



SOPC
WORLD
2004

**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

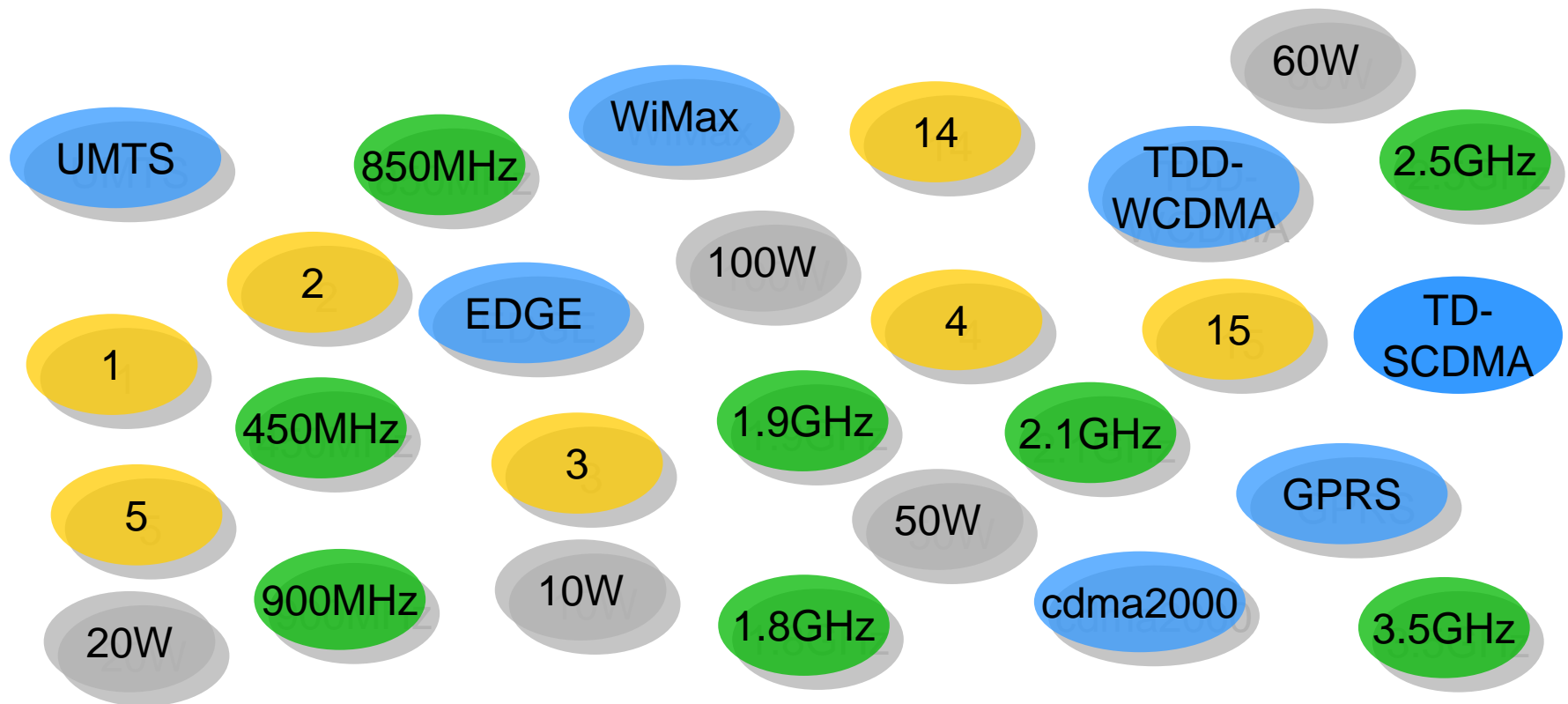
What we are going to present?

- 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

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



Channels
Per sector

Access
Technology

Output
Power

Frequency
Band

*Can we use one linearizer for all
types of PAs ?*

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

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

FOUR CARRIER

Ref 34.4 dBm

#Atten 2 dB

#Avg
Log
10
dB/
Offset
61.3
dB

PAvg

V1 W2

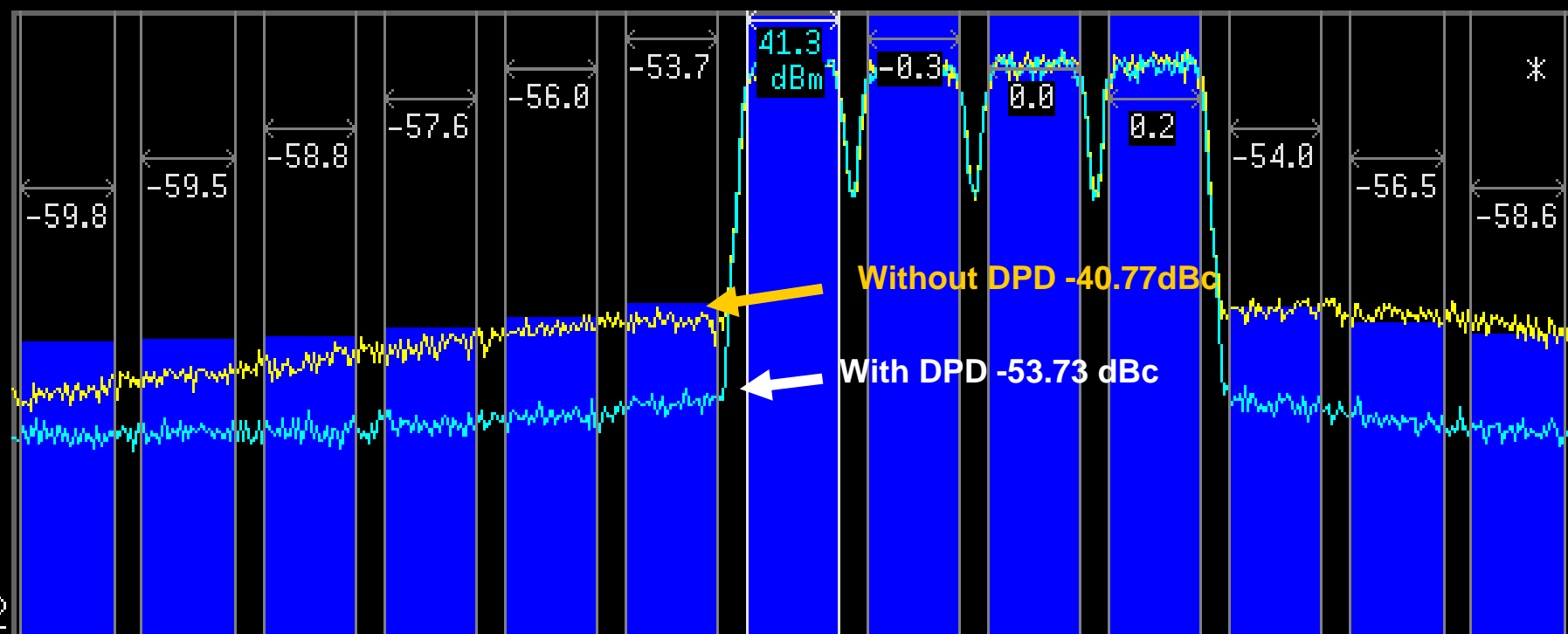
Center 2.132 32 GHz

#Res BW 100 kHz

#VBW 30 kHz

Span 64.68 MHz

Sweep 56.4 ms (601 pts)



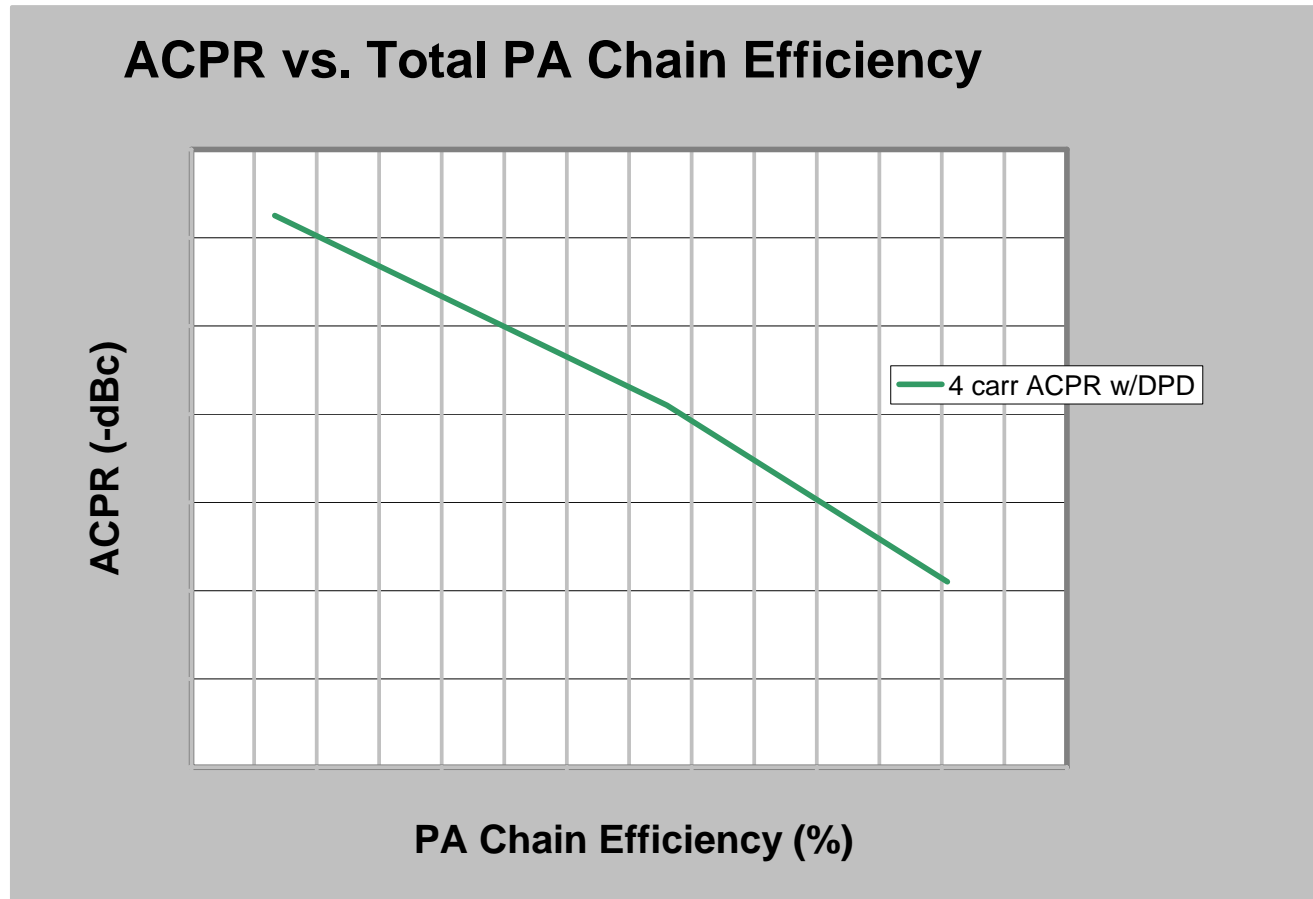
Without DPD -40.77 dBc

With DPD -53.73 dBc

RMS Results

| | Freq Offset | Ref BW | dBc | Lower | dBm | dBc | Upper | dBm |
|---------------|-------------|-----------|--------|--------|--------|--------|-------|-----|
| Carrier Power | 5.000 MHz | 3.840 MHz | -53.73 | -12.38 | -0.30 | 41.05 | | |
| 41.35 dBm / | 10.00 MHz | 3.840 MHz | -55.99 | -14.64 | 0.03 | 41.38 | | |
| 3.84000 MHz | 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 | | |

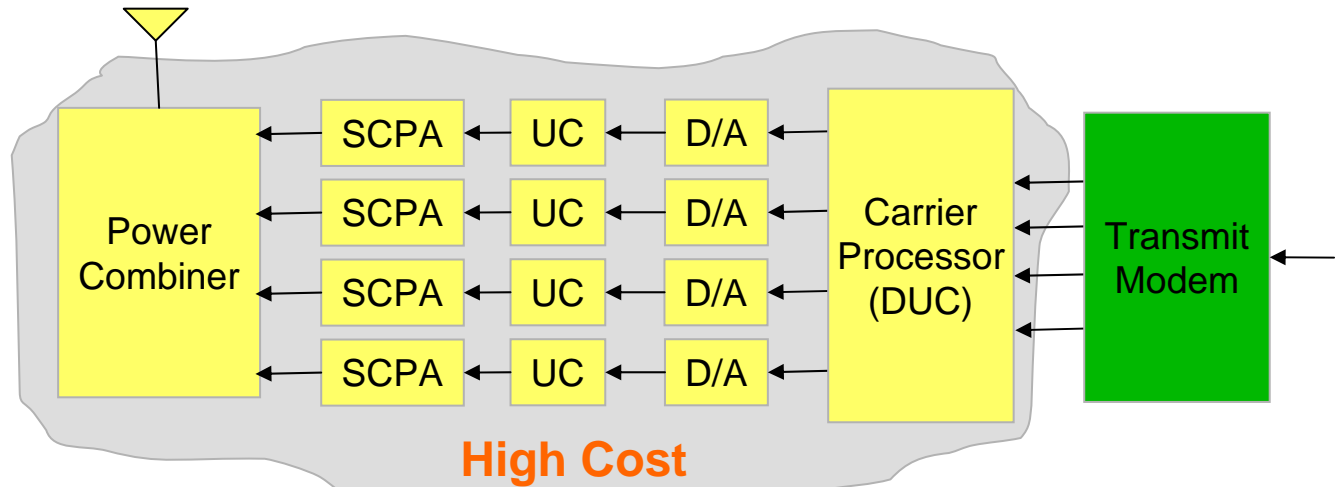
ACPR vs. PA Chain Efficiency



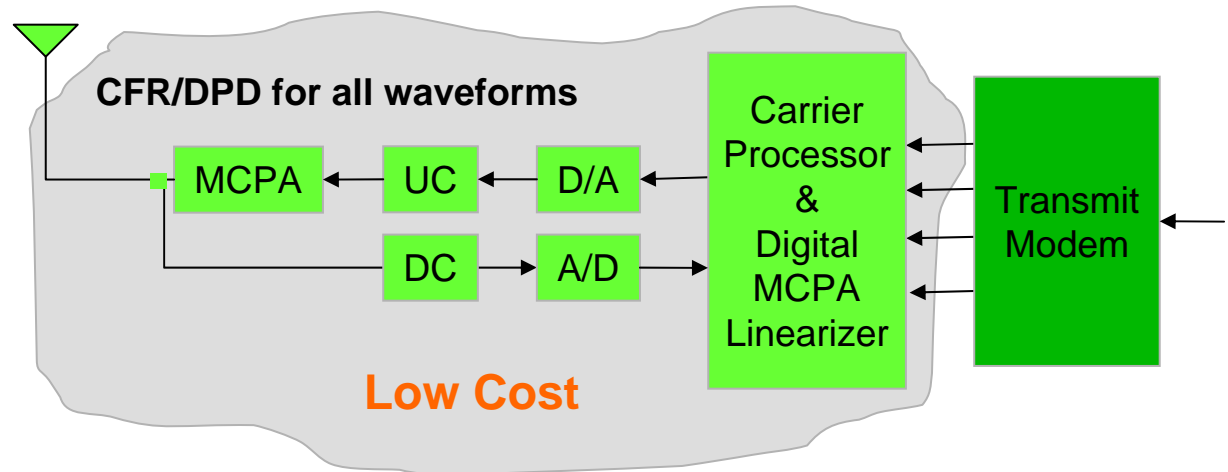
Example of PA behavior (not actual data)

Trend #3: Migration to MCPA

**Traditional
Multi-carrier
Transmitter**



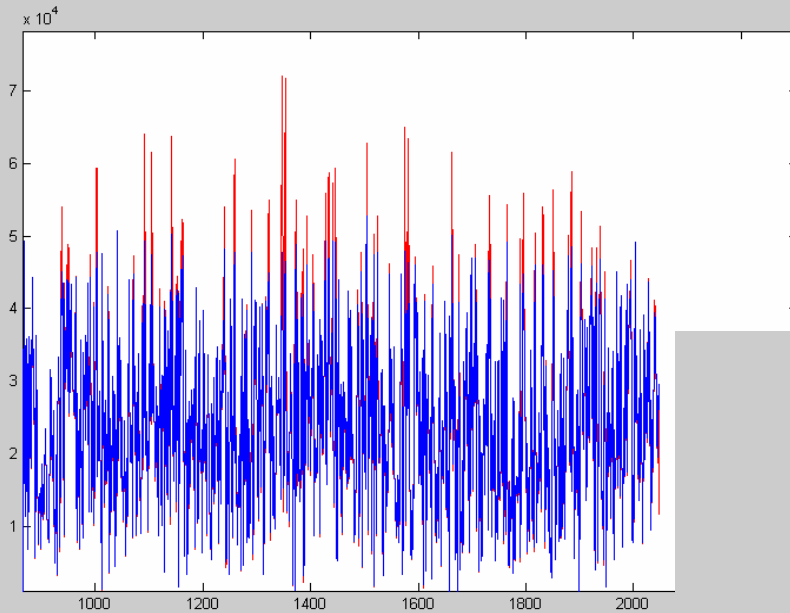
**MCPA with
DPD
Linearizer**



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

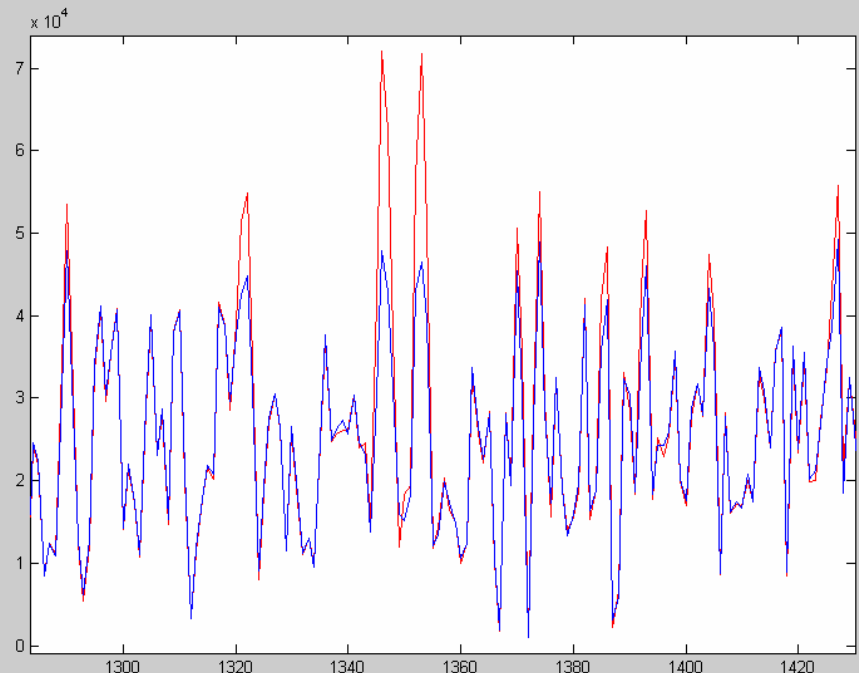
PA linearization: Role of CFR



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.



High bandwidth MCPA

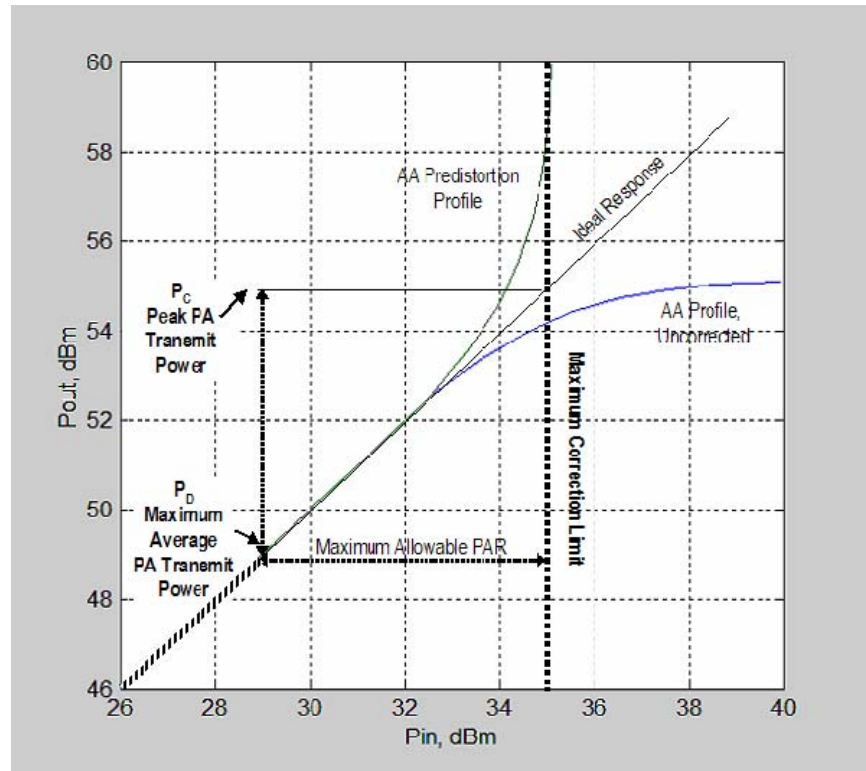
| | SCPA | Current MCPA | TelASIC technology |
|-----------------|----------------------------------|--------------------------------------|-----------------------------------|
| Method | Separate SCPA & PA Combiner | Feed forward / analog pre-distortion | Digital CFR and DPD |
| Complexity | Modular | 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**

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

ADC and DAC performance:

key to universal CFR and DPD

TC1411 14 bit A/D

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

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 |

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

If you are interested

**TelASIC will provide evaluation boards
and samples under NDA**

Please contact:

sales@telasic.com or

JR Lee, Uniquist: jrlee@infinitek.co.kr