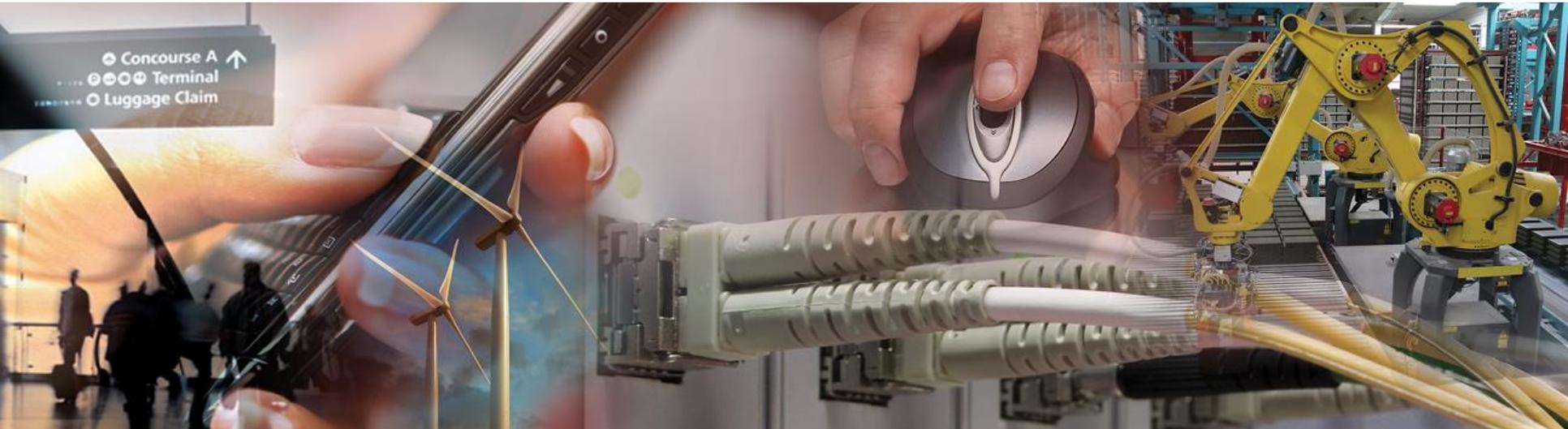


Technology for HP UE



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Introduction

Present TD systems are most commonly limited by the UL link budget

Increasing the UL power would help alleviate this problem

A Study Item has been introduced in 3GPP for a new “High Power UE” (HPUE) class of operation.

This presentation looks at the ability of today’s technology to support HPUE

Requirements for HP UE

Major Factors:

- Power level: 26 dBm +/- 2 dB
existing power class 3 is 23 dBm +/-2 dB
- Linearity in terms of spectral re-growth
present EUTRA ACLR is 30 dBc min; designs have 6 dB ACL margin at PA level
for same emissions level, HPUE ACLR would be 33 dBc min; not clear if this is required
- Emissions (harmonics, IMs, noise)
-50 dBm/MHz
- SAR
must pass regulatory requirements
- Co-Ex with WiFi
should limit emissions into WiFi to the same level as a class 3 devices

Considerations: Power

Present Class 3 UE power for B41 is 23 dBm +/- 2 dBm
Proposed HPUE is +26 dBm +/- 2 dB

Ways to increase power:

Larger die (more active area)

- 2x more active area (not die size!) increases power nominal 3 dB
- assumes perfect sharing
- ignores impedance transformation loss

Higher voltage operation

- similar active area (avoids impedance loss issue)
- possible with APT/ET Bias Boost
- requires coordination between ET vendor, Baseband, and PA

Getting the power level is not the limitation.

Considerations: Spectral Regrowth

UE has considerations for E-UTRA ACLR and UTRA ACLR

Higher Pout implies more headroom needed for linearity

For a linear PA, ACLR improves ~ 3 dB per dB of power reduction

Linearity can be improved by tuning (load line adjustment)

Linearity can be improved through DPD and ET shaping function

Chipset support of ET for TDD operation desirable (e.g. MTK, Intel)

UTRA-ACLR1 requirements are harder than E-UTRA ACLR due to choice of reference 3G system

3G TD-SCDMA has narrow channel, so places spectral regrowth in close

There is actually no such reference 3G system in operation in B41

Proposal: remove UTRA-ACLR requirement for B41 for class 2 operation

With proper design and use of linearization techniques, ACLR target can be achieved

Table 6.6.2.3.2-1: Requirements for UTRA_{ACLR1/2}

	Channel bandwidth / UTRA _{ACLR1/2} / Measurement bandwidth					
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz
UTRA _{ACLR1}	33 dB	33 dB	33 dB	33 dB	33 dB	33 dB
Adjacent channel centre frequency offset [MHz]	$0.7 + BW_{UTRA}/2$ / $-0.7 - BW_{UTRA}/2$	$1.5 + BW_{UTRA}/2$ / $-1.5 - BW_{UTRA}/2$	$+2.5 + BW_{UTRA}/2$ / $-2.5 - BW_{UTRA}/2$	$+5 + BW_{UTRA}/2$ / $-5 - BW_{UTRA}/2$	$+7.5 + BW_{UTRA}/2$ / $-7.5 - BW_{UTRA}/2$	$+10 + BW_{UTRA}/2$ / $-10 - BW_{UTRA}/2$
UTRA 5MHz channel Measurement bandwidth (Note 1)	3.84 MHz	3.84 MHz	3.84 MHz	3.84 MHz	3.84 MHz	3.84 MHz
UTRA 1.8MHz channel measurement bandwidth (Note 2)	1.28 MHz	1.28 MHz	1.28 MHz	1.28MHz	1.28MHz	1.28MHz

NOTE 1: Applicable for E-UTRA FDD co-existence with UTRA FDD in paired spectrum.
NOTE 2: Applicable for E-UTRA TDD co-existence with UTRA TDD in unpaired spectrum.

Figures and Tables from 3GPP TS36-101 v10.9.0 (release 10)

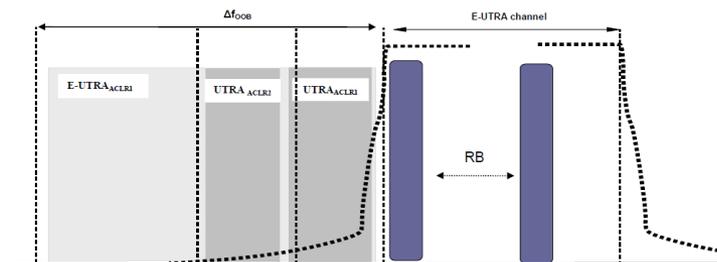


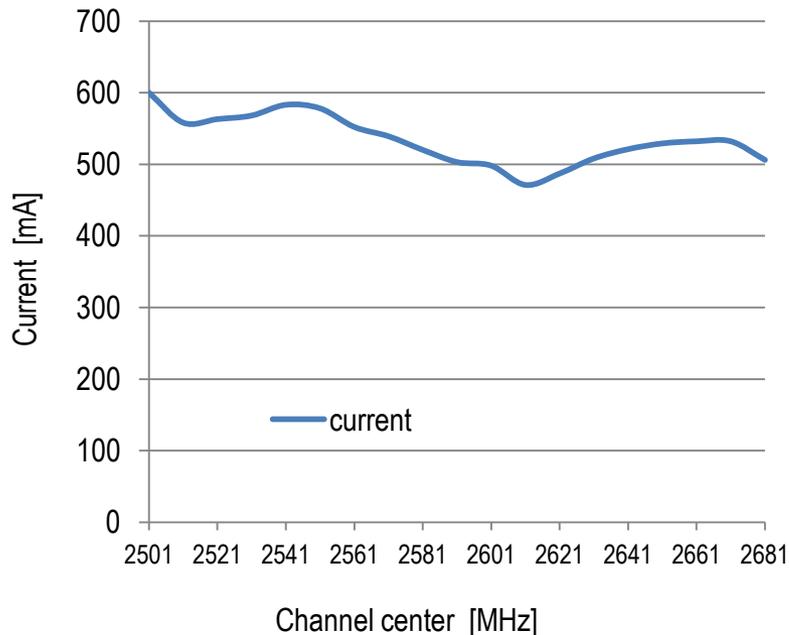
Figure 6.6.2.3-1: Adjacent Channel Leakage requirements

Module Power Measurements

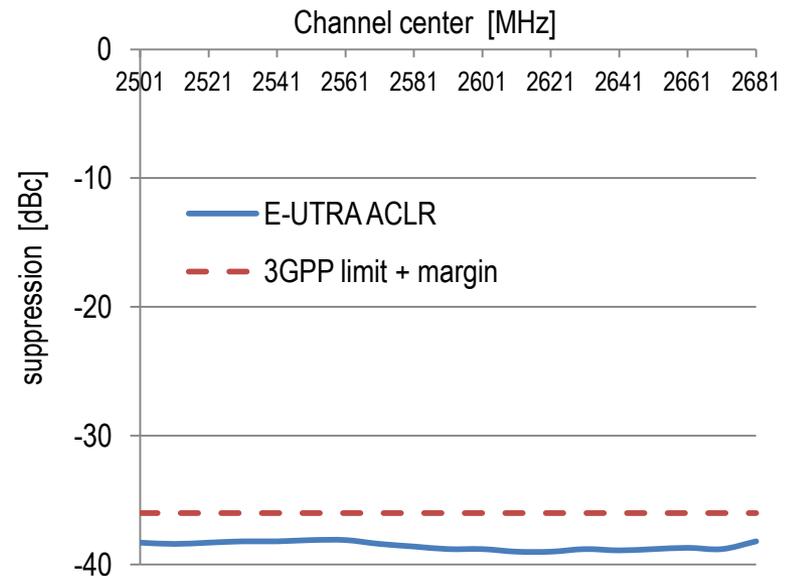
Measurements of a module including B41; power set to +25.5 dBm at module output
(includes all in-module post-PA losses such as filter and switches).

APT measurements at 40% duty cycle with PA voltage boosted to 3.8 V

**Current for $P_o=25.5$ dBm
10MHz 12RB 25°C**



**E-UTRA ACLR for $P_o=25.5$ dBm
10MHz 12RB 25°C**



Considerations: Reliability

Biggest concern is heat crowding in the PA

Current draw for HPUE will be significantly higher than for a class 2 device, creating heat

Heat reduces power sharing, degrades linearity

minimizing hotspot operation is one of the major limiters for HPUE

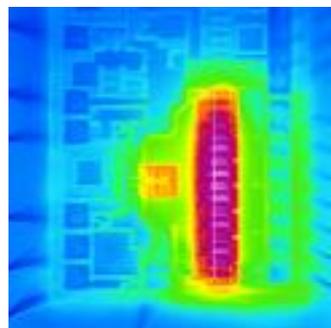
Mitigation:

Smart thermal design (heat balancing)

Improved efficiency (ET operation)

Decreased post-PA losses (lower loss filters, decreased matching losses)

Junction temperature is probably the major limitation for achievable power out of the PA



Considerations: SAR

Limitation set by safety of head absorption

The rules for SAR average power absorption over minutes, so TDD systems can take advantage of pulsed operation when making the measurement

The US FCC has said if operation is limited to exclude frame configuration 0, then increased peak power can be ok as long as average power over test time is within limits.

This interpretation makes class 2 operation possible for TDD operation, provided frame configuration 0 is prohibited.

Specific Absorption Rate (SAR) for Cellular Telephones



Working closely with federal health and safety agencies, such as the Food and Drug Administration (FDA), the FCC has adopted limits for safe exposure to radiofrequency (RF) energy. These limits are given in terms of a unit referred to as the Specific Absorption Rate (SAR), which is a measure of the amount of radio frequency energy absorbed by the body when using a mobile phone. The FCC requires cell phone manufacturers to ensure that their phones comply with these objective limits for safe exposure. Any cell phone at or below these SAR levels (that is, any phone legally sold in the U.S.) is a "safe" phone, as measured by these standards. The FCC limit for public exposure from cellular telephones is an SAR level of 1.6 watts per kilogram (1.6 W/kg).

Uplink-Downlink Allocations



UL/DL Configuration	Period (ms)	Subframe									
		0	1	2	3	4	5	6	7	8	9
0	5	D	S	U	U	U	D	S	U	U	U
1		D	S	U	U	D	D	S	U	U	D
2		D	S	U	D	D	D	S	U	D	D
3	10	D	S	U	U	U	D	D	D	D	D
4		D	S	U	U	D	D	D	D	D	D
5		D	S	U	D	D	D	D	D	D	D
6	5	D	S	U	U	U	D	S	U	U	D

New Low Loss ACFM-7241 B41 Filter

A large portion of the post PA loss comes from the insertion loss of the B41 filter.

Previous generations of filter had losses in the 2 dB to 3 dB region.

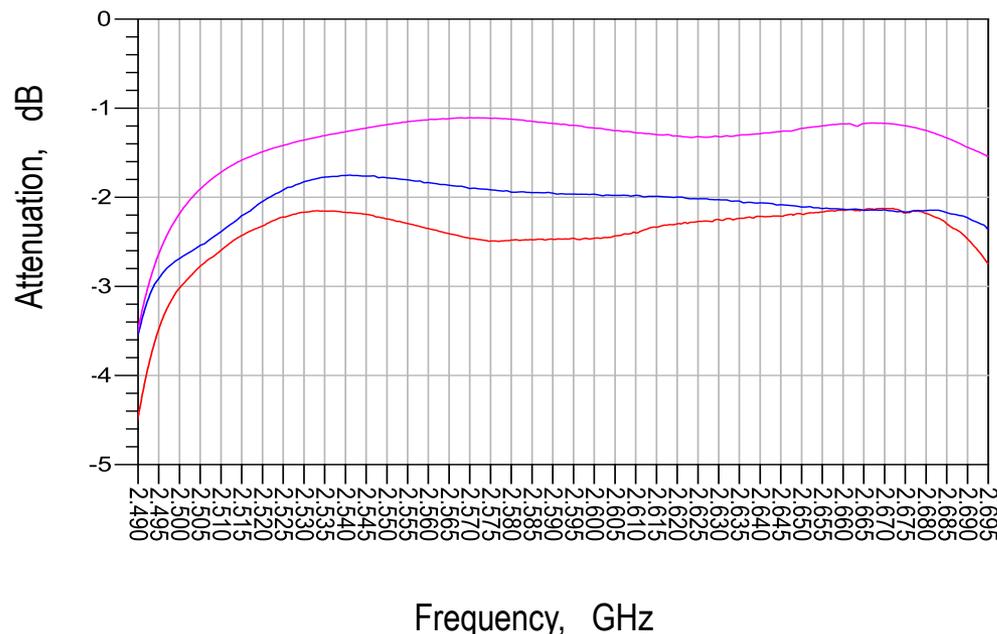
The latest generation filter has loss in the 1 to 2 dB region. This generation filter is used in the measured module.

Lower loss filter means higher output power at the same current level.

Lower loss also reduces power dissipation in the filter, raising power handling.

Footnote: The filter loss at the low frequency band edge is not a major concern due to A-MPR and spectral mask compliance

Loss of B41 Filter Improved by >0.5 dB



Red – 1st Generation (ACPF-7041)

Blue – 2nd Generation (ACPF-7141)

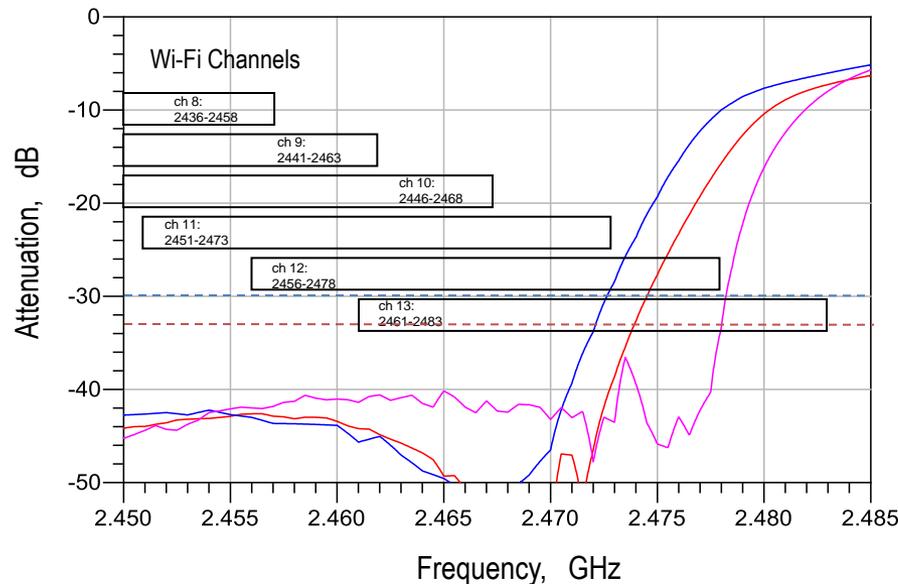
Magenta – 3rd Generation (ACPF-7241) – used in module

Considerations: WiFi Coex

Level of emissions sets co-ex standard

Present filters designed to provide >30 dB rejection through ch11. Measurement with this kind of filter show only 5-8% reduction to throughput in worst measured interference scenarios.

New design provides >33 dB through ch12 and also improves protection of ch13.



-30 dB desired for class 3

-33 dB desired for HPUE
(for same emissions level)

Red – 1st Generation (ACPF-7041): used in WiFi Co-existence tests

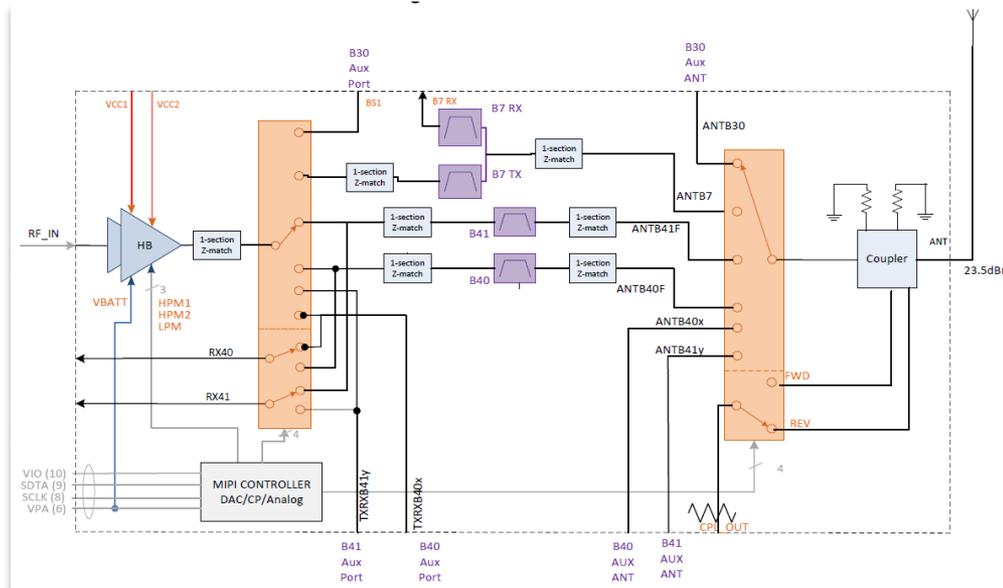
Blue – 2nd Generation (ACPF-7141)

Magenta – 3rd Generation (ACPF-7241): used in module

Module Used for Power Measurements

Power measurements were made using AFEM-9110 “High Band” Module
 Bands supported: B7, B38, B40, B41, B30
 Features include ET controlled MBMM PA, switching, filtering

AFEM-9110 Block Diagram



Sampling now

Conclusion

- Measurement have been presented that show a module capable of +25.5 dBm at module output.
- These measurements show existing technology can support HPUE in phones with typical loss after the B41 module
(e.g. regional phones with <10 bands and limited combining losses, or phones using a dedicated antenna for the B41 module).
- Additional work is required to reach full 26+/- 2 dBm in phones experiencing significant combining loss after the B41 module
(e.g. high band count world phones, or architectures supporting multiple CA combinations with B41 and sharing a common antenna).
- It is believed that those challenges can be met in the next few years.