



# Power Amplifier Linearization using RF Pre-Distortion

JUNE, 2012

# PA Linearization Overview

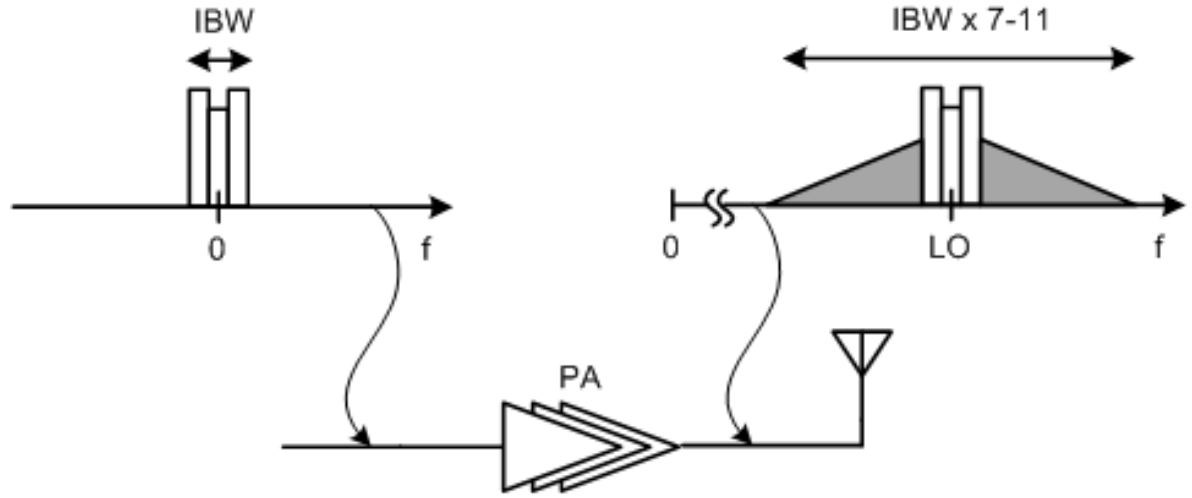


- General principles
- Overview/Block Diagram of DPD and RFPD
- RFPAL System architecture & Implementation

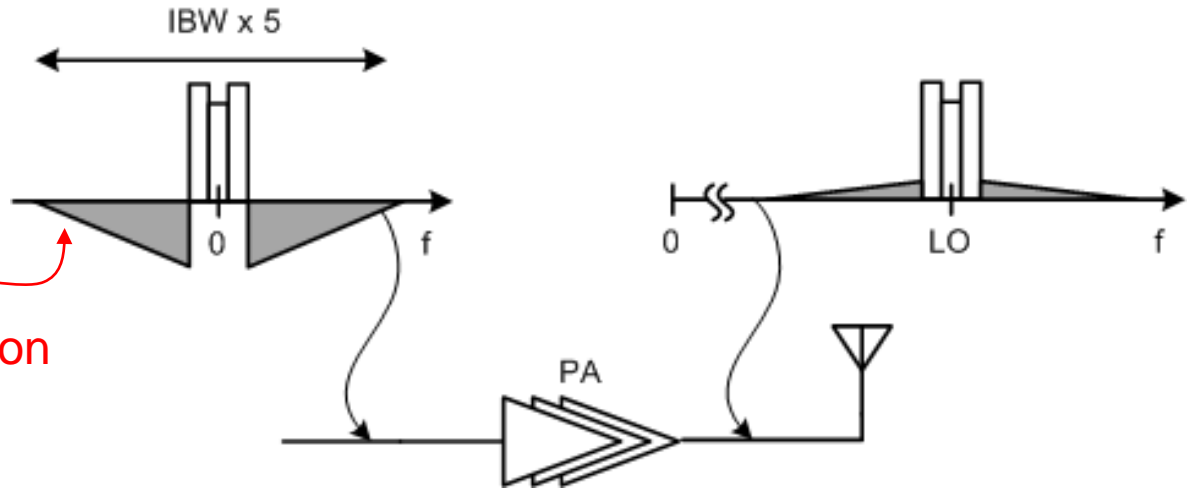


# Predistortion Principle

No predistorion



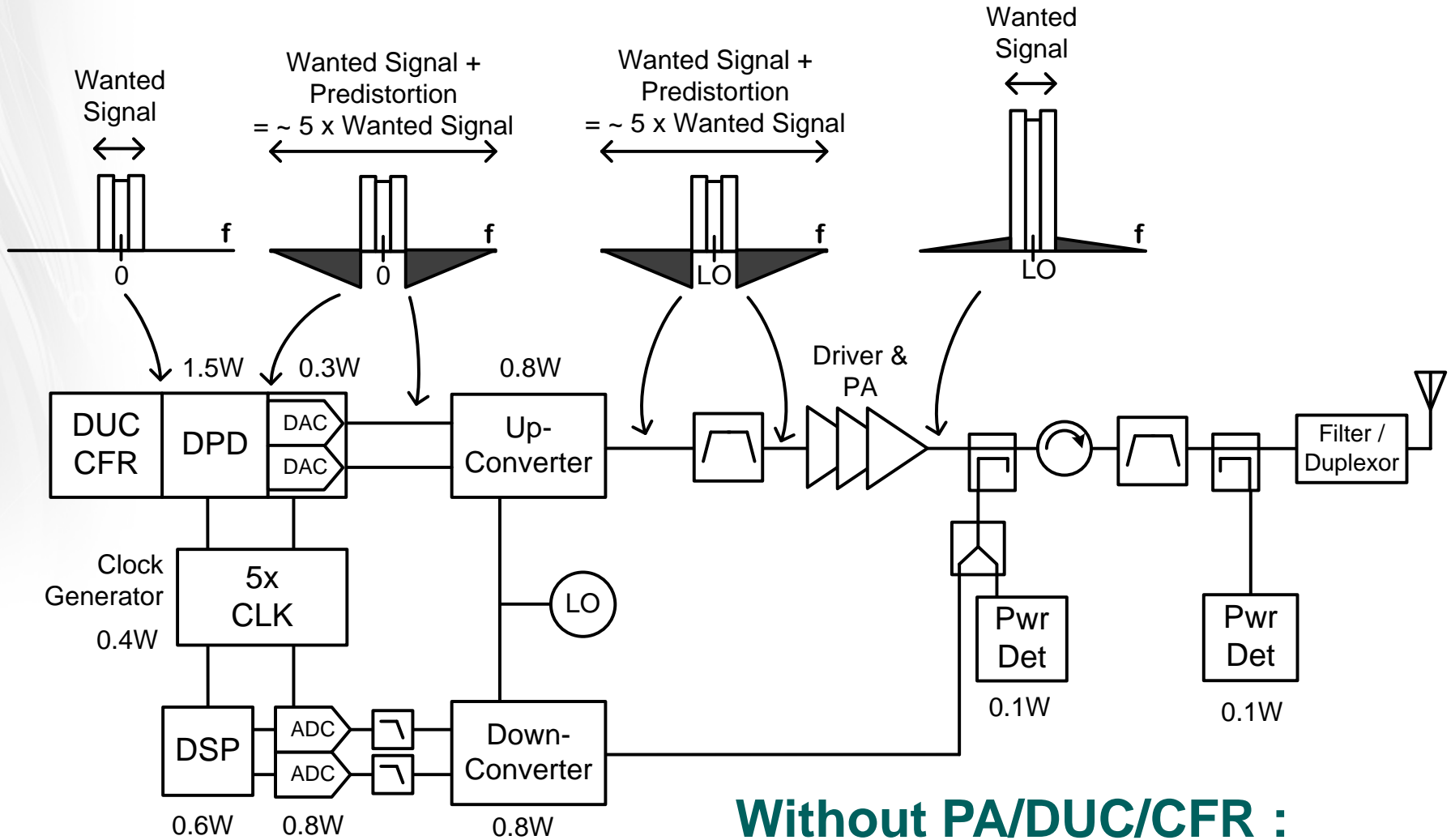
With predistorion



5-10 x BW expansion

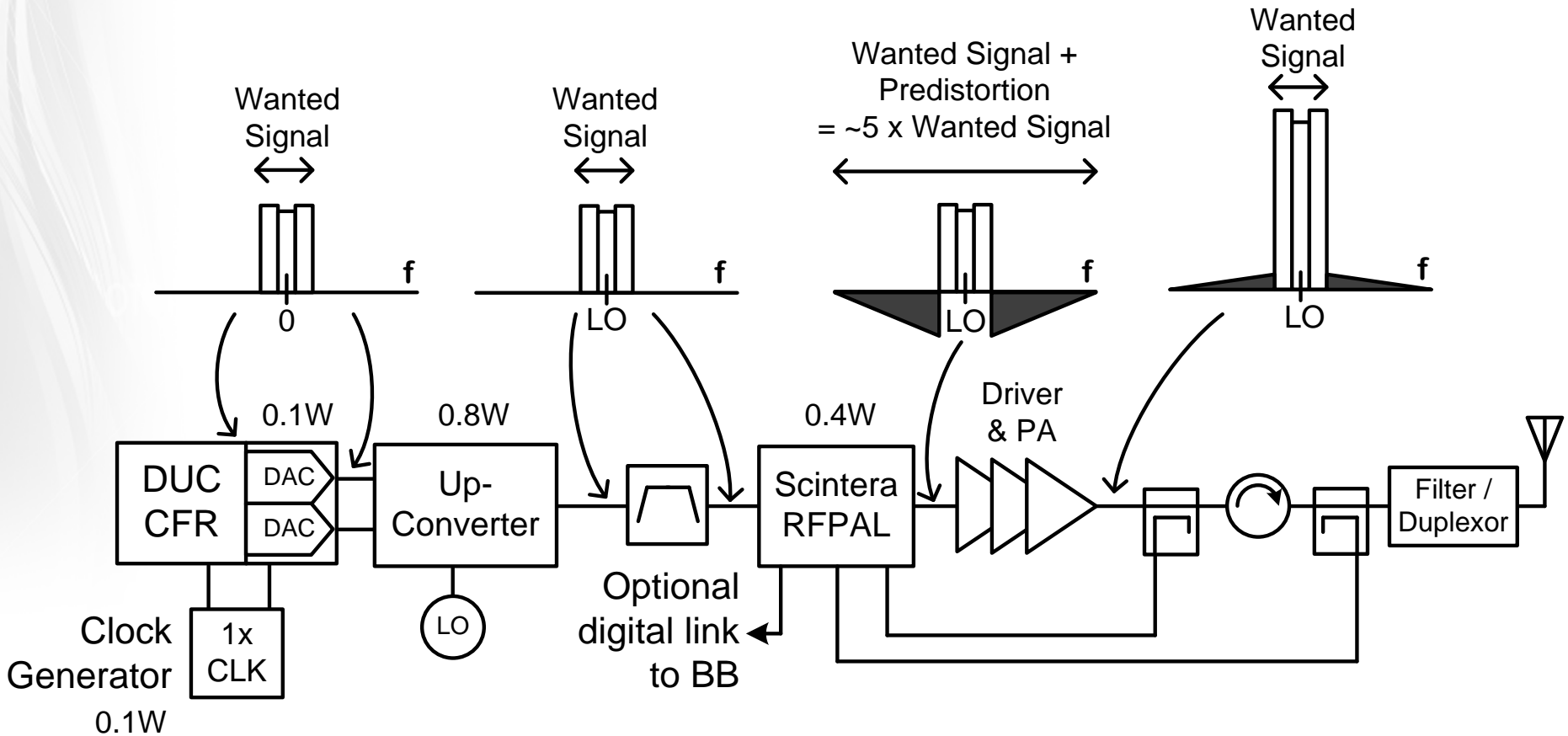


# Digital Pre-Distortion (DPD)



**Without PA/DUC/CFR :**  
**Power consumption ~5.4W**

# RFPAL (RF PA Linearization)

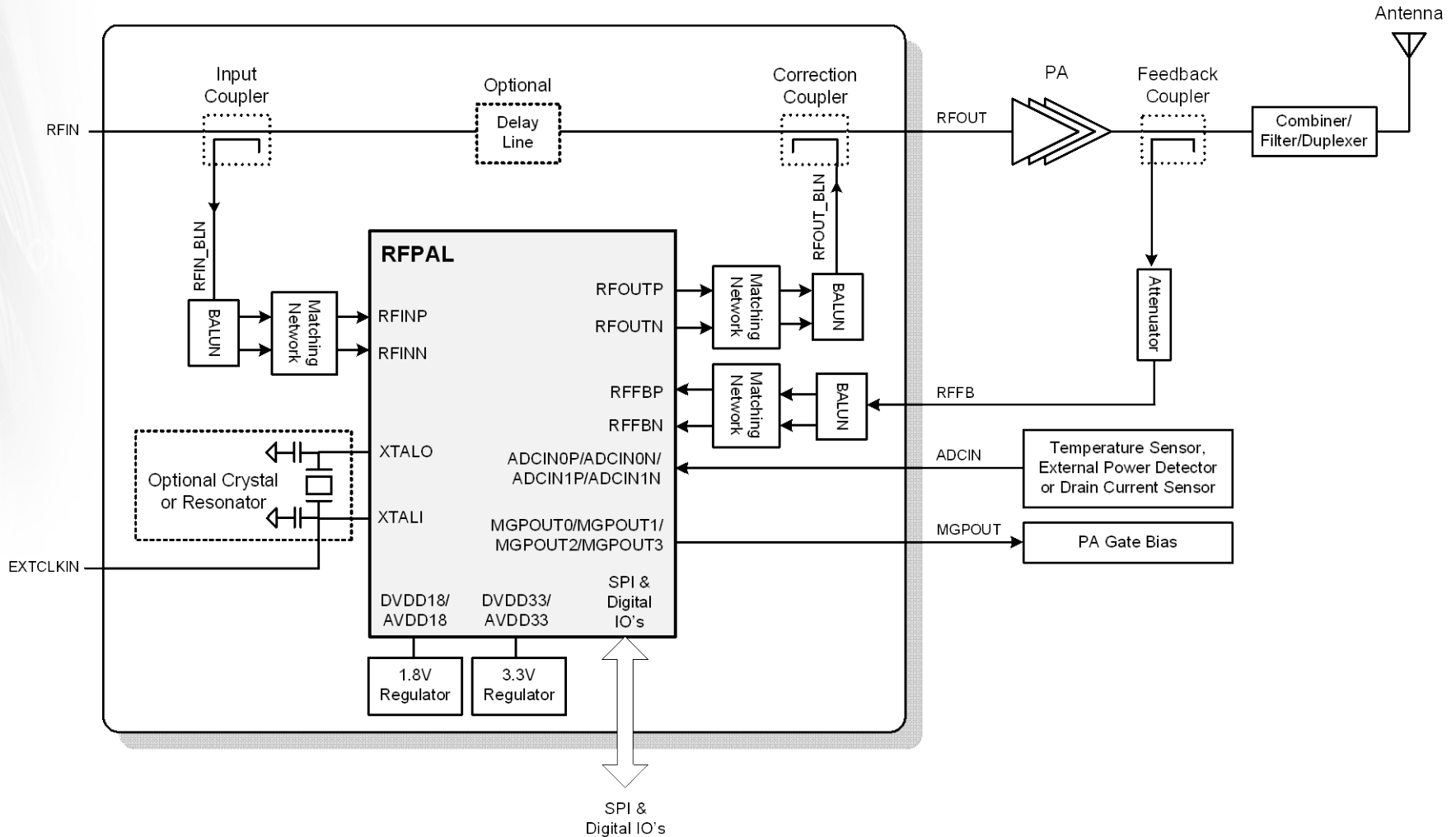


Without PA/DUC/CFR

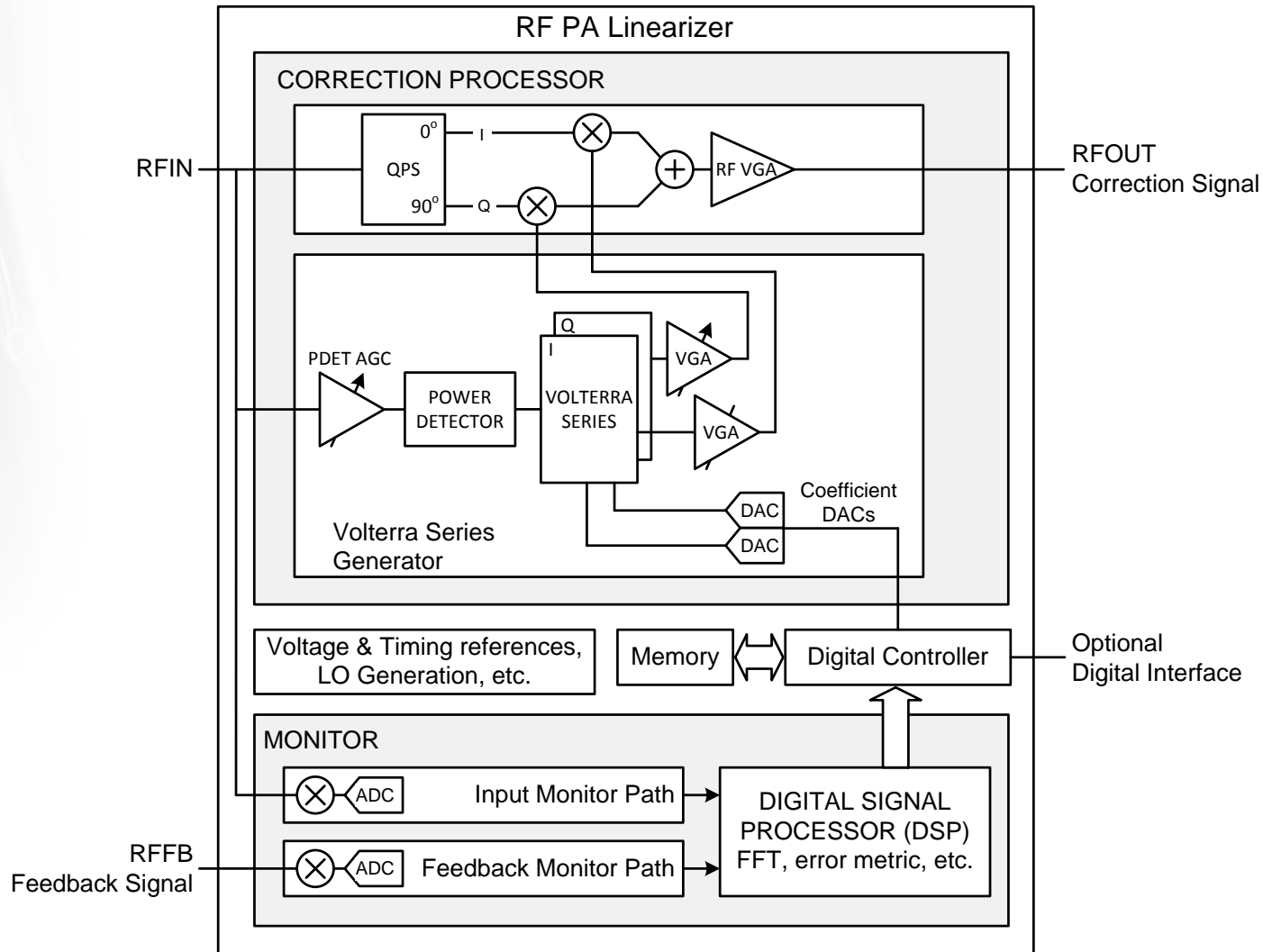
Power consumption  $\sim 1.4W$

# RFPAL System Architecture & Implementation

# RFPAL Application



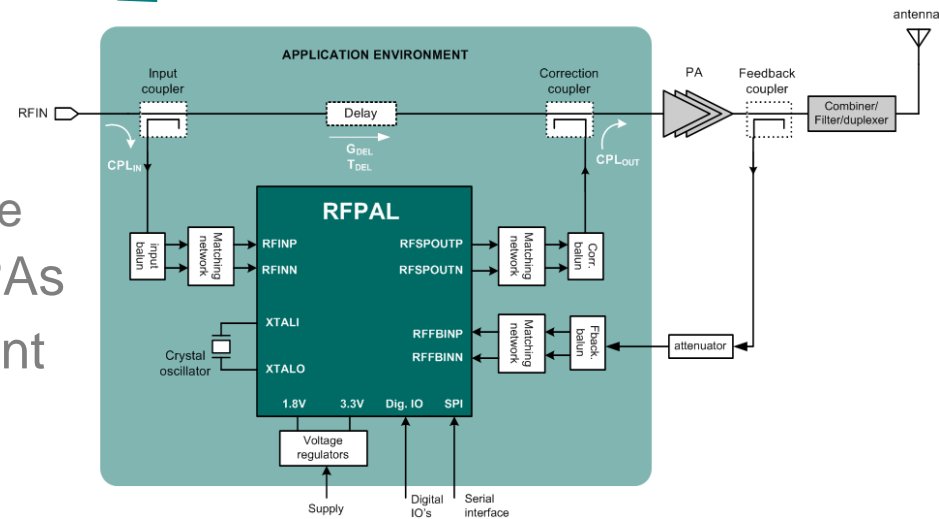
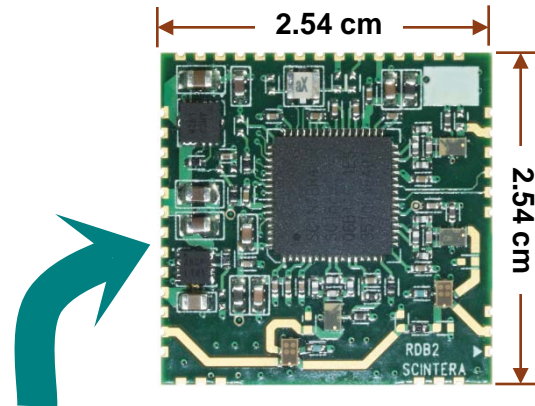
# RFPAL System Architecture





# Scintera Advantages

- Single chip CMOS linearization solution
  - Easy to evaluate and design in
  - Simplifies TX chain
- High system efficiency
  - Very low power consumption
- Low system cost
- Small footprint
- Future proof
  - In-system & in-field reprogrammable
- RFin/RFout supports stand-alone PAs
- Waveform & modulation independent
- Power Amp Independent
  - Linearize even lowest power PAs
- Robust & field-proven solution



More Complete Information on Theory of Operation and Datasheets Available on Line at [www.scintera.com](http://www.scintera.com) or [Richardson RFPD website](#)

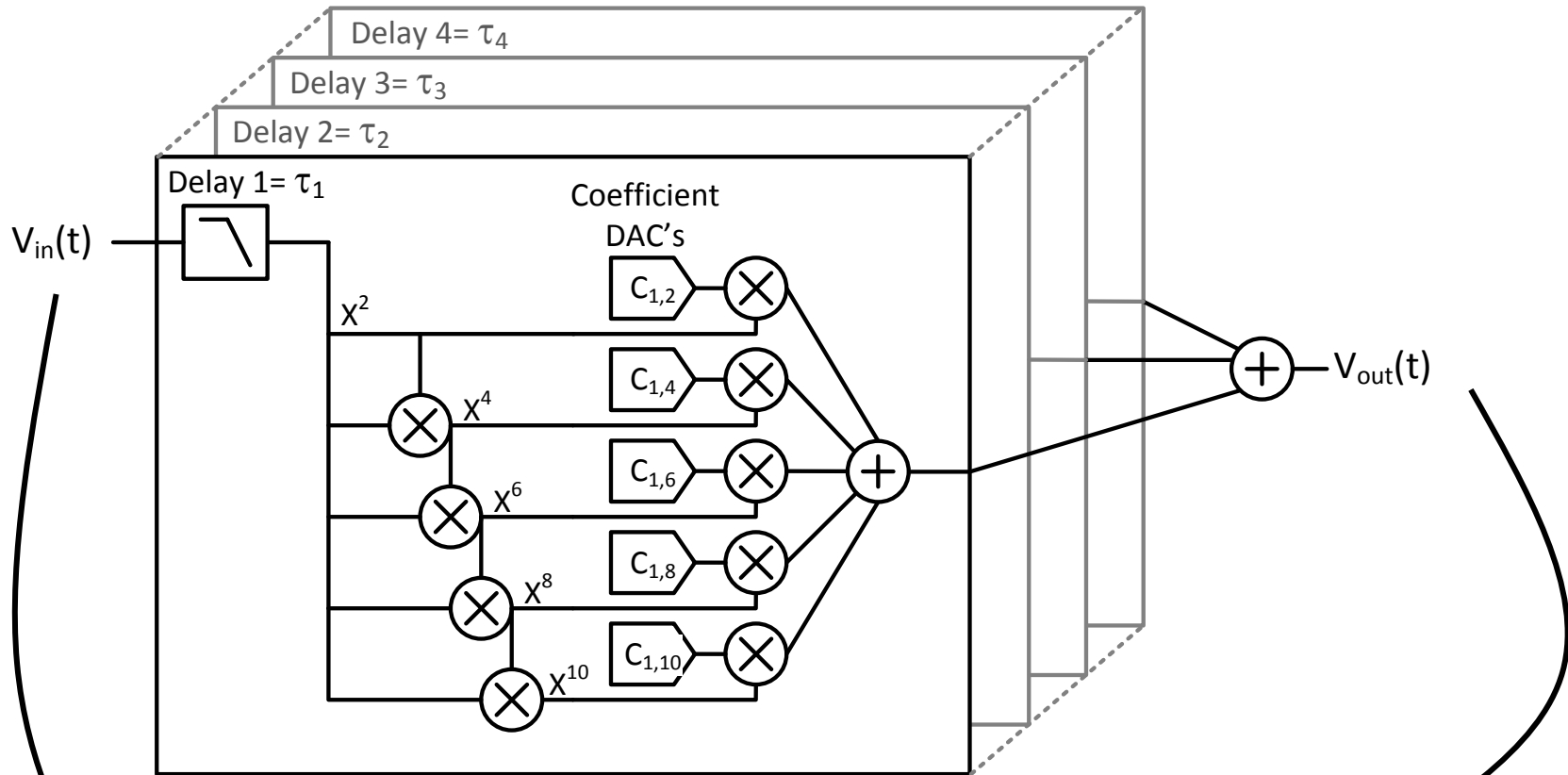
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# Additional Slides

# Analog Volterra Series



$$V_{IN}(t) = r^2(t)$$

$$V_{OUT}(t) \approx \sum_{p=1}^4 \sum_{m=1}^5 c_{p,2.m} r^{2.m}(t - \tau_p)$$

# RFPAL Key Architectural Attributes



- ⚡ Analog (RF & BB), Digital (high & low-speed) and SW partitioning minimize power & area
  - ⚡ Computation of correction terms in digital (software and hardware) domain
  - ⚡ Application of correction in the analog domain
  
- ⚡ RF and most of baseband analog circuitry is *unclocked*
  - ⚡ enables robustness and flexibility for various modulation schemes & carrier frequencies.
  
- ⚡ Flexible Work Function
  - ⚡ Synthesizes wide range of PA AM/AM and AM/PM compensation and memory compensation (1ns - 300ns)
  - ⚡ Enables robust adaptation (orthogonal basis terms of work function)
  
- ⚡ Robust performance with process, voltage, aging and temperature variations
  - ⚡ Extensive digital/analog compensation loops for analog cells, with process/temp sensing, calibration routines, etc.
  - ⚡ Optimized calibration algorithms using a low-power, on-chip spectral estimator.
  - ⚡ *Software-driven* analog circuit design that can be conveniently tuned /optimized.
  
- ⚡ Software-driven correction enables flexibility
  - ⚡ With respect to waveforms, PA, power consumption (duty-cycle), etc.
  - ⚡ Allows customization of solutions by application and customer

# RFPAL Reference PCB

