ENGINEERING TEST REPORT

Broadcom WLAN MiniPCI card
Model No.: BCM94309MP

Tested For

Broadcom Corporation
190 Mathilda Place
Sunnyvale, California 94086
USA

In Accordance With

SAR (Specific Absorption Rate) Requirements
using guidelines established in IEEE C95.1-1991,
FCC OET Bulletin 65 (Supplement C),
Industry Canada RSS-102(Issue 1) and
ACA Radiocommunications (Electromagnetic Radiation – Human Exposure)
Amendment Standard 2000 (No. 1)

UltraTech's File No.: BRQ-003-SAR

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: April 10, 2003	
Report Prepared by: JaeWook Choi Issued Date: April 10, 2003	Tested by: JaeWook Choi Test Dates: April 3, 2003

The results in this Test Report apply only to the sample(s) tested, which has been randomly selected.

UltraTech

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EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	SAR (Specific Absorption Rate) Requirements IEEE C95.1-1991, FCC OET Bulletin 65 (Supplement C) Industry Canada RSS-102 (Issue 1). ACA Radiocommunications (Electromagnetic Radiation – Human Exposure), Amendment Standard 2000 (No. 1)
Title	Safety Levels with respect to human exposure to Radio Frequency Electromagnetic Fields Guideline for Evaluating the Environmental Effects of Radio Frequency Radiation
Purpose of Test:	To verify compliance with Federal regulated SAR requirements in Canada, Australia and the US.
Method of Measurements:	IEEE C95.1-1991, FCC OET Bulletin 65 (Supplement C) and Industry Canada RSS-102 (Issue 1)
Exposure Category	General Population/Uncontrolled

1.2. REFERENCES

The methods and procedures used for the measurements contained in this report are details in the following reference standards:

Publications	Year	Title
IEEE Std. 1528-2001 Draft	2001	Draft Recommended practice for determining the Peak Spatial-Average Specific Absorption rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques.
Industry Canada RSS102	1999	"Evaluation Procedure for Mobile and Portable Radio Transmitters with respect to Health Canada's Safety Code 6 for Exposure of Humans to Radio Frequency Fields"
ACA	2000	ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)
NCRP Report No.86	1986	"Biological Effects and Exposure Criteria for radio Frequency Electromagnetic Fields"
FCC OET Bulletin 65	1997	"Evaluating Compliance with FCC Guidelines for Human Exposure to radio Frequency Fields"
ANSI/IEEE C95.3	1992	"Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave"
ANSI/IEEE C95.1	1992	"Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz"
AS/NZS 2722.1	1998	Interim Australian/New Zealand Standard. "Radiofrequency fields, Part 1:Maximum exposure levels – 3kHz to 300GHz "

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT AND MANUFACTURER INFORMATION

APPLICANT:	
Name:	Broadcom Corporation
Address:	190 Mathilda Place Sunnyvale, California 94086 USA
Contact Person:	Chris McGough Phone #: +1 408 922 5810 Fax #: +1 408 543 3399 Email Address: cmcgough@broadcom.com

MANUFACTURER:	
Name:	Broadcom Corporation
Address:	190 Mathilda Place Sunnyvale, California 94086 USA
Contact Person:	Chris McGough Phone #: +1 408 922 5810 Fax #: +1 408 543 3399 Email Address: cmcgough@broadcom.com

2.2. DEVICE UNDER TEST (D.U.T.) DESCRIPTION

The following is the information provided by the applicant.

Trade Name	The Broadcom Wireless LAN mini-PCI card
Type/Model Number	BCM94309MP
Serial Number	1418
Type of Equipment	Wireless LAN Card
Frequency of Operation	2400 ~ 2483.5 MHz , 5150 ~ 5350 MHz
Rated RF Power	15 dBm avg power in packet @ 5,180 MHz 15 dBm avg power in packet @ 5,260 MHz 15 dBm avg power in packet @ 5,320 MHz*
Modulation Employed	DSSS (2GHz band), OFDM(5GHz band)
External Power Supply	Power supplied through the laptop computer
Primary User Functions of D.U.T.:	Data Radio Communication Through Air

* Refer to EXHIBIT 11. Manufacturer's Declaration Power Levels SAR

2.3. LIST OF D.U.T.'S ACCESSORIES:

N/A

2.4. SPECIAL CHANGES ON THE D.U.T.'S HARDWARE/SOFTWARE FOR TESTING PURPOSES

N/A

2.5. ANCILLARY EQUIPMENT

- Laptop #5: Laptop PC (Dell, M/N: PPT) with the Winstron Neweb Corp. PIFA type antenna (Main – M/N: CAB-A, Aux – M/N: CAB-A)
- Laptop #6: Laptop PC (Dell, M/N: PP07L) with the Wistron NeWeb Corp. (Main – M/N: CAA-C, Aux – M/N: CAA-C)
- Laptop #7: Laptop PC (Dell, M/N: PP07L) with the Phicomp antenna (Main - M/N: 4313 334 01250, Aux – M/N: 4313 334 02250)
- AC Power Adaptors (M/N: HP-065B83, M/N: PA-1900-05D)

Laptop #6 & #7 has the same housing case but each laptop has a different set of MAIN and AUX antenna from the different manufacturer.

		Laptop #5	Laptop #6	Laptop #7
Laptop Model Number		PPT	PP07L	PP07L
Antenna		Wistron NeWeb Corp.	Wistron NeWeb Corp.	Phicomp
Antenna Model Number	MAIN	CAB-A (Left)	CAA-C (Right side)	4313 334 01250 (Left side)
	AUX	CAB-A (Right)	CAA-C (Left side)	4313 334 02250 (Right side)
Comment		Tested in this report	Tested in this report	Tested in this report

2.6. GENERAL TEST CONFIGURATIONS

2.6.1. Equipment Configuration

Power and signal distribution, grounding, interconnecting cabling and physical placement of equipment of a test system shall simulate the typical application and usage in so far as is practicable, and shall be in accordance with the relevant product specifications of the manufacturer.

The configuration that tends to maximize the D.U.T.'s emission or minimize its immunity is not usually intuitively obvious and in most instances selection will involve some trial and error testing. For example, interface cables may be moved or equipment re-orientated during initial stages of testing and the effects on the results observed.

Only configurations within the range of positions likely to occur in normal use need to be considered.

The configuration selected shall be fully detailed and documented in the test report, together with the justification for selecting that particular configuration.

2.6.2. Exercising Equipment

The exercising equipment and other auxiliary equipment shall be sufficiently decoupled from the D.U.T. so that the performance of such equipment does not significantly influence the test results.

2.7. SPECIFIC OPERATING CONDITIONS

D.U.T. was made to transmit with 98% of the maximum duty cycle instead of with its actual duty cycle as a worst case consideration, using the exclusive controlling software for SAR test provided by the manufacturer.

2.8. BLOCK DIAGRAM OF TEST SETUP

The D.U.T. was configured as normal intended use. The following block diagram shows a representative equipment arrangement during tests:

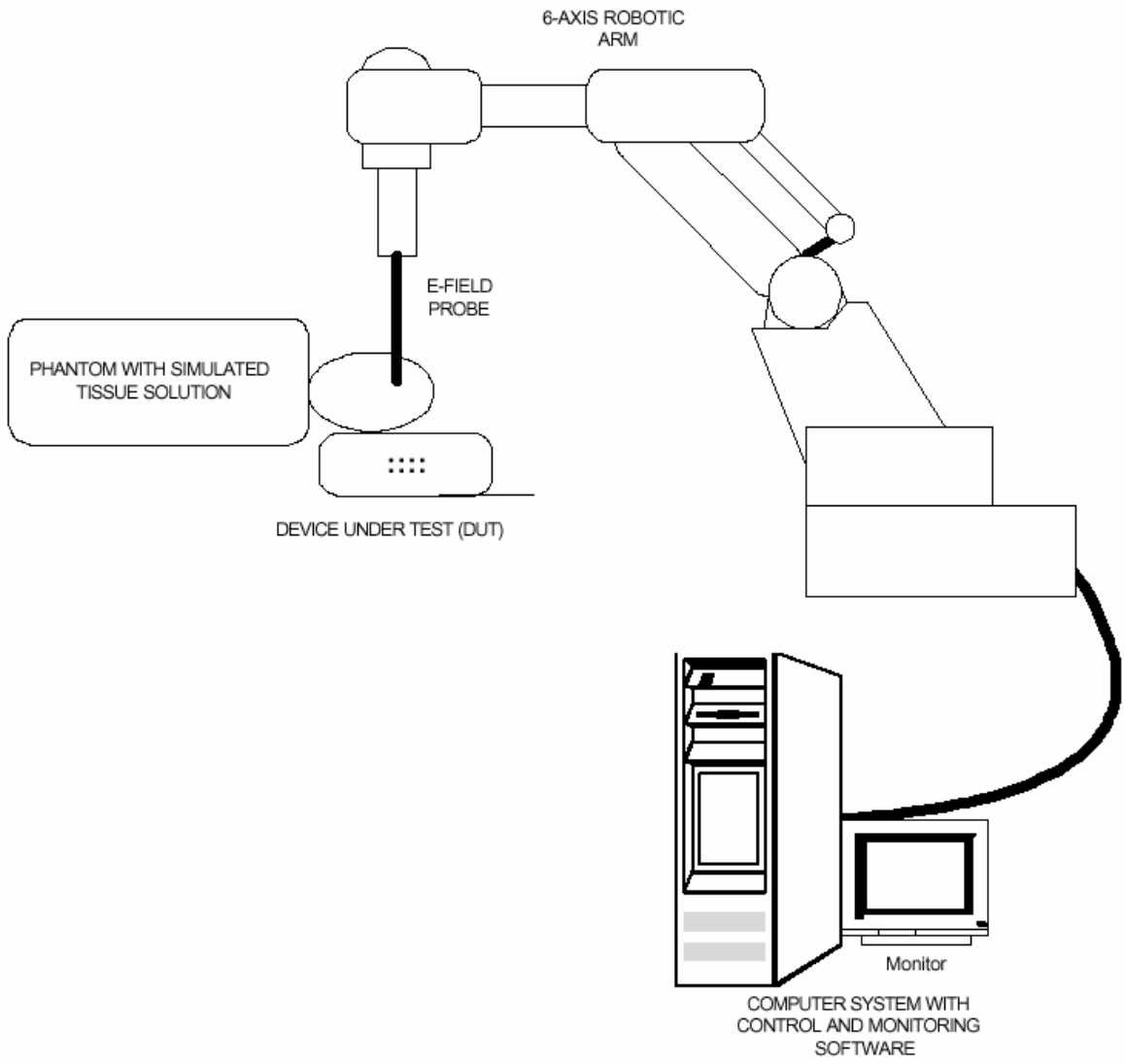


EXHIBIT 3. SUMMARY OF TEST RESULTS

3.1. LOCATION OF TESTS

All of the measurements described in this report were performed at UltraTech Group of Labs located at:

3000 Bristol Circle, in the city of Oakville, Province of Ontario, Canada.

All measurements were performed in UltraTech's shielded chamber, 24' x 16' x 8'.

3.2. APPLICABILITY & SUMMARY OF SAR RESULTS

The maximum peak spatial - average SAR measured was found to be 1.17 W/Kg.

Exposure Category and SAR Limits	Test Requirements	Compliance (Yes/No)
General population/Uncontrolled exposure 0.08W/kg whole body average and spatial peak SAR of 1.6W/kg, averaged over 1gram of tissue Hands, wrist, feet and ankles have a peak SAR not to exceed 4 W/kg, averaged over 10 grams of tissue.	Requirements using guidelines established in IEEE C95.1-1991 FCC OET Bulletin 65 (Supplement C) Industry Canada RSS-102 (Issue 1). ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)	YES
Occupational/Controlled Exposure 0.4W/kg whole body average and spatial peak SAR of 8W/kg, averaged over 1gram of tissue Hands, wrist, feet and ankles have a peak SAR not to exceed 20 W/kg, averaged over 10 grams of tissue.	Requirements using guidelines established in IEEE C95.1-1991 FCC OET Bulletin 65 (Supplement C), Industry Canada RSS-102 (Issue 1) ACA Radiocommunications (Electromagnetic Radiation – Human Exposure) Amendment Standard 2000 (No. 1)	N/A

EXHIBIT 4. MEASUREMENTS, EXAMINATIONS & TEST DATA

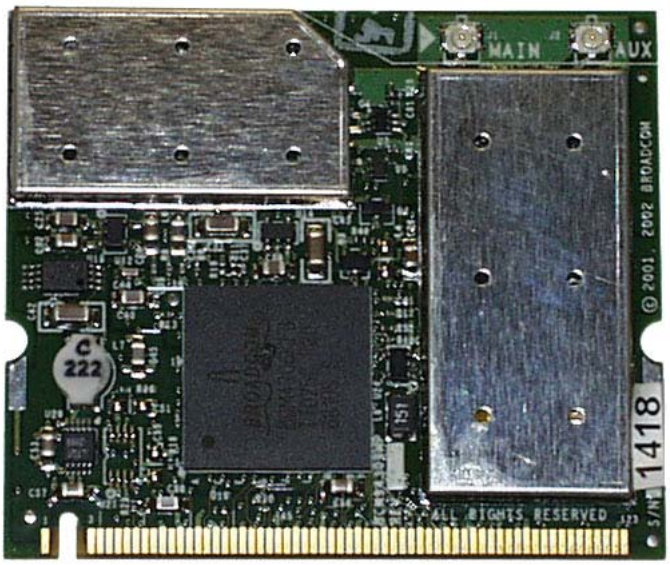
4.1. TEST SETUP

D.U.T. Information		Condition	
Product Name	Broadcom WLAN MiniPCI card	**Robot Type**	6 Axis
Model Number	BCM94309MP	**Scan Type**	SAR - Area/Zoom/Att Vs Depth
Serial Number	1418	**Measured Field**	E
Frequency Band [MHz]	5150 ~ 5350	**Phantom Type**	2_{mm} base Flat Phantom
Frequency Tested [MHz]	5180.0, 5260.0, 5320.0	**Phantom Position**	Waist
Measured Output Power [dBm]	22.0 @ 5,180 MHz 22.0 @ 5,260 MHz 22.0 @ 5,320 MHz*	**Room Temperature** [°C]	21.0 ± 1
Antenna Type	Refer to 2.5	**Room Humidity** [%]	30 ± 10
Modulation	OFDM @ 5GHz band	**Tissue Temperature** [°C]	21.0 ± 1
Duty Cycle	98 %		

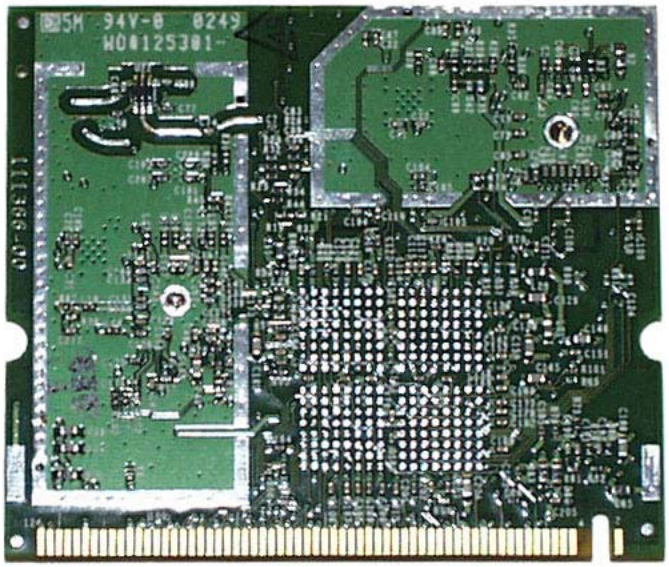
Type of Tissue	Muscle
Test Frequency [MHz]	5240
Measured Dielectric Constant	47.3 (-3.5 %)
Measured Conductivity [S/m]	5.56 (+3.9 %)
Penetration Depth (Plane Wave Excitation) [mm]	6.69
Probe Model Number	E-TR
Probe Serial Number	UT-0200-1
Probe Orientation	Isotropic
Probe Offset [mm]	2.00
Probe Tip Diameter [mm]	4.00
Sensor Factor (η_{pd}) [mV/(mW/cm^2)]	10.8
Conversion Factor (γ)	2.721
Sensitivity (ζ) [W/Kg/mV]	0.713

* Refer to EXHIBIT 11. Manufacturer's Declaration Power Levels SAR

4.2. PHOTOGRAPH OF D.U.T. AND ALL ACCESORIES



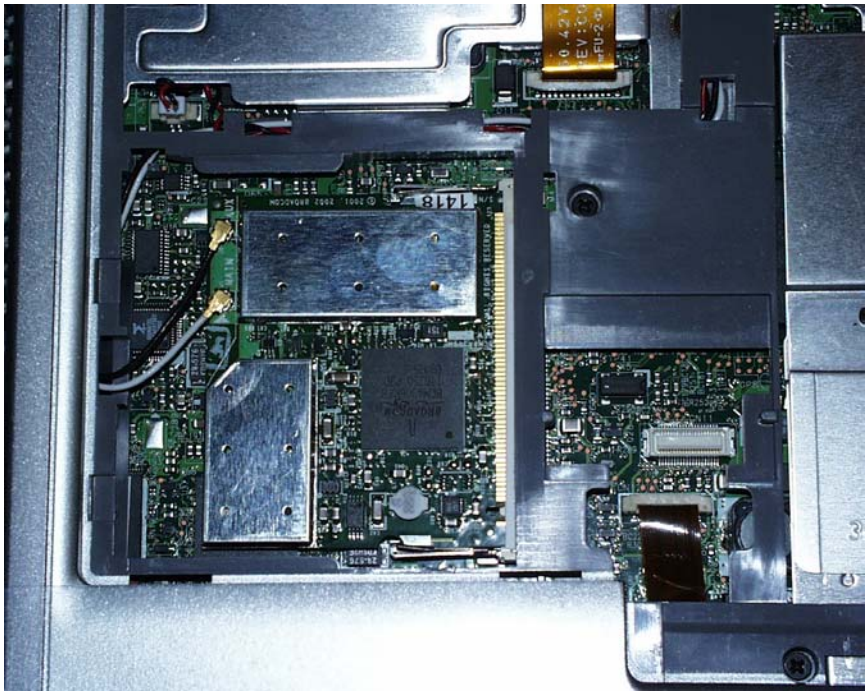
< BCM94309MP Broadcom WLAN MiniPCI card front view>



< BCM94309MP Broadcom WLAN MiniPCI card rear view>

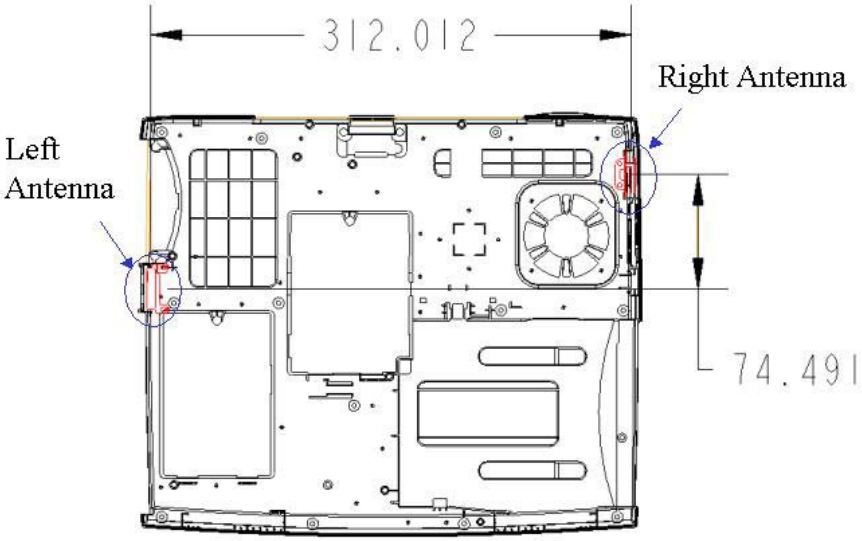
4.2.1. Laptop #5 (M/N: PPT, Wistron NeWeb Corp. Antenna)

< Dell Latitude D400 Laptop PC (M/N: PPT) – MAIN and AUX antenna location >

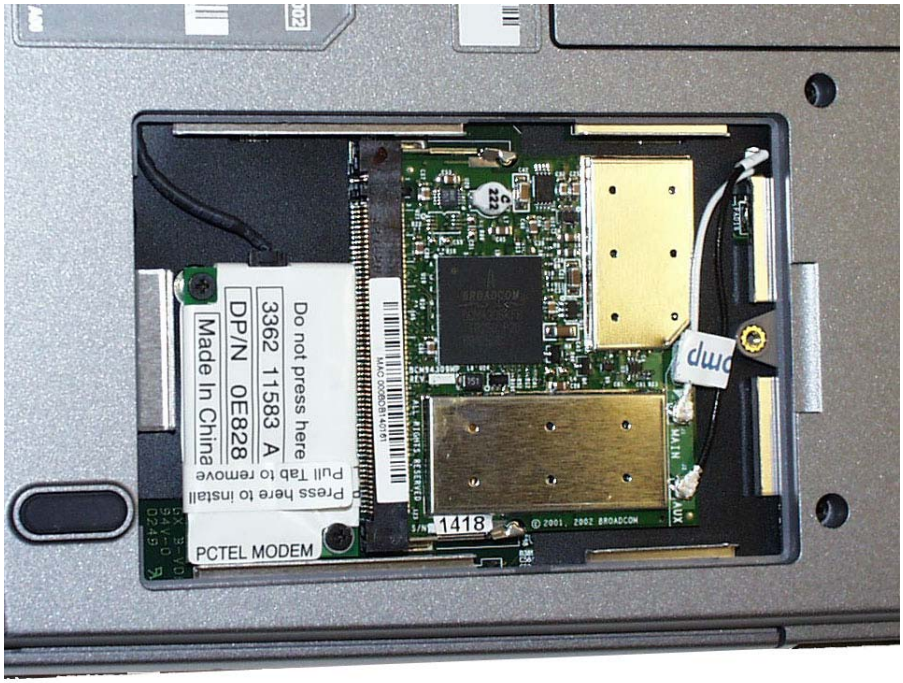


< D.U.T. installed in miniPCI slot >

4.2.2. Laptop #6 & #7 (M/N: PP07L, Wistron NeWeb Corp. Antenna or Phicomp Antenna)



< Dell Inspiron 5100 (M/N: PP07L) – Left and Right antenna location and cable routing >



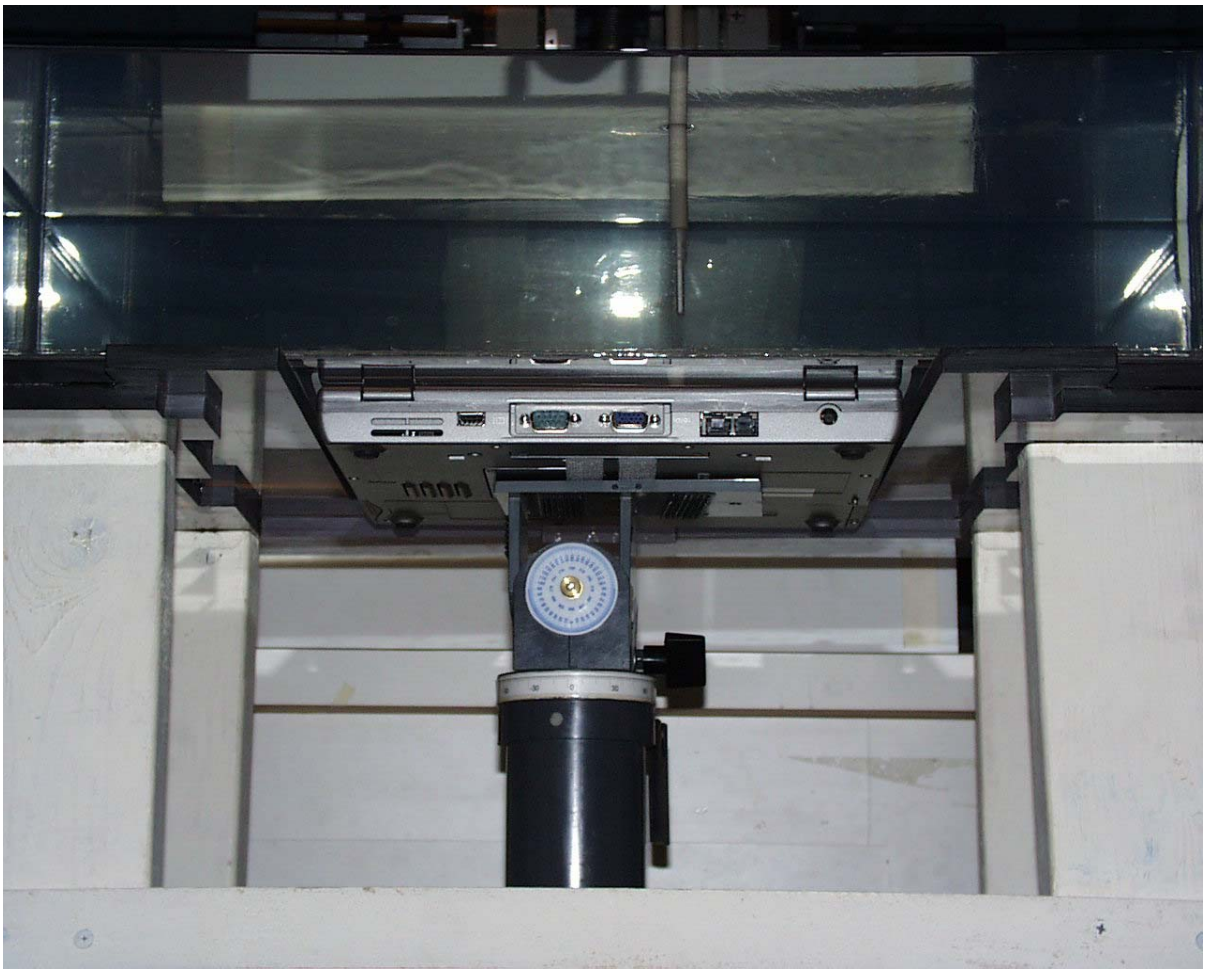
< D.U.T. installed in miniPCI slot >

4.3. PHOTOGRAPHS OF D.U.T. POSITION

4.3.1. Laptop #5 (M/N: PPT, Wistron NeWeb Corp. Antenna)

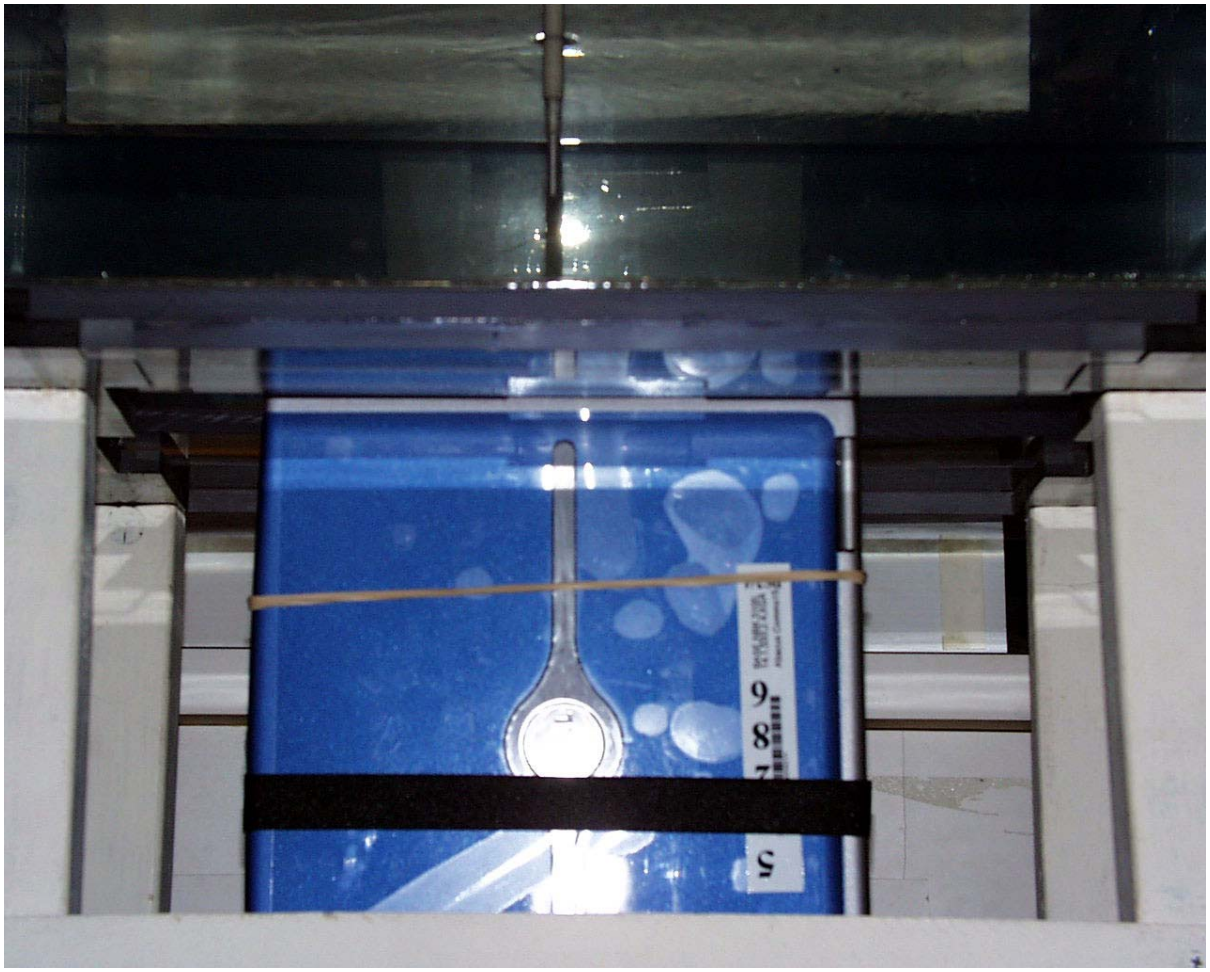
4.3.1.1. Back side of the host PC toward the phantom and in contact (Main(left) antenna and Aux(right antenna)

4.3.1.2. Top side of the host PC toward the phantom and in contact (Main and Aux antenna, Prescan)

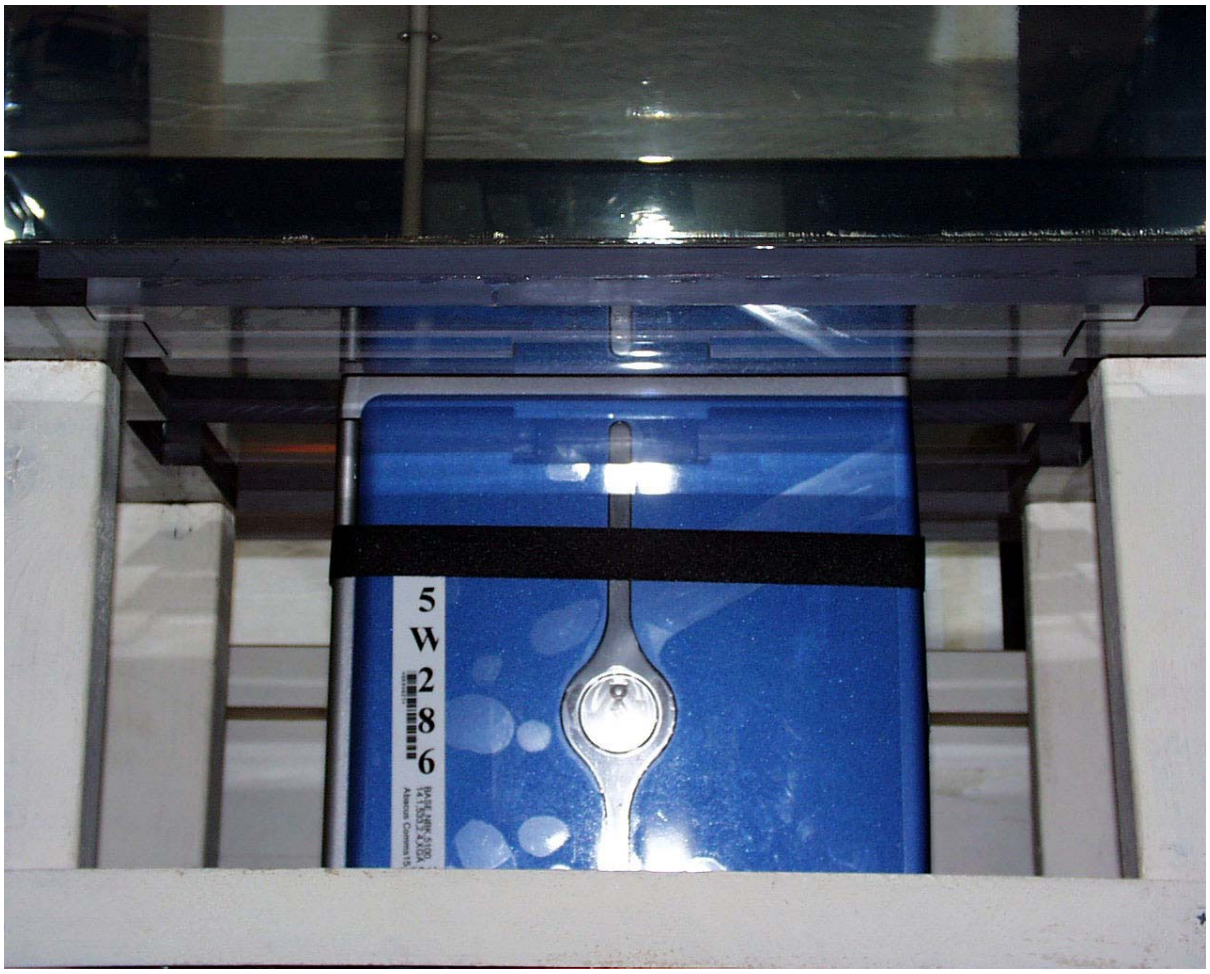


4.3.2. Laptop #6 & #7 (M/N: PP07L, Wistron NeWeb Corp. Antenna or Phicomp Antenna)

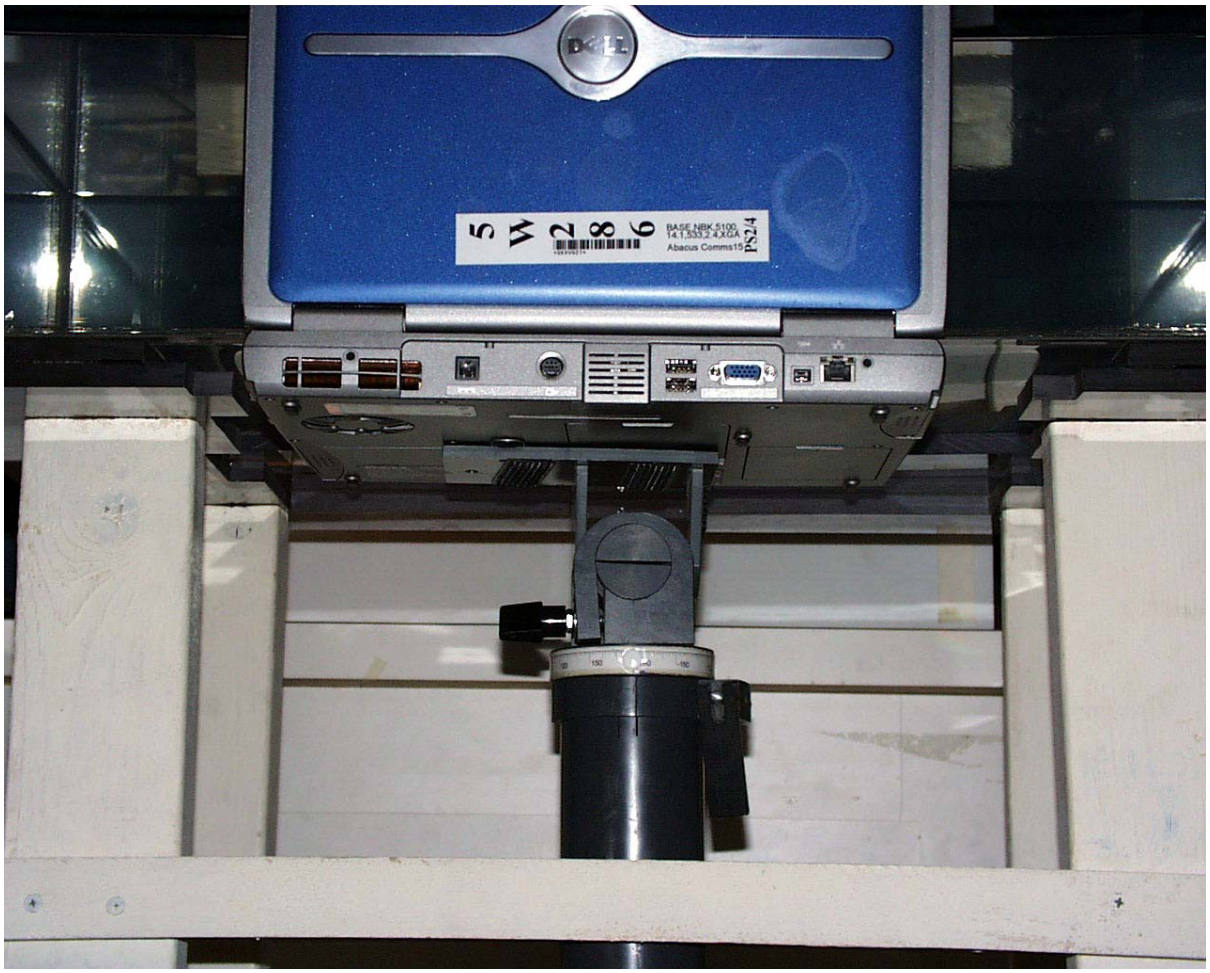
4.3.2.1. Left side of the host PC toward the phantom and in contact (Left antenna)



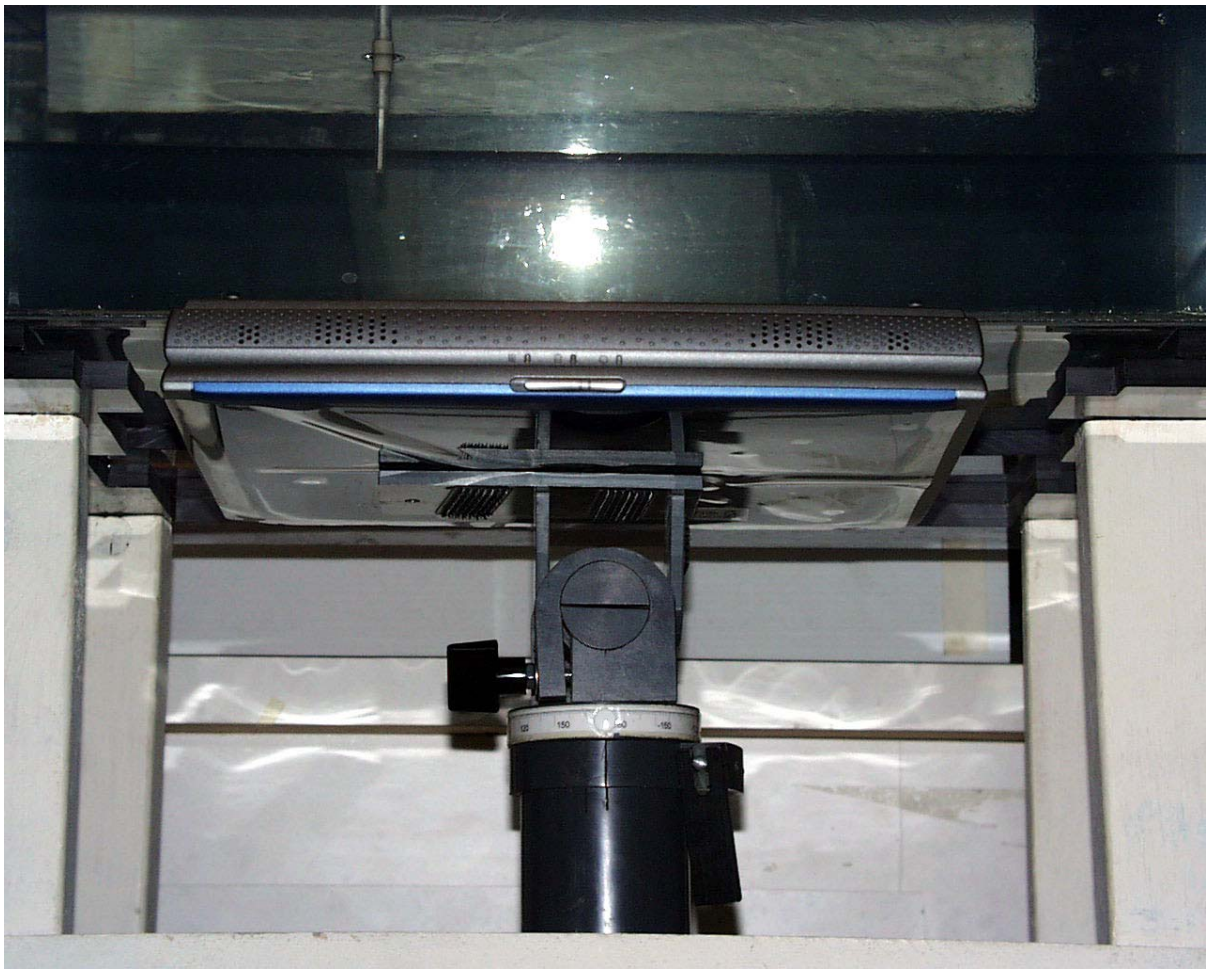
4.3.2.2. Right side of the host PC toward the phantom and in contact (Left antenna)



4.3.2.3. Top side of the host PC toward the phantom and in contact (Left and Right antenna, Prescan)



4.3.2.4. Bottom side of the host PC toward the phantom and in contact (Left and Right antenna, Prescan)



4.4. MAXIMUM PEAK SPATIAL-AVERAGE SAR

4.4.1. Laptop #5 (M/N: PPT, Wistron NeWeb Corp. Antenna)

4.4.1.1. Maximum peak spatial-average SAR data

#	Configuration	Device Test Positions	Antenna Position	Freq. [MHz]	Channel	MAX. SAR [W/Kg]
02	Back side of the host PC toward the phantom 6 MBPS data rate 0 mm separation distance	Body-worn (By Stander)	Main antenna (left side) - Fixed	5260	CH52	1.17

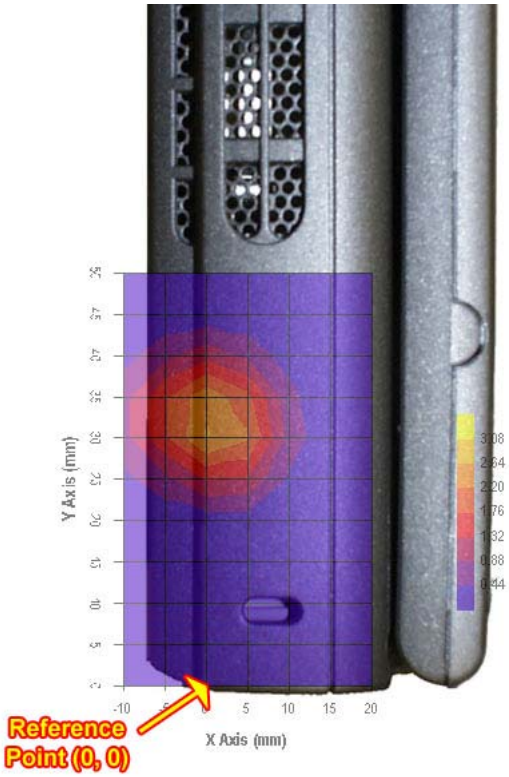
4.4.1.2. Maximum peak spatial-average SAR location

4.4.2. Laptop #6 (M/N: PP07L, Wistron NeWeb Corp. Antenna) & #7 (M/N: PP07L, Phicomp Antenna)

4.4.2.1. Maximum peak spatial-average SAR data

#	Configuration	Device Test Positions	Antenna Position	Freq. [MHz]	Channel	MAX. SAR [W/Kg]
16	Right side of the host PC toward the phantom 6 MBPS data rate 5 mm separation distance	Body-worn (By Stander)	Main antenna (back side) - Fixed	5180	CH36	0.90

4.4.2.2. Maximum peak spatial-average SAR location



4.5. SAR MEASUREMENT DATA

4.5.1. Body-worn (By Stander) Configuration Result

4.5.1.1. Laptop #5 (M/N: PPT, Wistron NeWeb Corp. Antenna)

4.5.1.1.1. Main antenna

#	Configuration	Device Test Positions	Antenna Position	Freq. [MHz]	Channel	Power reference before [dBm]	Power reference after [dBm]	MAX SAR [W/Kg]
01	Back side of the host PC toward the phantom 6 MBPS data rate	0 mm separation	Main antenna (left) - Fixed	5180	CH36	22.0	21.8	1.12
02				5260	CH52	22.0	21.8	1.17
03				5320	CH64	22.0	21.8	1.08

4.5.1.1.2. Aux Antenna

#	Configuration	Device Test Positions	Antenna Position	Freq. [MHz]	Channel	Power reference before [dBm]	Power reference after [dBm]	MAX SAR [W/Kg]
04	Back side of the host PC toward the phantom 6 MBPS data rate	0 mm separation	Aux antenna (right) - Fixed	5180	CH36	22.0	21.8	*note)
05				5260	CH52	22.0	21.8	0.71
06				5320	CH64	22.0	21.8	*note)

* If the SAR measured at the middle channel for each test configuration is at least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).

4.5.1.2. Laptop #6 (M/N: PPT, Wistron NeWeb Corp. Antenna)

4.5.1.2.1. Main antenna (Right side)

#	Configuration	Device Test Positions	Antenna Position	Freq. [MHz]	Channel	Power reference before [dBm]	Power reference after [dBm]	MAX SAR [W/Kg]
07	Right side of the host PC toward the phantom 6 MBPS data rate	0 mm separation	Main antenna (right side) - Fixed	5180	CH36	22.0	21.8	*note)
08				5260	CH52	22.0	21.8	0.10
09				5320	CH64	22.0	21.8	*note)

4.5.1.2.2. Aux Antenna (Left side)

#	Configuration	Device Test Positions	Antenna Position	Freq. [MHz]	Channel	Power reference before [dBm]	Power reference after [dBm]	MAX SAR [W/Kg]
10	Left side of the host PC toward the phantom 6 MBPS data rate	0 mm separation	Aux antenna (left side) - Fixed	5180	CH36	22.0	21.8	*note)
11				5260	CH52	22.0	21.8	0.60
12				5320	CH64	22.0	21.8	*note)

* If the SAR measured at the middle channel for each test configuration is at least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).

4.5.1.3. Laptop #7 (M/N: PPT, Phicomp Antenna)

4.5.1.3.1. Main antenna (Left side)

#	Configuration	Device Test Positions	Antenna Position	Freq. [MHz]	Channel	Power reference before [dBm]	Power reference after [dBm]	MAX SAR [W/Kg]
13	Left side of the host PC toward the phantom 6 MBPS data rate	0 mm separation	Main antenna (left side) - Fixed	5180	CH36	22.0	21.8	*note)
14				5260	CH52	22.0	21.8	Less than 0.01**
15				5320	CH64	22.0	21.8	*note)

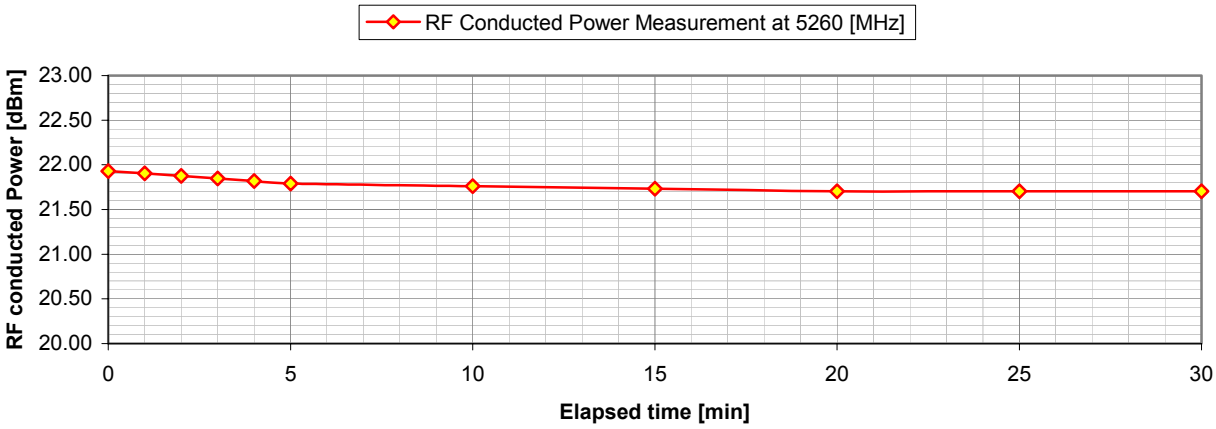
4.5.1.3.2. Aux Antenna (Right side)

#	Configuration	Device Test Positions	Antenna Position	Freq. [MHz]	Channel	Power reference before [dBm]	Power reference after [dBm]	MAX SAR [W/Kg]
16	Right side of the host PC toward the phantom 6 MBPS data rate	0 mm separation	Aux antenna (right side) - Fixed	5180	CH36	22.0	21.8	0.90
17				5260	CH52	22.0	21.8	0.84
18				5320	CH64	22.0	21.8	0.65

* If the SAR measured at the middle channel for each test configuration is at least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional for such test configuration(s).

** It was found to be below the SAR measurement system's sensitivity (less than 0.01[W/Kg]).

4.5.2. Power Measurement

Channel	Frequency [MHz]	Power [dBm] (conducted)
CH36	5180	22.0
CH52	5260	22.0
CH64	5320	22.0

The conducted power was measured at the antenna fed point at 5260 [MHz] during the period of 30 minute. The power drift after 30 minutes of the continuous exposure at the maximum power level was found to be –5.12 [%]. But, afterward, the conducted power was found to be stabilized and not drifting once the DUT had been warmed up.