Certificate of Test

NCT Co., Ltd. 211-71, Geumgok-ro, Hwaseong-si, Gyeonggi-do, 18511, Korea (Tel: +82-31-323-6070 / Fax: +82-31-323-6071)	Report No.: NW2008-F001 Page (1) / (20)	Your business' success starts with NCT

1. **Client**
   - ○ Name : ecarPlug Co., Ltd.
   - ○ Address : Mega-712, SKn Techno Park, 124, Sagimakgol-ro, Jungwon-gu, Seongnam-si, Gyeonggi-do, Republic of Korea
   - ○ Date of Receipt : 2020-08-05

2. **Use of Report :** FCC Approval

3. **Test Sample**
   - ○ Description / Model Name : NFC Reader / ECRF232C
   - ○ FCC ID : 2AW9X-ECRF232C

4. **Date of Test :** 2020-08-10 ~ 2020-08-19

5. **Test method used :** FCC Part 15 Subpart C 15.225

6. **Testing Environment :**
   - ○ Temperature: (25 ± 5) °C, Humidity: Less than 75 % R.H.
   - * Unless specified otherwise in the individual methods, the tests were conducted on ambient conditions.

7. **Test Results :** Refer to the test results

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
This Test Report cannot be reproduced, except in full
This test report is prepared according to the requirements of ISO / IEC 17025.

Affirmation	**Tested by** Jong-Myoung, Shin (signature)	**Technical Manager** Kyung-Taek, Lee (signature)

Aug 20, 2020

NCT CO., LTD. (seal)

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1. General Information's

1.1 Test Performed

Laboratory	:	NCT Co., Ltd.
Address	:	211-71, Geumgok-ro, Hwaseong-si, Gyeonggi-do, 18511, Korea
Telephone	:	+82-31-323-6070
Facsimile	:	+82-31-323-6071
FCC Designation No.	:	KR0166
FCC Registration Number	:	409631

2. Information's about Test Item

2.1 Applicant Information

Company name	:	ecarPlug Co., Ltd.
Address	:	Mega-712, SKn Techno Park, 124, Sagimakgol-ro, Jungwon-gu, Seongnam-si, Gyeonggi-do, Republic of Korea
Telephone / Facsimile	:	+82-31-778-6181 / +82-31-778-6182

2.2 Equipment Under Test (EUT) description

Test item particulars	:	NFC Reader
Model and/or type reference	:	ECRF232C
Additional model name	:	-
Serial number	:	Identification
Antenna type and gain	:	PCB Pattern Antenna
Date (s) of performance of tests:	:	2020-08-10 ~ 2020-08-19
Date of receipt of test item	:	2020-08-05
EUT condition	:	Pre-production, not damaged
Number of channel	:	1
EUT Power Source	:	DC 5.0 V
Type of Modulation	:	ASK
FirmWare version	:	1.0
Hardware version	:	1.0
Test software name(version)	:	-

2.3 Tested Frequency

Test Mode	Test frequency (㎒)		
	Low frequency	Middle frequency	High frequency
RFID	13.56	-	-

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3. Test Report

3.1 Test Summary

Applied	Test Items	Clause	Test Condition	Result
☒	Antenna Requirement	15.203	-	C
☒	20 dB Bandwidth	2.1049	Radiated	C
☒	In-Band Emissions (13.553 – 13.567 MHz)	15.225(a)		C
☒	In-Band Emissions (13.410 – 13.553 MHz, 13.567 – 13.710 MHz)	15.225(b)		C
☒	In-Band Emissions (13.110 – 13.410 MHz, 13.710 – 14.010 MHz)	15.225(c)		C
☒	Out-of-Band Emissions	15.225(d) 15.209		C
☒	Frequency Stability	15.225(e)	Temp & Humid Test Chamber	C
☐	Conducted Emissions	15.207	AC Line Conducted	NA[note 2]

Note 1: C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable

Note 2: This product is only using DC power. So, AC conducted emission test has not been performed.

Note 3: This test item was performed in each axis and the worst case data was reported.

The sample was tested according to the following specification: ANSI C63.10:2013

Compliance was determined by specification limits of the applicable standard according to customer requirements.

3.2 Test Report Version

Test Report No.	Date	Description
NW2008-F001	2020-08-20	Initial issue

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3.3 Transmitter Requirements

3.3.1 Antenna Requirement

Accoding 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.

Accoding to §15.247(b)(4) e 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 transmitting 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.

3.3.1.1 Result

Complies
(The transmitter has a PCB Pattern Antenna.)

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3.3.2 20 dB Bandwidth

3.3.2.1 Test Setup

Refer to the APPENDIX I.

3.3.2.2 Limit

N/A

3.3.2.3 Test Procedure

1. The 20 dB Bandwidth is measured with a spectrum analyzer connected via a receive antenna placed near the EUT while the EUT is operating in transmission mode.

2. Spectrum analyzer setting use following test procedure
   RBW = 1 % ~ 5 % OBW
   VBW ≥ 3 × RBW
   Span = Span = 2 ~ 5 times the OBW
   Sweep = Auto
   Detector = Peak
   Trace = Max hold
3. The trace was allowed to stabilize
4. Determine the reference value = Set the spectrum analyzer marker to the highest level of the displayed trace
5. Using the marker-delta function of the instrument, determine the "−xx dB down amplitude" using [(reference value) − xx].
6. Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

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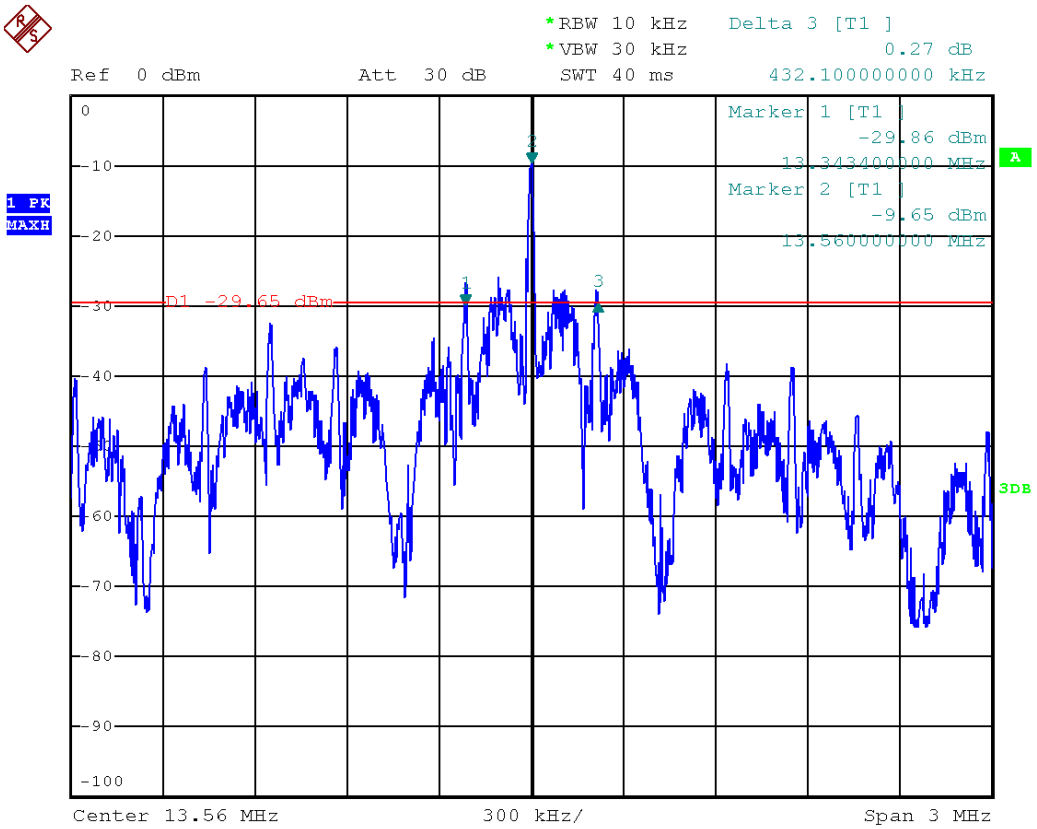
3.3.2.4 Test Result

- Measurement Data: Complies



3.3.3 In-Band Emissions

3.3.3.1 Test Setup

Refer to the APPENDIX I.

3.3.3.2 Limit

Frequency Band (㎒)	Limit at 30 m measurement distance	
	(㎶/m)	(dB㎶/m)
13.553-13.567	15,848	84.00
13.410-13.553 **13.567-13.710**	334	50.47
13.110-13.410 **13.710-14.010**	106	40.51

3.3.3.3 Test Procedure

The radiated emission was tested according to the section 6.4 of the ANSI C63.10-2013.

The EUT was placed on a 0.8 m high non-conductive table and it was placed at 3m distance from the antenna.
Measurements were performed for each of the three antenna orientations. (ie. parallel, perpendicular, and ground-parallel)
Also, measurements were performed with the EUT oriented in 3 orthogonal axis and rotated 360 degrees to determine worst-case orientation for maximum emissions.

RBW = As specified in below table
VBW ≥ 3 x RBW
Sweep = Auto
Detector = Peak
Trace mode = Max Hold until the trace stabilizes.

Frequency	RBW
9-150 ㎑	200-300 ㎐
0.15-30 ㎒	9-10 ㎑
30-1000 ㎒	100-120 ㎑
>1 000 ㎒	1 ㎒

3.3.3.4 Test Result

- Test Frequency: **13.56 ㎒**
- Measurement Distance: **3 m**

Test Frequency Band (㎒)	Freq. (㎒)	Ant	Reading Value (dB㎶)	T.F (dB/m)	Field Strength @3m (dB㎶/m)	Field Strength @30m (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
13.110-13.410	13.346	P	22.12	20.30	42.42	2.42	40.51	38.09
13.410-13.553	13.553	P	34.31	20.30	54.61	14.61	50.47	35.86
13.553-13.567	13.560	P	38.23	20.30	58.53	18.53	84.00	65.47
13.567-13.710	13.567	P	31.25	20.30	51.55	11.55	50.47	38.92
13.710-14.010	13.770	P	20.60	20.30	40.90	0.90	40.51	39.61

Note 1: Loop antenna orientation
"P": Parallel, "V": Perpendicular, "G": Ground-parallel
Note 2: This test item was performed at 3 m and the data were extrapolated to the specified measurement distance of 30 m using the square of an inverse linear distance extrapolation factor (40 dB/decade) as specified in §15.31(f)2.
- Extrapolation Factor = 20 $\log_{10}(30/3)^2$ = 40 ㏈

Note 3: All data were recorded using a spectrum analyzer employing a peak detector.
If PK results were meet Quasi-peak limit, Quasi-peak measurements were omitted.
Note 4: Sample Calculation.
Margin = Limit – Field Strength @ 30 m / Field Strength @ 30 m = Field Strength @ 3 m – 40 ㏈
Field Strength @ 3 m = Reading + T.F / T.F = AF + CL
Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss

3.3.4 Out-of-Band Emissions

3.3.4.1 Test Setup

Refer to the APPENDIX I.

3.3.4.2 Limit

Part 15.209, 225(d)

FCC Part 15.209(a):

Frequency (㎒)	Limit (uV/m)	Measurement Distance (meter)
0.009 ~ 0.490	2400/F (㎑)	300
0.490 ~ 1705	24000/F (㎑)	30
1705 ~ 30.0	30	30
30 ~ 88	100 **	3
88 ~ 216	150 **	3
216 ~ 960	200 **	3
Above 960	500	3

** Except as provided in 15.209(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. 15.231 and 15.241.

FCC Part 15.209(b): In the emission table above, the tighter limit applies at the band edges.

3.3.4.3 Test Procedure

The radiated emission was tested according to the section 6.4 of the ANSI C63.10-2013.

The EUT was tested from 9 kHz up to the 1 GHz excluding the band 13.110-14.010 MHz.
The EUT was placed on a 0.8 m high non-conductive table and it was placed at 3m distance from the antenna.
For measurements below 30MHz were performed for each of the three antenna orientations.(ie. parallel, perpendicular, and ground-parallel)
For measurements above 30MHz were performed for each of the both horizontal and vertical polarizations. Also, measurements were performed with the EUT oriented in 3 orthogonal axis and rotated 360 degrees to determine worst-case orientation for maximum emissions.

RBW = As specified in below table
VBW ≥ 3 x RBW
Sweep = Auto
Detector = Peak
Trace mode = Max Hold until the trace stabilizes.

Frequency	RBW
9-150 ㎑	200-300 ㎐
0.15-30 ㎒	9-10 ㎑
30-1000 ㎒	100-120 ㎑
>1 000 ㎒	1 ㎒

3.3.4.4 Test Result

- Test Frequency: **13.56 ㎒**
- Measurement Distance: **3 m**

Frequency (㎒)	Ant	Reading Value (㏈㎶)	T.F (㏈/m)	Distance Factor (㏈㎶/m)	Field Strength (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
311.57	V	28.40	-6.50	0.00	21.90	46.0	24.10
393.12	H	26.90	-6.50	0.00	20.40	46.0	25.60
420.68	H	27.60	-6.50	0.00	21.10	46.0	24.90
665.01	V	25.30	-6.50	0.00	18.80	46.0	27.20

Note 1: The radiated emissions were inverstigated 9 ㎑ to 1 ㎓. And no other spurious and harmonic emissions were found above listed frequencies.

Note 2: Loop antenna orientation (below 30 ㎒)
"P": Parallel, "V": Perpendicular, "G": Ground-parallel
Bilog antenna polarization (above 30 ㎒)
"H": Horizontal, "V": Vertical

Note 3: All data were recorded using a spectrum analyzer employing a peak detector.
If PK results were meet Quasi-peak limit, Quasi-peak measurements were omitted.

Note 4: Sample Calculation.
Margin = Limit – Field Strength
Field Strength = Reading + T.F – Distance factor
Distance factor = 20log(Measurement distance / The measured distance)^2 = 20log(30/3)^2 = 40 ㏈
T.F = AF + CL -AG
Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain

3.3.5 Frequency Stability

3.3.5.1 Limit

The frequency tolerance of the carrier signal shall be maintained within ±0.01 % of the operating frequency.

3.3.5.2 Test Procedure

Part 15.225 requires that devices operating in the 13.553 – 13.567 MHz shall maintain the carrier frequency within 0.01 % of the operating frequency over the temperature variation of -20 degrees to + 50 degrees C at normal supply voltage.

3.3.5.3 Test Result

Voltage		Temp	Frequency	Deviation	
(%)	(Vdc)	(℃)	(Hz)	(Hz)	(%)
100	5.0	-20	13 559 387	613	0.004 5
100		-10	13 559 387	613	0.004 5
100		0	13 559 312	688	0.005 1
100		+10	13 559 312	688	0.005 1
100		+20(Ref)	13 559 312	688	0.005 1
100		+30	13 559 300	700	0.005 2
100		+40	13 559 312	688	0.005 1
100		+50	13 559 300	700	0.005 2
115	5.75	+20	13 559 300	700	0.005 2
85	4.25	+20	13 559 312	688	0.005 1

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3.3.6 Conducted Emission

3.3.6.1 Test Setup

See test photographs for the actual connections between EUT and support equipment.

3.3.6.2 Limit

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 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50 uH/50 ohm line impedance stabilization network (LISN).
Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

Frequency Range (㎒)	Conducted Limit (dBuV)	
	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

3.3.6.3 Test Procedure

Conducted emissions from the EUT were measured according to the ANSI C63.10.

1. The test procedure is performed in a 6.5 m × 3.5 m × 3.5 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

3.3.6.4 Test Result

Not Applicable
(This product is only using DC power. So, AC conducted emission test has not been performed.)

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APPENDIX I

TEST SETUP

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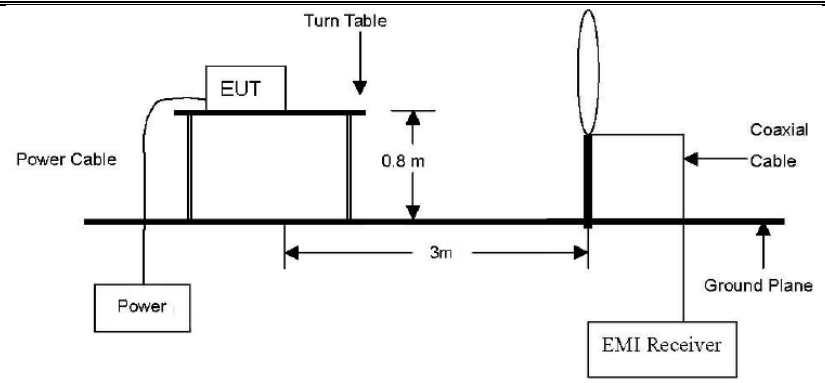
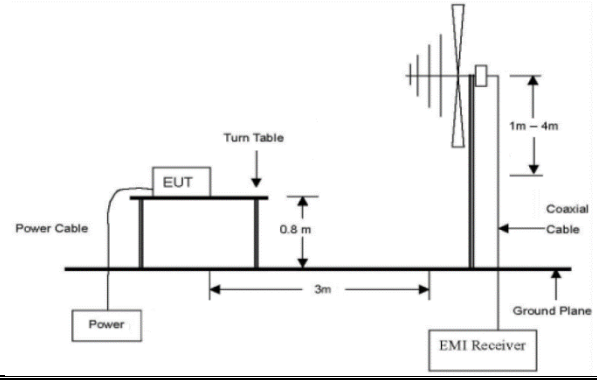
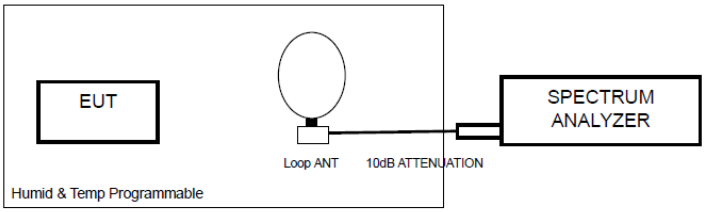
- Radiated Measurement

below 30 ㎒	
below 1 ㎓	

- Temp & Humid Chamber Measurement

Frequency Stability	

APPENDIX II

TEST EQUIPMENT USED FOR TESTS

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	Description	Manufacturer	Serial No.	Model No.	Cal. Date	Next Cal. Date
1	SPECTRUM ANALYZER	R&S	100250	FSU26	2019-09-23	2020-09-23
2	SPECTRUM ANALYZER	R&S	100617	FSP40	2020-03-10	2021-03-10
3	USB Power sensor	Agilent	MY52500002	U2021XA	2020-03-10	2021-03-10
4	Humi./Baro/Temp. data recorder	Lutron	38420	MHB-382SD	2019-11-18	2020-11-18
5	Temperature & humidity cabinet	TERCHY	1060906	MHCB-64AZDA	2019-12-09	2020-12-09
6	SIGNAL GENERATOR	HP	3614A00312	83640B	2019-11-22	2020-11-22
7	Vector SG	R&S	255563	SMBV100A	2020-03-10	2021-03-10
8	Power supply	GWInstsk	EH120798	PST-3202	2020-03-10	2021-03-10
9	Triple Output DC Power Supply	Agilent	MY40038816	E3631A	2020-03-10	2021-03-10
10	ATTENUATOR	Agilent	08259	8493C	2020-03-11	2021-03-11
11	ATTENUATOR	Weinschel	none	WA1444-14	2020-03-11	2021-03-11
12	ATTENUATOR	Weinschel	none	WA41/12-30-12	2020-03-10	2021-03-10
13	Attenuator	BRACKE	1	BM10060.6	2019-11-15	2020-11-15
14	POWER DIVIDER	Agilent	11664	11636B	2020-03-11	2021-03-11
15	POWER DIVIDER	Agilent	51623	11636B	2020-03-11	2021-03-11
16	STEP ATTENUATOR	HP	2852A00842	8495D	2020-03-11	2021-03-11
17	TRILOG BroadBand Antenna	Schwarzbeck	01027	VULB 9168	2019-06-17	2021-06-17
18	TRILOG BroadBand Antenna	Schwarzbeck	01029	VULB 9168	2019-06-20	2021-06-20
19	Double Ridged BroadBand Horn Antenna	Schwarzbeck	02087	BBHA 9120D	2020-06-05	2021-06-05
20	Double Ridged BroadBand Horn Antenna	Schwarzbeck	02086	BBHA 9120D	2020-06-15	2021-06-15
21	BroadBand Horn Antenna	Schwarzbeck	00938	BBHA 9170	2020-05-29	2021-05-29
22	BroadBand Horn Antenna	Schwarzbeck	00937	BBHA 9170	2020-05-29	2021-05-29
23	Amplifier	TESTEK	190007-L	TK-PA18H	2020-05-28	2021-05-28
24	Amplifier	TESTEK	190008-L	TK-PA1840H	2020-05-29	2021-05-29
25	Amplifier	H.P	3113A05434	8447F	2020-05-28	2021-05-28
26	LOOP-ANTENNA	Schwarzbeck	00124	FMZB1519 B	2019-06-27	2021-06-27
27	LISN	Schwarzbeck	00984	NSLK 8127	2020-05-28	2021-05-28
28	EMI Test Receiver	R&S	102116	ESRP3	2020-05-28	2021-05-28