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 Radar Sensor DRS4DL X-Class**

Type : **RTR-136**

Report Number : LIC 12-24-043

Date of Issue : 17 May 2024

Labotech International Co., Ltd.

1-16, Fukazu-cho, Nishinomiya-shi, Hyogo, 663-8203 Japan

Tel: +81 (0) 798 63 1094 Fax: +81 (0) 798 63 1098

URL: https://www.labotech-intl.co.jp/

Table of contents

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) Kiwa Listed Testing Laboratory:
- listed by Kiwa Netherlands 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) 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

(6) CCS Recognized Test Agency:
- recognized by China Classification Society
- Recognition certificate number: DB21PAA00001 (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

(7) 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

(8) 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, and RF Exposure

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

1 Report Summary

LIC project number	:	LIC 04-23-0580
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 Radar Sensor DRS4DL X-Class
Type	:	RTR-136
Serial number	:	See Clause 2.1 of this report.
Product function and intended use	:	Ship radar station
Date of receipt of samples	:	8 February 2024
Test period	:	From 14 March 2024 to 25 March 2024
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

- Nishinomiya Lab.
FCC Test firm Designation Number: JP2010
FCC Test firm Registration Number: 696248
9-52 Ashihara-cho, Nishinomiya-shi, Hyogo, 662-8580 Japan

- Nishinomiya-Hama Lab.
FCC Test firm Designation Number: JP2011
FCC Test firm Registration Number: 738202
2-20, Nishinomiya-Hama, Nishinomiya-shi, Hyogo, 662-0934 Japan

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

Approved Date : 17 May 2024

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
--	--	--	--	--

Disclaimer:
Information in Clause 2 and information of the cable(s) used on this report have been provided by the customer. LIC would not be responsible for this information and the test results, if the test results were affected by the information provided by the customer.

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 DRS4DL X-Class

Name	Type	Serial number	Note
Radar Sensor	RSB-150-136	1001-1810-0001	(*)
Transceiver module	RTR-136		--
Scanner module	RSB-150		Antenna rotation rate: 24 rpm

(*1) Used for Field Strength of Spurious Radiation.

Name	Type	Serial number	Note
Radar Sensor	RSB-150-136	1001-1810-0002	(*)
Transceiver module	RTR-136		--
Scanner module	RSB-150		Antenna rotation rate: 24 rpm

(*) Used for the tests other than Field Strength of Spurious Radiation.

Associated units (AU)

Name	Type	Serial number	Manufacturer
DISPLAY UNIT	FR-8 (RDP-162)	1001-7910-0001(*1)	FURUNO
		1001-7910-0002(*2)	

(*1) Used for Field Strength of Spurious Radiation.
(*2) Used for the tests other than Field Strength of Spurious Radiation.

Auxiliary Equipment (AE)

Name	Type	Serial number	Manufacturer
Dummy Load	4D376	R27200015	SPC

(d) FCC ID: ADB9ZWRTR136

(e) Primary function: Ship radar station operating in the band 9300 MHz – 9500 MHz

(f) Frequency range: Fixed frequency, 9410 MHz ± 30 MHz

(g) Type of emission: P0N

(h) Occupied bandwidth:

Pulse type	S	M	L
Occupied bandwidth (MHz)	43.23	23.75	14.49

Note: measured data

(i) Size and mass: 488 mm (ϕ) × 220 mm (H), 5.6 kg

(j) Power supply: 12–24 VDC

2.1.2 Transceiver module

Type: RTR-136 (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: M1653
- Peak output power: 4 kW nominal
- Fundamental frequency: 9410 MHz
- Manufacturing: ±30 MHz
- Pulling: 1.5 MHz
- Tolerance for 20°C temperature variation: -5 MHz

(c) Pulse characteristics:

Pulse type	S	M	L
Pulse length (μs)	0.08	0.30	0.80
PRF(Hz)	360	360	360

2.1.2.2 Modulator

(a) FET Type: FMC20N50E

Trigger Voltage: Approx. +11.5 VDC positive

2.1.2.3 Receiver

(a) Passband

RF Stage: 300 MHz

IF Stage:

Pulse type	S	M	L
Pass band (MHz)	19	4.5	4.5

(b) Intermediate Frequency: 60 MHz

(c) Gain (overall): Approximately 14 dB

(d) Overall Noise Figure: 6.5 dB (typical)

(e) Video Output Voltage: 2 V_{p-p}

(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)

(h) Frequency adjustable range: 9410 MHz (center) ± 30 MHz

2.1.3 Antenna and Scanner

(a) Antenna specifications

Antenna model		03P9458
Length (mm)		425
Rotation diameter (mm)		488
Transmission frequency		9410 ± 30 MHz
Horizontal beam width (-3 dB)		5.2°
Vertical beam width		25°
Side lobe (max.)	Less than ±20°	-23 dB
	Outside ±20°	-25 dB
Gain		21.5 dBi
Radiator		Patch array
Polarization		Horizontal
Type of beam		Vertical fan

(b) Antenna Rotation ON-OFF Switch: Not provided

(c) Scanning (rotating or oscillating): Rotating mechanically scanned antenna

(d) Antenna Rotation Rate: 24 rpm

(e) Sector Scan: 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 – IP26)

(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 measurements for the frequency below 6.54 GHz and the frequency range between 15.6 GHz to 15.7 GHz were unmeasurable due to the large path loss. The measurement results for the frequency below 6.54 GHz and the frequency range between 15.6 GHz to 15.7 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 H. Uchida

4 Test Results

4.1 RF Power Output

4.1.1 Test conditions:

For all TX (S/M/L) pulses, the transmitter output power was measured at the antenna port with a non-reflective load as a substitute for the antenna.

4.1.2 Test setup:

See Clause 5.

4.1.3 Test Results:

Complied.

Pulse type	S	M	L
Transmission mean power Pm (W)	0.1	0.3	0.9
Pulse length *T* (μs) (50% points)	0.077	0.303	0.792
Pulse Repetition Frequency (PRF) (Hz)	360	360	360
Transmission pulse power Pp (kW) (*)	3.1	3.1	3.1

(*) P_p (kW) = (P_m (W) / (*T* (μs) × *PRF* (Hz))) × 1000

where,

P_m (W) = AV measurement (mW) × $10^{(\text{pathloss (dB)} / 10)}$ / 1000

Environmental conditions observed: On 14 March 2024, 25°C to 25°C, 52%RH to 52%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	S	M	L
Pulse length T (μs) (50% points)	0.077	0.303	0.792
Rise time t_r (μs) (10 to 90% amplitude)	0.020	0.020	0.022
Fall time t_f (μs) (90 to 10% amplitude)	0.070	0.073	0.114
Pulse Repetition Frequency (Hz)	360	360	360

Measured Plots: See Clause 7.

Environmental conditions observed: On 14 March 2024, 25°C to 25°C, 52%RH to 52%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 (S/M/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: 12-24 VDC

V_L: 10.2 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	S	M	L
Guard Band f(1.5/T) (MHz) (*1)	19.5	5.0	1.9
Upper limit (MHz) (*2)	9480.5	9495.0	9498.1
Lower limit (MHz) (*2)	9319.5	9305.0	9301.9

(*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 (MHz)
Lower limit frequency, f(L) = 9300 +1.5/T (MHz)

4.3.4 Test Results:

Complied.

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

Pulse type		S	M	L	Result
Frequency at maximum emission (MHz)	-20°C	9417.8	9415.9	9415.0	Complied.
	-10°C	9417.0	9414.6	9413.3	Complied.
	0°C	9415.0	9412.7	9411.9	Complied.
	+10°C	9413.4	9411.2	9410.3	Complied.
	+20°C	9411.5	9409.4	9408.6	Complied.
	+30°C	9409.7	9407.6	9406.7	Complied.
	+40°C	9408.0	9405.8	9404.8	Complied.
	+50°C	9406.3	9404.3	9403.5	Complied.

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

Pulse type		S	M	L	Result
Frequency at maximum emission (MHz)	V_L	9411.8	9409.4	9408.7	Complied.
	V_{nom}	9411.5	9409.4	9408.6	Complied.
	V_H	9411.7	9409.5	9408.5	Complied.

Environmental conditions observed: On 14 March 2024, 23°C to 25°C, 45%RH to 47%RH
On 18 March 2024, 20°C to 24°C, 56%RH to 46%RH
On 19 March 2024, 22°C to 25°C, 47%RH to 41%RH

Power supply voltage measured: 24 VDC to 24 VDC

4.4 Occupied Bandwidth

4.4.1 Test conditions:

For S pulse, the transmitter output power was measured at the antenna port with a non-reflective load as a substitute for the antenna.

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)	Emission attenuation (mean power, dB)
50 to 100% (of the authorized bandwidth) (*2)	At least 25
100 to 250% (of the authorized bandwidth) (*2)	At least 35
more than 250% (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 band width = 200 MHz (for X-band radars)

4.4.4 Test Results:

Complied.
Spectrum plots: See Clause 8.1.

Environmental conditions observed: On 19 March 2024, 25°C to 25°C, 41%RH to 41%RH
Power supply voltage measured: 24 VDC to 24 VDC

4.5 Spurious Emissions at Antenna Terminals

4.5.1 Test Conditions:

(a) For S pulse, the transmitter output power was measured at the antenna port with a non-reflective load converter as a substitute for the antenna. (*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)
7.75999375	-52.15	-13.0	39.15

Spectrum plots: See Clause 8.2.

Environmental conditions observed: On 22 March 2024, 24°C to 25°C, 57%RH to 63%RH
On 25 March 2024, 23°C to 27°C, 53%RH to 46%RH

Power supply voltage measured: 24 VDC to 24 VDC

4.6 Field Strength of Spurious Radiation

4.6.1 Test Conditions:

(a) For S pulse, the transmitter output power was measured at the antenna port with a non-reflective load as a substitute for the antenna. (*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) A radio wave absorber was attached to the antenna.

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_0 (GHz)	$1/2f_0$	$2f_0$	$3f_0$	$4f_0$
9.410	4.705	18.820	28.23	37.64

4.6.7 Test Results:

Complied.

Measured maximum emission value

Frequency (GHz)	Level (dBμV/m)	Limit (dBμV/m) (*)	Margin (dB)
18.978340	68.85	82.2	13.4

(*) -13 dBm = 82.2 dBμV/m (3 m) (Refer to ITU-R SM.329-12/ Annex 1, Section 3.)

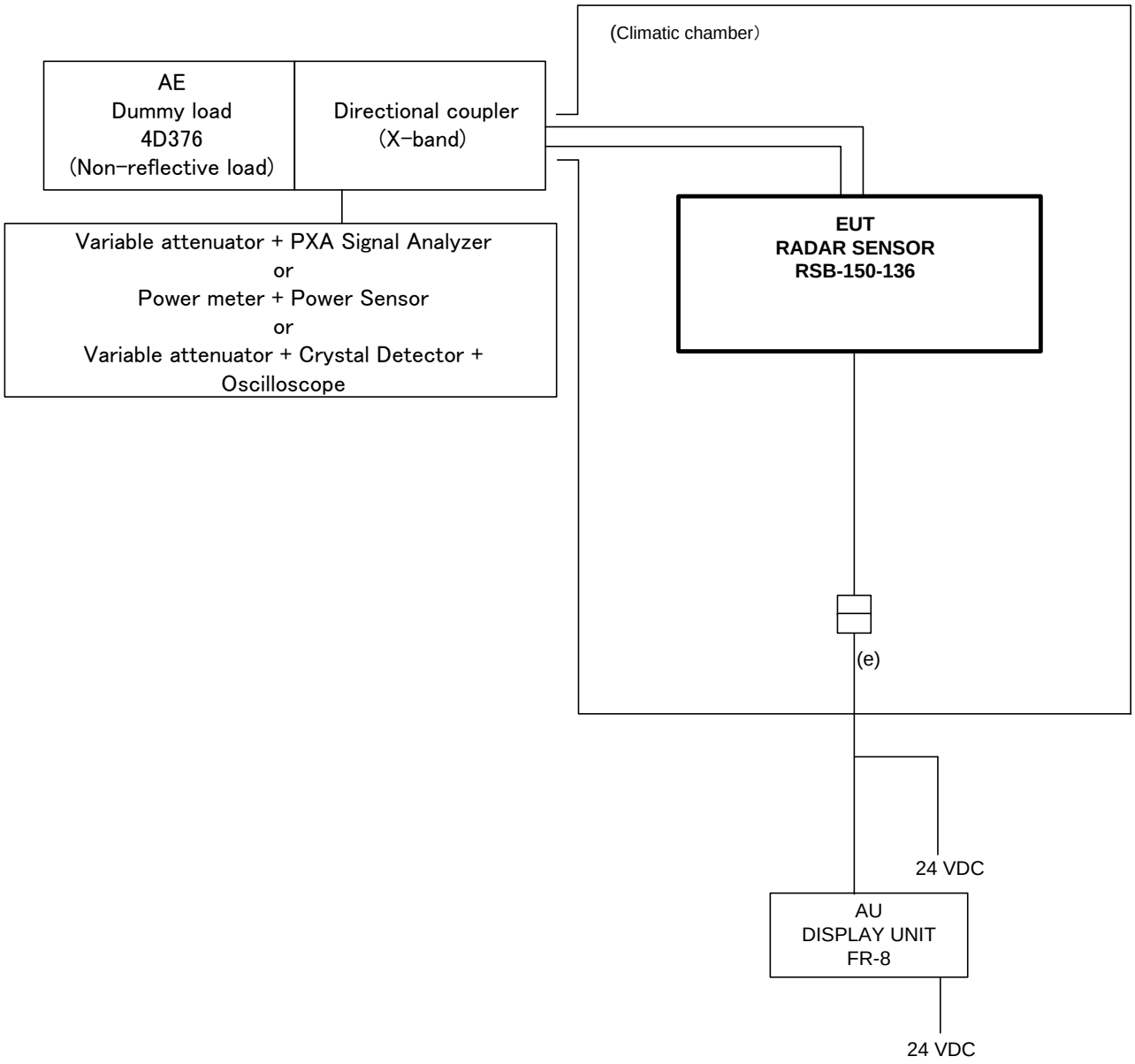
Spectrum plots: See Clause 9.

Environmental conditions observed: On 19 February 2024, 20°C to 20°C, 64%RH to 64%RH
On 20 February 2024, 20°C to 20°C, 68%RH to 68%RH

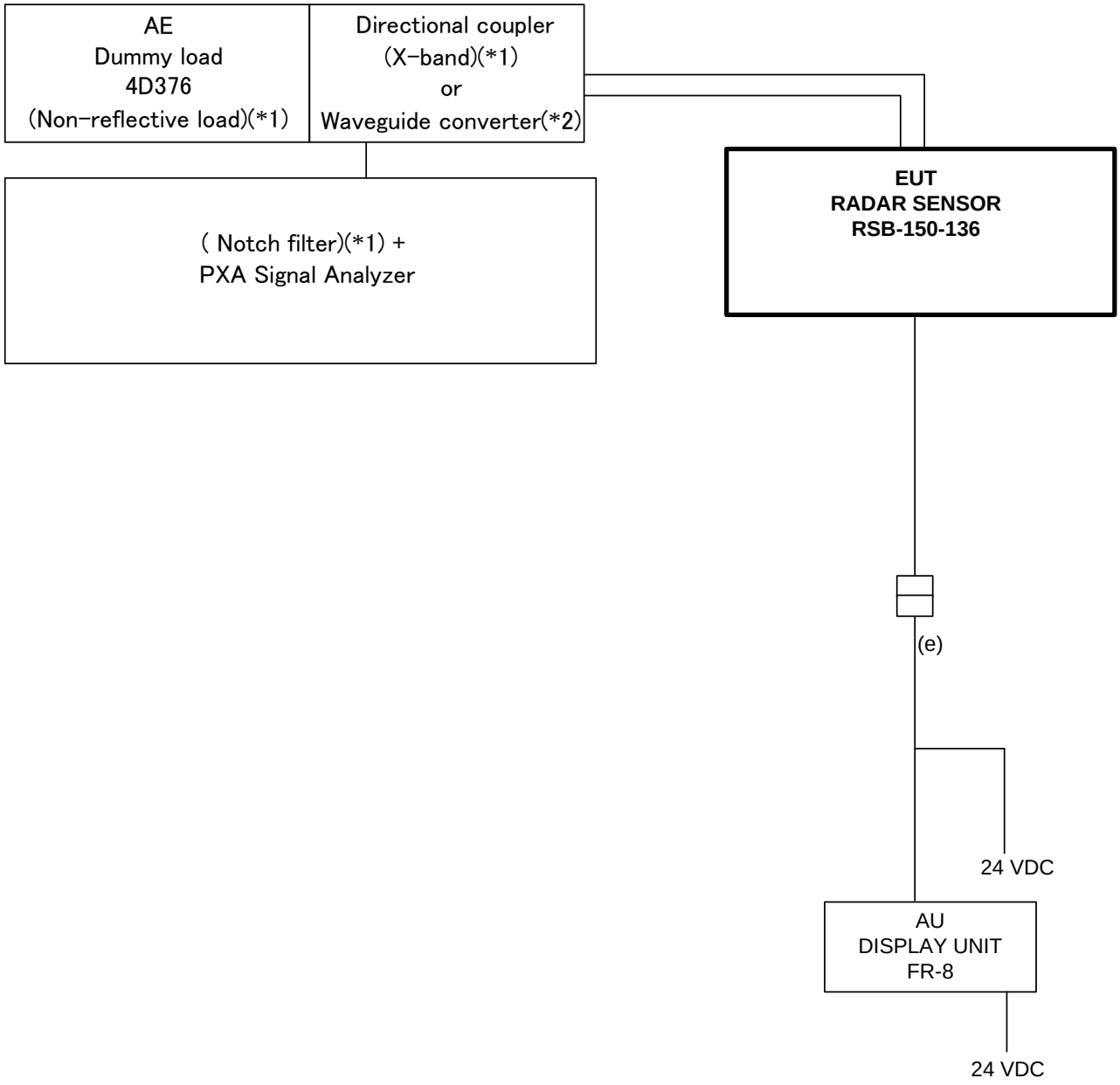
Power supply voltage measured: 24 VDC to 24 VDC

5 Test Setup for Measurements

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

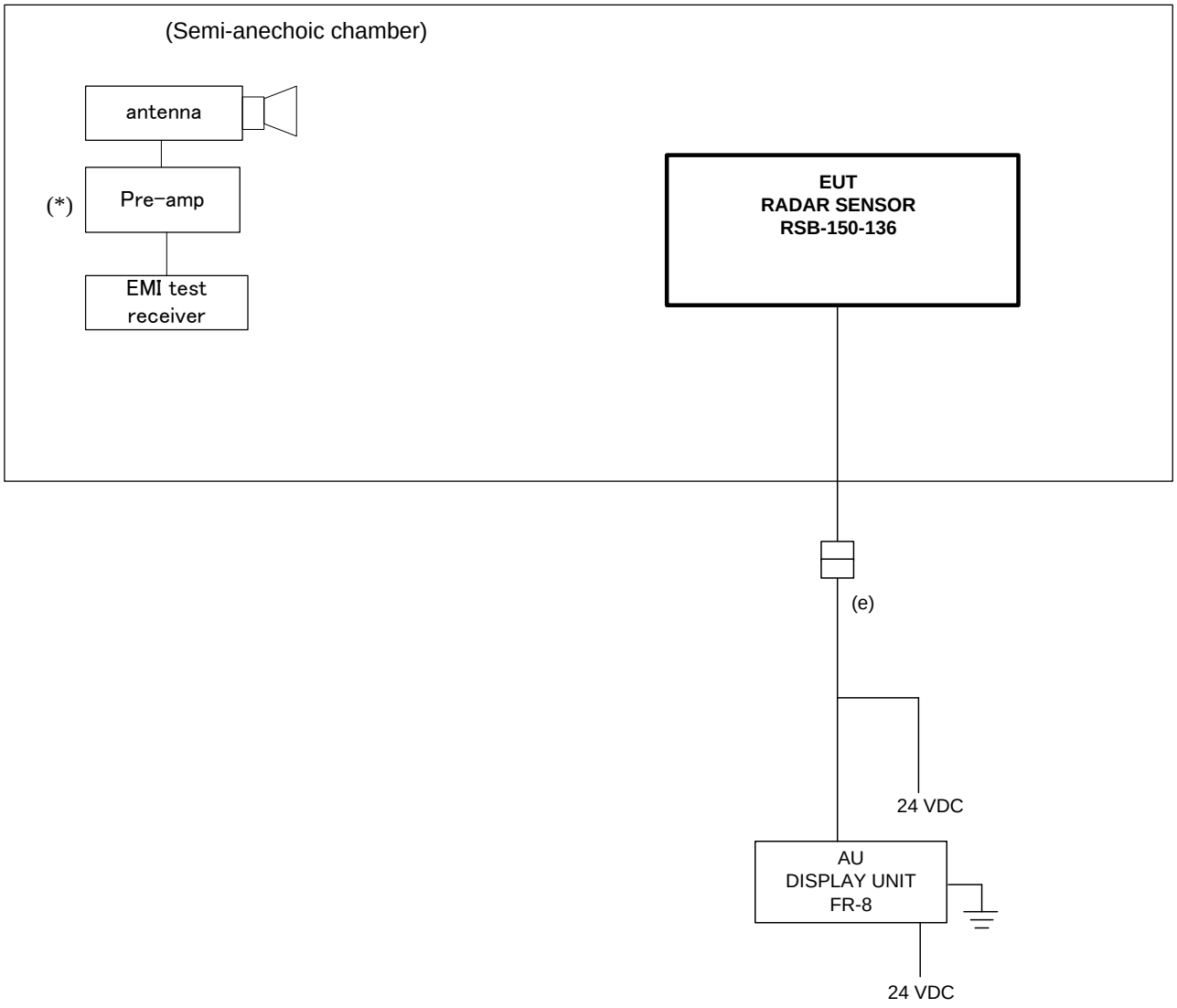


5.2 Test Setup for Clause 4.5



(*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
e	P/S	Antenna unit cable	FRU-2P5S-FF-20M-A	20	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	21 May 2023	1 year
RT200	Power meter	E4419B	MY45101375	Agilent	3 April 2023	1 year
RT201	Power sensor	8481A	2349A39603	Agilent	28 March 2023	1 year
RT213	Waveguide	WRJ-10	--	Furuno	31 July 2023	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	28 February 2024	1 year
HT1223	Attenuator	8495B	MY42148137	Keysight	22 December 2023	1 year
HT972	Oscilloscope	MSO4054B	C030483	Tektronix	9 January 2024	1 year
RT366	Climatic chamber(Small)	PL-4J	15030353	Espec	2 January 2024	1 year
HT688	Digital multimeter	115	10821184	Fluke	14 November 2023	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	21 May 2023	1 year
RT213	Waveguide	WRJ-10	--	Furuno	31 July 2023	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	28 February 2024	1 year
HT1223	Attenuator	8495B	MY42148137	Keysight	22 December 2023	1 year
HT1317	PXA Signal Analyzer	N9030B	SG57142024	Keysight	29 December 2023	1 year
RT366	Climatic chamber(Small)	PL-4J	15030353	Espec	2 January 2024	1 year
HT688	Digital multimeter	115	10821184	Fluke	14 November 2023	1 year
HT1221	Crystal detector	423B	MY51342422	Agilent	3 April 2023	1 year
HT972	Oscilloscope	MSO4054B	C030483	Tektronix	9 January 2024	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	21 May 2023	1 year
RT213	Waveguide	WRJ-10	--	Furuno	31 July 2023	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	28 February 2024	1 year
HT1223	Attenuator	8495B	MY42148137	Keysight	22 December 2023	1 year
HT1317	PXA Signal Analyzer	N9030B	SG57142024	Keysight	29 December 2023	1 year
RT366	Climatic chamber(Small)	PL-4J	15030353	Espec	2 January 2024	1 year
HT688	Digital multimeter	115	10821184	Fluke	14 November 2023	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	21 May 2023	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	28 February 2024	1 year
HT1223	Attenuator	8495B	MY42148137	Keysight	22 December 2023	1 year
HT1317	PXA Signal Analyzer	N9030B	SG57142024	Keysight	29 December 2023	1 year
RT366	Climatic chamber(Small)	PL-4J	15030353	Espec	2 January 2024	1 year
HT688	Digital multimeter	115	10821184	Fluke	14 November 2023	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	21 May 2023	1 year
--	Adapter	X281A	--	Hewlett Packard	Not applicable.	--
--	Adapter	BLOO-6256-00	--	Agilent	Not applicable.	--
--	Adapter	QWA28S29F	--	QUINSTAR	1456000016	--
--	Isolator	OMC FX0157	--	--	Not applicable.	--
HT1328	Notch filter	BRC20663	001	Micro-Tronics	11 August 2023	1 year
HT1317	PXA Signal Analyzer	N9030B	SG57142024	Keysight	29 December 2023	1 year
HT461	Digital multimeter	111	78410077	Fluke	9 February 2024	1 year
KB288	Coaxial cable	SF104A/11PC35/11 PC35/5500MM	800047/4A	HUBER+ SUHNER	11 August 2023	1 year
KB181	Coaxial cable	SUCOFLEX 102A	1261/2A	HUBER+ SUHNER	11 August 2023	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	28 February 2024	1 year
HT1223	Attenuator	8495B	MY42148137	Keysight	22 December 2023	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: 23 December 2022	3 years
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	11 August 2023	1 year
NK004	Double rigged horn antenna (1 GHz to 18 GHz)	TR17206	93370015	Advantest	18 August 2023	1 year
HT761	Double rigged horn antenna & amp. (18 GHz to 26 GHz)	HAP18-26N	B2010482304-144	Toyo	5 June 2023	1 year
HT762	Double rigged horn antenna & amp. (26 GHz to 40 GHz)	HAP26-40N	00000010	Toyo	6 December 2023	1 year
HT866	Digital multimeter	115	19170029	Fluke	27 February 2024	1 year

7 RF Envelope and Spectrum of the Output Pulse

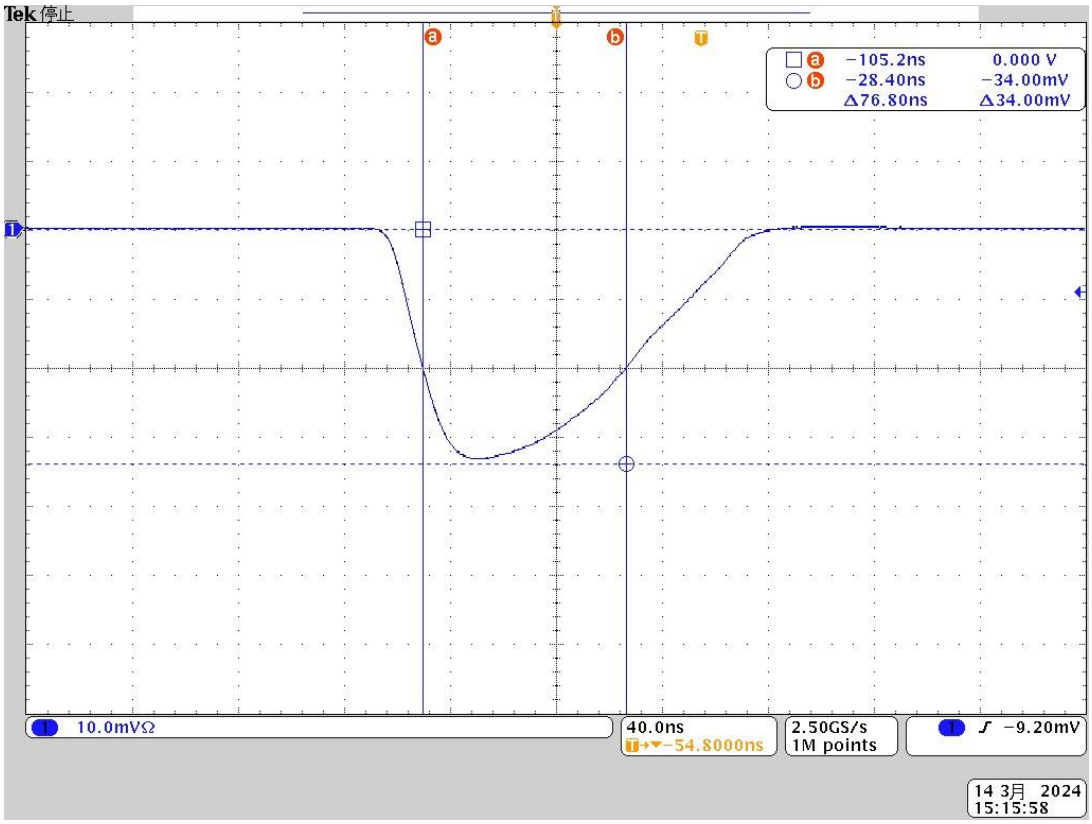


Fig. 7.1 S pulse envelope

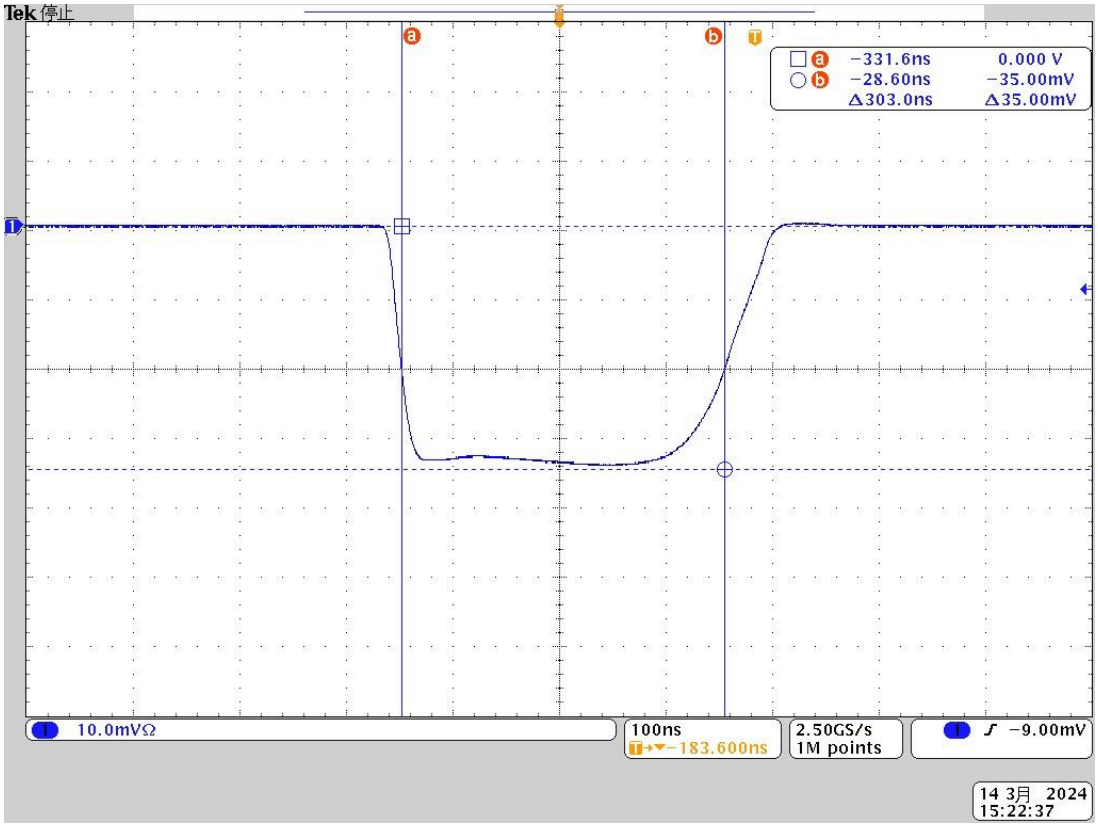


Fig. 7.2 M pulse envelope

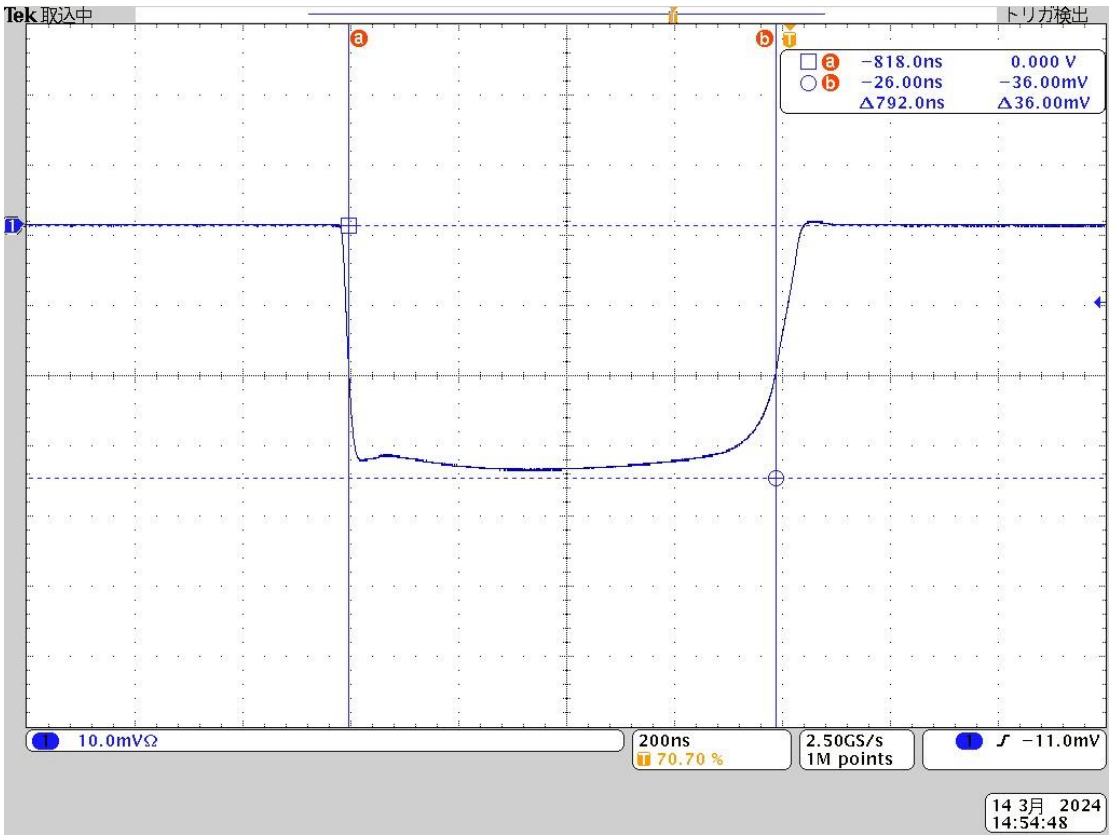


Fig. 7.3 L pulse envelope

8 Spurious Emission Plots measured at Antenna Terminal

8.1 Occupied Bandwidth

Occupied Bandwidth: 43.230 MHz

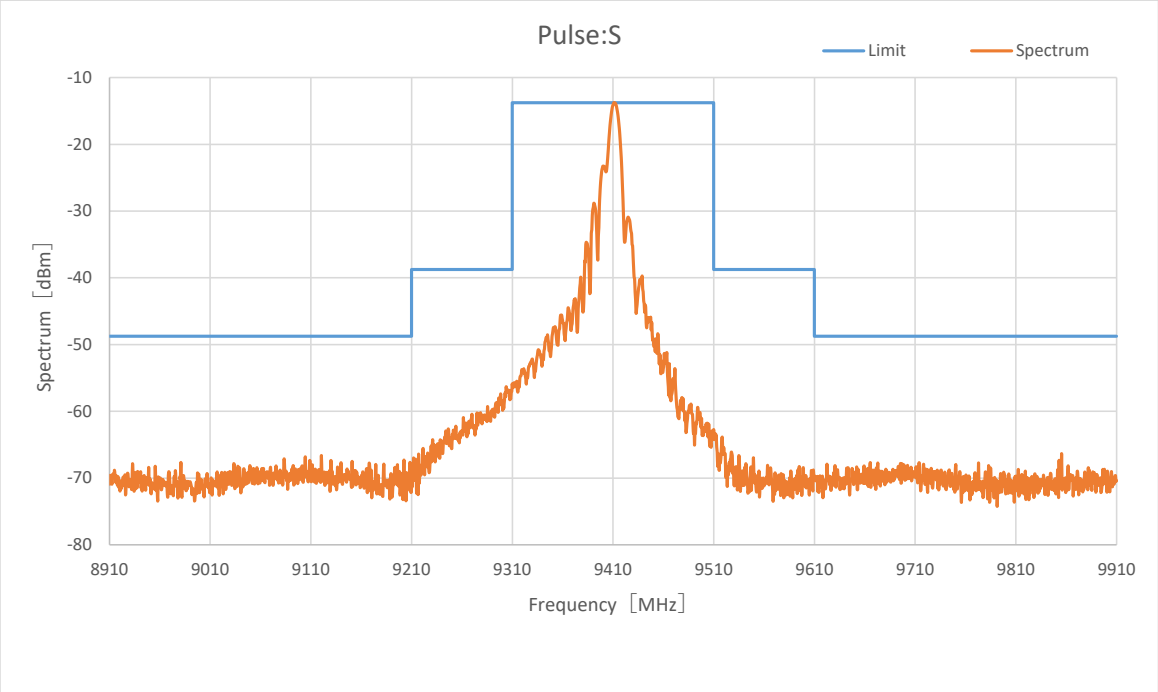


Fig. 8.1 S pulse

Occupied Bandwidth: 23.747 MHz

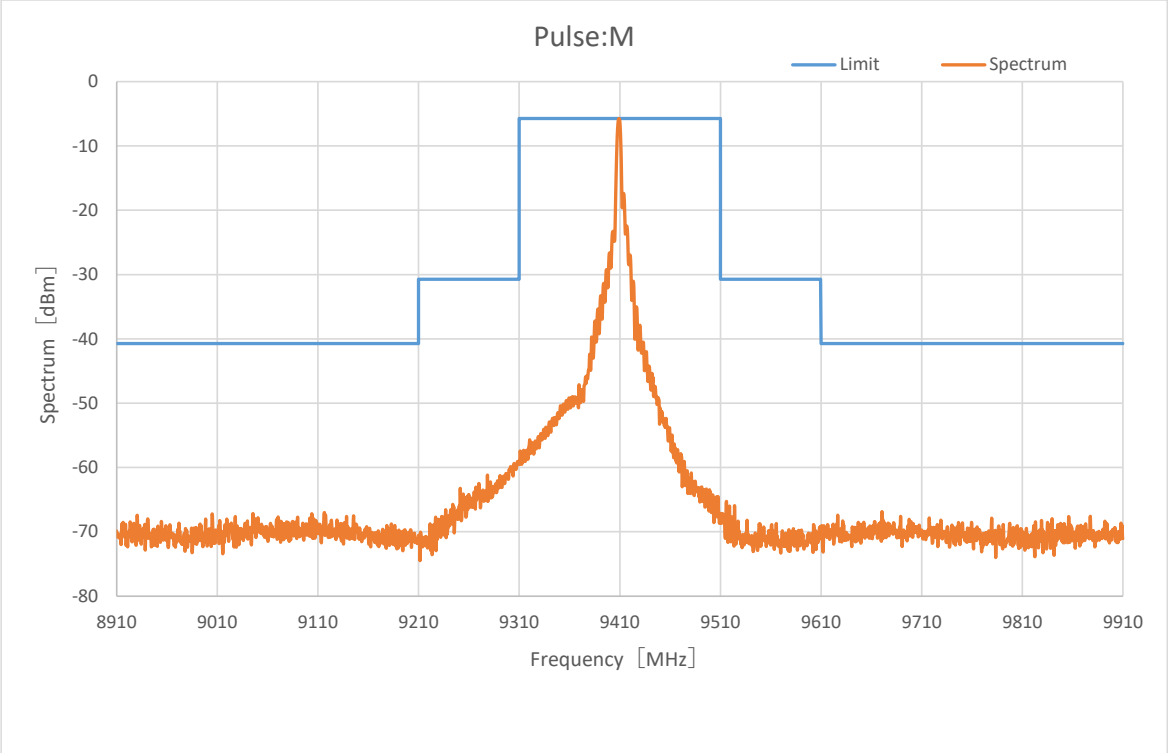


Fig. 8.2 M pulse

Note: Spectrum (dBm) = PK measurements (dBm) + pathloss (dB).

Occupied Bandwidth: 14.488 MHz

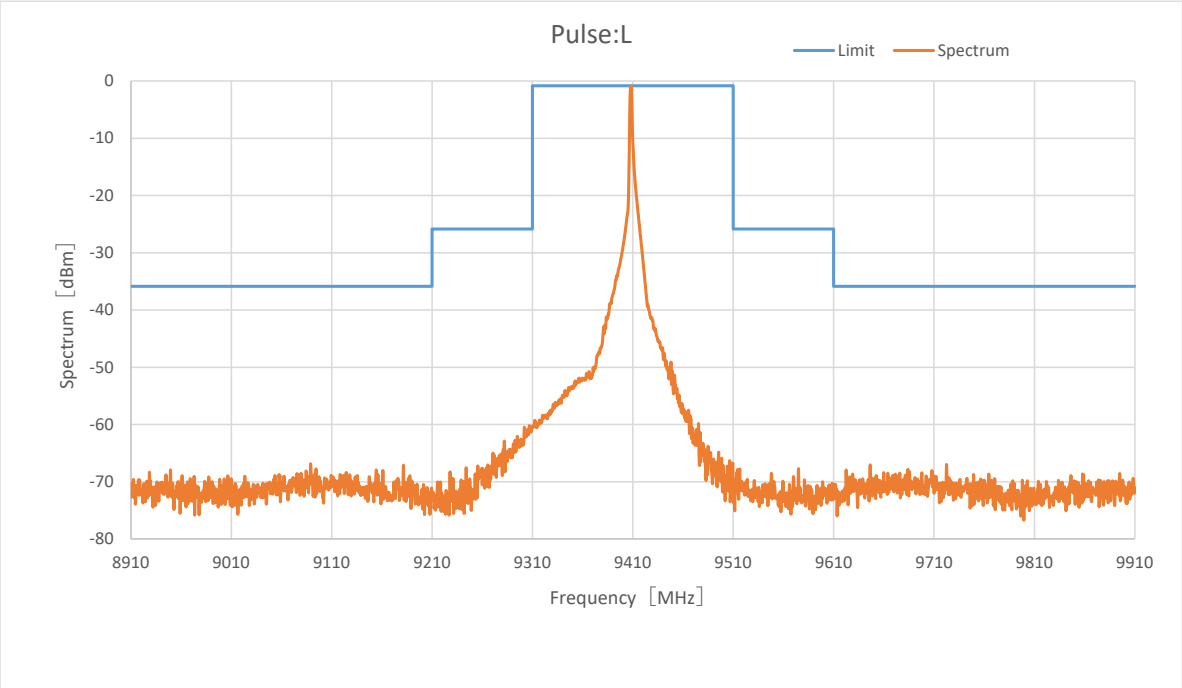


Fig. 8.3 L pulse

Note: Spectrum (dBm) = PK measurements (dBm) + pathloss (dB).

8.2 Spurious Emissions

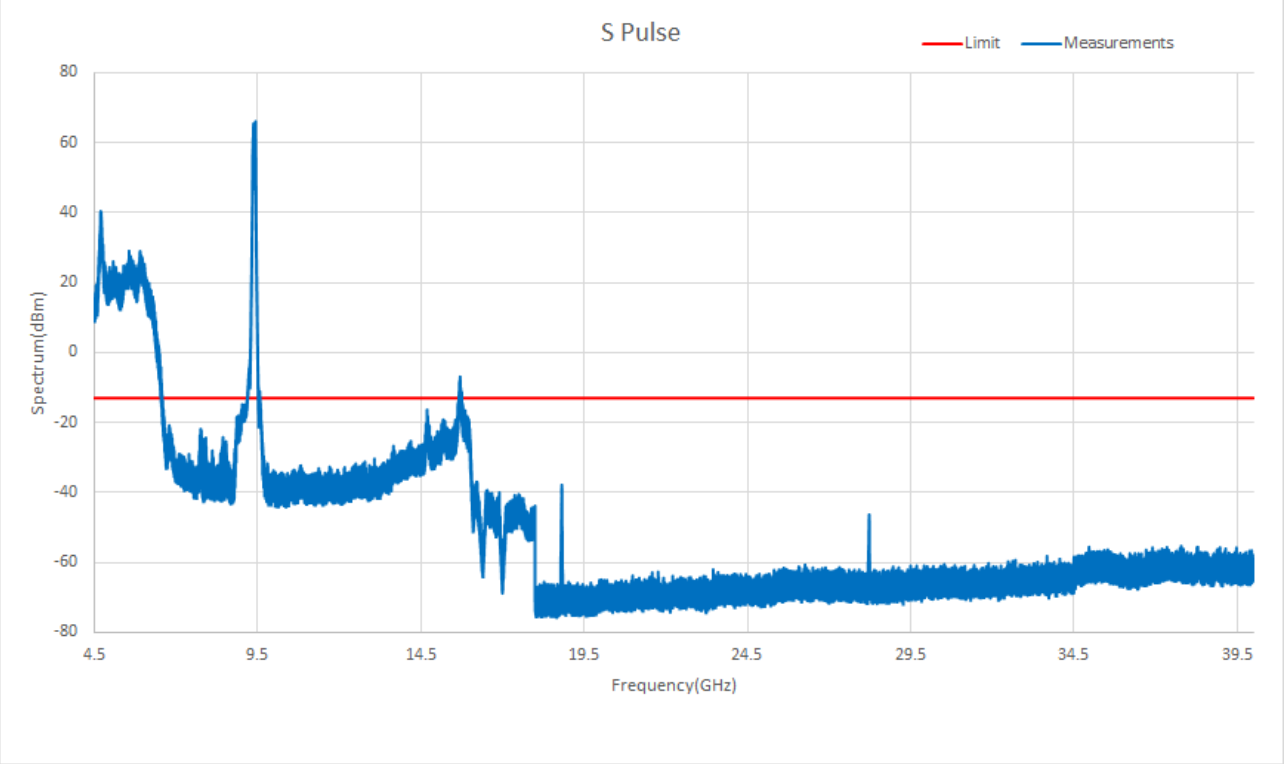


Fig 8.4 Peak, 4.5 GHz to 40 GHz

Note: The measurements for the frequency below 6.54 GHz and the frequency range between 15.6 GHz to 15.7 GHz were unmeasurable due to the large path loss even though the EUT operation was OFF.

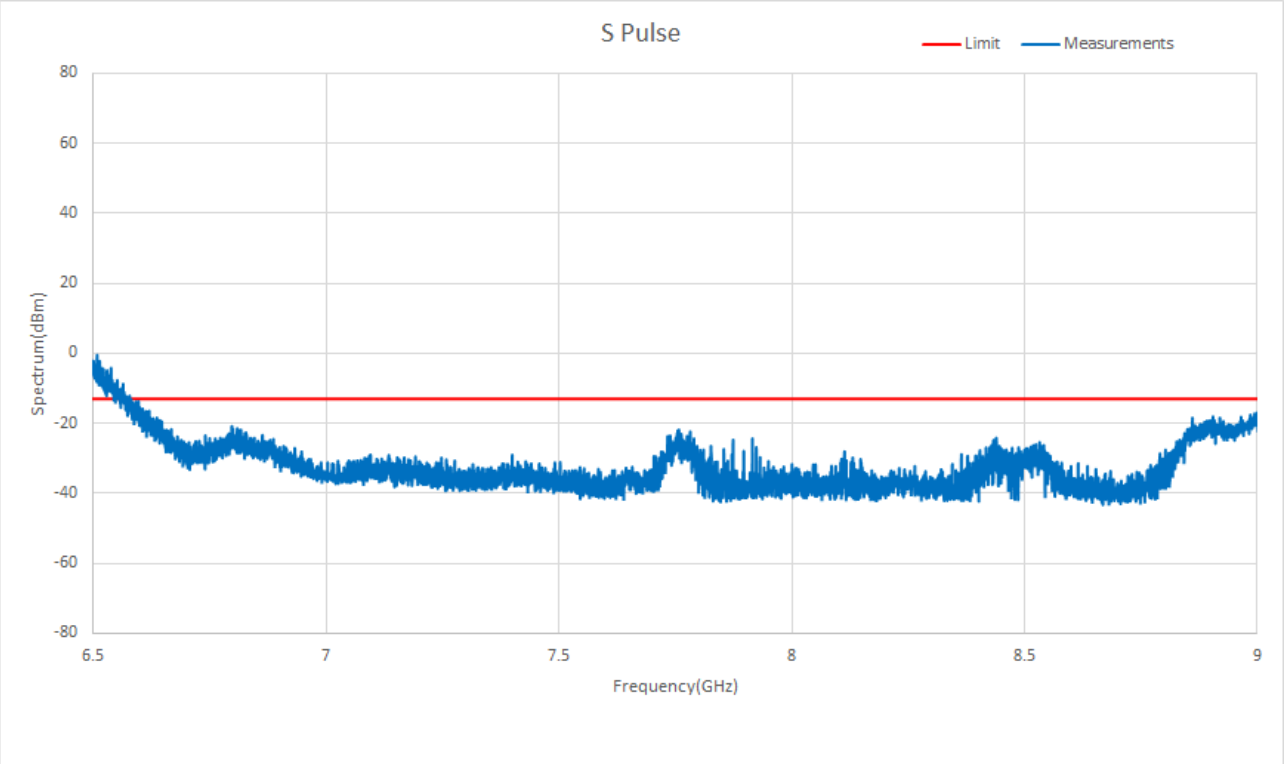


Fig 8.5 Peak, 6.5 GHz to 9.0 GHz (maximum peak value)
Note: Spectrum (dBm) = PK measurements (dBm) + pathloss (dB).

Compared average values of the frequencies around 7.7 GHz and 8.9 GHz.
The larger average value is shown in Fig 8.6.

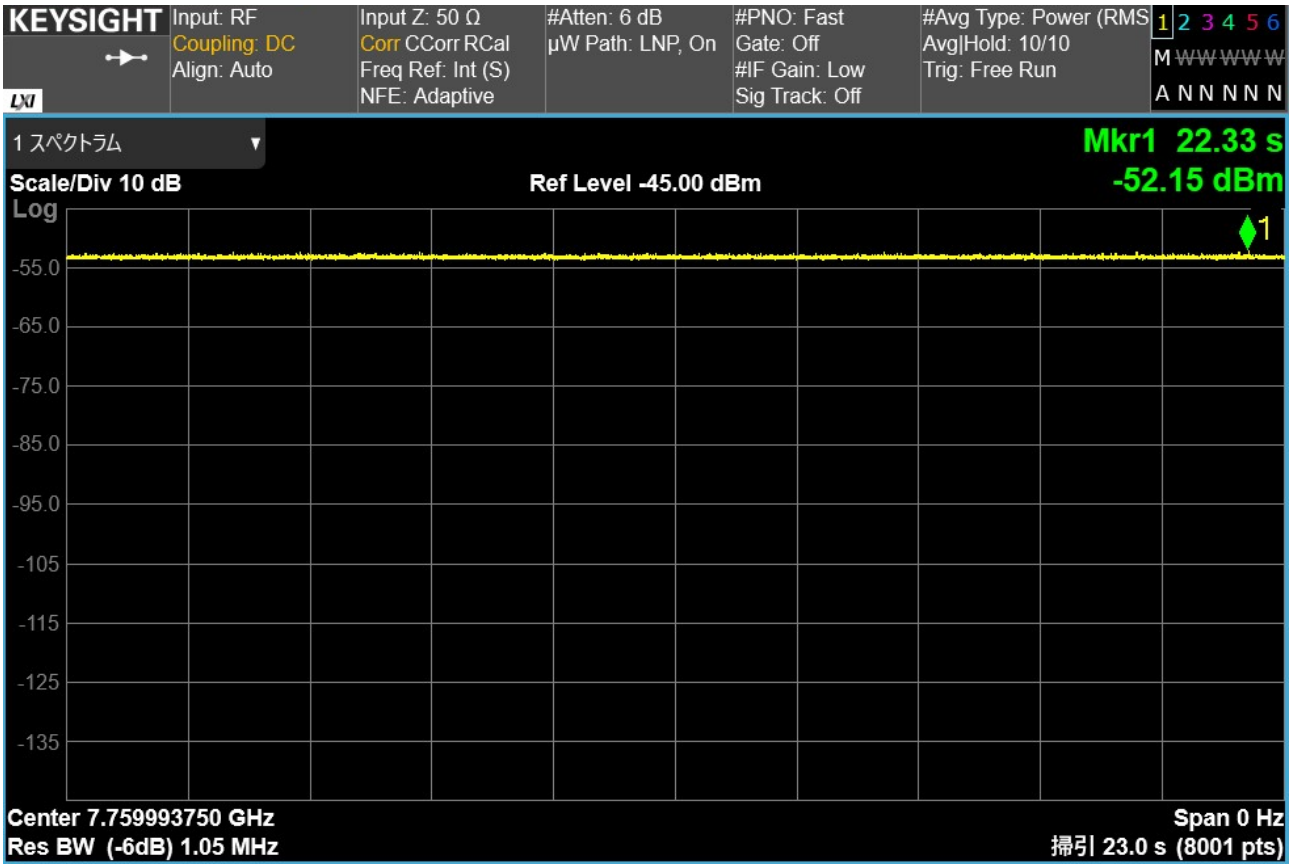
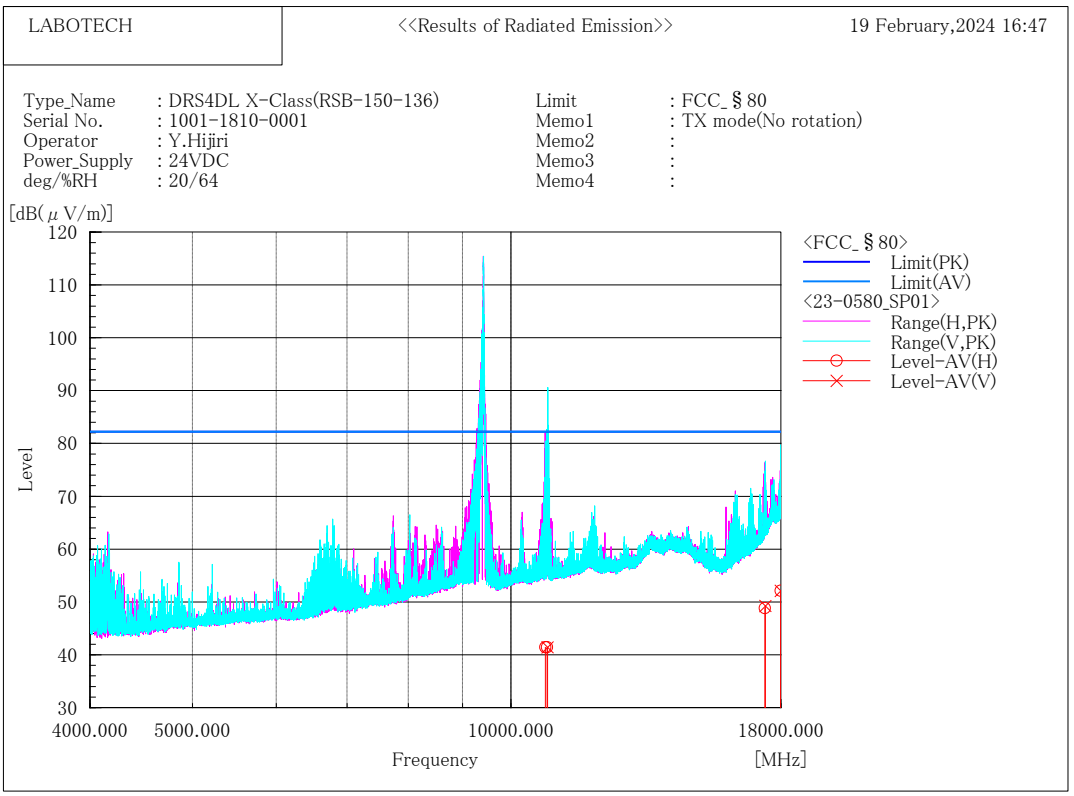


Fig 8.6 Maximum average value

Note: Spectrum (dBm) = AV measurements (dBm) + pathloss (dB).

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

9.1 Measured maximum emission value



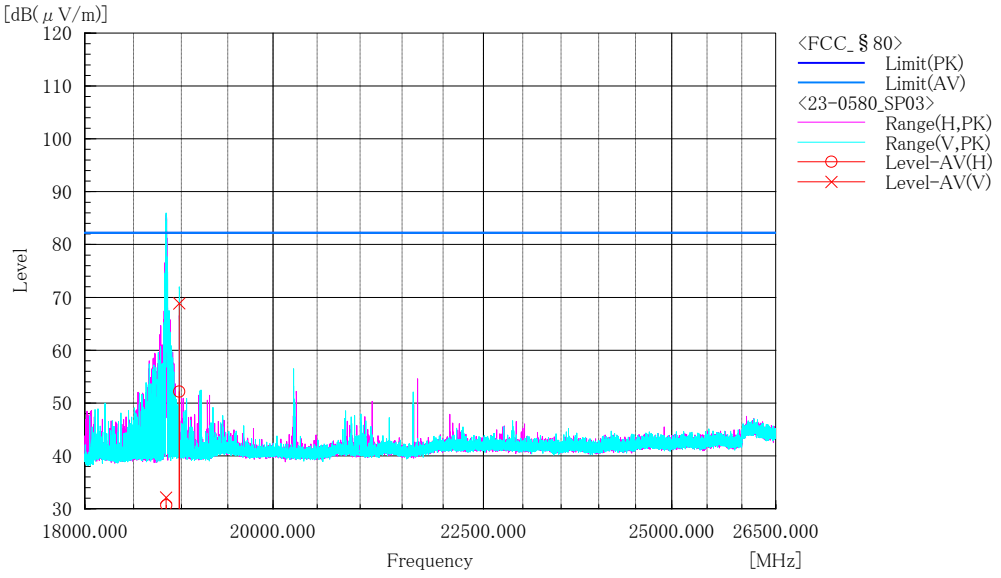
Final Result

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	10778.870	H	32.84	8.58	41.42	82.2	40.8	140.0	138.0
2	10818.820	H	32.82	8.61	41.43	82.2	40.8	313.0	202.0
3	10828.670	V	32.82	8.62	41.44	82.2	40.8	377.0	185.0
4	17380.780	H	32.46	16.36	48.82	82.2	33.4	121.0	330.0
5	17401.800	V	32.75	16.52	49.27	82.2	32.9	150.0	66.0
6	17994.070	V	32.74	19.39	52.13	82.2	30.1	165.0	73.0
7	17994.610	H	32.71	19.39	52.10	82.2	30.1	105.0	124.0

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

LABOTECH <<Results of Radiated Emission>> 20 February,2024 13:39

Type_Name	: DRS4DL X-Class(RSB-150-136)	Limit	: FCC_§80
Serial No.	: 1001-1810-0001	Memo1	: TX mode(No rotation)
Operator	: Y.Hijiri	Memo2	:
Power_Supply	: 24VDC	Memo3	:
deg/%RH	: 20/68	Memo4	:



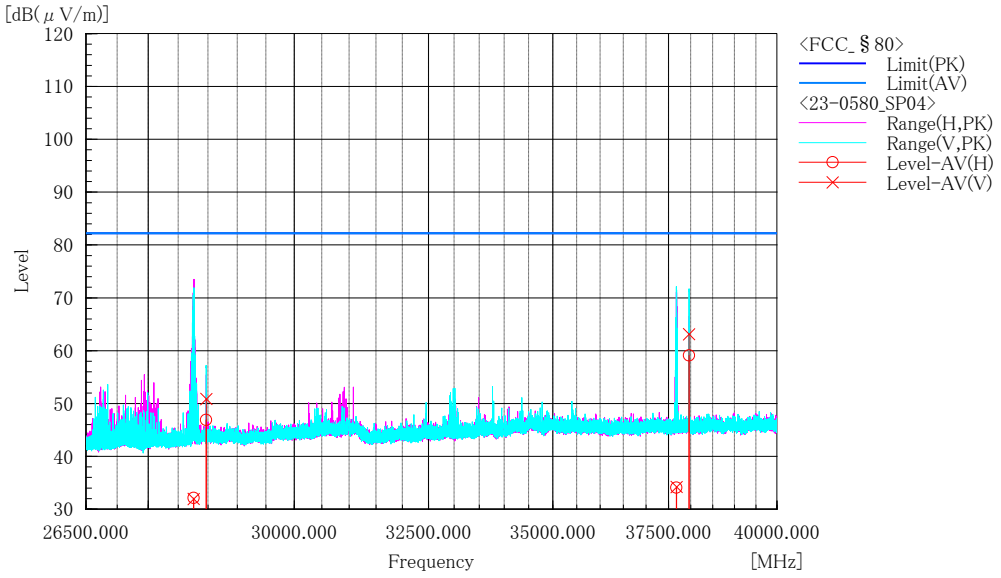
Final Result

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	18838.620	V	41.33	-9.19	32.14	82.2	50.1	161.0	189.0
2	18839.900	H	39.85	-9.19	30.66	82.2	51.5	198.0	180.0
3	18977.670	H	61.41	-9.23	52.18	82.2	30.0	152.0	180.0
4	18978.340	V	78.09	-9.24	68.85	82.2	13.4	177.0	189.0

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

LABOTECH <<Results of Radiated Emission>> 20 February,2024 15:59

Type_Name	: DRS4DL X-Class(RSB-150-136)	Limit	: FCC_§80
Serial No.	: 1001-1810-0001	Memo1	: TX mode(No roatition)
Operator	: Y.Hijiri	Memo2	:
Power_Supply	: 24VDC	Memo3	:
deg/%RH	: 20/68	Memo4	:



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	28256.450	H	44.78	-12.63	32.15	82.2	50.0	177.0	203.0
2	28256.790	V	44.56	-12.63	31.93	82.2	50.3	213.0	242.0
3	28467.980	H	59.51	-12.61	46.90	82.2	35.3	165.0	197.0
4	28468.660	V	63.47	-12.60	50.87	82.2	31.3	195.0	197.0
5	37675.450	H	42.04	-7.96	34.08	82.2	48.1	148.0	20.0
6	37675.820	V	42.16	-7.96	34.20	82.2	48.0	192.0	0.0
7	37957.800	H	66.96	-7.87	59.09	82.2	23.1	163.0	169.0
8	37957.990	V	71.01	-7.87	63.14	82.2	19.1	212.0	174.0

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

End of text