

LUND UNIVERSITY

Progress in RF and Millimeter Wave Circuits

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RF & mm Wave Research Team



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Waqas
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Tobias
Tired



Therese
Forsberg

Outline

- Projects
- Recent results
- Questions

Outline

- **Projects**
- Recent results
- Questions

LTE Receiver Front-Ends



SWEDISH FOUNDATION for
STRATEGIC RESEARCH

Part of SSF DARE

Anders Nejdell

Mohammed Abdulaziz

To obtain high analog performance using
digital calibration.

Remote Antenna Units



SWEDISH FOUNDATION for
STRATEGIC RESEARCH

Part of SSF Distrant

Waqas Ahmad

To obtain low cost highly integrated remote antenna unit fed by optical fiber

Just finished – Ultra low power RF



SWEDISH FOUNDATION for
STRATEGIC RESEARCH

Part of SSF UPD

Carl Bryant

To obtain low chip area and ultra low power consumption in 2.4GHz RF circuitry.

mm wave transmitters



Tobias Tired
Therese Forsberg
+ Carl Bryant, Jonas Lindstrand

To obtain cost and power efficient beam-steering transmitters for V-band and E-band.

Wideband PA and adaptive matching



Part of VINNOVA SoS

Jonas Lindstrand

To obtain efficient wideband PAs and adaptive matching networks for cellular applications, all in silicon technology

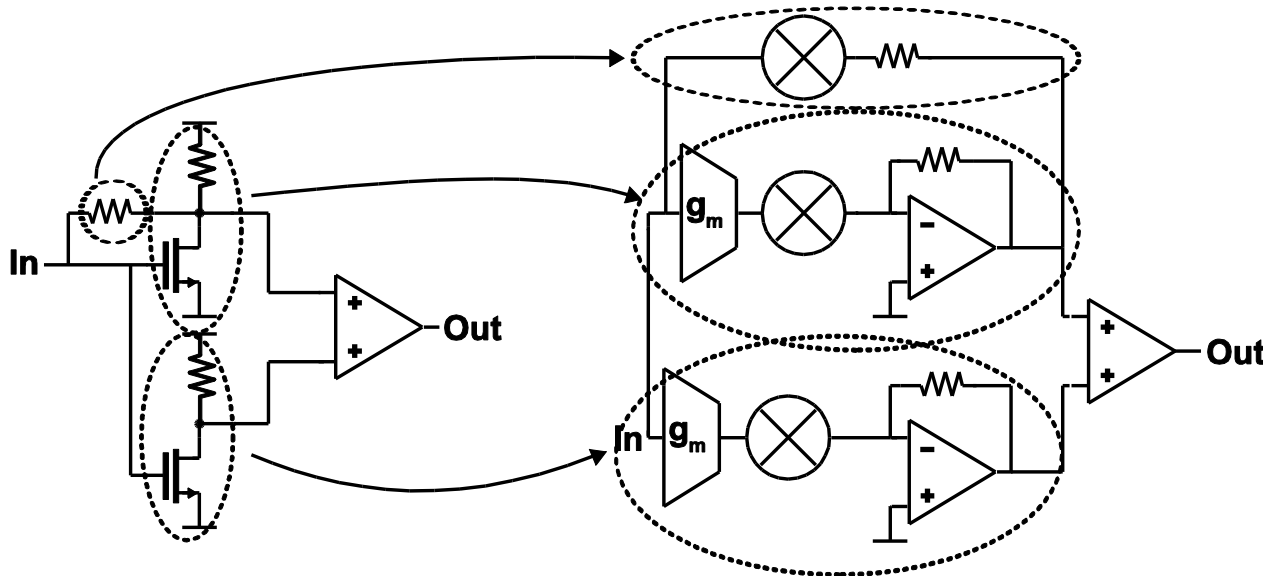
Outline

- Projects
- **Recent results**
- Questions



LTE Receiver Front-Ends

A Noise Cancelling 0.7-3.8 GHz Resistive Feedback Receiver Front-End in 65 nm CMOS



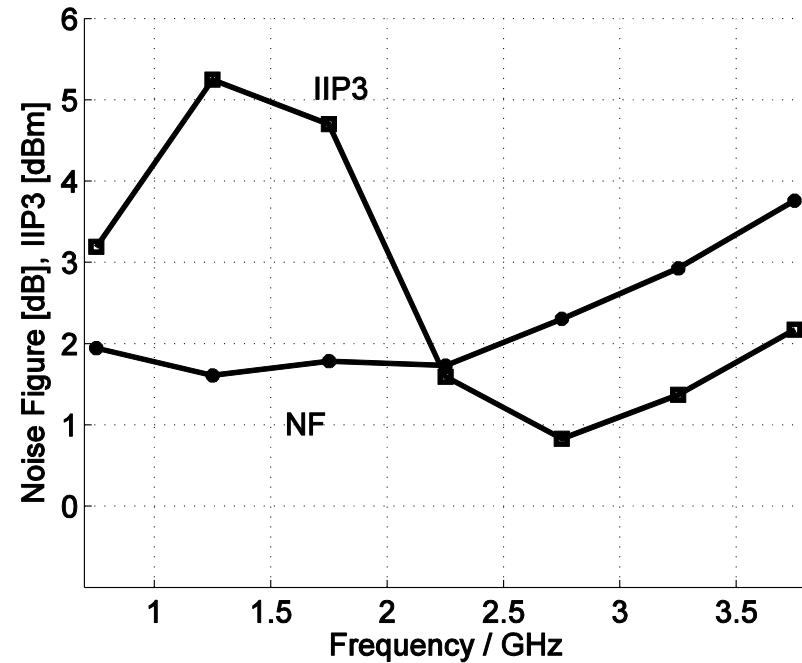
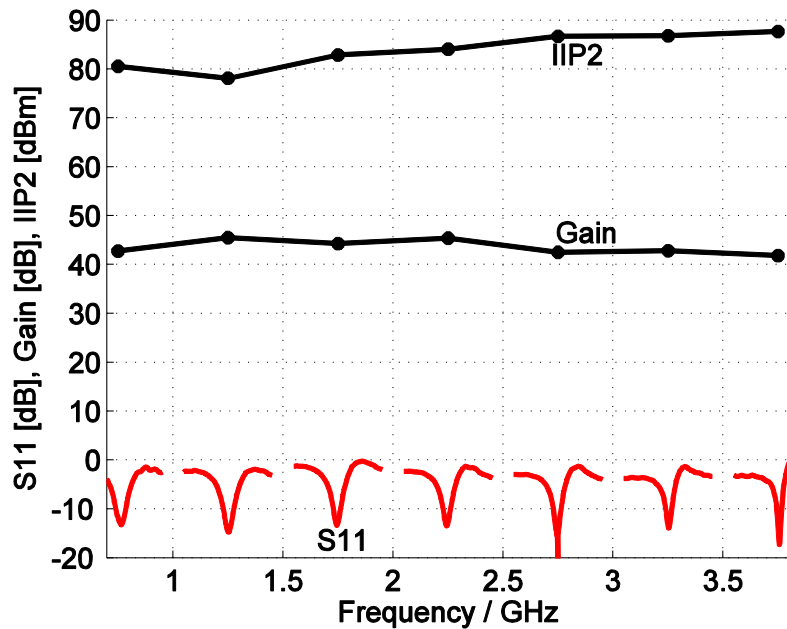
- Feedback phase can be tuned for complex Z_s
- Programmable g_m

RFIC 2014
Invited to JSSC



LTE Receiver Front-Ends

Measurements

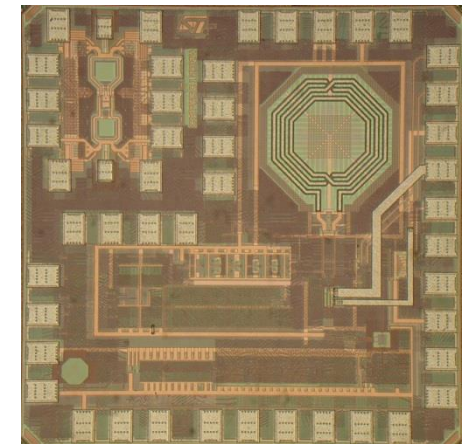
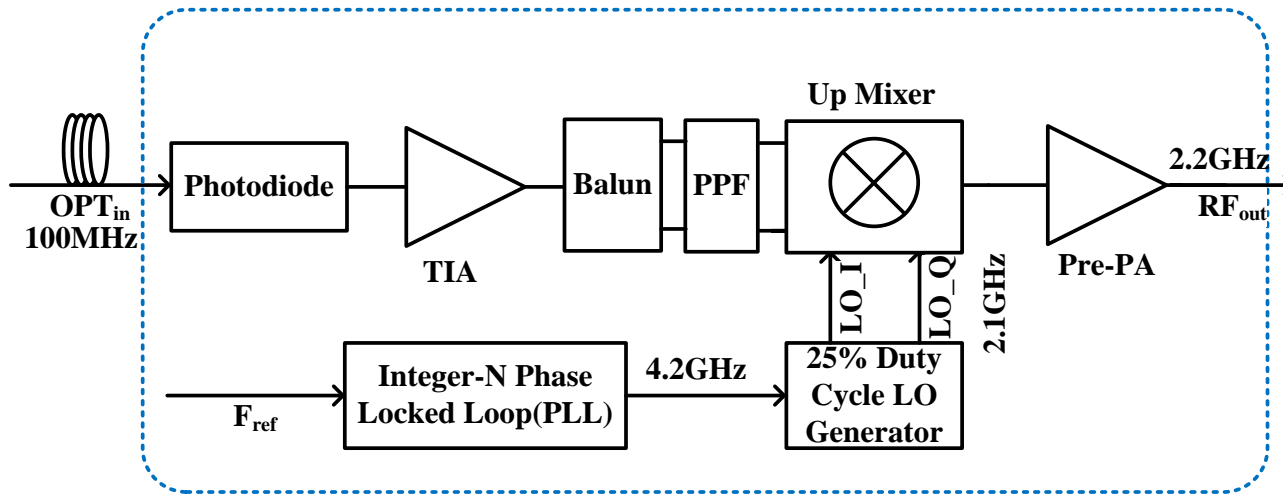




Remote Antenna Units

SWEDISH FOUNDATION for STRATEGIC RESEARCH

A Fully Integrated Radio-Fiber Interface in 65 nm CMOS



Area= 0.8mm²

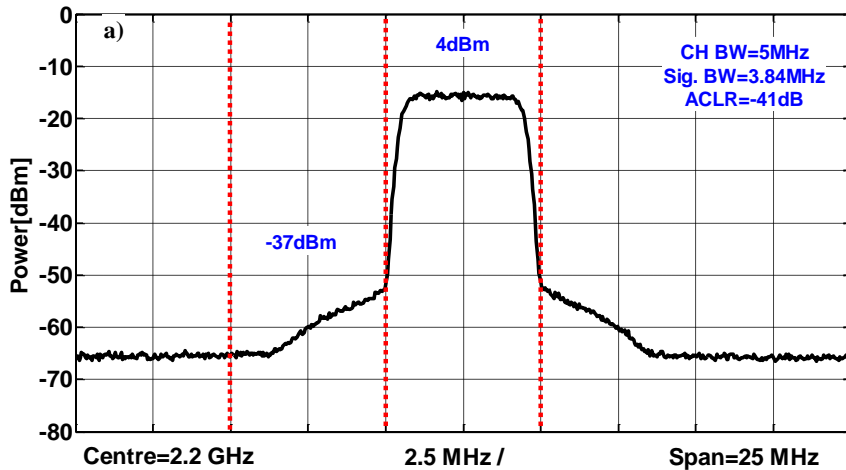
IEEE Photonics Technology Letters 2014



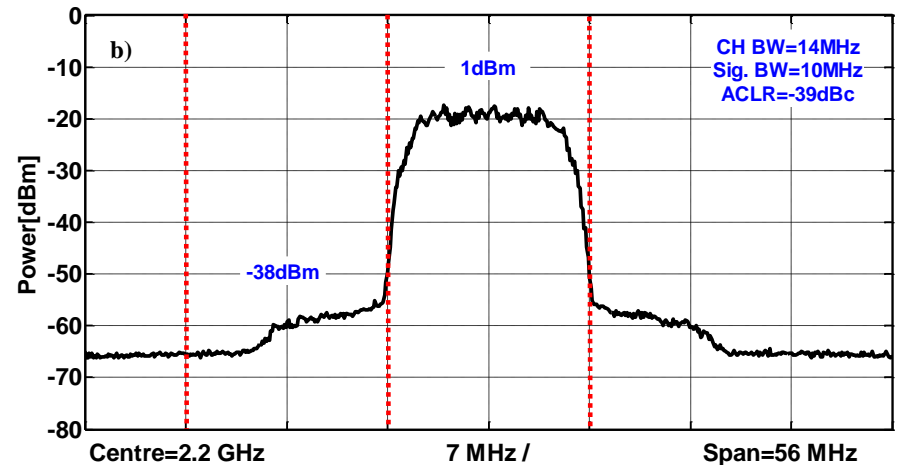
Remote Antenna Units

SWEDISH FOUNDATION for
STRATEGIC RESEARCH

Measurements



3.84MHz QPSK PAPR=5.8dB

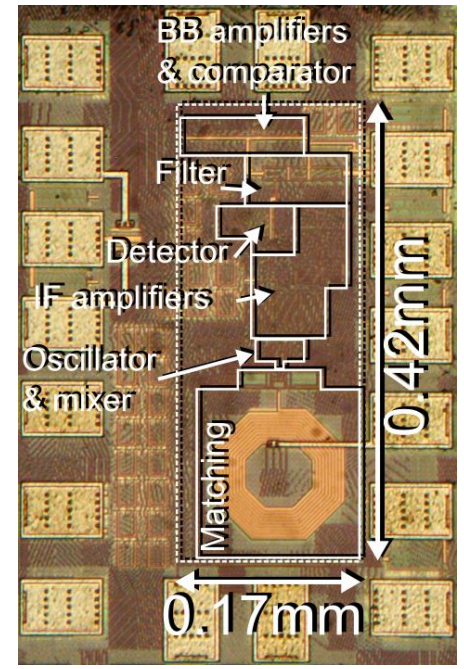
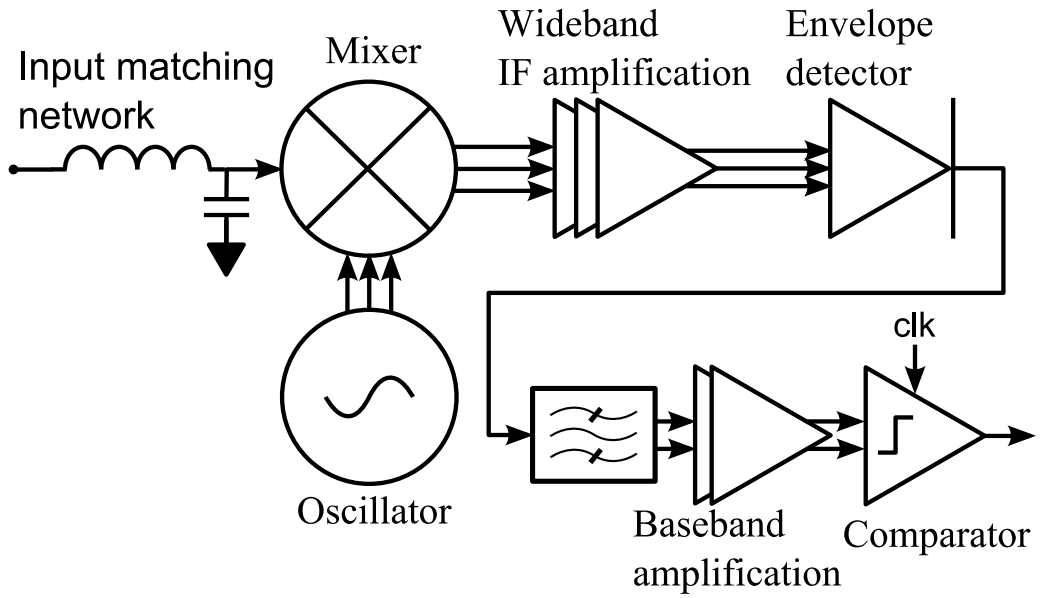


10MHz 32-QAM PAPR=6.9dB

Ultra Low Power RF

SWEDISH FOUNDATION for STRATEGIC RESEARCH

A 2.45GHz, 50uW Wake-up Receiver Front-End with -88dBm Sensitivity and 250kbps Data Rate



3-phase oscillator and mixer
Uncertain IF

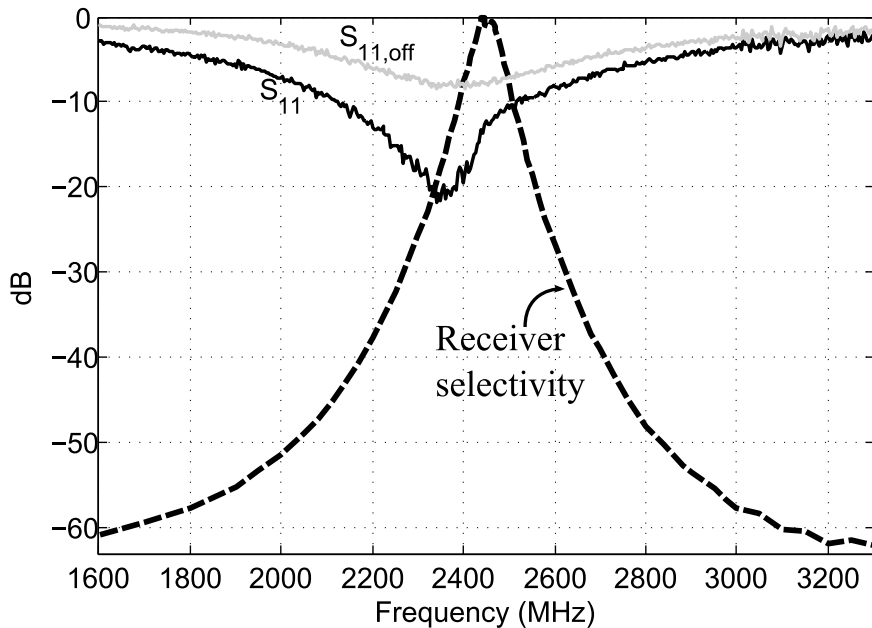
ESSCIRC 2014



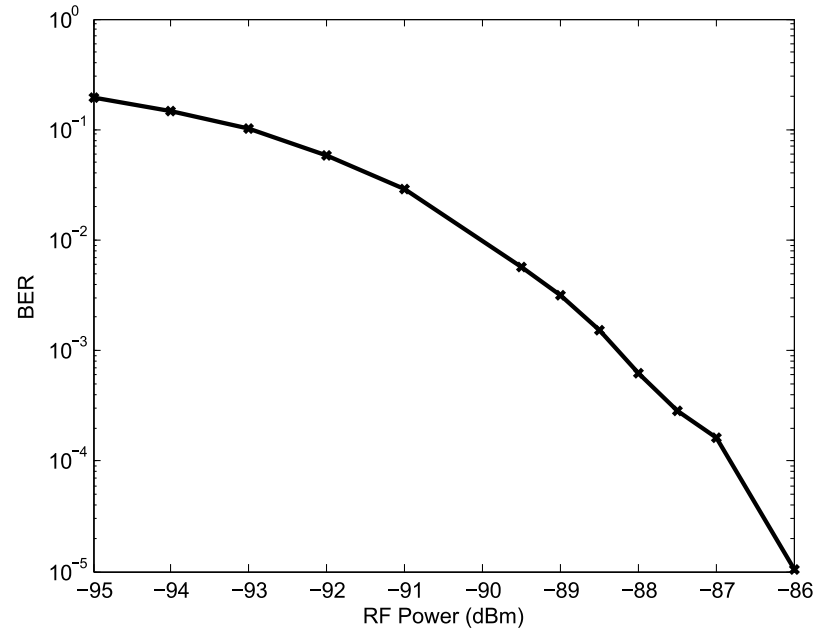
Ultra Low Power RF

SWEDISH FOUNDATION for
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Measurements



Matching & Selectivity



Sensitivity

mm wave transmitters

28GHz QVCO for E-band transmitter

Unpublished
material removed

mm wave transmitters

mm-Wave Pulse-Generation Circuits in 65nm CMOS

Unpublished
material removed



mm wave transmitters

A 65 nm CMOS varactorless mm-wave VCO

Unpublished
material removed

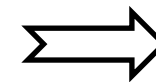
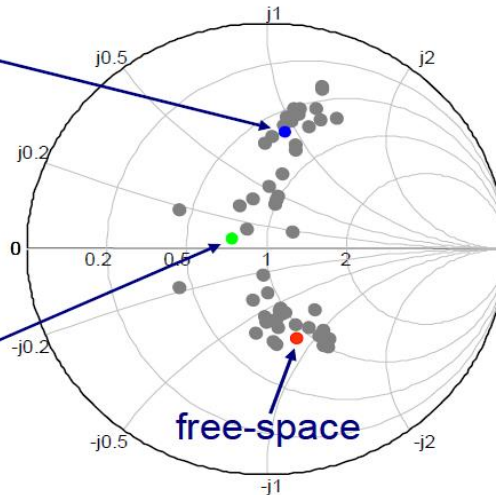
Wideband PA and adaptive matching

A Low Band Cellular Terminal Antenna Impedance Tuner in 130nm CMOS SOI Technology

Motivation – User Interaction



Commercial Phone Antenna



Tuners !

K. R. Boyle, EuCAP 2013

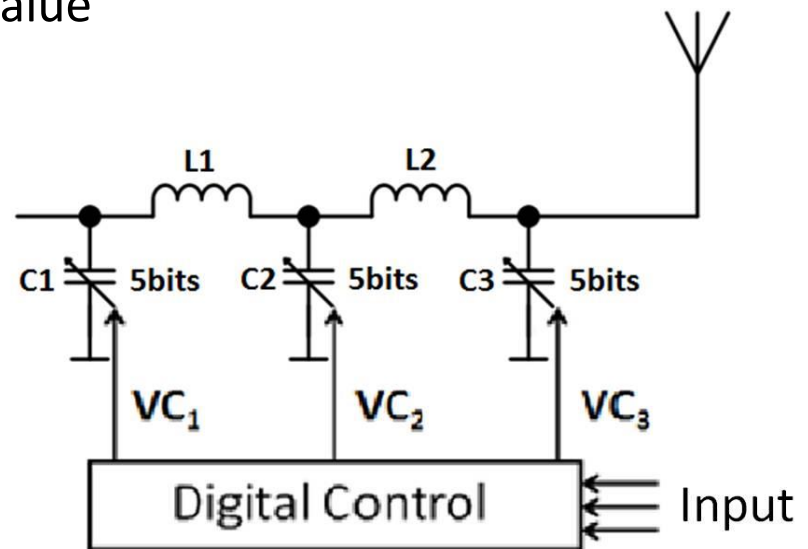
ESSCIRC 2014

Wideband PA and adaptive matching

Tuner – System Design

Double π network:

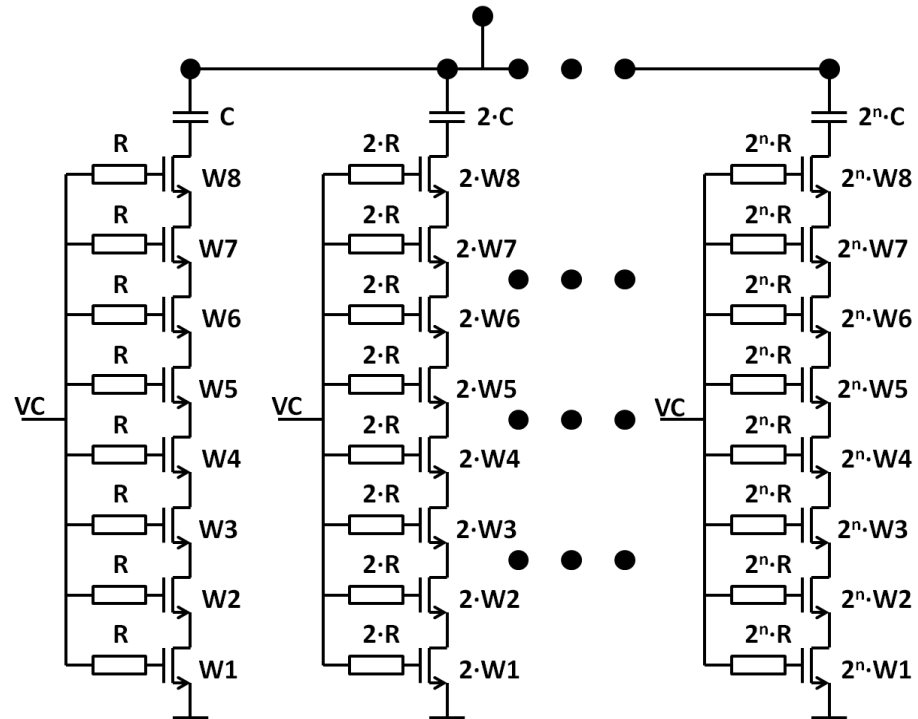
- Variable capacitors C_1 , C_2 and C_3
 - Designed for C_{\min}/C_{\max} and Q- value
- L_1 and L_2 are SMD
 - Q of 50 in Low-Band
- Digital control
 - Ser-to par. converter



Wideband PA and adaptive matching

Tuner – Switched Capacitors

- Binary weighted
- Voltage breakdown
 - 20V (or 40V_{pp})
 - 2.5V per MOST

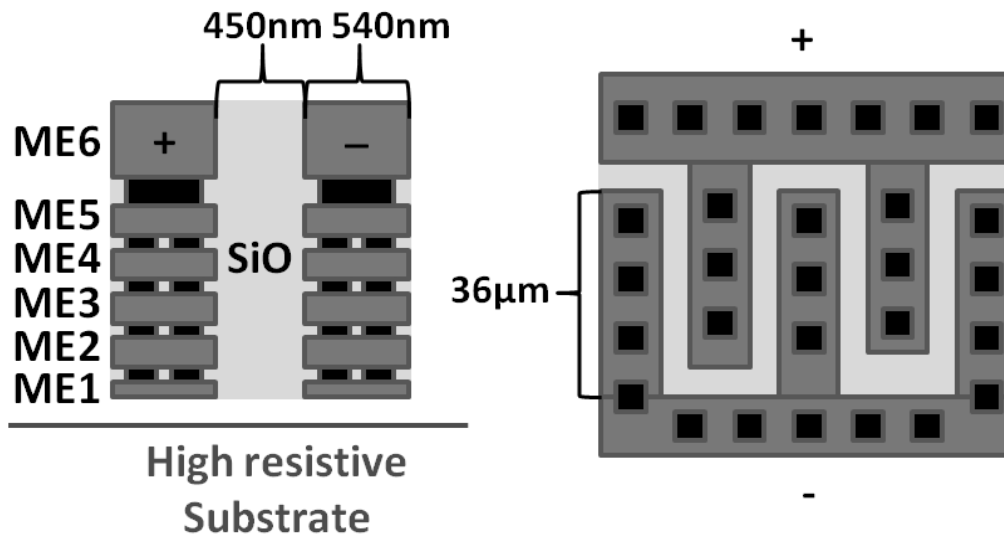


Wideband PA and adaptive matching

Tuner – Capacitor Design

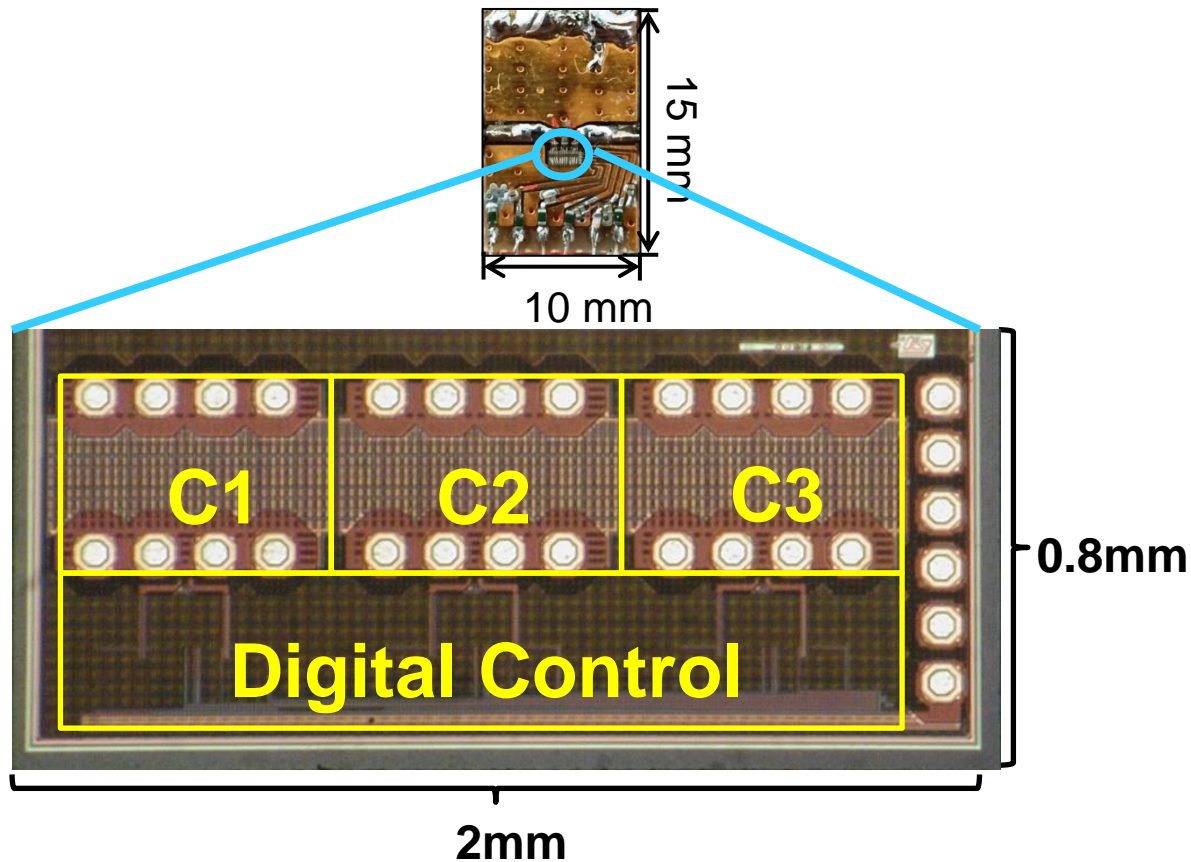
Custom made MOM capacitor to handle 20V

- SiO_2 has a voltage handling $100\text{V}/\mu\text{m}$
- Use all metal layers to maximize Q



Wideband PA and adaptive matching

Tuner – Chip and PCB Photo



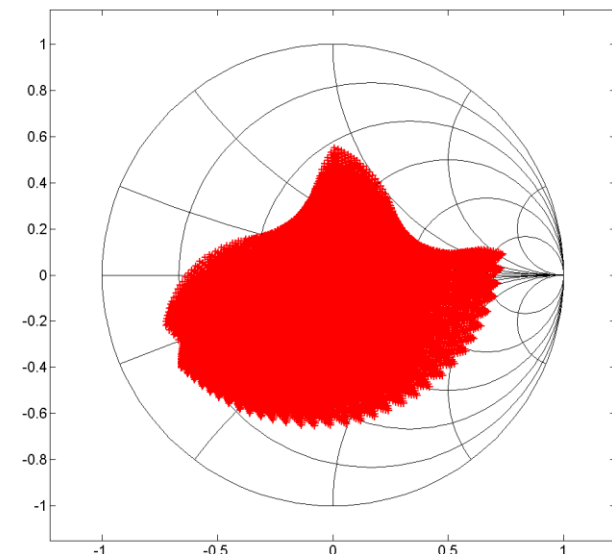
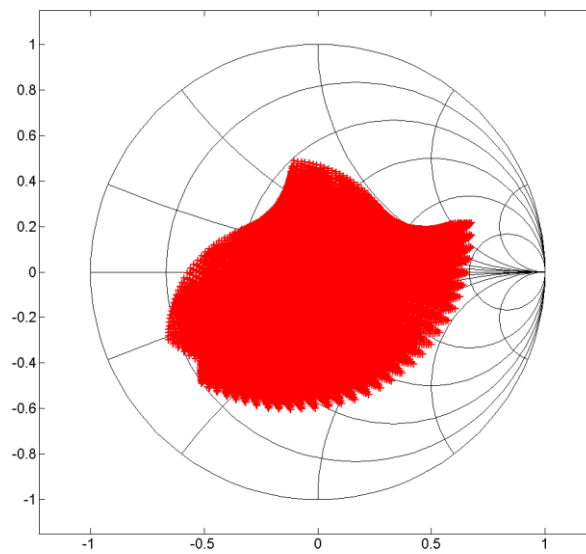
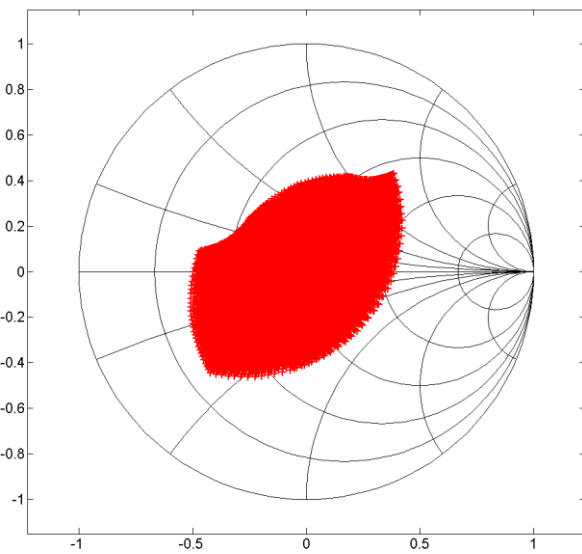
Wideband PA and adaptive matching

Tuner – Matching Domain

700 MHz

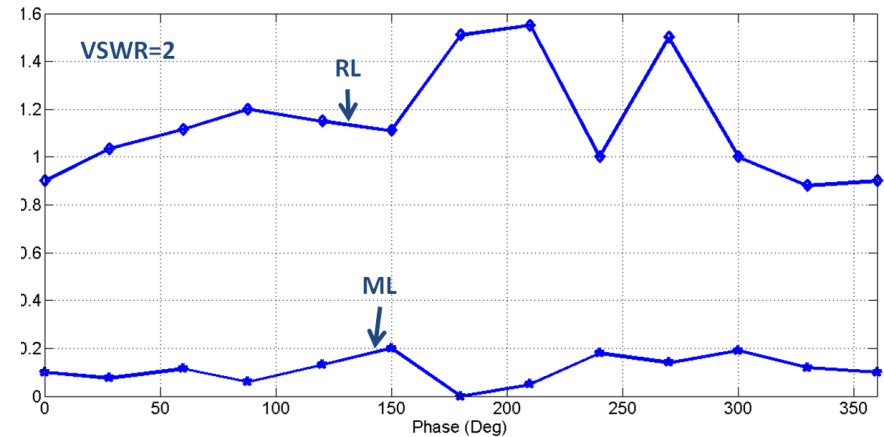
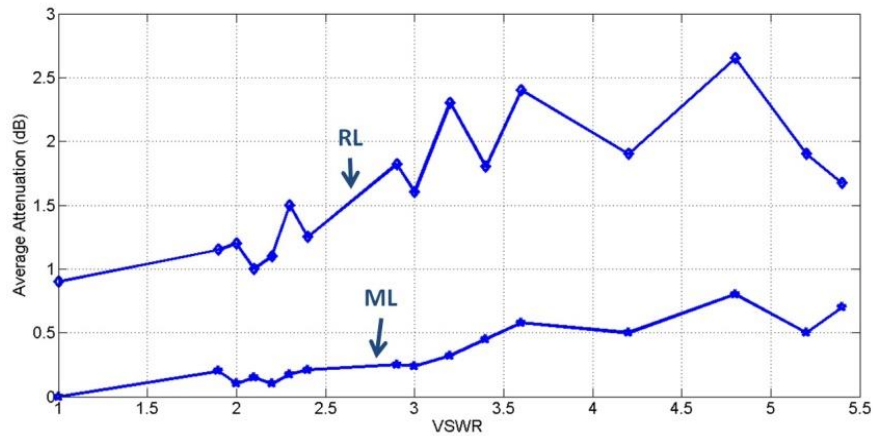
845 MHz

900 MHz



Wideband PA and adaptive matching

Tuner – Loss Measurement

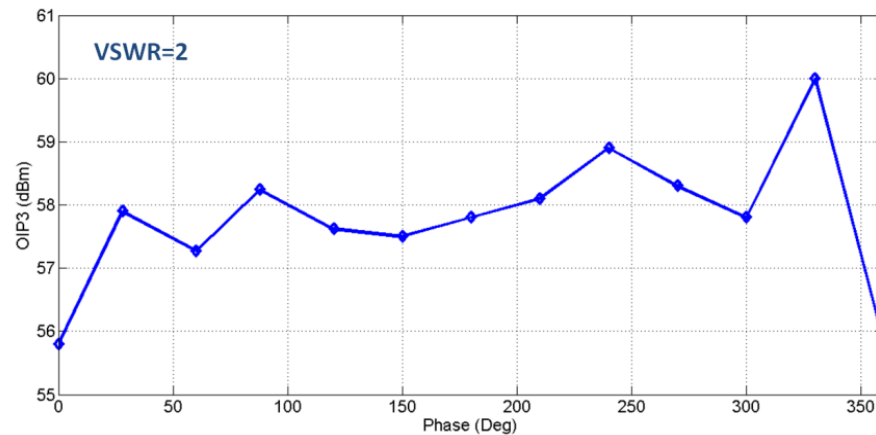
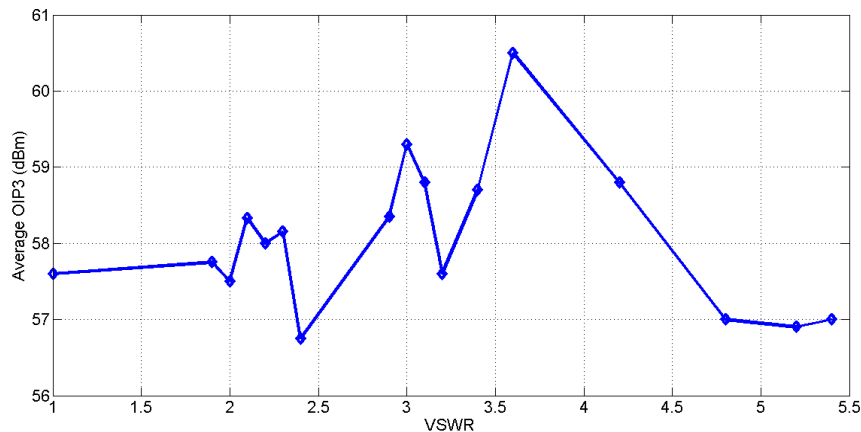


Tuner Loss at VSWR=1

0.76 dB @ 700 MHz, 0.93 dB @ 845 MHz, 1.03 dB @ 900 MHz

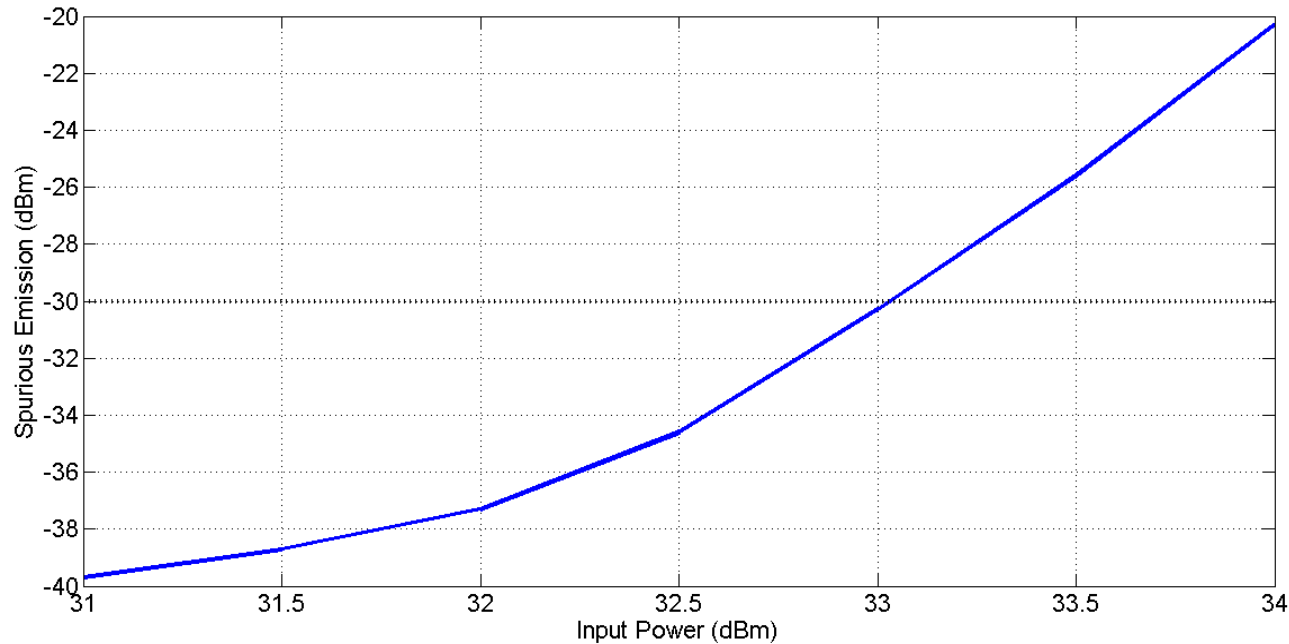
Wideband PA and adaptive matching

Tuner – IMD Measurement



Wideband PA and adaptive matching

Tuner – Spurious Emission



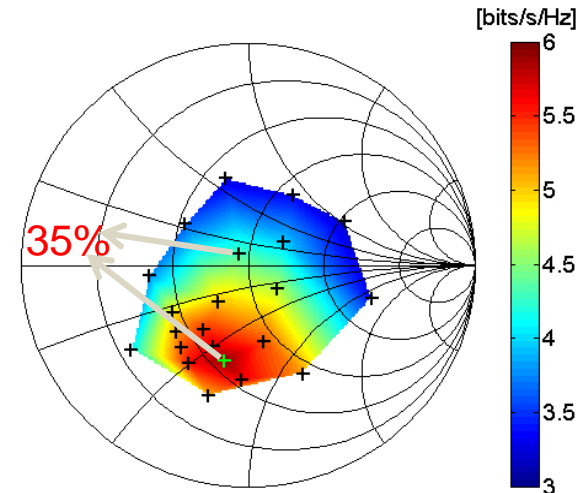
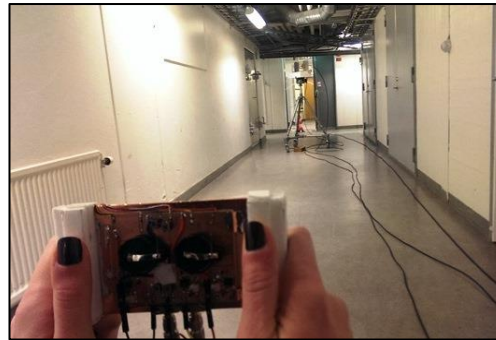
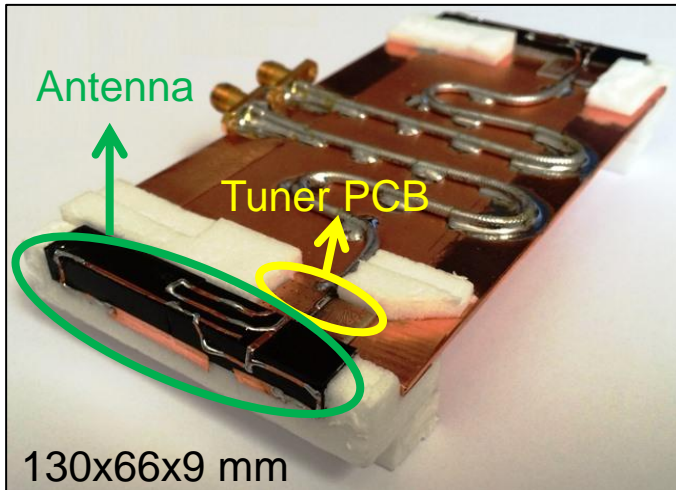
Meets the requirements of most cellular standards

Wideband PA and adaptive matching

MIMO Channel Measurements

In cooperation with Ivaylo Vasilev

- 2x environments
 - Shielded room
 - Basement corridor
- 5x user grips
- 10x users



	MUX (No Loss)	MUX
Shielded Room	2.9 dB	1.2 dB
Corridor LOS	3.4 dB	1.7 dB

Average Gain for 10x Users in TH Grip

Thanks!

To all sponsors and co-operation partners
For your attention



Questions

