# WIRELESS/RADIO HEAD SOLUTIONS

Next generation networks have increasingly adopted Remote Radio Head (RRH) technology to provide a flexible and scalable network architecture that is easy upgraded. These RRH designs include advanced signal processing technologies such as Crest Factor Reduction and Digital Pre-Distortion that optimise overall transmission efficiency and reduce net unit BOM cost, thereby providing additional CAPEX and OPEX advantages to operators.

Affarii Technologies make these core RRH technologies available on low cost FPGA platforms, providing complete multi-carrier RRH solutions with industry leading price, power and performance.

The Affarii Radio Head Solution supports 1-4 carriers of WCDMA or LTE occupying up to 20MHz of modulation bandwidth and includes crest factor reduction and digital pre-distortion providing 20-30dB of ACP improvement and peak reduction down to 6.5dB (WCDMA).

Key Features:

- Supports all RRH functions; DUC, DDC, CFR and DPD.

- Pre-integrated with CPU, CPRI and Ethernet blocks.

- On chip DPD adaption with acceleration.

- Predistortion transmitter operation up to 184Msps[†].

- Low power consumption: < 1500mW @ 125Msps[†].

- High integration, low power, low cost.
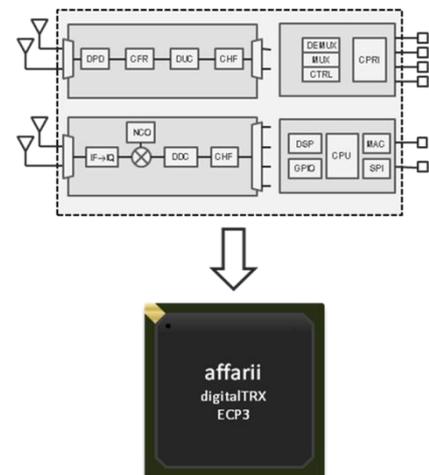
Integrated with CPRI/OBSAI transceiver functionality, GPIO and Ethernet blocks, the RRH Solution provides a complete single chip Remote Radio processing solution.

CFR - Crest Factor Reduction

By active control of the transmit signal error vector magnitude (EVM), crest factor reduction can significantly reduce the transmitted waveform peak to average power ratio (PAPR), improving amplifier linearity, efficiency and cost.
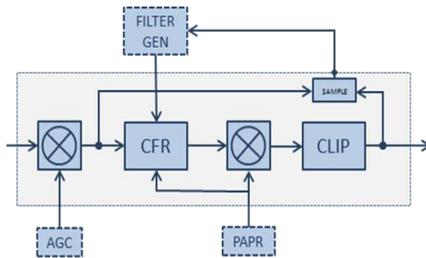

- **Multi-stage hybrid peak cancellation architecture.**
- **Suitable for multi-carrier applications with 1-4 carriers.**
- **Modulation agnostic - no signal knowledge required.**
- **Configurable cancellation stages and spectral filter length.**
- **Achieves >70dBc output ACLR.**

The CFR core design support peak reduction down to 6.5dB PAPR depending on modulation scheme and been qualified for operation with 3GPP WCDMA, LTE and WiMAX standards. Performance analysis and custom design configuration are supported with a PC based simulation environment.
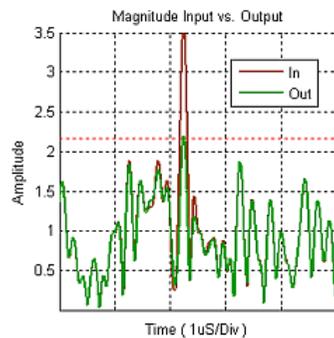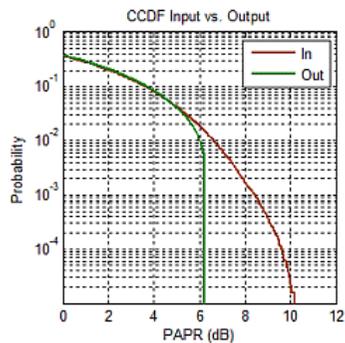

DPD - Digital Pre-Distortion

Digital Pre-distortion has become the industry standard for the correction of non-linearity in high power RF devices. By actively tracking and applying an inverse to the amplifier non-linearity, Digital Pre-distortion allows RF transistors to be operated linearly at their peak saturated power, improving amplifier efficiency and cost.
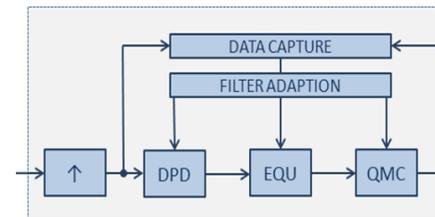
- **Memory effect adaptive pre-distortion core.**
- **Support 20MHz modulation bandwidth.**
- **Provides 20-30dB ACP correction capability.**
- **Adaptive transmit equalizer and AQM correction.**

The DPD processor supports both Class-AB and Doherty amplifier architectures with industry standard LDMOS and GaN RF devices. Adaption of the DPD and equaliser filter coefficients is provided by the Lattice MICO32 soft processor core with hardware acceleration operators.
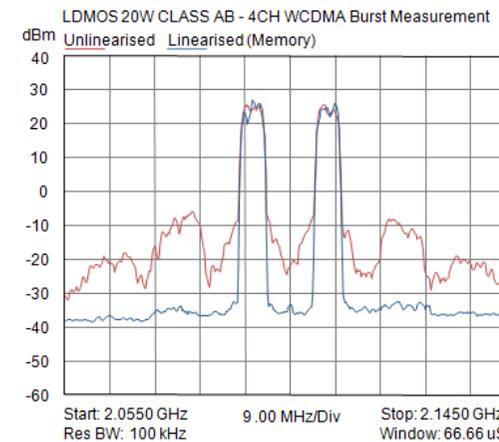
RRH – Remote Radio Head

The Affarii RRH solution integrates core CFR and DPD technologies with low resource DUC and DDC blocks to provide complete single chip RRH datapath reference designs.

RRH designs supporting 20MHz of modulation bandwidth with 1x2 antenna WCDMA or 2x2 antenna configurations are provided using the Lattice ECP3-150EA.

Solution provides high integration and low power consumption:

- ~570mW per DPD channel

- ~1300mW per Antenna

For a 4CH WCDMA design supporting 20MHz bandwidth at 122.88MHz DAC rate.

RRH Solution Capabilities:

- Digital Up/Down Conversion (DUC/DDC)
  - 4x5 WCDMA/LTE, 2x10 WiMAX/ LTE, 1x20 WiMAX/LTE

- Crest Factor Reduction (CFR)
  - WCDMA: 6% EVM @ 6.5dB PAPR
  - LTE: 4% EVM @ 7.0dB PAPR

- Adaptive Pre-distortion Engine (DPD)
  - 122-184Msps DAC sample rate
  - 20MHz modulation bandwidth
  - 30dB ACP correction capability

- Adaptive Equalizer & AQM Correction

- Multi-Interface Support
  - Direct Conversion, IF or Image Reject
  - LVCMOS, LVDS & SERDES I/O

- Measurement & Test Support
  - Built In Amplifier Self Test.
  - Modulation EVM/MER Measure.
  - Production Calibration

4CH WCDMA Design Example:

- 20MHz modulation BW

- 4CH 64 tap DUC+DDC

- CFR @ 6.5dB PAPR

- DPD @122.88Msps
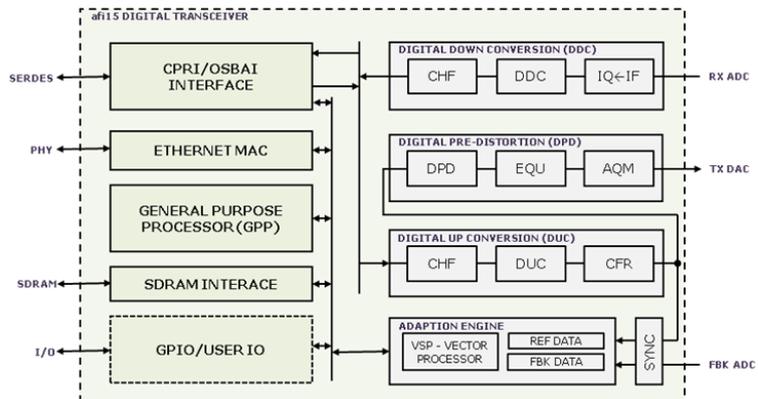
AFI-RRH-WCDMA01-SP-LSC					
Configuration	Device	SLICE	MULT18	EBR	CLK(max)
20MHz WCDMA	LFE3-150EA-8FN1156	27K	132	136	184MHz

DEMONSTRATION PLATFORM:

Evaluation of the RRH solution is supported using the RRH Demonstration Platform, based on the Lattice IO Protocol board.

ECP3 RRH DEMONSTRATION PLATFORM SETUP

PLATFORM BANDS	
Variant	**Band**
3G-4G-IMT	2110-2220 MHz
4G-US-EDD	730-830 MHz

Table 1: RRH Demonstration System Banding

PORT	DEVICE	BITS	Typical		Maximum	
TX	DAC5682Z[1]	16	122.88Msps	100 MHz	245.76Msps	200 MHz
RX	ADS62P49[1]	14	122.88Msps	50 MHz	245.76Msps	100 MHz
DPD	ADS62P49[1]	14	122.88Msps	50 MHz	245.76Msps	100 MHz

SUPPORTED SAMPLE RATES

Table 2: RRH Demonstration System Sample Rates

Note 1: In regions where ADC/DAC sample rate and bit resolution restrictions apply, devices DAC5687 and ADS62C17 are substituted with a maximum rate of 184Msps.
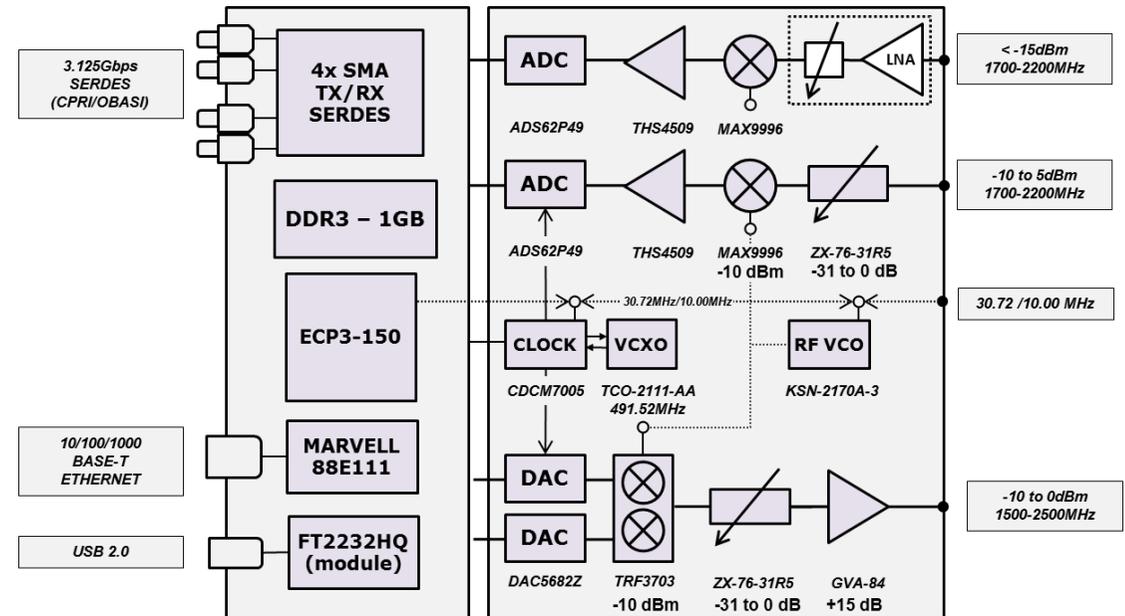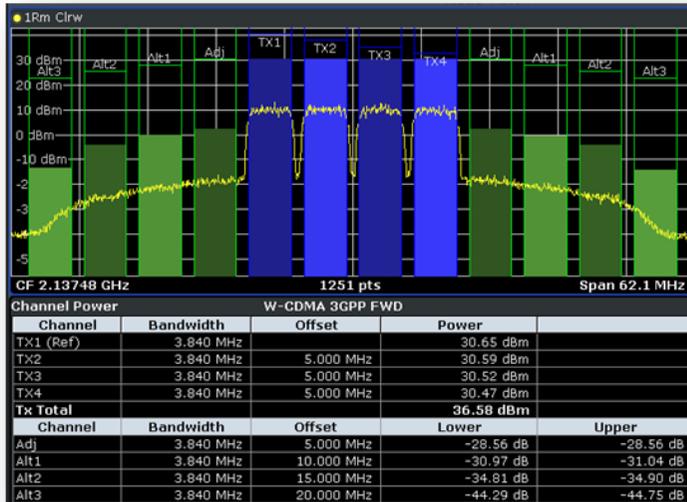

The RRU Demonstration Unit supports up to 100MHz of transmit bandwidth using a Texas Instruments DAC5682z DAC and TRF3703 mixer operating in either ZIF or CIF configurations. Receiver or DPD observation is provided by a TI ADS61B49 ADC with TriQuint ML-485 for 3G-4G-IMT or ML-483 for 4G-US-EDD variants.

EXAMPLE: BROADBAND AMPLIFIER (700-2500MHz)

- PA operated at 2.5dB compression point with initial -31dBc ACP.

- Supports 20MHz WCDMA waveform with 1FA to 4FA dynamically switched.

- ACP correction is >27dBc using Memory Effect Linearization ("1111" shown)

Channel Power — W-CDMA 3GPP FWD (CF 2.13748 GHz, 1251 pts, Span 62.1 MHz)

Channel	Bandwidth	Offset	Power	
TX1 (Ref)	3.840 MHz		30.65 dBm	
TX2	3.840 MHz	5.000 MHz	30.59 dBm	
TX3	3.840 MHz	5.000 MHz	30.52 dBm	
TX4	3.840 MHz	5.000 MHz	30.47 dBm	
Tx Total			36.58 dBm	
Channel	Bandwidth	Offset	Lower	Upper
Adj	3.840 MHz	5.000 MHz	-28.56 dB	-28.56 dB
Alt1	3.840 MHz	10.000 MHz	-30.97 dB	-31.04 dB
Alt2	3.840 MHz	15.000 MHz	-34.81 dB	-34.90 dB
Alt3	3.840 MHz	20.000 MHz	-44.29 dB	-44.75 dB

Channel Power — W-CDMA 3GPP FWD (CF 2.13748 GHz, 1251 pts, Span 70.0 MHz)

Channel	Bandwidth	Offset	Power	
TX1 (Ref)	3.840 MHz		30.88 dBm	
TX2	3.840 MHz	5.000 MHz	30.73 dBm	
TX3	3.840 MHz	5.000 MHz	30.48 dBm	
TX4	3.840 MHz	5.000 MHz	30.60 dBm	
Tx Total			36.69 dBm	
Channel	Bandwidth	Offset	Lower	Upper
Adj	3.840 MHz	5.000 MHz	-57.84 dB	-57.68 dB
Alt1	3.840 MHz	10.000 MHz	-59.95 dB	-59.41 dB
Alt2	3.840 MHz	15.000 MHz	-60.23 dB	-59.27 dB
Alt3	3.840 MHz	20.000 MHz	-60.66 dB	-60.33 dB

APPLICATION SUPPORT

The RRH Solution is supported with comprehensive PC based analysis tools to assist in amplifier performance analysis, RRH conformance testing and test production test. For further details please contact sales@affarii.com.
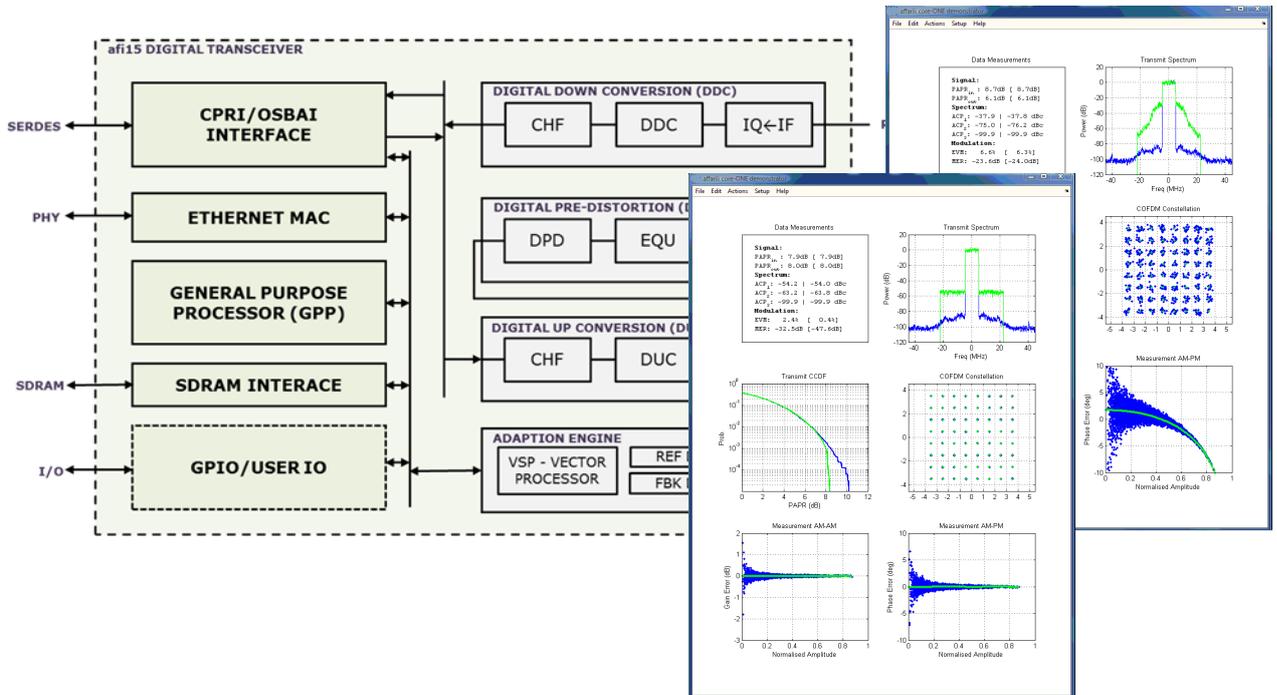
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