# 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**


**Labotech International Co., Ltd.**
1-16, Fukazu-cho, Nishinomiya-shi, Hyogo, 663-8203 Japan
Tel: +81-798-63-1094 Fax: +81-798-63-1098
URL: https://www.labotech-intl.co.jp/

# 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:<br>2.201 - Emission, modulation, and transmission characteristics<br>2.202 - Bandwidths<br>2.1046 - RF Power Output<br>2.1047 - Measurements required: Modulation Characteristics<br>2.1049 - Occupied Bandwidth<br>2.1051 - Spurious Emissions at Antenna Terminals<br>2.1053 - Field Strength of Spurious Radiation<br>2.1055 - Measurements required: Frequency Stability<br><br>80.209 - Transmitter frequency tolerances<br>80.211 - Emission limitations<br>80.213 - Modulation requirements<br>80.215 - Transmitter power<br>80.273 - Radar standards<br><br>(the latest version on the first day of the testing period) | | |
| Customer: | Furuno Electric Co., Ltd.<br>9-52, Ashihara-cho, Nishinomiya-city, Hyogo, 662-8580 Japan | | |
| Manufacturer: | Furuno Electric Co., Ltd.<br>9-52, Ashihara-cho, Nishinomiya-city, Hyogo, 662-8580 Japan | | |
| Trade name: | Furuno | | |
| Model: | Transceiver for MARINE RADAR<br>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.<br>FCC Test firm Designation Number: JP2007<br>FCC Test firm Registration Number: 838049<br>- LABOTECH EMC Center<br>1-16, Fukazu-cho, Nishinomiya-shi, Hyogo, 663-8203 Japan<br>- Nishinomiya-Hama Lab.<br>2-20, Nishinomiya-Hama, Nishinomiya-shi, Hyogo, 662-0934 Japan | | |
| Test results/Compliance: | Passed.<br>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<br>Name: Tadayuki Ekawa<br>Title: Head engineer, Technical Department<br>Labotech International Co., Ltd.<br>Signature:<br>  |

# 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 accreditted 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: ϕ1300 mm × 575 mm (H), 49 kg (*1)
MARINE RADAR ANTENNA UNIT: ϕ2100 mm × 575 mm (H), 51 kg (*2)
MARINE RADAR ANTENNA UNIT: ϕ2600 mm × 575 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 | -28 dB |
| | Outside ±10° | -30 dB | -32 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),<br>80.215 | RF Power Output | Passed. | K. Kawai |
| 3.2 | 2.201,<br>2.1047 (d) | Modulation Characteristics | Passed. | K. Kawai |
| 3.3 | 2.1055 (a)(2),(d)(1),(d)(3),<br>80.209 (b) | Frequency Stability –temperature & voltage | Passed. | K. Kawai and Y. Hijiri |
| 3.4 | 2.202 (a),<br>2.1049 (c)(1),<br>80.209 (b),<br>80.211 (f) | Occupied Bandwidth | Passed. | K. Kawai |
| 3.5 | 2.1051,<br>80.211 (f),<br>80.273 | Spurious Emissions at Antenna Terminals | Passed. | K. Kawai |
| 3.6 | 2.1053,<br>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* (μs) (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* (μs) (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* (μs) (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* (μs) (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* (μs) × *PRF* (Hz))) × 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* (μs) × *PRF* (Hz))) × 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* (μs) × *PRF* (Hz))) × 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 (μs) (50% points) | 0.047 | 0.140 | 0.289 | 0.492 | 0.688 | 1.190 |
| Rise time $t_r$ (μs) (10 to 90 % amplitude) | 0.032 | 0.026 | 0.026 | 0.026 | 0.026 | 0.026 |
| Fall time $t_f$ (μs) (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 (μs) (50% points) | 4.678 | 7.012 | 8.883 | 13.558 | 13.555 | 20.576 |
| Rise time $t_r$ (μs) (10 to 90 % amplitude) | 0.127 | 0.194 | 0.250 | 0.368 | 0.364 | 0.564 |
| Fall time $t_f$ (μs) (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 (μs) (50% points) | 0.048 | 0.141 | 0.289 | 0.493 | 0.690 | 1.191 |
| Rise time $t_r$ (μs) (10 to 90 % amplitude) | 0.029 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| Fall time $t_f$ (μs) (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 (μs) (50% points) | 4.679 | 7.015 | 8.881 | 13.556 | 13.562 | 20.566 |
| Rise time $t_r$ (μs) (10 to 90 % amplitude) | 0.130 | 0.196 | 0.256 | 0.372 | 0.372 | 0.572 |
| Fall time $t_f$ (μs) (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 (µs) (50% points) | 0.047 | 0.140 | 0.289 | 0.492 | 0.689 | 1.190 |
| Rise time $t_r$ (µs) (10 to 90 % amplitude) | 0.032 | 0.026 | 0.026 | 0.026 | 0.026 | 0.025 |
| Fall time $t_f$ (µs) (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 (µs) (50% points) | 4.680 | 7.013 | 8.878 | 13.562 | 13.561 | 20.573 |
| Rise time $t_r$ (µs) (10 to 90 % amplitude) | 0.130 | 0.196 | 0.246 | 0.376 | 0.368 | 0.560 |
| Fall time $t_f$ (µs) (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 (µs) (50% points) | 0.048 | 0.141 | 0.290 | 0.492 | 0.690 | 1.192 |
| Rise time $t_r$ (µs) (10 to 90 % amplitude) | 0.030 | 0.025 | 0.026 | 0.024 | 0.025 | 0.026 |
| Fall time $t_f$ (µs) (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 (µs) (50% points) | 4.678 | 7.011 | 8.885 | 13.564 | 13.566 | 20.580 |
| Rise time $t_r$ (µs) (10 to 90 % amplitude) | 0.132 | 0.194 | 0.252 | 0.376 | 0.380 | 0.572 |
| Fall time $t_f$ (µs) (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 (μs) (50% points) | 0.047 | 0.140 | 0.289 | 0.492 | 0.689 | 1.190 |
| Rise time $t_r$ (μs) (10 to 90 % amplitude) | 0.032 | 0.027 | 0.026 | 0.026 | 0.026 | 0.026 |
| Fall time $t_f$ (μs) (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 (μs) (50% points) | 4.679 | 7.008 | 8.882 | 13.558 | 13.567 | 20.577 |
| Rise time $t_r$ (μs) (10 to 90 % amplitude) | 0.124 | 0.194 | 0.242 | 0.380 | 0.372 | 0.572 |
| Fall time $t_f$ (μs) (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 (μs) (50% points) | 0.048 | 0.141 | 0.290 | 0.493 | 0.690 | 1.191 |
| Rise time $t_r$ (μs) (10 to 90 % amplitude) | 0.030 | 0.025 | 0.025 | 0.026 | 0.025 | 0.025 |
| Fall time $t_f$ (μs) (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 (μs) (50% points) | 4.681 | 7.014 | 8.884 | 13.566 | 13.565 | 20.575 |
| Rise time $t_r$ (μs) (10 to 90 % amplitude) | 0.130 | 0.194 | 0.248 | 0.380 | 0.374 | 0.574 |
| Fall time $t_f$ (μs) (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 %<br>(of the authorized bandwidth) (*2) | At least 25 |
| 100 to 250 %<br>(of the authorized bandwidth) (*2) | At least 35 |
| more than 250 %<br>(of the authorized bandwidth) (*2) | At least 43 + 10 $\log_{10}$ (mean power in watts)<br>= -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 |

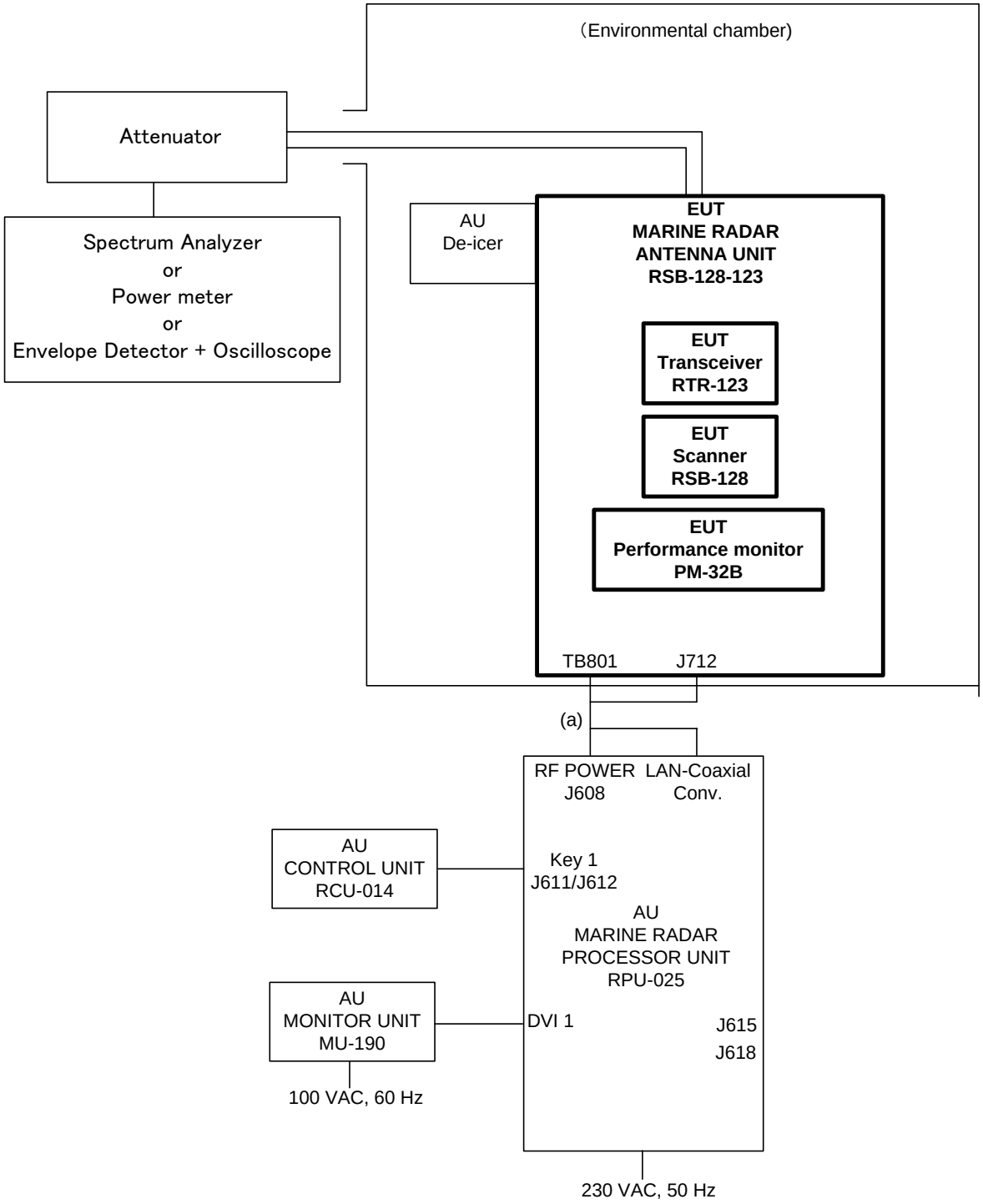
### 3.6.7 Test Results:

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

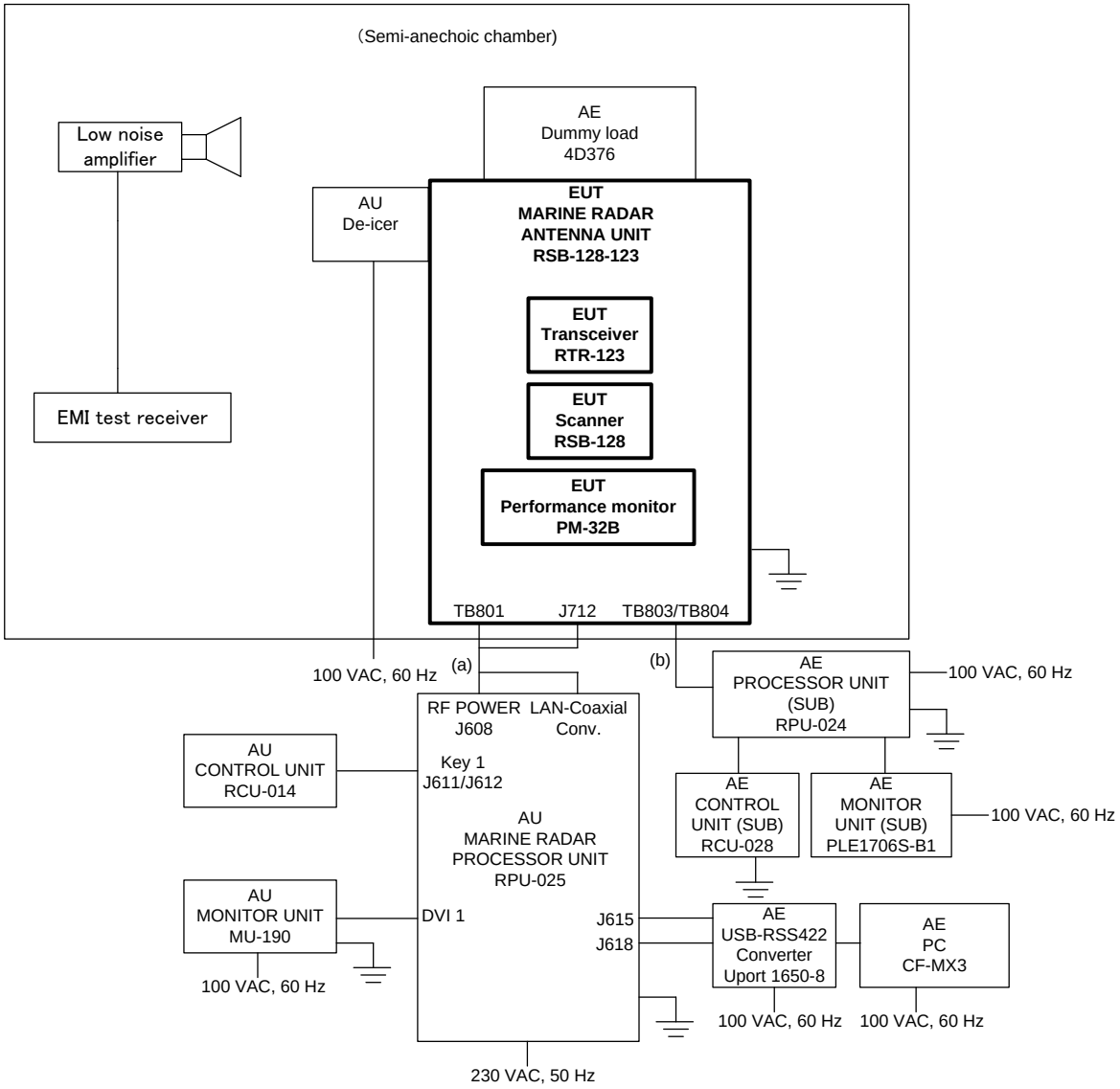
Environmental conditions observed: On 22 August 2019, 20°C to 20°C, 56%RH to 56%RH
Power supply voltage measured: 230 VAC, 50 Hz to 230 VAC, 50 Hz

# 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/11PC35/11PC35/5500MM | 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 rigged horn antenna & amp. (18 GHz to 26 GHz) | HAP18-26N | 00000017 | Toyo | 15 August 2019 | 1 year |
| HT762 | Double rigged 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

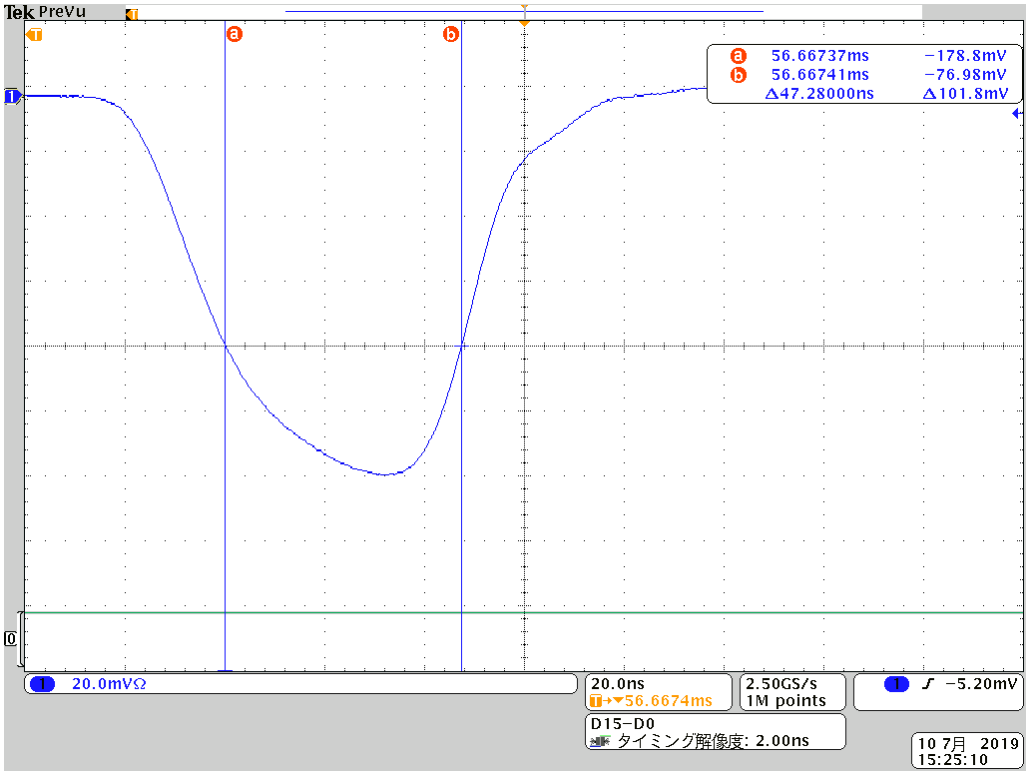



Fig. 6.1 ch1, P0N, S1 pulse envelope

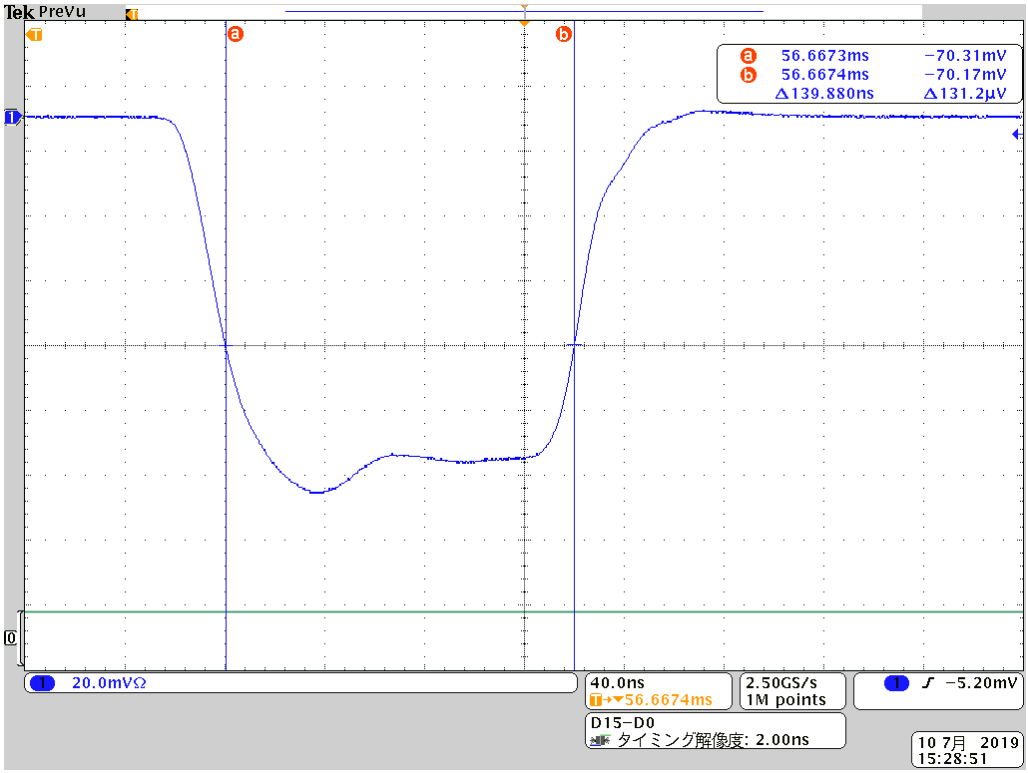



Fig. 6.2 ch1, P0N, S2 pulse envelope


Fig. 6.3 ch1, P0N, M1 pulse envelope

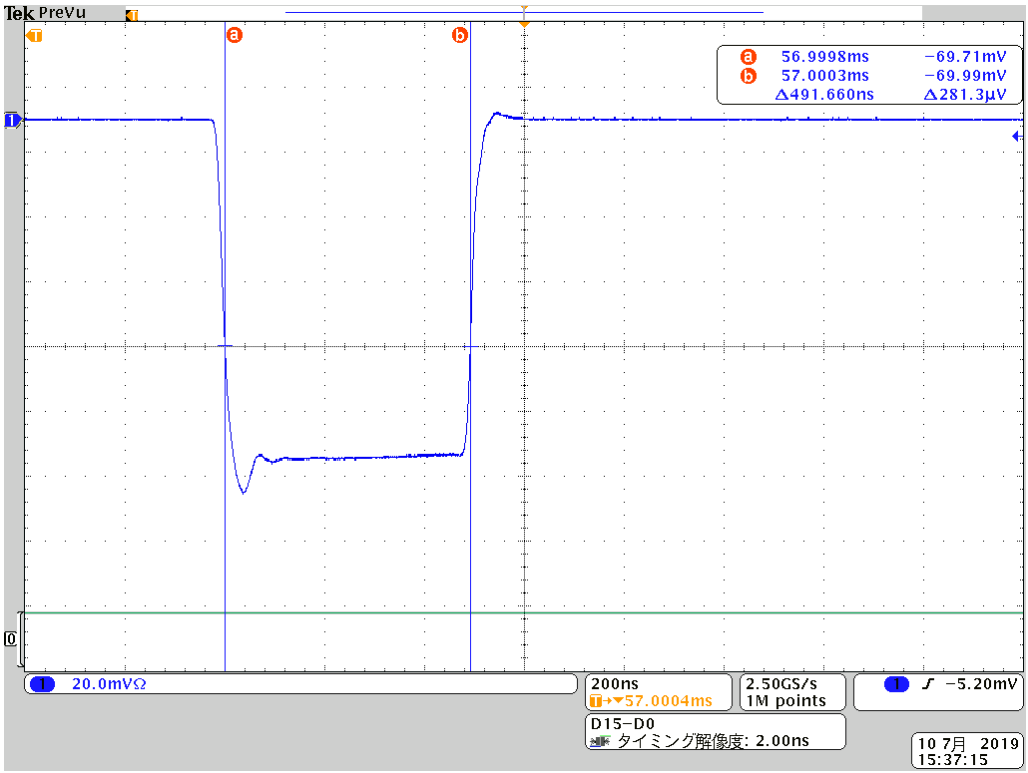



Fig. 6.4 ch1, P0N, M2 pulse envelope

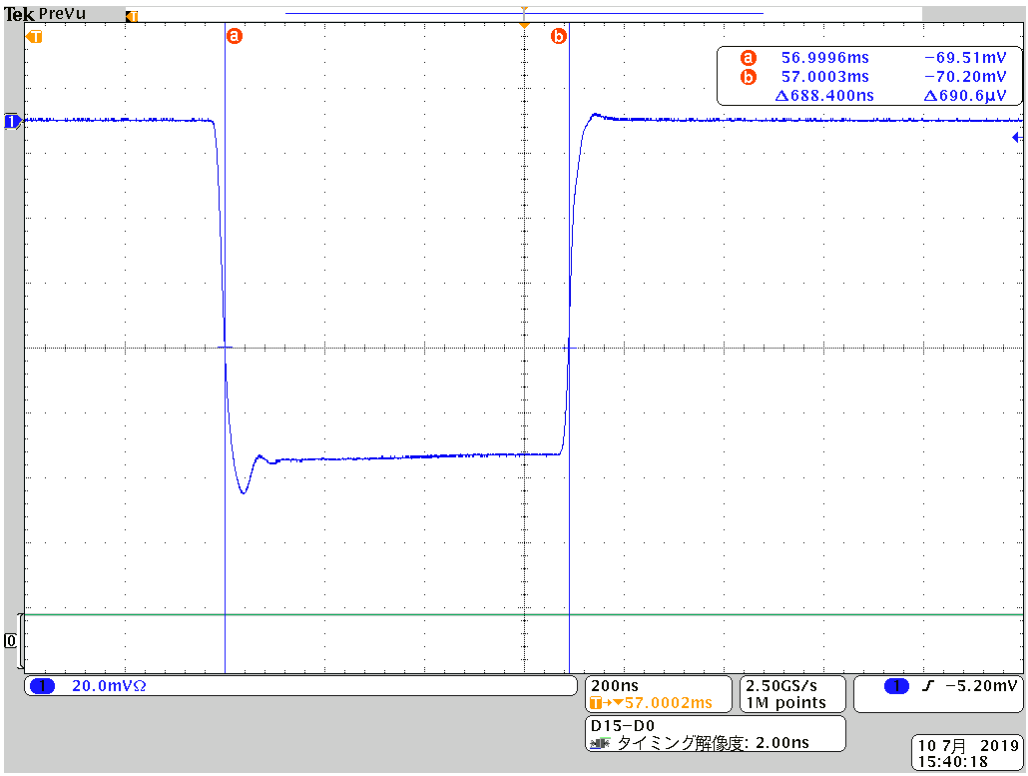



Fig. 6.5 ch1, P0N, M3 pulse envelope

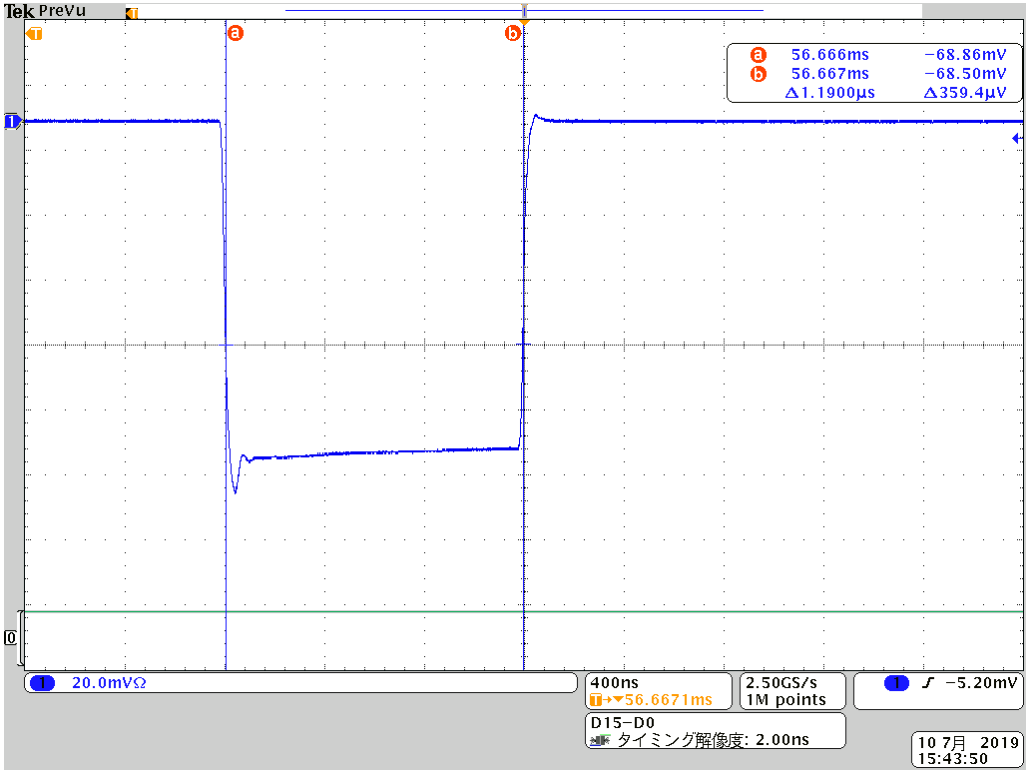



Fig. 6.6 ch1, P0N, L pulse envelope

ch1, Q0N

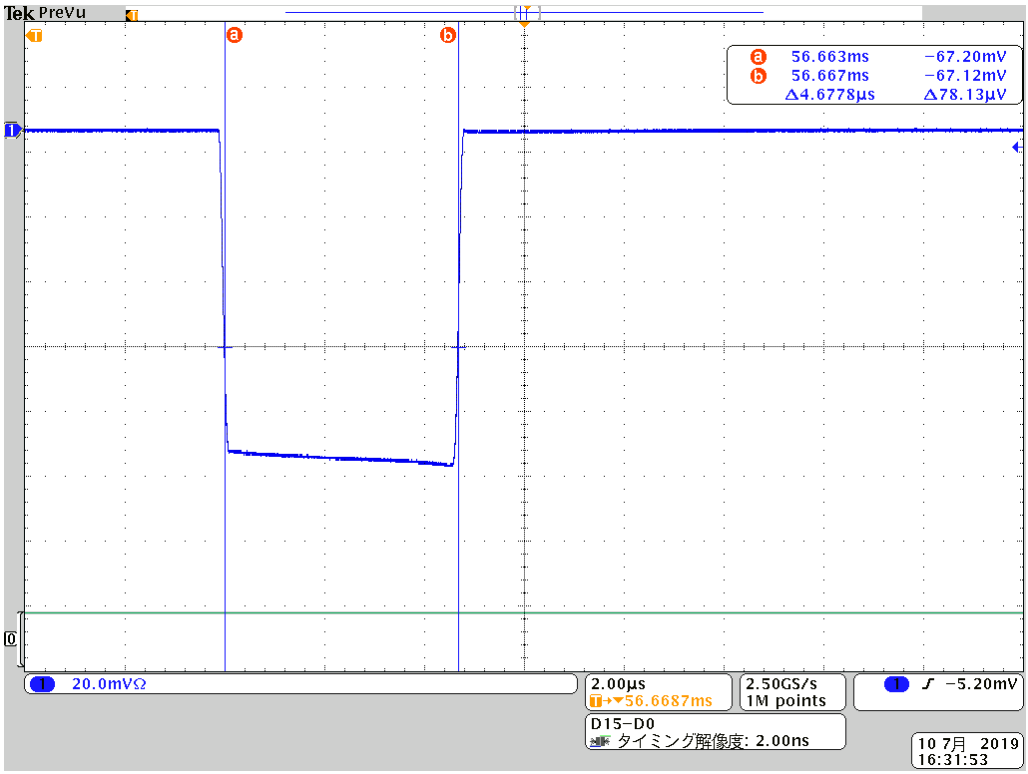



Fig. 6.7 ch1, Q0N, S1 pulse envelope

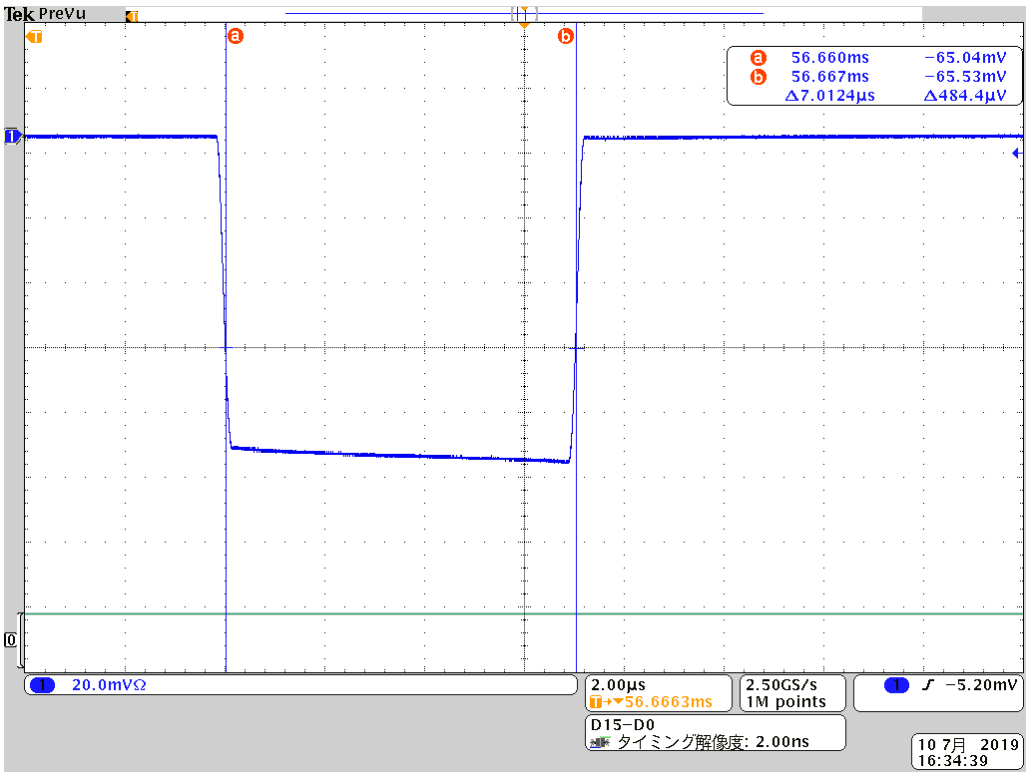



Fig. 6.8 ch1, Q0N, S2 pulse envelope

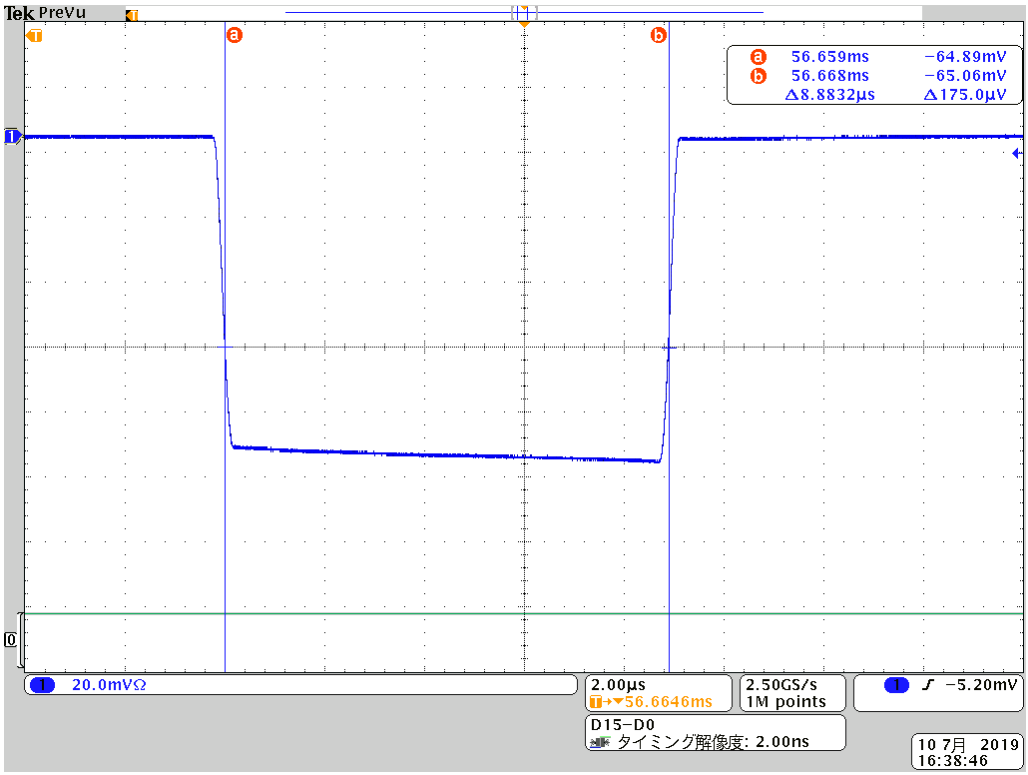



Fig. 6.9 ch1, Q0N, M1 pulse envelope

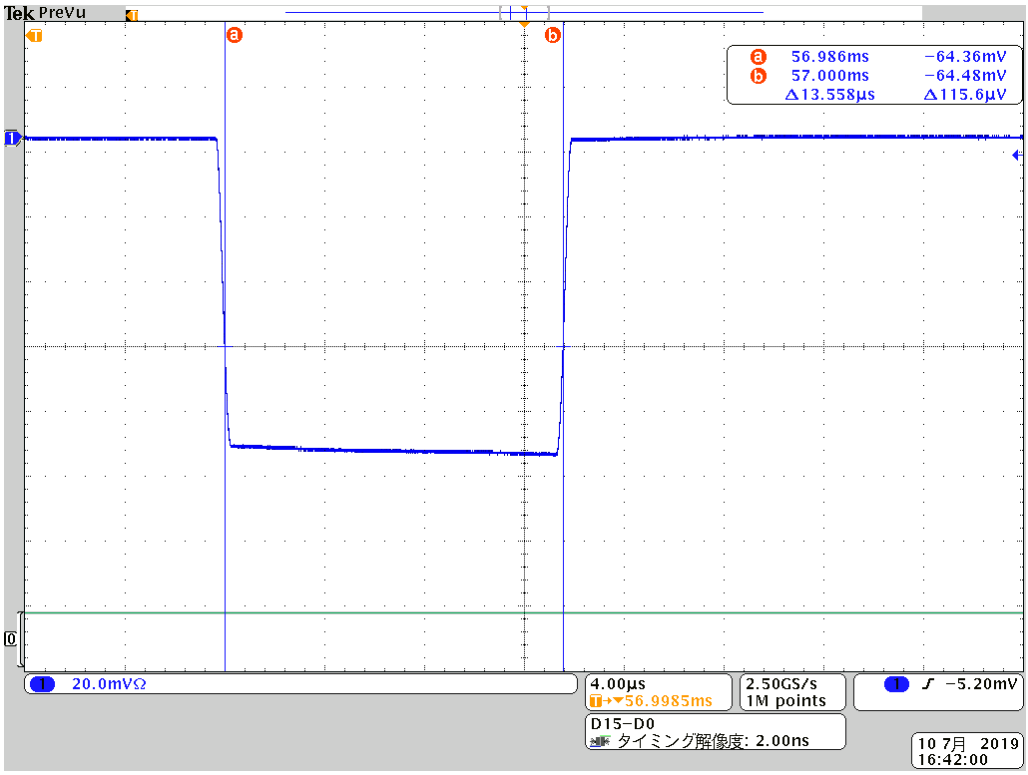



Fig. 6.10 ch1, Q0N, M2 pulse envelope

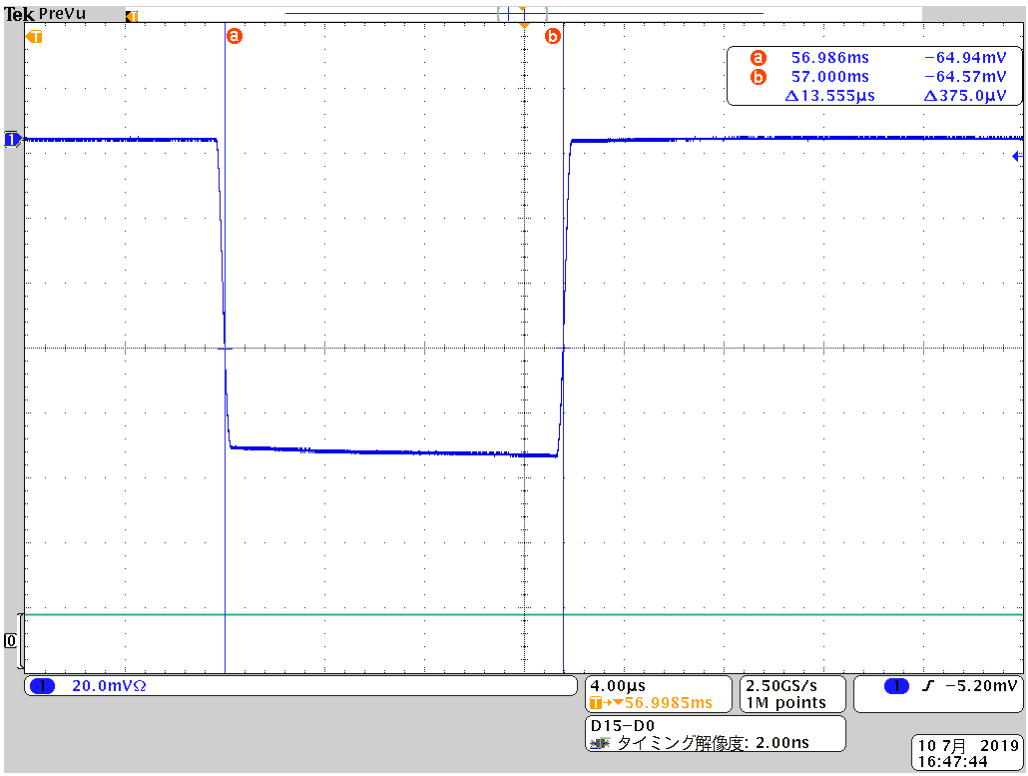



Fig. 6.11 ch1, Q0N, M3 pulse envelope

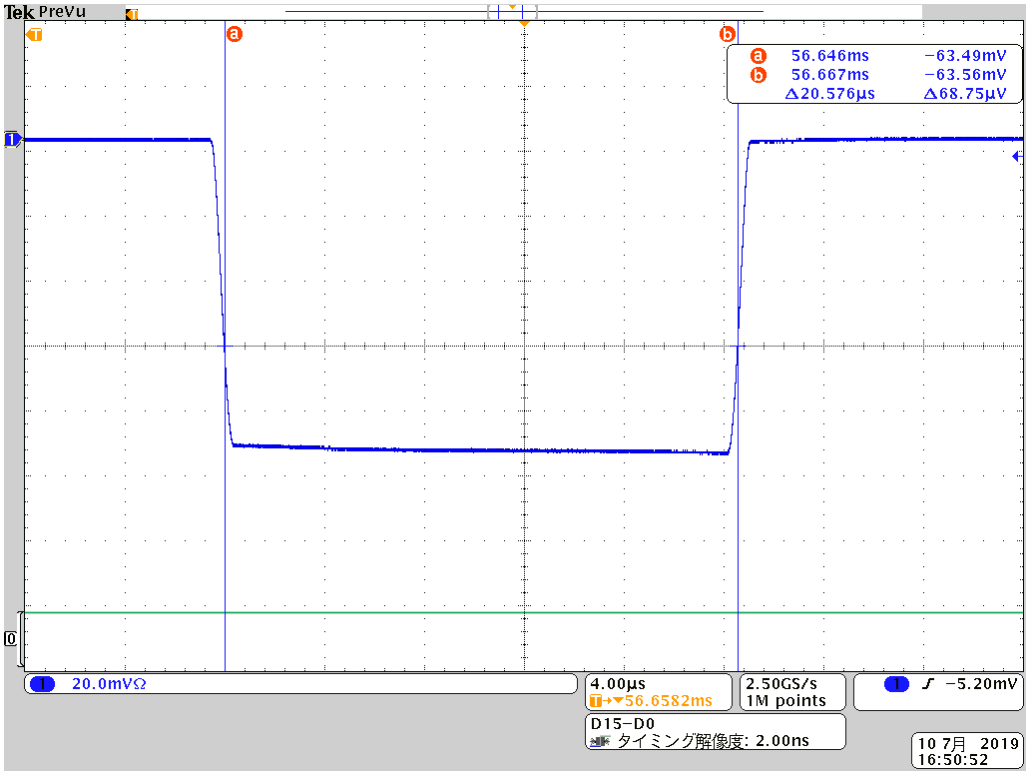



Fig. 6.12 ch1, Q0N, L pulse envelope

ch2, P0N

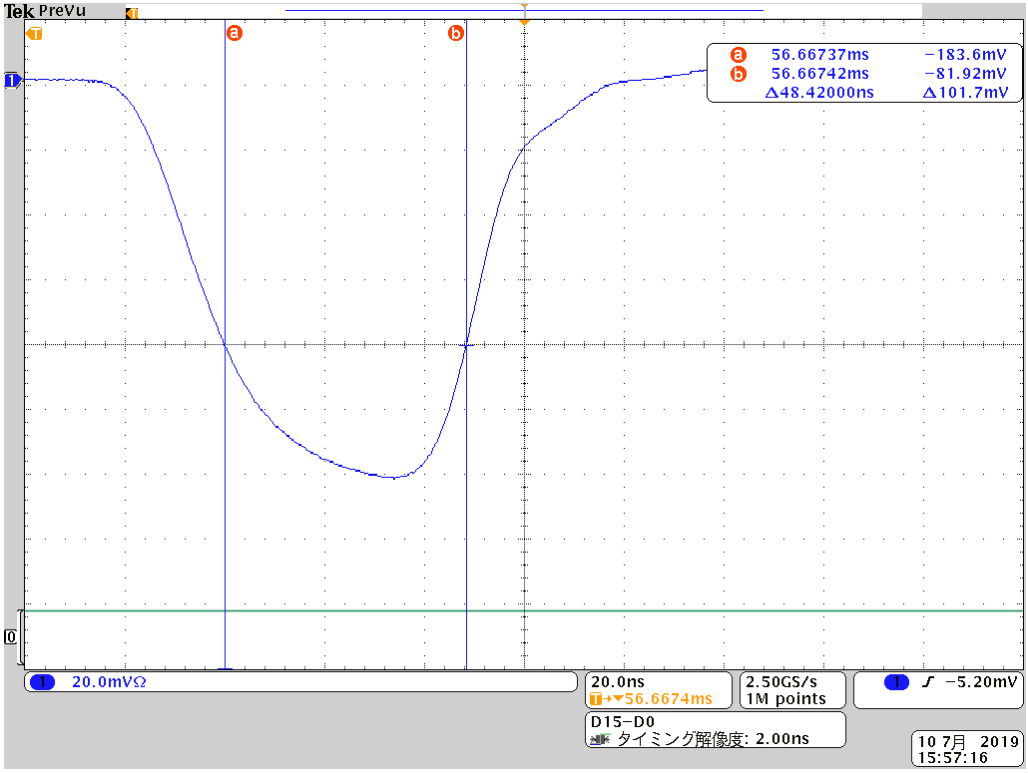



Fig. 6.13 ch2, P0N, S1 pulse envelope

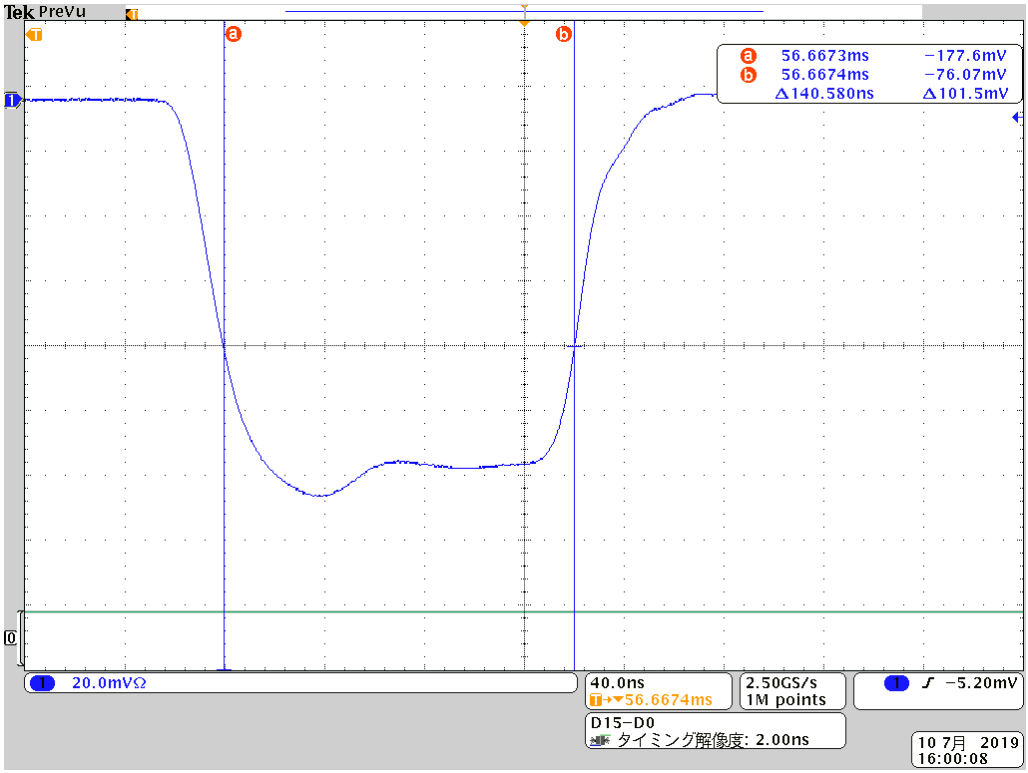



Fig. 6.14 ch2, P0N, S2 pulse envelope

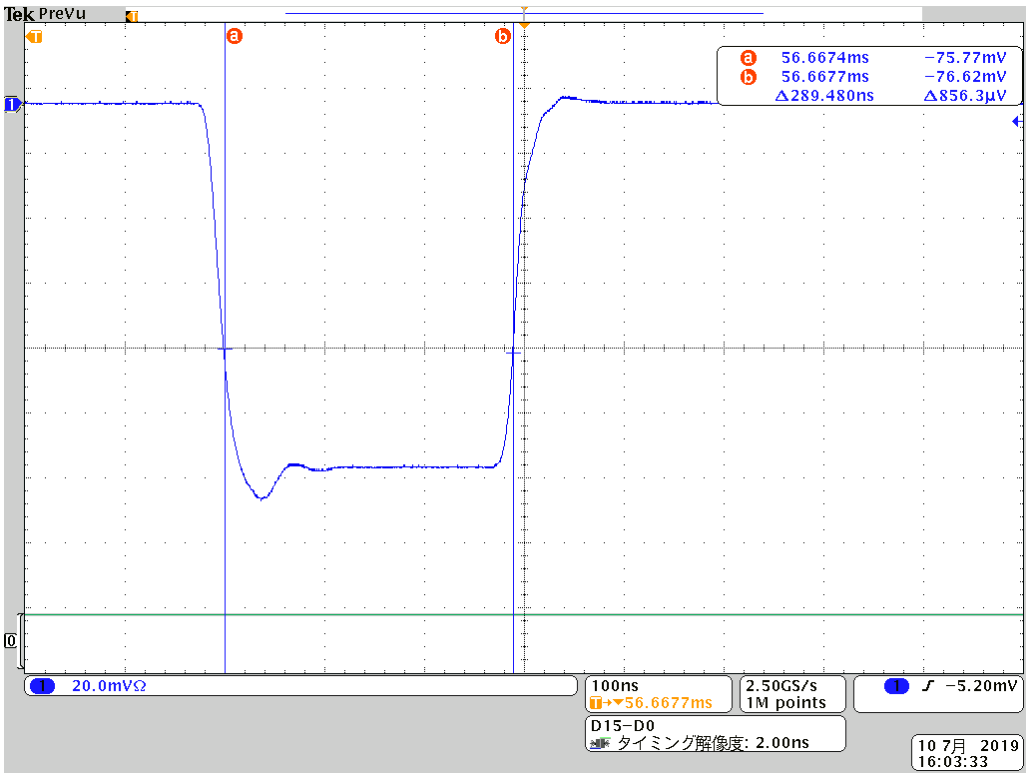



Fig. 6.15 ch2, P0N, M1 pulse envelope

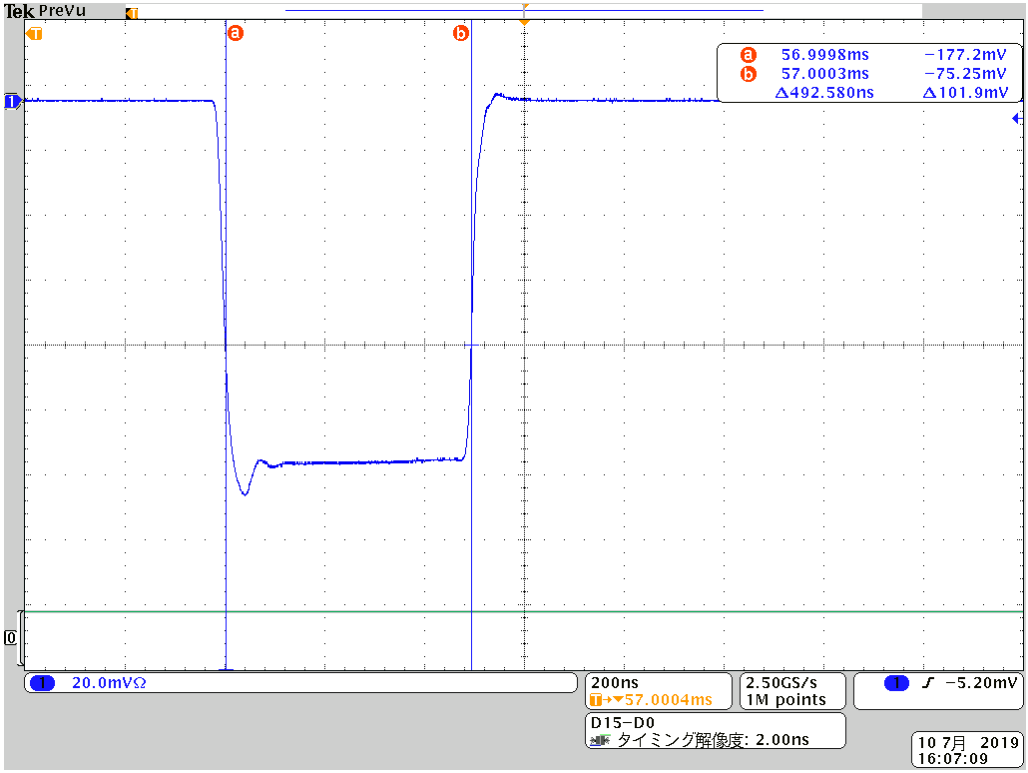



Fig. 6.16 ch2, P0N, M2 pulse envelope

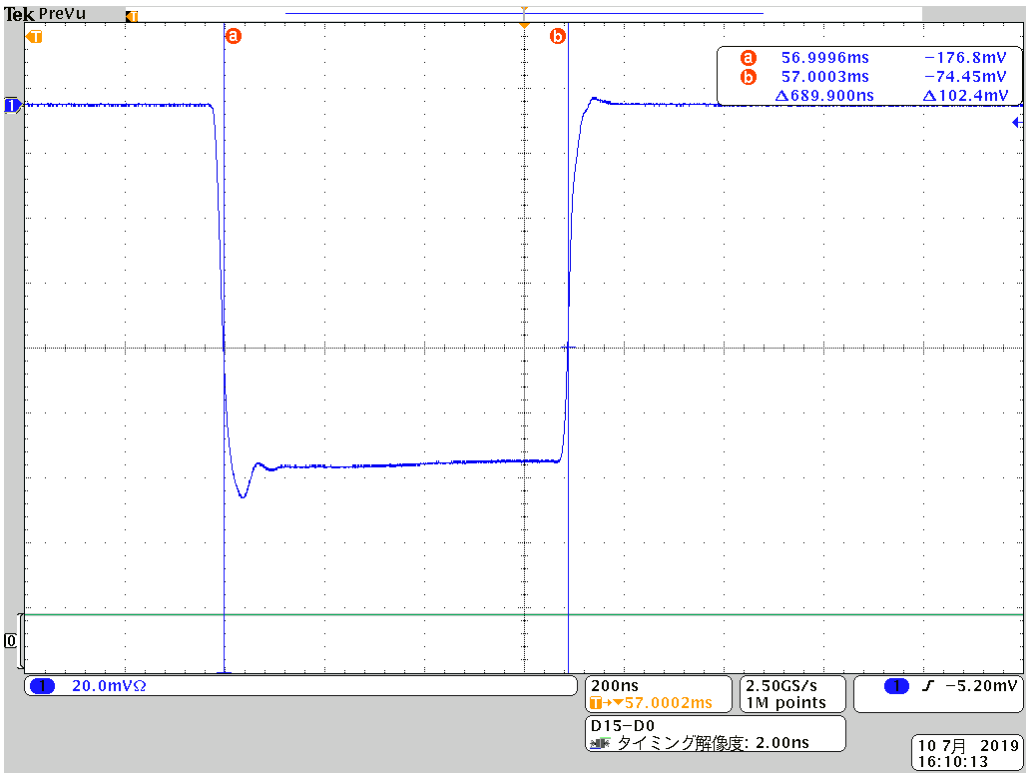



Fig. 6.17 ch2, P0N, M3 pulse envelope

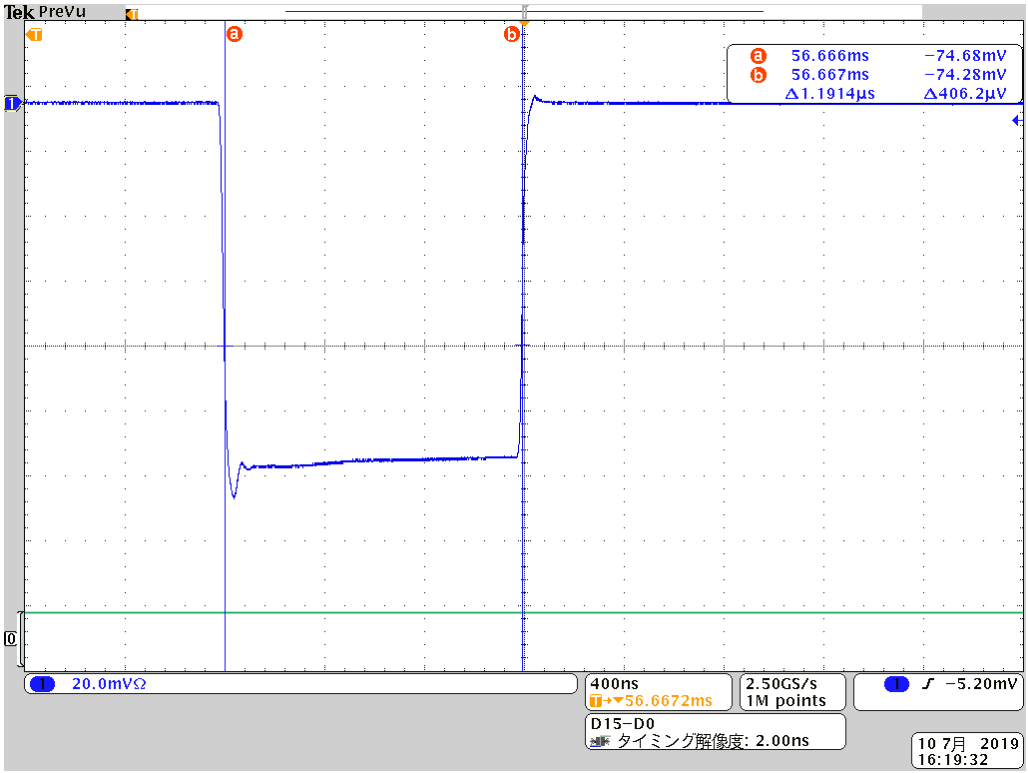



Fig. 6.18 ch2, P0N, L pulse envelope

ch2, Q0N

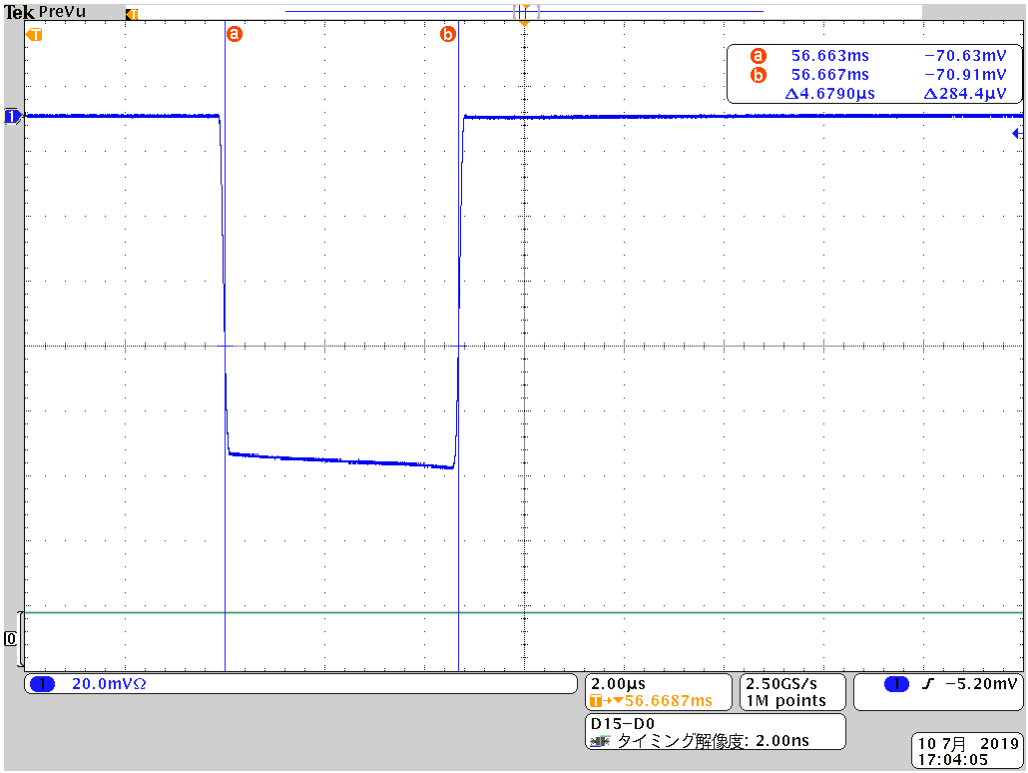



Fig. 6.19 ch2, Q0N, S1 pulse envelope

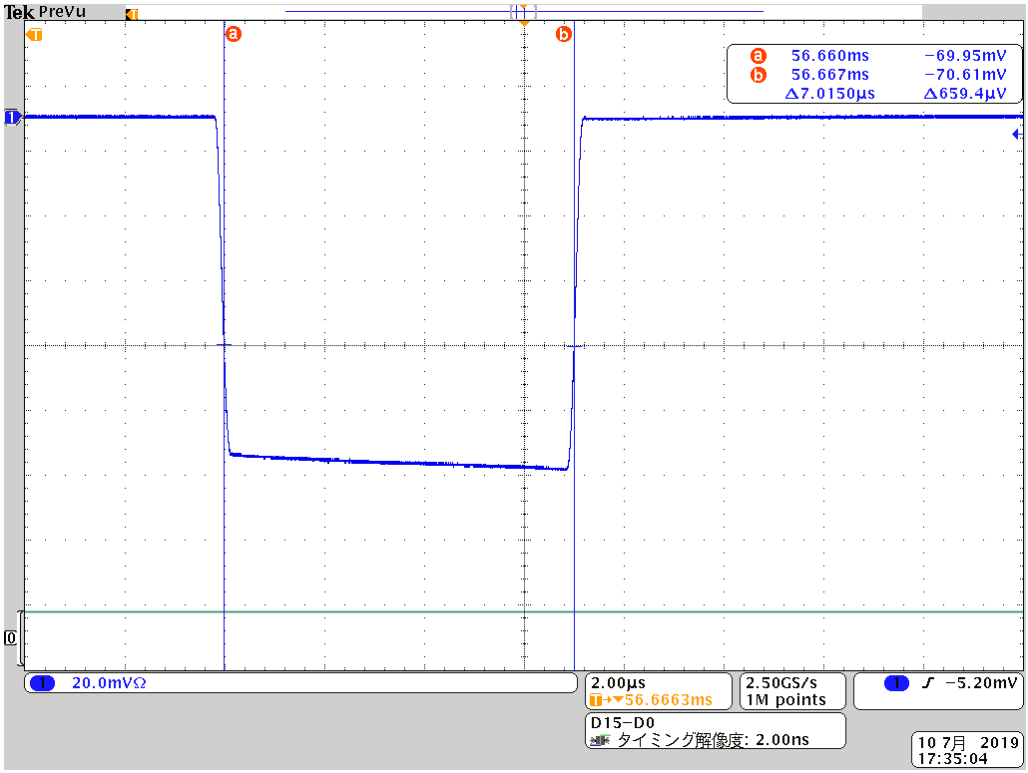



Fig. 6.20 ch2, Q0N, S2 pulse envelope

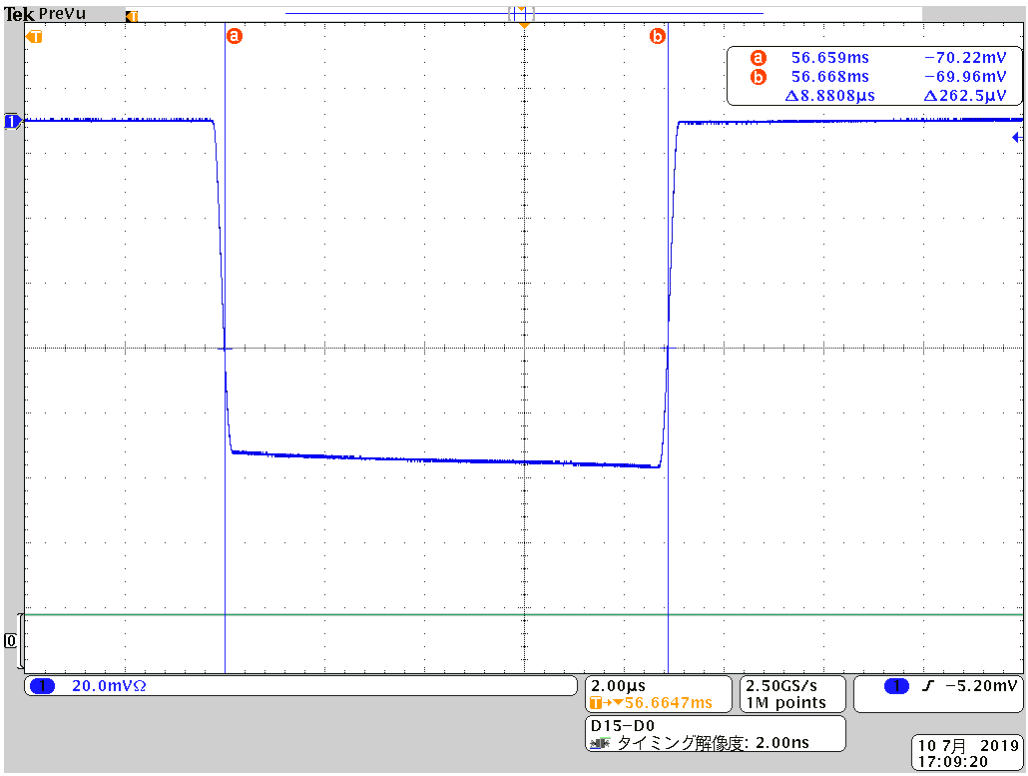



Fig. 6.21 ch2, Q0N, M1 pulse envelope

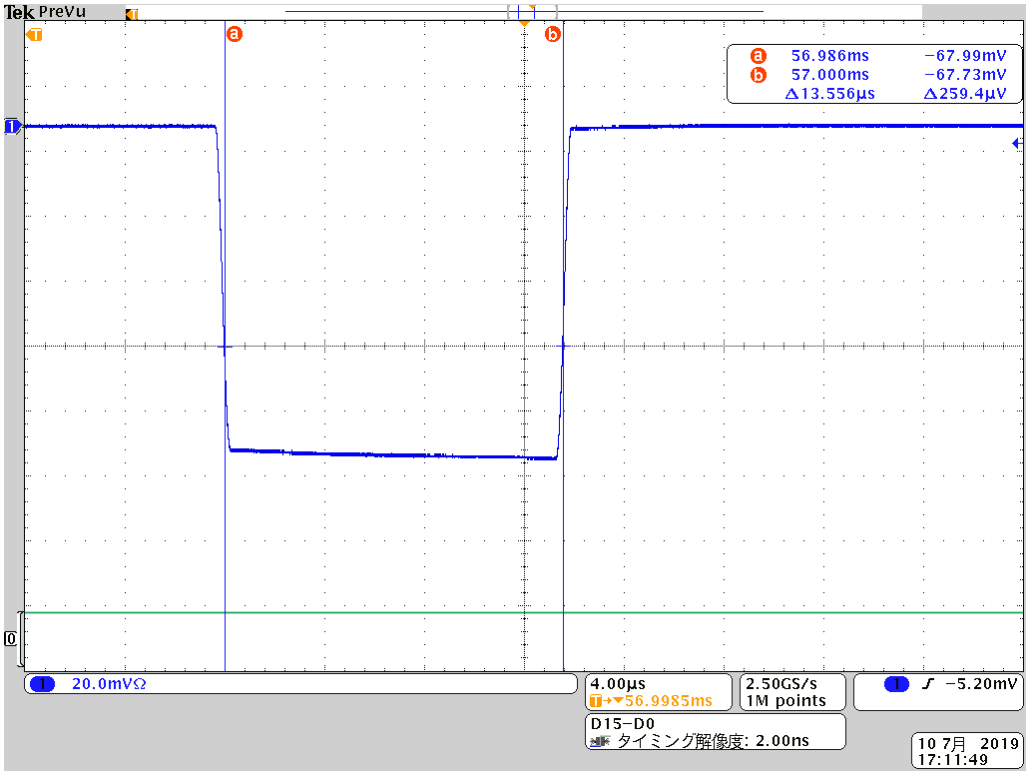



Fig. 6.22 ch2, Q0N, M2 pulse envelope

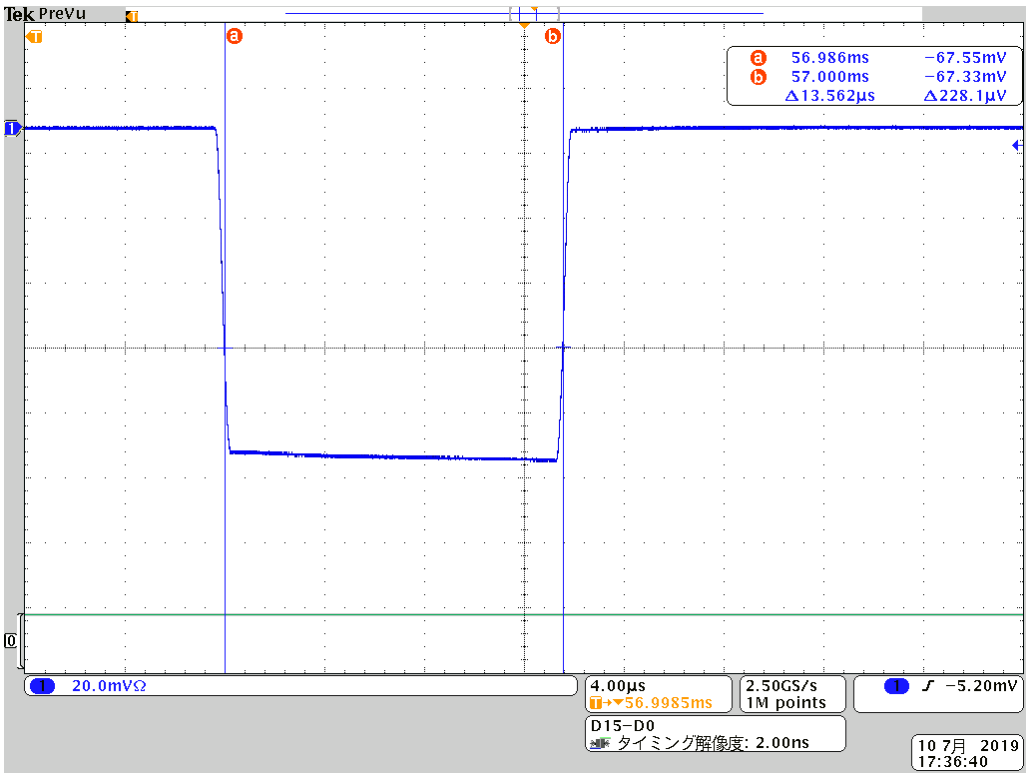



Fig. 6.23 ch2, Q0N, M3 pulse envelope

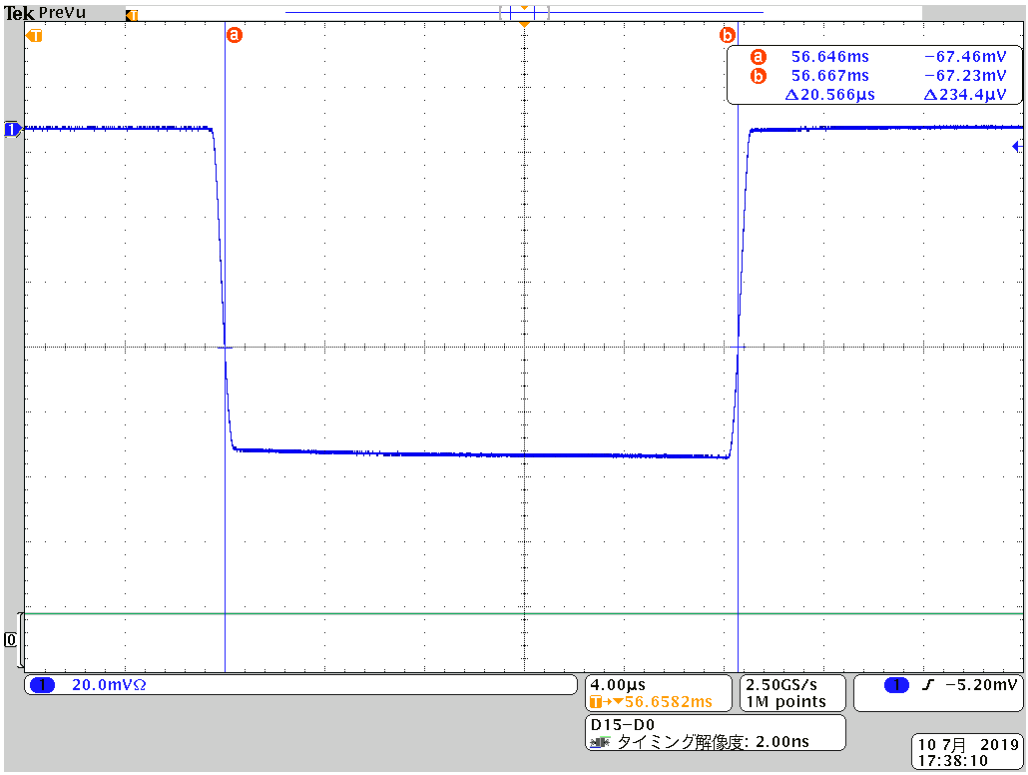



Fig. 6.24 ch2, Q0N, L pulse envelope

TT32NM mode

ch1, P0N

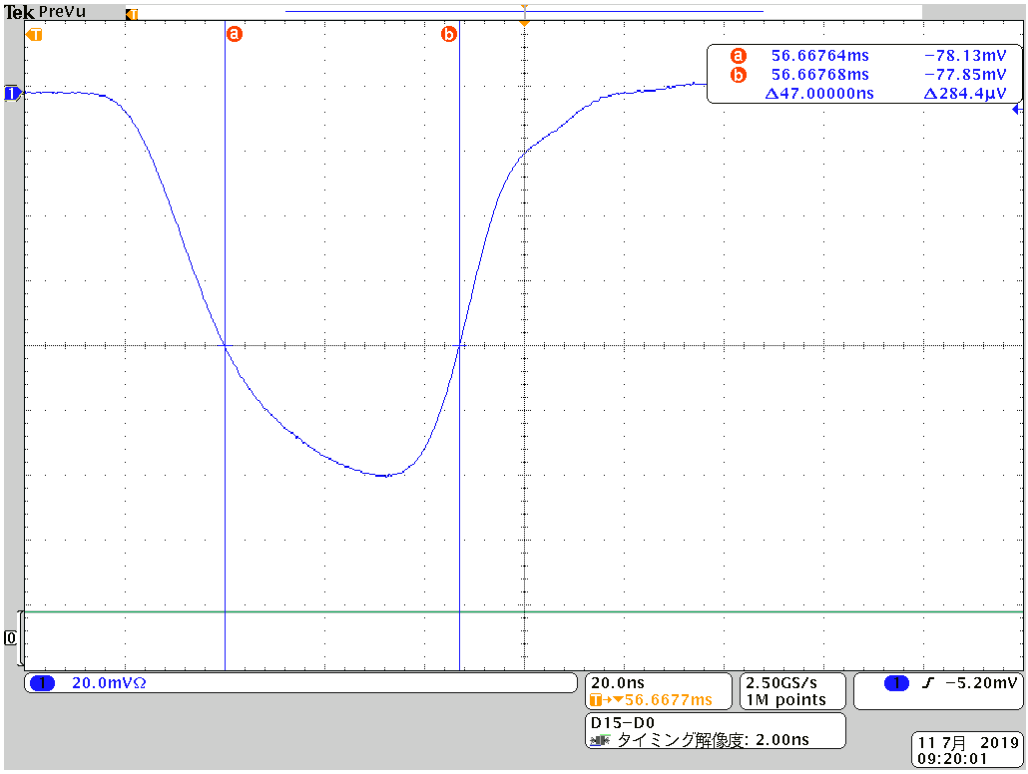



Fig. 6.25 ch1, P0N, S1 pulse envelope

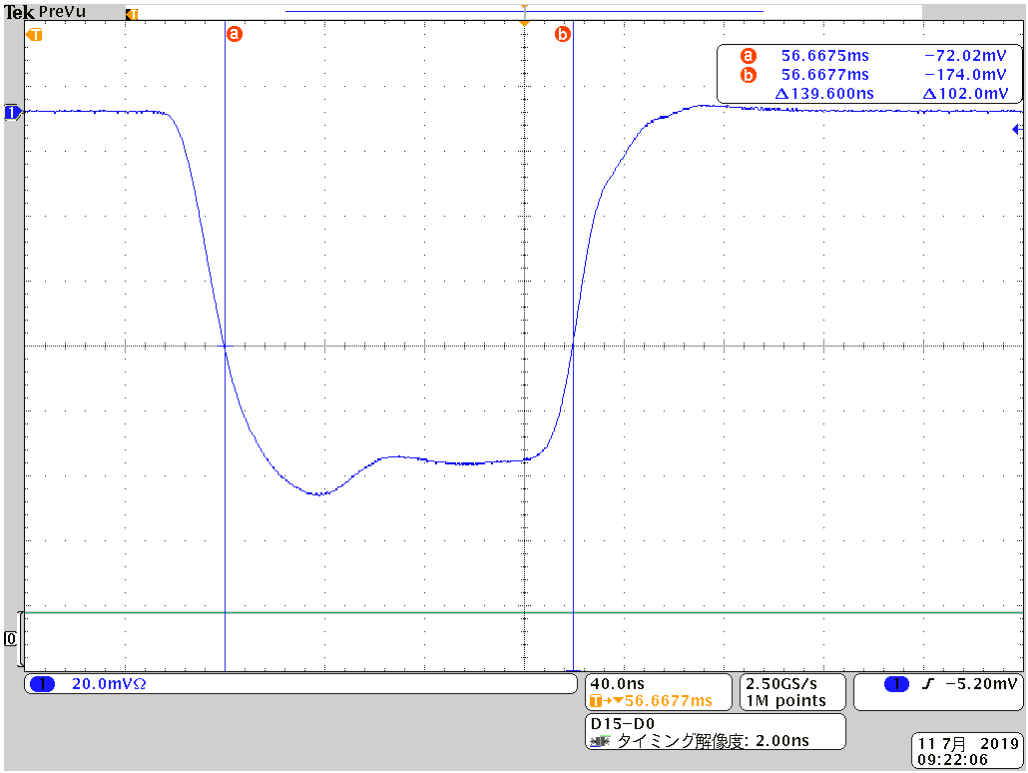



Fig. 6.26 ch1, P0N, S2 pulse envelope


Fig. 6.27 ch1, P0N, M1 pulse envelope

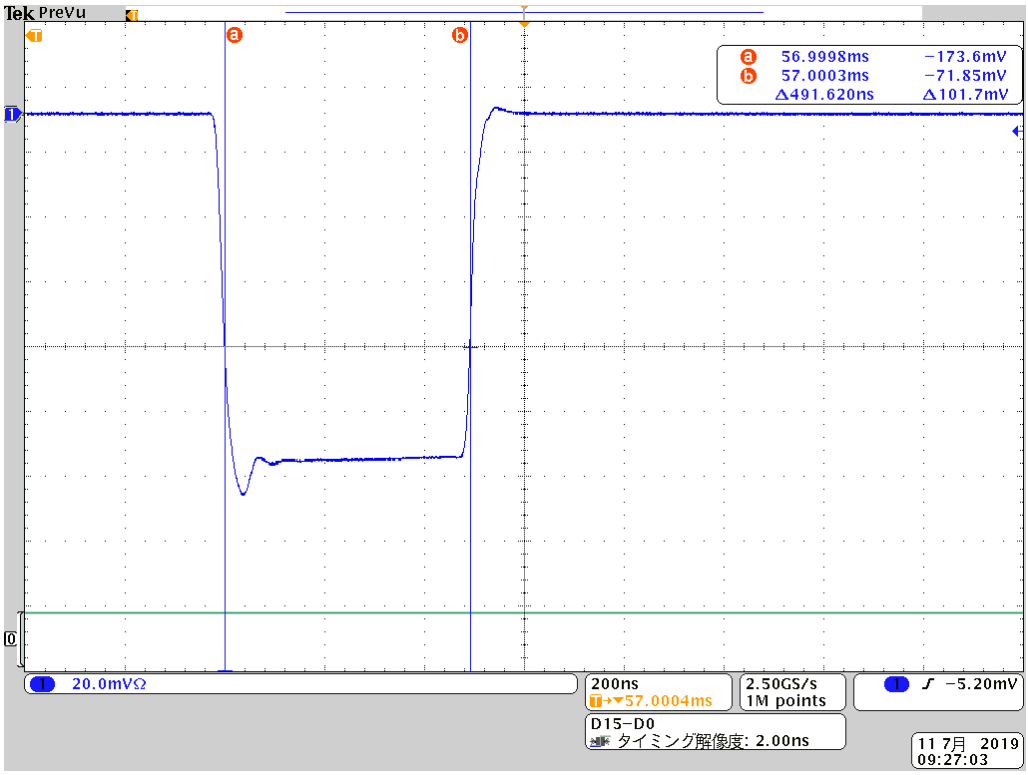



Fig. 6.28 ch1, P0N, M2 pulse envelope

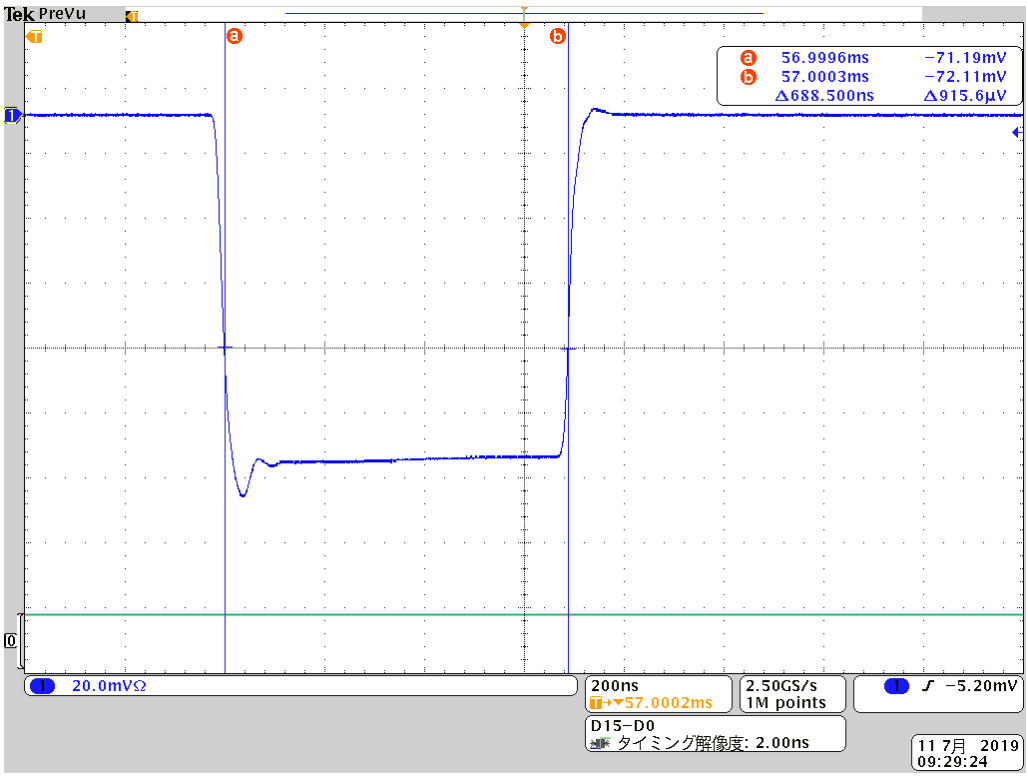



Fig. 6.29 ch1, P0N, M3 pulse envelope

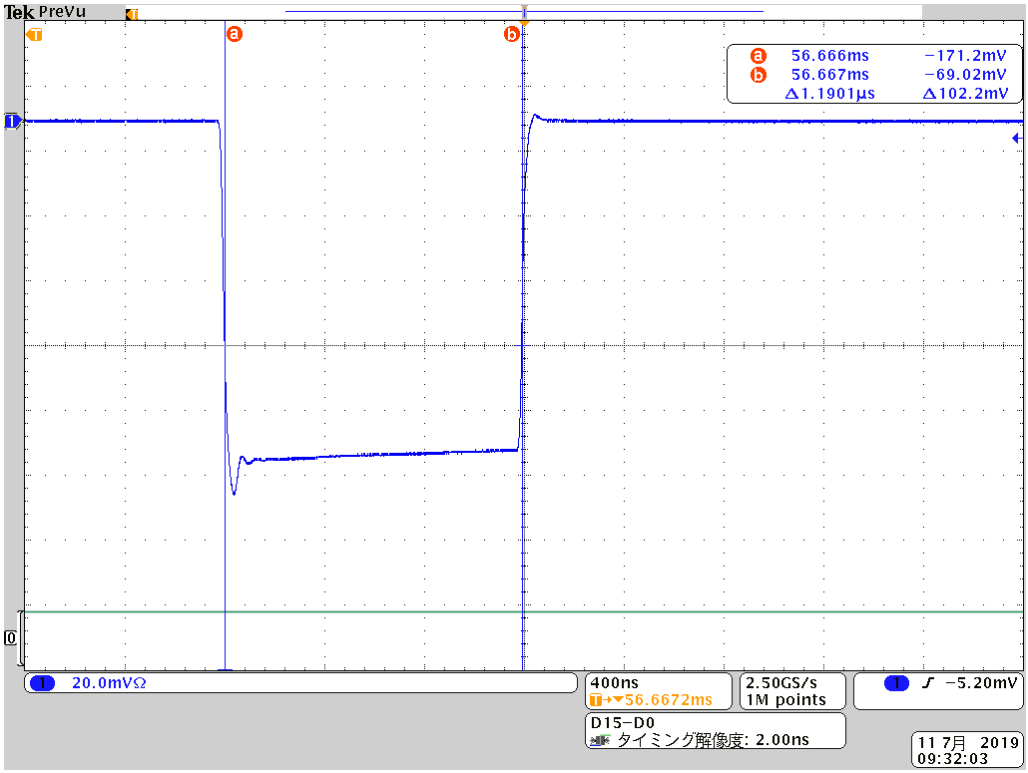



Fig. 6.30 ch1, P0N, L pulse envelope

ch1, Q0N

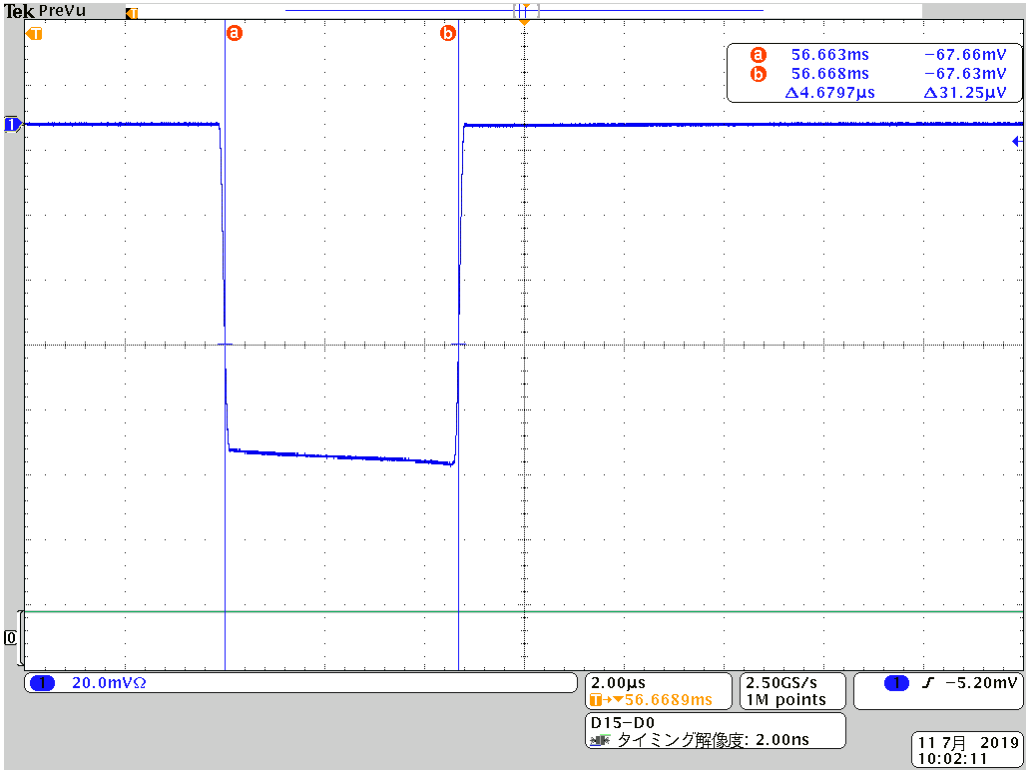



Fig. 6.31 ch1, Q0N, S1 pulse envelope

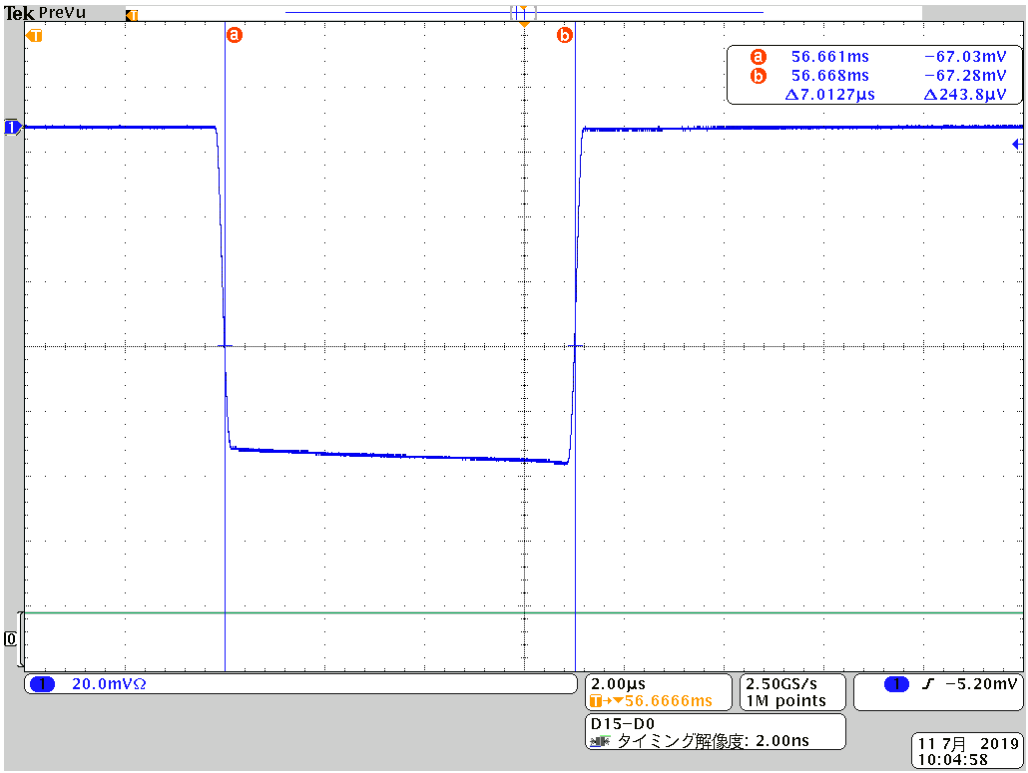



Fig. 6.32 ch1, Q0N, S2 pulse envelope

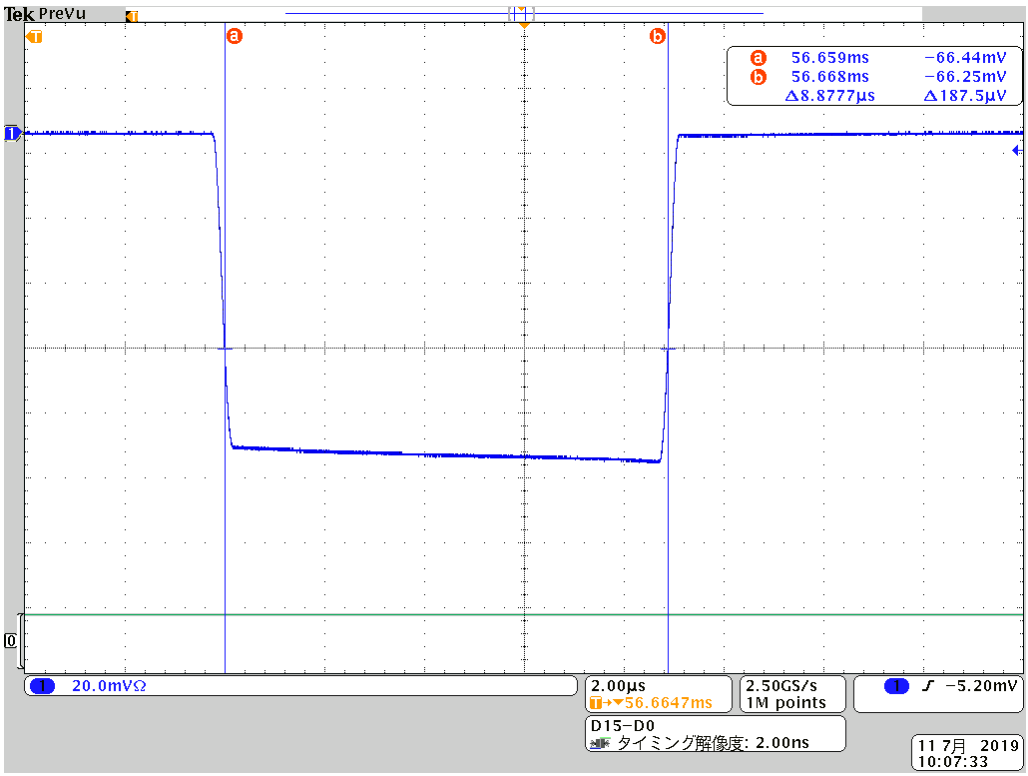



Fig. 6.33 ch1, Q0N, M1 pulse envelope

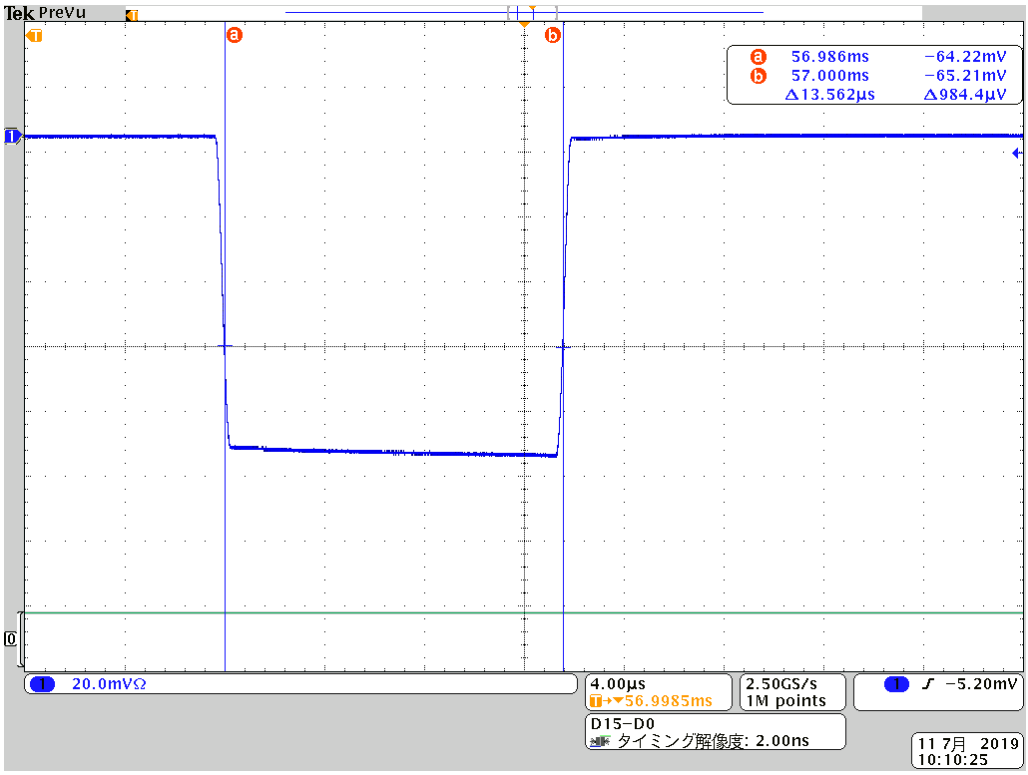



Fig. 6.34 ch1, Q0N, M2 pulse envelope

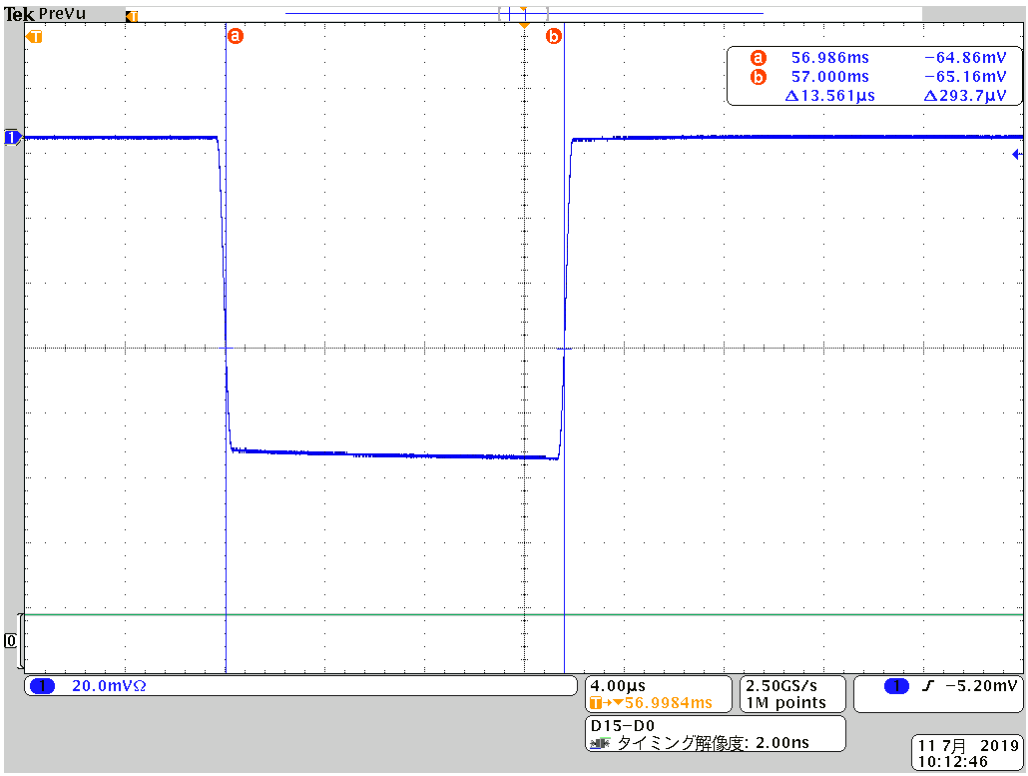



Fig. 6.35 ch1, Q0N, M3 pulse envelope

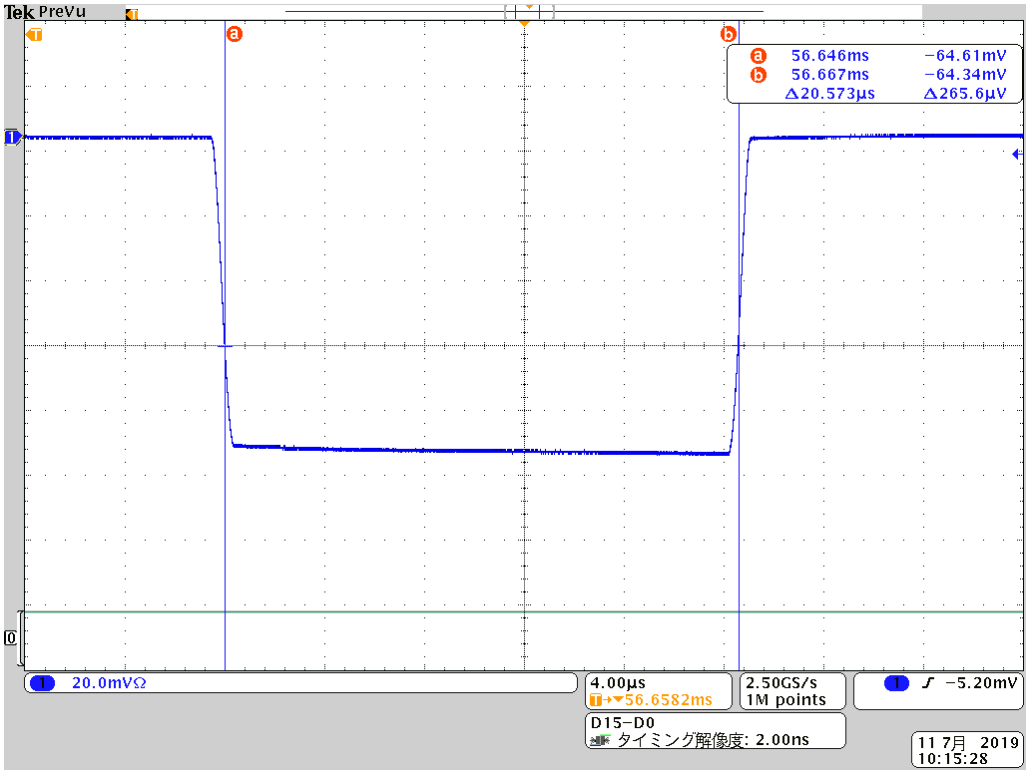



Fig. 6.36 ch1, Q0N, L pulse envelope

ch2, P0N

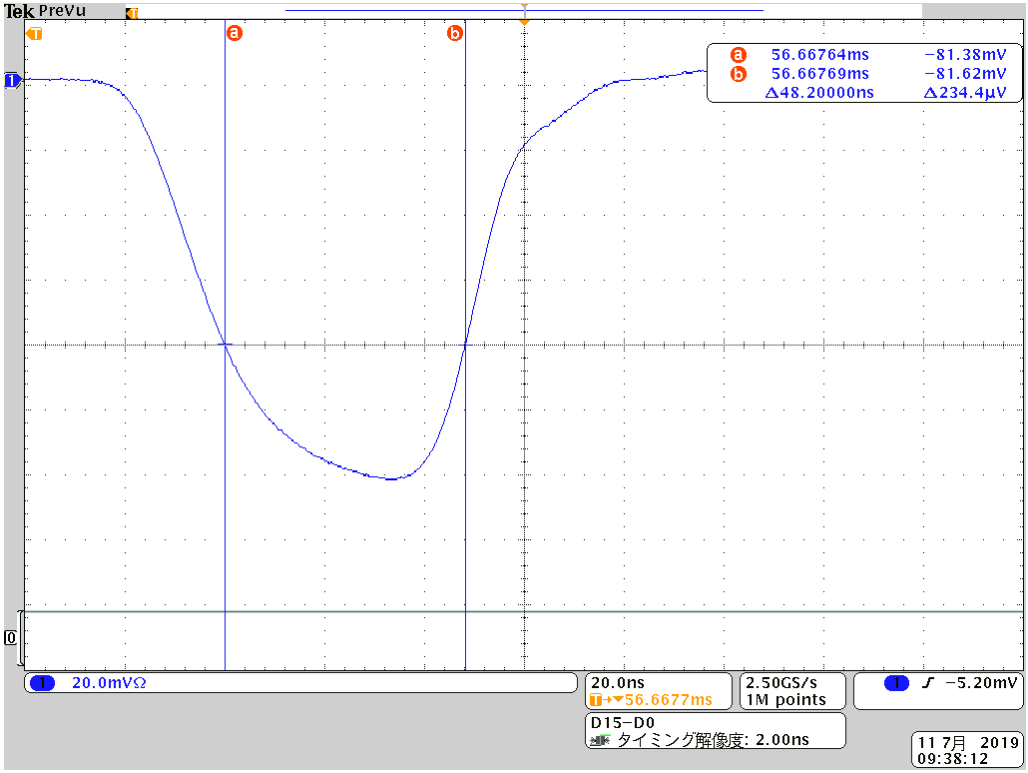



Fig. 6.37 ch2, P0N, S1 pulse envelope

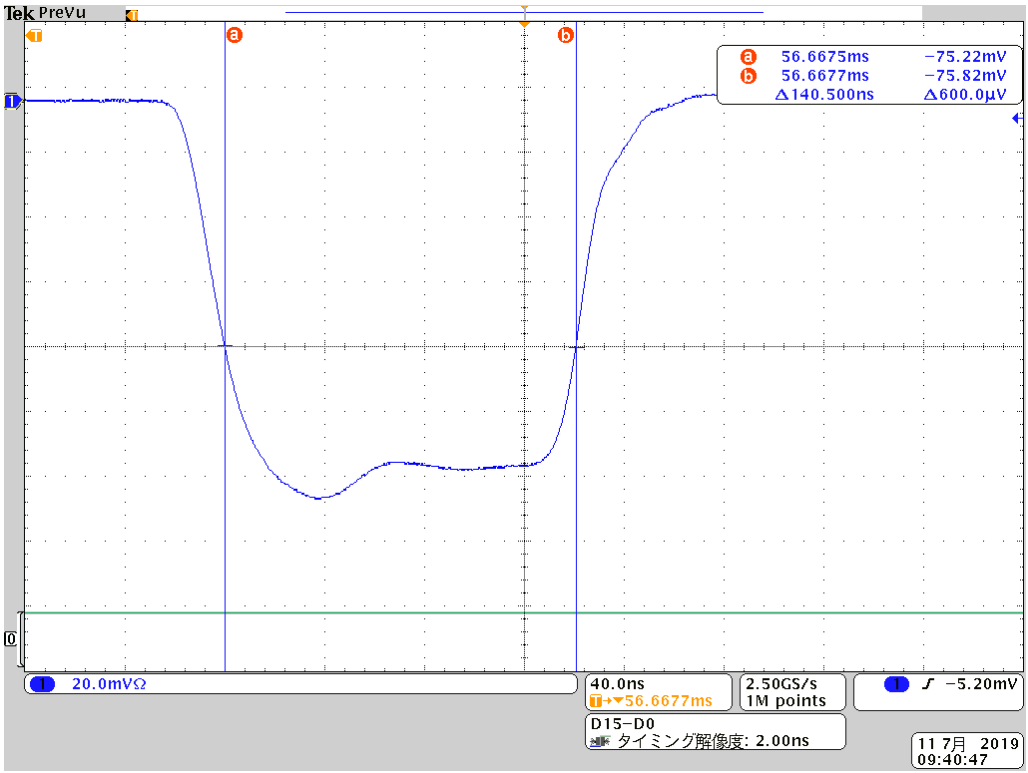



Fig. 6.38 ch2, P0N, S2 pulse envelope


Fig. 6.39 ch2, P0N, M1 pulse envelope

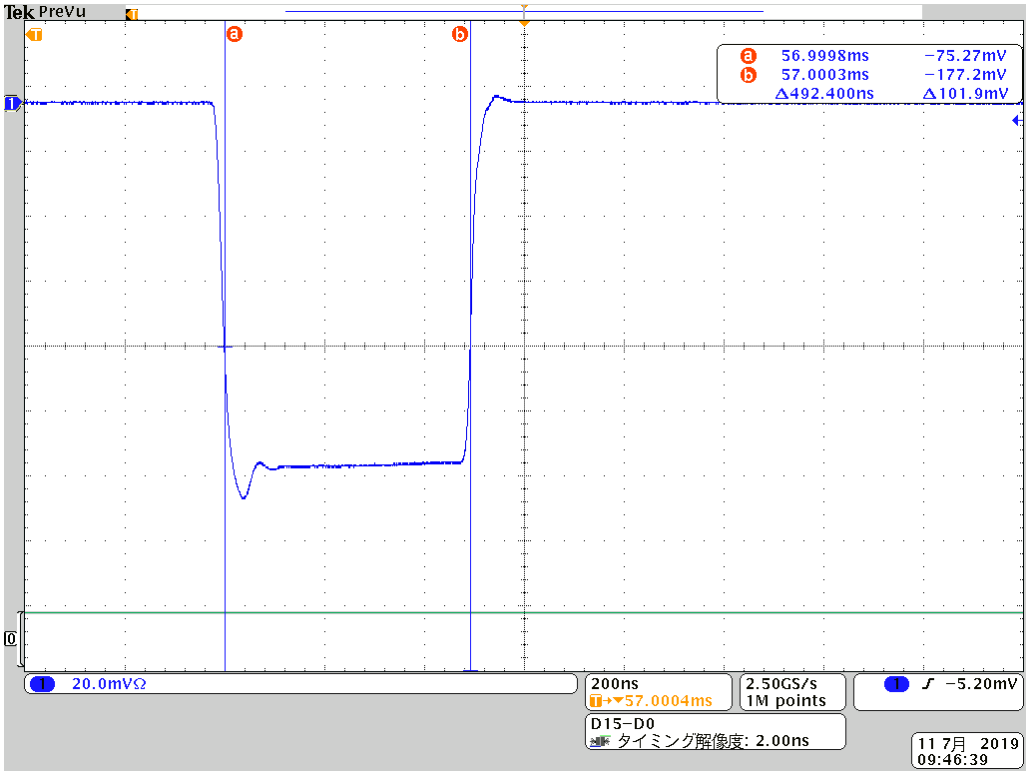



Fig. 6.40 ch2, P0N, M2 pulse envelope

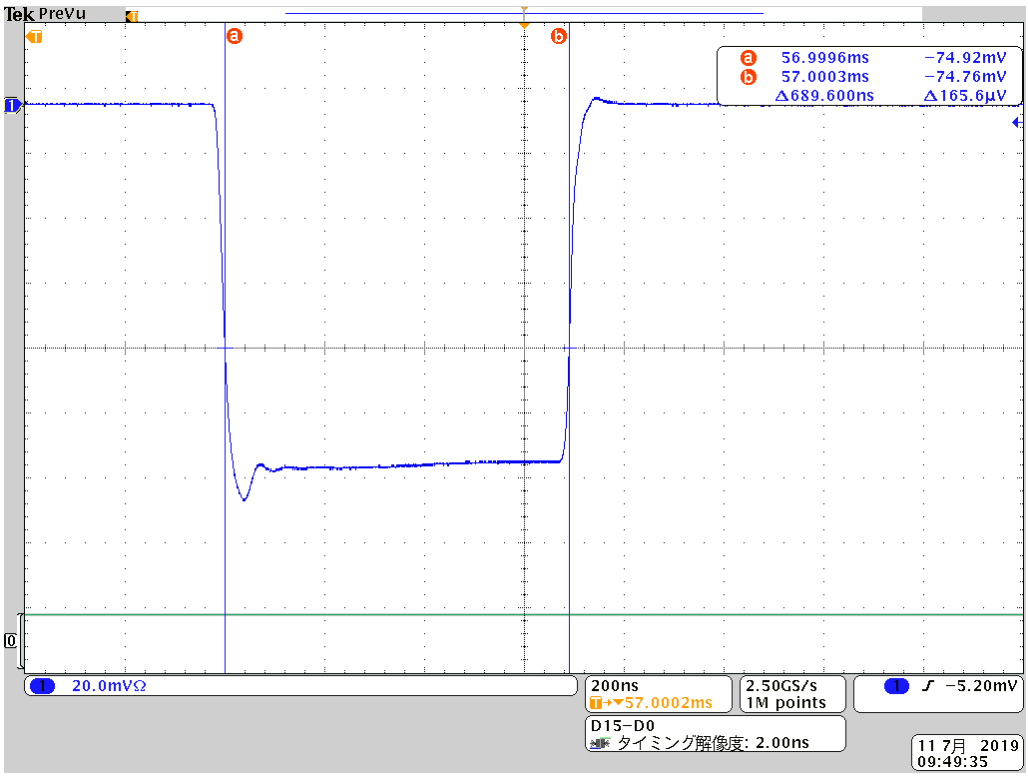



Fig. 6.41 ch2, P0N, M3 pulse envelope

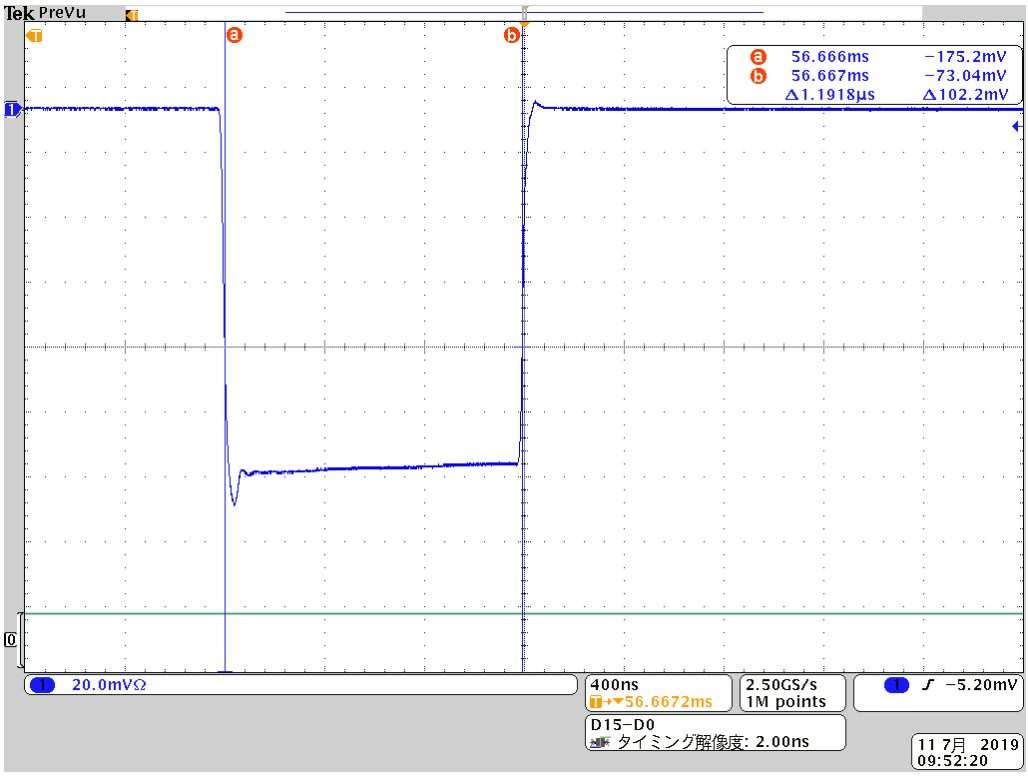



Fig. 6.42 ch2, P0N, L pulse envelope

ch2, Q0N

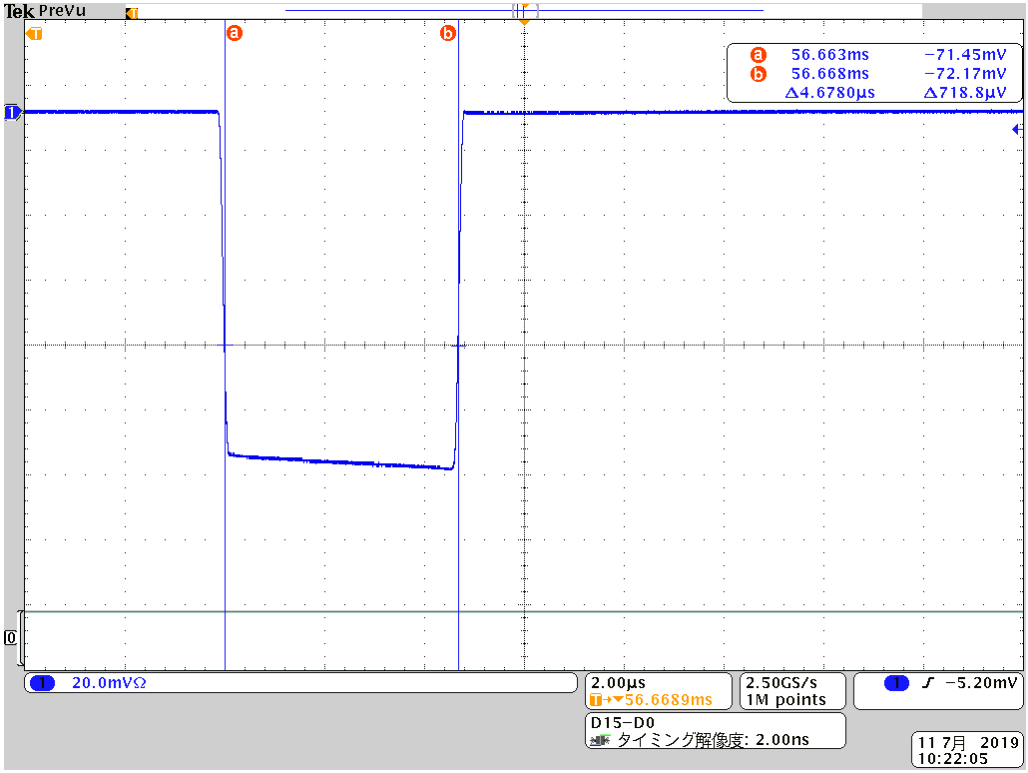



Fig. 6.43 ch2, Q0N, S1 pulse envelope

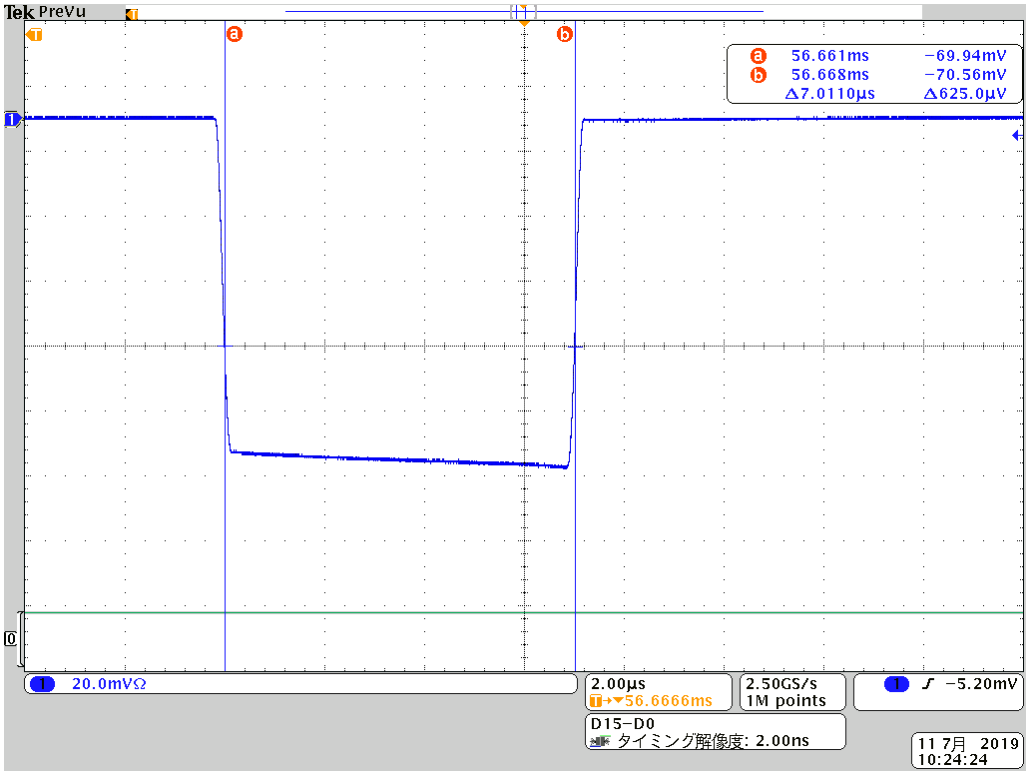



Fig. 6.44 ch2, Q0N, S2 pulse envelope

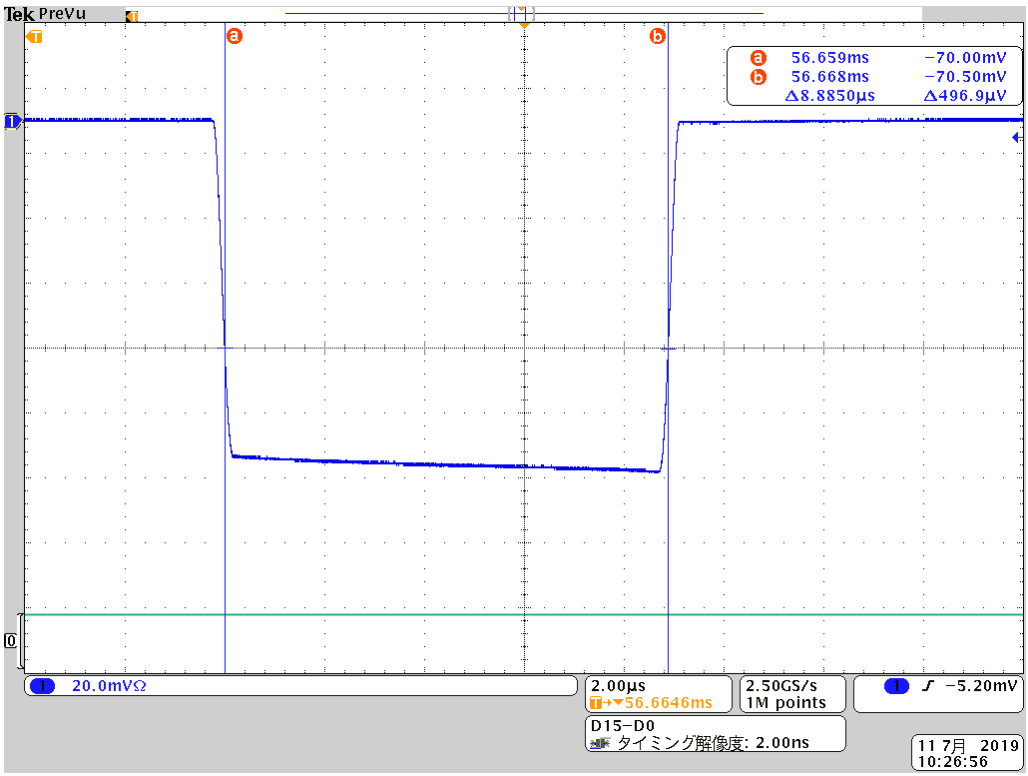



Fig. 6.45 ch2, Q0N, M1 pulse envelope

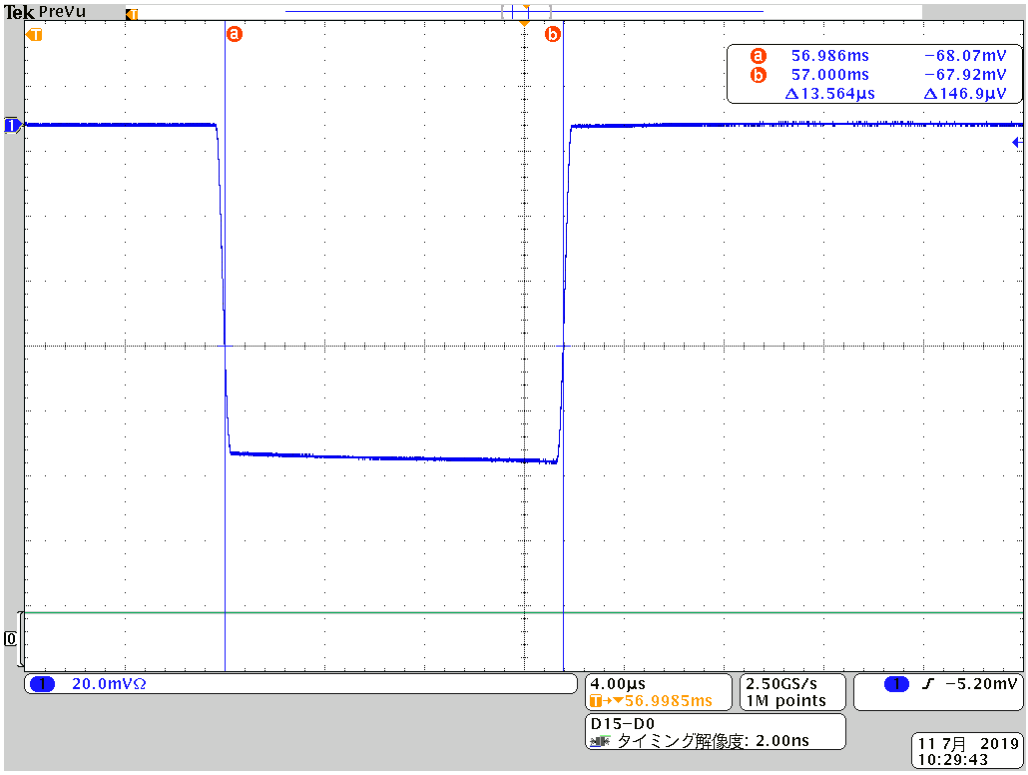



Fig. 6.46 ch2, Q0N, M2 pulse envelope

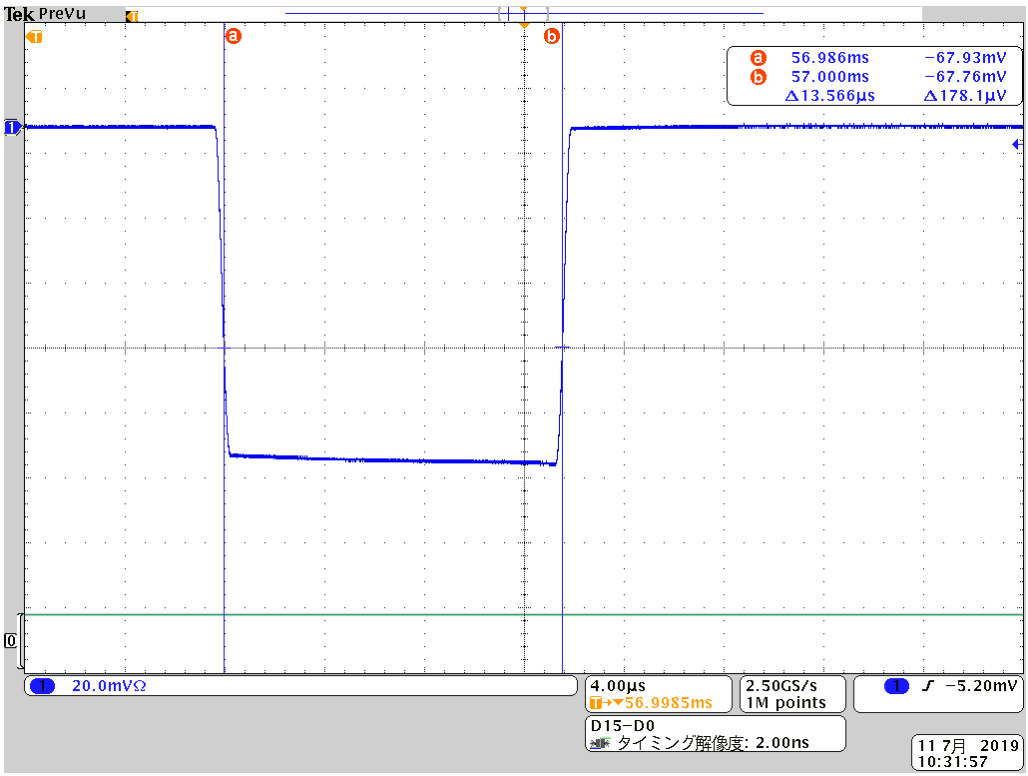



Fig. 6.47 ch2, Q0N, M3 pulse envelope

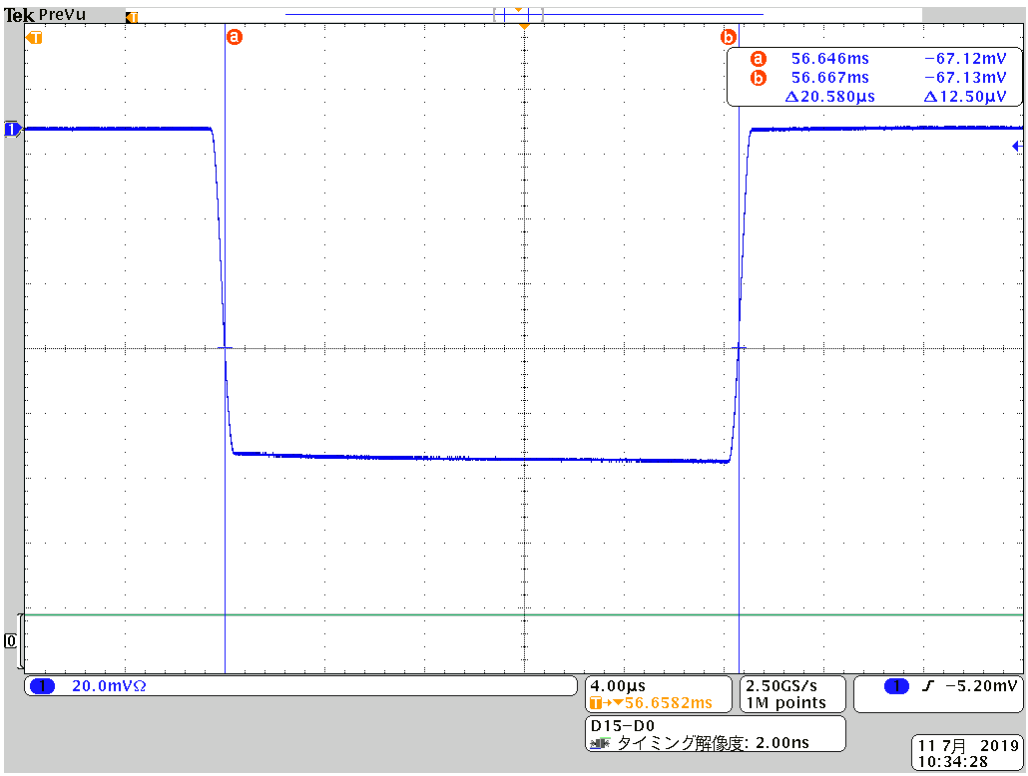



Fig. 6.48 ch2, Q0N, L pulse envelope

2nd trace mode

ch1, P0N

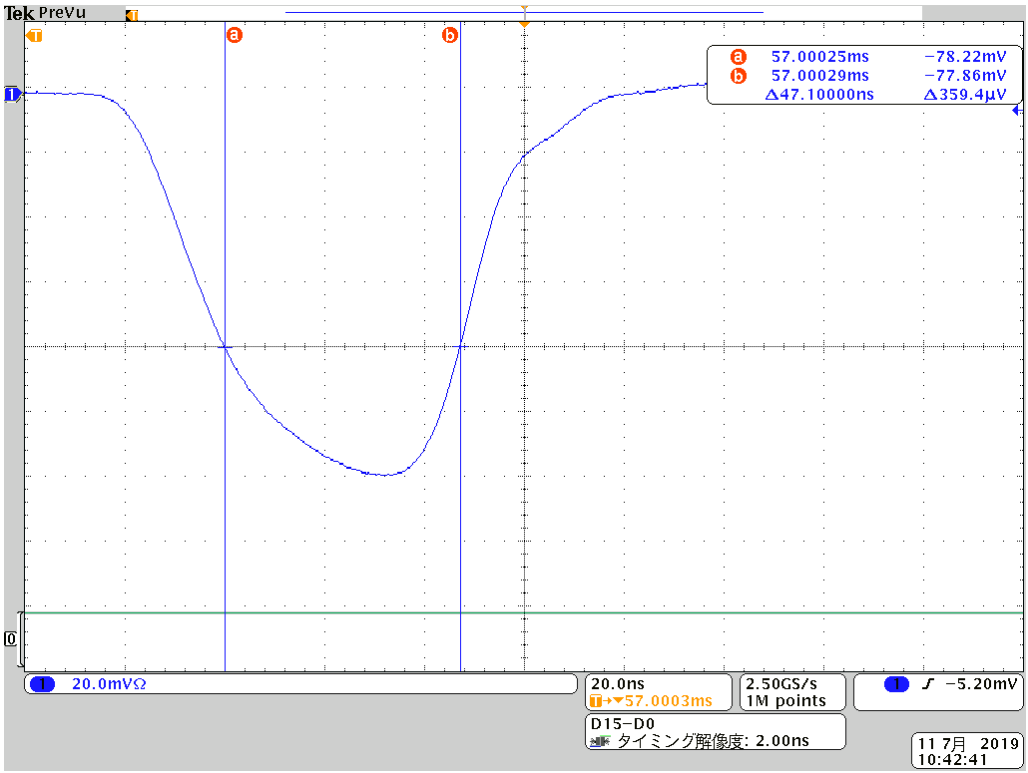



Fig. 6.49 ch1, P0N, S1 pulse envelope

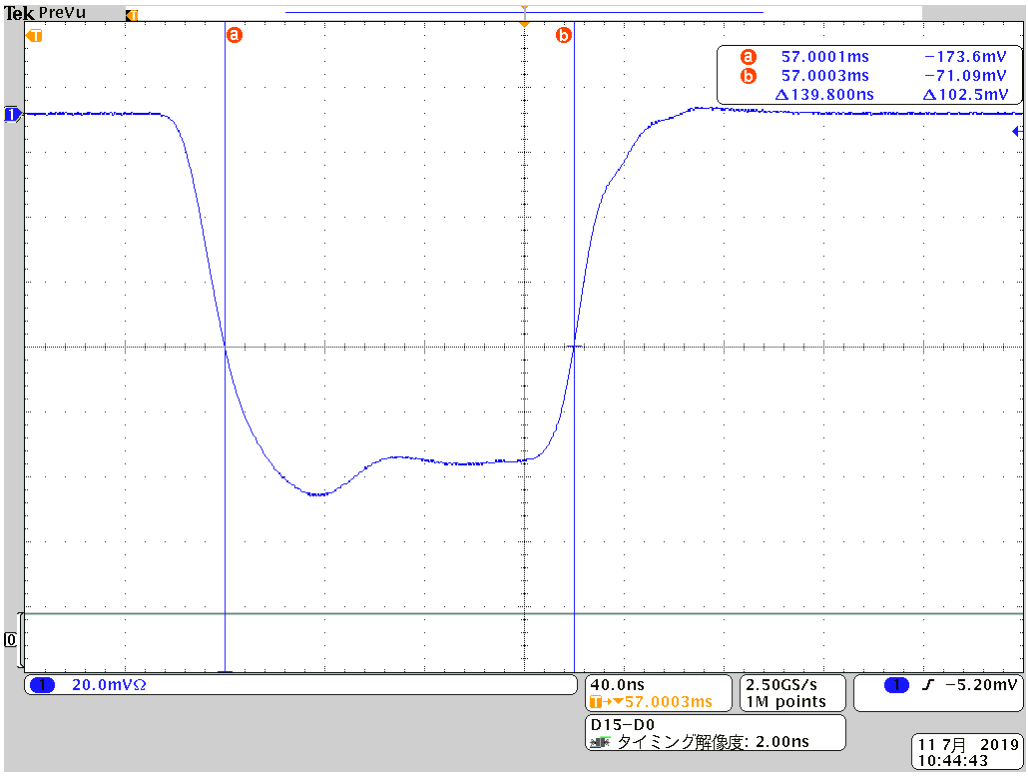



Fig. 6.50 ch1, P0N, S2 pulse envelope


Fig. 6.51 ch1, P0N, M1 pulse envelope

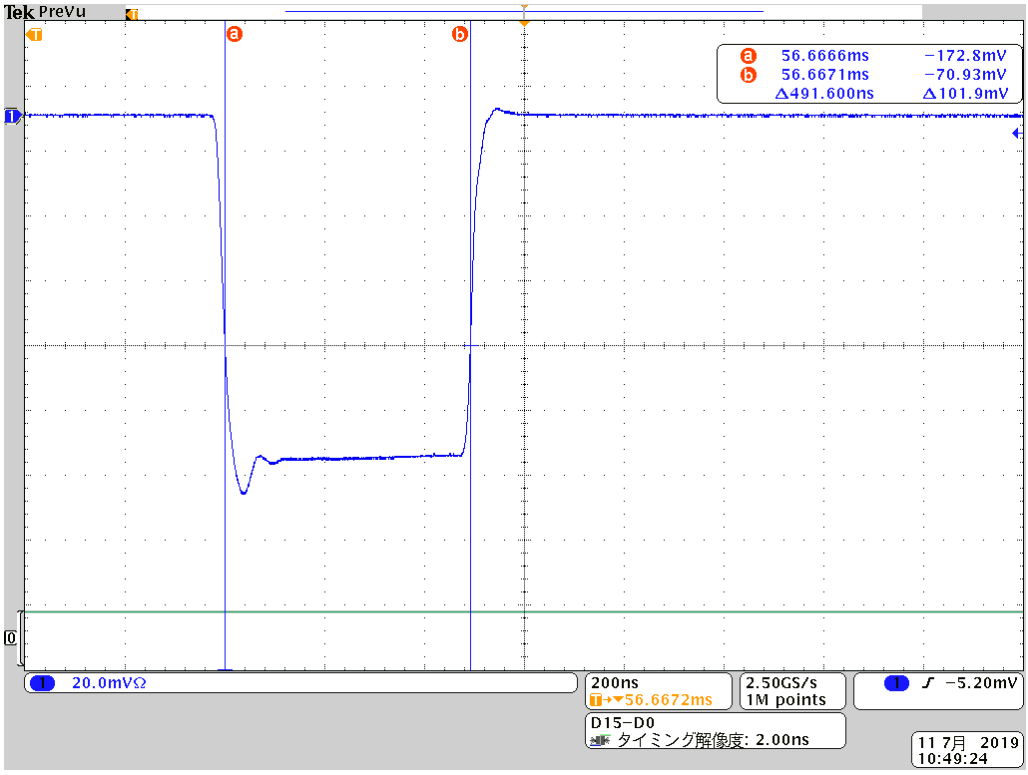



Fig. 6.52 ch1, P0N, M2 pulse envelope

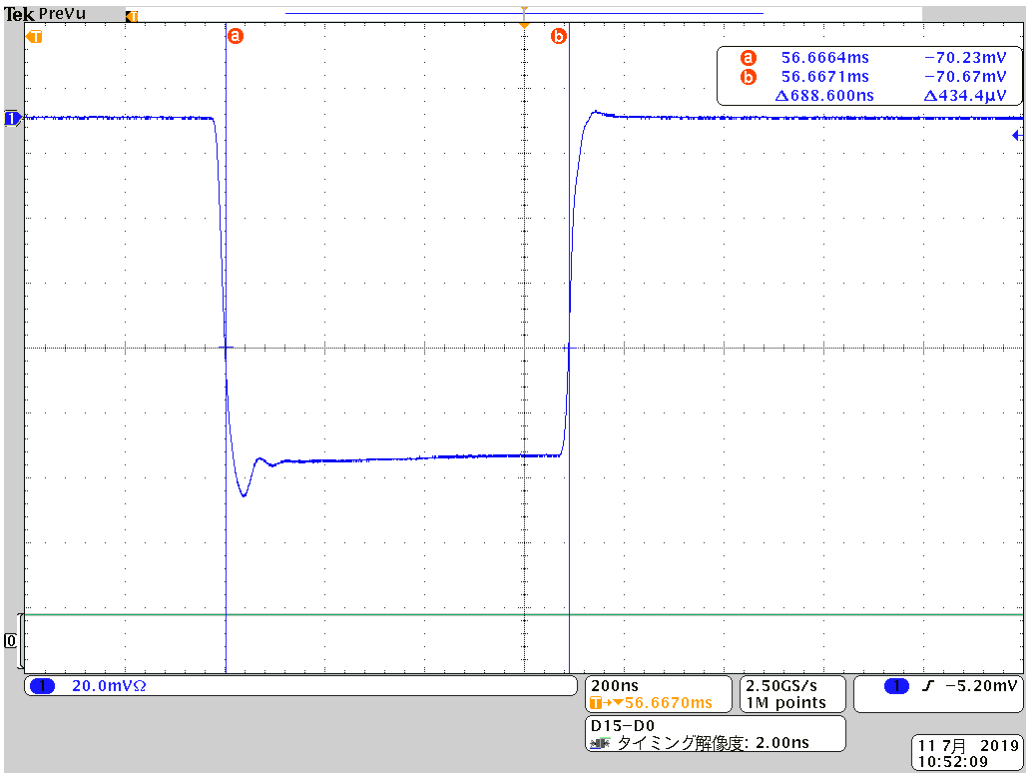



Fig. 6.53 ch1, P0N, M3 pulse envelope

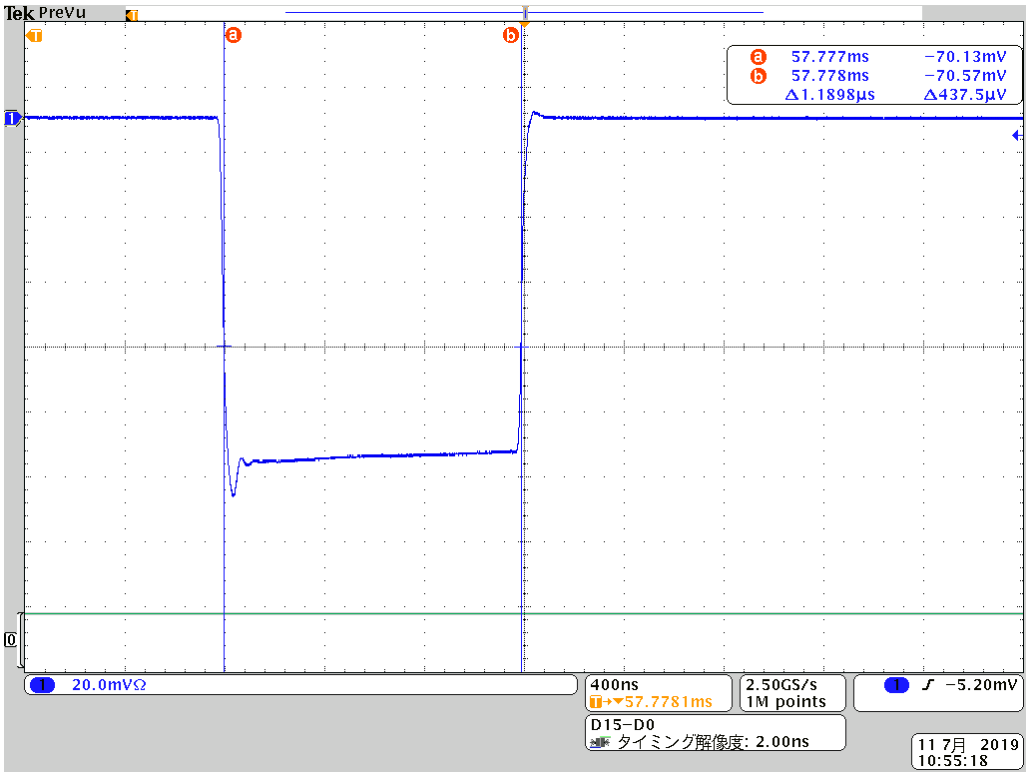



Fig. 6.54 ch1, P0N, L pulse envelope

ch1, Q0N

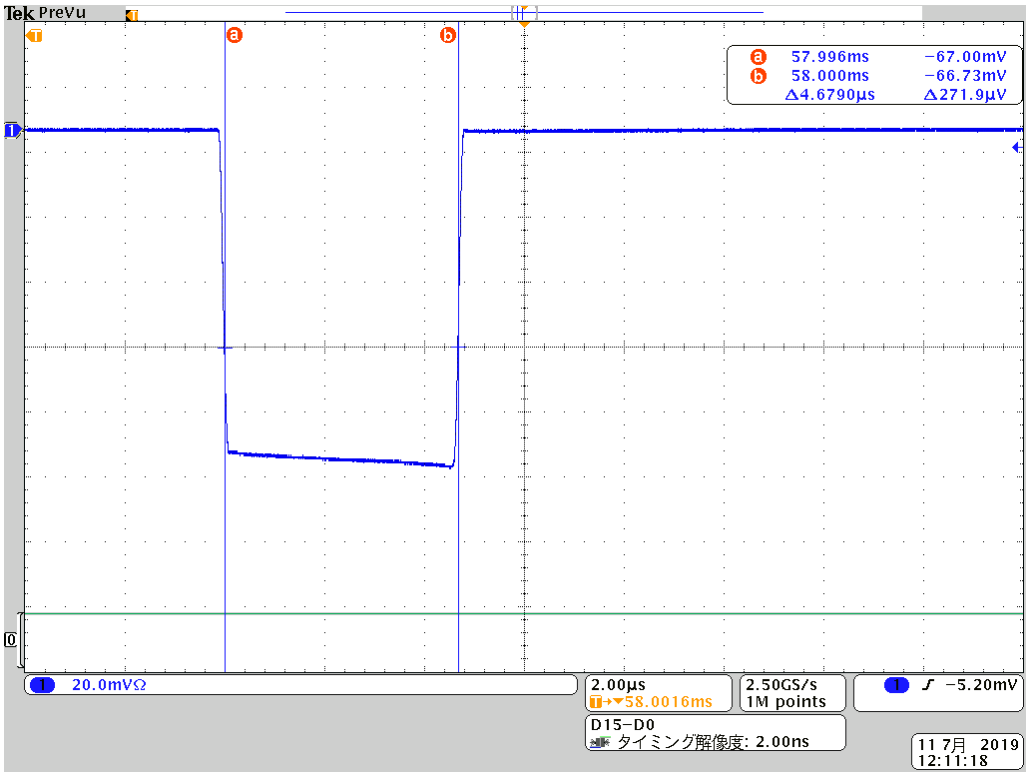



Fig. 6.55 ch1, Q0N, S1 pulse envelope

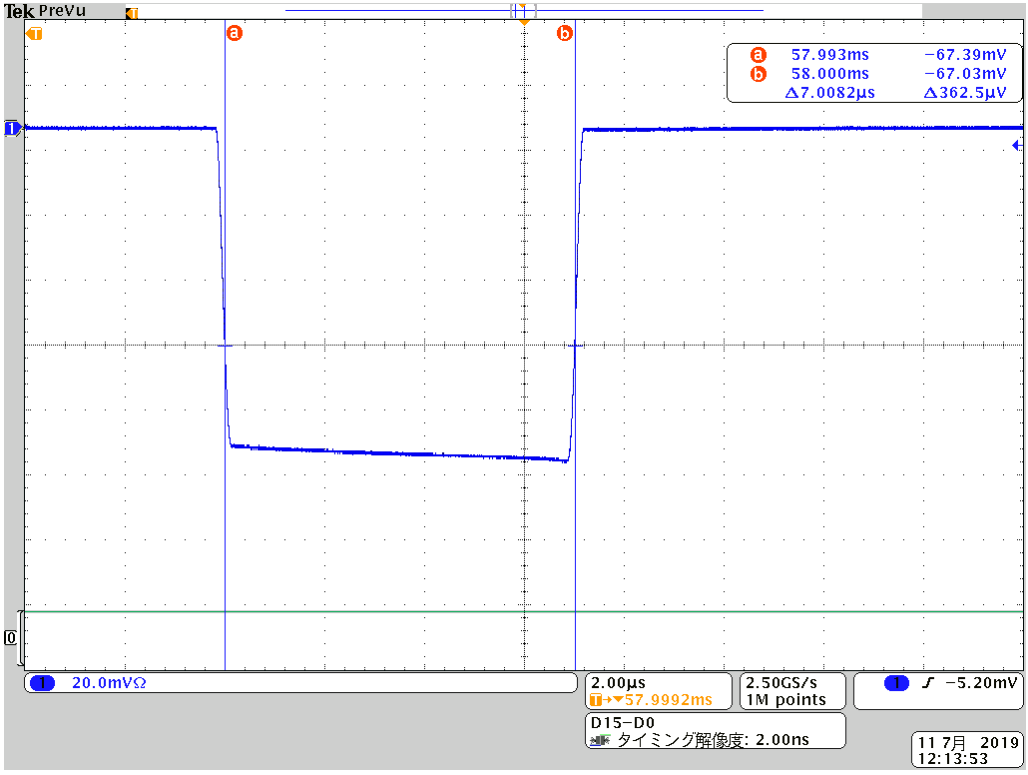



Fig. 6.56 ch1, Q0N, S2 pulse envelope

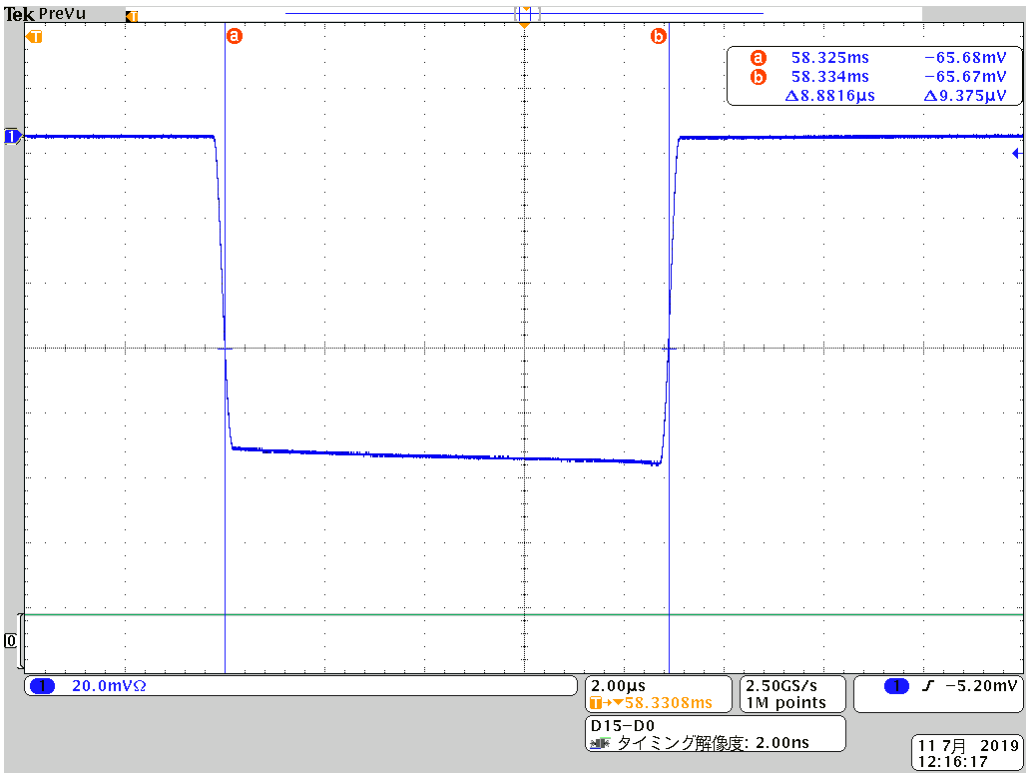



Fig. 6.57 ch1, Q0N, M1 pulse envelope

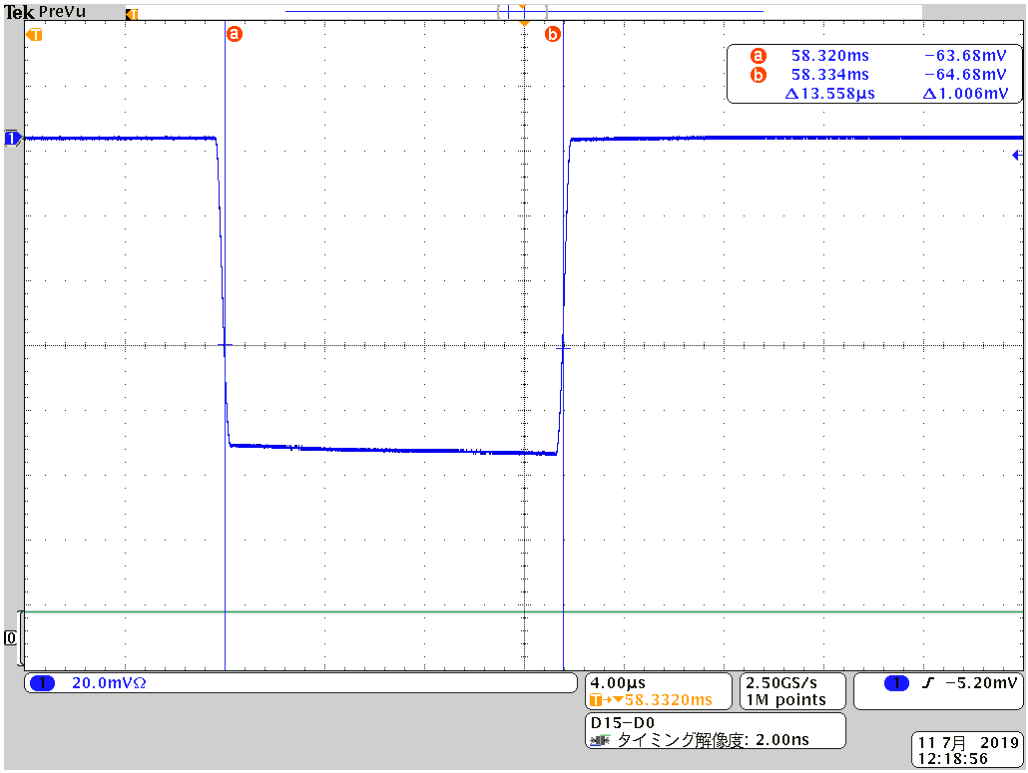



Fig. 6.58 ch1, Q0N, M2 pulse envelope

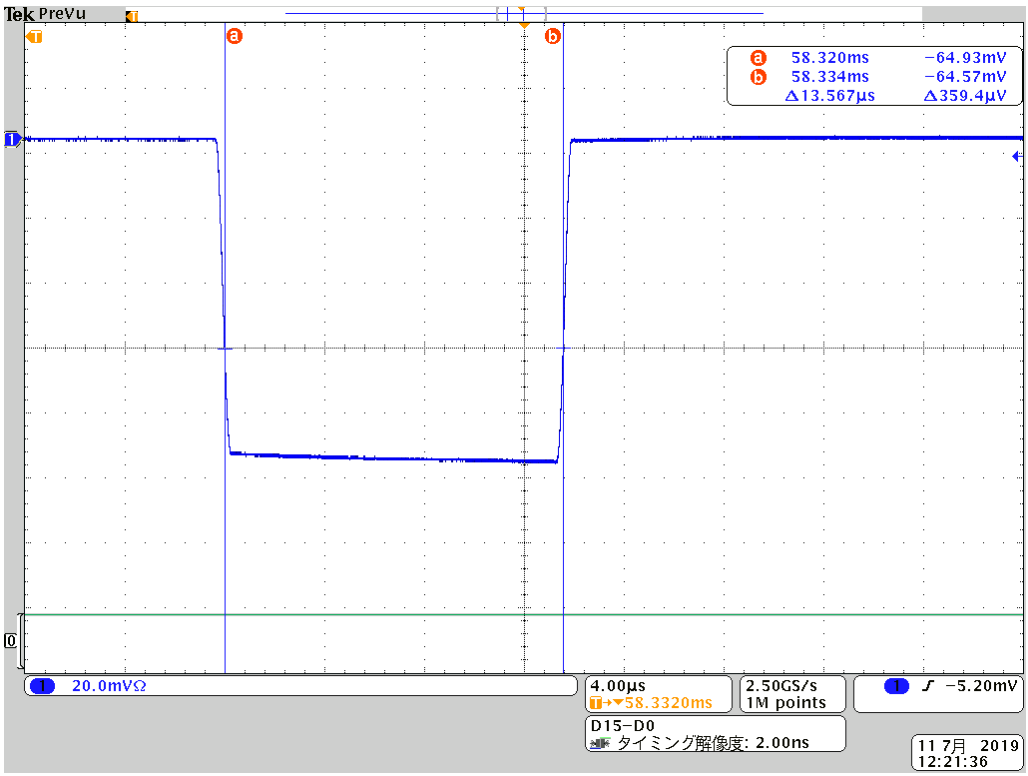



Fig. 6.59 ch1, Q0N, M3 pulse envelope

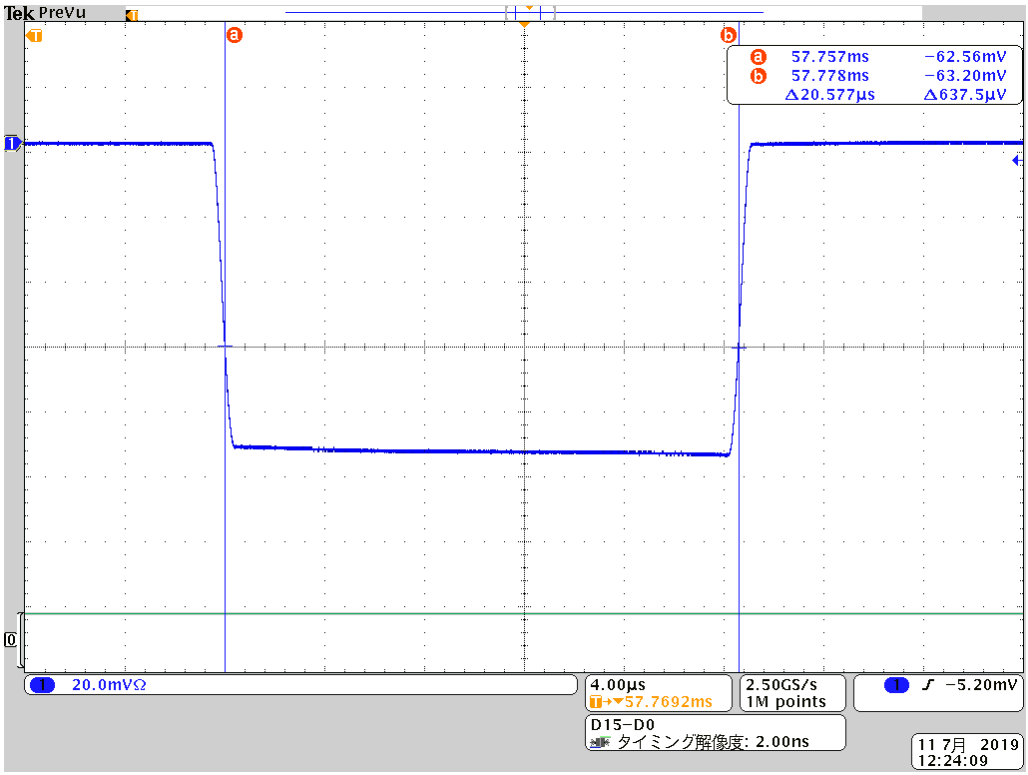



Fig. 6.60 ch1, Q0N, L pulse envelope

ch2, P0N

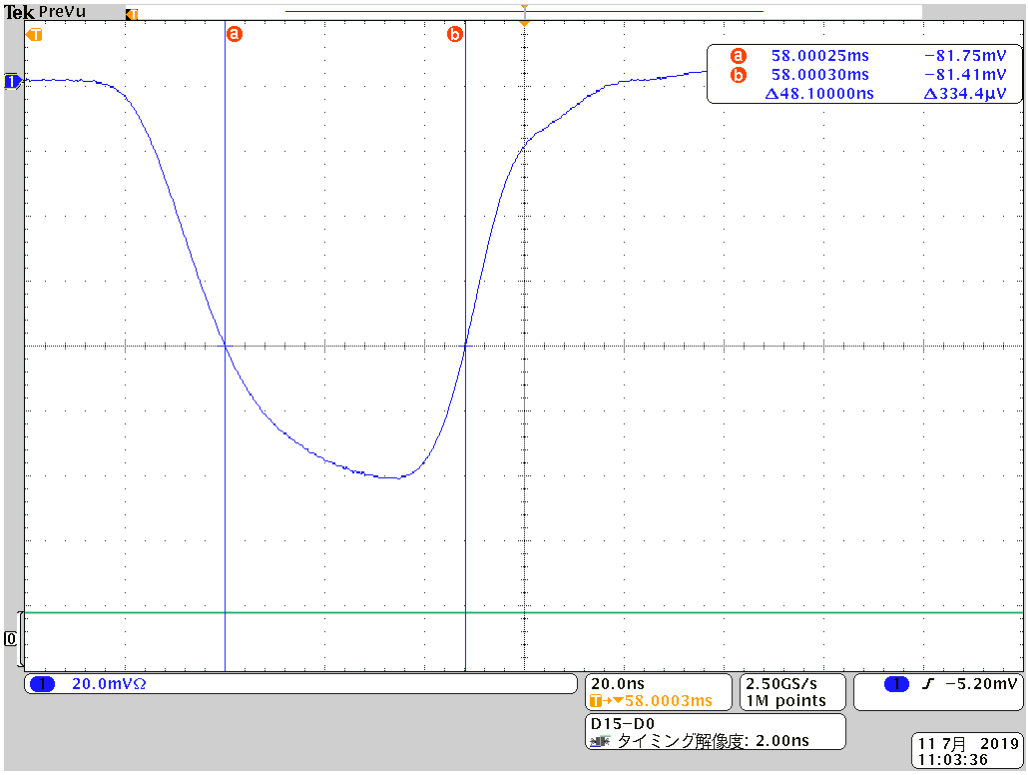



Fig. 6.61 ch2, P0N, S1 pulse envelope

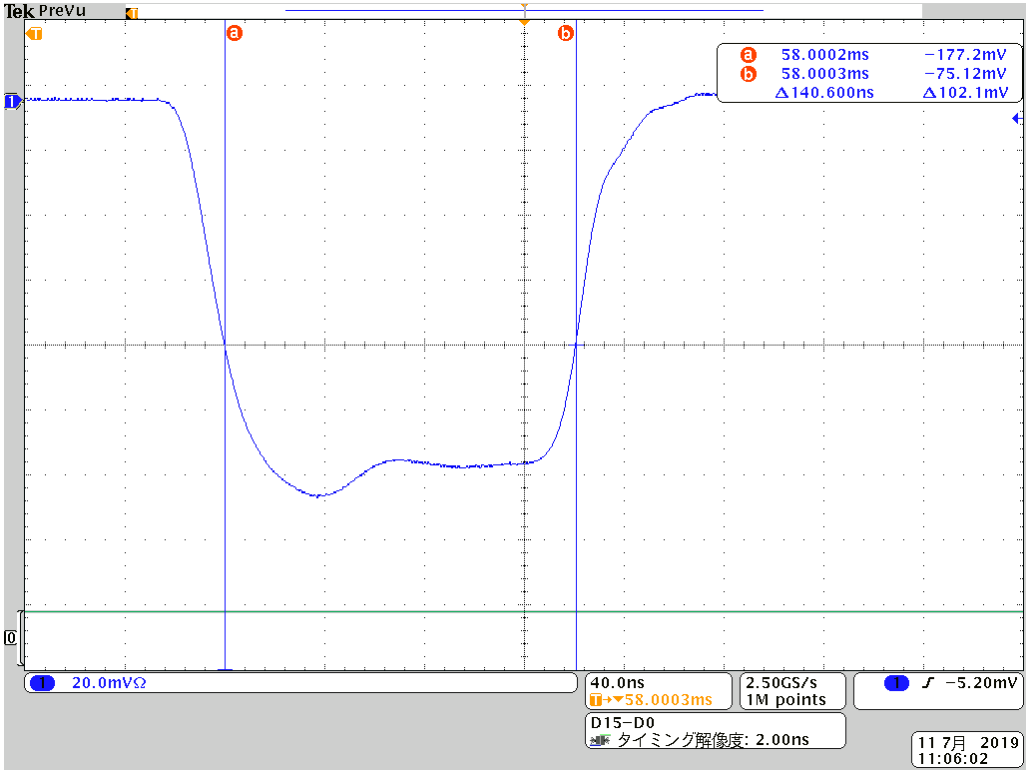



Fig. 6.62 ch2, P0N, S2 pulse envelope


Fig. 6.63 ch2, P0N, M1 pulse envelope


Fig. 6.64 ch2, P0N, M2 pulse envelope

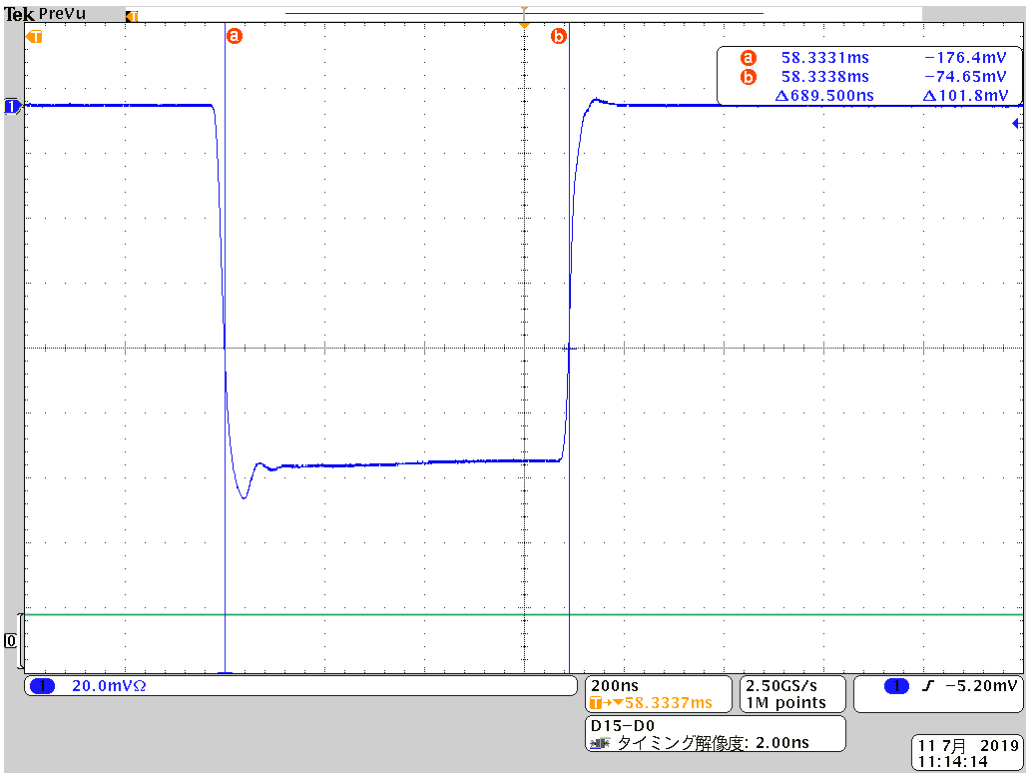



Fig. 6.65 ch2, P0N, M3 pulse envelope

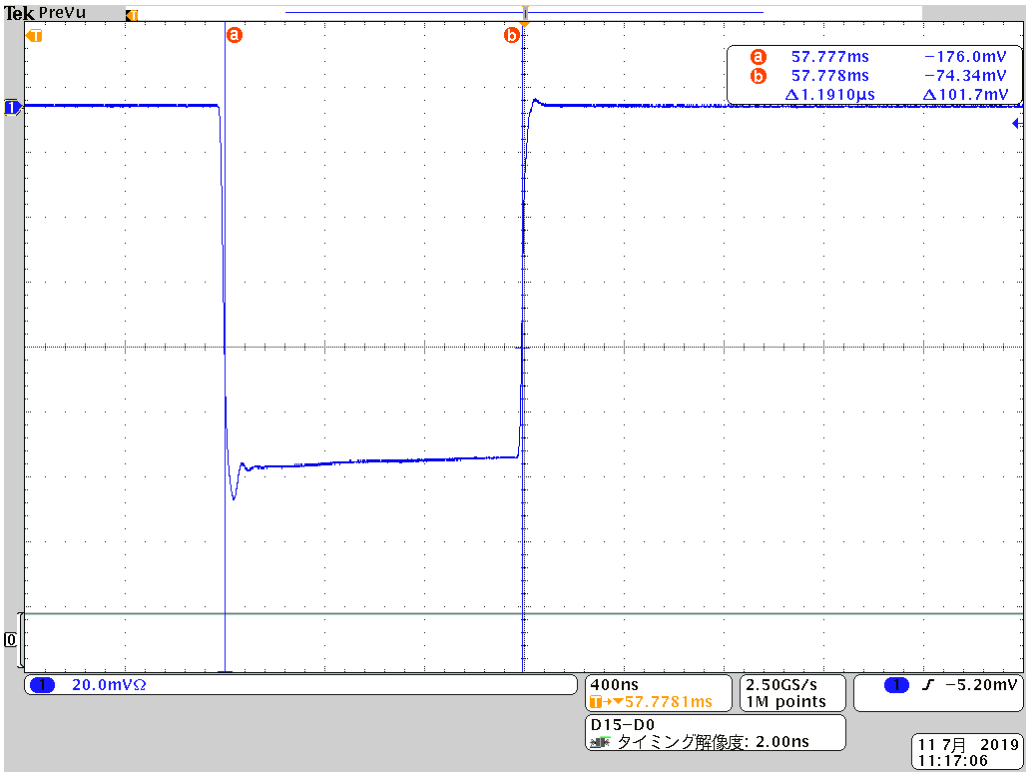



Fig. 6.66 ch2, P0N, L pulse envelope

ch2, Q0N

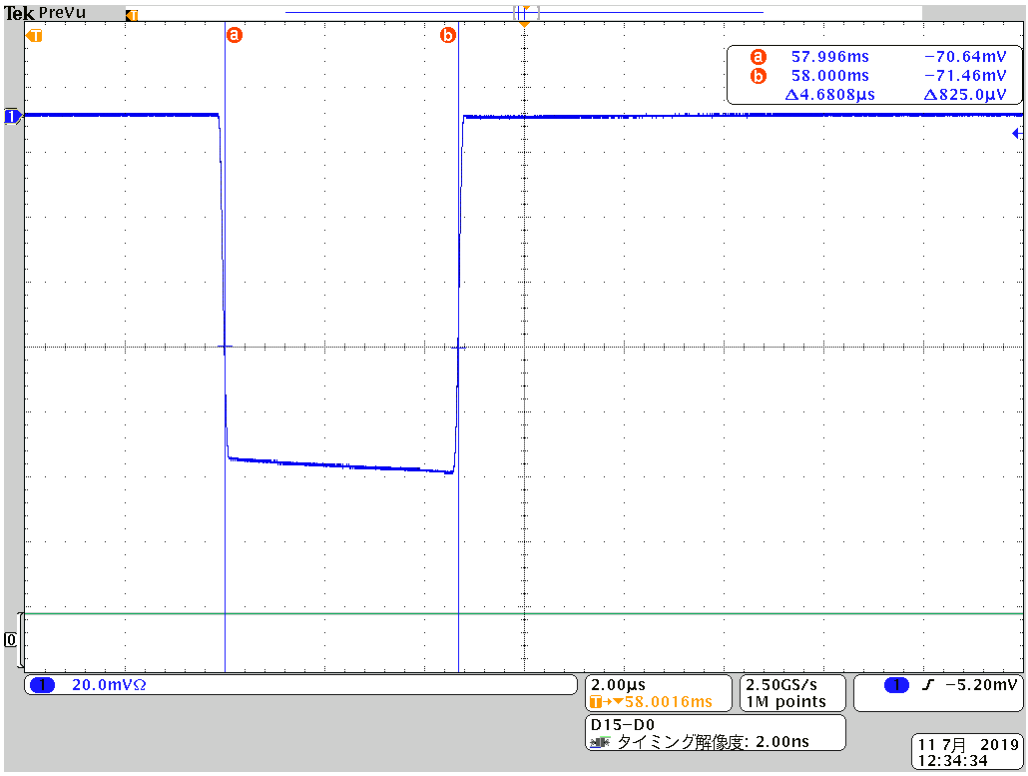



Fig. 6.67 ch2, Q0N, S1 pulse envelope

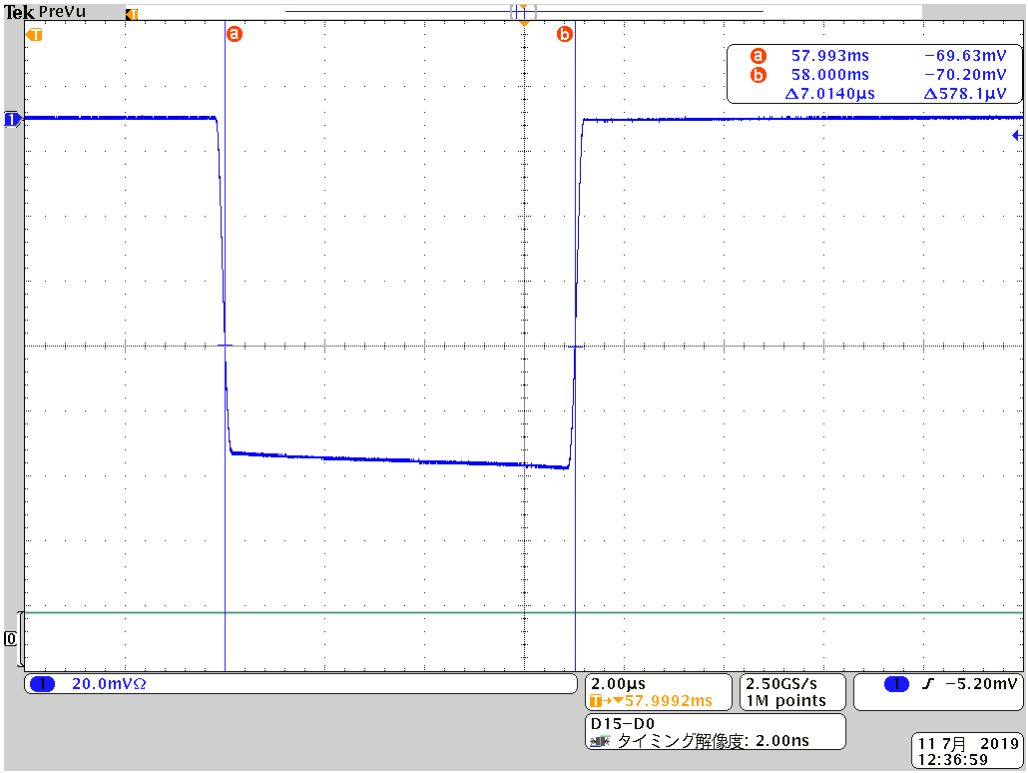



Fig. 6.68 ch2, Q0N, S2 pulse envelope

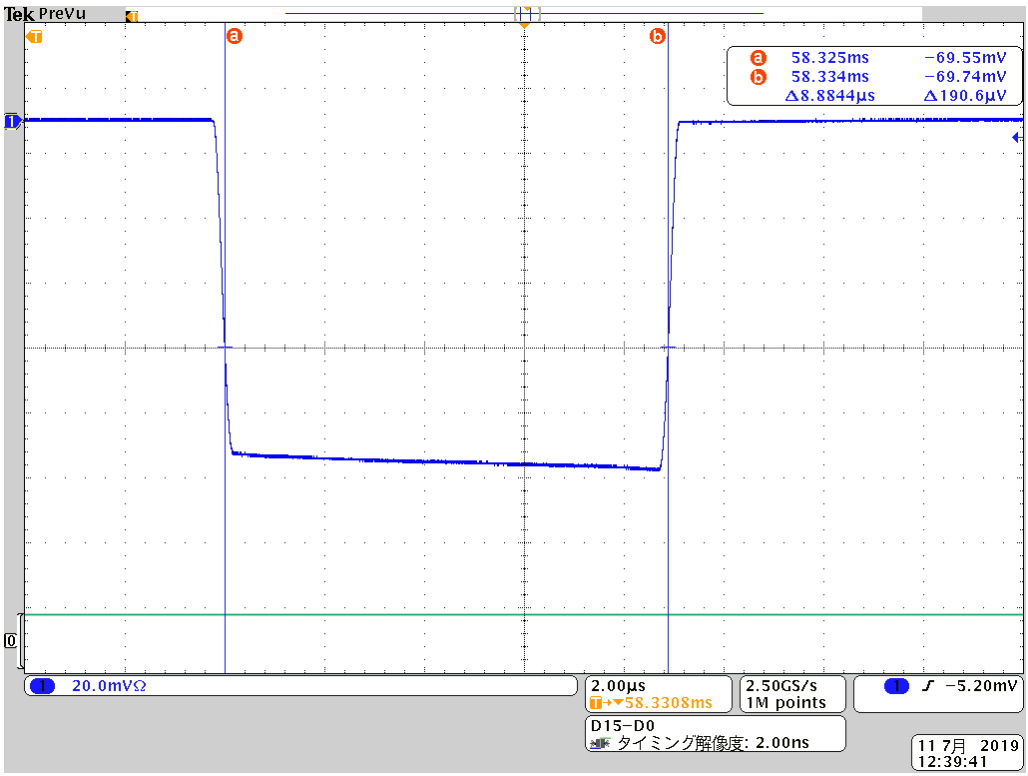



Fig. 6.69 ch2, Q0N, M1 pulse envelope

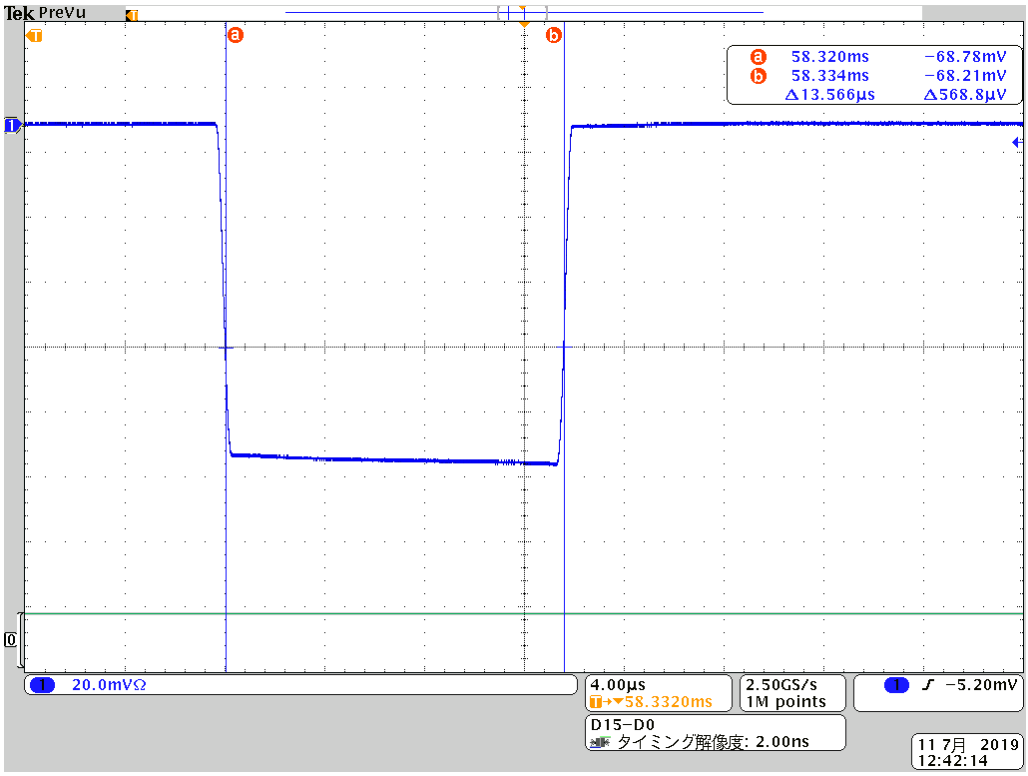



Fig. 6.70 ch2, Q0N, M2 pulse envelope

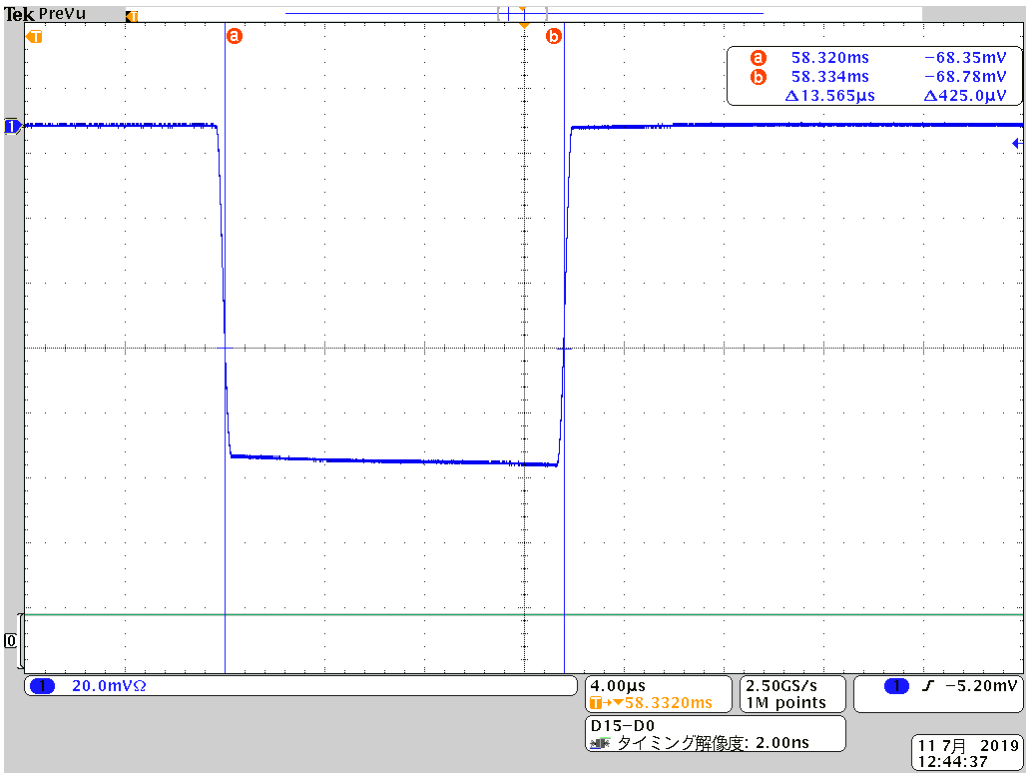



Fig. 6.71 ch2, Q0N, M3 pulse envelope

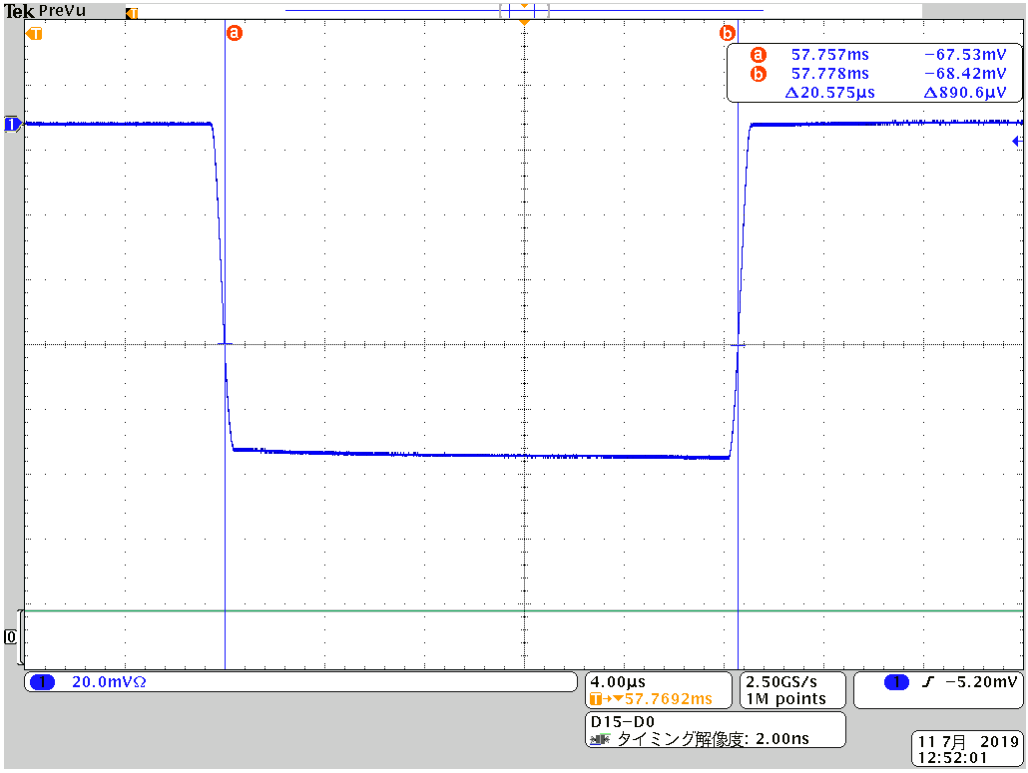



Fig. 6.72 ch2, Q0N, L pulse envelope

# 7 Spurious Emission Plots measured at Antenna Terminal

TT24NM mode

ch1, P0N

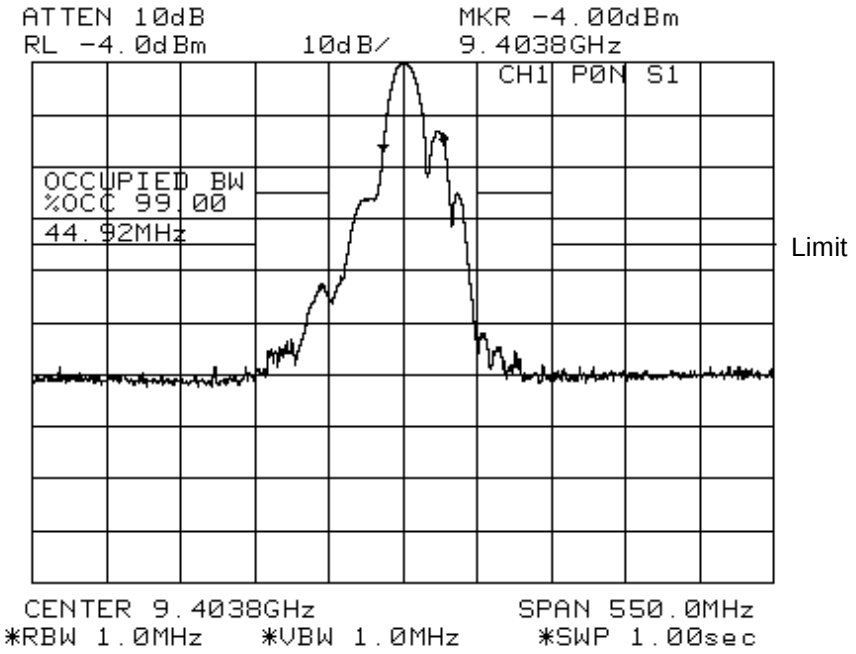



Fig. 7.1 ch1, P0N, S1 pulse

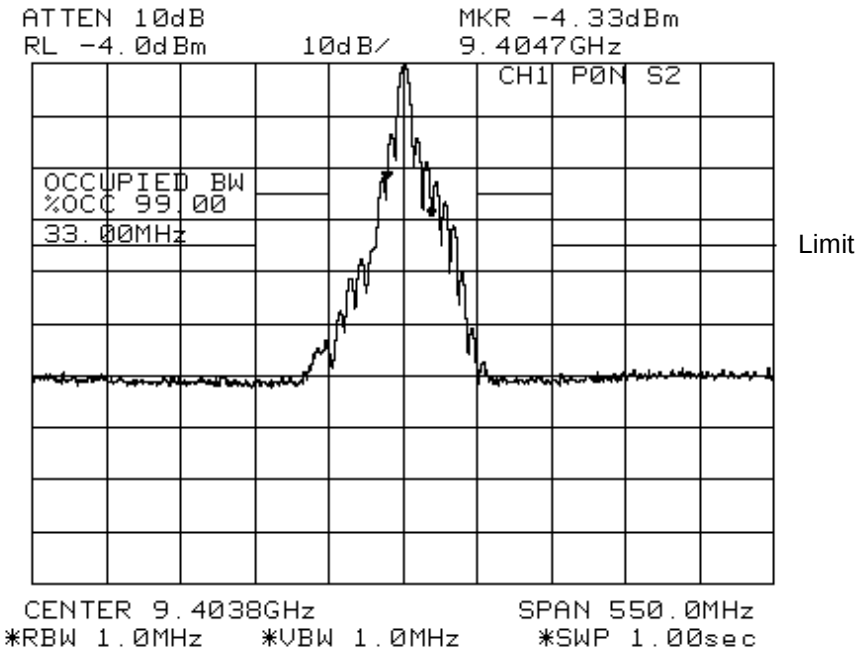



Fig. 7.2 ch1, P0N, S2 pulse

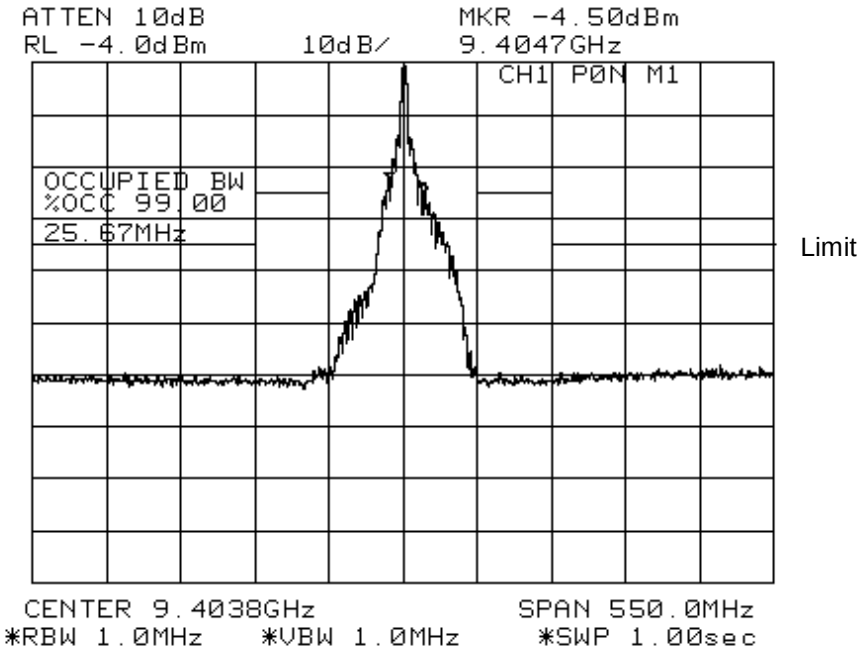



Fig. 7.3 ch1, P0N, M1 pulse

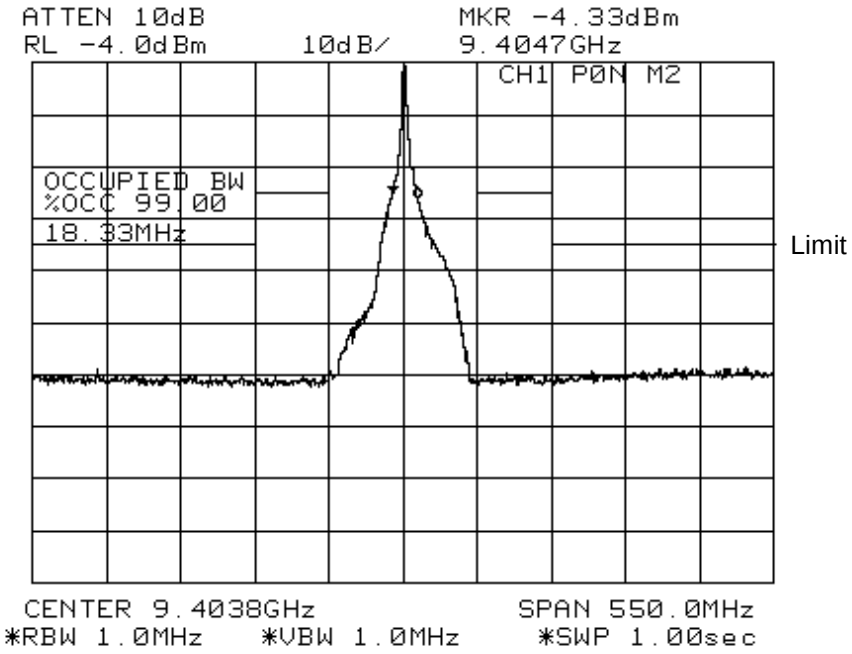



Fig. 7.4 ch1, P0N, M2 pulse

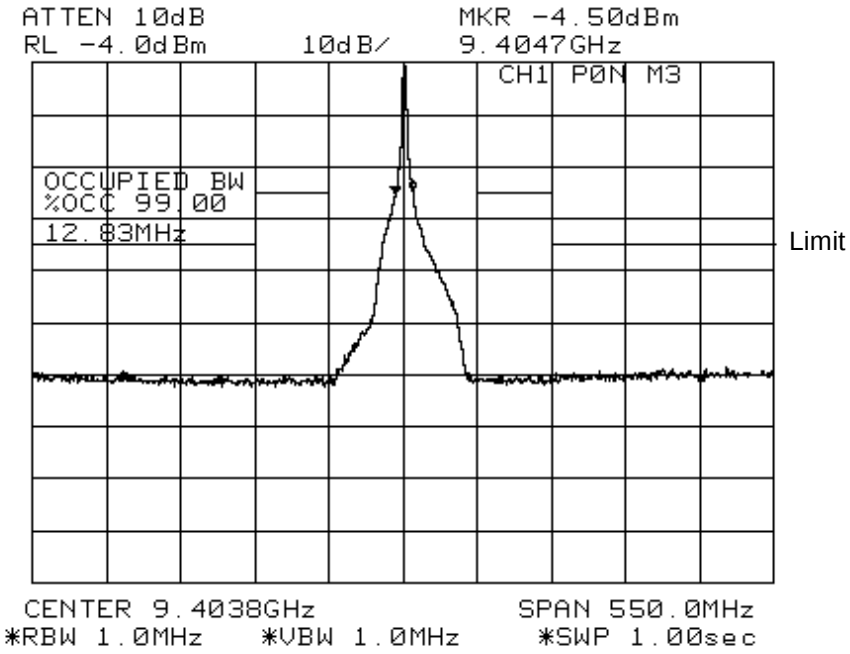



Fig. 7.5 ch1, P0N, M3 pulse

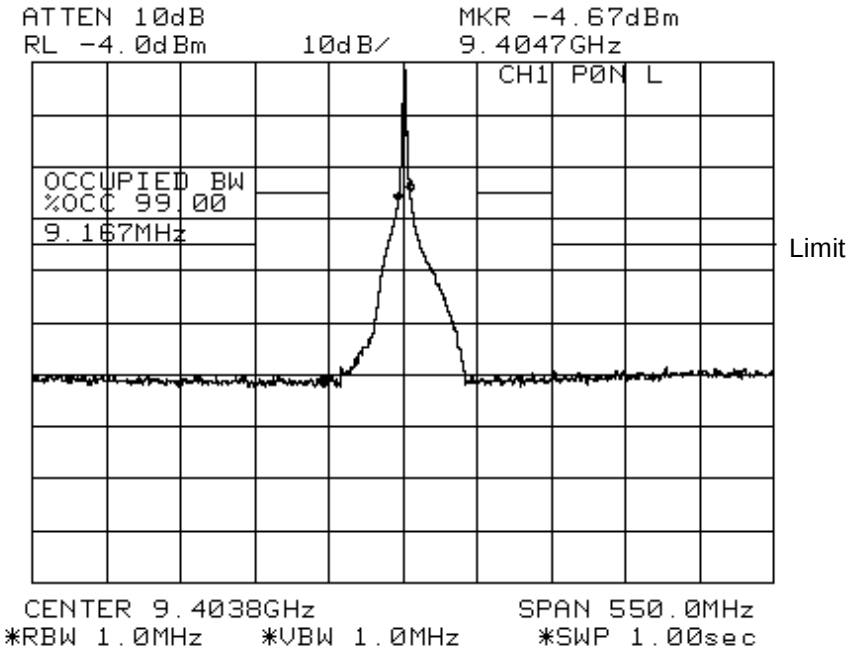



Fig. 7.6 ch1, P0N, L pulse

ch1, Q0N

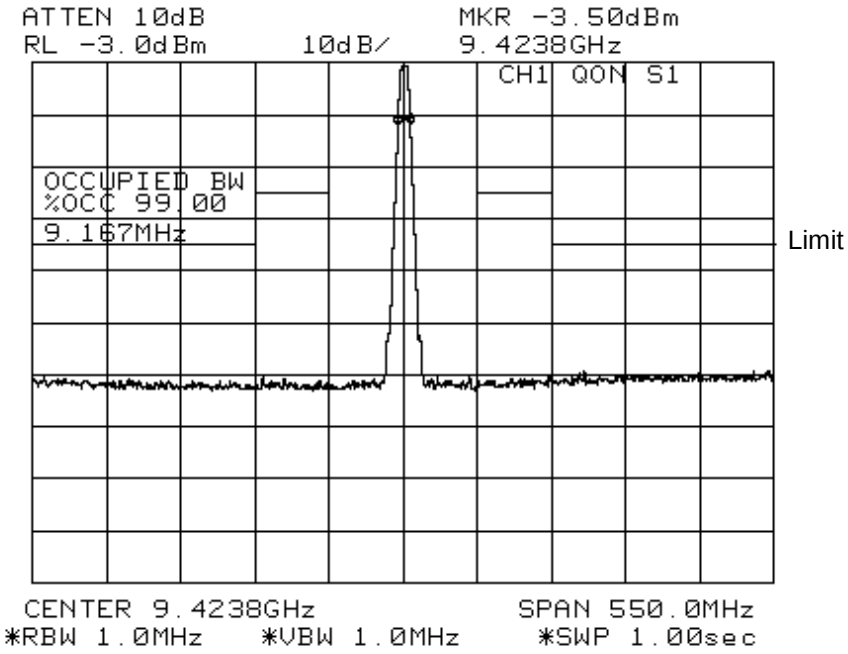



Fig. 7.7 ch1, Q0N, S1 pulse

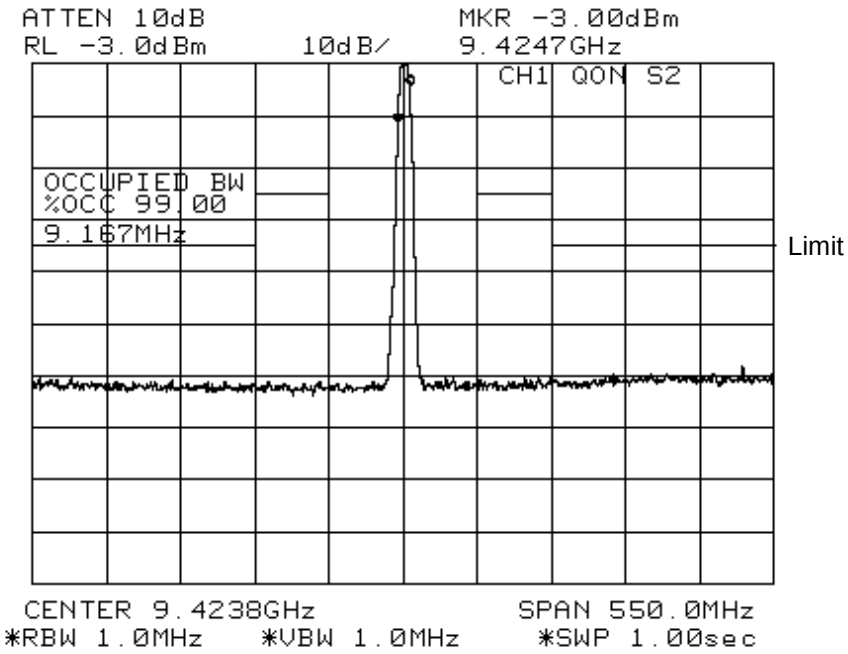



Fig. 7.8 ch1, Q0N, S2 pulse

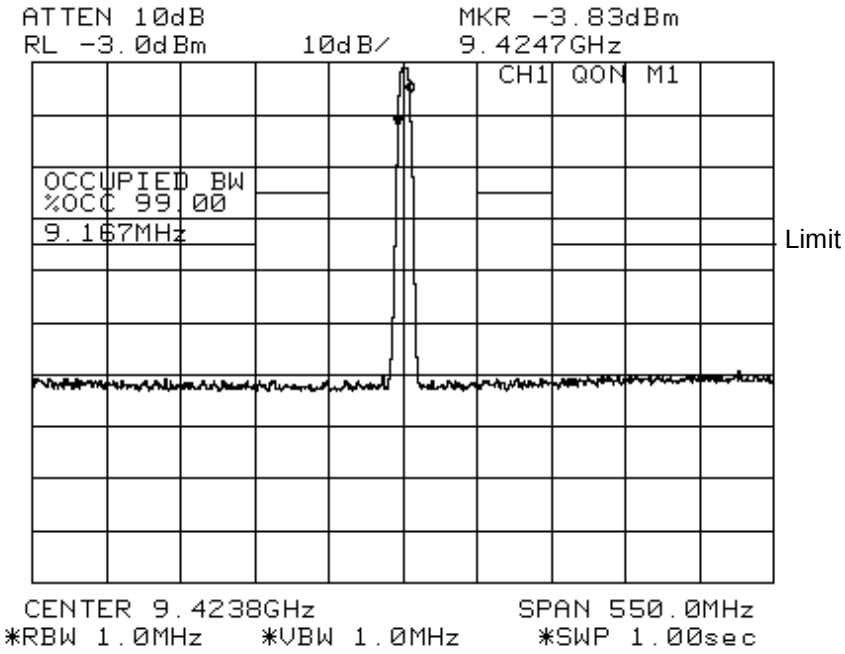



Fig. 7.9 ch1, Q0N, M1 pulse

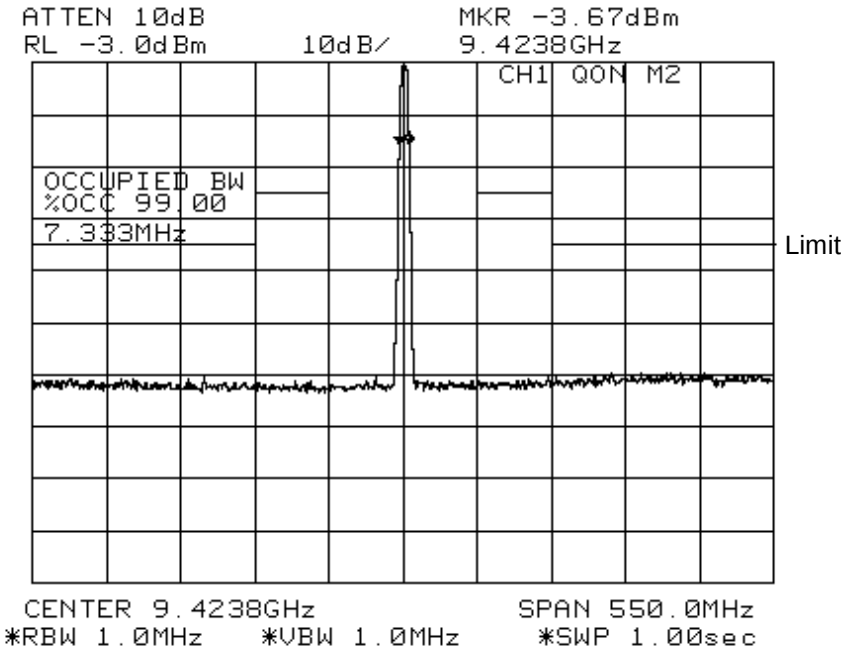



Fig. 7.10 ch1, Q0N, M2 pulse

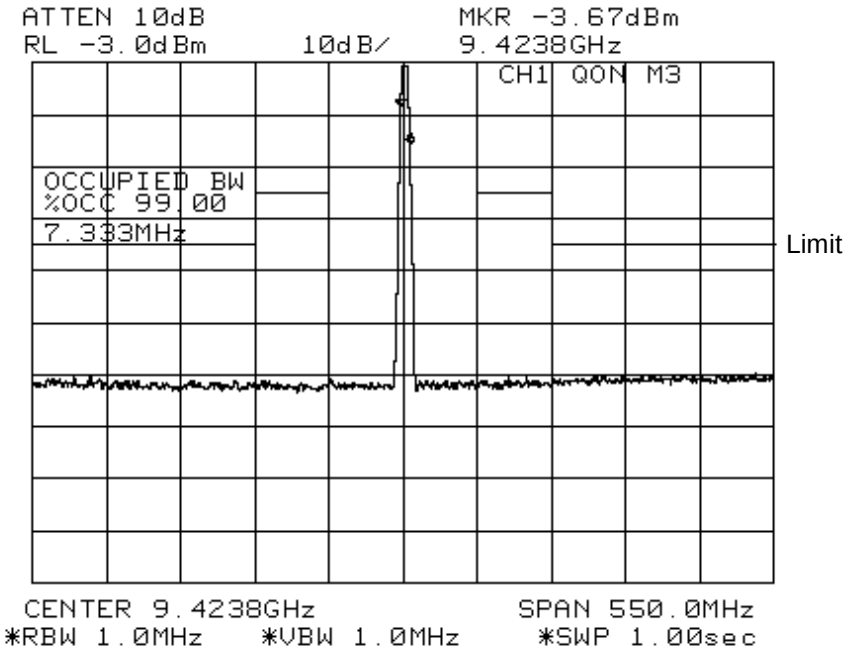



Fig. 7.11 ch1, Q0N, M3 pulse

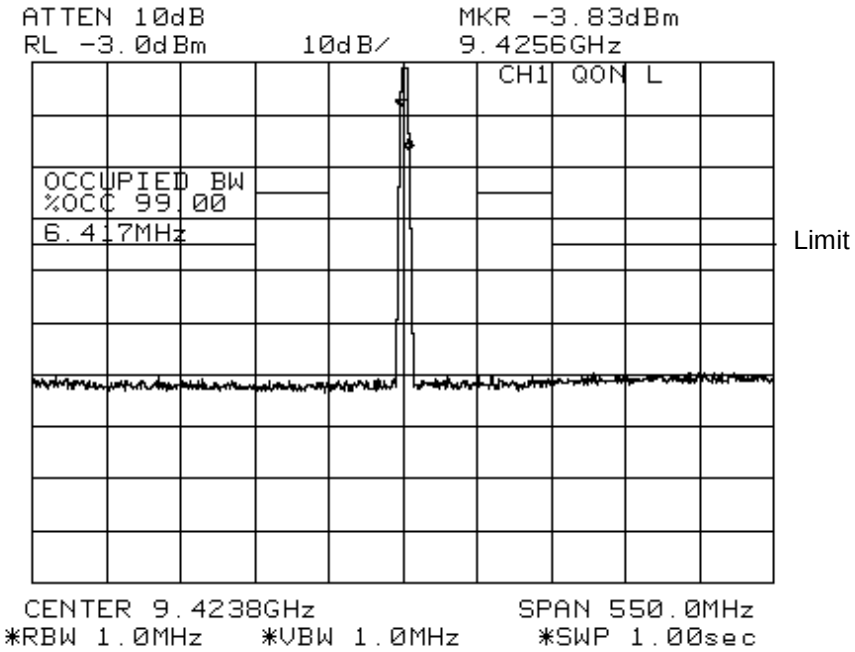



Fig. 7.12 ch1, Q0N, L pulse

ch2, P0N

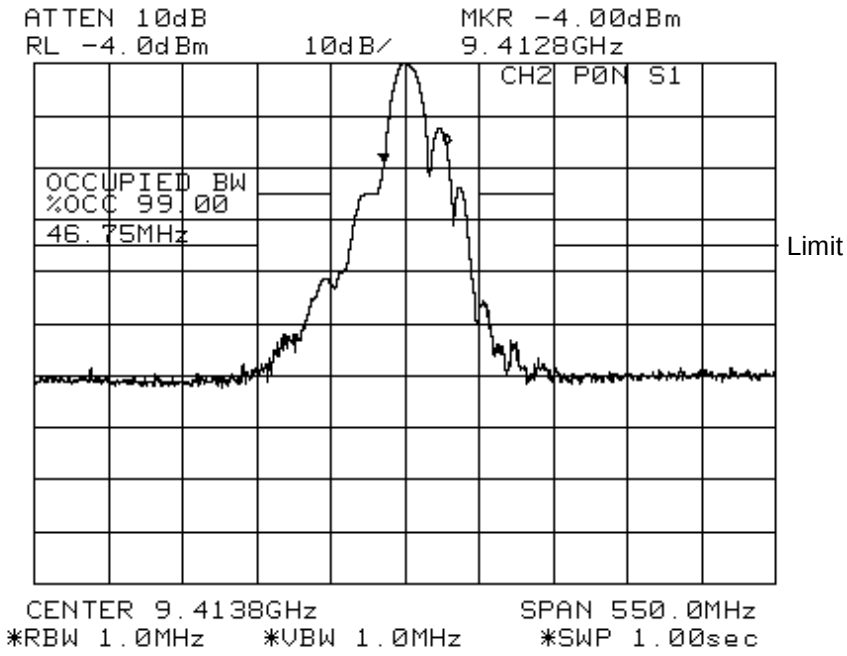



Fig. 7.13 ch2, P0N, S1 pulse

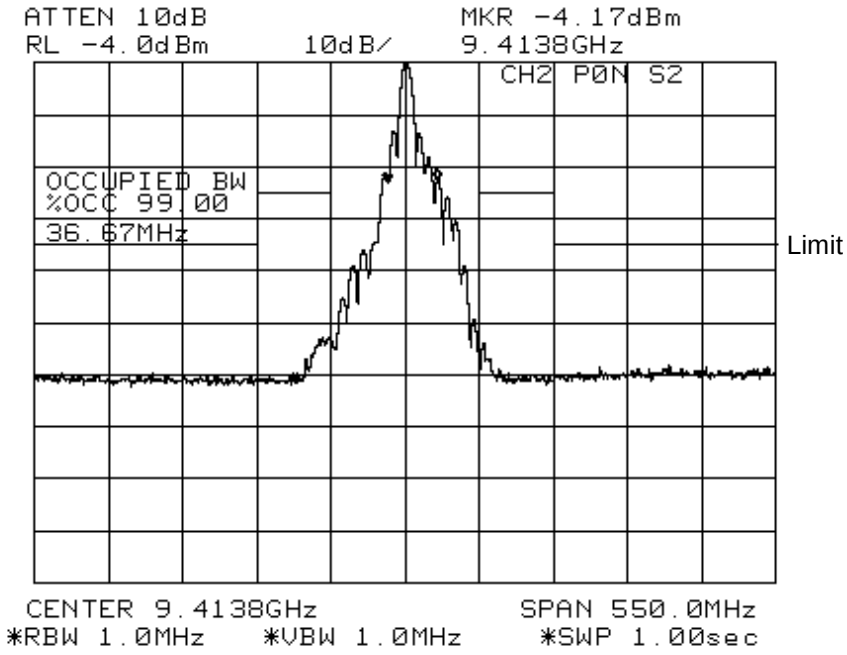



Fig. 7.14 ch2, P0N, S2 pulse

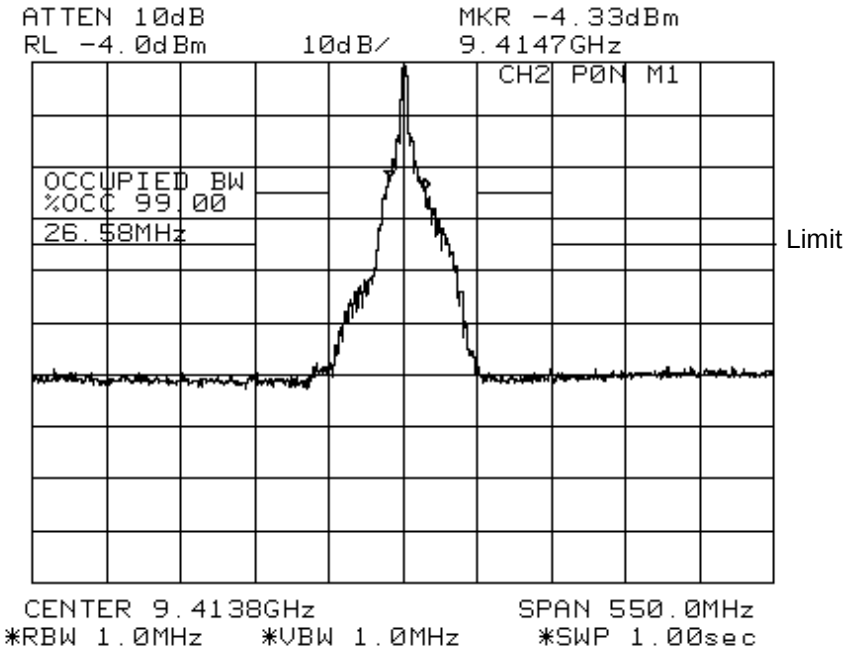



Fig. 7.15 ch2, P0N, M1 pulse

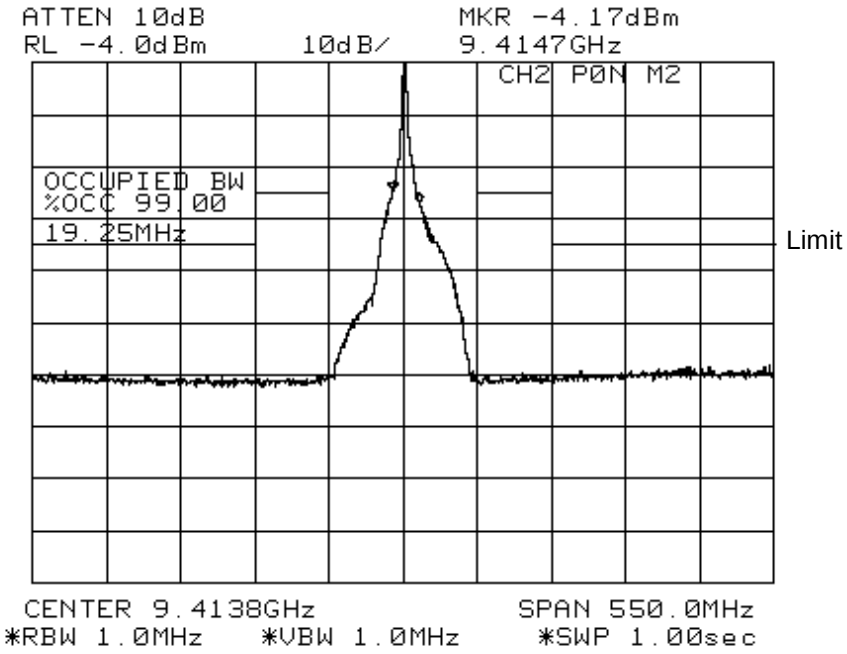



Fig. 7.16 ch2, P0N, M2 pulse

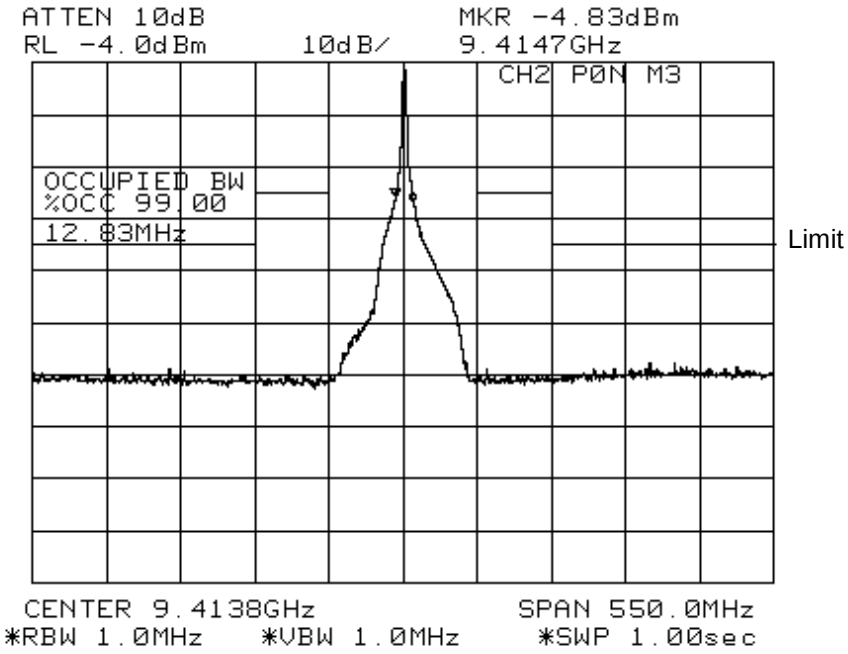



Fig. 7.17 ch2, P0N, M3 pulse

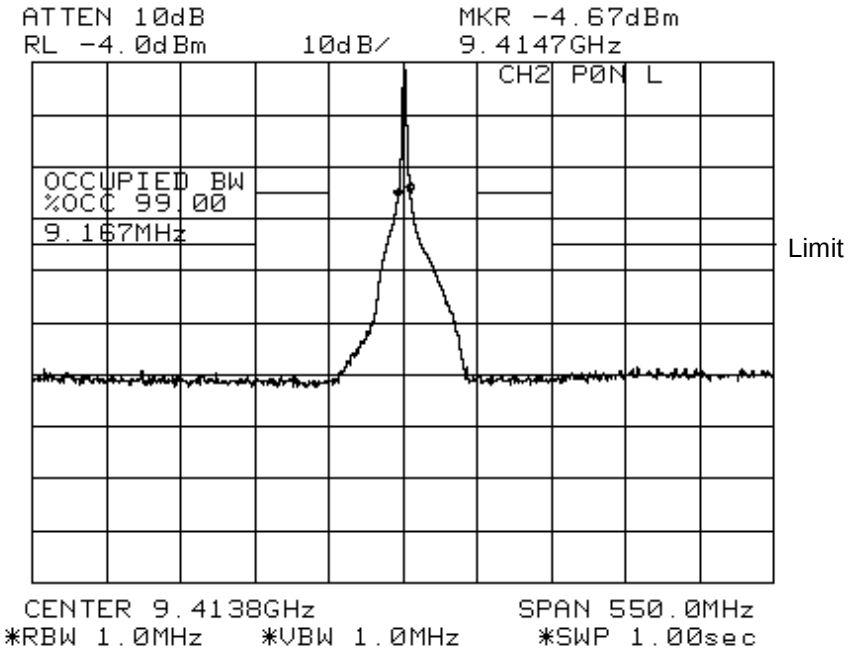



Fig. 7.18 ch2, P0N, L pulse

ch2, Q0N

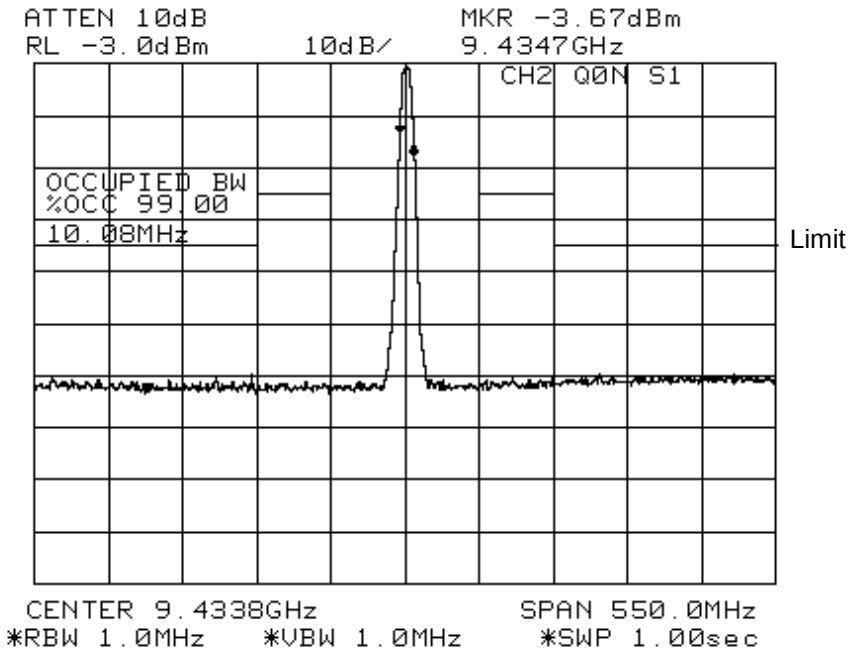



Fig. 7.19 ch2, Q0N, S1 pulse

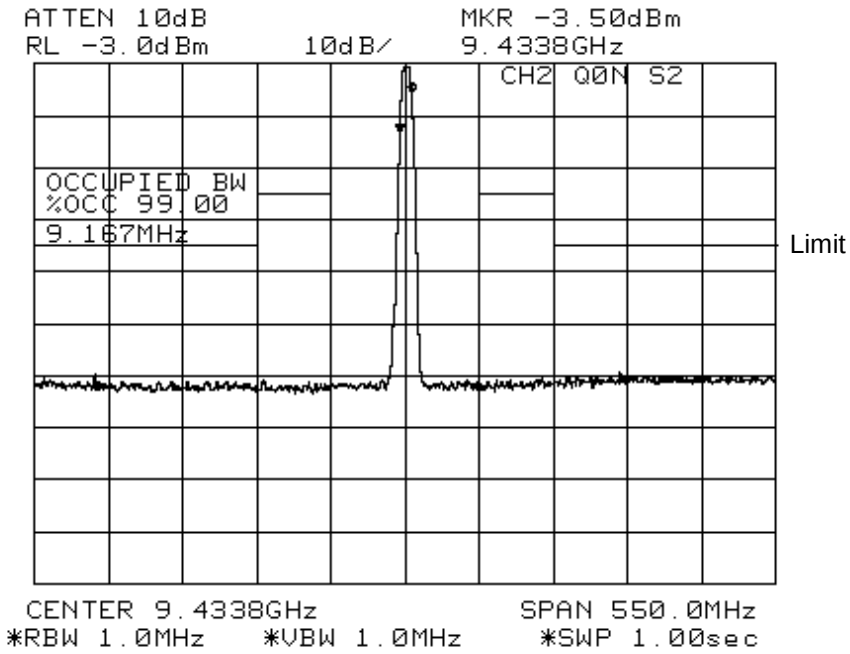



Fig. 7.20 ch2, Q0N, S2 pulse

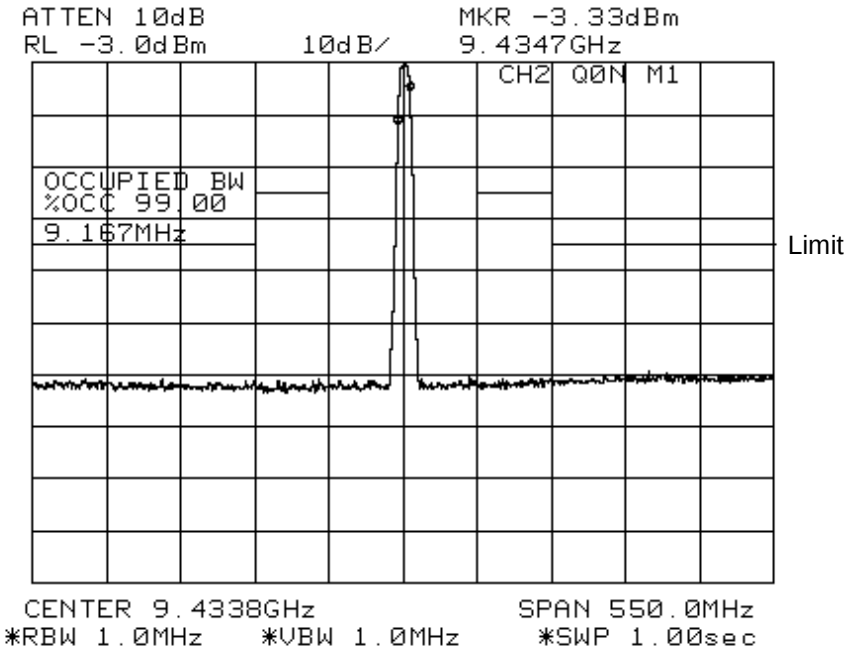



Fig. 7.21 ch2, Q0N, M1 pulse

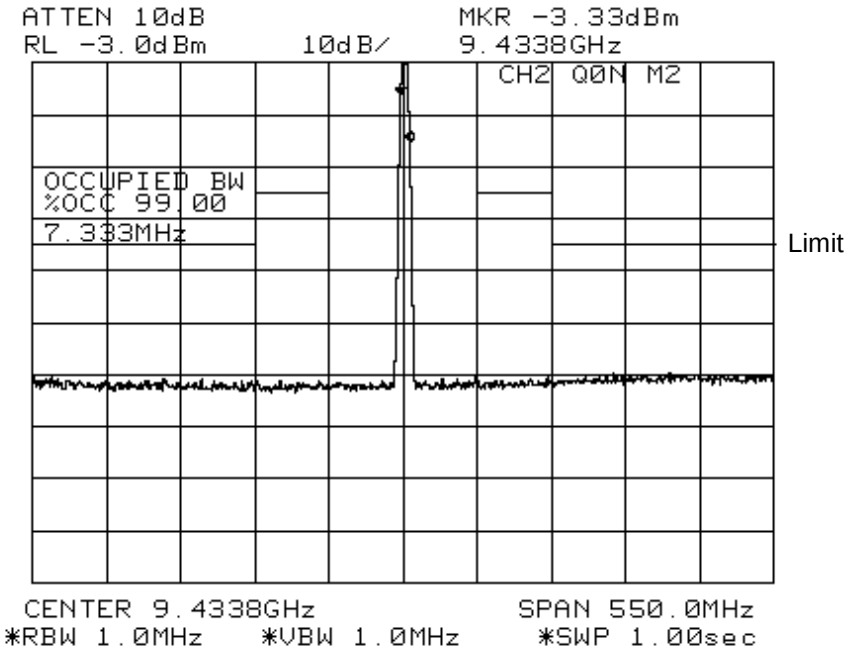



Fig. 7.22 ch2, Q0N, M2 pulse

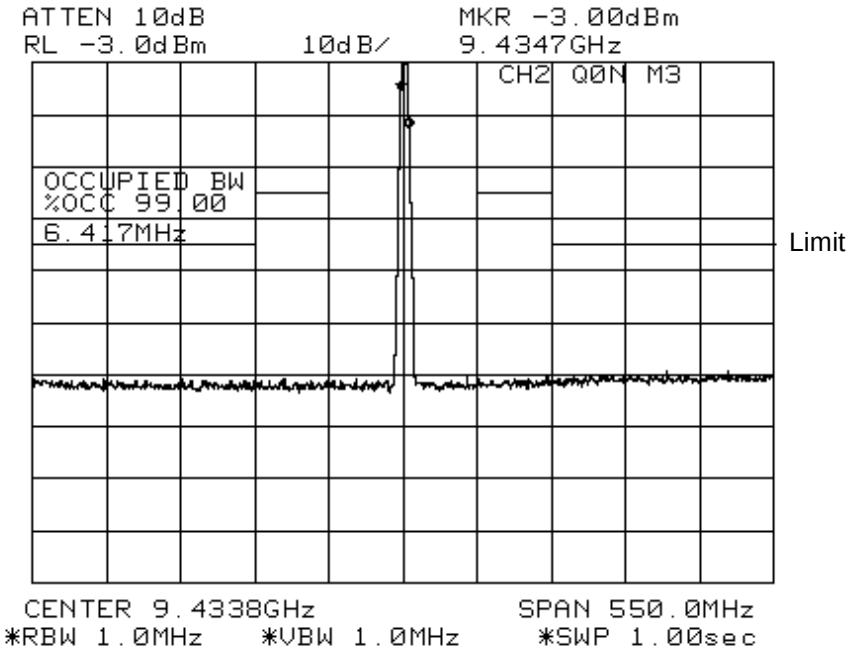



Fig. 7.23 ch2, Q0N, M3 pulse

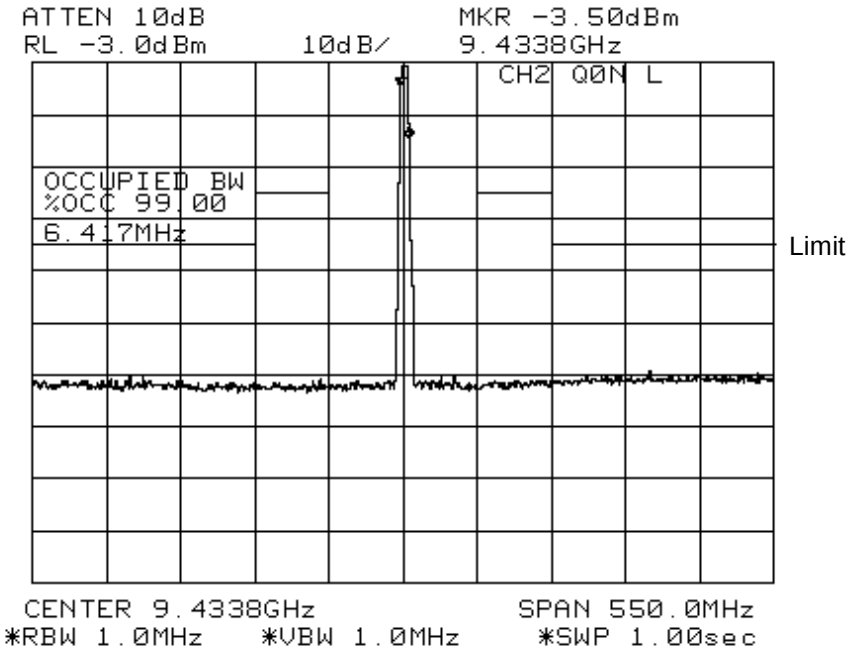



Fig. 7.24 ch2, Q0N, L pulse

TT32NM mode

ch1, P0N

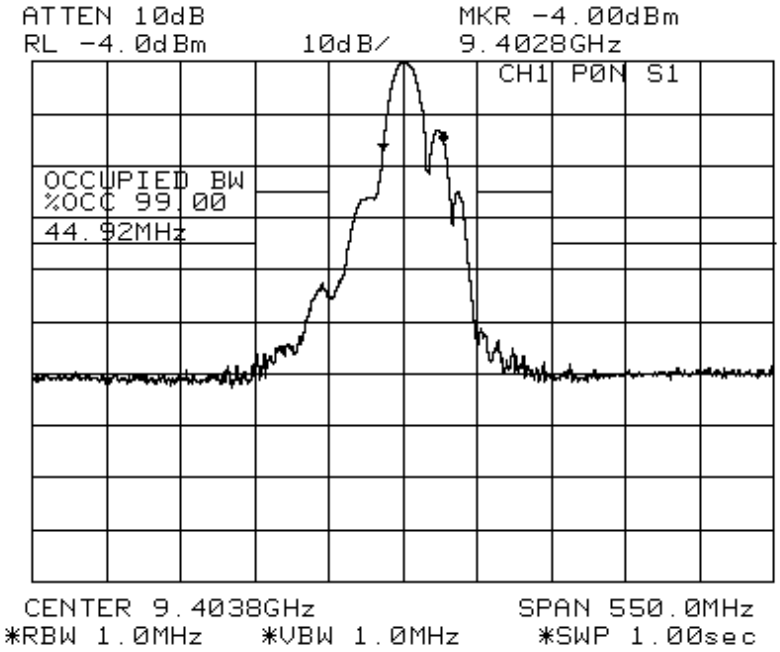



Fig. 7.25 ch1, P0N, S1 pulse

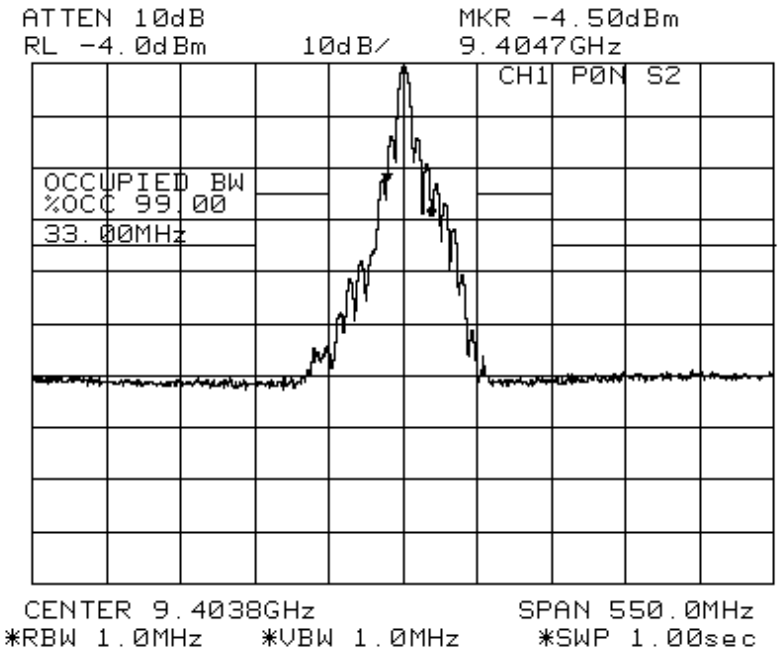



Fig. 7.26 ch1, P0N, S2 pulse

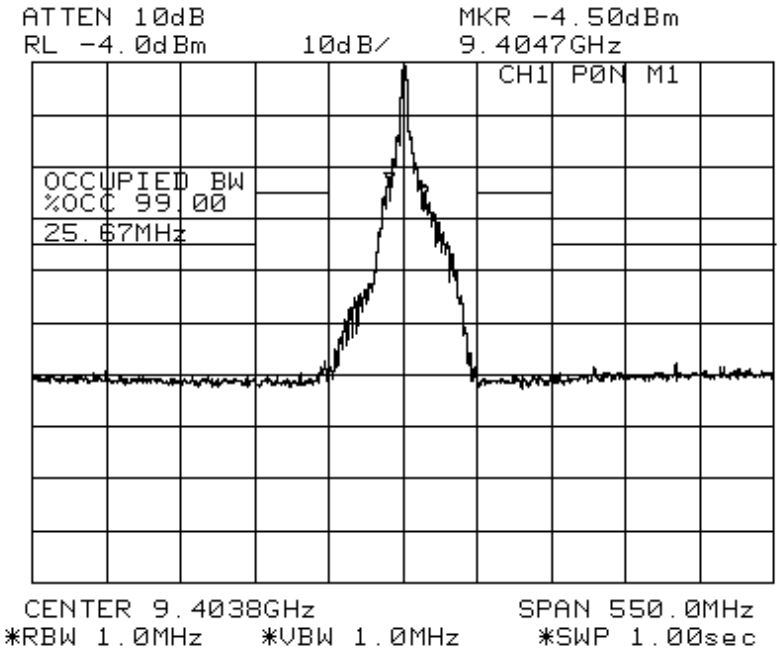



Fig. 7.27 ch1, P0N, M1 pulse

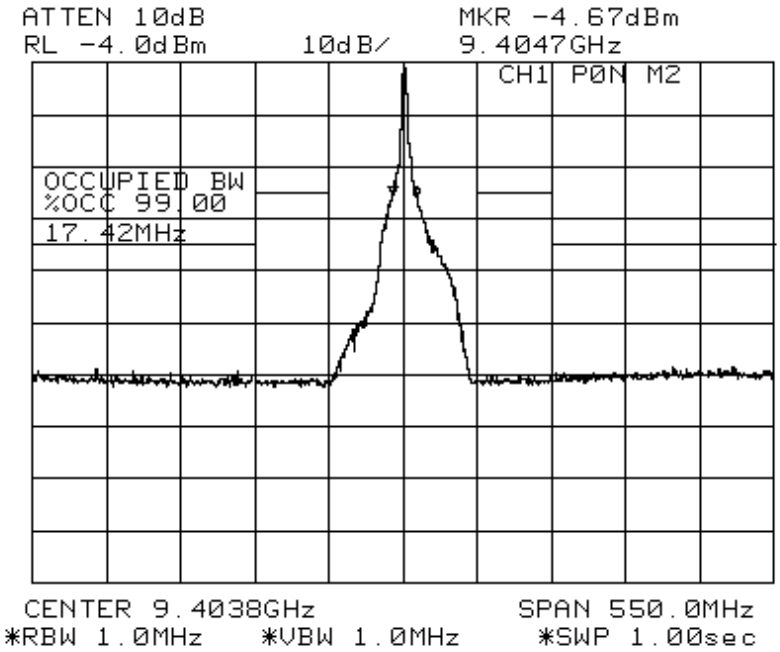



Fig. 7.28 ch1, P0N, M2 pulse

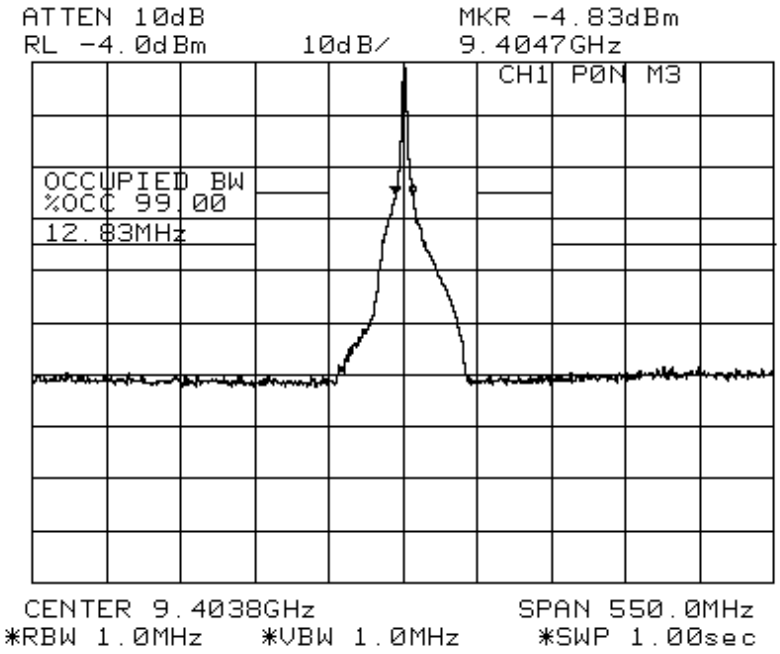



Fig. 7.29 ch1, P0N, M3 pulse

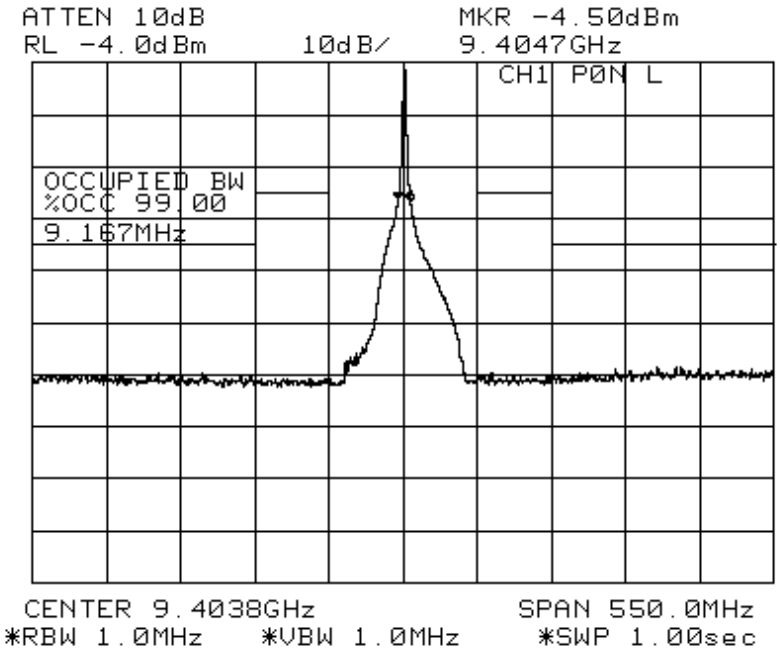



Fig. 7.30 ch1, P0N, L pulse

ch1, Q0N

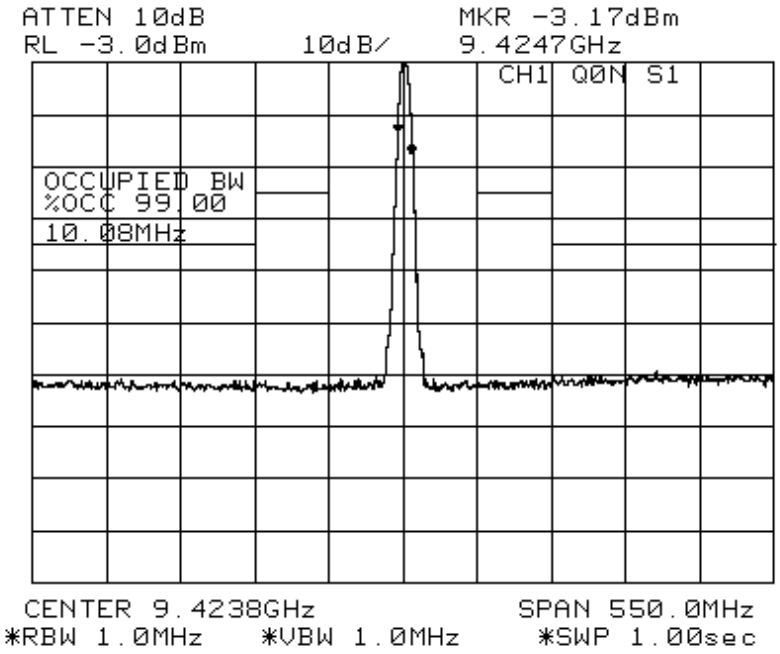



Fig. 7.31 ch1, Q0N, S1 pulse

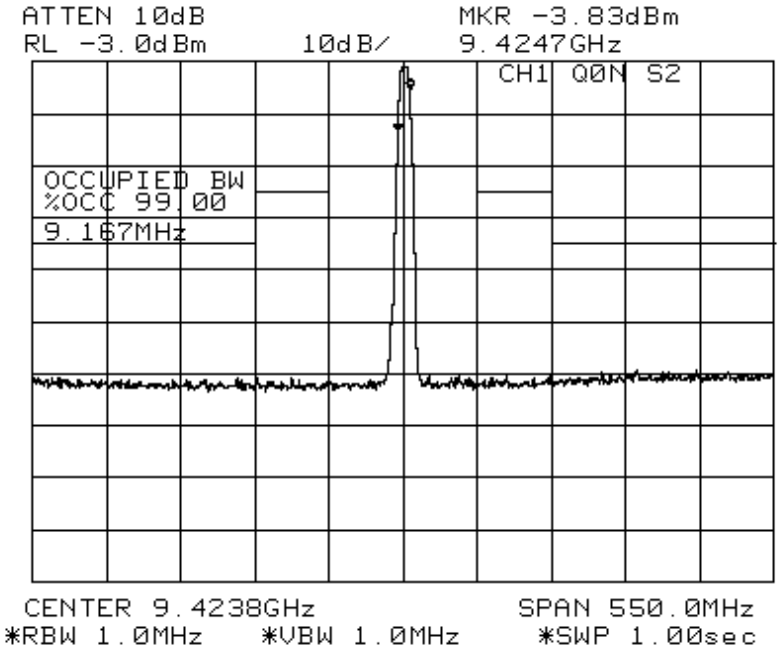



Fig. 7.32 ch1, Q0N, S2 pulse

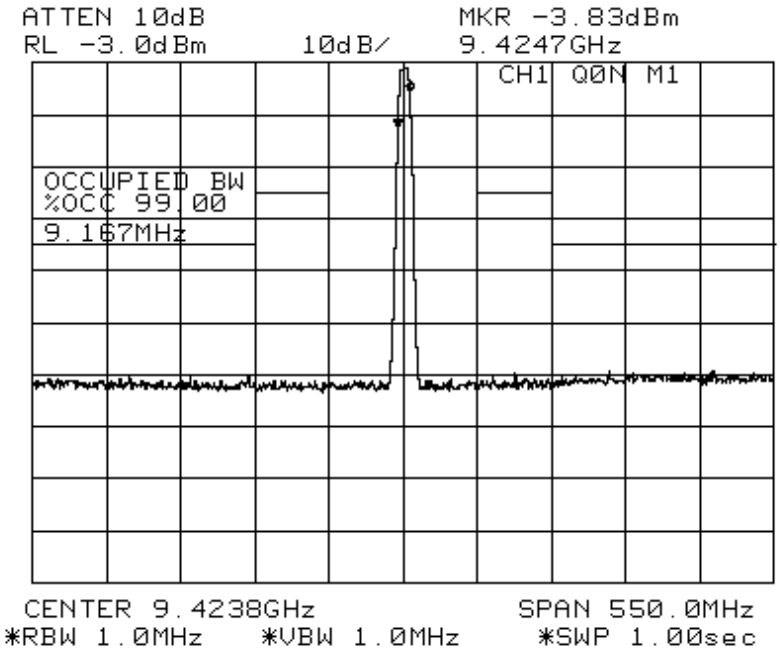



Fig. 7.33 ch1, Q0N, M1 pulse

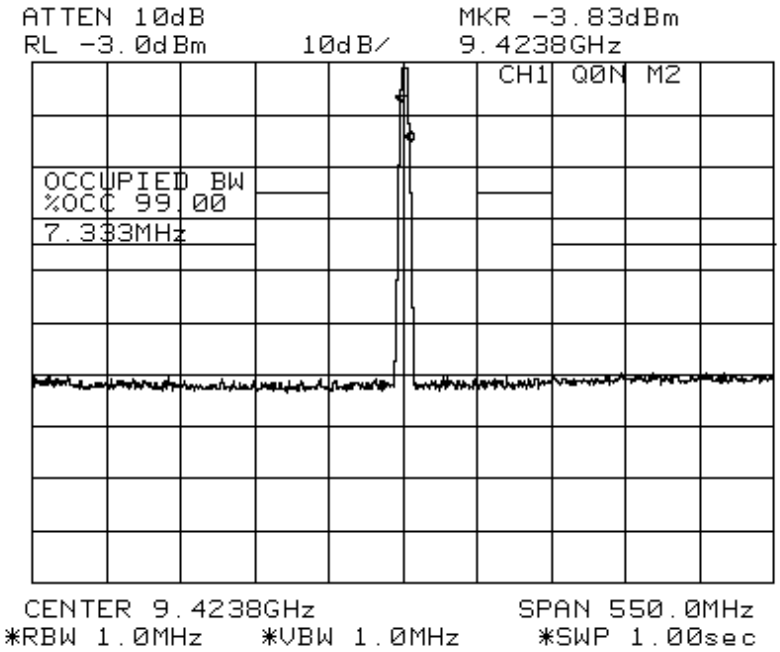



Fig. 7.34 ch1, Q0N, M2 pulse

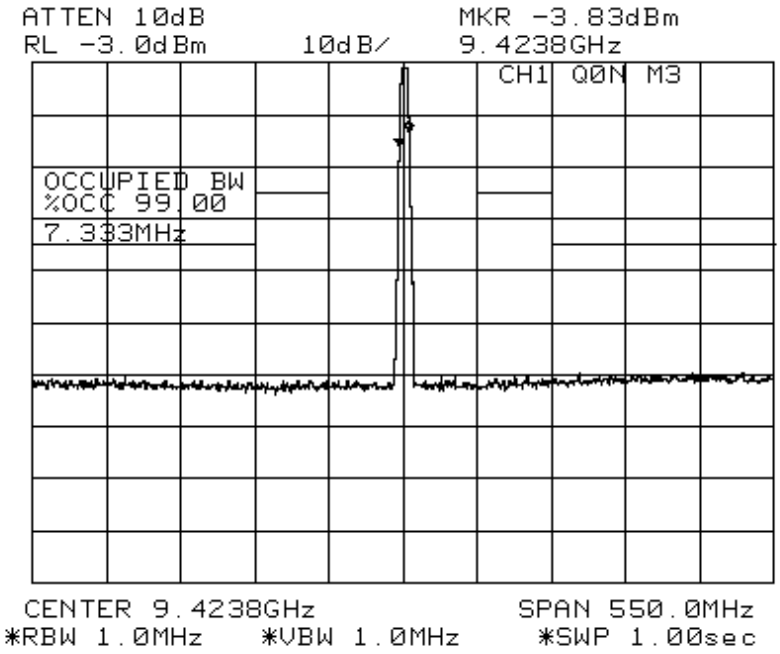



Fig. 7.35 ch1, Q0N, M3 pulse

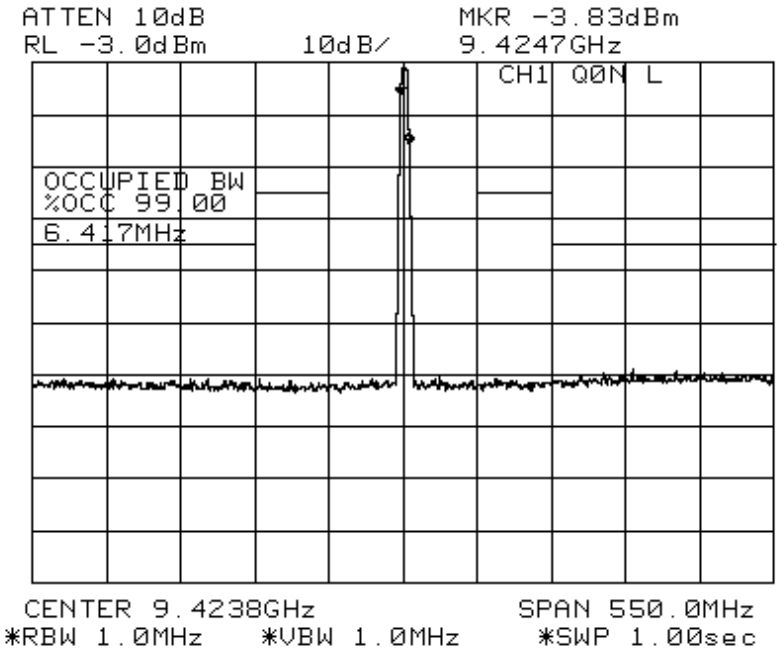



Fig. 7.36 ch1, Q0N, L pulse

ch2, P0N

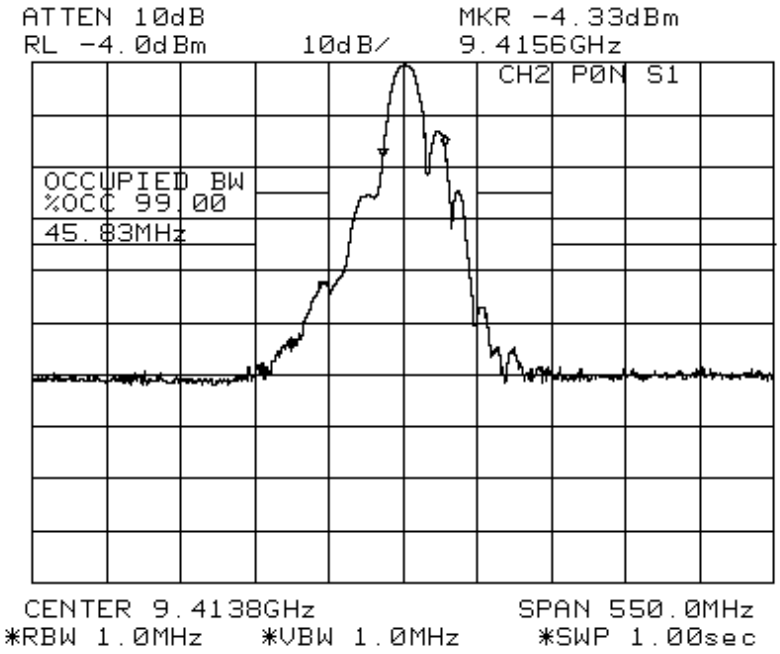



Fig. 7.37 ch2, P0N, S1 pulse

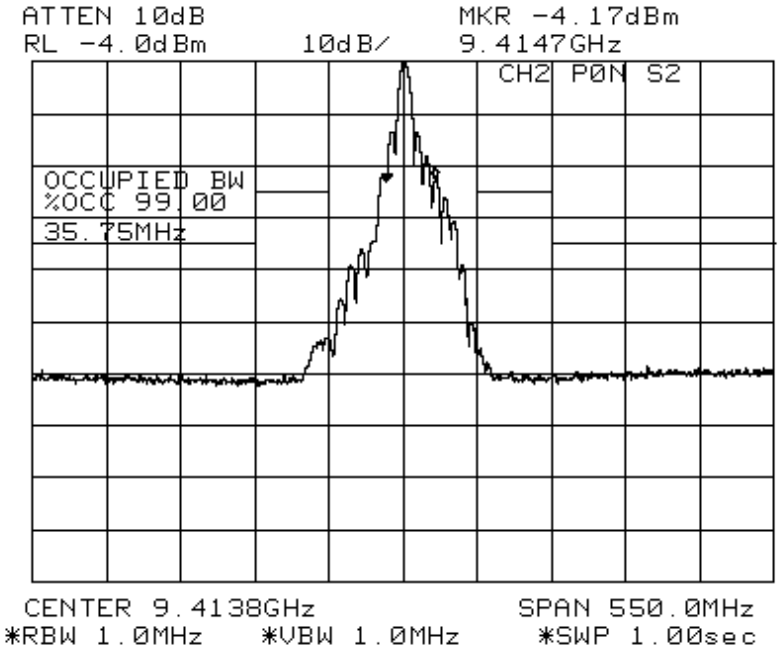



Fig. 7.38 ch2, P0N, S2 pulse

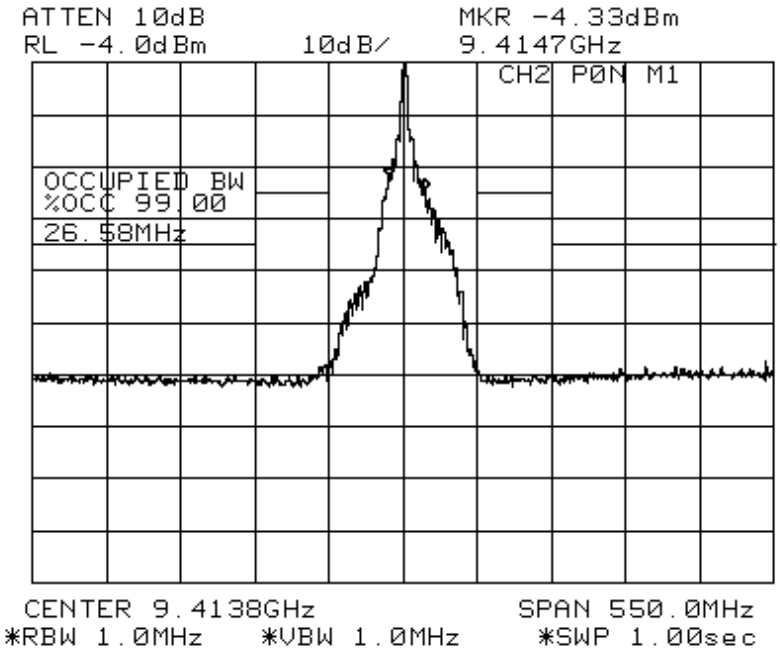



Fig. 7.39 ch2, P0N, M1 pulse

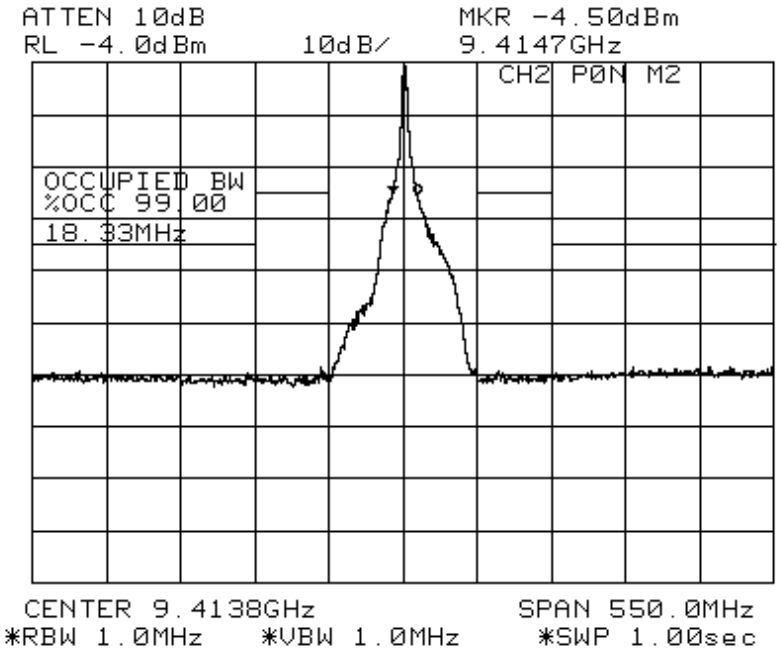



Fig. 7.40 ch2, P0N, M2 pulse

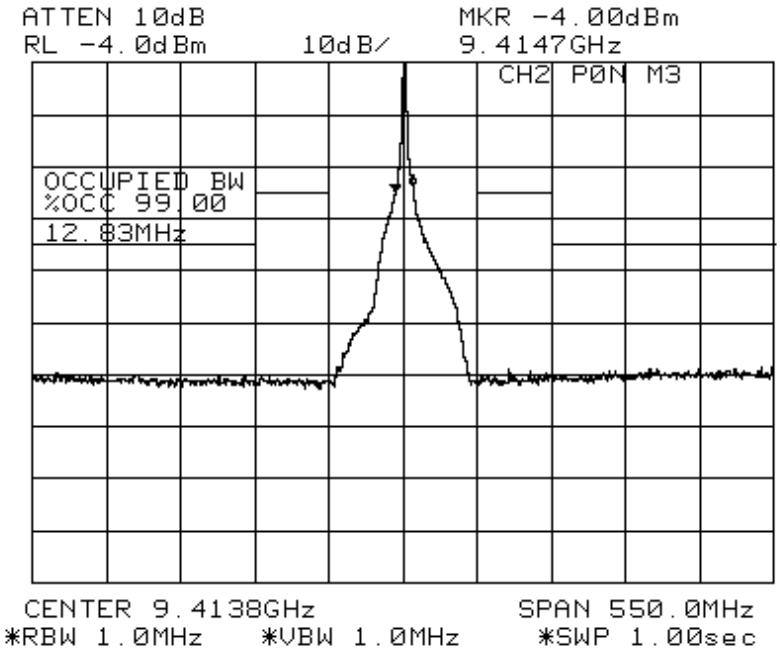



Fig. 7.41 ch2, P0N, M3 pulse

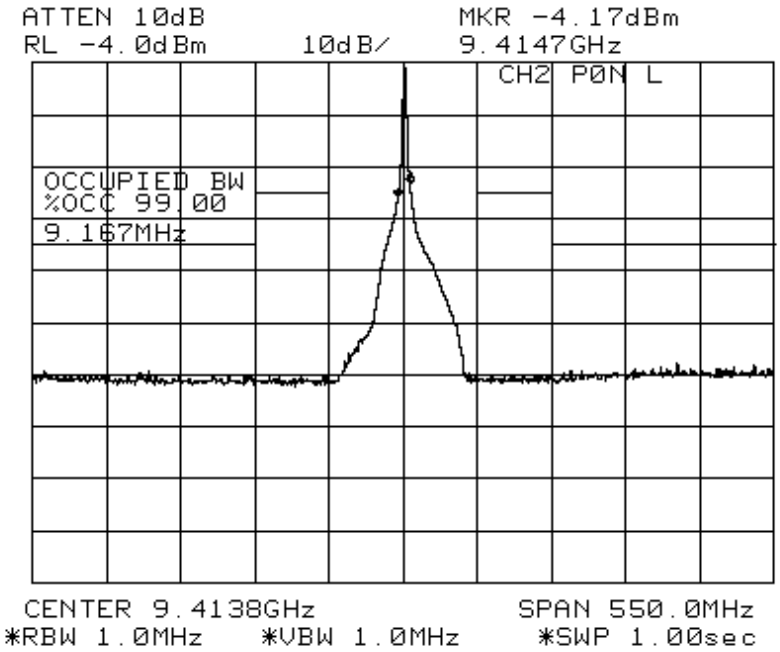



Fig. 7.42 ch2, P0N, L pulse

ch2, Q0N

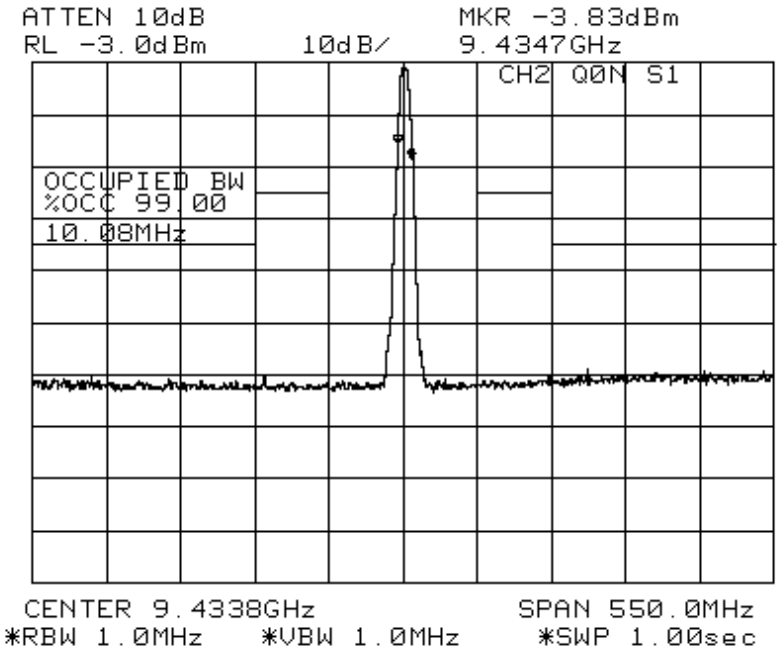



Fig. 7.43 ch2, Q0N, S1 pulse

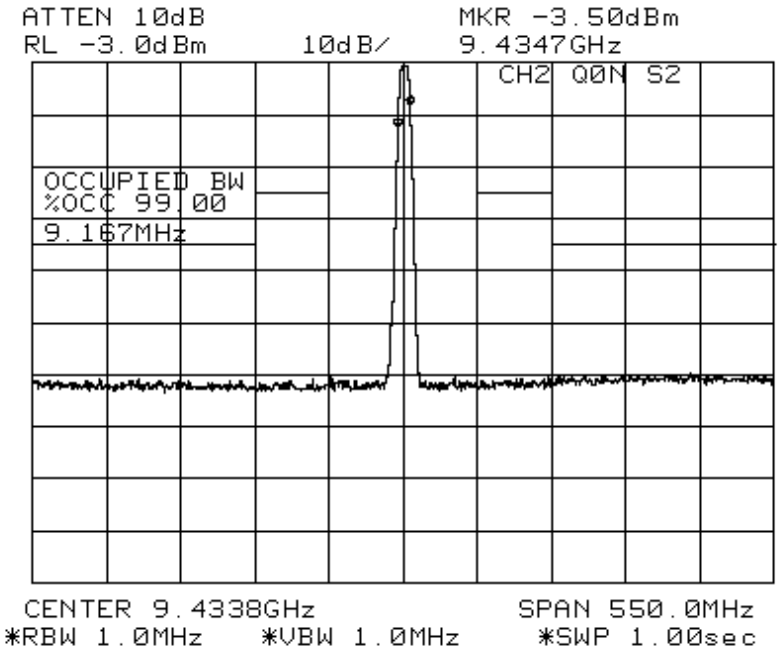



Fig. 7.44 ch2, Q0N, S2 pulse

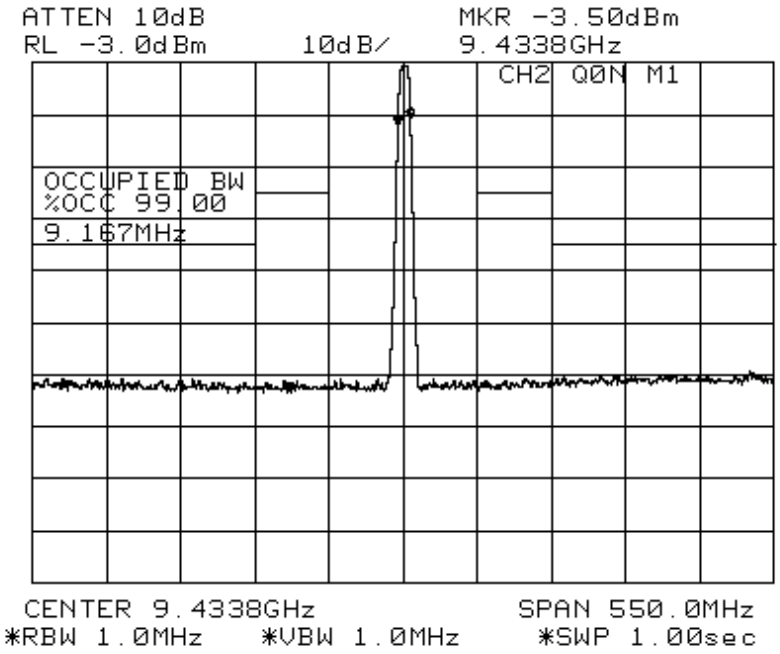



Fig. 7.45 ch2, Q0N, M1 pulse

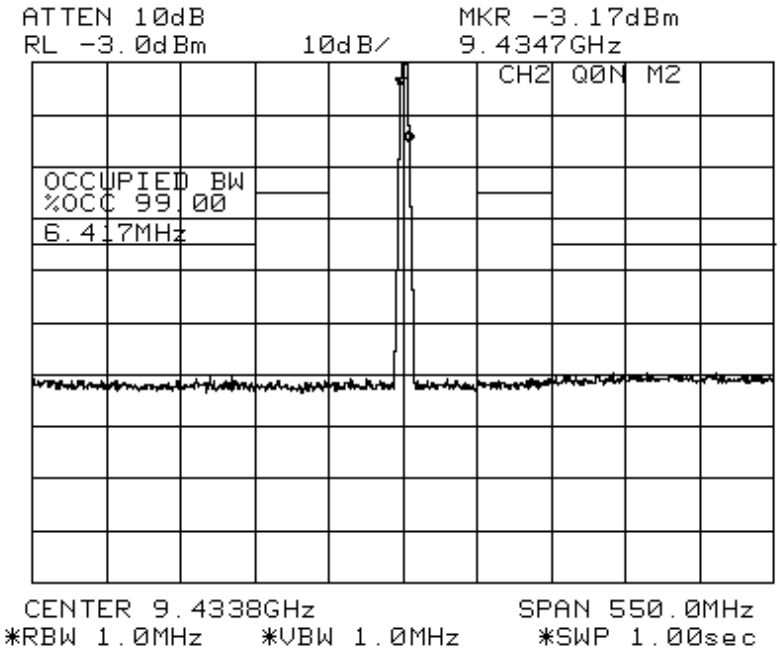



Fig. 7.46 ch2, Q0N, M2 pulse

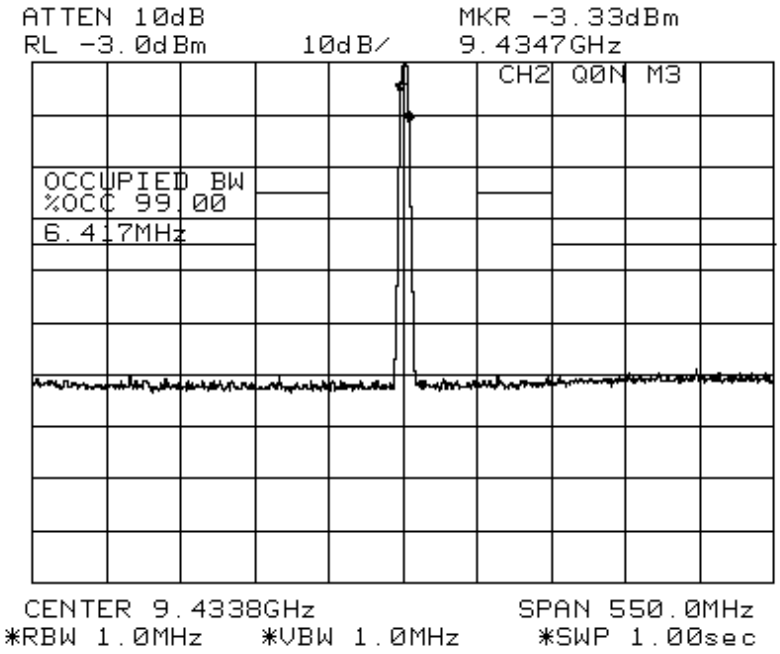



Fig. 7.47 ch2, Q0N, M3 pulse

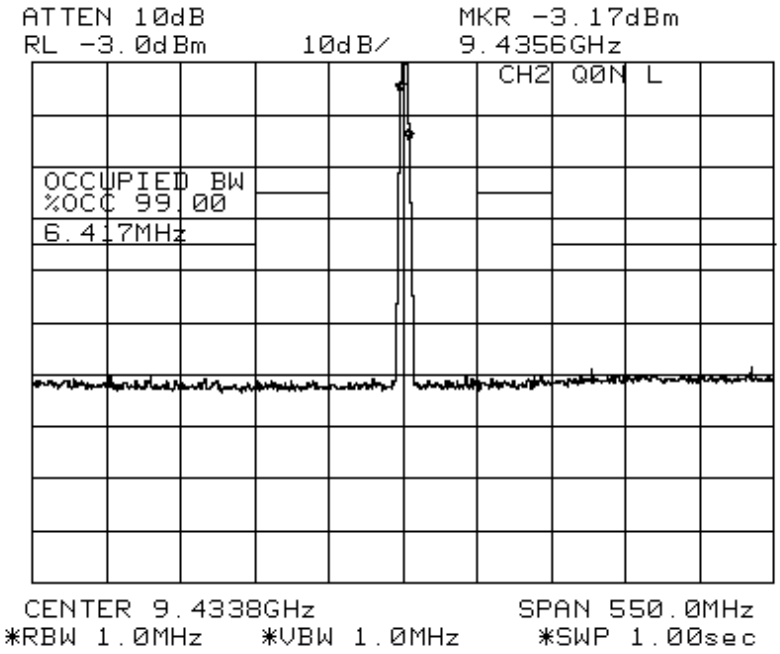



Fig. 7.48 ch2, Q0N, L pulse

2nd trace mode

ch1, P0N

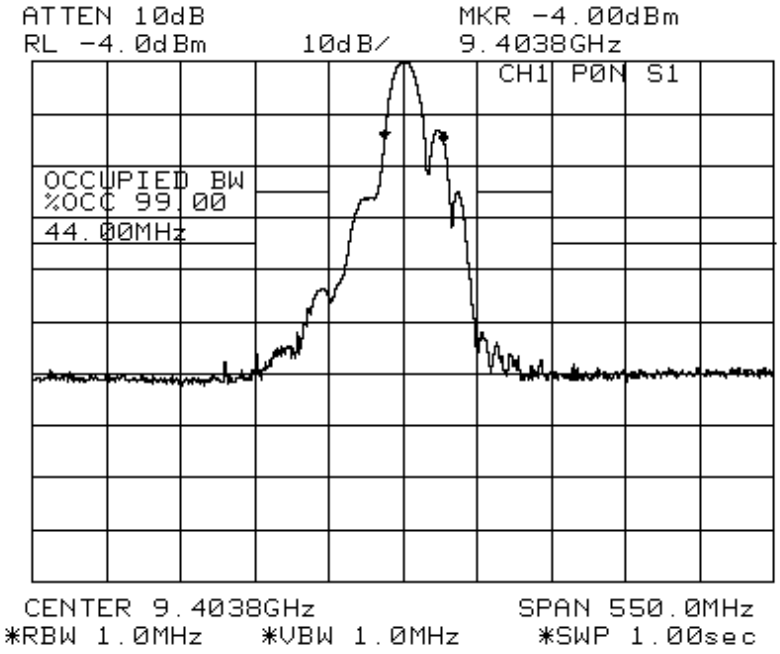



Fig. 7.49 ch1, P0N, S1 pulse

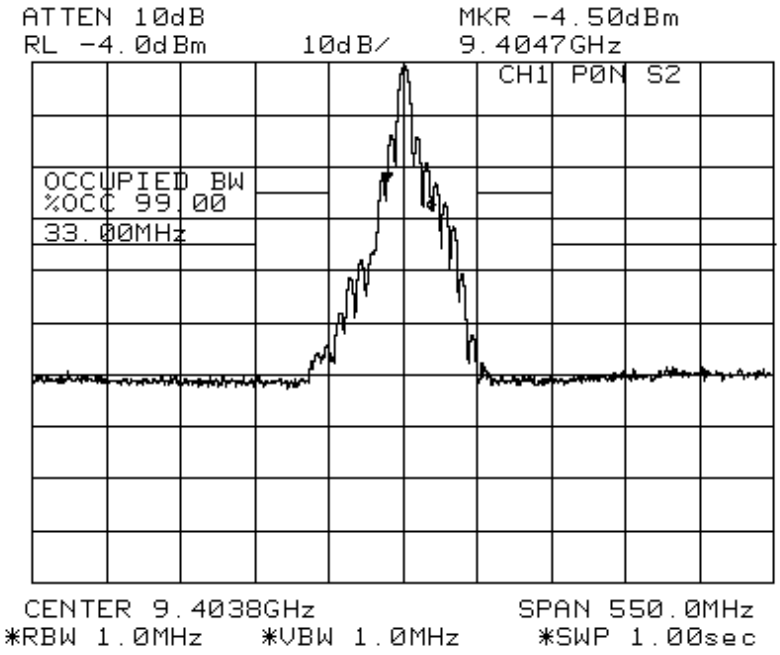



Fig. 7.50 ch1, P0N, S2 pulse

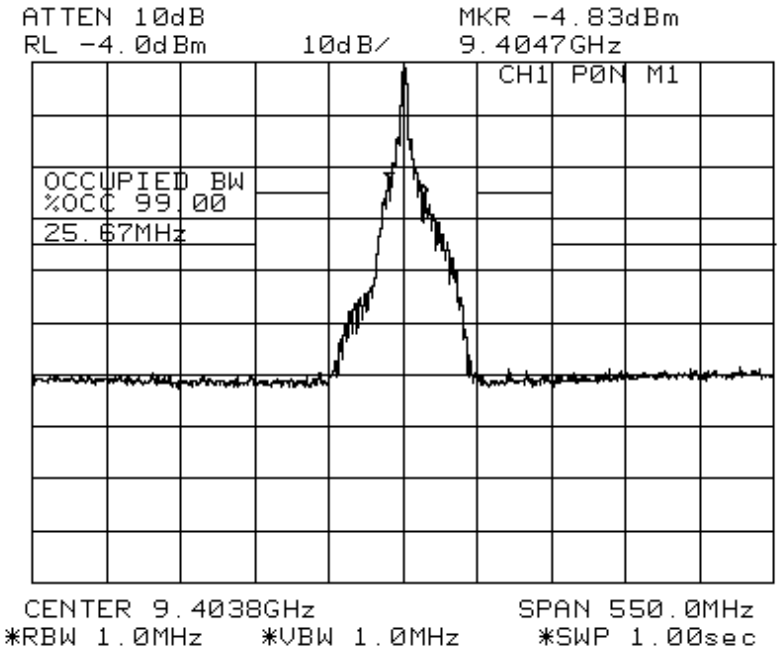



Fig. 7.51 ch1, P0N, M1 pulse

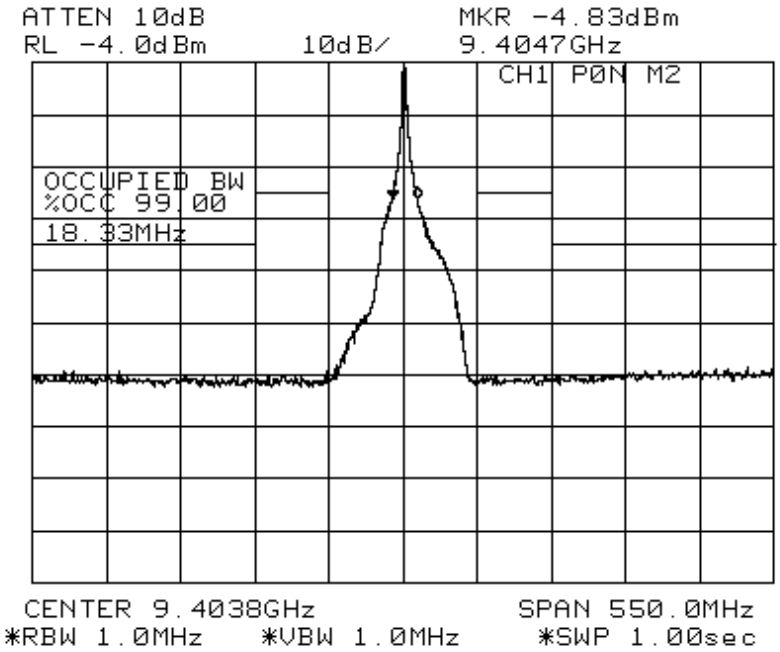



Fig. 7.52 ch1, P0N, M2 pulse

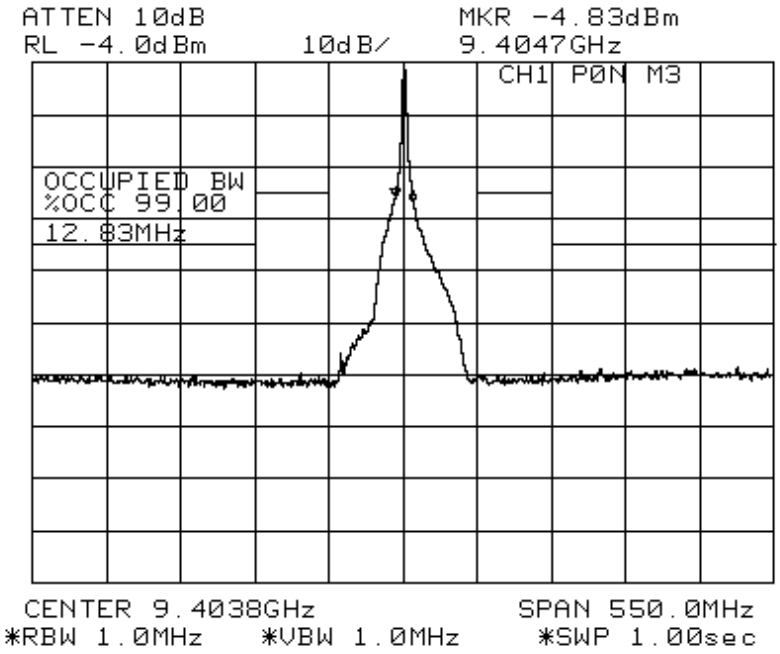



Fig. 7.53 ch1, P0N, M3 pulse

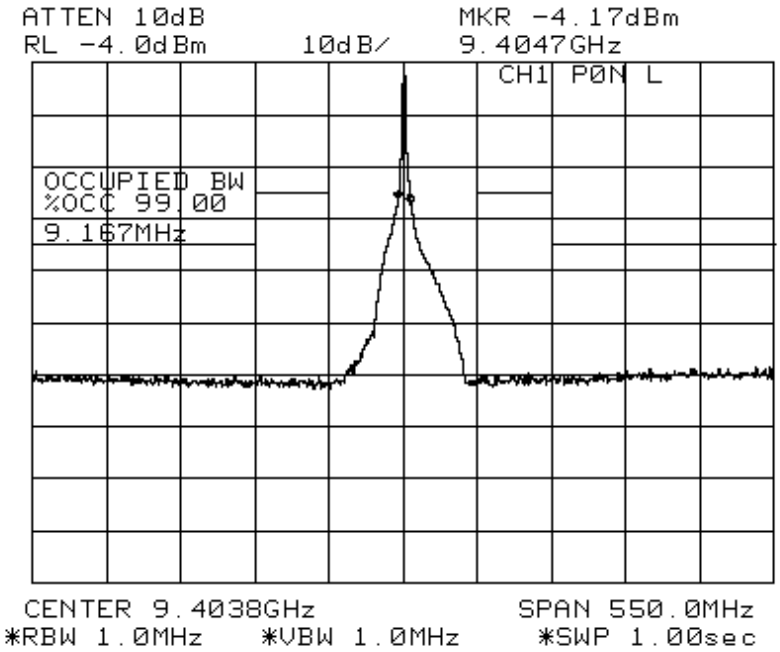



Fig. 7.54 ch1, P0N, L pulse

ch1, Q0N

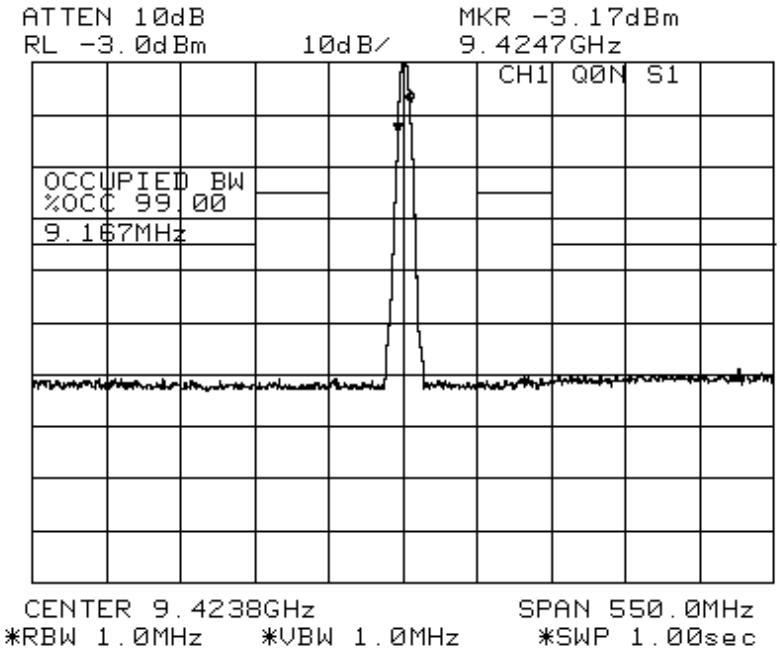



Fig. 7.55 ch1, Q0N, S1 pulse

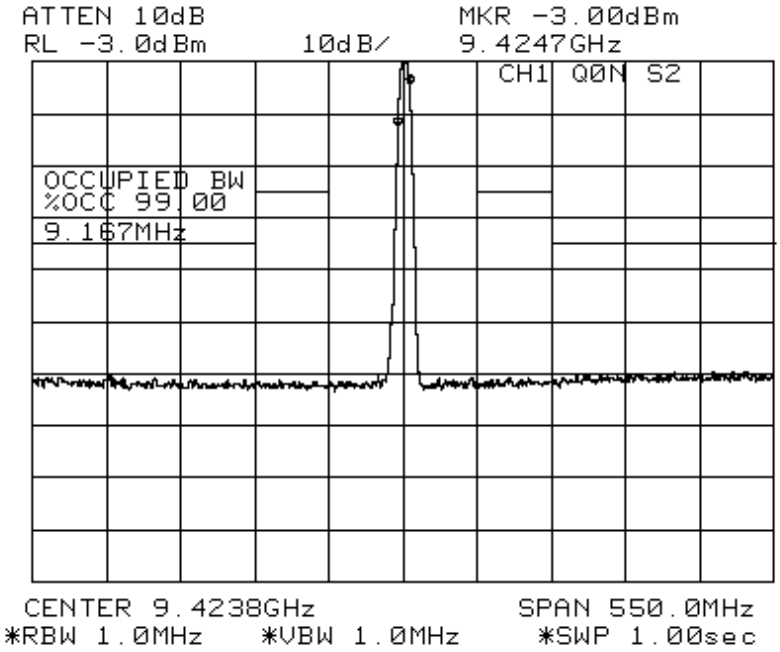



Fig. 7.56 ch1, Q0N, S2 pulse

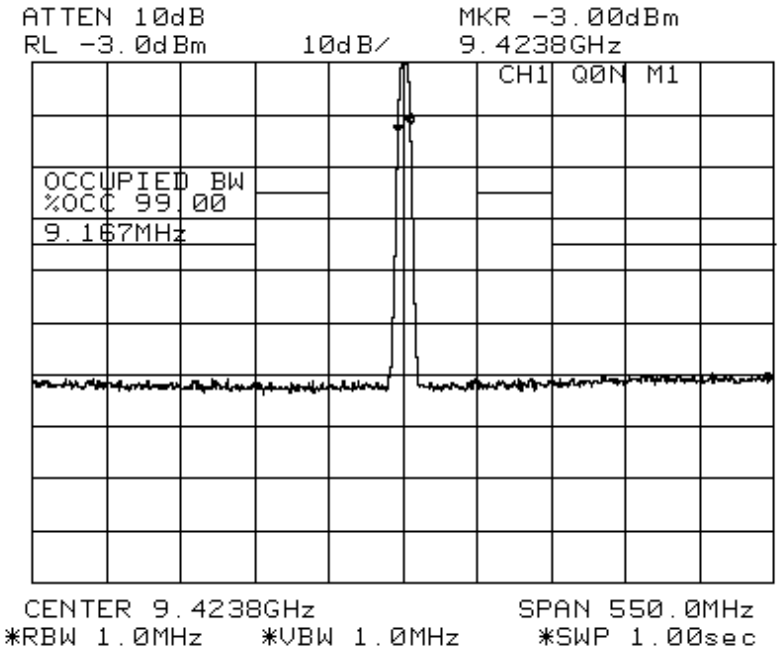



Fig. 7.57 ch1, Q0N, M1 pulse

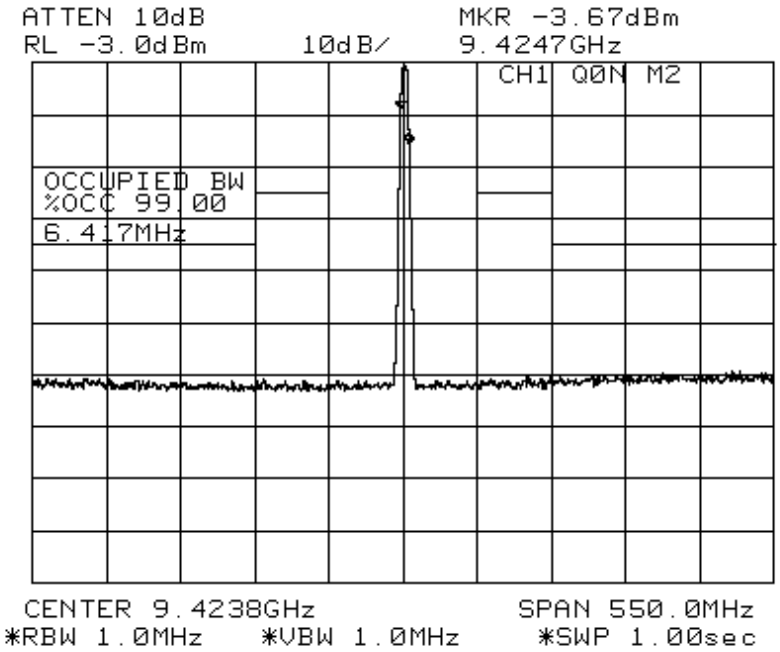



Fig. 7.58 ch1, Q0N, M2 pulse

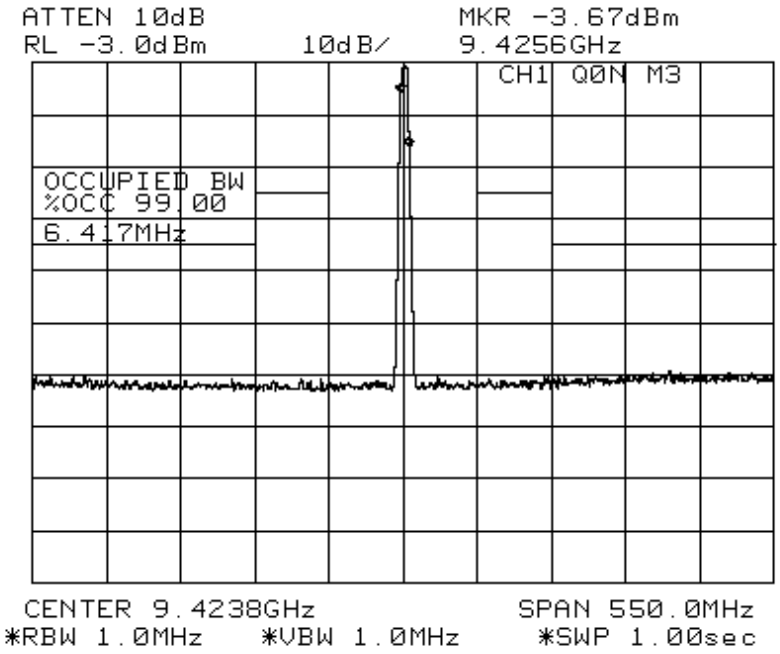



Fig. 7.59 ch1, Q0N, M3 pulse

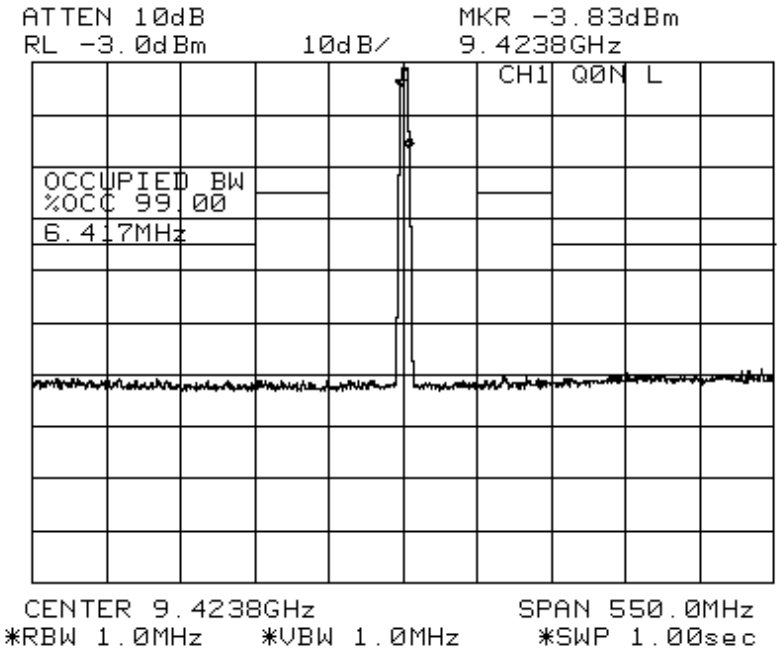



Fig. 7.60 ch1, Q0N, L pulse

ch2, P0N

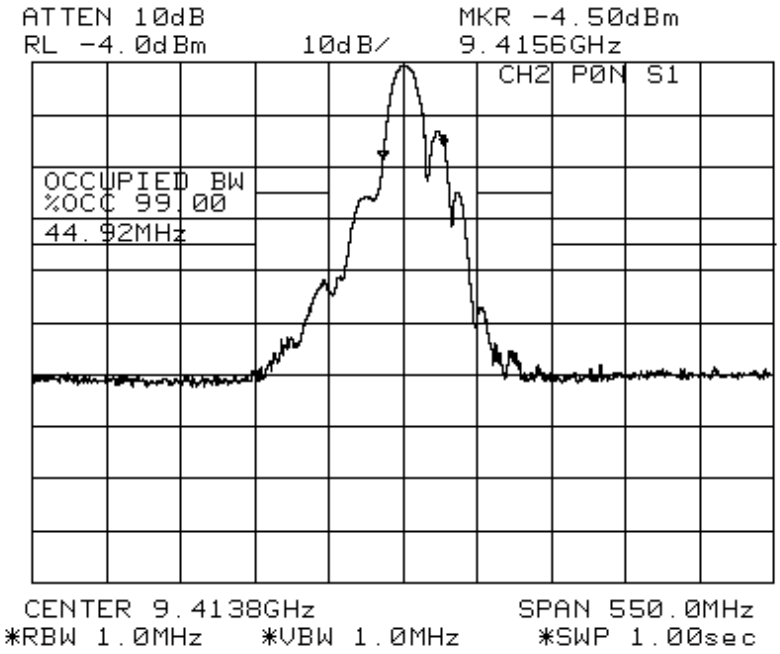



Fig. 7.61 ch2, P0N, S1 pulse

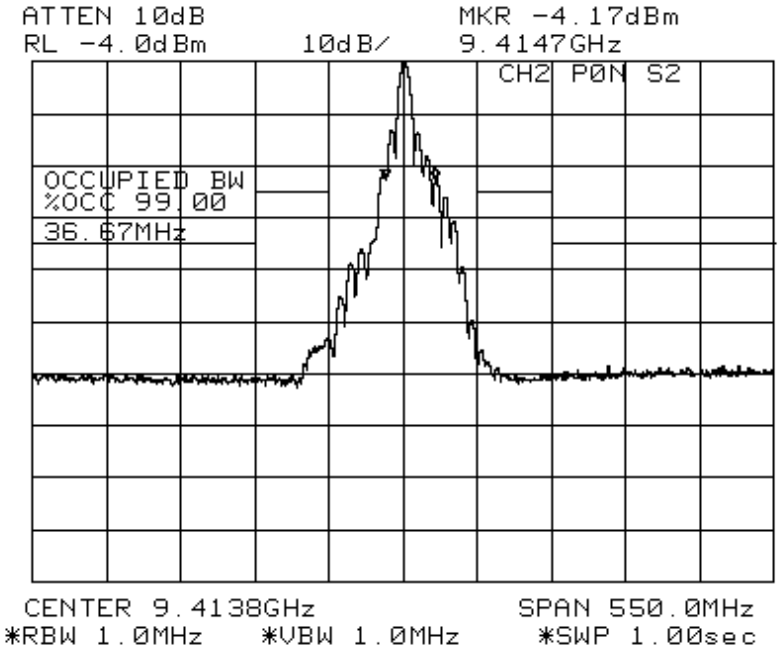



Fig. 7.62 ch2, P0N, S2 pulse

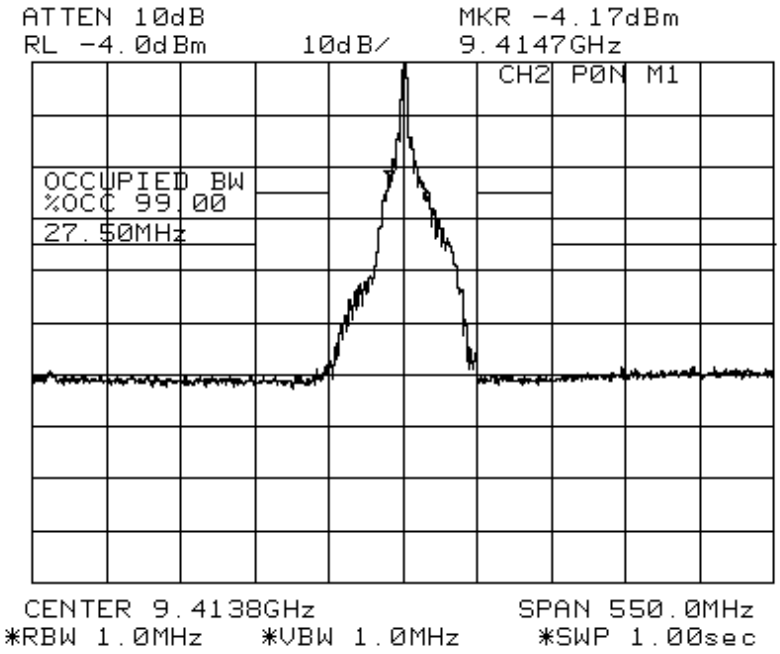



Fig. 7.63 ch2, P0N, M1 pulse

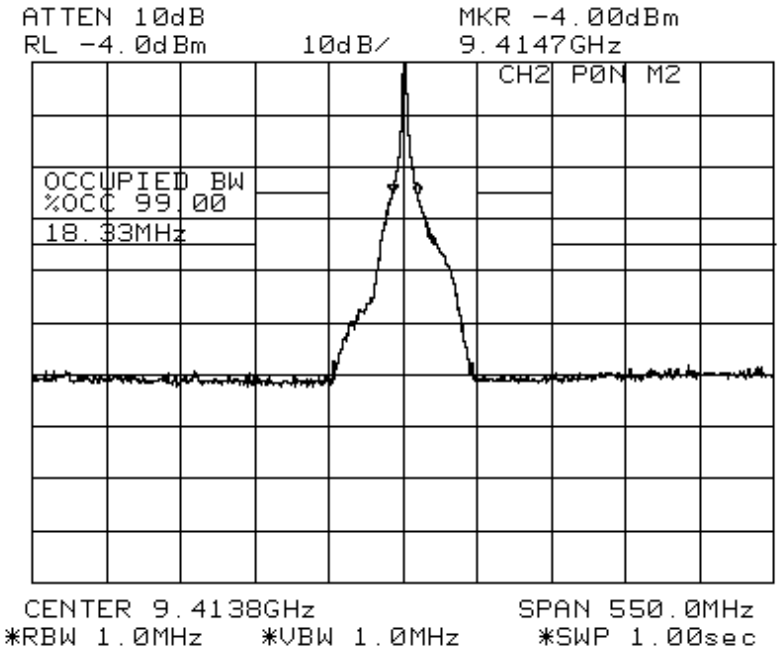



Fig. 7.64 ch2, P0N, M2 pulse

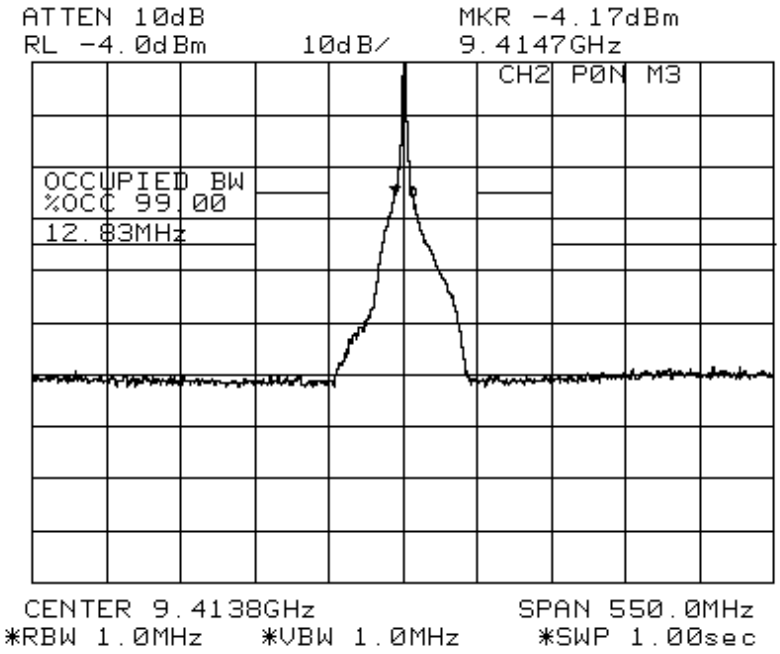



Fig. 7.65 ch2, P0N, M3 pulse

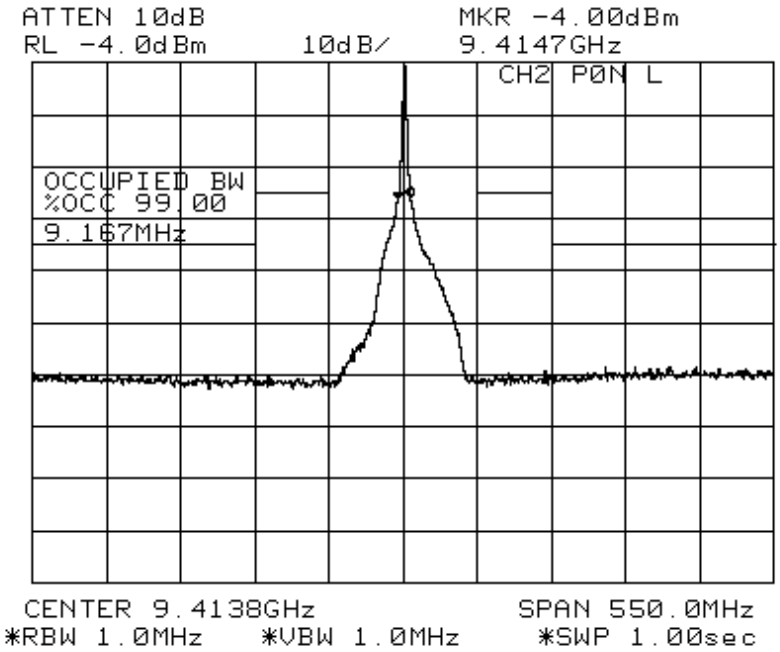



Fig. 7.66 ch2, P0N, L pulse

ch2, Q0N

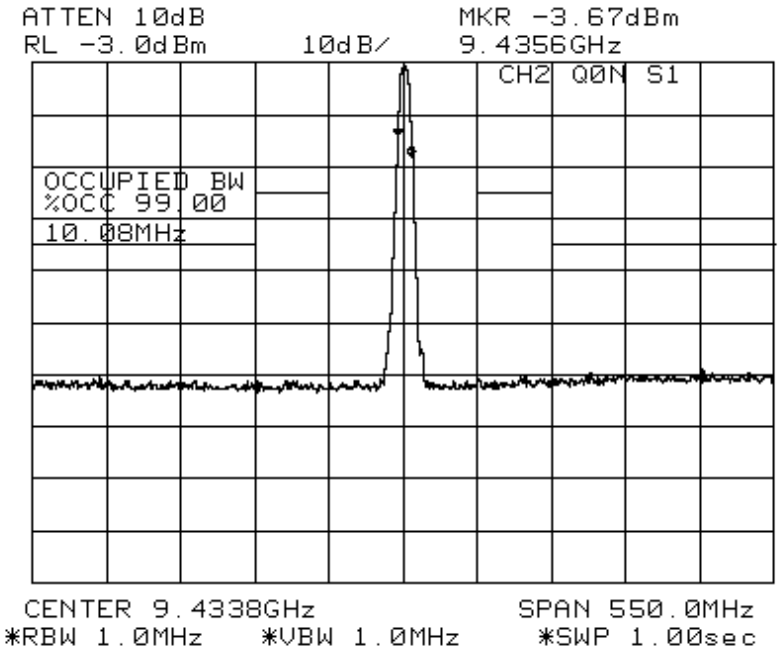



Fig. 7.67 ch2, Q0N, S1 pulse

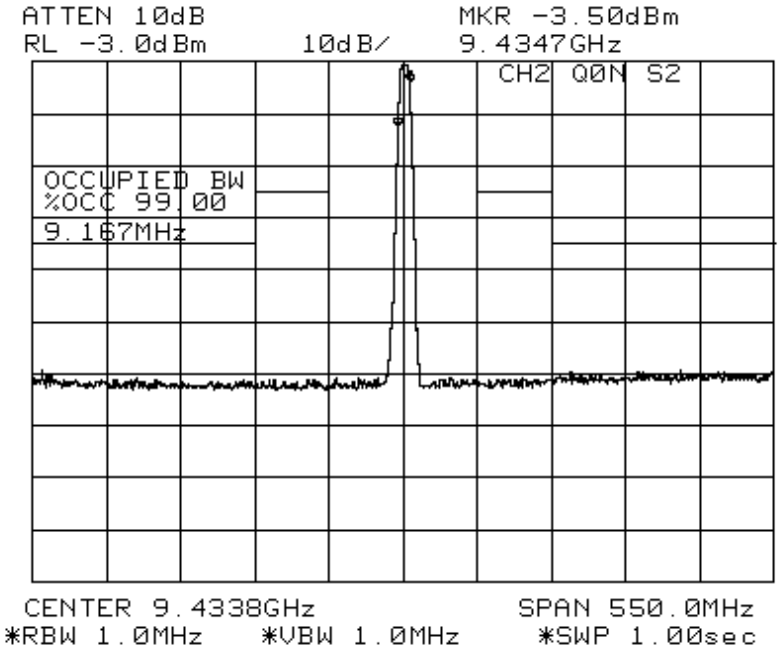



Fig. 7.68 ch2, Q0N, S2 pulse

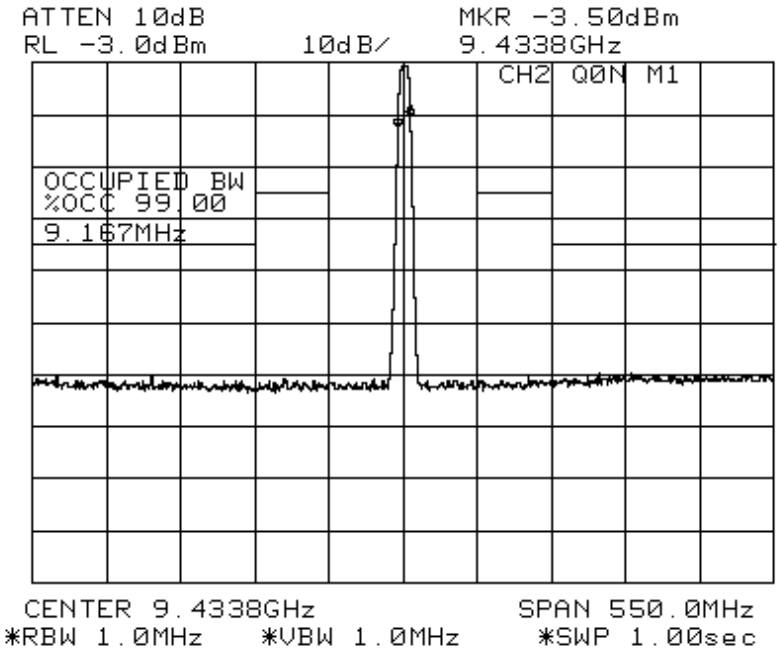



Fig. 7.69 ch2, Q0N, M1 pulse

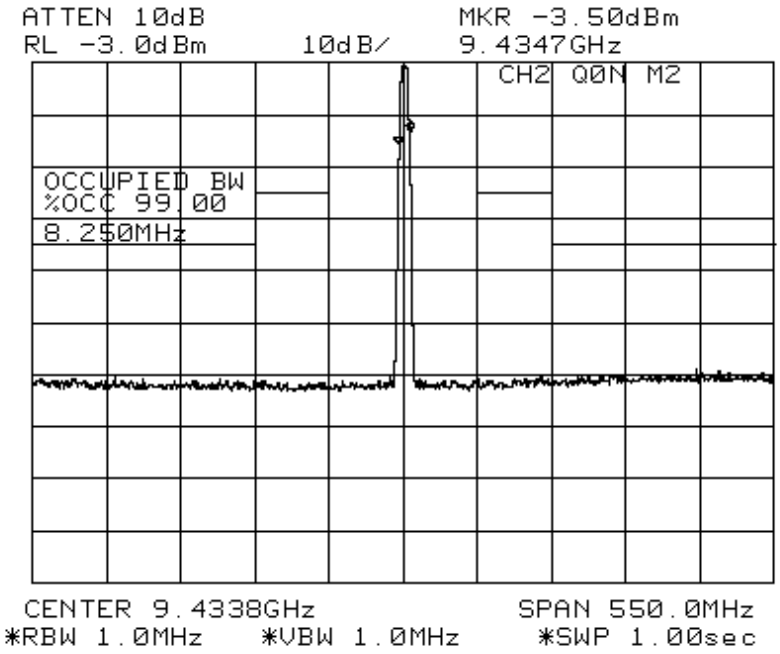



Fig. 7.70 ch2, Q0N, M2 pulse

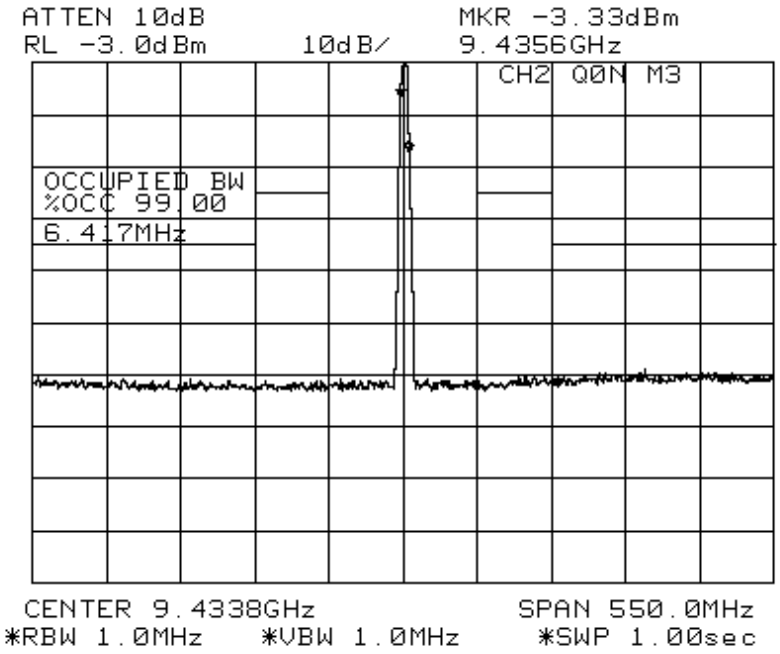



Fig. 7.71 ch2, Q0N, M3 pulse

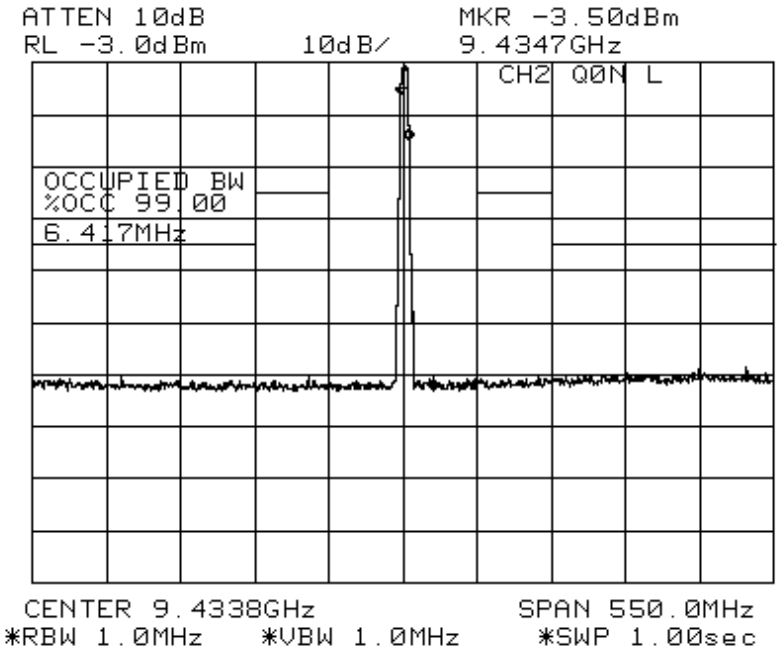



Fig. 7.72 ch2, Q0N, L pulse

End of text