TTI-P-G 158

Report

Dosimetric Assessment of the Mobile Telephone Telit GS/GSM SAT600 According to the American FCC Requirements

July 27, 2000

IMST GmbH
Carl-Friedrich-Gauß-Str. 2
D-47475 Kamp-Lintfort

customer
CETECOM
Untertürkheimer Str. 6-10
D-66117-Saarbrücken

dasy_report_us_2.1.doc/26.01.2000/AB

Executive Summary

The device GS/GSM SAT600 (IMEI: 004400/44/055055/4) is a new mobile phone from Telit operating in the 900 MHz and 1618 MHz / 2492 MHz frequency range. The system concepts supported are the GSM 900 and the Globalstar standards. The device is investigated in Globalstar mode only.

For the Globalstar mode the device has a helix antenna which has to be turned into the correct position.

The objective of the measurements done by IMST was the dosimetric assessment of one device in the Globalstar mode. The examinations have been carried out with the dosimetric assessment system „DASY".

The measurements were made according to the Federal Communications Commission (FCC) Guidelines [FCC 1997] for evaluating compliance of mobile phones with the American Standard ANSI C95.1 [ANSI 1992]. In [ANSI 1992] limits are defined to prevent harmful effects in human beings exposed to electromagnetic fields.

The Telit GS/GSM SAT600 mobile phone operating in the Globalstar mode is in compliance with the American Standard ANSI C95.1 [ANSI 1992].

prepared by: .... reviewed by: ....

Dipl.-Ing. Christoph Hennes
test engineer

Dr.-Ing. Frank Gustrau
quality assurance engineer

IMST GmbH
Carl-Friedrich-Gauß-Straße 2
D-47475 Kamp-Lintfort

Tel. +49- 2842-981 372
Fax +49- 2842-981 398
email: gustrau@imst.de

Table of Contents

1 Subject of Investigation

The device GS/GSM SAT600 shown in Fig. 1 is a mobile phone from Telit operating in the 900 MHz and 1618 MHz / 2492 MHz frequency range. The system concepts supported are the GSM 900 and the Globalstar standards. The device is investigated in Globalstar mode only. For the Globalstar mode the device has a helix antenna which has to be turned in the correct position shown in Fig. 1 (left image shows left hand use, right image shows right hand use).

Fig. 1: Pictures of the device under test.

The objective of the measurements done by IMST was the dosimetric assessment of one device in the Globalstar mode. The examinations have been carried out with the dosimetric assessment system „DASY“ described below.

2 The American Standard ANSI C95.1

In the USA the recent Standard ANSI C95.1 was published in April 1992 [ANSI 1992]. It sets limits for human exposure to radiofrequency fields in the frequency range 3 kHz to 300 GHz.

2.1 Distinction Between Exposed Population, Duration of Exposure and Frequencies

The American standard distinguishes between controlled and uncontrolled environment. Controlled environments are locations where there is exposure that may be incurred by persons who are aware of the potential for exposure as a concomitant of employment or by other cognizant persons. Uncontrolled environments are locations where there is the exposure of individuals who have no knowledge or control of their exposure. The exposures may occur in living quarters or workplaces.

For exposure in controlled environments higher field strengths are admissible. In addition the duration of exposure is considered. For the relevant frequency range the limit is made at 30 minutes exposure time. For short-term exposure below a duration of 30 minutes, higher field strengths are admissible.

Due to the influence of frequency on important parameters, as the penetration depth of the electromagnetic fields into the human body and the absorption capability of different tissues, the limits in general vary with frequency.

2.2 Distinction between Maximum Permissible Exposure and SAR Limits

The biological relevant parameter describing the effects of electromagnetic fields in the frequency range of interest is the specific absorption rate SAR (dimension: power/mass). It is a measure of the power absorbed per unit mass. The SAR may be spatially averaged over the total mass of an exposed body or its parts. The SAR is calculated from the r.m.s. electric field strength E inside the human body, the conductivity σ and the mass density ρ of the biological tissue:

$$SAR = \sigma \frac{E^2}{\rho} = c \frac{\partial T}{\partial t}\bigg|_{t \to 0+} \quad . \qquad (1)$$

The specific absorption rate describes the initial rate of temperature rise $\partial T / \partial t$ as a function of the specific heat capacity c of the tissue. A limitation of the specific absorption rate prevents an excessive heating of the human body by electromagnetic energy.

As it is sometimes difficult to determine the SAR directly by measurement (e.g. whole body averaged SAR), the standard specifies more readily measurable maximum permissible exposures in terms of external electric E and magnetic field strength H and power density S, derived from the SAR limits. The limits for E, H and S have been fixed so that even under worst case conditions, the limits for the specific absorption rate SAR are not exceeded.

For the relevant frequency range the maximum permissible exposure may be exceeded if the exposure can be shown by appropriate techniques to produce SAR values below the corresponding limits.

2.3 SAR Limit

In this report the comparison between the American exposure limits and the measured data is made using the spatial peak SAR; the power level of the device under test guarantees that the whole body averaged SAR is not exceeded.

Having in mind a worst case consideration, the SAR limit is valid for uncontrolled environment and for exposure times longer than 30 minutes [ANSI 1992]. According to Table 1 the SAR values have to be averaged over a mass of 1 g (SAR_{1g}) with the shape of a cube.

Standard	Status	SAR limit [W/kg]
ANSI C95.1	In force	1.6

Table 1: Relevant spatial peak SAR limit averaged over a mass of 1 g.

3 The American Measurement Procedure

The Federal Communications Commission (FCC) has published a report and order on the 1st of August 1996 [FCC 1996], which requires routine dosimetric assessment of mobile telecommunications devices, either by laboratory measurement techniques or by computational modeling, prior to equipment authorization or use. In 1997 the FCC has published additional information for evaluating compliance of mobile and portable devices with FCC limits for human exposure to radiofrequency emissions [FCC 1997]. This supplement is not intended, however, to establish mandatory procedures, and other methods and procedures may be acceptable if based on sound engineering practice.

3.1 Test Conditions

The device under test has to operate at maximum power level with a fully charged battery during the measurement. The SAR test has to be performed with the mobile phone transmitting at three different frequencies in the allocated frequency band: lowest frequency, center frequency, and highest frequency. For devices with retractable antenna the tests shall be performed with the antenna fully extended and fully retracted.

3.2 Test Position

The lack of standardized test positions for evaluating handsets can result in difficulties in determining RF compliance with SAR limits. Therefore the FCC recommends one test position (other test positions representing normal operating positions are also acceptable):

First the device is positioned in a normal operating position with the center of its ear-piece aligned with the location of the ear canal on a simulated head model. With the ear-piece pressed against the head, the next step is to align the vertical center-line of the body of the handset with an imaginary plane consisting of the three lines joining both ears and the tip of the mouth. While maintaining these alignments, the body of the handset is gradually moved towards the cheek until any point on the mouth-piece or keypad is in contact with the cheek.

4 The Measurement System

DASY is an abbreviation of „Dosimetric Assessment System“ and describes a system which is able to determine the SAR distribution inside a phantom of a human being according to different standards. It consists of a robot, several field probes calibrated for use in liquids, a shell phantom, tissue simulating liquid and software. The software controls the robot and processes the measured data to compare them with safety levels with respect to human exposure to radio frequency electromagnetic fields. Fig. 2 shows the equipment, similar to the installations in other laboratories [DASY 1995].

A mobile phone operating at the maximum power level is placed by a non metallic device holder in a well-defined position at a shell phantom of a human being. The distribution of the electric field strength E is measured in the tissue simulating liquid within the shell phantom. For this

Fig. 2: The measurement setup with a phantom containing tissue simulating liquid and a device under test.

miniaturized field probes with high sensitivity and low field disturbance are used. Afterwards the corresponding SAR values are calculated with the known electrical conductivity σ and the mass density ρ of the tissue. The system software is able to determine the averaged SAR values (averaging region 1 g or 10 g) for compliance testing.

This is done by two scans: first a coarse scan determines the region of the maximum SAR, afterwards the 1 g or 10 g averaged SAR is measured in a second fine scan. The measurement time takes about 20 minutes.

The phantom (generic twin phantom) is a fiberglass shell integrated in a wooden table. The thickness of the phantom amounts to 2 mm ± 0.1 mm. It enables the dosimetric evaluation of left and right hand phone usage. The phantom setup includes a coverage (polyethylene) which prevents the evaporation of the liquid. The ear is simulated by ensuring a space of 4 mm thickness between the tissue simulating liquid and the speaker of the phone.

4.1 Technical Parameters of the Measurement System

Parameter	**DASY**
Spatial resolution	5 mm
Repeatability of probe position	± 0.1 mm
Dynamic range	5 mW/kg - 100 W/kg

Table 2: DASY system specification.

Parameter	**Accuracy**
Frequency linearity	± 0.2 dB
Deviation from isotropy (in air)	± 0.8 dB
Surface detection	± 0.2 mm

Table 3: Probe specification.

Parameter	**Noise floor**
SAR values	< 0.005 W/kg
Electric field strength *E*	< 1 V/m

Table 4: Sensitivity of DASY.

Accuracy influencing conditions	**Accuracy of SAR values**
Isotropy, calibration, noise floor	< 13 % @ 1 W/kg
Extrapolation of SAR values	< 7 %
Dielectric parameters	< 5 %

Table 5: Accuracy of the SAR values determined by measurements [Kuster 1997].

5 SAR Results

The Tables below contain the measured SAR values averaged over a mass of 1 g.

left hand p.	channel	SAR(1g) W/kg	File
lowest freq.	R1	< 0.005 *)	600SLL_4.MEA
center freq.	R7	< 0.005 *)	600SLM_4.MEA
highest freq.	R13	< 0.005 *)	600SLH_4.MEA

Table 6: Measurement results in the Globalstar standard for the Telit GS/GSM SAT600, left hand position.

right hand p.	channel	SAR(1g) W/kg	File
lowest freq.	R1	< 0.005 *)	600SRL_4.MEA
center freq.	R7	< 0.005 *)	600SRM_4.MEA
highest freq.	R13	< 0.005 *)	600SRH_4.MEA

Table 7: Measurement results in the Globalstar standard for the Telit GS/GSM SAT600, right hand position (*) SAR values below noise floor.).

6 Evaluation

In Fig. 3 the SAR results for Globalstar mode given in Tables 6 - 7 are summarized and compared to the limit.

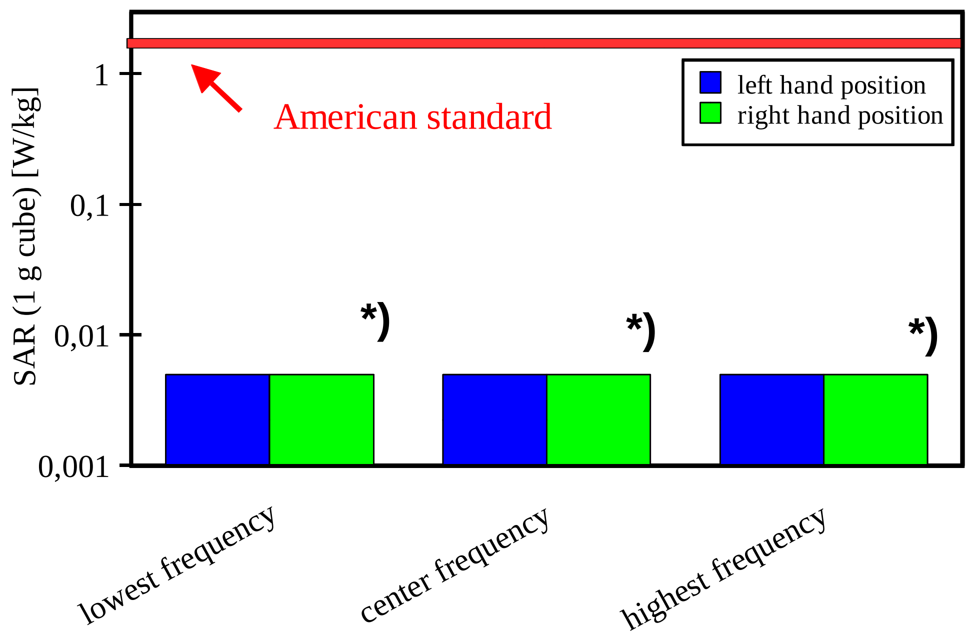

Fig. 3: The measured SAR values for the Globalstar mode using the Telit GS/GSM SAT600 in comparison to the American standard (*) SAR values below noise floor.).

The mobile phone Telit GS/GSM SAT600 operated in the Globalstar mode complies with the American Standard ANSI C95.1 [ANSI 1992]. The tests were performed according to the Federal Communications Commission (FCC) Guidelines [FCC 1997].

Note: The measured SAR values depend on the material parameters. Therefore the material parameters must be enclosed in all copies and publications of these results.

7 Appendix

7.1 Administrative Data

Date of measurement: July 25, 2000 - July 26, 2000 by: Dipl.-Ing. C. Hennes
Data stored: Cetecom_6575_105

7.2 Device under Test and Test Conditions

MTE:	Telit GS/GSM SAT600
IMEI:	004400/44/055055/4
Date of receipt of MTE:	July 24, 2000
Standard:	Globalstar
Base station Simulator:	Anritzu MT8803G
Modulation:	QPSK
Frequency Tx:	low end: channel R1, 1610.73 MHz center: channel R7, 1618.11 MHz high end: channel R13, 1625.49 MHz
MS Pwr TCH:	>26 dBm
Battery status:	charged batteries (7.2 V), battery status checked with the battery status bar of the MTE at the end of each measurement
Base station (BS):	Wavetek STABILOK 4032 GSM

7.3 DASY Options

Software version:	DASY V2.3d
Probe:	ET3DV5 SN: 1332
Validation:	July 19, 2000, dipole validation kit: D1800V2 #: 206
Phantom:	Schmid & Partner generic twin phantom, left and right hand position

7.4 Test Position

The test position used for the dosimetric assessment is shown in Fig. 5. For an exact description helpful geometrical definitions are introduced and shown in Fig. 4.

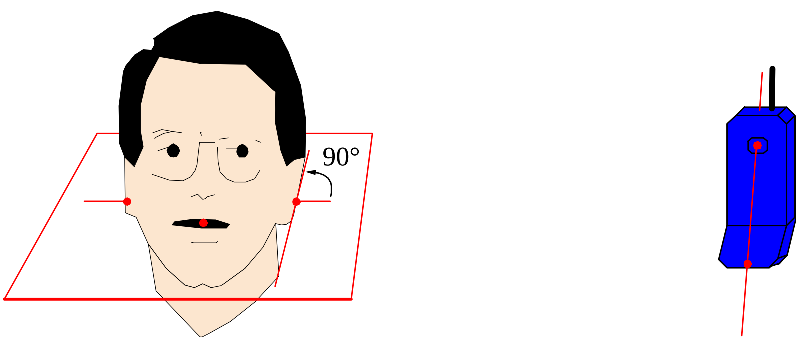

Fig. 4: Geometrical definitions for the description of the test position.

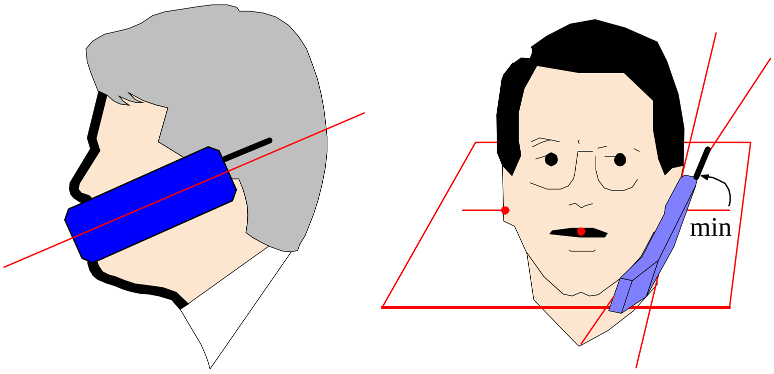

Fig. 5: The test position used for compliance testing.

A reference line describing the phone is defined as a line (on the surface of the phone facing the phantom) which connects the center of the ear piece with the center of the bottom of the case (typically near the microphone). The human head position is given by means of a reference plane defined by the following three points: auditory canal opening of both ears and the center of the closed mouth.

The center of the ear piece is placed directly at the entrance of the auditory canal. The telephone line lies in the head plane. The angle between the phone line and the line connecting both auditory canal openings is reduced until the device touches the surface of the phantom.

7.5 Material Measurement System

Type: HP85070B
Software version: HP85070 Rev. B.01.05 1993
VNA: HP8753D (6 GHz option)

Material parameters:

	Globalstar
Relative permittivity ε_r	39.4 ± 6.0
Conductivity σ	(1.49 ± 0.21) S/m
Mass density ρ	1.04 g/cm^3

Table 8: Parameters of the tissue simulating liquid.

7.6 Environment

Ambient temperature: 20-23 °C
Tissue simulating liquid: 20-23 °C

8 References

[ANSI 1992] ANSI C95.1: 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., 1992.

[DASY 1995] Referenzliste des Herstellers, der Fa. Schmid & Partner Engineering AG, über installierte DASY-Systeme mit RX90 Robotern: Deutsche Telekom, Forschungs- und Technologiezentrum; Motorola Cellular - MRO; Motorola; Ericsson Mobile Communications AB; Nokia Mobile Phones LTD; IMST GmbH, 1995.

[FCC 1996] Federal Communications Commission: Report and order: Guidelines for evaluating the environmental effects of radiofrequency radiation, Tech. Rep. FCC 96-326, FCC, 1996.

[FCC 1997] Federal Communications Commission: Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields, Supplement C to OET Bulletin 65, FCC, 1997.

[Kuster 1997] N. Kuster, R. Kästle and T. Schmid: Dosimetric evaluation of handheld mobile communications equipment with known precision, In: IEICE Trans. Commun., Vol. E80-B, No. 5, 645-652, 1997.