

# Test Report

**CFR Title 47 Sections:**

**Part 2 (2.201, 2.202, 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055)**

**Part 80 (80.209, 80.211, 80.213, 80.215, 80.273)**

**Trade Name : FURUNO**

**Model : Transceiver for Marine Radar**

**Type : RTR-112A**

**Report Number : LIC 12-23-040, Rev.2**

**Date of Revised Issue: 29 May 2023**

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## Testing Laboratory Status

Labotech International Co., Ltd. (hereafter called "LIC") has been holding the following status after having been assessed according to the provisions of ISO/IEC 17025 and/or the relevant rules:

- (1) JAB Accredited Testing Laboratory:
  - accredited by Japan Accreditation Board (JAB)
  - Laboratory accreditation number: RTL03220 (Date of initial accreditation: 14 January 2011 (\*))
  - Scope of accreditation: Electrical testing - EMC, Climatic, Vibration and Radio tests
- (2) Telefication Listed Testing Laboratory:
  - listed by Telefication B. V., (The Netherlands)
  - Laboratory assignment number: L116 (Date of initial listing: 26 July 1999 (\*))
  - for testing the following product categories/ test standards: EN 60945, IEC 61162-1/-2, IEC/EN 61162-450, IEC 62288, ETSI EN 301 843-1 / -2, ETSI EN 301 489-1 / -3 / -17
- (3) TÜV Appointed EMC Test Laboratory:
  - appointed by TÜV Rheinland Japan Ltd.
  - Laboratory assignment number: UA 50046428 (Date of initial appointment: 21 December 1998 (\*))
  - for carrying out the tests of EMC emission and immunity
- (4) RMRS Recognized Testing Laboratory:
  - recognized by Russian Maritime Register of Shipping (Russia)
  - Laboratory recognition number: 17.13259.170 (Date of initial recognition: 27 January 2009 (\*))
  - for carrying out testing in the field of:  
Electrical measurements and tests, EMC tests, Mechanical measurements and tests, Equipment protection degree tests, and Climatic tests for Ship's radio and navigational equipment and IEC 60945: 2002
- (5) RRR Recognized Test Laboratory:
  - recognized by Russian River Register (Russia)
  - Certificate number: 131927 (Date of initial recognition: 31 May 2013 (\*))
  - for carrying out of tests of ships radio and navigation equipment
- (6) DNV Recognized Environmental Test Laboratory:
  - recognized by Det Norske Veritas AS
  - Recognition certificate number: 262.1-015854-J-12 (Date of initial recognition: 12 July 2013 (\*))
  - Scope of recognition: Testing according to the standards IEC 60945, IEC 61162-1/-2/-450, IEC 62288, IEC 62388 and IEC 62252 Annex E
  - Application: Provisions of Environmental, interface and safety testing
- (7) CCS Recognized Test Agency:
  - recognized by China Classification Society
  - Recognition certificate number: DB13A00001 (Date of initial recognition: 29 January 2014 (\*))
  - Scope of recognition: Performance/Environmental/EMC/Special purpose/Safety precautions tests for Electrical & Electronic Product including Maritime Navigation and Radio-communication Equipment & Systems
- (8) SABS EMC A-Lab program Laboratory:
  - recognized by South African Bureau of Standards
  - Assigned Lab number: SABS/A-LAB/0042/2018 (Date of initial recognition: 5 July 2018 (\*))
  - Approved List of EMC Standards : SANS 211 / 214-1 / 214-2 / 222 / 2332 / 2335, CISPR 11 / 14-1 / 14-2 / 22 / 32 / 35, SANS/IEC 60601-1-2, SANS/IEC 61326-1, IEC 61326-2-6, SANS/IEC 61000-3-2 / -3-3 / -4-2 / -4-3 / -4-4 / -4-5 / -4-6 / -4-8 / -4-11 / -6-1 / -6-2 / -6-3 / -6-4
- (9) A2LA accredited Testing Laboratory:
  - accredited by American Association of Laboratory Accreditation (A2LA)
  - Certificate number: 5241.01 (Date of initial accreditation: 17 July 2019 (\*))
  - Scope of accreditation: Electrical testing - Emissions - Radiated and Conducted, Radio - Maritime Radio Systems, Stations in the maritime services, Private land mobile radio service, Radio / Intentional radiators, RF Exposure and EMC - Automotive Electronic Devices (AED), Machine and Vehicle

(\*) The latest certification status may be found on the LIC website (<https://www.labotech-intl.co.jp/>).

# 1 Report Summary

LIC project number : LIC 04-22-0488

Customer : FURUNO ELECTRIC CO., LTD.  
9-52 Ashihara-cho, Nishinomiya City, Hyogo. 662-8580, Japan

Manufacturer : FURUNO ELECTRIC CO., LTD.  
9-52 Ashihara-cho, Nishinomiya City, Hyogo. 662-8580, Japan

Trade name : FURUNO

Model : Transceiver for Marine Radar

Type : RTR-112A

Serial number : See Clause 2.1 of this report.

Product function and intended use : MARINE RADAR

Date of receipt of samples : 24 November 2022

Test period : From 24 November 2022 to 17 February 2023

Test standard(s)/  
Test specification(s) : CFR Title 47 Sections:  
2.201 - Emission, modulation, and transmission characteristics  
2.202 - Bandwidths  
2.1046 - RF Power Output  
2.1047 - Measurements required: Modulation Characteristics  
2.1049 - Occupied Bandwidth  
2.1051 - Spurious Emissions at Antenna Terminals  
2.1053 - Field Strength of Spurious Radiation  
2.1055 - Measurements required: Frequency Stability  
  
80.209 - Transmitter frequency tolerances  
80.211 - Emission limitations  
80.213 - Modulation requirements  
80.215 - Transmitter power  
80.273 - Radar standards  
  
(the latest version on the first day of the testing period)

Test results/Compliance : Passed.  
The test results of this report relate only to the samples tested.

Place of test : Labotech International Co., Ltd.  
 - LABOTECH EMC Center  
 FCC Test firm Designation Number: JP2007  
 FCC Test firm Registration Number: 838049  
 1-16, Fukazu-cho, Nishinomiya-shi, Hyogo, 663-8203 Japan

- Kishu Lab.  
 FCC Test firm Designation Number: JP2009  
 FCC Test firm Registration Number: 381950  
 579-1 Umehara, Wakayama-shi, Wakayama, 640-8452 Japan

Approved by : Tadayuki Ekawa  
 Title: Manager, Testing & Facilities Control Section, Technical Department,  
 Labotech International Co., Ltd.  
 Signature:



Approved Date : 29 May 2023

Note: The following abbreviations and symbols are used in this report.

- None
- NA Not applicable
- NP Not performed
- P Power
- S Signal/control

## Revision History

Version	Date	Page	Item	Description/ Reason of the change
0	4 April 2023	--	--	Issued the initial version.
1	26 April 2023	6	2 Principal Information 2.1 Equipment under test (EUT) 2.1.1 General (d) FCC ID	Modified FCC ID.
2	29 May 2023	1	Cover	Modified the type of Transceiver module.
		4	1 Report Summary Type	
		7	2 Principal Information 2.1 Equipment under test (EUT) 2.1.2 Transceiver module	

### Disclaimer:

The test results of this report relate only to the samples tested.

LIC has no responsibility for the followings except for the requirements of test standards.

- The thing(s) in association with the test and information pertaining to it/them, which are provided by the customer; information described in Clause 2 of this report and information of the cable(s) used.
- The matter(s) specified by the customer; Test standard(s) applied, test item(s), test conditions, criteria, object(s) to be tested or excluded, operation mode(s) and connection/configuration.

## 2 Principal Information

### 2.1 Equipment under test (EUT)

#### 2.1.1 General

- (a) Trade name: FURUNO  
 (b) Manufacturer: FURUNO ELECTRIC CO., LTD.  
 9-52 Ashihara-cho, Nishinomiya City, Hyogo. 662-8580, Japan  
 (c) Model: Transceiver for Marine Radar DRS6A X-CLASS

Name	Type	Serial number	Note
RADAR SENSOR	DRS6A X-CLASS	1000-5010-0104	--
Antenna radiator_1	XN10A	50050439	One (1) selectable
Antenna radiator_2	XN12A	53397879	
Antenna radiator_3	XN13A	50924709	

#### Associated units (AU)

Name	Type	Serial number	Manufacturer
DISPLAY UNIT	RDP-161	1001-3010-0016	FURUNO

#### Auxiliary Equipment (AE)

Name	Type	Serial number	Manufacturer
Dummy Load	4D376	R4535001	SPC

- (d) FCC ID: ADB9ZWRTR112A  
 (e) Primary function: Search, Navigation and Anti-collision  
 (f) Frequency range: Fixed frequency, X-band (9410 MHz)  
 (g) Type of emission: P0N  
 (h) Occupied bandwidth:

Pulse type	S1	S2	M1	M2	M3	L
Occupied bandwidth (MHz)	76.66	70.64	54.33	18.15	11.59	9.83

Note: measured data

- (i) Size and mass: 1036 mm (W) × 445 mm (H) × 330 mm (D), 20 kg (\*1)  
 1255 mm (W) × 445 mm (H) × 330 mm (D), 21 kg (\*2)  
 1795 mm (W) × 445 mm (H) × 330 mm (D), 23 kg (\*3)  
 (\*1) with Antenna radiator\_1 (Type: XN10A) installed.  
 (\*2) with Antenna radiator\_2 (Type: XN12A) installed.  
 (\*3) with Antenna radiator\_3 (Type: XN13A) installed.  
 (j) Power supply: 24 VDC, 96 W

## 2.1.2 Transceiver module

Type: RTR-112A (Contained in RADAR SENSOR)

### 2.1.2.1 Transmitter

- (a) Assignable frequency band: Between 9300 and 9500 MHz (CFR Title 47 Sections: 80.375 (d)-(1))
- (b) Type of RF generator:
  - Magnetron type: MAF1562R
  - Peak output power: 6 kW nominal
  - Fundamental frequency: 9410 MHz
  - Manufacturing:  $\pm 30$  MHz
  - Pulling: 18 MHz
  - Tolerance for 20°C temperature variation: -5 MHz

- (c) Pulse characteristics:

Pulse type	S1	S2	M1	M2	M3	L
Pulse length ( $\mu$ s)	0.08	0.15	0.30	0.50	0.80	1.2
PRF(Hz)	3000	3000	1500	1000	600	600

### 2.1.2.2 Modulator

- (a) FET Type: FMC20N50E-TE24RSC  
Trigger Voltage: Approx. +5 VDC positive

### 2.1.2.3 Receiver

- (a) Passband

RF Stage: 60 MHz

IF Stage:

Pulse type	S1	S2	M1	M2	M3	L
Pass band (MHz)	18	8	8	1.7	1.7	1.7

- (b) Intermediate Frequency: 60 MHz
- (c) Gain (overall): Approximately 100 dB
- (d) Overall Noise Figure: 4.5 dB (typical)
- (e) Video Output Voltage:  $\pm 1$  V differential
- (f) Features Provided: Sensitivity Time Controls (Anti-clutter Sea),  
Fast Time Constant (Anti-clutter Rain)
- (g) If receiver is tunable, describe method for adjusting frequency:  
by adjustment of tuning voltage of receiver local oscillator (Automatic and Manual)

### 2.1.3 Antenna and Scanner

(a) Antenna specifications

Antenna model	XN10A	XN12A	XN13A	
Length (mm)	1040	1260	1800	
Transmission frequency	9410±30 MHz			
Horizontal beam width (-3 dB)	2.3°	1.9°	1.4°	
Vertical beam width (-3 dB)	22°			
Side lobe (max.)	Less than ±10°	-20 dB	-27 dB	-29 dB
	Outside ±10°	-28 dB	-34 dB	-37 dB
Gain	27.5 dBi	28.5 dBi	30.0 dBi	
Radiator	Slot array			
Polarization	Horizontal			
Type of beam	Vertical fan			

- (b) Antenna Rotation ON-OFF Switch: Not provided
- (c) Scanning (rotating or oscillating): Rotating over 360° continuously clockwise
- (d) Antenna Rotation Rate: 24/36/42 rpm
- (e) Sector Scan: Not provided
- (f) Rated Loss of Transmission Line per 100 Feet: Negligible (Transmission path is only in RADAR SENSOR.)

### 2.1.4 Operational Features

- (a) Is positive means provided to indicate whether or not the overall operation of the equipment is such that it may be relied upon to provide effective operation in accordance with its primary function:  
Yes (Receiver tuning indicator)
- (b) Is the equipment for continuous operation: Yes
- (c) Is provision made for operation with shore based radar beacons (RACONS): Yes (RACONS)

### 2.1.5 Construction Features

- (a) Does equipment embody replacement units with chassis type assembly: Yes
- (b) Are fuse alarms provided: No
- (c) State units that are weatherproof: Antenna Unit (IEC 60529 – IP56)
- (d) If all units are not housed in a single container, indicate number and give description of individual units:  
See Clause 2.1.1 (c) of this report.
- (e) Approximate space required for installation excluding Antenna Unit: Not applicable

### 2.2 Observation and comments

For Conducted Spurious Emissions in Clause 4.5 of this report, the measurement for the frequency below 6.54 GHz were unmeasurable due to the large path loss. The measurement results for the frequency below 6.54 GHz were not taken into account as the final result of this test with the consent of the customer.

### 2.3 Modification made to the EUT

No modifications were made to the EUT during testing.



### 3 Test Results Summary

Clause number of this report	CFR Title 47 Sections	Item	Result	Test engineer
4.1	2.1046 (a) 80.215	RF Power Output	Passed.	Y. Hijiri
4.2	2.201 2.1047 (d)	Modulation Characteristics	Passed.	Y. Hijiri
4.3	2.1055 (a)(2),(d)(1),(d)(3) 80.209 (b) 80.213	Frequency Stability –temperature & voltage variation	Passed.	Y. Hijiri
4.4	2.202 (a) 2.1049 (c)(1) 80.209 (b) 80.211 (f)	Occupied Bandwidth	Passed.	Y. Hijiri
4.5	2.1051 80.211 (f) 80.273	Spurious Emissions at Antenna Terminals	Passed.	Y. Hijiri
4.6	2.1053 80.211 (f)	Field Strength of Spurious Radiation	Passed.	Y. Hijiri N. Yasuda

## 4 Test Results

### 4.1 RF Power Output

#### 4.1.1 Test conditions:

For all TX (S1/S2/M1/M2/M3/L) pulses, the transmitter output power was measured at the antenna port with a non-reflective load as a substitute for Antenna radiator\_1/2/3.

#### 4.1.2 Test setup:

See Clause 5.

#### 4.1.3 Test Results:

Complied.

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power $P_m$ (W)	0.9	1.8	2.1	2.5	2.6	3.9
Pulse length $T$ ( $\mu$ s) (50% points)	0.064	0.124	0.269	0.460	0.762	1.172
Pulse Repetition Frequency (PRF) (Hz)	3000	3000	1500	999.8	600	600
Transmission pulse power $P_p$ (kW) (*)	4.9	4.9	5.1	5.3	5.6	5.6

(\*)  $P_p$  (kW) =  $(P_m$  (W) / ( $T$  ( $\mu$ s)  $\times$  PRF (Hz)))  $\times$  1000

Environmental conditions observed: On 24 November 2022, 23°C to 21°C, 52%RH to 54%RH

Power supply voltage measured: 24 VDC to 24 VDC

## 4.2 Modulation Characteristics

### 4.2.1 Test Conditions:

The RF envelope of the output pulse was measured with an envelope detector and an oscilloscope.  
Each pulse spectrum was measured with a spectrum analyzer.

### 4.2.2 Test setup:

See Clause 5.

### 4.2.3 Test Results:

Complied.

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T ( $\mu$ s) (50% points)	0.064	0.124	0.269	0.460	0.762	1.172
Rise time $t_r$ ( $\mu$ s) (10 to 90% amplitude)	0.023	0.024	0.024	0.025	0.025	0.028
Fall time $t_f$ ( $\mu$ s) (90 to 10% amplitude)	0.072	0.076	0.075	0.072	0.070	0.079
Pulse Repetition Frequency (Hz)	3000	3000	1500	999.8	600	600

Measured Plots: See Clause 7.

Environmental conditions observed: On 24 November 2022, 23°C to 21°C, 52%RH to 54%RH

Power supply voltage measured: 24 VDC to 24 VDC

### 4.3 Frequency Stability –temperature & voltage

#### 4.3.1 Test Conditions:

- (1) Radar transmitter settings: All TX (S1/S2/M1/M2/M3/L) pulses
- (2) Ambient temperature settings: -20°C to +50°C (10°C interval)
- (3) Power supply voltage settings: 85/100/115% of nominal voltage: 24 VDC  
 $V_L$ : 20.4 VDC /  $V_{nom}$ : 24 VDC /  $V_H$ : 27.6 VDC

#### 4.3.2 Test setup:

See Clause 5.

#### 4.3.3 Frequency Tolerance Limits:

Pulse type	S1	S2	M1	M2	M3	L
Guard Band $f(1.5/T)$ (MHz) (*1)	23.4	12.1	5.6	3.3	2.0	1.3
Upper limit (MHz) (*2)	9476.6	9487.9	9494.4	9496.7	9498.0	9498.7
Lower limit (MHz) (*2)	9323.4	9312.1	9305.6	9303.3	9302.0	9301.3

(\*1) Guard Band is specified to be equal to 1.5/T MHz, where "T" is the pulse length in microseconds.

(CFR Title 47 Sections: 80.209 (b))

(\*2) Upper limit frequency,  $f(U) = 9500 - 1.5/T$   
 Lower limit frequency,  $f(L) = 9300 + 1.5/T$

#### 4.3.4 Test Results:

Complied.

(1) Temperature test at the rated supply voltage of 24 VDC:

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9425.0	9423.4	9422.4	9421.4	9420.7	9419.4	Complied.
	-10°C	9423.3	9422.2	9421.0	9420.1	9419.4	9418.1	Complied.
	0°C	9422.6	9421.1	9420.2	9419.2	9418.6	9417.4	Complied.
	+10°C	9421.7	9419.9	9418.8	9417.9	9417.3	9415.9	Complied.
	+20°C	9420.2	9418.7	9417.6	9417.0	9416.3	9414.7	Complied.
	+30°C	9418.9	9417.2	9416.2	9415.3	9414.7	9413.5	Complied.
	+40°C	9417.4	9416.1	9415.0	9414.1	9413.6	9412.4	Complied.
	+50°C	9415.8	9414.6	9413.6	9412.7	9412.1	9411.0	Complied.

(2) Voltage variation test at the temperature of +20°C:

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	$V_L$	9420.3	9418.7	9417.5	9417.0	9416.3	9414.7	Complied.
	$V_{nom}$	9420.2	9418.7	9417.6	9417.0	9416.3	9414.7	Complied.
	$V_H$	9420.1	9418.9	9417.6	9417.1	9416.3	9414.9	Complied.

Environmental conditions observed: On 25 November 2022, 22°C to 23°C, 46%RH to 46%RH  
 On 28 November 2022, 21°C to 21°C, 44%RH to 44%RH  
 On 29 November 2022, 23°C to 23°C, 67%RH to 67%RH

Power supply voltage measured: 24 VDC to 24 VDC

## 4.4 Occupied Bandwidth

### 4.4.1 Test conditions:

For S1 pulse, the transmitter output power was measured at the antenna port with a non-reflective load as a substitute for Antenna radiator\_1/2/3.

### 4.4.2 Test setup:

See Clause 5.

### 4.4.3 Emission Limits (CFR Title 47 Sections: 80.211 (f)):

Frequency removed from the assigned frequency (*1) (of the authorized bandwidth) (*2)	Emission attenuation (mean power, dB)
50 to 100%	At least 25
100 to 250%	At least 35
more than 250%	At least $43 + 10 \log_{10}$ (mean power in watts) = -13 dBm

(\*1) Assigned frequency (center frequency) = 9410 MHz (for X-band radars)

(\*2) Authorized band width = 200 MHz (for X-band radars)

### 4.4.4 Test Results:

Complied.

Spectrum plots: See Clause 8.1.

Environmental conditions observed: On 25 November 2022, 22°C to 22°C, 46%RH to 46%RH

Power supply voltage measured: 24 VDC to 24 VDC

## 4.5 Spurious Emissions at Antenna Terminals

### 4.5.1 Test Conditions:

(a) For S1 pulse, the transmitter output power was measured at the antenna port with a non-reflective load converter as a substitute for Antenna radiator\_1/2/3. (\*1)

(\*1) Emission measurements only need to be carried out for the pulse length setting producing the widest calculated B-40 bandwidth. (IEC 62388 Ed.2/ Annex B.4.2 part)

(b) Spurious measurement range for X-band radar: 4.59 GHz to 40 GHz

Lower measurement band	Upper measurement band
From 4.59 GHz (*2) to the lower OoB boundary	From the upper OoB boundary to 40 GHz

(\*2) 0.7 times of the waveguide cut-off frequency for WRJ-10 (ITU-R SM.329-12, Section 2.5)

### 4.5.2 Test setup:

See Clause 5.

### 4.5.3 Emission Limits (CFR Title 47 Sections: 80.211 (f)):

Frequency removed from the assigned frequency (*1)	Emission attenuation (mean power, dB)
More than 250% (*3) (of the authorized bandwidth) (*2)	At least $43 + 10 \log_{10}$ (mean power in watts) = -13 dBm

(\*1) Assigned frequency (center frequency) = 9410 MHz (for X-band radars)

(\*2) Authorized bandwidth = 200 MHz (for X-band radars)

(\*3) Spurious measurement range for X-band radar (WRJ-10): 4.59 GHz to 40 GHz

### 4.5.4 Harmonics Frequencies:

$f_0$ (GHz)	$1/2f_0$	$2f_0$	$3f_0$	$4f_0$
9.410	4.705	18.820	28.23	37.64

### 4.5.5 Test Results:

Complied.

Measured maximum emission value

Frequency (GHz)	Level (dBm)	Limit (dBm)	Margin (dB)
18.8395	-51.87	-13.0	38.87

Environmental conditions observed: On 2 December 2022, 24°C to 24°C, 30%RH to 30%RH

Power supply voltage measured: 24 VDC to 24 VDC

**4.6 Field Strength of Spurious Radiation**

**4.6.1 Test Conditions:**

(a) For S1 pulse, the transmitter output power was measured at the antenna port with a non-reflective load as a substitute for Antenna radiator\_1/2/3. (\*1)

(\*1) Emission measurements only need to be carried out for the pulse length setting producing the widest calculated B-40 bandwidth. (IEC 62388 Ed.2/ Annex B.4.2 part)

(b) Spurious measurement range for X-Band RADAR: 4.59 GHz to 40 GHz

Lower measurement band	Upper measurement band
From 4.59 GHz (*1) to the lower OoB boundary	From the upper OoB boundary to 40 GHz

(\*1) 0.7 times of the waveguide cut-off frequency for WRJ-10 (ITU-R SM.329-12, Section 2.5)

(c) Antenna port was terminated with dummy load.

**4.6.2 Test Site:** LIC EMC Center, Semi-anechoic chamber

**4.6.3 Distance between the Radar and Measuring Antenna:** 3 m

**4.6.4 Test setup:**

See Clause 5.

The GRP (Ground reference plane, metal floor) between the EUT and the measuring (receiving) antenna was lined with the radio absorbers (3.0 m × 2.4 m × 0.3 m) to reduce the influences of the reflections of the RF waves from the floor.

Measuring (receiving) the antenna polarization: Vertical and horizontal.

EUT height: 1.5 m

**4.6.5 Field Strength Limits (CFR Title 47 Sections: 80.211 (f)):**

Frequency removed from the assigned frequency (*1)	Emission attenuation (mean power, dB)
More than 250% (*3) (of the authorized bandwidth) (*2)	At least $43 + 10 \log_{10}$ (mean power in watts) = -13 dBm

(\*1) Assigned frequency (center frequency) = 9410 MHz (for X-band radars)

(\*2) Authorized bandwidth = 200 MHz (for X-band radars)

(\*3) Spurious measurement range for X-band radar: 4.59 GHz to 40 GHz

**4.6.6 Harmonics Frequencies:**

f <sub>0</sub> (GHz)	1/2f <sub>0</sub>	2f <sub>0</sub>	3f <sub>0</sub>	4f <sub>0</sub>
9.410	4.705	18.820	28.23	37.64

**4.6.7 Test Results:**

Complied.

Spurious emission levels measured were found to be attenuated more than 20 dB below the limits.

Measured maximum emission value

Frequency (GHz)	Level (dB $\mu$ V/m)	Limit (dB $\mu$ V/m) (*1)	Margin (dB)
17.95885	52.13	82.2	30.1

(\*1) -13 dBm = 82.2 dB $\mu$ V/m (3 m) (Refer to ITU-R SM.329-12/ Annex 1, Section 3.)

Spectrum plots: See Clause 9.

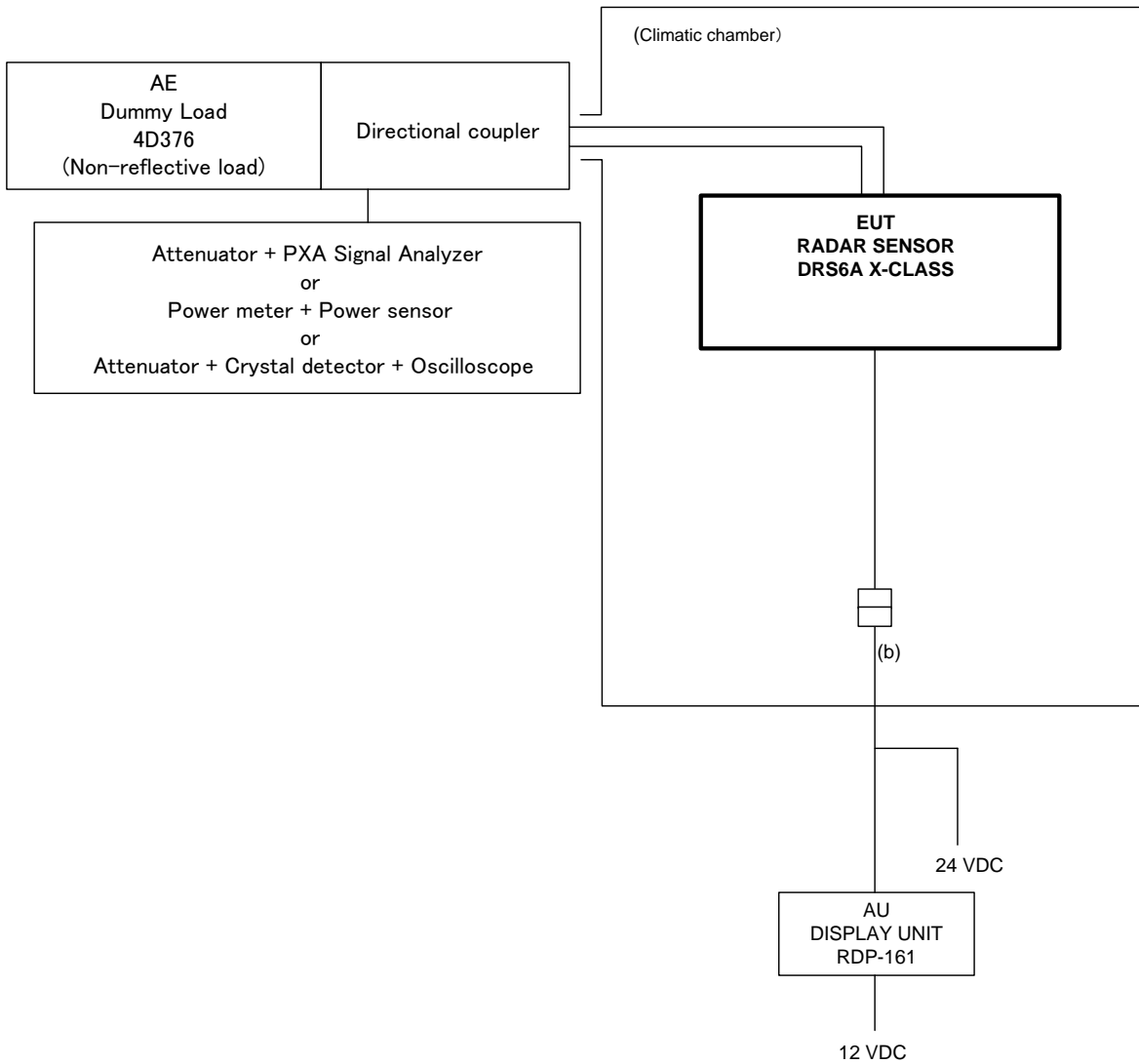
Environmental conditions observed: On 21 December 2022, 21°C to 21°C, 42%RH to 42%RH  
 On 17 February 2023, 21°C to 21°C, 42%RH to 42%RH

Power supply voltage measured: 24 VDC to 24 VDC

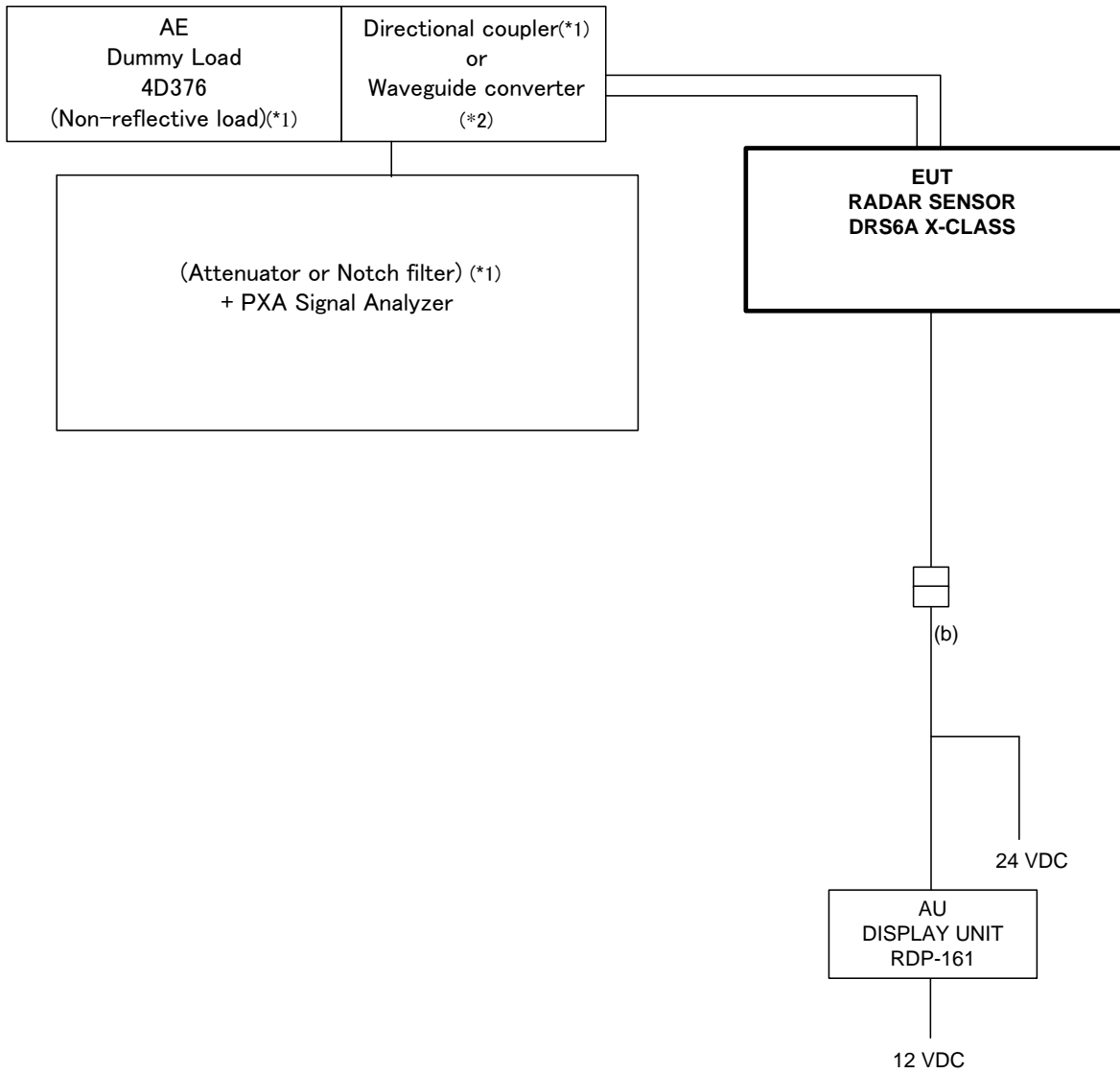


## 5 Test Setup for Measurements

### 5.1 Test Setup for Clause 4.1, 4.2, 4.3 and 4.4



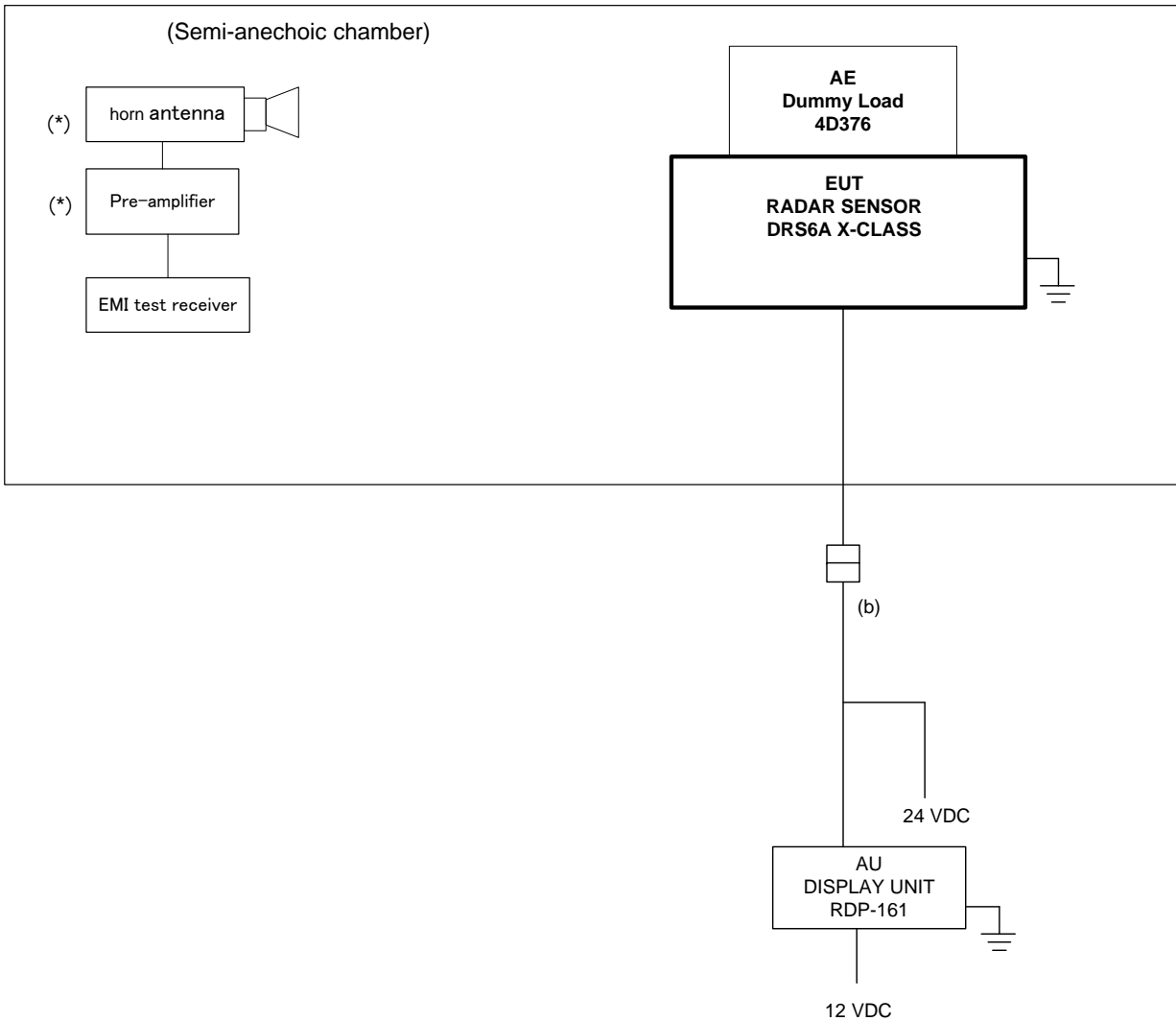
**5.2 Test Setup for Clause 4.5**



(\*1) Used for the measurement up to 18 GHz.

(\*2) Submitted by the customer and used for the measurement above 18 GHz.

**5.3 Test Setup for Clause 4.6**



(\*) Used depending on measurement frequency bandwidth.

**Cable designations**

No.	Category	Name	Type	Length (m)	Number of cables used	Cable shielded
b	P/S	Power / Signal Cable	FRU-2P5S-FF-30M	30	1	Yes

## 6 Measuring Equipment List

Measuring/Test instruments have been appropriately calibrated/maintained according to the LIC programs/procedures and ISO/IEC 17025. Measuring/Test instruments used for the tests are listed below.

### (1) For Clause 4.1 RF Power Output

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional coupler (X-band)	5D364S	R05762	SPC Electronics	8 April 2022	1 year
RT200	Power meter	E4419B	MY45101375	Agilent	3 March 2022	1 year
RT201	Power sensor	8481A	2349A39603	Agilent	7 March 2022	1 year
RT213	Waveguide	WRJ-10	--	Furuno	14 July 2022	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	7 March 2022	1 year
HT1223	Attenuator	8495B	MY42148137	Keysight	2 March 2022	1 year
HT972	Oscilloscope	MSO4054B	C030483	Tektronix	11 March 2022	1 year
HT1165	Climatic Chamber (Extra-Large)	TBE-6E20W0P3T	3015006336	Espec	18 August 2022	1 year
HT1040	EXTENDED RANGE DC POWER SUPPLY	EX-1500L2	405380030171	Takasago	Not applicable.	--
HT167	Digital multi-meter	E2377A	3651J18668	Agilent	15 February 2022	1 year

### (2) For Clause 4.2 Modulation Characteristics

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional coupler (X-band)	5D364S	R05762	SPC Electronics	8 April 2022	1 year
RT213	Waveguide	WRJ-10	--	Furuno	14 July 2022	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	7 March 2022	1 year
HT1223	Attenuator	8495B	MY42148137	Keysight	2 March 2022	1 year
HT1317	PXA Signal Analyzer	N9030B	SG57142024	Keysight	9 March 2022	1 year
HT1165	Climatic Chamber (Extra-Large)	TBE-6E20W0P3T	3015006336	Espec	18 August 2022	1 year
HT1040	EXTENDED RANGE DC POWER SUPPLY	EX-1500L2	405380030171	Takasago	Not applicable.	--
HT167	Digital multi-meter	E2377A	3651J18668	Agilent	15 February 2022	1 year
HT1221	Crystal detector	423B	MY51342422	Agilent	5 March 2022	1 year
HT972	Oscilloscope	MSO4054B	C030483	Tektronix	11 March 2022	1 year

### (3) For Clause 4.3 Frequency Stability –temperature & voltage

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional coupler (X-band)	5D364S	R05762	SPC Electronics	8 April 2022	1 year
RT213	Waveguide	WRJ-10	--	Furuno	14 July 2022	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	7 March 2022	1 year
HT1223	Attenuator	8495B	MY42148137	Keysight	2 March 2022	1 year
HT1317	PXA Signal Analyzer	N9030B	SG57142024	Keysight	9 March 2022	1 year
HT1165	Climatic Chamber (Extra-Large)	TBE-6E20W0P3T	3015006336	Espec	18 August 2022	1 year
HT1040	EXTENDED RANGE DC POWER SUPPLY	EX-1500L2	405380030171	Takasago	Not applicable.	--
HT167	Digital multi-meter	E2377A	3651J18668	Agilent	15 February 2022	1 year

## (4) For Clause 4.4 Occupied Bandwidth

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional coupler (X-band)	5D364S	R05762	SPC Electronics	8 April 2022	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	7 March 2022	1 year
HT1223	Attenuator	8495B	MY42148137	Keysight	2 March 2022	1 year
HT1317	PXA Signal Analyzer	N9030B	SG57142024	Keysight	9 March 2022	1 year
HT1040	EXTENDED RANGE DC POWER SUPPLY	EX-1500L2	405380030171	Takasago	Not applicable.	--
HT167	Digital multi-meter	E2377A	3651J18668	Agilent	15 February 2022	1 year

## (5) For Clause 4.5 Spurious Emissions at Antenna Terminals

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional coupler (X-band)	5D364S	R05762	SPC Electronics	8 April 2022	1 year
--	Adapter	X281A	--	Hewlett Packard	Not applicable.	--
--	Adapter	K281C	--	Agilent	Not applicable.	--
--	Adapter	R281B	--	Hewlett Packard	Not applicable.	--
--	Isolator	OMC FX0157	--	--	Not applicable.	--
HT1328	Notch filter	BRC20663	001	Micro-Tronics	6 August 2022	1 year
HT1317	PXA Signal Analyzer	N9030B	SG57142024	Keysight	9 March 2022	1 year
HT1040	EXTENDED RANGE DC POWER SUPPLY	EX-1500L2	405380030171	Takasago	Not applicable.	--
HT167	Digital multi-meter	E2377A	3651J18668	Agilent	15 February 2022	1 year
KB289	Coaxial cable	SF104A/11PC35/11PC35/5500MM	800048/4A	HUBER+SUHNER	6 August 2022	1 year
KB181	Coaxial cable	SUCOFLEX 102A	1261/2A	HUBER+SUHNER	6 August 2022	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	7 March 2022	1 year
HT1223	Attenuator	8495B	MY42148137	Keysight	2 March 2022	1 year

## (6) For Clause 4.6 Field Strength of Spurious Radiation

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
HT779	Semi-anechoic chamber	10mSAC	90984	Tokin	SVSWR: 9 December 2019 23 December 2023	3 years (*1)
HT1277	Test software	EP5/RE	Ver.6.0.112	Toyo	Not applicable.	--
HT1270	EMI test receiver (2 Hz to 44 GHz)	ESW44	101841	Rohde & Schwarz	6 August 2022	1 year
NK004	Double rigged horn antenna (1 GHz to 18 GHz)	TR17206	93370015	Advantest	23 August 2022	1 year
HTK011	Standard gain horn antenna	42-449-6/24/cal	K241504z-01	ATM	9 February 2023	1 year
NK012	Pre-amplifier	8449B	3008A01286	Agilent	1 December 2022	1 year
HT762	Double rigged horn antenna & amp. (26 GHz to 40 GHz)	HAP26-40N	00000010	Toyo	1 December 2021 26 December 2022	1 year (*1)
HT866	Digital multimeter	115	19170029	Fluke	1 February 2022	1 year
HT781	Programmable DC power supply	PAN60-20A	QM003356	KIKUSUI	Not applicable.	--

(\*) Due date of the calibrations on 9 December 2019 and 1 December 2021: 31 December 2022

### 7 RF Envelope and Spectrum of the Output Pulse

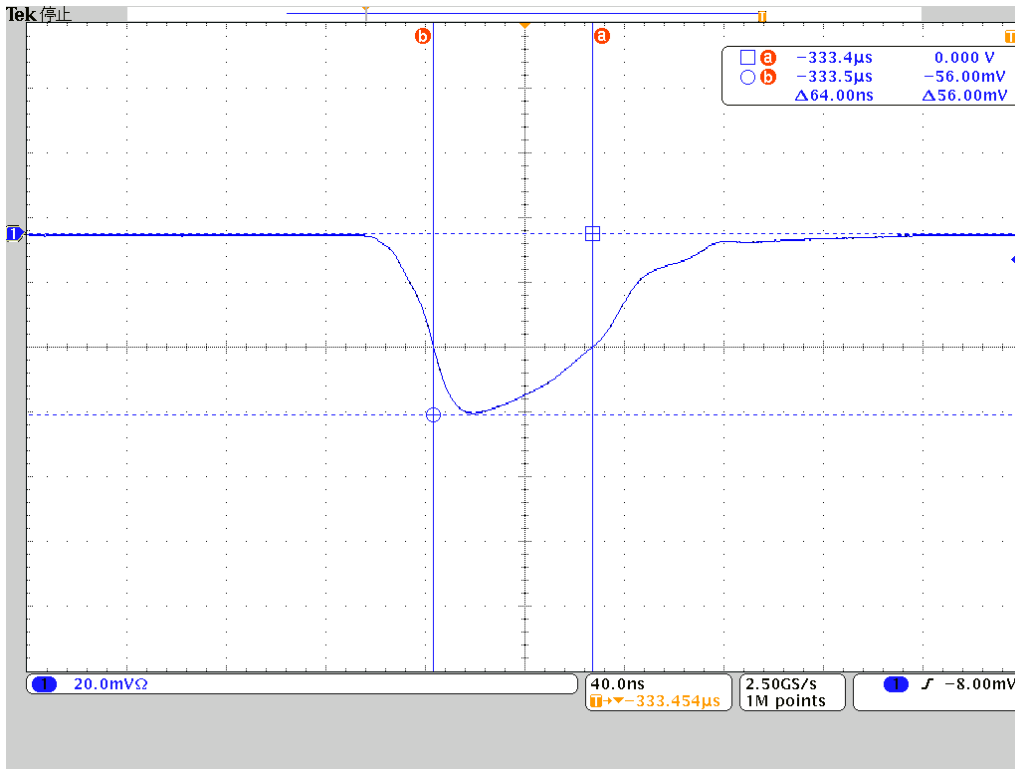


Fig. 7.1 S1 pulse envelope

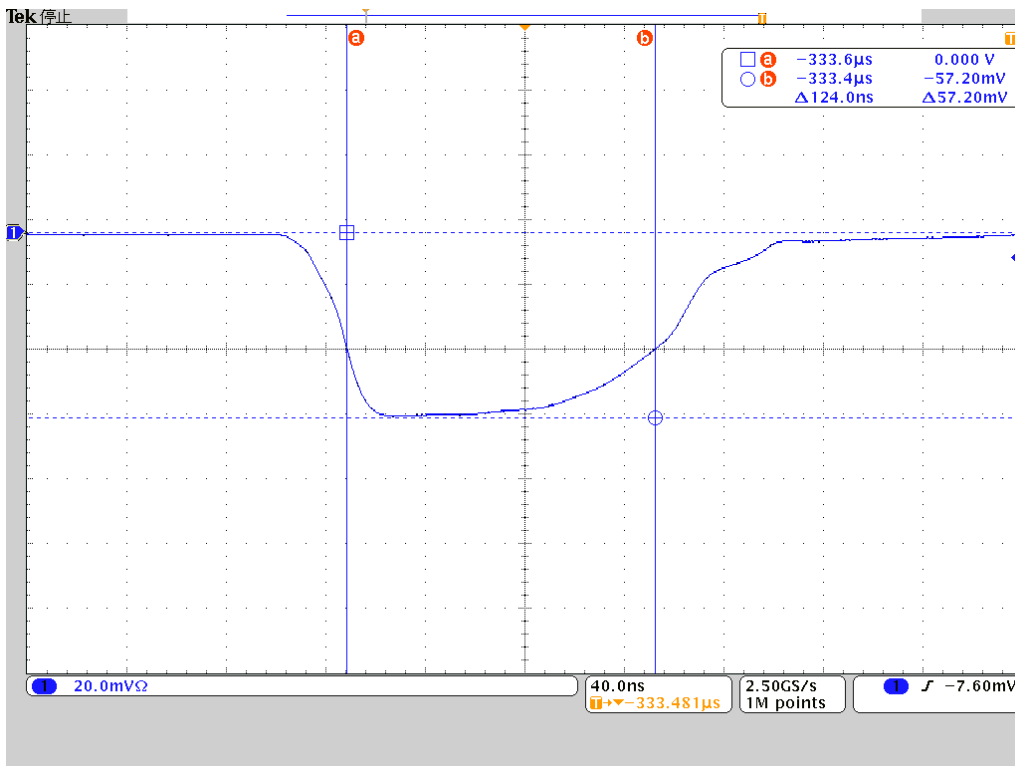


Fig. 7.2 S2 pulse envelope

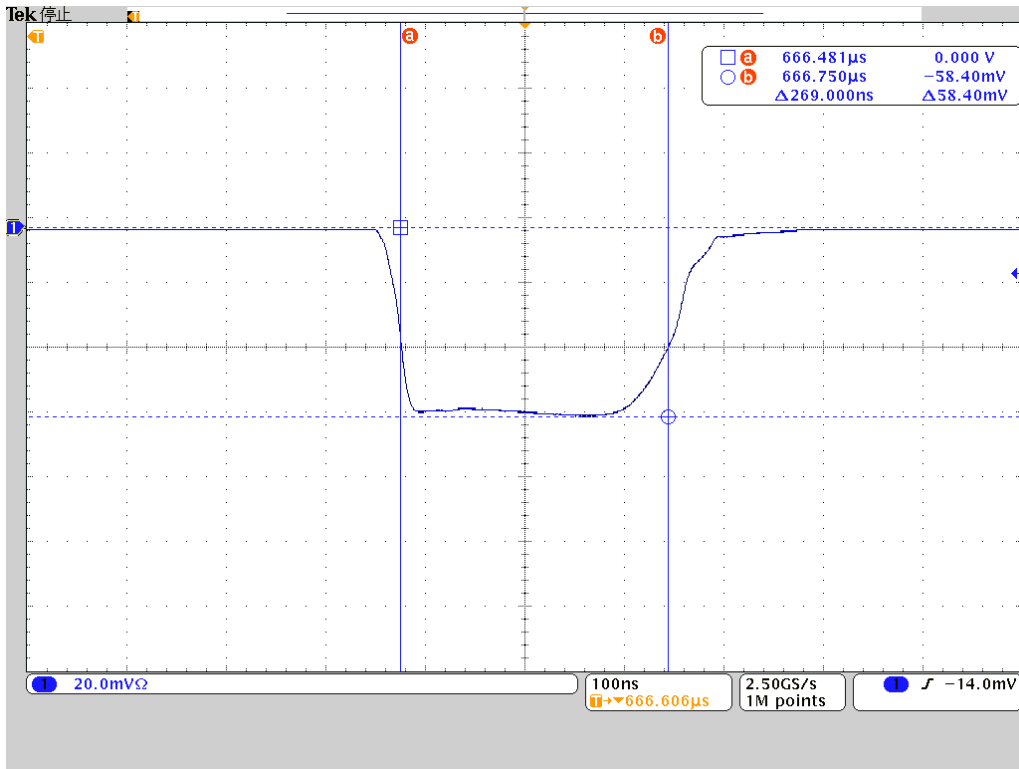


Fig. 7.3 M1 pulse envelope

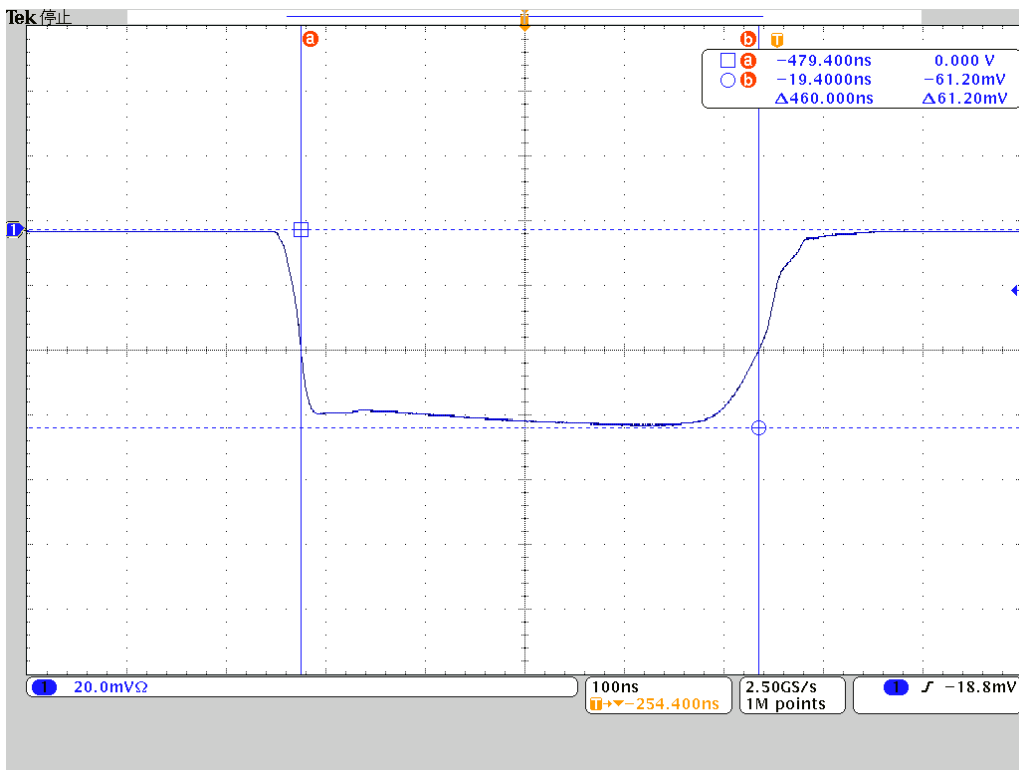


Fig. 7.4 M2 pulse envelope

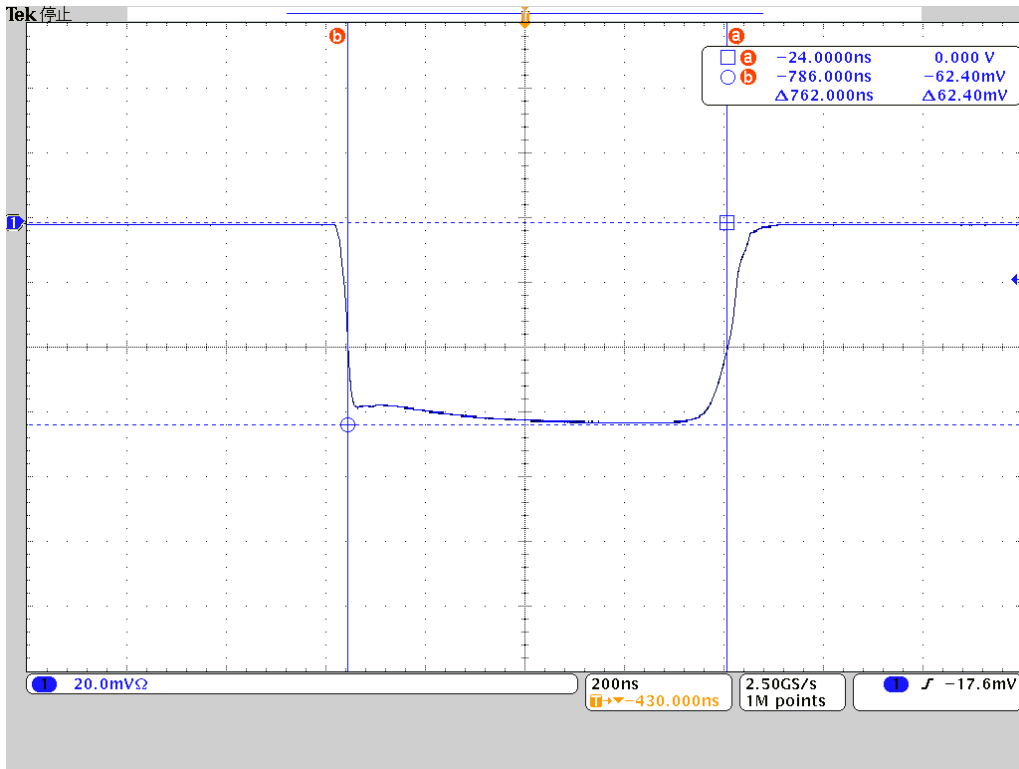


Fig. 7.5 M3 pulse envelope

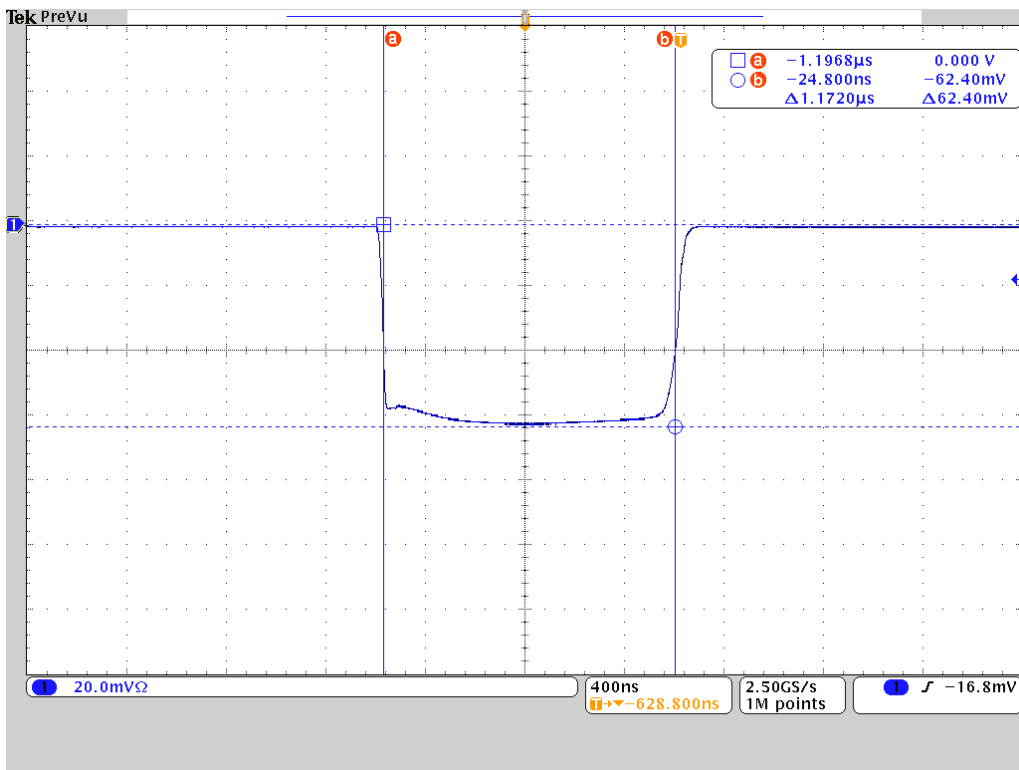
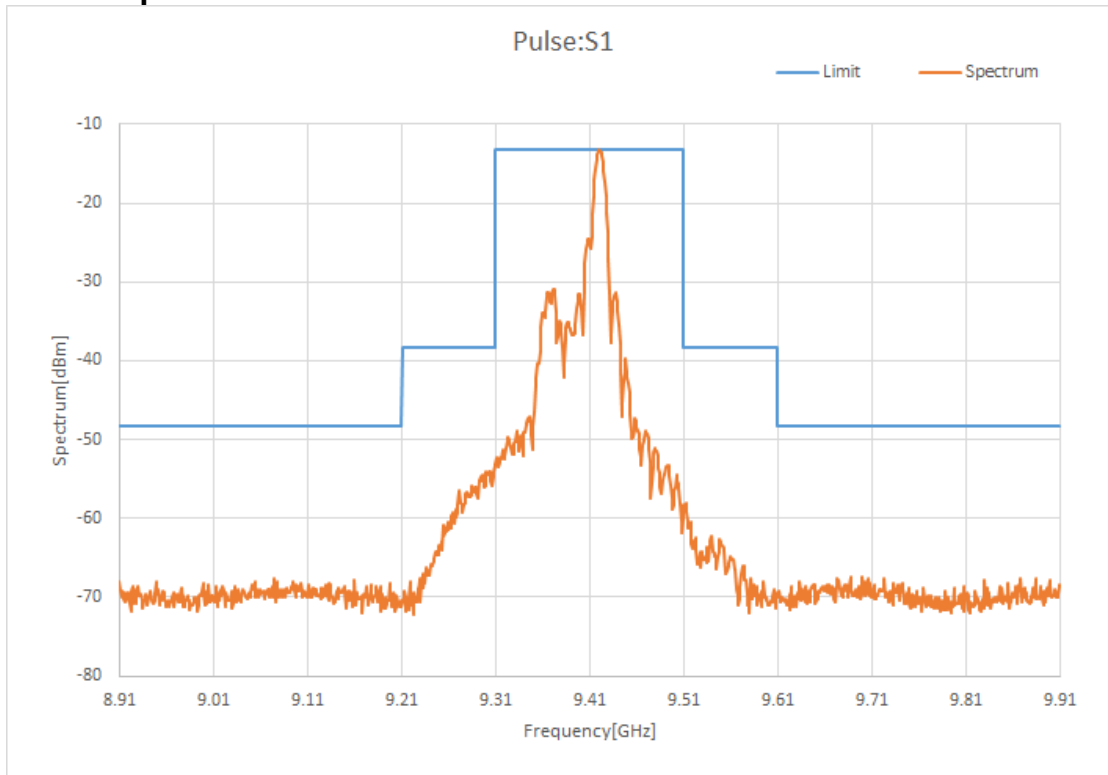


Fig. 7.6 L pulse envelope



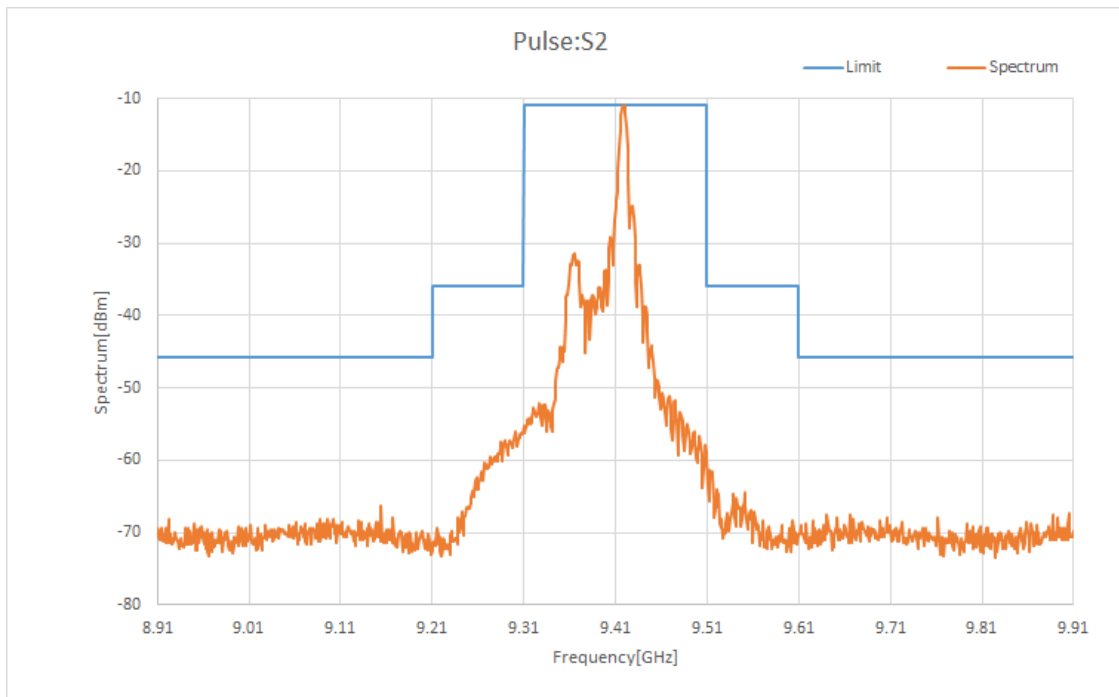
## 8 Spurious Emission Plots measured at Antenna Terminal

### 8.1 Occupied Bandwidth



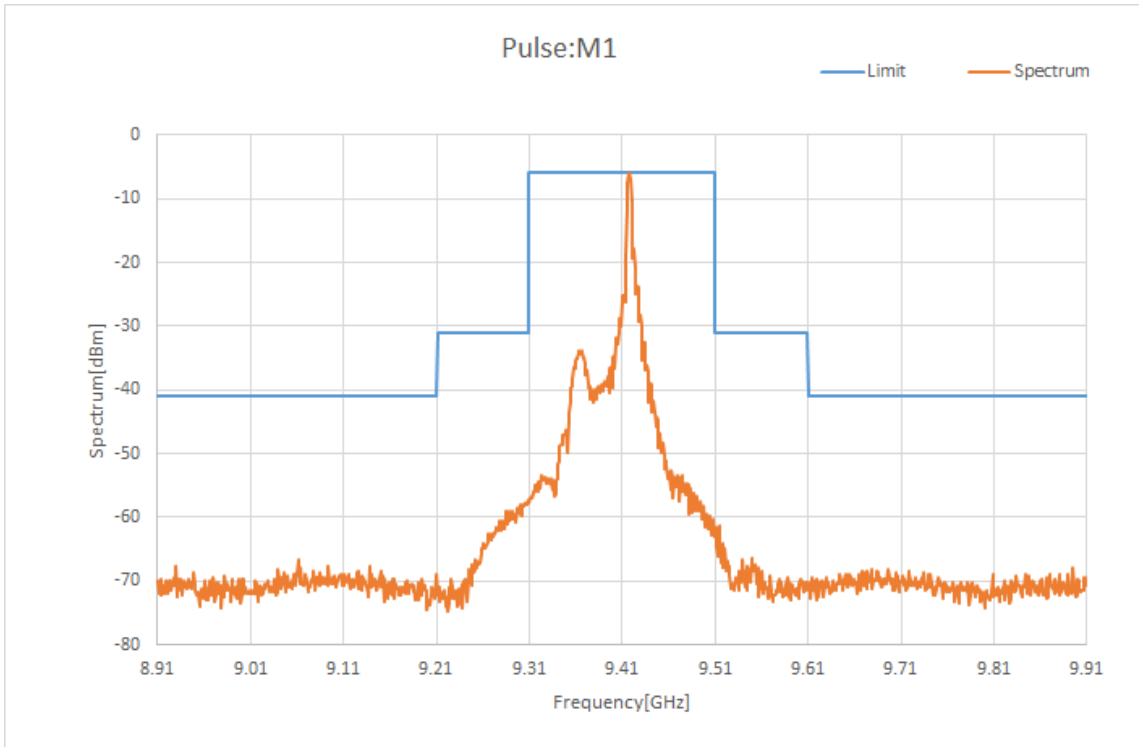
Occupied Bandwidth:76.664 MHz

Fig. 8.1 S1 pulse

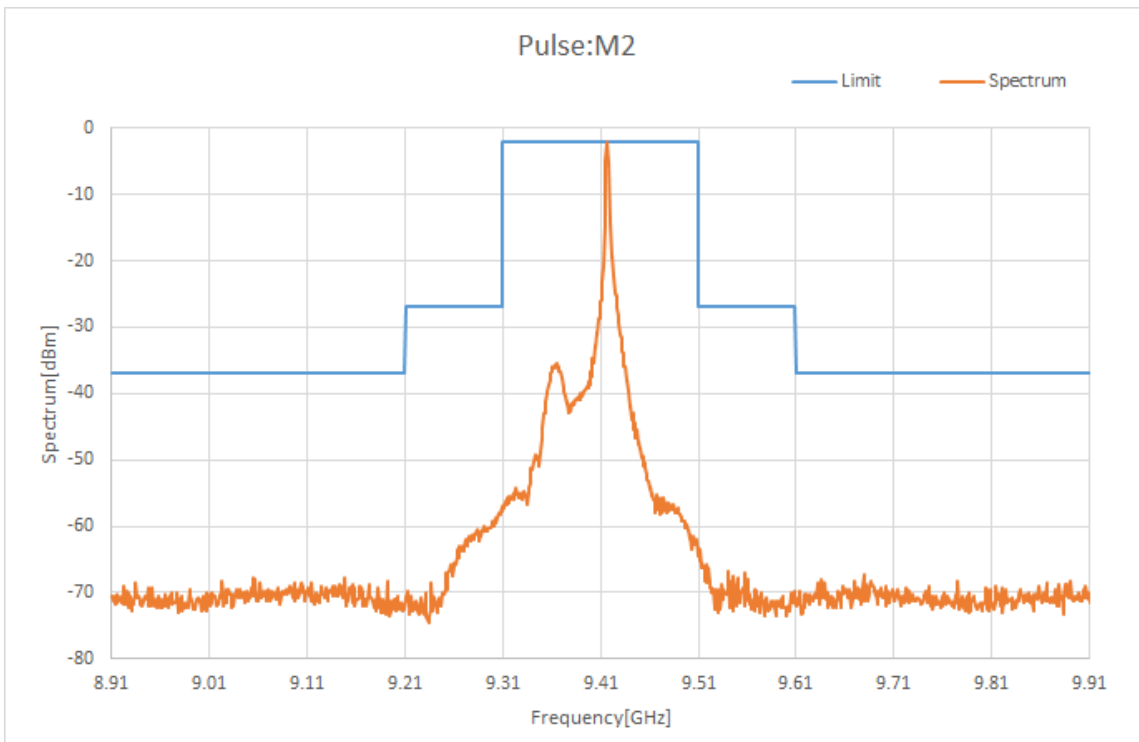


Occupied Bandwidth:70.635 MHz

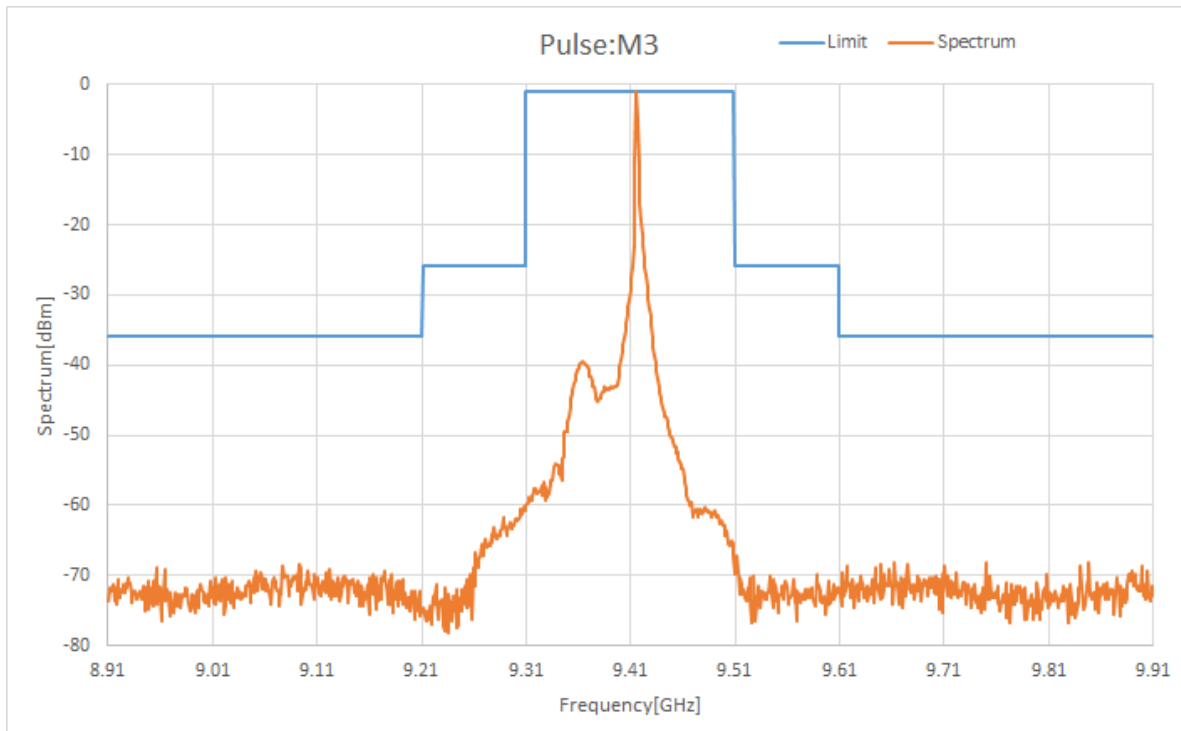
Fig. 8.2 S2 pulse



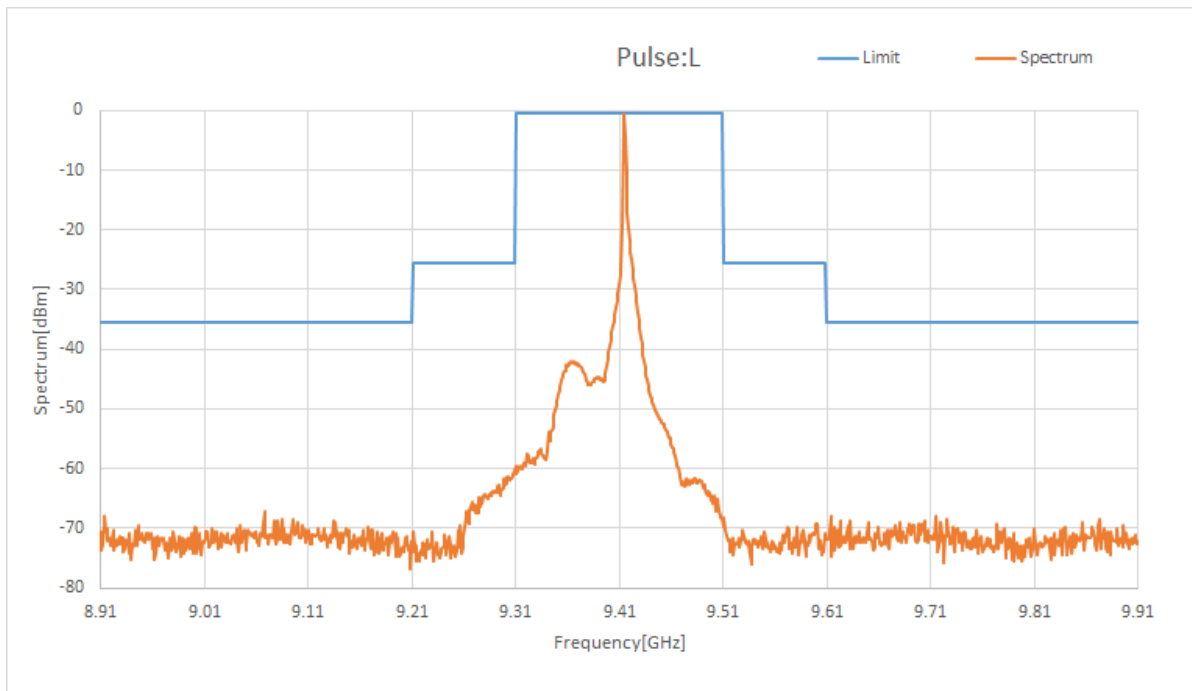
Occupied Bandwidth:54.331 MHz  
Fig. 8.3 M1 pulse



Occupied Bandwidth:18.145 MHz  
Fig. 8.4 M2 pulse



Occupied Bandwidth:11.586 MHz  
Fig. 8.5 M3 pulse



Occupied Bandwidth:9.8275 MHz  
Fig. 8.6 L pulse

**8.2 Spurious Emissions**

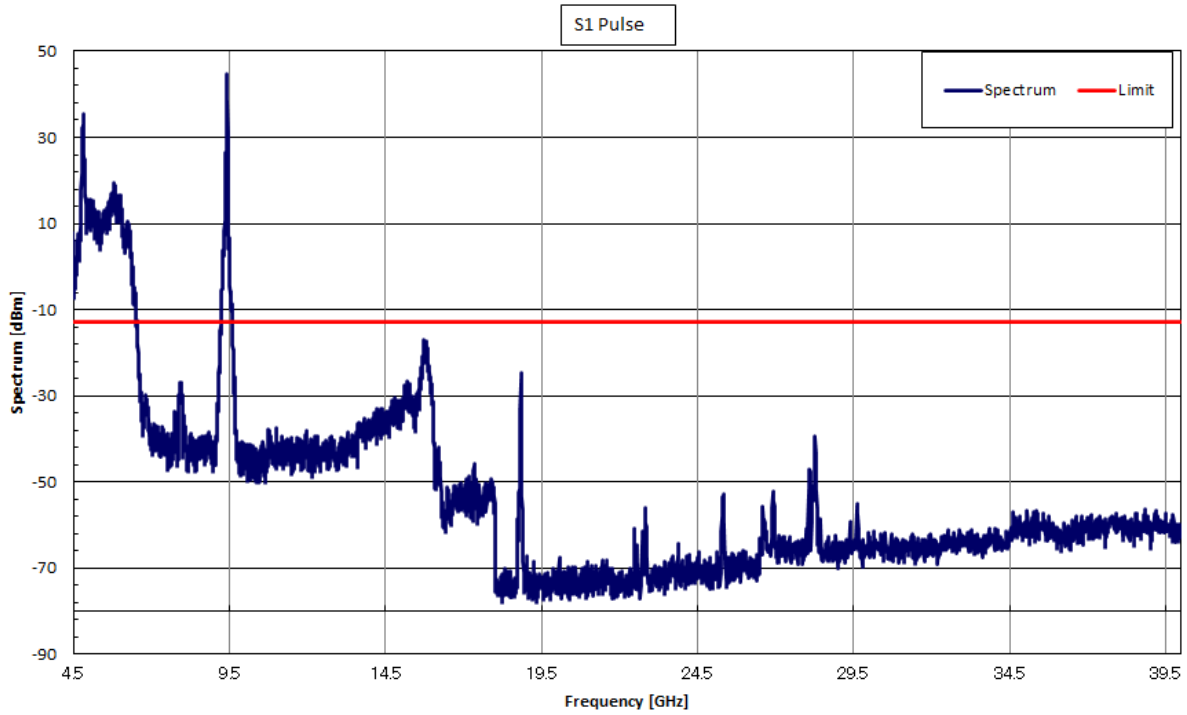


Fig 8.7 Peak, 4.5 GHz to 40 GHz

Note: The measurement for the frequency below 6.54 GHz were unmeasurable due to the large path loss even though the EUT operation was OFF.

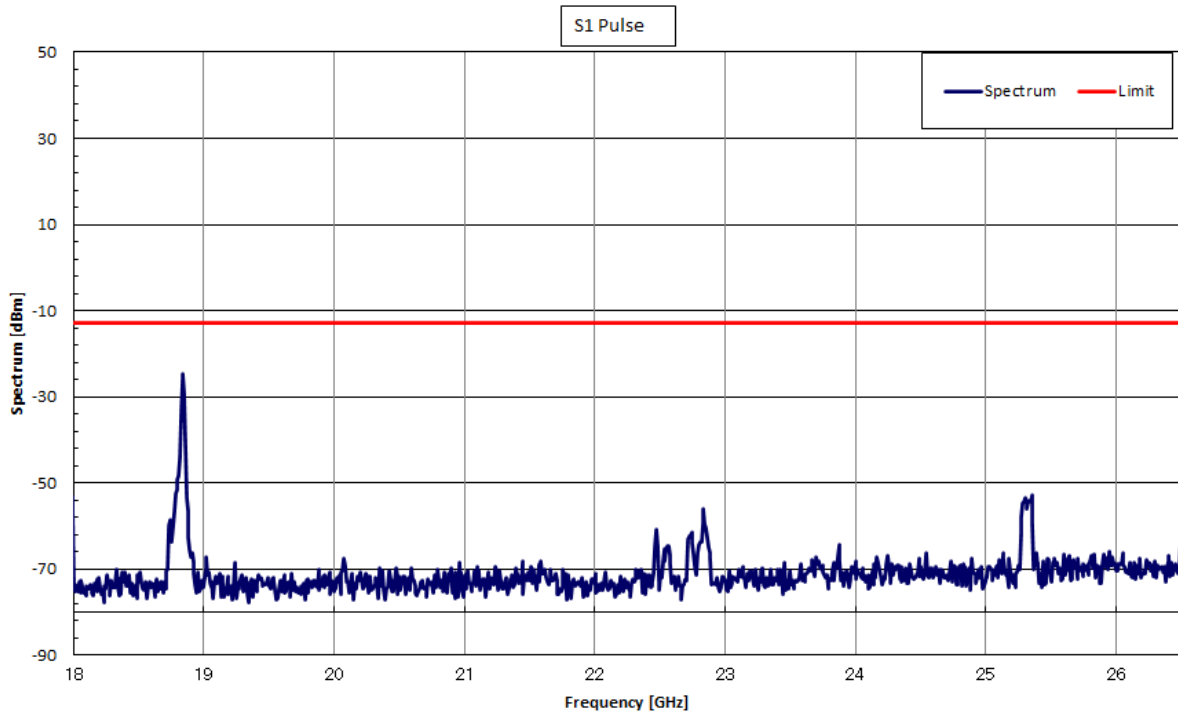


Fig 8.8 Peak, 18 GHz to 26.5 GHz (maximum peak value)

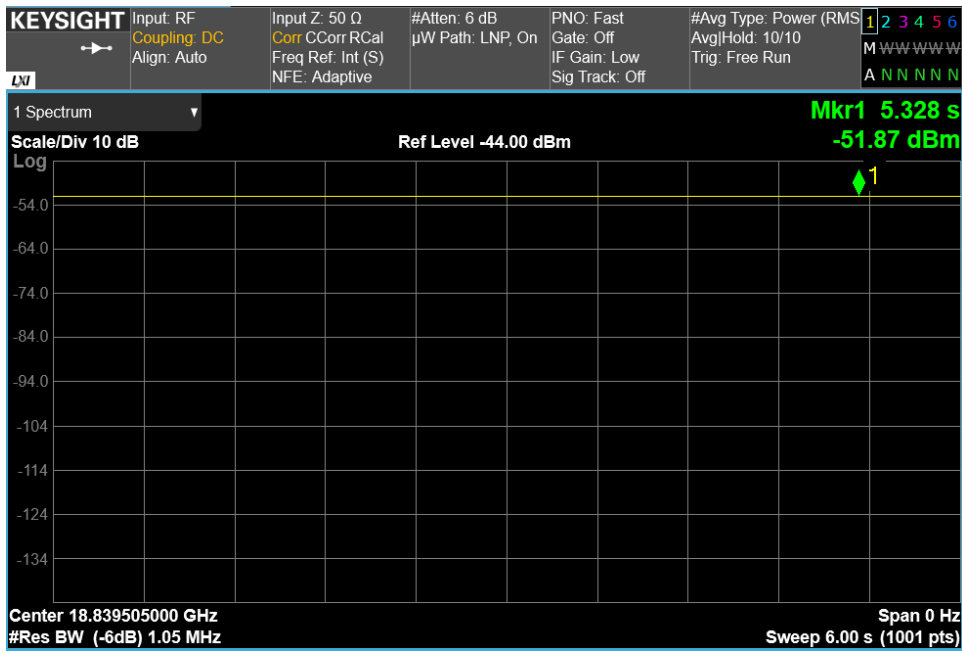
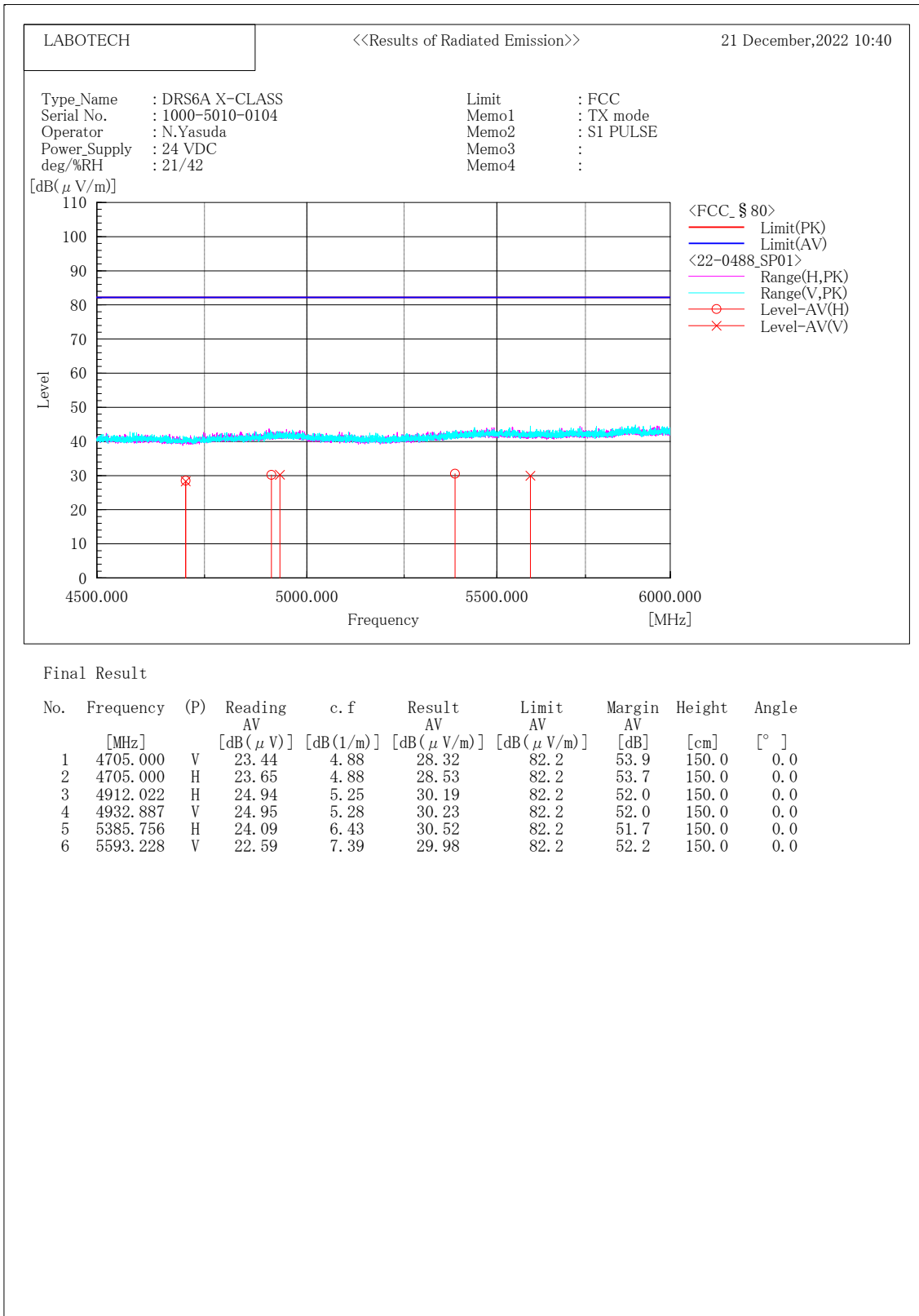


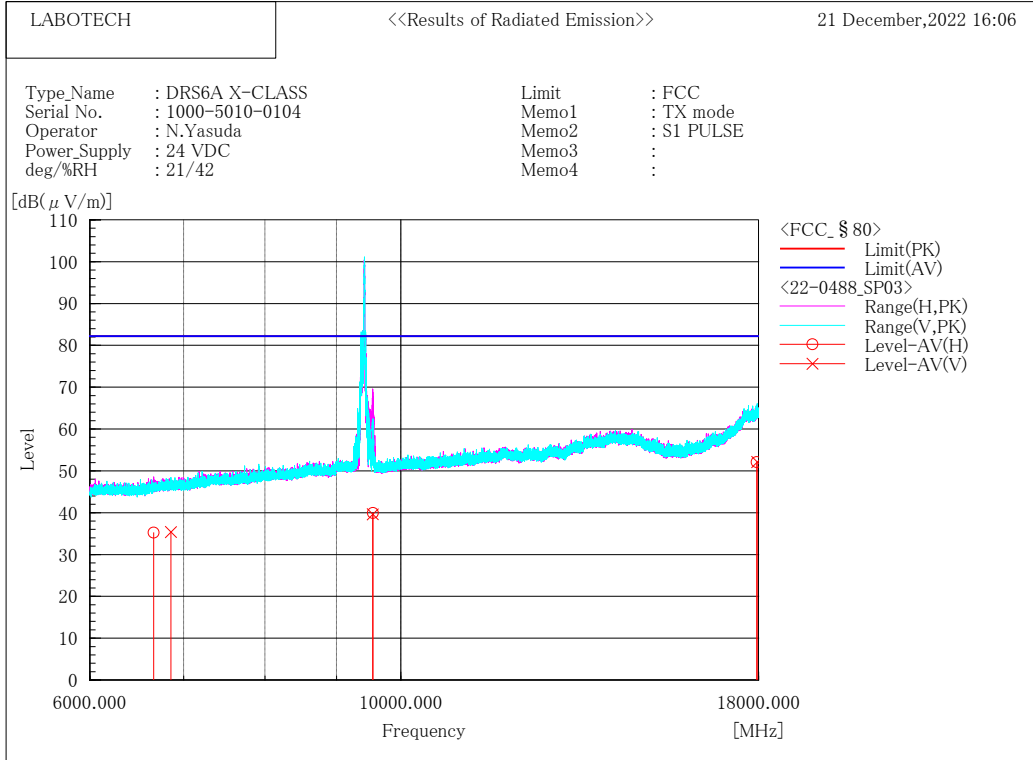
Fig 8.9 Average of the maximum peak value

# 9 Field Strength of Spurious Radiation Plots measured in the Spurious domain

## 9.1 Measured maximum emission value



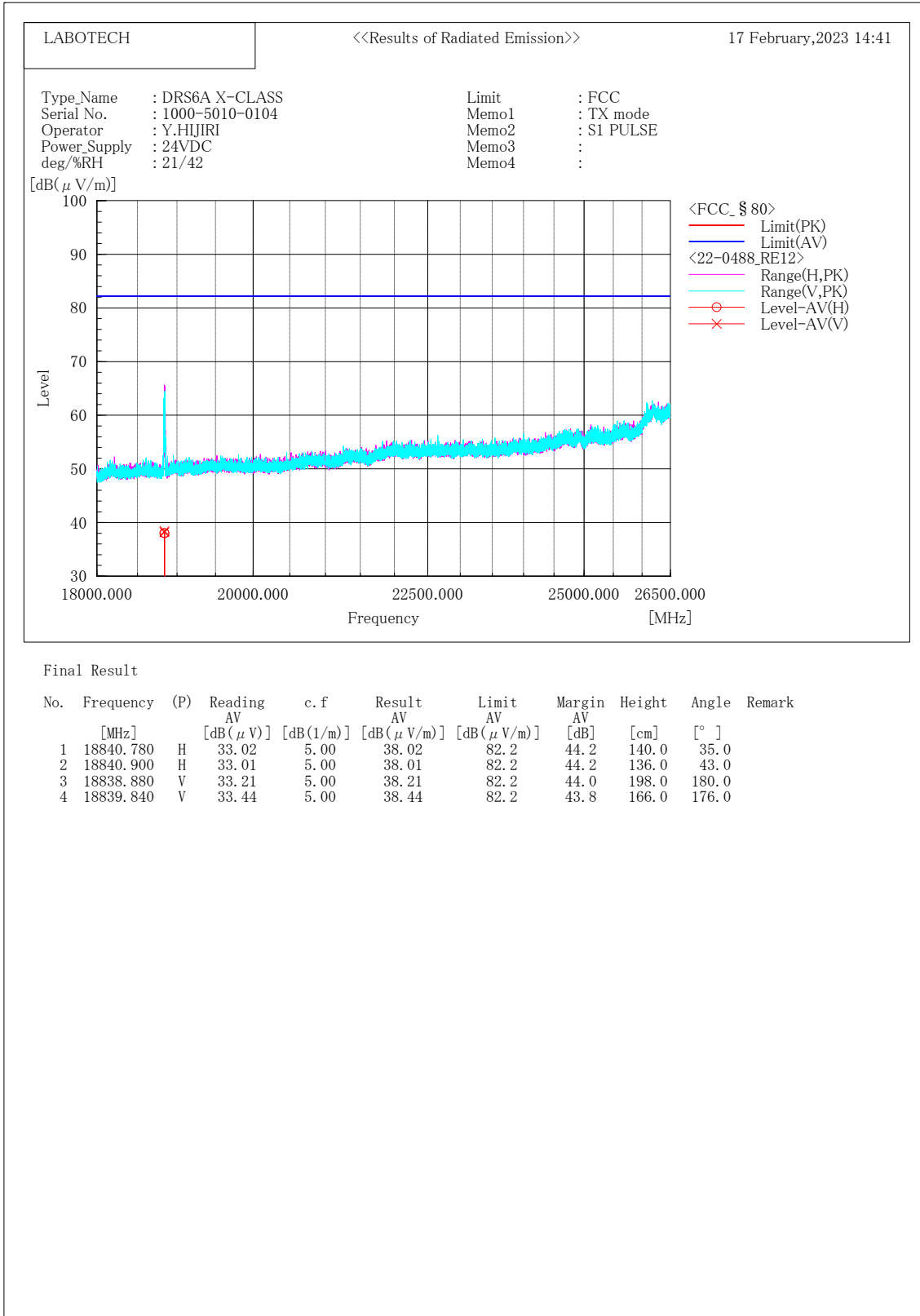
Note: Result AV (dBμV/m) = Reading (dBμV) + c.f (Antenna Factor (dB(1/m)) + Path Loss (dB))



Final Result

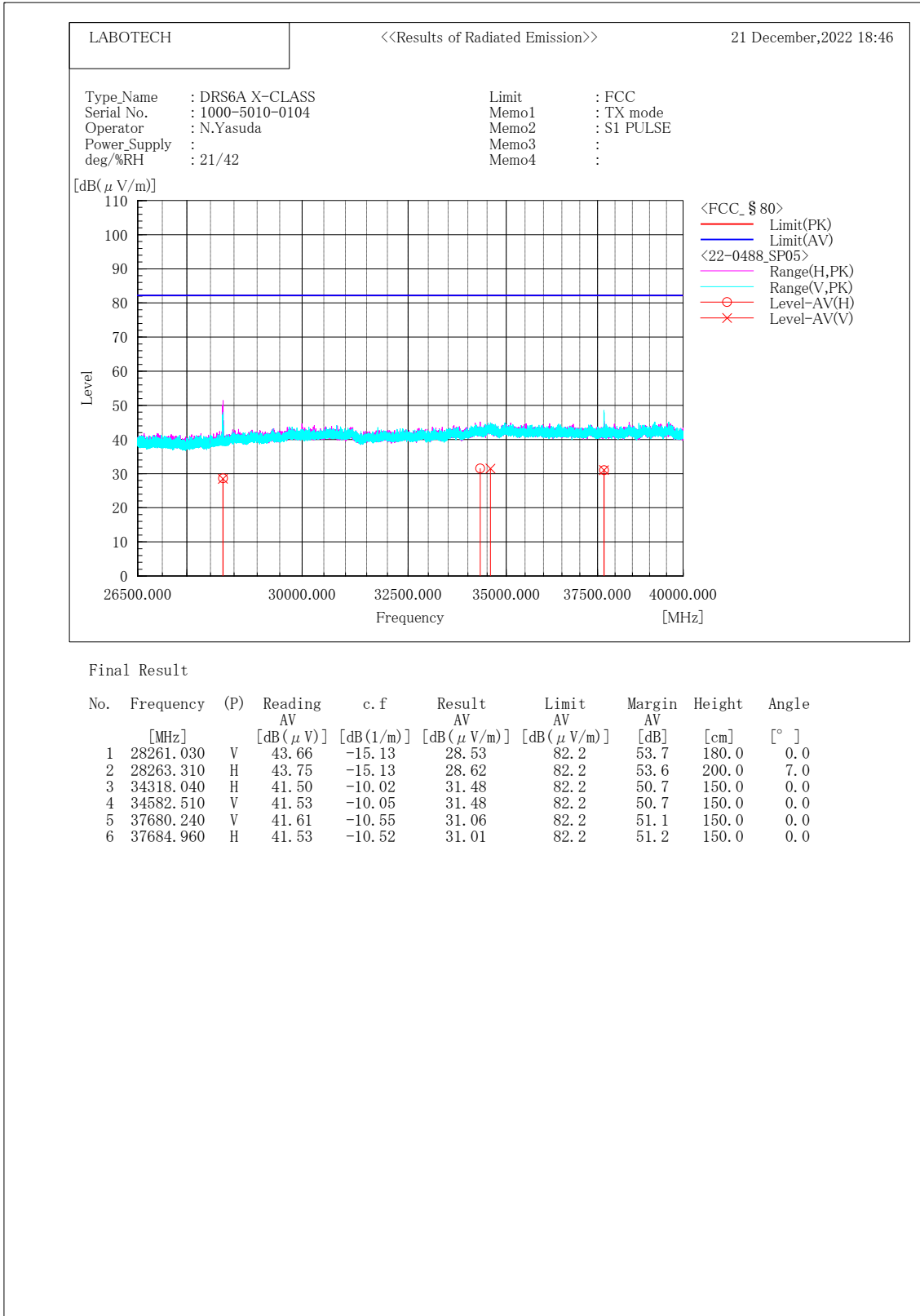
No.	Frequency [MHz]	(P)	Reading AV [dB(μV)]	c. f [dB(1/m)]	Result AV [dB(μV/m)]	Limit AV [dB(μV/m)]	Margin AV [dB]	Height [cm]	Angle [°]
1	6663.952	H	31.91	3.33	35.24	82.2	47.0	150.0	0.0
2	6854.265	V	31.73	3.70	35.43	82.2	46.8	150.0	0.0
3	9549.908	V	33.20	6.45	39.65	82.2	42.6	104.0	355.0
4	9551.260	H	33.46	6.45	39.91	82.2	42.3	170.0	353.0
5	17945.130	H	33.27	18.84	52.11	82.2	30.1	150.0	0.0
6	17958.850	V	33.26	18.87	52.13	82.2	30.1	150.0	0.0

Note: Result AV (dBμV/m) = Reading (dBμV) + c.f (Antenna Factor (dB(1/m))) + Path Loss (dB)



Note: Result AV (dBμV/m) = Reading (dBμV) + c.f (Antenna Factor (dB(1/m)) + Path Loss (dB))





Note: Result AV (dBμV/m) = Reading (dBμV) + c.f (Antenna Factor (dB(1/m)) + Path Loss (dB))

End of text