

# TEST REPORT

For

## 25 Watt VHF/FM Marine Transceiver

In conformity with

**IEC 60945 : 2002**

**Model: GX1850GPS / GX1850 / GX1800GPS / GX1800**

**FCC ID: K6630643X3D**

**ISED: 511B-30643X3D**

**Report No: WE180821BC1-13**

**Issue Date: 14 Nov. 2018**

### Prepared for

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## History

Report No	Date	Revisions	Issued by
WE180821BC1-11	26 Sep. 2018	Initial Issue	T.Kato
WE180821BC1-12	30 Oct. 2018	Change the model name of "GX1860" and "GX1800G"	T. Kato
WE180821BC1-13	14 Nov. 2018	Add FCC ID and ISED Cert. No.	T. Kato

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# 1 General information

## 1.1 Product description

Test item : 25 Watt VHF/FM Marine Transceiver  
 Manufacturer : QUANZHOU QIXIANG ELECTRON & TECHNOLOGY CO., LTD.  
 Address : Tangxi industrial Zone, Luojiang District, Quanzhou, Fujian, China  
 Model : GX1850GPS  
 Serial number : 8J000001  
 Operating frequency : 156.025 - 161.600 MHz (TX)  
                                   156.050 - 163.275 MHz (RX)  
 Modulation : G3E, G2B  
 Output power : 25 W  
 Hardware Version : SPP1 / SPP1.1 / SPP1.2  
 Software Version : V0.00.09

FCC ID : K6630643X3D  
 ISED Cert. No. : 511B-30643X3D

Equipment Classification : Exposed Equipment  
 Receipt date of EUT : 06 Sep. 2018  
 Nominal power voltages : DC 13.8V (DC Power supply)

Family model : GX1850 / GX1800GPS / GX1800

Model	GPS	NMEA2000
GX1850GPS	ON	ON
GX1850	OFF	ON
GX1800GPS	ON	OFF
GX1800	OFF	OFF

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## 1.2 Test(s) performed / Summary of test result

Applicable Standard(s) : IEC 60945 : 2002  
 Test(s) started : 06 Sep. 2018  
 Test(s) completed : 20 Sep. 2018  
 Purpose of test(s) : Verification of compliance with the applicable standards

Summary of test result : Complied

Note: The above judgment is only based on the measurement data and it does not include the measurement uncertainty. Accordingly, the statement below is applied to the test result.

The EUT complies with the limit required in the standard in case that the margin is not less than the measurement uncertainty in the Laboratory.

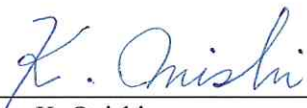
Compliance of the EUT is more probable than non-compliance is case that the margin is less than the measurement uncertainty in the Laboratory.

Test engineer

: 

T. Kato  
 (Wireless testing Lab.)

Reviewer

: 

K. Onishi  
 (Testing Leader, Wireless Testing Lab.)

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### 1.3 Applicable basic standards

#### 1.3.1 EMI test

Basic Standard	Title
IEC 60945 (2002) + Corr.1	"Maritime navigation and radio communication equipment and systems - General requirements - Methods of testing and required test results
CISPR 16-1-1 (2015)	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1: Radio disturbance and immunity measuring apparatus

#### 1.3.2 EMS test

Basic Standard	Title
IEC 60945 (2002) + Corr.1	"Maritime navigation and radio communication equipment and systems - General requirements - Methods of testing and required test results
IEC 61000-4-2 (2008)	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
IEC 61000-4-3 (2006) +A1/A2	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test
IEC 61000-4-4 (2012)	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test
IEC 61000-4-5 (2014)	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test
IEC 61000-4-6 (2013)	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields

### 1.4 Test facility

Test Site : SGS Japan Inc.  
 Address : 472, Nippa-cho, Kohoku-ku, Yokohama, 223-0057, Japan  
 TEL : +81-45-534-0645  
 FAX : +81-45-534-0646

Accredited by The Japan Accreditation Board for Conformity Assessment (JAB) for EMC tests stated in the scope of the certificate under Certificate Number RTL02770

Accredited by National Voluntary Laboratory Accreditation Program (NVLAP) for the emission tests stated in the scope of the certificate under Certificate Number 200780-0

Registered by Industry Canada (IC): The registered facility number is as follows  
 Test site No.1 (Semi-Anechoic chamber 3m): 6974A-1

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## 1.5 Measurement uncertainty

The treatment of uncertainty is based on the general matters on the definition of uncertainty in “Guide to the expression of uncertainty in measurement (GUM)” published by ISO. The Lab’s uncertainty is determined by referring UKAS Publication LAB34: 2002 “The Expression of Uncertainty in EMC Testing” and CISPR16-4-2: 2011 “Uncertainty in EMC Measurements”.

The uncertainty of the measurement result in the level of confidence of approximately 95% (k=2) is as follows;

Conducted emissions (10 kHz – 30 MHz):	± 3.7 dB
Radiated emissions (150 kHz - 30 MHz):	± 3.2 dB
Radiated emissions (30 MHz - 1000 MHz):	± 6.1 dB
Radiated emissions (1000 MHz - 2000 MHz):	± 4.4 dB
Electrostatic discharge:	Within the tolerance specified by the standard
Radiated disturbance:	±2.6 dB
Fast transients (bursts):	Within the tolerance specified by the standard
Conducted radio frequency disturbance:	± 1.3 dB
Slow transients (surges):	Within the tolerance specified by the standard

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## 1.6 Description of essential requirements and test results

This section refers to the standard IEC 60945 clause 9.1 and 10.1

### 1.6.1 EMC emission measurements

Phenomena	Equipment test requirement		Applied in this report	Result (Tested HW version)
	Exposed Equipment	Portable Equipment		
Radiated emissions	Applicable	Applicable	Yes	Complied (SPP1)
Conducted emissions	Applicable	Not applicable	Yes	Complied (SPP1)

### 1.6.2 Immunity tests

Phenomenon	Application	Equipment test requirement		Applicable for the EUT	Result (tested HW version)
		Exposed Equipment	Portable Equipment		
Radiated Disturbance	Enclosure	Applicable	Applicable	Yes	Complied (SPP1.1)
Electrostatic discharge	Enclosure	Applicable	Applicable	Yes	Complied (SPP1.1)
Fast transients (bursts)	Signal and control ports, DC and AC power port	Applicable	Not applicable	Yes	Complied (SPP1.1)
Conducted radio frequency disturbance	Signal and control ports, DC and AC power port	Applicable	Not applicable	Yes	Complied (SPP1.2)
Power supply short term variation	AC power input ports	Applicable	Not Applicable	No (Note 1)	-
Power supply failure	DC and AC power input ports	Applicable	Not applicable	Yes	Complied (SPP1.1)
Slow transients (surges)	AC power input ports	Applicable	Not applicable	No (Note 1)	-

Note 1: The EUT have no AC power port

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## 1.7 Performance Criteria

For the immunity tests, the results are evaluated against performance criteria relating to the operating conditions and functional specifications of the EUT, and defined as follows.

### 1.7.1 Performance criteria A

The EUT shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed, as defined in the relevant equipment standard and in the technical specification published by the manufacturer.

### 1.7.2 Performance criteria B

The EUT shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed, as defined in the relevant equipment standard and in the technical specification published by the manufacturer. During the test, degradation or loss of function or performance which is self-recoverable is however, allowed, but no change of actual operating state or stored data is allowed.

### 1.7.3 Performance criteria C

Temporary degradation or loss of function performance is allowed during the test, provided the function is self-recoverable, or can be restored at the end of the test by the operation of the controls, as defined in the relevant equipment standard and in the technical specification published by the manufacturer.

### 1.7.4 Judgment Method

Volume knob position is set to approximately center position.

When the EUT shall be amplified by 1 kHz sinusoidal tone, the SINAD of the audio output measured during each individual exposure in the test sequence shall not deteriorate below a level of 20 dB.

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## 1.8 Setup of equipment under test (EUT)

### 1.8.1 Test configuration of EUT

The test configuration of the equipment under test (EUT) refers to tables and figure below.

Table: Equipment

No.	Item	Manufacturer	Model No.	Serial No.
1	25 Watt VHF/FM Marine Transceiver	YAESU MUSEN CO., LTD	GX1850GPS	8J000001

Table: Support equipment

No.	Item	Manufacturer	Model No.	Serial No.
2	Remote Access Microphone	YAESU MUSEN CO., LTD	SSM-70H	8F040122
3	External GPS Antenna	YAESU MUSEN CO., LTD	SCU-38	ES1

Table: The following cables were used and connected to the EUT

No.	Cable Name	From	To	Length [m]	Shielded	Ferrite
A	Mic. Cable	EUT (Main)	EUT (Mic)	0.4	No	No
B	RAM Cable	EUT	2	7.7	Yes	Yes
C	GPS Cable	EUT	3	5.0	Yes	No
D	DC Cable	EUT	DC	1.3	No	Yes
E	ACC Cable	EUT	Load	3.0	No	Yes
F	EX SP Cable	EUT	Load	1.5	No	Yes
G	NMEA2000 Cable	EUT	Load	1.0	Yes	No
H	GND Cable	EUT	GND	2.0	No	No

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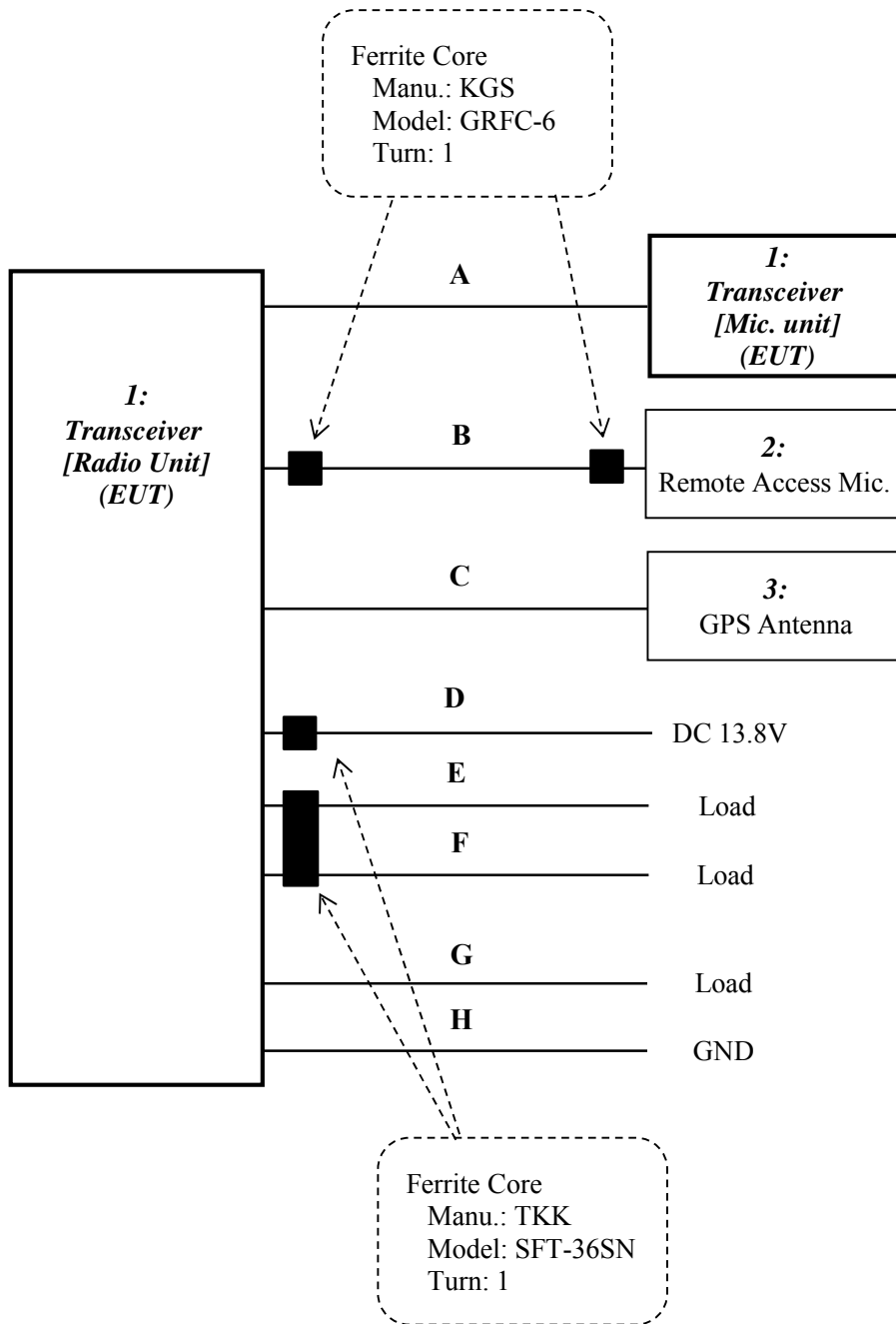


Figure: Test Configuration

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## 1.8.2 Operating condition:

- Rx 16ch: Receiving mode @ 16ch (156.800 MHz)
- Rx 70ch: Receiving mode @ 70ch (156.525 MHz)
- Tx 16ch: Transmitting mode @ 16ch (156.800 MHz)

## 1.9 Equipment modifications

No modifications have been made to the equipment in order to achieve compliance with the applicable standards described in clause 1.2.

## 1.10 Deviation from the standard

No deviations from the standards described in clause 1.2.

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## 2 Test result and procedure

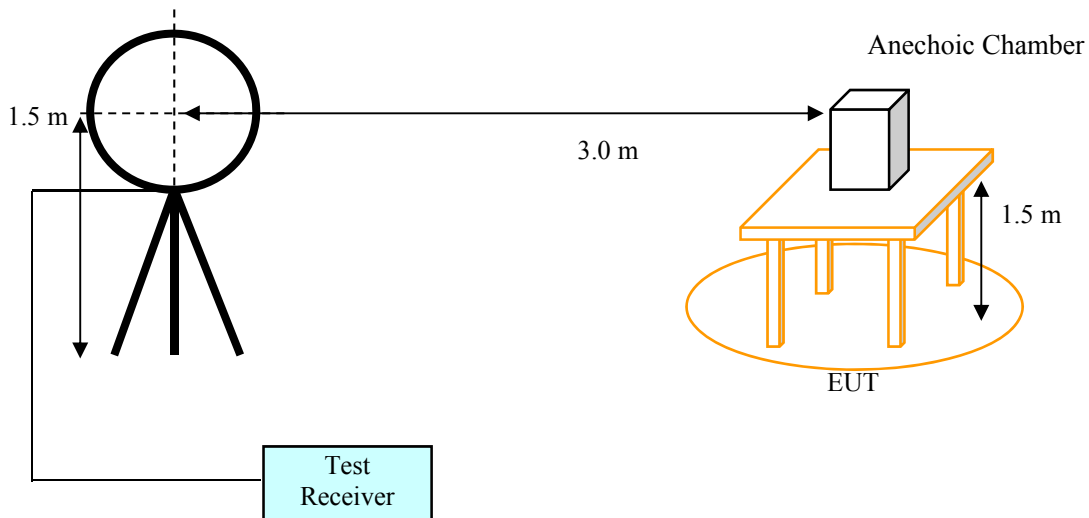
### 2.1 EMI requirement

#### 2.1.1 Radiated emissions

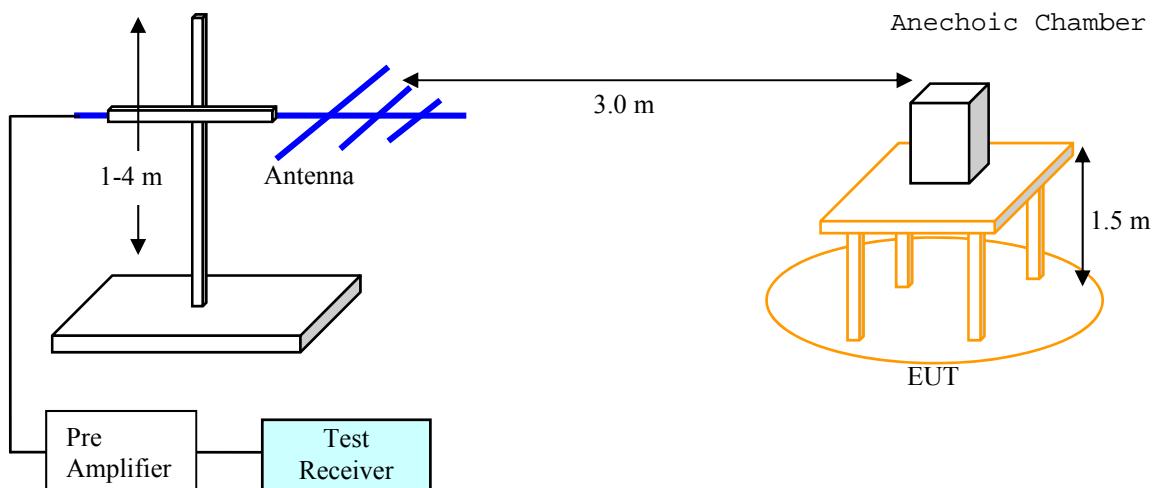
[Test setup]

Test setup is implemented according to the method of IEC 60945 "Radiated measurements".

150 kHz - 30 MHz



30 MHz - 2 GHz



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[Test method]

The test method shall be in accordance with IEC 60945.

The ancillary equipment shall be tested under operational conditions typical for its normal use. If these conditions cannot be achieved without connection to the radio equipment, then the ancillary equipment shall be tested in combination with the radio equipment to the related requirements for the enclosure radiation in the relevant radio product standard for the effective use of the radio spectrum.

The EUT shall be placed on a non-conductive support with a height of 1.5 m. The measuring distance between the centre of the test antenna and the EUT shall be 3 m. A test site in accordance with IEC 60945 and CISPR 16-1-1 shall be used.

The measuring bandwidth shall be in accordance with a table below.

Table: Measuring bandwidth for radiated emissions

Frequency Range	Measuring bandwidth
30 MHz to 2 GHz	120 kHz
156 MHz to 165 MHz	9 kHz
150 kHz to 30 MHz	9 kHz

The setting of controls which may affect the level of radiated interference shall be varied in order to ascertain the maximum emission level.

When the EUT consists of more than one unit the interconnecting cables shall have the maximum length and type as indicated by the manufacturer. Available input and output ports of the ancillary equipment under test shall be connected to the maximum length of cable as indicated by the manufacturer and terminated to simulate the impedance of the relevant ports of the radio equipment. These cables shall be bundled at the approximate centre of the cable with the bundles of 30 cm to 40 cm in length running in the horizontal plane from the port to which it is connected. If it is impractical to do so because of cable bulk or stiffness, the disposition of the excess cable shall be precisely noted in the test report.

The emissions shall be measured in the frequency range of 150 kHz to 2 GHz in accordance with CISPR 16-1-1 using the measuring receiver or a comparable spectrum analyzer. During the measurements up to 2 GHz the quasi-peak detector shall be used.

In addition, for the frequency band 156 MHz to 165 MHz, the measurement shall be repeated with a receiver bandwidth of 9 kHz to 10 kHz. The equipment shall meet both, the quasi peak and the peak emission limits set out in table below.

[Limits]

The levels of field strength of any radiated emission from the enclosure of the EUT in the frequency range 150 kHz to 2 GHz shall not exceed the values given in table below.

Table: EMC emission limits

Frequency range	Limit (QP) [dB $\mu$ V/m]	Limit (PK) [dB $\mu$ V/m]	Measuring distance
150 kHz - 300 kHz	80 - 52	-	3 m
300 kHz - 30 MHz	52 - 34	-	3 m
30 MHz - 1 GHz	54	-	3 m
1 GHz - 2 GHz	54	-	3 m
156 MHz - 165 MHz	24	30	3 m

[Test equipment used (refer to List of utilized test equipment)]

AC01(EM)	AC01(EG)	BA07	CL11	CL30	CL38
LP06	PR21	PR12	TR06	DH06	

[Test result] - **Complied with requirement**

[Test Date]

Tested Date: 06 Sep. 2018                      Temperature: 20 degC  
 Humidity: 52 %                                      Atmos. Press: 1008 hPa

[Test Result]      Tested HW version:              SPP1

*Range 1: 150 kHz - 30 MHz*

*Operating mode: Rx 16ch*

No.	Frequency [MHz]	Reading [dB $\mu$ V]	Antenna [dB/m]	Loss [dB]	Gain [dB]	Result [dB $\mu$ V/m]	Limit [dB $\mu$ V/m]	Margin [dB]	Ant. [deg]
1	0.43829	31.5	11.4	0.1	0.0	43.0	50.5	7.5	0deg
2	21.23761	3.5	9.0	0.8	0.0	13.3	35.4	22.1	0deg
3	24.03751	3.7	8.6	0.9	0.0	13.2	34.9	21.7	0deg
4	29.37618	4.8	7.5	1.0	0.0	13.3	34.1	20.8	0deg
5	0.30000	34.9	11.4	0.1	0.0	46.4	52.0	5.6	90deg
6	4.22061	10.6	11.1	0.4	0.0	22.1	41.7	19.6	90deg

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*Operating mode: Rx 70ch*

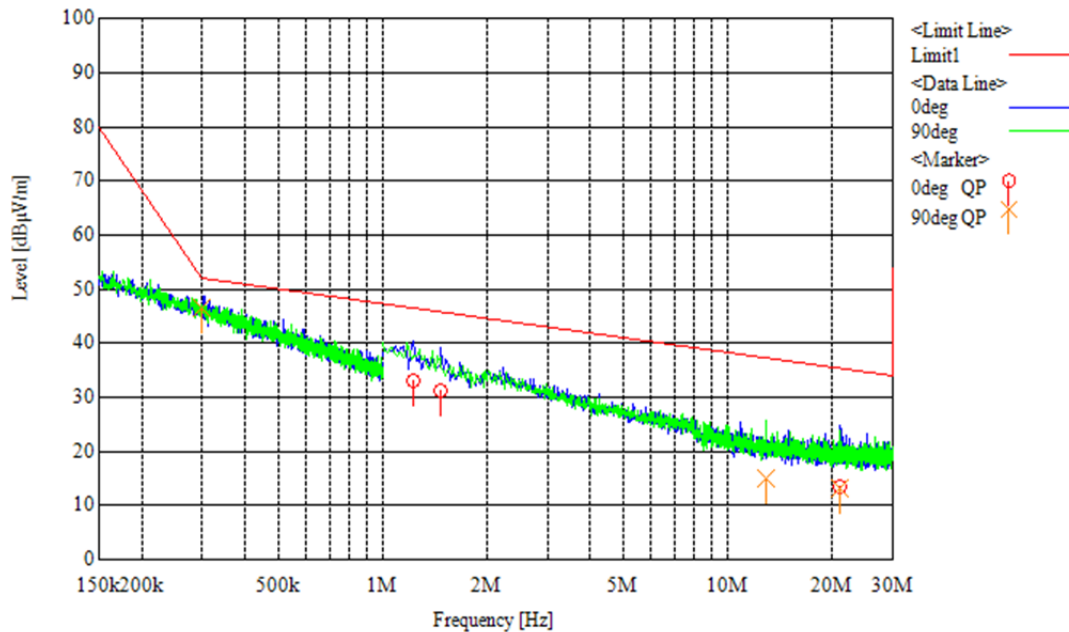
No.	Frequency [MHz]	Reading [dBμV]	Antenna [dB/m]	Loss [dB]	Gain [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Ant. [deg]
1	0.30733	34.8	11.4	0.1	0.0	46.3	51.9	5.6	0deg
2	1.14507	22.2	11.4	0.2	0.0	33.8	46.8	13.0	0deg
3	22.77538	3.5	8.8	0.9	0.0	13.2	35.1	21.9	0deg
4	0.26353	36.0	11.4	0.1	0.0	47.5	57.2	9.7	90deg
5	0.30733	34.7	11.4	0.1	0.0	46.2	51.9	5.7	90deg
6	1.10155	22.7	11.4	0.2	0.0	34.3	46.9	12.6	90deg

*Operating mode: Tx 16ch*

No.	Frequency [MHz]	Reading [dBμV]	Antenna [dB/m]	Loss [dB]	Gain [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Ant. [deg]
1	1.23212	21.4	11.4	0.2	0.0	33.0	46.5	13.5	0deg
2	1.47874	19.7	11.4	0.2	0.0	31.3	45.8	14.5	0deg
3	21.23761	3.8	9.0	0.8	0.0	13.6	35.4	21.8	0deg
4	0.30000	35.1	11.4	0.1	0.0	46.6	52.0	5.4	90deg
5	12.89594	4.1	10.1	0.7	0.0	14.9	37.3	22.4	90deg
6	21.16508	3.4	9.0	0.8	0.0	13.2	35.4	22.2	90deg

[Graph]

*Operating mode: Tx 16ch*



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Range 2: 30 MHz - 1000 MHz

*Operating mode: Rx 16ch*

No.	Freq. [MHz]	Reading [dBμV]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Ant.
1	405.300	42.9	16.2	10.2	30.2	39.1	54.0	14.9	Hori.
2	540.400	40.5	17.7	11.0	30.1	39.0	54.0	15.0	Hori.
3	675.500	36.8	18.6	11.6	30.2	36.8	54.0	17.2	Hori.
4	945.699	32.1	20.8	12.8	28.8	36.9	54.0	17.1	Hori.
5	135.100	45.3	12.4	8.1	30.2	35.6	54.0	18.4	Vert.
6	675.500	37.4	18.6	11.6	30.2	37.4	54.0	16.6	Vert.

*Operating mode: Rx 70ch*

No.	Freq. [MHz]	Reading [dBμV]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Ant.
1	404.475	39.4	16.1	10.2	30.2	35.5	54.0	18.5	Hori.
2	539.300	41.4	17.7	10.9	30.1	39.9	54.0	14.1	Hori.
3	674.125	35.8	18.6	11.6	30.2	35.8	54.0	18.2	Hori.
4	943.774	33.2	20.8	12.8	28.8	38.0	54.0	16.0	Hori.
5	539.300	38.2	17.7	10.9	30.1	36.7	54.0	17.3	Vert.
6	943.746	28.7	20.8	12.8	28.8	33.5	54.0	20.5	Vert.

*Operating mode: Tx 16ch*

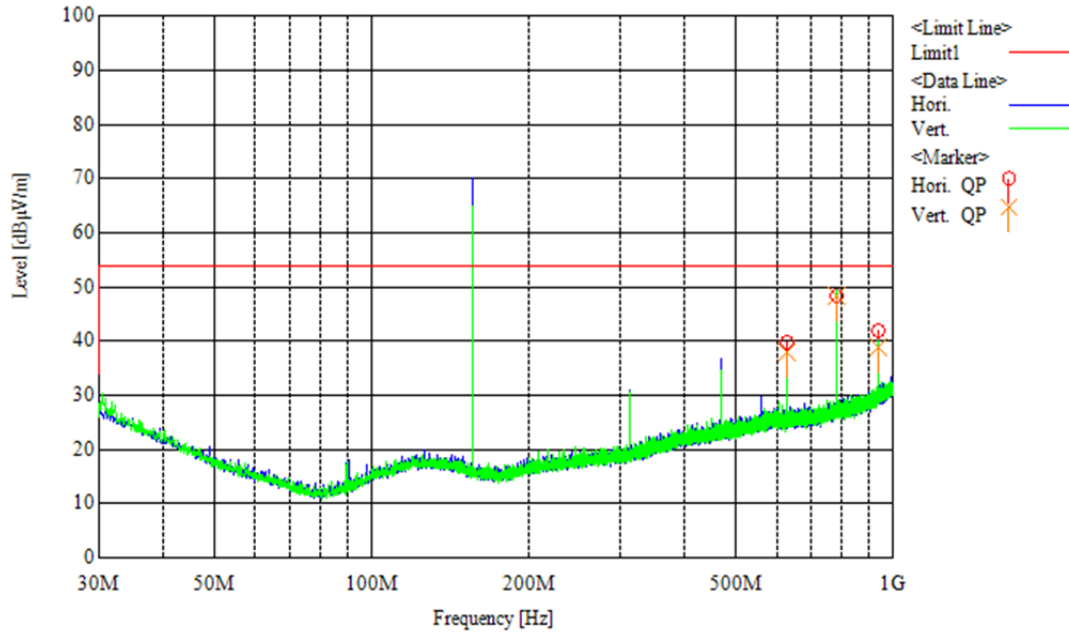
No.	Freq. [MHz]	Reading [dBμV]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Ant.
1	627.200	40.1	18.5	11.4	30.2	39.8	54.0	14.2	Hori.
2	783.999	46.9	19.6	12.1	30.1	48.5	54.0	5.5	Hori.
3	940.799	37.1	20.8	12.8	28.8	41.9	54.0	12.1	Hori.
4	627.200	38.2	18.5	11.4	30.2	37.9	54.0	16.1	Vert.
5	784.000	46.8	19.6	12.1	30.1	48.4	54.0	5.6	Vert.
6	940.800	34.2	20.8	12.8	28.8	39.0	54.0	15.0	Vert.

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[Graph]

Operating mode: Tx 16ch



Note: Spectrum @ 156.8MHz is a Tx carrier. This is not spurious emission.

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Range 3: 1000 MHz - 2000 MHz

*Operating mode: Rx 16ch*

No.	Freq. [MHz]	Reading [dBμV]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Ant.
1	1080.800	44.4	24.1	2.0	37.0	33.5	54.0	20.5	Hori.
2	1621.199	38.5	24.9	2.5	36.1	29.8	54.0	24.2	Hori.
3	1080.800	40.5	24.1	2.0	37.0	29.6	54.0	24.4	Vert.
4	1621.199	40.2	24.9	2.5	36.1	31.5	54.0	22.5	Vert.

Note: All emissions are below noise floor.

*Operating mode: Rx 70ch*

No.	Freq. [MHz]	Reading [dBμV]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Ant.
1	1078.599	41.2	24.1	2.0	37.0	30.3	54.0	23.7	Hori.
2	1078.599	37.6	24.1	2.0	37.0	26.7	54.0	27.3	Vert.

Note: All emissions are below noise floor.

*Operating mode: Tx 16ch*

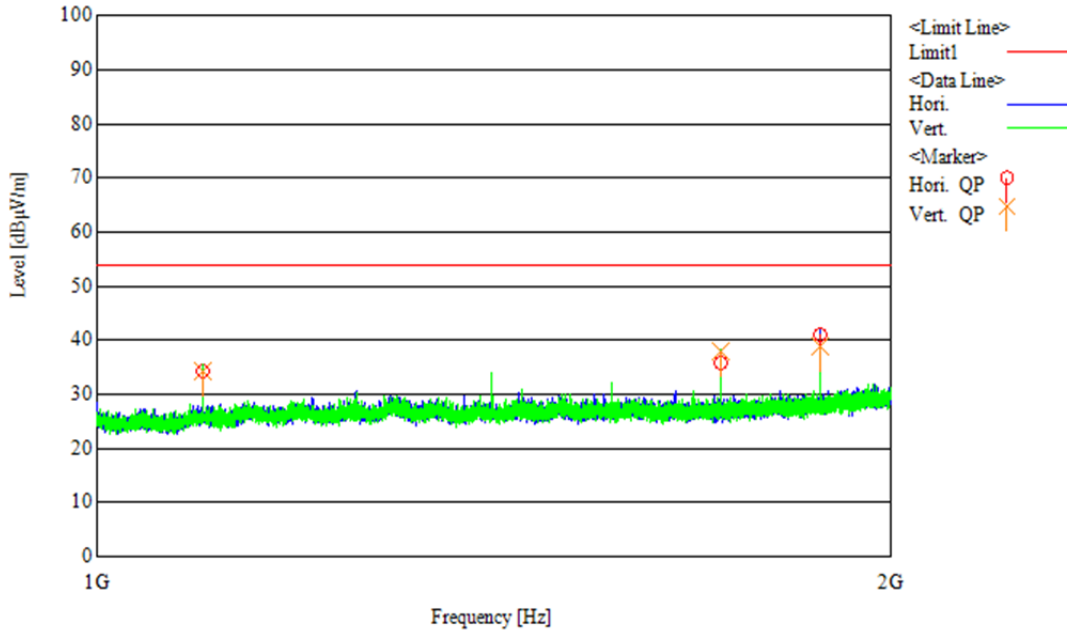
No.	Freq. [MHz]	Reading [dBμV]	Factor [dB/m]	Loss [dB]	Gain [dB]	Result [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Ant.
1	1097.599	45.0	24.4	2.0	37.0	34.4	54.0	19.6	Hori.
2	1724.799	44.6	24.8	2.6	36.1	35.9	54.0	18.1	Hori.
3	1881.599	48.9	25.4	2.7	36.0	41.0	54.0	13.0	Hori.
4	1097.599	44.9	24.4	2.0	37.0	34.3	54.0	19.7	Vert.
5	1724.799	46.6	24.8	2.6	36.1	37.9	54.0	16.1	Vert.
6	1881.599	46.7	25.4	2.7	36.0	38.8	54.0	15.2	Vert.

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[Graph]

Operating mode: Tx 16ch



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Range 4: 156 MHz - 165 MHz

*Operating mode: Rx 16ch*

No.	Freq. [MHz]	Reading PK [dB $\mu$ V]	Reading QP [dB $\mu$ V]	Correct. Factor [dB/m]	Result PK [dB $\mu$ V/m]	Result QP [dB $\mu$ V/m]	Limit PK [dB $\mu$ V/m]	Limit QP [dB $\mu$ V/m]	Margin PK [dB]	Margin QP [dB]	Ant.
1	161.294	32.3	25.5	-11.2	21.1	14.3	30.0	24.0	8.9	9.7	Hori.
2	161.294	30.0	23.9	-11.2	18.8	12.7	30.0	24.0	11.2	11.3	Vert.

*Operating mode: Rx 70ch*

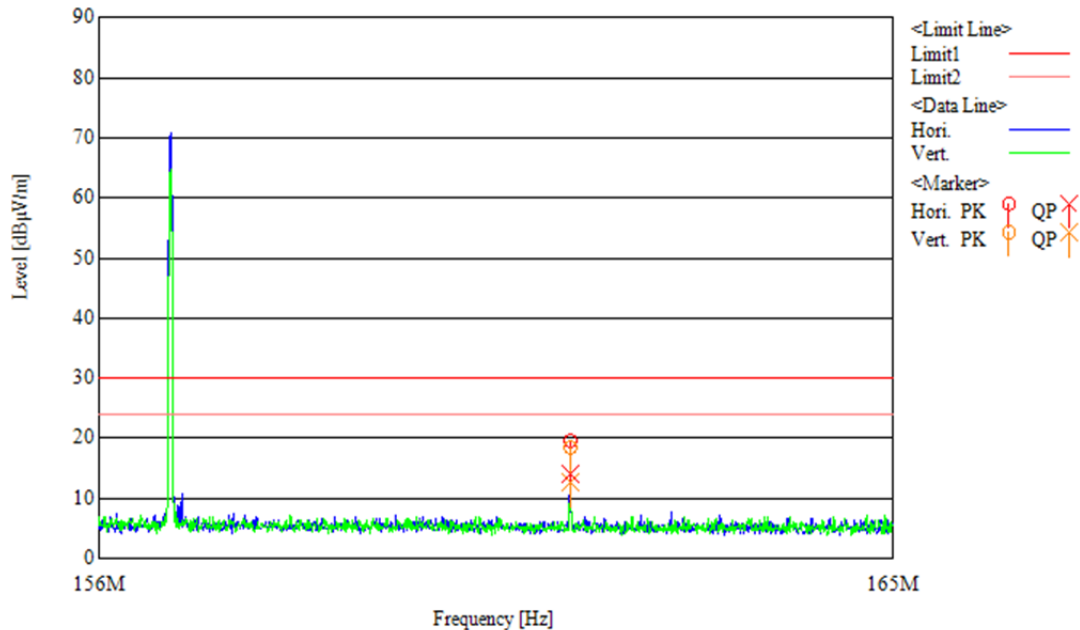
No.	Freq. [MHz]	Reading PK [dB $\mu$ V]	Reading QP [dB $\mu$ V]	Correct. Factor [dB/m]	Result PK [dB $\mu$ V/m]	Result QP [dB $\mu$ V/m]	Limit PK [dB $\mu$ V/m]	Limit QP [dB $\mu$ V/m]	Margin PK [dB]	Margin QP [dB]	Ant.
1	161.293	31.1	25.4	-11.2	19.9	14.2	30.0	24.0	10.1	9.8	Hori.
2	161.293	28.9	22.4	-11.2	17.7	11.2	30.0	24.0	12.3	12.8	Vert.

*Operating mode: Tx 16ch*

No.	Freq. [MHz]	Reading PK [dB $\mu$ V]	Reading QP [dB $\mu$ V]	Correct. Factor [dB/m]	Result PK [dB $\mu$ V/m]	Result QP [dB $\mu$ V/m]	Limit PK [dB $\mu$ V/m]	Limit QP [dB $\mu$ V/m]	Margin PK [dB]	Margin QP [dB]	Ant.
1	161.294	30.9	25.3	-11.2	19.7	14.1	30.0	24.0	10.3	9.9	Hori.
2	161.294	29.7	23.8	-11.2	18.5	12.6	30.0	24.0	11.5	11.4	Vert.

[Graph]

*Operating mode: Tx 16ch*



Note: Spectrum @ 156.8MHz is a Tx carrier. This is not spurious emission.

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## 2.1.2 Conducted emissions

### [Test Method]

The test method shall be in accordance with IEC 60945.

This test shall be performed on a representative configuration of the EUT in both, the receive and the transmit mode of operation, as appropriate.

The power input cable between DC input ports of the EUT and the Artificial Mains Network (AMN) shall be screened and not exceed 0.8 m in length.

If the EUT consists of more than one unit with individual DC power input ports, power input ports of identical nominal supply voltages shall be connected in parallel to the artificial mains network.

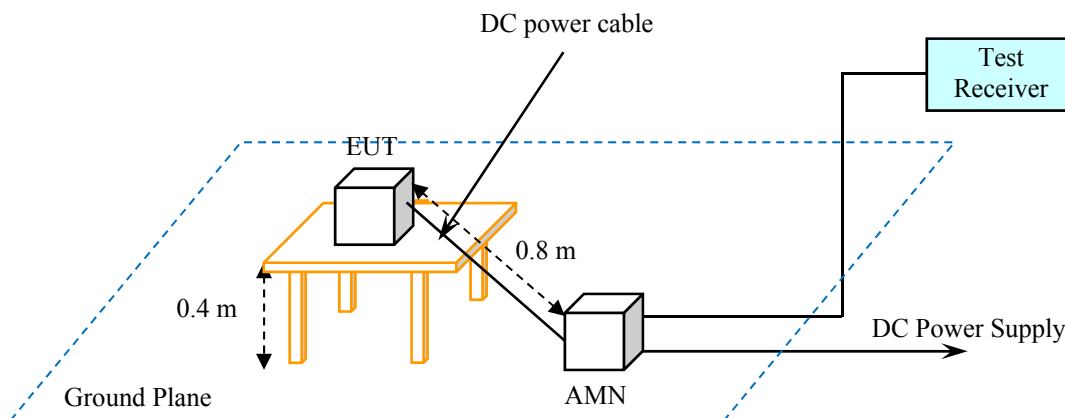
The setting of controls which may affect the level of conducted interference shall be varied in order to ascertain the maximum emission level.

The measuring bandwidth shall be:

- 200 Hz in the frequency range 10 kHz to 150 kHz
- 9 kHz in the frequency range 150 kHz to 30 MHz.

The measurement frequency range extends from 10 kHz to 30 MHz. When the EUT is a transmitter operating at frequencies below 30 MHz, then the exclusion band for transmitters applies (see clause 4.3) for measurements in the transmit mode of operation.

Test setup is implemented according to the method of IEC 60945 "Conducted measurements".



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[Limits]

The level of any conducted spurious signal shall not exceed the values given in below table.

Frequency range	Limit (QP) [dBμV]
10 kHz - 150 kHz	96 - 50
150 kHz - 350 kHz	60 - 50
350 kHz - 30 MHz	50

[Test equipment used (refer to List of utilized test equipment)]

TR06	LN18	CL11			
------	------	------	--	--	--

[Test result] - **Complied with requirement**

[Test Date]

Tested Date: 06 Sep. 2018                      Temperature: 20 degC  
 Humidity: 52 %                                      Atmos. Press: 1008 hPa

[Test Data]              Tested HW version:              SPP1

Tested line: DC power line

Operating mode: Rx 16ch

No.	Frequency [MHz]	Reading [dB]	LISN [dB]	Loss [dB]	Gain [dB]	Result [dBμV]	Limit [dBμV]	Margin [dB]	Phase
1	0.02960	28.1	10.9	0.1	0.0	39.1	77.6	38.5	Va
2	0.03531	28.8	10.7	0.1	0.0	39.6	74.6	35.0	Va
3	21.25001	12.2	10.0	0.8	0.0	23.0	50.0	27.0	Va
4	0.02960	21.3	10.9	0.1	0.0	32.3	77.6	45.3	Vb
5	0.03531	28.8	10.7	0.1	0.0	39.6	74.6	35.0	Vb
6	21.25000	12.1	10.0	0.8	0.0	22.9	50.0	27.1	Vb

The power line conducted emission voltage is calculated by adding the LISN factor and the cable loss attenuation from the measured reading. The calculation is as follows:

$$\text{Result} = \text{Reading} + C. F$$

where               $C.F = \text{LISN Factor} + \text{Cable Loss} + \text{Gain [dB]}$

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*Operating mode: Rx 70ch*

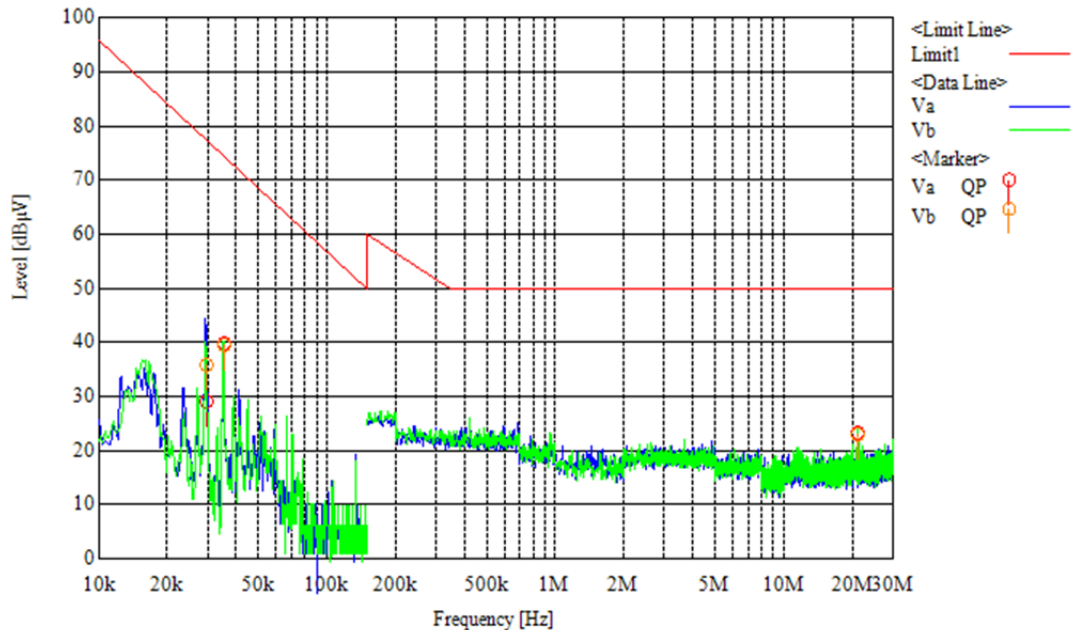
No.	Frequency [MHz]	Reading [dB]	LISN [dB]	Loss [dB]	Gain [dB]	Result [dBμV]	Limit [dBμV]	Margin [dB]	Phase
1	0.02971	26.6	10.9	0.1	0.0	37.6	77.5	39.9	Va
2	0.03531	27.8	10.7	0.1	0.0	38.6	74.6	36.0	Va
3	21.25022	12.2	10.0	0.8	0.0	23.0	50.0	27.0	Va
4	0.02965	31.3	10.9	0.1	0.0	42.3	77.5	35.2	Vb
5	0.03531	27.9	10.7	0.1	0.0	38.7	74.6	35.9	Vb
6	21.25002	12.1	10.0	0.8	0.0	22.9	50.0	27.1	Vb

*Operating mode: Tx 16ch*

No.	Frequency [MHz]	Reading [dB]	LISN [dB]	Loss [dB]	Gain [dB]	Result [dBμV]	Limit [dBμV]	Margin [dB]	Phase
1	0.02979	18.2	10.9	0.1	0.0	29.2	77.5	48.3	Va
2	0.03532	28.9	10.7	0.1	0.0	39.7	74.6	34.9	Va
3	21.24998	12.4	10.0	0.8	0.0	23.2	50.0	26.8	Va
4	0.02968	24.9	10.9	0.1	0.0	35.9	77.5	41.6	Vb
5	0.03533	28.7	10.7	0.1	0.0	39.5	74.6	35.1	Vb
6	21.25000	12.1	10.0	0.8	0.0	22.9	50.0	27.1	Vb

[Graph]

*Operating mode: Tx 16ch*



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## 2.2 EMS requirement

### 2.2.1 Radiated disturbance

[Test Condition]

Test level:	10 V/m
Frequency range:	80 - 2000 MHz
Modulation:	Amplitude, 400 Hz, 80 %
Frequency step size:	1.0 %
Dwell time:	3 s (80 - 1000 MHz), 9 s (1000 - 2000 MHz)
Field orientation:	Horizontal and vertical
Performance criteria:	A

[Test equipment used (refer to List of utilized test equipment)]

AC01(IM)	AC01(IG)	EM10	LA03	SL02	SG05	RP07
RP13	CL19	RC05				

[Test result] - **Complied with requirement**

[Test Date 1]

Tested Date:	07 Sep. 2018	Temperature:	22 degC
Humidity:	52 %	Atmos. Press:	1010 hPa

[Test Date 2]

Tested Date:	10 Sep. 2018	Temperature:	23 degC
Humidity:	54 %	Atmos. Press:	1014 hPa

[Test Date 3]

Tested Date:	11 Sep. 2018	Temperature:	22 degC
Humidity:	52 %	Atmos. Press:	1019 hPa

[Test Data] Tested HW version: SPP1.1

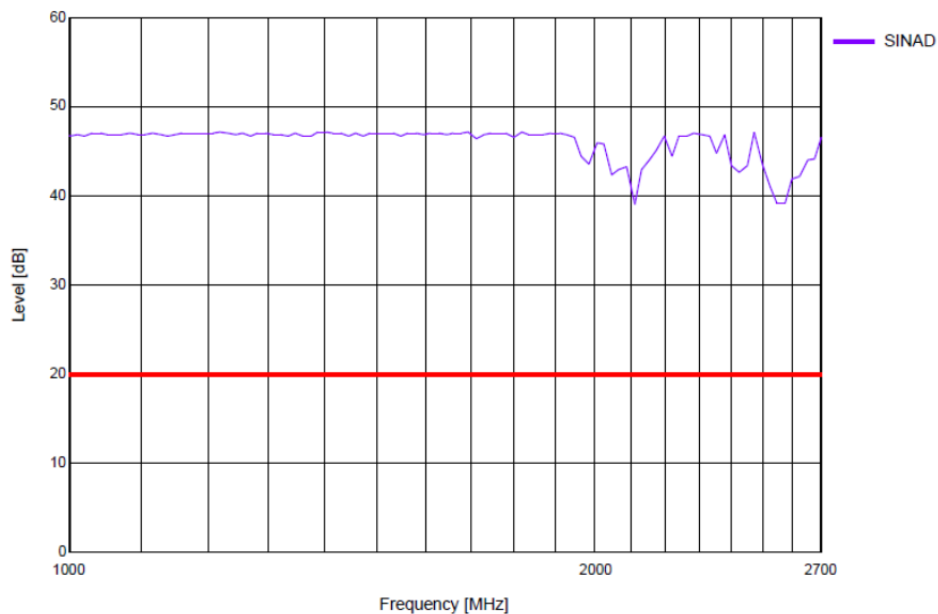
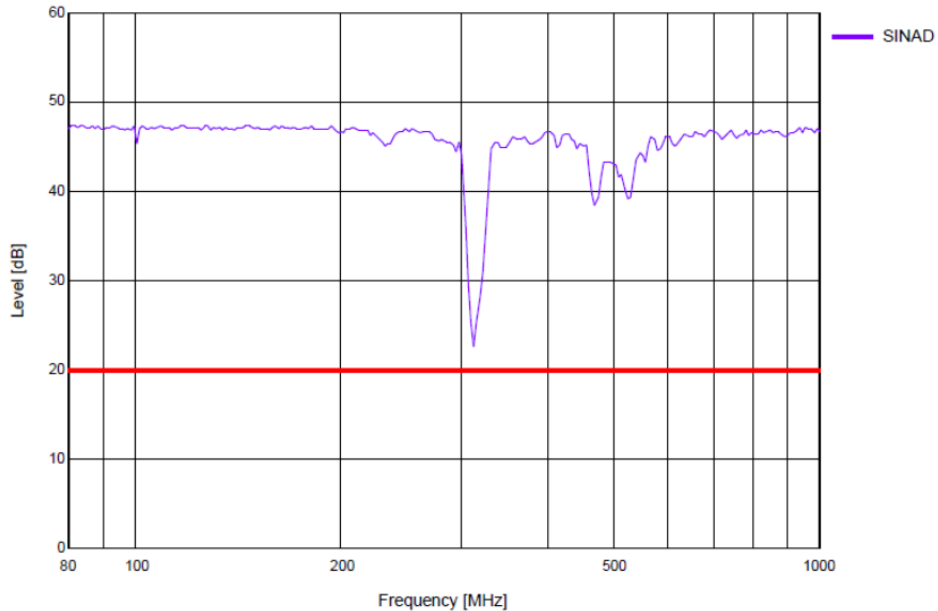
Operating Mode	Frequency	Test voltage	Criteria	Antenna Polarization	Result
Rx 16ch	80 MHz – 2.0GHz	10 V/m	A	Hori./Vert.	Pass
Rx 70ch	80 MHz – 2.0GHz	10 V/m	A	Hori./Vert.	Pass
Tx 16ch	80 MHz – 2.0GHz	10 V/m	A	Hori./Vert.	Pass

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[Graph (Worst) ]

Operating condition: Tx 16ch  
 Test condition: Front / Horizontal



Note: This test was applied up to 2700 MHz since the result will be used in common with EN 301 843-2 testing.

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## 2.2.2 Electrostatic discharge

[Test condition]

Test levels:  $\pm 6.0$  kV (Contact discharge)  
 $\pm 8.0$  kV (Air discharge)  
 Number of discharges: 10 for each polarity  
 Performance criteria: B

[Test equipment used (refer to List of utilized test equipment)]

ES04					
------	--	--	--	--	--

[Test result] - **Complied with requirement**

[Test Date]

Tested Date: 13 Sep. 2018                      Temperature: 23 degC  
 Humidity: 44 %                                      Atmos. Press: 1022 hPa

[Test Data]            Tested HW version:            SPP1.1

*Operating mode: Rx 16ch*

Discharge method	Coupling of interference	Test voltage	Criteria	Result
Contact discharge	VCP / HCP	$\pm 2$ kV, $\pm 4$ kV, $\pm 6$ kV	B	Pass
Air discharge	EUT	$\pm 2$ kV, $\pm 4$ kV, $\pm 8$ kV	B	Pass
Contact discharge	EUT	$\pm 2$ kV, $\pm 4$ kV, $\pm 6$ kV	B	Pass

VCP: Vertical coupling panel

HCP: Horizontal coupling panel

The discharge points of the EUT show the following photographs. (Refer to Sec 3.2.3)

*Operating mode: Rx 70ch*

Discharge method	Coupling of interference	Test voltage	Criteria	Result
Contact discharge	VCP / HCP	$\pm 2$ kV, $\pm 4$ kV, $\pm 6$ kV	B	Pass
Air discharge	EUT	$\pm 2$ kV, $\pm 4$ kV, $\pm 8$ kV	B	Pass
Contact discharge	EUT	$\pm 2$ kV, $\pm 4$ kV, $\pm 6$ kV	B	Pass

*Operating mode: Tx 16ch*

Discharge method	Coupling of interference	Test voltage	Criteria	Result
Contact discharge	VCP / HCP	$\pm 2$ kV, $\pm 4$ kV, $\pm 6$ kV	B	Pass
Air discharge	EUT	$\pm 2$ kV, $\pm 4$ kV, $\pm 8$ kV	B	Pass
Contact discharge	EUT	$\pm 2$ kV, $\pm 4$ kV, $\pm 6$ kV	B	Pass

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### 2.2.3 Fast transients (bursts)

[Test condition]

Test level:  $\pm 1.0$  kV (DC cable, GND/Signal Cable)  
 Repetition rate: 5.0 kHz  
 Duration of each test: 180 s  
 Application method: CDN (DC Cable), Capacitive Clamp (GND/Signal Cable)  
 Performance criterion: B

[Test equipment]

IM04	BC56					
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[Test result] - **Complied with requirement**

[Test Date]

Tested Date: 13 Sep. 2018                      Temperature: 23 degC  
 Humidity: 44 %                                      Atmos. Press: 1022 hPa

[Test Data]      Tested HW version:      SPP1.1

*Operating mode: Rx 16ch*

Tested Port	Injection	Test voltage	Criteria	Result
DC Cable	CDN	$\pm 1.0$ kV	B	Pass
GND Cable	Clamp	$\pm 1.0$ kV	B	Pass
Mic. Cable (Radio unit side)	Clamp	$\pm 1.0$ kV	B	Pass
Mic. Cable (Mic. unit side)	Clamp	$\pm 1.0$ kV	B	Pass
RAM Cable	Clamp	$\pm 1.0$ kV	B	Pass
GPS Cable	Clamp	$\pm 1.0$ kV	B	Pass
ACC Cable	Clamp	$\pm 1.0$ kV	B	Pass
EX SP Cable	Clamp	$\pm 1.0$ kV	B	Pass
NMEA2000 Cable	Clamp	$\pm 1.0$ kV	B	Pass

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*Operating mode: Rx 70ch*

Tested Port	Injection	Test voltage	Criteria	Result
DC Cable	CDN	± 1.0 kV	B	Pass
GND Cable	Clamp	± 1.0 kV	B	Pass
Mic. Cable (Radio unit side)	Clamp	± 1.0 kV	B	Pass
Mic. Cable (Mic. unit side)	Clamp	± 1.0 kV	B	Pass
RAM Cable	Clamp	± 1.0 kV	B	Pass
GPS Cable	Clamp	± 1.0 kV	B	Pass
ACC Cable	Clamp	± 1.0 kV	B	Pass
EX SP Cable	Clamp	± 1.0 kV	B	Pass
NMEA2000 Cable	Clamp	± 1.0 kV	B	Pass

*Operating mode: Tx 16ch*

Tested Port	Injection	Test voltage	Criteria	Result
DC Cable	CDN	± 1.0 kV	B	Pass
GND Cable	Clamp	± 1.0 kV	B	Pass
Mic. Cable (Radio unit side)	Clamp	± 1.0 kV	B	Pass
Mic. Cable (Mic. unit side)	Clamp	± 1.0 kV	B	Pass
RAM Cable	Clamp	± 1.0 kV	B	Pass
GPS Cable	Clamp	± 1.0 kV	B	Pass
ACC Cable	Clamp	± 1.0 kV	B	Pass
EX SP Cable	Clamp	± 1.0 kV	B	Pass
NMEA2000 Cable	Clamp	± 1.0 kV	B	Pass

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## 2.2.4 Conducted radio frequency disturbance

### [Test condition (sweep)]

Test level: 3 Vrms  
 Frequency range: 0.15 - 80 MHz  
 Modulation: Amplitude, 400 Hz, 80 %  
 Frequency step size: 1.0 %  
 Dwell time: 3.0 s  
 Application method: CDN (DC/GND Cable), EM clamp (Signal cable)  
 Performance criterion: A

### [Test condition (spot)]

Test level: 10 V rms  
 Test Frequency: 2, 3, 4, 6.2, 8.2, 12.6, 16.5, 18.8, 22, 25 MHz  
 Modulation: Amplitude, 400 Hz, 80 %  
 Dwell time: 3.0 s  
 Application method: CDN (DC/GND Cable), EM clamp (Signal cable)  
 Performance criterion: A

### [Test equipment]

CD21	CL65	SG13	RP04	EC01	RC05	CD25
------	------	------	------	------	------	------

[Test result] - **Complied with requirement**

### [Test Date 1]

Tested Date: 18 Sep. 2018      Temperature: 24 degC  
 Humidity: 47 %      Atmos. Press: 1014 hPa

### [Test Date 2]

Tested Date: 19 Sep 2018      Temperature: 25 degC  
 Humidity: 41 %      Atmos. Press: 1016 hPa

### [Test Date 3]

Tested Date: 20 Sep. 2018      Temperature: 25 degC  
 Humidity: 51 %      Atmos. Press: 1016 hPa

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[Test Data (Sweep\_3V)]      Tested HW version:      SPP1.2

*Operating mode: Rx 16ch*

Tested Port	Injection	Test voltage	Criteria	Result
DC Cable	CDN	3 Vrms	A	Pass
GND Cable	CDN	3 Vrms	A	Pass
Mic. Cable (Radio unit side)	EM Clamp	3 Vrms	A	Pass
Mic. Cable (Mic. unit side)	EM Clamp	3 Vrms	A	Pass
RAM Cable	EM Clamp	3 Vrms	A	Pass
GPS Cable	EM Clamp	3 Vrms	A	Pass
ACC Cable	EM Clamp	3 Vrms	A	Pass
EX SP Cable	EM Clamp	3 Vrms	A	Pass
NMEA2000 Cable	EM Clamp	3 Vrms	A	Pass

*Operating mode: Rx 70ch*

Tested Port	Injection	Test voltage	Criteria	Result
DC Cable	CDN	3 Vrms	A	Pass
GND Cable	CDN	3 Vrms	A	Pass
Mic. Cable (Radio unit side)	EM Clamp	3 Vrms	A	Pass
Mic. Cable (Mic. unit side)	EM Clamp	3 Vrms	A	Pass
RAM Cable	EM Clamp	3 Vrms	A	Pass
GPS Cable	EM Clamp	3 Vrms	A	Pass
ACC Cable	EM Clamp	3 Vrms	A	Pass
EX SP Cable	EM Clamp	3 Vrms	A	Pass
NMEA2000 Cable	EM Clamp	3 Vrms	A	Pass

*Operating mode: Tx 16ch*

Tested Port	Injection	Test voltage	Criteria	Result
DC Cable	CDN	3 Vrms	A	Pass
GND Cable	CDN	3 Vrms	A	Pass
Mic. Cable (Radio unit side)	EM Clamp	3 Vrms	A	Pass
Mic. Cable (Mic. unit side)	EM Clamp	3 Vrms	A	Pass
RAM Cable	EM Clamp	3 Vrms	A	Pass
GPS Cable	EM Clamp	3 Vrms	A	Pass
ACC Cable	EM Clamp	3 Vrms	A	Pass
EX SP Cable	EM Clamp	3 Vrms	A	Pass
NMEA2000 Cable	EM Clamp	3 Vrms	A	Pass

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[Test Data (Spot\_10V)]      Tested HW version:      SPP1.2

*Operating mode: Rx 16ch*

Tested Port	Injection	Test voltage	Criteria	Result
DC Cable	CDN	10 Vrms	A	Pass
GND Cable	CDN	10 Vrms	A	Pass
Mic. Cable (Radio unit side)	EM Clamp	10 Vrms	A	Pass
Mic. Cable (Mic. unit side)	EM Clamp	10 Vrms	A	Pass
RAM Cable	EM Clamp	10 Vrms	A	Pass
GPS Cable	EM Clamp	10 Vrms	A	Pass
ACC Cable	EM Clamp	10 Vrms	A	Pass
EX SP Cable	EM Clamp	10 Vrms	A	Pass
NMEA2000 Cable	EM Clamp	10 Vrms	A	Pass

*Operating mode: Rx 70ch*

Tested Port	Injection	Test voltage	Criteria	Result
DC Cable	CDN	10 Vrms	A	Pass
GND Cable	CDN	10 Vrms	A	Pass
Mic. Cable (Radio unit side)	EM Clamp	10 Vrms	A	Pass
Mic. Cable (Mic. unit side)	EM Clamp	10 Vrms	A	Pass
RAM Cable	EM Clamp	10 Vrms	A	Pass
GPS Cable	EM Clamp	10 Vrms	A	Pass
ACC Cable	EM Clamp	10 Vrms	A	Pass
EX SP Cable	EM Clamp	10 Vrms	A	Pass
NMEA2000 Cable	EM Clamp	10 Vrms	A	Pass

*Operating mode: Tx 16ch*

Tested Port	Injection	Test voltage	Criteria	Result
DC Cable	CDN	10 Vrms	A	Pass
GND Cable	CDN	10 Vrms	A	Pass
Mic. Cable (Radio unit side)	EM Clamp	10 Vrms	A	Pass
Mic. Cable (Mic. unit side)	EM Clamp	10 Vrms	A	Pass
RAM Cable	EM Clamp	10 Vrms	A	Pass
GPS Cable	EM Clamp	10 Vrms	A	Pass
ACC Cable	EM Clamp	10 Vrms	A	Pass
EX SP Cable	EM Clamp	10 Vrms	A	Pass
NMEA2000 Cable	EM Clamp	10 Vrms	A	Pass

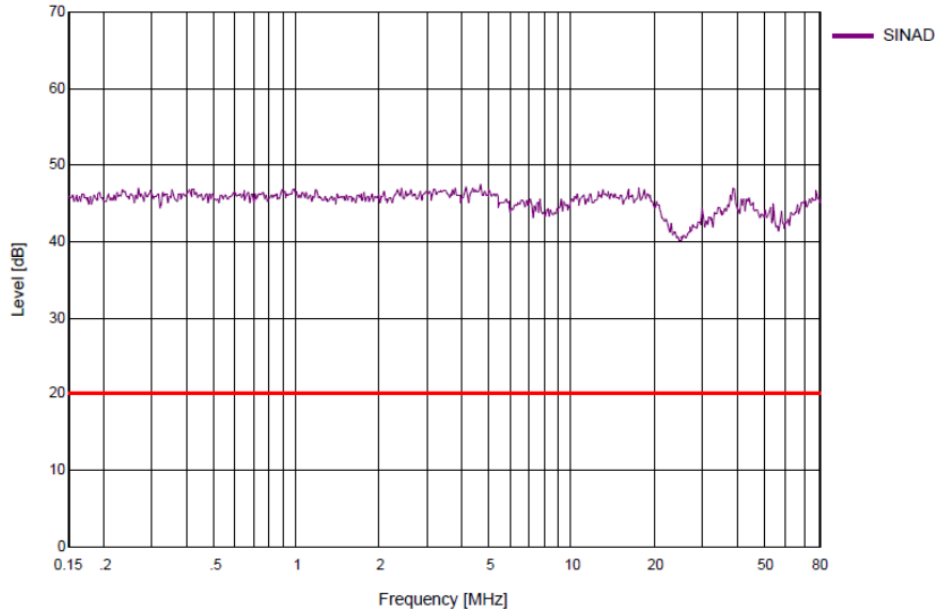
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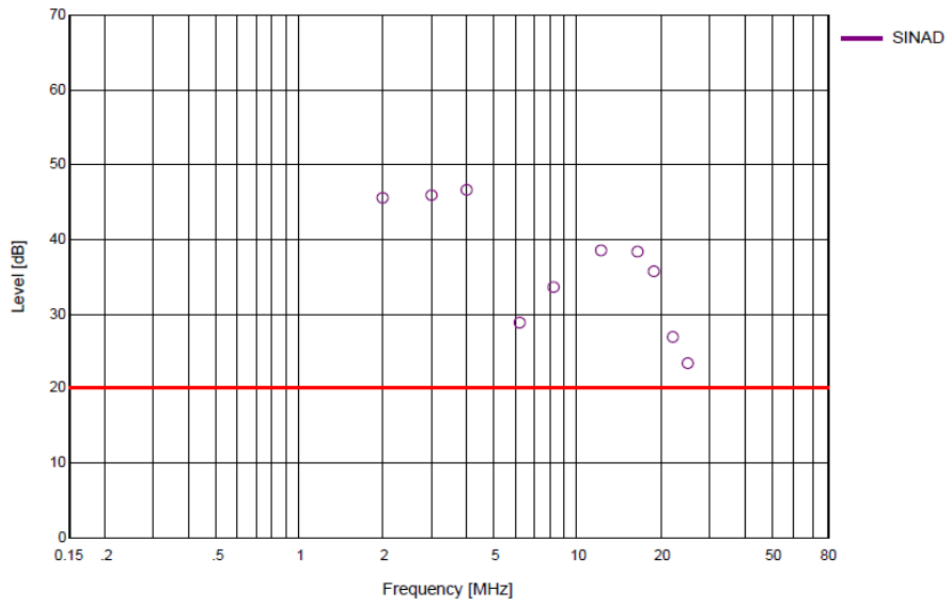
[Graph]

Operating mode: Rx 16ch  
 Tested port: ACC Cable

Sweep test



Spot test



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### 2.2.5 Power supply short term variation

[Test condition]

Variation A: Voltage (1.2 times), Frequency (1.1 times)  
 Variation B: Voltage (0.8 times), Frequency (0.9 times)  
 Duration: 1.5 s per minute (Voltage), 5.0 s per minute (Frequency)  
 Test time: 10 min  
 Performance criterion: B

[Test equipment]

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[Test result] - ***This item was not tested.***

[Test Data]

Variation	Voltage	Frequency	Criteria	Result
A	1.2 times	1.1 times	B	-
B	0.8 times	0.9 times	B	-

[Test Date]

Tested Date: - Temperature: - degC  
 Humidity: - % Atmos. Press: - hPa

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**2.2.6 Power supply failure**

[Test condition]

Break time: 60 s  
 Number of Break: 3  
 Performance criterion: C

[Test equipment]

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[Test result] - **Complied with requirement**

[Test Date]

Tested Date: 13 Sep. 2018                      Temperature: 23 degC  
 Humidity: 44 %                                      Atmos. Press: 1022 hPa

[Test Data]              Tested HW version:              SPP1.1

Tested Line	Operating mode	Criteria	Result
DC power	Rx 16ch	C	Pass
	Rx 70ch	C	Pass
	Tx 16ch	C	Pass

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**2.2.7 Slow transients (surges)**

[Test Condition]

Test levels:  $\pm 0.5$  kV (Line to Line; AC port)  
 $\pm 1.0$  kV (Line to GND; AC port)  
 Number of discharge: 18 (each polarity)  
 Repetition rate: 6 per minute

[Test equipment]

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[Test result] - ***This item was not tested.***

[Test Date]

Tested Date: - Temperature: - degC  
 Humidity: - % Atmos. Press: - hPa

[Test Data]

Discharge Point	Test level [kV]	Phase	Criteria	Result
L - N (Line to Line)	$\pm 0.5$	0/90/180/270 deg	B	-
	$\pm 1.0$	0/90/180/270 deg	B	-

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### 3.2.6 Power supply short term variation

This item was not tested.

### 3.2.7 Slow transients (surges)

This item was not tested.

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#### 4 List of utilized test equipment/ calibration

ID No.	Kind of Equipment	Manufacturer	Model No.	Serial Number	Cal. Date	Cal. until
AC01(EM)	Anechoic Chamber (1st test room)	JSE	203397C	-	2018/4/14	2019/4/30
AC01(EG)	Anechoic Chamber (1st test room)	JSE	203397C	-	2018/3/21	2019/3/31
BA07	Biological Antenna	TESEQ	CBL6143A	26670	2017/12/5	2018/12/31
CL11	RF Cable for RE	RFT	-	-	2018/3/26	2019/3/31
CL30	RF Cable 5 m	SUHNER	SUCOFLEX104PE	MY3599	2018/1/29	2019/1/31
CL38	RF Cable 2 m	Junkosha	MWX221	1603S626	2018/1/29	2019/1/31
DH06	DRG Horn Antenna	A.H. Systems	SAS-571	1339	2018/6/19	2020/6/30
LN18	LISN (9kHz)	Kyoritsu	TNW-242F2	12-15-54	2018/3/24	2019/3/31
LP06	Loop Antenna	ETS-Lindgren	6502	00164299	2018/4/3	2019/4/30
PR12	Pre. Amplifier (1-26G)	Agilent Technologies	8449B	3008A02513	2018/1/29	2019/1/31
PR21	Pre. Amplifier	Anritsu	MH648A	6200467119	2017/12/4	2018/12/31
TR06	Test Receiver (F/W : 4.73 SP4)	Rohde & Schwarz	ESU26	100002	2017/10/17	2018/10/31
AC01(IM)	Anechoic Chamber	JSE	203397C	-	2017/11/21	2018/11/30
AC01(IG)	Anechoic Chamber	JSE	203397C	-	2017/10/27	2018/10/31
BC56	Burst Clamp	EM Test	HFK	1112-125	2018/4/11	2019/4/30
CD21	CDN (M2)	FCC	FCC-801-M2-16A	141672	2018/4/3	2019/4/30
CD25	CDN (M1)	FCC	FCC-801-M1-16A	141671	2018/4/3	2019/4/30
CL19	RF Cable for RS	SUCOFLEX	-	-	2017/11/21	2018/11/30
CL65	RF Cable for CS	RFT	-	-	2018/5/1	2019/5/31
EC01	EM Injection Clamp	FCC	TSIC-32	472	2018/4/11	2019/4/30
EM10	EM Probe/Monitor	AR	FL7006	0334662	2017/11/2	2018/11/30
ES04	ESD Tester	EMC Partner	ESD3000	374	2018/5/28	2019/5/31
IM04	Surge/Burst/Dip Simulator	EM Test	UCS500N5	P1304111117	2018/4/10	2019/4/30
LA03	Logperiodic Antenna (High Power)	SCHWARZBECK	VULP9118-D	613	2017/11/21	2018/11/30

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ID No.	Kind of Equipment	Manufacturer	Model No.	Serial Number	Cal. Date	Cal. until
RP04	RF Power Amplifier	PRANA	AP32DT120	0509-688	2018/5/1	2019/5/31
RP07	RF Power Amplifier 350W	PRANA	AP32LT235	0604-740	2018/6/11	2019/6/30
RP13	RF Power AMP 0.8-4.2GHz 50W	AR	50S1G4A	0326341	2017/12/15	2018/12/31
SL02	Stacked logperiodic Antenna	SCHWARZBECK	STLP9149	507	2017/10/27	2018/10/31
RC05	Radio communication tester	Agilent Technologies	8920B	US35240529	2017/11/20	2018/11/30
SG05	Signal Generator	Rohde & Schwarz	SMR20	100905	2018/2/6	2019/2/28
SG13	Signal Generator	Agilent Technologies	N5181A	MY47420721	2017/8/1	2018/8/31

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.

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