

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-2228-NXT/2228-NXT-BB/2328-NXT

FAR-3220-NXT/3220-NXT-BB/3320-NXT

Type: RTR-123

Report no.: LIC 12-19-157

Date of issue: 8 November 2019

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Report Summary

LIC project number:	LIC 04-19-0380		
Test report number of initial issue:	LIC 12-19-157	Date of initial issue	8 November 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-2228-NXT/2228-NXT-BB/2328-NXT/FAR-3220-NXT/3220-NXT-BB/3320-NXT		
Type:	RTR-123		
Product function and intended use:	Marine radar: CAT 1C, 2C / 1HC, 2HC		
Number of samples tested:	One		
Serial number:	See Clause 1.1 of this report.		
Power rating:	100–230 VAC, 50–60 Hz, 2.9–1.3 A (for RPU-025 (AU))		
Product status:	Pre-production model		
Modifications made to samples during testing:	None		
Date of receipt of samples:	9 July 2019		
Test period:	From 9 July 2019 to 22 August 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:	Koji Kawai, Atsushi Takagi and Yukihiro Hijiri
Written by:	Arisa Ogino
Verified by:	Tadayuki Ekawa
Approved by:	8 November 2019 Name: Tadayuki Ekawa Title: Head engineer, 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, 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-2228-NXT/2228-NXT-BB/2328-NXT/
FAR-3220-NXT/3220-NXT-BB/3320-NXT

Name	Type	Serial number	Note
MARINE RADAR ANTENNA UNIT	RSB-128-123	R000-2500-0001	--
Transceiver	RTR-123	--	--
Scanner	RSB-128	--	Antenna rotation rate: 24/36/42 rpm
Performance monitor	PM-32B		--
ANTENNA RADIATOR	XN12CF	--	One (1) selectable
	XN20CF	--	
	XN24CF	--	

Associated units (AU)

Name	Type	Serial number	Note
De-icer	--	--	--
MARINE RADAR PROCESSOR UNIT	RPU-025	1000-7910-1918	--
CONTROL UNIT	RCU-014	201681	--
MONITOR UNIT	MU-190	030764	--

Auxiliary Equipment (AE)

Name	Type	Serial number	Note
USB-RSS422 Converter	UPort 1650-8	TADHB1008750	--
PC	CF-MX3	AD13-0227005	--
PROCESSOR UNIT (SUB)	RPU-024	1000-3700-0020	--
CONTROL UNIT (SUB)	RCU-028	000012	--
MONITOR UNIT (SUB)	PLE1706S-B1	11019C1400484	--
Dummy load	4D376	R4535002	--

- (d) FCC ID: ADB9ZWRTR123
- (e) Primary function: Ship radar station operating in the band 9300–9500 MHz
- (f) Frequency range: Fixed frequency, X-band (9380–9440 MHz)
- (g) Type of emission: P0N/Q0N
(Emission designator)

(h) Occupied bandwidth:

Pulse type			S1	S2	M1	M2	M3	L
Occupied bandwidth (MHz)	TT24NM	ch1 (P0N)	44.9	33.0	25.7	18.3	12.8	9.2
		ch2 (P0N)	46.8	36.7	26.6	19.3	12.8	9.2
		ch1 (Q0N)	9.2	9.2	9.2	7.3	7.3	6.4
		ch2 (Q0N)	10.1	9.2	9.2	7.3	6.4	6.4
	TT32NM	ch1 (P0N)	44.9	33.0	25.7	17.4	12.8	9.2
		ch2 (P0N)	45.8	35.8	26.6	18.3	12.8	9.2
		ch1 (Q0N)	10.1	9.2	9.2	7.3	7.3	6.4
		ch2 (Q0N)	10.1	9.2	9.2	6.4	6.4	6.4
	2nd trace	ch1 (P0N)	44.0	33.0	25.7	18.3	12.8	9.2
		ch2 (P0N)	44.9	36.7	27.5	18.3	12.8	9.2
		ch1 (Q0N)	9.2	9.2	9.2	6.4	6.4	6.4
		ch2 (Q0N)	10.1	9.2	9.2	8.3	6.4	6.4

Note: measured data

- (i) Size and mass: MARINE RADAR ANTENNA UNIT: $\phi 1300 \text{ mm} \times 575 \text{ mm}$ (H), 49 kg (*1)
MARINE RADAR ANTENNA UNIT: $\phi 2100 \text{ mm} \times 575 \text{ mm}$ (H), 51 kg (*2)
MARINE RADAR ANTENNA UNIT: $\phi 2600 \text{ mm} \times 575 \text{ mm}$ (H), 52 kg (*3)
(*1) with ANTENNA RADIATOR XN12CF installed.
(*2) with ANTENNA RADIATOR XN20CF installed.
(*3) with ANTENNA RADIATOR XN24CF installed.
- (j) Power supply: 100-230 VAC, 50-60 Hz (*1)
(*1) Powered from MARINE RADAR PROCESSOR UNIT, not directly from AC mains.

1.1.2 Transceiver module

Type: RTR-123 (Contained in MARINE RADAR 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: Solid-state device (no magnetron)
 - Peak output power: 600 W nominal
- (c) Fundamental frequency:
- ch1: P0N 9403.75 MHz/ Q0N 9423.75±5 MHz
- ch2: P0N 9413.75 MHz/ Q0N 9433.75±5 MHz

- (d) Pulse characteristics:

Pulse type		S1	S2	M1	M2	M3	L
Pulse length (μs)	P0N	0.06	0.15	0.3	0.5	0.7	1.2
	Q0N	4.68	7.02	8.89	13.57	13.57	20.59
PRF(Hz)	TT24NM (Normal mode)	1500	1500	1200	1000	1000	600
	TT32NM	1200	1200	1200	1000	1000	600
	2nd trace	1000	1000	600	600	600	450

1.1.2.2 Receiver

- (a) Passband
- RF Stage: 850 MHz
- IF Stage: 40 MHz
- (b) Intermediate Frequency: P0N 83.75 MHz
- Q0N 103.75 MHz
- (c) Gain (overall): Approximately 40 dB
- (d) Overall Noise Figure: 4 dB (typical)
- (e) Video Output Voltage: Not available
- (f) Features Provided: Anti-clutter Sea, Anti-clutter Rain
- (g) If receiver is tunable, describe method for adjusting frequency: Phase locked loop

1.1.3 Antenna and Scanner

(a) Antenna specifications

Antenna model	XN12CF	XN20CF	XN24CF
Length (mm)	1260	2110	2610
Rotation diameter (mm)	1400	2200	2700
Transmission frequency	X band: 9410±30 MHz		
Horizontal beam width (-3 dB)	1.9°	1.23°	0.95°
Vertical beam width (-3 dB)	20°		
Side lobe (max.)	Less than ±10°	-24 dB	-28 dB
	Outside ±10°	-30 dB	-32 dB
Gain	27.5 dBi	30.0 dBi	31.0 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: 24/36/42 rpm
- (e) Sector Scan: Provided
- (f) Rated Loss of Transmission Line per 100 Feet: Negligible (Transmission path is only in ANTENNA RADIATOR.)

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): 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 and Y. Hijiri
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.	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 (S1/S2/M1/M2/M3/L) pulses, the transmitter output power was measured with a non-reflective load and a directional coupler as a substitute for ANTENNA RADIATOR.

3.1.2 Test setup:

See Clause 4.

3.1.3 Test Results:

TT24NM mode

ch1, P0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	0.036	0.098	0.160	0.215	0.299	0.301
Pulse length T (μ s) (50% points)	0.047	0.140	0.289	0.492	0.688	1.190
Pulse Repetition Frequency (Hz)	1500	1500	1200	1000	1000	600
Transmission pulse power Pp (W) (*1)	501.7	469.0	461.6	436.9	434.4	421.4

ch1, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	3.652	5.375	5.356	6.633	6.624	5.923
Pulse length T (μ s) (50% points)	4.678	7.012	8.883	13.558	13.555	20.576
Pulse Repetition Frequency (Hz)	1500	1500	1200	1000	1000	600
Transmission pulse power Pp (W) (*1)	520.6	511.0	502.4	489.3	488.6	479.8

ch2, P0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	0.039	0.106	0.170	0.238	0.330	0.339
Pulse length T (μ s) (50% points)	0.048	0.141	0.289	0.493	0.690	1.191
Pulse Repetition Frequency (Hz)	1500	1500	1200	1000	1000	600
Transmission pulse power Pp (W) (*1)	535.5	502.6	490.3	484.1	478.7	473.9

ch2, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	3.927	5.753	5.791	7.097	7.125	6.349
Pulse length T (μ s) (50% points)	4.679	7.015	8.881	13.556	13.562	20.566
Pulse Repetition Frequency (Hz)	1500	1500	1200	1000	1000	600
Transmission pulse power Pp (W) (*1)	559.5	546.7	543.4	523.5	525.4	514.5

$$(*1) P_p (W) = (P_m (W) / (T (\mu s) \times PRF (Hz))) \times 1000000$$

TT32NM mode

ch1, P0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	0.029	0.080	0.161	0.225	0.300	0.301
Pulse length T (μs) (50% points)	0.047	0.140	0.289	0.492	0.689	1.190
Pulse Repetition Frequency (Hz)	1200	1200	1200	1000	1000	600
Transmission pulse power Pp (W) (*1)	515.1	477.3	464.6	458.1	435.7	421.4

ch1, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	2.895	4.268	5.346	6.624	6.378	5.706
Pulse length T (μs) (50% points)	4.680	7.013	8.878	13.562	13.561	20.573
Pulse Repetition Frequency (Hz)	1200	1200	1200	1000	1000	600
Transmission pulse power Pp (W) (*1)	515.6	507.1	501.9	488.4	470.3	462.3

ch2, P0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	0.032	0.090	0.179	0.249	0.332	0.341
Pulse length T (μs) (50% points)	0.048	0.141	0.290	0.492	0.690	1.192
Pulse Repetition Frequency (Hz)	1200	1200	1200	1000	1000	600
Transmission pulse power Pp (W) (*1)	553.0	533.7	514.4	505.4	481.6	476.4

ch2, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	3.142	4.618	5.772	7.097	7.106	6.349
Pulse length T (μs) (50% points)	4.678	7.011	8.885	13.564	13.566	20.580
Pulse Repetition Frequency (Hz)	1200	1200	1200	1000	1000	600
Transmission pulse power Pp (W) (*1)	559.6	548.9	541.4	523.2	523.8	514.2

$$(*1) P_p (W) = (P_m (W) / (T (\mu s) \times PRF (Hz))) \times 1000000$$

2nd trace mode

ch1, P0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	0.024	0.064	0.078	0.131	0.178	0.226
Pulse length T (μs) (50% points)	0.047	0.140	0.289	0.492	0.689	1.190
Pulse Repetition Frequency (Hz)	1000	1000	600	600	600	450
Transmission pulse power Pp (W) (*1)	500.2	458.2	449.0	442.7	430.6	422.4

ch1, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	2.432	3.577	2.706	3.974	3.965	4.400
Pulse length T (μs) (50% points)	4.679	7.008	8.882	13.558	13.567	20.577
Pulse Repetition Frequency (Hz)	1000	1000	600	600	600	450
Transmission pulse power Pp (W) (*1)	519.7	510.4	507.8	488.6	487.1	475.2

ch2, P0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	0.027	0.071	0.086	0.145	0.201	0.246
Pulse length T (μs) (50% points)	0.048	0.141	0.290	0.493	0.690	1.191
Pulse Repetition Frequency (Hz)	1000	1000	600	600	600	450
Transmission pulse power Pp (W) (*1)	552.8	508.1	496.0	489.5	484.9	459.0

ch2, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	2.631	3.870	2.914	4.173	4.173	4.788
Pulse length T (μs) (50% points)	4.681	7.014	8.884	13.566	13.565	20.575
Pulse Repetition Frequency (Hz)	1000	1000	600	600	600	450
Transmission pulse power Pp (W) (*1)	562.0	551.8	546.7	512.7	512.7	517.1

$$(*1) P_p (W) = (P_m (W) / (T (\mu s) \times PRF (Hz))) \times 1000000$$

Environmental conditions observed: On 9 July 2019, 23°C to 23°C, 59%RH to 67%RH
On 10 July 2019, 24°C to 23°C, 60%RH to 59%RH
On 11 July 2019, 24°C to 24°C, 60%RH to 68%RH
On 16 July 2019, 24°C to 23°C, 60%RH to 67%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:

TT24NM mode

ch1, P0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (50% points)	0.047	0.140	0.289	0.492	0.688	1.190
Rise time t_r (μ s) (10 to 90 % amplitude)	0.032	0.026	0.026	0.026	0.026	0.026
Fall time t_f (μ s) (90 to 10 % amplitude)	0.025	0.030	0.030	0.029	0.030	0.030
Pulse Repetition Frequency (Hz)	1500	1500	1200	1000	1000	600

ch1, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (50% points)	4.678	7.012	8.883	13.558	13.555	20.576
Rise time t_r (μ s) (10 to 90 % amplitude)	0.127	0.194	0.250	0.368	0.364	0.564
Fall time t_f (μ s) (90 to 10 % amplitude)	0.120	0.182	0.232	0.356	0.348	0.532
Pulse Repetition Frequency (Hz)	1500	1500	1200	1000	1000	600

ch2, P0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (50% points)	0.048	0.141	0.289	0.493	0.690	1.191
Rise time t_r (μ s) (10 to 90 % amplitude)	0.029	0.025	0.025	0.025	0.025	0.025
Fall time t_f (μ s) (90 to 10 % amplitude)	0.023	0.028	0.029	0.028	0.030	0.029
Pulse Repetition Frequency (Hz)	1500	1500	1200	1000	1000	600

ch2, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (50% points)	4.679	7.015	8.881	13.556	13.562	20.566
Rise time t_r (μ s) (10 to 90 % amplitude)	0.130	0.196	0.256	0.372	0.372	0.572
Fall time t_f (μ s) (90 to 10 % amplitude)	0.118	0.182	0.240	0.368	0.360	0.544
Pulse Repetition Frequency (Hz)	1500	1500	1200	1000	1000	600

TT32NM mode

ch1, P0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (50% points)	0.047	0.140	0.289	0.492	0.689	1.190
Rise time t_r (μ s) (10 to 90 % amplitude)	0.032	0.026	0.026	0.026	0.026	0.025
Fall time t_f (μ s) (90 to 10 % amplitude)	0.024	0.029	0.030	0.030	0.030	0.030
Pulse Repetition Frequency (Hz)	1200	1200	1200	1000	1000	600

ch1, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (50% points)	4.680	7.013	8.878	13.562	13.561	20.573
Rise time t_r (μ s) (10 to 90 % amplitude)	0.130	0.196	0.246	0.376	0.368	0.560
Fall time t_f (μ s) (90 to 10 % amplitude)	0.120	0.184	0.230	0.352	0.356	0.540
Pulse Repetition Frequency (Hz)	1200	1200	1200	1000	1000	600

ch2, P0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (50% points)	0.048	0.141	0.290	0.492	0.690	1.192
Rise time t_r (μ s) (10 to 90 % amplitude)	0.030	0.025	0.026	0.024	0.025	0.026
Fall time t_f (μ s) (90 to 10 % amplitude)	0.023	0.028	0.029	0.028	0.028	0.028
Pulse Repetition Frequency (Hz)	1200	1200	1200	1000	1000	600

ch2, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (50% points)	4.678	7.011	8.885	13.564	13.566	20.580
Rise time t_r (μ s) (10 to 90 % amplitude)	0.132	0.194	0.252	0.376	0.380	0.572
Fall time t_f (μ s) (90 to 10 % amplitude)	0.122	0.184	0.232	0.360	0.368	0.550
Pulse Repetition Frequency (Hz)	1200	1200	1200	1000	1000	600

2nd trace mode

ch1, P0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (50% points)	0.047	0.140	0.289	0.492	0.689	1.190
Rise time t_r (μ s) (10 to 90 % amplitude)	0.032	0.027	0.026	0.026	0.026	0.026
Fall time t_f (μ s) (90 to 10 % amplitude)	0.026	0.030	0.031	0.029	0.030	0.030
Pulse Repetition Frequency (Hz)	1000	1000	600	600	600	450

ch1, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (50% points)	4.679	7.008	8.882	13.558	13.567	20.577
Rise time t_r (μ s) (10 to 90 % amplitude)	0.124	0.194	0.242	0.380	0.372	0.572
Fall time t_f (μ s) (90 to 10 % amplitude)	0.122	0.178	0.230	0.358	0.364	0.540
Pulse Repetition Frequency (Hz)	1000	1000	600	600	600	450

ch2, P0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (50% points)	0.048	0.141	0.290	0.493	0.690	1.191
Rise time t_r (μ s) (10 to 90 % amplitude)	0.030	0.025	0.025	0.026	0.025	0.025
Fall time t_f (μ s) (90 to 10 % amplitude)	0.023	0.028	0.029	0.028	0.029	0.029
Pulse Repetition Frequency (Hz)	1000	1000	600	600	600	450

ch2, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (50% points)	4.681	7.014	8.884	13.566	13.565	20.575
Rise time t_r (μ s) (10 to 90 % amplitude)	0.130	0.194	0.248	0.380	0.374	0.574
Fall time t_f (μ s) (90 to 10 % amplitude)	0.122	0.183	0.232	0.360	0.360	0.556
Pulse Repetition Frequency (Hz)	1000	1000	600	600	600	450

Measured Plots: See Clause 6.

Environmental conditions observed: On 9 July 2019, 23°C to 23°C, 59%RH to 67%RH
On 10 July 2019, 23°C to 23°C, 59%RH to 67%RH
On 11 July 2019, 24°C to 24°C, 60%RH to 68%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 (S1/S2/M1/M2/M3/L) pulses
- (2) Ambient temperature settings: -20°C to +50°C (10°C interval)
- (3) Power supply voltage settings: 85/100/115% of nominal voltage

MARINE RADAR PROCESSOR UNIT: 100 VAC – 230 VAC

V_L : 85 VAC / V_{nom} : 230 VAC / V_H : 264.5 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)):

TT24NM mode

ch1, P0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band $f(1.5/T)$ (MHz) (*1)	31.7	10.7	5.2	3.1	2.2	1.3
Upper limit (MHz) (*2)	9468.3	9489.3	9494.8	9496.9	9497.8	9498.7
Lower limit (MHz) (*2)	9331.7	9310.7	9305.2	9303.1	9302.2	9301.3

ch1, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band $f(1.5/T)$ (MHz) (*1)	0.3	0.2	0.2	0.1	0.1	0.1
Upper limit (MHz) (*2)	9499.7	9499.8	9499.8	9499.9	9499.9	9499.9
Lower limit (MHz) (*2)	9300.3	9300.2	9300.2	9300.1	9300.1	9300.1

ch2, P0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band $f(1.5/T)$ (MHz) (*1)	31.0	10.7	5.2	3.0	2.2	1.3
Upper limit (MHz) (*2)	9469.0	9489.3	9494.8	9497.0	9497.8	9498.7
Lower limit (MHz) (*2)	9331.0	9310.7	9305.2	9303.0	9302.2	9301.3

ch2, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band $f(1.5/T)$ (MHz) (*1)	0.3	0.2	0.2	0.1	0.1	0.1
Upper limit (MHz) (*2)	9499.7	9499.8	9499.8	9499.9	9499.9	9499.9
Lower limit (MHz) (*2)	9300.3	9300.2	9300.2	9300.1	9300.1	9300.1

(*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, $f(L) = 9300 + 1.5/T$

TT32NM mode

ch1, P0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band $f(1.5/T)$ (MHz) (*1)	31.9	10.7	5.2	3.1	2.2	1.3
Upper limit (MHz) (*2)	9468.1	9489.3	9494.8	9496.9	9497.8	9498.7
Lower limit (MHz) (*2)	9331.9	9310.7	9305.2	9303.1	9302.2	9301.3

ch1, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band $f(1.5/T)$ (MHz) (*1)	0.3	0.2	0.2	0.1	0.1	0.1
Upper limit (MHz) (*2)	9499.7	9499.8	9499.8	9499.9	9499.9	9499.9
Lower limit (MHz) (*2)	9300.3	9300.2	9300.2	9300.1	9300.1	9300.1

ch2, P0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band $f(1.5/T)$ (MHz) (*1)	31.1	10.7	5.2	3.0	2.2	1.3
Upper limit (MHz) (*2)	9468.9	9489.3	9494.8	9497.0	9497.8	9498.7
Lower limit (MHz) (*2)	9331.1	9310.7	9305.2	9303.0	9302.2	9301.3

ch2, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band $f(1.5/T)$ (MHz) (*1)	0.3	0.2	0.2	0.1	0.1	0.1
Upper limit (MHz) (*2)	9499.7	9499.8	9499.8	9499.9	9499.9	9499.9
Lower limit (MHz) (*2)	9300.3	9300.2	9300.2	9300.1	9300.1	9300.1

(*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, $f(L) = 9300 + 1.5/T$

2nd trace mode

ch1, P0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band $f(1.5/T)$ (MHz) (*1)	31.8	10.7	5.2	3.1	2.2	1.3
Upper limit (MHz) (*2)	9468.2	9489.3	9494.8	9496.9	9497.8	9498.7
Lower limit (MHz) (*2)	9331.8	9310.7	9305.2	9303.1	9302.2	9301.3

ch1, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band $f(1.5/T)$ (MHz) (*1)	0.3	0.2	0.2	0.1	0.1	0.1
Upper limit (MHz) (*2)	9499.7	9499.8	9499.8	9499.9	9499.9	9499.9
Lower limit (MHz) (*2)	9300.3	9300.2	9300.2	9300.1	9300.1	9300.1

ch2, P0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band $f(1.5/T)$ (MHz) (*1)	31.2	10.7	5.2	3.0	2.2	1.3
Upper limit (MHz) (*2)	9468.8	9489.3	9494.8	9497.0	9497.8	9498.7
Lower limit (MHz) (*2)	9331.2	9310.7	9305.2	9303.0	9302.2	9301.3

ch2, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band $f(1.5/T)$ (MHz) (*1)	0.3	0.2	0.2	0.1	0.1	0.1
Upper limit (MHz) (*2)	9499.7	9499.8	9499.8	9499.9	9499.9	9499.9
Lower limit (MHz) (*2)	9300.3	9300.2	9300.2	9300.1	9300.1	9300.1

(*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, 50 Hz:

TT24NM mode

ch1, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9403.4	9403.4	9403.6	9403.7	9403.6	9403.7	Complied.
	-10°C	9402.8	9403.4	9403.6	9403.6	9403.6	9403.7	Complied.
	0°C	9403.8	9403.2	9403.6	9403.6	9403.6	9403.6	Complied.
	+10°C	9403.6	9403.5	9403.6	9403.7	9403.6	9403.7	Complied.
	+20°C	9402.1	9403.4	9403.5	9403.5	9403.7	9403.6	Complied.
	+30°C	9403.3	9403.2	9403.5	9403.5	9403.6	9403.6	Complied.
	+40°C	9402.4	9403.1	9403.5	9403.6	9403.5	9403.5	Complied.
	+50°C	9402.4	9403.2	9403.4	9403.4	9403.5	9403.6	Complied.

ch1, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9423.7	9423.7	9423.7	9423.8	9423.7	9423.7	Complied.
	-10°C	9423.7	9423.7	9423.7	9423.7	9423.7	9423.7	Complied.
	0°C	9423.7	9423.7	9423.7	9423.8	9423.8	9423.7	Complied.
	+10°C	9423.7	9423.8	9423.8	9423.7	9423.7	9423.7	Complied.
	+20°C	9423.8	9423.8	9423.5	9423.8	9423.7	9423.6	Complied.
	+30°C	9423.4	9423.3	9423.3	9423.6	9423.5	9423.6	Complied.
	+40°C	9423.5	9423.6	9423.7	9423.6	9423.8	9423.6	Complied.
	+50°C	9423.5	9423.7	9423.5	9423.4	9423.4	9423.6	Complied.

ch2, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9413.4	9413.4	9413.7	9413.7	9413.6	9413.7	Complied.
	-10°C	9413.0	9413.5	9413.6	9413.7	9413.7	9413.6	Complied.
	0°C	9413.9	9413.2	9413.6	9413.7	9413.6	9413.6	Complied.
	+10°C	9413.6	9413.8	9413.6	9413.7	9413.6	9413.7	Complied.
	+20°C	9413.4	9413.6	9413.5	9413.5	9413.5	9413.5	Complied.
	+30°C	9412.5	9413.2	9413.3	9413.5	9413.6	9413.7	Complied.
	+40°C	9413.1	9413.5	9413.3	9413.5	9413.5	9413.6	Complied.
	+50°C	9412.9	9413.7	9413.5	9413.5	9413.7	9413.6	Complied.

ch2, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9433.7	9433.7	9433.7	9433.7	9433.7	9433.6	Complied.
	-10°C	9433.7	9433.7	9433.7	9433.7	9433.7	9433.7	Complied.
	0°C	9433.7	9433.7	9433.7	9433.7	9433.7	9433.8	Complied.
	+10°C	9433.7	9433.7	9433.7	9433.8	9433.7	9433.7	Complied.
	+20°C	9433.8	9433.8	9433.8	9433.8	9433.7	9433.7	Complied.
	+30°C	9433.5	9433.5	9433.5	9433.6	9433.6	9433.5	Complied.
	+40°C	9433.6	9433.5	9433.5	9433.6	9433.7	9433.6	Complied.
	+50°C	9433.6	9433.6	9433.6	9433.5	9433.6	9433.6	Complied.

TT32NM mode

ch1, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9403.6	9403.6	9403.7	9403.6	9403.5	9403.6	Complied.
	-10°C	9403.1	9403.2	9403.6	9403.6	9403.6	9403.6	Complied.
	0°C	9403.6	9403.4	9403.5	9403.6	9403.6	9403.6	Complied.
	+10°C	9403.3	9403.4	9403.8	9403.7	9403.6	9403.7	Complied.
	+20°C	9403.0	9403.2	9403.4	9403.4	9403.5	9403.6	Complied.
	+30°C	9402.6	9403.1	9403.3	9403.7	9403.5	9403.5	Complied.
	+40°C	9403.0	9403.3	9403.4	9403.5	9403.6	9403.6	Complied.
	+50°C	9403.3	9403.5	9403.3	9403.5	9403.6	9403.6	Complied.

ch1, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9423.7	9423.7	9423.7	9423.7	9423.7	9423.6	Complied.
	-10°C	9423.7	9423.8	9423.8	9423.7	9423.7	9423.7	Complied.
	0°C	9423.7	9423.7	9423.8	9423.7	9423.7	9423.7	Complied.
	+10°C	9423.8	9423.8	9423.8	9423.7	9423.7	9423.7	Complied.
	+20°C	9423.6	9423.7	9423.7	9423.7	9423.6	9423.6	Complied.
	+30°C	9423.7	9423.5	9423.4	9423.6	9423.7	9423.7	Complied.
	+40°C	9423.6	9423.5	9423.4	9423.6	9423.6	9423.6	Complied.
	+50°C	9423.7	9423.5	9423.5	9423.5	9423.7	9423.7	Complied.

ch2, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9413.3	9413.3	9413.5	9413.6	9413.6	9413.7	Complied.
	-10°C	9413.0	9413.7	9413.5	9413.6	9413.5	9413.6	Complied.
	0°C	9413.4	9413.3	9413.7	9413.5	9413.6	9413.7	Complied.
	+10°C	9413.6	9413.6	9413.7	9413.7	9413.7	9413.6	Complied.
	+20°C	9413.0	9413.3	9413.4	9413.5	9413.5	9413.6	Complied.
	+30°C	9412.5	9413.3	9413.2	9413.6	9413.6	9413.6	Complied.
	+40°C	9412.6	9413.6	9413.3	9413.5	9413.7	9413.6	Complied.
	+50°C	9413.2	9413.7	9413.5	9413.5	9413.5	9413.5	Complied.

ch2, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9433.8	9433.7	9433.7	9433.7	9433.7	9433.7	Complied.
	-10°C	9433.7	9433.7	9433.8	9433.7	9433.7	9433.6	Complied.
	0°C	9433.7	9433.8	9433.8	9433.7	9433.7	9433.7	Complied.
	+10°C	9433.8	9433.8	9433.7	9433.7	9433.7	9433.7	Complied.
	+20°C	9433.7	9433.7	9433.8	9433.8	9433.7	9433.7	Complied.
	+30°C	9433.6	9433.5	9433.6	9433.6	9433.7	9433.6	Complied.
	+40°C	9433.6	9433.6	9433.6	9433.7	9433.6	9433.7	Complied.
	+50°C	9433.6	9433.6	9433.5	9433.7	9433.7	9433.6	Complied.

2nd trace mode

ch1, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9403.3	9403.6	9403.5	9403.6	9403.6	9403.6	Complied.
	-10°C	9403.8	9403.2	9403.7	9403.7	9403.7	9403.7	Complied.
	0°C	9403.8	9403.2	9403.8	9403.6	9403.6	9403.6	Complied.
	+10°C	9403.6	9403.4	9403.6	9403.6	9403.6	9403.7	Complied.
	+20°C	9402.5	9403.3	9403.4	9403.5	9403.6	9403.6	Complied.
	+30°C	9402.9	9403.3	9403.4	9403.6	9403.6	9403.7	Complied.
	+40°C	9403.6	9403.7	9403.6	9403.5	9403.5	9403.6	Complied.
	+50°C	9403.2	9403.3	9403.3	9403.6	9403.6	9403.6	Complied.

ch1, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9423.7	9423.8	9423.8	9423.7	9423.6	9423.7	Complied.
	-10°C	9423.7	9423.7	9423.8	9423.7	9423.7	9423.6	Complied.
	0°C	9423.8	9423.8	9423.8	9423.8	9423.7	9423.7	Complied.
	+10°C	9423.8	9423.8	9423.8	9423.8	9423.7	9423.6	Complied.
	+20°C	9423.8	9423.7	9423.7	9423.7	9423.7	9423.7	Complied.
	+30°C	9423.5	9423.5	9423.5	9423.7	9423.7	9423.5	Complied.
	+40°C	9423.7	9423.5	9423.5	9423.7	9423.7	9423.5	Complied.
	+50°C	9423.6	9423.5	9423.5	9423.5	9423.6	9423.6	Complied.

ch2, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9413.3	9413.3	9413.5	9413.5	9413.6	9413.6	Complied.
	-10°C	9413.2	9413.2	9413.6	9413.6	9413.6	9413.6	Complied.
	0°C	9413.3	9413.4	9413.7	9413.6	9413.6	9413.7	Complied.
	+10°C	9412.8	9413.7	9413.6	9413.6	9413.7	9413.7	Complied.
	+20°C	9412.2	9413.0	9413.4	9413.5	9413.5	9413.6	Complied.
	+30°C	9413.9	9413.3	9413.6	9413.6	9413.5	9413.6	Complied.
	+40°C	9412.7	9413.3	9413.6	9413.5	9413.6	9413.5	Complied.
	+50°C	9412.2	9413.6	9413.4	9413.6	9413.6	9413.6	Complied.

ch2, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9433.7	9433.8	9433.7	9433.7	9433.7	9433.7	Complied.
	-10°C	9433.7	9433.8	9433.8	9433.7	9433.7	9433.7	Complied.
	0°C	9433.7	9433.7	9433.7	9433.8	9433.7	9433.6	Complied.
	+10°C	9433.7	9433.7	9433.8	9433.7	9433.8	9433.7	Complied.
	+20°C	9433.7	9433.8	9433.8	9433.7	9433.7	9433.7	Complied.
	+30°C	9433.5	9433.5	9433.5	9433.6	9433.7	9433.6	Complied.
	+40°C	9433.5	9433.7	9433.7	9433.6	9433.6	9433.6	Complied.
	+50°C	9433.5	9433.6	9433.7	9433.6	9433.6	9433.7	Complied.

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

TT24NM mode

ch1, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	V _L	9402.5	9403.1	9403.6	9403.7	9403.6	9403.6	Complied.
	V _{nom}	9402.1	9403.4	9403.5	9403.5	9403.7	9403.6	Complied.
	V _H	9402.7	9403.4	9403.4	9403.6	9403.5	9403.6	Complied.

ch1, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	V _L	9423.6	9423.6	9423.7	9423.7	9423.6	9423.6	Complied.
	V _{nom}	9423.8	9423.8	9423.5	9423.8	9423.7	9423.6	Complied.
	V _H	9423.6	9423.7	9423.7	9423.7	9423.8	9423.7	Complied.

ch2, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	V _L	9412.2	9413.3	9413.7	9413.7	9413.5	9413.5	Complied.
	V _{nom}	9413.4	9413.6	9413.5	9413.5	9413.5	9413.5	Complied.
	V _H	9413.8	9413.7	9413.6	9413.5	9413.5	9413.7	Complied.

ch2, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	V _L	9433.7	9433.7	9433.8	9433.7	9433.7	9433.7	Complied.
	V _{nom}	9433.8	9433.8	9433.8	9433.8	9433.7	9433.7	Complied.
	V _H	9433.7	9433.7	9433.8	9433.8	9433.7	9433.7	Complied.

TT32NM mode

ch1, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	V _L	9403.0	9403.6	9403.5	9403.6	9403.6	9403.5	Complied.
	V _{nom}	9403.0	9403.2	9403.4	9403.4	9403.5	9403.6	Complied.
	V _H	9402.5	9403.2	9403.7	9403.7	9403.6	9403.6	Complied.

ch1, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	V _L	9423.7	9423.7	9423.6	9423.6	9423.7	9423.8	Complied.
	V _{nom}	9423.6	9423.7	9423.7	9423.7	9423.6	9423.6	Complied.
	V _H	9423.4	9423.7	9423.6	9423.7	9423.7	9423.6	Complied.

ch2, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	V _L	9412.0	9413.7	9413.5	9413.5	9413.5	9413.5	Complied.
	V _{nom}	9413.0	9413.3	9413.4	9413.5	9413.5	9413.6	Complied.
	V _H	9412.9	9413.1	9413.3	9413.5	9413.5	9413.6	Complied.

ch2, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	V _L	9433.7	9433.8	9433.8	9433.7	9433.7	9433.7	Complied.
	V _{nom}	9433.7	9433.7	9433.8	9433.8	9433.7	9433.7	Complied.
	V _H	9433.7	9433.7	9433.7	9433.7	9433.7	9433.7	Complied.

2nd trace mode

ch1, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	V _L	9402.9	9403.2	9403.4	9403.5	9403.5	9403.6	Complied.
	V _{nom}	9402.5	9403.3	9403.4	9403.5	9403.6	9403.6	Complied.
	V _H	9402.8	9403.0	9403.6	9403.6	9403.6	9403.6	Complied.

ch1, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	V _L	9423.7	9423.7	9423.7	9423.7	9423.7	9423.7	Complied.
	V _{nom}	9423.8	9423.7	9423.7	9423.7	9423.7	9423.7	Complied.
	V _H	9423.8	9423.7	9423.8	9423.7	9423.7	9423.7	Complied.

ch2, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	V _L	9413.0	9413.4	9413.6	9413.5	9413.4	9413.6	Complied.
	V _{nom}	9412.2	9413.0	9413.4	9413.5	9413.5	9413.6	Complied.
	V _H	9412.9	9413.2	9413.6	9413.5	9413.6	9413.6	Complied.

ch2, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	V _L	9433.7	9433.7	9433.7	9433.7	9433.6	9433.7	Complied.
	V _{nom}	9433.7	9433.8	9433.8	9433.7	9433.7	9433.7	Complied.
	V _H	9433.7	9433.7	9433.7	9433.7	9433.6	9433.7	Complied.

Environmental conditions observed: On 11 July 2019, 23°C to 23°C, 59%RH to 59%RH
On 12 July 2019, 23°C to 23°C, 67%RH to 59%RH
On 13 July 2019, 23°C to 23°C, 75%RH to 75%RH
On 14 July 2019, 24°C to 24°C, 68%RH to 68%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 (S1/S2/M1/M2/M3/L) pulses, the transmitter output power was measured with a non-reflective load and a directional coupler as a substitute for 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) = 9403.75, 9413.75, 9423.75, 9433.75 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 18 July 2019, 24°C to 23°C, 60%RH to 59%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 S1 pulse, the transmitter output power was measured with a waveguide converter as a substitute for 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) = 9403.75, 9413.75, 9423.75, 9433.75 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)	$1/2f_0$	$2f_0$	$3f_0$	$4f_0$
9.40375	4.70188	18.8075	28.2113	37.615
9.41375	4.70688	18.8275	28.2413	37.655
9.42375	4.71188	18.8475	28.2713	37.695
9.43375	4.71688	18.8675	28.3013	37.735

3.5.5 Test Results:

Complied.

ch1

Frequency (GHz)	Level (dBm)	Limit (dBm)	Margin (dB)
18.864	-31.14	-13.00	18.15
28.260	-30.70	-13.00	17.70

ch2

Frequency (GHz)	Level (dBm)	Limit (dBm)	Margin (dB)
18.878	-28.31	-13.00	15.31
28.300	-28.53	-13.00	15.53

Environmental conditions observed: On 16 July 2019, 23°C to 23°C, 67%RH to 67%RH

On 17 July 2019, 23°C to 23°C, 67%RH to 67%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 S1 pulse, the transmitter output power was measured with the non-reflective load as a substitute for 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 (1.90 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)	$1/2f_0$	$2f_0$	$3f_0$	$4f_0$
9.40375	4.70188	18.8075	28.2113	37.615
9.41375	4.70688	18.8275	28.2413	37.655
9.42375	4.71188	18.8475	28.2713	37.695
9.43375	4.71688	18.8675	28.3013	37.735

3.6.7 Test Results:

Complied.

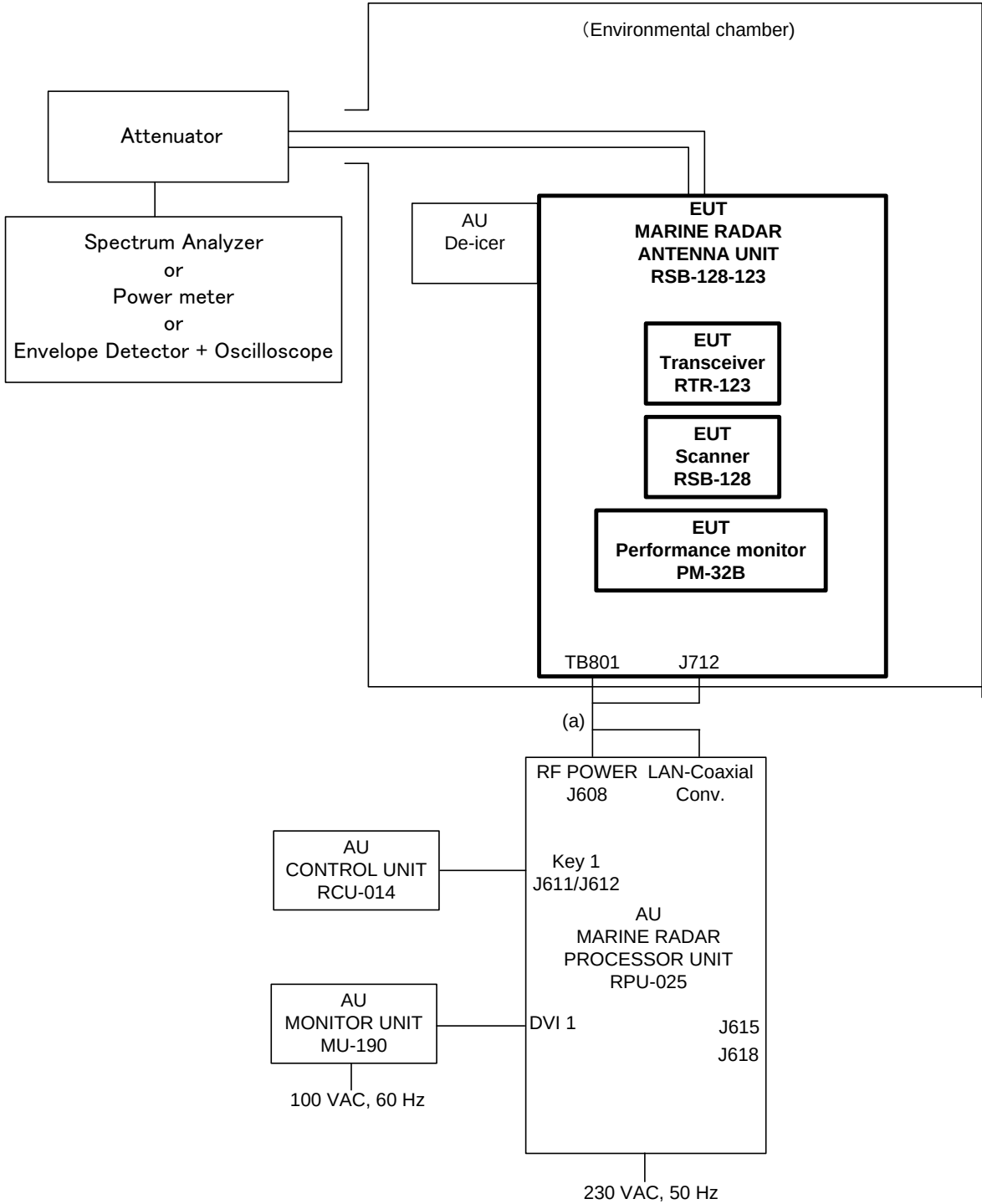
Spurious emission levels measured were found to be attenuated more than 20 dB below the limits.

Environmental conditions observed: On 22 August 2019, 20°C to 20°C, 56%RH to 56%RH

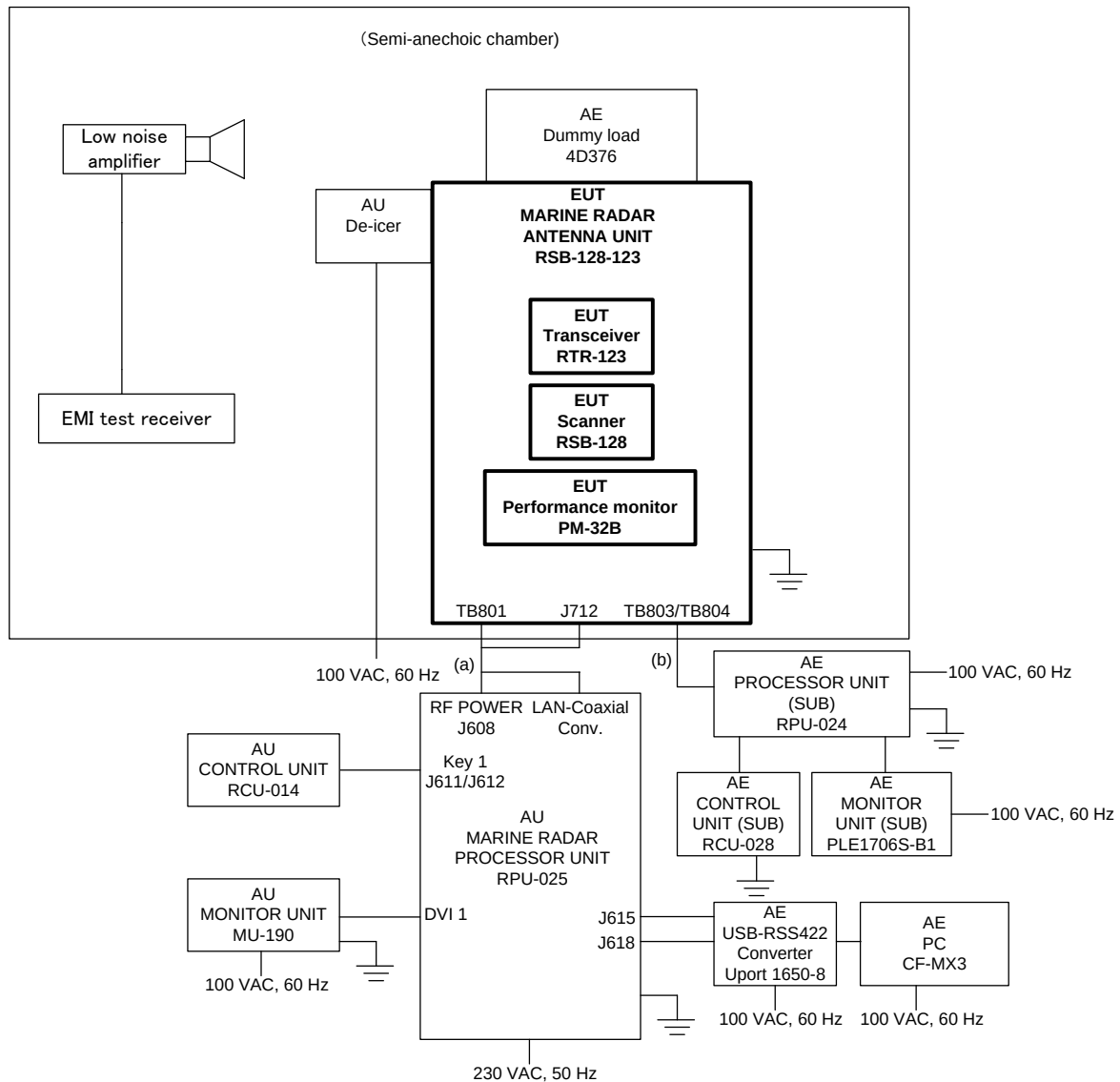
Power supply voltage measured: 230 VAC, 50 Hz to 230 VAC, 50 Hz

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	Multicore cable	RW-9600	20	1	Yes
b	Signal/control	Multicore cable	RW-00136	20	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
RT301	Attenuator	66-30-43	CE7304	Aeroflex/Weinschel	4 July 2019	1 year
HT552	Power meter	E4418B	GB43315050	Agilent	28 May 2019	1 year
HT325	Power sensor	8481A	2702A70235	Agilent	2 July 2019	1 year
RT255-1	Programmable AC Power Source	DP015S	9113780	NF	--	--
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	15 February 2019	1 year

(2) For Clause 3.2 Modulation Characteristics

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT301	Attenuator	66-30-43	CE7304	Aeroflex/Weinschel	4 July 2019	1 year
RT213	Waveguide	WRJ-10	--	Furuno	4 July 2019	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	21 February 2019	1 year
HT1223	Attenuator	8495B	MY42148137	Agilent	21 February 2019	1 year
HT676	Spectrum analyzer	8564EC	4103A00440	Agilent	10 May 2019	1 year
HT510	Climatic chamber (Large)	TBE-3HW4PE2F	3013002540	Espec	23 September 2018	1 year
HT725	Paperless recorder/ Dual communication logger	FX106-4-1	S5JA01447	Yokogawa	--	--
RT255-1	Programmable AC Power Source	DP015S	9113780	NF	--	--
HT1024	Digital multi-meter	233	27230019	Fluke	15 February 2019	1 year
HT1221	Envelope detector	423B	MY51342422	Agilent	18 March 2019	1 year
HT972	Oscilloscope	MSO4054B	C030483	TEKTRONIX	17 March 2019	1 year

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

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT301	Attenuator	66-30-43	CE7304	Aeroflex/Weinschel	4 July 2019	1 year
RT213	Waveguide	WRJ-10	--	Furuno	19 July 2018	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	21 February 2019	1 year
HT1223	Attenuator	8495B	MY42148137	Agilent	21 February 2019	1 year
HT676	Spectrum analyzer	8564EC	4103A00440	Agilent	10 May 2019	1 year
HT510	Climatic chamber (Large)	TBE-3HW4PE2F	3013002540	Espec	23 September 2018	1 year
HT725	Paperless recorder/ Dual communication logger	FX106-4-1	S5JA01447	Yokogawa	--	--
RT255-1	Programmable AC Power Source	DP015S	9113780	NF	--	--
HT1024	Digital multi-meter	233	27230019	Fluke	15 February 2019	1 year

(4) For Clause 3.4 Occupied Bandwidth

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT301	Attenuator	66-30-43	CE7304	Aeroflex/Weinschel	4 July 2019	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	21 February 2019	1 year
HT1223	Attenuator	8495B	MY42148137	Agilent	21 February 2019	1 year
HT676	Spectrum analyzer	8564EC	4103A00440	Agilent	10 May 2019	1 year
RT255-1	Programmable AC Power Source	DP015S	9113780	NF	--	--
HT1024	Digital multi-meter	233	27230019	Fluke	15 February 2019	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
RT301	Attenuator	66-30-43	CE7304	Aeroflex/Weinschel	4 July 2019	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.	--
--	Isolator	OMC FX0157	--	--	Not applicable.	--
HT676	Spectrum analyzer	8564EC	4103A00440	Agilent	10 May 2019	1 year
RT255-1	Programmable AC Power Source	DP015S	9113780	NF	--	--
HT1024	Digital multi-meter	233	27230019	Fluke	15 February 2019	1 year
KB289	Coaxial cable	SF104A/11PC35/11P C35/5500MM	800048/4A	HUBER+SUHNER	11 August 2018	1 year
KB181	Coaxial cable	SUCOFLEX 102A	1261/2A	HUBER+SUHNER	11 August 2018	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: 3 December 2016	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	11 August 2019	1 year
HT758	Broadband horn antenna (1 GHz to 6 GHz)	9120B	522	Schwarzbeck	17 August 2019	1 year
HT1263	Pre-amp. (1 GHz to 6 GHz)	00-T1885	BBB1932270	Noiseken	8 May 2019	1 year
HT759	Double ridged horn antenna & amp. (6 GHz to 18 GHz)	HAP06-18W	00000065	Toyo	17 August 2019	1 year
HT761	Double ridged horn antenna & amp. (18 GHz to 26 GHz)	HAP18-26N	00000017	Toyo	15 August 2019	1 year
HT762	Double ridged horn antenna & amp. (26 GHz to 40 GHz)	HAP26-40N	00000010	Toyo	15 August 2019	1 year
HT866	Digital multimeter	115	19170029	Fluke	15 February 2019	1 year
HT780	Programmable AC/DC power supply	ES18000W	9128767-1 +9128767-2	NF	--	--

6 RF Envelope and Spectrum of the Output Pulse

TT24NM mode

ch1, P0N

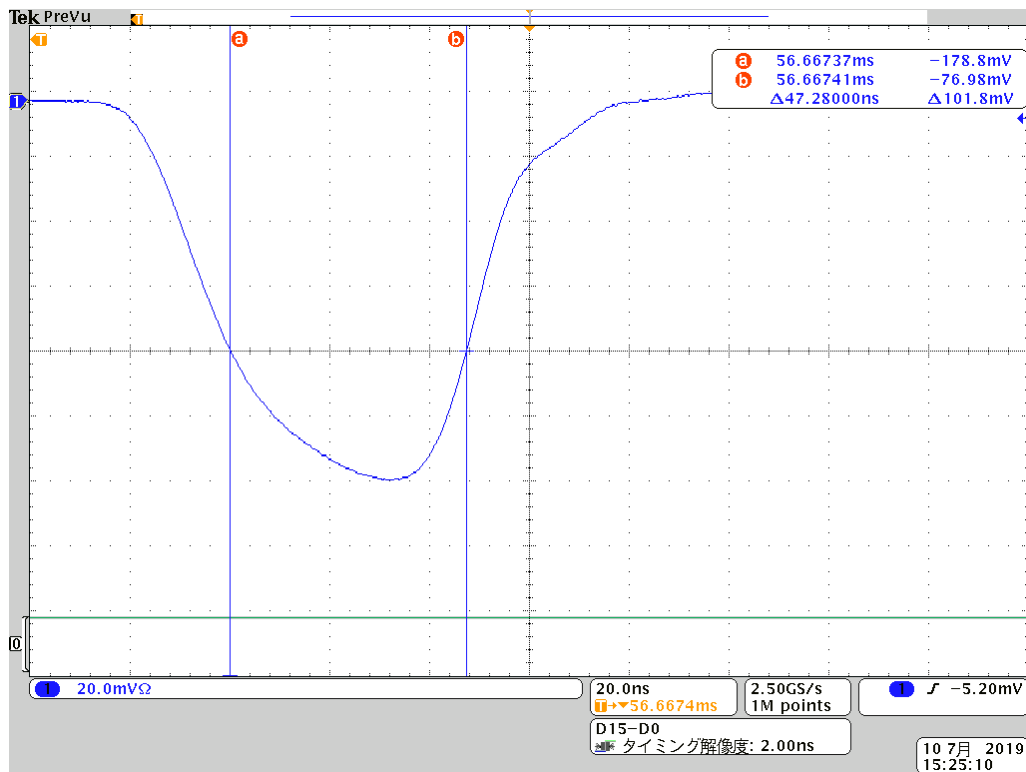


Fig. 6.1 ch1, P0N, S1 pulse envelope

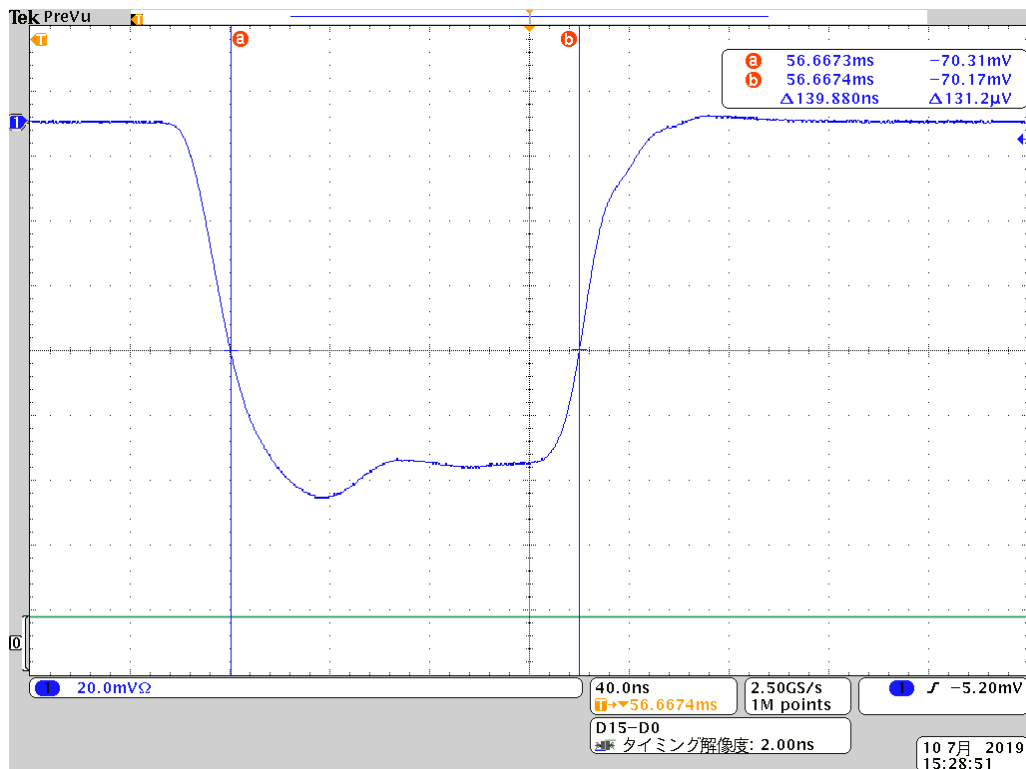


Fig. 6.2 ch1, P0N, S2 pulse envelope



Fig. 6.3 ch1, P0N, M1 pulse envelope

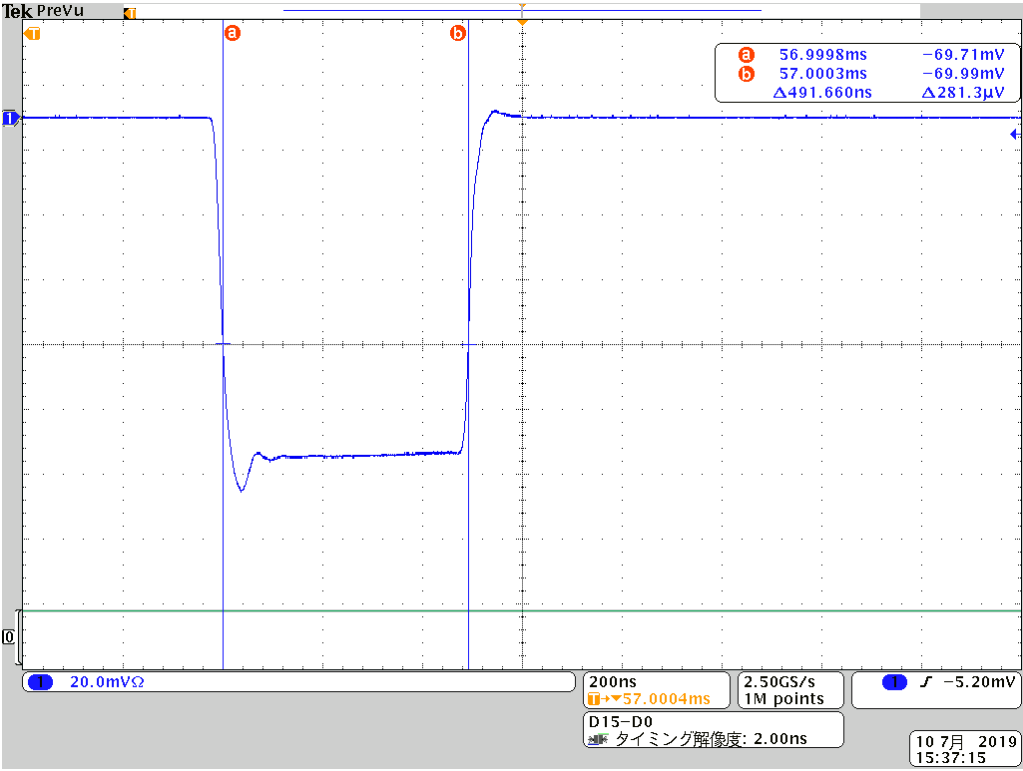


Fig. 6.4 ch1, P0N, M2 pulse envelope

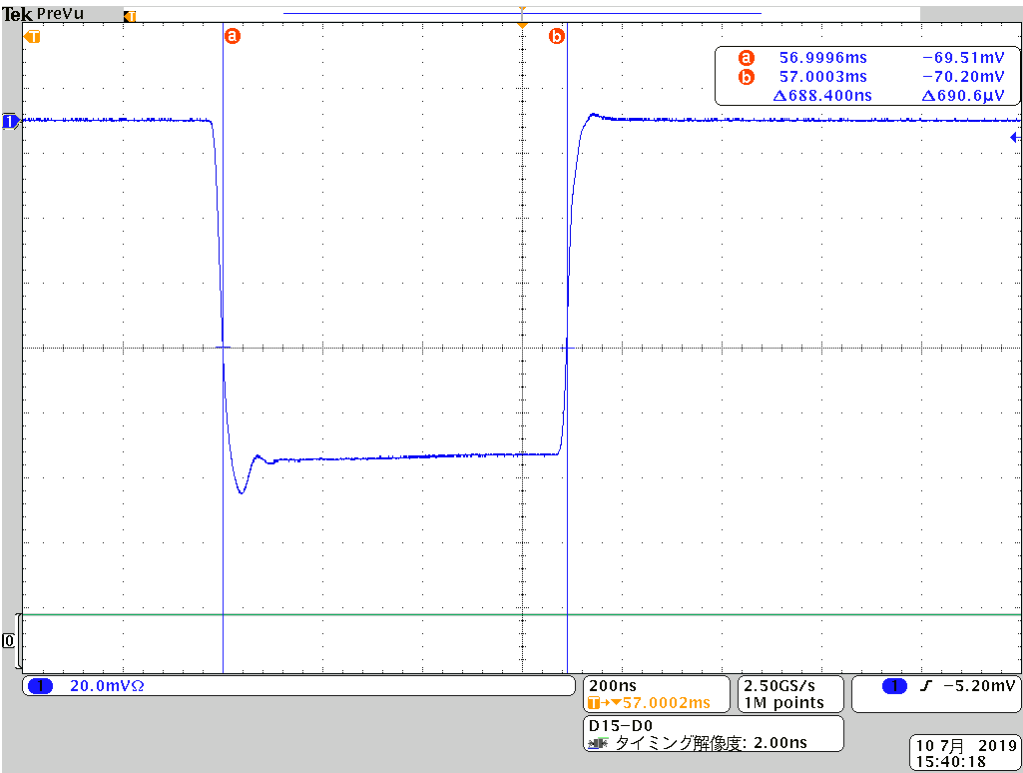


Fig. 6.5 ch1, P0N, M3 pulse envelope

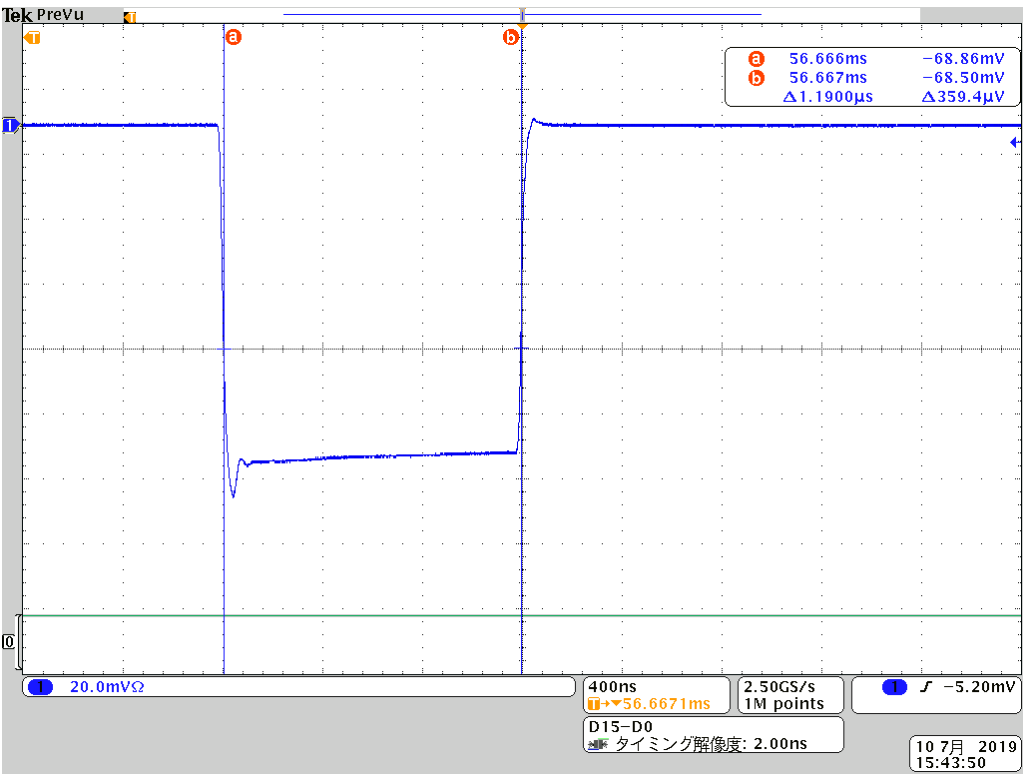


Fig. 6.6 ch1, P0N, L pulse envelope

ch1, Q0N

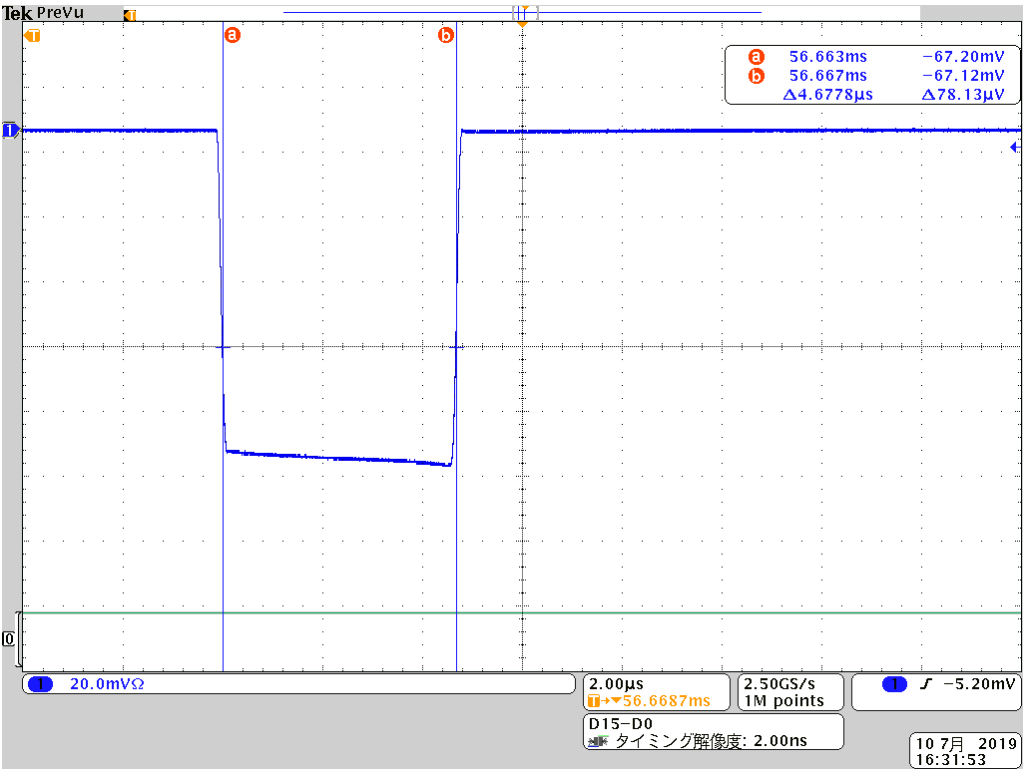


Fig. 6.7 ch1, Q0N, S1 pulse envelope

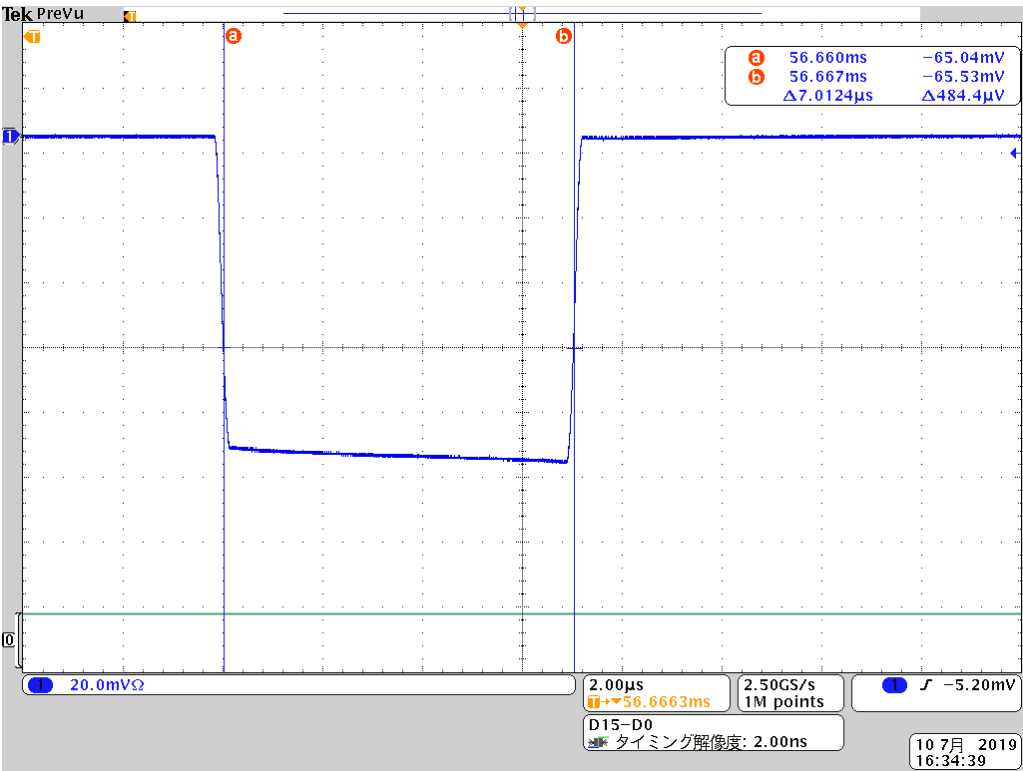


Fig. 6.8 ch1, Q0N, S2 pulse envelope

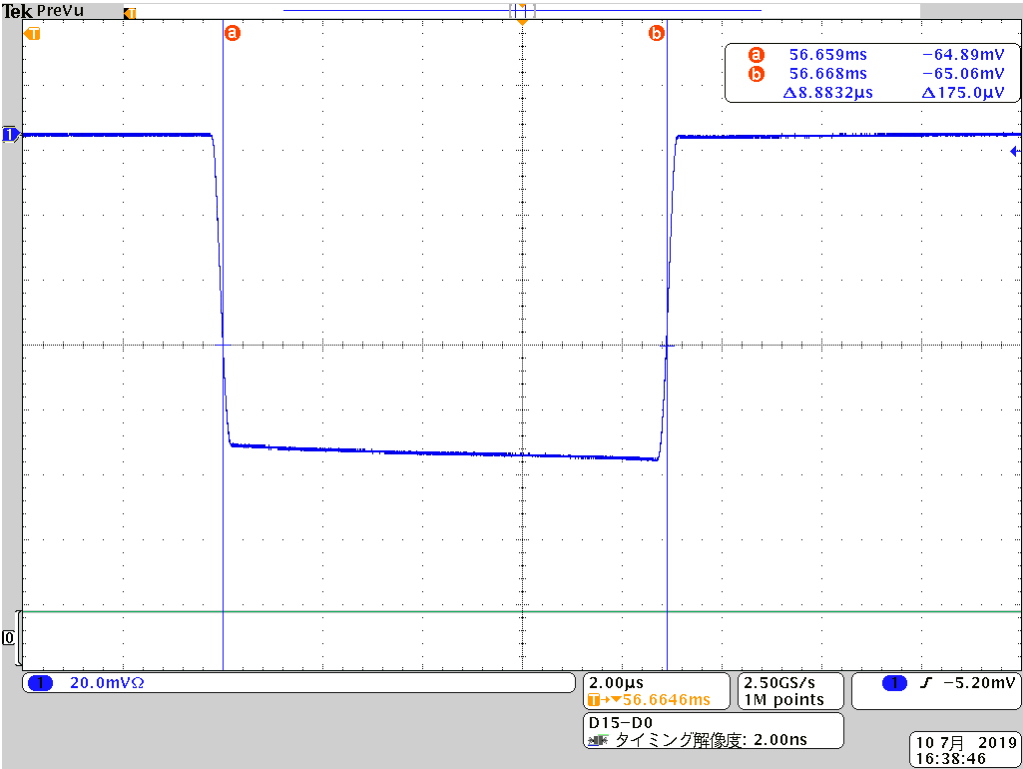


Fig. 6.9 ch1, Q0N, M1 pulse envelope

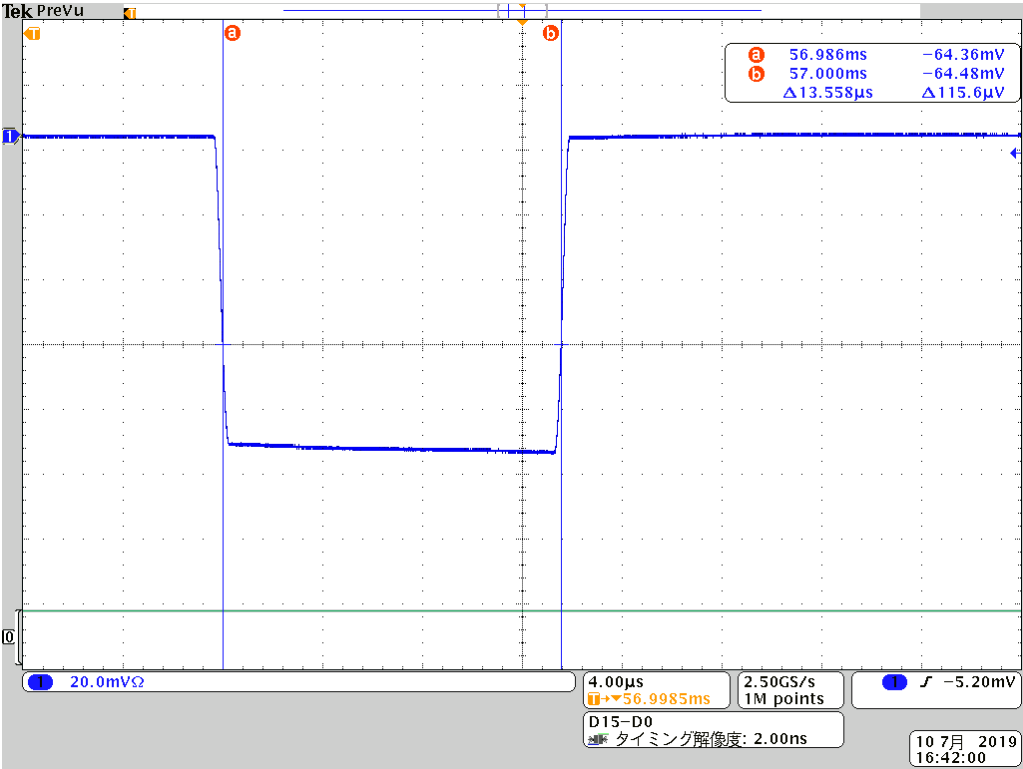


Fig. 6.10 ch1, Q0N, M2 pulse envelope

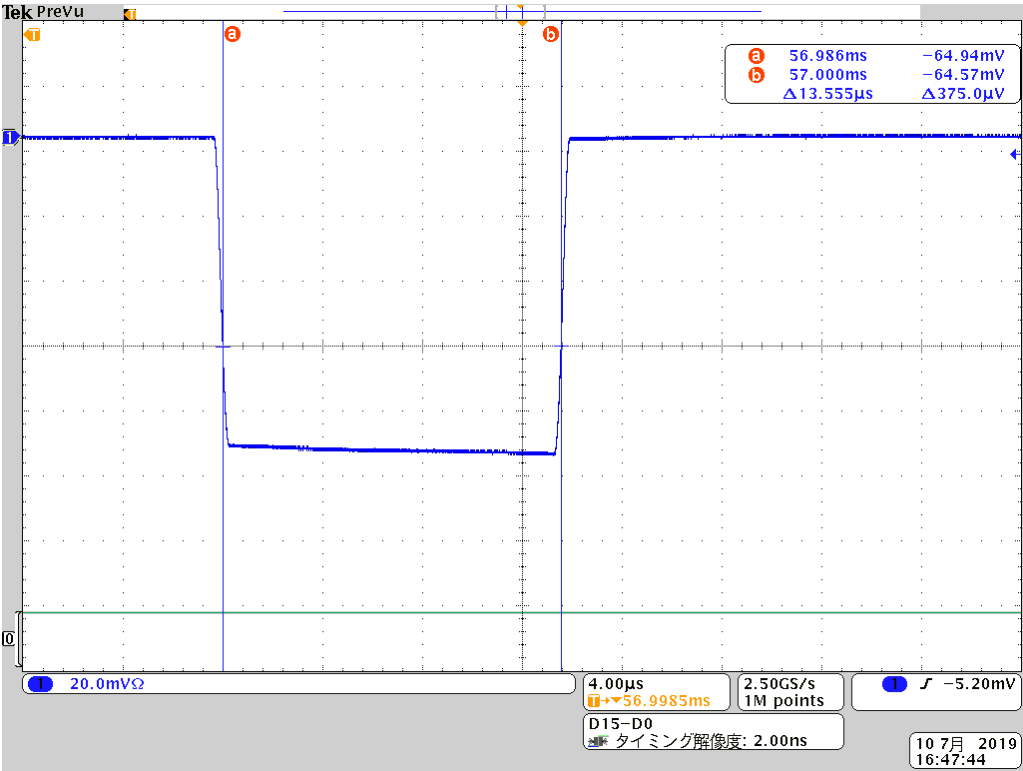


Fig. 6.11 ch1, Q0N, M3 pulse envelope

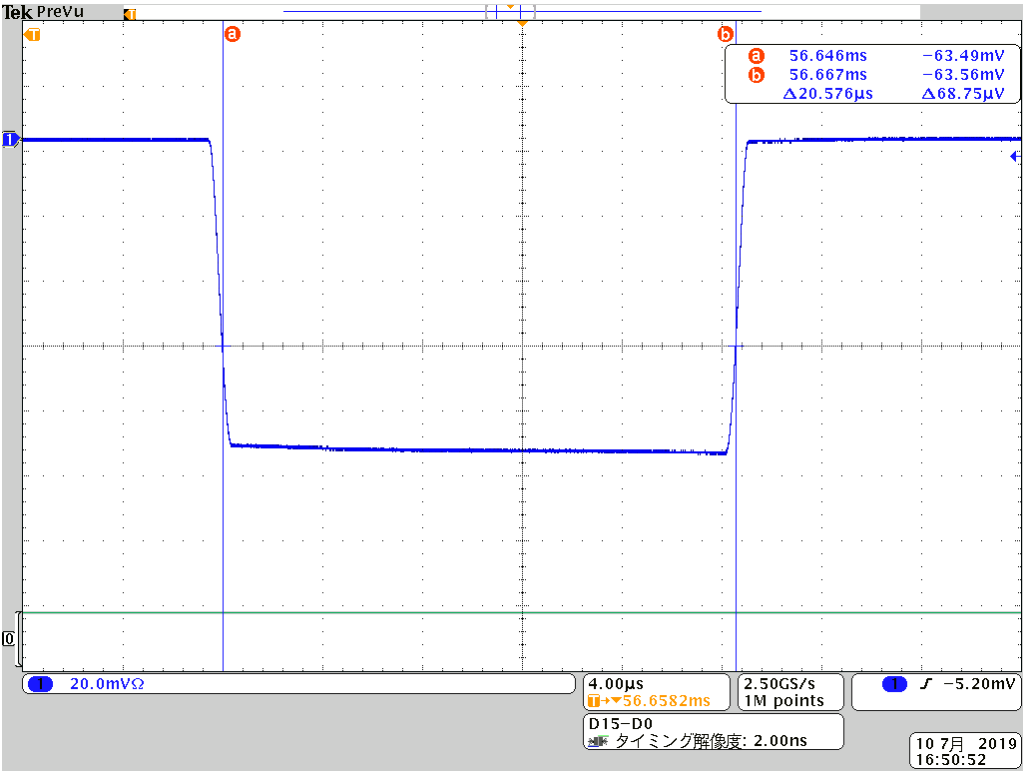


Fig. 6.12 ch1, Q0N, L pulse envelope

ch2, P0N

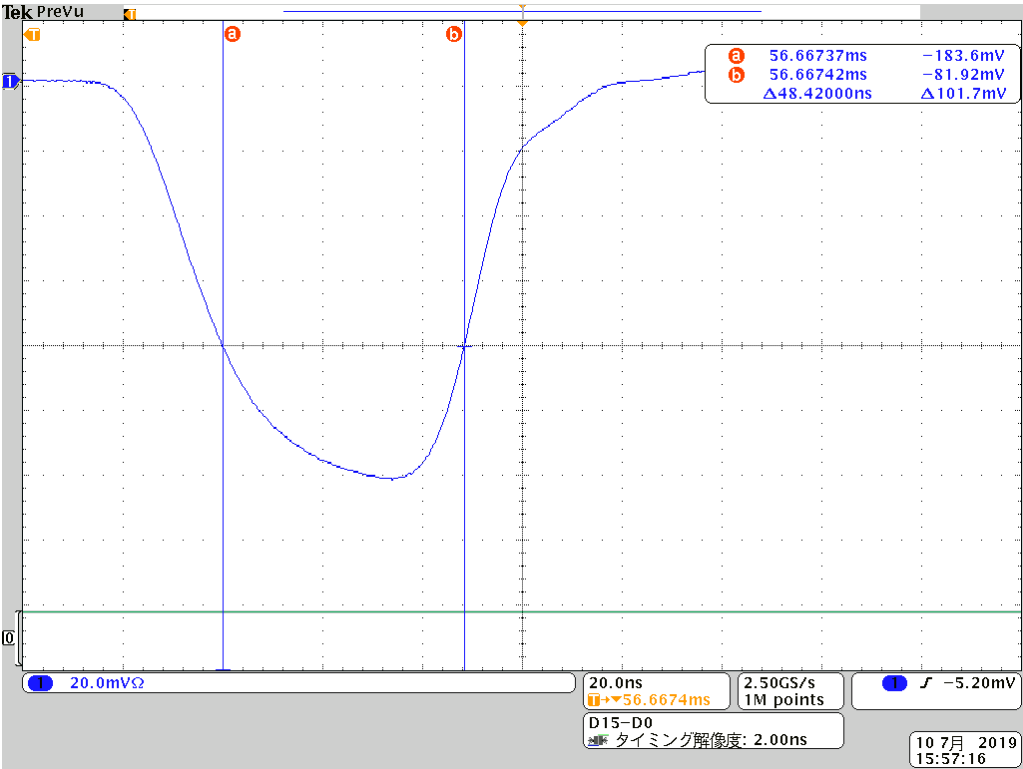


Fig. 6.13 ch2, P0N, S1 pulse envelope

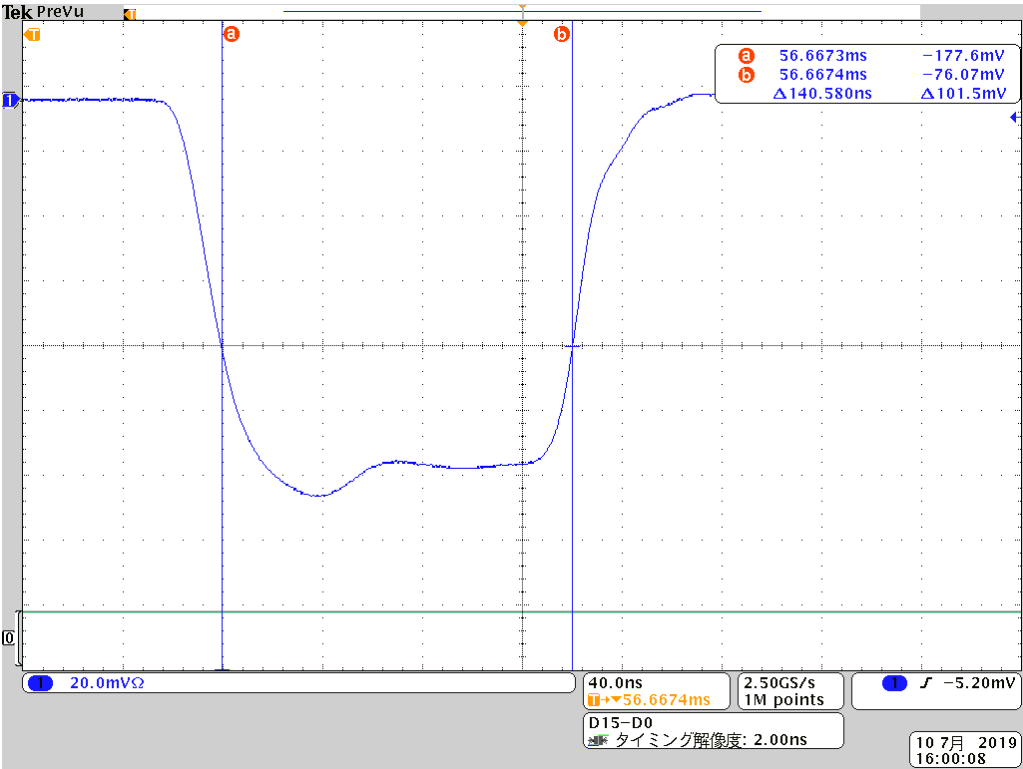


Fig. 6.14 ch2, P0N, S2 pulse envelope



Fig. 6.15 ch2, P0N, M1 pulse envelope

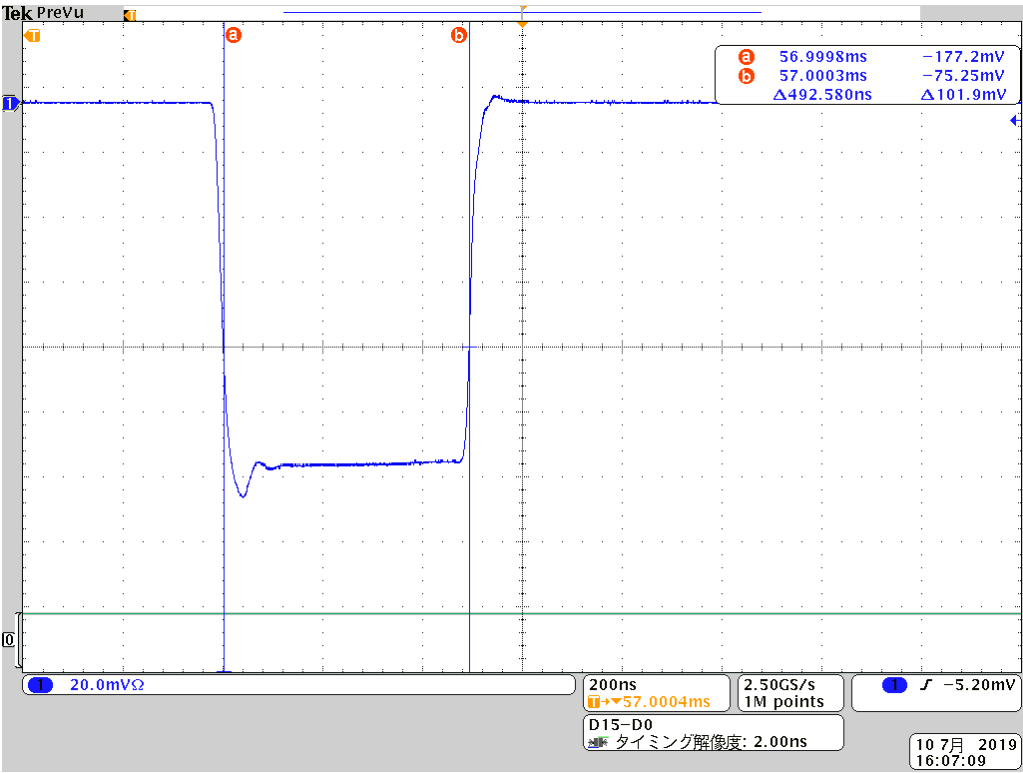


Fig. 6.16 ch2, P0N, M2 pulse envelope

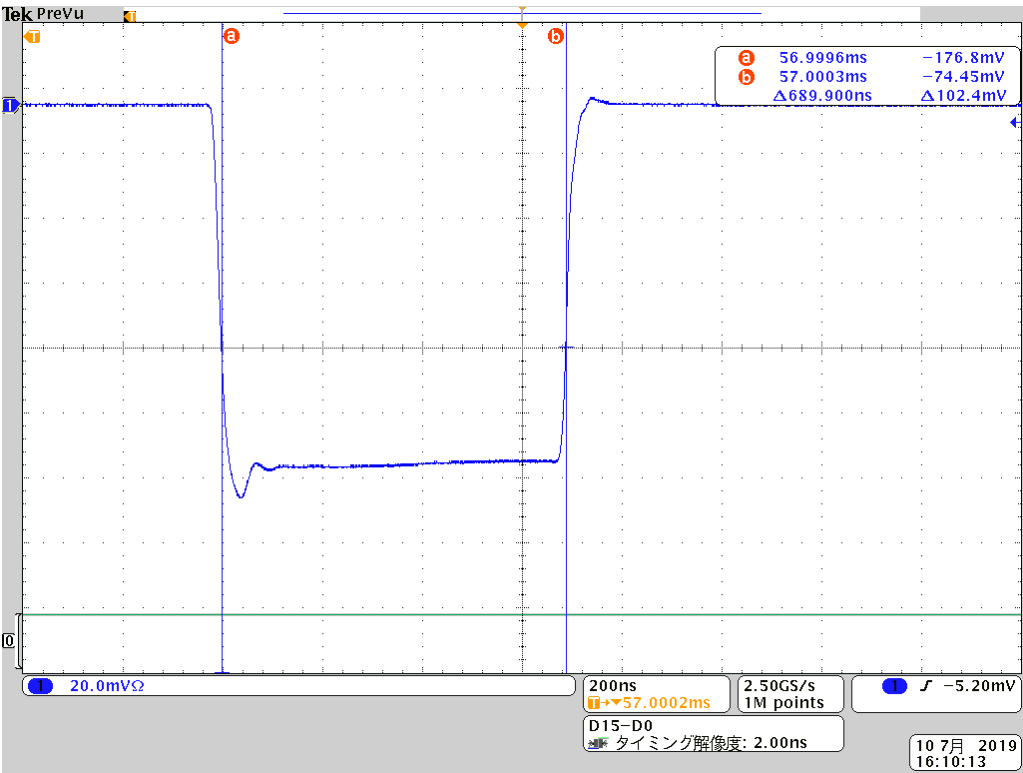


Fig. 6.17 ch2, PON, M3 pulse envelope

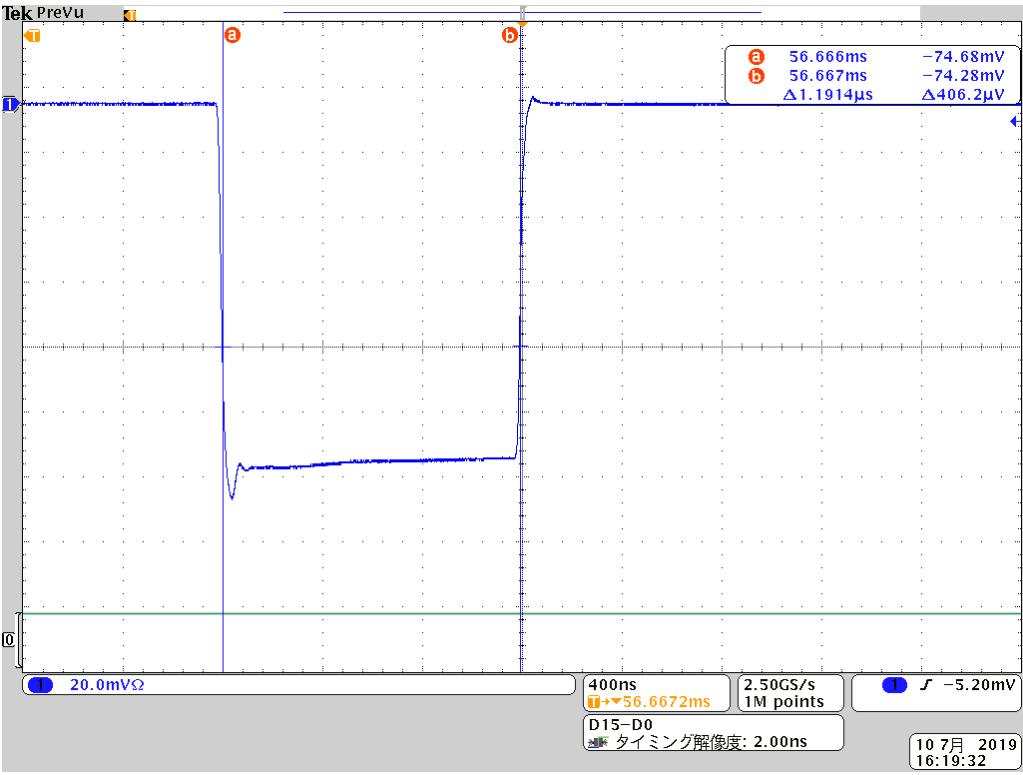


Fig. 6.18 ch2, PON, L pulse envelope

ch2, Q0N

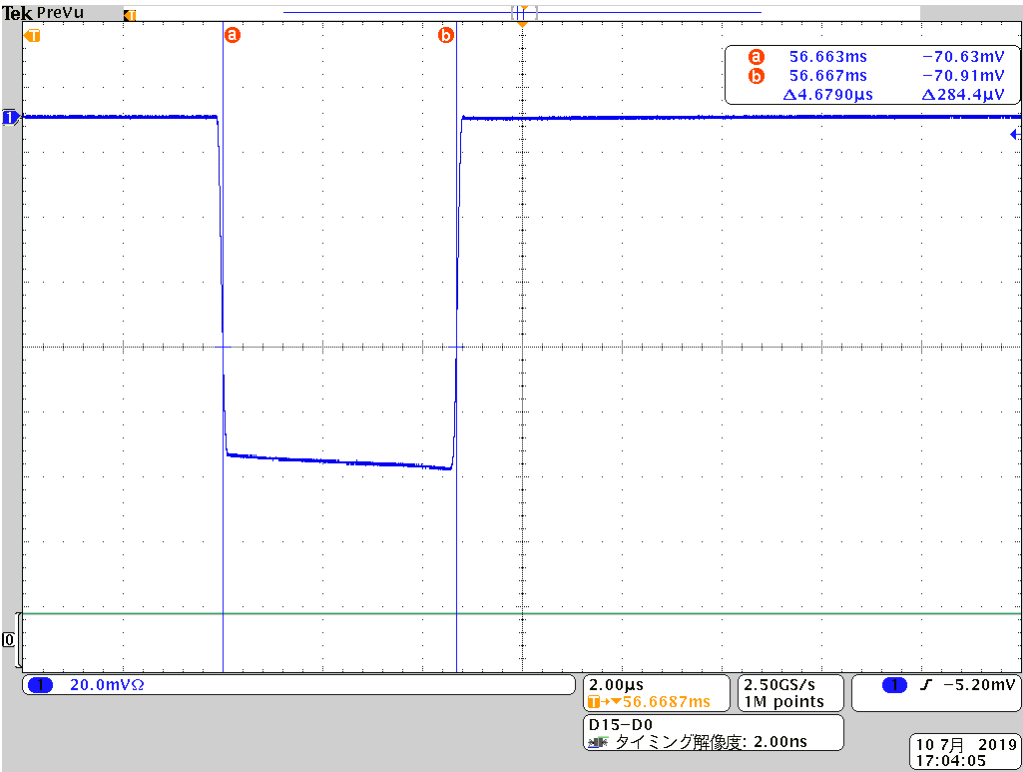


Fig. 6.19 ch2, Q0N, S1 pulse envelope

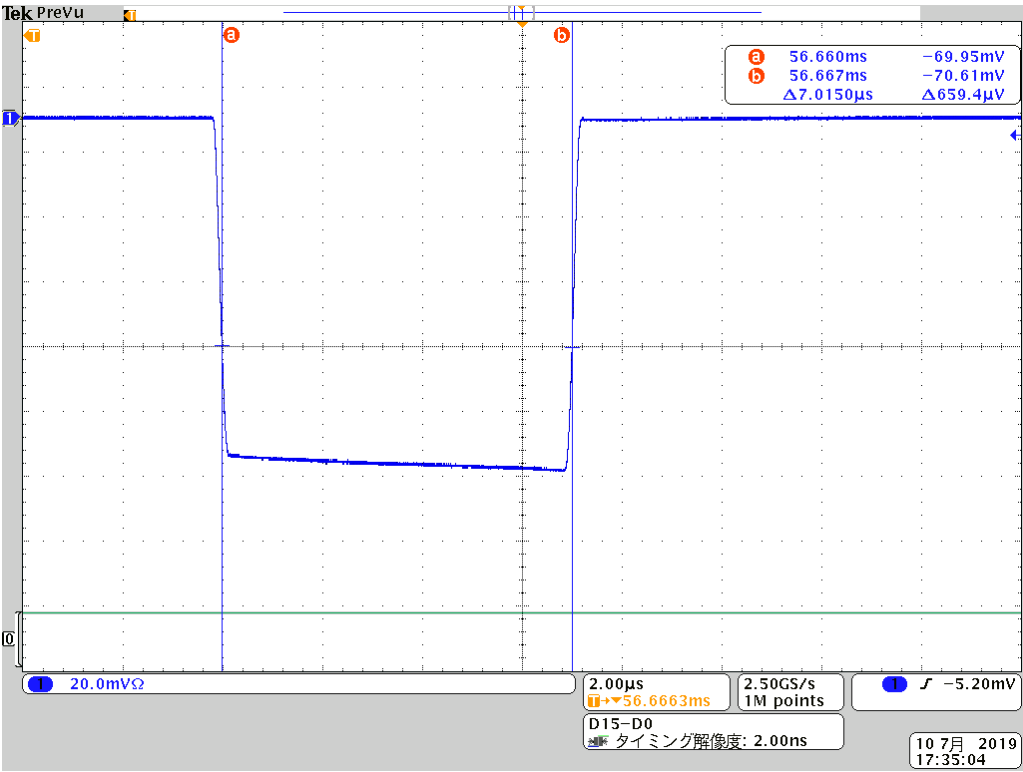


Fig. 6.20 ch2, Q0N, S2 pulse envelope

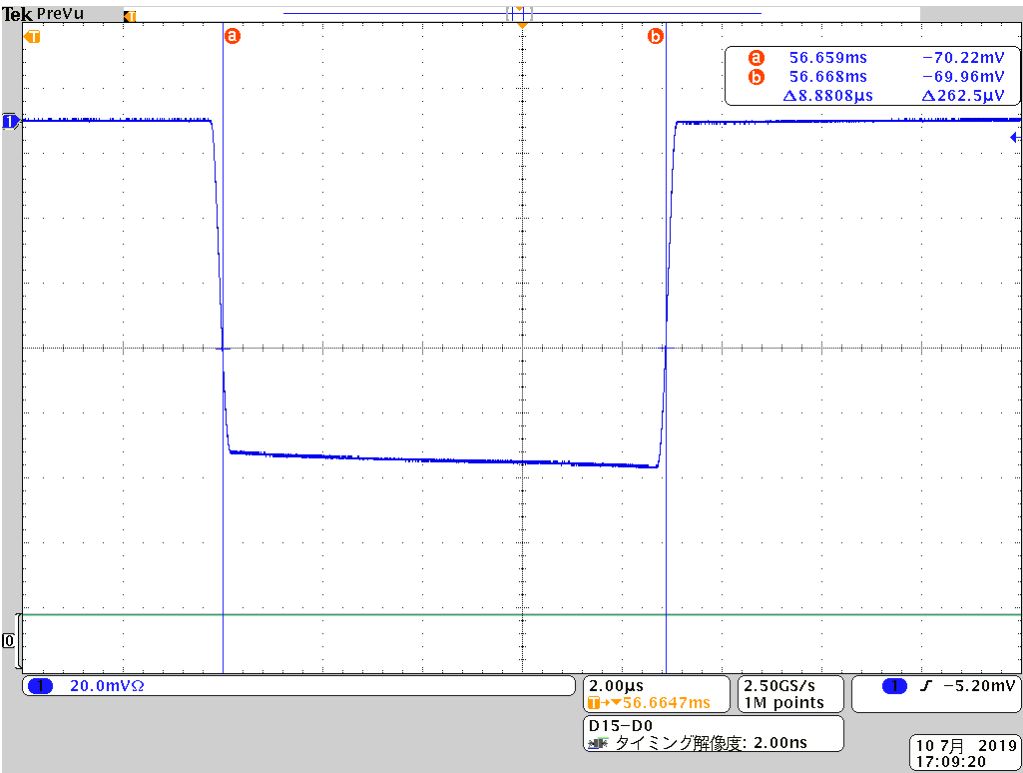


Fig. 6.21 ch2, Q0N, M1 pulse envelope

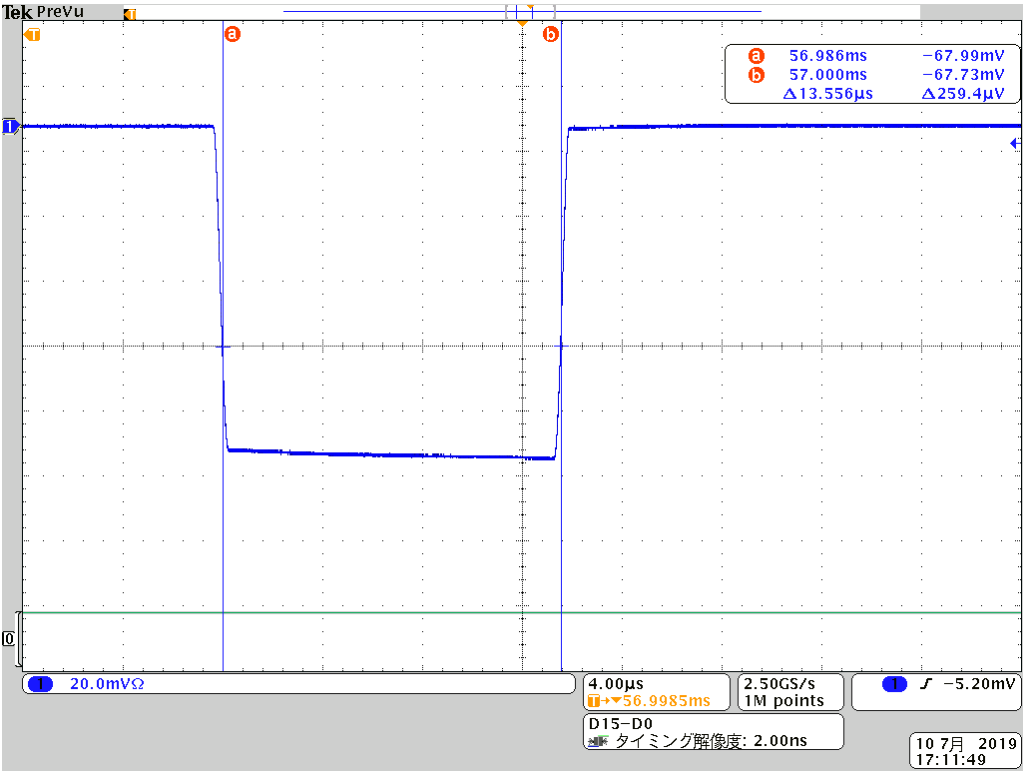


Fig. 6.22 ch2, Q0N, M2 pulse envelope

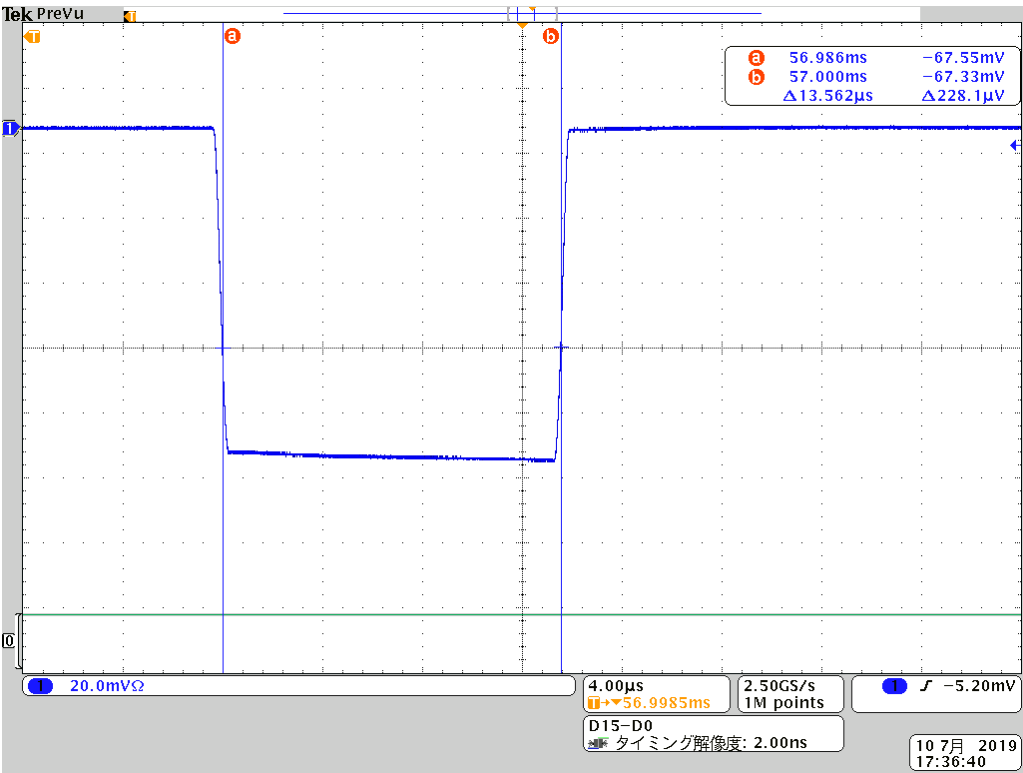


Fig. 6.23 ch2, Q0N, M3 pulse envelope

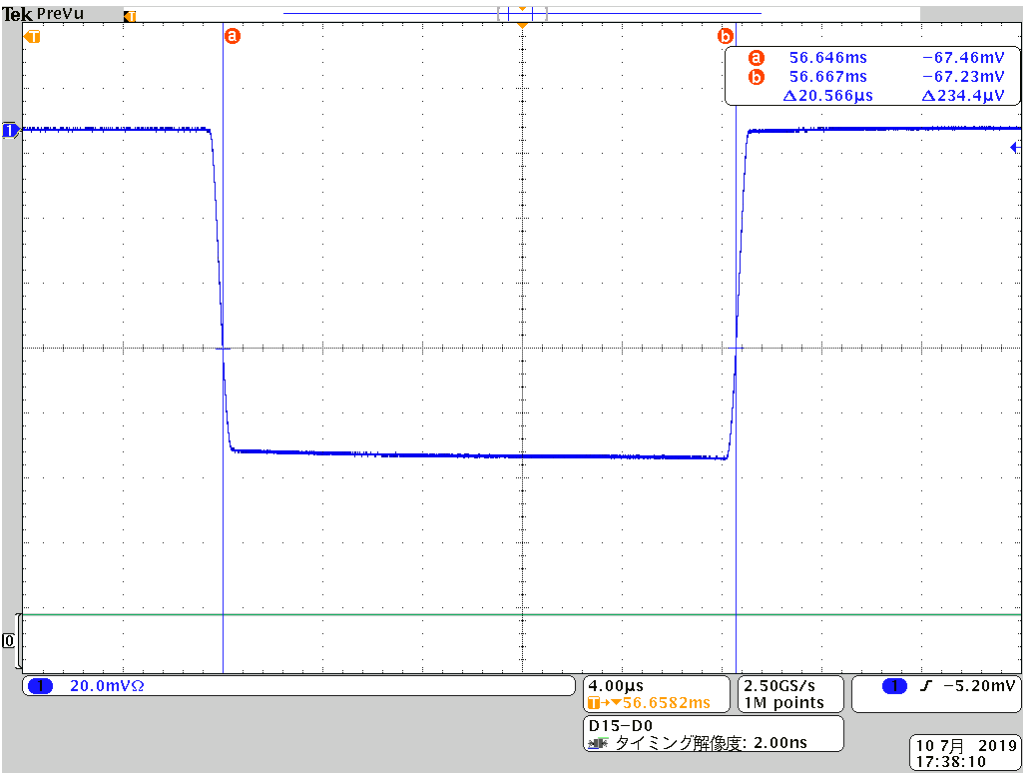


Fig. 6.24 ch2, Q0N, L pulse envelope

TT32NM mode

ch1, P0N

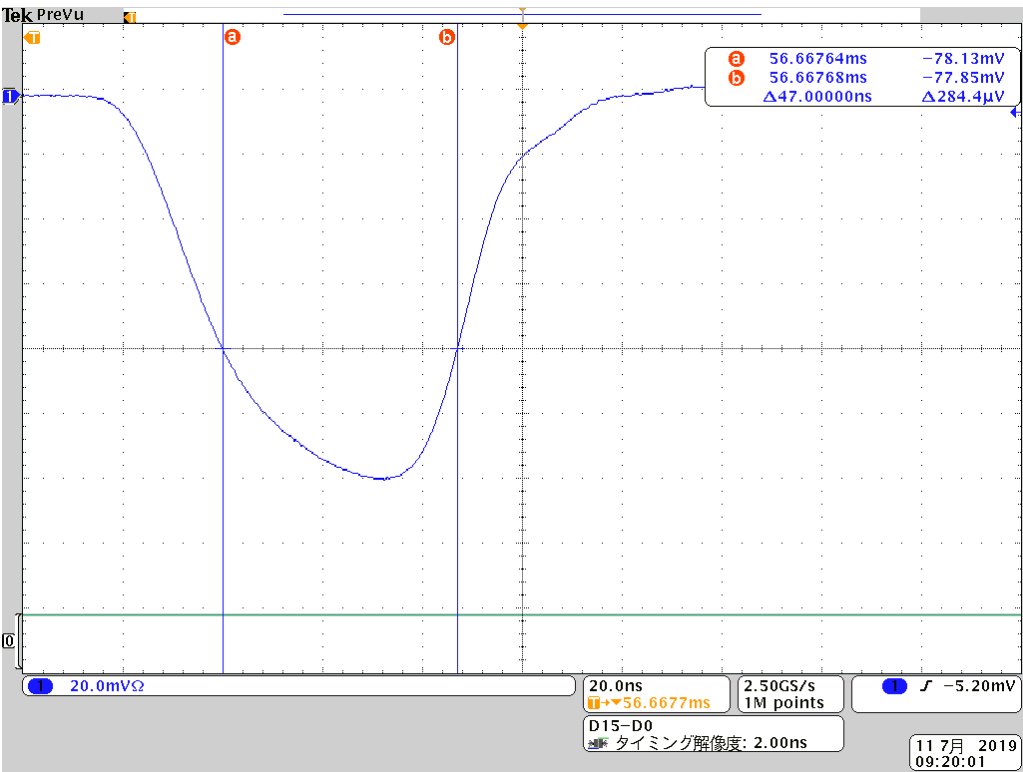


Fig. 6.25 ch1, P0N, S1 pulse envelope

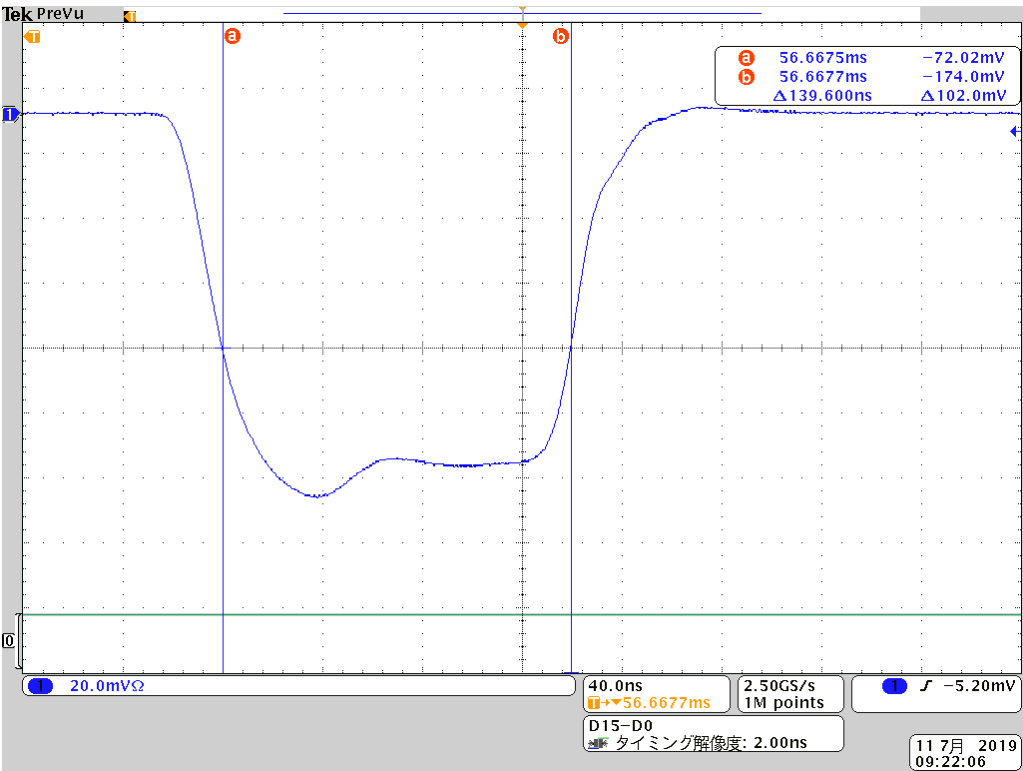


Fig. 6.26 ch1, P0N, S2 pulse envelope



Fig. 6.27 ch1, P0N, M1 pulse envelope

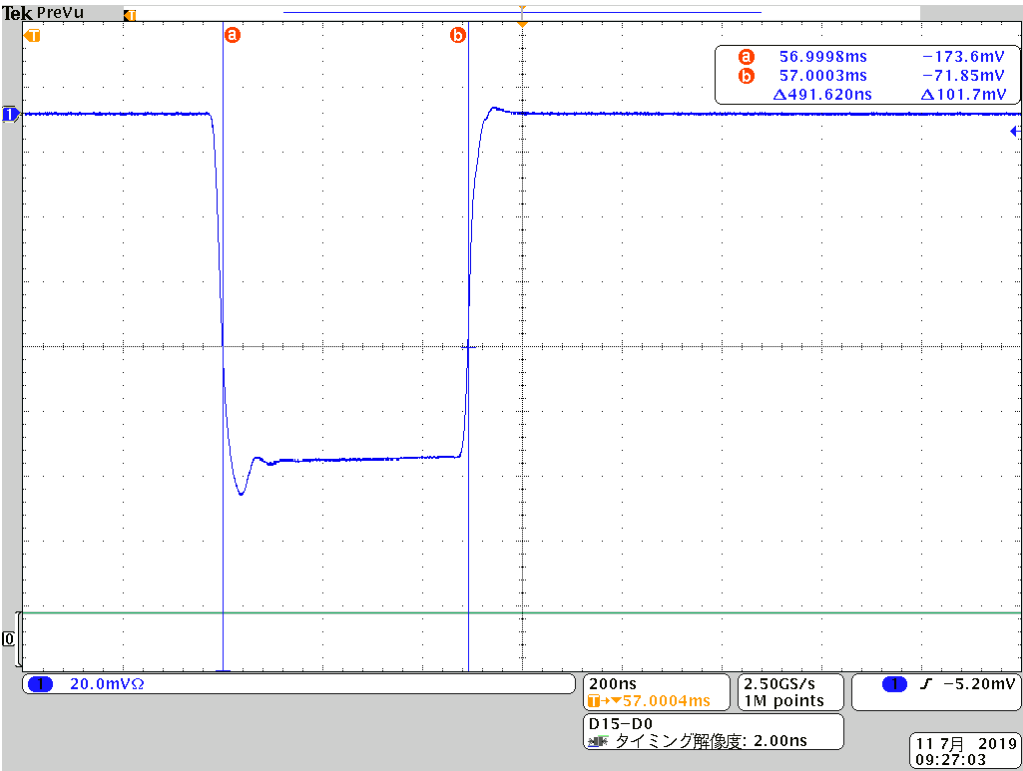


Fig. 6.28 ch1, P0N, M2 pulse envelope

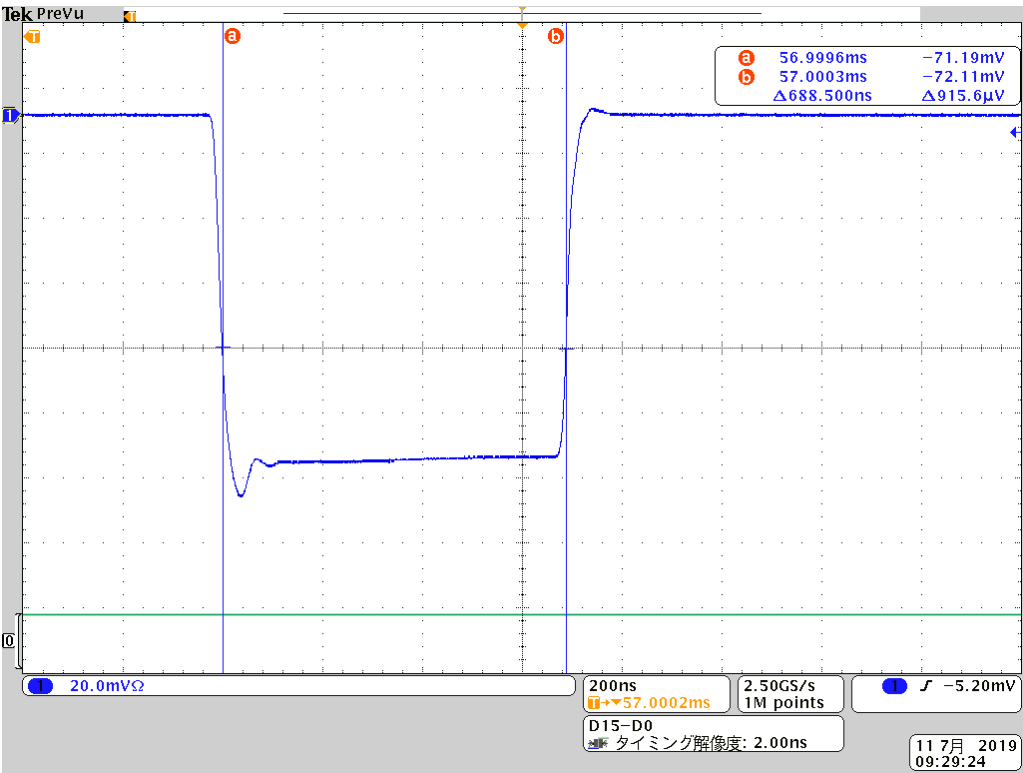


Fig. 6.29 ch1, P0N, M3 pulse envelope

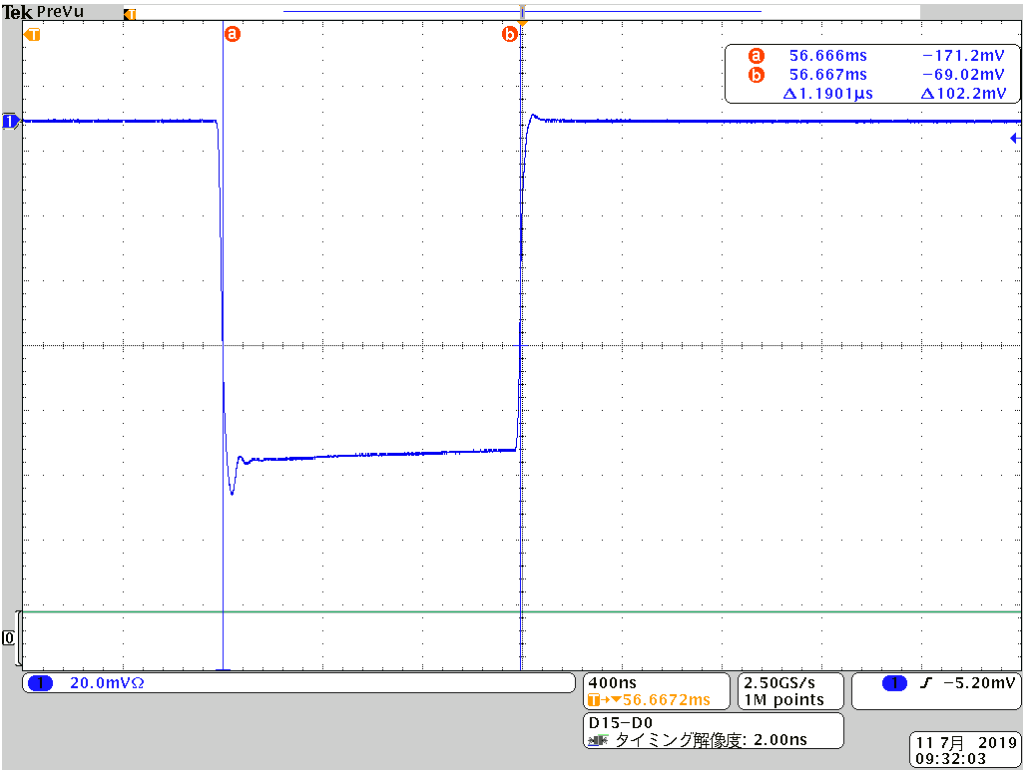


Fig. 6.30 ch1, P0N, L pulse envelope

ch1, Q0N

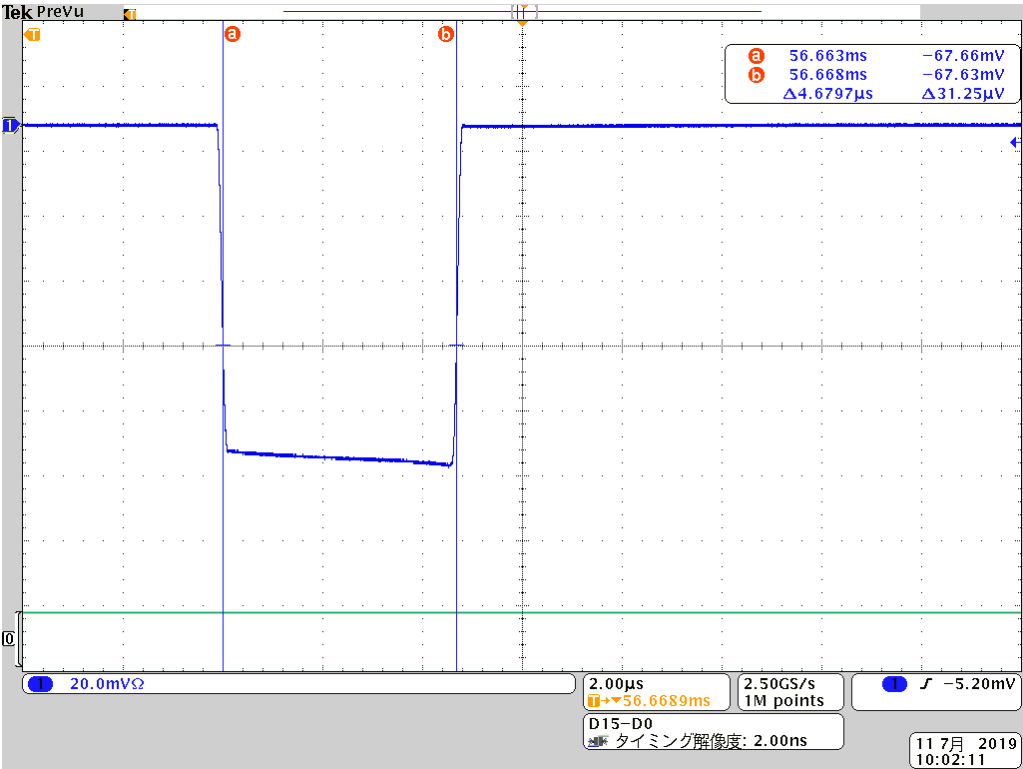


Fig. 6.31 ch1, Q0N, S1 pulse envelope

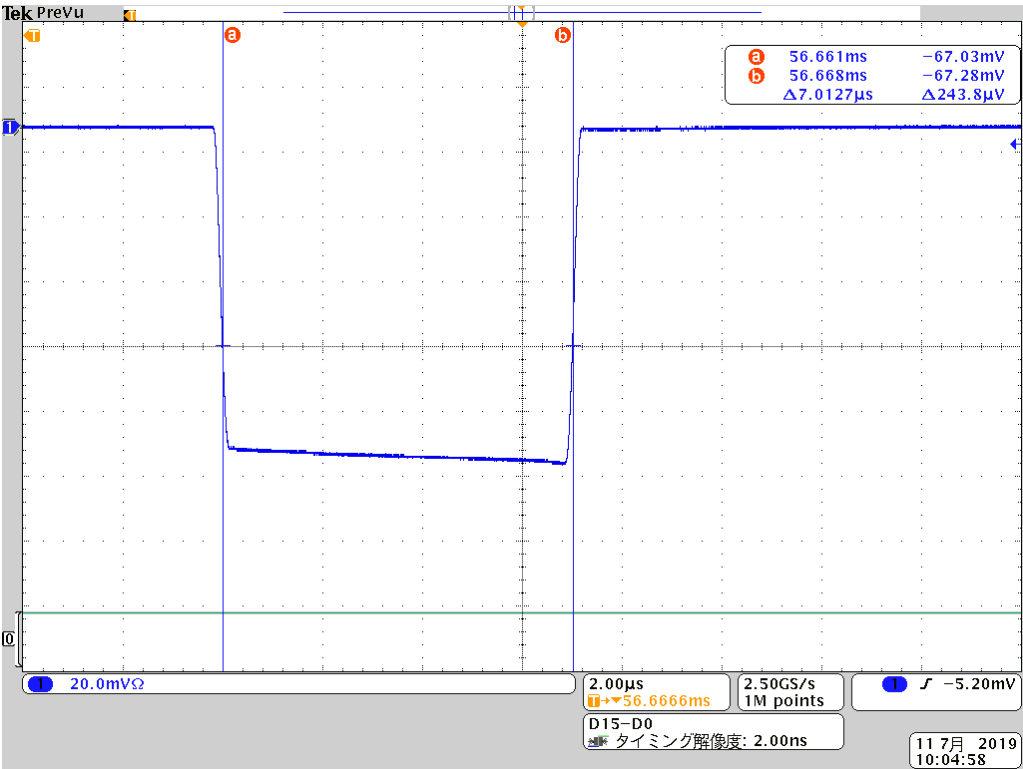


Fig. 6.32 ch1, Q0N, S2 pulse envelope

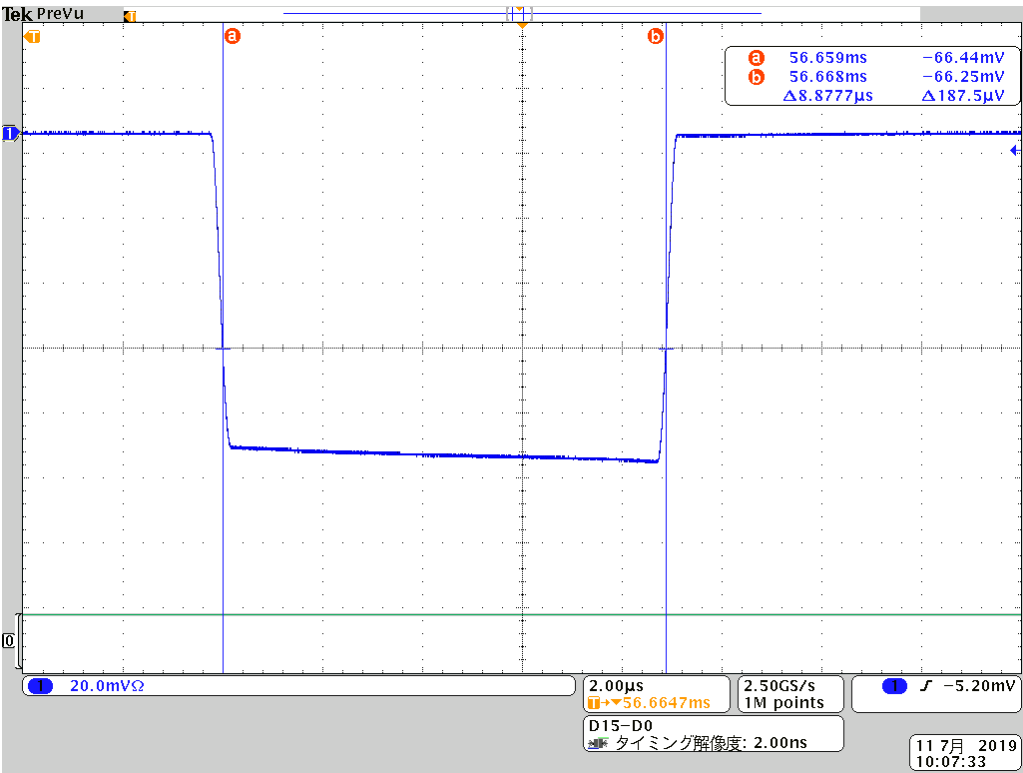


Fig. 6.33 ch1, Q0N, M1 pulse envelope

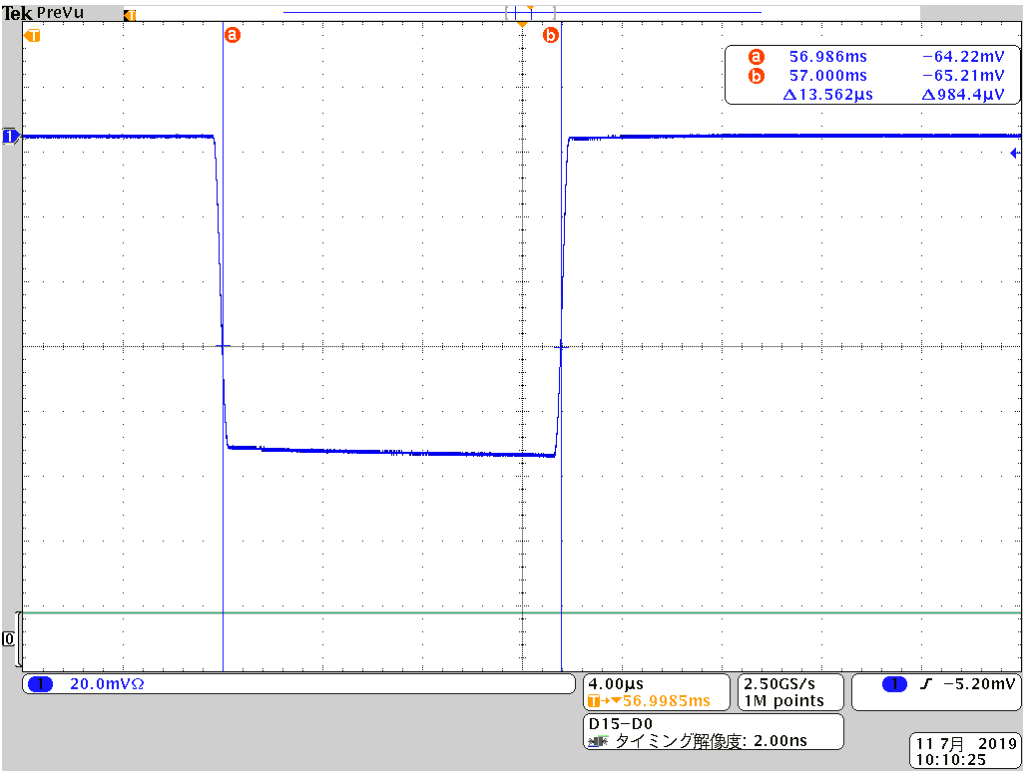


Fig. 6.34 ch1, Q0N, M2 pulse envelope

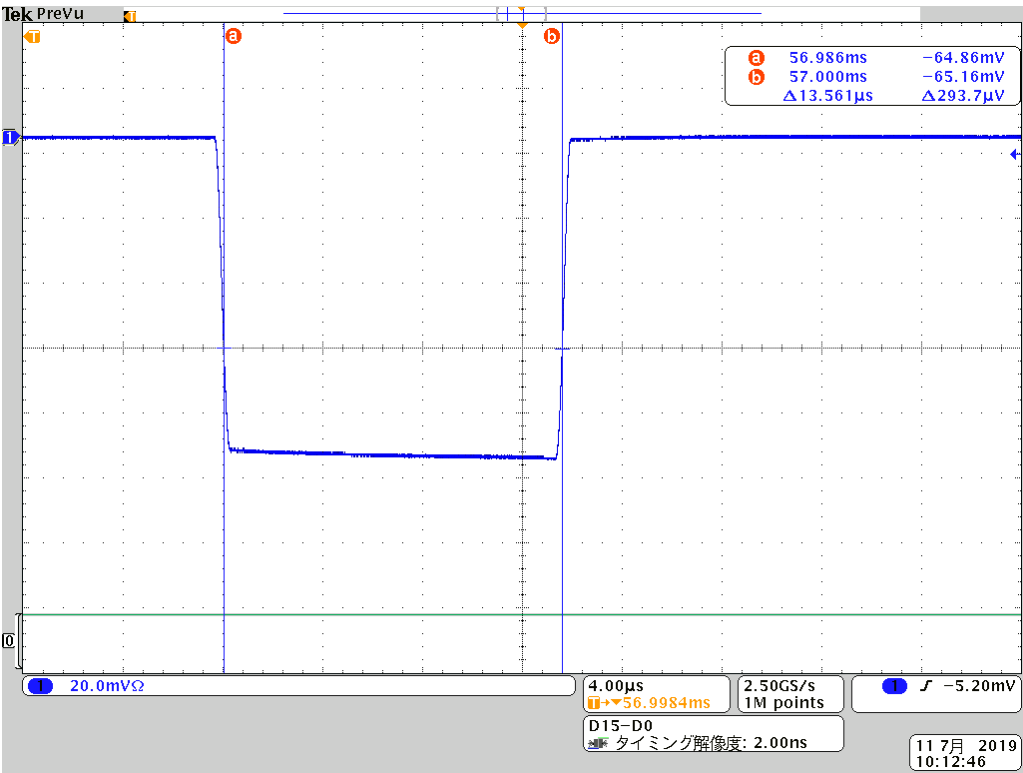


Fig. 6.35 ch1, Q0N, M3 pulse envelope

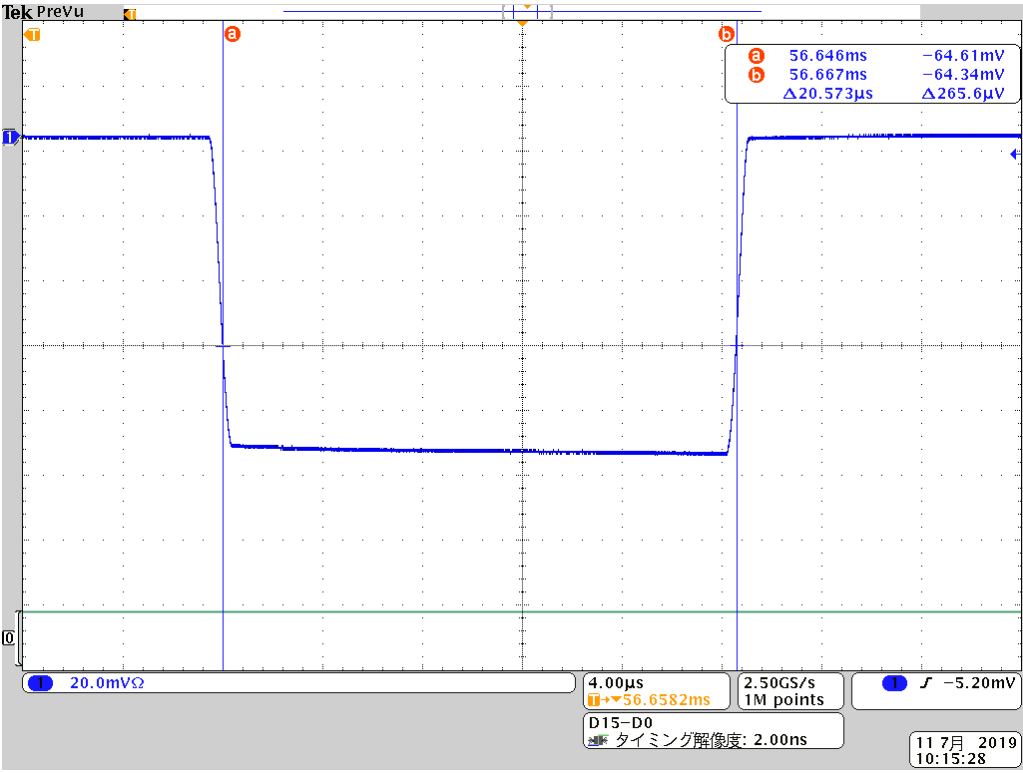


Fig. 6.36 ch1, Q0N, L pulse envelope

ch2, P0N

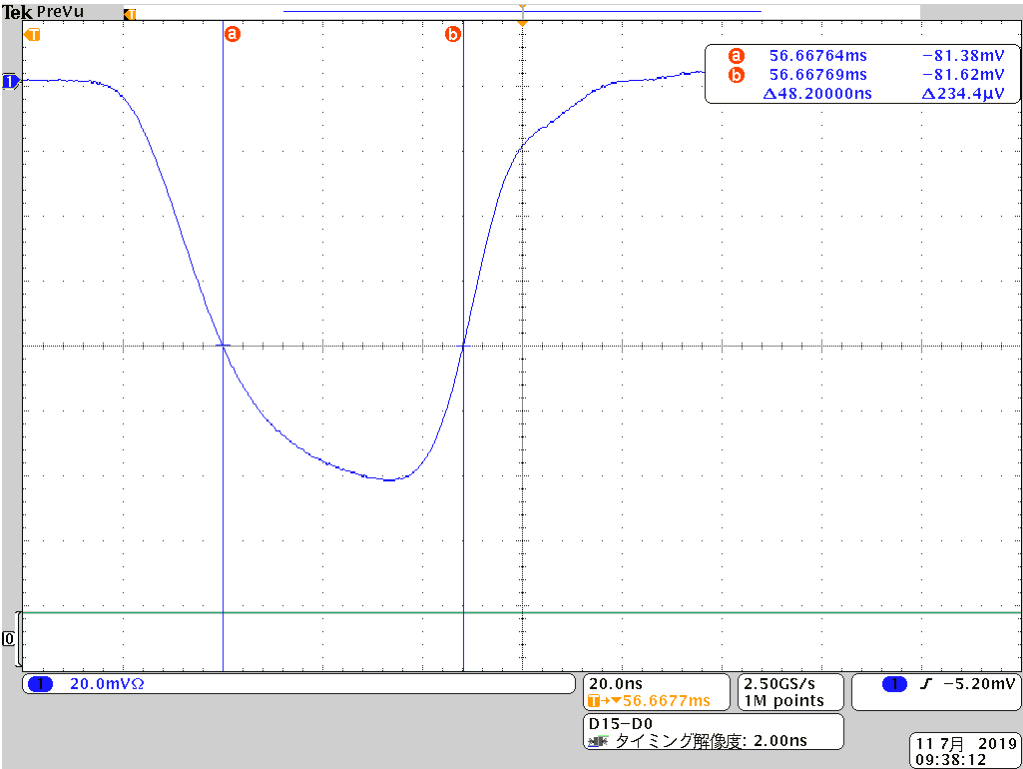


Fig. 6.37 ch2, P0N, S1 pulse envelope

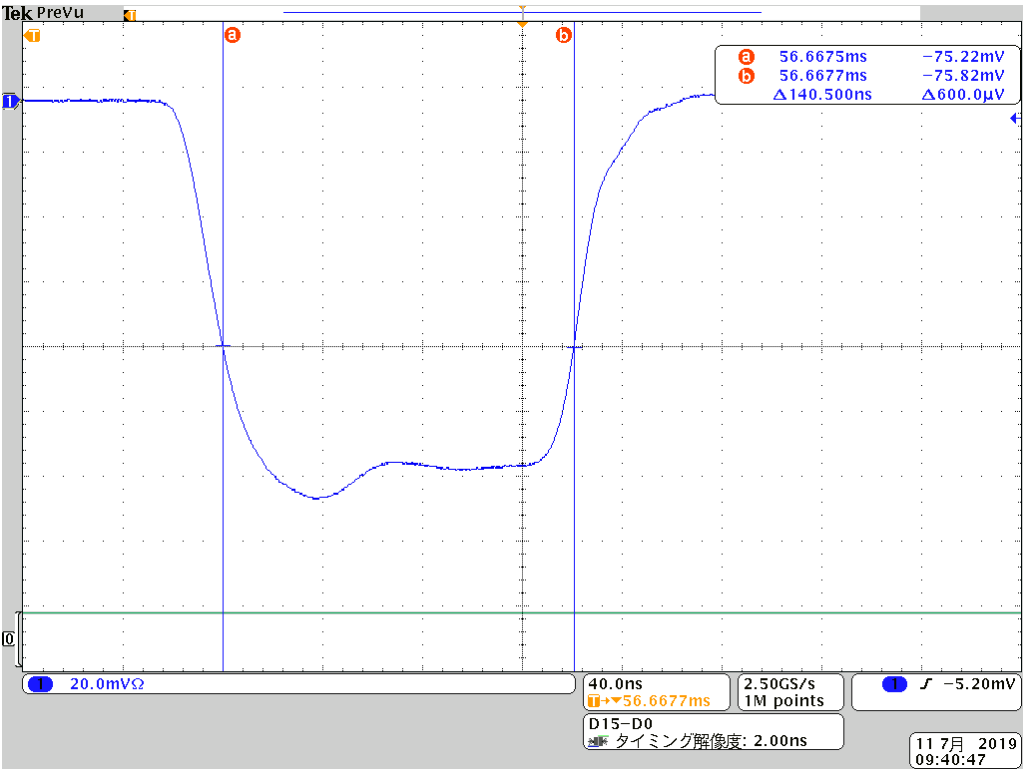


Fig. 6.38 ch2, P0N, S2 pulse envelope

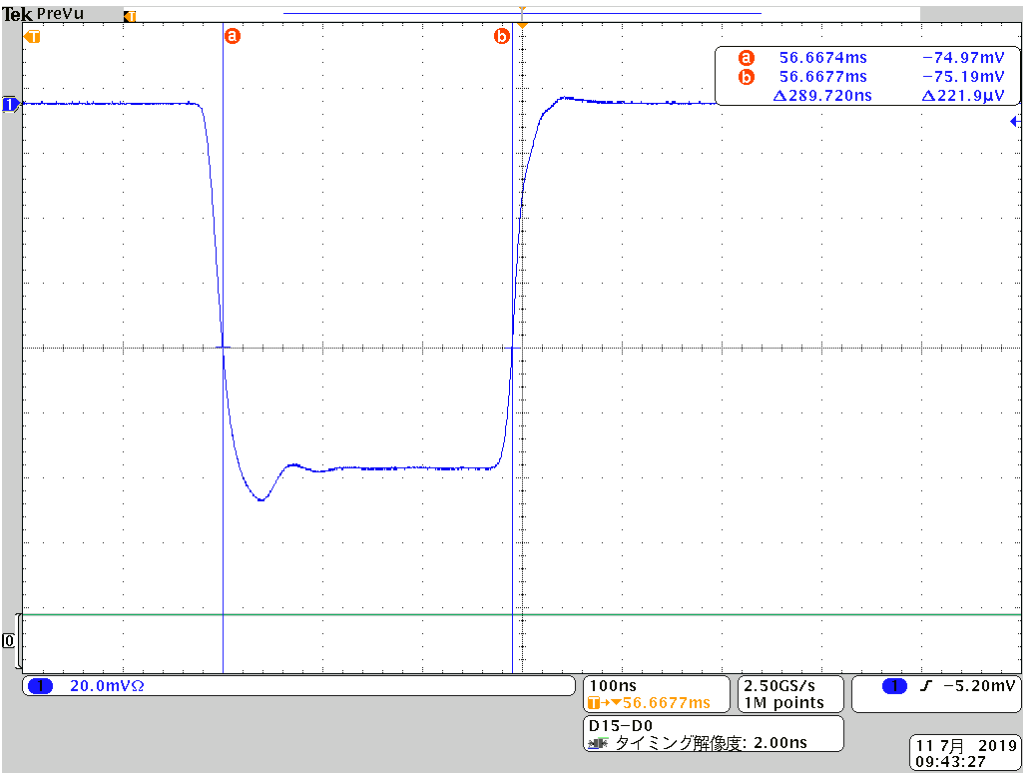


Fig. 6.39 ch2, P0N, M1 pulse envelope

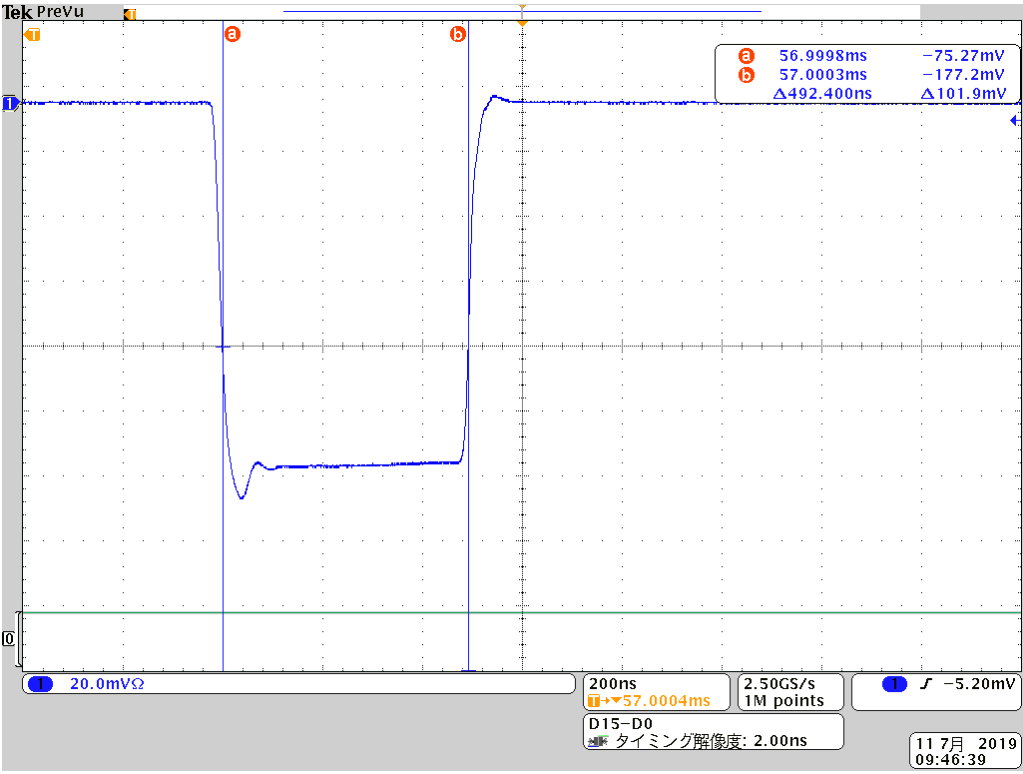


Fig. 6.40 ch2, P0N, M2 pulse envelope

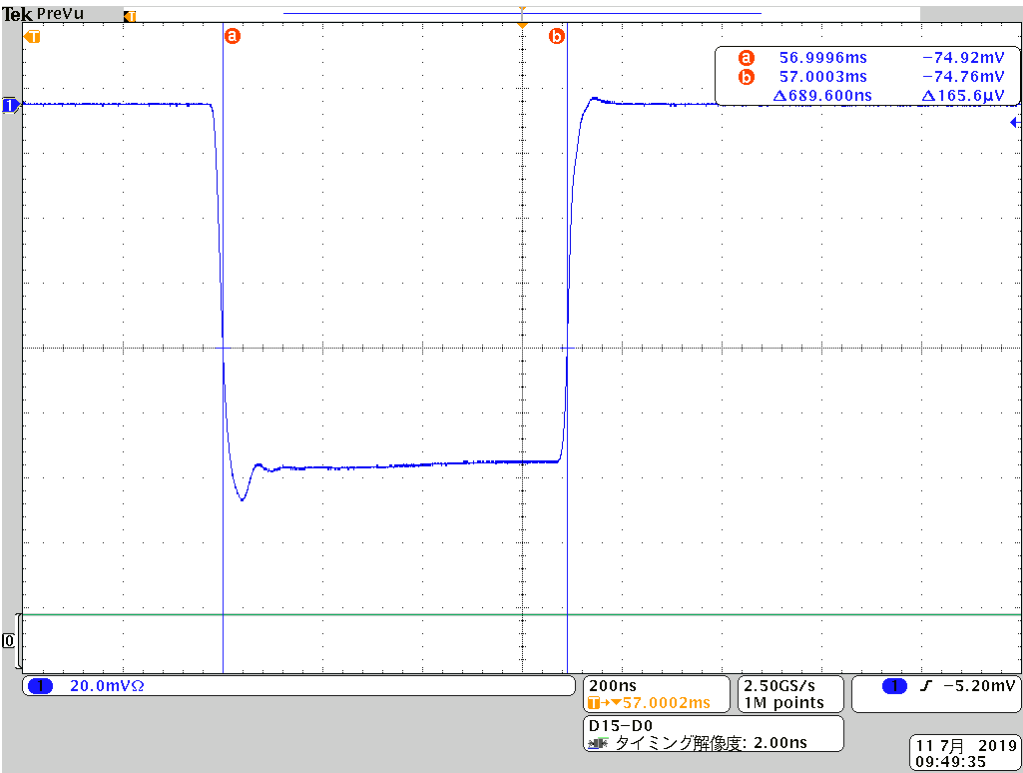


Fig. 6.41 ch2, P0N, M3 pulse envelope

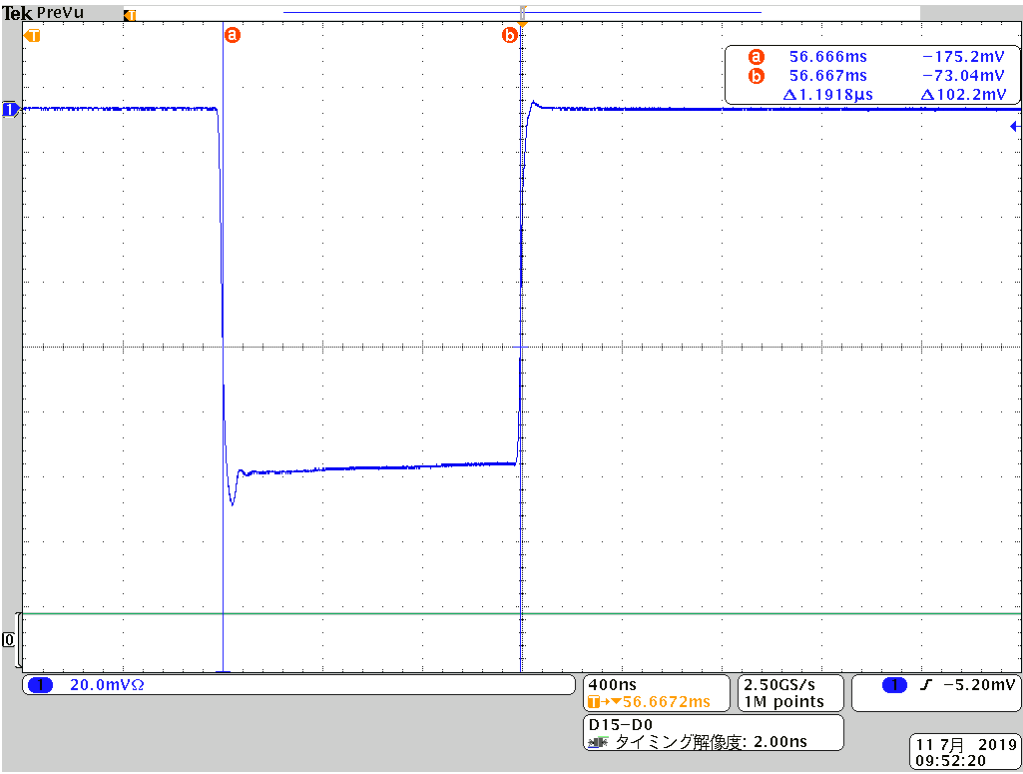


Fig. 6.42 ch2, P0N, L pulse envelope

ch2, Q0N

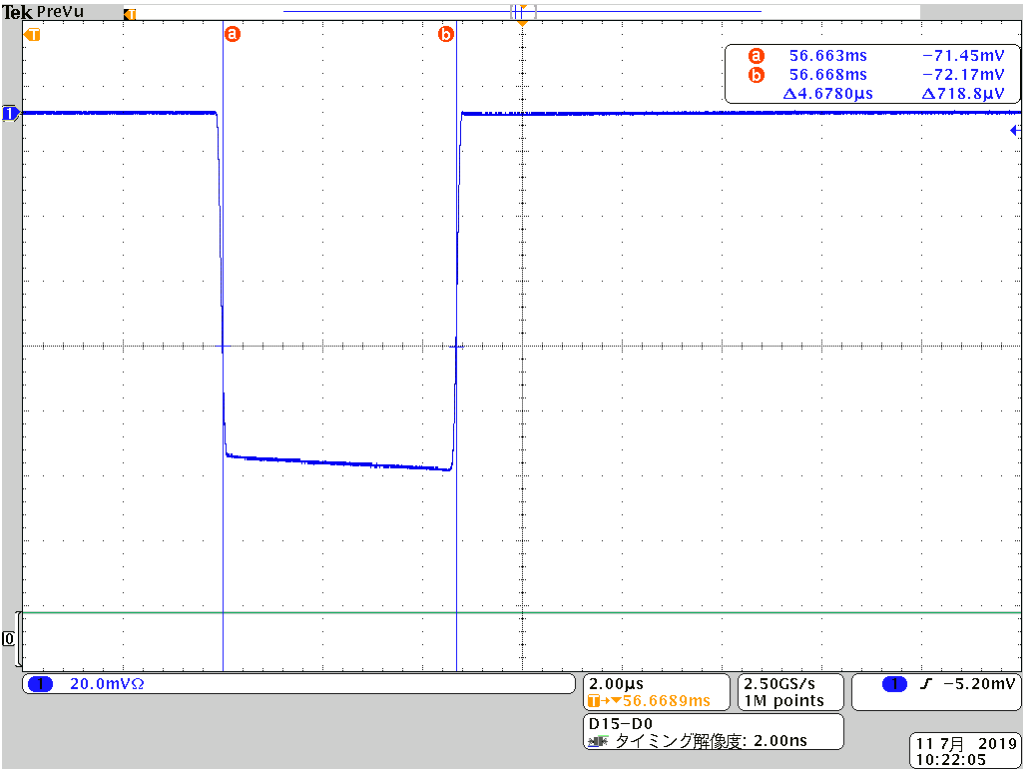


Fig. 6.43 ch2, Q0N, S1 pulse envelope

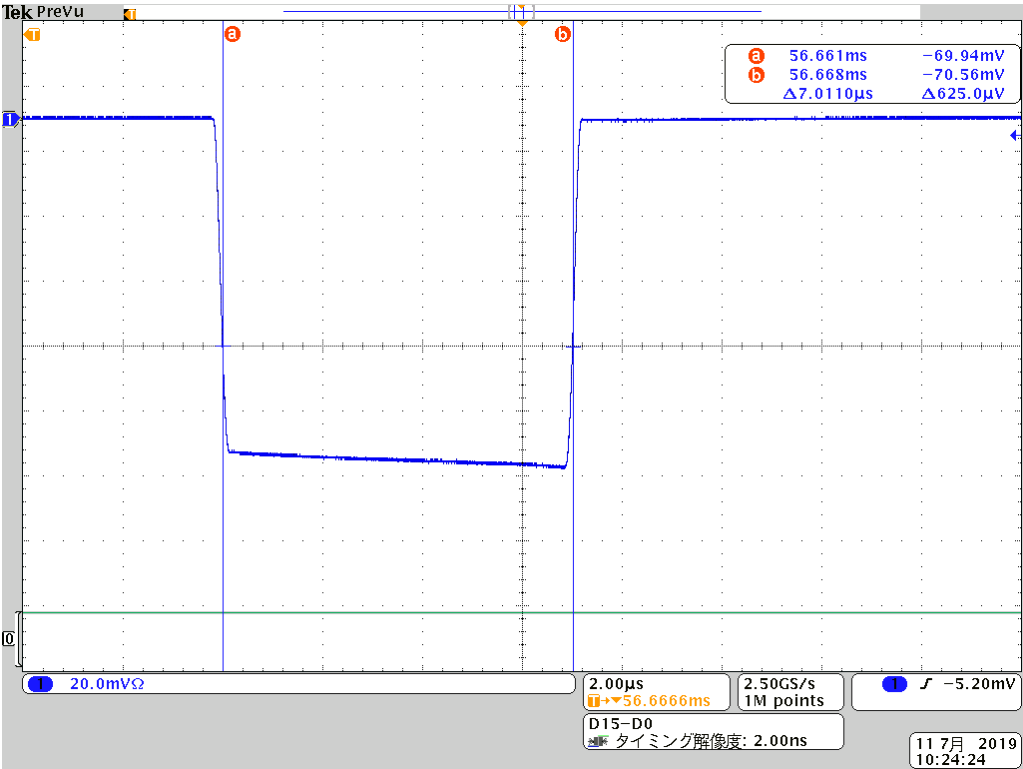


Fig. 6.44 ch2, Q0N, S2 pulse envelope

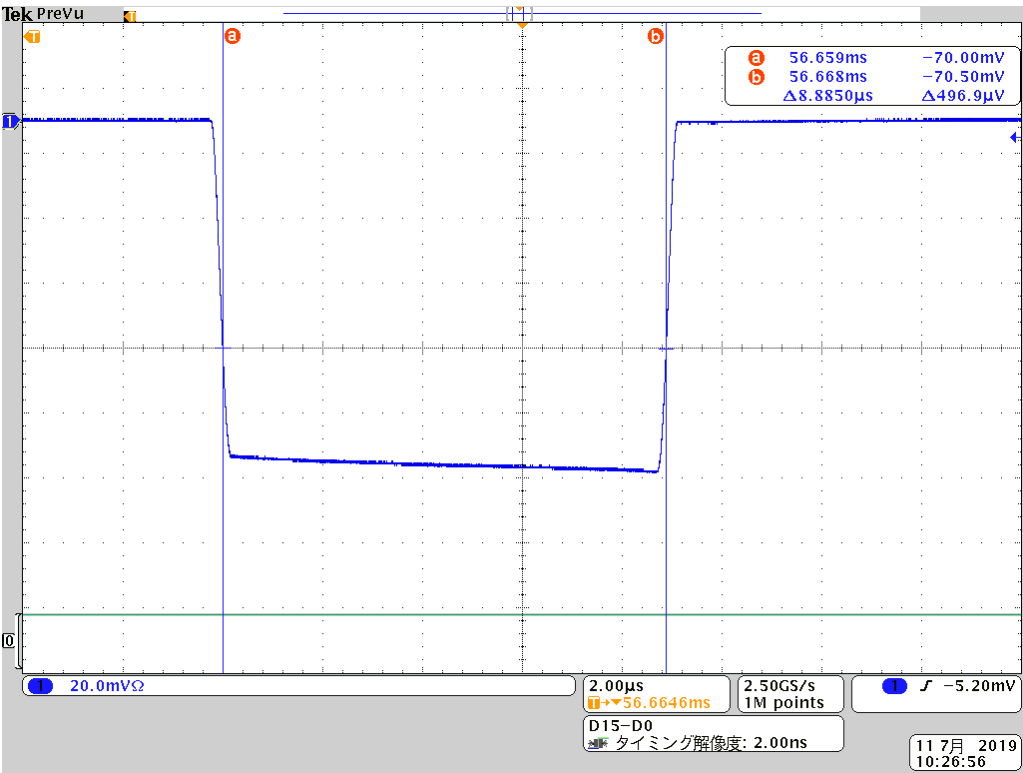


Fig. 6.45 ch2, Q0N, M1 pulse envelope

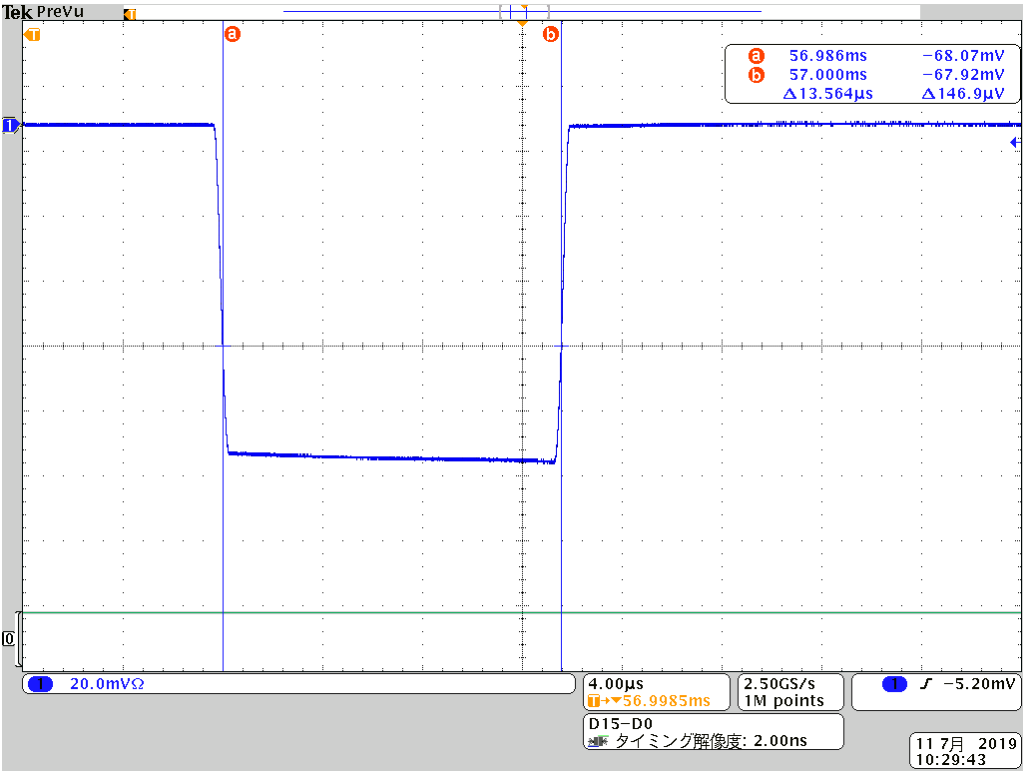


Fig. 6.46 ch2, Q0N, M2 pulse envelope

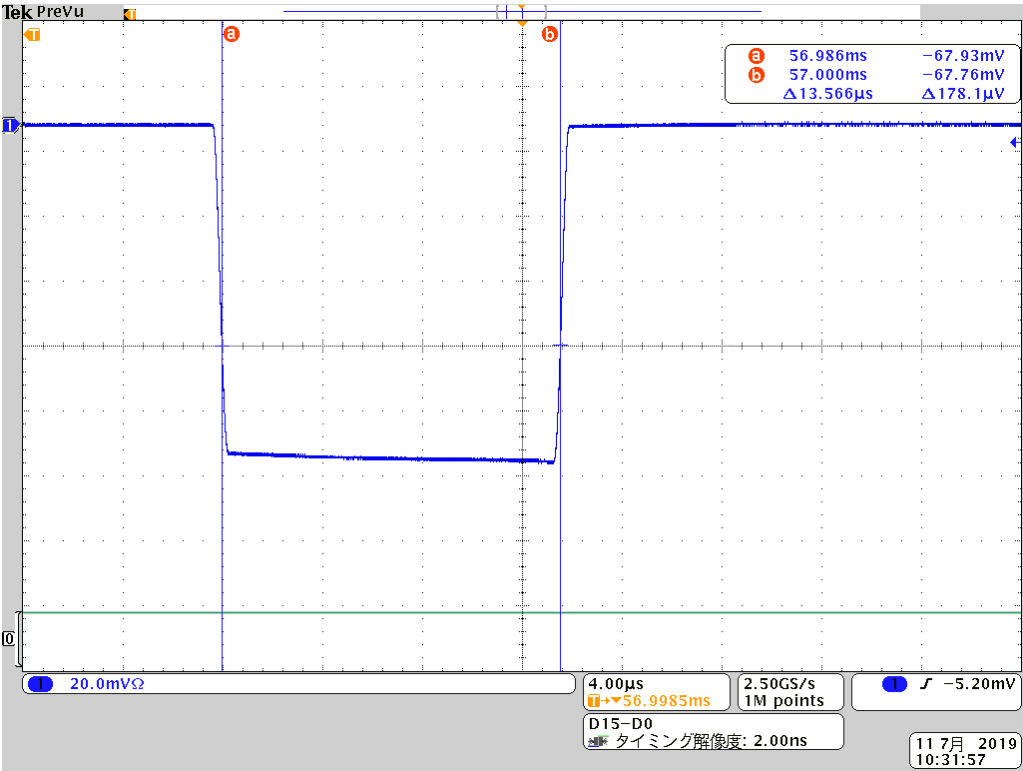


Fig. 6.47 ch2, Q0N, M3 pulse envelope

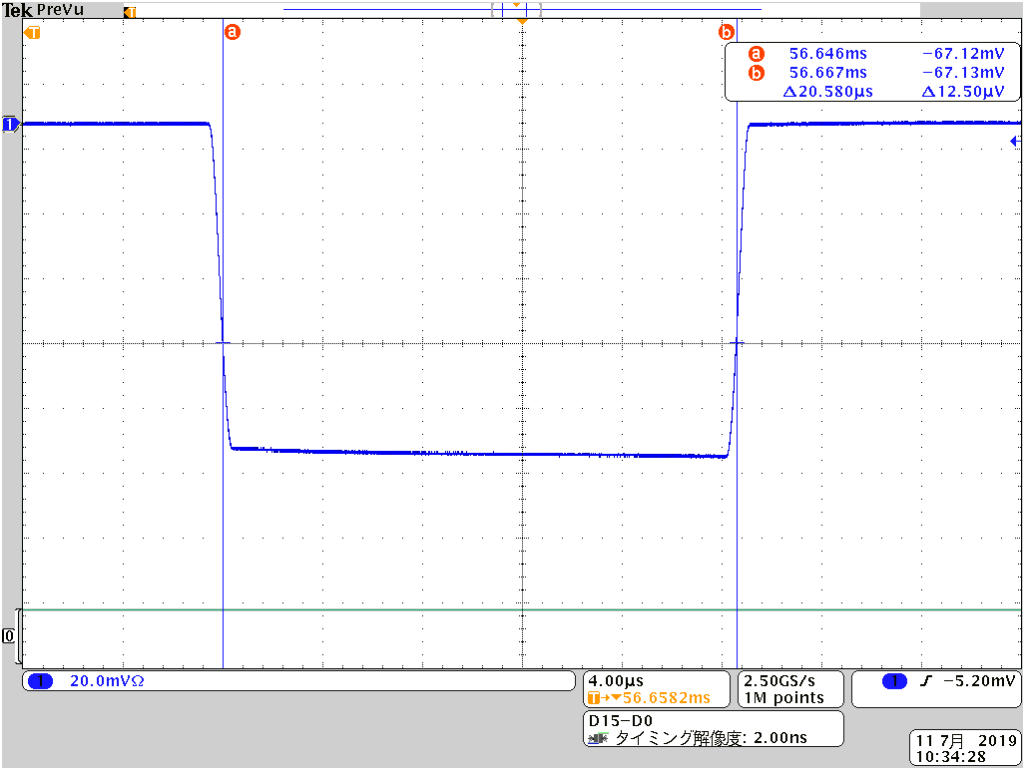


Fig. 6.48 ch2, Q0N, L pulse envelope

2nd trace mode

ch1, P0N

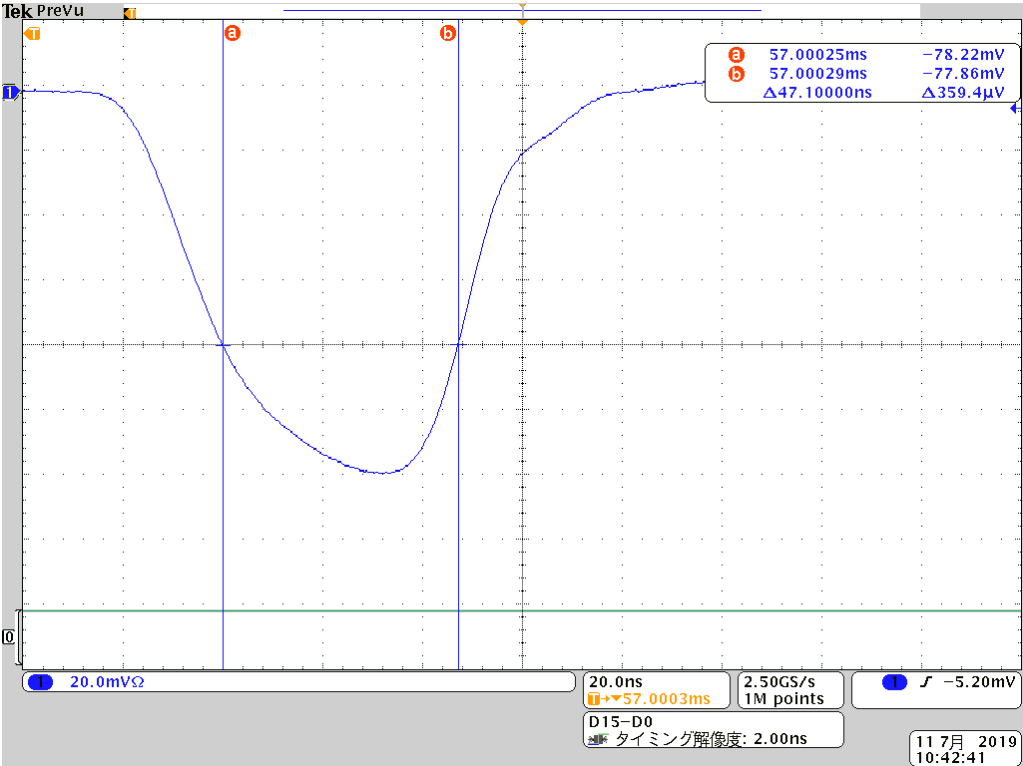


Fig. 6.49 ch1, P0N, S1 pulse envelope

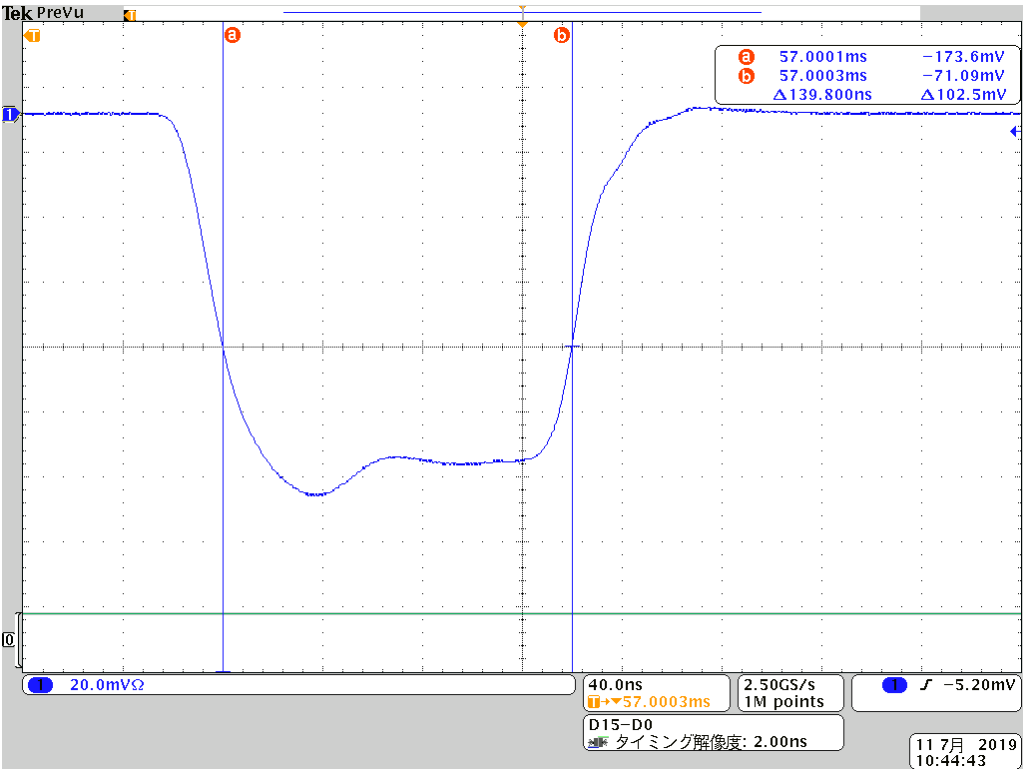


Fig. 6.50 ch1, P0N, S2 pulse envelope



Fig. 6.51 ch1, P0N, M1 pulse envelope

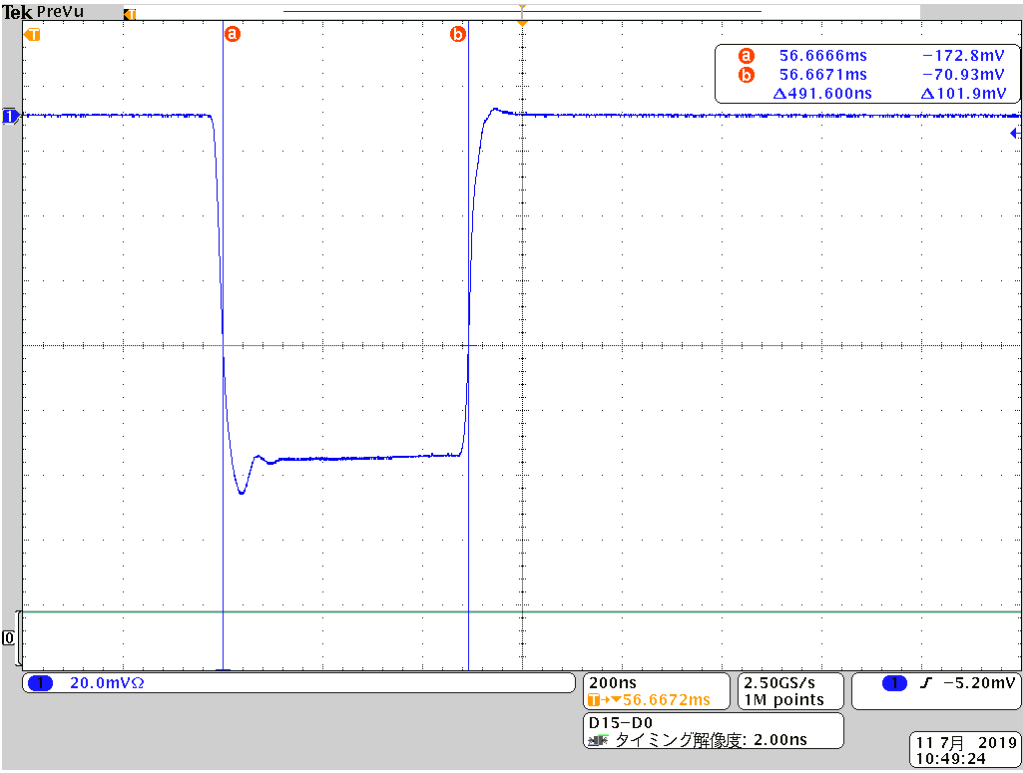


Fig. 6.52 ch1, P0N, M2 pulse envelope

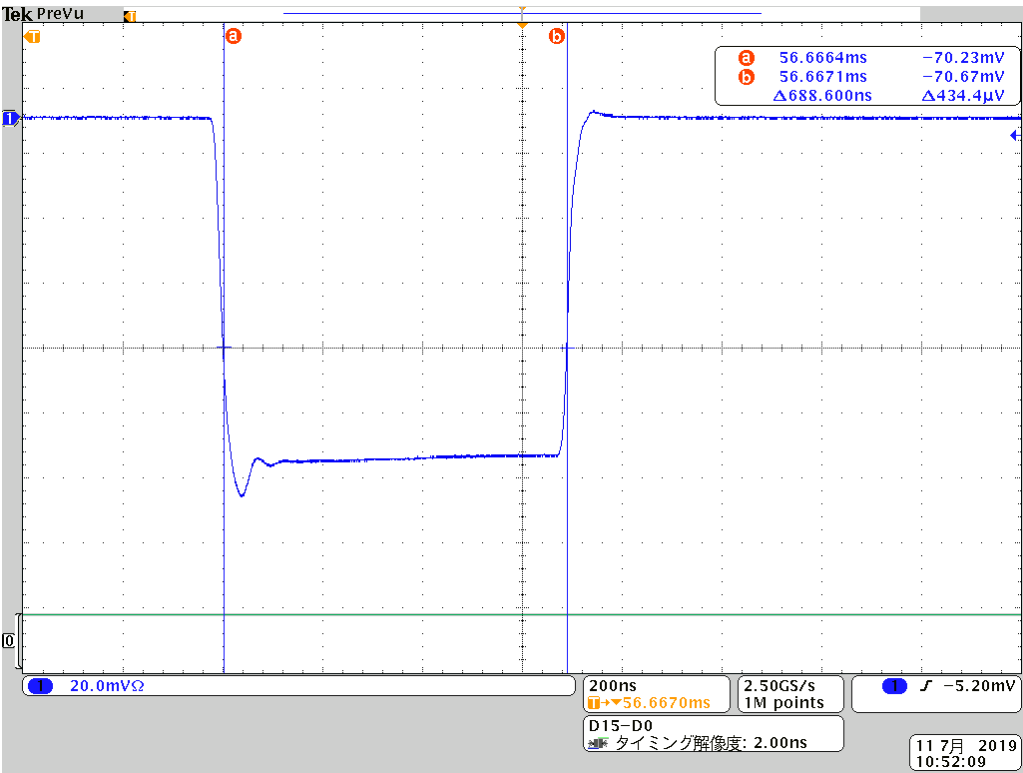


Fig. 6.53 ch1, P0N, M3 pulse envelope

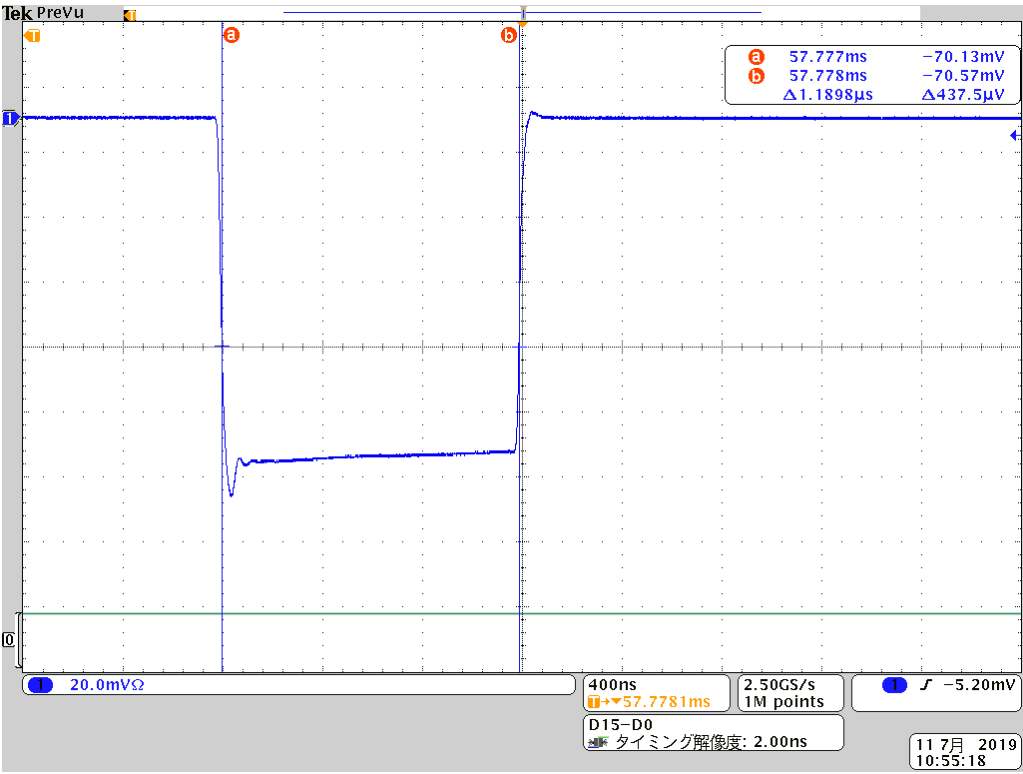


Fig. 6.54 ch1, P0N, L pulse envelope

ch1, Q0N

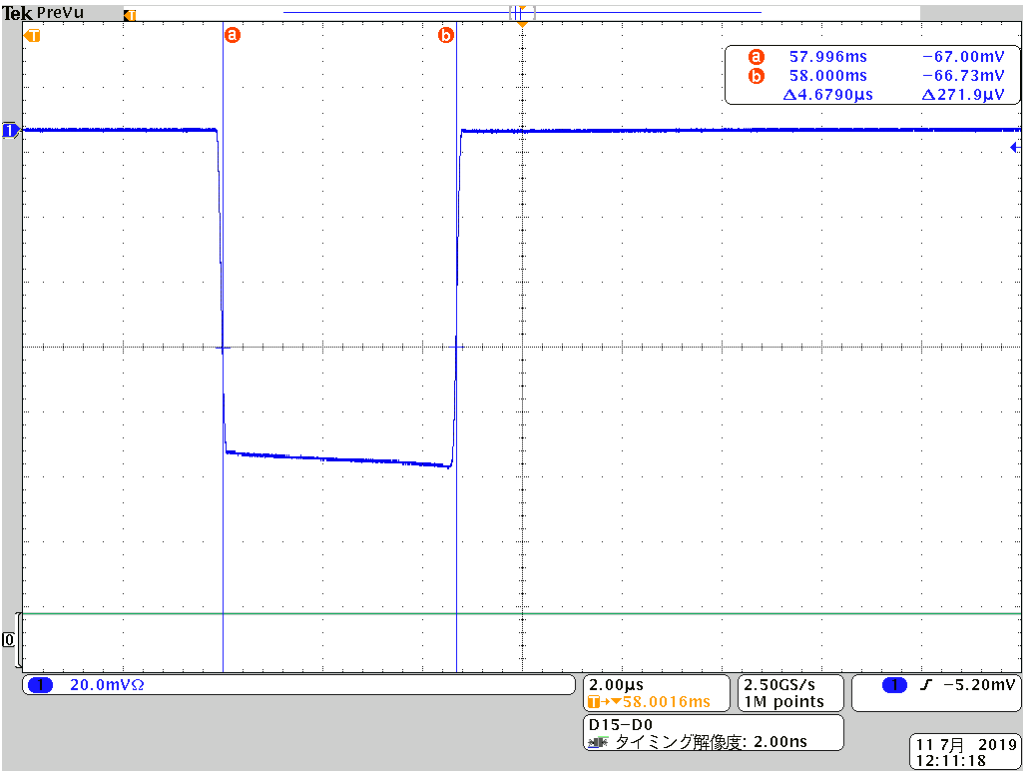


Fig. 6.55 ch1, Q0N, S1 pulse envelope

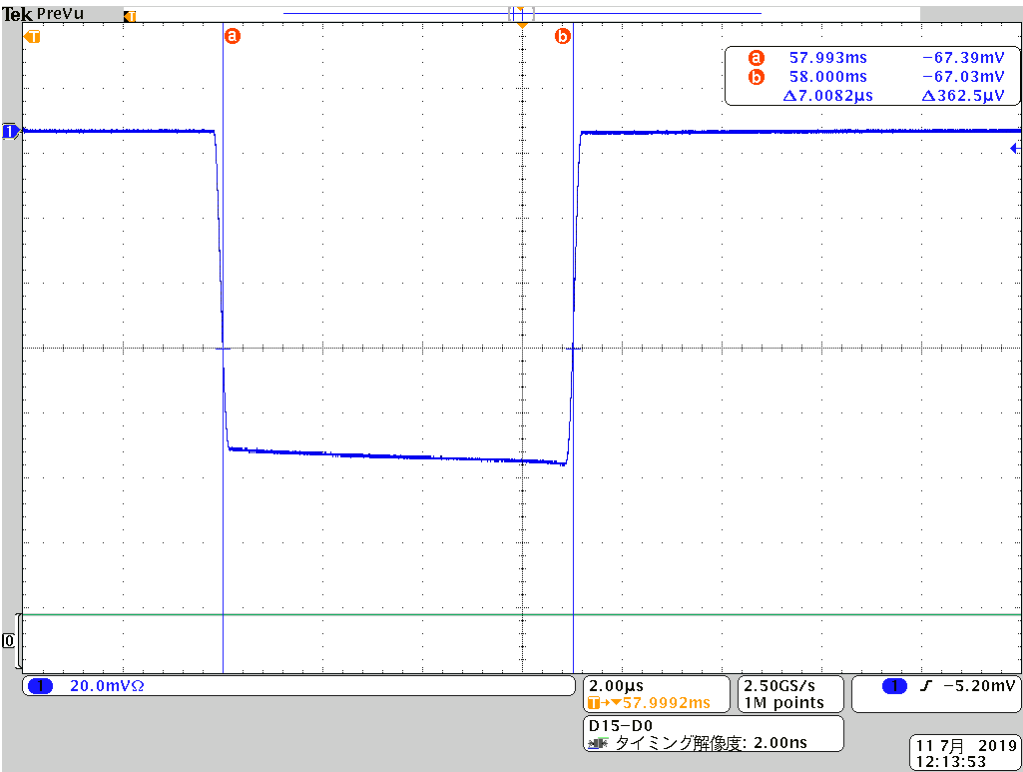


Fig. 6.56 ch1, Q0N, S2 pulse envelope

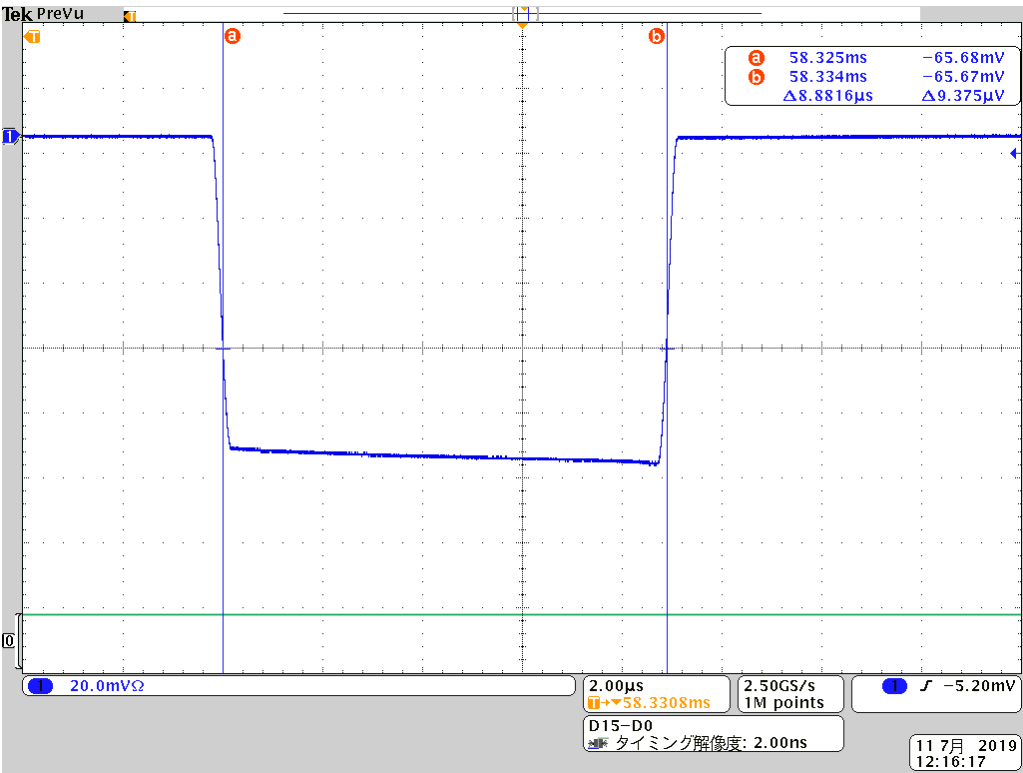


Fig. 6.57 ch1, Q0N, M1 pulse envelope

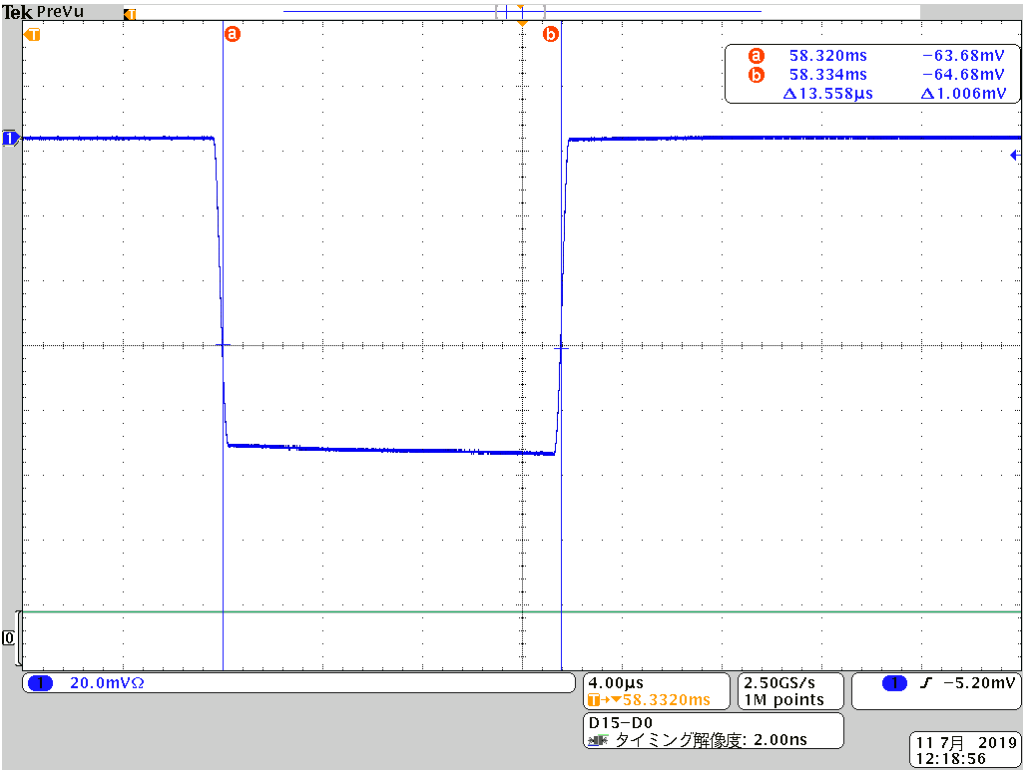


Fig. 6.58 ch1, Q0N, M2 pulse envelope

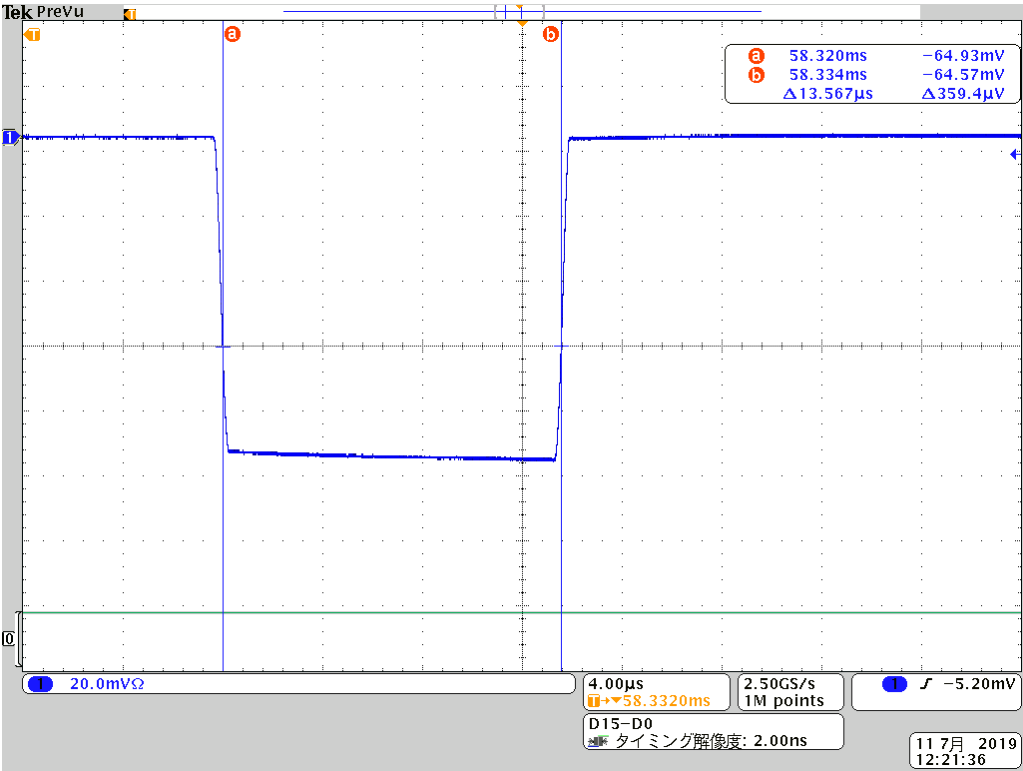


Fig. 6.59 ch1, Q0N, M3 pulse envelope

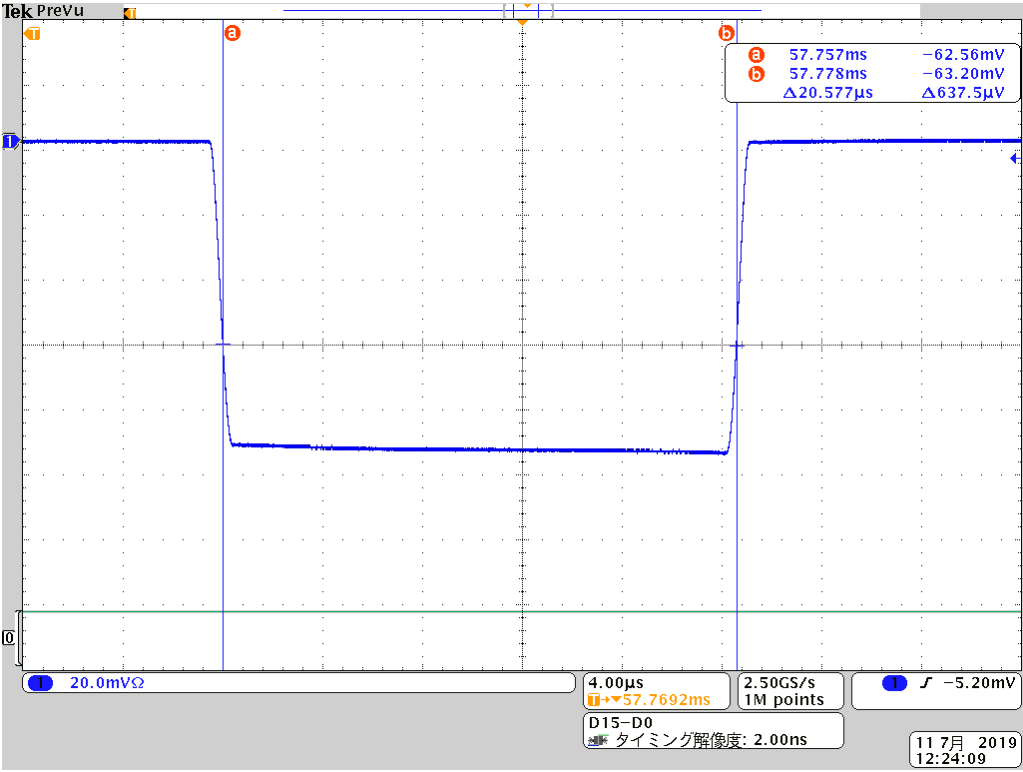


Fig. 6.60 ch1, Q0N, L pulse envelope

ch2, P0N

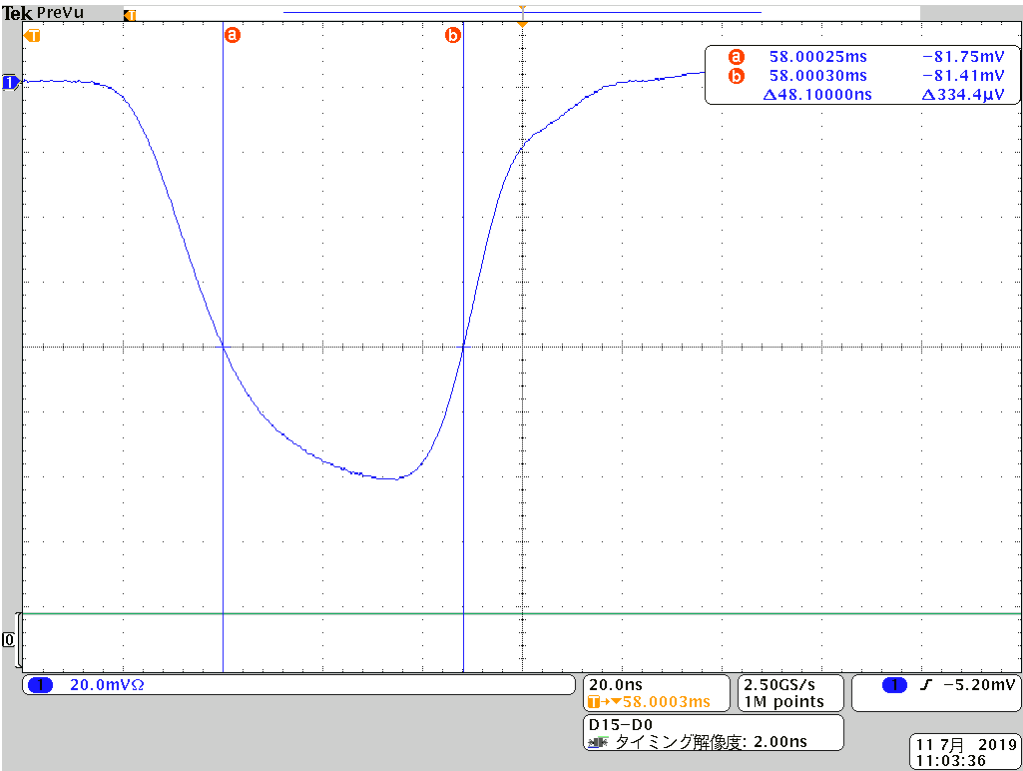


Fig. 6.61 ch2, P0N, S1 pulse envelope

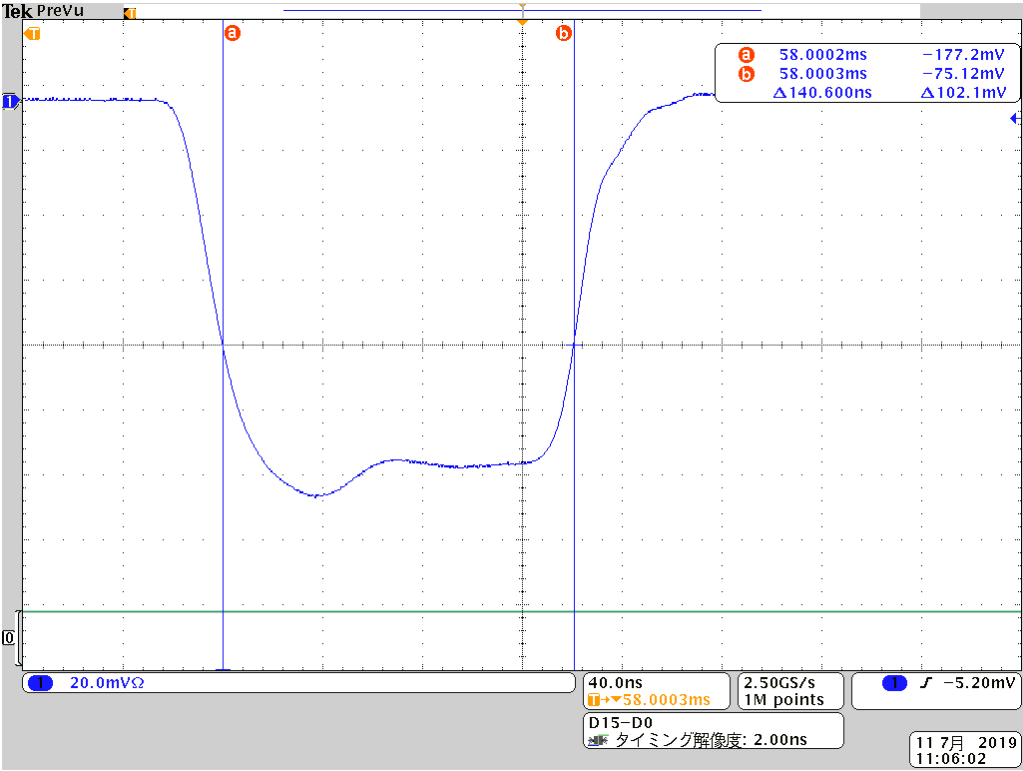


Fig. 6.62 ch2, P0N, S2 pulse envelope



Fig. 6.63 ch2, P0N, M1 pulse envelope

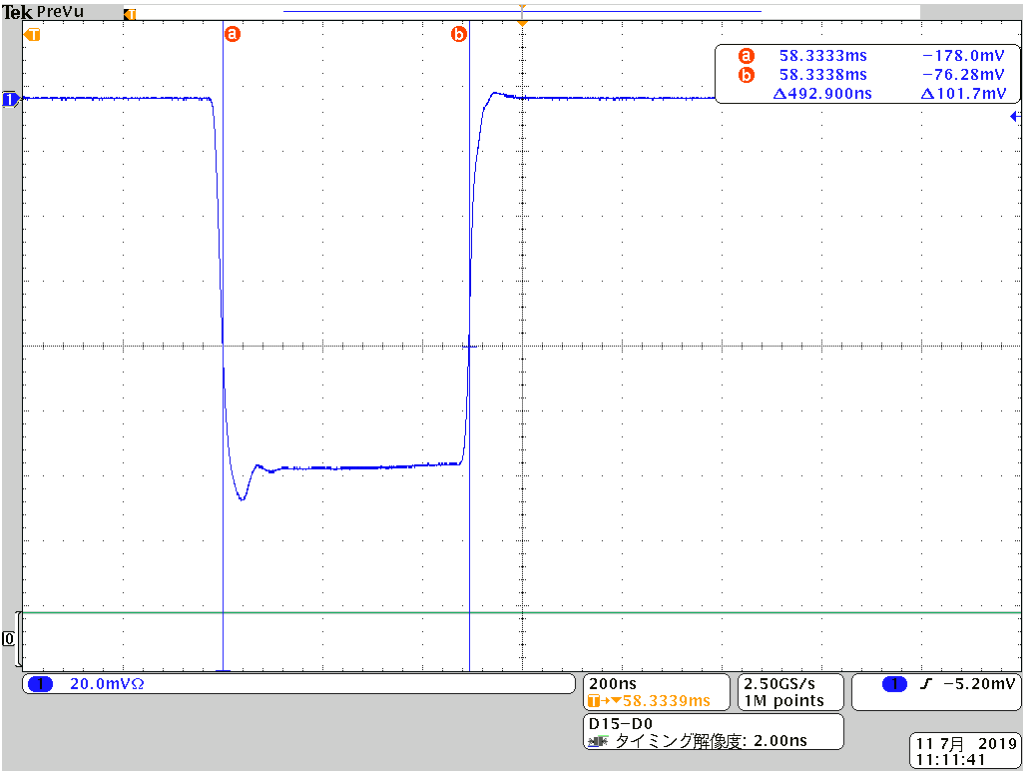


Fig. 6.64 ch2, P0N, M2 pulse envelope



Fig. 6.65 ch2, P0N, M3 pulse envelope

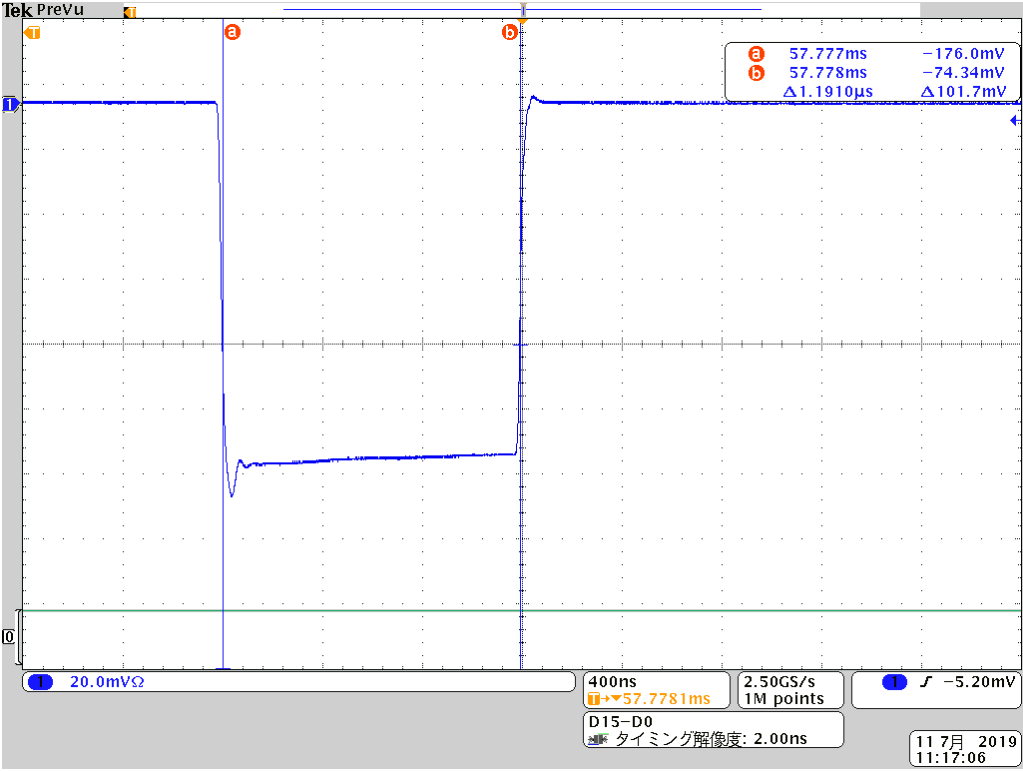


Fig. 6.66 ch2, P0N, L pulse envelope

ch2, Q0N

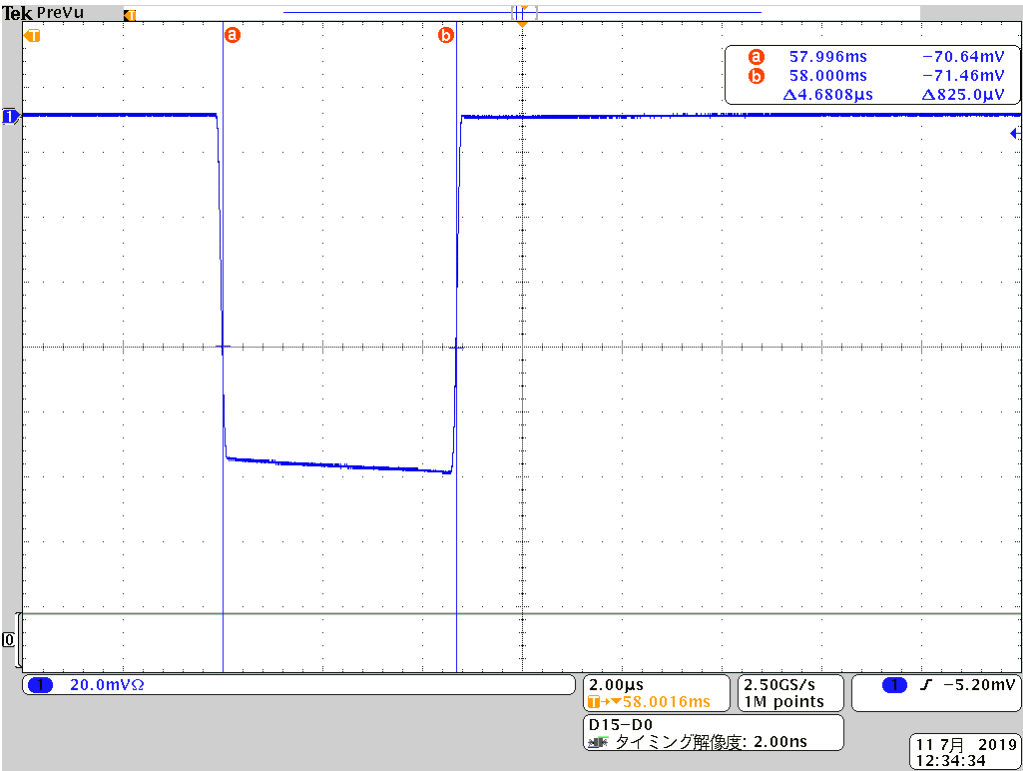


Fig. 6.67 ch2, Q0N, S1 pulse envelope

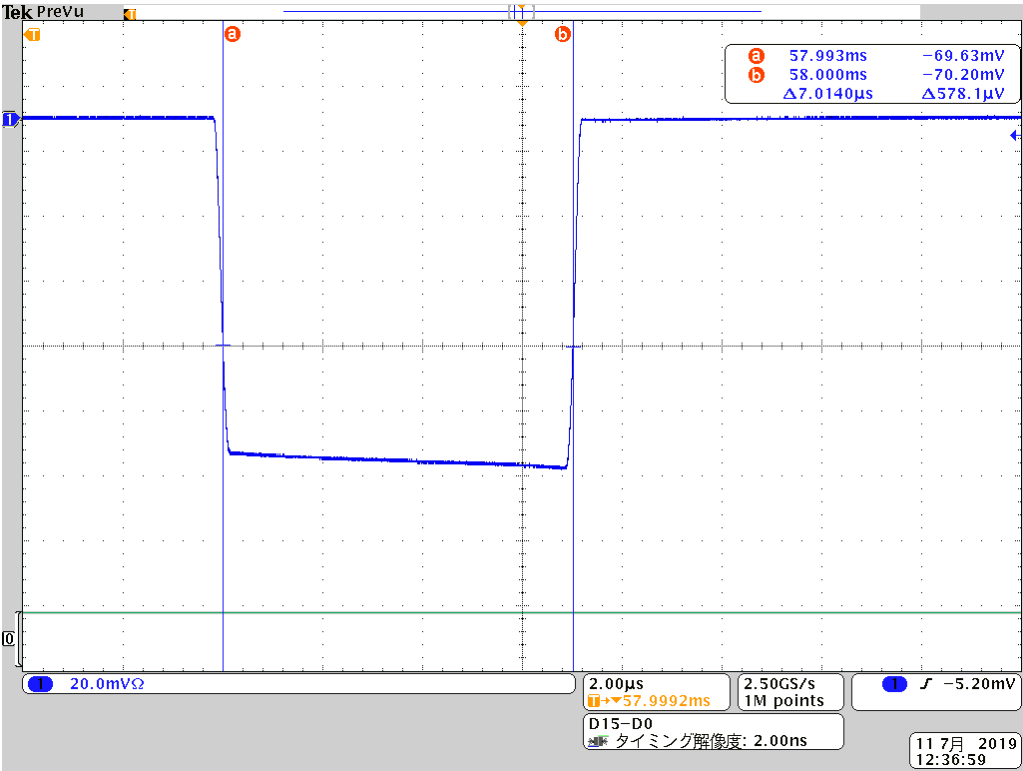


Fig. 6.68 ch2, Q0N, S2 pulse envelope

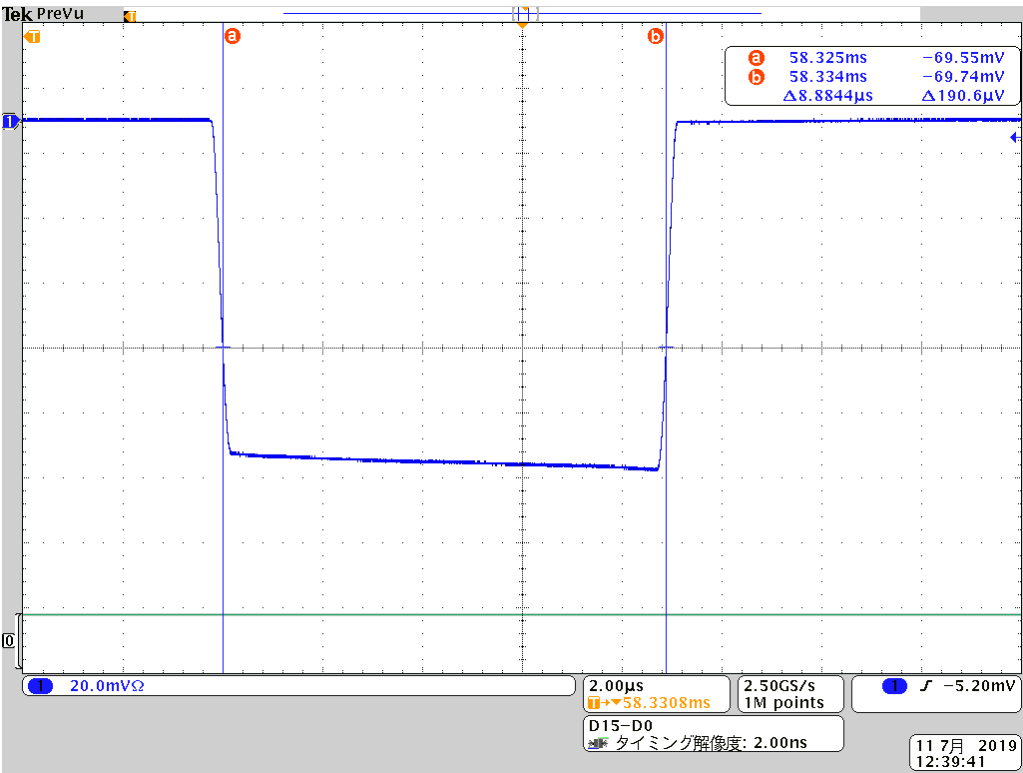


Fig. 6.69 ch2, Q0N, M1 pulse envelope

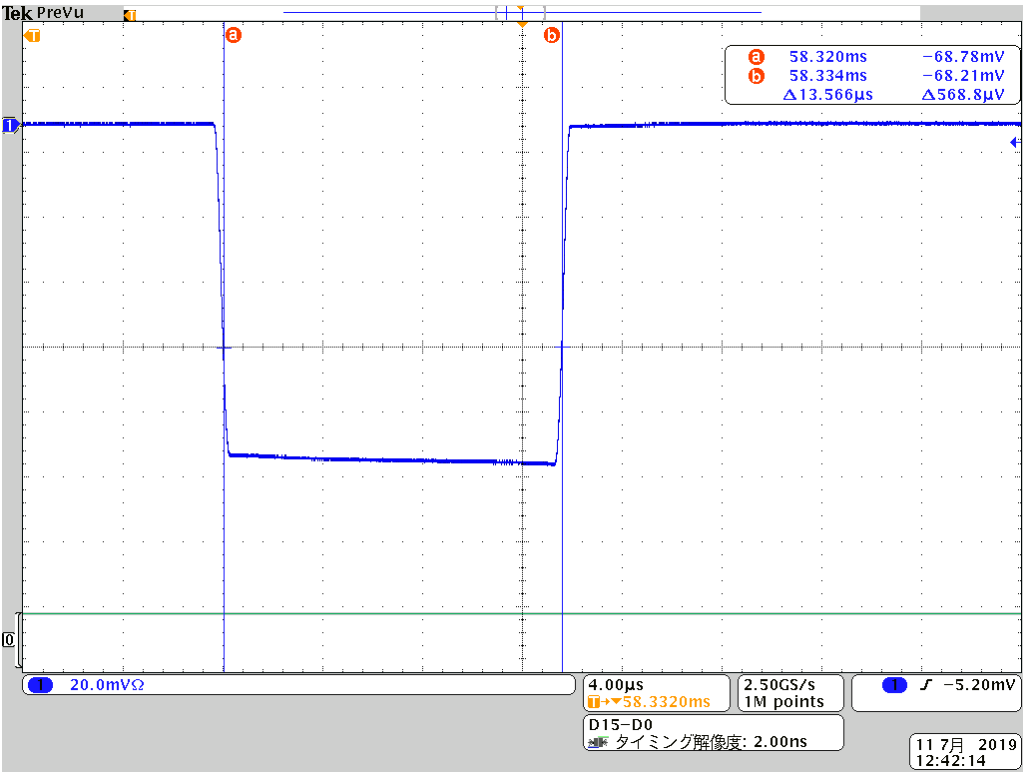


Fig. 6.70 ch2, Q0N, M2 pulse envelope

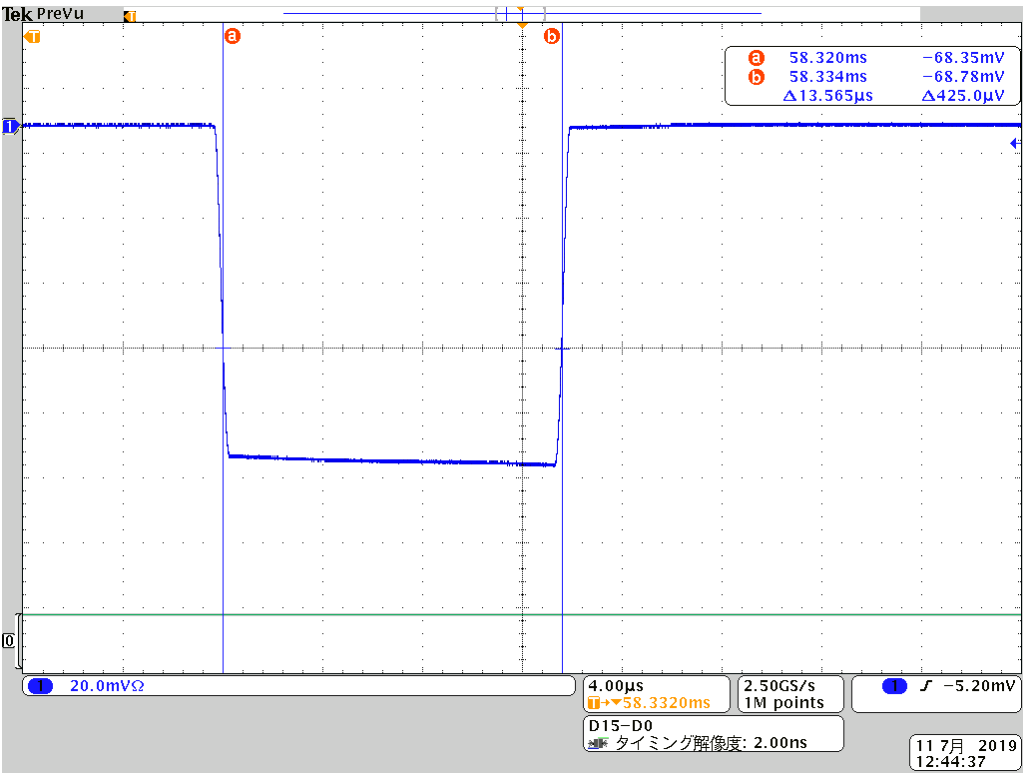


Fig. 6.71 ch2, Q0N, M3 pulse envelope

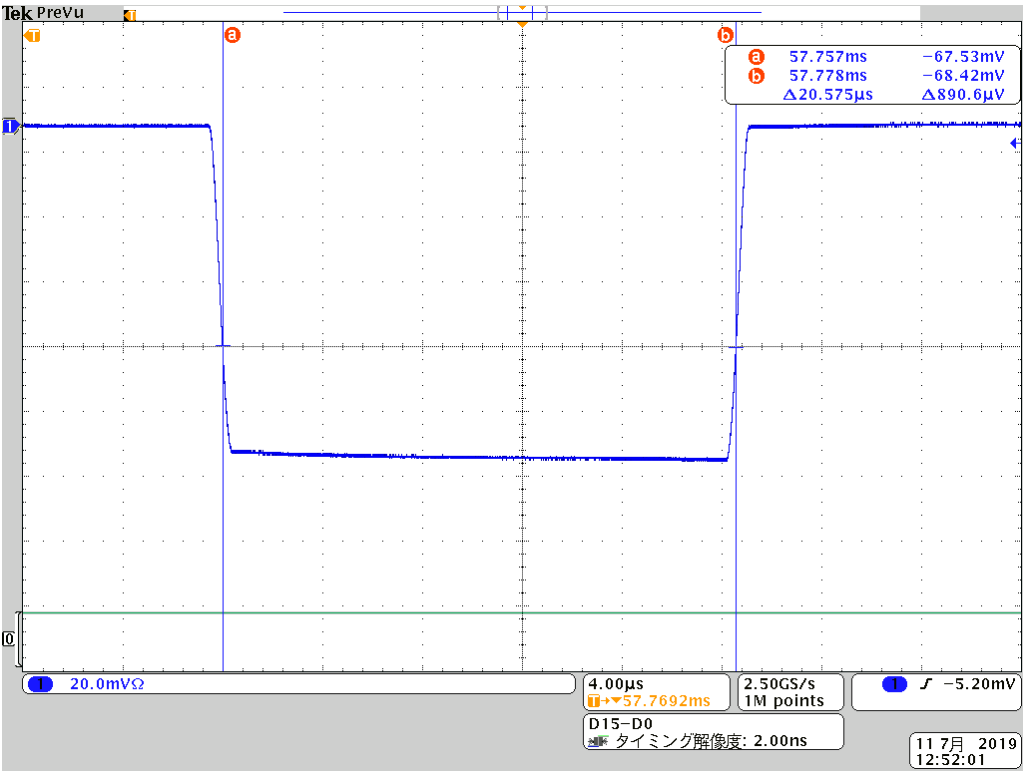


Fig. 6.72 ch2, Q0N, L pulse envelope

7 Spurious Emission Plots measured at Antenna Terminal

TT24NM mode

ch1, P0N

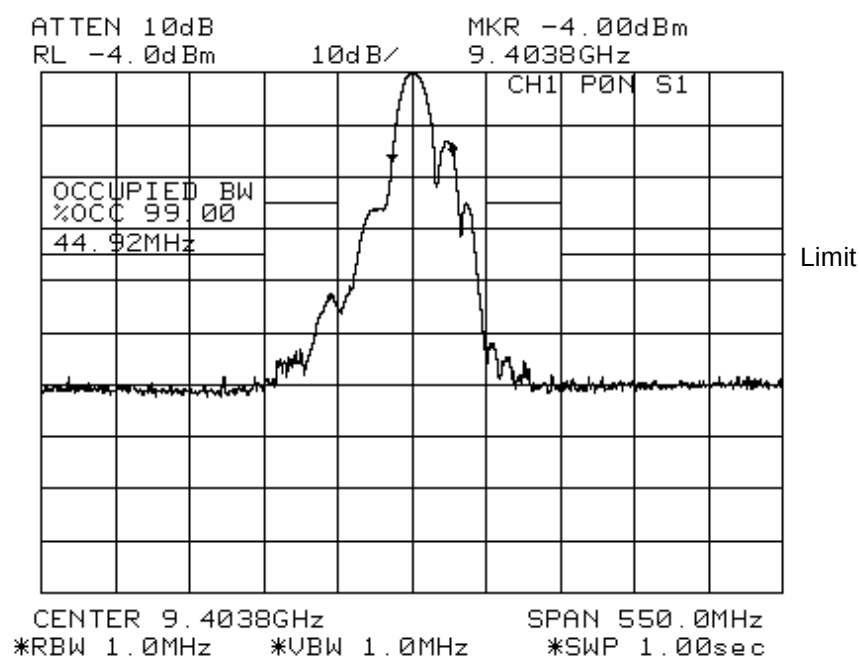


Fig. 7.1 ch1, P0N, S1 pulse

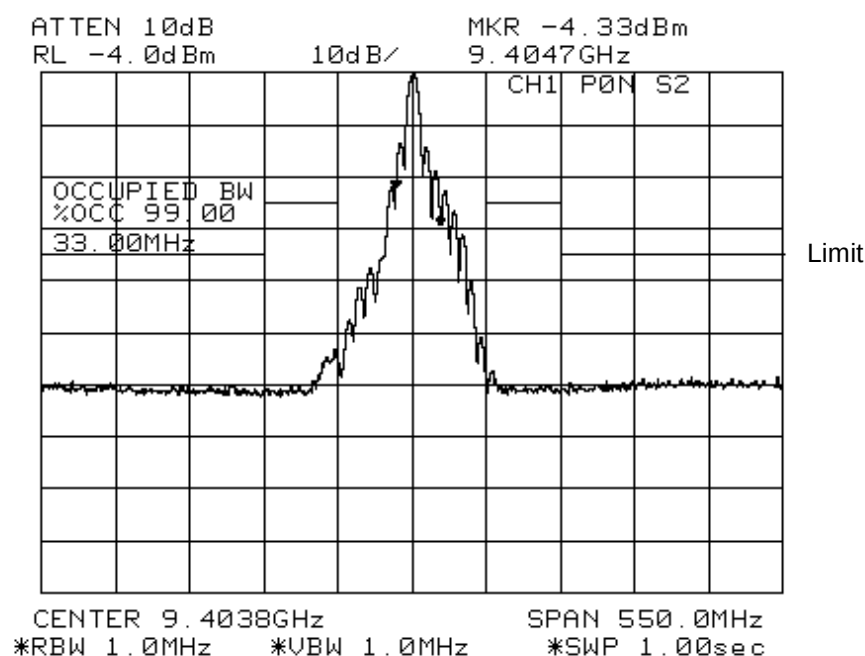


Fig. 7.2 ch1, P0N, S2 pulse

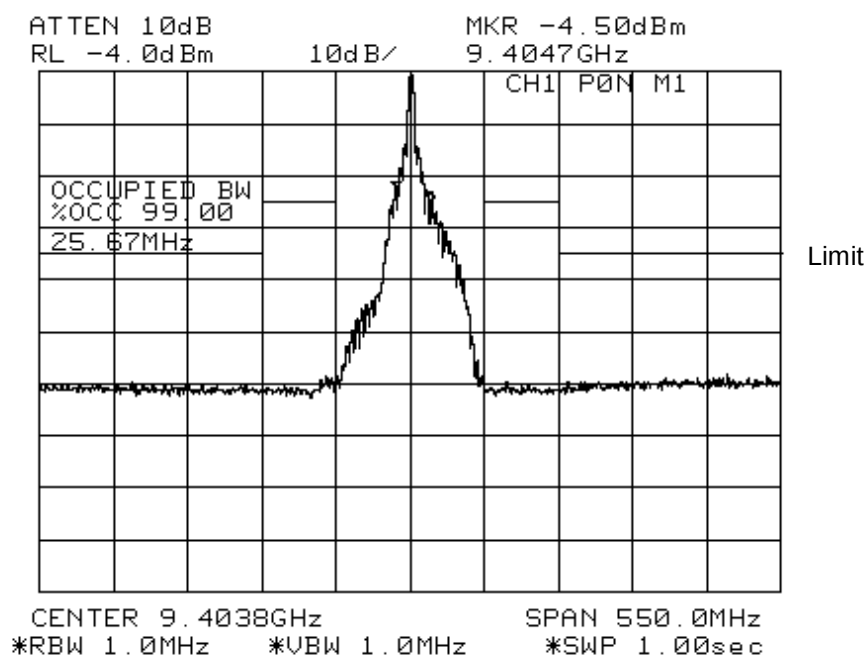


Fig. 7.3 ch1, P0N, M1 pulse

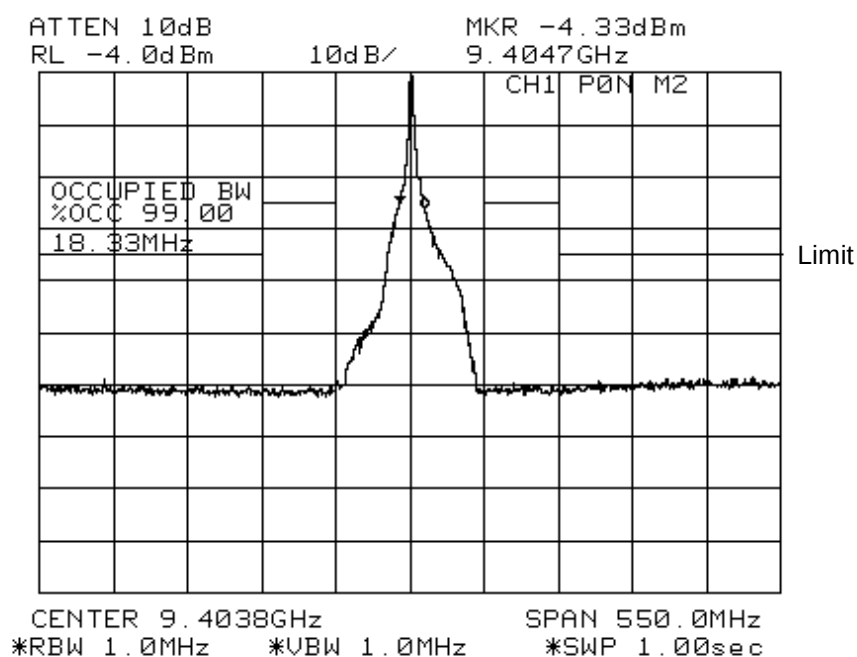


Fig. 7.4 ch1, P0N, M2 pulse

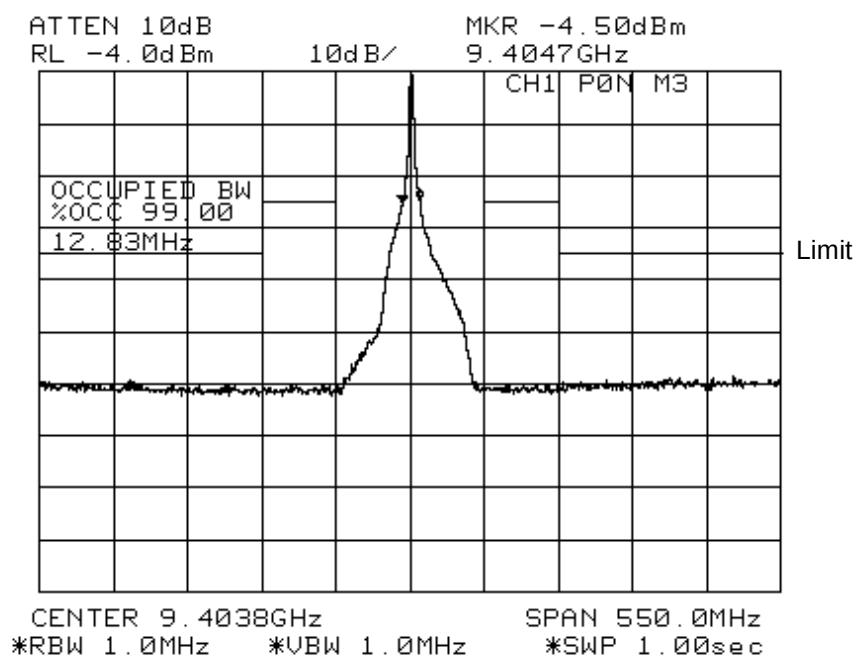


Fig. 7.5 ch1, P0N, M3 pulse

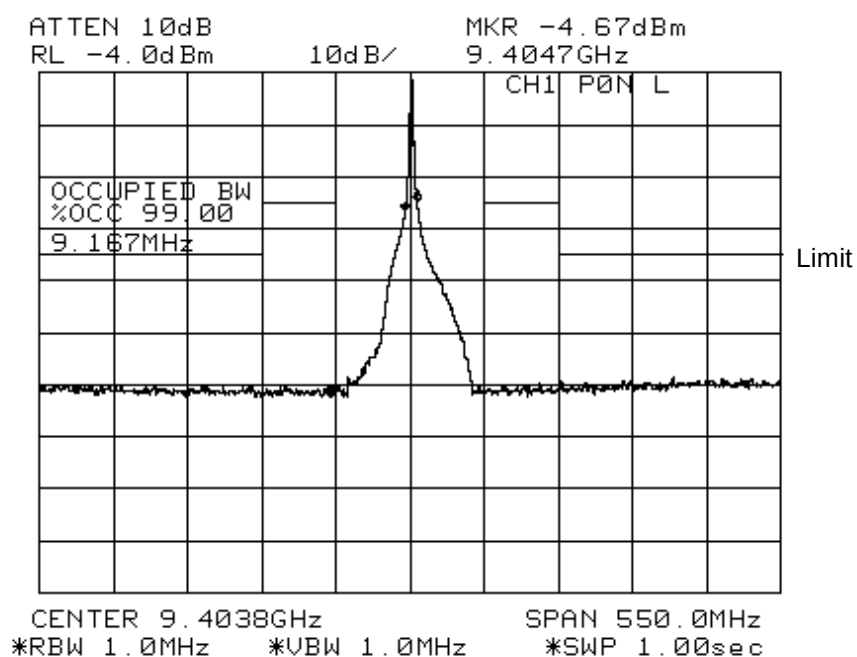


Fig. 7.6 ch1, P0N, L pulse

ch1, Q0N

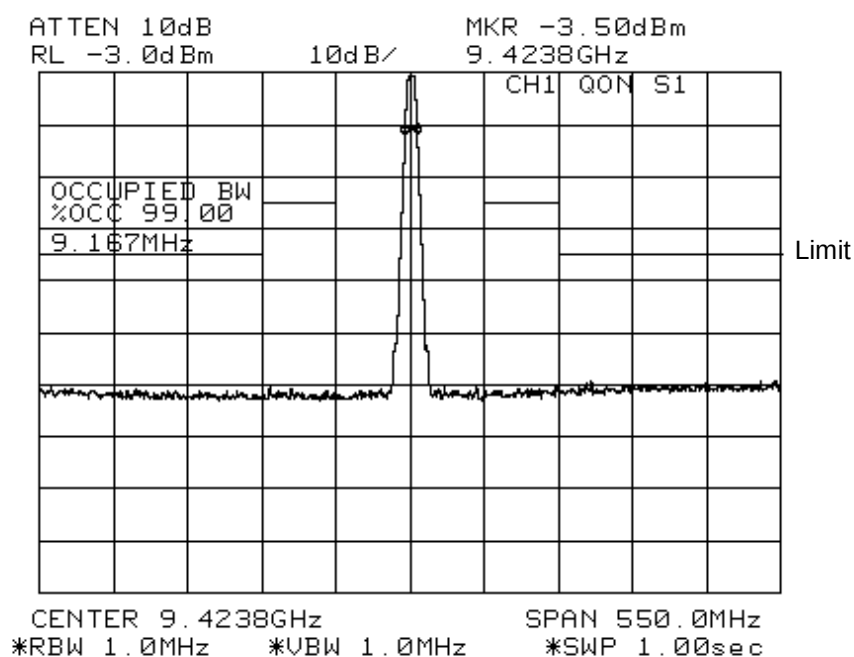


Fig. 7.7 ch1, Q0N, S1 pulse

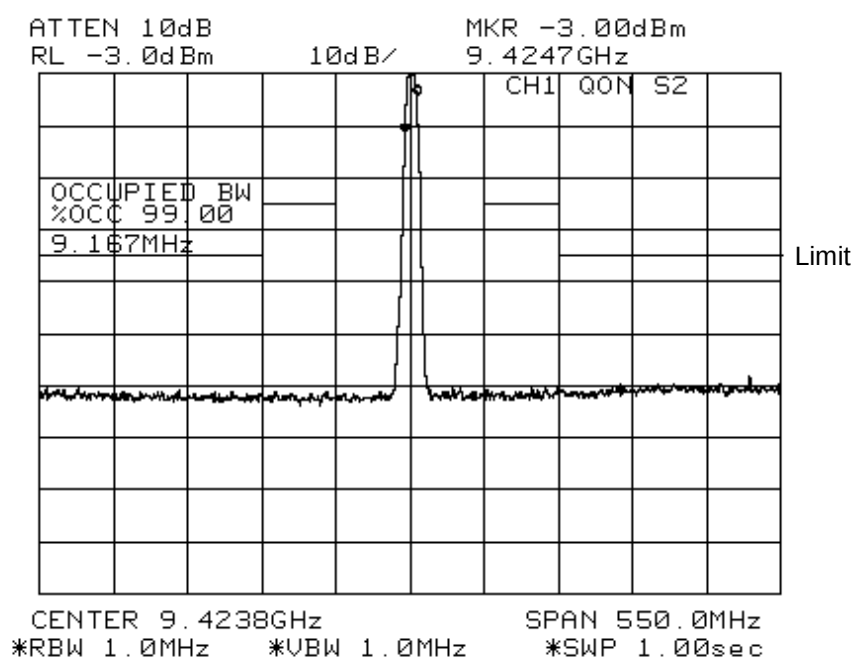


Fig. 7.8 ch1, Q0N, S2 pulse

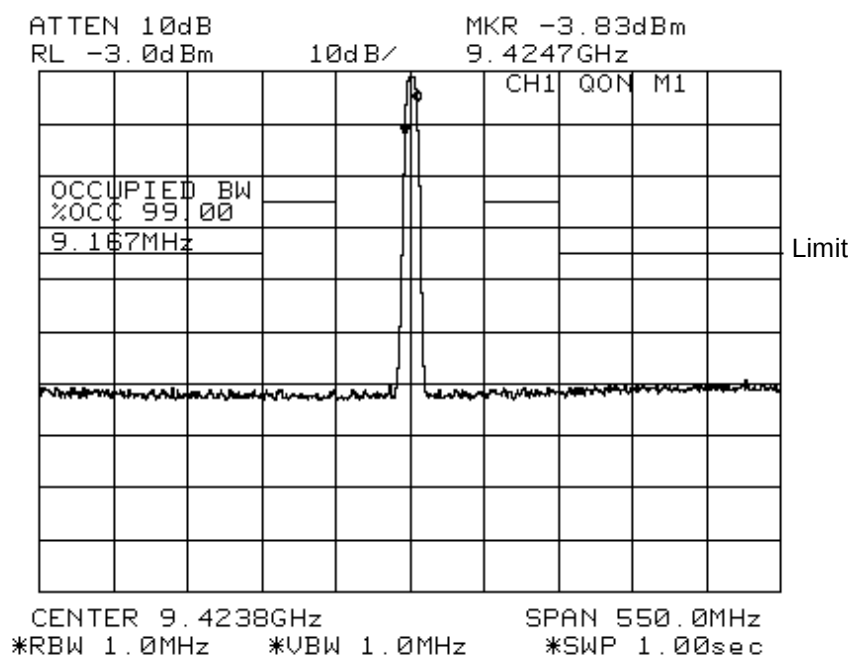


Fig. 7.9 ch1, QON, M1 pulse

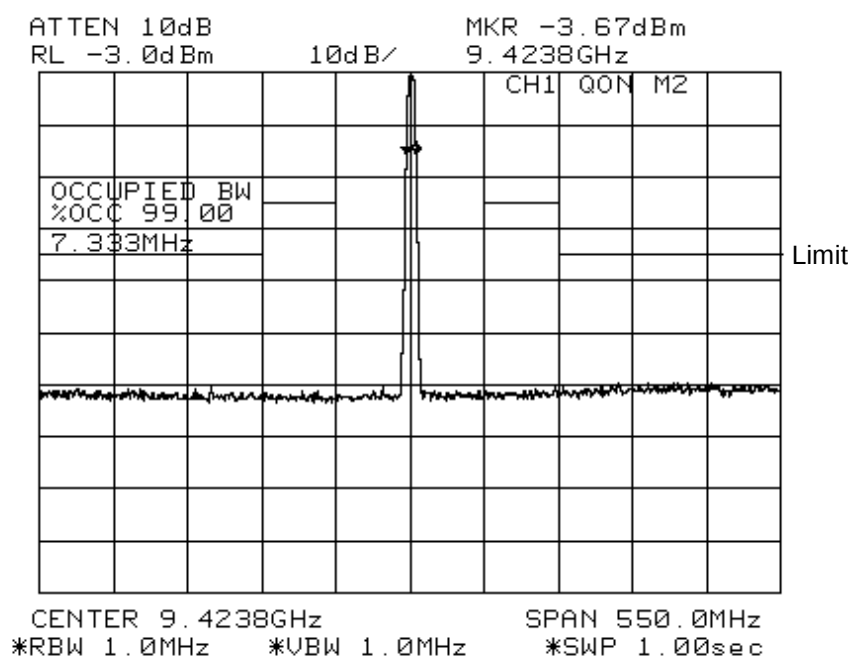


Fig. 7.10 ch1, QON, M2 pulse

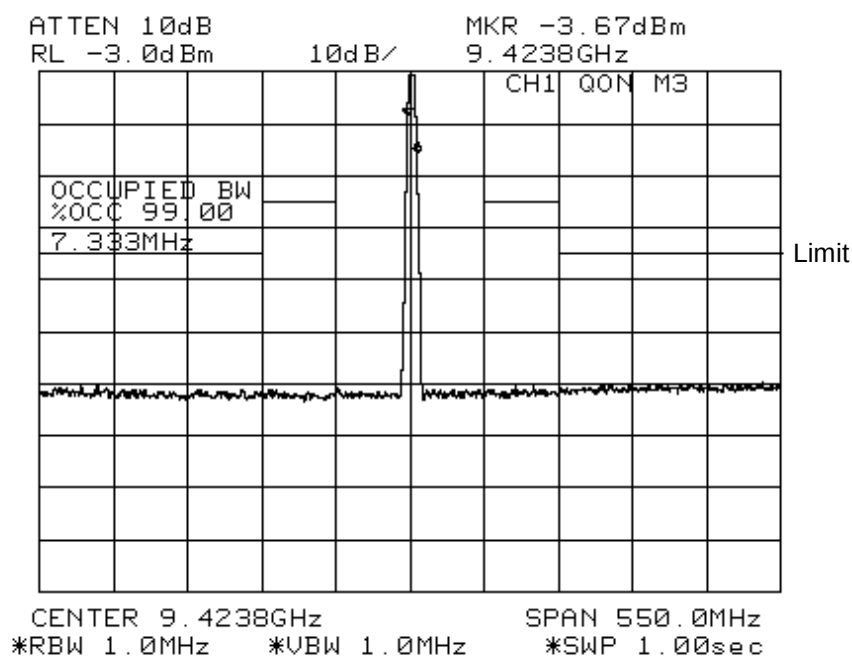


Fig. 7.11 ch1, QON, M3 pulse

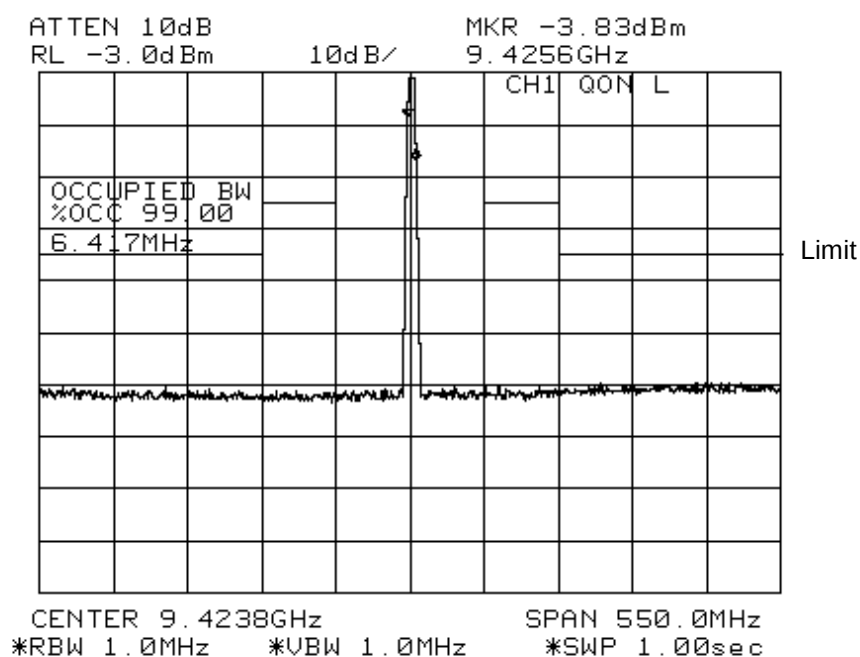


Fig. 7.12 ch1, QON, L pulse

ch2, P0N

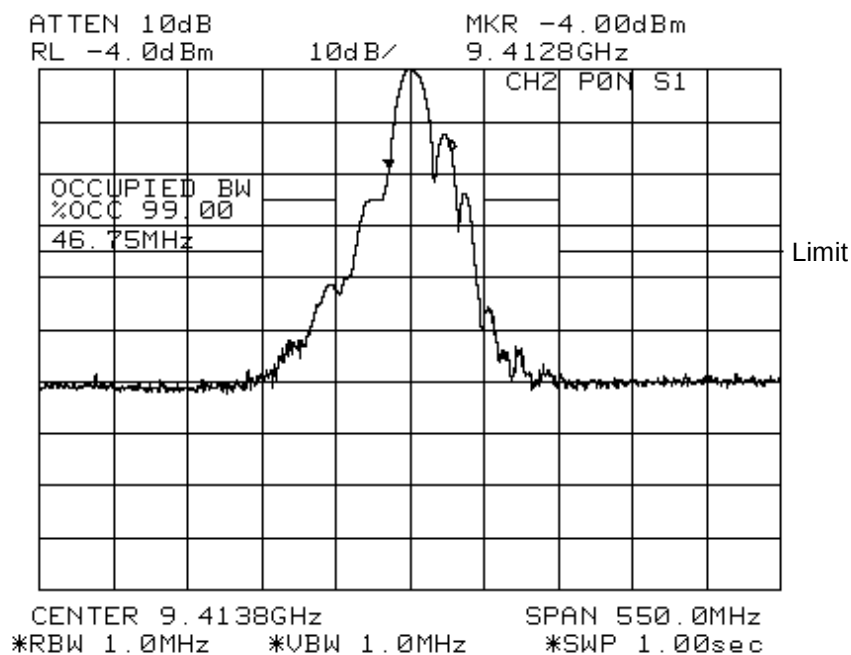


Fig. 7.13 ch2, P0N, S1 pulse

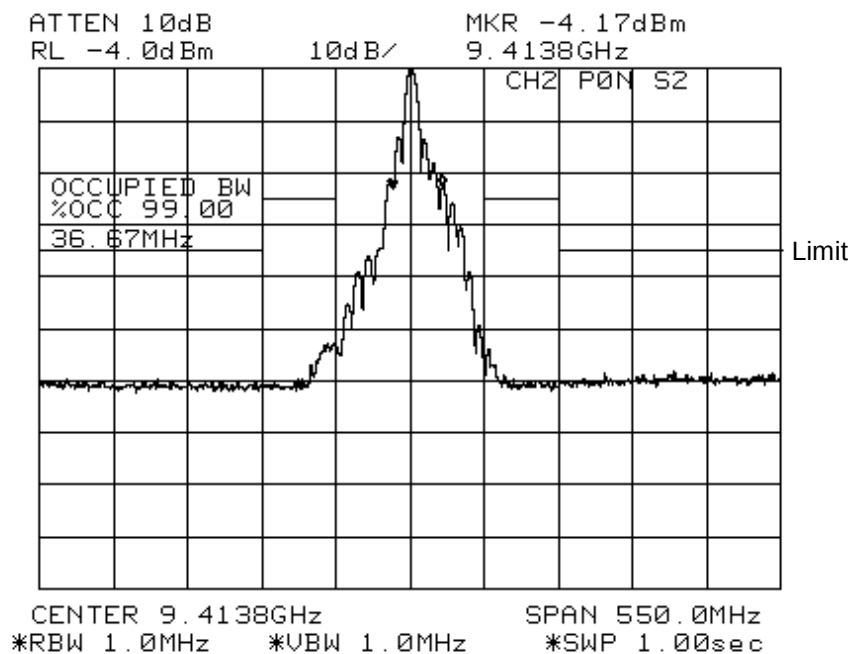


Fig. 7.14 ch2, P0N, S2 pulse

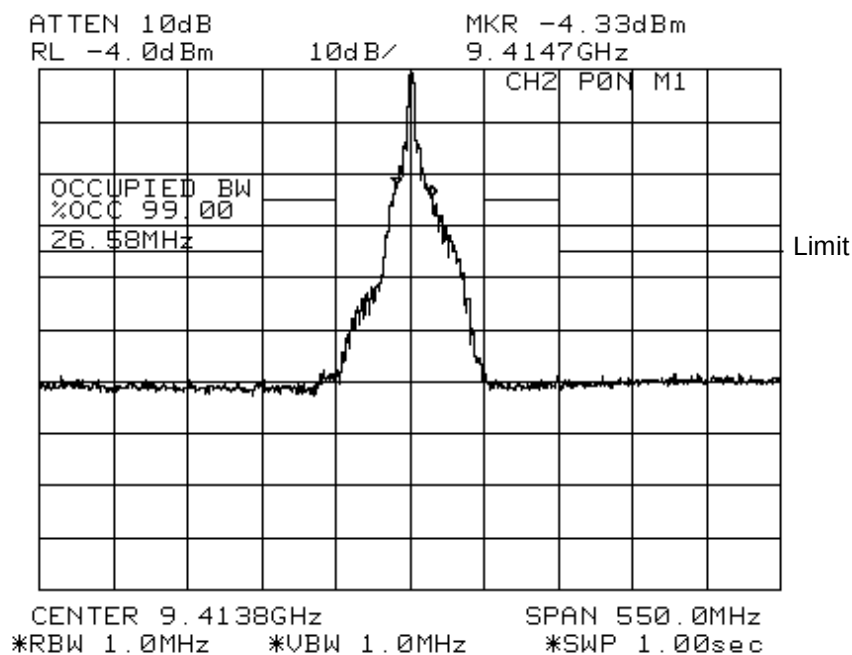


Fig. 7.15 ch2, P0N, M1 pulse

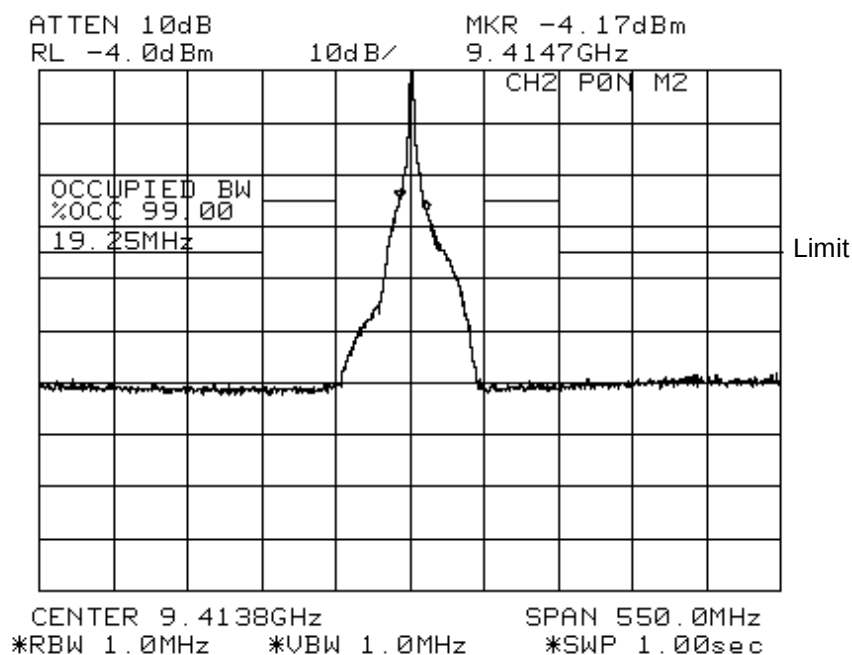


Fig. 7.16 ch2, P0N, M2 pulse

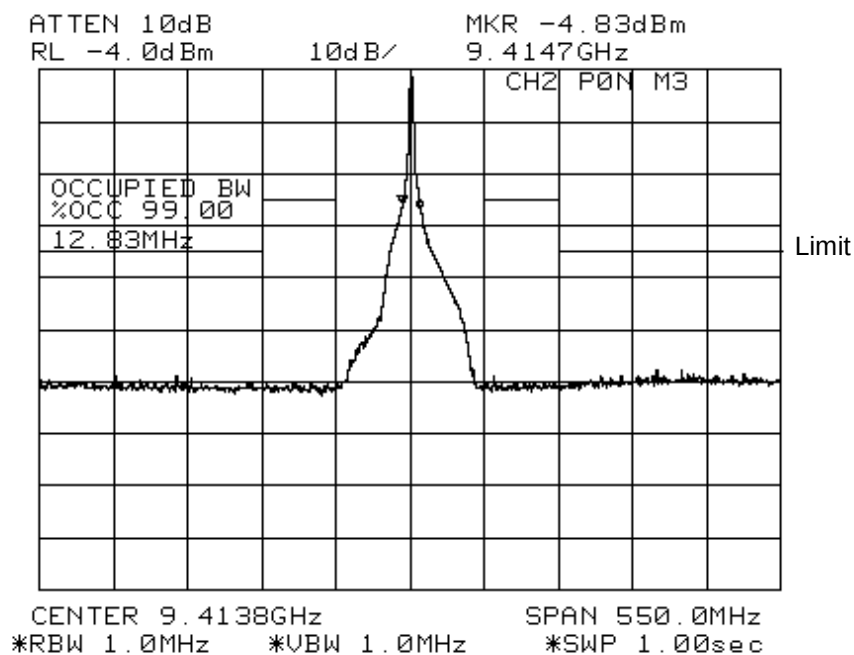


Fig. 7.17 ch2, P0N, M3 pulse

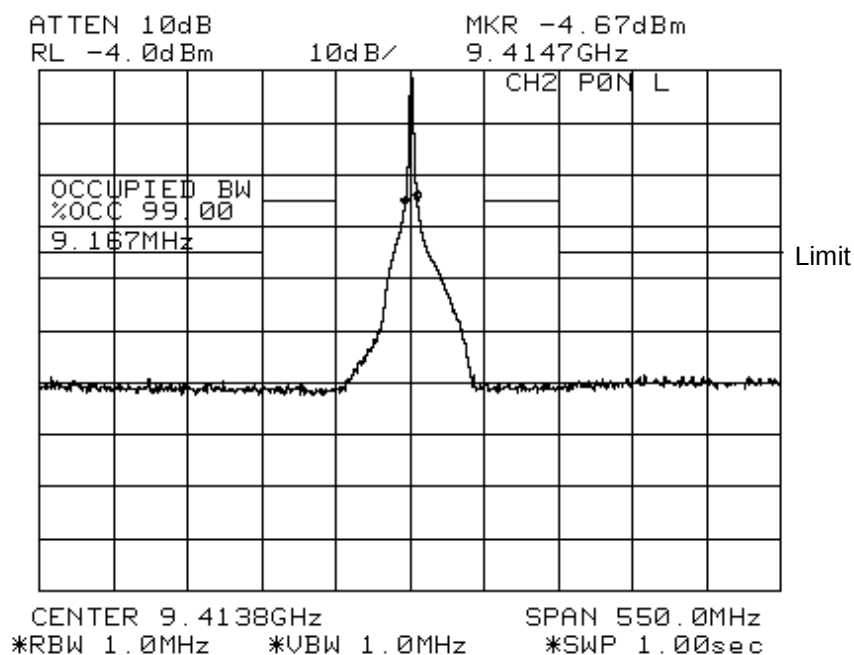


Fig. 7.18 ch2, P0N, L pulse

ch2, Q0N

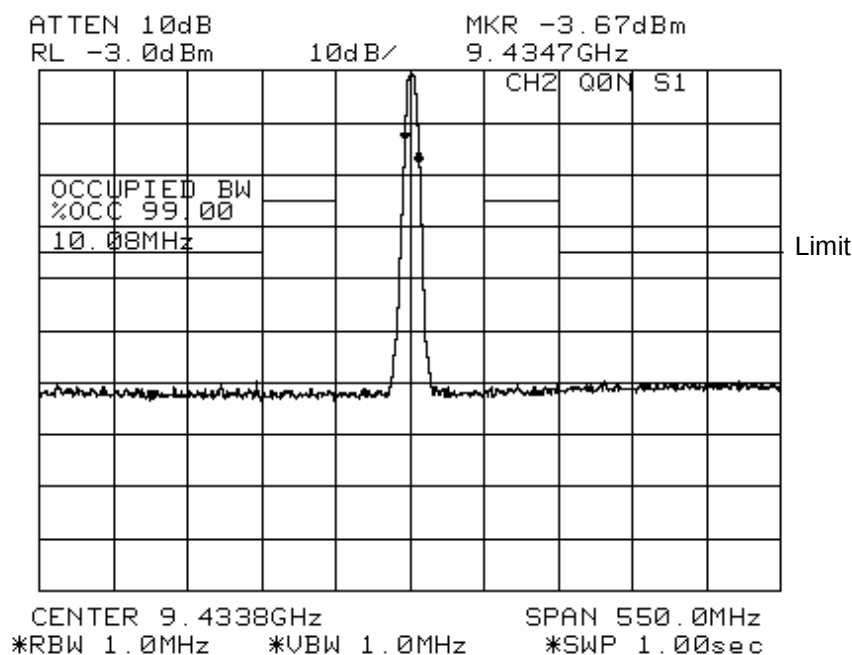


Fig. 7.19 ch2, Q0N, S1 pulse

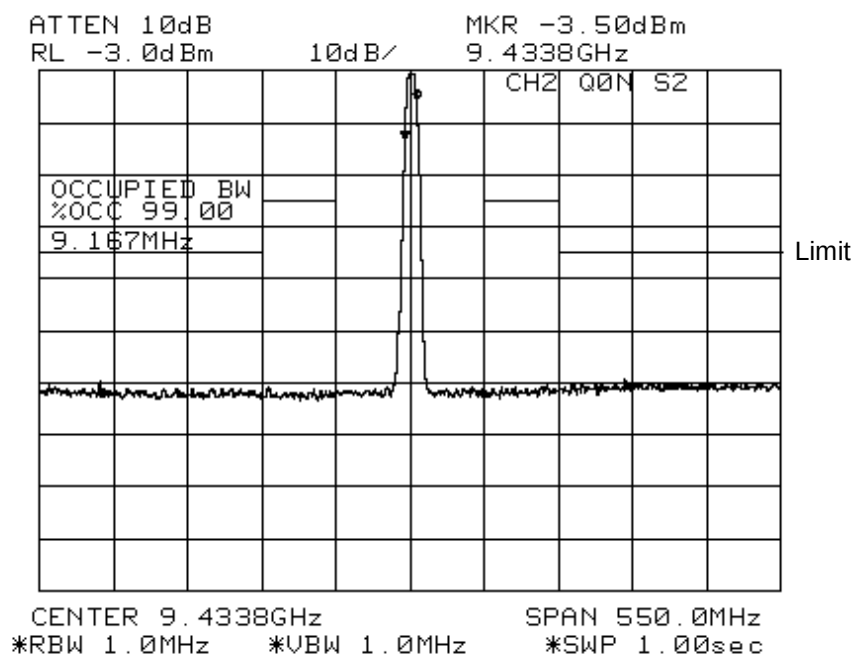


Fig. 7.20 ch2, Q0N, S2 pulse

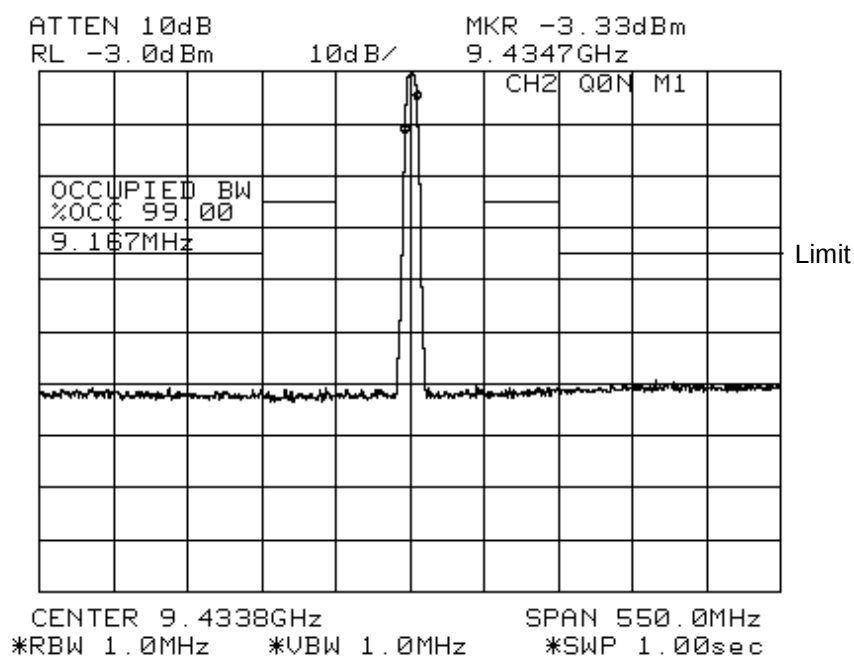


Fig. 7.21 ch2, Q0N, M1 pulse

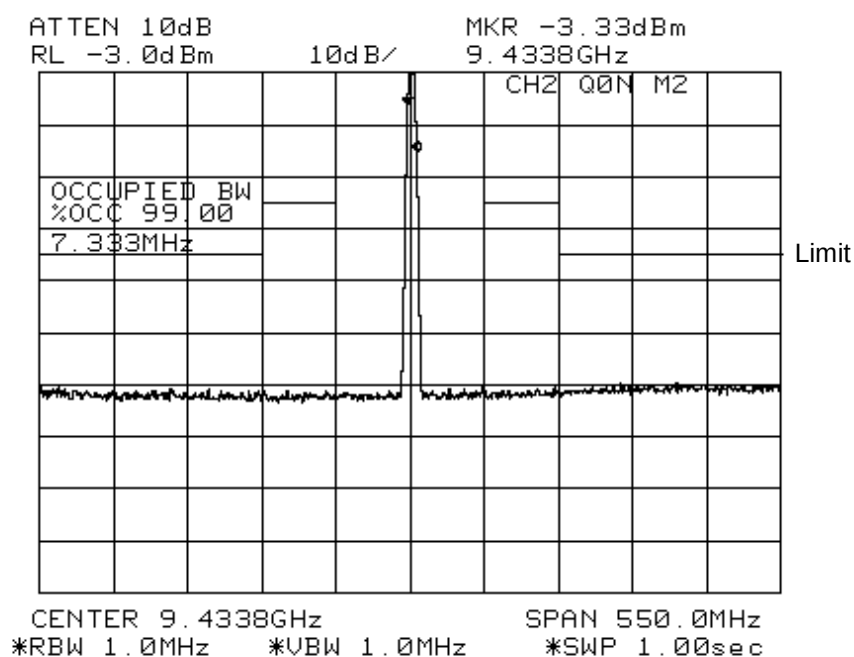


Fig. 7.22 ch2, Q0N, M2 pulse

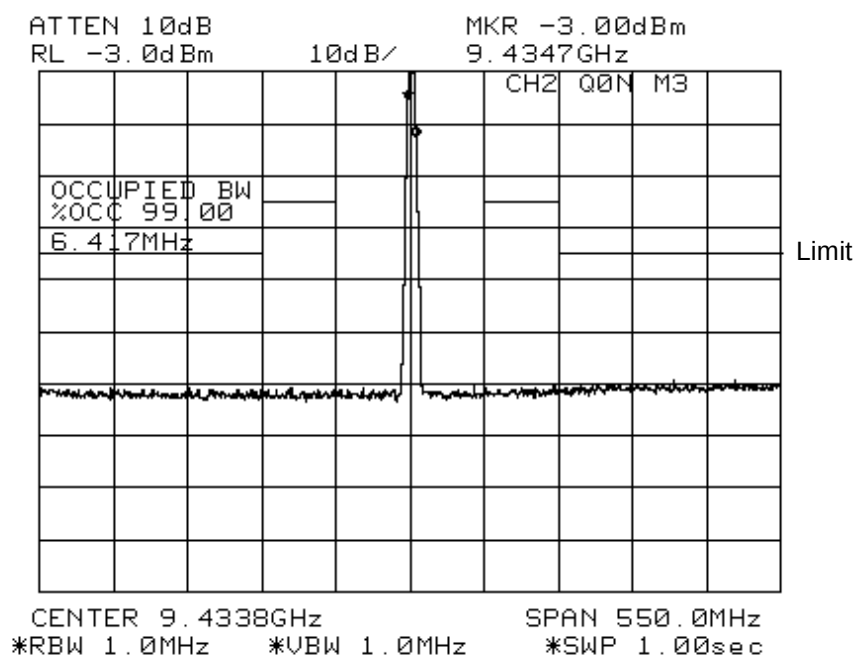


Fig. 7.23 ch2, Q0N, M3 pulse

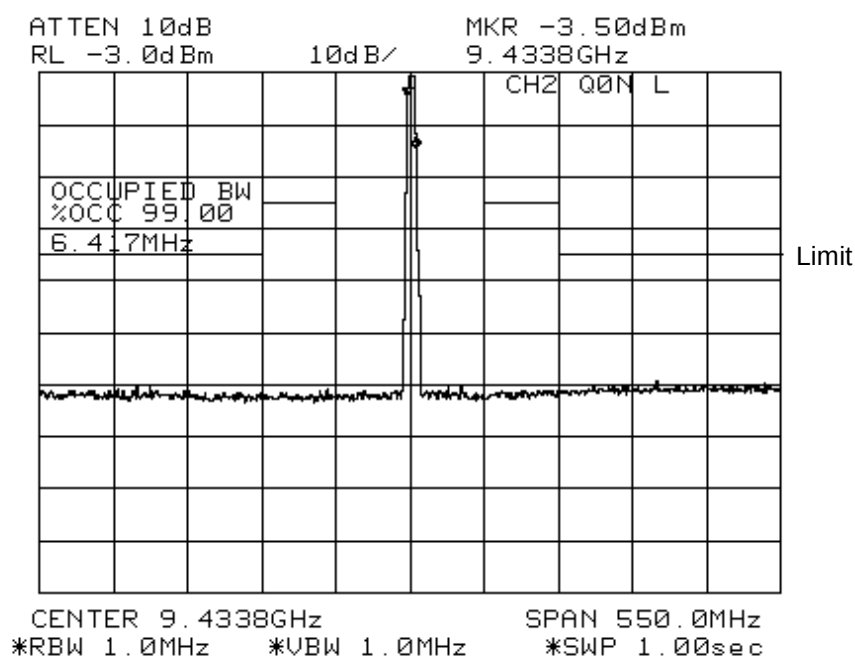


Fig. 7.24 ch2, Q0N, L pulse

TT32NM mode

ch1, P0N

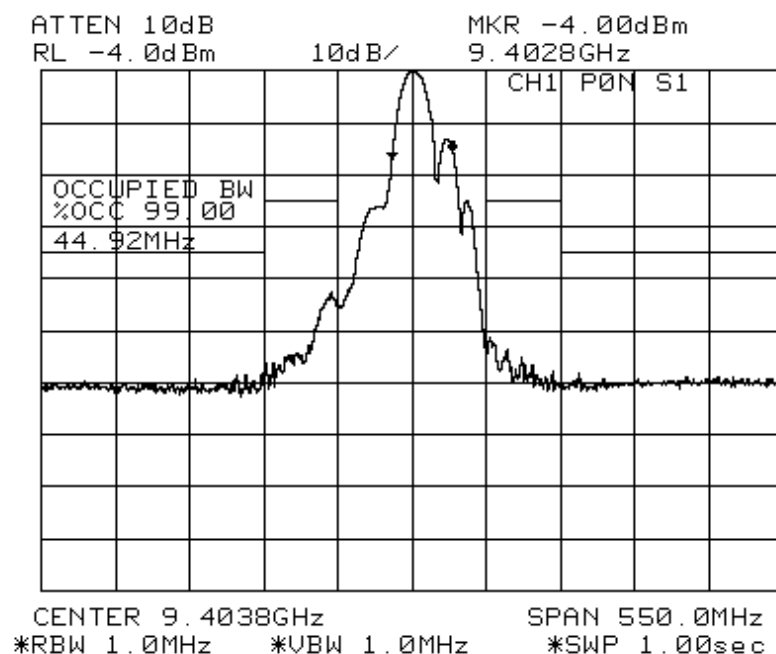


Fig. 7.25 ch1, P0N, S1 pulse

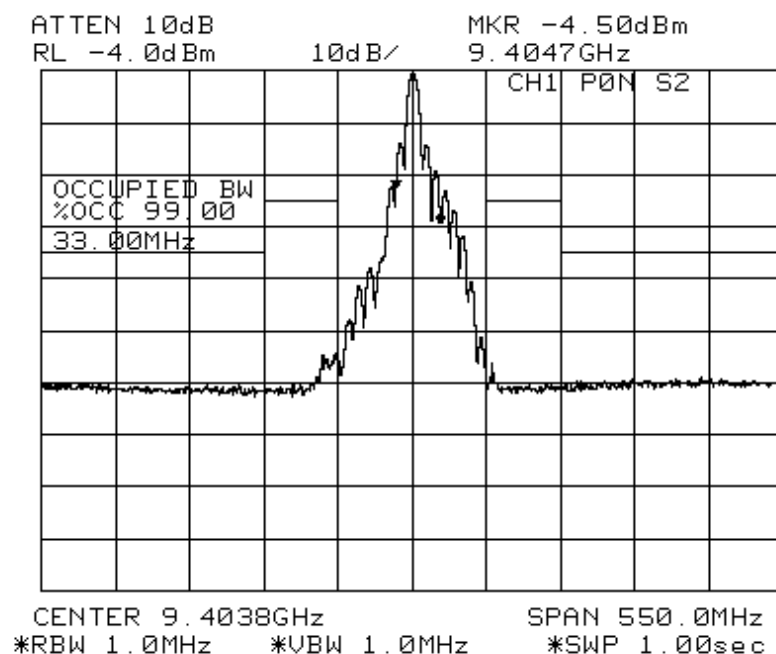


Fig. 7.26 ch1, P0N, S2 pulse

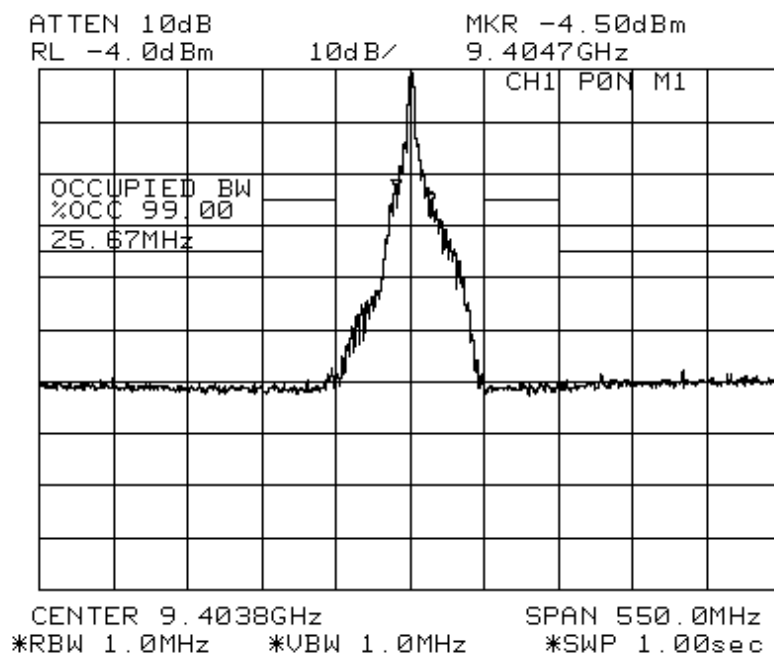


Fig. 7.27 ch1, P0N, M1 pulse

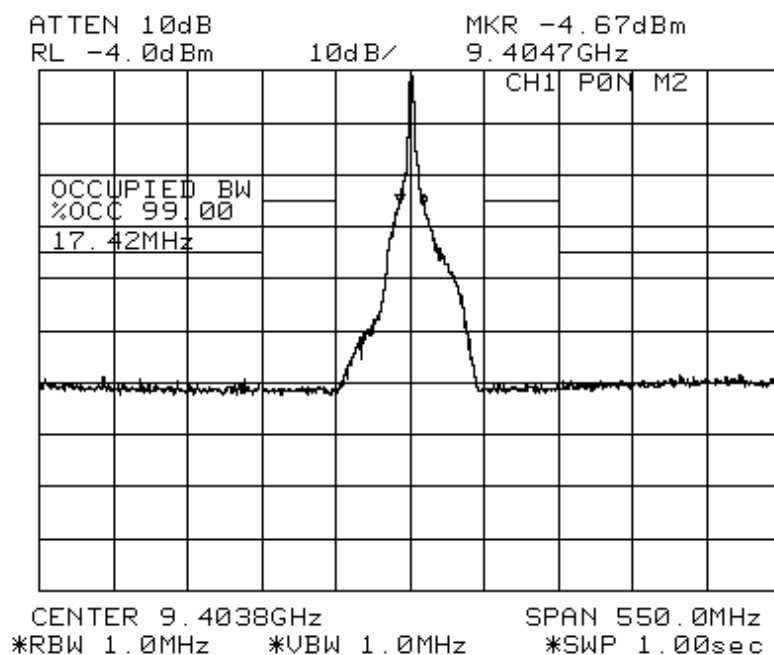


Fig. 7.28 ch1, P0N, M2 pulse

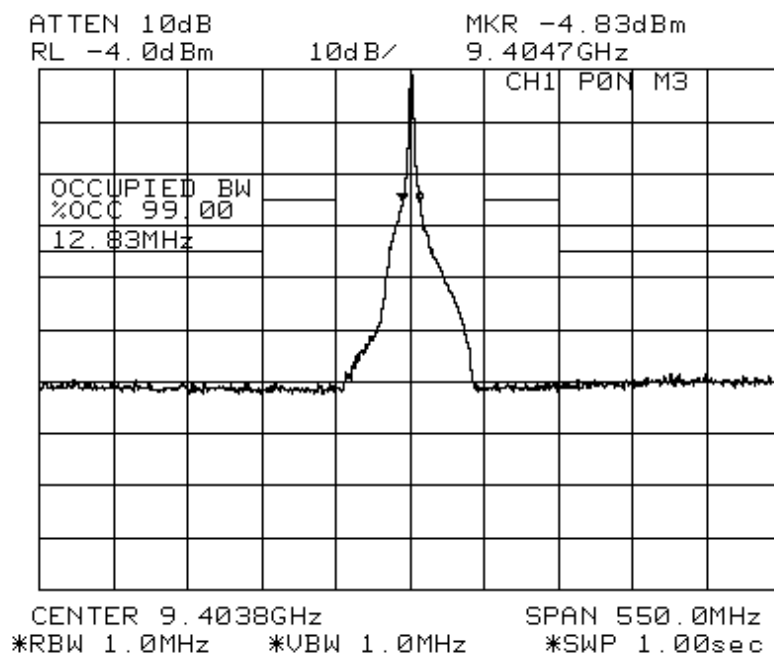


Fig. 7.29 ch1, P0N, M3 pulse

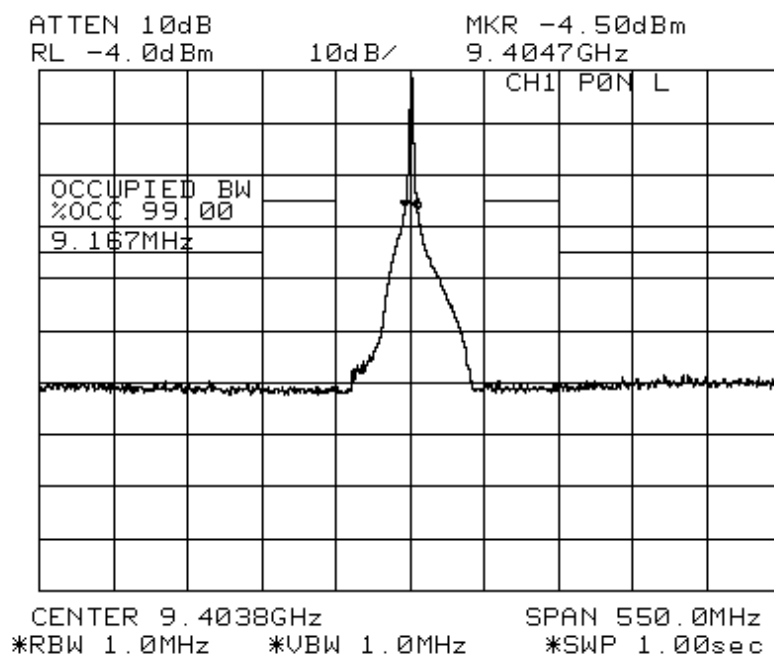


Fig. 7.30 ch1, P0N, L pulse

ch1, Q0N

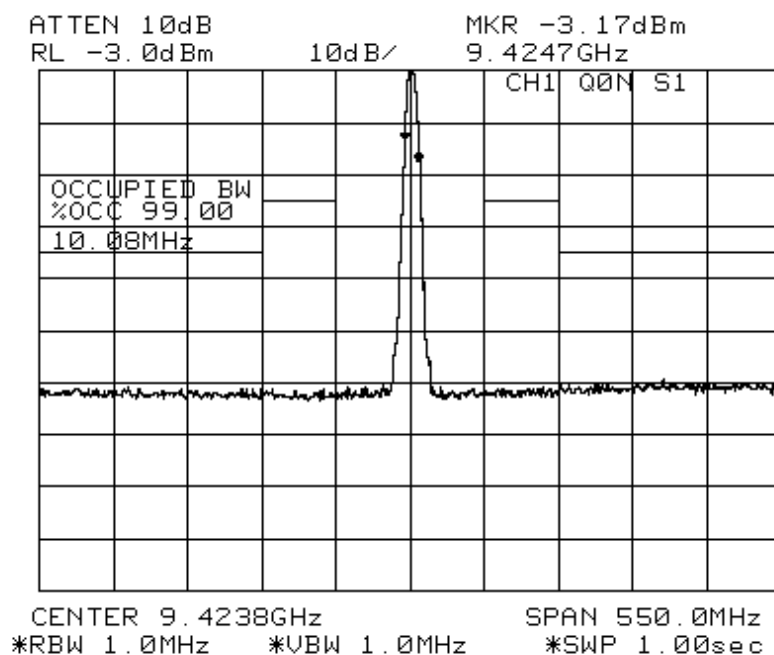


Fig. 7.31 ch1, Q0N, S1 pulse

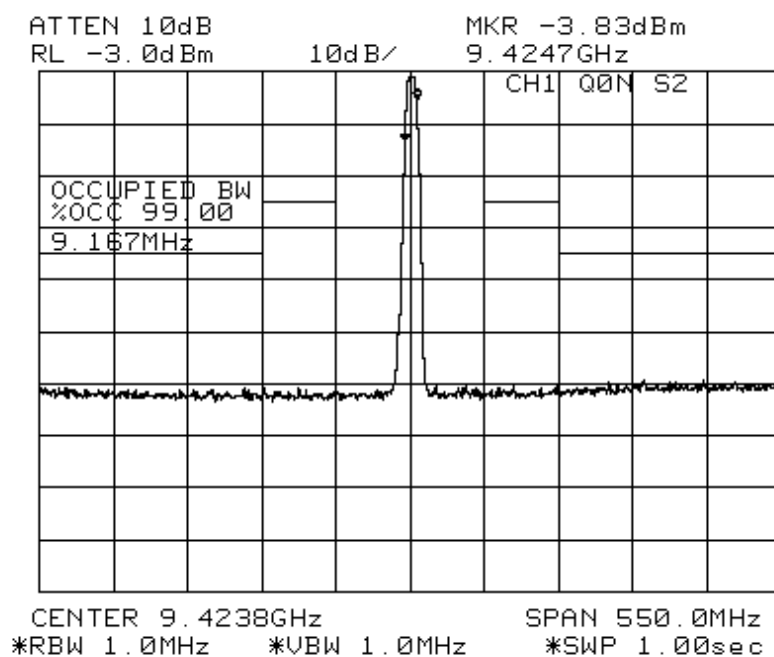


Fig. 7.32 ch1, Q0N, S2 pulse

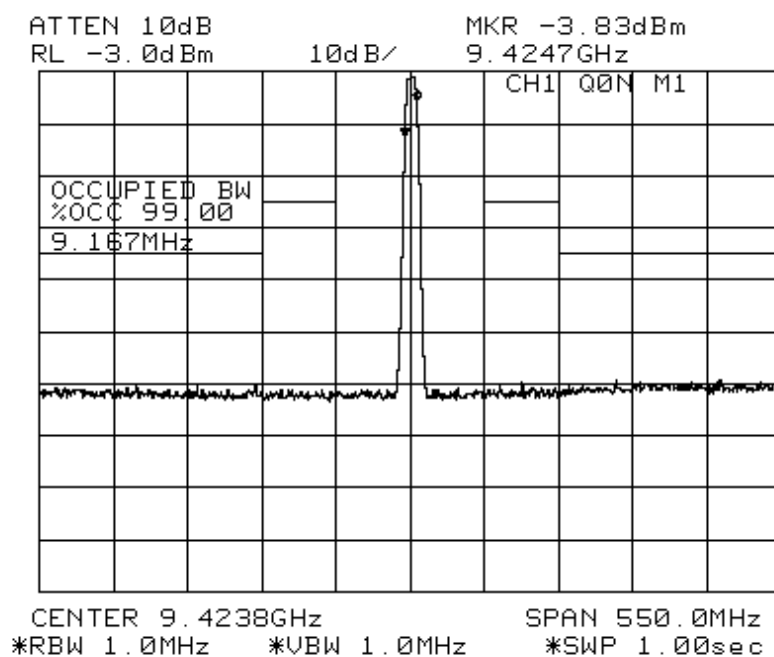


Fig. 7.33 ch1, Q0N, M1 pulse

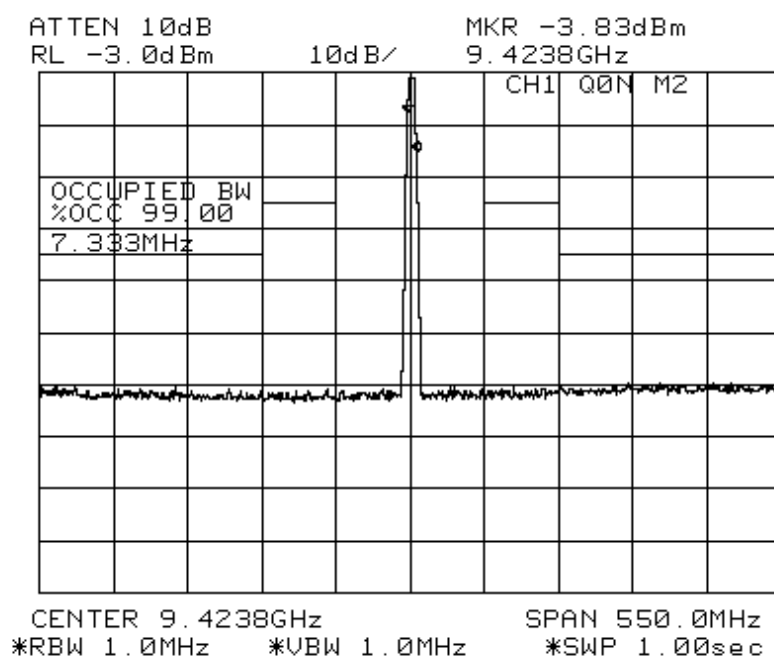


Fig. 7.34 ch1, Q0N, M2 pulse

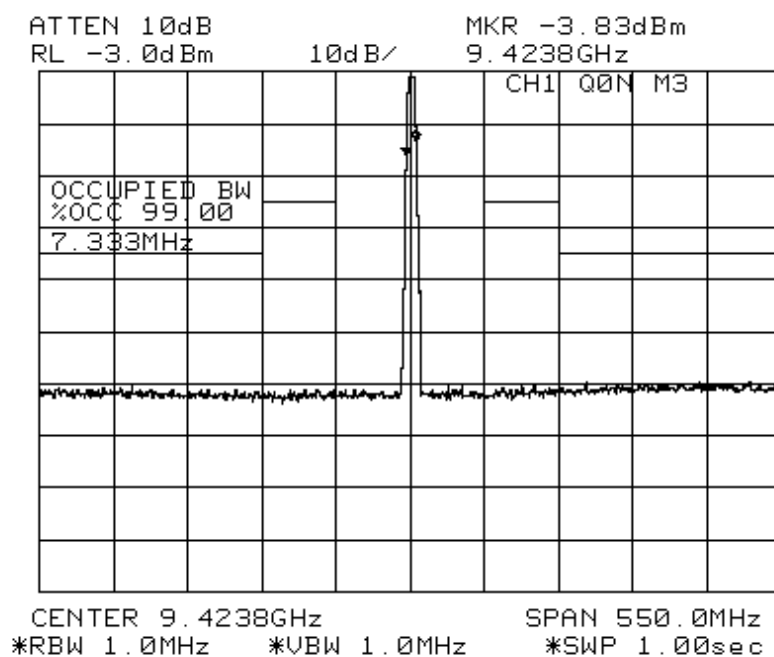


Fig. 7.35 ch1, Q0N, M3 pulse

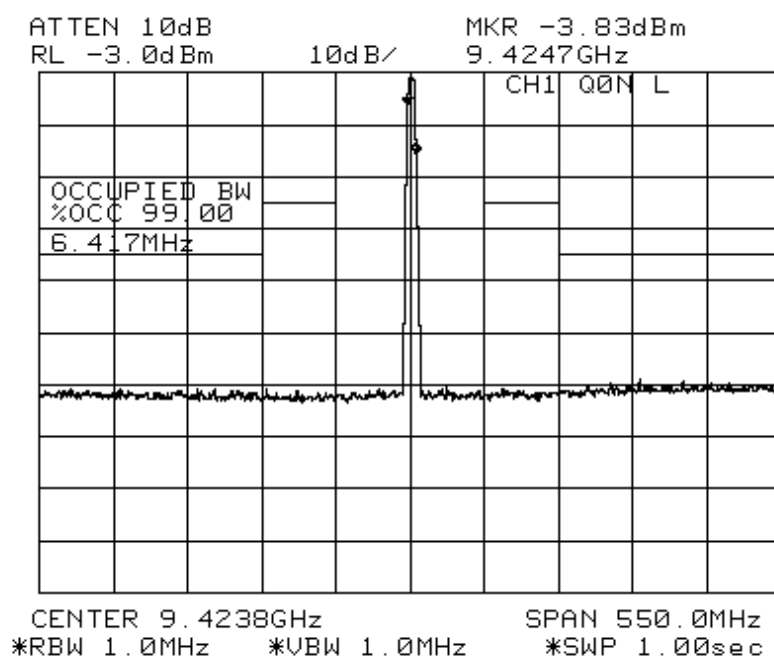


Fig. 7.36 ch1, Q0N, L pulse

ch2, P0N

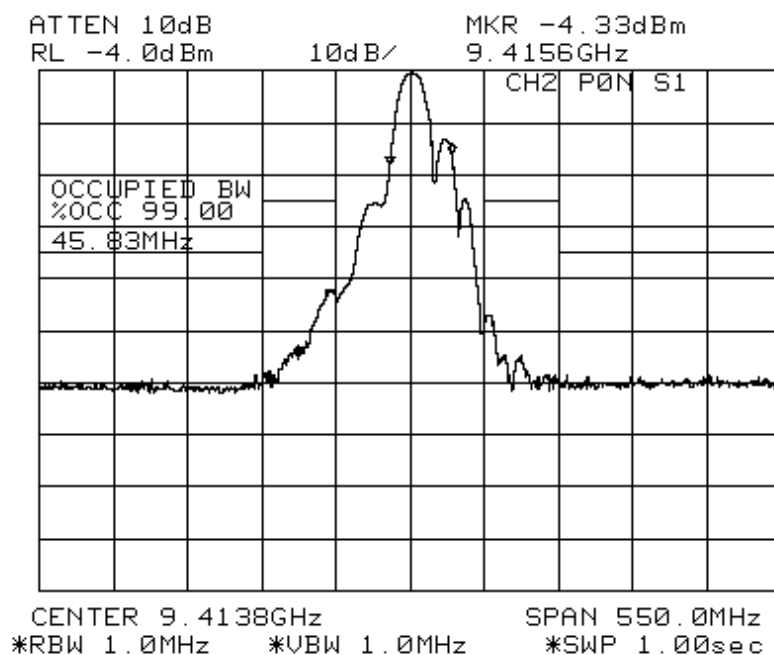


Fig. 7.37 ch2, P0N, S1 pulse

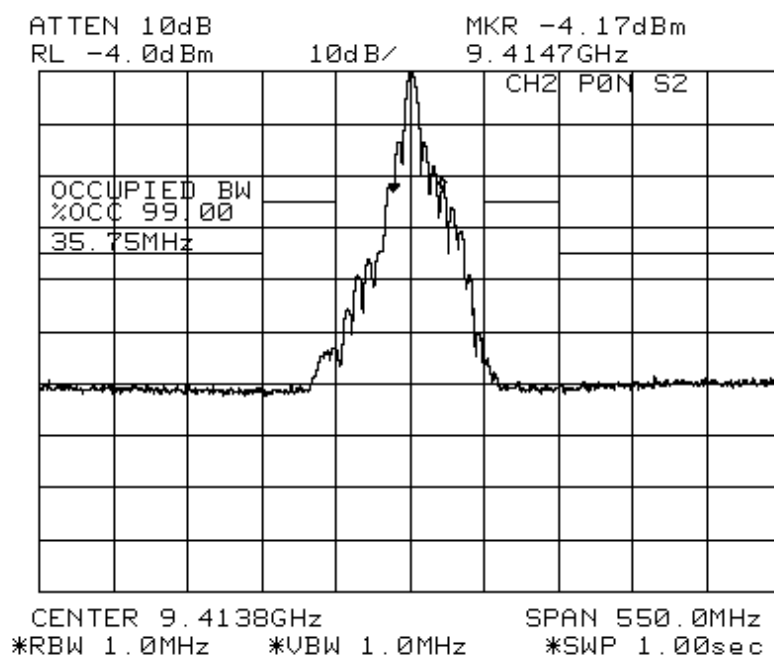


Fig. 7.38 ch2, P0N, S2 pulse

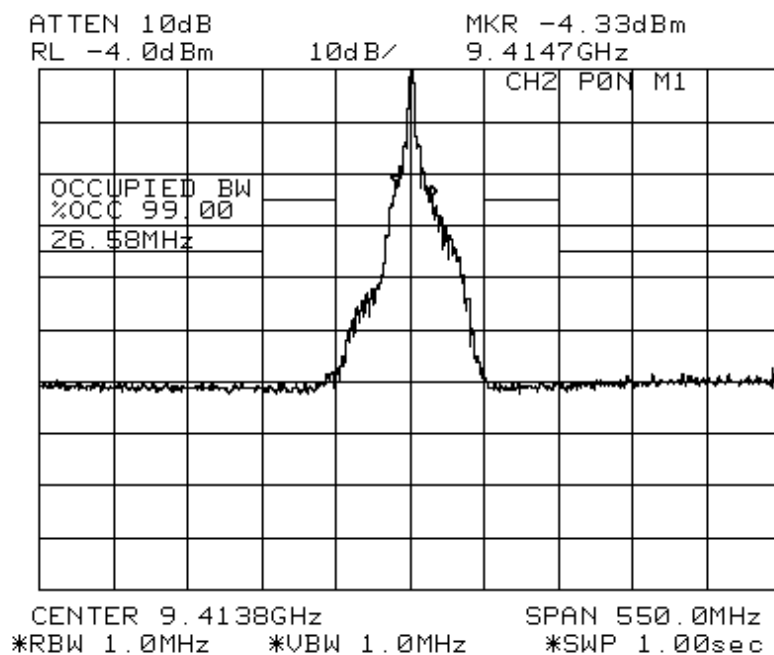


Fig. 7.39 ch2, P0N, M1 pulse

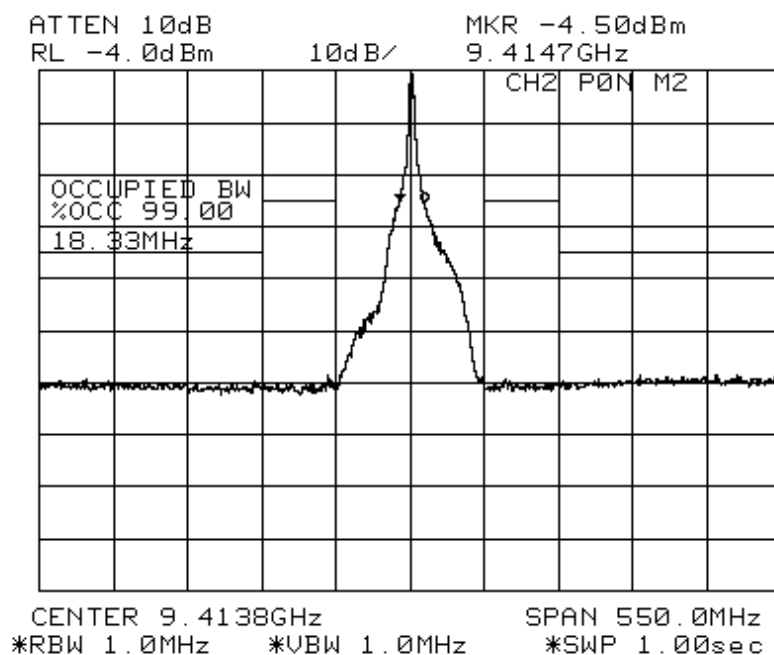


Fig. 7.40 ch2, P0N, M2 pulse

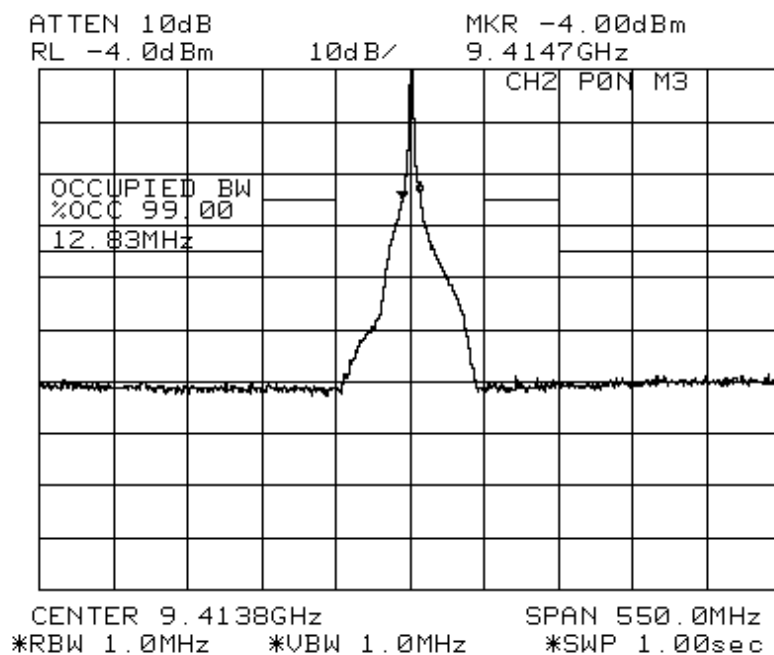


Fig. 7.41 ch2, P0N, M3 pulse

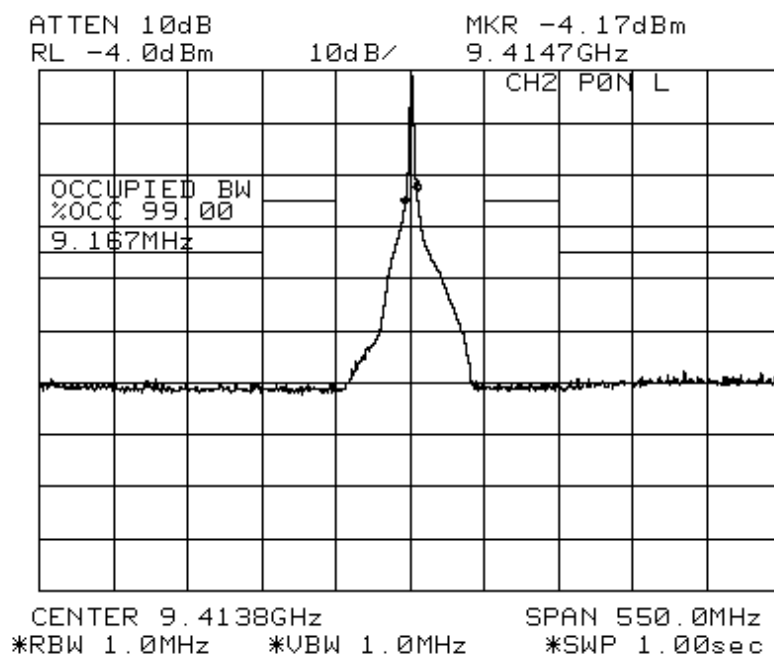


Fig. 7.42 ch2, P0N, L pulse

ch2, Q0N

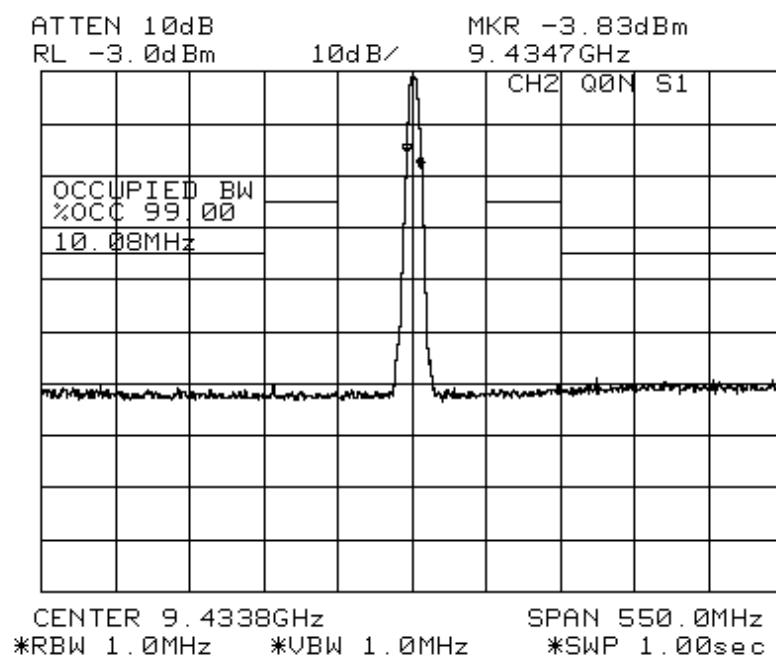


Fig. 7.43 ch2, Q0N, S1 pulse

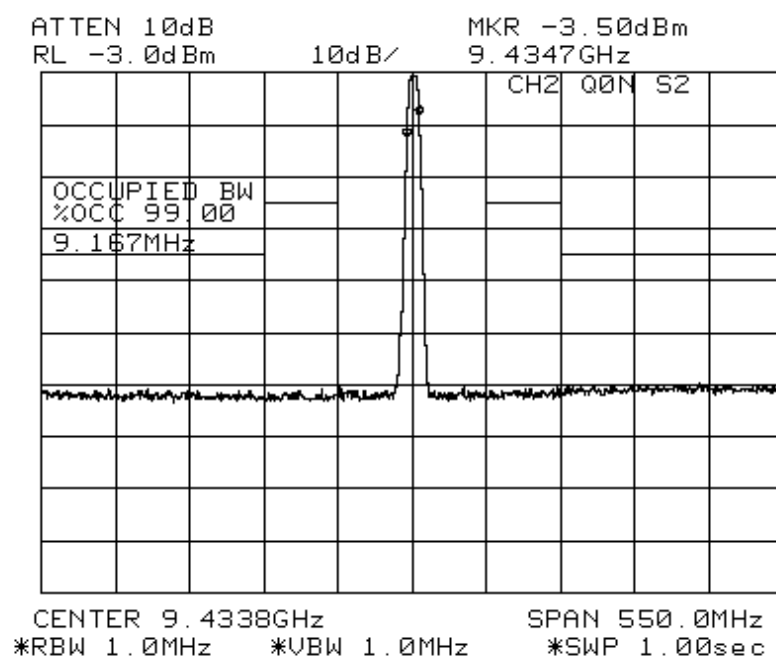


Fig. 7.44 ch2, Q0N, S2 pulse

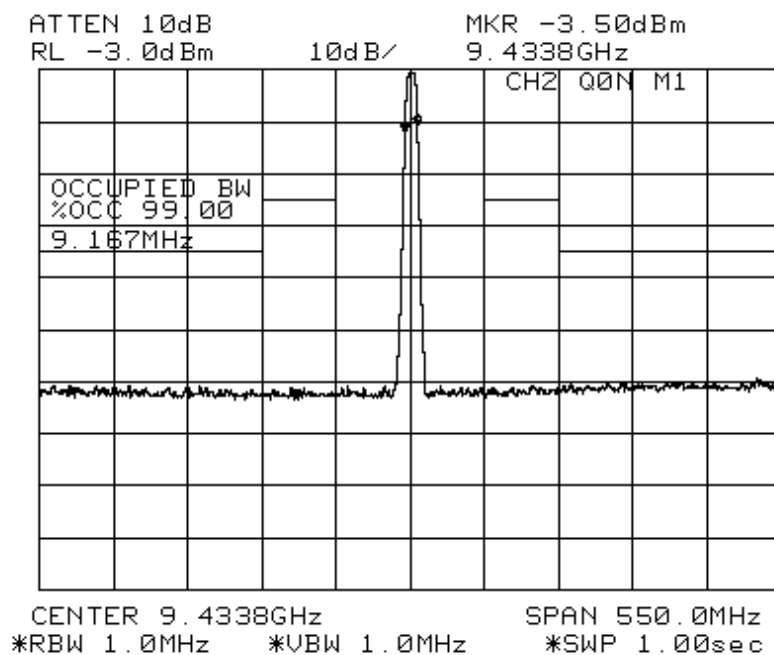


Fig. 7.45 ch2, Q0N, M1 pulse

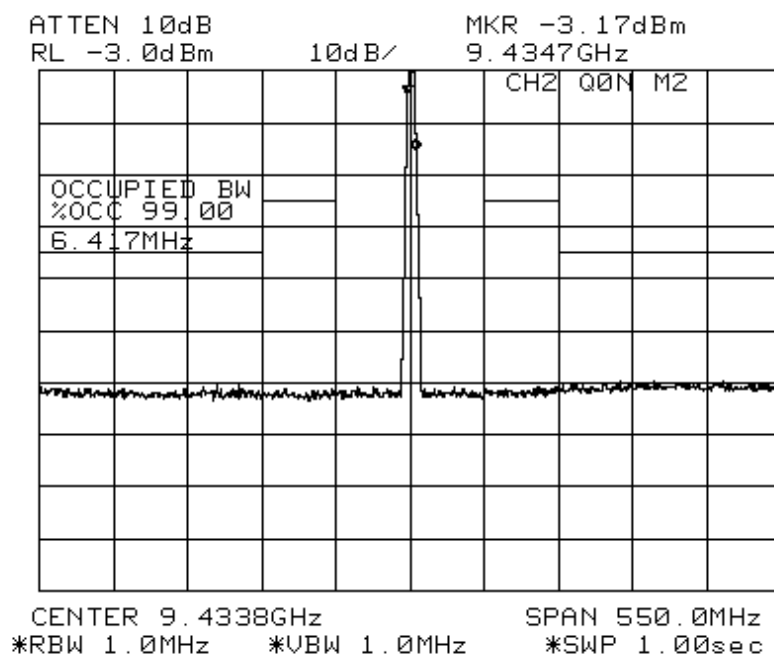


Fig. 7.46 ch2, Q0N, M2 pulse

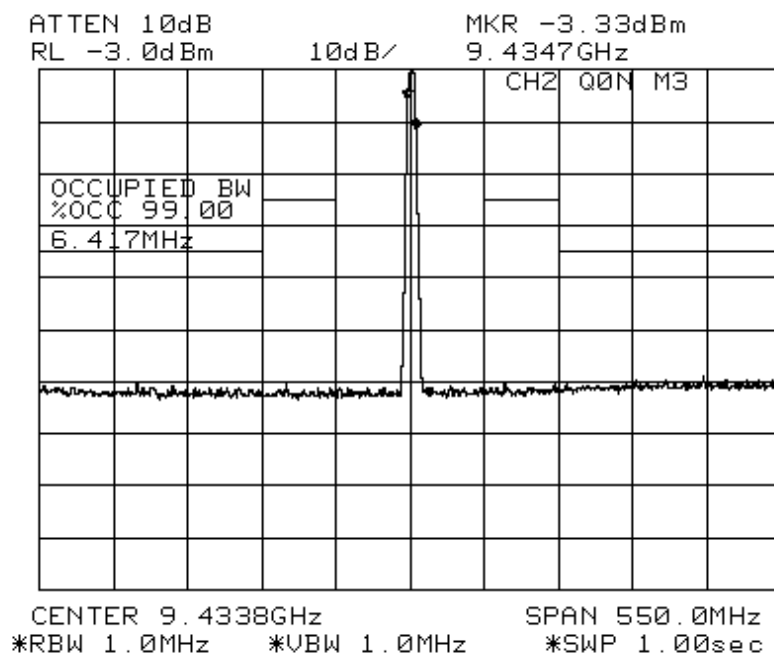


Fig. 7.47 ch2, Q0N, M3 pulse

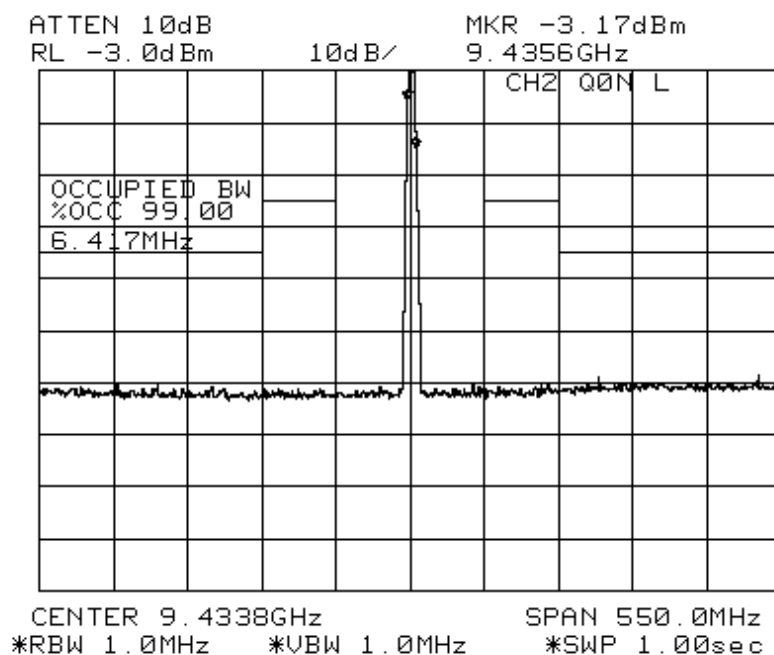


Fig. 7.48 ch2, Q0N, L pulse

2nd trace mode

ch1, P0N

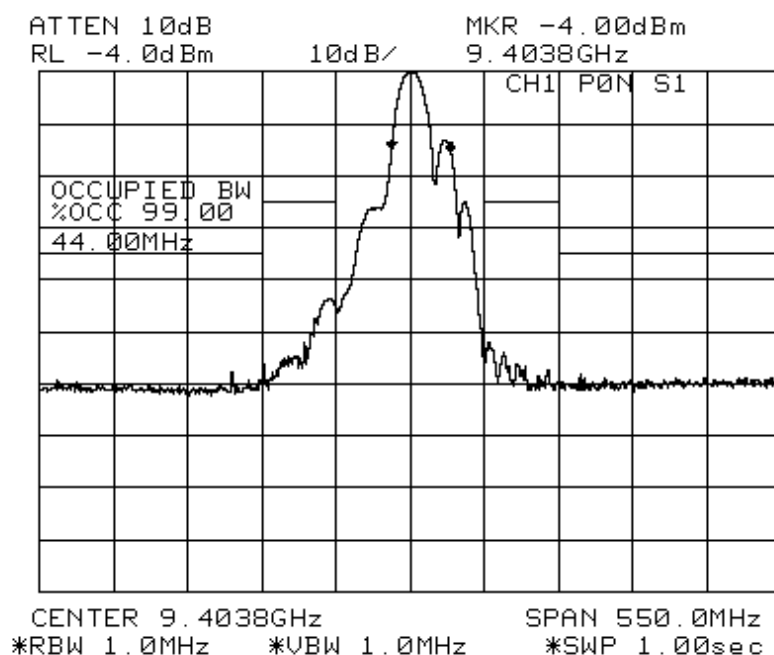


Fig. 7.49 ch1, P0N, S1 pulse

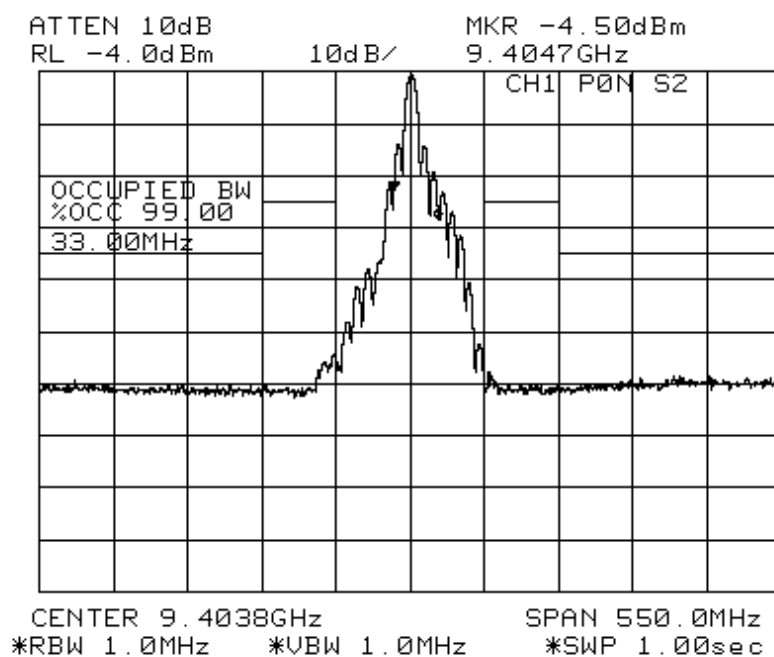


Fig. 7.50 ch1, P0N, S2 pulse

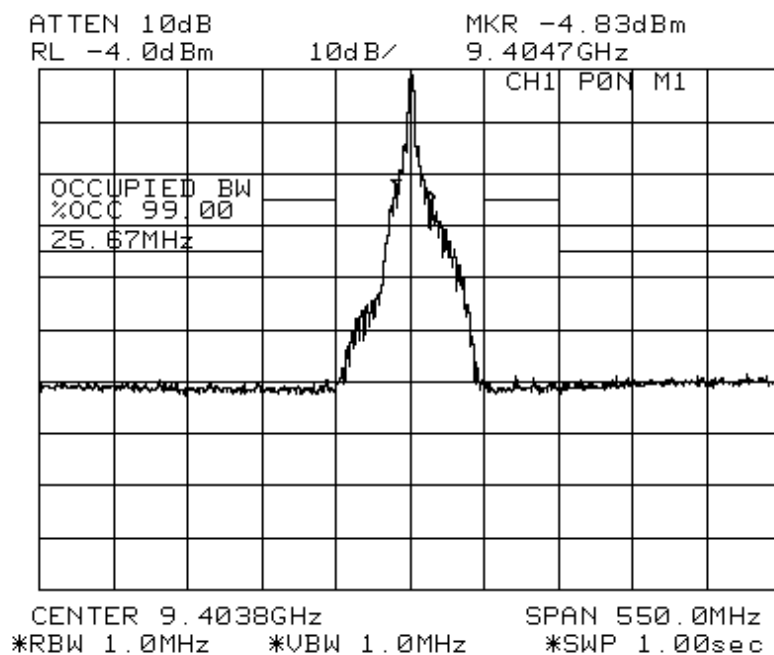


Fig. 7.51 ch1, P0N, M1 pulse

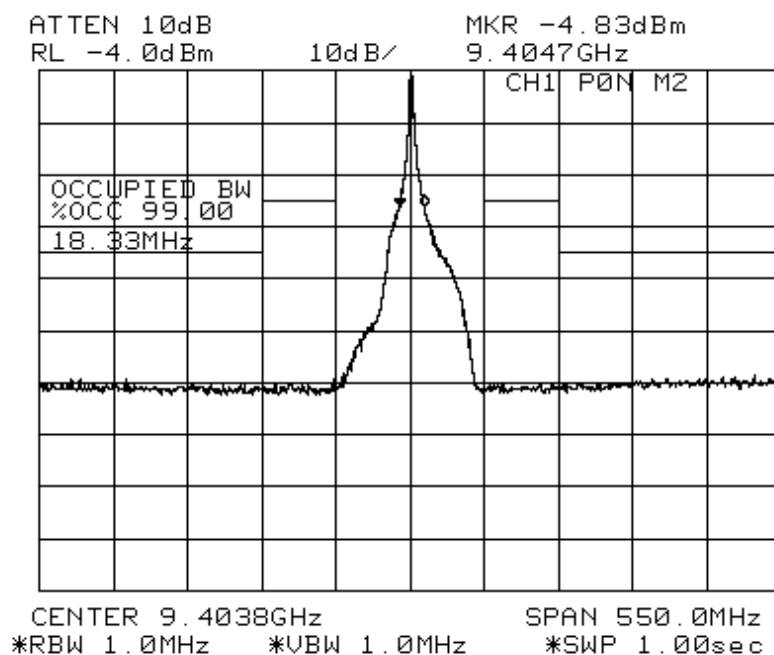


Fig. 7.52 ch1, P0N, M2 pulse

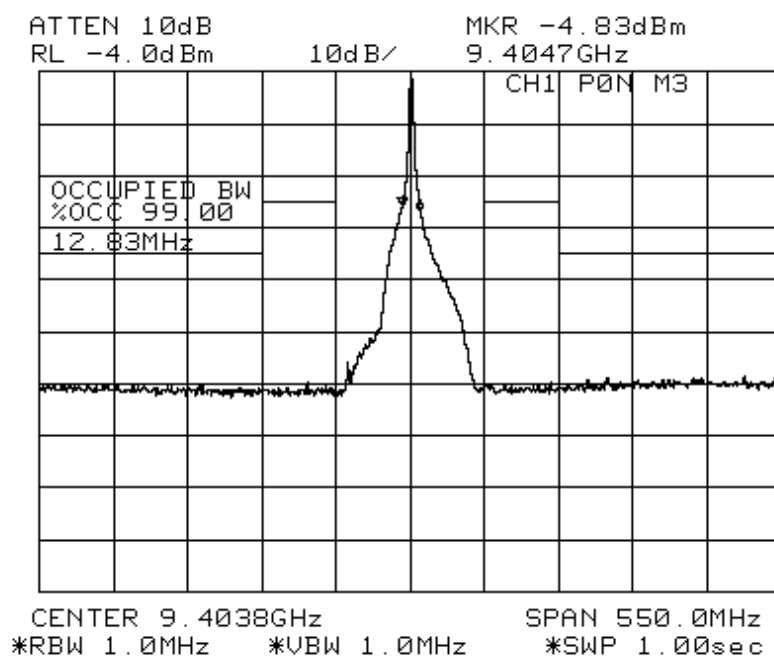


Fig. 7.53 ch1, P0N, M3 pulse

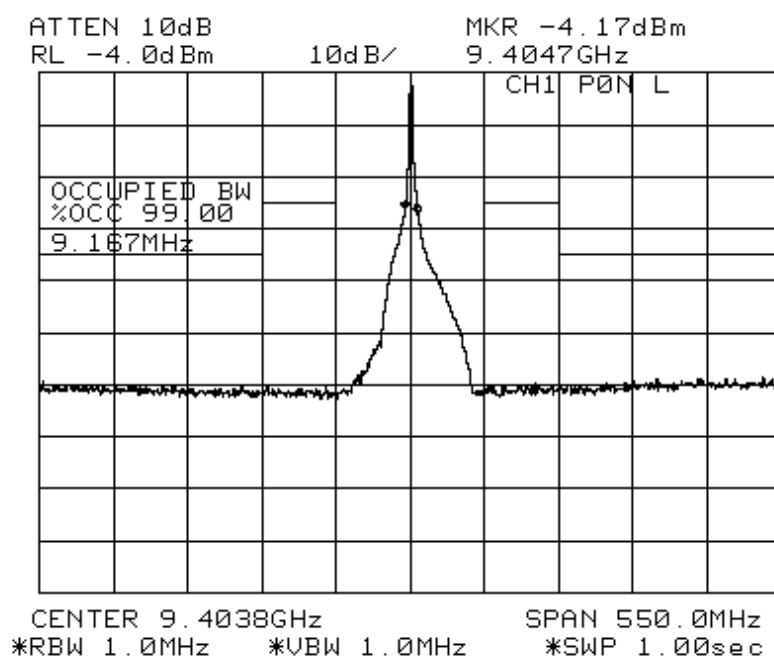


Fig. 7.54 ch1, P0N, L pulse

ch1, Q0N

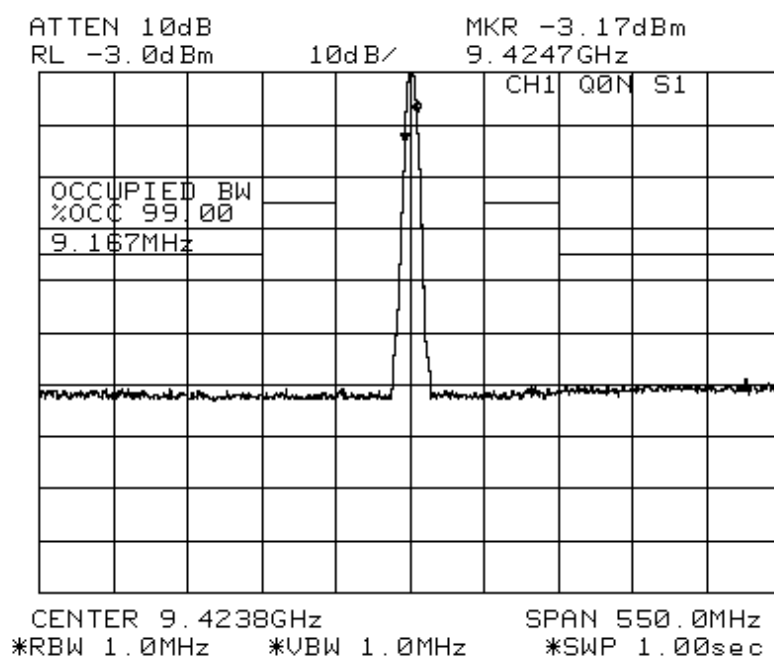


Fig. 7.55 ch1, Q0N, S1 pulse

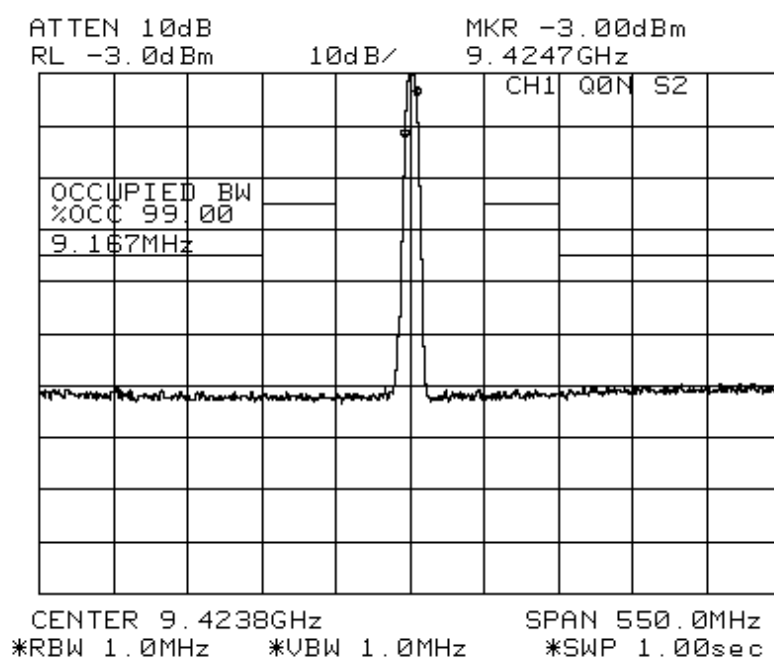


Fig. 7.56 ch1, Q0N, S2 pulse

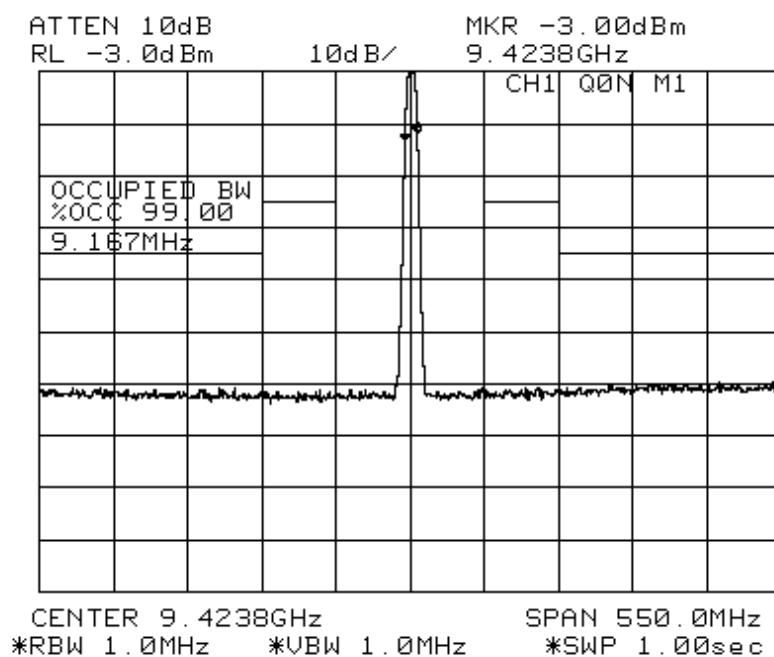


Fig. 7.57 ch1, Q0N, M1 pulse

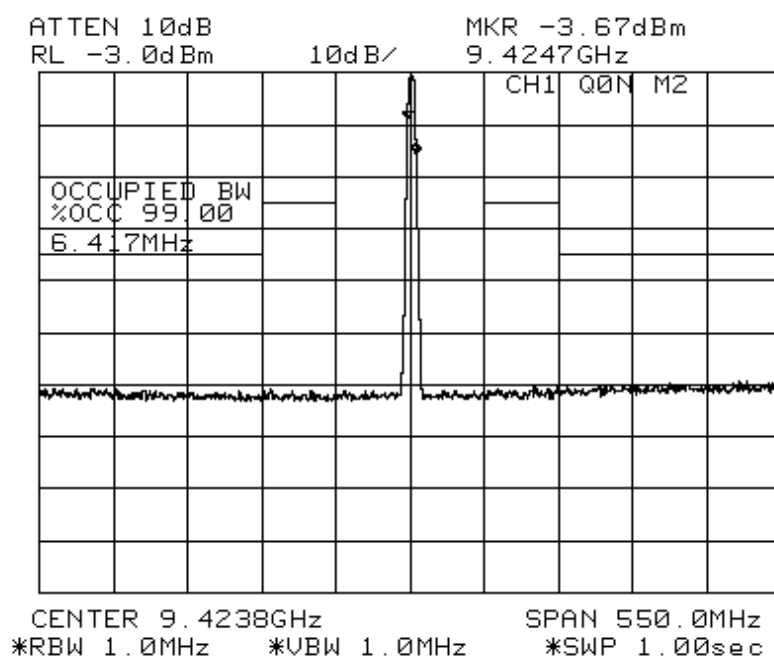


Fig. 7.58 ch1, Q0N, M2 pulse

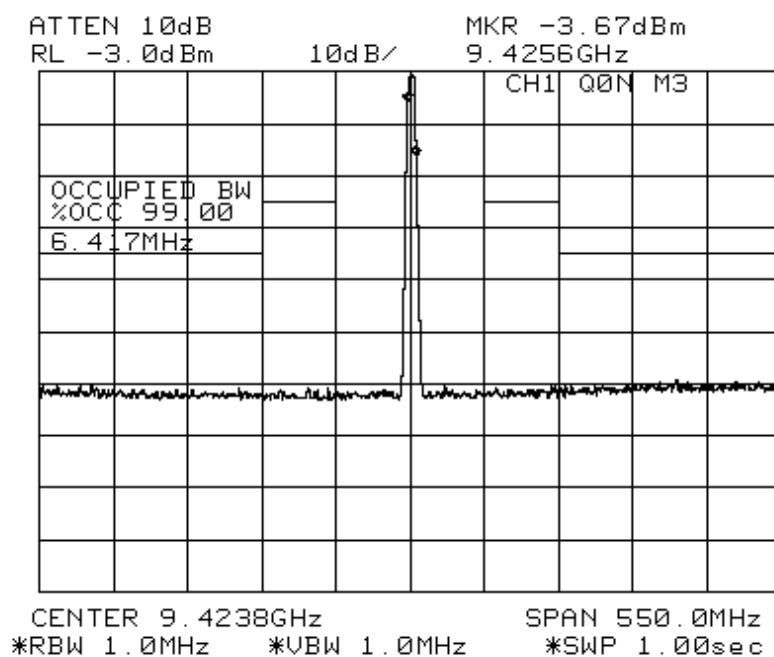


Fig. 7.59 ch1, Q0N, M3 pulse

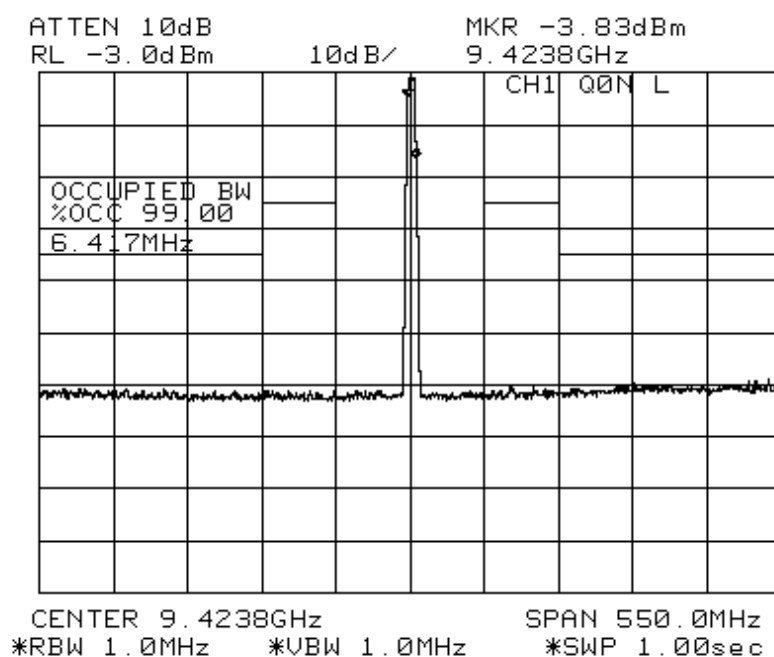


Fig. 7.60 ch1, Q0N, L pulse

ch2, P0N

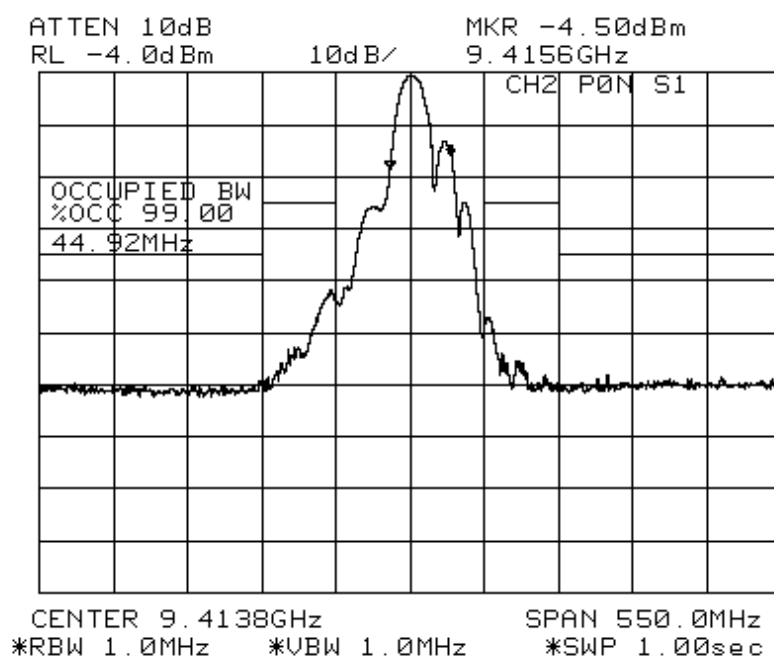


Fig. 7.61 ch2, P0N, S1 pulse

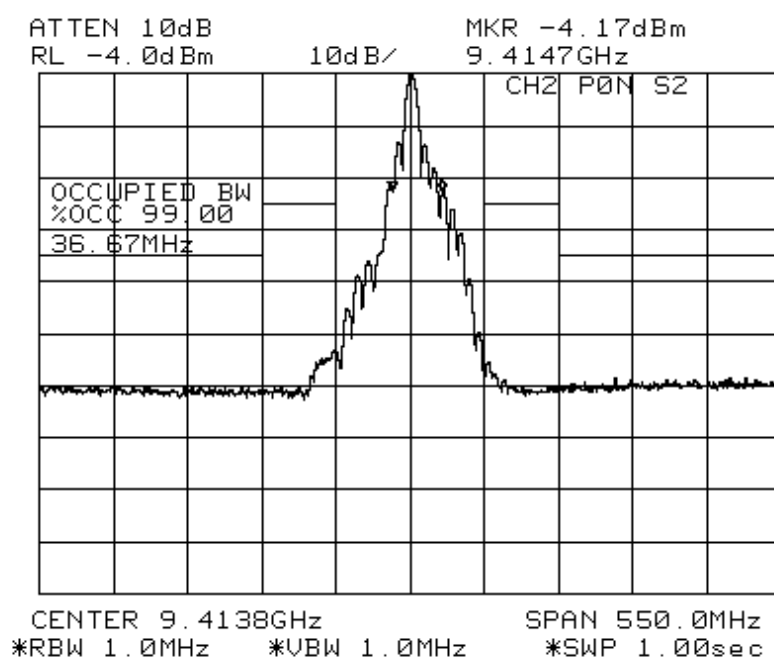


Fig. 7.62 ch2, P0N, S2 pulse

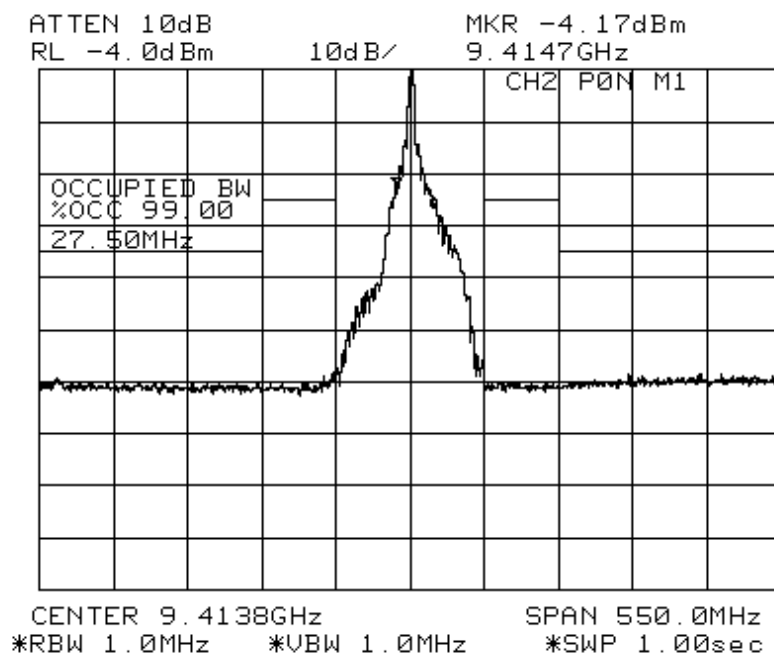


Fig. 7.63 ch2, P0N, M1 pulse

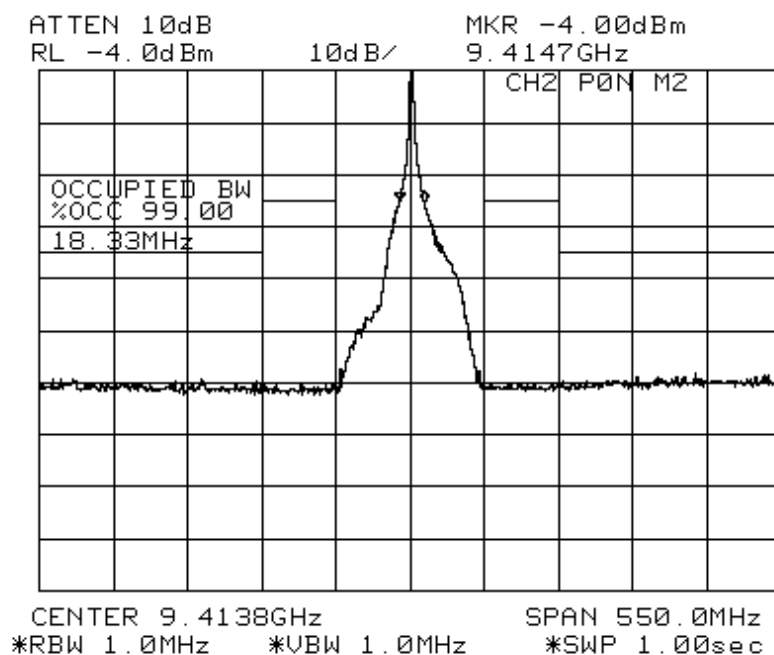


Fig. 7.64 ch2, P0N, M2 pulse

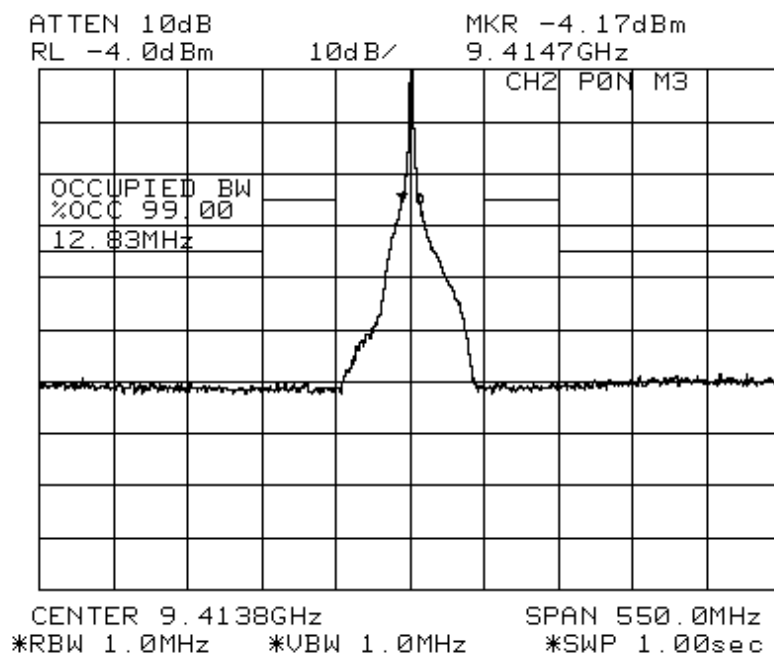


Fig. 7.65 ch2, P0N, M3 pulse

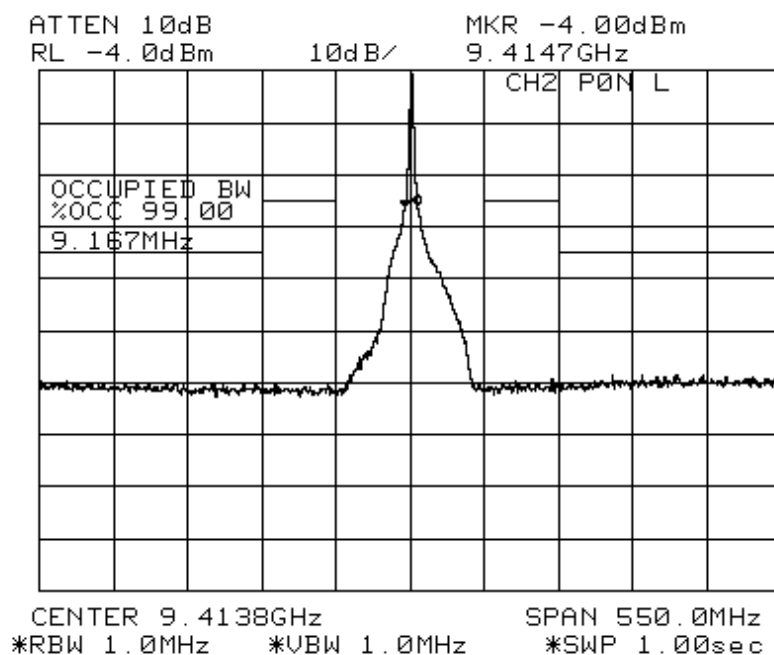


Fig. 7.66 ch2, P0N, L pulse

ch2, Q0N

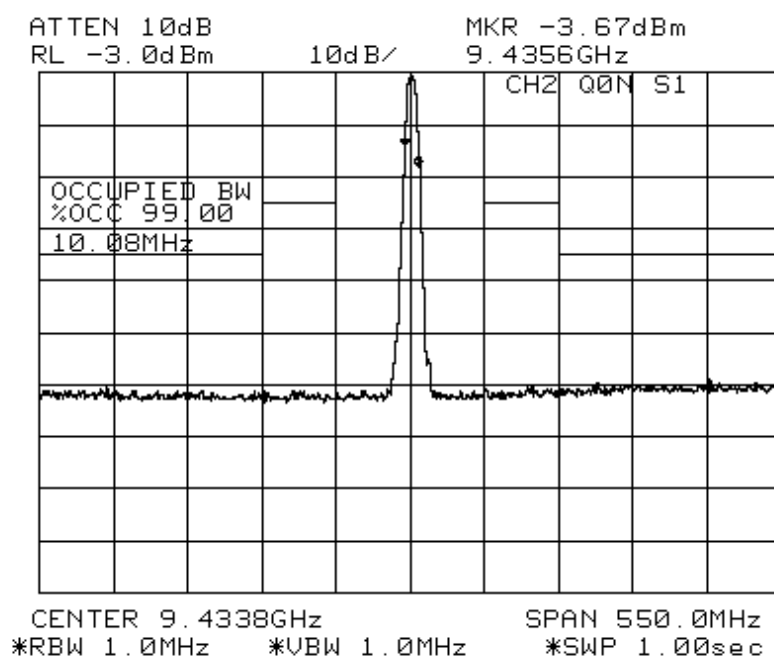


Fig. 7.67 ch2, Q0N, S1 pulse

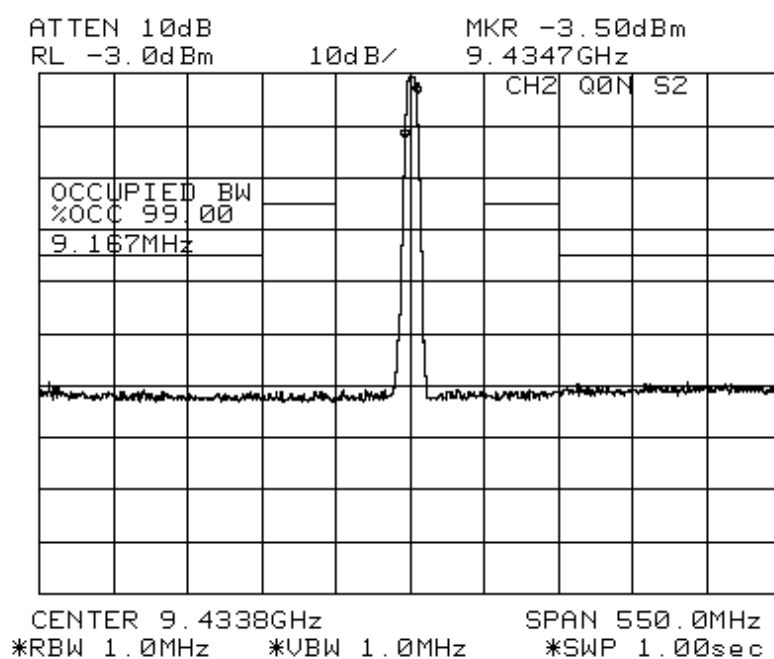


Fig. 7.68 ch2, Q0N, S2 pulse

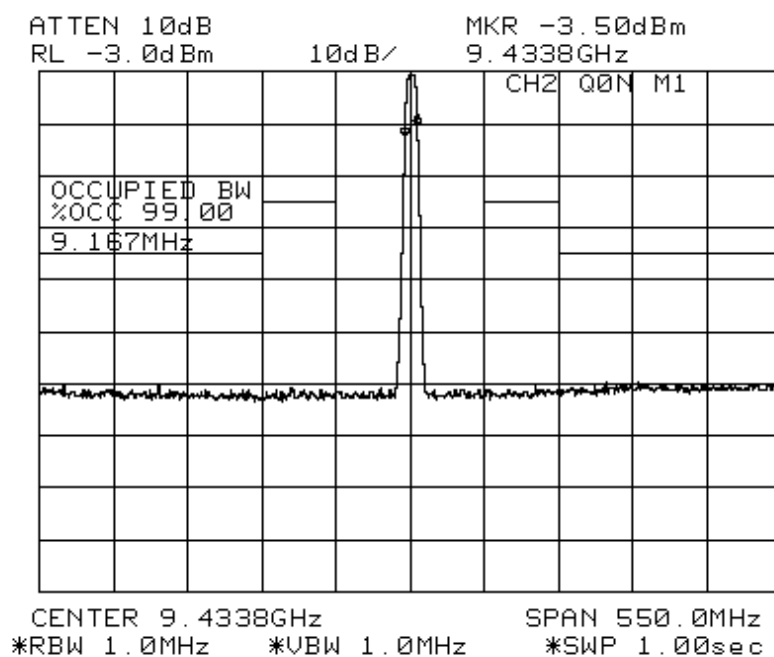


Fig. 7.69 ch2, Q0N, M1 pulse

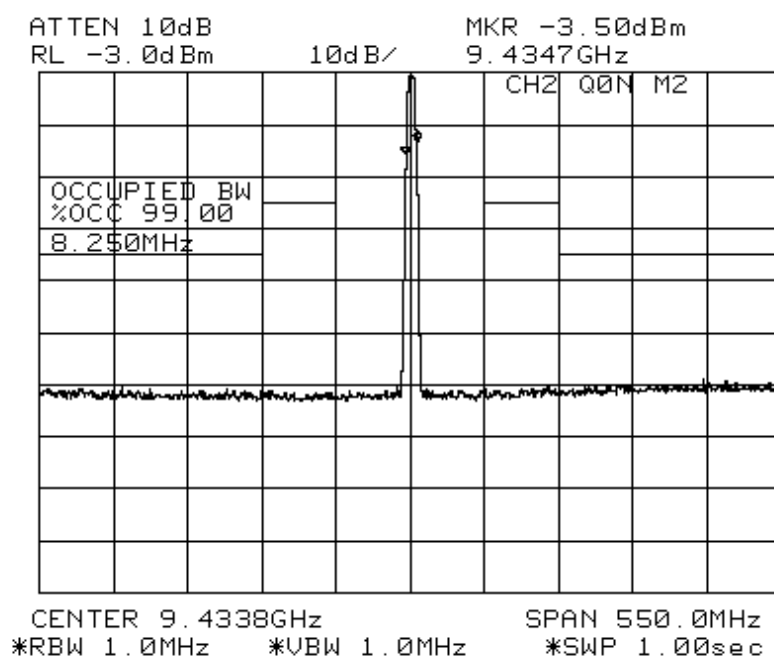


Fig. 7.70 ch2, Q0N, M2 pulse

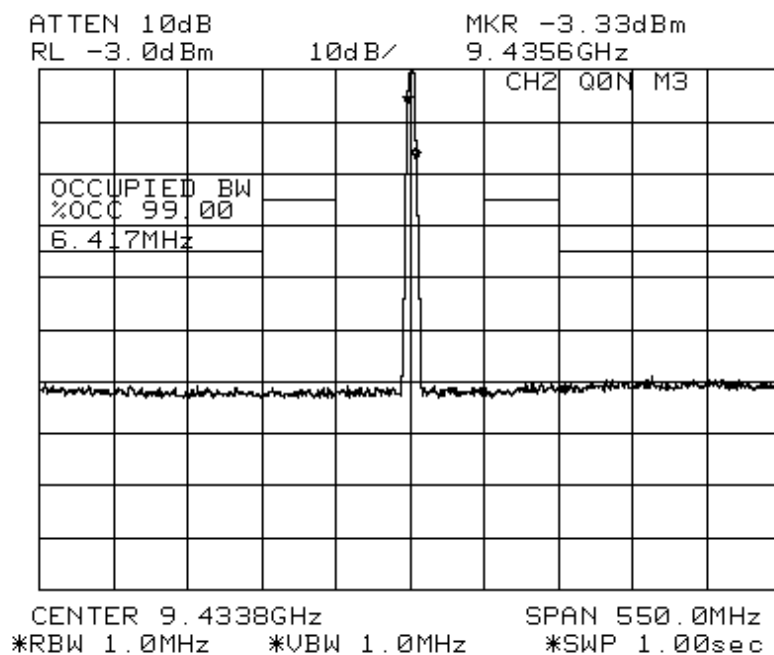


Fig. 7.71 ch2, Q0N, M3 pulse

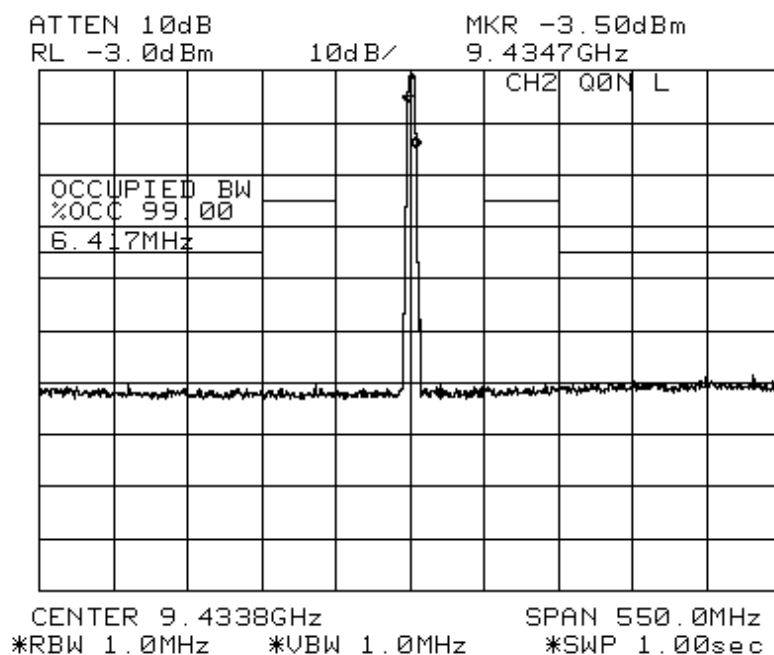


Fig. 7.72 ch2, Q0N, L pulse

End of text