

FCC Test Report

Product Name	Tyre Pressure Monitoring Sensor
Model No.	AG2SM4
FCC ID.	MRXAG2SM4

Applicant	Schrader Electronics Ltd.
Address	11 Technology Park, Belfast Road, Antrim, BT41 1QS, United Kingdom

Date of Receipt	Nov. 30, 2017
Issued Date	Mar. 26, 2018
Report No.	17B0531R-RFUSP14V00
Report Version	V1.0



The test results relate only to the samples tested.

The test results shown in the test report are traceable to the national/international standard through the calibration of the equipment and evaluated measurement uncertainty herein.

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Test Report

Issued Date : Mar. 26, 2018

Report No. : 17B0531R-RFUSP14V00



Product Name	Tyre Pressure Monitoring Sensor
Applicant	Schrader Electronics Ltd.
Address	11 Technology Park, Belfast Road, Antrim, BT41 1QS, United Kingdom
Manufacturer	Schrader Electronics Ltd.
Model No.	AG2SM4
FCC ID.	MRXAG2SM4
EUT Rated Voltage	DC 3V(Power by Battery)
EUT Test Voltage	DC 3V(Power by Battery)
Trade Name	SCHRADER ELECTRONICS
Applicable Standard	FCC CFR Title 47 Part 15 Subpart C: 2016 ANSI C63.4: 2014, ANSI C63.10: 2013
Test Result	Complied

Documented By : Jinn Chen
(Senior Adm. Specialist / Jinn Chen)

Tested By : Nova chu
(Engineer / Nova Chu)

Approved By : 
(Director / Vincent Lin)

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Attachment 1: EUT Test Photographs

Attachment 2: EUT Detailed Photographs

1. General Information

1.1. EUT Description

Product Name	Tyre Pressure Monitoring Sensor
Trade Name	SCHRADER ELECTRONICS
Model No.	AG2SM4
FCC ID	MRXAG2SM4
Frequency Range	433.92 MHz
Number of Channels	1
Type of Modulation	ASK+FSK

Frequency of Each Channel:

Channel	Frequency
Channel 1:	433.92 MHz

Note:

1. The EUT is a Tyre Pressure Monitoring Sensor with a built-in 433.92 MHz transmitter.
2. The antenna of EUT is conform to FCC 15.203
3. During the test, modulation FSK and ASK transmit the signal successively.
4. These tests are conducted on a sample for the purpose of demonstrating compliance with Part 15 Subpart C Paragraph 15.231(e).
5. The radiation measurements are performed in X, Y, Z axis positioning. Only the worst case is shown in the report.

Test Mode	Mode 1: Transmit (FSK+ASK)
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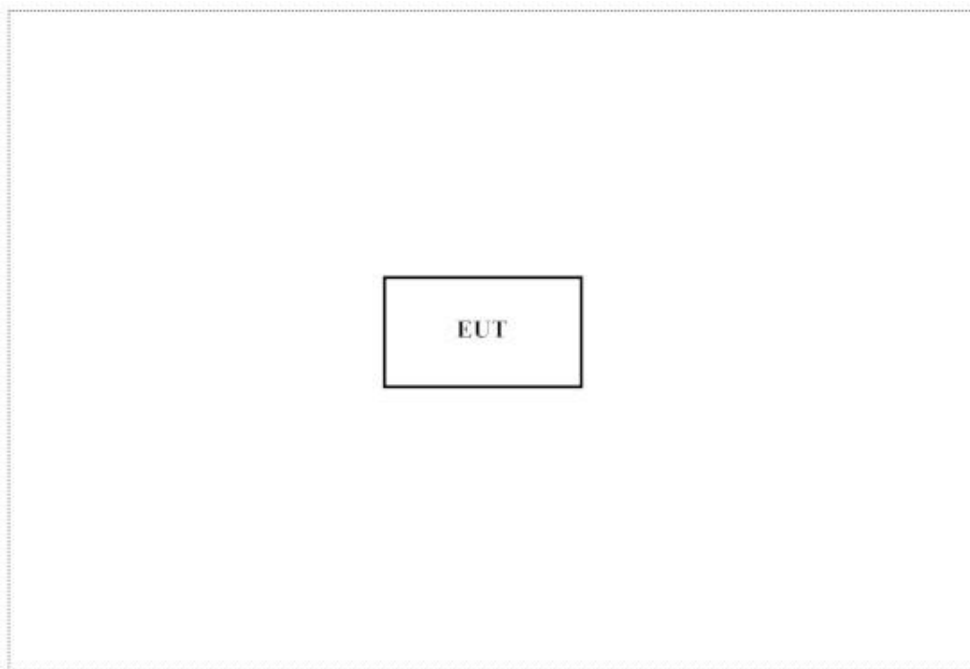
1.3. Tested System Details

The types for all equipments, plus descriptions of all cables used in the tested system (including inserted cards) are:

Product	Manufacturer	Model No.	Serial No.	FCC ID	Power Cord
N/A					

Signal Cable Type	Signal cable Description
N/A	

1.4. Configuration of tested System



1.5. EUT Exercise Software

1	Setup the EUT as shown in section 1.4.
2	Press the test button of the EUT.
3	Verify that the EUT works properly.

1.6. Test Facility

Ambient conditions in the laboratory:

Items	Required (IEC 68-1)	Actual
Temperature (°C)	15-35	20-35
Humidity (%RH)	25-75	30-65
Barometric pressure (mbar)	860-1060	950-1000

The related certificate for our laboratories about the test site and management system can be downloaded from DEKRA Testing and Certification Co., Ltd. Web Site:

<http://www.dekra.com.tw/english/about/certificates.aspx?bval=5>

The address and introduction of DEKRA Testing and Certification Co., Ltd. laboratories can be founded in our Web site: http://www.dekra.com.tw/index_en.aspx

Site Description: Accredited by TAF
Accredited Number: 3023

Site Name: DEKRA Testing and Certification Co., Ltd.
Site Address: No.159, Sec. 2, Wenhua 1st Rd., Linkou Dist.,
New Taipei City 24457, Taiwan.
TEL: 886-2-2602-7968 / FAX : 866-2-2602-3286
E-Mail : info.tw@dekra.com

FCC Accreditation Number: TW3023

1.7. List of Test Equipment

For Conducted measurements /ASR4

	Equipment	Manufacturer	Model No.	Serial No.	Cali. Data	Due. Data
X	Spectrum Analyzer	R&S	FSV30	103464	2018.01.23	2019.01.22
	Power Meter	Anritsu	ML2496A	1548003	2017.12.11	2018.12.10
	Power Sensor	Anritsu	MA2411B	1531024	2017.12.11	2018.12.10
	Power Sensor	Anritsu	MA2411B	1531025	2017.12.11	2018.12.10
	Bluetooth Tester	R&S	CBT	101238	2018.01.18	2019.01.17

Note:

1. All equipments are calibrated every one year.
2. The test instruments marked with "X" are used to measure the final test results.
3. Test Software version : QuieTek Conduction Test System V8.0.110

For Radiated measurements /ACB1

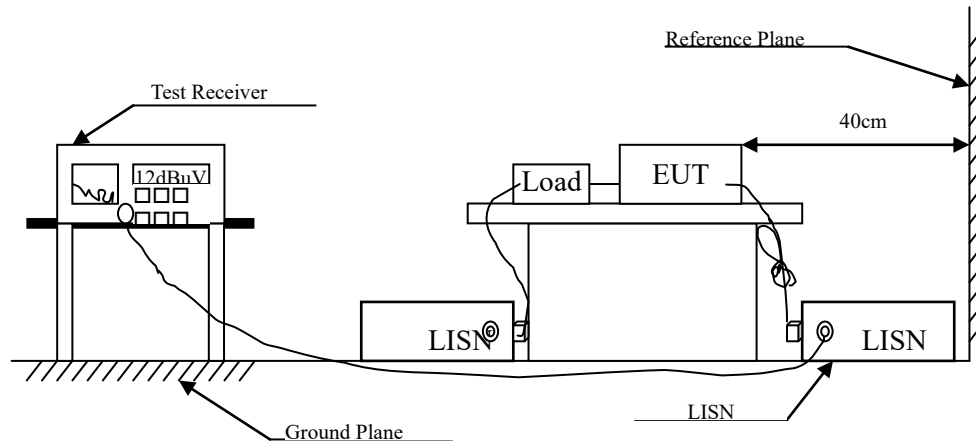
	Equipment	Manufacturer	Model No.	Serial No.	Cali. Data	Due. Data
X	Loop Antenna	AMETEK	HLA6121	49611	2018.01.26	2019.01.25
X	Bi-Log Antenna	SCHWARZBECK	VULB9168	9168-675	2017.06.01	2018.05.31
X	Horn Antenna	ETS-Lindgren	3117	00203800	2017.11.10	2018.11.09
	Horn Antenna	Com-Power	AH-840	101087	2017.05.24	2018.05.23
X	Pre-Amplifier	EMCI	EMC001330	980316	2017.05.16	2018.05.15
X	Pre-Amplifier	EMCI	EMC051835SE	980311	2017.05.17	2018.05.16
	Pre-Amplifier	EMCI	EMC05820SE	980310	2017.05.17	2018.05.16
	Pre-Amplifier	EMCI	EMC184045SE	980314	2017.05.17	2018.05.16
	Filter	MICRO TRONICS	BRM50702	G251	2017.08.30	2018.08.29
	Filter	MICRO TRONICS	BRM50716	G188	2017.08.30	2018.08.29
X	EMI Test Receiver	R&S	ESR7	101602	2017.12.11	2018.12.10
X	Spectrum Analyzer	R&S	FSV40	101148	2018.02.08	2019.02.07
X	Coaxial Cable	SUHNER	SUCOFLEX 106	RF002	2017.05.25	2018.05.24
	Mircoflex Cable	HUBER SUHNER	SUCOFLEX 102	MY3383/2	2017.08.11	2018.08.10

Note:

1. All equipments are calibrated every one year.
2. The test instruments marked with "X" are used to measure the final test results.
3. Test Software version : QuieTek EMI 2.0 V2.1.113

2. Conducted Emission

2.1. Test Setup



2.2. Limits

FCC Part 15 Subpart C Paragraph 15.207 Limits (dBuV)		
Frequency MHz	QP	AV
0.15 - 0.50	66-56	56-46
0.50-5.0	56	46
5.0 - 30	60	50

Remarks : In the above table, the tighter limit applies at the band edges.

2.3. Test Procedure

The EUT and simulators are connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50 ohm /50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uH coupling impedance with 50ohm termination. (Please refers to the block diagram of the test setup and photographs.)

Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4: 2014 on conducted measurement.

Conducted emissions were investigated over the frequency range from 0.15MHz to 30MHz using a receiver bandwidth of 9kHz.

2.4. Test Specification

According to FCC Part 15 Subpart C Paragraph 15.207(a)

2.5. Uncertainty

± 2.35 dB

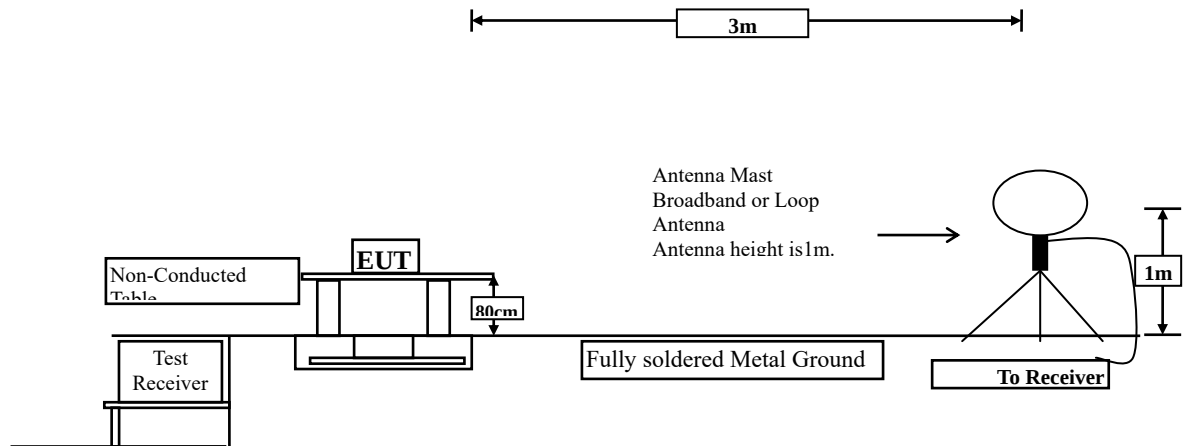
2.6. Test Result

Owing to the DC operation of EUT, this test item is not performed.

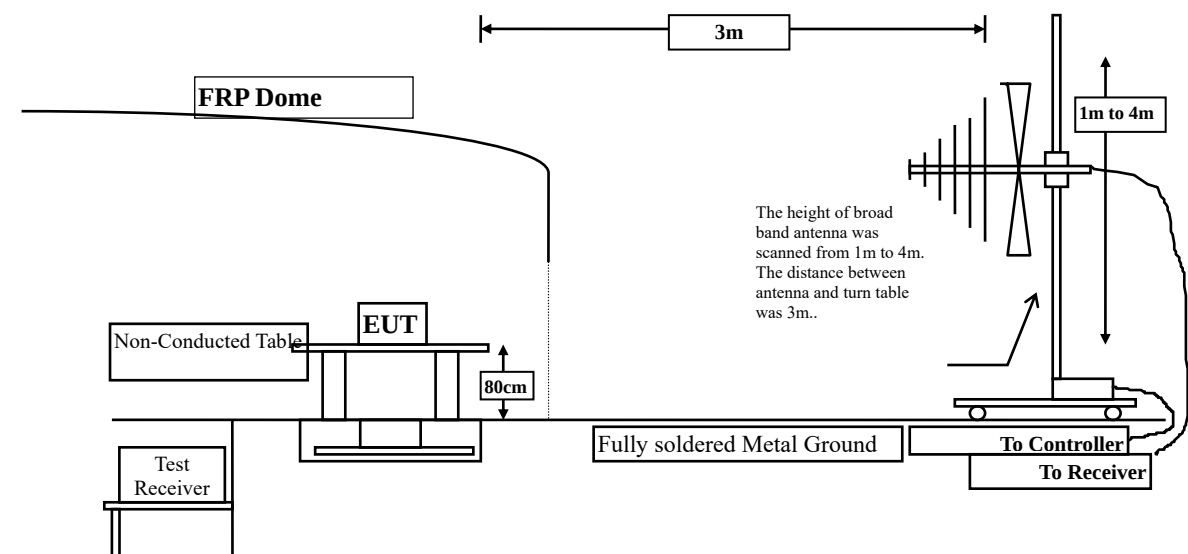
3. Radiated Emission

3.1. Test Setup

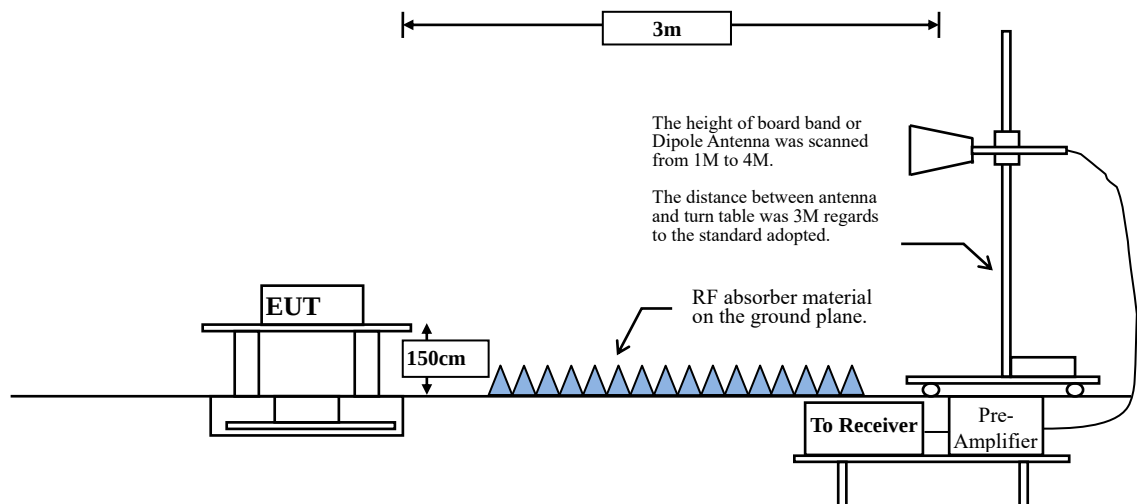
Radiated Emission Under 30MHz



Radiated Emission Below 1GHz



Radiated Emission Above 1GHz



3.2. Limits

➤ Fundamental and Harmonics Emission Limits

FCC Part 15 Subpart C Paragraph 15.231(e) Limits		
Fundamental Frequency MHz	Field Strength of Fundamental	Field Strength of Spurious Emission
40.66-40.70	1000	100
70-130	500	50
130-174	500 to 1500	50 to 150
174-260	1500	150
260-470	1500 to 5000	150 to 500
above 470	5000	500

- Remarks :
1. RF Voltage (dBuV) = 20 log RF Voltage (uV)
 2. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.
 3. The emission limit in this paragraph is based on measurement instrumentation employing an average detector.

➤ Spurious electric field strength limits

FCC Part 15 Subpart C Paragraph 15.209 Limits			
Frequency MHz	uV/m	dBuV/m	Measurement distance (meter)
0.009-0.490	2400/F(kHz)	See Remark ¹	300
0.490-1.705	24000/F(kHz)	See Remark ¹	30
1.705-30	30	29.5	30
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

- Remarks :
1. RF Voltage (dBuV) = 20 log RF Voltage (uV)
 2. In the Above Table, the tighter limit applies at the band edges.
 3. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.

3.3. Test Procedure

Measuring the frequency range below 1GHz, the EUT is placed on a turn table which is 0.8 meter above ground, when measuring the frequency range above 1GHz, the EUT is placed on a turn table which is 1.5 meter above ground.

Both horizontal and vertical polarization of the antenna are set on measurement. In order to find the maximum emission, all of the interface cables must be manipulated according to ANSI C63.10, 2013 on radiated measurement.

On the field strength of fundamental and harmonics, the limits shown are based on measuring equipment employing a average detector function. As an alternative, compliance with the limits may be based on the use of measurement instrumentation with a CISPR quasi-peak detector.

On the field strength of spurious electric, on any frequency or frequencies below or equal to 1000 MHz, the limits shown are based on measuring equipment employing a quasi-peak detector function and on any frequency or frequencies above 1000 MHz the radiated limits shown are based upon the use of measurement instrumentation employing an average detector function.

When average radiated emission measurement are included emission measurement below 1000 MHz, there also is a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.

The bandwidth The resolution bandwidth below 30MHz setting on the field strength meter is 9kHz and below 1GHz setting on the field strength meter is 120 kHz and above 1GHz is 1MHz.

3.4. Test Specification

According to FCC Part 15 Subpart C Paragraph 15.231(e).

3.5. Uncertainty

Horizontal polarization :

30-300MHz: $\pm 4.08\text{dB}$; 300M-1GHz: $\pm 3.86\text{dB}$; 1-18GHz: $\pm 3.77\text{dB}$; 18-40GHz: $\pm 3.98\text{dB}$

Vertical polarization :

30-300MHz: $\pm 4.81\text{dB}$; 300M-1GHz: $\pm 3.87\text{dB}$; 1-18GHz : $\pm 3.83\text{dB}$; 18-40GHz: $\pm 3.98\text{dB}$

3.6. Test Result

Product	Tyre Pressure Monitoring Sensor
Test Item	Fundamental Radiated Emission
Test Mode	Mode 1: Transmit
Date of Test	2018/03/22

Fundamental Power (X-Line)

Peak Detector:

Frequency MHz	Correct Factor dB	Reading Level dBuV	Measurement Level dBuV/m	Margin dB	Limit dBuV/m
------------------	-------------------------	--------------------------	--------------------------------	--------------	-----------------

Horizontal

433.920	-6.553	79.400	72.847	-20.019	92.866
---------	--------	--------	--------	---------	--------

Vertical

433.920	-6.553	85.400	78.847	-14.019	92.866
---------	--------	--------	--------	---------	--------

Average Detector:

Frequency MHz	Correct Factor dB	Reading Level dBuV	Measurement Level dBuV/m	Margin dB	Limit dBuV/m
------------------	-------------------------	--------------------------	--------------------------------	--------------	-----------------

Horizontal

433.920	-6.553	54.900	48.347	-24.519	72.866
---------	--------	--------	--------	---------	--------

Vertical

433.920	-6.553	60.000	53.447	-19.419	72.866
---------	--------	--------	--------	---------	--------

Note:

1. Correct factor = Antenna Factor + Cable Loss – Pre-amplifier Gain
2. The average measurement was not performed when the peak measured data under the limit of average detection. If the readings given are average, peak measurement should also be supplied.
3. Limit = $20\log(7232.0144\mu\text{V}) = 92.866\text{dBuV}$.

Product	Tyre Pressure Monitoring Sensor
Test Item	Fundamental Radiated Emission
Test Mode	Mode 1: Transmit
Date of Test	2018/03/22

Fundamental Power (Y-Line)

Peak Detector:

Frequency MHz	Correct Factor dB	Reading Level dBuV	Measurement Level dBuV/m	Margin dB	Limit dBuV/m
------------------	-------------------------	--------------------------	--------------------------------	--------------	-----------------

Horizontal

433.920	-6.553	83.700	77.147	-15.719	92.866
---------	--------	--------	--------	---------	--------

Vertical

433.920	-6.553	79.200	72.647	-20.219	92.866
---------	--------	--------	--------	---------	--------

Average Detector:

Frequency MHz	Correct Factor dB	Reading Level dBuV	Measurement Level dBuV/m	Margin dB	Limit dBuV/m
------------------	-------------------------	--------------------------	--------------------------------	--------------	-----------------

Horizontal

433.920	-6.553	59.300	52.747	-20.119	72.866
---------	--------	--------	--------	---------	--------

Vertical

433.920	-6.553	53.000	46.447	-26.419	72.866
---------	--------	--------	--------	---------	--------

Note:

1. Correct factor = Antenna Factor + Cable Loss – Pre-amplifier Gain
2. The average measurement was not performed when the peak measured data under the limit of average detection. If the readings given are average, peak measurement should also be supplied.
3. Limit = $20\log(7232.0144\mu\text{V}) = 92.866\text{dBuV}$.

Product	Tyre Pressure Monitoring Sensor
Test Item	Fundamental Radiated Emission
Test Mode	Mode 1: Transmit
Date of Test	2018/03/22

Fundamental Power (Z-Line)

Peak Detector:

Frequency	Correct Factor	Reading Level	Measurement Level	Margin	Limit
MHz	dB	dBuV	dBuV/m	dB	dBuV/m

Horizontal

433.920	-6.553	78.900	72.347	-20.519	92.866
---------	--------	--------	--------	---------	--------

Vertical

433.920	-6.553	84.800	78.247	-14.619	92.866
---------	--------	--------	--------	---------	--------

Average Detector:

Frequency	Correct Factor	Reading Level	Measurement Level	Margin	Limit
MHz	dB	dBuV	dBuV/m	dB	dBuV/m

Horizontal

433.920	-6.553	51.800	45.247	-27.619	72.866
---------	--------	--------	--------	---------	--------

Vertical

433.920	-6.553	59.700	53.147	-19.719	72.866
---------	--------	--------	--------	---------	--------

Note:

1. Correct factor = Antenna Factor + Cable Loss – Pre-amplifier Gain
2. The average measurement was not performed when the peak measured data under the limit of average detection. If the readings given are average, peak measurement should also be supplied.
3. Limit = $20\log(7232.0144\mu\text{V}) = 92.866\text{dBuV}$.

Product	Tyre Pressure Monitoring Sensor
Test Item	Harmonic Radiated Emission
Test Mode	Mode 1: Transmit
Date of Test	2017/12/05

Frequency	Correct	Reading	Measurement	Margin	Peak	Average
MHz	Factor	Level	Level		Limit	Limit
	dB	dBuV	dBuV/m	dB	dBuV/m	dBuV/m

Harmonic Radiated Emission

Horizontal

Peak

1301.760	-11.056	46.110	35.054	-38.946	74.000	54.000
1735.680	-8.925	46.130	37.205	-36.795	74.000	54.000
2169.600	-6.503	46.350	39.848	-34.152	74.000	54.000
2603.520	-5.616	46.010	40.395	-33.605	74.000	54.000
3037.440	-4.984	46.460	41.475	-32.525	74.000	54.000
3471.360	-4.850	45.670	40.820	-33.180	74.000	54.000
3905.280	-4.466	45.430	40.964	-33.036	74.000	54.000
4339.200	-3.430	45.380	41.950	-32.050	74.000	54.000

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Average measurements: RBW = 1MHz, VBW = 10 Hz, Sweep: Auto.
4. Measurement Level = Reading Level + Correct Factor.
5. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
6. The average measurement was not performed when the peak measured data under the limit of average detection.
7. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product	Tyre Pressure Monitoring Sensor
Test Item	Harmonic Radiated Emission
Test Mode	Mode 1: Transmit
Date of Test	2017/12/05

Frequency	Correct	Reading	Measurement	Margin	Peak	Average
	Factor	Level	Level		Limit	Limit
MHz	dB	dBuV	dBuV/m	dB	dBuV/m	dBuV/m

Harmonic Radiated Emission

Vertical

Peak

1301.760	-11.056	46.060	35.004	-38.996	74.000	54.000
1735.680	-8.925	46.110	37.185	-36.815	74.000	54.000
2169.600	-6.503	45.960	39.458	-34.542	74.000	54.000
2603.520	-5.616	45.730	40.115	-33.885	74.000	54.000
3037.440	-4.984	45.370	40.385	-33.615	74.000	54.000
3471.360	-4.850	45.740	40.890	-33.110	74.000	54.000
3905.280	-4.466	45.920	41.454	-32.546	74.000	54.000
4339.200	-3.430	45.630	42.200	-31.800	74.000	54.000

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Average measurements: RBW = 1MHz, VBW = 10 Hz, Sweep: Auto.
4. Measurement Level = Reading Level + Correct Factor.
5. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
6. The average measurement was not performed when the peak measured data under the limit of average detection.
7. The emission levels of other frequencies are very lower than the limit and not show in test report.

Product	Tyre Pressure Monitoring Sensor
Test Item	General Radiated Emission
Test Mode	Mode 1: Transmit
Date of Test	2017/12/05

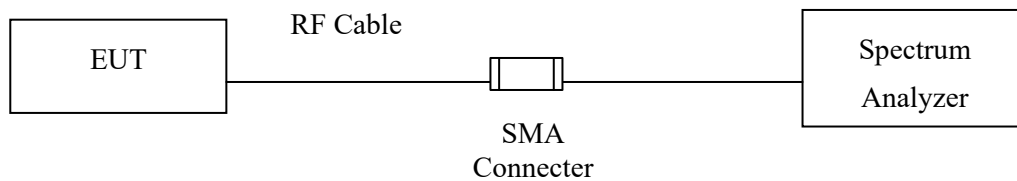
Frequency MHz	Correct Factor dB	Reading Level dBuV	Measurement Level dBuV/m	Margin dB	Limit dBuV/m
Horizontal					
Quasi-Peak					
157.928	-10.463	28.916	18.453	-25.047	43.500
292.884	-10.060	27.959	17.899	-28.101	46.000
484.072	-5.576	28.327	22.751	-23.249	46.000
604.971	-3.026	28.049	25.022	-20.978	46.000
739.928	-1.031	29.416	28.385	-17.615	46.000
910.029	1.035	27.722	28.758	-17.242	46.000
Vertical					
Quasi-Peak					
160.739	-10.462	29.687	19.226	-24.274	43.500
316.783	-9.525	28.841	19.317	-26.683	46.000
451.739	-6.138	28.843	22.704	-23.296	46.000
593.725	-3.219	28.191	24.973	-21.027	46.000
749.768	-0.883	29.140	28.257	-17.743	46.000
898.783	0.917	28.668	29.585	-16.415	46.000

Note:

1. All Readings below 1GHz are Quasi-Peak, above 1GHz are performed with peak and/or average measurements as necessary.
2. Peak measurements: RBW = 1MHz, VBW = 3 MHz, Sweep: Auto.
3. Average measurements: RBW = 1MHz, VBW = 10 Hz, Sweep: Auto.
4. Measurement Level = Reading Level + Correct Factor.
5. Correct Factor = Antenna factor + Cable loss – Amplifier gain.
6. The average measurement was not performed when the peak measured data under the limit of average detection.
7. The emission levels of other frequencies are very lower than the limit and not show in test report.
8. No emission found between lowest internal used/generated frequency to 30MHz.

4. Transmit time

4.1. Test Setup



4.2. Limits

In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

4.3. Test Specification

According to FCC Part 15 Subpart C Paragraph 15.231(e).

4.4. Uncertainty

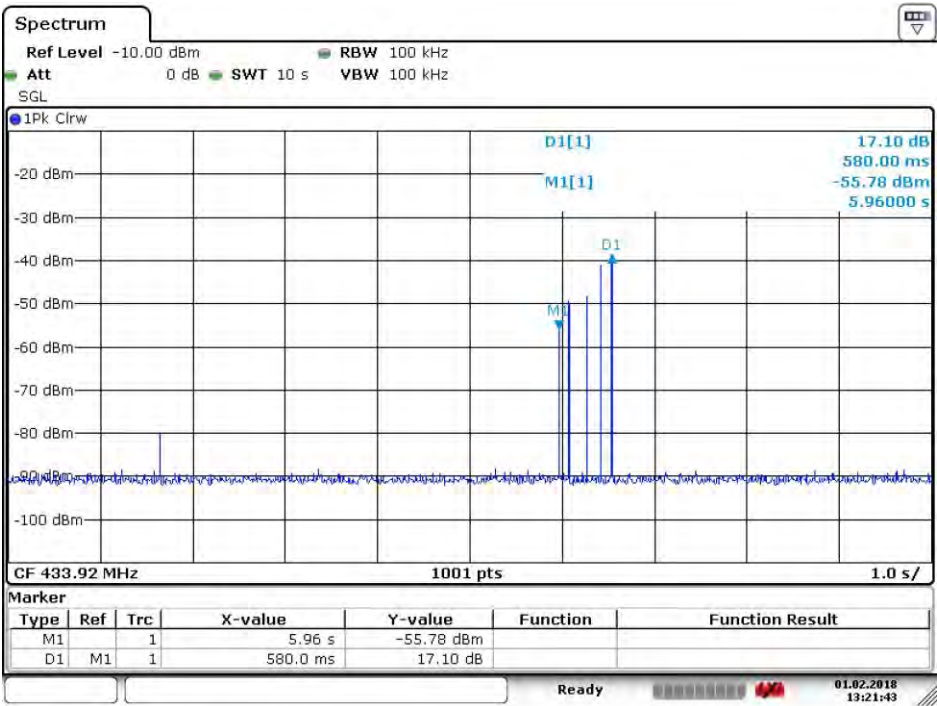
$\pm 2.31\text{ms}$

4.5. Test Result

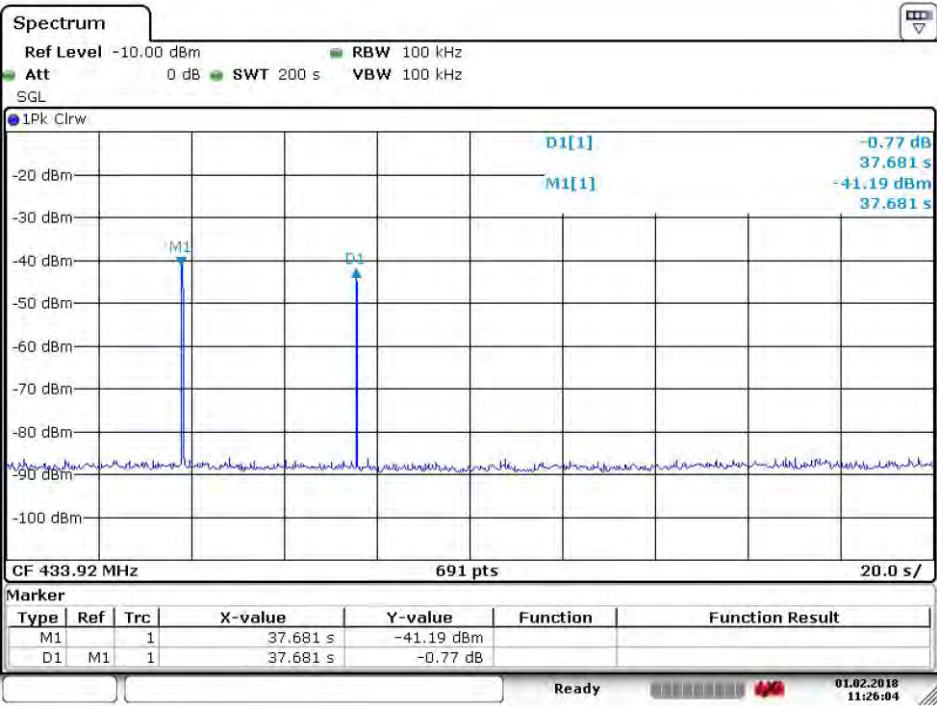
Product Tyre Pressure Monitoring Sensor
Test Item Transmit time
Test Site No.3 OATS
Test Mode Mode 1: Transmit

Channel No.	Frequency (MHz)	Measurement Value (Sec)	Limit (Sec)	Result
1 (Transmit time)	433.92	0.58	< 1	Pass
1 (Silent period time)	433.92	37.681	> 10	Pass
1 (Silent period time)	433.92	37.681	>17.4 _{note}	Pass

Note: Silent period time= Transmissions * 30 times =0.58s * 30 =17.4s



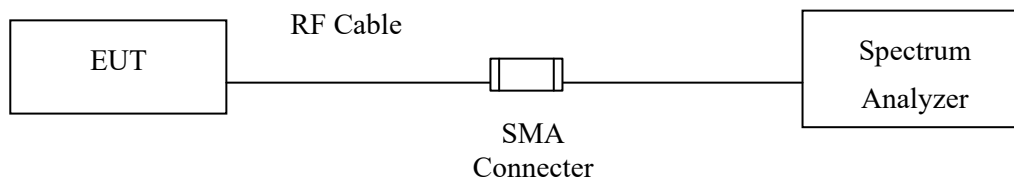
Date: 1.FEB.2018 13:21:43



Date: 1.FEB.2018 11:26:05

5. Occupied Bandwidth

5.1. Test Setup



5.2. Limits

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70MHz and below 900MHz. For devices operating above 900MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier

5.3. Test Specification

According to FCC Part 15 Subpart C Paragraph 15.231(c).

5.4. Uncertainty

$\pm 279.2\text{Hz}$

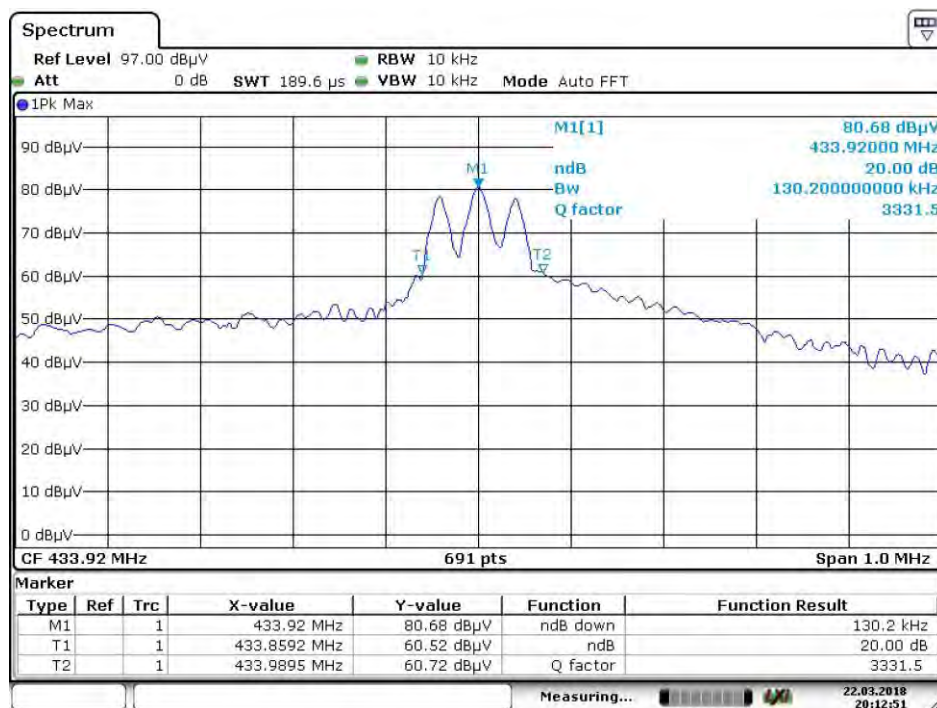
5.5. Test Result

Product Tyre Pressure Monitoring Sensor
 Test Item Occupied Bandwidth
 Test Site No.3 OATS
 Test Mode Mode 1: Transmit

Channel No.	Frequency (MHz)	Measurement Value (MHz)	Limit (MHz)	Result
1	433.92	0.1302	1.0848	Pass

Note: Limit = 433.92MHz * 0.25%= 1.0848MHz

Figure Channel 1:



Date: 22.MAR.2018 20:12:52