



Test Report No.:		17091401.fcc01	<i>Page 1 of 23</i>
<i>Client:</i>	Berlinger & Co. AG Mitteldorfstrasse 2, Ganterschwil CH-9608 Switzerland		
<i>Test Item:</i>	Digital Transmission System (DTS), SmartPoint IEEE802.15.4 based wireless sensor		
<i>Identification:</i>	SL-SP-T/ERS	<i>Serial Number:</i>	10:13:00:ee:00:25
<i>Project No.:</i>	17091401	<i>Date of Receipt:</i>	October 06, 2017
<i>Testing Location:</i>	TÜV Rheinland Nederland B.V. Eiberkamp 10 9351VT Leek		
<i>Test Specification:</i>	Based on parts of: FCC 47 CFR Part 15, Subpart C, Section 15.247 (10-1-16 Edition) RSS-Gen (Issue 4, November 2014) RSS-210 (Issue 9, August 2016) ANSI C63.10-2013		
<i>Test Result:</i>	The test item passed the test specification(s).		
<i>Testing Laboratory:</i>	TÜV Rheinland Nederland B.V. Eiberkamp 10 9351 VT Leek		
<i>Tested by:</i>		<i>Reviewed by:</i>	
2017-10-10	R. van der Meer / Inspector	2017-10-10	E. van der Wal / Reviewer
<i>Date</i>	<i>Name/Position</i>	<i>Signature</i>	<i>Date</i>
			<i>Name/Position</i>
			<i>Signature</i>
<i>Other Aspects: testing based on parts of Test Specifications in support of a Permissive Class 2 change.</i>			
<i>Abbreviations:</i> P(ass) = passed F(ail) = failed N/A = not applicable N/T = not tested			
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Test Report No.:

17091401.fcc01

Page 2 of 23

TEST SUMMARY

5.1.1 CONDUCTED MEASUREMENTS AT ANTENNA PORT

RESULT: Not tested

5.1.2 6dB AND 99% BANDWIDTH

RESULT: Not tested

5.1.3 PEAK POWER SPECTRAL DENSITY

RESULT: Not tested

5.1.4 BAND EDGE CONDUCTED EMISSIONS

RESULT: Not tested

5.1.5 RADIATED SPURIOUS EMISSIONS OF TRANSMITTER

RESULT: PASS

5.1.6 RADIATED SPURIOUS EMISSIONS OF TRANSMITTER IN RESTRICTED BANDS

RESULT: PASS

5.2.1 AC POWER LINE CONDUCTED EMISSION OF TRANSMITTER

RESULT: Not tested, Not Applicable

Contents

1.	GENERAL REMARKS	4
1.1	COMPLEMENTARY MATERIALS	4
2.	TEST SITES	4
2.1	TEST FACILITIES	4
2.2	LIST OF TEST AND MEASUREMENT INSTRUMENTS TABLE 1: LIST OF TEST AND MEASUREMENT EQUIPMENT.....	5
2.3	MEASUREMENT UNCERTAINTY	5
3.	GENERAL PRODUCT INFORMATION.....	6
3.1	PRODUCT FUNCTION AND INTENDED USE.....	6
3.2	SYSTEM DETAILS	6
3.3	COUNTERMEASURES TO ACHIEVE EMC COMPLIANCE.....	8
4.	TEST SET-UP AND OPERATION MODES	9
4.1	TEST METHODOLOGY	9
4.2	OPERATION MODES	9
4.3	PHYSICAL CONFIGURATION FOR TESTING	10
4.4	TEST SOFTWARE	11
4.5	SPECIAL ACCESSORIES AND AUXILIARY EQUIPMENT	11
5.	TEST RESULTS	12
5.1	CONDUCTED MEASUREMENTS AT ANTENNA PORT.....	12
5.1.1	<i>Conducted Output Power.....</i>	<i>12</i>
5.1.2	<i>6dB and 99% Bandwidth.....</i>	<i>12</i>
5.1.3	<i>Peak Power Spectral Density</i>	<i>12</i>
5.1.4	<i>Band Edge Conducted Emissions</i>	<i>12</i>
5.1.5	<i>Radiated Spurious Emissions of Transmitter.....</i>	<i>13</i>
5.2	AC POWER LINE CONDUCTED MEASUREMENTS.....	23
5.2.1	<i>AC Power Line Conducted Emission of Transmitter.....</i>	<i>23</i>

Test Report No.:

17091401.fcc01

Page 4 of 23

1. General Remarks

1.1 Complementary Materials

None.

2. Test Sites

2.1 Test Facilities

The Federal Communications Commission and Industry Canada has reviewed the technical characteristics of the test facilities at TÜV Rheinland Nederland B.V. , located in Leek, 9351VT Eiberkamp 10, The Netherlands, and has found these test facilities to be in compliance with the requirements of 47 CFR Part 15, section 2.948.

The description of the test facilities has been filed at the Office of the Federal Communications Commission under registration number 786213. The facility has been added to the list of laboratories performing these test services for the public on a fee basis.

The description of the test facilities has been filed to Industry Canada under registration number 2932G-2. The facility has been added to the list of laboratories performing these test services for the public on a fee basis.

Normal test conditions:

Temperature (*)	: +15°C to +35°C
Relative humidity(*)	: 20 % to 75 %
Supply voltage	: 120VAC/60Hz
Air pressure	: 950 – 1050 hPa

When it was impracticable to carry out the tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests are stated separately.

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Kind of Equipment	Manufacturer	Model Name	Inventory number	Calibration date (mm/yyyy)	Calibration due date (mm/yyyy)
For Radiated Emission					
Measurement Receiver	Rohde & Schwarz	ESR	A01982	07/2017	07/2018
RF Cable S-AR	Gigalink	APG0500	A00447	01/2017	01/2018
Controller	Maturo	SCU/088/ 8090811	A00450	N/A	N/A
Controller	EMCS	DOC202	A00257	N/A	N/A
Test facility	Comtest	FCC listed: 786213 IC: 2932G-2	A00435	07/2014	07/2018
Spectrum Analyzer	Rohde & Schwarz	FSV	A00337	06/2017	06/2018
Antenna mast	EMCS	AP-4702C	A00258	N/A	N/A
Temperature-Humiditymeter	Extech	SD500	A00444	04/2017	04/2018
Guidehorn 1-18 GHz	EMCO	3115	A00008	N/A	N/A
Biconilog Testantenna	Teseq	CBL 6111D	A00466	10-12/2016	10-12/2017
2.4 GHz bandreject filter	BSC	XN-1783	A00065	N/A	N/A
Preamplifier 0.5 - 18 GHz	Miteq	AMF-5D- 005180-28-13p	A00247	N/A	N/A
Filterbox	EMCS	RFS06S	A00255	02/2017	02/2018

Conformance of the used measurement and test equipment with the requirements of ISO/IEC 17025:2005 has been confirmed before testing.

2.3 Measurement Uncertainty

Table 2: Emission Measurement Uncertainty

Measurement Type	Frequency	Uncertainty
Radiated Emission		
	30MHz - 1GHz	±5.22 dB
	> 1GHz	±5.5 dB

3. General Product Information

3.1 Product Function and Intended Use

The brand Berlinger model SL-SP-T/ERS, hereafter referred to as EUT, is a battery powered 2.4GHz IEEE802.15.4 based wireless sensor, measuring temperature and humidity, equipped with reed contact. The EUT supports and utilizes OQPSK modulation techniques.

The product family consist of the following items:

Models:

SL-SP-T ==> internal temperature sensor

SL-SP-T/H ==> internal temperature sensor + internal humidity sensor

SL-SP-T/1W ==> internal temperature sensor + on wire temperature sensor

SL-SP-T/ERS ==> internal temperature sensor + on wire reed contact

The model SL-SP-T/ERS was selected on request by the applicant for testing.
See next page for photographs of the models.

The content of this report and measurement results have not been changed other than the way of presenting the data.

3.2 System Details

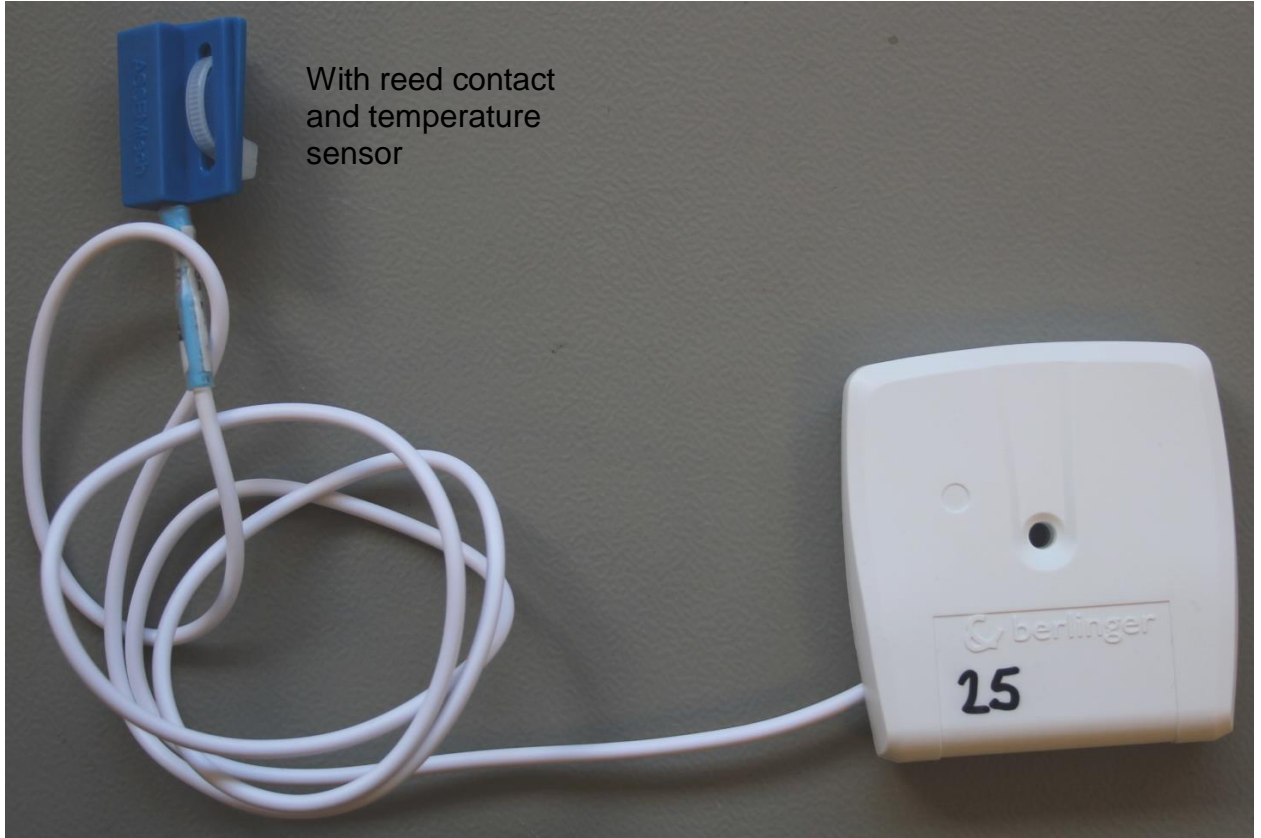
Details and an overview of the system and all of its components, as it has been tested, may be found below.

EUT	:	Digital Transmission System
Manufacturer	:	Berlinger & Co. AG
Brand	:	Berlinger
Model(s)	:	SL-SP-T/ERS (Note: EUT was not labeled)
Serial Number	:	10:13:00:ee:00:25
Voltage input rating	:	3.6 Vdc (battery power)
Voltage output rating	:	--
Current input rating	:	--
Antenna	:	Internal, integrated on the PCB
Antenna Gain	:	3.3 dBi (declared)
Operating frequency	:	2405MHz-2480MHz.
Modulation	:	OQPSK
Remarks	:	n.a.

Test Report No.:

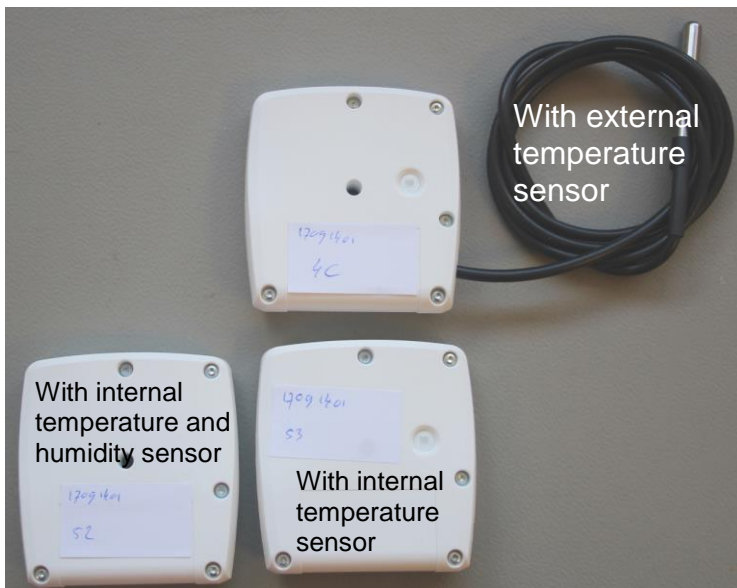
17091401.fcc01

Page 7 of 23



Photograph of the EUT

The following products are part of the system/ product family



Test Report No.:

17091401.fcc01

Page 8 of 23

3.2 .1 Table 3: Interfaces present on the EUT

No interfaces present on the EUT

3.3 Countermeasures to achieve EMC Compliance

No additional measures were employed to achieve compliance.

4. Test Set-up and Operation Modes

4.1 Test Methodology

The test methodology used is based on the requirements of RSS-GEN, RSS-210, 47 CFR Part 15, Sections 15.31, 15.33, 15.35, 15.205, 15.209, 15.247 and ANSI C63.10-2013

The test methods, which have been used, are based on parts of ANSI C63.10-2013.

For details, see under each test item.

The model SL-SP-T/ERS was selected on request by the applicant for testing as regarded the worst case from the original certification test report.

4.2 Operation Modes

Testing was performed at the lowest operating frequency (2405 MHz), at the operating frequency in the middle of the specified frequency band (2440 MHz) and at the highest operating frequency (2480 MHz). These operation modes were selected after review of the capabilities and characteristics of the EUT. The EUT was remotely programmed by the applicant.

The EUT has been tested in the modes as described in table below

Operation Mode	EUT Status	Channel	Frequency (MHz)	TX power
Transmit (Tx)	On	1	2405	-
Transmit (Tx)	On	7	2440	-
Transmit (Tx)	On	15	2480	-

4.3 Physical Configuration for Testing

The EUT was tested stand alone while maintaining a direct RF link with a router. The laptop computer was used to read data from the EUT. The test system was configured in a typical fashion (as a customer would normally use it).

The justification and manipulation of cables and equipment in order to simulate a worst-case behavior of the test setup has been carried out as prescribed in ANSI C63.10-2013.

Figure 1: Test Setup Diagram



Test Report No.:

17091401.fcc01

Page 11 of 23

4.4 Test Software

No test software was used. The EUT was programmed remotely by the applicant to enable the test operation modes listed in section 4.2 as appropriate.

4.5 Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

1. AUX1

Product: Notebook PC
Brand: HP
Model: Compaq 610
Inventory Number: A01877
Remark: property test lab, host for berlinger smartview

2. AUX2

Product: Router, including antennas and power supply
Brand: Not labeled
Model: Not labeled
Serial Number: 00.01.00.00.01.b4
FCC ID: Not labeled
IC: Not labeled
Remark: property applicant, communicates with EUT

Test Report No.:

17091401.fcc01

Page 12 of 23

5. Test Results

5.1 Conducted Measurements at Antenna Port

5.1.1 Conducted Output Power

RESULT: NOT APPLICABLE, NOT TESTED.

5.1.2 6dB and 99% Bandwidth

RESULT: NOT APPLICABLE, NOT TESTED

5.1.3 Peak Power Spectral Density

RESULT: NOT APPLICABLE, NOT TESTED

5.1.4 Band Edge Conducted Emissions

RESULT: NOT APPLICABLE, NOT TESTED

Test Report No.:

17091401.fcc01

Page 13 of 23

5.1.5 Radiated Spurious Emissions of Transmitter

RESULT: Pass

Date of testing: 2017-10-09

Frequency range: 30MHz - 18GHz

Requirements:

FCC 15.209 and FCC 15.247(d) and RSS-Gen

Radiated emissions which fall outside the operation frequency band and outside restricted bands shall either meet the limit specified in FCC 15.209(a) or be attenuated at least 20dB below the power level in the 100kHz bandwidth within the band that contains the highest level of the desired power (the less severe limit applies).

Radiated emissions which fall in the restricted bands, as defined in FCC 15.205(a), must comply with the radiated emission limits specified in FCC 15.209(a).

Test procedure:

ANSI C63.10-2013

The EUT was placed on a nonconductive turntable 0.8m above the ground plane. Before final measurements of radiated emissions were performed, the EUT was scanned to determine its emission spectrum profile. The physical arrangement of the test system, the associated cabling and the EUT orientation (X, Y, Z) were varied in order to ensure that maximum emission amplitudes were attained.

The spectrum was examined from 30MHz to 18 GHz since the original testing did not show significant unwanted emissions in the range 18-25 GHz. Final radiated emission measurements were made at 3m distance.

At each frequency where a spurious emission was found, the EUT was rotated 360° and the antenna was raised and lowered from 1 to 4m in order to determine the emission's maximum level. Measurements were taken using both horizontal and vertical antenna polarizations.

The highest emission amplitudes relative to the appropriate limit were recorded in this report. Field strength values of radiated emissions at frequencies not listed in the tables are more than 20 dB below the applicable limit.

Correction factors are incorporated in the spectrum analyzers as an automated function.

Refer to section 4.2 for the power settings and modes.

Correction factors includes: antenna factor, cable loss and pre-amplifier gain.

Test Report No.:

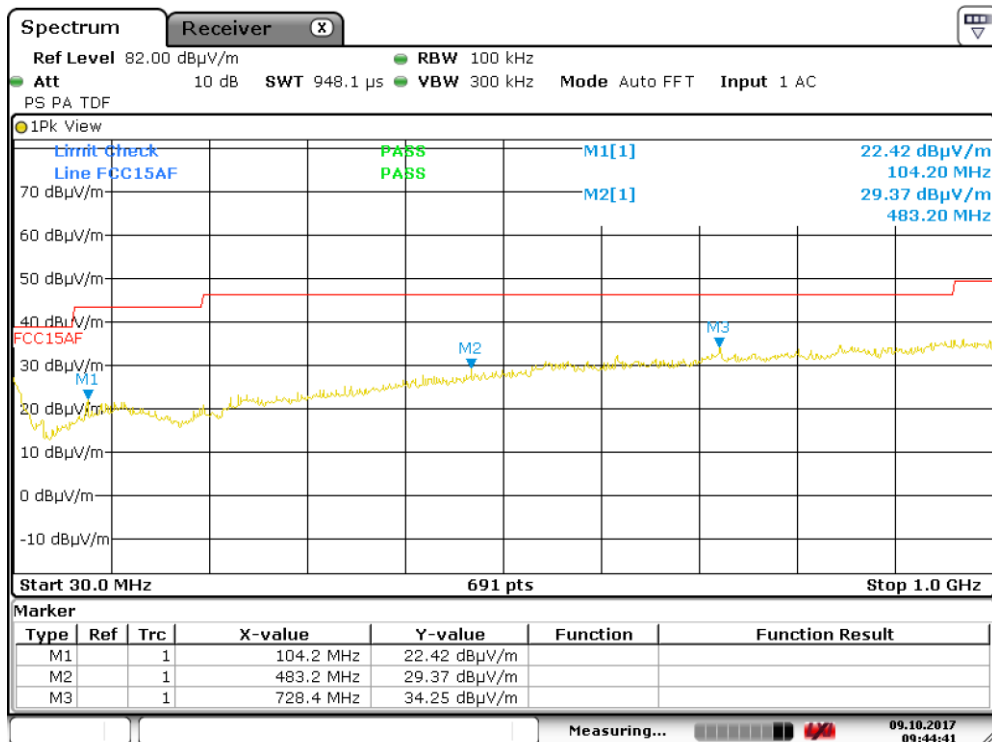
17091401.fcc01

Page 14 of 23

Radiated Emission, Quasi Peak Data, 30MHz - 1GHz

Frequency [MHz]	EUT Orientation	Antenna Orientation	Level QP [dBµV/m]	Limit [dBµV/m]	Margin [dB]
103.2	Vertical	Vertical	16.7	43.5	-26.8
252.5	Horizontal	Vertical	11.2	46.0	-34.8
483.2	Vertical	Vertical	17.0	46.0	-29.0
728.4	Vertical	Vertical	22.0	46.0	-24.0
770.5	Horizontal	Vertical	20.8	46.0	-25.2
971.2 noise	Horizontal	Vertical	24.8 *Pk	54.0 Av	-29.2

- Note:
- Quasi Peak detector used, (except *) with a bandwidth of 120 kHz
 - Peak detector used with a bandwidth of 120 kHz, Peak detector value already within Av limit, therefor not tested with Av detector.
 - Tested in modes as described in section 4.2, the 6 highest values noted.
 - Preliminary measurements indicated that the radiated emissions from EUT were not affected by the EUT's operating frequency.



Date: 9.OCT.2017 09:44:41

Plot of the emissions in the frequency range 30 – 1000 MHz
 (example shown: EUT Horizontal, Antenna Vertical, EUT set at 2440MHz, Peak detector values)

Test Report No.:

17091401.fcc01

Page 15 of 23

Radiated Emission, 1 – 18 GHz, 2405 MHz.

Frequency [MHz]	Antenna Orientation	Detector	Resolution Bandwidth (kHz)	Level Pk [dBµV/m]	Limit Pk / Av [dBµV/m]	Result
1020.46 ^{*R}	Horizontal	Peak (Pk)	1000	37.7	74.0 / 54.0	Pass
1195.88 ^{*R}	Horizontal	Peak (Pk)	1000	43.6	74.0 / 54.0	Pass
1598.68 ^{*R}	Horizontal	Peak (Pk)	1000	38.6	74.0 / 54.0	Pass
4849.65 ^{*R}	Horizontal	Peak (Pk)	1000	47.1	74.0 / 54.0	Pass
11500 ^{*R}	Horizontal	Peak (Pk)	1000	56.6 Pk / 45.4 Av	74.0 / 54.0	Pass
14170	Horizontal	Peak (Pk)	1000	57.6 Pk / 45.0 Av	74.0 / 54.0	Pass
17871 ^{*R} noise	Vertical	Peak (Pk)	1000	63.0 Pk / 51.0 Av	74.0 / 54.0	Pass

See notes on page 17

Radiated Emission, 1 – 18 GHz, 2440 MHz.

Frequency [MHz]	Antenna Orientation	Detector	Resolution Bandwidth (kHz)	Level Pk [dBµV/m]	Limit Pk / Av [dBµV/m]	Result
1798.78	Vertical	Peak (Pk)	1000	42.5	74.0 / 54.0	Pass
1926.11	Vertical	Peak (Pk)	1000	46.7	74.0 / 54.0	Pass
4880 ^{THR}	Horizontal	Peak (Pk)	1000	48.3	74.0 / 54.0	Pass
6540.5	Vertical	Peak (Pk)	1000	53.0 Pk / 45.7 Av	74.0 / 54.0	Pass
7288.5 ^{*R}	Horizontal	Peak (Pk)	1000	56.0 Pk / 48.3 Av	74.0 / 54.0	Pass
11500 ^{*R} noise	Vertical	Peak (Pk)	1000	58.4 Pk / 45.5 Av	74.0 / 54.0	Pass
17810 ^{*R} noise	Vertical	Peak (Pk)	1000	64.5 Pk / 50.0 Av	74.0 / 54.0	Pass

See notes on page 17

Test Report No.:

17091401.fcc01

Page 16 of 23

Radiated Emission, 1 – 18 GHz, 2480 MHz.

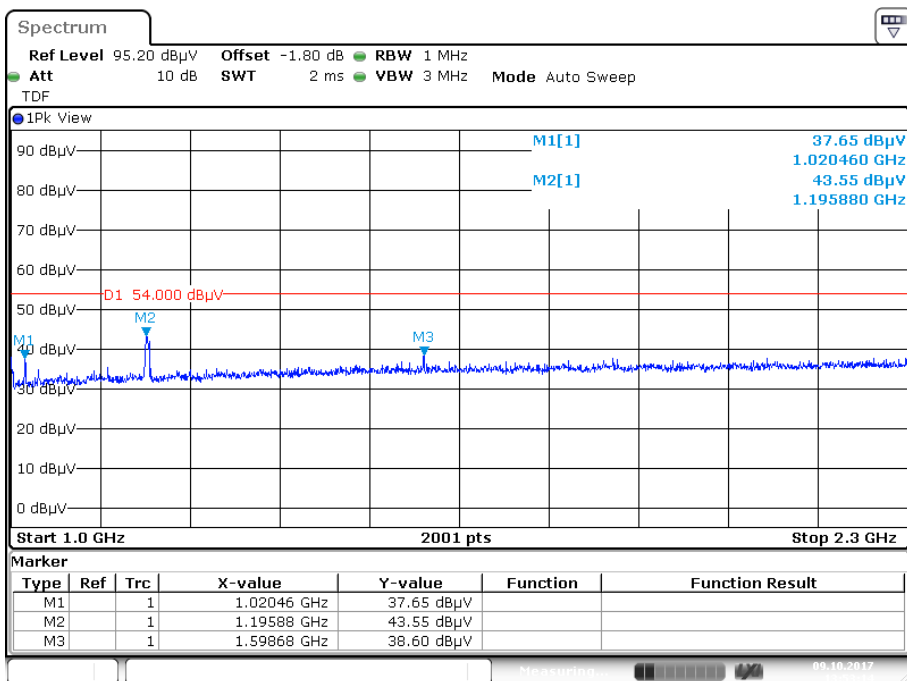
Frequency [MHz]	Antenna Orientation	Detector	Resolution Bandwidth (kHz)	Level Pk [dBµV/m]	Limit Pk / Av [dBµV/m]	Result
1199.78 ^{*R}	Horizontal	Peak (Pk)	1000	41.9	74.0 / 54.0	Pass
1845.55	Vertical	Peak (Pk)	1000	42.7	74.0 / 54.0	Pass
1929.36	Horizontal	Peak (Pk)	1000	47.9	74.0 / 54.0	Pass
2147.0	Vertical	Peak (Pk)	1000	49.2	74.0 / 54.0	Pass
11489 ^{*R}	Horizontal	Peak (Pk)	1000	58.4 Pk / 44.0 Av	74.0 / 54.0	Pass
13127	Vertical	Peak (Pk)	1000	54.9 Pk / 47.7 Av	74.0 / 54.0	Pass
17698 ^{*R} noise	Vertical	Peak (Pk)	1000	62.8 Pk / 50.5 Av	74.0 / 54.0	Pass

- Note:
- Peak detector used with a bandwidth of 1 MHz
 - Tested in modes as described in section 4.2, highest values noted.
 - From pre-tests the worst case orientation for the EUT proved to be the EUT in vertical orientation
 - Where Peak value was already within Average limits, Average not tested.
 - ^{*H} denotes a harmonic of the fundamental frequency, ^{*R} denotes emission in restricted band.
 - a selection of plots are provided on the next pages.

Test Report No.:

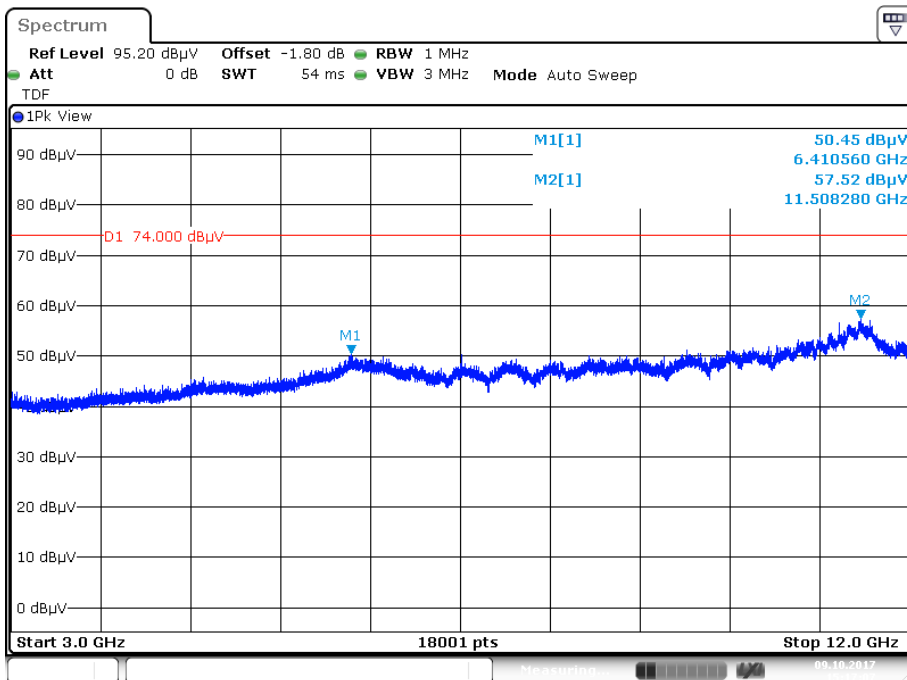
17091401.fcc01

Page 17 of 23



Date: 9.OCT.2017 13:53:14

Plot of the emissions at 2405 MHz, in the range 1- 2.3 GHz, Vertical polarization, Peak values shown



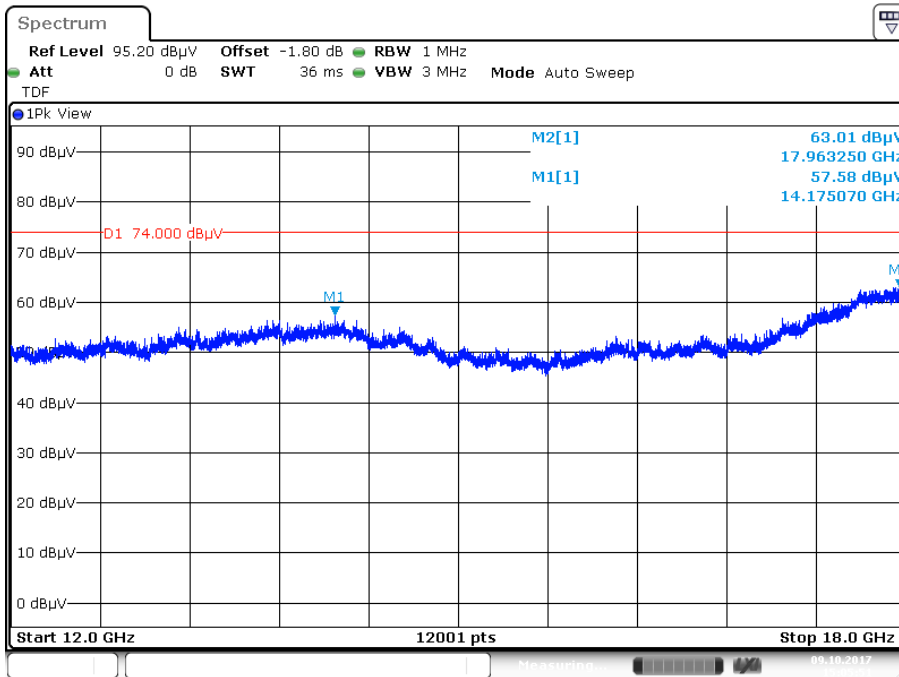
Date: 9.OCT.2017 15:17:07

Plot of the emissions at 2405 MHz, in the range 3-12 GHz, Vertical polarization, Peak values shown

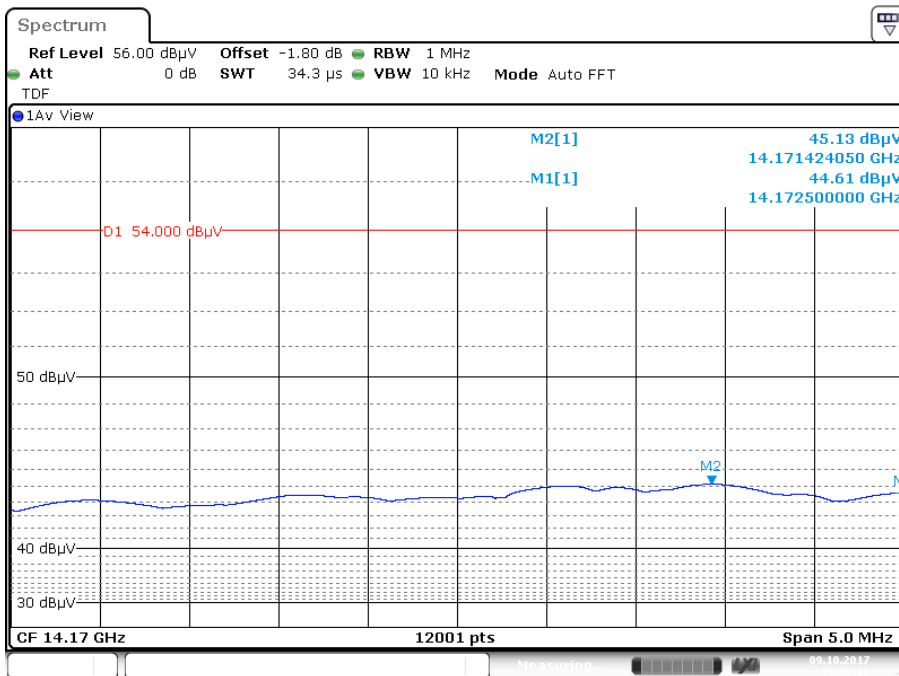
Test Report No.:

17091401.fcc01

Page 18 of 23



Plot of the emissions at 2405 MHz, in the range 12-18 GHz Horizontal polarization, Peak values shown

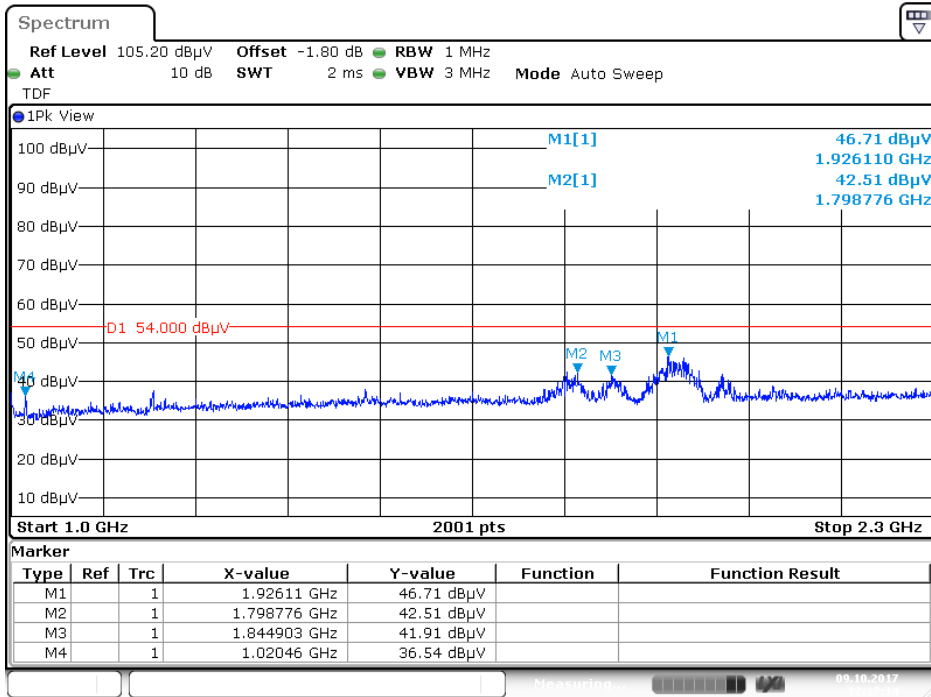


Plot of the emissions, Average value of the emission at 14.17 GHz

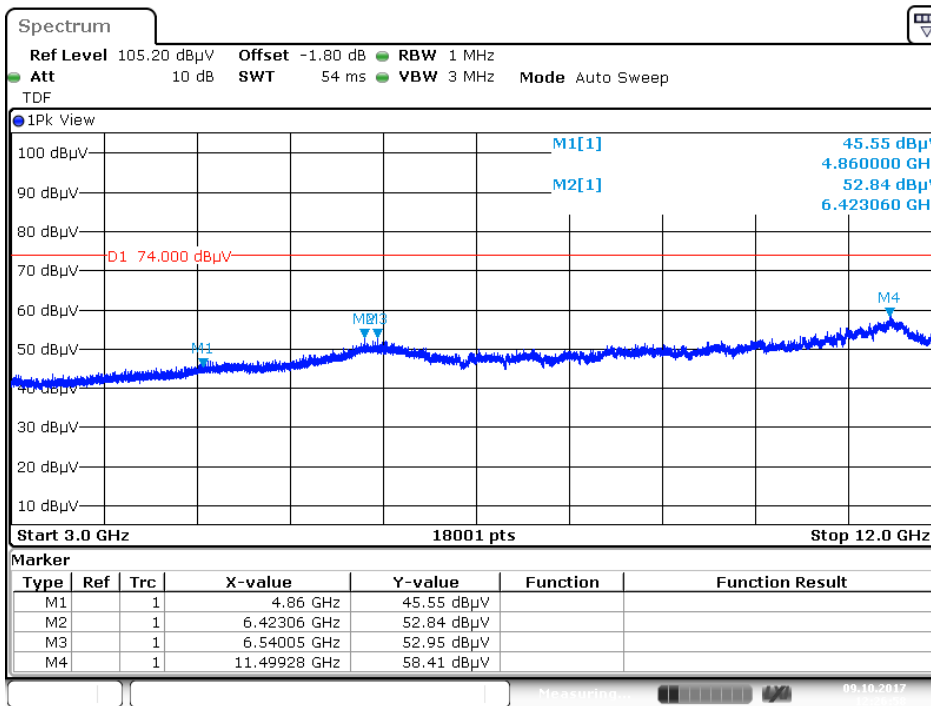
Test Report No.:

17091401.fcc01

Page 19 of 23



Plot of the emissions at 2440 MHz, in the range 1- 2.3 GHz, Vertical polarization, Peak values shown

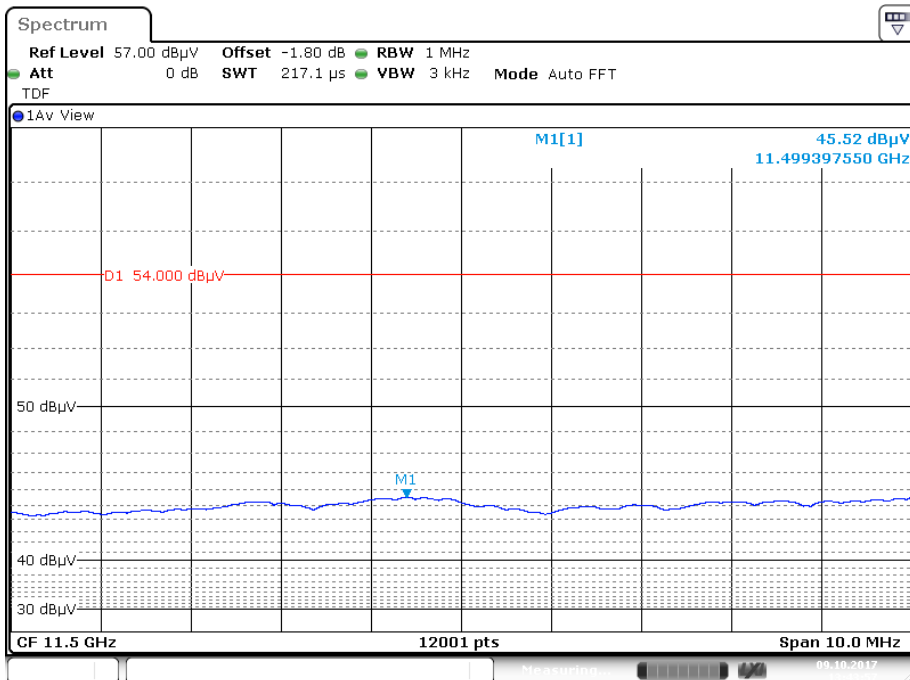


Plot of the emissions at 2440 MHz, in the range 3-12 GHz, Vertical polarization, Peak values shown

Test Report No.:

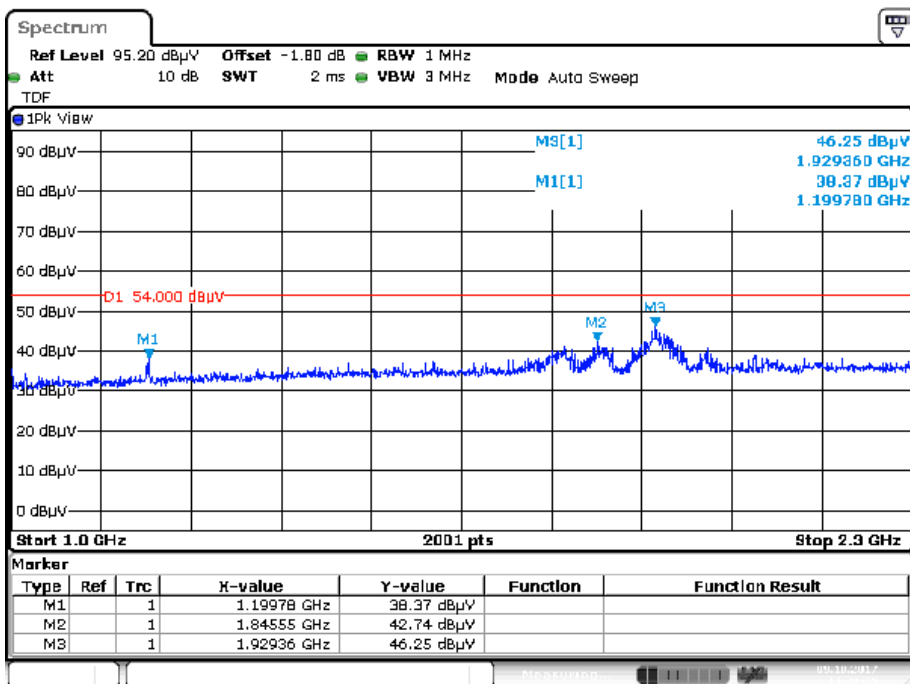
17091401.fcc01

Page 20 of 23



Date: 9.OCT.2017 13:43:57

Plot of the emissions at 2440 MHz, 11.5 GHz Vertical polarization, Average value shown



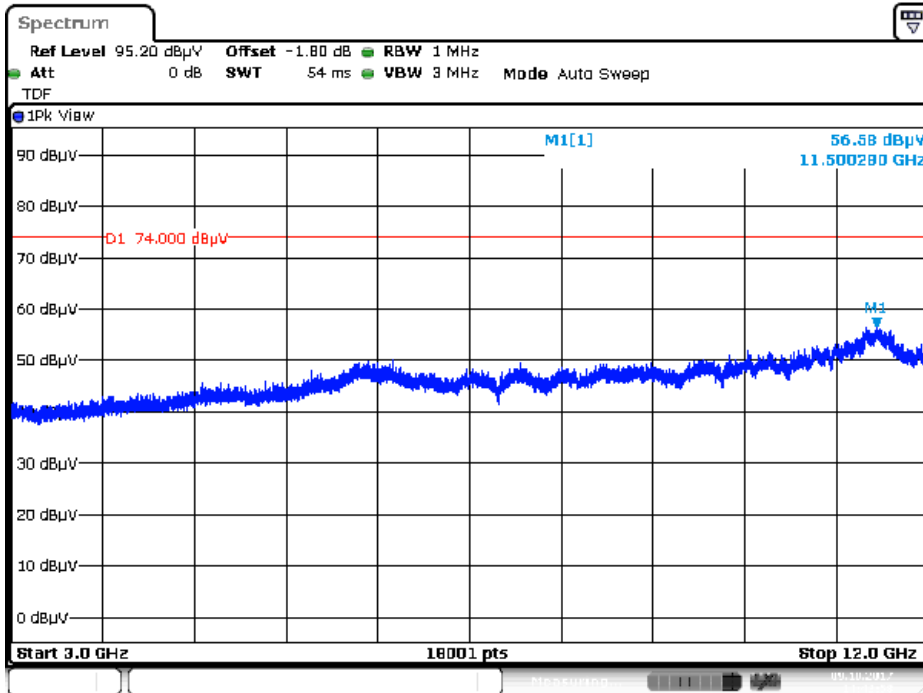
Date: 9.OCT.2017 13:47:25

Plot of the emissions at 2480 MHz, in the range 1- 2.3 GHz, Horizontal polarization, Peak values shown

Test Report No.:

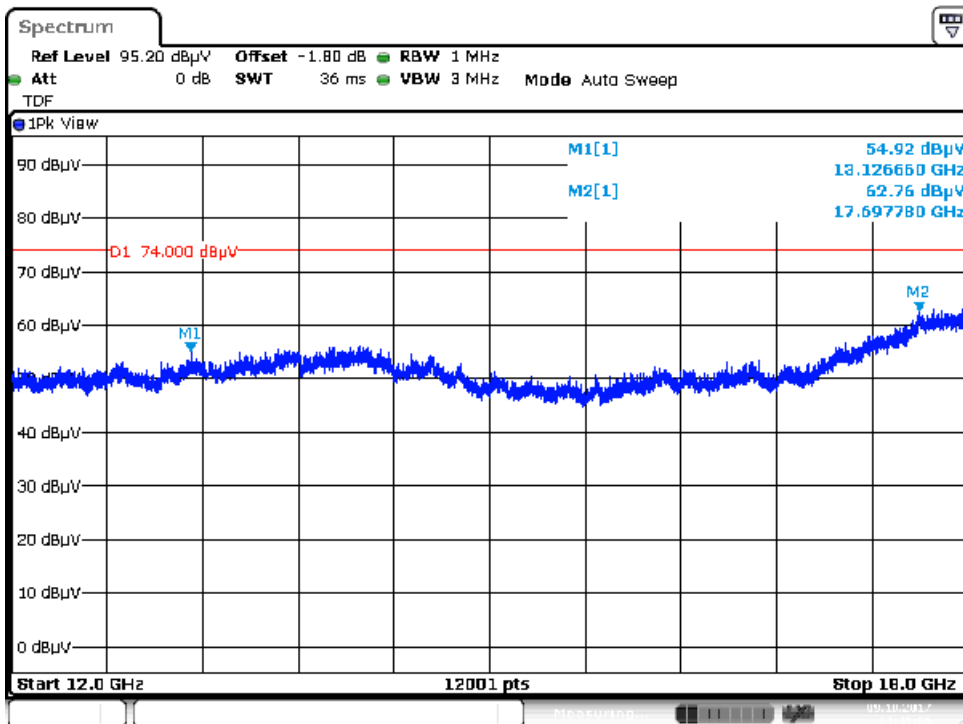
17091401.fcc01

Page 21 of 23



Date: 9.OCT.2017 14:42:58

Plot of the emissions at 2480 MHz, in the range 3-12 GHz, Vertical polarization, Peak values shown



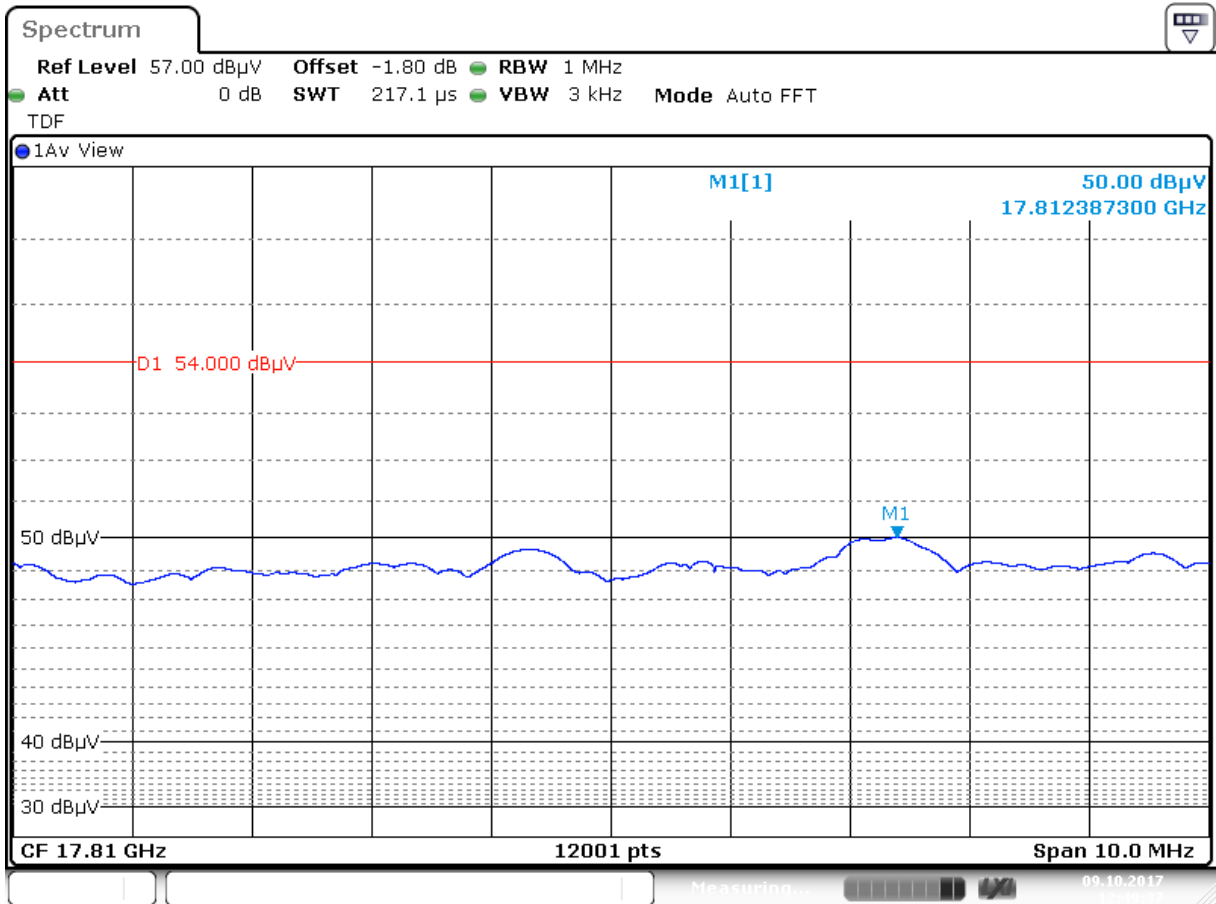
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Plot of the emissions at 2480 MHz, in the range 12-18 GHz Vertical polarization, Peak values shown

Test Report No.:

17091401.fcc01

Page 22 of 23



Date: 9.OCT.2017 12:49:37

Plot of the emissions at 17.8 GHz, Average value of the emission noise emission shown

Test Report No.:

17091401.fcc01

Page 23 of 23

5.2 AC Power Line Conducted Measurements

5.2.1 AC Power Line Conducted Emission of Transmitter

AC power line conducted emissions is not applicable, EUT is battery operated only.

End of report