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1 Scope

The present document is a technical report for "Adding L-Band LTE for ATC of MSS in North America" work item, which was approved at 3GPP TSG RAN#48 [2]. The objective of this work item is to add L-Band to the appropriate 3GPP core specifications for LTE FDD networks. In addition to the schedule and status of the work items, the report includes a description of the motivation, requirements, study results and specification recommendations.

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] RP-100640 "Adding L-Band LTE for ATC of MSS in North America", RAN #48

[3] FCC Report 03-15 (2003), IB Docket No. 01-185, February 10, 2003, http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-03-15A1.pdf

[4] FCC Report DA-10-534, March 26, 2010, http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-10-534A1.pdf

[5] FCC Report 03-50, February 25, 2005, http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-05-30A1.pdf

[6] FCC Report DA-04-3553, November 8, 2004, http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-04-3553A1.pdf

[7] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception"

[8] 3GPP TS 36.104: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception"

[9] 3GPP TS 36.113: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) and repeater ElectroMagnetic Compatibility (EMC)"

[10] 3GPP TS 36.124: "Evolved Universal Terrestrial Radio Access (E-UTRA); Electromagnetic compatibility (EMC) requirements for mobile terminals and ancillary equipment"

[11] 3GPP TS 36.133: "Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management"

[12] 3GPP TS 36.141: "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing"

[13] 3GPP TS 36.307: "Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements on User Equipments (UEs) supporting a release-independent frequency band"

[14] 3GPP TS 25.461: "UTRAN Iuant interface: Layer 1"

[15] 3GPP TS 25.466: "UTRAN Iuant interface: Application part"

[16] 3GPP TS 25.101: "User Equipment (UE) radio transmission and reception (FDD)"

[17] 3GPP TS 25.104: "Base Station (BS) radio transmission and reception (FDD)"

[18] 3GPP TS 25.141: "Base Station (BS) conformance testing (FDD)"

[19] 3GPP TS 37.104: "E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) radio transmission and reception"

[20] 3GPP TS 37.141: "E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) conformance testing"

[21] R4-110597 "RAN4#57 meeting report" RAN4 #57, Jacksonville, FL, Nov. 2010

[22] RP-104941, "L-Band WI Way Forward", RAN4 #57, LightSquared, Jacksonville, FL, Nov. 2010

[23] R4-110371, "Preliminary results on Overload Characteristics of GPS Receivers in Proximity to LightSquared's L-band Terrestrial Base Stations (BTS) and User Equipment (UE) " RAN4 #57AH, Austin, TX, January. 2011

[24] R4-111579, "Final Report on Overload Characteristics of GPS Receivers in Proximity to LightSquared's L-band Terrestrial Base Stations (BTS) ", RAN4 #58, Taipei, Taiwan, Feb. 2011

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] 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 [1].

3.2 Symbols

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

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] 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 [1].

UE	User Equipment
BS	Base station
UL	Uplink (Reverse Link)
DL	Downlink (Forward Link)

4 Background

L-Band is licensed by the FCC as:

- 1525 – 1559 MHz: Down-link (eNodeB transmit, UE receive)
- 1626.5 – 1660.5 MHz: Up-link (UE transmit, eNodeB receive)

In 2003, the FCC changed its rules to permit the use of the L-band (and other bands) by satellite operators to provide nationwide terrestrial service (see [3]).

In 2004, the FCC granted LightSquared (formerly known as SkyTerra Communications and MSV) a license to reuse its satellite spectrum to provide terrestrial service (see [4]).

The Canadian government has approved similar rules to those adopted by the FCC.

Initially, LightSquared is planning on 5 & 10 MHz wide channel deployments, but this could change based on business needs. Our LTE ATC deployment will, at least, adhere to all 3GPP terrestrial out-of-band requirements for spurious emissions including those for UE, BS, and UE-to-UE emissions as defined in 3GPP TS 36.101 [7] for the US (i.e. Bands 2, 4, 5, 10, 12, 13, 14, 17). Where additional requirements exist, driven by local regulatory obligations, these are described.

Requirements for spurious emission into L-band are expected to be the same as those required from the addition of other new US bands in 3GPP.

4.1 Task description

The purpose of this work item is to:

1) Study of Adding L-Band LTE for ATC of MSS in North America
2) Generate CRs to necessary 3GPP specifications
3) Generate a new technical report based on the study results

   The specific spectrum band to be studied is Band 24:

   - 1626.5 – 1660.5 MHz: Up-link
   - 1525 - 1559 MHz: Down-link

4) Generate CR's to update the appropriate TSG RAN WG2 and WG3 documents
5) TSG RAN WG2 - study signalling issues related to Adding L-Band LTE
6) Any additional related issues

4.2 Regulatory and Emissions Background

In 2003, the FCC and Industry Canada approved rules permitting Mobile Satellite Services (MSS) and Ancillary Terrestrial Component (ATC) operations in assigned L-Band frequency bands [3]. In the US and Canada, these rules allow ATC network operations to coexist with neighboring bands and services. Subsequently in 2010, FCC improved the rules to allow for a high powered, cost-efficient LTE network [4]. The arrangement of the band is shown below:

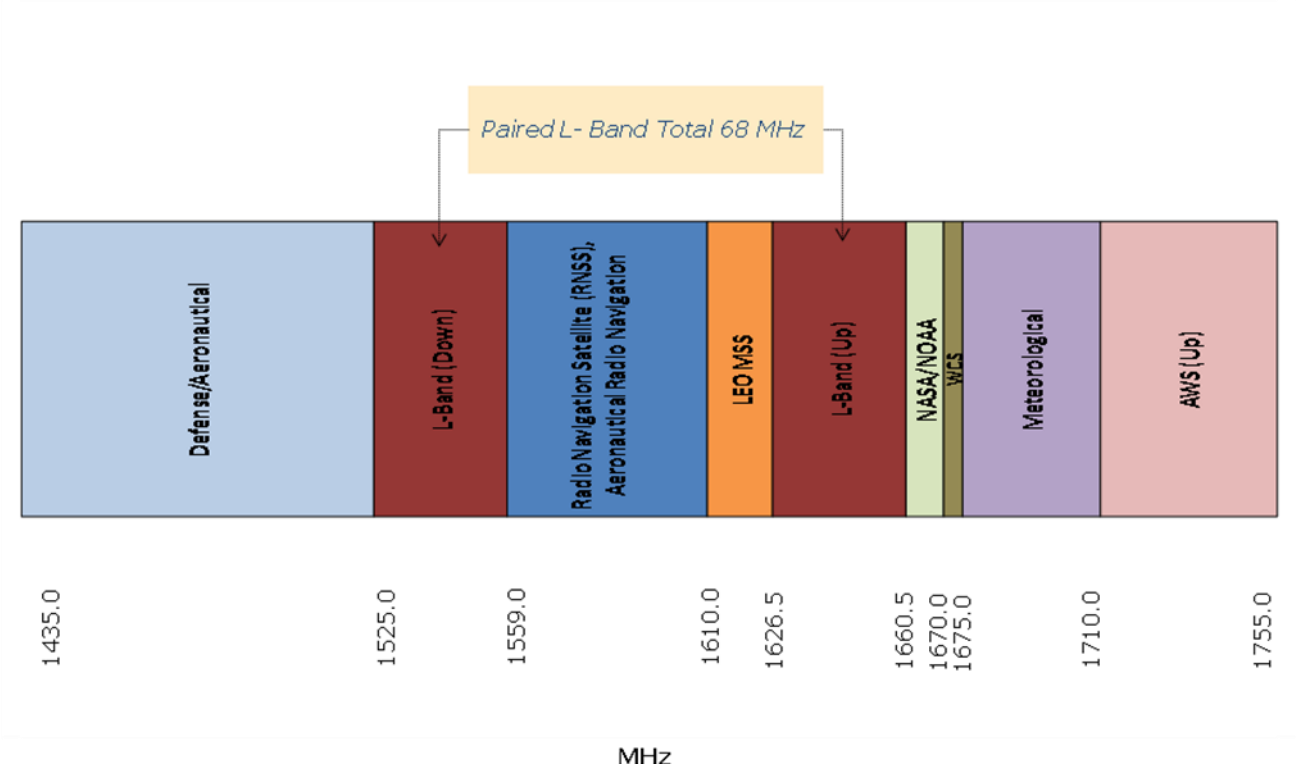


Fig 4.2-1: L-Band Spectrum Band Plan

Subject to coordination with other satellite operators, of which Inmarsat is the principal "other operator" in North America, the FCC permits LightSquared to operate its ATC (i.e. terrestrial LTE network) anywhere in the following bands:

- 1525 – 1559 MHz: Down-link (eNodeB transmit, UE receive)
- 1626.5 – 1660.5 MHz: Up-link (UE transmit, eNodeB receive)

Pursuant to the above authorization, LightSquared plans to deploy 5 MHz and 10 MHz LTE channels, along with satellite service, anywhere within the 34 MHz band of the UL/DL.

4.2.1 Intra-L-Band Geographic Coordination Requirements

Within the L-band, coordination with other satellite operators is a bilateral matter between LightSquared and the other operator(s) (both under ITU and FCC rules). Furthermore, it is subject to confidentiality agreements with those operators and also subject to change over time. Hence it is not considered appropriate to discuss them in 3GPP. The only exception to the above is the requirement in the FCC Order to coordinate with the SAR and RAS services (see Fig 2 below), which are public services with fixed spectrum allocation within the L-band. The requirements for coordinating these are described below.

4.2.1.1 Search & Rescue (SAR) Protection

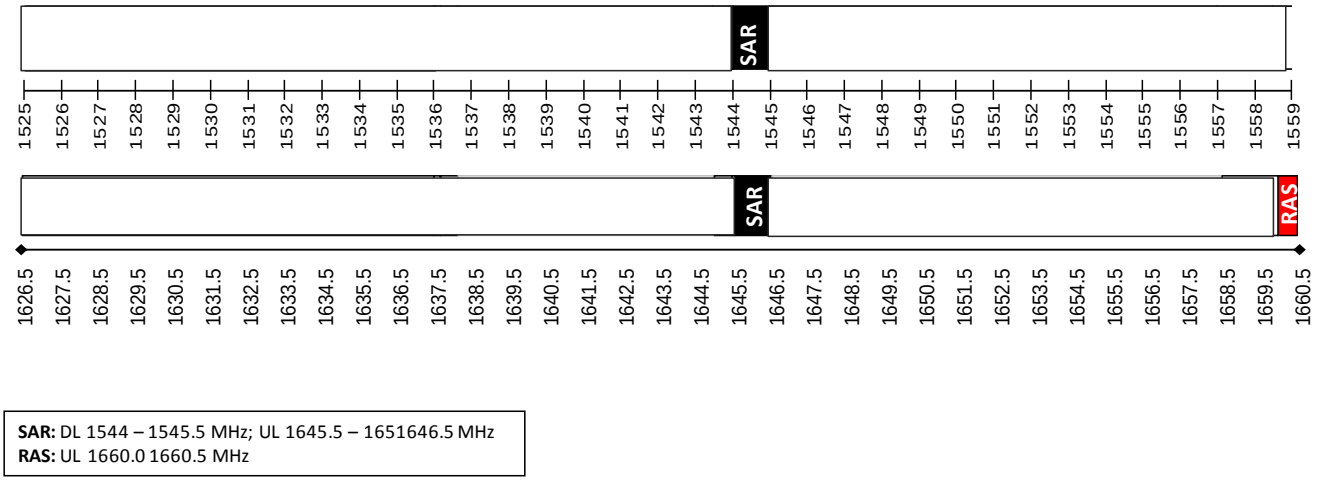
FCC Requirement: Every LightSquared eNodeB within 80 km or radio horizon of a SARSAT receiver operating in the 1544 – 1545 MHz, whichever is shorter, would be required to be coordinated with that SARSAT receiver. Similarly, every outdoor microcell within 45 km or radio horizon of a SARSAT receiver, whichever is shorter, would be required to be coordinated with that SARSAT receiver.

Compliance Plan: LightSquared plans to achieve compliance with the SAR requirements through geographical coordination between the ATC eNB and SARSAT receiver. It is not considered necessary to introduce special emission rules, over and above normal 3GPP rules, for SAR coordination.

4.2.1.2 Radio Astronomy System (RAS) Protection

FCC Requirement: ATC mobile terminals shall be operated in a fashion that takes all practicable steps to avoid causing interference to U.S. radio astronomy service (RAS) observations in the 1660–1660.5 MHz band.

Compliance Plan: Protection to RAS will be offered through geographical coordination.



SAR: DL 1544 – 1545.5 MHz; UL 1645.5 – 1651646.5 MHz
RAS: UL 1660.0 1660.5 MHz

Fig 4.2.1.2-1: Spectral location of SAR and RAS within L-band

4.2.2 eNodeB Out-Of-Band-Emissions (OOBE) to non-3GPP Bands outside L-band

The FCC Order obligates LightSquared to protect services in adjacent bands as described below.

4.2.2.1 Defense/Aeronautical (MAT) Protection

FCC Requirement: The obligations of an ATC network to Mobile Aeronautical Telemetry systems operating in 1435 – 1525 MHz band are outlined as follows:

- Take all practicable steps to avoid locating ATC base stations within radio line of sight of Mobile Aeronautical Telemetry (MAT) receive sites in order to protect U.S. MAT systems consistent with ITU-R Recommendation ITU-R M.1459. MSS ATC base stations located within radio line of sight of a MAT receiver must be coordinated with the Aerospace and Flight Test Radio Coordinating Council (AFTRCC) for non-Government MAT receivers on a case-by-case basis prior to operation. For government MAT receivers, the MSS licensee shall supply sufficient information to the Commission to allow coordination to take place. A listing of current and planned MAT receiver sites can be obtained from AFTRCC for non-Government sites and through the FCC's IRAC Liaison for Government MAT receiver sites.

Compliance Plan: Protection will be offered through geographical coordination during deployment.

4.2.2.2 RNSS (GPS) Band Protection

FCC Requirement: The obligations of an L-band eNodeB to the GPS band operating in 1559 – 1610 MHz are outlined as follows:

- **Narrowband Emissions** - (EIRP of discrete emissions of less than 700 Hz bandwidth, averaged over any 2 millisecond active transmission interval):
  - [-80 dBm from 1559 to 1610 MHz]
- **Wideband Emissions** - (averaged over any 2 millisecond active transmission interval):

- [-70 dBm/MHz from 1559 to 1610 MHz]

Compliance Plan: Compliance will be achieved through eNodeB OOBE mask.

4.2.3 UE Emissions Requirements

The following information outlines the UE emissions masks for L-Band, in EIRP metrics, consistent with FCC's ATC rules.

- Maximum Power: +23 (+/- 2) dBm
- Out-of-Band Emissions for Mobile Terminals:
  - OOCE/OOBE Emission:
    - Limit of -58 dBW/4kHz (-28 dBm/4kHz) per terminal at a 1 MHz offset from the edge of the spectrum used for ATC.
  - Specific Emissions Requirement to protect RNSS (GPS) band:
    - Wideband Emissions - (averaged over any 2 millisecond active transmission interval):
      - 1559 – 1605 MHz: -60 dBm/MHz; After 5 years: -65 dBm/MHz
      - 1605 – 1610 MHz: Linear interpolation from -60 dBm/MHz to -36 dBm/MHz; After 5 years: linear interpolation from -65 dBm/MHz to -41 dBm/MHz
    - Narrowband Emissions - (EIRP of discrete emissions of less than 700 Hz bandwidth, averaged over any 2 millisecond active transmission interval):
      - 1559 – 1605 MHz: -70 dBm; -75 dBm after 5 years
      - 1605 – 1610 MHz: Linear interpolation from -70 dBm to -46 dBm; After 5 years: linear interpolation from -75 dBm to -51 dBm

Compliance Plan: L-Band UEs will meet the 3GPP spurious emission requirements for UE-to-UE co-existence per 3GPP TS 36.101 [7]. Spurious emission requirements from the addition of this new band are expected to be the same as those required from the addition of other new US bands in 3GPP.

4.2.4 Overload Characteristics of GPS Receivers in Proximity to LTE Band 24 eNBs

In response to 3GPP RAN4 request for LightSquared to perform a study on the overload impact of LTE Band 24 on GPS receivers involved in cellular applications [21, 22], LightSquared has performed Field and Lab Tests for six (6) CellPhones/SmartPhones, as well as fixed GPS timing unites, used in network infrastructure, to determine the impact of LTE Band 24 eNB transmission to their overload Characteristics. The details of field and lab test configuration and test results are captured in [23], and [24]. A summary of the contents of [23] and [24] are provided in Section 4.2.4.1

Although results were provided for a limited number of devices (6), the study was concluded at this point considering that, in the meantime, a more comprehensive study, covering a wider variety of GPS receivers than those involved in cellular applications, was initiated under the auspices of the FCC [2]. The latter study will be conducted by a cross-industry group led by LightSquared and USGPSIC, the reports of the study having complete public visibility.

4.2.4.1 Summary of Study Results

In [23], a field trial was undertaken to test the operational behaviour of cell-phones equipped with GPS receivers in an open parking lot with some tree shadowing. The criterion of GPS service failure was defined to be the point where either the number of satellites tracked simultaneously fell below 4, or a positioning application on the device declared that it was switching from using GPS to cellular triangulation. The test results are summarized in Table 4.2.4-1.

Table 4.2.4-1 Per Carrier LTE Power Thresholds for GPS Receivers

Cell Phone GPS Test Results (Interferer Threshold Level at which device switches to AGPS)			
	One 5MHz carrier @ 1552.5MHz	One 10MHz carrier @ 1550.5MHz	Two 10MHz carriers @ 1550.5MHz & 1531MHz
Device 1	-15dBm	-16dBm	-17dBm
Device 2	-29dBm	-32dBm	-34dBm
Device 3	>-10dBm	>-10dBm	>-10dBm

Under the assumption and test set up described in [23], and LightSquared's deployment plans regarding spectrum occupancy and base station EIRP, it was concluded (based on the particular analytical/geometric link calculation methods used and described in [23]) that, for one (1) out of the three (3) phones tested, the maximum exclusion zone (where GPS service would be affected as defined above) would be approximately 20m around the base of the tower. For two (2) phones, there were no exclusion zones at all. Interpreting the outdoor test results with a cellular planning tool, incorporating market specific morphologies, suggested that (for the one affected phone) the exclusion zone would be 1.1 – 2.5 % of the coverage area.

In addition to the work on mobile GPS receivers, [23] includes the work done by LightSquared over the past several years to analyze the overload effect of L-band base stations antennas on proximate timing unit GPS antennas. A GPS antenna pre-selector, sufficient to allow deployments as close as 3m, was specified by Lightsquared and developed by more than one GPS timing unit vendor. This antenna utilizes receive filters which produce a signal attenuation of 65 dB at 1575.42 MHz ±50 MHz.

In [24], lab results are provided for three additional smartPhone GPS receivers. The key performance indicators (KPI's) used in this experiment were Position Error and SNR (as reported by the GPS processor). The results show that the Position Error was found to have a very sharp threshold, which often occurred at relatively high values of SNR degradation (in some cases around 10 dB) relative to the case of zero OOB LTE power. The GPS Rx Signal level used in the experiment was assumed to between -125dBm and -130dBm. The lab test setup is depicted in [24].

Eight (8) satellites were emulated for desired signal levels of -125 dBm and -130 dBm. In a given test, all emulated satellites had the same desired signal level. It is noteworthy, that these devices were tested in standalone GPS mode with no A-GPS assistance. In the real world, the mobile device may benefit from increased sensitivity offered by the mobile assistance data.

The results are captured in Table 4.2.4-24.2.4-2, 4.2.4-3, 4.2.4-4, 4.2.4-5, 4.2.4-6, and 4.2.4-7 for 3 devices under test. The average values were taken over 75 samples.

Table 4.2.4-2: Device 4 Measurements at -125 dBm GPS Rx Level

GPS/Sat	LTE	Avg	Avg	Sat	Sat	Sat	Sat	Sat	Sat	Sat	Sat
dBm	dBm	Error (2D) in meters	SNR	11	14	17	20	23	24	31	32
-125	OFF	5.80	35.07	35.06	35.05	35.15	35.04	35.05	35.15	35.05	35.03
-125	-50	6.53	34.60	34.41	34.63	34.76	34.51	34.67	34.77	34.71	34.34
-125	-40	5.21	34.40	34.47	34.43	34.42	34.51	34.49	34.03	34.51	34.32
-125	-30	6.61	34.76	34.75	34.73	34.84	34.75	34.77	34.74	34.78	34.68
-125	-25	5.39	33.63	33.79	34.06	34.09	33.56	33.09	33.70	33.51	33.26
-125	-20	6.19	32.21	32.30	32.17	32.17	32.28	32.30	31.92	32.37	32.17
-125	-15	4.66	31.68	31.78	32.45	31.96	31.51	31.52	31.42	31.49	31.28
-125	-10	6.17	28.30	25.76	31.35	28.25	29.52	26.1	29	25.2	31.17

Table 4.2.4-3: Device 5 Measurements at -125 dBm GPS Rx Level

GPS/Sat	LTE	Avg	Avg	Sat	Sat	Sat	Sat	Sat	Sat	Sat	Sat
dBm	dBm	Error (2D) in Meters	SNR	11	14	17	20	23	24	31	32
-125	OFF	7.57	36.11	36.11	36.11	36.14	36.11	36.08	36.11	36.14	36.08
-125	-50	7.41	36.05	36.04	36.04	36.06	36.06	36.02	36.04	36.04	36.06
-125	-40	7.11	35.33	35.34	35.36	35.36	35.34	35.32	35.27	35.39	35.29
-125	-30	7.12	33.05	33.04	33.11	33.26	32.96	32.94	33.06	33.06	32.94
-125	-25	5.45	32.38	32.19	32.51	32.39	32.38	32.48	32.18	32.47	32.45
-125	-20	7.00	27.84	27.81	27.94	27.77	27.90	27.75	27.79	27.92	27.87
-125	-15	38.22	27.09	27.83	26.75	26.70	27.19	26.55	27.72	26.80	27.16
-125	-10	35,960.34	22.44	25.79	23.81	19.29	20.00	20.41	26.27	19.76	24.18

Table 4.2.4-4: Device 6 Measurements at -125 dBm GPS Rx Level

GPS/Sat	LTE	Avg	Avg	Sat	Sat	Sat	Sat	Sat	Sat	Sat	Sat
dBm	dBm	Error (2D) in Meters	SNR	11	14	17	20	23	24	31	32
-125	OFF	2.49	34.21	34.21	34.20	34.23	34.18	34.20	34.23	34.24	34.20
-125	-50	3.01	34.73	34.74	34.74	34.75	34.71	34.72	34.76	34.71	34.73
-125	-40	6.03	34.77	34.77	34.78	34.80	34.72	34.74	34.83	34.74	34.75
-125	-30	4.28	34.69	34.67	34.70	34.70	34.67	34.69	34.73	34.66	34.68
-125	-25	4.74	34.62	34.63	34.62	34.63	34.60	34.61	34.66	34.59	34.61
-125	-20	4.36	34.45	34.45	34.46	34.48	34.45	34.42	34.49	34.40	34.44
-125	-15	4.87	33.44	33.44	33.42	33.46	33.46	33.41	33.49	33.41	33.42
-125	-10	4.44	31.44	31.55	31.53	31.58	31.57	31.51	31.02	31.56	31.21

Table 4.2.4-5: Device 4 Measurements at -130 dBm GPS Rx Level

GPS/Sat	LTE	Avg	Avg	Sat	Sat	Sat	Sat	Sat	Sat	Sat	Sat
dBm	dBm	Error (2D) in meters	SNR	11	14	17	20	23	24	31	32
-130	OFF	10.60	29.69	30.03	30.09	29.39	29.19	28.35	30.03	30.31	30.09
-130	-50	8.81	30.09	30.25	30.11	29.88	30.02	30.15	30.29	30.35	29.68
-130	-40	4.10	30.57	30.66	30.47	30.70	30.75	30.61	30.62	30.69	30.10
-130	-30	5.64	30.18	30.17	30.17	30.19	N/A	30.17	30.20	30.17	30.17
-130	-25	2.31	28.05	29.80	27.22	26.45	29.65	29.83	29.40	22.06	29.97
-130	-20	10.23	23.14	29.00	N/A	N/A	20.08	18.24	19.36	29.00	N/A
-130	-15	4.05	25.18	26.83	26.85	26.45	N/A	19.50	26.63	23.14	26.83
-130	-10	9.53	23.81	24.88	25.00	18.00	25.00	23.79	26.00	N/A	24.00

Table 4.2.4-6: Device 5 Measurements at -130 dBm GPS Rx Level

GPS/Sat	LTE	Avg	Avg	Sat	Sat	Sat	Sat	Sat	Sat	Sat	Sat
dBm	dBm	Error (2D) in meters	SNR	11	14	17	20	23	24	31	32
-130	OFF	10.16	30.91	30.91	30.89	30.95	30.89	30.87	31.12	30.81	30.83
-130	-50	6.99	30.57	30.60	30.54	30.61	30.48	30.54	30.67	30.59	30.53
-130	-40	7.01	29.19	29.16	29.19	29.18	29.21	29.18	29.18	29.23	29.21
-130	-30	6.80	28.11	28.15	28.14	28.27	28.12	28.05	28.14	28.29	27.73
-130	-25	6.57	26.60	27.01	25.06	26.11	26.88	26.67	27.07	27.01	26.97
-130	-20	28587.34	25.46	27.66	24.49	23.46	25.57	23.17	27.92	23.54	27.85
-130	-15	54597.55	25.38	26.60	21.78	27.30	24.52	20.46	27.47	26.61	28.32
-130	-10	46038.95	22.56	27.14	17.57	20.26	20.97	19.00	27.58	21.04	26.93

Table 4.2.4-7: Device 6 Measurements at -130 dBm GPS Rx Level

GPS/Sat	LTE	Avg	Avg	Sat	Sat	Sat	Sat	Sat	Sat	Sat	Sat
dBm	dBm	Error (2D) in meters	SNR	11	14	17	20	23	24	31	32
-130	OFF	4.78	30.56	30.56	30.58	30.58	30.55	30.53	30.61	30.53	30.56
-130	-50	4.11	30.17	30.20	30.21	30.18	30.13	30.17	30.21	30.13	30.14
-130	-40	14.00	30.62	30.61	N/A	30.64	30.62	30.63	30.64	N/A	30.59
-130	-30	6.27	29.74	29.75	29.76	29.75	29.72	29.73	29.77	29.70	29.76
-130	-25	5.51	29.93	29.95	29.92	29.96	29.91	29.91	29.95	29.92	29.92
-130	-20	4.82	29.71	29.73	29.72	29.73	29.71	29.76	29.75	29.63	29.67
-130	-15	5.16	28.53	28.62	28.60	28.58	28.46	28.49	28.47	28.52	28.53
-130	-10	37964.43	27.31	26.94	27.08	27.37	27.59	26.77	27.61	27.06	28.06

Also included in [24], is a description of a field trial to gather data about GPS received signal levels from different satellites in suburban and urban morphologies, validating the GPS receive signal strength used in the lab experiment (-125dBm and -130dBm) for outdoor use case. The field trial was performed using a widely used commercial GPS receiver, with a calibrated antenna mounted on the roof of a vehicle, allowing the C/N of signals received from individual satellites to be monitored, referenced to a 0 dBi antenna. Measurements were made in the open sky, suburban, and urban environments.

5 Study of E-UTRA requirements

5.1 Operating band and channel arrangement

5.1.1 Operating bands

The L-Band LTE for ATC of MSS in North America is designed to operate in the operating band defined in Table 5.1.1-1:

Table 5.1.1-1: E-UTRA frequency bands

E-UTRA Operating Band	Uplink (UL) operating band BS receive UE transmit	Downlink (DL) operating band BS transmit UE receive	Duplex Mode
	F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	
24	1626.5 MHz – 1660.5 MHz	1525 MHz – 1559 MHz	FDD

5.1.2 Channel bandwidths per operating band

The transmission bandwidth configuration in Table 5.1.2-1 shall be supported for each of the specified channel bandwidths.

Table 5.1.2-1: E-UTRA channel bandwidth

E-UTRA band / channel bandwidth						
E-UTRA Band	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
24			Yes	Yes		

5.1.3 Carrier frequency and EARFCN

The relation between EARFCN and the carrier frequency in MHz for the downlink is given by the following equation, where F_{DL_low} and $N_{Offs\text{-}DL}$ are given in Table 5.1.3-1 and N_{DL} is the downlink EARFCN.

$$F_{DL} = F_{DL\_low} + 0.1(N_{DL} - N_{Offs\text{-}DL})$$

The relation between EARFCN and the carrier frequency in MHz for the uplink is given by the following equation where F_{UL_low} and $N_{Offs\text{-}UL}$ are given in Table 5.1.3-1 and N_{UL} is the uplink EARFCN.

$$F_{UL} = F_{UL\_low} + 0.1(N_{UL} - N_{Offs\text{-}UL})$$

Table 5.1.3-1: E-UTRA channel numbers

E-UTRA Operating Band	Downlink			Uplink		
	F_{DL_low}(MHz)	$N_{Offs\text{-}DL}$	Range of N_{DL}	F_{UL_low}(MHz)	$N_{Offs\text{-}UL}$	Range of N_{UL}
24	1525	7700	7700 – 8039	1626.5	25700	25700 – 26039

5.1.4 TX–RX frequency separation

The default E-UTRA TX channel (carrier centre frequency) to RX channel (carrier centre frequency) separation is specified in Table 5.1.4-1 for the TX and RX channel bandwidths defined in Table 5.1.2-1.

Table 5.1.4-1: Default UE TX-RX frequency separation

E-UTRA Operating Band	TX - RX carrier centre frequency separation
24	-101.5 MHz

5.1.5 Band Release Independence

Band 24 is specified in Release 10, but is defined as a release-independent frequency band. This approach aligns the Band 24 band with other frequency bands when considering features that have to be supported in different releases.

UEs that conform to Release 8 and support Band 24 shall support the following requirements in Release 10.

Release 8 UEs shall comply with the Release 10 RF requirements for Band 24 specified in 3GPP TS 36.101 [7] as indicated in Table 5.1.5-1. These new requirements should be added as a new section of 3GPP TS 36.307 [13].

Table 5.1.5-1: RF Requirements for Band 24 UE

Section / Clause	Description
5.5	Operating bands
5.6	Channel bandwidth
5.7	Channel arrangement
6.2	Transmit power
6.3	Output power dynamics
6.6	Output RF spectrum emissions
6.7	Transmit intermodulation
7.3	Reference sensitivity power level
7.4	Maximum input level
7.5	Adjacent Channel Selectivity (ACS)
7.6	Blocking characteristics
7.7	Spurious response
7.8	Intermodulation characteristics

The UE shall comply with the Release 10 RF requirements for the following RRM requirements for Band 24 specified in 3GPP TS 36.133 [11] as indicated in Table 5.1.5-2:

Table 5.1.5-2: RRM Requirements for Band 24 UE

Section / Clause	Description
4	E-UTRAN RRC_IDLE state mobility
8	UE Measurements Procedures in RRC_CONNECTED State
9	Measurement Performances for UE.
A.9	Measurement Performances for UE Test Cases

Similar requirements for Release 9 UEs that conform to Release 10 support of Band 24 will be provided as well.

5.2 Specific UE RF requirements

5.2.1 Maximum Output Power

Band 24 will operate at the same maximum output power level as bands listed in Table 5.2.1-1 (Table 6.2.2-1 from 3GPP TS 36.101 [7]). The following UE Power Classes define the maximum output power for any transmission bandwidth within the channel bandwidth.

Table 5.2.1-1: 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)
…								
24					23	±2		
…								

5.2.2 Maximum Output Power with additional Requirements

Band 24 will use the default value for Additional Maximum Power Reduction (A-MPR) of 0 dB.

5.2.3 Spurious Emissions

Spurious emissions are emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, inter-modulation products and frequency conversion products, but exclude out of band emissions.

In section 4.2.3 of the TR [2], LightSquared previously noted that the FCC requirements for L-Band to protect the GPS band were measured in terms of EIRP. However, owing to the proximity of Band 24 to the GPS band, RAN-4 requested that some assurance be provided in 3GPP TS 36.101 [7] that it would be feasible to meet the spurious emission requirements mandated by the FCC to protect GPS receivers. Therefore, 3GPP TS 36.101 [7] has been modified for Band 24 to meet the FCC requirements as conducted power requirements, assuming a UE 0 dBi antenna gain.

In terms of bands with harmonic issues relative to Band 24, it is known that 3GPP Band 13 has second order harmonics that fall into the downlink (1525 to 1559 MHz) of Band 24. Along with the addition of Band 24, an exception for Band 13 has been added to Table 5.2.3-1 (Table 6.6.3.2-1 in 3GPP TS 36.101 [7]) for the UE-to-UE requirements below.

Table 5.2.3-1: Requirements

E-UTRA Band	Spurious emission						
	Protected band	Frequency range (MHz)			Maximum Level (dBm)	MBW (MHz)	Comment
1	E-UTRA Band 1, 3, 7, 8, 9, 11, 20, 21, 34, 38, 40	FDL_low	-	FDL_high	-50	1	
	E-UTRA band 33	FDL_low	-	FDL_high	-50	1	Note[3]
	E-UTRA band 39	FDL_low	-	FDL_high	-50	1	Note[3]
	Frequency range	860	-	895	-50	1	
		1884.5	-	1919.6	-41	0.3	Note[6],Note[7]
	Frequency range	1884.5	-	1915.7			Note [6], Note[8]
2	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 24	FDL_low	-	FDL_high	-50	1	
3	E-UTRA Band 1, 3, 7, 8, 20, 33, 34, 38	FDL_low	-	FDL_high	-50	1	
4	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 24	FDL_low	-	FDL_high	-50	1	
5	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 24	FDL_low	-	FDL_high	-50	1	
6	E-UTRA Band 1, 9, 11, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	875	-37	1	
	Frequency range	875	-	895	-50	1	
		1884.5	-	1919.6	-41	0.3	Note[7]
	Frequency range	1884.5	-	1915.7			Note[8]
7	E-UTRA Band 1, 3, 7, 8, 20, 33, 34	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 38	FDL_low	-	FDL_high	-50	1	Note [3]
8	E-UTRA Band 1, 8, 20, 33, 34, 38, 39, 40	FDL_low	-	FDL_high	-50	1	
	E-UTRA band 3	FDL_low	-	FDL_high	-50	1	Note [2]
	E-UTRA band 7	FDL_low	-	FDL_high	-50	1	Note [2]
9	E-UTRA Band 1, 9, 11, 21, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	895	-50	1	
		1884.5	-	1919.6	-41	0.3	Note[7]
	Frequency range	1884.5	-	1915.7			Note[8]
10	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 24	FDL_low	-	FDL_high	-50	1	
11	E-UTRA Band 1, 9, 11, 21, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	895	-50	1	
		1884.5		1919.6	-41	0.3	Note[7]
	Frequency range	1884.5	-	1915.7			Note[8]
12	E-UTRA Band 2, 5, 12, 13, 14, 17, 24	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 4, 10	FDL_low	-	FDL_high	-50	1	Note[2]
13	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 24	FDL_low	-	FDL_high	-50	1	Note[2]
	Frequency range	763	-	775	-35	0.00625	
14	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 24	FDL_low	-	FDL_high	-50	1	
	Frequency range	763	-	775	-35	0.00625	
17	E-UTRA Band 2, 5, 12, 13, 14, 17, 24	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 4, 10	FDL_low	-	FDL_high	-50	1	Note[2]
18	E-UTRA Band 1, 9, 11, 21, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	895	-40	1	
		1884.5	-	1919.6	-41	0.3	Note[7]
	Frequency range	1884.5	-	1915.7			Note[8]
19	E-UTRA Band 1, 9, 11, 21, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	895	-40	1	Note[9]
		1884.5	-	1919.6	-41	0.3	Note[7]
	Frequency range	1884.5	-	1915.7			Note[8]

	E-UTRA Band 1, 3, 7, 8, 33, 34, 38, 39, 40	FDL_low	-	FDL_high	-50	1	
20	E-UTRA Band 38	FDL_low	-	FDL_high	-50	1	Note [2]
21	E-UTRA Band 11, 21	FDL_low	-	FDL_high	-35	1	Note[10]
	E-UTRA Band 1, 9, 34	FDL_low	-	FDL_high	-50	1	
	Frequency range	860	-	895	-50	1	
	Frequency range	1884.5	-	1919.6	-41	0.3	Note[7]
		1884.5	-	1915.7			Note[8]
…							
24	E-UTRA Band 2, 4, 5, 10, 12, 13, 14, 17, 24	FDL_low	-	FDL_high	-50	1	
…							
33	E-UTRA Band 1, 3, 7, 8, 20, 34, 38, 39, 40	FDL_low	-	FDL_high	-50	1	Note[5]
34	E-UTRA Band 1, 3, 7, 8, 9, 11, 20, 21, 33, 38,39, 40	FDL_low	-	FDL_high	-50	1	Note[5]
	Frequency range	860	-	895	-50	1	
	Frequency range	1884.5	-	1919.6	-41	0.3	Note[7]
		1884.5	-	1915.7			Note[8]
35							
36							
37			-				
38	E-UTRA Band 1,3, 8, 20, 33, 34	FDL_low	-	FDL_high	-50	1	
	E-UTRA Band 7	FDL_low	-	FDL_high	-50	1	Note[3]
39	E-UTRA Band 34, 40	FDL_low	-	FDL_high	-50	1	
40	E-UTRA Band 1, 3, 20, 33, 34, 39	FDL_low	-	FDL_high	-50	1	

Note [1]: FDL_low and FDL_high refer to each E-UTRA frequency band specified in 3GPP TS 36.101 [7] Table 5.5-1
Note [2]: As exceptions, measurements with a level up to the applicable requirements defined in 3GPP TS 36.101 [7] Table 6.6.3.1-2 are permitted for each assigned E-UTRA carrier used in the measurement due to 2nd or 3rd harmonic spurious emissions. An exception is allowed if there is at least one individual RE within the transmission bandwidth (see Figure 5.6-1) for which the 2nd or 3rd harmonic, i.e. the frequency equal to two or three times the frequency of that RE, is within the measurement bandwidth (MBW).
Note [3]: To meet these requirements some restriction will be needed for either the operating band or protected band
Note [4]: N/A
Note [5]: For non synchronised TDD operation to meet these requirements some restriction will be needed for either the operating band or protected band
Note [6]: Applicable when NS_05 in section 6.6.3.3.1 is signalled by the network.
Note [7]: Applicable when co-existence with PHS system operating in 1884.5-1919.6 MHz.
Note [8]: Applicable when co-existence with PHS system operating in 1884.5 -1915.7 MHz.
Note [9]: Applicable when NS_08 in section 6.6.3.3.3 is signalled by the network
Note [10]: Applicable when NS_09 in section 6.6.3.3.4 is signalled by the network

5.2.4 Reference Sensitivity Power Level

The reference sensitivity power level REFSENS is the minimum mean power applied to both the UE antenna ports at which the throughput shall meet or exceed the requirements for the specified reference measurement channel.

For the $P_{REFSENS}$ parameters provided in Table 5.2.4-1 below (from 3GPP TS 36.101 [7], Table 7.3.1-1) for Band 24, the following link budgets for the 5 and 10 MHz bandwidth cases have been calculated as follows:

- For 5 MHz: -174 + 10*log(4.5 MHz) + NF + SNR + CL – DG + IM = **-100 dBm**
- For 10 MHz: -174 + 10*log(9.0 MHz) + NF + SNR + CL – DG + IM = **-97 dBm**

Where:

- NF (noise figure) = 9 dB
- SNR (for QPSK @ rate 1/3)= - 1 dB
- CL (R_x combiner loss) = 0.5 dB

- DG (R_x diversity gain) = 3 dB
- IM (implementation margin) = 2 dB

Table 5.2.4-1: 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
…							
24			-100	-97			FDD
…							

Table 5.2.4-2 (3GPP TS36.101, Table 7.3.1-2) specifies the minimum number of allocated uplink resource blocks for which the reference receive sensitivity requirement must be met. Band 24 is capable of transmitting all available RB's on the uplink.

Table 5.2.4-2: Minimum 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
…							
24			25	50			FDD
…							

The combination of channel bandwidths and operating bands for E-UTRA is shown in Table Table 5.2.4-3 (3GPP TS 36.101 [7], Table 5.6.1-1). The transmission bandwidth configuration in Table 5.2.4-3 is supported by Band 24 for each of the specified channel bandwidths.

Table 5.2.4-3: E-UTRA channel bandwidth

E-UTRA band / channel bandwidth						
E-UTRA Band	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
...						
24			Yes	Yes		
...						

5.3 Specific BS RF requirements

5.3.1 Operating band unwanted emissions

The operating band unwanted emission limits, specified in EIRP metrics, are defined from 10 MHz below the lowest frequency of the downlink operating band up to 10 MHz above the highest frequency of the downlink operating band. The requirements shall apply to whatever the type of transmitter considered (single carrier or multi-carrier) and for all transmission modes foreseen by the manufacturer's specification.

As discussed in Section 4, the BS out-of-band-emission limits mandated by the FCC on this band, in general, are specified as required attenuation below the mean output power of the transmitter in accordance with Table 5.3.1-1 below. These should be viewed as the minimum, default requirements, and may be superseded by additional requirements where so specified.

Table 5.3.1-1: FCC emission limits for the L-Band

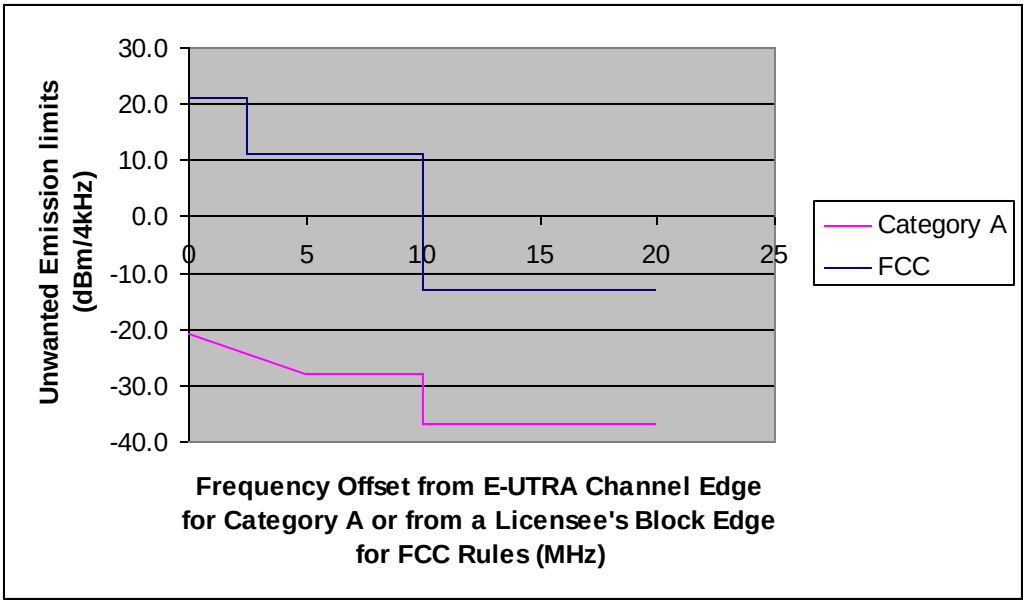
Frequency offset (f_offset) from the FCC authorized bandwidth (B)	Attenuation (dB) below the mean output power in watts (P) of the transmitter	Measurement bandwidth
B/2 ≤ f_offset < B	25	4 kHz
B ≤ f_offset < 5B/2	35	4 kHz
5B/2 ≤ f_offset	43 + 10log(P)	4 kHz

The quantity B in Table 5.3.1-1 is the FCC authorized BW which corresponds to the LTE channel bandwidth in 3GPP. Requirements in Table 5.3.1-1 are measured from the carrier centre frequency. As requirements should be measured from the channel edge as is usual in 3GPP, the requirements are converted as shown in Table 5.3.1-2 for the 5 and 10 MHz channel bandwidth.

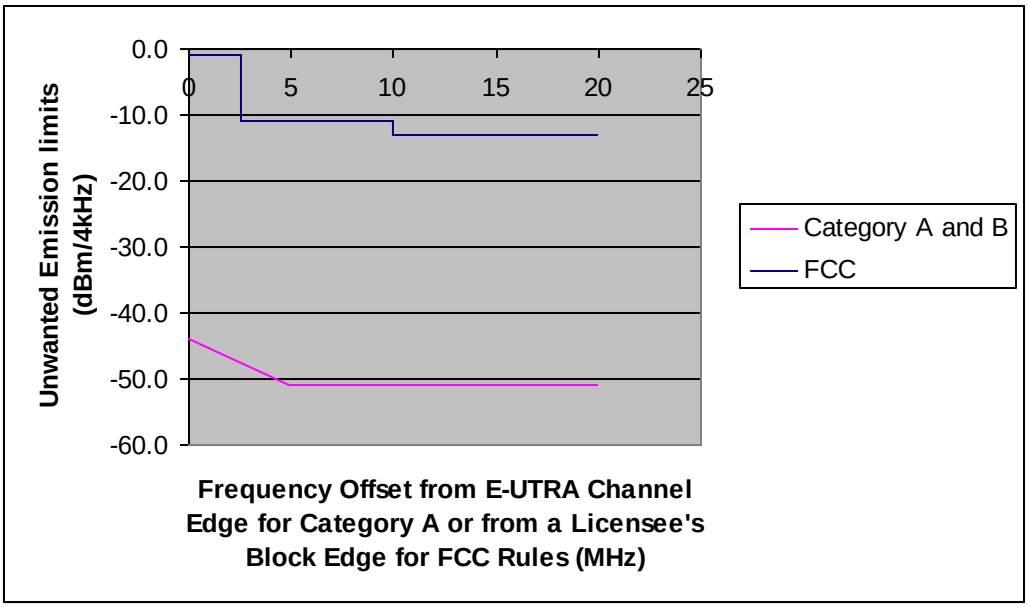
Table 5.3.1-2: FCC emission limits related to channel edge for the L-Band

Channel bandwidth	Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement attenuation (dB) below maximum output power in watts (P) of the transmitter	Measurement bandwidth
5 MHz	0 MHz ≤ Δf < 2.5 MHz	0.002 MHz ≤ f_offset < 2.502 MHz	25	4 kHz
	2.5 MHz ≤ Δf < 10 MHz	2.502 MHz ≤ f_offset < 10.002 MHz	35	4 kHz
	10 MHz ≤ Δf < Δf_{max}	10.002 MHz MHz ≤ f_offset < f_offset_{max}	43 + 10log(P)	4 kHz
10 MHz	0 MHz ≤ Δf < 5 MHz	0.002 MHz ≤ f_offset < 5.002 MHz	25	4 kHz
	5 MHz ≤ Δf < 20 MHz	5.002 MHz ≤ f_offset < 20.002 MHz	35	4 kHz
	20 MHz ≤ Δf < Δf_{max}	20.002 MHz MHz ≤ f_offset < f_offset_{max}	43 + 10log(P)	4 kHz

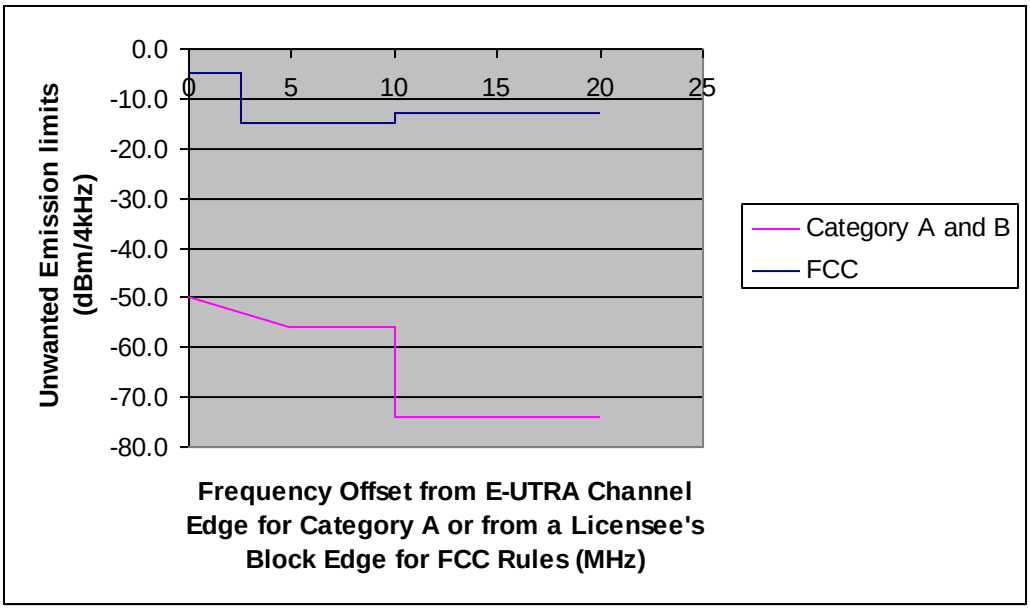
The operating band unwanted emission limits for Category A for E-UTRA bands >1GHz (as specified in Clause 6.6.3 of 3GPP TS 36.104 [8] and 3GPP TS 36.141 [12]) and the FCC emission limits for this band are shown in Figure 5.3.1-1 below for the 5MHz channel bandwidth option, for the cases of Wide Area, Local Area, and Home BS with 46 dBm, 24 dBm, and 20 dBm output power, respectively. It can be seen that the operating band unwanted emission (Category A) limits are always tighter. Therefore, the operating band unwanted emission limits for Category A for E-UTRA bands >1GHz shall be applied to this band. Note that the operating band unwanted emission limits for Category B are not applicable in North America, and thus need not be specified for this band.



(1a) Wide Area BS with 46 dBm output power



(1b) Local Area BS with 24 dBm output power



(1c) Home BS with 20 dBm output power

Figure 5.3.1-1: The operating band unwanted emission (Category A) limits for E-UTRA bands >1GHz and the additional (FCC) limits

5.3.2 Additional spurious emissions requirements

These requirements may be applied for the protection of systems operating in frequency ranges other than the E-UTRA BS downlink operating band. The limits may apply as an optional protection of such systems that are deployed in the same geographical area as the E-UTRA BS, or they may be set by local or regional regulation as a mandatory requirement for an E-UTRA operating band.

The E-UTRA BS spurious emissions limits currently specified for co-existence with systems operating in other frequency bands are more stringent than the out-of-band emissions limits by the FCC. To ensure sufficient protection to the co-existing systems, the same limits as the other E-UTRA bands BS apply for this band in Clause 6.6.4.3 of 3GPP TS 36.104 [8] (Tables 6.6.4.3.1-1 and 6.6.4.3.1-1x) and Clause 6.6.4.5.4 of 3GPP TS 36.141 [12] (Tables 6.6.4.5.4-1

and 6.6.4.5.4-1x). And to ensure sufficient protection from the co-existing systems, the same limits as the other E-UTRA bands BS shall be specified for coexistence with the BS in this band in Clause 6.6.4.3 of 3GPP TS 36.104 [8] (Tables 6.6.4.3.1-1 and 6.6.4.3.1-1x) and Clause 6.6.4.5.4 of 3GPP TS 36.141 [12] (Tables 6.6.4.5.4-1 and 6.6.4.5.4-1x).

Moreover, as discussed in Section 4, the BS in this band shall meet the following limits on emissions into the 1559-1610 MHz band as requested in [6] and shown in Table 5.3.2-1 below:

Table 5.3.2-1: FCC emission limits into the 1559-1610 MHz band

	Frequency	dBW/MHz EIRP (Measurement bandwidth = 1 MHz)	dBW EIRP of discrete emissions of less than 700 Hz bandwidth (Measurement bandwidth = 1 kHz)
Wide Area and Local Area Base Stations	1559-1610 MHz	-100	-110
Home Base Stations	1559-1605 MHz	-114.7	-110

This emission limit is expressed as EIRP, not as a conducted emission requirement suitable for BS equipment. EIRP (effective isotropic radiated power), is dependent on both the BS emissions at the antenna connector and the deployment (including antenna gain and feeder loss). In this form, the EIRP requirement is not testable at the BS antenna connector. An alternative is to define maximum unwanted emission levels based on declared values by the manufacturer, similarly to the requirements for Band 20 for DTT band protection in 3GPP TS 36.104 [8] Table 6.6.3.3-4. To provide assurance that the FCC mandated emission levels for the protection of GPS can be achieved by practical base stations, Appendix A provides an example of an actual base station mask for a particular antenna gain and cable loss.

Even though the victim band 1559 – 1610 MHz band is still within 10 MHz of Band 24 DL operating band, it is proposed that this FCC requirement shall be specified as additional spurious emissions requirements in Clause 6.6.4.3 of TS 36 104.

Maximum emission levels shall be specified as P_{E_1MHz} and P_{E_1kHz} which are declared values by the manufacturer. The requirement then provides the characteristics of the base station needed to verify compliance with the regional EIRP requirement.

The following Table 5.3.2-2 and note shall be added to 3GPP TS 36.104 [8] and 3GPP TS36.141 [12] (as Table 5.3-4):

Table 5.3.2-2: Declared emissions levels for protection of the 1559-1610 MHz band

Operating Band	Frequency range	Declared emission level [dBW] (Measurement bandwidth = 1 MHz)	Declared emission level [dBW] of discrete emissions of less than 700 Hz bandwidth (Measurement bandwidth = 1 kHz)
24	1559 - 1610 MHz	P_{E_1MHz}	P_{E_1kHz}

Note: The regional requirement is defined in terms of EIRP (effective isotropic radiated power), which is dependent on both the BS emissions at the antenna connector and the deployment (including antenna gain and feeder loss). The EIRP level is calculated using: $P_{EIRP} = P_E + G_{ant}$ where P_E denotes the BS unwanted emission level at the antenna connector, G_{ant} equals the BS antenna gain minus feeder loss. The requirement defined above provides the characteristics of the base station needed to verify compliance with the regional requirement.

5.3.3 Co-location with other base stations

These requirements may be applied for the protection of other BS receivers when GSM900, DCS1800, PCS1900, GSM850, UTRA FDD, UTRA TDD and/or E-UTRA BS are co-located with an E-UTRA BS. The requirements assume

a 30 dB coupling loss between transmitter and receiver and are based on co-location with base stations of the same class.

The E-UTRA BS spurious emissions limits currently specified for co-location with another BS are more stringent than the out-of-band emissions limits by the FCC. To ensure sufficient protection to the co-located BS, the same BS limits as the other E-UTRA bands use shall be specified for this band in Clause 6.6.4.4 of 3GPP TS 36.104 [8] and Clause 6.6.4.5.5 of 3GPP TS 36.141 [12]. To ensure sufficient protection from the co-located BS, the same BS limits as the other E-UTRA bands use shall be specified for co-location with the BS in this band in Clause 6.6.4.3 of 3GPP TS 36.104 [8] and Clause 6.6.4.5.4 of 3GPP TS 36.141 [12].

5.3.4 General blocking requirement

The blocking characteristics are a measure of the receiver's ability to receive a wanted signal at its assigned channel in the presence of an unwanted interferer, which is a 1.4MHz, 3MHz or 5MHz E-UTRA signal for in-band blocking or a CW signal for out-of-band blocking.

The general blocking requirements currently specified for E-UTRA BS apply the in-band blocking signal within the +/-20 MHz of the UL frequency range of a band, except when the DL frequency range of the same band falls within such range. Since the duplex distance of this band is larger than 20 MHz and thus no exception is needed, the same general blocking requirements as specified for E-UTRA Bands 2 and 5 BS shall be specified for this band in Clause 7.6.1 of 3GPP TS 36.104 [8] and Clause 7.6.5.1 of 3GPP TS 36.141 [12] to ensure sufficient BS receiver blocking ability.

5.3.5 Blocking requirement for co-location with other base stations

This additional blocking requirement may be applied for the protection of E-UTRA BS receivers when GSM, UTRA or E-UTRA BS operating in a different frequency band are co-located with an E-UTRA BS. The requirements assume a 30 dB coupling loss between interfering transmitter and E-UTRA BS receiver and are based on co-location with base stations of the same class.

The blocking requirements currently specified for E-UTRA BS when co-located with BS in other frequency bands do not apply when the interfering signal falls within the +/-10 MHz of the UL frequency range of a band, except for Band 13 in order to allow co-location with Band 14 BS. Since no UTRA/E-UTRA DL is operating within the +/-10 MHz of the UL frequency range of this band, the blocking requirements shall be specified for this band in Clause 7.6.2 of 3GPP TS 36.104 [8] and Clause 7.6.5.2 of 3GPP TS 36.141 [12] using the same interfering signal as the other E-UTRA bands BS, and do not apply when the interfering signal falls within +/-10 MHz of the UL frequency range of this band (i.e. 1616.5 – 1670.5 MHz).

5.3.6 UTRAN requirements

5.3.6.1 Required changes to 3GPP TS 25.461

In 3GPP TS 25.461 [14], section 4.3.7 "Operating bands" and the corresponding Table 4.3.7.1 (Table 5.3.6.1-1 below) "Frequency bands" of 3GPP TS 25.461 [14] require alteration to accommodate the new L_Band_LTE_ATC_MSS frequency band parameters, as follows. (Section 6.8 of the TR for the work item summarizes these changes.)

Table 5.3.6.1-1: Frequency bands

UTRA Operating Band	E-UTRA Operating Band	UL operating band UE transmit, BS receive	DL operating band UE receive, BS transmit
–	24	1626.5 – 1660.5 MHz	1525 – 1559 MHz

5.3.6.2 Required changes to 3GPP TS 25.466

In 3GPP TS 25.466 [15], Annex B "Assigned fields for additional data" and the corresponding Table B.2-1 (Table 5.3.6.2-1 in 3GPP TS 25.466 [15]) "Coding for operating bands in field 0x08" of 3GPP TS 25.466 [15] require alteration to accommodate the new L_Band_LTE_ATC_MSS frequency band parameters, as follows. (Section 6.9 of the TR for the work item summarizes these changes.)

Table 5.3.6.2-1: Coding for operating bands in field 0x08

Bit no	15	14…10	9	8	7	6	5	4	3	2	1	0
Operating band	Res.	Spare	XXIV	Res.	Res.-	XXI	XX	XIX	XVIII	XVII	Res.	Res.

6 Summary of required changes to E-UTRA specifications

6.1 Required changes to 3GPP TS 36.101

Required changes in 3GPP TS 36.101 [7] are shown in Table 6.1-1.

Table 6.1-1: Required Changes for 3GPP TS 36.101 [7]

Clause	Description	Description of change	Proposed changes
5.5	Operating bands	Add a new row for the band into Table 5.5-1.	R4-102509
5.6.1	Channel bandwidths per operating band	Add channel bandwidths 5 and 10 MHz for the band into Table 5.6.1-1.	R4-103452
5.7.3	Carrier frequency and EARFCN	Add a new channel numbering for the band into Table 5.7.3-1.	R4-102509
5.7.4	TX–RX frequency separation	Add a new row for the band into Table 5.7.4-1.	R4-102509
6.2.2	UE Maximum Output Power	Add a new row for the band into Table 6.2.2-1.	R4-103452
6.2.4	UE Maximum Output Power with additional requirements	(FFS) Add a new row for the band into Table 6.2.4-1.	R4-103452
6.6.2.2	Additional Spectrum Emission Mask	(FFS) Add new requirements for the band.	R4-103452
6.6.3.2	Spurious emission band UE co-existence	Add the band into Table 6.6.3.2-1 for mutual protection with E-UTRA Band 2, 4, 5, 10, 12, 13, 14 and 17.	R4-103452
6.6.3.3	Additional spurious emissions	(FFS) Add new requirements for the band.	R4-103452
7.3	Reference sensitivity power level	Add a new row for the band into Tables 7.3.1-1, 7.3.1-2, 7.3.2-1 and, when deems necessary, 7.3.1-3.	R4-103452
7.6.1	In-band blocking	Add the band into Table 7.6.1.1-2.	R4-103452
7.6.2	Out-of-band blocking	Add the band into Table 7.6.2.1-2.	R4-103452

6.2 Required changes to 3GPP TS 36.104

Required changes in 3GPP TS 36.104 [8] are shown in Table 6.2-1.

Table 6.2-1: Required Changes for 3GPP TS 36.104 [8]

Clause	Description	Description of change	Proposed changes
5.5	Operating bands	Add a new row for the band into Table 5.5-1.	R4-102509
5.7.3	Carrier frequency and EARFCN	Add new channel numbers for the band into Table 5.7.3-1.	R4-102509
6.6.3	Operating band unwanted emissions	Add the band to Category A.	R4-103353
6.6.4.3	Additional spurious emissions requirements	Add a new row for the band into Tables 6.6.4.3.1-1 and 6.6.4.3-1x.	R4-103353
6.6.4.4	Co-location with other base stations	Add a new row for the band into Tables 6.6.4.4.1-1 and 6.6.4.4.1-2.	R4-102508
7.6.1	General blocking requirement	Add the band into Tables 7.6.1.1-1, 7.6.1.1-1a, and 7.6.1.1-1b.	R4-102508
7.6.2	Co-location with other base stations	Add a new row for the band into Tables 7.6.2.1-1 and 7.6.2.1-2.	R4-102508

6.3 Required changes to 3GPP TS 36.113

Required changes in 3GPP TS 36.113 [9] are shown in Table 6.3-1.

Table 6.3-1: Required changes for 3GPP TS 36.113 [9]

Clause	Description	Description of change	Proposed changes
4.5.2	Receiver exclusion band	Add a new row for the band.	R4-102509

6.4 Required changes to 3GPP TS 36.124

Required changes in 3GPP TS 36.124 [10] are shown in Table 6.4-1.

Table 6.4-1: Required changes for 3GPP TS 36.124 [10]

Clause	Description	Description of change	Proposed changes
4.4	Receiver exclusion band	Add a new row for the band.	R4-102509

6.5 Required changes to 3GPP TS 36.133

Required changes in 3GPP TS 36.133 [11]are shown in Table 6.5-1.

Table 6.5-1: Required changes for 3GPP TS 36.133 [11]

Clause	Description	Description of change	Proposed changes
4.2.2.3	Measurements of intra-frequency E-UTRAN cells	Add the band to the band list for RSRP and SCH_RP.	R4-103619
4.2.2.4	Measurements of inter-frequency E-UTRAN cells	Add the band to the band list for RSRP and SCH_RP.	R4-103619
8.1.2.2	E-UTRAN intra frequency measurements	Add the band to the band list for SCH_RP.	R4-103619
8.1.2.3	E-UTRAN inter frequency measurements	Add the band to the band list for RSRP and SCH_RP.	R4-103619
8.1.2.5	E-UTRAN OTDOA Intra-Frequency RSTD Measurements	Add the band to the band list for PRP.	R4-103619
8.1.2.6	E-UTRAN Inter-Frequency OTDOA Measurements	Add the band to the band list for PRP.	R4-103619
9.1.2	Intra-frequency RSRP Accuracy Requirements	Add the band to the band list for RSRP.	R4-103619
9.1.3	Inter-frequency RSRP Accuracy Requirements	Add the band to the band list for RSRP.	R4-103619
9.1.5	Intra-frequency RSRQ Accuracy Requirements	Add the band to the band list for RSRP.	R4-103619
9.1.6	Inter-frequency RSRQ Accuracy Requirements	Add the band to the band list for RSRP.	R4-103619
9.1.9	UE Rx – Tx time difference	Add the band to the band list for RSRP.	R4-103619
9.1.10	Reference Signal Time Difference (RSTD)	Add the band to the band list for PRP.	R4-103619
A.9.1.1	(RSRP) FDD Intra frequency case	Add the band to the band list for Noc, RSRP, and Io.	R4-103619
A.9.1.3	(RSRP) FDD—FDD Inter frequency case	Add the band to the band list for Noc, RSRP, and Io.	R4-103619
A.9.2.1	(RSRQ) FDD Intra frequency case	Add the band to the band list for Noc, RSRP, RSRQ, and Io.	R4-103619
A.9.2.3	(RSRQ) FDD—FDD Inter frequency case	Add the band to the band list for Noc, RSRP, RSRQ, and Io.	R4-103619

6.6 Required changes to 3GPP TS 36.141

Required changes in 3GPP TS 36.141 [12] are shown in Table 6.6-1.

Table 6.6-1: Required Changes for 3GPP TS 36.141 [12]

Clause	Description	Description of change	Proposed changes
5.5	Operating bands	Add a new row for the band into Table 5.5-1.	R4-102509
5.7.3	Carrier frequency and EARFCN	Add new channel numbers for the band into Table 5.7.3-1.	R4-102509
6.6.3	Operating band unwanted emissions	Add the band to Category A.	R4-102508
6.6.4.5.4	Co-existence with other systems in the same geographical area	Add a new row for the band into Tables 6.6.4.5.4.1-1 and 6.6.4.5.4-1x.	R4-102508
6.6.4.5.5	Co-location with other base stations	Add a new row for the band into Tables 6.6.4.5.5-1 and 6.6.4.5.5-2.	R4-102508
7.6.5.1	(Blocking) General requirement	Add the band into Tables 7.6-1, 7.6-1a and 7.6-1x.	R4-102508
7.6.5.2	Co-location with other base stations	Add a new row for the band into Table 7.6-3 and 7.6-4.	R4-102508

6.7 Required changes to 3GPP TS 36.307

Required changes in 3GPP TS 36.307 [13] are shown in Table 6.7-1.

Table 6.7-1: Required Changes for 3GPP TS 36.307 [13]

Clause	Description	Description of change	Proposed Changes
New clause	Band 24 Independent of Release	Add a new clause to specify the extra requirements for UE conforming to earlier releases to support this band.	R4-103241

6.8 Required changes to 3GPP TS 25.461

Required changes in 3GPP TS 25.461 [14] are shown in Table 6.8-1.

Table 6.8-1: Required changes for 3GPP TS 25.461 [14]

Clause	Description	Description of change	Proposed Changes
4.3.7	Operating bands	Add a new row for the band in Table 4.3.7.1.	R4-103240

6.9 Required changes to 3GPP TS 25.466

Required changes in 3GPP TS 25.466 [15] are shown in Table 6.9-1.

Table 6.9-1: Required changes for 3GPP TS 25.466 [15]

Clause	Description	Description of change	Proposed Changes
Annex B	Assigned fields for additional data	Add an entry for the band in Table B.2-1.	R4-103240

6.10 Required changes to 3GPP TS 25.101

Required changes in 3GPP TS 25.101 [16] are shown in Table 6.10-1.

Table 6.10-1: Required Changes for 3GPP TS 25.101 [16]

Clause	Description	Description of change	Proposed Changes
6.6.3	Spurious emissions	Add the band DL frequency range into Tables 6.13 and 6.13A for UTRA Band II, IV, V, X, XII, XIII and XIV.	R4-104674

6.11 Required changes to 3GPP TS 25.104

Required changes in 3GPP TS 25.104 [17] are shown in Table 6.11-1.

Table 6.11-1: Required Changes for 3GPP TS 25.104 [17]

Clause	Description	Description of change	Proposed Changes
6.6.3.3	Co-existence with other systems in the same geographical area	Add a new row for the band into Table 6.11.	R4-104052
6.6.3.4	Co-existence with co-located and co-sited base stations	Add a new row for the band into Tables 6.12 and 6.14.	R4-104052
6.6.3.9	Co-existence with Home BS operating in other bands	Add a new row for the band into Tables 6.20.	R4-104052
7.5.2	Minimum Requirement - Co-location with GSM900, DCS 1800, PCS1900, GSM850, UTRA FDD and/or E-UTRA FDD	Add a new row for the band into Tables 7.5C and 7.5E.	R4-104052

6.12 Required changes to 3GPP TS 25.141

Required changes in 3GPP TS 25.141 [18] are shown in Table 6.12-1.

Table 6.12-1: Required Changes for 3GPP TS 25.141 [18]

Clause	Description	Description of change	Proposed Changes
6.5.3.7.4	Co-existence with other systems in the same geographical area	Add a new row for the band into Table 6.38.	R4-104053
6.5.3.7.5	Co-existence with co-located and co-sited base stations	Add a new row for the band into Tables 6.39 and 6.41.	R4-104053
6.5.3.7.10	Co-existence with Home BS operating in other bands	Add a new row for the band into Tables 6.47.	R4-104053
7.5.5	Blocking characteristics - Test Requirements	Add a new row for the band into Tables 7.4N and 7.4Q.	R4-104053

6.13 Required changes to 3GPP TS 37.104

Required changes in 3GPP TS 37.104 [19] are shown in Table 6.13-1.

Table 6.13-1: Required Changes for 3GPP TS 37.104 [19]

Clause	Description	Description of change	Proposed Changes
6.6.1.3	Additional spurious emissions requirements	Add a new row for the band into Table 6.6.1.3.1-1.	R4-104054
6.6.1.4	Co-existence with co-located and co-sited base stations	Add a new row for the band into Table 6.6.1.4.1-1.	R4-104054
7.5.2	Co-location minimum requirement	Add a new row for the band into Table 7.5.2-1.	R4-104054

6.14 Required changes to 3GPP TS 37.141

Required changes in 3GPP TS 37.141 [20] are shown in Table 6.14-1.

Table 6.14-1: Required Changes for 3GPP TS 37.141 [20]

Clause	Description	Description of change	Proposed Changes
6.6.1.5.5	Additional spurious emission requirements	Add a new row for the band into Table 6.6.1.5.5-1.	R4-104055
6.6.1.5.6	Co-location with other Base Stations	Add a new row for the band into Table 6.6.1.5.6-1.	R4-104055
7.5.5.2	Co-location test requirements	Add a new row for the band into Table 7.5.5.2-1.	R4-104055

7 Project plan

7.1 Schedule and Work Task Status

The schedule and work task status for this work item are summarized in Table 7.1-1 below.

Table 7.1-1 Schedule and Work Task Status

RAN4 Meeting and Date	Work Tasks	Status
RAN4#55 (April 2010)	TR Skeleton	Approved
	Summary of required changes to E-UTRA specifications	Approved
	Band and channel arrangement	Approved
RAN4 Ad-hoc#3 (June 2010)	Work plan	Approved
	Task description and regulatory background	Approved
	Discussion on specific BS RF requirements	Approved
	Discussion on specific UE RF requirements (maximum output power with additional requirements, spurious emissions, reference sensitivity power level, blocking characteristics)	Approved
	Agreement on band and channel arrangement	Approved
RAN4#56 (August 2010)	Agreement on specific BS RF requirements	Approved
	Continue discussion on specific UE RF requirements	Approved
RAN4 Ad-hoc#4 (October 2010)	Agreement on specific UE RF requirements	Approved
	Draft CRs for review and comment	Approved
RAN4#57 (November 2010)	Final TR	Approved
	Final CRs	Approved

8 Open issues

None as of December, 2010.

Annex A (informative): Configuration Example

This section provides one example of how a practical L-Band eNodeB may be configured. The example uses the following parameters: Two 10 MHz LTE carriers in a given sector.

- Centre frequency of Carrier-1: 1526-1536MHz
  - Channel Power : 20Watt +20watts (2Tx)
  - Power of Carrier-1: Maximum 32 dBW
- Centre frequency of Carrier-2: 1545.2-1555.2 MHz
  - Channel Power : 20Watt + 20watts (2Tx)
  - Power of Carrier-2: Maximum 32 dBW
- Peak antenna gain: 16 dBi
- Cable Loss: 0.5-2 dB

The emission mask and the actual BTS power spectral density measured at the antenna connector is shown below in Figure A.1

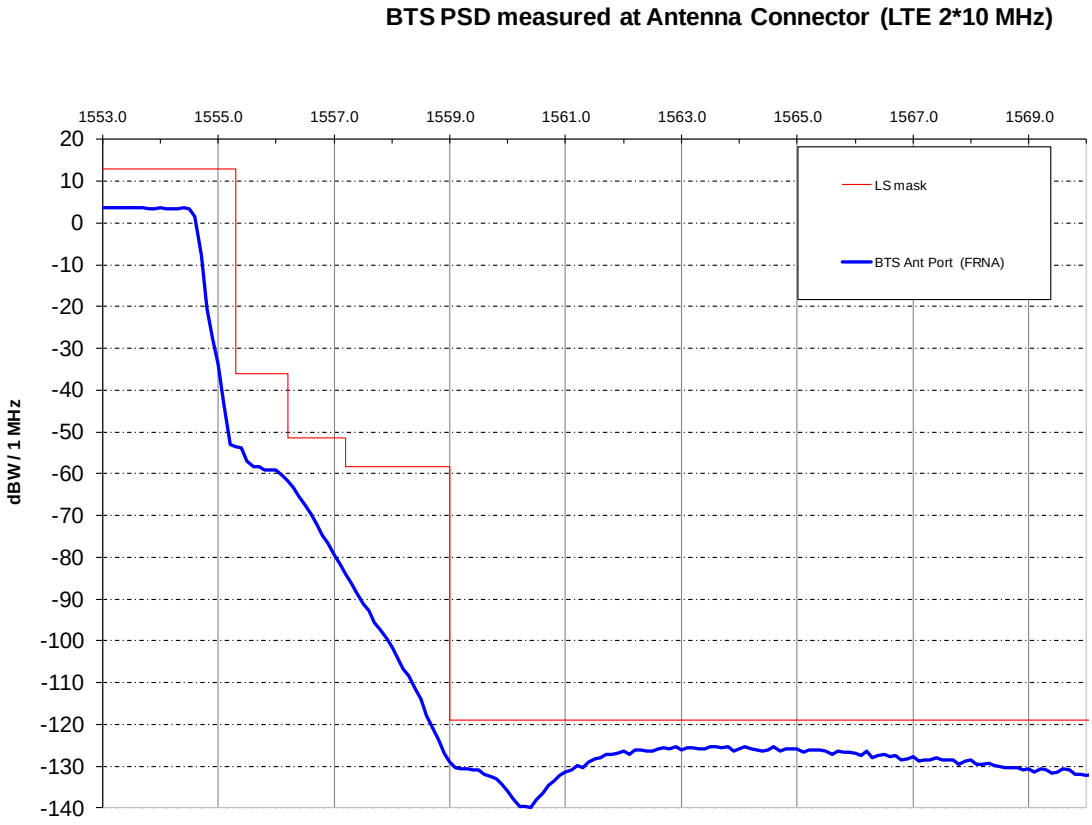


Figure A.1: BTS PSD measured at the antenna connector (LTE 2*10 MHz)

It is noteworthy that this is no more than an example. It is technically feasible to deploy at other centre frequencies anywhere in the L-band (subject to coordination with other satellite operators such as Inmarsat), at other BTS power levels, with other types of filters offering greater selectivity, and with other antenna gains.

While it is acknowledged that meeting the GPS emission level gets more demanding as one gets closer to the upper edge of the band (1559 MHz), several deployment options exist that make it feasible to use frequencies up to 1559 MHz for ATC. These include the following:

- Reducing the BTS power level (e.g. use for microcells)
- Using a post-selector filter per carrier – the above example uses a single (band-wide) filter to cover both carriers
- Use a bulkier filter with more elements – the present filter was designed for use on remote radio heads
- Use lower antenna gain

Annex B (informative): Change history

Change history

Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2010-05	RAN4 #55	R4-102213			TR skeleton created from 3GPP TS template.		0.0.1
2010-06	RAN4 AH #3	R4-102590			TR updated to include L-Band description of changes to specifications; addition of TS 36.307	0.0.1	0.0.2
2010-08	RAN4 #56	R4-103402			TR updated to include changes to sections 4.2, 5.1, 5.3, 6.7, 7.1, and 8	0.0.2	0.1.0
2010-08	RAN4 #56	R4-103430			TR updated to include changes to sections 4.1, 4.2, 5.1.5, 5.3, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, and 7.1	0.1.0	0.2.0
2010-08	RAN4 #56	R4-103453			TR updated to include changes to sections 5.2, 6.1, 6.2, 7.1, and 8	0.2.0	0.3.0
2010-08	RAN4 #56	R4-103462			TR corrects Band 24 parameter references in the tables listed in section 5.2.1, and removes operator references in section 5.2.3 and section 8	0.3.0	0.3.1
2010-09	RAN #49	RP-100995			TR updated to v1.0.0 based on completion status.	0.3.1	1.0.0
2010-11	RAN4 #57	R4-104678			TR updated to include changes in section 2, 3.1, 4, 5.1.5, 5.2.3, 5.3.1, 5.3.2, 5.3.3, 5.3.4, 6.5, 6.10, 6.11, 6.12, 6.13. 6.14, 7.1, 8, and removed brackets for Band [24] references and parameters throughout the TR	1.0.0	1.1.0
2010-11	RAN4 #57	R4-104970			TR updated to include changes in sections: 5.1.5, 5.3.2, 5.3.6.2, 7.1, and 9	1.1.0	1.2.0
2010-12	RAN #50	RP-10285			TR updated to v2.0.0 based on completion status and presented to RAN for approval	1.2.0	2.0.0
2010-12	RAN #50	RP-10285			TR Approved	2.0.0	10.0.0
2011-04	RP-51	RP-110118	002	1	Overload Characteristics of GPS Receivers in Proximity to LTE L-band Terrestrial Base Stations (BTS)	10.0.0	10.1.0