



Report ITU-R RS.2336-0
(11/2014)

**Consideration of the frequency bands
1 375-1 400 MHz and 1 427-1 452 MHz for
the mobile service – Compatibility with
systems of the Earth exploration-satellite
service (EESS) within the 1 400-1 427 MHz
frequency band**

RS Series
Remote sensing systems

Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

Policy on Intellectual Property Right (IPR)

ITU-R policy on IPR is described in the Common Patent Policy for ITU-T/ITU-R/ISO/IEC referenced in Annex 1 of Resolution ITU-R 1. Forms to be used for the submission of patent statements and licensing declarations by patent holders are available from <http://www.itu.int/ITU-R/go/patents/en> where the Guidelines for Implementation of the Common Patent Policy for ITU-T/ITU-R/ISO/IEC and the ITU-R patent information database can also be found.

Series of ITU-R Reports

(Also available online at <http://www.itu.int/publ/R-REP/en>)

Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	Fixed service
M	Mobile, radiodetermination, amateur and related satellite services
P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management

Note: This ITU-R Report was approved in English by the Study Group under the procedure detailed in Resolution ITU-R 1.

Electronic Publication
Geneva, 2015

© ITU 2015

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without written permission of ITU.

REPORT ITU-R RS.2336-0¹**Consideration of the frequency bands 1 375-1 400 MHz and 1 427-1 452 MHz for the mobile service – Compatibility with systems of the Earth exploration-satellite service (EESS) within the 1 400-1 427 MHz frequency band****1 Introduction**

In order to support requirements for “mobile broadband”, the frequency bands 1 375-1 400 MHz and 1 427-1 452 MHz have been called for studies.

The frequency band 1 400-1 427 MHz is currently allocated to the Earth exploration-satellite service (EESS)(passive), used in particular by the ESA SMOS (Soil Moisture and Ocean Salinity) satellite as well as to the more recent NASA Aquarius/SAC-D sensor.

Coexistence studies between the mobile service and EESS (passive) at 1.4 GHz have already been carried out in ITU-R and led to the adoption of Report ITU-R SM.2092 (§ 6). However, these studies only considered the uplink case (user equipment (UE) emissions) in Japan (2G and 3G) in the 1 427-1 452 MHz frequency band and roughly concluded that, under various assumptions and conditions, a level of unwanted emissions of –60 dBW/27 MHz in the 1 400-1 427 MHz frequency band is required to ensure protection of EESS (passive). This level of –60 dBW/27 MHz was subsequently included in Resolution **750 (Rev.WRC-12)** as a “recommended level” for the “mobile” frequency bands 1 350-1 400 MHz and 1 427-1 452 MHz.

It appears obvious that these studies have to be reconsidered to take into account the surrounding of the passive band 1 400-1 427 MHz by both uplink and downlink of mobile systems, the larger deployment of mobile networks compared to the situation in Japan, the deployment of base-stations and not only UE as well as most likely different characteristics of mobile systems expected in these frequency bands.

The present Report provides analyses based on both static scenario and dynamic methodology to address the compatibility between IMT systems in the frequency bands 1 375-1 400 MHz and 1 427-1 452 MHz and EESS (passive) systems in the 1 400-1 427 MHz frequency band.

This Report also provides possible mitigation measures to reduce unwanted emission level of IMT systems falling into the EESS (passive) frequency band as shown in Annex 1.

2 Technical characteristics**2.1 EESS (passive) systems****2.1.1 Interference criteria**

The EESS (passive) interference criterion in the 1 400-1 427 MHz frequency band is given in Recommendation ITU-R RS.2017, as a value of –174 dBW/27 MHz associated with a 0.1% of area or time it may be exceeded (over a measurement area of 10 000 000 km²).

Although the level of unwanted emissions –60 dBW/27 MHz in Resolution **750 (Rev.WRC-12)** was assessed in Report ITU-R SM.2092 using this EESS (passive) interference criterion (–174 dBW/27 MHz), it is necessary to stress the fact that this criterion is given for all interference

¹ This Report was approved jointly by Radiocommunication Study Groups 5 and 7, and any future revision should also be undertaken jointly.

sources (not only the immediately adjacent channel). Hence, under WRC-15 agenda item 1.1, unwanted emissions should be apportioned between the mobile service and the other services operating in the two adjacent frequency bands.

In the case both 1 375-1 400 MHz and 1 427-1 452 MHz frequency bands are considered to be used simultaneously by mobile applications (uplink and downlink), the above level will have to be considered against the aggregate interference from equipment in both frequency bands as well as possible other sources as detailed below:

- 1 dB interference margin for interference from all other sources (e.g. spurious from systems of services below 1 375 MHz or above 1 452 MHz), taking into account that a country deploying IMT systems in these frequency bands may not deploy systems or stations of other services in the same frequency band;
- Apportionment between base-station and UE of the mobile service can be weighted to account for the likely difficulty for UE to comply with the required limit. An apportionment ratio (ABT) of 20% for base-station and 80% for UE has been considered.

Under these assumptions, the relevant maximum interference can be calculated as:

$$\text{Maximum interference} = -174 \text{ dBW/27MHz} - 1 \text{ dB} + 10 \times \log(\text{ABT})$$

and are given in the following Table 1.

TABLE 1
Maximum interference levels

	Unit	User equipment	Base-station
Maximum interference	dBW/27 MHz	-176	-182

On the other hand, if only one of the 1 375-1 400 MHz or 1 427-1 452 MHz frequency bands were to be considered for mobile applications (uplink or downlink), a different apportionment would be required, assuming a 3 dB interference margin for interference from all other sources. Under these assumptions, the relevant maximum interference level would be -177 dBW/27 MHz .

2.1.2 Parameters

The following Table 2 provides relevant EESS (passive) parameters to be used in the study, mainly taken from Recommendation ITU-R RS.1861.

TABLE 2
EESS (passive) parameters

	Sensor A1	Sensor A1*	Sensor A2	Sensor A3
Sensor type	Interferometric radiometer (single)	Interferometric radiometer (composite)	Conical scan	Push broom
Orbit parameters				
Altitude	757 km		670 km	657 km
Inclination	98°			
Eccentricity	0°			
Repeat period	3 days		3 days	7 days

TABLE 2 (end)

	Sensor A1	Sensor A1*	Sensor A2	Sensor A3
Sensor type	Interferometric radiometer (single)	Interferometric radiometer (composite)	Conical scan	Push broom
Sensor antenna parameters				
Number of beams	1	16 384	1	3
Reflector diameter	19 cm	3 arms 4 m length, equi-spaced 120°	6.2 m	2.5 m
Maximum beam gain	9 dBi	24 dBi	37 dBi	29.1, 28.8, 28.5 dBi
Polarization	V, H			
–3 dB beamwidth	64°	1.8-2.4°	2.6°	6.1°, 6.3°, 6.6°
Off-nadir pointing angle	32°		35.5°	25.8°, 33.8°, 40.3°
Beam dynamics	Fixed		14.6 rpm	Fixed
Incidence angle at Earth	2°/48°		39.9°	27.8°, 37.8° and 45.6°
–3 dB beam dimensions	64°	50 km (35 km centre of FOV)	50.1 × 38.5 km	94 × 76 km, 120 × 84 km 156 × 97 km
Instantaneous field of view	Front semi-sphere (2π stereoradians)		Same as –3 dB dimensions, above	
Main beam covering area	2 638 745 km ²	8 300 km ²	1 402 km ²	TBD
Sensor antenna pattern	Recommendation ITU-R RS.1813			
Sensor receiver parameters				
Sensor integration time	1.2 s		84 ms	6 s
Channel bandwidth	19 MHz		27 MHz	26 MHz

* The sensor A1 antenna is composed of 69 single 9 dBi antenna elements forming a composite antenna of 24 dBi. Interference need to be assessed for both figures noting that their respective covering area is different.

2.2 Mobile systems deployment and parameters

The compatibility studies being related to unwanted emissions, for both UE and base-stations the level of unwanted emissions of –60 dBW/27 MHz in the 1 400-1 427 MHz frequency band (consistent with Resolution **750 (Rev.WRC-12)**) was taken as a reference.

As far as the base-stations are concerned, it has been considered that each base-station will include three sectors of 120°. However, it has also been assumed that, on average, emissions from one sector will always be blocked. In the end, only two sectors per base-stations have been considered with the following parameters:

- antenna gain = 17 dBi;

- antenna pattern = Recommendation ITU-R F.1336-4 ($k_v = 0.3$);
- antenna elevation = -6° (downtilt);
- feeder losses = 3 dB;
- average activity factor = 50%.

Considering UE, it has been assumed that, on average, 1 UE will always be transmitting within each of the two sectors. The following parameters have been considered for UE:

- antenna gain = -3 dBi;
- antenna pattern = omnidirectional;
- body loss = 4 dBi;
- outdoor terminal in visibility of the satellite = 10%;
- outdoor terminals with blocking (10 dB attenuation) = 20%;
- indoor terminals (12 dB attenuation) = 70%.

3 Analysis for unwanted emissions levels applied for a station of IMT systems to ensure protection for EESS (passive) systems

Based on the above assumptions and mobile service deployments, the relevant analyses are performed using a static scenario (§ 3.1) and a dynamic methodology (§ 3.2).

3.1 Static analysis

3.1.1 Mobile systems deployment

In addition to the parameters given in § 2 above, the following assumptions were considered.

The maximum number of sites in the main beam cover (2 000) is derived from the number of sites around Paris (as a dense urban area). In a country like France (550 000 km²) the number of sites for one national network is approximately 20 000 and taking into account geographical variation and the presence of seas, a number of 50 000 sites has been roughly assumed for the SMOS single main beam cover.

Base-stations that are within the beam coverage of a satellite have their antenna gain discrimination that may vary depending on the size of this covered area:

- slight variations with small beam coverage (directional antenna: SMOS Composite & Hydros) resulting in strong discrimination value (22 dB, using an incidence angle of $\sim 35^\circ$);
- strong variations with large beam coverage (non-directional antenna SMOS Single elements), resulting in lower discrimination value (17 dB, assuming an incidence angle ranging from 2° to 48°) (See Table 2).

The aggregate interference from UE in a given cell is assumed to correspond, on average, to one UE transmitting at an average output power of 15 dBm (over all resource block (RB)) per base-station sector. This assumption is equivalent to the case in which there would be several UE in a given cell with a low activity factor. With this, the number of UE is considered to be the same as the number of sectors.

3.1.2 Maximum unwanted emissions limits for user equipment and base-station

The calculations of unwanted emissions limits in Report ITU-R SM.2092 were only considering a deployment of UE (i.e. uplink) in Japan (i.e. an area of 377 000 km²). At this stage, using the methodology and assumptions in Report ITU-R SM.2092, it is possible to reassess the compatibility between EESS (passive) sensors and UE (e.g. within 1 375-1 400 MHz uplink) which

unwanted emissions are limited to -60 dBW/27 MHz and also between EESS (passive) sensors and base-stations (e.g. within 1 427-1 452 MHz downlink).

According to the Report ITU-R SM.2092, single-entry interference level and aggregate interference level formula are given:

$$\text{unwanted emissions Interference} = E_{\text{unwanted}} - L_{\text{free space}} + G_r \quad (1)$$

where:

E_{unwanted} : e.i.r.p. density (dB(W/27 MHz)) of mobile unwanted emissions integrated over 1 400-1 427 MHz

$L_{\text{free space}}$: free space loss to passive sensor (dB)

G_r : EESS receiving antenna gain (dBi).

The aggregate interference level is calculated while considering the average number of devices (UE/base-stations) (N_m) within -3 dB contour of the sensor main beam. The following Tables 3 and 4 provide the detailed calculations for the UE and base-stations cases respectively.

TABLE 3

Detailed derivation of the unwanted emissions limits for UE required for different satellite systems

Mobile Terminals scenario		SMOS Single	SMOS Composite	HYDROS
Free Space losses (at 1 413.5 MHz)	dBi	154.59	154.59	154.01
EESS main beam cover area	km ²	2 638 745	8 300	1 402
EESS Receiving antenna gain	dBi	9	24	35
Total number of equivalent full power terminals in the main beam cover		50 000	2 000	330
Outdoor UE in visibility (P1)	%	10	10	10
Outdoor UE with blocking (P2)	%	20	20	20
Indoor UE (P3)	%	70	70	70
Indoor/outdoor attenuation (A3)	dB	12	12	12
Blocking attenuation (A2)	dB	10	10	10
Nb of Equivalent visibility outdoor terminals ²		8 208.4	328.3	54.2
UE antenna gain	dBi	-3	-3	-3
Effect of human body absorption	dB	-4	-4	-4
Interference level for a -60 dBW/27 MHz unwanted emissions	dBW/27 MHz	-173.4	-172.4	-168.7
Maximum interference level (2 Mobile bands)	dBW/27 MHz	-176	-176	-176
Maximum unwanted emissions per terminal (2 adjacent mobile allocations)	dBW/27 MHz	-62.6	-63.6	-67.3

² Equivalent visibility outdoor terminal = total number of terminals in main beam x $(P1+P2*10^{(-A2/10)}+P3*10^{(-A3/10)})$.

TABLE 3 (*end*)

Mobile Terminals scenario		SMOS Single	SMOS Composite	HYDROS
Maximum interference level (1 Mobile band)	dBW/27 MHz	-177	-177	-177
Maximum unwanted emissions per terminal (1 adjacent mobile allocation)	dBW/27 MHz	-63.6	-64.6	-68.3

TABLE 4

**Detailed derivation of the unwanted emissions limits for base-stations
required for different satellite systems**

Base-stations scenario	Unit	SMOS Single	SMOS Composite	HYDROS
EESS Receiving antenna gain	dBi	9	24	35
Total number of sites in the main beam cover		50 000	2 000	330
2 sectors per site	dB	+3	+3	+3
Base-station Activity Factor (50%)	dB	-3	-3	-3
Base-station antenna gain (including the average antenna gain discrimination in the direction of the EESS sensor)	dBi	0	-5	-5
Effect of human body absorption	dB	0	0	0
Interference level for a -60 dBW/27 MHz unwanted emissions	dBW/27 MHz	-161.6	-165.6	-161.8
Maximum interference level (2 Mobile bands)	dBW/27 MHz	-182	-182	-182
Maximum unwanted emissions per base-station (2 adjacent mobile allocations)	dBW/27 MHz	-80.4	-76.4	-80.2
Maximum interference level (1 Mobile band)	dBW/27 MHz	-177	-177	-177
Maximum unwanted emissions per base-station (1 adjacent mobile allocation)	dBW/27 MHz	-75.4	-71.4	-75.2

3.1.3 Summary of the static analysis

TABLE 5A

Maximum unwanted emissions value to protect EESS (passive)
(case both 1 375-1 400 MHz and 1 427-1 452 MHz frequency bands are considered to be used simultaneously by mobile applications)

	Unit	SMOS Single	SMOS Composite	HYDROS
Maximum unwanted emissions per base-station (see Table 4)	dBW/27 MHz	-80.4	-76.4	-80.2
Maximum unwanted emissions per UE (see Table 3)	dBW/27 MHz	-62.6	-63.6	-67.3

TABLE 5B

Maximum unwanted emissions value to protect EESS (passive)
(case only one of the 1 375-1 400 MHz and 1 427-1 452 MHz frequency bands is considered to be used by mobile applications)

	Unit	SMOS Single	SMOS Composite	HYDROS
Maximum unwanted emissions per base-station (see Table 4)	dBW/27 MHz	-75.4	-71.4	-75.2
Maximum unwanted emissions per UE (see Table 3)	dBW/27 MHz	-63.6	-64.6	-68.3

3.2 Dynamic analysis

3.2.1 EESS sensors dynamic parameters

The dynamic analysis below only considers the sensor type A1 (i.e. SMOS) for both single and composite scenario as described in § 2 above.

Since the conditions defined by Recommendation ITU-R RS.2017 encompasses a 10 000 000 km² reference area for the application of the EESS protection criteria, this reference area has been considered as follows for this study:

- Coordinates of the centre of the area: 46 N – 3 E;
- Radius = 1 785 km.

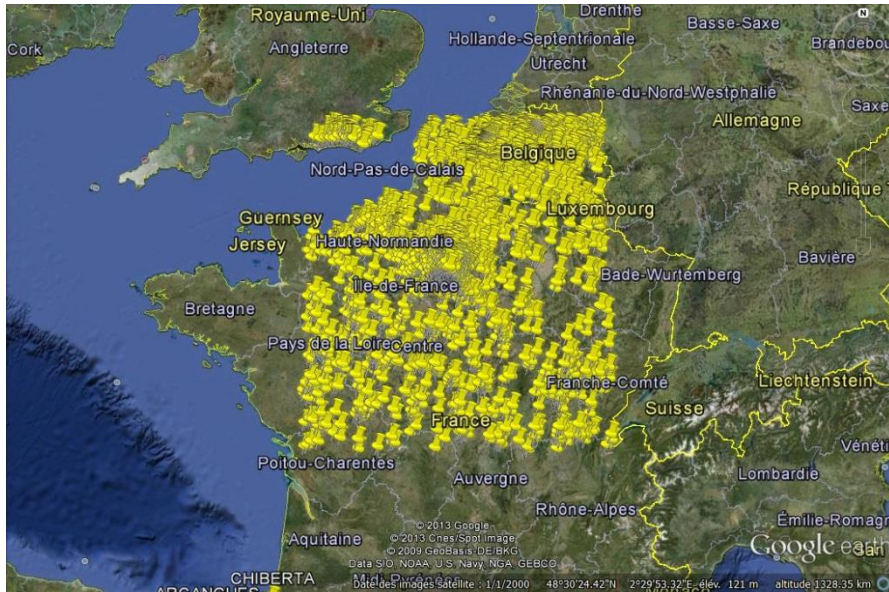
The satellite orbit and sensor pointing have been simulated with a one second time step and a period of six days. Over the 10 000 000 km² reference area, these simulations lead to around 10 000 interference calculation samples.

3.2.2 Mobile systems deployment and parameters

A deployment of 3 000 base-stations has been considered, deployed over a square area of 300 000 km² centred on Paris as shown in Fig. 1. This represents a density of 1 base-station per 100 km².

It should be noted that this deployment is made according to the population densities and that, to this respect, the number of stations within a square of 10 000 km² including Paris area is about 1 800. This represents a density of 18 base-stations per 100 km².

FIGURE 1
Deployment of mobile base-stations



It is expected that each base station will include three sectors of 120°. However, it has also been assumed that, on average, emissions from one sector will always be blocked. In addition, it was considered that one of the remaining two sectors per base-station will be further attenuated by 10 dB.

The azimuth of each base-station has been selected randomly (i.e. the azimuth A1 of the first sector is randomly selected and the azimuth A2 of the second sector is derived as $A2 = A1 + 120^\circ$).

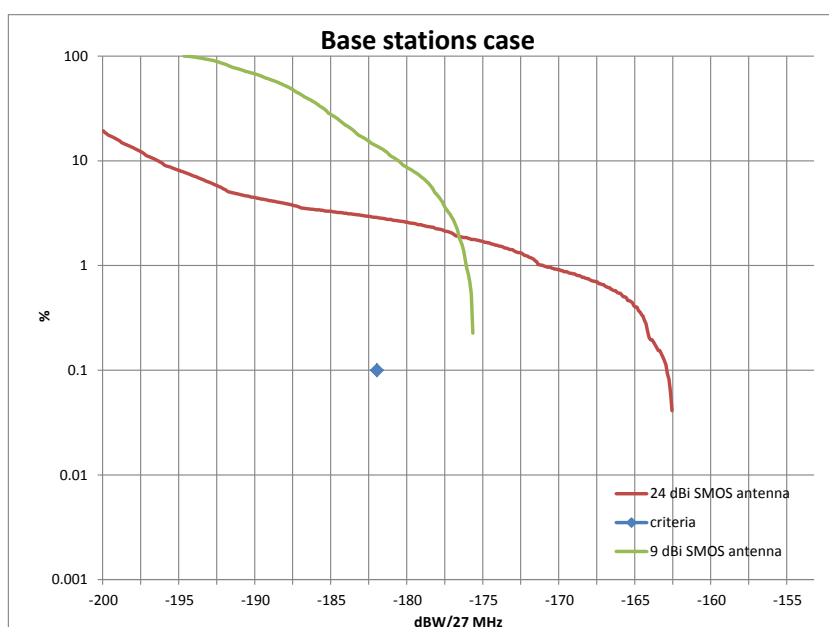
Considering UE, it has been assumed that, on average, 1 UE will always be transmitting at an average output power of 15 dBm (over all RB) within each base-station sector. At the end, 6 000 UE simultaneously transmitting have been considered.

Parameters of both base-stations and UE given in § 2 above have been used in the calculations for the two scenarios pertaining to the SMOS sensor (single antenna 9 dBi and composite antenna 24 dBi).

3.2.3 Dynamic simulations for base-stations

Figure 2 below provides the resulting interference distributions for the base-stations case, obviously depicting a large exceedance of the interference criteria, about 19 dB (for the radiometer 24 dBi composite antenna) and 6 dB (for the radiometer 9 dBi antenna elements).

FIGURE 2
Interference distribution for the base-stations case



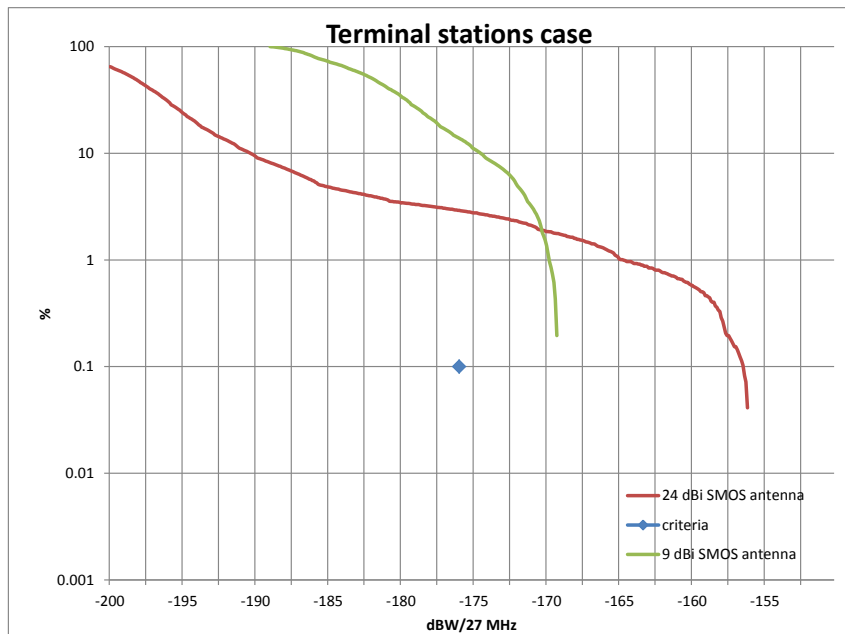
These calculations confirm the previous conclusion that, for base-stations, the current unwanted emissions level of -60 dBW/27 MHz is not able to ensure protection of passive sensors.

It is not expected that any mitigation technique could be applied in this case, meaning that to ensure protection of passive sensors in the 1 400-1 427 MHz frequency band, an unwanted emissions level of -79 dBW/27 MHz in the 1 400-1 427 MHz frequency band will be required for each sector of the base-stations according to this study.

3.2.4 Dynamic simulations for user equipment

Figure 3 below provides the resulting interference distributions for the UE case. The raw calculations obviously depict a large exceedance of the interference criteria, about 20 dB (for the radiometer 24 dBi composite antenna) and 7 dB (for the radiometer 9 dBi antenna elements).

FIGURE 3
Interference distributions for the UE case



Unlike for the base-station case, a number of mitigation techniques can be expected to improve this situation.

These raw calculations represents a situation where all UE would be operated outdoor and in visibility of the EESS (passive) sensor.

Assuming the following assumptions as given in § 2 above would lead to a mitigation factor of about 8 dB:

- 10% outdoor UE in visibility;
- 20% outdoor UE with blocking (10 dB);
- 70% indoor UE (12 dB attenuation).

Consideration of a “human body absorption” factor could also provide additional mitigation and a factor of 4 dB has been proposed (see § 2 above).

Overall, however, these calculations show that, for UE also, the current unwanted emissions level of -60 dBW/27 MHz is not able to ensure protection of passive sensors.

Applying the abovementioned mitigation factors would mean that to ensure protection of passive sensors in the 1 400-1 427 MHz frequency band, an unwanted emissions level of -68 dBW/27 MHz in the 1 400-1 427 MHz frequency band will be required for each UE. This level is to be considered for an average output power of 15 dBm (over all RB).

4 Analysis of compatibility between EESS (passive) systems and IMT systems using measured unwanted emission levels of IMT equipment

In this section, it is analysed if currently available IMT equipment³ could meet the maximum allowable emission levels to protect the EESS (passive) systems calculated in § 3. It is essential to evaluate compatibility between the EESS (passive) systems and IMT systems based on realistic assumptions. For example, although the technical characteristics of IMT equipment are specified in telecommunication standards (e.g. 3GPP), the values specified in these standards include margin for implementation of the equipment.

Nevertheless the current standards as well as specification for IMT systems appear to specify unwanted emission levels that are as much as 30 dB less stringent than the one recommended in the Radio Regulations (RR) edition 2012 (−60 dBW/27 MHz).

Achievable performance in IMT equipment, such as unwanted emission levels, is probably better than those specified in the standards. Furthermore, as each station in IMT systems is operated under dynamic transmission power control to minimize intra-system interference, the station does not always use maximum transmission power.

Therefore, the assessment of the feasibility for IMT stations to meet the unwanted emissions levels resulting from the compatibility studies should be made taking into account practical design consideration of IMT systems and consistently with study assumptions.

In order to assess the compatibility under such realistic conditions, measured unwanted emission levels assuming different operating conditions for IMT UE and base-stations are summarized as shown in Tables 6 and 7.

TABLE 6

Measured unwanted emission levels of an IMT UE (in dBW per 27 MHz)

		Guard band (Frequency separation from the measured 27 MHz bandwidth)				
		0 MHz	0.9 MHz	5 MHz	10 MHz	20 MHz
Transmitting output power of an IMT UE	23 dBm	−49.6	−49.5 ⁴	−52.5 ⁵	−57.6	−76.2
	15 dBm	−54.9	−55.8	−59.6	−65.8	−87.6
	0 dBm	−64.8	−67.3	−71.6	−81.5	−98.1
	−9 dBm	−77.9	−80.1	−84.3	−93.9	−100.5

NOTE – Measurement conditions are as follows:

- Two commercial LTE UE of different vendors were used for the measurement. The UE had the capability to transmit LTE signals in the 1 447.9-1 462.9 MHz frequency band (measured in the 1 420.9-1 447.9 MHz).
- Transmitting bandwidth of LTE signal was 15 MHz using full RB assignment. Unwanted emission levels would be reduced in the case of smaller transmitting bandwidth of the LTE signal and/or fewer resources blocks.

³ For the purposes of this section, LTE equipment were used to represent IMT systems.

⁴ According to the specifications in the 3GPP TS 25.101, the unwanted emission level of −30.2 dBW/27 MHz is calculated, which is about 19 dB higher than the measured value here.

⁵ According to the specifications in the 3GPP TS 25.101, the unwanted emission level of −32.8 dBW/27 MHz is calculated, which is about 20 dB higher than measured value here.

- The averaged values obtained through the measurements were used.
- The transmitting output power of 23 dBm corresponded to the maximum output power, 15 dBm to the average output power value for transmitting UE, 0 dBm to the average output power value for terminals in an active mode in a rural area, and –9 dBm to the average output power value for terminals in an active mode in a suburban/urban area.

For UE, the measured unwanted emission levels do not exceed the levels calculated in § 3 to protect the EESS (passive) systems when using the transmission power values such as 0 and –9 dBm. On the other hand, these measurements show that the unwanted emissions of LTE UE operating at the average power (15 dBm) and the maximum power (23 dBm) do exceed these levels.

Also, these measurements show that increasing the guard band size would improve the IMT UE unwanted emission level in the 1 400-1 427 MHz frequency band.

TABLE 7

Measured unwanted emission levels of an IMT base-station (in dBW per 27 MHz)

		Guard band (Frequency separation from the measured 27 MHz bandwidth)				
		0 MHz	0.9 MHz	5 MHz	10 MHz	20 MHz
Transmitting output power of an IMT base-station	23 dBm	–31.6	–44.4	–53.3	–83.3	–113.8

NOTE – Measurement conditions are as follows:

- One commercial LTE base-station was used for the measurement. The station had the capability to transmit LTE signals in the 1 495.9-1 510.9 MHz frequency band.
- Transmitting bandwidth of LTE signal was 15 MHz using full RB assignment.

For IMT base-stations, the measured unwanted emission levels exceed the levels calculated in § 3 to protect the EESS (passive) systems when the guard band size is 5 MHz or less. In the case of the guard band size of 10 MHz or larger, the measured unwanted emission levels are drastically reduced as shown in Table 7.

Differences between IMT user terminals and base-stations in relation to achievable unwanted emission levels may be considered as follows;

- reduced unwanted emission level of IMT mobile stations could be usually obtained in accordance with effect of transmission power control in IMT systems;
- additional filtering to reduce unwanted emission in the adjacent frequency band could be implemented to IMT base-stations assuming a certain size of guard band.

Taking into account the above considerations, it is concluded that when considering lower output power of 0 or –9 dBm, unwanted emission level in IMT user terminals could meet the required unwanted emission level to protect the EESS (passive) systems which is not the case when using the average (15 dBm) or the maximum (23 dBm) power. Meanwhile, the unwanted emission level in IMT base-stations would need to be improved when employing a small size of guard band.

5 Analysis of existing technical standards

Based on the current unwanted emission mask specified in 3 GPP for UE (LTE) in the frequency band 1 427-1 452 MHz, it is possible to calculate the corresponding total unwanted emission power in the 1 400-1 427 MHz frequency band, as follows in Tables 8 and 9.

TABLE 8

Case of LTE system with 5 MHz BW

unwanted emission level (dBm/1 MHz)	in dBW/1 MHz	from (MHz)	to (MHz)	bandwidth (MHz)	unwanted emission power in this band (dBW)
-1.5	-31.5	1 427	1 426.9	0.1	-41.5
-8.5	-38.5	1 426.9	1 422.9	4	-32.5
-11.5	-41.5	1 422.9	1 421.9	1	-41.5
-23.5	-53.5	1 421.9	1 417.9	4	-47.5
-30	-60	1 417.9	1 400	17.9	-47.5
TOTAL		1 427	1 400	27	-31.3

TABLE 9

Case of LTE system with 10 MHz BW

unwanted emission level (dBm/1 MHz)	in dBW/1 MHz	from (MHz)	to (MHz)	bandwidth (MHz)	unwanted emission power in this band (dBW)
1.5	-28.5	1 427	1 426.9	0.1	-38.5
-8.5	-38.5	1 426.9	1 422.9	4	-32.5
-11.5	-41.5	1 422.9	1 417.9	5	-34.5
-23.5	-53.5	1 417.9	1 412.9	5	-46.5
-30	-60	1 412.9	1 400	12.9	-48.9
TOTAL		1 427	1 400	27	-29.6

These calculation show that unwanted emissions masks as currently specified in international technical standards depict a situation exceeding the currently recommended levels in Resolution **750 (Rev.WRC-12)** (-60 dBW/27 MHz) by 28.7 dB and 30.4 dB for LTE systems with bandwidth of 5 MHz and 10 MHz respectively.

6 Conclusions

This Report provides studies with both static and dynamic analysis on the compatibility between IMT systems in the frequency bands 1 375-1 400 MHz and 1 427-1 452 MHz and systems of EESS (passive) in the 1 400-1 427 MHz frequency band.

These studies show that, for base-stations, the following levels of unwanted emissions in the 1 400-1 427 MHz frequency band are required:

- -80 dBW/27 MHz in the case where both 1 375-1 400 MHz and 1 427-1 452 MHz frequency bands are considered to be used simultaneously by IMT mobile applications;

- -75 dBW/27 MHz in the case where only one of the 1 375-1 400 MHz or 1 427-1 452 MHz frequency bands is to be considered for IMT mobile applications.

As for UE, these studies depict a quite important deficit compared to the currently recommended level of -60 dBW/27 MHz and show that the following level of unwanted emissions in the 1 400-1 427 MHz frequency band is required:

- -65 dBW/27 MHz⁶ to be considered for IMT mobile applications.

Finally, before concluding on the IMT identification in the frequency bands adjacent to 1 400-1 427 MHz, further work may be needed to evaluate the feasibility to design mobile equipment (base-station or UE) compliant with the values above.

Possible mitigation measures to reduce unwanted emissions of IMT systems falling into the 1 400-1 427 MHz frequency band allocated to the EESS (passive) are investigated and provided in the Annex 1. The adoption of these measures would require careful consideration of their potential impacts on IMT systems.

It is to be noted that this discussion on techniques to reduce unwanted emissions does not have an impact on the required unwanted emission levels but rather discusses how these levels can be achieved.

Annex 1

Consideration on possible mitigation measures to reduce unwanted emissions of IMT systems falling into the 1 400-1 427 MHz EESS (passive) band

In order to protect the EESS (passive) systems and allow unwanted emissions of IMT systems to comply with required level specified in the present Report, some mitigation measures might be necessary under some conditions.

It is to be noted that the measures identified in this section do not have an impact on the required unwanted emission levels, but simply indicate how these levels could be achieved by the IMT stations (channel arrangements, guard bands, improved filters).

Possible mitigation measures for IMT systems are listed in the table below. When employing these mitigation measures, potential impacts on the IMT systems should also be taken into account.

⁶ This value is derived under the assumption of one terminal transmitting at an average output power of 15 dBm (over all RB) per sector, as shown in § 3.1.1. It would therefore have to be verified consistently according to these conditions.

TABLE

Possible mitigation measures to be applied to IMT systems

Possible mitigation measures	Expected effect and assessment
<p>Frequency arrangement related matters:</p> <ul style="list-style-type: none"> – To adopt a certain guard band between the frequency edge of the EESS (passive) frequency band and the nearest IMT operating frequency. – To assign IMT uplink to the frequency range adjacent or closer to the passive frequency band. 	<ul style="list-style-type: none"> – This measure further reduces unwanted emission levels from IMT stations falling into the EESS (passive) frequency band. It could become more effective in case additional filtering is applied in IMT base-stations; however, it will reduce the frequency band usage efficiency of IMT systems. – It reduces efficiency of frequency band usage, since certain frequency bands cannot be used in IMT systems. – One study indicates that adjacent channel simulations estimate 6 MHz guard band for the UE transmitters without another mitigation technique. It also shows that for the eNodeB, apart from the 6 MHz guard band and further attenuation of 13 dB is necessary in case without another mitigation technique. – By this assignment, compatible operation of both systems could be more facilitated. – It limits IMT frequency arrangements employed in the frequency band.
<p>Equipment related matters:</p> <ul style="list-style-type: none"> – To employ additional or improved filter devices to reduce unwanted emission levels. – To use antennas with improved radiation patterns with lower side-lobe levels towards the stations in EESS (passive) systems. 	<ul style="list-style-type: none"> – This measure further reduces unwanted emission levels from IMT stations. It is more applicable to IMT base stations than IMT UE, for which equipment cost and size restrictions are more stringent. – It could further reduce unwanted emission levels from IMT base-stations. – It is not likely to reduce the unwanted emission from IMT UE. – Adoption of or replacement to such an antenna may require additional cost in IMT networks.