

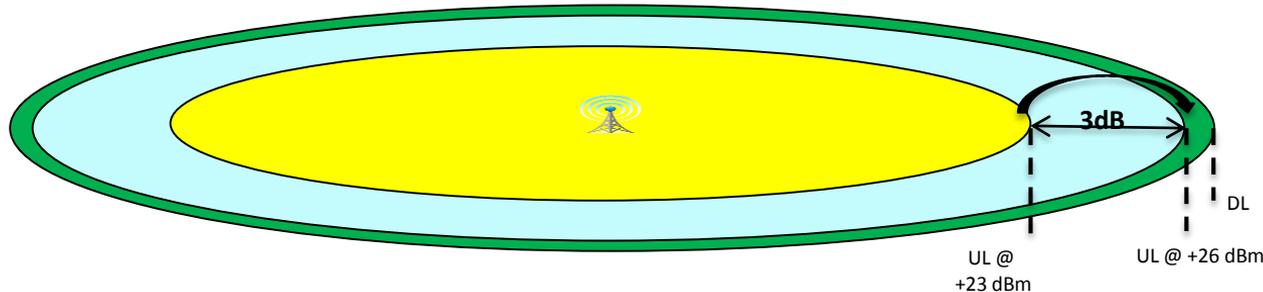
Motivation for New Band 41 UE power class

Sprint, CMCC, ALU, Softbank

Higher UL UE Tx Power Increases Band 41 Coverage

Band 41 coverage is UL limited

- Data (1 Mbps DL, 256 kbps UL) link budget is UL limited as shown in TR 36.824
- Planet Simulation shows ~30% increase in B41 coverage area from 3dB increase in UL Power

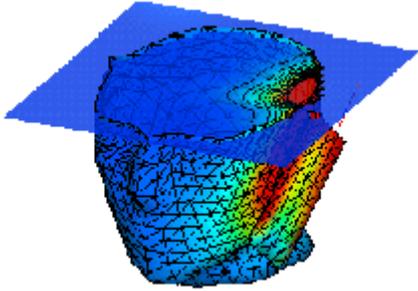


UE UL Tx Power Increase Enabling Technologies

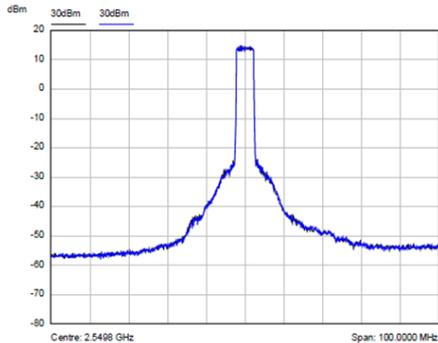
- “Boost” Envelope Tracking allows increased PA_{out} with similar linearity with same battery supply voltage
- Multi-Stage Amplifiers allows higher power while mitigating thermal issues from single PA
- Implementation of flexible B41 FBAR Filters would allow for reduced insertion losses
- New RF switches with higher linearity and lower insertion loss (e.g. MEMS)
- Optimized RF Front End B41 Tx chain to reduce insertion losses

Regulatory Considerations

In the US market there are two factors that limit a UE's output power



- Specific Absorption Rate (SAR)
 - FCC has specific requirements to protect public health.
 - Based on the FCC test reports most of current Band 41 devices pass FCC SAR testing (<1.6 W/kg) with comfortable margin
 - SAR mediation is implementation specific



- Out of Band Emissions / ACLR
 - Analysis of FCC Certification reports shows current Sprint devices meeting OOB limits with comfortable margins (~7-8 dB)
 - Analysis of detailed data from a tier 1 RF Front End vendor shows 8 dB margin (worst case) for OOB limits when operating at +23 dBm (at antenna connector)
 - Consultations with vendors indicate that higher powers (+26 dBm, or more) within current emissions limits are definitely possible with PA linearization techniques such as EnvelopTracking.

Implementation Aspects

Power Consumption / Battery Life not significantly impacted

- Most smartphone power is used for App Processor and Display.
- Theoretical extrapolation analysis suggests +3 dB TDD Tx Power would increase overall device power consumption 7-12%, assuming 100% UL TTI usage, which is absolute worse case.
- Increased use of TDD with higher power will allow device power savings for the offered UL traffic due to frame configuration, compared to continuous FDD transmissions.
- Therefore, use of higher TDD Tx power may have insignificant impact on overall device power consumption.

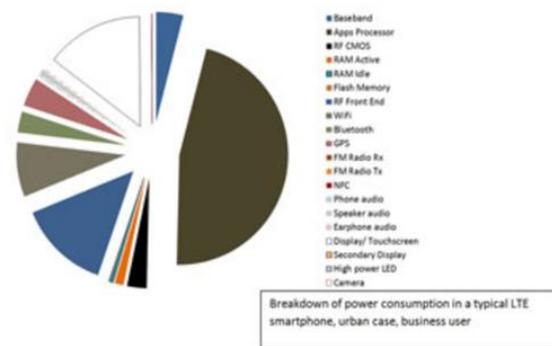


Figure 1 Breakdown of power consumption in a typical LTE smartphone, urban case, business user.

3GPP Power Class Definitions

Currently, nearly all LTE UEs use the same Power Class 3 (+23 dBm)

- Other cellular technologies have multiple UE classes for different purposes.
 - **GSM/Edge have 5/7 Power Classes, with Tx powers ranging from +23..+39 dBm**
 - **UMTS has 5 Power Classes, with Tx powers ranging from +21..+33 dBm**
- 3GPP LTE standards designed for 4 Power Classes from the beginning, but to date, full standards definition only complete for Power Class 3.
 - **One exception: Power Class 1 (31 dBm) for Band 14 introduced in Rel-11**
 - **Power Class 3 was originally defined to maintain cell site count parity with UMTS, which is not applicable to Band 41 deployments.**