TEST REPORT

Part 15 C & RSS-247 (Issue 2)

Equipment under test	Car Dash CAM
Model name	Q1000
FCC ID	2ADTG-Q1000
IC	12594A-Q1000
Applicant	THINKWARE CORPORATION
Manufacturer	THINKWARE CORPORATION
Date of test(s)	2022.02.28 ~ 2022.03.31
Date of issue	2022.04.04

Issued to

THINKWARE CORPORATION

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Test and report completed by :	**Report approval by :**
Gu-Bong, Kang Test engineer	Yeong-Jun Cho Technical manager

This test report is not related to KS Q ISO/IEC 17025 and KOLAS.

Revision history

Revision	Date of issue	Test report No.	Description
-	2022.04.04	KES-RF1-22T0022	Initial

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1. General information

Applicant:	THINKWARE CORPORATION
Applicant address:	A, 9FL., Samwhan Hipex, 240, Pangyoyeok-ro, Bundang-gu, Seongnam-si, Gyeonggi-do, South Korea
Test site:	KES Co., Ltd.
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Test Facility	FCC Accreditation Designation No.: KR0100, Registration No.: 444148 ISED Registration No.: 4769B
FCC rule part(s):	15.247
IC rule part(s):	RSS-247
FCC ID:	2ADTG-Q1000
IC Certification	12594A-Q1000
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	Car Dash CAM
Frequency range	**2 402 ㎒ ~ 2 480 ㎒ (BLE 1 Mbps)** **2 412 ㎒ ~ 2 462 ㎒ (802.11b/g/n_HT20)** **2 422 ㎒ ~ 2 452 ㎒ (802.11n_HT40)** 5 180 ㎒ ~ 5 240 ㎒ (802.11a/n_HT20/ac_VHT20) 5 190 ㎒ ~ 5 230 ㎒ (802.11n_HT40/ac_VHT40)
Model	Q1000
Modulation technique	**GFSK, CCK, DQPSK, DBPSK, OFDM,** QPSK, BPSK 16QAM, 64QAM, 256QAM
Antenna specification	(BLE & WLAN) Chip Antenna // 2.4 ㎓ Peak gain: -2.008 dBi // 5 ㎓ Peak gain: 5.818 dBi
Power source	DC 12 V, DC 24 V
Number of channels	**2 402 ㎒ ~ 2 480 ㎒ (BLE 1 Mbps) : 40 ch** **2 412 ㎒ ~ 2 462 ㎒ (802.11b/g/n_HT20) : 11 ch** **2 422 ㎒ ~ 2 452 ㎒ (802.11n_HT40) : 7 ch** 5 180 ㎒ ~ 5 240 ㎒ (802.11a/n_HT20/ac_VHT20) : 4 ch 5 190 ㎒ ~ 5 230 ㎒ (802.11n_HT40/ac_VHT40) : 2 ch
H/W Version	HELIOS_PP_V3.0
S/W Version	Ver 0.06.00 (micom : V131)

1.2. Test configuration

The **THINKWARE CORPORATION // Car Dash CAM // Q1000**
FCC ID: 2ADTG-Q1000 // IC: 12594A-Q1000 was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

FCC Part 15.247
ISED RSS-247 Issue 2 and RSS-Gen Issue 5
KDB 558074 D01 v05 r02
ANSI C63.10-2013

1.3. Derivative Model Information

N/A

1.4. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
-	-	-	-	-

1.5. Sample calculation

Where relevant, the following sample calculation is provided

For all conducted test items :

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).
= 0.64 + 10 = 10.64 (dB)

For Radiation test :
Field strength level (dBμV/m) = Measured level (dBμV) + Antenna factor (dB) + Cable loss (dB) – Amplifier gain (dB)

1.6. Measurement Uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.46 dB
Uncertainty for Radiation emission test (include Fundamental emission)	Below 1GHz	4.40 dB
	Above 1GHz	5.94 dB
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

1.8. Frequency/channel operations

Ch.	Frequency (㎒)	Mode
00	2 402	BLE 1 Mbps
.	.	.
20	2 442	BLE 1 Mbps
.	.	.
39	2 480	BLE 1 Mbps

Ch.	Frequency (㎒)	Mode
1	2 412	802.11b/g/n_HT20
.	.	.
6	2 437	802.11b/g/n_HT20
.	.	.
11	2 462	802.11b/g/n_HT20

Ch.	Frequency (㎒)	Mode
3	2 422	802.11n_HT40
.	.	.
6	2 437	802.11n_HT40
.	.	.
9	2 452	802.11n_HT40

Ch.	Frequency (㎒)	Mode
36	5 180	802.11a/n_HT20/ac_VHT20
.	.	.
40	5 200	802.11a/n_HT20/ac_VHT20
.	.	.
48	5 240	802.11a/n_HT20/ac_VHT20

Ch.	Frequency (㎒)	Mode
38	5 190	802.11n_HT40/ac_VHT40
46	5 230	802.11n_HT40/ac_VHT40

2. Summary of tests

Section in FCC Part 15	Section in RSS-247 & Gen	Parameter	Test results
-	RSS-Gen 6.7	99% occupied bandwidth	N/A(1)
15.247(a)(1)	RSS-247 5.1(a)	20 dB bandwidth	N/A(1)
15.247(b)(1)	RSS-247 5.4(b)	Output power	Pass
15.247(a)(1)	RSS-247 5.1(b)	Channel separation	N/A(1)
15.247(a)(1)(iii)	RSS-247 5.1(d)	Number of channels	N/A(1)
15.247(a)(1)(iii)	RSS-247 5.1(d)	Time of occupancy	N/A(1)
15.205 15.209	RSS-247 5.5 RSS-Gen 8.9, 8.10	Radiated restricted band and emission	Pass
15.247(d)	RSS-247 5.5	Conducted spurious emission and band edge	N/A(1)

Note :

1. This product is equipped with an approved module, please refer to
   FCC Report No.: NTC1712035FV00, NTC1712033FV00
   IC Report No.: EC1905007RI03, EC1905007RI01
   for details.
2. The product is set to a lower target power compared to the module in the complete product as below:
   802.11b : 30 -> 23
   802.11g : 26 -> 22
   802.11n_HT20 : 22 -> 17
   802.11n_HT40 : 22 -> 16

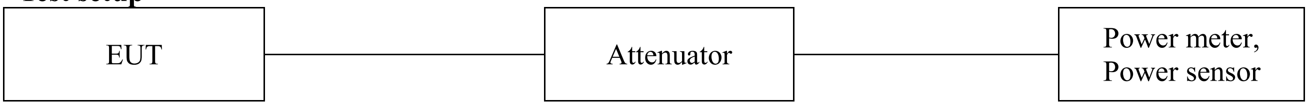
3. Test results

3.1. Output power

Test procedure

ANSI C63.10-2013 - Section 11.9.1.3 and 11.9.2.3.2

Test setup



ANSI C63.10-2013 - Section 11.9.1.3

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS ba ndwidth and shall use a fast-responding diode detector.

ANSI C63.10-2013 - Section 11.9.2.3.2

Alternatively, measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Because the measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

Limit

According to §15.247(b)(3), For systems using digital modulation in the 902~928 ㎒, 2 400~2 483.5 ㎒, and 5 725~5 850 ㎒ bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted out-put power. Maximum Conducted Out-put Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

According to §15.247(b)(4), The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmit-ting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

According to RSS-247 5.4 (d), For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in Section 5.4(e).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

Test results

Mode : 12 V

Measured output power (㏈m)						
Mode	2 402 ㎒		2 442 ㎒		2 480 ㎒	
	Average	Peak	Average	Peak	Average	Peak
BLE 1 Mbps	-4.20	-3.60	-3.25	-2.64	-2.65	-2.12
Mode	2 412 ㎒		2 437 ㎒		2 462 ㎒	
	Average	Peak	Average	Peak	Average	Peak
802.11b	11.05	13.56	11.31	13.89	10.48	13.57
802.11g	10.59	17.02	10.95	17.23	10.42	17.02
802.11n_HT 20	9.83	16.57	10.44	16.87	9.94	16.60
Mode	2 422 ㎒		2 437 ㎒		2 452 ㎒	
	Average	Peak	Average	Peak	Average	Peak
802.11n_HT 40	9.73	16.15	10.05	17.15	9.81	16.21

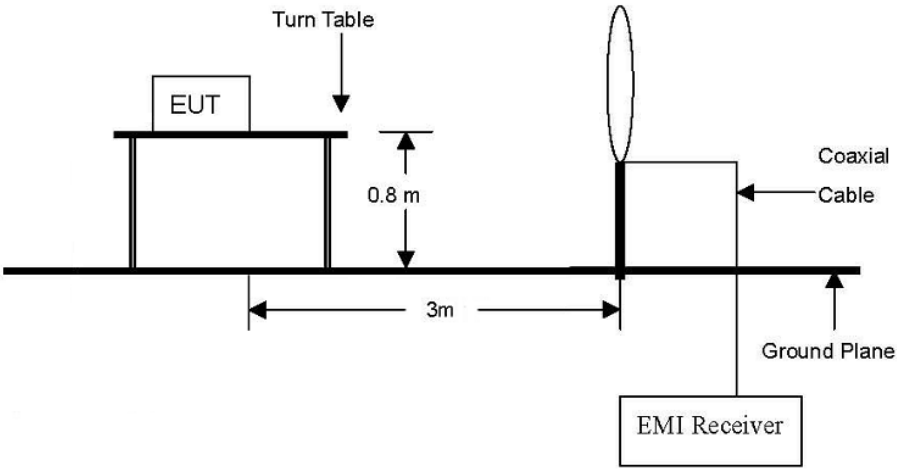
Mode : 24 V

Measured output power (㏈m)						
Mode	2 402 ㎒		2 442 ㎒		2 480 ㎒	
	Average	Peak	Average	Peak	Average	Peak
BLE 1 Mbps	-4.01	-3.52	-3.07	-2.64	-2.51	-2.16
Mode	2 412 ㎒		2 437 ㎒		2 462 ㎒	
	Average	Peak	Average	Peak	Average	Peak
802.11b	11.21	13.83	11.52	14.01	10.99	13.77
802.11g	10.82	17.23	11.24	17.41	10.72	17.26
802.11n_HT 20	10.05	16.71	10.58	16.98	10.23	16.74
Mode	2 422 ㎒		2 437 ㎒		2 452 ㎒	
	Average	Peak	Average	Peak	Average	Peak
802.11n_HT 40	9.96	16.43	10.18	17.39	10.08	16.44

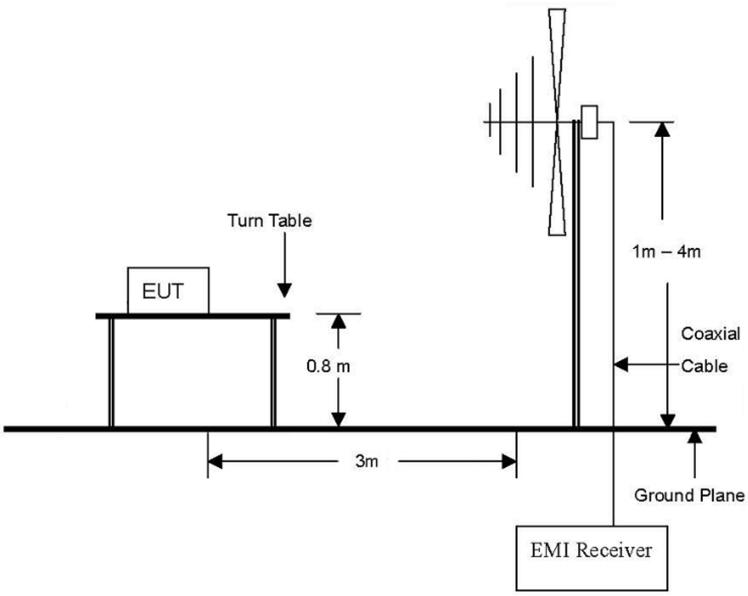
3.2. Radiated restricted band and emissions

Test setup

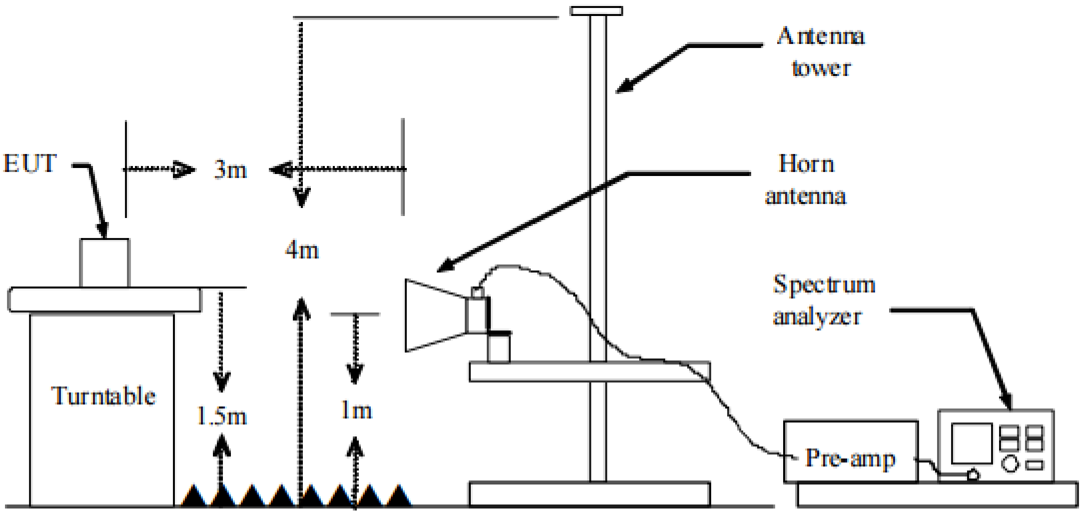
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



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 the tenth harmonic of the highest fundamental frequency or to 40 ㎓ emissions, whichever is lower.



Test procedure

Radiated emissions from the EUT were measured according to the dictates in section 11.11 & 11.12 of ANSI C63.10-2013.

Test procedure below 30 ㎒

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. 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, ground parallel and perpendicular of the antenna are set to make the measurement. It was determined that **parallel** was worst-case orientation; therefore, all final radiated testing was performed with the EUT in **parallel.**
3. 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.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum hold mode.

Test procedure above 30 ㎒

1. The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. The antenna is a bi-log antenna, a horn antenna ,and its height are varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

5. Spectrum analyzer settings for f < 1 ㎓:
   ① Span = wide enough to fully capture the emission being measured
   ② RBW = 100 ㎑
   ③ VBW ≥ RBW
   ④ Detector = quasi peak
   ⑤ Sweep time = auto
   ⑥ Trace = max hold
6. Spectrum analyzer settings for f ≥1 ㎓: Peak
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒
   ③ VBW ≥ 3 ㎒
   ④ Detector = peak
   ⑤ Sweep time = auto
   ⑥ Trace = max hold
   ⑦ Trace was allowed to stabilize

7. Spectrum analyzer settings for *f* ≥1 ㎓: Average
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒
   ③ VBW ≥ 3 × RBW
   ④ Detector = RMS, if span/(# of points in sweep) ≤ (RBW/2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
   ⑤ Averaging type = power(i.e., RMS)
      1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
      2) Some instruments require linear display mode in order to use linear voltage averaging. Log or ㏈ averaging shall not be used.
   ⑥ Sweep = auto
   ⑦ Trace = max hold
   ⑧ Perform a trace average of at least 100 traces.
   ⑨ A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:
      1) If power averaging (RMS) mode was used in step ⑤, then the applicable correction factor is 10 log(1/x), where x is the duty cycle.
      2) If linear voltage averaging mode was used in step ⑤, then the applicable correction factor is 20 log(1/x), where x is the duty cycle.
      3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

Note.

1. *f* <30 ㎒, extrapolation factor of 40 ㏈/decade of distance. $F_d = 40\log(D_m/Ds)$
   f ≥30 ㎒, extrapolation factor of 20 ㏈/decade of distance. $F_d = 20\log(D_m/Ds)$
   Where:
   F_d = Distance factor in ㏈
   D_m = Measurement distance in meters
   D_s = Specification distance in meters
2. Field strength(㏈㎶/m) = Level(㏈㎶) + CF (㏈) + or DCF(㏈)
3. Margin(㏈) = Limit(㏈㎶/m) - Field strength(㏈㎶/m)
4. Emissions below 18 ㎓ were measured at a 3 meter test distance while emissions above 18 ㎓ were measured at a 1 meter test distance with the application of a distance correction factor.
7. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z, it was determined that **X orientation** was worst-case orientation; therefore, all final radiated testing was performed with the EUT in **X orientation.**
8. The worst-case emissions are reported however emissions whose levels were not within 20 ㏈ of respective limits were not reported.
9. According to exploratory test no any obvious emission were detected from 9 ㎑ to 30 ㎒. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

Limit

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values :

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.

According to RSS-Gen, Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits :

Frequency (㎒)	Distance (Meters)	Radiated (㎶/m)
0.009 ~ 0.490	300	2 400 / F(㎑)
0.490 ~ 1.705	30	24 000 / F(㎑)
1.705 ~ 30.0	30	30
30 ~ 88	3	100
88 ~ 216	3	150
216 ~ 960	3	200
Above 960*	3	500

* Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.