

# Test Report

Report Number: F142568E1

Applicant:

**Werner Turck GmbH & Co. KG**

Manufacturer:

**Werner Turck GmbH & Co. KG**

Equipment under Test (EUT):

**TN902-Q120L130-H1147**



Laboratory (CAB) accredited by  
Deutsche Akkreditierungsstelle GmbH (DAkkS)  
in compliance with DIN EN ISO/IEC 17025  
under the Reg. No. D-PL-17186-01-02,  
FCC Test site registration number 90877 and  
Industry Canada Test site registration IC3469A-1



## REFERENCES

- [1] **ANSI C63.4-2009** American National Standard for Methods of Measuring of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- [2] **FCC CFR 47 Part 15 (July 2014)** Radio Frequency Devices
- [3] **FCC Public Notice DA 00-705 (March 2000)**
- [4] **RSS-210 Issue 8 (December 2010)** Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
- [5] **RSS-Gen Issue 3 (December 2010)** General Requirements and Information for the Certification of Radio Apparatus

## TEST RESULT

The requirements of the tests performed as shown in the overview (clause 3) were fulfilled by the equipment under test.

The complete test results are presented in the following.

Test engineer:	Thomas KÜHN		18 July 2014
	Name	Signature	Date
Authorized reviewer:	Bernd STEINER		18 July 2014
	Name	Signature	Date

## RESERVATION

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<b>Contents:</b>	<b>Page</b>
1 Identification .....	4
1.1 Applicant .....	4
1.2 Manufacturer .....	4
1.3 Test laboratory .....	4
2 EUT (Equipment Under Test).....	5
2.1 Technical data of equipment.....	5
2.2 Dates.....	6
2.3 Operational states .....	6
3 Overview .....	7
4 Test results.....	8
4.1 20 dB bandwidth .....	8
4.1.1 Method of measurement (20 dB bandwidth) .....	8
4.1.2 Test results (20 dB bandwidth) .....	9
4.2 Carrier frequency separation .....	11
4.2.1 Method of measurement (carrier frequency separation) .....	11
4.2.2 Test results (carrier frequency separation) .....	12
4.3 Number of hopping frequencies.....	14
4.3.1 Method of measurement (number of hopping frequencies) .....	14
4.3.2 Test results (number of hopping frequencies) .....	15
4.4 Dwell time.....	16
4.4.1 Method of measurement (dwell time) .....	16
4.4.2 Test results (dwell time).....	17
4.5 Maximum peak output power.....	18
4.5.1 Method of measurement (maximum peak output power) .....	18
4.5.2 Test results (maximum peak output power) .....	19
4.6 Radiated emissions.....	21
4.6.1 Method of measurement (radiated emissions) .....	21
4.6.2 Test results (radiated emissions).....	28
4.6.2.1 Preliminary radiated emission measurement .....	28
4.6.2.2 Final radiated emission measurement (30 MHz to 1 GHz) .....	36
4.6.2.3 Final radiated emission measurement (1 GHz to 40 GHz).....	40
4.7 Conducted emissions on power supply lines (150 kHz to 30 MHz).....	42
4.7.1 Method of measurement.....	42
4.7.2 Test results (conducted emissions on power supply lines) .....	43
5 Test equipment and ancillaries used for tests.....	45
6 Report history .....	46
7 List of annexes .....	46

# 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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Address:	Goethestraße 7 58553 Halver
Country:	Germany
Name for contact purposes:	Dr.-Ing. Michael REPPPEL
Phone:	+49 23 53 709 – 61 29
Fax:	+49 23 53 709 – 61 74
eMail Address:	michael.reppel@turck.com
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 site registration number 90877 and Industry Canada Test site registration IC3469A-1.

## 2 EUT (Equipment Under Test)

Test object: *	UHF RFID read/write device
Model name: *	TN902-Q120L130-H1147
FCC ID: *	YQ7TN902-Q120L130
IC: *	8821A-T902Q12L13
PCB identifier: *	3828 (main PCB), 3691 (coupler), 3692 (antenna)
Serial number: *	10-02538 #23 (engineering sample)
Hardware version: *	2.01
Software version: *	1.48
Lowest / highest internal frequency: *	16 MHz / reference frequency for PLL 928 MHz / RF carrier

### 2.1 Technical data of equipment

Channel 0	RX:	902.75 MHz	TX:	902.75 MHz
Channel 24	RX:	914.75 MHz	TX:	914.75 MHz
Channel 49	RX:	927.25 MHz	TX:	927.25 MHz

Rated RF output power: *	27 dBm (erp)					
Antenna type: *	Internal					
Antenna gain: *	3.14 dBi					
Adaptive frequency agility: *	Yes					
Modulation: *	FHSS (PR-ASK / DSB-ASK)					
Supply Voltage: *	U <sub>nom</sub> =	24.0 V DC	U <sub>min</sub> =	9.6 V DC	U <sub>max</sub> =	30.0 V DC
Temperature range: *	-20 °C to +50 °C					
Ancillary used for test:	An USB/RS485 converter type SNG 3 was used to connect the EUT to the power supply and the laptop computer. During the conducted emission measurement on the AC-supply line a AC / DC adaptor type FW3288 was used.					

\* declared by the applicant.

The following external I/O cables were used:

Identification	Connector		Length
	EUT	Ancillary	
Power / RS485	5 pin M12-connector	4 pole Combicon-connector	2.5 m
-	-	-	-

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

## 2.2 Dates

Date of receipt of test sample:	10 June 2014
Start of test:	01 July 2014
End of test:	08 July 2014

## 2.3 Operational states

All tests were carried out with an unmodified sample.

During all tests the TN902-Q120L130-H1147 was powered by an external power supply with 24.0 V DC.

The operation mode could be chosen with the help of a laptop computer with a test-software, which communicates with the EUT via the RS485 line. The RS485 connection between the laptop PC and the EUT (via the USB/RS485 converter) was maintained during all tests.

The conducted measurements were carried out at the internal antenna connector of the EUT.

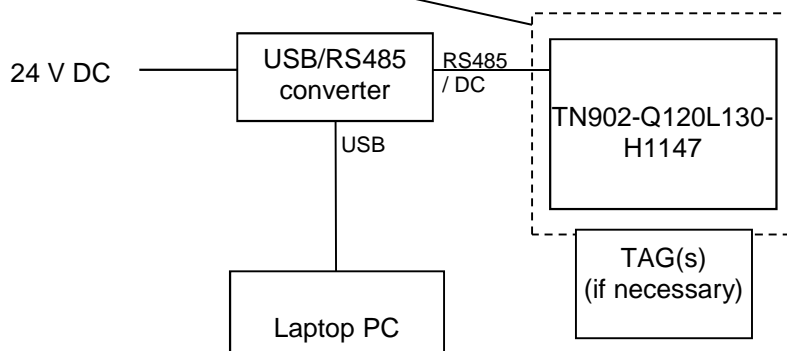
For all measurements the output power of the EUT was set to 27 dBm (maximum value).

The tested sample was not labelled.

The following operation modes were used during the tests:

Operation mode	Description of the operation mode
1	Transmit on 902.750 MHz (channel 0)
2	Transmit on 914.750 MHz (channel 24)
3	Transmit on 927.250 MHz (channel 49)
4	Transmit on all channels (hopping enabled)

Physical boundary of the EUT



### 3 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS 210, Issue 8 [4] or RSS-Gen, Issue 3 [5]	Status	Refer page
20 dB bandwidth	General	15.247 (a) (1) (i)	A8.1 (c) [4]	Passed	8 et seq.
Carrier frequency separation	General	15.247 (a) (1) (i)	-	Passed	11 et seq.
Number of hopping channels	902.0 – 928.0	15.247 (a) (1) (i)	A8.1 (c) [4]	Passed	14 et seq.
Dwell time	902.0 – 928.0	15.247 (a) (1) (i)	A8.1 (c) [4]	Passed	16 et seq.
Maximum peak output power	902.0 – 928.0	15.247 (b) (2)	A8.4 (1) [4]	Passed	18 et seq.
Radiated emissions (transmitter)	0.009 - 10,000	15.247 (d) 15.205 (a) 15.209 (a)	A8.5 [4] 2.5 [4] 7.2.2 [5]	Passed	21 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	7.2.4 [5]	Passed	42 et seq.

## 4 Test results

### 4.1 20 dB bandwidth

#### 4.1.1 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 disabled, the transmitter shall work with its maximum data rate.

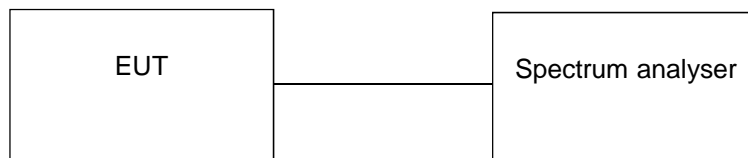
The following spectrum analyser settings shall be used:

- Span: App. 2 to 3 times the 20 dB bandwidth, centred on the actual hopping channel.
- Resolution bandwidth:  $\geq 1\%$  of the 20 dB bandwidth.
- Video bandwidth:  $\geq$  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 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.

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

Test set-up:

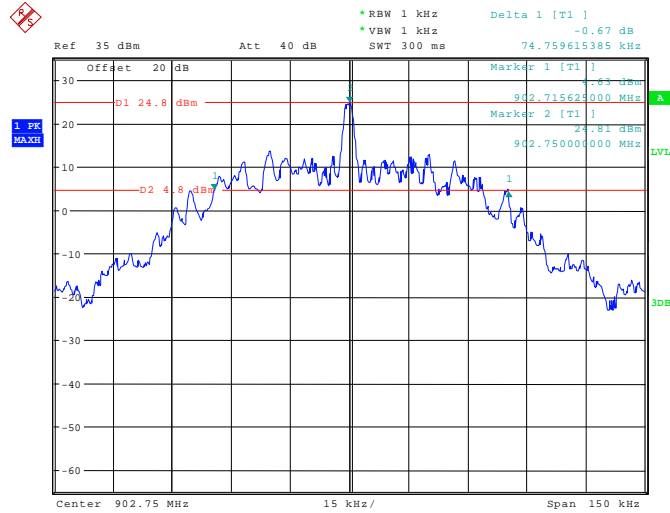




#### 4.1.2 Test results (20 dB bandwidth)

Ambient temperature	22 °C	Relative humidity	59 %
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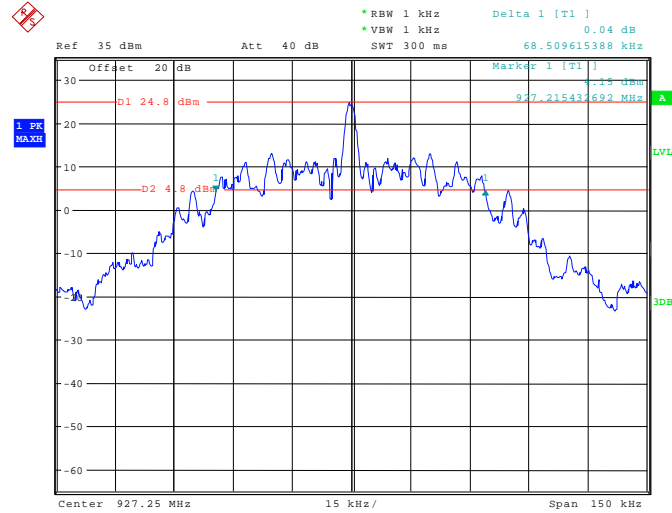
142568\_016.wmf: 20 dB bandwidth at the lower end of the assigned frequency band:



142568\_017.wmf: 20 dB bandwidth at the middle of the assigned frequency band:



142568\_018.wmf: 20 dB bandwidth at the upper end of the assigned frequency band:



Channel number	Channel frequency [MHz]	20 dB bandwidth [kHz]
0	902.750	74.759615 kHz
24	914.750	74.519231 kHz
49	927.250	68.509615 kHz
Measurement uncertainty		+0.66 dB / -0.72 dB

Test equipment used (refer clause 5):

6, 114

## 4.2 Carrier frequency separation

### 4.2.1 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.

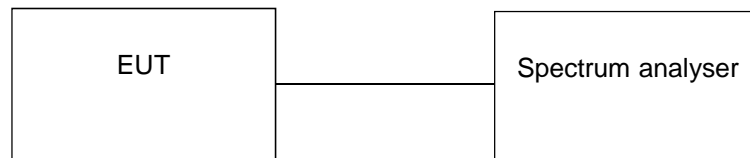
The following spectrum analyser settings shall be used:

- Span: Wide enough to capture the peaks of two adjacent channels.
- Resolution bandwidth:  $\geq 1\%$  of the span.
- Video bandwidth:  $\geq$  the 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.

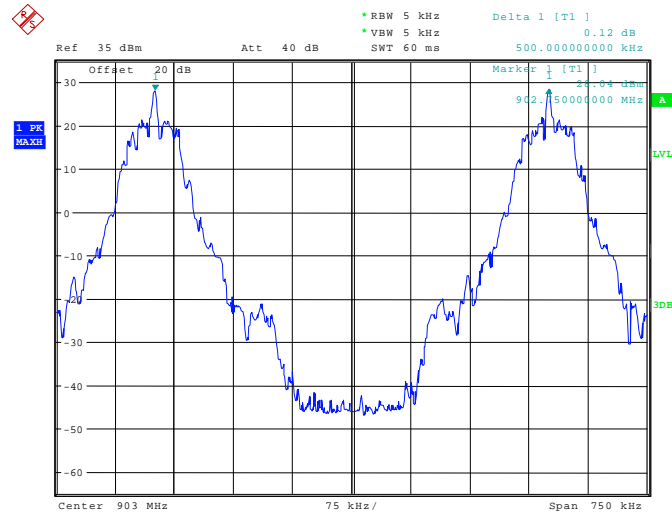
Test set-up:



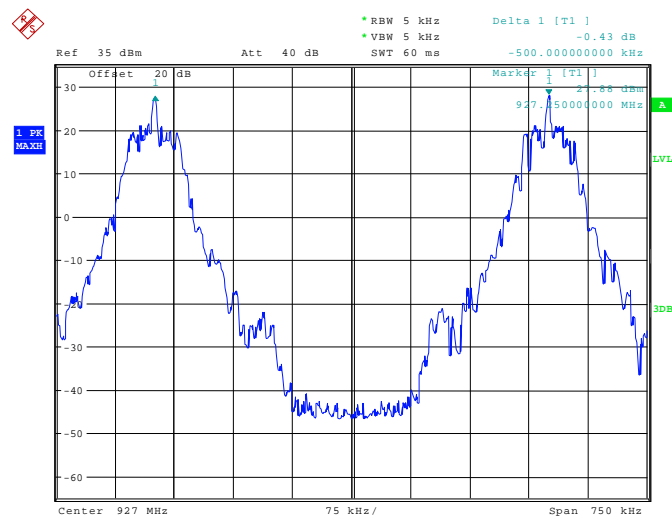
#### 4.2.2 Test results (carrier frequency separation)

Ambient temperature	22 °C	Relative humidity	59 %
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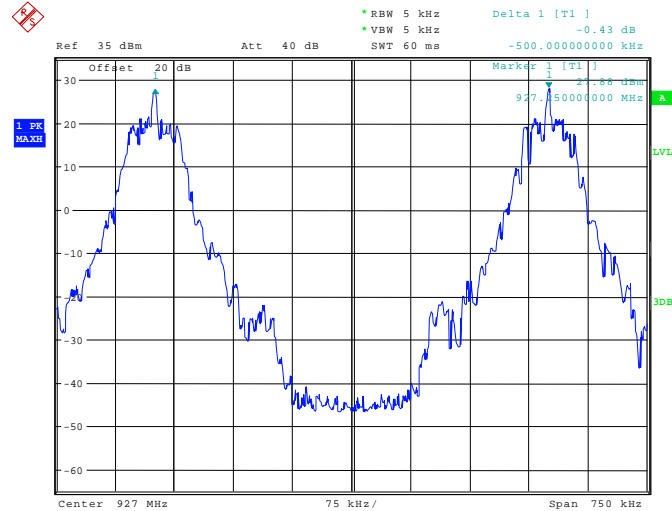
142568\_019.wmf: Channel separation at the lower end of the assigned frequency band:



142568\_020.wmf: Channel separation at the middle of the assigned frequency band:



142568\_021.wmf: Channel separation at the upper end of the assigned frequency band:



Remark: A smaller Resolution bandwidth was used in order to receive a better optical separation of the signal peaks.

Channel number	Channel frequency [MHz]	Channel separation [kHz]	Minimum limit [kHz]
0	902.750	500.000 kHz	74.759615 kHz (the 20 dB bandwidth)
24	914.750	500.000 kHz	74.519231 kHz (the 20 dB bandwidth)
49	927.250	500.000 kHz	68.509615 kHz (the 20 dB bandwidth)
Measurement uncertainty			$<10^{-7}$

Test: Passed

Test equipment used (refer clause 5):

6, 114

## 4.3 Number of hopping frequencies

### 4.3.1 Method of measurement (number of hopping frequencies)

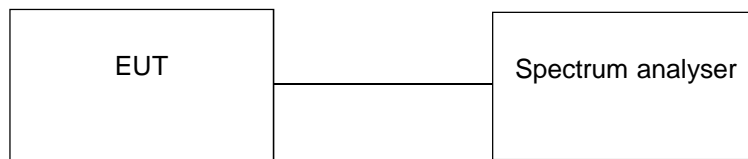
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT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

The following spectrum analyser settings shall be used:

- Span: Equal to the assigned frequency band.
- Resolution bandwidth:  $\geq 1\%$  of the span.
- Video bandwidth:  $\geq$  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.

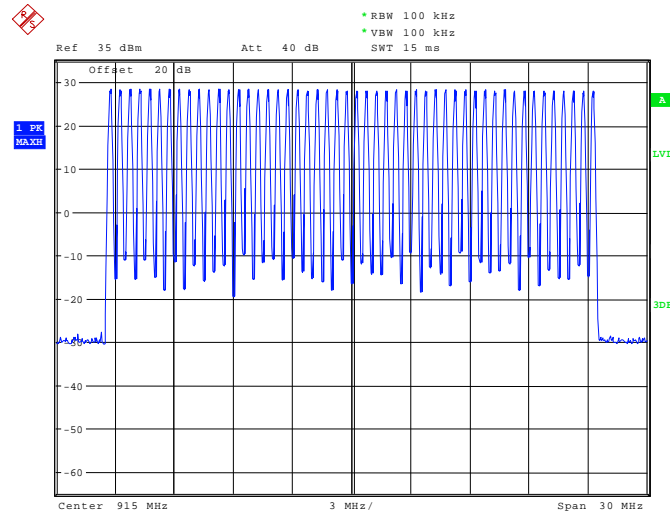
Test set-up:



#### 4.3.2 Test results (number of hopping frequencies)

Ambient temperature	22 °C	Relative humidity	59 %
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142568\_014.wmf: Number of hopping channels:



Remark: A smaller Resolution bandwidth was used in order to receive a better optical separation of the signal peaks.

Number of hopping channels	Limit
Operation mode 4	
50	At least 50

Test: Passed

Test equipment used (refer clause 5):

6, 114
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## 4.4 Dwell time

### 4.4.1 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 shall be used:

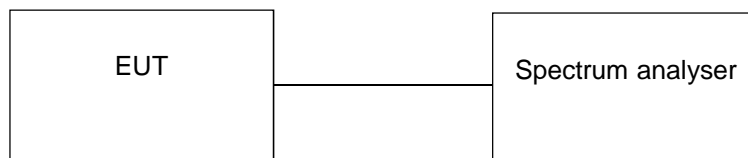
- Span: Zero, centred on a hopping channel.
- Resolution bandwidth: 1 MHz.
- Video bandwidth:  $\geq$  the resolution bandwidth.
- Sweep: As necessary to capture the entire dwell time per hopping channel.
- Detector function: peak.
- Trace mode: Max hold.

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.

If the EUT is possible to operate with different mode of operation (data rates, modulation formats etc.) the test will be repeated with every different operation mode of the EUT.

Test set-up:

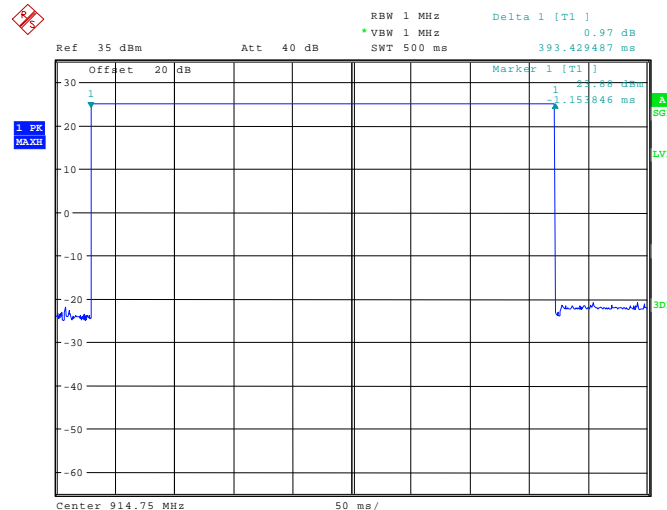




#### 4.4.2 Test results (dwell time)

Ambient temperature	22 °C	Relative humidity	59 %
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142568\_0015.wmf: Dwell time at the middle of the assigned frequency band:



The dwell time is calculated with the following formula:

$$\text{Dwell time} = t_{\text{pulse}} \times n_{\text{hops}} / \text{number of hopping channels} \times 20 \text{ s}$$

Where:

$t_{\text{pulse}}$  is the measured pulse time (pls. refer the plots of the spectrum analyser above) [s],  
 $n_{\text{hops}}$  is the number of hops per second in the actual operating mode of the transmitter [1/s].

The hopping rate of the system is 2.5 hops per second and the system uses 50 channels.

Channel number	Channel frequency [MHz]	$t_{\text{pulse}}$ [ms]	Dwell time [ms]	Limit [ms]
24	914.750	393.429	393.429	400
Measurement uncertainty			<10 <sup>-7</sup>	

Test: Passed

Test equipment used (refer clause 5):

6, 114
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## 4.5 Maximum peak output power

### 4.5.1 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.

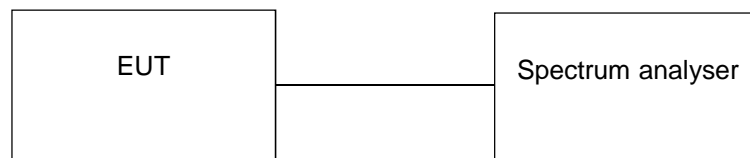
The following spectrum analyser settings shall be used:

- 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:  $\geq$  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.

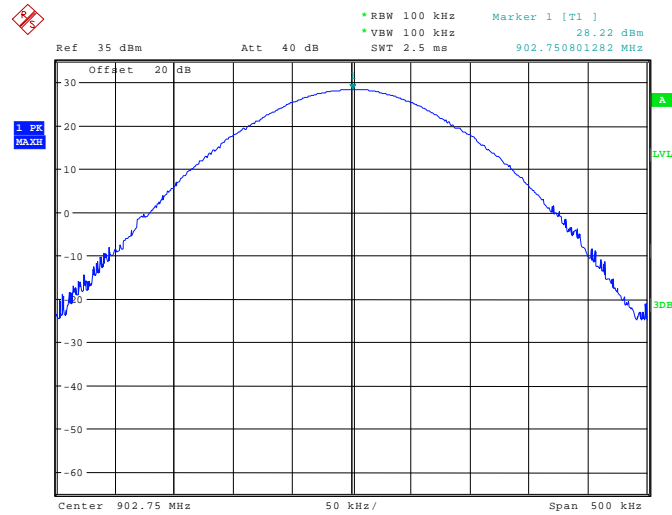
Test set-up:



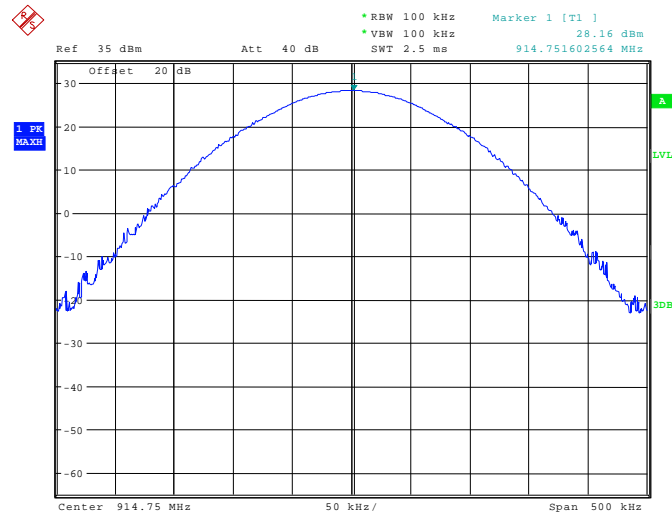
#### 4.5.2 Test results (maximum peak output power)

Ambient temperature	22 °C	Relative humidity	59 %
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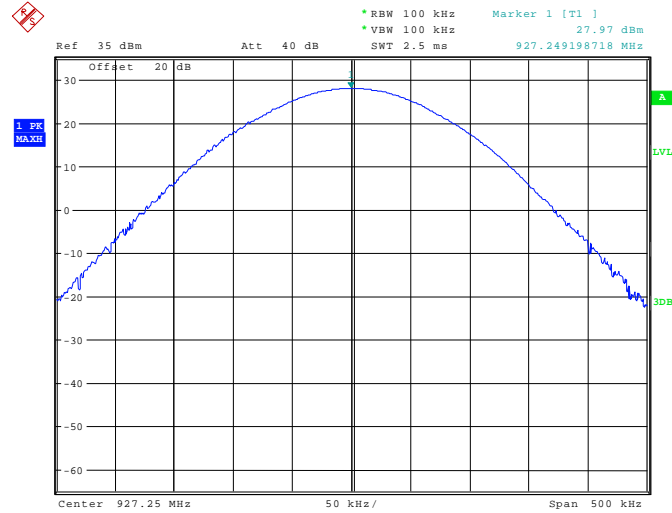
142568\_024.wmf: Maximum peak output power at the lower end of the assigned frequency band:



142568\_023.wmf: Maximum peak output power at the middle of the assigned frequency band:



142568\_022.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	902.750	28.2	3.15	30.0
2	24	914.750	28.2	3.15	30.0
3	49	927.250	28.0	3.15	30.0
Measurement uncertainty				+0.66 dB / -0.72 dB	

Test: Passed

Test equipment used (refer clause 5):

6, 114

## 4.6 Radiated emissions

### 4.6.1 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into four stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 9 kHz to 110 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 final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 110 GHz.

All measurements will be carried out with the EUT working on the middle and upper and lower edge of the assigned frequency band. For this reason the hopping function of the EUT has to be disabled.

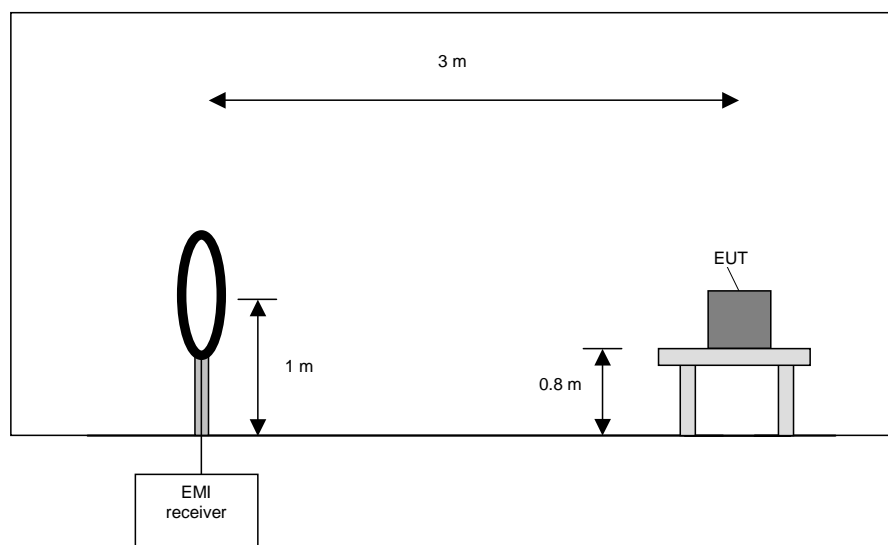
#### **Preliminary measurement (9 kHz to 30 MHz):**

In the first stage a preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. 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. 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 ANSI C63.4-2009 [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, 150 kHz to 1 MHz and 1 MHz 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).

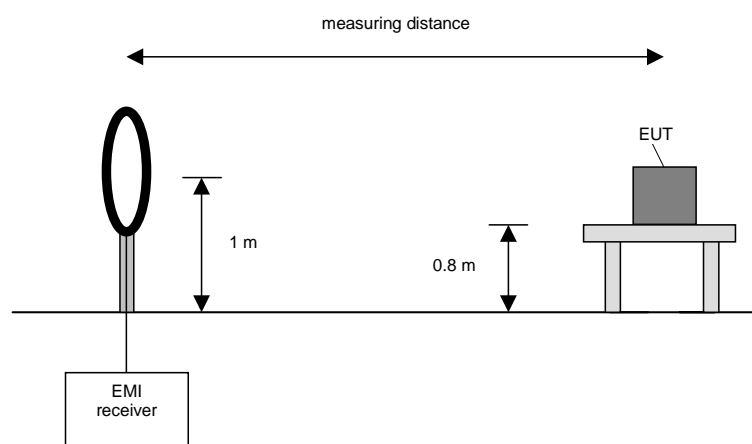
**Final measurement (9 kHz to 30 MHz):**

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane with 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 during the preliminary measurement detected frequencies 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	10 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 (because of EUT is a module and might be used in a handheld equipment application).

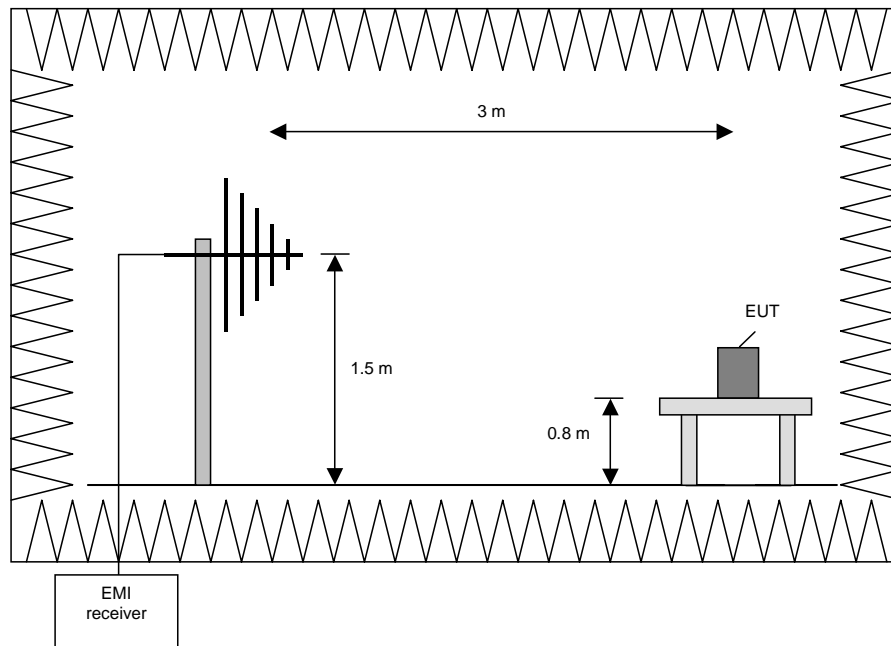
**Preliminary measurement (30 MHz to 1 GHz)**

In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. 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. Floor-standing devices will be placed directly on the turntable/ground plane. The setup of the Equipment under test will be in accordance to ANSI C63.4-2009 [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 °.

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

Frequency range	Resolution bandwidth
30 MHz to 200 MHz	100 kHz
200 MHz to 1 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 200 MHz and 200 MHz to 1 GHz.

The following procedure will be used:

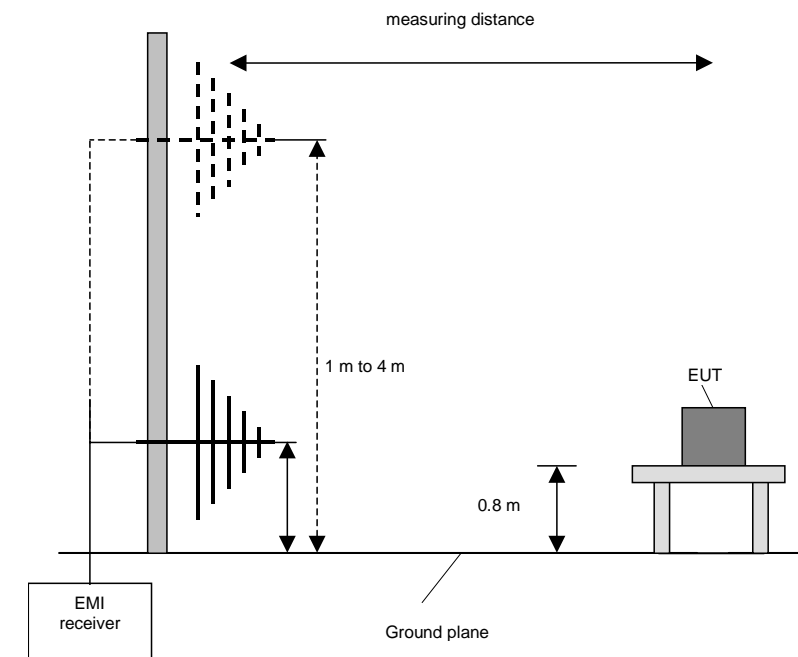
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the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

**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 110 GHz)**

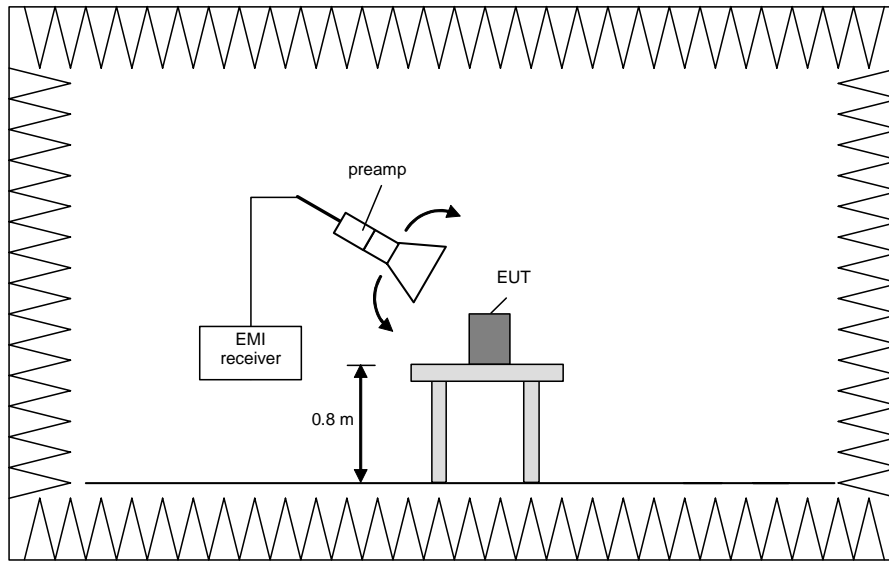
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The setup of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

**Preliminary measurement (1 GHz to 110 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, the antenna close to the EUT and while moving the antenna over all sides of the EUT. With the spectrum analyser in CLEAR / WRITE mode the cone of the emission should be found and than the measuring distance will be set to 3 m with the receiving antenna moving in this cone of emission. At this position the final measurement will be carried out.

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 26.5 GHz	100 kHz
26.5 GHz to 40 GHz	100 kHz
40 GHz to 60 GHz	100 kHz
50 GHz to 75 GHz	100 kHz
75 GHz to 110 GHz	100 kHz

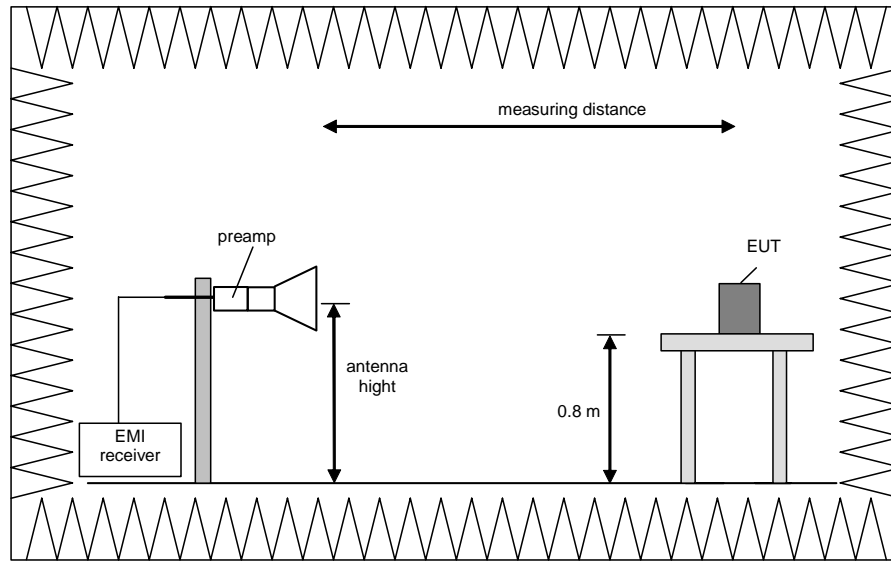


### **Final measurement (1 GHz to 110 GHz)**

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 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 ° in order to have the antenna inside the cone of radiation.

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 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz
40 GHz to 60 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 GHz	1 MHz



#### Procedure of measurement:

The measurements were performed in the frequency range 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 26.5 GHz, 26.5 GHz to 40 GHz, 40 GHz to 60 GHz, 60 GHz to 75 GHz and 75 GHz to 110 GHz.

The following procedure will be used:

- 1) Monitor the frequency range at horizontal polarisation and move the antenna over all sides of the EUT (if necessary move the EUT to another orthogonal axis).
- 2) Change the antenna polarisation and repeat 1) with vertical polarisation.
- 3) Make a hardcopy of the spectrum.
- 4) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
- 5) Change the analyser mode to Clear / Write and found the cone of emission.
- 6) Rotate and move the EUT, so that the measuring distance can be enlarged to 3 m and the antenna will be still inside the cone of emission.
- 7) Measure the level of the detected frequency with the correct resolution bandwidth, with the antenna polarisation and azimuth and the peak and average detector, which causes the maximum emission.
- 8) Repeat steps 1) to 7) for the next antenna spot if the EUT is larger than the antenna beamwidth.

Step 1) to 6) are defined as preliminary measurement.

## 4.6.2 Test results (radiated emissions)

### 4.6.2.1 Preliminary radiated emission measurement

Ambient temperature	22 °C	Relative humidity	49 %
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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.

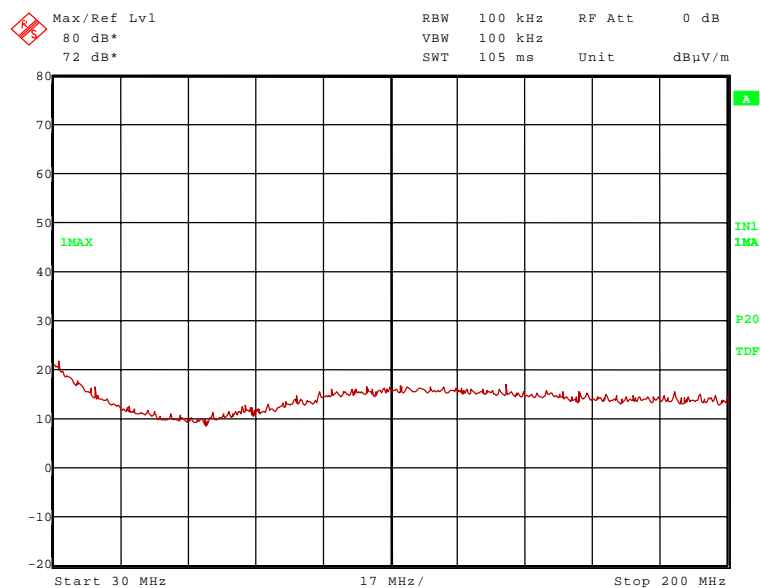
Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 24 V DC by an external power supply.

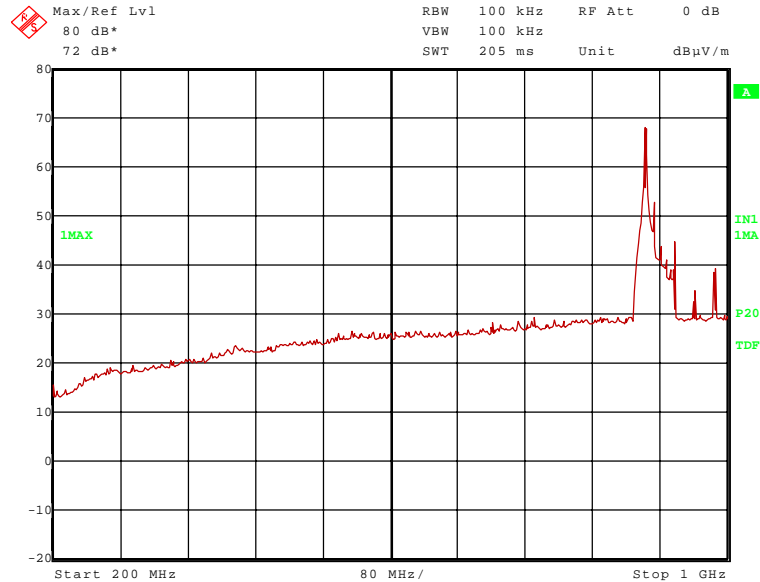
Remark: As pre-tests have shown, the emissions in the frequency range 10 MHz to 30 MHz are not depending on the transmitter operation mode. Therefore the emissions in this frequency range were measured only with the transmitter operates in operation mode 2.

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

142568\_2.wmf: Spurious emissions from 30 MHz to 200 MHz (operation mode 1):



142568\_1.wmf: Spurious emissions from 200 MHz to 1 GHz (operation mode 1, carrier notched):



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

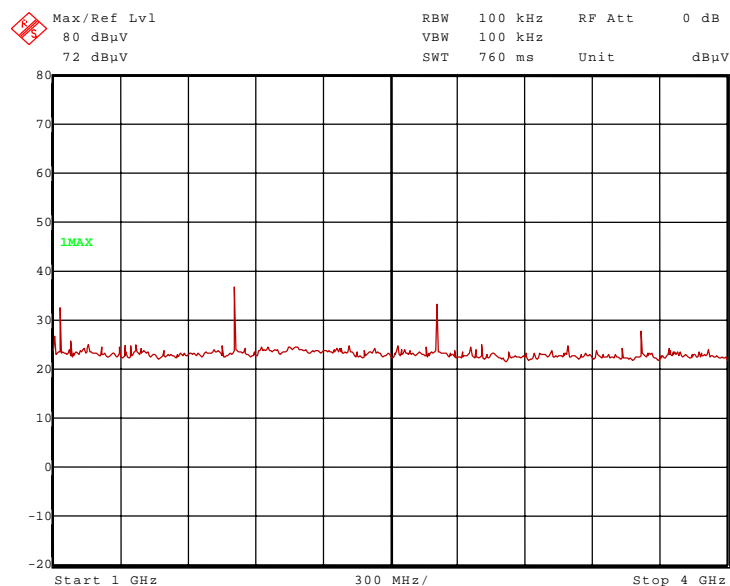
- 902.750 MHz, 912.000 MHz and 936.000 MHz.

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

- 960.000 MHz and 983.975 MHz.

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

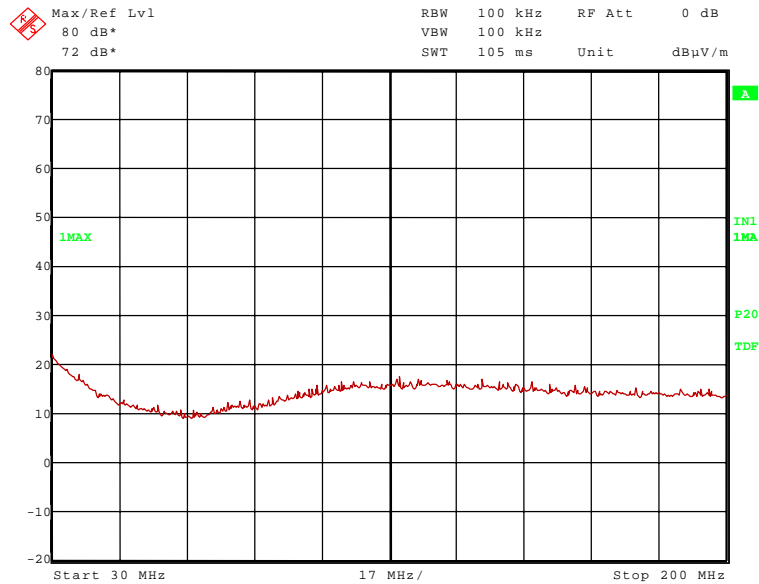
142568\_9.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



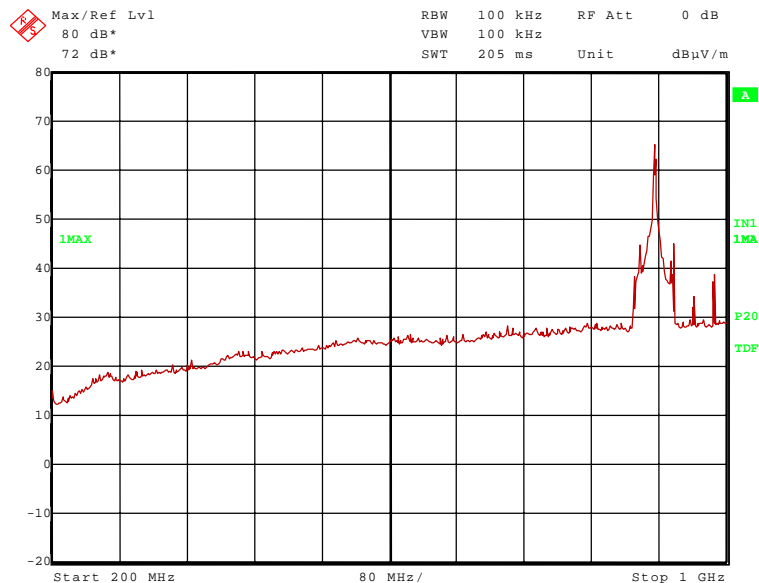


No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

142568 4.wmf: Spurious emissions from 30 MHz to 200 MHz (operation mode 2):



142568 3.wmf: Spurious emissions from 200 MHz to 1 GHz (operation mode 2, carrier notched):







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

- 1.032 GHz, 2.74425 GHz, 3.659 GHz and 4.57375 GHz.

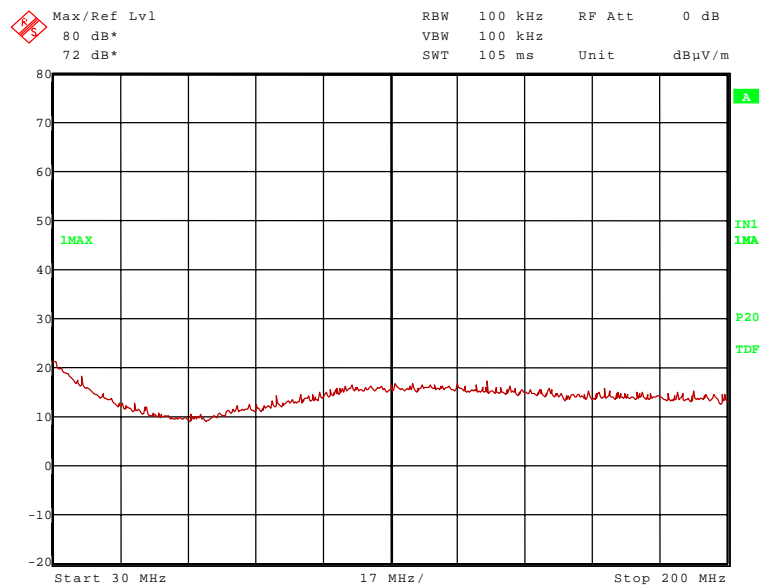
The following frequency was found outside the restricted bands during the preliminary radiated emission test:

- 1.8295 GHz.

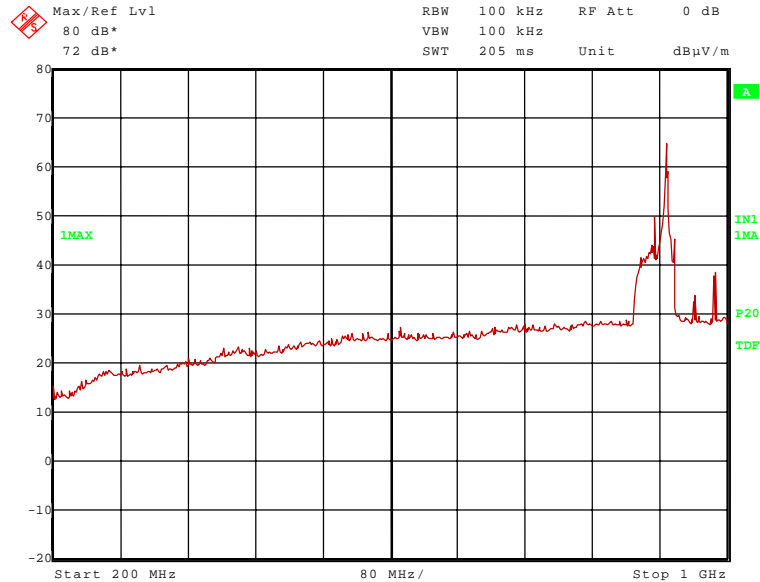
These frequencies have to be measured in a final measurement. The results were presented in the following.

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

142568\_6.wmf: Spurious emissions from 30 MHz to 200 MHz (operation mode 3):



142568\_5.wmf: Spurious emissions from 200 MHz to 1 GHz (operation mode 3, carrier notched):



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

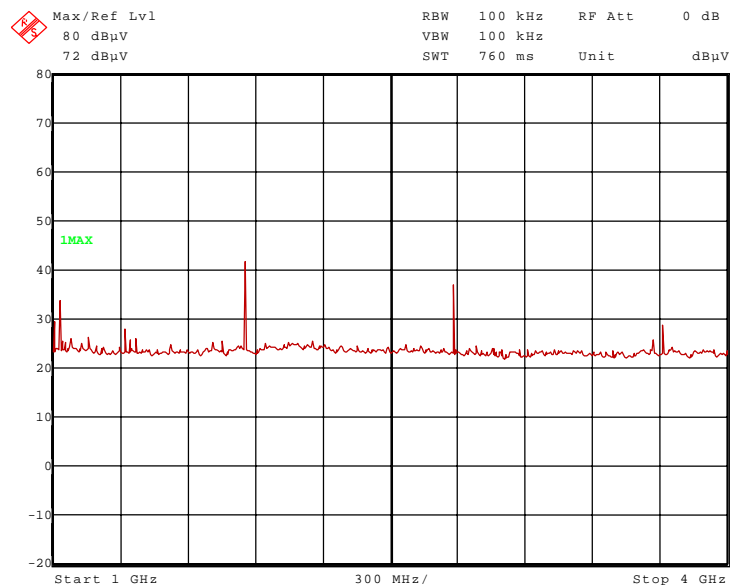
- 912.000 MHz, 927.250 MHz and 936.000 MHz

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

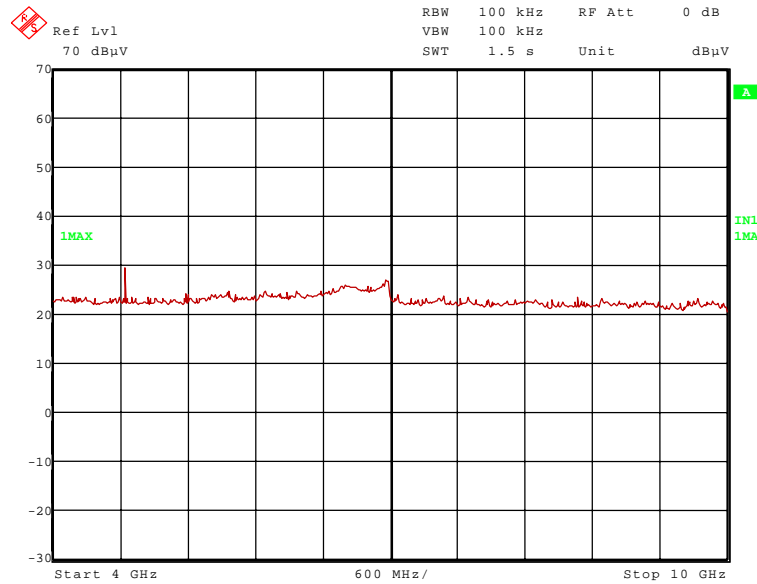
- 960.000 MHz and 983.975 MHz

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

142568\_7.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



142568\_12.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 3):



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

- 1.0233 GHz, 2.78175 GHz, 3.709 GHz and 4.63625 GHz.

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

- 1.8545 GHz.

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

Test equipment used (refer clause 5):

29, 31 - 36, 43 - 45, 49, 55, 73, 75, 83

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

Ambient temperature	22 °C	Relative humidity	42 %
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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.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 24 V DC by an external power supply.

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

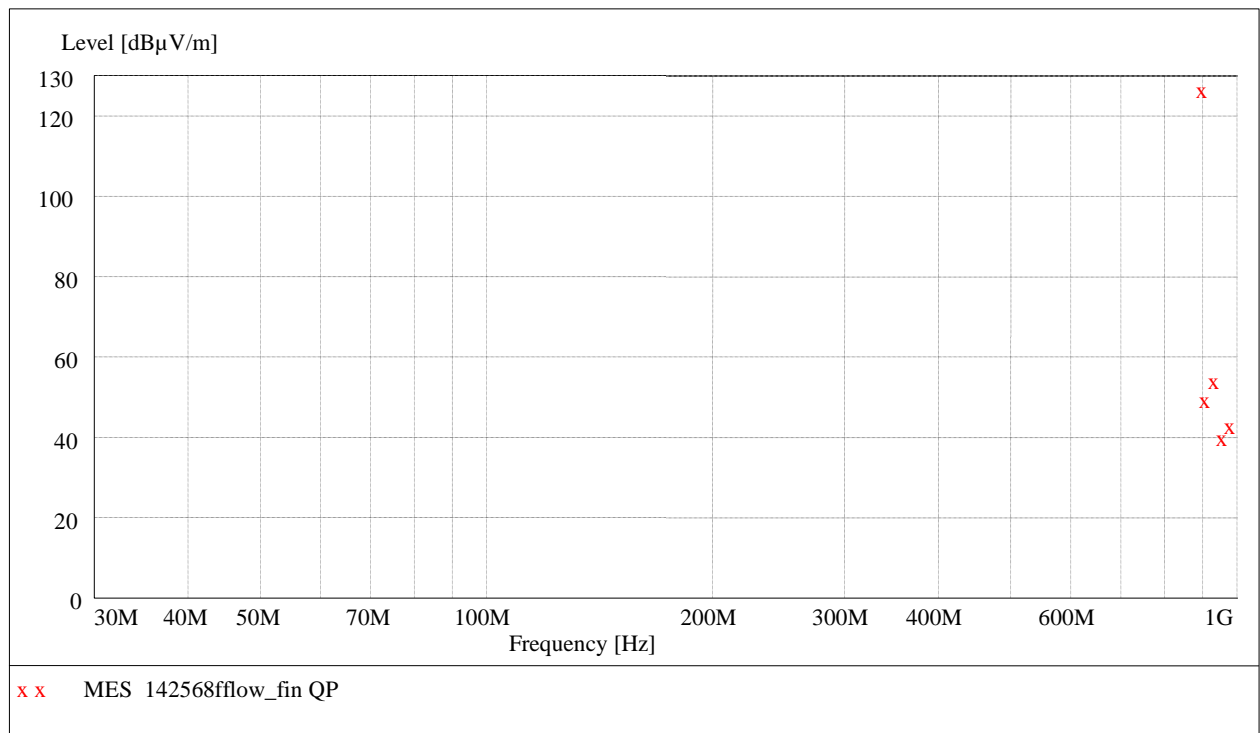
$$\text{Result [dB}\mu\text{V/m]} = \text{reading [dB}\mu\text{V]} + \text{cable loss [dB]} + \text{antenna factor [dB/m]}$$

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)

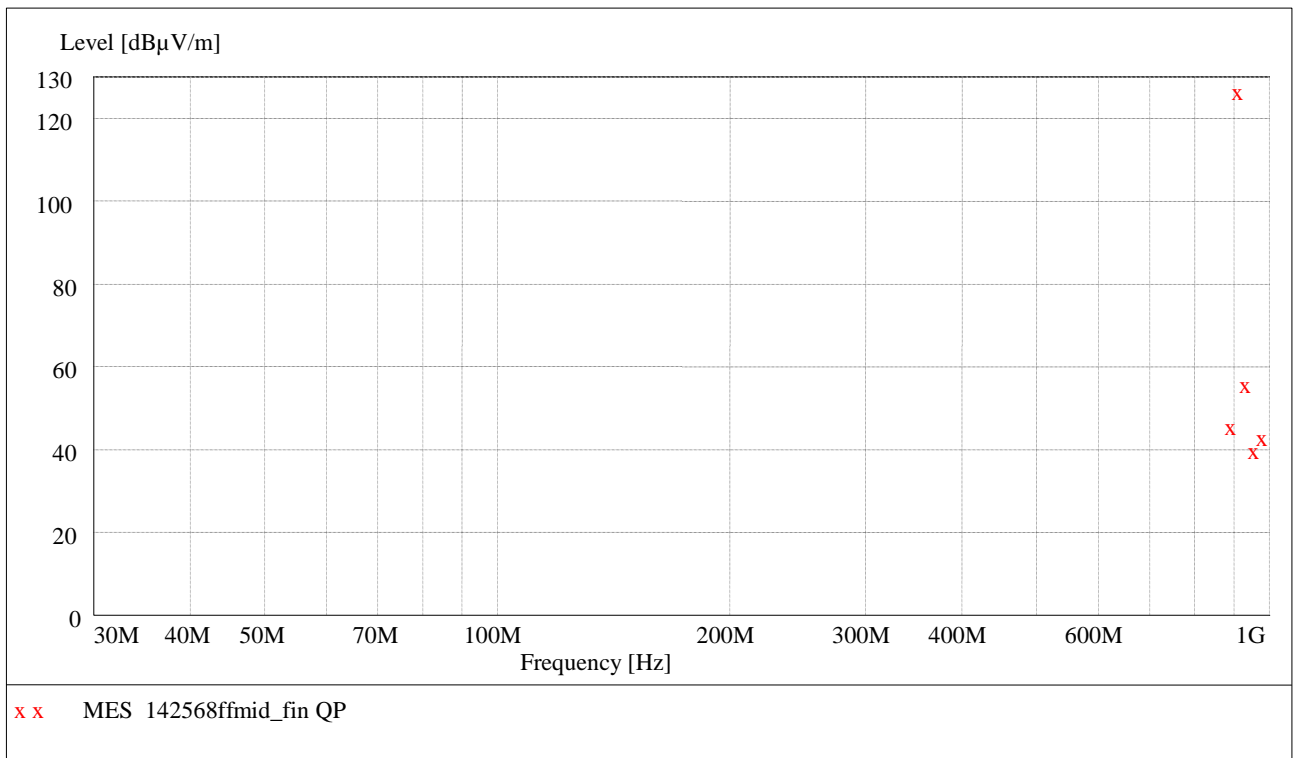


Data record name: 142568fflow

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

Transmitter operates on the lower end of the assigned frequency band (operation mode 1)									
Spurious emissions outside restricted bands									
Frequency MHz	Result dB $\mu$ V/m	Limit dB $\mu$ V/m	Margin dB	Readings dB $\mu$ V	Antenna factor dB/m	Cable loss dB	Height cm	Azimuth deg	Pol.
902.750	127.4	Carrier	-	101.5	22.5	3.4	178.0	0.0	Hor.
912.000	49.9	107.4	57.5	23.8	22.7	3.4	177.0	338.0	Hor.
936.000	54.7	107.4	52.7	27.6	23.7	3.4	100.0	1.0	Hor.
Spurious emissions inside restricted bands									
Frequency MHz	Result dB $\mu$ V/m	Limit dB $\mu$ V/m	Margin dB	Readings dB $\mu$ V	Antenna factor dB/m	Cable loss dB	Height cm	Azimuth deg	Pol.
960.000	40.5	54.0	13.5	13.2	23.8	3.5	142.0	0.0	Vert.
983.975	43.7	54.0	10.3	16.4	23.8	3.5	138.0	0.0	Vert.
Measurement uncertainty				+2.2 dB / -3.6 dB					

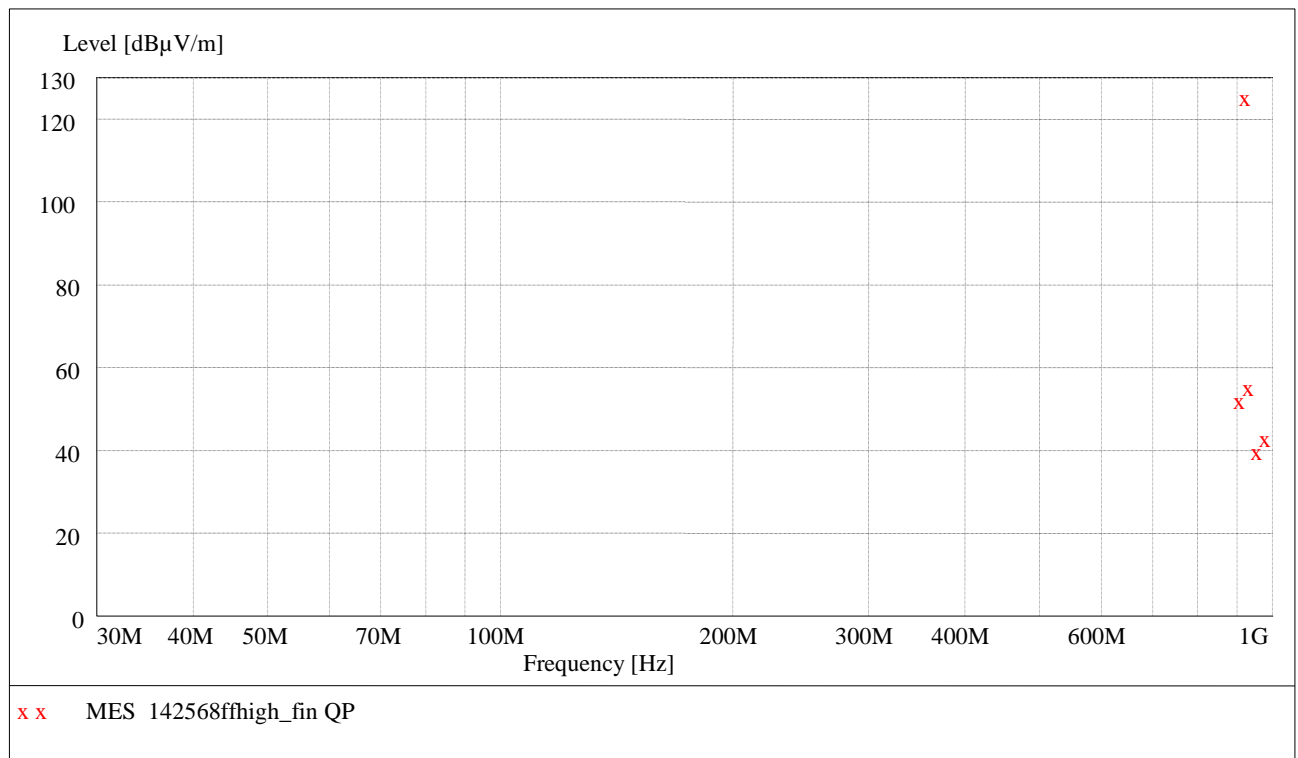
**Transmitter operates on the middle of the assigned frequency (operation mode 2)**



Data record name: 142568ffmid

Transmitter operates on the middle of the assigned frequency band (operation mode 2)									
Spurious emissions outside restricted bands									
Frequency MHz	Result dB $\mu$ V/m	Limit dB $\mu$ V/m	Margin dB	Readings dB $\mu$ V	Antenna factor dB/m	Cable loss dB	Height cm	Azimuth deg	Pol.
896.250	46.3	107.1	60.8	20.5	22.3	3.5	174.0	30.0	Hor.
914.750	127.1	Carrier	-	100.9	22.8	3.4	179.0	0.0	Hor.
936.000	56.5	107.1	50.6	29.4	23.7	3.4	391.0	314.0	Hor.
Spurious emissions inside restricted bands									
Frequency MHz	Result dB $\mu$ V/m	Limit dB $\mu$ V/m	Margin dB	Readings dB $\mu$ V	Antenna factor dB/m	Cable loss dB	Height cm	Azimuth deg	Pol.
960.000	40.3	54.0	13.7	13.0	23.8	3.5	137.0	359.0	Vert.
983.975	43.7	54.0	10.3	16.4	23.8	3.5	139.0	0.0	Vert.
Measurement uncertainty					+2.2 dB / -3.6 dB				

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



Data record name: 142568ffhigh

Transmitter operates on the upper end of the assigned frequency band (operation mode 3)									
Spurious emissions outside restricted bands									
Frequency	Result	Limit	Margin	Readings	Antenna factor	Cable loss	Height	Azimuth	Pol.
MHz	dB $\mu$ V/m	dB $\mu$ V/m	dB	dB $\mu$ V	dB/m	dB	cm	deg	
912.000	52.8	105.9	53.1	26.7	22.7	3.4	178.0	358.0	Hor.
927.250	125.9	Carrier	-	99.1	23.4	3.4	108.0	23.0	Hor.
936.000	55.8	105.9	50.1	28.7	23.7	3.4	100.0	0.0	Vert.
Spurious emissions inside restricted bands									
Frequency	Result	Limit	Margin	Readings	Antenna factor	Cable loss	Height	Azimuth	Pol.
MHz	dB $\mu$ V/m	dB $\mu$ V/m	dB	dB $\mu$ V	dB/m	dB	cm	deg	
960.000	40.4	54.0	13.6	13.1	23.8	3.5	143.0	10.0	Vert.
983.975	43.7	54.0	10.3	16.4	23.8	3.5	140.0	0.0	Vert.
Measurement uncertainty					+2.2 dB / -3.6 dB				

Test: Passed

Test equipment used (refer clause 5):

14 - 20

#### 4.6.2.3 Final radiated emission measurement (1 GHz to 40 GHz)

Ambient temperature	22 °C	Relative humidity	49 %
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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.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 24 V DC by an external power supply.

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

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

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

Frequency GHz	Corr. Value 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
1.03200	40.3	74.0	33.7	40.2	24.1	25.9	1.9	150	Vert.	Yes
1.80550	43.1	107.4	64.3	40.0	26.5	25.9	2.5	150	Hor.	No
2.70825	43.7	74.0	30.3	37.8	28.7	26.1	3.2	150	Vert.	Yes
3.61100	43.7	74.0	30.3	34.5	31.3	25.9	3.7	150	Vert.	Yes
4.51375	46.4	74.0	27.6	35.1	32.3	25.2	4.3	150	Vert.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

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

Frequency GHz	Corr. Value 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
1.03200	32.0	54.0	22.0	31.9	24.1	25.9	1.9	150	Vert.	Yes
1.80550	32.7	107.4	74.7	29.6	26.5	25.9	2.5	150	Hor.	No
2.70825	32.3	54.0	21.7	26.4	28.7	26.1	3.2	150	Vert.	Yes
3.61100	32.5	54.0	21.5	23.3	31.3	25.9	3.7	150	Vert.	Yes
4.51375	34.7	54.0	19.3	23.4	32.3	25.2	4.3	150	Vert.	Yes
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 GHz	Corr. Value 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
1.03200	40.3	74.0	33.7	40.2	24.1	25.9	1.9	150	Vert.	Yes
1.82950	46.0	107.1	61.0	42.8	26.7	26.1	2.6	150	Hor.	No
2.74425	44.8	74.0	29.2	38.2	28.9	25.6	3.3	150	Hor.	Yes
3.65900	44.5	74.0	29.5	34.6	31.5	25.4	3.8	150	Vert.	Yes
4.57375	46.6	74.0	27.4	35.4	32.4	25.5	4.3	150	Vert.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			



**Result measured with the average detector:**

Frequency GHz	Corr. Value 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
1.03200	32.0	54.0	22.0	31.9	24.1	25.9	1.9	150	Vert.	Yes
1.82950	35.8	107.1	71.3	32.6	26.7	26.1	2.6	150	Hor.	No
2.74425	33.6	54.0	20.4	27.0	28.9	25.6	3.3	150	Hor.	Yes
3.65900	33.2	54.0	20.8	23.3	31.5	25.4	3.8	150	Vert.	Yes
4.57375	34.8	54.0	19.2	23.6	32.4	25.5	4.3	150	Vert.	Yes
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 GHz	Corr. Value 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
1.02330	52.1	74.0	21.9	52.1	24.1	25.9	1.8	150	Hor.	Yes
1.85450	50.3	105.9	55.6	46.4	27.0	25.7	2.6	150	Vert.	No
2.78175	48.8	74.0	25.2	42.5	29.0	26.1	3.4	150	Hor.	Yes
3.70900	44.8	74.0	29.2	34.9	31.8	25.7	3.8	150	Vert.	Yes
4.63625	47.1	74.0	26.9	35.9	32.4	25.4	4.3	150	Vert.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

**Result measured with the average detector:**

Frequency GHz	Corr. Value 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
1.02330	26.8	54.0	27.2	26.8	24.1	25.9	1.8	150	Hor.	Yes
1.85450	39.7	105.9	66.2	35.8	27.0	25.7	2.6	150	Vert.	No
2.78175	36.7	54.0	17.3	30.4	29.0	26.1	3.4	150	Hor.	Yes
3.70900	33.3	54.0	20.7	23.4	31.8	25.7	3.8	150	Vert.	Yes
4.63625	35.0	54.0	19.0	23.8	32.4	25.4	4.3	150	Vert.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Test: Passed

Test equipment used (refer clause 5):

29, 31 - 34, 36, 44, 45, 49, 73, 75

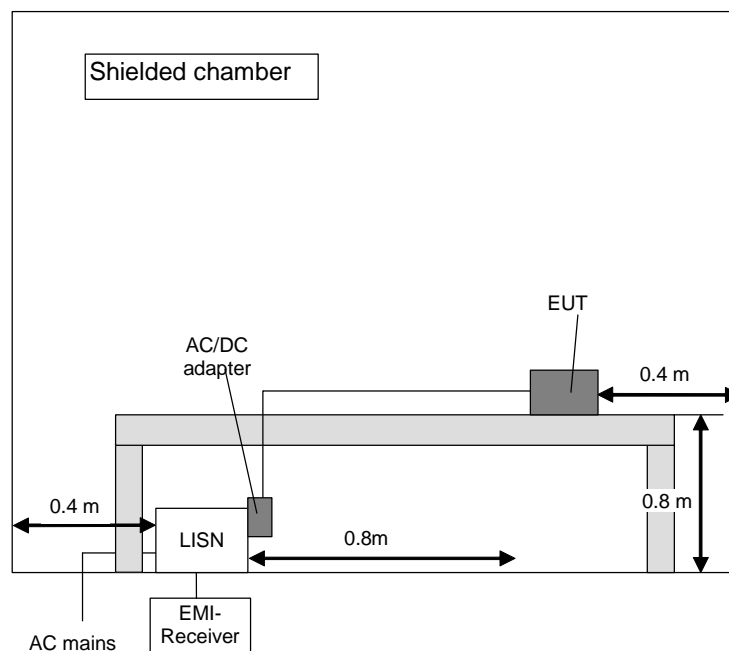
## 4.7 Conducted emissions on power supply lines (150 kHz to 30 MHz)

### 4.7.1 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 set up of the Equipment under test will be in accordance to ANSI C63.4-2009 [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 appropriate 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



#### 4.7.2 Test results (conducted emissions on power supply lines)

Ambient temperature	22 °C	Relative humidity	42 %
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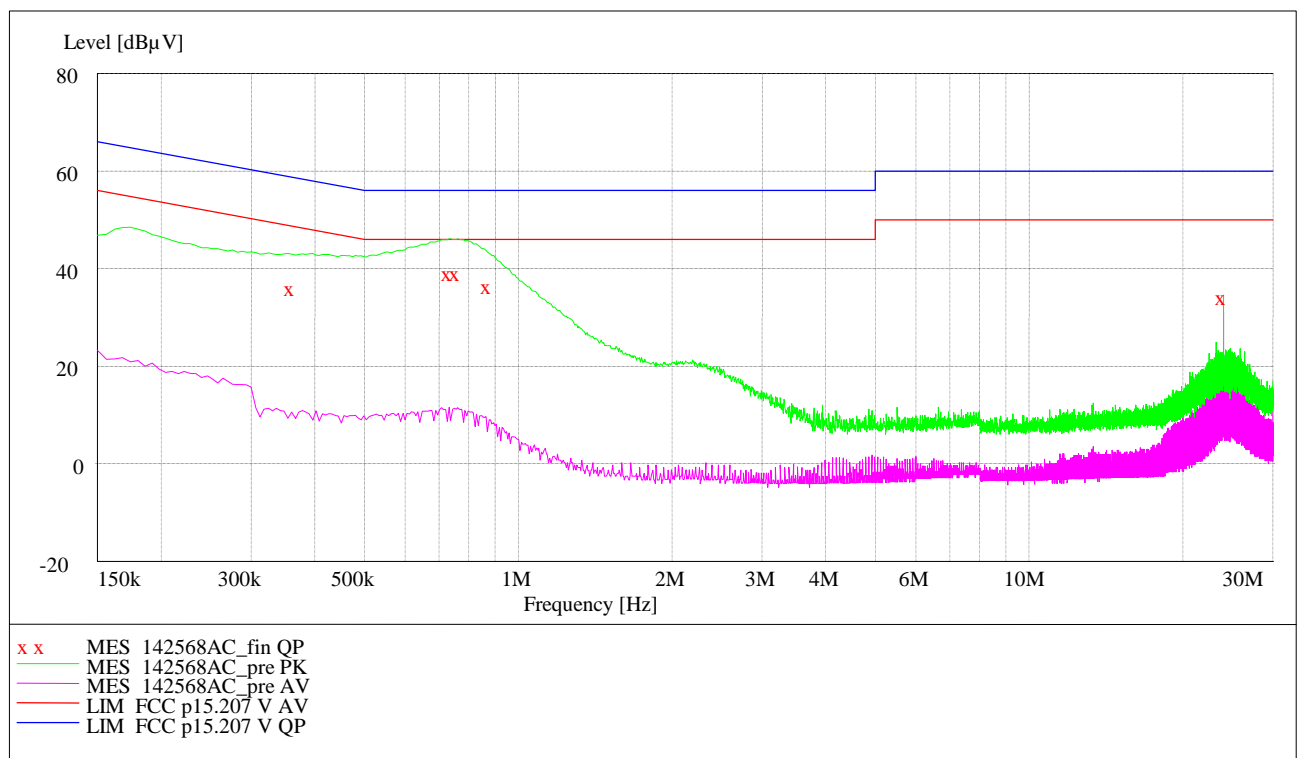
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

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: All results are shown in the following. This test was carried out in

Supply voltage: During all measurements the EUT was supplied with 12.0 V DC by an AC / DC adaptor type FW3288. which was supplied by 120 V AC / 60 Hz.

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.



Data record name: 142568AC

**Result measured with the quasipeak detector (marked in the diagram by an x):**

Frequency MHz	Level dB $\mu$ V	Transducer dB	Limit dB $\mu$ V	Margin dB	Line	PE
0.3597	36.5	0.9	48.7	12.2	L1	GND
0.7332	39.4	0.8	46.0	6.6	L1	FLO
0.7593	39.5	0.8	46.0	6.5	L1	FLO
0.8754	36.9	0.7	46.0	9.1	L1	FLO
24.0018	34.7	2.8	50.0	15.3	N	FLO
Mmeasurement uncertainty			+6.7 dB / -6.0 dB			

Test: Passed

Test equipment used (refer clause 5):

1 – 4, 20
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## 5 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
1	Shielded chamber M47	-	Albatross Projects	B83117-C6439-T262 -	480662	Weekly verification (system cal.)	
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	03/21/2014	03/2016
3	LISN	NSLK8128	Schwarzbeck	8128161	480138	12/20/2013	12/2014
4	High pass filter	HR 0.13- 5ENN	FSY Microwave Inc.	DC 0109 SN 002	480340	Weekly verification (system cal.)	
6	Spectrum Analyzer	FSU	Rohde & Schwarz	200125	480956	02/24/2014	02/2015
14	Open area test site	-	Phoenix Test-Lab	-	480085	Weekly verification (system cal.)	
15	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	03/21/2014	03/2016
16	Controller	HD100	Deisel	100/670	480139	-	-
17	Turntable	DS420HE	Deisel	420/620/80	480087	-	-
18	Antenna support	AS615P	Deisel	615/310	480086	-	-
19	Antenna	CBL6111 D	Chase	25761	480894	09/28/2011	09/2014
20	EMI Software	ES-K1	Rohde & Schwarz	-	480111	-	-
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/16/14	02/2016
32	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
33	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
34	Antenna support	AS615P	Deisel	615/310	480187	-	-
35	Antenna	CBL6112 B	Chase	2688	480328	04/14/2014	04/2017
36	Antenna	3115 B	EMCO	9609-4922	480184	09/28/2011	09/2014
43	RF-cable No. 36	Sucoflex 106B	Suhner	0522/6B	480571	Weekly verification (system cal.)	
44	RF-cable No. 3	Sucoflex 106B	Suhner	0563/6B	480670	Weekly verification (system cal.)	
45	RF-cable No. 40	Sucoflex 106B	Suhner	0708/6B	481330	Weekly verification (system cal.)	
49	Preamplifier	JS3- 00101200- 23-5A	Miteq	681851	480337	06/11/2014	06/2015
55	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	02/18/2014	02/2016
73	High Pass Filter	WHJS1000C 11/60EF	Wainwright Instruments GmbH	1	480413	09/26/2013	09/2014
75	High Pass Filter	WHKX4.0/18 G-8SS	Wainwright Instruments GmbH	1	480587	09/19/2013	09/2014
83	Tuneable Notch Filter	WRCA800/90 0-0.2/40- 6EEK	Wainwright Instruments GmbH	15	480414	Weekly verification (system cal.)	
114	20 dB attenuator	WA8/18-20- 34	Weinschel	-	481451	09/19/2013	09/2014

## 6 Report history

Report Number	Date	Comment
F142568E1	18 July 2014	Document created

## 7 List of annexes

ANNEX A            TEST SETUP PHOTOGRAPHS            7 pages

142568\_b.JPG: TN902-Q120L130-H1147, test set-up fully anechoic chamber  
 142568\_c.JPG: TN902-Q120L130-H1147, test set-up fully anechoic chamber  
 142568\_e.JPG: TN902-Q120L130-H1147, test set-up fully anechoic chamber  
 142568\_a.JPG: TN902-Q120L130-H1147, test set-up fully anechoic chamber  
 142568\_d.JPG: TN902-Q120L130-H1147, test set-up fully anechoic chamber  
 142568\_f.JPG: TN902-Q120L130-H1147, test set-up open area test site  
 142568\_i.JPG: TN902-Q120L130-H1147, test shielded chamber

ANNEX B            EXTERNAL PHOTOGRAPHS            2 pages

142568\_2.JPG: TN902-Q120L130-H1147, 3-D-view 1  
 142568\_1.JPG: TN902-Q120L130-H1147, 3-D-view 2

ANNEX C            INTERNAL PHOTOGRAPHS            8 pages

142568\_12.JPG: TN902-Q120L130-H1147, internal view 1 (cover removed)  
 142568\_9.JPG: TN902-Q120L130-H1147, internal view 2 (antenna removed)  
 142568\_10.JPG: TN902-Q120L130-H1147, main PCB, top view  
 142568\_11.JPG: TN902-Q120L130-H1147, main PCB, bottom view  
 142568\_6.JPG: TN902-Q120L130-H1147, coupler PCB, top view  
 142568\_5.JPG: TN902-Q120L130-H1147, coupler PCB, bottom view  
 142568\_4.JPG: TN902-Q120L130-H1147, antenna PCB, top view  
 142568\_7.JPG: TN902-Q120L130-H1147, antenna PCB, bottom view