

Electromagnetic Emission

FCC MEASUREMENT REPORT

CERTIFICATION OF COMPLIANCE

FCC Part 15 Certification Measurement

PRODUCT	:	KDCSLED HF RFID Module Pack
MODEL/Serial No.	:	KDCSLED-HF / NONE
MULTIPLE MODEL	:	-
BRAND NAME	:	KOAMTAC
FCC ID	:	VH9KDCSLED-HF
APPLICANT	:	AISOLUTION CO., LTD. 28-4, Samyang-ro 29-gil, Gangbuk-gu, Seoul, South Korea Attn.: Hyun Su, Cho / Assistant Manager
MANUFACTURER	:	AISOLUTION CO., LTD. 28-4, Samyang-ro 29-gil, Gangbuk-gu, Seoul, South Korea
EQUIPMENT CLASS	:	DXX - Part 15 Low Power Communication Device Transmitter
TYPE OF MODULATION	:	ASK
FREQUENCY CHANNEL	:	1 CH
ANTENNA TYPE	:	PCB Pattern Antenna (Integral)
RULE PART(S)	:	FCC Part 15 Subpart C
FCC PROCEDURE	:	ANSI C63.10-2013
TEST REPORT No.	:	ETLT180307.0038
DATES OF TEST	:	March 12, 2018 to March 24, 2018
REPORT ISSUE DATE	:	April 03, 2018
TEST LABORATORY	:	ETL Inc. (FCC Designation Number : KR0022)

The KDCSLED HF RFID Module Pack, Model KDCSLED-HF has been tested in accordance with the measurement procedures specified in ANSI C63.10-2013 at the ETL Test Laboratory and has been shown to be complied with the electromagnetic radiated emission limits specified in FCC Rule Part15 Subpart C section 15.247.

I attest to the accuracy of data. All measurement herein was performed by me or was made under my supervision and is correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

The results of testing in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Prepared by:

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April 03, 2018

Reviewed by:

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April 03, 2018

ETL Inc.

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The test report merely corresponds to the test sample(s).

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FCC MEASUREMENT REPORT

Scope – *Measurement and determination of electromagnetic emission (EME) of radio frequency devices including intentional radiators and/or unintentional radiators for compliance with the technical rules and regulations of the U.S Federal Communications Commission(FCC)*

General Information

Applicant Name	: AISOLUTION CO., LTD.
Address	: 28-4, Samyang-ro 29-gil, Gangbuk-gu, Seoul, South Korea
Attention	: Hyun Su, Cho / Assistant Manager

- **EUT Type** : KDCSLED HF RFID Module Pack
- **Model Number** : KDCSLED-HF
- **S/N** : NONE
- **Freq. Range** : 13.56 MHz
- **Modulation Technique** : ASK
- **Antenna Type** : PCB Pattern Antenna (Integral)
- **Environmental of Tests** : Temperature: $(17.6 \pm 6.5) ^\circ\text{C}$
Humidity: $(55 \pm 18) \% \text{ R.H.}$
Atmospheric Pressure: $(101.8 \pm 0.5) \text{ kPa}$
- **FCC Rule Part(s)** : FCC Part 15 Subpart C
- **Test Procedure** : ANSI C63.10-2013
- **EQUIPMENT CLASS** : DXX - Part 15 Low Power Communication Device Transmitter
- **Place of Tests** : ETL Inc. Testing Lab. (FCC Designation Number : KR0022)

Radiated Emission test 1;
#499-1, Sagot-ri, Seosin-myeon, Hwaseong-si,
Gyeonggi-do, 445-882, Korea
- Radiated Emission test 2 and Conducted Emission test;
#371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea

1. INTRODUCTION

The measurement test for radiated and conducted emission test was conducted at the ETL Inc. The site is constructed in conformance with the requirements of the ANSI C63.10-2013 and CISPR Publication 16. The ETL has site descriptions on file with the FCC for 3 m and 10 m site configurations. Detailed description of test facility was found to be in compliance with FCC Rules according to the ANSI C63.10-2013 and registered to the Federal Communications Commission (FCC Designation Number : KR0022).

The measurement procedure described in American National Standard for Method of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.10-2013) was used in determining radiated and conducted emissions from the AISOLUTION CO., LTD., Model: KDCSLED-HF

2. PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the KDCSLED HF RFID Module Pack (model: KDCSLED-HF).

The model KDCSLED-HF is basic model that was tested.

2.2 General Specification

Item	Specification
Frequency	13.56 MHz
Supported standard	ISO/IEC 14443A, 14443B, 15693 MIFARE 1K/4K, Ultra light
Interfaces	I2C
Supply Voltage	3.3 V
Dimensions	104.5 mm (L) x 60 mm (W) x 10 mm (H)
Weight	39.5 g
Drop Spec	4 feet (1.22 M)
Operating Temperature	(22.5 ± 22.5) °C ((72.5 ± 40.5) °F)
Storage Temperature	(12.5 ± 32.5) °C ((54.5 ± 58.5) °F)
Humidity	(45 ± 40) % (noncondensing)
High Internal Frequency	NFC PN544 → 27.120 MHz

3. DESCRIPTION OF TESTS

The tests documented in this report were performed in accordance with ANSI C63.10-2013 and FCC CFR 47 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, 2.1057, 15.207, 15.209, 15.225 and 15.215

3.1 Radiated Emission Measurement

Radiated emission measurements were made in accordance with § 13 in ANSI C63.10-2013 "Measurement of Intentional radiators" The measurements were performed over the frequency range of 30 MHz to 40 GHz using antenna as the input transducer to a Spectrum analyzer or a Field Intensity Meter. The measurements were made with the detector set for "Peak, Quasi-peak, Average" within a bandwidth of 120 kHz and above 1 GHz is 1 MHz.

Preliminary measurements were made at 3 m using broadband antennas, and spectrum analyzer to determine the frequency producing the maximum emission in shielded room. Appropriate precaution was taken to ensure that all emission from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth and height with respect to the antenna were noted for each frequency found. The spectrum was scanned from 30 MHz to 1 000 MHz using Log-Bicon antenna. Above 1 GHz, linearly polarized double ridge horn antennas were used. Final measurements were made open site or SVSWR chamber at 3 m. The test equipment was placed on a styrofoam table. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. Each frequency found during pre-scan measurements was re-examined by manual. The EUT, support equipment and interconnecting cables were re-configured to the set-up producing the maximum emission for the frequency and were placed on top of a table height for below 1GHz is 0.8 m, and for above 1GHz is 1.5 m. nonmetallic 1.0 m x 1.5 m table. The EUT, support equipment, and interconnecting cables were re-arranged and manipulated to maximize each emission. The turntable containing the system was rotated; the antenna height was varied 1 m to 4 m and stopped at the azimuth or height producing the maximum emission.

Varying the mode of operating frequencies of the EUT maximized each emission. The system was tested in all the three orthogonal planes and changing the polarity of the antenna. The worst-case emissions are recorded in the data tables. If necessary, the radiated emission measurement could be performed at a closer distance to ensure higher accuracy and the results were extrapolated to the specified distance using an inverse linear distance extrapolation factor (20 dB/decade) as per section 15.31(f).

Photographs of the worst-case emission can be seen in Photographs of the worst-case emission test setup can be seen in Appendix B.

3.1.1 Radiated Emission Limits:**(1) According to §15.209 Radiated emission limits, general requirements**

(a) 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:

Frequencies [MHz]	Field Strength [μV/m]	Measurement Distance [m]
0.009 - 0.490	2400/F (kHz)	300
0.490 - 1.705	24000/F (kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

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

3.2 Carrier field strength and field strength outside 13.110 MHz - 14.010 MHz and occupied bandwidth

(1) According to §15.225 Operation within the band 13.110 MHz - 14.010 MHz

- (a) The field strength of any emissions within the band 13.553 MHz - 13.567 MHz shall not exceed 15 848 microvolts/meter at 30 meters
- (b) Within the bands 13.410 MHz - 13.553 MHz and 13.567 MHz - 13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters
- (c) Within the bands 13.110 MHz - 13.410 MHz and 13.710 MHz - 14.010 MHz, the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters
- (d) The field strength of any emissions appearing outside of the 13.110 MHz - 14.010 MHz band shall not exceed the general radiated emission limits in § 15.209

Frequency [MHz]	Field Strength Limit [μ V/m] @ 30 m	Field Strength Limit [dB(μ V/m)] @ 30 m	Field Strength Limit [dB(μ V/m)] @ 3 m
13.110 - 13.410	106	40.5	80.5
13.410 - 13.553	334	50.5	90.5
13.553 - 13.567	15 848	84.0	124.0
13.567 - 13.710	334	50.5	90.5
13.710 - 14.010	106	40.5	80.5

(2) According to §15.215(c) Occupied bandwidth

- (a) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in § 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80 % of the permitted band in order to minimize the possibility of out-of-band operation.

3.3 Frequency tolerance

(1) According to §15.225 Operation within the band 13.110 MHz - 14.010 MHz

- (e) The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency over a temperature variation of -20°C to $+50^{\circ}\text{C}$ at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rated supply voltage at a temperature of 20°C . For battery-operated equipment, the equipment tests shall be performed using a new battery.

3.4 Conducted Emission Measurement

Conducted emissions measurements were made in accordance with section § 13 in ANSI C63.10-2013 "measurement of intentional radiators". The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to a Spectrum Analyzer or a Test Receiver. The measurements were made with the detector set for "Peak" amplitude within a bandwidth of 9 kHz or for "quasi-peak" within a bandwidth of 9 kHz.

The line-conducted emission test is conducted inside a shielded anechoic chamber room with 1 m x 1.5 m x 0.8 m wooden table which is placed 0.4 m away from the vertical wall and 1.5 m away from the side wall of the chamber room. Two LISN are bonded to the shielded room. The EUT is powered from the LISN and the support equipment is powered from the other LISN. Power to the LISNs are filtered by a noise cut power line filters. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and these supply lines will be connected to the LISN. Non-inductive bundling to a 1 m length shortened all interconnecting cables more than 1 m. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the EMI Test Receiver to determine the frequency producing the maximum emission from the EUT. The frequency producing the maximum level was reexamined using to set Quasi-Peak mode by manual, after scanned by automatic Peak mode from 0.15 MHz to 30 MHz. The bandwidth of the spectrum analyzer was set to 9 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission.

Photographs of the worst-case emission can be seen in Photographs of the worst-case emission test setup can be seen in Appendix B.

3.5 FCC Part 15.205 Restricted Bands of Operations

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
¹ 0.495 - 0.505	16.694 75 - 16.695 25	608 - 614	5.35 - 5.46
2.173 5 - 2.190 5	16.804 25 - 16.804 75	960 - 1 240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1 300 - 1 427	8.025 - 8.5
4.177 25 - 4.177 75	37.5 - 38.25	1 435 - 1 626.5	9.0 - 9.2
4.207 25 - 4.207 75	73 - 74.6	1 645.5 - 1 646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1 660 - 1 710	10.6 - 12.7
6.267 75 - 6.268 25	108 - 121.94	1 718.8 - 1 722.2	13.25 - 13.4
6.311 75 - 6.312 25	123 - 138	2 200 - 2 300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2 310 - 2 390	15.35 - 16.2
8.362 - 8.366	156.524 75 - 156.525 25	2 483.5 - 2 500	17.7 - 21.4
8.376 25 - 8.386 75	156.7 - 156.9	2 690 - 2 900	22.01 - 23.12
8.414 25 - 8.414 75	162.012 5 - 167.17	3 260 - 3 267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3 332 - 3 339	31.2 - 31.8
12.519 75 - 12.520 25	240 - 285	3 345.8 - 3 358	36.43 - 36.5
12.576 75 - 12.577 25	322 - 335.4	3 600 - 4 400	(²)
13.36 - 13.41			

¹ Until February 1, 1999, this restricted band shall be 0.490 MHz - 0.510 MHz.

² Above 38.6

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1 000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

3.6 Antenna connection requirement

(1) According to §15.203

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

4. TEST CONDITION

4.1 Test Configuration

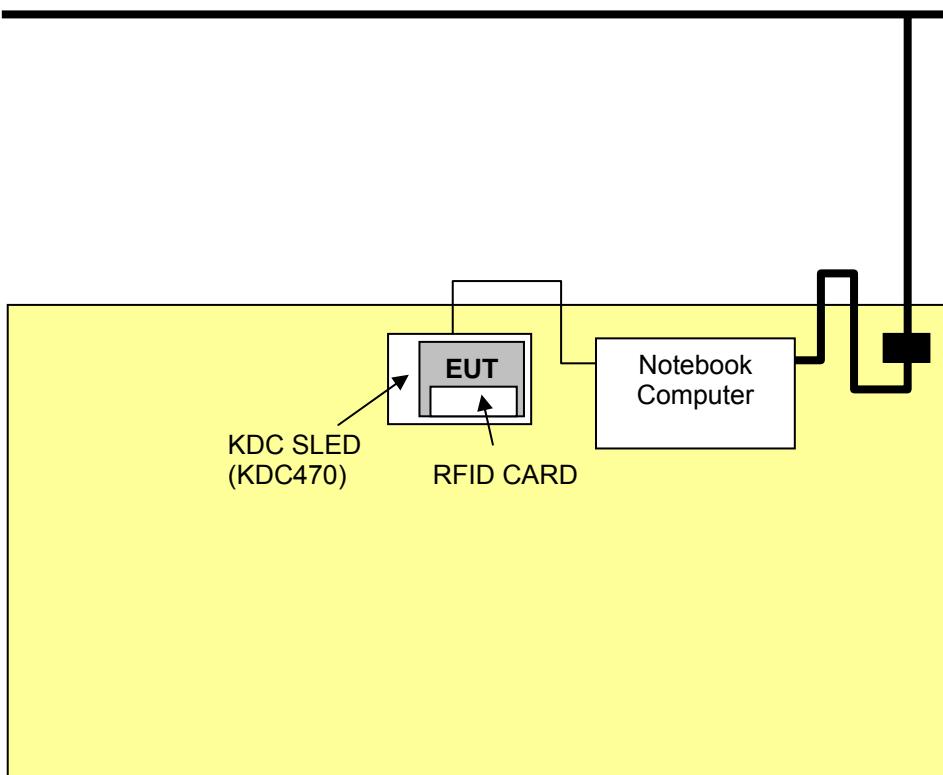
The device was configured for testing in a typical fashion (as a customer would normally use it). During the tests, the following conditions and configurations were used.

* This test was applied to X, Y, Z. and the worst result were investigated and reported.

4.2 Description of Test modes

KDCSLED HF RFID Module Pack that has the control software.

4.3 The setup drawing(s)



____ : Signal Line
_____ : Power Line
■ : Standard Adapter

4.4 Support Equipment Used

Description	Model Name	Serial No.	Manufacturer
Notebook Computer	ProBook 6560b	4CZ124083M	HEWLETT-PACKARD COMPANY
Adapter (for Notebook Computer)	PPP009D	NONE	DELTA ELECTRONICS(JIANG SU)LTD.
KDC SLED* (Bar code scanner)	KDC470	NONE	AISOLUTION CO., LTD.

* EUT was mounted on KDC SLED (As like KDC470)

5. TEST RESULTS

5.1 Summary of Test Results

The measurement results were obtained with the EUT tested in the conditions described in this report. Detailed measurement data and plots showing the maximum emission of the EUT are reported.

Test Rule Parts	Measurement Required	Result
15.207(a),(c)	Conducted emissions	Pass *
15.209 15.225(d)	Radiated emissions Field strength outside 13.110 MHz - 14.010 MHz	Pass
15.225(a)(b)(c)	13.56 MHz carrier field strength within the bands	Pass
15.215	Occupied Bandwidth	Pass
15.225(e)	Frequency Tolerance	Pass
15.203	Antenna connection requirement	Integral antenna which is permanently attached and cannot be replaced.

* This test was tested at main host notebook computer. (EUT was mounted on KDC SLED (As like KDC470) and KDC SLED (As like KDC470) was connected USB port of the host notebook computer.)

The data collected shows that the **AISOLUTION CO., LTD. / KDCSLED HF RFID Module Pack / KDCSLED-HF** complied with technical requirements of above rules part 15.207, 209, 225 and 15.215 Limits.

The equipment is not modified anything, mechanical or circuits to improve EMI status during a measurement. No EMI suppression device(s) was added and/or modified during testing.

5.2 Conducted Emissions Measurement

EUT	KDCSLED HF RFID Module Pack / KDCSLED-HF
Limit apply to	FCC Part 15.207
Test Date	March 12, 2018
Environmental of Test	(22.6 ± 0.0) °C, (38 ± 0) % R.H., (102.3 ± 0.0) kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed by 7.62 dB

Limit

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency of Emission [MHz]	Conducted limit [dB(μ V)]	
	Quasi-peak	Average
0.15 - 0.5	66 to 56 *	56 to 46 *
0.5 - 5	56	46
5 - 30	60	50

* Decreases with the logarithm of the frequency.

Test Results

- Refer to see the measured plot in next page.

Conducted Emission Test Data

The following data and graph shows the highest levels of conducted emissions on both polarizations of hot and neutral line.

Detector mode: CISPR Quasi-Peak mode (6 dB Bandwidth: 9 kHz)

NOTES:

1. Please see the measured data and graph in next page.
2. The Level (Result) value was included the reading, LISN factor and cable loss.
3. Delta (Margin) value = Limit - Level (Result)
4. Measurement were performed at the AC Power Inlet in the frequency band of 150 kHz ~ 30 MHz according to the FCC Part 15.207.
5. If the Quasi-Peak limit is met when using a Peak detector receiver, the EUT shall be deemed to meet both limits and measurement with the Quasi-Peak detector receiver is unnecessary.
6. If the average limit is met when using a Quasi-peak detector receiver, the EUT shall be deemed to meet both limits and measurement with the average detector receiver is unnecessary.

Line: HOT

ETL EMC Laboratory

Conducted Emission Test Result

EUT: ETLT180307.0038

Manuf:

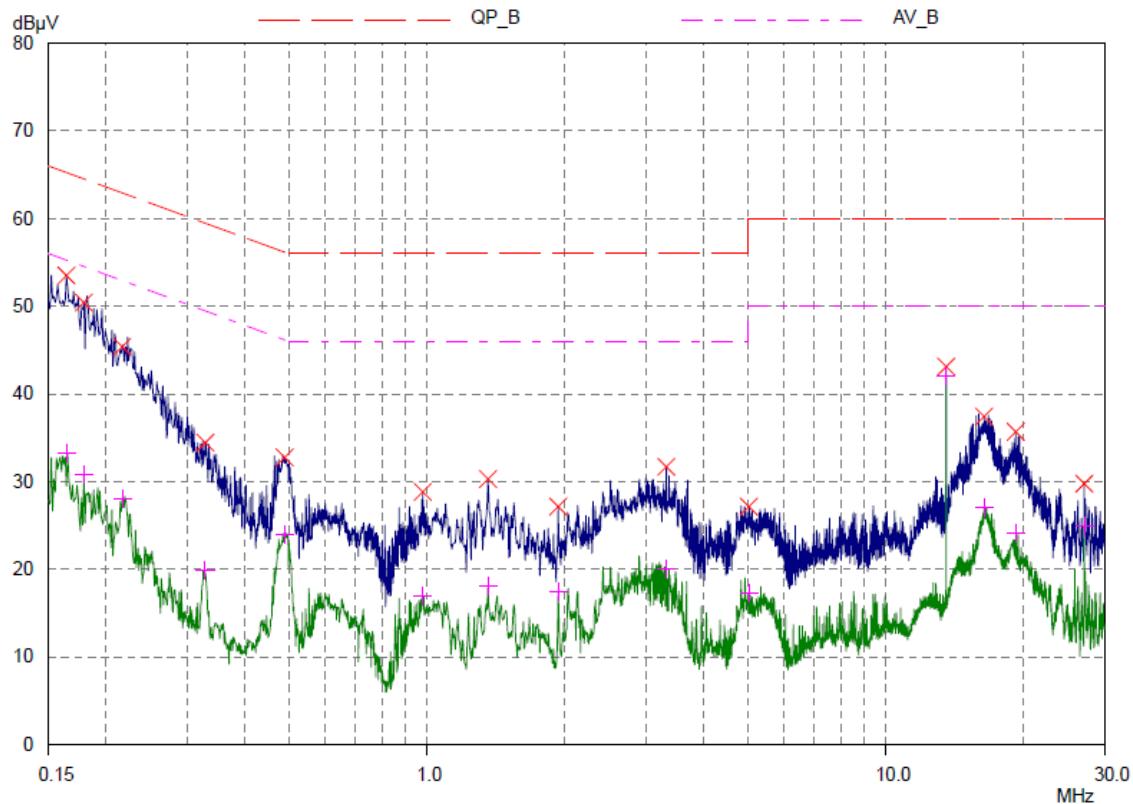
Op Cond:

Operator:

Test Spec:

Comment: HOT

Prescan Measurement: Detectors: X PK / + AV
Meas Time: see scan settings
Peaks: 16
Acc Margin: 10 dB



ETL EMC Laboratory

Conducted Emission Test Result

EUT: ETLT180307.0038

Manuf:

Op Cond:

Operator:

Test Spec:

Comment: HOT

Prescan Measurement:	Detectors:	X PK / + AV
	Meas Time:	see scan settings
	Peaks:	16
	Acc Margin:	10 dB

Peak Search Results

Frequency MHz	PK Level dB μ V	PK Limit dB μ V	PK Delta dB
0.164	53.50	65.26	11.76
0.179	50.42	64.53	14.11
0.217	45.37	62.93	17.56
0.329	34.42	59.48	25.06
0.49	32.75	56.17	23.42
0.981	28.83	56.00	27.17
1.36	30.29	56.00	25.71
1.935	27.13	56.00	28.87
3.33	31.69	56.00	24.31
5.045	27.12	60.00	32.88
13.56	43.10	60.00	16.90
16.41	37.43	60.00	22.57
19.23	35.68	60.00	24.32
27.12	29.75	60.00	30.25

Frequency MHz	AV Level dB μ V	AV Limit dB μ V	AV Delta dB
0.164	33.21	55.26	22.05
0.179	30.77	54.53	23.76
0.217	27.99	52.93	24.94
0.329	19.89	49.48	29.59
0.49	24.01	46.17	22.16
0.981	16.92	46.00	29.08
1.36	18.11	46.00	27.89
1.935	17.36	46.00	28.64
3.33	20.02	46.00	25.98
5.045	17.31	50.00	32.69
13.56	42.11	50.00	7.89
16.41	27.02	50.00	22.98
19.23	24.04	50.00	25.96
27.12	25.00	50.00	25.00

* limit exceeded

Line: Neutral

ETL EMC Laboratory

Conducted Emission Test Result

EUT: ETLT180307.0038

Manuf:

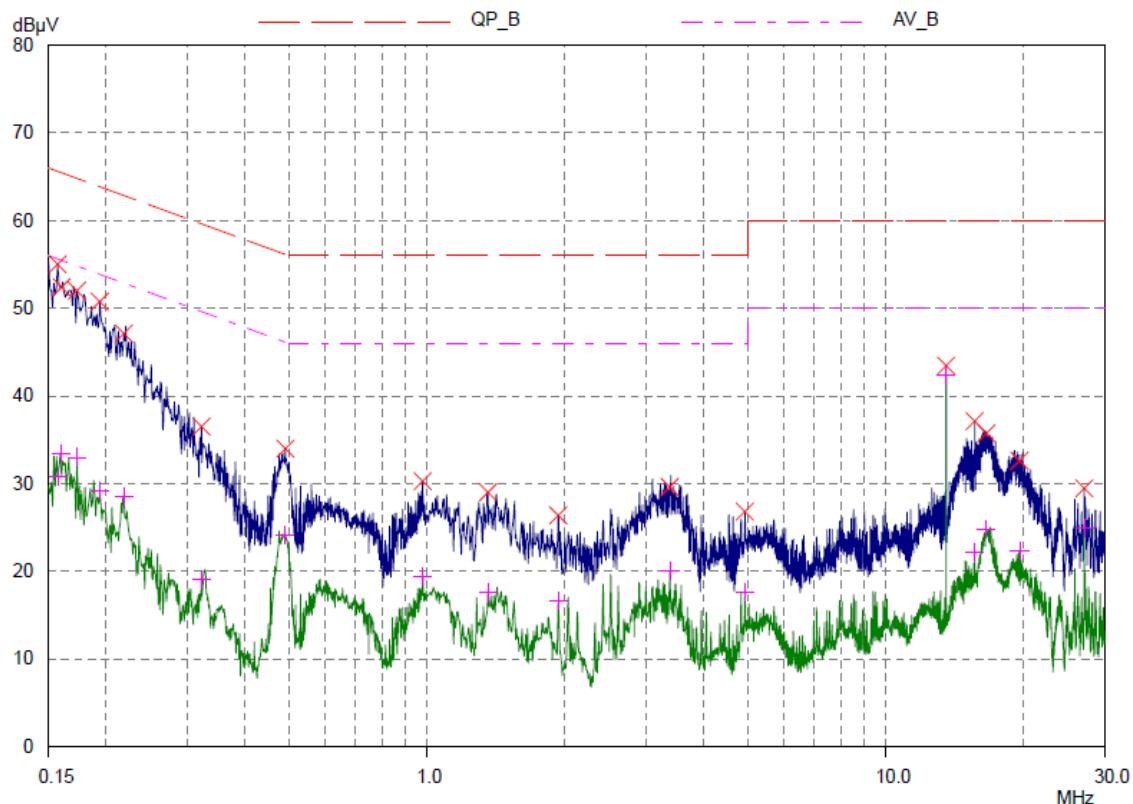
Op Cond:

Operator:

Test Spec:

Comment: N

Prescan Measurement: Detectors: X PK / + AV
Meas Time: see scan settings
Peaks: 16
Acc Margin: 10 dB



ETL EMC Laboratory

Conducted Emission Test Result

EUT: ETLT180307.0038

Manuf:

Op Cond:

Operator:

Test Spec:

Comment: N

Prescan Measurement:	Detectors:	X PK / + AV
	Meas Time:	see scan settings
	Peaks:	16
	Acc Margin:	10 dB

Peak Search Results

Frequency MHz	PK Level dB μ V	PK Limit dB μ V	PK Delta dB
0.157	55.01	65.62	10.61
0.16	52.40	65.46	13.06
0.173	52.00	64.82	12.82
0.194	50.76	63.86	13.10
0.219	47.11	62.86	15.75
0.323	36.50	59.63	23.13
0.492	33.98	56.13	22.15
0.98	30.28	56.00	25.72
1.36	29.00	56.00	27.00
1.935	26.37	56.00	29.63
3.39	29.61	56.00	26.39
4.945	26.80	56.00	29.20
13.56	43.44	60.00	16.56
15.66	37.11	60.00	22.89
16.61	35.72	60.00	24.28
19.62	32.59	60.00	27.41
27.12	29.45	60.00	30.55

Frequency MHz	AV Level dB μ V	AV Limit dB μ V	AV Delta dB
0.157	30.78	55.62	24.84
0.16	33.37	55.46	22.09
0.173	33.00	54.82	21.82
0.194	29.12	53.86	24.74
0.219	28.59	52.86	24.27
0.323	19.02	49.63	30.61
0.492	24.16	46.13	21.97
0.98	19.40	46.00	26.60
1.36	17.52	46.00	28.48
1.935	16.63	46.00	29.37
3.39	20.02	46.00	25.98

* limit exceeded

Peak Search Results (continued)

Frequency MHz	AV Level dB μ V	AV Limit dB μ V	AV Delta dB
4.945	17.57	46.00	28.43
13.56	42.38	50.00	7.62
15.66	22.16	50.00	27.84
16.61	24.82	50.00	25.18
19.62	22.35	50.00	27.65
27.12	24.96	50.00	25.04

* limit exceeded

5.3 Spurious Emissions

EUT	KDCSLED HF RFID Module Pack / KDCSLED-HF
Limit apply to	FCC Part 15.209
Operating Condition	RF transmitting continuously during the tested.
Result	Passed

Limit

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:

Frequencies [MHz]	Field Strength [μ V/m]	Measurement Distance [m]
0.009 - 0.490	2 400/F(kHz)	300
0.490 - 1.705	24 000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

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

Test Results

- Refer to see the measured plot in next page.

Radiated Emissions Test data

- 9 kHz to 1 GHz

Test Date	March 19, 2018
Environmental of Test	(11.2 ± 0.1) °C, (72 ± 1) % R.H., (101.3 ± 0.0) kPa

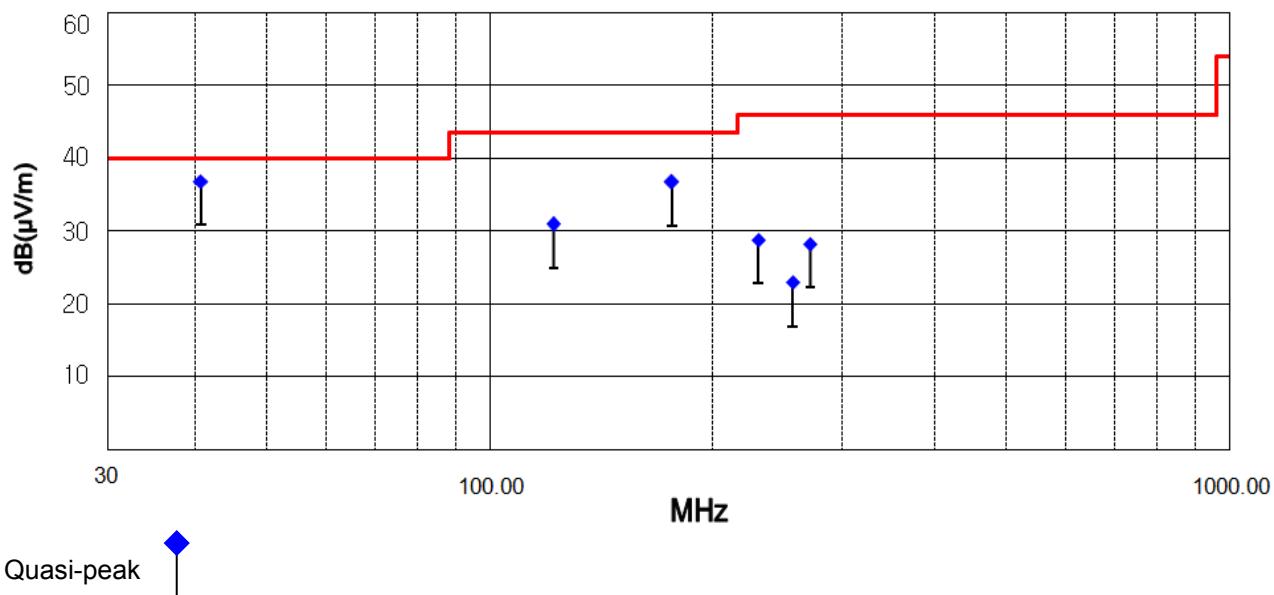
The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical. Detector mode: CISPR Quasi-Peak mode (100 Hz, 9 kHz) (6 dB Bandwidth: 120 kHz)

Frequency [MHz]	Reading [dB(µV)]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB(µV)]	Height [cm]	Result [dB(µV/m)]	Limit [dB(µV/m)]	Margin [dB]
40.68	57.15	V	12.38	-32.59	100	36.94	40.00	3.06
122.04	54.01	V	9.12	-32.09	125	31.04	43.50	12.46
176.28	59.64	V	9.01	-31.85	130	36.80	43.50	6.70
230.55	48.24	V	12.44	-31.79	138	28.89	46.00	17.11
256.95	41.83	V	13.03	-31.81	140	23.05	46.00	22.95
271.20	46.85	H	13.25	-31.77	360	28.33	46.00	17.67

NOTES:

- * H : Horizontal polarization , ** V : Vertical polarization
- The cable loss value was included the Amp. Gain.
- Result = Reading + Antenna factor + Cable loss
- Margin value = Limit - Result
- The measurement was performed for the frequency range above 9 kHz according to FCC Part 15.209.

— : Limit



5.4 13.56 MHz carrier field strength within bands

EUT	KDCSLED HF RFID Module Pack / KDCSLED-HF						
Limit apply to	FCC Part 15.225(a)(b)(c)						
Test Date	March 19, 2018						
Environmental of Test	$(11.3 \pm 0.0)^\circ\text{C}$, $(72 \pm 0)\%$ R.H., $(101.3 \pm 0.0)\text{kPa}$						
Operating Condition	RF transmitting continuously during the tested						
Result	Passed						

Radiated Emission Test Data

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical. Detector mode: CISPR Quasi-Peak mode (6 dB Bandwidth: 9 kHz)

Frequency [MHz]	Reading [dB(μ V) @ 3 m]	Polarization (*H/**V)	Ant. Factor [dB/m]	Cable Loss [dB]	Result [dB(μ V/m) @ 3 m]	Limit [dB(μ V/m) @ 3 m]	Margin [dB]
13.56	44.96	H	10.27	0.59	55.82	124.00	68.18

NOTES:

1. * H : Horizontal polarization , ** V : Vertical polarization
2. Result = Reading + Antenna factor + Cable loss
3. Margin value = Limit - Result
4. The measurement was performed for the frequency range 13.56 MHz according to FCC Part 15.225(a)(b)(c)
5. This test was applied both to Horizontal polarization and Vertical polarization.
(Worst case: Horizontal polarization)

5.5 Occupied Bandwidth

EUT	KDCSLED HF RFID Module Pack / KDCSLED-HF
Limit apply to	FCC Part 15.215
Test Date	March 24, 2018
Environmental of Test	(23.0 \pm 0.0) °C, (41 \pm 0) % R.H., (102.2 \pm 0.0) kPa
Operating Condition	RF transmitting continuously during the tested.
Result	Passed

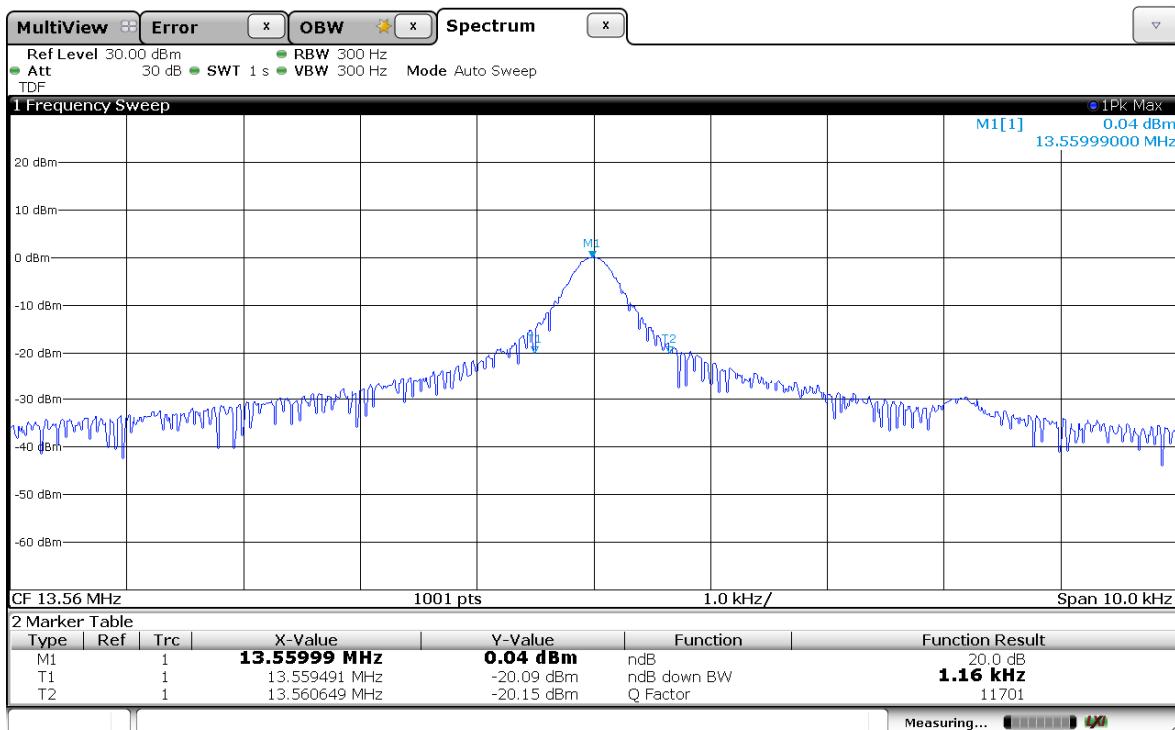
5.5.1 Occupied Bandwidth

Frequency [MHz]	20 dB Bandwidth [kHz]
13.56	1.16

NOTES:

1. Measure frequency separation of relevant channel using spectrum analyzer.

Plots of 20 dB Bandwidth



5.6 Frequency Tolerance

EUT	KDCSLED HF RFID Module Pack / KDCSLED-HF
Limit apply to	FCC Part 15.225(e)
Test Date	March 24, 2018
Environmental of Test	(23.2 ± 0.8) °C, (41 ± 4) % R.H., (102.2 ± 0.0) kPa
Operating Condition	RF transmitting continuously during the tested
Result	Passed

Frequency Tolerance Test Data

The Frequency Tolerance of the carrier signal shall be maintained within ± 0.01 % of operating frequency over a temperature variation of -20 °C to +50 °C at normal supply voltage, and for a variation in the primary supply voltage from 85 % to 115 % of the rated supply voltage at a temperature of 20 °C.

- Operating frequency: 13.56 MHz
- Limit: ± 1 356 Hz
- Within the band: 13.559 644 MHz - 13.562 356 MHz

Frequency Stability Versus Environment Temperature (+50 °C ~ -20 °C)

Reference Frequency: 13.56 MHz				Limit: ± 1 356 Hz				
Environment Temperature [°C]	Frequency Measure with Time Elapsed							
	Start up		2 Minute		5 Minute		10 Minute	
	MHz	Deviation	MHz	Deviation	MHz	Deviation	MHz	
50	13.559 946	-0.000 054	13.559 941	-0.000 059	13.559 940	-0.000 060	13.559 934	-0.000 066
40	13.559 974	-0.000 026	13.559 959	-0.000 041	13.559 959	-0.000 041	13.559 959	-0.000 041
30	13.560 020	0.000 020	13.559 993	-0.000 007	13.555 996	-0.000 004	13.559 995	-0.000 005
20	13.560 034	0.000 034	13.560 011	0.000 011	13.560 006	0.000 006	13.560 012	0.000 012
10	13.560 099	0.000 099	13.560 054	0.000 054	13.560 047	0.000 047	13.560 039	0.000 039
0	13.560 133	0.000 133	13.560 092	0.000 092	13.560 082	0.000 082	13.560 082	0.000 082
-10	13.560 129	0.000 129	13.560 135	0.000 135	13.560 126	0.000 126	13.560 139	0.000 139
-20	13.560 116	0.000 116	13.560 137	0.000 137	13.560 138	0.000 138	13.560 136	0.000 136

Frequency Stability Versus Input Power (± 15 %): Environment Temperature: 20 °C

Reference Frequency: 13.56 MHz				Limit: ± 1 356 Hz				
Power Supplied [Vdc]	Frequency Measure with Time Elapsed							
	Start up		2 Minute		5 Minute		10 Minute	
	MHz	Deviation	MHz	Deviation	MHz	Deviation	MHz	
3.83	13.559 990	-0.000 010	13.559 989	-0.000 011	13.559 990	-0.000 010	13.559 990	-0.000 010
4.50	13.559 981	-0.000 019	13.559 983	-0.000 017	13.559 984	-0.000 016	13.559 986	-0.000 014
5.18	13.559 991	-0.000 009	13.559 990	-0.000 010	13.559 990	-0.000 010	13.559 990	-0.000 010

6. SAMPLE CALCULATION

Sample Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor.

The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF$$

Where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor - Preamplifier Factor

$$dB(\mu V) = 20 \log_{10} (\mu V) : \text{Equation}$$

$$dB(\mu V) = dBm + 107$$

Example : @ 40.68 MHz

Limit	= 40.00 dB(μ V/m)
Reading	= 57.15 dB(μ V)
Antenna Factor + (Cable Loss - Amp. Gain)	= 12.38 + (-32.59) = -20.21 dB(μ V/m)
Total	= 57.15 + (-20.21) = 36.94 dB(μ V/m)
Margin	= 40.00 - 36.94 = 3.06 dB
	= 3.06 dB below Limit

7. List of test equipments used for measurements

Test Equipment		Model	Mfg.	Serial No.	Cal. Date	Cal. Due Date
<input checked="" type="checkbox"/>	EMI Test Receiver	ESCS30	R&S	100087	18.03.12	19.03.12
<input checked="" type="checkbox"/>	Amplifier	BLWA 0310-1	BONN Elektronik	045672	18.01.31	19.01.31
<input checked="" type="checkbox"/>	Loop Antenna	6502	EMCO	00033743	16.09.05	18.09.05
<input checked="" type="checkbox"/>	Bi-Log Antenna	VULB9163	Schwarzbeck	01069	17.02.17	19.02.17
<input checked="" type="checkbox"/>	TEMP.&HUMID. Chamber	PL-1KP	Tabai Espec Corp.	14006754	18.03.13	19.03.13
<input checked="" type="checkbox"/>	Spectrum Analyzer	FSW43	R&S	103794	17.09.05	18.09.05
<input checked="" type="checkbox"/>	EMI Test Receiver	ESPI3	R&S	100478	17.08.31	18.08.31
<input checked="" type="checkbox"/>	Two-Line V-network	ENV216	R&S	102055	18.03.12	19.03.12
<input checked="" type="checkbox"/>	Attenuator	BW-S10-2W263+	Mini-Circuits	NONE	18.03.14	19.03.14
<input checked="" type="checkbox"/>	DC Power Supply	SDP 60-5D	SM Techno	605DOD 002	18.03.12	19.03.12
<input checked="" type="checkbox"/>	DC Block	NONE	NONE	NONE	18.03.12	19.03.12
<input checked="" type="checkbox"/>	Turn-Table	TT 1.35 SI	SES	-	N/A	N/A
<input checked="" type="checkbox"/>	Antenna Master	AM 4.5	SES	-	N/A	N/A