Antenna TEST REPORT

Radiated radio performances GSM850/PCS terminal

Equipment under test:
C61B
OT-E100a

Company:
tcl&alcatel

Number of pages: 12

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CONTENTS

1 / INTRODUCTION :

This document presents the radiated radio performances of the equipment **C61B EU** according to test methods described below. It's antenna is offered by speed.

2 / REFERENCE OF THE DOCUMENT :

3GPP Technical Specification: TS 51.010-1 - Edition 2004-02 - Version 5.7.0
(Annex 1: Reference test methods)

3 / EQUIPMENT UNDER TEST CONFIGURATION

Dual Band (GSM850/PCS) phone: C61B

4 / TEST METHOD DESCRIPTION

The used method is a generalization of the method described by the GSM850 and PCS specifications but advantageously takes into account the total radiation of the MS (all directions and polarizations – cf Annex 1 for comments).

The method is based on regularly spaced measurements along meridians (elevation planes). All the measured values (taking into account co- and cross-polarization) are averaged with a cosine function weighting, in order to provide a single value representing the radiation on the whole space.
The cosine weighting is there to give each measured value a weight corresponding to the surface (on the sphere) each measured value represents.
The measurements are performed with the same kind of set-up as needed for the azimuth measurements (in the Recs). The difference is that the phone is installed on the set-up horizontally rather than vertically. The orientation of the phone around its main axis (then horizontal) defines the elevation cut tested.

For accurate assessment of performances, the qualification test is performed on the traffic channels located at the down, medium and high of the radio band tested (GSM850: 975-38-124 and PCS: 512-698-885) according:

- 2 orthogonal elevation planes (E1: back to front plane of the phone and E2: slice plane of the phone).
- 120 measurement samples in Tx mode (step: 3°), 20 samples for sensitivity measurement (step: 18°), on each elevation plane.
- Both polarizations of the test antenna.

That is to say 480 (or 80) measurement samples for one Tx (or Rx) traffic channel.

Summing up the processing, an average value is extracted from the measured data:

- For each angular point, by summing of both polarizations.
- For each elevation cut, by summing the points with a cosine weighting (taking also into account the number of cuts).
- Then summing all the two elevation cuts to provide one single value representing the radiation on the whole space.

Data are processed according to the parameter under qualification: Tx level will be treated as power value and sensitivity as inverse ratio of power (cf. annex 2 for detailed description).

Note: In the document are also given the averaged radiated values for each elevation plane (determination for total polarization). The measuring method is similar to those used for method with cosine weighting, only the post-processing differs (cf. Annex 2 for detailed description).

The test method of SAR refer to Annex 3 please

5/ TESTS CONDITIONS

5.1/ Test configuration

The measurements are made in an anechoic shielded chamber.
The MS is located on a rotating mast at about 2.5 m above the ground plane, at the same height than the test antenna. The measuring distance is 4.80 m.
The MS model C61B is Bar,
During the tests, the communication is established with the GSM850/PCS Test Set (R&S CMU200) and the Tx level is put at its maximum (Tx Level = 5 for GSM850 and Tx Level = 0 for PCS).
The measurements are performed for each polarization of test antenna and for two elevation planes of the MS.

5.2/ TRP measurement principle

For each measurement sample, the radiated power (in dBm) corresponds to the peak value on the power meter, minus the reference attenuation (see Figure 1).

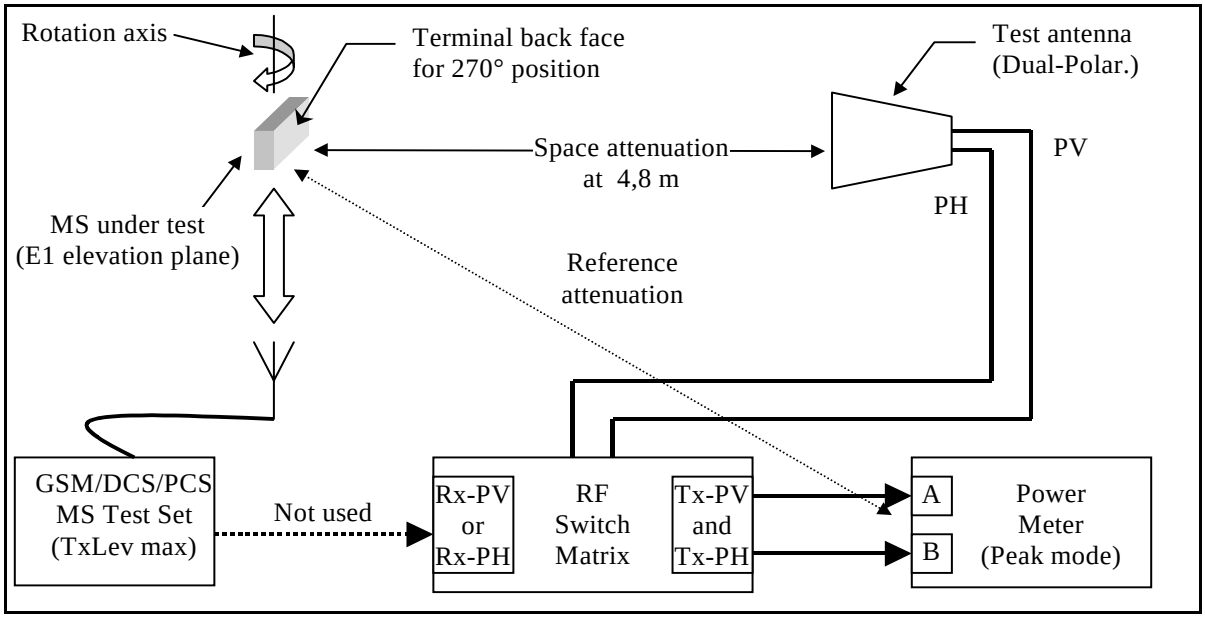

Figure 1: TRP measurement principle

The precision of this TRP measurement method is estimated at **± 0.5dB**.

5.3/ TIS measurement principle

For each measurement sample, the sensitivity (in dBm) corresponds to the minimum level for the internal RF generator of the MS Test Set (for RBER class2 = 2.44%), minus the reference attenuation (see Figure 2).

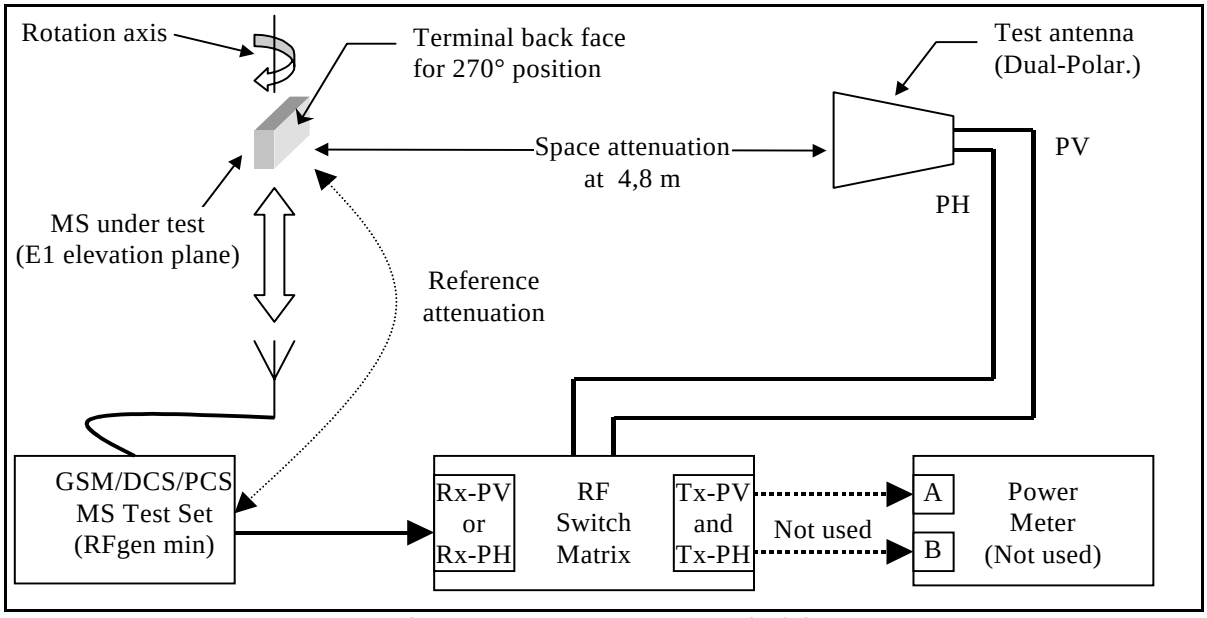

Figure 2: TIS measurement principle

The precision of this TIS measurement method is estimated at **± 1dB**.

5.3/ SAR measurement principle
see Annex 3 please

5.4/ Test apparatus

Category	Manufacturer	Type	Serial Number	Tcl&alcatel
Anechoic Chamber	Siepel	1426B		000009902208
3-axes HDP Positioning robot	Berger Lahr	Berger Lahr	Totem	
3-axes GMT positioning robot	Siepel	Siepel	Turntable	
Dual-Polarization Horn Antenna	SE EGC Espace	CNP 3DR		
Horn Antenna	Schwarzbeck	BBHA 9120-LF		000009902219
Horn Antenna	Schwarzbeck	BBHA 9120-A	BBHA 9120-A/267	
Power Meter	Rohde & Schwarz	NRV 828.2511.02	893284/010	000009902206
Diode Power Sensor	Rohde & Schwarz	NRV-Z1 828.3018.02	890211/029	
Diode Power Sensor	Rohde & Schwarz	NRV-Z1 828.3018.02	830912/001	
Digital Radiocom. Tester	Rohde & Schwarz	CMD 55 1050.9008.55	825673/0076	000009902215
RF Switch Matrix	Rohde & Schwarz	PSU 290.8014.02	871691/110	930000698
Signal Generator	Rohde & Schwarz	SML 03 1090.3000.13	837260/012	20011000372
Network Analyzer	Hewlett Packard	HP8753C + HP85046A	3033U00978 3033A04510	930003143 930003019
PC (+carte PCI HP-IB)	Compaq	Deskpro EP Series 6350/4.3 FRE	8914CCJ82528	000009902202
Software	Tcl&alcatel	Tcl&alcatel		
Spectrum Analyzer	Rohde & Schwarz	FSEB 30	839323/009	0083116097

Table 1: Used apparatus

6 / RADIATED RADIO RESULTS

6.1/ GSM850 mode

The radiated performances in TRP,TIS and SAR on the whole space in GSM850 mode are summarized in Table 2 .

Traffic Channel	TRP (dBm)	TIS (dBm)	SAR (Kg/w 1g/10g)
975	28.4	-104.9	1.17/0.79
38	28.4	-104.8	
124	27.4	-104	

Table 2: Radiated performances (radiated value on whole sphere) in GSM850 mode

6.2/ PCS mode

The radiated performances in TRP and TIS on the whole space in PCS mode are summarized in Table 3 .

Traffic Channel	TRP (dBm)	TIS (dBm)
512	26.1	-105.6
661	27.4	-105.8
810	27.6	-105

Table 3: Radiated performances (radiated value on whole sphere) in PCS mode

Annex 1

Comments on the method described by the GSM specifications

The measurement suggested on antenna in the Rec 11/10 (for MS without RF connector) could be considered a good solution in order to evaluate the performances of MS's antenna. However, the fact that the method is only testing what is happening on the azimuth plane (with the MS vertical) leads that it is not representative of the real MS performances on the whole sphere. Moreover this method could lead to sensitive and irreproducible results, mainly for the following reasons:

- The use of only eight positions for averaging.
- The method is only valid if the MS has a radiation pattern similar to a dipole (*In fact GSM 850/900 small handsets could present a radiation pattern quite close to the dipole pattern, but typical PCS/PCS handsets exhibit radiation patterns with nulls in the azimuthal plane*).
- The method cannot give reliable results if the MS has a depletion of the radiation in the azimuth plane.

The fact that the performances of the MS are checked only in this plane has the following drawbacks:

- 1° Poor assessment of the real performances of the MS
- 2° Uncertainty of the results dependant on the quality and the choice of the alignment of the mobile with the vertical line.
- 3° Because this azimuth radiation pattern is a cut of the 3D pattern in an area with possible deep nulls, the eight positions averaging is very dependant on the choice of the origin for the zero degree position. Hence the inaccuracy caused by this choice is difficult to evaluate.

The minimum requirement, if one still wants to apply this azimuth plane test, is to have very precise rules for the positioning of the MS (this could be difficult because MS are not rectangular boxes).
Consequently, with this test method, even simple comparisons or ranking of MS can be wrong.

Another issue is that the Recs originally intended for GSM 850/900 do not take into account the important and useful part of the energy that is sent in the other polarization (cross polarization). Complex radiation patterns and energy sent in the cross polarization are certainly useful for the quality of the radio link. In real life due to the multi-path environment and the variety of position in which MS are used, it is difficult to define any ideal kind of polarization or any shape of ideal radiation pattern.
One goal of antenna optimization is to send a maximum of energy: it is necessary, at least in PCS/PCS, for this optimization to take into account what is radiated in both polarizations.

In GSM, polarization co-linear with the phone could be considered a representative of the main part of the energy, but one has to consider that other types of design and different optimizations could lead to different types of antenna and hence to a different orientation for the main polarization.

Annex 2

Detailed description of the method

A - Determination of radiated power and sensitivity in total polarization

For each elevation plane and each given angular position, the radiated power in total polarization is given by the formula:

$$Tx_{TOTAL-POLAR} = 10 * \log_{10}\left(10^{(Tx_{POLAR\_V}/10)} + 10^{(Tx_{POLAR\_H}/10)}\right)$$

For the sensitivity, we applied the formula with inverse ratio of power :

$$Sensitivity_{TOTAL-POLAR} = -10 * \log_{10}\left(10^{(-Sensitivity_{POLAR\_V}/10)} + 10^{(-Sensitivity_{POLAR\_H}/10)}\right)$$

B - Determination of radiated power and sensitivity on a whole sphere

The method uses an averaging of samples of elevation measurements with a weighting of each samples according to the solid angle they represent (relative to 4π Steradians).
Each sample, of course, takes into account all the energy radiated (or received) summing up two measurement in crossed polarizations (determined with formulae above).

The description hereafter is based on “power values” (suitable for Tx power and Rx levels). For sensitivity calculations, the processing will have to use reciprocals.

Let
N be the number of elevation planes
n be the number of samples along the complete circle of one elevation plane
This defines the angles between samples in the meshing of the whole sphere.
With a sample defined by an elevation angle θ and an azimuth angle φ, we associate a surface on the sphere (sphere normalized to a radius of 1):
This surface is defined by the angles comprised between $\theta \pm \Delta\theta$ et $\varphi \pm \Delta\varphi$

$$\text{Surface} = (2\pi/N)\,(\,|\cos\theta|.\sin(\Delta\theta/2)\,)$$

The weighting to apply for each sample, according to its position is (taking into account a normalization by $1/4\pi$):

$$\mathbf{Pe = (\,|\cos\theta|.\sin(\Delta\theta/2)\,) / 2N}$$

In order to take into account the overlapping on the pole of the other elevation planes, we have to apply a different formula (consistent with the energetic budget on the sphere) for samples located at the poles of the sphere.
For the correct weighting we use for these samples a weight defined by the intersection of the spherical lune and the polar portion of the sphere : the spherical lune width $\Delta\varphi$ and the radius of the polar zone
$r=\Delta\theta/2$.
The surface of the polar zone being:

$$Sc = 2\pi(1-\cos(\Delta\theta/2))$$

We have to divide this surface by the number of samples overlapping on the pole (N).
Hence the weighting for samples located at the poles:

$$\mathbf{Pp = (\,1 - \cos(\Delta\theta/2)\,) / 2N}$$

If we call the measurements samples:

Me (natural power value) - for any sample not located at a pole.
Mp (natural power value) - for a sample located at a pole.

All the samples are summed according to the following formulae, giving as a final result the performances in radiation of the MS on the tested parameter for one elevation plane:

$$\mathbf{P_{EN}total = \Sigma\ Pe.Me + \Sigma\ Pp.Mp}$$

with $\mathbf{Pe = (|\cos\theta|.\sin(\Delta\theta/2)) / 2N}$

and at the poles $\mathbf{Pp = (1 - \cos(\Delta\theta/2)) / 2N}$

To provide one single value representing the radiation on the whole space, all the P_{EN}total are summed.

$$\mathbf{Ptotal = \Sigma\ P_{EN}total}$$

Ptotal is then transformed into a suitable expression according to the tested parameter: the radiated power being treated as power values, sensitivity as inverse ratio of power.

C - Determination of averaged radiated power and sensitivity for each elevation plane

The method uses a simple averaging of samples for each elevation. Each sample, of course, takes into account all the energy radiated (or received) summing up two measurements in crossed polarizations (determined with formulae in paragraph A).

For each elevation plane, the averaged radiated power is given by the formula:

$$Tx_{averaged} = 10 * \log_{10}\left(\frac{\sum_{i=1}^{n} 10^{(Tx_i/10)}}{n} \right)$$

For the sensitivity, we applied the formula with inverse ratio of power :

$$Sensitivity_{averaged} = -10 * \log_{10}\left(\frac{\sum_{i=1}^{n} 10^{(-Sensitivity_i/10)}}{n} \right)$$