



RADIO TEST REPORT

Test Report No. : 12403128S-A-R4

Applicant : Pioneer Corporation
Type of Equipment : Pedaling Monitor Sensor
Model No. : SGY-PM930HL
FCC ID : AJDK108
Test regulation : FCC Part 15 Subpart C: 2018
(* Bluetooth low energy part)
Test Result : Complied

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8. The opinions and the interpretations to the result of the description in this report are outside scopes where UL Japan has been accredited.
9. This report is a revised version of 12403128S-A-R3. 12403128S-A-R3 is replaced with this report.

Date of test: August 8 to 17, 2018

Representative test engineer:

K. Noda

Kazuya Noda

Engineer

Consumer Technology Division

Approved by:

H. Shirasawa

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Engineer

Consumer Technology Division



- ☐ The testing in which "Non-accreditation" is displayed is outside the accreditation scopes in UL Japan.
☒ There is no testing item of "Non-accreditation".

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REVISION HISTORY

Original Test Report No.: 12403128S-A

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SECTION 1: Customer information

Company Name	:	Pioneer Corporation
Address	:	25-1 Yamada, Kawagoe-shi, Saitama, 350-8555, Japan
Telephone Number	:	+81-49-228-7787
Facsimile Number	:	+81-49-228-6493
Contact Person	:	Masahiro Sato

SECTION 2: Equipment under test (E.U.T.)

2.1 Identification of E.U.T.

Type of Equipment	:	Pedaling Monitor Sensor
Model No.	:	SGY-PM930HL
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	DC 3.0 V
Receipt Date of Sample	:	August 8, 2018
Country of Mass-production	:	Japan
Condition of EUT	:	Production prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification of EUT	:	No Modification by the test lab

2.2 Product Description

Model: SGY-PM930HL (referred to as the EUT in this report) is a Pedaling Monitor Sensor.

Radio Specification

Bluetooth Low Energy

Equipment Type	:	Transceiver
Frequency of Operation	:	2402 MHz - 2480 MHz
Type of Modulation	:	GFSK
Antenna Type	:	Planar inverted F type (SGY-PM930HL)
Antenna connector type	:	None
Antenna Gain	:	-8.2 dBi
Operating Temperature	:	-10 deg. C to +50 deg. C

SECTION 3: Test specification, procedures & results

3.1 Test Specification

Test Specification : FCC Part 15 Subpart C
FCC Part 15 final revised on March 12, 2018 and effective April 11, 2018

Title : FCC 47CFR Part15 Radio Frequency Device Subpart C Intentional Radiators
Section 15.207 Conducted limits
Section 15.247 Operation within the bands 902-928MHz,
2400-2483.5MHz, and 5725-5850MHz

3.2 Procedures and results

Item	Test Procedure	Specification	Worst margin	Results	Remarks
Conducted Emission	FCC: ANSI C63.10-2013 6. Standard test methods	FCC: Section 15.207	-	N/A	-
	IC: RSS-Gen 8.8	IC: RSS-Gen 8.8			
6dB Bandwidth	FCC: KDB 558074 D01 DTS Meas Guidance v04	FCC: Section 15.247(a)(2)	See data.	Complied	Conducted
	IC: -	IC: RSS-247 5.2(a)			
Maximum Peak Output Power	FCC: KDB 558074 D01 DTS Meas Guidance v04	FCC: Section 15.247(b)(3)		Complied	Conducted
	IC: RSS-Gen 6.12	IC: RSS-247 5.4(d)			
Power Density	FCC: KDB 558074 D01 DTS Meas Guidance v04	FCC: Section 15.247(e)		Complied	Conducted
	IC: -	IC: RSS-247 5.2(b)			
Spurious Emission Restricted Band Edges	FCC: KDB 558074 D01 DTS Meas Guidance v04	FCC: Section 15.247(d)	7.4 dB 7206.00 MHz, 2402 MHz, AV, Horizontal Tx BT LE 2402 MHz	Complied	Conducted (below 30 MHz)/ Radiated (above 30 MHz) *1)
	IC: RSS-Gen 6.13	IC: RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10			

Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422.

*1) Radiated test was selected over 30 MHz based on section 15.247(d) and KDB 558074 D01 DTS Meas Guidance v04 12.2.7.

Symbols:

Complied The data of this test item has enough margin, more than the measurement uncertainty.

Complied# The data of this test item meets the limits unless the measurement uncertainty is taken into consideration.

* In case any questions arise about test procedure, ANSI C63.10: 2013 is also referred.

FCC Part 15.31 (e)

The test was performed with the New Battery and the stable voltage was supplied to the EUT during the tests.
Therefore, this EUT complies with the requirement.

FCC Part 15.203 Antenna requirement

It is impossible for end users to replace the antenna, because the antenna is mounted inside of the EUT. Therefore, the equipment complies with the antenna requirement of Section 15.203.

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3.3 Addition to standard

Item	Test Procedure	Specification	Worst margin	Remarks
99% Occupied Bandwidth	IC: RSS-Gen 6.6	IC: -	N/A	Conducted

Other than above, no addition, exclusion nor deviation has been made from the standard.

3.4 Uncertainty

EMI

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor $k=2$.

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Item	Frequency range	Uncertainty (+/-)				
		No. 1 SAC / SR	No. 2 SAC / SR	No. 3 SAC / SR	No. 4 SAC / SR	No. 5,6,8 SR
Conducted emission (AC Mains) LISN	150 kHz-30 MHz	2.5 dB	2.5 dB	2.5 dB	2.6 dB	2.6 dB
Radiated emission (Measurement distance: 3 m)	9 kHz-30 MHz	3.2 dB	3.2 dB	3.3 dB	-	-
	30 MHz-200 MHz	4.9 dB	4.8 dB	4.9 dB	-	-
	200 MHz-1 GHz	6.1 dB	6.1 dB	6.1 dB	-	-
	1 GHz-6 GHz	4.7 dB	4.7 dB	4.7 dB	-	-
	6 GHz-18 GHz	5.3 dB	5.3 dB	5.3 dB	-	-
	18 GHz-40 GHz	5.6 dB	5.6 dB	5.6 dB	-	-
	1 GHz-18 GHz	5.6 dB	5.6 dB	5.6 dB	-	-
Radiated emission (Measurement distance: 1 m)	18 GHz-40 GHz	5.9 dB	5.9 dB	5.9 dB	-	-

SAC=Semi-Anechoic Chamber

SR= Shielded Room is applied besides radiated emission

Antenna terminal test	Uncertainty (+/-)
Power Measurement above 1 GHz (Average Detector)_SPM-06	0.48 dB
Power Measurement above 1 GHz (Peak Detector)_SPM-06	0.66 dB
Power Measurement above 1 GHz (Average Detector)_SPM-07	0.47 dB
Power Measurement above 1 GHz (Peak Detector)_SPM-07	0.64 dB
Power Measurement above 1 GHz (Average Detector)_SPM-13	0.90 dB
Power Measurement above 1 GHz (Peak Detector)_SPM-13	1.04 dB
Spurious emission (Conducted) below 1GHz	1.8 dB
Spurious emission (Conducted) 1 GHz-3 GHz	1.7 dB
Spurious emission (Conducted) 3 GHz-18 GHz	2.5 dB
Spurious emission (Conducted) 18 GHz-26.5 GHz	2.5 dB
Spurious emission (Conducted) 26.5 GHz-40 GHz	2.7 dB
Bandwidth Measurement	1.01 %

3.5 Test Location

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JAB Accreditation No. RTL02610
FCC Test Firm Registration Number: 839876

Test site	IC Registration Number	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Maximum measurement distance
No.1 Semi-anechoic chamber	2973D-1	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.2 Semi-anechoic chamber	2973D-2	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.3 Semi-anechoic chamber	2973D-3	12.7 x 7.7 x 5.35	12.7 x 7.7	5 m
No.4 Semi-anechoic chamber	-	8.1 x 5.1 x 3.55	8.1 x 5.1	-
No.1 Shielded room	-	6.8 x 4.1 x 2.7	6.8 x 4.1	-
No.2 Shielded room	-	6.8 x 4.1 x 2.7	6.8 x 4.1	-
No.3 Shielded room	-	6.3 x 4.7 x 2.7	6.3 x 4.7	-
No.4 Shielded room	-	4.4 x 4.7 x 2.7	4.4 x 4.7	-
No.5 Shielded room	-	7.8 x 6.4 x 2.7	7.8 x 6.4	-
No.6 Shielded room	-	7.8 x 6.4 x 2.7	7.8 x 6.4	-
No.8 shielded room	-	3.45 x 5.5 x 2.4	3.45 x 5.5	-
No.1 Measurement room	-	2.55 x 4.1 x 2.5	-	-

3.6 Test data, Test instruments, and Test set up

Refer to APPENDIX.

SECTION 4: Operation of E.U.T. during testing

4.1 Operating Mode(s)

Mode	Remarks*
Bluetooth Low Energy (BT LE)	PRBS9
*Power of the EUT was set by the software as follows; Power settings: Fixed Software: 0.001 *This setting of software is the worst case. Any conditions under the normal use do not exceed the condition of setting. In addition, end users cannot change the settings of the output power of the product.	

*The details of Operating mode(s)

Test Item	Operating Mode	Tested frequency
Spurious Emission 6dB Bandwidth Maximum Peak Output Power Power Density 99% Occupied Bandwidth	Tx BT LE	2402 MHz 2440 MHz 2480 MHz

4.2 Configuration and peripherals



* Cabling and setup(s) were taken into consideration and test data was taken under worst case conditions.

Description of EUT and Support equipment

No.	Item	Model number	Serial number	Manufacturer	Remark
A	Pedaling Monitor Sensor (Transmitter)	SGY-PM930HL	RHTP600005WL *1) RHTP600040WL *2)	Pioneer	EUT
B	Battery	CR2032	-	-	-

*1) Used for AT (Antenna Terminal Conducted test)

*2) Used for RE (Radiated emission test)

SECTION 5: Radiated Spurious Emission

Test Procedure

It was measured based on "11.0 Emissions in non-restricted frequency bands" of "KDB 558074 D01 DTS Meas Guidance v04".

[For below 1 GHz]

EUT was placed on a platform of nominal size, 1.0 m by 1.5 m, raised 0.8 m above the conducting ground plane. The table is made of expanded polystyrol and expanded polypropylene and the table top is covered with polycarbonate. That has very low permittivity. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with a ground plane.

[For above 1 GHz]

EUT was placed on a urethane platform of nominal size, 0.5 m by 0.5 m, raised 1.5 m above the conducting ground plane. The Radiated Electric Field Strength has been measured in a Semi Anechoic Chamber with absorbent materials lined on a ground plane.

The height of the measuring antenna varied between 1 and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.

The measurements were performed for both vertical and horizontal antenna polarization with the Test Receiver, or the Spectrum Analyzer.

The measurements were made with the following detector function of the test receiver and the Spectrum analyzer (in linear mode).

The test was made with the detector (RBW/VBW) in the following table.

When using Spectrum analyzer, the test was made with adjusting span to zero by using peak hold.

Test Antennas are used as below;

Frequency	30 MHz to 200 MHz	200 MHz to 1 GHz	Above 1 GHz
Antenna Type	Biconical	Logperiodic	Horn

In any 100 kHz bandwidth outside the restricted band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator confirmed 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on a radiated measurement.

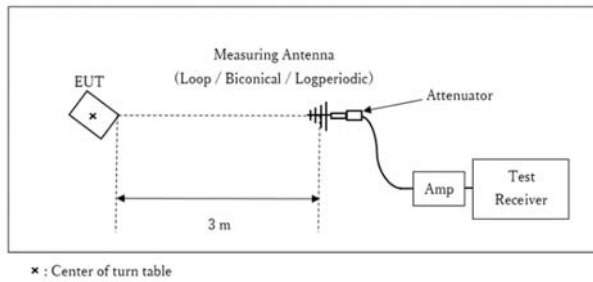
20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9(IC) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (IC).

Frequency	Below 1 GHz	Above 1 GHz		20 dBc
Instrument used	Test Receiver	Spectrum Analyzer		Spectrum Analyzer
Detector	QP	PK	AV *1) *2)	PK
IF Bandwidth	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	Average Power Method: <u>12.2.5.2</u> RBW: 1 MHz VBW: 3 MHz Detector: Power Averaging (Linear voltage) Trace: 100 traces Duty factor and Averaging factor was added to the results.	RBW: 100 kHz VBW: 300 kHz

*1) Average Power Measurement was performed based on 6.0 & 12.2.5 of "KDB 558074 D01 DTS Meas Guidance v04".

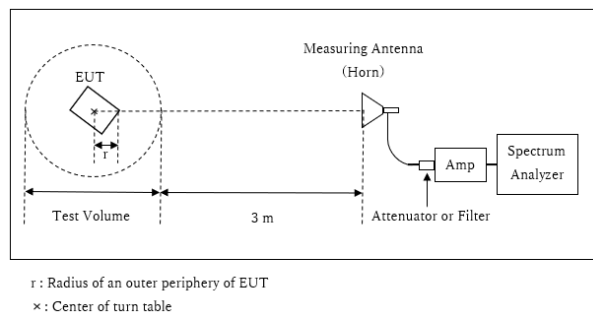
*2) As for Carrier related spurious emissions, "Averaging factor" based on FCC section 15.35(c) / RSS-Gen section 8.2 were used.

Below 1 GHz



Test Distance: 3 m

1 GHz - 13 GHz



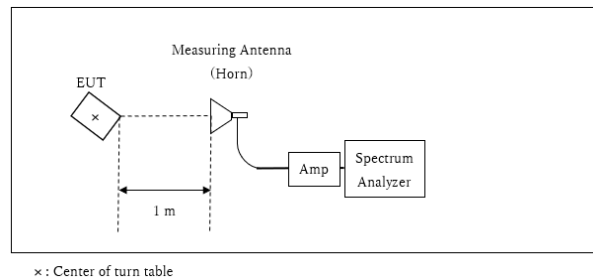
Distance Factor: $20 \times \log (3.98 \text{ m}^*/3.0 \text{ m}) = 2.47 \text{ dB}$

* Test Distance: $(3 + \text{Test Volume} / 2) - r = 3.98 \text{ m}$

Test Volume: 2 m

(Test Volume has been calibrated based on CISPR 16-1-4.)
 $r = 0.02 \text{ m}$

13 GHz - 26.5 GHz



Distance Factor: $20 \times \log (1.0 \text{ m}^* / 3.0 \text{ m}) = -9.54 \text{ dB}$

*Test Distance: 1 m

- The carrier level and noise levels were confirmed at each position of X, Y and Z axes of EUT to see the position of maximum noise, and the test was made at the position that has the maximum noise.
The test results and limit are rounded off to one decimal place, so some differences might be observed.

Combinations of the worst case

Antenna polarization \ Frequency	Spurious				
	Below 1 GHz	1 GHz – 2.8 GHz	2.8 GHz – 13 GHz	13 GHz-18 GHz	18 GHz-26 GHz
Horizontal	X	X	X	X	X
Vertical	X	Z	Y	X	X

The test results and limit are rounded off to one decimal place, so some differences might be observed.

Measurement range : 30 MHz - 26 GHz

Test data : APPENDIX 1

Test result : Pass

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SECTION 6: Antenna Terminal Conducted Tests

Test Procedure

The tests were made with below setting connected to the antenna port.

Test	Span	RBW	VBW	Sweep time	Detector	Trace	Instrument used
6dB Bandwidth	10 MHz	100 kHz	300 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
99% Occupied Bandwidth *1)	Enough width to display emission skirts	1 to 5 % of OBW	Three times of RBW	Auto	Peak	Max Hold	Spectrum Analyzer
Maximum Peak Output Power	-	-	-	Auto	Peak/ Average *2)	-	Power Meter (Sensor: 50 MHz BW)
Peak Power Density	1.5 times the 6dB Bandwidth	3 kHz	9.1 kHz	Auto	Peak	Max Hold	Spectrum Analyzer *3)
Conducted Spurious Emission *4)	9kHz to 150kHz	200 Hz	620 Hz	Auto	Peak	Max Hold	Spectrum Analyzer
	150kHz to 30MHz	10 kHz	30 kHz				
*1) Peak hold was applied as Worst-case measurement. *2) Reference data *3) Section 11.10.2 Method PKPSD (peak PSD) of "ANSI C63.10-2013". *4) In the frequency range below 30MHz, RBW was narrowed to separate the noise contents. Then, wide-band noise near the limit was checked separately, however the noise was not detected as shown in the chart. (9 kHz - 150 kHz: RBW = 200 Hz, 150 kHz - 30 MHz: RBW = 10 kHz)							

The test results and limit are rounded off to two decimals place, so some differences might be observed.

Test data	: APPENDIX
Test result	: Pass

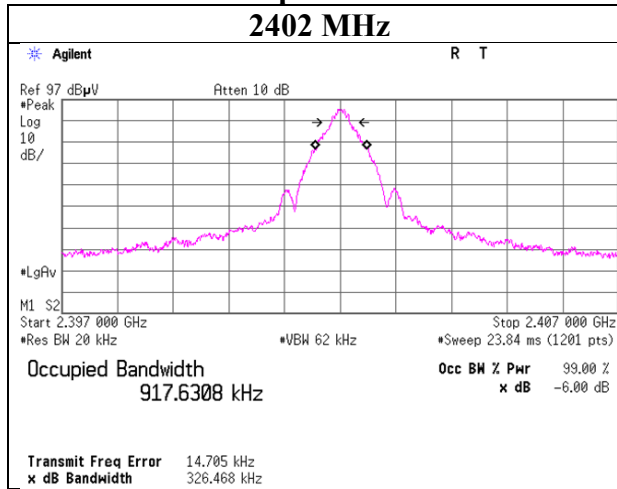
APPENDIX 1: Test data

6 dB Bandwidth and 99 % Occupied Bandwidth

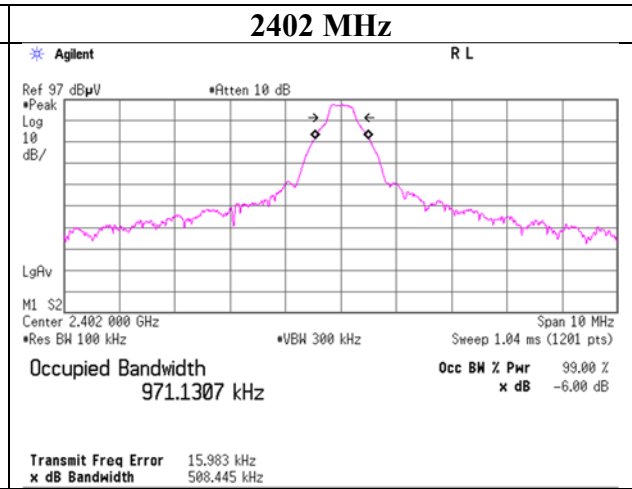
Report No. 12403128S-A-R4
Test place Shonan EMC Lab. No.5 Shielded Room
Date August 8, 2018
Temperature / Humidity 26 deg. C / 51 % RH
Engineer Kazuya Noda
Mode Tx BT LE

Mode	Frequency [MHz]	99% Occupied Bandwidth [kHz]	6dB Bandwidth [MHz]	Limit for 6dB Bandwidth [MHz]
BT LE	2402	917.6	0.508	> 0.5000
	2440	931.0	0.515	> 0.5000
	2480	935.3	0.510	> 0.5000

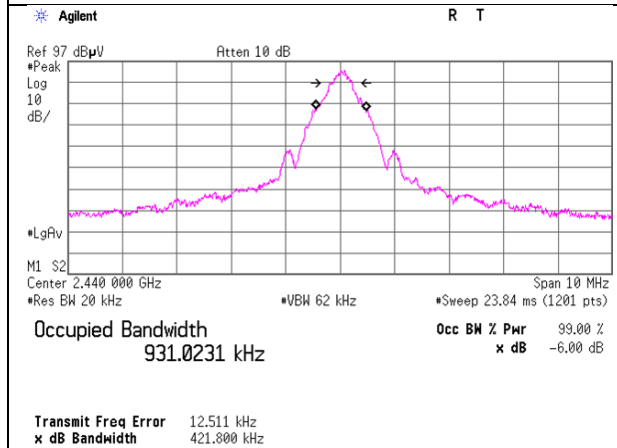
99%Occupied Bandwidth



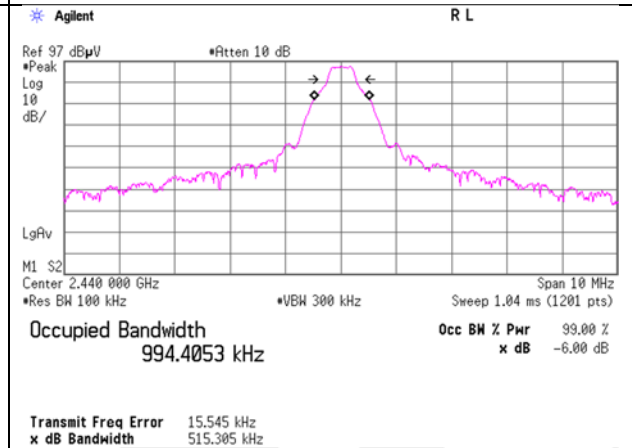
6dB Bandwidth



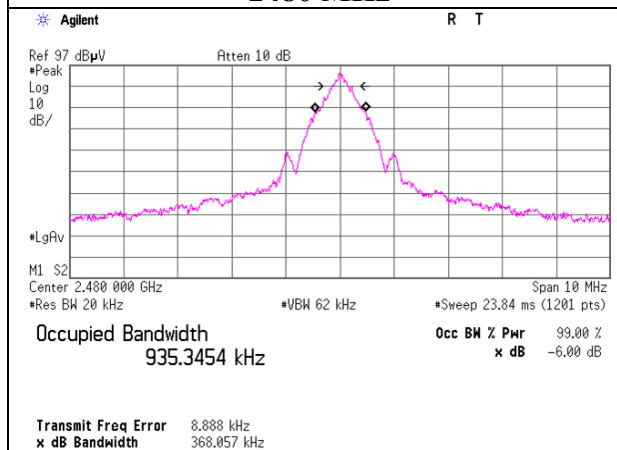
2440 MHz



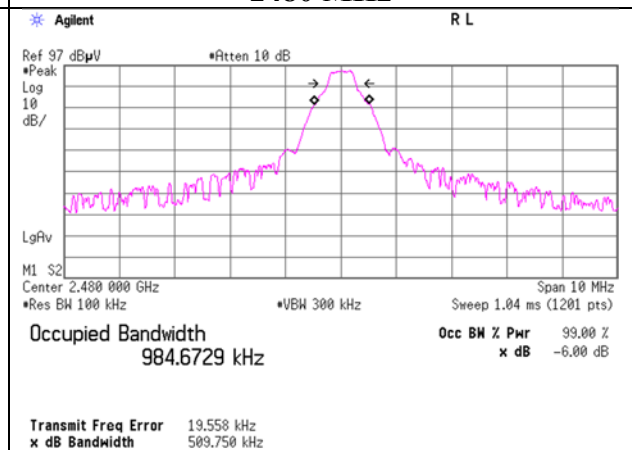
2440 MHz



2480 MHz



2480 MHz



Maximum Peak Output Power

Report No. 12403128S-A-R4
Test place Shonan EMC Lab. No.5 Shielded Room
Date August 8, 2018
Temperature / Humidity 26 deg. C / 51 % RH
Engineer Kazuya Noda
Mode Tx BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Conducted Power					e.i.r.p. for RSS-247					
				Result		Limit		Margin [dB]	Antenna Gain [dBi]	Result		Limit		Margin [dB]
				[dBm]	[mW]	[dBm]	[mW]			[dBm]	[mW]	[dBm]	[mW]	
2402	-12.01	2.05	10.18	0.22	1.05	30.00	1000	29.78	-8.20	-7.98	0.16	36.02	4000	44.00
2440	-12.09	2.07	10.18	0.16	1.04	30.00	1000	29.84	-8.20	-8.04	0.16	36.02	4000	44.06
2480	-12.14	2.08	10.18	0.12	1.03	30.00	1000	29.88	-8.20	-8.08	0.16	36.02	4000	44.10

Sample Calculation:

Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

e.i.r.p. Result = Conducted Power Result + Antenna Gain

*The equipment and cables were not used for factor 0 dB of the data sheets.

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Average Output Power
(Reference data for RF Exposure / SAR testing)

Report No. 12403128S-A-R4
Test place Shonan EMC Lab. No.5 Shielded Room
Date August 8, 2018
Temperature / Humidity 26 deg. C / 51 % RH
Engineer Kazuya Noda
Mode Tx BT LE

BT LE

Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result (Time average)		Duty factor [dB]	Result (Burst power average)	
				[dBm]	[mW]		[dBm]	[mW]
2402	-12.81	2.05	10.18	-0.58	0.87	0.23	-0.35	0.92
2440	-12.88	2.07	10.18	-0.63	0.86	0.23	-0.40	0.91
2480	-12.95	2.08	10.18	-0.69	0.85	0.23	-0.46	0.90

Sample Calculation:

Result (Time average) = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

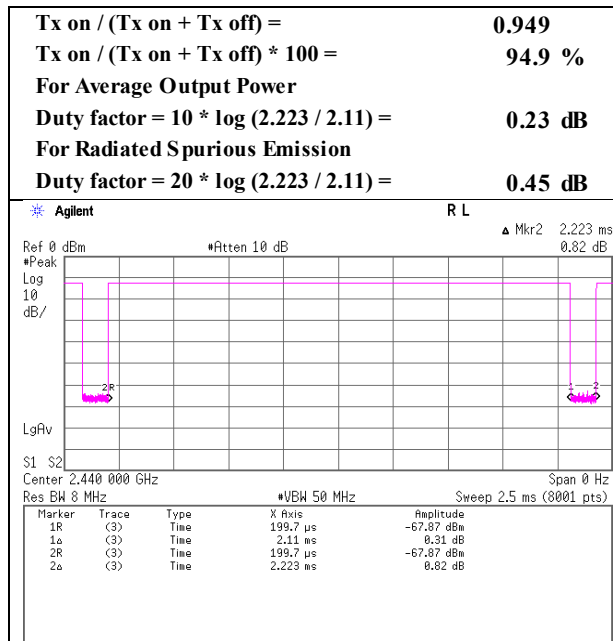
Result (Burst power average) = Time average + Duty factor

*The equipment and cables were not used for factor 0 dB of the data sheets.

Burst rate confirmation

Report No.	12403128S-A-R4
Test place	Shonan EMC Lab. No.5 Shielded Room
Date	August 8, 2018
Temperature / Humidity	26 deg. C / 51 % RH
Engineer	Kazuya Noda
Mode	Tx BT LE

BT LE



Radiated Spurious Emission

Report No. 12403128S-A-R4
Test place Shonan EMC Lab.
Semi Anechoic Chamber No.3
Date August 17, 2018 August 15, 2018 August 16, 2018 August 17, 2018
Temperature / Humidity 24 deg. C / 58 % RH 21 deg. C / 56 % RH 24 deg. C / 63 % RH 24 deg. C / 58 % RH
Engineer Kazutaka Takeyama Shiro Kobayashi Shiro Kobayashi Kazutaka Takeyama
(30 MHz - 1 GHz) (1 GHz - 13 GHz) (13 GHz - 18 GHz) (18 GHz - 26 GHz)
Mode Tx BT LE 2402 MHz

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	103.330	QP	28.50	10.83	7.32	32.16	0.00	14.49	43.50	29.0	300	11	
Hori.	607.133	QP	20.90	19.53	10.03	31.95	0.00	18.51	46.00	27.4	150	6	
Hori.	2338.010	PK	49.28	27.93	14.08	44.12	2.47	49.64	73.90	24.2	100	48	
Hori.	2390.000	PK	49.51	27.86	14.13	44.13	2.47	49.84	73.90	24.0	100	48	
Hori.	4804.000	PK	54.95	31.43	6.42	44.45	2.47	50.82	73.90	23.0	100	142	
Hori.	7206.000	PK	51.19	36.79	8.24	43.99	2.47	54.70	73.90	19.2	203	253	
Hori.	9608.000	PK	48.49	38.51	9.14	43.83	2.47	54.78	73.90	19.1	150	0	
Hori.	2338.010	AV	40.49	27.93	14.08	44.12	2.47	40.85	53.90	13.0	100	48	
Vert.	38.547	QP	22.40	15.41	6.61	32.20	0.00	12.22	40.00	27.7	100	309	
Vert.	43.619	QP	22.80	13.53	6.71	32.19	0.00	10.85	40.00	29.1	100	301	
Vert.	166.606	QP	22.00	15.41	7.89	32.10	0.00	13.20	43.50	30.3	100	239	
Vert.	240.001	QP	26.50	11.65	8.31	32.03	0.00	14.43	46.00	31.5	100	344	
Vert.	622.596	QP	20.90	19.78	10.09	31.96	0.00	18.81	46.00	27.1	100	98	
Vert.	2338.040	PK	49.14	27.93	14.08	44.12	2.47	49.50	73.90	24.4	239	119	
Vert.	2390.000	PK	49.09	27.86	14.13	44.13	2.47	49.42	73.90	24.4	239	119	
Vert.	4804.000	PK	52.99	31.43	6.42	44.45	2.47	48.86	73.90	25.0	123	8	
Vert.	7206.000	PK	50.44	36.79	8.24	43.99	2.47	53.95	73.90	19.9	111	92	
Vert.	9608.000	PK	48.46	38.51	9.14	43.83	2.47	54.75	73.90	19.1	150	0	
Vert.	2338.040	AV	40.04	27.93	14.08	44.12	2.47	40.40	53.90	13.5	239	119	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor

Distance factor : 1 GHz - 13 GHz : $20\log(3.98 \text{ m} / 3.0 \text{ m}) = 2.47 \text{ dB}$

13 GHz - 40 GHz : $20\log(1.0 \text{ m} / 3.0 \text{ m}) = -9.54 \text{ dB}$

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2390.000	AV	39.69	27.86	14.13	44.13	0.45	2.47	40.47	53.90	13.4	*1)
Hori.	4804.000	AV	49.97	31.43	6.42	44.45	0.45	2.47	46.29	53.90	7.6	
Hori.	7206.000	AV	42.57	36.79	8.24	43.99	0.45	2.47	46.53	53.90	7.4	
Hori.	9608.000	AV	39.76	38.51	9.14	43.83	0.45	2.47	46.50	53.90	7.4	
Vert.	2390.000	AV	39.93	27.86	14.13	44.13	0.45	2.47	40.71	53.90	13.2	*1)
Vert.	4804.000	AV	46.99	31.43	6.42	44.45	0.45	2.47	43.31	53.90	10.6	
Vert.	7206.000	AV	41.78	36.79	8.24	43.99	0.45	2.47	45.74	53.90	8.2	
Vert.	9608.000	AV	39.63	38.51	9.14	43.83	0.45	2.47	46.37	53.90	7.5	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Duty factor + Distance factor

Distance factor : 1 GHz - 13 GHz : $20\log(3.98 \text{ m} / 3.0 \text{ m}) = 2.47 \text{ dB}$

13 GHz - 40 GHz : $20\log(1.0 \text{ m} / 3.0 \text{ m}) = -9.54 \text{ dB}$

Duty factor refer to "Duty factor Calculation chart" sheet.

*1) Not out of band emission (Leakage Power)

20 dBc Data Sheet (RBW 100 kHz, VBW 300 kHz)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2402.000	PK	90.05	27.86	14.14	44.14	2.47	90.38	-	-	
Hori.	2400.000	PK	43.67	27.86	14.14	44.14	2.47	44.00	70.38	26.4	
Vert.	2402.000	PK	86.00	27.86	14.14	44.14	2.47	86.33	-	-	
Vert.	2400.000	PK	41.19	27.86	14.14	44.14	2.47	41.52	66.33	24.8	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor

Distance factor : 1 GHz - 13 GHz : $20\log(3.98 \text{ m} / 3.0 \text{ m}) = 2.47 \text{ dB}$

13 GHz - 40 GHz : $20\log(1.0 \text{ m} / 3.0 \text{ m}) = -9.54 \text{ dB}$

UL Japan, Inc.

Shonan EMC Lab.

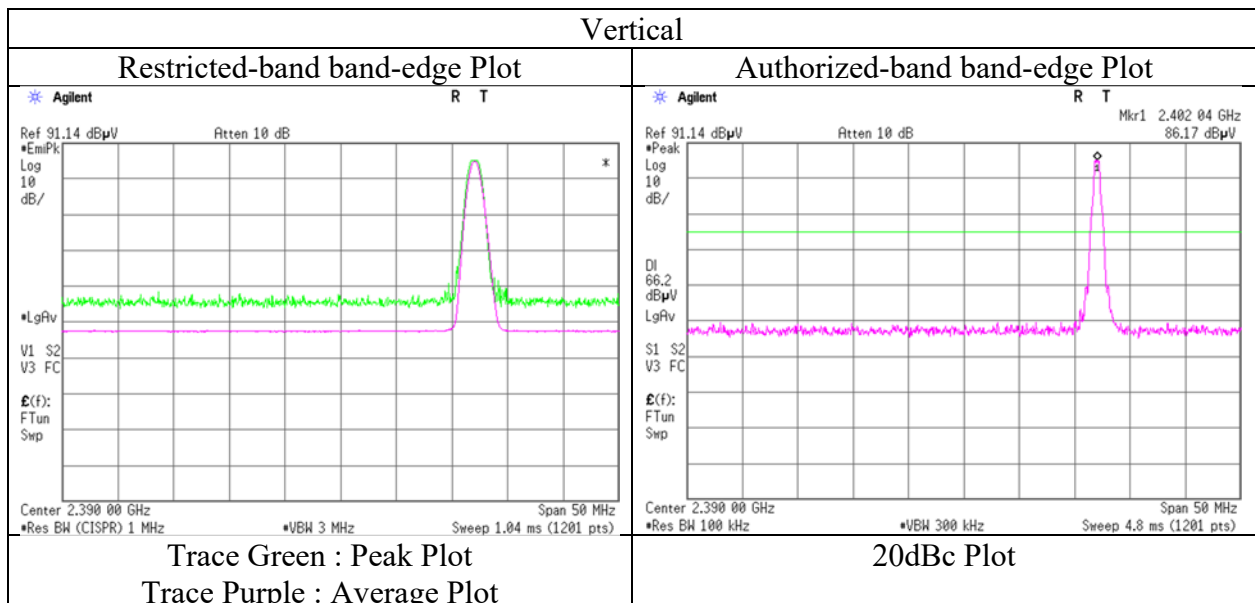
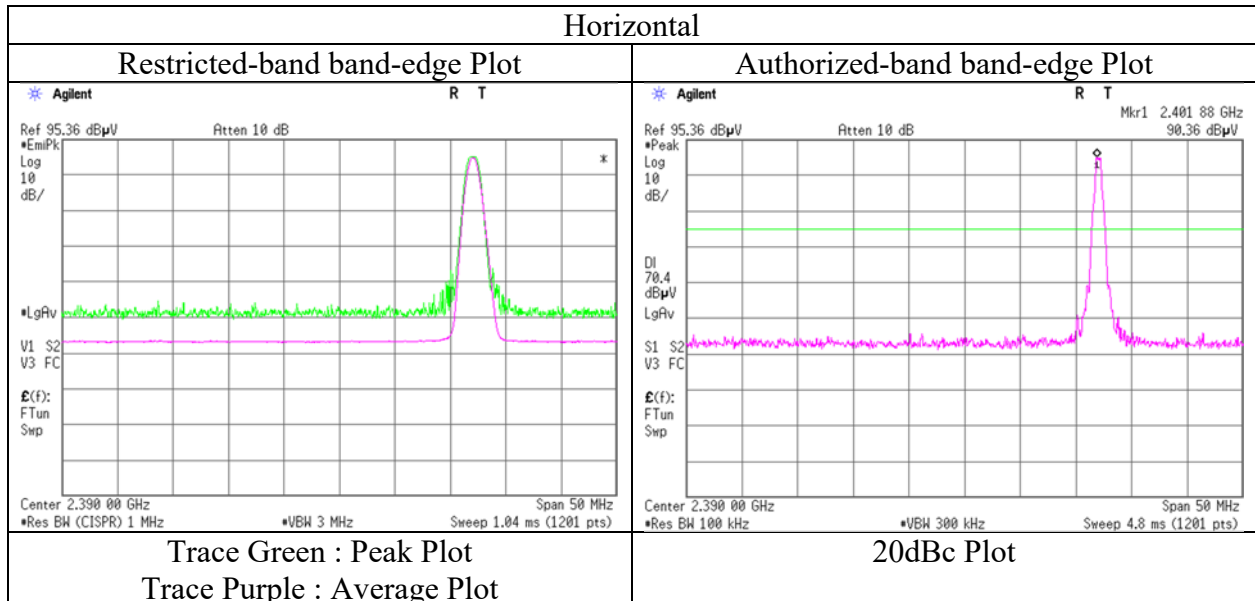
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN

Telephone : +81 463 50 6400

Facsimile : +81 463 50 6401

Radiated Spurious Emission (Reference Plot for band-edge)

Report No.	12403128S-A-R4
Test place	Shonan EMC Lab.
Semi Anechoic Chamber	No.3
Date	August 15, 2018
Temperature / Humidity	21 deg. C / 56 % RH
Engineer	Shiro Kobayashi
	(1 GHz - 13 GHz)
Mode	Tx BT LE 2402 MHz



* Final result of restricted band edge was shown in tabular data.

Radiated Spurious Emission

Report No. 12403128S-A-R4
Test place Shonan EMC Lab.
Semi Anechoic Chamber No.3
Date August 17, 2018 August 15, 2018 August 16, 2018 August 17, 2018
Temperature / Humidity 24 deg. C / 58 % RH 21 deg. C / 56 % RH 24 deg. C / 63 % RH 24 deg. C / 58 % RH
Engineer Kazutaka Takeyama Shiro Kobayashi Shiro Kobayashi Kazutaka Takeyama
(30 MHz - 1 GHz) (1 GHz - 13 GHz) (13 GHz - 18 GHz) (18 GHz - 26 GHz)
Mode Tx BT LE 2440 MHz

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	103.329	QP	28.40	10.83	7.32	32.16	0.00	14.39	43.50	29.1	300	12	
Hori.	598.693	QP	21.00	19.25	10.00	31.95	0.00	18.30	46.00	27.7	150	340	
Hori.	4880.000	PK	53.88	31.37	6.45	44.48	2.47	49.69	73.90	24.2	106	133	
Hori.	7320.000	PK	49.83	37.00	8.32	44.03	2.47	53.59	73.90	20.3	203	256	
Hori.	9760.000	PK	48.83	38.92	9.17	43.85	2.47	55.54	73.90	18.3	100	172	
Vert.	38.917	QP	22.20	15.29	6.62	32.20	0.00	11.91	40.00	28.0	100	94	
Vert.	43.366	QP	22.80	13.61	6.71	32.19	0.00	10.93	40.00	29.0	100	358	
Vert.	159.039	QP	22.00	15.05	7.86	32.11	0.00	12.80	43.50	30.7	100	139	
Vert.	240.003	QP	26.40	11.65	8.31	32.03	0.00	14.33	46.00	31.6	100	345	
Vert.	618.229	QP	20.80	19.76	10.07	31.96	0.00	18.67	46.00	27.3	100	353	
Vert.	4880.000	PK	52.68	31.37	6.45	44.48	2.47	48.49	73.90	25.4	100	270	
Vert.	7320.000	PK	49.65	37.00	8.32	44.03	2.47	53.41	73.90	20.4	107	85	
Vert.	9760.000	PK	48.36	38.92	9.17	43.85	2.47	55.07	73.90	18.8	150	0	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor

Distance factor : 1 GHz - 13 GHz : 20log(3.98 m / 3.0 m) = 2.47 dB

13 GHz - 40 GHz : 20log(1.0 m / 3.0 m) = -9.54 dB

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	4880.000	AV	48.54	31.37	6.45	44.48	0.45	2.47	44.80	53.90	9.1	
Hori.	7320.000	AV	41.66	37.00	8.32	44.03	0.45	2.47	45.87	53.90	8.0	
Hori.	9760.000	AV	39.19	38.92	9.17	43.85	0.45	2.47	46.35	53.90	7.5	
Vert.	4880.000	AV	46.05	31.37	6.45	44.48	0.45	2.47	42.31	53.90	11.6	
Vert.	7320.000	AV	40.75	37.00	8.32	44.03	0.45	2.47	44.96	53.90	8.9	
Vert.	9760.000	AV	39.05	38.92	9.17	43.85	0.45	2.47	46.21	53.90	7.7	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Duty factor + Distance factor

Distance factor : 1 GHz - 13 GHz : 20log(3.98 m / 3.0 m) = 2.47 dB

13 GHz - 40 GHz : 20log(1.0 m / 3.0 m) = -9.54 dB

Duty factor refer to "Duty factor Calculation chart" sheet.

UL Japan, Inc.

Shonan EMC Lab.

1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN

Telephone : +81 463 50 6400

Facsimile : +81 463 50 6401

Radiated Spurious Emission

Report No. 12403128S-A-R4
Test place Shonan EMC Lab.
Semi Anechoic Chamber No.3
Date August 17, 2018 August 15, 2018 August 16, 2018 August 17, 2018
Temperature / Humidity 24 deg. C / 58 % RH 21 deg. C / 56 % RH 24 deg. C / 63 % RH 24 deg. C / 58 % RH
Engineer Kazutaka Takeyama Shiro Kobayashi Shiro Kobayashi Kazutaka Takeyama
(30 MHz - 1 GHz) (1 GHz - 13 GHz) (13 GHz - 18 GHz) (18 GHz - 26 GHz)
Mode Tx BT LE 2480 MHz

(* PK: Peak, AV: Average, QP: Quasi-Peak)

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Angle [deg]	Remark
Hori.	103.329	QP	28.50	10.83	7.32	32.16	0.00	14.49	43.50	29.0	300	2	
Hori.	600.600	QP	21.00	19.31	10.00	31.95	0.00	18.36	46.00	27.6	150	340	
Hori.	2483.500	PK	52.67	27.65	14.22	44.16	2.47	52.85	73.90	21.0	100	38	
Hori.	4960.000	PK	53.49	31.54	6.48	44.51	2.47	49.47	73.90	24.4	119	136	
Hori.	7440.000	PK	49.34	37.10	8.41	44.08	2.47	53.24	73.90	20.6	194	262	
Hori.	9920.000	PK	47.65	38.97	9.22	43.87	2.47	54.44	73.90	19.4	150	0	
Vert.	37.792	QP	22.20	15.68	6.60	32.20	0.00	12.28	40.00	27.7	100	2	
Vert.	42.904	QP	22.65	13.76	6.69	32.19	0.00	10.91	40.00	29.0	100	28	
Vert.	166.727	QP	22.20	15.42	7.89	32.10	0.00	13.41	43.50	30.0	100	143	
Vert.	240.003	QP	26.60	11.65	8.31	32.03	0.00	14.53	46.00	31.4	100	345	
Vert.	620.200	QP	20.90	19.81	10.08	31.96	0.00	18.83	46.00	27.1	100	353	
Vert.	2483.500	PK	49.79	27.65	14.22	44.16	2.47	49.97	73.90	23.9	233	93	
Vert.	4960.000	PK	52.14	31.54	6.48	44.51	2.47	48.12	73.90	25.7	106	260	
Vert.	7440.000	PK	49.07	37.10	8.41	44.08	2.47	52.97	73.90	20.9	104	88	
Vert.	9920.000	PK	47.22	38.97	9.22	43.87	2.47	54.01	73.90	19.8	150	0	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Distance factor

Distance factor : 1 GHz - 13 GHz : $20\log(3.98\text{ m} / 3.0\text{ m}) = 2.47\text{ dB}$

13 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

Average measurement value with duty factor

Polarity	Frequency [MHz]	Detector	Reading [dBuV]	Ant.Fac. [dB/m]	Loss [dB]	Gain [dB]	Duty Factor [dB]	Distance Factor [dB]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Hori.	2483.500	AV	39.97	27.65	14.22	44.16	0.45	2.47	40.60	53.90	13.3	*1)
Hori.	4960.000	AV	47.95	31.54	6.48	44.51	0.45	2.47	44.38	53.90	9.5	
Hori.	7440.000	AV	40.79	37.10	8.41	44.08	0.45	2.47	45.14	53.90	8.8	
Hori.	9920.000	AV	38.48	38.97	9.22	43.87	0.45	2.47	45.72	53.90	8.2	
Vert.	2483.500	AV	39.70	27.65	14.22	44.16	0.45	2.47	40.33	53.90	13.6	*1)
Vert.	4960.000	AV	44.89	31.54	6.48	44.51	0.45	2.47	41.32	53.90	12.6	
Vert.	7440.000	AV	40.86	37.10	8.41	44.08	0.45	2.47	45.21	53.90	8.7	
Vert.	9920.000	AV	38.62	38.97	9.22	43.87	0.45	2.47	45.86	53.90	8.0	

Result = Reading + Ant.Fac. + Loss (Cable+(Attenuator or Filter)(below 18 GHz)) - Gain(Amplifier) + Duty factor + Distance factor

Distance factor : 1 GHz - 13 GHz : $20\log(3.98\text{ m} / 3.0\text{ m}) = 2.47\text{ dB}$

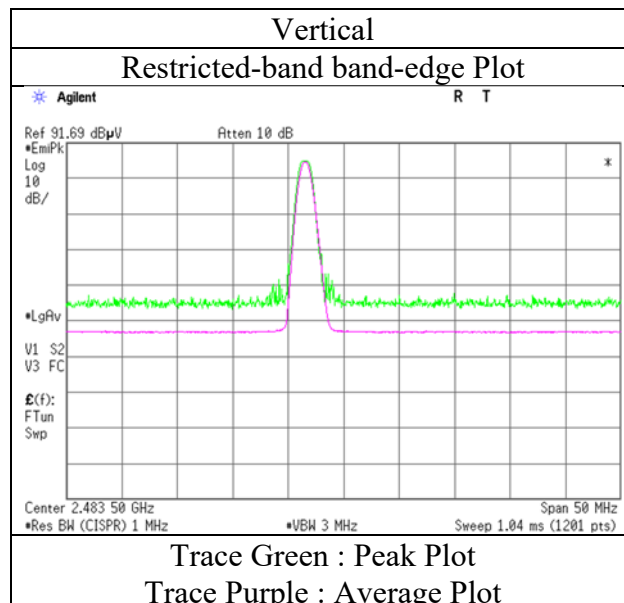
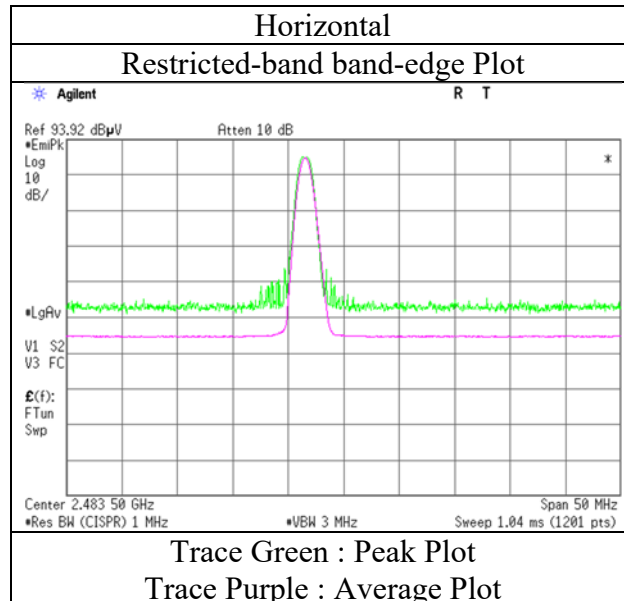
13 GHz - 40 GHz : $20\log(1.0\text{ m} / 3.0\text{ m}) = -9.54\text{ dB}$

Duty factor refer to "Duty factor Calculation chart" sheet.

*1) Not out of band emission (Leakage Power)

Radiated Spurious Emission (Reference Plot for band-edge)

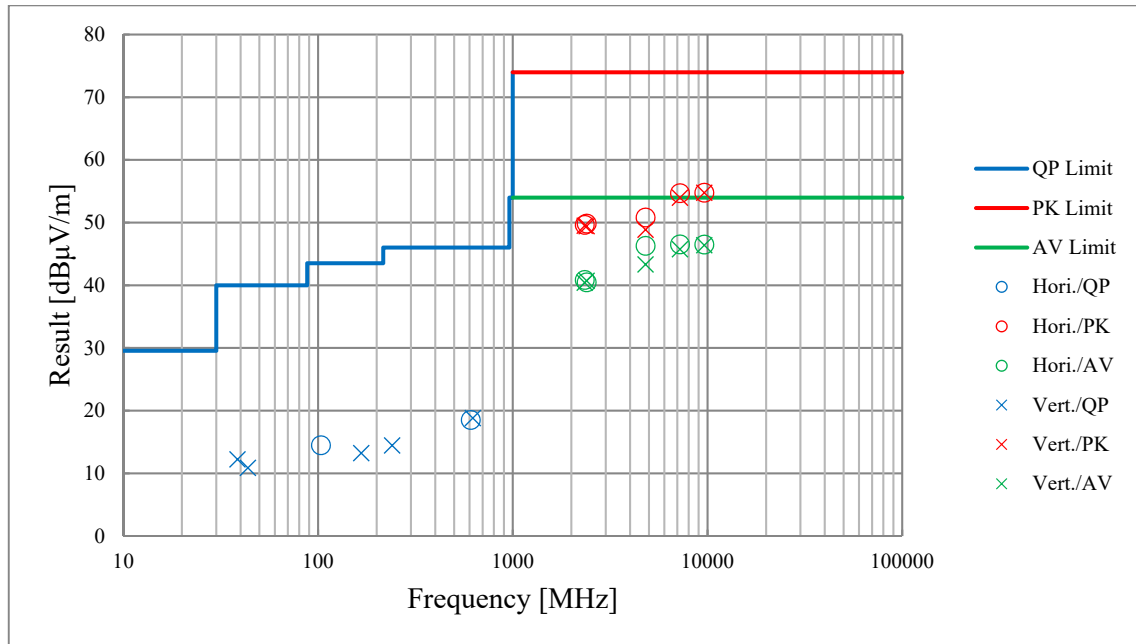
Report No.	12403128S-A-R4
Test place	Shonan EMC Lab.
Semi Anechoic Chamber	No.3
Date	August 15, 2018
Temperature / Humidity	21 deg. C / 56 % RH
Engineer	Shiro Kobayashi (1 GHz - 13 GHz)
Mode	Tx BT LE 2480 MHz



* Final result of restricted band edge was shown in tabular data.

Radiated Spurious Emission
(Plot data, Worst case)

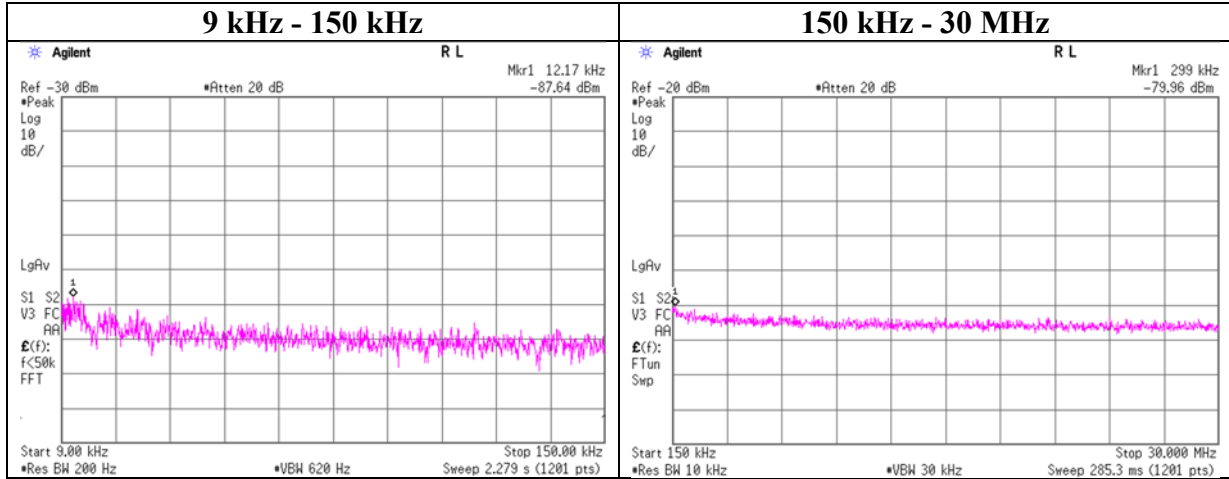
Report No.	12403128S-A-R4			
Test place	Shonan EMC Lab.			
Semi Anechoic Chamber	No.3			
Date	August 17, 2018	August 15, 2018	August 16, 2018	August 17, 2018
Temperature / Humidity	24 deg. C / 58 % RH	21 deg. C / 56 % RH	24 deg. C / 63 % RH	24 deg. C / 58 % RH
Engineer	Kazutaka Takeyama (30 MHz - 1 GHz)	Shiro Kobayashi (1 GHz - 13 GHz)	Shiro Kobayashi (13 GHz - 18 GHz)	Kazutaka Takeyama (18 GHz - 26 GHz)
Mode	Tx BT LE 2402 MHz			



*These plots data contains sufficient number to show the trend of characteristic features for EUT.

Conducted Spurious Emission

Report No. 12403128S-A-R4
Test place Shonan EMC Lab. No.5 Shielded Room
Date August 8, 2018
Temperature / Humidity 26 deg. C / 51 % RH
Engineer Kazuya Noda
Mode Tx BT LE 2402 MHz



Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain* [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
12.17	-87.64	0.01	10.11	2.0	1	-75.5	300	6.0	-14.3	45.8	60.1	
299.00	-79.96	0.02	10.11	2.0	1	-67.8	300	6.0	-6.6	18.0	24.6	

$E [dBuV/m] = EIRP [dBm] - 20 \log (Distance [m]) + Ground bounce [dB] + 104.8 [dBuV/m]$

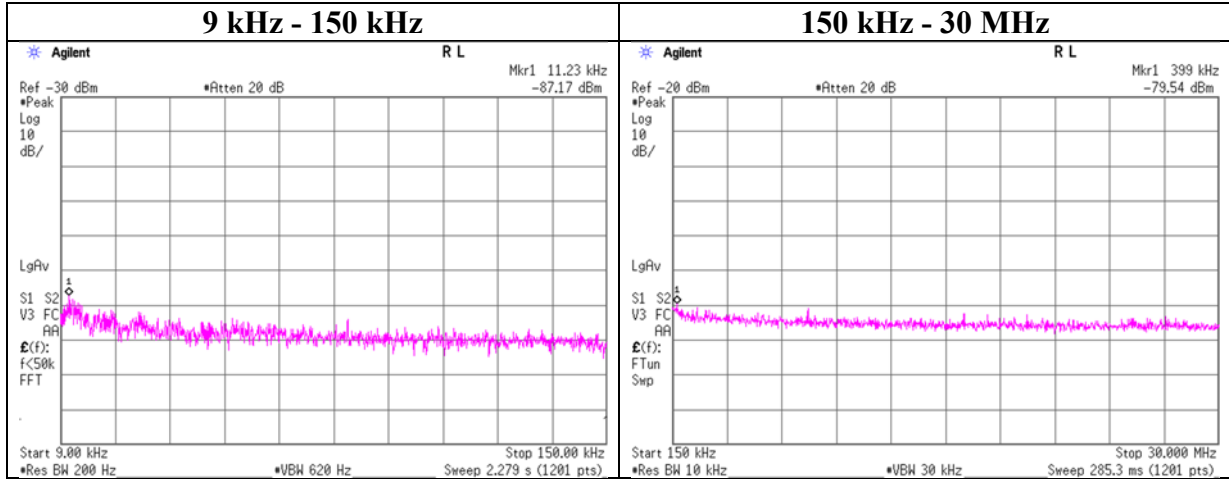
$EIRP [dBm] = Reading [dBm] + Cable loss [dB] + Attenuator Loss [dB] + Antenna gain [dBi] + 10 * \log (N)$

N: Number of output

*2.0 dBi was applied to the test result based on KDB 558074 since antenna gain was less than 2.0 dBi.

Conducted Spurious Emission

Report No. 12403128S-A-R4
Test place Shonan EMC Lab. No.5 Shielded Room
Date August 8, 2018
Temperature / Humidity 26 deg. C / 51 % RH
Engineer Kazuya Noda
Mode Tx BT LE 2440 MHz



Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain* [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
11.23	-87.17	0.01	10.11	2.0	1	-75.1	300	6.0	-13.8	46.5	60.3	
399.00	-79.54	0.03	10.11	2.0	1	-67.4	300	6.0	-6.1	15.5	21.6	

$E [dBuV/m] = EIRP [dBm] - 20 \log (Distance [m]) + Ground\ bounce [dB] + 104.8 [dBuV/m]$

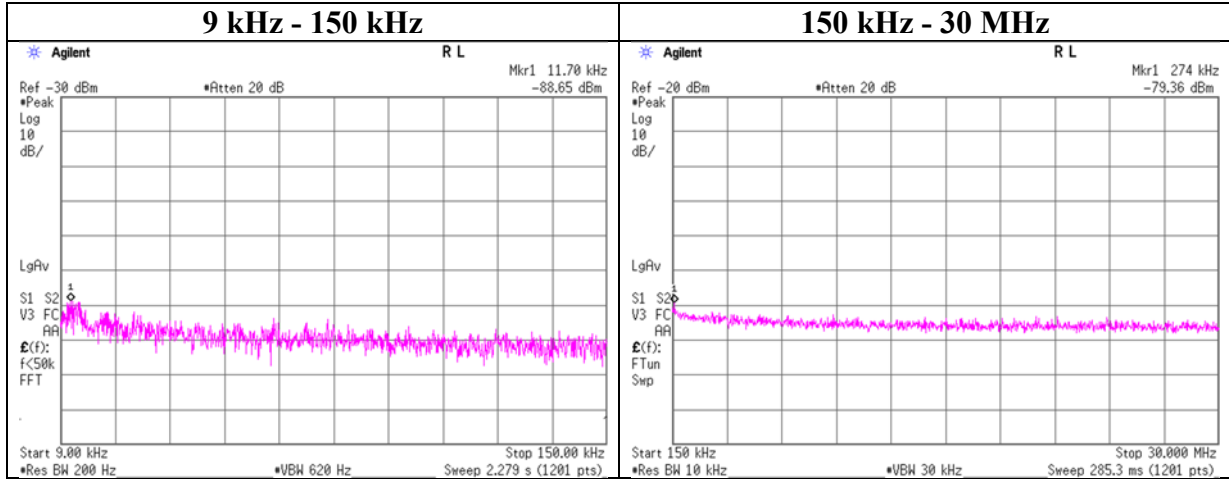
$EIRP[dBm] = Reading [dBm] + Cable\ loss [dB] + Attenuator\ Loss [dB] + Antenna\ gain [dBi] + 10 * \log (N)$

N: Number of output

*2.0 dBi was applied to the test result based on KDB 558074 since antenna gain was less than 2.0 dBi.

Conducted Spurious Emission

Report No. 12403128S-A-R4
Test place Shonan EMC Lab. No.5 Shielded Room
Date August 8, 2018
Temperature / Humidity 26 deg. C / 51 % RH
Engineer Kazuya Noda
Mode Tx BT LE 2480 MHz



Frequency [kHz]	Reading [dBm]	Cable Loss [dB]	Attenuator Loss [dB]	Antenna Gain* [dBi]	N (Number of Output)	EIRP [dBm]	Distance [m]	Ground bounce [dB]	E (field strength) [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
11.70	-88.65	0.01	10.11	2.0	1	-76.5	300	6.0	-15.3	46.2	61.5	
274.00	-79.36	0.02	10.11	2.0	1	-67.2	300	6.0	-6.0	18.8	24.8	

$$E \text{ [dBuV/m]} = \text{EIRP [dBm]} - 20 \log (\text{Distance [m]}) + \text{Ground bounce [dB]} + 104.8 \text{ [dBuV/m]}$$

$$\text{EIRP [dBm]} = \text{Reading [dBm]} + \text{Cable loss [dB]} + \text{Attenuator Loss [dB]} + \text{Antenna gain [dBi]} + 10 * \log (N)$$

N: Number of output

*2.0 dBi was applied to the test result based on KDB 558074 since antenna gain was less than 2.0 dBi.

Power Density

Report No. 12403128S-A-R4
Test place Shonan EMC Lab. No.5 Shielded Room
Date August 8, 2018
Temperature / Humidity 26 deg. C / 51 % RH
Engineer Kazuya Noda
Mode Tx BT LE

BT LE

Freq.	Reading	Cable Loss	Atten. Loss	Result	Limit	Margin
[MHz]	[dBm]	[dB]	[dB]	[dBm]	[dBm]	[dB]
2402	-22.92	2.05	10.18	-10.69	8.00	18.69
2440	-22.22	2.07	10.18	-9.97	8.00	17.97
2480	-22.86	2.08	10.18	-10.60	8.00	18.60

Sample Calculation:

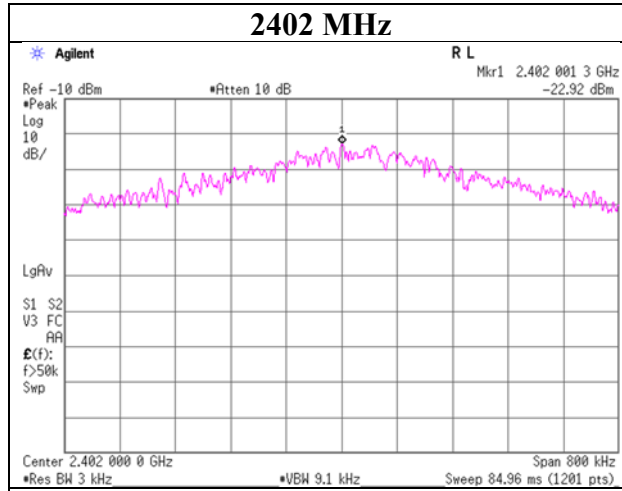
Result = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

*The equipment and cables were not used for factor 0 dB of the data sheets.

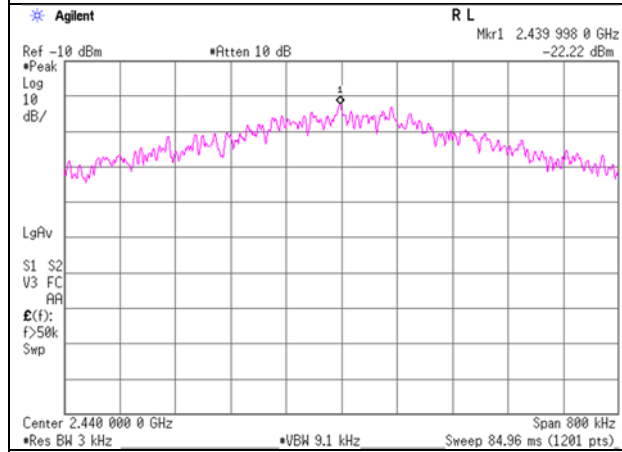
Power Density

BT LE

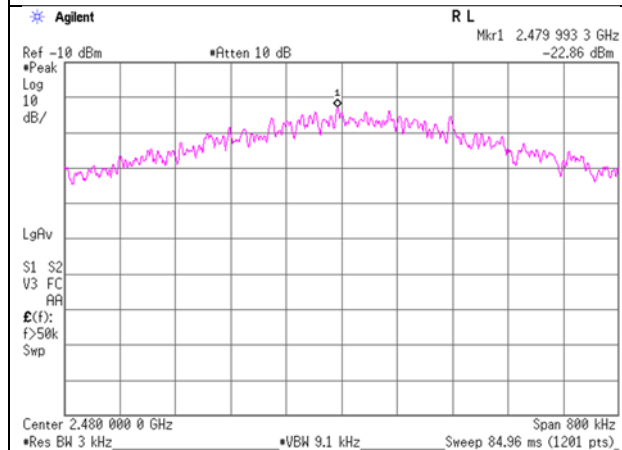
2402 MHz



2440 MHz



2480 MHz



APPENDIX 2: Test instruments

Test Instruments

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
SSA-02	Spectrum Analyzer	Agilent	E4448A	MY48250106	AT	2018/03/05 * 12
SPM-07	Power Meter	Agilent	8990B	MY5100272	AT	2018/07/13 * 12
SPSS-04	Power sensor	Agilent	N1923A	MY53260009	AT	2018/07/13 * 12
SCC-G32	Coaxial Cable	Junkosha	MWX241-02000KMSKMS	OCT-09-13-005	AT	2017/11/22 * 12
SAT10-15	Attenuator	Weinschel Corp.	54A-10	83406	AT	2017/12/08 * 12
SOS-09	Humidity Indicator	A&D	AD-5681	4061484	AT	2017/12/21 * 12
SAEC-03(SVSWR)	Semi-Anechoic Chamber	TDK	SAEC-03(SVSWR)	3	RE	2018/06/02 * 12
SAF-06	Pre Amplifier	TOYO Corporation	TPA0118-36	2046104	RE	2017/09/22 * 12
SCC-G06	Coaxial Cable	Junkosha	J12J102207-00	MAY-23-16-091	RE	2018/06/01 * 12
SCC-G40	Coaxial Cable	Junkosha	MWX221-01000NFSNMS/B	1612S005	RE	2018/01/29 * 12
SCC-G23	Coaxial Cable	Suhner	SUCOFLEX 104	297342/4	RE	2018/05/11 * 12
SHA-03	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-739	RE	2018/07/23 * 12
SOS-05	Humidity Indicator	A&D	AD-5681	4062518	RE	2017/10/30 * 12
KSA-08	Spectrum Analyzer	Agilent	E4446A	MY46180525	RE	2017/10/10 * 12
SJM-02	Measure	KOMELON	KMC-36	-	RE	-
COTS-SEMI-1	EMI Software	TSJ	TEPTO-DV(RE,CE,RFI,MF)	-	RE	-
STS-03	Digital Hitester	Hioki	3805-50	080997823	RE	2017/10/16 * 12
SFL-02	Highpass Filter	MICRO-TRONICS	HPM50111	051	RE	2017/11/16 * 12
SAT10-06	Attenuator	Agilent	8493C-010	74865	RE	2017/11/22 * 12
SAEC-03(NSA)	Semi-Anechoic Chamber	TDK	SAEC-03(NSA)	3	RE	2018/06/02 * 12
SHA-04	Horn Antenna	ETS LINDGREN	3160-09	LM9861	RE	2018/07/23 * 12
SAF-08	Pre Amplifier	TOYO Corporation	HAP18-26W	00000019	RE	2018/03/27 * 12
SCC-G33	Coaxial Cable	Junkosha	MWX241-01000KMSKMS	-	RE	2018/04/20 * 12
SCC-G45	Coaxial Cable	HUBER+SUHNER	SUCOFLEX 102 E	800137/2EA	RE	2018/03/28 * 12
SBA-03	Biconical Antenna	Schwarzbeck	BBA9106	91032666	RE	2018/06/17 * 12
SLA-07	Logperiodic Antenna	Schwarzbeck	VUSLP9111B	196	RE	2018/06/17 * 12
SAT6-13	Attenuator	JFW	50HF-006N	-	RE	2018/02/09 * 12
SCC-C1/C2/C3/C4/C5/C10/SRSE-03	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner/Suhner/Suhner/TOYO	8D2W/12DSFA/141PE/141PE/141PE/NS4906	-/0901-271(RF Selector)	RE	2018/04/09 * 12
SAF-03	Pre Amplifier	SONOMA	310N	290213	RE	2018/02/16 * 12
STR-08	Test Receiver	Rohde & Schwarz	ESW44	101581	RE	2017/11/24 * 12

The expiration date of the calibration is the end of the expired month.

All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.

Test item: RE: Radiated Emission test
AT: Antenna Terminal Conducted test

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