

# 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 Marine Radar**  
**Type: RTR-110**

**Report no.: FLI 12-12-055**

**Date of issue: 6 April 2012**


**Furuno Labotech International Co., Ltd.**

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## Report Summary

FLI project number:	FLI 04-11-0451					
Test report number of initial issue:	FLI 12-12-055			Date of initial issue		6 April 2012
Test report number of revised/replaced issue:	---			Date of revised/replaced issue		---
Test report revision/ replacement history:	Test report no.	Rev. no.	Date	Page	Item	Description of change/reason
	---	---	---	---	---	---
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 2010)					
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-110					
Product function and intended use:	For Marine Safety navigation					
Number of samples tested:	One					
Serial number:	R156-0460					
Power rating:	100 - 115/ 200 - 230 VAC, 50/60 Hz, 2.5/1.3A (for Processer Unit RPU-021) (The EUT was powered through the Processor unit, not directly from AC mains.					
Product status:	Pre-production model					
Modifications made to samples during testing:	None.					
Date of receipt of samples:	14 December 2011					
Test period:	14 December 2011 to 9 February 2012					
Place of test:	Furuno Labotech International Co., Ltd. - LABOTECH EMC Center 1-16, Fukazu-cho, Nishinomiya-shi, Hyogo, 663-8203 Japan <b>(File number: 818191)</b> - Nishinomiya-Hama Lab. 2-20 Nishinomiya-Hama, Nishinomiya City, Hyogo Prefecture, 662-0934 Japan Anechoic Chamber used for the test has been registered by FCC. <b>(File number: 90607)</b> <b>Test firm Designation Number: JP2007,</b> <b>Test firm Registration #: 838049</b>					
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: 6 April 2012 Name: Yoshihiro Ishii Title: Manager, Technical Department, Furuno Labotech International Co., Ltd. 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),  
Gotanda AN Bldg. 3F 22-1 Higashigotanda 1-chome, Shinagawa-ku, Tokyo 141-0022, JAPAN
- 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.,  
Edisonstraat 12a, 6902 PK Zevenaar, 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 for Maritime navigation and radiocommunication equipment and systems

(3) BSH Recognized Testing Laboratory:

- recognized by Bundesamt für Seeschifffahrt und Hydrographie (BSH),  
Bernhad-Nocht-Str. 78, 20359 Hamburg, Federal Republic of 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 for Marine navigational and radiocommunication equipment and systems

(4) TÜV Appointed EMC Test Laboratory:

- appointed by TÜV Rheinland Japan Ltd.,  
19-5 Shin Yokohama 3-chome, Kohoku-ku, Yokohama 222-0033 Japan
- 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),  
8, Dvortsovaya Nab., St. Petersburg, 191186 Russia
- Laboratory recognition number: 11.02594.011
- Date of initial recognition: 27 January 2009 (\*)
- for carrying out testing in the field of:
  - 21001301 Electrical measurements and tests, 21001302 EMC tests, 21001500 Mechanical measurements and tests, 21002000 Equipment protection degree tests, and 21002100 Climatic tests for Ship's radio and navigational equipment and IEC 60945: 2002

Note: (\*) – The current certificates may be found in the FLI web site (<http://www.furuno-labotech.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.  
Ashihara-cho 9-52, Nishinomiya-city, 662-8580 Japan
- (c) Model:

	Type	Serial Number	
Transceiver	RTR-110	R156-0460	Contained in the Scanner.
Scanner	RSB-132		
Antenna:	SN24AF	---	One (1) selectable.
	SN30AF		
	SN36AF (used for the tests.)		

- (d) Primary Function: Search, Navigation and Anti-collision
- (e) Frequency Range: Fixed frequency, S-band (3050 MHz)  
Type of Emission: P0N
- (f) Power Supply: 100 - 115/220 - 230 VAC, 50/60 Hz  
(fed through the specified external equipment, not directly from AC mains)

### 1.1.2 Radar Sensor

#### 1.1.2.1 Transceiver

**Type:** RTR-110

#### (1) Transmitter

- (a) Assignable Frequency for Shipborne Radar:  
Between 2900 and 3100 MHz (FCC Rule, 80.375 (d)-(1))
- (b) Type of RF Generator  
Magnetron Type: MG5240F  
Peak Output Power: 60 kW nominal
- (c) Magnetron Ratings  
Center frequency of Magnetron: 3050 MHz  
Tolerances:  $\pm 30$  MHz  
Pulling: 13 MHz  
Tolerance for 20°C temperature variation: -1.4 MHz

(d) Pulse Characteristics:

Pulse type	S	M1	M2	L
Pulse length (μs)	0.08	0.20	0.60	1.2
P.R.R.(Hz)	1900	1100	600	600

**(2) Modulator**

- (a) PFN Type: SCR TF563D  
Trigger Voltage: Approx. +20 VDC positive

**(3) Receiver**

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

Pulse type	S	M1	M2	L
Passband (MHz)	18	11	4	1.7

- (b) Gain (overall): approximately 120 dB  
(c) Overall Noise Figure: 6 dB (typical)  
(d) Video Output Voltage: 4 V positive  
(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: Provided.  
(b) Antenna structure: Slotted array antenna  
(installed on the Scanner)

- (c) Antenna size:

Antenna type	SN24AF	SN30AF	SN36AF
Length (cm)	255	309	376

- (d) Type of Beam: Vertical fan  
(e) Beam Width (3 dB):

Antenna type	SN24AF	SN30AF	SN36AF
Horizontal (°)	2.6	2.3	1.8
Vertical (°)	25	25	25

- (f) Polarization: Horizontal

(g) Antenna Gain:

Antenna type	SN24AF	SN30AF	SN36AF
Gain (dB)	24.0	25.2	26.5

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

Antenna type	SN24AF	SN30AF	SN36AF
Within $\pm 10^\circ$ (dB)	-23	-24	-24
Outside $\pm 10^\circ$ (dB)	-27	-30	-30

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

(j) Antenna Rotation Rate: 21 rpm (50 Hz), 26 rpm (60 Hz)

(k) Number of Degrees Scanned: 360°

(l) Sector Scan: Not provided.

**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:

Yes (Magnetron/Xtal checker)

(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: 100 - 115/ 200 - 230 VAC, 50/60 Hz 2.5 / 1.3 A  
(for Processor Unit RPU-021)  
(Transceiver unit was powered through the Processor unit, not directly from AC mains)

100 - 115/ 200 - 230 VAC, 50/60 Hz 4.4 / 2.0 A  
3 $\phi$  220 VAC, 60 Hz/200 VAC, 50 Hz 3.0 A  
(for Power Supply Unit PSU-006)

(b) Power consumption: 245/275 VA (RPU-021)

**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 – IP26)

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

1 X Transceiver Type: RTR-110  
1 X Antenna Unit Type: RSB-132 (21/26 rpm)

1 X Processor Unit	Type:	RPU-021
1 X Power Supply Unit	Type:	PCU-006
1 X Control Unit	Type:	RCU-021
1 X Monitor Unit	Type:	MU-190HD (19 inch LCD)

(e) Approximate Weight of Complete Installation:

Antenna Unit: 148 kg (with Antenna SN36AF installed.)

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

## 1.2 Observation and comments

None.

## 2 Test Results Summary

CFR 47 Section	Item	Result	Test Engineer
2.1046	RF Power Output	Passed.	A. Inoue
2.1047	Modulation Characteristics	Passed.	A. Inoue
2.1049	Occupied Bandwidth	Passed.	A. Inoue
2.1055	Frequency Stability	Passed.	A. Inoue
	Spurious Emissions	---	---
2.1051	- Spurious Emissions at Antenna Terminal	Passed.	A. Inoue
2.1053	- Field Strength of Spurious Radiation	Passed.	A. Inoue
80.217	Suppression of Interference Aboard Ships	Passed.	A. Inoue



### 3 Test Results

#### 3.1 RF Power Output (FCC Rule, 2.1046)

**(1) Test conditions:**

For all TX (S/M1/M2/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	M1	M2	L
Magnetron Output, mean (W):	5.3	7.9	18.6	40.6
Magnetron Output, peak (kW):	38.8	36.7	47.2	53.3

Environmental conditions observed: On 8 February 2012, 21°C to 22°C, 42% to 43%RH

Power supply voltage measured (\*): 230.0 VAC to 230.0.0 VAC.

(\*): Power input voltages to the external equipment (Processor Unit RPU-021) measured.

#### 3.2 Modulation Characteristics (FCC Rule, 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)):**

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 ( $f_0$ ): 3050 MHz

Authorized bandwidth ( $f(AUBW)$ ): 110 MHz

**(4) Test Results:**

Complied.

Pulse type	S	M1	M2	L	Result
Pulse length T (μs) (-3 dB points)	0.072	0.195	0.658	1.270	Not applicable
Rise time $t_r$ (μs) (10 - 90 % amplitude)	0.010	0.010	0.010	0.010	Not applicable

Pulse type	S	M1	M2	L	Result
Decay time $t_f$ ( $\mu$ s) (90 - 10 % amplitude)	0.117	0.118	0.192	0.268	Not applicable
PRR (Hz)	1899	1100	600	600	Not applicable
Guard Band $f(1.5/T)$ (MHz) (*)	20.8	7.7	2.3	1.2	Not applicable
f(U) (MHz)	3084.2	3097.3	3102.7	3103.8	Not applicable
f(L) (MHz)	3015.8	3002.7	2997.3	2996.2	Not applicable
Frequency at maximum emission (MHz)	3050.2	3051.0	3049.5	3046.8	Complied

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

Measured Plots: See Clause 7.

Environmental conditions observed: On 8 February 2012, 21°C to 22°C, 42% to 43%RH

Power supply voltage measured (\*): 230.0 VAC to 230.0 VAC.

(\*): Power input voltages to the external equipment (Processor Unit RPU-021) measured.

### 3.3 Occupied Bandwidth (FCC Rule, 2.1049)

#### (1) Test conditions:

For all TX (S/M1/M2/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	M1	M2	L
Occupied bandwidth (MHz)	58.0	30.0	13.3	8.0

Environmental conditions observed: On 8 February 2012, 21°C to 22°C, 42% to 43%RH

Power supply voltage measured (\*): 230.0 VAC to 230.0 VAC.

(\*): Power input voltages to the external equipment (Processor Unit RPU-021) measured.

### 3.4 Frequency Stability (FCC Rule, 2.1055)

#### (1) Test Conditions:

- 1) Radar Transmitter settings: All TX (S/M1/M2/L) Pulses
- 2) Ambient Temperature settings: - 20°C to + 50°C (10°C interval)
- 3) Power Supply Voltage settings: 85 /115 % of nominal voltage (170 VAC/264.5 VAC)

#### (2) Test setup:

See Clause 4.

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

Pulse type	S	M1	M2	L
f(U) (MHz)	3084.2	3097.3	3102.7	3103.8
f(L) (MHz)	3015.8	3002.7	2997.3	2996.2

See Clause 3.2 for details.

#### (4) Test Results:

Complied.

Power Supply Voltage setting (\*): 170.0 VAC

Pulse type		S	M1	M2	L	Result
Frequency at maximum emission (MHz)	-30°C	3051.6	3052.6	3051.6	3049.2	Complied
	-20°C	3051.1	3052.1	3051.1	3048.7	Complied
	-10°C	3050.7	3051.7	3050.6	3048.2	Complied
	0°C	3050.2	3051.2	3050.2	3047.8	Complied
	+10°C	3049.8	3050.8	3049.7	3047.3	Complied
	+20°C	3049.3	3050.3	3049.2	3046.8	Complied
	+30°C	3048.5	3049.5	3048.4	3046.3	Complied
	+40°C	3047.8	3048.8	3047.6	3045.8	Complied
	+50°C	3047.0	3048.0	3046.8	3045.3	Complied

Power Supply Voltage setting (\*):264.5 VAC

Pulse type		S	M1	M2	L	Result
Frequency at maximum emission (MHz)	-30°C	3051.6	3052.7	3051.6	3049.0	Complied
	-20°C	3051.1	3052.2	3051.1	3048.6	Complied
	-10°C	3050.7	3051.7	3050.6	3048.1	Complied
	0°C	3050.2	3051.3	3050.2	3047.7	Complied
	+10°C	3049.8	3050.8	3049.7	3047.2	Complied
	+20°C	3049.3	3050.3	3049.2	3046.8	Complied
	+30°C	3048.6	3049.6	3048.6	3046.4	Complied
	+40°C	3048.0	3049.0	3047.9	3046.1	Complied
	+50°C	3047.3	3048.3	3047.3	3045.7	Complied

Environmental conditions observed: On 3 February 2012, 20°C to 20°C, 40% to 40%RH  
 On 4 February 2012, 19°C to 19°C, 42% to 42%RH  
 On 5 February 2012, 19°C to 19°C, 42% to 42%RH

(\*): Power input voltages to the external equipment (Processor Unit RPU-021) measured.

**3.5 Spurious Emissions**

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

**(1) Test Conditions:**

For all TX (S/M1/M2/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, 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 <sub>10</sub> (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 8 February 2012, 21°C to 22°C, 42% to 43%RH

Power supply voltage measured (\*): 230.0 VAC to 230.0 VAC.

(\*): Power input voltages to the external equipment (Processor Unit RPU-021) measured.

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

**(1) Test Conditions:**

For all TX (S/M1/M2/L) Pulses, the Radiated Emission test was performed.

(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 Scanner Unit with the stop mode and directed so as to detect the maximum spurious radiation.

**(2) Test Site:** LABOTECH Nishinomiya-Hama Laboratory, Semi-Anechoic Chamber  
( for 9 kHz to 2000 MHz) **(FCC file number: 90607)**

LABOTECH EMC Center , Semi-Anechoic Chamber  
( for 2 GHz to 40 GHz) **(FCC file number: 818191)**

**(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 (3.0 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:**

- (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 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 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, 80.211 (f)):**

Frequency removed from the assigned frequency	Frequency (MHz) (for S-band)	Emission attenuation (mean power, dB)
50 - 100 % (*) (of the authorized bandwidth)	2,950 - 3,000	At least 25
	3,100 - 3,150	
100 - 250 % (*)	2,800 - 2,950	At least 35
	3,150 - 3,300	
more than 250 %	0.009 - 2,800	At least 43 + 10 log <sub>10</sub> (mean power in watts)
	3,300 - 40,000	

Note: (1) Assigned frequency (center frequency) = 3050 MHz

(2) Authorized bandwidth = 110 MHz

(\*) - for the relevant frequency bands, tests were performed according to FCC Rule, 2.1051. See Clause 3.5.1.

**(6) Test Results:**

Complied.

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

$$\begin{aligned}
 [\text{Limit}] &= 43 + 10 \log_{10} (\text{mean power in watts}) \\
 &= 43 + 10 \log_{10} (40.6) \\
 &= 59 \text{ dB}
 \end{aligned}$$

where, [ mean power in watts ] = 40.6 W for L pulse. See 3.1.

For this time, Limit of 60 dB was applied for the test.

The electric field strength of the maximum power radiation was 182.7 dB $\mu$ V/m with L pulse. Consequently, the allowable emission limit was set to 122.7 dB $\mu$ V/m (= 182.7 dB $\mu$ V/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 are listed in the following table.

Frequency (GHz)	Antenna Polarization	Pulse type	Electric Field Strength measured (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
6.080	Horizontal	L	116.08	122.7	6.60
6.080	Vertical	L	119.08	122.7	3.60

Environmental conditions observed: On 16 December 2011, 20°C to 20°C, 40% to 44%RH  
Power supply voltage measured (\*):100.2 VAC to 100.2 VAC.

On 19 December 2011, 20°C to 20°C, 48% to 48%RH  
Power supply voltage measured (\*): 100.1 VAC to 100.0 VAC.

(\*): Power input voltages to the external equipment (Processor Unit RPU-021) measured.

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

**(1) Test Conditions/Test Setup:** Stand-by mode/ See Clause 4.

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

**(3) Spurious Emission Limits for Receivers:**

(a) for delivered power to artificial antenna,

Frequency	Power to artificial antenna		Resolution bandwidth of Spectrum analyzer
	( $\mu$ W)	(dBm)	
9 kHz - 150 kHz	400	-4	1 kHz
150 kHz - 30 MHz		-4	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.

Frequency (GHz)	Power to artificial antenna measured		Limits		Margin (dB)
	(dBm)	( $\mu$ W)	(dBm)	( $\mu$ W)	
6.670	-59.70	0.0011	+26.0	400000	84.87

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

Spurious emission levels measured for the specified test frequency range were found below the limits.

Environmental conditions observed: On 15 December 2011, 20°C to 20°C, 40% to 40%RH

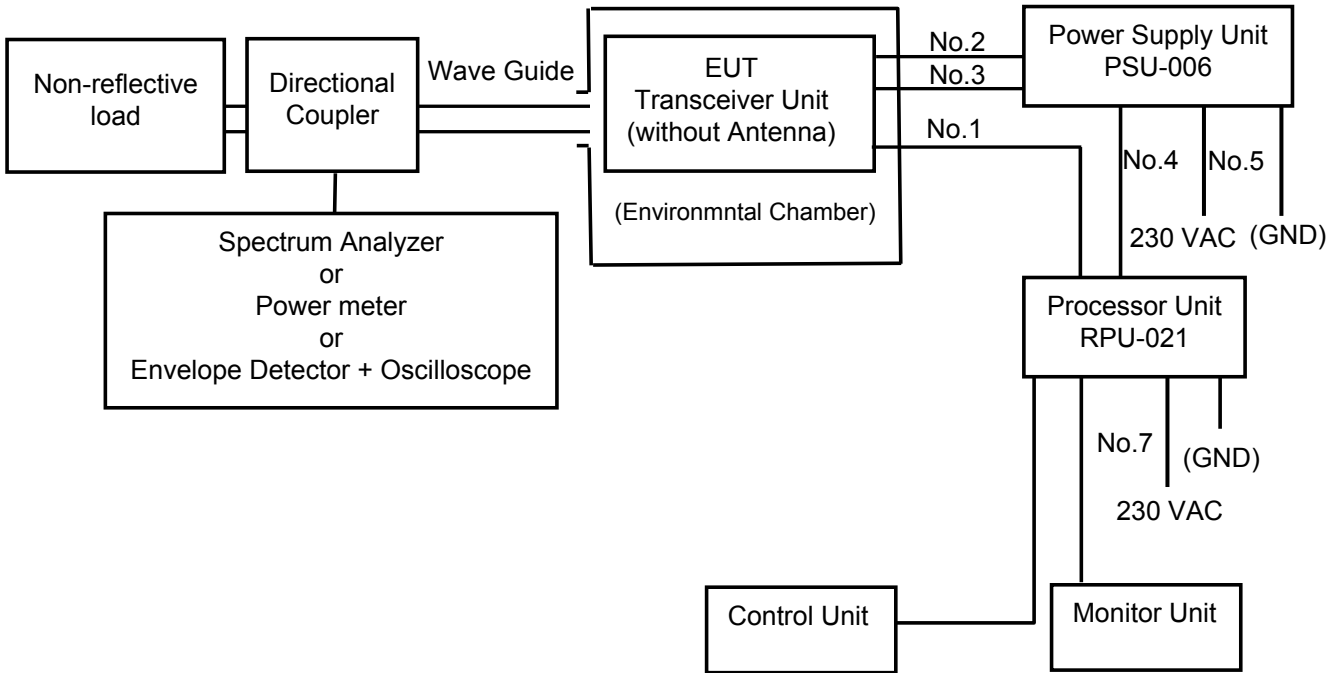
Power supply voltage measured (\*): 100.2 VAC to 100.2 VAC.

(\*): Power input voltages to the external equipment (Processor Unit RPU-021) measured.

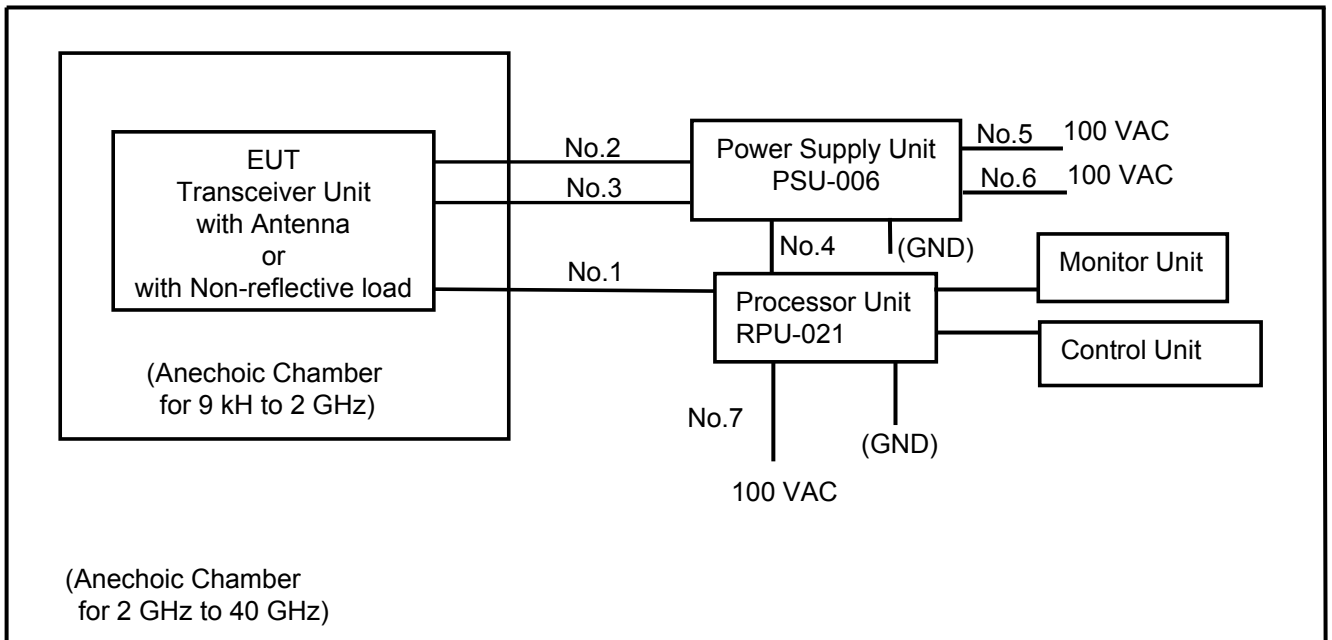
Spectrum plots: See Clause 10.

### 4 Test Setup for Measurement:

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

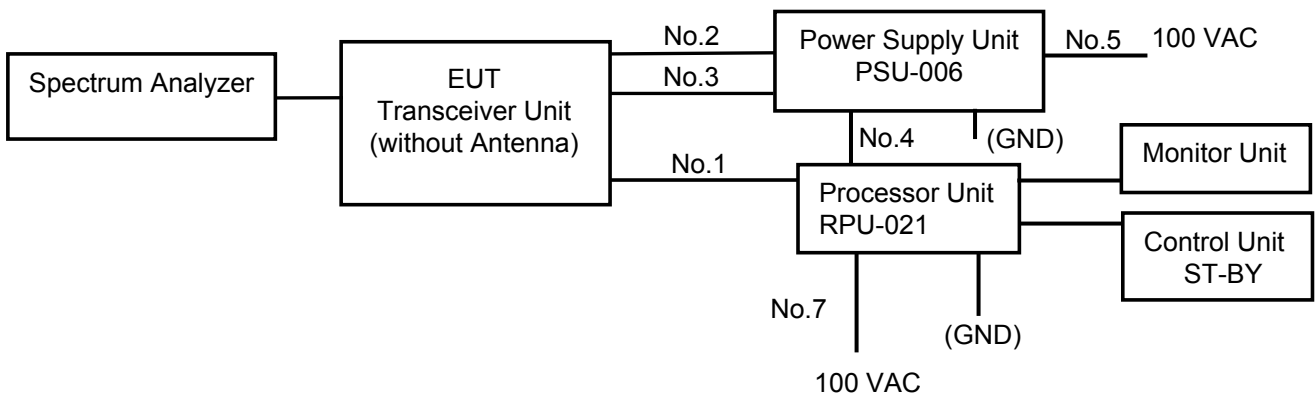


#### (2) Test Setup for Clause 3.5.2.





**(3) Test Setup for Clause 3.6.**



**Cable designations:**

No.	Name	Length (m)
1	RW0013	20
2	TPYCY-1.5	25
3	TPYCY-2.5	25
4	250V-MPYC-7	25
5	0.6 / 1kV-DPYC-2.5	1.6
6	TPYC-2.5	1.3
7	0.6 / 1kV-DPYC-2.5	1.6

## 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
8408089	Power meter	436A	2410A19137	HP
8408089	Power Sensor	8481A	2349A39603	HP
HT859	Crystal Detector	432B	MY42245069	Agilent
9001012	Directional Coupler (S-band)	MDC-30	R7231	Shimada
---	Dummy Load (S-band)	4D106	R18083	Shimada
8408087	Frequency Counter	TR5824A	41940036	Advantest
0404008	Attenuator	8494B	MY42141964	Agilent
0404008	Attenuator	8495B	MY42140929	Agilent
HT168	Oscilloscope	TDS680B	B030202	Tektronix

### (2) For 3.2 Modulation Characteristics:

C/N	Instrument	Type	S/N	Manufacturer
8408089	Power meter	436A	2410A19137	HP
8408089	Power Sensor	8481A	2349A39603	HP
HT859	Crystal Detector	432B	MY42245069	Agilent
9001012	Directional Coupler (S-band)	MDC-30	R7231	Shimada
---	Dummy Load (S-band)	4D106	R18083	Shimada
8408087	Frequency Counter	TR5824A	41940036	Advantest
0404008	Attenuator	8494B	MY42141964	Agilent
0404008	Attenuator	8495B	MY42140929	Agilent
HT168	Oscilloscope	TDS680B	B030202	Tektronix

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

C/N	Instrument	Type	S/N	Manufacturer
9001012	Directional Coupler (S-band)	MDC-30	R7231	Shimada
---	Dummy Load (S-band)	4D106	R18083	Shimada
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent
0404008	Attenuator	8494B	MY42141964	Agilent
0404008	Attenuator	8495B	MY42140929	Agilent
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
HT510	Climatic chamber (Hama-L)	TBE-3HW4PE2F	3013002540	Tabai Espec
HT725	Paperless recorder/Dual communication logger DAQSTATION FX100	FX106-4-1	S5JA01447	Yokogawa
9001012	Directional Coupler (S-band)	MDC-30	R7231	Shimada
---	Dummy Load (S-band)	4D106	R18083	Shimada
----	Waveguide (for S-band)	WRJ-3 (l = 70 cm)	----	Furuno

C/N	Instrument	Type	S/N	Manufacturer
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent
HT654	Attenuator	8494B	MY42148134	Agilent
HT655	Attenuator	8495B	MY42144403	Agilent
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

(5.1) for 9 kHz to 2000 MHz:

C/N	Instrument	Type	S/N	Manufacturer
HT463	Spectrum analyzer (9 kHz to 3 GHz)	R3132	110401654	Advantest
HT565	Loop antenna (0.15 - 30 MHz)	HFH2-Z2	100093	Rohde & Schwarz
HT459	Biconical antenna (30 MHz to 300 MHz)	VBA6106A	1296	Schaffner
HT331	Log periodic antenna (300 MHz to 1000 MHz)	UHALP9107	8411059	Schwarzbeck
HT467	Double-ridged waveguide horn antenna (1 GHz to 18 GHz)	3115	6520	EMCO
HT518	Pre-amplifier (30 MHz to 2 GHz)	87405A	3207A01643	Agilent
HT365	Semi-anechoic Chamber	3mSAC	D-002	Riken
---	Dummy Load (S-band)	4D106	R18083	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

(5.2) for 2 GHz to 40 GHz:

C/N	Instrument	Type	S/N	Manufacturer
RT008	Double-ridged waveguide horn antenna (1 GHz to 18 GHz)	3115	00134386	ETS-LINDGREN
HT779	Semi-Anechoic chamber	10mAC	90984	TOKIN
HT756	Antenna tower/Turn table controller	5909E	A090021	TOKIN
HT761	Double rigged horn antenna & amp. (18 GHz - 26 GHz)	HAP18-26N	00000017	Toyo Corp.
HT762	Double rigged horn antenna & amp. (26 GHz - 40 GHz)	HAP26-40N	00000010	Toyo Corp.
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent
KB-138	Coaxial cable	MWX221 - 5m	0804S166	Junkosha
----	Notch Filter (S-band)	CBR-S7-3A	R1189001	Shimada

(6) For 3.6 Suppression of Interference Aboard Ships:

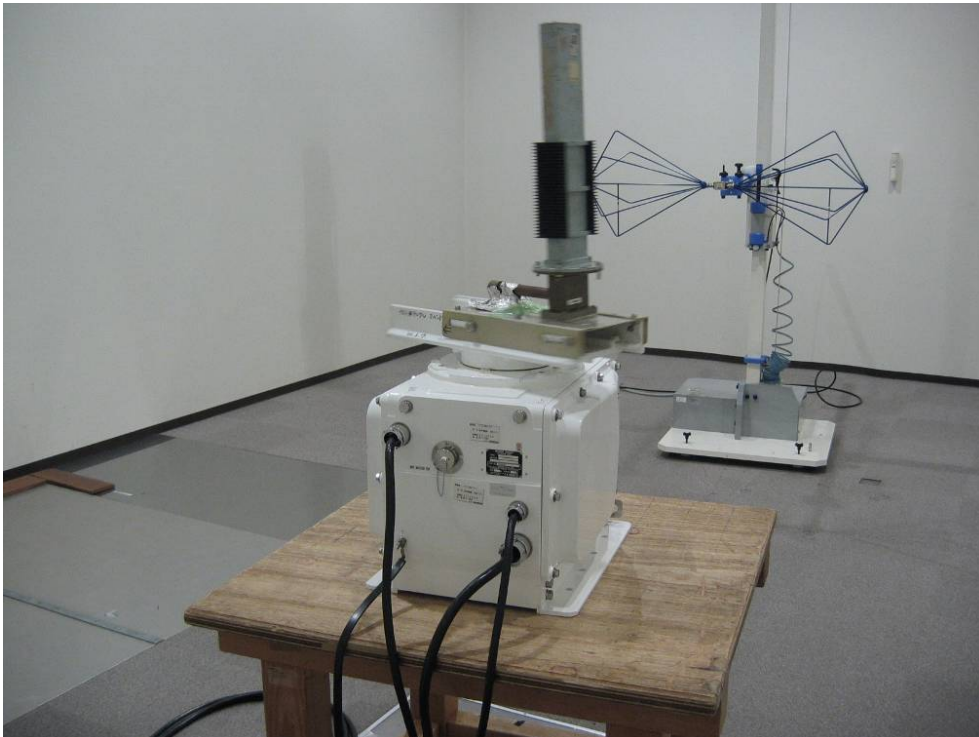
C/N	Instrument	Type	S/N	Manufacturer
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent
KB-137	3.5 mm cable	MWX221-2m	0804S167	Junkosha

## 6 Photograph of Test Setup/Arrangement

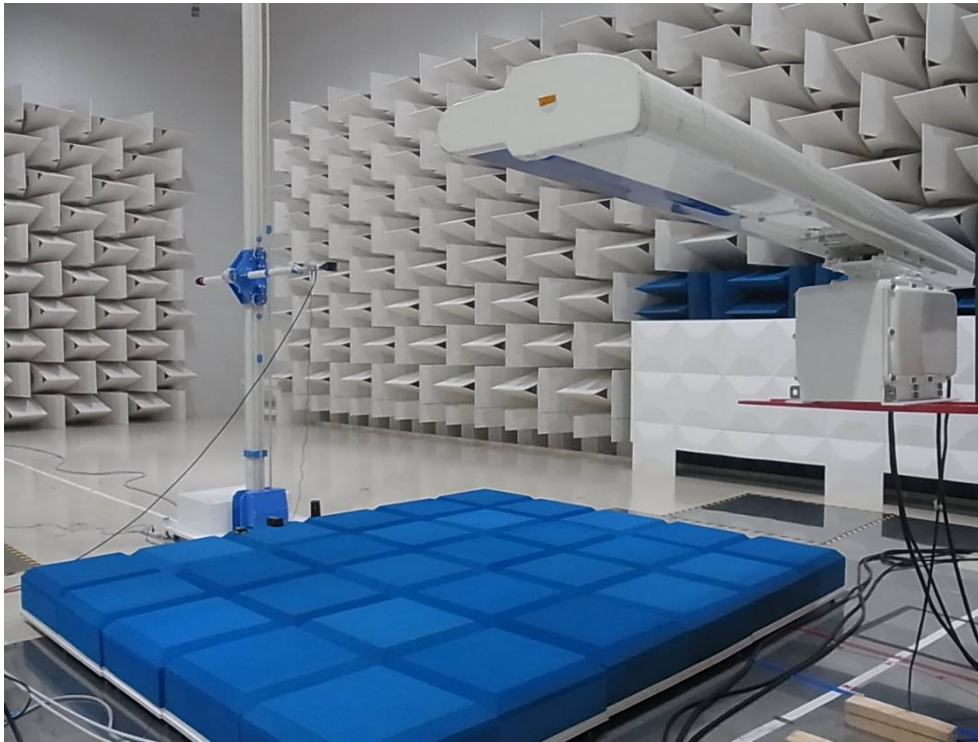
(1) For Temperature (TX frequency stability) tests,



(2) For Spurious Emission measurements,



for 9 kHz to 2000 MHz



for 2 GHz to 40 GHz

### 7 RF Envelope and Spectrum of the output pulse

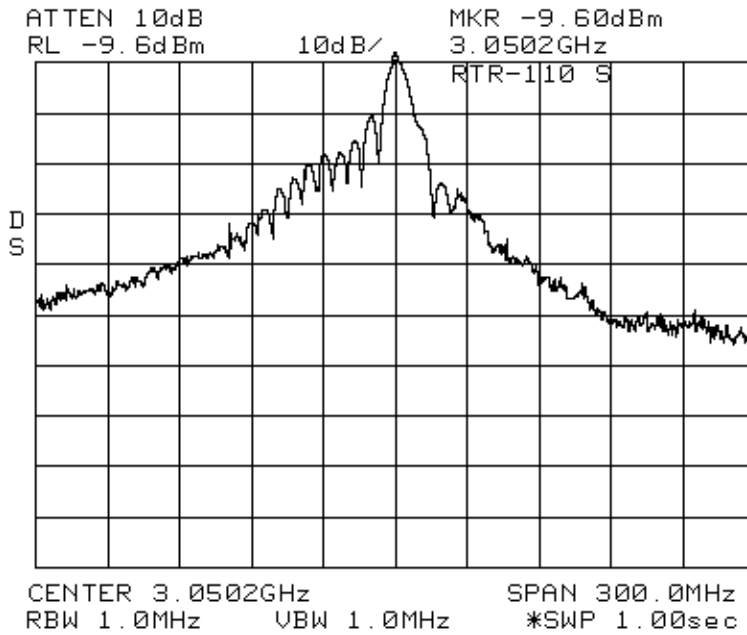
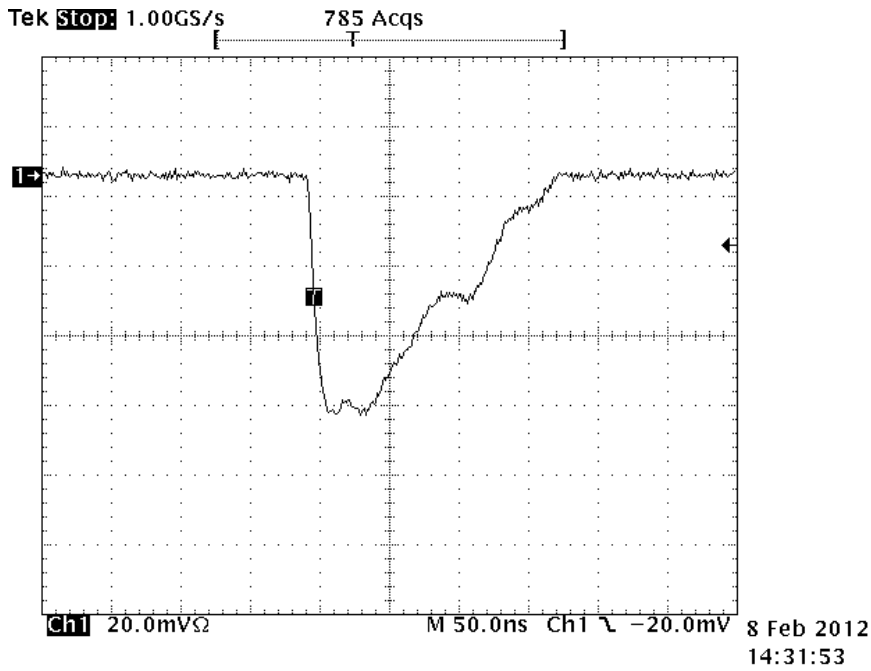


Fig. 7.1 S Pulse Envelope and Spectrum

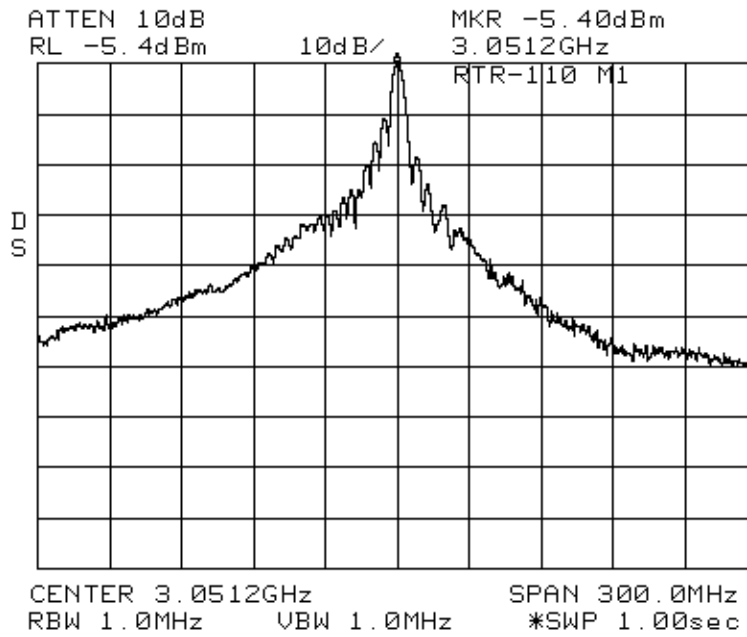
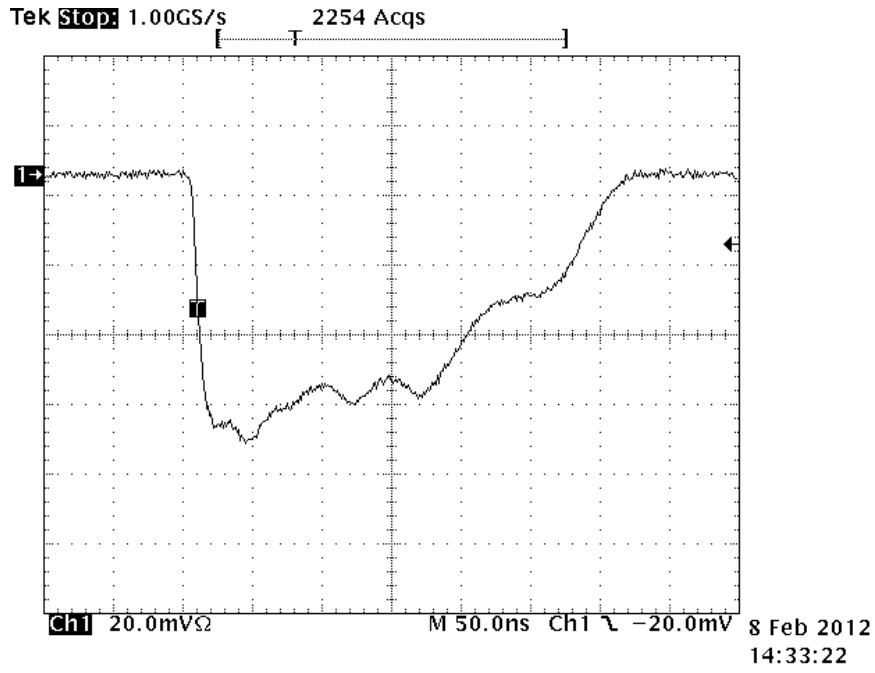


Fig. 7.2 M1 Pulse Envelope and Spectrum

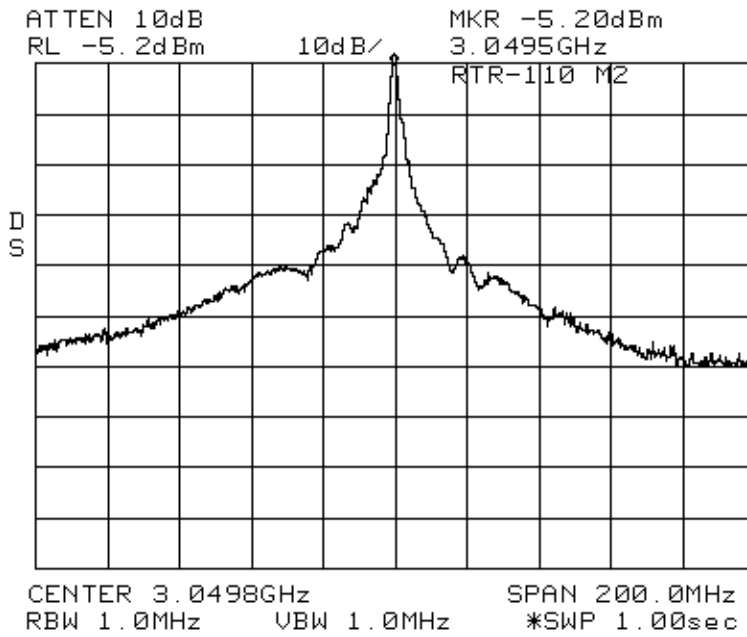
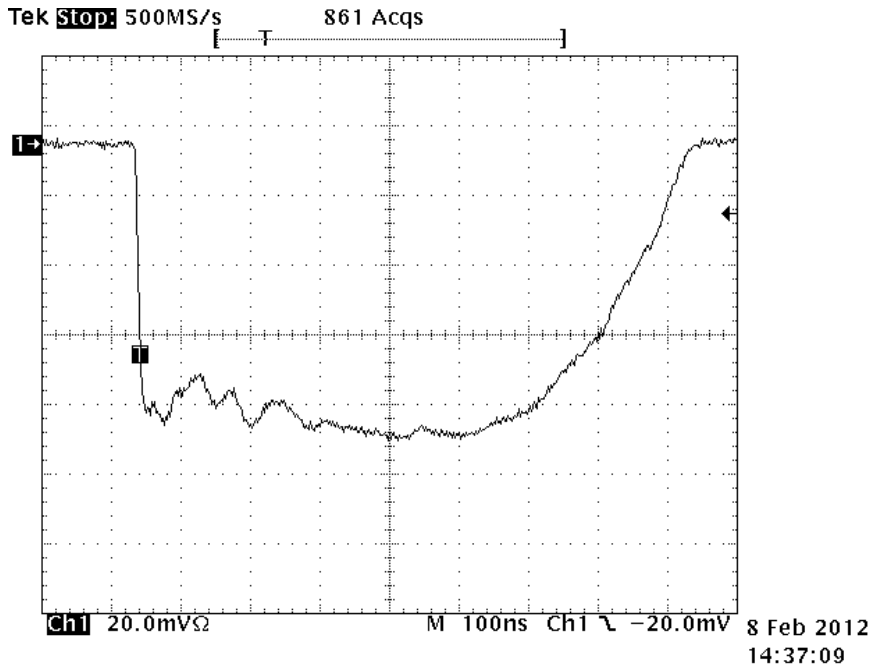


Fig. 7.3 M2 Pulse Envelope and Spectrum



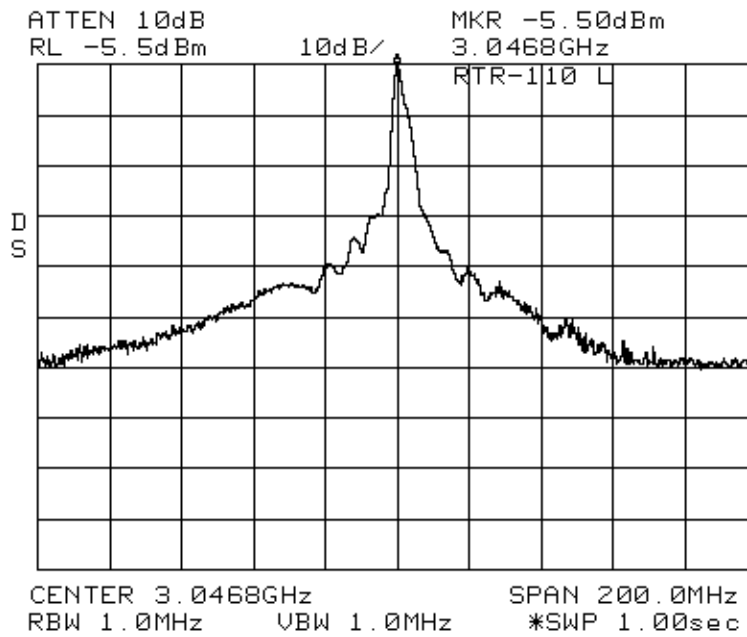
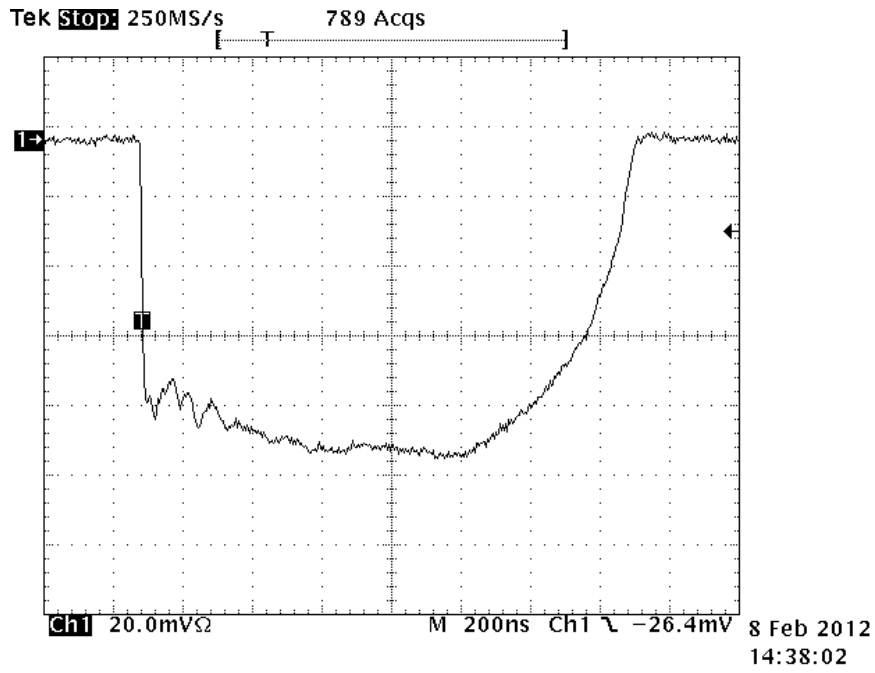
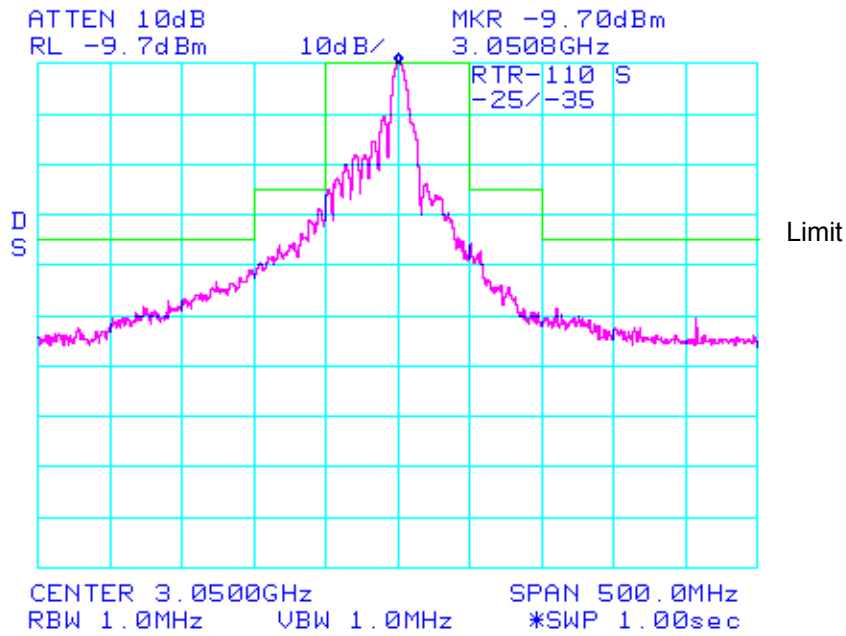


Fig. 7.4 L Pulse Envelope and Spectrum

## 8 Spurious Emission Plots measured at Antenna Terminal

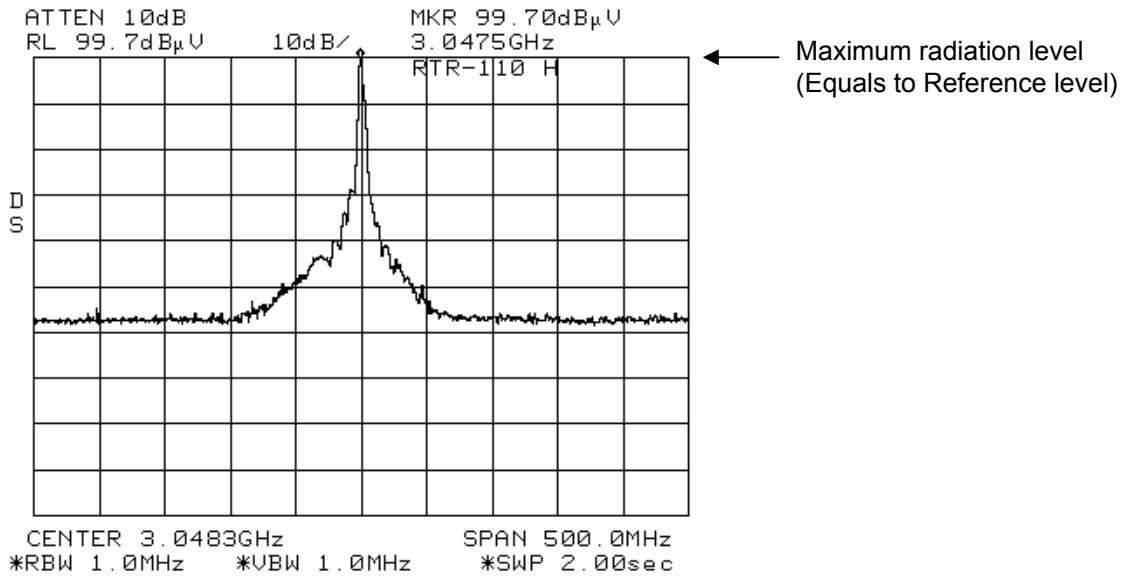
for S pulse



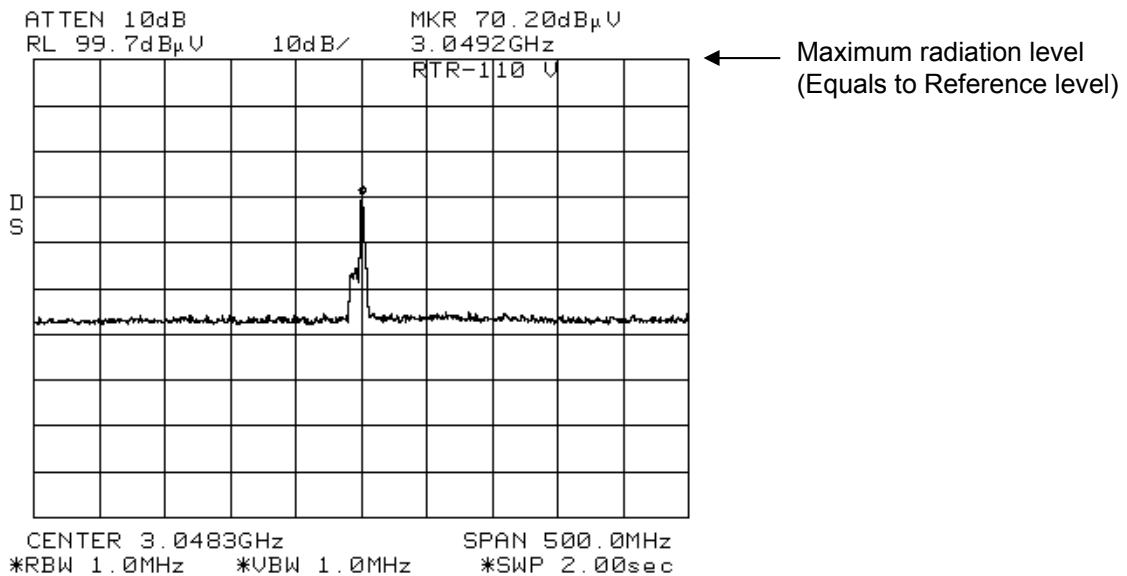
## 9 Field Strength Plots of Spurious Radiation

### 9.1 Maximum power radiation level (for L Pulse)

- Horizontal



- Vertical



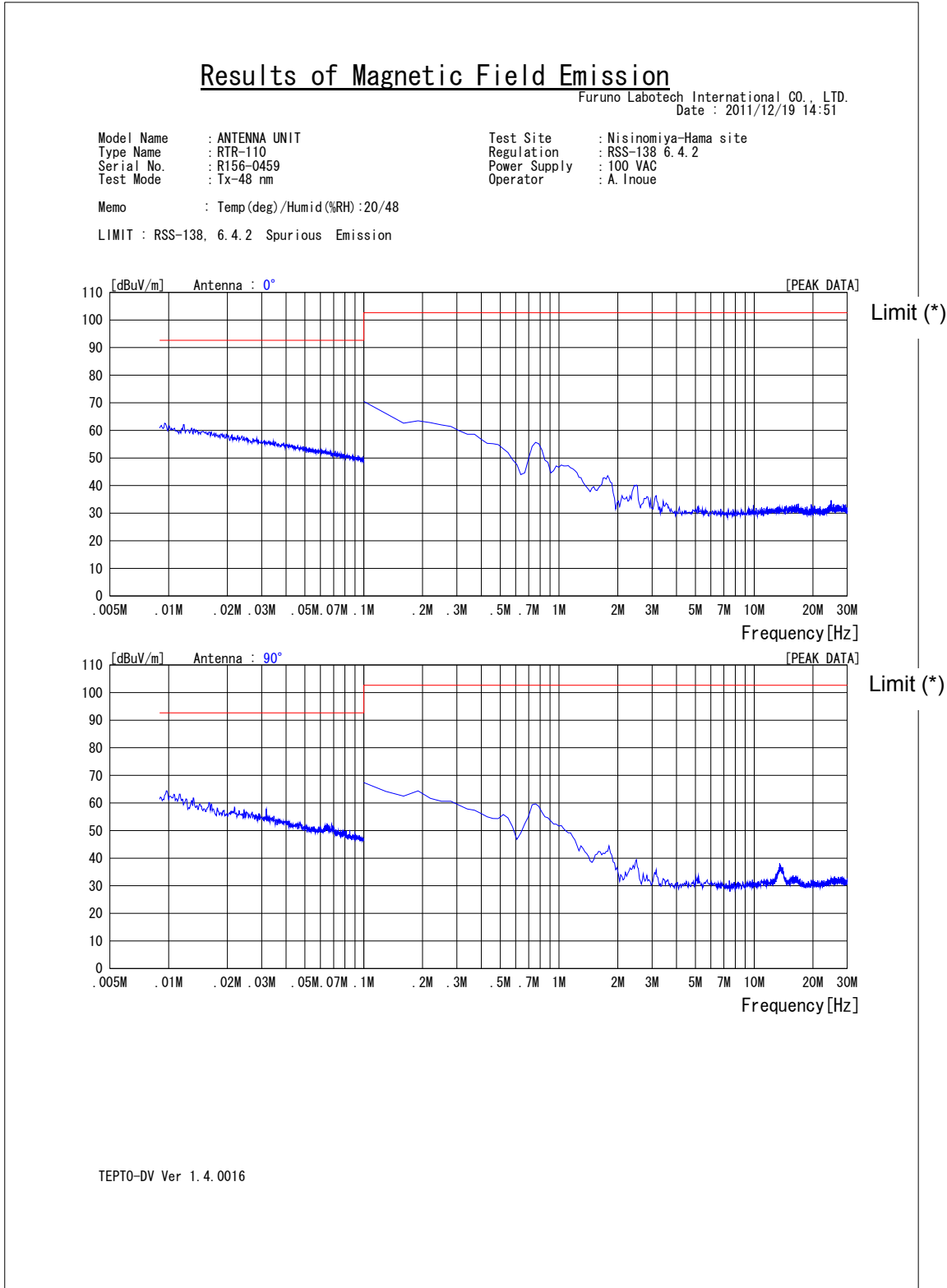
For the maximum power radiation level, the voltage value measured by the spectrum analyzer was converted into the electric field strength with the measuring antenna factor, Cable loss and Amp. gain.

Maximum power radiation level = 182.7 dBμV/m

Therefore, Emission Limit = 182.7 dBμV/m - 60 dB = 122.7 dBμV/m

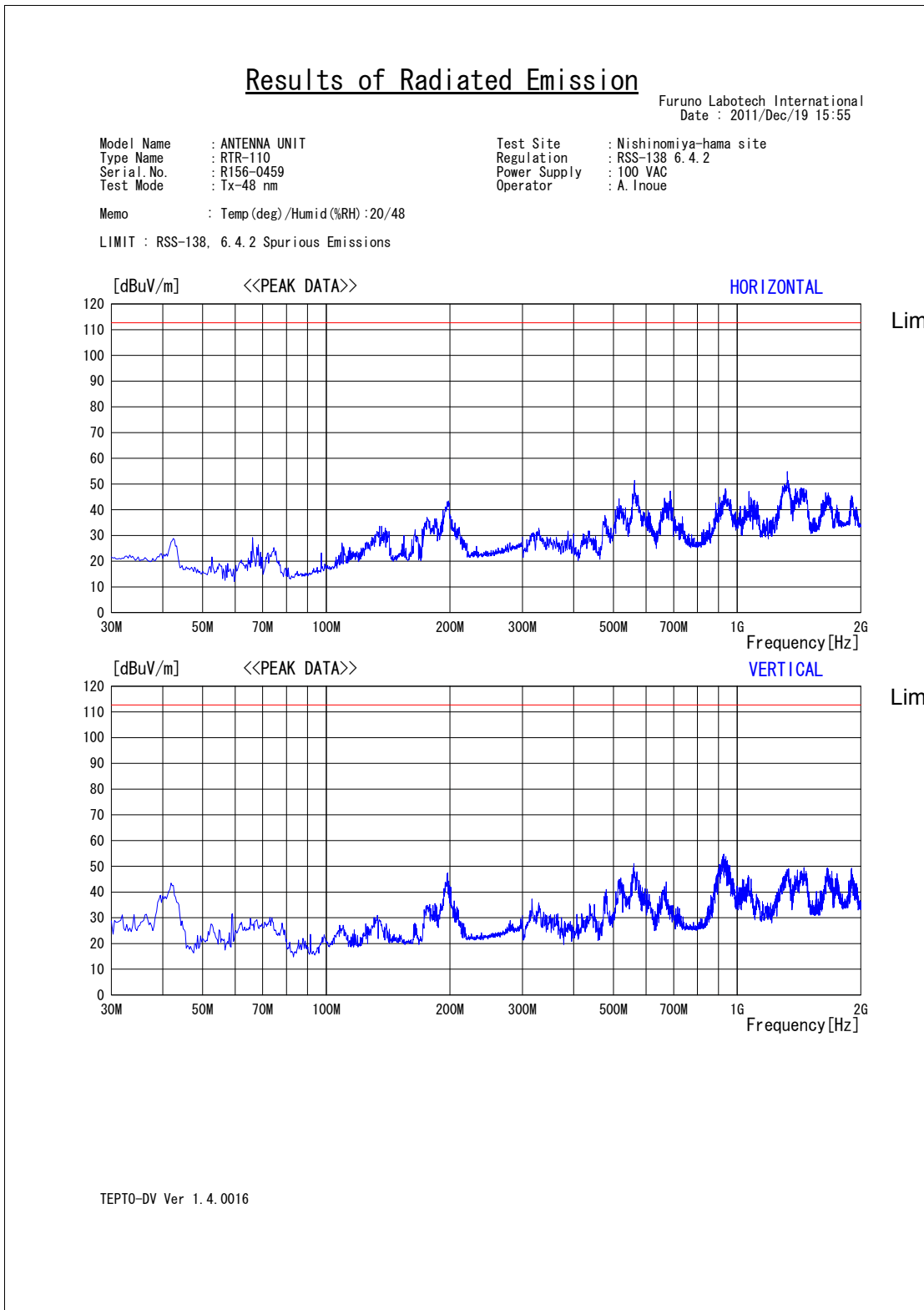
**9.2 Spurious emissions (L pulse)**

(1) for 9 kHz to 30 MHz



(\*) The resolution bandwidth of the spectrum analyzer for the frequency range of 9 kHz to 100 kHz was set to 1 kHz, and to 10 kHz for 100 kHz to 30 MHz, instead of 1 MHz for the frequency range of 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.

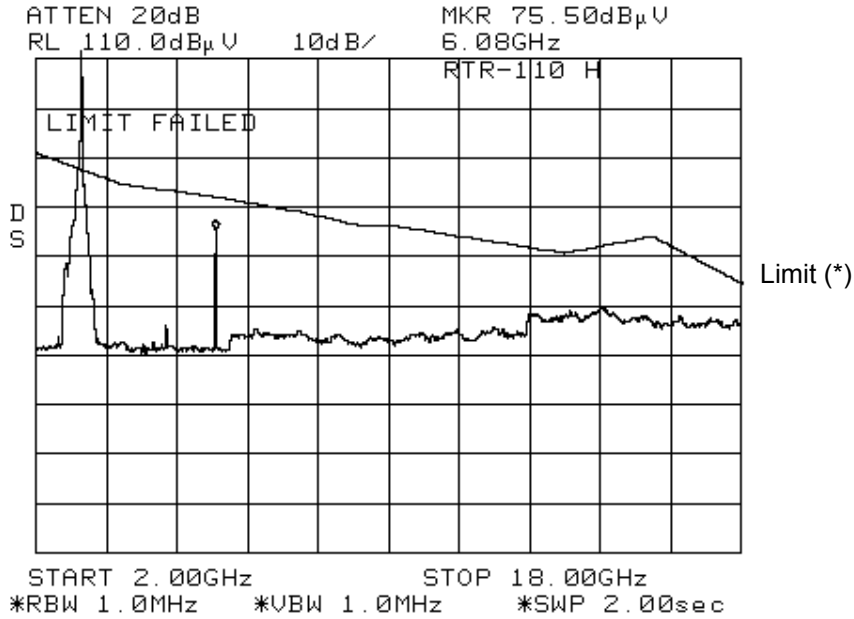
(2) for 30 MHz to 2000 MHz



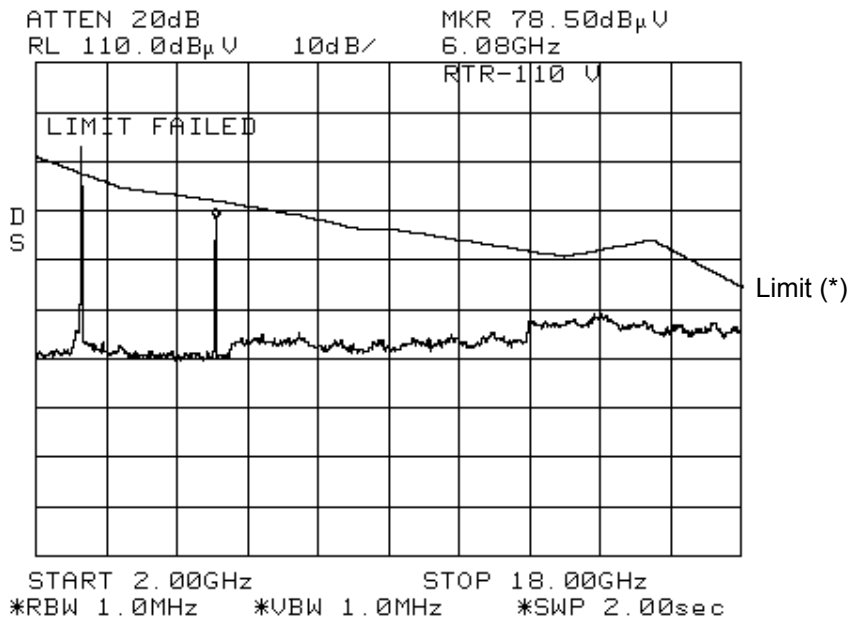
(\*) The resolution bandwidth of the spectrum analyzer for the frequency range of 30 MHz to 2000 MHz was set to 100 kHz instead of 1 MHz for the frequency range of 2 GHz to 40 GHz. The applicable limit was set at 10 dB lower than that computed in Clause 9.1.

( 3 ) for 2 GHz to 18 GHz

- for Horizontal



- for Vertical

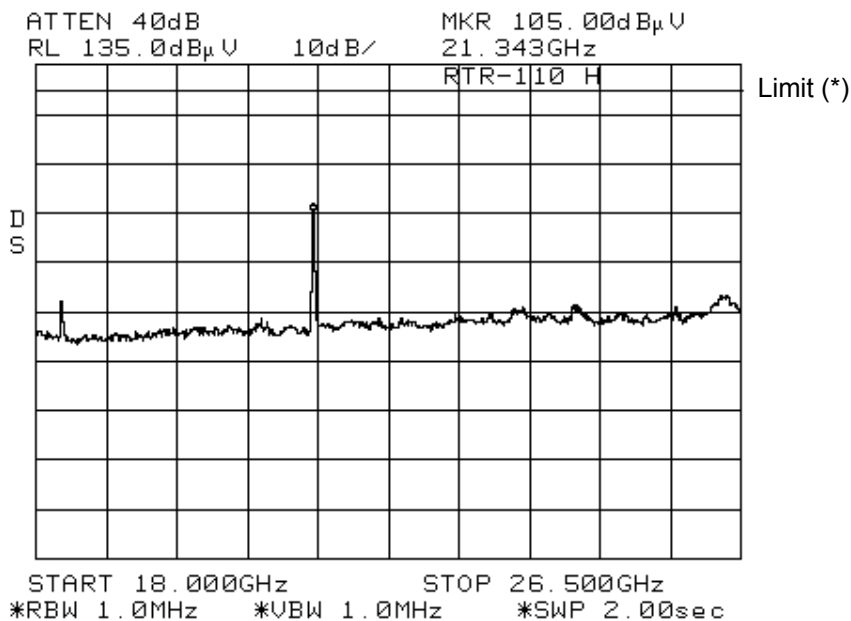


The notch filter ( Pass band: 3050 ± 150 MHz) was inserted between the measuring antenna and Spectrum Analyzer to prevent the excessive input to Spectrum Analyzer only for the test frequency range of 2 GHz to 18 GHz.

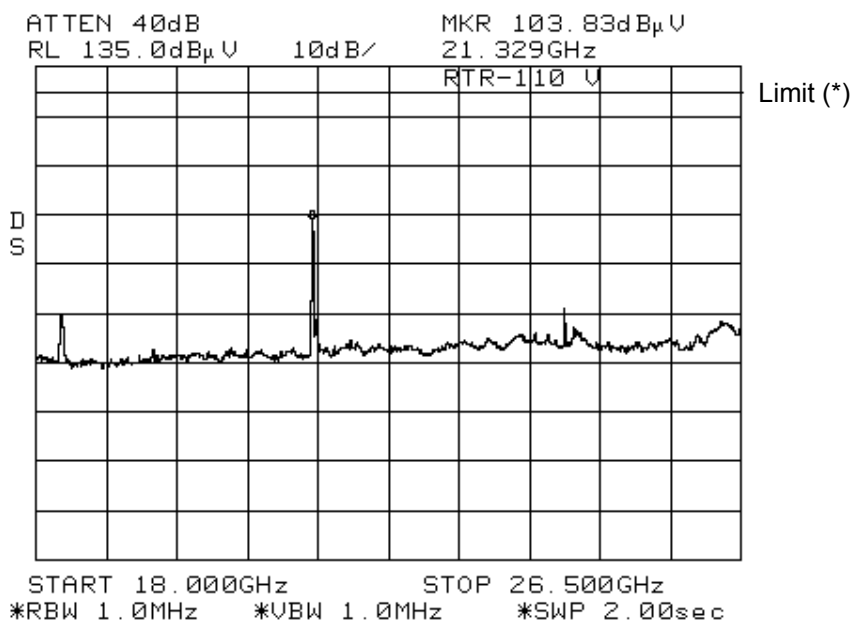
(\*) The Limit is represented by the voltage value, which was derived from the electric field strength value with Antenna factor, Cable loss and Amp. gain included.

(4) for 18 GHz to 26.5 GHz

- for Horizontal



- for Vertical

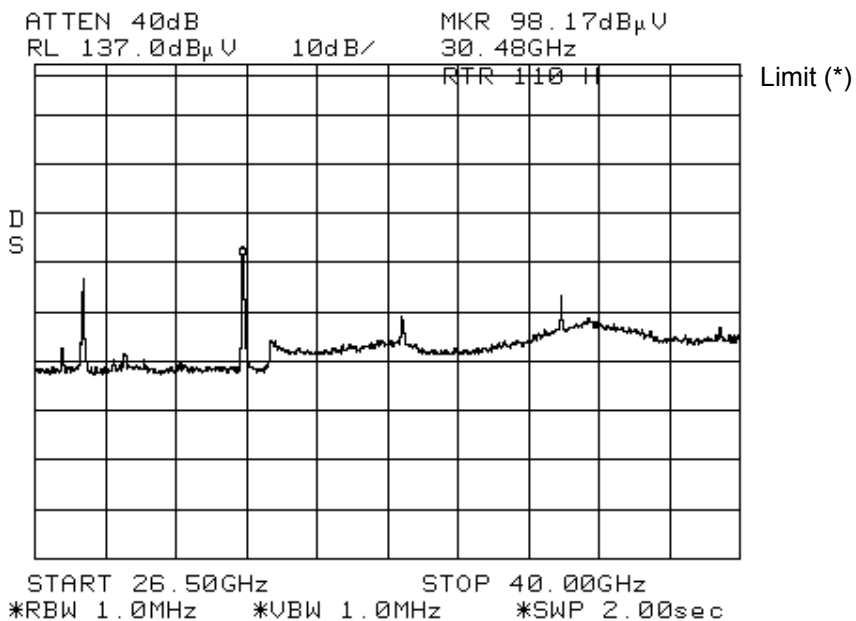


(\*) The Limit is represented by the voltage value, which was derived from the electric field strength value with Antenna factor, Cable loss and Amp. gain.

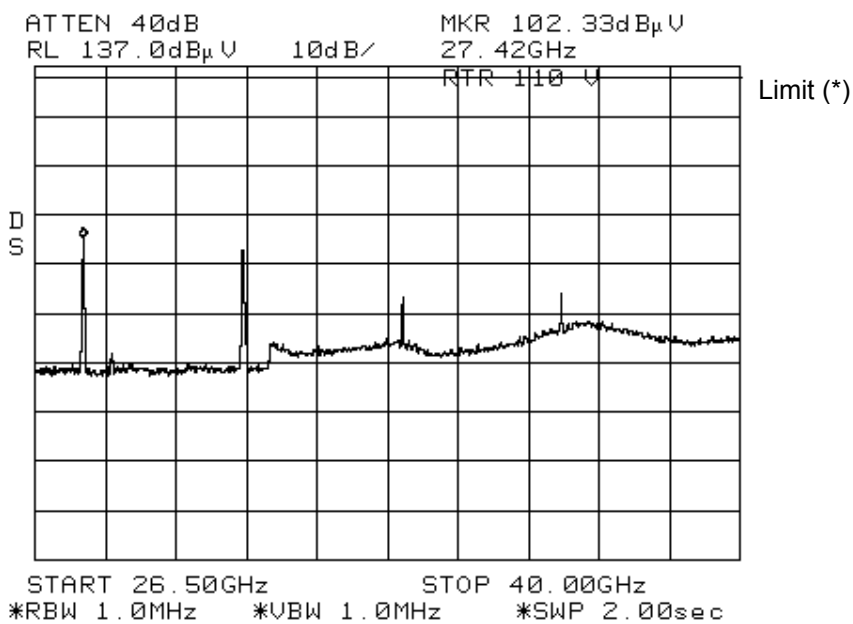
Minimum limit line for the frequency range of 18 GHz to 26.5 GHz is indicated in the above plots.

(5) for 26.5 GHz to 40 GHz

- for Horizontal



- for Vertical



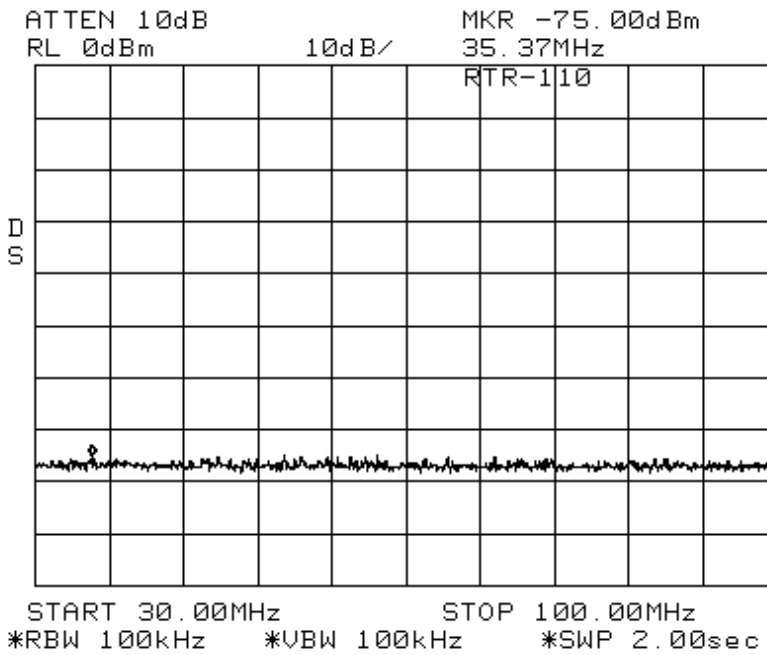
(\*) Emission limit was converted from the electric field strength into the voltage values with Antenna factor, Cable loss and Amp. gain added to the calculation.

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

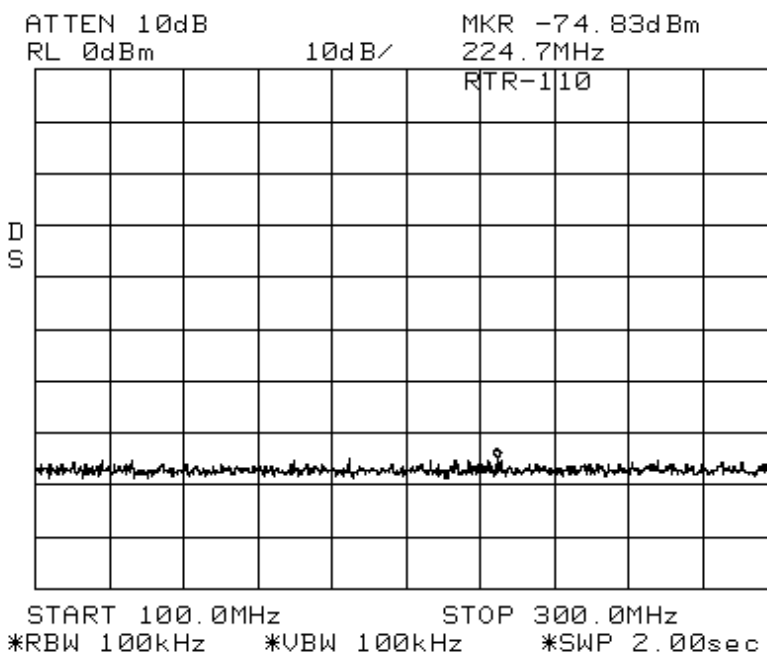




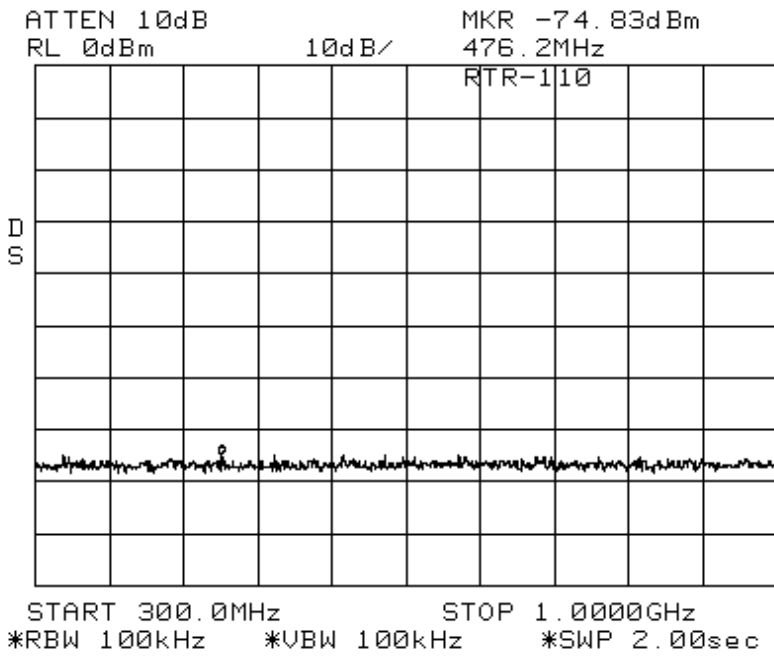
(3) 30 MHz – 100 MHz: Limit = 4000 µW (+6 dBm)



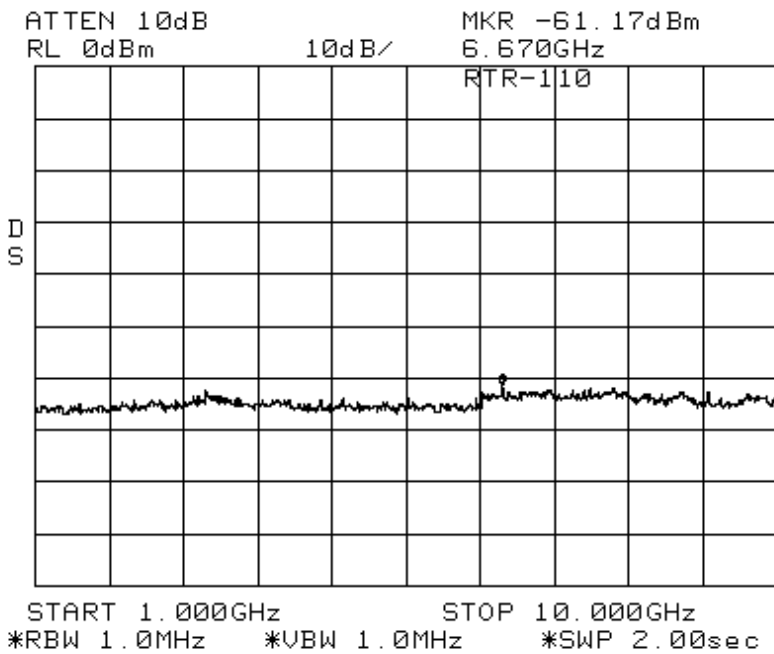
(4) 100 MHz – 300 MHz: Limit = 40000 µW (+16 dBm)



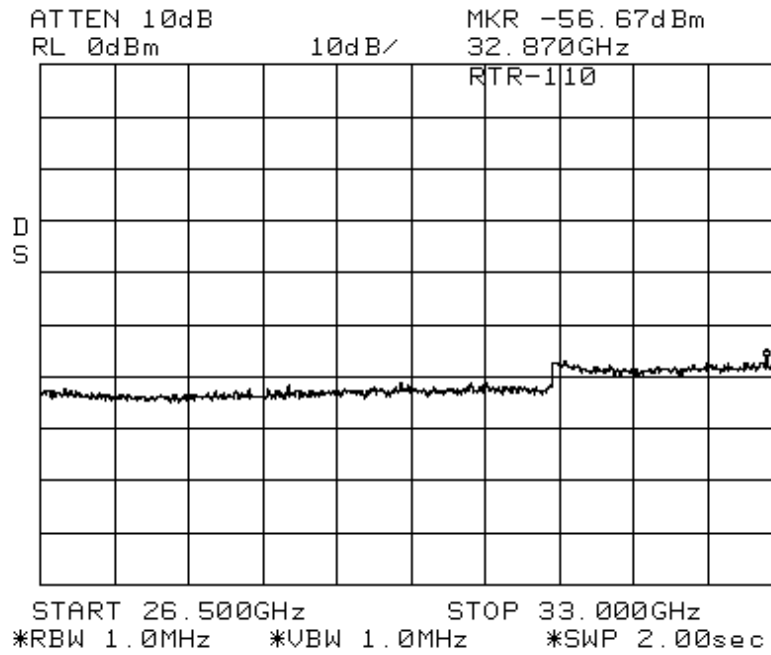
(5) 300 MHz – 1 GHz: Limit = 400000  $\mu$ W (+26 dBm)



(6) 1 GHz – 10 GHz: Limit = 400000  $\mu$ W (+26 dBm)





(9) 26.5 GHz – 33 GHz: Limit = 400000  $\mu$ W (+26 dBm)(10) 33 GHz – 40 GHz: Limit = 400000  $\mu$ W (+26 dBm)