Test Report

(FCC Rules 2.1046/2.1047/2.1049/2.1051/2.1053/2.1055/80.217)

For

Trade name: Furuno
Model: Transceiver for Radar Sensor DRS4W
Type: RTR-103

Report no.: FLI 12-13-152
Rev. 1
Date of revised issue: 17 April 2014

Furuno Labotech International Co., Ltd.
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Report Summary

FLI project number:	FLI 04-13-0695				
Test report number:	FLI 12-13-152			Date of Initial Issue:	14 March 2014
Revision number:	1			Date of Revised Issue:	17 April 2014
Test report revision made:	Rev. no.	Date	Page	Item	Description of change/reason
	1	17 April 2014	5	1.1 Equipment under test (EUT)	(d) "FCC ID" was added.
Test standard(s)/ Test specifications:	FCC 47 CFR, Sections: 2.1046 - RF Power Output, 2.1047 - Modulation Characteristics, 2.1049 - Occupied Bandwidth, 2.1051 - Spurious Emissions at Antenna Terminal, 2.1055 - Frequency Stability, 2.1053 - Field Strength of Spurious Radiation, 80.217 - Suppression of Interference Aboard Ships. (Date of issue: 1 October 2013)				
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 RADAR SENSOR DRS4W				
Type:	RTR-103				
Product function and intended use:	For Maritime Safety Navigation				
Number of samples tested:	One				
Serial number:	100018-000002				
Power rating:	12 - 24 VDC, 2.1 - 1.0 A				
Product status:	Pre-production model				
Modifications made to samples during testing:	None.				
Date of receipt of samples:	26 December 2013				
Test period:	From 26 December 2013 to 13 March 2014				
Place of test:	Furuno Labotech International Co., Ltd. - LABOTECH EMC Center 1-16, Fukazu-cho, Nishinomiya-shi, Hyogo, 663-8203 Japan (File number: 818191) - 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 - Nishinomiya Lab. 9-52 Ashihara-cho, Nishinomiya-shi, Hyogo, 662-8580 Japan				
Test results/ Compliance:	Passed. The test results of this report relate only to the samples tested.				
Tested by:	Katsumi Imamura, Sadatomo Kuwahara, Yasuharu Nakamura and Koji Kawai				
Written by:	Akiko Inoue				
Verified by:	Yoshihiro Ishii				
Approved by:	Date: 17 April 2014 Name: Yoshihiro Ishii Title: Senior Manager, Technical Department Signature: 				

Testing Laboratory Status

Furuno Labotech International Co., Ltd. (hereafter called “FLI”) 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, 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, 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:
  Elecrtrical 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 Resister (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)
- Recogintion 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, interfave and safety testing.

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

TABLE OF CONTENTS

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 DRS4W

	Type	Serial Number	Note
Radar Sensor	DRS4W	100018-000002	
Scanner	RSB-126	---	Antenna rotation rate: 24 rpm
Transceiver	RTR-103	---	Contained in the Scanner.
Antenna	03P9307-8N	---	Microstrip patch array antenna

(d) FCC ID: ADB9ZWRTR103

(e) Primary Function: Search, Navigation and anticollison

(f) Frequency Range: Fixed frequency, X-band (9410 MHz)

Type of Emission: P0N

(g) Power Supply: 12 - 24 VDC, 2.1 - 1.0 A.

1.1.2 Radar Sensor

1.1.2.1 Transceiver

Type: RTR-103

(Contained in the Scanner)

(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: E3571

Peak Output Power: 4 kW nominal

(c) Magnetron Ratings

Center frequency of Magnetron: 9410 MHz

Tolerances

Manufacturing: ±30 MHz

Pulling: 27 MHz

Tolerance for 20°C temperature variation: -5 MHz

(d) Pulse Characteristics:

Pulse type	S	M	L
Pulselength (μs)	0.08	0.30	0.80
P.R.R.(Hz)	360	360	360

(2) Modulator

(a) FET Type: FMC20N50E

Trigger Voltage: Approx. +20 VDC positive

(3) Receiver

(a) Passband

RF Stage: 60 MHz

IF Stage:

Pulse type	S	M	L
Passband (MHz)	20	4.5	4.5

(b) Gain (overall): approximately 70 dB

(c) Overall Noise Figure: 10 dB (typical)

(d) Video Output Voltage: ±1 V differential

(e) Features Provided: Sensitivity Time Controls (Anti-clutter Sea),
Fast Time Constant (Anti-clutter Rain)

(f) If receiver is tunable, describe method for adjusting frequency:
by adjustment of tuning voltage of receiver local oscillator (Automatic and manual)

1.1.2.2 Antenna and Scanner

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

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

(c) Antenna size:

Antenna type	03P9307-8N
Length (cm)	32.9 (1.1 ft.)

(d) Type of Beam: Vertical fan

(e) Beam Width (3 dB):

Antenna type	03P9307-8N
Horizontal (°)	7.2
Vertical (°)	25

(f) Polarization: Horizontal

(g) Antenna Gain:

Antenna type	03P9307-8N
Gain (dB)	20.0 or more

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

Antenna type	03P9307-8N
Within ±20° (dB)	-20 or less
Outside ±20° (dB)	-25 or less

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

(j) Antenna Rotation Rate: 24 rpm

(k) Number of Degrees Scanned: 360°

(l) Sector Scan: Setting start: 0-359°, Angle: 135°

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

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

1.1.3 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:

No (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)

1.1.4 Line Power Supply Requirements

(a) Input Voltage: 12 - 24 VDC

(b) Power consumption: 23 W

1.1.5 Construction Features

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

(b) Are fuse alarms provided: Yes

(c) State units that are weatherproof: Radar Sensor (IEC 60529 – IP26)

(d) If all units are not housed in a single container, indicate number and give description of individual units:

1 X Radar Sensor

Scanner Type: RSB-126

Transceiver Type: RTR-103 (contained in the Scanner)

Antenna Type: 03P9307-6N (Microstrip patch array antenna)

(e) Approximate Weight of Complete Installation:

Radar Sensor: 4.9 kg

(f) Approximate space required for installation excluding scanner: not applicable.

1.2 Observation and comments

None.

1.3 Modifications made to the EUT

No modifications were made to the EUT during testing.

2 Test Results Summary

Clause no. of this report	47 CFR Section	Item	Result	Test Engineer
3.1	2.1046	RF Power Output	Passed.	S. Kuwahara
3.2	2.1047	Modulation Characteristics	Passed.	S. Kuwahara
3.3	2.1049	Occupied Bandwidth	Passed.	S. Kuwahara
3.4	2.1055	Frequency Stability	Passed.	S. Kuwahara
3.5		Spurious Emissions	---	
3.5.1	2.1051	- Spurious Emissions at Antenna Terminal	Passed.	K. Imamura
3.5.2	2.1053	- Field Strength of Spurious Radiation	Passed.	K. Imamura Y. Nakamura K. Kawai
3.6	80.217	Suppression of Interference Aboard Ships	Passed.	K. Imamura

Note: n. a. - Not applicable, n. p. - Not performed.

3 Test Results

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

(1) Test conditions:

For all TX (S/ M/ L) Pulses, 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	S	M	L
Magnetron Output, mean Pm (W)	0.092	0.363	0.933
Magnetron Output, peak Pp (kW) (*1)	3.12	3.35	3.46
Pulselength T (µs) (-3 dB points) (*2)	0.081	0.301	0.750
PRR (Hz)	360	360	360

(*1) Pp (kW)= (Pm (W) / (T (µs) × PRR (Hz))) × 1000

(*2): Measured at -3 dB points of the RF envelope of the magnetron output pulse instead of at 50% points of the voltage/current of the magnetron, which are equivalent.

Environmental conditions observed: On 5 February 2014, 20°C to 20°C, 56%RH to 56%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) Limits (FCC Rule, 80.213 (g)/80.209(b)):

Upper limit frequency, $f(U) = f_0 + f(AUBW)/2 - 1.5/T$
Lower limit frequency, $f(L) = f_0 - f(AUBW)/2 + 1.5/T$

Note: Assigned frequency (f_0): 9410 MHz
Authorized bandwidth (f(AUBW)): 110 MHz

(4) Test Results:

Complied.

Pulse type	S	M	L	Result
Pulselength T (µs) (-3 dB points) (*1)	0.081	0.301	0.750	Not applicable
Rise time t_r (µs) (10 - 90 % amplitude)	0.010	0.009	0.009	Not applicable
Decay time t_f (µs) (90 - 10 % amplitude)	0.071	0.087	0.087	Not applicable
PRR (Hz)	360.0	360.0	360.0	Not applicable
Guard Band f(1.5/T) (MHz) (*2)	18.3	5.0	2.0	Not applicable
f(U) (MHz)	9441.7	9455.0	9458.0	Not applicable
f(L) (MHz)	9378.3	9365.0	9362.0	Not applicable
Frequency at maximum emission (MHz)	9408.5	9407.5	9406.5	Complied

(*1): Measured at -3 dB points of the RF envelope of the magnetron output pulse instead of at 50% points of the voltage/current of the magnetron, which are equivalent.

(*2): Guard Band is specified to be equal to 1.5/T MHz, where "T" is the pulselength in microseconds. (FCC Rule 47 CFR, 80.209(b))

Measured Plots: See Clause 7.

Environmental conditions observed: On 20 January 2014, 26°C to 25°C, 55%RH to 54%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC.

3.3 Occupied Bandwidth (FCC Rule 47 CFR, 2.1049)

(1) Test conditions:

For all TX (S/M/L) Pulses, the transmitter occupied bandwidth was measured at the antenna port with Antenna replaced with the Non-reflective load.

(2) Test setup:

See Clause 4.

(3) Test Results:

Pulse type	S	M	L
Occupied bandwidth (MHz)	50.7	24.6	9.5

Environmental conditions observed: On 20 January 2014, 26°C to 25°C, 55%RH to 54%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC.

3.4 Frequency Stability (FCC Rule 47 CFR, 2.1055)

(1) Test Conditions:

1) Radar Transmitter settings: All TX (S/ M/ L) Pulses
2) Ambient Temperature settings: - 20°C to + 50°C (10°C interval)
3) Power Supply Voltage settings: 85 /115 % of nominal voltage (10.2 VDC/27.6 VDC)

(2) Test setup:

See Clause 4.

(3) Frequency Tolerance Limits (FCC Rule 47 CFR, 80.213 (g)):

Pulse type	S	M	L
f(U) (MHz)	9441.7	9455.0	9458.0
f(L) (MHz)	9378.3	9365.0	9362.0

See Clause 3.2 for details.

(4) Test Results:

Complied.

Power Supply Voltage setting: 10.2 VDC

Pulse type		S	M	L	Result
Frequency at maximum emission (MHz)	-30°C	9416.3	9414.3	9413.3	Complied
	-20°C	9417.0	9415.0	9413.5	Complied
	-10°C	9413.0	9412.0	9411.5	Complied
	0°C	9412.0	9410.5	9410.0	Complied
	+10°C	9410.0	9408.5	9408.0	Complied
	+20°C	9408.0	9406.5	9406.5	Complied
	+30°C	9407.0	9405.5	9404.5	Complied
	+40°C	9405.0	9403.5	9402.5	Complied
	+50°C	9402.7	9401.0	9400.7	Complied

Power Supply Voltage setting: 12.0 VDC

Pulse type		S	M	L	Result
Frequency at maximum emission (MHz)	-30°C	9415.7	9414.3	9413.3	Complied
	-20°C	9417.0	9414.5	9413.0	Complied
	-10°C	9414.0	9412.0	9412.0	Complied
	0°C	9412.0	9411.0	9410.0	Complied
	+10°C	9410.5	9409.0	9408.0	Complied
	+20°C	9408.5	9407.5	9406.5	Complied
	+30°C	9407.0	9405.5	9404.5	Complied
	+40°C	9405.0	9403.5	9403.0	Complied
	+50°C	9402.3	9401.7	9401.0	Complied

Power Supply Voltage setting: 24.0 VDC

Pulse type		S	M	L	Result
Frequency at maximum emission (MHz)	-30°C	9415.7	9414.3	9413.0	Complied
	-20°C	9416.5	9414.5	9413.0	Complied
	-10°C	9414.0	9412.0	9411.5	Complied
	0°C	9412.0	9411.0	9410.0	Complied
	+10°C	9410.5	9409.0	9407.5	Complied
	+20°C	9409.5	9407.5	9406.5	Complied
	+30°C	9407.0	9405.5	9404.5	Complied
	+40°C	9404.5	9403.5	9402.5	Complied
	+50°C	9402.3	9402.0	9400.7	Complied

Power Supply Voltage setting: 27.6 VDC

Pulse type		S	M	L	Result
Frequency at maximum emission (MHz)	-30°C	9416.0	9414.3	9412.7	Complied
	-20°C	9416.5	9414.5	9412.5	Complied
	-10°C	9414.0	9412.5	9412.0	Complied
	0°C	9412.0	9411.5	9410.0	Complied
	+10°C	9410.0	9409.0	9407.5	Complied
	+20°C	9408.5	9407.5	9406.5	Complied
	+30°C	9407.5	9405.5	9404.5	Complied
	+40°C	9404.5	9403.5	9403.0	Complied
	+50°C	9403.3	9401.7	9400.7	Complied

Environmental conditions observed: On 9 January 2014, 20°C to 22°C, 56%RH to 50%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC.
On 10 January 2014, 21°C to 22°C, 57%RH to 50%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC.

3.5 Spurious Emissions

3.5.1 Spurious Emissions at Antenna Terminal (FCC Rule 47 CFR, 2.1051)

(1) Test Conditions:
For all TX (S/M/L) Pulses, the transmitter output power will be measured at the antenna port with Antenna replaced with the Non-reflective load.

(2) Test setup:
See Clause 4.

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

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

Note: (1) Authorized bandwidth = 110 MHz
(*) - for the relevant frequency bands, tests were performed according to FCC Rule, 2.1053. See Clause 3.5.2.

(4) Test Results:
Complied.

From the results of the pre-tests, the EUT emission level was found to be the maximum with S pulse. Consequently, the test was performed only with S pulse.

Spectrum Plots: See Clause 8.

Environmental conditions observed: On 7 February 2014, 19°C to 19°C, 54%RH to 54%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC.

3.5.2 Field Strength of Spurious Radiation (FCC Rule 47 CFR, 2.1053)

(1) Test Conditions:

Tests were performed with all TX (S/M/L) Pulses.

(a) For the test frequency range of 9 kHz to 2000 MHz, the Antenna for Transceiver was replaced with the rotating non-reflective load. Spurious emissions for 9 kHz to 2000 MHz are not found at the antenna terminal due to its structure (Waveguide tube). The EUT cabinet radiation was measured with the EUT rotated 360°.
(b) For 2 GHz to 40 GHz, the Antenna was set to the Transceiver with the rotating mode.

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

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

(4) Test setup:
For the test frequency range of 2 GHz to 40 GHz, the GRP (Ground reference plane, metal floor) between the EUT and the measuring (receiving) antenna was lined with the Radio Absorbers (2.4 m × 3.0 m × 0.5 m) to reduce the influences of the reflections of the RF waves from the floor.

Measuring (Receiving) Antenna height and polarization:
(a1) 1.5 m for the test frequency range of 9 kHz to 30 MHz,
(a2) 1 m to 4 m for the test frequency range of 30 MHz to 2000 MHz,
(b) 2.0 m that was same as those for the EUT for the test frequency range of 2 GHz to 40 GHz.
(c) Antenna polarization: vertical and horizontal.

EUT height:
(a) 0.8 m for the test frequency range of 9 kHz to 2000 MHz,
(b) 2.0 m for the test frequency range of 2 GHz to 40 GHz (To reduce the influences of the reflections from GRP).

See Clauses 4 and 6.

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

Frequency removed from the assigned frequency	Frequency (MHz) (for X-band)	Emission attenuation (mean power, dB)
50 - 100 % (*) (of the authorized bandwidth)	9,310 - 9,360 9,460 - 9,510	At least 25
100 - 250 % (*)	9,160 - 9,310 9,510 - 9,660	At least 35
more than 250 %	0.009 - 9,160 9,660 - 40,000	At least 43 + 10 $\log_{10}$ (mean power in watts)

Note: (1) Assigned frequency (center frequency) = 9410 MHz
(2) Authorized bandwidth = 110 MHz
(*) - for the relevant frequency bands, tests were performed according to FCC Rule 47 CFR, 2.1051. See Clause 3.5.1.

(6) Test Results:

Complied.

Tests were performed with S Pulse as the worst case after the pre-tests were made with all Pulses.

[Limit] = 43 + 10 $\log_{10}$ (mean power in watts)
= 43 + 10 $\log_{10}$ (0.092)
= 32.6 dB
where, [mean power in watts] = 0.092 W for S pulse. See Clause 3.1 of this report..

For this time, more stringent limit of 60 dB was applied for the test, instead of the above 32.6 dB at customer's request.

The electric field strength of the maximum power radiation was 156.1 dBμV/m with S pulse.
Consequently, the allowable emission limit was set to 96.1 dBμV/m (= 156.1 dBμV/m - 60 dB).

As a result, the minimum emission attenuation was found to be more than 60 dB.

Spectrum plots: See Clause 9.

Spurious Emission Frequency and Electric Field Strength that were prominent were listed in the following table.

Frequency (GHz)	Antenna Polarization	Pulse type	Electric Field Strength measured (dBμV/m)	Limit (dBμV/m)	Margin (dB)
18.822	Horizontal	S	93.3	96.1	2.8
18.822	Vertical	S	91.8	96.1	4.3

Environmental conditions observed: On 26 December 2013, 21°C to 21°C, 45%RH to 45 %RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC.
On 13 March 2014, 21°C to 21°C, 45%RH to 45%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC

3.6 Suppression of Interference Aboard Ships (FCC Rule 47 CFR, 80.217)

(1) Test Conditions/Test Setup: Spurious emission measurements were made at the antenna port of the transceiver with the Standby mode.

See Clause 4.

(2) Test frequency range: 9 kHz to 40 GHz

(3) Spurious Emission Limits for Receivers:

for delivered power to artificial antenna,

Frequency	Power to artificial antenna		Resolution bandwidth of Spectrum analyzer
	(μW)	(dBm)	
9 kHz - 150 kHz	400	-4	1 kHz
150 kHz - 30 MHz			10 kHz
30 MHz - 100 MHz	4,000	6	100 kHz
100 MHz to 300 MHz	40,000	16	
300 MHz - 1 GHz	400,000	26	
1 GHz - 40 GHz			1 MHz

(4) Test Results:

Complied.

Spurious emissions: Not found.

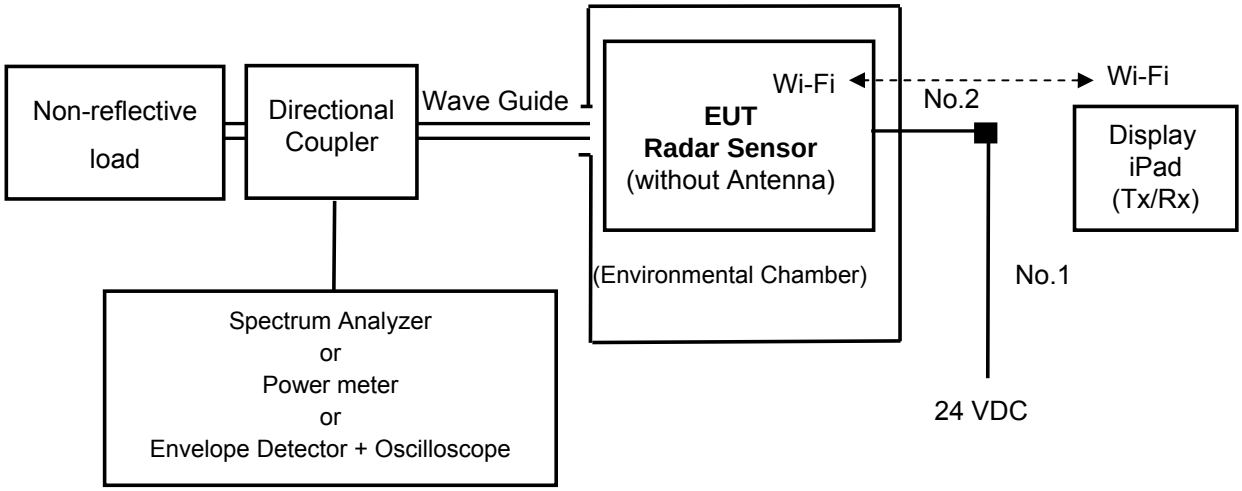
Tests were performed with the EUT Standby mode (= receive only mode).

Environmental conditions observed: On 27 December 2013, 20°C to 20°C, 48%RH to 48%RH
Power supply voltage measured: 24.0 VDC to 24.0 VDC.

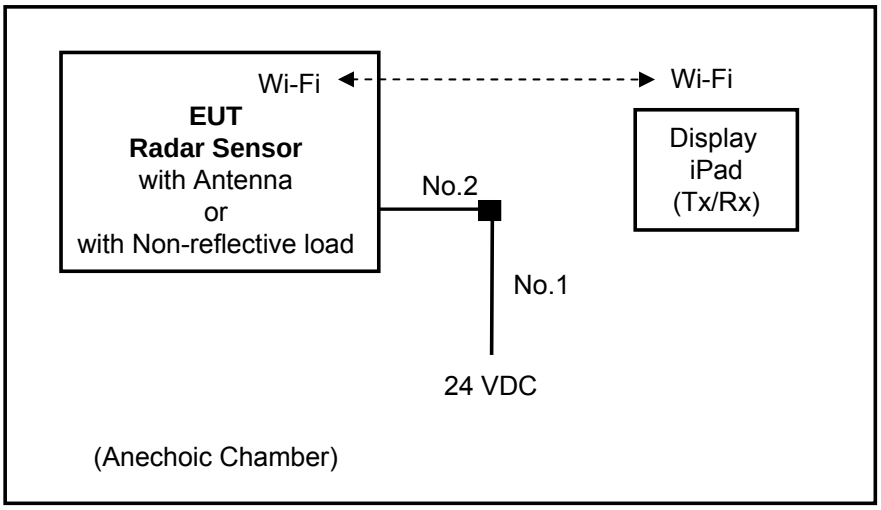
Spectrum plots: See Clause 10.

4 Test Setup for Measurement:

(1) Test Setup for Clauses 3.1, 3.2, 3.3, 3.4, and 3.5.1.

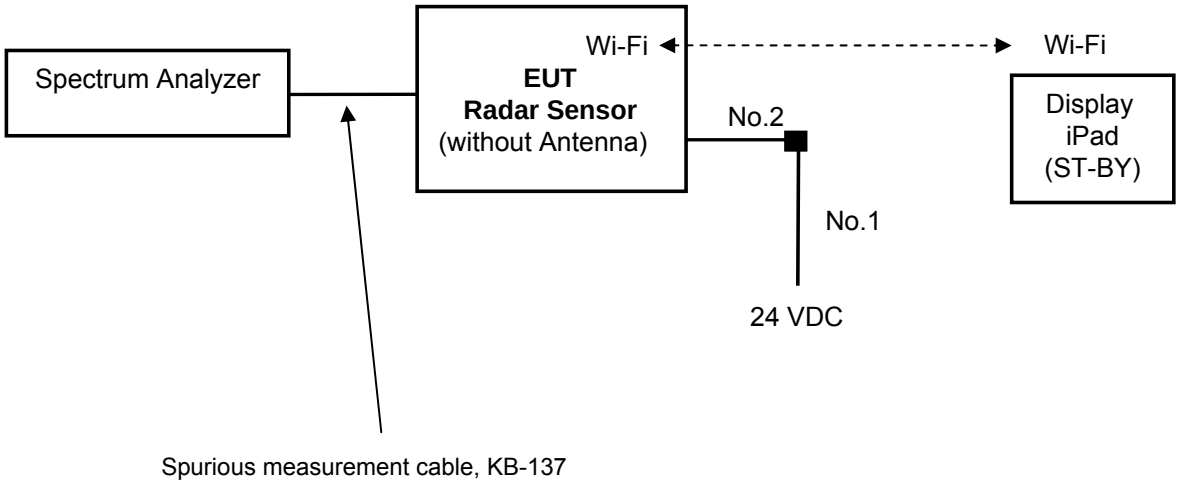


(2) Test Setup for Clause 3.5.2.



■ : Connector

(3) Test Setup for Clause 3.6.



■ : Connector

Cable designations

No.	Name	Length (m)
1	FRU-3P-FF-20M	20
2	FRU-3P-MM-1.4M	1.4

5 Measuring Equipment List:

Measuring/Test instruments have been appropriately calibrated/maintained according to the FLI programs/ procedures and ISO/IEC 17025. Measuring/Test instruments used for the tests are listed below.

(1) For 3.1 RF Power Output:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration
8408089	Power meter	436A	2410A19137	Agilent	14 November 2013
8408089	Power Sensor	8481A	2349A39603	Agilent	14 November 2013
HT913	Crystal Detector	423B	MY51340543	Agilent	22 February 2013
8411096	Directional Coupler (X-band)	5D364S	R05762	Shimada	23 May 2013
8411057	Dummy Load (X-band)	4D376	---	Shimada	---
8408087	Frequency Counter	TR5824A	41940036	Advantest	14 April 2013
HT654	Attenuator	8494B	MY42148134	Agilent	8 March 2013
HT655	Attenuator	8495B	MY42144403	Agilent	8 March 2013
HT168	Oscilloscope	TDS680B	B030202	Agilent	13 August 2013

(2) For 3.2 Modulation Characteristics:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration
8408089	Power meter	436A	2410A19137	Agilent	14 November 2013
8408089	Power Sensor	8481A	2349A39603	Agilent	14 November 2013
HT913	Crystal Detector	423B	MY51340543	Agilent	22 February 2013
8411096	Directional Coupler (X-band)	5D364S	R05762	Shimada	23 May 2013
8411057	Dummy Load (X-band)	4D376	---	Shimada	---
8408087	Frequency Counter	TR5824A	41940036	Advantest	14 April 2013
HT654	Attenuator	8494B	MY42148134	Agilent	8 March 2013
HT655	Attenuator	8495B	MY42144403	Agilent	8 March 2013
HT168	Oscilloscope	TDS680B	B030202	Agilent	13 August 2013

(3) For 3.3 Occupied Bandwidth and for 3.5.1 Spurious Emissions at Antenna Terminal:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration
8411096	Directional Coupler (X-band)	5D364S	R05762	Shimada	23 May 2013
8411057	Dummy Load (X-band)	4D376	---	Shimada	---
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent	15 April 2013
HT654	Attenuator	8494B	MY42148134	Agilent	8 March 2013
HT655	Attenuator	8495B	MY42144403	Agilent	8 March 2013
KB-011	Coaxial cable	SUCOFLEX 106 - 2m	12226/6	SUHNER	---
KB-137	3.5 mm cable	MWX221-2m	0804S167	Junkosha	---

(4) For 3.4 Frequency Stability:

C/N	Instrument	Type	S/N	Manufacturer	Date of calibration
HT370	Climatic chamber (L)	TBE-3HW5GE2F	3013000995	Tabai Espec	14 September 2013
HT723	Temperature recorder (L)	FX106-4-1	S5JA01445	Yokogawa	14 September 2013
8411096	Directional Coupler	5D364S	R05762	Shimada	23 May 2013
8411057	Dummy Load	4D376	---	Shimada	---
----	Waveguide (for X-band)	WRJ-10 (l = 60 cm)	----	Furuno	---
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent	15 April 2013
HT654	Attenuator	8494B	MY42148134	Agilent	8 March 2013
HT655	Attenuator	8495B	MY42144403	Agilent	8 March 2013
KB-011	Coaxial cable	SUCOFLEX 100 - 2m	12226/6	SUHNER	---
KB-137	Coaxial cable	MWX221 - 2m	0804S167	Junkosha	---
HT432	DC power supply	PAN55-20	AK003307	Kikusui	---

(5) For 3.5.2 Field Strength of Spurious Radiation:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration
HT463	Spectrum analyzer (9 kHz to 3 GHz)	R3132	110401654	Advantest	26 July 2013
HT565	Loop antenna (0.15 - 30 MHz)	HFH2-Z2	100093	Rohde & Schwarz	19 August 2013
HT459	Biconical antenna (30 MHz to 300 MHz)	VBA6106A	1296	Schaffner	19 August 2013

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration
HT331	Log periodic antenna (300 MHz to 1000 MHz)	UHALP9107	8411059	Schwarzbeck	19 August 2013
HT467	Double-ridged waveguide horn antenna (1 GHz to 18 GHz)	3115	6520	EMCO	19 August 2013
RT133	Broadband Horn Antenna (15 GHz to 40 GHz)	BBHA9170	366	Schwarzbeck	24 June 2013
HT518	Pre-amplifier (30 MHz to 2 GHz)	87405A	3207A01643	Agilent	24 June 2013
HT365	Semi-anechoic Chamber	3mSAC	D-002	Riken	10 October 2012
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent	15 April 2013
740060501	Horn antenna (18 GHz to 26.5 GHz)	42-442-6	E414109-01	A.H. Systems	---
0511041	Low-noise amplifier	JSWV4-18002600-30-8P	1058348	MITEQ	---
----	DC power supply for Low-noise amplifier	EX-375L2	405650060347	Takasago	---
740060502	Horn antenna (26.5 GHz to 40 GHz)	28-442-6	E414209-01	A.H. Systems	---
----	Notch Filter (X-band)	CBR-X7-3A	R9865001	Shimada	---
-----	Coaxial cable	SUCOFLEX 106 - 2m	-----	SUHNER	---
-----	Coaxial cable	SUCOFLEX 104 - 2m	-----	SUHNER	---
-----	Coaxial cable	SUCOFLEX 104 - 5m	250497	SUHNER	---
-----	Coaxial cable	SUCOFLEX 102 - 5m	265055	SUHNER	---

(6) For 3.6 Suppression of Interference Abroad Ships:

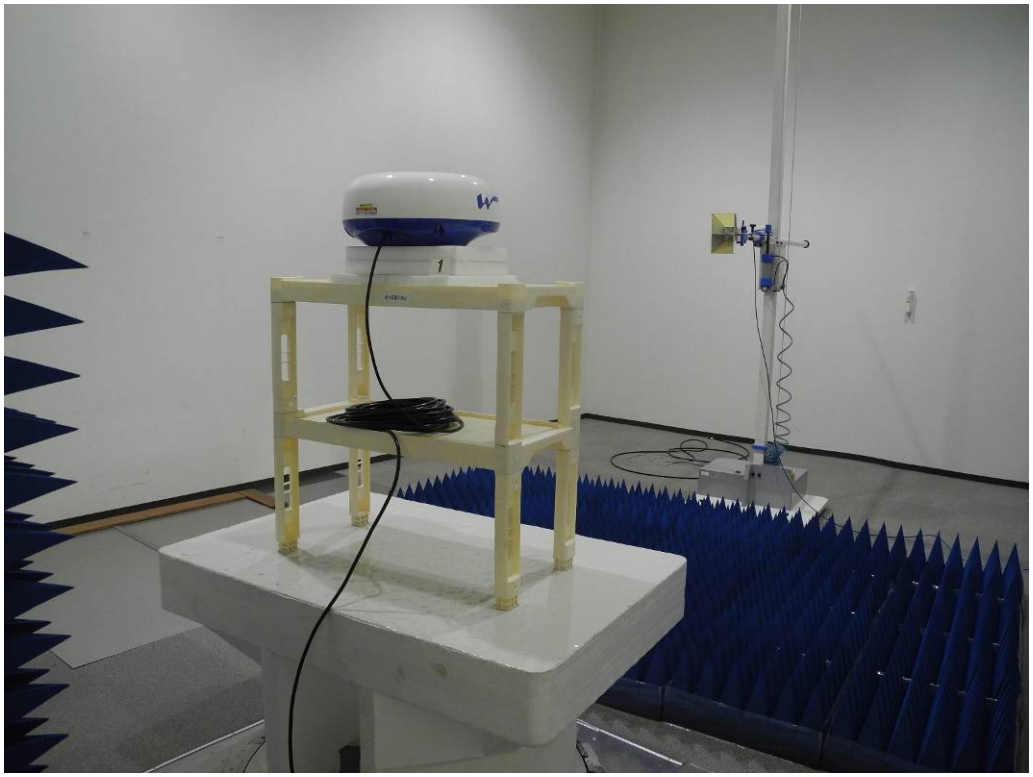
C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent	23 March 2011
KB-137	3.5 mm cable	MWX221-2m	0804S167	Junkosha	---

6 Photograph of Test Setup/Arrangement

(1) For Temperature (TX frequency stability) tests,

(2) For Spurious Emission measurements,

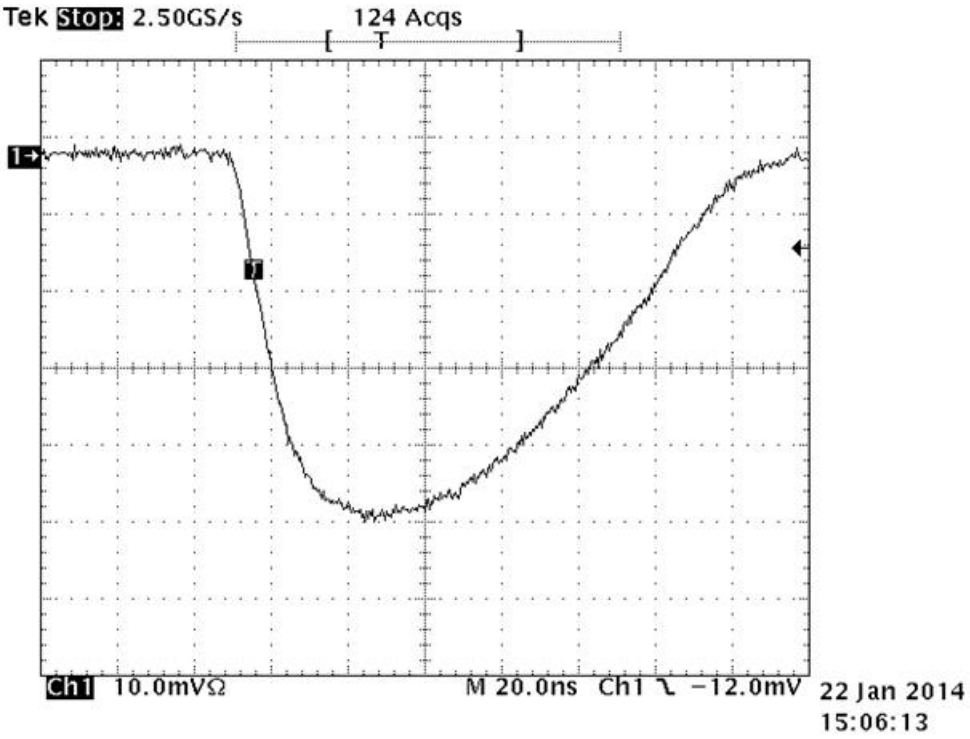
for 9 kHz to 2000 MHz



for 2 GHz to 18 GHz

for 18 GHz to 40 GHz

7 RF Envelope and Spectrum of the output pulse



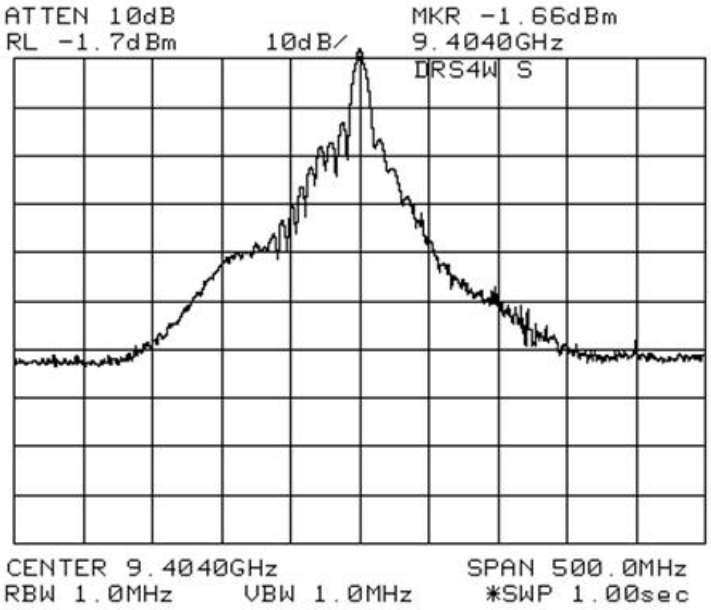
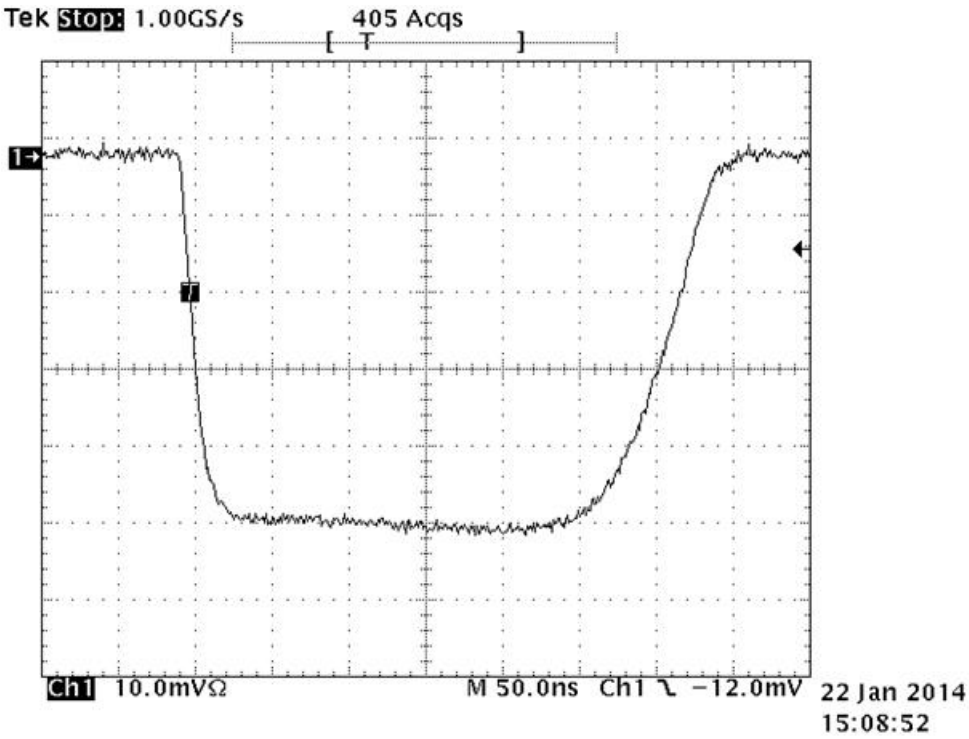


Fig. 7.1 S Pulse Envelope and Spectrum



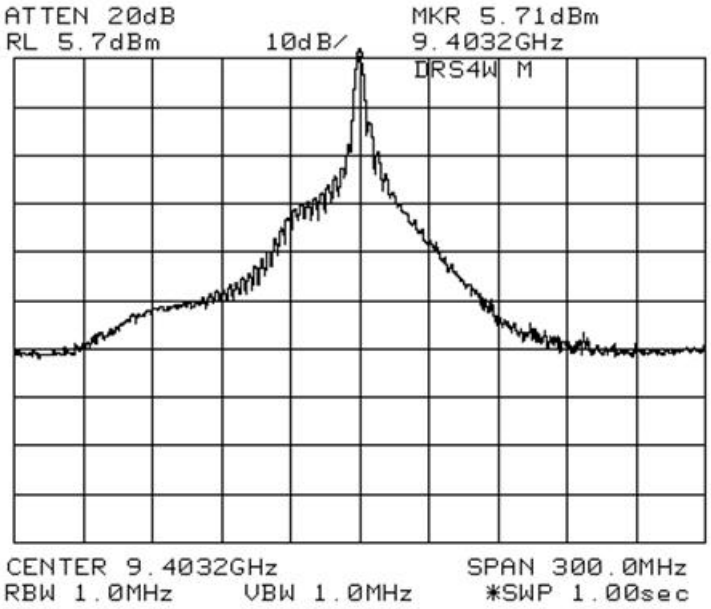
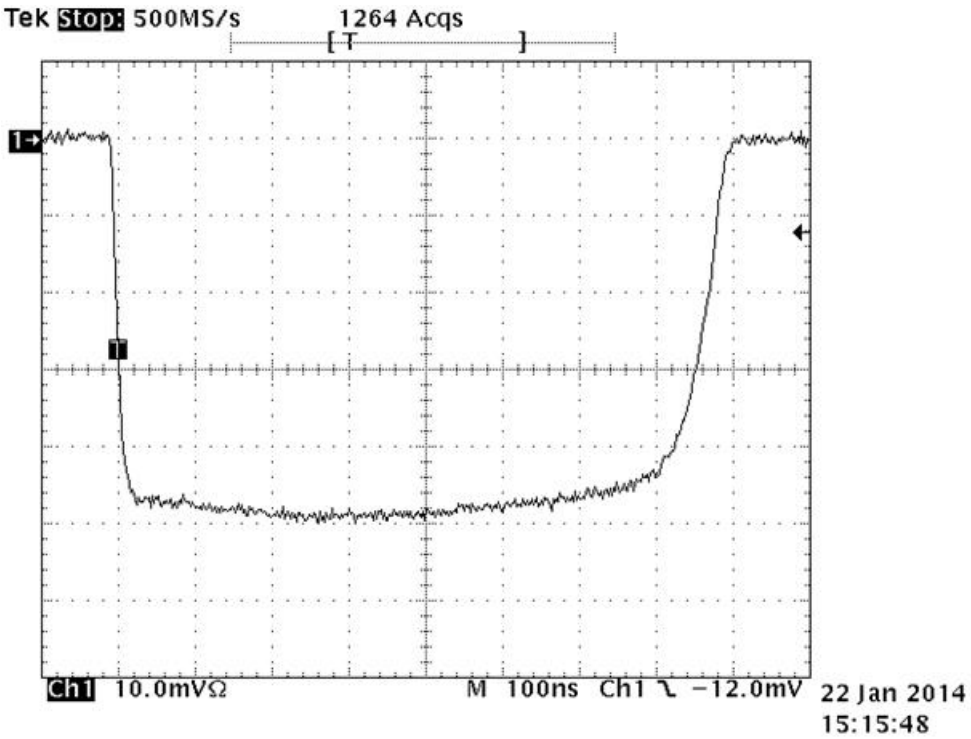


Fig. 7.2 M Pulse Envelope and Spectrum



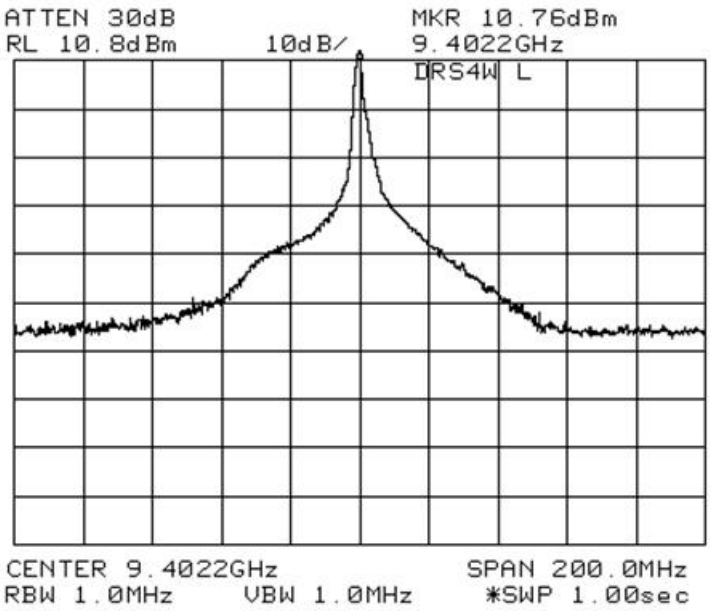
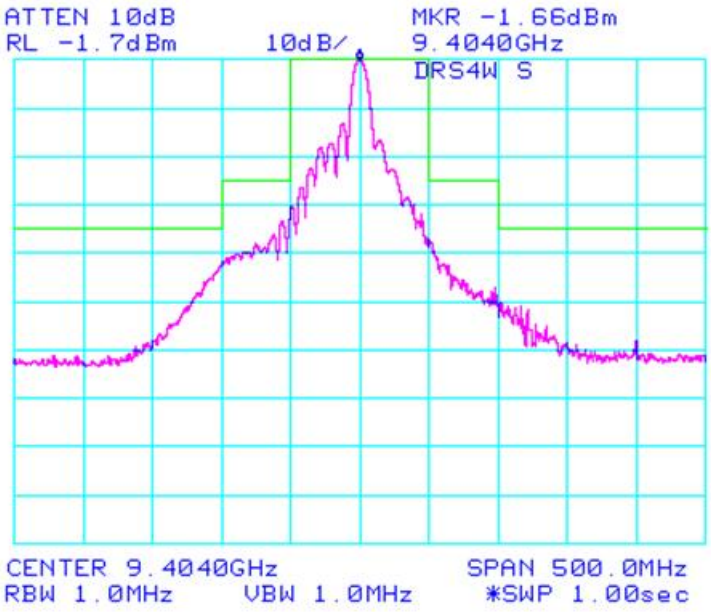


Fig. 7.3 L Pulse Envelope and Spectrum

8 Spurious Emission Plots measured at Antenna Terminal

for S pulse

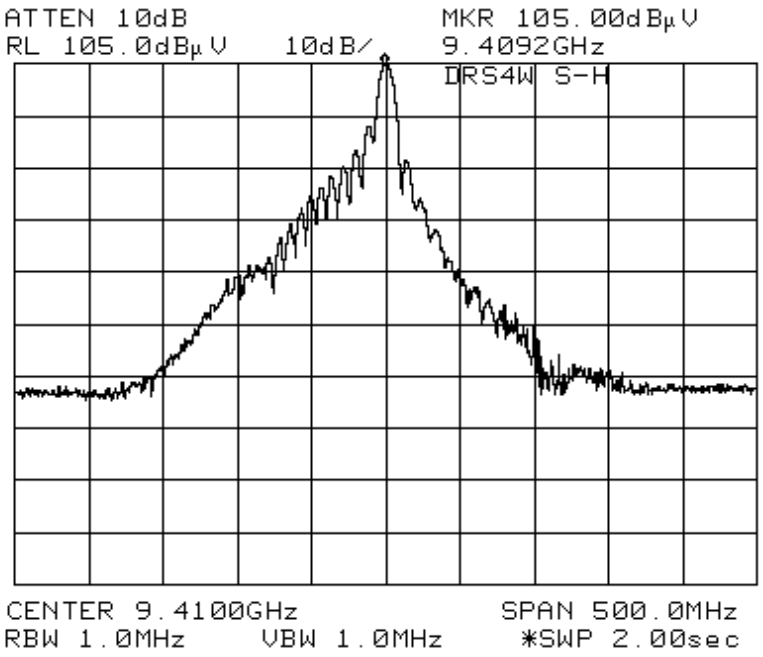


Limit

9 Field Strength Plots of Spurious Radiation

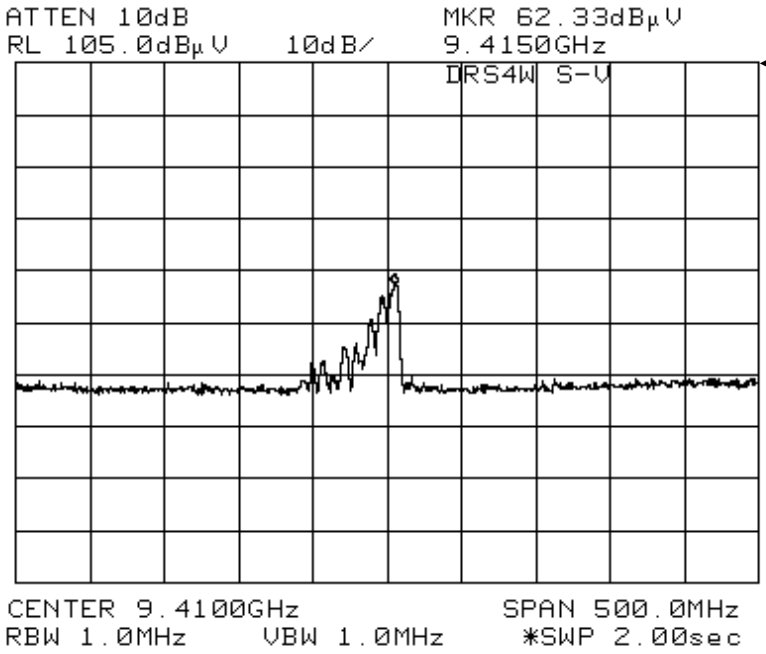
9.1 Maximum power radiation level (for Short Pulse)

- Horizontal



Maximum radiation level
(Equals to Reference level)

- Vertical



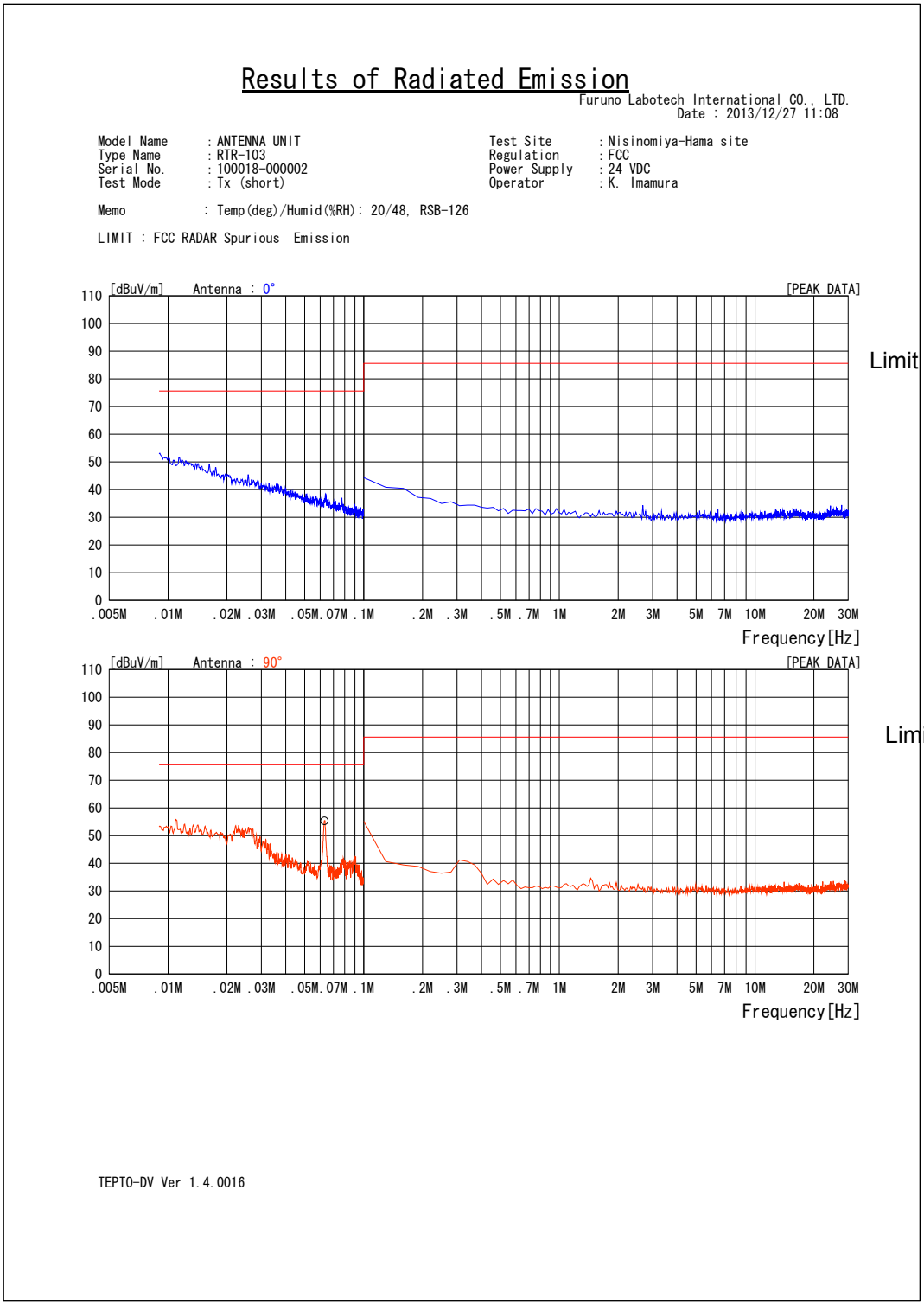
Maximum radiation level
(Equals to Reference level)

For the maximum power radiation level, the voltage value measured by the spectrum analyzer was converted into the electric field strength with the measuring antenna factor, Cable loss and Amp. gain.

Maximum power radiation level = 156.1 dBµV/m
Therefore, Emission Limit = 156.1 dBµV/m - 60 dB = 96.1 dBµV/m

9.2 Spurious emissions (S pulse)

(1) for 9 kHz to 30 MHz



(*) The resolution bandwidth of the spectrum analyzer in the frequency range of 9 kHz to 100 kHz was set to 1 kHz, and 100 kHz to 30 MHz, to 10 kHz, instead of 1 MHz at the frequency range from 2 GHz to 40 GHz. The applicable limit was set at 30 dB lower than that computed in Clause 9.1 for the former frequency range, and 20 dB lower for the latter frequency range.

(2) for 30 MHz to 2000 MHz

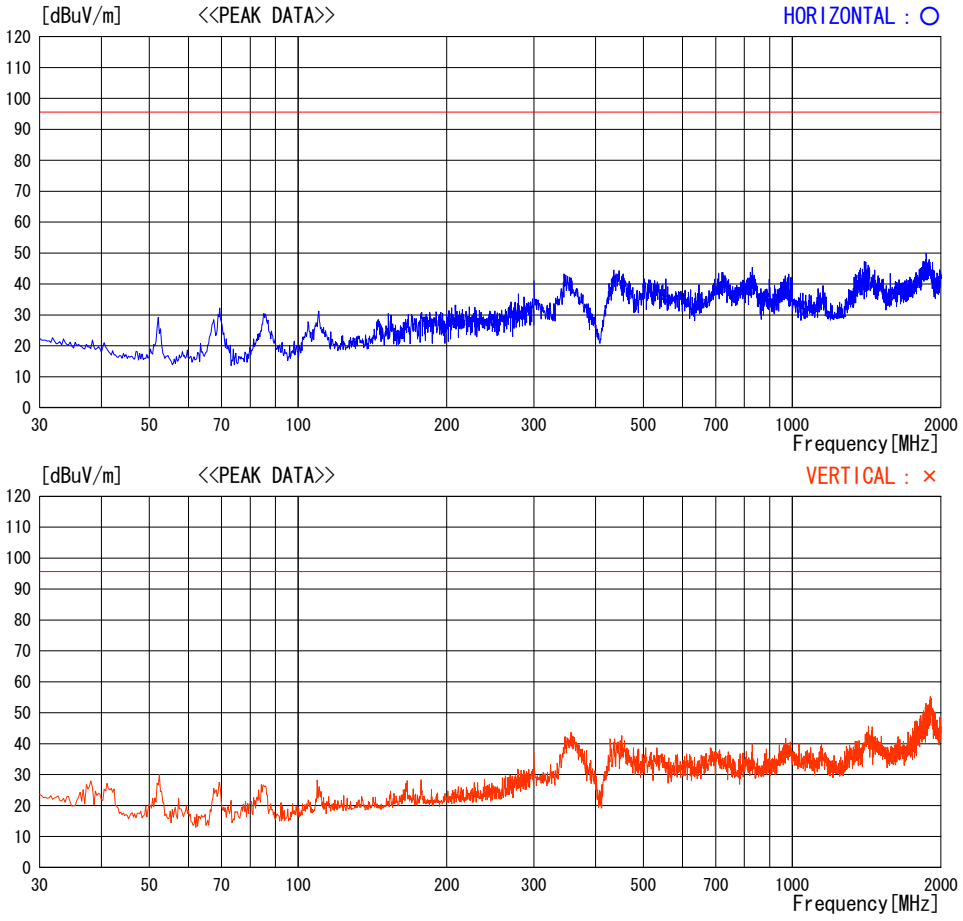
Results of Radiated Emission

Furuno Labotech International
Date : 2013/Dec/27 10:09

Model Name	: ANTENNA UNIT	Test Site	: Nishinomiya-hama site
Type Name	: RTR-103	Regulation	: FCC
Serial.No.	: 100018-000002	Power Supply	: 24 VDC
Test Mode	: Tx (Short)	Operator	: K. Imamura

Memo : Temp(deg)/Humid(%RH): 20/48, RSB-126

LIMIT : RSS-238(2013) 4.3 Unwanted Emissions

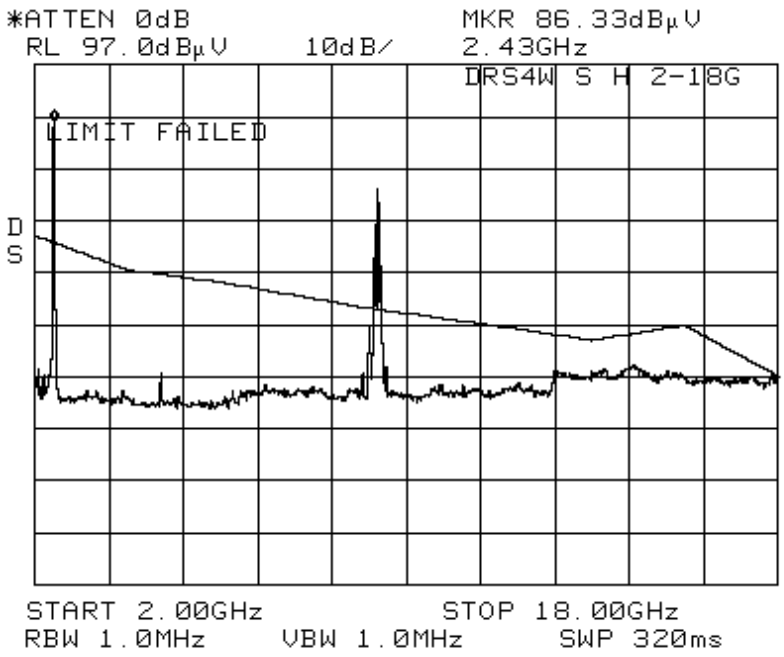


TEPTO-DV Ver 1.4.0016

(*) The resolution bandwidth of the spectrum analyzer in the frequency range of 30 MHz to 2000 MHz was set to 100 kHz instead of 1 MHz at the frequency range from 2 GHz to 40 GHz. The applicable limit was set at 10 dB lower than that computed in Clause 9.1.

(3) for 2 GHz to 18 GHz (Notch Filter used)

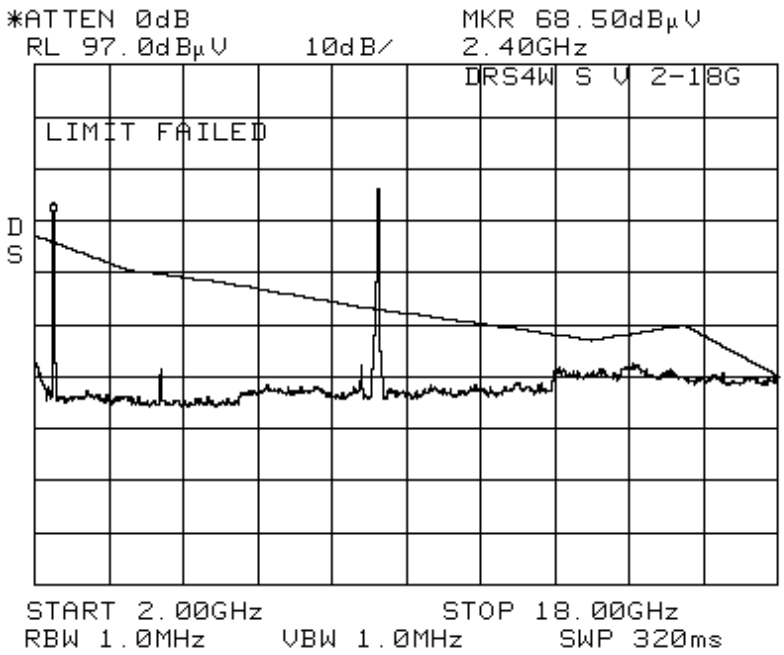
- for Horizontal



Limit (*)

WLAN signal at 2.43 GHz was detected.

- for Vertical



Limit (*)

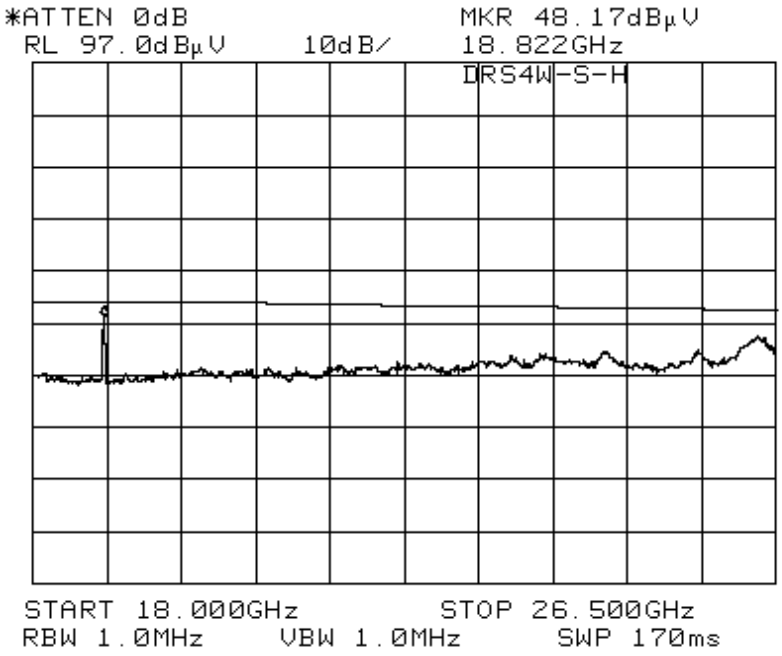
WLAN signal at 2.40 GHz was detected.

The notch filer (Pass band: 9410 ± 150 MHz) was inserted between the measuring antenna and Spectrum Analyzer to prevent the excessive input to Spectrum Analyzer only for the test frequency range of 2 GHz to 18 GHz.

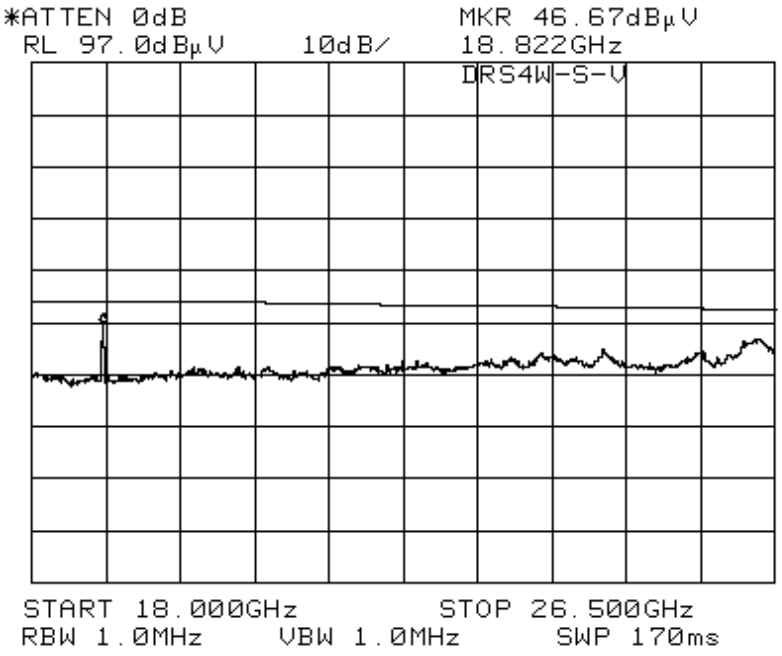
(*) The Limit is represented by the voltage value, which was derived from the electric field strength value with Antenna factor, Cable loss and Amp. gain.

(4) for 18 GHz to 26.5 GHz

- for Horizontal



- for Vertical

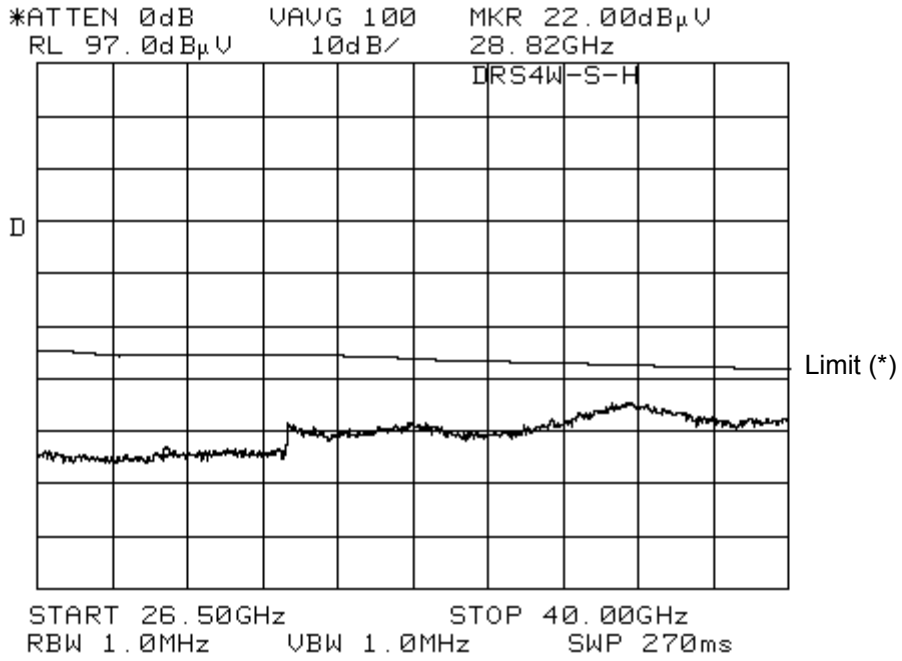


(*) The Limit is represented by the voltage value, which was derived from the electric field strength value with Antenna factor, Cable loss and Amp. gain.

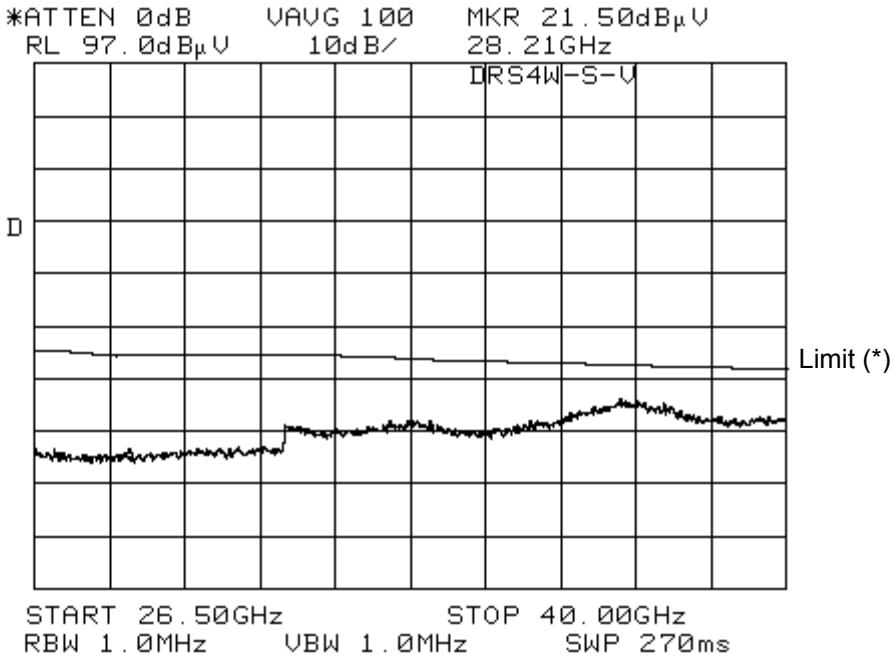
Minimum limit line for the frequency range of 18 GHz to 26.5 GHz is indicated in the above plots.

(5) for 26.5 GHz to 40 GHz

- for Horizontal



- for Vertical

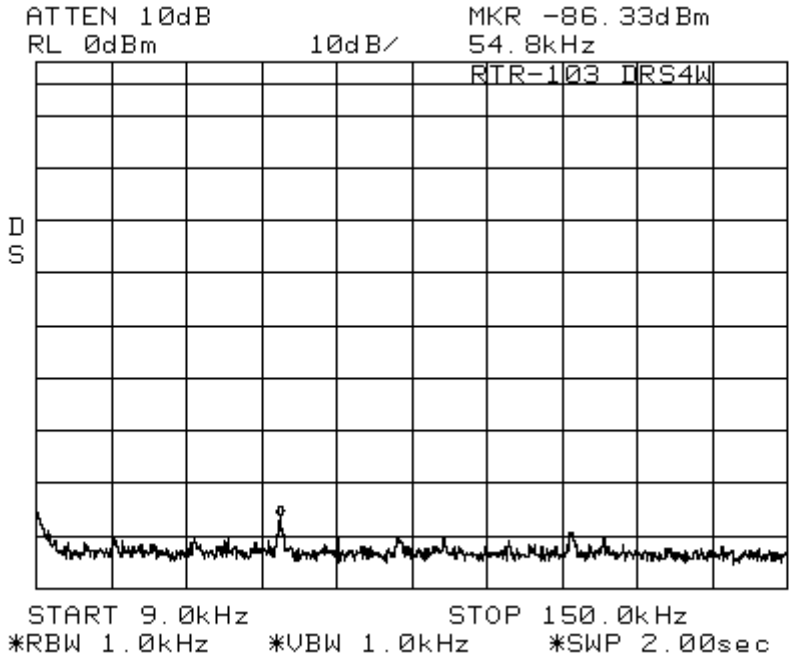


(*) Emission limit was converted from the electric field strength into the voltage values with Antenna factor, Cable loss and Amp. gain added to the calculation.

Minimum limit line for the frequency range of 26.5 GHz to 40 GHz is indicated in the above plots.

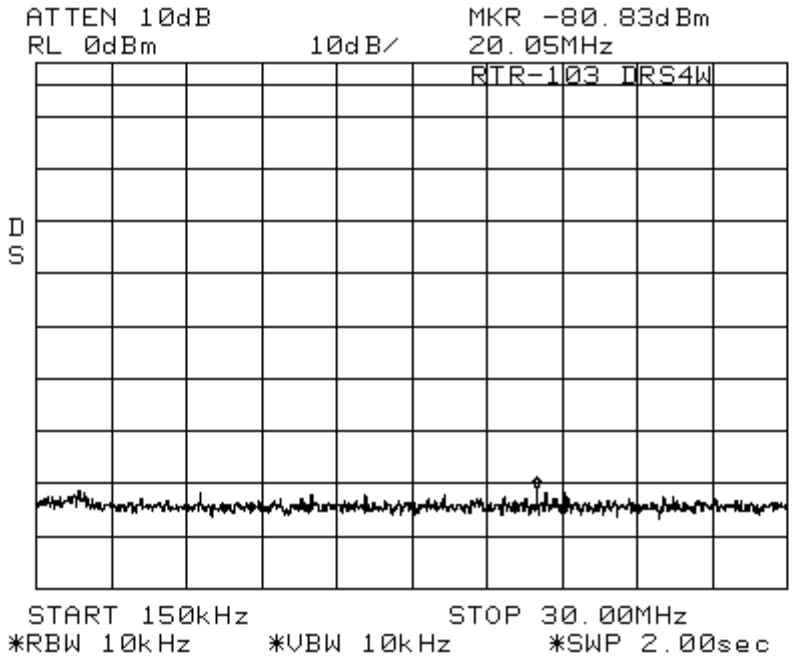
10 Field Strength Plots for Suppression of Interference Aboard Ships

(1) 9 kHz – 150 kHz: Limit = 400 µW (-4 dBm)



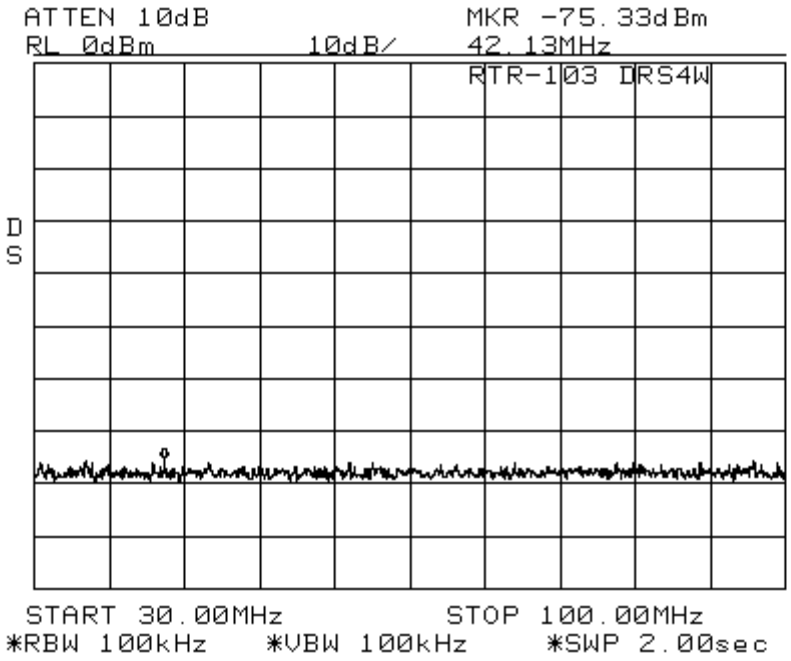
Limit

(2) 150 kHz – 30 MHz: Limit = 400 µW (-4 dBm)

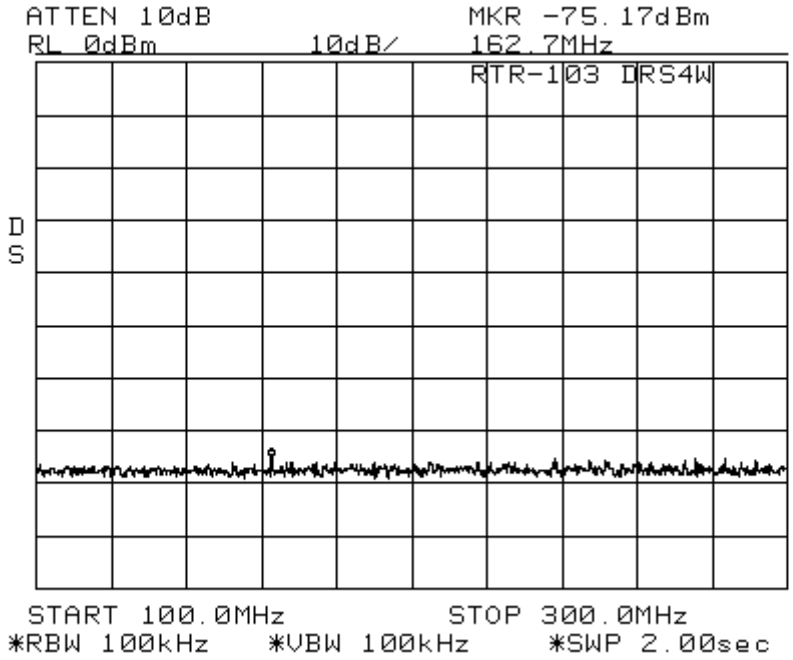


Limit

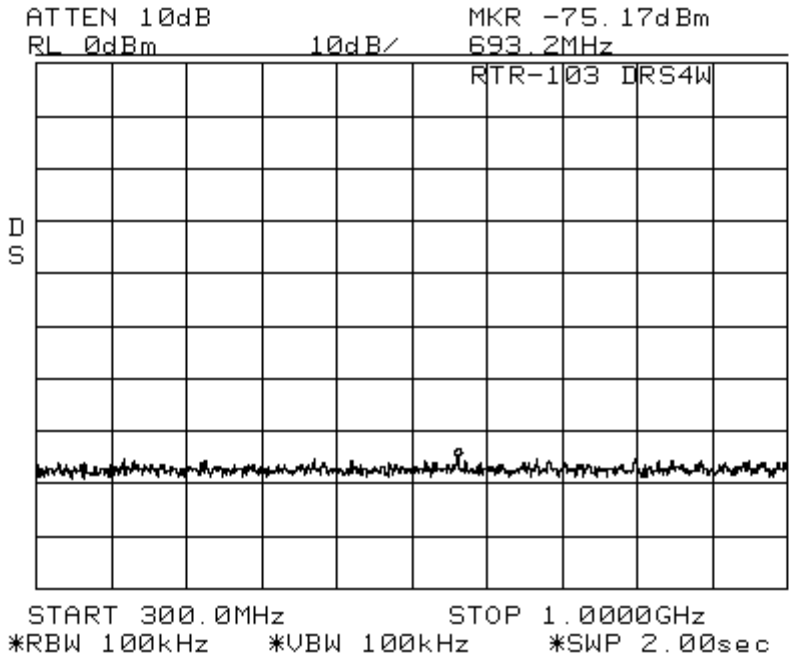
(3) 30 MHz – 100 MHz: Limit = 4000 µW (+6 dBm)



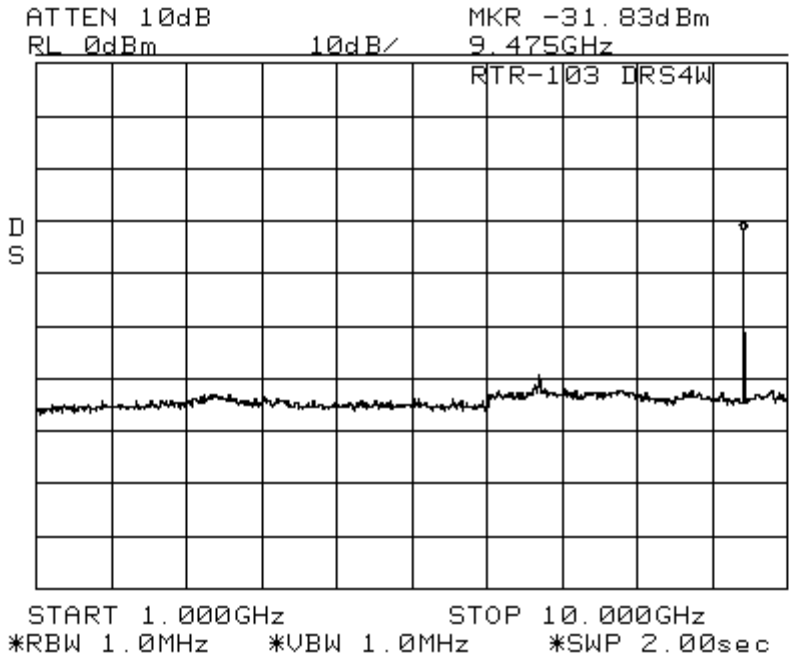
(4) 100 MHz – 300 MHz: Limit = 40000 µW (+16 dBm)



(5) 300 MHz – 1 GHz: Limit = 400000 µW (+26 dBm)



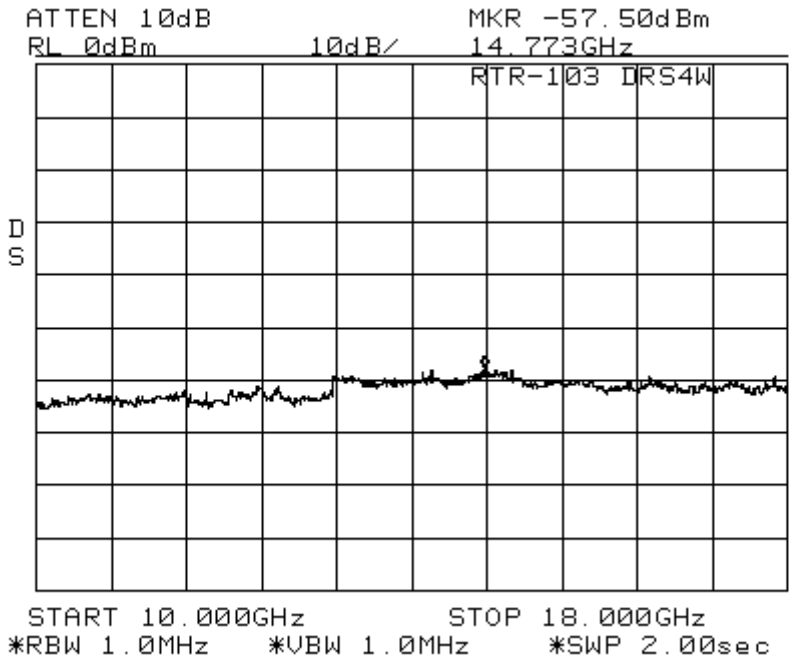
(6) 1 GHz – 10 GHz: Limit = 400000 µW (+26 dBm)



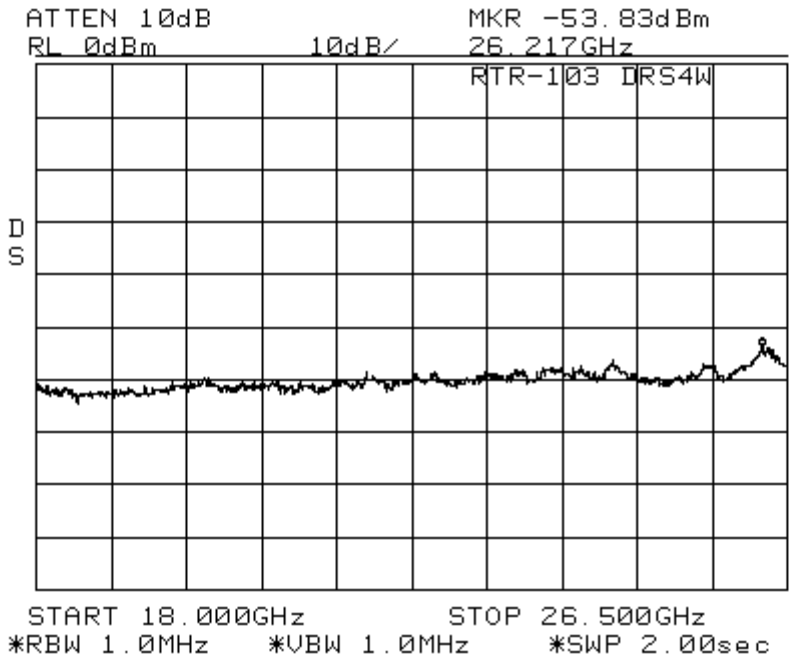
Spurious frequency: 9.745 GHz, Cable loss: 1.8 dB

Spurious strength = 10^((-31.83+1.8)/10) mW = 0.001 mW = 1.0 µW

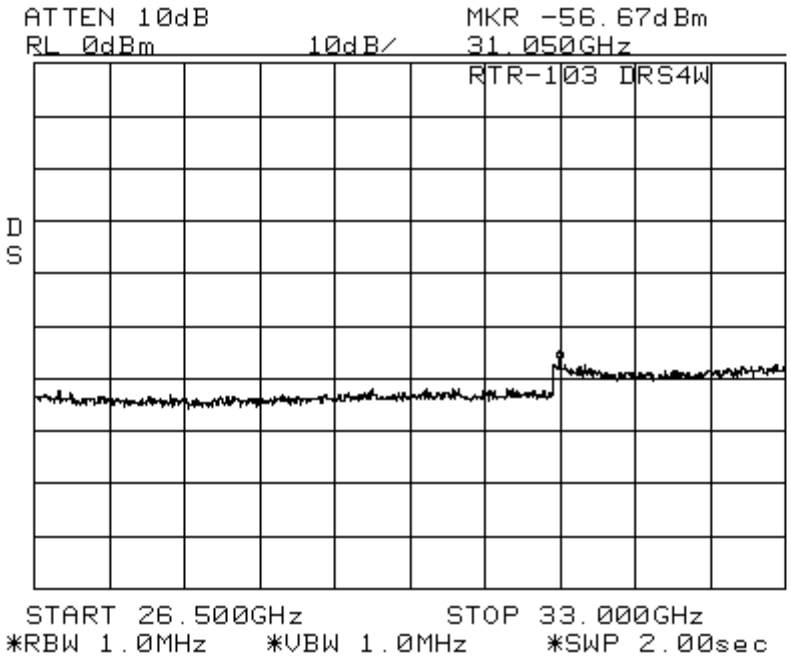
(7) 10 GHz – 18 GHz: Limit = 400000 µW (+26 dBm)



(8) 18 GHz – 26.5 GHz: Limit = 400000 µW (+26 dBm)



(9) 26.5 GHz – 33 GHz: Limit = 400000 µW (+26 dBm)



(10) 33 GHz – 40 GHz: Limit = 400000 µW (+26 dBm)