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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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where:

x the first digit:

1 presented to TSG for information;

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3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document a technical report for the LTE for 700 MHz digital dividend work item. It is intended to define both FDD and TDD arrangements on the 698-806 MHz frequency band in Region 3.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] APT/AWF/REP-14 “APT Report on Harmonized Frequency Arrangements for the Band 698-806 MHz”, Asia Pacific Telecommunity Sep 2010

[3] 3GPP TR 30.007: “Guideline on WI/SI for new Operating Bands”

[4] 3GPP TS 25.942, “Radio Frequency (RF) system scenarios”

[5] AWG-11/OUT 10 “NEW APT REPORT: IMPLEMENTATION ISSUES ASSOCIATED WITH USE OF THE BAND 698-806 MHZ BY MOBILE SERVICES”, Asia Pacific Telecommunity, 14 September 2011

[6] http://www.soumu.go.jp/menu_news/s-news/01kiban14_02000061.html

[7] TS 37.806, “Extending 850MHz Study Item Technical Report”

[8] SAW Duplexer, LTE Band 20, Series/type B7679, TDK/EPCOS AG (available on www.epcos.com)

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [x] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [x].

Definition format (Normal)

<defined term>: *<definition>.*

example: text used to clarify abstract rules by applying them literally.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Symbol format (EW)

<symbol> <Explanation>

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [x] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [x].

Abbreviation format (EW)

<ACRONYM> <Explanation>

4 Background

The switch off of analogue television (Digital Dividend) will make available for IMT services a portion of the UHF spectrum in Region 3. In other regions the switch to digital television will also create a digital dividend that may be used for IMT services.

At the ninth meeting of the APT Wireless Forum (AWF-9), held in Seoul, Korea from September 13th to 16th 2010, agreement was reached on two harmonized frequency arrangements for IMT in the 698-806 MHz frequency band in Region 3. This agreement is the result of extensive studies undertaken by Region 3 administrations, network operators and manufacturers of equipment, user devices and electronic components, following the decisions taken WRC-07. [2]

The agreed FDD arrangement is: Uplink: 703-748 MHz, Downlink 758-803 MHz, i.e. 2x45 MHz.

The agreed TDD arrangement is: 698-806 MHz, i.e. 1x108 MHz. However APT notes that "a minimum internal guard-band of 5 MHz at the lower edge (698 MHz) and 3 MHz at the upper edge (806 MHz) needs to be considered".

The AWF-9 meeting also invited further studies to determine UE out-of-band emission limits and implementation issues relating to the usage of the band 698-806 MHz by the Mobile Service. The APT Wireless Group (AWG)[1] is continuing these studies and plans to finalize them in the 11th meeting of AWG in October 2011.

Note that studies on implementation issues for countries which cannot make the whole band 698-806MHz available and therefore cannot apply the APT-agreed arrangements but will use some part of the frequency arrangement should be conducted in order to suit their national considerations, which will consequently allow more deployments using the APT-agreed arrangements in various countries.

The purpose of this work item is to:

- Study the technical requirements for deploying LTE in the band 698-806 MHz in region 3, e.g. coexistence requirements with service in adjacent frequency bands, considering the on-going work in the AWG. Both TDD and FDD should be considered.
- Develop channel arrangements for LTE in the band 698-806 MHz in line with the APT decision for region 3 and the study above. Both TDD and FDD should be considered.
- Develop technical requirements for deployment of LTE in the band 698-806 MHz, considering implementation issues for countries which cannot make the whole band 698-806MHz available and therefore cannot apply the APT-agreed arrangements but will use some part of the channel arrangement. Both TDD and FDD should be considered.

[1] AWF is now renamed as AWG.

- Consider possible deployment in region 2 outside of US.
- Generate CR’s to update the appropriate documents

5 Frequency band arrangements and regulatory background

5.1 Adjacent 3GPP bands

In figure 5.1-1 an overview of the already standardised 3GPP frequency bands is given. However some of the bands are regional or local and thus the coexistence situation is slightly different in different regions and countries.

We can see that for all the adjacent 3GPP bands the new band has a downlink allocated next to an uplink of the already standardised bands. Thus there will may be interference from the BS of the new band into the BS of the already standardized bands. In addition there may be interference from UEs in the already defined bands into UEs for the new band.

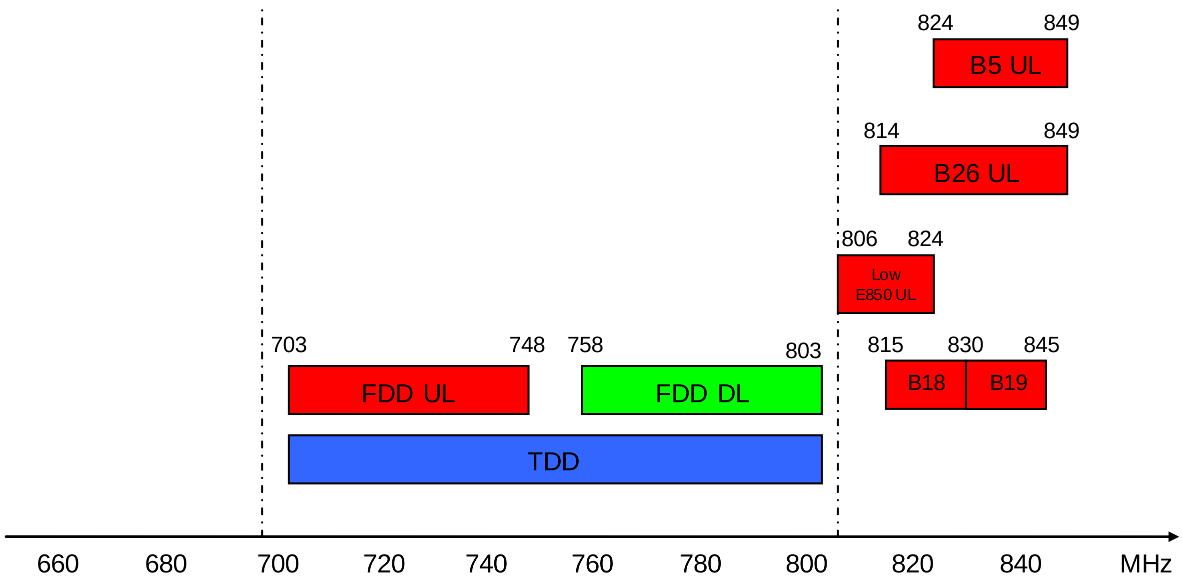

Figure 5.1-1 Overview of adjacent bands defined by 3GPP

In table 5.1-1 we give some further details on where bands are used and the frequency separation between the new band and the already existing bands.

Table 5.1-1 Further details on 3GPP bands close to the new band

Band	Frequency separation	Comments/Notes
Band 5	21 MHz	Used in various places in the APAC region
Band 18	12 MHz	Used in Japan
Band 19	27 MHz	Used in Japan
Band 26	11 MHz	Band planned for global use.
Low E850	3 MHz	WI ongoing (Jun 2011), but band not in standard

5.2 Services below the band

Below the new band the spectrum is mainly allocated to broadcasting. There are four different digital TV standards used in the regions (ATSC, DTMB, DVB-T/T" and ISDB-T). In addition there are three different channel rasters used (6,7 and 8 MHz). In figure 5.2-1 an overview of the frequency arrangement is given for the countries where the band below 698 MHz will be freed up by the transision to digital TV technology. However, there would be some countries which cannot make the whole band 698-806MHz available for the mobile service even after the digtail TV transision. For example, Japan will have the channel arrangement for digital TV as shown in figure 5.2-2. In table 5.2-1 further details are given some of the countries in the region.

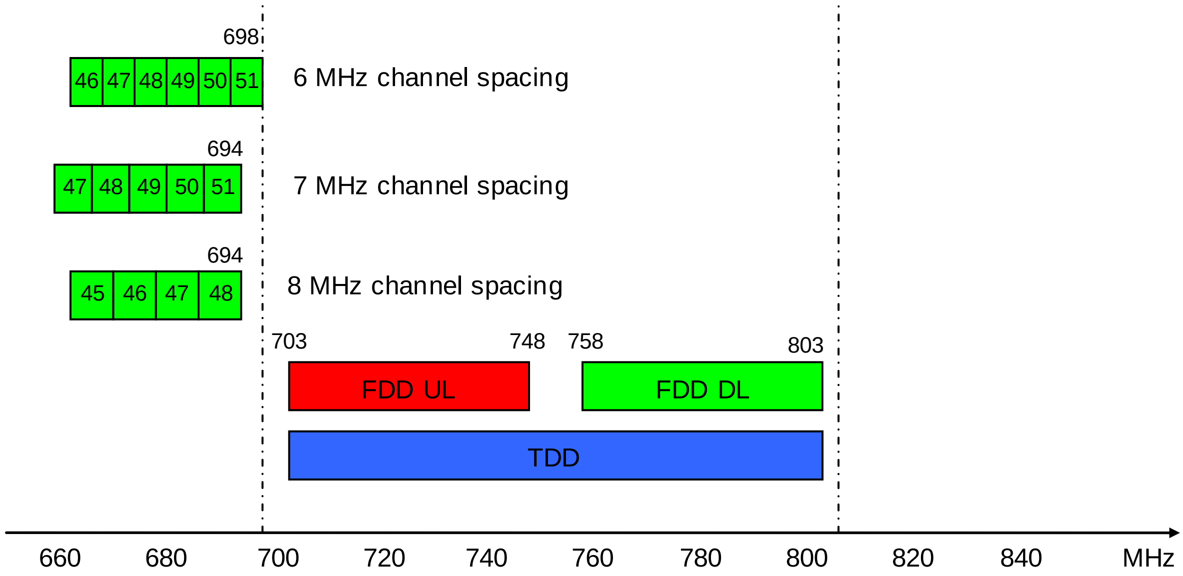

Figure 5.2-1 Channel arrangements for digital TV below the band

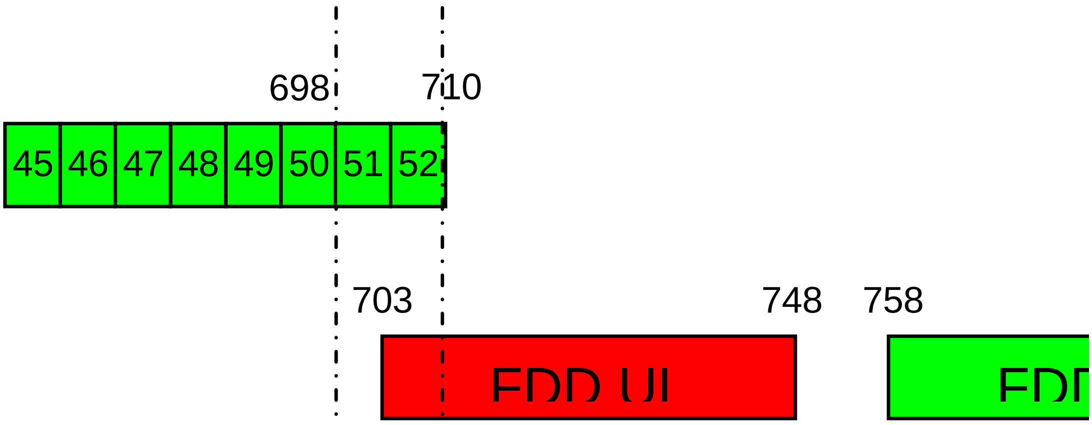

Figure 5.2-2 Channel arrangements for digital TV in Japan

The main interference paths are from a FDD and TDD UE uperating in the new band to digital TV receivers. In addition there will be interference from TDD BS to TV receivers. The TV transmitter may create interfere at the BS receiver in the new band.

Table 5.2-1 Further details digital TV channel raster and broadcasting standard

Channel raster	Frequency separation	Used in /system
6 MHz	5 MHz	Americas (most countries), Guam, American Samoa and Northern Mariana Islands (ATSC) South Korea(ATSC), Taiwan, the Philippines(ISDB-T),
6 MHz	TBD[1]	Japan (ISDB-T)
7 MHz	9 MHz	Australia (DVB-T/T2),
8 MHz	9 MHz	Europe (DVB-T/T2), Hong Kong (DTMB), Macau (DTMB), Falkland Islands, Southern Africa, most countries in Asia and Africa, most of Oceania
NOTE 1: The frequency for digital TV is below 710MHz. Available frequency for the mobile service is TBD		

5.2.1 AWG decisions on emissions

In the report "IMPLEMENTATION ISSUES ASSOCIATED WITH USE OF THE BAND 698-806 MHZ BY MOBILE SERVICES" [5] AWG have studied coexistence with TV services extensively. In the conclusion the following is stated:

> *"As a result of the probabilistic, deterministic and empirical studies it is considered that the probability of interference to adjacent digital television receivers below 694 MHz from IMT UE would be low when the UE maximum out-of-band emissions were between -30 and -40 dBm/MHz (averaged over the DTV bandwidth).*
>
> *Considering technical and economic factors associated with UE equipment, it was concluded that the average out of band emissions of IMT UE, measured over the bandwidth of the applicable television channel in the country of deployment, must not exceed -34 dBm/MHz below 694 MHz .*
>
> *To further reduce the probability of interference in certain cases, such as where digital television broadcasting services are operating immediately below 694 MHz, Administrations may wish to implement, on a local basis, network and operational deployment measures. This discretionary approach would have the effect of further lowering the emissions into the adjacent broadcast band below 694 MHz by up to 6 dB. This would have no impact on the IMT UE handset specifications or roaming requirements and can be achieved solely through network implementation by operators.*
>
> *For countries which have 6 MHz broadcast channel raster, if it is found that additional coexistence conditions are needed, they should be considered in an amendment to this report."*

Thus we can expect the emission requirements for TV protection to be -34 dBm/MHz below 694 MHz with an averaging bandwidth of 6, 7 or 8 MHz. In certain countries the emission level may be as low as -40 dBm/MHz in certain countries. Finally for countries which use 6 MHz TV channels AWG may consider further requirements.

5.3 Services above the band

There are different services deployed above the band. In table 5.3-1 some services are listed. Some of the standards used for trunked radio is iDEN and TETRA.

Table 5.3-1 Examples of services above the new band

Service	Frequency separation	Bandsplan	Country
Digital trunked radio system	3 MHz	806~817 UL 851~862 DL	Korea
Wireless trunked system	3 MHz	806~821	China
ITS	TBD	TBD	Japan
Trunked radio	3 MHz	806~824 UL 851~869 DL	Thailand
Trunked radio	3 MHz	806~820	Vietnam
Digital trunked radio system	3 MHz	806~824/851~869	India
Trunked radio	3 MHz	806~821/851~866 (821~824/866~869 reserved for trunked radio)	Malaysia
Fixed service bands (restricted to digital linking)	3 MHz	806~812/851~857	New Zealand
Land mobile service(Trunked)	17 MHz	820~825 UL 865-870 DL	Australia
Land Mobile Service (iDEN, trunked)	3 MHz	806-824 UL 851-869 DL	Argentina
Land Mobile Service (iDEN, trunked)	3 MHz	806-824 UL 851-869 DL	Chile
Land Mobile Service (iDEN, trunked)	3 MHz	806-824 UL 851-869 DL	Mexico
Land Mobile Service (iDEN, trunked)	3 MHz	806-824 UL 851-869 DL	Brazil
iDEN	3 MHz	806-824 UL 851-869 DL	Peru

6 List of band specific issues for LTE for 700 MHz digital dividend

- General issues
    - TDD frequency arrangement
    - Co-existence with nearby 3GPP bands
        - o Co-existence with lower E850 sub-band
        - o Co-existence with Band 26
        - o Co-existence with Band 5
        - o Co-existence with Band 18 and 19
    - Co-existence with TV broadcasting
    - Co-existence with PPDR and TETRA systems
    - Regional frequency arrangements
- E-UTRA issues
    - UE duplexer

  - o FDD dual duplexer
  - o TDD filter
- UE transmitter requirements
  - o FDD
    - o Maximum output power
    - o Unwanted emissions requirements for protection of own RX band
  - o TDD
    - o Maximum output power
- UE receiver requirements
  - o FDD
    - o REFSENS
    - o In- band blocking
  - o TDD
    - o REFSENS
    - o In-band blocking
- BS Transmitter Requirements
  - o Unwanted emissions
- BS Receiver Requirements
  - o Blocking

- MSR issues
  - No issues found

7 General issues

7.1 TDD frequency arrangement

The frequency arrangement for TDD should be aligned with the outer ends of the FDD arrangement i.e. the frequency arrangement for TDD is:

- 703-803 MHz

7.2 Co-existence with nearby 3GPP bands

Figure 7.2-1 shows the 3GPP spectrum around APT700. Band 5/V, Band 18 and Band 19/XIX are legacy bands being deployed, thus impact in current performance needs to be specifically addressed. Band 26 and lower E850 sub-band are bands being standarized at the same time as APT700.

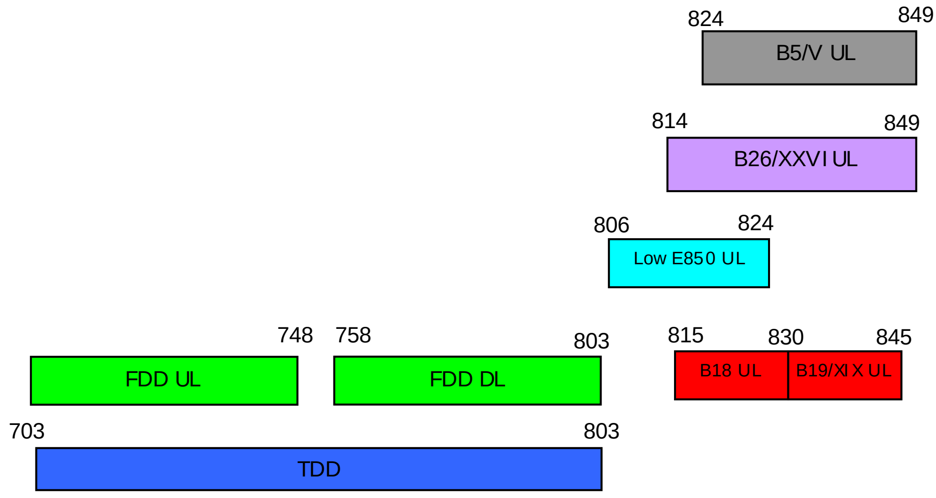

Figure 7.2-1. 3GPP spectrum around 700 MHz in APAC

7.2.1 Co-existence with lower E850 sub-band

Lower E850 UL is situated 4 MHz from APT700 FDD DL and APT700 TDD, as shown in Figure 7.2-1.

For the APT700 and lower E850 BS co-existence scenario, the following issues should be considered:

- APT700 LTE BS TX OOBE → Lower E850 LTE BS Receiver
- APT700LTE BS TX Power → Lower E850 LTE BS Receiver (ACS, blocking)

The spurious emission requirement for co-existence with BS operating in lower E850 is -49dBm/MHz. Assuming ACLR1 and ACLR2 is equal to 45dB, the BS RF filter will need to attenuate 40dB. In addition, the BS TX filter should be able to provide enough attenuation in order to protect its own UL.

The interfering signal for lower E850 BS receiver with 6dB degradation is -52dBm for ACS and -43dBm for in-band blocking requirements. Assuming a BS output power is 43 dBm/5MHz, and MCL=67 dB, the interfering signal into lower E850 UL is -24 dBm/5MHz. Therefore additional 28dB and 19dB rejection is needed in the filter to meet the ACS and in-band blocking requirements are required respectively. The more realistic assumption is 1 dB desense for BS, the corresponding allowed interference power adjusts to be -63dBm and -54dBm respectively. Hence the required attenuation is 39 dB for adjacent protection and 30 dB for other in-band channels protection.

Regarding the BS co-existence issues between APT700 MHz and lower E850 bands, filter capability is an important factor. From the investigation R4-122788, it can be concluded that there exists possible solutions to solve the co-existence issues between lower E850 and APT700. Lower E850 Rx filter can provide enough attenuation to fulfil ACS and in band-blocking. By using certain specific solutions, sub-band filters as an example, APT700 can protect lower E850 UL with the standard level of -49dBm/MHz.

7.2.2 Co-existence with Band 26/XXVI

The frequency distance between Band 26/XXVI UL and APT700 FDD DL and APT700 TDD is 11 MHz, see Figure 7.2-1.

BS-BS

Band 26/XXVI UL is located in the spurious emissions region of APT700. Therefore, co-existence is possible and the common protection limits from APT700 towards Band 26 UL, i. e. -49 dBm/MHz can be reused.

Band 26/XXVI blocking requirement at 803 MHz is specified as 6 dB degradation for a -43/-40 dBm blocking signal. Considering MCL=67 dB (co-existence) and a BS transmitting at 43dBm, the blocking signal into Band 26 is -24dBm. An extra attenuation of 19/16 dB is needed which is feasible at such frequency.

BS-BS co-existence between Band 26/XXVI and APT700 is not an issue

UE-UE

Band 26/XXVI UE emissions into APT700 have been defined as -50dBm/MHz @703-799 MHz and -40 dBm/MHz @799-803 MHz [7].

7.2.3 Co-existence with Band 5/V

Band 5/V UL, is situated 21 MHz from APT700 FDD UL and APT700 TDD, as shown in Figure 7.2-1

BS-BS

Co-existence between BSs is not a problem in this scenario due to the large frequency separation. APT700 FDD DL and APT700 TDD emissions at Band 5/V frequency range are defined as spurious emissions. The DL spurious emissions to protect Band 5 UL can be defined as the common spurious emission requirement for co-existence -49dBm/MHz since the frequency separation is large enough to allow the BS to limit its emissions to this level.

Band 5 UL blocking requirement @803 MHz is currently enough to co-exist with APT700. The current requirement at that frequency is the general out of band blocking, -15 dBm blocking signal and 6 dB degradation, which is based on a co-existence scenario as defined in [4].

BS-BS co-existence between Band 5/V and APT700 is not an issue

UE-UE

UE-UE coexistence is facilitated by the 21 MHz separation. For OOB emissions from a Band 5 aggressor into the APT700 DL the Band 5 duplexer must provide an additional attenuation of the order of 10 dB in order to meet the standard -50 dBm/MHz requirement in the victim band. This rejection is supplied by many implementations. It is noted that A-MPR cannot be defined for Band 5 in order to reduce unwanted emissions.

UE-UE co-existence between Band 5/V and APT700 is not an issue

7.2.4 Co-existence with Band 18 and 19/XIX

Band 18 UL and Band 19/XIX UL are situated 12 and 27 MHz from APT700 FDD DL and APT700 TDD, as shown in Figure 7.2-1.

BS-BS

The situation for band 19/XIX is similar to band 5/V. The difference is that the band is narrower and that the frequency separation is larger. Thus the same conclusions as for band 5/V can be made.

The applicable blocking requirement for Band 18 UL @803 MHz is in band blocking, -43 dBm blocking signal and 6 dB degradation. Considering a BS with 46 dBm output power, and MCL=67 dB, the blocking signal into Band 18 UL is -21 dBm. The signal needs to be reduced by 20 dB at Band 18 UL BS @ 803 MHz, which is feasible since the frequency separation is large.

BS-BS co-existence between Band 18 and 19/XIX and APT700 is achievable.

UE-UE

UE-UE coexistence is not an issue for Band 19. However, it may be a challenge for Band 18 with 12 MHz separation.

Table 7.2.4-1 shows data from a Band 18+5 duplexer from a filter vendor. We can observe that the minimum attenuation of a Band 18+5 duplexer is 28 dB at 803 MHz, while the typical attenuation is 38 dB.

Table 7.2.4-1. Filter data for a Band 18+5 duplexer

	Frequency (MHz)	Min (dB)	Typical (dB)	Max (dB)	
TX-ANT	815-849		2.0	3.0	TX IL
	770-804	28	38		Attenuation around APT700
	860-894	42	46		
ANT-RX	860-894		3.2	3.5	RX IL
	815-849	50	56		
TX ISO	815-849	55	59		
RX-ISO	860-894	48	50		RX isolation

Considering that Band 18 is a legacy band and A-MPR cannot be defined and assuming LO and image rejection as 25 dBc, simulations indicate that -40 dBm/MHz is reachable without A-MPR for a 15 MHz E-UTRA carrier (while -50 dBm/MHz is possible to achieve for smaller channel bandwidths)

As conclusion, the emissions from Band 18 to protect APT700 can be defined as follows from Rel-11 and onwards:

- o -50 dBm/MHz @703-799 MHz
- o -40 dBm/MHz @799-803 MHz

7.3 Co-existence with TV broadcasting

Based on the TV broadcasting protection limits specified by the regulatory bodies (chapter 5.2.1 and 5.2.2), the APT700 FDD UE emission limits are:

- o -26.2 dBm/6 MHz in the frequency range TBD-694 MHz for any E-UTRA carrier within 703-748 MHz with up to 20 MHz bandwidth. No A-MPR is required.
- o -26.2 dBm/6 MHz in the frequency range TBD-710 MHz for any E-UTRA carrier located above 718 MHz for 5 and 10 MHz channel bandwidth. No A-MPR is required

According to AWG, there is no requirement in the frequency range of 694~698MHz. For the frequency range from 692 – 698 MHz, to maintain consistency with the requirements below 694 MHz the emission limit is set to:

- o -26.2 dBm/6 MHz in the frequency range 692-698 MHz for any E-UTRA carrier within 703-748 MHz with up to 20 MHz bandwidth

Simulations have shown that the following A-MPR is needed to fulfil -26.2dBm/6MHz, at 692-698 MHz.

Table 7.3-1: A-MPR for NS_xx for protection of 692-698 MHz

Channel bandwidth (MHz)	Resources Blocks (N_{RB})	A-MPR (dB)
5	≥ 2	≤ 1
10, 15, 20	≥ 1	≤ 4

APT700 TDD

- o -25 dBm/8 MHz in the frequency range TBD-694 MHz for any E-UTRA carrier within 703-803 MHz with up to 20 MHz bandwidth. Up to 2.5 dB at full allocation and about 1.5 dB for single RB allocation is needed for 15 and 20 MHz and around 1 dB for full allocation for 10 MHz. No A-MPR is required for 3 and 5 MHz.

7.3.1 A-MPR for TV broadcasting protection

Simulations to study the backoff (A-MPR) needed to comply with the agreed APT700 FDD UE emissions towards DTV were conducted considering the following assumptions:

- PA with UTRA ACLR1 = 33dB

- LO leakage, IQ image rejection = -28 dBc
- CIM3 = -60dBc

7.3.1.1 APT700 FDD UE emissions below 694 MHz

Simulations have shown that A-MPR is not needed for any E-UTRA channel bandwidth to fulfill -26.2dBm/6 MHz. As example, emissions from a 20 MHz E-UTRA carrier averaged over 6 MHz are shown in Figure 7.3.1.1-1. It can be seen that emissions at 694 MHz are below -26.2 dBm/6MHz for 1 RB and full allocation, Simulations assume 15 dB filter rejection at such frequency, according to filter data in subclause 8.1.1.

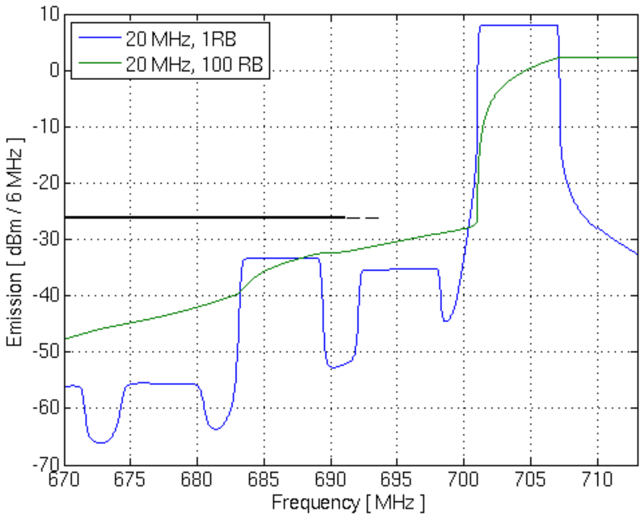

Figure 7.3.1.1-1. Emissions from a 20 MHz E-UTRA carrier located at 703-723 MHz

7.3.1.2 APT700 FDD UE emissions below 710 MHz

The UE duplexer is assumed to be a dual duplexer, DUP1: 703-733/758-788 MHz and DUP2: 718-748/773-803 MHz, refer to chapter 8.1.1. DUP2 can achieve an attenuation of 15dB at 710 MHz. and the frequency separation between the edge of DUP2 towards 710 Mhz is comparable to the distance between DUP1 and 694 MHz. Therefore, Figure 7.3.1.1-1 can also be used to conclude that A-MPR is not needed for protection below 710 MHz

7.3.1.3 APT700 TDD UE emissions below 694 MHz

A-MPR simulations to fulfill -25dBm/8MHz assuming no filter rejection at 694 MHz are presented in Figure 7.3.1.3-1 to Figure 7.3.1.3-3. Up to 2.5 dB A-MPR is needed at full allocation for 15 and 20 MHz and about 1.5 dB for single RB allocation. A back-off of about 1 dB is required for full allocation for 10 MHz. 3 and 5 MHz do not require any A-MPR

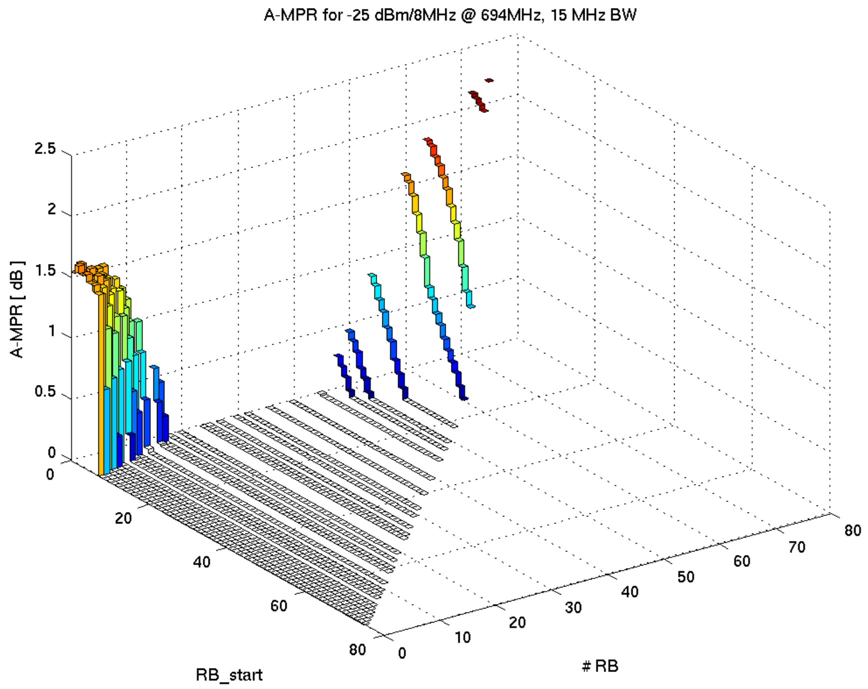

Figure 7.3.1.3-1. A-MPR for a 15 MHz E-UTRA carrier located at 703-718 MHz

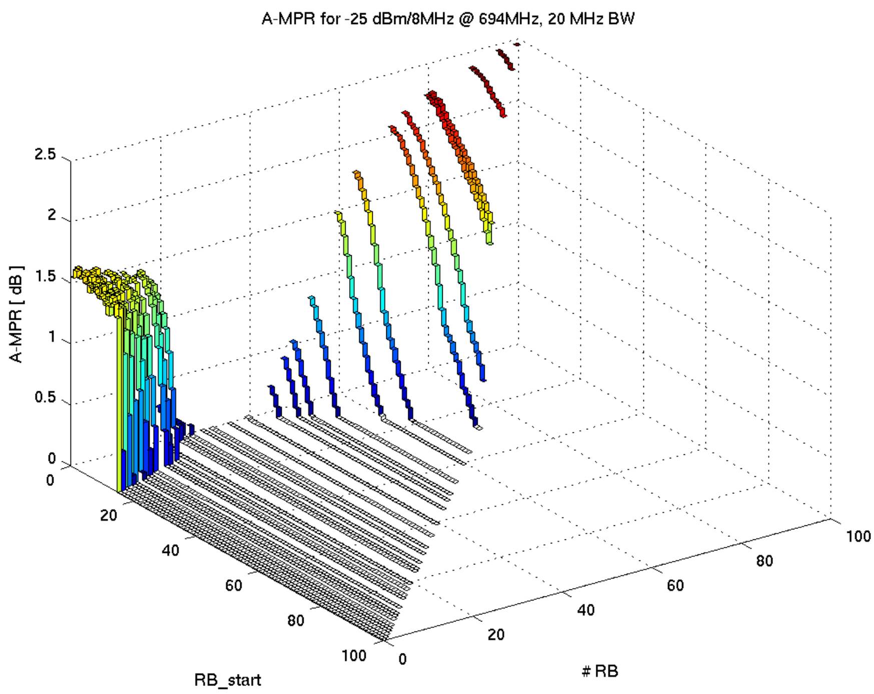

Figure 7.3.1.3-2. A-MPR for a 20 MHz E-UTRA carrier located at 703-723 MHz

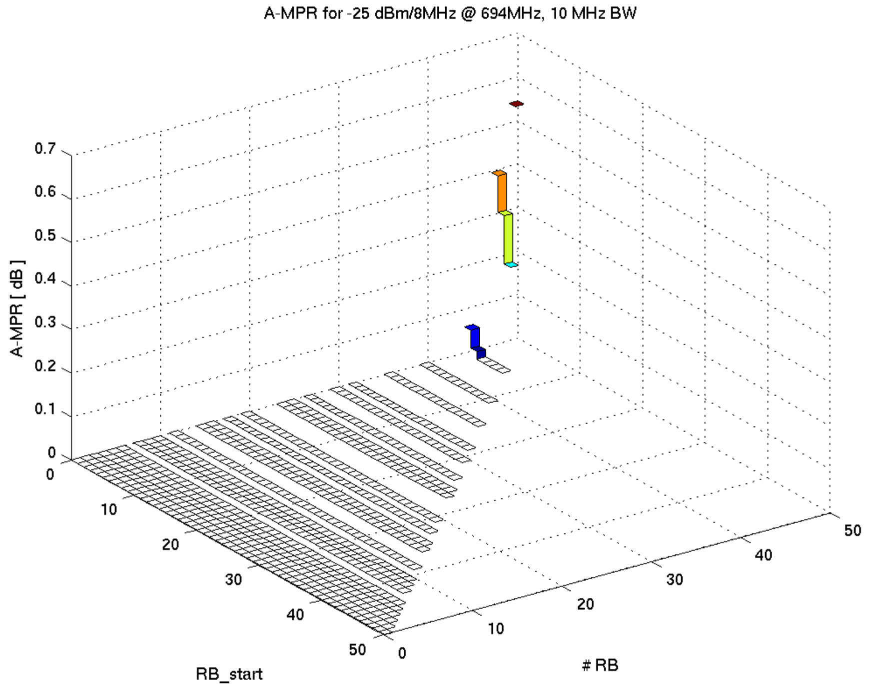

Figure 7.3.1.3-3. A-MPR for a 10 MHz E-UTRA carrier located at 703-713 MHz

7.3.2 Digital TV signal level at UE antenna port study

During the study DTV signal power field measurements were performed. These results were scaled based on expected UE antenna performance.

Measurement location

Measurements were performed in Helsinki metropolitan area in Finland where Kivenlahti national broadcast station locates. At the time when the measurements were done Kivenlahti station had both analogue and digital TV transmissions on air, see 7.3.2-1.

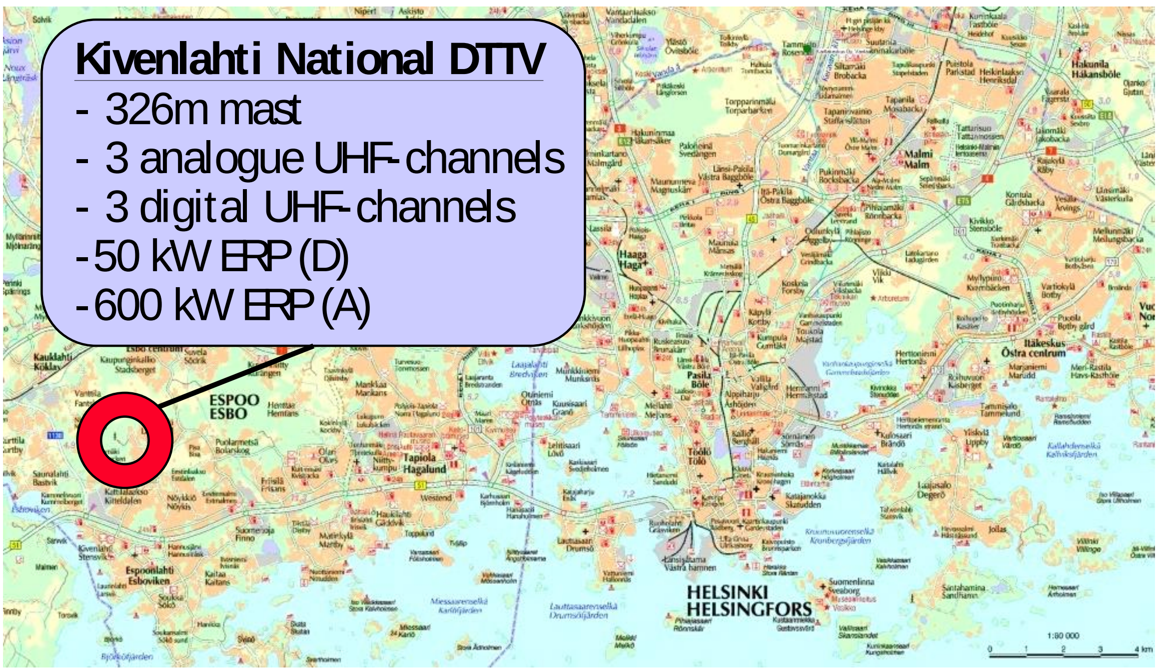

Figure 7.3.2-1 Location of Kivenlahti TV station

TV channels were at following channels

- Analogue channels: 24 (498 MHz), 52(722 MHz), 35(586 MHz)
- Digital channels: 32(562 MHz), 44(658 MHz), 46(674 MHz)

Measurement equipment and procedure

- Measurement were done with portable equipment.
  - Promax field strength meter
  - Reference dipole, 2.1 dBi gain
- Measurement height approximately 1.5 m
- For each channel the antenna was moved and turned to get the highest reading (max. hold).
- Measurements were performed in locations presented in Figure 7.3.2-2

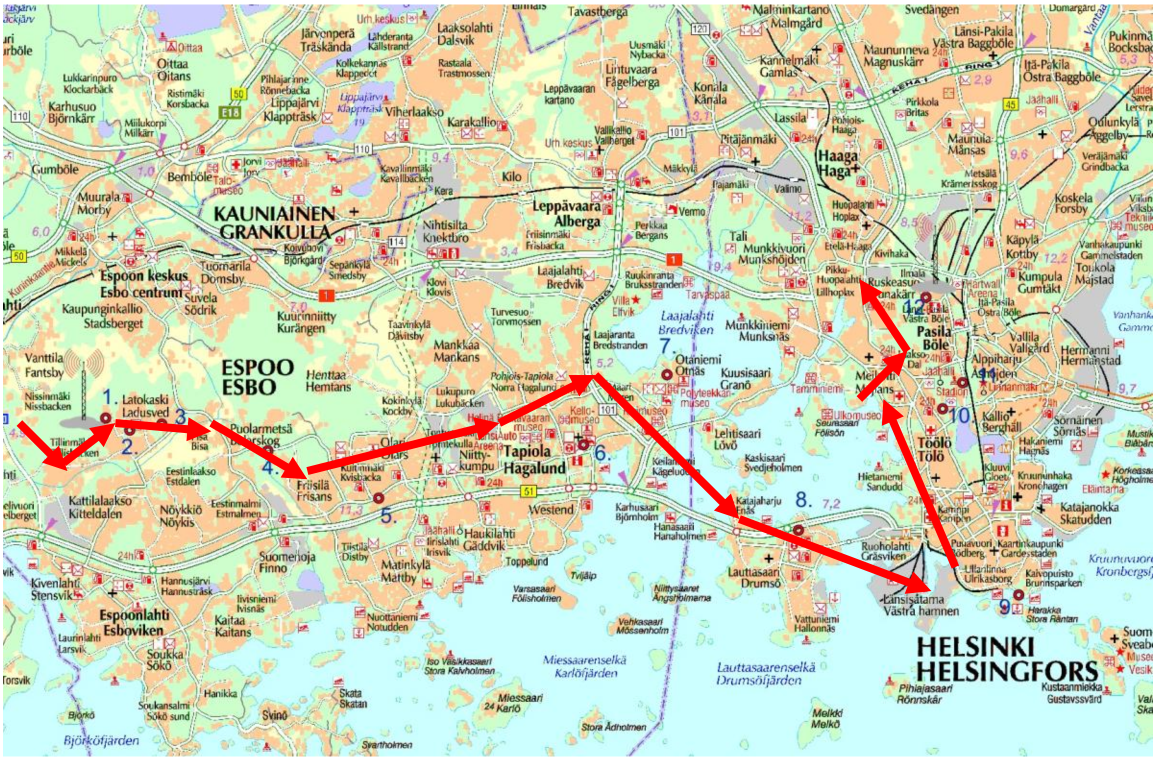

Figure 7.3.2-2 Measurement route

Measurement Results

Results are listed in Table 7.3.2-1 were columns contain following information

- Number = Location number referring to Figure 7.3.2-2
- Place = Location name
- Lat & Long = coordinates
- Distance Tx1 = distance from Kivenlahti TV station
- Distance Tx2 = distance to TV repeater, not applicable in this presentation
- Calibrated measured power / Analogue = Measured power of analogue TV transmission in a given channel
- Calibrated measured power / Digital = Measured power of Digital TV transmission in a given channel

- Calibrated measured power / RTT = Measured power of repeater TV transmission, not applicable

Table 7.3.2-1 Measurement results

						Calibrated Measured Power [dBm]						
				Distance [km]		Analogue			Digital			RTT
Number	Place	Lat	Long	Tx1	Tx2	24	35	52	32	44	46	27
1	Latokaski	60 10 42.4	24 38 49.8	0.4	15.6	-26	-23	-26	-29	-25	-36	-83
2	Latokaski	60 10 36.0	24 39 17.5	0.9	15.2	-20	-25	-21	-27	-23	-41	-79
3	Latokaski	60 10 39.0	24 40 01.3	1.5	14.6	-27	-38	-26	-25	-27	-23	-77
4	Puolarmet	60 10 25.9	24 42 06.0	3.5	12.8	-33	-23	-28	-26	-27	-29	-75
5	Kuitinmäk	60 09 59.3	24 44 21.4	5.6	11.1	-43	-40	-38	-36	-39	-39	-69
6	Tapiontori	60 10 36.0	24 48 25.2	9.3	7.2	-43	-46	-50	-48	-47	-53	-61
7	Otaniemi	60 11 20.4	24 50 02.0	10.9	5.3	-46	-47	-47	-49	-53	-46	-64
8	Lauttasaa	60 09 48.6	24 52 46.6	13.5	5.2	-34	-37	-41	-32	-36	-37	-46
9	Kaisaniem	60 09 15.2	24 57 15.2	17.6	5.8	-40	-41	-38	-44	-44	-45	-69
10	Stadion	60 11 04.1	24 55 35.8	15.9	2.3	-53	-61	-63	-59	-62	-60	-50
11	Stadion	60 11 21.1	24 56 00.9	16.3	1.8	-61	-61	-57	-63	-63	-62	-35
12	Pasila	60 12 09.9	24 55 11.5	15.8	0.3	-50	-49	-41	-45	-52	-49	-29

Results from Table 7.3.2-1 are presented in graphical form in Figure 7.3.2-3 where measured TV transmission power is presented as a function of distance from TV tower. When studying the graph there are two issues which are good to mention.

Firstly typically in areas close to TV transmitter i.e. distance < 1 km the TV transmission antenna pattern is such that only the side lobes point toward ground, this causes the signal power to fluctuate considerable when reception antenna position is moving. This can be seen in the measurement graph as a big variation in received power.

Secondly because TV transmission antennas are located in very high masts, antennas are slightly tilted downwards toward densely populated areas. This can be seen on results as a measured signal power level increase on distances between 10 and 15 km. This distance appears to be the area where the highest antenna gain points to.

Pink curve presents the TV repeater signal strength. Repeater was located in different position than the DTV broadcasting transmitter therefore the signal streght vs. distance reults are different.

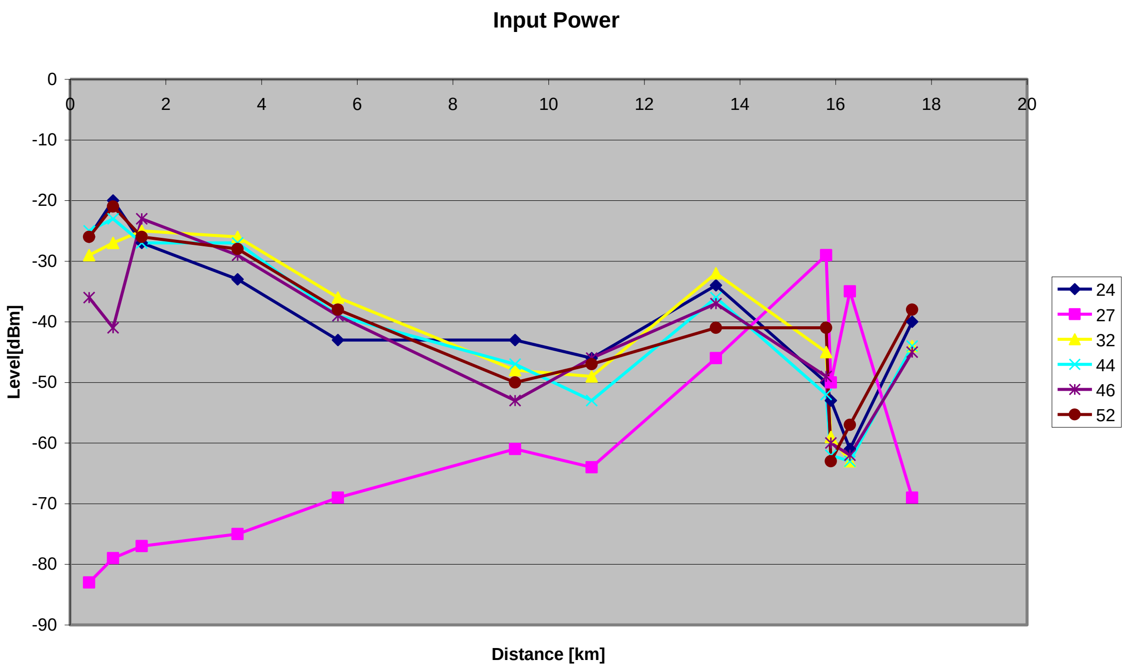

Figure 7.3.2-3 Measured TV signal power vs. distance

UE antenna port input power

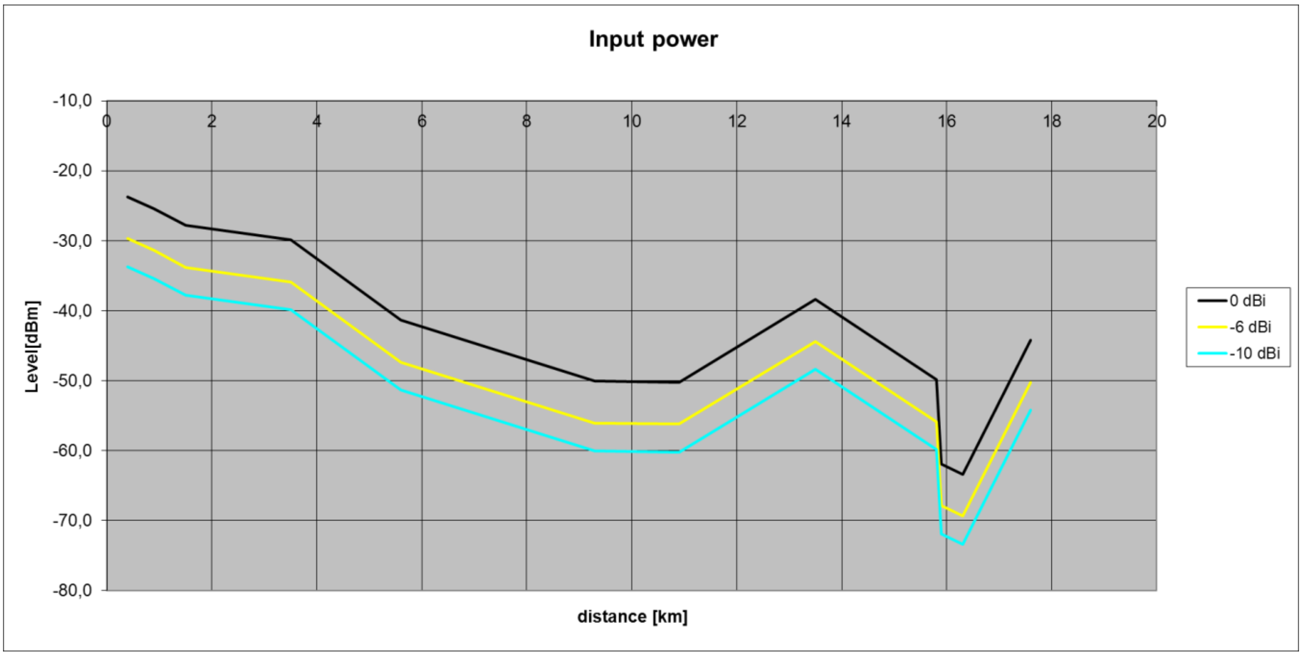

Figure 7.3.2-4 UE antenna port received power

For the Figure 7.3.2-4 firstly we have calculated the average of measured values in each test location. For a couple of points one result is discarded because it varied too much from the general level.

Secondly we have scaled the curves for more useful antenna gain values. Antenna gain values in graph are

- 0 dBi for reference
- -6 dBi representing a UE free space antenna gain (lap top)
- -10 dBi representing a UE beside the head antenna gain (speech position)

When considering the – 6 dBi and – 10 dBi antenna gain graphs we can note that the maximum expected TV signal power in UE input is roughly – 30 dBm or below.

Conclusion

We have presented results of measurements where it was studied how much live TV transmission (50 kW ERP) couples to UE antenna port when TV transmissions are located next to mobile band and UE antenna can be assumed to be tuned also for TV band. Measurements were performed in live TV network were both analogue (600 kW ERP) and digital TV(50 kW ERP) transmissions were present. Results indicate that maximum TV signal power in UE antenna port is approximately – 30 dBm.

7.4 Co-existence with PPDR and TETRA systems

iDEN is one type of Land Mobile Radio systems that is commonly deployed in Latin America, where the APT700 MHz band is being seriously considered. iDEN is also deployed in Korea. The iDEN radio uplink is in the band 806-824 MHz. iDEN radios use 25 kHz channels. While some models of iDEN mobiles can transmit up to 30 dBm, the typical iDEN mobile can transmit up to 28 dBm. iDEN handsets usually have an external stub antenna with a typical gain of 2 dB.

7.5 Coexistence with GPS, Compass/Beidou-2 and Galileo

The second harmonics of APT700 TDD UE(s) transmissions may overlap with navigation signals in the allocated in the frequency range 1559-1610 MHz (Radio Navigation Satellite and Aeronautical Radio Navigation). In particular, for Compass/BeiDou-2, we have the

- 1. E2 signal centered at 1561.098 MHz with 2.046 Mchip/s rate
- 2. E1 signal centered at 1589.74 MHz with 2.046 Mchip/s rate

These signals cover the band 1559.052~1591.788 MHz and are part of a set of signals (also in other bands) intended for both civilian and military use. For GPS we have the

- 1. L1 signal centered at 1575.42 MHz for the civilian L1C code and the M-code (10.23 Mchip/s)

The Galileo signals in the range overlap with Beidou-2 and GPS and are also denoted E2-L1-E1. These are used for both Open Services (OS) and Public Regulated Services (PRS) available to authorized users by government for e.g. emergency services.

It is clear that the UE must comply with regulatory requirements and thus the terminal manufacturer has to ensure compliance. However it is unclear what the regulatory requirements will be in the regions where the TDD allocation is used. Furthermore it is noted that the FCC requirements are EIRP based which makes conversion to conducted requirements challenging.

It is expected that filters are necessary to reduce the emissions in the RNSS band. Filters generally have losses and in order to accommodate a filter in the UE design a relaxation is needed to enable the manufacturer to comply with regulatory requirements. Since the regulatory status is unclear no explicit requirements will be included in the specification. However the requirements should be set to enable inclusion of filters in the design.

8 Study of E-UTRA specific issues

8.1 UE duplexer

8.1.1 FDD dual duplexer

APT700 FDD plan is defined as a 45 MHz wide band. The current state-of-art allows an implementation of a single duplexer with a bandwidth equal to 3-4% the centre frequency, which leads to 30MHz in the case of APT700 FDD. Therefore, a possible implementation of the filter could be a dual duplexer of 30 MHz bandwidth each duplexer and 15 MHz overlap. This configuration would put a restriction on the 20 MHz carrier, which will not be able to be placed at centre frequencies between 723.1 and 727.9 MHz.

To be able to place a 20 MHz carrier anywhere within the passband, a dual duplexer with 32.5 MHz passband and 20 MHz overlap is needed. However, the filter becomes more challenging.

Filter data from different UE vendors for both dual duplexer configurations are shown in Table 8.1.1-1 and Table 8.1.1-2 considering protection of adjacent services (TV@694 MHz following AWG recommendation, -34dBm/MHz) and own DL operating band as well as rejection against UL blockers in its own band. This data is preliminary and just indicate the performance difference between the two possible dual duplexers.

Table 8.1.1-1. Simulation results for the lower filter

Vendor	pass-band	Tx IL (min)	Rx IL (min)	Rx Iso (min)	Tx Iso (min)	Tx Att (min) @694MHz
1	30 MHz	3.8 dB	3.7 dB	42 dB	55 dB	35 dB
	32.5 MHz	5.0 dB	4.5 dB	42 dB	55 dB	35 dB
2	30 MHz	5.0 dB	5.0 dB	40 dB	51 dB	15 dB
	32.5 MHz	7.5 dB	5.0 dB	40 dB	53 dB	15 dB
3	30 MHz	3.5 dB	3.5 dB	47 dB	55 dB	23 dB
	32.5 MHz	4.0 dB	3.5 dB	47 dB	50 dB	23 dB

Table 8.1.1-2. Simulation results for the upper filter

Vendor	pass-band	Tx IL (min)	Rx IL (min)	Rx Iso (min)	Tx Iso (min)	Tx Att (min) @758MHz
1	30 MHz	3.8 dB	3.7 dB	42 dB	55 dB	37 dB
	32.5 MHz	5.0 dB	4.5 dB	42 dB	55 dB	37 dB
2	30 MHz	5.0 dB	5.0 dB	40 dB	48 dB	25 dB
	32.5 MHz	7.5 dB	6.0 dB	40 dB	48 dB	25 dB
3	30 MHz	3.5 dB	3.5 dB	43 dB	55 dB	23 dB
	32.5 MHz	4.0 dB	3.5 dB	43 dB	55 dB	9 dB

Some regions, as e.g. Japan, cannot have the complete APT700 FDD designated to wideband systems since TV is allocated up to 710 MHz [6]. A duplexer configuration 2x32.5 MHz may put very stringent requirements on AMPR since the rejection from the filter will be lower than in case of 2x30 MHz.

8.1.1.1 FDD dual duplexer assumption for UE requirements

The most suitable dual duplexer assumption to fit AWG frequency arrangement as well as Japanese regional arrangement is 2x30 MHz. At the same time, the in-band performance of this filter is better than for a 2x32.5 MHz for the same stop band requirements. The only constraint is that it does not support a 20 MHz E-UTRA carrier for centre frequencies between 723.1 and 727.9 MHz. However, assuming that the spectrum is auctioned in chunks of 5 MHz, this will most likely not happen. Therefore, an assumption of 2x30 MHz is taken to define the UE requirements.

Optimization for a 2x30 MHz duplexer is still needed in order to define appropriate UE requirements.

8.1.2. TDD filter

8.2 UE Transmitter Requirements

8.2.1 FDD

For the UE transmitter minimum requirements we assume a split-duplexer arrangement with a 30 MHz passband and characteristics according to Tables 8.1.1-1 and 8.1.1-2. However, this arrangement should not be specified in TS 36.101, which means that the minimum requirements apply for the entire frequency range 703-748/758-803 MHz. In specifying the tolerance for the maximum output power, special consideration is given to protection of

- broadcast below 694 MHz (Section 7.3)
- broadcast below 710 MHz in Japan (Section 7.3)
- the own RX (758-803 MHz).

8.2.1.1 Maximum output power

The split-duplexer architecture in Figure 8.2.1.1-1 is similar to those already used in designs for the 850/900 MHz range in which one low-band PA is shared e.g. Band 5 and Band 8. Hence, when comparing the front-end loss in different frequency ranges, one should account for the fact that additional switches in the TX part are accounted for also in 850 MHz designs that are subject to the standard 23 dBm ±2 dB requirement. It is recognised that the arrangement in Figure 8.2.1.1-1 consumes one extra port in the antenna switch, at the expense of support of another operating band.

For the tolerance limits, we observe that the provisionally specified IL for the lower DPX1 filter and upper DPX2 filter is around 3.5 dB (specified), which is similar to the corresponding specified values for Band 20 (around 3.5 dB [8]), which has the same passband width and similar duplex gap but smaller relative bandwidth. Band 20 also allows a □TC relaxation at the band edges. From the duplexer data in Tables 8.1.1-1 and 8.1.1-2 for the TX IL it is therefore relevant to consider either the standard ±2 dB for the mid-band performance with ΔT_C relaxation is applied at the band edges (additional 1.5 dB) or consider a flat-out relaxation of the lower tolerance limit.

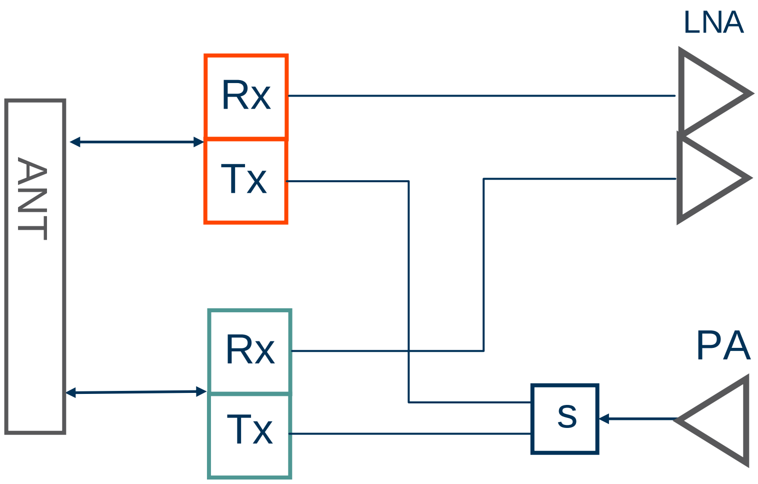

Figure 8.2.1.1-1: basic split-duplexer approach (DPX1 and DPX2) using only one antenna-switch port.

For band-edge performance, it is reasonable to consider a relaxation using at the band edges in order to facilitate compliance with broadcast protection requirements and protection of the own RX. In particular, a relaxation at the lower edge would allow possibilities for eliminating the need for A-MPR for coexistence below 694 MHz (DPX1) by means of a steeper filter response and increased stop-band rejection of DPX1, and a relaxation at the upper edge a more stringent emission limit for protection of the lower range of the own RX at the upper edge by means of DPX2.

A-MPR is not needed for protection of broadcast below 694 MHz assuming a -26.2 dBm/6MHz limit due to the rejection supplied by the DPX1 filter. The stop-band requirement below 694 MHz is then 15 dB, and it is therefore relevant to consider a modest relaxation of the output power at the lower edge rather than the 1.5 dB relaxation that would be allowed by a ΔT_C at the lower edge. For protection of the own receive band, duplexer data indicates that a protection level below –[32] dBm/MHz is feasible at a specified TX IL in the range 3.5-5.0 dB for the DPX2, which motivates a relaxation of the output power at the upper edge.

The coexistence requirement for protection of broadcast below 710 MHz in Japan could motivate a mid-band □TC relaxation at the lower edge of DPX2 to allow a steeper filter response below 718 MHz. However, this local requirement would then allow a relaxation of the output power performance for all other markets.

The relaxation at the band edges 703 MHz and 748 MHz could also facilitate future development of a single duplexer for the band. Now, a single DPX may not be at all feasible; implementation of the split-duplexer arrangement is already challenging in high-volume SAW technique.

In view of the stop-band requirements above 758 MHz for protection of own receive and the DTV protection below 694 MHz, it may be reasonable to adopt a maximum output power of +23 dBm +2/-[2.5] dB as a compromise between filter requirements (power consumption) and the impact on uplink coverage. This is shown in Table 8.2.1.1-1 along with the corresponding for Band 12 (also in the 700 MHz range), Band 20 and Band 22 as comparison, where the latter also assumes split-duplexer arrangement for requirement due to a challenging duplex arrangement.

Table 8.2.1.1-1: UE Power Class

EUTRA band	Class 1 (dBm)	Tolerance (dB)	Class 2 (dBm)	Tolerance (dB)	Class 3 (dBm)	Tolerance (dB)	Class 4 (dBm)	Tolerance (dB)
12					23	±2[2]		
20					23	±2[2]		
22					23	+2/-3.5[2]		
APT700					23	+2/-[2.5]		

Note 1: The above tolerances are applicable for UE(s) that support up to 4 E-UTRA operating bands. For UE(s) that support 5 or more E-UTRA bands the maximum output power is expected to decrease with each additional band and is FFS

Note 2: For transmission bandwidths (Figure 5.6-1) confined within F_{UL_low} and F_{UL_low} + 4 MHz or F_{UL_high} – 4 MHz and F_{UL_high}, the maximum output power requirement is relaxed by reducing the lower tolerance limit by 1.5 dB

Note 3: For the UE which supports both Band 11 and Band 21 operating frequencies, the tolerance is FFS.

Note 4: $P_{PowerClass}$ is the maximum UE power specified without taking into account the tolerance

8.2.2. TDD

Before starting we make some general remarks on the specification for TDD:

- the minimum requirements should apply for the entire frequency range 703-803 MHz,
- any possible filter arrangement is not specified just as for FDD, but may be assumed for the requirements,
- support of 20 MHz bandwidth,
- protection of broadcast below 694/698 MHz (section 7.3),

The requirements discussed below are based on limited filter data, and are subject to changes when the band is due for deployment.

8.2.2.1 Maximum output power

First we look at the impact of the unwanted emissions requirements on the MOP specification and possible need for band edge relaxations. Filter help is not readily at hand: a band-pass filter for the entire 100 MHz range is challenging even if a filter bank is used, but other more feasible filter solutions may work in view of the coexistence scenarios.

Considering unwanted emissions at the lower band edge

- ΔT_C need not be introduced for protection of broadcast below 694 MHz, the A-MPR is still modest for compliance with -26.6 dBm/6MHz or -25 dBm/8MHz requirement below 694 MHz also without additional filter rejection.

For the upper band edge

- no ΔT_C need not be introduced for protection of higher bands (see Figure 1), the closest protected band above the passband is still at around ~ 50 MHz separation.

A low-pass filter can possibly be used to suppress emissions into the higher bands, see Figure 8.2.2.1-1, and relaxation of the maximum output power requirements could also be introduced for improved blocking rejection at either edge if a bidirectional TX/RX RF filter is used (for close-in interferers), see Section 8.3.2.2.

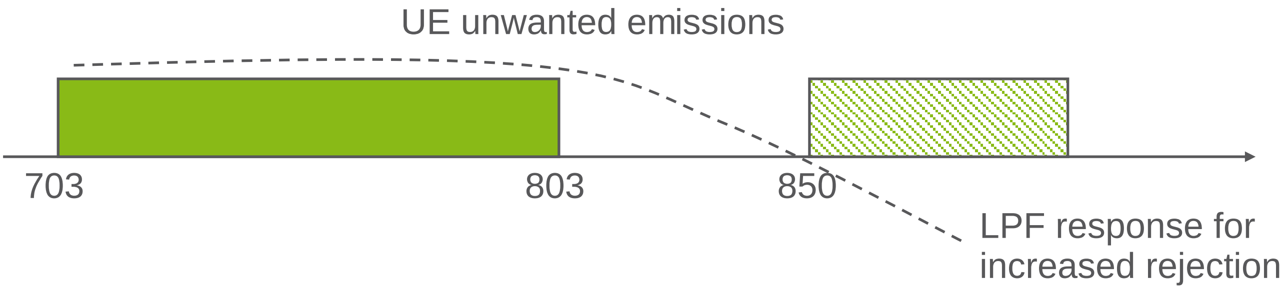

Figure 8.2.2.1-1: suppression of UE spurious emissions

Radio Navigation Satellite Services (RNSS that includes GPS and Beidou-2/Compass) may have to be protected: the second harmonics of TDD transmissions fall into the range 1559-1592 MHz used for open services, Section 7.5. To accommodate the increased IL a modification of the lower tolerance of the MOP for the APT700 TDD band should be allowed: tentatively +23 dBm +2/[-3] dB for power class 3. This would also allow filtering to improve coexistence with high bands as shown in Figure 8.2.2.1-1 should this design option be chosen.

The maximum output power requirement is shown in Table 8.2.2.1-1 along with the requirements for other TDD bands.

Table 8.2.2-1: maximum output power for APT700 TDD and other selected TDD bands

EUTRA band	Class 1 (dBm)	Tolerance (dB)	Class 2 (dBm)	Tolerance (dB)	Class 3 (dBm)	Tolerance (dB)	Class 4 (dBm)	Tolerance (dB)
…								
33					23	±2		
34					23	±2		
38					23	±2		
39					23	±2		
40					23	±2		
41					23	±2[2]		
42					23	+2/-3		
43					23	+2/-3		
APT700 TDD					23	+2/[-3]		
NOTE 1: The above tolerances are applicable for UE(s) that support up to 4 E-UTRA operating bands. For UE(s) that support 5 or more E-UTRA bands the maximum output power is expected to decrease with each additional band and is FFS NOTE 2: 2 refers to the transmission bandwidths (Figure 5.6-1) confined within FUL_low and FUL_low + 4 MHz or FUL_high – 4 MHz and FUL_high, the maximum output power requirement is relaxed by reducing the lower tolerance limit by 1.5 dB NOTE 3: For the UE which supports both Band 11 and Band 21 operating frequencies, the tolerance is FFS. NOTE 4: PPowerClass is the maximum UE power specified without taking into account the tolerance								

8.3 UE receiver requirements

8.3.1 FDD

For the UE receiver minimum requirements we assume a split-duplexer arrangement with 30 MHz and characteristics according to Tables 8.1.1-1 and 8.1.1-2, but we assume that the minimum requirements apply for the entire frequency range 703-748/758-803 MHz just as for the transmitter requirements. We also assume that the constituent filters DPX1 and DPX2 of the split-duplexer arrangement cannot be selected by the network: this selection is UE implementation specific.

8.3.1.1 REFSENS

For estimating reference sensitivity we do not apply scaling of WCDMA requirements by the bandwidth like for many other operating bands. One alternative is to assume that the thermal noise contribution excluding transmitter noise is

$$\mathrm{V}n = L_{ANT-RX}\,NF_{RFIC}$$

where $L_{ANT\text{-}RX}$ and NF_{RFIC} is the attenuation from the antenna to the LNA and the noise factor of the RFIC, respectively. For simplicity we assume that the noise contribution is the same on both RX branches since different architectures, diversity or UL MIMO, must be covered by the minimum requirement. We then add the impact of the transmitter noise for these configurations and pick the worst case as dimensioning.

For the transmitter noise, we assume the standard test configuration with the UL PRB allocation located at the upper edge of the TX band, the worst case. The purpose of the test is to verify the noise factor, and recognising that the transmitter noise may be smaller if a PRB allocation of the same size is allocated away from the upper edge.

The requirement should apply for a standard diversity receiver with one main TX/RX branch and one diversity RX, whence the SNR is

$$SNR = \frac{|s|^2}{\mathrm{V}n + \mathrm{V}t} + \frac{|s|^2}{\mathrm{V}n + |c|^2\,\mathrm{V}t}$$

assuming standard MRC expression can be used, and

$$SNR \approx \frac{|s|^2}{\mathrm{V}n + |c|^2\,\mathrm{V}t}$$

when the transmitter noise is dominating (correlated noise). Here $\mathrm{V}t$ denotes the transmitter noise and c the attenuation between the TX/RX branches in a conductive test. We then have $P_{REFSENS} = |s|^2$ at the minimum SNR.

The requirements should also apply for 2 TX for a UE supporting UL MIMO, hence

$$SNR = \frac{|s|^2}{\mathrm{V}n + \mathrm{V}t_1} + \frac{|s|^2}{\mathrm{V}n + \mathrm{V}t_2}$$

assuming that the UE is configured for dual-codeword transmission (uncorrelated transmitter noise), with $\mathrm{V}t_1$ and $\mathrm{V}t_2$ the transmitter noise of the two transmitters. The total output power at the antenna port is up to 23 dBm (nominal).

The transmitter noise is estimated as

$$\mathrm{V}t = P_{TX}\, a_{TX-RX}^{-1}\, ACLR_{RX}^{-1}\, L_{ANT-RX}$$

where $a_{TX\text{-}RX}$ and $ACLR_{RX}$ is s the duplexer isolation@RX and the noise falling into the receive bandwidth, respectively. Following the data in Tables 8.1.1-1 and 8.1.1-2 we assume $a_{TX\text{-}RX}$ = 45 dB. The $ACLR_{RX}$ is shown in Table 8.3.1.1-1 for various UL allocations.

Table 8.3.1.1-1 $ACLR_{RX}$ (dBc) for various UL allocations

E-UTRA Band	10 MHz	15 MHz	20 MHz
APT700	[99.2] (15 RB) [94.4] (20 RB) [88.7] (25 RB)	[81.8] (15 RB)[1] [84.5] (20 RB) [81.9] (25 RB)	[71.9] (15 RB)[1] [75.0] (20 RB) [73.9] (25 RB)
NOTE 1: MPR = 0 dB			

The 20 MHz bandwidth is challenging; the TX-RX separation is only 35 MHz (duplex separation 55 MHz), close to the OOB boundary of the uplink carrier which is 25 MHz for the 20 MHz bandwidth. This can be compared to 21 MHz for Band 20, which has an exceptional arrangement for its 25 PRB uplink allocation.

Using $L_{ANT\text{-}RX}$ = 5 dB, NF_{RFIC} = 4 dB, $|c|^2$ = 10, $ACLR_{RX}$ (dBc) according to Table 8.3.1.1-1 and a 25 PRB UL allocation with a minimum SNR = 1 dB including implementation margin, we obtain P_{REFSENS} = -96.9 dBm for the 10 MHz bandwidth for the diversity-only and the 2 UL MIMO architectures. For the 20 MHz channel we obtain P_{REFSENS} = -90.5 dBm for both architectures assuming P_{TX} = +27 dBm for the diversity-only architecture.

For the 3 MHz bandwidth, the IP2 performance may motivate a relaxation since the TX isolation may be limited, standard values are more challenging in the switched architecture with overlapping bands, and the RX IL is higher as discussed in Section 8.2.1.1.

The proposed reference sensitivity is shown in Table 8.3.1.1-2 and Table 8.3.1.1-3 that includes selected other bands for comparison (Band 3 with duplex spacing of 95 MHz with 50 PRB allocation and Band 4 with a very large spacing and full uplink allocation).

Table 8.3.1.1-2: Reference sensitivity QPSK $P_{REFSENS}$

Channel bandwidth							
E-UTRA Band	1.4 MHz (dBm)	3 MHz (dBm)	5 MHz (dBm)	10 MHz (dBm)	15 MHz (dBm)	20 MHz (dBm)	Duplex Mode
3	-101.7	-98.7	-97	-94	-92.2	-91	FDD
4	-104.7	-101.7	-100	-97	-95.2	-94	FDD
12	-101.7	-98.7	-97	-94			FDD
13			-97	-94			FDD
17	-102.2	-99.2	-97	-94			FDD
18			-100	-97	-95.2		FDD
19			-100	-97	-95.2		FDD
20			-97	-94	-91.2	-90	FDD
APT700		[-100.2]	[-98.5]	[-95.5]	[-93.7]	[-93.7]	FDD

Table 8.3.1.1-3: Uplink configuration for reference sensitivity

E-UTRA Band / Channel bandwidth / NRB / Duplex mode							
E-UTRA Band	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz	Duplex Mode
3	6	15	25	50	501	501	FDD
4	6	15	25	50	75	100	FDD
12	6	15	201	201			FDD
13			201	201			FDD
17			201	201			FDD
18			25	25[1]	25[1]		FDD
19			25	25[1]	25[1]		FDD
20			25	20[1]	20[3]	20[3]	FDD
APT700		15	25	[251]	[251]	[251]	FDD
Note 1. The UL resource blocks shall be located as close as possible to the downlink operating band but confined within the transmission bandwidth configuration for the channel bandwidth (Table 5.6-1). 2. For the UE which supports both Band 11 and Band 21 the uplink configuration for reference sensitivity is FFS. 3. For Band 20; in the case of 15MHz channel bandwidth, the UL resource blocks shall be located at RBstart _11 and in the case of 20MHz channel bandwidth, the UL resource blocks shall be located at RBstart _16							

For the smaller bandwidth, the isolation at TX is important. Tables 8.1.1-1 and 8.1.1-2 indicate that the attenuation at TX is less than the 52 dB commonly assumed and leakage through switches may have to be considered for the overlapping DPX1 and DPX2 ranges, which should be considered for IIP2 performance.

8.3.1.2 In-band blocking

For the in-band blocking requirements, we observe from Figure 5.1-1 that both Band 26 and the lower E850 TX bands fall within the in-band blocking range for APT700, which could merit additional in-band blocking cases for APT700 to reduce the risk of blocking. Figure 8.3.1.2-1 shows a typical duplexer response for DPX2 at room temperature.

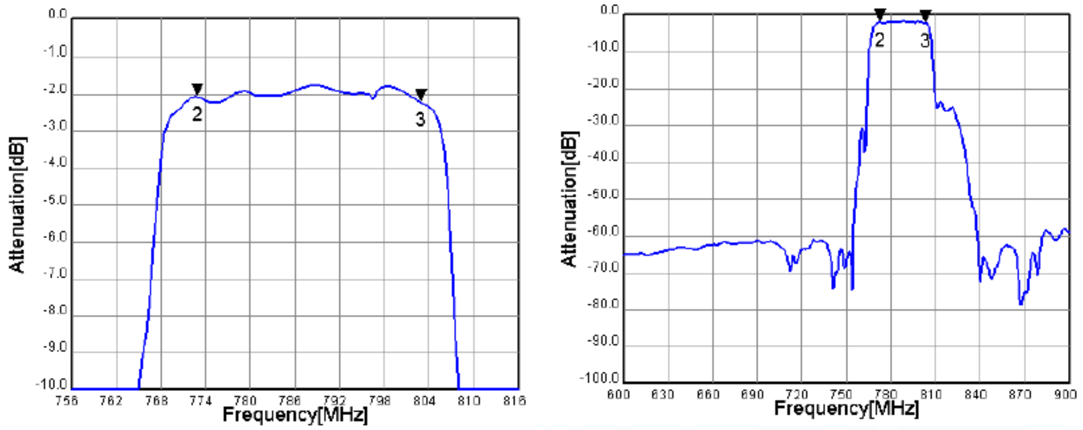

Figure 8.3.1.2-1: a typical duplexer response for DPX2 in the receive range (provisional data).

For a Band 26 aggressor, we observe that the upper filter DPX2 would provide a 20 dB rejection above 814 MHz, which indicates (only one example filter implementation) that no additional in-band blocking case is needed for protection from Band 26 blockers.

For a lower E850 aggressor, the rejection is very limited, the worst blocking case is a 1.4 MHz carrier allocated down to 806 MHz: the filter in Figure 8.3.1.2-1 would only provide rejection above 808 MHz (10 dB at room temperature). The rejection would not be much better than that provided by the adjacent channel selectivity (ACS). For many deployments, e.g. in Region 2, there are narrowband (25 kHz) blockers down to 806 MHz for which there is no rejection. One possibility is to specify a tighter requirement (higher blocker level) for the in-band blocking Case 1 for which a 5 MHz interferer is assigned at 808-813 MHz for the larger bandwidths; the DPX2 would then provide limited rejection. The standard blocking level for this case is -56 dBm. However, narrowband 25 kHz or 1.4 MHz E-UTRA carriers down to 806 MHz is still the worst case.

Another way for improving blocking performance is to limit the E-UTRA channel bandwidths allocated at the upper edge of the APT700 band. However, for wideband interferers like E-UTRA lower E850 carriers, the OOB emission is the dominant interferer source in most cases. It is therefore more important to specify a relevant unwanted emission level for lower E850 aggressors rather than restricting the APT700 bandwidth for the fewer cases where blocking is the liming case.

Hence specification of additional in-band blocking cases or bandwidth restrictions to reduce impact for lower E850 blockers would be of limited value: there is no duplexer rejection of a 1.4 MHz E-UTRA blocker down to 806 MHz. Blockers above 810 MHz (including temperature variation) would be attenuated by the DPX2 filter for the filter implementation shown in Figure 8.3.1.2-1.

8.3.2 TDD

8.3.2.1 REFSENS

The APT700 TDD band may be the victim of in-band blocking signals below 694 MHz (DTV) in the proximity of the passband. In order to allow implementations with band-stop (notch) filters in the RX front-end at the expense of RX IL, the baseline reference sensitivity of Band 33 should be modified. Provisional filter data suggests a 2 dB relaxation of the baseline Band 33 reference sensitivity, see Section 8.3.2.2. The resulting REFSENS requirement is shown in Table 8.3.2.1-1.

Table 8.3.2.1-1: reference sensitivity for APT700 TDD and other selected TDD bands

Channel bandwidth							
E-UTRA Band	1.4 MHz (dBm)	3 MHz (dBm)	5 MHz (dBm)	10 MHz (dBm)	15 MHz (dBm)	20 MHz (dBm)	Duplex Mode
1			-100	-97	-95.2	-94	FDD
…							
33			-100	-97	-95.2	-94	TDD
34			-100	-97	-95.2		TDD
38			-100	-97	-95.2	-94	TDD
39			-100	-97	-95.2	-94	TDD
40			-100	-97	-95.2	-94	TDD
41			-98	-95	-93.2	-92	TDD
42			-99	-96	-94.2	-93	TDD
43			-99	-96	-94.2	-93	TDD
APT700TDD		[-100.2]	[-98]	[-95]	[-93.2]	[-92]	TDD

NOTE 1: The transmitter shall be set to PUMAX as defined in subclause 6.2.5
NOTE 2: Reference measurement channel is A.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD as described in Annex A.5.1.1/A.5.2.1
NOTE 3: The signal power is specified per port
NOTE 4: For the UE which supports both Band 3 and Band 9 the reference sensitivity level is FFS.
NOTE 5: For the UE which supports both Band 11 and Band 21 the reference sensitivity level is FFS.
NOTE 6: [6] indicates that the requirement is modified by -0.5 dB when the carrier frequency of the assigned E-UTRA channel bandwidth is within 865-894 MHz.

8.3.2.2 In-band blocking

The closest interferer to be considered for in-band blocking (in addition to E-UTRA APT700 TDD) is DTV below 694/698 MHz that also falls inside the in-band blocking range. Band 26/XXVI and Band 27 also fall within this range, but are not considered for deployment in China.

Just as for FDD, any additional in-band blocking cases are not introduced. However, the specification should allow implementations with filters to suppress DTV blockers, which would imply a relaxation of the RX IL at the upper edge.

For blocking by DTV signals, notch filters may be used, which would have an impact on RX IL at lower edge and allow a relaxation to accommodate an increased insertion loss. It could be possible to rely on standard in-band blocking requirements for DTV below 694 MHz, which corresponds to a -44 dBm level as displayed in Figure 8.3.2.2-1, but recognizing that the received DTV power may well exceed this level in some deployment scenarios (see Section 7.3.1).

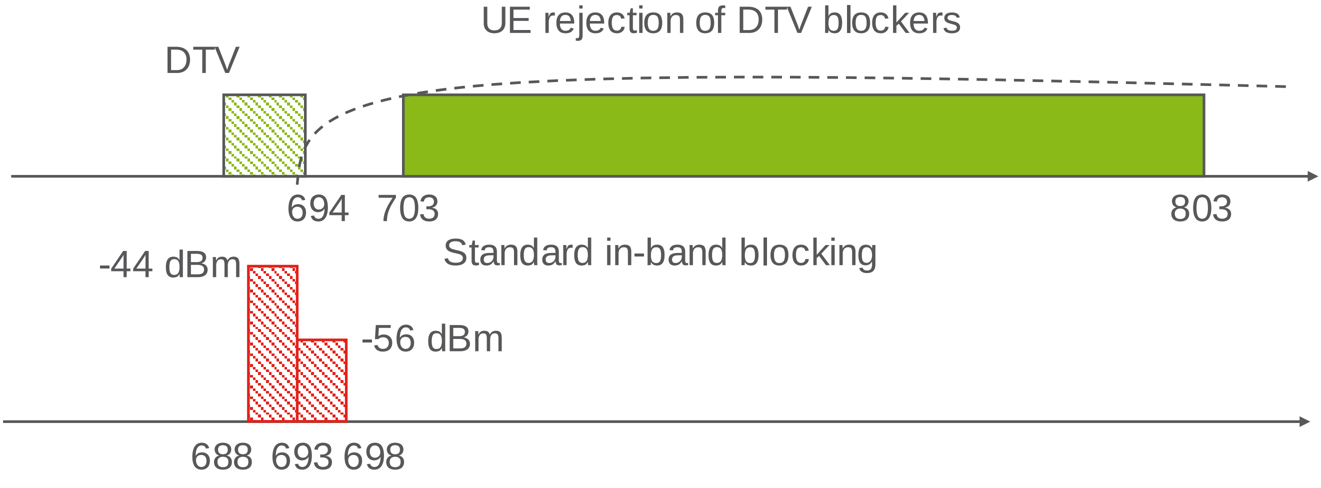

Figure 8.3.2.2-1: blocking by DTV and relation to the standard in-band requirements.

Even if the standard in-band blocking test is used, the specification should allow implementations with filter to suppress these blockers, which would imply a relaxation of the RX IL at the lower edge. This may also imply an IL penalty in the TX path if a bidirectional TX/RX filter is used.

Figure 8.3.2.2-2 shows provisional results of a band-stop filter suppressing the highest DTV channel below 694 MHz with the filter traces displayed at room temperature. Significant rejection can be achieved but there is no room for temperature variation. The RX IL penalty at the upper band edge (803 MHz) is 2.5 dB.

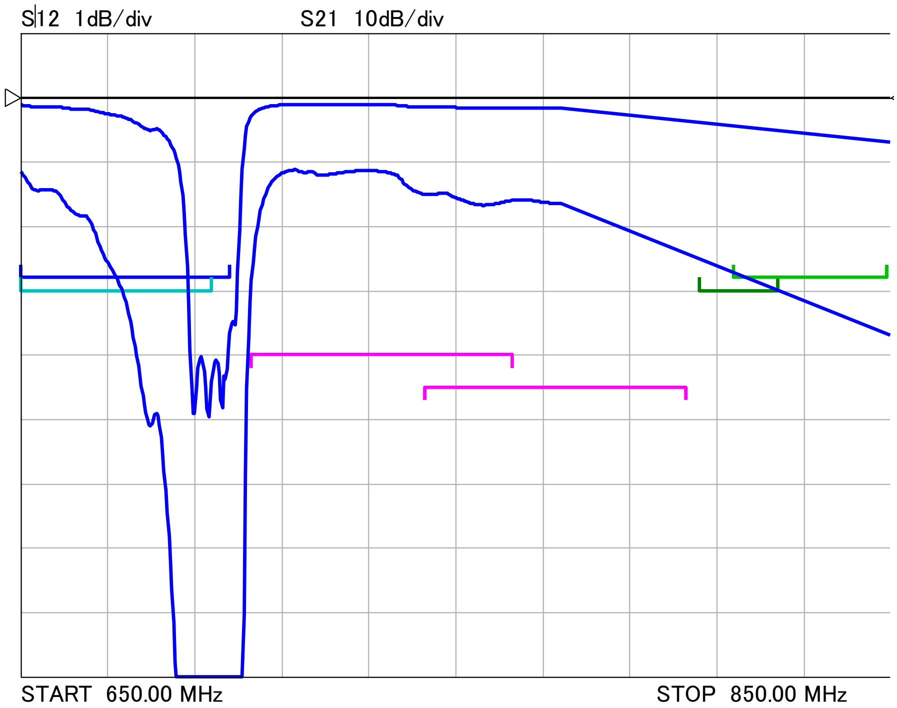

Figure 8.3.2.2-2: provisional trace of band-stop filter for the highest DTV channel below 694 MHz.

In general, provisional simulations from one filter vendor suggests that, using band-stop (notch) filters,

- rejection of DTV channels below 698 MHz (5 MHz separation) is not feasible at a reasonable RX IL penalty,
- rejection of DTV channels below 694 MHz (9 MHz separation) is feasible,

For the case of DTV below 694 MHz (the most common upper limit for DTV), the estimated specified RX IL is of the order of 4 dB at 30 dB rejection.

The estimation of the RX IL is based on the assumption that the filter is designed for one of the interference cases above; if multiple cases need consideration the IL increase and stop-band rejection may not be achieved. Therefore, this suggests that no additional in-band blocking case be specified but that a relaxation of the reference sensitivity is considered to make room for additional IL in the RX path if a band-stop filter is implemented for one particular blocking scenario. Anticipating further optimization, a relaxation of the reference sensitivity of 2 dB may be relevant.

8.4 BS Transmitter Requirements

8.4.1 Unwanted emissions for TDD

The service below the band is assumed to be TV. Above the band there are uplinks of trunking systems. Since the regulatory situation is not clear, it's proposed not to define special requirements at this moment. These regional regulatory requirements could be introduced in the future when the situation is clear.

8.5 BS Receiver Requirements

8.5.1 Blocking

The service adjacent to the low end of the band is TV. The BS specifications differentiate between the frequencies more than 20 MHz outside of the band and the region less than 20 MHz outside or inside the band. The requirements in the specifications are -15 dBm CW carrier and -43 dBm wideband interferer for 6 dB noise rise. Considering that 1) it is mainly the uppermost TV channel and 3 MHz of the second uppermost channel that lie inside the “inside” region and 2) that there are few BS sites that will be located close to TV transmitters using the two uppermost channels, there is no need for special blocking requirements at the low end of the band. Since TV transmitters that use the uppermost channels are relatively rare any remaining problems can be solved using site solutions.

At the upper end of the band the adjacent bands have uplinks. Since the in-band blocking requirements are derived considering uplinks also there is no need to define special blocking requirements above the band.

The blocking requirements for collocation with other BS in TS 36.104 only takes into account other 3GPP bands and thus other technologies above the band should not be considered.

9 Study of MSR specific issues

10 Channel numbering for E-UTRA, MSR

10.1 Channel bandwidths

For APT700 band specification of radio requirements are considered for the bandwidths shown in Table 10.1-1 and 10.1-2.

Table 10.1-1: E-UTRA channel bandwidth for FDD

E-UTRA band / channel bandwidth						
E-UTRA Band	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
25	Yes	Yes	Yes	Yes	Yes	Yes
…						
[TBD]	-	Yes	Yes	Yes	Yes	Yes

Table 10.1-2: E-UTRA channel bandwidth for TDD

E-UTRA band / channel bandwidth						
E-UTRA Band	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
43			Yes	Yes	Yes	Yes
…						
[TBD]	-	Yes	Yes	Yes	Yes	Yes

11 Required changes to E-UTRA and MSR specifications

The required changes to the 3GPP specifications for the new band are summarised in a Table 11-1.

Table 11-1: Overview of 3GPP specifications with required changes

3GPP specification	Clause in TR 30.007 where the required changes are given	Clause in the present document identifying additional changes
TS 36.101	8.2.1.1	
TS 36.104	8.2.1.2	
TS 36.106	8.2.1.3	
TS 36.113	8.2.1.4	
TS 36.124	8.2.1.5	
TS 36.133	8.2.1.6	
TS 36.141	8.2.1.7	
TS 36.143	8.2.1.8	
TS 36.307	8.2.1.9	
TS 25.101	8.2.2.1	
TS 25.102	8.2.2.2	
TS 25.104	8.2.2.3	
TS 25.105	8.2.2.4	
TS 25.106	8.2.2.5	
TS 25.113	8.2.2.6	
TS 25.123	8.2.2.7	
TS 34.124	8.2.2.8	
TS 25.133	8.2.2.9	
TS 25.141	8.2.2.10	
TS 25.142	8.2.2.11	
TS 25.143	8.2.2.12	
TS 25.307	8.2.2.13	
TS 25.331	8.2.2.14	
TS 25.461	8.2.2.15	
TS 25.466	8.2.2.16	
TS 37.104	8.2.3.1	
TS 37.113	8.2.2.2	
TS 37.141	8.2.2.3	

Annex A: Change history

Change history							
Date	**TSG#**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2011-08	RAN4-60	R4-114356			The following TPs have been implemented: R4-113863, "TP to TR for APAC700: general issues on APAC700" R4-113866, "Overview of adjacent bands and services for 700 MHz digital dividend" Editorial updates: Version number changed	0.0.1	0.1.0
2011-10	RAN4-60bis	R4-115172			The following TPs have been implemented: R4-114802, "TP for TR ab.cde (APAC700): APAC700 co-existence with 3GPP legacy bands" Editoral changes: Version number changed TR number updated to 36.820 since the report previously did not have a number Table of contents updated Minor corrections to figure numbers.	0.1.0	0.2.0
2011-11	RAN4-61	R4-115945			The following TPs have been implemented: R4-115173, "TDD frequency allocation for APAC700" R4-115376, "TP for TR 36.820: 700 MHz APAC Coexistence with iDEN in 806-824 MHz" Editoral changes: Version number changed Table of contents updated	0.2.0	0.3.0
2012-02	RAN4-62	R4-120586			The following TPs have been implemented: R4-116257, "TP on TDD channel number and bandwidth for APAC700" Editoral changes: Version number changed Table of contents updated	0.3.0	0.4.0
2012-03	RAN4-62bis	R4-121912			The following TPs have been implemented: R4-120373, "TP for Correction on APAC700 WI TR regarding Digital Trunked Radio System band in Korea" R4-120588, "Regulatory aspects of APAC700" R4-120591, "BS requirements for TDD" R4-121066, "TP to TR 36.820: UE reference sensitivity for APAC700 and blocking requirements for adjacent bands (FDD)" R4-121067, "TP for TR 36.820: APAC700 FDD UE dual duplexer" R4-121072, "TP for 36.820: Co-existence between APAC700 and DTV" Editoral changes: Version number changed Table of contents updated Minor spelling correction and updates of references	0.4.0	0.5.0
2012-05	RAN4-63	R4-123128			R4-121132, "DTV signal level at UE antenna port" R4-121442, "Text proposal on APAC700 TDD BS requirements" R4-121811, "TP for 36.820: Co-existence between APAC700 and other 3GPP bands" R4-121916, "TP Required changes to BS" R4-121941, "APAC700 protection of TV at 698 MHz" Editoral changes: Version number changed Table of contents updated Minor spelling correction and updates of references	0.5.0	0.6.0
2012-05	RAN4-63	R4-123697			The following TPs have been implemented: R4-122887, "TP for 36.820: APAC700 FDD MOP and REFSENS" R4-123604, "TP on GPS requirements" R4-123613, "TP for 36.820: APAC700 TDD MOP, REFSENS	0.6.0	0.7.0

					and blocking requirements" R4-123614, "TP on co-existence analysis between APAC700 FDD BS with lower E850 BS" R4-123674, "TP for 36.820: APAC700 UE emissions towards DTV" Editoral changes: Version number changed Table of contents updated Empty headings and “text to be added” removed		
2012-05	RAN-56	RP-120707			Prepared for submission to RAN #56: Version number updated. Reference [9] removed according to drafting rules since it refers a RAN4 internal doc.	0.7.0	1.0.0
2012-06	RAN-56	RP-120844			The term “APAC700” replaced with “APT700” to correctly reflect the regulatory terminology.	1.0.0	1.0.1
2012-06	RAN-56				Approved by RAn	1.0.1	11.0.0
2012-09	RAN-57	RP-121316	0001		CR to 36.820 APAC700	11.0.0	11.1.0
2012-12	RAN-58	RP-121878	0002		Band 28 UE emissions at 692-698 MHz and AMPR for DTV protection	11.1.0	11.2.0