PHOENIX TESTLAB

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TEST REPORT

Test Report Reference: R40690C Revision 1 Edition 2

Equipment under Test: HT-1

Serial Number: DUT 081U and DUT 083U

Applicant: Nokia GmbH

Manufacturer: Nokia GmbH

Test Laboratory
(CAB)
accredited by
DATech e.V.
in compliance with DIN EN ISO/IEC 17025
under the
Reg. No. DAT-P-105/99-20
and listed by
FCC 31040/SIT1300F2

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1 IDENTIFICATION

1.1 APPLICANT

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Country:	Germany
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Phone:	+ 49 23 49 84 48 10
Fax:	+ 49 23 49 84 38 01
Mail address:	Frank.wittmann@nokia.com
Applicant represented during the test by the following person:	-

1.2 MANUFACTURER

Name:	Nokia GmbH
Address:	Meesmannstr. 103 44807 Bochum
Country:	Germany
Name for contact purposes:	-
Phone:	-
Fax:	-
Mail address:	-
Manufacturer represented during the test by the following person:	-

1.3 DATES

Date of receipt of test sample:	06 August and 10 September 2004
Start of test:	02 September 2004
End of test:	14 September 2004

1.4 TEST LABORATORY

The tests were carried out at: **PHOENIX TESTLAB GmbH**
Königswinkel 10
D-32825 Blomberg **Phone:** **+49 (0) 52 35 / 95 00-0**
Germany **Fax:** **+49 (0) 52 35 / 95 00-10**

accredited by DATech e.V. in compliance with DIN EN ISO/IEC 17025 under Reg. No. DAT-P-105/99-20 and listed by FCC 31040/SIT1300F2.

Test engineer:	Thomas KÜHN		28 September 2004
	Name	Signature	Date
Test report checked:	Bernd STEINER		28 September 2004
	Name	Signature	Date

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Stamp

1.5 RESERVATION

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

1.6 NORMATIVE REFERENCES

[1] **ANSI C63.4-2001** 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 47 CFR Part 15 (April 2004)** Radio Frequency Devices

[3] **FCC Public Notice DA 00-705 (March 2000)**

1.7 TEST RESULTS

The requirements of this test document are fulfilled by the equipment under test. The complete test results are presented in the following.

2 TECHNICAL DATA OF EQUIPMENT

2.1 DEVICE UNDER TEST

Type of equipment: *	Bluetooth handsfree terminal for vehicular use
Type designation: *	HT-1
Antenna type: *	Nokia integrated F-antenna type Internal IFA
Antenna gain: *	2.3 dBi
Power supply: *	13.5 V DC
Type of modulation: *	FHSS (GFSK)
Operating frequency range:*	2.402 to 2.480 GHz
Number of channels: *	79
Output power: *	0 dBm
Temperature range: *	-20 °C to + 55 °C

*: declared by the applicant

Bluetooth operates in the unlicensed ISM band at 2.4 GHz. In the USA a band with a width of 83.5 MHz is available. In this band 79 RF channels spaced 1 MHz apart are defined. The channel is represented by a pseudo random hopping sequence through the 79 channels. The normally occupancy time of one frequency will be 625 µs. The ordinary hopping rate will be 1600 hops/s. All frequencies will be used equally.

The following external I/O cables were used:

Cable	Length	Shielding	Connector
Cable harness	-	-	54 pole, customized
-	-	-	-
-	-	-	-
-	-	-	-

2.2 PERIPHERY DEVICES

The following equipment was used as control unit and ancillary equipment:

- Nokia Car Box CD 944,
- Nokia Low-Baseplate (DUT 071U),
- Nokia cradle (DUT 075U) for Nokia mobile phone 6310i,
- Nokia mobile phone 6310i (DUT 009U).

3 OPERATIONAL STATES AND PHYSICAL BOUNDARIES

The tests were carried out with three samples, one sample with an integrated antenna type internal IFA (DUT 083U) and two with a temporary antenna connector, SMA-type (DUT 081U and without ID). All radiated tests were carried out at the EUT with the integrated antenna (DUT 083U). The conducted tests at the EUT with the temporary antenna connector (DUT 081U). The measurements in paging mode were carried with the sample without ID, which operates with a mobile phone Nokia 6310i inside the cradle (on the baseplate) instead of the bluetooth tester. All samples were working with a test-software to set the operation modes with the help of a bluetooth tester or the Nokia mobile phone.

During all tests the EUT's were connected to original cable harness including a Baseplate (DUT 071U). All cables were connected directly to the EUT. The supply voltage of the EUT was 13.5 V DC during all tests, because the EUT is intended to be mounted in a vehicle.

The speaker output, the microphone input and the GSM-antenna port were terminated with suitable terminations during all tests. The CAN-bus was connected to a car-box, which was provided by the applicant.

For selecting an operation mode, a bluetooth tester was connected to the EUT via the RF connector (for conducted tests with a the help of a power divider and for radiated tests with a narrowband antenna inside the false floor below the EUT).

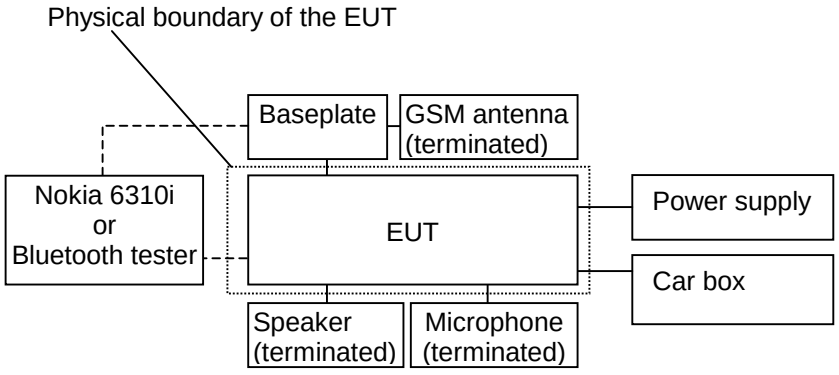
Because the EUT is not intended to operate in inquiry mode, no tests were carried out in this mode.

For modulating the transmitter, a pseudo random bit sequence with a length of 27 byte and with a pattern type DH5 (if not otherwise stated) was used.

During the tests, the EUT's were not labelled with a FCC-label.

The following operation modes were used during the tests:

Operation mode	Description of the operation mode
1	Continuous transmitting on 2402 MHz,
2	Continuous transmitting on 2441 MHz,
3	Continuous transmitting on 2480 MHz,
4	Paging
5	Transmitter hopping on all channels



4 LIST OF MEASUREMENTS

Application	Frequency range [MHz]	Limit	Reference standard	FCC 47 CFR Part 15 section	Status
20 dB bandwidth	General	max. 1 MHz	-	15.247 (a) (1) (iii)	Passed
Carrier frequency separation	General	25 kHz or 20 dB bandwidth of the hopping channel	-	15.247 (a) (1)	Passed
Number of hopping channels	2400.0 – 2483.5	At least 15	-	15.247 (a) (1) (iii)	Passed
Dwell time	2400.0 – 2483.5	Max. 0.4 seconds multiplied with the number of hopping channels	-	15.247 (a) (1) (ii)	Passed
Maximum peak output power	2400.0 – 2483.5	1 W (> 75 channels); 0.125 W (all other); 1 W (digital systems)	-	15.247 (b) (1)	Passed
Power spectral density	2441	Less than 8 dBm in any 3 kHz band	-	15.247 (d)	Passed
Band edge compliance	2400.0 – 2483.5	In any 100 kHz bandwidth outside the frequency band at least 20 dBc.	-	15.247 (c)	Passed
Conducted emissions (transmitter)	0.09 – 25,000	In any 100 kHz bandwidth outside the frequency band at least 20 dBc.	-	15.247 (c)	Passed
Radiated emissions (transmitter)	30 – 25,000	In any 100 kHz bandwidth outside the frequency band at least 20 dBc. In restriced bands see 15.209.	ANSI C63.4 (2001);	15.205 (a) 15.209 (a)	Passed

Note:
The test were selected and performed with reference to the FCC Public notice DA 00-705, released March 30, 2000. [3]

5 TEST RESULTS

5.1 20 dB BANDWIDTH

5.1.1 METHODE 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.

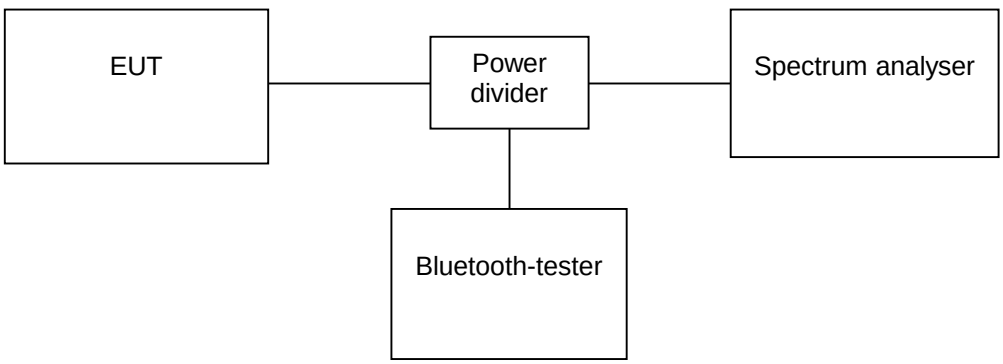
The following spectrum analyser settings shall be used:

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

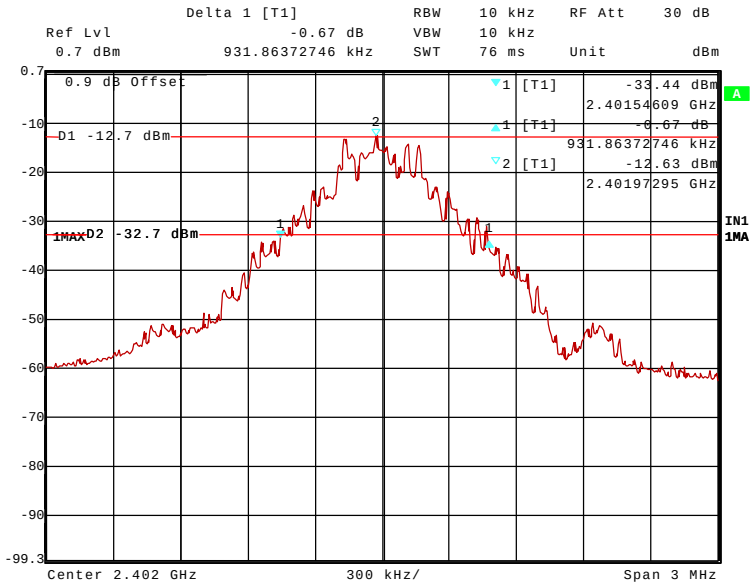
Test set-up:



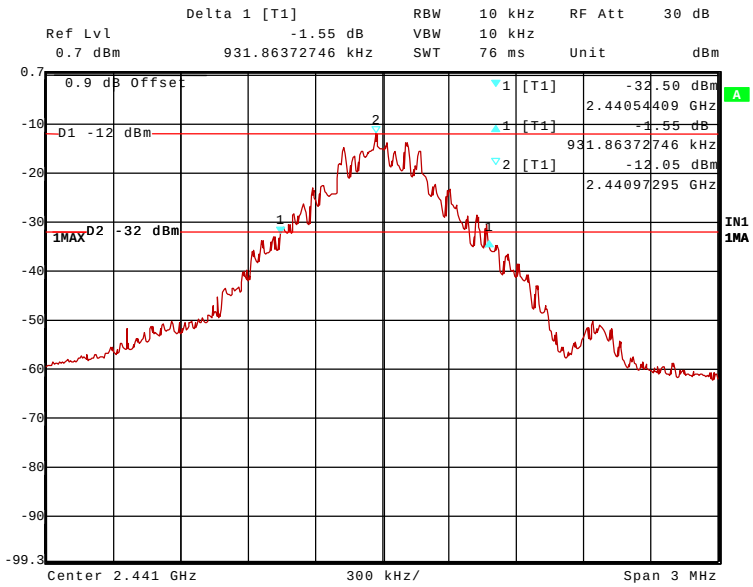
5.1.2 TEST RESULTS (20 dB BANDWIDTH)

Ambient temperature	21 °C	Relative humidity	42 %

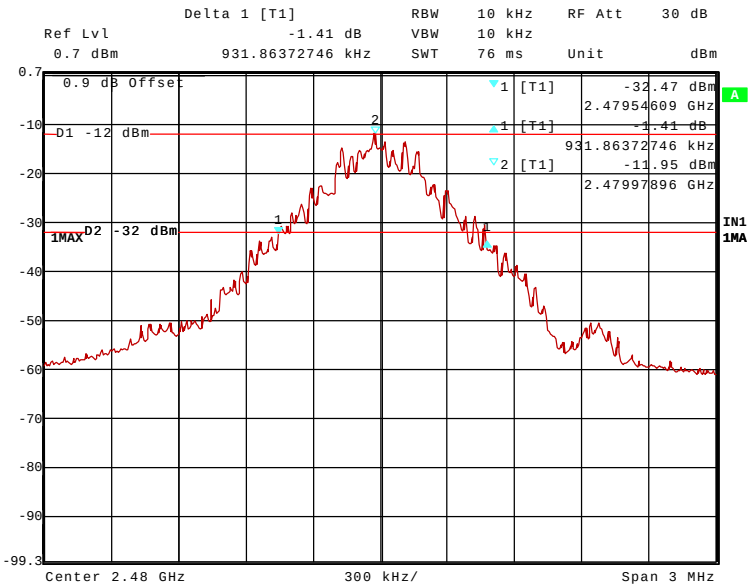
40690c15.wmf (20 dB bandwidth at the lower end of the assigned frequency band):



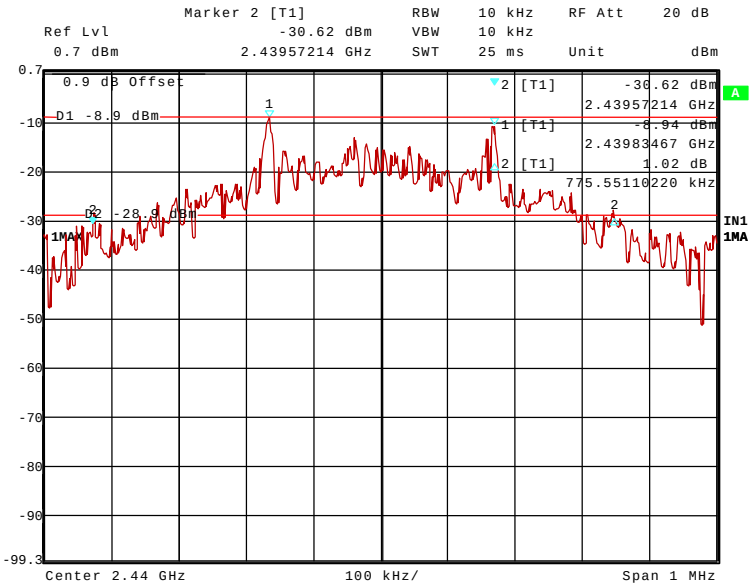
40690c16.wmf (20 dB bandwidth at the middle of the assigned frequency band):



40690c17.wmf (20 dB bandwidth at the upper end of the assigned frequency band):



40690c44.wmf (20 dB bandwidth paging mode):



Channel number	Channel frequency [MHZ]	20 dB bandwidth [kHz]
0	2402	931.9
39	2441	931.9
78	2480	931.9
38 (paging)	2440	775.5

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54 – 57

5.2 CARRIER FREQUENCY SEPARATION

5.2.1 METHODE 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.

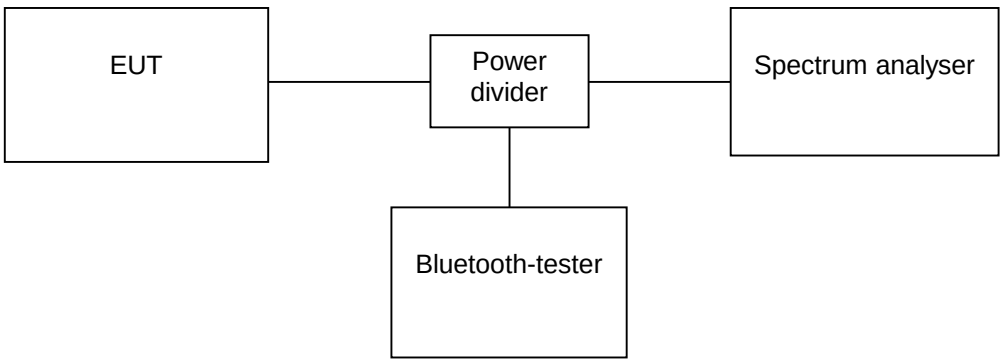
The following spectrum analyser settings shall be used:

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

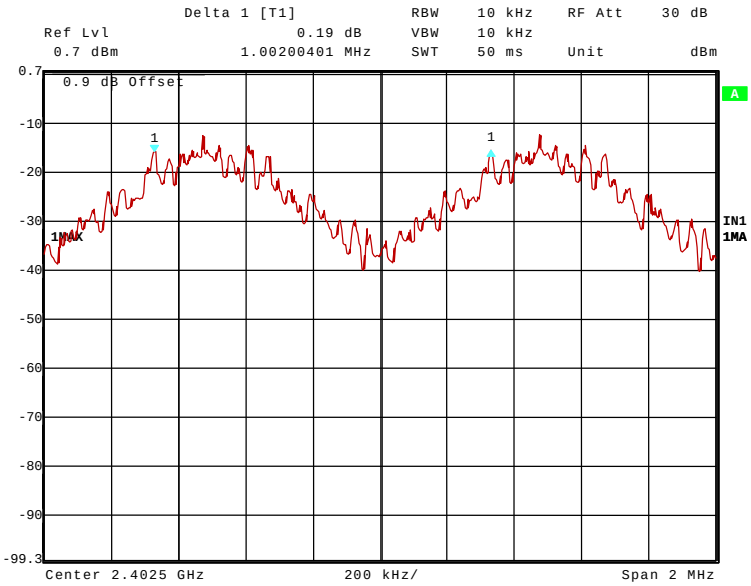
Test set-up:



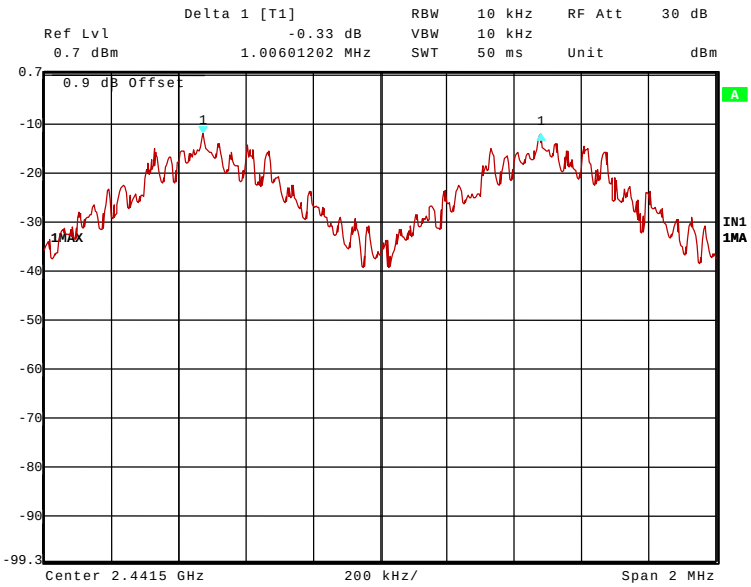
5.2.2 TEST RESULTS (CARRIER FREQUENCY SEPARATION)

Ambient temperature	21 °C	Relative humidity	42 %

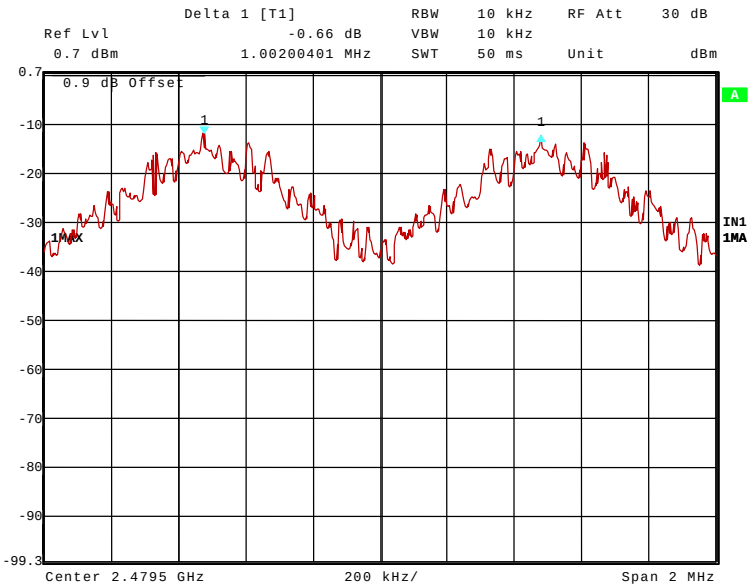
40690c18.wmf (channel separation at the lower end of the assigned frequency band):



40690c19.wmf (channel separation at the middle of the assigned frequency band):



40690c20.wmf (channel separation at the upper end of the assigned frequency band):



Channel number	Channel frequency [MHZ]	Channel separation [MHz]	Minimum limit [kHz]
0	2402	1.002	931.9 (20 dB bandwidth)
39	2441	1.006	931.9 (20 dB bandwidth)
78	2480	1.002	931.9 (20 dB bandwidth)

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54 – 57

5.3 NUMBER OF HOPPING FREQUENCIES

5.3.1 METHODE OF MEASUREMENT (NUMBER OF HOPPING FREQUENCIES)

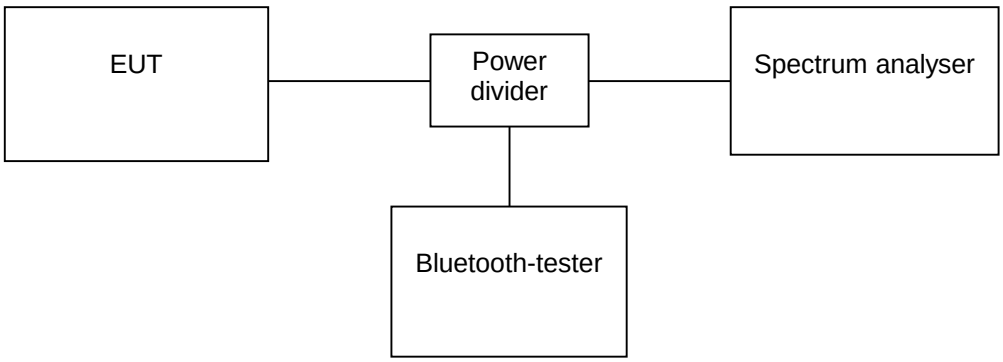
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT 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: ≥ 1 % of the span.
- Video bandwidth: ≥ the resolution bandwidth.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

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

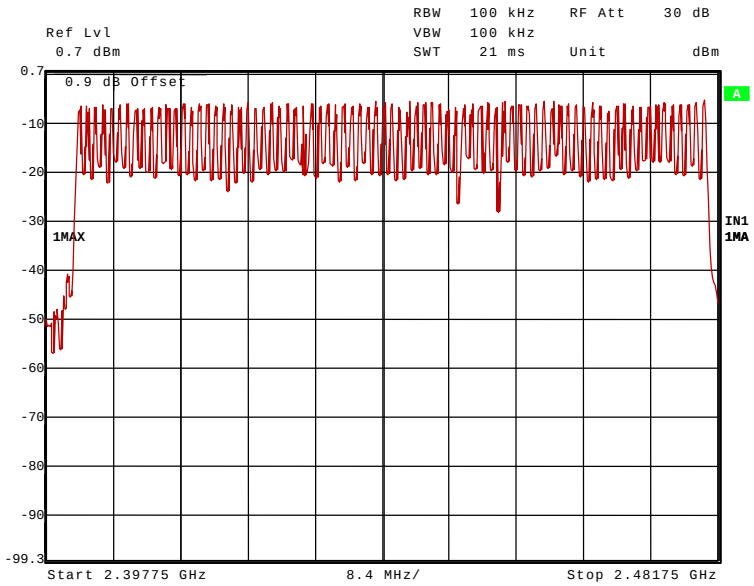
Test set-up:



5.3.2 TEST RESULTS (NUMBER OF HOPPING FREQUENCIES)

Ambient temperature	21 °C	Relative humidity	42 %

40690c21.wmf (number of hopping channels):



Number of hopping channels	Limit
79	At least 15

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54 – 57

5.4 DWELL TIME

5.4.1 METHODE 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:

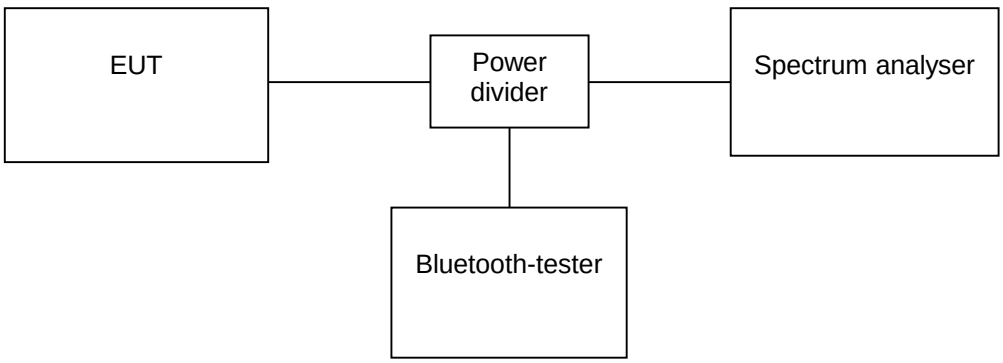
- Span: Zero, centred on a hopping channel.
- Resolution bandwidth: 1 MHz.
- Video bandwidth: ≥ the resolution bandwidth.
- Sweep: As necessary to capture the entire dwell time per hopping channel.
- Detector function: peak.
- Trace mode: Max hold.

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 upper and lower end and 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.

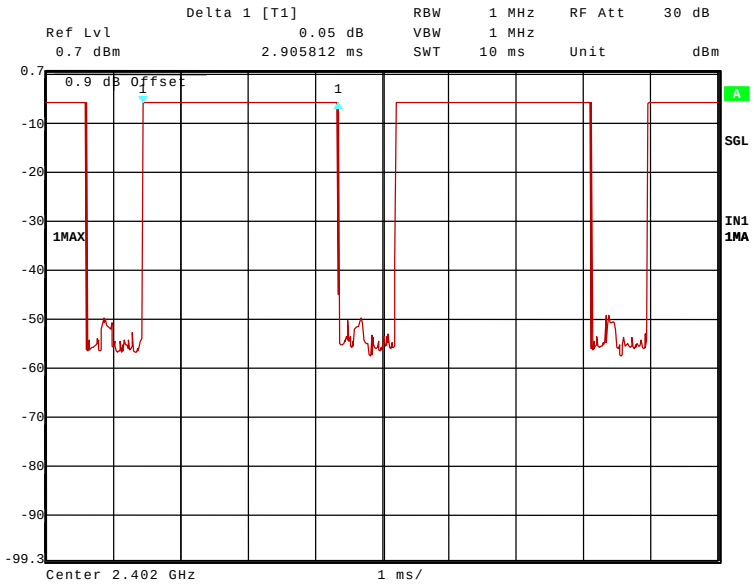
Test set-up:



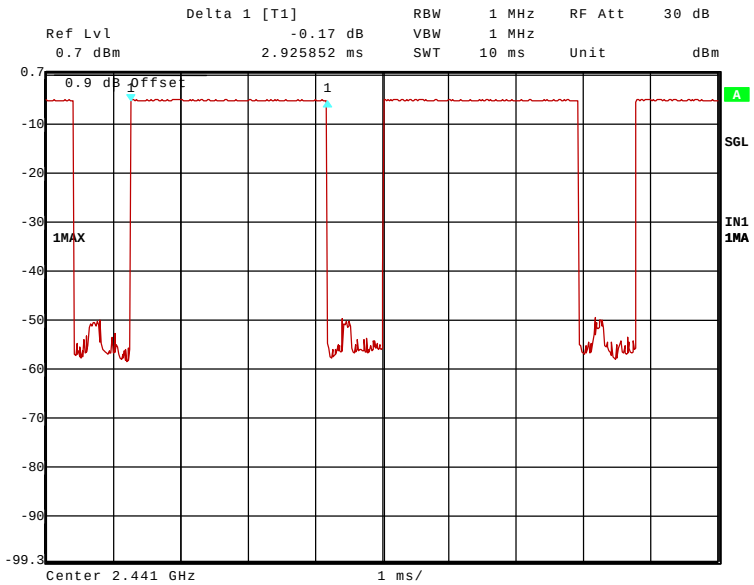
5.4.2 TEST RESULTS (DWELL TIME)

Ambient temperature	21 °C	Relative humidity	42 %

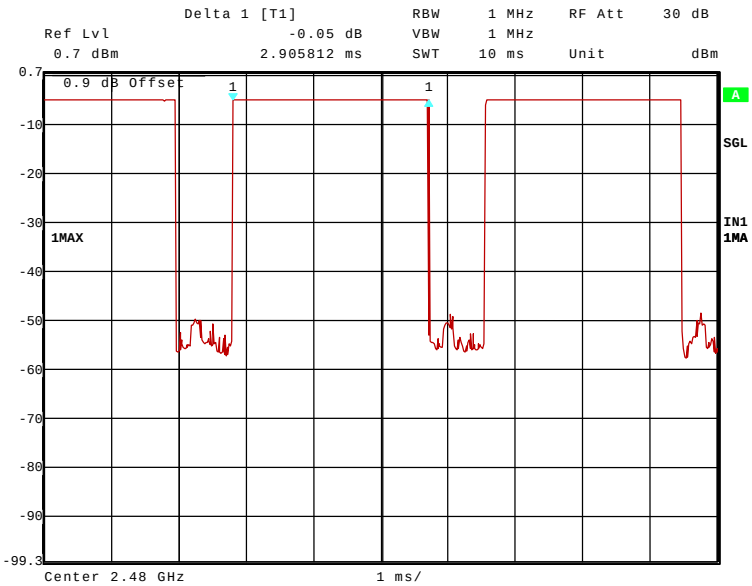
40690c22.wmf (dwell time at the lower end of the assigned frequency band), hopping mode DH5:



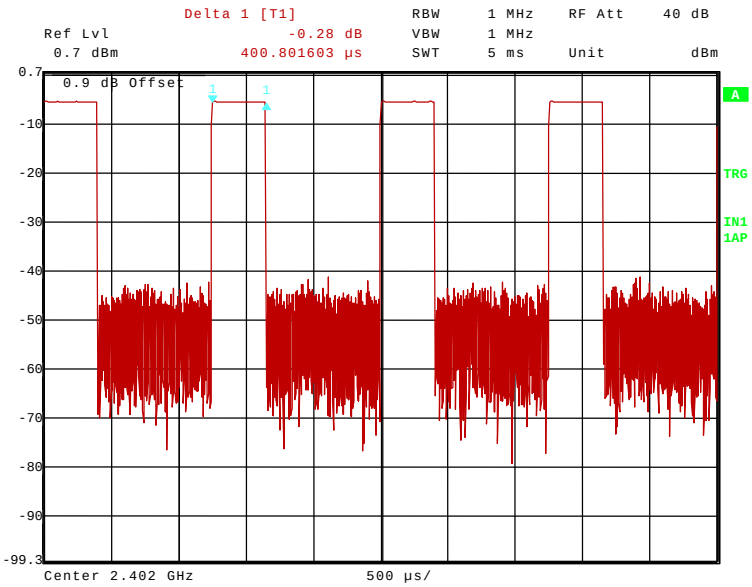
40690c23.wmf (dwell time at the middle of the assigned frequency band), hopping mode DH5:



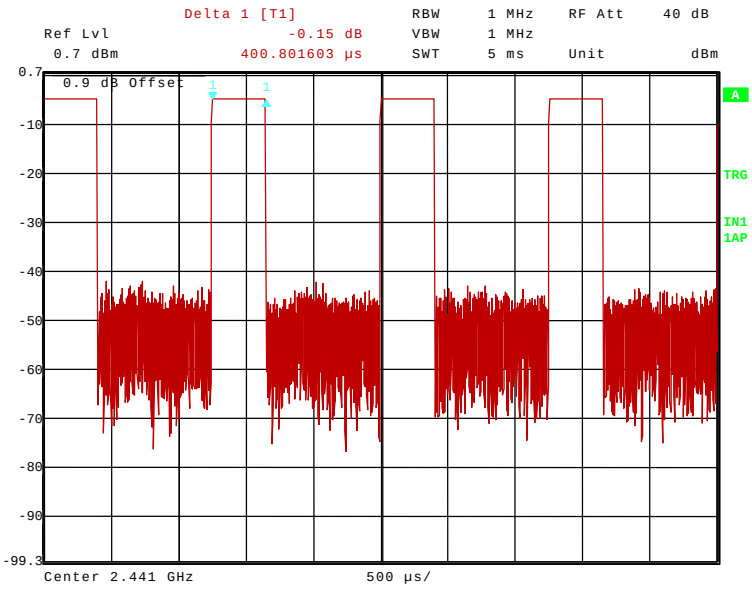
40690c24.wmf (dwell time at the upper end of the assigned frequency band), hopping mode DH5:



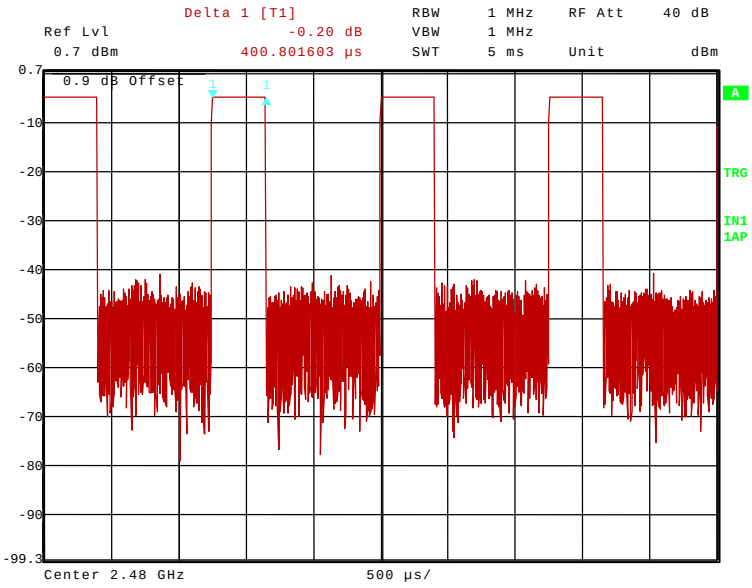
40690c40.wmf (dwell time at the lower end of the assigned frequency band), hopping mode DH1:



40690c41.wmf (dwell time at the middle of the assigned frequency band), hopping mode DH1:



40690c42.wmf (dwell time at the upper end of the assigned frequency band), hopping mode DH1:



The dwell time is calculated with the following formula:

Dwell time = t_{pulse} x n_{hops} / number of channels x 30s

Where:

t_{pulse} is the measured pulse time (pls. refer the plots of the spectrum analyser above) [s],
n_{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 1600 hops per second and the system uses 79 channels. For this reason one time slot has a length of 625µs.

A DH1 packet needs 1 timeslot for transmitting and the next timeslot for receiving. So the system makes in worst case 800 hops per second in transmit mode (n_{hops} = 800 1/s)

With the used hopping mode (DH5) a packet needs 5 timeslots for transmitting and the next timeslot for receiving. So the system makes in worst case 266,67 hops per second in transmit mode (n_{hops} = 266.667 1/s)

Channel number	Channel frequency [MHZ]	t_{pulse}	Dwell time [ms]
0 (DH5)	2402	2.906 ms	294.28
39 (DH5)	2441	2.926 ms	296.30
78 (DH5)	2480	2.906 ms	294.28
0 (DH1)	2402	400 µs	121.52
39 (DH1)	2441	400 µs	121.52
78 (DH1)	2480	400 µs	121.52

Limit:

The dwell time of the channel shall be less than 0.4s in a 30s period

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54 – 57

5.5 MAXIMUM PEAK OUTPUT POWER

5.5.1 METHODE 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 disabled.

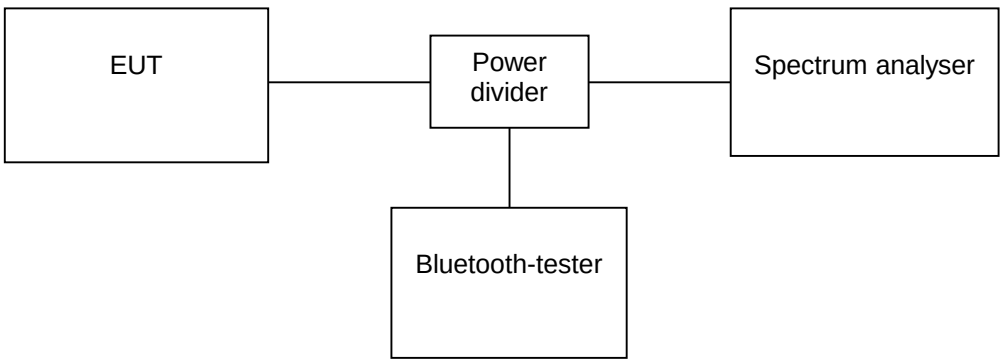
The following spectrum analyser settings shall be used:

- 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: ≥ the resolution bandwidth.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.

After trace stabilisation the marker shall be set on the signal peak. The indicated level is the peak output power, which has to be corrected with the value of the cable loss and an external attenuation (if necessary).

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

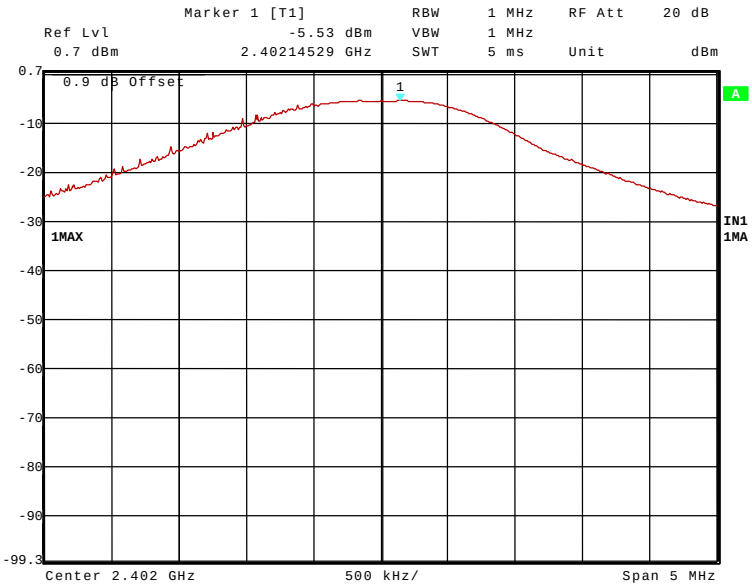
Test set-up:



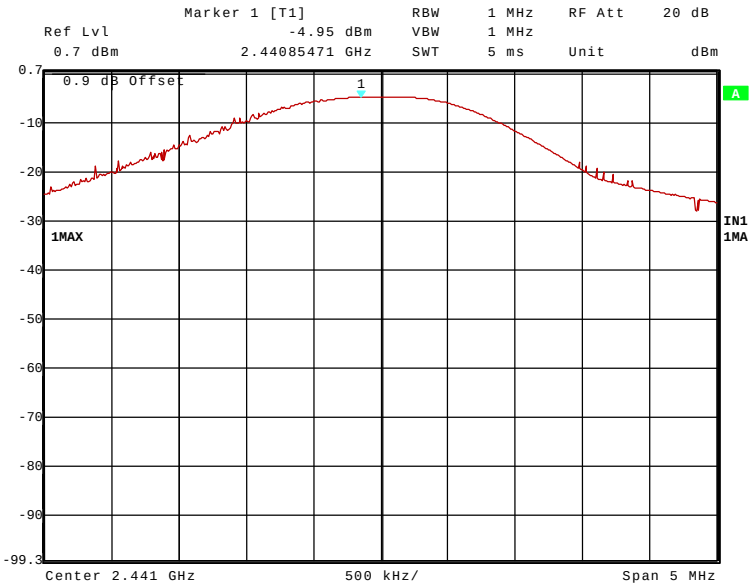
5.5.2 TEST RESULTS (MAXIMUM PEAK OUTPUT POWER)

Ambient temperature	21 °C	Relative humidity	42 %

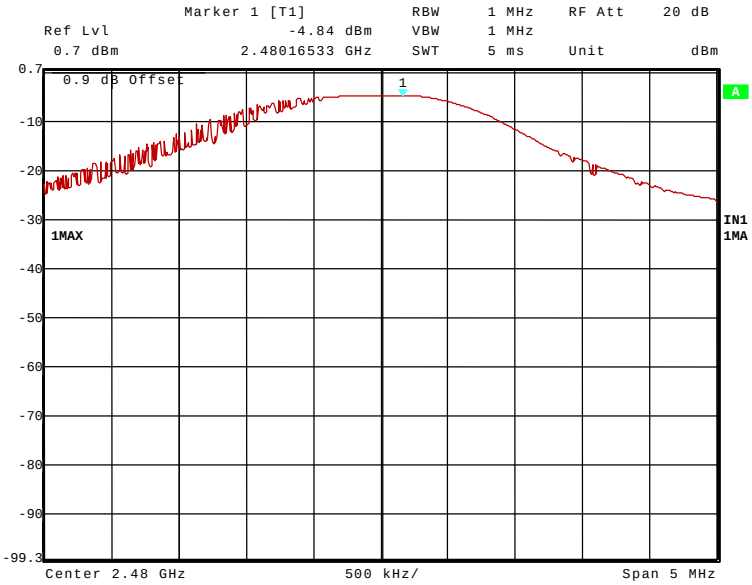
40690c25.wmf (maximum peak output power at the lower end of the assigned frequency band):



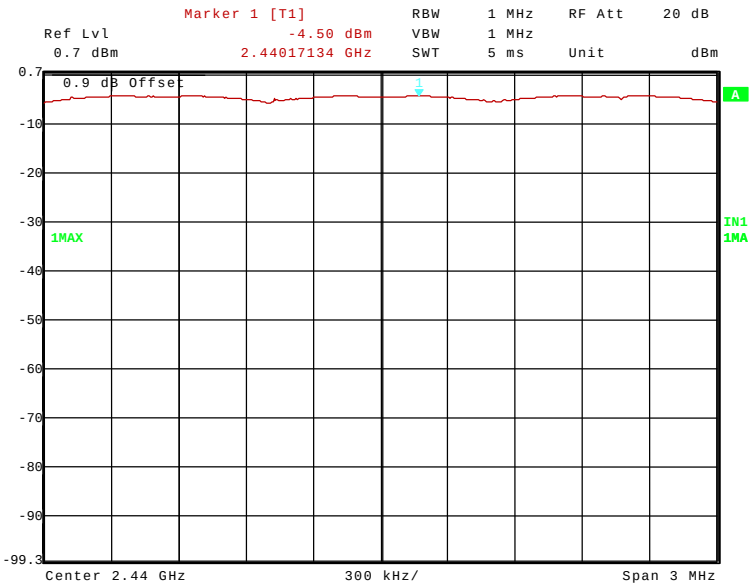
40690c26.wmf (maximum peak output power at the middle of the assigned frequency band):



40690c27.wmf (maximum peak output power at the upper end of the assigned frequency band):



40690c38.wmf (maximum peak output power paging mode):



Channel number	Channel frequency [MHz]	Maximum peak output power [dBm]	Antenna gain [dBi]	Calculated EIRP [dBm]	Peak power limit [dBm]
0	2402	-5.5	2.3	2.8	30
39	2441	-5.0	2.3	3.3	30
78	2480	-4.8	2.3	3.5	30
38 (paging)	2440	-4.5	2.3	3.8	30

The EIRP was calculated with the following formular:

EIRP = Maximum peak output power + Attenuation of the power divider (6 dB) + Antenna gain

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54 – 57

5.6 POWER SPECTRAL DENSITY

5.6.1 METHODE OF MEASUREMENT (POWER SPECTRAL DENSITY)

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 in page/inquiry mode.

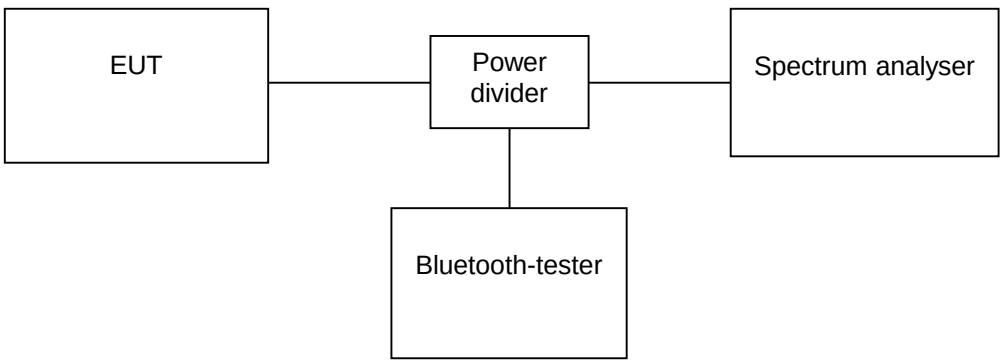
The following spectrum analyser settings shall be used:

- Span: 1.5 MHz, centred in the middle of the assigned frequency range.
- Resolution bandwidth: 3 kHz.
- Video bandwidth: 3 kHz.
- 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 power spectral density.

The measurement will be performed with the EUT in page mode and inquiry mode.

Test set-up:

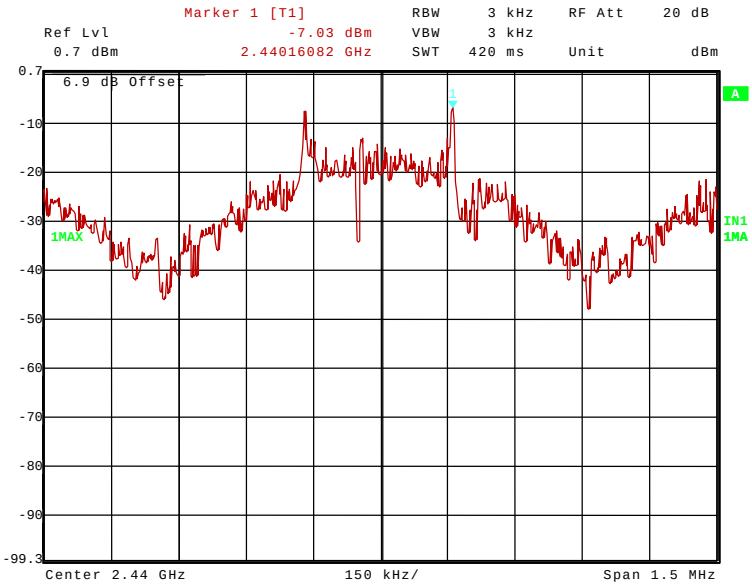


5.6.2 TEST RESULTS (POWER SPECTRAL DENSITY)

Ambient temperature	21 °C

Relative humidity	42 %

40690c39.wmf (power spectral density (page mode)):



Operation mode	Power spectral density [dBm / 3 kHz] *	Power spectral density limit [dBm / 3 kHz]
Page mode	-7.0	8

*: Insertion loss of 6.9 dB (0.9 dB cable loss, 6 dB power divider) respected

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54 – 57

5.7 BAND-EDGE COMPLIANCE

5.7.1 METHODE OF MEASUREMENT (BAND-EDGE COMPLIANCE)

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.

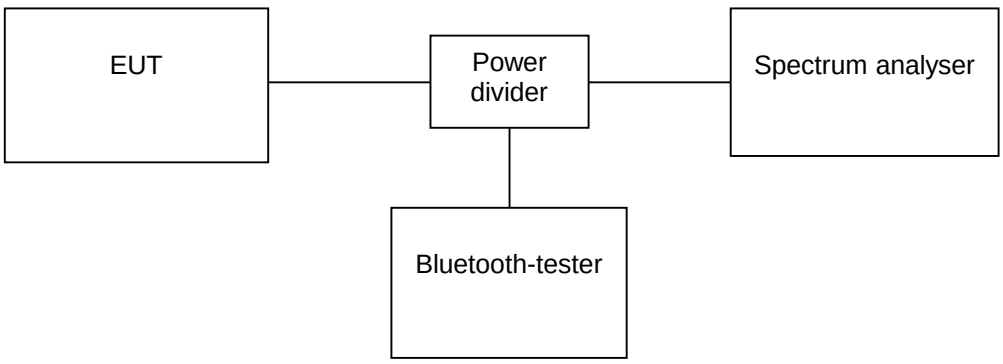
The following spectrum analyser settings shall be used:

- Span: Wide enough to capture the peak level of the emission on the channel closest to the band-edge, as well as any modulation products, which fall outside the assigned frequency band.
- Resolution bandwidth: ≥ 1 % of the span, but not below 30 kHz.
- Video bandwidth: ≥ 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 line shall be set on the edge of the assigned frequency band. Set the second marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is higher than that at the band-edge. After this the difference between this emission level and the signal peek will be calculated. With the value of measured field strength of the signal peak and the calculated difference to the emission level, the level of the field strength of the emission will be calculated.

The measurement will be performed at the upper and lower end of the assigned frequency band and with hopping on and off.

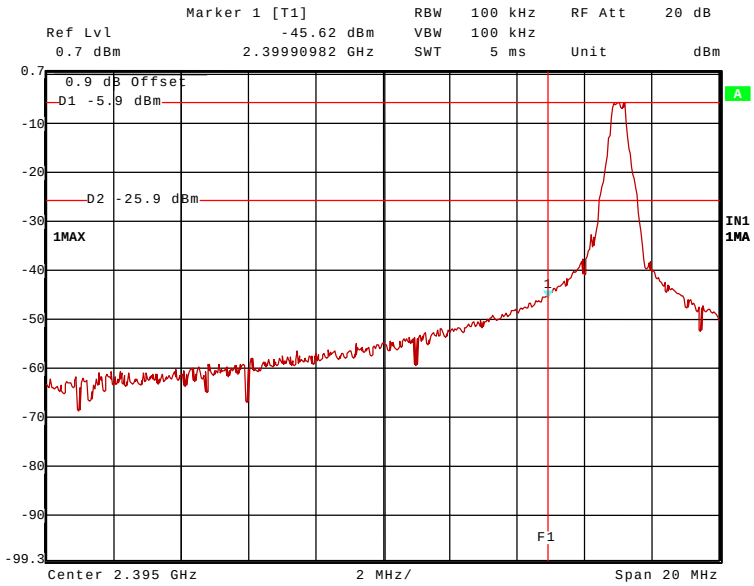
Test set-up:



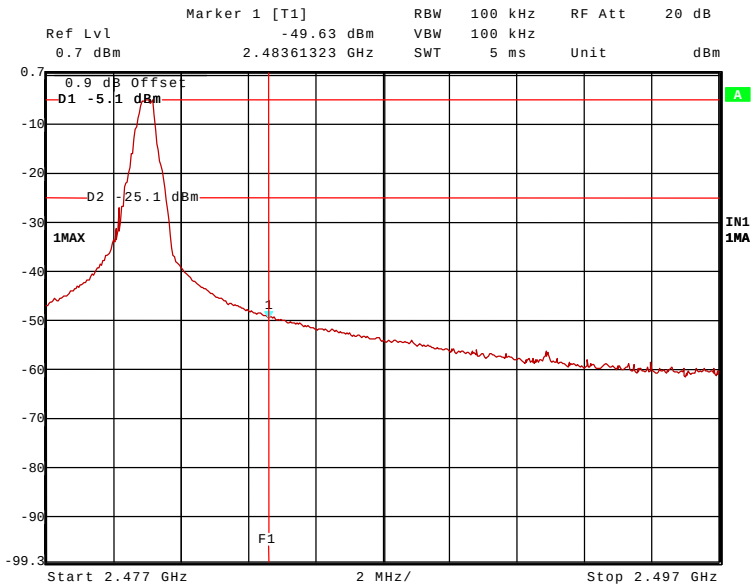
5.7.2 TEST RESULT (BAND-EDGE COMPLIANCE)

Ambient temperature	21 °C	Relative humidity	42 %

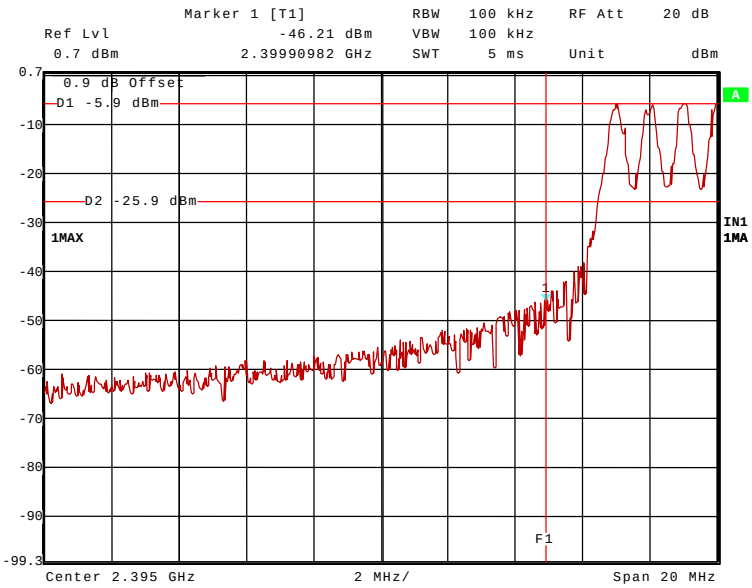
40690c28.wmf (band-edge compliance, lower band edge, hopping off):



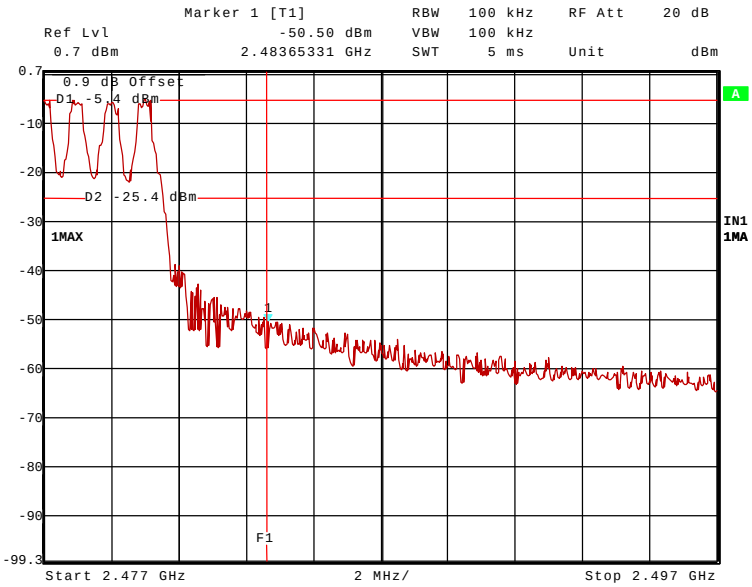
40690c30.wmf (band-edge compliance, upper band edge, hopping off):



40690c29.wmf (band-edge compliance, lower band edge, hopping on):



40690c31.wmf (band-edge compliance, upper band edge, hopping on):



The plots on the two pages before are showing the band-edge compliance for the upper and lower band-edge, with and without hopping. The display line 1 (D1) in these plots represents the highest level within the assigned frequency band. The display line 2 (D2) represents the 20 dB offset to this highest level and shows the compliance with FCC 47 CFR Part 15.247 (c). The frequency line 1 (F1) shows the edge of the assigned frequency plus or minus 100 kHz.

Band-edge compliance (hopping disabled)				
Band-edge	Difference to the signal peak [dB]	Field strength of this signal peak [dBµV/m]	Field strength at the band edge [dBµV/m]	Limit
Upper	44.5	97.6	53.1	54.0 dBµV/m
Lower	39.7	97.5	57.8	77.5 dBµV/m

Band-edge compliance (hopping enabled)				
Band-edge	Difference to the signal peak [dB]	Field strength of this signal peak [dBµV/m]	Field strength at the band edge [dBµV/m]	Limit
Upper	45.1	97.6	52.5	54.0 dBµV/m
Lower	40.3	97.5	57.2	77.5 dBµV/m

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54 – 57

5.8 CONDUCTED EMISSIONS (TRANSMITTER)

5.8.1 METHODE OF MEASUREMENT (CONDUCTED EMISSIONS)

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 following spectrum analyser settings shall be used:
In the frequency range from 9 kHz to 1 MHz:

- Start frequency: 9 kHz.
- Stop frequency: 1 MHz.
- Resolution bandwidth: 200 Hz.
- Video bandwidth: 200 Hz.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

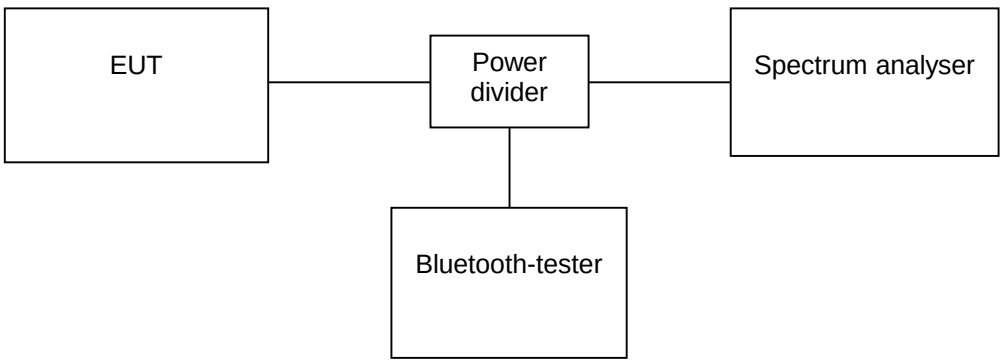
In the frequency range from 1 MHz to 25 GHz:

- Start frequency: 1 MHz.
- Stop frequency: 25 GHz.
- Resolution bandwidth: 100 kHz.
- Video bandwidth: 100 kHz.
- 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 20 dB below the peak marker. Every emission has to be below the display line.

The measurement will be performed with the EUT operates at the middle, the upper and lower end of the assigned frequency band and with hopping off.

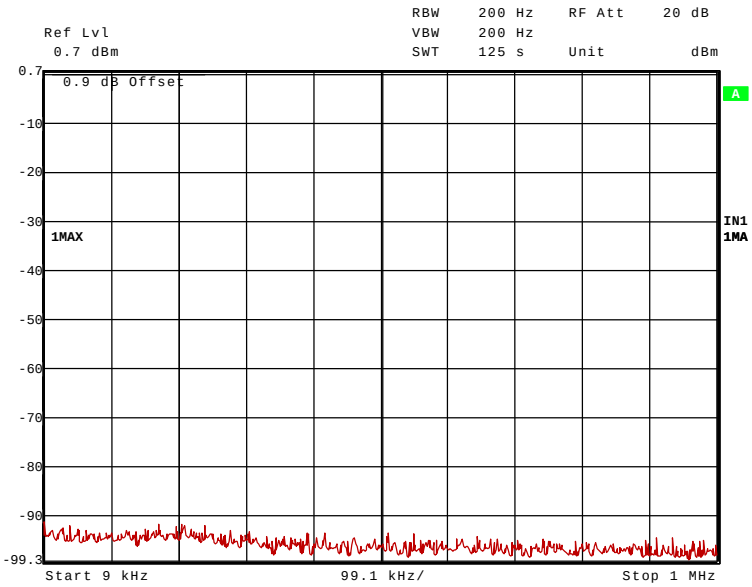
Test set-up:



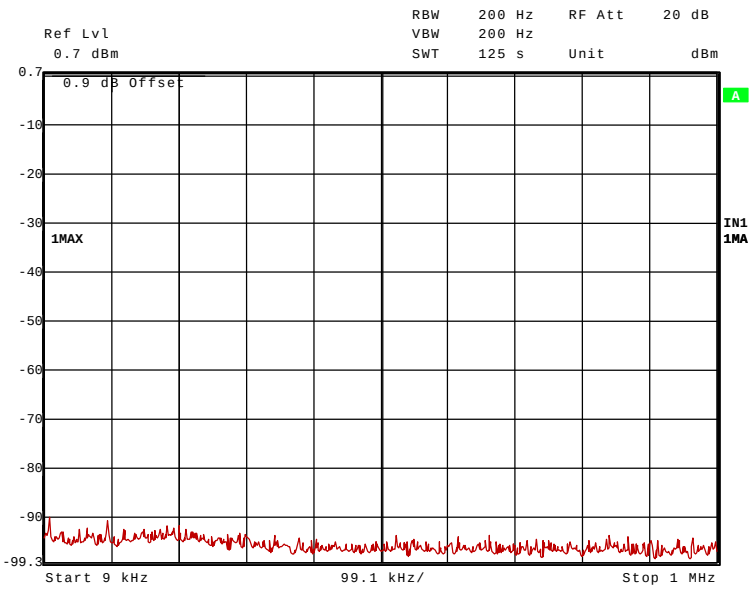
5.8.2 TEST RESULTS (CONDUCTED EMISSIONS)

Ambient temperature	21 °C	Relative humidity	42 %

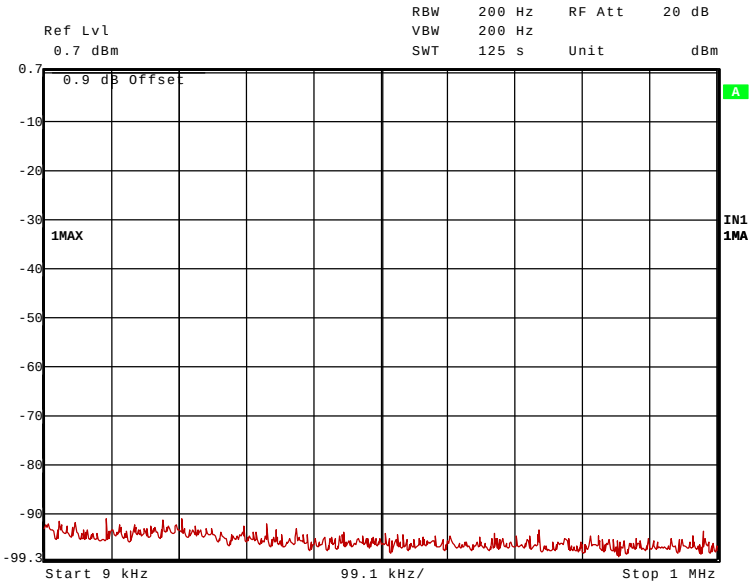
40690c32.wmf (conducted emissions form 9 kHz to 1 MHz, transmitter at 2402 MHz):



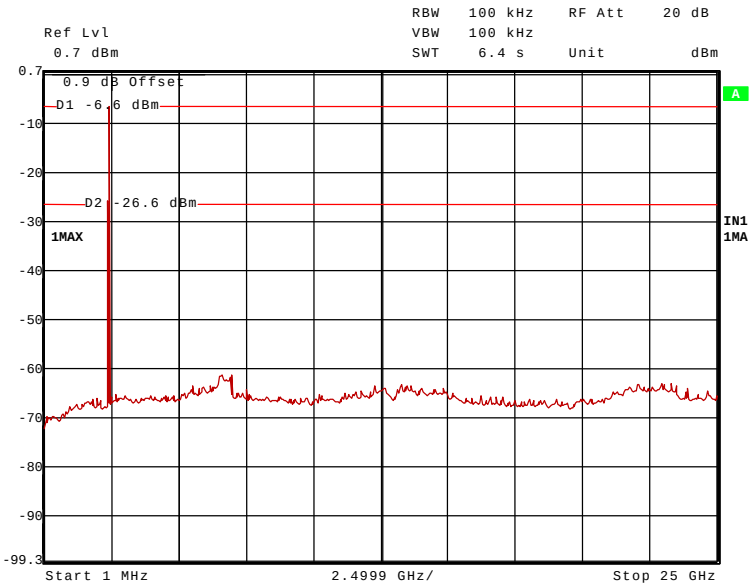
40690c33.wmf (conducted emissions 9 kHz to 1 MHz, transmitter at 2441 MHz):



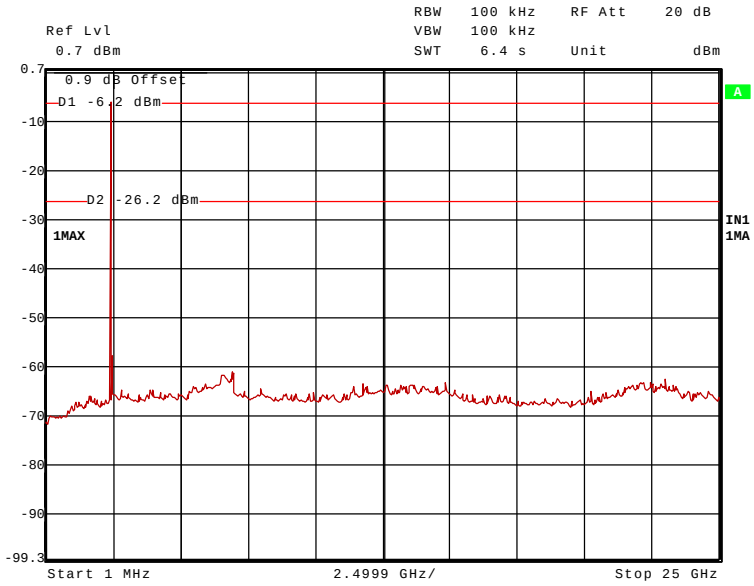
40690c34.wmf (conducted emissions 9 kHz to 1 MHz, transmitter at 2480 MHz):



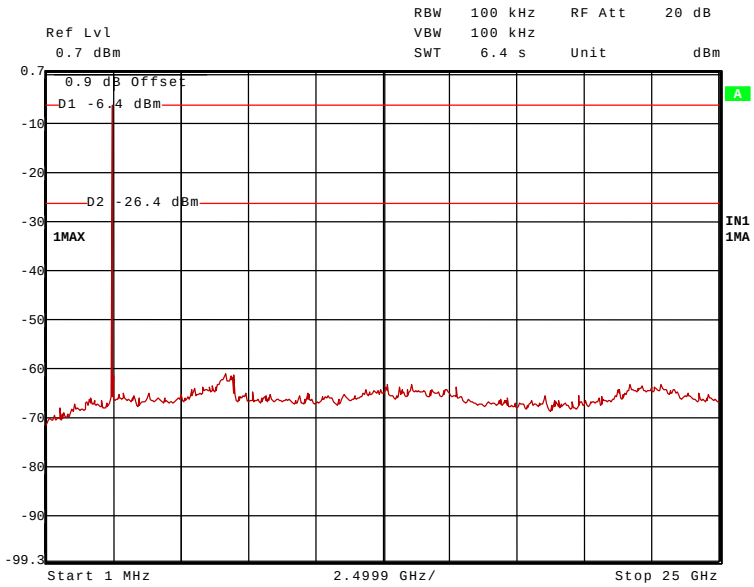
40690c35.wmf (conducted emissions form 1 MHz to 25 GHz, transmitter at 2402 MHz):



40690c36.wmf (conducted emissions 1 MHz to 25 GHz, transmitter at 2441 MHz):



40690c37.wmf (conducted emissions 1 MHz to 25 GHz, transmitter at 2480 MHz):



Conducted emissions with transmitter operates at 2402 MHz						
Frequency	Result dBm	Limit dBm	Margin dB	Reading dBm	Cable loss dB	Reference level [dBm]
-	-	No spurious emissions found in this operation mode			-	-
-	-				-	-
-	-				-	-
-	-	-	-	-	-	-
Conducted emissions with transmitter operates at 2441 MHz						
Frequency GHz	Result dBm	Limit dBm	Margin dB	Reading dBm	Cable loss dB	Reference level [dBm]
-	-	No spurious emissions found in this operation mode			-	-
-	-				-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
Conducted emissions with transmitter operates at 2480 MHz						
Frequency GHz	Result dBm	Limit dBm	Margin dB	Reading dBm	Cable loss dB	Reference level [dBm]
-	-	No spurious emissions found in this operation mode			-	-
-	-				-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31, 46, 54 – 57

5.9 RADIATED EMISSIONS (TRANSMITTER)

5.9.1 METHOD OF MEASUREMENT (RADIATED EMISSIONS)

The radiated emission measurement is subdivided into two stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 30 MHz to 1 GHz.
- A final measurement carried out on an open area test side with reflecting ground plane and various antenna height in the frequency range 30 MHz to 1 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 25 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.

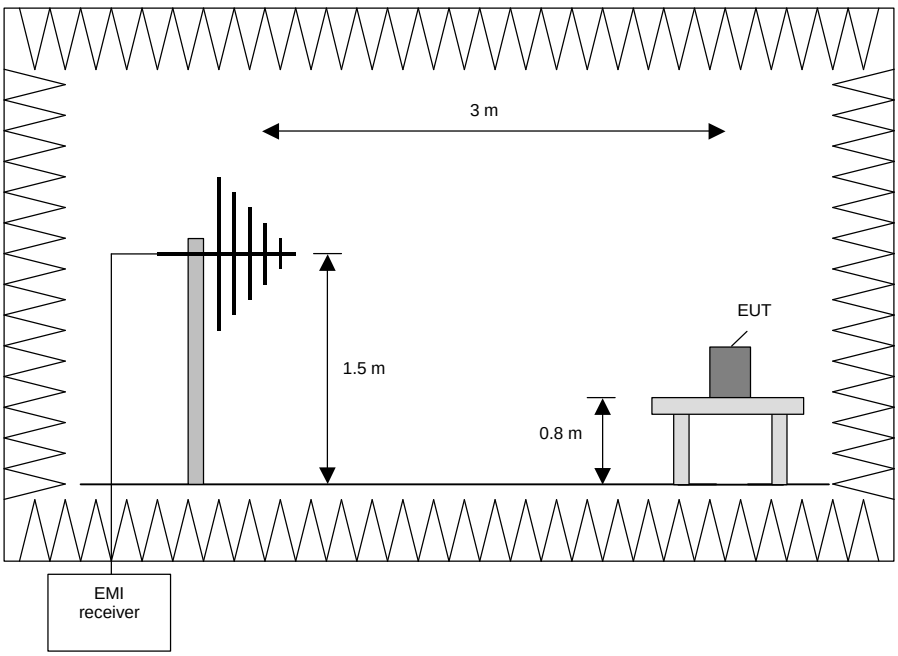
Preliminary measurement

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 set up of the Equipment under test will be in accordance to ANSI C63.4-2001 [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 230 MHz	100 kHz
230 MHz to 1 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.
The following procedure will be used:

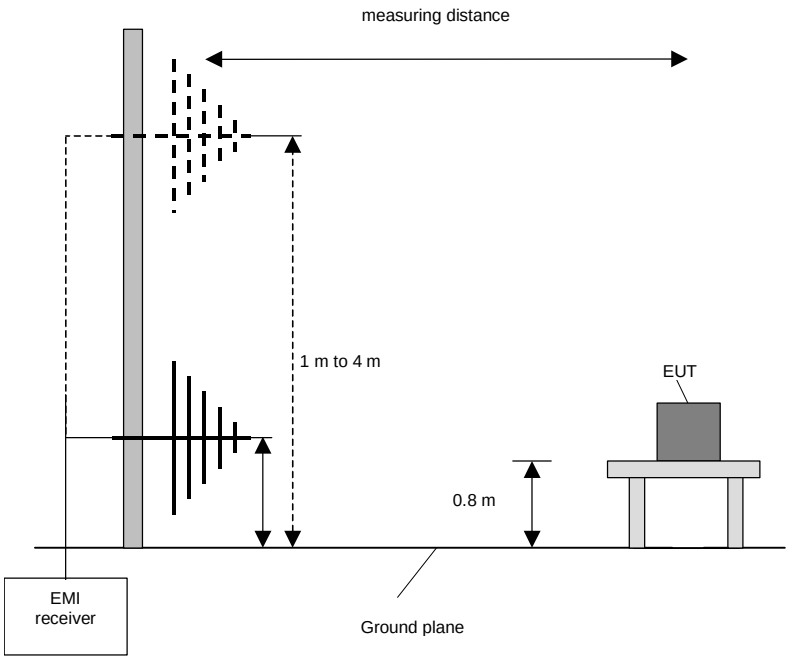
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the 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 if handheld equipment.
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 if handheld equipment.

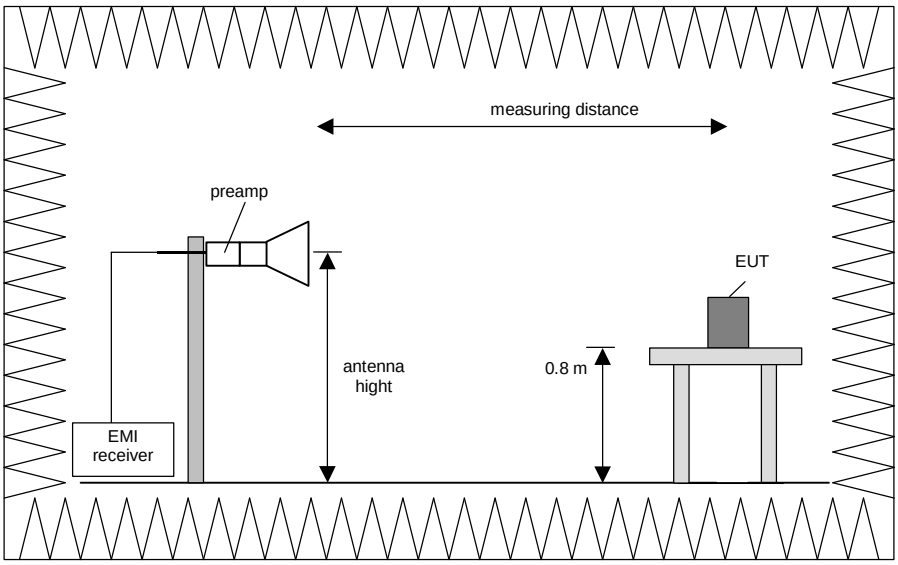
Final measurement (1 GHz to 26 GHz)

This 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 set up of the Equipment under test will be in accordance to ANSI C63.4-2001 [1].

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 MAX Hold 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 °. If the EUT is larger than the antenna beamwidth, the antenna will be moved to various positions, to cover the whole surface of the EUT. It might be possible to shorter the measuring distance to higher the measurement sensitivity.

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 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 and 18 GHz to 26 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) Change the antenna polarisation.
4) Rotate the EUT by 360 ° to maximize the detected signals.
5) Make a hardcopy of the spectrum.
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) 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) with the other orthogonal axes of the EUT if handheld equipment.
9) Repeat steps 1) to 8) for the next antenna spot if the EUT is lager than the antenna beamwidth.

5.9.2 TEST RESULTS (RADIATED EMISSIONS)

Ambient temperature	21 °C	Relative humidity	55 %

Position of EUT: The EUT was set-up on a wooden table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

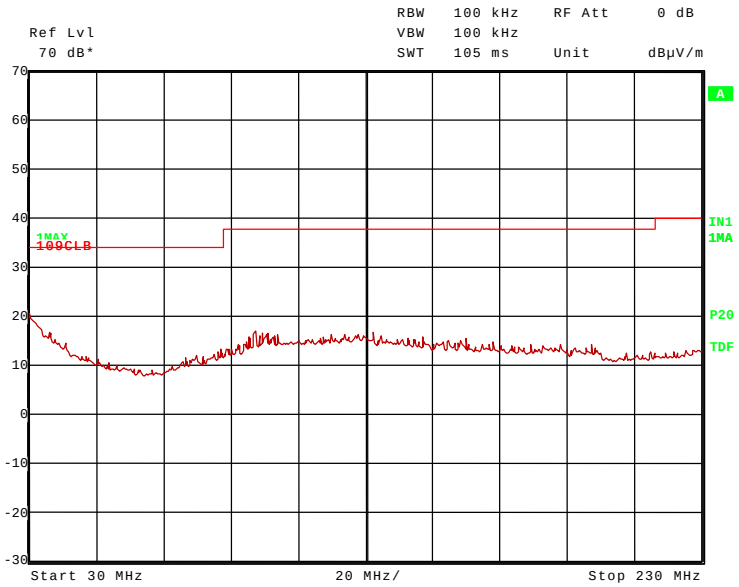
Cable guide: The cables of the EUT were fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: The test was carried out in test mode 2 of the EUT, because there was no difference to the other test modes in this frequency range. All results are shown in the following.

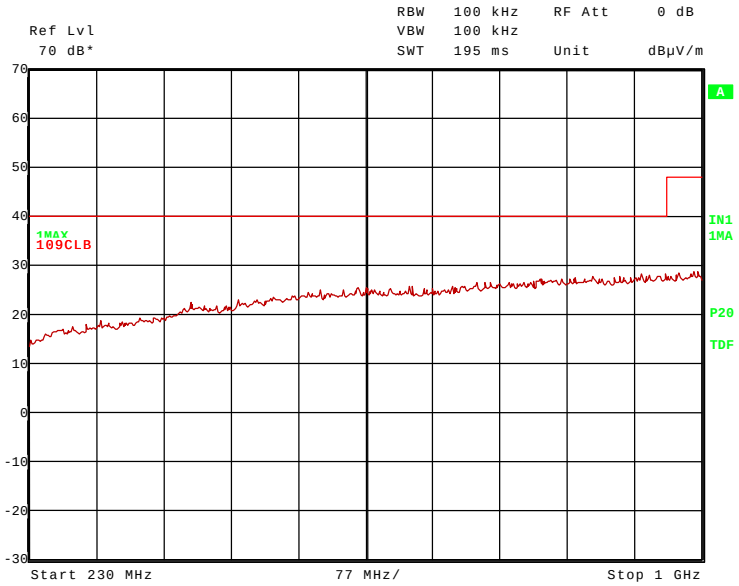
Supply voltage: During all measurements the EUT was supplied with 13.5 V DC.

Preliminary measurement

40690c1.wmf (30 MHz to 230 MHz):



40690c2.wmf (230 MHz to 1 GHz):

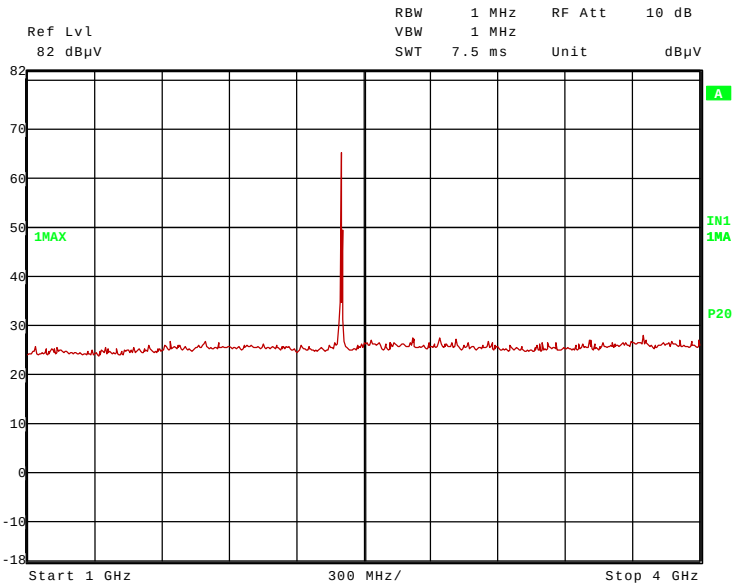


No significant frequencies at least 13 dB below the limit found. Therefore no final measurements on the open area test site were carried out.

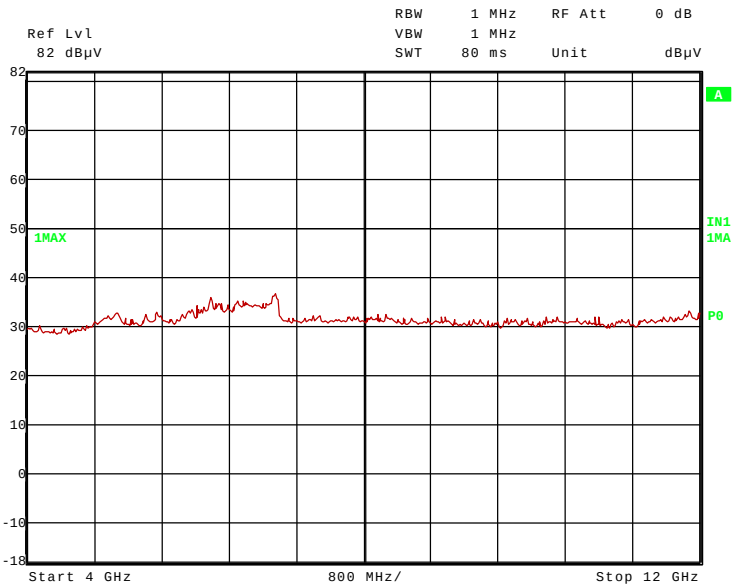
Final measurement (1 GHz to 26 GHz)

Transmitter operates at the lower band of the assigned frequency band

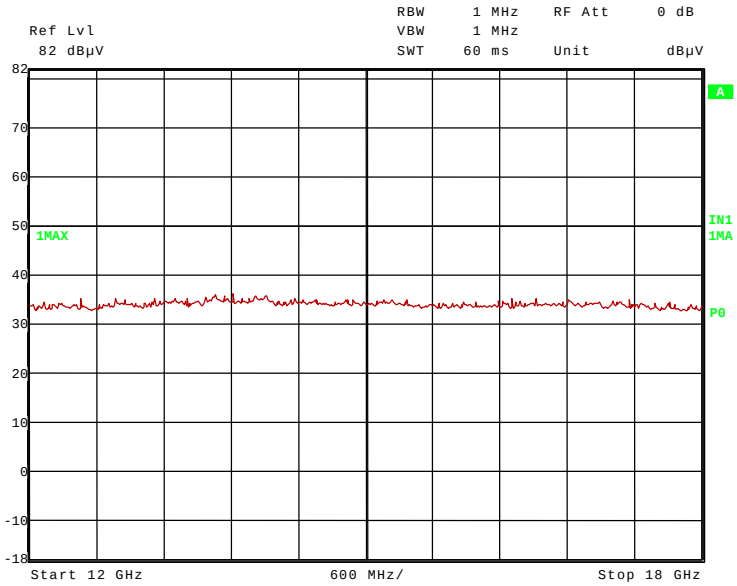
40690c4.wmf (1 GHz to 4 GHz):



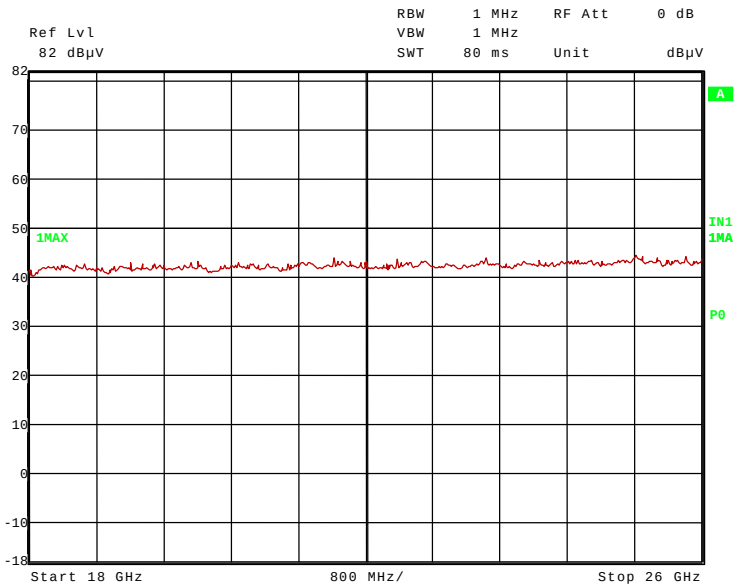
40690c8 (4 GHz to 12 GHz):



40690c9.wmf (12 GHz to 18 GHz):

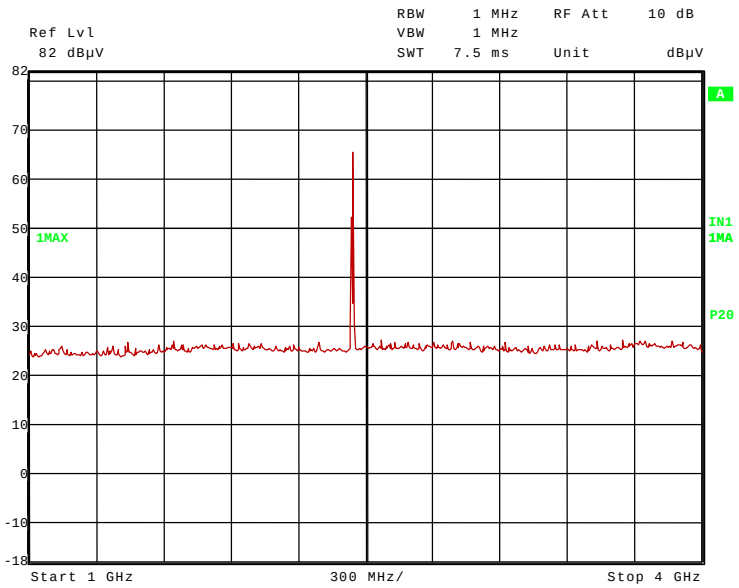


40690c14.wmf (18 GHz to 26 GHz):

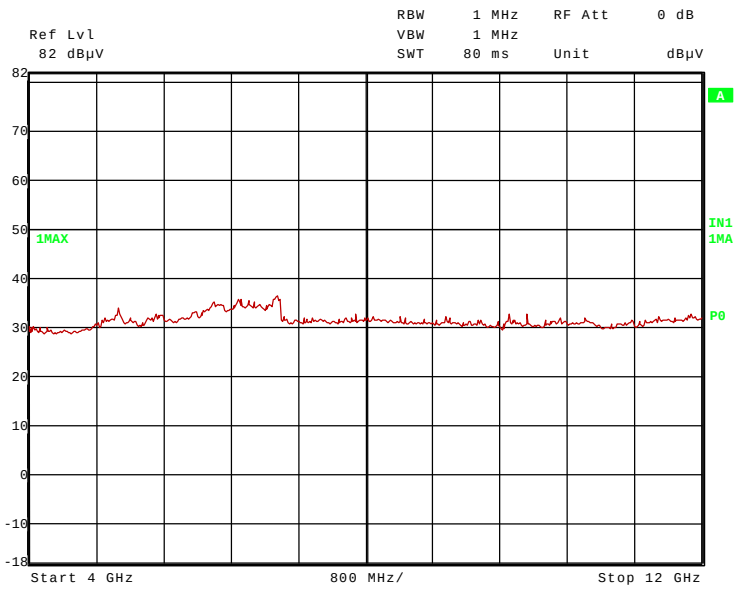


Transmitter operates at the middle of the assigned frequency band

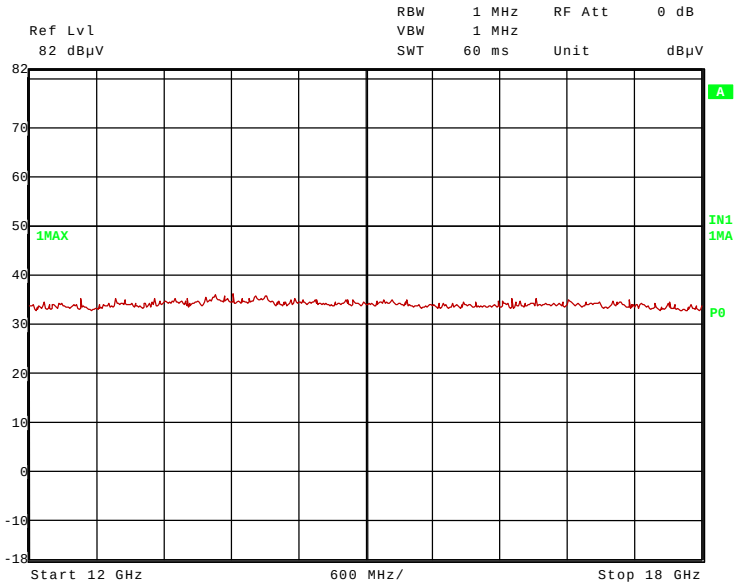
40690c3.wmf (1 GHz to 4 GHz):



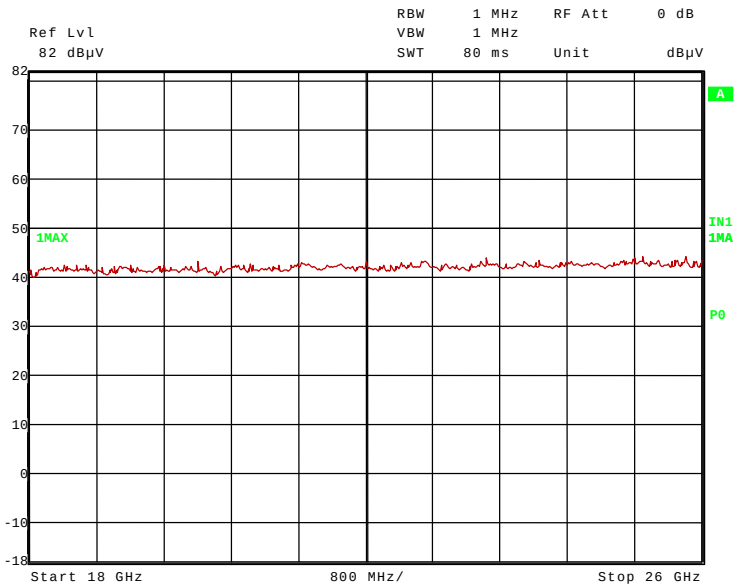
40690c7.wmf (4 GHz to 12 GHz):



40690c10.wmf (12 GHz to 18 GHz):

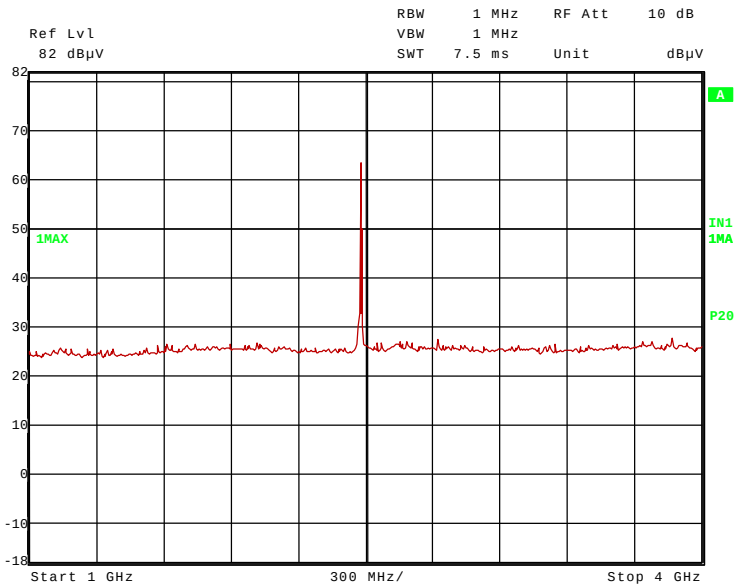


40690c13.wmf (18 GHz to 26 GHz):

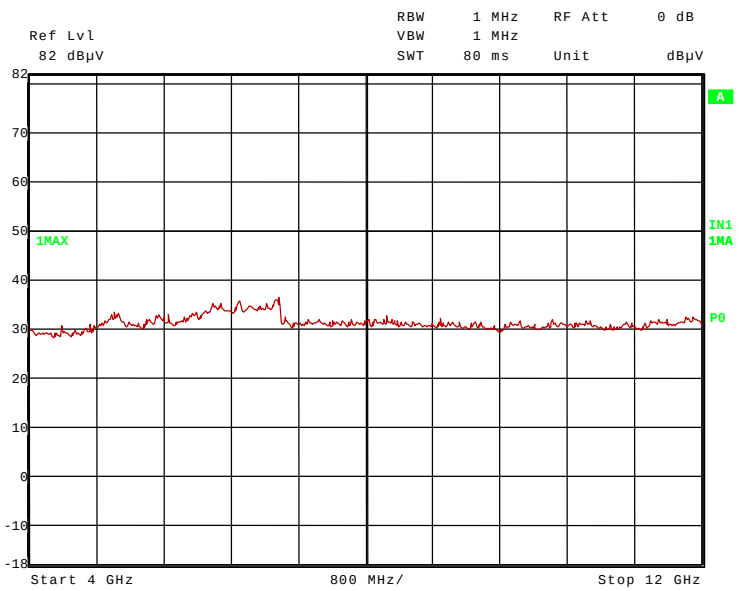


Transmitter operates at the upper band of the assigned frequency band

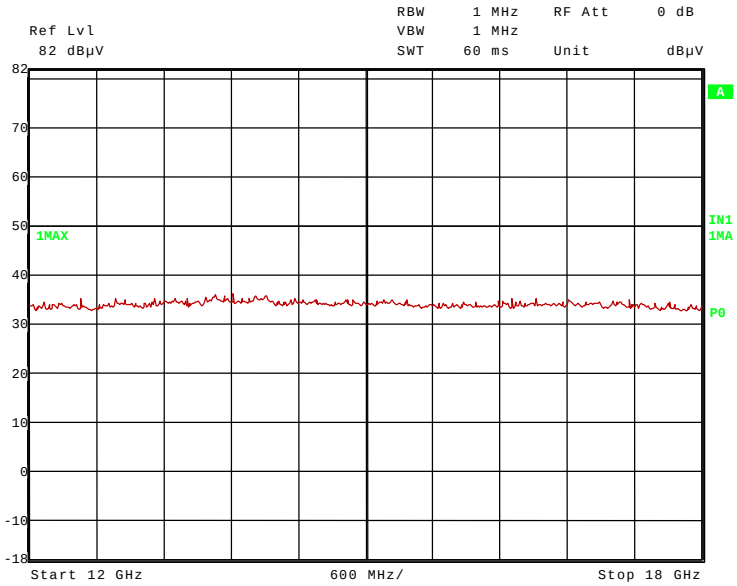
40690c5.wmf (1 GHz to 4 GHz):



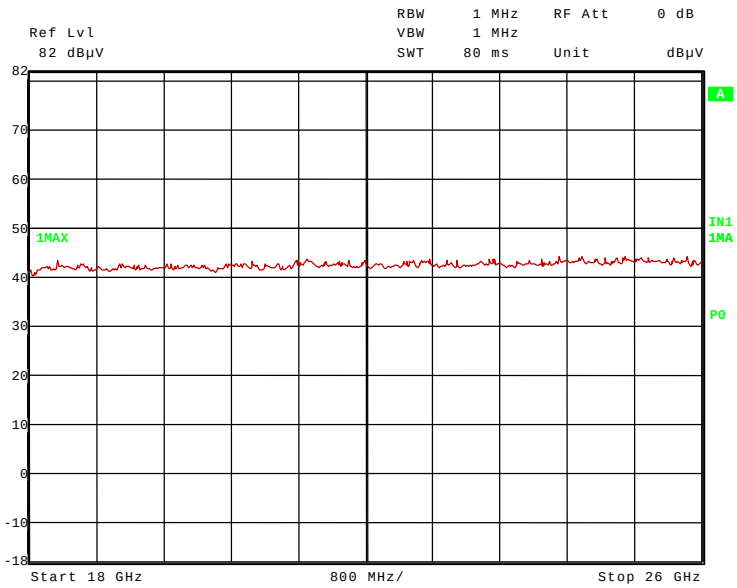
40690c6.wmf (4 GHz to 12 GHz):



40690c11.wmf (12 GHz to 18 GHz):



40690c12.wmf (18 GHz to 26 GHz):



Result measured with the peak detector:

Transmitter operates at the lower edge of the assigned frequency band										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	97.5	-	-	64.9	28.5	0	4.1	150	Hor.	-
Transmitter operates at the middle of the assigned frequency band										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.441	97.7	-	-	65.1	28.5	0	4.1	150	Hor.	-
Transmitter operates at the upper edge of the assigned frequency band										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	97.6	-	-	65.0	28.5	0	4.1	150	Hor.	-

Result measured with the average detector:

Transmitter operates at the lower edge of the assigned frequency band										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.402	85.0	-	-	52.4	28.5	0	4.1	150	Hor.	-
Transmitter operates at the middle of the assigned frequency band										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.441	85.2	-	-	52.6	28.5	0	4.1	150	Hor.	-
Transmitter operates at the upper edge of the assigned frequency band										
Frequency GHz	Corr. value dBµV/m	Limit dBµV/m	Margin dB	Readings dBµV	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
2.480	85.1	-	-	52.5	28.5	0	4.1	150	Hor.	-

Remark: No other emissions found.

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

14 – 20, 29, 31 – 37, 39, 43, 47, 49 – 51, 54, 55, 58, 59

6 TEST EQUIPMENT AND ANCILLARIES USED FOR TESTS

Emission measurement at AC mains and DC in / out ports at M4					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
1	Shielded chamber M4	-	Siemens	B83117S1-X158	480088
2	Measuring receiver	ESAI	Rohde & Schwarz	831953/001 833181/018	480025 480026
3	LISN	NSLK8128	Schwarzbeck	8128155	480058
4	DC-filter	B84266-A21-E13	Siemens	940164525	480099
5	AC-filter	B84299-D87-E3	Siemens	930262292	480097
6	EMI-Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M5					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
7	Fully anechoic chamber M5	-	Siemens	B83177-S1-X156	480073
8	Measuring receiver	ESVS30	Rohde & Schwarz	829673/012	480024
9	Controller	HD100	Deisel	100/324	480067
10	Antenna support	MA240	Deisel	228/314	480069
11	Turntable	DS412	Deisel	412/317	480070
12	Antenna	CBL6112C	Chase	2689	480327
13	EMI Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M6					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
14	Open area test site	-	Phoenix Test-Lab	-	480085
15	Measuring receiver	ESVS30	Rohde & Schwarz	829673/012	480024
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 A	Chase	1643	480147
20	EMI Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M8					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
21	Fully anechoic chamber M8	-	Siemens	B83117-E7019-T231	480190
22	Measuring receiver	ESMI	Rohde & Schwarz	843977/001 843530/018	480179 480180
23	Measuring receiver	ESCS 30	Rohde & Schwarz	828985/014	480270
24	Controller	HD100	Deisel	100/427	480181
25	Turntable	DS420	Deisel	420/435/97	480186
26	Antenna support	AS615P	Deisel	615/310	480187
27	Antenna	CBL6112 A	Chase	2034	480185
28	EMI Software	ES-K1	Rohde & Schwarz	-	480111

Radiated emission measurement at M20					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303
30	Measuring receiver	ESMI	Rohde & Schwarz	843977/001 843530/018	480179 480180
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355
32	Controller	HD100	Deisel	100/670	480326
33	Turntable	DS420HE	Deisel	420/620/80	480315
34	Antenna support	AS615P	Deisel	615/310	480187
35	Antenna	CBL6112 B	Chase	2688	480328
36	Antenna	3115 A	EMCO	9609-4918	480183
37	Standard Gain Horn 11.9GHz – 18GHZ	18240-20	Flann Microwave	483	480294
38	Standard Gain Horn 11.9GHz – 18GHZ	18240-20	Flann Microwave	482	480295
39	Standard Gain Horn 17.9GHz – 26.7GHZ	20240-20	Flann Microwave	411	480297
40	Standard Gain Horn 17.9GHz – 26.7GHZ	20240-20	Flann Microwave	410	480296
41	Standard Gain Horn 26.4GHz – 40.1GHZ	22240-20	Flann Microwave	469	480299

No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
42	Standard Gain Horn 26.4GHz – 40.1GHZ	22240-20	Flann Microwave	468	480298
43	RF-cable No. 30	RTK 081	Rosenberger	-	410141
44	RF-cable No. 31	RTK 081	Rosenberger	-	410142
45	RF-cable 1m	KPS-1533-400-KPS	Insulated Wire	-	480300
46	RF-cable 1m	KPS-1533-400-KPS	Insulated Wire	-	480301
47	RF-cable 2m	KPS-1533-400-KPS	Insulated Wire	-	480302
48	RF-cable No. 5	RTK 081	Rosenberger		410097
49	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337
50	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343
51	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342
52	Preamplifier	JS3-26004000-25-5A	Miteq	563593	480344
53	EMI Software	ES-K1	Rohde & Schwarz	-	480111

Ancillary equipment used for testing					
No.	Test equipment	Type	Manufacturer	Serial No.	PM-No
54	Power supply	TOE 8852	Toellner	51712	480233
55	Universal Communication tester	CMU 200	Rohde & Schwarz	101140	-
56	Power divider	PWD-2533-02-SMA-79	Midwest Microwave	-	480443
57	Attenuator / 20 dB / 5 W	WA2-20	Weinschel	8258	410126
58	High Pass Filter	WHJS1000C 11/60EF	Wainwright Instruments GmbH	1	480413
59	High Pass Filter	HP 4000	Dirk Fischer Elektronik	-	480445

All used measurement equipment was calibrated (if necessary). The calibration intervals and the calibration history will be given out on request.

7 LIST OF ANNEXES

ANNEX A	**PHOTOGRAPHS OF THE TEST SET-UPS**:	**2 pages**
	HT-1, test set-up fully anechoic chamber	40690_d.jpg
	HT-1, test set-up fully anechoic chamber	40690_e.jpg
ANNEX B	**INTERNAL PHOTOGRAPHS OF THE TEST SAMPLE**:	**5 pages**
	HT-1, internal view	40690_4.jpg
	HT-1, internal view	40690_3.jpg
	HT-1, PCB, top view	40690_1.jpg
	HT-1, PCB, bottom view	40690_2.jpg
	HT-1, PCB, top view of the sample with temporary antenna connector	40690_8.jpg
ANNEX C	**EXTERNAL PHOTOGRAPHS OF THE TEST SAMPLE**:	**4 pages**
	HT-1, top view	40690_7.jpg
	HT-1, bottom view	40690_6.jpg
	HT-1, side (connector) view	40690_5.jpg
	HT-1, top view of sample in paging mode	40690_9.jpg