

**Source: ETSI SMG2**

**Title: LS on "replacement antennas" from SMG2  
to TCAM, GSM Association-TWG, GTAAB (copy to TSG-T)**

**Agenda item: 5**

**Document for: Discussion, Information**

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**To:** TCAM, GSM Association-TWG, GTAAB  
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**From:** ETSI SMG2

**LS on replacement antennas**

SMG2 has received an input containing measurement results on **twinkling replacement antennas** for GSM MS. This is attached.

These antennas are not provided by the original MS manufacturer, but are commercially available for a wide range of MS. These MS are becoming increasingly popular especially with younger people.

The LEDs in the antenna that produce the **twinkling** light effects, are non-linear and thus produce output on the harmonic frequencies.

The first harmonic for a GSM900 MS can fall in the DCS1800 band, and the second can fall into the Air Traffic Control band.

The measurements show that use of these antennas increases the interference into the DCS band by up to 40 dB. The interfering level from a GSM MS in the DCS band has been measured to go up to 21 dBm, which is only 9 dB lower than a DCS MS operating at maximum power. Measurements for the Air Traffic Control band have not been performed.

As this interfering signal from the GSM 900 MS cannot be (power) controlled by the DCS operator, this MS has a significant impact on the performance of the DCS network, especially if the GSM900 MS is close to the DCS BTS. This gives rise to serious concern amongst the GSM operators.

SMG2 has no means of solving this problem, as the RF specification reference point is the antenna connector.

It is understood that regulators see the antenna as a passive device, that does not need regulation. This assumption can no longer be seen as valid, as the measurements show a significant impact of these on the efficient use of spectrum, and causing serious harm to other operators and services.

Furthermore, SMG2 is currently working on a new 8 PSK modulation for GSM. Twinkling antennas are expected to degrade the output spectrum mask.

TCAM is asked to consider which regulatory means exist or can be developed to solve these problems.

The other groups are asked to use their influence to minimise the problem created by **twinkling replacement antennas**.

**ETSI STC SMG2 #33**  
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**SMG2 #33 Agenda Item: 6.6, 7.2.6.5**

**Source: Telia AB**

**Title: Spurious emission and antenna measurement on twinkling antennas for handheld GSM mobiles**

**Document for: Discussion**

### **Summary**

Today there are several pirate antennas for handheld mobiles available on the market. Some of these antennas have one or two built-in light-emitting diodes. The diodes are twinkling when the mobile is transmitting.

The test results for the spurious emission measurement show that there is a very high level of the first harmonic in 1800 MHz from mobiles in GSM 900 band. This may cause strong interference signal in the GSM 1800 band. The frequencies that can be disturbed is every other frequency channel from 1805.2 – 1827.6 MHz downlink and 1780.4 – 1784.8 MHz uplink.

The antenna efficiency is also poor for these types of antenna with an average of 10 dB more loss than with the original antenna.

### **Test Results**

The spectrum analyser measurements of the transmitted level of the first harmonic in 1800 MHz compensated with the coupling loss in the antenna coupler 900/1800/1900 MHz CTS-Z10, the directional coupler, and the cables (45 dB)

Mobile	Original antenna	Twinkling antenna Red/Blue	Twinkling antenna Red
DUT1	-15 dBm	+19 dBm	
DUT2	-15 dBm	+12 dBm	
DUT3	-10 dBm	+8 dBm	+7 dBm
DUT4	-19 dBm	+21 dBm	

### **Conclusion**

The core specification GSM 05.05 is for conformance tests today only applied on a 50 Ohms connector for the radio parameters, but should in the near future for handheld MS only be applied on integral antenna, e.g. a built-in patch antenna, in order to avoid the easy misuse of replacing the original antenna by a non-linear pirate antenna. Also the new 8PSK EDGE modulation will most likely get its spectrum mask to grow outside such a non-linear antenna compared with what is specified for a matched linear antenna.



## REPORT

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## Spurious emission and antenna measurement on twinkling antennas for handheld GSM mobiles

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## Summary

Today there is several pirate antennas for handheld mobiles available on the market. Some of these antennas have one or two built-in light-emitting diodes. The diodes are twinkling when the mobile is transmitting.

In order to investigate the spurious emission and the antenna efficiency from these twinkling antennas we have performed a spurious emission- and antenna measurement. These measurements have been performed at three Ericsson and one Nokia mobile equipped with twinkling antennas.

The test results for the spurious emission measurement shows that there is a very high level of the first harmonic in 1800 MHz from mobiles in GSM 900 band. This may cause strong interference signal in the GSM 1800 band. The frequencies that can be disturbed is every other frequency channel from 1805.2 – 1827.6 MHz downlink and 1780.4 – 1784.8 MHz uplink.

The antenna efficiency is also poor for this types of antennas with an average of 10 dB more loss than with the original antenna.

The conclusion is that the end users must be warned of the consequences of using these antennas.

## References

“Antenna test method in scattered field environment” doc:  
4/0363-2FCPA 109 0006, Telia Research

## Abbreviation

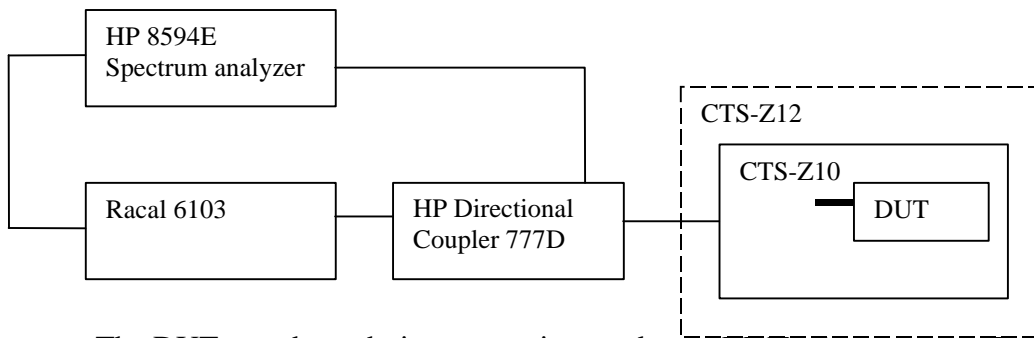
AFRCN	Absolute Radio Frequency Channel Number
DUT	Device Under Test
MS	Mobile Station
Reference signal	Dipole-antenna in free space with an carrier power as the nominal power for the highest power level that is applicable to the mobile classmark

## Spurious emission measurement

### *Test Equipment*

Racal 6103 GSM test simulator  
Hewlet Pacard Spectrum analyzer 8594E  
Rohde&Schwarz Antenna coupler 900/1800/1900 MHz CTS-Z10  
Rohde&Schwarz Shielded Chamber for mobiles radios CTS-Z12  
Hewlet Pacard Dual Directional Coupler 778D

## Test Performance



The DUT was brought i conversation mode at ARFCN 50 by using a Racal GSM MS TEST SET 6103.

The measuring antenna CTS-Z10 is connected to the HP 8594E spectrum analyzer through a directional coupler. The spectrum analyzer is synchronised to the GSM-timeslot with the GSM tester Racal 6103.

The spectrum analyzer measures the transmitted level of the first harmonic in 1800 MHz. The measured level is compensated with the coupling loss in CTS-Z10, directional coupler, and for the cables (45 dB)

## Test Result

Mobile	Original antenna	Twinkling antenna Red/Blue	Twinkling antenna Red
DUT1	-15 dBm	+19 dBm	
DUT2	-15 dBm	+12 dBm	
DUT3	-10 dBm	+8 dBm	+7 dBm
DUT4	-19 dBm	+21 dBm	

## Antenna measurement

### Test Equipment

Spectrum analyzer 8594E sn 3239U00183 and GSM measurement program 85715B from Hewlett-Packard

Dipole antenna with balun 3121C sn 9501-1087 from EMCO (reference antenna 900 MHz)

Dipole antenna with balun 3121C sn 9510-1106 from EMCO (measurement antenna with antenna rotator 900 MHz)

Dipole antenna Schmid & Partner Engineering D1800V3 (reference antenna 1800 Mhz)

Dipole antenna Schmid & Partner Engineering D1800V3 (measurement antenna with antenna rotator 1800 MHz)

Simulated human head, Torso Phantom V2.2 from Scmid & Partner Engineering AG filled with 22,2 litres water with a salt concentration of 1,49 g/litre

Simulated human hand, plastic glove filled with 0,4 litres water with a salt concentration of 1,49 g/litres

Turning table

GSM MS TEST SET 6103 from Racal

## ***Test performance***

This document mainly describes the prerequisites for the test. For a more detailed test description see ref. [1].

The measurement method compares a mobile radiated power, while held against a simulated human head, relative to a half-dipole antenna in free space (reference antenna) fed with a carrier power inline with the nominal power that the power class of the mobile says. The results is expressed as a loss in dB relative the reference antenna.

When the mobile is in active mode the radiated power is measured with a rotating measuring antenna (half-dipole antenna mounted in vertical polarisation).

## ***Prerequisites***

An ordinary office room of 5 x 8 metres size where roof, floor and one and a half of the wall are made of concrete, the remaining half and the other two walls are of plasterboard. To get the desired scattered field radio environment 5 corrugated sheet of metal (900 x 2100 mm) has been placed in the part of the room where the mobile and turn table was placed. See figures 1-3.

The mobile antenna (during reference measurement: the reference antenna) was mounted on the turntable.

For the reference measurement, the reference antenna should be placed at the centre of the turn table on the same place as the MS later on will be placed during the test.

The turn table was rotated in 8 different angles with 45 degrees interval. The turn table must be fixed during the measurements at each angle.

The mobile was brought into conversation mode at ARFCN 647 (GSM 900 ARFCN 50) by using a Racal GSM MS TEST SET 6103.

The measuring antenna was connected to the spectrum analyser who measured the carrier power in one burst from the MS and from the reference antenna. While the measuring antenna rotates, one measuring sample per second is taken. Hundred samples are collected while the measurement antenna rotates approximately 1 turn. The median value is calculated from these samples. This procedure is repeated for each of the 8 different angles. An average value is calculated from the median values of the 8 different angles.

The difference between this average value for the MS relative to the average value for the reference antenna gives the output result for the measurement.

The MS was measured during these different conditions:

- Simulated head and hand

With a simulated human head the mobile was applicated so that the ear speaker matched against the assumed ear point. The mobile was also tilted 30 degrees see figure 3 and the simulated hand was applicated to mobile.

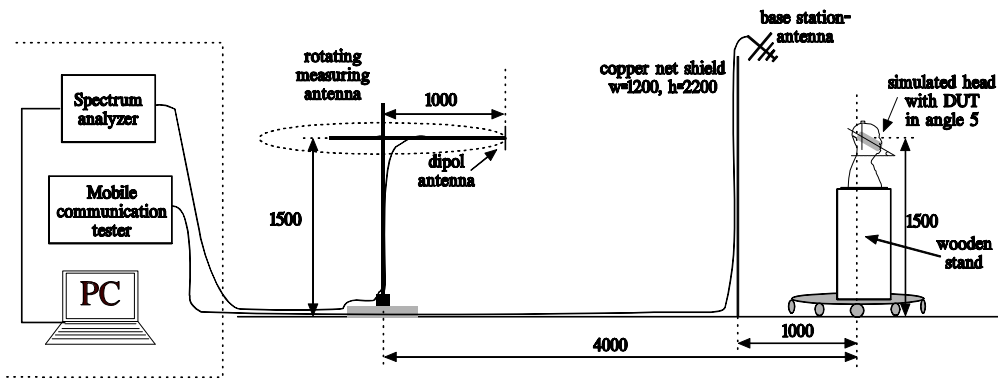


Figure A. Arrangement of test equipment

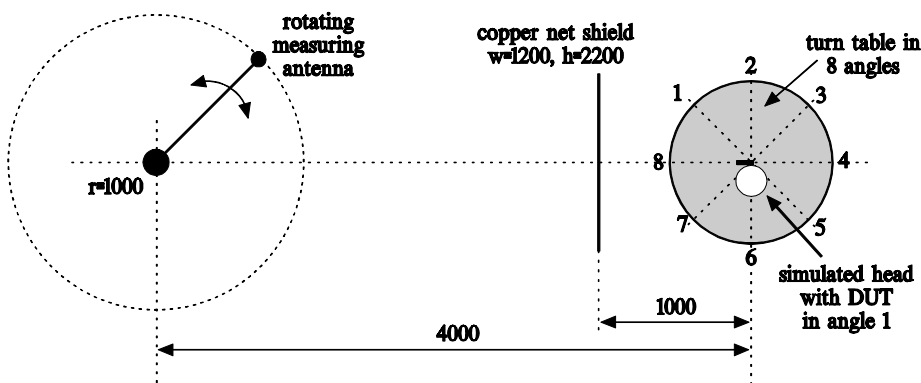


Figure B. Arrangement of test equipment, top view.

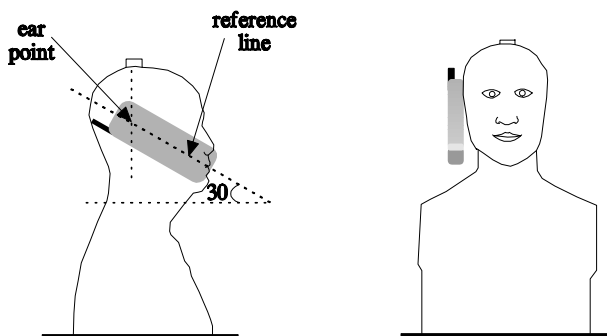


Figure 3. Simulated head.

### Test result

The deviation is  $\pm 2.0$  dB.

*The measurement results are expressed as a gain in dB relative a half-dipole antenna (reference antenna) without the presence of a simulated human head and hand.*

Mobile	Original antenna	Twinkling antenna Red/Blue	Twinkling antenna Red
DUT1	-12.0 dB	-22 dB	
DUT2	-11.7 dB	-25.4 dB	
DUT3	-9.6 dB	-22.0 dB	-14.2 dB
DUT4	-8.8 dB	-16.5 dB	
Average	-10.5 dB	-21.5 dB	-14.2 db