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Test Report

Report Number:

F161191E1

Equipment under Test (EUT):

SePem 155

Applicant:

Hermann Sewerin GmbH

Manufacturer:

Hermann Sewerin GmbH



Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

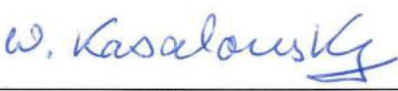

REFERENCES

- [1] **FCC CFR 47 Part 90 (October 25, 2016)** Private Land Mobile Radio Services
- [2] **FCC CFR 47 Part 2 (October 25, 2016)** Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
- [3] **TIA-603-E (2016)** Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
- [4] **ANSI C63.4-2014** American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

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: | Wolfgang KASALOWSKY |  <hr/> <small>Signature</small> | <hr/> 28.10.2016 <small>Date</small> |
| | <small>Name</small> | | |
| Authorized reviewer: | Bernd STEINER |  <hr/> <small>Signature</small> | <hr/> 28.10.2016 <small>Date</small> |
| | <small>Name</small> | | |

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1 Identification

1.1 Applicant

| | |
|--|---|
| Name: | Hermann Sewerin GmbH |
| Address: | Robert-Bosch-Strasse 3 33334 Gütersloh |
| Country: | Germany |
| Name for contact purposes: | Mr. Christian KREIENBRINCK |
| Phone: | +49 (0)5241 934 319 |
| Fax: | +49 (0)5241 934 444 |
| eMail Address: | Christian.Kreienbrinck@sewerin.com |
| Applicant represented during the test by the following person: | --- |

1.2 Manufacturer

| | |
|--|---|
| Name: | Hermann Sewerin GmbH |
| Address: | Robert-Bosch-Strasse 3 33334 Gütersloh |
| Country: | Germany |
| Name for contact purposes: | Mr. Christian KREIENBRINCK |
| Phone: | +49 (0)5241 934 319 |
| Fax: | +49 (0)5241 934 444 |
| eMail Address: | Christian.Kreienbrinck@sewerin.com |
| Applicant represented during the test by the following person: | --- |

1.3 Test laboratory

The tests were carried out at: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

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

1.4 EUT (Equipment Under Test)

| | |
|------------------|-------------------------|
| Test object: * | Stationary noise logger |
| HVIN: * | SF02-A0205 |
| PMN: * | SePem 155 |
| FCC ID: * | WSP-SF02A0205 |
| IC: * | 7994A-SF02A0205 |
| Serial number: * | 100 09 00002 |

* declared by the applicant.

1.5 Technical data of equipment

| | | | |
|------------------------------|--|--|--|
| Operating frequency range: * | TX: 461.0375 MHz to 464.5625 MHz RX: 466.0375 MHz to 469.5625 MHz | | |
| Channel spacing: * | 12.5 kHz | | |
| Modulation: * | GFSK | | |
| Rated Power: * | <p>-6dBm: - when the logger will be activated by a magnet. - when the reading device (Master) and the logger are close together.</p> <p>13dBm: - when the logger sends in its transmission window (depends on the settings). - when the transmission quality (between master and logger) falls below a specific value (RSSI).</p> <p>The customer cannot choose directly the output power.</p> | | |
| Data Rate: * | 4800 kbps | | |
| Duty cycle: * | 10% | | |
| Antenna type: * | YUE-XP-378 | | |
| Antenna gain: * | 1.8 dBi | | |
| Antenna connector: * | TNC | | |
| Power supply: * | 3.6 V _{DC} by internal lithium battery | | |
| Supply Voltage: * | U _{nom} = 3.6 V _{DC} | U _{min} = 3.1 V _{DC} | U _{max} = 3.7 V _{DC} |
| Audio Filter: * | None | | |
| Temperature range: * | - 20°C to + 55°C | | |
| Lowest internal frequency: * | 32 kHz | | |

* declared by the applicant.

List of Operating Frequencies (Transmit / Receive) *

| §90.267 (d) Group B Frequencies [MHz] | §90.267 (e) Group C Frequencies [MHz] | |
|--|--|---------------------|
| 462.2125 / 467.2125 | 461.0375 / 466.0375 | 461.2875 / 466.2875 |
| 462.2375 / 467.2375 | 461.0625 / 466.0625 | 461.3125 / 466.3125 |
| 462.2625 / 467.2625 | 461.0875 / 466.0875 | 461.3375 / 466.3375 |
| 462.2875 / 467.2875 | 461.1125 / 466.1125 | 461.3625 / 466.3625 |
| 462.3125 / 467.3125 | 461.1375 / 466.1375 | 462.8625 / 467.8625 |
| 462.3375 / 467.3375 | 461.1625 / 466.1625 | 462.8875 / 467.8875 |
| 462.3625 / 467.3625 | 461.1875 / 466.1875 | 462.9125 / 467.9125 |
| 462.3875 / 467.3875 | 461.2125 / 466.2125 | 464.4875 / 469.4875 |
| 467.4125 / 467.4125 | 461.2375 / 466.2375 | 464.5125 / 469.5125 |
| 462.4375 / 467.4375 | 461.2625 / 466.2625 | 464.5375 / 469.5375 |
| | | 464.5625 / 469.5625 |

* declared by the applicant.

The following external I/O cables were used:

No cables were connectable to the EUT

1.6 Dates

| | |
|---------------------------------|------------|
| Date of receipt of test sample: | 29.06.2016 |
| Start of test: | 30.06.2016 |
| End of test: | 18.07.2016 |

2 Operational states

The test was carried out with an unmodified test sample operating in test mode. The test mode was implemented by the applicant. To enter the test mode, the EUT has to be activated with the help of a permanent magnet, presented on the housing of the EUT. So the operational state of the SePem 155 (Logger) could be chosen with the help of a SePem 01 (Master).

During the spurious emission and radiation measurement the test sample was powered by the internal 3.6 V battery.

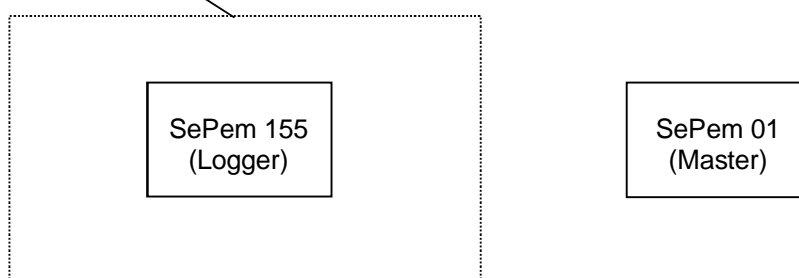
For measurements under extreme conditions, an external power supply was connected to the battery contacts of the EUTs transmitter.

As declared by the applicant, the EUT is intended to be used in the frequency range $-20\text{ }^{\circ}\text{C}$ to $+55\text{ }^{\circ}\text{C}$. Due to this fact the measurements under extreme conditions were carried out using this temperature range.

The EUT is equipped with a permanent external antenna connector, but is intended to be used with the antenna type YUE-XP-378 from Yue Young only (dedicated antenna).

During the tests, the EUT was labelled with a preliminary label.

Physical boundary of the EUT



3 Additional information

A SePem01 Master with special configuration software was used to set the SePem 01 Data Logger in the requested operation mode.

All measurements were performed with the EUT set to maximum RF power.

4 Overview

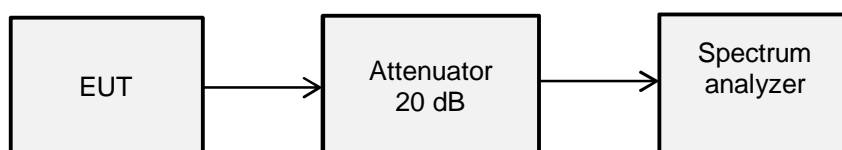
| Application | FCC CFR 47 section | Status | Refer page |
|--|--|--------|------------|
| Transmitter output power | 90.205 [1] 2.1046 [2] | Passed | 9 et seq. |
| Occupied bandwidth | 90.209 [1] 2.1049 [2] | Passed | 10 et seq. |
| Spectrum emission mask | 90.217 [1] 2.1049 [2] | Passed | 13 et seq. |
| Spurious emissions (transmitter, radiated) | 90.210 [1] 2.1057 [2] 2.1053 [2] | Passed | 19 et seq. |
| Frequency stability | 90.213 [1] 2.1055 [2] | Passed | 34 et seq. |

5 Test results

5.1 Transmitter output power

5.1.1 Method of measurement

Test setup:



The EUT is set to transmit continuously at maximum RF power.

The following spectrum analyser settings were used:

- Span: 100kHz
- Resolution bandwidth: 50 kHz
- Video bandwidth: 500 kHz
- Sweep time: 45 ms
- Detector function: Peak
- Trace mode: Max hold

5.1.2 Test result

| | | | |
|---------------------|-------|-------------------|------|
| Ambient temperature | 23 °C | Relative humidity | 22 % |
|---------------------|-------|-------------------|------|

| Test Condition | Measured output power [dBm] | | | Limit [dBm] |
|--|-----------------------------|--------------|--------------|-------------|
| T _{nom} (20 °C) | 461.0375 MHz | 462.8625 MHz | 464.5625 MHz | |
| U _{nom} (3.6 V DC) | 12.9 | 12.9 | 12.9 | 13.0 ±1 |
| U _{min} (3.1 V DC) | 13.2 | 13.2 | 13.2 | |
| U _{max} (3.7 V DC) | 13.2 | 13.2 | 13.2 | |
| Measurement uncertainty: +0.66 dB / -0.72 dB | | | | |

Limit:

The output power shall be within ±1 dB of the manufacturer's rated power listed in the equipment specifications.

Test: Passed

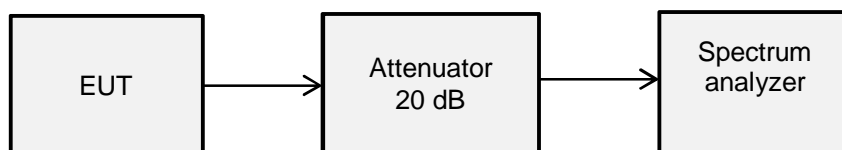
Test equipment used (refer clause 6):

23, 29

5.2 Occupied bandwidth

5.2.1 Method of measurement

Test setup:



The EUT is set to transmit continuously.

The following spectrum analyser settings were used:

- Channel spacing: 12.5 kHz
- Span: 50 kHz
- Resolution bandwidth: 300 Hz
- Video bandwidth: 1 kHz
- Sweep time: 560 ms
- Detector function: Peak
- Trace mode: Max hold

5.2.2 Test result

| | | | |
|---------------------|-------|-------------------|------|
| Ambient temperature | 23 °C | Relative humidity | 22 % |
|---------------------|-------|-------------------|------|

| Measured 99% bandwidth [kHz] | | | Limit [kHz] (Authorized bandwidth) |
|--|--------------|--------------|---------------------------------------|
| 461.0375 MHz | 462.8625 MHz | 464.5625 MHz | |
| 7.292 | 7.292 | 7.372 | 11.25 |
| Measurement uncertainty: <10 ⁻⁷ (frequency), 0.66 dB / -0.72 dB (level) | | | |

Limit:

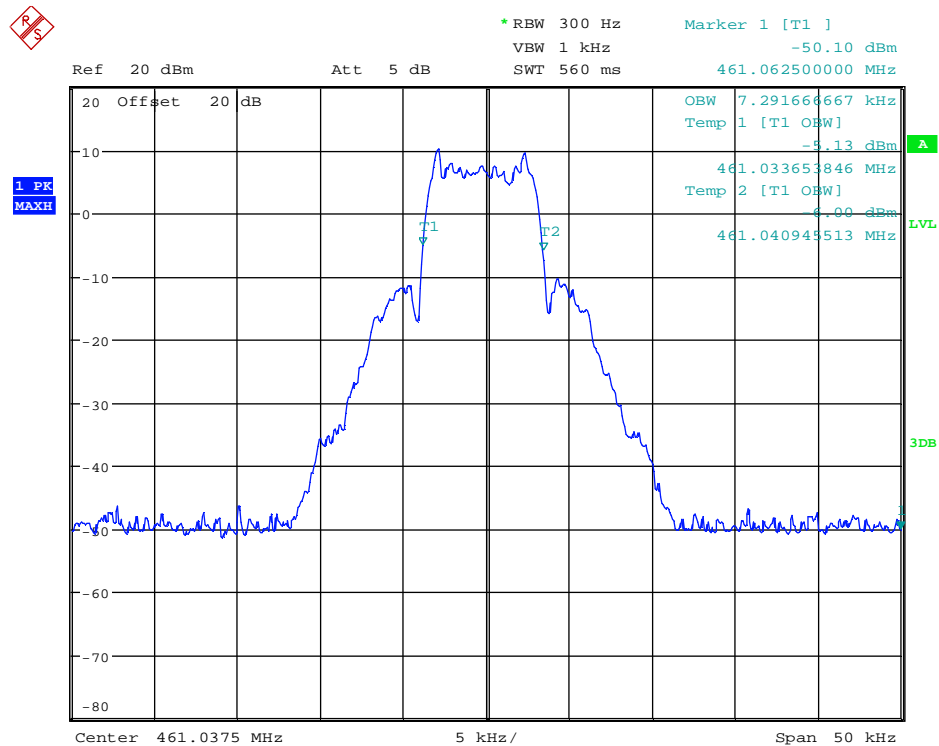
The maximum permissible occupied bandwidth shall not exceed the authorized bandwidth. The authorized bandwidth is defined as the maximum width of the band of frequencies used to derive spectrum masks and is not necessarily equivalent to the bandwidth found on radio and spectrum licenses.

| Frequency Band (MHz) | Channel Spacing (kHz) | Authorized Bandwidth (kHz) | Spectrum Masks for Equipment With Audio Filter | Spectrum Masks for Equipment Without Audio Filter |
|-----------------------|-----------------------|----------------------------|--|---|
| 406.1-430 and 450-470 | 25 | 20 22 | B Y | C (G) * Y |
| | 12.5 | 11.25 | D | D |

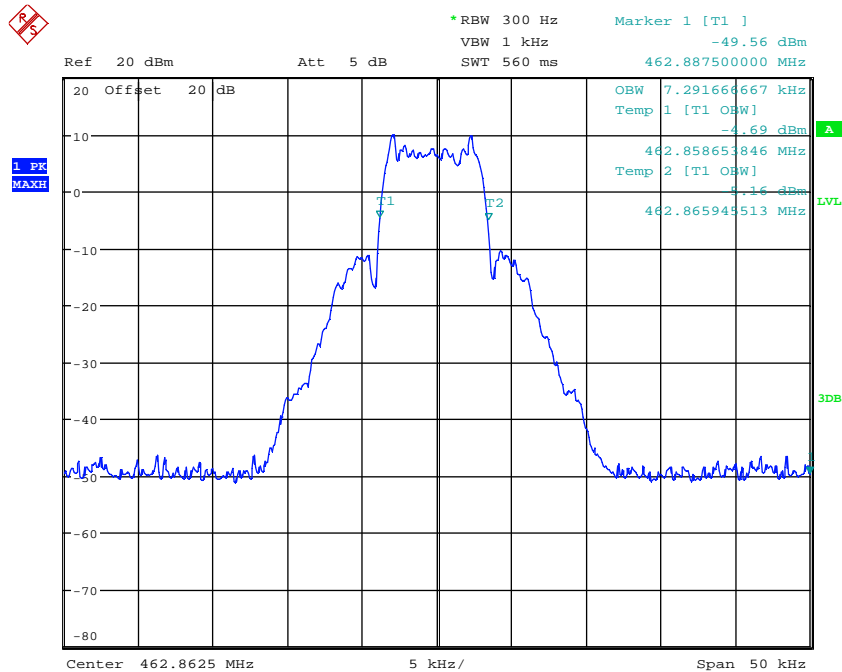
* Paging transmitters in the bands 406.1-430 MHz and 450-470 MHz are to use mask G.

Test: Passed

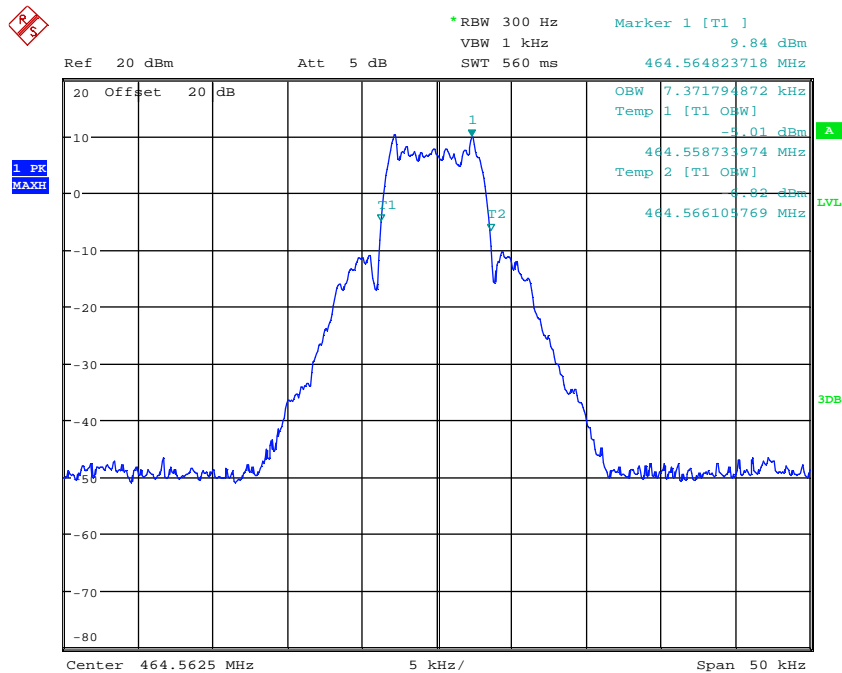
161191_OBW_461.0375_PERM.wmf



161191_OBW_462.8625_PERM.wmf



161191_OBW_464.5625_PERM.wmf



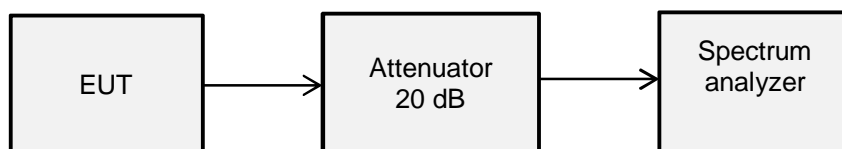
Test equipment used (refer clause 6):

23, 29

5.3 Emission masks

5.3.1 Method of measurement

Test setup:



The following spectrum analyser settings were used:

| | |
|-------------------------|------------|
| Channel spacing: | 12.5 kHz |
| - Span: | 50 kHz |
| - Resolution bandwidth: | 300 Hz |
| - Video bandwidth: | 1 kHz |
| - Mode: | Auto sweep |
| - Sweep time: | 500 ms |
| - Detector function: | Peak |
| - Trace mode: | Max hold |

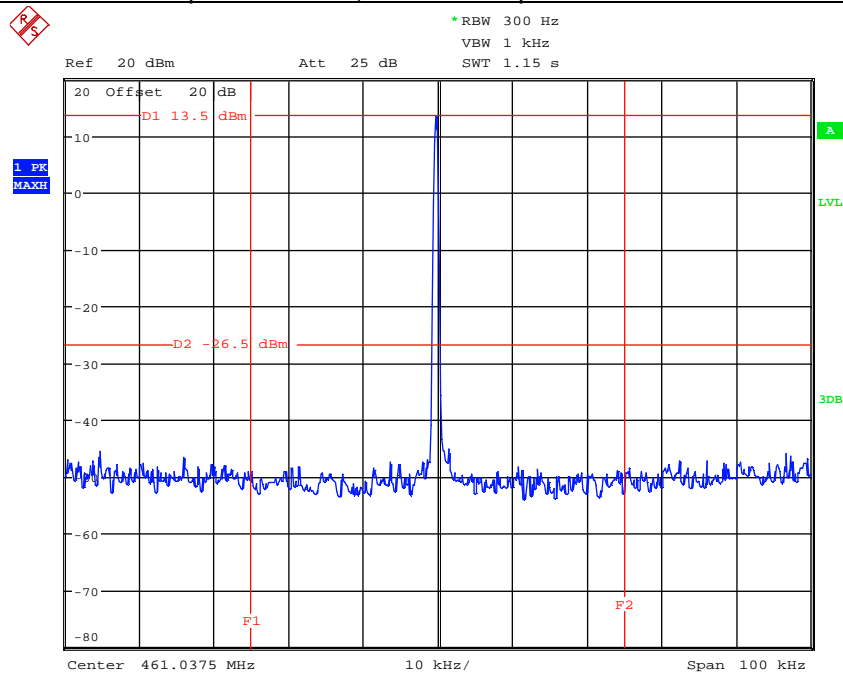
The measurement is done with unmodulated carrier, continuous transmission with modulation and transmission of bursts.

5.3.2 Test Results

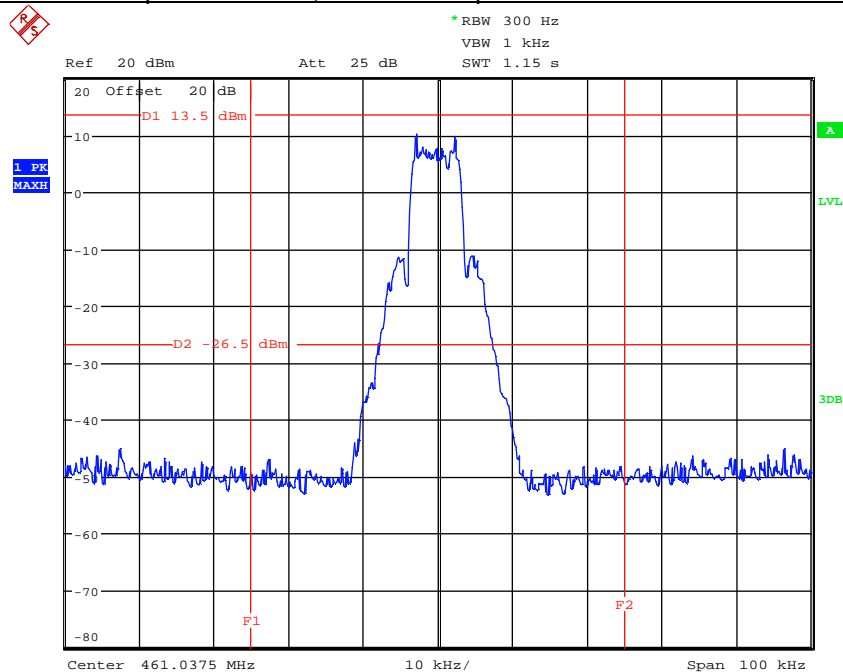
| | | | |
|---------------------|-------|-------------------|------|
| Ambient temperature | 23 °C | Relative humidity | 22 % |
|---------------------|-------|-------------------|------|

Transmitter operates on 461.0375 MHz:

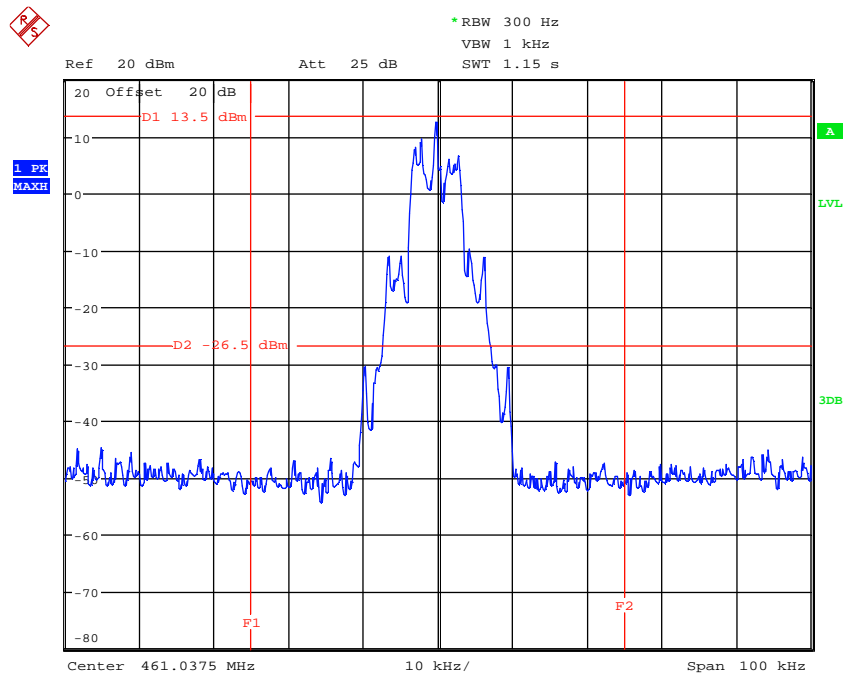
161191_LOW_CARRIER.wmf: Spectrum mask, transmitter operates without modulation at 461.0375 MHz:



161191_LOW_PERM.wmf: Spectrum mask, transmitter operates continuous modulation at 461.0375 MHz:

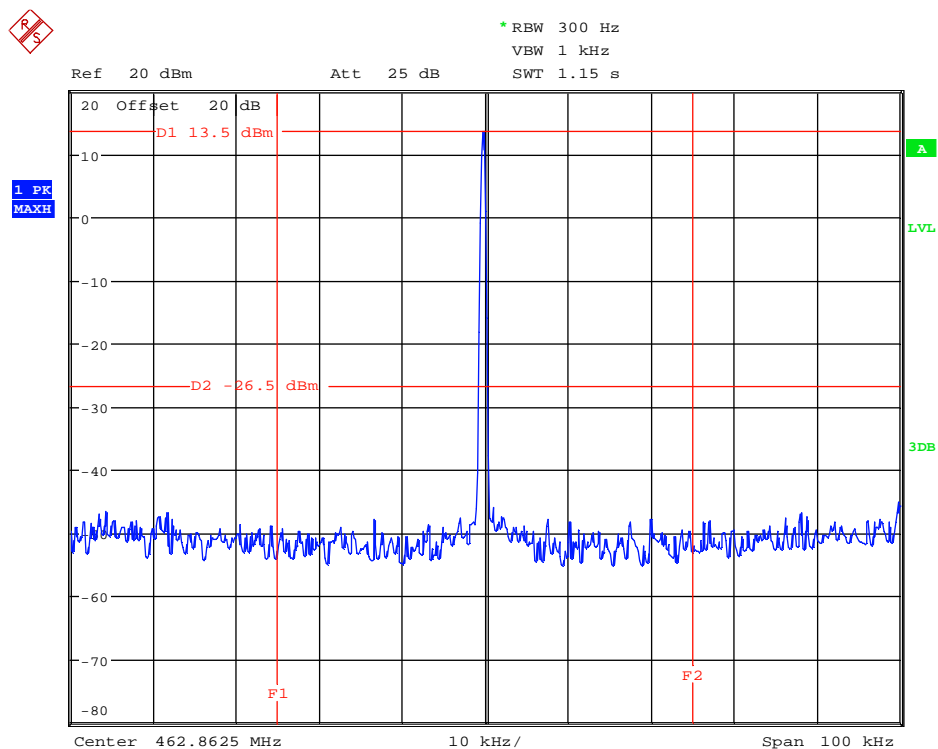


161191_LOW_BURST.wmf: Spectrum mask, transmitter operates with burst modulation at 461.0375 MHz:

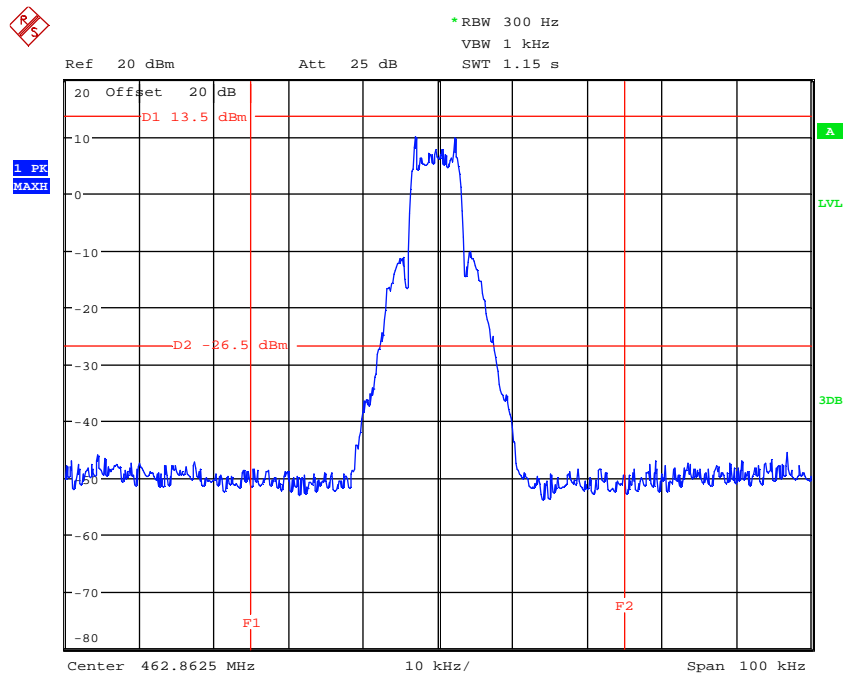


Transmitter operates on 462.8625 MHz:

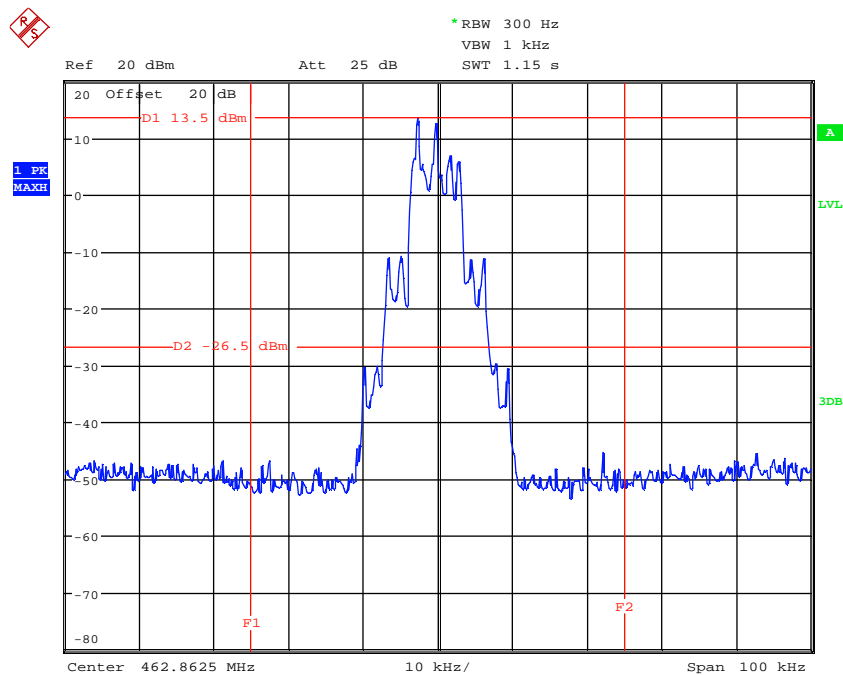
161191_MID_CARRIER.wmf: Spectrum mask, transmitter operates without modulation at 462.8625 MHz:



161191 MID_PERM.wmf: Spectrum mask, transmitter operates continuous modulation at 462.8625 MHz:

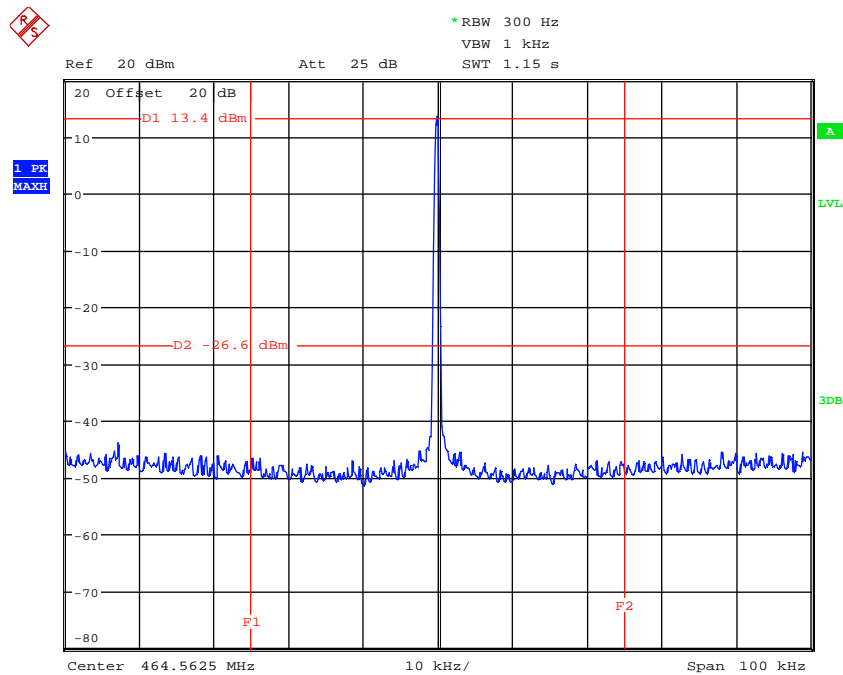


161191 MID_BURST.wmf: Spectrum mask, transmitter operates with burst modulation at 462.8625 MHz:



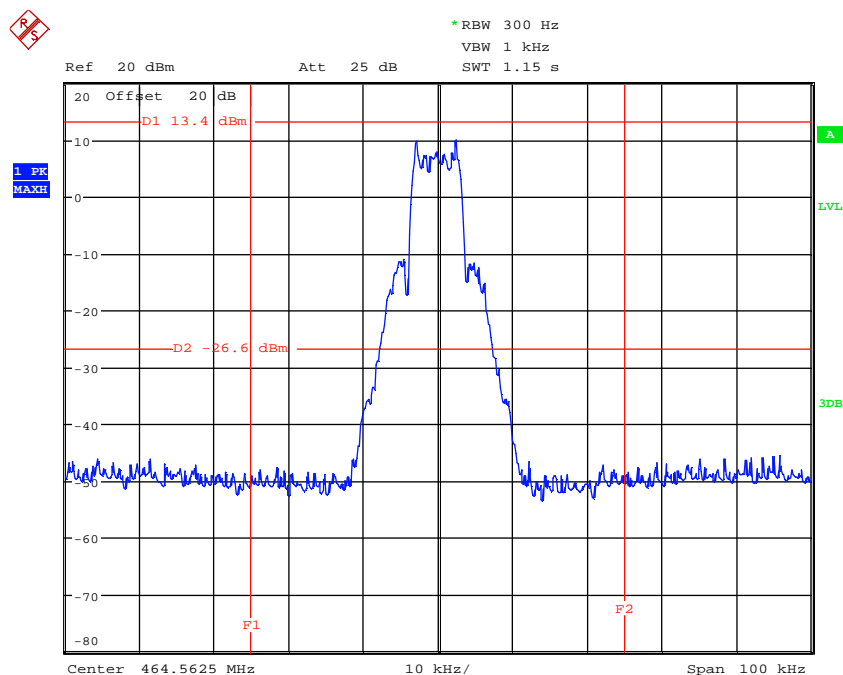
Transmitter operates on 464.5625 MHz:

161191_HIGH_CARRIER.wmf: Spectrum mask, transmitter operates without modulation at 464.5625 MHz:

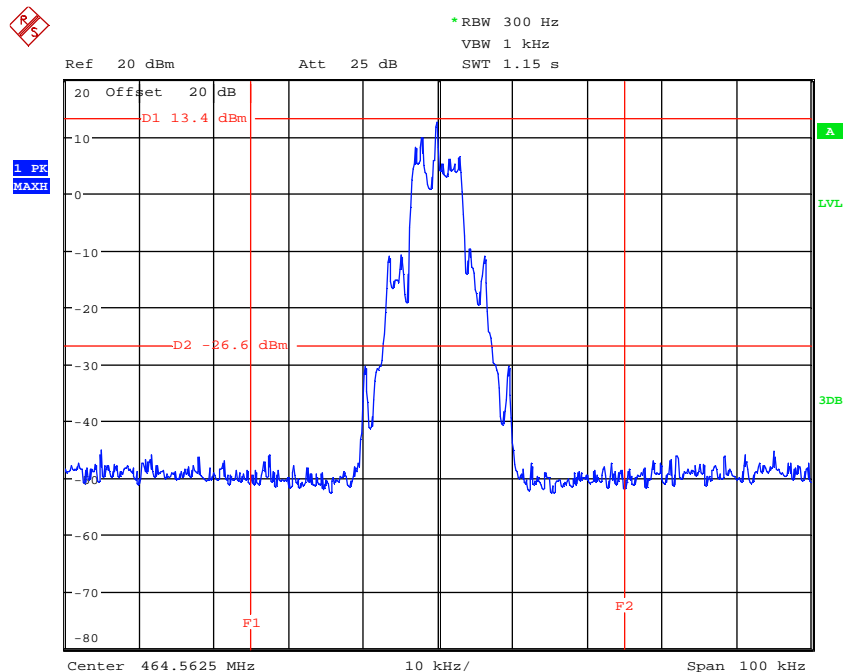


161191_HIGH_PERM.wmf:

Spectrum mask, transmitter operates with continuous modulation at 464.5625 MHz:



161191_HIGH_BURST.wmf: Spectrum mask, transmitter operates with burst modulation at 464.5625 MHz:



Limit:

Transmitters that have an output power that does not exceed 120 mW are exempt from the emission masks provided that they comply with the following:

The sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a displacement frequency, f_d , from the assigned frequency as shown in the table below is attenuated below the unmodulated carrier power by at least 30 dB, when measured with a resolution bandwidth of 300 Hz. If the unmodulated carrier power is not available, the modulated transmitter output power can be used instead. The transmitter output power is measured or integrated over its occupied bandwidth.

| Displacement frequency for required attenuation for transmitters having an output power of less than 120 mW | |
|---|-------------------------------------|
| Equipment channel bandwidth (kHz) | Displacement frequency, f_d (kHz) |
| 25 | $f_d \geq 40$ |
| 30 | |
| 12.5 | $f_d \geq 25$ |
| 15 | |
| 6.25 | $f_d \geq 12.5$ |
| 7.5 | |

Test: Passed

Test equipment used (refer clause 6):

23, 29

5.4 Spurious emissions (radiated)

5.4.1 General method of measurement

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 at an outdoor test site without reflecting ground plane and a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- A final measurement carried out at an open area test site 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 fixed antenna height and various EUT positions in the frequency range 1 GHz to 5 GHz.
- A final measurement carried out in a fully anechoic chamber with various antenna heights in the frequency range 1 GHz to 5 GHz.

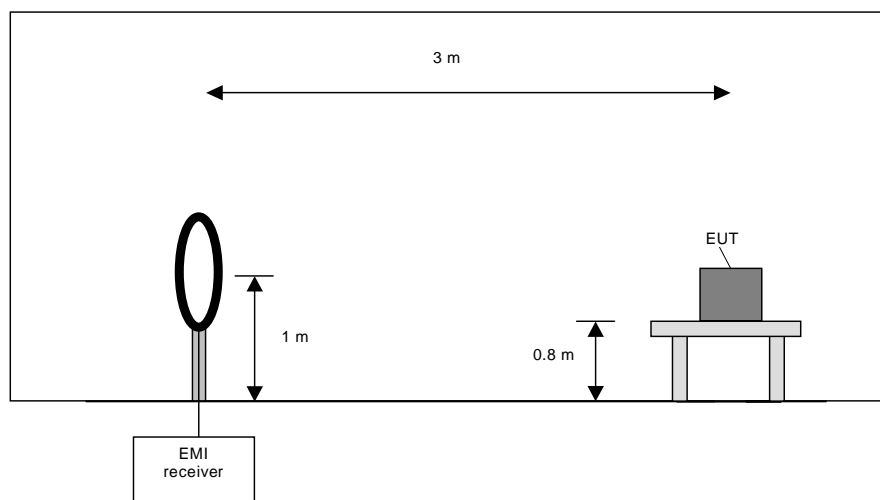
Preliminary measurement (9 kHz to 30 MHz):

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 be 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 [4].

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 find 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 | 300 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).

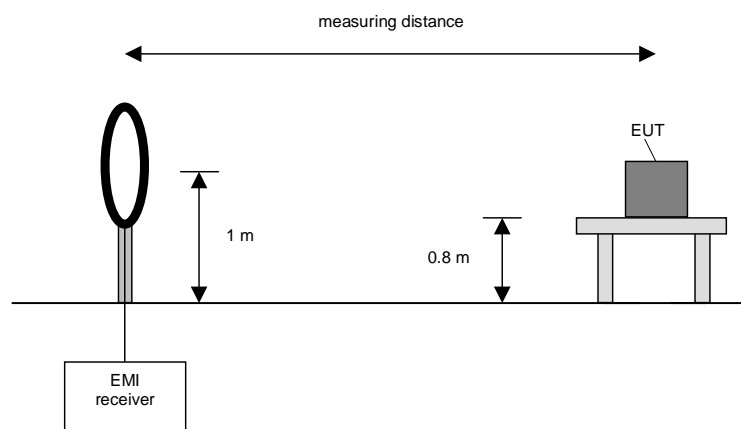
Final measurement (9 kHz to 30 MHz):

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

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) If the EUT is a module and might be used in a handheld equipment application:
Repeat steps 1) to 4) with the other orthogonal axes of the EUT.

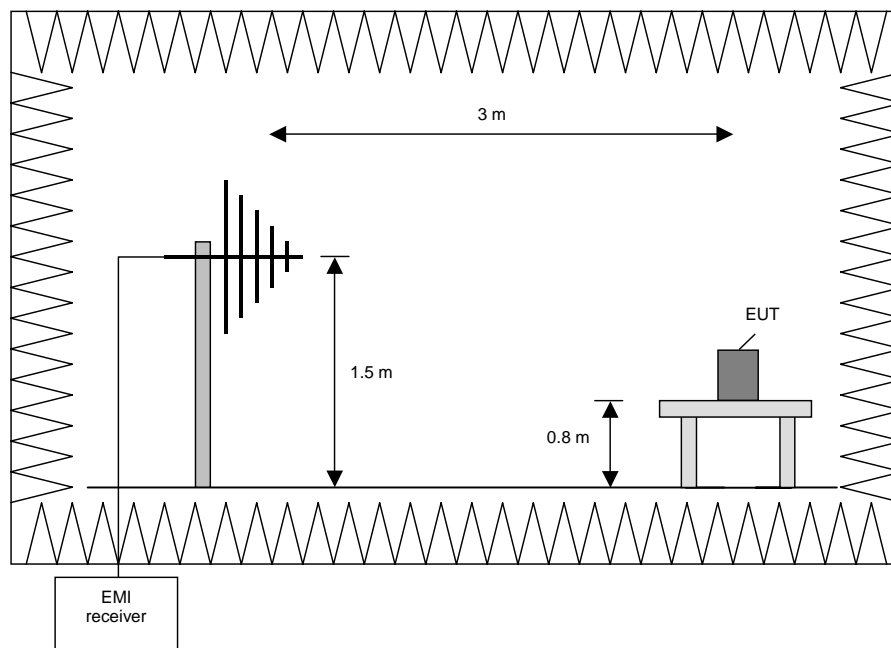
Preliminary measurement (30 MHz to 1 GHz)

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 table at the height of 0.8 m. Floor-standing devices will be placed directly on the turntable/ground plane.

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 230 MHz | 100 kHz |
| 230 MHz to 1 GHz | 100 kHz |



Procedure preliminary measurement:

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

The following procedure will be used:

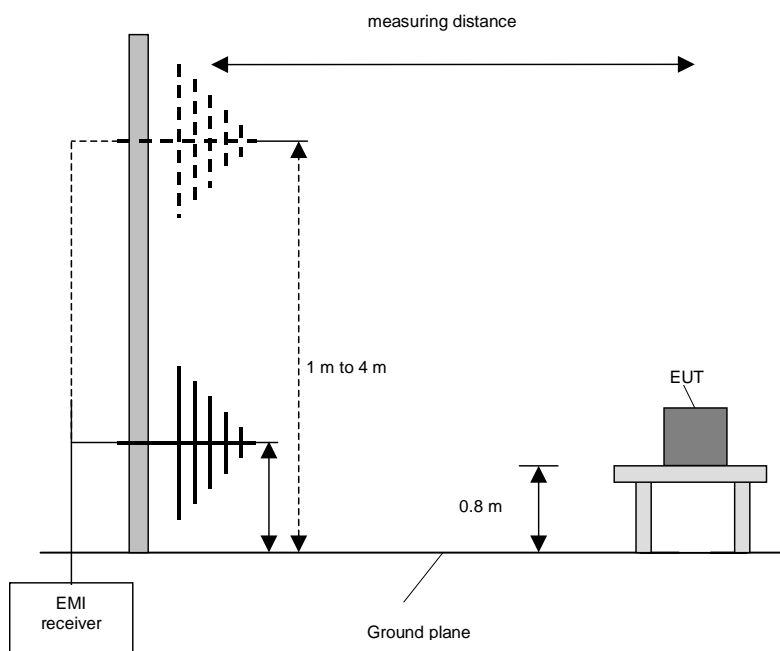
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the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

Final measurement (30 MHz to 1 GHz)

A final measurement at 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:

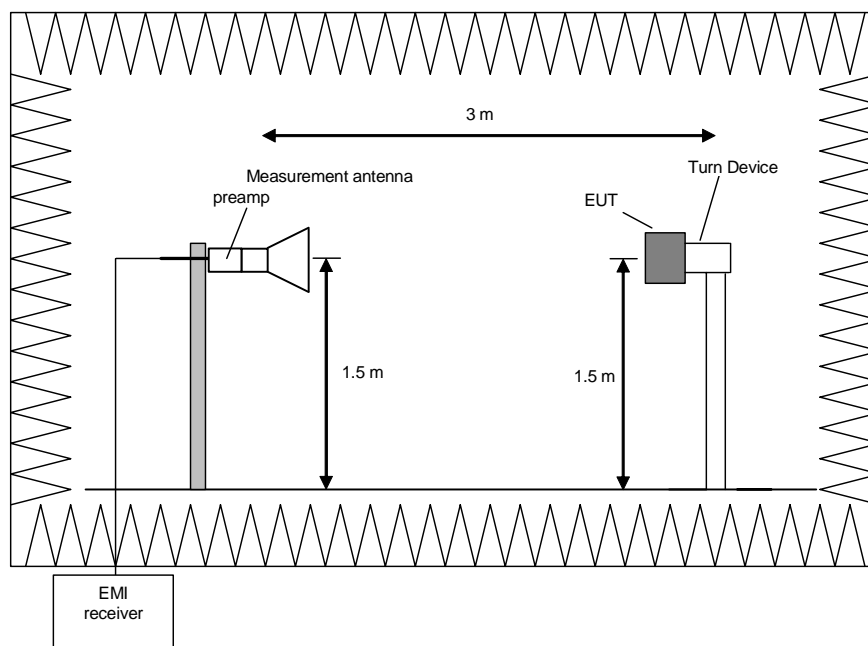
- 1) Measure on the selected frequencies at an antenna height of 1 m and a EUT azimuth of 23 °.
- 2) Move the antenna from 1 m to 4 m and note the maximum value at each frequency.
- 3) Rotate the EUT by 45 ° and repeat 2) until an azimuth of 337 ° is reached.
- 4) Repeat 1) to 3) for the other orthogonal 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, if the EUT is a module and might be used in a handheld equipment application).

Preliminary and final measurement (1 GHz to 5 GHz)

This measurement will be performed in a fully anechoic chamber. The EUT will be set up on a non-conducting support at the height of 1.5 m. The set up of the Equipment under test will be in accordance to [4].

Preliminary measurement (1 GHz to 5 GHz)

The spectrum analyser is 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 from 0° to 150°.



Procedure of preliminary measurement:

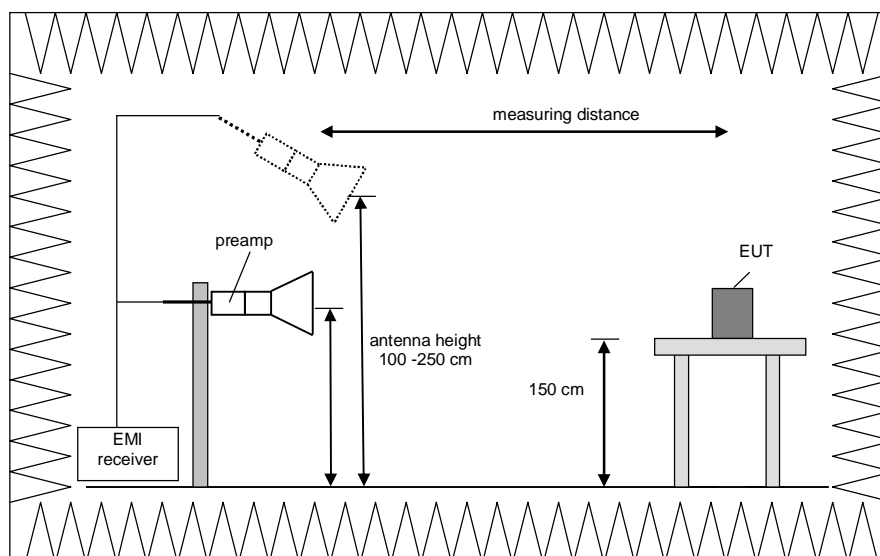
Prescans were performed in the frequency range 1 to 5 GHz.

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°).
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.

Final measurement (1 GHz to 5 GHz)

The EMI Receiver is set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed at the frequencies found during the preliminary measurements by rotating the turntable from 0 to 360° and at antenna height varied from 100 cm up to 250 cm. The setup will be in accordance to [3] and [4].



Procedure of final measurement:

The measurements were performed in the frequency range 1 GHz to 5 GHz.

The following procedure will be used:

- 1) Monitor the selected frequencies from the preliminary measurement at horizontal and vertical polarisation and turn the EUT 360°.
- 2) Change the antenna height and repeat 1) with 100, 150, 200 and 250 cm height and an elevation pointing towards the EUT.
- 3) Make a hardcopy of the spectrum with each antenna height.
- 4) Compare the spectrum plots and take for each frequency the antenna height with the maximum emission.
- 5) 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.
- 6) Replace the EUT by a suitable substitution antenna and connect this antenna to a signal generator.
- 7) Set the turntable to the azimuth and the antenna height to the position where the maximum value was found.
- 8) Change the output power for each frequency until the level of the EUT's emission is found.
- 9) Note the output power of the signal generator.

5.4.2 Preliminary radiated emission measurement

| | | | |
|---------------------|------|-------------------|------|
| Ambient temperature | 22°C | Relative humidity | 72 % |
|---------------------|------|-------------------|------|

Position of EUT: The EUT was set-up on a non-conducting table at a height of 0.8 m below 1 GHz and on a positioner at a height of 1,5 m above 1 GHz. The positioner was set to 0°, 30°, 60°, 90°, 120° and 150°. The distance between EUT and antenna was 3 m.

Cable guide: No cables were connectable to the EUT.

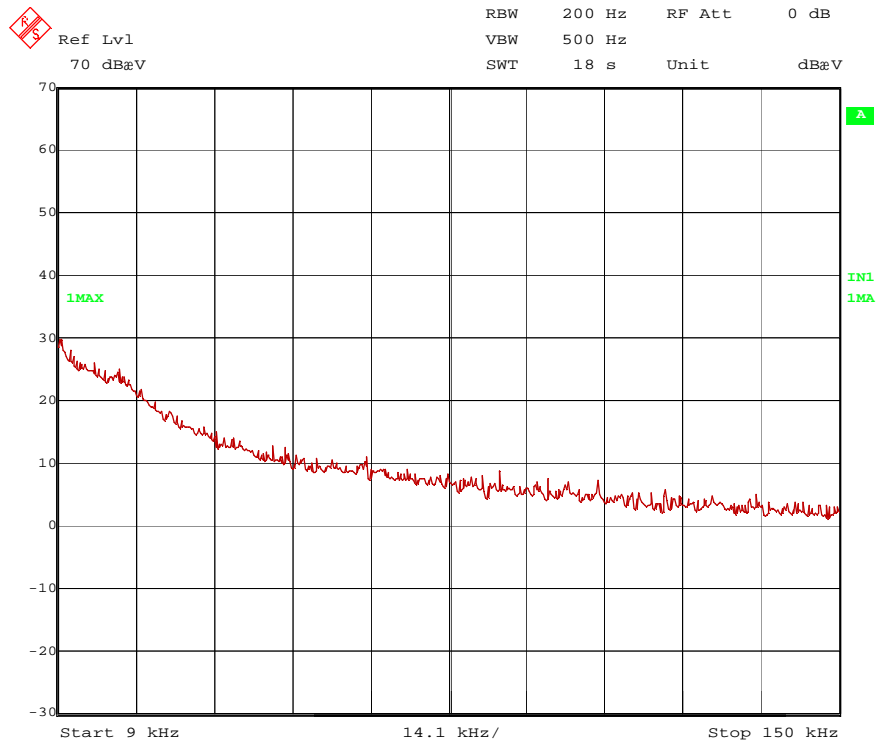
Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was powered with 3.6 V DC via the internal battery.

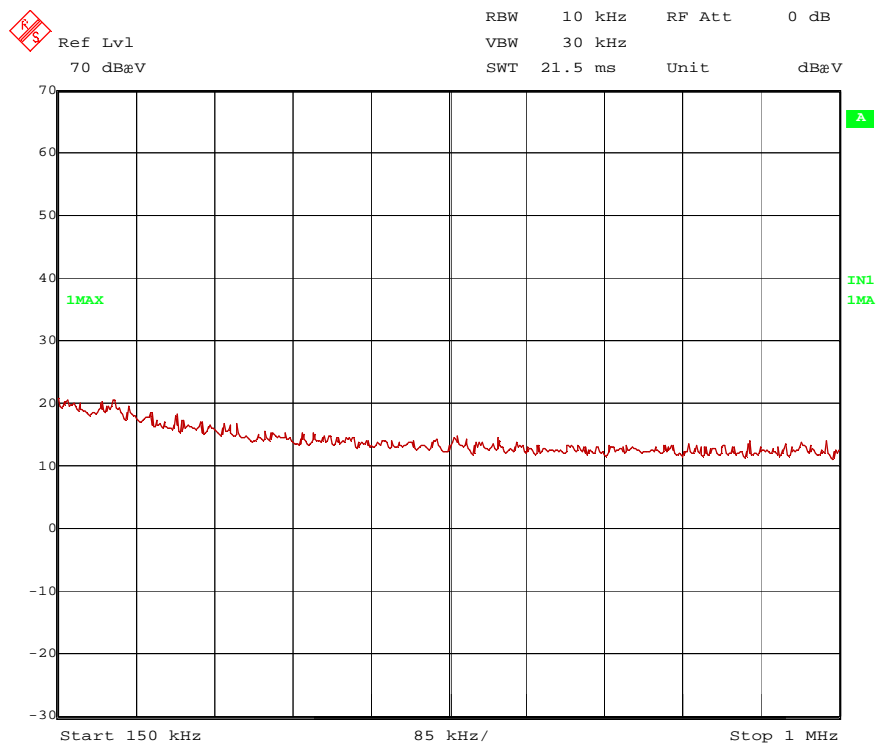
Remark: Only the plots of the worst case emissions are submitted for every frequency range above 30 MHz in the preliminary results.

The Emissions below 30 MHz were similar for all transmit frequencies. Therefore only the results of an exemplary test case are submitted in the following.

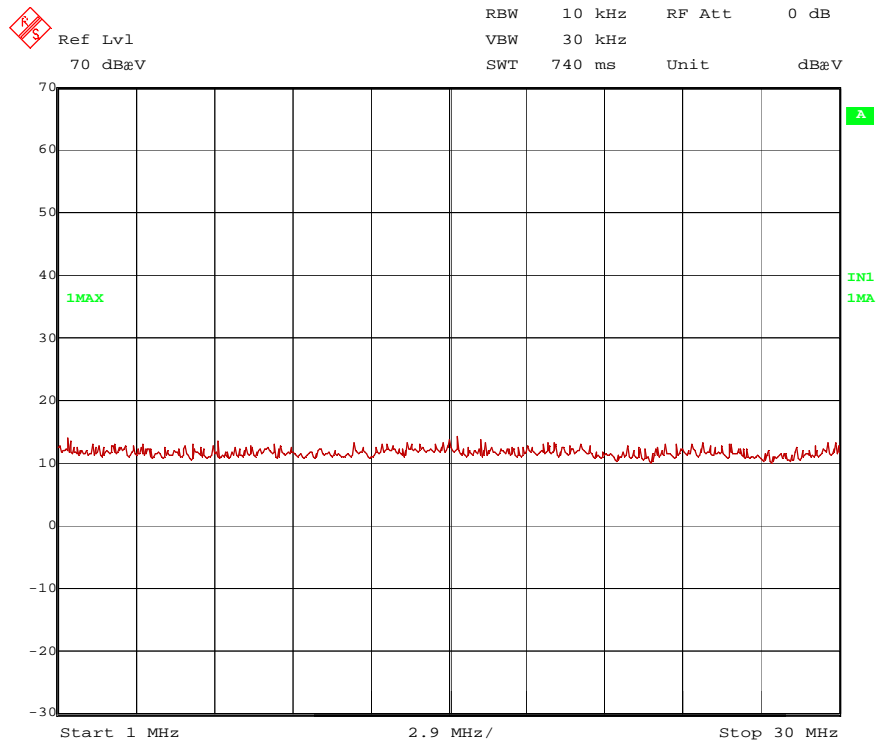
161191_TX_9k-150k.wmf



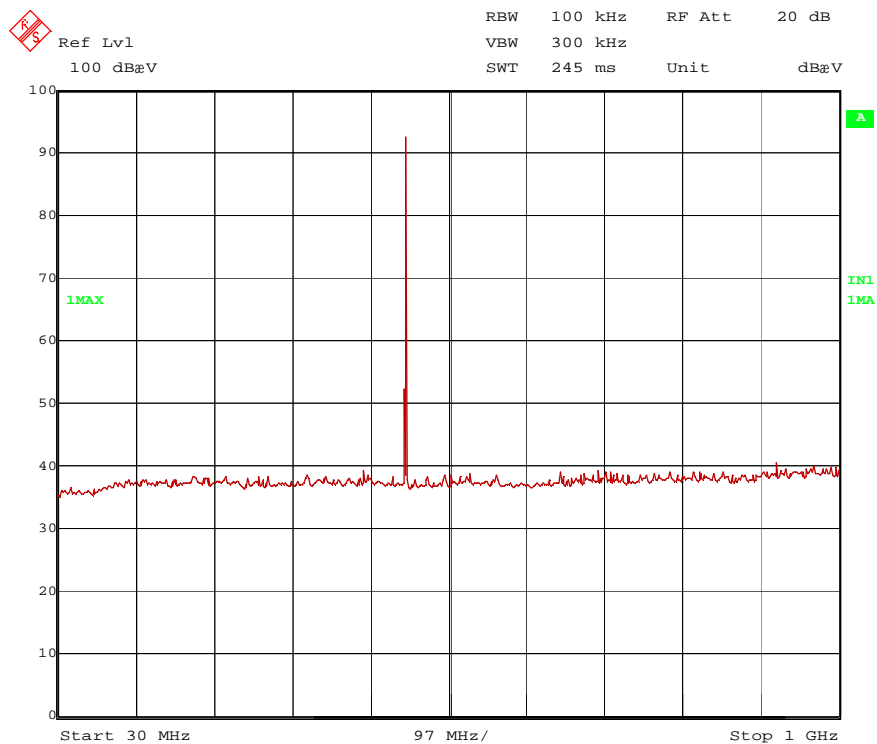
161191_TX_150k-1M.wmf



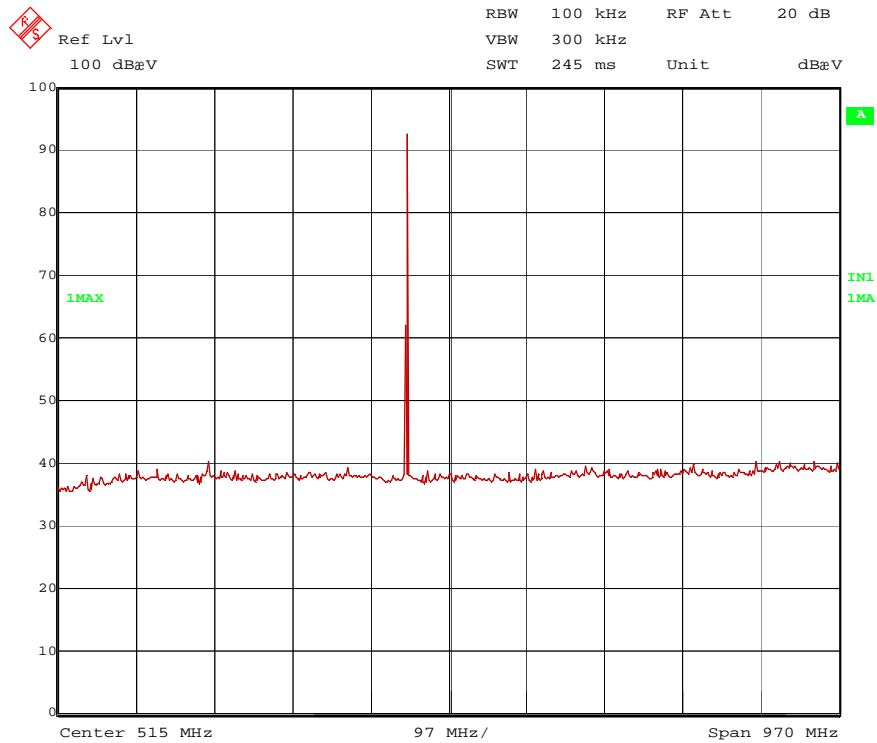
161191_TX_1-30M.wmf



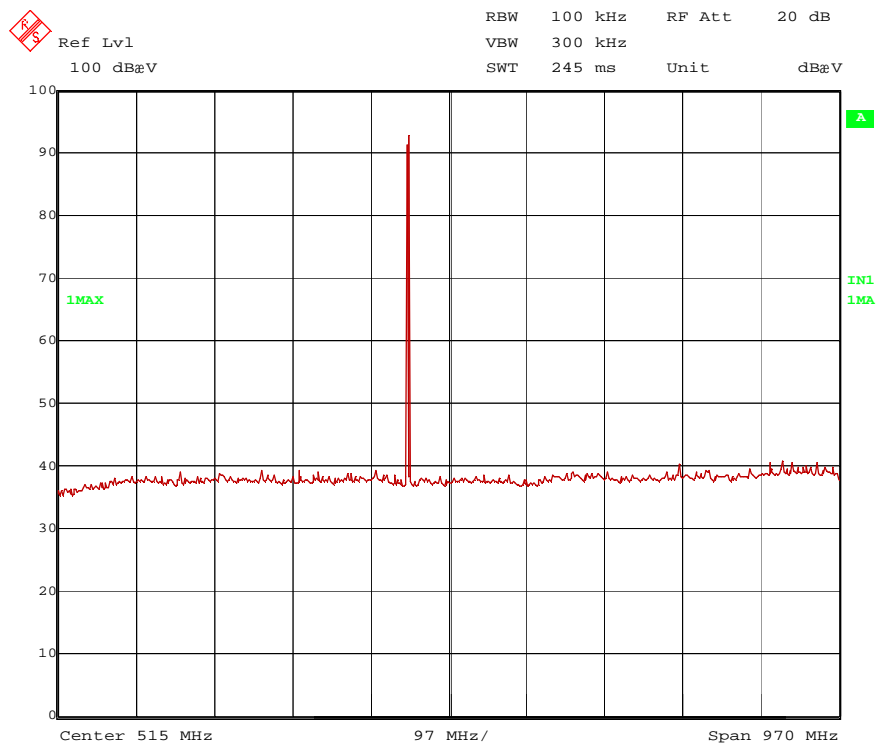
161191_461.0375M_30M-1G.wmf



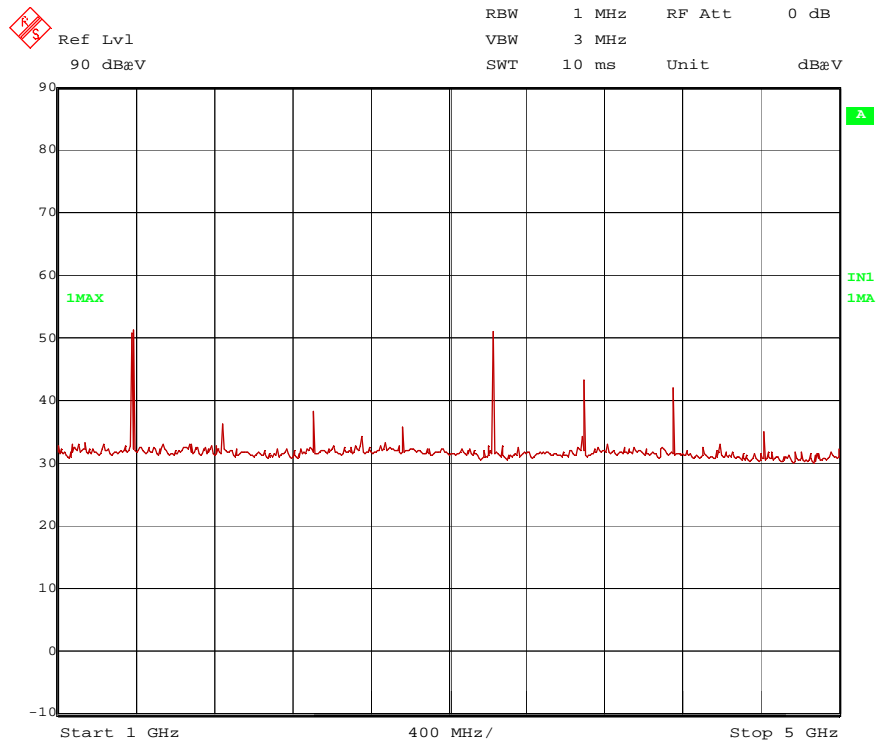
161191_462.8625M_30M-1G.wmf



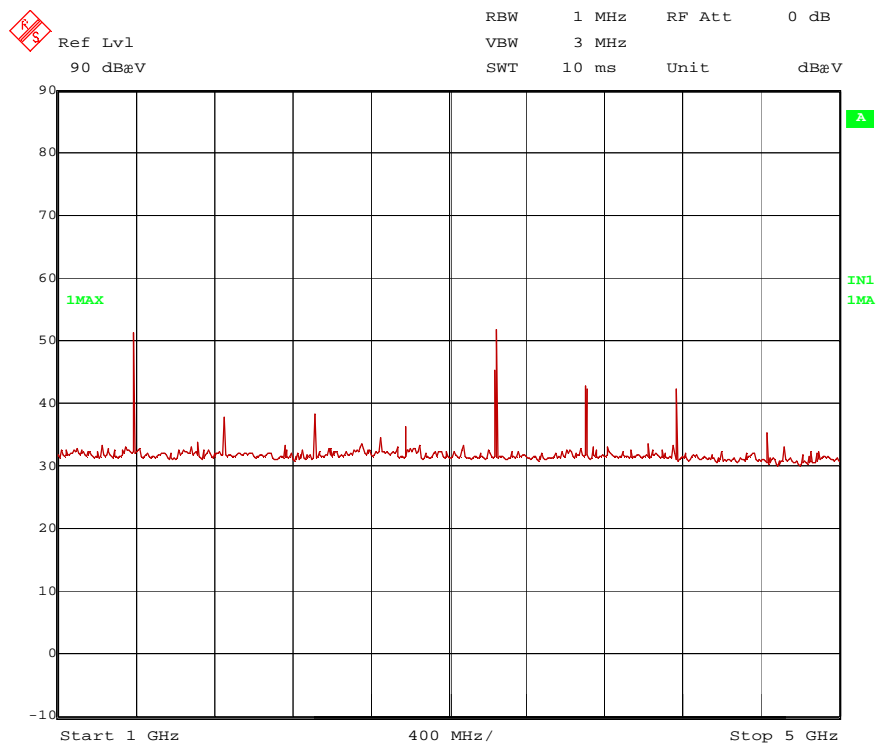
161191_464.5625_30M-1G.wmf



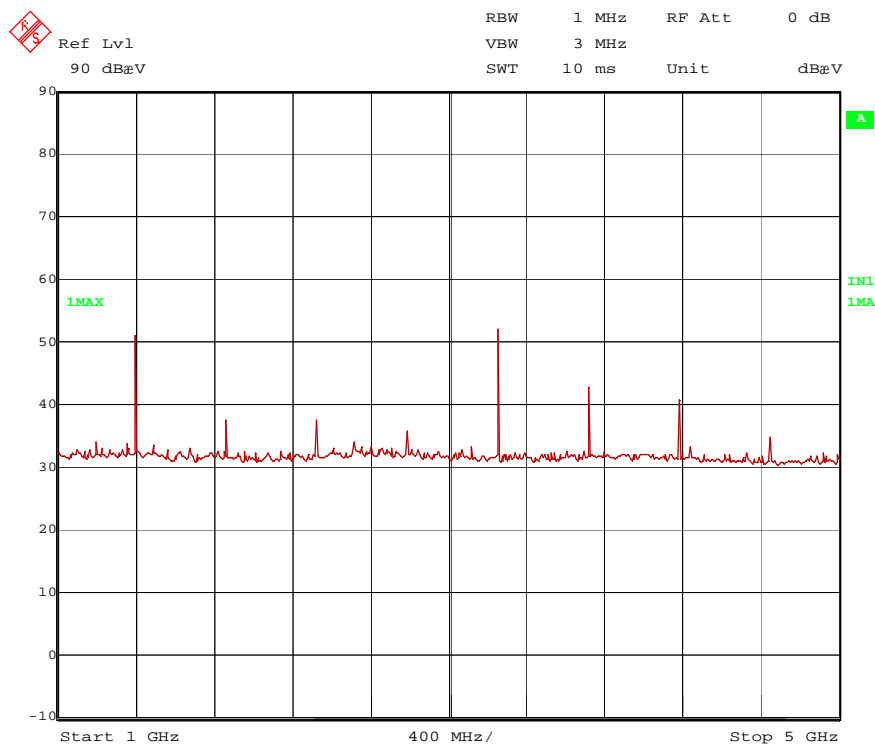
161191_461.0375_1-5G.wmf



161191_462.8625_1-5G.wmf



161191_464.5625_1-5G.wmf



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

1383.1125 MHz, 3227.2625 MHz, 3688.3 MHz, 4149.3375 MHz,
1388.5875 MHz, 3240.0375 MHz, 3702.9 MHz, 4165.7625 MHz,
1393.6875 MHz, 3251.9375 MHz, 3716.5 MHz, 4181.0625 MHz

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

5.4.3 Final Results

5.4.3.1 Final radiated emission measurement (9 kHz to 1 GHz)

No emissions could be found in the preliminary measurement. Therefore no final measurement was performed.

5.4.3.2 Final radiated emission measurement (1 GHz to 5 GHz)

| | | | |
|---------------------|-------|-------------------|------|
| Ambient temperature | 22 °C | Relative humidity | 72 % |
|---------------------|-------|-------------------|------|

Position of EUT: The EUT was set-up on a non-conducting support at a height of 1.5 m. The antenna height was varied from 100 cm up to 250 cm. The distance between EUT and antenna was 1.9 m.

Cable guide: No cables were connectable to the EUT.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was powered with 3.6 V DC via the internal battery.

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

| Tx frequency: 416.0375 MHz | | | | | | |
|--|--------------|-------------|-------------|----------------------|--------------------|---------------------|
| Frequency [MHz] | Result [dBm] | Limit [dBm] | Margin [dB] | Antenna Polarisation | Antenna height [m] | Turntable Angle [°] |
| 1383.1 | -44.1 | -17.2 | 26,9 | Ver. | 1.5 | 54.00 |
| 3227.3 | -37.7 | -17.2 | 20,5 | Ver. | 1.5 | 229.00 |
| 3688.3 | -43.1 | -17.2 | 25,9 | Ver. | 1.5 | 230.00 |
| 4149.3 | -43.5 | -17.2 | 26,3 | Ver. | 1.5 | 203.00 |
| Tx frequency: 462.8625 MHz | | | | | | |
| Frequency [MHz] | Result [dBm] | Limit [dBm] | Margin [dB] | Antenna Polarisation | Antenna height [m] | Turntable Angle [°] |
| 1388.6 | -44.4 | -17.2 | 27,2 | Ver. | 1.5 | 54.00 |
| 3240.0 | -36.7 | -17.2 | 19,5 | Ver. | 1.5 | 227.00 |
| 3702.9 | -43.5 | -17.2 | 26,3 | Ver. | 1.5 | 230.00 |
| 4165.8 | -43.6 | -17.2 | 26,4 | Ver. | 1.5 | 204.00 |
| Tx frequency: 464.5625MHz | | | | | | |
| Frequency [MHz] | Result [dBm] | Limit [dBm] | Margin [dB] | Antenna Polarisation | Antenna height [m] | Turntable Angle [°] |
| 1393.7 | -45.6 | -17.2 | 28,4 | Ver. | 1.5 | 51.00 |
| 3251.9 | -37.5 | -17.2 | 20,3 | Ver. | 1.5 | 227.00 |
| 3716.5 | -46.7 | -17.2 | 29,5 | Ver. | 1.5 | 231.00 |
| 4181.1 | -47.1 | -17.2 | 29,9 | Ver. | 1.5 | 206.00 |
| Measurement uncertainty: +2.2 dB / -3.6 dB | | | | | | |

Limit:

Any emission appearing on a displacement frequency, f_d , from the assigned frequency as shown in the table below has to be attenuated below the unmodulated carrier power by at least 30 dB.

| Equipment channel bandwidth (kHz) | Displacement frequency, f_d (kHz) |
|-----------------------------------|-------------------------------------|
| 25 | $f_d \geq 40$ |
| 30 | |
| 12.5 | $f_d \geq 25$ |
| 15 | |
| 6.25 | $f_d \geq 12.5$ |
| 7.5 | |

$$ERP = P_{\text{conducted}} + G_{\text{antenna}} = 13.2 \text{ dBm} + 1.8 \text{ dBi} - 2.15 \text{ dB} = 12.85 \text{ dBm}$$

$$ERP \text{ limit for any spurious emission: } 12.85 \text{ dBm} - 30 \text{ dB} = -17.15 \text{ dBm}$$

Test: Passed

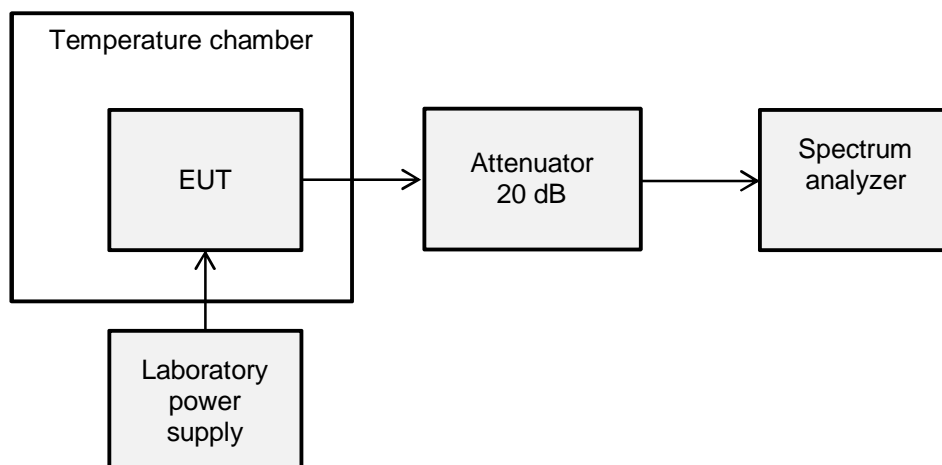
Test equipment used (refer clause 6):

8, 11 – 22, 29, 31 – 34, 37

5.5 Frequency Stability

5.5.1 Method of measurement

Test setup:



The battery of the EUT was removed. The EUT was supplied by a laboratory power supply.

5.5.1.1 Test results

| | |
|---------------------|-------|
| Ambient temperature | 22 °C |
|---------------------|-------|

| | |
|-------------------|------|
| Relative humidity | 38 % |
|-------------------|------|

Frequency stability versus voltage variations

| Voltage [V] | Frequency [MHz] | | Frequency error | | |
|--|-----------------|------------|-----------------|-------|-------------|
| | measured | nominal | [Hz] | [ppm] | Limit [ppm] |
| 3.7 | 461.037260 | 461.037500 | -240 | -0.52 | ±1.5 |
| 3.6 | 461.037260 | | -240 | -0.52 | |
| 3.1 | 461.037258 | | -242 | -0.52 | |
| | | | | | |
| 3.7 | 462.862244 | 462.862500 | -256 | -0.55 | ±1.5 |
| 3.6 | 462.862244 | | -256 | -0.55 | |
| 3.1 | 462.862243 | | -257 | -0.56 | |
| | | | | | |
| 3.7 | 464.562358 | 464.562500 | -142 | -0.30 | ±1.5 |
| 3.6 | 464.562358 | | -142 | -0.30 | |
| 3.1 | 464.562356 | | -144 | -0.31 | |
| Measurement uncertainty: $<10^{-7}$ (frequency), +0.66 dB / -0.72 dB (level) | | | | | |

Frequency stability versus temperature variations

| Temperature [°C] | Frequency [MHz] | | Frequency error | | |
|--|-----------------|------------|-----------------|-------|-------------|
| | measured | nominal | [Hz] | [ppm] | Limit [ppm] |
| 55 | 461.037200 | 461.037500 | -300 | -0.65 | ±1.5 |
| 50 | 461.037200 | | -300 | -0.65 | |
| 40 | 461.037240 | | -260 | -0.56 | |
| 30 | 461.037280 | | -220 | -0.48 | |
| 20 | 461.037260 | | -240 | -0.52 | |
| 10 | 461.037220 | | -280 | -0.61 | |
| 0 | 461.037220 | | -280 | -0.61 | |
| -10 | 461.037280 | | -220 | -0.48 | |
| -20 | 461.037300 | | -200 | -0.43 | |
| | | | | | |
| 55 | 462.862180 | 462.862500 | -320 | -0.69 | ±1.5 |
| 50 | 462.862160 | | -340 | -0.73 | |
| 40 | 462.862220 | | -280 | -0.60 | |
| 30 | 462.862270 | | -230 | -0.50 | |
| 20 | 462.862240 | | -260 | -0.56 | |
| 10 | 462.862200 | | -300 | -0.65 | |
| 0 | 462.862200 | | -300 | -0.65 | |
| -10 | 462.862260 | | -240 | -0.52 | |
| -20 | 462.862280 | | -220 | -0.48 | |
| | | | | | |
| 55 | 464.562280 | 464.5625 | -220 | -0.47 | ±1.5 |
| 50 | 464.562260 | | -240 | -0.52 | |
| 40 | 464.562320 | | -180 | -0.39 | |
| 30 | 464.562360 | | -140 | -0.30 | |
| 20 | 464.562358 | | -142 | -0.31 | |
| 10 | 464.562300 | | -200 | -0.43 | |
| 0 | 464.562300 | | -200 | -0.43 | |
| -10 | 464.562360 | | -140 | -0.30 | |
| -20 | 464.562380 | | -120 | -0.26 | |
| Measurement uncertainty: <10 ⁻⁷ (frequency) | | | | | |

Limit:

The equipment tested shall not deviate more than 1.5 ppm from the nominal frequency.

Test: Passed

Test equipment used (refer clause 6):

23, 24, 29, 30, 35, 36

6 Test equipment used for tests

| No. | Test equipment | Type | Manufacturer | Serial No. | PM. No. | Cal. Date | Cal. due |
|-----|----------------------------|--------------------|-----------------------------|-------------------|---------|------------------------------------|----------|
| 1 | Open area test site | - | Phoenix Testlab | - | 480085 | Weekly verification (system cal.) | |
| 2 | Measuring receiver | ESIB7 | Rohde & Schwarz | 100304 | 480521 | 18.02.2016 | 02/2018 |
| 3 | Controller | HD100 | Deisel | 100/670 | 480139 | - | - |
| 4 | Turntable | DS420HE | Deisel | 420/620/80 | 480087 | - | - |
| 5 | Antenna support | AS615P | Deisel | 615/310 | 480086 | - | - |
| 6 | Antenna | CBL6111 D | Chase | 25761 | 480894 | - | - |
| 7 | EMI Software | EMC32 | Rohde & Schwarz | 100061 | 481022 | - | - |
| 8 | Fully anechoic chamber M20 | - | Albatross Projects | B83107-E2439-T232 | 480303 | Weekly verification (system cal.) | |
| 11 | Measuring receiver | ESI 40 | Rohde & Schwarz | 100064 | 480355 | 16.02.2016 | 02/2017 |
| 12 | Controller | MCU | Maturo | MCU/043/971107 | 480832 | - | - |
| 13 | Turntable | DS420HE | Deisel | 420/620/80 | 480315 | - | - |
| 14 | Antenna support | AS615P | Deisel | 615/310 | 480187 | - | - |
| 15 | Positioner | TDF 1.5 | Maturo | 15920215 | 482034 | - | - |
| 16 | Antenna | CBL6112 B | Chase | 2688 | 480328 | 14.04.2014 | 04/2017 |
| 17 | Horn Antenna | 3115 A | EMCO | 9609-4918 | 480183 | 10.11.2014 | 11/2017 |
| 18 | High Pass Filter | WHJS1000C11/6 OEF | Wainwright Instruments GmbH | 1 | 480413 | Monthly verification (system cal.) | |
| 19 | RF-cable No. 36 | Sucoflex 106B | Huber + Suhner | - | 480865 | Weekly verification (system cal.) | |
| 20 | RF-cable No. 3 | Sucoflex 106B | Suhner | 0563/6B | 480670 | Weekly verification (system cal.) | |
| 21 | RF-cable No. 40 | Sucoflex 106B | Suhner | 0708/6B | 481330 | Weekly verification (system cal.) | |
| 22 | Loop antenna | HFH2-Z2 | Rohde & Schwarz | 832609/014 | 480059 | 29.02.2016 | 02/2018 |
| 23 | Spectrum analyser | FSU46 | Rohde & Schwarz | 200125 | 480596 | 17.02.2016 | 02/2017 |
| 24 | Temperature Test Chamber | MK 240 | Binder | 05-79022 | 480462 | 06.08.2015 | 02/2017 |
| 29 | Coaxial-Attenuator | WA47-20-34 | Weinschel | A1169 | 481452 | 25.08.2015 | 08/2016 |
| 31 | Precision dipole | HZ-12 | Rohde & Schwarz | 831781/02 | 480061 | - | |
| 32 | Precision dipole | HZ-13 | Rohde & Schwarz | 831782/02 | 480062 | - | |
| 33 | Horn Antenna | 3115 B | EMCO | 9609-4922 | 480184 | 18.09.2014 | 09/2017 |
| 34 | Swept CW generator | 83650L | Agilent | 3844A00554 | 480333 | 25.02.2015 | 02/2017 |
| 35 | Power Supply | TOE8871 | Toellner Electronic | 61008 | 480835 | 11.01.2016 | 01/2018 |
| 36 | Multimeter | 971A | Hewlett Packard | JP40010640 | 480724 | 19.01.2016 | 01/2018 |
| 37 | Preamplifier | JS3-00101200-23-5A | Miteq | 681851 | 480337 | 18.02.2016 | 02/2018 |

7 Report history

| Report Number | Date | Comment |
|---------------|------------|------------------|
| F161191E1 | 28.10.2016 | Document created |
| - | - | - |
| - | - | - |

8 List of annexes

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161191_01.JPG: Test setup - Radiated emission (fully anechoic chamber)
 161191_02.JPG: Test setup - Radiated emission (fully anechoic chamber)
 161191_03.JPG: Test setup - Radiated emission (fully anechoic chamber)
 161191_04.JPG: Temperature chamber

ANNEX B EXTERNAL PHOTOS 7 pages

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 161191_06.jpg: Side view 1 of the EUT
 161191_07.jpg: Side view 2 of the EUT
 161191_08.jpg: Backside view of the EUT
 161191_09.jpg: Top view of the EUT
 161191_10.jpg: Bottom view of the EUT
 161191_11.jpg: Bottom view of the EUT, permanent magnet removed

ANNEX C INTERNAL PHOTOS 10 pages

161191_12.jpg: EUT, exploded view (drawing supplied by the applicant)
 161191_13.jpg: EUT, cabinet opened, battery and antenna cable
 161191_14.jpg: EUT, cabinet opened, PCB 1
 161191_15.jpg: PCB 1, top view
 161191_16.jpg: PCB 1 without shielding, top view
 161191_17.jpg: PCB 1, bottom view
 161191_18.jpg: EUT, PCB 1 removed
 161191_19.jpg: PCB 2, top view
 161191_20.jpg: PCB 2, bottom view
 161191_21.jpg: EUT, PCB 1 and PCB 2 removed