Global Test Specification for Terminals for Performance Measurements
- Performance TST -

Free Space Device Radiated Performance
VF_Ant_Req_V1_92

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Classification

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This document has been classified as “public”. It is allowed to share it with interested persons and bodies to promote a discussion about a certain measurement method.

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1 Document Information

1.1 Scope

Vodafone buys terminals to be used within its network. Through purchasing contract and by accompanied product requirement specification, Vodafone requires that all terminals supplied are tested and comply with relevant standards and guidelines appropriate for that device. Launching a terminal is subject to technical acceptance (TA, see [1]). The purpose of this test case description is to define the Vodafone test requirements for performing Radiated RF Power and Receiver Performance measurements on terminals.

Good radiated performance is critical to the effective operation of a mobile station in today's networks. As devices become smaller, radiated performance can often become compromised. For example, achieving an efficient antenna in a small size and over both GSM 900 and 1800 frequency bands is a difficult task. A comprehensive and accurate characterization of radiated performance will enable network providers and manufacturers to determine how well mobile stations will work within the constraints of a specific cellular network design.

Generally, peak EIRP (Effective Isotropic Radiated Power) or measurements assuming a dipole like pattern for all frequencies (as in GSM 11.10, [3] chapter 13.3) are not good indications of mobile performance in the field.

Therefore the test case description below is focused on:

- Spherical effective isotropic radiated power (termed Total Radiated Power, TRP) as well as
- the appropriate Spherical effective isotropic radiated sensitivity (termed Total Radiated Sensitivity, TRS) ,
- Both to be measured basically using the methodology outlined by CTIA [2], but with a special concept in order to reduced effort for sensitivity measurements.

The human head can alter the shape and peak value of the EUT radiation pattern. Losses due to the head can vary significantly with frequency, device size, and the antenna design implemented and hence they are mainly design dependent. Due to the fact of design impact, an increasing number of uses cases not at the head (such as browsing and video telephony), in order to reduce uncertainties and due to the fact the head impact is lower at UMTS frequencies where our focus is on.

Vodafone is focused on free space measurements in terms of a core or minimum test scenario.

For more comprehensive investigations,

- Measurements simulating the situation when the phone is held at a human ear

will be required also.

Additionally Vodafone is requesting sensitivity measurements providing visibility of so called

- Self-interference or de-sense effects.

Due to the fact a mobile phone comprises a computer and several devices driven by clock signals situated close to a very sensitive receiver, there are specific interference effects known. The most common disturbance is caused by the GSM typical 13 MHz internal clock signal. Two harmonics of the 13 MHz are effecting channel 5 and 70 (72 x 13 MHz = 936 MHz = ARFCN 5 and 73 x 13 MHz = 949 MHz = ARFCN 70).

1.2 Document History

Version	Date	Editor	Remarks
0.3	01.03.04	Punit K. Sharma	Initial draft
0.9	31.10.04	Punit K. Sharma	Draft for first FBT discussions
1.0	11.11.04	Punit K. Sharma	Remove Appendix A (Vodafone limits) and change classification to “public”.
1.1	23.11.04	Punit K. Sharma	Fix mix-up in angle resolution and some editorial changes
1.2	20.12.11.04	Punit K. Sharma	Remove 1900 Test cases, add head (talk position) test cases, add heating check and add self-interference measurement. Split in core and additional test cases.
1.3	21.12.11.04	Punit K. Sharma	Change self-interference method according to 20.12.04 meeting decisions
1.4	21.03.05	Jürgen Deurwaerder	Adding VF Target Values
1.5	29.03.05	Punit K. Sharma	Grammatical, Editorial and amendments
1.6	31.05.05	Markus Larkamp	Update additional internal VF requirements
1.7	31.05.05	Markus Larkamp	Update of TRP, TRS and self interferer requirements. Update Revision of CTIA Performance description
1.8	02.06.05	Markus Larkamp	Update additional internal VF requirements
1.9	02.06.05	Markus Larkamp	Update UMTS RX values

1.3 Reference

[1] Ready for Acceptance and Technical Acceptance Criteria for Terminals (RFA_TA_Terminal_Vendors_V2.0.pdf)

[2] Cellular Telecommunications & Internet Association Method of Measurement for Radiated RF Power and Receiver Performance, April 2005, Revision 2.1 (see: http://www.wow-com.com/certification/eval_criteria/index.cfm)

[3] ETSI EN 300 607-1, V8.1.1, (2000-10): “Digital cellular telecommunications system (Phase 2+); MS conformance specification; part 1 (GSM 11.10, Release 1999)”.

[4] IEEE 1528: “Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”, Draft CBD 1.0, April, 2002.

2 General Methodology

2.1 Set Up

In order to get as reproducible results as possible, an antenna fully anechoic room (AFAR) shall be used. The recommended distance between measurement antennas and the device under test (DUT) shall be 2 m. Lower distances are acceptable when CTIA calibration requirements are met (see [2]). There exist two acceptable principle test up's: The DUT is being rotated in two axis and only a few (usually one) measurement antenna is used, or the DUT is rotated in one axis and there is an arch containing a number of measurement antennas. The pictures in Fig. 1 and Fig. 2 show the set up respectively.

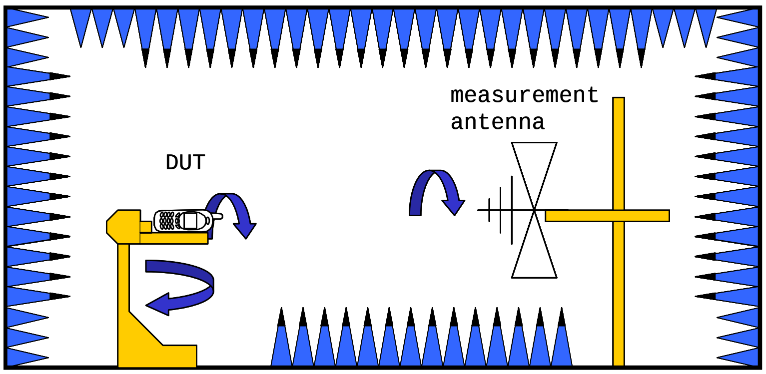


Fig 1: Set up using a two-axis controller and one (or a few) measurement antennas.

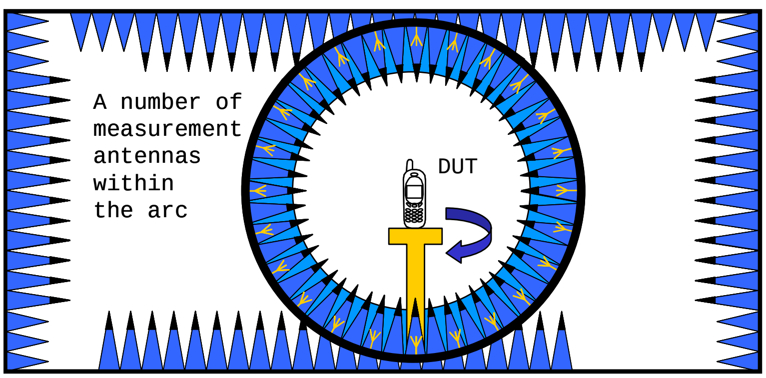


Fig 2: Set up using a one-axis controller and a larger number of measurement antennas forming an arc.

Set up using a phantom simulating the system: Phone at a human head. This system shall be handled as DUT (device under test) as shown in Fig. 1 or Fig. 2 with the origin at the ear reference point of the phantom and the phantom defining the coordinate system.

Measuring the radiated performance of mobile phones while positioned at a human head, the exact position is important because of its influence on antenna pattern and de-tuning effects. In order to have a reproducible set up Vodafone recommend following the CTIA approach:

- The phone is to be placed in a head adjacent talk position
- against the SAM head phantom.

The head adjacent talk position is the same as the "cheek" or "touch" position as described in IEEE 1528 standard [4]. The required phantom is taken from the "SAM" head phantom in the same IEEE standard.

For describing the relative position the phone and the phantom will be characterized by several reference points. As indicated in Fig. 3 the phone will be described by the centre of the loud speaker and the centre of the edge at the mechanical bottom line. The head phantom is described by a plane defined by the mouth reference point and the two ear reference points. For positioning the phone at the head phantom the loud speaker centre must be at the left ear reference point. The phone “line” shall lie in the head plane. The phone than must be moved as close a possible to the head phantom keeping the phone line in the head plane as shown in and Fig. 4.

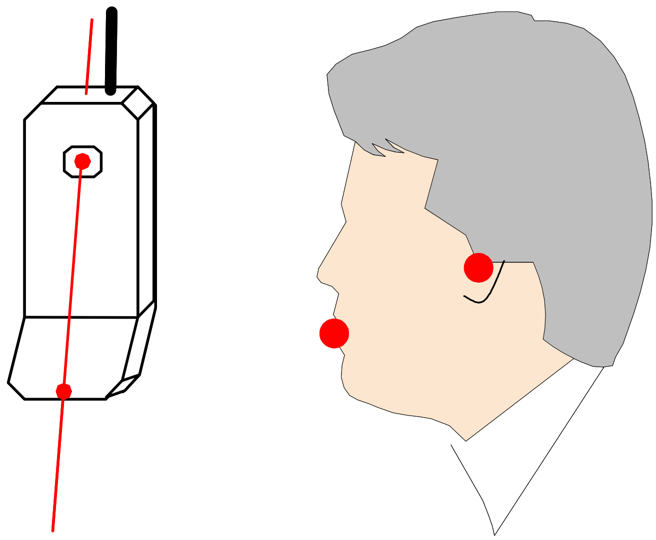


Fig 3: Definitions of reference points for positioning the phone at the human head.

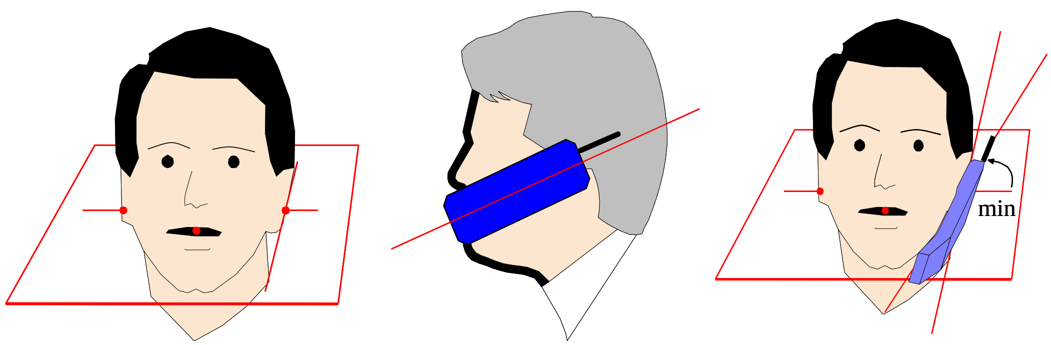


Fig 4: Sketches about how to place the phone at the human head. The approach is according to CTIA [2]: “touch position” shall be used.

2.2 Procedure and Equations to be used

The basic methodology requested by Vodafone is following mostly the four principles outlined in CTIA the test plan [2]:

1. Measure all radiation in all directions for determining the antenna pattern. Consider for output power measurements the full sphere around the DUT in order to cover all power sent out.
2. Measure both polarizations to get the power flux density (Pointing Vector).
3. Calculate the total radiated power by taking into account the appropriate area and performing a mathematically correct integral over the full sphere surrounding the DUT and taking into account no isotropic distribution of measurement points.
4. To get one value per frequency band by means of linear average over three channels: low, mid and high. Linear means: take all powers in Watt).

The determination of the power flux density is based on the far field relation:

$$power\ \ flux\ density = E \times H = \frac{E^2}{Z_0}$$

Where *H* is the magnetic and *E* the electric field. Only *E* will be measured and the power flux density than calculated by using Z_0, the free space impedance ($Z_0 = 377\ \Omega$).

The total radiated power (TRP) is calculated using power readings in spherical coordinates. The total radiated power therefore equals to:

$$TRP = \oiint \frac{E_{eff}^2}{Z_0} r^2 \sin\Theta \, d\Theta \, d\phi$$

Where *r* is the measurement distance and E_{eff} is the effective field strength measured in certain directions and by taking into account both polarizations according to:

$$E_{eff} = \sqrt{E_{vertical}^2 + E_{horiz}^2}\ .$$

In case of discrete, constant angle steps $\Delta\Theta$ and $\Delta\phi$ the integration becomes a summation in terms of:

$$TRP = \sum_{\Theta,\phi} \frac{E_{eff}^2(\Theta,\phi)}{Z_0} w(r,\Theta,\phi,\Delta\Theta,\Delta\phi)$$

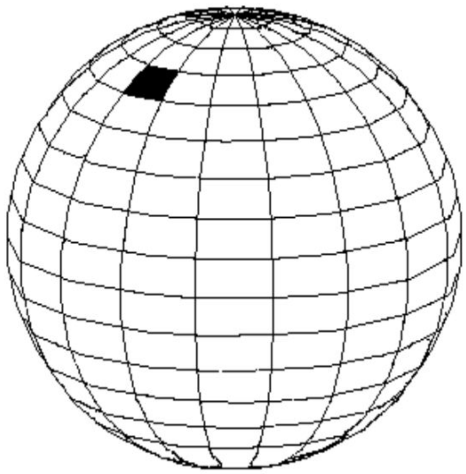
Where *w* is the area:

$$w = r^2 \Delta\phi \left(\cos\left(\Theta - \frac{\Delta\Theta}{2}\right) - \cos\left(\Theta + \frac{\Delta\Theta}{2}\right) \right)$$

shown in figure Fig. 5. Note, a good approximation for small $\Delta\Theta$ is:

$$\left(\cos\left(\Theta - \frac{\Delta\Theta}{2}\right) - \cos\left(\Theta + \frac{\Delta\Theta}{2}\right) \right) \approx \Delta\Theta \cdot \sin(\Theta)$$

This is used in the CTIA test plan [2].



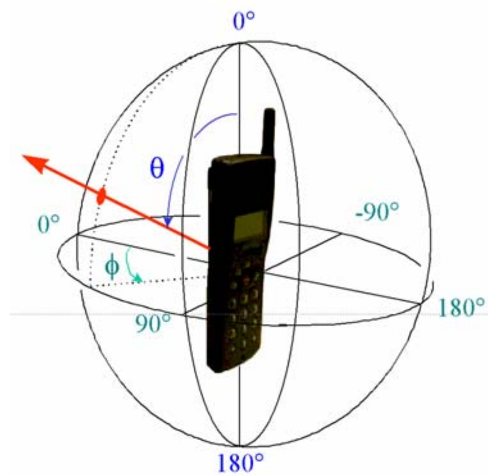


Fig. 5: Net in spherical coordinates assuming constant steps in Θ and ϕ as used in measurements.

At the poles the area w is considered to become:

$$w = r^2 \Delta\phi \left(1 - \cos\left(\frac{\Delta\Theta}{2}\right)\right)$$

Because of the fact some of the measurement positions are used more than once there is a need for additional weighting dependent on measurement procedure (usually weighting with 1/n, where n is the number of measurement at the pole).

The Sensitivity calculation can follow the same procedure: Treat 1/*S* as a power, where *S* is sensitivity:

The total radiated sensitivity (TRS) equals to:

$$\frac{1}{TRS} = \oiint \frac{1}{S_{eff}\, 4\pi r^2} r^2 \sin\Theta \, d\Theta \, d\phi$$

where *r* is the measurement distance and S_{eff} is the effective sensitivity taking both polarizations into account:

$$\frac{1}{S_{eff}} = \frac{1}{S_{vertical}} + \frac{1}{S_{horizontal}}$$

In case of discrete, constant angle steps ΔΘ and Δϕ the integration becomes a summation in terms of:

$$\frac{1}{TRS} = \sum_{\Theta,\phi} \frac{1}{4\pi r^2 S_{eff}(\Theta,\phi)} w(r,\Theta,\phi,\Delta\Theta,\Delta\phi)$$

where *w* is again the area:

$$w = r^2 \Delta\phi \left(\cos\left(\Theta - \frac{\Delta\Theta}{2}\right) - \cos\left(\Theta + \frac{\Delta\Theta}{2}\right)\right)$$

For more information about the theory and derivations of the equations presented here, please see CTIA test plan [2], appendix E.

2.3 Frequency Ranges

Frequencies used in Europe, Japan and U.S.A. and which are of interest for Vodafone are given in Tab. 1Tab. 2and Fig. 6.

TX	Low channel			Mid channel			High channel		
Mode	ARFCN	Frequency		ARFCN	Frequency		ARFCN	Frequency	
GSM 850	128	824,2	MHz	190	836,6	MHz	251	848,8	MHz
EGSM 900	975	880,2	MHz	38	897,6	MHz	124	914,8	MHz
GSM 900	1	890,2	MHz	62	902,4	MHz	124	914,8	MHz
DCS / GSM 1800	512	1710,2	MHz	701	1748	MHz	885	1784,8	MHz
PCS / GSM 1900	512	1850,2	MHz	661	1880	MHz	810	1909,8	MHz
3G UMTS (Band I)	9612	1922,4	MHz	9750	1950,0	MHz	9888	1977,6	MHz

Tab. 1: Frequencies and channel numbers to be used for TX measurements.

RX	Low channel			Mid channel			High channel		
Mode	ARFCN	Frequency		ARFCN	Frequency		ARFCN	Frequency	
GSM 850	128	869,2	MHz	190	881,6	MHz	251	893,8	MHz
EGSM 900	975	925,2	MHz	38	942,6	MHz	124	959,8	MHz
GSM 900	1	935,2	MHz	62	947,4	MHz	124	959,8	MHz
DCS / GSM 1800	512	1805,2	MHz	701	1843	MHz	885	1879,8	MHz
PCS / GSM 1900	512	1930,2	MHz	661	1960	MHz	810	1989,8	MHz
3G UMTS (Band I)	10562	2112,4	MHz	10700	2140,0	MHz	10838	2167,6	MHz

Tab. 2: Frequencies and channel numbers to be used for RX measurements.

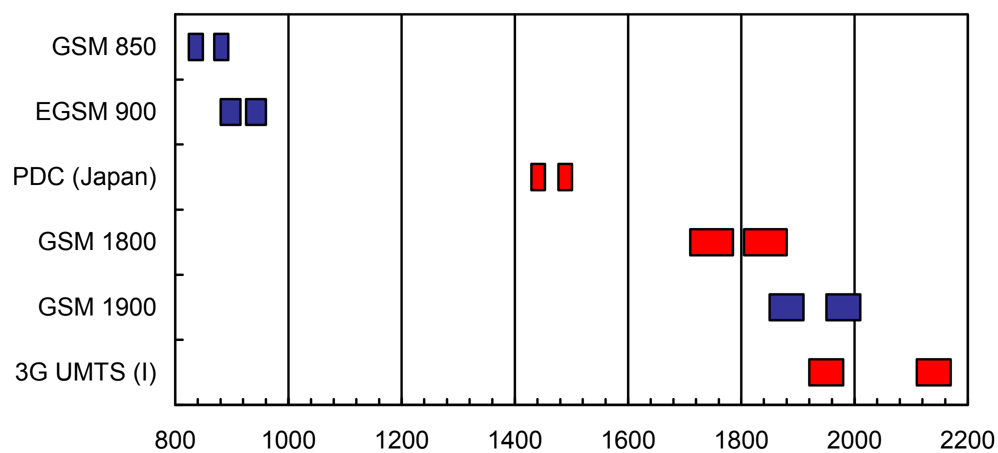


Fig 6: Overview about Frequency bands.

Following other methods ([2] and [3]), measurement at three channels or frequencies shall be used to find a final averaged value. Note, “linear” averaging based on physical units such a Watt must be applied.

Assuming TRP_low, TRP_mid, TRP_high being power values in dBm for low, mid and high channel respectively, you may use in Excel:

TRP_band_average_in_dBm =

10*LOG10(1/3*(POWER(10;TRP_low/10)+POWER(10;TRP_mid/10)+POWER(10;TRP_high/10)))

2.4 TRP Measurement Procedure and Settings

The following procedure shall be applied:

- Establish a call to the mobile, set maximum RF output power.
- Execute measurement as described in 2 by using:
  $\Delta\phi$ = 22.5°
  $\Delta\Theta$ = 30° (at least)
  and at three TX frequencies according to Tab. 1: low, mid and high.
  (Note: CTIA asks for: 15° and 15°)
- Measure both vertical and horizontal polarization’s.
- Vodafone is requesting that in general all channels are considered and meet the target values (e.g. relevant channels checked in one position).
- Calculate one TRP value for the appropriate band as described in 2.

Note: Power is the RF out put power as defined in the appropriate 3GPP standard (e.g. average power of useful part of a burst for GSM)

2.5 TRS Measurement Procedure and Settings

The following procedure shall be applied:

- Execute TRP measurement in the appropriate band first
- Vodafone is requesting that in general all channels are considered and meet the target values (e.g. relevant channels checked in one position).
- Establish a call to the mobile
- Check at one position whether the output power does have an impact on the sensitivity (usually it should not have any impact). In case there is an impact or in case of doubt, set maximum RF output power. When the output power does have no impact on the sensitivity, reduce the output power to a reasonable minimum to save battery lifetime.
- Execute sensitivity measurements based on bit error measurements* (BER) in 3D or one plane by using:
  $\Delta\Theta$ = 15°
  ϕ = 0° or ϕ = 180° and $\Delta\phi$ = 360°
  and at three RX frequencies according to Tab. 2: low, mid and high.
  Contrary to CTIA, Vodafone allows to assume the same pattern for RX and TX. Doing so it becomes possible to calculate the TRS value by using results form TRS measurements. The plane should be a so called *E*-plane, which is according to Fig. 5the plane for ϕ = 0° and ϕ = 180°.
- Measure both vertical and horizontal polarization’s.
- Check whether the pattern looks sufficient similar to the appropriate pattern for the TX direction. Provide a picture of both patterns.
- Calculate TRS_{one_plane} value for the appropriate band as described in 0 by using ϕ = 0° and ϕ = 180°, assuming $\Delta\phi$ = 360°.
- Calculate TRP_{one_plane} value for the appropriate band as described in 0 by using ϕ = 0° and ϕ = 180°, assuming $\Delta\phi$ = 360°.
- Calculate the TRS value by scaling:

  $$TRS = TRS_{one\_plane} - TRP + TRP_{one\_plane}$$

  (assuming all variables in dBm).

*Note: Sensitivity is the sensitivity based on BER measurements as defined in the appropriate 3GPP standards (e.g. at BER = 2.4 % for GSM and for 3G UMTS / WCDMA it is <REF I_{or}>).

2.6 Measurement of the Self-Interference Effect

The following procedure shall be applied:

- Position the phone at the maximum gain position (in respect to angle and polarisation).
- Establish a call to the mobile
- Execute sensitivity measurements based on bit error measurements* (BER) at this fixed position but at a reasonable high number of different channels for all bands and different settings (e.g. Bluetooth active). For all bands Vodafone requires information for all channels that show interferer of more than 3 dB compared to neighbour channels. All channels and if needed certain settings (e.g. special features, like MP3 player active) have to be considered. Probably for EGSM 900 at least the following ARFCN list have to be measured (see fig. 7):

  975, 1, 3, 5, 7, 9, 38, 62, 66, 68, 70, 72, 74 and 124.

- Compile the
  - absolute peak values,
  - number of peaks higher than 3 dB, and the
  - average sensitivity (without peaks higher 3 dB, see Fig. 7).

An assessment will be done on the absolute sensitivity values in respect to 3GPP recommendations (-102 dBm for GSM 900, fading included). If the number of peaks becomes higher than two, the average sensitivity will be become part of an overall assessment and the measurements will be extended to all relevant bands.

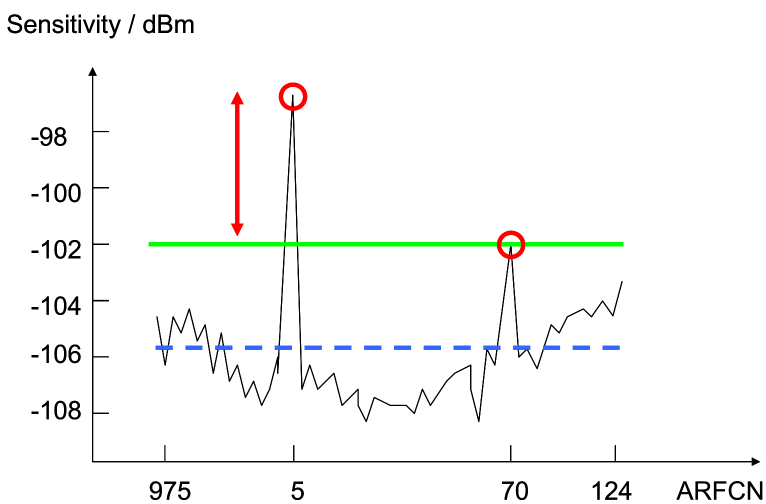


Fig 7: Parameters for assessing self-interference effects: Absolute peak values O in respect to GSM recommendation and average - - - - (without peaks).

2.7 Estimation of Heat Effects

During the operation the DUT may become hot. Since RF output power and sensitivity in principle depend on device temperature an estimation of the heating impact is required. For both, TRP and TRS measurement it is therefore required:

- Store one measured value (either radiated output power or sensitivity value) at the begin of the measurement.
- Redo the exact same measurement at the very same position (and polarisation, channel and so on) at the end of the measurement of before any break, such as due to changing the battery.
- Report the appropriate difference as power or sensitivity “drift”.

2.8 System Calibration

Vodafone accepts CTIA certification as good and sufficient proof for accuracy of the measurement. Since CTIA requirements for chamber (absorber) quality and equipment are rather high, Vodafone allow an alternative method for system calibration.

2.8.1 Set Up

For calibration the complete set up shall be as close as possible to the one used in the measurements. Therefore we recommend using an actual phone connected to a reference dipole which shall be assumed to have no losses as reference device.

A reference device sketch is shown in Fig. 8 and shall consist of:

- A phone capable of operating in the appropriate band at almost the same power levels as for the final measurements
- with a proofed stable output power (watch out temperature/time effects) and
- featuring a connector to connect a RF cable.
- A reference dipole with a matching better than 15 dB at appropriate frequencies and a known or almost 100% efficiency.

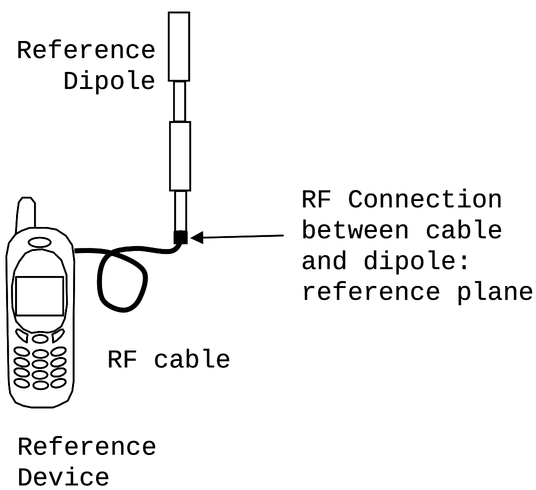


Fig 8: Reference device for calibration.

2.8.2 Calibration Procedure

- Measure connected power as well as connected sensitivity <u>at the end of the cable</u> at the "reference plane" for all frequencies as depicted in Fig. 8.
- Create a support holding the reference dipole close to the phone but provide reasonable distance to avoid interactions and matching disturbance.
- Execute measurements as described in this document.
- Define appropriate calibration data by comparing connected values to actual radiated values.

2.9 Vodafone Acceptance Criteria

2.9.1 Total Radiated Power (TRP 3D, free space)

Band	TX Target Value
EGSM 900 / GSM 850	29 dBm
GSM 1800 /1900	26 dBm
3G UMTS Band I Power class 3	21 dBm
3G UMTS Band I Power class 4	18 dBm

2.9.2 Total Received Sensitivity (TRS 3D or 2D, free space, static conditions)

Band	RX Target Value
EGSM 900 / GSM 850	-104,5 dBm
GSM 1800 /1900	-103 dBm
3G UMTS Band I	-106 dBm

Values are at BER = 2.4% (GSM) or <REF $\hat{I}_{or}$> per 3.84 MHz (WCDMA, P-CPICH).

If 2D measurements are performed the plane has to be defined and an explanation is needed how to compare to 3D measurements.

2.9.3 Remarks

- All channel need to comply with the target values. Minimum three channels have to be measured.
- Manufacture MUST present PTCRB certification for 1900 MHz band.
- Clam Shell Mobiles will have measurements performed in the open position.
- Target Values apply also to Datacards.
- The Datacard and laptop are regarded as one UE.

3 Vodafone Core Test Cases

3.1 Radiated Power in Free Space Situation EGSM 900

3.1.1 Test purpose

Measure the overall or total radiated power in EGSM 900 mode (see Tab. 1).

3.1.2 Related Vodafone Requirement or International Specifications

GSM: EN 300 607-1 (GSM 11.10 Version 8.1.1, Release 1999, chapter 13.3 and Annex 1) and 3GPP TS 25.101.

VF: R8 bearer requirements.

3.1.3 Required equipment / initial conditions

See 2.1.

3.1.4 Procedure

See 2.4.

3.1.5 Expected Result

See 2.9

3.2 Radiated Power in Free Space Situation GSM 1800

3.2.1 Test purpose

Measure the overall or total radiated power in GSM 1800 mode (see Tab. 1).

3.2.2 Related Vodafone Requirement or International Specifications

GSM: EN 300 607-1 (GSM 11.10 Version 8.1.1, Release 1999, chapter 13.3 and Annex 1) and 3GPP TS 25.101.

VF: R8 bearer requirements.

3.2.3 Required equipment / initial conditions

See 2.1.

3.2.4 Procedure

See 2.4.

3.2.5 Expected Result

See 2.9

3.3 Radiated Power in Free Space Situation 3G UMTS Band I

3.3.1 Test purpose

Measure the overall or total radiated power in 3G UMTS band I (see Tab. 1).

3.3.2 Related Vodafone Requirement or International Specifications

GSM: EN 300 607-1 (GSM 11.10 Version 8.1.1, Release 1999, chapter 13.3 and Annex 1) and 3GPP TS 25.101.

VF: R8 bearer requirements.

3.3.3 Required equipment / initial conditions

See 2.1.

3.3.4 Procedure

See 2.4.

3.3.5 Expected Result

See 2.9

3.4 Radiated Sensitivity in Free Space Situation EGSM 900

3.4.1 Test purpose

Measure the overall or total radiated sensitivity in EGSM 900 mode (see Tab. 2).

3.4.2 Related Vodafone Requirement or International Specifications

GSM: EN 300 607-1 (GSM 11.10 Version 8.1.1, Release 1999, chapter 13.3 and Annex 1) and 3GPP TS 25.101.

VF: R8 bearer requirements.

3.4.3 Required equipment / initial conditions

See 2.1.

3.4.4 Procedure

See 2.5.

3.4.5 Expected Result

See 2.9

3.5 Radiated Sensitivity in Free Space Situation GSM 1800

3.5.1 Test purpose

Measure the overall or total radiated sensitivity in GSM 1800 mode (see Tab. 2).

3.5.2 Related Vodafone Requirement or International Specifications

GSM: EN 300 607-1 (GSM 11.10 Version 8.1.1, Release 1999, chapter 13.3 and Annex 1) and 3GPP TS 25.101.

VF: R8 bearer requirements.

3.5.3 Required equipment / initial conditions

See 2.1.

3.5.4 Procedure

See2.5.

3.5.5 Expected Result

See 2.9

3.6 Radiated Sensitivity in Free Space Situation 3G UMTS Band I

3.6.1 Test purpose

Measure the overall or total radiated sensitivity in 3G UMTS band I (see Tab. 2).

3.6.2 Related Vodafone Requirement or International Specifications

GSM: EN 300 607-1 (GSM 11.10 Version 8.1.1, Release 1999, chapter 13.3 and Annex 1) and 3GPP TS 25.101.

VF: R8 bearer requirements.

3.6.3 Required equipment / initial conditions

See 2.1.

3.6.4 Procedure

See 2.5.

3.6.5 Expected Result

See 2.9

4 Vodafone Addendum Test Cases

4.1 Radiated Power in Talk Situation EGSM 900

4.1.1 Test purpose

Measure the overall or total radiated power in EGSM 900 mode (see Tab. 1).

4.1.2 Related Vodafone Requirement or International Specifications

VF: R8 bearer requirements.

4.1.3 Required equipment / initial conditions

See2.1.

4.1.4 Procedure

See 2.4.

4.2 Radiated Power in Talk Situation GSM 1800

4.2.1 Test purpose

Measure the overall or total radiated power in GSM 1800 mode (see Tab. 1).

4.2.2 Related Vodafone Requirement or International Specifications

VF: R8 bearer requirements.

4.2.3 Required equipment / initial conditions

See 2.1.

4.2.4 Procedure

See 2.4.

4.3 Radiated Power in Talk Situation 3G UMTS Band I

4.3.1 Test purpose

Measure the overall or total radiated power in 3G UMTS band I (see Tab. 1).

4.3.2 Related Vodafone Requirement or International Specifications

VF: R8 bearer requirements.

4.3.3 Required equipment / initial conditions

See 2.1.

4.3.4 Procedure

See 2.4.

4.4 Radiated Sensitivity in Talk Situation EGSM 900

4.4.1 Test purpose

Measure the overall or total radiated sensitivity in EGSM 900 mode (see Tab. 2).

4.4.2 Related Vodafone Requirement or International Specifications

VF: R8 bearer requirements.

4.4.3 Required equipment / initial conditions

See 2.1.

4.4.4 Procedure

See 2.5.

4.5 Radiated Sensitivity in Talk Situation GSM 1800

4.5.1 Test purpose

Measure the overall or total radiated sensitivity in GSM 1800 mode (see Tab. 2).

4.5.2 Related Vodafone Requirement or International Specifications

VF: R8 bearer requirements.

4.5.3 Required equipment / initial conditions

See 2.1.

4.5.4 Procedure

See2.5.

4.6 Radiated Sensitivity in Talk Situation 3G UMTS Band I

4.6.1 Test purpose

Measure the overall or total radiated sensitivity in 3G UMTS band I (see Tab. 2).

4.6.2 Related Vodafone Requirement or International Specifications

VF: R8 bearer requirements.

4.6.3 Required equipment / initial conditions

See 2.1.

4.6.4 Procedure

See 2.5.

4.7 Self-Interference Measurement in Free Space Situation

4.7.1 Test purpose

Measure the relative sensitivity in all relevant bands and use cases in respect to frequenciy (ARFCN).

4.7.2 Related Vodafone Requirement or International Specifications

VF: R8 bearer requirements.

4.7.3 Required equipment / initial conditions

See 2.1.

4.7.4 Procedure

See 2.52.6.