

Test Report

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

For

Trade name: Furuno

Model: Transceiver for Marine Radar

Type: RTR-112

Report no.: LIC 12-15-100


Date of issue: 30 September 2015

Labotech International Co., Ltd.

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

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

Report Summary

| | | | |
|---|---|--------------------------------|-------------------|
| LIC project number: | LIC 04-15-0236 | | |
| Test report number of initial issue: | LIC 12-15-100 | Date of initial issue | 30 September 2015 |
| Test report number of revised/replaced issue: | --- | Date of revised/replaced issue | --- |
| Test report revision/ replacement history: | --- | | |
| Test standard(s)/ Test specifications: | <p>FCC Rules 47 CFR, Sections: 2.1046 - RF Power Output 2.1047 - Modulation Characteristics, 2.1049 - Occupied Bandwidth, 2.1051 - Spurious Emissions at Antenna Terminals, 2.1053 - Field Strength of Spurious Radiation, 2.1055 - Frequency Stability, (Date of issue: 23 June 2015)</p> <p>80.209 - Transmitter frequency tolerances 80.211 - Emission limitations. 80.213 - Modulation requirements. 80.215 - Transmitter power</p> | | |
| Customer: | Furuno Electric Co., Ltd. 9-52 Ashihara-Cho, Nishinomiya-City, 662-8580 Japan | | |
| Manufacturer: | Furuno Electric Co., Ltd. 9-52 Ashihara-Cho, Nishinomiya-City, 662-8580 Japan | | |
| Trade name: | FURUNO | | |
| Model: | Transceiver for Marine Radar | | |
| Type: | RTR-112 | | |
| Product function and intended use: | For marine safety navigation | | |
| Number of samples tested: | One | | |
| Serial number: | 1000-5000-0011 | | |
| Power rating: | 24 VDC | | |
| Product status: | Pre-production model | | |
| Modifications made to samples during testing: | None. | | |
| Date of receipt of samples: | 3 July 2015 | | |
| Test period: | From 3 July 2015 to 27 August 2015 | | |
| Place of test: | Labotech International Co., Ltd. - Nishinomiya-Hama Lab. 2-20, Nishinomiya-Hama, Nishinomiya-shi, Hyogo, 662-0934 Japan Anechoic Chamber used for the test has been registered by FCC. (File number: 90607) Test firm Designation Number: JP2007, Test firm Registration #: 838049 | | |
| Test results/ Compliance: | Passed. The test results of this report relate only to the samples tested. | | |
| Tested by: | Akira Inoue | | |
| Written by: | Akiko Inoue | | |
| Verified by: | Yoshihiro Ishii | | |
| Approved by: | Date: 30 September 2015 Name: Yoshihiro Ishii Title: Senior Manager, Technical Department Labotech International Co., Ltd Signature:  | | |

Testing Laboratory Status

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

- (1) JAB Accredited Testing Laboratory:
 - accredited by Japan Accreditation Board (JAB),
 - Laboratory accreditation number: RTL03220
 - Date of initial accreditation: 14 January 2011 (*)
 - Scope of accreditation: Electrical testing - EMC testing
- (2) Telefication Listed Testing Laboratory:
 - listed by Telefication B. V., (The Netherlands)
 - Laboratory assignment number: L116
 - Date of initial listing: 26 July 1999 (*)
 - for testing the following product categories/ test standards: EN 60945, IEC 61162-1/-2, IEC/EN 61162-450 and IEC 62288
- (3) BSH Recognized Testing Laboratory:
 - recognized by Bundesamt für Seeschifffahrt und Hydrographie (BSH), (Germany)
 - Recognition certificate number: BSH/4613/06202/1864/11
 - Date of initial recognition: 4 April 2003 (*)
 - for testing the following product categories/test standards:
 - IEC/EN 60945, IEC 62388, IEC 61162-1/-2, and IEC 62288
- (4) TÜV Appointed EMC Test Laboratory:
 - appointed by TÜV Rheinland Japan Ltd.,
 - Laboratory assignment number: UA 50046428
 - Date of initial appointment: 21 December 1998 (*)
 - for carrying out the tests of: EN 55011, CISPR 11, EN 55022, CISPR 22, EN 55024, CISPR 24, EN 55025, CISPR 25, EN/IEC 61000-3-2/-3, EN/IEC 61000-4-2/-3/-4/-5/-6/-8/-11, EN/IEC 61000-6-1/-2/-3/-4, EN/IEC 60945, EN/IEC 61326-1, EN/IEC 61326-2-6, EN/IEC 60601-1-2, JIS T 0601-1-2, JIS C 1806-1, and ISO 11452-1/-2/-4.
- (5) RMRS Recognized Testing Laboratory:
 - recognized by Russian Maritime Register of Shipping (RMRS), (Russia)
 - Laboratory recognition number: 11.02594.011
 - Date of initial recognition: 27 January 2009 (*)
 - for carrying out testing in the field of:
 - Electrical measurements and tests, EMC tests, Mechanical measurements and tests, Equipment protection degree tests, and Climatic tests for Ship's radio and navigational equipment and IEC 60945: 2002
- (6) RRR Recognized Test Laboratory:
 - recognized by Russian River Register (RRR), (Russia)
 - Recognition certificate number: 154262
 - Date of initial recognition: 31 May 2013 (*)
 - for carrying out of tests of ships radio and navigation equipment
- (7) DNV Recognized Environmental Test Laboratory:
 - recognized by Det Norske Veritas AS (DNV), (Norway)
 - Recognition certificate number: 262.1-015854-J-12
 - Date of initial recognition: 12 July 2013 (*)
 - Scope of recognition: Testing according to the standards IEC 60945, IEC 61162-1/-2/-450, IEC 62288, IEC 62388 and IEC 62252 Annex E
 - Application: Provisions of Environmental, interface and safety testing.
- (8) CCS Recognized Test Agency :
 - recognized by China Classification Society
 - Recognition certificate number : DB13A00001
 - Date of initial recognition : 29 January 2014 (*)
 - Scope of recognition : Performance/Environmental/EMC/Special purpose/Safety precautions tests for Electrical & Electronic Product including Maritime Navigation and Radio-communication Equipment & Systems

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

TABLE OF CONTENTS

| | |
|--|----|
| Testing Laboratory Status | 3 |
| 1 Principal Information | 5 |
| 1.1 Equipment under test (EUT) | 5 |
| 1.2 Observation and comments | 8 |
| 2 Test Results Summary | 8 |
| 3 Test Results | 9 |
| 3.1 RF Power Output (FCC Rule 47 CFR, 2.1046 (a), 80.215) | 9 |
| 3.2 Modulation Characteristics (FCC Rule 47 CFR, 2.1047) | 10 |
| 3.3 Frequency Stability –temperature & voltage (FCC Rule 47 CFR, 2.1055(a)(2)/(d)(1)/(d)(3), 80.209(b)) | 11 |
| 3.4 Occupied Bandwidth (FCC Rule 47 CFR, 2.1049(c)(1), 80.209(b), 80.211(f)) | 12 |
| 3.5 Spurious Emissions at Antenna Port (FCC Rule 47 CFR, 2.1051, 80.211(f)) | 13 |
| 3.6 Field Strength of Spurious Radiation (FCC Rule 47 CFR, 2.1053, 80.211(f)) | 14 |
| 4 Test Setup for Measurements | 15 |
| 5 Measuring Equipment List | 16 |
| 6 Photographs of Test Setup/Arrangement | 18 |
| 7 RF Envelopes and Spectrum of the output pulse | 19 |
| 8 Spurious Emission Plots measured at Antenna Terminal | 22 |

1 Principal Information

1.1 Equipment under test (EUT)

1.1.1 General

- (a) Trade name: Furuno
- (b) Manufacturer: Furuno Electric Co., Ltd.
Ashihara-cho 9-52, Nishinomiya-city, 662-8580 Japan
- (c) Model: Radar Sensor DRS6A X-Class

| | Type | Serial Number | Note |
|--------------------|-------------------|----------------|--|
| Radar Sensor | DRS6A X-Class | 1000-5000-0011 | |
| Scanner module | RSB-134 | --- | Antenna rotation rate: 24/36/48 rpm |
| Transceiver module | RTR-112 | --- | Contained in the Antenna Unit |
| Antenna radiator | XN10A/XN12A/XN13A | --- | |

- (d) Certification number: FCC ID: ADB9ZWRTR112
- (e) Primary Function: Search, Navigation and Anti-collision
- (f) Frequency Range: Fixed frequency, X-band (9410 MHz)
Type of Emission: P0N
(Emission designator)
- (g) Occupied bandwidth:

| Pulse type | S1 | S2 | M1 | M2 | M3 | L |
|--------------------------|------|------|------|------|------|-----|
| Occupied bandwidth (MHz) | 61.4 | 55.9 | 38.5 | 17.4 | 10.1 | 8.3 |

Note: representative measured data.

- (h) Size and mass:
 - Antenna Unit: 1036 mm X 445 mm (H), 20 kg (*1)
 - Antenna Unit: 1255 mm X 445 mm (H), 21 kg (*2)
 - Antenna Unit: 1795 mm X 445 mm (H), 23 kg (*3)

(*1): with Antenna XN10A installed.
(*2): with Antenna XN12A installed.
(*3): with Antenna XN13A installed.
- (i) Power Supply: 24 VDC, 96 W.

1.1.2 Transceiver

Type: RTR-112 (Contained in the Antenna Unit)

1.1.2.1 Transmitter

- (a) Assignable Frequency for Shipborne Radar:
Between 9300 and 9500 MHz (FCC Rule, 80.375 (d)-(1))

- (b) Type of RF Generator:
 - Magnetron Type: MAF1422B
 - Peak Output Power: 6 kW nominal
- (c) Magnetron Ratings:
 - Center frequency of Magnetron: 9410 MHz nominal
 - Tolerances:
 - Manufacturing: ± 30 MHz
 - Pulling: 18 MHz
 - Tolerance for 20°C temperature variation: -5 MHz

(d) Pulse Characteristics:

| Pulse type | S1 | S2 | M1 | M2 | M3 | L |
|------------------------|------|------|------|------|-----|-----|
| Pulselength (μ s) | 0.08 | 0.15 | 0.3 | 0.5 | 0.8 | 1.2 |
| PRR (Hz) | 3000 | 3000 | 1500 | 1000 | 600 | 600 |

1.1.2.2 Modulator

- (a) FET Type: FMC20N50E-TE24RSC
- Trigger Voltage: Approximately +5 VDC positive

1.1.2.3 Receiver

- (a) Passband
 - RF Stage: 60 MHz
 - IF Stage:

| Pulse type | S1 | S2 | M1 | M2 | M3 | L |
|----------------|----|----|----|-----|-----|-----|
| Passband (MHz) | 18 | 8 | 8 | 1.7 | 1.7 | 1.7 |

- (b) Intermediate Frequency: 60 MHz
- (c) Gain (overall): Approximately 100 dB
- (d) Overall Noise Figure: 4.5 dB (typical)
- (e) Video Output Voltage: ± 1 V differential
- (f) Features Provided: Sensitivity Time Controls (Anti-clutter Sea),
Fast Time Constant (Anti-clutter Rain)
- (g) If receiver is tunable, describe method for adjusting frequency:
By adjusting of tuning voltage of receiver local oscillator (automatic and manual)
- (h) Frequency adjustable range: 9410 MHz (center) ± 30 MHz

1.1.3 Antenna and Scanner

- (a) Antenna Rotation ON-OFF Switch: Not Provided.
- (b) Construction: Slotted array antenna

(c) Length:

| | | | |
|--------------|-------|-------|-------|
| Antenna type | XN10A | XN12A | XN13A |
| Length (cm) | 104 | 126 | 180 |

(d) Type of Beam: Vertical fan

(e) Beam Width (3 dB):

| | | | |
|----------------|-------|-------|-------|
| Antenna type | XN10A | XN12A | XN13A |
| Horizontal (°) | 2.3 | 1.9 | 1.4 |
| Vertical (°) | 22 | 22 | 22 |

(f) Polarization: Horizontal

(g) Antenna Gain:

| | | | |
|--------------|-------|-------|-------|
| Antenna type | XN10A | XN12A | XN13A |
| Gain (dBi) | 27.5 | 28.5 | 30.0 |

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

| | | | |
|-------------------|-------|-------|-------|
| Antenna type | XN10A | XN12A | XN13A |
| Within ±10° (dB) | 20 | 27 | 29 |
| Outside ±10° (dB) | 28 | 34 | 37 |

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

(j) Antenna Rotation Rate: 24/36/48 rpm

(k) Sector Scan: Not provided.

(l) Rated Loss of Transmission line per hundred feet:

Negligible. (Transmission path is only in the antenna unit.)

1.1.4 Operational Features

(a) Is positive means provided to indicate whether or not the overall operation of the equipment is such that it may be relied upon to provide effective operation in accordance with its primary function: Yes (Receiver tuning indicator)

(b) Is the equipment for continuous operation: Yes.

(c) Is provision made for operation with shore based radar beacons (RACONS): Yes. (RACONS)

1.1.5 Construction Features

(a) Does equipment embody replacement units with chassis type assembly: Yes.

(b) Are fuse alarms provided: No.

(c) State units that are weatherproof: Antenna Unit (IEC 60529 – IP56)

(d) If all units are not housed in a single container, indicate number and give description of individual units: See Clause 1.1.1 (c) of this report.

(e) Approximate space required for installation excluding antenna unit: Not applicable.

1.2 Observation and comments

None.

2 Test Results Summary

| Clause no. of this report | 47 CFR Section | Item | Result | Test Engineer |
|---------------------------|--|--|---------|---------------|
| 3.1 | 2.1046 (a), 80.215 | RF Power Output | Passed. | A. Inoue |
| 3.2 | 2.1047 | Modulation Characteristics | Passed. | A. Inoue |
| 3.3 | 2.1055 (a)(2),(d)(1),(d)(3) 80.209 (b) | Frequency Stability | Passed. | A. Inoue |
| 3.4 | 2.1049 (c)(1), 80.219 (b), 80.211 (f) | Occupied Bandwidth | Passed. | A. Inoue |
| 3.5 | 2.1051, 80.211 (f) | - Spurious Emissions at Antenna Terminals | Passed. | A. Inoue |
| 3.6 | 2.1053, 80.211 (f) | - Field Strength of Spurious Radiation | Passed. | A. Inoue |

3 Test Results

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

(1) Test conditions:

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

(2) Test setup:

See Clause 4.

(3) Test Results:

| Pulse type | S1 | S2 | M1 | M2 | M3 | L |
|---|-------|-------|-------|-------|-------|-------|
| Magnetron Output, mean P _m (W) | 1.2 | 2.1 | 2.1 | 2.3 | 2.2 | 3.5 |
| Magnetron Output, peak P _p (kW) (*1) | 4.6 | 4.4 | 4.5 | 4.6 | 4.6 | 4.6 |
| Pulse length T (μs) (-3 dB points) | 0.091 | 0.158 | 0.307 | 0.496 | 0.799 | 1.246 |
| PRF (Hz) | 3000 | 3000 | 1500 | 1000 | 600 | 600 |

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

Environmental conditions observed: On 6 July 2015, 24°C to 24°C, 64%RH to 64%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC.

3.2 Modulation Characteristics (FCC Rule 47 CFR, 2.1047)

(1) Test Conditions:

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

(2) Test setup:

See Clause 4.

(3) Test Results:

| Pulse type | S1 | S2 | M1 | M2 | M3 | L |
|--|-------|-------|-------|-------|-------|-------|
| Pulse length T (μ s) (-3 dB points) | 0.091 | 0.158 | 0.307 | 0.496 | 0.799 | 1.246 |
| Rise time t_r (μ s) (10 - 90 % amplitude) | 0.019 | 0.019 | 0.020 | 0.022 | 0.022 | 0.022 |
| Decay time t_f (μ s) (90 - 10 % amplitude) | 0.079 | 0.076 | 0.075 | 0.077 | 0.077 | 0.081 |
| PRR (Hz) | 3000 | 3000 | 1500 | 1000 | 600 | 600 |

Measured Plots: See Clause 7.

Environmental conditions observed: On 6 July 2015, 24°C to 24°C, 64%RH to 64%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC.

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

(1) Test Conditions:

- (1) Radar Transmitter settings: All TX pulses (S1/S2/M1/M2/M3/L)
- (2) Ambient Temperature settings: - 20°C to + 50°C (10°C interval)
- (3) Power Supply Voltage settings: 85 /100/115 % of nominal voltage
DC Processor unit (24 VDC): (20.4/24.0/27.6 VDC),

(2) Test setup:

See Clause 4.

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

| Pulse type | S1 | S2 | M1 | M2 | M3 | L |
|--------------------------------|--------|--------|--------|--------|--------|--------|
| Guard Band f(1.5/T) (MHz) (*1) | 16.5 | 9.5 | 4.9 | 3.0 | 1.9 | 1.2 |
| f(U) (MHz) (*2) | 9483.5 | 9490.5 | 9495.1 | 9497.0 | 9498.1 | 9498.8 |
| f(L) (MHz) (*2) | 9316.5 | 9309.5 | 9304.9 | 9303.0 | 9301.9 | 9301.2 |

(*1): Guard Band is specified to be equal to 1.5/T MHz, where "T" is the pulse length in microseconds.

(FCC Rule 47 CFR, 80.209(b))

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

Lower limit frequency, f(L) = 9300 +1.5/T

(4) Test Results:

Complied.

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

| Pulse type | | S1 | S2 | M1 | M2 | M3 | L | Result |
|-------------------------------------|-------|--------|--------|--------|--------|--------|--------|-----------|
| Frequency at maximum emission (MHz) | -20°C | 9430.0 | 9428.7 | 9427.3 | 9426.3 | 9425.3 | 9424.3 | Complied. |
| | -10°C | 9428.0 | 9426.7 | 9426.0 | 9425.3 | 9424.7 | 9423.0 | Complied. |
| | 0°C | 9426.7 | 9426.0 | 9424.7 | 9424.0 | 9423.3 | 9422.0 | Complied. |
| | +10°C | 9426.0 | 9424.7 | 9423.3 | 9422.7 | 9421.7 | 9420.3 | Complied. |
| | +20°C | 9423.0 | 9423.0 | 9421.6 | 9421.0 | 9420.0 | 9419.3 | Complied. |
| | +30°C | 9422.7 | 9421.3 | 9420.0 | 9419.3 | 9419.0 | 9417.7 | Complied. |
| | +40°C | 9421.3 | 9420.0 | 9419.3 | 9418.7 | 9417.3 | 9416.3 | Complied. |
| | +50°C | 9420.7 | 9418.7 | 9417.3 | 9416.7 | 9416.0 | 9415.0 | Complied. |

(4.2) At the temperature of +20°C:

| Pulse type | | S1 | S2 | M1 | M2 | M3 | L | Result |
|------------|----------|--------|--------|--------|--------|--------|--------|----------|
| 24 VDC | 20.4 VDC | 9423.0 | 9422.3 | 9421.6 | 9421.0 | 9420.6 | 9419.0 | Complied |
| | 24.0 VDC | 9423.0 | 9423.0 | 9421.6 | 9421.0 | 9420.0 | 9419.3 | Complied |
| | 27.6 VDC | 9423.0 | 9423.0 | 9421.6 | 9421.0 | 9420.0 | 9419.3 | Complied |

Environmental conditions observed: On 3 July 2015, 24°C to 24°C, 64%RH to 64%RH

On 4 July 2015, 23°C to 24°C, 67%RH to 68%RH

On 5 July 2015, 24°C to 24°C, 64%RH to 68%RH

Power supply voltage measured: 24.0 VDC to 24.0 VDC.

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

(1) Test conditions:

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

(*1): Tested only with S1 pulse that is the widest in B-40 calculation. The requirement is as follows.
Emission measurements only need to be carried out for the pulse length setting producing the widest calculated B-40 bandwidth. (IEC 62388 Ed.2/ Annex B.4.2 part)

(2) Test setup:

See Clause 4.

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

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

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

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

(4) Test Results:

Complied.

Spectrum plots: See Clause 8.

Environmental conditions observed: On 6 July 2015, 24°C to 24°C, 64%RH to 64%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC.

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

(1) Test Conditions:

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

(*1): Tested only with S1 pulse that is the widest in B-40 calculation. The requirement is as follows.
Emission measurements only need to be carried out for the pulse length setting producing the widest calculated B-40 bandwidth. (IEC 62388 Ed.2/ Annex B.4.2 part)

(2) Test setup:

See Clause 4.

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

| Frequency removed from the assigned frequency (*1) | Emission attenuation (mean power, dB) |
|--|--|
| more than 250 % (*3) (of the authorized bandwidth) (*2) | At least $43 + 10 \log_{10}$ (mean power in watts) = -13 dBm |

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

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

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

(4) Spurious Frequencies:

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

(5) Test Results:

Complied.

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

Environmental conditions observed: On 6 August 2015, 24°C to 27°C, 53%RH to 50%RH

On 7 August 2015, 24°C to 26°C, 53%RH to 48%RH

Power supply voltage measured: 24.0 VDC to 24.0 VDC.

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

(1) Test Conditions:

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

(*1): Tested only with S1 pulse that is the widest in B-40 calculation. The requirement is as follows:
Emission measurements only need to be carried out for the pulse length setting producing the widest calculated B-40 bandwidth. (IEC 62388 Ed.2/ Annex B.4.2 part)

- (a): The measurement range for X-Band RADAR: from 4.59 GHz to 40 GHz
- (b): The antenna port was terminated with dummy load.

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

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

(4) Test setup:
See Clause 4.

The GRP (Ground reference plane, metal floor) between the EUT and the measuring (receiving) antenna was lined with the Radio Absorbers (2.4 m × 3.6 m × 0.3 m) to reduce the influences of the reflections of the RF waves from the floor.

Measuring (Receiving) Antenna height and polarization:

- (a) Antenna height: EUT center (1.68 m)
- (b) Antenna polarization: vertical and horizontal.

EUT height: 1.5 m

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

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

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

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

(6) Spurious Frequencies:

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

(7) Test Results:

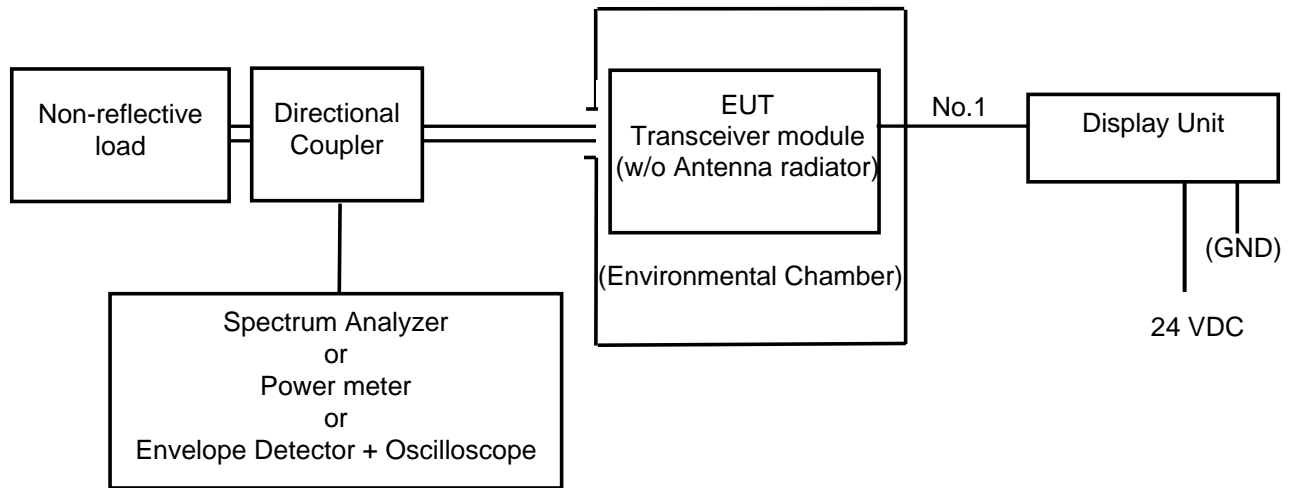
Complied.

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

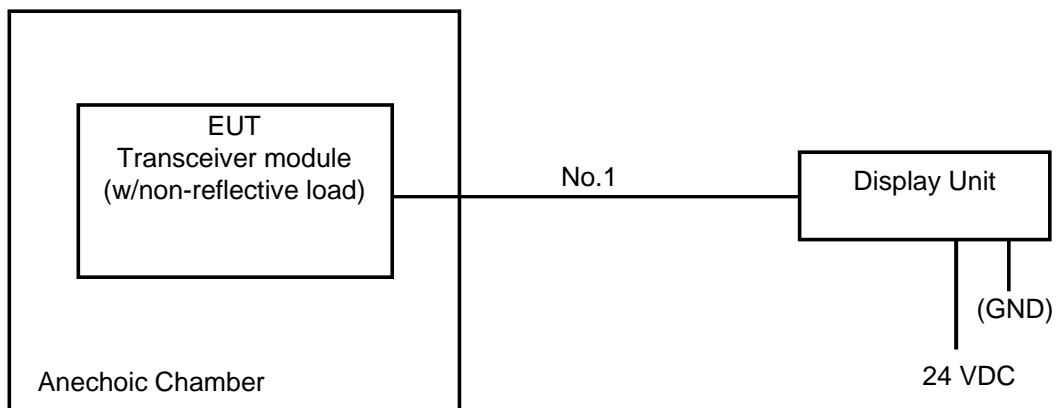
Environmental conditions observed: On 19 August 2015, 25°C to 25°C, 56%RH to 56%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC

4 Test Setup for Measurements

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



(2) Test Setup for Clause 3.6.



Cable designations:

| No. | Type | Length (m) |
|-----|-----------------|------------|
| 1 | FRU-2P5S-FF-30M | 30 |

5 Measuring Equipment List

(1) For 3.1 RF Power Output:

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

(2) For 3.2 Modulation Characteristics:

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

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

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

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

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

(5) For 3.6 Field Strength of Spurious Radiation:

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

6 Photographs of Test Setup/Arrangement

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



(2) For Field Strength of Spurious Radiation



7 RF Envelopes and Spectrum of the output pulse

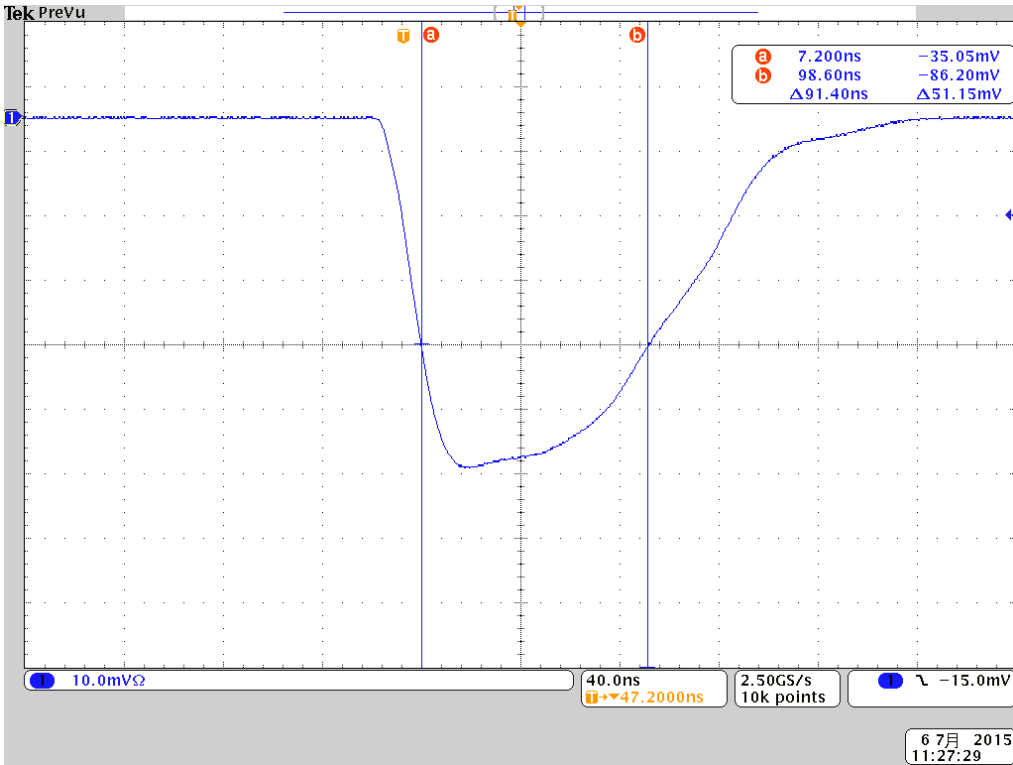


Fig. 7.1 S1 Pulse Envelope

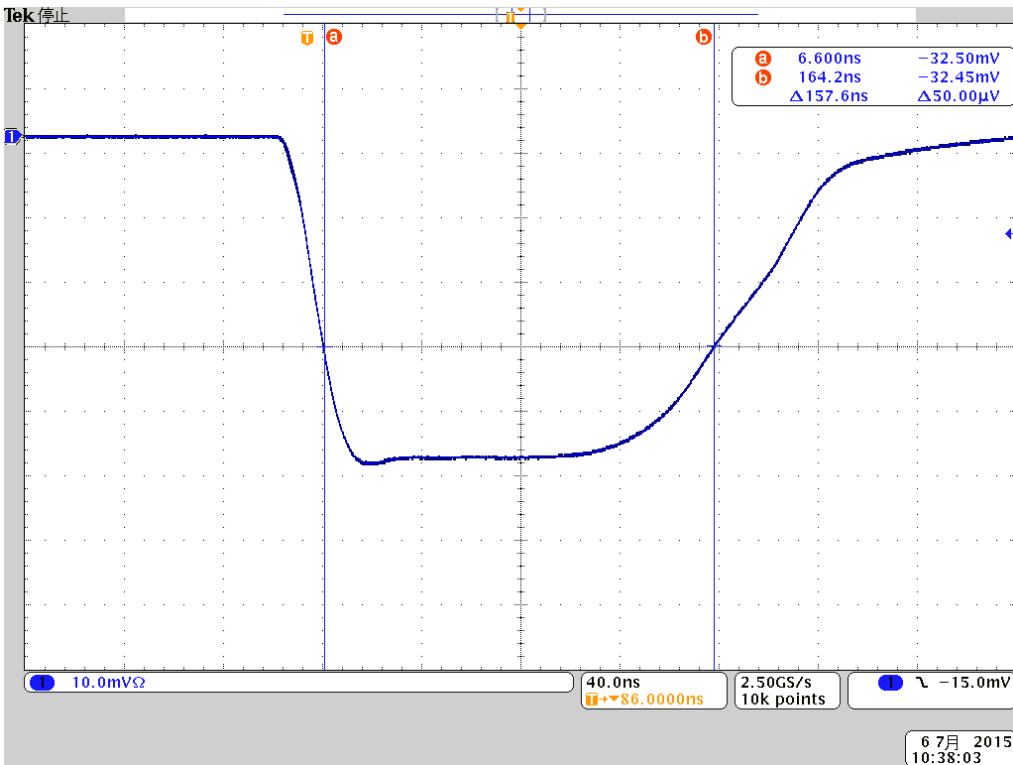


Fig. 7.2 S2 Pulse Envelope

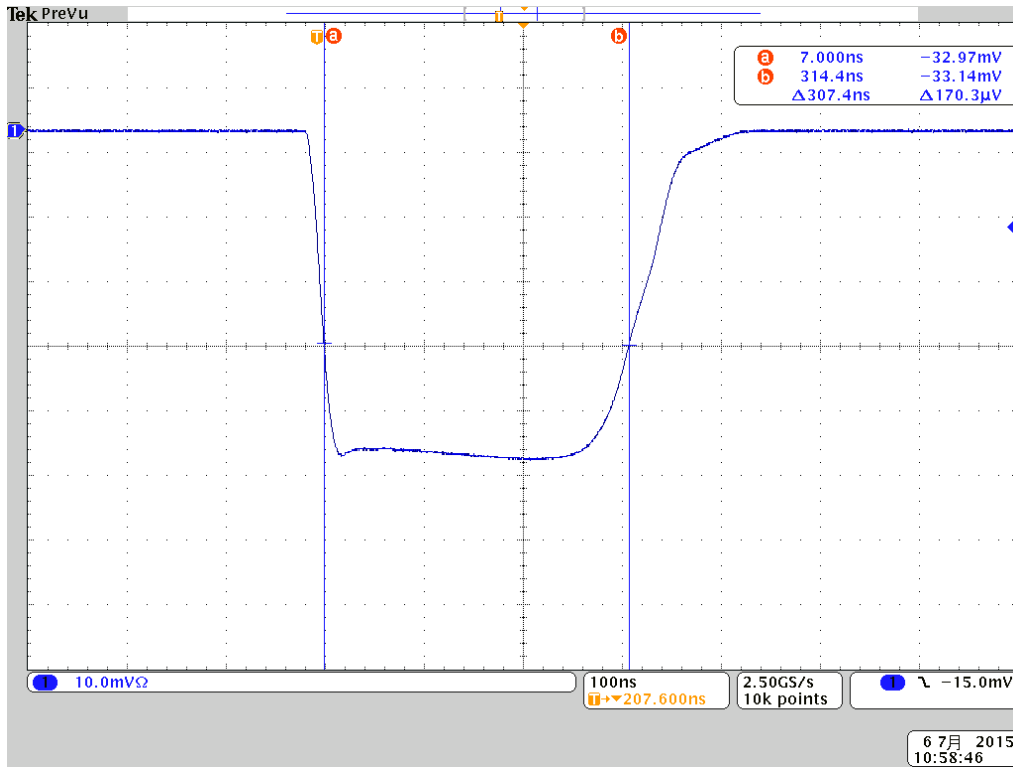


Fig. 7.3 M1 Pulse Envelope

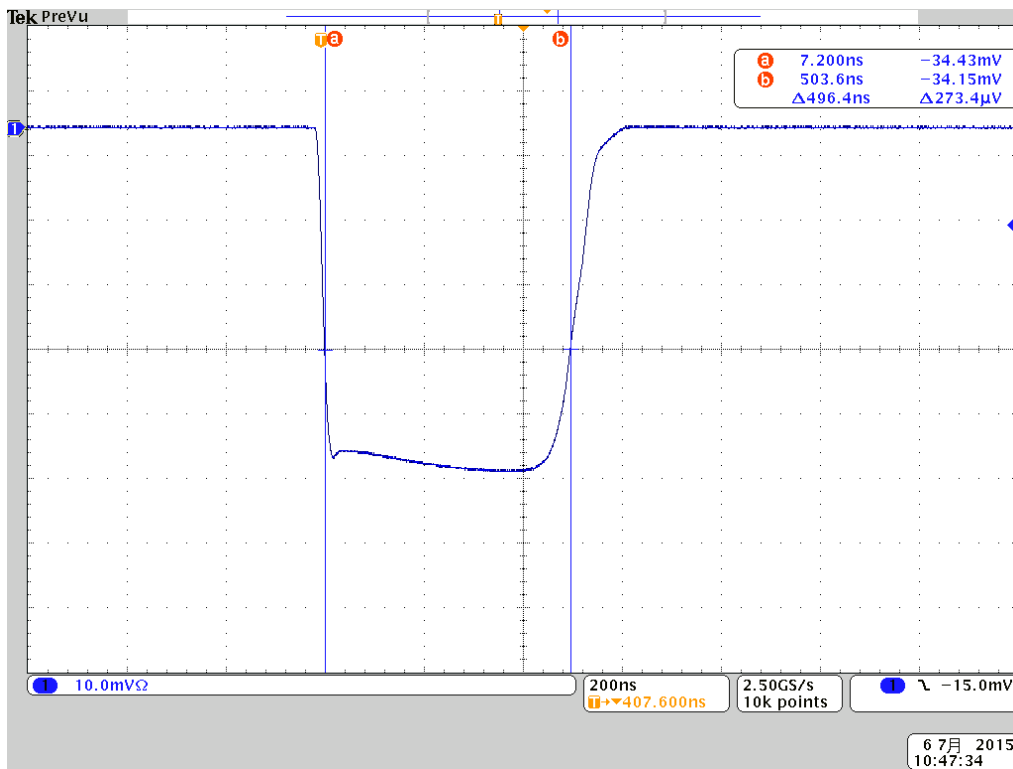


Fig. 7.4 M2 Pulse Envelope

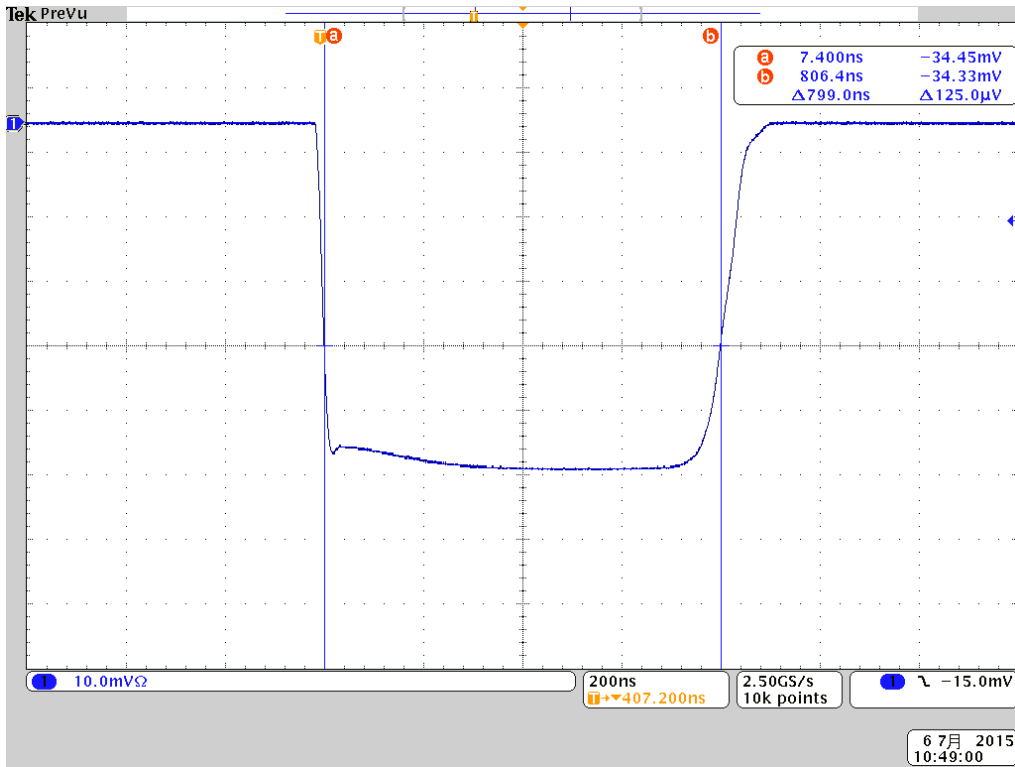


Fig. 7.5 M3 Pulse Envelope

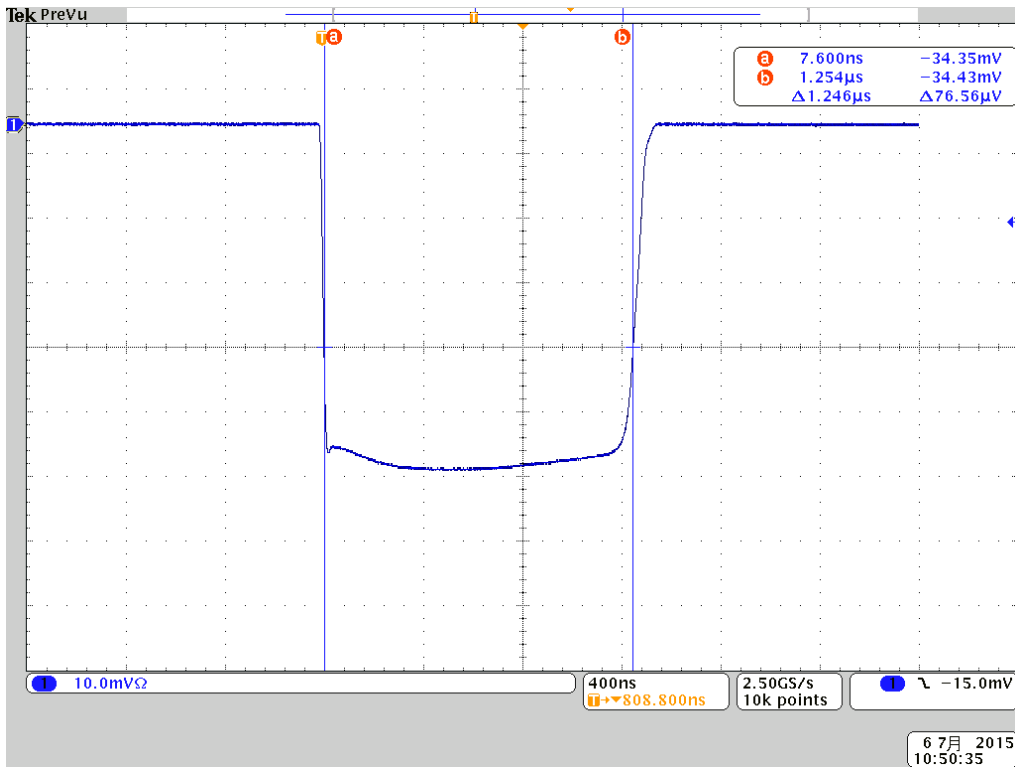


Fig. 7.6 L Pulse Envelope

8 Spurious Emission Plots measured at Antenna Terminal

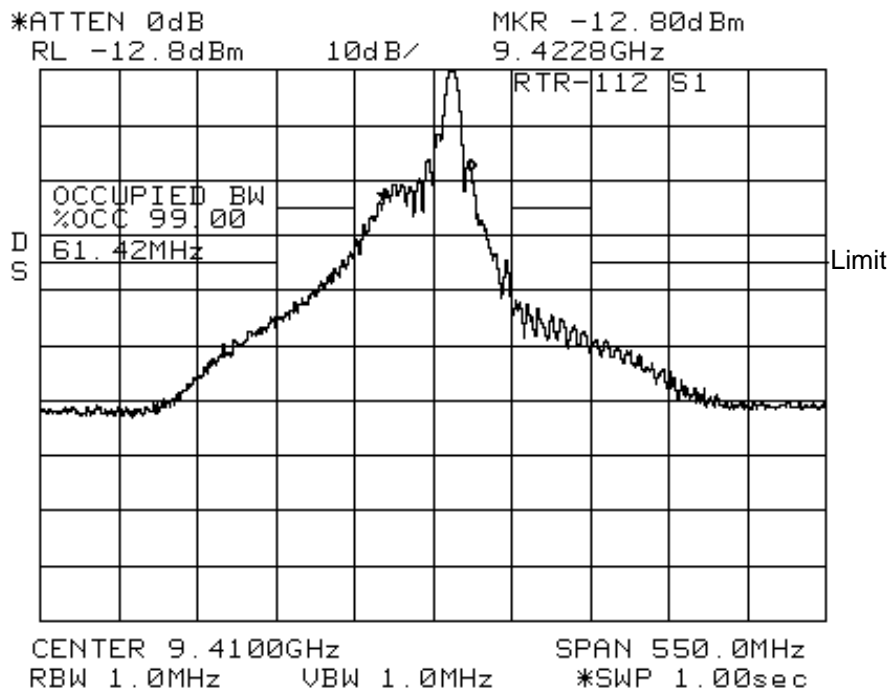


Fig. 8.1 for S1 Pulse

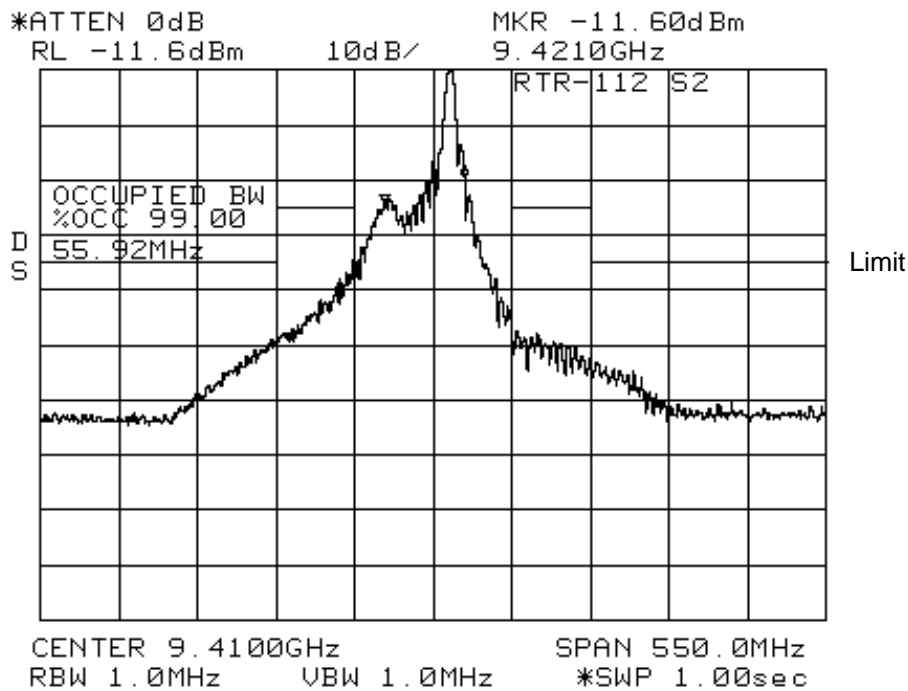


Fig. 8.2 for S2 Pulse

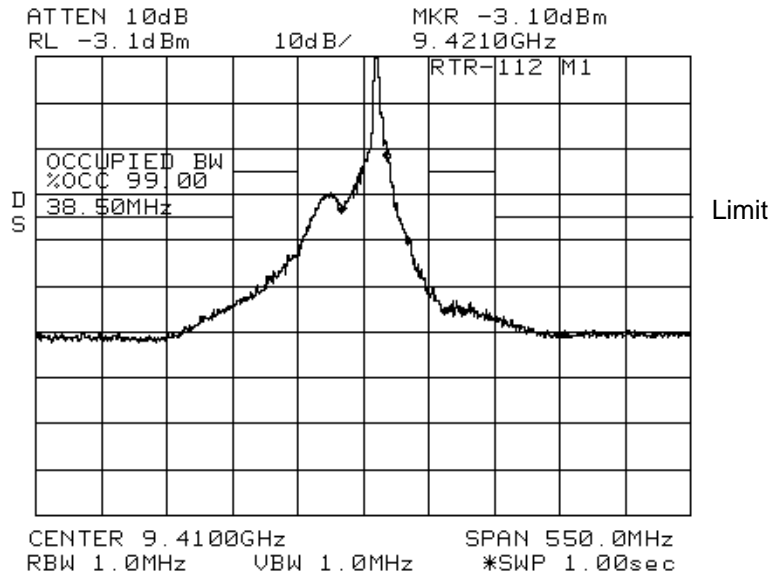


Fig. 8.3 for M1 Pulse

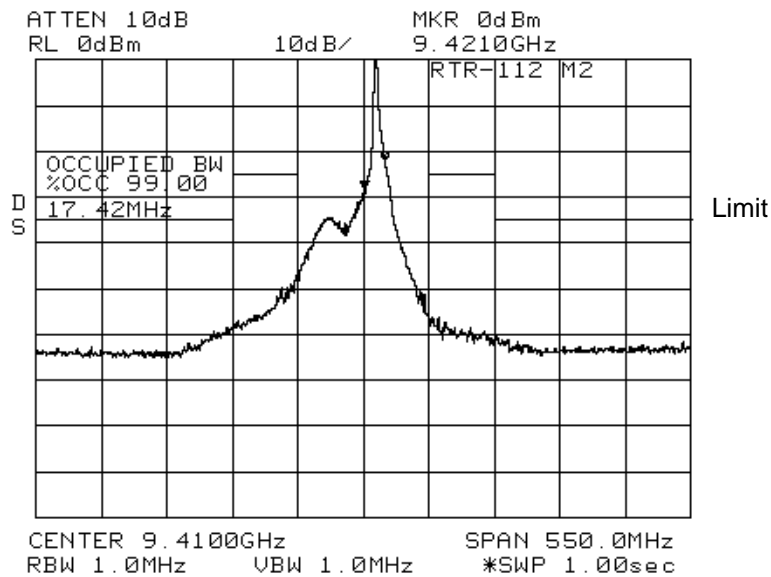


Fig. 8.4 for M2 Pulse

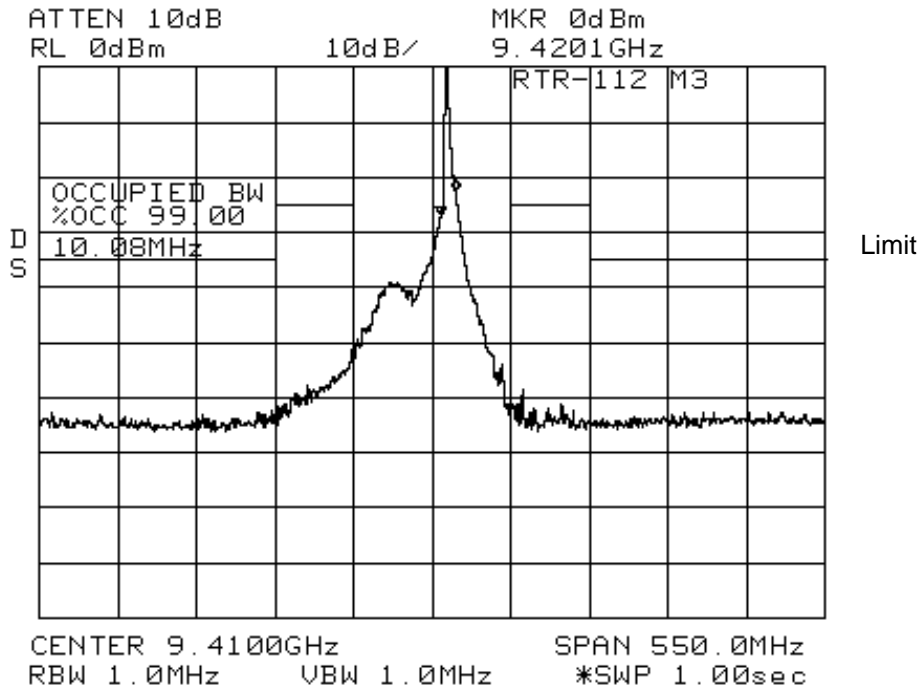


Fig. 8.5 for M3 Pulse

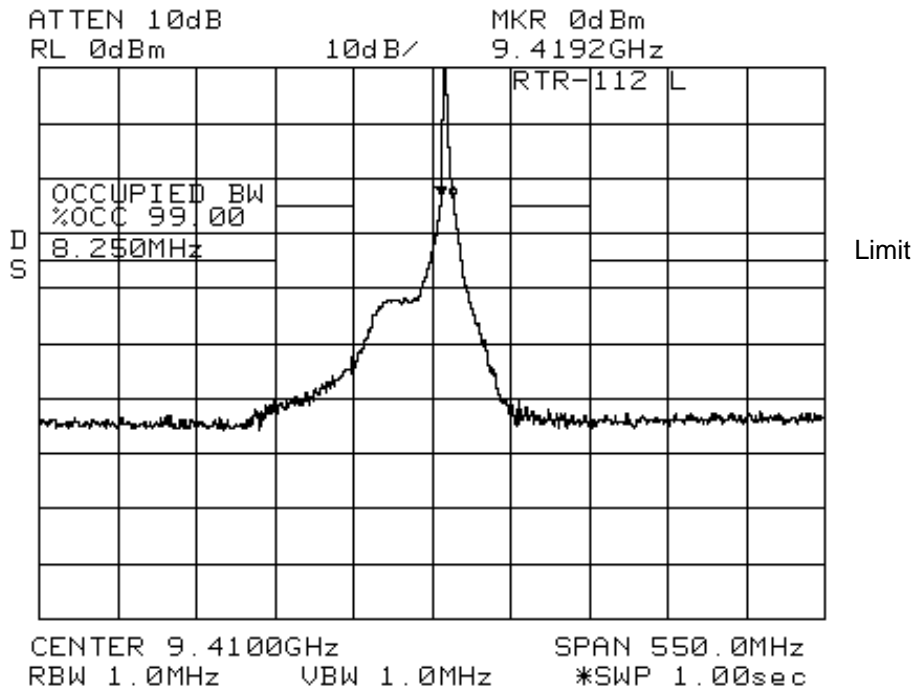


Fig. 8.6 for L Pulse