PERFORMANCE ASSESSMENT OF THE IPHONE6 RADICOVER ANTI-RADIATION PHONE CASE BY RADICOVER, DENMARK WHEN USED AT A HUMAN HEAD

No.: 16-1-01434-09-28

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Customer: RadiCover ApS

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1. Administrative Data

1.1. Identification of Entity Providing the Service

Company name:	CETECOM GmbH
Address:	Im Teelbruch 116 45219 Essen Germany
Report No.:	16-1-01434-09-28
Date of Report:	28.09.2016
Project Management:	Dr. Peter Nevermann
Assessment by:	Dr. Peter Nevermann

1.2. Identification of Entity Executing the Tests

SAR Lab:	CETECOM Inc.
Address:	411 Dixon Landing Road Milpitas, CA 95035 USA
OTA Lab:	CETECOM GmbH
Address:	Im Teelbruch 116 45219 Essen Germany

1.3. Customer Details

Customer:	RadiCover ApS
Address:	Kirstine Jensens Vej 11 DK-9240 Nibe Denmark
Contact person:	Enrico Kaarsberg (RadiCover ApS) <eka@radicover.dk>

1.4. Task and Device Used

Task:	Measure the impact of a phone cover for iPhone 6 on a human head in terms of SAR (specific absorption rate) and its impact on the to be expected reduction of the phone RF performance in terms of TRP (total radiated power) for GSM 900. Provide an assessment of the impact of both, SAR and TRP data in respect to the real world related effectiveness.
Device under Test:	Radicover anti-radiation phone case
Used Mobil Phone:	iPhone6 (A1586), SN: 359284065790286, The phone was configured to have only the lower antenna active to avoid TX diversity issues.

1.5. Signature

Signature:	
	Dr. Peter Nevermann, Director Performance Services

2. Rationale for the Test

2.1. Head Phantoms

Today's mobile phones are used in "free space", e.g. lying on the table while streaming videos. However, when making a phone call, the phone is hold to the human head. In such a case an energy entry in the human head occurs. The head does absorb a certain amount of RF energy. There are limits for this energy entry in terms of a specific absorption rate (SAR) in W/kg, measured for certain amount of material (1g or 10g). There are very specific test methods as described by international standards (see [1], [2] and [6]). Part of test specification is the definition of head phantom and material simulating the human head material [6].

The very same phantom is used for testing the mobile phone performance in terms of total radiated power as described by other standards (see [3], [4] and [5]).

2.2. Actual used SAR and TRP Test Procedures

In the tests of the Radicover one SAR test and one TRP test have been chosen out of the test specifications mentioned above (actually the European versions: [1] and [5]). All tests were done with the RF output power set to maximum, as required by all test specifications. To compare SAR and TRP data, the following tests have been carried out:

- On the left ear (BHL) and in
- In GSM 900 MHz band (because this is usually the worst case).
- There have been always two tests: with and without the Radicover.

The details are described in the appropriate CETECOM test reports (see [7] and [8]).

Below are shown the photos of the actual set up.

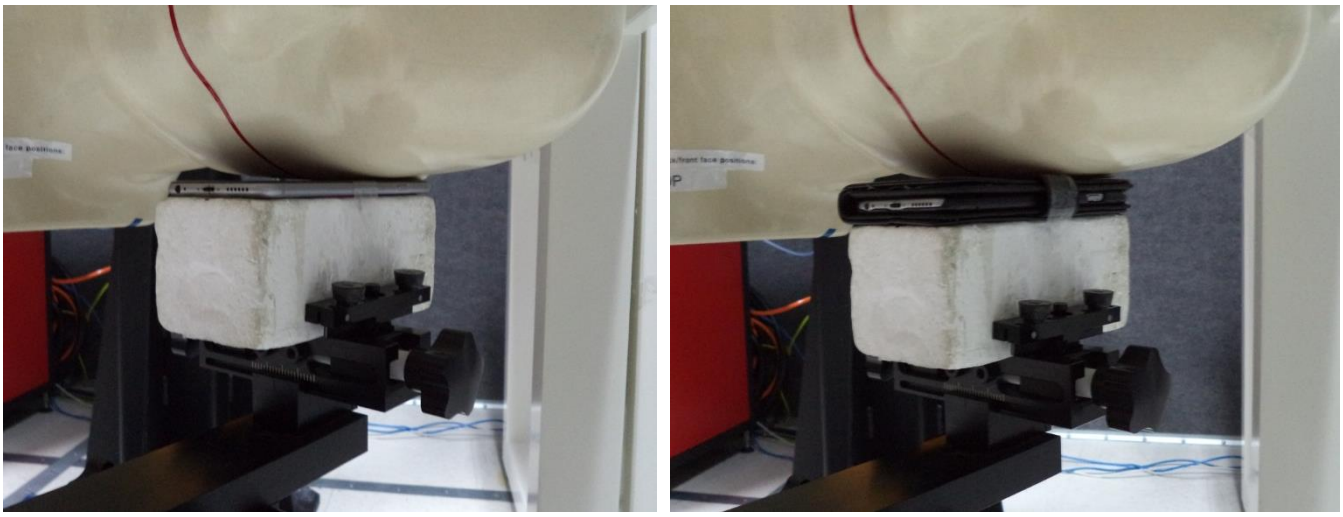

Fig.: 1 SAR tests at human head phantom without and with the cover.

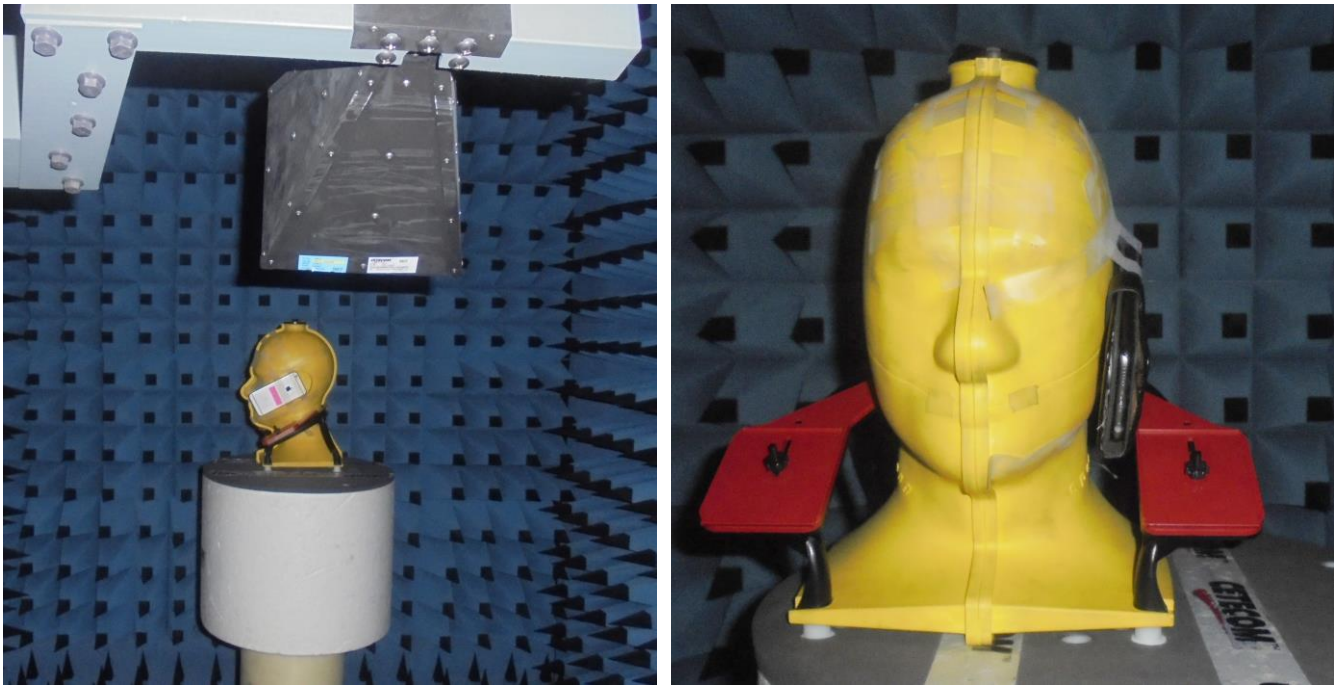

Fig.: 2 OTA tests at human head phantom without and with the cover.

2.3. Impact of Power Control Mechanism of real World Networks

Contrary to the test procedures described below, where the phone is forced to operate at maximum RF power, this situation is rather seldom in the real world. All mobile phone technologies such as 2G (GSM), 3G (UMTS) or 4G (LTE) do support an adaptive RF power control mechanism. In certain time intervals the base station and the mobile phone exchange information about the link budget (e.g. receive level) and adjust the phone RF power, to make sure the phone operates at the lowest possible RF output power. This has been once introduced to save battery power and avoid unnecessary interferences.

In case of using a phone cover which simply absorbs RF power equally, this mechanism does in effect the following: When introducing such a cover, any reduction of the reduced phone power would be recognized by the base station. The base station would now command the phone to raise the power exactly by the amount of the absorbed energy to restore the link quality. Hence, this mechanism is good for canceling out RF power absorbing effects.

Therefore, an effect of a SAR reduction under real world conditions exist only, when the impact of a cover on the SAR value is higher than on the total radiated power. In such a case the effective SAR reduction would be the difference between the SAR reduction and the reduction in the TRP value.

Fortunately, it is known for years, the total radiated power (responsible for the link budget) and the SAR (amount of absorbed energy by the human head) can be influenced differently. This is, because the TRP is a far field property and depend on details of the antenna an the complete metal related design of the phone, whereas the SAR value is a near field effect and depend only on details of some parts of the antenna and parts of the metal casing and frame. To the assessor's knowledge one of the earliest scientific publications on this difference was issued in 1999 by Wang and Fujiwara [9].

3. Test Results and Assessment

3.1. SAR and TRP Data

The SAR tests with and without the cover showed a reduction from 0.336 W/kg to 0.039 W/kg (SAR-10g value, see [7]). This is a reduction by 9.4 dB, or in terms of a linear power related values a reduction by 88%.

The reduction of the phone performance in terms of the total radiated power was found to be from 24.4 dBm down to 23.5 dBm (see [8]). This is a reduction by 0.9 dB, or in terms of a linear power related values a reduction by 19%.

All results are valid for GSM 900 and the particular iPhone6 as described in chapter 1.4 only.

3.2. Calculation of SAR Reduction for Real World Conditions

As discussed in chapter 2.3 the effect of a SAR reducing mobile phone cover in real world conditions is about the difference between the SAR reduction (measured at maximum power) and the TRP reduction (measured at maximum RF power setting). That is, because under typical real life conditions, the network will compensate the TRP reduction.

In terms of the physically relevant RF power, 23.5 dBm equals to 224 mW and 24.4 dBm is 275 mW. Hence, assuming there are two iPhones in the same distance to a base station, one with and one without a cover, the BS would command the iPhone with the cover to enhance its RF output power by the factor 275/224 = 1.23 (by 23 %). Since the SAR value is directly linear proportional to the RF output power, the actual SAR value would also be enhance by 23 %. Therefore, for calculating the effective SAR reduction, we have to compare the SAR value of the phone without a cover (0.336 W/kg) with the partly compensated value: 0.039 W/kg x 1.23 = 0.048 W/kg for the phone with a cover. Now it is 0.048/0.336 = 0.14. This means that the effective SAR reduction is a reduction down to 14 % or a reduction by 86 %.

3.3. Assessment and Conclusion

In fact, the measured data for the Radicover show an substantial difference in the SAR reduction caused by the Cover, which has been found by approximately 90%, whereas the TRP reduction was only around 20%.

Therefore, under typical real life conditions, the network will compensate the TRP reduction leaving an effective SAR reduction by 86%.

Although those results are strictly speaking only valid for the iPhone tested and only for GSM900, the results show the SAR reduction concept applied by Radicover is working – at least in this particular case.

4. References

[1] IEC 62209-1: "Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 1: Devices used next to the ear (Frequency range of 300 MHz to 6 GHz)", 2016.

[2] IEEE Std C95.1-2005: "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz", Inst. of Electrical and Electronics Engineers, Inc., 2005.

[3] CTIA OTA Test Requirement: "Test Plan for Wireless Device Over-the-Air Performance / Method of Measurement for Radiated RF Power and Receiver Performance", Revision 3.6, June 2016, available via www.ctia.org.

[4] Vodafone: „Vodafone Specification for Terminals on Over the Air RF Performance", Version 2.5, March 2012.

[5] 3GPP 34.114, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; User Equipment (UE) / Mobile Station (MS) Over The Air (OTA) antenna performance; Conformance testing", Version 12.1.0, September 2014.

[6] IEEE Std 1528-2003: "IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", The Institute of Electrical and Electronics Engineers, Inc., New York, 2003.

[7] CETECOM SAR Test Report: "SAR Summary Data for Radicover", September 2016.

[8] CETECOM OTA Test Report: "OTA Performance of Radicover", August 2016.

[9] J. Wang and O. Fujiwara: „Reduction of SAR in Human Head by Suppression of Surface Currents due to a Portable Telephone", presented at the 13th International Zurich Symposium on EMC, February, 1999.