

FCC Test Report

Product Name	Tyre Pressure Monitoring Sensor
Model No.	AG2SM3
FCC ID.	MRXAG2SM3

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

Date of Receipt	Jul. 25, 2018
Issued Date	Aug. 10, 2018
Report No.	1870381R-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. : 1870381R-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.	AG2SM3
FCC ID.	MRXAG2SM3
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: 2017 ANSI C63.4: 2014, ANSI C63.10: 2013
Test Result	Complied

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

Tested By : Ivan Chuang
(Senior Engineer / Ivan Chuang)

Approved By : 
(Director / Vincent Lin)

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1. General Information

1.1. EUT Description

Product Name	Tyre Pressure Monitoring Sensor
Trade Name	SCHRADER ELECTRONICS
Model No.	AG2SM3
FCC ID	MRXAG2SM3
Frequency Range	314.97 MHz
Number of Channels	1
Type of Modulation	FSK
Antenna Type	Integral antenna

Frequency of Each Channel:

Channel	Frequency
Channel 1:	314.97 MHz

Note:

1. The EUT is a Tyre Pressure Monitoring Sensor with a built-in 314.97 MHz transmitter.
2. The antenna of EUT is conform to FCC 15.203.
3. These tests are conducted on a sample for the purpose of demonstrating compliance of transmitter with Part 15 Subpart C Paragraph 15.231.
4. 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
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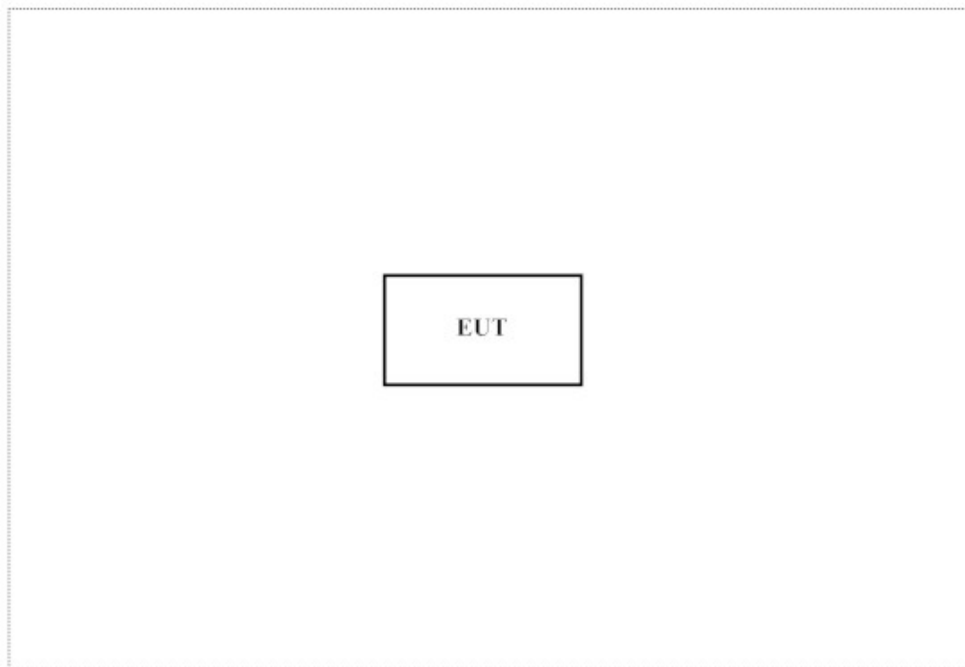
1.3. Tested System Details

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	Use the remote control to trigger EUT transmit signal.
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: TW0023

1.7. List of Test Equipment

For Conduction measurements /ASR1

	Equipment	Manufacturer	Model No.	Serial No.	Cali. Data	Due. Data
	EMI Test Receiver	R&S	ESR7	101601	2018.02.08	2019.02.07
	Two-Line V-Network	R&S	ENV216	101306	2018.03.09	2019.03.08
	Two-Line V-Network	R&S	ENV216	101307	2018.03.20	2019.03.19
	Coaxial Cable	Quietek	RG400_BNC	RF001	2018.05.24	2019.05.23

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

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 : DEKRA Conduction Test System V9.0.1

For Radiated measurements /ACB1

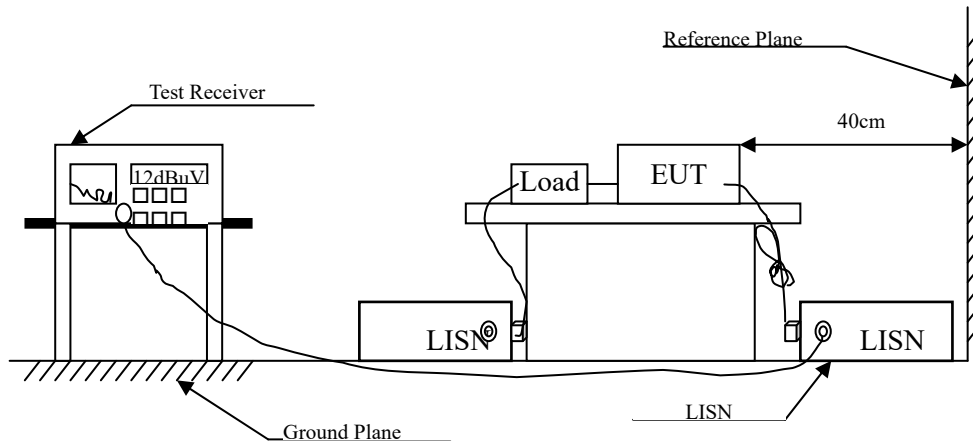
	Equipment	Manufacturer	Model No.	Serial No.	Cali. Data	Due. Data
X	Loop Antenna	AMETEK	HLA6121	49611	2018.01.26	2019.01.25
X	Bi-Log Antenna	SCHWARZBECK	VULB9168	9168-674	2018.04.02	2019.04.01
X	Horn Antenna	ETS-Lindgren	3117	00203800	2017.11.10	2018.11.09
	Horn Antenna	Com-Power	AH-840	101087	2018.06.01	2019.05.31
X	Pre-Amplifier	EMCI	EMC001330	980316	2018.06.01	2019.05.31
X	Pre-Amplifier	EMCI	EMC051835SE	980311	2018.06.04	2019.06.03
	Pre-Amplifier	EMCI	EMC05820SE	980310	2018.06.04	2019.06.03
	Pre-Amplifier	EMCI	EMC184045SE	980314	2018.05.16	2019.05.15
	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	2018.05.25	2019.05.24
	Mircoflex Cable	HUBER SUHNER	SUCOFLEX 102	MY3381/2	2018.05.16	2019.05.15

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. Uncertainty

± 2.35 dB

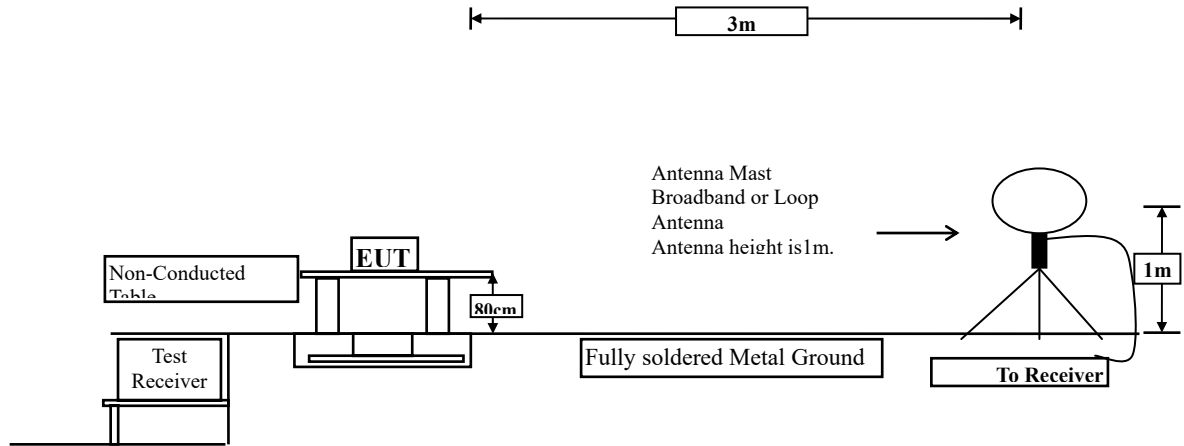
2.5. Test Result

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

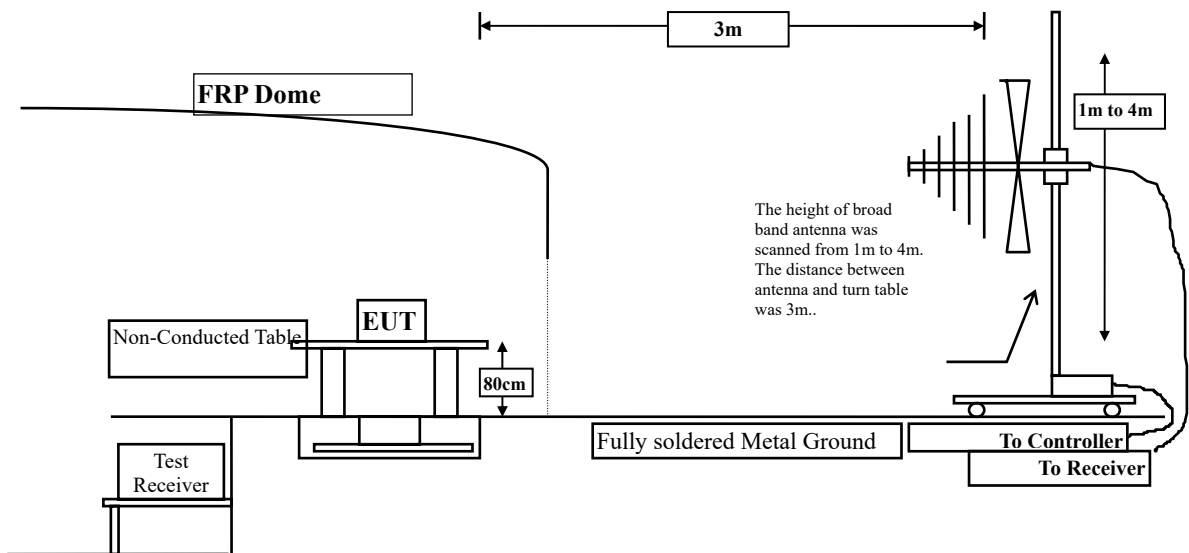
3. Radiated Emission

3.1. Test Setup

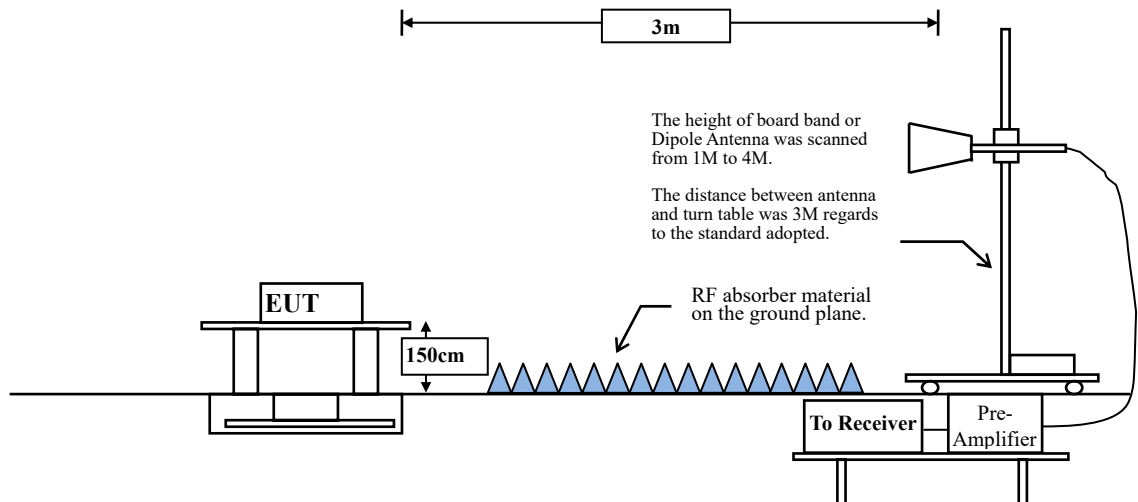
Radiated Emission Under 30MHz



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.

The EUT was positioned such that the distance from antenna to the EUT was 3 meters.

The turn table is rotated 360 degrees to determine the position of the maximum emission level.

The antenna can move up and down between 1 meter and 4 meters to find out the maximum emission level.

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.

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

Radiated emission measurements below 30MHz are made using Loop Antenna and 30MHz~1GHz are made using broadband Bilog antenna and above 1GHz are made using Horn Antennas.

The measurement is divided into the Preliminary Measurement and the Final Measurement.

The suspected frequencies are searched for in Preliminary Measurement with the measurement antenna kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. The antenna is pointed at an angle towards the source of the emission, and the EUT is rotated in both height and polarization to maximize the measured emission. The emission is kept within the illumination area of the 3 dB bandwidth of the antenna. The measurement frequency range from 9kHz - 10th Harmonic of fundamental was investigated.

3.4. Uncertainty

Horizontal polarization :

30-300MHz: ± 4.08 dB ; 300M-1GHz: ± 3.86 dB ; 1-18GHz: ± 3.77 dB ; 18-40GHz: ± 3.98 dB

Vertical polarization :

30-300MHz: ± 4.81 dB ; 300M-1GHz: ± 3.87 dB ; 1-18GHz: ± 3.83 dB ; 18-40GHz: ± 3.98 dB

3.5. Test Result

Product	Tyre Pressure Monitoring Sensor
Test Item	Fundamental Radiated Emission
Test Mode	Mode 1: Transmit
Date of Test	2018/07/30

Fundamental Power (X-Line)

Peak Detector:

Frequency MHz	Correct Factor dB	Reading Level dBuV	Measurement Level dBuV/m	Margin dB	Limit dBuV/m
Horizontal					
314.970	-9.337	81.200	71.863	-15.799	87.662
Vertical					
314.970	-9.337	84.100	74.763	-12.899	87.662

Average Detector:

Frequency MHz	Correct Factor dB	Reading Level dBuV	Measurement Level dBuV/m	Margin dB	Limit dBuV/m
Horizontal					
314.970	-9.337	63.100	53.763	-13.899	67.662
Vertical					
314.970	-9.337	62.700	53.363	-14.299	67.662

Note:

1. Measurement Level = Reading Level + Correct Factor
2. Average Limit=20log(2416.17)=67.662dBuV 、 Peak Limit=87.662dBuV

Product	Tyre Pressure Monitoring Sensor
Test Item	Fundamental Radiated Emission
Test Mode	Mode 1: Transmit
Date of Test	2018/07/30

Fundamental Power (Y-Line)

Peak Detector:

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

314.970	-9.337	82.400	73.063	-14.599	87.662
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Vertical

314.970	-9.337	83.600	74.263	-13.399	87.662
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Average Detector:

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

314.970	-9.337	60.300	50.963	-16.699	67.662
---------	--------	--------	--------	---------	--------

Vertical

314.970	-9.337	59.300	49.963	-17.699	67.662
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Note:

1. Measurement Level = Reading Level + Correct Factor
2. Average Limit=20log(2416.17)=67.662dBuV 、 Peak Limit=87.662dBuV

Product	Tyre Pressure Monitoring Sensor
Test Item	Fundamental Radiated Emission
Test Mode	Mode 1: Transmit
Date of Test	2018/07/30

Fundamental Power (Z-Line)

Peak Detector:

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

314.970	-9.337	80.500	71.163	-16.499	87.662
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Vertical

314.970	-9.337	83.800	74.463	-13.199	87.662
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Average Detector:

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

Horizontal

314.970	-9.337	58.800	49.463	-18.199	67.662
---------	--------	--------	--------	---------	--------

Vertical

314.970	-9.337	62.000	52.663	-14.999	67.662
---------	--------	--------	--------	---------	--------

Note:

1. Measurement Level = Reading Level + Correct Factor
2. Average Limit=20log(2416.17)=67.662dBuV 、 Peak Limit=87.662dBuV

Fundamental Radiated Emission	PASS
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Product	Tyre Pressure Monitoring Sensor
Test Item	Harmonic Radiated Emission
Test Mode	Mode 1: Transmit
Date of Test	2018/07/30

Frequency MHz	Correct Factor dB	Reading Level dBuV	Measurement Level dBuV/m	Margin dB	Peak Limit dBuV/m	Average Limit dBuV/m
Horizontal Peak						
1259.880	-10.961	48.030	37.069	-36.931	74.000	54.000
1574.850	-9.986	38.600	28.613	-45.387	74.000	54.000
1889.820	-7.558	30.930	23.372	-50.628	74.000	54.000
2204.790	-6.300	31.040	24.740	-49.260	74.000	54.000
2519.760	-5.588	49.620	44.033	-29.967	74.000	54.000
2834.730	-5.035	31.260	26.225	-47.775	74.000	54.000
3149.700	-4.704	45.560	40.855	-33.145	74.000	54.000
Average						
--					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	2018/07/30

Frequency MHz	Correct Factor dB	Reading Level dBuV	Measurement Level dBuV/m	Margin dB	Peak Limit dBuV/m	Average Limit dBuV/m
Vertical						
Peak						
1259.880	-10.961	39.890	28.929	-45.071	74.000	54.000
1574.850	-9.986	30.300	20.313	-53.687	74.000	54.000
1889.820	-7.558	31.080	23.522	-50.478	74.000	54.000
2204.790	-6.300	31.600	25.300	-48.700	74.000	54.000
2519.760	-5.588	46.050	40.463	-33.537	74.000	54.000
2834.730	-5.035	34.640	29.605	-44.395	74.000	54.000
3149.700	-4.704	44.850	40.145	-33.855	74.000	54.000
Average						
--	--	--	--	--	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.

Harmonic Radiated Emission	PASS
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Product	Tyre Pressure Monitoring Sensor
Test Item	General Radiated Emission
Test Mode	Mode 1: Transmit
Date of Test	2018/07/30

Frequency MHz	Correct Factor dB	Reading Level dBuV	Measurement Level dBuV/m	Margin dB	Limit dBuV/m
Horizontal					
Quasi-Peak					
58.116	-11.484	41.779	30.294	-9.706	40.000
101.696	-15.407	40.436	25.029	-18.471	43.500
145.275	-10.641	32.473	21.833	-21.667	43.500
365.986	-8.124	31.939	23.815	-22.185	46.000
433.464	-6.314	30.261	23.947	-22.053	46.000
559.986	-3.772	29.611	25.839	-20.161	46.000
Vertical					
Quasi-Peak					
53.899	-11.064	34.361	23.298	-16.702	40.000
134.029	-11.410	32.469	21.060	-22.440	43.500
365.986	-8.124	33.617	25.493	-20.507	46.000
446.116	-5.986	29.543	23.557	-22.443	46.000
485.478	-5.185	29.735	24.550	-21.450	46.000
600.754	-2.886	29.813	26.927	-19.073	46.000

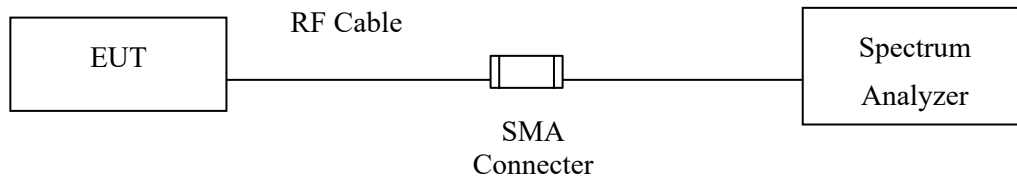
Note:

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.

General Radiated Emission	PASS
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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. Uncertainty

$\pm 2.31\text{ms}$

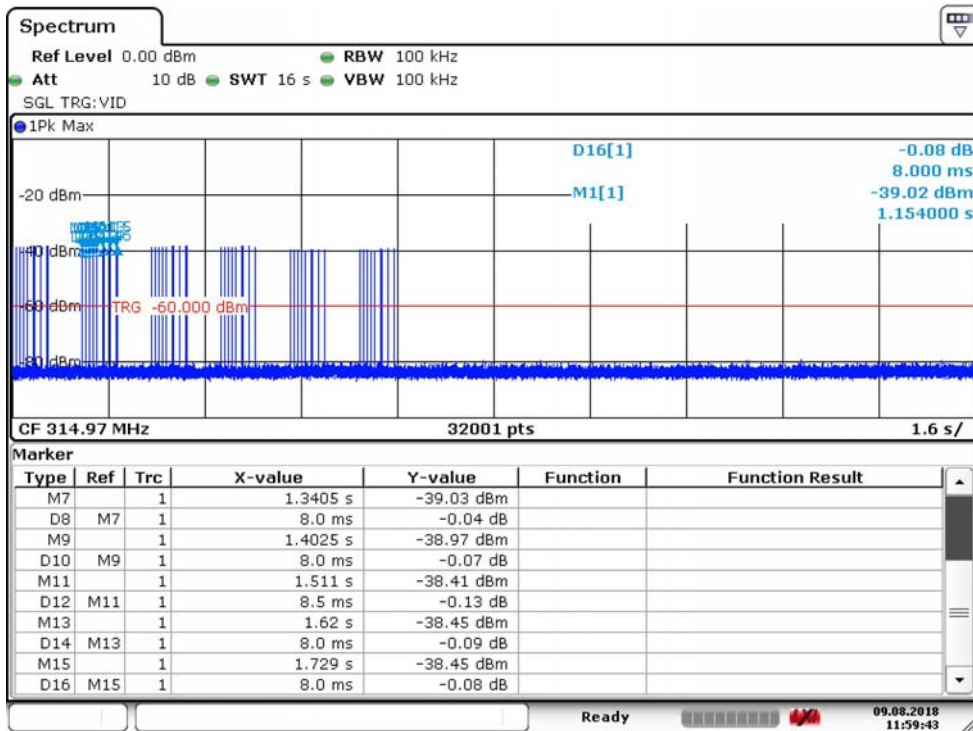
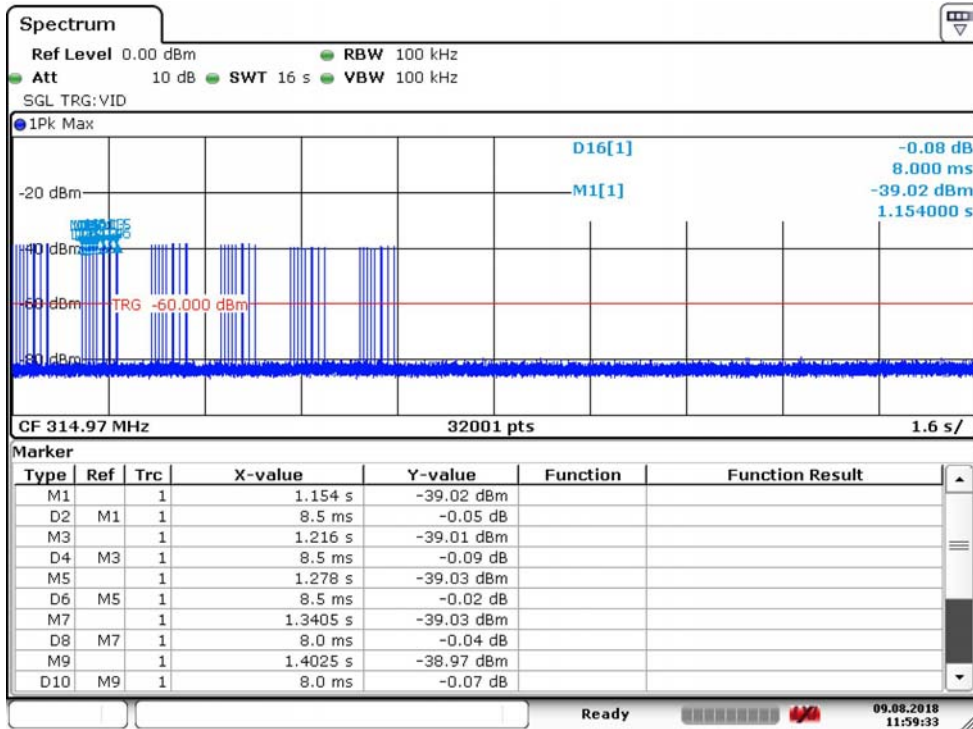
4.4. Test Result

Product Tyre Pressure Monitoring Sensor
Test Item Transmit time
Test Mode Mode 1: Transmit

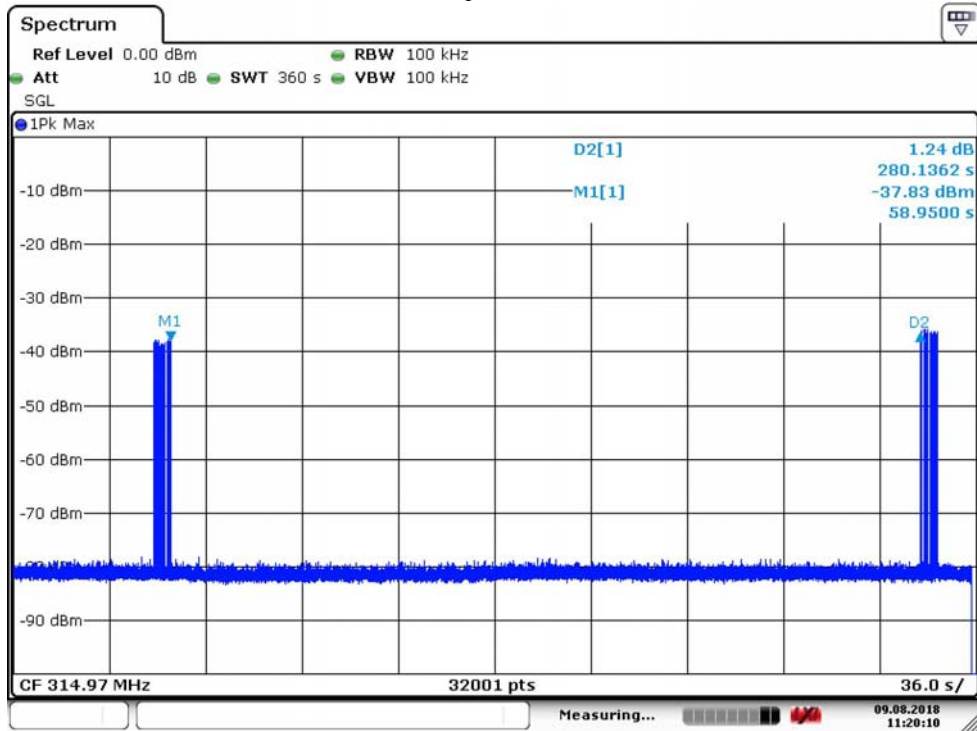
Channel No.	Frequency (MHz)	Measurement Value (Sec)	Limit (Sec)	Result
1 (Transmit time)	314.97	0.396	< 1	Pass
1 (Silent period time)	314.97	280.13	> 10	Pass
1 (Silent period time)	314.97	280.13	> 11.88	Pass

Note: Silent period time Limit = 10s and Transmissions * 30 times = 0.396s * 30 = 11.88s

Transmit time



Silent period time

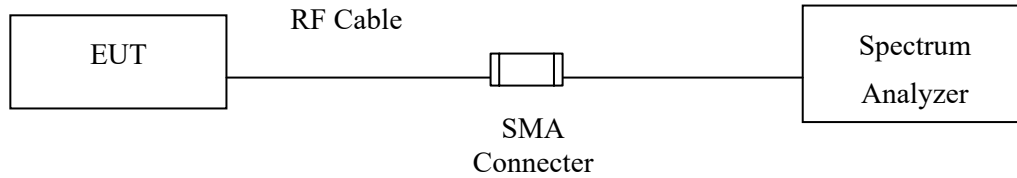


Transmit Time

PASS

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. Uncertainty

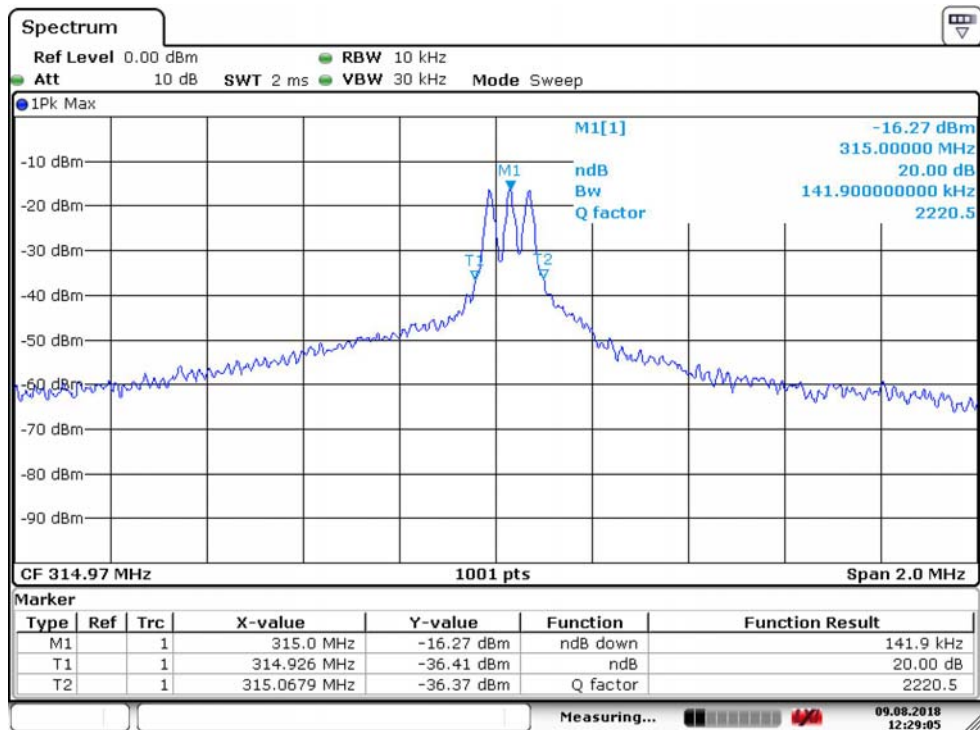
±279.2Hz

5.4. Test Result

Product Tyre Pressure Monitoring Sensor
 Test Item Occupied Bandwidth
 Test Mode Mode 1: Transmit

Channel No.	Frequency (MHz)	Measurement Value (MHz)	Limit (MHz)	Result
1	314.97	0.1419	0.7874	Pass

Note: Limit = 314.97MHz * 0.25%= 0.7874MHz



Occupied Bandwidth	PASS
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6. EMI Reduction Method During Compliance Testing

No modification was made during testing.