

Appendices

Calibration documents

Antenna Information



NCL CALIBRATION LABORATORIES

Calibration File No: DC-789
Project Number: APREL-ALSAS10U

C E R T I F I C A T E O F C A L I B R A T I O N

It is certified that the equipment identified below has been calibrated in the
NCL CALIBRATION LABORATORIES by qualified personnel following recognized
procedures and using transfer standards traceable to NRC/NIST.

APREL Validation Dipole

Manufacturer: APREL Laboratories

Part number: ALS-D-5200-S-2

Frequency: 5200 MHz

Serial No: 301460

Customer: APREL

Calibrated: 1st March 2007
Released on: 1st March 2007

Released By: _____

NCL CALIBRATION LABORATORIES

51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6

Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4162

Conditions

Dipole 301460 was new and taken from stock prior to calibration.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C

Temperature of the Tissue: 21 °C +/- 0.5°C

We the undersigned attest that to the best of our knowledge the calibration of this device has been accurately conducted and that all information contained within this report has been reviewed for accuracy.

Stuart Nicol

C. Teodorian

Calibration Results Summary

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

Mechanical Dimensions

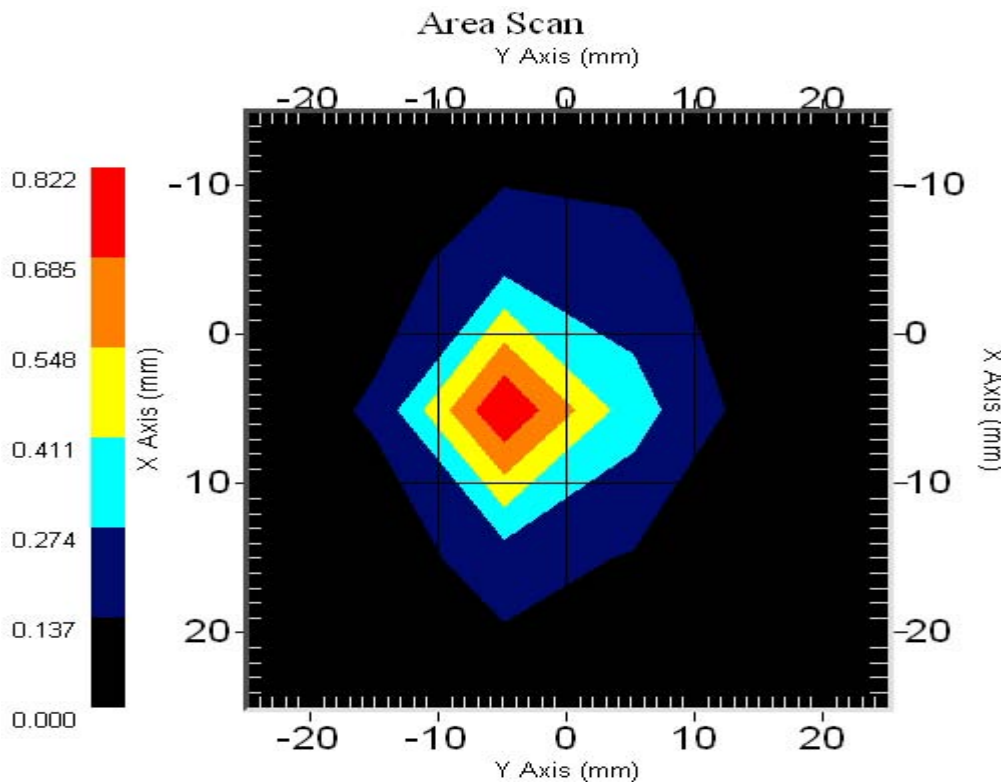
Length: 23.6 mm
Height: 14.0 mm

Electrical Specification

SWR: 1.12 U
Return Loss: -24.9 dB
Impedance: 55.8 Ω

System Validation Results

Frequency	1 Gram	10 Gram	Peak
5200 MHz	58.8	x	223.1



Introduction

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018-ALSAS. The results contained within this report are for Validation Dipole 301460. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the mechanical specifications. Step 2 was an Electrical Calibration for the Validation Dipole, where the SWR, Impedance, and the Return loss were assessed. Step 3 involved a System Validation using the ALSAS-10U, along with APREL E-020 130 MHz to 26 GHz E-Field Probe Serial Number 212.

References

SSI-TP-018-ALSAS Dipole Calibration Procedure

SSI-TP-016 Tissue Calibration Procedure

IEEE 1528 “Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”

IEC-62209 “Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures”

Part 1: “Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 300 MHz to 3 GHz)”

IEC-62209 “Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures”

Part 2 *Draft*: “Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 30 MHz to 6 GHz)”

Conditions

Dipole 301460 was new taken from stock.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C

Temperature of the Tissue: 20 °C +/- 0.5°C

Dipole Calibration Results

Mechanical Verification

APREL Length	APREL Height	Measured Length	Measured Height
23.6 mm	14.0 mm	23.4 mm	16.6 mm

Tissue Validation

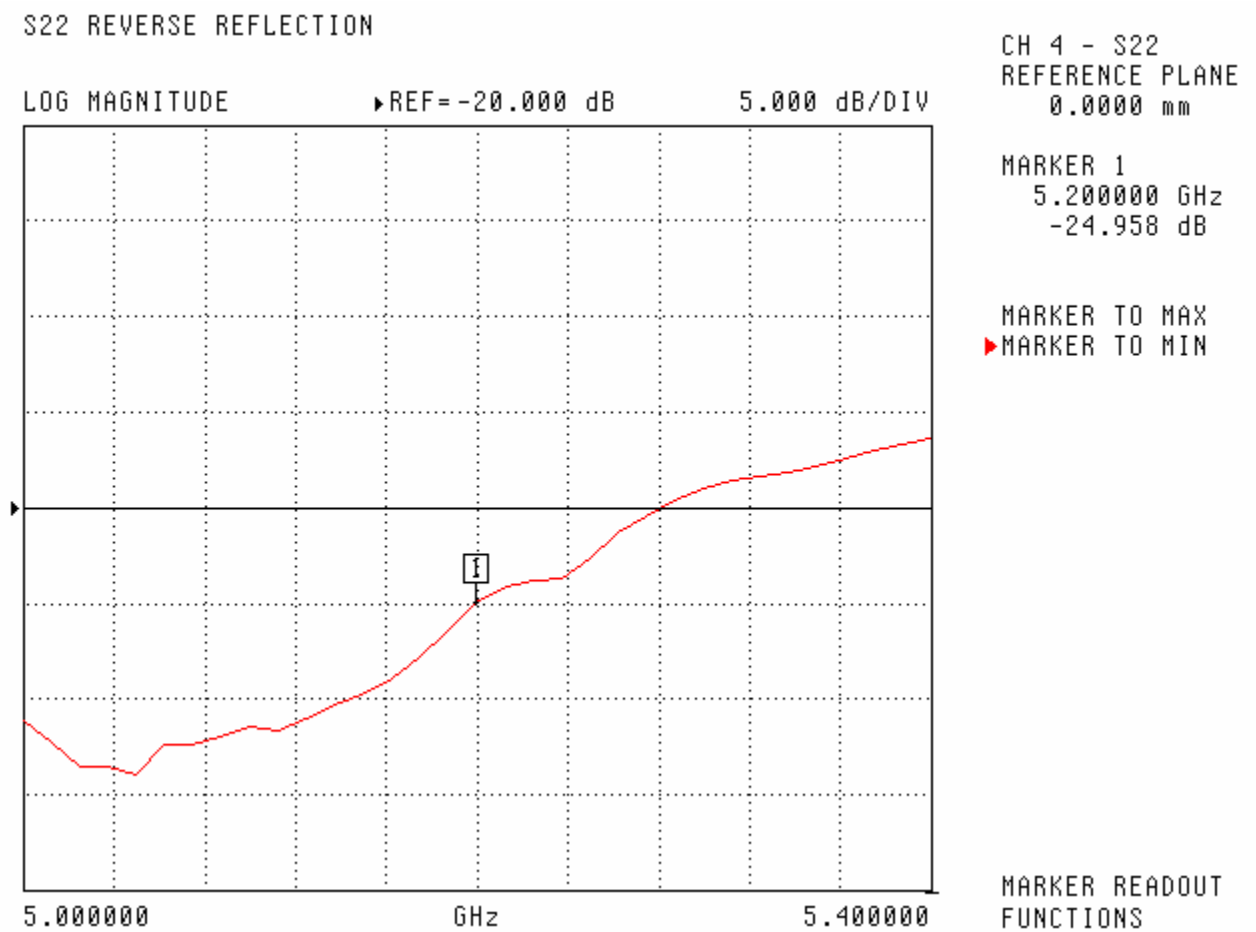
Head Tissue 5200 MHz	Measured
Dielectric constant, ϵ_r	49.0
Conductivity, σ [S/m]	5.4

Electrical Calibration

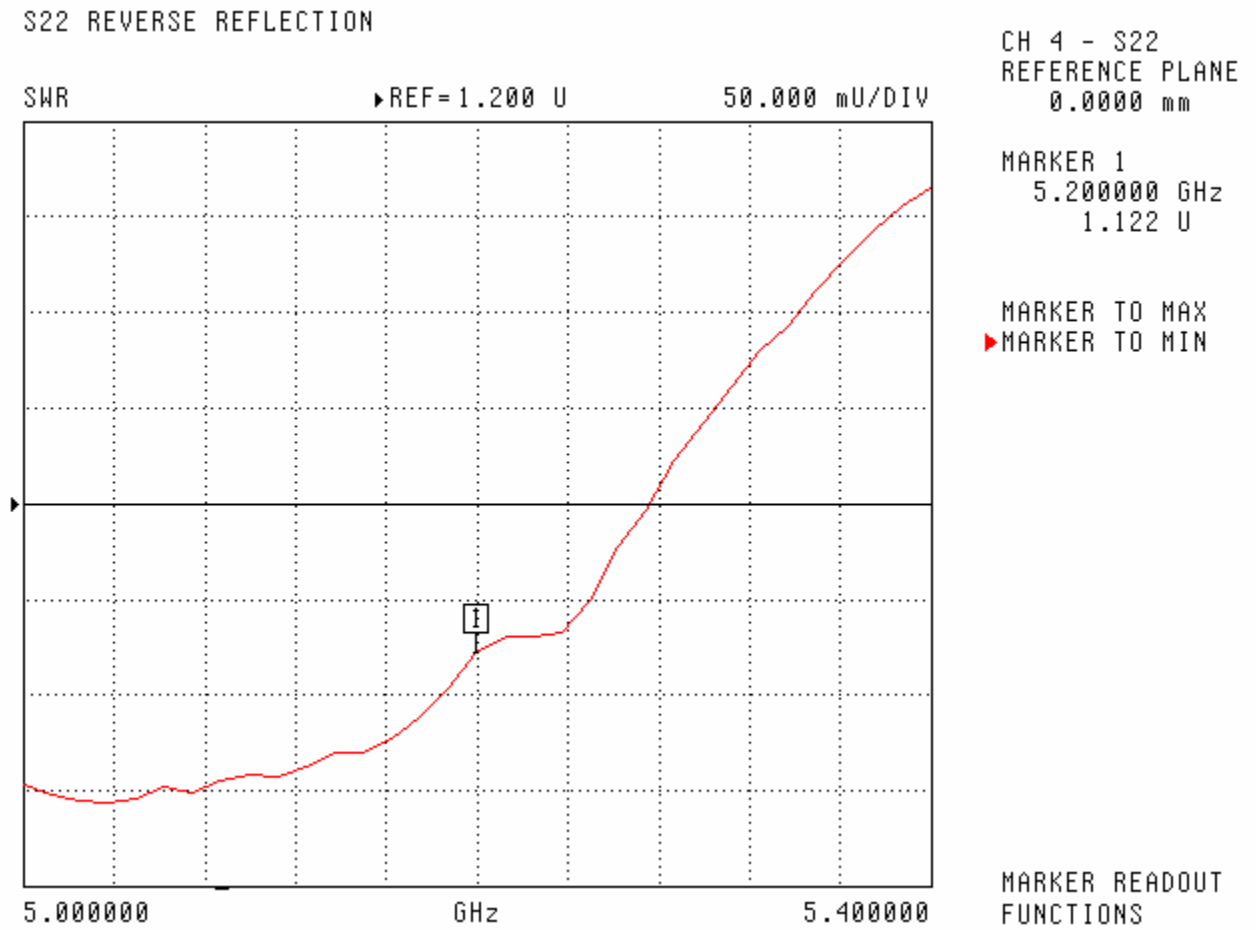
Test	Result
S11 R/L	-24.9 dB
SWR	1.12 U
Impedance	55.8 Ω

The Following Graphs are the results as displayed on the Vector Network Analyzer.

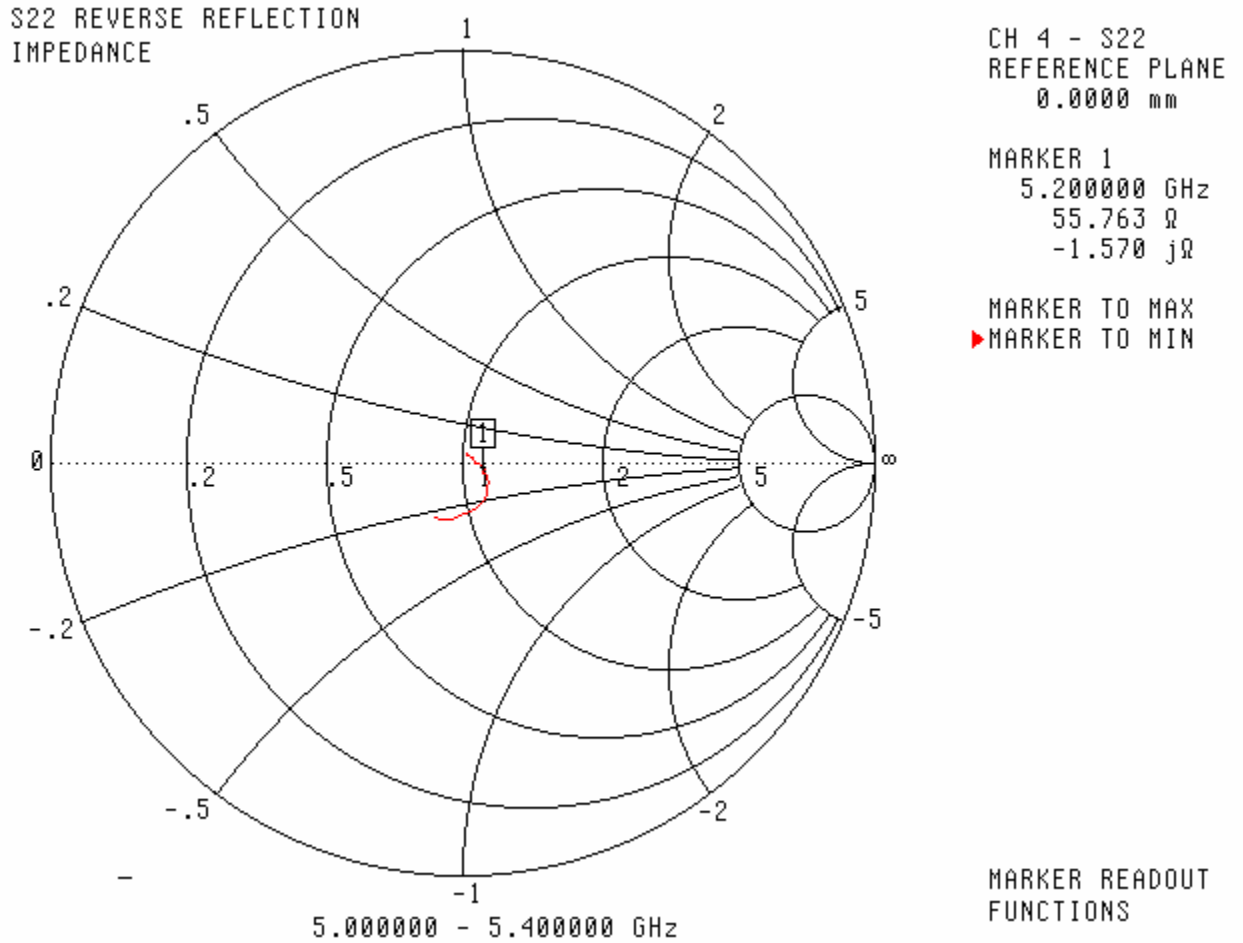
S11 Parameter Return Loss



SWR

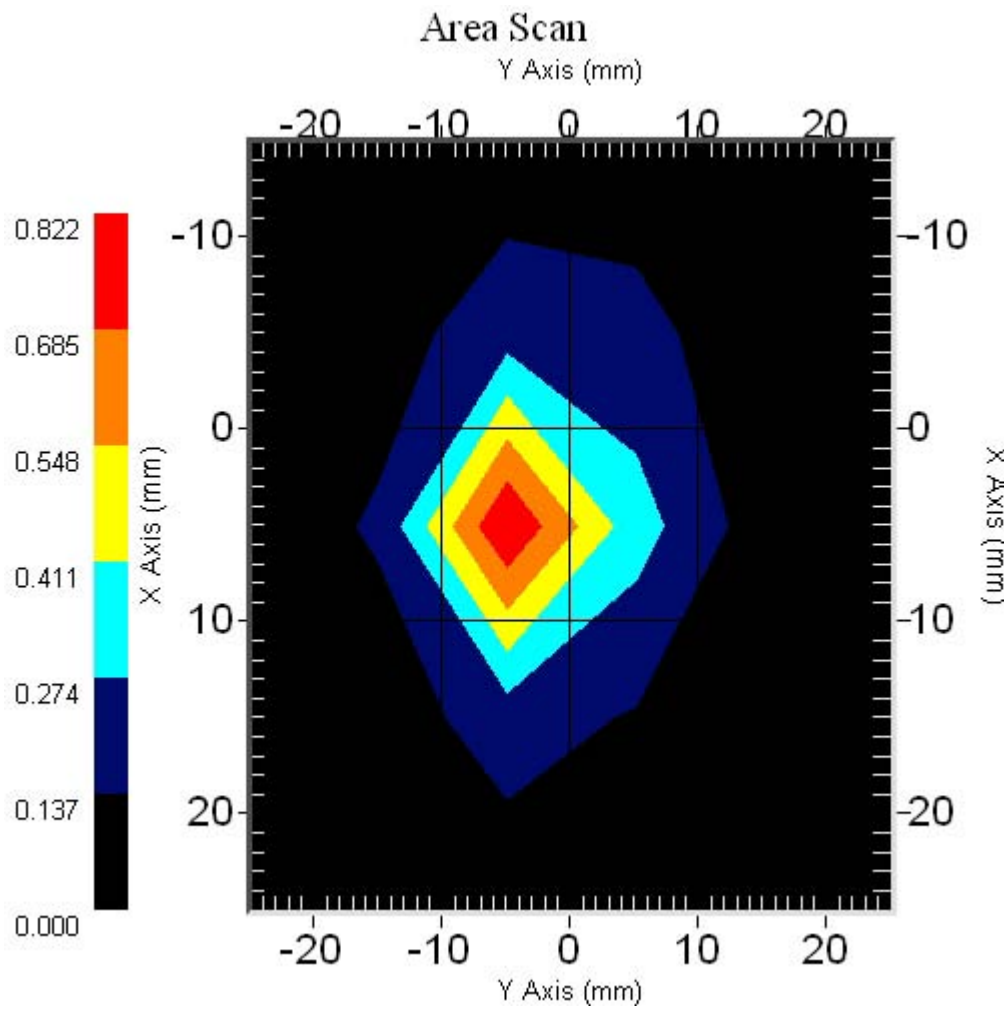


Smith Chart Dipole Impedance



System Validation Results Using the Electrically Calibrated Dipole

Head Tissue Frequency	1 Gram	10 Gram	Peak Above Feed Point
5200 MHz	58.8	x	223.1



Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2007.

NCL CALIBRATION LABORATORIES

Calibration File No: DC-788
Project Number: APREL-ALSAS10U

C E R T I F I C A T E O F C A L I B R A T I O N

It is certified that the equipment identified below has been calibrated in the
NCL CALIBRATION LABORATORIES by qualified personnel following recognized
procedures and using transfer standards traceable to NRC/NIST.

APREL Validation Dipole

Manufacturer: APREL Laboratories

Part number: ALS-D-2450-S-2

Frequency: 2450 MHz

Serial No: 301581

Customer: APREL

Calibrated: 11th November 2006
Released on: 11th November 2006

Released By: _____

NCL CALIBRATION LABORATORIES

51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6

Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4162

Conditions

Dipole 301581 was new and taken from stock prior to calibration.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C

Temperature of the Tissue: 21 °C +/- 0.5°C

We the undersigned attest that to the best of our knowledge the calibration of this device has been accurately conducted and that all information contained within this report has been reviewed for accuracy.

Stuart Nicol
Director Product Development

D. Brooks
Member of Engineering Staff
(Calibration Engineer)

Calibration Results Summary

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

Mechanical Dimensions

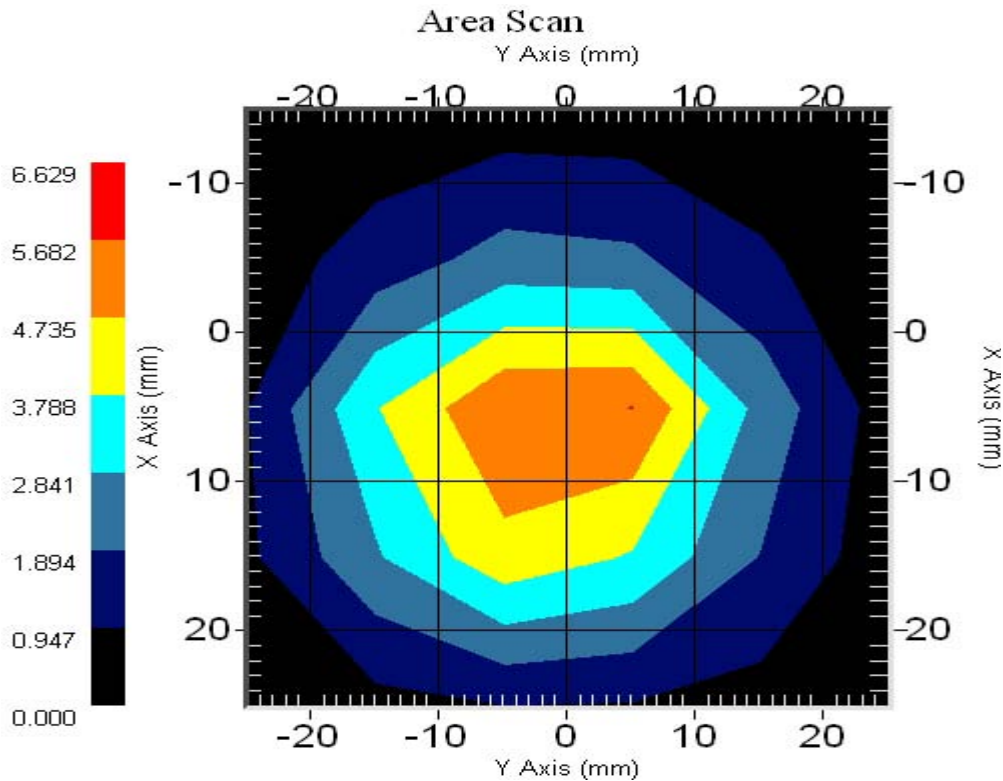
Length: 52.4 mm
Height: 30.3 mm

Electrical Specification

SWR: 1.056 U
Return Loss: -32.0 dB
Impedance: 50.2 Ω

System Validation Results

Frequency	1 Gram	10 Gram	Peak
2450 MHz	53.1	24.4	101.8



Introduction

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018-ALSAS. The results contained within this report are for Validation Dipole 301581. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the mechanical specifications. Step 2 was an Electrical Calibration for the Validation Dipole, where the SWR, Impedance, and the Return loss were assessed. Step 3 involved a System Validation using the ALSAS-10U, along with APREL E-020 130 MHz to 26 GHz E-Field Probe Serial Number 212.

References

SSI-TP-018-ALSAS Dipole Calibration Procedure

SSI-TP-016 Tissue Calibration Procedure

IEEE 1528 “Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”

IEC-62209 “Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures”

Part 1: “Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 300 MHz to 3 GHz)”

IEC-62209 “Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures”

Part 2 *Draft*: “Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 30 MHz to 6 GHz)”

Conditions

Dipole 301581 was new taken from stock.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C

Temperature of the Tissue: 20 °C +/- 0.5°C

Dipole Calibration Results

Mechanical Verification

APREL Length	APREL Height	Measured Length	Measured Height
51.5 mm	30.4 mm	52.4 mm	30.3 mm

Tissue Validation

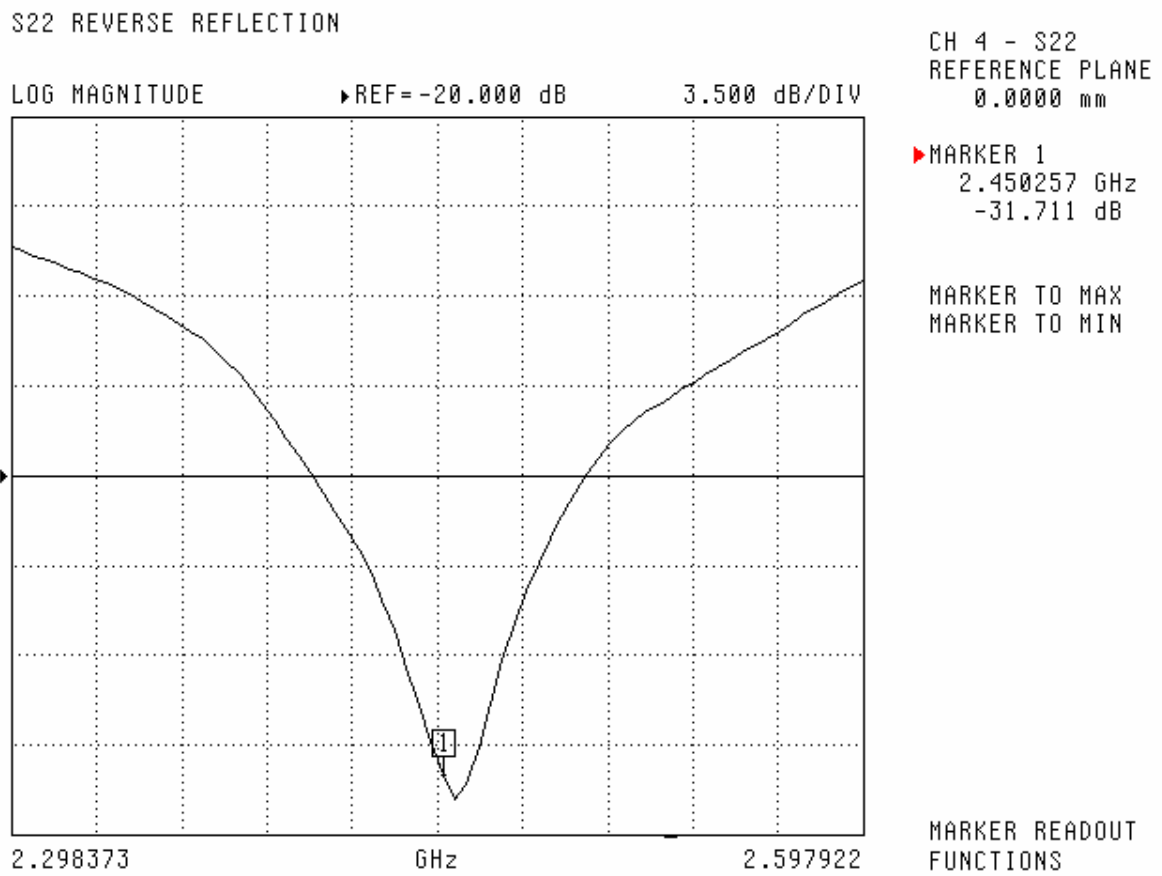
Head Tissue 2450 MHz	Measured
Dielectric constant, ϵ_r	39.2
Conductivity, σ [S/m]	1.80

Electrical Calibration

Test	Result
S11 R/L	-32.0 dB
SWR	1.05 U
Impedance	50.2 Ω

The Following Graphs are the results as displayed on the Vector Network Analyzer.

S11 Parameter Return Loss



SWR

S22 REVERSE REFLECTION

SWR

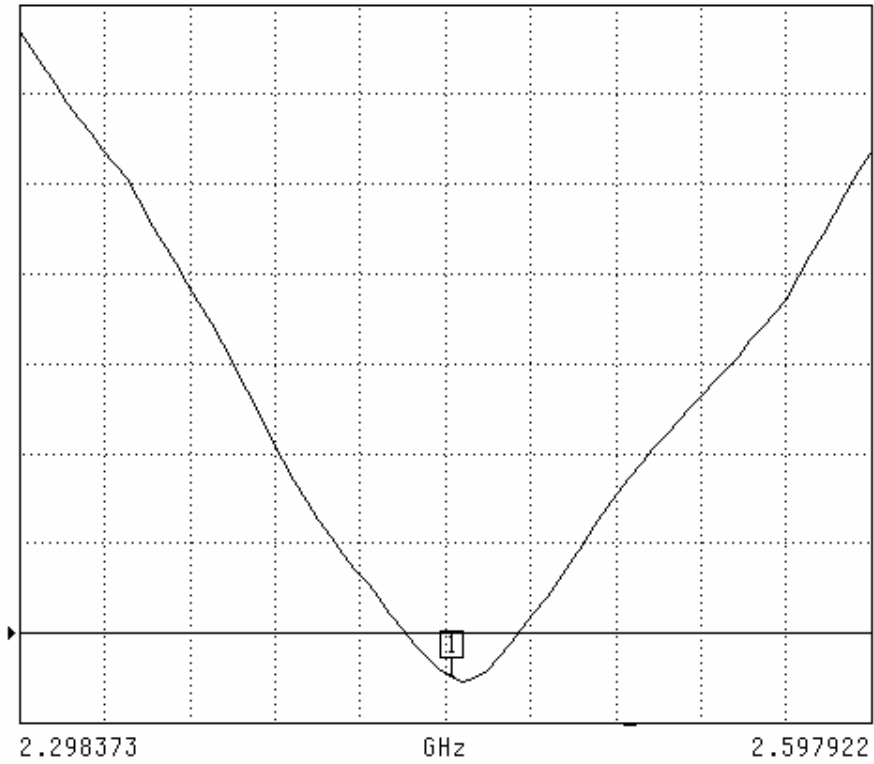
REF=1.100 U

100.000 mU/DIV

CH 4 - S22
REFERENCE PLANE
0.0000 mm

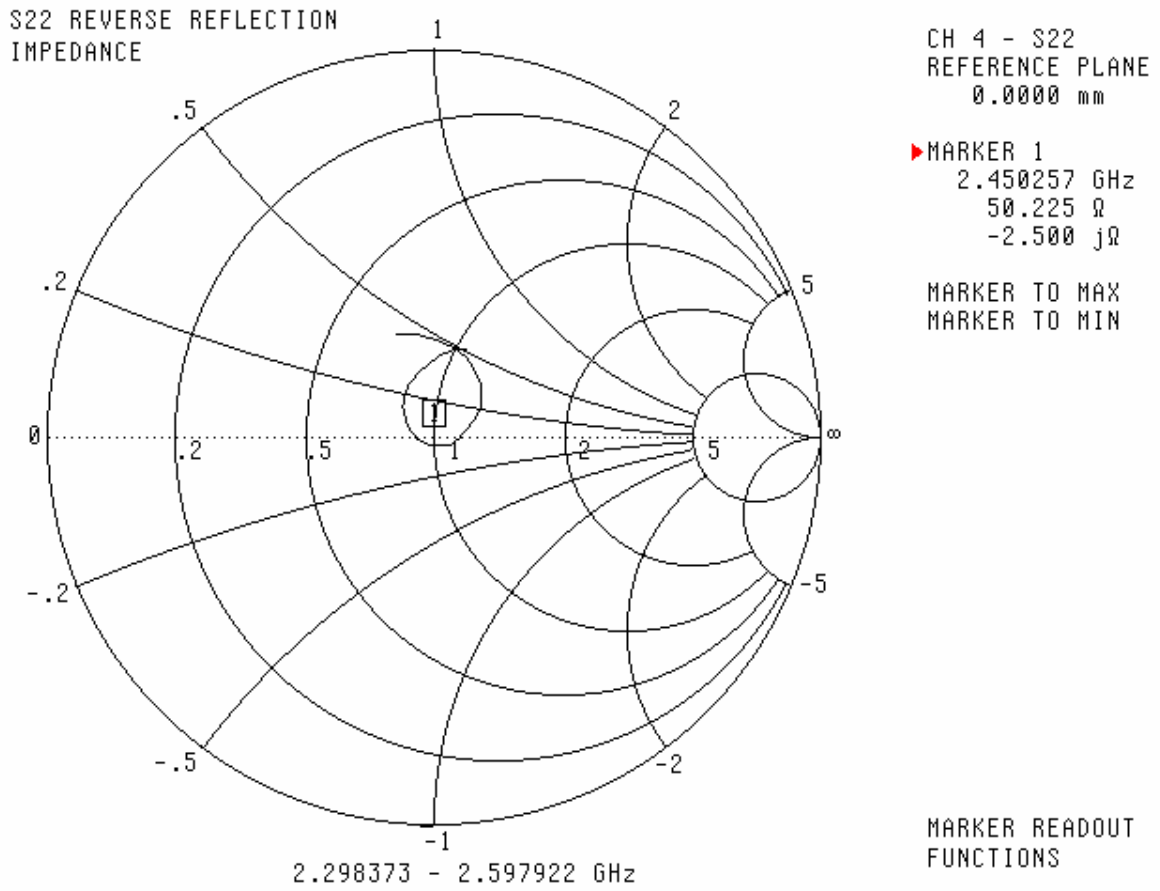
MARKER 1
2.450257 GHz
1.051 U

MARKER TO MAX
MARKER TO MIN



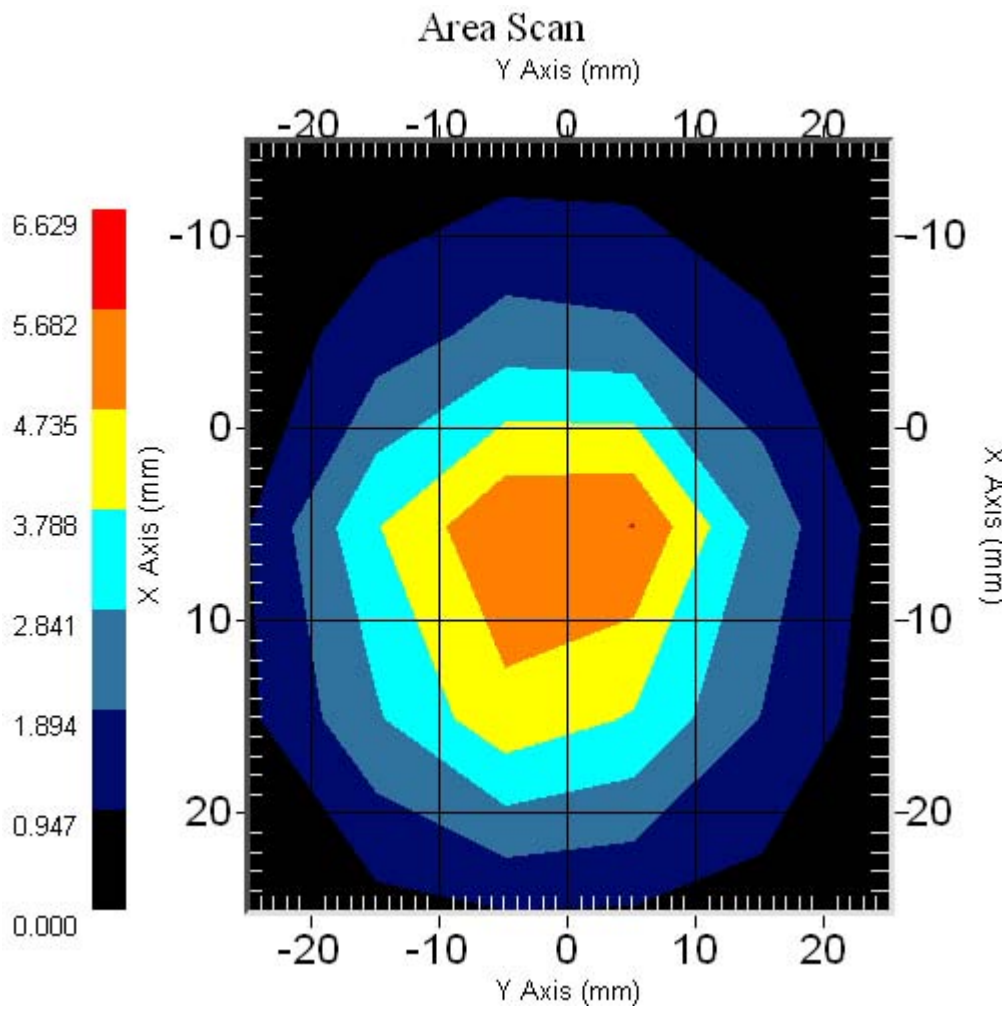
MARKER READOUT
FUNCTIONS

Smith Chart Dipole Impedance



System Validation Results Using the Electrically Calibrated Dipole

Frequency	1 Gram	10 Gram	Peak
2450 MHz	53.1	24.4	101.8



Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2004

NCL CALIBRATION LABORATORIES

Calibration File No.: CP-787

Client.: APREL

CERTIFICATE OF CALIBRATION

It is certified that the equipment identified below has been calibrated in the
NCL CALIBRATION LABORATORIES by qualified personnel following recognized
procedures and using transfer standards traceable to NRC/NIST.

Equipment: Miniature Isotropic RF Probe 5800 MHz

Manufacturer: APREL Laboratories

Model No.: E-020

Serial No.: 226

Calibration in Body Tissue

Calibration Procedure: SSI/DRB-TP-D01-032-E020-V2

Project No: Internal APREL

Calibrated: 3rd May 2007
Released on: 3rd May 2007

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration Results Summary

Released By: _____

NCL CALIBRATION LABORATORIES

51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6

Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4161

Introduction

This Calibration Report reproduces the results of the calibration performed in line with the SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-020 226.

References

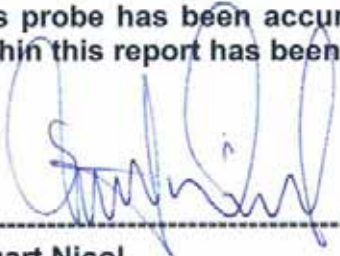
SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure
IEEE 1528 "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"
SSI-TP-011 Tissue Calibration Procedure

Conditions

Probe 226 was a new probe taken from stock prior to calibration.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 21 °C +/- 0.5°C

We the undersigned attest that to the best of our knowledge the calibration of this probe has been accurately conducted and that all information contained within this report has been reviewed for accuracy.



Stuart Nicol



Jesse Hones

Calibration Results Summary

Probe Type:	E-Field Probe E-020
Serial Number:	226
Frequency:	5800 MHz
Sensor Offset:	1.56 mm
Sensor Length:	2.5 mm
Tip Enclosure:	Ertalyte*
Tip Diameter:	<2.9 mm
Tip Length:	60 mm
Total Length:	290 mm

*Resistive to recommended tissue recipes per IEEE-1528

Sensitivity in Air

Channel X:	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
Channel Y:	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
Channel Z:	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
Diode Compression Point:	95 mV

Sensitivity in Body Tissue

Frequency: 5800 MHz

Epsilon: 48.2 (+/-10%) **Sigma:** 6.0 S/m (+/-10%)

ConvF

Channel X: 4.01

Channel Y: 4.01

Channel Z: 4.01

Tissue sensitivity values were calculated using the load impedance of the APREL Laboratories Daq-Paq.

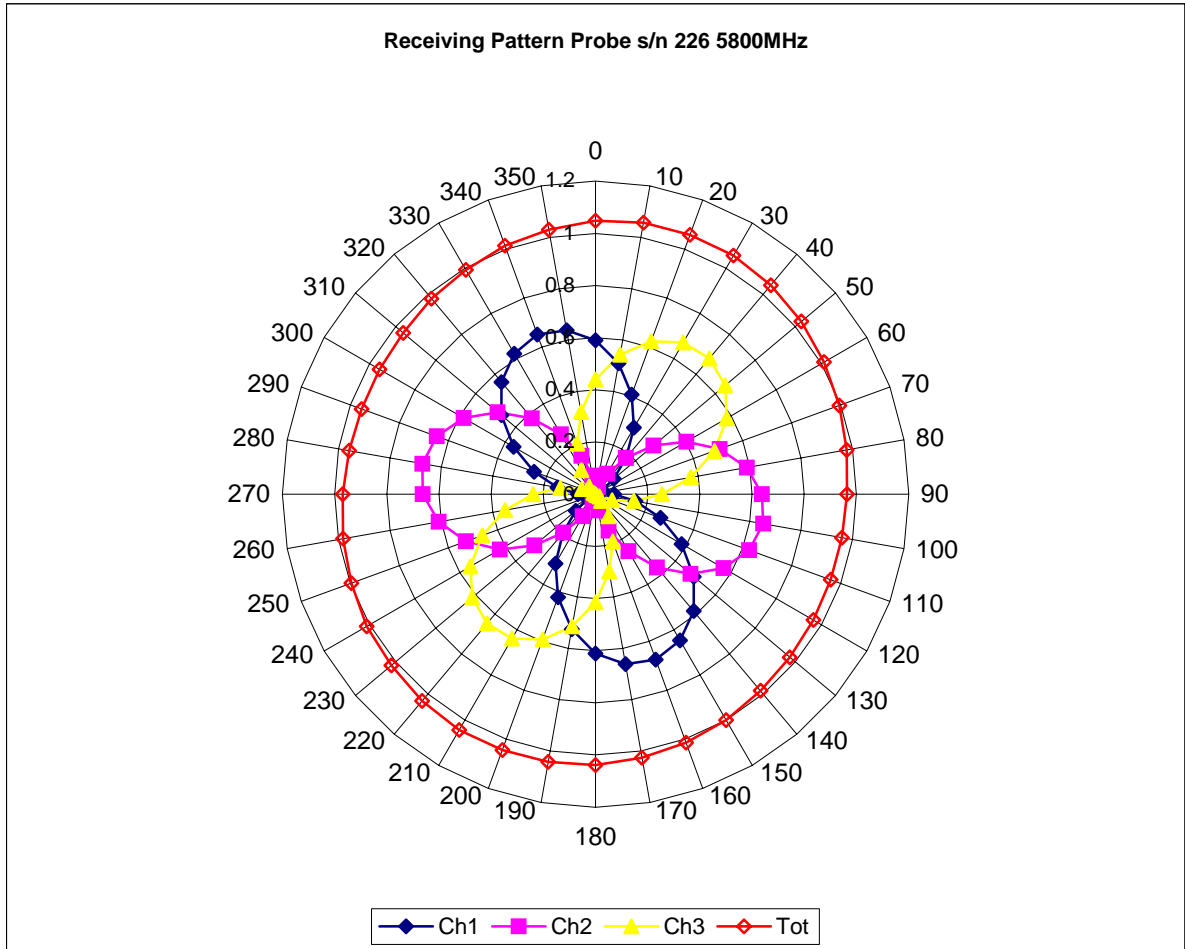
Boundary Effect:

Uncertainty resulting from the boundary effect is less than 2% for the distance between the tip of the probe and the tissue boundary, when less than 2.44mm.

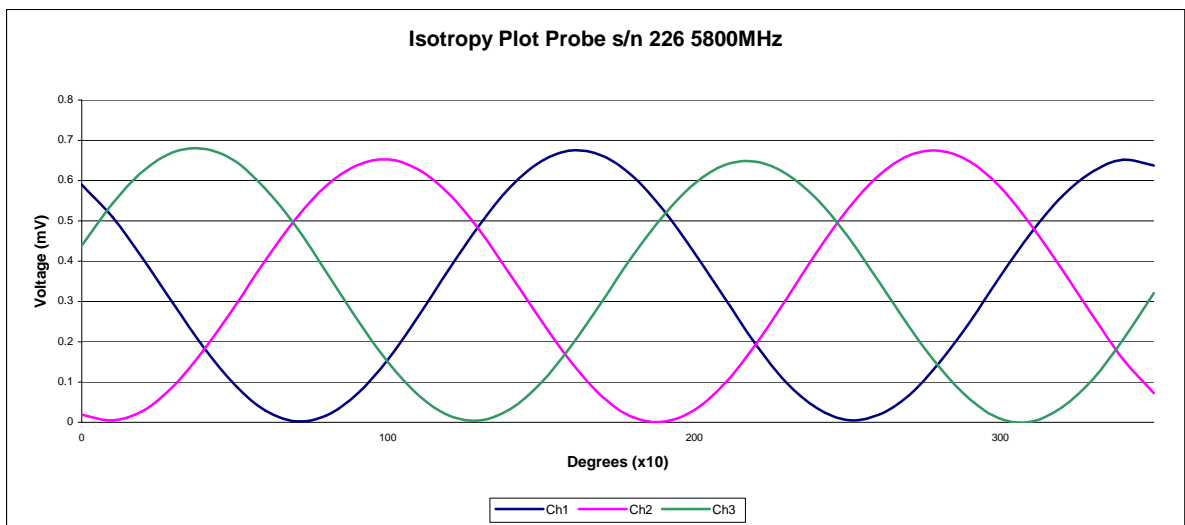
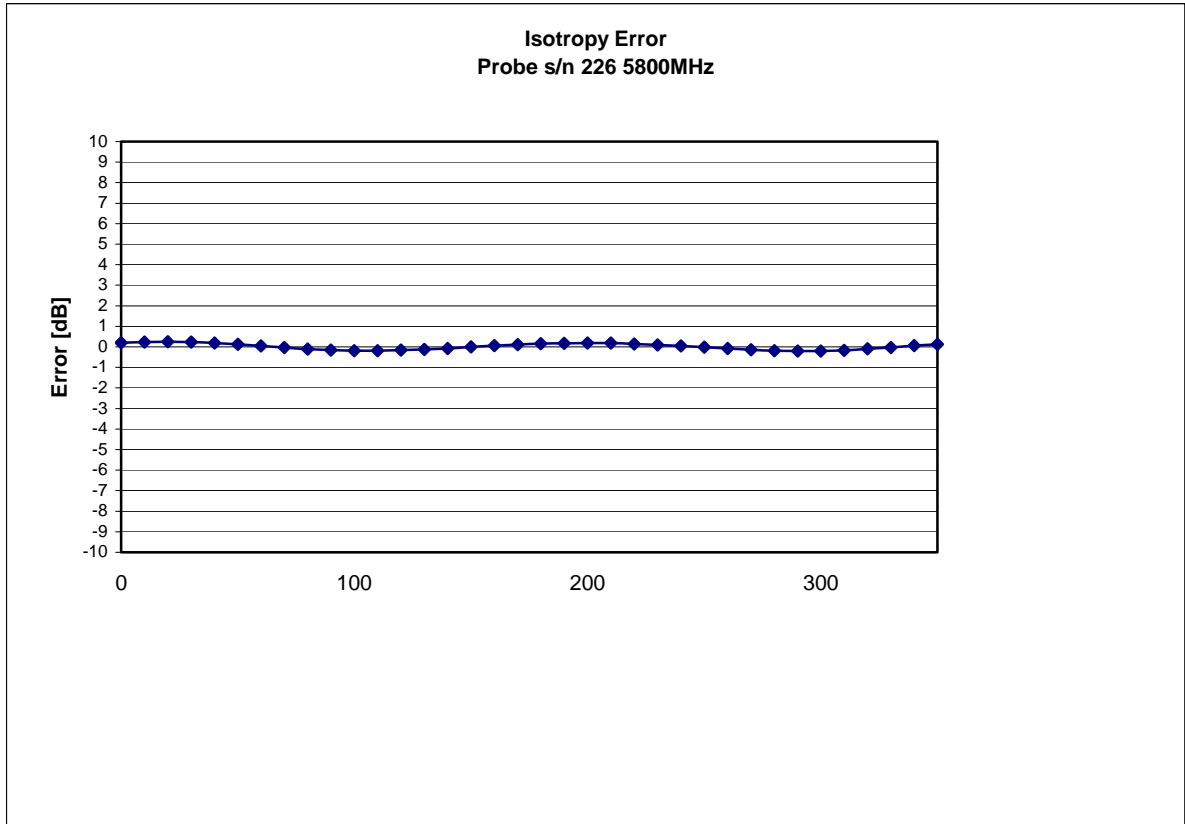
Spatial Resolution:

The measured probe tip diameter is 2.9 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

Receiving Pattern 5800 MHz (Air)



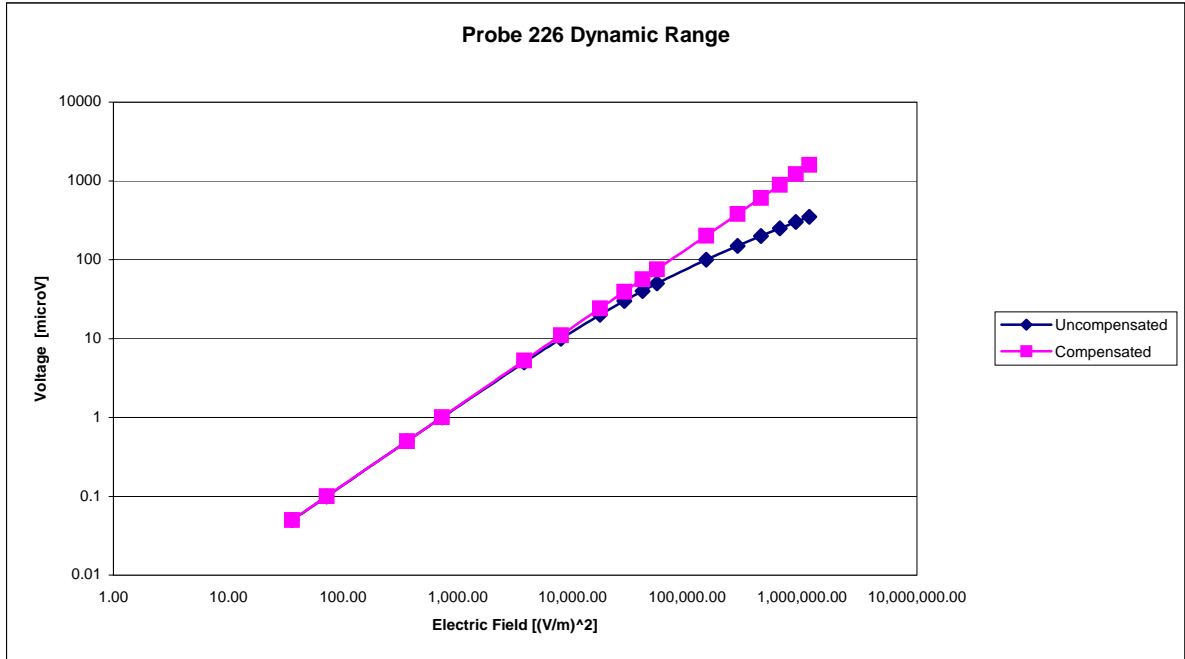
Isotropy Error 5800 MHz (Air)



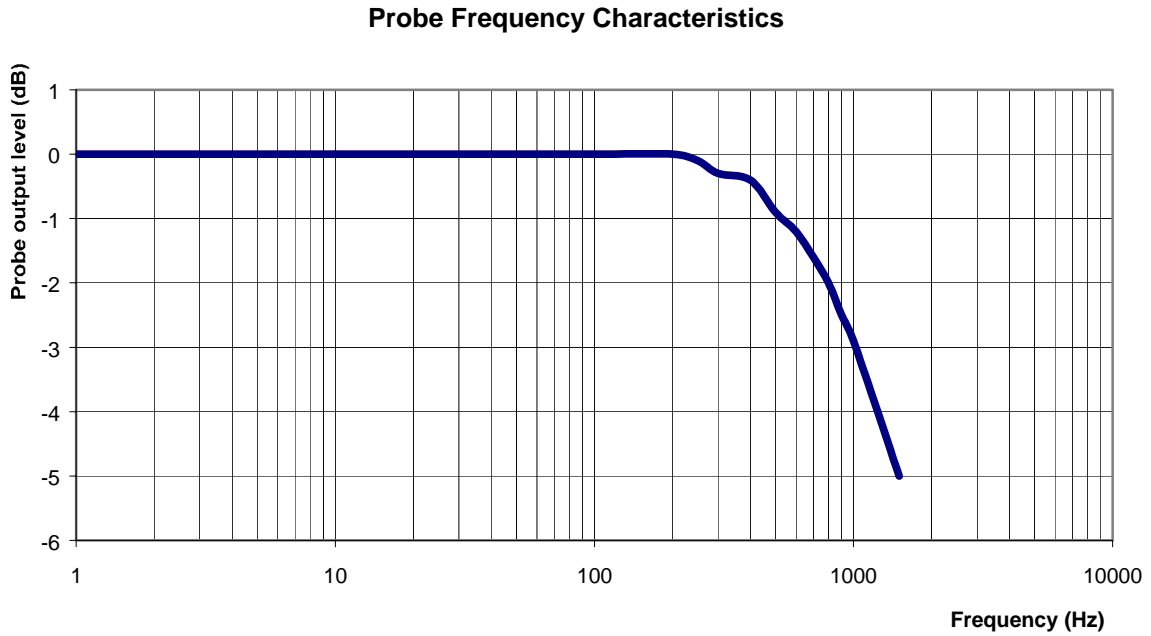
Isotropicity in Tissue:

0.10 dB

Dynamic Range



Video Bandwidth



Video Bandwidth at 500 Hz 1 dB
Video Bandwidth at 1.02 KHz: 3 dB

Conversion Factor Uncertainty Assessment

Frequency: 5800MHz
Epsilon: 48.2 (+/-10%) **Sigma:** 6.0 S/m (+/-10%)

ConvF

Channel X: 4.01 7%(K=2)

Channel Y: 4.01 7%(K=2)

Channel Z: 4.01 7%(K=2)

To minimize the uncertainty calculation all tissue sensitivity values were calculated using a load impedance of 5 MΩ.

Boundary Effect:

For a distance of 1.4mm the evaluated uncertainty (increase in the probe sensitivity) is less than 2%.

Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2007.

NCL CALIBRATION LABORATORIES

Calibration File No.: CP-786

Client.: APREL

CERTIFICATE OF CALIBRATION

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

Equipment: Miniature Isotropic RF Probe 5200 MHz

Manufacturer: APREL Laboratories

Model No.: E-020

Serial No.: 226

Calibration in Body Tissue

Calibration Procedure: SSI/DRB-TP-D01-032-E020-V2

Project No: Internal APREL

Calibrated: 3rd May 2007

Released on: 3rd May 2007

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration Results Summary

Released By: _____

NCL CALIBRATION LABORATORIES

51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6

Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4161

Introduction

This Calibration Report reproduces the results of the calibration performed in line with the SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-020 226.

References

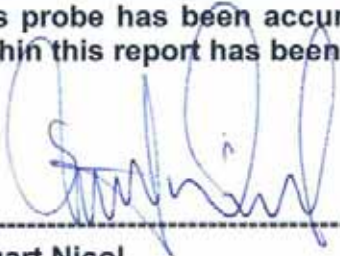
SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure
IEEE 1528 "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"
SSI-TP-011 Tissue Calibration Procedure

Conditions

Probe 226 was a new probe taken from stock prior to calibration.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 21 °C +/- 0.5°C

We the undersigned attest that to the best of our knowledge the calibration of this probe has been accurately conducted and that all information contained within this report has been reviewed for accuracy.



Stuart Nicol



Jesse Hones

Calibration Results Summary

Probe Type:	E-Field Probe E-020
Serial Number:	226
Frequency:	5200 MHz
Sensor Offset:	1.56 mm
Sensor Length:	2.5 mm
Tip Enclosure:	Ertalyte*
Tip Diameter:	<2.9 mm
Tip Length:	60 mm
Total Length:	290 mm

*Resistive to recommended tissue recipes per IEEE-1528

Sensitivity in Air

Channel X:	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
Channel Y:	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
Channel Z:	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
Diode Compression Point:	95 mV

Sensitivity in Body Tissue

Frequency:

5200 MHz

Epsilon: 43.0 (+/-10%)

Sigma: 5.75 S/m (+/-10%)

ConvF

Channel X: 3.5

Channel Y: 3.5

Channel Z: 3.5

Tissue sensitivity values were calculated using the load impedance of the APREL Laboratories Daq-Paq.

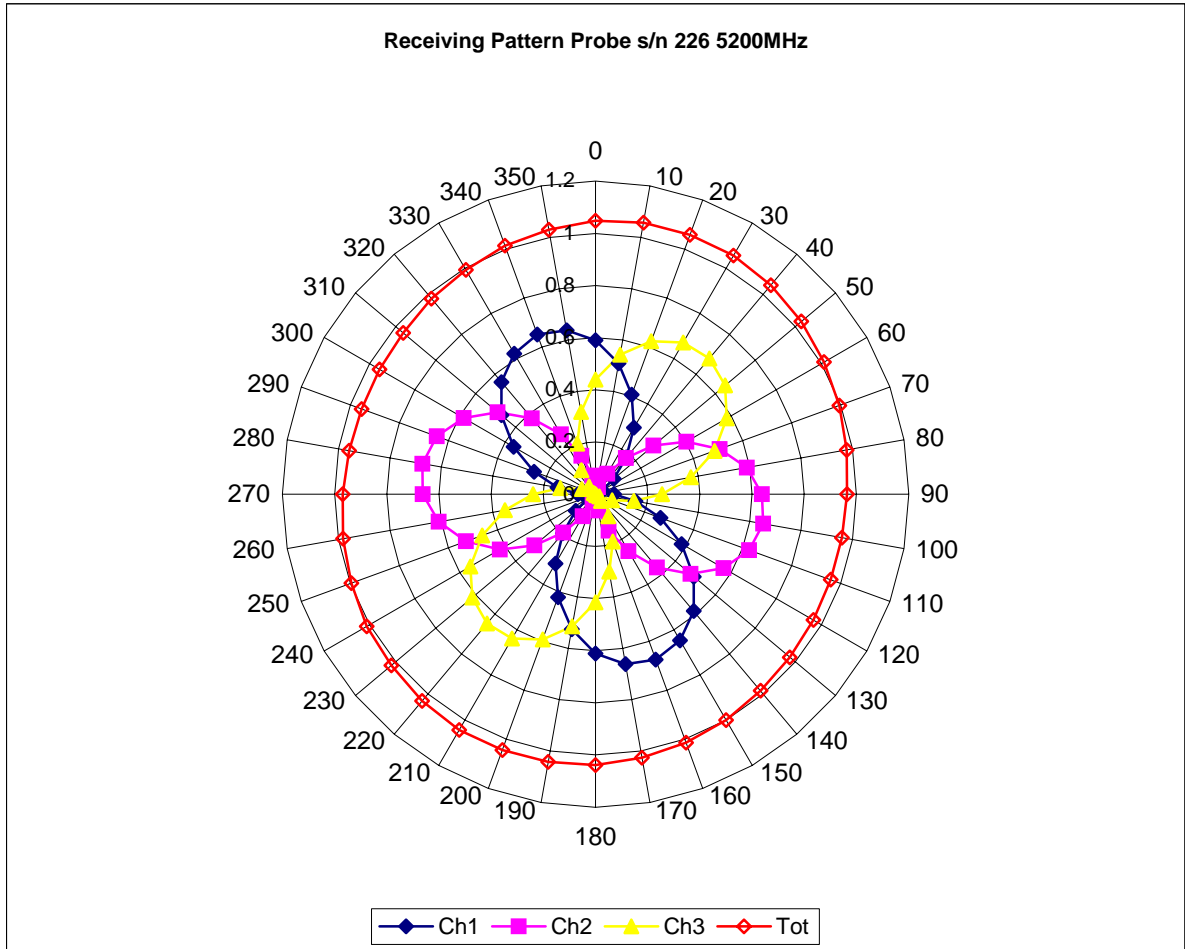
Boundary Effect:

Uncertainty resulting from the boundary effect is less than 2% for the distance between the tip of the probe and the tissue boundary, when less than 2.44mm.

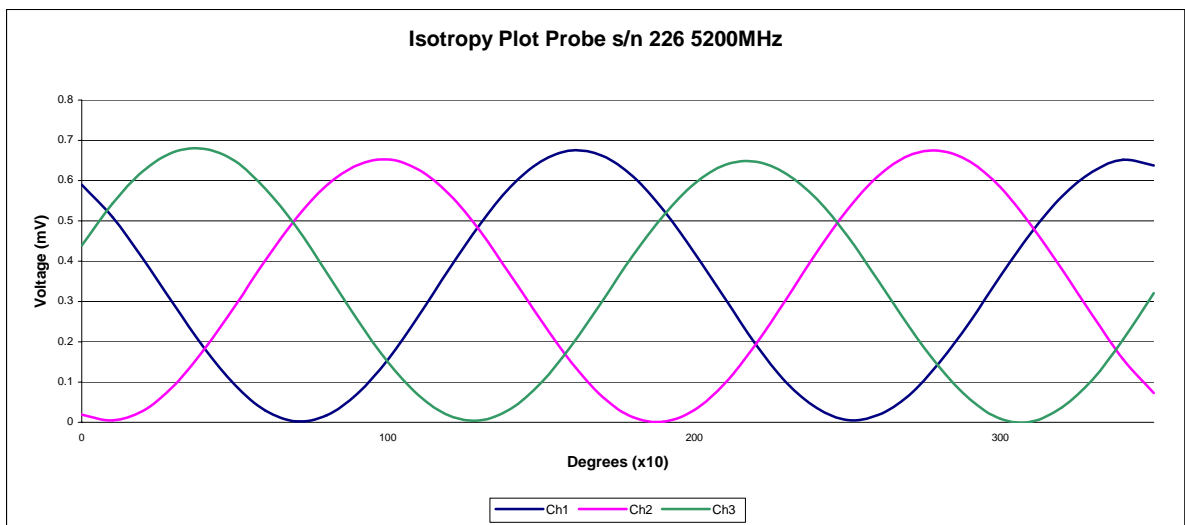
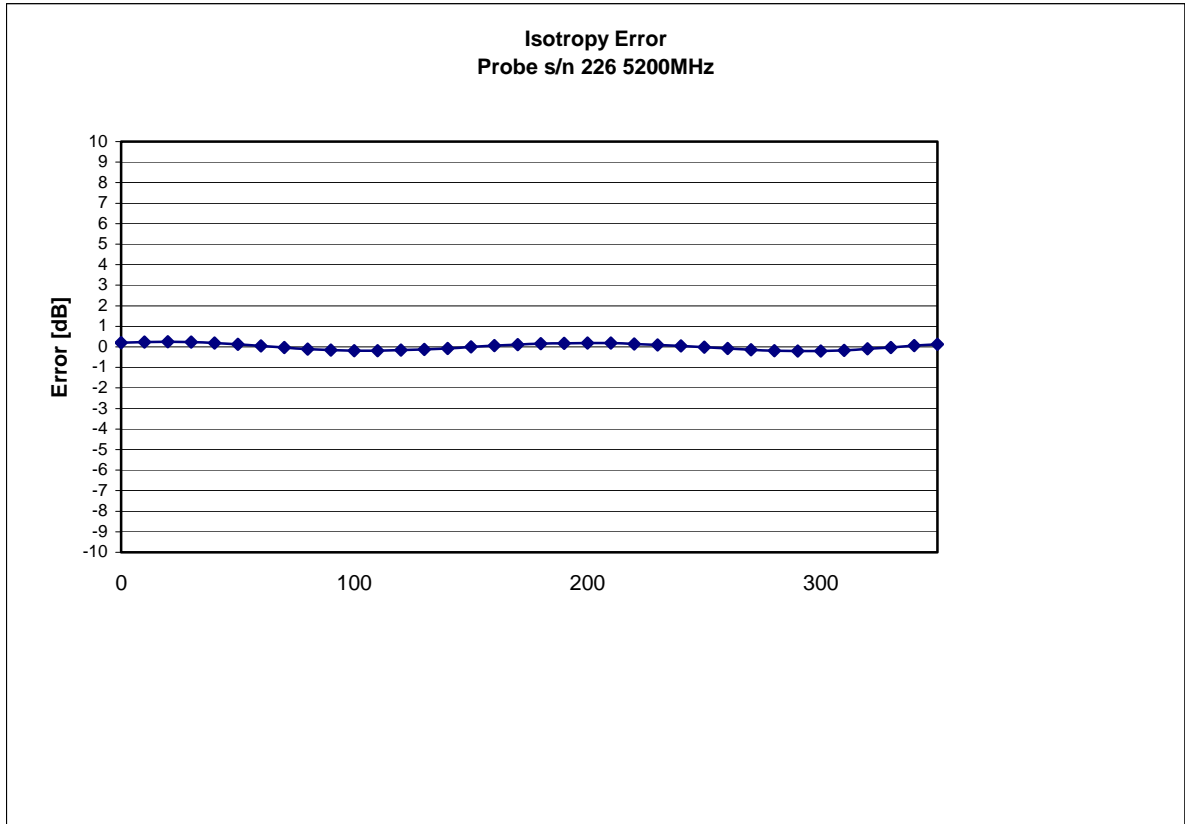
Spatial Resolution:

The measured probe tip diameter is 2.9 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

Receiving Pattern 5200 MHz (Air)



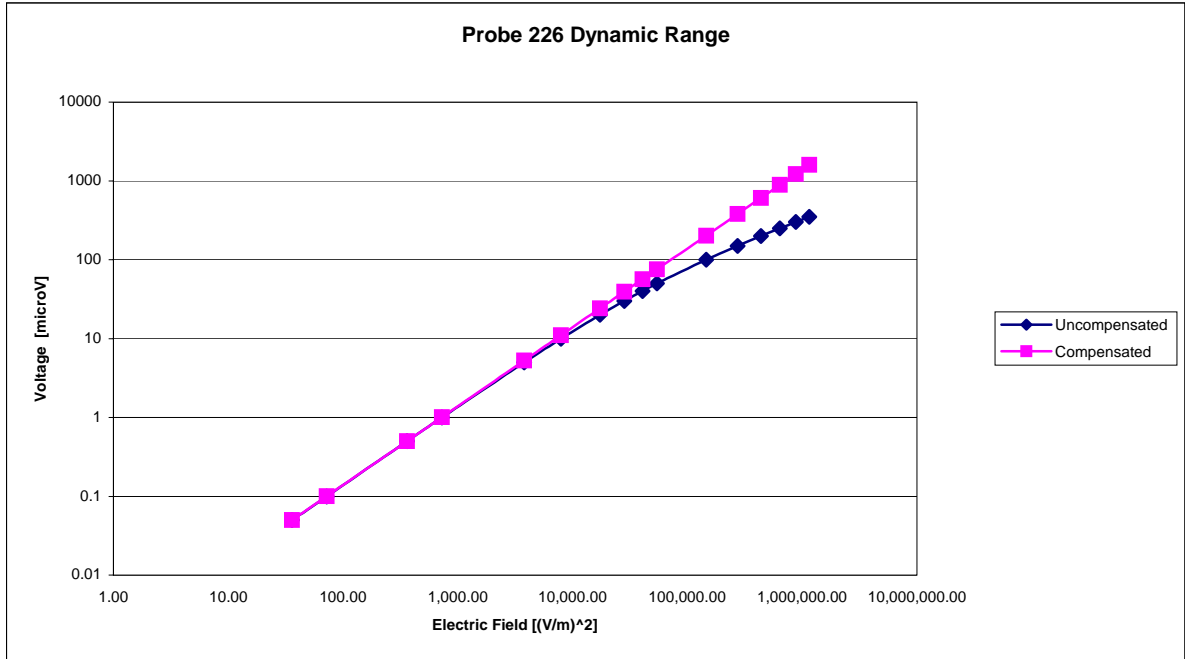
Isotropy Error 5200 MHz (Air)



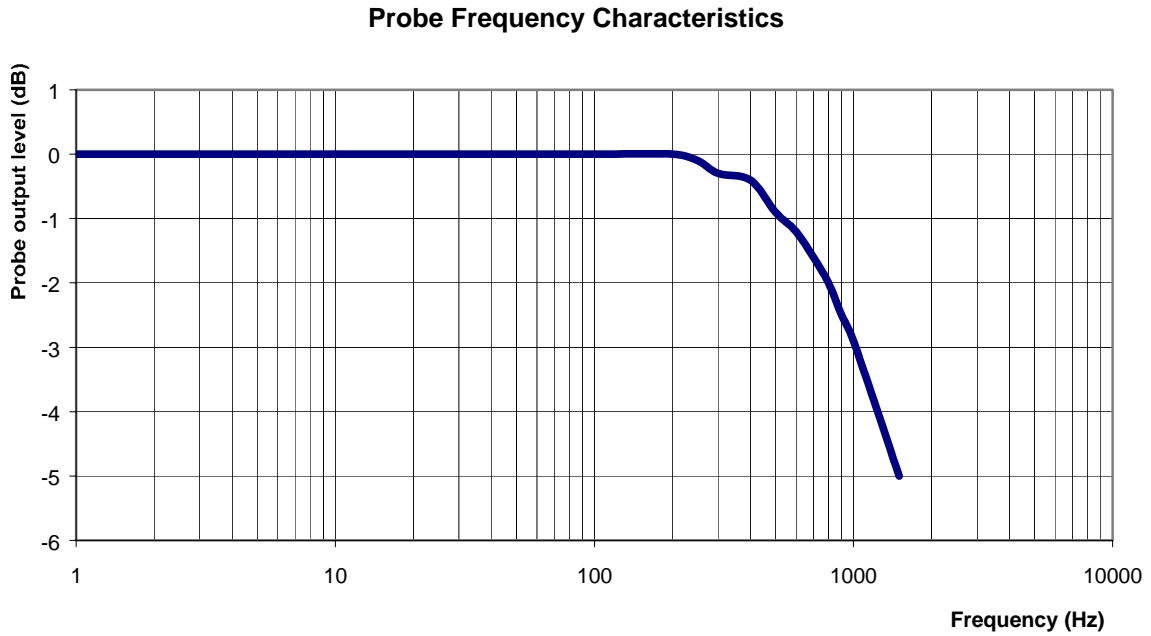
Isotropicity in Tissue:

0.10 dB

Dynamic Range



Video Bandwidth



Video Bandwidth at 500 Hz 1 dB
Video Bandwidth at 1.02 KHz: 3 dB

Conversion Factor Uncertainty Assessment

Frequency: 5200MHz
Epsilon: 43.0 (+/-10%) **Sigma:** 5.75 S/m (+/-10%)

ConvF

Channel X: 3.5 7%(K=2)

Channel Y: 3.5 7%(K=2)

Channel Z: 3.5 7%(K=2)

To minimize the uncertainty calculation all tissue sensitivity values were calculated using a load impedance of 5 MΩ.

Boundary Effect:

For a distance of 1.4mm the evaluated uncertainty (increase in the probe sensitivity) is less than 2%.

Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2007.

NCL CALIBRATION LABORATORIES

Calibration File No.: CP-785

Client.: APREL

CERTIFICATE OF CALIBRATION

It is certified that the equipment identified below has been calibrated in the
NCL CALIBRATION LABORATORIES by qualified personnel following recognized
procedures and using transfer standards traceable to NRC/NIST.

Equipment: Miniature Isotropic RF Probe 2450 MHz

Manufacturer: APREL Laboratories

Model No.: E-020

Serial No.: 226

Calibration in Body Tissue

Calibration Procedure: SSI/DRB-TP-D01-032-E020-V2

Project No: Internal APREL

Calibrated: 3rd May 2007
Released on: 3rd May 2007

This Calibration Certificate is Incomplete Unless Accompanied with the Calibration Results Summary

Released By: _____

NCL CALIBRATION LABORATORIES

51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6

Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4161

Introduction

This Calibration Report reproduces the results of the calibration performed in line with the SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure. The results contained within this report are for APREL E-Field Probe E-020 226.

References

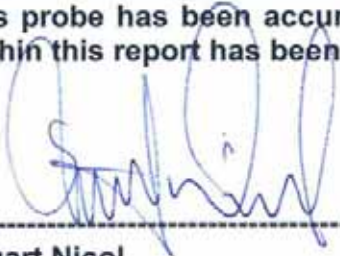
SSI/DRB-TP-D01-032-E020-V2 E-Field Probe Calibration Procedure
IEEE 1528 "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques"
SSI-TP-011 Tissue Calibration Procedure

Conditions

Probe 226 was a new probe taken from stock prior to calibration.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C
Temperature of the Tissue: 21 °C +/- 0.5°C

We the undersigned attest that to the best of our knowledge the calibration of this probe has been accurately conducted and that all information contained within this report has been reviewed for accuracy.



Stuart Nicol



Jesse Hones

Calibration Results Summary

Probe Type:	E-Field Probe E-020
Serial Number:	226
Frequency:	2450 MHz
Sensor Offset:	1.56 mm
Sensor Length:	2.5 mm
Tip Enclosure:	Ertalyte*
Tip Diameter:	<2.9 mm
Tip Length:	60 mm
Total Length:	290 mm

*Resistive to recommended tissue recipes per IEEE-1528

Sensitivity in Air

Channel X:	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
Channel Y:	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
Channel Z:	1.2 $\mu\text{V}/(\text{V}/\text{m})^2$
Diode Compression Point:	95 mV

Sensitivity in Body Tissue

Frequency:

2450 MHz

Epsilon: 52.7 (+/-5%)

Sigma: 1.95 S/m (+/-5%)

ConvF

Channel X: 4.4

Channel Y: 4.4

Channel Z: 4.4

Tissue sensitivity values were calculated using the load impedance of the APREL Laboratories Daq-Paq.

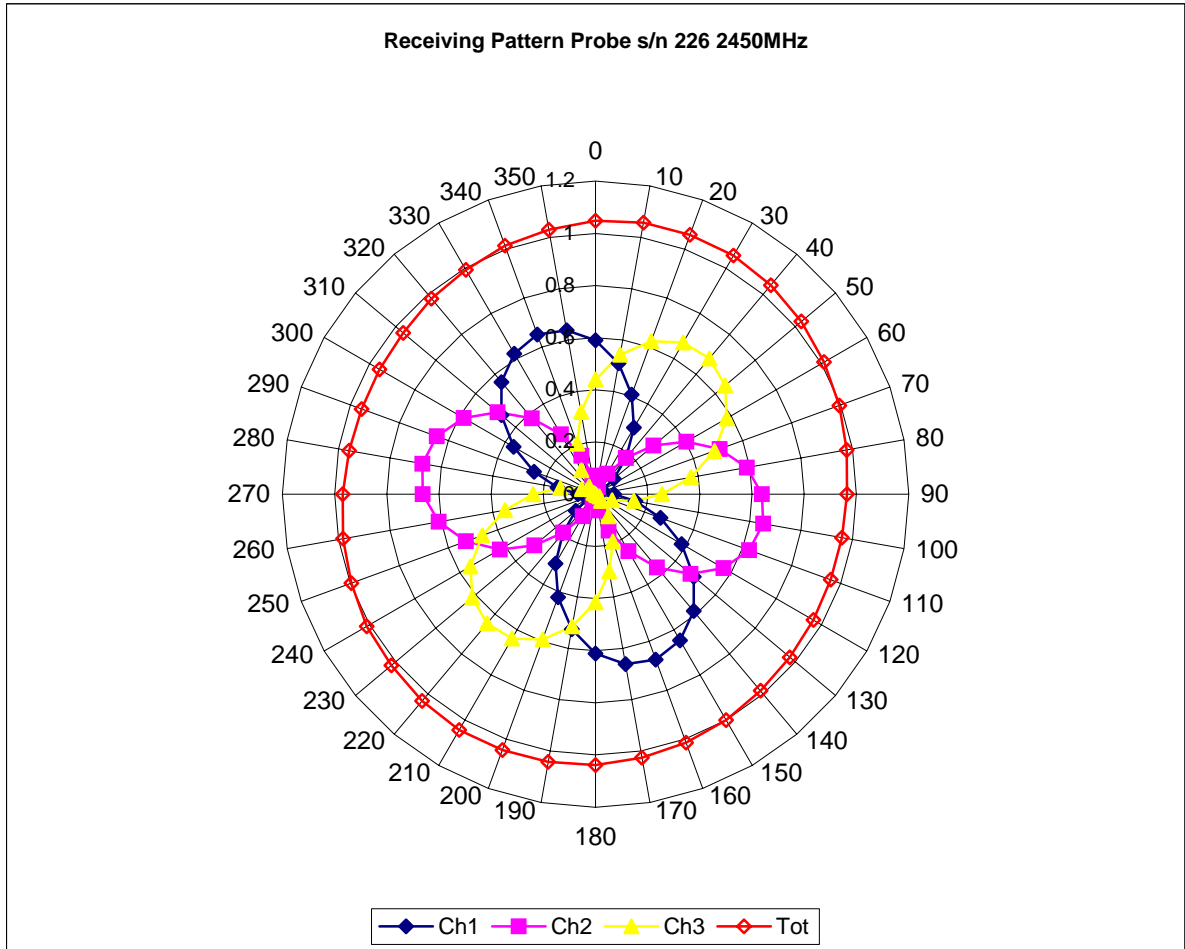
Boundary Effect:

Uncertainty resulting from the boundary effect is less than 2% for the distance between the tip of the probe and the tissue boundary, when less than 1.44mm.

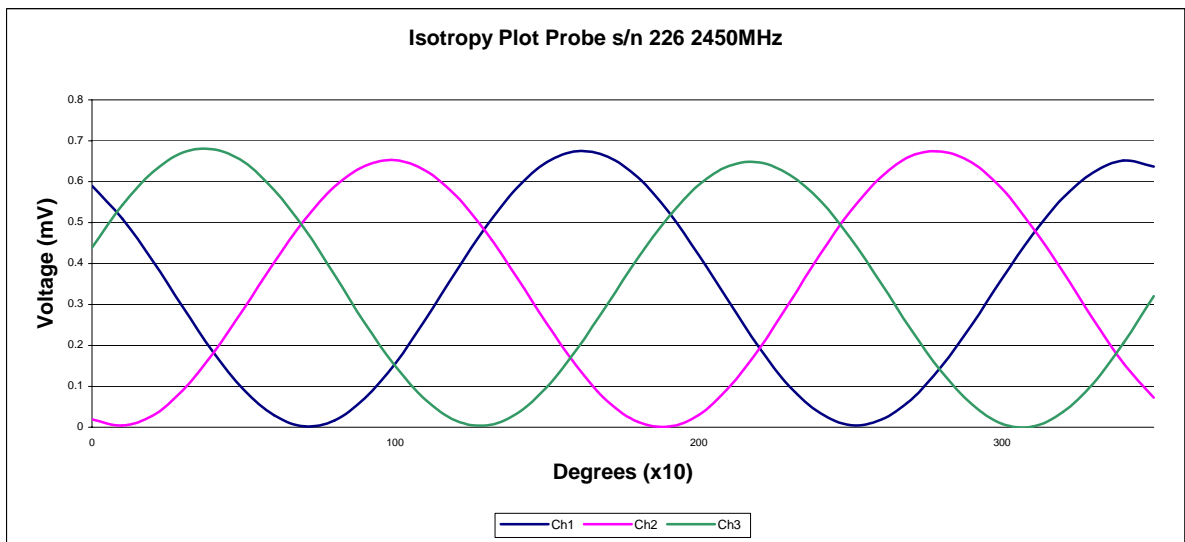
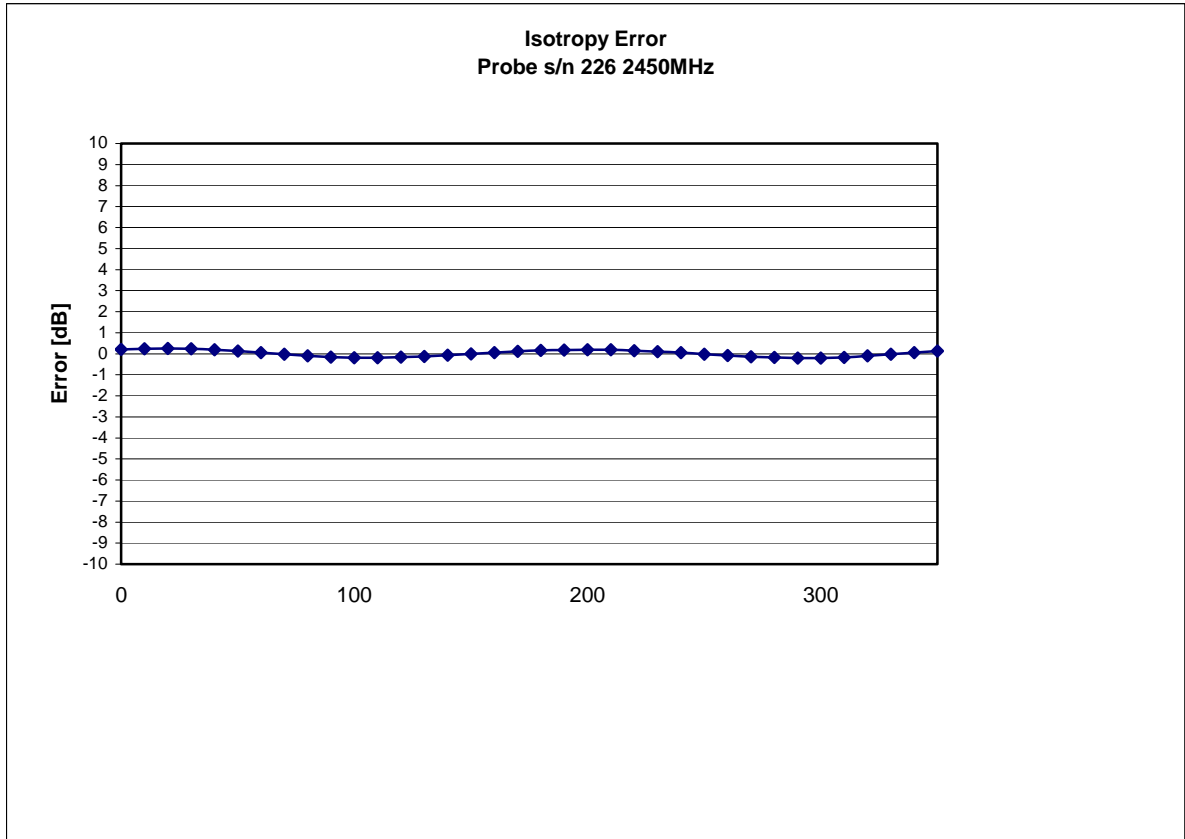
Spatial Resolution:

The measured probe tip diameter is 2.9 mm (+/- 0.01 mm) and therefore meets the requirements of SSI/DRB-TP-D01-032 for spatial resolution.

Receiving Pattern 2450 MHz (Air)



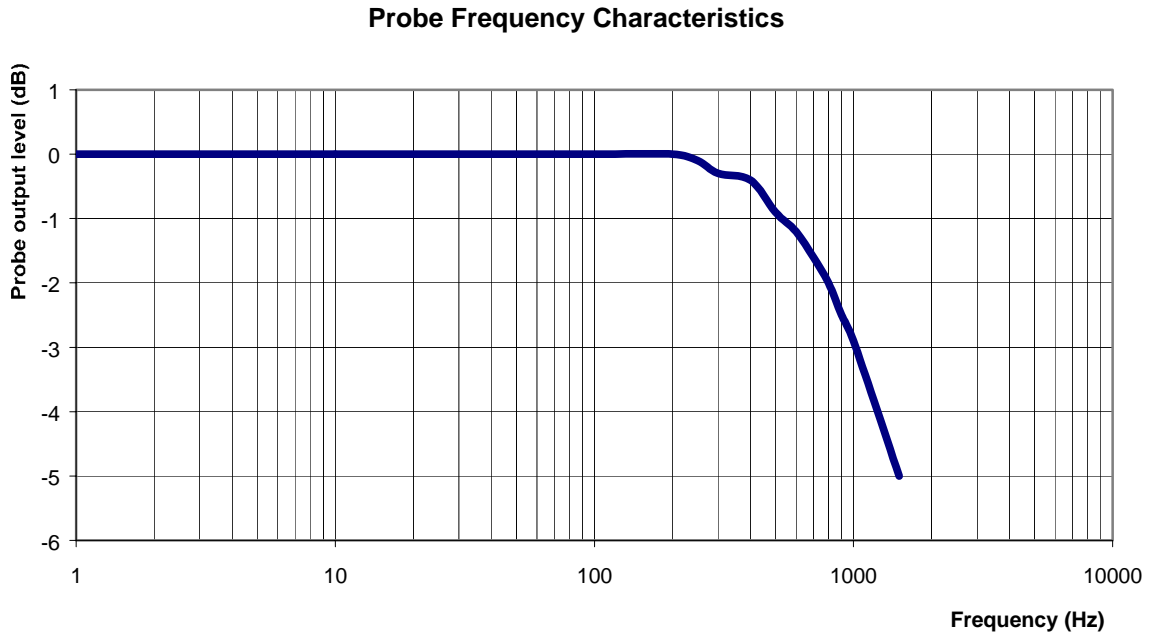
Isotropy Error 2450 MHz (Air)



Isotropicity in Tissue:

0.10 dB

Video Bandwidth



Video Bandwidth at 500 Hz 1 dB
Video Bandwidth at 1.02 KHz: 3 dB

Conversion Factor Uncertainty Assessment

Frequency: 2450MHz
Epsilon: 52.7 (+/-5%) **Sigma:** 1.95 S/m (+/-5%)

ConvF

Channel X: 4.4 7%(K=2)

Channel Y: 4.4 7%(K=2)

Channel Z: 4.4 7%(K=2)

To minimize the uncertainty calculation all tissue sensitivity values were calculated using a load impedance of 5 M Ω .

Boundary Effect:

For a distance of 1.4mm the evaluated uncertainty (increase in the probe sensitivity) is less than 2%.

Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2007.

NCL CALIBRATION LABORATORIES

Calibration File No: DC-790
Project Number: APREL-ALSAS10U

C E R T I F I C A T E O F C A L I B R A T I O N

It is certified that the equipment identified below has been calibrated in the
NCL CALIBRATION LABORATORIES by qualified personnel following recognized
procedures and using transfer standards traceable to NRC/NIST.

APREL Validation Dipole

Manufacturer: APREL Laboratories

Part number: ALS-D-5800-S-2

Frequency: 5800 MHz

Serial No: PT-015-a

Customer: APREL

Calibrated: 1st March 2007
Released on: 1st March 2007

Released By: _____

NCL CALIBRATION LABORATORIES

51 SPECTRUM WAY
NEPEAN, ONTARIO
CANADA K2R 1E6

Division of APREL Lab.
TEL: (613) 820-4988
FAX: (613) 820-4162

Conditions

Dipole PT-015-a was new and taken from stock prior to calibration.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C

Temperature of the Tissue: 21 °C +/- 0.5°C

We the undersigned attest that to the best of our knowledge the calibration of this device has been accurately conducted and that all information contained within this report has been reviewed for accuracy.

Stuart Nicol

C. Teodorian

Calibration Results Summary

The following results relate the Calibrated Dipole and should be used as a quick reference for the user.

Mechanical Dimensions

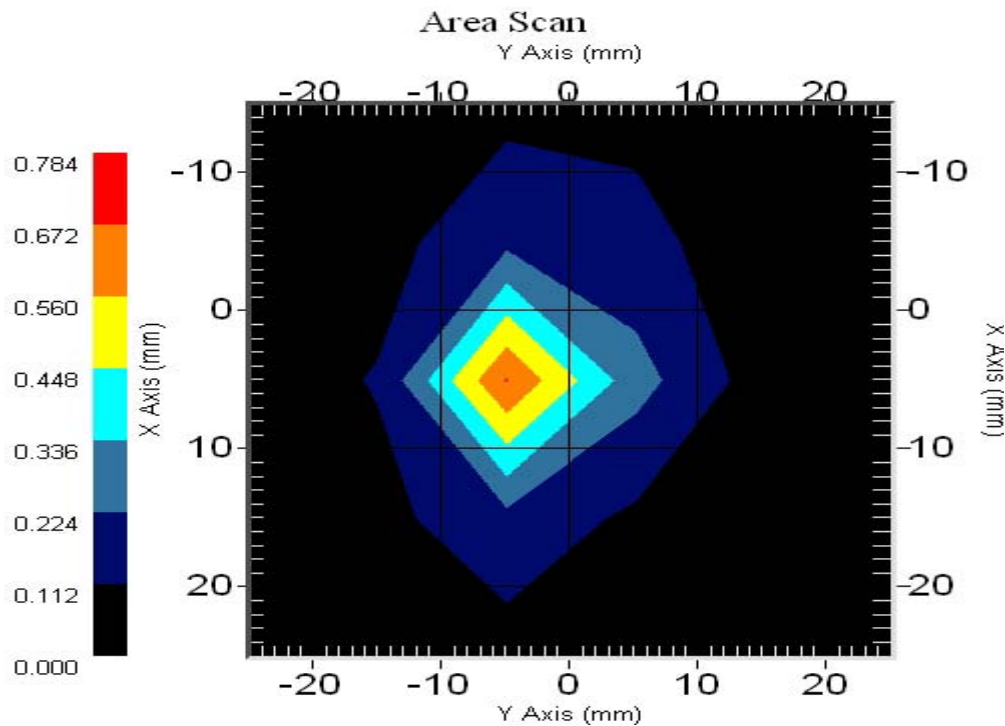
Length: 21.6 mm
Height: 12.6 mm

Electrical Specification

SWR: 1.37 U
Return Loss: -16.2 dB
Impedance: 62.5 Ω

System Validation Results

Frequency	1 Gram	10 Gram	Peak
5800 MHz	49.1	x	207.1



Introduction

This Calibration Report has been produced in line with the SSI Dipole Calibration Procedure SSI-TP-018-ALSAS. The results contained within this report are for Validation Dipole PT-015-a. The calibration routine consisted of a three-step process. Step 1 was a mechanical verification of the dipole to ensure that it meets the mechanical specifications. Step 2 was an Electrical Calibration for the Validation Dipole, where the SWR, Impedance, and the Return loss were assessed. Step 3 involved a System Validation using the ALSAS-10U, along with APREL E-020 130 MHz to 26 GHz E-Field Probe Serial Number 212.

References

SSI-TP-018-ALSAS Dipole Calibration Procedure

SSI-TP-016 Tissue Calibration Procedure

IEEE 1528 “Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques”

IEC-62209 “Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures”

Part 1: “Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 300 MHz to 3 GHz)”

IEC-62209 “Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures”

Part 2 *Draft*: “Procedure to determine the Specific Absorption Rate (SAR) for hand-held devices used in close proximity of the ear (frequency range of 30 MHz to 6 GHz)”

Conditions

Dipole PT-015-a was new taken from stock.

Ambient Temperature of the Laboratory: 22 °C +/- 0.5°C

Temperature of the Tissue: 20 °C +/- 0.5°C

Dipole Calibration Results

Mechanical Verification

APREL Length	APREL Height	Measured Length	Measured Height
21.6 mm	12.6 mm	21.6 mm	16.0 mm

Tissue Validation

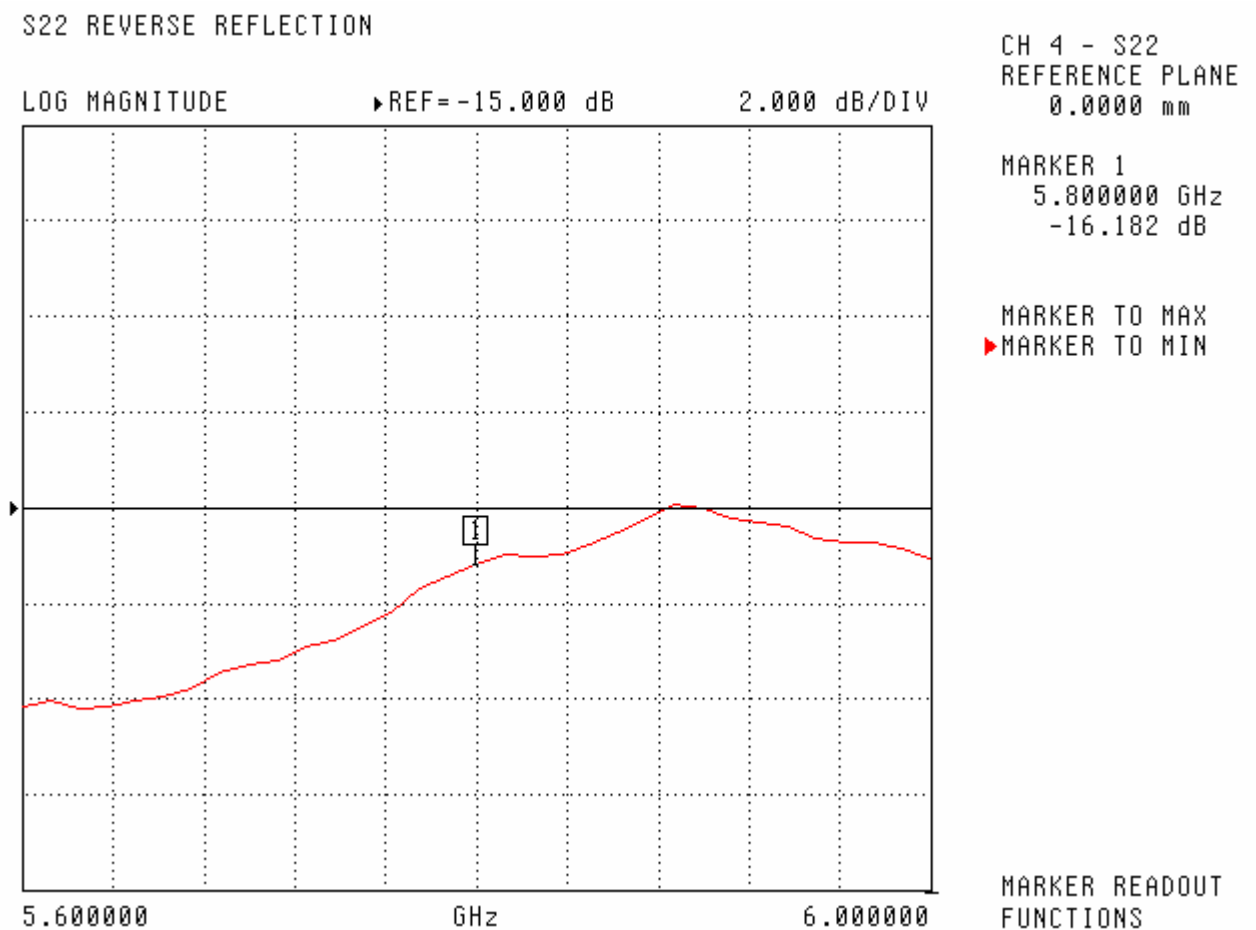
Head Tissue 5800 MHz	Measured
Dielectric constant, ϵ_r	45.0
Conductivity, σ [S/m]	6.32

Electrical Calibration

Test	Result
S11 R/L	-16.2 dB
SWR	1.37 U
Impedance	62.5 Ω

The Following Graphs are the results as displayed on the Vector Network Analyzer.

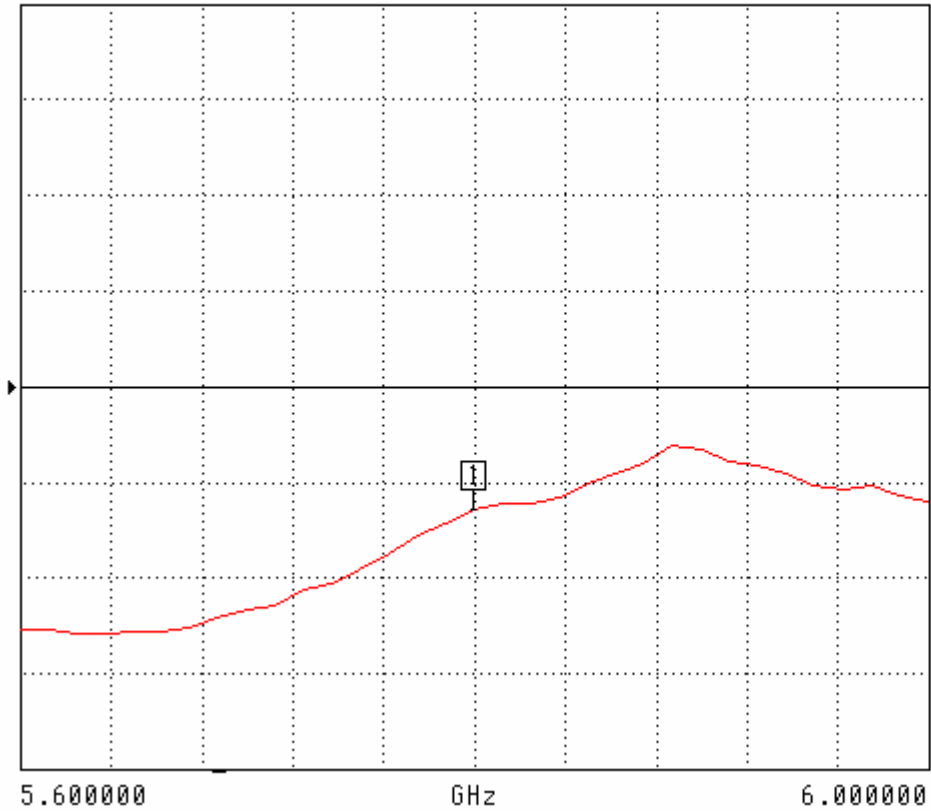
S11 Parameter Return Loss



SWR

S22 REVERSE REFLECTION

SWR ▶REF= 1.500 U 100.000 mU/DIV



CH 4 - S22
REFERENCE PLANE
0.0000 mm

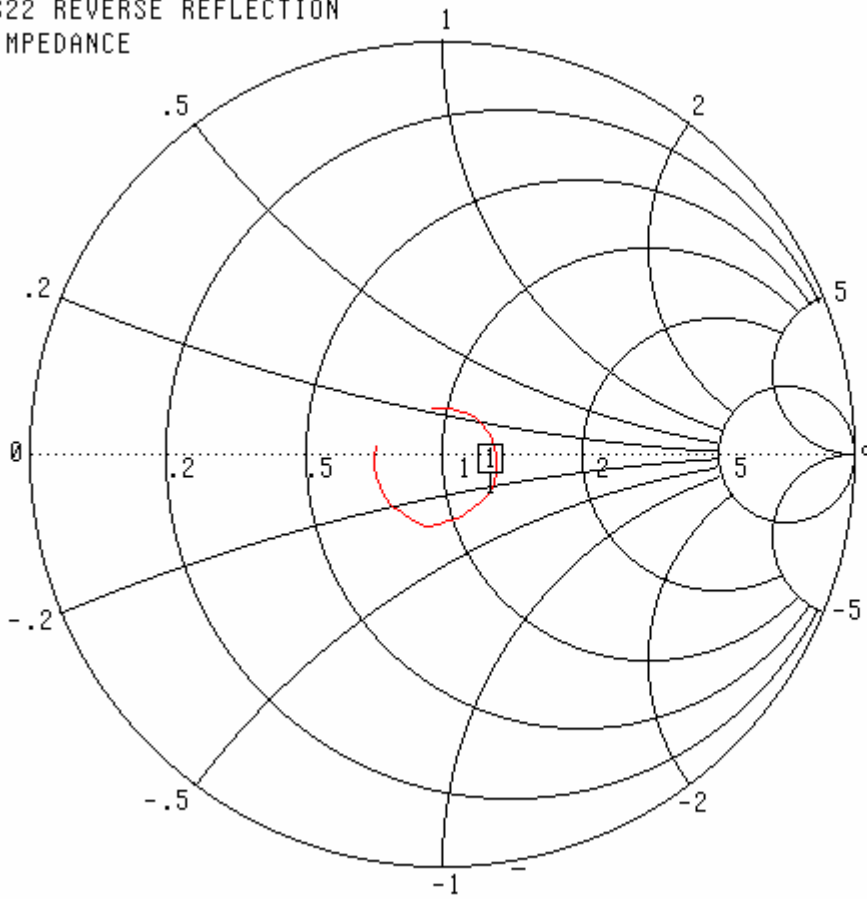
MARKER 1
5.800000 GHz
1.370 U

MARKER TO MAX
▶ MARKER TO MIN

MARKER READOUT
FUNCTIONS

Smith Chart Dipole Impedance

S22 REVERSE REFLECTION
IMPEDANCE



5.600000 - 6.000000 GHz

CH 4 - S22
REFERENCE PLANE
0.0000 mm

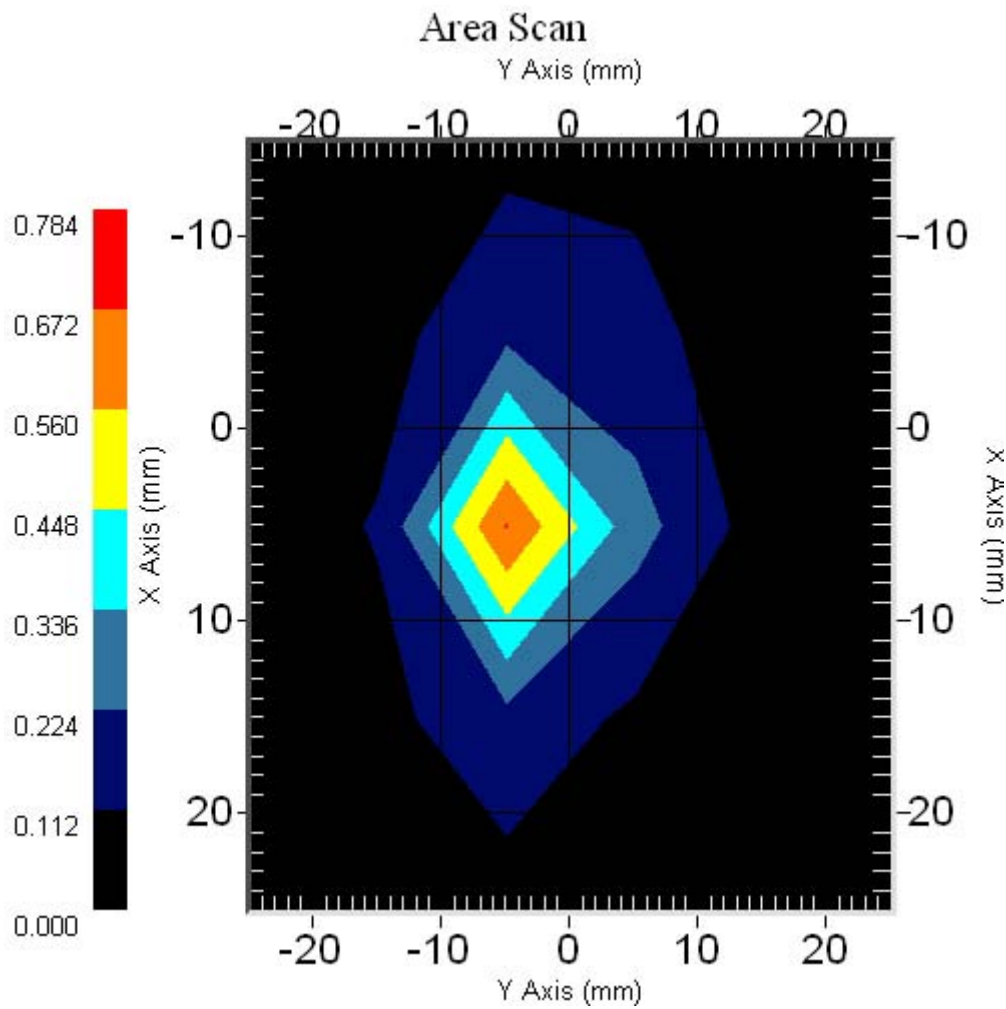
MARKER 1
5.800000 GHz
62.491 Ω
-12.202 $j\Omega$

MARKER TO MAX
▶ MARKER TO MIN

MARKER READOUT
FUNCTIONS

System Validation Results Using the Electrically Calibrated Dipole

Head Tissue Frequency	1 Gram	10 Gram	Peak Above Feed Point
5800 MHz	49.1	x	207.1



Test Equipment

The test equipment used during Probe Calibration, manufacturer, model number and, current calibration status are listed and located on the main APREL server R:\NCL\Calibration Equipment\Instrument List May 2007.

Regulatory WLAN Antenna Information

Spears Combo – Acon – 2007/07/02

Platform	Spears
Platform Owner	
Brand Name	Dell
Model Name	PP29L
ODM	Wistron
Target Launch Date	(2007/ 11/05)
Antenna	
Brand Name	ADVANCED-CONNECTEK INC.
Part Number	<input checked="" type="checkbox"/> Tx1 Antenna: AMP8P-700036
	<input checked="" type="checkbox"/> Tx2 Antenna: APP8P-700002
	<input type="checkbox"/> Tx3 (or Rx3) Antenna:
Module	
With WLAN Module	<input type="checkbox"/> WM3B2200BG
(Check Box)	<input type="checkbox"/> WM3B2915ABG
	<input checked="" type="checkbox"/> WM3945ABG
	<input checked="" type="checkbox"/> 4965AGN

Antenna Sample / Antenna Data Requirements for worldwide regulatory approval

Section	Description of Required OEM / ODM Antenna Information	US / IC	EU	Japan	Taiwan	S.Korea
1A	Part Number for Antenna only	Required	Required	Required	Required	Required
1B	Antenna Manufacturer Name	Required	Required	Required	Required	Required
1C	Description of Antenna Type	Required	N/A	N/A	N/A	N/A
1D	Part number of Antenna Assembly / cable impedance, length & diameter.	Required	Desired	Desired	Desired	Desired
1E	Tx1, Tx2 & Tx3 antenna (Peak Gain W/ cable loss) *	Required	Required	Required	Required	Required
	1E OR 1F, 1G, 1H					
1F	Tx1, Tx2 & Tx3 antenna (Peak Gain only) *	Required	Required	Required	Required	Required
1G	VSWR of cable including connector	Required	Required	Required	Required	Required
1H	Tx1, Tx2 & Tx3 antenna (Cable loss W/ connector) *	Required	Required	Required	Required	Required
2	Dimensioned Photographs and Drawings of Tx1, Tx2, and Tx3 (or Rx3) antennas	Required	Required	Required	Required	Required
3	Radiation patterns of antennas loaded in the host platform.	Required	Desired	Required	N/A	Required
4	Platform model name / number - correlated to antenna manufacturer and antenna part number	Required	Required	Desired	Required	Desired
5	Photograph(s) or Drawings showing location of antennas in platform. (S. Korea requires photographs of antennas for approval submission). Taiwan requires pictures of each antenna type shown in the system.	Required	Required	Desired	Required (Photos)	Required (Photos)
6	Mech. drawings / photos with dimensions of antenna locations and distance from end-user (For evaluation of SAR testing requirement).	Required	N/A	N/A	N/A	N/A
7	Photograph(s) or Drawings showing the location of all antennas (WLAN, other) and distance between those transmitting antennas. Information will be used to evaluate whether co-location testing is required.	Required	N/A	N/A	N/A	N/A
8	Local representative contact information for LMA/ PARS process.	Required	N/A	N/A	N/A	N/A

NOTE:

(*) if 3rd antenna is Rx only (e.g. receive only for 4965AGN) then peak gain and cable loss not required

Antenna Information

Section 1. Antenna Assembly Specifications

Antenna Assembly Summary:

1A Antenna Part Number	1B Manufacture	1C Antenna Type	1D Cable Assembly Part Number and Information	1E *Peak Gain W/ Cable loss (dBi)	1F Peak Gain w/o Cable Loss (dBi)	1G VSWR	1H Cable Loss (dBi)
(P/N: AMP8P-7 00036) Tx1 antenna	ADVANCED-C ONNECTEK INC.	PCB, Inverted-F Antenna (IFA)	Color: White OD: 1.37 mm Length: 726 mm Vendor: Kurabe/Hitachi/S umitomo Connector: IPEX 20531-111R-37	2400-2500MHz -0.50 dBi (peak)	2400-2500MHz 0.80 dBi (peak)	2400-2500MHz 2.0 max	2400-2500MHz 1.3 dB (peak)
				5150-5350MHz -0.40 dBi (peak)	5150-5350MHz 1.90 dBi (peak)	5150-5350MHz 2.0 max	5150-5350MHz 2.3 dB (peak)
				5470-5725MHz -1.30 dBi (peak)	5470-5725MHz 1.00 dBi (peak)	5470-5725MHz 2.0 max	5470-5725MHz 2.3 dB (peak)
				5725-5850MHz -0.40 dBi (peak)	5725-5850MHz 1.90 dBi (peak)	5725-5850MHz 2.0 max	5725-5850MHz 2.3 dB (peak)
(P/N: APP8P-70 0002) Tx2 antenna	ADVANCED-C ONNECTEK INC.	PCB, Inverted-F Antenna (IFA)	Color: Black OD: 1.37 mm Length: 398 mm Vendor: Kurabe/Hitachi/S umitomo Connector: IPEX 20531-111R-37	2400-2500MHz 2.00 dBi (peak)	2400-2500MHz 3.20 dBi (peak)	2400-2500MHz 2.0 max	2400-2500MHz 1.2 dB (peak)
				5150-5350MHz -1.00 dBi (peak)	5150-5350MHz 1.00 dBi (peak)	5150-5350MHz 2.0 max	5150-5350MHz 2.0 dB (peak)
				5470-5725MHz -0.50 dBi (peak)	5470-5725MHz 1.50 dBi (peak)	5470-5725MHz 2.0 max	5470-5725MHz 2.0 dB (peak)
				5725-5850MHz -1.10 dBi (peak)	5725-5850MHz 1.90 dBi (peak)	5725-5850MHz 2.0 max	5725-5850MHz 2.0 dB (peak)

NOTE:

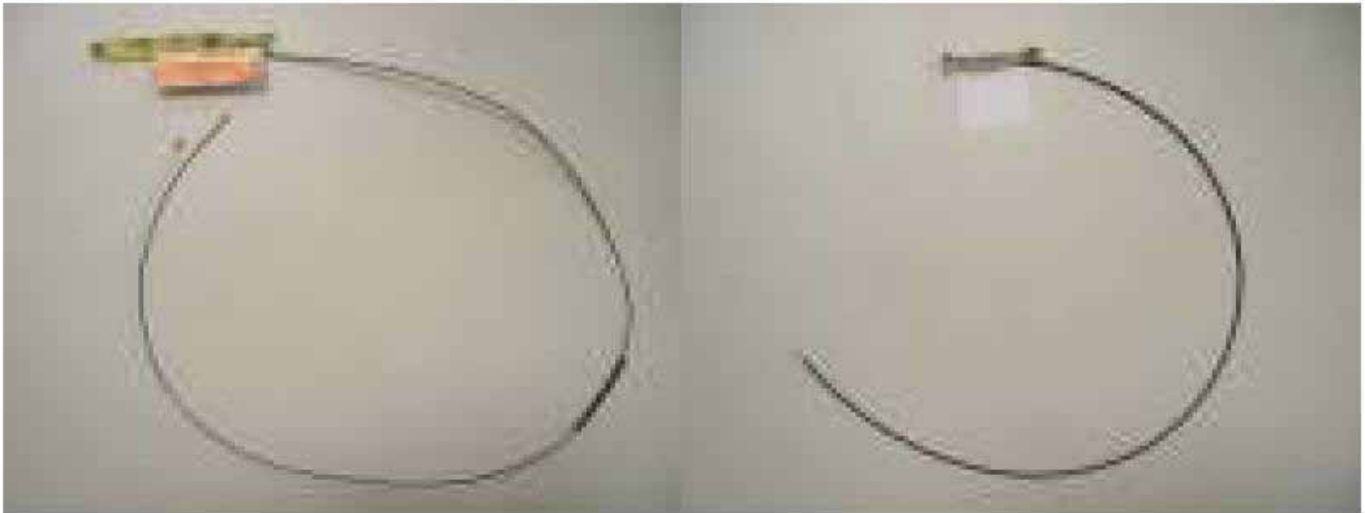
(*) If Rx3 only (3rd antenna receives only, e.g. for 4965AGN) then the information marked with * is not required

Antenna Peak Gain Table:

Frequency (MHz)	Tx1 antenna		Tx2 Antenna		Tx3 (or Rx3) Antenna	
	Horizontal (dBi)	Vertical (dBi)	Horizontal (dBi)	Vertical (dBi)	Horizontal (dBi)	Vertical (dBi)
2412	-1.70	-2.60	0.60	2.00	-	-
2437	-1.00	-2.00	0.40	2.00	-	-
2462	-0.50	-1.70	-0.40	1.30	-	-
4900	-0.40	-1.10	-3.40	-3.80	-	-
5150	-4.70	-1.80	-2.50	-3.70	-	-
5350	-2.90	-1.50	-1.00	-3.40	-	-
5470	-2.90	-4.50	-0.50	-3.00	-	-
5725	-1.30	-2.00	-1.30	-1.20	-	-
5875	-0.40	-2.80	-1.10	-1.40	-	-

- Antenna Peak Gain required being test in system basis.
- 1E frame contend absolutely peak antenna gain include H/V
- If Rx3 only (3rd antenna receives only, e.g. for 4965AGN) then the information is not required for Rx3.

Tx1 Antenna Photo:



Main Antenna

Aux Antenna

Include a dimensioned photo and dimensioned drawing of Tx2 antenna here.

Tx2 Antenna Dimensioned Drawing:

See TX1 Drawing

Tx2 Antenna Photo:

See TX1 Photo

Include a dimensioned photo and dimensioned drawing of Tx3 (or Rx3) antenna here.

Tx3 (or Rx3) Antenna Dimensioned Drawing:

n/a

Tx3 (or Rx3) Antenna Photo:

n/a

Section 3. Radiation characteristics of antennae Loaded in Host Platform

2400-2500MHz radiation characteristic

Tx1 antenna:

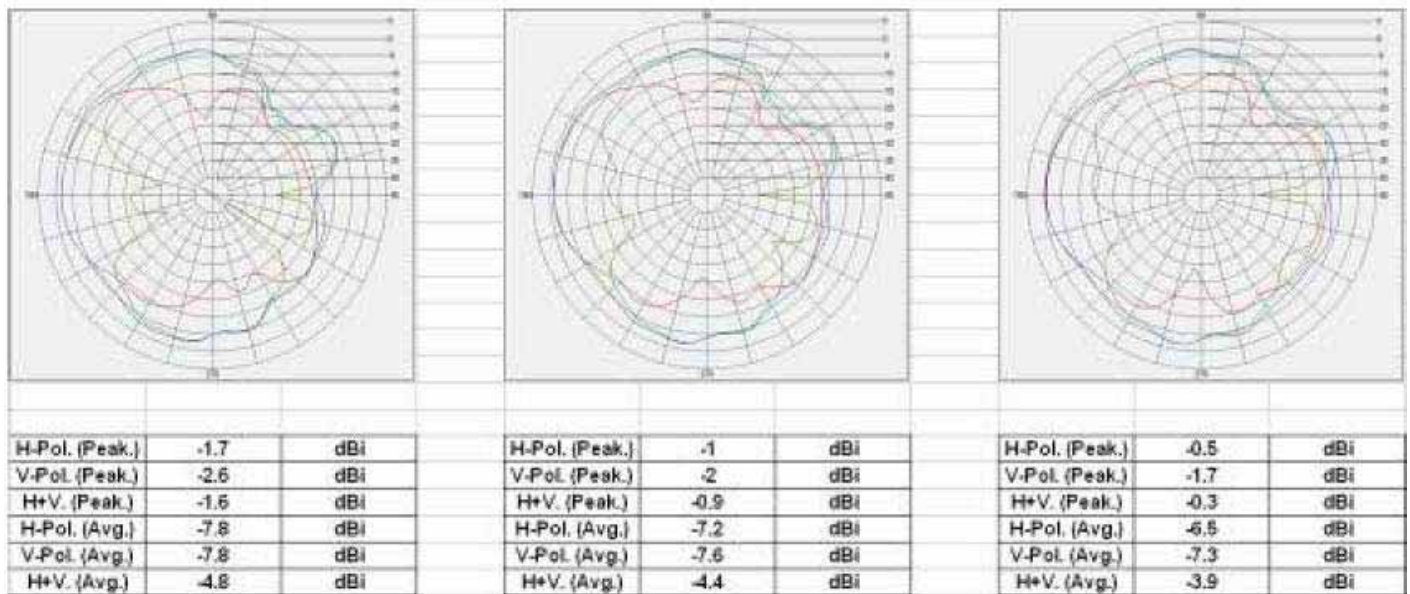
- Main Antenna



Fre. = 2412 MHz

Fre. = 2437 MHz

Fre. = 2462 MHz

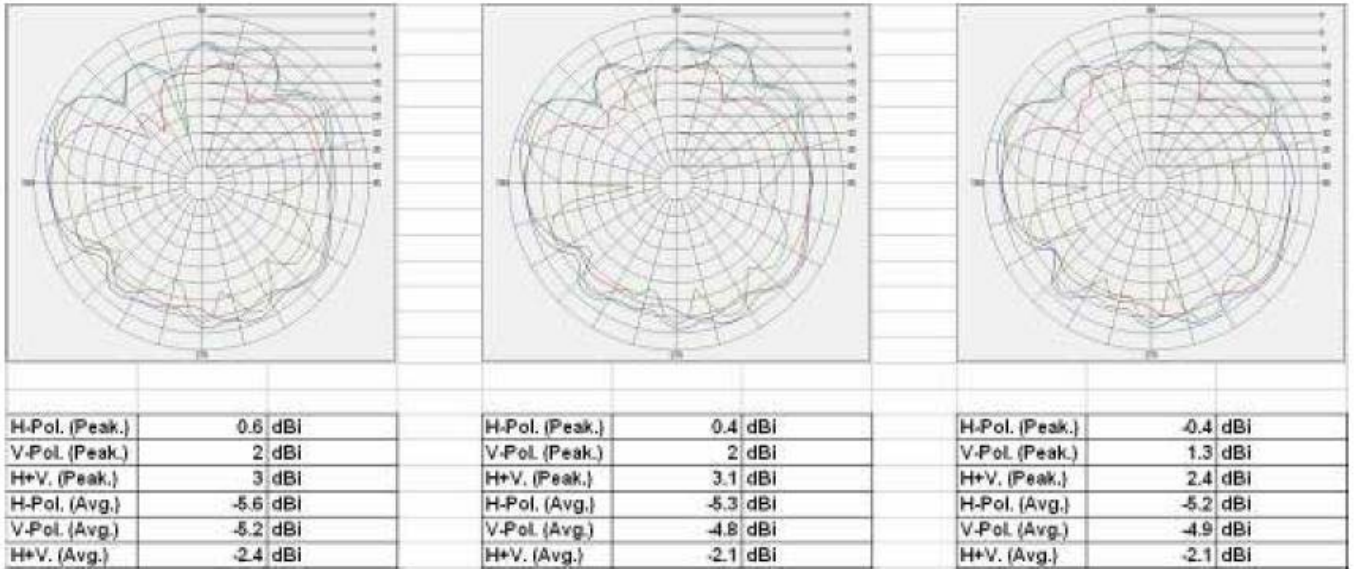


Tx2 antenna:

Fre. = 2412 MHz

Fre. = 2437 MHz

Fre. = 2462 MHz



Tx3 (or Rx3) antenna:

n/a

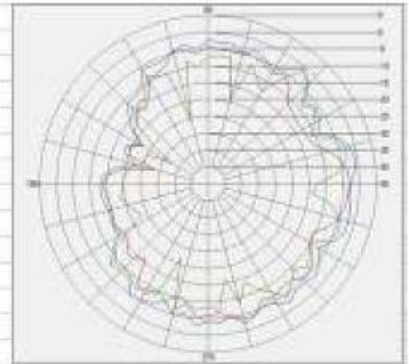
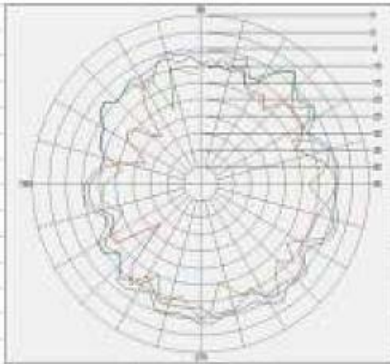
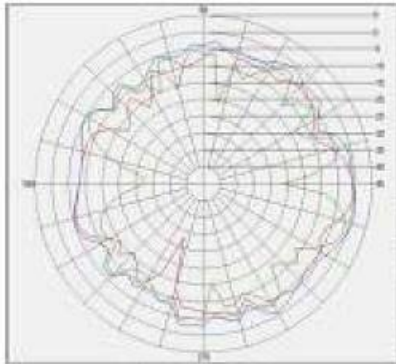
4900-5875 MHz radiation characteristic

Tx1 antenna:

Fre. = 4900 MHz

Fre. = 5150 MHz

Fre. = 5350 MHz



H-Pol. (Peak.)	-0.4 dBi
V-Pol. (Peak.)	-1.1 dBi
H+V. (Peak.)	0.8 dBi
H-Pol. (Avg.)	-6.5 dBi
V-Pol. (Avg.)	-7.6 dBi
H+V. (Avg.)	-4 dBi

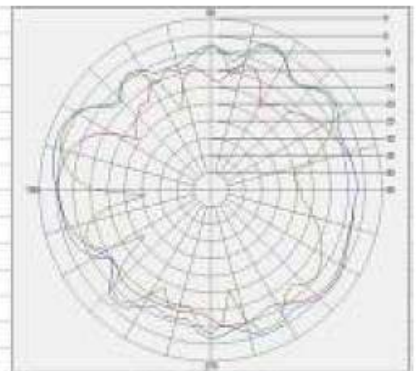
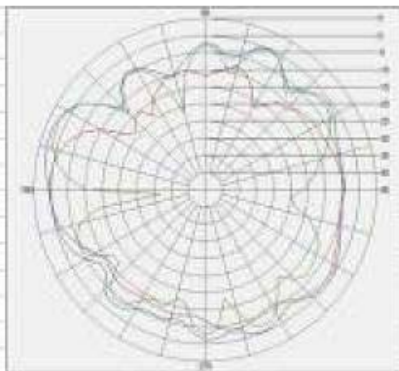
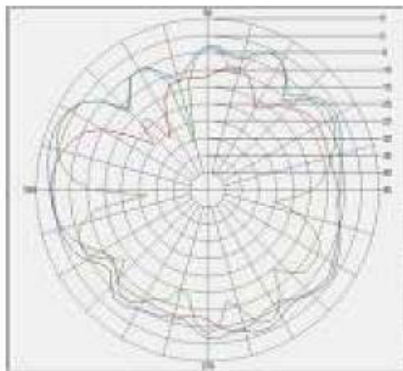
H-Pol. (Peak.)	-4.7 dBi
V-Pol. (Peak.)	-1.8 dBi
H+V. (Peak.)	-1.7 dBi
H-Pol. (Avg.)	-9.6 dBi
V-Pol. (Avg.)	-9 dBi
H+V. (Avg.)	-6.3 dBi

H-Pol. (Peak.)	-2.9 dBi
V-Pol. (Peak.)	-1.5 dBi
H+V. (Peak.)	-0.5 dBi
H-Pol. (Avg.)	-7.7 dBi
V-Pol. (Avg.)	-8.5 dBi
H+V. (Avg.)	-5.1 dBi

Fre. = 2412 MHz

Fre. = 2437 MHz

Fre. = 2462 MHz



H-Pol. (Peak.)	0.8 dBi
V-Pol. (Peak.)	2 dBi
H+V. (Peak.)	3 dBi
H-Pol. (Avg.)	-5.6 dBi
V-Pol. (Avg.)	-5.2 dBi
H+V. (Avg.)	-2.4 dBi

H-Pol. (Peak.)	0.4 dBi
V-Pol. (Peak.)	2 dBi
H+V. (Peak.)	3.1 dBi
H-Pol. (Avg.)	-5.3 dBi
V-Pol. (Avg.)	-4.8 dBi
H+V. (Avg.)	-2.1 dBi

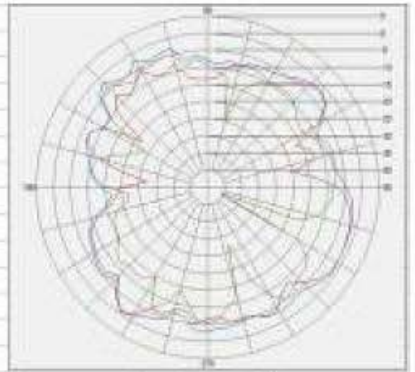
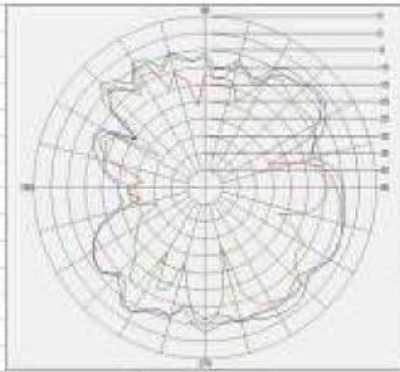
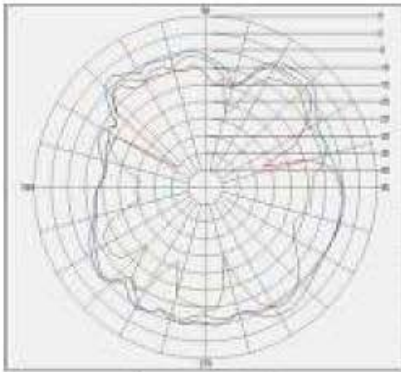
H-Pol. (Peak.)	-0.4 dBi
V-Pol. (Peak.)	1.3 dBi
H+V. (Peak.)	2.4 dBi
H-Pol. (Avg.)	-5.2 dBi
V-Pol. (Avg.)	-4.9 dBi
H+V. (Avg.)	-2.1 dBi

Tx2 antenna:

Fre. = 4900 MHz

Fre. = 5150 MHz

Fre. = 5350 MHz



H-Pol. (Peak.)	-3.4	dBi
V-Pol. (Peak.)	-3.8	dBi
H+V. (Peak.)	-1.3	dBi
H-Pol. (Avg.)	-7.4	dBi
V-Pol. (Avg.)	-10	dBi
H+V. (Avg.)	-5.5	dBi

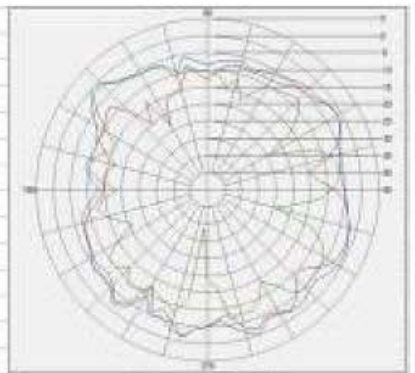
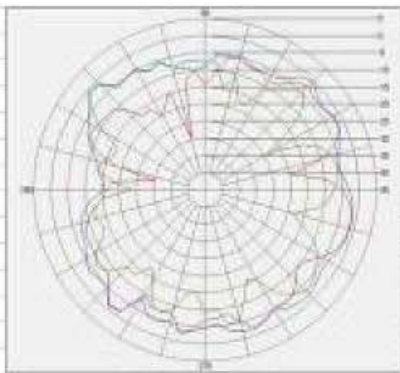
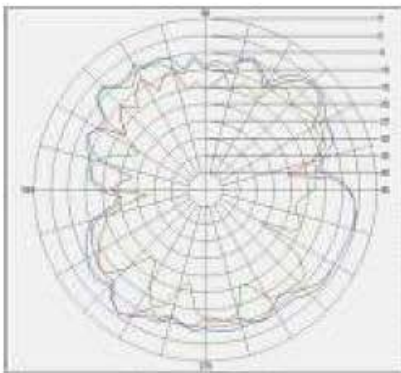
H-Pol. (Peak.)	-2.5	dBi
V-Pol. (Peak.)	-3.7	dBi
H+V. (Peak.)	-1.6	dBi
H-Pol. (Avg.)	-7	dBi
V-Pol. (Avg.)	-10	dBi
H+V. (Avg.)	-5.3	dBi

H-Pol. (Peak.)	-1	dBi
V-Pol. (Peak.)	-3.4	dBi
H+V. (Peak.)	-0.7	dBi
H-Pol. (Avg.)	-6.3	dBi
V-Pol. (Avg.)	-9.4	dBi
H+V. (Avg.)	-4.5	dBi

Fre. = 5470 MHz

Fre. = 5725 MHz

Fre. = 5875 MHz



H-Pol. (Peak.)	-0.5	dBi
V-Pol. (Peak.)	3	dBi
H+V. (Peak.)	-0.5	dBi
H-Pol. (Avg.)	-5.7	dBi
V-Pol. (Avg.)	-9.3	dBi
H+V. (Avg.)	-4.1	dBi

H-Pol. (Peak.)	-1.3	dBi
V-Pol. (Peak.)	-1.2	dBi
H+V. (Peak.)	-0.4	dBi
H-Pol. (Avg.)	-6.1	dBi
V-Pol. (Avg.)	-8.2	dBi
H+V. (Avg.)	-4	dBi

H-Pol. (Peak.)	-1.1	dBi
V-Pol. (Peak.)	-1.4	dBi
H+V. (Peak.)	-0.7	dBi
H-Pol. (Avg.)	-6.1	dBi
V-Pol. (Avg.)	-8.8	dBi
H+V. (Avg.)	-4.2	dBi

Tx3 (or Rx3) antenna:

n/a

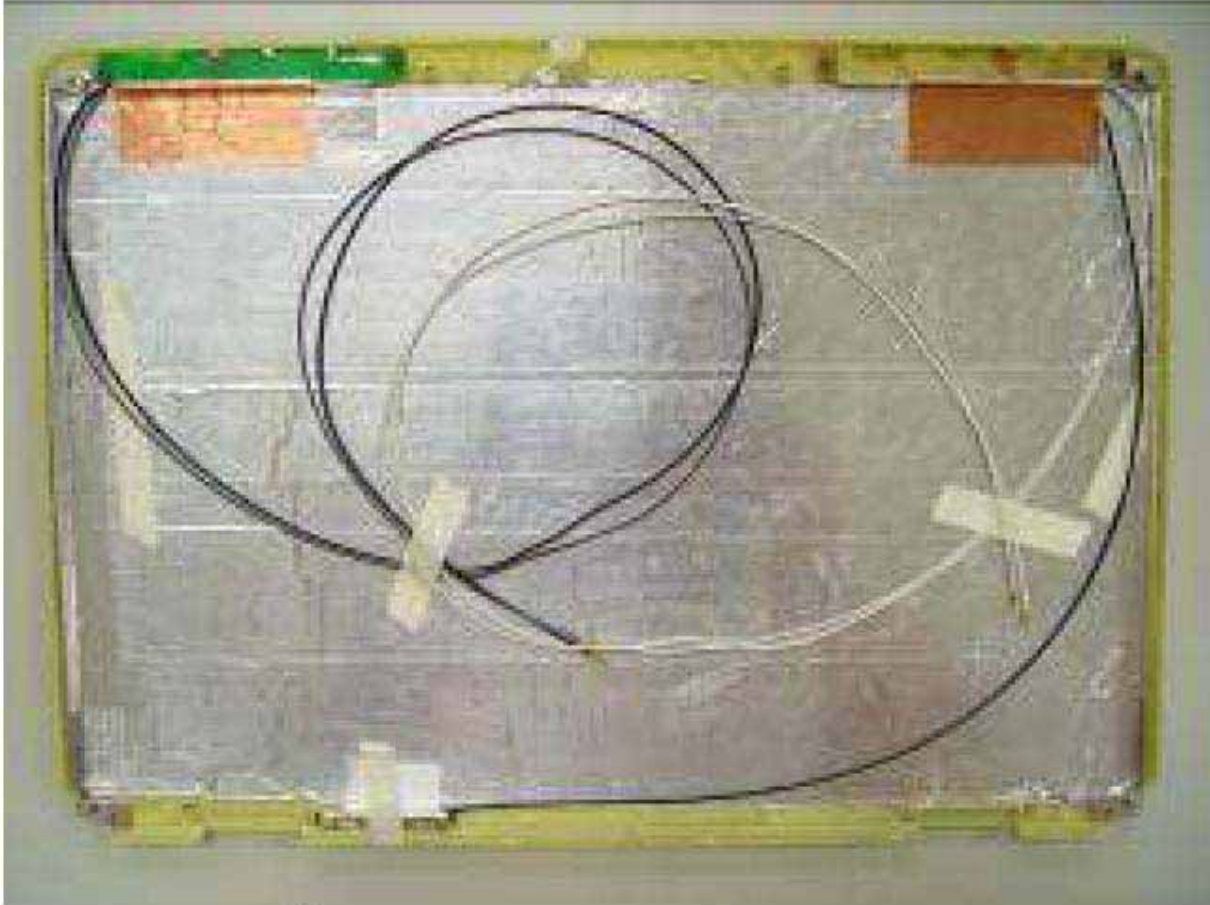
Section 4. Host Platform Information

OEM / ODM Host platform: (XXXXXXX) platform correlated to antenna data
Rating Label Photo:

Section 5. Antenna Host Platform Location Information

Include a **dimensioned photo or dimensioned drawing** of Tx1, Tx2 and Tx3 antenna placements. (Not applicable for receive-only antenna e.g. Rx3 for 4965AGN)

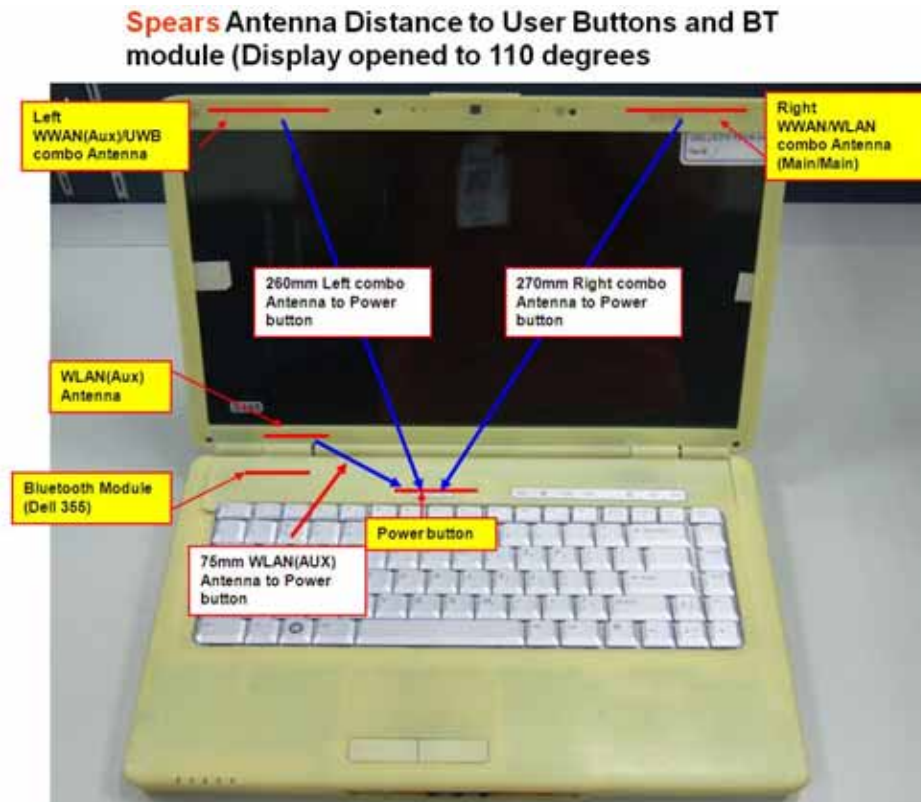
Main Antenna



Aux Antenna

Section 6. Antenna dimensional information for SAR evaluation

Include a **dimensioned photo or dimensioned drawing** showing the distance (mm) between the transmit antennas and the user (excluding hands, wrist, feet, lap/ thigh, and ankle)



Section 7. Diagram Example of Co-Location Antenna Separation

Include a **dimensioned photo or dimensioned drawing** showing the distance (mm) between **all WLAN transmit antennas** and other co-located radiator transmit antenna such as Bluetooth, WWAN,..

(Note: Due to the evolving rules regarding co-location, each platform will need to be reviewed on a case by case basis)

See section 6.

Section 8. Local representative contact information

Local representative contact information is required for regulatory support for target countries below.

	Local company name	Contact name	Phone number	FAX Number	e-Mail Address	Notes
Argentina	DELL COMPUTER DE CHILE	Hermann Obermoller	(562) 685 6803	(562) 232-4290	Hermann_Obermoller@dell.com	
Brazil		Rodrigo Sagredo	+55 (019) 252-8170		rodrigossagredo@mpc.com.br	
Indonesia	Dell Asia Pacific Sdn.	Catherine Mulia			Indonesia Representative Office Wisma GKBI 39 Floor, Suite 3901 Jl. Jend. Sudirman No. 28 Jakarta 10210, Indonesia.	
Israel	Dell	Raanan Biber	+972-(0)3-767 4001	+972-(0)3-644 4106	raanan_biber@dell.com	
Malaysia	Dell Asia Pacific Sdn.	Lily Wong	6-04-504-4670	6-04-633-8670	Lily_Wong@dell.com	
Mexico	DELL Computer	Maria Garcia	011-5255-5081-8849		Maria_Garcia@dell.com	
Singapore	Dell Computer Asia Pte Ltd	Doreen Koh	65-335-3282		Doreen_Koh@dell.com	Telecommunication Equipment Dealer License Required
South Africa	Dell South Africa	Leigh Hancock	+44 1344 372 647		Leigh_Hancock@dell.com	
USA, Canada	DELL CANADA INC.	KRISTIAN KOT	416-773-5095		Kristian_kot@dell.com	