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Linearize Any Power Amplifier (PA), Any Waveform with High Efficiency

TelASIC Communication, Inc.

TELASIC communications

Terms we will use frequently

- ACPR: Adjacent Channel Power Ratio
- CFR: Crest Factor Reduction
- DPD: Digital Pre-Distortion
- SFDR: Spur-Free Dynamic Range
- PA: Power Amplifier
- PAR: Peak to Average Power Ratio
- UC: Up Converter
- DUC: Digital Up Converter
- DC: Down Converter
- ADC: Analog to Digital Converter
- DAC: Digital to Analog Converter

What we are going to present?

- Market trends for 2G/3G basestations that affect Power Amplifier linearization
- What problems Operators and OEMs are facing regarding use of Power Amplifier
- How TelASIC is addressing these Problems
  - Universal CFR
  - PA-blind, waveform-agnostic linearization

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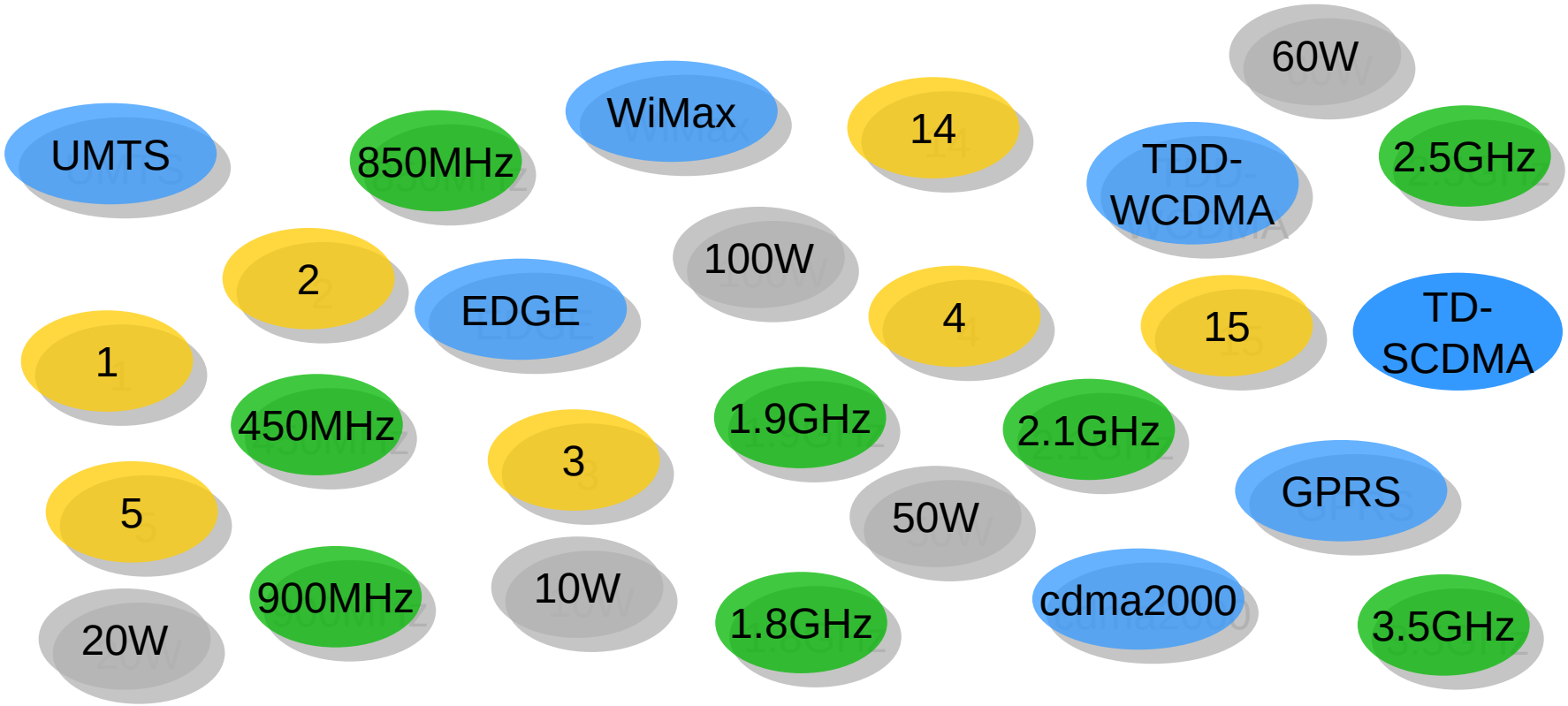
Three Major Market Trends

1. Diversification of Standards and Frequency Bands

2. Operator requirements for adjacent channel interference higher than standards to improve quality of service

3. Cost pressures drive migration from single carrier power amplifiers (SCPA) to multi carrier power amplifiers (MCPA)

Trend #1: Diversification



Can we use one linearizer for all types of PAs ?

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Key requirement: PA-blind and waveform-agnostic linearization

- TelASIC innovation: truly blind algorithm adapts to any PA, any waveform, any frequency
  - No tuning required – highly producible solution
  - Continuously adaptive solution stable over time and temperature
- TelASIC has partnered with Altera to offer solution to BTS vendors, MCPA module vendors

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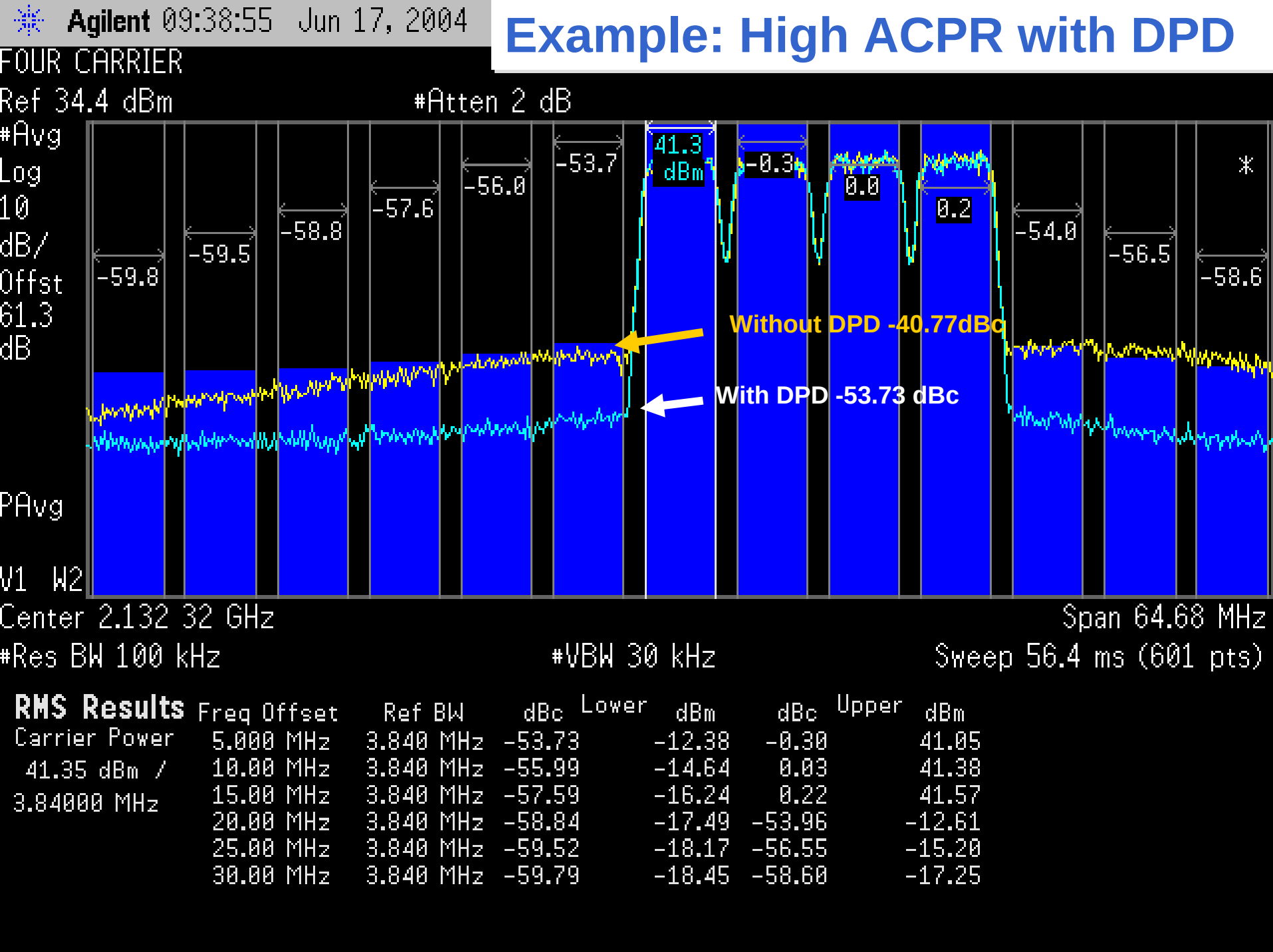
Trend # 2: High ACPR Requirement

- UMTS specification for ACPR: 45 dB
- Operators specifying much higher ACPR to avoid any interference from competing carriers
- To achieve high ACPR required by Operators, PA efficiency is sacrificed
- TelASIC offers solution that allows BTS vendors to achieve high ACPR at high PA efficiency

Example: High ACPR with DPD

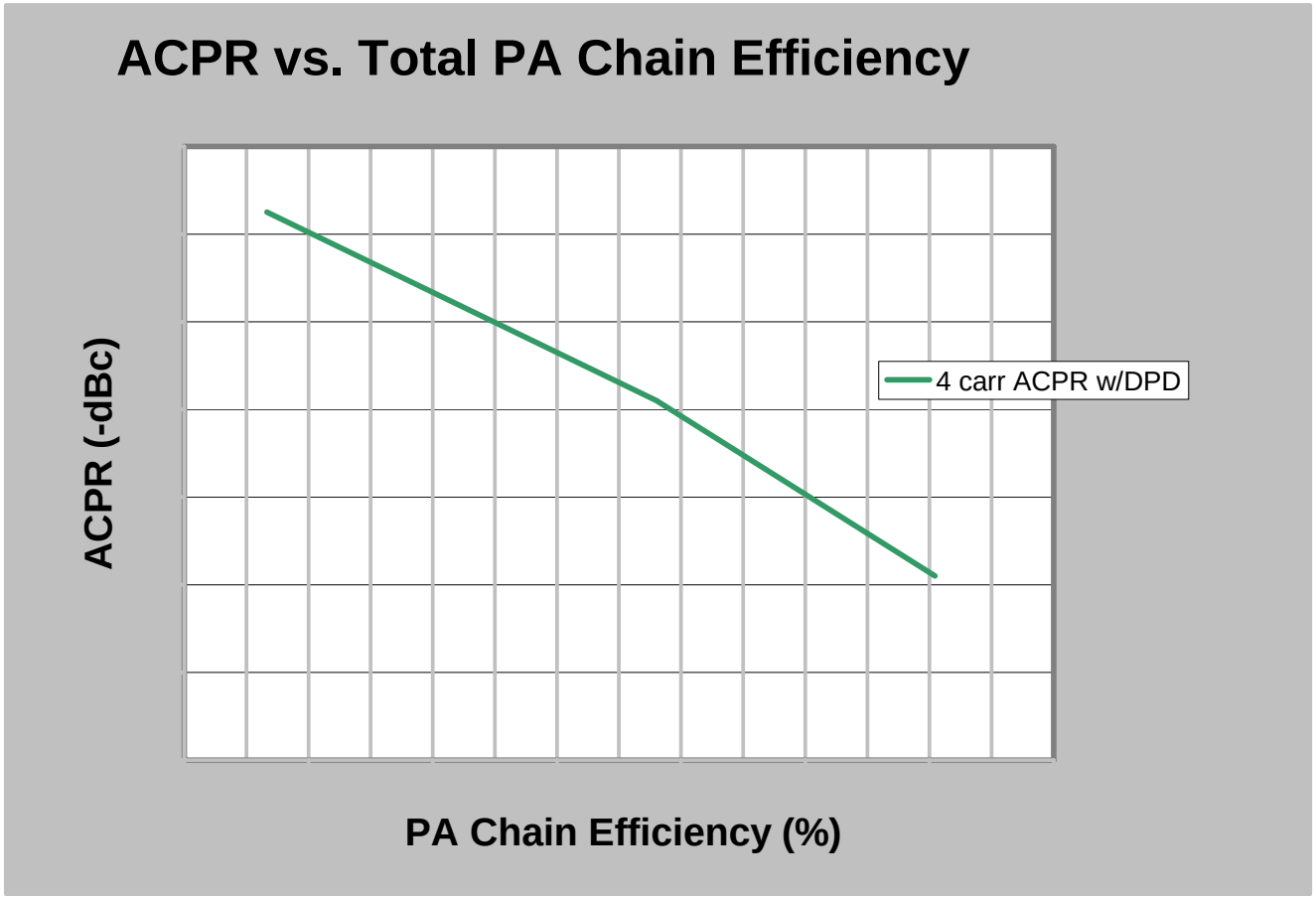


RMS Results

Carrier Power
41.35 dBm /
3.84000 MHz

Freq Offset	Ref BW	dBc	Lower dBm	dBc	Upper dBm
5.000 MHz	3.840 MHz	-53.73	-12.38	-0.30	41.05
10.00 MHz	3.840 MHz	-55.99	-14.64	0.03	41.38
15.00 MHz	3.840 MHz	-57.59	-16.24	0.22	41.57
20.00 MHz	3.840 MHz	-58.84	-17.49	-53.96	-12.61
25.00 MHz	3.840 MHz	-59.52	-18.17	-56.55	-15.20
30.00 MHz	3.840 MHz	-59.79	-18.45	-58.60	-17.25

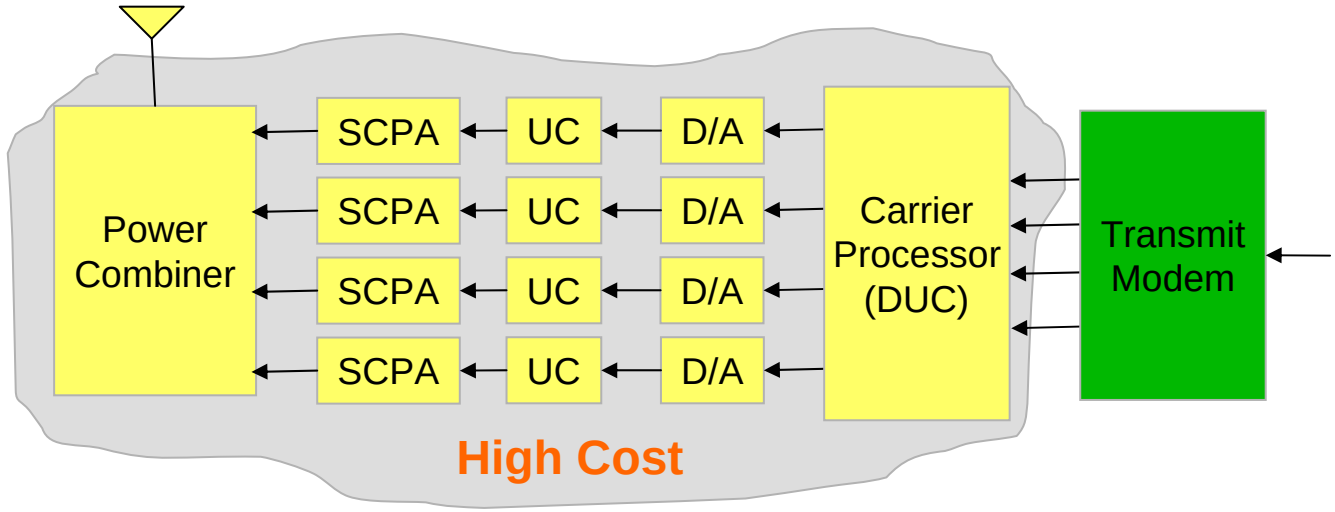
ACPR vs. PA Chain Efficiency



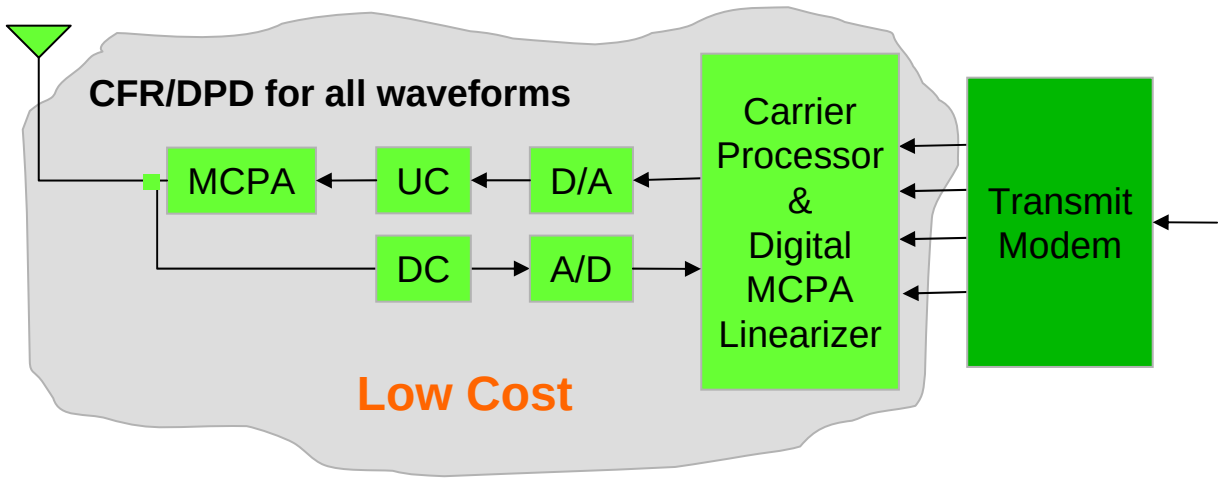
Example of PA behavior (not actual data)

Trend #3: Migration to MCPA

Traditional Multi-carrier Transmitter



MCPA with DPD Linearizer



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Evolution of Linearization Technology

- SCPA and PA combiner
- MCPA using analog pre-distortion
- MCPA using analog feed forward and pre-distortion
- MCPA using digital pre-distortion and crest factor reduction (CFR)
  - TelASIC's universal CFR technology supports all types of waveforms

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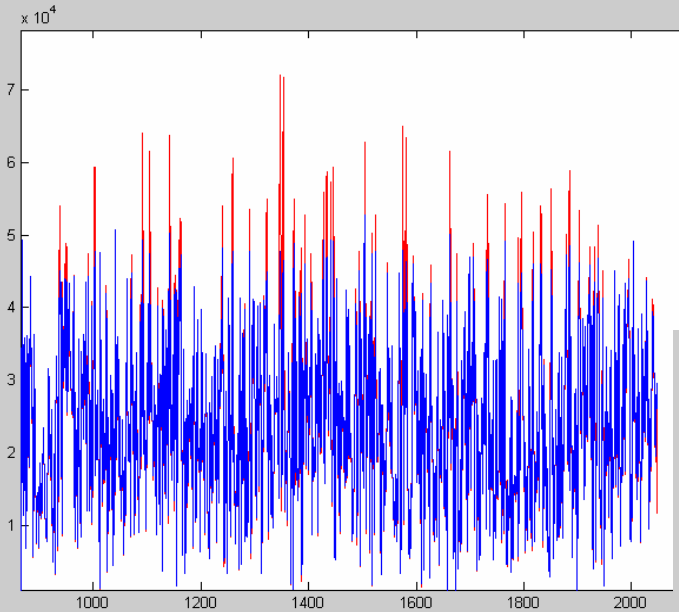
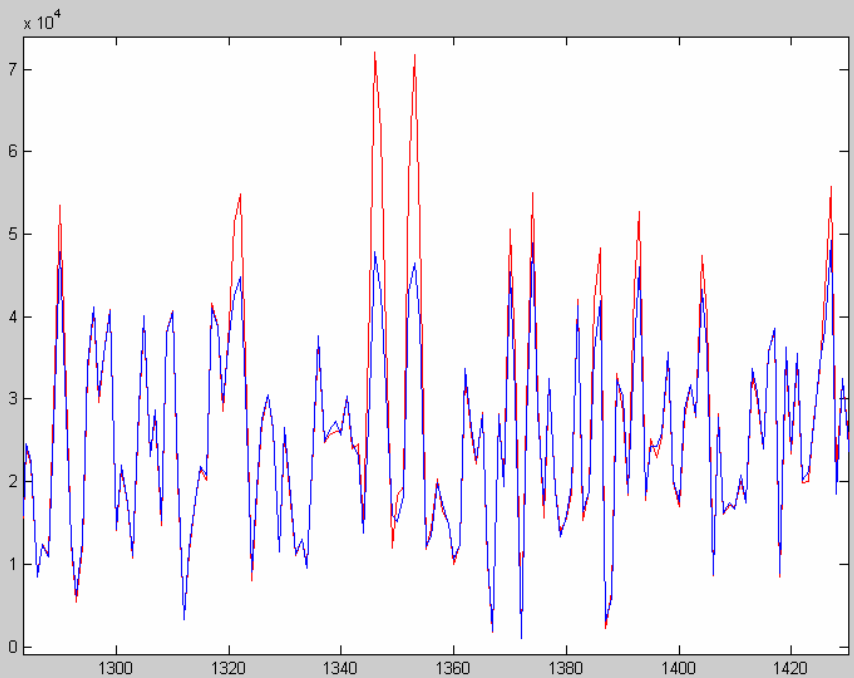
PA linearization: Role of CFR



4 WCDMA Carriers with 64 DPCH

The RED shows the signal power input to the CFR circuitry, BLUE shows the output signal.



The Crest Factor Reduction circuitry reduces the peak signal excursion without significantly distorting the code channels.

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High bandwidth MCPA

	SCPA	Current MCPA	TelASIC technology
Method	Separate SCPA & PA Combiner	Feed forward / analog pre-distortion	Digital CFR and DPD
Complexity	Modular	Modular	Integrated
Performance	High performance, low efficiency	High performance, low efficiency	High performance, high efficiency
Total Signal BW	Large	20-30 MHz	20-40 MHz
Cost	HIGH COST	HIGH COST	LOW COST

Digital pre-distortion and CFR offers best solution

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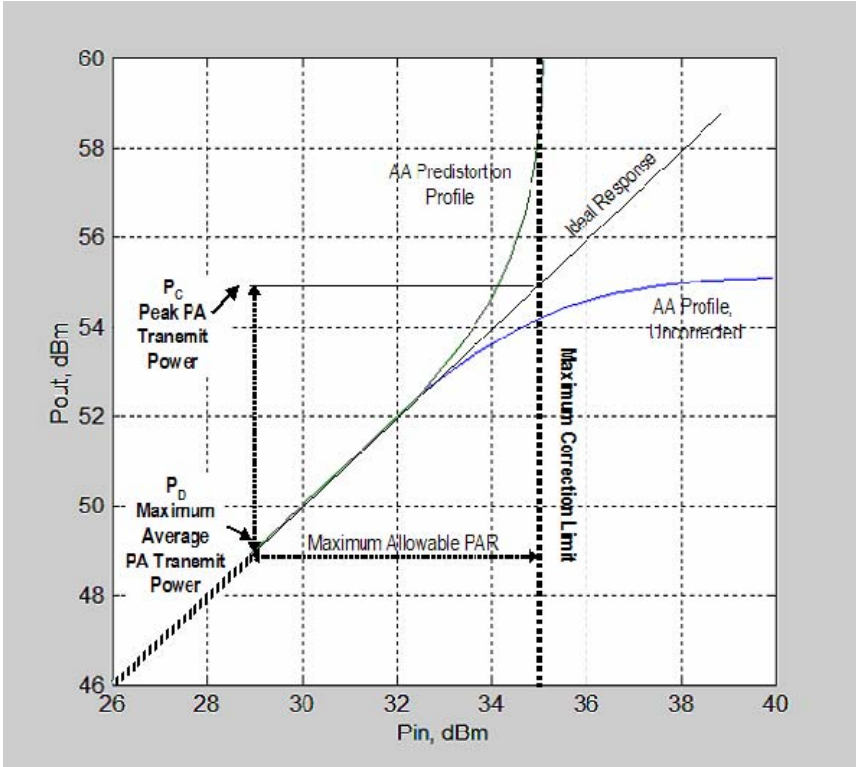
Universal CFR

PAR Challenge

- Typical signals have high PAR
  - Typical PAR ~ 9-11 dB
- High PAR increases intermods
- High PAR requires large back off
- Large back off reduces PA efficiency



TelASIC Crest Factor Reduction Solution

- Universal CFR
  - Independent from the signal characteristics (UMTS, cdma2000, WiMax)
  - Supports both single carrier or multi carrier applications
- Highest Efficiency
  - Reduces PAR from 12-13 dB to 6-6.5 dB

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ADC and DAC performance: key to universal CFR and DPD

TC1411 14 bit A/D

Sample rate	245.76 MSPS
Full scale input	16 dBm (4Vpp)
SNR	-71 dBFS in 2nd Nyquist @ -1 dBFS
SFDR	> -80 dBFS in 2nd Nyquist @ -1 dBFS
2nd Harmonic	-80 dBFS or greater typical @ -1 dBFS
3rd Harmonic	-82 dBFS or greater typical @ -1 dBFS

2nd Nyquist Input enables High IF Sampling

TC2411 14 bit DAC

Clock	737.28 MSPS
Full scale output	-5 dBm @ fs/4
SFDR	> -70 dBc @ -0.5 dBFS
ACPR (4 tone UMTS)	-76 dBc @ -17.5 dBFS
Output noise level	< -160 dBm/Hz

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Conclusion

- Diversification of Standards and Frequency Bands

  → **Common platform**

- Operator requirements for adjacent channel interference higher than standards to improve quality of service

  → **High ACPR**

- Cost pressures drive migration from single carrier power amplifiers (SCPA) to multi carrier power amplifiers (MCPA)

  → **Cost Savings through DPD**

TelASIC's high performance chipset is Meeting the challenging requirements

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If you are interested ….

TelASIC will provide evaluation boards and samples under NDA

Please contact:

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