



SKYWORKS®

High Power UE Tx Solution for Improved Cell Edge/OTA Performance

Pout, Icc, Linearity, Emissions in use cases

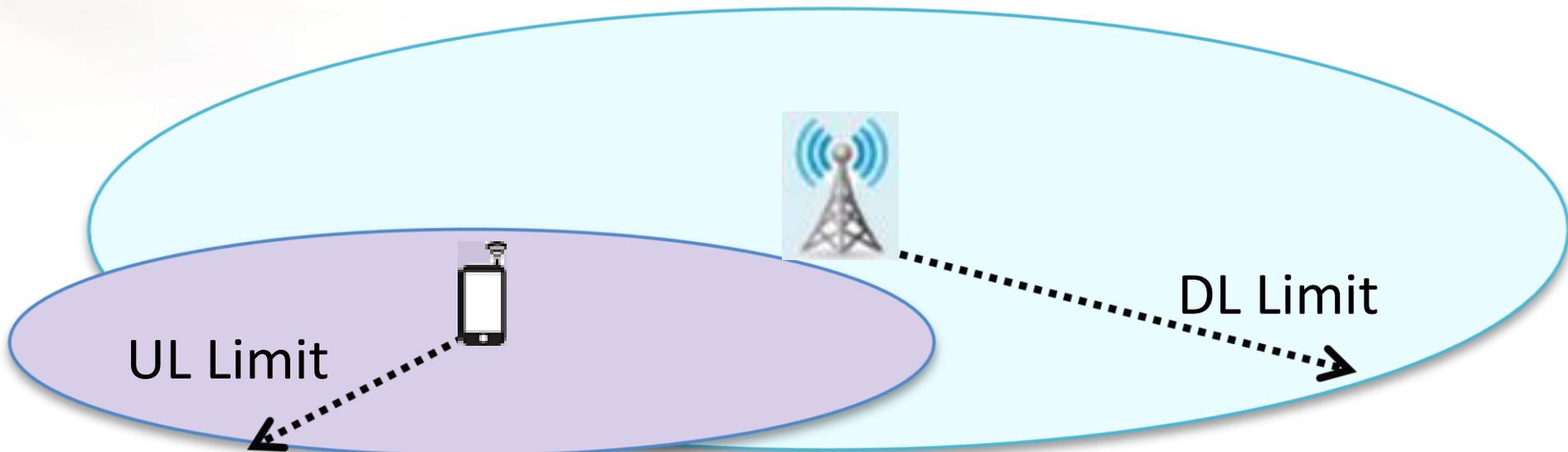
Motivation for B41 HPUE

**Measured Amplifier Performance :
+26 dBm Power, Linearity and Efficiency to Support**

**Optimization of Class 2 UE Architecture and Impact for Shared
Bands/CA**

B41 HPUE Motivation

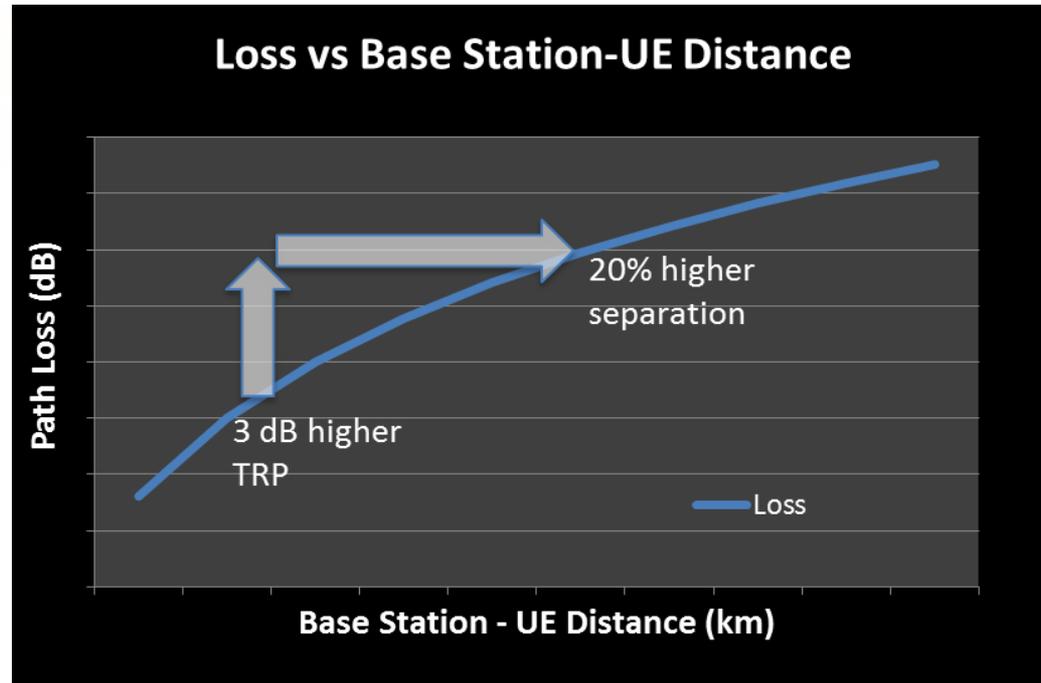
Cell Edge Performance is UL Limited



UE UL Tx Power Limits Cell Edge Performance

+3 dB Pout Improves Cell Coverage ~20%

- General Improvement in Data Rate Coverage area / Cell Size for 2x UL Power

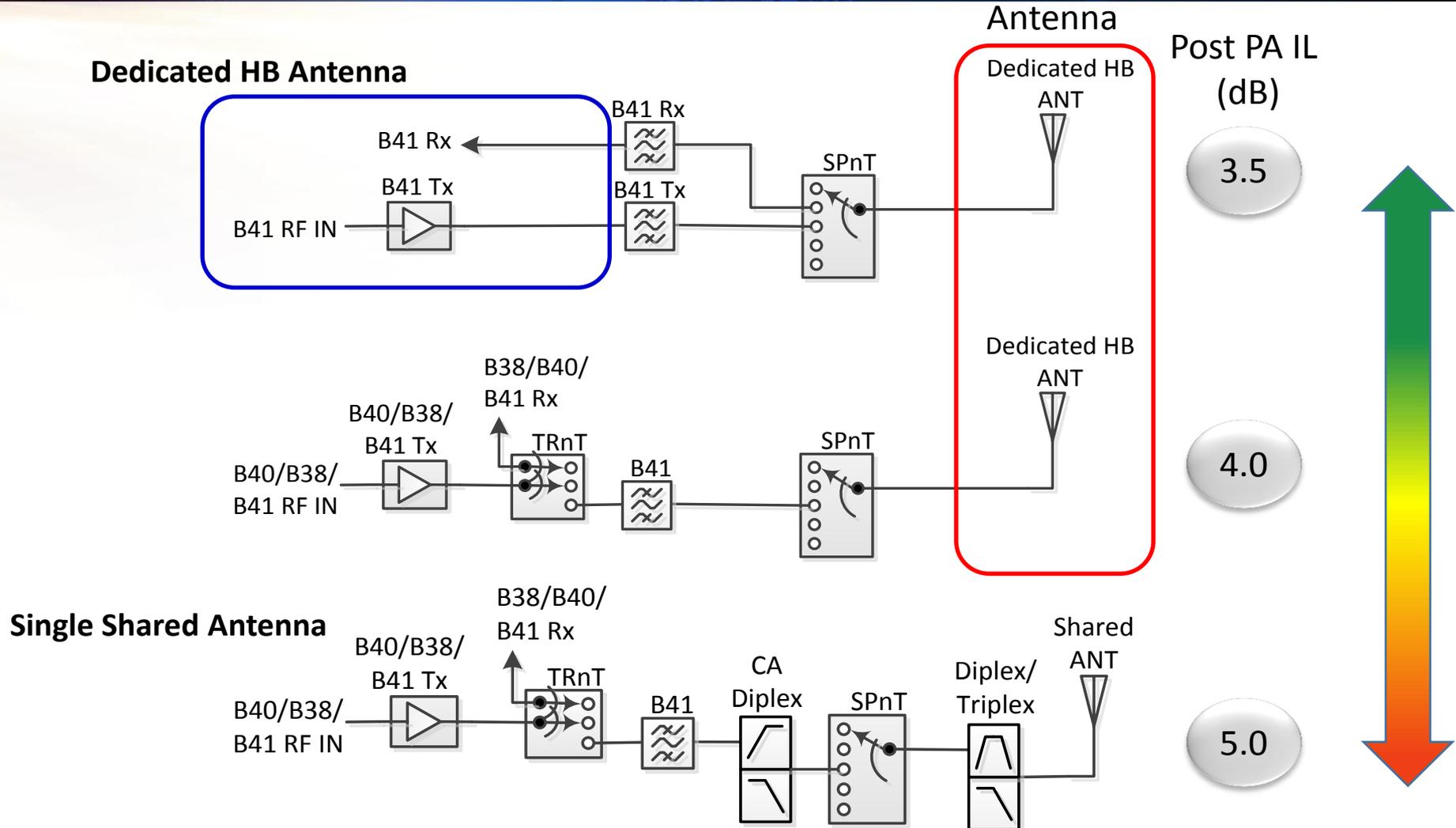


- $\sim R^4$ relationship
 - Operators indicate this correlates within 1-3%
- 3dB extra UL power \rightarrow \sim 19% increase in cell radius (42% increase in coverage area)



| Measurement Results

Use Cases Examined for B41 +26dBm

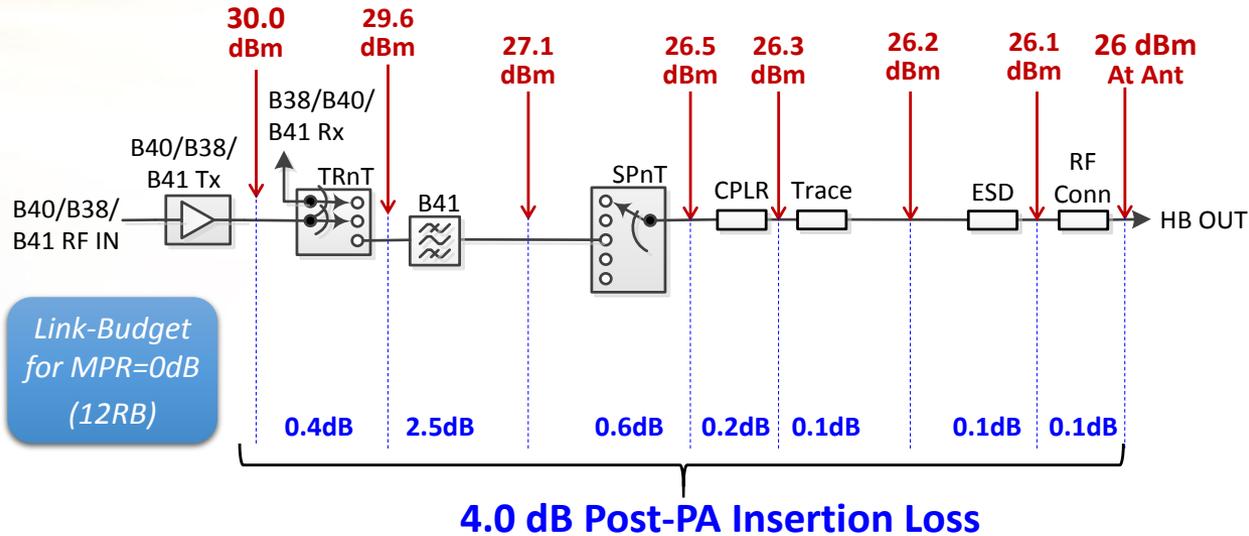


- **Dedicated HB Antenna Line-up Preferred to Minimize FE IL**
- **Dedicated HB PA is also Preferred for Optimization of B41 Performance**

Architectural Assessment of Required PA Output Power for +26dBm at the B41 Antenna

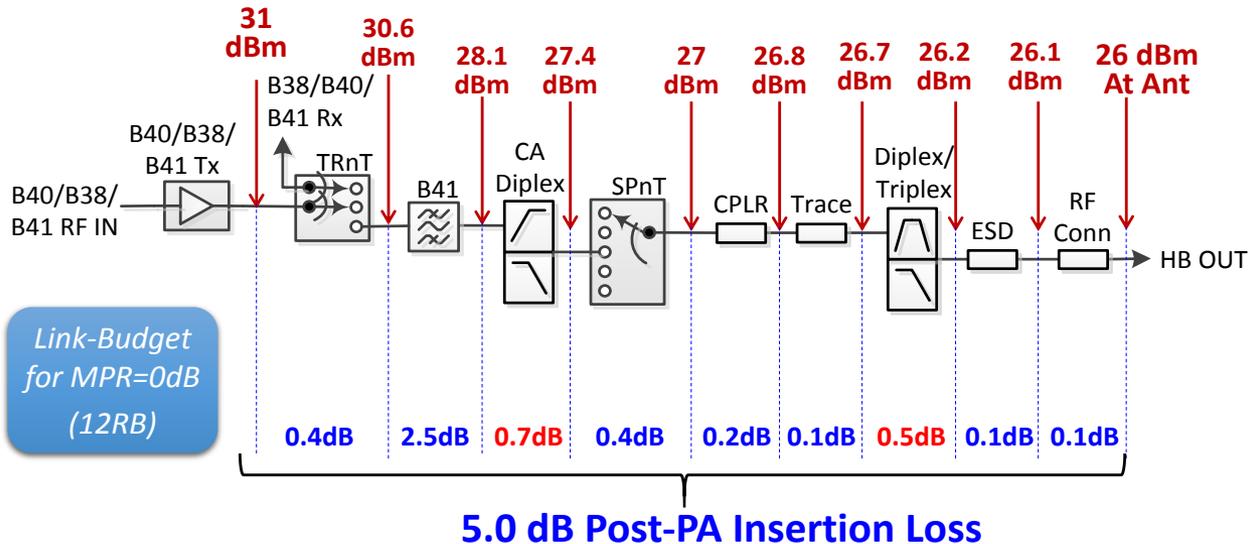


30



26

31



26

Measured Power Amplifier Performance

Linearity and Efficiency to Support +26dBm



PA Data* with MPR =1.0 dB Waveform (QPSK_10MHz_50RB)				
* T/R Switch not included				
B41 Tx Frequency [MHz]	Output Power 10MHz/50RB (dBm) (MPR=1)	Gain (dB)	EUTRA1 (dBc)	UTRA1 (dBc)
(L/C/H) 2501/ 2593/ 2685	26.90	29.11/29.14/28.83	-40.72/-41.29/-39.44	-43.10/-43.85/-41.86
	27.90	29.54/29.19/28.91	-41.63/-40.74/-39.17	-44.19/-43.29/-41.66
	28.90	29.42/29.14/28.87	-40.59/-40.63/-39.49	-42.78/-43.14/-42.04
	29.90	29.23/28.97/28.70	-38.63/-40.20/-39.45	-40.41/-42.43/-41.88

- PA Engines Supports Linear Power of 31 dBm with shared antenna architecture (5 dB post PA losses)
- XCVR_{Class2Pwr} ≈ 2.0 dBm
 - RFFE_{Gain} = 24 dB (29 dB PA gain -5dB loss)
 - PA gain can be increased further if required to mitigate temperature & mismatch variation to maintain XCVR linear power

Existing PA Engine supports +31 dBm without impact to XCVR

EUTRA Linearity Impact for class 2

- What is the expected EUTRA limit for class 2?
 - 3GPP working group to consider -33 dBc the baseline assumption
 - Class 3 nominal pout = 24 dBm (E-UTRA -6 dBm equivalent)

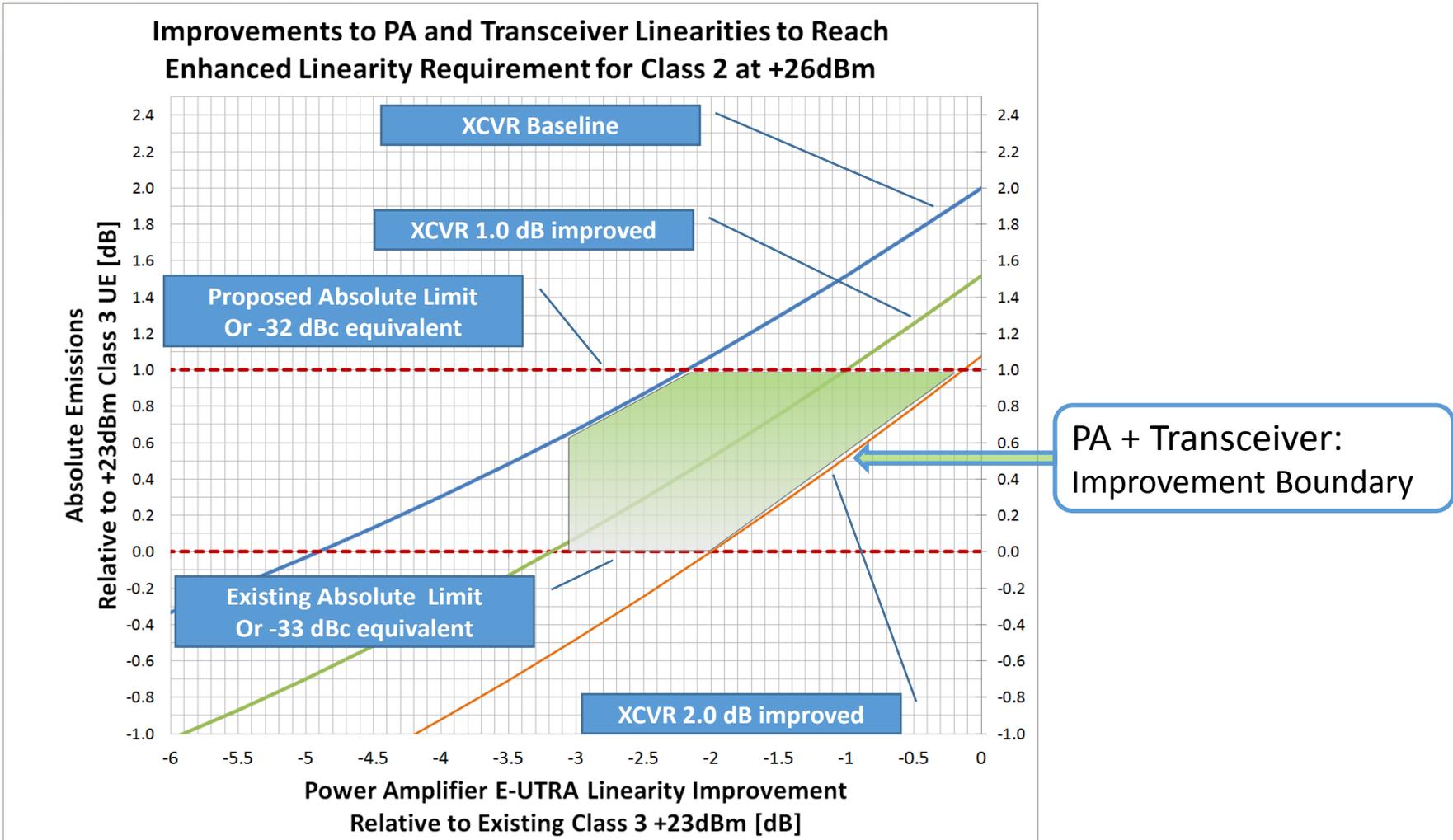
Class #	Nominal Pout	EUTRA (dBc)	Equivalent EUTRA (dBm)
Class 3	24 (market nominal)	-30	-6
Class 2 (Proposed)	26	-32	-6

- Antenna Efficiency: Head and Hand Loading on the order of 3-5 dB
 - Adds coexistence margin

SWKS Position: Technically -33dBc is feasible, however recommend consideration of class 2 EUTRA @ -32

Relative Linearity Improvement Required by Transceiver and PA

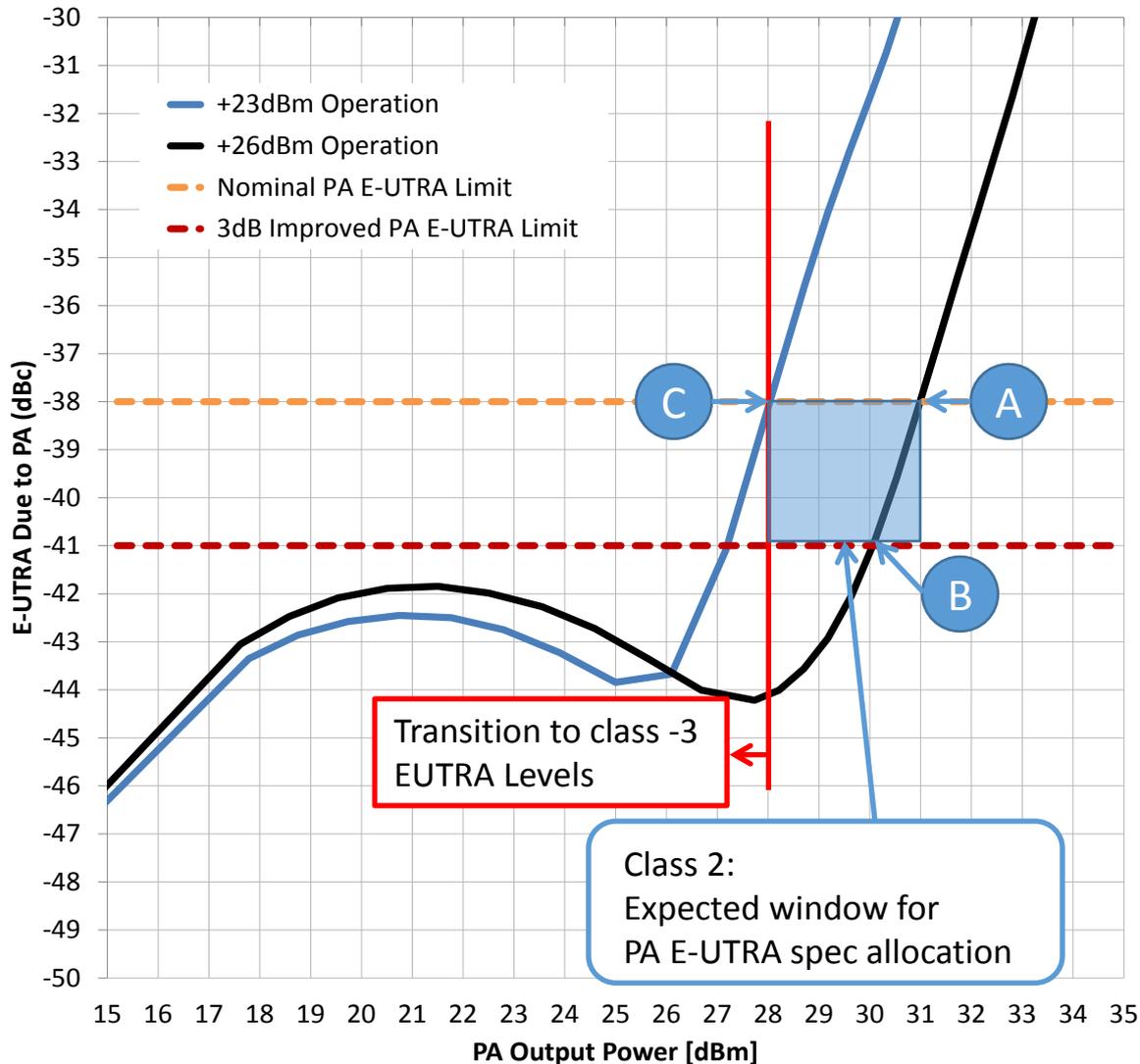
- Proposed PA + XCVR improvements are bounded as indicated below



E-UTRA @ -33 dBc: Requires 3 dB PA improvement & 1 dB XCVR
E-UTRA @ -32 dBc: Several PA + XCVR improvement combinations

Optimization of Class 2 UE Architecture and Impact for Shared Bands/CA

+26dBm-Capable Power Amplifier : Post-PA IL = 5dB
E-UTRA Performance / QPSK 10MHz 12RB / MPR = 0dB



Shared Antenna - RFFE Loss = 5.0 dB

- A) -38 dBc @ 31 dBm
- B) -41 dBc @ 30.1 dBm
- C) -38 dBc transition to class 3 levels

Optimization of Class 2 UE Architecture and Impact for Shared Bands/CA



Shared Antenna RFFE with 5.0 dB Post PA Losses				
All data summarized with 0 dB MPR Waveform – QPSK_10MHz_12RB				
	Class 2PA at +26dBm		Class 2 PA at +23dBm	
	High Linearity	Nominal Linearity	High Linearity	Nominal Linearity
Pout	+30.1	+31	+27.1	+28
E-UTRA ACLR (dBc)	-41	-38	-41	-38
Total System Efficiency (inc converter)	37.1%	41.1%	33.4%	37.8%
Efficiency Degradation for 3dB Improved E-UTRA	4%	N/A	N/A	
Efficiency Degradation for 3dB Backed-off Operation of Class 2 PA	N/A	N/A	3.63%	3.29%

- Existing PA engine supports -41 dBc with 4 dB RFFE Losses
 - Loadline adjustment required for shared antenna architecture (5.0 dB)

-41 dBc Allocation to the PA engine impacts PAE by 4%

Optimization of Class 2 UE Architecture and Impact for Shared Bands/CA

PA Engine + PMU DC (QPSK_10MHz_12RB) [Post-PA Insertion Loss = 5dB]					
		26 dBm B41+B40 PA		23 dBm B41 PA	23 dBm B25 PA
		26 dBm*	23 dBm	23 dBm	23 dBm
Best-in-Class ET PA + PMU	Total Eff [%]	40.6%	34.7%	41.3%	42.9%
Present Best-in-Class APT PA+PMU**	Total Eff [%]	32.3%	31.4%	36.1%	39.9%
Next Generation APT PA+PMU**	Total Eff [%]	37.1%	37.8	41.1%	43.1%

* Excess Linearity required for Class 2 Max powers (41 dBc case)- PAE will improve at -38 dBc
 ** NPD quoted for APT. Estimated improvement with EPT = 2-4% PAE improvement

- Next Generation PA designed to mitigate PAE degradation for shared class 2 & 3 operation

Summary: Higher UE Power B41



- System Performance Can Be Met at B41 +26dBm Pout
 - Feasibility Demonstrated for higher power using measured data from existing product development
 - Feasibility was evaluated a worst case Link-Budget condition, more optimal implementation is possible and likely
- EUTRA system specification of -32 dBc can be achieved with PA improvement of 2.5 dBc with existing transceiver EUTRA performance levels
- Performance at nominal Class 3 UE in other bands is minimized with next generation PA engine
- We expect commercialization in 1H16 in UE form factors

Ecosystem can enjoy benefits of HPUE without system degradation