Gigahertz Signal Processor:

RF-Domain Power Amplifier Linearization

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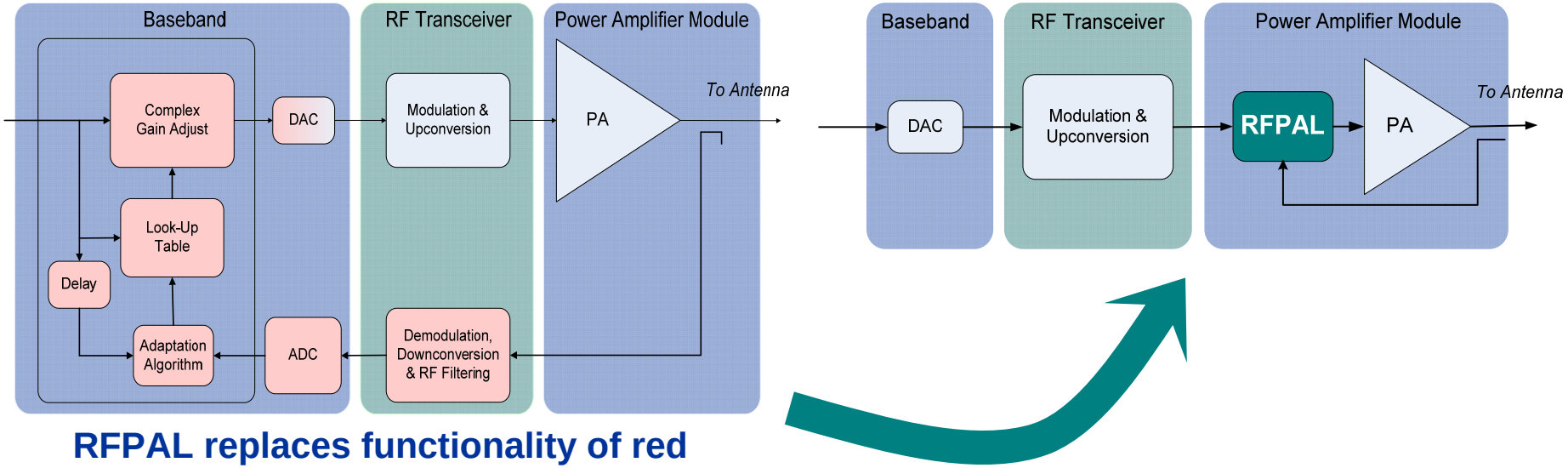
Scintera Overview

- Technology
  - Provide *analog* signal processing platform delivering higher performance *and* lower power consumption than traditional DSP solutions
  - Improve ops/sec/watt > 10x in wide range of applications
- Initial Focus
  - RF Power Amplifier Linearizer = RFPAL
  - Offer high performance linearization for infrastructure PA's and other applications
- Headquartered in Sunnyvale
  - World class team in signal processing/systems, RF/analog IC development, RF applications
- Investors
  - August Capital, Sevin Rosen, Kleiner Perkins Caufield & Byers, Ridgewood Capital

RFPAL: Digitally Controlled Analog Processor

- Digitally-driven Adaptive Analog Signal Processor in CMOS
- Firmware Controlled: Programmable/Flexible
- Optimal split of RF, analog and digital
- Fully adaptive
- RFin/RFout solution
- Broadband
- Low power
- Low complexity/cost

RFPAL



RFPAL replaces functionality of red blocks with single IC

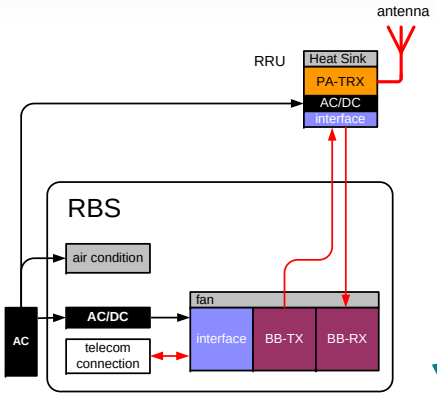
Reduced Complexity & Cost

- Replaces downconverter, ADC, & Baseband DPD
- Reduces software burden for current platform & upgrades
- Supports system modularity

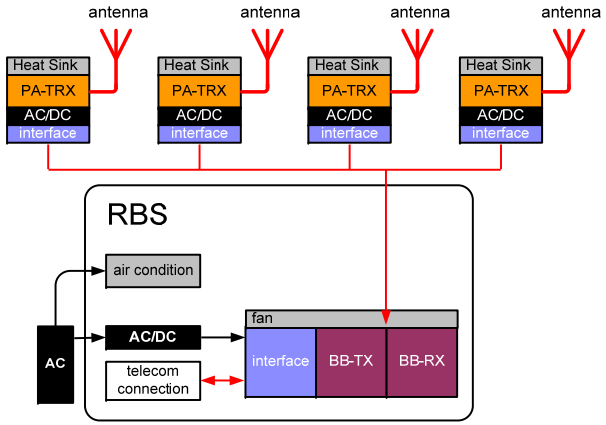
RF Power Amplifier Linearizer (RFPAL)

- Standards, modulation-agnostic
- Continuously adaptive
- Wideband performance
- Supports system modularity
- Lower cost & complexity
- Lower power

RFPAL Enables Distributed Architectures…

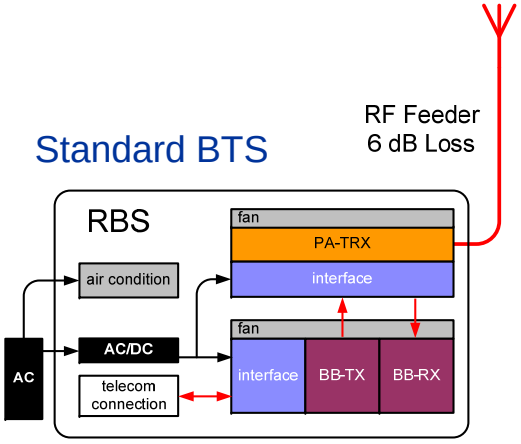


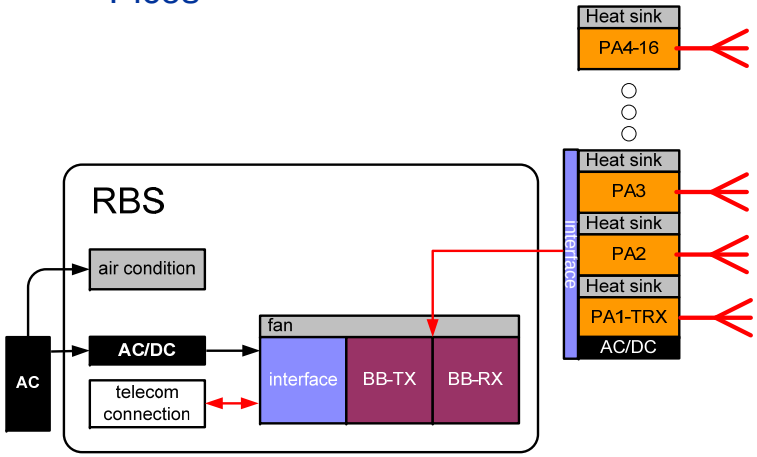
RRU



Distributed Antennas, MIMO, Picos

Standard BTS

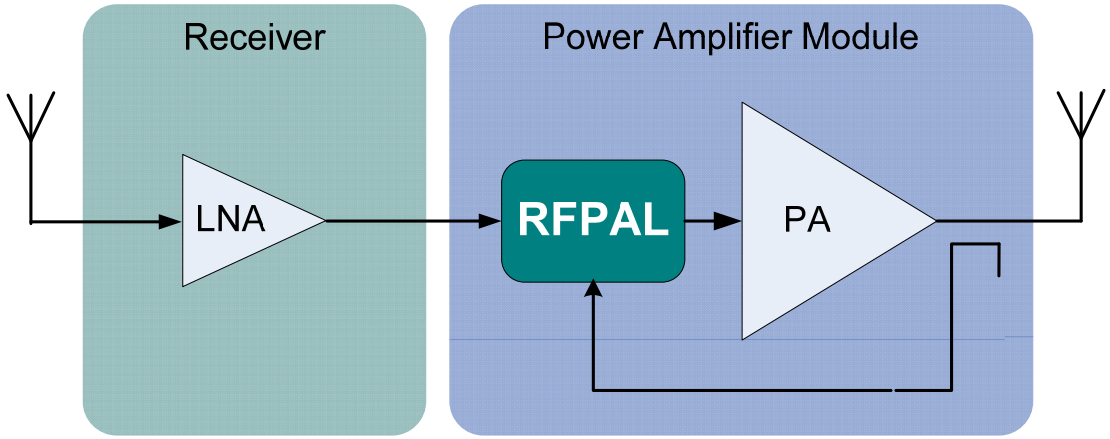




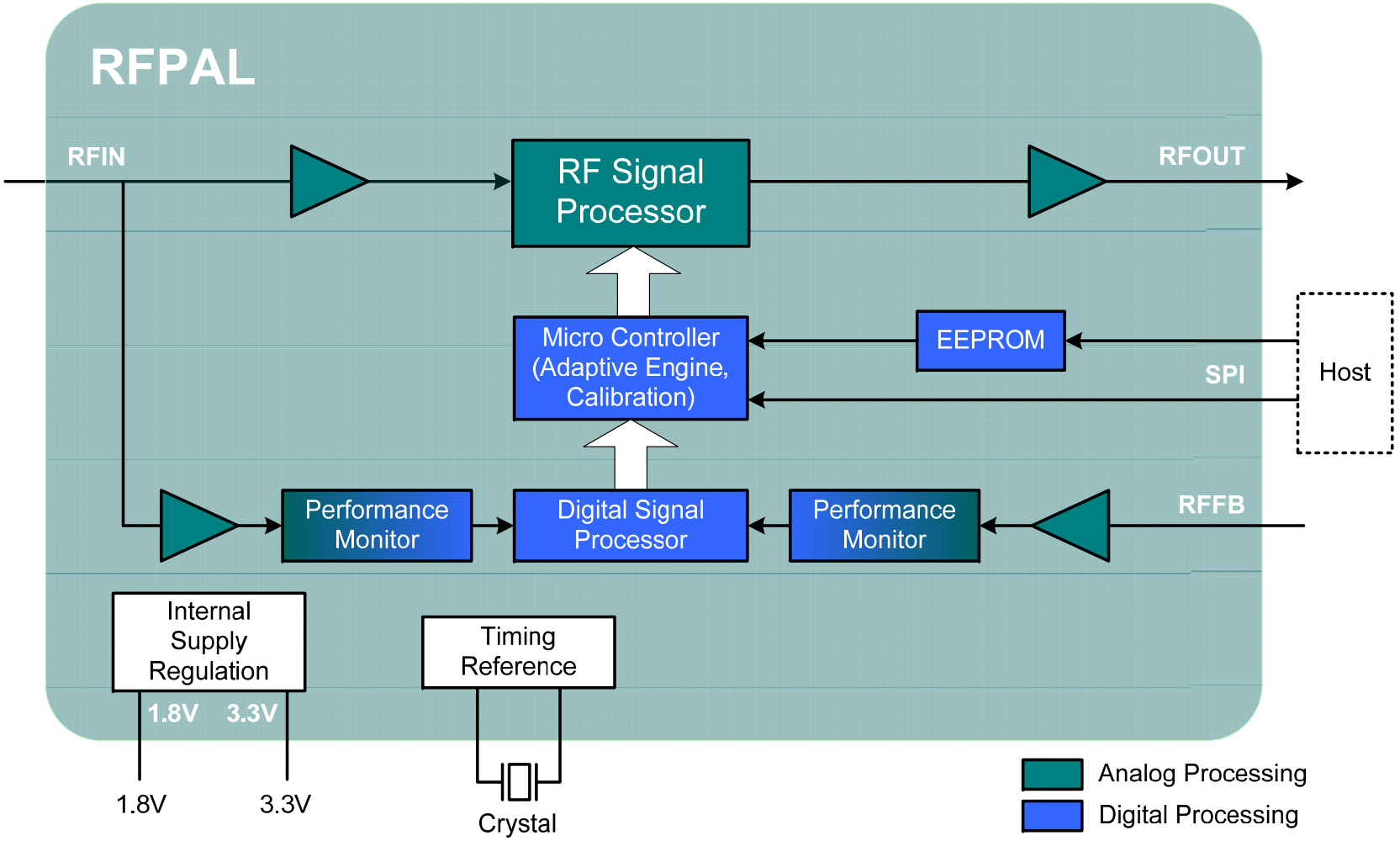
Active Antenna Systems

Adapted from Ericsson, "Power Systems Efficiency in Wireless Communications"

… and Simpler Repeater Architectures



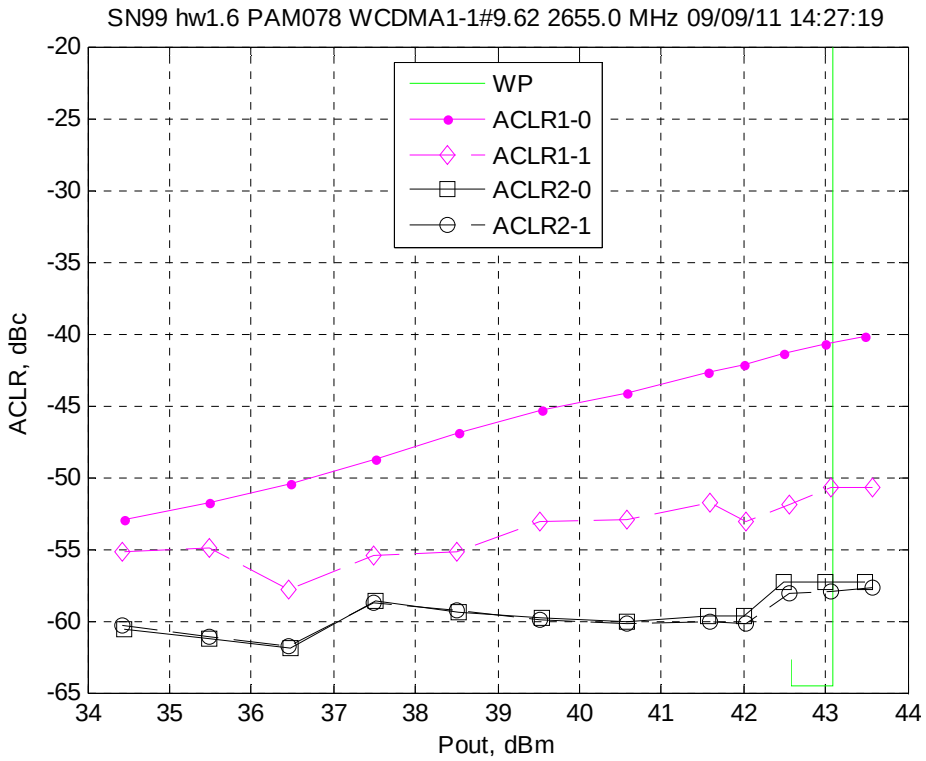
RFPAL System



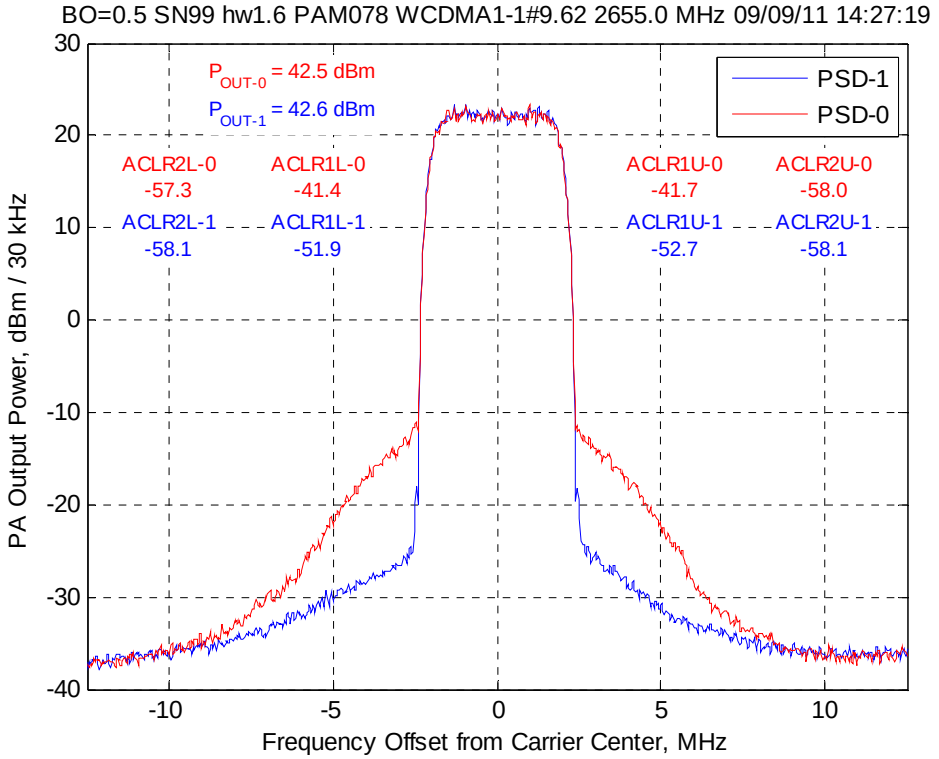
RFPAL: Key Parameters

- Operating Frequency: 700-2700 MHz
- Bandwidth: >250 MHz Linearization Bandwidth
- Power Consumption: <500 mW Average
- Temperature Range: -40 to +85 ^{o}C
- Linearization
  - Class AB and Doherty Configurations + Others
  - Short and Long Term Memory Effects
  - Continuously Adaptive (<3s adaptation time)
  - Independent of PA Output Power
- Modulation Agnostic
  - WCDMA, WiMax, LTE, TD-SCDMA, CDMA, MC-GSM, etc.
- Single chip solution implemented in standard CMOS: 9x9 mm 64 lead QFN
- Serial bus control or stand-alone autonomous operation
  - Extended functions for PA monitoring and advanced PA control
  - Field Programmable/upgradeable

Measured Performance: Doherty, 1-carrier WCDMA, 9.6 dB PAR



ACLR1/2 (dBc) before/after* correction vs. PA output power (dBm)

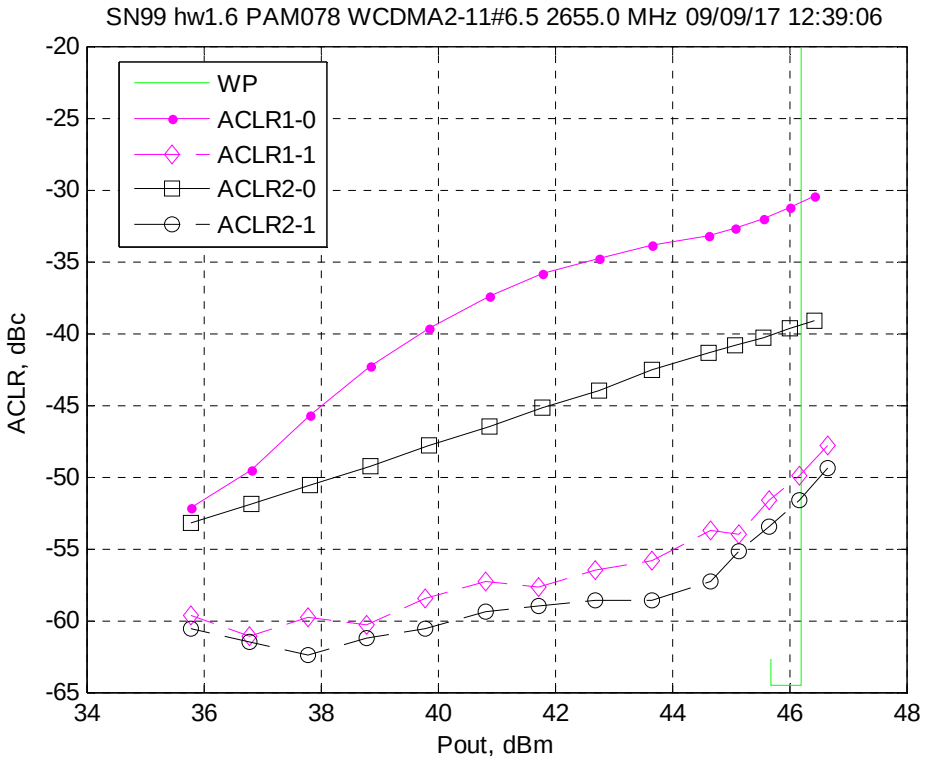


PA output power (dBm/30 kHz) vs. frequency (MHz)*

NXP BLF6G27-150P at 2655 MHz, 150 device, integrated
Pout = 42.6 dBm

* 0=before, 1=after

Measured Performance: Doherty, 2-carrier WCDMA, 6.5 dB PAR



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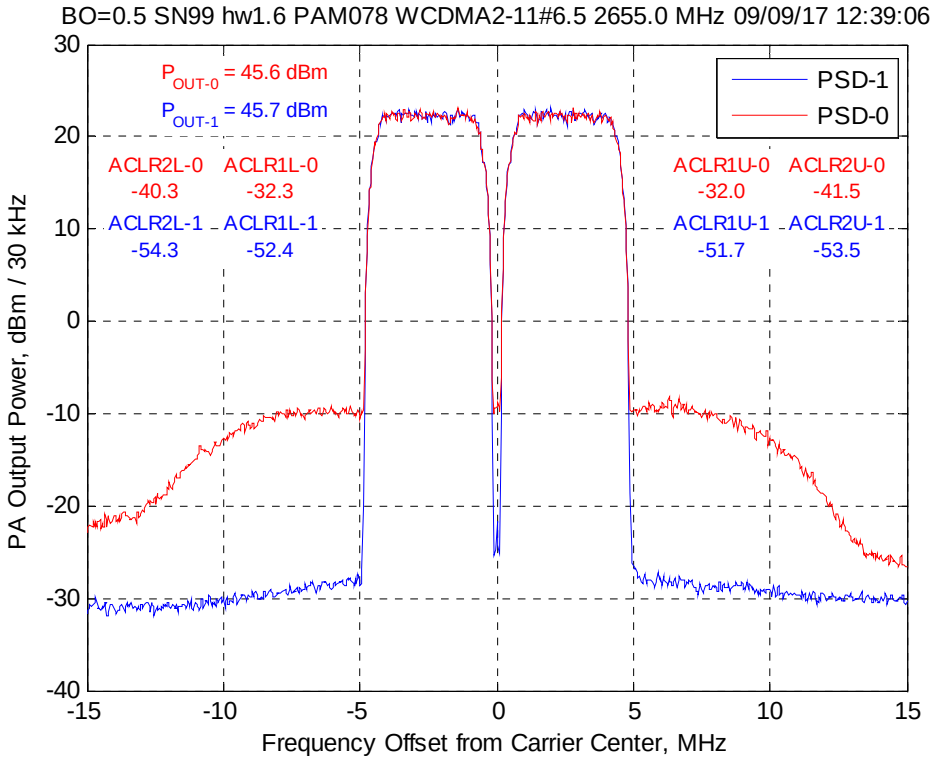
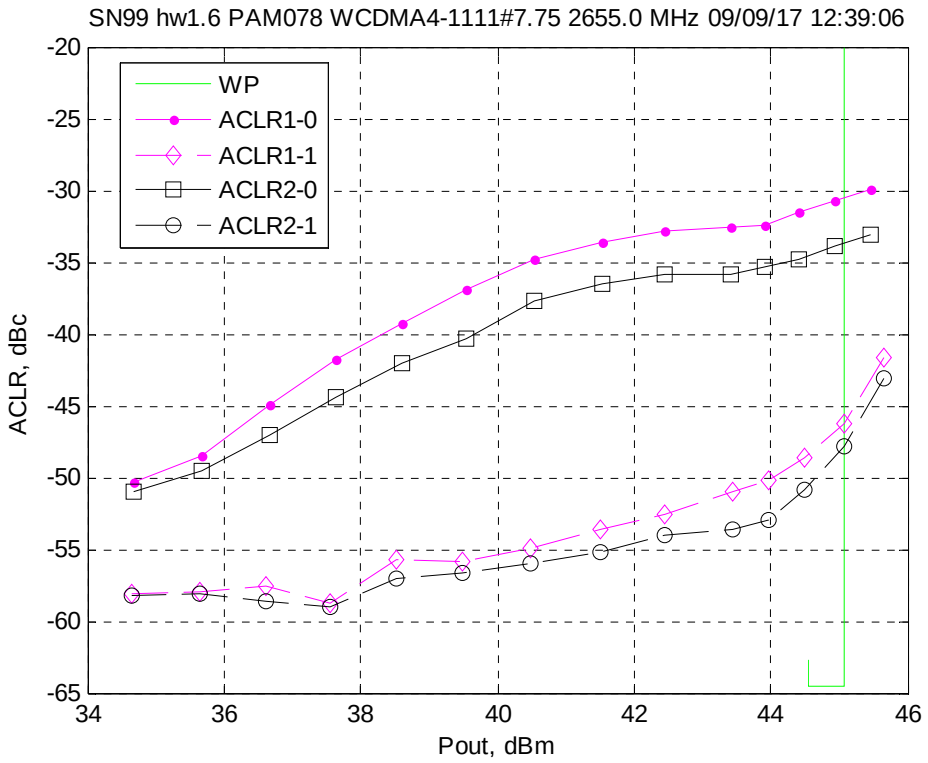


PA output power (dBm/30 kHz) vs. frequency (MHz)*

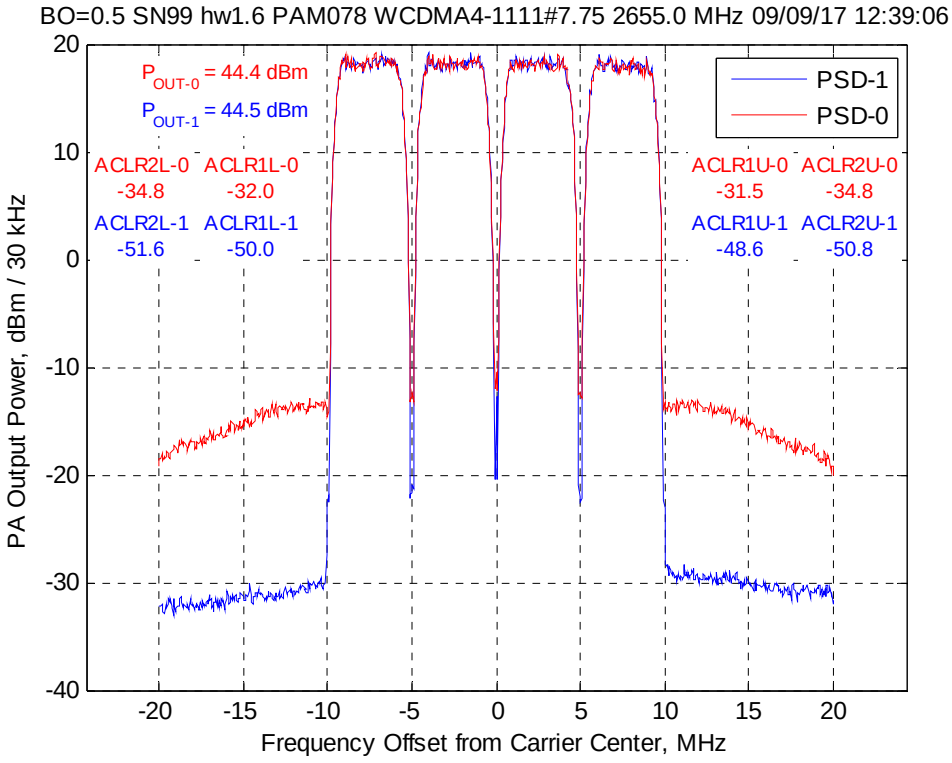
NXP BLF6G27-150P at 2655 MHz, 150 device, integrated
Pout = 45.7 dBm

* 0=before, 1=after

Measured Performance: Doherty, 4-carrier WCDMA, 7.75 dB PAR



ACLR1/2 (dBc) before/after* correction vs. PA output power (dBm)

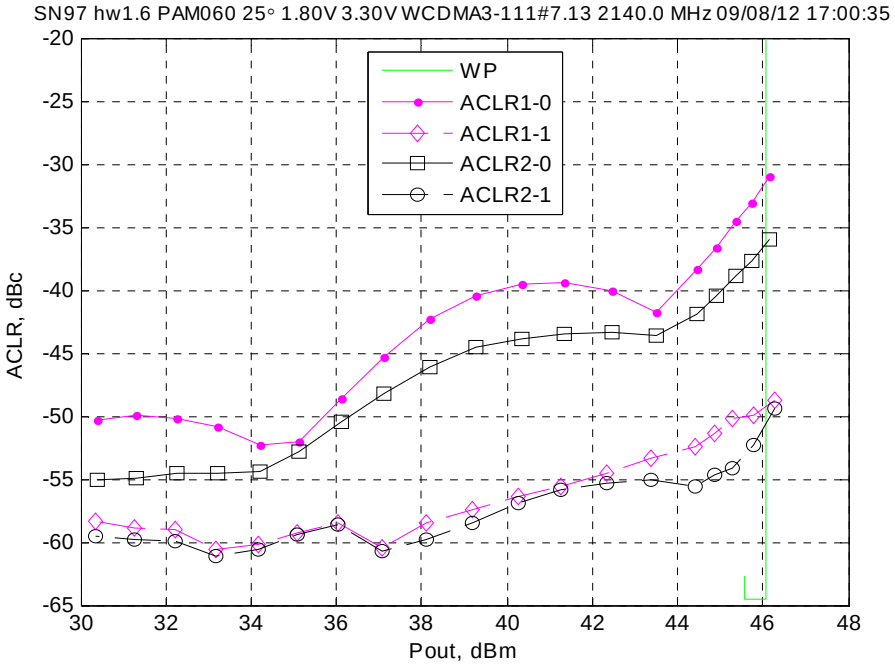


PA output power (dBm/30 kHz) vs. frequency (MHz)*

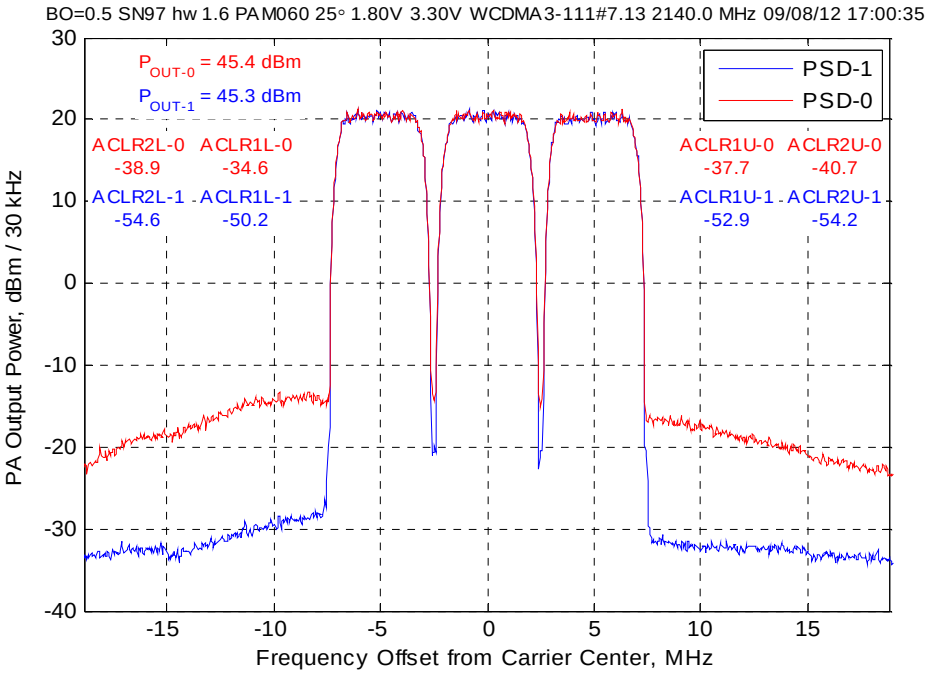
NXP BLF6G27-150P at 2655 MHz, 150 device, integrated
Pout = 44.5 dBm

* 0=before, 1=after

Measured Performance: Doherty, 3-carrier WCDMA, 7 dB PAR



ACLR1/2 (dBc) before/after* correction vs. PA output power (dBm)

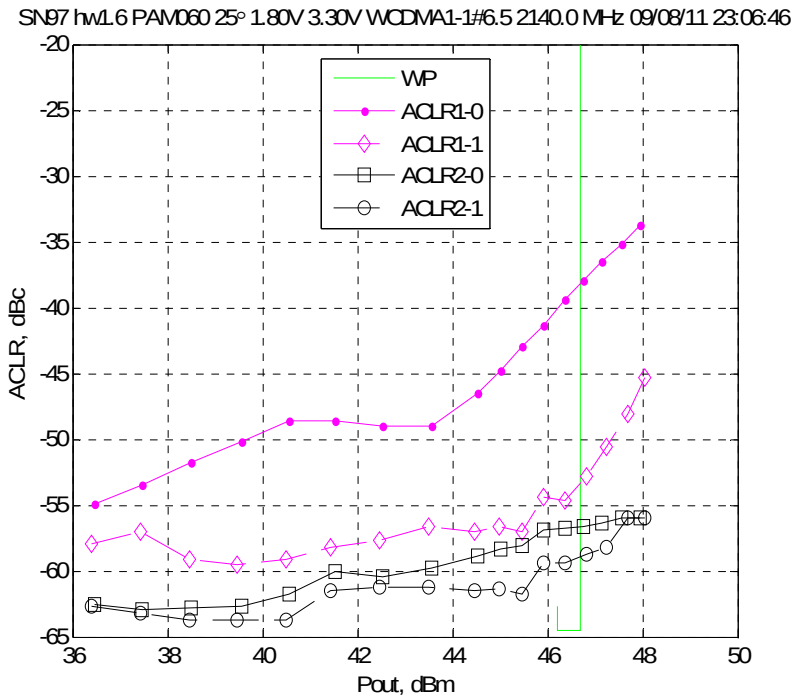


PA output power (dBm/30 kHz) vs. frequency (MHz)*

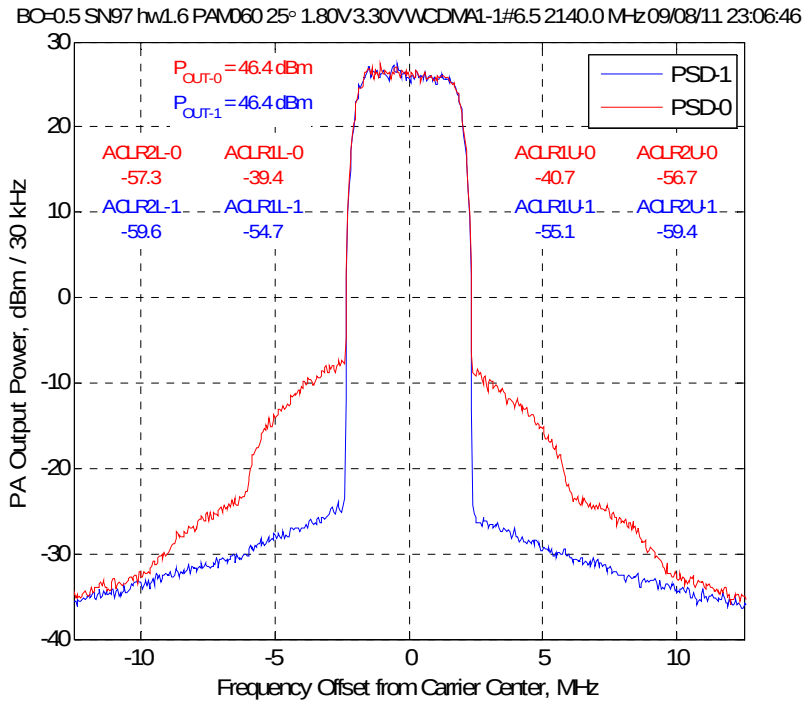
Freescale MRF7S21080 at 2140 MHz, 080 device
Pout = 45.3 dBm

* 0=before, 1=after

Measured Performance: Doherty, 1-carrier WCDMA, 6.5 dB PAR



ACLR1/2 (dBc) before/after* correction vs. PA output power (dBm)

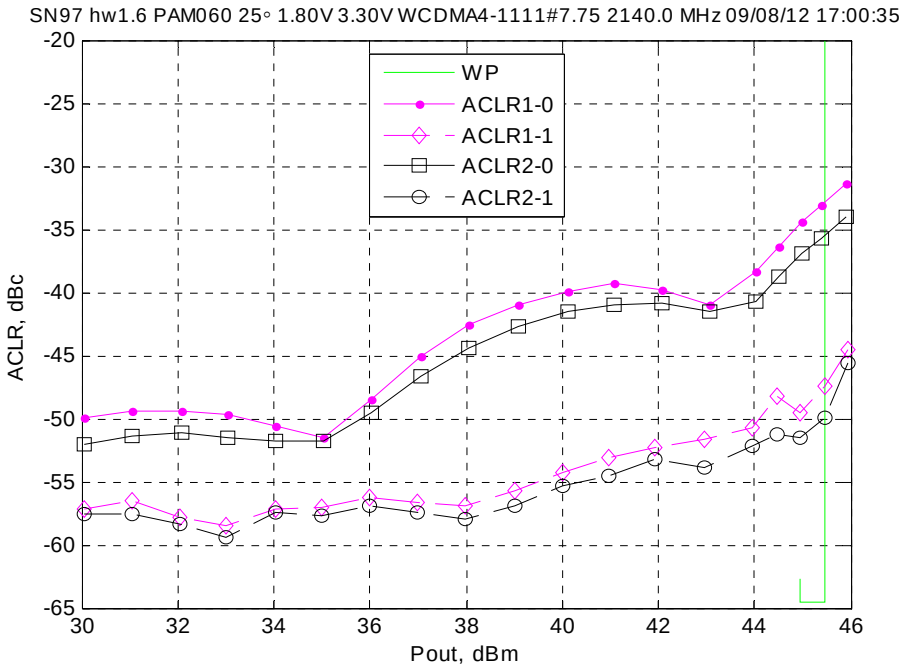


PA output power (dBm/30 kHz) vs. frequency (MHz)*

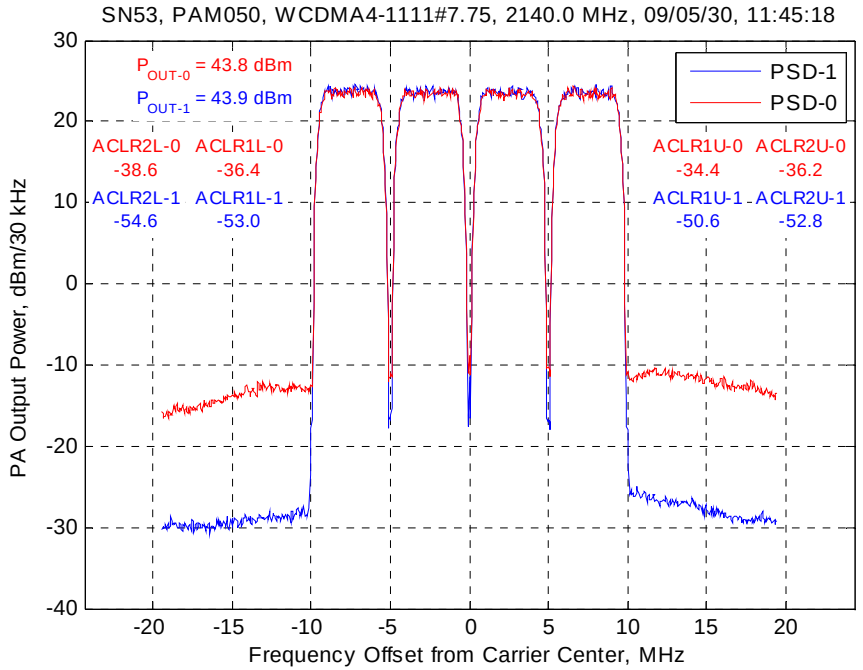
Freescale MRF7S21080 at 2140 MHz, 080 device
Pout = 46.4 dBm

* 0=before, 1=after

Measured Performance: Doherty, 4-carrier WCDMA, 8 dB PAR



ACLR1/2 (dBc) before/after* correction vs. PA output power (dBm)

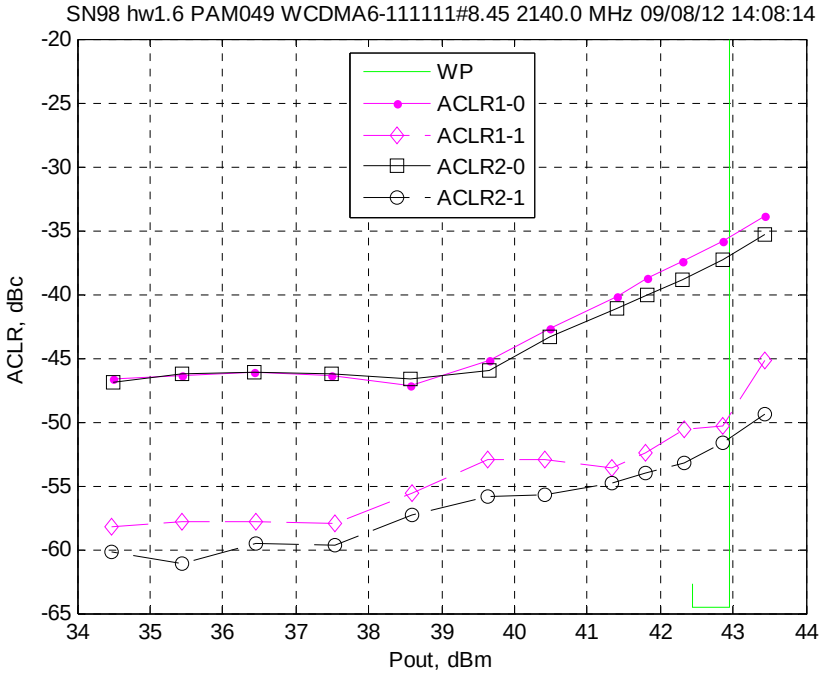


PA output power (dBm/30 kHz) vs. frequency (MHz)*

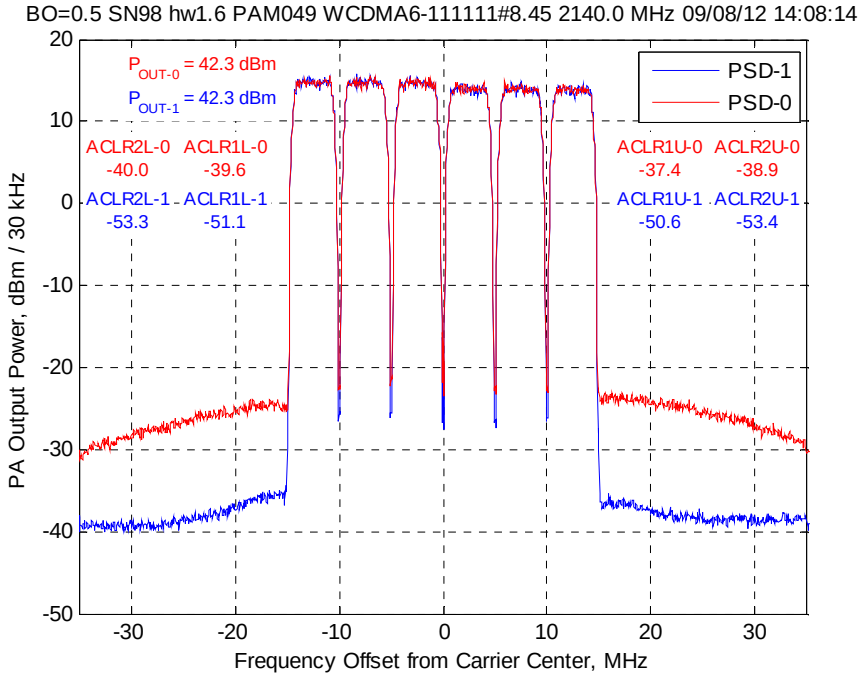
Freescale MRF7S21080 at 2140 MHz, 080 device
Pout = 43.9 dBm

* 0=before, 1=after

Measured Performance: Class AB, 6-carrier WCDMA - 8.5 dB PAR



ACLR1/2 (dBc) before/after* correction vs. PA output power (dBm)

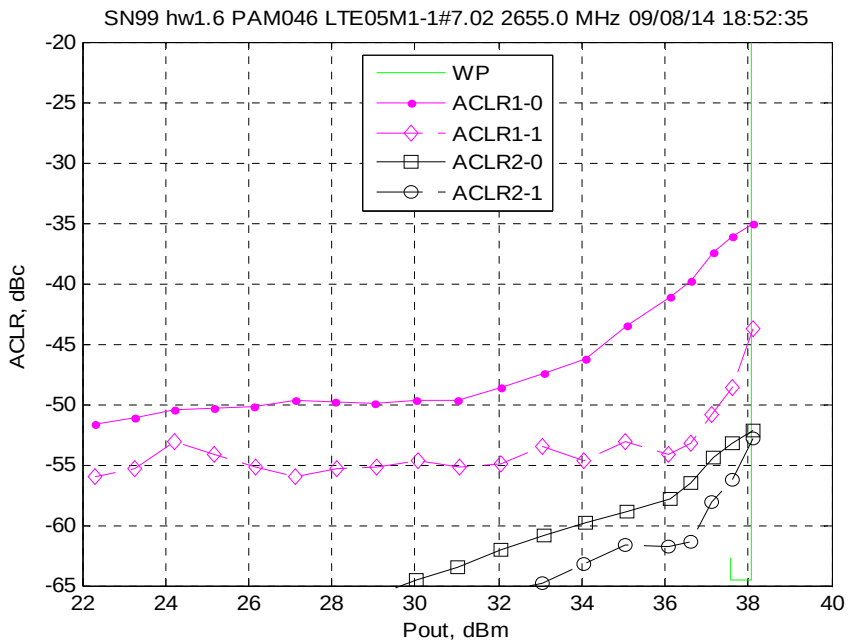


PA output power (dBm/30kHz) vs. frequency (MHz)*

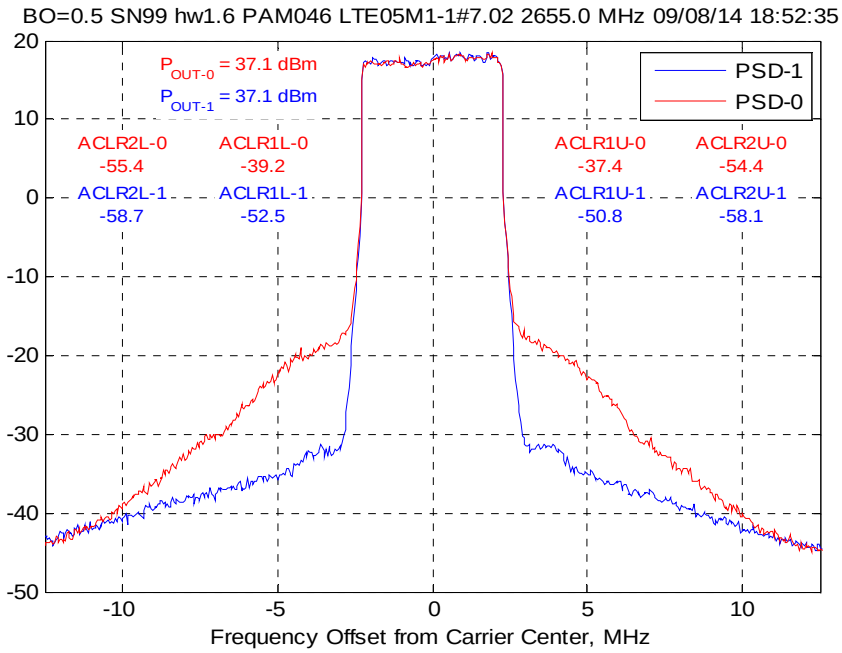
Freescale MRF7S21110 at 2140 MHz, 080 device
Pout = 42.3 dBm

* 0=before, 1=after

Measured Performance: Class AB, 1-carrier LTE – 5 MHz - 7 dB PAR



ACLR1/2 (dBc) before/after* correction vs. PA output power (dBm)

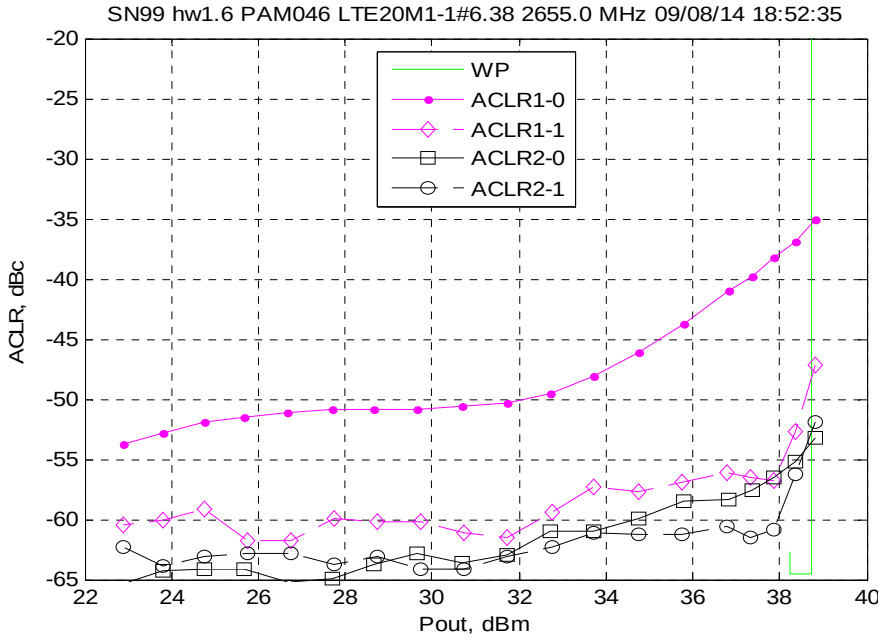


PA output power (dBm/30 kHz) vs. frequency (MHz)*

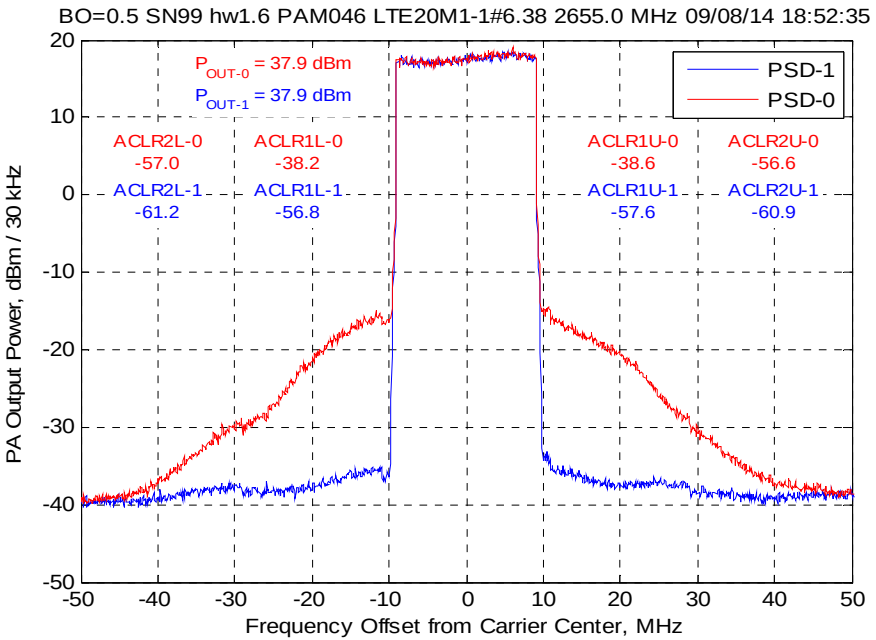
Freescale MW7IC2725N at 2655 MHz, 080 device
Pout = 37.1 dBm

* 0=before, 1=after

Measured Performance: Class AB, 1-carrier LTE – 20 MHz – 6.4 dB PAR



ACLR1/2 (dBc) before/after* correction vs. PA output power (dBm)



PA output power (dBm/30 kHz) vs. frequency (MHz)*

Freescale MW7IC2725N at 2655 MHz, 080 device
Pout = 37.9 dBm

* 0=before, 1=after

Summary: Gigahertz Signal Processor

- Ideal transmitter linearization solution
  - Low Cost
  - Low Power
  - Low Complexity
  - High Flexibility
- Applicable across a broad range of output powers
  - <1 W to >80 W
  - Class AB and Doherty
- Applicable across a broad range of solutions
  - Distributed Antenna Systems
  - MIMO Systems
  - Traditional in-cabinet amplifiers
  - Remote Radio Units (RRU)
  - Tower Mounted Power Amplifiers
  - Repeaters and Booster Amplifiers
  - Micro/Pico Basestations
  - Active Antenna Systems

Summary: RFPAL

- Operating Frequency
  - One part covers all applications (700 to 2700 MHz)
- Power Consumption
  - RFPAL power consumption < 500 mW
- Ease of Use
  - Simple BoM
  - Simple system
  - Modular solution reduces development and verification cost/time
  - ONLY solution that enables standalone linearized PA module
- BoM Savings
  - Single chip vs. complex multi IC solution