Bluetooth Over The Air Performance Test Report for Seaboard RISE 25 by Roli

Report Reference:	MDE_ROLI_1601_BT_1_RP
Date:	09.09.2016
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Content:

1 References and Standards Used

[1] CTIA: "Test Plan for Wireless Device Over the Air Performance", Revision Number 3.5.2, 09/2015.

[2] 3GPP TS 25.101: "User Equipment (UE) radio transmission and reception (FDD)", (Release 11), Version V11.2.0, June 2012.

[3] 7 layers document: "Test Procedure for Over the Air Performance Estimation Applied by the OTA Test Lab at 7 layers Ratingen", Version January 2009.

2 Project and Result Summary

DUT	Roli Seaboard RISE 25	SN	R25111112313
Test lab	7 layers GmbH Borsigstr. 11 40880 Ratingen Germany	Set up	free space
		Test start	08.09.2016
Customer	ROLI Limited 2 Globe Road London E8 4BD	Report date	09.09.2016
		Report by	Dieter Sütthoff
		Approved by	Dieter Sütthoff

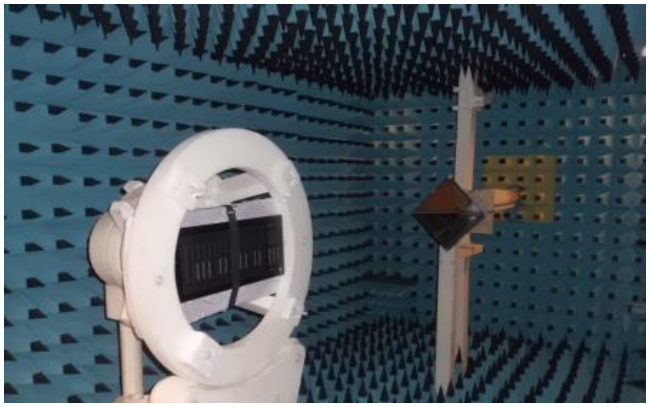


Fig. 1: Photo of DUT.

3 Brief Description of Settings and Test Method

3.1 Test Procedure TRP Bluetooth

The method of measurement for radiated RF power performance are based on the principals of the test standard CTIA: "Test Plan for Mobile Station Over the Air Performance" [1].

In general the following approach is applied for TRP measurements:

- For TRP measurement put OUT in a mode where it transmitting periodical RF energy.
- Rotate the OUT in all room directions with a angle grid of 15°.
- Gather power data for both, vertical and horizontal polarization.
- Calculate total radiated power by integrating over the whole sphere as outlined in [1].

The test setup was placed at the turning device inside a fully anechoic chamber. The object under test (OUT) was set to transmit permanently signal on specific frequencies
The total radiated power (TRP) of the test setup on low mid and high channel of the Bluetooth band was measured in all angle direction (3D) using a step width of 15° and using two measurement antenna polarizations (vertical and horizontal).

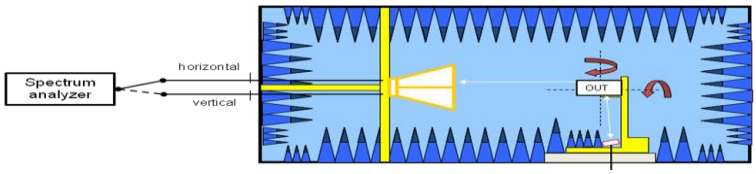
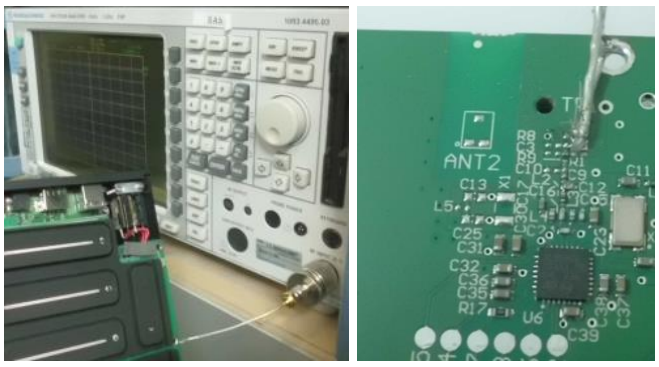


Fig. 1: Block diagram for TRP measurement

3.2 Test conducted power Bluetooth



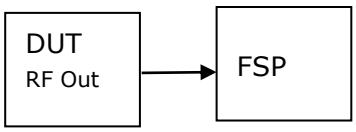
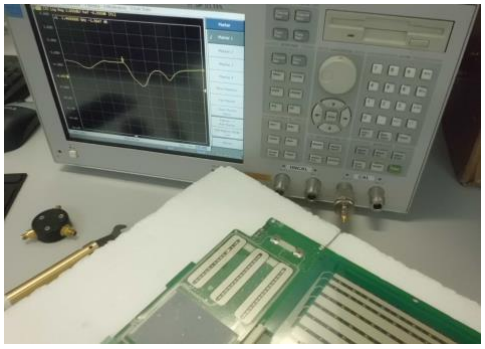


Fig. 2: Test set up and block diagram peak antenna port input

3.3 Test S11 matching of Bluetooth antenna



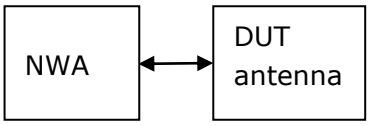


Fig. 3: Test set up and block diagram peak antenna port input

3.4 Definitions:

3GPP	3rd Generation Partnership Project
CTIA	Cellular Telecommunications & Internet Association
DUT	Device under test
FS	Free space
TRP	Total Radiated Power
EIRP	Effective Isotropic Radiated Power
FSP	FSP3 spectrum analyzer by R&S for 2.4 GHz
NWA	Network Analyzer

3.5 Equipment List

For TRP measurements:

Antenna:	Dual polarized horn ETS3164-03 by ETS	SN 00052619
Receiver:	FSP3 spectrum analyzer by R&S for 2.4 GHz	SN 838164/004
NWA:	E5071B by Agilent	SN: MY42200813

4 Test Results and Pattern

4.1 Results Bluetooth TRP and Conducted peak antenna port input power

Roli Seaboard RISE 25			
Tested Frequincy (MHz)	2402	2440	2480
Ant. Port Input Pwr. (dBm)	-1.7	-1.7	-3.2
Tot. Rad. Pwr. (dBm)	**-18.4**	**-19.1**	**-18.7**
Peak EIRP (dBm)	-10.1	-12.6	-12.1
Directivity (dBi)	8.2	6.4	6.6
Efficiency (dB)	-16.7	-17.4	-15.5
Efficiency (%)	2.1	1.8	2.8
Gain (dBi)	-8.5	-10.9	-8.9

Tab. 1: Test result summary Bluetooth

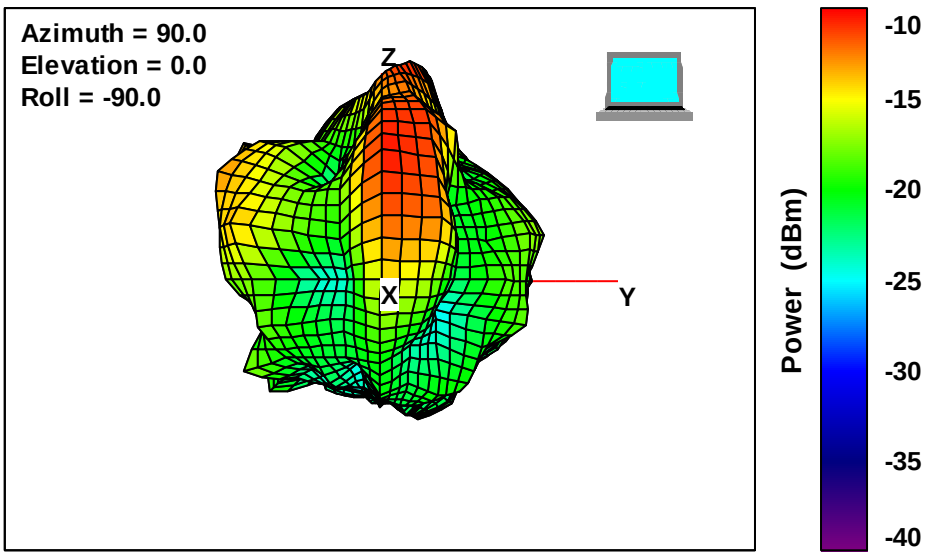
Orientation of EUT compared to a standard device

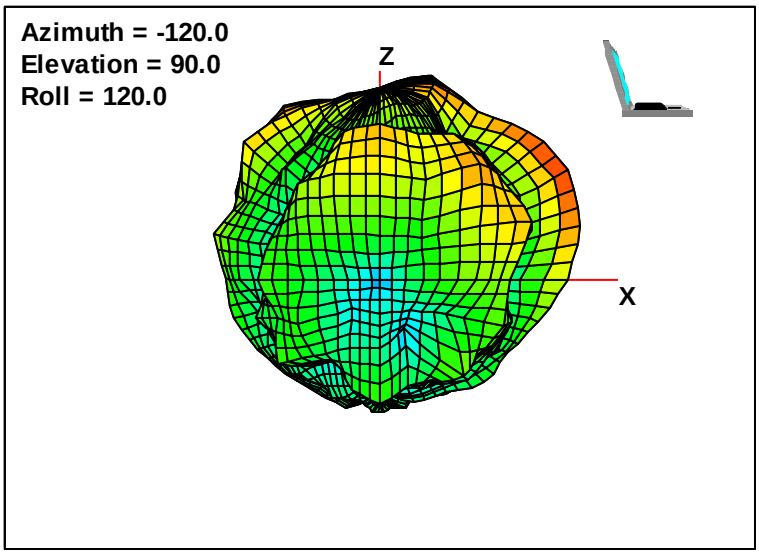
For orientation of the EUT in the result pictures below the following photos illustrate the used orientation compared to a standard device:

Fig. 2: Photo orientation of DUT compared to a Laptop.

4.2 TRP settings and Antenna Pattern BLUETOOTH 2402 MHz

```
-------------------------------------------------------------------------------
Site:            7 layers, Ratingen, Germany
Set up:          free space
-------------------------------------------------------------------------------
Mode:            Bluetooth Transmitter Test Freq. 2402 MHz_
                 Packet length: 37 bytes
                 Psuedorandom bit sequence 9
-------------------------------------------------------------------------------
Distance:        2.05 m
Chamber antenna: ETS 3164-03
Antenna cal.:    c:\afar\cal\ETS.cal
Cable att.:      c:\afar\cal\FSP.cal
Polarization:    both
Table speed:     3
Turn table:      from 0° to 345°, step 15° ("0"=0°)
Tilt device:     from 0° to 165°, step 15° ("0"=0°)
DUT height:      1.44 m
-------------------------------------------------------------------------------
Resolution band: 1000 kHz
Video band:      10000 kHz
Sweep time:      10 ms
Detector:        Positive Prak Detector
-------------------------------------------------------------------------------
Equipment:
Receiver:        GPIB=30: FSP
Turn table:      GPIB= 7: CO 2000
Tilt device:     GPIB= 7: CO 2000
RSU:             GPIB= 4: KRE-3078
-------------------------------------------------------------------------------
Pattern:
```

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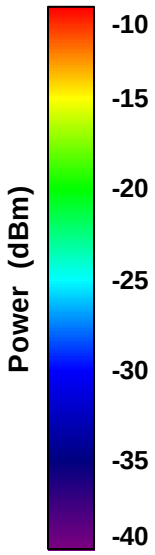
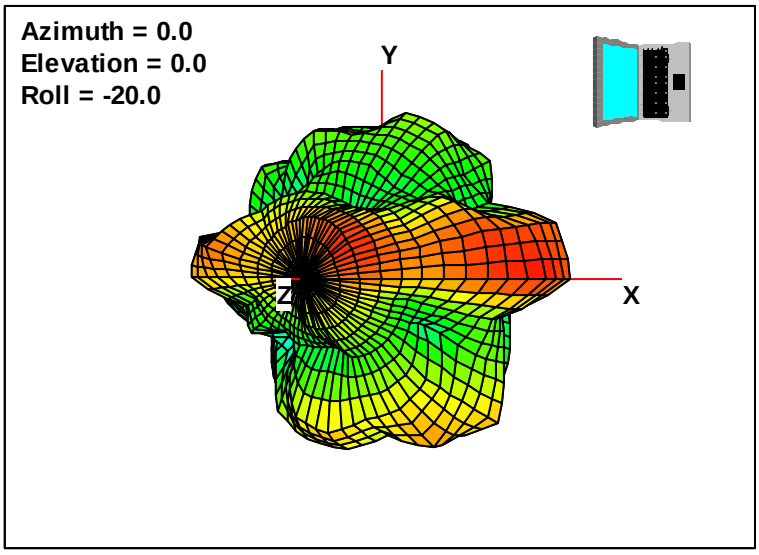
X


Power (dBm)
-10
-15
-20
-25
-30
-35
-40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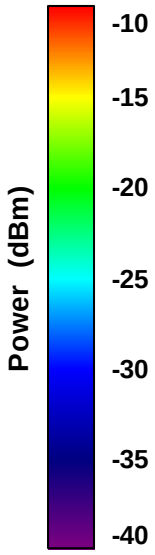
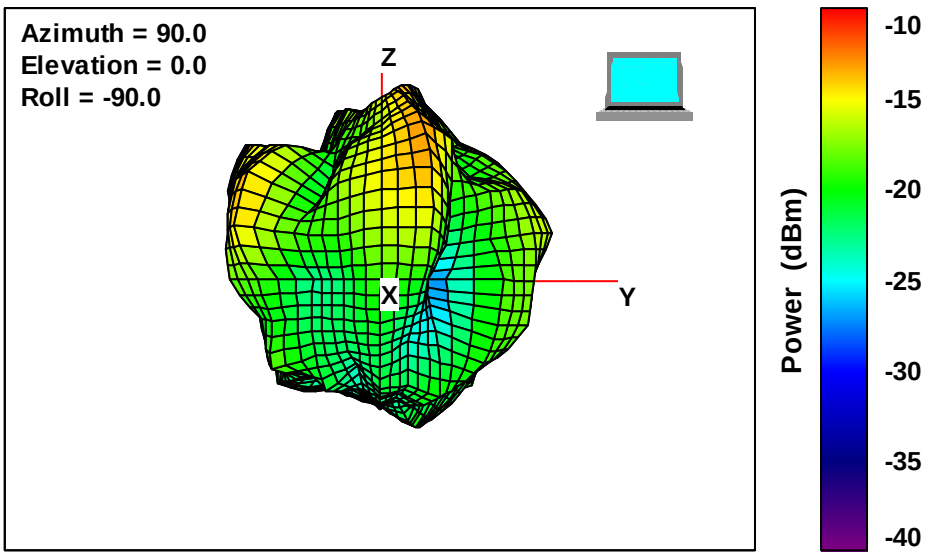
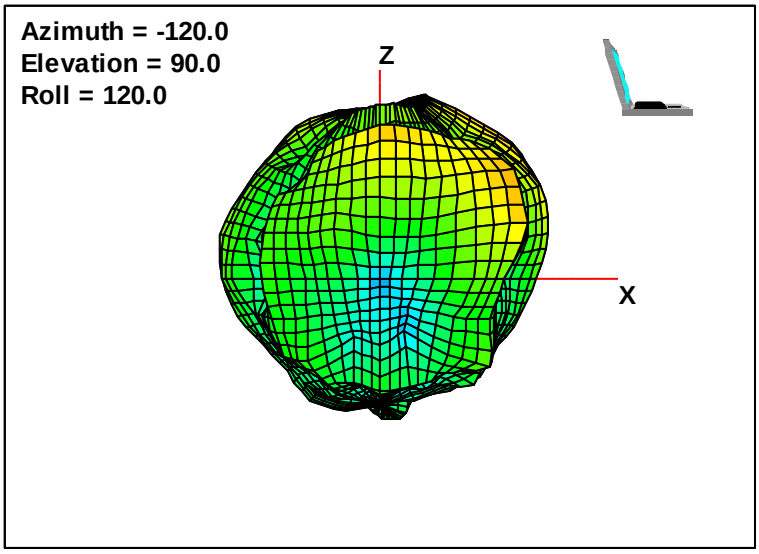

Power (dBm)
-10
-15
-20
-25
-30
-35
-40

4.3 TRP settings and Antenna Pattern BLUETOOTH 2440 MHz

```
---------------------------------------------------------------------------
Site:            7 layers, Ratingen, Germany
Set up:          free space
---------------------------------------------------------------------------
Mode:            Bluetooth Transmitter Test Freq. 2440 MHz_
                 Packet length: 37 bytes
                 Psuedorandom bit sequence 9
---------------------------------------------------------------------------
Distance:        2.05 m
Chamber antenna: ETS 3164-03
Antenna cal.:    c:\afar\cal\ETS.cal
Cable att.:      c:\afar\cal\FSP.cal
Polarization:    both
Table speed:     3
Turn table:      from 0° to 345°, step 15° ("0"=0°)
Tilt device:     from 0° to 165°, step 15° ("0"=0°)
DUT height:      1.44 m
---------------------------------------------------------------------------
Resolution band: 1000 kHz
Video band:      10000 kHz
Sweep time:      10 ms
Detector:        Positive Prak Detector
---------------------------------------------------------------------------
Equipment:
Receiver:        GPIB=30: FSP
Turn table:      GPIB= 7: CO 2000
Tilt device:     GPIB= 7: CO 2000
RSU:             GPIB= 4: KRE-3078
---------------------------------------------------------------------------
Pattern:
```

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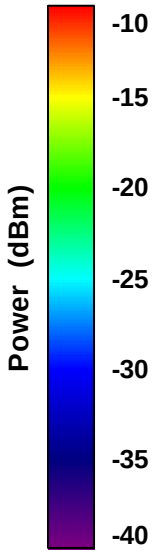
Power (dBm)
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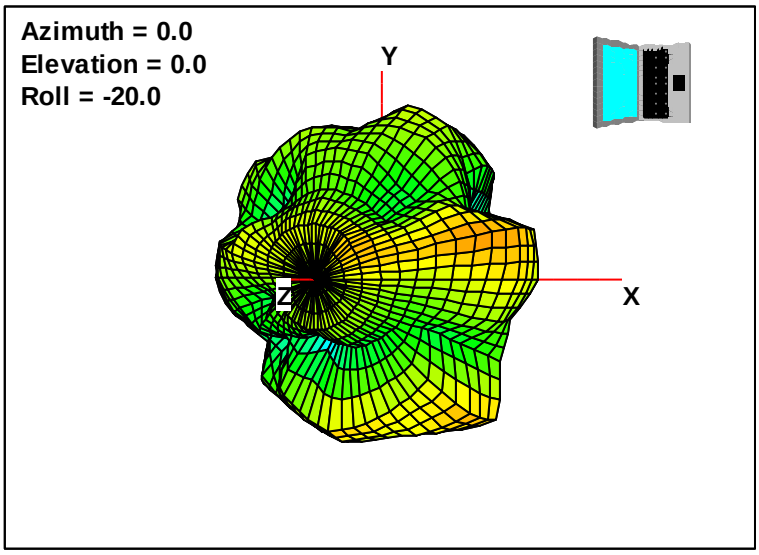
-15
-20
-25
-30
-35
-40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Z
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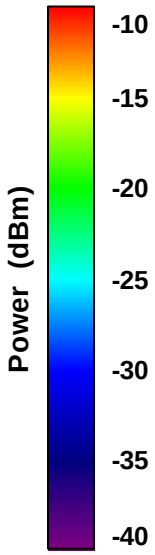
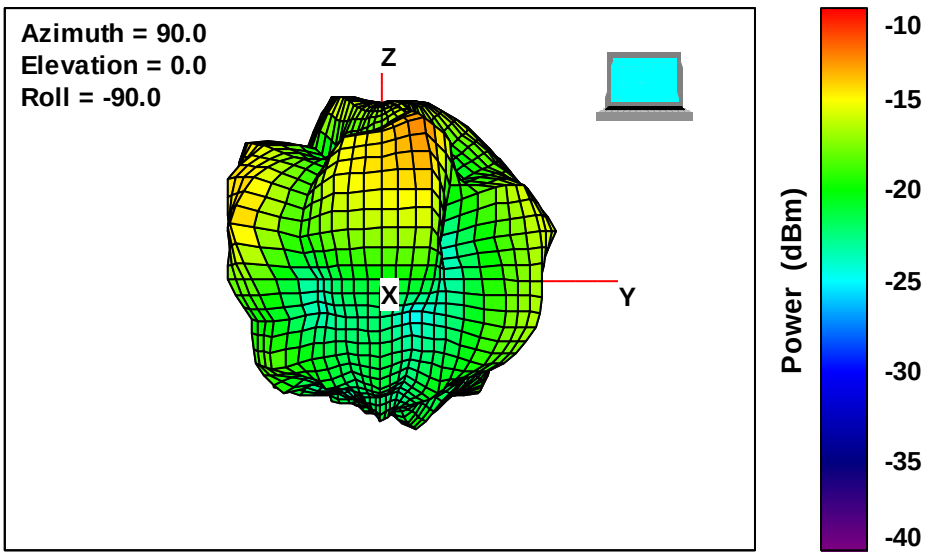
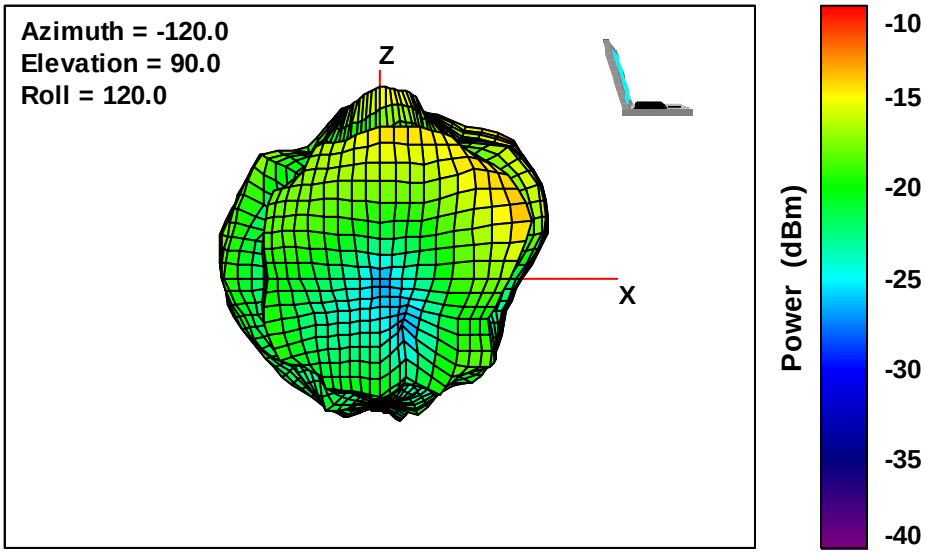

Power (dBm)
-10
-15
-20
-25
-30
-35
-40

4.4 TRP settings and Antenna Pattern BLUETOOTH 2480 MHz

```
---------------------------------------------------------------------------
Site:            7 layers, Ratingen, Germany
Set up:          free space
---------------------------------------------------------------------------
Mode:            Bluetooth Transmitter Test Freq. 2480 MHz_
                 Packet length: 37 bytes
                 Psuedorandom bit sequence 9
---------------------------------------------------------------------------
Distance:        2.05 m
Chamber antenna: ETS 3164-03
Antenna cal.:    c:\afar\cal\ETS.cal
Cable att.:      c:\afar\cal\FSP.cal
Polarization:    both
Table speed:     3
Turn table:      from 0° to 345°, step 15° ("0"=0°)
Tilt device:     from 0° to 165°, step 15° ("0"=0°)
DUT height:      1.44 m
---------------------------------------------------------------------------
Resolution band: 1000 kHz
Video band:      10000 kHz
Sweep time:      10 ms
Detector:        Positive Prak Detector
---------------------------------------------------------------------------
Equipment:
Receiver:        GPIB=30: FSP
Turn table:      GPIB= 7: CO 2000
Tilt device:     GPIB= 7: CO 2000
RSU:             GPIB= 4: KRE-3078
---------------------------------------------------------------------------
Pattern:
```

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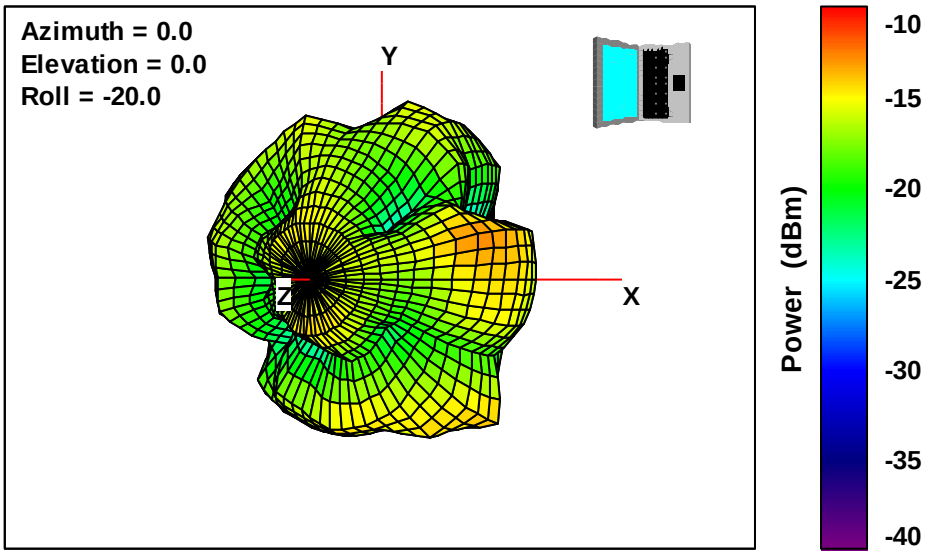
Roll = 120.0
Z
X
Power (dBm)
-10
-15
-20
-25
-30
-35
-40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Roll = -20.0
Y
Z
X
Power (dBm)
-10
-15
-20
-25
-30
-35
-40

4.5 Matching results

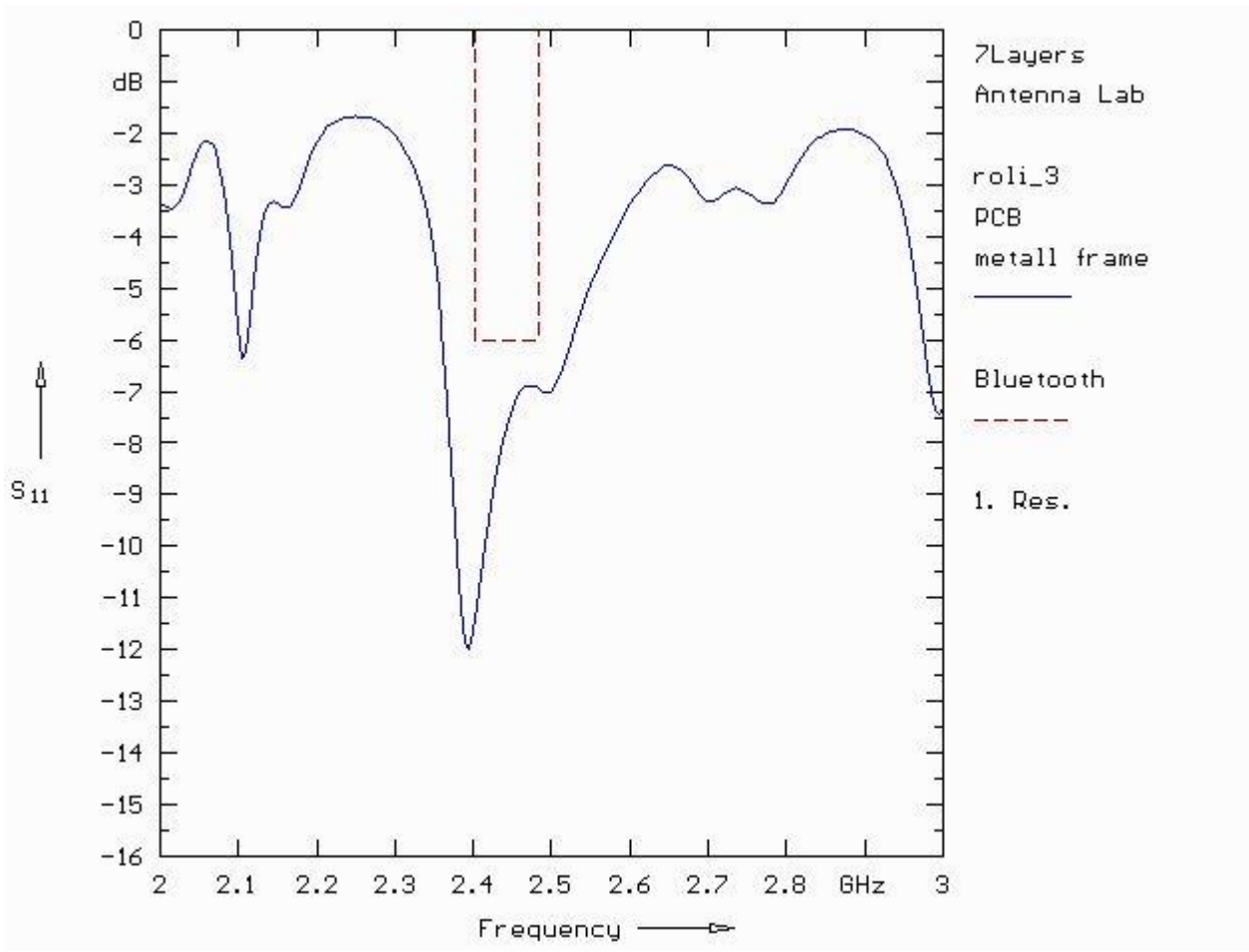
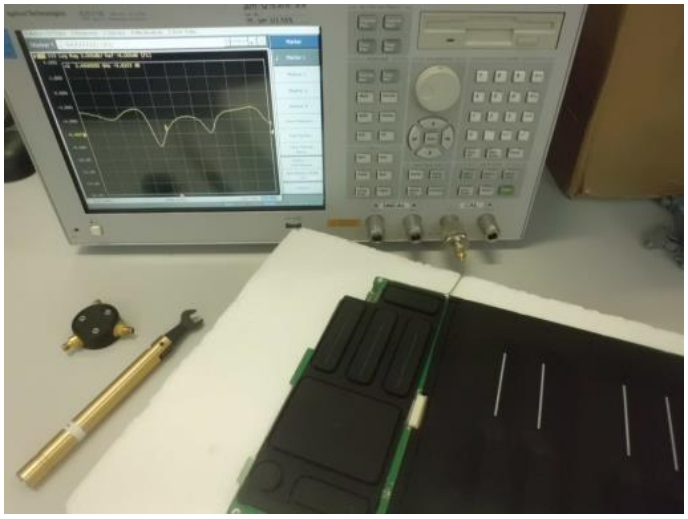


Fig. 3: Matching test result, free space situation, with metal frame and keypad.



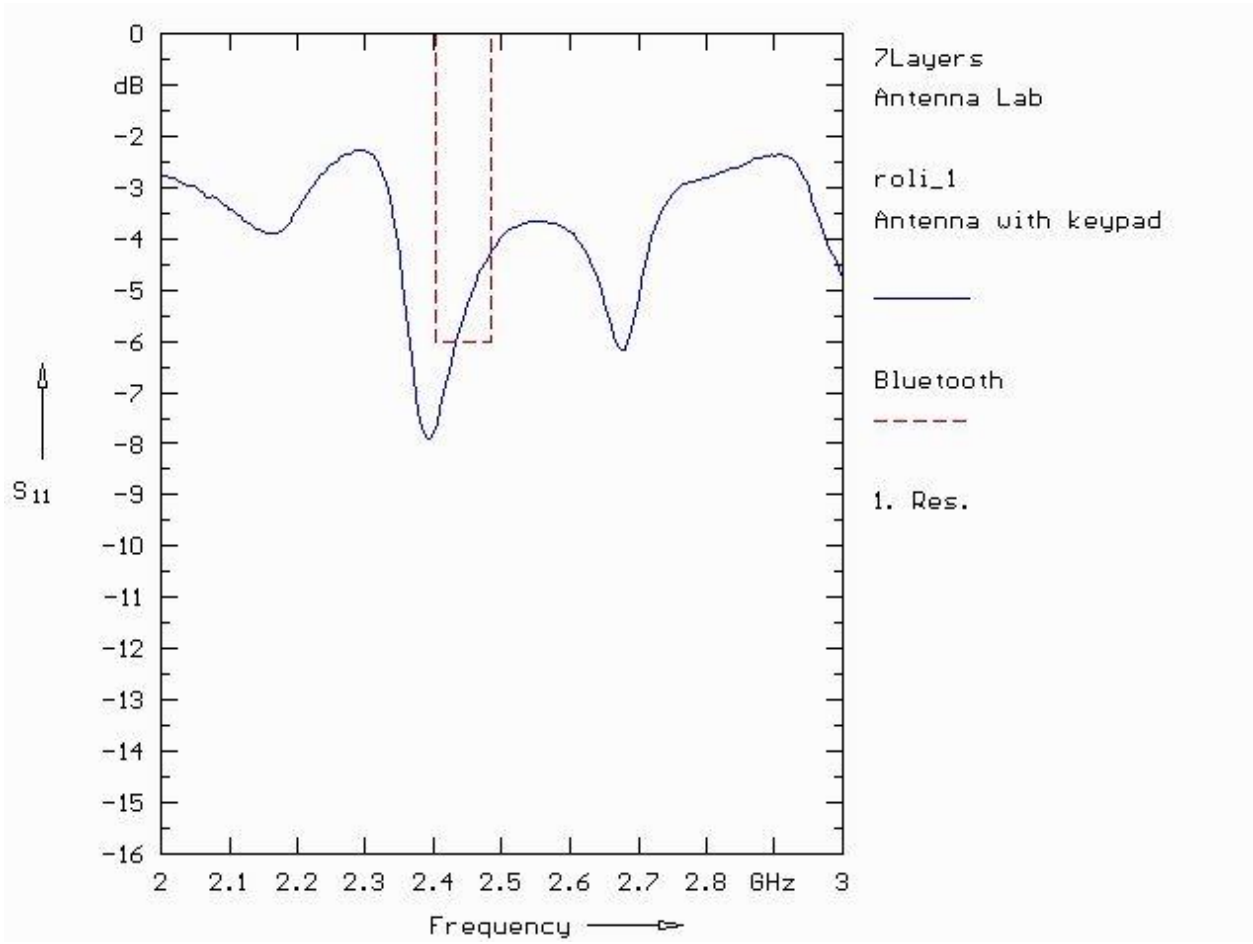
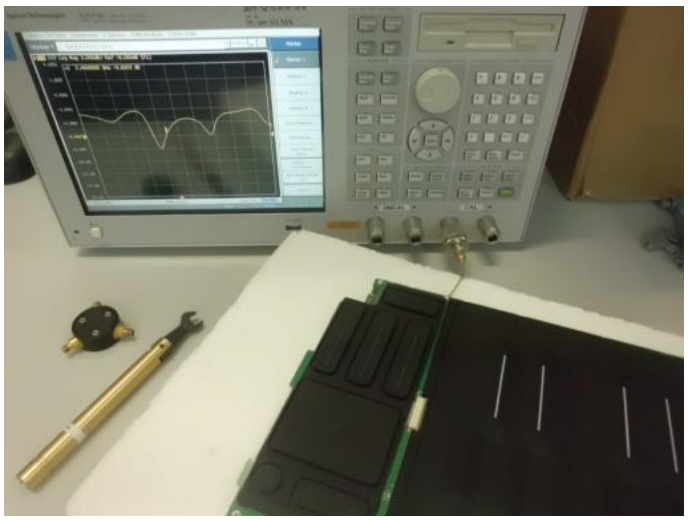


Fig. 4: Matching test result, free space situation, without metal frame and with keypad.



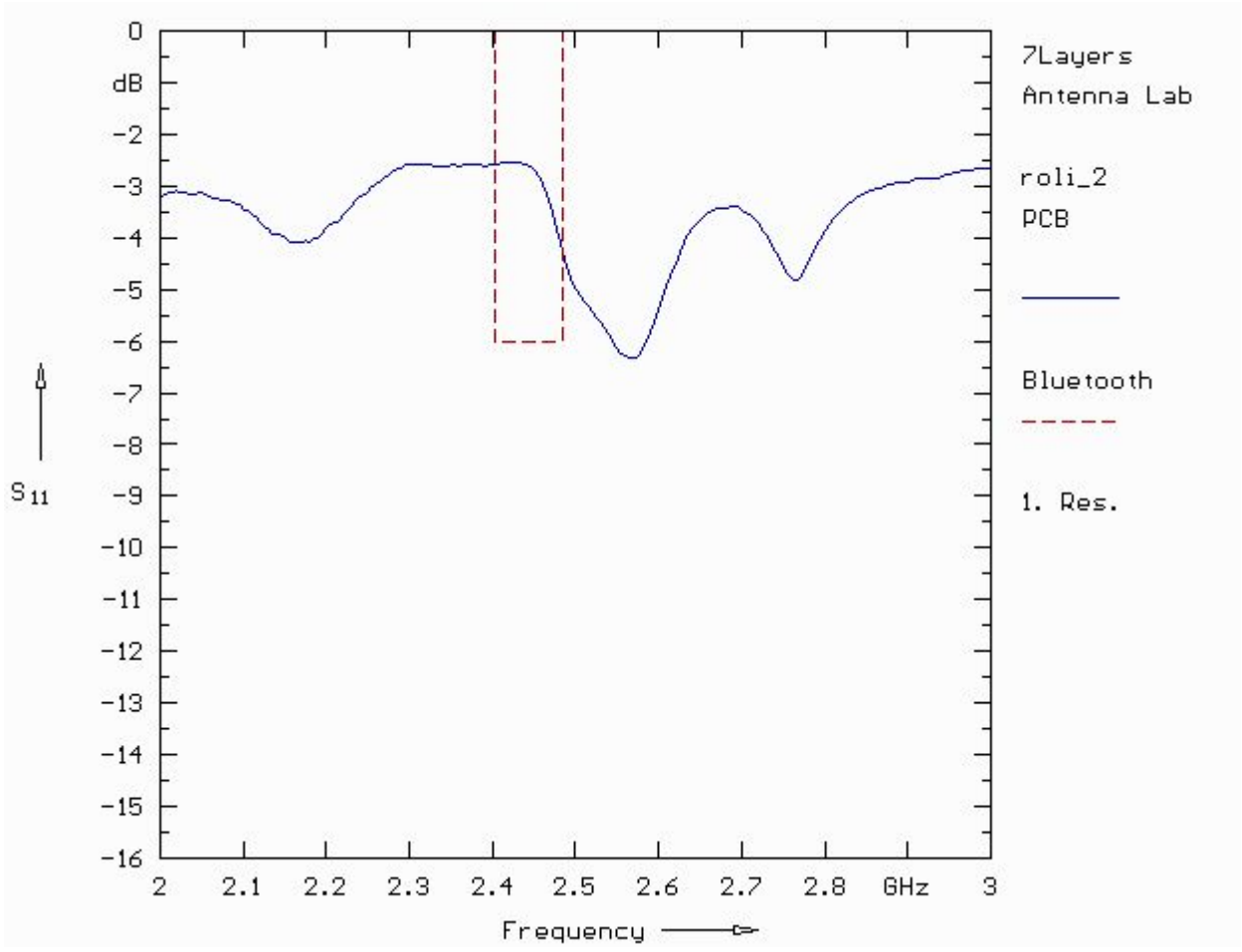


Fig. 5: Matching test result, free space situation, without metal frame and with keypad.