

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-2268DS
Type: RTR-129**

Report no.: LIC 12-21-005

Date of issue: 26 February 2021

Labotech International Co., Ltd.

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Report Summary

LIC project number:	LIC 04-20-0540		
Test report number of initial issue:	LIC 12-21-005	Date of initial issue	26 February 2021
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-2268DS		
Type:	RTR-129		
Product function and intended use:	Radio detection and ranging		
Number of samples tested:	One		
Serial number:	See Clause 1.1 of this report.		
Power rating:	100-230 VAC, 50-60 Hz, 2.8-1.4 A (for RPU-025 (AU)) 100-115/220-230 VAC, 50-60 Hz, 3.2/1.5 A (for PSU-019 (AU))		
Modifications made to samples during testing:	See Clause 1.3 of this report.		
Date of receipt of samples:	30 October 2020		
Test period:	From 13 November 2020 to 9 December 2020		
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 Lab. 9-52 Ashihara-cho, Nishinomiya-shi, Hyogo, 662-8580 Japan		
Test results/Compliance:	Passed. The test results of this report relate only to the samples tested.		

Tested by:	Atsushi Takagi and Yukihiro Hijiri
Written by:	Arisa Ogino
Verified by:	Tadayuki Ekawa
Approved by:	26 February 2021 Name: Tadayuki Ekawa Title: Head engineer, Technical Department Labotech International Co., Ltd. Signature: 

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 1 (except for Clause 1.1.1 (h)) 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.

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 GL Recognized Environmental Test Laboratory:

- recognized by Det Norske Veritas AS, Germanischer Lloyd (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

(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 (A2LA)
- Certificate number: 5241.01 (Date of initial accreditation: 17 Jul 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/>).

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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-2268DS

Name	Type	Serial number	Note
ANTENNA UNIT	RSB-144-129	R000-2710-0001	--
Transceiver	RTR-129	--	--
Gear Box	RSB-144	--	Antenna rotation rate: 24 rpm
Antenna	SN24AF	--	One (1) selectable
	SN30AF	--	
	SN36AF	--	
	SN30DF	--	

Associated units (AU)

Name	Type	Serial number	Note
Processor Unit	RPU-025	1000-7910-0052	--
Power Supply Unit	PSU-019	100104	--
Control Unit	RCU-014	100068	--
Monitor Unit	MU-190	000027	--

Auxiliary Equipment (AE)

Name	Type	Serial number	Note
Dummy Load	4D106	R18083	--
Directional coupler	5D108	R1788	--

- (d) FCC ID: ADB9ZWRTR129
- (e) Primary function: Ship radar station operating in the band 2900–3100 MHz
- (f) Frequency range: Fixed frequency, S-band (3050±30 MHz)
- (g) Type of emission: P0N
(Emission designator)
- (h) Occupied bandwidth:

Pulse type		S	M1	M2	L
Occupied bandwidth (MHz)	Normal mode	55.8	39.2	15.0	7.5
	TT48NM	55.8	39.2	14.2	7.5
	2nd trace	56.7	40.0	13.3	7.5

Note: Measured data

- (i) Size and mass: ANTENNA UNIT: 2565 mm (W) × 710 mm (H) × 575 mm (D), 130 kg (*1)
ANTENNA UNIT: 3090 mm (W) × 710 mm (H) × 575 mm (D), 134 kg (*2)
ANTENNA UNIT: 3765 mm (W) × 710 mm (H) × 575 mm (D), 140 kg (*3)
ANTENNA UNIT: 3090 mm (W) × 780 mm (H) × 575 mm (D), 137 kg (*4)
(*1) with Antenna SN24AF installed.
(*2) with Antenna SN30AF installed.
(*3) with Antenna SN36AF installed.
(*4) with Antenna SN30DF installed.
- (j) Power supply: 100-115/220-230 VAC, 50-60 Hz (for PSU-019 (AU))
100-230 VAC, 50-60 Hz (for RPU-025 (AU))
Note: EUT is powered from Power Supply Unit (PSU-019) and Processor Unit (RPU-025), not directly from AC mains.

1.1.2 Transceiver module

Type: RTR-129 (Contained in ANTENNA UNIT)

1.1.2.1 Transmitter

- (a) Assignable frequency band: Between 2900 and 3100 MHz (CFR Title 47 Sections: 80.375 (d)-(1))
- (b) Type of RF generator:
- Magnetron type: MG5240F (e2V)
- Peak output power: 60 kW nominal
- (c) Magnetron ratings:
- Center frequency of magnetron: 3050 MHz nominal
- Tolerances
- Manufacturing: ±30 MHz
- Pulling: ±1.5 MHz
- Tolerance for 20°C temperature variation: -5 MHz

- (d) Pulse characteristics:

Pulse type		S	M1	M2	L
Pulse length (μs)		0.08	0.2	0.6	1.2
PRF(Hz)	Normal mode	1900	1100	600	600
	TT48NM	1100	1100	600	600
	2nd trace	1500	500	500	500

1.1.2.2 Modulator

- (a) FET Type: TFC563D
Trigger Voltage: +8 VDC positive

1.1.2.3 Receiver

(a) Passband

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

(b) Intermediate frequency: 60 MHz

(c) Gain (overall): Approximately 30.5 dB

(d) Overall noise figure: 3.3 dB (typical)

(e) Video output voltage: 2 V

(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)

1.1.3 Antenna and Scanner

(a) Antenna specifications

Antenna model		SN24AF	SN30AF	SN36AF	SN30DF
Length (mm)		2565	3090	3765	3090
Rotation diameter (mm)		2700	3200	3860	3220
Transmission frequency		S band: 3050 $\pm$ 30 MHz			
Horizontal beam width (-3 dB)		2.6°	2.3°	1.8°	2.3°
Vertical beam width (-3 dB)		25°			22°
Side lobe (max.)	Less than $\pm 10^\circ$	-23 dB or less	-24 dB or less	-24 dB or less	-24 dB or less
	Outside $\pm 10^\circ$	-27 dB or less	-30 dB or less	-30 dB or less	-30 dB or less
Gain		25.7 dBi	26.2 dBi	27.2 dBi	27.1 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: Provided

(f) Rated loss of transmission line per 100 feet: Negligible (Transmission path is only in Antenna.)

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 (Hardware alarms)

(b) Is the equipment for continuous operation: Yes

(c) Is provision made for operation with shore based radar beacons (RACONS): No

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.

1.3 Modification made to the EUT

Following modifications were made to the EUT during testing:

State	Description	Made by	Date
0	As supplied by the customer.	--	--
1	The version of software, (Program name: MTR APPLICATION, Program number: 0359293) in the EUT was updated as below. 01.09 → 01.10	Customer	2 December 2020

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.	A. Takagi
3.2	2.201, 2.1047 (d)	Modulation Characteristics	Passed.	Y. Hijiri
3.3	2.1055 (a)(2),(d)(1),(d)(3), 80.209 (b)	Frequency Stability –temperature & voltage	Passed.	A. Takagi and Y. Hijiri
3.4	2.202 (a), 2.1049 (c)(1), 80.209 (b), 80.211 (f)	Occupied Bandwidth	Passed.	Y. Hijiri
3.5	2.1051, 80.211 (f), 80.273	Spurious Emissions at Antenna Terminals	Passed.	Y. Hijiri
3.6	2.1053, 80.211 (f)	Field Strength of Spurious Radiation	Passed.	A. Takagi and Y. Hijiri

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 Antenna.

3.1.2 Test setup:

See Clause 4.

3.1.3 Test Results:

Normal mode

Pulse type	S	M1	M2	L
Transmission mean power P_m (W)	6.7	8.7	19.8	43.2
Pulse length T (μ s) (50% points)	0.068	0.185	0.604	1.144
Pulse Repetition Frequency (Hz)	1899	1100	600	600
Transmission pulse power P_p (kW) (*)	52.2	43.0	54.7	62.9

TT48NM mode

Pulse type	S	M1	M2	L
Transmission mean power P_m (W)	3.6	8.8	19.8	43.2
Pulse length T (μ s) (50% points)	0.067	0.183	0.600	1.152
Pulse Repetition Frequency (Hz)	1100	1100	600	600
Transmission pulse power P_p (kW) (*)	48.9	43.6	55.1	62.5

2nd trace mode

Pulse type	S	M1	M2	L
Transmission mean power P_m (W)	5.1	3.6	16.3	35.7
Pulse length T (μ s) (50% points)	0.068	0.173	0.600	1.144
Pulse Repetition Frequency (Hz)	1499	500	500	500
Transmission pulse power P_p (kW) (*)	50.5	42.0	54.3	62.4

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

Modification status: 0

Environmental conditions observed: On 17 November 2020, 26°C to 25°C, 52%RH to 54%RH

Power supply voltage measured: 230 VAC, 50 Hz to 230 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 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 (μ s) (50% points)	0.068	0.185	0.604	1.144
Rise time t_r (μ s) (10 to 90 % amplitude)	0.010	0.010	0.012	0.135
Fall time t_f (μ s) (90 to 10 % amplitude)	0.120	0.220	0.233	0.350
Pulse Repetition Frequency (Hz)	1899	1100	600	600

TT48NM mode

Pulse type	S	M1	M2	L
Pulse length T (μ s) (50% points)	0.067	0.183	0.600	1.152
Rise time t_r (μ s) (10 to 90 % amplitude)	0.010	0.010	0.012	0.135
Fall time t_f (μ s) (90 to 10 % amplitude)	0.121	0.221	0.231	0.349
Pulse Repetition Frequency (Hz)	1100	1100	600	600

2nd trace mode

Pulse type	S	M1	M2	L
Pulse length T (μ s) (50% points)	0.068	0.173	0.600	1.144
Rise time t_r (μ s) (10 to 90 % amplitude)	0.010	0.009	0.011	0.135
Fall time t_f (μ s) (90 to 10 % amplitude)	0.120	0.214	0.230	0.349
Pulse Repetition Frequency (Hz)	1499	500	500	500

Modification status: 0

Measured Plots: See Clause 6.

Environmental conditions observed: On 17 November 2020, 26°C to 25°C, 52%RH to 54%RH

Power supply voltage measured: 230 VAC, 50 Hz to 230 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 VAC – 230 VAC

V_L : 187 VAC / V_{nom} : 230 VAC, 50 Hz / V_H : 265 VAC (*1)

(*1) Specified by the customer.

Processor Unit: 100 VAC – 230 VAC

V_L : 85 VAC / V_{nom} : 230 VAC, 50 Hz / V_H : 265 VAC (*2)

(*2) Specified by the customer.

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)):

Normal mode

Pulse type	S	M1	M2	L
Guard Band $f(1.5/T)$ (MHz) (*1)	22.2	8.1	2.5	1.3
Upper limit (MHz) (*2)	3077.8	3091.9	3097.5	3098.7
Lower limit (MHz) (*2)	2922.2	2908.1	2902.5	2901.3

TT48NM mode

Pulse type	S	M1	M2	L
Guard Band $f(1.5/T)$ (MHz) (*1)	22.3	8.2	2.5	1.3
Upper limit (MHz) (*2)	3077.7	3091.8	3097.5	3098.7
Lower limit (MHz) (*2)	2922.3	2908.2	2902.5	2901.3

2nd trace mode

Pulse type	S	M1	M2	L
Guard Band $f(1.5/T)$ (MHz) (*1)	22.2	8.7	2.5	1.3
Upper limit (MHz) (*2)	3077.8	3091.3	3097.5	3098.7
Lower limit (MHz) (*2)	2922.2	2908.7	2902.5	2901.3

(*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, $f(U) = 3100 - 1.5/T$

Lower limit frequency, $f(L) = 2900 + 1.5/T$

3.3.4 Test Results:

Complied. (Modification status: 0)

(1) Temperature test at the rated supply voltage of 230 VAC, 50 Hz:

Pulse type		S	M1	M2	L	Result
Frequency at maximum emission (MHz)	-20°C	3052.0	3052.5	3051.5	3051.5	Complied.
	-10°C	3051.5	3052.0	3051.0	3050.5	Complied.
	0°C	3052.0	3052.0	3051.5	3051.0	Complied.
	+10°C	3051.5	3051.5	3050.5	3050.0	Complied.
	+20°C	3051.0	3051.5	3050.0	3049.5	Complied.
	+30°C	3050.5	3050.5	3049.5	3048.0	Complied.
	+40°C	3050.0	3050.0	3049.0	3048.0	Complied.
	+50°C	3048.0	3048.0	3046.5	3045.5	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	3050.5	3050.0	3049.5	3048.5	Complied.
	V _{nom}	3051.0	3051.5	3050.0	3049.5	Complied.
	V _H	3050.5	3050.5	3049.5	3048.0	Complied.

Environmental conditions observed: On 13 November 2020, 22°C to 22°C, 58%RH to 58%RH

On 16 November 2020, 21°C to 21°C, 65%RH to 65%RH

Power supply voltage measured: 230 VAC, 50 Hz to 230 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 Antenna.

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) = 3050 MHz (for S-band radars)

(*2) Authorized band width = 100 MHz (for S-band radars)

3.4.4 Test Results:

Complied. (Modification status: 0)

Spectrum plots: See Clause 7.

Environmental conditions observed: On 24 November 2020, 22°C to 22°C, 58%RH to 58%RH
Power supply voltage measured: 230 VAC, 50 Hz to 230 VAC, 50 Hz

3.5 Spurious Emissions at Antenna Terminals

(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 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 S-band radar: 1.46 GHz to 30.6 GHz

Lower measurement band	Upper measurement band
From 1.46 GHz (*2) to the lower OoB boundary	From the upper OoB boundary to 30.6 GHz

(*2) 0.7 times of the waveguide cut-off frequency for WRJ-3 (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) = 3050 MHz (for S-band radars)

(*2) Authorized bandwidth = 100 MHz (for S-band radars)

(*3) Spurious measurement range for S-band radar: 1.46 GHz to 30.6 GHz

3.5.4 Harmonics Frequencies:

f_0 (GHz)	$1/2f_0$	$2f_0$	$3f_0$	$4f_0$	$5f_0$	$6f_0$	$7f_0$	$8f_0$	$9f_0$	$10f_0$
3.050	1.525	6.100	9.150	12.200	15.250	18.300	21.350	24.400	27.450	30.500

3.5.5 Test Results:

Complied. (Modification status: 0)

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

Environmental conditions observed: On 30 November 2020, 24°C to 24°C, 46%RH to 46%RH

Power supply voltage measured: 230 VAC, 50 Hz to 230 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 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 S-Band RADAR: 1.46 GHz to 30.6 GHz

Lower measurement band	Upper measurement band
From 1.46 GHz (*2) to the lower OoB boundary	From the upper OoB boundary to 30.6 GHz

(*2) 0.7 times of the waveguide cut-off frequency for WRJ-3 (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: 1 m to 4 m

(b) Antenna polarization: vertical and horizontal.

EUT height: 0.8 m (specified by the customer.)

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) = 3050 MHz (for S-band radars)

(*2) Authorized bandwidth = 100 MHz (for S-band radars)

(*3) Spurious measurement range for S-band radar: 1.46 GHz to 30.6 GHz

3.6.6 Harmonics Frequencies:

f_0 (GHz)	$1/2f_0$	$2f_0$	$3f_0$	$4f_0$	$5f_0$	$6f_0$	$7f_0$	$8f_0$	$9f_0$	$10f_0$
3.050	1.525	6.100	9.150	12.200	15.250	18.300	21.350	24.400	27.450	30.500

3.6.7 Test Results:

Complied. (Modification status: 1)

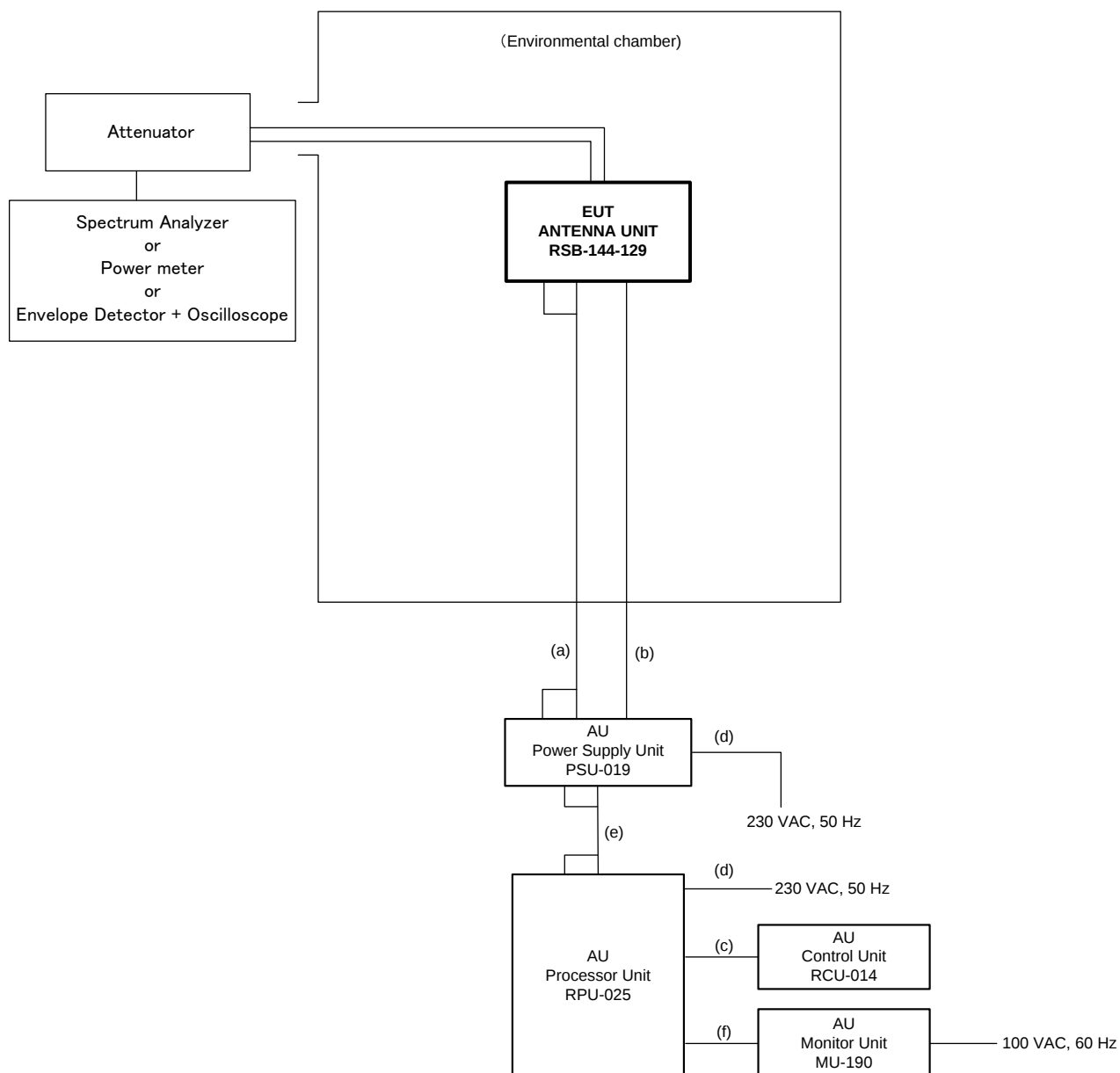
Spurious emission levels measured were found to be attenuated more than 20 dB below the limits.

Environmental conditions observed: On 9 December 2020, 23°C to 23°C, 41%RH to 41%RH

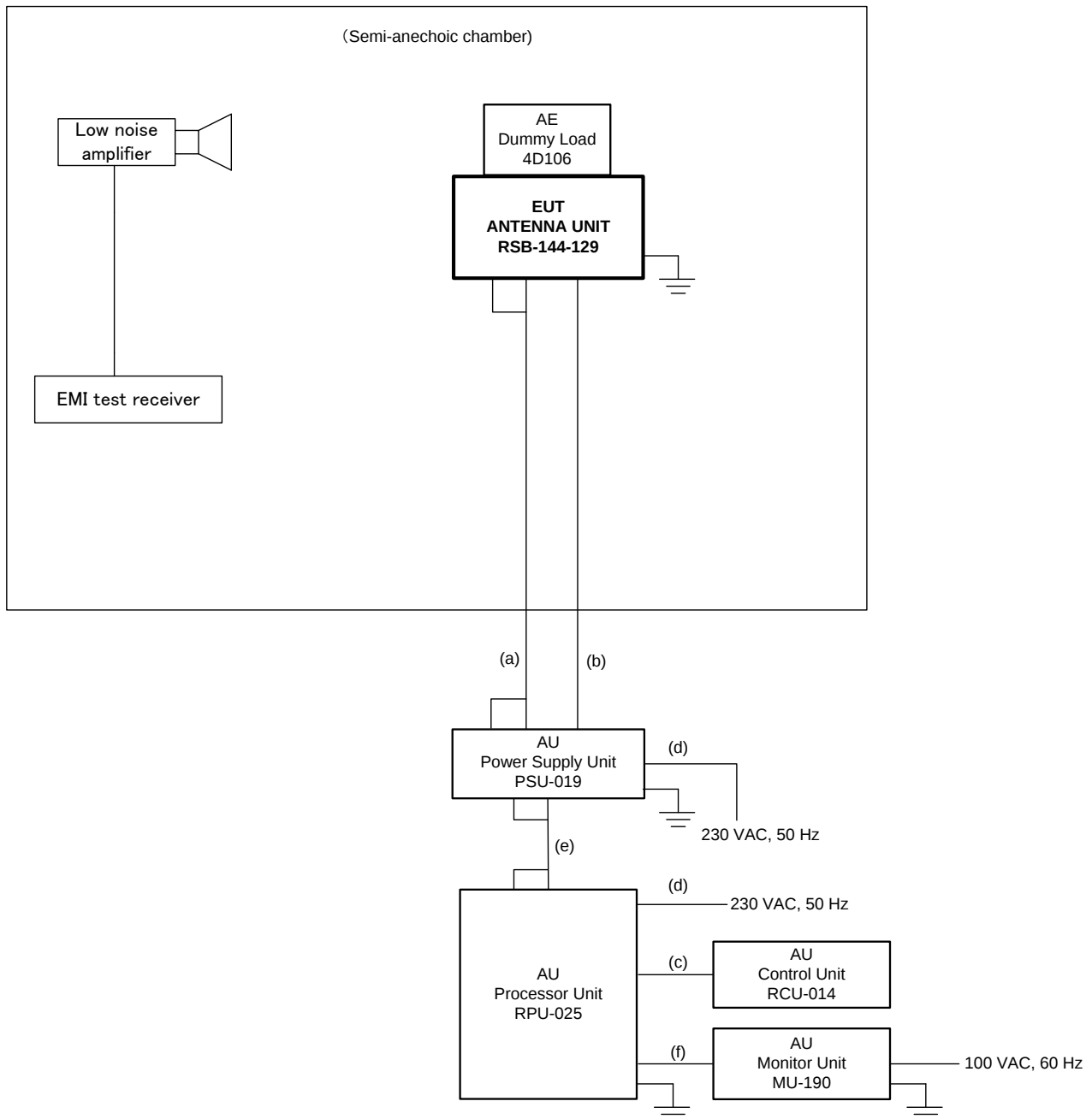
Power supply voltage measured: 230 VAC, 50 Hz to 230 VAC, 50 Hz

4 Test Setup for Measurements

4.1 Test Setup for Clause 3.1, 3.2, 3.3, 3.4 and 3.5



4.2 Test Setup for Clause 3.6



Cable designations

No.	Category	Name	Type	Length (m)	Number of cables used	Cable shielded
a	Signal/control	Antenna Cable (multicore Cable)	RW-0013	20	1	Yes
b	Power	Motor Cable (Power Cable)	0.6/1kV TPYCY-2.5	20	1	No
c	Signal/control	Cable assy	XH10P-W-6P	20	1	Yes
d	Power	Power Cable	0.6/1kV DPYC-2.5	20	2	No
e	Signal/control	PSU - Processor Cable (Multicore Cable)	RW-00339	20	1	Yes
f	Signal/control	DVI Cable	DVI-D/D S-LINK	10	1	Yes

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
RT199	Directional coupler (S-band)	5D108	R1788	Shimada	2 March 2020	1 year
--	Waveguide(for S-band)	--	--	Furuno	--	--
RT200	Power meter	E4418B	GB43315050	Agilent	21 February 2020	1 year
RT201	Power sensor	8481A	2349A39603	Agilent	21 February 2020	1 year
HT370	Climatic chamber (Large)	TBE-3HW5GE2F	3013000995	Espec	8 September 2020	1 year
HT723	Paperless recorder/ Dual communication logger	FX106-4-1	S5JA01445	Yokogawa	--	--
HT1204	Programmable AC power source	DP045M	9158465	NF	--	--
HT434	AC/DC power supply	PCR2000L	BB002789	Kikusui	--	--
HT831	Digital multimeter	115	15540244	Fluke	12 May 2020	1 year

(2) For Clause 3.2 Modulation Characteristics

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT199	Directional coupler (S-band)	5D108	R1788	Shimada	2 March 2020	1 year
--	Waveguide(for S-band)	--	--	Furuno	--	--
HT654	Attenuator	8494B	MY42148134	Agilent	7 February 2020	1 year
HT1223	Attenuator	8495B	MY42148137	Agilent	7 February 2020	1 year
HT676	Spectrum analyzer	8564EC	4103A00440	Agilent	1 May 2020	1 year
HT370	Climatic chamber (Large)	TBE-3HW5GE2F	3013000995	Espec	8 September 2020	1 year
HT723	Paperless recorder/ Dual communication logger	FX106-4-1	S5JA01445	Yokogawa	--	--
HT1221	Envelope detector	423B	MY51342422	Agilent	25 February 2020	1 year
HT972	Oscilloscope	MSO4054B	C030483	TEKTRONIX	28 February 2020	1 year
HT831	Digital multimeter	115	15540244	Fluke	12 May 2020	1 year
HT1204	Programmable AC power source	DP045M	9158465	NF	--	--
HT434	AC/DC power supply	PCR2000L	BB002789	Kikusui	--	--

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

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT199	Directional coupler (S-band)	5D108	R1788	Shimada	2 March 2020	1 year
--	Waveguide(for S-band)	--	--	Furuno	--	--
HT654	Attenuator	8494B	MY42148134	Agilent	7 February 2020	1 year
HT1223	Attenuator	8495B	MY42148137	Agilent	7 February 2020	1 year
HT676	Spectrum analyzer	8564EC	4103A00440	Agilent	1 May 2020	1 year
HT370	Climatic chamber (Large)	TBE-3HW5GE2F	3013000995	Espec	8 September 2020	1 year
HT723	Paperless recorder/ Dual communication logger	FX106-4-1	S5JA01445	Yokogawa	--	--
HT1204	Programmable AC power source	DP045M	9158465	NF	--	--
HT434	AC/DC power supply	PCR2000L	BB002789	Kikusui	--	--
HT831	Digital multimeter	115	15540244	Fluke	12 May 2020	1 year

(4) For Clause 3.4 Occupied Bandwidth

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT199	Directional coupler (S-band)	5D108	R1788	Shimada	2 March 2020	1 year
--	Waveguide(for S-band)	--	--	Furuno	--	--
HT654	Attenuator	8494B	MY42148134	Agilent	7 February 2020	1 year
HT1223	Attenuator	8495B	MY42148137	Agilent	7 February 2020	1 year
HT676	Spectrum analyzer	8564EC	4103A00440	Agilent	1 May 2020	1 year
HT1204	Programmable AC power source	DP045M	9158465	NF	--	--
HT434	AC/DC power supply	PCR2000L	BB002789	Kikusui	--	--
HT831	Digital multimeter	115	15540244	Fluke	12 May 2020	1 year

(5) For Clause 3.5 Spurious Emissions at Antenna Terminals

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT199	Directional coupler (S-band)	5D108	R1788	Shimada	2 March 2020	1 year
--	Waveguide(for S-band)	--	--	Furuno	--	--
--	Adapter	S281A	---	HEWLETT PACKARD	Not applicable.	--
--	Adapter	BL00-6256-00	--	Orient Microwave	Not applicable.	--
--	Adapter	PE9826	---	Pasternack	Not applicable.	--
--	Isolator	OMC FX0157	--	--	Not applicable.	--
HT676	Spectrum analyzer	8564EC	4103A00440	Agilent	1 May 2020	1 year
HT1204	Programmable AC power source	DP045M	9158465	NF	--	--
HT434	AC/DC power supply	PCR2000L	BB002789	Kikusui	--	--
HT831	Digital multimeter	115	15540244	Fluke	12 May 2020	1 year
KB289	Coaxial cable	SF104A/11PC35/11P C35/5500MM	800048/4A	HUBER+ SUHNER	8 August 2020	1 year
KB181	Coaxial cable	SUCOFLEX 102A	1261/2A	HUBER+ SUHNER	8 August 2020	1 year

(6) For Clause 3.6 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: 7 December 2019	3 years
HT1277	Test software	EP5/RE	Ver.6.0.112	Toyo	--	--
HT1270	EMI test receiver (2 Hz to 44 GHz)	ESW44	101841	Rohde & Schwarz	8 August 2020	1 year
HT758	Broadband horn antenna (1 GHz to 6 GHz)	9120B	522	Schwarzbeck	13 August 2020	1 year
HT1263	Pre-amp. (1 GHz to 6 GHz)	00-T1885	BBB1932270	Noiseken	11 May 2020	1 year
HT759	Double ridged horn antenna & amp. (6 GHz to 18 GHz)	HAP06-18W	00000065	Toyo	13 August 2020	1 year
HT761	Double ridged horn antenna & amp. (18 GHz to 26 GHz)	HAP18-26N	00000017	Toyo	14 August 2020	1 year
HT762	Double ridged horn antenna & amp. (26 GHz to 40 GHz)	HAP26-40N	00000010	Toyo	14 August 2020	1 year
30-0022	Notch Filter	CBR-S7-3A	R1189001	Shimada	--	--
HT866	Digital multimeter	115	19170029	Fluke	13 February 2020	1 year
HT780	Programmable AC/DC power supply	ES18000W	9128767-1 +9128767-2	NF	--	--

6 RF Envelope and Spectrum of the Output Pulse

Normal mode

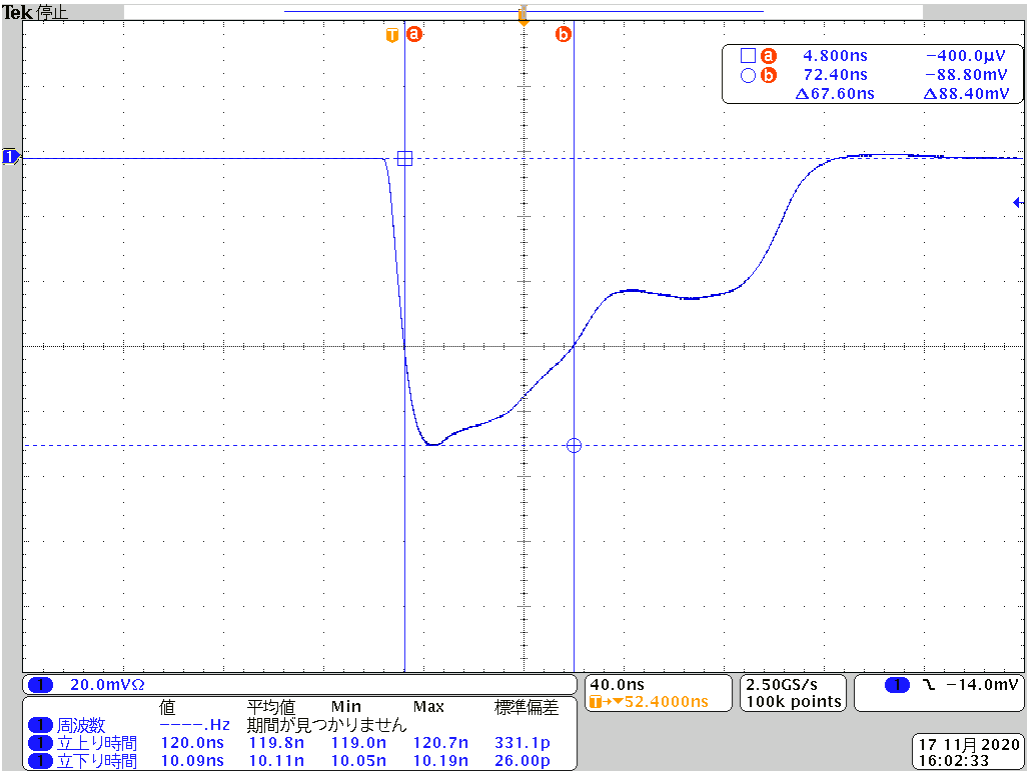


Fig. 6.1 S pulse envelope

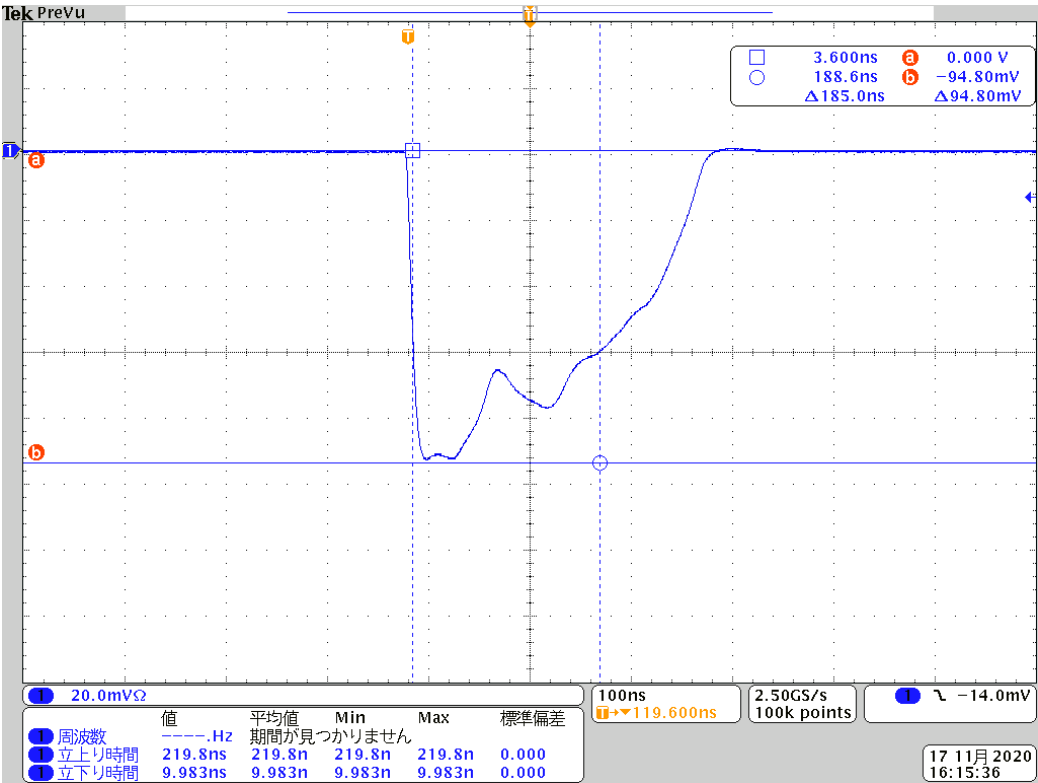


Fig. 6.2 M1 pulse envelope

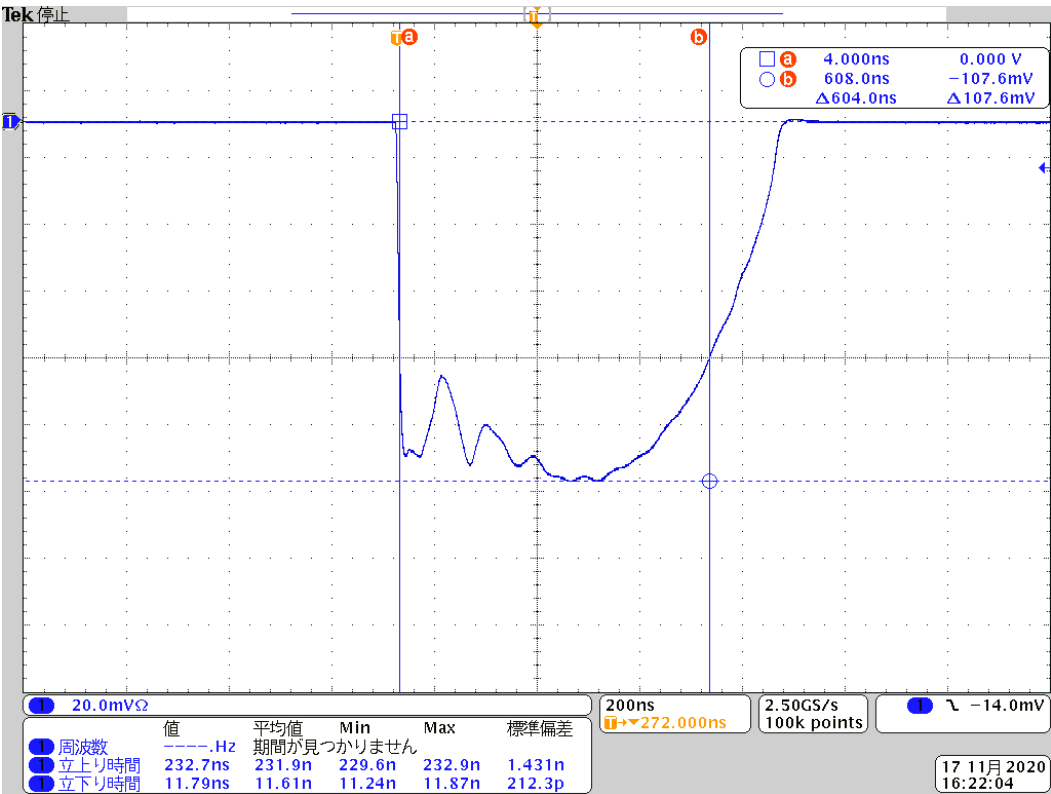


Fig. 6.3 M2 pulse envelope

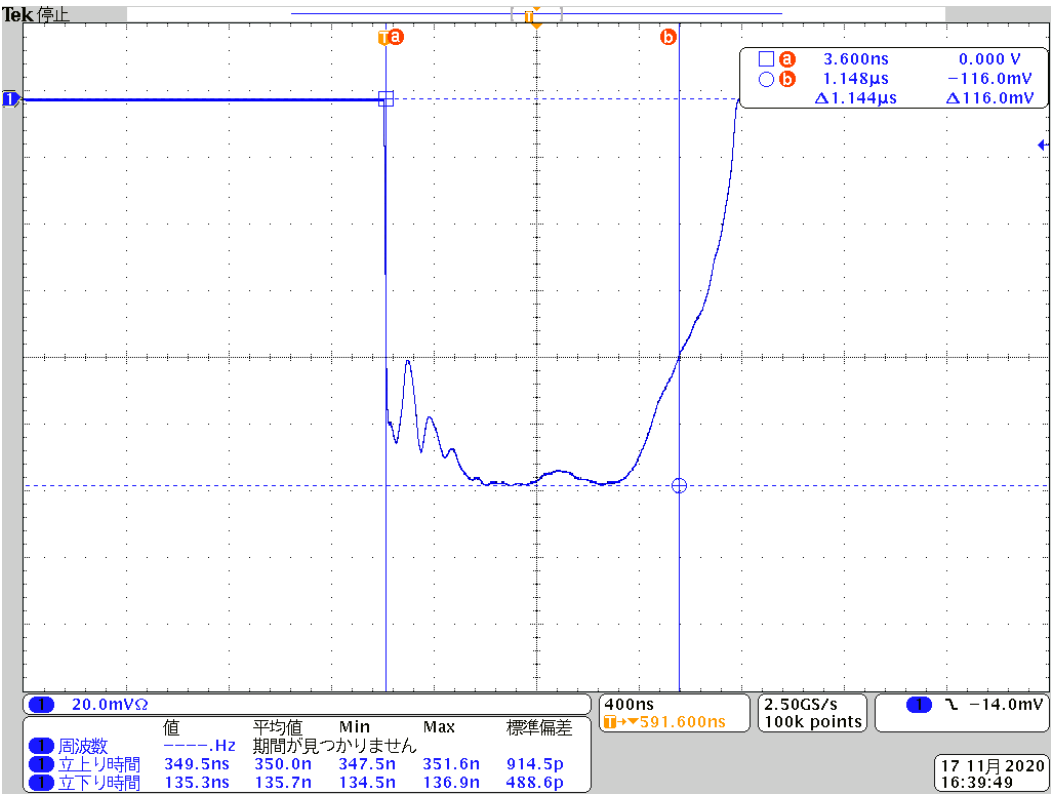


Fig. 6.4 L pulse envelope

TT48NM mode

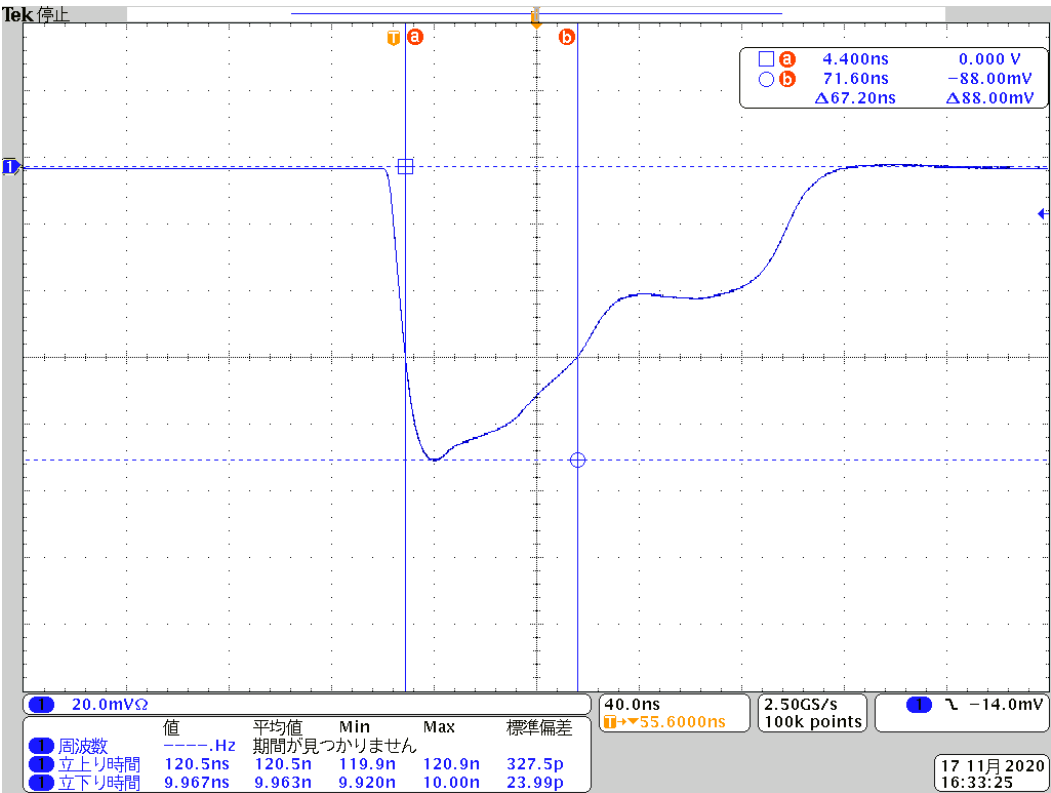


Fig. 6.5 S pulse envelope

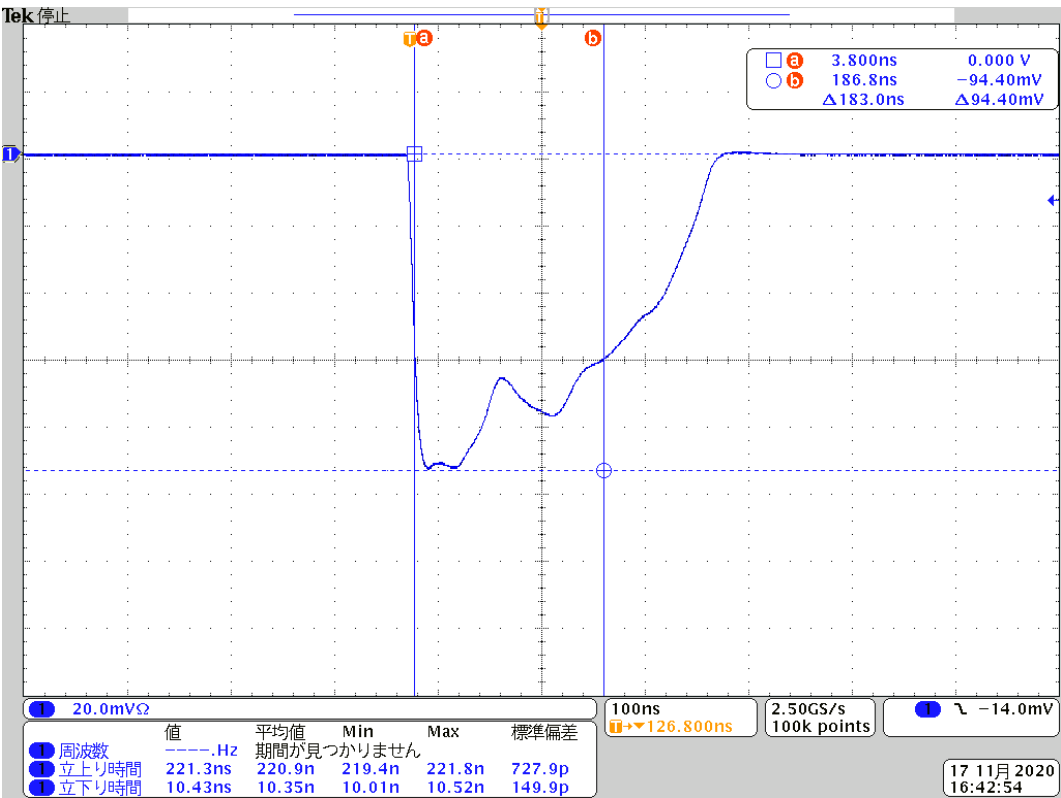


Fig. 6.6 M1 pulse envelope

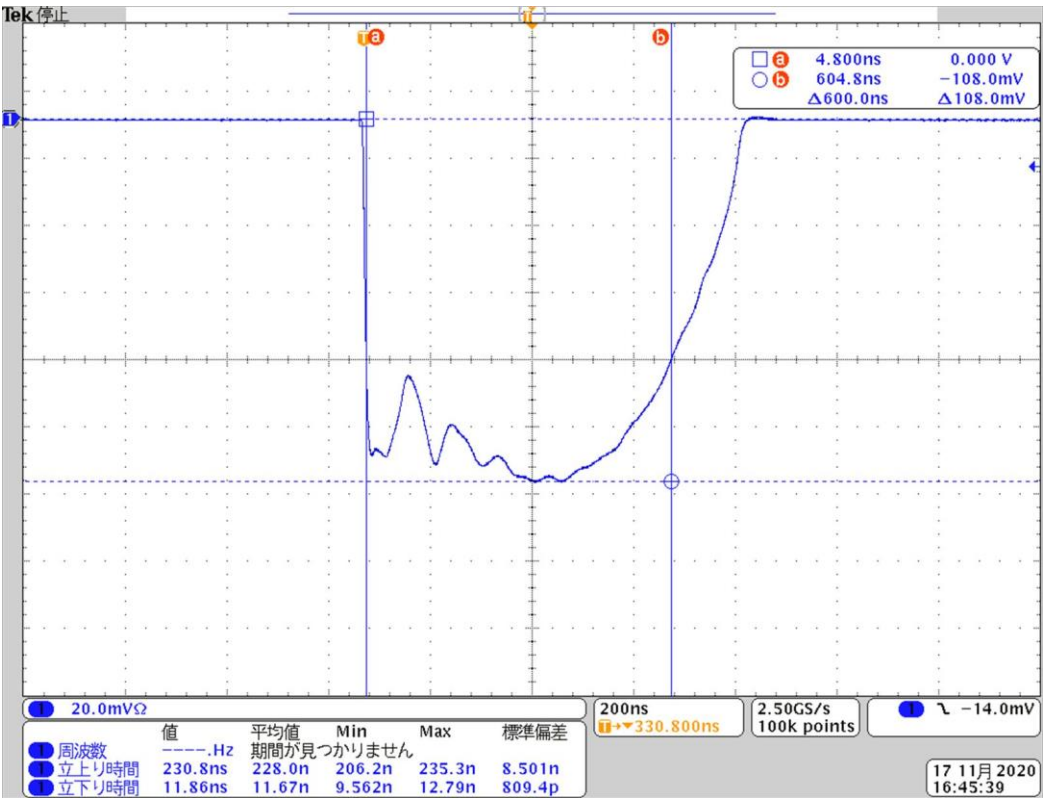


Fig. 6.7 M2 pulse envelope



Fig. 6.8 L pulse envelope

2nd trace mode

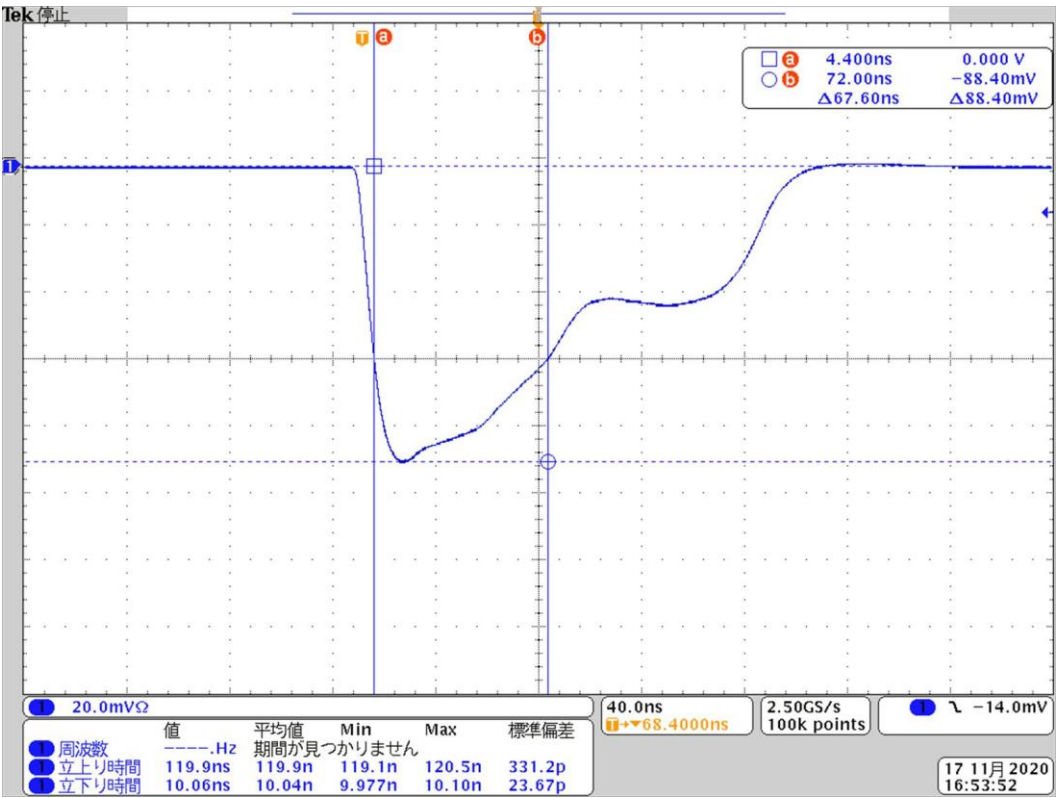


Fig. 6.9 S pulse envelope

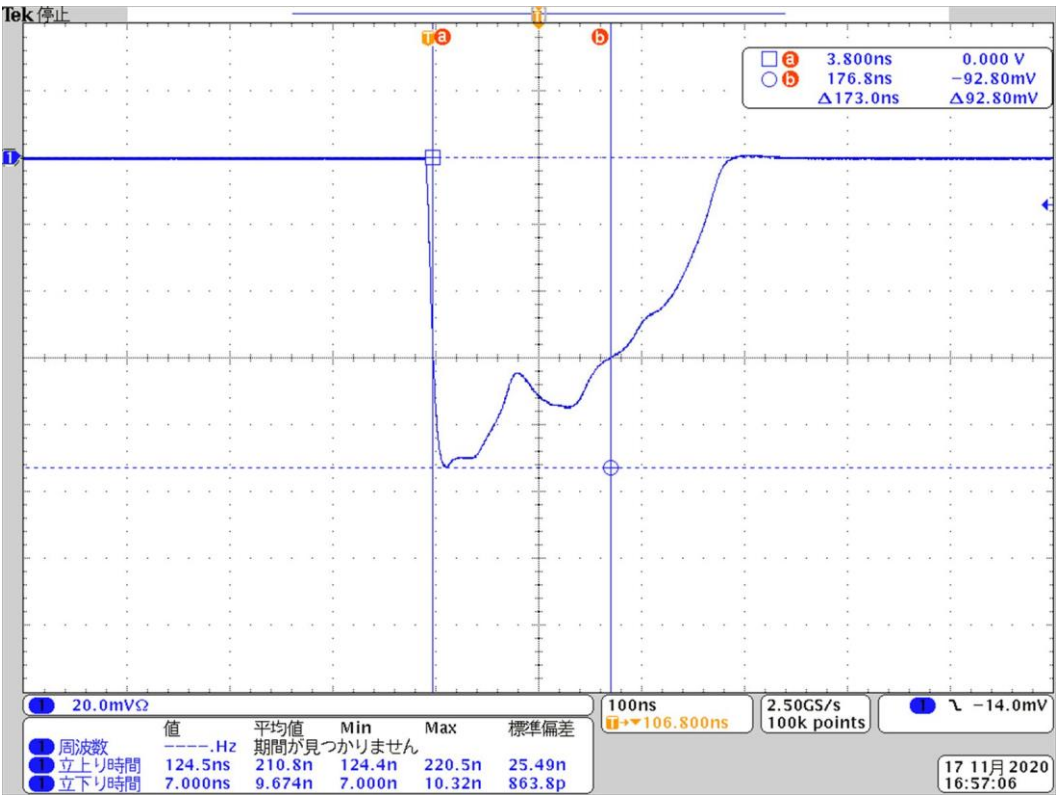


Fig. 6.10 M1 pulse envelope

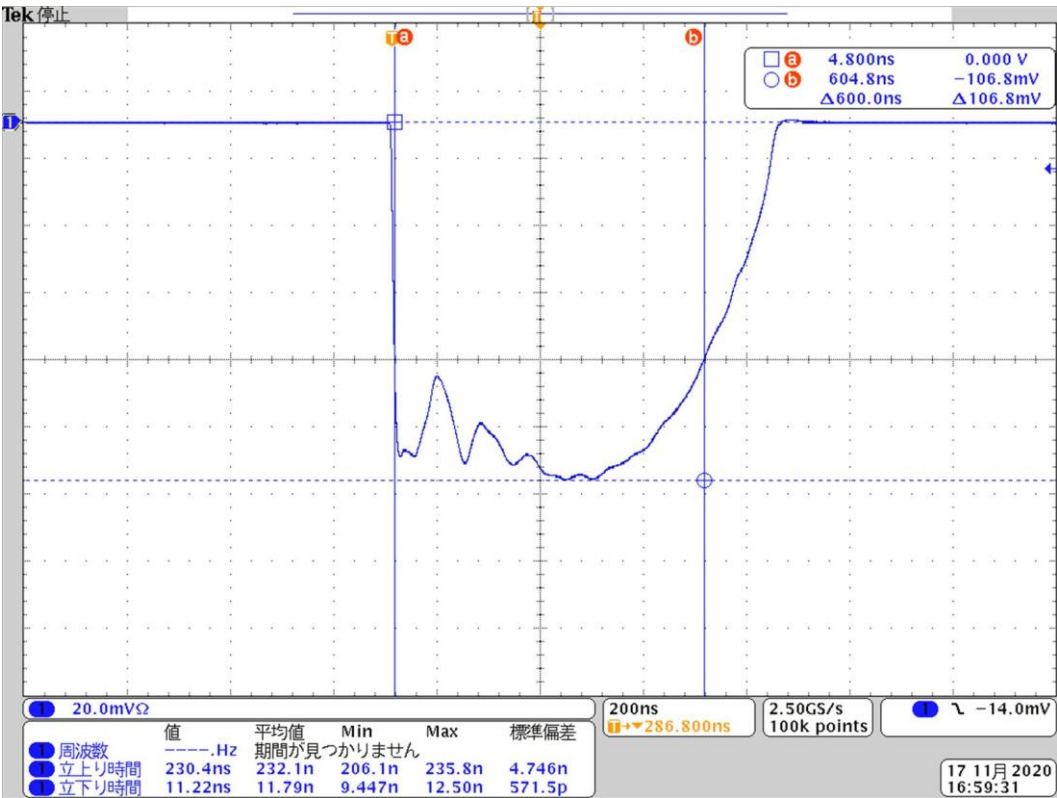


Fig. 6.11 M2 pulse envelope

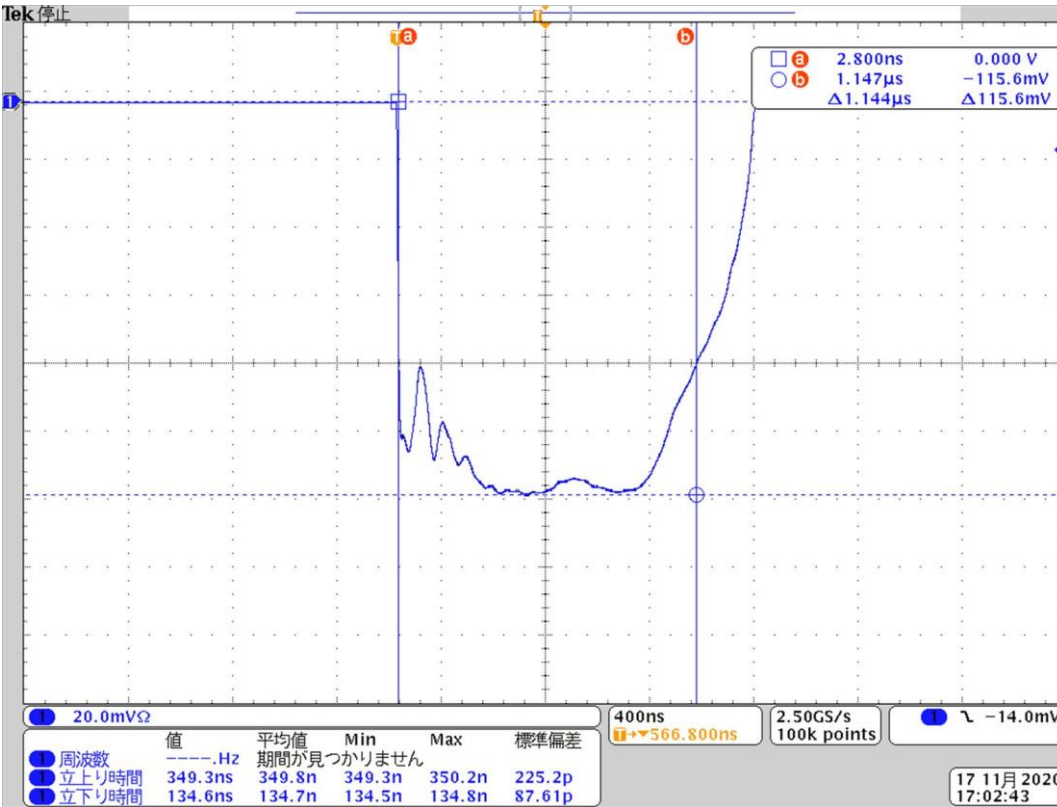


Fig. 6.12 L pulse envelope

7 Spurious Emission Plots measured at Antenna Terminal

Normal mode

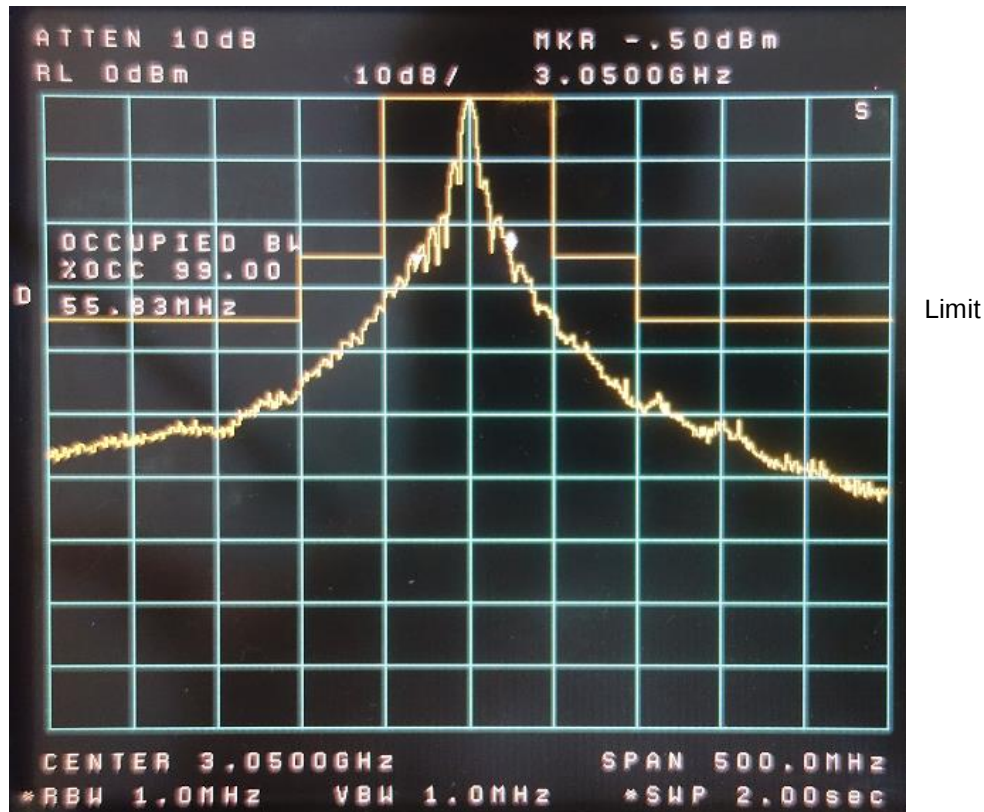


Fig. 7.1 S pulse

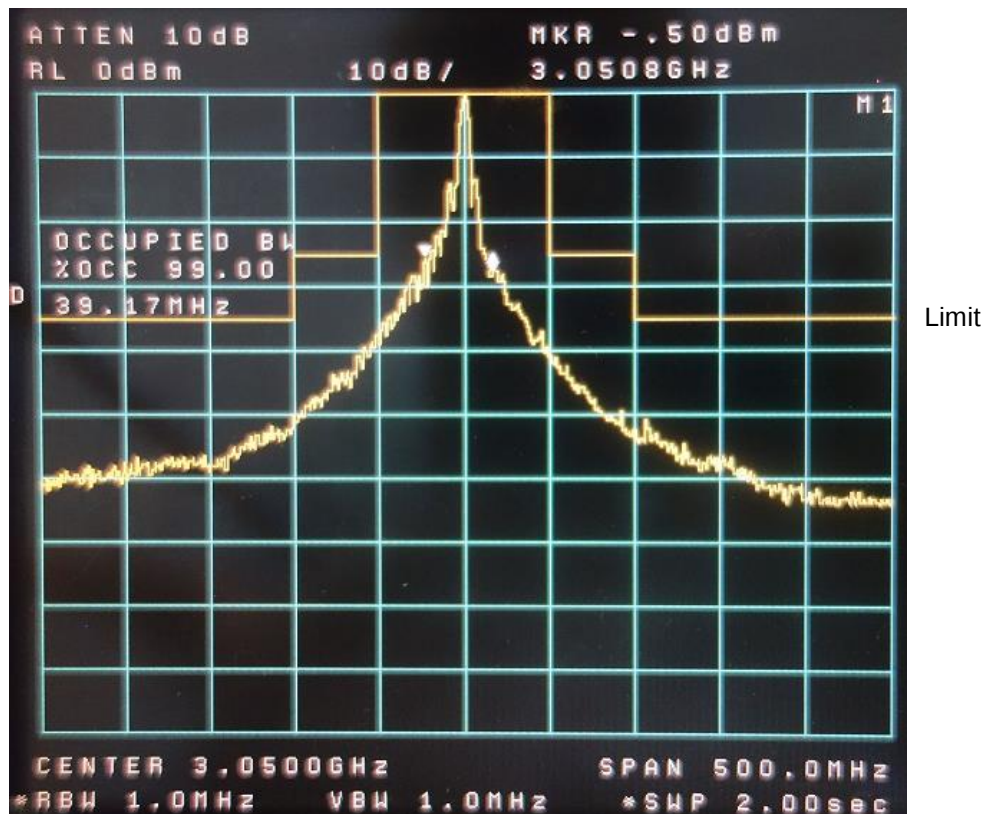


Fig. 7.2 M1 pulse

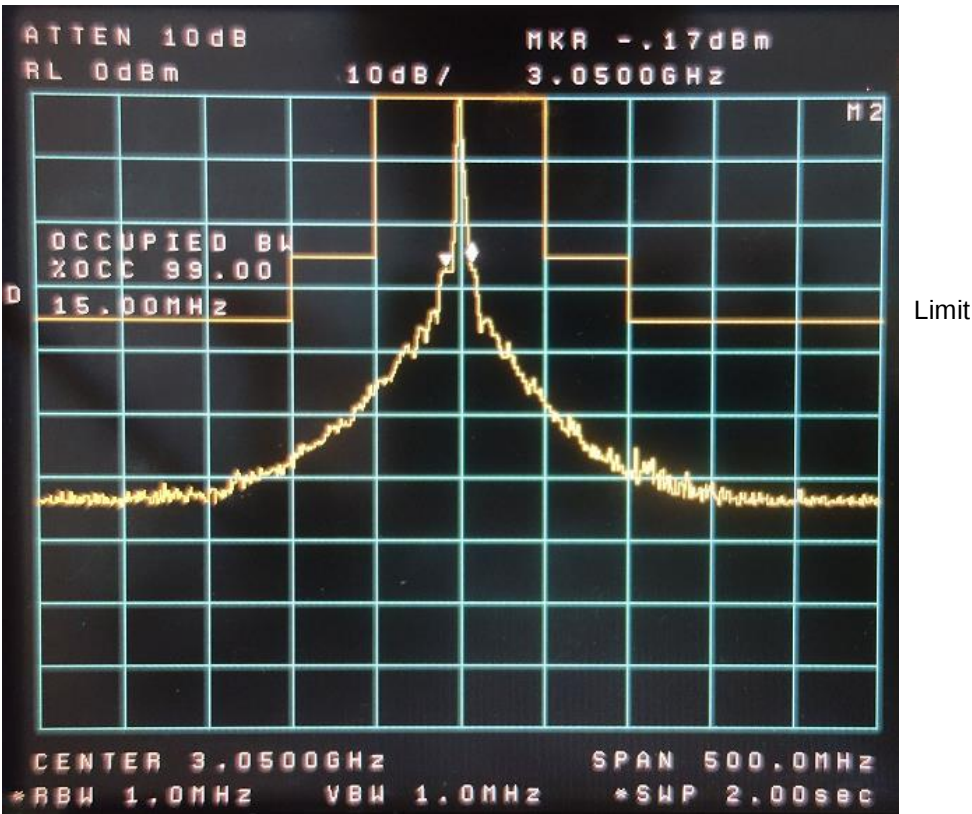


Fig. 7.3 M2 pulse

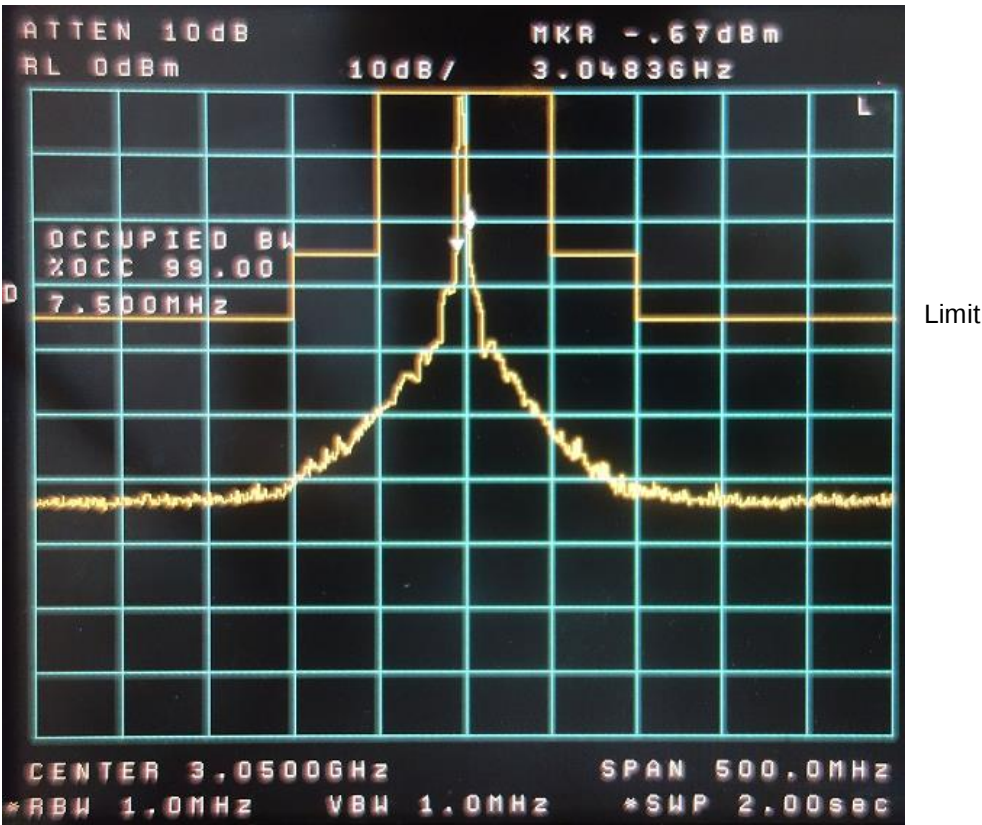


Fig. 7.4 L pulse

TT48NM mode

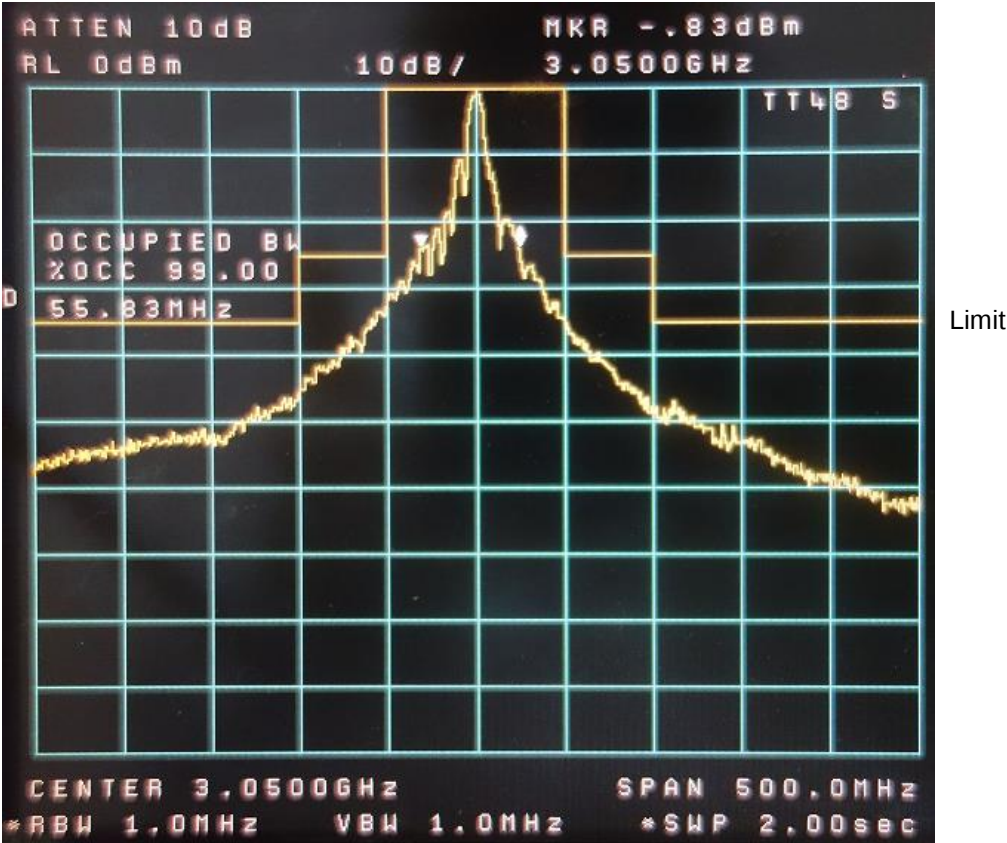


Fig. 7.5 S pulse

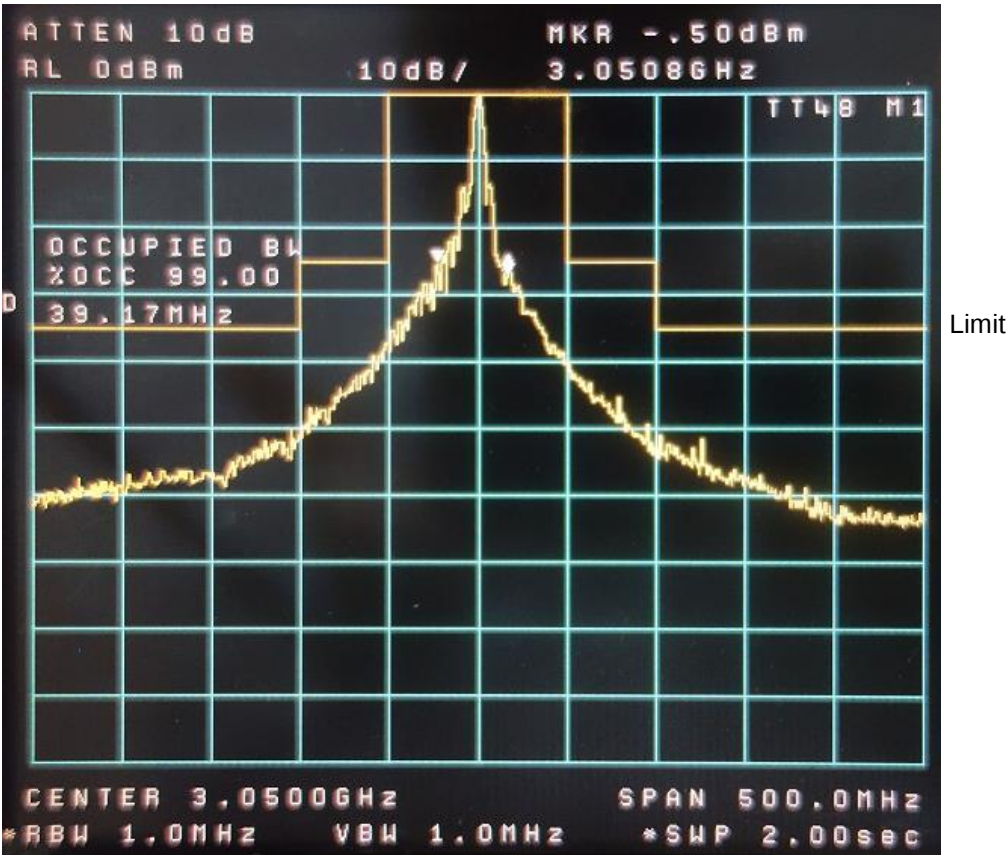


Fig. 7.6 M1 pulse

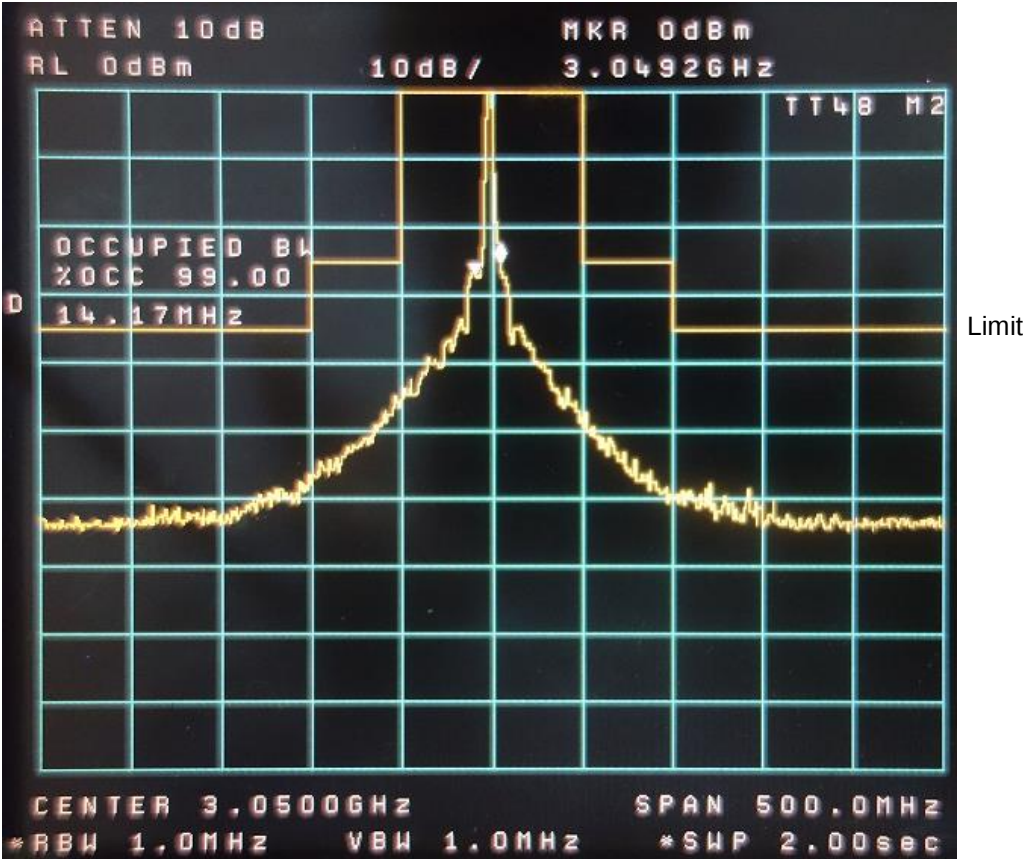


Fig. 7.7 M2 pulse

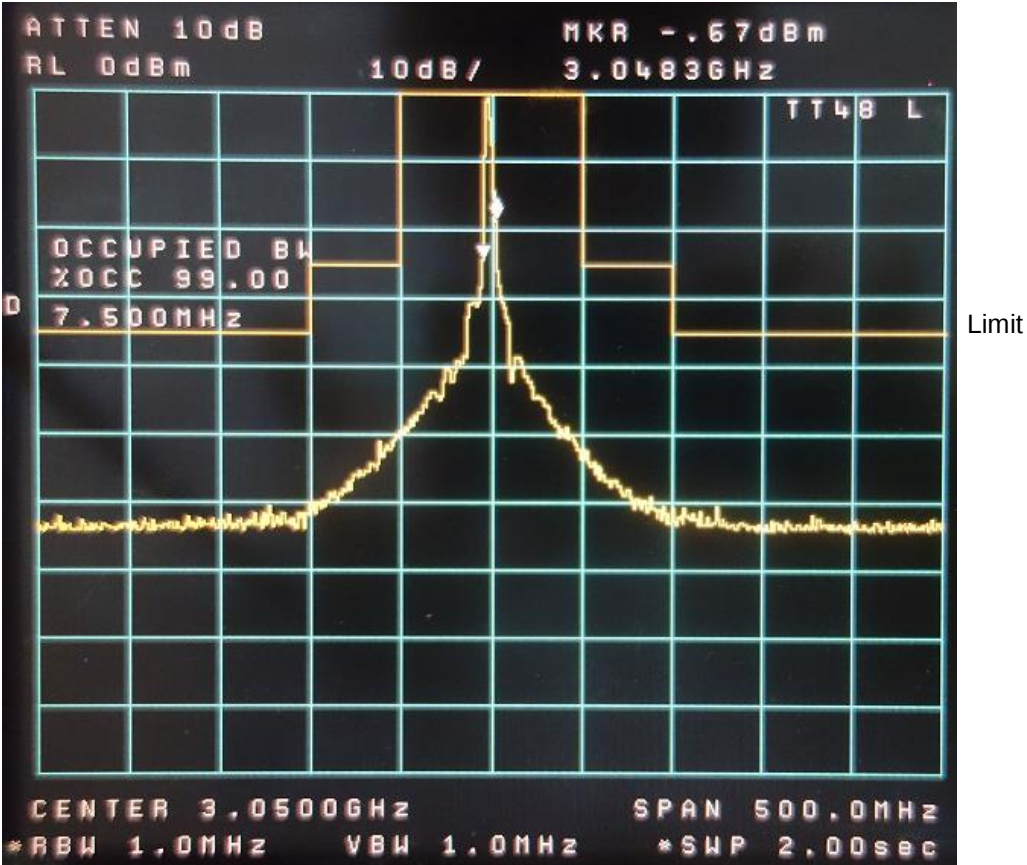


Fig. 7.8 L pulse

2nd trace mode

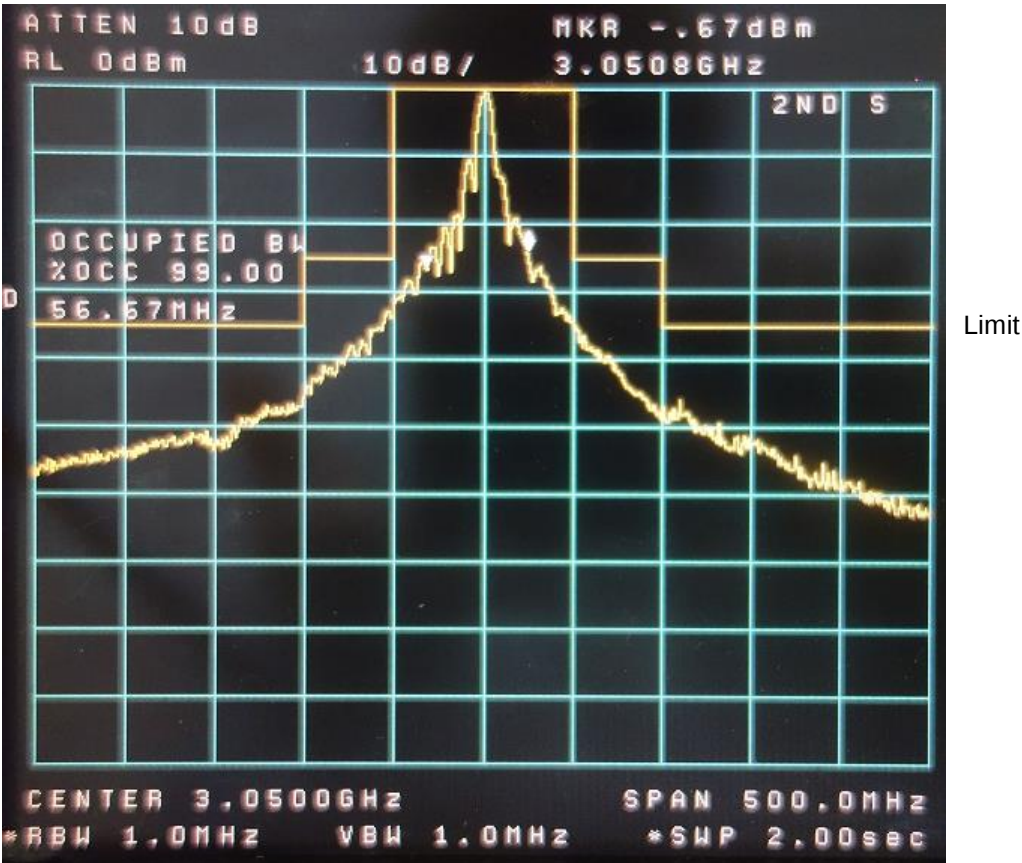


Fig. 7.9 S pulse

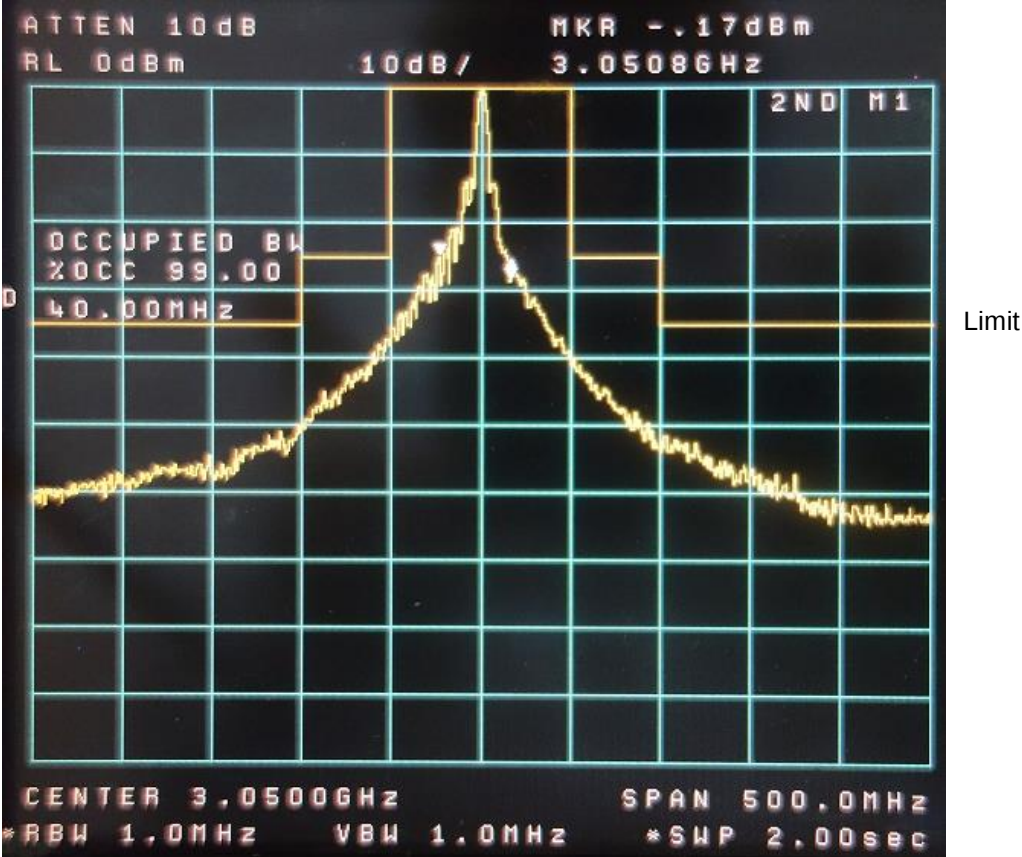


Fig. 7.10 M1 pulse

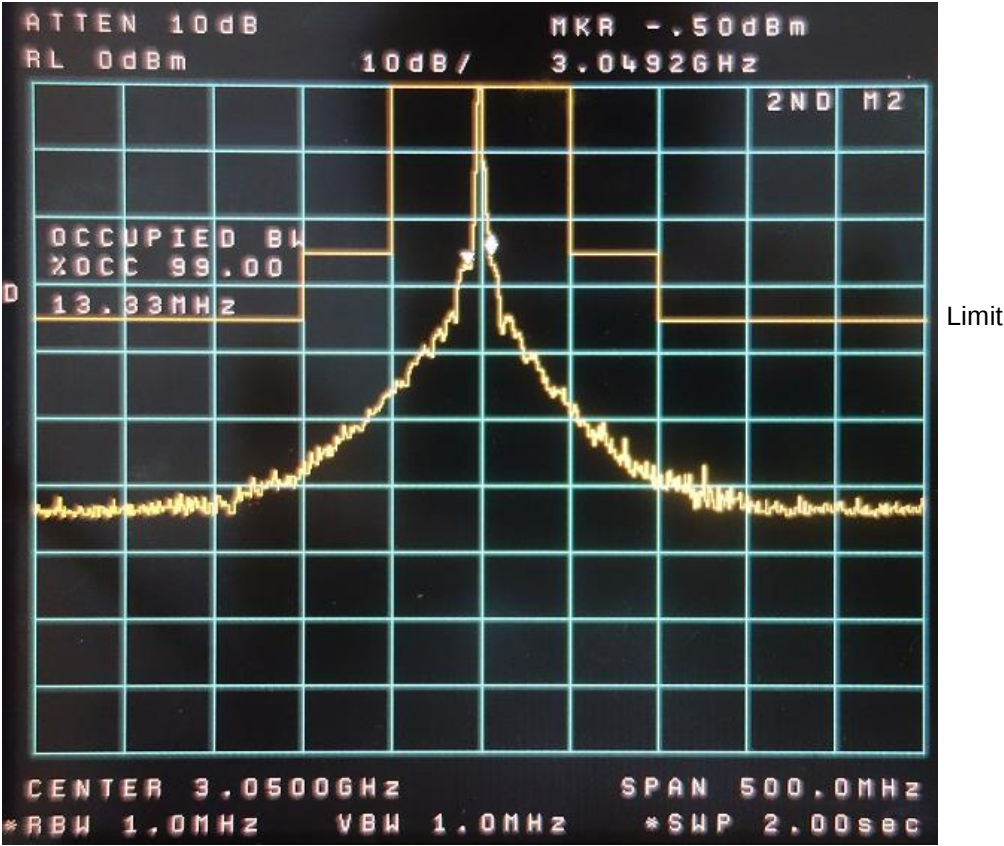


Fig. 7.11 M2 pulse

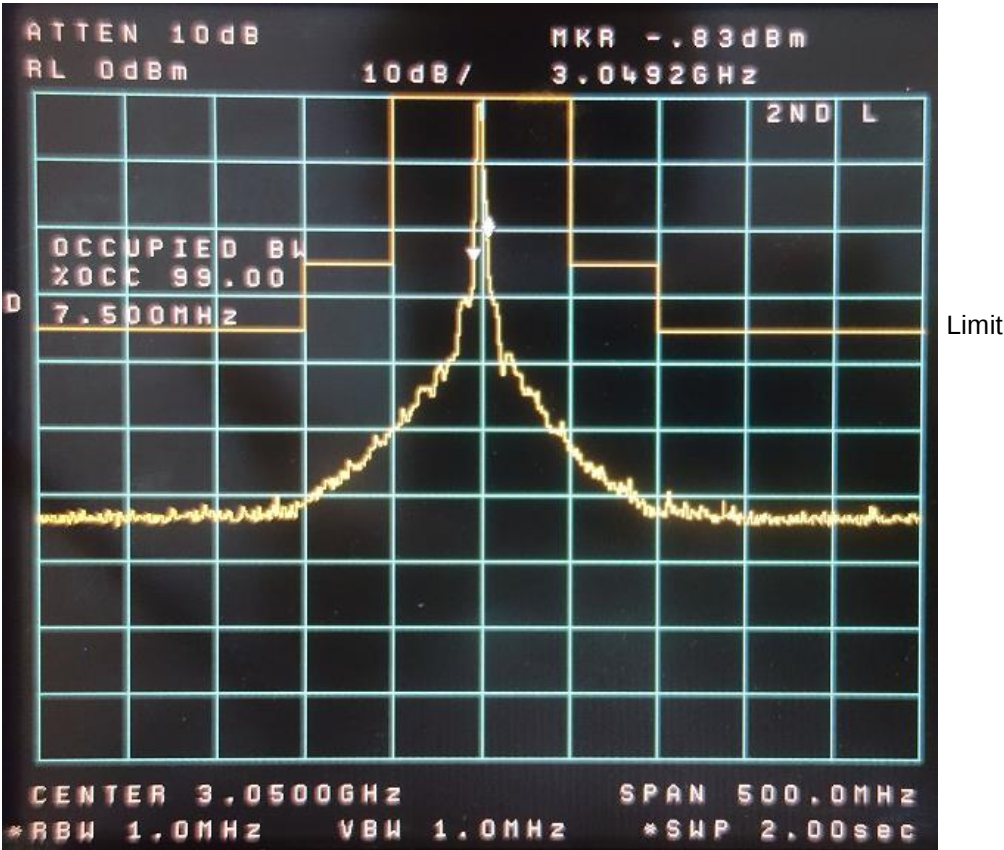


Fig. 7.12 L pulse

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