RADIO TEST REPORT

Test Report No. : 12747098H-A-R1

Applicant	:	**DENSO CORPORATION**
Type of Equipment	:	**Electronic Key**
Model No.	:	**4ES**
FCC ID	:	**HYQ4ES**
Test regulation	:	**FCC Part 15 Subpart C: 2018**
Test Result	:	**Complied (Refer to SECTION 3.2)**

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2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with above regulation.
4. The test results in this report are traceable to the national or international standards.
5. This test report covers Radio technical requirements. It does not cover administrative issues such as Manual or non-Radio test related Requirements. (if applicable)
6. The all test items in this test report are conducted by UL Japan, Inc. Ise EMC Lab.
7. This test report must not be used by the customer to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.
8. The information provided from the customer for this report is identified in SECTION 1.
9. This report is a revised version of 12747098H-A. 12747098H-A is replaced with this report.

Date of test: March 6 to April 16, 2019

Representative test engineer:
Takumi Shimada
Engineer
Consumer Technology Division

Approved by:
Motoya Imura
Leader
Consumer Technology Division

NVLAP LAB CODE: 200572-0

This laboratory is accredited by the NVLAP LAB CODE 200572-0, U.S.A. The tests reported herein have been performed in accordance with its terms of accreditation.
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http://japan.ul.com/resources/emc_accredited/

☐ 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.: 12747098H-A

Revision	Test report No.	Date	Page revised	Contents
- (Original)	12747098H-A	April 24, 2019	-	-
1	12747098H-A-R1	May 28, 2019	P.16	Correction of test data (PK with Duty factor)

CONTENTS **PAGE**

SECTION 1: Customer information

Company Name	:	DENSO CORPORATION
Address	:	1-1, Showa-cho, Kariya-shi, Aichi-ken, 448-8661, Japan
Telephone Number	:	+81-566-20-3955
Facsimile Number	:	+81-566-25-4837
Contact Person	:	TAKAYUKI HATTORI

The information provided from the customer is as follows;
- Applicant, Type of Equipment, Model No., FCC ID on the cover and other relevant pages
- SECTION 1: Customer information
- SECTION 2: Equipment under test (E.U.T.)
- SECTION 4: Operation of E.U.T. 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 (E.U.T.)

2.1 Identification of E.U.T.

Type of Equipment	:	Electronic Key
Model No.	:	4ES
Serial No.	:	Refer to Section 4, Clause 4.2
Rating	:	DC 3.0 V
Receipt Date of Sample (Information from test lab.)	:	February 27, 2019
Country of Mass-production	:	United States of America, China
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: 4ES (referred to as the EUT in this report) is a Electronic Key.
The EUT (4ES) transmits radio wave signals of ASK and FSK.
The radio wave signals of ASK and FSK are not transmitted simultaneously.
Either one of ASK and FSK is transmitted by operator's action.
End users cannot control which of ASK and FSK to be transmitted.

EUT has variations of Type A and Type B.
The difference of these variations is only the outer case.
After test results of the two types were compared, the test was performed only with Type A as its result was the worst one.

Radio Specification

Radio Type	:	Transceiver
Frequency of Operation	:	433.92 MHz
Modulation	:	ASK (A1D) / FSK (F1D)
Type of Battery	:	One lithium battery
Antenna type	:	Built-in type (Fixed)
Clock frequency (Maximum)	:	27.6 MHz Crystal
Radio Type	:	Receiver
Frequency of Operation	:	125 kHz *1)

*1) The test of receiver part was performed separately from this test report, and the conformability is confirmed.

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 15.231 Periodic operation in the band 40.66-40.70 MHz and above 70 MHz.

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	N/A *1)	-
	IC: RSS-Gen 8.8	**IC:** RSS-Gen 8.8			
Automatically Deactivate	**FCC:** ANSI C63.10:2013 6 Standard test methods	**FCC:** Section 15.231(a)(1)	N/A	Complied a)	Radiated
	IC: -	**IC:** RSS-210 A1.1			
Electric Field Strength of Fundamental Emission	**FCC:** ANSI C63.10:2013 6 Standard test methods	**FCC:** Section 15.231(b)	8.1 dB 433.920 MHz PK with Duty Factor Vertical <FSK>	Complied b)	Radiated
	IC: RSS-Gen 6.12	**IC:** RSS-210 A1.2			
Electric Field Strength of Spurious Emission	**FCC:** ANSI C63.10:2013 6 Standard test methods	**FCC:** Section 15.205 Section 15.209 Section 15.231(b)	6.8 dB 3471.360 MHz PK with Duty Factor Vertical <FSK>	Complied b)	Radiated
	IC: RSS-Gen 6.13	**IC:** RSS-210 A1.2, 4.4 RSS-Gen 8.9			
-20dB Bandwidth	**FCC:** ANSI C63.10:2013 6 Standard test methods	**FCC:** Section 15.231(c)	N/A	Complied c)	Radiated
	IC: -	**IC:** Reference data			

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 does not have AC Mains.

a) Refer to APPENDIX 1 (data of Automatically deactivate)
b) Refer to APPENDIX 1 (data of Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission))
c) Refer to APPENDIX 1 (data of -20dB and 99% Occupied Bandwidth)

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.

FCC Part 15.31 (e)
This test was performed with the New Battery (DC 3.0 V) and the constant voltage was supplied to the EUT during the tests. Therefore, the 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.

3.3 Addition to standard

Item	Test Procedure	Specification	Worst margin	Results	Remarks
99 % Occupied Bandwidth	**IC:** RSS-Gen 6.7	**IC:** RSS-210 A1.3	N/A	-	Radiated
Note: UL Japan, Inc.'s EMI Work Procedures No. 13-EM-W0420 and 13-EM-W0422.					

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 following 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 $k = 2$.

Test distance	Radiated emission (+/-)
	9 kHz to 30 MHz
3 m	3.3 dB
10 m	3.2 dB

*Measurement distance

Polarity	Radiated emission (Below 1 GHz)			
	(3 m*)(+/-)		(10 m*)(+/-)	
	30 MHz to 200 MHz	200 MHz to 1000 MHz	30 MHz to 200 MHz	200 MHz to 1000 MHz
Horizontal	4.8 dB	5.2 dB	4.8 dB	5.0 dB
Vertical	5.0 dB	6.3 dB	4.9 dB	5.0 dB

Radiated emission (Above 1 GHz)				
(3 m*)(+/-)		(1 m*)(+/-)		(10 m*)(+/-)
1 GHz to 6 GHz	6 GHz to 18 GHz	10 GHz to 26.5 GHz	26.5 GHz to 40 GHz	1 GHz to 18 GHz
5.0 dB	5.3 dB	5.8 dB	5.8 dB	5.2 dB

* Measurement distance

Automatically Deactivate
0.10 %

Bandwidth
0.96 %

3.5 Test Location

UL Japan, Inc. Ise EMC Lab.
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone: +81 596 24 8999, Facsimile: +81 596 24 8124
NVLAP Lab. code: 200572-0 / FCC Test Firm Registration Number: 199967

Test site	IC Registration Number	Width x Depth x Height (m)	Size of reference ground plane (m) / horizontal conducting plane	Other rooms	Maximum measurement distance
No.1 semi-anechoic chamber	2973C-1	19.2 x 11.2 x 7.7	7.0 x 6.0	No.1 Power source room	10 m
No.2 semi-anechoic chamber	2973C-2	7.5 x 5.8 x 5.2	4.0 x 4.0	-	3 m
No.3 semi-anechoic chamber	2973C-3	12.0 x 8.5 x 5.9	6.8 x 5.75	No.3 Preparation room	3 m
No.3 shielded room	-	4.0 x 6.0 x 2.7	N/A	-	-
No.4 semi-anechoic chamber	2973C-4	12.0 x 8.5 x 5.9	6.8 x 5.75	No.4 Preparation room	3 m
No.4 shielded room	-	4.0 x 6.0 x 2.7	N/A	-	-
No.5 semi-anechoic chamber	-	6.0 x 6.0 x 3.9	6.0 x 6.0	-	-
No.6 shielded room	-	4.0 x 4.5 x 2.7	4.0 x 4.5	-	-
No.6 measurement room	-	4.75 x 5.4 x 3.0	4.75 x 4.15	-	-
No.7 shielded room	-	4.7 x 7.5 x 2.7	4.7 x 7.5	-	-
No.8 measurement room	-	3.1 x 5.0 x 2.7	3.1 x 5.0	-	-
No.9 measurement room	-	8.8 x 4.6 x 2.8	2.4 x 2.4	-	-
No.11 measurement room	-	6.2 x 4.7 x 3.0	4.8 x 4.6	-	-

* Size of vertical conducting plane (for Conducted Emission test) : 2.0 m x 2.0 m for No.1, No.2, No.3, and No.4 semi-anechoic chambers and No.3 and No.4 shielded rooms.

3.6 Test data, Test instruments, and Test set up

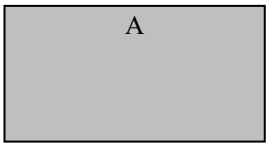
Refer to APPENDIX.

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

4.1 Operating Mode(s)

Test Item*	Mode
Automatically Deactivate Duty Cycle	Normal use mode ASK/FSK (433.92 MHz)
Electric Field Strength of Fundamental Emission Electric Field Strength of Spurious Emission -20 dB & 99 % Occupied Bandwidth	Transmitting mode ASK/FSK (433.92 MHz) *1)
* The system was configured in typical fashion (as a user would normally use it) for testing. *1) The software of this mode is the same as one of normal product, except that EUT continues to transmit when transmitter button is being pressed (For Normal use mode, EUT stops to transmit in a given time, even if transceiver button is being pressed.) End users cannot change the settings of the output power of the product.	

4.2 Configuration and peripherals



* Setup was taken into consideration and test data was taken under worse case conditions.

Description of EUT

No.	Item	Model number	Serial number	Manufacturer	Remarks
A	Electronic Key	4ES	No.2 *1) No.1 *2)	DENSO CORPORATION	EUT

*1) Used for Normal use mode
*2) Used for Transmitting mode

SECTION 5: Radiated emission (Electric Field Strength of Fundamental and Spurious Emission)

Test Procedure and conditions

[For below 30 MHz]
The noise level was checked by moving a search-coil (Loop Antenna) close to the EUT.

[For 30 MHz to 1 GHz]
EUT was placed on a urethane platform of nominal size, 1.0 m by 1.5 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 measuring antenna height was 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.
The radiated emission measurements were made with the following detector function of the test receiver / spectrum analyzer.

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.

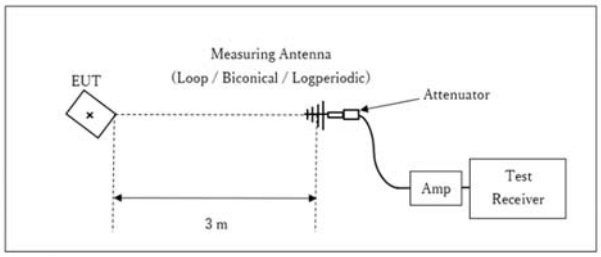
Test Antennas are used as below;

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

	From 9 kHz to 90 kHz and From 110 kHz to 150 kHz	From 90 kHz to 110 kHz	From 150 kHz to 490 kHz	From 490 kHz to 30 MHz	From 30 MHz to 1 GHz	Above 1 GHz
Detector Type	Peak	Peak	Peak	Peak	Peak and Peak with Duty factor	Peak and Peak with Duty factor
IF Bandwidth	200 Hz	200 Hz	9.0 kHz	9.0 kHz	120 kHz	PK: S/A: RBW 1 MHz, VBW: 3 MHz

[Test Setup]

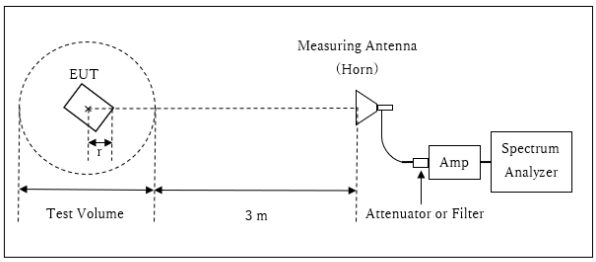
Below 1 GHz



× : Center of turn table

Test Distance: 3 m

1 GHz - 10 GHz



r : Radius of an outer periphery of EUT
× : Center of turn table

Distance Factor: 20 x log (4.0 m / 3.0 m) = 2.50 dB
* Test Distance: (3 + Test Volume /2) - r = 4.0 m

Test Volume : 2.0 m
(Test Volume has been calibrated based on CISPR 16-1-4.)
r = 0.0 m

* The test was performed with r = 0.0 m since EUT is small and it was the rather conservative condition.

- The carrier level (or, noise levels) was (or were) measured at each position of all three axes X, Y and Z, and the position that has the maximum noise was determined.
Noise levels of all the frequencies were measured at the position.

This EUT has two modes which mechanical key is inserted or not. The worst case was confirmed with and without mechanical key, as a result, the test with mechanical key was the worst case. Therefore the test with mechanical key was performed only.

*The result is rounded off to the second decimal place, so some differences might be observed.

Measurement range : 9 kHz – 4.4 GHz
Test data : APPENDIX
Test result : Pass

SECTION 6: Automatically deactivate

Test Procedure

The measurement was performed with Electric field strength using a spectrum analyzer.

Test data : APPENDIX
Test result : Pass

SECTION 7: -20 dB and 99 % Occupied Bandwidth

Test Procedure

The test was measured with a spectrum analyzer using a test fixture.

Test	Span	RBW	VBW	Sweep	Detector	Trace	Instrument used
20 dB Bandwidth	300 kHz	3 kHz	9.1 kHz	Auto	Peak	Max Hold	Spectrum Analyzer
99 % Occupied Bandwidth	Between 1.5 times and 5.0 times of the OBW	1 to 5 % of OBW	Three times of RBW	Auto	Peak	Max Hold	Spectrum Analyzer
Peak hold was applied as Worst-case measurement.							

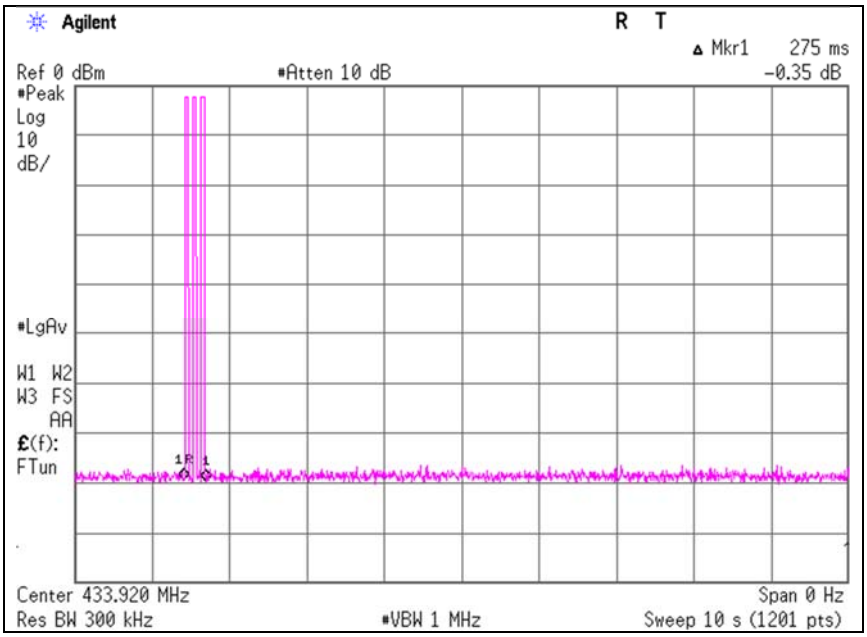
Test data : APPENDIX
Test result : Pass

APPENDIX 1: Test data

Automatically deactivate

Report No.	12747098H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	March 6, 2019
Temperature / Humidity	22 deg. C / 40% RH
Engineer	Akihiko Maeda
Mode	Normal Use Mode ASK

Time of Transmitting [sec]	Limit [sec]	Result
0.275	5.00	Pass

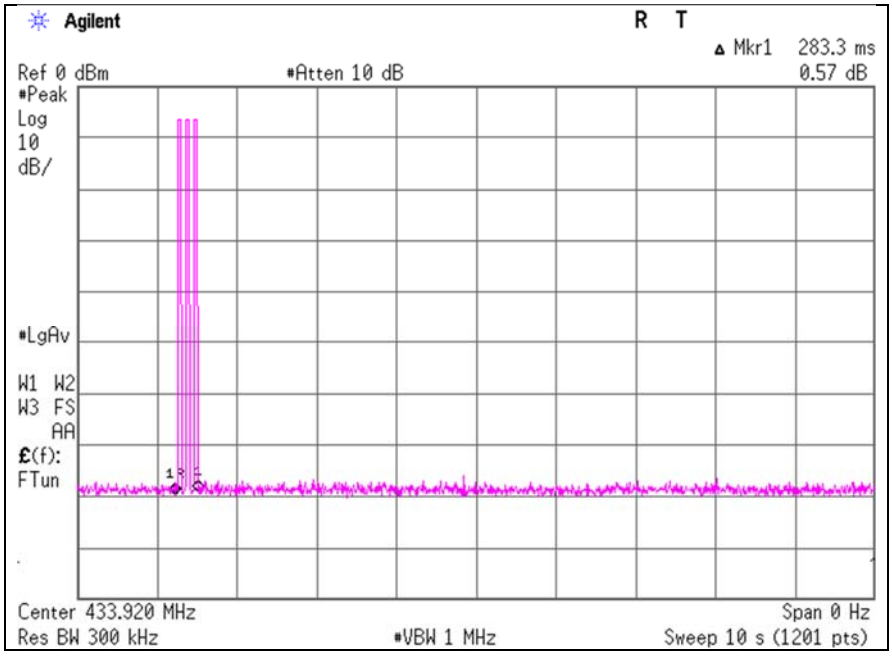


* The EUT transmits UHF when LF signal is received from a car or a button on the EUT is pressed. In both cases, the UHF transmission is stopped within 5 seconds. So the test was performed by a button-pressed operation as the worst case. Please refer to the "Theory of Operation" for details.

Automatically deactivate

Report No.	12747098H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	March 6, 2019
Temperature / Humidity	22 deg. C / 40% RH
Engineer	Akihiko Maeda
Mode	Normal Use Mode FSK

Time of Transmitting [sec]	Limit [sec]	Result
0.2833	5.00	Pass



* The EUT transmits UHF when LF signal is received from a car or a button on the EUT is pressed. In both cases, the UHF transmission is stopped within 5 seconds. So the test was performed by a button-pressed operation as the worst case. Please refer to the “Theory of Operation” for details.

Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission)

Report No.	12747098H	
Semi Anechoic Chamber	No.4	
Date	April 15, 2019	April 16, 2019
Temperature / Humidity	22 deg. C / 30 % RH	21 deg. C / 27 % RH
Engineer	Takumi Shimada	Takumi Shimada
	(Below 1 GHz)	(Above 1 GHz)
Mode	Transmitting Mode ASK (433.92 MHz)	

QP or PK

Frequency	Detector	Reading [dBuV]		Ant Factor	Loss	Gain	Duty Factor	Result [dBuV/m]		Limit	Margin [dB]		Remark Inside or Outside
[MHz]		Hor	Ver	[dB/m]	[dB]	[dB]	[dB]	Hor	Ver	[dBuV/m	Hor	Ver	of Restricted Bands
433.920	PK	88.1	88.3	16.2	10.8	32.0	-	83.1	83.3	100.8	17.7	17.5	Carrier
867.840	PK	45.5	44.8	21.6	13.1	31.3	-	48.9	48.2	80.8	31.9	32.6	Outside
1301.760	PK	44.7	44.5	25.4	4.4	33.3	-	41.2	41.0	73.9	32.7	32.9	Inside
1735.680	PK	43.4	43.8	25.3	4.7	32.2	-	41.2	41.6	80.8	39.6	39.2	Outside
2169.600	PK	42.7	44.2	27.5	5.0	31.5	-	43.8	45.2	80.8	37.0	35.6	Outside
2603.520	PK	46.4	50.2	28.2	5.3	31.3	-	48.6	52.4	80.8	32.2	28.4	Outside
3037.440	PK	50.6	50.6	28.5	5.5	31.1	-	53.4	53.5	80.8	27.4	27.4	Outside
3471.360	PK	58.4	59.1	29.0	5.7	30.9	-	62.2	62.9	80.8	18.6	17.9	Outside
3905.280	PK	47.5	48.3	29.7	5.9	30.8	-	52.3	53.2	73.9	21.6	20.7	Inside
4339.200	PK	52.8	53.1	30.4	6.1	30.7	-	58.6	58.9	73.9	15.3	15.0	Inside

PK with Duty factor

Frequency	Detector	Reading [dBuV]		Ant Factor	Loss	Gain	Duty Factor	Result [dBuV/m]		Limit	Margin [dB]		Remark
[MHz]		Hor	Ver	[dB/m]	[dB]	[dB]	[dB]	Hor	Ver	[dBuV/m	Hor	Ver	
433.920	PK	88.1	88.3	16.2	10.8	32.0	-14.0	69.1	69.3	80.8	11.7	11.5	Carrier
867.840	PK	45.5	44.8	21.6	13.1	31.3	-14.0	34.9	34.2	60.8	25.9	26.6	Outside
1301.760	PK	44.7	44.5	25.4	4.4	33.3	-14.0	27.2	27.0	53.9	26.7	26.9	Inside
1735.680	PK	43.4	43.8	25.3	4.7	32.2	-14.0	27.2	27.6	60.8	33.6	33.2	Outside
2169.600	PK	42.7	44.2	27.5	5.0	31.5	-14.0	29.8	31.2	60.8	31.0	29.6	Outside
2603.520	PK	46.4	50.2	28.2	5.3	31.3	-14.0	34.6	38.4	60.8	26.2	22.4	Outside
3037.440	PK	50.6	50.6	28.5	5.5	31.1	-14.0	39.4	39.5	60.8	21.4	21.4	Outside
3471.360	PK	58.4	59.1	29.0	5.7	30.9	-14.0	48.2	48.9	60.8	12.6	11.9	Outside
3905.280	PK	47.5	48.3	29.7	5.9	30.8	-14.0	38.3	39.2	53.9	15.6	14.7	Inside
4339.200	PK	52.8	53.1	30.4	6.1	30.7	-14.0	44.6	44.9	53.9	9.3	9.0	Inside

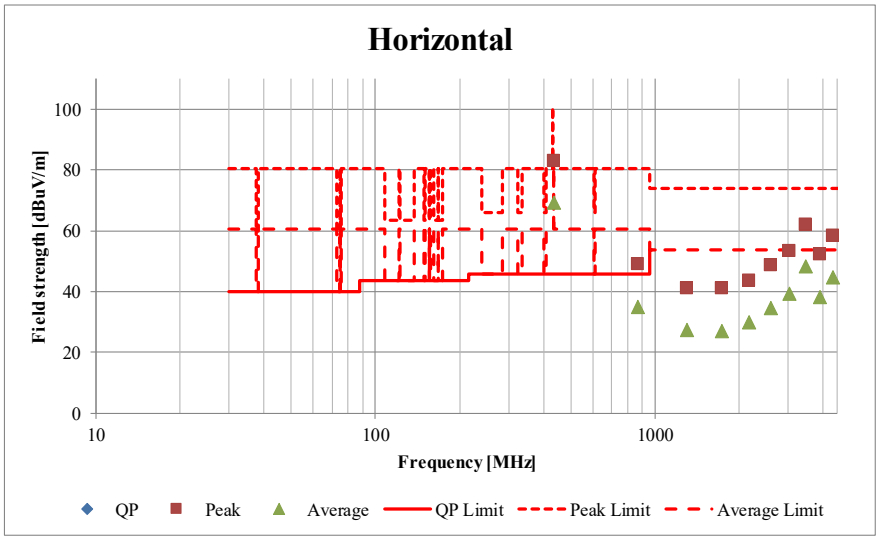
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20dB).

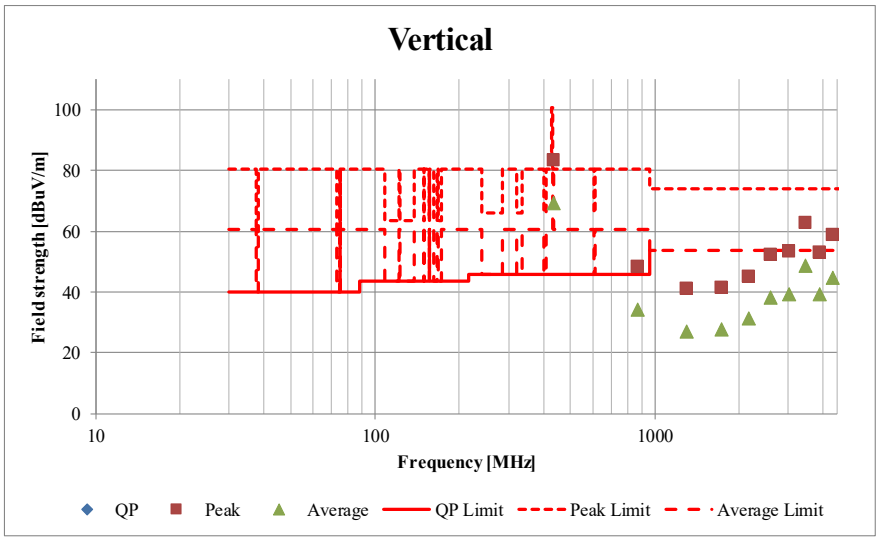
Sample calculation:
Result of PK = Reading + Ant Factor + Loss {Cable + Attenuator + Filter (above 1GHz) +Distance factor (above 1 GHz)} - Gain (Amplifier)
Result of PK with Duty factor = Reading + Ant Factor + Loss {Cable + Attenuator + Filter (above 1 GHz) +Distance factor (above 1 GHz)} - Gain (Amplifier) + Duty factor

For above 1GHz : Distance Factor: 20 x log (4.0 m/3.0 m) = 2.50 dB
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20dB).

Radiated Spurious Emission
(Plot data, Worst case)

Report No.	12747098H	
Semi Anechoic Chamber	No.4	
Date	April 15, 2019	April 16, 2019
Temperature / Humidity	22 deg. C / 30 % RH	21 deg. C / 27 % RH
Engineer	Takumi Shimada	Takumi Shimada
	(Below 1 GHz)	(Above 1 GHz)
Mode	Transmitting Mode ASK (433.92 MHz)	





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

Radiated Emission (Electric Field Strength of Fundamental and Spurious Emission)

Report No.	12747098H	
Semi Anechoic Chamber	No.4	
Date	April 15, 2019	April 16, 2019
Temperature / Humidity	22 deg. C / 30 % RH	21 deg. C / 27 % RH
Engineer	Takumi Shimada	Takumi Shimada
	(Below 1 GHz)	(Above 1 GHz)
Mode	Transmitting Mode FSK (433.92 MHz)	

QP or PK

Frequency	Detector	Reading [dBuV]		Ant Factor	Loss	Gain	Duty Factor	Result [dBuV/m]		Limit	Margin [dB]		Remark Inside or Outside
[MHz]		Hor	Ver	[dB/m]	[dB]	[dB]	[dB]	Hor	Ver	[dBuV/m	Hor	Ver	of Restricted Bands
433.920	PK	85.9	86.9	16.2	10.8	32.0	-	80.9	81.9	100.8	19.9	18.9	Carrier
867.840	PK	42.9	42.7	21.6	13.1	31.3	-	46.3	46.1	80.8	34.5	34.7	Outside
1301.760	PK	43.1	44.5	25.4	4.4	33.3	-	39.6	41.0	73.9	34.3	32.9	Inside
1735.680	PK	43.4	43.4	25.3	4.7	32.2	-	41.2	41.2	80.8	39.6	39.6	Outside
2169.600	PK	44.0	45.4	27.5	5.0	31.5	-	45.1	46.5	80.8	35.7	34.3	Outside
2603.520	PK	48.2	50.3	28.2	5.3	31.3	-	50.4	52.5	80.8	30.4	28.3	Outside
3037.440	PK	52.0	51.4	28.5	5.5	31.1	-	54.9	54.3	80.8	26.0	26.5	Outside
3471.360	PK	58.1	59.4	29.0	5.7	30.9	-	61.9	63.2	80.8	18.9	17.6	Outside
3905.280	PK	47.8	48.9	29.7	5.9	30.8	-	52.6	53.7	73.9	21.3	20.2	Inside
4339.200	PK	48.5	48.7	30.4	6.1	30.7	-	54.4	54.5	73.9	19.6	19.4	Inside

PK with Duty factor

Frequency	Detector	Reading [dBuV]		Ant Factor	Loss	Gain	Duty Factor	Result [dBuV/m]		Limit	Margin [dB]		Remark
[MHz]		Hor	Ver	[dB/m]	[dB]	[dB]	[dB]	Hor	Ver	[dBuV/m	Hor	Ver	
433.920	PK	85.9	86.9	16.2	10.8	32.0	-9.2	71.7	72.7	80.8	9.1	8.1	Carrier
867.840	PK	42.9	42.7	21.6	13.1	31.3	-9.2	37.1	36.9	60.8	23.7	23.9	Outside
1301.760	PK	43.1	44.5	25.4	4.4	33.3	-9.2	30.4	31.8	53.9	23.5	22.1	Inside
1735.680	PK	43.4	43.4	25.3	4.7	32.2	-9.2	32.0	32.0	60.8	28.8	28.8	Outside
2169.600	PK	44.0	45.4	27.5	5.0	31.5	-9.2	35.9	37.3	60.8	24.9	23.5	Outside
2603.520	PK	48.2	50.3	28.2	5.3	31.3	-9.2	41.2	43.3	60.8	19.6	17.5	Outside
3037.440	PK	52.0	51.4	28.5	5.5	31.1	-9.2	45.6	45.1	60.8	15.2	15.7	Outside
3471.360	PK	58.1	59.4	29.0	5.7	30.9	-9.2	52.7	54.0	60.8	8.1	6.8	Outside
3905.280	PK	47.8	48.9	29.7	5.9	30.8	-9.2	43.4	44.5	53.9	10.5	9.4	Inside
4339.200	PK	48.5	48.7	30.4	6.1	30.7	-9.2	45.1	45.3	53.9	8.8	8.6	Inside

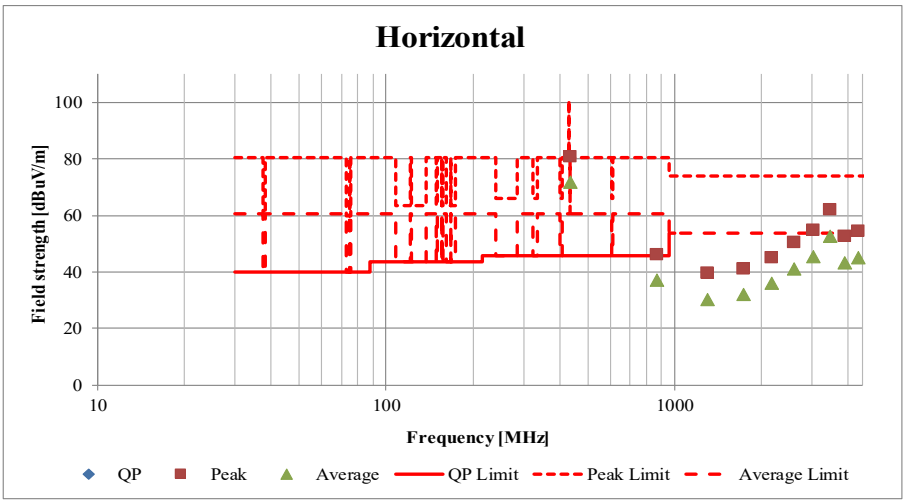
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20dB).

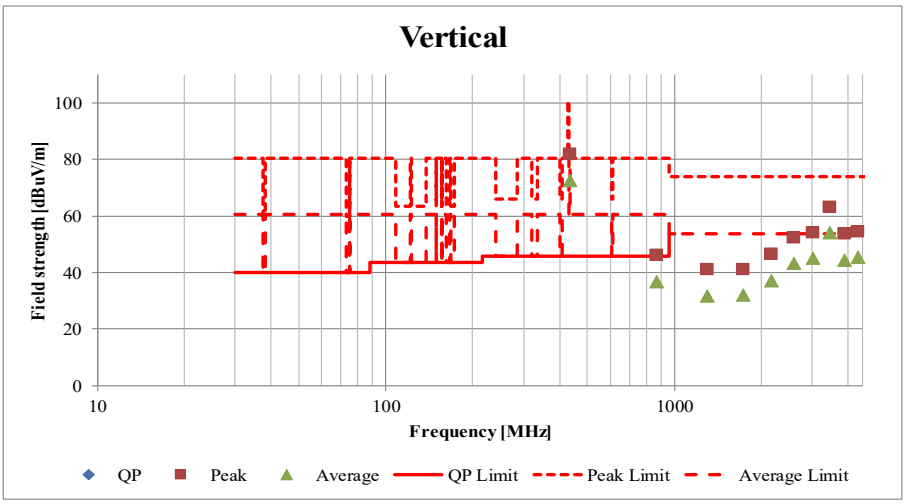
Sample calculation:
Result of PK = Reading + Ant Factor + Loss {Cable + Attenuator + Filter (above 1GHz) +Distance factor (above 1 GHz)} - Gain (Amplifier)
Result of PK with Duty factor = Reading + Ant Factor + Loss {Cable + Attenuator + Filter (above 1 GHz) +Distance factor (above 1 GHz)} - Gain (Amplifier) + Duty factor

For above 1GHz : Distance Factor: 20 x log (4.0 m/3.0 m) = 2.50 dB
*Other frequency noises omitted in this report were not seen or had enough margin (more than 20dB).

Radiated Spurious Emission
(Plot data, Worst case)

Report No.	12747098H	
Semi Anechoic Chamber	No.4	
Date	April 15, 2019	April 16, 2019
Temperature / Humidity	22 deg. C / 30 % RH	21 deg. C / 27 % RH
Engineer	Takumi Shimada	Takumi Shimada
	(Below 1 GHz)	(Above 1 GHz)
Mode	Transmitting Mode FSK (433.92 MHz)	





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

-20dB and 99% Occupied Bandwidth

Report No.	12747098H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	March 6, 2019
Temperature / Humidity	22 deg. C / 40% RH
Engineer	Akihiko Maeda
Mode	Transmitting Mode ASK/FSK (433.92MHz)

ASK

Bandwidth Limit : Fundamental Frequency **433.92** MHz x 0.25% = 1084.80 kHz

* The above limit was calculated from more stringent nominal frequency.

-20dB Bandwidth [kHz]	Bandwidth Limit [kHz]	Result
28.434	1084.80	Pass

99% Occupied Bandwidth [kHz]	Bandwidth Limit [kHz]	Result
85.4298	1084.80	Pass

FSK

Bandwidth Limit : Fundamental Frequency **433.92** MHz x 0.25% = 1084.80 kHz

* The above limit was calculated from more stringent nominal frequency.

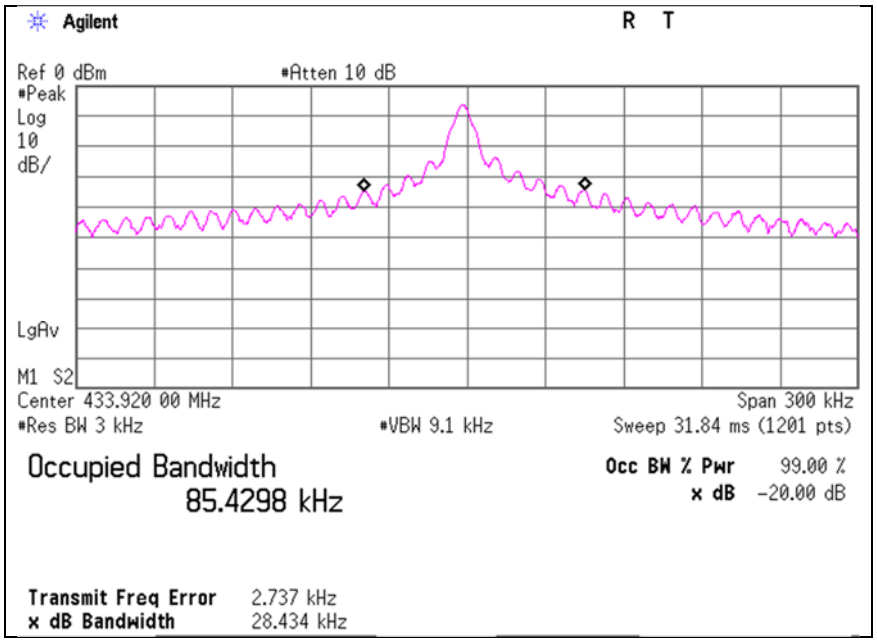
-20dB Bandwidth [kHz]	Bandwidth Limit [kHz]	Result
86.327	1084.80	Pass

99% Occupied Bandwidth [kHz]	Bandwidth Limit [kHz]	Result
87.1600	1084.80	Pass

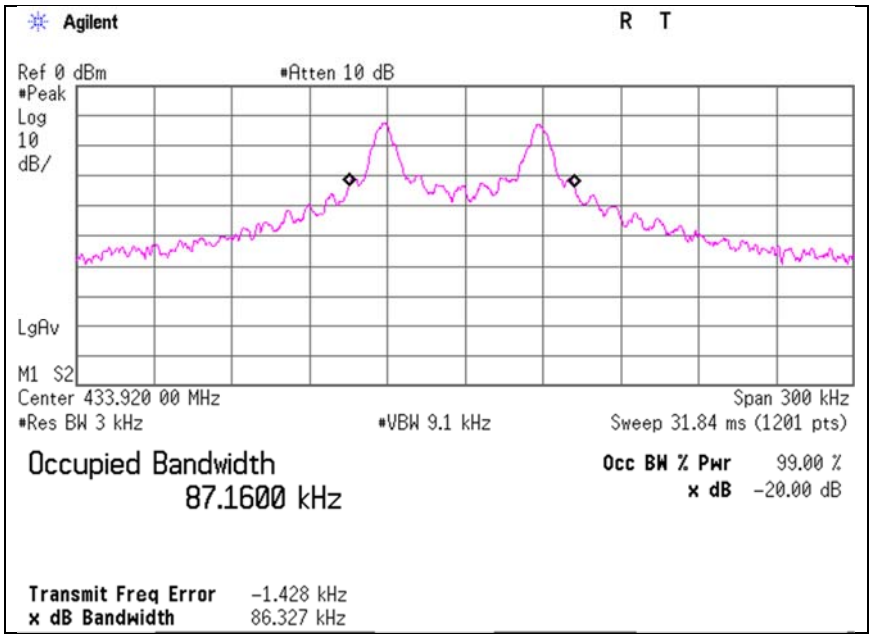
-20dB and 99% Occupied Bandwidth

Report No.	12747098H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	March 6, 2019
Temperature / Humidity	22 deg. C / 40% RH
Engineer	Akihiko Maeda
Mode	Transmitting Mode ASK/FSK (433.92MHz)

ASK



FSK



Duty Cycle

Report No.	12747098H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	March 6, 2019
Temperature / Humidity	22 deg. C / 40% RH
Engineer	Akihiko Maeda
Mode	Transmitting Mode ASK (433.92MHz)

Type	Times	ON time(One pulse) [ms]	ON time(in 100ms) [ms]
A	58	0.143	8.2824
B	43	0.269	11.5584

*1)ON time(in 100ms) = Times * ON time(One pulse)
*2)The train of pulses was exceeding 100msec, and that sampled 100msec was the worst case against the pulse train.

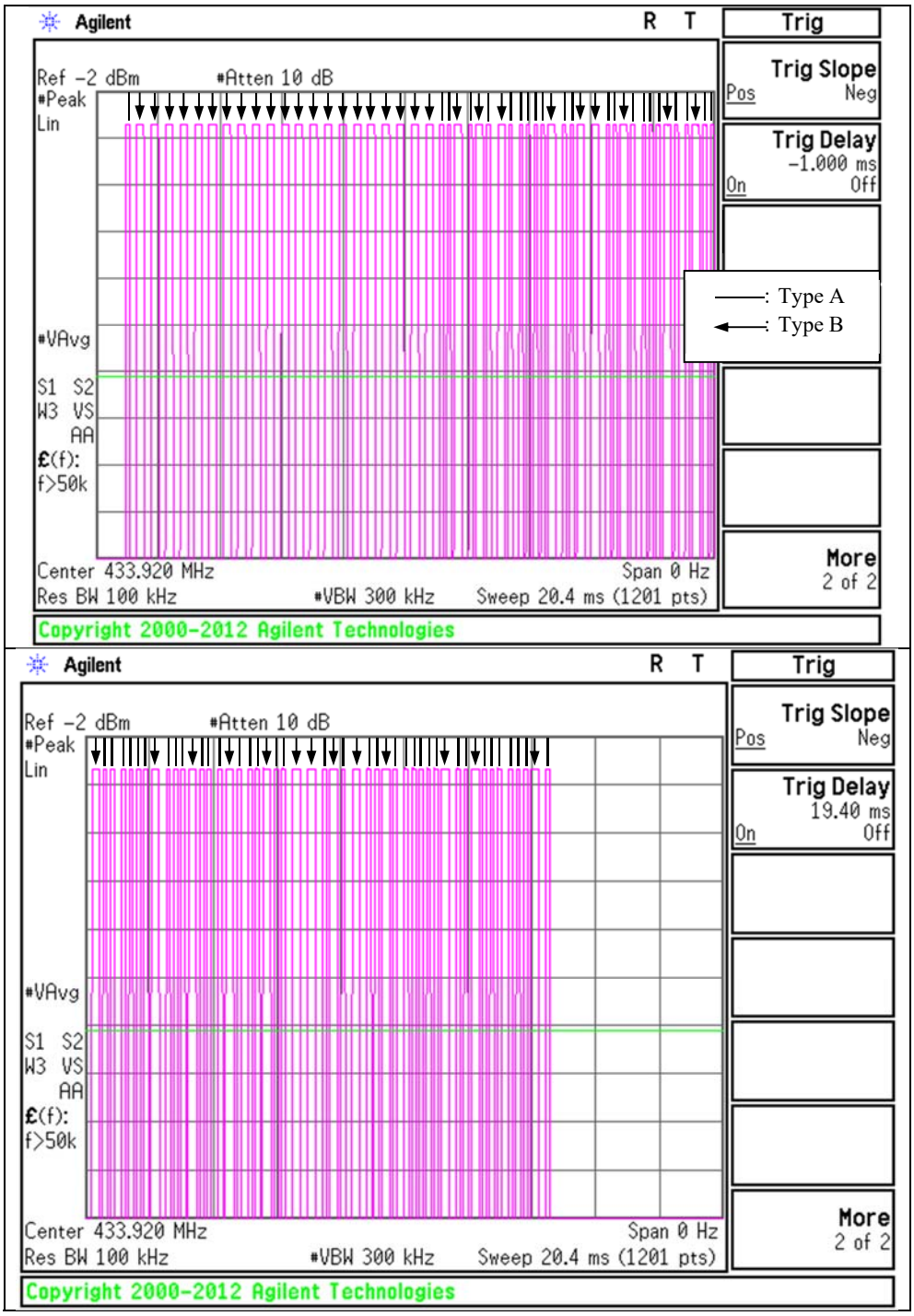
(Total)

ON time [ms]	Cycle [ms]	Duty (On time/Cycle)	Duty [dB]
19.84	100.00	0.20	-14.0

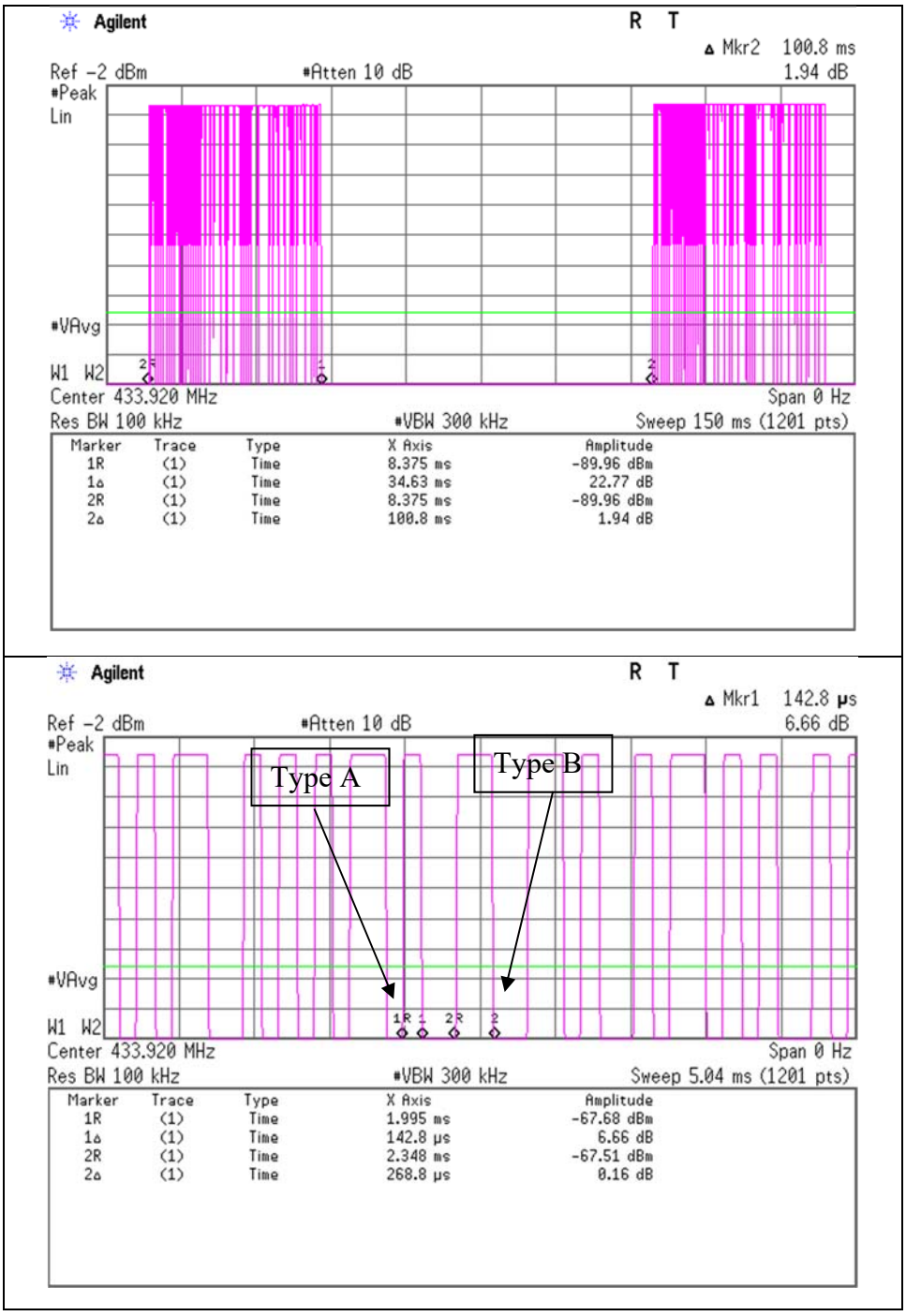
*3)ON time = Type A's ON time (in 100ms) + Type B's ON time (in 100ms)
*4)Duty = $20\log_{10}$(ON time/Cycle)

*The test was performed by a button-pressed operation as the worst case.
Please refer to the “Theory of Operation” for details.

Duty Cycle


Agilent
R T
Trig
Trig Slope
Pos Neg
Trig Delay
-1.000 ms
On Off
Ref -2 dBm
#Atten 10 dB
#Peak
Lin
: Type A
: Type B
#VAvg
S1 S2
W3 VS
AA
£(f):
f>50k
Center 433.920 MHz
Span 0 Hz
Res BW 100 kHz
#VBW 300 kHz
Sweep 20.4 ms (1201 pts)
More
2 of 2
Copyright 2000-2012 Agilent Technologies
Agilent
R T
Trig
Trig Slope
Pos Neg
Trig Delay
19.40 ms
On Off
Ref -2 dBm
#Atten 10 dB
#Peak
Lin
#VAvg
S1 S2
W3 VS
AA
£(f):
f>50k
Center 433.920 MHz
Span 0 Hz
Res BW 100 kHz
#VBW 300 kHz
Sweep 20.4 ms (1201 pts)
More
2 of 2
Copyright 2000-2012 Agilent Technologies

Duty Cycle


Agilent
R T
Mkr2 100.8 ms
Ref -2 dBm
#Atten 10 dB
1.94 dB
#Peak
Lin
#VAvg
W1 W2
Center 433.920 MHz
Span 0 Hz
Res BW 100 kHz
#VBW 300 kHz
Sweep 150 ms (1201 pts)
Marker Trace Type X Axis Amplitude
1R (1) Time 8.375 ms -89.96 dBm
1Δ (1) Time 34.63 ms 22.77 dB
2R (1) Time 8.375 ms -89.96 dBm
2Δ (1) Time 100.8 ms 1.94 dB
Agilent
R T
Mkr1 142.8 µs
Ref -2 dBm
#Atten 10 dB
6.66 dB
#Peak
Lin
Type A
Type B
#VAvg
W1 W2
Center 433.920 MHz
Span 0 Hz
Res BW 100 kHz
#VBW 300 kHz
Sweep 5.04 ms (1201 pts)
Marker Trace Type X Axis Amplitude
1R (1) Time 1.995 ms -67.68 dBm
1Δ (1) Time 142.8 µs 6.66 dB
2R (1) Time 2.348 ms -67.51 dBm
2Δ (1) Time 268.8 µs 0.16 dB

Duty Cycle

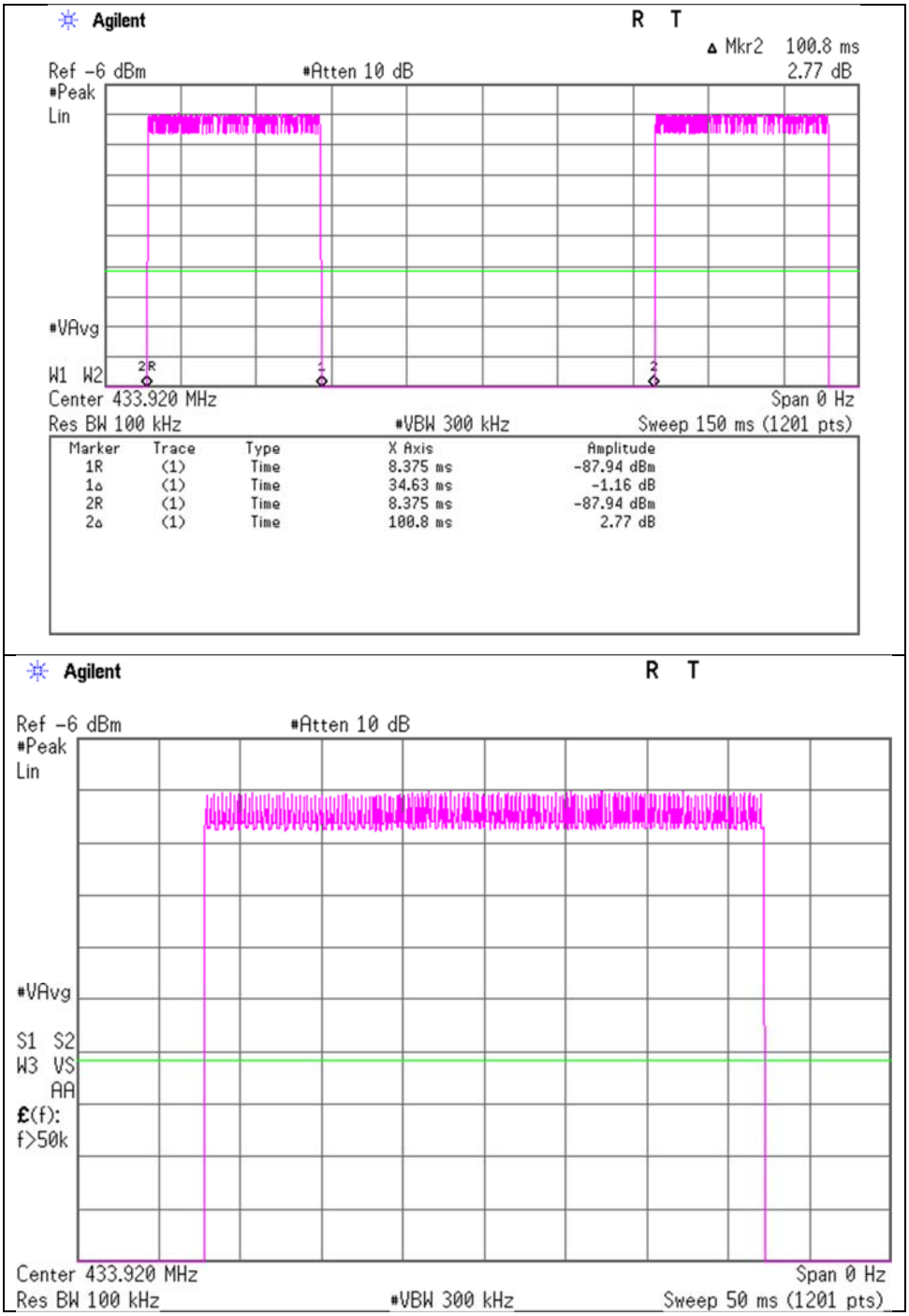
Report No.	12747098H
Test place	Ise EMC Lab. No.6 Measurement Room
Date	March 6, 2019
Temperature / Humidity	22 deg. C / 40% RH
Engineer	Akihiko Maeda
Mode	Transmitting Mode FSK(433.92MHz)

(Total)

ON time [ms]	Cycle [ms]	Duty (On time/Cycle)	Duty [dB]
34.630	100.00	0.3463	-9.21

*1)Duty = $20\log_{10}$(ON time/Cycle)

Duty Cycle


Agilent
R T
Mkr2 100.8 ms
Ref -6 dBm
#Atten 10 dB
2.77 dB
#Peak
Lin
#VAvg
W1 W2
Center 433.920 MHz
Span 0 Hz
Res BW 100 kHz
#VBW 300 kHz
Sweep 150 ms (1201 pts)
Marker Trace Type X Axis Amplitude
1R (1) Time 8.375 ms -87.94 dBm
1Δ (1) Time 34.63 ms -1.16 dB
2R (1) Time 8.375 ms -87.94 dBm
2Δ (1) Time 100.8 ms 2.77 dB
Agilent
R T
Ref -6 dBm
#Atten 10 dB
#Peak
Lin
#VAvg
S1 S2
W3 VS
AA
£(f):
f>50k
Center 433.920 MHz
Span 0 Hz
Res BW 100 kHz
#VBW 300 kHz
Sweep 50 ms (1201 pts)

APPENDIX 2: Test instruments

Test Instruments

Test Name	LIMS ID	Description	Manufacturer	Model	Serial	Last Calibration Date	Calibration Due Date	Cal Int
RE	141949	Test Receiver	Rohde & Schwarz	ESCI	100767	8/6/2018	8/31/2019	12
RE	142183	Measure	KOMELON	KMC-36	-	-	-	-
RE	141554	Thermo-Hygrometer	CUSTOM	CTH-180	1301	1/11/2019	1/31/2020	12
RE	142008	AC3_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	6/26/2018	6/30/2020	24
RE	141424	Biconical Antenna	Schwarzbeck	BBA9106	1915	6/4/2018	6/30/2019	12
RE	141323	Coaxial cable	UL Japan	-	-	7/3/2018	7/31/2019	12
RE	141266	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-191	3/25/2019	3/31/2020	12
RE	141532	DIGITAL HiTESTER	HIOKI	3805	51201197	1/29/2019	1/31/2020	12
RE	141152	EMI measurement program	TSJ	TEPTO-DV	-	-	-	-
RE	141582	Pre Amplifier	SONOMA INSTRUMENT	310	260834	2/8/2019	2/29/2020	12
RE	148897	Attenuator	KEYSIGHT	8491A	MY52462349	12/20/2018	12/31/2019	12
RE	141899	Spectrum Analyzer	AGILENT	E4448A	MY46180655	8/10/2018	8/31/2019	12
RE	141561	Thermo-Hygrometer	CUSTOM	CTH-201	1401	1/11/2019	1/31/2020	12
RE	141884	Spectrum Analyzer	AGILENT	E4448A	MY44020357	3/13/2019	3/31/2020	12
RE	142011	AC4_Semi Anechoic Chamber(NSA)	TDK	Semi Anechoic Chamber 3m	DA-10005	6/28/2018	6/30/2020	24
RE	141562	Thermo-Hygrometer	CUSTOM	CTH-201	0010	1/11/2019	1/31/2020	12
RE	141583	Pre Amplifier	SONOMA INSTRUMENT	310	260833	2/8/2019	2/29/2020	12
RE	142227	Measure	KOMELON	KMC-36	-	-	-	-
RE	141267	Logperiodic Antenna(200-1000MHz)	Schwarzbeck	VUSLP9111B	911B-192	3/21/2019	3/31/2020	12
RE	141545	DIGITAL HiTESTER	HIOKI	3805	51201148	1/29/2019	1/31/2020	12
RE	141397	Coaxial Cable	UL Japan	-	-	6/13/2018	6/30/2019	12
RE	141425	Biconical Antenna	Schwarzbeck	BBA9106	1302	6/1/2018	6/30/2019	12
RE	148898	Attenuator	KEYSIGHT	8491A	MY52462282	10/3/2018	10/31/2019	12
RE	141412	Microwave Cable	Junkosha	MWX221	1305S002R(1m) / 1405S146(5m)	6/14/2018	6/30/2019	12
RE	141581	MicroWave System Amplifier	AGILENT	83017A	650	10/4/2018	10/31/2019	12
RE	141506	Horn Antenna 15-40GHz	Schwarzbeck	BBHA9170	BBHA9170307	6/8/2018	6/30/2019	12
RE	141508	Horn Antenna 1-18GHz	Schwarzbeck	BBHA9120D	9120D-557	6/8/2018	6/30/2019	12
RE	142017	AC4_Semi Anechoic Chamber(SVSWR)	TDK	Semi Anechoic Chamber 3m	DA-10005	4/4/2019	4/30/2020	12
RE	142645	Loop Antenna	UL Japan	-	-	-	-	-

***Hyphens for Last Calibration Date, Calibration Due 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.
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, 99 % Occupied Bandwidth, -20 dB bandwidth, Automatically deactivate and Duty cycle tests