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)

for

Trade name: Furuno
Model: Transceiver
for Marine Radar FAR-2258-BB/-2258/-2358
Type: RTR-122

Report no.: LIC 12-19-048

Date of issue: 29 May 2019

Labotech International Co., Ltd.
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Report Summary

LIC project number:	LIC 04-18-0640		
Test report number of initial issue:	LIC 12-19-048	Date of initial issue	29 May 2019
Test report number of revised/replaced issue:	--	Date of revised/replaced issue	--
Test report revision/ replacement history:	--		
Test standard(s)/ Test specifications:	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)		
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 FAR-2258-BB/-2258/-2358		
Type:	RTR-122		
Product function and intended use:	Navigation radar		
Number of samples tested:	One		
Serial number:	R000-2410-0008		
Power rating:	100-115 VAC/220-230 VAC, 50-60 Hz, 3.1/1.5 A (for Power Supply Unit), 100-230 VAC, 50/60 Hz, 2.4-1.2 A (for Processor Unit)		
Product status:	Pre-production model		
Modifications made to samples during testing:	None		
Date of receipt of samples:	13 December 2018		
Test period:	From 20 December 2018 to 3 February 2019		
Place of test:	Labotech International Co., Ltd. FCC Test firm Designation Number: JP2007 FCC Test firm Registration Number: 838049 - LABOTECH EMC Center 1-16, Fukazu-cho, Nishinomiya-shi, Hyogo, 663-8203 Japan - Nishinomiya-Hama Lab. 2-20, Nishinomiya-Hama, Nishinomiya-shi, Hyogo, 662-0934 Japan		
Test results/Compliance:	Passed. The test results of this report relate only to the samples tested.		

Tested by:	Atsushi Takagi, Osamu Araki, Akihiro Sakai and Koji Kawai
Written by:	Arisa Ogino
Verified by:	Atsushi Takagi
Approved by:	29 May 2019 Name: Atsushi Takagi Title: Manager, Technical Department, Labotech International Co., Ltd. Signature: 

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 and IEC 62288

(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:
  EN 55011, CISPR 11, EN 55012, CISPR 12,EN 55022, CISPR 22, EN 55024, CISPR 24, EN 55025, CISPR 25, EN/IEC 61000-3-2/-3, EN/IEC 61000-4-2/-3/-4/-5/-6/-8/-11, EN/IEC 61000-6-1/-2/-3/-4, EN/IEC 60945, EN/IEC 61326-1, EN/IEC 61326-2-6, EN/IEC 60601-1-2, JIS T 0601-1-2, JIS C 1806-1, ISO 11452-1/-2/-4, EN ISO 14982, IEC 62236-3-2 and EN 50121-3-2

(4) RMRS Recognized Testing Laboratory:
- recognized by Russian Maritime Register of Shipping (RMRS) (Russia)
- Laboratory recognition number: 11.02594.011
- 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 (RRR) (Russia)
- Recognition certificate number: 131927 (*)
- Date of initial recognition: 31 May 2013
- for carrying out of tests of ships radio and navigation equipment

(6) DNV GL Recognized Environmental Test Laboratory:
- recognized by Det Norske Veritas AS, Germanischer Lloyd (DNV GL) (Norway)
- 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

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

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1 Principal Information

1.1 Equipment under test (EUT)

1.1.1 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 FAR-2258-BB/-2258/-2358

Name	Type	Serial number	Note
Antenna Unit	RSB-139	R000-2410-0008	--
Transceiver module	RTR-122	--	--
Scanner module	RSB-139	--	Antenna rotation rate: 24 rpm
Antenna radiator	XN24AF	--	One (1) selectable
	XN30AF	--	

Ancillary equipment

Name	Type	Serial number	Note
Power Supply Unit	PSU-019	000012	--
MONITOR UNIT	MU-190	000006	--
Processor Unit	PRU-025	1000-7910-0057	--
Control Unit	RCU-031	100002	--
Control Unit	RCU-014	0031	--
Dummy load (X-band)	WDL-105	521504-1	--
Dummy load	7342-1A	--	--
Processor Unit	RPU-024	1000-3700-0010	--
Control Unit	RCU-028	000003	--
Color LCD Display	LCD-AS191WM(BK)(G)	13103233TJ	--

(d) FCC ID: ADB9ZWRTR122

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

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

(g) Type of emission: P0N
(Emission designator)

(h) Occupied bandwidth:

Pulse type	S	M1	M2	L
Occupied bandwidth (MHz)	68.75	44.92	9.17	5.50

Note: measured data

(i) Size and mass: Antenna Unit: 2550 mm × 635 mm (H), 74.0 kg (*1)
Antenna Unit: 3171 mm × 635 mm (H), 79.0 kg (*2)
(*1) with Antenna radiator XN24AF installed.
(*2) with Antenna radiator XN30AF installed.

(j) Power supply: 100-115 / 220-230 VAC (*1)
(*1) Powered from Power Supply Unit, not directly from AC mains.

1.1.2 Transceiver module

Type: RTR-122 (Contained in Antenna Unit)

1.1.2.1 Transmitter

(a) Assignable frequency band: Between 9300 and 9500 MHz (CFR Title 47 Sections: 80.375 (d)-(1))

(b) Type of RF generator:

- Type: 9M31
- Peak output power: 50 kW nominal
- Fundamental frequency: 9410 MHz nominal
- Tolerances:
  - Manufacturing: ±30 MHz
  - Pulling: 15 MHz
  - Tolerance for 20°C temperature variation: -5 MHz

(c) Pulse characteristics:

Pulse type		S	M1	M2	L
Pulse length (μs)		0.08	0.20	0.60	1.2
PRF(Hz)	Normal mode	1900	1100	600	600
	TT 48NM	1100	1100	600	600
	2nd trace	1500	500	500	500

1.1.2.2 Modulator

SCR Type: TFC563D

Trigger Voltage: Approx. +12 VDC positive

1.1.2.3 Receiver

(a) Passband

RF Stage: 60 MHz

IF Stage:

Pulse type	S	M1	M2	L
Passband (MHz)	18	11	4	1.7

(b) Intermediate Frequency: 60 MHz

(c) Gain (overall): Approximately 26.5 dB

(d) Overall Noise Figure: 3.4 dB (typical)

(e) Video Output Voltage: 2 V Negative

(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 adjusting tuning voltage of receiver local oscillator (automatically and manually)

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

1.1.3 Antenna and Scanner

(a) Antenna specifications

Antenna model		XN24AF	XN30AF
Length (mm)		2548	3172
Rotation diameter (mm)		2700	3340
Transmission frequency		9410±30 MHz	
Horizontal beam width (-3 dB)		0.95°	0.75°
Horizontal beam width (-20 dB)		2.4°	1.8°
Vertical beam width		20°	20°
Side lobe (max.)	Less than ±10°	-28 dB	-26 dB
	Outside ±10°	-32 dB	-33 dB
Gain		31.5 dBi	32.5 dBi
Radiator		Slot array	
Polarization		Horizontal	
Type of beam		Vertical fan	

(b) Antenna Rotation ON-OFF Switch: Provided

(c) Scanning (rotating or oscillating): Rotating over 360° continuously clockwise

(d) Antenna Rotation Rate: 24 rpm

(e) Sector Scan: Not provided

(f) Rated Loss of Transmission Line per 100 Feet: Negligible (Transmission path is only in Antenna Unit.)

1.1.4 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)

1.1.5 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 1.1.1 (c) of this report.

(e) Approximate space required for installation excluding Antenna Unit: Not applicable

1.2 Observation and comments

None.

2 Test Results Summary

Clause number of this report	CFR Title 47 Sections	Item	Result	Test engineer
3.1	2.1046 (a), 80.215	RF Power Output	Passed.	K. Kawai
3.2	2.201, 2.1047 (d)	Modulation Characteristics	Passed.	K. Kawai
3.3	2.1055 (a)(2),(d)(1),(d)(3), 80.209 (b)	Frequency Stability –temperature & voltage	Passed.	K. Kawai
3.4	2.202 (a), 2.1049 (c)(1), 80.209 (b), 80.211 (f)	Occupied Bandwidth	Passed.	K. Kawai
3.5	2.1051, 80.211 (f), 80.273	Spurious Emissions at Antenna Terminals	Passed.	K. Kawai
3.6	2.1053, 80.211 (f)	Field Strength of Spurious Radiation	Passed.	O. Araki, A. Sakai and A. Takagi

3 Test Results

3.1 RF Power Output (CFR Title 47 Sections: 2.1046 (a) and 80.215)

3.1.1 Test conditions:

For all TX (S/M1/M2/L) pulses, the transmitter output power was measured with a non-reflective load and a directional coupler as a substitute for the antenna radiator.

3.1.2 Test setup:

See Clause 4.

3.1.3 Test Results:

Normal mode

Pulse type	S	M1	M2	L
Transmission mean power Pm (W)	4.0	6.4	16.0	34.1
Pulse length *T* (μs) (50% points)	0.078	0.166	0.653	1.288
Pulse Repetition Frequency (Hz)	1899	1100	600	600
Transmission pulse power Pp (kW) (*1)	26.9	34.9	40.9	44.2

TT 48NM mode

Pulse type	S	M1	M2	L
Transmission mean power Pm (W)	2.2	6.4	16.1	34.1
Pulse length *T* (μs) (50% points)	0.077	0.169	0.655	1.285
Pulse Repetition Frequency (Hz)	1100	1100	600	600
Transmission pulse power Pp (kW) (*1)	26.2	34.6	41.1	44.3

2nd trace mode

Pulse type	S	M1	M2	L
Transmission mean power Pm (W)	3.1	2.7	13.2	28.3
Pulse length *T* (μs) (50% points)	0.078	0.165	0.650	1.286
Pulse Repetition Frequency (Hz)	1499	500	500	500
Transmission pulse power Pp (kW) (*1)	26.5	32.1	40.7	44.0

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

Environmental conditions observed: On 20 December 2018, 21°C to 21°C, 57%RH to 57%RH
Power supply voltage measured: 230.0 VAC, 50 Hz to 230.0 VAC, 50 Hz

3.2 Modulation Characteristics (CFR Title 47 Sections: 2.201, 2.1047 (d))

3.2.1 Test Conditions:

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

3.2.2 Test setup:

See Clause 4.

3.2.3 Test Results:

Normal mode

Pulse type	S	M1	M2	L
Pulse length T (μs) (-3 dB points)	0.078	0.166	0.653	1.288
Rise time t_r (μs) (10 to 90 % amplitude)	0.016	0.026	0.028	0.032
Fall time t_f (μs) (90 to 10 % amplitude)	0.067	0.158	0.138	0.235
Pulse Repetition Frequency (Hz)	1899	1100	600	600

TT 48NM mode

Pulse type	S	M1	M2	L
Pulse length T (μs) (-3 dB points)	0.077	0.169	0.655	1.285
Rise time t_r (μs) (10 to 90 % amplitude)	0.014	0.025	0.027	0.030
Fall time t_f (μs) (90 to 10 % amplitude)	0.067	0.160	0.135	0.227
Pulse Repetition Frequency (Hz)	1100	1100	600	600

2^{nd} trace mode

Pulse type	S	M1	M2	L
Pulse length T (μs) (-3 dB points)	0.078	0.165	0.650	1.286
Rise time t_r (μs) (10 to 90 % amplitude)	0.015	0.023	0.028	0.031
Fall time t_f (μs) (90 to 10 % amplitude)	0.066	0.156	0.136	0.228
Pulse Repetition Frequency (Hz)	1499	500	500	500

Measured Plots: See Clause 6.

Environmental conditions observed: On 20 December 2018, 21°C to 21°C, 57%RH to 57%RH
Power supply voltage measured: 230.0 VAC, 50 Hz to 230.0 VAC, 50 Hz

3.3 Frequency Stability –temperature & voltage (CFR Title 47 Sections: 2.1055 (a)(2)/(d)(1)/(d)(3), 80.209(b))

3.3.1 Test Conditions:

(1) Radar transmitter settings: All TX (S /M1/M2/ 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

Power supply unit: 220 – 230 VAC V_L: 187 VAC/ V_{nom}: 230 VAC/ V_H: 265 VAC

Processor unit: 100 – 230 VAC V_L: 85 VAC/ V_{nom}: 230 VAC/ V_H: 265 VAC

3.3.2 Test setup:

See Clause 4.

3.3.3 Frequency Tolerance Limits (CFR Title 47 Sections: 2.1055 (a)(2)/(d)(1)/(d)(3),80.209(b)):

Pulse type	S	M1	M2	L
Guard Band f(1.5/T) (MHz) (*1)	19.3	9.0	2.3	1.2
Upper limit (MHz) (*2)	9480.7	9491.0	9497.7	9498.8
Lower limit (MHz) (*2)	9319.3	9309.0	9302.3	9301.2

(*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

3.3.4 Test Results:

Complied.

(1) Temperature test at the rated supply voltage of 230 VAC:

Pulse type		S	M1	M2	L	Result
Frequency at maximum emission (MHz)	-20°C	9428.3	9429.5	9429.4	9428.1	Complied.
	-10°C	9427.7	9428.3	9428.0	9427.3	Complied.
	0°C	9424.7	9425.5	9425.2	9424.3	Complied.
	+10°C	9423.6	9424.0	9423.8	9423.1	Complied.
	+20°C	9423.2	9422.9	9422.6	9421.6	Complied.
	+30°C	9421.4	9421.4	9421.3	9420.7	Complied.
	+40°C	9420.0	9420.8	9420.5	9419.5	Complied.
	+50°C	9417.3	9417.0	9416.3	9416.0	Complied.

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

Pulse type		S	M1	M2	L	Result
Frequency at maximum emission (MHz)	V_L	9422.5	9422.4	9422.5	9421.9	Complied.
	V_{nom}	9423.2	9422.9	9422.6	9421.6	Complied.
	V_H	9423.2	9423.0	9422.4	9421.8	Complied.

Environmental conditions observed: On 21 December 2018, 22°C to 22°C, 50%RH to 50%RH
On 22 December 2018, 22°C to 22°C, 58%RH to 58%RH
On 25 December 2018, 21°C to 21°C, 57%RH to 57%RH
On 26 December 2018, 24°C to 24°C, 46%RH to 46%RH

Power supply voltage measured: 230.0 VAC, 50 Hz to 230.0 VAC, 50 Hz

3.4 Occupied Bandwidth
(CFR Title 47 Sections: 2.202 (a), 2.1049 (c)(1), 80.209 (b), 80.211 (f))

3.4.1 Test conditions:

For all TX (S/M1/M2/L) pulses, the transmitter output power was measured with a non-reflective load and a directional coupler as a substitute for the antenna radiator.

3.4.2 Test setup:

See Clause 4.

3.4.3 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 = 110 MHz (for X-band radars)

3.4.4 Test Results:

Complied.
Spectrum plots: See Clause 7.

Environmental conditions observed: On 20 December 2018, 21°C to 21°C, 57%RH to 57%RH
Power supply voltage measured: 230.0 VAC, 50 Hz to 230.0 VAC, 50 Hz

3.5 Spurious Emissions at Antenna Port (CFR Title 47 Sections: 2.1051, 80.211 (f), 80.273 and ITU-R SM.329-12)

3.5.1 Test Conditions:

(a) For S pulse, the transmitter output power was measured with a waveguide converter as a substitute for the antenna radiator. (*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)

3.5.2 Test setup:

See Clause 4.

3.5.3 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 = 110 MHz (for X-band radars)
(*3) Spurious measurement range for X-band radar: 4.59 GHz to 40 GHz

3.5.4 Harmonics Frequencies:

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

3.5.5 Test Results:

Complied.

Spurious emission frequency and levels measured of which margins were below 20 dB were listed in the following table.

Frequency (GHz)	Level (dBm)	Limit (dBm)	Margin (dB)
10.755	-20.70	-13.00	7.7
18.850	-23.13	-13.00	10.13

Environmental conditions observed: On 9 January 2019, 22°C to 22°C, 50%RH to 50%RH
Power supply voltage measured: 230.0 VAC, 50 Hz to 230.0 VAC, 50 Hz

3.6 Field Strength of Spurious Radiation (CFR Title 47 Sections: 2.1053, 80.211 (f) and ITU-R SM.329-12)

3.6.1 Test Conditions:

(a) For S pulse, the transmitter output power was measured with the non-reflective load as a substitute for the antenna radiator. (*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.

3.6.2 Test Site: LIC EMC Center, Semi-anechoic chamber

3.6.3 Distance between the Radar and Measuring Antenna: 3 m

3.6.4 Test setup:

See Clause 4.
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 height and polarization:

(a) Antenna height: EUT center (1.95 m)

(b) Antenna polarization: vertical and horizontal.

EUT height: 1.5 m

3.6.5 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 = 110 MHz (for X-band radars)
(*3) Spurious measurement range for X-band radar: 4.59 GHz to 40 GHz

3.6.6 Harmonics Frequencies:

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

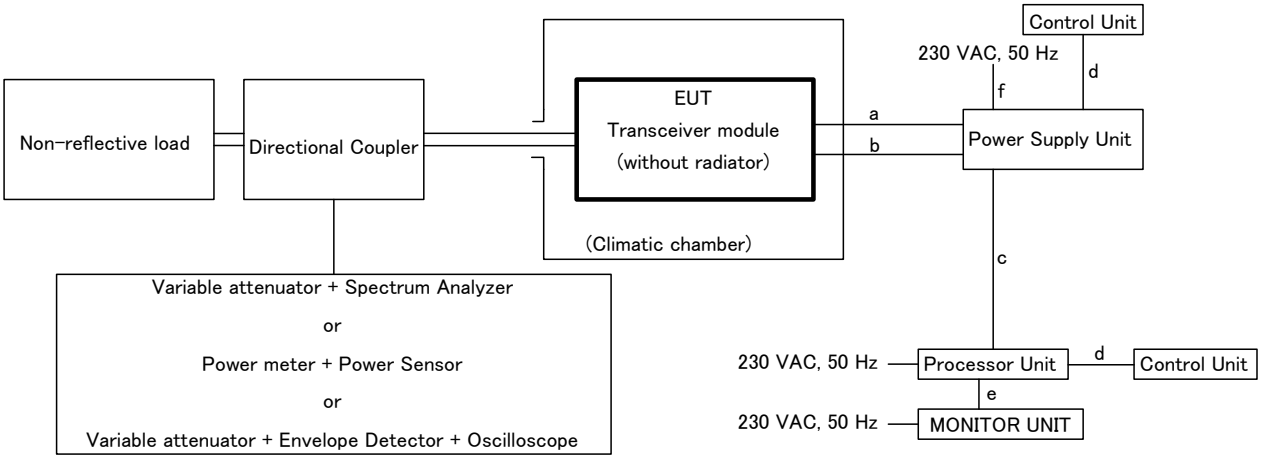
3.6.7 Test Results:

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

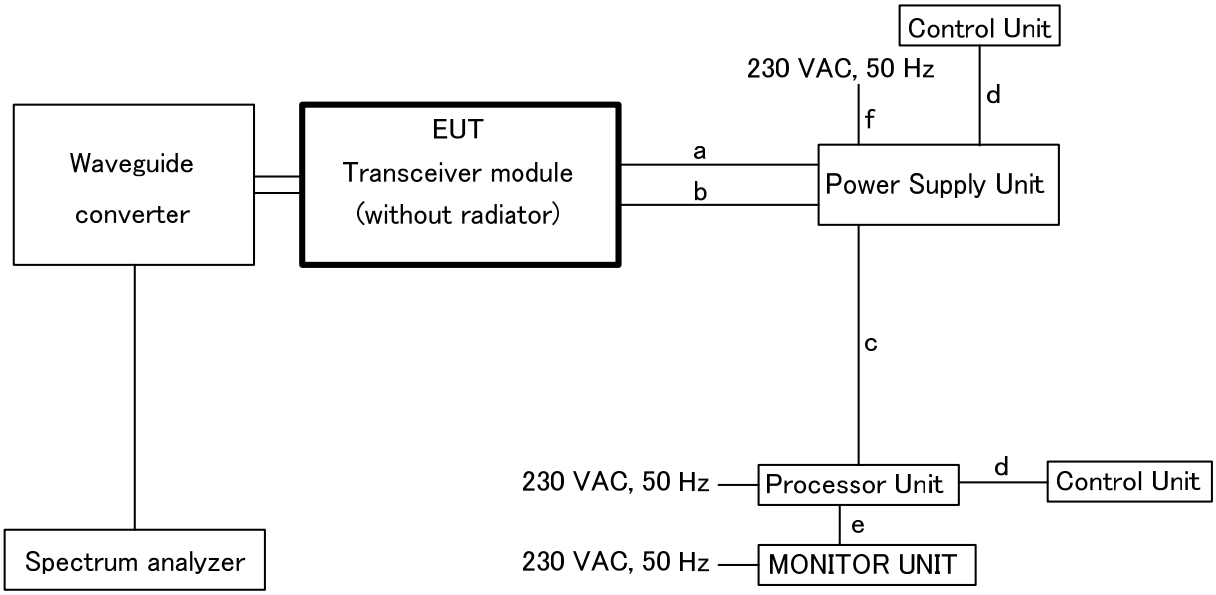
Environmental conditions observed: On 2 February 2019, 23°C to 23°C, 48%RH to 48%RH
On 3 February 2019, 22°C to 22°C, 43%RH to 43%RH
Power supply voltage measured: 120.0 VAC, 60 Hz to 120.0 VAC, 60 Hz

4 Test Setup for Measurements

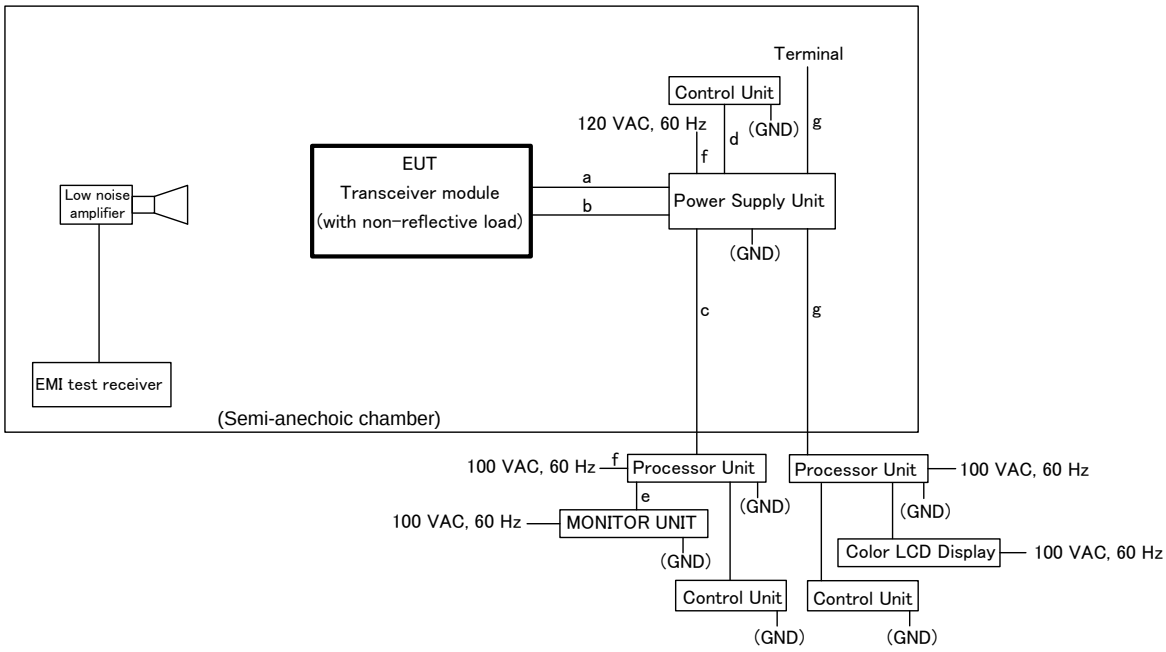
4.1 Test Setup for Clause 3.1, 3.2, 3.3 and 3.4



4.2 Test Setup for Clause 3.5



4.3 Test Setup for Clause 3.6



Cable designations

No.	Category (*)	Cable name	Type	Length (m)	Number of cables	Cable Shielded
a	S	Antenna Cable (Multicore Cable)	RW-0030	20	1	Yes
b	P	Motor Cable (Power Cable)	TPYCY-2.5	20	1	No
c	S	PSU – Processor Cable (Multicore Cable)	RW-00339	20	1	Yes
d	S	Cable assy.	XH10P-W-6P	20	2	Yes
e	S	DVI Cable	DVI-D/D S-LINK	10	1	Yes
f	P	Power Cable	DPYC-2.5	20	2	No
g	S	Cable assy.	RW-4864	20	2	Yes

(*) P – Power cable, S – Signal/control cable.

5 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 3.1 RF Power Output

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional coupler (X-band)	5D364S	R05762	Shimada	6 March 2018	1 year
RT200	Power meter	E4419B	MY45101375	ANRITSU	16 March 2018	1 year
RT201	Power sensor	8481A	2349A39603	Agilent	16 March 2018	1 year
RT213	Waveguide	WRJ-10	--	Furuno	18 July 2018	1 year
RT255-2	AC/DC power supply	PCR4000LE	TE001770	Kikusui	--	--
HT510	Climatic chamber (Large)	TBE-3HW4PE2F	3013002540	Espec	23 September 2018	1 year
HT725	Paperless recorder/ Dual communication logger	FX106-4-1	S5JA01447	Yokogawa	--	--
HT1024	Digital multi-meter	233	27230019	Fluke	26 February 2018	1 year

(2) For Clause3.2 Modulation Characteristics

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional coupler (X-band)	5D364S	R05762	Shimada	6 March 2018	1 year
RT213	Waveguide	WRJ-10	--	Furuno	18 July 2018	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	21 February 2018	1 year
HT1223	Attenuator	8495B	MY42148137	Agilent	15 May 2018	1 year
HT1221	Crystal detector	423B	MY51342422	Agilent	8 March 2018	1 year
0808052	Frequency counter	MF2414C	6200769857	ANRITSU	20 July 2018	1 year
HT972	Oscilloscope	MSO4054B	C030483	TEKTRONIX	5 March 2018	1 year
RT255-2	AC/DC power supply	PCR4000LE	TE001770	Kikusui	--	--
HT510	Climatic chamber (Large)	TBE-3HW4PE2F	3013002540	Espec	23 September 2018	1 year
HT725	Paperless recorder/ Dual communication logger	FX106-4-1	S5JA01447	Yokogawa	--	--
HT1024	Digital multi-meter	233	27230019	Fluke	26 February 2018	1 year

(3) For Clause 3.3 Frequency Stability –temperature & voltage

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional coupler (X-band)	5D364S	R05762	Shimada	6 March 2018	1 year
RT213	Waveguide	WRJ-10	--	Furuno	19 July 2018	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	21 February 2018	1 year
HT1223	Attenuator	8495B	MY42148137	Agilent	15 May 2018	1 year
HT676	Spectrum analyzer	8564EC	4103A00440	Agilent	18 April 2018	1 year
RT255-2	AC/DC power supply	PCR4000LE	TE001770	Kikusui	--	--
HT510	Climatic chamber (Large)	TBE-3HW4PE2F	3013002540	Espec	23 September 2018	1 year
HT725	Paperless recorder/ Dual communication logger	FX106-4-1	S5JA01447	Yokogawa	--	--
HT1024	Digital multi-meter	233	27230019	Fluke	26 February 2018	1 year

(4) For Clause 3.4 Occupied Bandwidth

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional coupler (X-band)	5D364S	R05762	Shimada	6 March 2018	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	21 February 2018	1 year
HT1223	Attenuator	8495B	MY42148137	Agilent	15 May 2018	1 year
HT676	Spectrum analyzer	8564EC	4103A00440	Agilent	18 April 2018	1 year
RT255-2	AC/DC power supply	PCR4000LE	TE001770	Kikusui	--	--
HT510	Climatic chamber (Large)	TBE-3HW4PE 2F	3013002540	Espec	23 September 2018	1 year
HT725	Paperless recorder/ Dual communication logger	FX106-4-1	S5JA01447	Yokogawa	--	--
HT1024	Digital multi-meter	233	27230019	Fluke	26 February 2018	1 year

(5) For Clause 3.5 Spurious Emissions at Antenna Port

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional coupler (X-band)	5D364S	R05762	Shimada	6 March 2018	1 year
--	Adapter	BL00-6254-00	--	Orient Microwave	Not applicable.	--
--	Adapter	PE9803	---	Pasternack	Not applicable.	--
--	Adapter	BL00-6256-00	--	Orient Microwave	Not applicable.	--
--	Adapter	PE9826	---	Pasternack	Not applicable.	--
--	Circulator	RC-3686H	1253 DSP	TDK	Not applicable.	--
HT676	Spectrum analyzer	8564EC	4103A00440	Agilent	18 April 2018	1 year
RT255-2	AC/DC power supply	PCR4000LE	TE001770	Kikusui	--	--
HT1024	Digital multi-meter	233	27230019	Fluke	26 February 2018	1 year
KB289	Coaxial cable for radiated emission measurement	SF104A/11PC 35/11PC35/55 00MM	800048/4A	HUBER+ SUHNER	11 August 2018	1 year

(6) For Clause 5.6 Field Strength of Spurious Radiation

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
HT744	Radiated emission measurement Software	EP5/RE	Ver. 6.0.10	TOYO	Not applicable.	--
HT745	EMI test receiver (20 Hz to 40 GHz)	ESU40	110243	Rohde & Schwarz	11 August 2018	1 year
HT758	Broadband horn antenna (1 GHz to 6 GHz)	9120B	522	Schwarzbeck	13 August 2018	1 year
HT905	Magnetic loop antenna (9 kHz to 30 MHz)	HLA6120	34698	Teseq	15 August 2018	1 year
HT788	Biconical antenna (30 MHz to 300 MHz)	VHBB9124/BBA9106	9124-521	Schwarzbeck	14 August 2018	1 year
HT789	Log.-Per. antenna (300 MHz to 1 GHz)	3148B	00123951	ETS-Lindgren	14 August 2018	1 year
HT759	Double ridged horn antenna & amp. (6 GHz to 18 GHz)	HAP06-18W	00000065	TOYO	1 August 2018	1 year
HT761	Double rigged horn antenna & amp. (18 GHz to 26 GHz)	HAP18-26N	00000017	TOYO	15 August 2018	1 year
HT762	Double rigged horn antenna & amp. (26 GHz to 40 GHz)	HAP26-40N	00000010	TOYO	15 August 2018	1 year
HT754	Pre-amplifier (9 kHz to 1 GHz, Gain 32 dB)	310N	304877	Sonoma Instrument	19 July 2018	1 year
NK012	Pre-amp. (1 GHz to 26.5 GHz)	8449B	3008A01286	Agilent	12 December 2018	1 year
HT779	Semi-anechoic chamber	10mSAC	90984	Tokin	NSA: 7 January 2017	3 years
					SVSWR: 3 December 2016	3 years
HT883	Test table	W1500-D1000-H800	No.01	JSE	Not applicable.	--
HT866	Digital multimeter	115	19170029	Fluke	27 February 2018	1 year
HT780	AC/DC power supply	ES18000W	9128767-1+9128767-2	NF	Not applicable.	--

6 RF Envelope and Spectrum of the Output Pulse

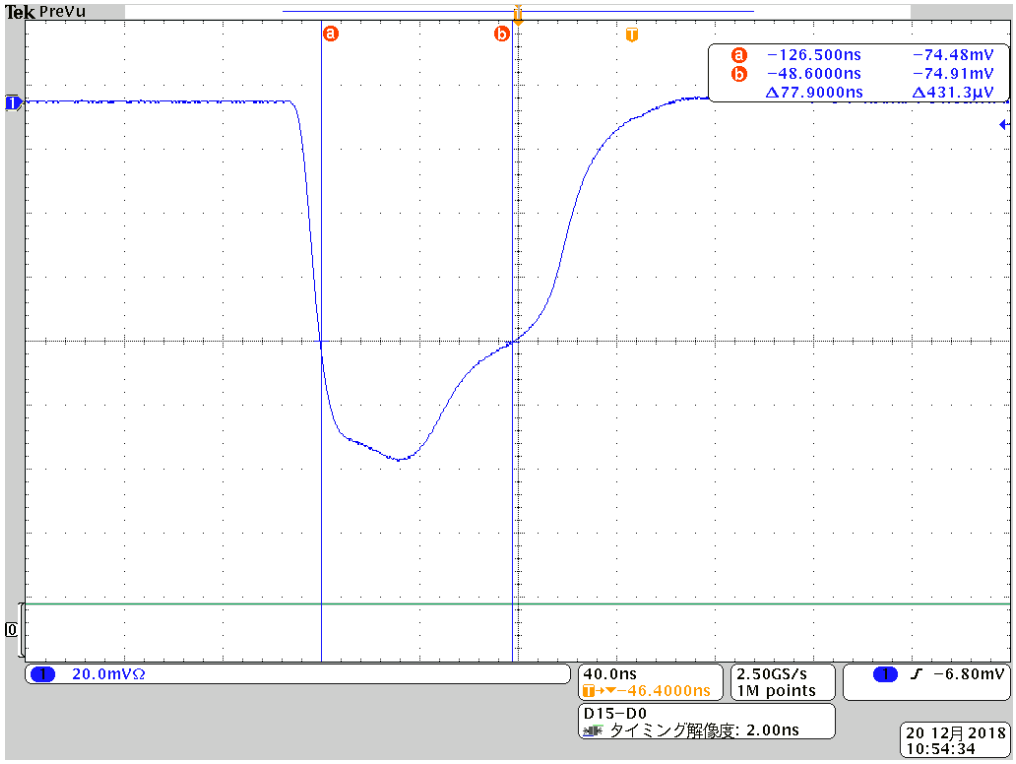


Fig. 6.1 S pulse envelope (Normal mode)

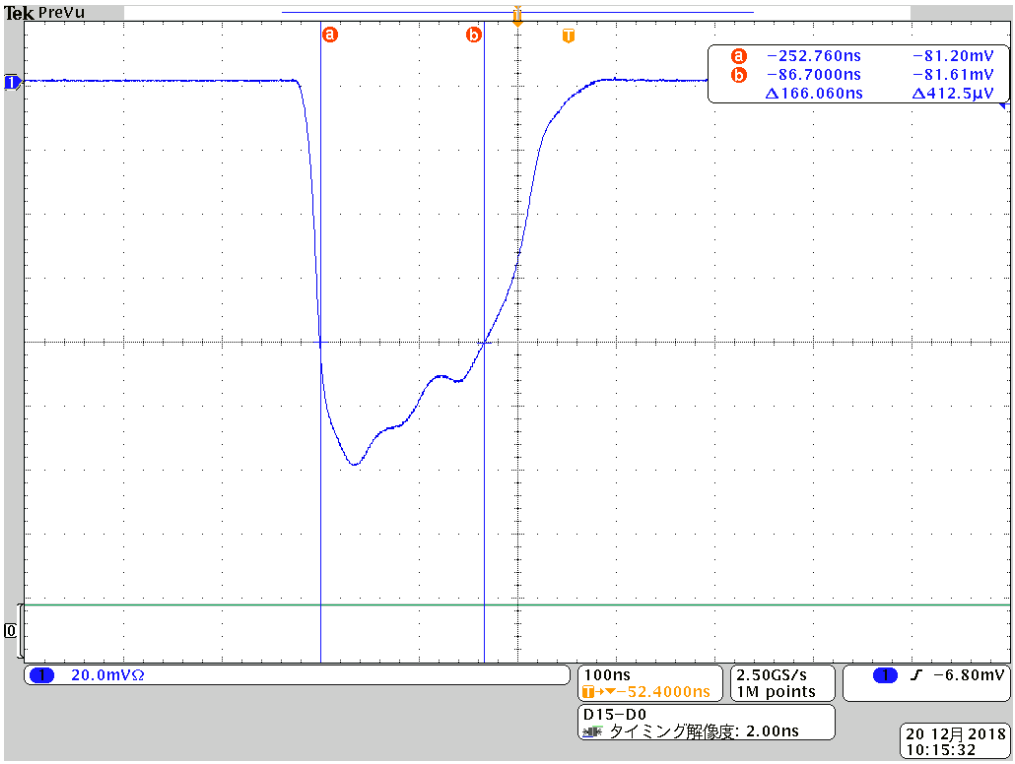


Fig. 6.2 M1 pulse envelope (Normal mode)

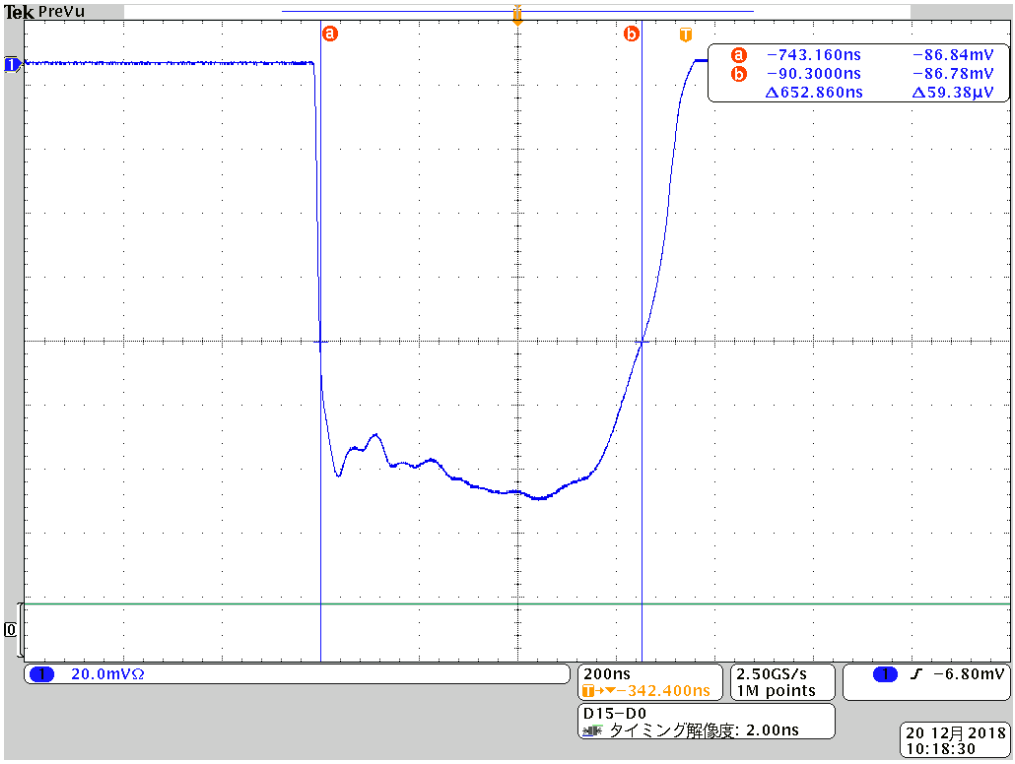


Fig. 6.3 M2 pulse envelope (Normal mode)

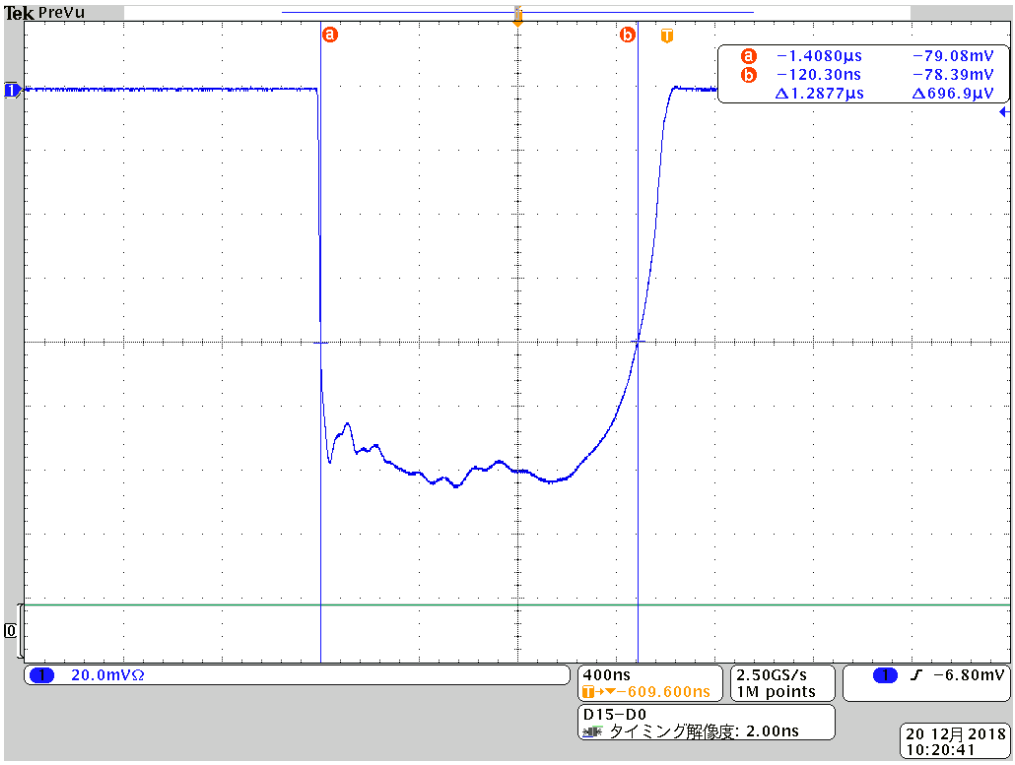


Fig. 6.4 L pulse envelope (Normal mode)

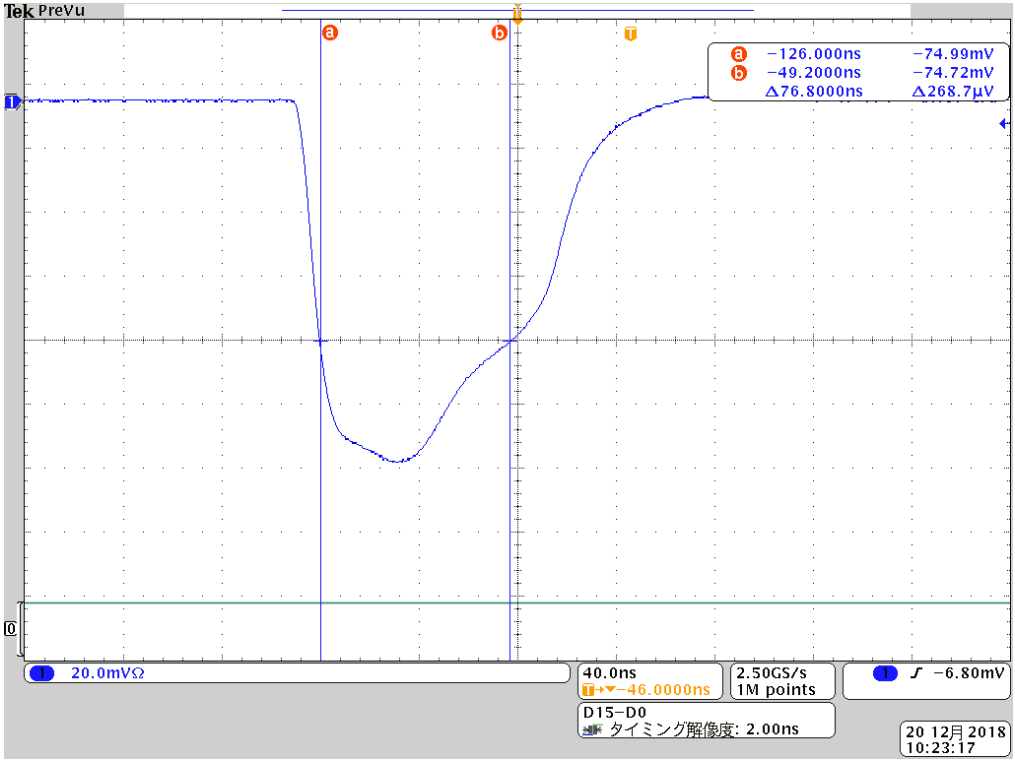


Fig. 6.5 S pulse envelope (TT 48NM mode)

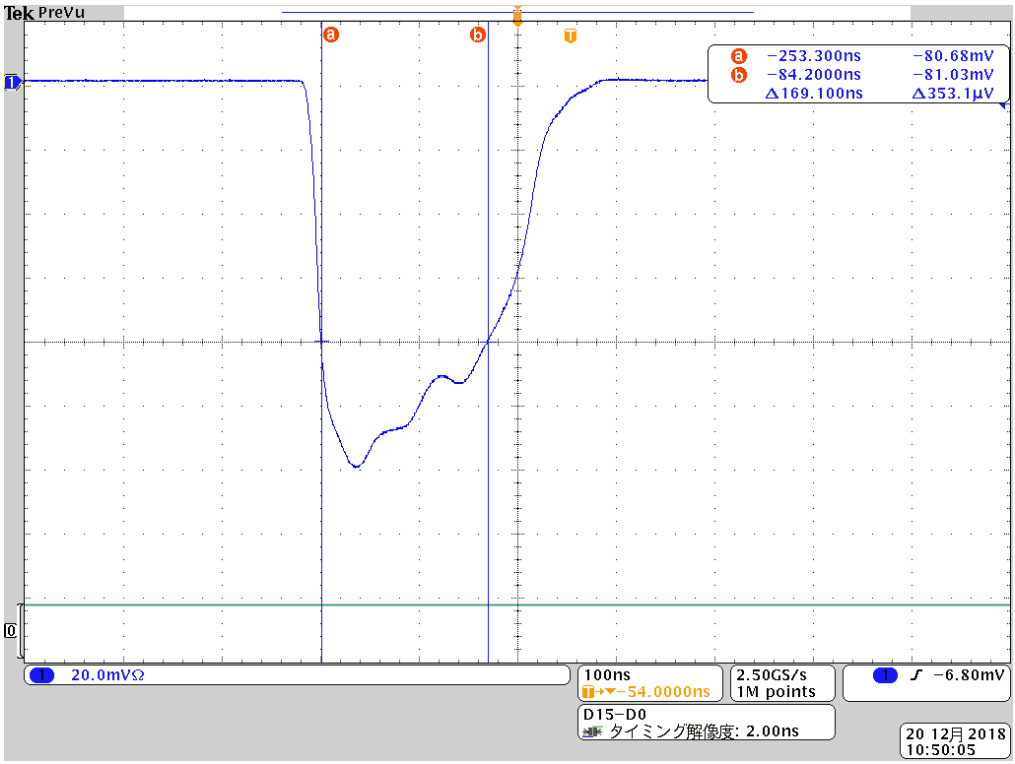


Fig. 6.6 M1 pulse envelope (TT 48NM mode)

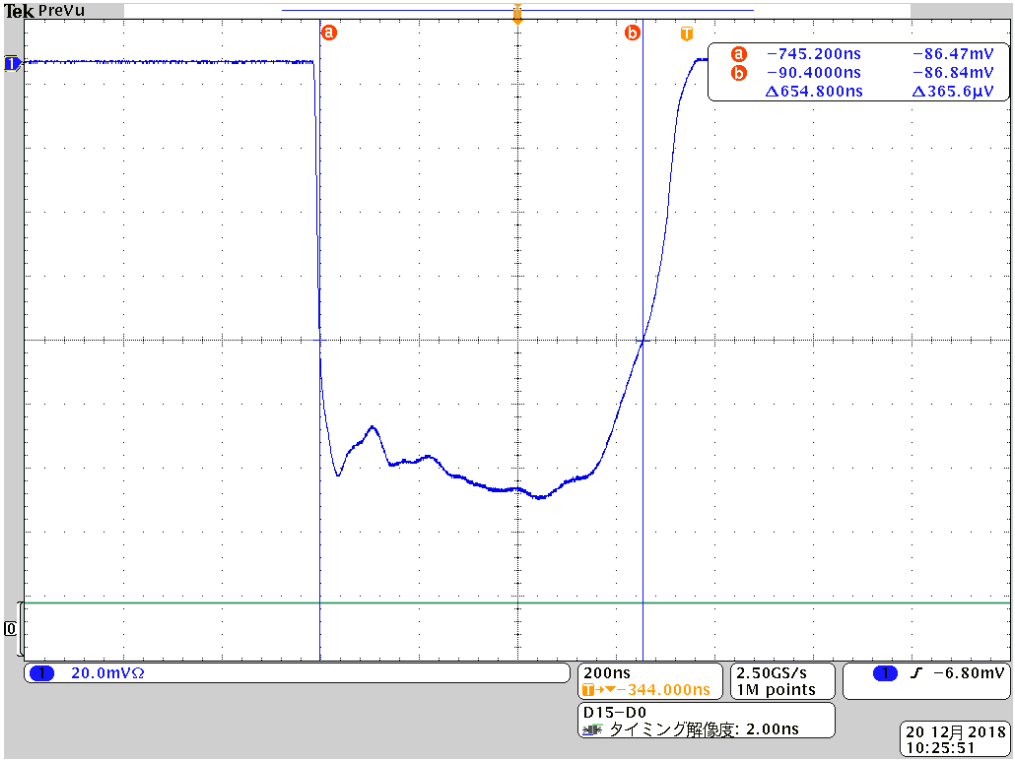


Fig. 6.7 M2 pulse envelope (TT 48NM mode)

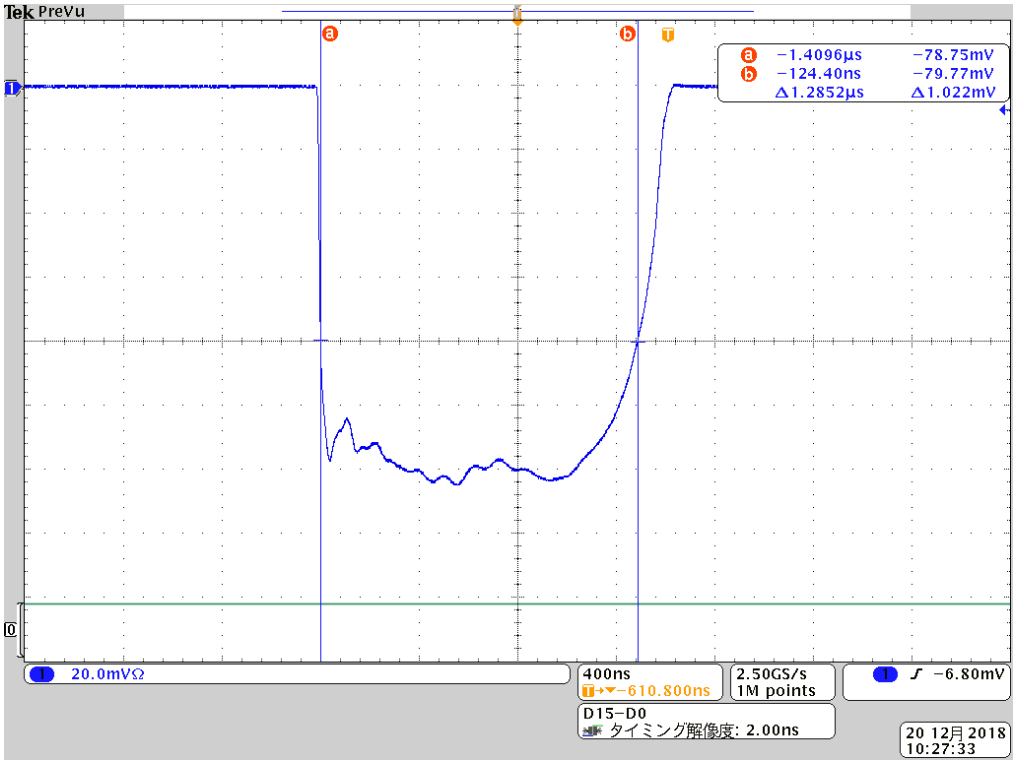


Fig. 6.8 L pulse envelope (TT 48NM mode)

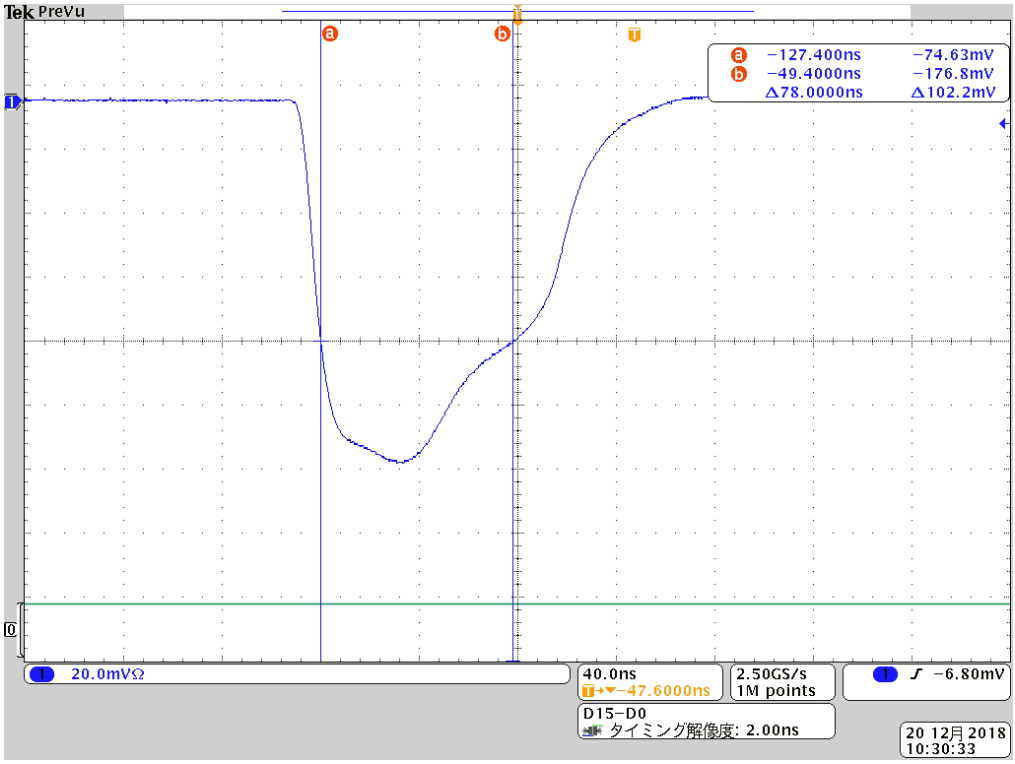


Fig. 6.9 S pulse envelope (2nd trace mode)

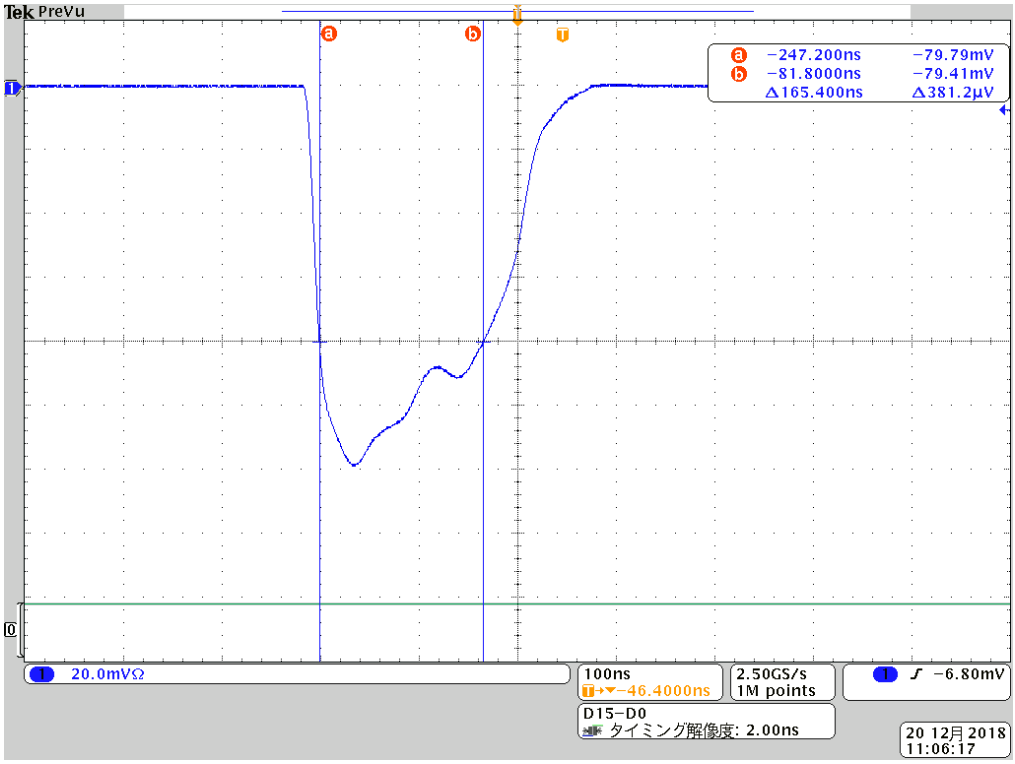


Fig. 6.10 M1 pulse envelope (2nd trace mode)

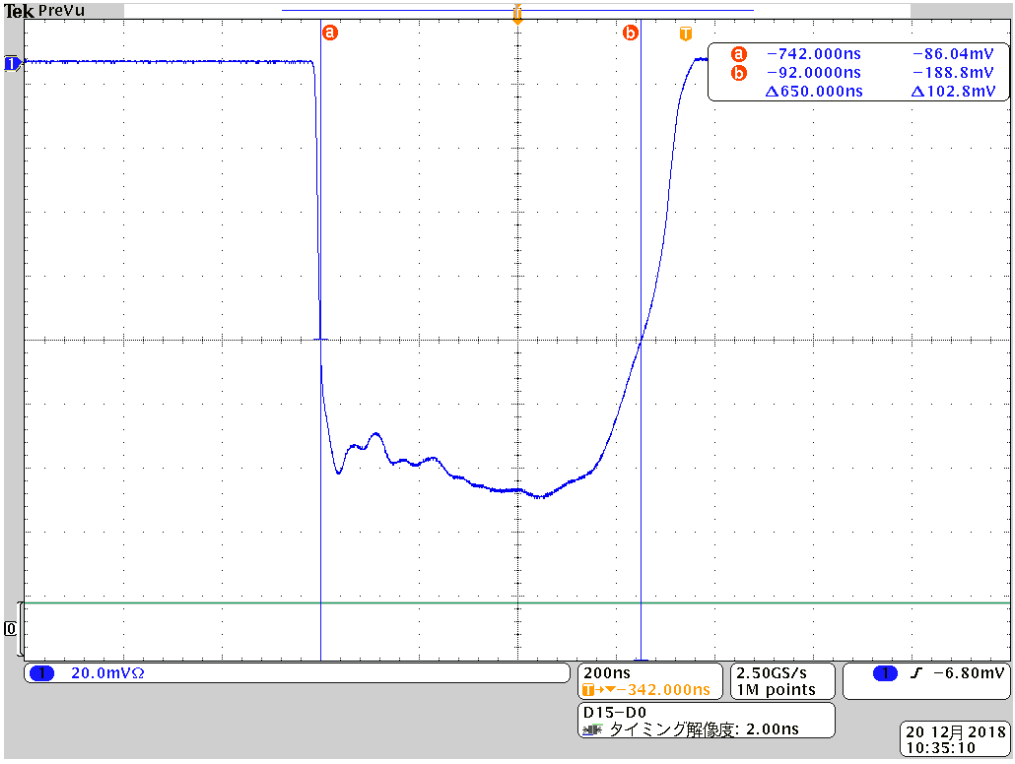


Fig. 6.11 M2 pulse envelope (2nd trace mode)

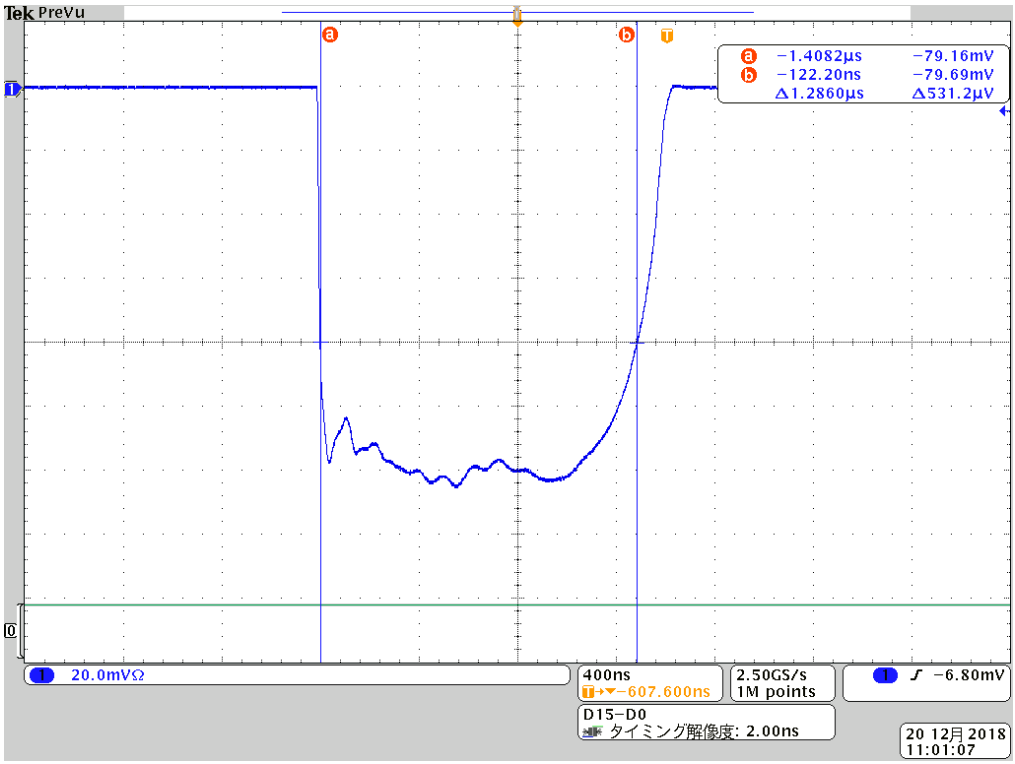


Fig. 6.12 L pulse envelope (2nd trace mode)

7 Spurious Emission Plots measured at Antenna Terminal

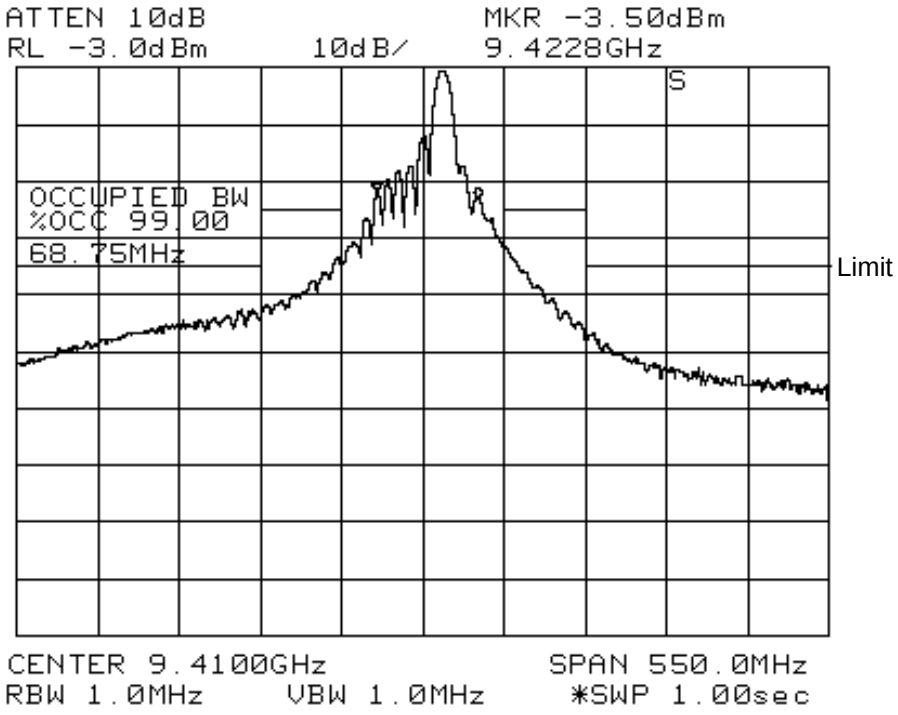


Fig. 7.1 for S pulse

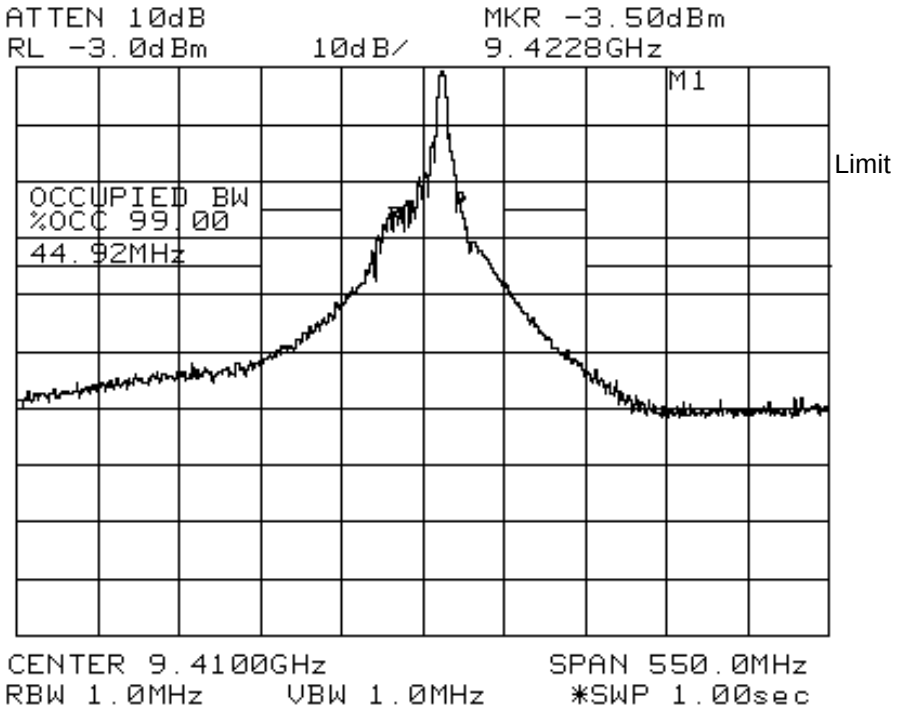


Fig. 7.2 for M1 pulse

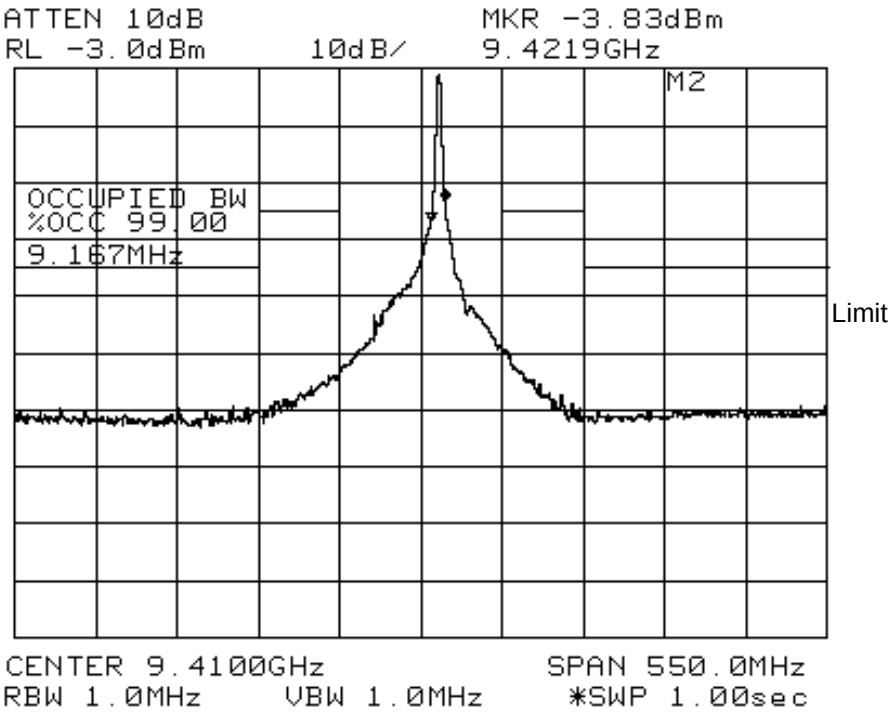


Fig. 7.3 for M2 pulse

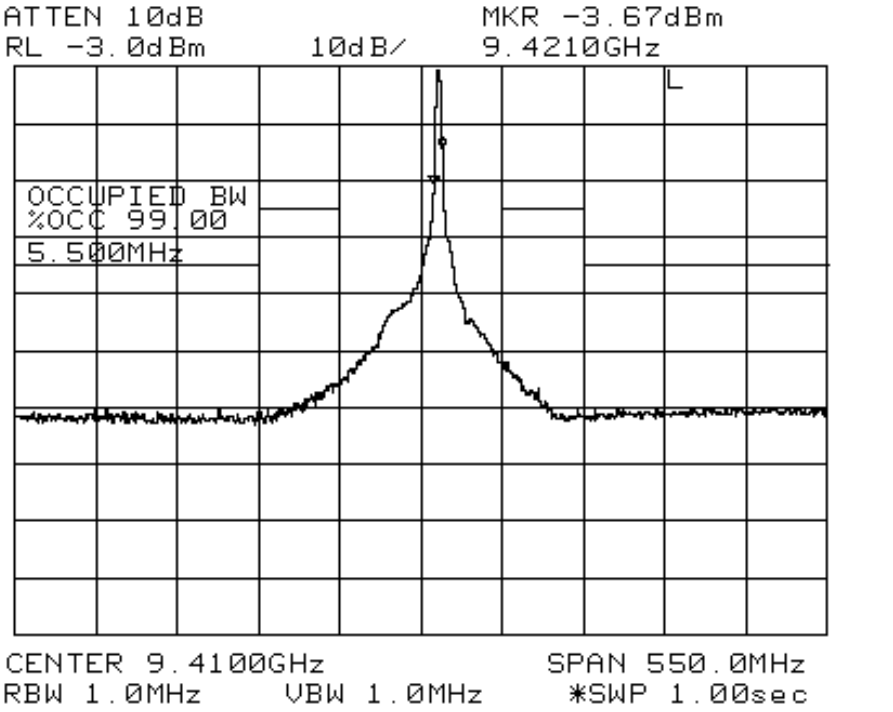


Fig. 7.4 for L pulse

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