QUALCOMM
CDMA Technologies

Lenovo T400/T500 SAR Addendum

80-VH688-5 Rev. A

March 04, 2008

Submit technical questions to:
regulatory.support@qualcomm.com

QUALCOMM Incorporated
5775 Morehouse Drive
San Diego, CA 92121-1714
U.S.A.

March 04, 2008

Lenovo T400/T500 SAR Addendum
80-VH688-5 Rev. A

Revision history

Revision	Date	Description
A	February 2008	Initial release

This Page Intentionally Left Blank

5775 Morehouse Dr.
San Diego CA 92121

Overview

Test Report Reference:	80-VH688-5 Rev. A
Responsible Engineer:	John Forrester
Signature:	
Test Engineer:	Pete Pereira
Date of issue:	4 March 2008
Test Laboratory:	QUALCOMM Incorporated 5775 Morehouse Dr. San Diego CA 92121 (General Telephone) 1 858 587 1121
Model Tested:	UNDP-1 with Lenovo T400 and T500 Notebook Computers
Test Specification Standard(s):	*FCC CFR47 Part 2.1093: Radiofrequency radiation exposure evaluation: portable devices* *FCC/OET Bulletin 65, including Supplement C, Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields* *FCC "SAR Measurement Procedures for 3G Devices" (October 2007)* *FCC "SAR Evaluation Considerations for Laptop Computers with Antennas Built-in on Display Screens" (December 2007)* *ANSI/IEEE P1528/D1.2 Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques*
Results:	The UNDP-1 embedded in Lenovo Host notebook T400 and T500 complies with the requirements of the aforementioned standards and is in compliance with the FCC Part 2.1093 RF exposure limit when tested with a 90 degree display angle.

Contents

Figures

Tables

This Page Intentionally Left Blank

1. Test summary

1.1 Equipment tested

This report is an addendum to SAR reports for a UNDP-1 WWAN mPCIe card embedded in Lenovo ThinkPad T400 (document # 80-VH6885-3) and T500 (document # 80-VH6885-4) Series notebook computers where the notebooks were retested using a display angle of 90 degrees from the phantom. This data compliments the original SAR reports where the display angle was 100 degrees.

1.2 Maximum (Worst Case Results)

Tables 1-1 and 1-2 give maximum SAR results for head and body-worn positions respectively.

Table 1-1 T400 Maximum SAR

Band	Mode	Channel	1 g SAR	Result
Cell	GPRS 2 UL	High	0.081mW/g	Pass
PCS	EV-DO	High	0.094mW/g	Pass

Table 1-2 T500 Maximum SAR

Band	Mode	Channel	1 g SAR	Result
Cell	GPRS 2 UL	High	0.056mW/g	Pass
PCS	EV-DO	High	0.049mW/g	Pass

1.3 Measurement Uncertainty

Table 1-3 Measurement Uncertainty

Combined Standard Uncertainty	10.0%
Extended Standard Uncertainty (k=2)	20.1%

1.4 SAR Limits

Table 1-3 gives 1 gram SAR limits for general public for the frequency range of 10 MHz to 10 GHz as called out in FCC CFR 47 Part 2.1093.

Table 1-3 1 Gram SAR Limits

Localized SAR (head and trunk)	1.6 mW/g

This page intentionally left blank.

2. EUT Description

2.1 General

Table 2-1 WWAN Module Information

WWAN Module Model	UNDP-1
WWAN Module FCC ID	J9CUNDP-1L
WWAN Module Description	UNDP-1 is a PCI Express Mini Card with WWAN connectivity for the WCDMA/HSPA, GSM/GPRS/EDGE and CDMA2000 1x/1x-EVDO protocols, plus GPS position location.
Host(s) Tested:	Lenovo ML3
WWAN Technologies	GSM/GPRS/EDGE CDMA 1x Rel0 CDMA EV-DO RevA WCDMA/HSPA
Equipment Categories	GPRS Category 10 EDGE Category 10 HSDPA Category 8 (Release 6) HSUPA Category 5 (Release 6)
TX Frequencies	GSM/GPRS/EDGE: 824.2 – 848.8 MHz GSM/GPRS/EDGE: 1850.2 – 1909.8 MHz CDMA 1x/EV-DO: 824.7 – 848.31 MHz CDMA 1x/EV-DO: 1851.25 – 1908.75 MHz WCDMA/HSPA: 826.4 – 846.6 MHz WCDMA/HSPA: 1852.4 – 1907.5 MHz Bands Not used in the United States: GSM/GPRS/EDGE: 880.2 – 914.8 MHz GSM/GPRS/EDGE: 1710.2 – 1784.8 MHz WCDMA/HSPA: 1922.6 – 1977.4 MHz
Duty Cycle(s)	CDMA/WCMDA: 100% GPRS 1 uplink slot: 12.5% GPRS 2 uplink slots: 25%
Power Supply	3.3Vdc supplied by host notebook computer

Table 2-2 T400 Host Notebook Information

Host Notebook Model	T-400 (also referred to as ML3)
Serial Number	ZZC3240
WLAN FCC ID	N/A
Bluetooth FCC ID	QDS-BRCM1033
UWB FCC IC	N/A
WWAN Antenna(s)	The WWAN transmitter uses a Planner Inverted F antenna manufactured by NISSEI , PN 3172475.
BT Antenna(s)	N/A
WLAN Antenna(s)	N/A
WWAN to user separation distance (cm)	7.4
WLAN to user separation distance (cm)	N/A
Bluetooth to user separation distance (cm)	N/A
WWAN to WLAN antenna separation distance (cm)	6
WWAN to Bluetooth antenna separation distance (cm)	7.4

Table 2-3 T500 Host Notebook Information

Host Notebook Model	T-500 (also referred to as C5)
Serial Number	ZZH3083
WLAN FCC ID	N/A
Bluetooth FCC ID	QDS-BRCM1033
UWB FCC IC	N/A
WWAN Antenna(s)	The WWAN transmitter uses a Planner Inverted F antenna manufactured by NISSEI , PN 3172533
BT Antenna(s)	N/A
WLAN Antenna(s)	N/A
WWAN to user separation distance (cm)	7.1
WLAN to user separation distance (cm)	N/A
Bluetooth to user separation distance (cm)	N/A
WWAN to WLAN antenna separation distance (cm)	5.3
WWAN to Bluetooth antenna separation distance (cm)	7.3

Table 2-4 Simultaneous Transmission Information

	WLAN	Bluetooth
WWAN	No	Yes
WLAN	N/A	Yes

3. Conducted Transmit Power Results

Conducted transmit power was tested in accordance with FCC 3G procedures, 3GPP and 3GPP2 standards. The test procedure for configuring the EUT to transmit at maximum output power is in section 11. .

All transmit power results are based on an average detector. The rationale and calculations determining the SAR configurations tested per the FCC procedure are detailed in section 4. .

Table 3-1 GPRS Maximum Transmit Power

	GSM850 Channel			GSM1900 Channel		
Mode	**128**	**190**	**251**	**512**	**661**	**810**
GPRS 1 UL	23.6	23.5	23.7	20.8	20.9	20.4
GPRS 2UL	26.6	26.5	26.7	23.8	23.9	23.4

Table 3-2 CDMA 1x/EV-DO Maximum Transmit Power

REV	CDMA BCO (850MHz)			CDMA BC1 (1900MHz)		
RC/TAP	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
RC1 (SO2)	24.4	24.4	24.3	24.5	24.5	23.7
RC1 (SO55)	24.5	24.4	24.9	24.5	24.1	23.6
RC2 (SO9)	24.4	24.1	24.4	24.6	24.2	23.8
RC2 (SO55)	24.3	24.2	24.6	24.6	24	23.6
RC3 (SO55)	24.3	24.4	24.4	24.5	24.1	24
RTAP rate = 153.6kbps	24.3	24.5	24.5	24.5	24.2	24
RETAP - payload size = 4096	24.2	24.5	24.4	24.4	23.8	22.2

Table 3-3 WCDMA/HSPA Maximum Transmit Power Results

		Band V Channel			Band II Channel		
Mode	**3GPP Subtest**	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
Rel99	R99	24.1	24.2	24.1	24.4	24.1	24.2
Rel6 HSDPA	24.1	24.1	24.3	24.1	24.3	24.2	24.1
	23.9	23.9	24.0	23.9	24.5	24.1	24.2
	24.1	24.1	24.3	24.3	24.8	24.0	24.1
	23.8	23.8	23.9	23.8	23.9	24.0	24.1
Rel6 HSUPA	23.9	23.9	24.0	23.9	24.1	24.1	23.7
	22.96	23.0	22.7	22.6	21.9	21.2	21.3
	23.26	23.3	23.3	23.4	23.4	23.8	24.0
	22.9	22.9	21.8	22.6	22.6	22.4	22.1
	23.3	23.3	23.4	23.6	23.9	23.7	23.8

This page intentionally left blank.

4. SAR Test Matrix

Per FCC correspondence (Tracking Number 203660), the host notebook computers have been retested with the display orientated at 90 degrees. A single channel has been tested for each host notebook in the 850MHz and 1900MHz bands.

This page intentionally left blank.

5. SAR Test Facility

5.1 General

Test Location	QUALCOMM Incorporated 5775 Morehouse Dr. San Diego CA 92121
Temperature Range	15-35 °C (23°C actual)
Humidity Range	25-75% (38% actual)
Pressure	860-1060 mbar (1015 mB)

All of Qualcomm's dosimetry equipment is operated within a shielded screen room manufactured by Lindgren RF Enclosures to provide isolation from external EM fields. The E-field probes of the DASY4 system are capable of detecting signals as low as 5μW/g in the liquid dielectric, and so external fields are minimized by the screen room, leaving the phone as the dominate radiation source. The floor of the screen room is reflective, so the phantom bench is placed on four ferrite panels measuring 2 ft^2 each, in order to minimize reflected energy that would otherwise re-enter the phantom and combine constructively or destructively with the desired results.

5.2 Dosimetry System

The dosimetry equipment consists of a complete state-of-the-art DASY4 dosimetry system manufactured and calibrated by Schmid & Partner Engineering AG of Zurich, Switzerland. The DASY4 system consists of a six axis robot, a robot controller, a teach pendant, automation software on a 2.4 GHz Intel Pentium4 computer, data acquisition system, isotropic E-field probe, device positioning holder, and validation kit.
Figure 3-1 shows the robot arm, controller box and device positioning holder.

Figure 5-1 DASY4 system: Robot Arm, Controller box, Device Positioning Holder

5.3 E-field probe

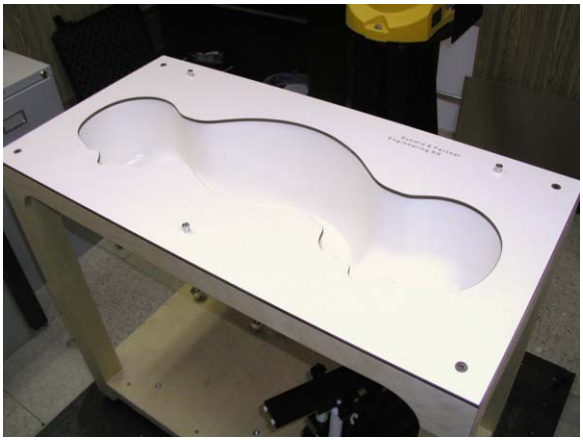
Manufactured by Schmid & Partner, Model ET3DV6. Calibrated by the manufacturer in head tissue simulating liquid at frequencies ranging from 835 MHz to 1.95 GHz. Dynamic range is said by the manufacturer to be 5

μW/gm to approx.100 mW/g. The probe contains 3 small dipoles positioned symmetrically on a triangular core to provide for isotropic detection of the field. Each dipole contains a diode at the feed point that converts the RF signal to DC, which is conducted down a high impedance line to the data acquisition system.

5.4 Phantom

The phantom is the Standard Anthropomorphic Model ("SAM") phantom supplied by Schmid & Partner AG, and is designed for compliance to the guidelines provided in standard IEEE P1528. It consists of a left and right side head for simulating phone usage on both sides of the head, as well as a flat area for simulating phone usage against the body. The phantom is constructed of fiberglass with 2 mm ±0.1mm shell thickness. The DASY4 system uses a homogeneous tissue phantom based on studies concerning energy absorption of the human head, and the different absorption rates between adults and children. These studies indicated that a homogeneous phantom should overestimate SAR by no more than 15% for 10 g averages and should not underestimate SAR.
Figure 3-2 shows the SAM phantom.

Figure 5-2 SAM Phantom



5.5 Liquid Dielectric

The tissue-simulating liquid filling the phantom is mixed by Qualcomm staff per manufacturer instructions and regulatory standards. There are separate formulas for the various applicable frequencies. Before the test, the permittivity and conductivity were measured with an automated Hewlett-Packard 85070B dielectric probe in conjunction with a H-P 8752C network analyzer to monitor permittivity change due to evaporation and settling of ingredients. The electromagnetic parameters of the liquid were maintained as shown in Tables 3-1. The target values were obtained from the FCC web page for Tissue Dielectric Properties at http://www.fcc.gov/fcc-bin/dielec.sh.

Table 5-1 Tissue Dielectric Properties at Time of Testing

			Permittivity (ε_r)				Conductivity (σ)			
	Frequency (MHz)	Section	Measured Values	Target Values	Deviation (%)	Limit	Measured Values	Target Values	Deviation (%)	Limit
3/4/2008	835	Body	54.2	55.2	-1.19%	5%	0.97	0.97	0.24%	5%
3/4/2008	1900	Body	51.6	53.3	-2.99%	5%	1.54	1.52	0.26%	5%

25 L of each of the tissue simulating liquids were prepared using the following proportions of ingredients:

Body Liquids:
835 Mhz Body Tissue Simulating Liquid
Water – 50.8%
Salt – 9.94%
Preventol – 0.01%
Sugar – 48%
1900 Mhz Body Tissue Simulating Liquid
Water – 70.2%
Glycol Monobutyl Ether – 29.4%
Salt – 0.4%

This page intentionally left blank.

6. SAR System Specifications and Calibration

6.1 System Specifications

Figure 6-1 shows a diagram of the Schmid & Partner DASY4 system.

Figure 6-1 Diagram of DASY4 System, from S&P Applications Notes System Description and Setup

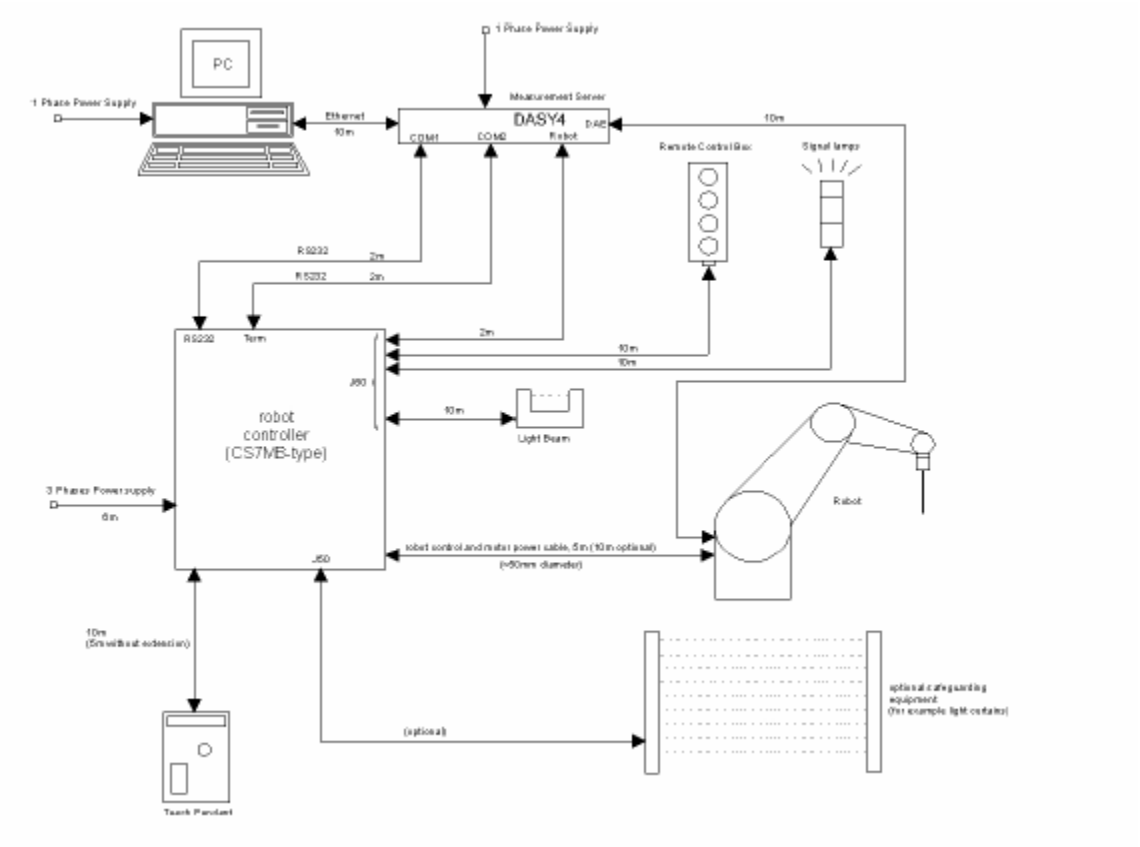


Table 6-1 Data Acquisition Information

Processor	Intel® Pentium® 4, 2.40 GHz
Operating System	Microsoft® Windows® XP
Software	DASY4 V4.7 Build 55, Schmid & Partners Eng. AG, Switzerland SEMCAD V1.8 Build 176
Surface Detection	Optical and Mechanical

Table 6-2 E-Field Probe Information

Offset tip to sensor center	2.7 mm
Offset surface to probe tip	1.8 ± 0.2
Frequency	30 MHz to 3.0 GHz
Dynamic Range	5μW/g to 100 mW/g
Isotropy	±0.15 dB (in brain liquid)

Table 6-3 Phantom Information

Dielectric	Cellular band: Homogeneous sugar/salt/cellulose liquid PCS band: Homogeneous water/glycol/salt liquid
Shell	2 mm ± 0.2 mm polyester fiber glass
Ear:	Integral model per SAM phantom specification

6.2 Calibration

Table 6-4 SAR System Calibration Information

Equipment Mfr & Type	Serial number	Last Calibrated	Next Calibration
Schmid & Partner Engineering AG Dosimetric E-field Probe, ET3DV5	1543	4/26/2007	4/26/2008
Schmid & Partner Engineering AG dipole validation kit, D1900V2	5d019	11/28/2007	11/28/2008
Schmid & Partner Engineering AG dipole validation kit, D835V2	466	11/24/2007	11/24/2008
Schmid & Partner Engineering AG Data Acquisition Electronics, DAE3 V1	566	4/20/2007	4/20/2008
Gigatronics 8541C RF Power Meter	K82228	9/21/07	9/21/08
Hewlett-Packard 8714C Vector Network Analyzer	US38171129	5/2/2007	5/2/2008
Hewlett-Packard 85070M Dielectric Probe System	N/A	N/A	N/A
835 MHz Body Tissue Simulating Liquid	N/A	August 2006	N/A
1900 MHz Body Tissue Simulating Liquid	N/A	August 2006	N/A

7. SAR Measurement Procedure

7.1 EUT Configuration

The EUT was configured into the desired transmit configuration per the procedures defined in section 11.

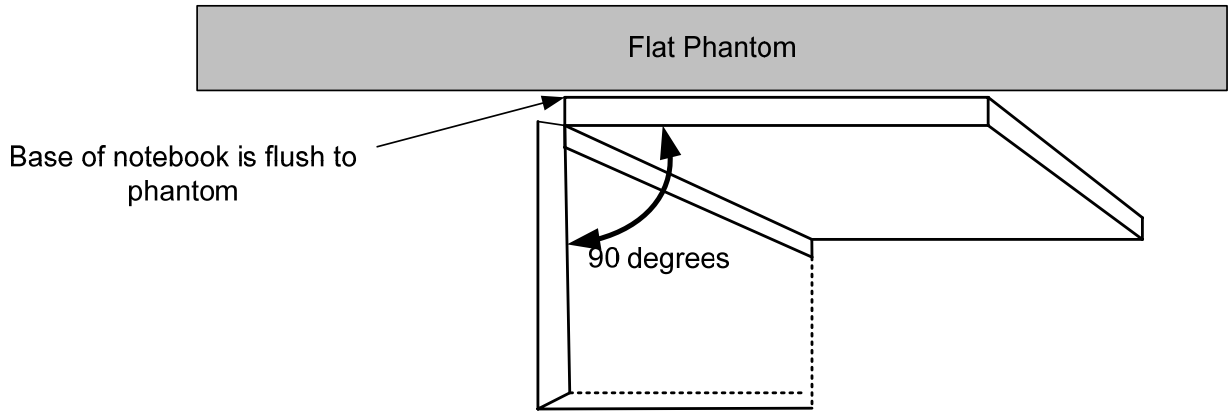
7.2 Power Verification

Prior to beginning SAR testing, conducted power was measured on the UNDP-1 module embedded in the host computer to verify functionality and the WWAN maximum transmit power values using the procedures defined in section 11. The results of the conducted power measurements are found in section 3.

7.3 Test Configurations

The host computer was tested in the Lap-held position as shown in Figure 7-1.

Figure 7-1 Lap-held position drawing



7.4 Scan procedure

The scan routine is set up as follows:
- Power verification measurement
- Area scan
- 7x7x7 cube (zoom) scan
- 15 cm Z-scan located at measured maximum
- Power verification re-test (Drift)

Both 1 g and 10 g measurements are handled with the same scan process.