

Test Report

(FCC Rules 47 CFR,
2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, and 80.209, 80.211, 80.213, 80.215)

For

Trade name: Furuno

Model: Transceiver for Marine Radar

Type: RTR-115

Report no.: LIC 12-15-102

Date of issue: 30 September 2015

Labotech International Co., Ltd.

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

Tel: +81-798-63-1094 Fax: +81-798-63-1098

Report Summary

LIC project number:	LIC 04-15-0239		
Test report number of initial issue:	LIC 12-15-102	Date of initial issue	30 September 2015
Test report number of revised/replaced issue:	---	Date of revised/replaced issue	---
Test report revision/ replacement history:	---		
Test standard(s)/ Test specifications:	FCC Rules 47 CFR, Sections: 2.1046 - RF Power Output 2.1047 - Modulation Characteristics, 2.1049 - Occupied Bandwidth, 2.1051 - Spurious Emissions at Antenna Terminals, 2.1053 - Field Strength of Spurious Radiation, 2.1055 - Frequency Stability, (Date of issue: 23 June 2015) 80.209 - Transmitter frequency tolerances 80.211 - Emission limitations. 80.213 - Modulation requirements. 80.215 - Transmitter power		
Customer:	Furuno Electric Co., Ltd. 9-52 Ashihara-Cho, Nishinomiya-City, 662-8580 Japan		
Manufacturer:	Furuno Electric Co., Ltd. 9-52 Ashihara-Cho, Nishinomiya-City, 662-8580 Japan		
Trade name:	FURUNO		
Model:	Transceiver for Marine Radar		
Type:	RTR-115		
Product function and intended use:	For marine safety navigation		
Number of samples tested:	One		
Serial number:	1000-4900-0011		
Power rating:	12-24 VDC		
Product status:	Pre-production model		
Modifications made to samples during testing:	None.		
Date of receipt of samples:	3 July 2015		
Test period:	From 7 July 2015 to 2 September 2015		
Place of test:	Labotech International Co., Ltd. - Nishinomiya-Hama Lab. 2-20, Nishinomiya-Hama, Nishinomiya-shi, Hyogo, 662-0934 Japan Anechoic Chamber used for the test has been registered by FCC. (File number: 90607) Test firm Designation Number: JP2007, Test firm Registration #: 838049		
Test results/ Compliance:	Passed. The test results of this report relate only to the samples tested.		
Tested by:	Akira Inoue		
Written by:	Akiko Inoue		
Verified by:	Yoshihiro Ishii		
Approved by:	Date: 30 September 2015 Name: Yoshihiro Ishii Title: Senior Manager, Technical Department Labotech International Co., Ltd. Signature: 		

Testing Laboratory Status

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

(1) JAB Accredited Testing Laboratory:

- accredited by Japan Accreditation Board (JAB),
- Laboratory accreditation number: RTL03220
- Date of initial accreditation: 14 January 2011 (*)
- Scope of accreditation: Electrical testing - EMC testing

(2) Telefication Listed Testing Laboratory:

- listed by Telefication B. V., (The Netherlands)
- Laboratory assignment number: L116
- Date of initial listing: 26 July 1999 (*)
- for testing the following product categories/ test standards: EN 60945, IEC 61162-1/-2, IEC/EN 61162-450 and IEC 62288

(3) BSH Recognized Testing Laboratory:

- recognized by Bundesamt für Seeschifffahrt und Hydrographie (BSH), (Germany)
- Recognition certificate number: BSH/4613/06202/1864/11
- Date of initial recognition: 4 April 2003 (*)
- for testing the following product categories/test standards:
- IEC/EN 60945, IEC 62388, IEC 61162-1/-2, and IEC 62288

(4) TÜV Appointed EMC Test Laboratory:

- appointed by TÜV Rheinland Japan Ltd.,
- Laboratory assignment number: UA 50046428
- Date of initial appointment: 21 December 1998 (*)
- for carrying out the tests of: EN 55011, CISPR 11, EN 55022, CISPR 22, EN 55024, CISPR 24, EN 55025, CISPR 25, EN/IEC 61000-3-2/-3, EN/IEC 61000-4-2/-3/-4/-5/-6/-8/-11, EN/IEC 61000-6-1/-2/-3/-4, EN/IEC 60945, EN/IEC 61326-1, EN/IEC 61326-2-6, EN/IEC 60601-1-2, JIS T 0601-1-2, JIS C 1806-1, and ISO 11452-1/-2/-4.

(5) RMRS Recognized Testing Laboratory:

- recognized by Russian Maritime Register of Shipping (RMRS), (Russia)
- Laboratory recognition number: 11.02594.011
- Date of initial recognition: 27 January 2009 (*)
- for carrying out testing in the field of:
Electrical measurements and tests, EMC tests, Mechanical measurements and tests, Equipment protection degree tests, and Climatic tests for Ship's radio and navigational equipment and IEC 60945: 2002

(6) RRR Recognized Test Laboratory:

- recognized by Russian River Register (RRR), (Russia)
- Recognition certificate number: 154262
- Date of initial recognition: 31 May 2013 (*)
- for carrying out of tests of ships radio and navigation equipment

(7) DNV Recognized Environmental Test Laboratory:

- recognized by Det Norske Veritas AS (DNV), (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.

(8) 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

Note: (*) – The current certificates may be found in the LIC web site (<http://www.furuno-labotech.co.jp>).

TABLE OF CONTENTS

Testing Laboratory Status	3
1 Principal Information	5
1.1 Equipment under test (EUT).....	5
1.2 Observation and comments.....	7
2 Test Results Summary	7
3 Test Results	8
3.1 RF Power Output (FCC Rule 47 CFR, 2.1046 (a), 80.215)	8
3.2 Modulation Characteristics (FCC Rule 47 CFR, 2.1047)	10
3.3 Frequency Stability –temperature & voltage (FCC Rule 47 CFR, 2.1055(a)(2), 80.209(b))	12
3.4 Occupied Bandwidth (FCC Rule 47 CFR, 2.1049(c)(1), 80.209(b), 80.211(f))	15
3.5 Spurious Emissions at Antenna Port (FCC Rule 47 CFR, 2.1051, 80.211(f))	16
3.6 Field Strength of Spurious Radiation (FCC Rule 47 CFR, 2.1053, 80.211(f))	17
4 Test Setup for Measurements.....	18
5 Measuring Equipment List	19
6 Photographs of Test Setup/Arrangement	21
7 RF Envelopes and Spectrum of the output pulse	22
8 Spurious Emission Plots measured at Antenna Terminal	40

1 Principal Information

1.1 Equipment under test (EUT)

1.1.1 General

- (a) Trade name: Furuno
- (b) Manufacturer: Furuno Electric Co., Ltd.
Ashihara-cho 9-52, Nishinomiya-city, 662-8580 Japan
- (c) Model: Radar Sensor DRS4D-NXT

	Type	Serial number	Note
Radar Sensor	DRS4D-NXT	1000-4900-0011	
Scanner module	RSB-135	---	Antenna rotation rate: 24/36/48 rpm (depends on range scale)
Transceiver module	RTR-115	---	Contained in the Radome.
Antenna radiator	03P9459-1NLF	---	Microstrip patch array antenna

- (d) Certification number: FCC ID: ADB9ZWRTR115
- (e) Primary Function: Search, Navigation and Anti-collision
- (f) Frequency Range: Fixed frequency, X-band (9410 MHz)
- Type of Emission: P0N/Q0N
(Emission designator)
- (g) Size and mass: Radar Sensor: 610 mm (dia) X 220 mm (H), 8.0 kg
- (h) Power Supply: 12 - 24 VDC, 2.1 - 1.0 A.

1.1.2 Transceiver

Type: RTR-115 (Contained in the Radome)

1.1.2.1 Transmitter

- (a) Assignable Frequency for Shipborne Radar:
Between 9300 and 9500 MHz (for X-band radars) (FCC Rule, 80.375 (d)-(1))
- (b) Type of RF Generator:
Type: Solid-state device (no magnetron)
Peak Output Power: 20 W (nominal)
- (c) Tx frequency: 9380 MHz (P0N)/ 9400 MHz $\pm$ 12.5MHz (Q0N)
9400 MHz (P0N)/ 9420 MHz $\pm$ 12.5MHz (Q0N)
9420 MHz (P0N)/ 9440 MHz $\pm$ 12.5MHz (Q0N)
Tolerance of reference frequency (including temperature and power-supply voltage fluctuation): $\pm$ 1 MHz

(d) Pulse Characteristics:

Pulse type	S1	S2	M1	M2	M3	L
Pulse length (μs) P0N/Q0N	0.08/5.0	0.15/7.5	0.30/11	0.60/13	1.20/15	1.20/18
P.R.F.(Hz)	2000	2000	2000	2000	2000	1400

1.1.2.2 Receiver

(a) Passband

RF Stage: 300 MHz

IF Stage: 60 MHz

(b) Intermediate Frequency: 93.75 MHz

(c) Gain (overall): Approximately 40 dB

(d) Overall Noise Figure: 5 dB (typical)

(e) Video Output Voltage: Not Provided (by LAN communication)

(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: Not Provided

1.1.3 Antenna and Scanner

(a) Antenna Rotation ON-OFF Switch: Not Provided

(b) Construction: Microstrip patch array antenna
(installed on the Scanner)

(c) Length:

Antenna type	03P9459-1NLF
Length (cm)	55.5

(d) Type of Beam: Vertical fan

(e) Beam Width (3 dB):

Antenna type	03P9459-1NLF
Horizontal (°)	4.0
Vertical (°)	25

(f) Polarization: Horizontal

(g) Antenna Gain:

Antenna type	03P9459-1NLF
Gain (dBi)	23

(h) Attenuation of Major Side and Back Lobes with respect to main beam:

Antenna type	03P9459-1NLF
Within ±20° (dB)	-25
Outside ±20° (dB)	-27

- (i) Scanning (rotating or oscillating): Rotating over 360° continuously clockwise
- (j) Antenna Rotation Rate: 24/36/48 rpm
- (k) Sector Scan: Provided.
- (l) Rated Loss of Transmission line per hundred feet:
Negligible. (Transmission path is only in the scanner unit.)

1.1.4 Operational Features

- (a) Is positive means provided to indicate whether or not the overall operation of the equipment is such that it may be relied upon to provide effective operation in accordance with its primary function: Yes. (Alarm function)
- (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: Radar Sensor (IEC 60529 – IP26)
- (d) If all units are not housed in a single container, indicate number and give description of individual units: Not applicable.
- (e) Approximate space required for installation excluding scanner:
Not applicable.

1.2 Observation and comments

None.

2 Test Results Summary

Clause no. of this report	47 CFR Section	Item	Result	Test Engineer
3.1	2.1046 (a), 80.215	RF Power Output	Passed.	A. Inoue
3.2	2.1047	Modulation Characteristics	Passed.	A. Inoue
3.3	2.1055 (a)(2) 80.209 (b)	Frequency Stability	Passed.	A. Inoue
3.4	2.1049 (c)(1), 80.219 (b), 80.211 (f)	Occupied Bandwidth	Passed.	A. Inoue
3.5	2.1051, 80.211 (f)	- Spurious Emissions at Antenna Terminals	Passed.	A. Inoue
3.6	2.1053, 80.211 (f)	- Field Strength of Spurious Radiation	Passed.	A. Inoue

3 Test Results

3.1 RF Power Output (FCC Rule 47 CFR, 2.1046 (a), 80.215)

(1) Test conditions:

For all TX pulses (S1/S2/M1/M2/M3/L), the transmitter output power was measured at the antenna port with Antenna replaced with the Non-reflective load.

(2) Test setup:

See Clause 4.

(3) Test Results:

CH1, P0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	0.004	0.007	0.013	0.025	0.050	0.035
Transmission pulse power Pp (W) (*1)	20.8	20.8	20.8	20.9	20.8	20.8
Pulse length T (μs) (-3 dB points)	0.088	0.157	0.308	0.607	1.209	1.209
PRF (Hz)	2000	2000	2000	2000	2000	1400

CH1, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	0.165	0.246	0.352	0.415	0.472	0.389
Transmission pulse power Pp (W) (*1)	16.5	16.4	16.0	15.9	15.7	15.4
Pulse length T (μs) (-3 dB points)	4.993	7.497	11.000	13.000	15.000	18.020
PRF (Hz)	2000	2000	2000	2000	2000	1400

CH2, P0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	0.004	0.006	0.012	0.025	0.049	0.034
Transmission pulse power Pp (W) (*1)	19.8	20.0	20.2	20.3	20.4	20.4
Pulse length T (μs) (-3 dB points)	0.089	0.158	0.308	0.607	1.210	1.209
PRF (Hz)	2000	2000	2000	2000	2000	1400

CH2, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power Pm (W)	0.156	0.242	0.357	0.418	0.477	0.397
Transmission pulse power Pp (W) (*1)	15.6	16.2	16.2	16.1	15.9	15.7
Pulse length T (μs) (-3 dB points)	4.982	7.482	10.990	12.990	15.000	18.000
PRF (Hz)	2000	2000	2000	2000	2000	1400

CH3, P0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power P _m (W)	0.003	0.006	0.012	0.024	0.048	0.034
Transmission pulse power P _p (W) (*1)	19.4	19.7	19.8	19.9	19.9	19.9
Pulse length T (μs) (-3 dB points)	0.088	0.158	0.307	0.606	1.209	1.209
PRF (Hz)	2000	2000	2000	2000	2000	1400

CH3, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Transmission mean power P _m (W)	0.157	0.241	0.360	0.429	0.488	0.407
Transmission pulse power P _p (W) (*1)	15.8	16.1	16.4	16.5	16.3	16.1
Pulse length T (μs) (-3 dB points)	4.983	7.483	10.990	12.990	15.000	18.000
PRF (Hz)	2000	2000	2000	2000	2000	1400

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

Environmental conditions observed: On 10 July 2015, 24°C to 24°C, 64%RH to 64%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC.

3.2 Modulation Characteristics (FCC Rule 47 CFR, 2.1047)

(1) Test Conditions:

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

(2) Test setup:

See Clause 4.

(3) Test Results:

CH1, P0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (-3 dB points)	0.088	0.157	0.308	0.607	1.209	1.209
Rise time t_r (μ s) (10 - 90 % amplitude)	0.033	0.033	0.032	0.032	0.030	0.030
Decay time t_f (μ s) (90 - 10 % amplitude)	0.029	0.027	0.027	0.026	0.026	0.026
PRR (Hz)	2000	2000	2000	2000	2000	1400

CH1, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (-3 dB points)	4.993	7.497	11.000	13.000	15.000	18.020
Rise time t_r (μ s) (10 - 90 % amplitude)	0.376	0.224	0.320	0.368	0.416	0.480
Decay time t_f (μ s) (90 - 10 % amplitude)	0.124	0.184	0.288	0.344	0.408	0.480
PRR (Hz)	2000	2000	2000	2000	2000	1400

CH2, P0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (-3 dB points)	0.089	0.158	0.308	0.607	1.210	1.209
Rise time t_r (μ s) (10 - 90 % amplitude)	0.029	0.029	0.028	0.027	0.023	0.028
Decay time t_f (μ s) (90 - 10 % amplitude)	0.029	0.028	0.028	0.026	0.027	0.027
PRR (Hz)	2000	2000	2000	2000	2000	1400

CH2, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (-3 dB points)	4.982	7.482	10.990	12.990	15.010	18.000
Rise time t_r (μ s) (10 - 90 % amplitude)	0.252	0.232	0.320	0.368	0.432	0.480
Decay time t_f (μ s) (90 - 10 % amplitude)	0.128	0.184	0.296	0.360	0.408	0.480
PRR (Hz)	2000	2000	2000	2000	2000	1400

CH3, P0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (-3 dB points)	0.088	0.158	0.307	0.606	1.209	1.209
Rise time t_r (μ s) (10 - 90 % amplitude)	0.025	0.026	0.025	0.025	0.026	0.025
Decay time t_f (μ s) (90 - 10 % amplitude)	0.032	0.030	0.030	0.030	0.033	0.030
PRR (Hz)	2000	2000	2000	2000	2000	1400

CH3, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Pulse length T (μ s) (-3 dB points)	4.983	7.483	10.990	12.990	15.000	18.000
Rise time t_r (μ s) (10 - 90 % amplitude)	0.152	0.216	0.312	0.360	0.424	0.480
Decay time t_f (μ s) (90 - 10 % amplitude)	0.132	0.200	0.304	0.360	0.392	0.460
PRR (Hz)	2000	2000	2000	2000	2000	1400

Measured Plots: See Clause 7.

Environmental conditions observed: On 11 July 2015, 24°C to 24°C, 68%RH to 68%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC.

3.3 Frequency Stability –temperature & voltage (FCC Rule 47 CFR, 2.1055(a)(2), 80.209(b))

(1) Test Conditions:

- (1) Radar Transmitter settings: All TX pulses (S1/S2/M1/M2/M3/L)
- (2) Ambient Temperature settings: - 20°C to + 50°C (10°C interval)
- (3) Power Supply Voltage settings: 85 /100/115 % of nominal voltage
DC Processor unit (24 VDC): (10.2/12.0/24.0/27.6 VDC),

(2) Test setup:

See Clause 4.

(3) Frequency Tolerance Limits (FCC Rule 47 CFR, 80.209(b)):

CH1, P0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band f(1.5/T) (MHz) (*1)	17.0	9.5	4.9	2.5	1.2	1.2
f(U) (MHz) (*2)	9483.0	9490.5	9495.1	9497.5	9498.8	9498.8
f(L) (MHz) (*2)	9317.0	9309.5	9304.9	9302.5	9301.2	9301.2

CH1, Q0N

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

CH2, P0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band f(1.5/T) (MHz) (*1)	16.9	9.5	4.9	2.5	1.2	1.2
f(U) (MHz) (*2)	9483.1	9490.5	9495.1	9497.5	9498.8	9498.8
f(L) (MHz) (*2)	9316.9	9309.5	9304.9	9302.5	9301.2	9301.2

CH2, Q0N

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

CH3, P0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band f(1.5/T) (MHz) (*1)	17.0	9.5	4.9	2.5	1.2	1.2
f(U) (MHz) (*2)	9483.0	9490.5	9495.1	9497.5	9498.8	9498.8
f(L) (MHz) (*2)	9317.0	9309.5	9304.9	9302.5	9301.2	9301.2

CH3, Q0N

Pulse type	S1	S2	M1	M2	M3	L
Guard Band f(1.5/T) (MHz) (*1)	0.3	0.2	0.1	0.1	0.1	0.1
f(U) (MHz) (*2)	9499.7	9499.8	9499.9	9499.9	9499.9	9499.9
f(L) (MHz) (*2)	9300.3	9300.2	9300.1	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.
(FCC Rule 47 CFR, 80.209(b))

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

(4) Test Results:

Complied.

(4.1) At the rated supply voltage of 24.0 VDC:

CH1, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9380.7	9380.0	9380.0	9380.1	9379.9	9379.9	Complied.
	-10°C	9381.0	9380.2	9380.2	9379.8	9379.8	9379.9	Complied.
	0°C	9380.7	9379.8	9379.8	9379.7	9379.7	9379.9	Complied.
	+10°C	9380.7	9379.7	9379.7	9379.9	9379.7	9379.8	Complied.
	+20°C	9379.8	9380.5	9380.0	9379.8	9379.8	9379.8	Complied.
	+30°C	9380.3	9380.2	9379.7	9379.7	9379.8	9379.7	Complied.
	+40°C	9380.0	9380.0	9379.8	9379.7	9379.7	9379.8	Complied.
	+50°C	9380.0	9380.0	9379.8	9379.9	9379.8	9379.8	Complied.

CH1, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9400.2	9400.8	9400.0	9400.1	9400.0	9399.7	Complied.
	-10°C	9400.0	9399.3	9399.5	9399.9	9400.7	9399.3	Complied.
	0°C	9399.7	9399.5	9399.5	9400.3	9399.5	9400.1	Complied.
	+10°C	9399.7	9399.7	9400.2	9399.7	9399.4	9399.5	Complied.
	+20°C	9399.5	9399.7	9400.7	9399.9	9399.6	9400.1	Complied.
	+30°C	9399.7	9399.7	9399.7	9399.5	9399.7	9399.8	Complied.
	+40°C	9399.7	9399.7	9399.8	9399.8	9399.8	9399.7	Complied.
	+50°C	9399.7	9399.7	9399.5	9399.7	9399.7	9399.7	Complied.

CH2, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9400.3	9399.8	9400.2	9399.9	9399.9	9399.9	Complied.
	-10°C	9401.0	9400.2	9400.0	9399.9	9400.1	9399.9	Complied.
	0°C	9400.0	9399.8	9399.9	9399.9	9399.9	9400.0	Complied.
	+10°C	9400.0	9399.8	9399.7	9399.9	9400.0	9399.9	Complied.
	+20°C	9400.7	9400.7	9400.2	9399.9	9399.9	9399.9	Complied.
	+30°C	9400.0	9399.7	9399.8	9400.0	9399.9	9399.9	Complied.
	+40°C	9400.0	9400.0	9400.0	9399.9	9399.9	9399.9	Complied.
	+50°C	9400.0	9400.0	9400.0	9399.9	9400.0	9399.9	Complied.

CH2, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9420.2	9420.2	9419.7	9419.5	9420.0	9420.4	Complied.
	-10°C	9420.0	9420.7	9420.7	9419.9	9419.7	9419.5	Complied.
	0°C	9419.7	9419.5	9420.7	9419.5	9419.7	9420.3	Complied.
	+10°C	9420.0	9419.7	9419.8	9419.7	9420.2	9420.5	Complied.
	+20°C	9420.3	9420.0	9419.7	9419.7	9419.5	9420.0	Complied.
	+30°C	9420.0	9419.7	9419.5	9420.7	9419.5	9420.3	Complied.
	+40°C	9419.7	9420.0	9419.8	9419.9	9419.8	9419.8	Complied.
	+50°C	9420.0	9420.3	9419.8	9419.9	9419.9	9420.0	Complied.

CH3, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9420.0	9420.0	9420.0	9419.9	9420.0	9420.0	Complied.
	-10°C	9420.0	9420.0	9420.2	9419.9	9419.9	9420.1	Complied.
	0°C	9420.3	9419.8	9419.9	9419.8	9420.1	9419.9	Complied.
	+10°C	9420.3	9419.8	9419.9	9419.9	9419.9	9419.9	Complied.
	+20°C	9420.3	9419.5	9419.7	9419.9	9419.7	9419.9	Complied.
	+30°C	9419.7	9420.2	9419.8	9419.7	9419.8	9419.8	Complied.
	+40°C	9419.3	9419.7	9419.8	9419.8	9419.9	9419.9	Complied.
	+50°C	9419.7	9419.7	9419.8	9419.9	9419.9	9419.9	Complied.

CH3, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	-20°C	9440.0	9439.7	9439.8	9439.5	9439.6	9439.9	Complied.
	-10°C	9440.0	9440.7	9439.7	9439.7	9439.5	9439.7	Complied.
	0°C	9439.7	9439.8	9439.8	9439.5	9439.5	9439.2	Complied.
	+10°C	9440.7	9440.0	9440.0	9439.5	9439.7	9440.0	Complied.
	+20°C	9440.0	9439.7	9439.7	9439.7	9439.7	9439.7	Complied.
	+30°C	9440.0	9439.7	9440.3	9439.7	9440.2	9439.5	Complied.
	+40°C	9439.7	9440.0	9440.0	9439.8	9439.7	9439.8	Complied.
	+50°C	9439.7	9439.7	9439.8	9440.0	9440.0	9440.0	Complied.

(4.2) At the temperature of +20°C:

CH1, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	10.2 VDC	9380.2	9379.8	9380.0	9379.8	9379.8	9379.8	Complied.
	24.0 VDC	9379.8	9380.5	9380.0	9379.8	9379.8	9379.8	Complied.
	27.6 VDC	9379.8	9380.2	9380.0	9379.8	9379.8	9379.8	Complied.

CH1, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	10.2 VDC	9400.5	9399.3	9399.3	9399.9	9399.5	9399.8	Complied.
	24.0 VDC	9399.5	9399.7	9400.7	9399.9	9399.6	9400.1	Complied.
	27.6 VDC	9399.5	9399.7	9399.7	9399.6	9399.5	9399.5	Complied.

CH2, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	10.2 VDC	9400.7	9399.7	9399.8	9399.8	9399.9	9400.0	Complied.
	24.0 VDC	9400.7	9400.7	9400.2	9399.9	9399.9	9399.9	Complied.
	27.6 VDC	9400.0	9400.3	9400.0	9399.8	9399.9	9399.9	Complied.

CH2, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	10.2 VDC	9420.0	9420.7	9420.0	9419.7	9419.8	9420.0	Complied.
	24.0 VDC	9420.3	9420.0	9419.7	9419.7	9419.5	9420.0	Complied.
	27.6 VDC	9420.3	9419.7	9420.0	9419.8	9419.8	9420.0	Complied.

CH3, P0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	10.2 VDC	9420.3	9419.8	9420.0	9419.7	9419.9	9419.8	Complied.
	24.0 VDC	9420.3	9419.5	9419.7	9419.9	9419.7	9419.9	Complied.
	27.6 VDC	9419.0	9420.0	9419.7	9419.9	9419.9	9419.9	Complied.

CH3, Q0N

Pulse type		S1	S2	M1	M2	M3	L	Result
Frequency at maximum emission (MHz)	10.2 VDC	9439.7	9440.0	9439.5	9439.8	9439.5	9439.8	Complied.
	24.0 VDC	9440.0	9439.7	9439.7	9439.7	9439.7	9439.7	Complied.
	27.6 VDC	9439.7	9439.7	9439.7	9439.7	9439.8	9440.0	Complied.

Environmental conditions observed: On 7 July 2015, 24°C to 25°C, 64%RH to 68%RH
On 8 July 2015, 24°C to 24°C, 68%RH to 68%RH
On 9 July 2015, 24°C to 25°C, 68%RH to 65%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC.

3.4 Occupied Bandwidth (FCC Rule 47 CFR, 2.1049(c)(1), 80.209(b), 80.211(f))

(1) Test conditions:

For all TX pulses (S1/S2/M1/M2/M3/L/L2), the transmitter occupied bandwidth was measured at the antenna port with Antenna replaced with the Non-reflective load.

(2) Test setup:

See Clause 4.

(3) Emission Limits (FCC Rule 47 CFR, 80.211 (f)):

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

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

(*2): Authorized bandwidth = 110 MHz (for X-band radars)

(4) Test Results:

Spectrum plots: See Clause 8.

Environmental conditions observed: On 12 July 2015, 24°C to 24°C, 64%RH to 64%RH

Power supply voltage measured: 24.0 VDC to 24.0 VDC.

3.5 Spurious Emissions at Antenna Port (FCC Rule 47 CFR, 2.1051, 80.211(f))

(1) Test Conditions:

For S1 Pulses, the transmitter output power was measured at the antenna port with Antenna replaced with the non-reflective load. (*1)

(*1): Tested only with S1 pulse that is the widest in B-40 calculation. The requirement is as follows.

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)

(2) Test setup:

See Clause 4.

(3) Emission Limits (FCC Rule 47 CFR, 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): The measurement range for X-Band RADAR: from 4.59 GHz to 40 GHz

(4) Spurious Frequencies:

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

(5) Test Results:

Complied.

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

Environmental conditions observed: On 28 August 2015, 25°C to 25°C, 65%RH to 65%RH

Power supply voltage measured: 24.0 VDC to 24.0 VDC.

3.6 Field Strength of Spurious Radiation (FCC Rule 47 CFR, 2.1053, 80.211(f))

(1) Test Conditions:

For S1 Pulses, the transmitter output power was measured at the antenna port with Antenna replaced with the Non-reflective load. (*1)

(*1): Tested only with S1 pulse that is the widest in B-40 calculation. The requirement is as follows:

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)

(a): The measurement range for X-Band RADAR: from 4.59 GHz to 40 GHz

(b): The antenna port was terminated with dummy load.

(2) **Test Site:** LIC Nishinomiya-Hama Laboratory, Semi-Anechoic Chamber
(FCC file number: 90607)

(3) **Distance between the radar set and measuring antenna:** 3 m

(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 (2.4 m × 3.6 m × 0.3 m) to reduce the influences of the reflections of the RF waves from the floor.

Measuring (Receiving) Antenna height and polarization:

(a) Antenna height: EUT center (1.61 m)

(b) Antenna polarization: vertical and horizontal.

EUT height: 1.5 m

(5) Field Strength Limits (FCC Rule 47 CFR, 80.211 (f)):

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

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

(*2): Authorized bandwidth = 110 MHz (for X-band radars)

(6) Spurious Frequencies:

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

(7) Test Results:

Complied.

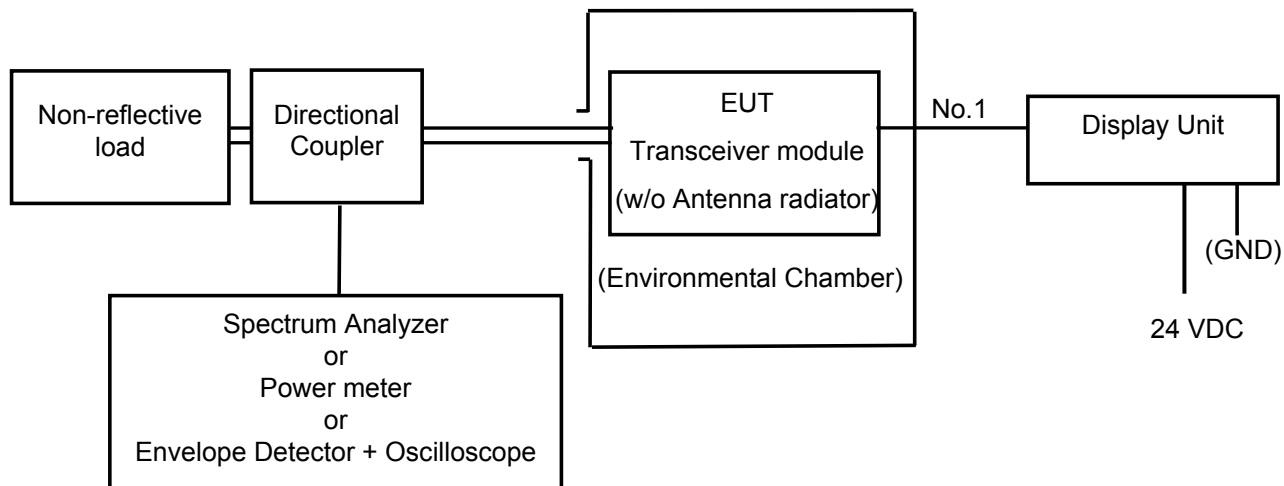
Spurious emission levels measured were found to be attenuated more than 20 dB below the limits.

Environmental conditions observed: On 2 September 2015, 25°C to 25°C, 54%RH to 54%RH

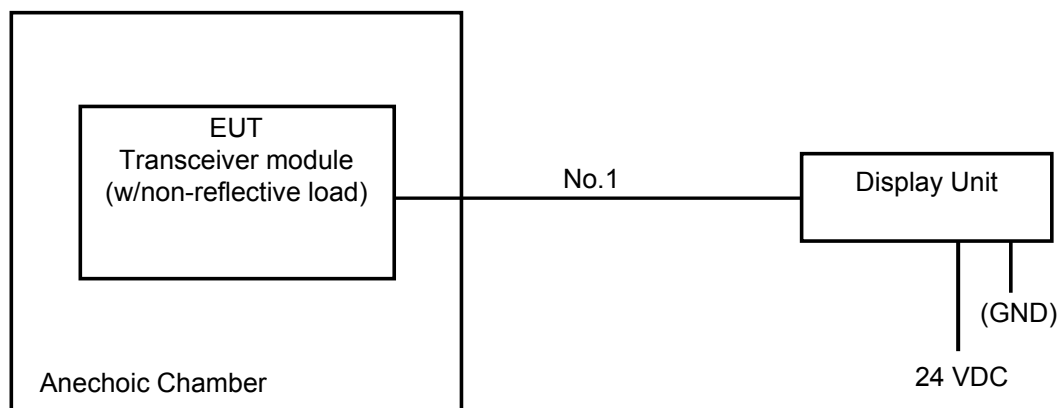
Power supply voltage measured: 24.0 VDC to 24.0 VDC.

4 Test Setup for Measurements

Test Setup for Clauses 3.1, 3.2, 3.3, 3.4, and 3.5.



(2) Test Setup for Clause 3.6.



Cable designations:

No.	Type	Length (m)
1	FRU-2P5S-FF-20M	20

5 Measuring Equipment List

(1) For 3.1 RF Power Output:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
120121202	Directional Coupler (X-band)	5D364S	R05762	Shimada	1 July 2015	1 year
120121202	Dummy Load (X-band)	4D376	R4535004	Shimada	1 July 2015	1 year
----	Waveguide (for X-band)	WRJ-10 (l = 60 cm)	----	Furuno	----	----
0505026	Power meter	E4418B	GB43317662	Agilent	15 June 2015	1 year
HT654	Step Attenuator	8494B	MY42148134	Agilent	6 March 2015	1 year
HT655	Step Attenuator	8495B	MY42144403	Agilent	6 March 2015	1 year
120110402	Power Sensor	N8481A	MY48100658	Agilent	15 June 2015	1 year
HT432	DC Power Supply	PAN55-20	AK003307	KIKUSUI	----	----

(2) For 3.2 Modulation Characteristics:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
120121202	Directional Coupler (X-band)	5D364S	R05762	Shimada	1 July 2015	1 year
120121202	Dummy Load (X-band)	4D376	R4535004	Shimada	1 July 2015	1 year
----	Waveguide (for X-band)	WRJ-10 (l = 60 cm)	----	Furuno	----	----
HT654	Step Attenuator	8494B	MY42148134	Agilent	6 March 2015	1 year
HT655	Step Attenuator	8495B	MY42144403	Agilent	6 March 2015	1 year
HT913	Crystal Detector	423B	MY51340543	Agilent	10 February 2015	1 year
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent	11 March 2015	1 year
8408087	Frequency Counter	TR5824A	41940036	ADVANTEST	18 May 2015	1 year
HT972	Oscilloscope	MSO4054B	C030483	Tektronix	23 March 2015	1 year
HT432	DC Power Supply	PAN55-20	AK003307	KIKUSUI	----	----

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

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
HT414	Climatic Chamber (Small)	PL-4KP	14004203	Espec	18 September 2014	1 year
HT726	Paperless recorder/Dual communication logger DAQSTATION FX100	FX106-4-1	S5JA01448	Yokogawa	9 September 2014	1 year
120121202	Directional Coupler (X-band)	5D364S	R05762	Shimada	1 July 2015	1 year
120121202	Dummy Load (X-band)	4D376	R4535004	Shimada	1 July 2015	1 year
----	Waveguide (for X-band)	WRJ-10 (l = 60 cm)	----	Furuno	----	----
HT654	Step Attenuator	8494B	MY42148134	Agilent	6 March 2015	1 year
HT655	Step Attenuator	8495B	MY42144403	Agilent	6 March 2015	1 year
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent	11 March 2015	1 year
HT432	DC Power Supply	PAN55-20	AK003307	KIKUSUI	----	----

(4) For 3.4 Occupied Bandwidth and for 3.5 Spurious Emissions at Antenna Port:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
120121202	Directional Coupler (X-band)	5D364S	R05762	Shimada	1 July 2015	1 year
120121202	Dummy Load (X-band)	4D376	R4535004	Shimada	1 July 2015	1 year
----	Waveguide (for X-band)	WRJ-10 (l = 60 cm)	----	Furuno	----	----
HT654	Step Attenuator	8494B	MY42148134	Agilent	6 March 2015	1 year
HT655	Step Attenuator	8495B	MY42144403	Agilent	6 March 2015	1 year
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent	11 March 2015	1 year
HT432	DC Power Supply	PAN55-20	AK003307	KIKUSUI	----	----
KB179	Coaxial Cable for Radiated Emission Measurement	SUCOFLEX 104A	48932/4A	HUBER +SUHNER	1 July 2015	1 year
KB180	Coaxial Cable for Radiated Emission Measurement	SUCOFLEX 104A	48933/4A	HUBER +SUHNER	8 August 2015	1 year
KB181	Coaxial Cable for Radiated Emission Measurement	SUCOFLEX 102A	1261/2A	HUBER +SUHNER	8 August 2015	1 year

(5) For 3.6 Field Strength of Spurious Radiation:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent	11 March 2015	1 year
HT467	Double-ridged waveguide horn antenna (1 GHz to 18 GHz)	3115	6520	EMCO	12 August 2014	1 year
HT759	Double rigged horn antenna & amp.	HAP06-18W	00000065	TOYO	29 December 2014	1 year
HT761	Double rigged horn antenna & amp.	HAP18-26N	00000017	TOYO	29 December 2014	1 year
HT762	Double rigged horn antenna & amp.	HAP26-40N	00000010	TOYO	29 December 2014	1 year
HT755	Pre-amp. (1 GHz - 8 GHz, Gain 40 dB)	TAP0108-40	1017	Toyo Corp.	7 July 2015	1 year
HT365	Semi-anechoic Chamber	3mSAC	D-002	Riken	----	----
HT156	DC power supply	GP035-30	1014396080	Takasago	----	----
---	Dummy Load (X-band)	4D376	R27200013	Shimada	----	----
KB179	Coaxial Cable for Radiated Emission Measurement	SUCOFLEX 104A	48932/4A	HUBER +SUHNER	1 July 2015	1 year
KB180	Coaxial Cable for Radiated Emission Measurement	SUCOFLEX 104A	48933/4A	HUBER +SUHNER	8 August 2015	1 year
KB181	Coaxial Cable for Radiated Emission Measurement	SUCOFLEX 102A	1261/2A	HUBER +SUHNER	8 August 2015	1 year

6 Photographs of Test Setup/Arrangement

(1) For RF Power Output, Modulation Characteristics, Occupied Bandwidth, Frequency Stability –temperature & voltage, Spurious Emissions at Antenna Terminal.



(2) For Field Strength of Spurious Radiation



7 RF Envelopes and Spectrum of the output pulse

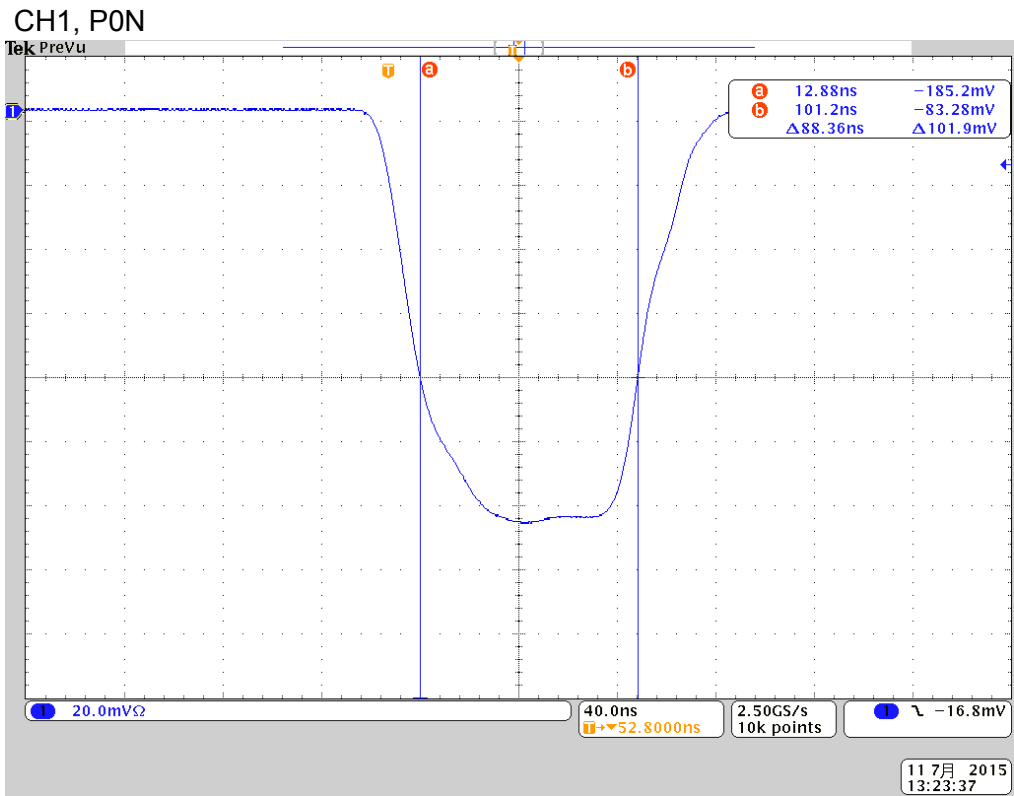


Fig. 7.1 S1 Pulse Envelope

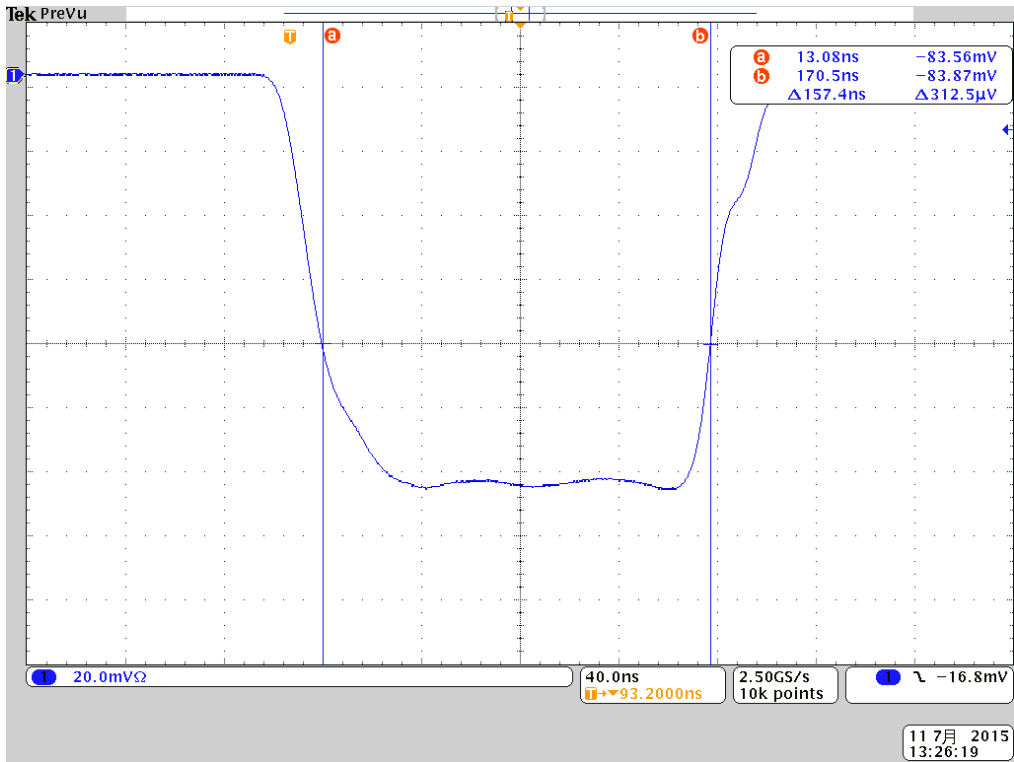


Fig. 7.2 S2 Pulse Envelope



Fig. 7.3 M1 Pulse Envelope

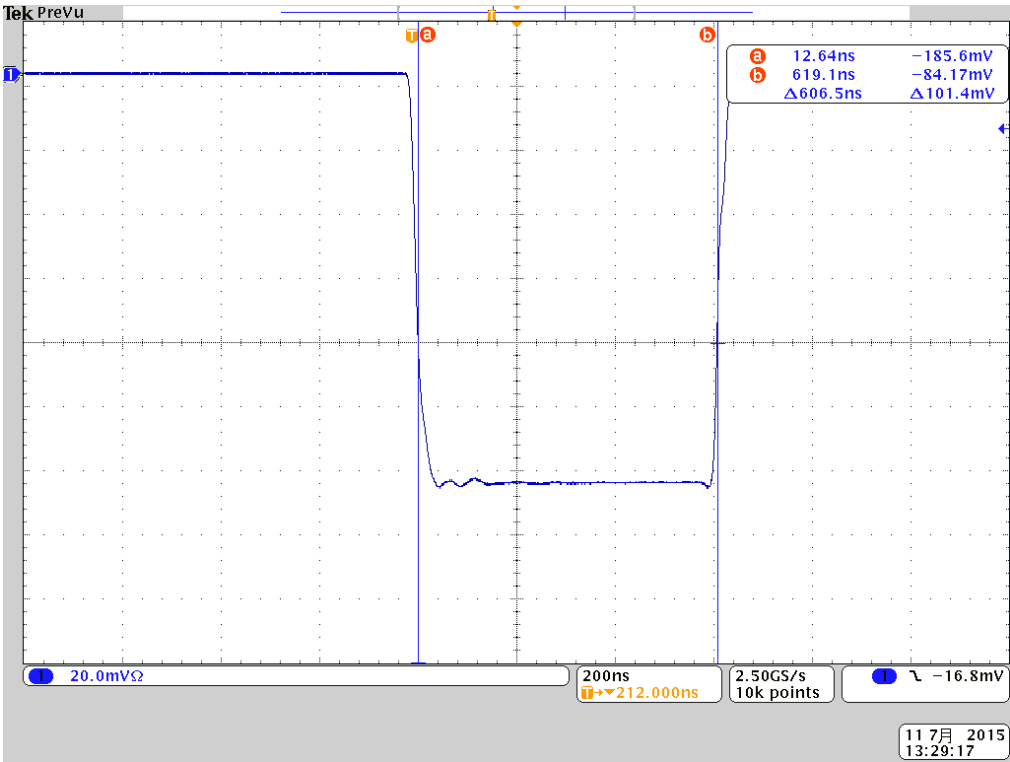


Fig. 7.4 M2 Pulse Envelope

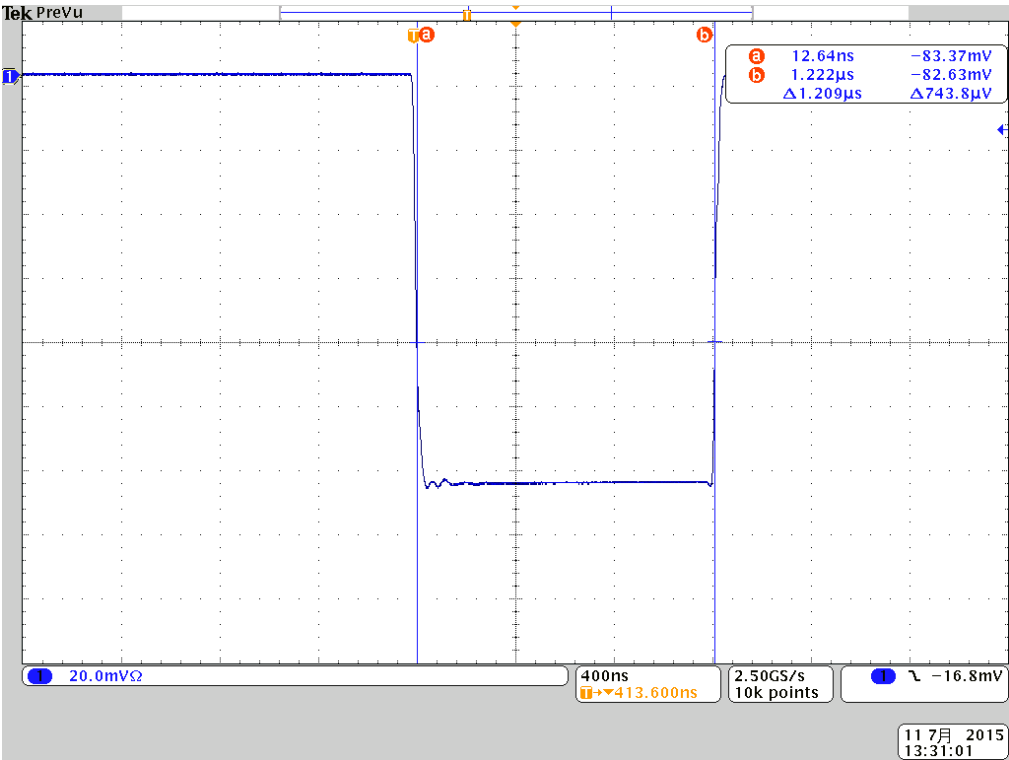


Fig. 7.5 M3 Pulse Envelope

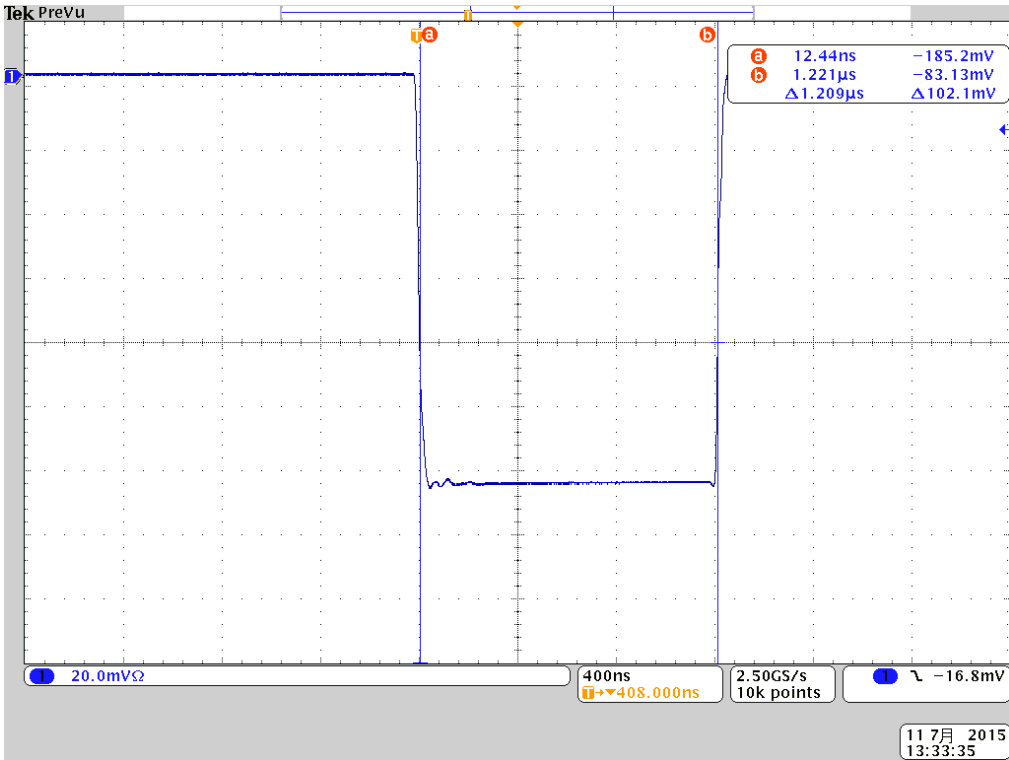


Fig. 7.6 L Pulse Envelope

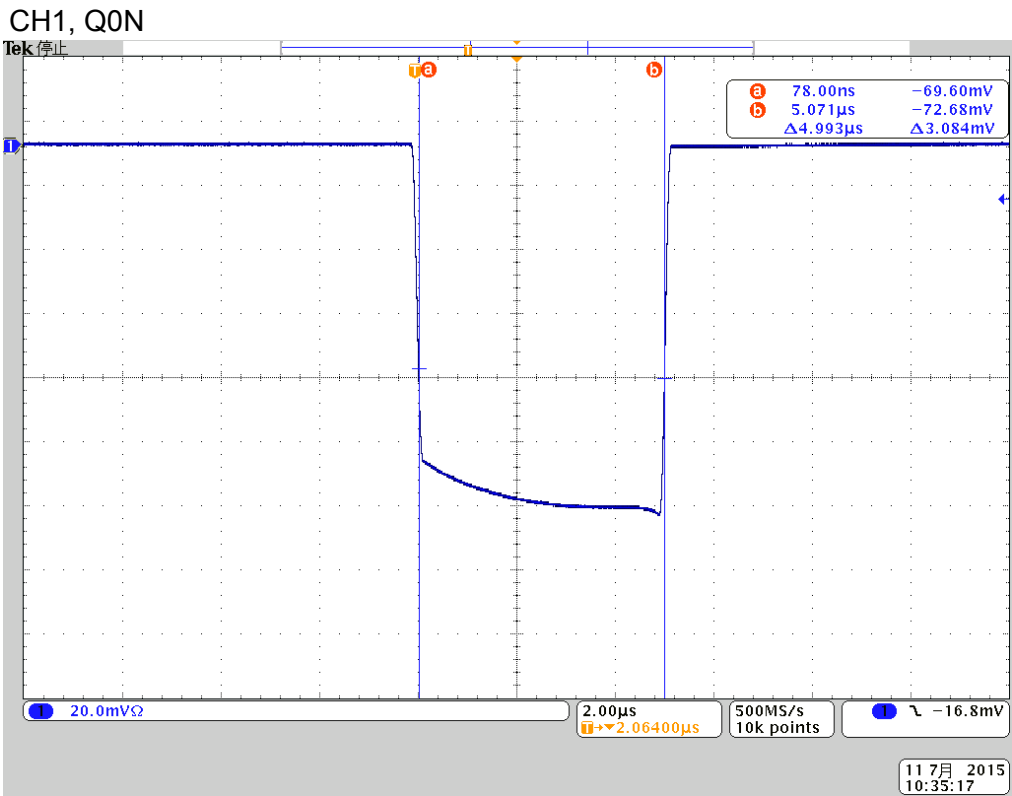


Fig. 7.7 S1 Pulse Envelope

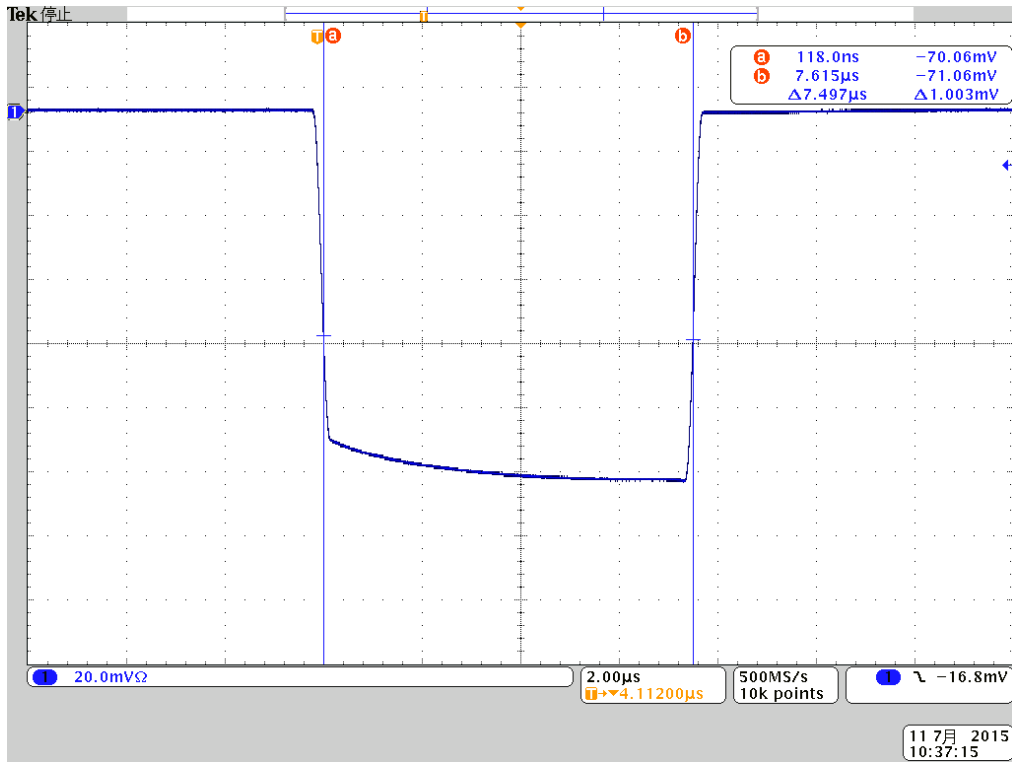


Fig. 7.8 S2 Pulse Envelope

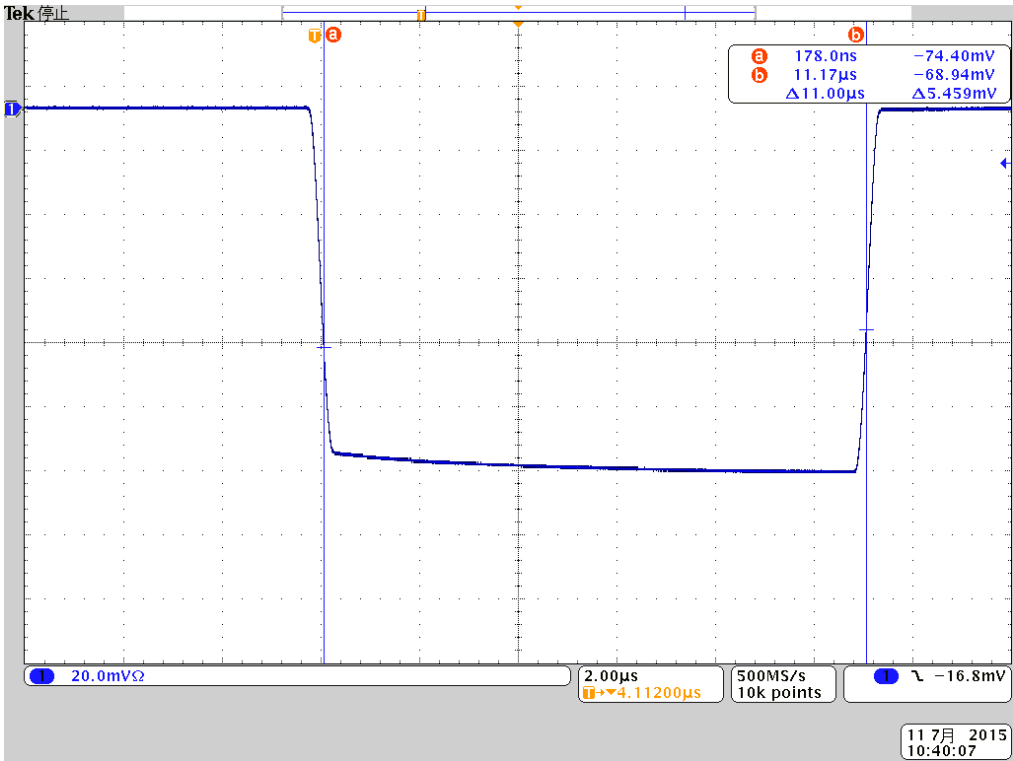


Fig. 7.9 M1 Pulse Envelope

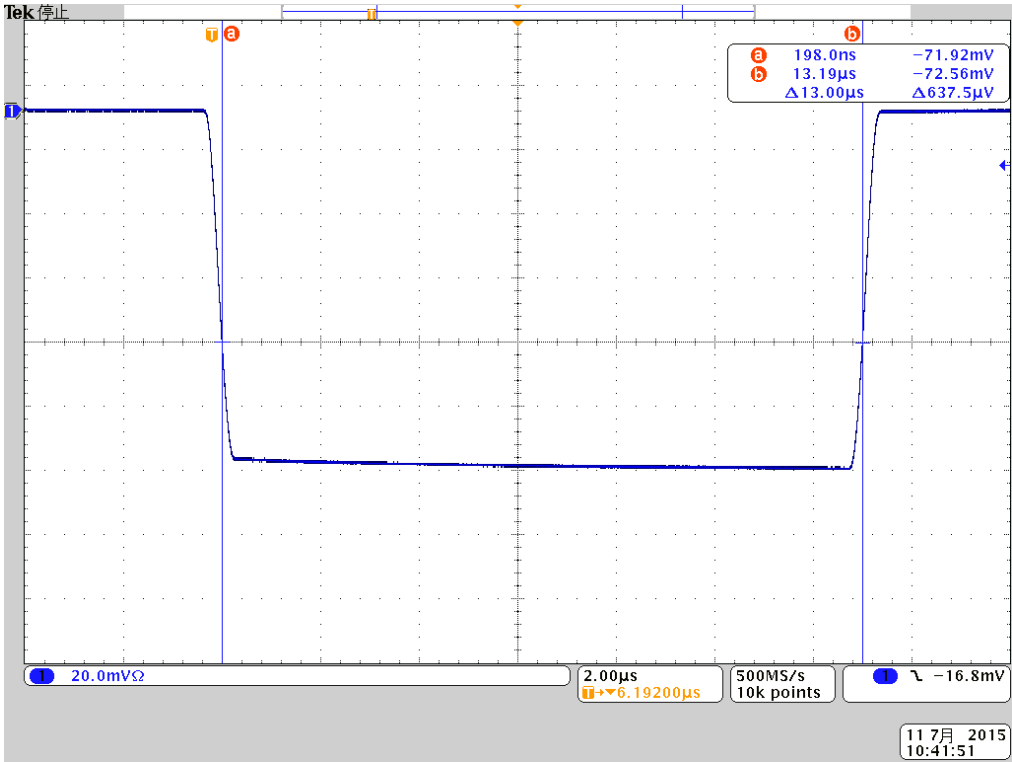


Fig. 7.10 M2 Pulse Envelope

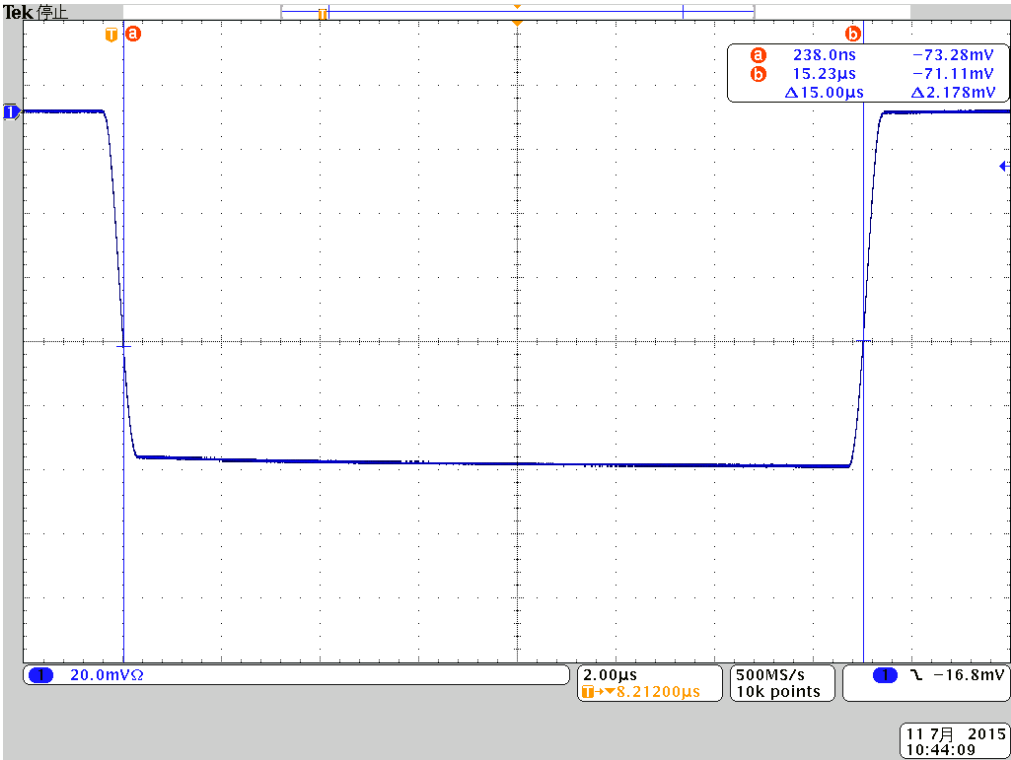


Fig. 7.11 M3 Pulse Envelope

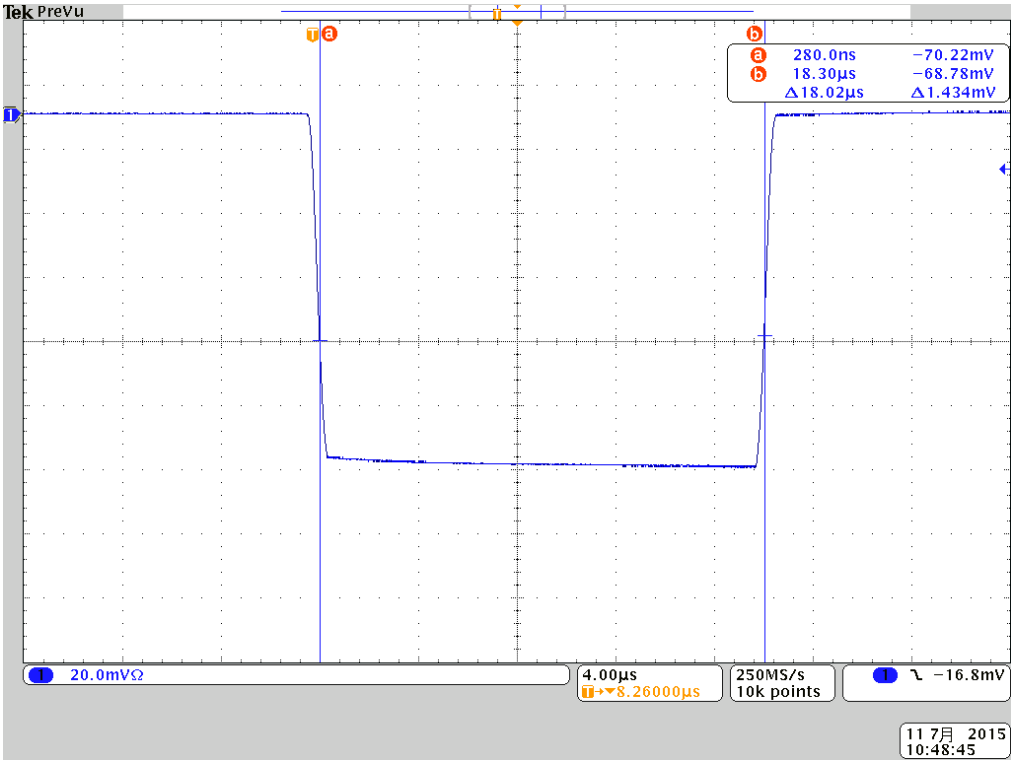


Fig. 7.12 L Pulse Envelope

CH2, P0N

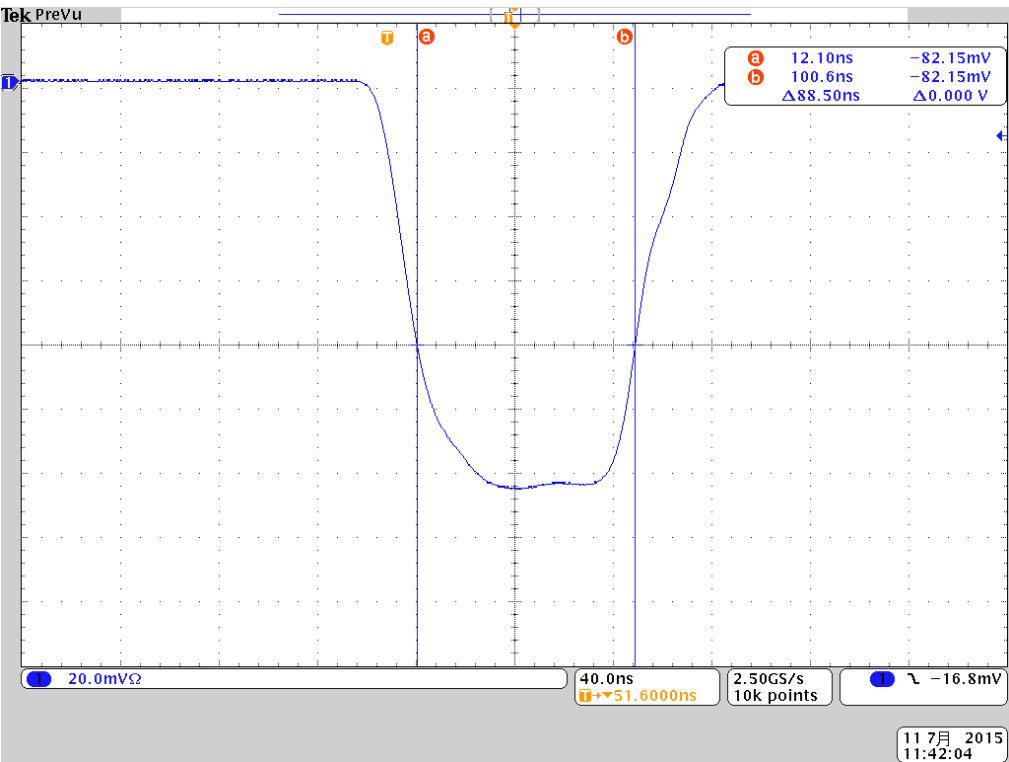


Fig. 7.13 S1 Pulse Envelope

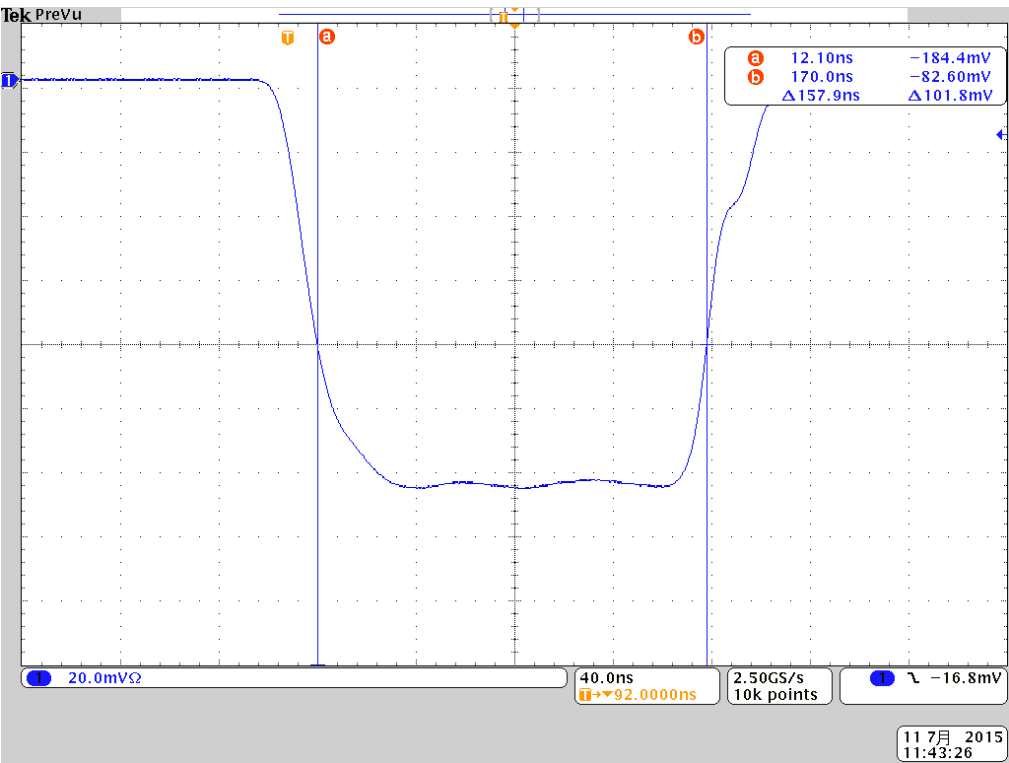


Fig. 7.14 S2 Pulse Envelope

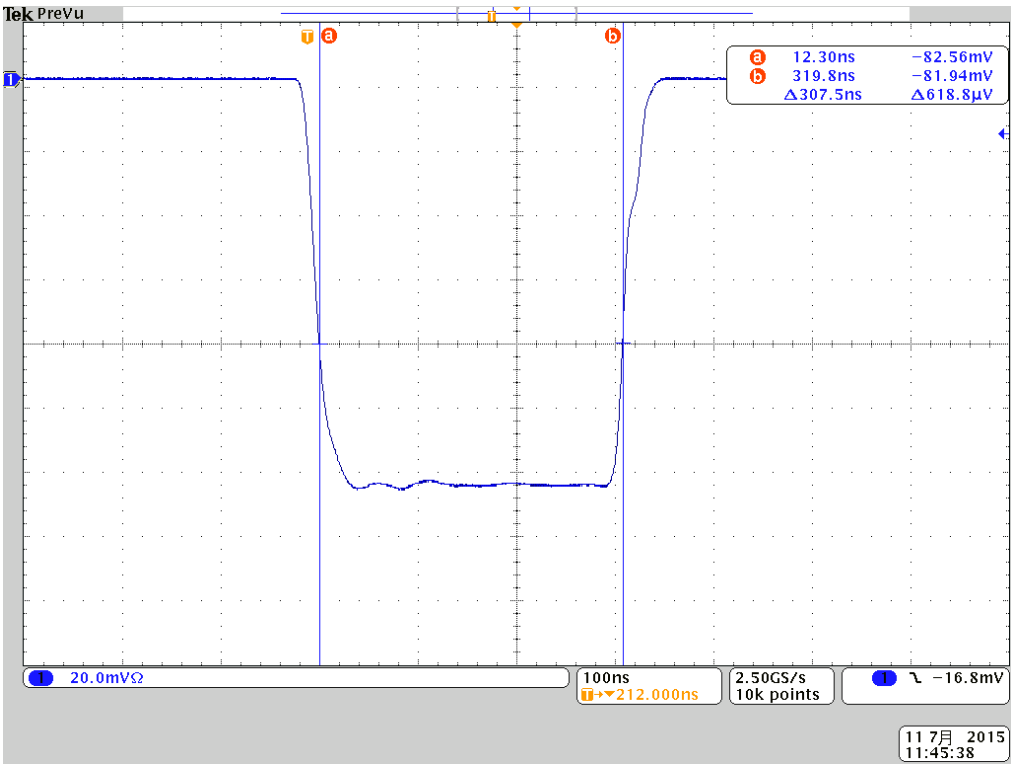


Fig. 7.15 M1 Pulse Envelope

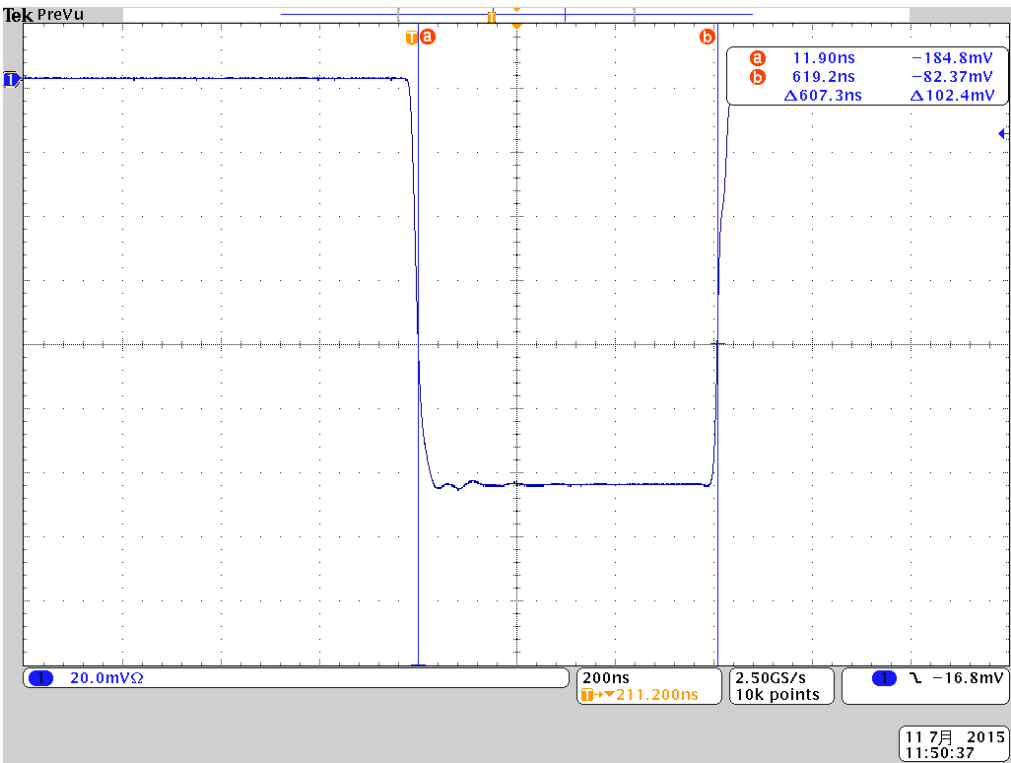


Fig. 7.16 M2 Pulse Envelope

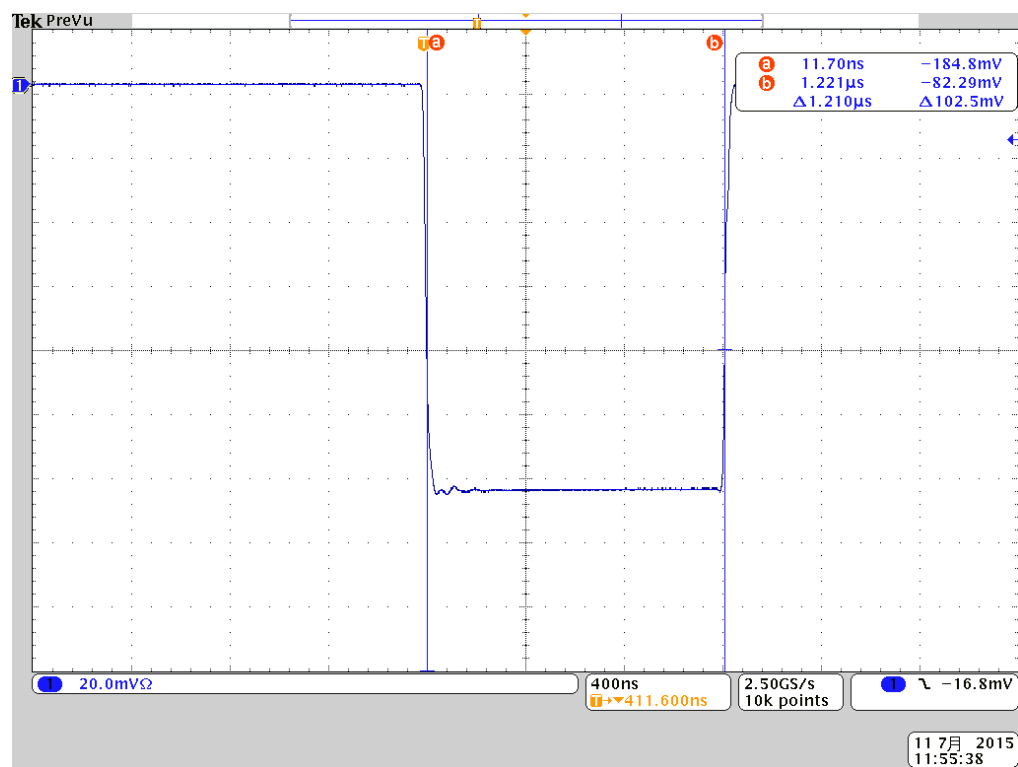


Fig. 7.17 M3 Pulse Envelope

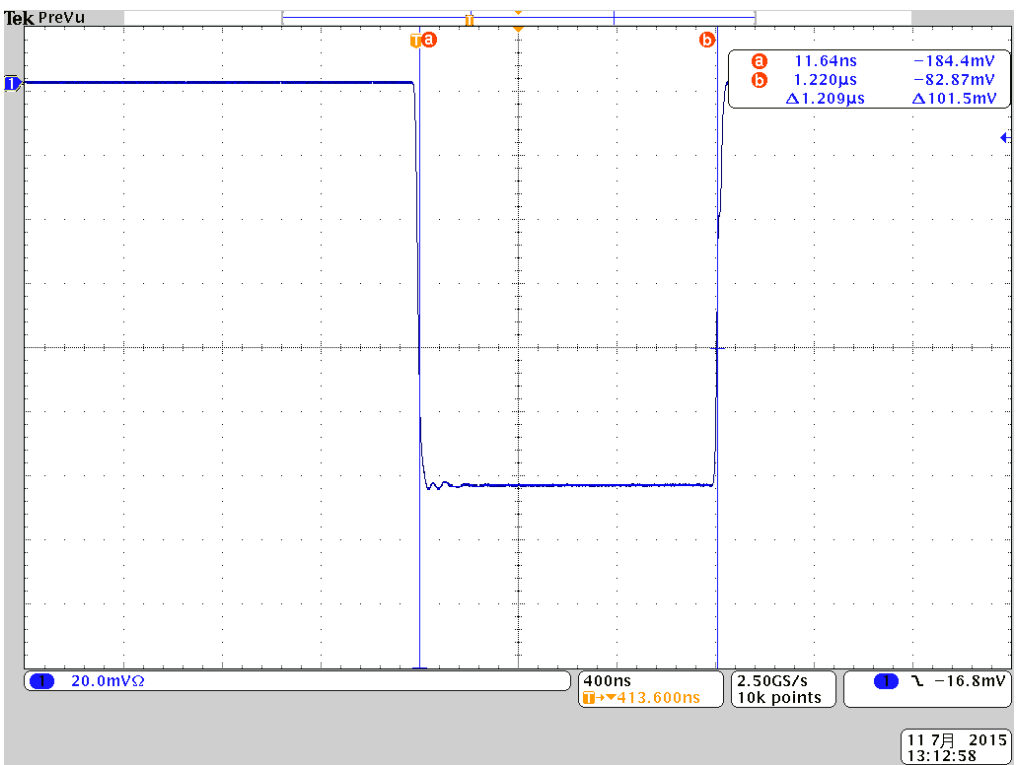


Fig. 7.18 L Pulse Envelope

CH2, Q0N

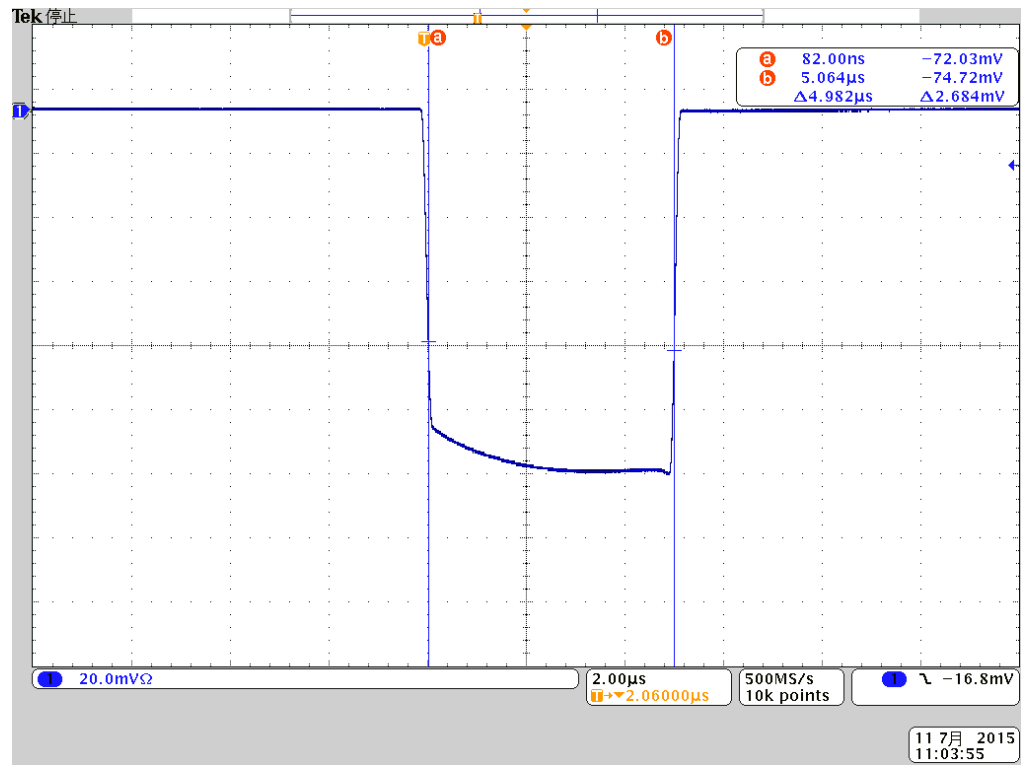


Fig. 7.19 S1 Pulse Envelope

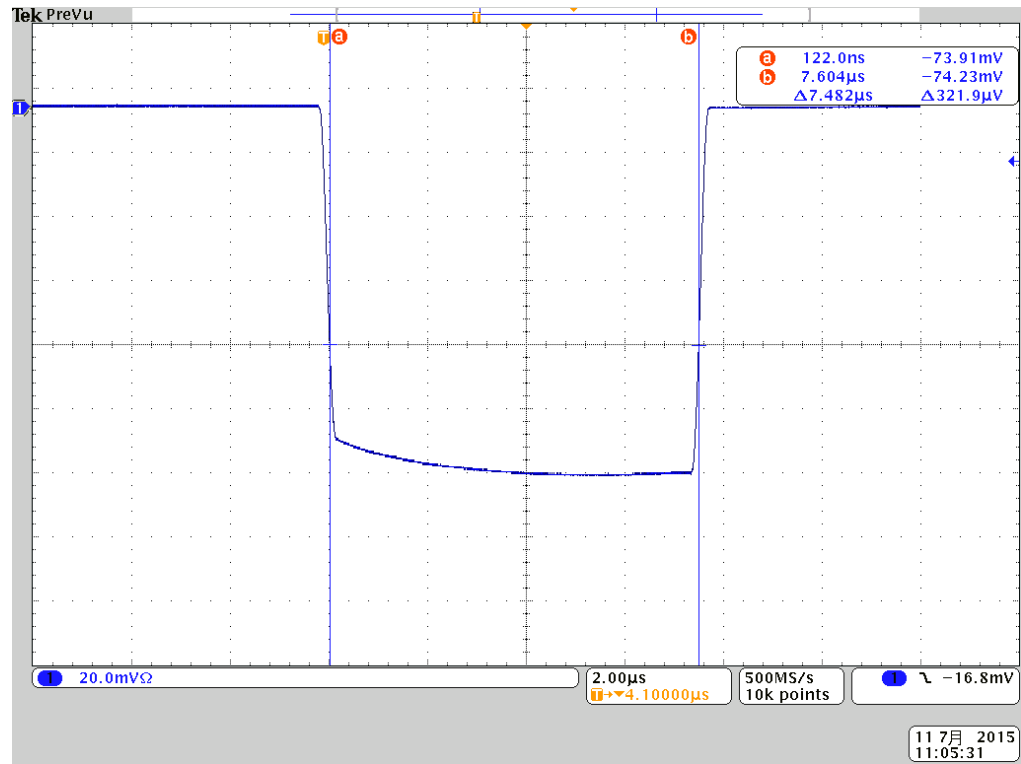


Fig. 7.20 S2 Pulse Envelope

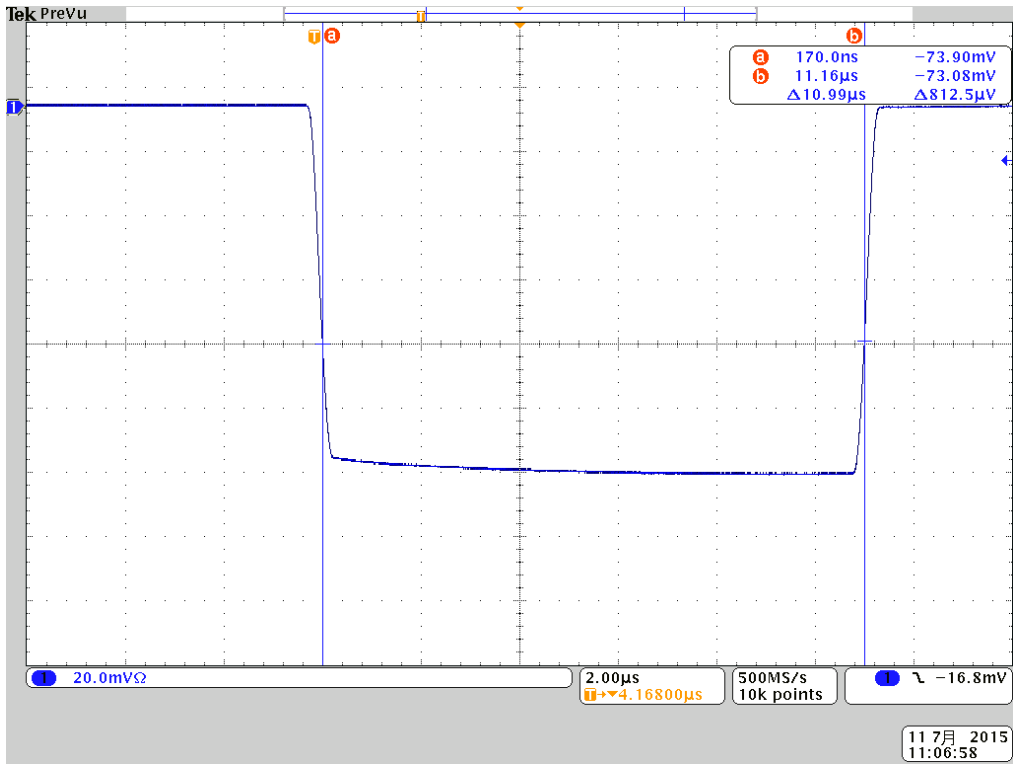


Fig. 7.21 M1 Pulse Envelope

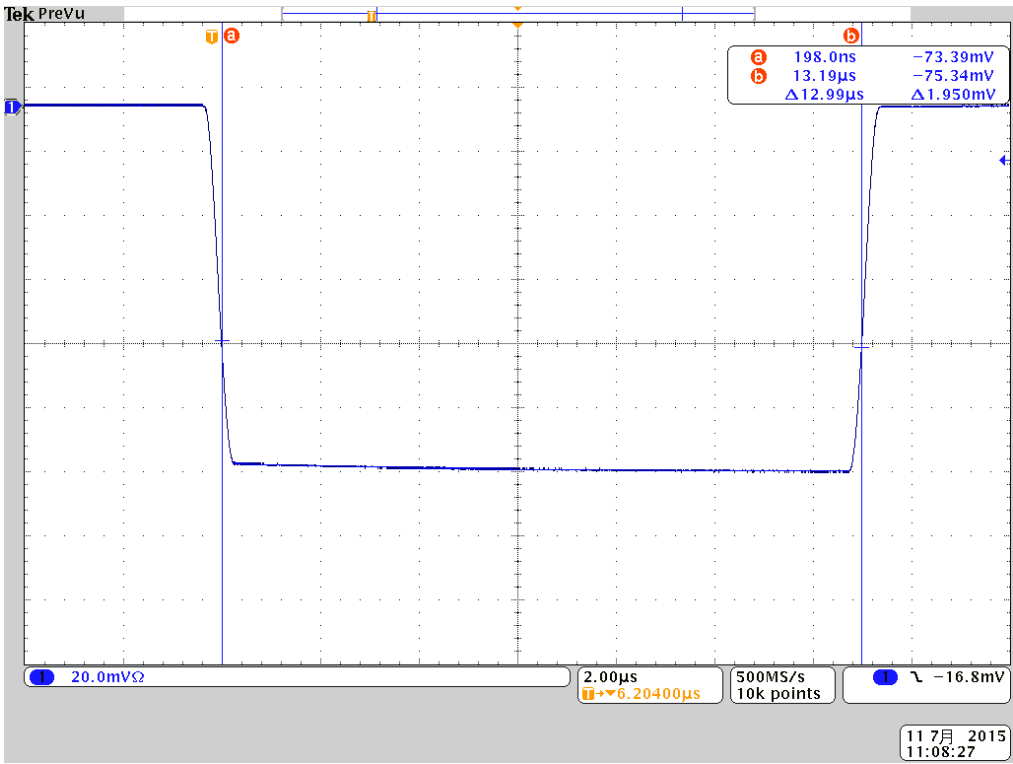


Fig. 7.22 M2 Pulse Envelope

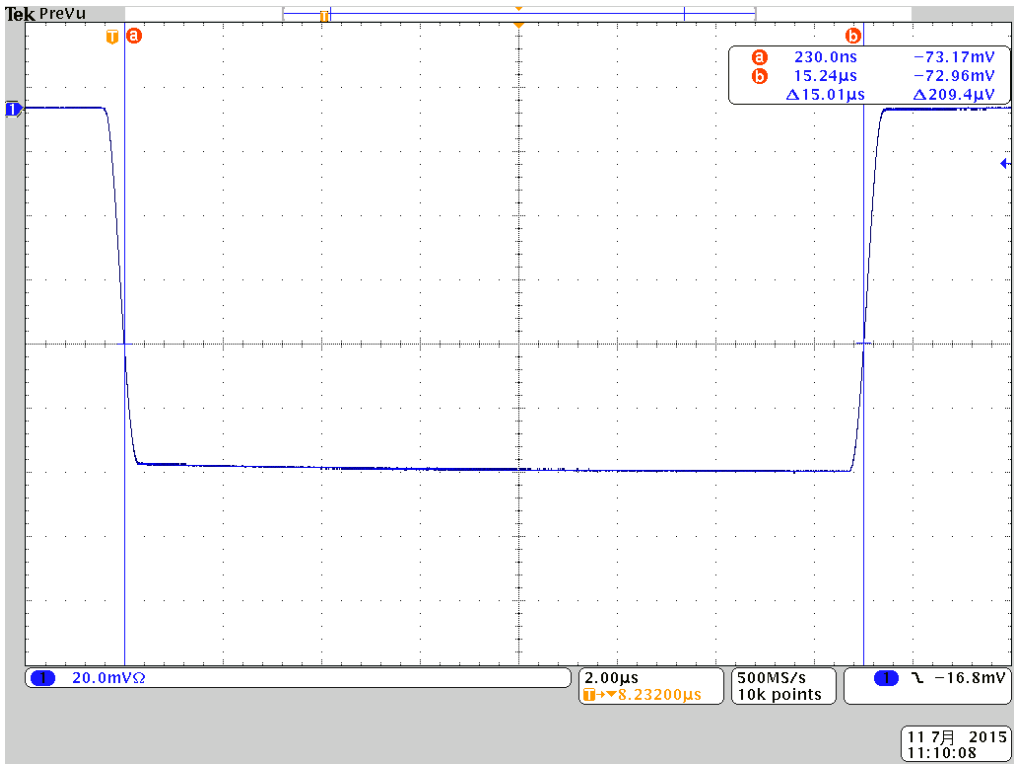


Fig. 7.23 M3 Pulse Envelope

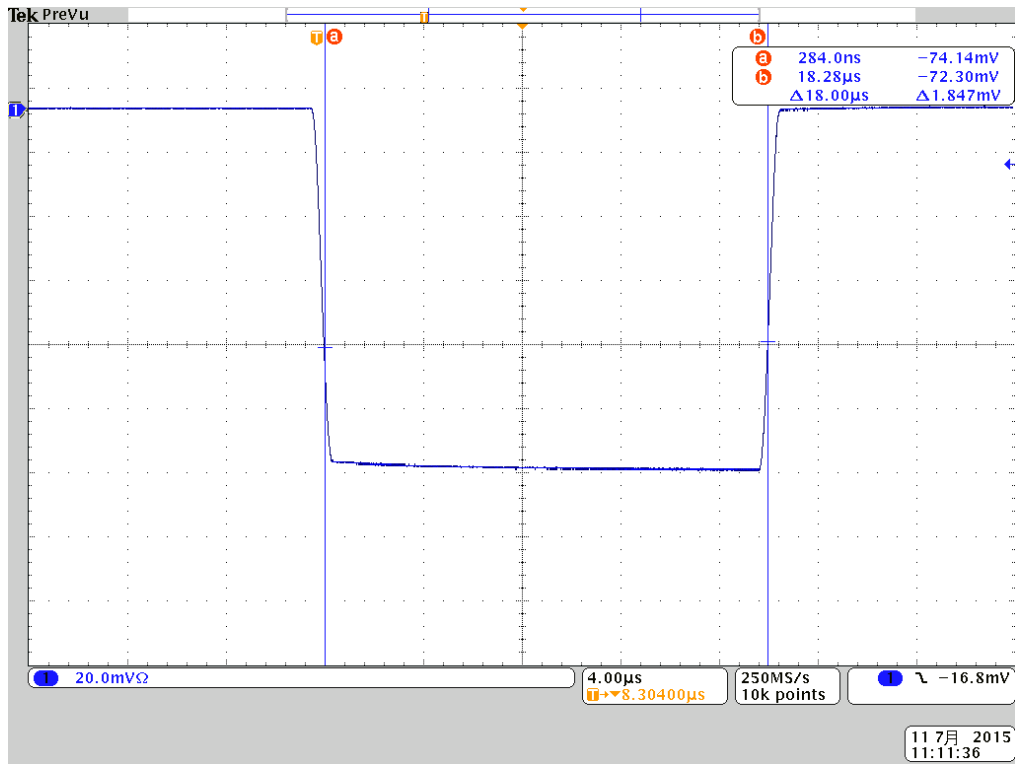


Fig. 7.24 L Pulse Envelope

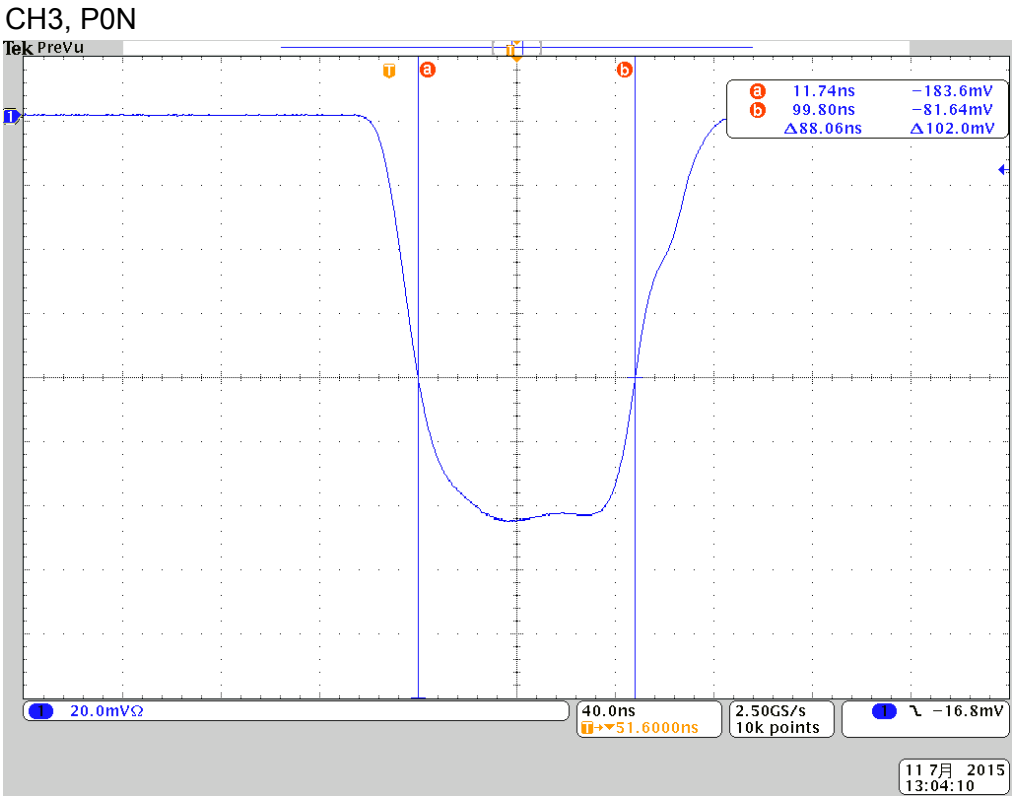


Fig. 7.25 S1 Pulse Envelope

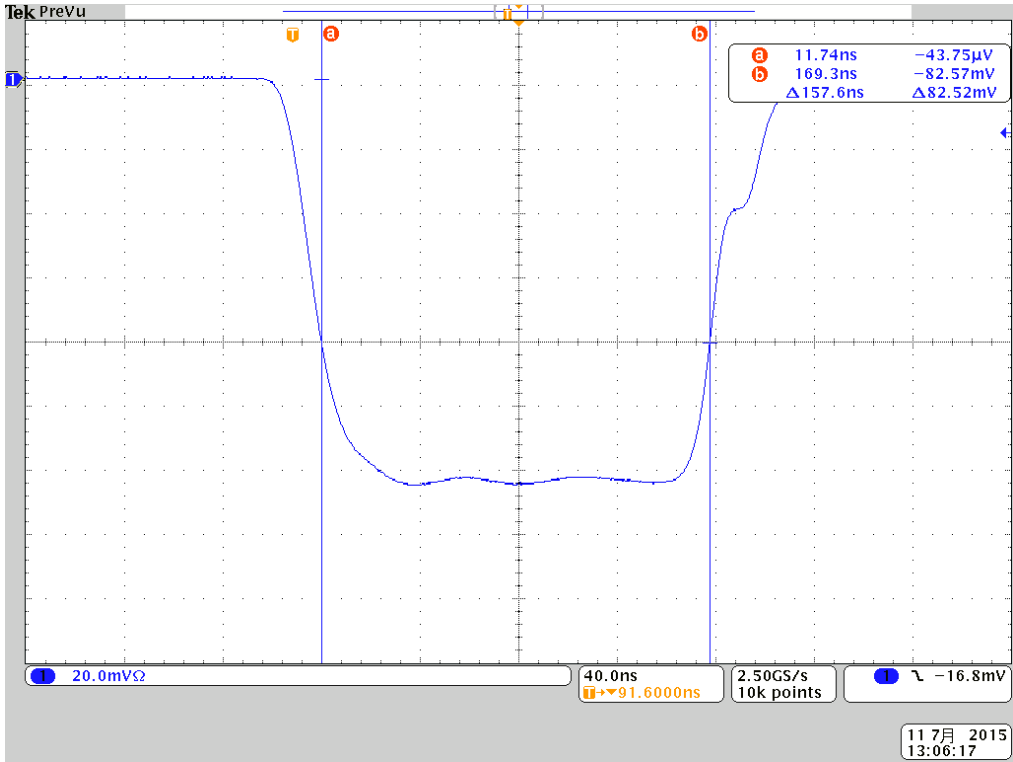


Fig. 7.26 S2 Pulse Envelope

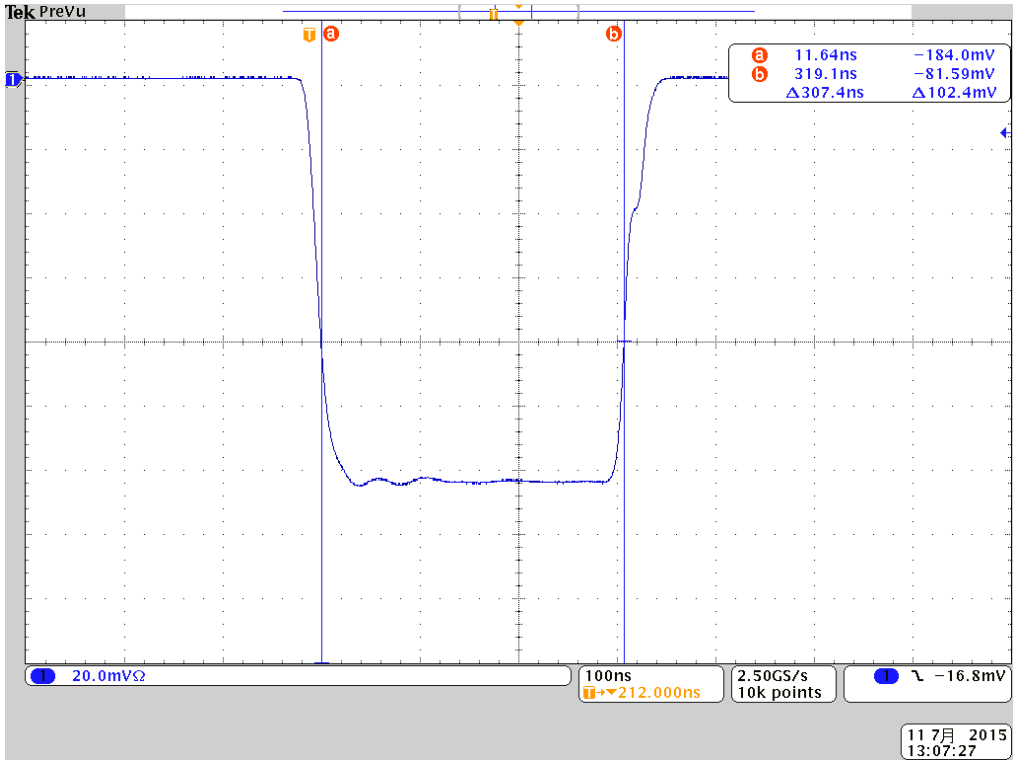


Fig. 7.27 M1 Pulse Envelope

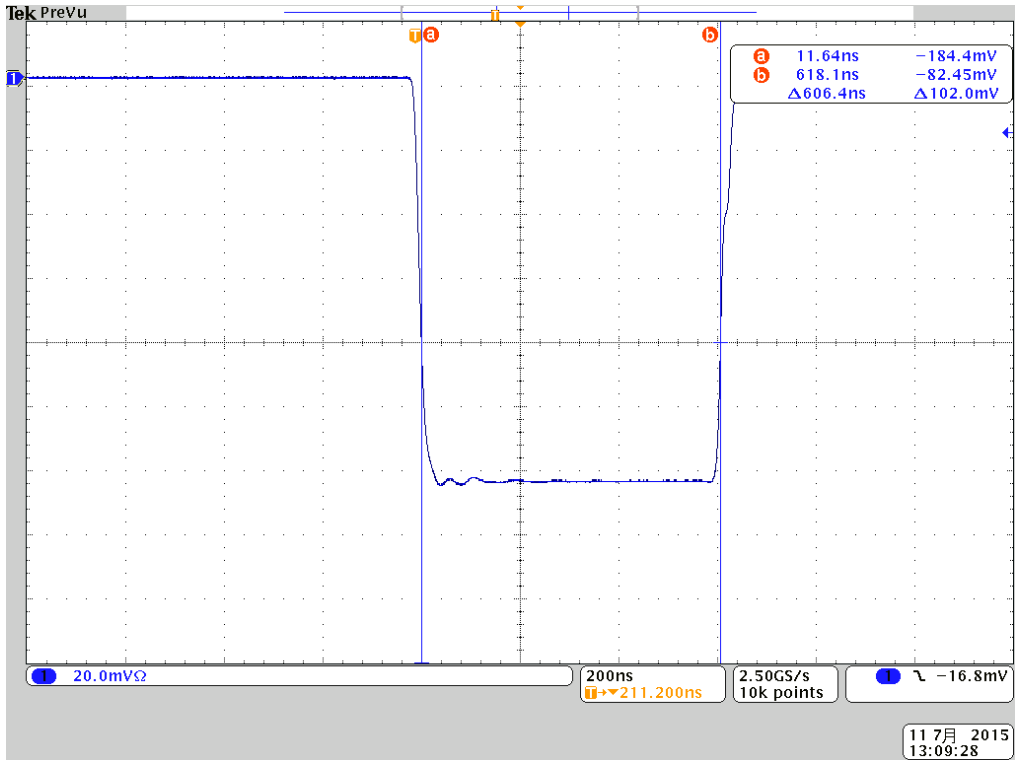


Fig. 7.28 M2 Pulse Envelope

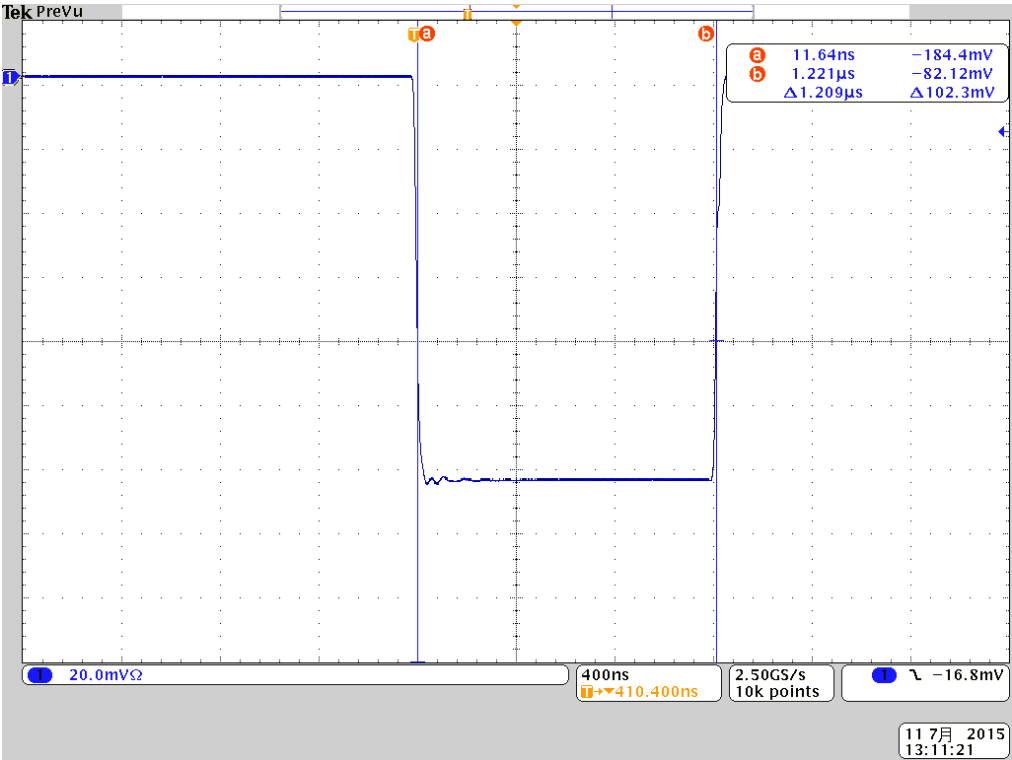


Fig. 7.29 M3 Pulse Envelope

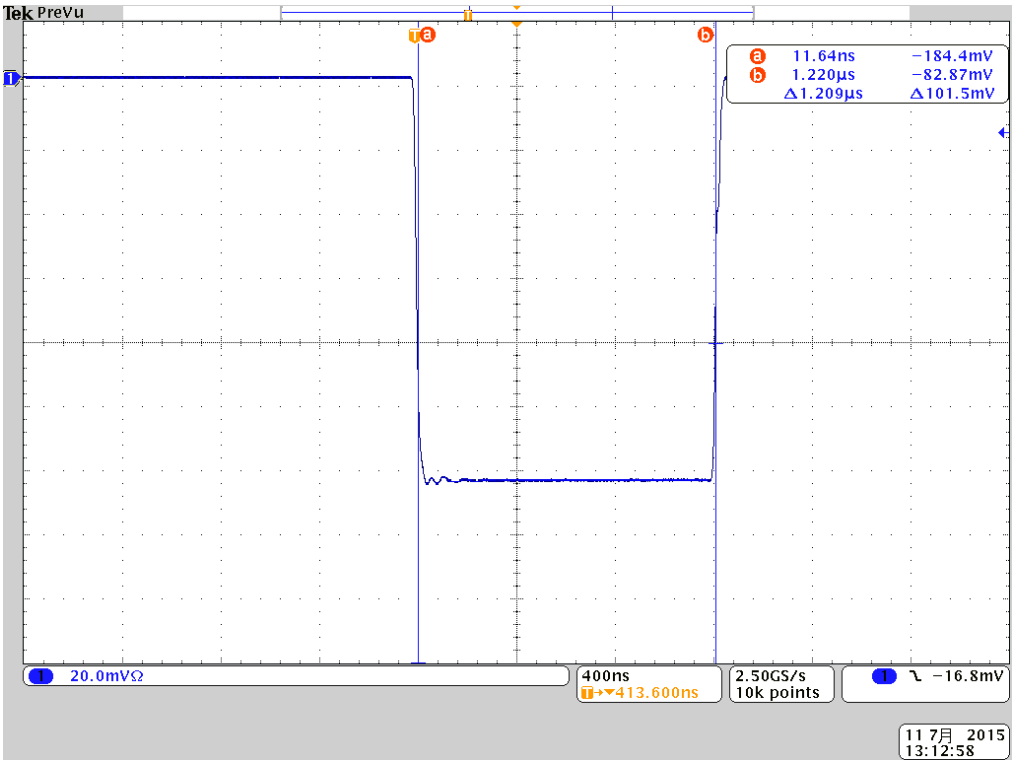


Fig. 7.30 L Pulse Envelope

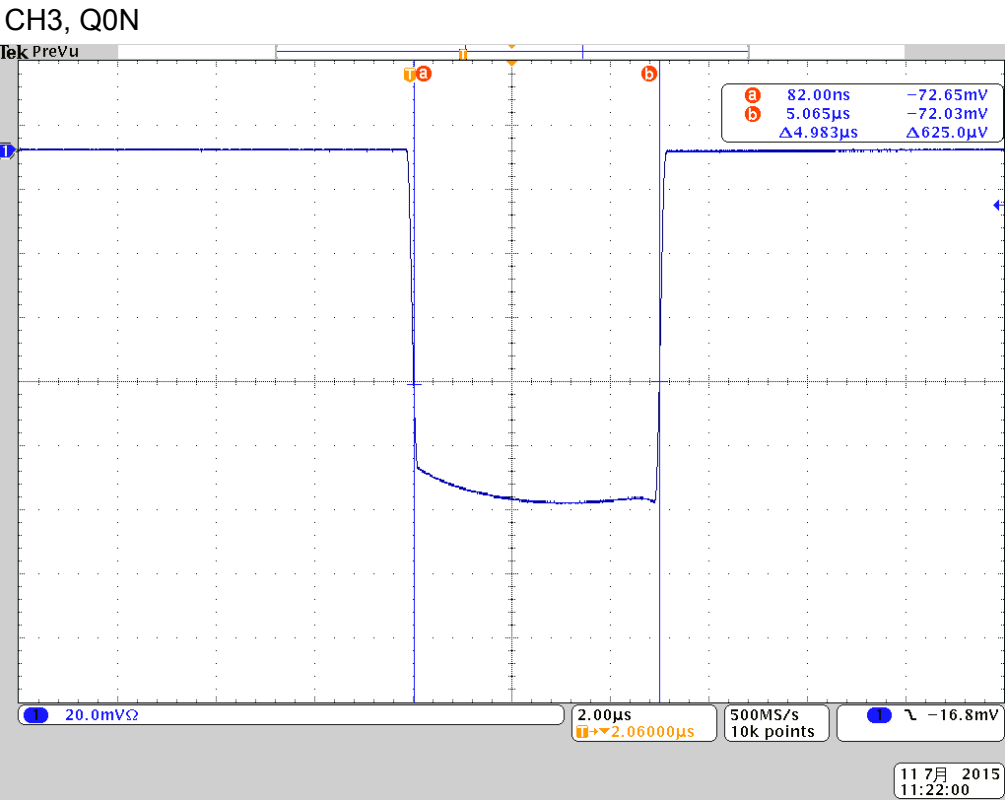


Fig. 7.31 S1 Pulse Envelope

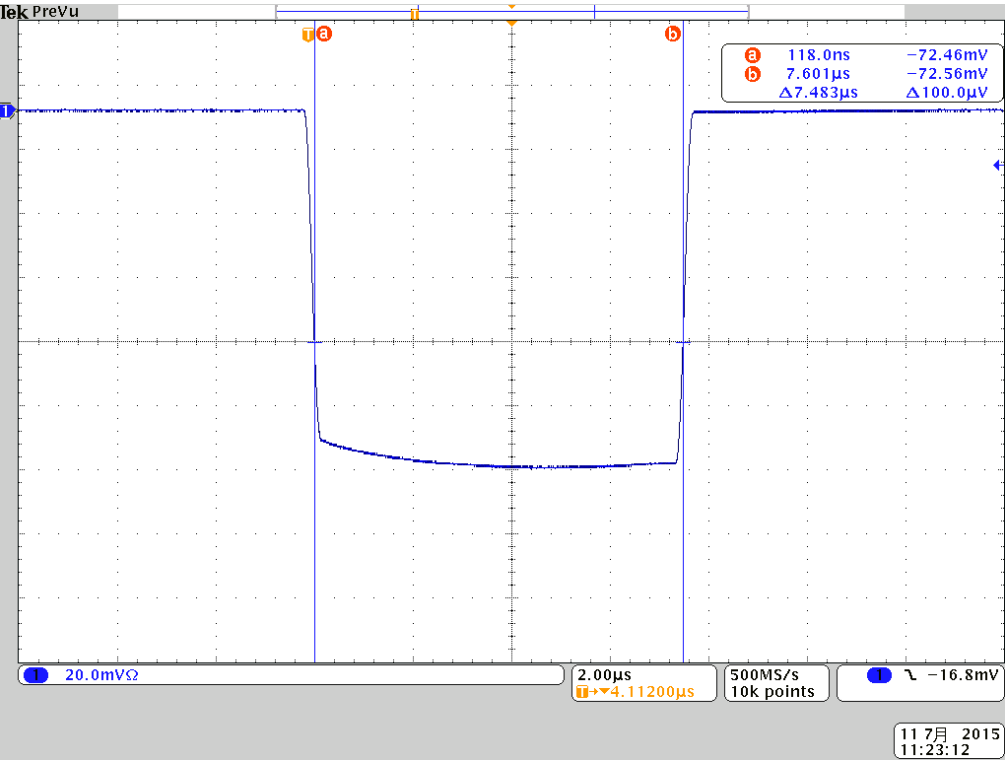


Fig. 7.32 S2 Pulse Envelope

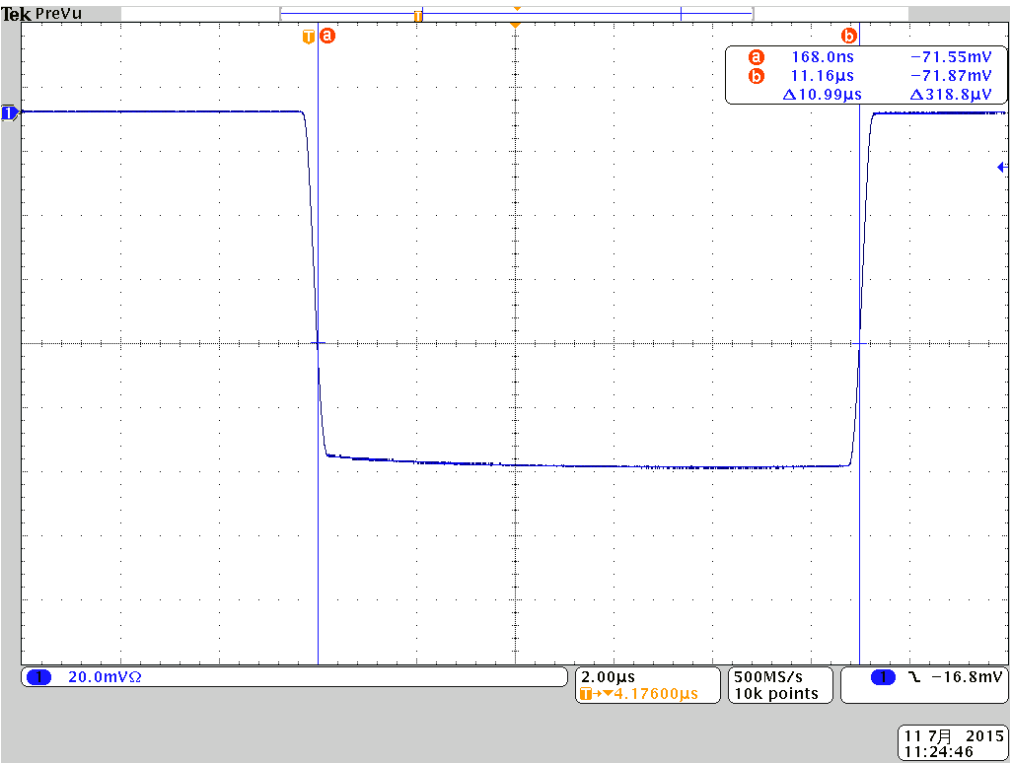


Fig. 7.33 M1 Pulse Envelope

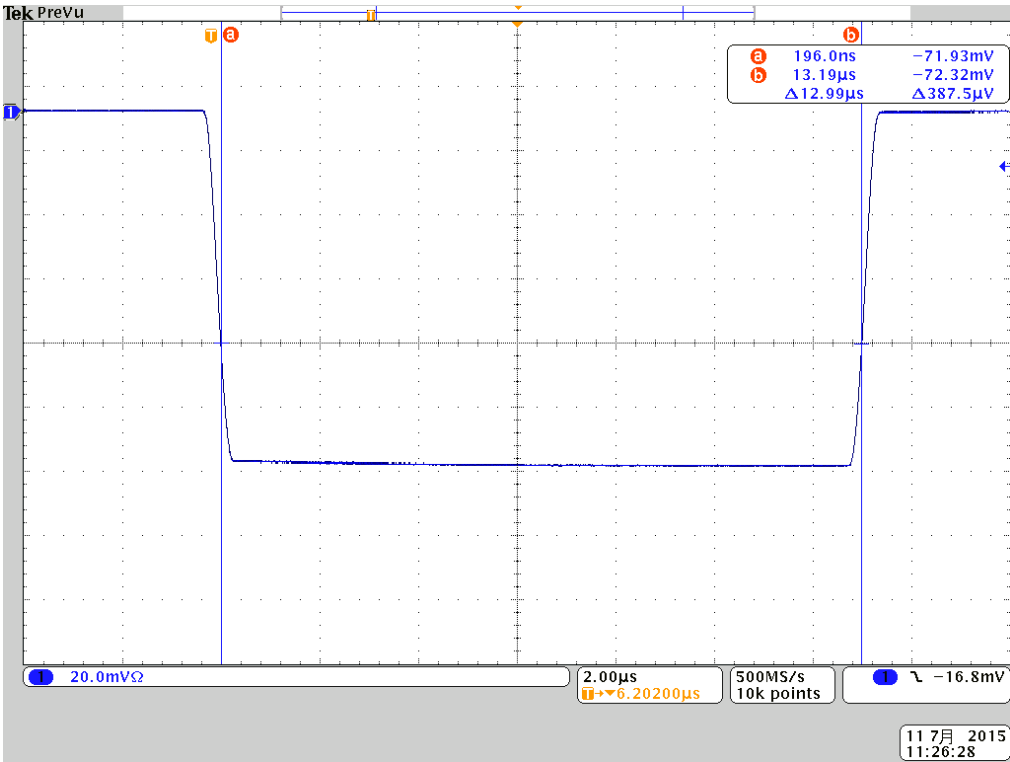


Fig. 7.34 M2 Pulse Envelope

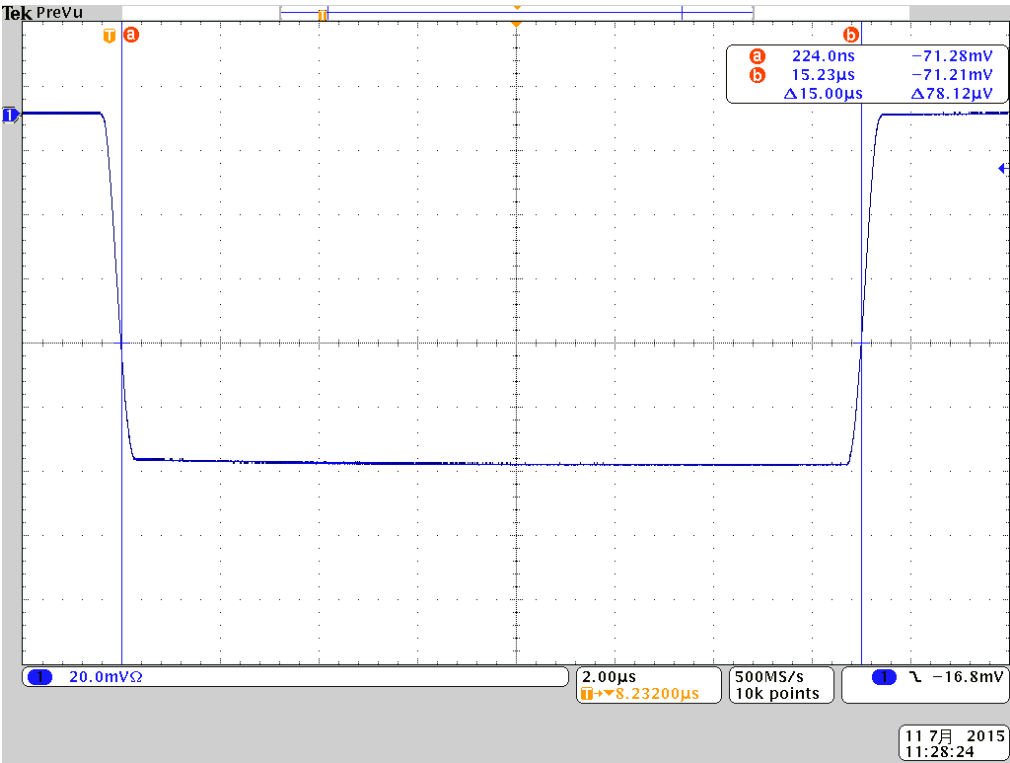


Fig. 7.35 M3 Pulse Envelope

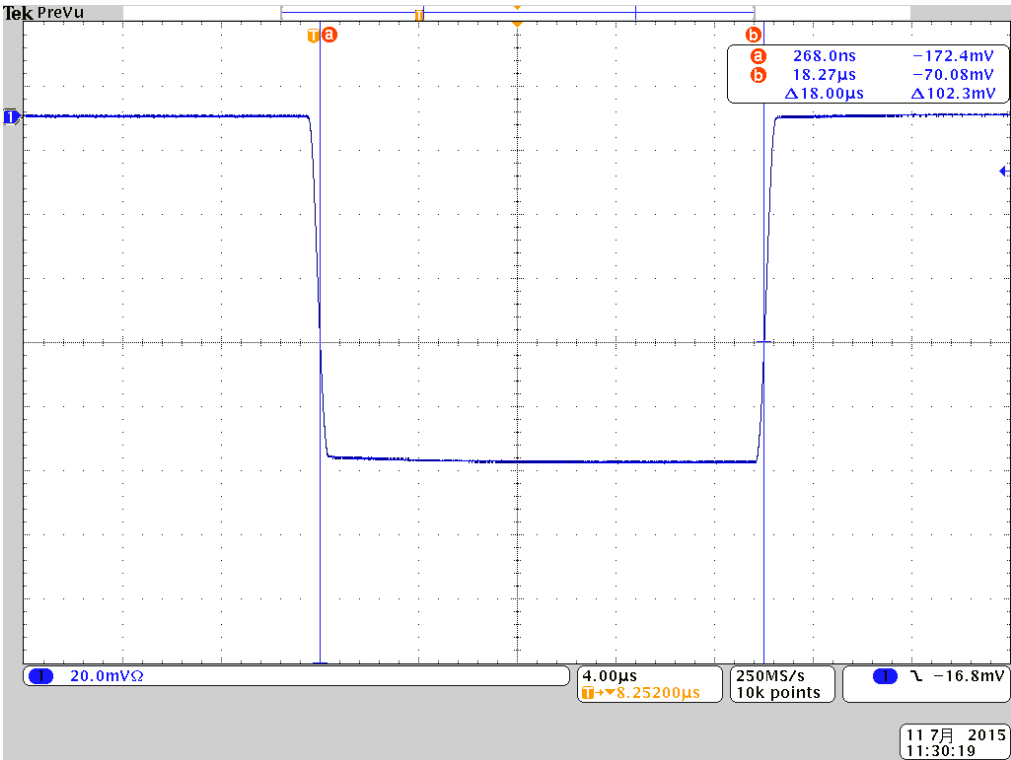


Fig. 7.36 L Pulse Envelope

8 Spurious Emission Plots measured at Antenna Terminal

CH1, P0N

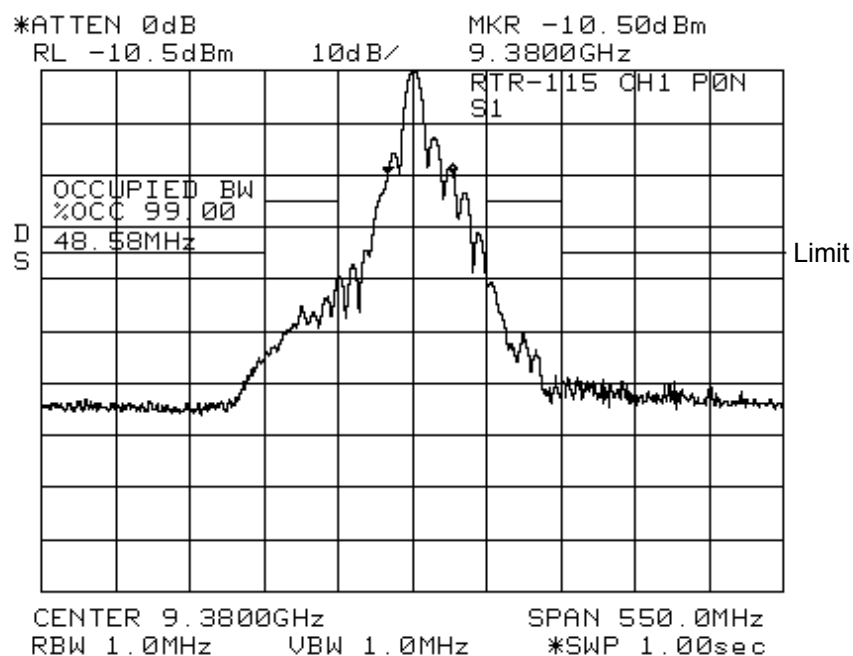


Fig. 8.1 for S1 Pulse

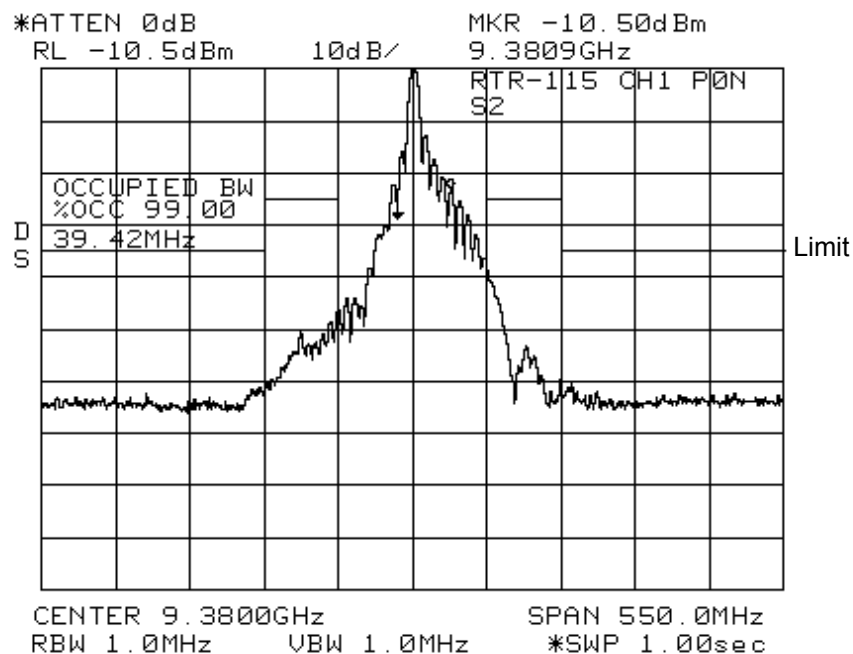


Fig. 8.2 for S2 Pulse

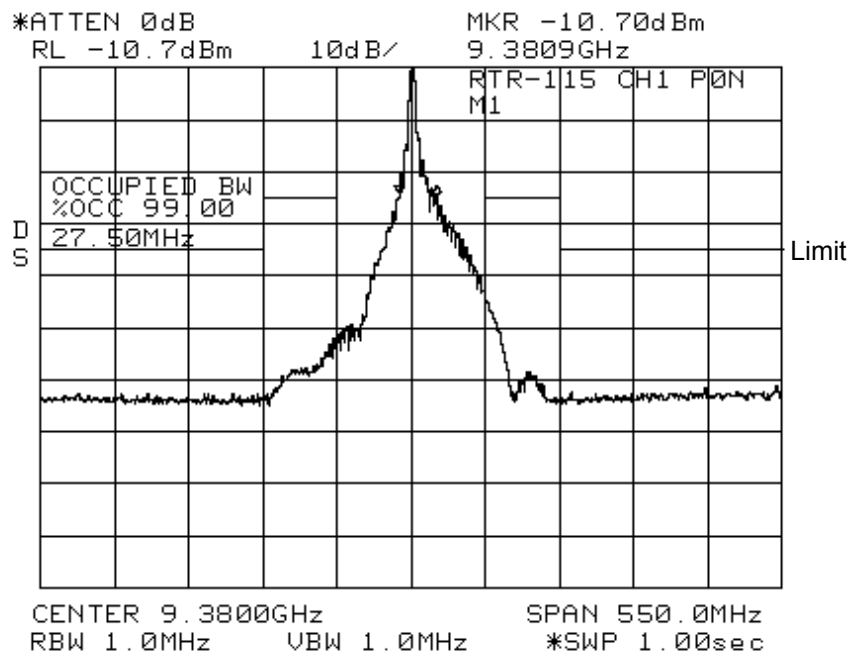


Fig. 8.3 for M1 Pulse

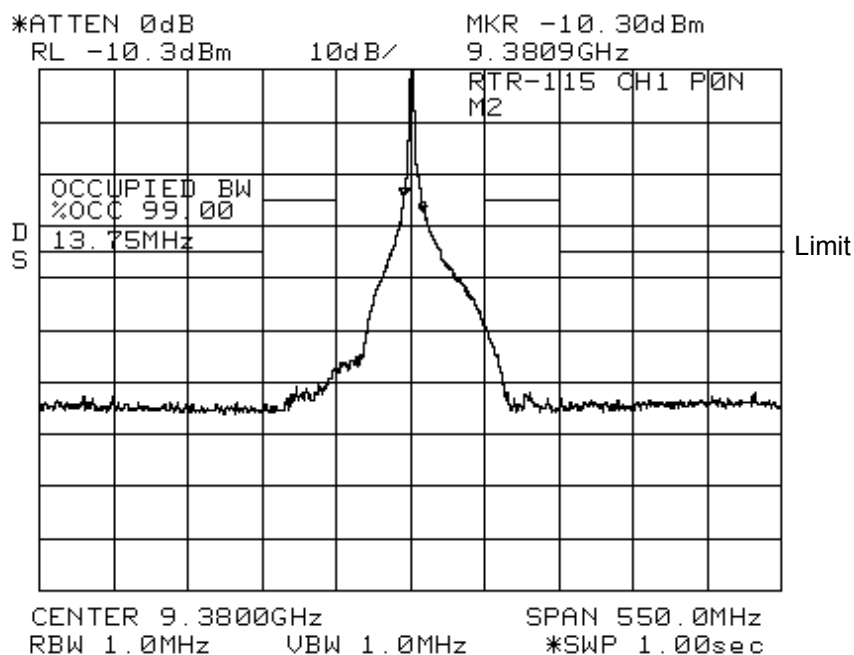


Fig. 8.4 for M2 Pulse

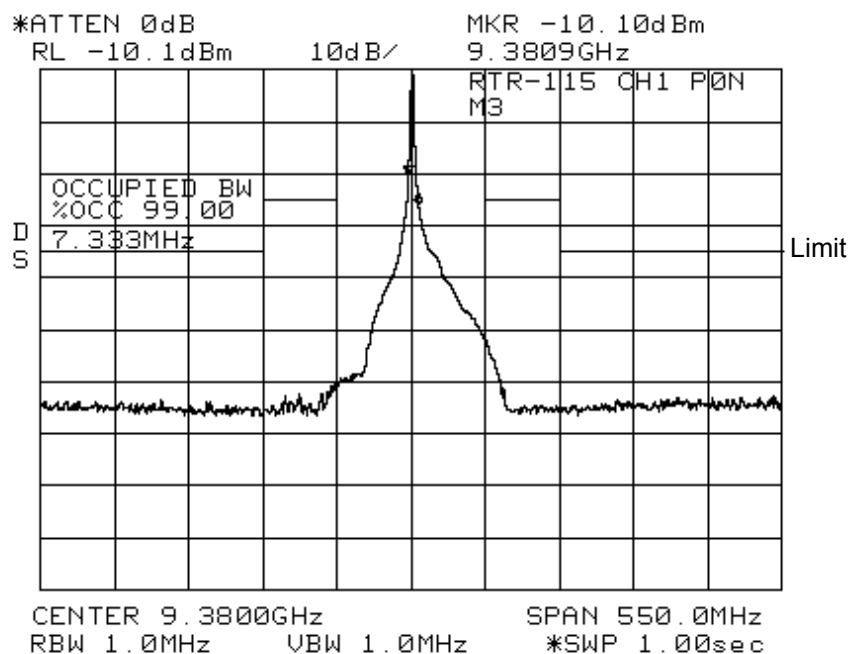


Fig. 8.5 for M3 Pulse

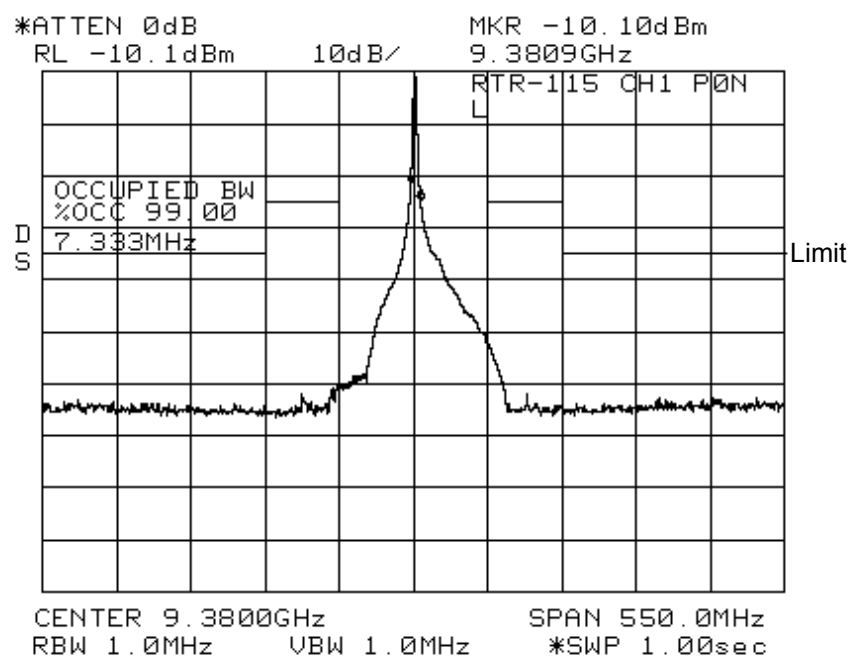


Fig. 8.6 for L Pulse

CH1, Q0N

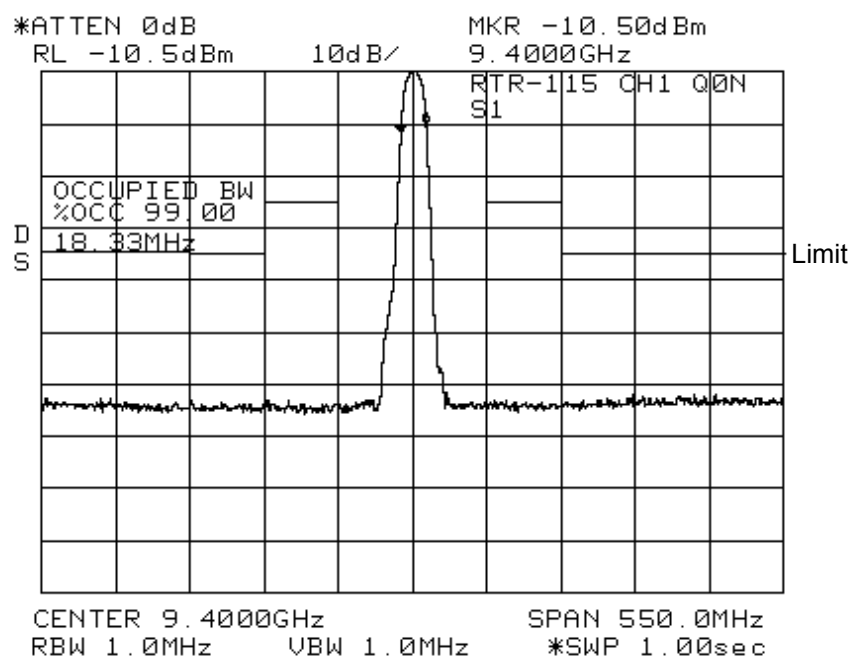


Fig. 8.7 for S1 Pulse

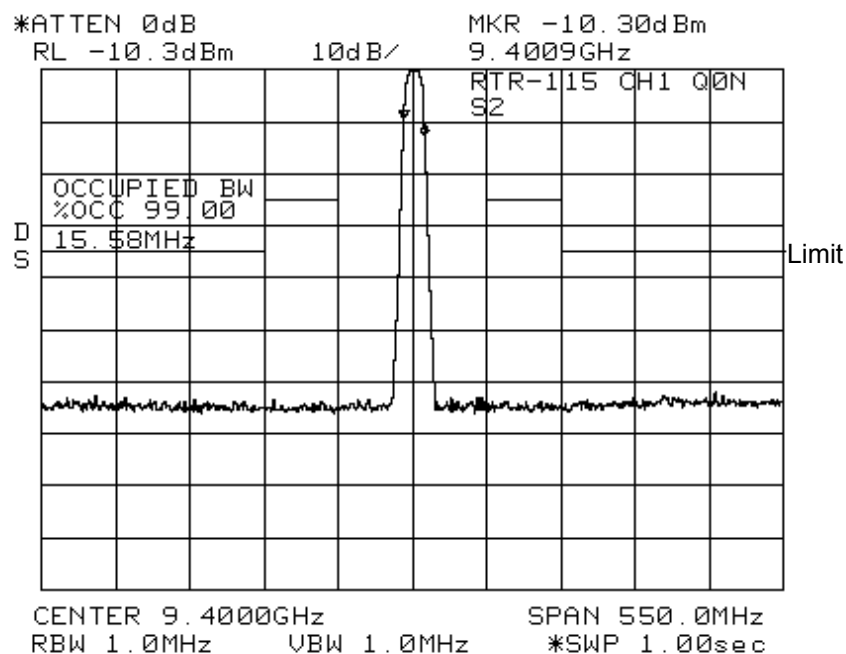


Fig. 8.8 for S2 Pulse

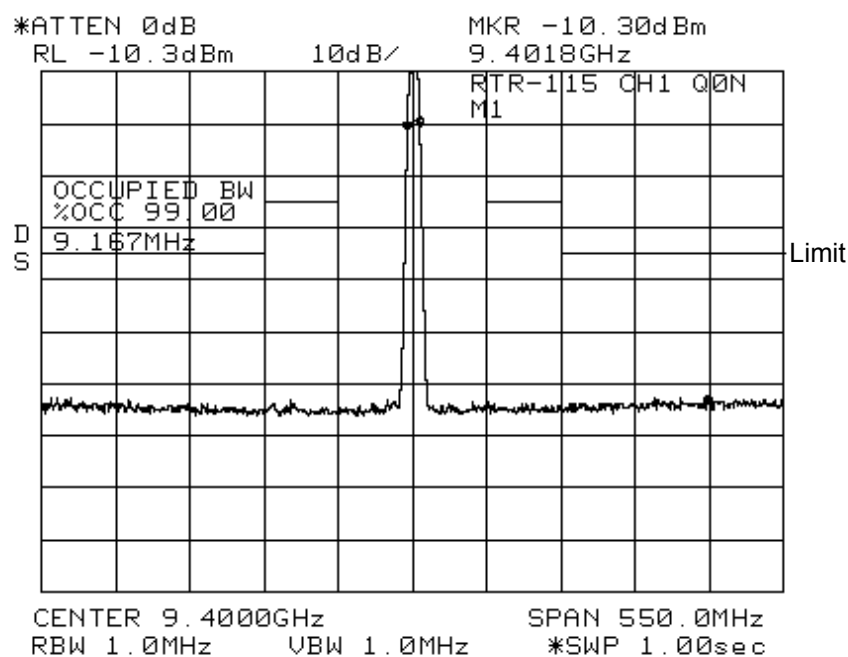


Fig. 8.9 for M1 Pulse

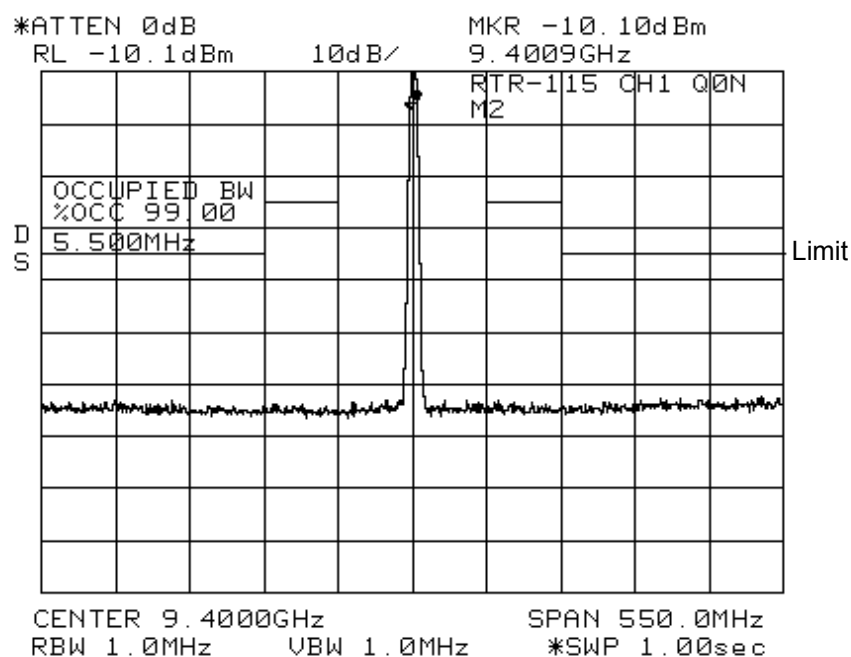


Fig. 8.10 for M2 Pulse

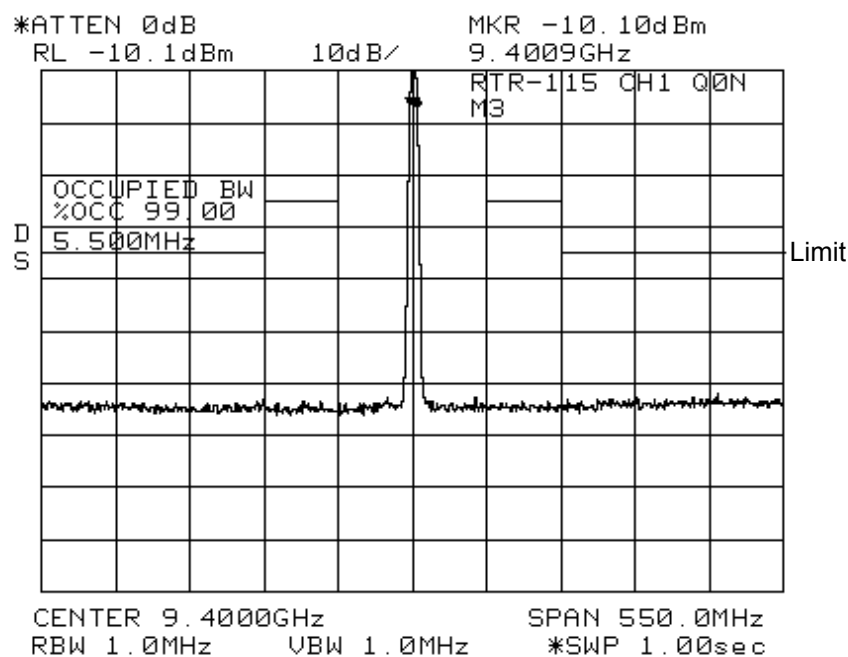


Fig. 8.11 for M3 Pulse

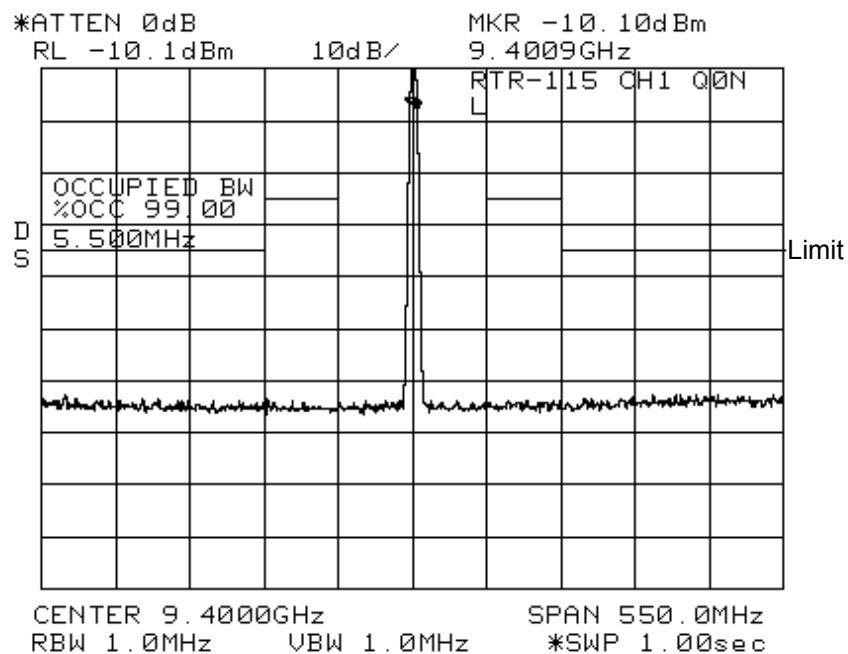


Fig. 8.12 for L Pulse

CH2, P0N

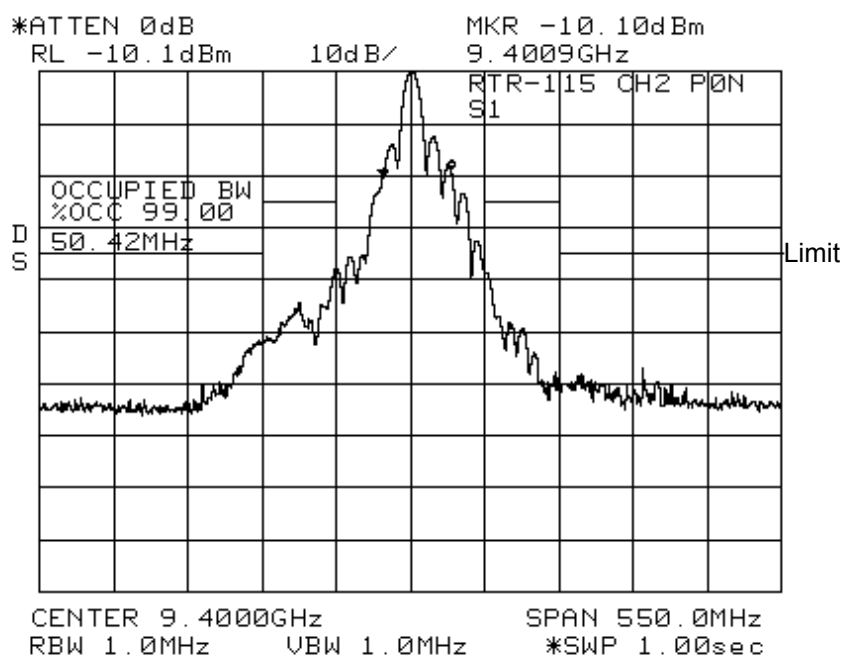


Fig. 8.13 for S1 Pulse

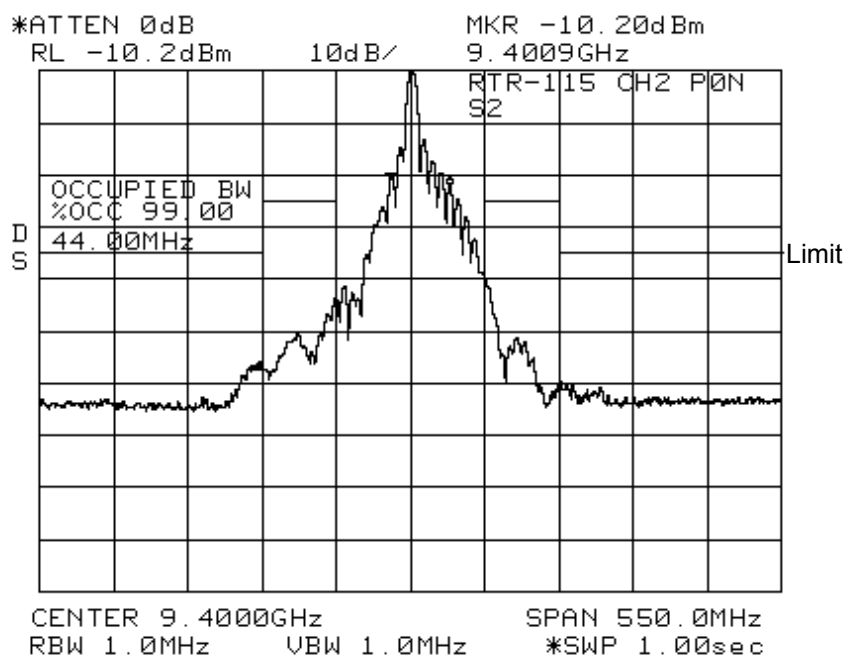


Fig. 8.14 for S2 Pulse

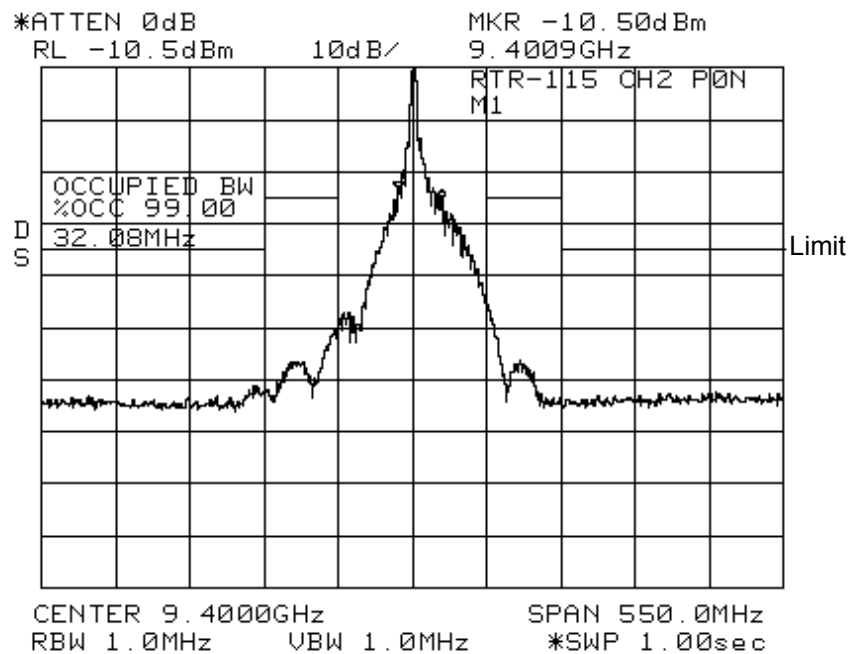


Fig. 8.15 for M1 Pulse

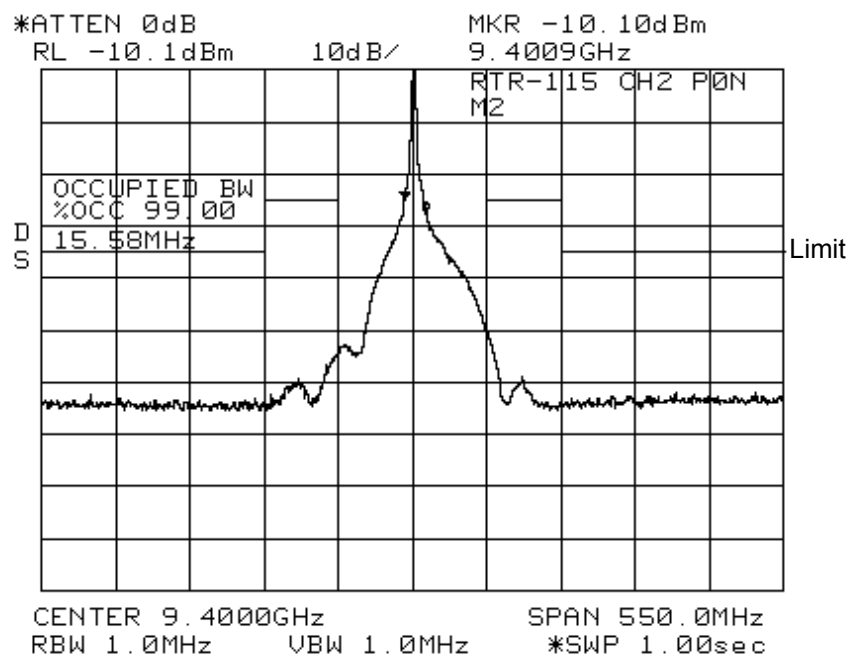


Fig. 8.16 for M2 Pulse

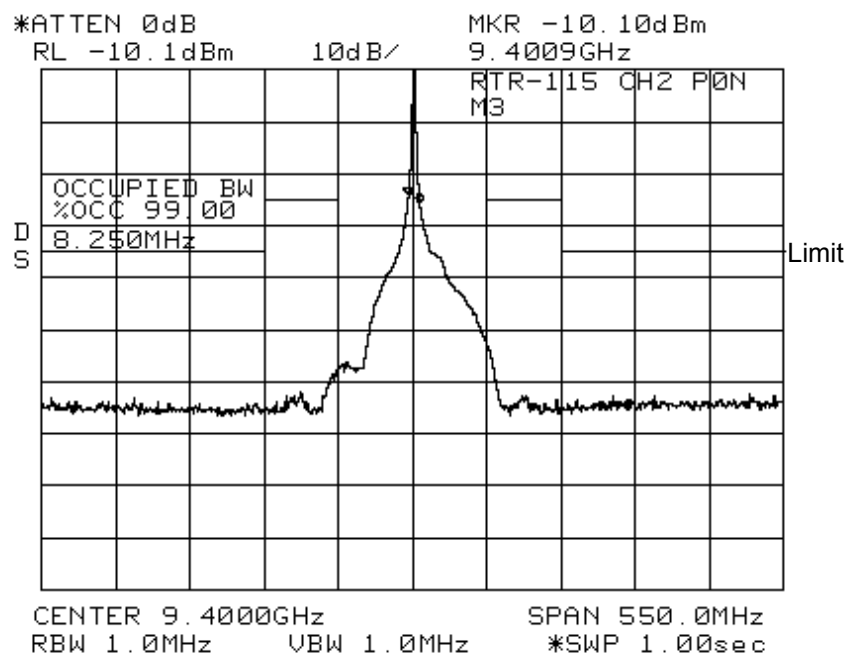


Fig. 8.17 for M3 Pulse

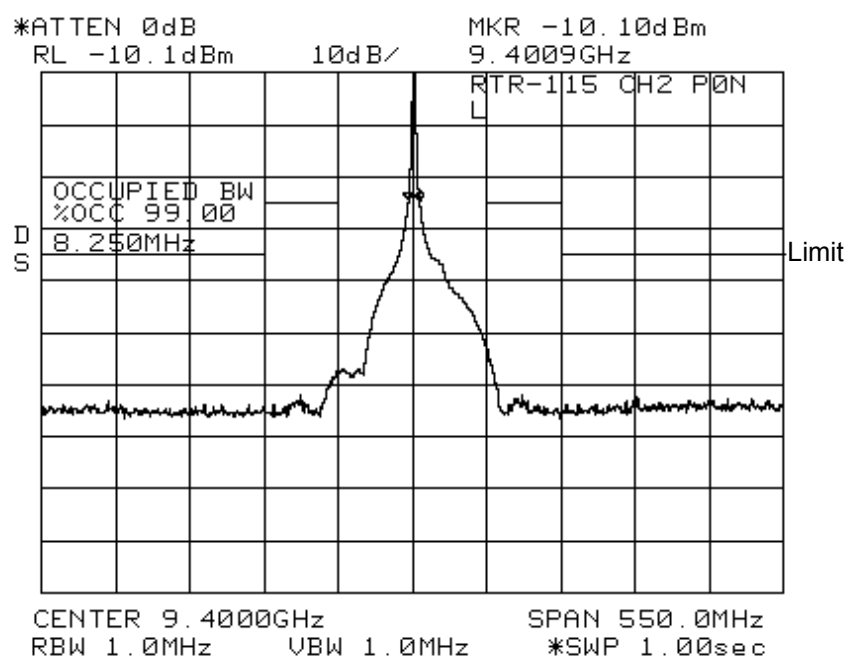


Fig. 8.18 for L Pulse

CH2, Q0N

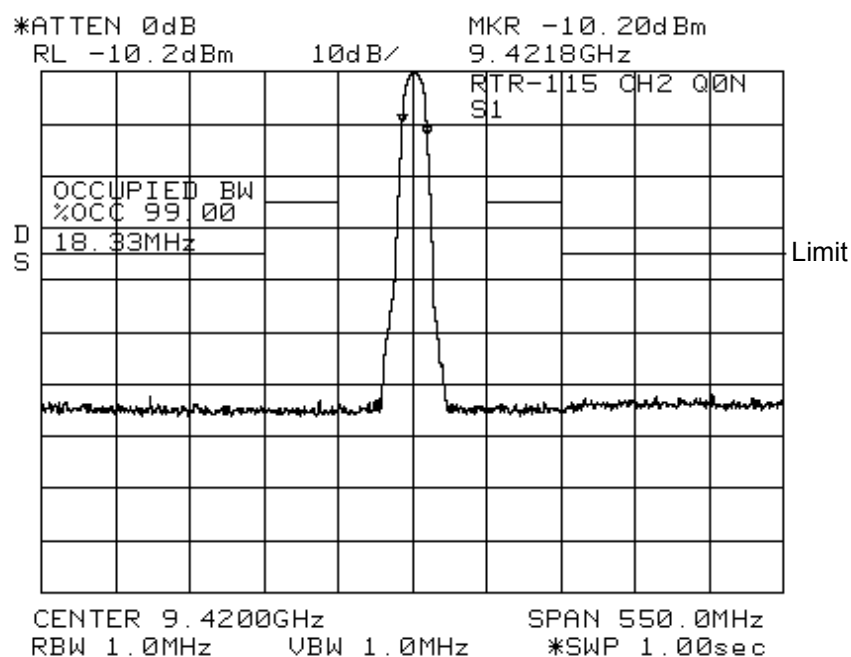


Fig. 8.19 for S1 Pulse

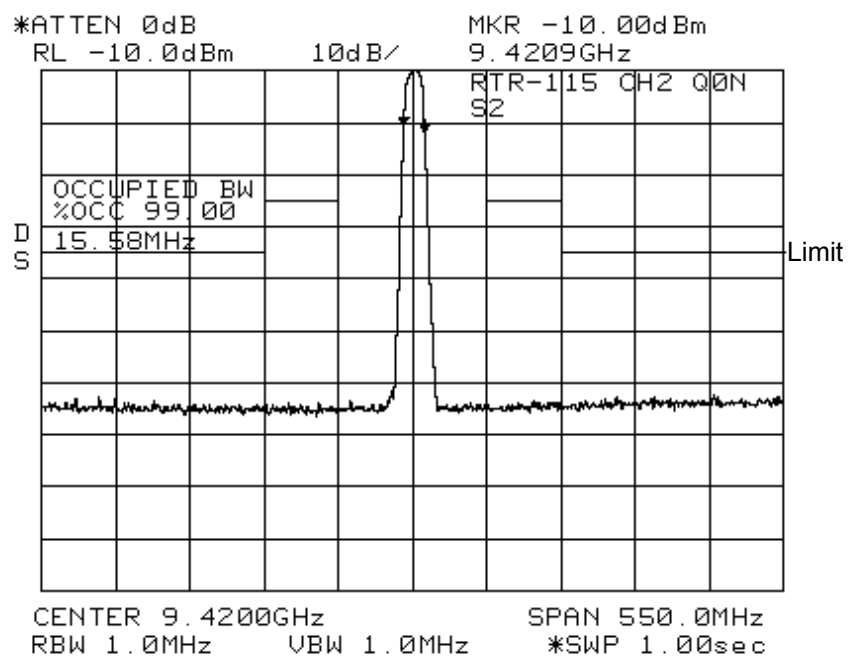


Fig. 8.20 for S2 Pulse

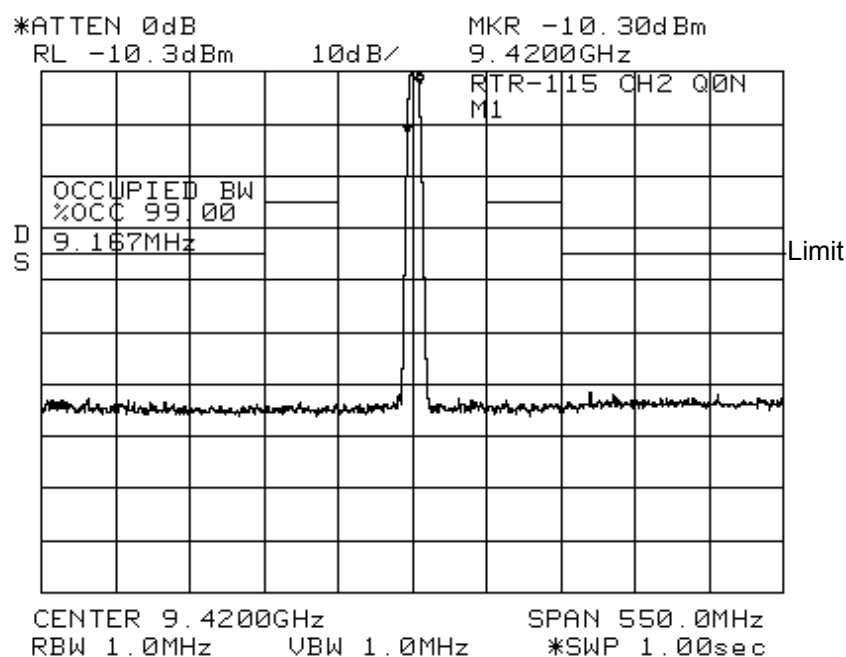


Fig. 8.21 for M1 Pulse

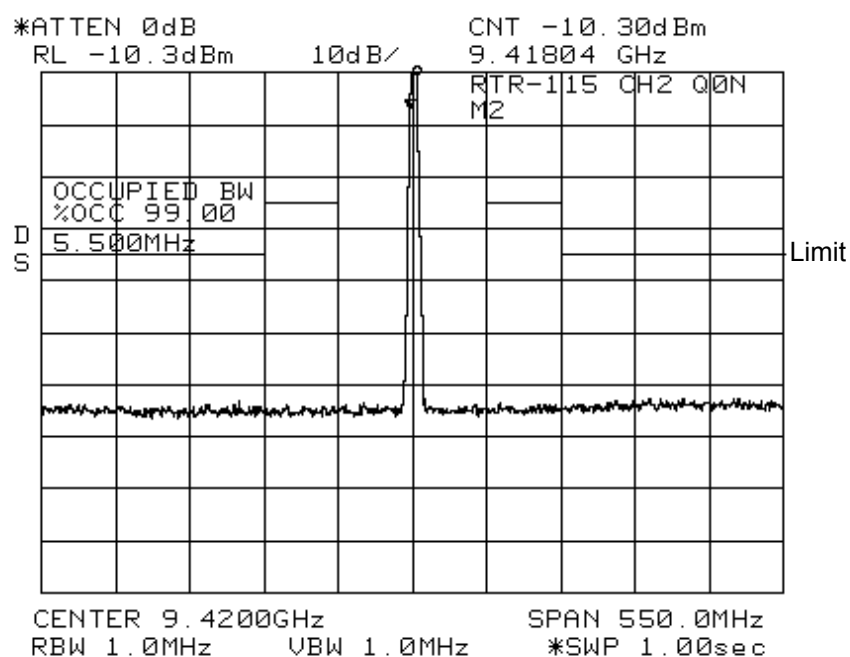


Fig. 8.22 for M2 Pulse

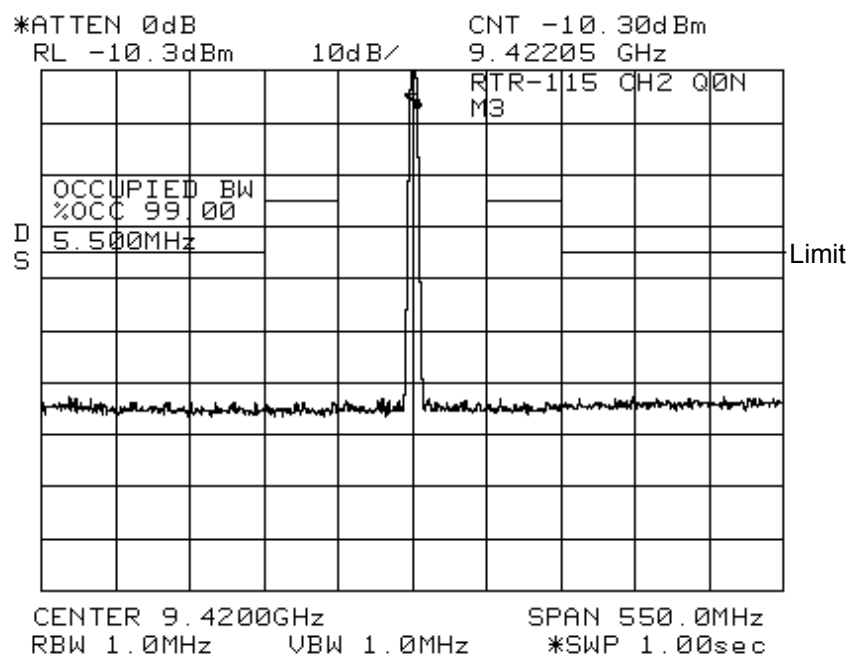


Fig. 8.23 for M3 Pulse

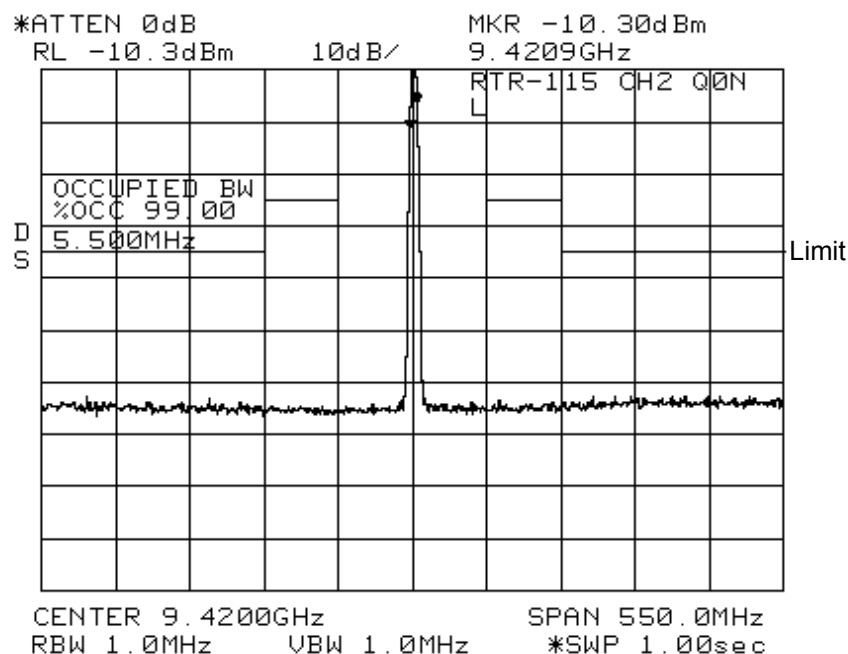


Fig. 8.24 for L Pulse

CH3, P0N

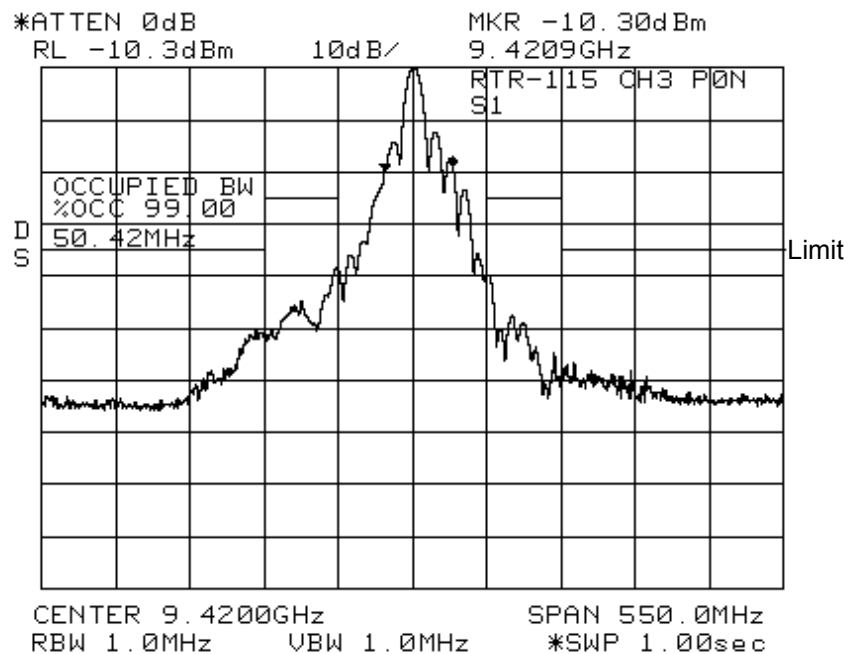


Fig. 8.25 for S1 Pulse

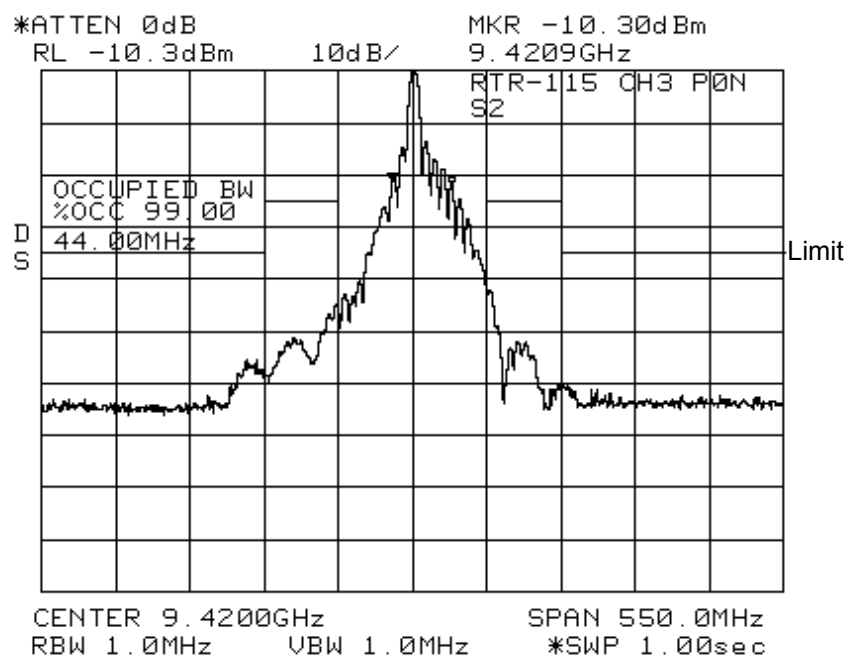


Fig. 8.26 for S2 Pulse

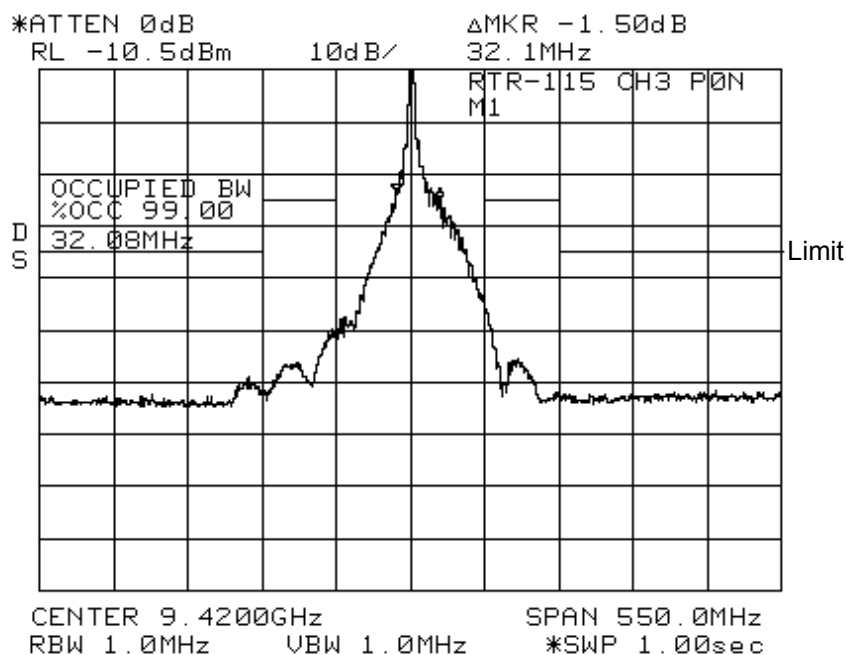


Fig. 8.27 for M1 Pulse

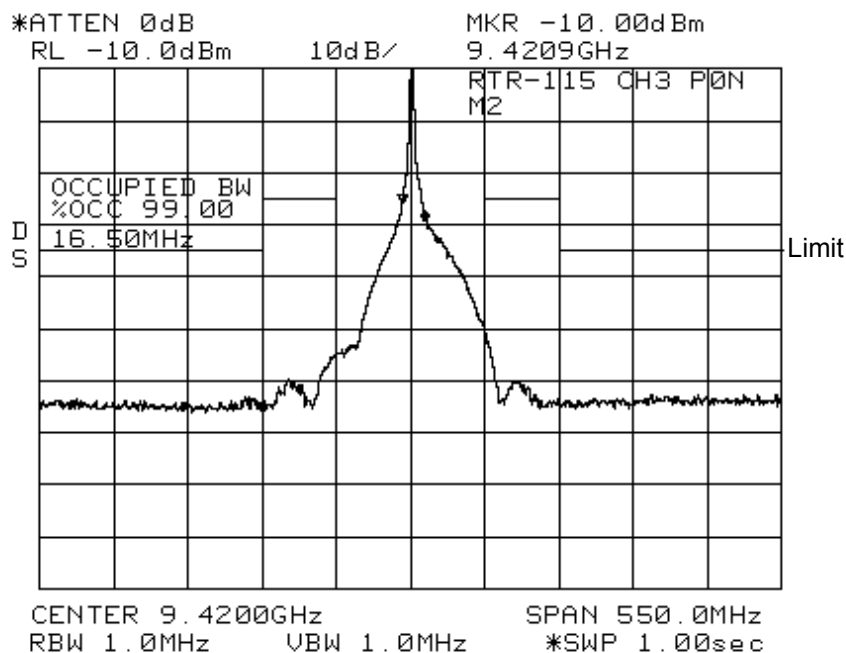


Fig. 8.28 for M2 Pulse

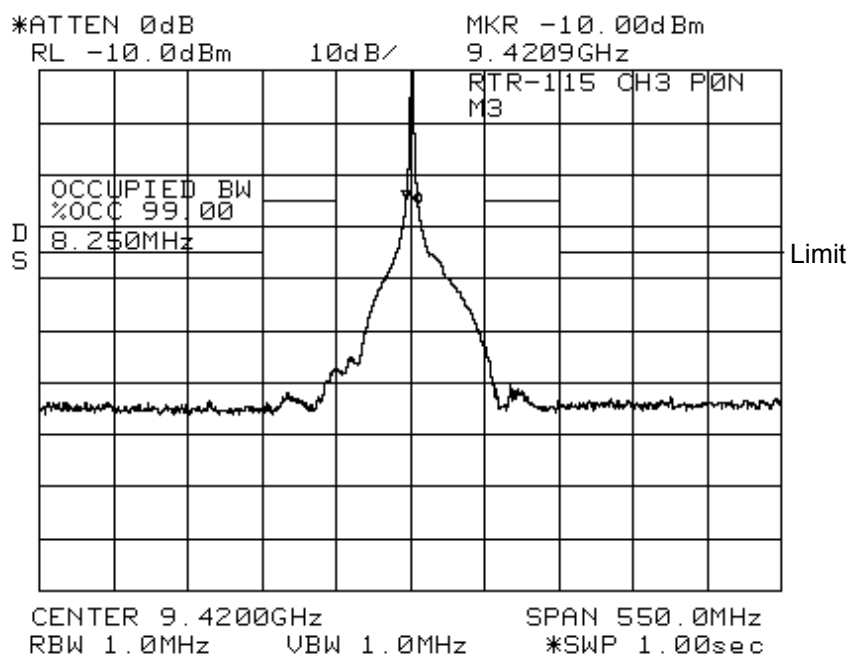


Fig. 8.29 for M3 Pulse

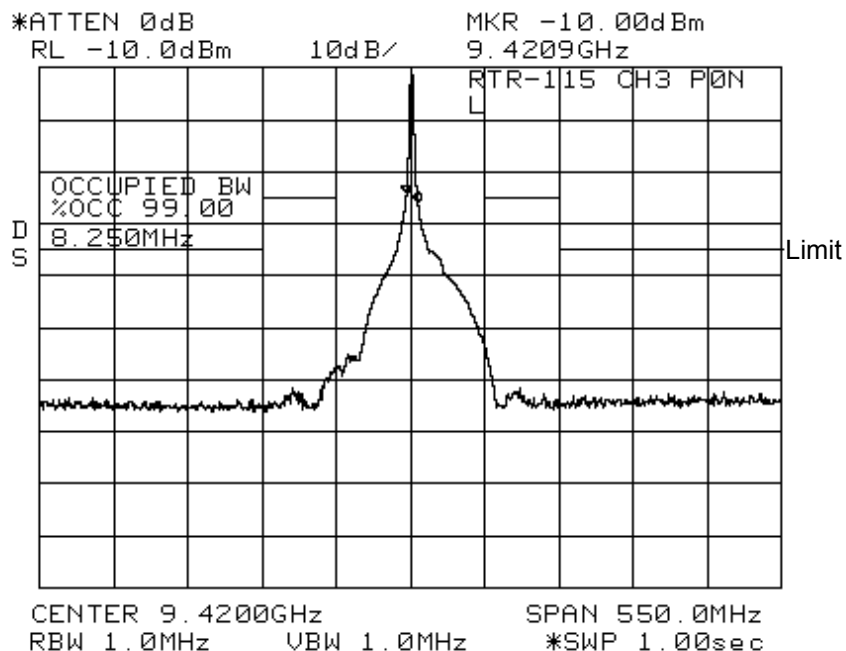


Fig. 8.30 for L Pulse

CH3, Q0N

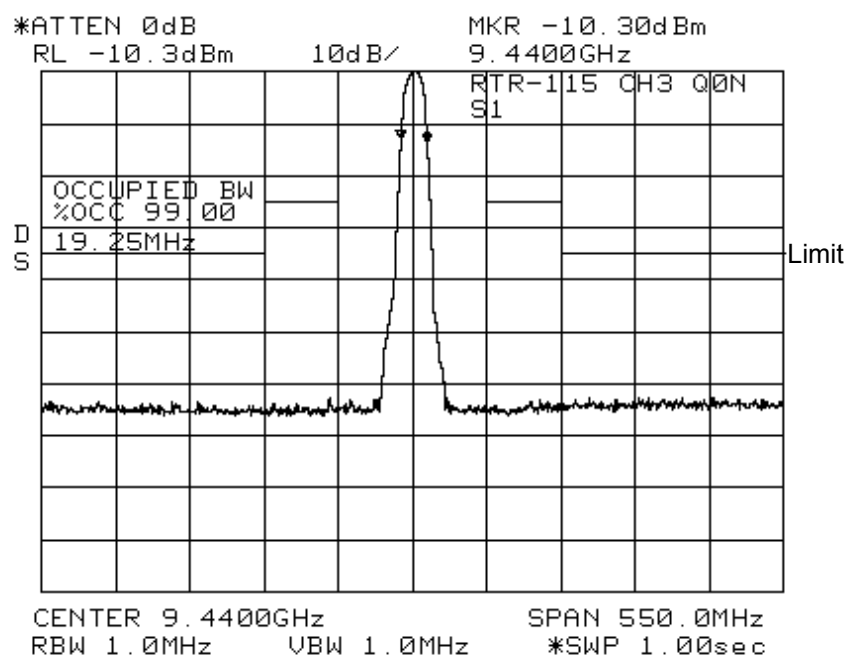


Fig. 8.31 for S1 Pulse

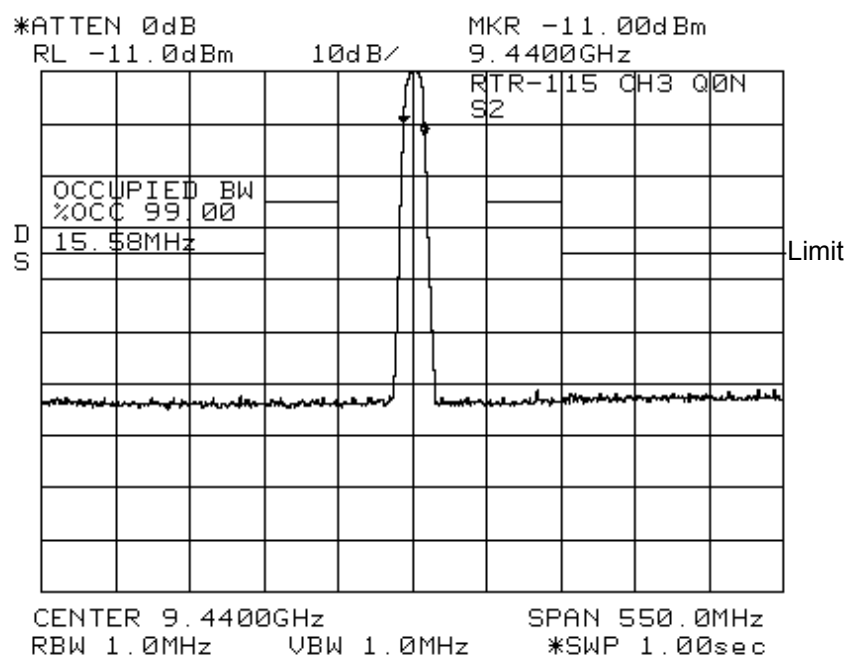


Fig. 8.32 for S2 Pulse

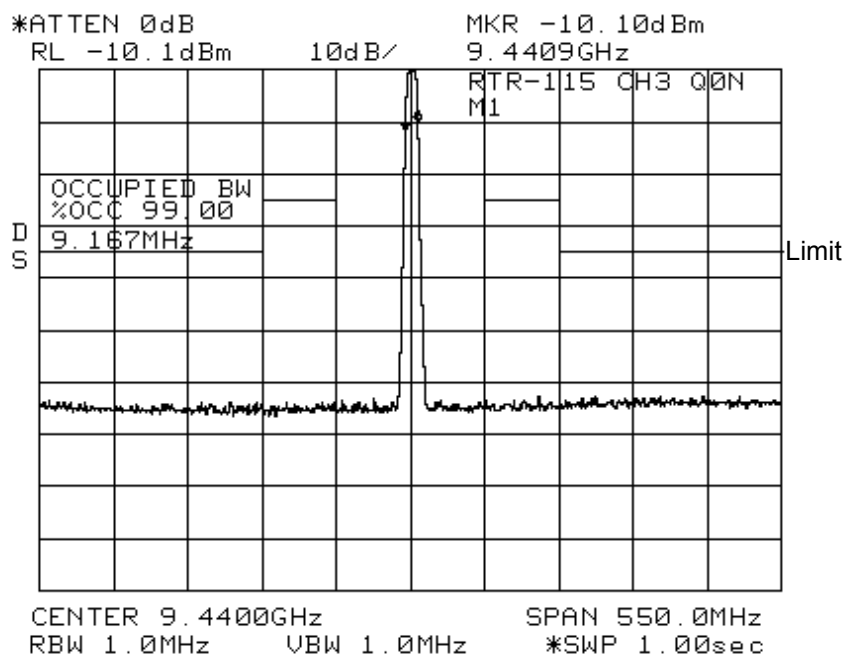


Fig. 8.33 for M1 Pulse

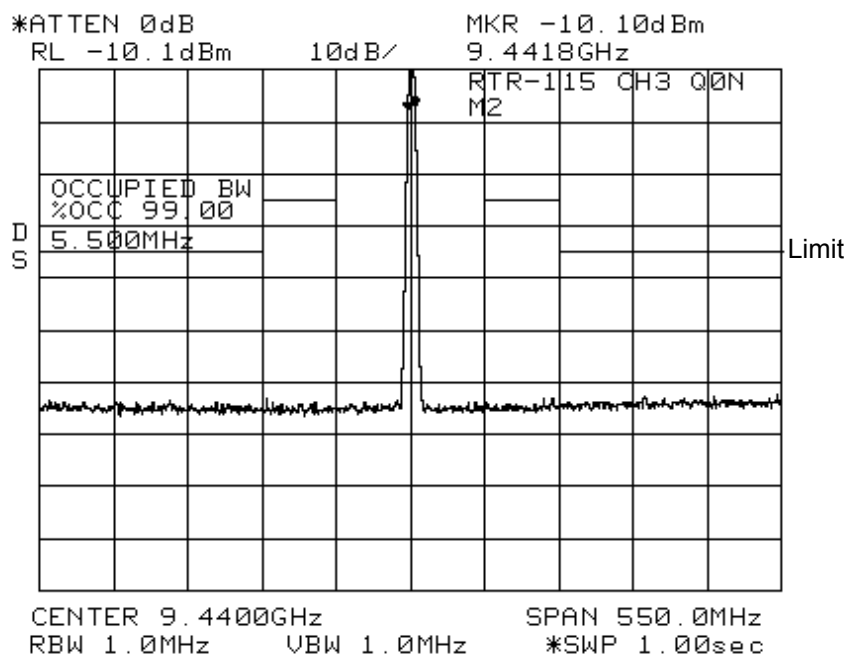


Fig. 8.34 for M2 Pulse

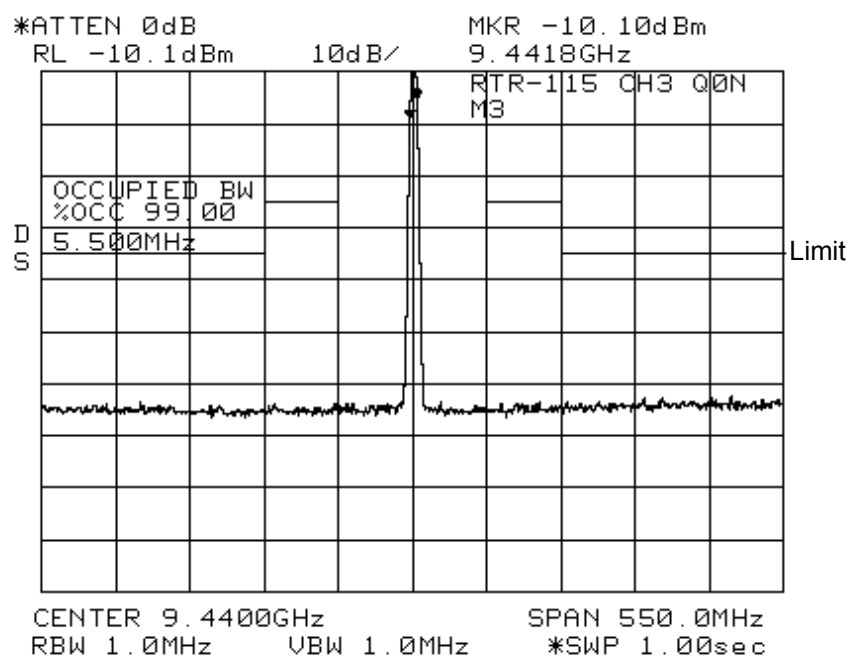


Fig. 8.35 for M3 Pulse

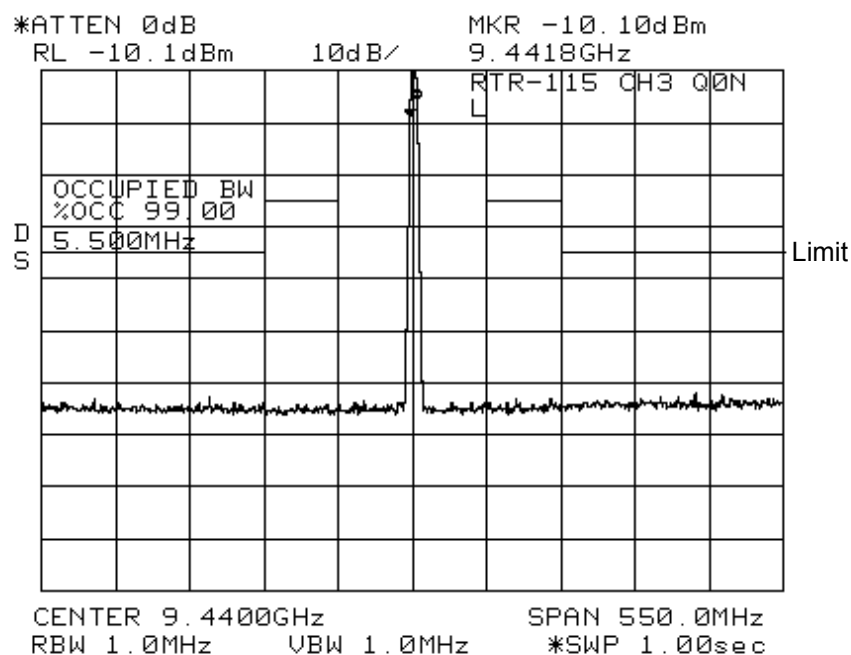


Fig. 8.36 for L Pulse