

# Test Report

Report Number:

**F160125E1**

Equipment under Test (EUT):

**Physiological Pulse Unit  
PPU\_098**

Applicant:

**Siemens Healthcare GmbH**

Manufacturer:

**Siemens Healthcare GmbH**

## References

- [1] **ANSI C63.10: 2013** American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- [2] **FCC CFR 47 Part 15** Radio Frequency Devices
- [3] **RSS-210 Issue 9 (August 2016)** Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
- [4] **RSS-Gen Issue 4 (November 2014)** General Requirements for Compliance of Radio Apparatus
- [5] **Publication Number 913591 (March 2007)** Measurement of radiated emissions at the edge of the band for a Part 15 RF Device

## TEST RESULT

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test.

The complete test results are presented in the following.

Test engineer:	Thomas KÜHN		09/23/2016
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		09/23/2016
	Name	Signature	Date

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## Contents:

	Page
1 Identification.....	4
1.1 Applicant.....	4
1.2 Manufacturer.....	4
1.3 Test laboratory.....	4
1.4 EUT (Equipment Under Test) .....	5
1.5 Technical data of equipment.....	5
1.6 Dates .....	5
2 Operational states.....	6
3 Additional information.....	6
4 Overview.....	6
5 Test results .....	7
5.1 Bandwidth.....	7
5.1.1 Method of measurement (bandwidth).....	7
5.1.2 Test results (bandwidth) .....	8
5.2 Band-edge compliance.....	12
5.2.1 Method of measurement (band-edge compliance (radiated)) .....	12
5.2.2 Test results (band-edge compliance (radiated)) .....	13
5.3 Radiated emissions.....	15
5.3.1 General method of measurement (radiated emissions) .....	15
5.3.2 Test results (radiated emissions) .....	22
5.3.2.1 Preliminary radiated emission measurement (150 kHz to 25 GHz) .....	22
5.3.2.2 Final radiated emission measurement (150 kHz to 30 MHz).....	33
5.3.2.3 Final radiated emission measurement (30 MHz to 1 GHz).....	33
5.3.2.4 Final radiated emission measurement (1 GHz to 25 GHz).....	34
6 Test equipment and ancillaries used for tests .....	36
7 Report history .....	37
8 List of annexes.....	37

# 1 Identification

## 1.1 Applicant

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Applicant represented during the test by the following person:	-

## 1.2 Manufacturer

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Manufacturer represented during the test by the following person:	-

## 1.3 Test laboratory

The tests were carried out at:

**PHOENIX TESTLAB GmbH**  
**Königswinkel 10**  
**32825 Blomberg**  
**Germany**

accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-02, FCC Test Firm Accreditation with the registration number 469623, designation number DE0004 and Industry Canada Test site registration SITE# IC3469A-1.

## 1.4 EUT (Equipment Under Test)

Test object: *	Physiological Pulse Unit
Model number / HVIN: *	10432918
Model name / PMN: *	PPU_098
FCC ID: *	S5H-PPU098
IC: *	21958-PPU098
Serial number: *	6353, 6354 and 6355
PCB identifier: *	K2301 D5 E6
Hardware version: *	08
Software version / FVIN: *	none
Lowest internal frequency	1 MHz

## 1.5 Technical data of equipment

Channel 02	RX:	None	TX:	2402 MHz
Channel 40	RX:	None	TX:	2440 MHz
Channel 80	RX:	None	TX:	2480 MHz

Rated RF output power: *	0 dBm (EIRP)					
Antenna type: *	Internal					
Number of channels: *	4 (frequency agile)					
Antenna gain: *	0 dBi					
Antenna connector: *	Non					
Modulation: *	GFSK					
Supply Voltage: *	$U_{\text{nom}} =$	3.7 V DC	$U_{\text{min}} =$	3.0 V DC	$U_{\text{max}} =$	4.0 V DC
Temperature range: *	5 °C to +35 °C					
Ancillary used for test:	-					

\* declared by the applicant.

### The following external I/O cables were used:

Identification	Connector		Length *
	EUT	Ancillary	
Connection cables	Pulse sensor	-	0.45 m
DC supply	DC jack	DC plug	-

\*: Length during the test if no other specified.

## 1.6 Dates

Date of receipt of test sample:	02/09/2016
Start of test:	03/09/2016
End of test:	03/17/2016

## 2 Operational states

All tests were carried out with a modified samples transmitting continuously with modulation.

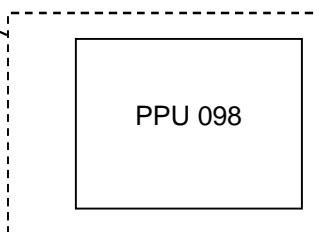
During all tests the PPU\_098 was powered by the internal battery, which has to be charged with a charging station. The EUT is not operational during charging.

Because no operation frequency of the EUT was selectable, the following three samples were used:

- transmit continuously on 2042 MHz, serial number 6353,
- transmit continuously on 2440 MHz, serial number 6354 and
- transmit continuously on 2480 MHz, serial number 6355.

Because the EUT is a battery powered device, which is intended to be used to monitor vital signs of persons during a MRT analysis, it was tested in various positions either on a positioner (from 30 MHz to 25 GHz) or with different orthogonal directions (from 150 kHz to 30 MHz).

Physical boundary of the EUT



## 3 Additional information

During the tests the EUT was not labelled as required by FCC / IC.

## 4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS 210, Issue 9 [3] or RSS-Gen, Issue 4 [4]	Status	Refer page
Bandwidth	General	15.215 (c)	6.6 [4]	Passed	7 et seq.
Band edge compliance	2,400.0 – 2,483.5	15.249 (d)	Annex B B.10 (b) [3] 8.5 [4]	Passed	12 et seq.
Radiated emissions (transmitter)	0.009 - 25,000	15.249 (a), (d) 15.205 (a) 15.209 (a)	Annex B B10 (a) [3] 8.9 [4] 8.10 [4]	Passed	15 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	8.8 [4]	N. a. *	-
Radiated emissions (receiver)	30 – 12,500	15.109 (a)	7.1 [4]	N. a. **	-
Antenna requirement	-	15.203	-	Passed ***	-

\*: Not applicable because of battery powered device.

\*\*: Not applicable because EUT is a transmitter only.

\*\*\*: Integrated antennas only, requirement fulfilled.

## 5 Test results

### 5.1 Bandwidth

#### 5.1.1 Method of measurement (bandwidth)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on, the transmitter shall work with its maximum data rate.

The measurement will be performed at the upper, the lower end and the middle of the assigned frequency band.

##### 20 dB bandwidth:

The following spectrum analyser settings according to [1] shall be used:

- Span: App. 2 to 5 times the 20 dB bandwidth, centred on the actual channel.
- Resolution bandwidth: 1 % to 5 % of the 20 dB bandwidth.
- Video bandwidth: three times the resolution bandwidth.
- Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than  $[10 \log (OBW/RBW)]$  below the reference level.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.

After trace stabilisation the marker shall be set on the signal peak. The first display line has to be set on this value. The second display line has to be set 20 dB below the first line (or the peak marker). The frequency lines shall be set on the intersection points between the second display line and the measured curve.

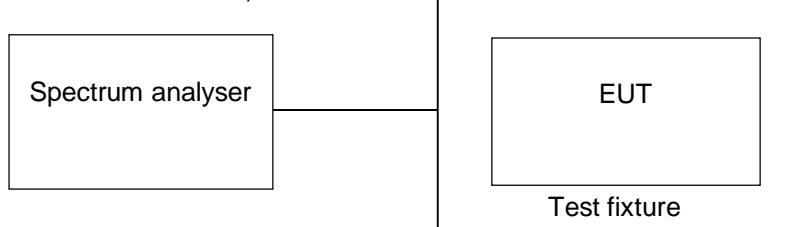
##### 99 % bandwidth:

The following spectrum analyser settings according to [1] shall be used:

- Span: The span of the analyser shall be set to capture all products of the modulation process, including the emission skirts.
- Resolution bandwidth: The resolution bandwidth shall be in the range 1 % to 5 % of the occupied bandwidth.
- Video bandwidth: App. three times the resolution bandwidth.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.

After trace stabilisation the marker shall be set on the signal peak and use the 99 % bandwidth measurement function of the analyser.

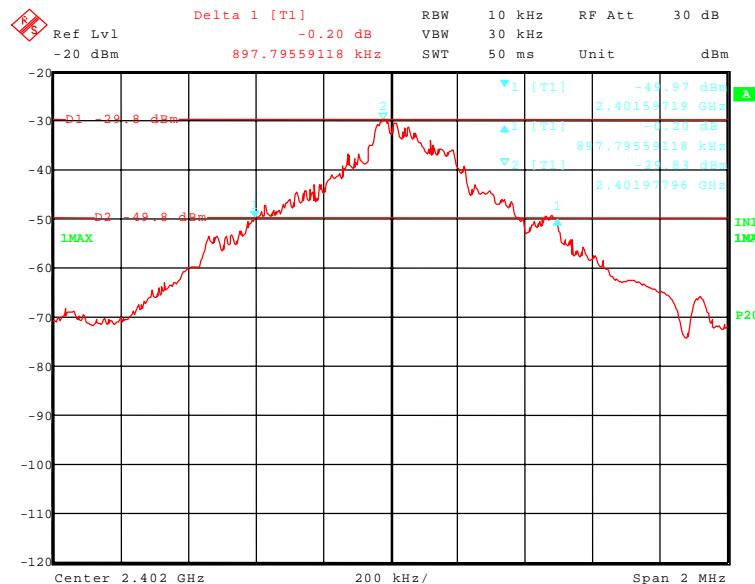
Test set-up (20 dB and 99 % bandwidth):



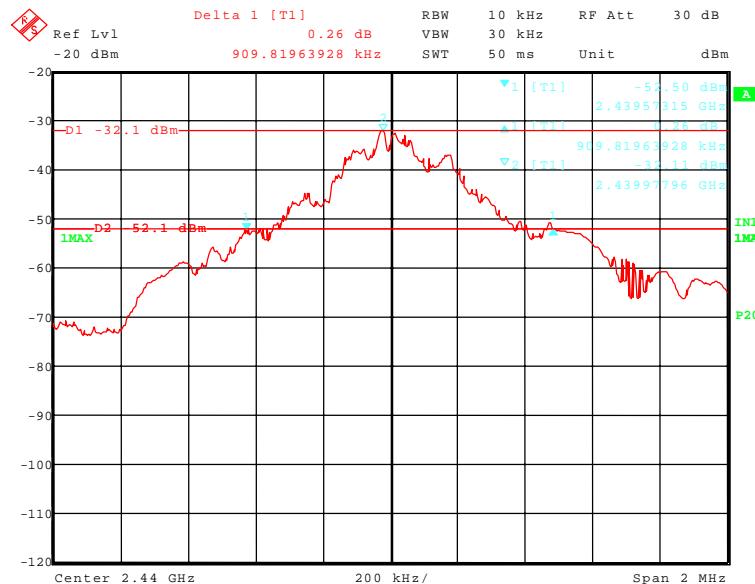
### 5.1.2 Test results (bandwidth)

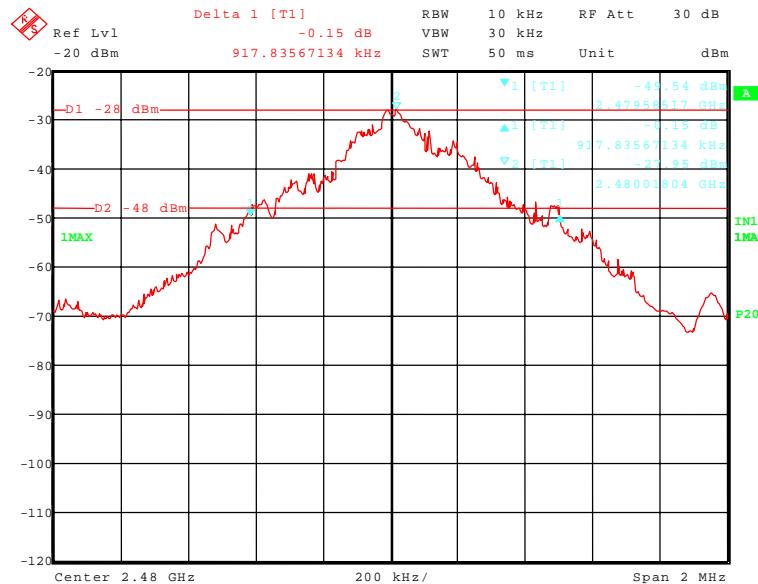
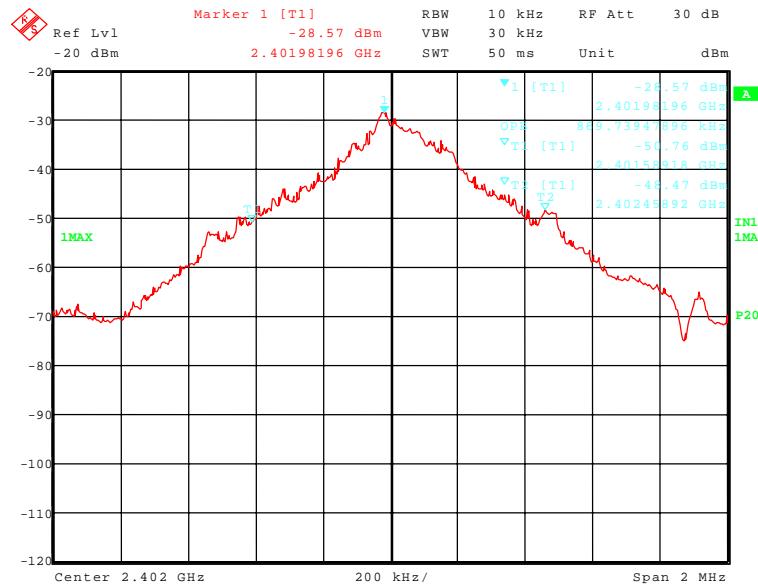
Ambient temperature	21 °C	Relative humidity	33 %
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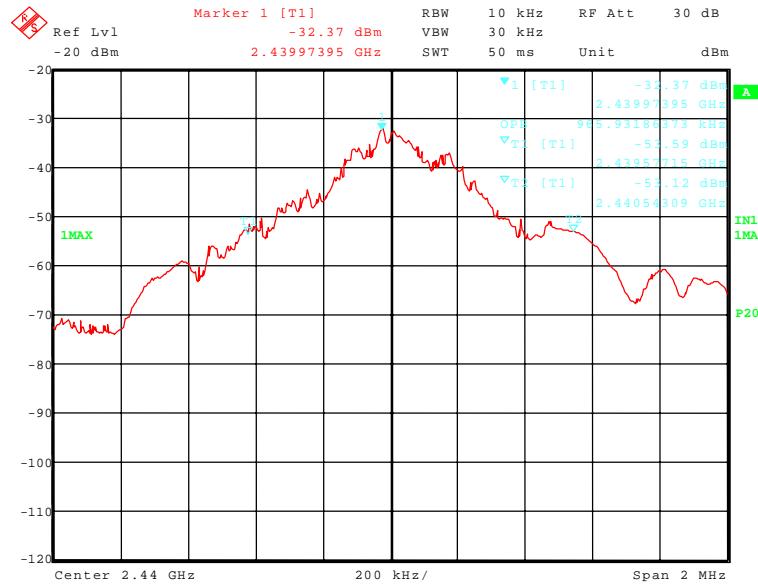
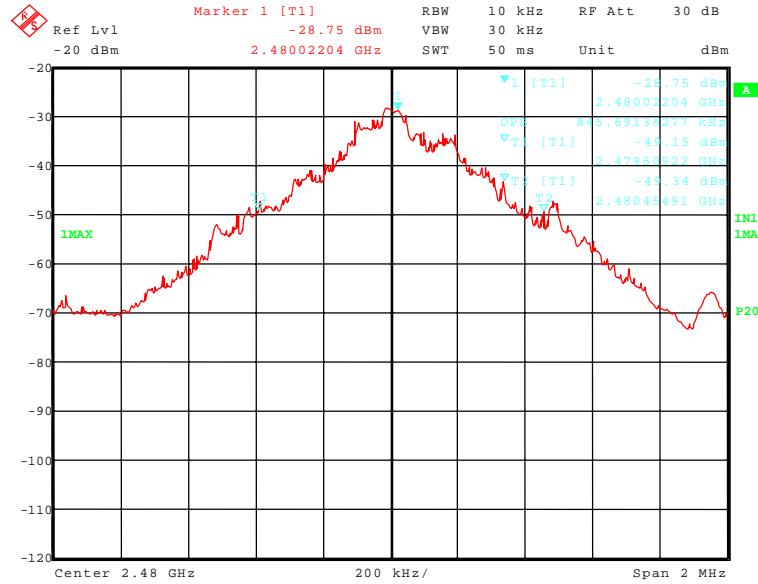
160125\_72.wmf: 20 dB bandwidth at the lower end of the assigned frequency band:



160125\_73.wmf: 20 dB bandwidth at the middle of the assigned frequency band:



160125\_74.wmf: 20 dB bandwidth at the upper end of the assigned frequency band:

160125\_75.wmf: 99 % bandwidth at the lower end of the assigned frequency band:


160125\_76.wmf: 99 % bandwidth at the middle of the assigned frequency band:

160125\_77.wmf: 99 % bandwidth at the upper end of the assigned frequency band:


Channel number	Channel frequency [MHz]	20 dB bandwidth [kHz]	99 % bandwidth [kHz]
Channel 02	2402	897.796	869.739
Channel 40	2440	909.820	965.932
Channel 80	2480	917.836	845.691
Measurement uncertainty		+0.66 dB / -0.72 dB	

Test equipment used (see chapter 6):

2, 20

## 5.2 Band-edge compliance

### 5.2.1 Method of measurement (band-edge compliance (radiated))

The same test set-up as used for the final radiated emission measurement shall be used (refer also subclause 5.3.1 of this test report). The measurements shall be carried out with using a resolution bandwidth of 100 kHz.

The following spectrum analyser settings shall be used:

- Span: Wide enough to capture the peak level of the emission on the channel closest to the band-edge, as well as any modulation products, which fall outside the assigned frequency band.
- Resolution bandwidth: 100 kHz.
- Video bandwidth: <sup>3</sup> the resolution bandwidth.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

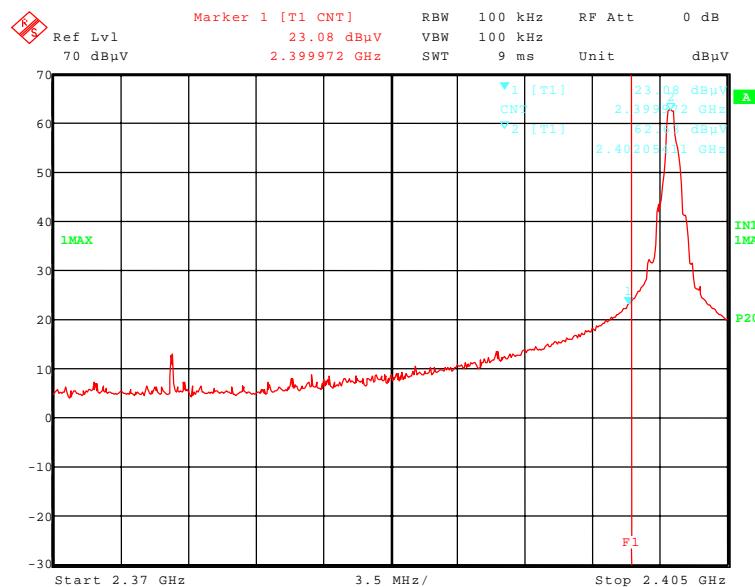
After trace stabilisation the marker shall be set on the signal peak. The frequency line shall be set on the edge of the assigned frequency band. Set the second (delta)marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is higher than that at the band-edge. This frequency shall be measured with the EMI receiver as described in subclause 5.3.1 of this test report, but 100 kHz resolution bandwidth shall be used.

The measurement will be performed at the upper end of the assigned frequency band.

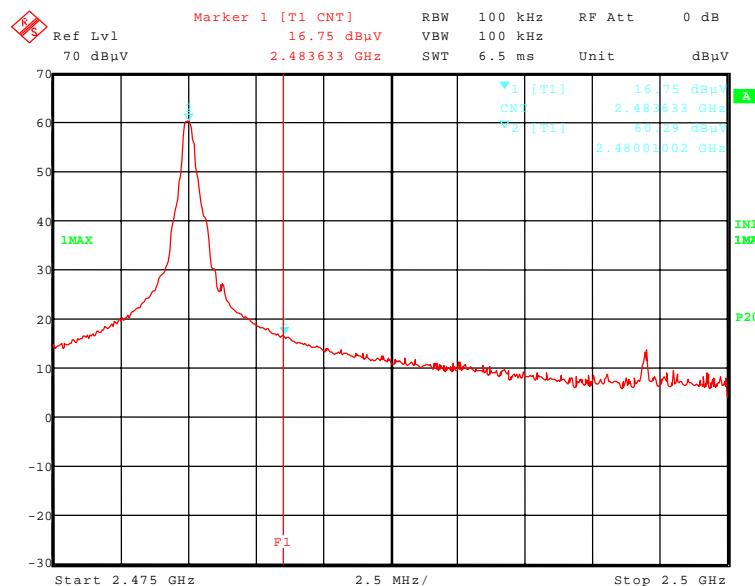
### 5.2.2 Test results (band-edge compliance (radiated))

Ambient temperature	22 °C	Relative humidity	30 %
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#### 160125\_68.wmf: Radiated band-edge compliance, lower band edge:



#### 160125\_69.wmf: Radiated band-edge compliance, upper band edge:



The plots on the page before are showing the radiated band-edge compliance for the upper and lower band-edge. The frequency line 1 (F1) shows the edge of the assigned frequency.

Band-edge compliance (lower band edge)										
Result measured with the peak detector:										
Frequency	Measured field strength	Limit	Margin	Readings	Antenna factor	Preamp	Cable loss	Height	Pol.	Restr. Band
GHz	dB $\mu$ V/m	dB $\mu$ V/m	dB	dB $\mu$ V	1/m	dB	dB	cm		
2.402	99.4	114.0	14.6	66.2	30.2	0.0	3.0	150	Hor.	carrier
2.399972	58.3	74.0	15.7	25.1	30.2	0.0	3.0	150	Hor.	No
Result measured with the average detector:										
Frequency	Measured field strength	Limit	Margin	Readings	Antenna factor	Preamp	Cable loss	Height	Pol.	Restr. Band
GHz	dB $\mu$ V/m	dB $\mu$ V/m	dB	dB $\mu$ V	1/m	dB	dB	cm		
2.402	85.6	94.0	8.4	52.4	30.2	0.0	3.0	150	Hor.	carrier
2.399972	38.6	54.0	15.4	5.4	30.2	0.0	3.0	150	Hor.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Band-edge compliance (upper band edge)										
Result measured with the peak detector:										
Frequency	Measured field strength	Limit	Margin	Readings	Antenna factor	Preamp	Cable loss	Height	Pol.	Restr. Band
GHz	dB $\mu$ V/m	dB $\mu$ V/m	dB	dB $\mu$ V	1/m	dB	dB	cm		
2.480	99.6	114.0	14.4	66.5	30.2	0.0	2.9	150	Hor.	carrier
2.483633	53.1	74.0	20.9	20.0	30.2	0.0	2.9	150	Hor.	Yes
Result measured with the average detector:										
Frequency	Measured field strength	Limit	Margin	Readings	Antenna factor	Preamp	Cable loss	Height	Pol.	Restr. Band
GHz	dB $\mu$ V/m	dB $\mu$ V/m	dB	dB $\mu$ V	1/m	dB	dB	cm		
2.480	85.8	94.0	8.2	52.7	30.2	0.0	2.9	150	Hor.	carrier
2.483633	37.8	54.0	16.2	4.7	30.2	0.0	2.9	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Test result: Passed

Test equipment used (see chapter 6):
1, 2 - 5, 6, 7, 11 - 13

## 5.3 Radiated emissions

### 5.3.1 General method of measurement (radiated emissions)

The radiated emission measurement is subdivided into five stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 9 kHz to 1 GHz.
- A final measurement carried out on an outdoor test side without reflecting ground plane and a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- A final measurement carried out on an open area test side with reflecting ground plane and various antenna height in the frequency range 30 MHz to 1 GHz.
- A preliminary measurement carried out in a fully anechoic chamber with a variable antenna distance and height in the frequency range 1 GHz to 25 / 40 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 40 GHz.

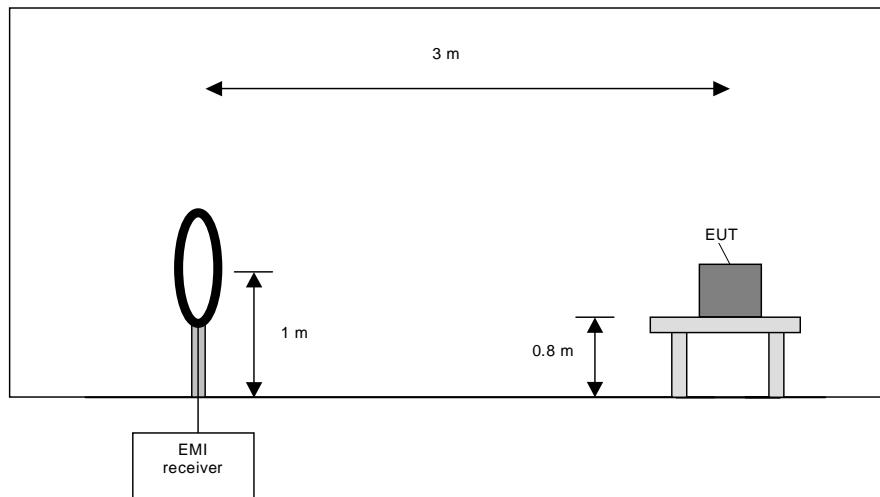
#### Preliminary measurement (9 kHz to 30 MHz):

In the first stage a preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. Table-top devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The setup of the Equipment under test will be in accordance to [1].

The frequency range 9 kHz to 30 MHz will be monitored with a spectrum analyser while the system and its cables will be manipulated to find out the configuration with the maximum emission levels if applicable. The EMI Receiver will be set to MAX Hold mode. The EUT and the measuring antenna will be rotated around their vertical axis to found the maximum emissions.

The resolution bandwidth of the spectrum analyser will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	10 kHz



Preliminary measurement procedure:

Prescans were performed in the frequency range 9 kHz to 150 kHz and 150 kHz to 30 MHz.

The following procedure will be used:

- 1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
- 2) Manipulate the system cables within the range to produce the maximum level of emission.
- 3) Rotate the EUT by 360 ° to maximize the detected signals.
- 4) Make a hardcopy of the spectrum.
- 5) Measure the frequencies of highest detected emission with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
- 6) Repeat steps 1) to 5) with the other orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).
- 7) Rotate the measuring antenna and repeat steps 1) to 5).

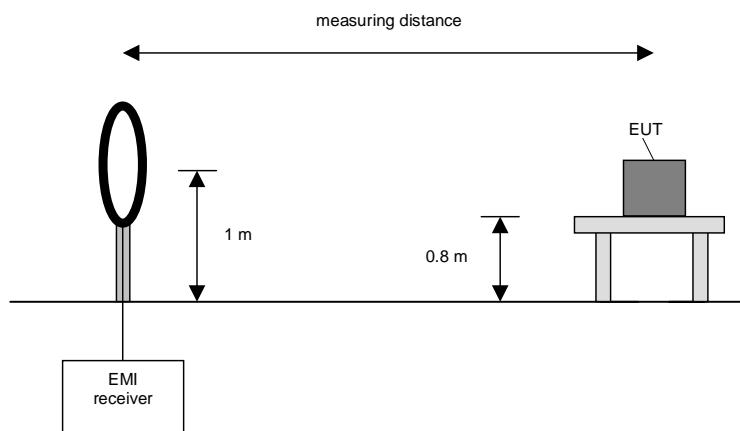
Final measurement (9 kHz to 30 MHz):

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane in a measuring distances of 3 m, 10 m and 30 m. In the case where larger measuring distances are required the results will be extrapolated based on the values measured on the closer distances according to Section 15.31 (f) (2) [2]. The final measurement will be performed with a EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 kHz to 490 kHz where an average detector will be used according Section 15.209 (d) [2].

On the frequencies, which were detected during the preliminary measurements, the final measurement will be performed while rotating the EUT and the measuring antenna in the range of 0 ° to 360 ° around their vertical axis until the maximum value is found.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	9 kHz



### Final measurement procedure:

The following procedure will be used:

- 1) Monitor the frequency range with the measuring antenna at vertical orientation parallel to the EUT at an azimuth of 0 °.
- 2) Rotate the EUT by 360 ° to maximize the detected signals and note the azimuth and orientation.
- 3) Rotate the measuring antenna to find the maximum and note the value.
- 4) Rotate the measuring antenna and repeat steps 1) to 3) until the maximum value is found.
- 5) Repeat steps 1) to 4) with the other orthogonal axes of the EUT (if the EUT is a module and might be used in a handheld equipment application).

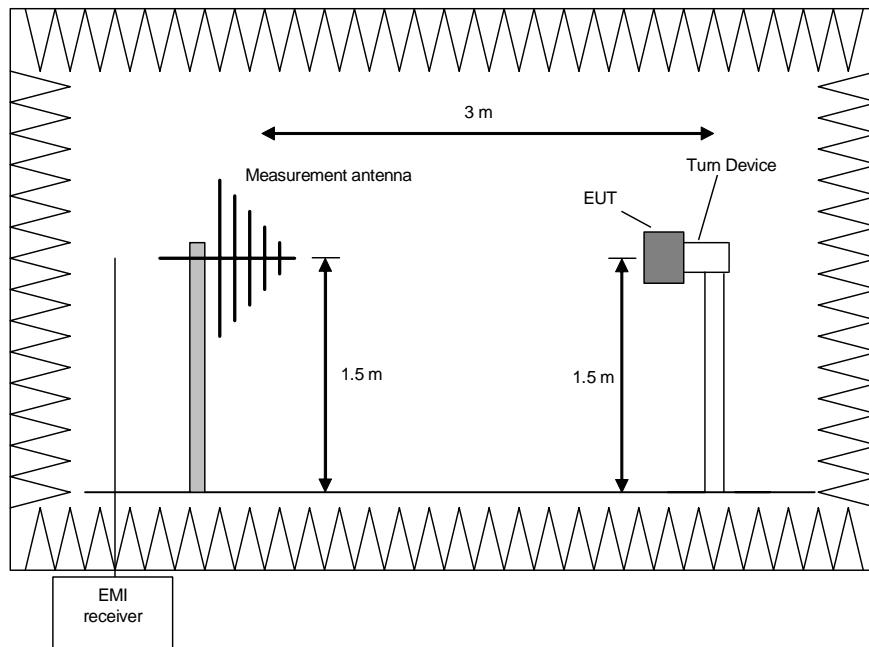
### Preliminary measurement (30 MHz to 1 GHz)

In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Table top devices will set up on a non-conducting turn device on the height of 1.5 m. Floor-standing devices will be placed directly on the turntable/ground plane. The set up of the Equipment under test will be in accordance to [1].

The frequency range 30 MHz to 1 GHz will be measured with an EMI Receiver set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30 ° steps according 6.6.5.4 in [1].

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 230 MHz	100 kHz
230 MHz to 1 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.

The following procedure will be used:

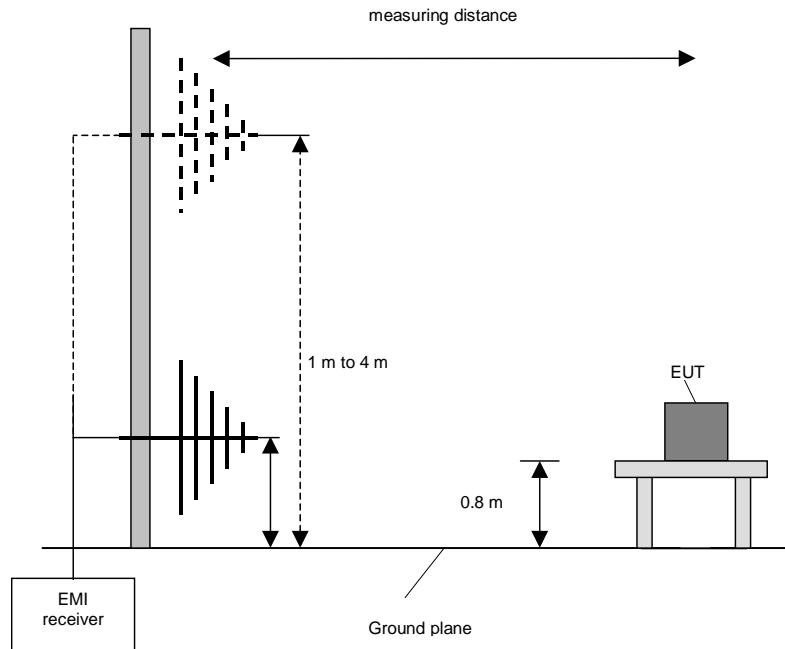
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Repeat 1) to 3) with the vertical polarisation of the measuring antenna.
5. Make a hardcopy of the spectrum.
6. Repeat 1) to 5) with the EUT raised by an angle of 30 ° (60 °, 90 °, 120 ° and 150 °) according to 6.6.5.4 in [1].
7. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.

**Final measurement (30 MHz to 1 GHz)**

A final measurement on an open area test site will be performed on selected frequencies found in the preliminary measurement. During this test the EUT will be rotated in the range of 0 ° to 360 °, the measuring antenna will be set to horizontal and vertical polarisation and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure final measurement:

The following procedure will be used:

- 1) Measure on the selected frequencies at an antenna height of 1 m and a EUT azimuth of 23 °.
- 2) Move the antenna from 1 m to 4 m and note the maximum value at each frequency.
- 3) Rotate the EUT by 45 ° and repeat 2) until an azimuth of 337 ° is reached.
- 4) Repeat 1) to 3) for the other orthogonal antenna polarization.
- 5) Move the antenna and the turntable to the position where the maximum value is detected.
- 6) Measure while moving the antenna slowly +/- 1 m.
- 7) Set the antenna to the position where the maximum value is found.
- 8) Measure while moving the turntable +/- 45 °.
- 9) Set the turntable to the azimuth where the maximum value is found.
- 10) Measure with Final detector (QP and AV) and note the value.
- 11) Repeat 5) to 10) for each frequency.
- 12) Repeat 1) to 11) for each orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).

Preliminary and final measurement (1 GHz to 40 GHz)

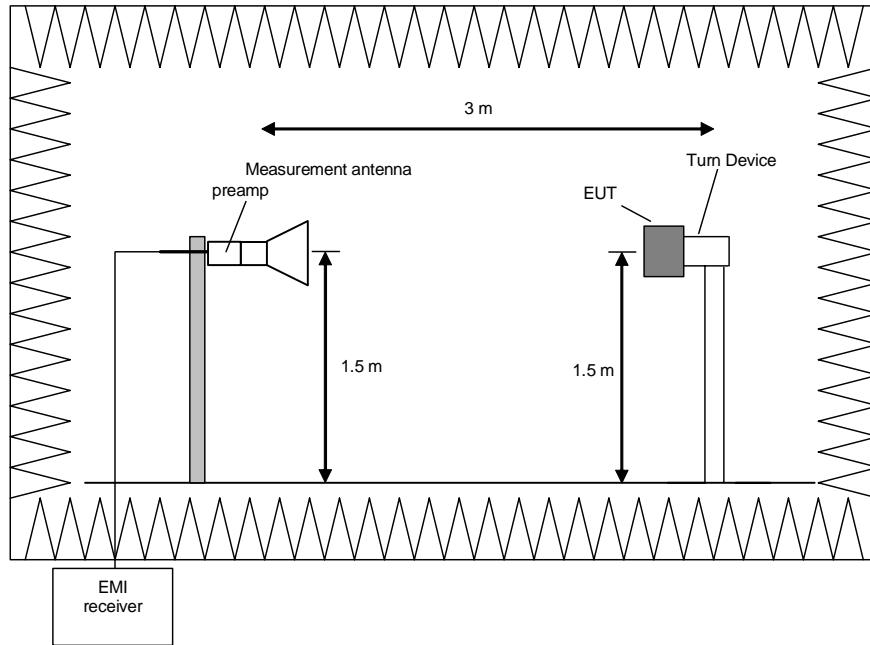
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5 m. The set-up of the Equipment under test will be in accordance to [1].

Preliminary measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT in 30 ° steps according 6.6.5.4 in [1].

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	100 kHz
4 GHz to 12 GHz	100 kHz
12 GHz to 18 GHz	100 kHz
18 GHz to 25 / 26.5 GHz	100 kHz
26.5 GHz to 40 GHz	100 kHz



#### Procedure preliminary measurement:

Prescans were performed in the frequency range 1 to 40 GHz.

The following procedure will be used:

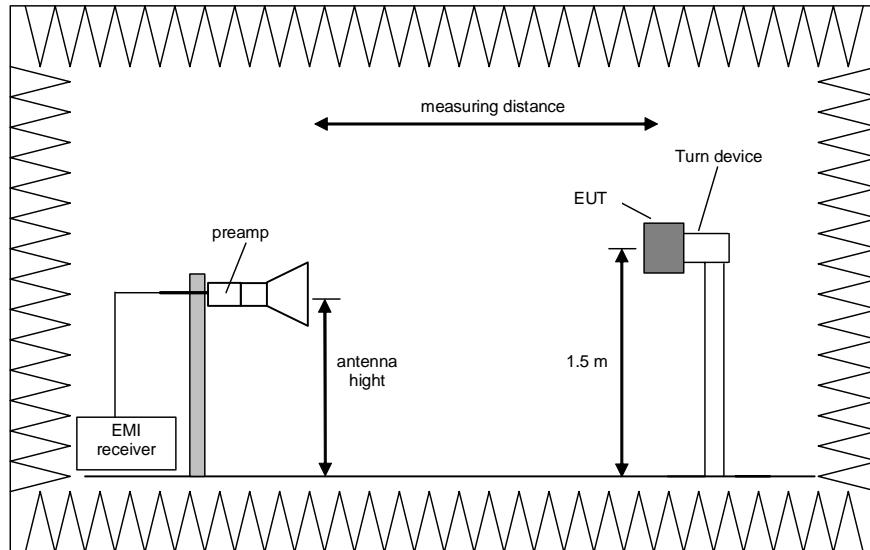
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an angle of 30° (60°, 90°, 120° and 150°) according to 6.6.5.4 in [1].
6. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
7. The measurement antenna polarisation, with the according EUT position (Turntable and Turn device) which produces the highest emission for each frequency will be used for the final measurement. The six closest values to the applicable limit will be used for the final measurement.

#### Final measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed by rotating the turntable through 0 to 360° in the worst-case EUT orientation which was obtained during the preliminary measurements.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	1 MHz
4 GHz to 12 GHz	1 MHz
12 GHz to 18 GHz	1 MHz
18 GHz to 25 / 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency ranges 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 25 /26.5 GHz and 26.5 GHz to 40 GHz.

The following procedure will be used:

- 1) Set the turntable and the turn device to obtain the worst-case emission for the first frequency identified in the preliminary measurements.
- 2) Set the measurement antenna polarisation to the orientation with the highest emission for the first frequency identified in the preliminary measurements.
- 3) Set the spectrum analyser to EMI mode with peak and average detector activated.
- 4) Rotate the turntable from 0° to 360° to find the EUT angle that produces the highest emissions.
- 5) Note the highest displayed peak and average values
- 6) Repeat the steps 1) to 5) for each frequency detected during the preliminary measurements.

### 5.3.2 Test results (radiated emissions)

#### 5.3.2.1 Preliminary radiated emission measurement (150 kHz to 25 GHz)

Ambient temperature	22 °C	Relative humidity	22 %
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Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m and 1.5 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

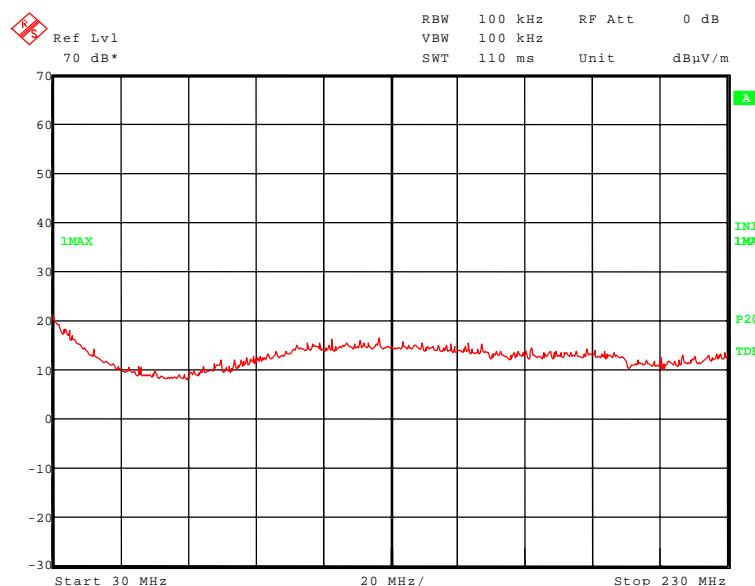
Supply voltage: During all measurements the EUT was supplied by the internal battery.

Frequency range: The preliminary measurement was carried out in the frequency range 150 kHz to 25 GHz according to [2].

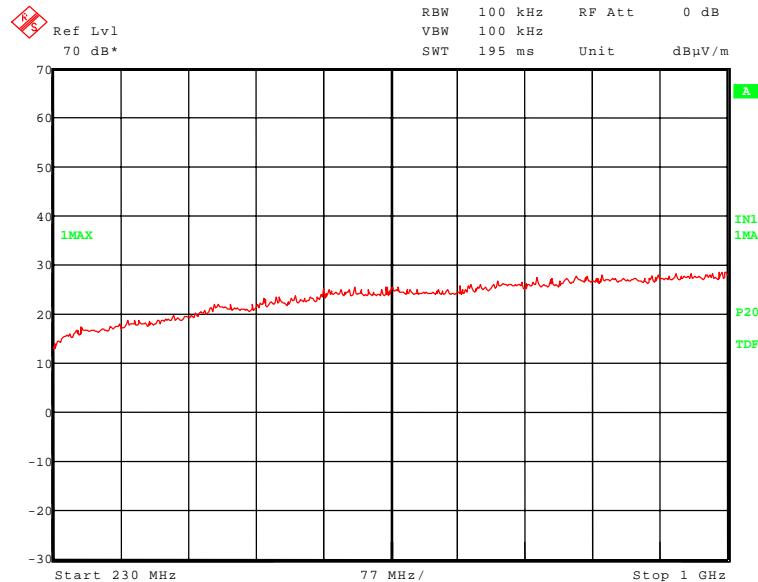
Remark: As pre-tests have shown, the emissions in the frequency range 150 kHz to 30 MHz are not depending on the transmitter operation mode. Therefore the emissions in this frequency range were measured only with the transmitter operates in the middle of the assigned frequency band (channel 40 / 2440 MHz).

#### Transmitter operates at the lower end of the assigned frequency band (channel 02 / 2402 MHz)

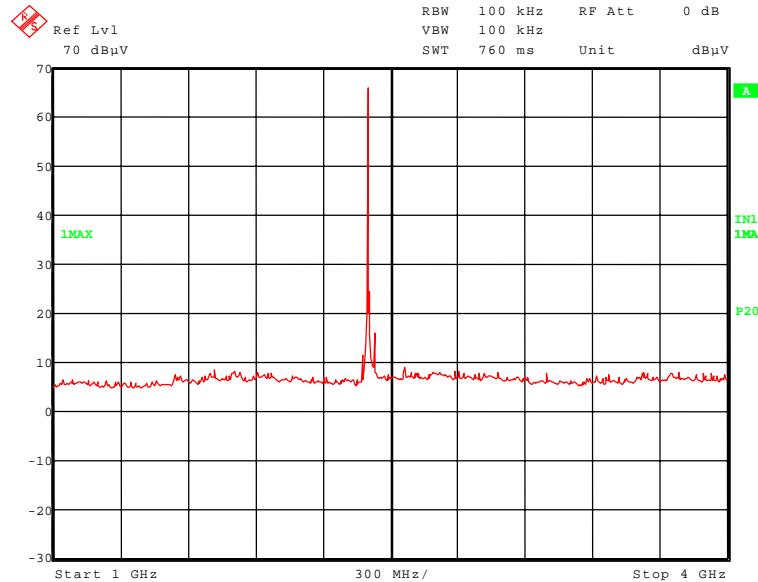
160125\_62.wmf: Spurious emissions from 30 MHz to 230 MHz:



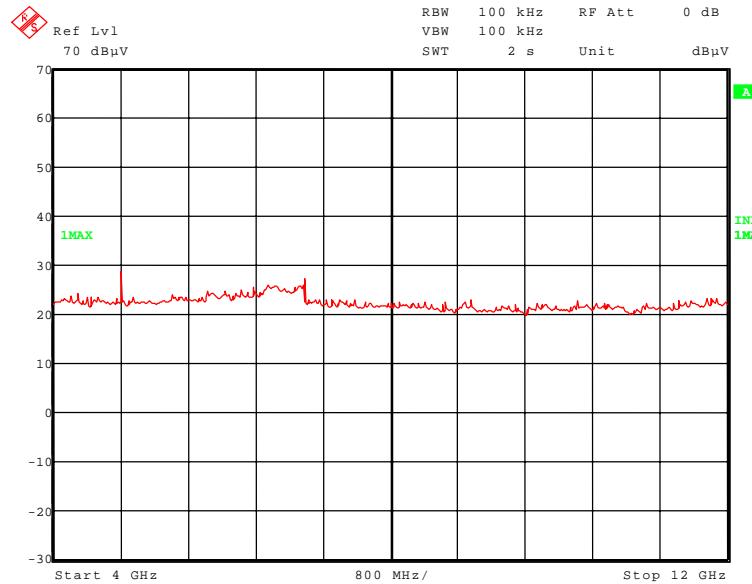
No significant frequencies above the noise floor of the system (max. 21 dB $\mu$ V/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

1620125\_63.wmf: Spurious emissions from 230 MHz to 1 GHz:


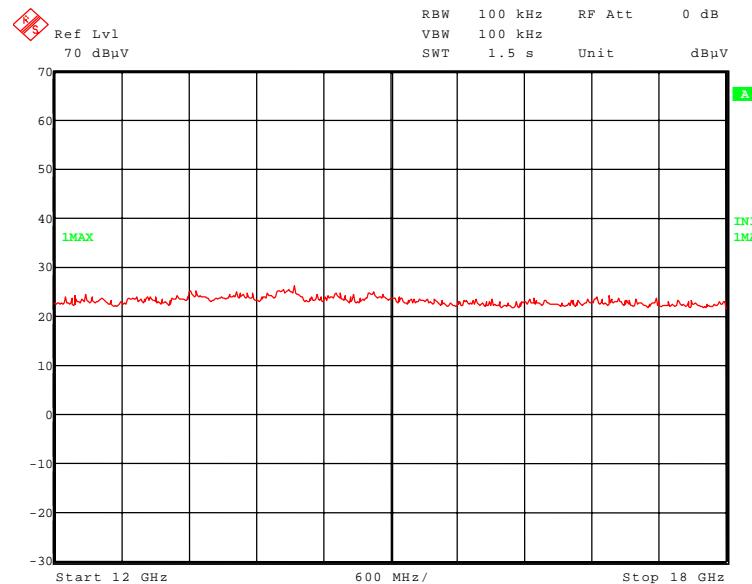
No significant frequencies above the noise floor of the system (max. 29 dB $\mu$ V/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

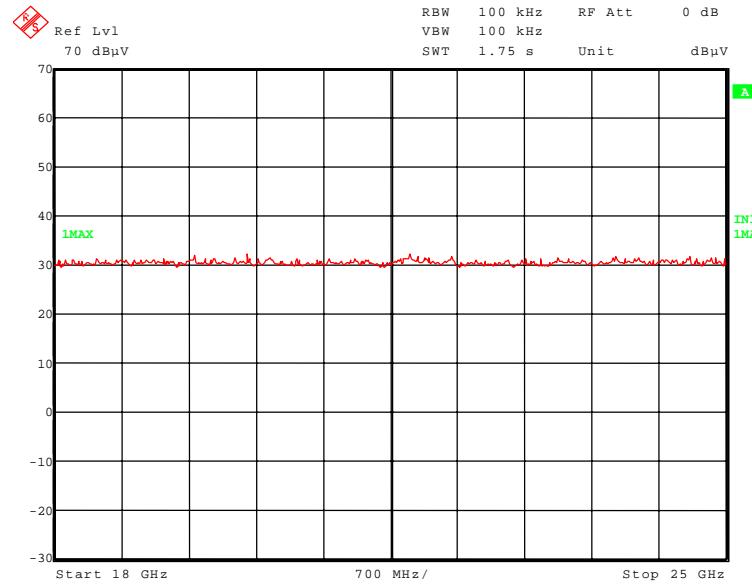
160125\_52.wmf: Spurious emissions from 1 GHz to 4 GHz:


160125\_53.wmf: Spurious emissions from 4 GHz to 12 GHz:



160125\_58.wmf: Spurious emissions from 12 GHz to 18 GHz:



160125\_59.wmf: Spurious emissions from 18 GHz to 25 GHz:


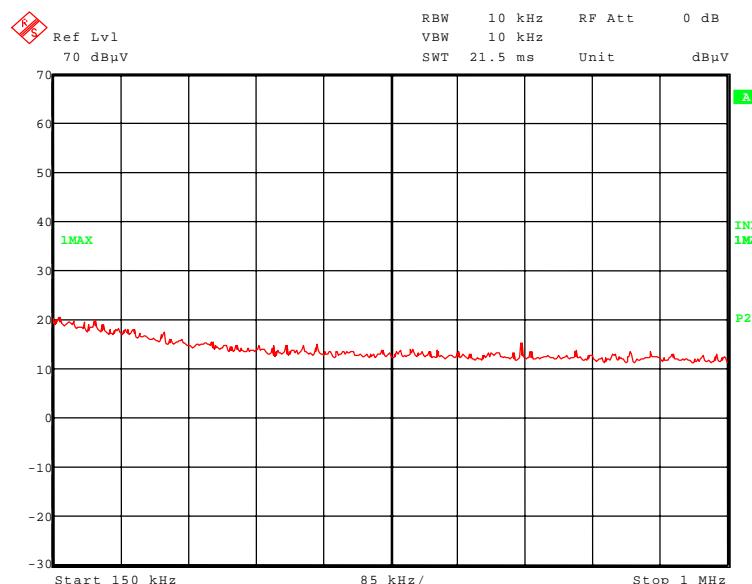
The following frequencies were found inside the restricted bands during the preliminary radiated emission test:

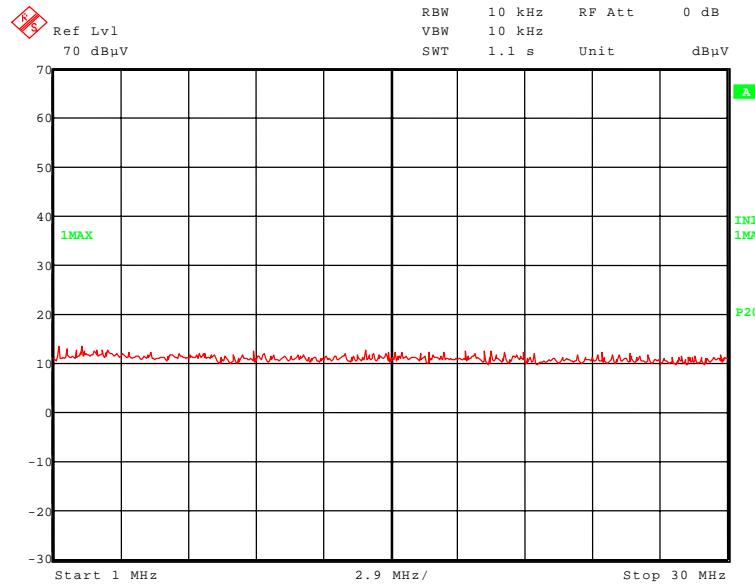
- 2376.000 MHz and 4804.000 MHz.

The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

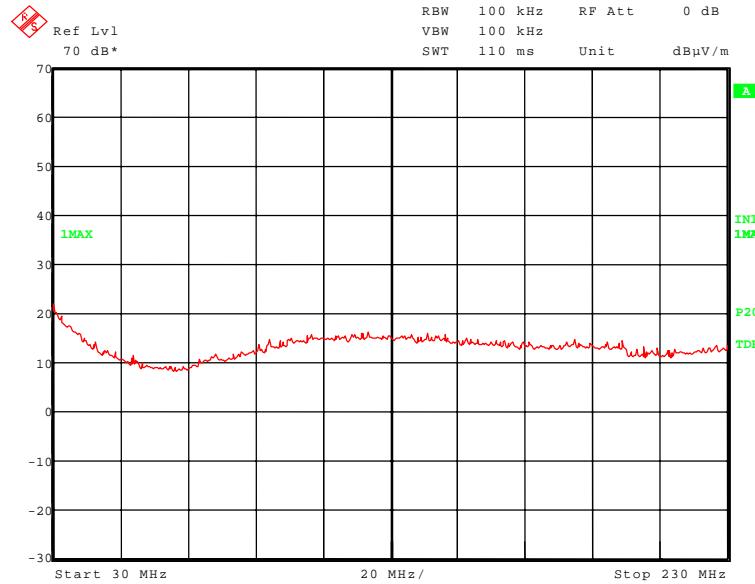
- 2402.000 MHz and 2431.800 MHz.

These frequencies have to be measured in a final measurement. The results were presented in the following.

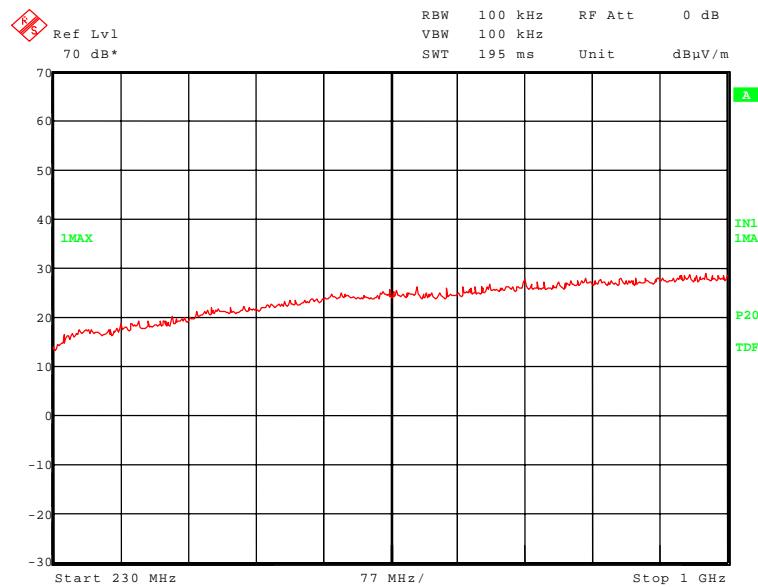
**Transmitter operates on the middle of the assigned frequency band (channel 40 / 2440 MHz)**
160125\_70.wmf: Spurious emissions from 150 kHz to 1 MHz:


160125\_71.wmf: Spurious emissions from 1 MHz to 30 MHz:


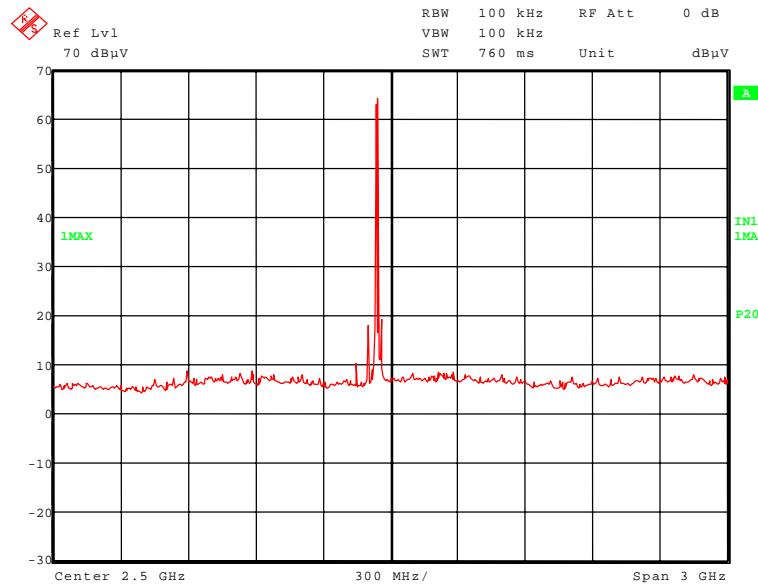
No significant frequencies above the noise floor of the system (max. 41 dB $\mu$ V/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

160125\_65.wmf: Spurious emissions from 30 MHz to 230 MHz:


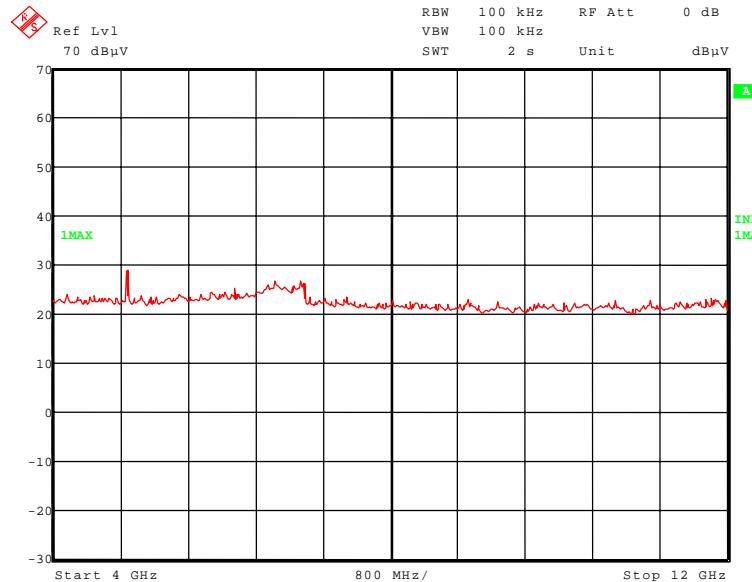
No significant frequencies above the noise floor of the system (max. 21 dB $\mu$ V/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

160125\_64.wmf: Spurious emissions from 230 MHz to 1 GHz:


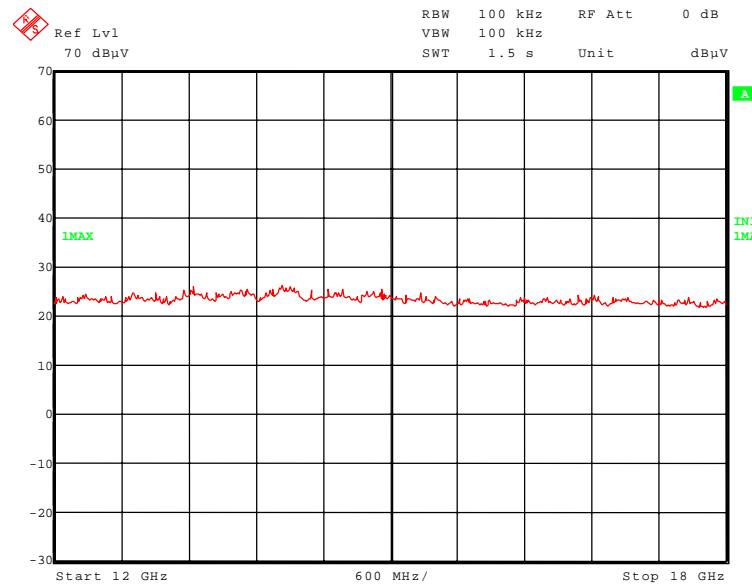
No significant frequencies above the noise floor of the system (max. 29 dB $\mu$ V/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

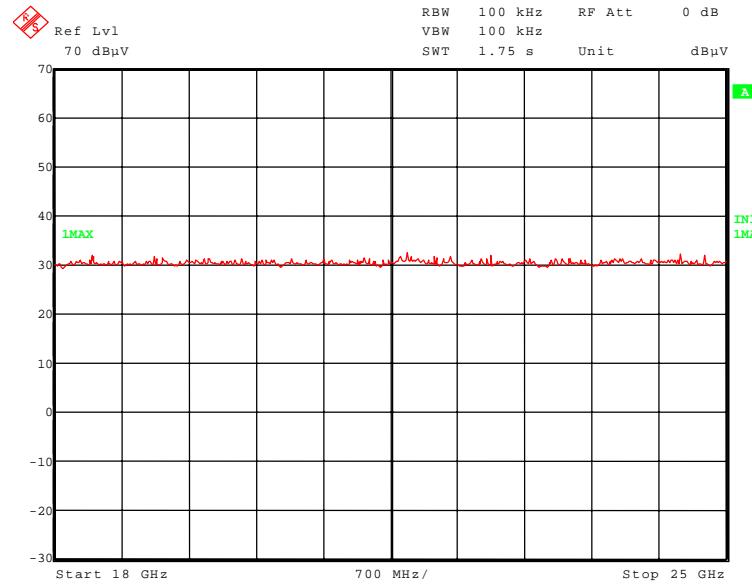
160125\_50.wmf: Spurious emissions from 1 GHz to 4 GHz:


160125\_54.wmf: Spurious emissions from 4 GHz to 12 GHz:



160125\_57.wmf: Spurious emissions from 12 GHz to 18 GHz:



160125\_60.wmf: Spurious emissions from 18 GHz to 25 GHz:


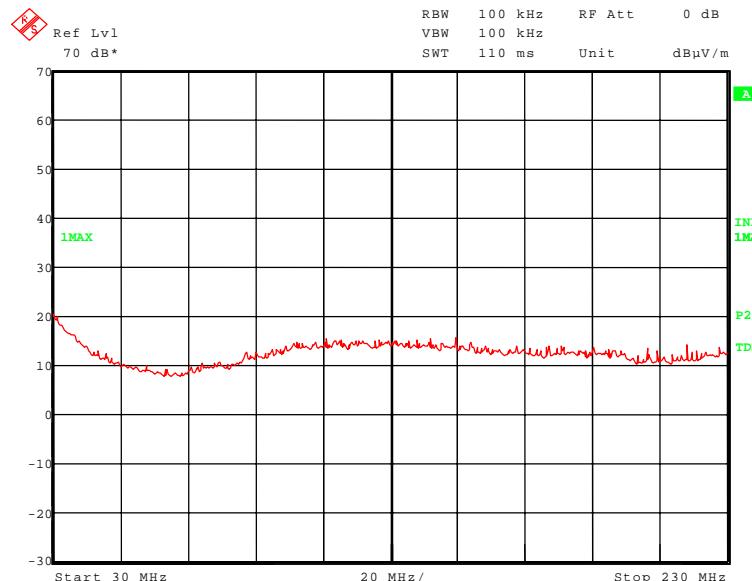
The following frequency was found inside the restricted bands during the preliminary radiated emission test:

- 4880.000 MHz.

The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

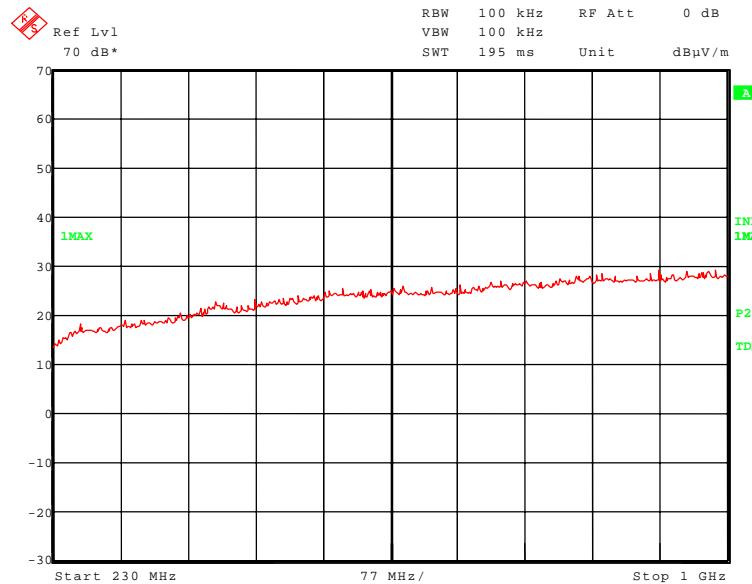
- 2401.700 MHz, 2440.000 MHz and 2458.700 MHz.

These frequencies have to be measured in a final measurement. The results were presented in the following.

Transmitter operates on the upper end of the assigned frequency (channel 80 / 2480 MHz)
160125\_66.wmf: Spurious emissions from 30 MHz to 230 MHz:


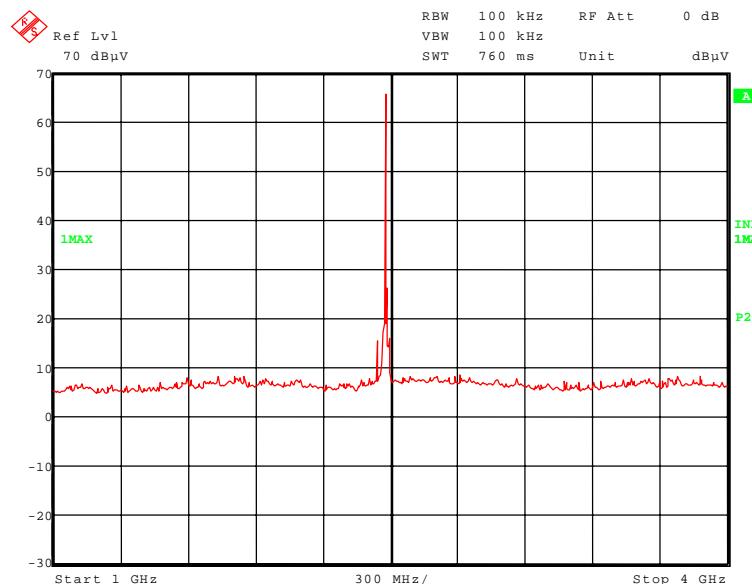
No significant frequencies above the noise floor of the system (max. 21 dB $\mu$ V/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

160125\_67.wmf: Spurious emissions from 200 MHz to 1 GHz:

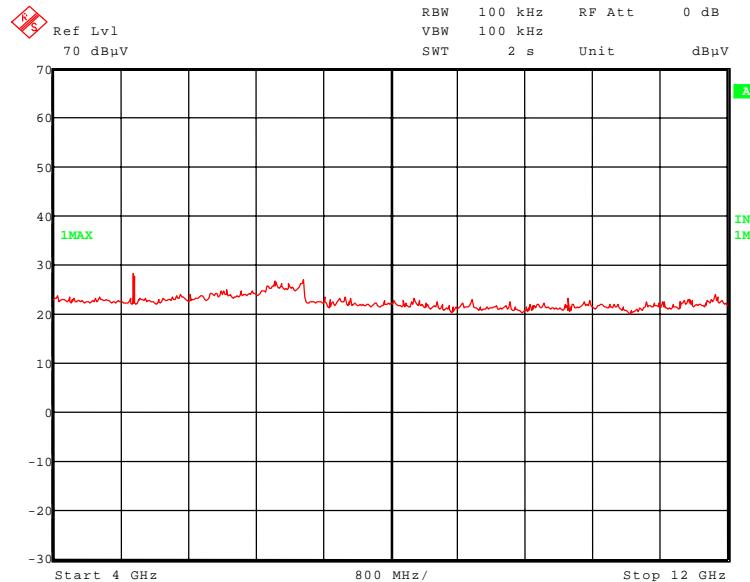


No significant frequencies above the noise floor of the system (max. 29 dB $\mu$ V/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

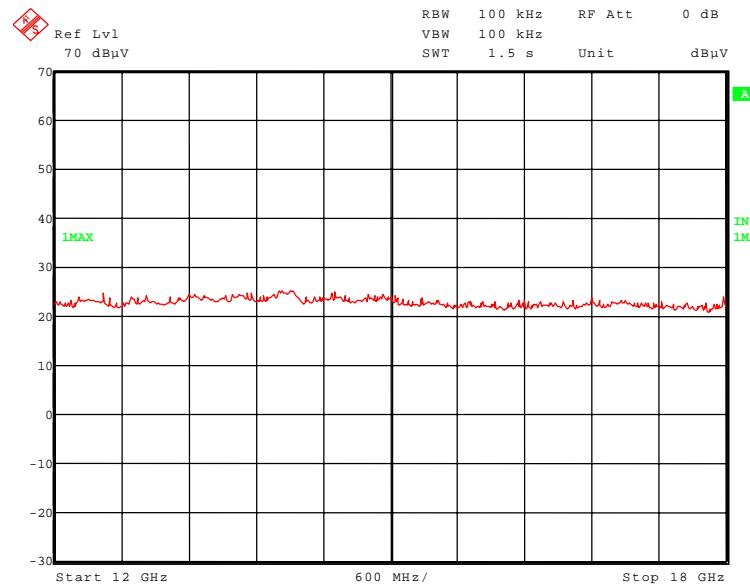
160125\_51.wmf: Spurious emissions from 1 GHz to 4 GHz:

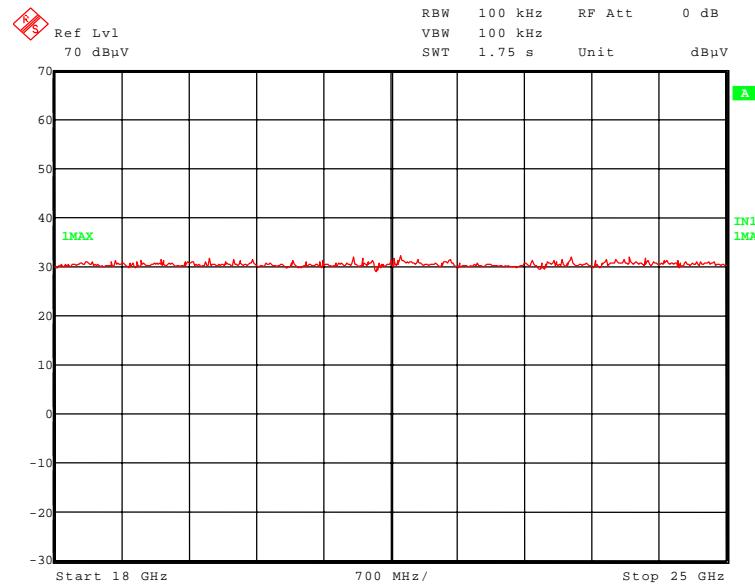


160125\_55.wmf: Spurious emissions from 4 GHz to 12 GHz:



160125\_56.wmf: Spurious emissions from 12 GHz to 18 GHz:



160125\_61.wmf: Spurious emissions from 18 GHz to 25 GHz:


The following frequencies were found inside the restricted bands during the preliminary radiated emission test:

- 2496.700 MHz and 4960.000 MHz

The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 2440.500 MHz and 2480.000 MHz.

These frequencies have to be measured in a final measurement. The results were presented in the following.

Test equipment used (refer clause 6):

1 - 19

### **5.3.2.2 Final radiated emission measurement (150 kHz to 30 MHz)**

No significant frequencies above the noise floor of the system (max. 40 dB $\mu$ V/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no final measurements were carried out on the outdoor test site.

### **5.3.2.3 Final radiated emission measurement (30 MHz to 1 GHz)**

No significant frequencies above the noise floor of the system (max. 21 dB $\mu$ V/m in the frequency range 30 MHz to 230 MHz and max. 29 dB $\mu$ V/m in the frequency range 230 MHz to 1 GHz (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

### 5.3.2.4 Final radiated emission measurement (1 GHz to 25 GHz)

Ambient temperature	22 °C	Relative humidity	22 %
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Position of EUT: The EUT was set-up on a non-conducting table of a height of 1.5 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied by the internal battery.

Resolution bandwidth: For all measurements a resolution bandwidth of 1 MHz was used.

Test results: The test results were calculated with the following formula:

$$\text{Result [dB}\mu\text{V/m]} = \text{reading [dB}\mu\text{V]} + \text{cable loss [dB]} + \text{antenna factor [dB/m]} - \text{preamp [dB]}$$

#### Transmitter operates at the lower end of the assigned frequency band (channel 02 / 2402 MHz)

##### **Result measured with the peak detector:**

Frequency MHz	Result dB $\mu$ V/m	Limit dB $\mu$ V/m	Margin dB	Readings dB $\mu$ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2376.000	54.0	74.0	20.0	20.9	30.1	0.0	3.0	150	Hor.	Yes
2402.000	99.4	114.0	14.6	66.2	30.2	0.0	3.0	150	Hor.	carrier
2431.800	57.1	74.0	16.9	23.8	30.3	0.0	3.0	150	Hor.	No
4804.000	50.6	74.0	23.4	35.0	36.1	24.9	4.4	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

##### **Result measured with the average detector:**

Frequency MHz	Result dB $\mu$ V/m	Limit dB $\mu$ V/m	Margin dB	Readings dB $\mu$ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2376.000	36.0	54.0	18.0	2.9	30.1	0.0	3.0	150	Hor.	Yes
2402.000	85.6	94.0	8.4	52.4	30.2	0.0	3.0	150	Hor.	carrier
2431.800	37.2	54.0	16.8	3.9	30.3	0.0	3.0	150	Hor.	No
4804.000	36.5	58.0	21.5	20.9	36.1	24.9	4.4	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

**Transmitter operates at the middle of the assigned frequency band (channel 40 / 2440 MHz)**

**Result measured with the peak detector:**

Frequency MHz	Result dB $\mu$ V/m	Limit dB $\mu$ V/m	Margin dB	Readings dB $\mu$ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2401.700	56.6	74.0	17.4	23.4	30.2	0.0	3.0	150	Hor.	No
2440.000	98.3	114.0	15.7	65.0	30.3	0.0	3.0	150	Hor.	carrier
2458.700	59.0	74.0	15.0	25.7	30.3	0.0	3.0	150	Hor.	No
4880.000	49.7	74.0	24.3	34.3	36.1	25.1	4.4	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

**Result measured with the average detector:**

Frequency MHz	Result dB $\mu$ V/m	Limit dB $\mu$ V/m	Margin dB	Readings dB $\mu$ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2401.700	36.8	54.0	17.2	3.6	30.2	0.0	3.0	150	Vert.	No
2440.000	84.3	94.0	9.7	51.0	30.3	0.0	3.0	150	Vert.	carrier
2458.700	37.1	54.0	16.9	3.8	30.3	0.0	3.0	150	Vert.	No
4880.000	35.5	54.0	18.5	20.1	36.1	25.1	4.4	150	Vert.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

**Transmitter operates at the upper end of the assigned frequency band (channel 80 / 2480 MHz)**

**Result measured with the peak detector:**

Frequency MHz	Result dB $\mu$ V/m	Limit dB $\mu$ V/m	Margin dB	Readings dB $\mu$ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2440.500	56.6	74.0	17.4	23.3	30.3	0.0	3.0	150	Hor.	No
2480.000	99.6	114.0	14.4	66.5	30.2	0.0	2.9	150	Hor.	carrier
2496.700	59.7	74.0	14.3	26.6	30.1	0.0	3.0	150	Hor.	Yes
4960.000	49.4	74.0	24.6	34.2	36.0	25.3	4.5	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

**Result measured with the average detector:**

Frequency MHz	Result dB $\mu$ V/m	Limit dB $\mu$ V/m	Margin dB	Readings dB $\mu$ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2440.500	37.1	54.0	16.9	3.8	30.3	0.0	3.0	150	Hor.	No
2480.000	85.8	94.0	8.2	52.7	30.2	0.0	2.9	150	Hor.	carrier
2496.700	36.6	54.0	17.4	3.5	30.1	0.0	3.0	150	Hor.	Yes
4960.000	35.3	54.0	18.7	20.1	36.0	25.3	4.5	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Test: Passed

Test equipment used (see chapter 6):

1 - 5, 7, 11 - 13, 14, 18

## 6 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
1	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
2	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/16/2016	02/2017
3	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
4	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
5	Antenna support	AS615P	Deisel	615/310	480187	-	-
6	Antenna	CBL6112 B	Chase	2688	480328	04/14/2014	04/2017
7	Antenna	HL50	Rohde & Schwarz	100438	481170	08/27/2014	08/2017
8	Standard gain horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Calibration not necessary	
9	Standard gain horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	410	480296	Calibration not necessary	
10	RF-cable No. 36	Sucoflex 106B	Suhner	0587/6B	480865	Weekly verification (system cal.)	
11	RF-cable No. 3	Sucoflex 106B	Suhner	0563/6B	480670	Weekly verification (system cal.)	
12	RF-cable No. 40	Sucoflex 106B	Suhner	0708/6B	481330	Weekly verification (system cal.)	
13	Positioner	TDF 1.5- 10Kg	Maturo	15920215	482034	-	-
14	Preamplifier 100 MHz - 13 GHz	JS3-00101200-23-5A	MITEQ Hauppauge N.Y.	681851	480337	02/18/2016	02/2018
15	Preamplifier 12 GHz - 18 GHz	JS3-12001800-16-5A	MITEQ Hauppauge N.Y.	571667	480343	02/18/2016	02/2018
16	Preamplifier 18 GHz - 26 GHz	JS4-18002600-20-5A	MITEQ Hauppauge N.Y.	658697	480342	02/17/2016	02/2018
17	Loop antenna	HFH2-Z2	Rohde & Schwarz	100417	481912	09/15/2015	09/2016
18	High Pass Filter	WHKX4.0/18G-8SS	Wainwright Instruments GmbH	1	480587	Weekly verification (system cal.)	
19	RF-cable 2m	KPS-1533-400-KPS	Insulated Wire	-	480302	Weekly verification (system cal.)	
20	Test fixture	-	Phoenix Test-Lab	-	410160	-	-

## 7 Report history

Report Number	Date	Comment
F160125E1	09/23/2016	Document created

## 8 List of annexes

Annex A                    Test set-up photographs                    7 pages

160125\_h1.JPG: PPU\_098, test setup fully anechoic chamber below 30 MHz (pos. 1)  
 160125\_f1.JPG: PPU\_098, test setup fully anechoic chamber below 30 MHz (pos. 2)  
 160125\_i1.JPG: PPU\_098, test setup fully anechoic chamber below 30 MHz  
 160125\_a1.JPG: PPU\_098, test setup fully anechoic chamber above 30 MHz  
 160125\_e1.JPG: PPU\_098, test setup fully anechoic chamber above 30 MHz  
 160125\_b1.JPG: PPU\_098, test setup fully anechoic chamber above 1 GHz  
 160125\_d1.JPG: PPU\_098, test setup fully anechoic chamber above 1 GHz

Annex B                    External photographs                    3 pages

160125\_1.JPG: PPU\_098, 3-D-view 1  
 160125\_2.JPG: PPU\_098, 3-D-view 2  
 160125\_8.JPG: PPU\_098, type plates of tested samples

Annex C                    Internal photographs                    6 pages

160125\_3.JPG: PPU\_098, internal view 1  
 160125\_5.JPG: PPU\_098, PCB, top view  
 160125\_6.JPG: PPU\_098, PCB, top view, shielding opened  
 160125\_7.JPG: PPU\_098, PCB, top view, battery removed  
 160125\_10.JPG: PPU\_098, PCB, top view, shielding and battery removed  
 (supplied by the applicant)  
 160125\_9.JPG: PPU\_098, PCB, bottom view