



RADIO TEST REPORT

Test Report No. : 13153638S-A-R1

Applicant : Yokogawa Electric Corporation
Type of EUT : Wireless Communication Module
Model Number of EUT : XS110A
FCC ID : SGJ-WFC017
Test regulation : **FCC Part 15 Subpart C: 2020**
* Tx 125 kHz mode
Test Result : **Complied (Refer to SECTION 3.2)**

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2. The results in this report apply only to the sample tested.
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7. The all test items in this test report are conducted by UL Japan, Inc. Shonan EMC Lab.
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. The information provided from the customer for this report is identified in SECTION 1.
10. his report is a revised version of 13153638S-A. 13153638S-A is replaced with this report.

Date of test: February 14 to 22, 2020
April 8, 2020

Representative test engineer: 
Hiromasa Sato
Engineer
Consumer Technology Division

Approved by: 
Kazutaka Takeyama
Engineer
Consumer Technology Division



CERTIFICATE 1266.03

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

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

REVISION HISTORY

Original Test Report No.: 13153638S-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	13153638S-A	April 17, 2020	-	-
1	13153638S-A-R1	May 13, 2020	1	Update of test specification From "FCC Part 15 Subpart C: 2019" To "FCC Part 15 Subpart C: 2020"
			6	Update of test specification From "FCC Part 15 final revised on July 19, 2019 and effective August 19, 2019 except 15.258" To "FCC Part 15 final revised on April 1, 2020 and effective June 1, 2020 except 15.258" * The revision does not affect the test result conducted before its effective date."
			15	Addition of remarks "*5)"

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

Reference: Abbreviations (Including words undescribed in this report)

A2LA	The American Association for Laboratory Accreditation	MCS	Modulation and Coding Scheme
AC	Alternating Current	MRA	Mutual Recognition Arrangement
AFH	Adaptive Frequency Hopping	N/A	Not Applicable
AM	Amplitude Modulation	NIST	National Institute of Standards and Technology
Amp, AMP	Amplifier	NS	No signal detect.
ANSI	American National Standards Institute	NSA	Normalized Site Attenuation
Ant, ANT	Antenna	NVLAP	National Voluntary Laboratory Accreditation Program
AP	Access Point	OBW	Occupied Band Width
ASK	Amplitude Shift Keying	OFDM	Orthogonal Frequency Division Multiplexing
Atten., ATT	Attenuator	P/M	Power meter
AV	Average	PCB	Printed Circuit Board
BPSK	Binary Phase-Shift Keying	PER	Packet Error Rate
BR	Bluetooth Basic Rate	PHY	Physical Layer
BT	Bluetooth	PK	Peak
BT LE	Bluetooth Low Energy	PN	Pseudo random Noise
BW	BandWidth	PRBS	Pseudo-Random Bit Sequence
Cal Int	Calibration Interval	PSD	Power Spectral Density
CCK	Complementary Code Keying	QAM	Quadrature Amplitude Modulation
Ch., CH	Channel	QP	Quasi-Peak
CISPR	Comite International Special des Perturbations Radioelectriques	QPSK	Quadri-Phase Shift Keying
CW	Continuous Wave	RBW	Resolution Band Width
DBPSK	Differential BPSK	RDS	Radio Data System
DC	Direct Current	RE	Radio Equipment
D-factor	Distance factor	RF	Radio Frequency
DFS	Dynamic Frequency Selection	RMS	Root Mean Square
DQPSK	Differential QPSK	RSS	Radio Standards Specifications
DSSS	Direct Sequence Spread Spectrum	Rx	Receiving
EDR	Enhanced Data Rate	SA, S/A	Spectrum Analyzer
EIRP, e.i.r.p.	Equivalent Isotropically Radiated Power	SG	Signal Generator
EMC	ElectroMagnetic Compatibility	SVSWR	Site-Voltage Standing Wave Ratio
EMI	ElectroMagnetic Interference	TR	Test Receiver
EN	European Norm	Tx	Transmitting
ERP, e.r.p.	Effective Radiated Power	VBW	Video BandWidth
EU	European Union	Vert.	Vertical
EUT	Equipment Under Test	WLAN	Wireless LAN
Fac.	Factor		
FCC	Federal Communications Commission		
FHSS	Frequency Hopping Spread Spectrum		
FM	Frequency Modulation		
Freq.	Frequency		
FSK	Frequency Shift Keying		
GFSK	Gaussian Frequency-Shift Keying		
GNSS	Global Navigation Satellite System		
GPS	Global Positioning System		
Hori.	Horizontal		
ICES	Interference-Causing Equipment Standard		
IEC	International Electrotechnical Commission		
IEEE	Institute of Electrical and Electronics Engineers		
IF	Intermediate Frequency		
ILAC	International Laboratory Accreditation Conference		
ISED	Innovation, Science and Economic Development Canada		
ISO	International Organization for Standardization		
JAB	Japan Accreditation Board		
LAN	Local Area Network		
LIMS	Laboratory Information Management System		

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

Telephone : +81 463 50 6400

Facsimile : +81 463 50 6401

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SECTION 1: Customer information

Company Name	:	Yokogawa Electric Corporation
Address	:	2-9-32 Nakacho, Musashino-shi, Tokyo 180-8750 Japan
Telephone Number	:	+81-422-52-5885
Facsimile Number	:	+81-422-52-2102
Contact Person	:	Atsunori Okada

The information provided from the customer is as follows;

- Applicant, Type of EUT, Model Number of EUT, FCC ID on the cover and other relevant pages
- Operating/Test Mode(s) (Mode(s)) on all the relevant pages
- SECTION 1: Customer information
- SECTION 2: Equipment under test (EUT)
- SECTION 4: Operation of EUT during testing

* The laboratory is exempted from liability of any test results affected from the above information in SECTION 2 and 4.

SECTION 2: Equipment under test (EUT)

2.1 Identification of EUT

Type of Equipment	:	Wireless Communication Module
Model No.	:	XS110A
Serial No.	:	Refer to SECTION 4.2
Rating	:	DC 3.6 V
Receipt Date of Sample (Information from test lab.)	:	January 30, 2020
Country of Mass-production	:	Japan
Condition of EUT	:	Engineering 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: XS110A (referred to as the EUT in this report) is a Wireless Communication Module.

General Specification

Clock frequencies in the system	:	CPU: 11 MHz External CLK HIGH: 12 MHz External CLK LOW: 32.768 kHz TCXO: 32 MHz
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Radio Specification

Radio Type	:	Transceiver
Frequency of Operation	:	902 MHz – 928 MHz * 902.3 MHz - 914.9 MHz (Tx 125 kHz mode) * 903.0 MHz - 914.2 MHz (Tx 500 kHz mode)
Modulation	:	LoRa, CSS
Antenna type	:	Built-in omni-directional antenna
Antenna Gain	:	-1.4 dBi
Operating temperature range	:	-40 deg.C to +85 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 April 1, 2020 and effective June 1, 2020 except 15.258
* The revision does not affect the test result conducted before its effective date.

Title : FCC 47 CFR Part 15 Radio Frequency Device Subpart C Intentional Radiators
Section 15.207 Conducted limits
Section 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz,
and 5725-5850 MHz

* Also the EUT complies with FCC Part 15 Subpart B

3.2 Procedures and results

Item	Test Procedure	Specification	Worst Margin	Results	Remarks
Conducted Emission	FCC: ANSI C63.10-2013 6. Standard test methods ISED: RSS-Gen 8.8	FCC: Section 15.207 ISED: RSS-Gen 8.8	-	N/A	*1)
Carrier Frequency Separation	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: -	FCC: Section 15.247(a)(1) ISED: RSS-247 5.1 (b)	See data.	Complied a)	Conducted
20 dB Bandwidth	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: -	FCC: Section 15.247(a)(1)(i) ISED: RSS-247 5.1 (a)		Complied a)	Conducted
Dwell time	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: -	FCC: Section 15.247(f) ISED: RSS-247 5.1 (c)		Complied b)	Conducted
Maximum Peak Output Power	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: RSS-Gen 6.12	FCC: Section 15.247(a)(b)(2) ISED: RSS-247 5.4 (a)		Complied c)	Conducted
Spurious Emission & Band Edge Compliance	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: RSS-Gen 6.13	FCC: Section 15.247(d) ISED: RSS-247 5.5 RSS-Gen 8.9 RSS-Gen 8.10		Complied d) / e)	Conducted/ Radiated (above 30 MHz) *2)
6 dB Bandwidth	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: -	FCC: Section 15.247(a)(2) ISED: RSS-247 5.2(a)	See data.	Complied f)	Conducted
Power Density	FCC: KDB 558074 D01 15.247 Meas Guidance v05r02 ISED: -	FCC: Section 15.247(f) ISED: RSS-247 5.2(b)		Complied g)	Conducted

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

*1) The test is not applicable since the EUT has no AC mains.

*2) Radiated test was selected over 30 MHz based on section 15.247(d).

a) Refer to APPENDIX 1 (data of 20 dB Bandwidth, 99 %Occupied Bandwidth and Carrier Frequency Separation)

b) Refer to APPENDIX 1 (data of Dwell time)

c) Refer to APPENDIX 1 (data of Maximum Peak Output Power)

d) Refer to APPENDIX 1 (data of Conducted Spurious Emission)

e) Refer to APPENDIX 1 (data of Radiated Spurious Emission)

f) Refer to APPENDIX 1 (data of 6 dB Bandwidth)

g) Refer to APPENDIX 1 (data of Power Density)

The EUT was tested as the hybrid system equipment in accordance with KDB 558074 D01 15.247 Meas Guidance v05r02 Section 10.

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

FCC Part 15.31 (e)

The EUT is a battery-operated device and test was performed with the full-charged battery. 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.

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

3.3 Addition to standard

Item	Test Procedure	Specification	Worst margin	Results	Remarks
99 % Occupied Bandwidth	RSS-Gen 6.7	ISED: -	N/A	- a)	Conducted
a) Refer to APPENDIX 1 (data of 20 dB Bandwidth, 99 %Occupied Bandwidth and Carrier Frequency Separation)					

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

3.4 Uncertainty

There is no applicable rule of uncertainty in this applied standard. Therefore, the results are derived depending on whether or not laboratory uncertainty is applied.

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. 4,5,6,8 SR
Conducted emission (AC Mains) LISN	150 kHz-30 MHz	2.6 dB	2.6 dB	2.5 dB	2.6 dB
Radiated emission (Measurement distance: 3 m)	9 kHz-30 MHz	3.0 dB	3.0 dB	3.0 dB	-
	30 MHz-200 MHz	4.6 dB	4.6 dB	4.6 dB	-
	200 MHz-1 GHz	6.0 dB	6.0 dB	6.0 dB	-
	1 GHz-6 GHz	4.9 dB	4.9 dB	4.9 dB	-
	6 GHz-18 GHz	5.5 dB	5.5 dB	5.5 dB	-
	18 GHz-40 GHz	5.4 dB	5.4 dB	5.4 dB	-
Radiated emission (Measurement distance: 1 m)	1 GHz-18 GHz	5.8 dB	5.8 dB	5.8 dB	-
	18 GHz-40 GHz	5.7 dB	5.7 dB	5.7 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	0.98 dB
Power Measurement above 1 GHz (Peak Detector)_SPM-06	1.75 dB
Power Measurement above 1 GHz (Average Detector)_SPM-07	0.89 dB
Power Measurement above 1 GHz (Peak Detector)_SPM-07	1.12 dB
Power Measurement above 1 GHz (Average Detector)_SPM-13	1.06 dB
Power Measurement above 1 GHz (Peak Detector)_SPM-13	1.24 dB
Spurious emission (Conducted) below 1GHz	0.9 dB
Spurious emission (Conducted) 1 GHz-3 GHz	0.9 dB
Spurious emission (Conducted) 3 GHz-18 GHz	2.9 dB
Spurious emission (Conducted) 18 GHz-26.5 GHz	2.6 dB
Spurious emission (Conducted) 26.5 GHz-40 GHz	2.0 dB
Bandwidth Measurement	0.07 %
Duty cycle and Time Measurement	0.262 %
Temperature	0.95 deg.C.
Voltage	0.83 %

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

Telephone : +81 463 50 6400

Facsimile : +81 463 50 6401

3.5 Test Location

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

A2LA Certificate Number: 1266.03 (FCC Test Firm Registration Number: 626366, ISED Lab Company Number: 2973D)

Test site	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Maximum measurement distance
No.1 Semi-anechoic chamber	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.2 Semi-anechoic chamber	20.6 x 11.3 x 7.65	20.6 x 11.3	10 m
No.3 Semi-anechoic chamber	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 EUT during testing

4.1 Operating Mode(s)

Details of Operating Mode(s)

Test Item	Mode	Tested frequency *2)
Spurious Emission (Conducted/Radiated)	Tx (Transmitting), Hopping Off, 125 kHz mode, SF10 *1)	902.3 MHz 908.5 MHz 914.9 MHz
Carrier Frequency Separation	Tx (Transmitting), Hopping On, 125 kHz mode, SF10	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping On, 125 kHz mode, SF9	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping On, 125 kHz mode, SF8	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping On, 125 kHz mode, SF7	902.3 MHz 908.5 MHz 914.9 MHz
20 dB Bandwidth	Tx (Transmitting), Hopping Off, 125 kHz mode, SF10	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping Off, 125 kHz mode, SF9	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping Off, 125 kHz mode, SF8	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping Off, 125 kHz mode, SF7	902.3 MHz 908.5 MHz 914.9 MHz
Dwell time	Tx (Transmitting), Hopping On, 125 kHz mode, SF10	-
	Tx (Transmitting), Hopping On, 125 kHz mode, SF9	-
	Tx (Transmitting), Hopping On, 125 kHz mode, SF8	-
	Tx (Transmitting), Hopping On, 125 kHz mode, SF7	-
Maximum Peak Output Power	Tx (Transmitting), Hopping Off, 125 kHz mode, SF10	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping Off, 125 kHz mode, SF9	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping Off, 125 kHz mode, SF8	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping Off, 125 kHz mode, SF7	902.3 MHz 908.5 MHz 914.9 MHz
Band Edge Compliance (Conducted)	Tx (Transmitting), 125 kHz mode, SF10 -Hopping On -Hopping Off	902.3 MHz 914.9 MHz

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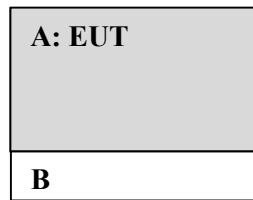
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Telephone : +81 463 50 6400

Facsimile : +81 463 50 6401

99 % Occupied Bandwidth	Tx (Transmitting),125 kHz mode, SF10 -Hopping On -Hopping Off	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting),125 kHz mode, SF9 -Hopping On -Hopping Off	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting),125 kHz mode, SF8 -Hopping On -Hopping Off	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting),125 kHz mode, SF7 -Hopping On -Hopping Off	902.3 MHz 908.5 MHz 914.9 MHz
6 dB Bandwidth	Tx (Transmitting), Hopping Off, 125 kHz mode, SF10	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping Off, 125 kHz mode, SF9	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping Off, 125 kHz mode, SF8	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping Off, 125 kHz mode, SF7	902.3 MHz 908.5 MHz 914.9 MHz
Power Density	Tx (Transmitting), Hopping Off, 125 kHz mode, SF10	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping Off, 125 kHz mode, SF9	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping Off, 125 kHz mode, SF8	902.3 MHz 908.5 MHz 914.9 MHz
	Tx (Transmitting), Hopping Off, 125 kHz mode, SF7	902.3 MHz 908.5 MHz 914.9 MHz
*1) As a result of preliminary test, the formal test was performed with the worst condition was determined based on the test result of Maximum Peak Output Power *2) Tested frequency (Low channel/Middle channel/High channel) has been chosen from Tx 125 kHz mode. *EUT has the power settings by the software as follows; Power settings: fixed Software (Firmware): XS110A Wireless Communication Module Version: R0.21.01r (Date: 2020/1/28) *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.		

4.2 Configuration and peripherals



* Test data was taken under worse case conditions.

Description of EUT

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Wireless Communication Module	XS110A	91V809468	Yokogawa Electric Corporation	EUT
B	Connector cover	-	-	Yokogawa Electric Corporation	-

SECTION 5: Radiated Spurious Emission

Test Procedure

[For below 1 GHz]

EUT was placed on a urethane platform of nominal size, 1.0 m by 0.5 m, raised 0.8 m above the conducting ground plane. 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 m and 4 m and EUT was rotated a full revolution in order to obtain the maximum value of the electric field strength.

Test antenna was aimed at the EUT for receiving the maximum signal and always kept within the illumination area of the 3 dB beamwidth of the antenna.

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.

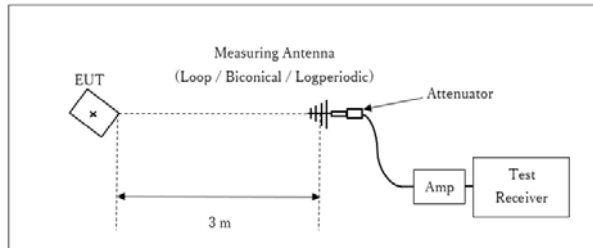
20 dBc was applied to the frequency over the limit of FCC 15.209 / Table 4 of RSS-Gen 8.9 (ISED) and outside the restricted band of FCC15.205 / Table 6 of RSS-Gen 8.10 (ISED).

Frequency	Below 1 GHz	Above 1 GHz		20 dBc
Instrument used	Test Receiver	Spectrum Analyzer		Spectrum Analyzer
Detector	QP	PK	AV *1)	PK
IF Bandwidth	BW 120 kHz	RBW: 1 MHz VBW: 3 MHz	RBW: 1 MHz VBW: 1/T (T: burst length, refer to Burst rate confirmation sheet) Detector: Peak	RBW: 100 kHz VBW: 300 kHz

*1) Average Power Measurement was performed based on KDB 558074 D01 15.247 Meas Guidance v05r02.

Figure 2: Test Setup

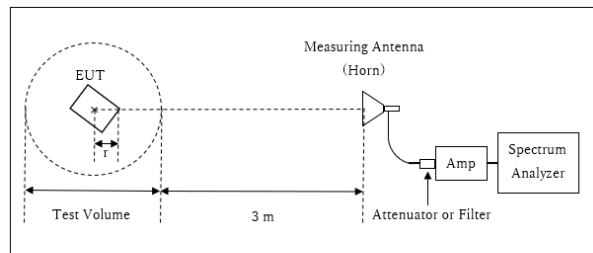
Below 1 GHz



x : Center of turn table

Test Distance: 3 m

1 GHz - 10 GHz



r : Radius of an outer periphery of EUT

x : Center of turn table

Distance Factor: $20 \times \log (3.93 \text{ m} / 3.0 \text{ m}) = 2.35 \text{ dB}$

* Test Distance: $(3 + \text{Test Volume} / 2) - r = 3.93 \text{ m}$

Test Volume : 2.0 m

(Test Volume has been calibrated based on CISPR 16-1-4.)

$r = 0.07 \text{ m}$

- 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.

Antenna polarization \ Frequency	Spurious		
	Carrier	Below 1 GHz	1 GHz – 10 GHz
Horizontal	Y	Z	Y
Vertical	X	Y	Z

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

Measurement range : 30 MHz - 10 GHz

Test data : APPENDIX

Test result : Pass

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
20 dB Bandwidth	500 kHz	5.1 kHz	16 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 *1)	Spectrum Analyzer
Maximum Peak Output Power	-	-	-	Auto	Peak Average *2)	-	Power Meter (Sensor: 160 MHz BW)
Carrier Frequency Separation	600 kHz	30 kHz	91 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
Dwell Time	Zero Span	100 kHz	300 kHz	As necessary capture the entire dwell time per hopping channel	Peak	Clear Write	Spectrum Analyzer
Conducted Spurious Emission *3) *5)	9 kHz to 150 kHz	200 Hz	620 Hz	Auto	Peak	Max Hold	Spectrum Analyzer
	150 kHz to 30 MHz	10 kHz	30 kHz				
	30 MHz to 25 GHz	100 kHz	300 kHz				
Conducted Spurious Emission Band Edge compliance	5 MHz or 40 MHz	100 kHz	300 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
6 dB Bandwidth	3 MHz	100 kHz	300 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
Peak Power Density	1.5 times the 6 dB Bandwidth	3 kHz	9.1 kHz	Auto	Peak	Max Hold	Spectrum Analyzer *4)
*1) The measurement was performed with Max Hold. Peak hold was applied as Worst-case measurement. *2) Reference data *3) In the frequency range below 30 MHz, 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) *4) Section 11.10.2 Method PKPSD (peak PSD) of "ANSI C63.10-2013" *5) The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-Gen section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377 Ohms. For example, the measurement at frequency 9 kHz resulted in a level of 45.5 dBuV/m, which is equivalent to $45.5 - 51.5 = -6.0$ dBuA/m, which has the same margin, 3 dB, to the corresponding RSS-Gen Table 6 limit as it has to 15.209(a) limit.							

The test results and limit are rounded off to two decimals place, so some differences might be observed.
 The equipment and cables were not used for factor 0 dB of the data sheets.

Test data : APPENDIX
 Test result : Pass

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APPENDIX 1: Test data

20dB Bandwidth, 99%Occupied Bandwidth and Carrier Frequency Separation

Report No.	13153638S-A-R1
Test place	Shonan EMC Lab. No.5 Shield Room
Date	February 14, 2020 February 19, 2020
Temperature / Humidity	26 deg. C / 48 % RH 23 deg. C / 39 % RH
Engineer	Hiromasa Sato Toshinori Yamada
Mode	Tx, Hopping Off, Tx, Hopping On

Mode	Freq. [MHz]	20 dB Bandwidth [kHz]	99 % Occupied Bandwidth [kHz]	Carrier Frequency Separation [kHz]	Limit for Carrier Frequency separation [kHz]
SF10	902.3	147.313	131.250	200.000	>= 147.313
SF10	908.5	147.670	131.247	200.000	>= 147.670
SF10	914.9	147.800	131.302	200.000	>= 147.800
SF10	Hopping On	-	12928.900	-	-
SF9	902.3	146.604	129.622	200.000	>= 146.604
SF9	908.5	146.616	129.603	200.000	>= 146.616
SF9	914.9	146.543	129.632	200.000	>= 146.543
SF9	Hopping On	-	12937.400	-	-
SF8	902.3	146.272	127.702	200.000	>= 146.272
SF8	908.5	146.234	127.695	200.000	>= 146.234
SF8	914.9	146.266	127.700	200.000	>= 146.266
SF8	Hopping On	-	12876.100	-	-
SF7	902.3	145.177	128.162	200.000	>= 145.177
SF7	908.5	145.131	128.129	200.000	>= 145.131
SF7	914.9	145.173	128.123	200.000	>= 145.173
SF7	Hopping On	-	12924.000	-	-

Limit: 20 dB Bandwidth or 25 kHz (whichever is greater).

20 dB Bandwidth limit is 500 kHz or less than. (902 - 928 MHz)

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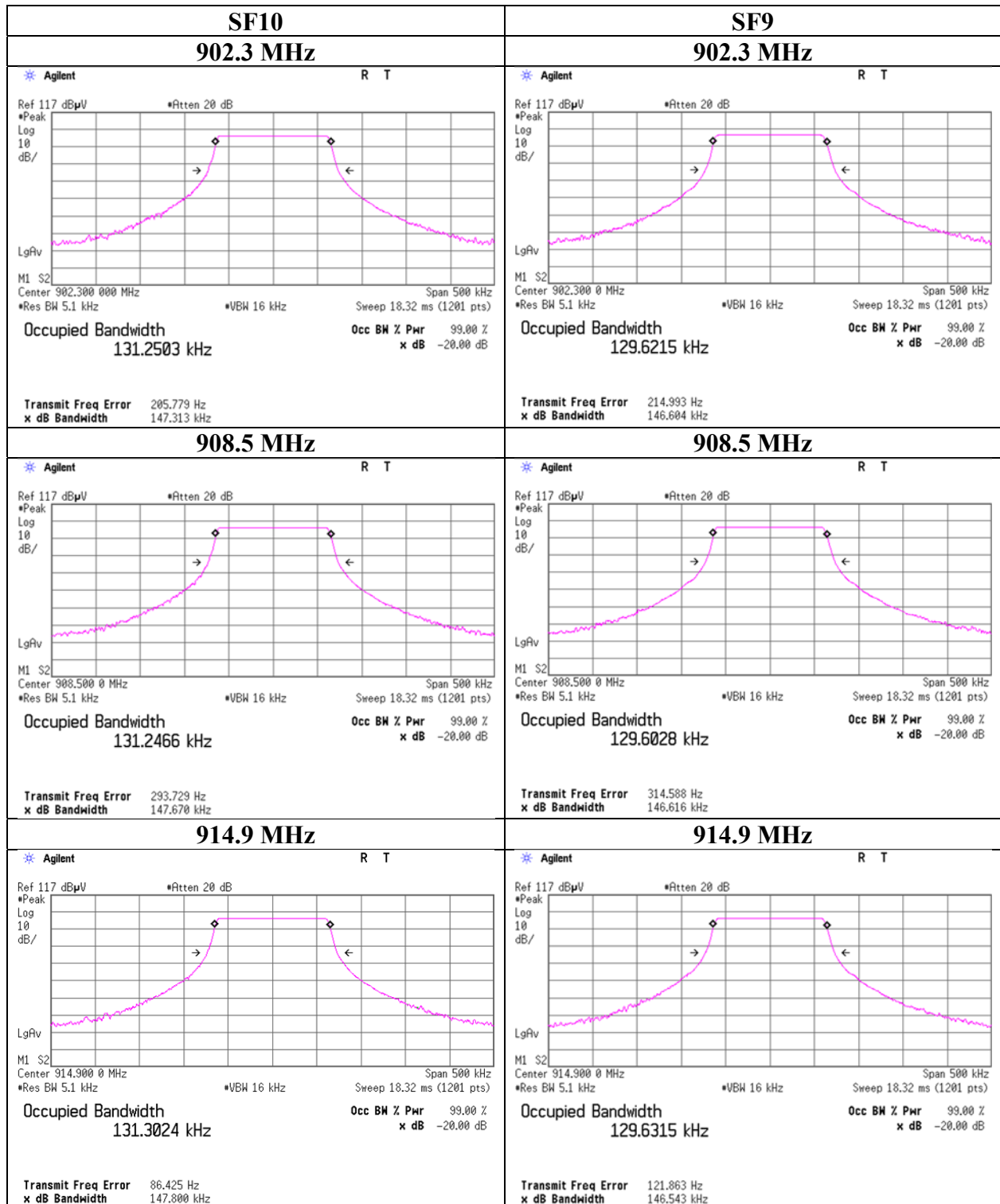
Shonan EMC Lab.

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20 dB Bandwidth and 99 % Occupied Bandwidth



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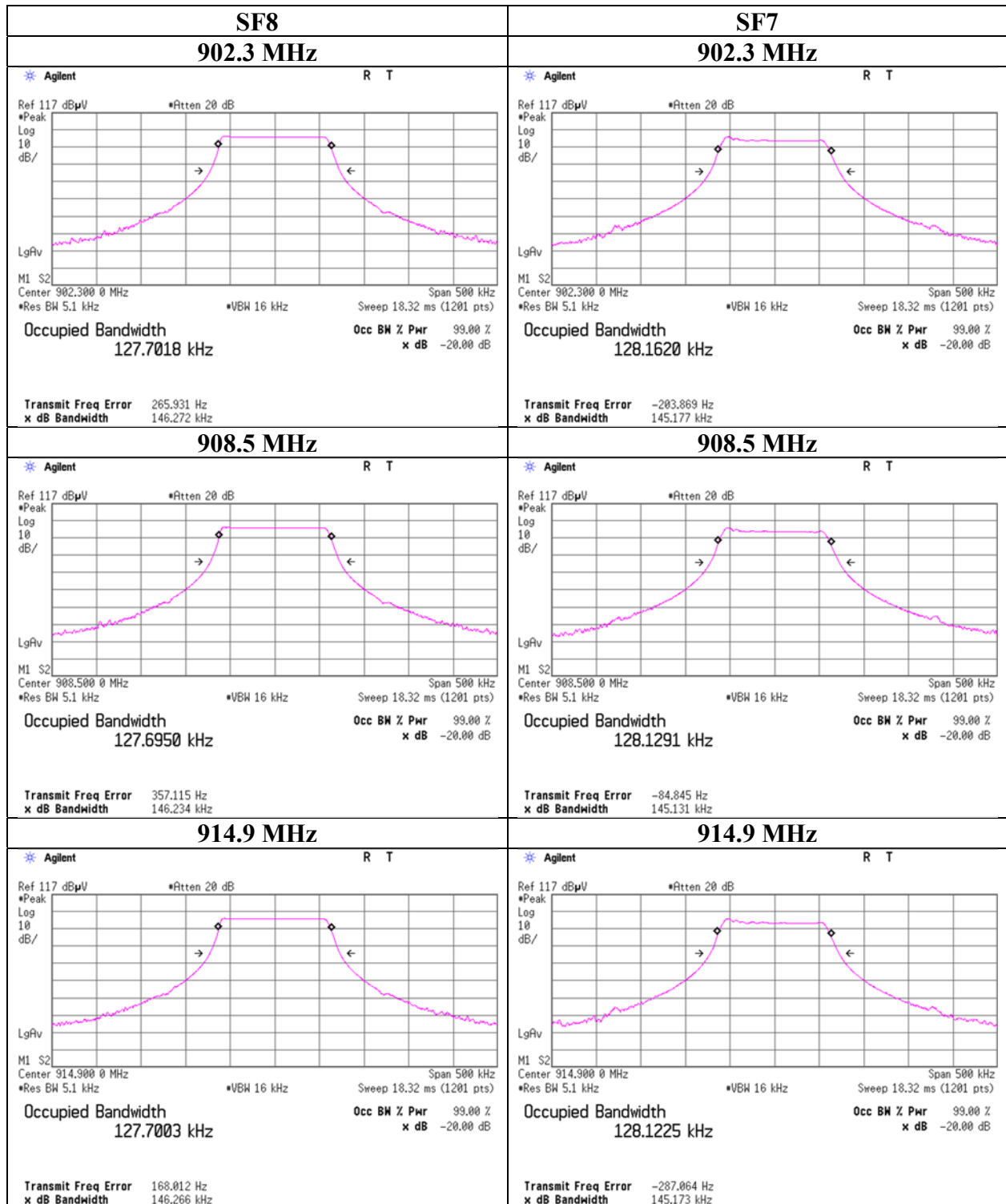
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20 dB Bandwidth and 99 % Occupied Bandwidth



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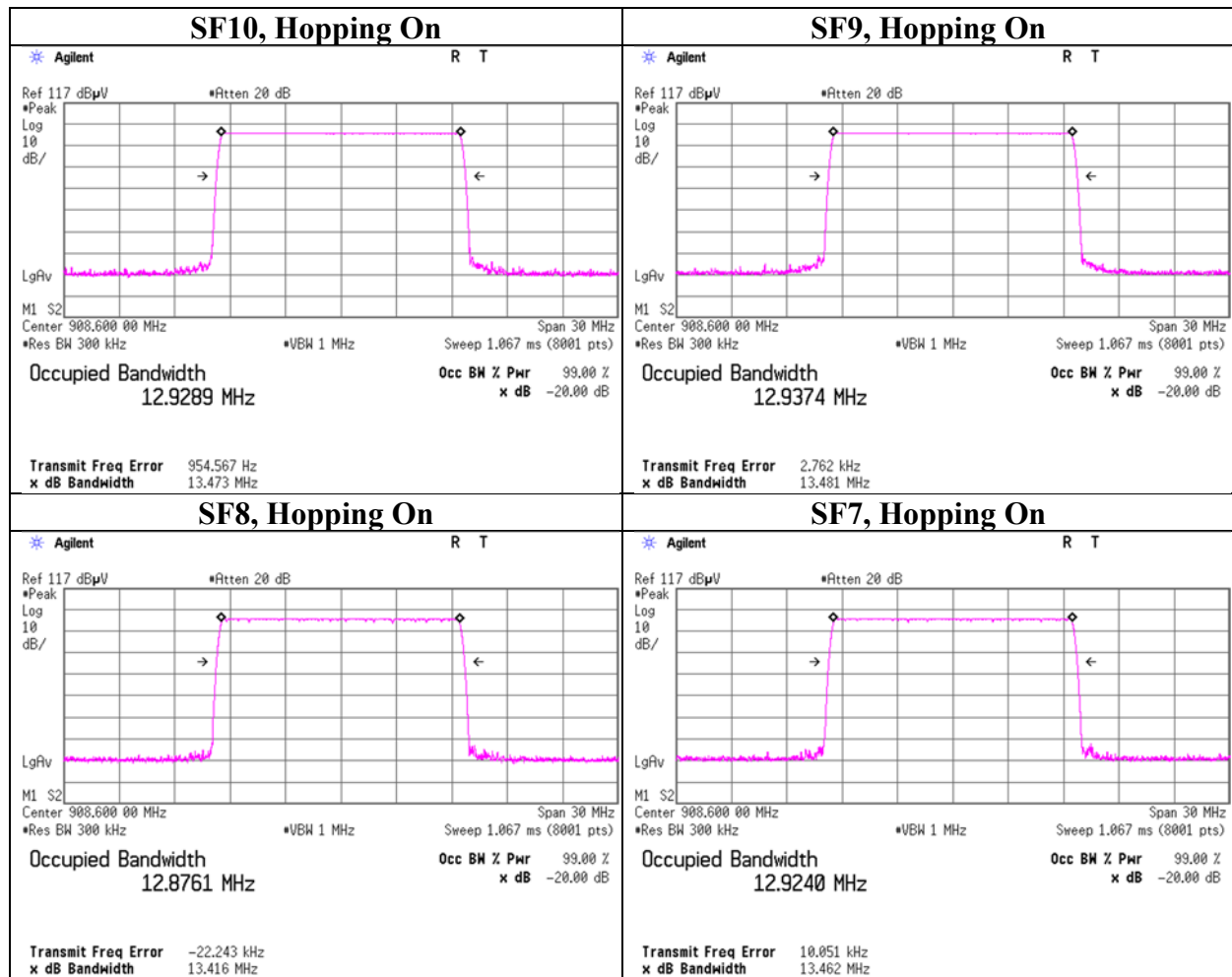
Shonan EMC Lab.

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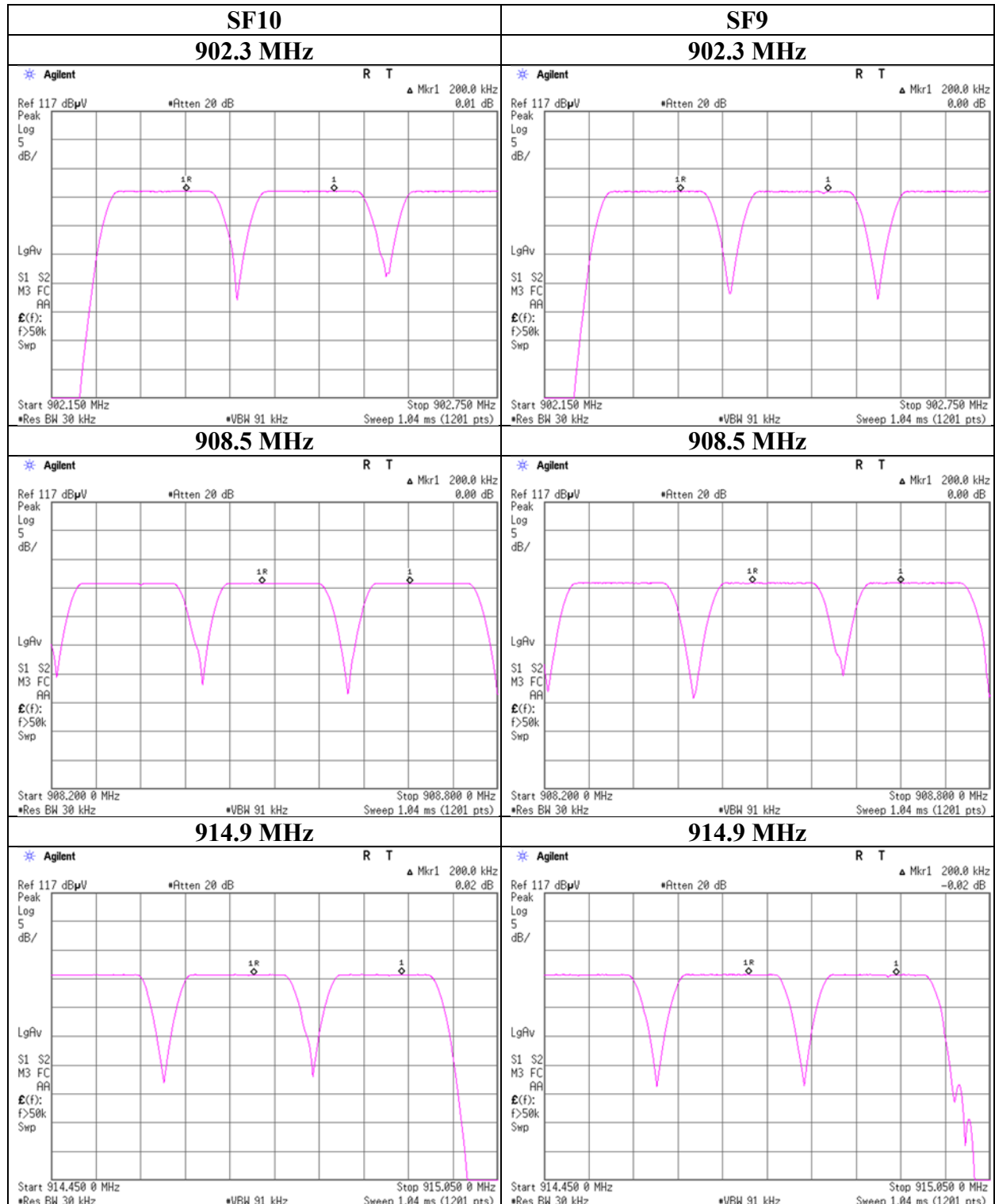
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99 % Occupied Bandwidth



Carrier Frequency Separation



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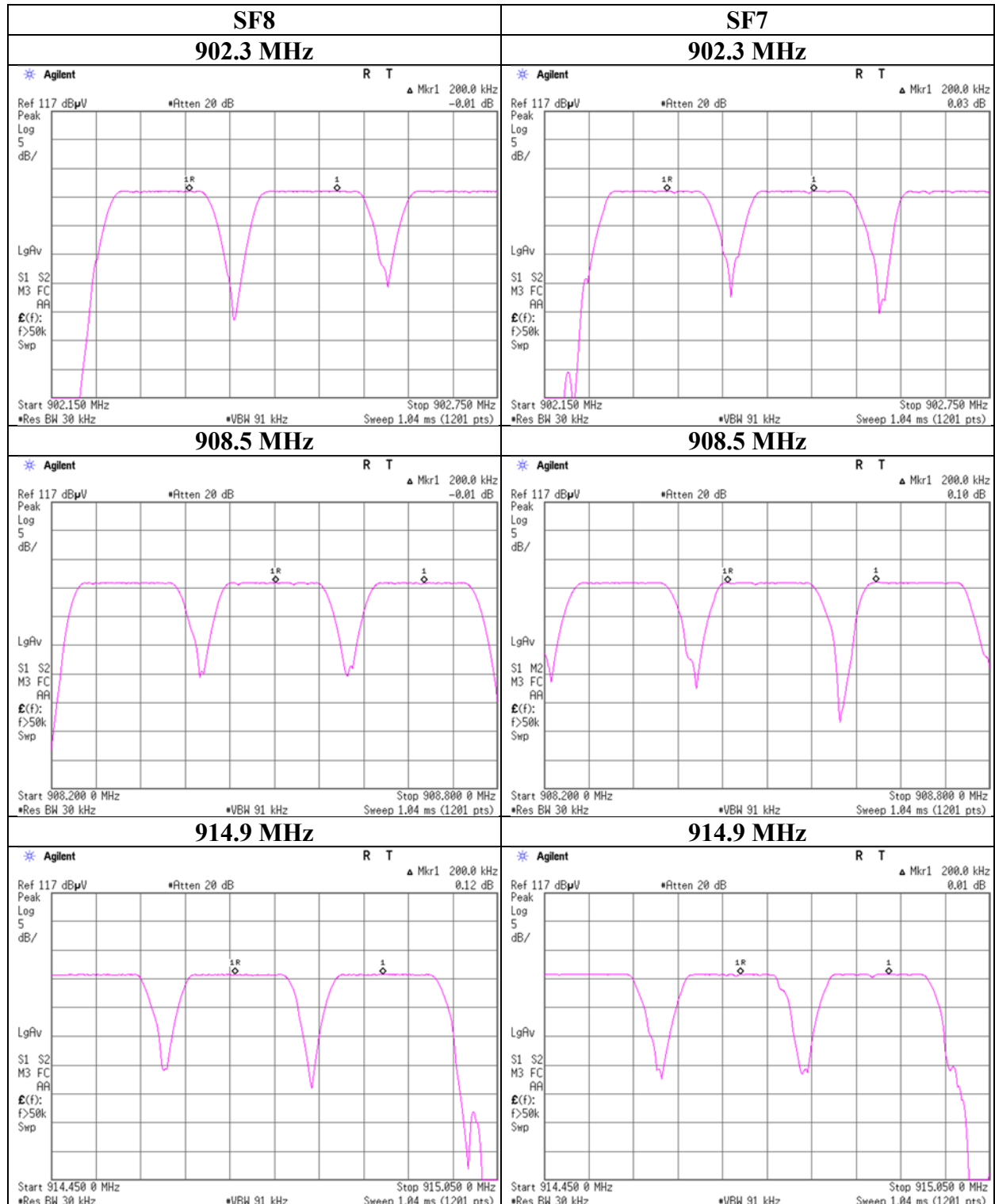
Shonan EMC Lab.

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Carrier Frequency Separation



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Telephone : +81 463 50 6400

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Dwell time

Report No. 13153638S-A-R1
Test place Shonan EMC Lab. No.5 Shield Room
Date April 8, 2020
Temperature / Humidity 24 deg. C / 37 % RH
Engineer Toshinori Yamada
Mode Tx, Hopping On

Mode	Number of transmission in a 25.6 second period					Length of transmission [msec]	Result [msec]	Limit [msec]
SF10	1.0 times	/	25.6 sec.	x	25.6 sec. = 1 times	371.0	371	400
SF9	1.0 times	/	25.6 sec.	x	25.6 sec. = 1 times	206.1	206	400
SF8	1.0 times	/	25.6 sec.	x	25.6 sec. = 1 times	113.3	113	400
SF7	1.0 times	/	25.6 sec.	x	25.6 sec. = 1 times	61.8	62	400

Sample Calculation

Time period in seconds = the number of hopping frequencies × 0.4 = 25.6 second period

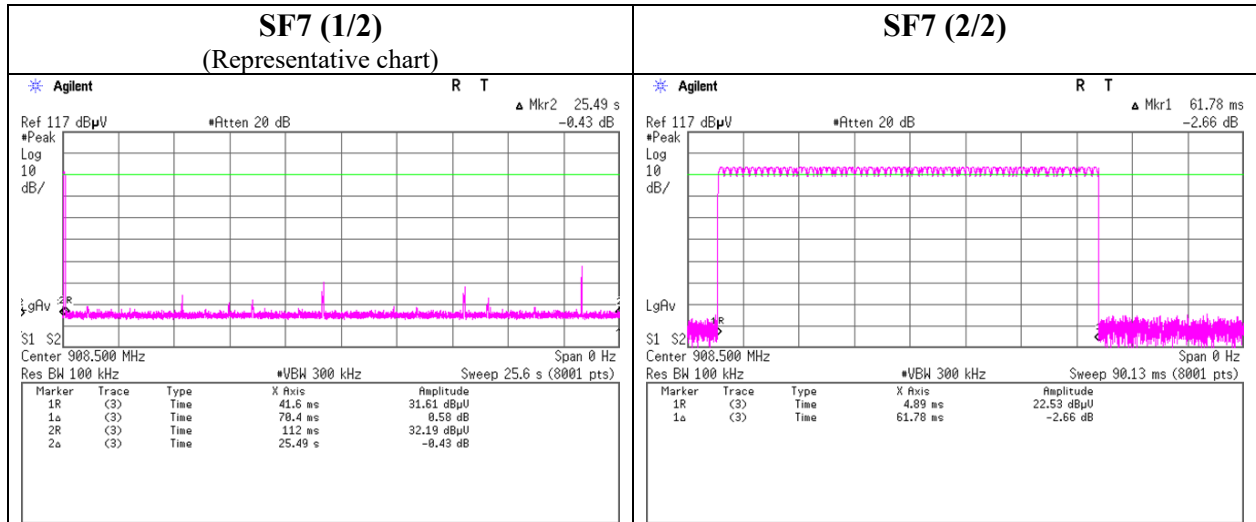
(The number of hopping frequencies = 64)

Result = Number of transmission x Length of transmission

Dwell time



Dwell time



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Maximum Peak Output Power

Report No. 13153638S-A-R1
Test place Shonan EMC Lab. No.5 Shielded Room
Date February 14, 2020
Temperature / Humidity 26 deg. C / 48 % RH
Engineer Hiromasa Sato
Mode Tx, Hopping Off

Mode	Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Conducted Power					Antenna Gain [dBi]	e.i.r.p. for RSS-247				
					Result		Limit		Margin [dB]		Result		Limit		Margin [dB]
					[dBm]	[mW]	[dBm]	[mW]			[dBm]	[mW]	[dBm]	[mW]	
SF10	902.3	-4.01	0.90	9.75	6.64	4.61	30.00	1000	23.36	-1.40	5.24	3.34	36.02	4000	30.78
SF10	908.5	-4.13	0.90	9.75	6.52	4.49	30.00	1000	23.48	-1.40	5.12	3.25	36.02	4000	30.90
SF10	914.9	-4.21	0.91	9.75	6.45	4.42	30.00	1000	23.55	-1.40	5.05	3.20	36.02	4000	30.97
SF9	902.3	-4.03	0.90	9.75	6.62	4.59	30.00	1000	23.38	-1.40	5.22	3.33	36.02	4000	30.80
SF9	908.5	-4.14	0.90	9.75	6.51	4.48	30.00	1000	23.49	-1.40	5.11	3.24	36.02	4000	30.91
SF9	914.9	-4.23	0.91	9.75	6.43	4.40	30.00	1000	23.57	-1.40	5.03	3.18	36.02	4000	30.99
SF8	902.3	-4.02	0.90	9.75	6.63	4.60	30.00	1000	23.37	-1.40	5.23	3.33	36.02	4000	30.79
SF8	908.5	-4.15	0.90	9.75	6.50	4.47	30.00	1000	23.50	-1.40	5.10	3.24	36.02	4000	30.92
SF8	914.9	-4.23	0.91	9.75	6.43	4.40	30.00	1000	23.57	-1.40	5.03	3.18	36.02	4000	30.99
SF7	902.3	-4.04	0.90	9.75	6.61	4.58	30.00	1000	23.39	-1.40	5.21	3.32	36.02	4000	30.81
SF7	908.5	-4.15	0.90	9.75	6.50	4.47	30.00	1000	23.50	-1.40	5.10	3.24	36.02	4000	30.92
SF7	914.9	-4.23	0.91	9.75	6.43	4.40	30.00	1000	23.57	-1.40	5.03	3.18	36.02	4000	30.99

Sample Calculation:

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

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

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Average Output Power (Reference data for RF Exposure)

Report No.	13153638S-A-R1
Test place	Shonan EMC Lab. No.5 Shielded Room
Date	February 14, 2020
Temperature / Humidity	26 deg. C / 48 % RH
Engineer	Hiromasa Sato
Mode	Tx, Hopping Off

Mode	Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result (Time average)		Duty factor [dB]	Result (Burst power average)	
					[dBm]	[mW]		[dBm]	[mW]
SF10	902.3	-4.03	0.90	9.75	6.62	4.59	0.00	6.62	4.59
SF10	908.5	-4.28	0.90	9.75	6.37	4.34	0.00	6.37	4.34
SF10	914.9	-4.35	0.91	9.75	6.31	4.28	0.00	6.31	4.28
SF9	902.3	-4.14	0.90	9.75	6.51	4.48	0.00	6.51	4.48
SF9	908.5	-4.28	0.90	9.75	6.37	4.34	0.00	6.37	4.34
SF9	914.9	-4.36	0.91	9.75	6.30	4.27	0.00	6.30	4.27
SF8	902.3	-4.15	0.90	9.75	6.50	4.47	0.00	6.50	4.47
SF8	908.5	-4.28	0.90	9.75	6.37	4.34	0.00	6.37	4.34
SF8	914.9	-4.36	0.91	9.75	6.30	4.27	0.00	6.30	4.27
SF7	902.3	-4.15	0.90	9.75	6.50	4.47	0.00	6.50	4.47
SF7	908.5	-4.28	0.90	9.75	6.37	4.34	0.00	6.37	4.34
SF7	914.9	-4.35	0.91	9.75	6.31	4.28	0.00	6.31	4.28

Sample Calculation:

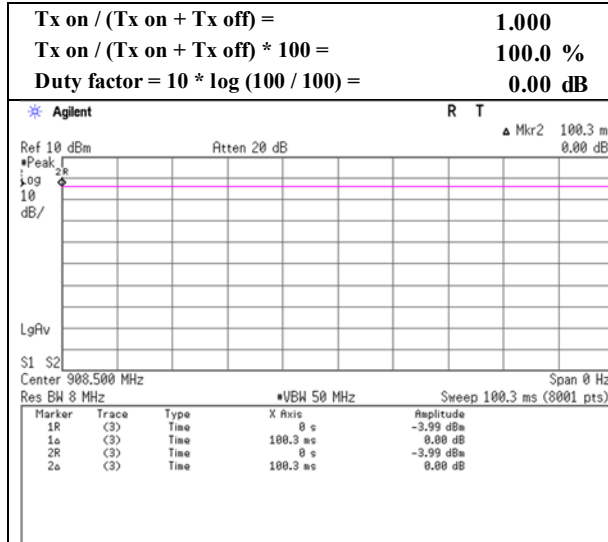
Result (Time average) = Reading + Cable Loss (including the cable(s) customer supplied) + Attenuator Loss

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

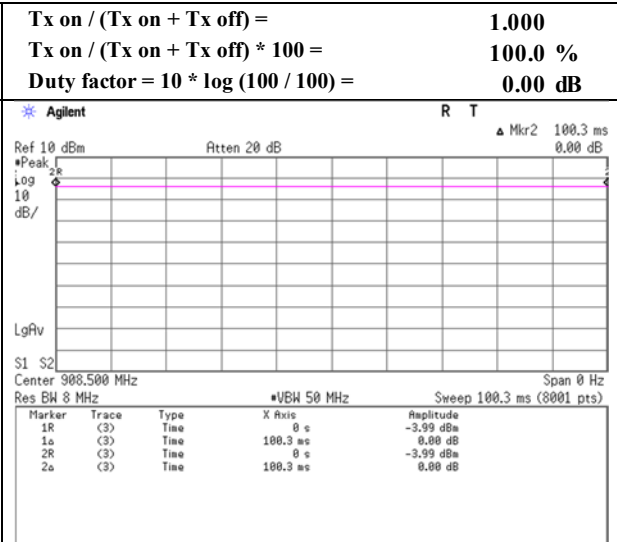
Burst Rate Confirmation

Report No. 13153638S-A-R1
Test place Shonan EMC Lab. No.1 Measurement Room
Date February 14, 2020
Temperature / Humidity 26 deg. C / 48 % RH
Engineer Hiromasa Sato
Mode Tx, Hopping Off

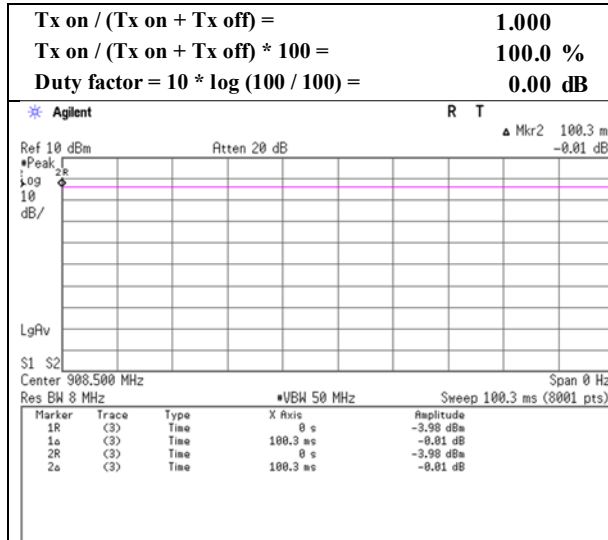
SF10



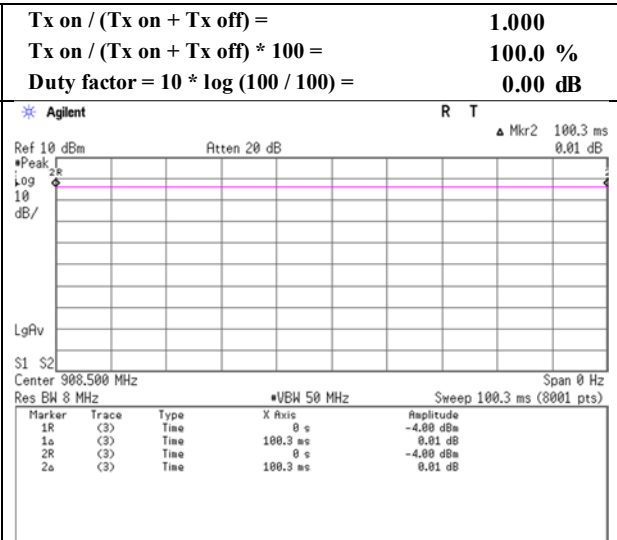
SF9



SF8



SF7



Radiated Spurious Emission

Report No. 13153638S-A-R1
Test place (Semi-Anechoic Chamber) No.1 No.2
Date February 17, 2020 February 16, 2020
Temperature / Humidity 23 deg. C / 40 % RH 22 deg. C / 41 % RH
Engineer Kazuya Noda Kazuya Noda
(30 MHz - 1 GHz) (1 GHz - 10 GHz)
Mode Tx, Hopping Off, 125 kHz mode, SF10, 902.3 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.	400.836	QP	39.20	15.81	8.03	31.81	0.00	31.23	46.0	14.7	100	131	
Hori.	1804.600	PK	47.55	25.66	4.39	38.95	2.35	41.00	73.9	32.9	126	175	
Hori.	2706.900	PK	48.28	28.34	4.82	38.53	2.35	45.26	73.9	28.6	113	219	
Hori.	3609.200	PK	50.02	29.45	5.55	38.17	2.35	49.20	73.9	24.7	222	260	
Hori.	4511.500	PK	47.65	31.06	6.12	38.54	2.35	48.64	73.9	25.2	220	157	
Hori.	5413.800	PK	47.76	32.20	6.78	38.77	2.35	50.32	73.9	23.5	100	39	
Hori.	6316.100	PK	50.19	34.04	7.42	39.03	2.35	54.97	73.9	18.9	221	14	
Hori.	7218.400	PK	46.17	37.30	7.81	39.17	2.35	54.46	73.9	19.4	114	107	
Hori.	8120.700	PK	45.37	37.98	8.25	39.42	2.35	54.53	73.9	19.3	252	257	
Hori.	9023.000	PK	46.69	37.96	8.87	39.81	2.35	56.06	73.9	17.8	105	233	
Hori.	1804.600	AV	39.14	25.66	4.39	38.95	2.35	32.59	53.9	21.3	126	175	
Hori.	2706.900	AV	41.54	28.34	4.82	38.53	2.35	38.52	53.9	15.3	113	219	
Hori.	3609.200	AV	43.51	29.45	5.55	38.17	2.35	42.69	53.9	11.2	222	260	
Hori.	4511.500	AV	38.58	31.06	6.12	38.54	2.35	39.57	53.9	14.3	220	157	
Hori.	5413.800	AV	39.93	32.20	6.78	38.77	2.35	42.49	53.9	11.4	100	39	
Hori.	6316.100	AV	43.67	34.04	7.42	39.03	2.35	48.45	53.9	5.4	221	14	
Hori.	7218.400	AV	35.11	37.30	7.81	39.17	2.35	43.40	53.9	10.5	114	107	
Hori.	8120.700	AV	33.91	37.98	8.25	39.42	2.35	43.07	53.9	10.8	252	257	
Hori.	9023.000	AV	35.47	37.96	8.87	39.81	2.35	44.84	53.9	9.0	105	233	
Vert.	400.854	QP	38.80	15.81	8.03	31.81	0.00	30.83	46.0	15.1	100	94	
Vert.	1804.600	PK	47.24	25.66	4.39	38.95	2.35	40.69	73.9	33.2	145	177	
Vert.	2706.900	PK	50.29	28.34	4.82	38.53	2.35	47.27	73.9	26.6	143	262	
Vert.	3609.200	PK	49.27	29.45	5.55	38.17	2.35	48.45	73.9	25.4	163	243	
Vert.	4511.500	PK	46.95	31.06	6.12	38.54	2.35	47.94	73.9	25.9	160	22	
Vert.	5413.800	PK	48.06	32.20	6.78	38.77	2.35	50.62	73.9	23.2	100	297	
Vert.	6316.100	PK	49.54	34.04	7.42	39.03	2.35	54.32	73.9	19.5	105	25	
Vert.	7218.400	PK	45.84	37.30	7.81	39.17	2.35	54.13	73.9	19.7	100	239	
Vert.	8120.700	PK	45.41	37.98	8.25	39.42	2.35	54.57	73.9	19.3	119	2	
Vert.	9023.000	PK	46.01	37.96	8.87	39.81	2.35	55.38	73.9	18.5	288	255	
Vert.	1804.600	AV	38.87	25.66	4.39	38.95	2.35	32.32	53.9	21.5	145	177	
Vert.	2706.900	AV	44.85	28.34	4.82	38.53	2.35	41.83	53.9	12.0	143	262	
Vert.	3609.200	AV	42.62	29.45	5.55	38.17	2.35	41.80	53.9	12.1	163	243	
Vert.	4511.500	AV	37.14	31.06	6.12	38.54	2.35	38.13	53.9	15.7	160	22	
Vert.	5413.800	AV	39.10	32.20	6.78	38.77	2.35	41.66	53.9	12.2	100	297	
Vert.	6316.100	AV	42.29	34.04	7.42	39.03	2.35	47.07	53.9	6.8	105	25	
Vert.	7218.400	AV	34.51	37.30	7.81	39.17	2.35	42.80	53.9	11.1	100	239	
Vert.	8120.700	AV	33.32	37.98	8.25	39.42	2.35	42.48	53.9	11.4	119	2	
Vert.	9023.000	AV	34.59	37.96	8.87	39.81	2.35	43.96	53.9	9.9	288	255	

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

Distance factor : 1 GHz - 10 GHz : 20log (3.93 m / 3.0 m) = 2.35 dB

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.	902.300	PK	103.89	22.10	9.86	31.33	0.00	104.52	-	-	Carrier
Hori.	902.000	PK	60.81	22.10	9.86	31.33	0.00	61.44	84.52	23.0	
Vert.	902.300	PK	102.20	22.10	9.86	31.33	0.00	102.83	-	-	Carrier
Vert.	902.000	PK	58.27	22.10	9.86	31.33	0.00	58.90	82.83	23.9	

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

Distance factor : 1 GHz - 10 GHz : 20log (3.93 m / 3.0 m) = 2.35 dB

*These results have sufficient margin without taking account Duty cycle correction factor.

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Shonan EMC Lab.

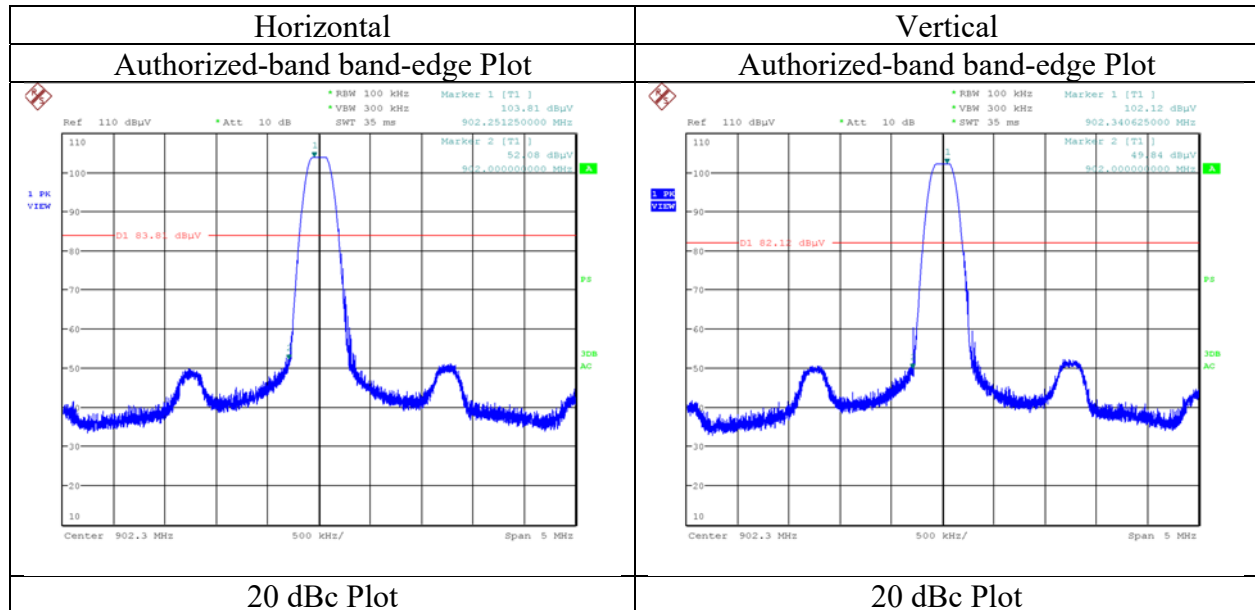
1-22-3 Megumigaoka, Hiratsuka-shi, Kanagawa-ken, 259-1220 JAPAN

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Facsimile : +81 463 50 6401

Radiated Spurious Emission (Reference Plot for band-edge)

Report No.	13153638S-A-R1
Test place (Semi-Anechoic Chamber)	No.1
Date	February 17, 2020
Temperature / Humidity	23 deg. C / 40 % RH
Engineer	Kazuya Noda
	(30 MHz - 1 GHz)
Mode	Tx, Hopping Off, 125 kHz mode, SF10, 902.3 MHz



* The measurement was conducted for a sufficiently long enough time to detect any possible spurious emissions.
Final result of restricted band edge was shown in tabular data.

Radiated Spurious Emission

Report No. 13153638S-A-R1
Test place (Semi-Anechoic Chamber) No.1 No.2
Date February 17, 2020 February 16, 2020
Temperature / Humidity 23 deg. C / 40 % RH 22 deg. C / 41 % RH
Engineer Kazuya Noda Kazuya Noda
(30 MHz - 1 GHz) (1 GHz - 10 GHz)
Mode Tx, Hopping Off, 125 kHz mode, SF10, 908.5 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.	400.764	QP	39.10	15.81	8.03	31.81	0.00	31.13	46.0	14.8	100	142	
Hori.	902.000	QP	26.60	22.10	9.86	31.33	0.00	27.23	46.0	18.7	100	222	
Hori.	928.000	QP	24.90	22.00	9.96	31.11	0.00	25.75	46.0	20.2	100	222	
Hori.	1817.000	PK	47.51	25.73	4.39	38.95	2.35	41.03	73.9	32.8	201	168	
Hori.	2725.500	PK	47.86	28.39	4.84	38.52	2.35	44.92	73.9	28.9	111	219	
Hori.	3634.000	PK	48.88	29.54	5.55	38.17	2.35	48.15	73.9	25.7	259	258	
Hori.	4542.500	PK	47.75	31.13	6.13	38.54	2.35	48.82	73.9	25.0	179	156	
Hori.	5451.000	PK	48.26	32.25	6.81	38.79	2.35	50.88	73.9	23.0	100	39	
Hori.	6359.500	PK	49.56	34.25	7.44	39.02	2.35	54.58	73.9	19.3	175	12	
Hori.	7268.000	PK	46.25	37.35	7.84	39.25	2.35	54.54	73.9	19.3	117	108	
Hori.	8176.500	PK	45.68	37.73	8.29	39.45	2.35	54.60	73.9	19.3	119	313	
Hori.	9085.000	PK	46.23	38.15	8.92	39.81	2.35	55.84	73.9	18.0	102	232	
Hori.	1817.000	AV	38.18	25.73	4.39	38.95	2.35	31.70	53.9	22.2	201	168	
Hori.	2725.500	AV	41.59	28.39	4.84	38.52	2.35	38.65	53.9	15.2	111	219	
Hori.	3634.000	AV	43.12	29.54	5.55	38.17	2.35	42.39	53.9	11.5	259	258	
Hori.	4542.500	AV	39.31	31.13	6.13	38.54	2.35	40.38	53.9	13.5	179	156	
Hori.	5451.000	AV	40.65	32.25	6.81	38.79	2.35	43.27	53.9	10.6	100	39	
Hori.	6359.500	AV	42.37	34.25	7.44	39.02	2.35	47.39	53.9	6.5	175	12	
Hori.	7268.000	AV	34.41	37.35	7.84	39.25	2.35	42.70	53.9	11.2	117	108	
Hori.	8176.500	AV	33.38	37.73	8.29	39.45	2.35	42.30	53.9	11.6	119	313	
Hori.	9085.000	AV	35.16	38.15	8.92	39.81	2.35	44.77	53.9	9.1	102	232	
Vert.	400.794	QP	38.70	15.81	8.03	31.81	0.00	30.73	46.0	15.2	138	85	
Vert.	902.000	QP	25.90	22.10	9.86	31.33	0.00	26.53	46.0	19.4	117	122	
Vert.	928.000	QP	24.30	22.00	9.96	31.11	0.00	25.15	46.0	20.8	117	122	
Vert.	1817.000	PK	46.73	25.73	4.39	38.95	2.35	40.25	73.9	33.6	144	175	
Vert.	2725.500	PK	50.41	28.39	4.84	38.52	2.35	47.47	73.9	26.4	126	267	
Vert.	3634.000	PK	49.65	29.54	5.55	38.17	2.35	48.92	73.9	24.9	152	241	
Vert.	4542.500	PK	46.13	31.13	6.13	38.54	2.35	47.20	73.9	26.7	148	26	
Vert.	5451.000	PK	47.56	32.25	6.81	38.79	2.35	50.18	73.9	23.7	100	294	
Vert.	6359.500	PK	49.26	34.25	7.44	39.02	2.35	54.28	73.9	19.6	102	22	
Vert.	7268.000	PK	45.65	37.35	7.84	39.25	2.35	53.94	73.9	19.9	105	18	
Vert.	8176.500	PK	46.42	37.73	8.29	39.45	2.35	55.34	73.9	18.5	113	1	
Vert.	9085.000	PK	46.28	38.15	8.92	39.81	2.35	55.89	73.9	18.0	291	257	
Vert.	1817.000	AV	37.38	25.73	4.39	38.95	2.35	30.90	53.9	23.0	144	175	
Vert.	2725.500	AV	45.02	28.39	4.84	38.52	2.35	42.08	53.9	11.8	126	267	
Vert.	3634.000	AV	43.59	29.54	5.55	38.17	2.35	42.86	53.9	11.0	152	241	
Vert.	4542.500	AV	36.02	31.13	6.13	38.54	2.35	37.09	53.9	16.8	148	26	
Vert.	5451.000	AV	37.89	32.25	6.81	38.79	2.35	40.51	53.9	13.3	100	294	
Vert.	6359.500	AV	41.16	34.25	7.44	39.02	2.35	46.18	53.9	7.7	102	22	
Vert.	7268.000	AV	32.97	37.35	7.84	39.25	2.35	41.26	53.9	12.6	105	18	
Vert.	8176.500	AV	32.17	37.73	8.29	39.45	2.35	41.09	53.9	12.8	113	1	
Vert.	9085.000	AV	33.98	38.15	8.92	39.81	2.35	43.59	53.9	10.3	291	257	

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

Distance factor : 1 GHz - 10 GHz : $20\log(3.93\text{ m}/3.0\text{ m}) = 2.35\text{ dB}$

*These results have sufficient margin without taking account Duty cycle correction factor.

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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. 13153638S-A-R1
Test place (Semi-Anechoic Chamber) No.1 No.2
Date February 17, 2020 February 16, 2020
Temperature / Humidity 23 deg. C / 40 % RH 22 deg. C / 41 % RH
Engineer Kazuya Noda Kazuya Noda
(30 MHz - 1 GHz) (1 GHz - 10 GHz)
Mode Tx, Hopping Off, 125 kHz mode, SF10, 914.9 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.	400.888	QP	39.00	15.81	8.03	31.81	0.00	31.03	46.0	14.9	100	139	
Hori.	928.000	QP	25.30	22.00	9.96	31.11	0.00	26.15	46.0	19.8	100	222	
Hori.	1829.800	PK	47.12	25.81	4.38	38.95	2.35	40.71	73.9	33.1	158	148	
Hori.	2744.700	PK	49.17	28.45	4.85	38.52	2.35	46.30	73.9	27.6	105	213	
Hori.	3659.600	PK	49.89	29.63	5.57	38.16	2.35	49.28	73.9	24.6	324	246	
Hori.	4574.500	PK	47.53	31.21	6.17	38.54	2.35	48.72	73.9	25.1	100	207	
Hori.	5489.400	PK	47.56	32.27	6.83	38.81	2.35	50.20	73.9	23.7	100	34	
Hori.	6404.300	PK	47.56	34.43	7.46	39.01	2.35	52.79	73.9	21.1	119	79	
Hori.	7319.200	PK	45.82	37.42	7.85	39.33	2.35	54.11	73.9	19.7	134	28	
Hori.	8234.100	PK	44.79	37.48	8.32	39.48	2.35	53.46	73.9	20.4	102	324	
Hori.	9149.000	PK	45.72	38.39	8.94	39.81	2.35	55.59	73.9	18.3	104	233	
Hori.	1829.800	AV	38.74	25.81	4.38	38.95	2.35	32.33	53.9	21.5	158	148	
Hori.	2744.700	AV	42.98	28.45	4.85	38.52	2.35	40.11	53.9	13.7	105	213	
Hori.	3659.600	AV	44.61	29.63	5.57	38.16	2.35	44.00	53.9	9.9	324	246	
Hori.	4574.500	AV	40.34	31.21	6.17	38.54	2.35	41.53	53.9	12.3	100	207	
Hori.	5489.400	AV	39.83	32.27	6.83	38.81	2.35	42.47	53.9	11.4	100	34	
Hori.	6404.300	AV	40.18	34.43	7.46	39.01	2.35	45.41	53.9	8.4	119	79	
Hori.	7319.200	AV	34.15	37.42	7.85	39.33	2.35	42.44	53.9	11.4	134	28	
Hori.	8234.100	AV	33.70	37.48	8.32	39.48	2.35	42.37	53.9	11.5	102	324	
Hori.	9149.000	AV	34.77	38.39	8.94	39.81	2.35	44.64	53.9	9.2	104	233	
Vert.	401.971	QP	38.30	15.84	8.03	31.81	0.00	30.36	46.0	15.6	141	96	
Vert.	928.000	QP	24.70	22.00	9.96	31.11	0.00	25.55	46.0	20.4	115	121	
Vert.	1829.800	PK	46.84	25.81	4.38	38.95	2.35	40.43	73.9	33.4	141	155	
Vert.	2744.700	PK	51.03	28.45	4.85	38.52	2.35	48.16	73.9	25.7	144	266	
Vert.	3659.600	PK	49.76	29.63	5.57	38.16	2.35	49.15	73.9	24.7	161	237	
Vert.	4574.500	PK	46.04	31.21	6.17	38.54	2.35	47.23	73.9	26.6	102	122	
Vert.	5489.400	PK	47.73	32.27	6.83	38.81	2.35	50.37	73.9	23.5	100	298	
Vert.	6404.300	PK	48.12	34.43	7.46	39.01	2.35	53.35	73.9	20.5	101	23	
Vert.	7319.200	PK	44.95	37.42	7.85	39.33	2.35	53.24	73.9	20.6	104	21	
Vert.	8234.100	PK	45.75	37.48	8.32	39.48	2.35	54.42	73.9	19.4	109	4	
Vert.	9149.000	PK	46.43	38.39	8.94	39.81	2.35	56.30	73.9	17.6	274	253	
Vert.	1829.800	AV	37.38	25.81	4.38	38.95	2.35	30.97	53.9	22.9	141	155	
Vert.	2744.700	AV	46.11	28.45	4.85	38.52	2.35	43.24	53.9	10.6	144	266	
Vert.	3659.600	AV	44.72	29.63	5.57	38.16	2.35	44.11	53.9	9.7	161	237	
Vert.	4574.500	AV	37.09	31.21	6.17	38.54	2.35	38.28	53.9	15.6	102	122	
Vert.	5489.400	AV	37.78	32.27	6.83	38.81	2.35	40.42	53.9	13.4	100	298	
Vert.	6404.300	AV	39.83	34.43	7.46	39.01	2.35	45.06	53.9	8.8	101	23	
Vert.	7319.200	AV	33.95	37.42	7.85	39.33	2.35	42.24	53.9	11.6	104	21	
Vert.	8234.100	AV	33.34	37.48	8.32	39.48	2.35	42.01	53.9	11.8	109	4	
Vert.	9149.000	AV	34.63	38.39	8.94	39.81	2.35	44.50	53.9	9.4	274	253	

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

Distance factor : 1 GHz - 10 GHz : $20\log(3.93\text{ m} / 3.0\text{ m}) = 2.35\text{ dB}$

*These results have sufficient margin without taking account Duty cycle correction factor.

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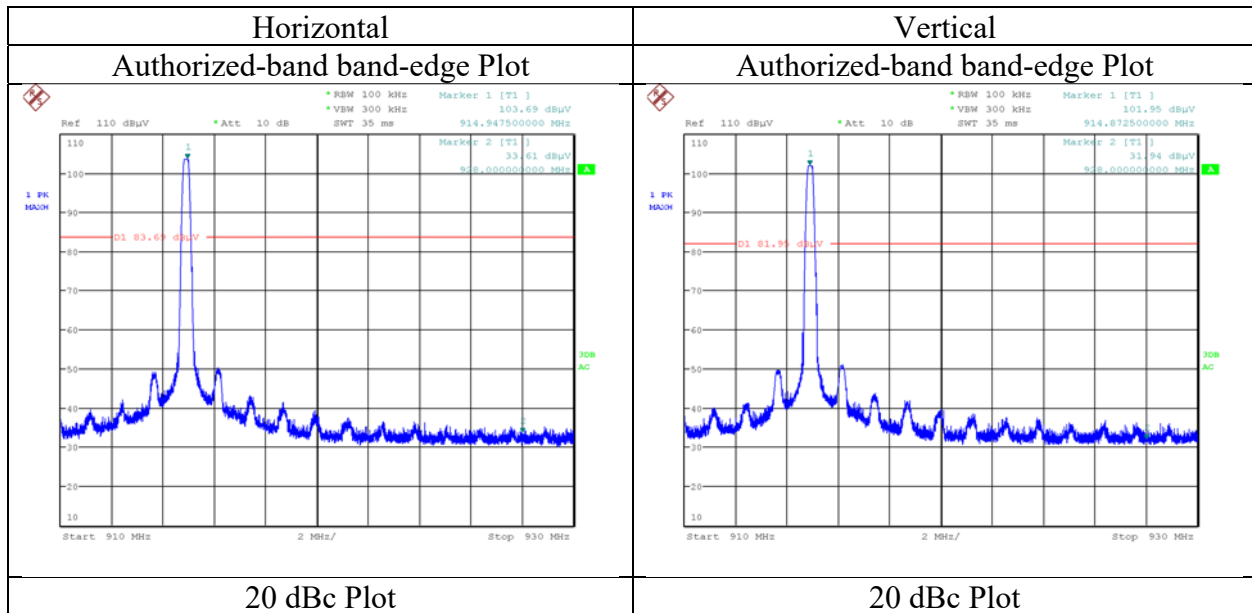
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Telephone : +81 463 50 6400

Facsimile : +81 463 50 6401

Radiated Spurious Emission (Reference Plot for band-edge)

Report No.	13153638S-A-R1
Test place (Semi-Anechoic Chamber)	No.1
Date	February 17, 2020
Temperature / Humidity	23 deg. C / 40 % RH
Engineer	Kazuya Noda
	(30 MHz - 1 GHz)
Mode	Tx, Hopping Off, 125 kHz mode, SF10, 914.9 MHz

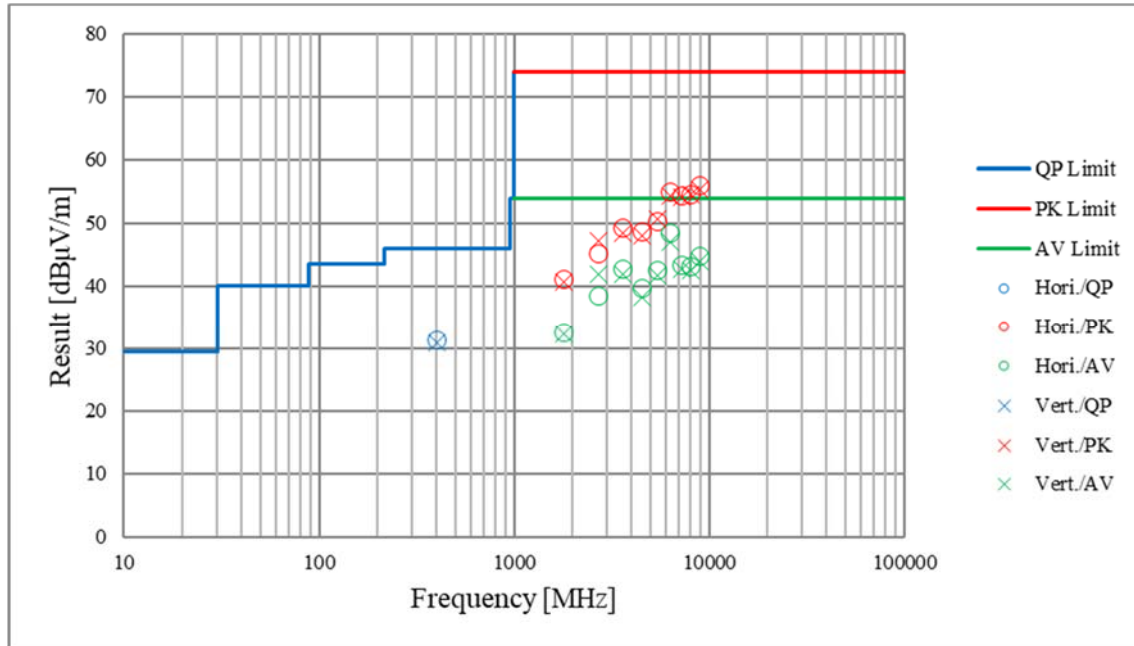


* The measurement was conducted for a sufficiently long enough time to detect any possible spurious emissions.

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

Radiated Spurious Emission
(Plot data, Worst case)

Report No.	13153638S-A-R1	
Test place (Semi-Anechoic Chamber)	No.1	No.2
Date	February 17, 2020	February 16, 2020
Temperature / Humidity	23 deg. C / 40 % RH	22 deg. C / 41 % RH
Engineer	Kazuya Noda	Kazuya Noda
	(30 MHz - 1 GHz)	(1 GHz - 10 GHz)
Mode	Tx, Hopping Off, 125 kHz mode, SF10, 902.3 MHz	

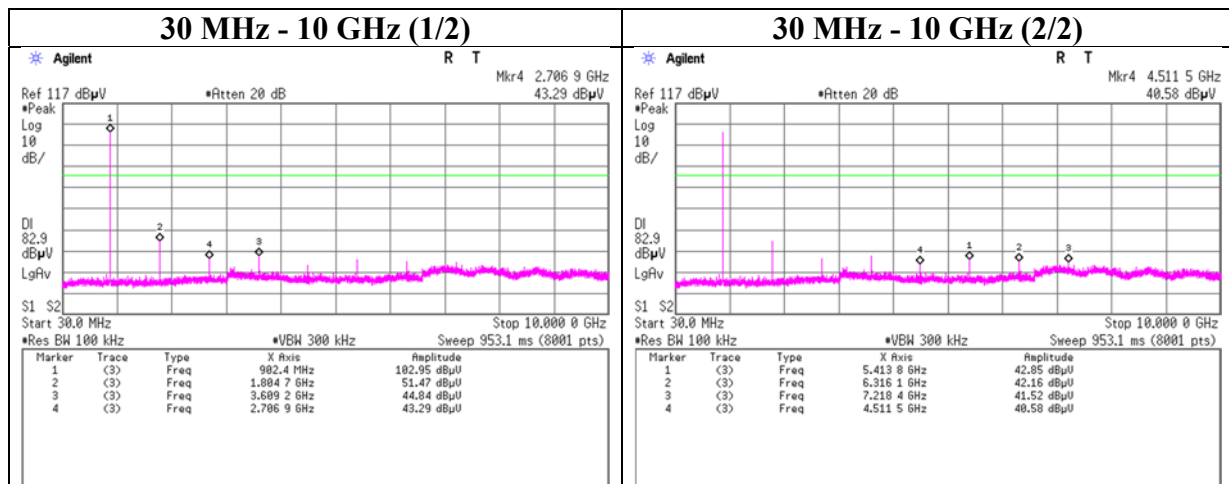
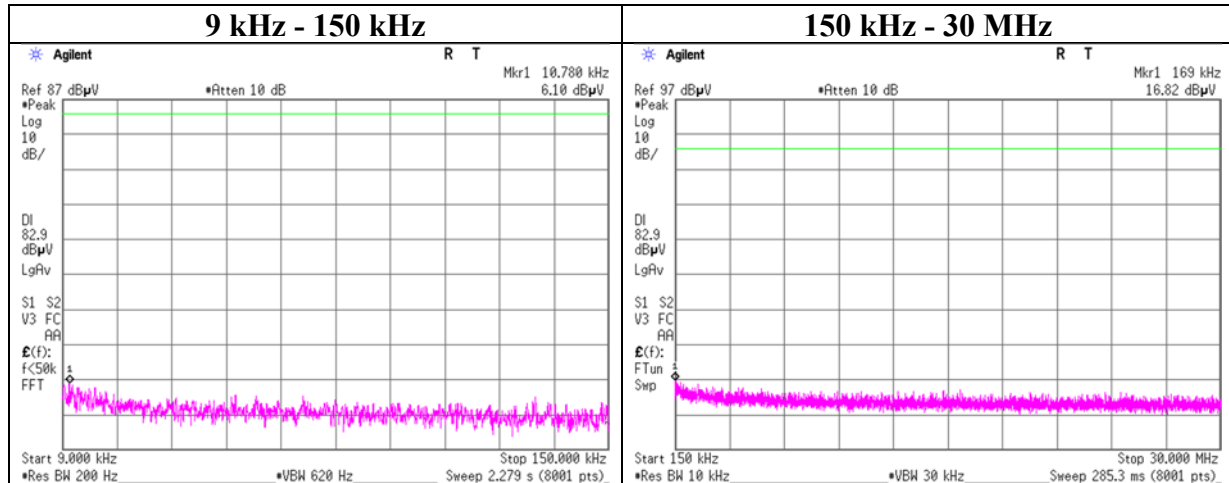


*These plots data contains sufficient number to show the trend of characteristic features for EUT.

Conducted Spurious Emission

Report No. 13153638S-A-R1
Test place Shonan EMC Lab. No.5 Shield Room
Date February 22, 2020
Temperature / Humidity 22 deg. C / 50 % RH
Engineer Toshinori Yamada
Mode Tx, Hopping Off, 125 kHz mode, SF10

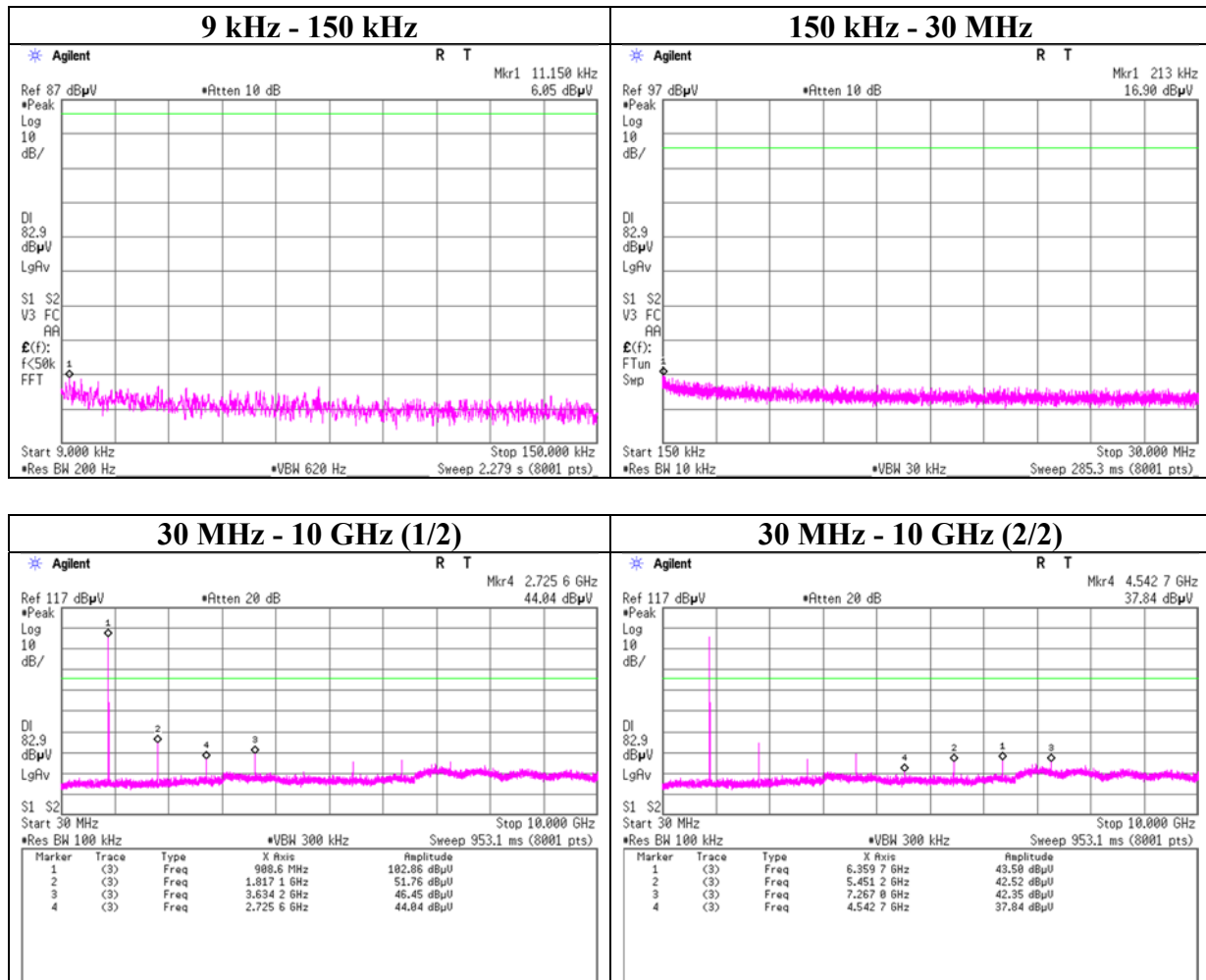
902.3 MHz



Conducted Spurious Emission

Report No. 13153638S-A-R1
Test place Shonan EMC Lab. No.5 Shield Room
Date February 22, 2020
Temperature / Humidity 22 deg. C / 50 % RH
Engineer Toshinori Yamada
Mode Tx, Hopping Off, 125 kHz mode, SF10

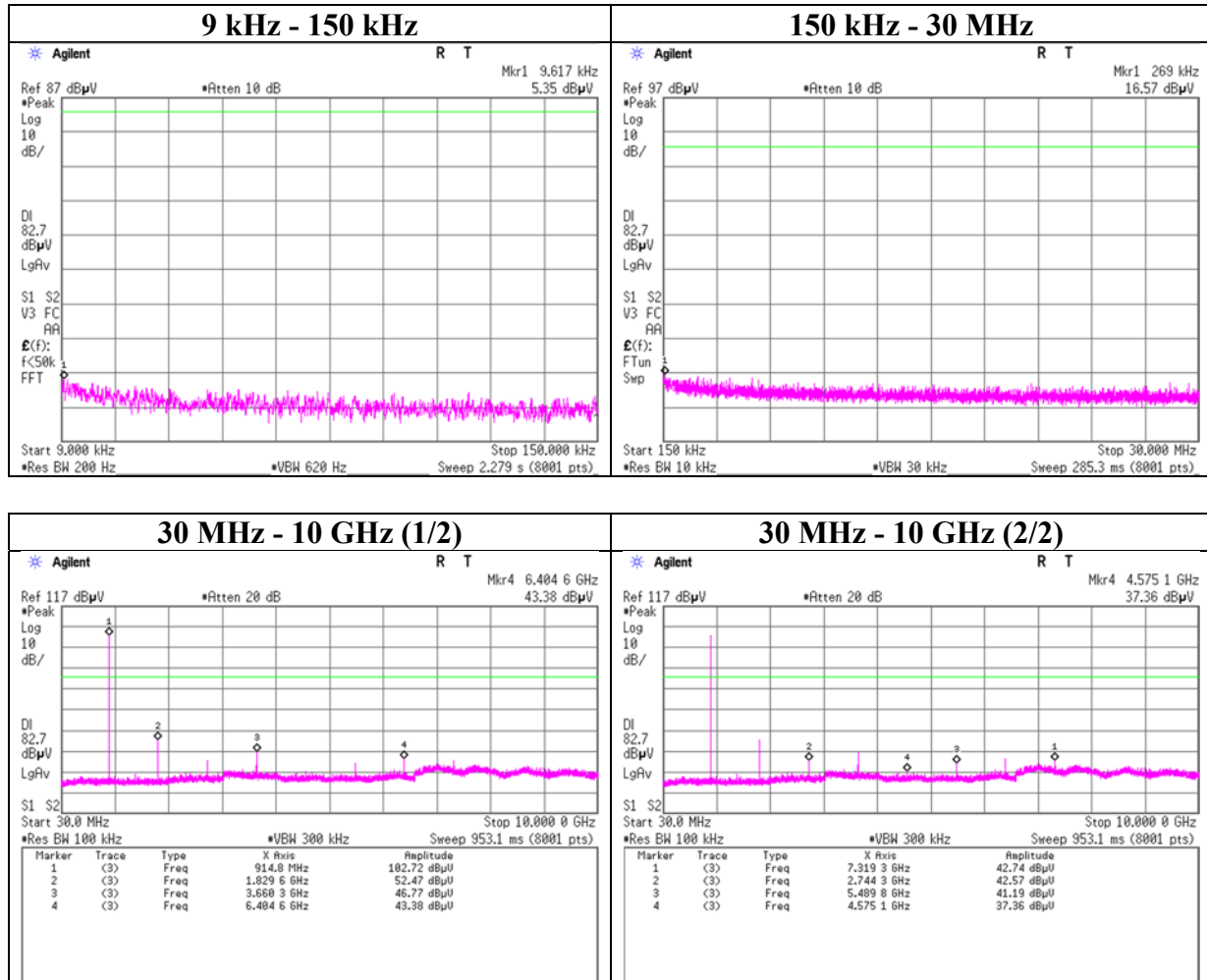
908.5 MHz



Conducted Spurious Emission

Report No. 13153638S-A-R1
Test place Shonan EMC Lab. No.5 Shield Room
Date February 22, 2020
Temperature / Humidity 22 deg. C / 50 % RH
Engineer Toshinori Yamada
Mode Tx, Hopping Off, 125 kHz mode, SF10

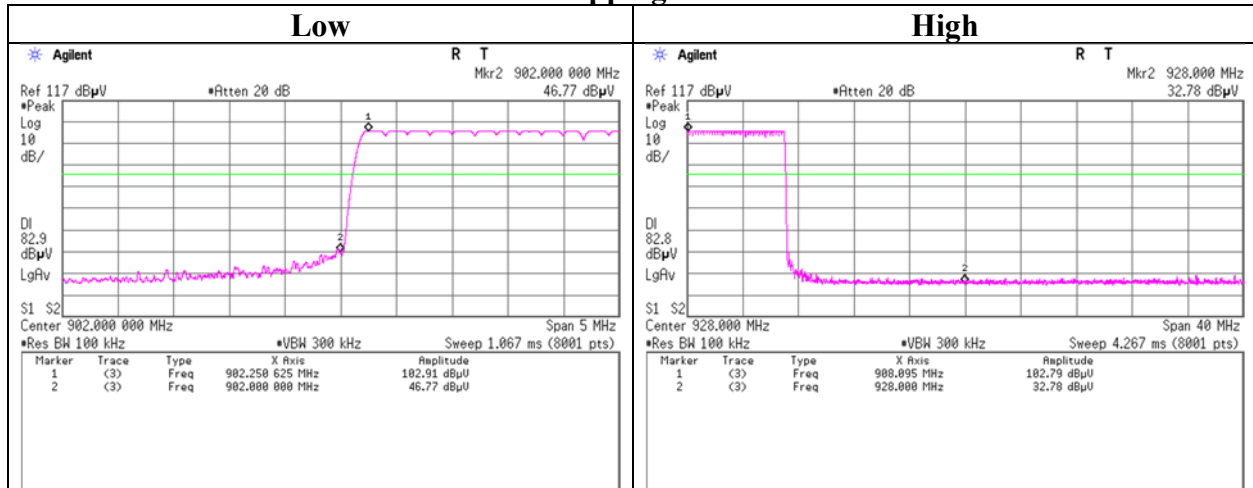
914.9 MHz



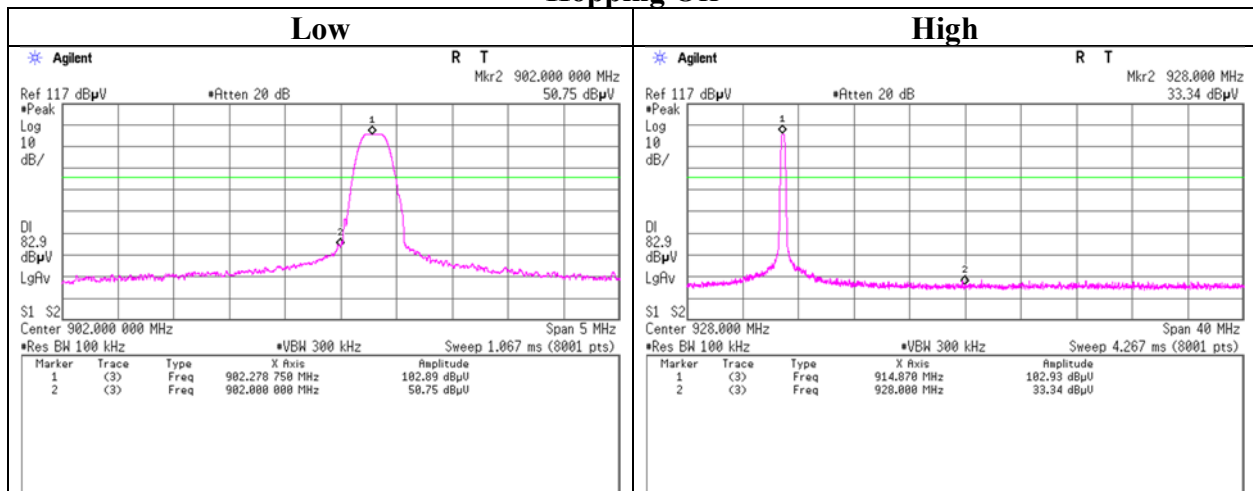
Conducted Emission Band Edge compliance

Report No.	13153638S-A-R1
Test place	Shonan EMC Lab. No.5 Shield Room
Date	February 19, 2020
Temperature / Humidity	23 deg. C / 39 % RH
Engineer	Toshinori Yamada
Mode	Tx, Hopping Off, 125 kHz mode, SF10

Hopping On



Hopping Off



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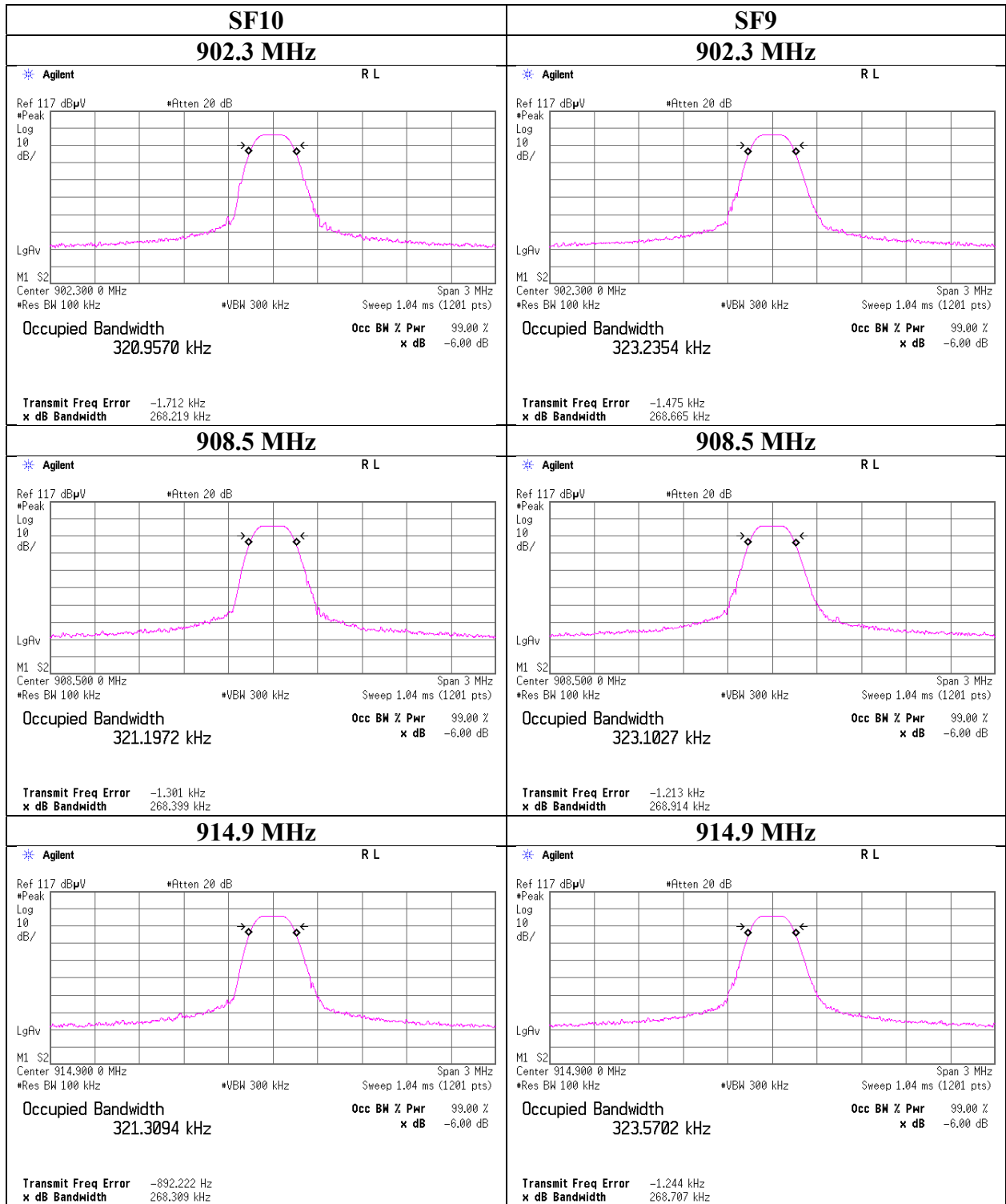
Facsimile : +81 463 50 6401

6 dB Bandwidth
(Reference data for Power Density testing)

Report No. 13153638S-A-R1
Test place Shonan EMC Lab. No.1 Measurement Room
Date February 14, 2020
Temperature / Humidity 26 deg. C / 48 % RH
Engineer Hiromasa Sato
Mode Tx

Mode	Frequency	6 dB Bandwidth
	[MHz]	[MHz]
SF10	902.3	0.268
SF10	908.5	0.268
SF10	914.9	0.268
SF9	902.3	0.269
SF9	908.5	0.269
SF9	914.9	0.269
SF8	902.3	0.268
SF8	908.5	0.268
SF8	914.9	0.268
SF7	902.3	0.266
SF7	908.5	0.266
SF7	914.9	0.266

6 dB Bandwidth



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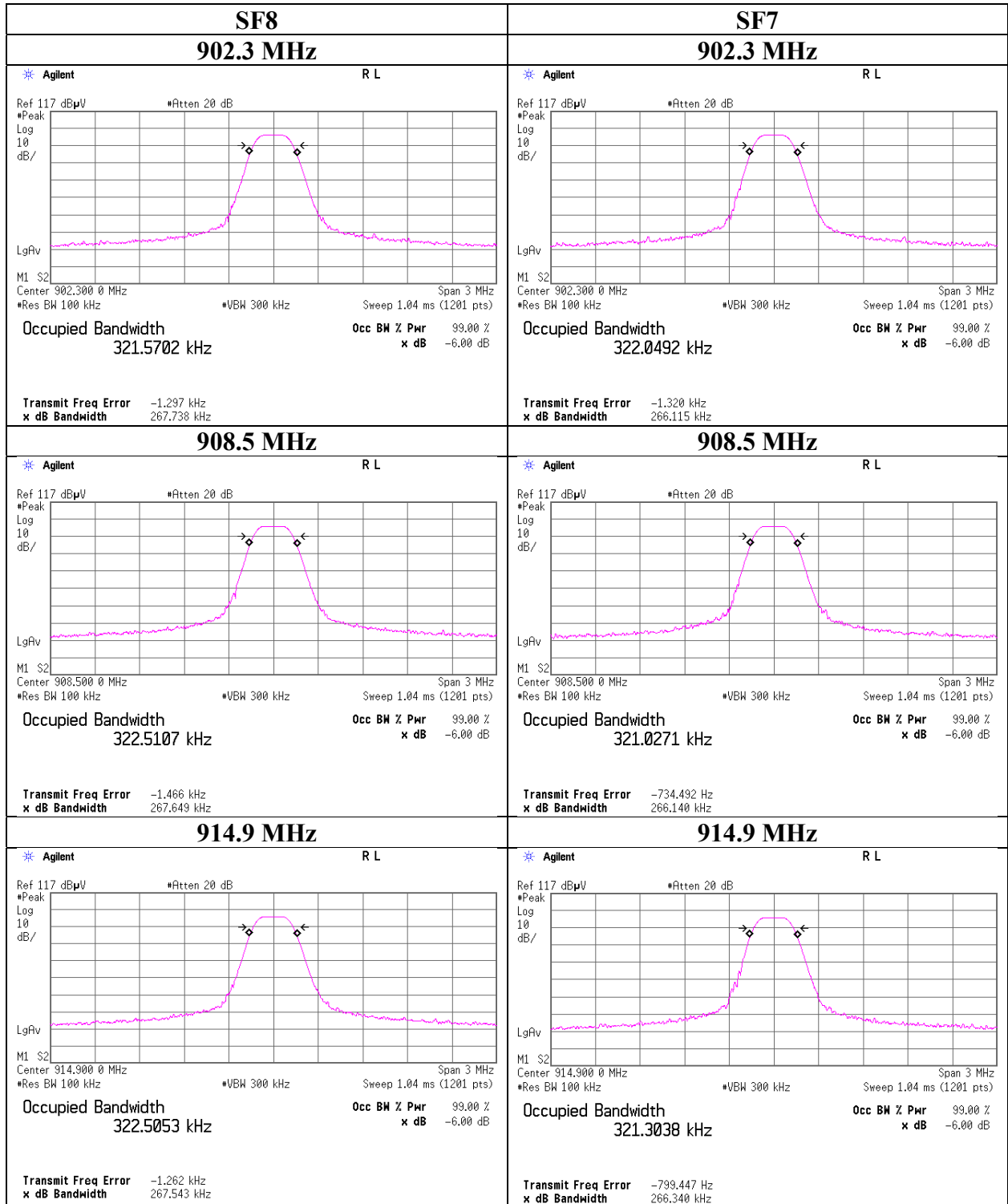
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6 dB Bandwidth



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Telephone : +81 463 50 6400

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Power Density

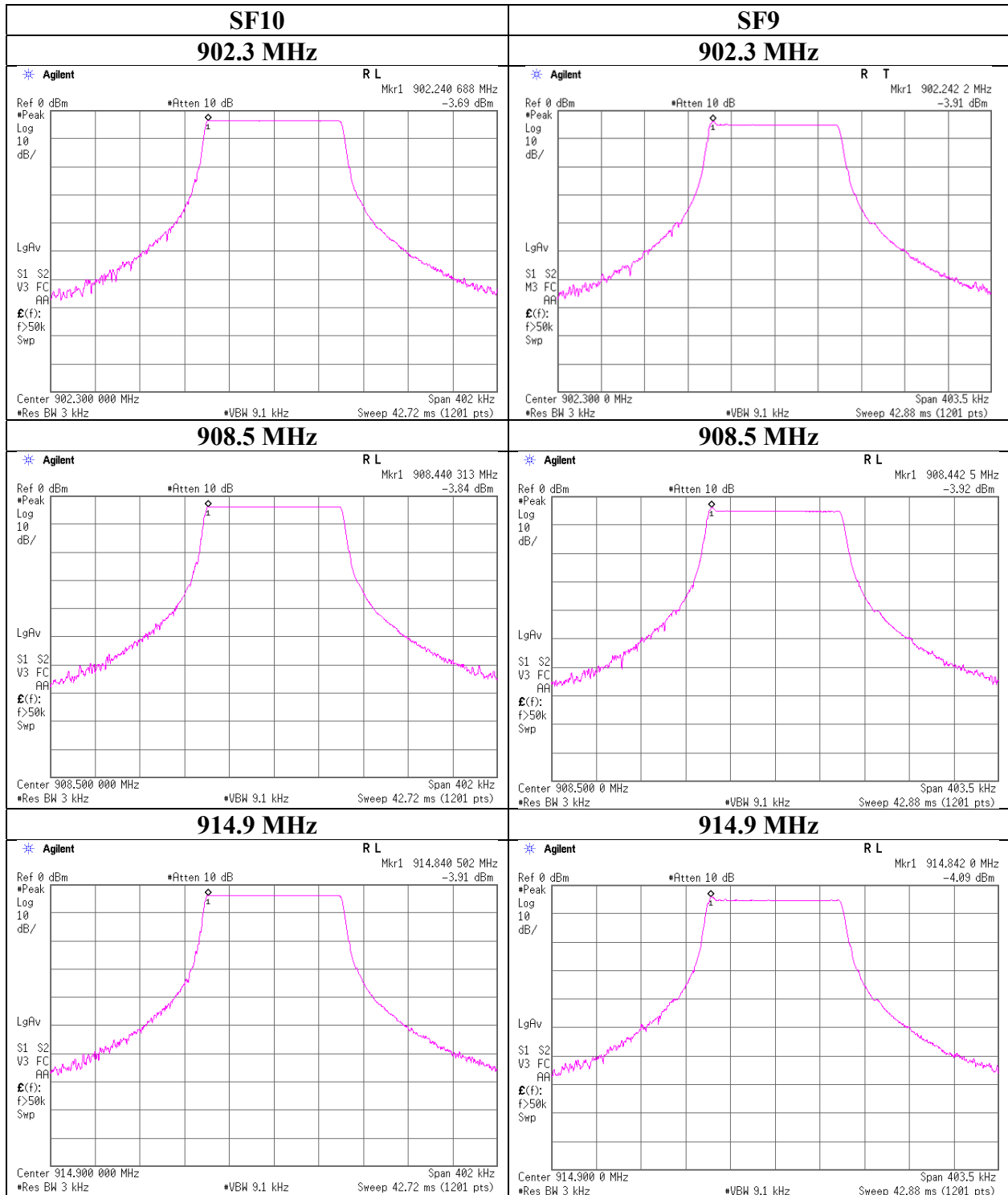
Report No. 13153638S-A-R1
Test place Shonan EMC Lab. No.1 Measurement Room
Date February 14, 2020
Temperature / Humidity 26 deg. C / 48 % RH
Engineer Hiromasa Sato
Mode Tx

Mode	Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
SF10	902.3	-3.69	0.90	9.75	6.96	8.00	1.04
SF10	908.5	-3.84	0.90	9.75	6.81	8.00	1.19
SF10	914.9	-3.91	0.91	9.75	6.75	8.00	1.25
SF9	902.3	-3.91	0.90	9.75	6.74	8.00	1.26
SF9	908.5	-3.92	0.90	9.75	6.73	8.00	1.27
SF9	914.9	-4.09	0.91	9.75	6.57	8.00	1.43
SF8	902.3	-4.58	0.90	9.75	6.07	8.00	1.93
SF8	908.5	-4.70	0.90	9.75	5.95	8.00	2.05
SF8	914.9	-4.83	0.91	9.75	5.83	8.00	2.17
SF7	902.3	-6.06	0.90	9.75	4.59	8.00	3.41
SF7	908.5	-6.19	0.90	9.75	4.46	8.00	3.54
SF7	914.9	-6.30	0.91	9.75	4.36	8.00	3.64

Sample Calculation:

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

Power Density



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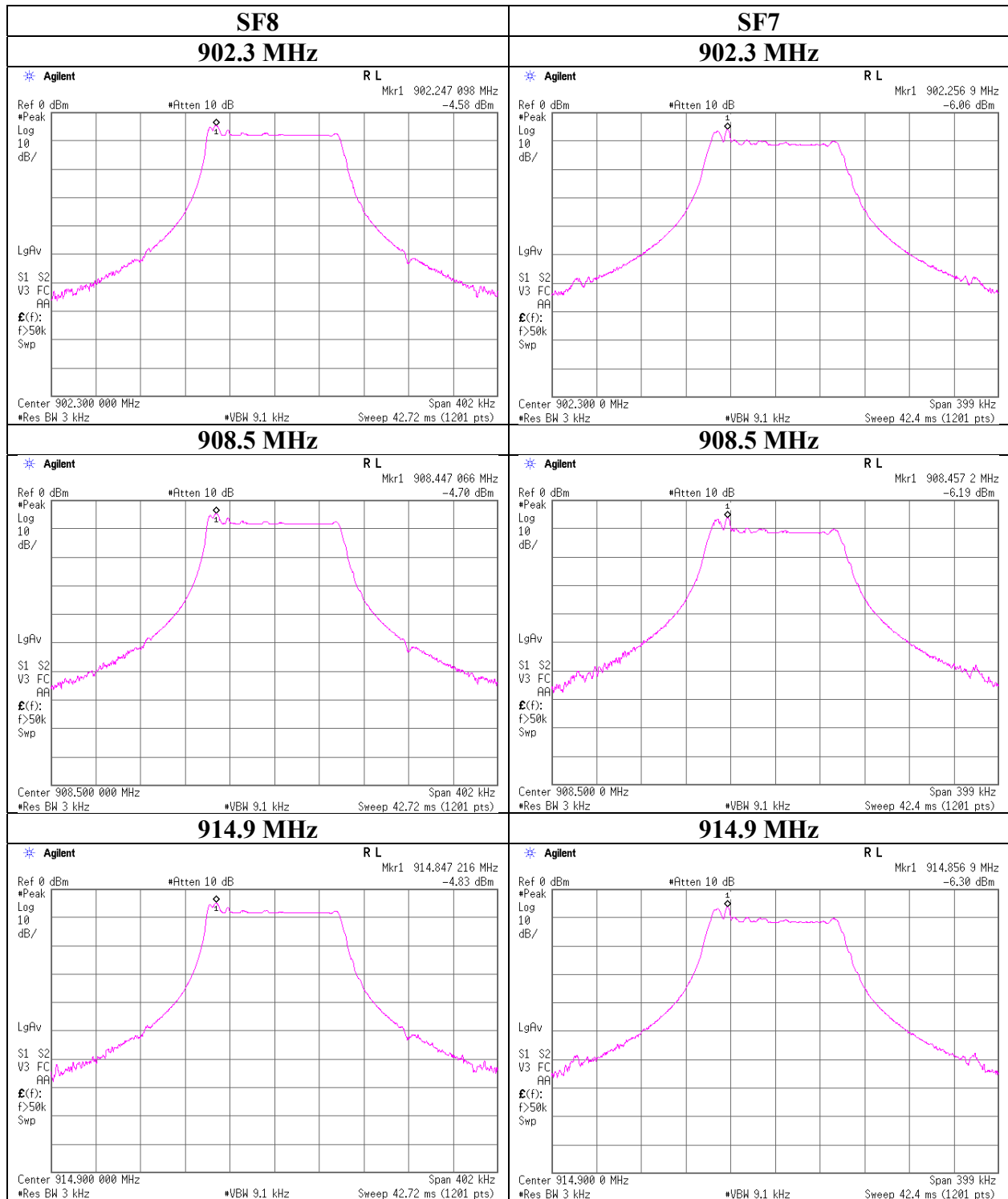
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Power Density



APPENDIX 2: Test instruments

Test equipment (1/2)

Test Name	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Calibration Interval (Month)
RE	COTS-SEMI-5	170932	EMI Software	TSJ	TEPTO-DV3(RE,CE,M E,PE)	-	-	-
RE	KAT6-04	144899	Attenuator	Inmet	18N-6dB	-	2019/12/05	12
RE	KJM-09	145929	Measure	KOMELON	KMC-36	-	-	-
RE	SAEC-01 (NSA)	145597	Semi-Anechoic Chamber	TDK	SAEC-01(NSA)	1	2019/04/02	12
RE	SAEC-02 (SVSWR)	145598	Semi-Anechoic Chamber	TDK	SAEC-02(SVSWR)	2	2019/05/09	12
RE	SAF-01	145003	Pre Amplifier	SONOMA	310N	290211	2019/02/05	12
RE	SAF-05	145128	Pre Amplifier	Toyo Corporation	TPA0118-36	1440490	2019/07/12	12
RE	SAT20-01	145142	Attenuator(above 1GHz)	Keysight Technologies Inc	8493C-020	74889	2019/11/06	12
RE	SAT3-09	144959	Attenuator	JFW	50HF-003N	-	2019/08/06	12
RE	SBA-01	145161	Biconical Antenna	Schwarzbeck	BBA9106	91032664	2019/04/01	12
RE	SCC-A1/A3/A5/A7/A8/A13/SRSE-01	144967	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner/Suhner/TOYO	8D2W/12DSFA/141PE/141PE/141PE/141PE/NS4906	-/0901-269(RF Selector)	2019/04/19	12
RE	SCC-A2/A4/A6/A7/A8/A13/SRSE-01	144968	Coaxial Cable&RF Selector	Fujikura/Fujikura/Suhner/Suhner/TOYO	8D2W/12DSFA/141PE/141PE/141PE/141PE/NS4906	-/0901-269(RF Selector)	2019/04/19	12
RE	SCC-G41	151617	Coaxial Cable	Junkosha	MWX221-01000NFSNMS/B	1612S006	2020/01/08	12
RE	SCC-G50	178573	Coaxial Cable	HUBER+SUNER	SUCOFLEX_104 E	MY13407/4E	2019/03/26	12
RE	SCC-G51	178572	Coaxial Cable	HUBER+SUNER	SUCOFLEX 104	800288 /4A	2019/03/26	12
RE	SFL-22	168802	Highpass Filter	MICRO-TRONICS	HPM50114	G035	2019/04/16	12
RE	SHA-02	145384	Horn Antenna	Schwarzbeck	BBHA9120D	9120D-726	2019/06/26	12
RE	SJM-09	145336	Measure	PROMART	SEN1935	-	-	-
RE	SLA-05	145527	Logperiodic Antenna	Schwarzbeck	VUSLP9111B	193	2019/04/01	12
RE	SOS-20	191837	Humidity Indicator	CUSTOM	CTH-201	-	2019/12/12	12
RE	SOS-21	191838	Humidity Indicator	CUSTOM	CTH-201	-	2019/12/12	12
RE	STR-01	145790	Test Receiver	Rohde & Schwarz	ESU40	100093	2019/04/14	12
RE	STS-01	145792	Digital Hitester	HIOKI	3805-50	80997812	2019/10/01	12
RE	STS-02	145793	Digital Hitester	HIOKI	3805-50	80997819	2019/04/02	12

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

Telephone : +81 463 50 6400

Facsimile : +81 463 50 6401

Test equipment (2/2)

Test Name	Local ID	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Calibration Interval (Month)
AT	SAT10-13	151610	Attenuator	Weinschel Corp.	54A-10	81626	2019/03/27	12
AT	SAT10-14	154591	Attenuator	Weinschel Corp.	54A-10	81595	2019/04/16	12
AT	SCC-G12	145040	Coaxial Cable	Suhner	SUCOFLEX 102	30790/2	2019/03/27	12
AT	SOS-27	191845	Humidity Indicator	Not Indicated or Known	CTH-201	-	2019/12/12	12
AT	SPM-13	169910	Power Meter	EMC Instruments Corporation	8990B	MY51000448	2020/01/28	12
AT	SPSS-06	169911	Power sensor	EMC Instruments Corporation	N1923A	MY57270004	2020/01/28	12
AT,RE	SSA-02	145800	Spectrum Analyzer	Keysight Technologies Inc	E4448A	MY48250106	2019/04/04	12

***Hyphens for Last Calibration Date and Cal Int (month) are instruments that Calibration is not required (e.g. software), or instruments checked in advance before use.**

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

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

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

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