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TEST REPORT

Part 15 Subpart C 15.231

Equipment under test	Tire pressure monitoring system
Model name	TPM Q104
FCC ID	F2OTPMQ104
Applicant	Nae Woi Korea.,ltd
Manufacturer	Nae Woi Korea.,ltd
Date of test(s)	2012.02.17 ~ 2012.03.19
Date of issue	2012.03.22

Issued to

Nae Woi Korea.,ltd
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Test and report completed by :	**Report approval by :**
	
Jeff Do Test engineer	Gyu-cheol Shin Technical manager

Revision history

Revision	Date of issue	Test report No.	Description
-	2012.03.22	KES-RF-120012	Initial

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1.0 General product description

Equipment under test	Tire pressure monitoring system
Model name	TPM Q104
Serial number	N/A
Frequency Range	433.92 ㎒
Modulation technique	ASK
Number of channels	1
Antenna type	STUB antenna
Power source	DC 3 V

1.1 Test frequency

	Low channel	**Middle channel**	**High channel**
Frequency (㎒)	433.92	N/A	N/A

1.2 Model differences

N/A

1.3 Device modifications

N/A

1.4 Test facility

C3701 Dongil Techno Town, 889-1, Gwanyang 2-dong, Dongan-gu, Anyang-si, Gyeonggi-do, 431-716, Korea
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The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 and CISPR Publication 22.

1.5 Laboratory accreditations and listings

Country	Agency	Scope of accreditation	Logo
USA	FCC	3 & 10 meter Open Area Test Sites and one conducted site to perform FCC Part 15/18 measurements.	343818
KOREA	KC	EMI (10 meter Open Area Test Site and two conducted sites) Radio (3 & 10 meter Open Area Test Sites and one conducted site)	KR0100
Canada	IC	3 & 10 meter Open Area Test Sites and one conducted site	4769B-1

2.0 Summary of tests

Section in FCC Part 15	Parameter	Status
15.231(e) 15.209(a)	The field strength of fundamental and the field strength of spurious emission	C
15.231(c)	20 dB bandwidth	C
15.231(e)	Transmission plot	C
Note 1: C=Complies NC=Not complies NT=Not tested NA=Not applicable		

2.1 Test data

2.1.1 Fundamental, spurious emission

Test location
Testing was performed at a test distance of 3 meter Open Area Test Site

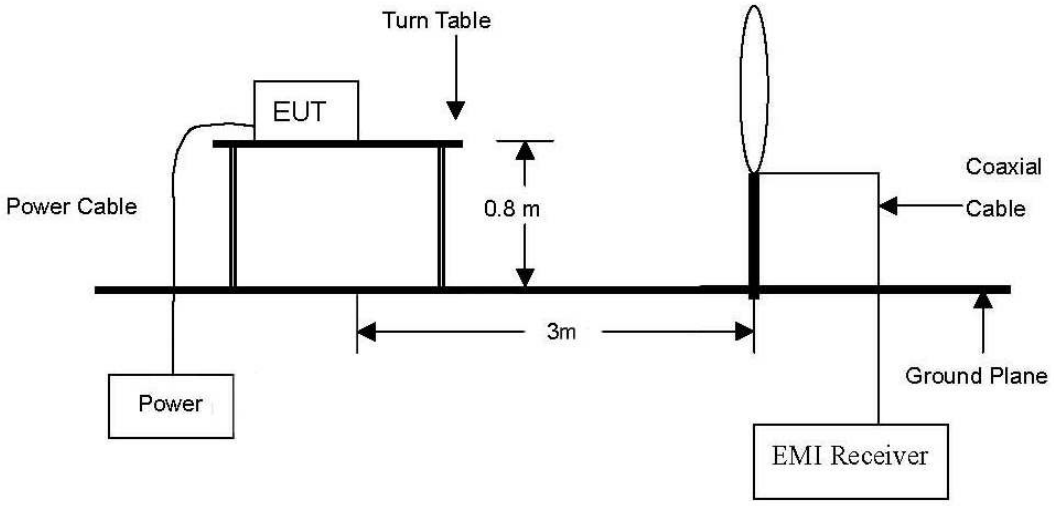
Test procedures
[9 ㎑ to 30 ㎒]
The EUT was placed on the top of a rotating table 0.8 meter above the ground at a 3 meter open area test site. The table was rotated 360 degrees to determine the position of the highest radiation. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading. The test-receiver system was set to Quasi-peak function and specified bandwidth with maximum hold mode.

The spectrum analyzer is set to:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 200 ㎐ for Quasi-peak detection (QP) at frequency below 9 ㎑~ 150 ㎑.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer 9 ㎑ for Quasi-peak detection (QP) at frequency below 150 ㎑~ 30 ㎒.

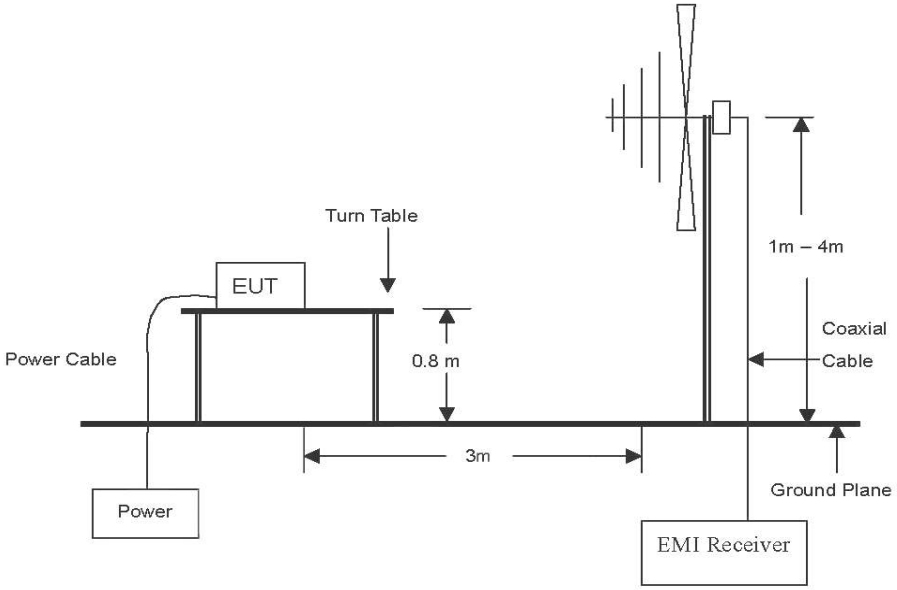
[30 ㎒ to 1 ㎓ and above 1 ㎓]
The height of the measuring antenna was varied between 1 to 4 m and the table was rotated a full revolution in order to obtain maximum values of the electric field intensity.
The measurement was made in both the vertical and horizontal polarization, and the maximum value is presented in the report.

The spectrum analyzer is set to:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 ㎑ for Peak detection (PK) or Quasi-peak detection (QP) at frequency below 1 ㎓.
2. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 1 ㎒ for Peak detection at frequency above 1 ㎓.

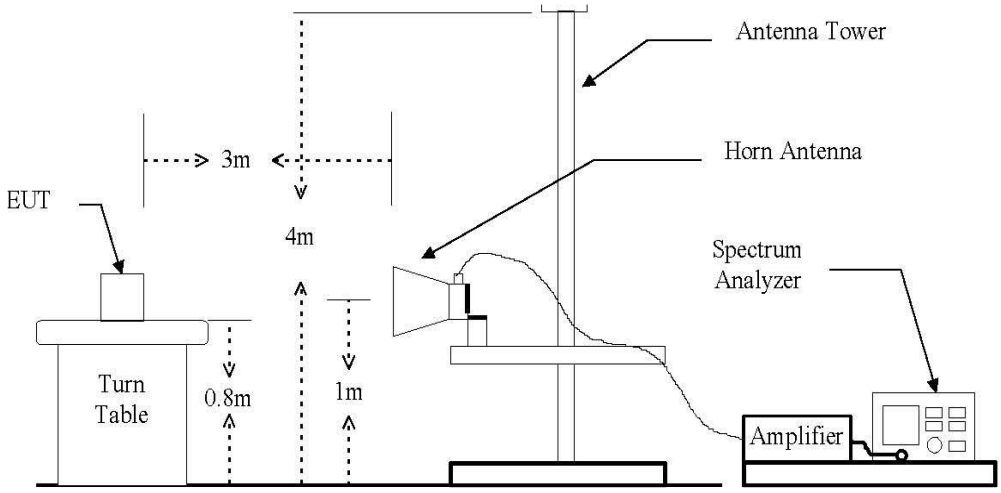
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to 5 ㎓ emissions.



Limit

In the section 15.209:

Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (㎒)	Distance (Meters)	Radiated (㎶/m)
0.009 ~ 0.490	300	2400 / F(㎑)
0.490 ~ 1.705	30	24000 / F(㎑)
1.705 ~ 30.0	30	30
30 ~ 88	3	100**
88 ~ 216	3	150**
216 ~ 960	3	200**
Above 960	3	500

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54 ~ 72 ㎒, 76 ~ 88 ㎒, 174 ~ 216 ㎒ or 470 ~ 806 ㎒. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

In the section 15.231(e):
Intentional radiators may operate at a periodic rate exceeding that specified in paragraph (a) and may be employed for any type of operation, including operation prohibited in paragraph (a), provided the intentional radiator complies with the provisions of paragraphs (b) through (d) of this Section, except the field strength table in paragraph (b) is replaced by the following:

Fundamental frequency (㎒)	Field strength of fundamental (microvolts / meter)	Field strength of spurious emission (microvolts / meter)
40.66 ~ 40.70	1,000	100
70 ~ 130	500	50
130 ~ 174	500 to 1,500**	50 to 150**
174 ~ 260	1,500	150
260 ~ 470	1,500 to 5,000**	150 to 500**
Above 470	5,000	500

Where F is the frequency in ㎒, the formulas for calculating the maximum permitted fundamental field strengths are as follows: for the band 130 ~ 174 ㎒, ㎶/m at 3 meters = 22.72727(F) – 2454.545; for the band 260 ~ 470 ㎒, ㎶/m at 3 meters = 16.6667(F) – 2833.3333. The maximum permitted unwanted emission level is 20 ㏈ below the maximum permitted fundamental level.

Test results (Below 30 ㎒)
The frequency spectrum from 9 ㎑ to 30 ㎒ was investigated. Emission levels are not reported much lower than the limits by over 20 ㏈.

Radiated emissions		Ant.	Correction factors			Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Pol.	Ant. factor (㏈/m)	Cable loss (㏈)	F_d (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
No emissions were detected at a level greater than 20 ㏈ below limit.								

※ Remark
1. All spurious emission at channels are almost the same below 30 ㎒, so that high channel was chosen at representative in final test.
2. Actual = Reading + Ant. factor + Cable loss + F_d
3. $F_d = 40\log(D_m / D_s)$
   Where:
   F_d = Distance factor in ㏈
   D_m = Measurement distance in meters
   D_s = Specification distance in meters

Test results for fundamental

Radiated emissions		Ant.	Correction factors		Total	Limit		Detector mode
Frequency (㎒)	Reading (dB㎶)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Result (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)	
433.92	43.51	H	16.33	4.43	64.27	72.87	8.60	Quasi-peak
433.92	39.68	V	16.33	4.43	60.44	72.87	12.43	Quasi-peak

※ Remark

1. Actual = Reading + Ant. factor + Cable loss (or Amp. gain + cable loss)
2. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes

Test results for spurious

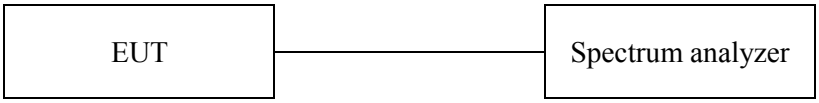
Radiated emissions		Ant.	Correction factors		Total	Limit		Detector mode
Frequency (㎒)	Reading (dB㎶)	Pol.	Ant. factor (dB/m)	Cable loss (dB)	Result (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)	
56.70	10.81	V	13.29	1.40	25.50	40.00	14.50	Quasi-peak
129.40	12.81	H	11.91	2.15	26.87	43.50	16.63	Quasi-peak
255.50	11.30	V	11.86	3.33	26.48	46.00	19.52	Quasi-peak
301.60	8.10	H	13.40	3.62	25.12	46.00	20.88	Quasi-peak
301.60	11.82	V	13.40	3.62	28.84	46.00	17.16	Quasi-peak
867.84	14.78	H	22.97	6.64	44.39	52.87	8.48	Quasi-peak
867.84	12.19	V	22.97	6.64	41.80	52.87	11.07	Quasi-peak
Radiated emissions		**Ant.**	**Correction factors**		**Total**	**Limit**		**Detector mode**
Frequency (㎒)	**Reading (dB㎶)**	**Pol.**	**Ant. factor (dB/m)**	**Amp. gain + cable loss (dB)**	**Result (dB㎶/m)**	**Limit (dB㎶/m)**	**Margin (dB)**	
1301.80	51.42	H	24.62	-41.16	34.88	72.87	37.99	Peak
1301.80	-	H	24.62	-41.16	28.98	52.87	23.89	Average
2169.60	49.62	V	27.86	-39.30	31.18	72.87	34.69	Peak
2169.60	-	V	27.86	-39.30	32.28	52.87	20.59	Average
2169.60	51.31	H	27.86	-39.30	39.87	72.87	33.00	Peak
2169.60	-	H	27.86	-39.30	33.97	52.87	18.90	Average
2603.50	46.83	V	28.75	-38.55	37.03	72.87	35.84	Peak
2603.50	-	V	28.75	-38.55	31.13	52.87	21.74	Average
2603.50	50.18	H	28.75	-38.55	40.38	72.87	32.49	Peak
2603.50	-	H	28.75	-38.55	34.48	52.87	18.39	Average
3471.40	42.50	H	30.36	-36.85	36.01	72.87	36.86	Peak
3471.40	-	H	30.36	-36.85	30.11	52.87	22.76	Average

※ Remark

1. Actual = Reading + Ant. factor + Cable loss (or Amp. gain + cable loss)
2. To get a maximum emission level from the EUT, the EUT was moved throughout the XY, XZ and YZ planes
3. Average result = result (peak) - duty factor.
4. Duty factor = $20\log(T_{on} / T_p) = 20\log(50.72 / 100) = -5.90$ dB

2.1.2 20 dB bandwidth

Test setup



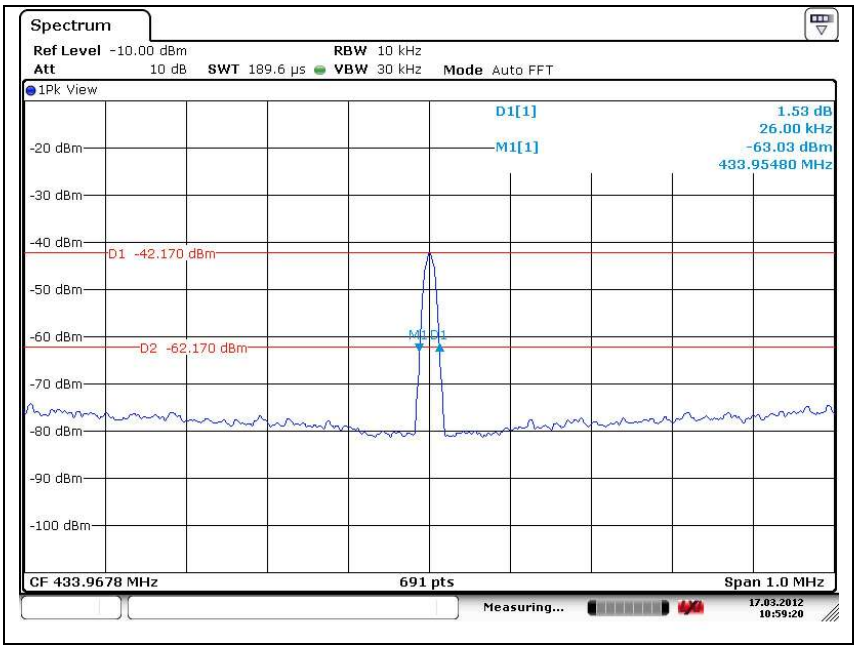
Test procedure

1. Use the following spectrum analyzer setting
   RBW = 10 ㎑
   VBW = 30 ㎑ (≥ RBW)
   Span = 1 ㎒
   Detector function = peak
   Trace = max hold

Limit

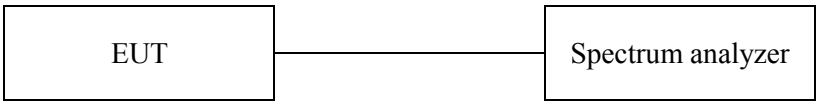
The bandwidth of the emissions hall be no wider than 0.25 % of the center frequency for devices operating above 70 ㎒ and below 900 ㎒. Bandwidth is determined at the points 20 dB down from the modulated carrier.

Test results



2.1.3 Transmission plot

Test setup



Test procedure

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW=100 ㎑, VBW=100 ㎑.

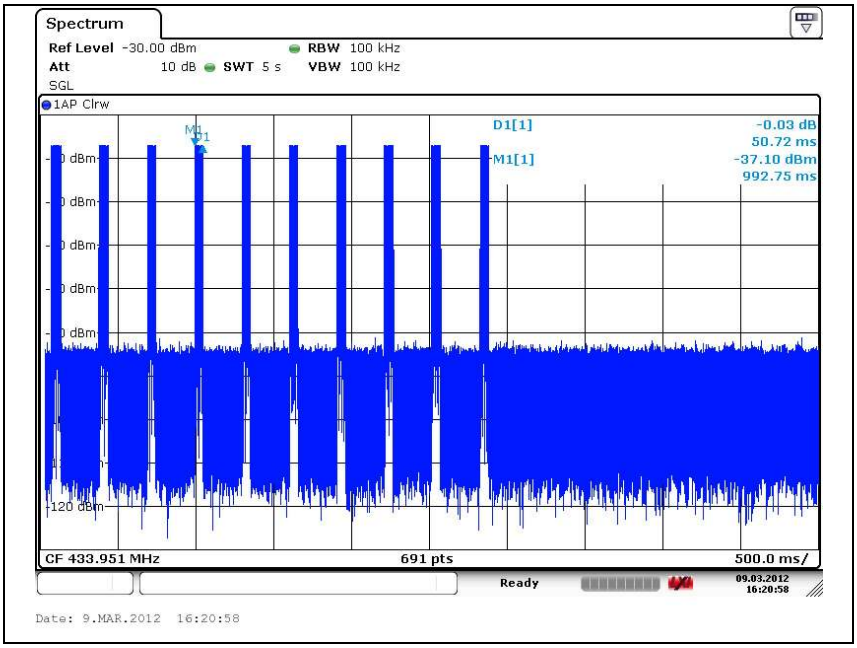
Limit

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 on 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.

Test results

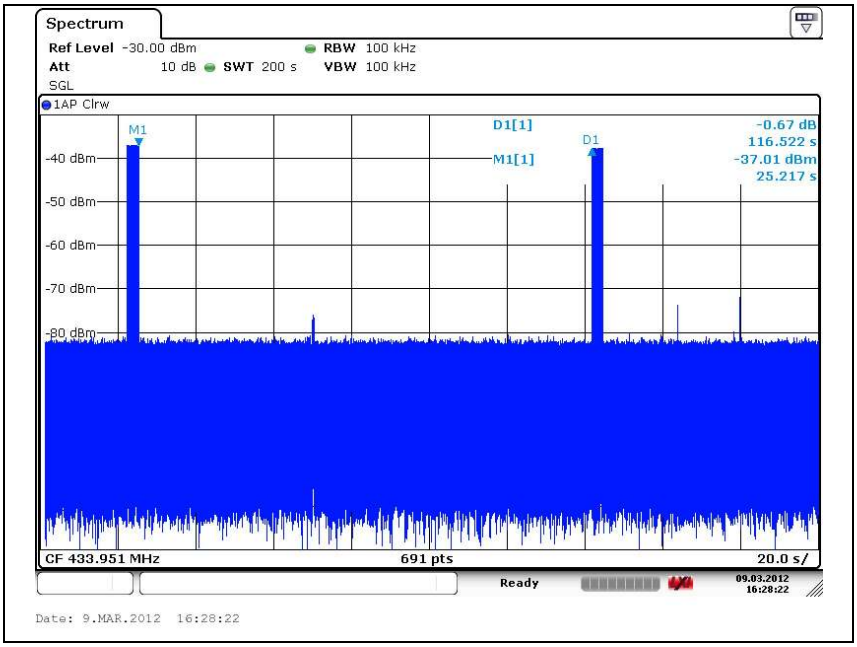
Transmission time

Frequency(㎒)	Transmission time (㎳)	Frame no.	Result(s)	Limit (s)
433.92	50.72	10	0.5072	<1



Silent time

Frequency(㎒)	Silent time(s)	Limit (s)
433.92	116.522	≥15.216



Appendix A. Test equipment used for test

Equipment	Manufacturer	Model	Calibration due.
Spectrum Analyzer	R&S	FSV30	2013.01.10
Vector Signal Generator	R&S	SMBV2100A	2013.01.10
DC Power Supply	Agilent	6632B	2012.12.05
High Pass Filter	Mini-Circuits	NHP-800+	2012.08.05
Preamplifier	A.H.	PAM-0118	2012.05.04
Loop Antenna	R&S	HFH2-Z2.335.4711.52	2013.03.18
Trilog-Broadband Antenna	SCHWARZBECK	VULB 9168	2013.04.28
Horn Antenna	A.H.	SAS-571	2013.03.22
EMC Analyzer	Agilent	E7405A	2012.08.22

Peripheral device

Device	Manufacturer	Model No.	Serial No.
N/A			

Appendix B. Test setup photos

Radiated field emissions