

Operator Acceptance Values for Device Antenna Performance

Version 3.0

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1 Introduction

1.1 Overview

Mobile handset design has changed significantly over the past few years. Antennas, which were external in many cases, moved inside the terminal and evolved to be light-weight and low-volume.

The increasing focus on design conflicts with radio performance of the antenna systems can lead to service disruption and increased dropped call rates impacting customer experience. Increasing network density is not an option as it may not be viable in many cases.

Whilst the 3GPP standards define the absolute global minimum OTA performance requirements to be met by devices, numerous operators are already requesting higher values in their own procurement activities to serve customer needs and network rollout plans.

However, the test methods used and antenna performance values requested by the various operators differ widely, leaving vendors with a fragmented requirements landscape.

To facilitate this alignment and agreement, the antenna experts of operators within the GSMA Terminal Steering Group have reviewed results of antenna performance tests (conducted within their own organisations as well as by the GSMA), and have aligned test methods and agreed on performance values to be used as guidelines for acceptable and achievable performance of antennas in Mobile devices. The values are supported by operators representing the USA, Europe and Asia regions.

Following the publication of version two, dedicated to 2G and 3G bands in February 2014 [TS.24], the TSG operators have now aligned performance also for the LTE bands, which have been added TS24 V3.0.

1.2 Scope

This document defines the Operator Acceptance Values for Device Antenna Performance. The values are determined taking into consideration

- devices being held **close to head** with **left and right hand**
- devices being held with **one hand only** for the purpose of **Browsing**
- devices being measured with the **Free Space** method

The requirements (which include measurement uncertainty) are relevant for mobile devices, including feature phones, smart phones, tablets and dongles. More details can be found in the relevant sections.

These GSMA Operator Acceptance Values for Device Antenna Performance are non-binding, and operators are free to request alternative values as required. It will be up to each individual operator to adopt and enforce the GSMA Operator OTA requirements.

These values serve to align, enhance and promote antenna performance requirements across the industry while seeking to improve device antenna performance and network interoperability.

Note: the alignment of the GSMA Operator Acceptance Values for Device Antenna Performance does not impact the test process; this will continue as is the case today in Operator-Manufacturer bilateral agreements.

Each phase of the work carried out in updating TS.24 has also involved independent tests on commercially available Smartphones. The purpose of these tests was to benchmark the Acceptance Values defined in TS.24.

In this version of TS.24 we publish the results of these tests in Appendix 1

1.3 Definition of Terms

Term	Description
3GPP	3rd Generation Partnership Project
BHH	Beside Head and Hand
BHHL	Beside Head and Hand Left
BHHR	Beside Head and Hand Right
CS	Circuit Switched (voice mode)
CTIA	Cellular Telecommunications & Internet Association
FDD	Frequency Division Duplex
FS	Free Space
GSM / E-GSM	Global System for Mobile Communication/ Extended-GSM
GSMA	GSM Association
LTE	Long Term Evolution
MIMO	Multiple Input Multiple Output
OTA	Over The Air (without cable)
RB	Resource Block
RMC	Reference Measurement Channel
TDD	Time Division Duplex
TRP	Total Radiated Power
TRS	Total Radiated Sensitivity
TSG	Terminal Steering Group
TSGFM	Terminal Steering Group Full Memebers
VoLTE	Voice over LTE
VoIP	Voice over Internet Protocol
WCDMA	Wideband Code Division Multiple Access

1.4 Document Cross-References

Ref	Document Number	Title
CTIA	3.4.2 or later	Test Plan for Wireless Device Over the Air Performance http://www.ctia.org/docs/default-source/default-document-library/ctia_ota_test_plan_rev_3_4_2.pdf?sfvrsn=2
3GPP	TS 25.144	User Equipment (UE) and Mobile Station (MS) over the air performance requirements

2 Antenna Performance Requirements

The following table serves as an internal guideline for mobile operators, who are encouraged to apply the required values in their bilateral agreements with their vendors.

2.1 Antenna Performance Calculation Formula

Req ID	Requirement
TSG24_AP_01	For the scenario "**Head and Hand**" (BHH) and in line with CTIA, the terminal SHALL support an average value of the low, medium and high frequency channels, on both, the left (BHHL) and right (BHHR) hand-side, a performance equal to or above the GSMA performance requirements for that frequency band listed in table 1 and 2 in section 2.2 for 2G/3G and table 3 and 4 in section 2.3 for LTE bands.
TSG24_AP_02	For the scenario "**Browsing**" and in line with CTIA, the terminal SHALL support an average value of the low, medium and high frequency channels, on both the left and right hand-side, a performance equal to or above the GSMA performance requirements for that frequency band listed in table 1 and 2 in section 2.2 for 2G/3G and table 3 and 4 in section 2.3 for LTE bands.
TSG24_AP_03	For the scenario "**Free Space**" (FS) and in line with CTIA, the terminal SHALL support an average value of the low, medium and high frequency channels a performance equal to or above the GSMA performance requirements for that frequency band listed in table 1 and 2 in section 2.2 for 2G/3G and table 3 and 4 in section 2.3 for LTE bands.
TSG24_AP_04	No measured channel SHALL be 1 dB worse than the performance values defined for that frequency band.

Table 1: Antenna Performance Calculation Formula

Note:

a) The values include measurement uncertainty.

b) Operators may accept alternative values for bands outside of their home market.

2.2 Operator Antenna Performance Acceptance Values for 2G and 3G Bands

The following tables list the Operator Antenna Performance Values per test scenario and frequency band (2G and 3G).

Test scenario:

Head and Hand (BHH):

Relevant for devices that support voice and do not exceed the maximum dimensions specified for hand phantom (i.e.72 mm) [CTIA]. The values are defined considering head and hand and are relevant for left or right hand.

Browsing:

Relevant for devices where the display is visible to the end user for data usage and where width ranges between 56 mm and 72 mm [CTIA]. The values are defined considering one-hand only and are relevant for left or right hand. The 3G frequencies are measured, using a 12.2 Kbps reference measurement channel (RMC).

Free Space:

Relevant for any device that embeds an antenna, including devices wider than 72 mm that support voice. The applicable measurement method is voice (CS) mode. The 3G frequencies are measured, using a 12.2 Kbps reference measurement channel (RMC).

These acceptance values include measurement uncertainty.

Frequency Band 2G/3G	GSMA Operator Acceptance Values for TRP [dBm]		
	BHH	Browsing	Free Space
GSM 850	20.0	24.0	27.0
EGSM 900	20.0	25.0	28.0
GSM 1800	21.0	23.0	26.0
GSM 1900	21.0	23.0	26.0
WCDMA Band 1	15.0	17.0	20.0
WCDMA Band 2	16.5	17.0	20.0
WCDMA Band 3	13.5	14.7	17.7
WCDMA Band 5	11.0	14.7	17.7
WCDMA Band 8	11.0	15.0	18.0
WCDMA Band 19	11.0	15.5	18.0

Table 2 GSMA Operator Acceptance Values for TRP for 2G and 3G bands

Frequency Band 2G/3G	GSMA Operator Acceptance Values for TRS [dBm]		
	BHH	Browsing	Free Space
GSM 850	-97.0	-99.0	-103.0
EGSM 900	-95.0	-99.0	-103.0
GSM 1800	-99.0	-100.0	-104.0
GSM 1900	-99.5	-100.0	-103.0

WCDMA Band 1	**-101.0**	**-103.0**	**-106.0**
WCDMA Band 2	**-98.5**	**-101.0**	**-104.0**
WCDMA Band 3	**-98.5**	**-99.0**	**-102.0**
WCDMA Band 5	**-94.5**	**-100.0**	**-103.0**
WCDMA Band 8	**-96.0**	**-101.0**	**-104.0**
WCDMA Band 19	**-96.0**	**-102.0**	**-104.5**

Table 3 GSMA Operator Acceptance Values for TRS for 2G and 3G bands

2.3 Operator Antenna Performance Acceptance Values for LTE Bands

The following tables list the Operator Antenna Performance Values per test scenario and frequency band (LTE).

Test scenario:

Head and Hand (BHH):

Relevant for devices that support voice (e.g. VoLTE, VoIP) and do not exceed the maximum dimensions specified for hand phantom (i.e.72 mm) [CTIA].

Browsing:

Relevant for devices where the display is visible to the end user for data usage and where width ranges between 56mm and 72 mm [CTIA]. The values are defined considering one-hand only and are relevant for left or right hand.

Free Space:

Relevant for any device that embeds an antenna, including devices wider than 72 mm that support voice (e.g. VoLTE, VoIP).

These acceptance values include measurement uncertainty.

Settings during testing

TRP:

Single antenna transmitting

Uplink RB Allocation : 12

TRS:

All receivers/antennas active

Downlink RB Allocation: 50

Bandwidth: 10 MHz

Frequency Band LTE	GSMA Operator Acceptance Values for TRP [dBm]		
	BHH	Browsing	Free Space
FDD Band 1	13.5	15.5	18.5
FDD Band 2	13.5	15.5	18.5
FDD Band 3	13.5	15.5	18.5
FDD Band 4	13.5	15.5	18.5
FDD Band 5	9.8	14.3	18.0
FDD Band 7	13.5	15.5	18.5
FDD Band 8	9.8	14.3	18.0
FDD Band 11	11.5	14.5	18.0
FDD Band 12	9.8	14.3	18.0
FDD Band 13	9.8	14.3	18.0
FDD Band 17	9.8	14.3	18.0
FDD Band 18	9.8	14.3	18.0
FDD Band 19	9.8	14.3	18.0
FDD Band 20	9.8	14.3	18.0
FDD Band 21	11.5	14.5	18.0
FDD Band 25	13.5	15.5	18.5
FDD Band 26	9.8	14.3	18.0
FDD Band 28	9.8	14.3	18.0
TDD Band 38	13.5	15.5	18.5
TDD Band 39	13.5	15.5	18.5
TDD Band 40	13.5	15.5	18.5
TDD Band 41	13.5	15.5	18.5
TDD Band 42	13.5	15.5	18.5
TDD Band 43	13.5	15.5	18.5

Table 4: GSMA Operator Acceptance Values for TRP for the LTE Bands

Frequency Band LTE	GSMA Operator Acceptance Values for TRS [dBm]		
	BHH	Browsing	Free Space
FDD Band 1	-89.0	-91.0	-94.0
FDD Band 2	-89.0	-91.0	-94.0
FDD Band 3	-89.0	-91.0	-94.0
FDD Band 4	-89.0	-91.0	-94.0
FDD Band 5	-85.0	-89.5	-93.5
FDD Band 7	-89.0	-91.0	-94.0
FDD Band 8	-85.0	-89.5	-93.5
FDD Band 11	-87.0	-90.0	-93.5
FDD Band 12	-85.0	-89.5	-93.5
FDD Band 13	-85.0	-89.5	-93.5
FDD Band 17	-85.0	-89.5	-93.5
FDD Band 18	-85.0	-89.5	-93.5
FDD Band 19	-85.0	-89.5	-93.5
FDD Band 20	-85.0	-89.5	-93.5
FDD Band 21	-87.0	-90.0	-93.5
FDD Band 25	-89.0	-91.0	-94.0
FDD Band 26	-85.0	-89.5	-93.5
FDD Band 28	-85.0	-89.5	-93.5
TDD Band 38	-89.0	-91.0	-94.0
TDD Band 39	-89.0	-91.0	-94.0
TDD Band 40	-89.0	-91.0	-94.0
TDD Band 41	-89.0	-91.0	-94.0
TDD Band 42	-89.0	-91.0	-94.0
TDD Band 43	-89.0	-91.0	-94.0

Table 5 GSMA Operator Acceptance Values for TRS for the LTE Bands

3 Moving Forward

As part of Phase 4, the GSMA operators will progress:

- Alignment of MIMO OTA test method and performance for LTE frequency bands
- Antenna performance values for devices supporting voice which are wider than 72 mm.

In addition, operators will continue to test antenna performance of market devices and actively monitor and/or engage in work driven in relevant industry bodies.

Annex A Measured Values

As part of the process to derive the harmonised Operator Acceptance Values published in this document the GSMA has, for each phase of the work, carried out independent tests on commercially available Smartphones. These devices are taken from consumer stock, and are not prototype or engineering samples provided by the OEM's.

In this appendix we have published the results from these tests.

The purpose of the tests was to benchmark the acceptance values defined in TS.24 and to ensure that they represent a realistic achievable target that manufacturers of devices can readily achieve.

All device results have been anonymised.

A.1 RAG Status Tables:

The tables published in this appendix include a RAG (Red Amber Green) colour coding. This RAG status can be interpreted as follows

Green = meets or surpasses the GSMA TS.24 acceptance value

Amber = within 2 dB of the GSMA TS.24 acceptance value

Red = fails to meet the GSMA TS.24 acceptance value by a value greater than 2 dB

The 2 dB margin used to define the Amber category reflects that the acceptance values published in this document are a harmonised average of the values contributed by operators who took part in this work.

It also recognises that some operators have a small tolerance in their acceptance values so that they do not block the launch of a device that marginally fails to meet their requirements. These tolerances are usually defined on a bilateral basis and are reviewed per device.

Because of the above the tables below try to reflect this reality through use of the 2 dB margin which defines values in Amber.

A.1.1 Test Methodology

Device selection was based on a random selection of commercially available devices at the time of measurement, typically these devices are from Tier 1 OEM's, and are their Flagship or high volume selling products.

The tests were carried out in an independent antenna lab, accredited by both CTIA (e.g. a CATL) and GCF (Global Certification Forum).

The specific test methodologies used followed the recommendations issued by CTIA.

A.1.2 Interpretation

For the purposes of this work these tables were used to assess the values defined in TS.24, and to ensure that when the 2 dB margin is taken into account, the significant majority of devices are able to meet or surpass the acceptance values published in TS.24.

A.1.3 Measured Results Tables

TRP and TRS [dBm]	Operator Acceptance		Device 1		Device 2		Device 3		Device 4		Device 5		Device 6		Device 7		Device 8		Device 9	
2G/3G Frequency Band	Browsing	Free Space	Browsing	FS	Browsing	FS	Browsing	FS	Browsing	FS	Browsing	FS	Browsing	FS	Browsing	FS	Browsing	FS	Browsing	FS
GSM 850	24,0	27,0																		
EGSM 900	25,0	28,0																		
GSM 1800	23,0	26,0																		
GSM 1900	23,0	26,0																		
WCDMA Band 1	17,0	20,0	14,72	17,99	14,55	16,79	19,50	21,57	16,97	20,21	16,45	19,46	17,62	19,84		20,15		18,30		16,72
WCDMA Band 2	17,0	20,0			15,66	18,97	17,98	20,21			16,11	18,96						17,82		14,24
WCDMA Band 5	14,7	17,7	12,73	15,94	6,13	19,45	14,68	19,34			13,79	17,56				16,43				14,76
WCDMA Band 6	14,7	17,7					14,77	19,65												
WCDMA Band 8	15,0	18,0	13,74	17,08	4,39	20,53			15,83	18,91	14,25	18,92				20,91		18,75		17,30
WCDMA Band 19	15,5	18,0											14,89	20,09						
GSM 850	-99,0	-103,0																		
EGSM 900	-99,0	-103,0																		
GSM 1800	-100,0	-104,0																		
GSM 1900	-100,0	-103,0																		
WCDMA Band 1	-103,0	-106,0	-107,16	-109,21	-105,12	-107,46	-109,19	-111,10	-103,28	-107,64	-108,08	-110,84	-109,65	-111,12		-108,27		-105,52		-106,86
WCDMA Band 2	-101,0	-104,0			-104,16	-106,71	-110,05	-111,57			-105,06	-108,11						-106,33		-107,68
WCDMA Band 5	-99,0	-102,0	-104,30	-107,39	-95,42	-110,94	-106,91	-109,64			-102,99	-107,05				-110,62				-103,39
WCDMA Band 6	-100,0	-103,0					-106,94	-109,73												
WCDMA Band 8	-101,0	-104,0	-100,89	-104,13	-98,98	-107,94			-102,08	-105,55	-102,47	-106,91				-110,36		-106,84		-104,32
WCDMA Band 19	-102,0	-104,5											-106,36	-110,03						

Table 6: TRP and TRS RAG status of tested devices in 2G/3G bands for the use cases Browsing and Free Space (status: 2013)

TRP and TRS [dBm]	Phone Type	Operator Acceptance	Device 1		Device 2		Device 3		Device 4		Device 5		Device 6		Device 7		Device 8		Device 9	
2G/3G Frequency Band		BHH	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL
GSM 850	Dual 2G+3G	20,0	20,53	20,73	22,65	17,88	21,83	21,73			18,05	18,62	13,26	16,37	15,27	17,43	22,78	22,31		
EGSM 900	Dual 2G+3G	20,0	20,49	19,95	20,89	16,03	20,47	22,26	17,54	19,25	17,33	19,12	16,44	17,90	20,19	22,54	22,00	22,06	16,88	16,79
GSM 1800	Dual 2G+3G	21,0	20,31	19,50	21,48	20,84	22,20	22,11	15,74	19,11	20,23	20,33	21,29	19,94	20,47	16,88	21,00	19,46	19,98	19,88
GSM 1900	Dual 2G+3G	21,0	19,90	19,69	20,32	20,35	21,18	20,72	18,02	17,80	20,91	20,01	21,76	20,41	20,71	18,62	23,42	21,99		
WCDMA Band 1	Dual 2G+3G	15,0	13,90	13,06	13,55	13,12	15,17	15,01	11,71	11,15	14,14	13,06	14,79	13,28	14,69	12,94	16,35	16,54	14,30	14,77
WCDMA Band 2	Dual 2G+3G	16,5																		
WCDMA Band 3	Dual 2G+3G	13,5																		
WCDMA Band 5	Dual 2G+3G	11,0																		
WCDMA Band 6	Dual 2G+3G	11,0																		
WCDMA Band 8	Dual 2G+3G	11,0			12,19	6,97	9,51	11,67			6,67	9,68	6,94	8,24	10,88	13,32			8,32	9,09
WCDMA Band 19	Dual 2G+3G	11,0																		
GSM 850	2G only	20,0																		
EGSM 900	2G only	21,0																		
GSM 1800	2G only	22,0																		
GSM 1900	2G only	21,0																		
GSM 850	Dual 2G+3G	-97,0	-97,16	-96,94	-96,02	-94,88	-97,29	-97,97			-93,54	-96,28	-90,06	-90,89	-96,14	-96,76	-98,79	-98,57		
EGSM 900	Dual 2G+3G	-95,0	-94,36	-93,89	-94,47	-91,84	-95,33	-96,62	-91,70	-93,12	-93,56	-95,12	-93,04	-93,76	-94,05	-96,89	-96,46	-95,84	-91,90	-92,82
GSM 1800	Dual 2G+3G	-99,0	-98,40	-97,64	-100,18	-95,63	-100,32	-99,78	-95,40	-96,61	-99,96	-99,39	-99,51	-98,88	-95,02	-96,29	-100,81	-100,10	-99,81	-99,65
GSM 1900	Dual 2G+3G	-99,5	-98,85	-97,89	-97,84	-97,90	-101,08	-100,52	-96,81	-97,03	-99,73	-98,66	94,63	-99,35	-98,47	-96,56	-99,99	-99,76		
WCDMA Band 1	Dual 2G+3G	-101,0	-97,88	-97,47	-100,01	-100,85	-102,28	-101,24	-99,04	-97,82	-99,75	-99,46	-102,99	-101,67	-100,53	-98,10	-101,30	-102,23	-101,65	-101,04
WCDMA Band 2	Dual 2G+3G	-98,5																		
WCDMA Band 3	Dual 2G+3G	-98,5																		
WCDMA Band 5	Dual 2G+3G	-94,5																		
WCDMA Band 6	Dual 2G+3G	-96,0																		
WCDMA Band 8	Dual 2G+3G	-96,0			-98,58	-94,33	-95,82	-97,69			-93,39	-96,08	-94,59	-94,90	-95,74	-98,76			-94,44	-95,29
WCDMA Band 19	Dual 2G+3G	-96,0																		
GSM 850	2G only	-97,0																		
EGSM 900	2G only	-97,0																		
GSM 1800	2G only	-99,0																		
GSM 1900	2G only	-99,5																		

TRP and TRS [dBm]	Phone Type	Operator Acceptance	Device 10		Device 11		Device 12		Device 13		Device 14		Device 15		Device 16		Device 17		Device 18	
2G/3G Frequency Band		BHH	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL
GSM 850	Dual 2G+3G	20,0																		
EGSM 900	Dual 2G+3G	20,0	16,86	17,73	19,52	18,55	18,58	21,44	19,34	19,47	20,83	20,48	18,70	19,92	17,31	15,96	18,20	19,80	20,04	18,75
GSM 1800	Dual 2G+3G	21,0	23,55	19,35	21,49	23,19	20,10	20,32	20,86	21,79	19,74	19,17	19,91	20,85	19,38	17,62	21,44	20,53	21,13	20,94
GSM 1900	Dual 2G+3G	21,0																		
WCDMA Band 1	Dual 2G+3G	15,0	17,36	15,48	15,21	16,25	16,20	16,41	15,33	16,79	15,22	14,47	13,56	14,76	16,17	15,26	15,76	14,04	16,40	15,47
WCDMA Band 2	Dual 2G+3G	16,5																		
WCDMA Band 3	Dual 2G+3G	13,5																		
WCDMA Band 5	Dual 2G+3G	11,0																		
WCDMA Band 6	Dual 2G+3G	11,0																		
WCDMA Band 8	Dual 2G+3G	11,0	7,28	8,28	11,98	10,58	10,47	13,75			11,83	11,81	8,62	9,16	10,24	9,40	9,86	11,33	11,38	10,79
WCDMA Band 19	Dual 2G+3G	11,0																		
GSM 850	2G only	20,0																		
EGSM 900	2G only	21,0																		
GSM 1800	2G only	22,0																		
GSM 1900	2G only	21,0																		
GSM 850	Dual 2G+3G	-97,0																		
EGSM 900	Dual 2G+3G	-95,0	-91,57	-94,48	-95,93	-97,57	-93,73	-97,67	-96,32	-96,57	-96,66	-93,98	-93,06	-93,07	-93,12	-90,98	-93,74	-95,00	-94,66	-95,24
GSM 1800	Dual 2G+3G	-99,0	-102,05	-98,61	-101,71	-102,86	-98,96	-99,20	-101,02	-102,35	-99,44	-99,17	-100,00	-101,28	-98,86	-97,24	-100,89	-99,54	-100,68	-100,72
GSM 1900	Dual 2G+3G	-99,5																		
WCDMA Band 1	Dual 2G+3G	-101,0	-105,54	-102,90	-102,42	-102,42	-104,99	-104,73	-100,31	-102,30	-101,60	-101,77	-98,95	-99,55	-100,73	-100,69	-101,99	-101,01	-100,19	-99,45
WCDMA Band 2	Dual 2G+3G	-98,5																		
WCDMA Band 3	Dual 2G+3G	-98,5																		
WCDMA Band 5	Dual 2G+3G	-94,5																		
WCDMA Band 6	Dual 2G+3G	-96,0																		
WCDMA Band 8	Dual 2G+3G	-96,0	-93,81	-95,47	-98,30	-96,86	-97,30	-101,33			-99,96	-99,09	-95,24	-94,86	-94,96	-91,93	-95,98	-96,58	-96,53	-96,99
WCDMA Band 19	Dual 2G+3G	-96,0																		
GSM 850	2G only	-97,0																		
EGSM 900	2G only	-97,0																		
GSM 1800	2G only	-99,0																		
GSM 1900	2G only	-99,5																		

Table 7: TRP and TRS RAG status of tested devices in 2G/3G bands for head & hand use case (status: 2013)

TRP [dBm]	Operator Acceptance	Device 1		Device 2		Device 3		Device 4		Device 5		Device 6		Device 7		Device 8		Device 9	
LTE Frequency Band	BHH	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL
FDD Band 1	13,50	11,81	12,90			12,43	15,30									16,89	15,82	15,67	12,59
FDD Band 2	13,50					11,93	14,81												
FDD Band 3	13,50	13,60	13,26	12,52	13,83	13,36	16,21									15,18	13,16	14,92	12,90
FDD Band 4	13,50													16,95	12,81				
FDD Band 5	9,75	8,23	11,02			6,39	4,82												
FDD Band 7	13,50	10,98	12,79	14,50	9,62	11,74	17,45												
FDD Band 8	9,75	11,71	10,70			7,81	6,15												
FDD Band 11	11,50																		
FDD Band 12	9,75																		
FDD Band 13	9,75													10,96	11,24				
FDD Band 17	9,75																		
FDD Band 18	9,75																		
FDD Band 19	9,75															9,90	10,71	11,90	12,68
FDD Band 20	9,75	11,80	9,78	9,27	7,77	8,11	7,14												
FDD Band 21	11,50															13,04	9,73	11,33	11,95
FDD Band 25	13,50							15,59	16,02	14,98	13,30	13,33	11,48						
FDD Band 26	9,75							11,77	12,77	12,60	11,54	10,52	9,51						
FDD Band 28	9,75																		
TDD Band 38	13,50																		
TDD Band 39	13,50																		
TDD Band 40	13,50																		
TDD Band 41	13,50							12,24	16,65	13,70	15,87	13,63	4,31						
TDD Band 42	13,50																		
TDD Band 43	13,50																		

Table 8: TRP RAG status of tested devices in LTE bands for head & hand use case (status: 2015)

TRS [dBm]	Operator Acceptance	Device 1		Device 2		Device 3		Device 4		Device 5		Device 6		Device 7		Device 8		Device 9	
LTE Frequency Band	BHH/Both Antennas Active	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL	BHHR	BHHL
FDD Band 1	*-89,00*	-87,73	-88,31			-89,36	-89,49									-91,51	-90,20	-87,82	-86,95
FDD Band 2	*-89,00*					-90,35	-90,78												
FDD Band 3	*-89,00*	-91,37	-92,09	-89,03	-88,84	-88,79	-89,70									-92,28	-91,42	-89,55	-88,38
FDD Band 4	*-89,00*													-91,74	-92,00				
FDD Band 5	*-85,00*	-85,87	-86,87			-82,61	-81,86												
FDD Band 7	*-89,00*	-92,46	-93,47	-88,88	-84,24	-86,69	-89,01												
FDD Band 8	*-85,00*	-85,72	-84,99			-85,01	-84,34												
FDD Band 11	*-87,00*																		
FDD Band 12	*-85,00*																		
FDD Band 13	*-85,00*													-86,65	-89,06				
FDD Band 17	*-85,00*																		
FDD Band 18	*-85,00*																		
FDD Band 19	*-85,00*															-86,17	-87,97	-86,25	-86,66
FDD Band 20	*-85,00*	-86,68	-87,19	-87,08	-86,30	-83,99	-82,84												
FDD Band 21	*-87,00*															-89,46	-89,76	-89,74	-90,06
FDD Band 25	*-89,00*							-91,09	-91,95	-92,40	-92,04	-89,17	-87,24						
FDD Band 26	*-85,00*							-85,76	-86,08	-87,45	-86,66	-86,97	-85,02						
FDD Band 28	*-85,00*																		
TDD Band 38	*-89,00*																		
TDD Band 39	*-89,00*																		
TDD Band 40	*-89,00*																		
TDD Band 41	*-89,00*							-88,89	-92,02	-87,74	-89,16	-90,48	-84,86						
TDD Band 42	*-89,00*																		
TDD Band 43	*-89,00*																		

Table 9: TRS RAG status of tested devices in LTE bands for head & hand use case (status: 2015)

A.1.4 Further Analysis

As part of the results analysis it was noticed that there could be a perceived trend that demonstrates a difference between left hand and right hand performance. Further analysis of this trend is required to establish if this is a genuine trend or just an anomaly in the results. The TSGFM Group would like to draw attention to this as it was noted that accreditation in some regions is still limited to testing with the right hand, and therefore there could be a correlation between this and some products being optimized for performance in the right hand.

The sample of measured product is too small to establish if this trend is real, but it has been noted for further study during future measurement and test campaigns carried out by GSMA.

Document Management

Document History

Version	Date	Brief Description of Change	Approval Authority	Editor / Company
V1.0	14 May 2013	Published on GSM world	TSG	Katrin Jordan, DT
V2.0	Feb 2014	Updated scope, references, requirements and added performance values for Free Space and Browsing.	TSG	Katrin Jordan, DT
V3.0	Sept. 2015	Performance values for LTE and Annex A added	TSG	Xiaolong Zhou, China Unicom Abbas Alpaslan, Vodafone

Other Information

Type	Description
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