



TEST REPORT

KCTL Inc.

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Report No.:
KR18-SRF0086
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1. Client

- Name : SMARTeLock CO., LTD.
- Address : B-402, Geumgang Penterium IT Tower, 215, Galmachi-ro, Jungwon-gu, Seongnam-si, Gyeonggi-do, 13217, Rep. of KOREA
- Date of Receipt : 2018-06-01

2. Use of Report : -

3. Name of Product and Model : IN-Furniture Safe / ES100

4. Manufacturer and Country of Origin : SMARTeLock CO., LTD. / Korea

5. FCC ID : 2AQAVES100

6. Date of Test : 2018-06-21 to 2018-06-22

7. Test Standards : FCC Part 15 Subpart C 15.225

8. Test Results : Refer to the test result in the test report

Affirmation	Tested by	Technical Manager
	Name : Seonjun Yun (Signature)	Name : Jongha Choi (Signature)

2018-06-26

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As a test result of the sample which was submitted from the client, this report does not guarantee the whole product quality. This test report should not be used and copied without a written agreement by KCTL Inc.

REPORT REVISION HISTORY

Date	Revision	Page No
2018-06-26	Originally issued	-

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1. Client information

Applicant: SMARTeLock CO., LTD.
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Manufacturer: SMARTeLock CO., LTD.
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2. Laboratory information

Address

KCTL Inc.

65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea

Telephone Number: 82 31 285 0894

Facsimile Number: 82 505 299 8311

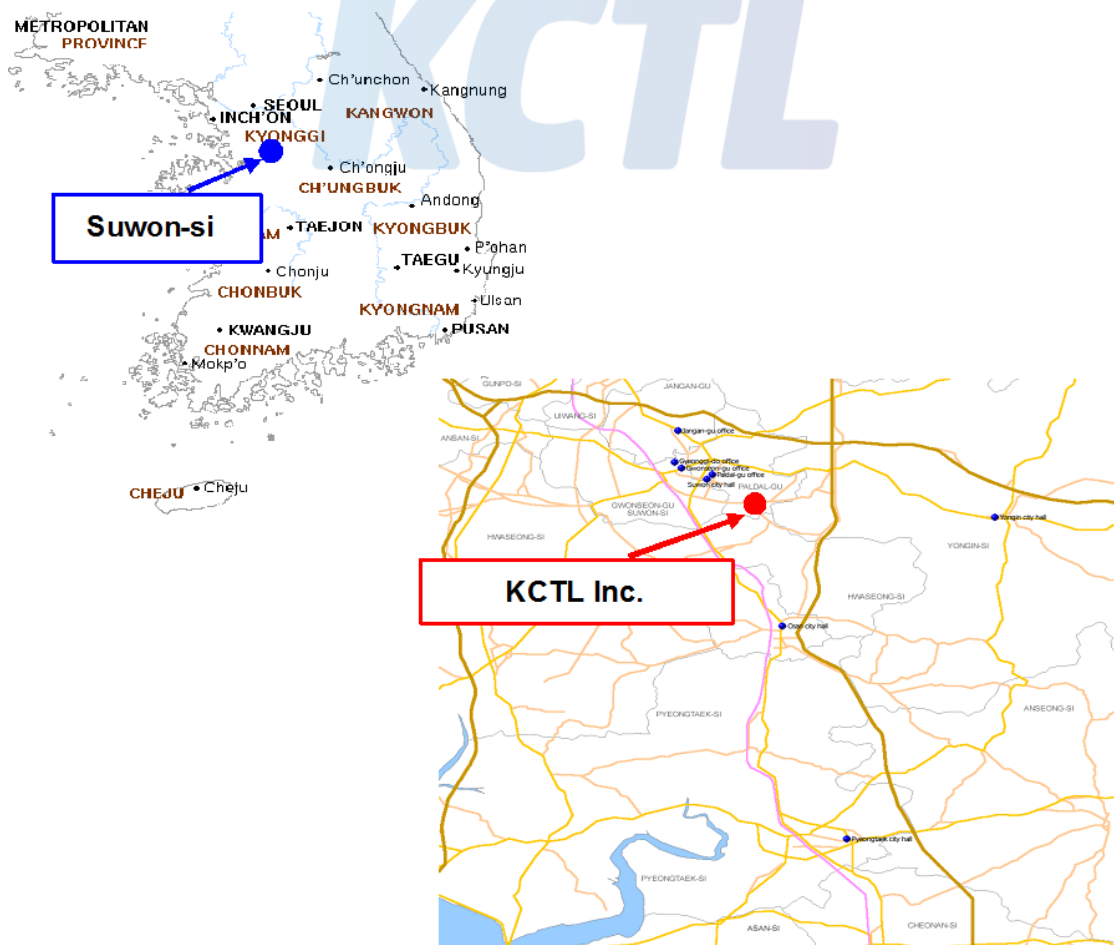
FCC Site Designation No: KR0040, FCC Site Registration No: 687132

VCCI Registration No. : R-3327, G-198, C-3706, T-1849

Industry Canada Registration No. : 8035A-2

KOLAS NO.: KT231

SITE MAP



3. Description of E.U.T.

3.1 Basic description

Applicant	SMARTeLock CO., LTD.
Address of Applicant	B-402, Geumgang Penterium IT Tower, 215, Galmachi-ro, Jungwon-gu, Seongnam-si, Gyeonggi-do, 13217 Rep. of KOREA
Manufacturer	SMARTeLock CO., LTD.
Address of Manufacturer	B-402, Geumgang Penterium IT Tower, 215, Galmachi-ro, Jungwon-gu, Seongnam-si, Gyeonggi-do, 13217 Rep. of KOREA
Type of equipment	IN-Furniture Safe
Basic Model	ES100
Serial number	N/A

3.2 General description

Frequency Range	2 402 MHz ~ 2 480 MHz (Bluetooth Low Energy), 13.56 MHz (NFC)
Type of Modulation	GFSK MHz (Bluetooth Low Energy), ASK (NFC)
The number of channels	40 ch (Bluetooth Low Energy), 1 ch (NFC)
Type of Antenna	Chip Antenna (Bluetooth Low Energy), Loop Antenna (NFC)
Power supply	DC 6 V
Product SW/HW version	nRF51_ES100_HW11_V1.0.0 / V1.1
Radio SW/HW version	nRF51_ES100_HW11_V1.0.0 / V1.1
Test SW Version	Toggle button ON/OFF
RF power setting in TEST SW	default

Note : The above EUT information was declared by the manufacturer.

3.3 Test frequency

Frequency	13.56 MHz
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4. Summary of test results

4.1 Standards & results

Rule Reference	Parameter	Status
15.203	Antenna Requirement	C
15.225 (a)	In-band Fundamental Emission	C
15.225 (b)	In-band Spurious Emission	C
15.225 (c)	In-band Spurious Emission	C
15.225 (d) 15.209	Out-of-band Spurious Emission	C
15.225 (e)	Frequency Stability Tolerance	C
15.207	Conducted Emissions	NA (Note ₂)
Note ₁): C = Complies, NC = Not Complies, NT = Not Tested, NA = Not Applicable Note ₂): Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power line or contain provisions for operation while connected to the AC power lines.		

4.2 Measurement Uncertainty

Measurement Item	Expanded Uncertainty $U = kU_c (k = 2)$	
Radiated Spurious Emissions	30 MHz ~ 300 MHz:	+4.94 dB, -5.06 dB
		+4.93 dB, -5.05 dB
	300 MHz ~ 1 000 MHz:	+4.97 dB, -5.08 dB
		+4.84 dB, -4.96 dB
Conducted Emissions	9 kHz ~ 150 kHz:	3.75 dB
	150 kHz ~ 30 MHz:	3.36 dB

5. Test results

5.1 Antenna Requirement

5.1.1 Regulation

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.

5.1.2 Result

-Complied

The Loop antenna is permanantly attached on board.

5.2 In-band Fundamental Emission

5.2.1 Regulation

15.225 (a) The field strength of any emission within the band 13.553-13.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.

5.2.2 Measurement Procedure

Test Procedure The Radiated Electric Field Strength intensity has been measured on semi anechoic chamber with a ground plane and at a distance of 3m.

Frequency : From 9 kHz to 30 MHz at distance 3m The EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity.

Frequency : From 30 MHz to 1 GHz at distance 3m The measuring antenna height varied between 1 and 4m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field intensity.

The measurements were performed for both vertical and horizontal antenna polarization.

Measurements were performed with a QP, PK, and AV detector. The radiated emission measurements were made with the following detector function of the test receiver (below 1 GHz).

Frequency	9 - 90 kHz	90 - 110 kHz	110 - 490 kHz	490 kHz - 30 MHz	30 MHz -1 GHz
Detector type	PK/AV	QP	PK/AV	QP	QP
IF bandwidth	200 Hz	200 Hz	9 kHz	9 kHz	120 kHz

- Part 15 Section 15.31 (f)(2) (9 kHz - 30 MHz)

[Limit at 3m]=[Limit at 300m]-40 x log(3[m]/300[m])

[Limit at 3m]=[Limit at 30m]-40 x log (3[m]/30[m])

Note : Axis among X, Y and Z plans (Please refer to the "Test setup photos" to check X, Y, Z configuration).

5.2.3 Test Result

- Complied

Voltage [V]	Frequency [MHz]	Reading [dBμV]	Cable Loss [dB]	Amp Gain [dB]	Antenna Factor [dB]	Factor [dB]	Result [dBμV/m at 3 m]	Limit [dBμV/m at 3 m]	Margin [dB]
QP DATA.									
6.0	13.56	48.50	1.43	-32.67	18.64	-12.60	35.90	124.00	88.10

[Result = Reading + Amp Gain + AF + CL]

1. H = Horizontal, V = Vertical Polarization
2. AF/CL = Antenna Factor and Cable Loss
3. Factor = CL+AF+AG

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5.3 In-band Spurious Emission

5.3.1 Regulation

15.225 (b) With in the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

15.225 (c) With in the bands 13.110-13.410 MHz and 13.710-14.010 MHz, the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

5.3.2 Test Result

- Complied

Measurement Distance: 3 m

Frequency [MHz]	Receiver Bandwidth [kHz]	Reading [dB(μV)]	Pol. [V/H]	Cable Loss [dB]	Amp Gain [dB]	Antenna Factor [dB]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
PEAK DATA.										
13.13	9	41.00	V	1.43	-32.67	18.64	-12.60	28.40	80.50	52.10
13.43	9	40.50	V	1.43	-32.67	18.64	-12.60	27.90	90.47	62.57
13.57	9	44.20	H	1.43	-32.67	18.64	-12.60	31.60	90.47	58.87
13.83	9	40.80	H	1.43	-32.67	18.64	-12.60	28.20	80.50	52.30

Note : This test was performed by using peak

[Result = Reading + Amp Gain + AF + CL]

1. H = Horizontal, V = Vertical Polarization
2. AF/CL = Antenna Factor and Cable Loss
3. Factor = CL+AF+AG
4. The distance factor was calculated and included in limit.

5.4 Out-of-band Spurious Emission

5.4.1 Regulation

15.225 (d) The Field Strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in 15.209

Frequency (MHz)	Field Strength ($\mu\text{V/m}$)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30(29.54 dB $\mu\text{V/m}$)	30
30.0-88.0	100(40 dB $\mu\text{V/m}$)	3
88-216	150(43.5 dB $\mu\text{V/m}$)	3
216-960	200 (46 dB $\mu\text{V/m}$)	3
Above 960	500 (53.98 dB $\mu\text{V/m}$)	3

5.4.2 Measurement Procedure

The spurious emissions from the EUT will be measured on an 10 m Anechoic chamber in the frequency range of 9 kHz to 30 MHz using a tuned receiver and a shielded loop antenna.

The antenna was positioned 3, 10 or 30 meters horizontally from the EUT.

Measurements have been made in all three orthogonal axes and the shielded loop antenna was rotated to locate the maximum of the emissions.

In the case where larger measuring distances are required the results will be extrapolated based on the values measuring on the closer distances according to Section 15.31 (f) (2) [2].

The final measurement will be performed with an EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 to 490 kHz where an average detector will be used according to Section 15.209 (d) [2].

The final level, expressed in dB $\mu\text{V/m}$, is arrived at by taking the reading from the EMI receiver (Level dB μV) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has to be compared with the relevant FCC limit. The resolution bandwidth during the measurement is as follows:

9 kHz – 150 kHz: ResBW: 200 Hz

150 kHz – 30 MHz: ResBW: 9 kHz

The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions in an anechoic chamber at a distance of 3 meters.

The EUT was placed on the top of the 0.8 meter height, 1 x 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360°.

The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 30 to 1 000 MHz using the BILOG antenna. To obtain the final measurement data, the EUT was arranged on a turntable situated on a 10 m chamber. The EUT was tested at a distance 3 meters.

Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

5.4.3 Test Result

- Complied

Measurement Distance: 3 m

-Below 30 MHz

Frequency [MHz]	Receiver Bandwidth [kHz]	Reading [dB(μV)]	Pol. [V/H]	Cable Loss [dB]	Amp Gain [dB]	Antenna Factor [dB]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
PEAK DATA.										
0.18	9	46.00	V	0.48	-32.75	19.87	-12.40	33.60	102.50	68.90
22.09	9	43.10	V	1.87	-32.68	18.21	-12.60	30.50	69.54	39.04

Note : The distance factor was calculated and included in limit.

-Above 30 MHz

Frequency [MHz]	Receiver Bandwidth [kHz]	Reading [dB(μV)]	Pol. [V/H]	Cable Loss [dB]	Amp Gain [dB]	Antenna Factor [dB]	Factor [dB]	Result [dB(μV/m)]	Limit [dB(μV/m)]	Margin [dB]
QUASI PEAK DATA.										
35.21	120	35.80	H	1.18	-29.60	12.52	-15.90	19.90	40.00	20.10
189.81	120	36.00	H	3.03	-29.60	10.77	-15.80	20.20	43.50	23.30
216.97	120	36.70	H	3.25	-29.59	10.54	-15.80	20.90	46.00	25.10
244.13	120	37.50	H	3.46	-29.54	11.58	-14.50	23.00	46.00	23.00
271.17	120	38.80	H	3.67	-29.19	12.52	-13.00	25.80	46.00	20.20
705.24	120	29.10	V	6.22	-28.70	21.18	-1.30	27.80	46.00	18.20

Note : This test was performed by using peak detector mode. If peak result meets the limit, QP measurement is skipped.

[Result = Reading + Amp Gain + AF + CL]

1. H = Horizontal, V = Vertical Polarization
2. AF/CL = Antenna Factor and Cable Loss
3. Factor = CL+AF+AG

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5.5 Frequency tolerance

5.5.1 Regulation

15.225 (e) The frequency tolerance of the carrier signal shall be maintained within ± 0.01 % of the operating frequency over a temperature variation of -20 degrees to $+50$ degrees 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 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

5.5.2 Test Result

- Complied

VOLTAGE [%]	POWER [V]	TEMP [°C]	FREQ [Hz]	FREQ.DEV [Hz]	Deviation [%]
100	6.0	-20	13 561 343	1 343.00	0.009 90
		-10	13 561 313	1 313.00	0.009 68
		0	13 561 349	1 348.70	0.009 95
		10	13 561 337	1 337.00	0.009 86
		20	13 561 334	1 333.70	0.009 83
		25	13 561 355	1 355.00	0.009 99
		30	13 561 351	1 351.00	0.009 96
		40	13 561 340	1 340.00	0.009 88
		50	13 561 349	1 349.00	0.009 95
85	5.1	20	13 561 307	1 307.00	0.009 64
115	6.9	20	13 561 349	1 348.70	0.009 95

5.6 Conducted Emission

5.6.1 Regulation

According to §15.207(a), 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 Ω 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 frequency 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.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

5.6.2 Measurement Procedure

- 1) The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5m away from the side wall of the shielded room.
- 2) Each current-carrying conductor of the EUT power cord was individually connected through a 50 Ω /50 μ H LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.
- 3) Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
- 4) The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.
- 5) The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 kHz or to QUASI-PEAK and AVERAGE within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.

5.6.3 Test Result

Result: NA : Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines.

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5.7 Occupied Bandwidth

5.7.1 Regulation

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth. When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

5.7.2 Measurement procedure

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

The difference between the two recorded frequencies is the 99% occupied bandwidth.

5.7.3 Test Result

- Complied

Voltage [V]	Frequency [MHz]	Occupied Bandwidth (99 % BW) [kHz]
DC 6	13.56	0.21

NOTE: We took the insertion loss of the cable loss into consideration within the measuring instrument.

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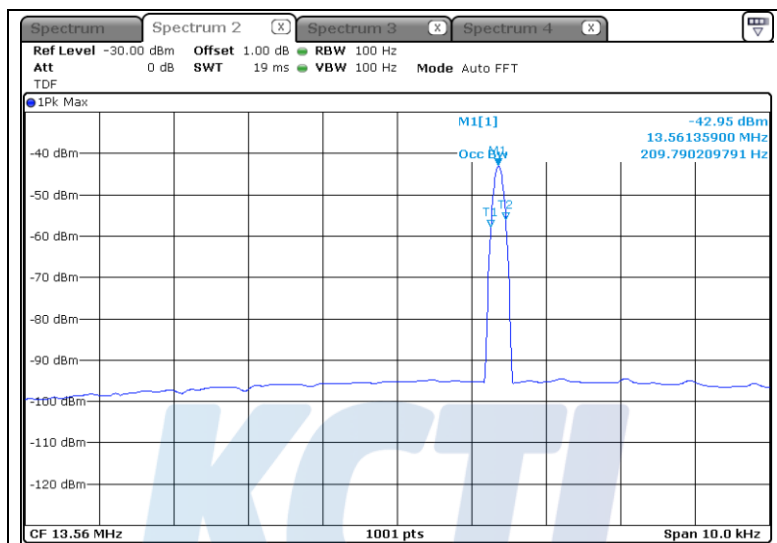
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5.7.4 Test Plot

Figure 2. Plot of the Occupied Bandwidth (Conducted)

- Occupied Bandwidth



6. Test equipment used for test

	Equipment Name	Manufacturer	Model No.	Serial No.	Next Cal. Date
■	SPECTRUM ANALYZER	R&S	FSV40	100988	19.01.05
■	DC Power Supply	AGILENT	E3632A	KR75304571	19.05.14
■	Temp & Humid Chamber	Myeongseong R&P	CTHC-50P-DT	20150824-1	18.08.01
■	Signal Generator	R & S	SMR40	100007	19.05.15
■	Vector Signal Generator	R&S	SMBV100A	257566	19.01.05
■	Loop Antenna	R&S	HFH2-Z2	892665/035	19.01.25
■	Bilog Antenna	SCHWARZBECK	VULB9163	440	19.10.23
■	Attenuator	HP	8491A	MY52461848	19.10.23
■	Amplifier	SONOMA	310N	284608	18.08.24
■	EMI Test Receiver	R&S	ESCI7	100732	18.08.24
■	Turn Table	Innco Systems	DT2000	79	-
■	Antenna Mast	Innco Systems	MA4640-XP-ET	-	-
■	Turn Table	Innco Systems	DT2000	79	-
■	Cable Assembly	Radiall	2301762000PJ	1724.66	-
■	Cable Assembly	Gigalane	RF-400	-	-