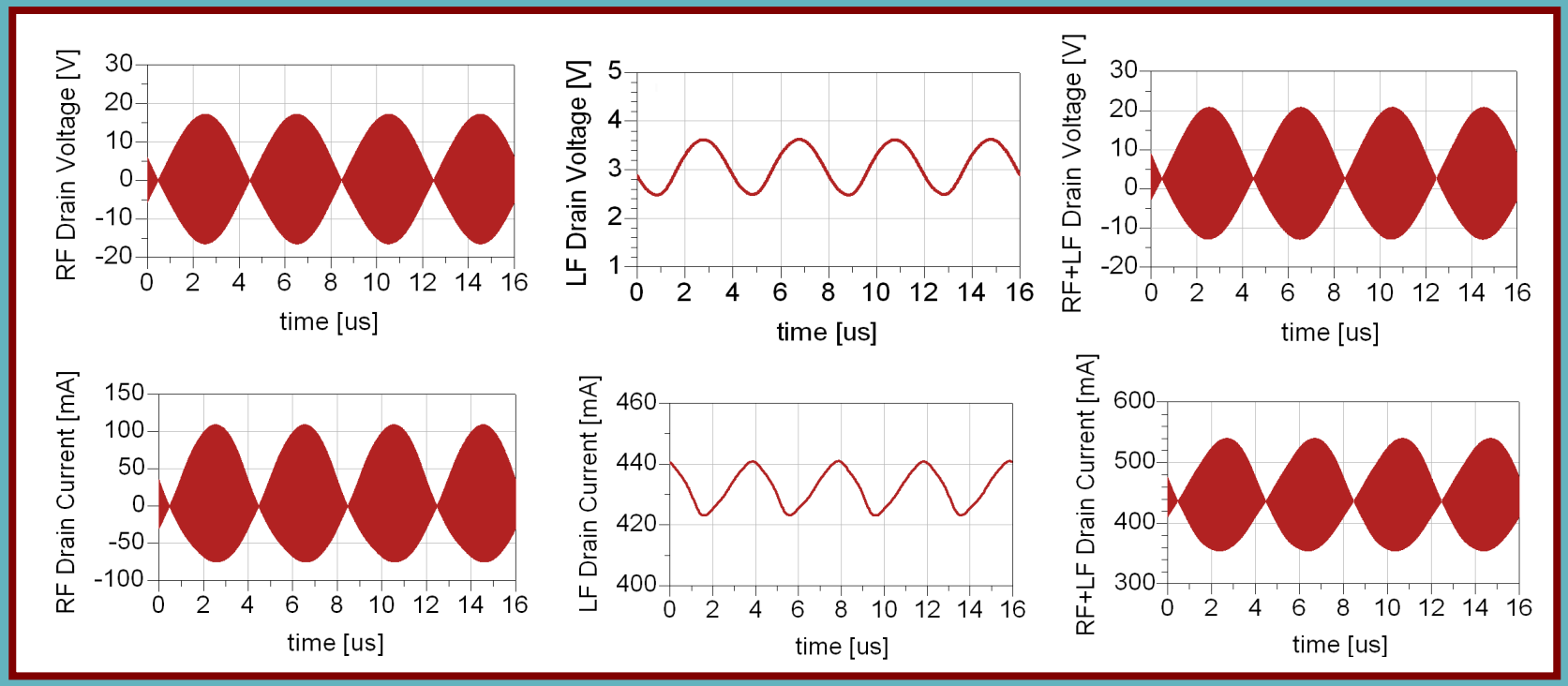
Experimental results (III)

Time domain (Δf=70 kHz)



Experimental results (IV)

Time domain (Δf=250 kHz)



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Conclusions

- **Combined LF and RF vectorial large-signal measurement set-up has been demonstrated**
  - ➢ extended hardware & calibration
  - ➢ de-embedding to obtain data at common reference plane
- **Further work:**
  - – Use data for
    - analyse sources of LTM
    - modeling purposes

Acknowledgements

- J. Portilla, University of the Basque Country
- C. Fager, Chalmers University
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