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Test Report

Report Number:

F172289E6

Equipment under Test (EUT):

**BT10
inside FMR50**

Applicant:

Endress+Hauser SE+Co. KG

Manufacturer:

Endress+Hauser SE+Co. KG



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

References

- [1] **ANSI C63.10-2013**, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- [2] **FCC CFR 47 Part 15**, Radio Frequency Devices
- [3] **RSS-210 Issue 9 August 2016 (Amendment)**, Spectrum Management and Telecommunications Radio Standards Specification Licence-Exempt Radio Apparatus: Category I Equipment
- [4] **RSS RSS-Gen Issue 4 November 2014**, Spectrum Management and Telecommunications Radio Standards Specification General Requirements for Compliance of Radio Apparatus

Test Result

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

The complete test results are presented in the following.

Test
engineer

Thomas KÜHN

Name

T. Li

Signature

03/13/2018

Date

Authorized
reviewer:

Bernd STEINER

Name

B. Steiner

Signature

03/13/2018

Date

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1 Identification

1.1 Applicant

Name:	Endress+Hauser SE+Co. KG
Address:	Hauptstr. 1, 79689 Maulburg
Country:	Germany
Name for contact purposes:	Mr. Ralph STIB
Phone:	+49 76 22 28 – 19 43
eMail Address:	ralph.stib@pcm.endress.com
Applicant represented during the test by the following person:	None

1.2 Manufacturer

Name:	Endress+Hauser SE+Co. KG
Address:	Hauptstr. 1, 79689 Maulburg
Country:	Germany
Name for contact purposes:	Mr. Ralph STIB
Phone:	+49 76 22 28 – 19 43
eMail Address:	ralph.stib@pcm.endress.com
Manufacturer represented during the test by the following person:	None

1.3 Test Laboratory

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

Accredited by *Deutsche Akkreditierungsstelle GmbH* in compliance with
 DIN EN ISO/IEC 17025 under Reg. No. **D-PL-17186-01-02**.

1.4 EUT (Equipment Under Test)

Test object: *	BT10 inside Level probing radar (host)
Type designation / model name: *	BT10 inside FMR50 (host)
FCC ID: *	LCGBT10 (wireless adaptor), LCGFMR5XK (LPR)
IC: *	2519A-BT10 (wireless adaptor), 2519A-5K (LPR)

*: Declared by the applicant.

Ports / Connectors:

Identification	Connector		Length
	EUT	Ancillary	
DC in	Fixed	-	2.0 m
4 ... 20 mA	Fixed	-	Not used
-	-	-	-
-	-	-	-

All lines were unshielded.

1.5 Technical Data Of Equipment (wireless adaptor)

Model number:*	BT10					
Order number:*	SAP number: 71377355					
Serial number:*	BTM_3_001					
PCB identifier:*	71374363 Index 3					
Hardware version:*	BTM_3					
Software version:*	V00.63.00 and DTM Software Nordic					
Fulfills Bluetooth specification:*	Bluetooth low energy (only)					
Antenna type:*	PCB					
Antenna name:*	None					
Antenna gain:*	2.15 dBi					
Antenna connector:*	None					
Power supply:*	DC by the LPR (host)					
Supply voltage wireless adaptor:*	U _{nom} =	4.5 V DC	U _{min} =	3.0 V DC	U _{max} =	5.5 V DC
Type of modulation:*	GFSK					
Operating frequency range:*	2402 MHz to 2480 MHz					
Number of channels:*	39					
Temperature range:*	-40 °C to +80 °C					

*: Declared by the applicant

1.6 Technical Data Of Equipment (LPR (host))

Model number:*	Micropilot				
Order number:*	FMR50-3W70/0				
Serial number:*	LC00C201133				
PCB identifier:*	Not available (identification with serial number possible)				
Hardware version:*	Dev.Ref.: 3				
Software version:*	01.02.zz, HART 7, DevRev03				
Antenna type: *	Horn 40mm/1-1/2", PVDF gekapselt, -40...130oC/-40...266oF				
Antenna connector: *	None				
Type of modulation: *	1G50P0NAN				
Data rate:*	None				
Operating frequency range:*	24.05 GHz to 29.0 GHz				
Operating frequency:*	25.2 GHz				
Number of channels: *	1				
Channel spacing: *	None (on channel operation only)				
Power supply – EUT: *	$U_{nom} =$	24.0 V DC	$U_{min} =$	12 V DC	$U_{max} =$ 30.0 V DC
Temperature range: *	-20 °C to 50 °C				

*: Declared by the applicant

1.7 Dates

Date of receipt of test sample:	01/23/2018
Start of test:	02/28/2018
End of test:	03/01/2018

2 Operational States

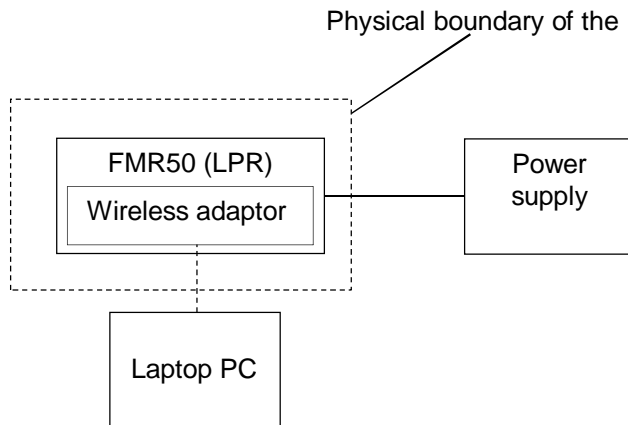
All tests were carried out with an unmodified sample. The EUT is a Level Probing Radar (host) which could be equipped with a wireless adaptor.

During all tests the LPR was supplied with 24 V DC, which was provided by an external power supply. The wireless adaptor was powered by the LPR.

In order to configure wireless adaptor a "BT Testsoftware" (provided by the applicant) was used to configure the RF parameter of the wireless adaptor (maximum output power and transmit continuously with pseudo random bit sequence on mid channel (2439 MHz)) via a controlling laptop and a USB connection. This connection was removed after adjusting the operation mode.

All emission tests were carried out in two positions of the host: Position 1 is the normal installation position (antenna shows downwards), for position 2 measurement the antenna shows sideways (antenna boresight). For details of the positions refer also the photographs in annex A of this test report. The plots in the following showing the maximum results of both measurements.

The physical boundaries of the Equipment Under Test are shown below.



3 Additional Information

During the tests neither the LPR nor the wireless adaptor was labeled as required by the FCC rules.

This test report shows the emissions of the combination of two transceivers, which were both, tested and certified individually and which are able to transmit simultaneously. The distance between the two transceivers is less than 20 cm. In respect to the operation frequencies of the transceivers the tests were carried out in the frequency range 1 GHz to 100 GHz

4 Overview

Application	Frequency range	FCC 47 CFR Part 15 section [2]	RSS-210 [3] or RSS-Gen, Issue 4 [4]	Status	Refer page
Unwanted emissions	1 GHz to 100 GHz	15.209	4.1 [3], 8.9 [4], 8.10 [4]	Passed	8 et seq.

5 Results

5.1 Radiated emissions

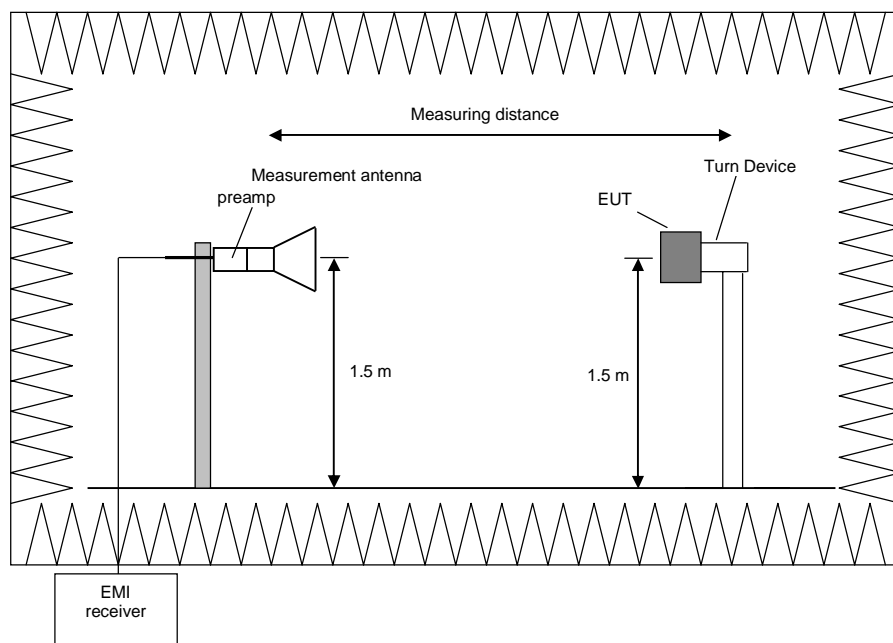
5.1.1 Method of measurement (radiated emissions)

The radiated emission measurement is subdivided into six stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 12 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 12 GHz.
- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 12 GHz to 40 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 12 GHz to 40 GHz.
- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 40 GHz to 100 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 40 GHz to 100 GHz.

Preliminary and final measurement (1 GHz to 12 GHz)

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



Preliminary measurement (1 GHz to 12 GHz)

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

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

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	1 MHz
4 GHz to 12 GHz	1 MHz

Procedure preliminary measurement:

Prescans were performed in the frequency range 1 to 12 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 90°.
6. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
7. The measurement antenna polarisation, with the according EUT position (Turntable and Turn device) which produces the highest emission for each frequency will be used for the final measurement. The six closest values to the applicable limit will be used for the final measurement.

Final measurement (1 GHz to 12 GHz)

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

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

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	1 MHz
4 GHz to 12 GHz	1 MHz

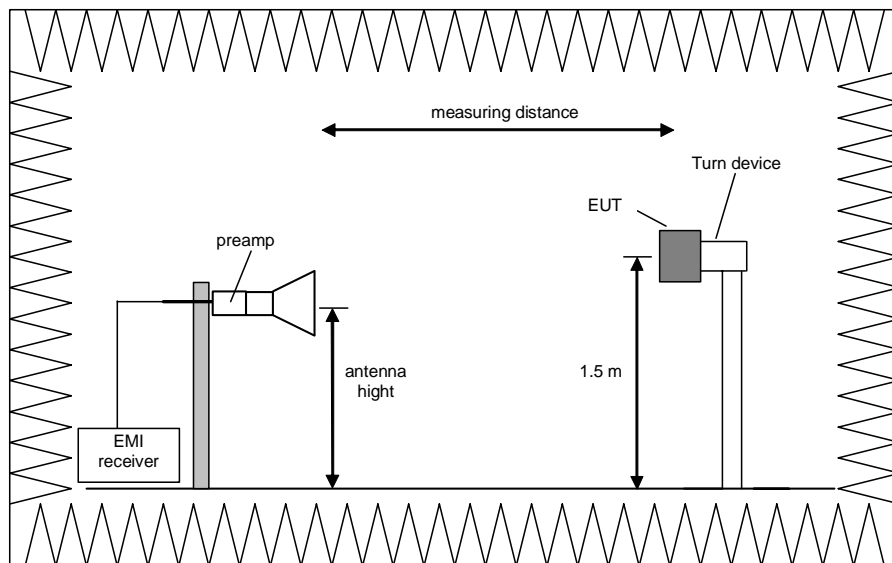
Procedure of measurement:

The measurements were performed in the frequency ranges 1 GHz to 4 GHz and 4 GHz to 12 GHz. The following procedure will be used:

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

Preliminary and final measurement (12 GHz to 40 GHz)

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



Preliminary measurement (1 GHz to 40 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °. This measurement is repeated after raising the EUT to 90 °.

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

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

Procedure preliminary measurement:

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

The following procedure will be used:

8. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
9. Rotate the EUT by 360° to maximize the detected signals.
10. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
11. Make a hardcopy of the spectrum.
12. Repeat 1) to 4) with the EUT raised by an angle of 90°.
13. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
14. The measurement antenna polarisation, with the according EUT position (Turntable and Turn device) which produces the highest emission for each frequency will be used for the final measurement. The six closest values to the applicable limit will be used for the final measurement.

Final measurement (12 GHz to 40 GHz)

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

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

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

Procedure of measurement:

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

The following procedure will be used:

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

Preliminary and final measurement (40 GHz to 100 GHz)

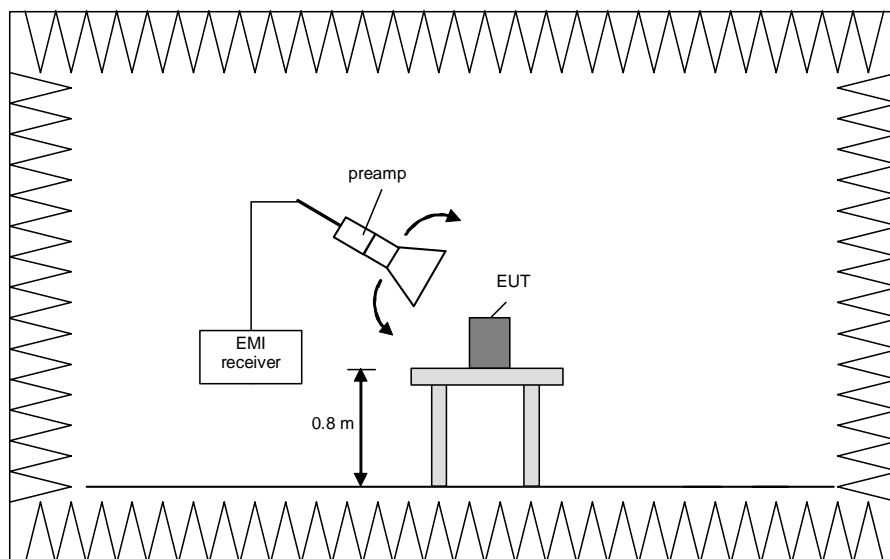
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The setup of the Equipment under test will be in accordance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

Preliminary measurement (40 GHz to 100 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 1 MHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna, the antenna close to the EUT and while moving the antenna over all sides of the EUT. With the spectrum analyser in CLEAR / WRITE mode the cone of the emission should be found and than the measuring distance will be set to documented measuring distance with the receiving antenna moving in this cone of emission. At this position the final measurement will be carried out.

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

Frequency range	Resolution bandwidth
40 GHz to 60 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 GHz	1 MHz

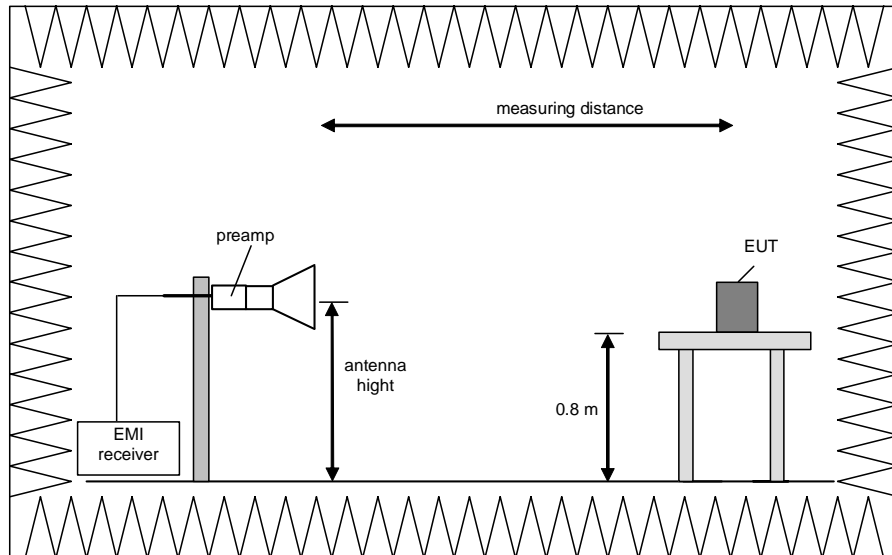


Final measurement (40 GHz to 100 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 ° in order to have the antenna inside the cone of radiation.

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

Frequency range	Resolution bandwidth
40 GHz to 60 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency range 40 GHz to 60 GHz, 60 GHz to 75 GHz and 75 GHz to 100 GHz.

The following procedure will be used:

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

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

5.1.2 Test results (radiated emissions)

5.1.2.1 Preliminary radiated emission measurement

Ambient temperature	20 °C	Relative humidity	10 %
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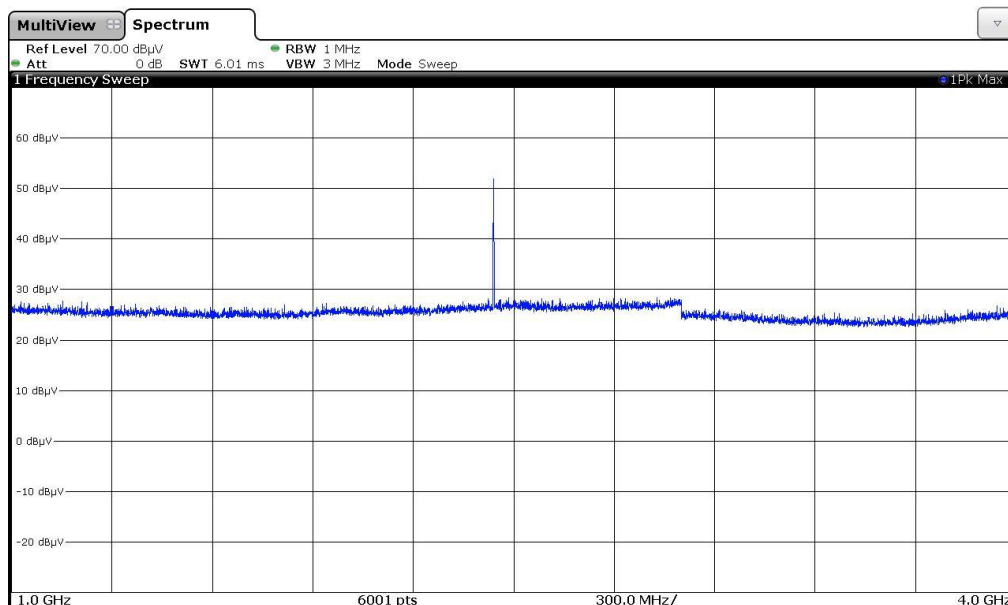
Position of EUT: The EUT was set-up on a turn device of a height of 1.5 m. The distance between EUT and antenna was 3 m.

Test record: All results are shown in the following.

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

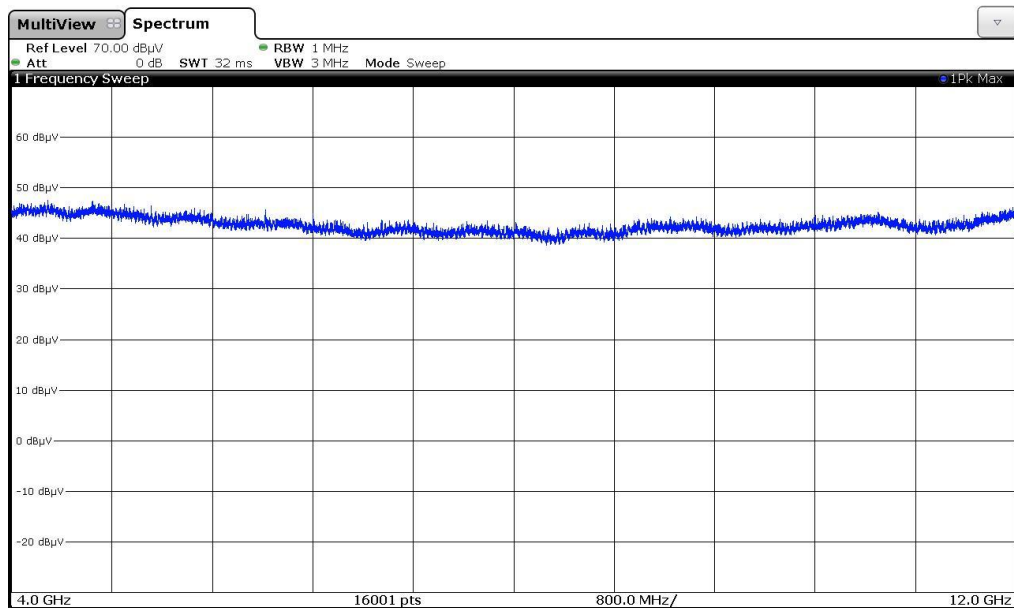
Remark: All emission tests were carried out in two positions of the EUT: Position 1 is the normal installation position (antenna shows downwards), for position 2 measurement the antenna shows sideward (boresight view). For details of the positions refer also the photographs in annex A of this test report. The plots in the following showing the maximum results from both measurements.

172289_200.jpeg: Spurious emissions from 1 GHz to 4 GHz:



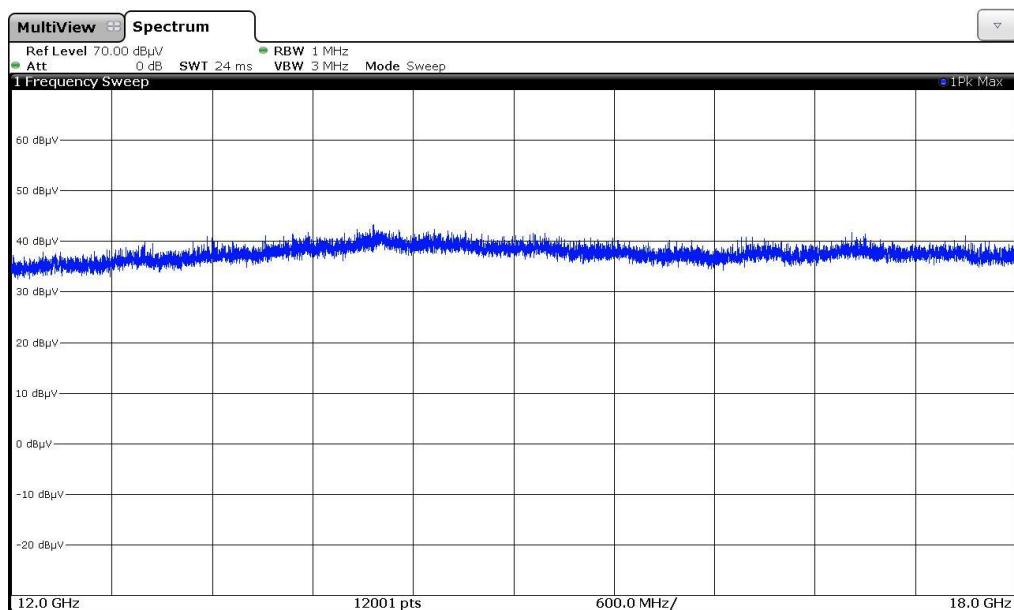
No emission above noise floor of the measuring system (61 dBμV/m measured with peak detector with 3 m measuring distance) except the wanted signal of the Bluetooth Low Energy device found in this frequency range.

172289_201.jpeg: Spurious emissions from 4 GHz to 12 GHz:



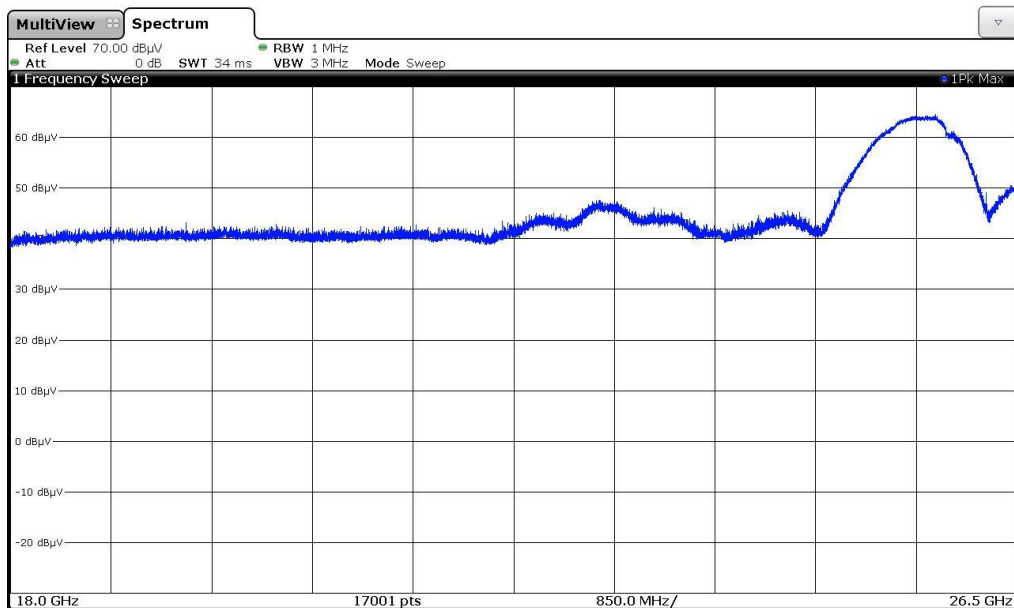
No emission above noise floor of the measuring system (50.2 dBµV/m measured with peak detector with 3 m measuring distance) found in this frequency range.

172289_202.jpeg: Spurious emissions from 12 GHz to 18 GHz:



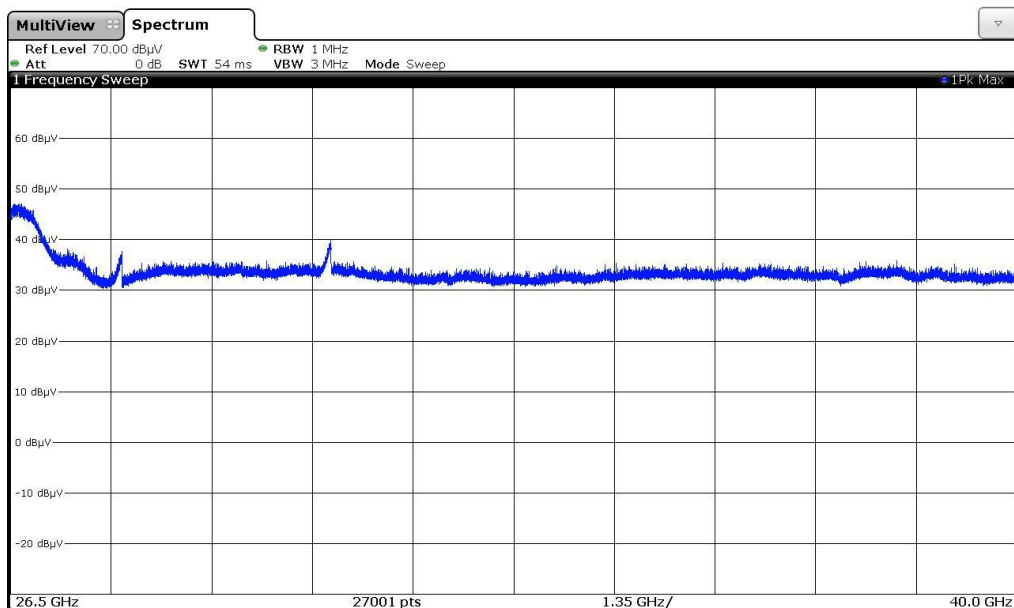
No emission above noise floor of the measuring system (45 dBµV/m measured with peak detector with 3 m measuring distance) found in this frequency range.

172289_203.jpeg: Spurious emissions from 18 GHz to 26.5 GHz:



No emission above noise floor of the measuring system (48 dB μ V/m measured with peak detector with 3 m measuring distance) except the wanted signal of the LPR device found in this frequency range.

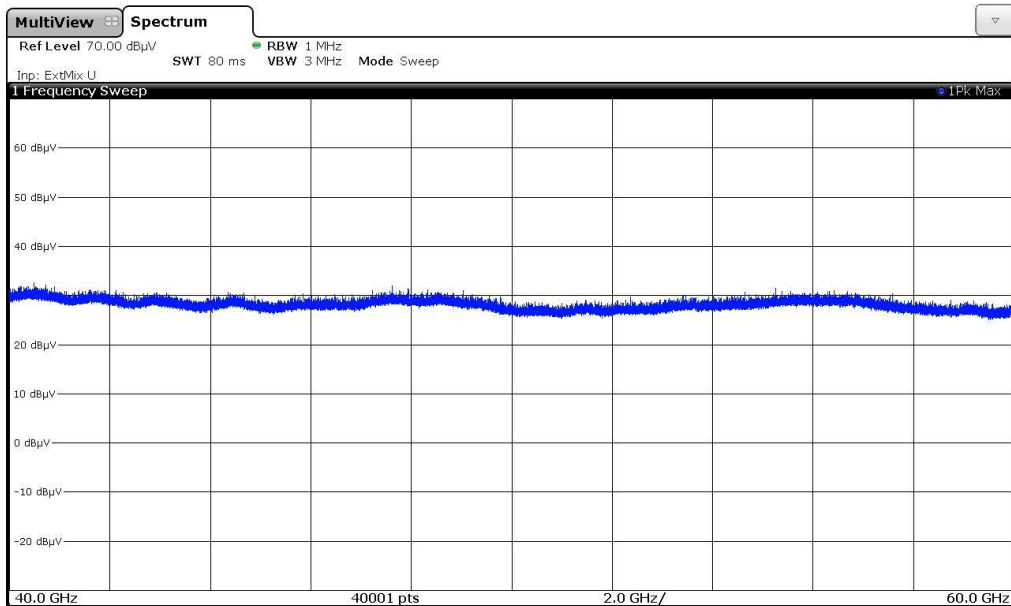
172289_204.jpeg: Spurious emissions from 26.5 GHz to 40 GHz:



No emission above noise floor of the measuring system (56 dB μ V/m measured with peak detector with 1 m measuring distance) found in this frequency range.

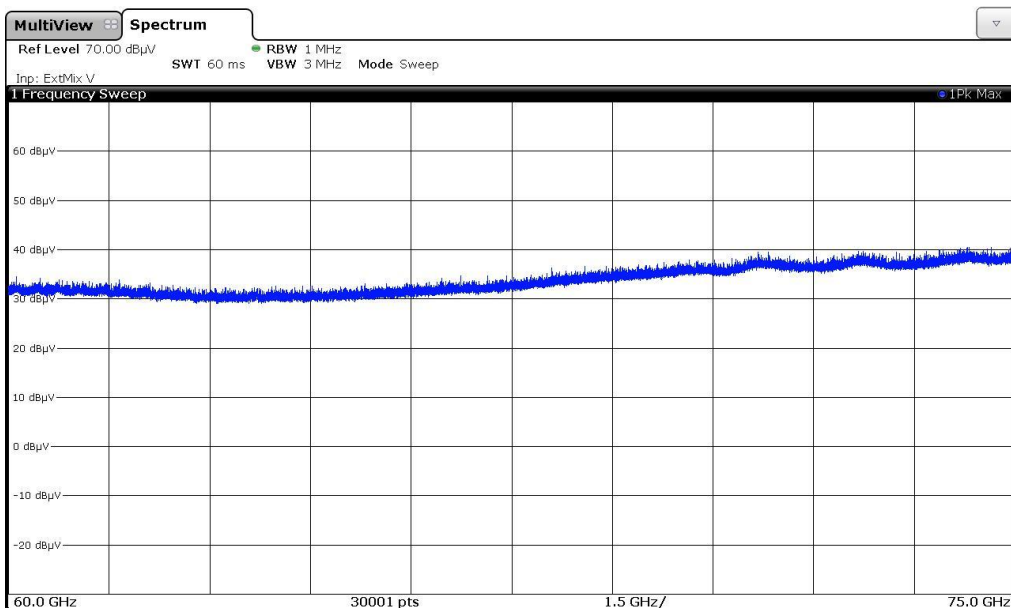
Remark: The peaks at 28 GHz and 30 GHz caused by the measuring system and not by the EUT.

172289_205.jpeg: Spurious emissions from 40 GHz to 60 GHz:



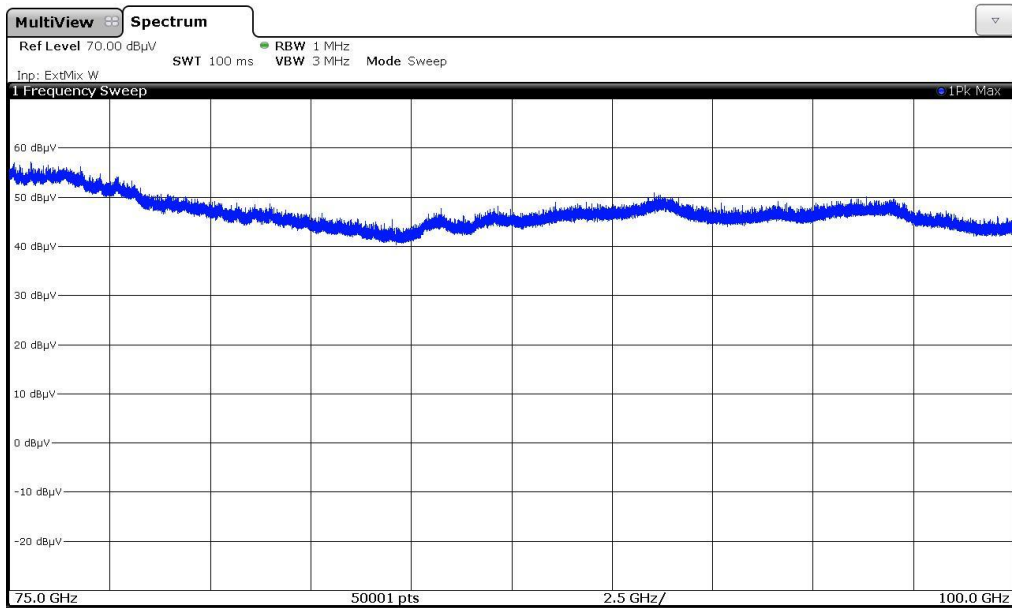
No emission above noise floor of the measuring system (77.1 dBμV/m measured with peak detector with 0.1 m measuring distance) found in this frequency range.

172289_206.jpeg: Spurious emissions from 60 GHz to 75 GHz:



No emission above noise floor of the measuring system (69 dBμV/m measured with peak detector with 0.1 m measuring distance) found in this frequency range.

172289_207.jpeg: Spurious emissions from 75 GHz to 100 GHz:



No emission above noise floor of the measuring system (105 dBµV/m measured with peak detector with 0.03 m measuring distance) found in this frequency range.

Test equipment used (refer clause 6):

1 - 24

6 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
1	Spectrum Analyzer	FSW	Rohde & Schwarz	100586	481720	02/24/2016	02/2018
2	Power supply	TOE8752-32	Toellner	31566	480010	Calibration not necessary	
3	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Calibration not necessary	
4	Measuring receiver	ESW44	Rohde & Schwarz	101635	482467	06/22/2017	06/2019
5	Controller	MCU	Maturo	MCU/043/971107	480832	Calibration not necessary	
6	Turntable	DS420HE	Deisel	420/620/80	480315	Calibration not necessary	
7	Antenna support	AS615P	Deisel	615/310	480187	Calibration not necessary	
8	Positioner	TDF 1.5- 10Kg	Maturo	15920215	482034	Calibration not necessary	
9	Antenna	HL050	Rohde & Schwarz	100438	481170	10/09/2017	10/2020
10	Standard Gain Horn 11.9 GHz – 18 GHz	18240-20	Flann Microwave	483	480294	Calibration not necessary	
11	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	411	480297	Calibration not necessary	
12	Standard Gain Horn 17.9 GHz – 26.7 GHz	20240-20	Flann Microwave	410	480296	Calibration not necessary	
13	Standard Gain Horn 26.4 GHz – 40.1 GHz	22240-20	Flann Microwave	468	480298	Calibration not necessary	
14	RF-cable No. 3	Sucoflex 106B	Suhner	0563/6B	480670	Calibration not necessary	
15	RF-cable No. 40	Sucoflex 106B	Suhner	0708/6B	481330	Calibration not necessary	
16	Preamplifier	AFS6-00101600-23-10P-6-R	Miteq	2011215	482333	11/23/2016	11/2018
17	Preamplifier	JS3-12001800-16-5A	Miteq	571667	480343	02/18/2016	02/2018
18	Preamplifier	JS3-18002600-20-5A	Miteq	658697	480342	02/17/2016	02/2018
19	Preamplifier	JS3-26004000-25-5A	Miteq	563593	480344	02/18/2016	02/2018
20	Standard Gain Horn 40 GHz – 60 GHz	24240-20	Flann Microwave	133313	480481	Calibration not necessary	
	Harmonic Mixer 40...60 GHz	FS-Z60	Rohde & Schwarz	100071			
21	Standard Gain Horn 50 GHz – 75 GHz	25240-20	Flann Microwave	135181	480480	Calibration not necessary	
	Harmonic Mixer 50...75 GHz	FS-Z75	Rohde & Schwarz	100045			
22	Standard Gain Horn 75 GHz – 110 GHz	27240-20	Flann Microwave	132148	480482	Calibration not necessary	
	Harmonic Mixer 75...110 GHz	FS-Z110	Rohde & Schwarz	100049			
23	RF cable	KPS-1533-800-KPS	Insulated Wire		480302	Calibration not necessary	
24	Multimeter	971A	Hewlett Packard	JP39009358	480721	01/31/2018	01/2019

7 Report history

Report Number	Date	Comment
F172289E6	03/13/2018	Initial test report
-	-	-
-	-	-

8 List of Annexes

Annex A Test setup photographs

7 pages

- 172289_201.JPG: BT10 inside FMR50, test setup fully anechoic chamber (pos. 1)
- 172289_202.JPG: BT10 inside FMR50, test setup fully anechoic chamber (pos. 2)
- 172289_203.JPG: BT10 inside FMR50, test setup fully anechoic chamber (1 GHz to 12 GHz)
- 172289_204.JPG: BT10 inside FMR50, test setup fully anechoic chamber (12 GHz to 26.5 GHz)
- 172289_205.JPG: BT10 inside FMR50, test setup fully anechoic chamber (26.5 GHz to 40 GHz)
- 172289_206.JPG: BT10 inside FMR50, test setup fully anechoic chamber (pos. 1, 40 GHz to 100 GHz)
- 172289_207.JPG: BT10 inside FMR50, test setup fully anechoic chamber (pos. 2, 40 GHz to 100 GHz)

Annex B External photographs

3 pages

- 172289_f.JPG: BT10 inside FMR50, external view 1
- 172289_g.JPG: BT10 inside FMR50, external view 2
- 172289_h.JPG: BT10 inside FMR50, type plate view

Annex C Internal photographs

1 page

- 172289_e.JPG: BT10 inside FMR50, internal view to mounted wireless adaptor (display removed)