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Test Report

Report Number:

F161597E1

Equipment under Test (EUT):

ZONESCAN 820 Solar Alpha

Applicant:

Gutermann Technology GmbH

Manufacturer:

Gutermann Technology GmbH

ilac-MRA
DAkkS Deutsche Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

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-247 Issue 2 (February 2017)** Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

[4] **RSS-Gen Issue 4 (November 2014)** General Requirements for Compliance of Radio Apparatus

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		04/24/2017
	Name	Signature	Date
Authorized reviewer:	Michael DINTER		04/24/2017
	Name	Signature	Date

This test report is only valid in its original form.

The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

This test report is valid in hardcopy form as well as in electronic form.

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1 Identification

1.1 Applicant

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Fax:	+49 751 35 90 16 - 99
eMail Address:	hermann.waibel@gutermann-water.com
Applicant represented during the test by the following person:	Mr. Hermann WAIBEL, Mr. Stefan LANG

1.2 Manufacturer

Name:	Gutermann Technology GmbH
Address:	Gottlieb Daimler Straße 10 88214 Ravensburg
Country:	Germany
Name for contact purposes:	Mr. Hermann WAIBEL
Phone:	+49 751 35 90 16 - 83
Fax:	+49 751 35 90 16 - 99
eMail Address:	hermann.waibel@gutermann-water.com
Manufacturer represented during the test by the following person:	Mr. Hermann WAIBEL, Mr. Stefan LANG

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: *	Wireless transceiver for data collection
(PMN): *	ZONESCAN 820 Solar Alpha
Modelname / HVIN: *	S-ALPHA-5-0-A1
FCC ID:*	ZSSZS820915AL2
IC: *	9789A-ZS820915AL2
Serial number: *	50167
PCB identifier: *	S820-41A 0916-01, ZS820-40A 0916-03
Hardware version: *	A1
Software version: *	A1.20
Lowest internal frequency: *	32.768 kHz

* declared by the applicant.

1.5 Technical data of equipment

Channel 0	RX:	904.000 MHz	TX:	904.000 MHz
Channel 24	RX:	911.200 MHz	TX:	911.200 MHz
Channel 49	RX:	918.700 MHz	TX:	918.700 MHz

Rated RF output power: *	16 dBm					
Antenna type: *	Integral or external					
Antenna gain: *	0 dBi (internal) up to 12 dBi (external)					
Antenna connector: *	Yes					
Adaptive frequency agility: *	No					
Modulation: *	FHSS (GFSK)					
Supply Voltage: *	U_{nom}=	3.3 V DC	U_{min}=	2.6 V DC	U_{max}=	3.6 V DC
Temperature range: *	-30 °C to +70 °C					
Ancillary used for test:	External power supply type enercell CAT: NO. 273-316 for emission measurement on power supply lines.					

* declared by the applicant.

The following external I/O cables were used:

Identification	Connector		Length *
	EUT	Ancillary	
DC power	3 pole M8 plug	-	2 m
External SRD-antenna	RP-TNC male	-	-
External SRD-antenna	RP-TNC male	-	-
External SRD-antenna	RP-TNC male	-	-

*: Length during the test if no other specified.

1.6 Dates

Date of receipt of test sample:	10/05/2016
Start of test:	10/18/2016
End of test:	11/04/2016

2 Operational states

The tested sample was unmodified and could be configured via the programming interface with the help of a laptop PC with a configuration software (LapView program SolarAlphaTest), which were both supplied by the applicant. After adjusting the operation mode, the connection between the programming interface and the Laptop PC was disconnected. The programming interface is intended to be used for testing purposes only it is located below the shielding of the EUTs RF circuit.

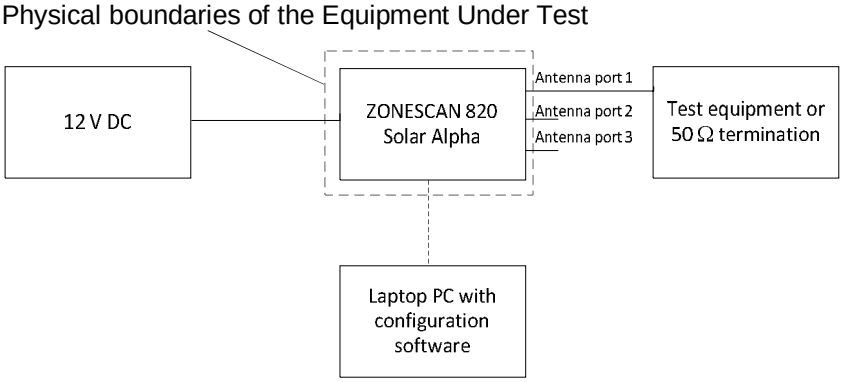
All radiated measurements were carried out with a connection to an external 12 V DC power supply (buffering the internal battery), because preliminary measurements has shown, that the use of an external power supply causes higher emissions than the use of the internal battery without any connection to an external power supply. Furthermore the EUT is intended to be used either with an external power supply or a solar panel.

The EUT uses either the internal antenna or one of the external antenna ports; no simultaneous transmission on more than one RF output port of the EUTs RF circuit is possible. The used antenna port was adjustable with the help of the configuration software

The spurious emission measurements were carried out with the EUT configured operating either with its internal antenna or radiated with all on the external antenna ports terminated with 50 W, because the applicant will not marketing an external antenna in combination with the EUT. Conducted measurements were carried out at the external antenna port, which causes the highest RF output level (port 1); this port number was investigated during a preliminary measurement.

If not otherwise stated the radiated measurements were carried out in normal operation position of the EUT (connectors showing downwards), because of fixed mounting position.

Physical boundaries of the Equipment Under Test



The following test modes were adjusted during the tests:

Test items	Operation	Operation mode
20 dB bandwidth	Transmit with normal modulation on channel 0, 24 or 49	1, 2, 3
Carrier frequency separation	Transmit with normal modulation on channel 0, 24 or 49	1, 2, 3
Number of hopping channels	Transmit with normal modulation, hopping on all channels	4
Dwell time	Transmit with normal modulation on channel 0, 24 or 49	1, 2, 3
Maximum peak output power	Transmit with normal modulation on channel 0, 24 or 49	1, 2, 3
Radiated emissions (transmitter)	Transmit with normal modulation on channel 0, 24 or 49	1, 2, 3
Conducted emissions on supply line	Transmit with normal modulation, hopping on all channels	4

3 Additional information

During the tests the EUT was not labelled as required by FCC / IC.
The EUT contains also a GSM / UMTS transceiver and a GNSS receiver. Measurement results of these parts of the EUT are documented in the test reports F161597E3 and F161597E2. As declared by the applicant, simultaneous transmission of GSM/UMTS part and frequency hopper part of the EUT is not possible.

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS 247, Issue 2 [3] or RSS-Gen, Issue 4 [4]	Status	Refer page
20 dB bandwidth	General	15.247 (a) (1) (i)	5.1 (a) [3]	Passed	8 et seq.
Carrier frequency separation	General	15.247 (a) (1) (i)	5.1 (c) [3]	Passed	11 et seq.
Number of hopping channels	902.0 – 928.0	15.247 (a) (1) (i)	5.1 (c) [3]	Passed	14 et seq.
Dwell time	902.0 – 928.0	15.247 (a) (1) (i)	5.1 (c) [3]	Passed	16 et seq.
Maximum peak output power	902.0 – 928.0	15.247 (b) (2)	5.4 (a) [3]	Passed	19 et seq.
Radiated emissions (transmitter)	0.009 - 10,000	15.247 (d) 15.205 (a) 15.209 (a)	5.5 [3] 8.9 [4]	Passed	22 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	8.8 [4]	Passed	61 et seq.
Antenna requirement	-	15.203 [2]	-	Passed *	-

*: The EUT has an internal antenna and reverse TMC antenna connectors. Furthermore the antenna specifications for the external antenna are defined in the user manual, so the requirement is regarded as fulfilled.

5 Test results

5.1 20 dB bandwidth

5.1.1 Method of measurement (20 dB 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 and the hopping function has to be disenabled, the transmitter shall work with its maximum data rate.

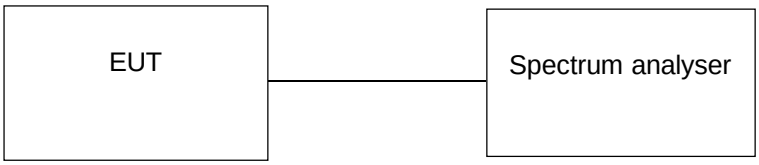
The following spectrum analyser settings according to [1] shall be used:

- Span: App. 2 to 5 times the 20 dB bandwidth, centred on the actual hopping 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 either above the measured peak conducted output power level or 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. Alternatively the 20 dB down function of the spectrum analyser could be used.

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

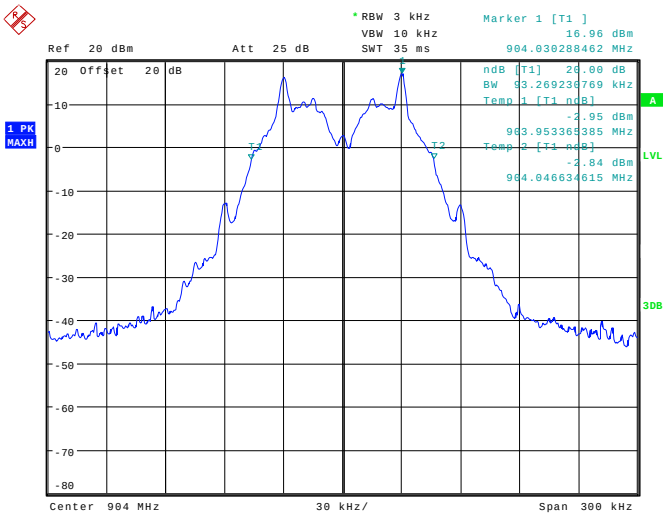
Test set-up:



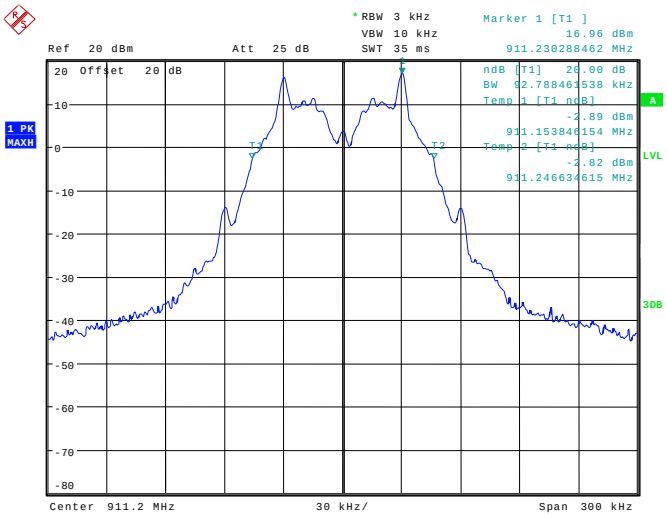
5.1.2 Test results (20 dB bandwidth)

Ambient temperature	22 °C		Relative humidity	37 %

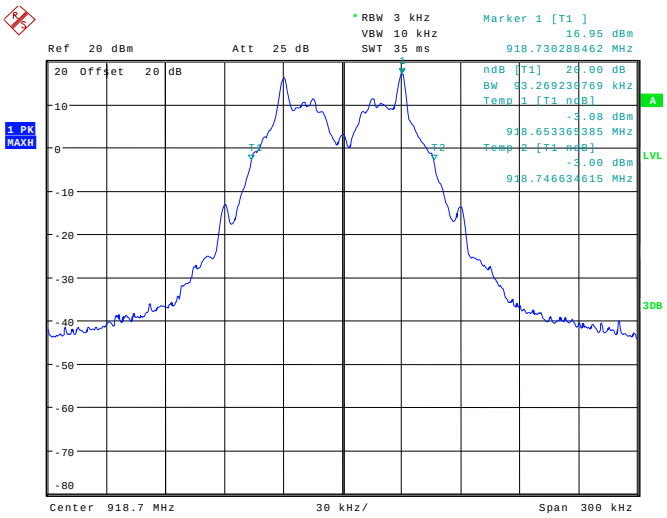
161597_33.wmf: 20 dB bandwidth at the lower end of the assigned frequency band:



161597_32.wmf: 20 dB bandwidth at the middle of the assigned frequency band:



161597_31.wmf: 20 dB bandwidth at the upper end of the assigned frequency band:



Channel number	Channel frequency [MHz]	20 dB bandwidth [kHz]
0	904.000	93.269
24	911.200	92.788
49	918.700	93.269
Measurement uncertainty		+0.66 dB / -0.72 dB

Test equipment used (see chapter 6):

15, 31

5.2 Carrier frequency separation

5.2.1 Method of measurement (carrier frequency separation)

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 and the hopping function has to be enabled.

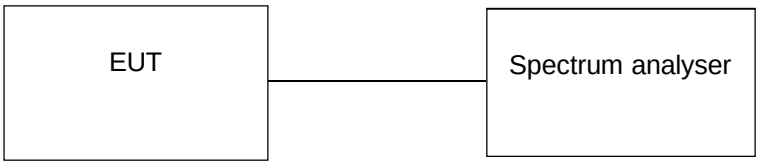
The following spectrum analyser settings according to [1] shall be used:

- Span: Wide enough to capture the peaks of two adjacent channels.
- Resolution bandwidth: Start with the Resolution bandwidth set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
- Video bandwidth ≥ Resolution bandwidth.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

After trace stabilisation the marker and the delta marker function will be used to determine the separation between the peaks of two adjacent channel signals.

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

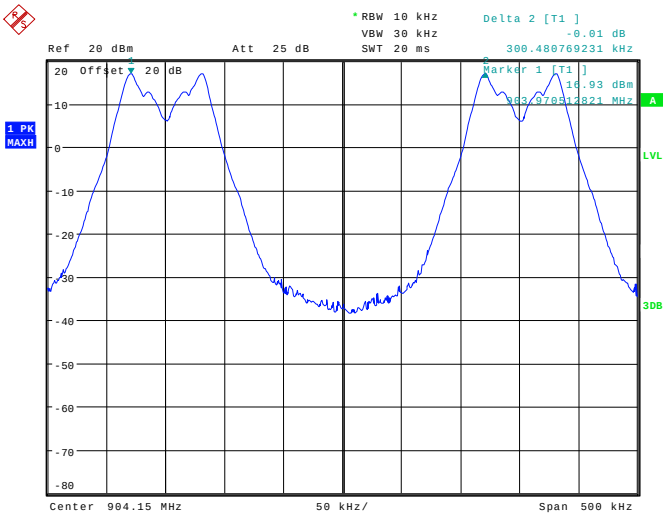
Test set-up:



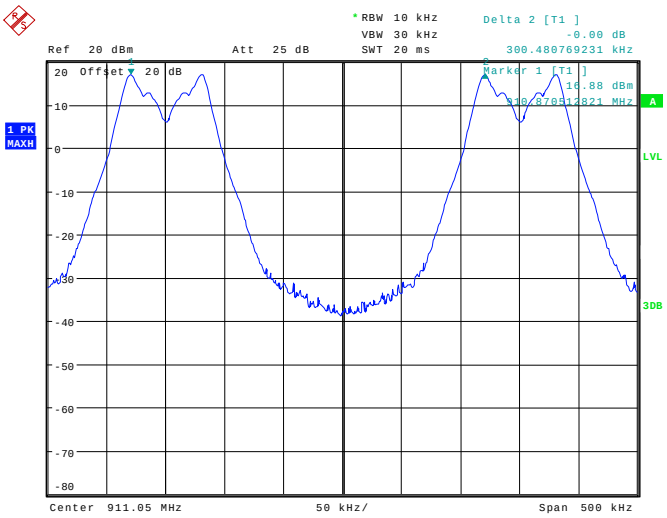
5.2.2 Test results (carrier frequency separation)

Ambient temperature	22 °C		Relative humidity	37 %

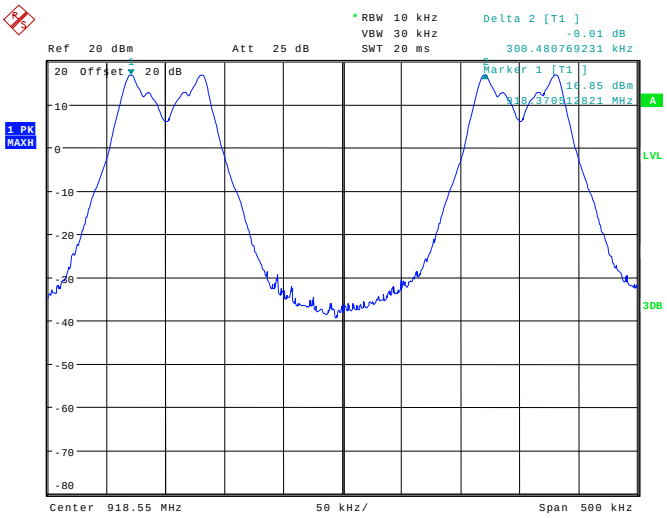
161597_34.wmf: Channel separation at the lower end of the assigned frequency band:



161597_35.wmf: Channel separation at the middle of the assigned frequency band:



161597_36.wmf: Channel separation at the upper end of the assigned frequency band:



Channel number	Channel frequency [MHz]	Channel separation [kHz]	Minimum limit [kHz]
0	904.000	300.481	93.269
24	911.200	300.481	92.788
49	918.700	300.481	93.269
Measurement uncertainty			$<10^{-7}$

Test: Passed

Test equipment used (see chapter 6):

15, 31

5.3 Number of hopping frequencies

5.3.1 Method of measurement (number of hopping frequencies)

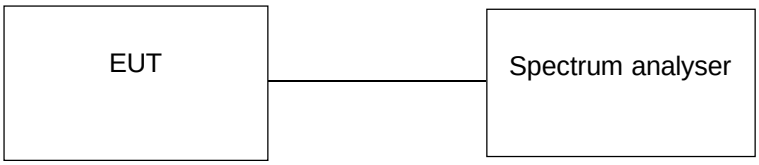
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on and the hopping function has to be enabled.

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

- Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
- Resolution bandwidth: To identify clearly the individual channels, set the Resolution bandwidth to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
- Video bandwidth: ³ the resolution bandwidth.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

After trace stabilisation the number of hopping channels could be counted. It might be possible to divide the span into some sub ranges in order to clearly show all hopping frequencies.

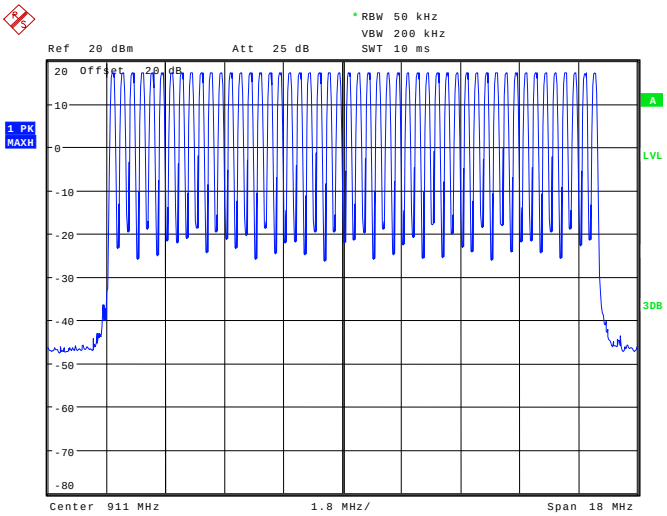
Test set-up:



5.3.2 Test results (number of hopping frequencies)

Ambient temperature	22 °C	Relative humidity	37 %

161597_37.wmf: Number of hopping channels:



Number of hopping channels	Limit
50	At least 50

Test: Passed

Test equipment used (see chapter 6):

15, 31

5.4 Dwell time

5.4.1 Method of measurement (dwell time)

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 and the hopping function has to be enabled.

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

- Span: Zero, centred on a hopping channel.
- Resolution bandwidth shall be ≤ channel spacing and where possible Resolution bandwidth should be set >> 1 / *T*, where *T* is the expected dwell time per channel.
- Video bandwidth: ³ the resolution bandwidth.
- Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
- Detector function: peak.
- Trace mode: Max hold.

The marker and delta marker function of the spectrum analyser will be used to determine the dwell time.

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

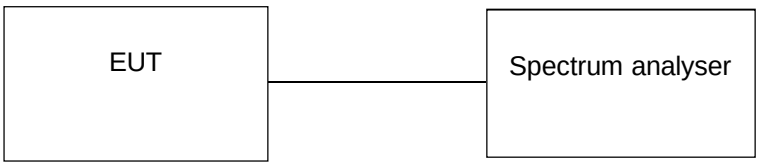
Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

(Number of hops in the period specified in the requirements) =
(number of hops on spectrum analyzer) × (period specified in the requirements / analyzer sweep time)

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.

The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

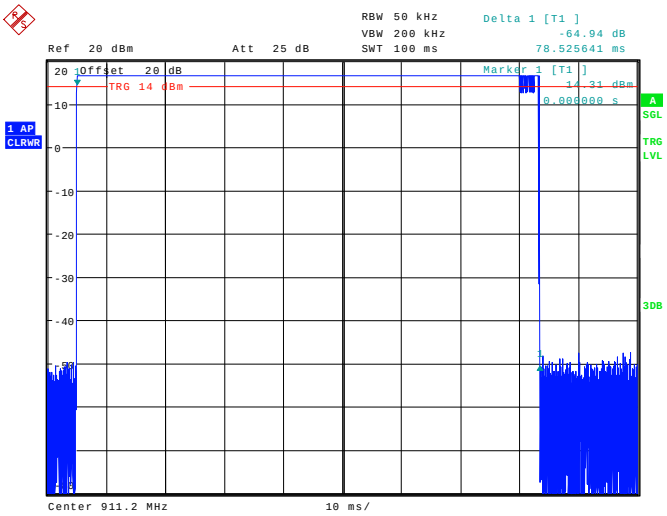
Test set-up:



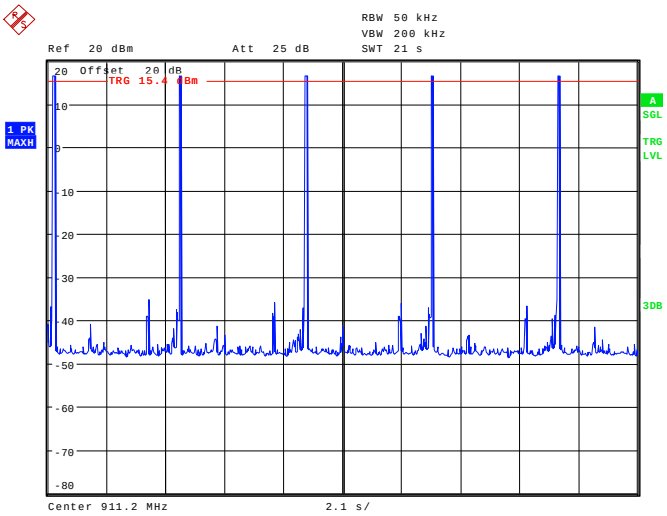
5.4.2 Test results (dwell time)

Ambient temperature	22 °C	Relative humidity	37 %

161597_41.wmf: Dwell time at the middle of the assigned frequency band (single hop):



161597_42.wmf: Dwell time at the middle of the assigned frequency band (21 s sweep):



Channel number	Channel frequency [MHz]	t_{pulse} [ms]	Number of pulses	Dwell time [ms]	Limit [ms]
24	911.200	78.526	5	392.630	400.000
Measurement uncertainty				$<10^{-7}$	

Test: Passed

Test equipment used (see chapter 6):

15, 31

5.5 Maximum peak output power

5.5.1 Method of measurement (maximum peak output power)

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 and the hopping function has to be disenabled.

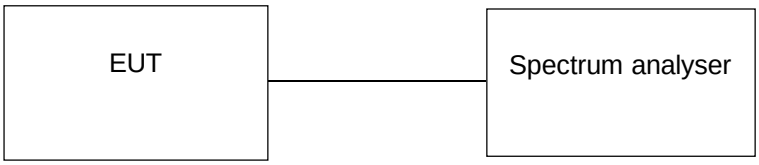
The following spectrum analyser settings according to [1] shall be used:

- Span: Approx. 5 times the 20 dB bandwidth, centred on a hopping channel.
- Resolution bandwidth: > the 20 dB bandwidth of the emission being measured.
- Video bandwidth: ³ 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 indicated level is the peak output power, which has to be corrected with the value of the cable loss and an external attenuation (if necessary).

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

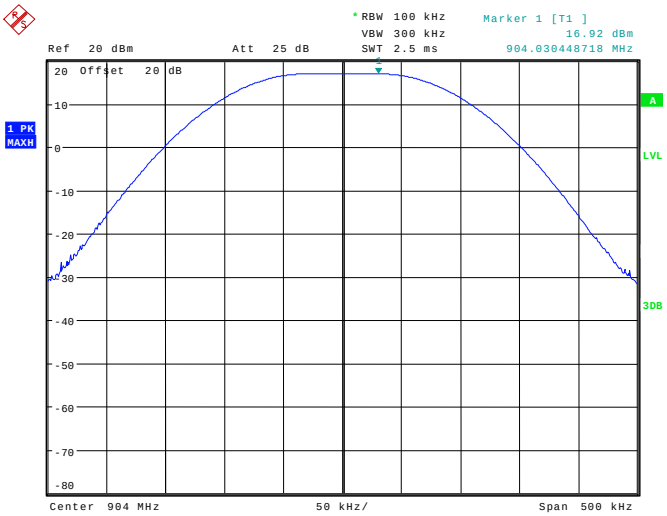
Test set-up:



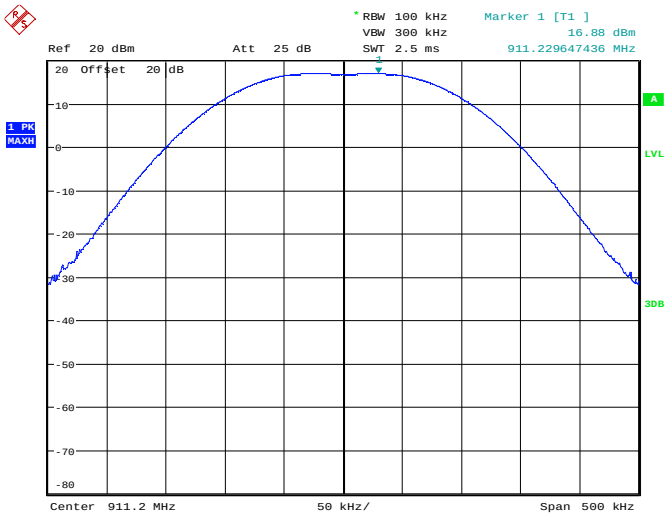
5.5.2 Test results (maximum peak output power)

Ambient temperature	22 °C	Relative humidity	37 %

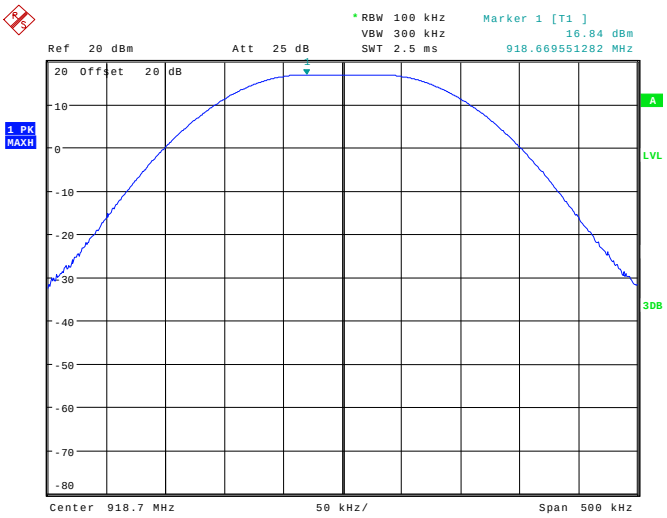
161597_38.wmf: Maximum peak output power at the lower end of the assigned frequency band:



161597_39.wmf: Maximum peak output power at the middle of the assigned frequency band:



161597_40.wmf: Maximum peak output power at the upper end of the assigned frequency band:



Operation mode	Channel number	Channel frequency [MHz]	Maximum peak output power [dBm]	Antenna gain [dBi]	Peak power limit [dBm]
1	0	904.000	16.9	12.0	24.0
2	24	911.200	16.9	12.0	24.0
3	49	918.700	16.8	12.0	24.0
Measurement uncertainty				+0.66 dB / -0.72 dB	

Test: Passed

Test equipment used (see chapter 6):

15, 31

5.6 Radiated emissions

5.6.1 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 heights 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.

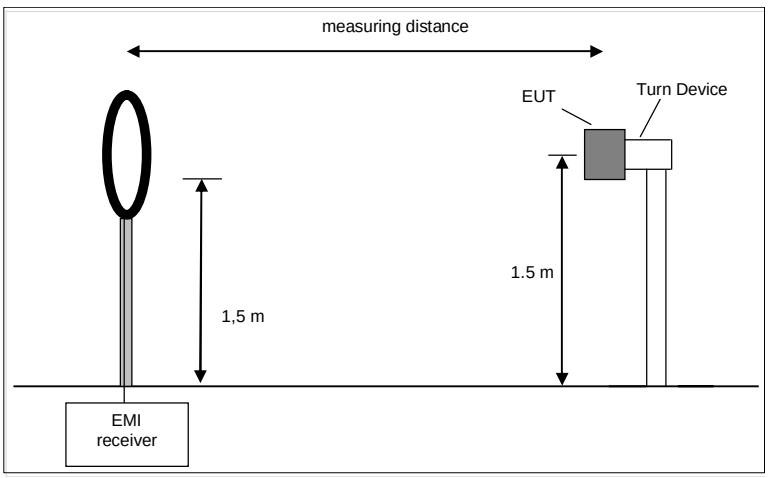
Preliminary measurement (9 kHz to 30 MHz):

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 set up 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).

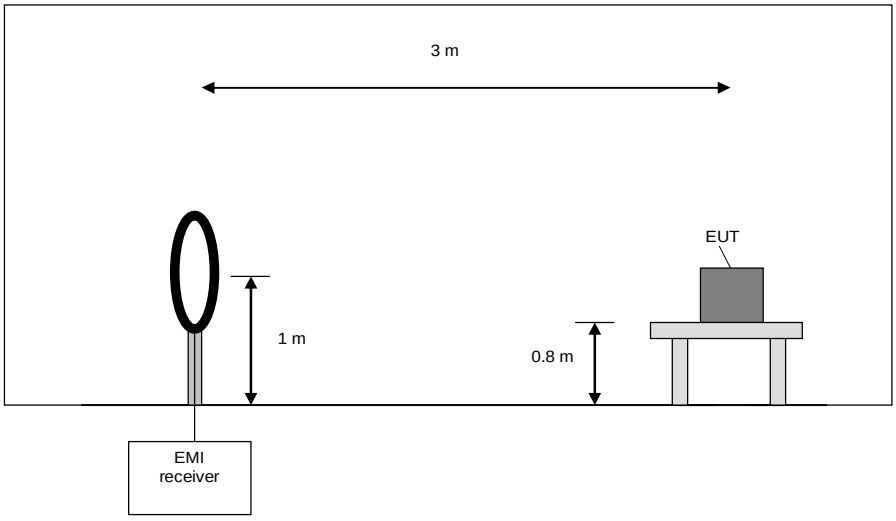
Final measurement (9 kHz to 30 MHz):

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).

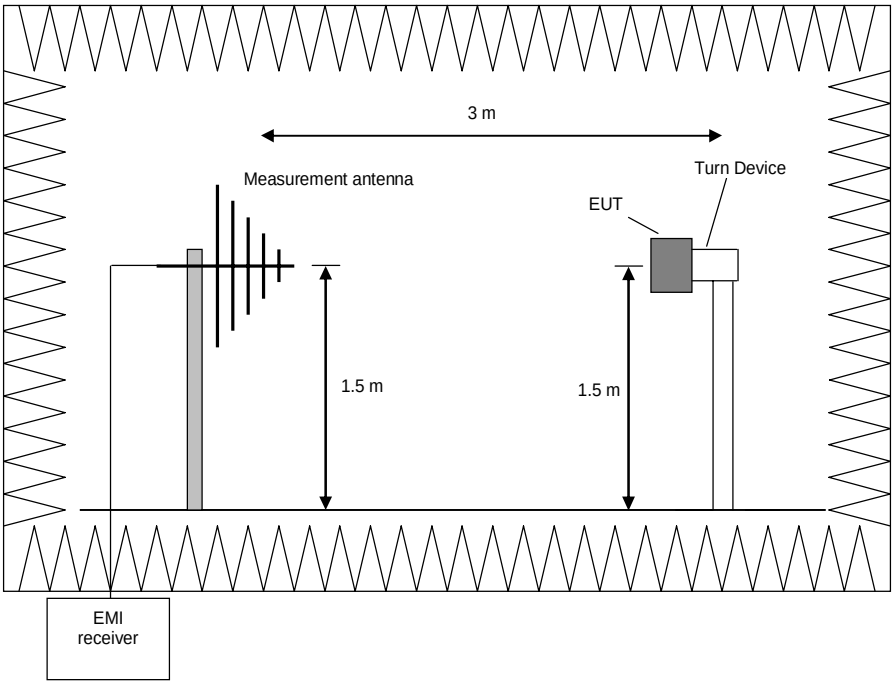
Preliminary measurement (30 MHz to 1 GHz)

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:

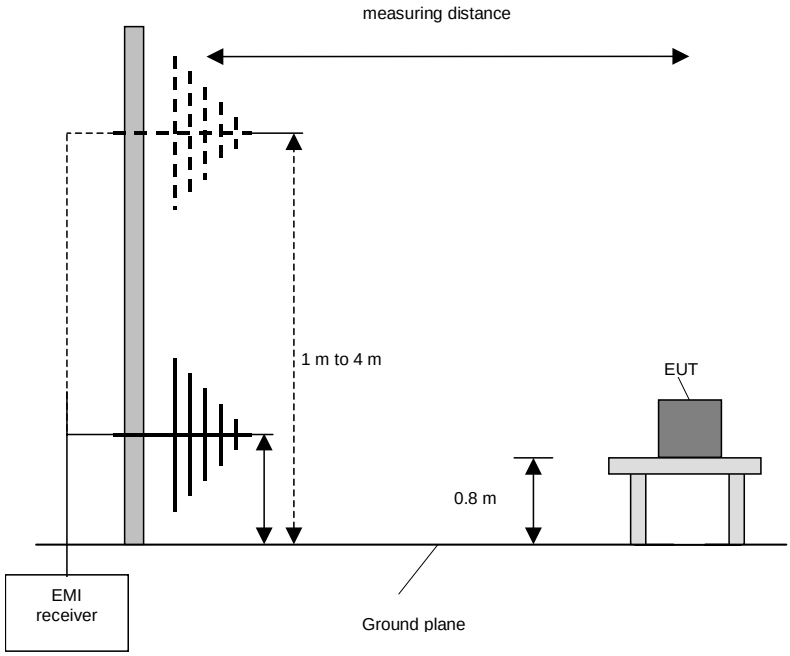
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Repeat 1) to 3) with the vertical polarisation of the measuring 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)

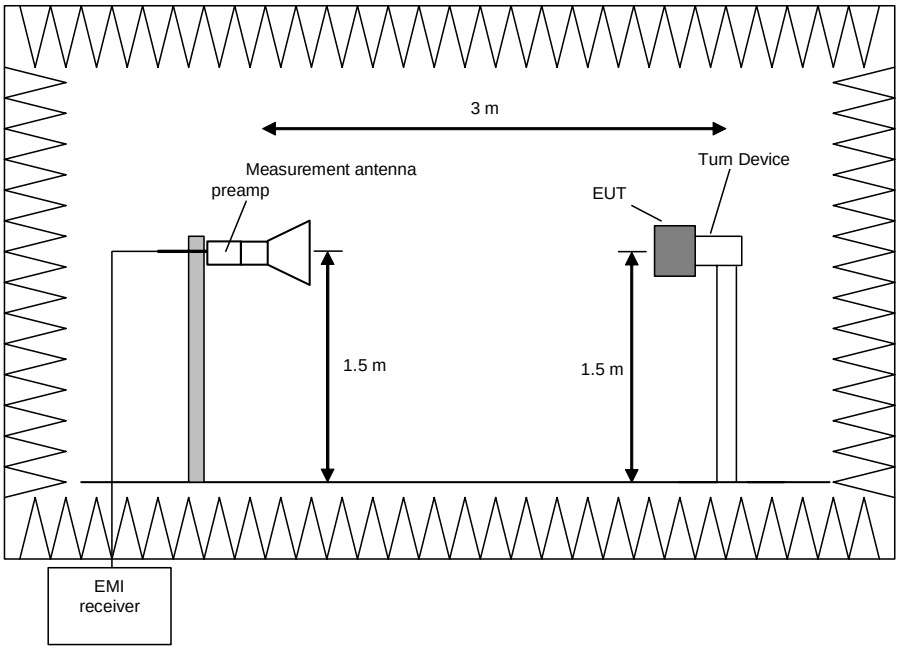
This measurement will be performed in a fully anechoic chamber. Table top devices will set up on a non-conducting turn device on the height of 1.5 m. The set-up of the Equipment under test will be in accordance to [1].

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:

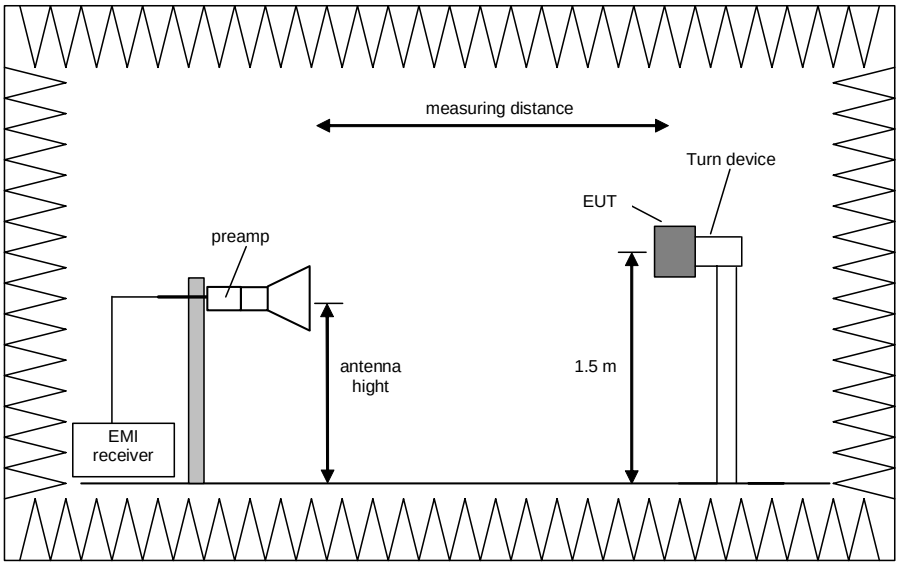
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Rotate the EUT by 360° to maximize the detected signals.
3. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
4. Make a hardcopy of the spectrum.
5. Repeat 1) to 4) with the EUT raised by an 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.

5.6.2 Test results (radiated emissions)

5.6.2.1 Preliminary radiated emission measurement with internal antenna

Ambient temperature	22 °C	Relative humidity	50 %

Position of EUT: The EUT was set-up on the positioner at 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.

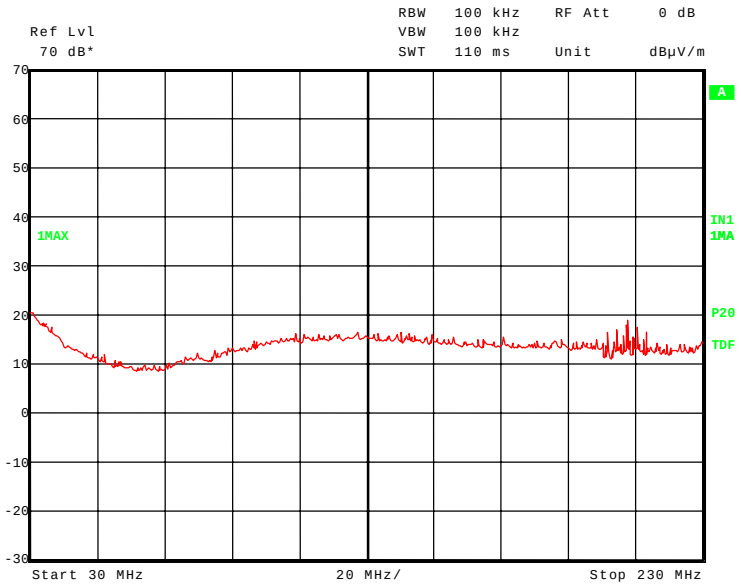
Supply voltage: During all measurements the EUT was supplied 3.3 V DC by the internal battery.

Frequency range: The preliminary measurement was carried out in the frequency range 9 kHz to 10 GHz according to [2].

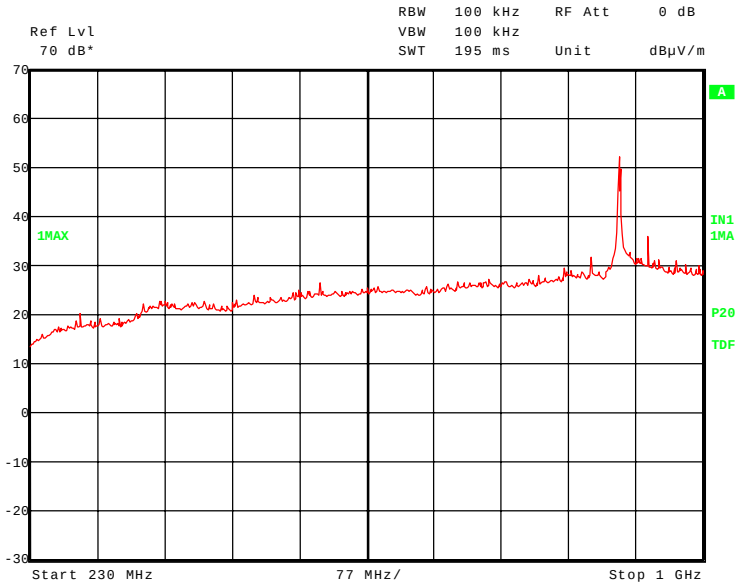
Remark: As pre-tests have shown, the emissions in the frequency range 9 kHz to 30 MHz are not depending on the transmitter operation mode. Therefore the emissions in this frequency range were measured only with the transmitter operates in operation mode 2.

Transmitter operates at the lower end of the assigned frequency band (operation mode 1)

161597_2.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 1):



161597_1.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 1, carrier notched):



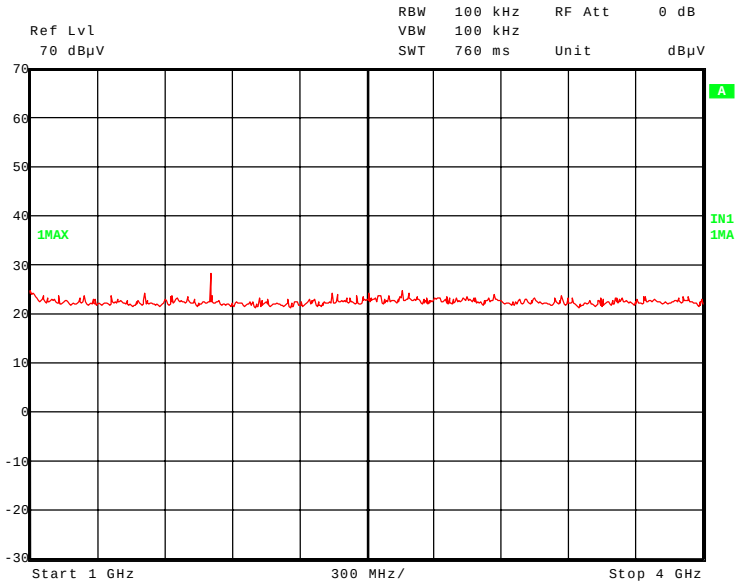
No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

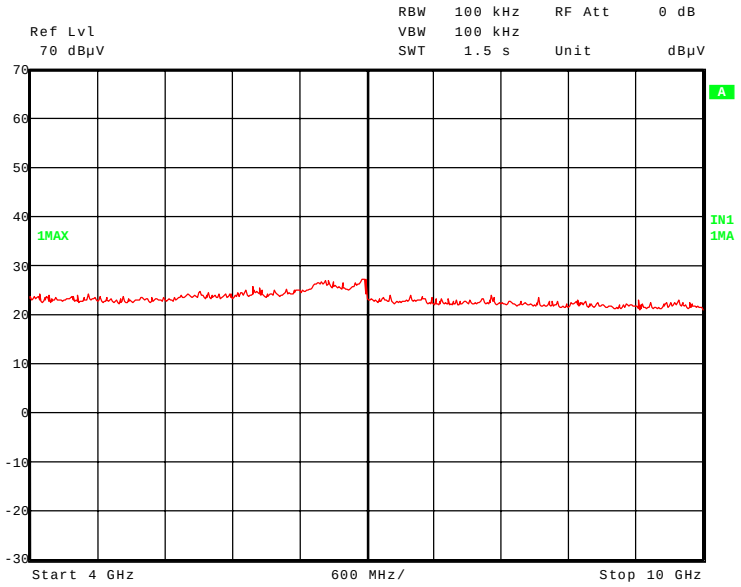
- 207.192 MHz, 271.981 MHz, 904.000MHz and 936.032 MHz.

These frequencies have to be measured on the open area test site. The result is presented in the following.

161597_11.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



161597_12.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 1):



No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

- 1808.000 MHz.

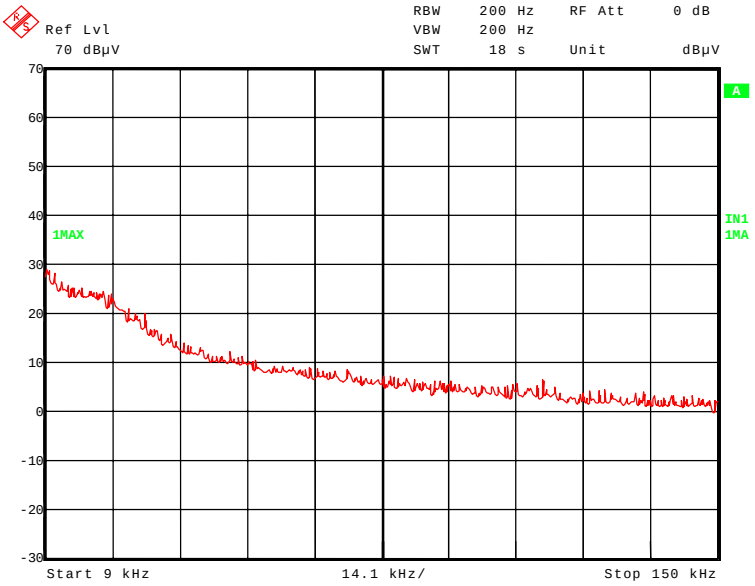
These frequencies have to be measured in a final measurement. The results were presented in the following.

Test equipment used (see chapter 6):

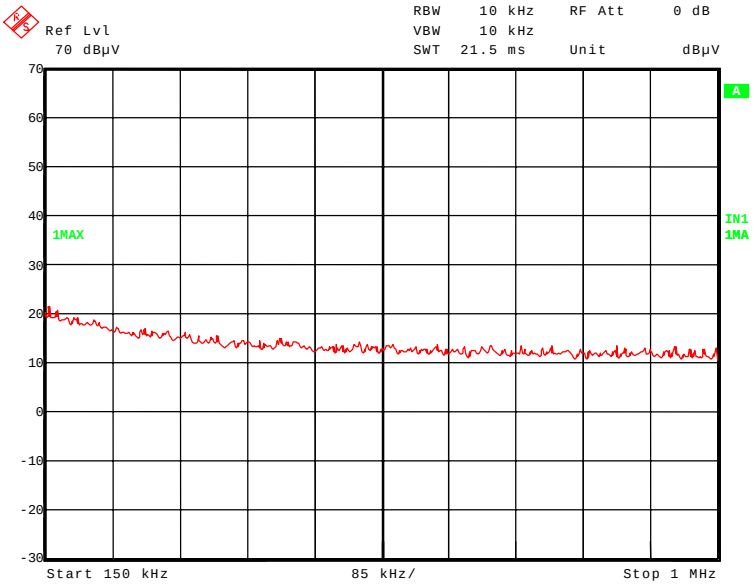
14, 16 - 30

Transmitter operates on the middle of the assigned frequency band (operation mode 2)

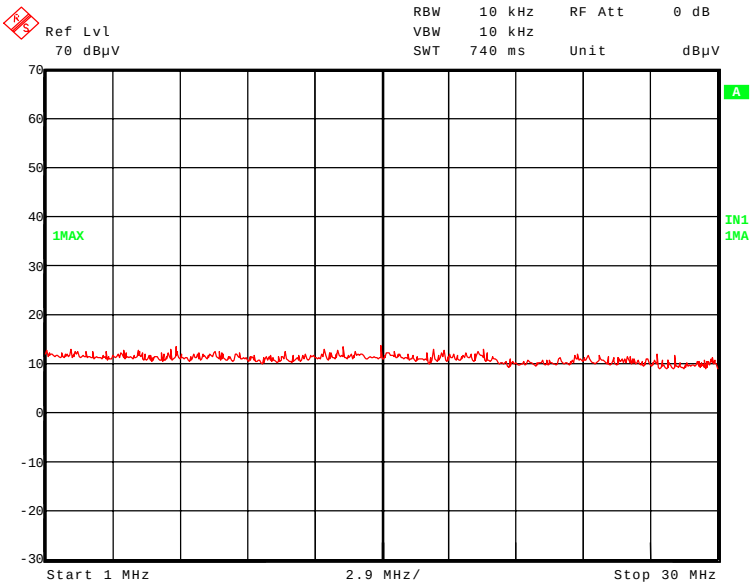
161597_13.wmf: Spurious emissions from 9 kHz to 150 kHz (operation mode 2):



161597_14.wmf: Spurious emissions from 150 kHz to 1 MHz (operation mode 2):

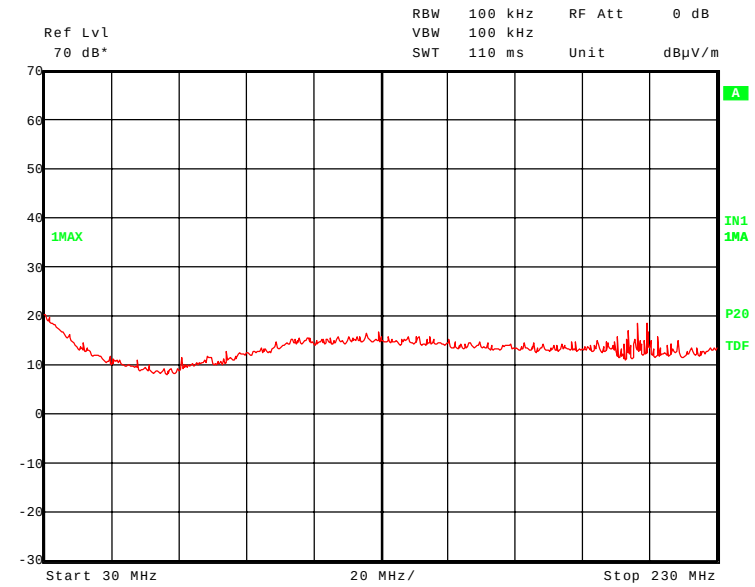


161597_15.wmf: Spurious emissions from 1 MHz to 30 MHz (operation mode 2):

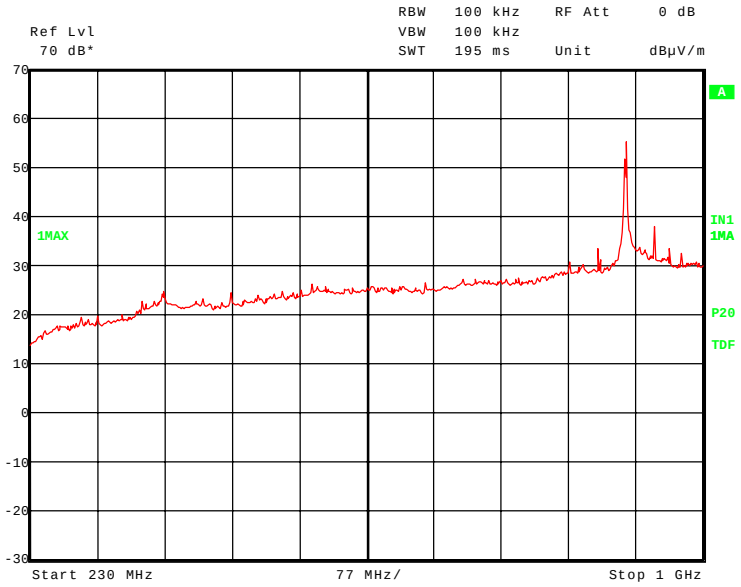


No significant frequencies above the noise floor of the system (max 30 dBµV/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

161597_4.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 2):



161597_3.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 2, carrier notched):



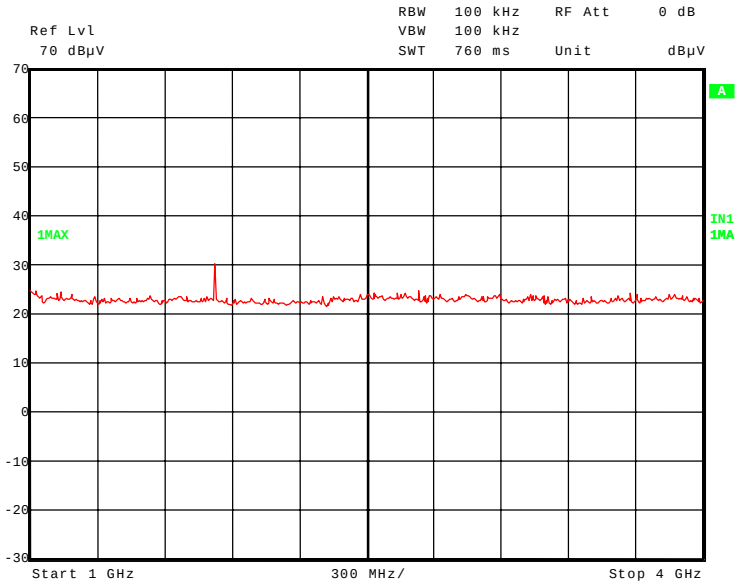
No emissions were found inside the restricted bands during the preliminary radiated emission test.

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

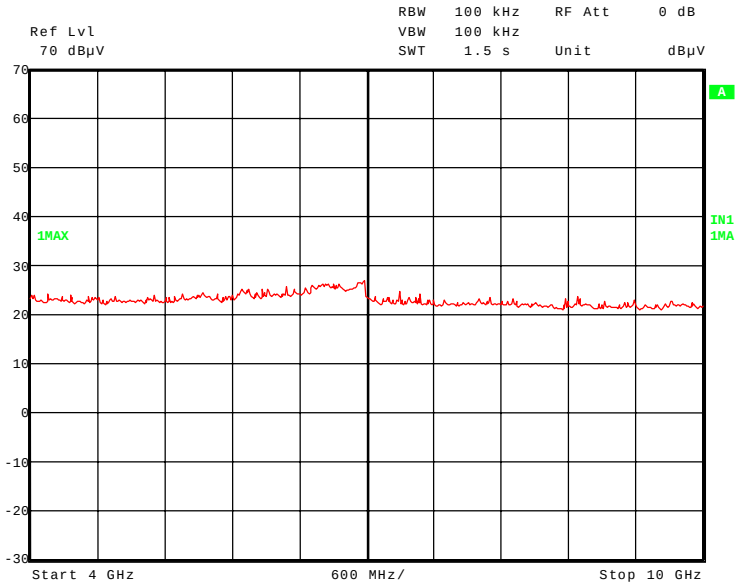
- 206.197 MHz, 382.364 MHz, 879.190 MHz, 911.200 MHz, 943.164 MHz and 959.992 MHz

These frequencies have to be measured on the open area test site. The result is presented in the following.

161597_10.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



161597_9.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 2):



No emissions were found inside the restricted bands during the preliminary radiated emission test.

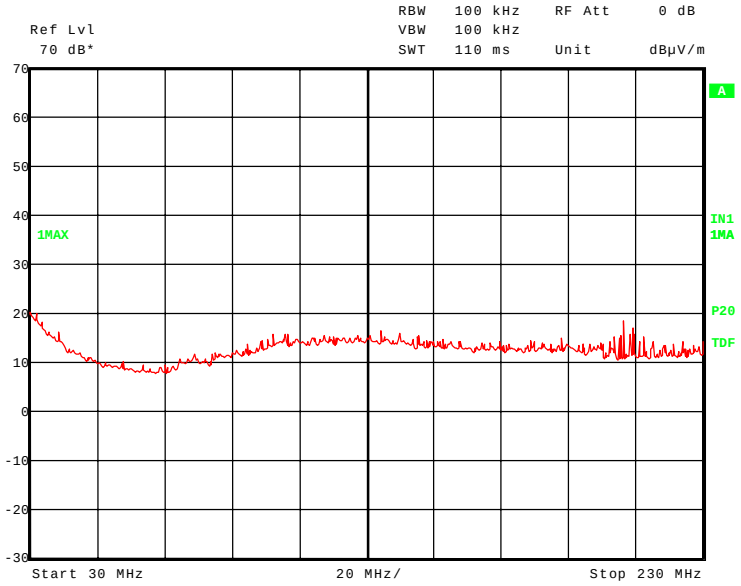
The following frequency was were found outside the restricted bands during the preliminary radiated emission test:

- 1822.400 MHz.

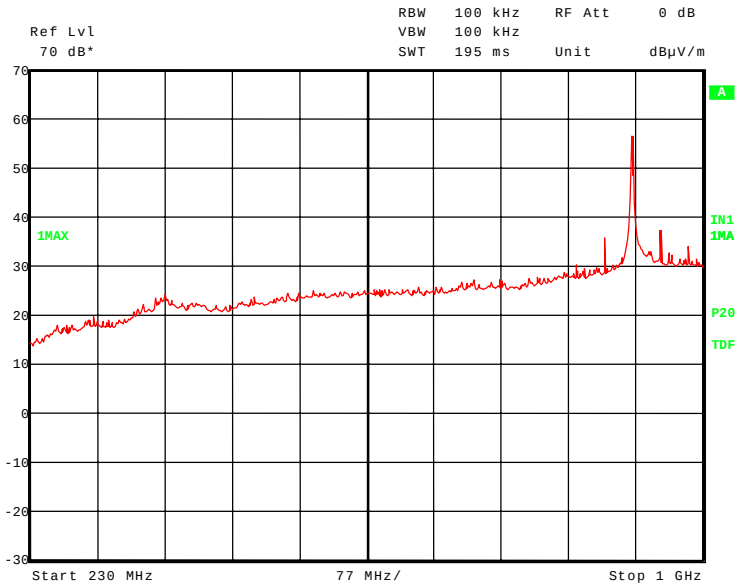
These frequencies have to be measured in a final measurement. The results were presented in the following.

Transmitter operates on the upper end of the assigned frequency (operation mode 3)

161597_5.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 3):



161597_6.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 3, carrier notched):



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

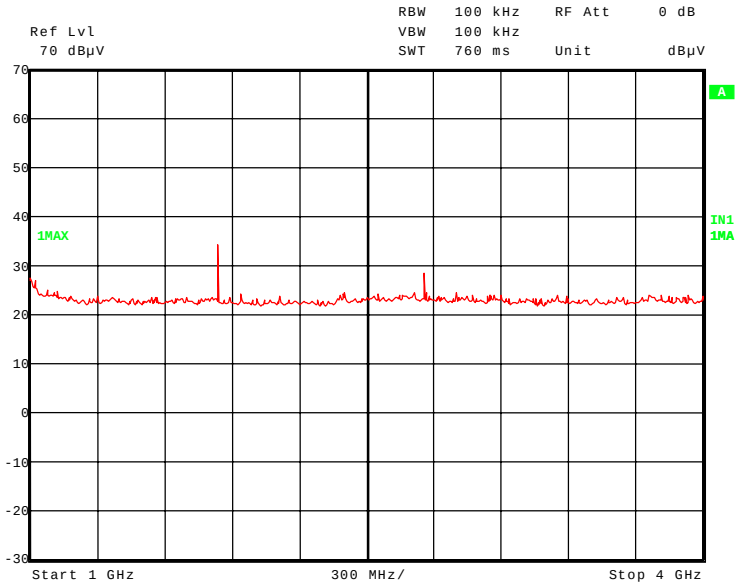
- 982.651 MHz

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

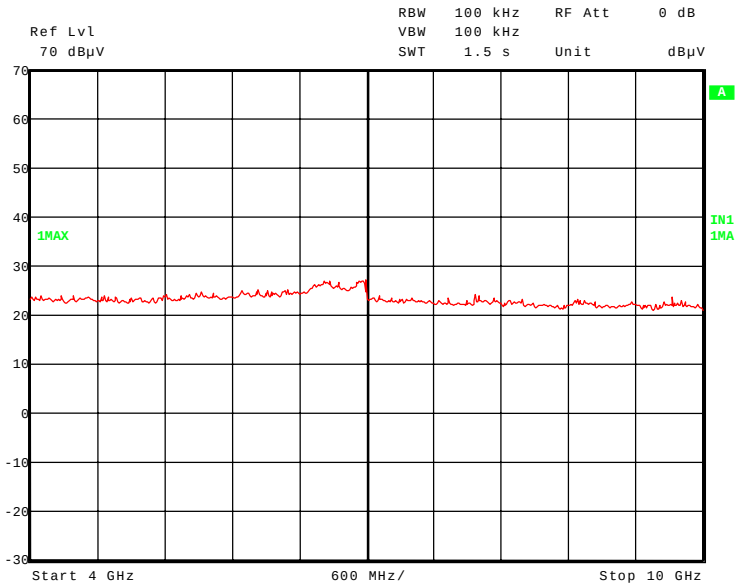
- 206.197 MHz, 886.715 MHz, 918.700 MHz and 950.683 MHz.

These frequencies have to be measured on the open area test site. The result is presented in the following.

161597_7.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



161597_8.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 3):



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

- 2756.100

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

- 1837.400 MHz

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

5.6.2.2 Final radiated emission measurement (9 kHz to 30 MHz) with internal antenna

No significant frequencies above the noise floor of the system (max. 30 dBµV/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.

5.6.2.3 Final radiated emission measurement (30 MHz to 1 GHz) with internal antenna

Ambient temperature	22 °C	Relative humidity	40 %

Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 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 3.6 V DC by the internal battery, which was buffered by an external power supply with 12 V DC.

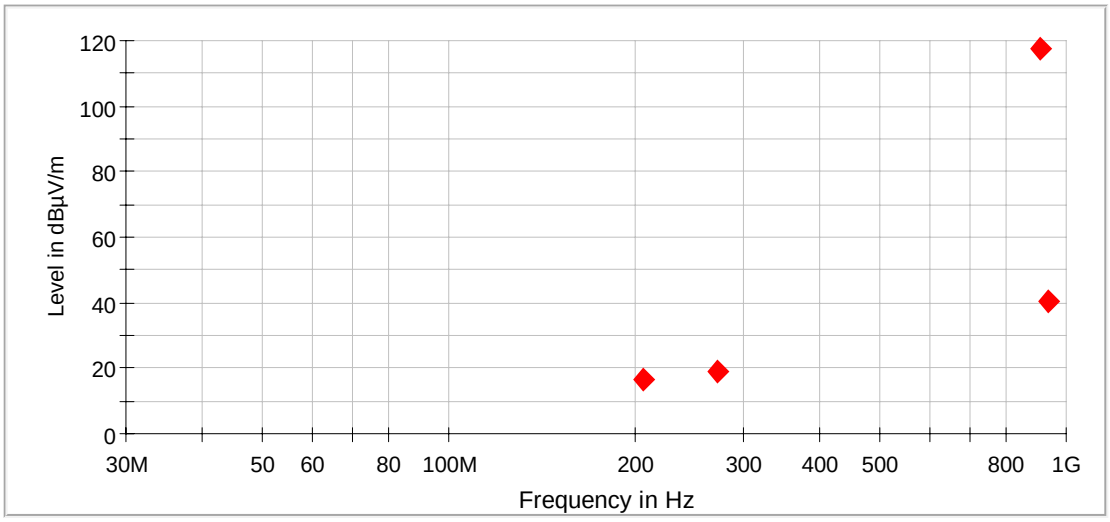
Test results: The test results were calculated with the following formula:

Result [dBµV/m] = reading [dBµV] + cable loss [dB] + antenna factor [dB/m] + 6 dB

The measured points and the limit line in the following diagrams refer to the standard measurement of the emitted interference in compliance with the above-mentioned standard. The measured points marked with an x are the measured results of the standard final measurement on the open area test site.
The results of the standard subsequent measurement on the open area test site are indicated in the table below. The limits as well as the measured results (levels) refer to the above mentioned standard while taking account of the specified requirements for a 3 m measuring distance.

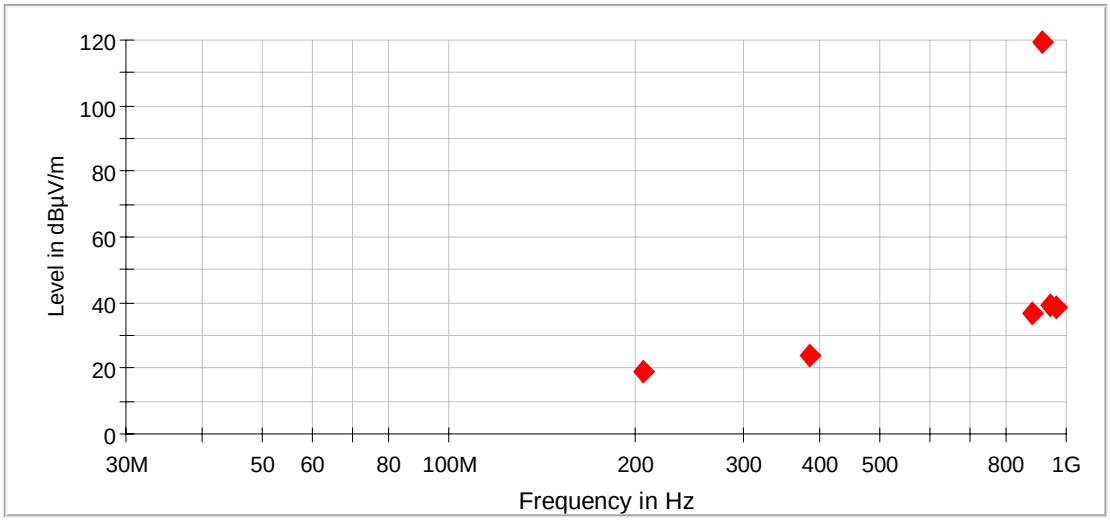
The measurement time with the quasi-peak measuring detector is 1 second.

Transmitter operates on the lower end of the assigned frequency (operation mode 1)



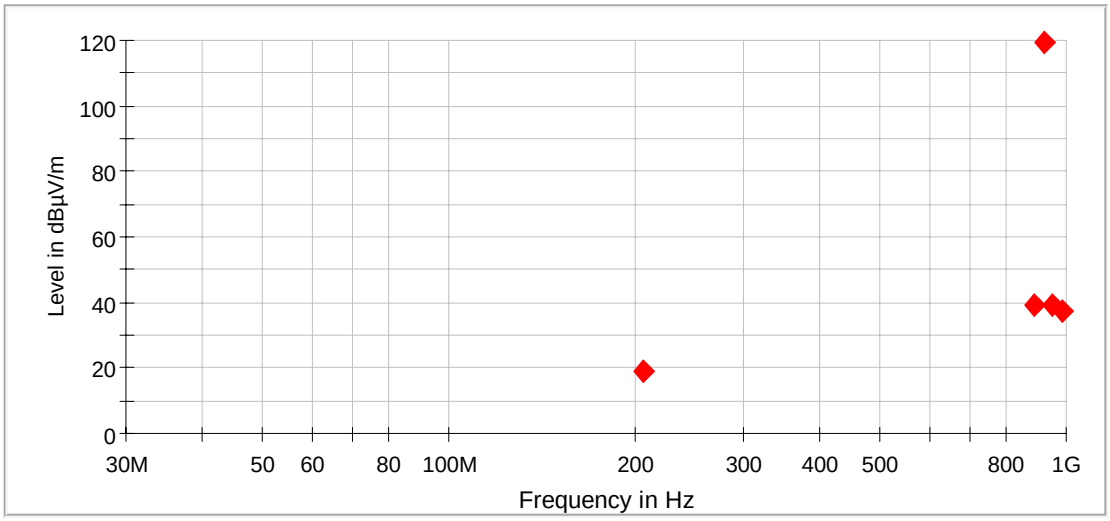
Data record name: 161597low

Transmitter operates on the middle of the assigned frequency (operation mode 2)



Data record name: 161597mid

Transmitter operates on the upper end of the assigned frequency (operation mode 3)



◆ Final_Result QPK

Data record name: 161597high

Result measured with the quasi-peak detector:
(These values were marked in the diagrams by an ◆)

Transmitter operates on the lower end of the assigned frequency band (operation mode 1)										
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Restr. Band
207.192	16.4	97.7	81.3	1000.0	120.000	102.0	V	30.0	18.9	N
271.981	18.9	46.0	27.1	1000.0	120.000	107.0	V	9.0	21.4	Y
904.000	117.7	Carrier	-	1000.0	120.000	107.0	V	318.0	34.6	-
936.032	40.3	99.4	59.1	1000.0	120.000	100.0	V	105.0	36.0	N
Transmitter operates on the middle of the assigned frequency band (operation mode 2)										
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Restr. Band
206.197	19.1	99.4	80.3	1000.0	120.000	150.0	H	102.0	18.8	N
382.634	24.0	99.4	75.4	1000.0	120.000	103.0	H	61.0	24.8	N
879.190	36.8	99.4	62.6	1000.0	120.000	109.0	V	351.0	34.1	N
911.200	119.4	Carrier	-	1000.0	120.000	104.0	V	351.0	34.8	-
943.164	39.2	99.5	60.3	1000.0	120.000	150.0	V	354.0	36.1	N
959.992	38.7	99.5	60.8	1000.0	120.000	100.0	V	0.0	36.1	N
Transmitter operates on the upper end of the assigned frequency band (operation mode 3)										
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol.	Azimuth (deg)	Corr. (dB)	Restr. Band
206.197	18.8	99.5	80.7	1000.0	120.000	150.0	H	102.0	18.8	N
886.715	38.9	99.5	60.6	1000.0	120.000	112.0	V	328.0	34.1	N
918.700	119.5	Carrier	-	1000.0	120.000	104.0	V	352.0	35.1	-
950.683	39.2	99.5	60.3	1000.0	120.000	104.0	H	3.0	36.2	N
982.651	37.5	54.0	16.5	1000.0	120.000	100.0	V	6.0	36.0	Y
Measurement uncertainty				+2.2 dB / -3.6 dB						

Test: Passed

Test equipment used (see chapter 6):

6 - 13

5.6.2.4 Final radiated emission measurement (1 GHz to 10 GHz) with internal antenna

Ambient temperature	22 °C	Relative humidity	50 %

Position of EUT: The EUT was set-up on the positioner at 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 3.3 V DC 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:

Result [dBµV/m] = reading [dBµV] + cable loss [dB] + antenna factor [dB/m] – preamp [dB]

Transmitter operates at the lower end of the assigned frequency band (operation mode 2)

Result measured with the peak detector:

Frequency MHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1808.000	38.0	97.7	59.7	34.9	26.5	25.9	2.5	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1808.000	29.8	97.7	67.9	26.7	26.5	25.9	2.5	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Transmitter operates at the middle of the assigned frequency band (operation mode 2)

Result measured with the peak detector:

Frequency MHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1822.400	39.6	99.4	59.8	36.4	26.7	26.1	2.6	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1822.400	31.0	99.4	68.4	27.8	26.7	26.1	2.6	150	Vert.	No
Measurement uncertainty							+2.2 dB / -3.6 dB			

Transmitter operates at the upper end of the assigned frequency band (operation mode 3)

Result measured with the peak detector:

Frequency MHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1837.400	40.8	99.5	58.7	37.4	26.8	26.0	2.7	150	Vert.	No
2756.100	41.6	74.0	32.4	34.9	28.9	25.5	3.3	150	Vert.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Result dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1837.400	34.3	99.5	65.2	30.9	26.8	26.0	2.7	150	Vert.	No
2756.000	32.5	54.0	21.5	25.8	28.9	25.5	3.3	150	Vert.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Test: Passed

Test equipment used (see chapter 6):

14, 16 – 19, 21, 22 – 26, 28

5.6.2.5 Preliminary radiated emission measurement with external antenna port terminated

Ambient temperature	22 °C	Relative humidity	39 %

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.

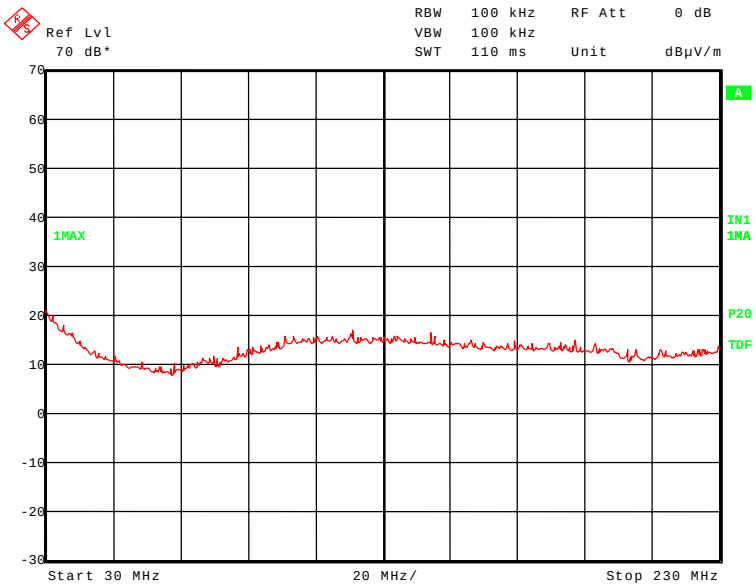
Supply voltage: During all measurements the EUT was supplied 3.6 V DC by the internal battery.

Frequency range: The preliminary measurement was carried out in the frequency range 10 MHz to 10 GHz according to [2].

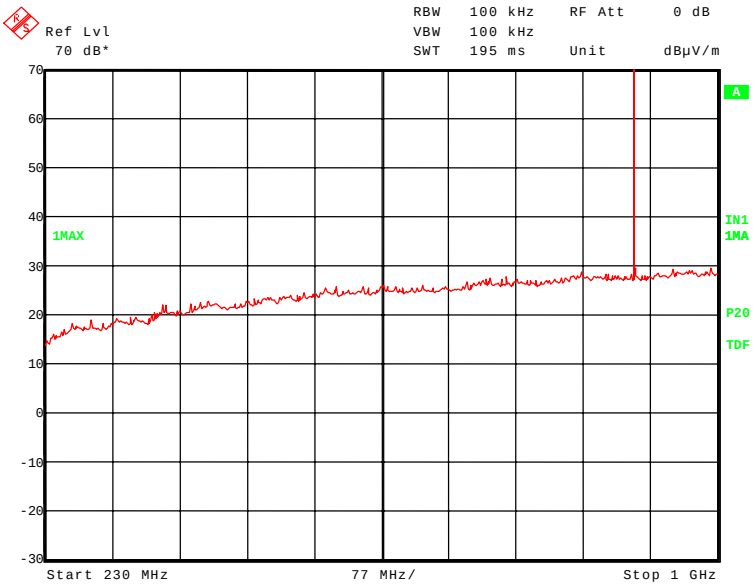
Remark: As pre-tests have shown, the emissions in the frequency range 10 MHz to 30 MHz are not depending on the transmitter operation mode. Therefore the emissions in this frequency range were measured only with the transmitter operates in operation mode 2.

Transmitter operates at the lower end of the assigned frequency band (operation mode 1)

161597_17.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 1):

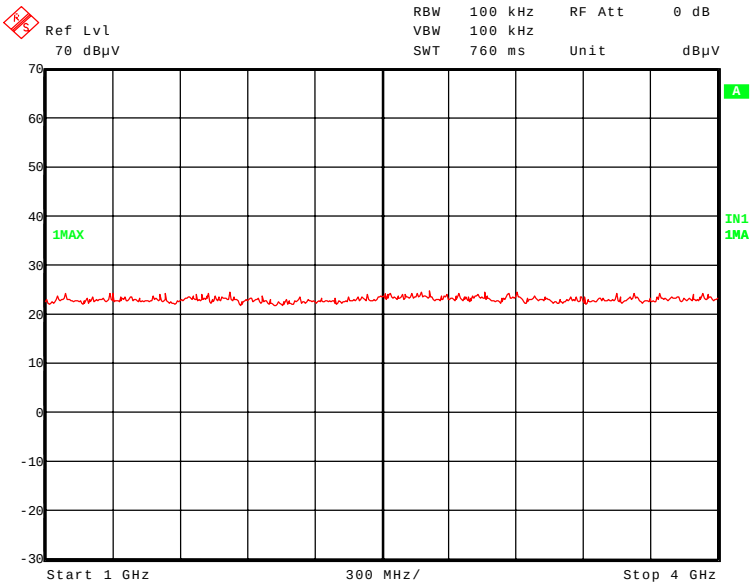


161597_16.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 1):

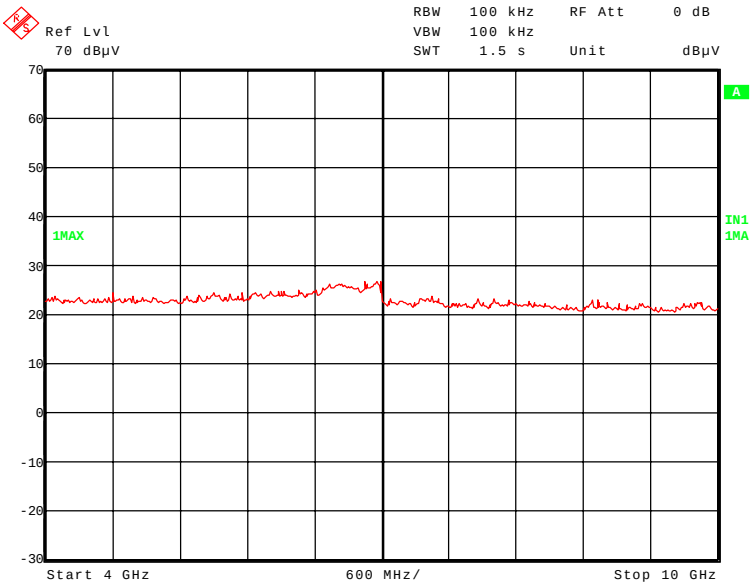


No significant frequencies (except the wanted signal) above the noise floor of the system (max 28.5 dBµV/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

161597_28.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



161597_27.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 1):



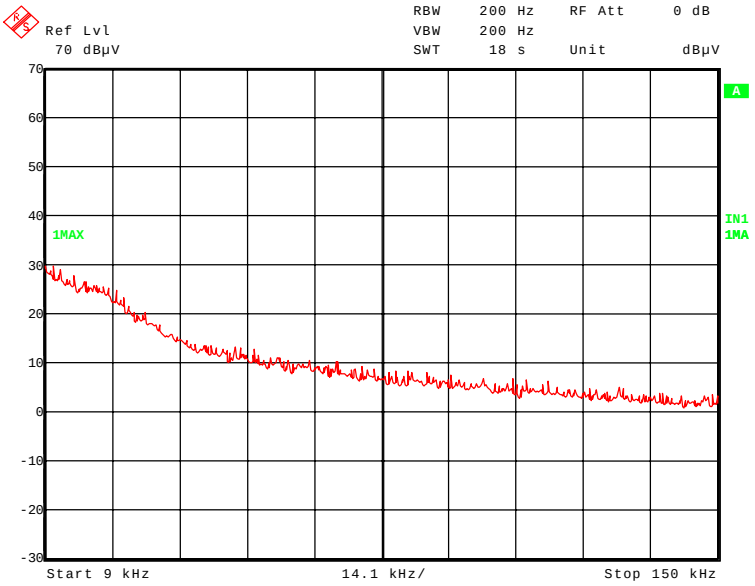
No significant frequencies (except the wanted signal) above the noise floor of the system (max 28.5 dBµV/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

Test equipment used (see chapter 6):

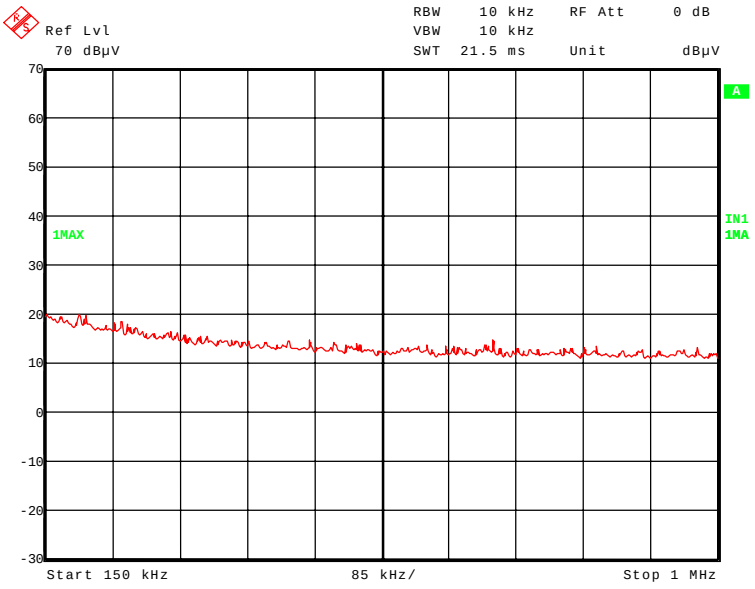
14, 16 - 30

Transmitter operates on the middle of the assigned frequency band (operation mode 2)

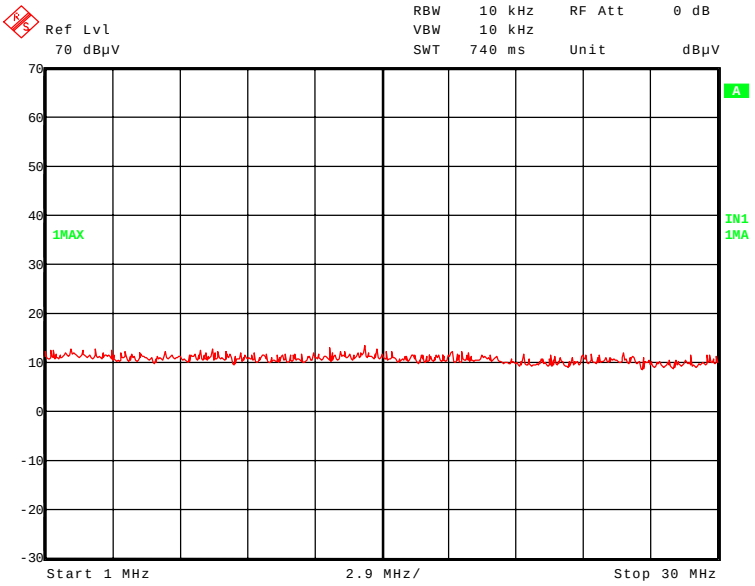
161597_22.wmf: Spurious emissions from 9 kHz to 150 kHz (operation mode 2):



161597_23.wmf: Spurious emissions from 150 kHz to 1 MHz (operation mode 2):

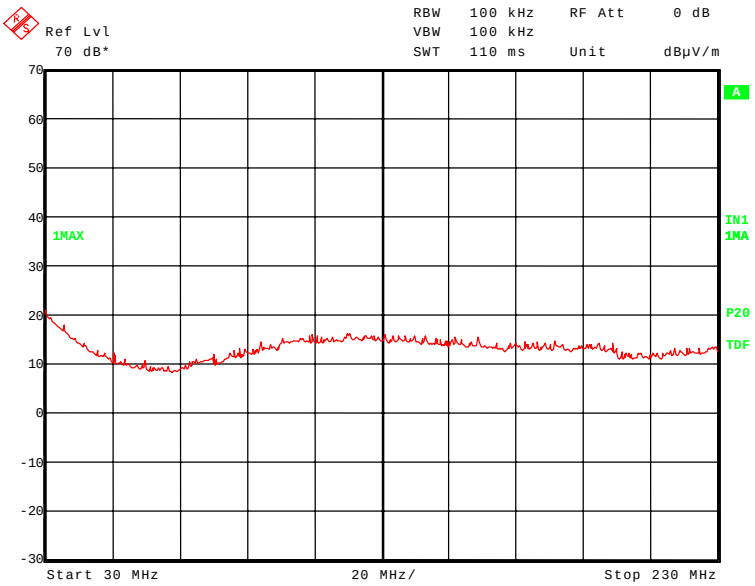


161597_24.wmf: Spurious emissions from 1 MHz to 30 MHz (operation mode 2):

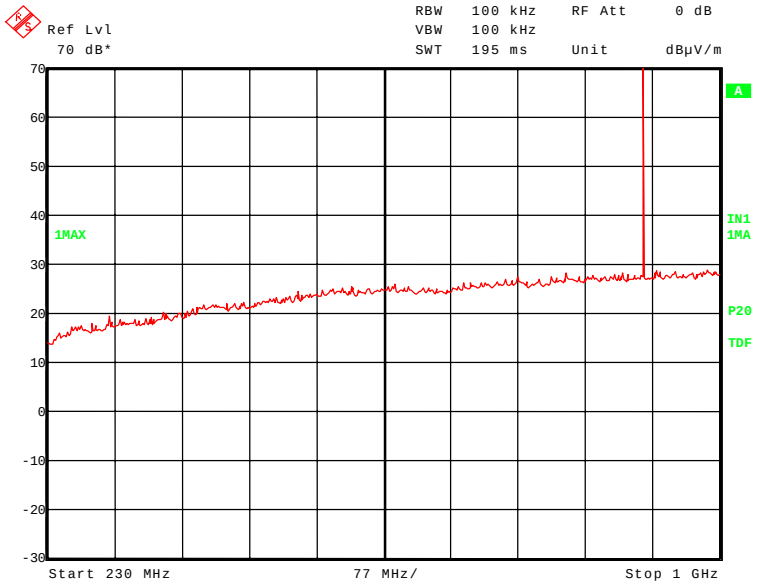


No significant frequencies above the noise floor of the system (max. 30 dBµV/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

161597_18.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 2):

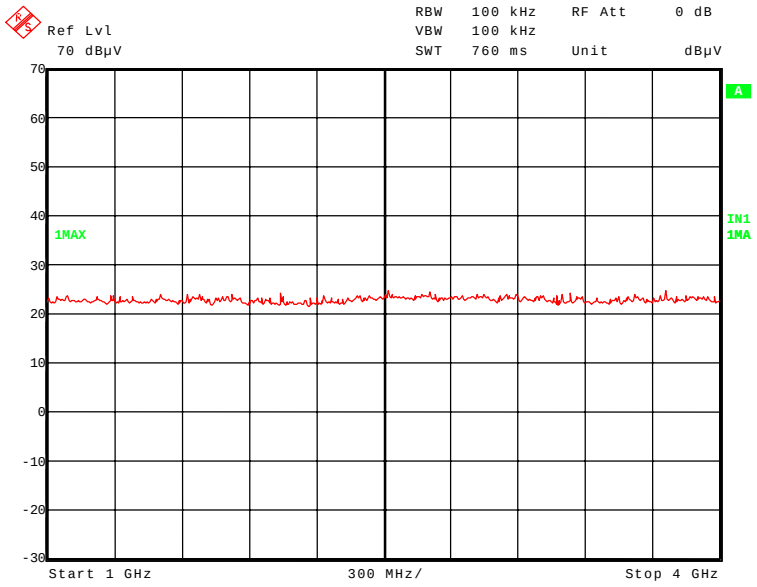


161597_19.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 2, carrier notched):

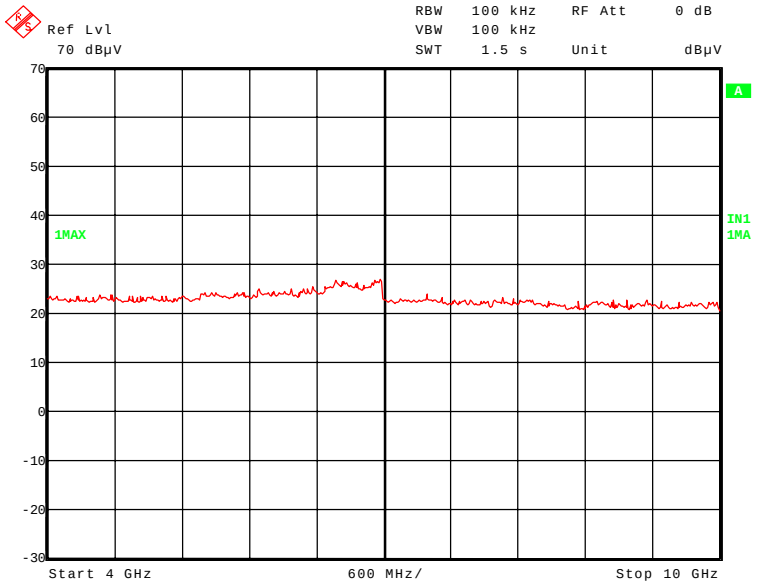


No significant frequencies (except the wanted signal) above the noise floor of the system (max 28.5 dBµV/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

161597_25.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



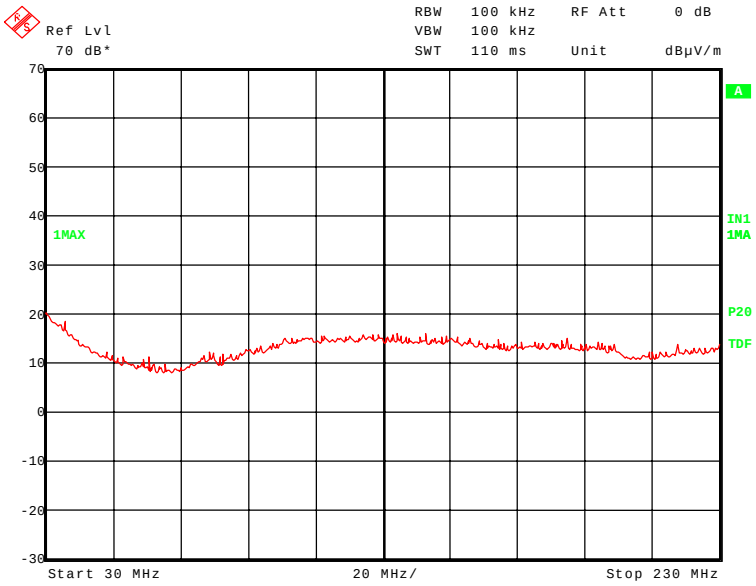
161597_26.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 2):



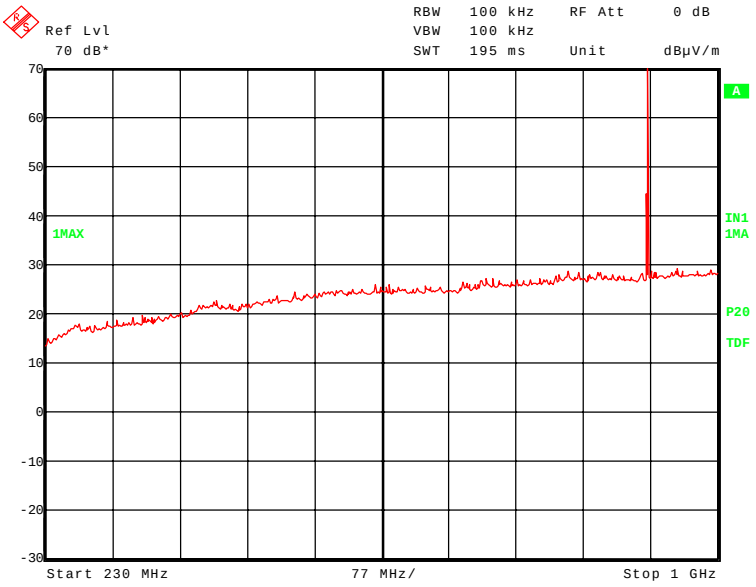
No significant frequencies above the noise floor of the system (max. 40 dBµV/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no final measurements were carried in this operation mode.

Transmitter operates on the upper end of the assigned frequency (operation mode 3)

161597_21.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 3):

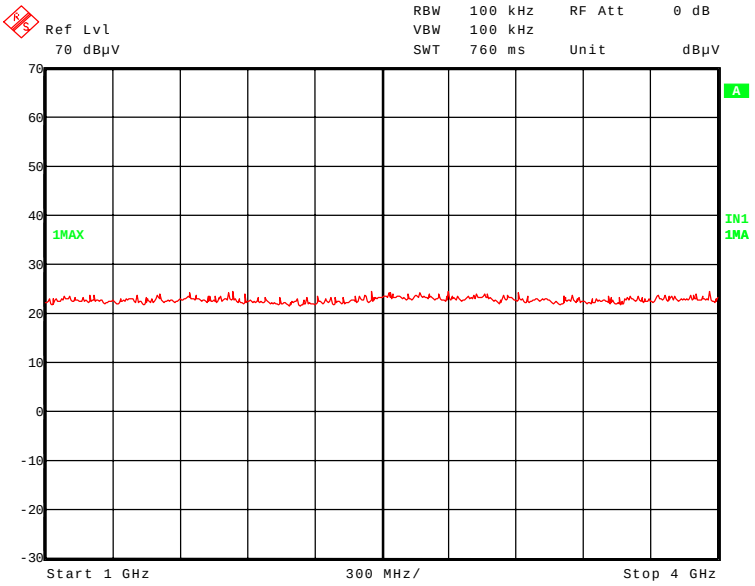


161597_20.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 3):

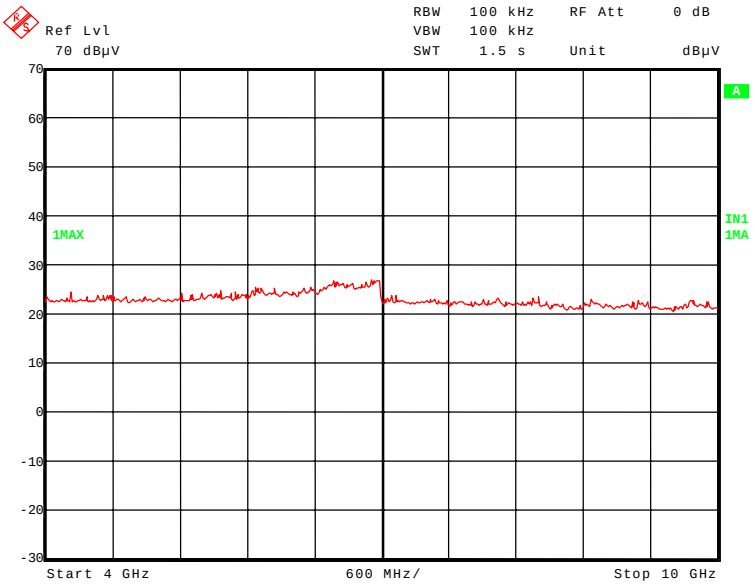


No significant frequencies (except the wanted signal) above the noise floor of the system (max 28.5 dBµV/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no measurements were carried out on the open area test site.

161597_29.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



161597_30.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 3):



No significant frequencies above the noise floor of the system (max. 40 dBµV/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no final measurements were carried in this operation mode.

5.6.2.7 Final radiated emission measurement (9 kHz to 30 MHz) with external antenna port terminated

No significant frequencies above the noise floor of the system (max. 30 dBµV/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.

5.6.2.8 Final radiated emission measurement (30 MHz to 1 GHz) with external antenna port terminated

No significant frequencies (except the wanted signal) above the noise floor of the system (max 28.5 dBµV/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.

5.6.2.9 Final radiated emission measurement (1 GHz to 10 GHz) with external antenna port terminated

No significant frequencies above the noise floor of the system (max. 40 dBµV/m (measured with peak detector) at 3 m distance) were found during the preliminary radiated emission test, so no final measurements were carried in this operation mode.

5.8 Conducted emissions on antenna port

5.8.1 Method of measurement (conducted emissions in the restricted bands)

The relating measurements were carried out in a conducting manner. Therefore, the antenna connector was directly mounted to a spectrum analyser. The measurement procedure refers to part 11.12.2.2 in document [1].

If emissions were detected during the preliminary measurements, they were measured using the following measurement procedures:

Procedure for average measurement: 11.12.2.5.2 – Trace averaging across ON and OFF times of the EUT transmissions followed by duty cycle correction:

If continuous transmission of the EUT (D ≥ 98%) cannot be achieved and the duty cycle is constant (duty cycle variations are less than ±2%), then the following procedure shall be used:

- The EUT shall be configured to operate at the maximum achievable duty cycle.
- Measure the duty cycle D of the transmitter output signal as described in 11.6 in [1].
- Set the RBW = 1 MHz (unless otherwise specified).
- Set the VBW ≥ 3 x RBW.
- Detector = power average (RMS).
- Ensure that the number of measurement points in the sweep to ≥ 2 x (span/RBW).
- Averaging type = power
- Sweep time = auto
- Perform a trace average of at least 100 traces
- Correct the resulting measurement value by adding the duty cycle correction value (only applicable if not transmit continuously).

Peak measurement procedure: 11.12.2.4 in [1]

- Set the analyzer span to encompass the entire unwanted emission bandwidth.
- Set the RBW = specified in Table 1.
- Set the VBW ≥ RBW.
- Set sweep time = auto.
- Detector = peak.
- Trace mode = max hold.
- Allow the trace to stabilize.
- Use the peak marker function to determine the peak power over the emission bandwidth.

Table 1 RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

5.8.1.1 Limit calculations

The following general procedure is described in chapter 11.12.2.2 in [1].

a) Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency (see 11.12.2.3 through 11.12.2.5 for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP (see 11.12.2.6 for guidance on determining the applicable antenna gain).
c) Add the appropriate maximum ground reflection factor to the EIRP (6 dB for frequencies ≤ 30 MHz; 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive; and 0 dB for frequencies > 1000 MHz).
d) For MIMO devices, measure the power of each chain and sum the EIRP of all chains in linear terms (i.e., watts and mW).
e) Convert the resultant EIRP to an equivalent electric field strength using the following relationship:

$$E = EIRP - 20\log(d) + 104.8 \quad (1)$$

where

E is the electric field strength in dBµV/m
EIRP is the equivalent isotropically radiated power in dBm
d is the specified measurement distance in m

f) Compare the resultant electric field strength level with the applicable regulatory limit.
g) C Perform the radiated spurious emission test.

Chapter 14 in [1] states, that for transmitters with multiple outputs in the same band, summing of emissions and accounting for array gain have to be considered.

For this test report the procedure of summing of emissions as described in 14.3.2.2 in [1] was used.

To account for directional gain which might occur in case of N transmit antennas, the directional has to be calculated as

$$G_{Dir} = G_{Ant} + 10\log(N)dBi ,$$

whereby N is the number of antennas.

This EUT has only one antenna port, therefore no calculation for multiple ports have to be performed.

5.8.2 Method of measurement (conducted emissions in the unrestricted bands)

In any 100 kHz outside the authorized frequency band, the power shall be attenuated by 20 dB, compared to the highest in band power in any 100 kHz. This shall be demonstrated by using the peak power procedure. The reference level shall be measured using the procedure described in 5.8.2.1 and the emission level according to procedure 5.8.2.2. The procedures are based on chapter 11.11.2 and 11.11.3 in [1].

5.8.2.1 Reference level measurement

a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.

5.8.2.2 Emission level measurement

a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ 3 x RBW.
d) Detector = peak.
e) Ensure that the number of measurement points ≥ span/RBW
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level.

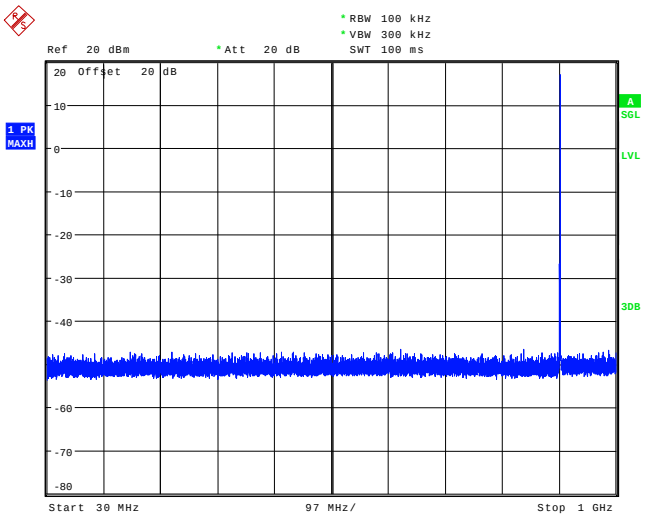
5.8.3 Test results (conducted emissions)

Ambient temperature	22 °C		Relative humidity	34 %

Transmitter operates at the lower end of the assigned frequency band (operation mode 1)

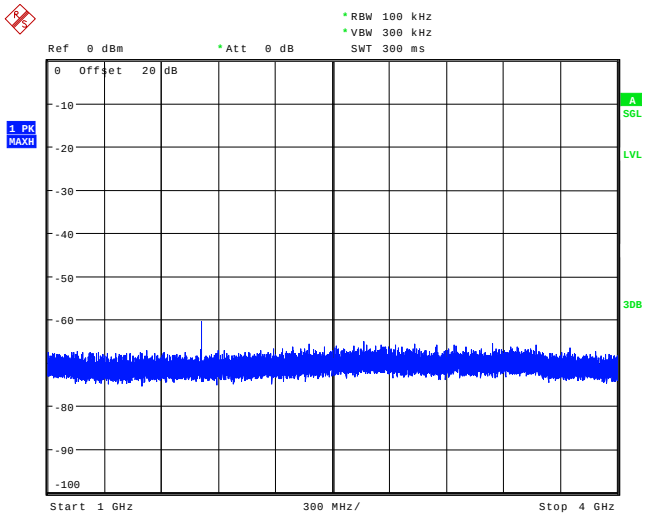
No significant emissions up to 20 dB to the limit were found in the frequency range below 30 MHz, therefore no results are submitted below.

161597_43.wmf: Conducted spurious emissions from 30 MHz to 1 GHz (operation mode 1):

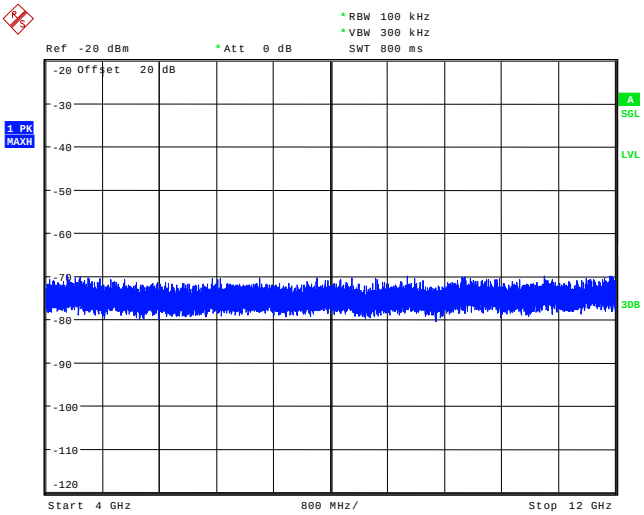


Remark: No emissions except the wanted signal were found in this frequency range.

161597_44.wmf: Conducted spurious emissions from 1 GHz to 4 GHz (operation mode 1):



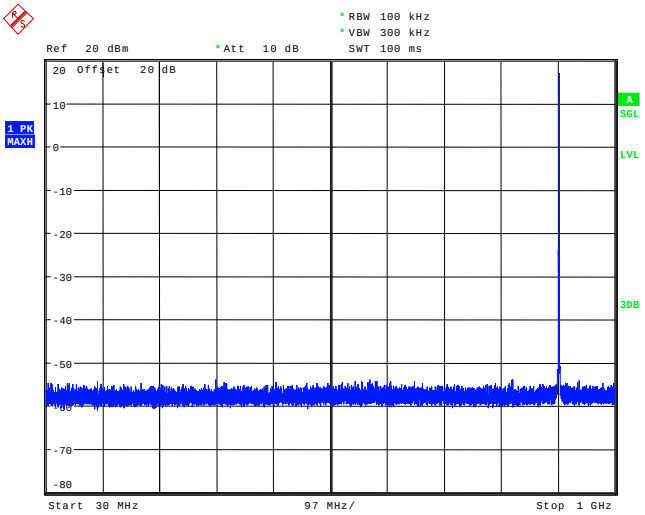
161597_45.wmf: Conducted spurious emissions from 4 GHz to 12 GHz (operation mode 1):



Transmitter operates at the middle of the assigned frequency band (operation mode 2)

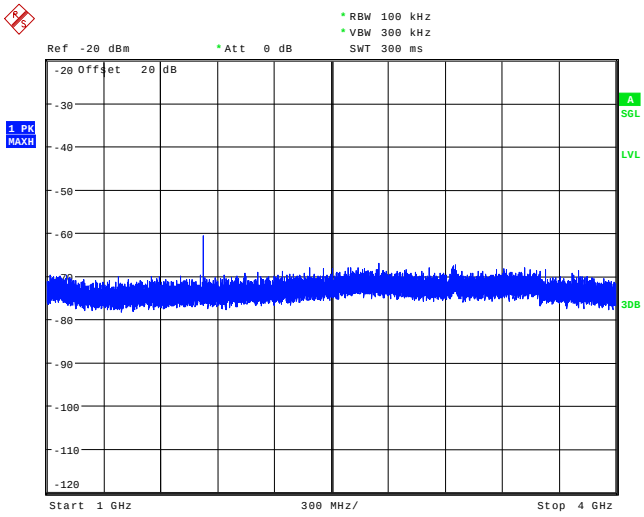
No significant emissions up to 20 dB to the limit were found in the frequency range below 30 MHz, therefore no results are submitted below.

161597_46.wmf: Conducted spurious emissions from 30 MHz to 1 GHz (operation mode 2):

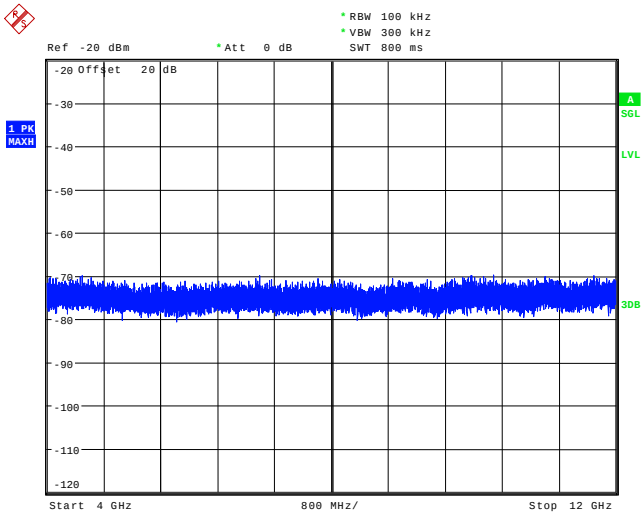


Remark: No emissions except the wanted signal were found in this frequency range.

161597_47.wmf: Conducted spurious emissions from 1 GHz to 4 GHz (operation mode 2):



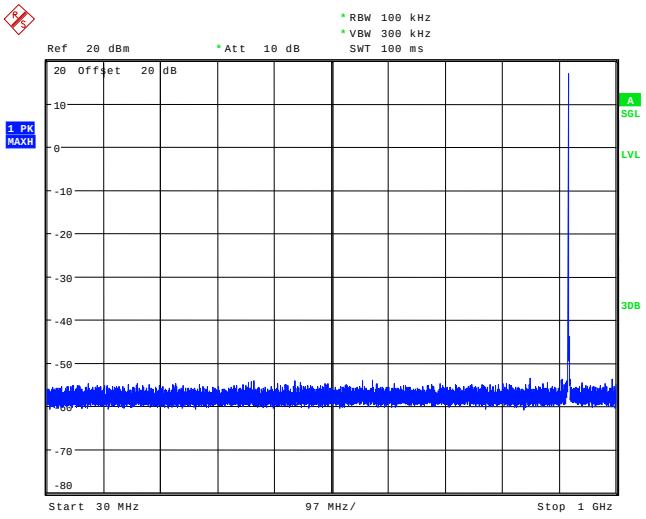
161597_48.wmf: Conducted spurious emissions from 4 GHz to 12 GHz (operation mode 2):



Transmitter operates at the upper end of the assigned frequency band (operation mode 3)

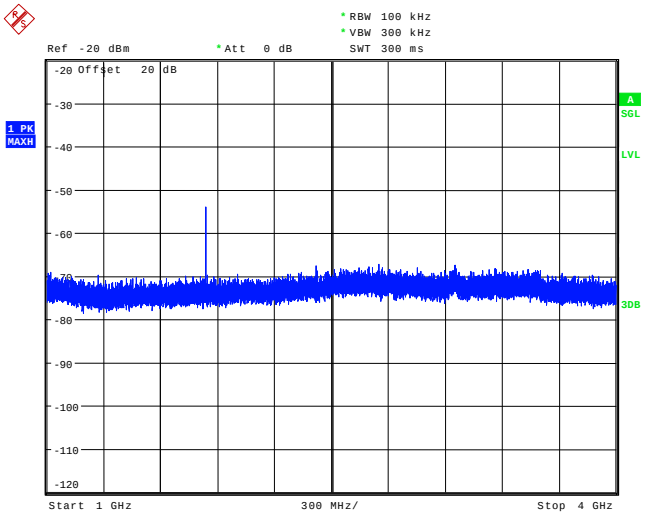
No significant emissions up to 20 dB to the limit were found in the frequency range below 30 MHz, therefore no results are submitted below.

161597_49.wmf: Conducted spurious emissions from 30 MHz to 1 GHz (operation mode 3):



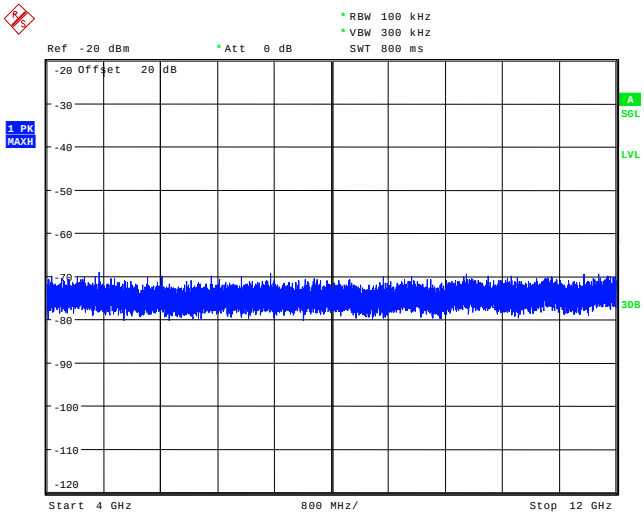
Remark: No emissions except the wanted signal were found in this frequency range.

161597_50.wmf: Conducted spurious emissions from 1 GHz to 4 GHz (operation mode 3):



Remark: No emissions except the wanted signal were found in this frequency range.

161597_51.wmf: Conducted spurious emissions from 4 GHz to 12 GHz (operation mode 3):



Spurious emissions (operation mode 1)						
No emissions were found in the restricted bands						
Peak emission – Unrestricted bands						
Operating channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
0 (904.000 MHz)	1807.990	-59.4	-3.1	56.3	Passed	N
Spurious emissions (operation mode 2)						
No emissions were found in the restricted bands						
Peak emission – Unrestricted bands						
Operating channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
24 (911.200 MHz)	1822.360	-59.1	-3.1	56.0	Passed	N
Spurious emissions (operation mode 3)						
No emissions were found in the restricted bands						
Peak emission – Unrestricted bands						
Operating channel	Frequency [MHz]	Reading [dBm]	Limit [dBm]	Margin [dB]	Result	Restricted Band?
49 (918.700 MHz)	1837.430	-53.8	-3.2	50.6	Passed	N
Measurement uncertainty			+2.3 dB / - 3.2 dB			

Test: Passed

Test equipment used (see chapter 6):

15, 28 - 31

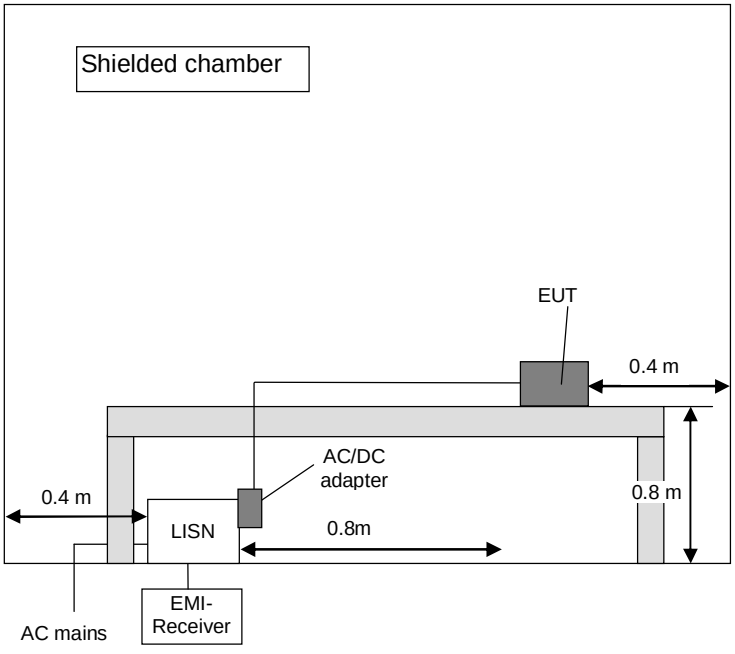
5.9 Conducted emissions on power supply lines (150 kHz to 30 MHz)

5.9.1 Method of measurement

This test will be carried out in a shielded chamber. Tabletop 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 above the ground plane. Floor-standing devices will be placed directly on the ground plane. The setup of the Equipment under test will be in accordance to [1].

The frequency range 150 kHz to 30 MHz will be measured with an EMI Receiver set to MAX Hold mode with peak and average detector and a resolution bandwidth of 9 kHz. A scan will be carried out on the phase (or plus pole in case of DC powered devices) of the AC mains network. If levels detected 10 dB below the appropriable limit, this emission will be measured with the average and quasi-peak detector on all lines.

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz



5.9.2 Test results (conducted emissions on power supply lines)

Ambient temperature	22 °C	Relative humidity	40 %

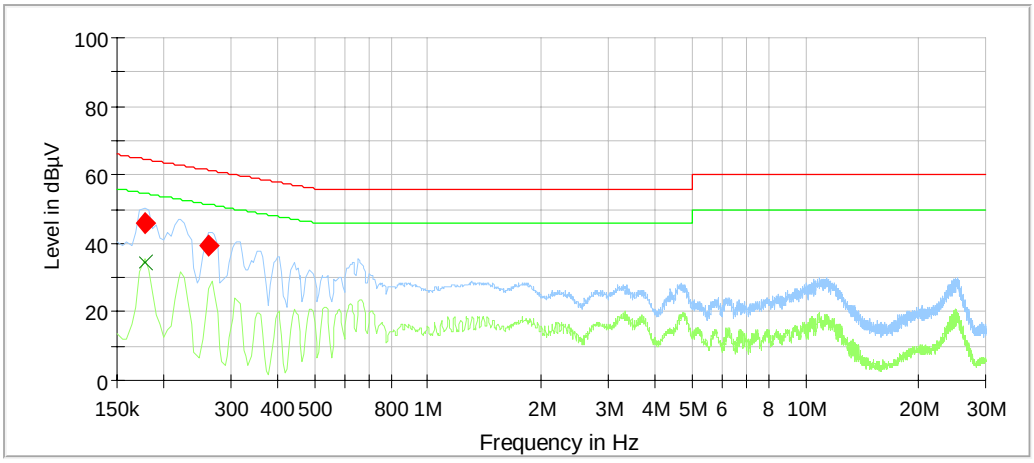
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

Cable guide: The cables of the EUT were fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: The test was carried out in operation mode 1 of the EUT (refer also clause 2 of this test report). All results are shown in the following.

Supply voltage: During this test the EUT was supplied 3.6 V DC by the internal battery, which was buffered by an external power supply type enercell CAT: NO. 273-316.

The curves in the diagram only represent for each frequency point the maximum measured value of all preliminary measurements which were made for each power supply line. The top measured curve represents the peak measurement and the bottom measured curve the average measurement. The quasi-peak measured points are marked by ◆ and the average measured points by X.



Data record name: 161597_15C

Remark: The limits of FCC 15.207 are identical to [3]

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	Transducer (dB)
0.177000	-	34.6	54.6	20.0	5000.0	9.000	N	GND	9.8
0.177000	46.0	-	64.6	18.6	5000.0	9.000	N	GND	9.8
0.263400	39.2	-	61.3	22.1	5000.0	9.000	N	GND	9.9
Measurement uncertainty			±2.76 dB						

Test: Passed

Test equipment used (see chapter 6):

1 - 5

6 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
1	Shielded chamber M4	-	Siemens	B83117-S1-X158-	480088	Weekly verification (system cal.)	
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	02/15/2016	02/2018
3	LISN	NSLK8128	Schwarzbeck	8128161	480138	02/16/2016	02/2018
4	Transient Filter Limiter	CFL 9206A	Teseq GmbH	38268	481982	Weekly verification (system cal.)	
5	EMI Software	EMC 32	Rohde & Schwarz	100061	481022	-	-
6	Open area test site	-	Phoenix Test-Lab	-	480085	Weekly verification (system cal.)	
7	Measuring receiver	ESIB7	Rohde & Schwarz	100304	480521	03/06/2015	03/2017
8	Controller	HD100	Deisel	100/670	480139	-	-
9	Turntable	DS420HE	Deisel	420/620/80	480087	-	-
10	Antenna support	AS615P	Deisel	615/310	480086	-	-
11	Antenna	CBL6111 D	Chase	25761	480894	09/18/2014	09/2017
12	EMI Software	EMC 32	Rohde & Schwarz	100061	481022	-	-
13	6 dB attenuator	R412706000	Radiall	9833	410082	Weekly verification (system cal.)	
14	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
15	Spectrum analyser	FSU	Rohde & Schwarz	200125	480956	02/17/2016	02/2017
16	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/16/2016	02/2017
17	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
18	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
19	Antenna support	AS615P	Deisel	615/310	480187	-	-
20	Antenna	CBL6112 B	Chase	2688	480328	04/14/2014	04/2017
20	Antenna	HL50	Rohde & Schwarz	100438	481170	08/27/2014	08/2017
21	RF-cable No. 36	Sucoflex 106B	Suhner	0587/6B	480865	Weekly verification (system cal.)	
22	RF-cable No. 3	Sucoflex 106B	Suhner	0563/6B	480670	Weekly verification (system cal.)	
23	RF-cable No. 40	Sucoflex 106B	Suhner	0708/6B	481330	Weekly verification (system cal.)	
24	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337	Six month verification (system cal.)	
25	Turn device	TDF 1.5- 10Kg	Maturo	15920215	482034	-	-
26	Loop antenna	HFH2-Z2	Rohde & Schwarz	100417	481912	09/15/2015	09/2016
27	High Pass Filter	WHJS1000C11 /60EF	Wainwright Instruments GmbH	1	480413	Weekly verification (system cal.)	
28	High Pass Filter	WHKX4.0/18G-8SS	Wainwright Instruments GmbH	1	480587	Weekly verification (system cal.)	
29	Tuneable Notch Filter	WRCA800/900-0.2/40-6EEK	Wainwright Instruments GmbH	15	480414	Weekly verification (system cal.)	
30	20 dB attenuator	WA8 / 18-20-34	Weinschel	-	481450	Weekly verification	

7 Report history

Report Number	Date	Comment
F161597E1	04/24/2017	Document created
-	-	-
-	-	-
-	-	-

8 List of annexes

Annex A Test set-up photos 7 pages

161597_14.JPG: ZONESCAN 820 Solar Alpha, test setup fully anechoic chamber
161597_13.JPG: ZONESCAN 820 Solar Alpha, test setup fully anechoic chamber
161597_7.JPG: ZONESCAN 820 Solar Alpha, test setup fully anechoic chamber
161597_8.JPG: ZONESCAN 820 Solar Alpha, test setup fully anechoic chamber
161597_11.JPG: ZONESCAN 820 Solar Alpha, test setup open area test site
161597_12.JPG: ZONESCAN 820 Solar Alpha, test setup shielded chamber
161597_15.JPG: ZONESCAN 820 Solar Alpha, test setup shielded chamber

Annex B External photos 3 pages

161597_a.JPG: ZONESCAN 820 Solar Alpha, 3D view 1
161597_b.JPG: ZONESCAN 820 Solar Alpha, 3D view 2
161597_c.JPG: ZONESCAN 820 Solar Alpha, detail view to connectors

Annex C Internal photos 12 pages

161597_d.JPG: ZONESCAN 820 Solar Alpha, internal view
161597_f.JPG: ZONESCAN 820 Solar Alpha, internal view, shielding removed
161597_e.JPG: ZONESCAN 820 Solar Alpha, internal view, main PCB removed
161597_i.JPG: ZONESCAN 820 Solar Alpha, internal view to GSM/UMTS antennas
161597_q.JPG: ZONESCAN 820 Solar Alpha, GSM/UMTS module, top view
161597_g.JPG: ZONESCAN 820 Solar Alpha, GSM/UMTS module, bottom view
161597_l.JPG: ZONESCAN 820 Solar Alpha, main PCB, shielding removed, top view
161597_n.JPG: ZONESCAN 820 Solar Alpha, main PCB, bottom view
161597_j.JPG: ZONESCAN 820 Solar Alpha, power supply PCB, bottom view
161597_m.JPG: ZONESCAN 820 Solar Alpha, power supply PCB, top view, battery holder removed
161597_k.JPG: ZONESCAN 820 Solar Alpha, power supply PCB, bottom view
161597_p.JPG: ZONESCAN 820 Solar Alpha, power supply PCB, bottom view, battery removed