

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 Radar
Type: RTR-102

Report no.: LIC 12-17-121

Rev. 1

Date of revised issue: 14 February 2018

Labotech International Co., Ltd.


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

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

URL: <http://www.labotech-intl.co.jp/>

Report Summary

LIC project number:	LIC 04-17-0615					
Test report number of initial issue:	LIC 12-17-121			Date of initial issue	1 November 2017	
Test report number of revised/replaced issue:	LIC 12-17-121, Rev. 1			Date of revised/replaced issue	14 February 2018	
Test report revision/replacement history:	Rev. No	Date	Page	Item	Description of change/reason	
	1	14 Feb. 2018	9	3.1.3 Test Results	Error was corrected. Transmission pulse power Pp (W) → Transmission pulse power Pp (kW)	
Test standard(s)/Test specifications:	FCC Rules 47 CFR, Sections: 2.1046 - RF Power Output 2.1047 - Modulation Characteristics 2.1049 - Occupied Bandwidth 2.1051 - Spurious Emissions at Antenna Terminals 2.1053 - Field Strength of Spurious Radiation 2.1055 - Frequency Stability 80.209 - Transmitter frequency tolerances 80.211 - Emission limitations 80.213 - Modulation requirements 80.215 - Transmitter power					
Customer:	Furuno Electric Co., Ltd. 9-52, Ashihara-Cho, Nishinomiya-City, Hyogo, 662-8580 Japan					
Manufacturer:	Furuno Electric Co., Ltd. 9-52, Ashihara-Cho, Nishinomiya-City, Hyogo, 662-8580 Japan					
Trade name:	Furuno					
Model:	Transceiver for Radar					
Type:	RTR-102					
Product function and intended use:	Object-detection for safety navigation					
Number of samples tested:	One					
Serial number:	R000-2100-0001					
Power rating:	24 VDC 3.9 A (for Processor Unit)					
Product status:	Production model					
Modifications made to samples during testing:	None					
Date of receipt of samples:	22 September 2017					
Test period:	From 22 September 2017 to 29 September 2017					
Place of test:	Labotech International Co., Ltd. FCC Test firm Designation Number: JP2007 FCC Test firm Registration Number: 838049 - LABOTECH EMC Center 1-16, Fukazu-cho, Nishinomiya-shi, Hyogo, 663-8203 Japan Anechoic Chamber used for the test has been registered by FCC. (FCC 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. (FCC File number: 90607)					
Test results/Compliance:	Passed. The test results of this report relate only to the samples tested.					

Tested by:	Atsushi Takagi and Koji Kawai
Written by:	Shozo Hasegawa
Verified by:	Yasuharu Nakamura
Approved by:	14 February 2018 Name: Yasuharu Nakamura Title: Vice General 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, Climatic, and Vibration tests

(2) Telefication Listed Testing Laboratory:

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

(3) TÜV Appointed EMC Test Laboratory:

- appointed by TÜV Rheinland Japan Ltd.,
- Laboratory assignment number: UA 50046428
- Date of initial appointment: 21 December 1998 (*)
- for carrying out the tests of:
 - EN 55011, CISPR 11, EN 55012, CISPR 12, 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, EN ISO 14982, IEC 62236-3-2, EN 50121-3-2.

(4) 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

(5) 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

(6) DNV GL Recognized Environmental Test Laboratory:

- recognized by Det Norske Veritas AS, Germanischer Lloyd (DNV GL), (Norway)
- Recognition certificate number: 262.1-015854-J-12
- Date of initial recognition: 12 July 2013 (*)
- Scope of recognition: Testing according to the standards IEC 60945, IEC 61162-1/-2/-450, IEC 62288, IEC 62388 and IEC 62252 Annex E
- Application: Provisions of Environmental, interface and safety testing.

(7) CCS Recognized Test Agency :

- recognized by China Classification Society
- Recognition certificate number : DB13A00001
- Date of initial recognition : 29 January 2014 (*)
- Scope of recognition : Performance/Environmental/EMC/Special purpose/Safety precautions tests for Electrical & Electronic Product including Maritime Navigation and Radio-communication Equipment & Systems

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

TABLE OF CONTENTS

Report Summary	2
Testing Laboratory Status	4
1 Principal Information	6
1.1 Equipment under test (EUT)	6
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 and 80.215).....	9
3.2 Modulation Characteristics (FCC Rule 47 CFR, 2.1047)	9
3.3 Frequency Stability –temperature & voltage (FCC Rule 47 CFR, 2.1055(a)(2)/(d)(1)/(d)(3), 80.209(b)).....	10
3.4 Occupied Bandwidth (FCC Rule 47 CFR, 2.1049(c)(1), 80.209(b), 80.211(f)).....	11
3.5 Spurious Emissions at Antenna Port (FCC Rule 47 CFR, 2.1051, 80.211(f)).....	11
3.6 Field Strength of Spurious Radiation (FCC Rule 47 CFR, 2.1053, 80.211(f)).....	12
4 Test Setup for Measurements.....	13
5 Measuring Equipment List	15
6 RF Envelope and Spectrum of the Output Pulse	17
7 Spurious Emission Plots measured at Antenna Terminal	19

1 Principal Information

1.1 Equipment under test (EUT)

1.1.1 General

(a) Trade name: Furuno

(b) Manufacturer: Furuno Electric Co., Ltd.

9-52, Ashihara-cho, Nishinomiya-city, Hyogo, 662-8580 Japan

(c) Model:

	Type	Serial Number	Note
Transceiver module	RTR-102	R000-2100-0001	Contained in Antenna Unit.
Scanner module	RSB-120		---
Antenna radiator	XN20AF/XN24AF	---	Selectable

(d) FCC ID: ADB9ZWRTR102

(e) Primary Function: Search, Navigation and Anti-collision

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

(g) Type of Emission: P0N

(Emission designator)

(h) Occupied bandwidth:

Pulse type	S	M1	M2	L1
Occupied bandwidth (MHz)	60.5	37.6	21.1	10.1

Note: measured data.

(h) Size and mass: Antenna Unit: 2040 mm x 570 mm (H), 37 kg with Antenna XN20AF installed.

Antenna Unit: 2550 mm x 570 mm (H), 39 kg with Antenna XN24AF installed.

(i) Power Supply: 24 VDC (for Processor unit) or 100 to 115/220 to 230 VAC (*) (for Processor unit)

(*): fed through the specified external equipment, not directly from AC/DC mains.

1.1.2 Transceiver

Type: RTR-102 (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:

Type: MAF1611B

Peak Output Power: 4 kW nominal

(c) Magnetron Ratings:

Center frequency of Magnetron: 9410 MHz nominal

Tolerances:

Manufacturing: ± 30 MHz

Pulling: 23 MHz

Tolerance for 20°C temperature variation: -5 MHz

(d) Pulse Characteristics:

Pulse type	S	M1	M2	L
Pulse length (μ s)	0.044	0.122	0.269	0.592
PRF(Hz)	3993	1998	1998	995

1.1.2.2 Modulator

FET Type: RJK5015DPK

Trigger Voltage: Approximately +12 VDC positive

1.1.2.3 Receiver

(a) Passband

RF Stage: 100 MHz

IF Stage:

Pulse type	S	M1	M2	L
Passband (MHz)	38	10	10	4.0

(b) Intermediate Frequency: 60 MHz

(c) Gain (overall): Approximately 100 dB

(d) Overall Noise Figure: 4 dB (typical)

(e) Video Output Voltage: 4 V Negative

(f) Features Provided: Main bang suppression

(g) Method for adjusting frequency: By adjusting tuning voltage of receiver local oscillator (automatically and manually)

(h) Frequency adjustable range: 9410 MHz (center) \pm 30 MHz

1.1.3 Antenna and Scanner

(a) Antenna Rotation ON-OFF Switch: Provided.

(b) Construction: Slotted array antenna

(c) Length:

Antenna type	XN20AF	XN24AF
Length (cm)	204	255

(d) Type of Beam: Vertical fan

(e) Beam Width (3 dB):

Antenna type	XN20AF	XN24AF
Horizontal (°)	1.23	0.95
Vertical (°)	20	20

(f) Polarization: Horizontal

(g) Antenna Gain:

Antenna type	XN20AF	XN24AF
Gain (dBi)	30.0	31.0

(h) Attenuation of Major Side and Back Lobes with respect to Main Beam:

Antenna type	XN20AF	XN24AF
Within \pm 20° (dB)	-28	-28
Outside \pm 20° (dB)	-32	-32

(i) Scanning (rotating or oscillating): Rotating

(j) Antenna Rotation Rate: 26 rpm

(k) Sector Scan: Not provided.

(l) Rated Loss of Transmission Line per 100 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 number of this report	47 CFR Section	Item	Result	Test Engineer
3.1	2.1046 (a), 80.215	RF Power Output	Passed.	K. Kawai
3.2	2.1047	Modulation Characteristics	Passed.	K. Kawai
3.3	2.1055 (a)(2),(d)(1),(d)(3), 80.209 (b)	Frequency Stability	Passed.	K. Kawai
3.4	2.1049 (c)(1), 80.209 (b), 80.211 (f)	Occupied Bandwidth	Passed.	K. Kawai
3.5	2.1051, 80.211 (f)	Spurious Emissions at Antenna Terminals	Passed.	K. Kawai
3.6	2.1053, 80.211 (f)	Field Strength of Spurious Radiation	Passed.	A. Takagi

3 Test Results

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

3.1.1 Test conditions:

For all TX (S /M1/M2/ L) Pulses, the transmitter output power was measured with the Non-reflective load and the Directional Coupler as a substitute for the Antenna.

3.1.2 Test setup:

See Clause 4.

3.1.3 Test Results:

Pulse type	S	M1	M2	L
Transmission mean power P _m (W)	0.6	0.8	1.8	1.9
Transmission pulse power P _p (kW) (*1)	3.6	3.3	3.3	3.3
Pulse length T (μs) (-3 dB points)	0.044	0.122	0.269	0.592
PRF (Hz)	3993	1998	1998	995

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

Environmental conditions observed: On 27 September 2017, 24°C to 24°C, 60%RH to 60%RH

Power supply voltage measured: 24.0 VDC to 24.0 VDC

3.2 Modulation Characteristics (FCC Rule 47 CFR, 2.1047)

3.2.1 Test Conditions:

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

3.2.2 Test setup:

See Clause 4.

3.2.3 Test Results:

Pulse type	S	M1	M2	L
Pulse length T (μs) (-3 dB points)	0.044	0.122	0.269	0.592
Rise time t _r (μs) (10 to 90 % amplitude)	0.016	0.016	0.017	0.014
Fall time t _f (μs) (90 to 10 % amplitude)	0.036	0.038	0.042	0.046
PRF (Hz)	3993	1998	1998	995

Measured Plots: See Clause 7.

Environmental conditions observed: On 27 September 2017, 24°C to 24°C, 60%RH to 60%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))**

3.3.1 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: 85/100/115% of nominal voltage
DC Processor unit (24 VDC): 20.4/24.0/27.6 VDC

3.3.2 Test setup:

See Clause 4.

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

Pulse type	S	M1	M2	L
Guard Band f(1.5/T) (MHz) (*1)	34.4	12.3	5.6	2.5
f(U) (MHz) (*2)	9465.6	9487.7	9494.4	9497.5
f(L) (MHz) (*2)	9334.4	9312.3	9305.6	9302.5

(*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

3.3.4 Test Results:

Complied.

(1) at the rated supply voltage of 24.0 VDC:

Pulse type		S	M1	M2	L	Result
Frequency at maximum emission (MHz)	-20°C	9426.3	9427.7	9427.0	9427.0	Complied.
	-10°C	9425.0	9425.3	9426.0	9425.0	Complied.
	0°C	9424.0	9424.7	9424.3	9424.3	Complied.
	+10°C	9422.7	9422.7	9422.0	9422.7	Complied.
	+20°C	9420.0	9420.7	9420.0	9420.0	Complied.
	+30°C	9419.0	9419.7	9418.7	9418.0	Complied.
	+40°C	9416.7	9416.0	9416.0	9416.0	Complied.
	+50°C	9414.7	9414.7	9414.0	9414.0	Complied.

(2) at the temperature of +20°C:

Pulse type		S	M1	M2	L	Result
Frequency at maximum emission (MHz)	20.4 VDC	9420.7	9420.7	9420.0	9420.0	Complied.
	24.0 VDC	9420.0	9420.7	9420.0	9420.0	Complied.
	27.6 VDC	9420.7	9420.7	9420.0	9420.0	Complied.

Environmental conditions observed: On 26 September 2017, 24°C to 24°C, 60%RH to 60%RH
On 27 September 2017, 24°C to 24°C, 60%RH to 60%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))

3.4.1 Test conditions:

For all TX (S/M1/M2 /L) Pulses, the transmitter occupied bandwidth was measured with the Non-reflective load and the Directional Coupler as a substitute for the Antenna.

3.4.2 Test setup:

See Clause 4.

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

Frequency removed from the assigned frequency (*1)	Emission attenuation (mean power, dB)
50 to 100 % (of the authorized bandwidth) (*2)	At least 25
100 to 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 band width = 110 MHz (for X-band radars)

3.4.4 Test Results:

Complied.

Spectrum plots: See Clause 8.

Environmental conditions observed: On 28 September 2017, 24°C to 24°C, 60%RH to 60 %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))

3.5.1 Test Conditions:

For S Pulse, the transmitter output power was measured with the Waveguide Converter as a substitute for the Antenna. (*1)

(*1): Emission measurements only need to be carried out for the pulse length setting producing the widest calculated B-40 bandwidth. (IEC 62388 Ed.2/ Annex B.4.2 part)

3.5.2 Test setup:

See Clause 4.

3.5.3 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): Spurious measurement range for X-Band RADAR: 4.59 GHz to 40 GHz

3.5.4 Spurious Frequencies:

f ₀ (GHz)	1/2f ₀	2f ₀	3f ₀	4f ₀
9.410	4.705	18.820	28.23	37.64

3.5.5 Test Results:

Complied.

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

Environmental conditions observed: On 29 September 2017, 24°C to 24°C, 53 %RH to 53 %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))

3.6.1 Test Conditions:

For S Pulse, the transmitter output power was measured with the Non-reflective load as a substitute for the Antenna. (*1)

(*1): Emission measurements only need to be carried out for the pulse length setting producing the widest calculated B-40 bandwidth. (IEC 62388 Ed.2/ Annex B.4.2 part)

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

(b) Antenna port was terminated with dummy load.

3.6.2 Test Site: LIC EMC Center, Semi-Anechoic Chamber (FCC file number: 818191)

3.6.3 Distance between the Radar and Measuring Antenna: 3 m

3.6.4 Test setup:

See Clause 4.

The GRP (Ground reference plane, metal floor) between the EUT and the measuring (receiving) antenna was lined with the Radio Absorbers (3.0 m × 2.4 m × 0.3 m) to reduce the influences of the reflections of the RF waves from the floor.

Measuring (receiving) Antenna Height and Polarization:

(a) Antenna height: EUT center (1.75 m)

(b) Antenna polarization: vertical and horizontal.

EUT height: 1.5 m

3.6.5 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)

3.6.6 Spurious Frequencies:

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

3.6.7 Test Results:

Complied.

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

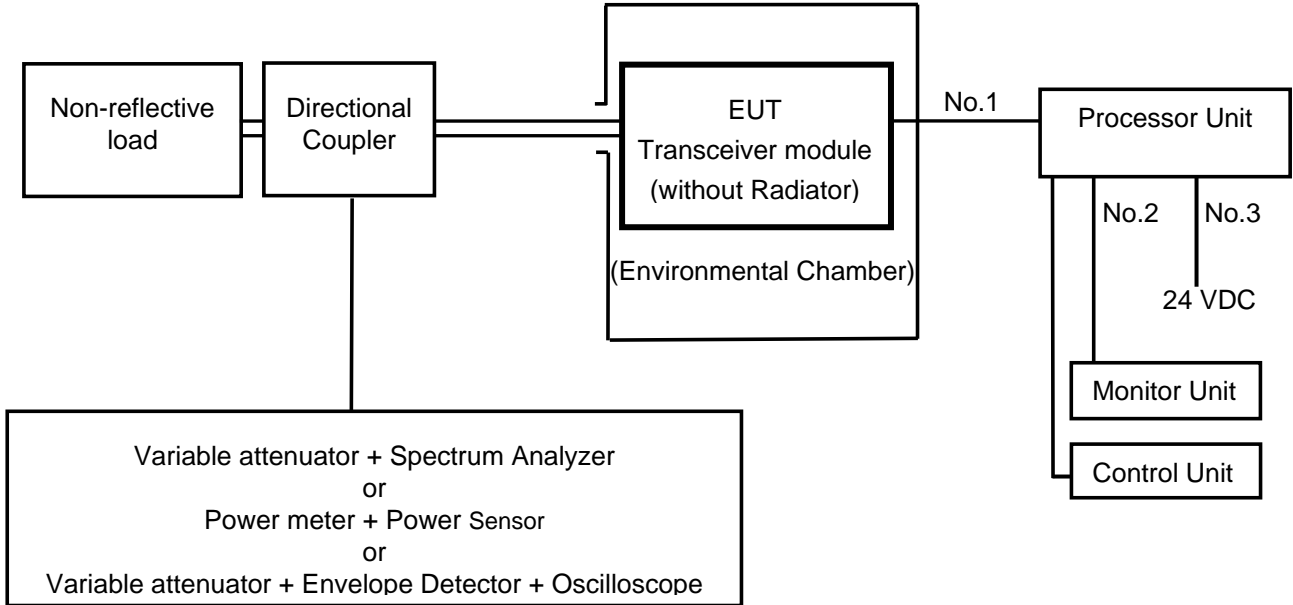
Environmental conditions observed: On 23 September 2017, 25°C to 25°C, 61%RH to 61%RH

On 24 September 2017, 25°C to 25°C, 61%RH to 61%RH

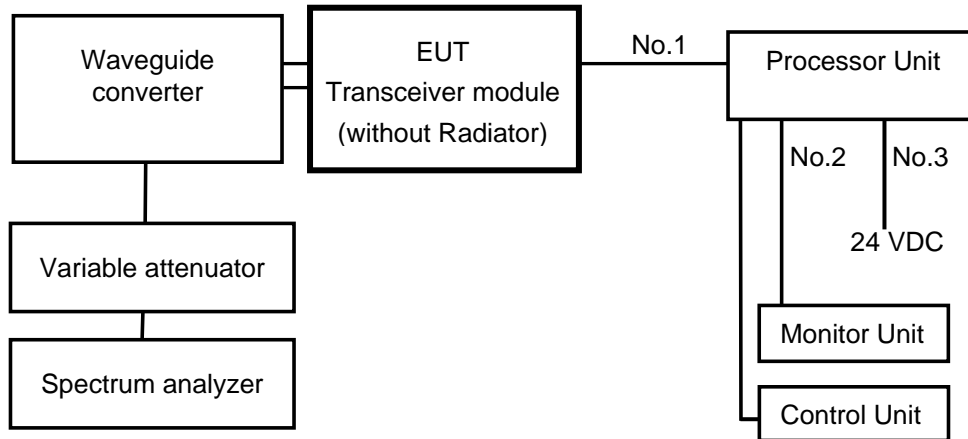
Power supply voltage measured: 24.0 VDC to 24.0 VDC

4 Test Setup for Measurements

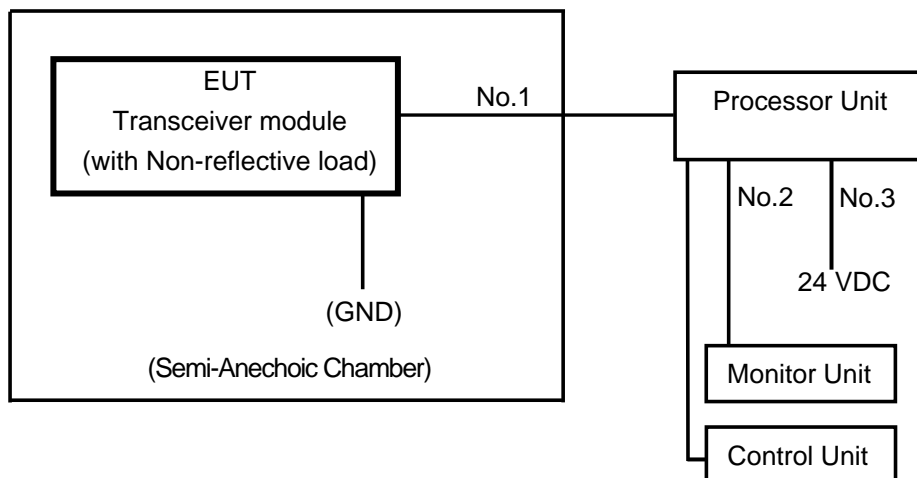
4.1 Test Setup for Clauses 3.1, 3.2 and 3.3



4.2 Test Setup for Clauses 3.4 and 3.5



4.3 Test Setup for Clause 3.6



Cable designations:

No.	Name	Length (m)
1	RW-0013	20
2	DVI-D/D S-LINK	10
3	DPYC-6	5

5 Measuring Equipment List

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

5.1 RF Power Output:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional Coupler (X-band)	5D364S	R05762	Shimada	10 February 2017	1 year
RT198	Dummy Load (X-band)	4D376	R4535004	Shimada	10 February 2017	1 year
RT200	Power Meter	E4419B	6200769857	ANRITSU	9 March 2017	1 year
RT201	Power Sensor	8481A	2349A39603	Agilent	8 March 2017	1 year
RT213	Waveguide	WRJ-10	---	Furuno	4 July 2017	1 year
HT430	DC Power Supply	PAN55-20	AK003303	Kikusui	---	---
HT510	Climatic Chamber (Hama-L)	TBE-3HW4PE2F	3013002540	Tabai Espec	21 September 2017	1 year
HT725	Paperless Recorder/Dual Communication Logger DAQSTATION FX100	FX106-4-1	S5JA01447	Yokogawa	21 September 2017	1 year
HT1024	Digital Multi-Meter	233	27230019	FLUKE	7 February 2017	1 year

5.2 Modulation Characteristics:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional Coupler (X-band)	5D364S	R05762	Shimada	10 February 2017	1 year
RT198	Dummy Load (X-band)	4D376	R4535004	Shimada	10 February 2017	1 year
RT213	Waveguide	WRJ-10	---	Furuno	4 July 2017	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	13 February 2017	1 year
HT655	Attenuator	8495B	MY42144403	Agilent	13 February 2017	1 year
HT913	Crystal Detector	423B	MY51340543	Agilent	1 February 2017	1 year
808052	Frequency Counter	MF2414C	6200769857	ANRITSU	18 July 2017	1 year
HT972	Oscilloscope	MSO4054B	C030483	TEKTRONIX	13 February 2017	1 year
HT430	DC Power Supply	PAN55-20	AK003303	Kikusui	---	---
HT510	Climatic Chamber (Hama-L)	TBE-3HW4PE2F	3013002540	Tabai Espec	21 September 2017	1 year
HT725	Paperless Recorder/Dual Communication Logger DAQSTATION FX100	FX106-4-1	S5JA01447	Yokogawa	21 September 2017	1 year
HT1024	Digital Multi-Meter	233	27230019	FLUKE	7 February 2017	1 year

5.3 Frequency Stability –temperature & voltage:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional Coupler (X-band)	5D364S	R05762	Shimada	10 February 2017	1 year
RT198	Dummy Load (X-band)	4D376	R4535004	Shimada	10 February 2017	1 year
HT510	Climatic Chamber (Hama-L)	TBE-3HW4PE2F	3013002540	Tabai Espec	21 September 2017	1 year
HT725	Paperless Recorder/Dual Communication Logger DAQSTATION FX100	FX106-4-1	S5JA01447	Yokogawa	21 September 2017	1 year
RT213	Waveguide	WRJ-10	---	Furuno	4 July 2017	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	13 February 2017	1 year
HT655	Attenuator	8495B	MY42144403	Agilent	13 February 2017	1 year
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent	12 April 2017	1 year
HT430	DC Power Supply	PAN55-20	AK003303	Kikusui	---	---
HT1024	Digital Multi-Meter	233	27230019	FLUKE	7 February 2017	1 year

5.4 Occupied Bandwidth:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional Coupler (X-band)	5D364S	R05762	Shimada	10 February 2017	1 year
RT198	Dummy Load (X-band)	4D376	R4535004	Shimada	10 February 2017	1 year
HT654	Attenuator	8494B	MY42148134	Agilent	13 February 2017	1 year
HT655	Attenuator	8495B	MY42144403	Agilent	13 February 2017	1 year
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent	12 April 2017	1 year
HT430	DC Power Supply	PAN55-20	AK003303	Kikusui	---	---
HT1024	Digital Multi-Meter	233	27230019	FLUKE	7 February 2017	1 year

5.5 Spurious Emissions at Antenna Port:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
RT198	Directional Coupler (X-band)	5D364S	R05762	Shimada	10 February 2017	1 year
RT198	Dummy Load (X-band)	4D376	R4535004	Shimada	10 February 2017	1 year
---	Adapter	BL00-6254-00	---	Orient Microwave	---	---
---	Adapter	P281C	MY46040318	Agilent	---	---
---	Adapter	BL00-6256-00	---	Orient Microwave	---	---
---	Adapter	R281B	51328	Agilent	---	---
---	Isolator	OMC FX0157	8H0028	---	---	---
HT676	Spectrum Analyzer	8564EC	4103A00440	Agilent	12 April 2017	1 year
HT430	DC Power Supply	PAN55-20	AK003303	Kikusui	---	---
HT1024	Digital Multi-Meter	233	27230019	FLUKE	7 February 2017	1 year
KB181	Coaxial Cable for Radiated Emission Measurement	SUCOFLEX 102A	1261/2A	HUBER+ SUHNER	12 August 2017	1 year

5.6 Field Strength of Spurious Radiation:

C/N	Instrument	Type	S/N	Manufacturer	Date of last calibration	Calibration interval
HT744	Radiated Emission Measurement Software	EP5/RE	Ver. 5.6.0	TOYO	---	---
HT745	EMI Test Receiver (20 Hz to 40 GHz)	ESU40	110243	Rohde & Schwarz	6 January 2017	1 year
HT758	Broadband Horn Antenna (1 GHz to 6 GHz)	9120B	522	Schwarzbeck	29 December 2016	1 year
HT759	Double Rigged Horn Antenna & Amp.	HAP06-18W	00000065	TOYO	29 December 2016	1 year
HT761	Double Rigged Horn Antenna & Amp.	HAP18-26N	00000017	TOYO	29 December 2016	1 year
HT762	Double Rigged Horn Antenna & Amp.	HAP26-40N	00000010	TOYO	29 December 2016	1 year
HT755	Pre-Amplifier	TPA018-40	1017	TOYO	21 July 2017	1 year
HT779	Semi-Anechoic Chamber	10mSAC	90984	TOKIN	---	---
HT781	Programmable DC Power Supply	PAN60-20A	QM003356	Kikusui	---	---
RT198	Dummy Load (X-band)	4D376	R4535004	Shimada	10 February 2017	1 year
KB181	Coaxial Cable for Radiated Emission Measurement	SUCOFLEX 102A	1261/2A	HUBER+ SUHNER	12 August 2017	1 year

6 RF Envelope and Spectrum of the Output Pulse

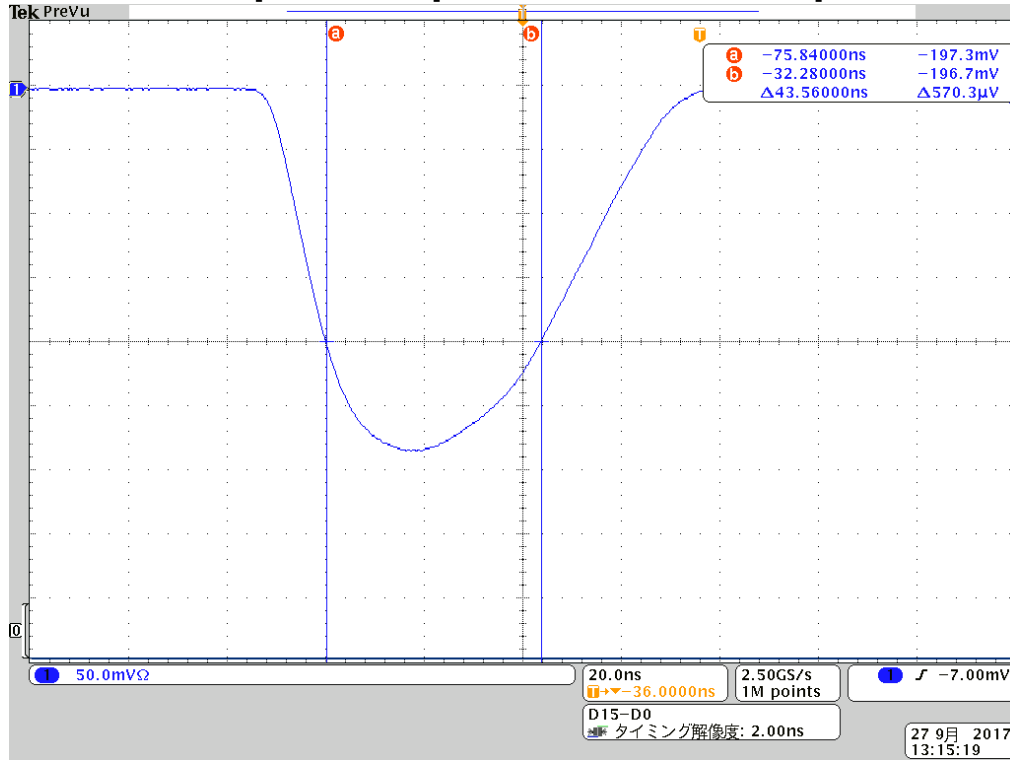


Fig. 7.1 S Pulse Envelope

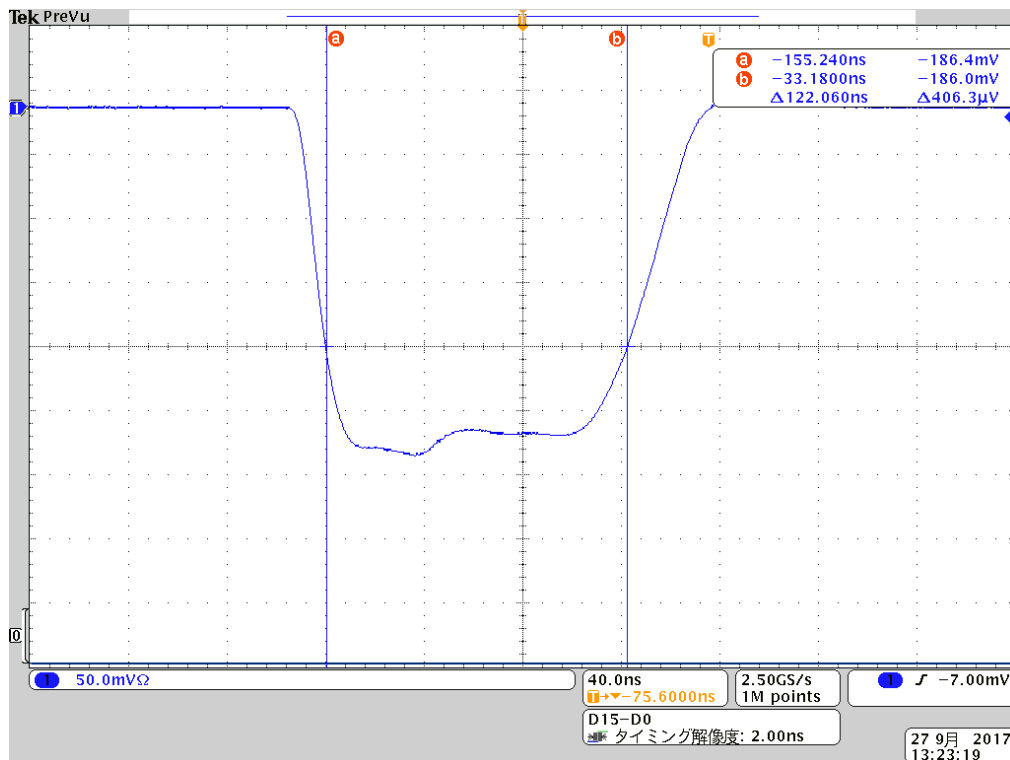


Fig. 7.2 M1 Pulse Envelope

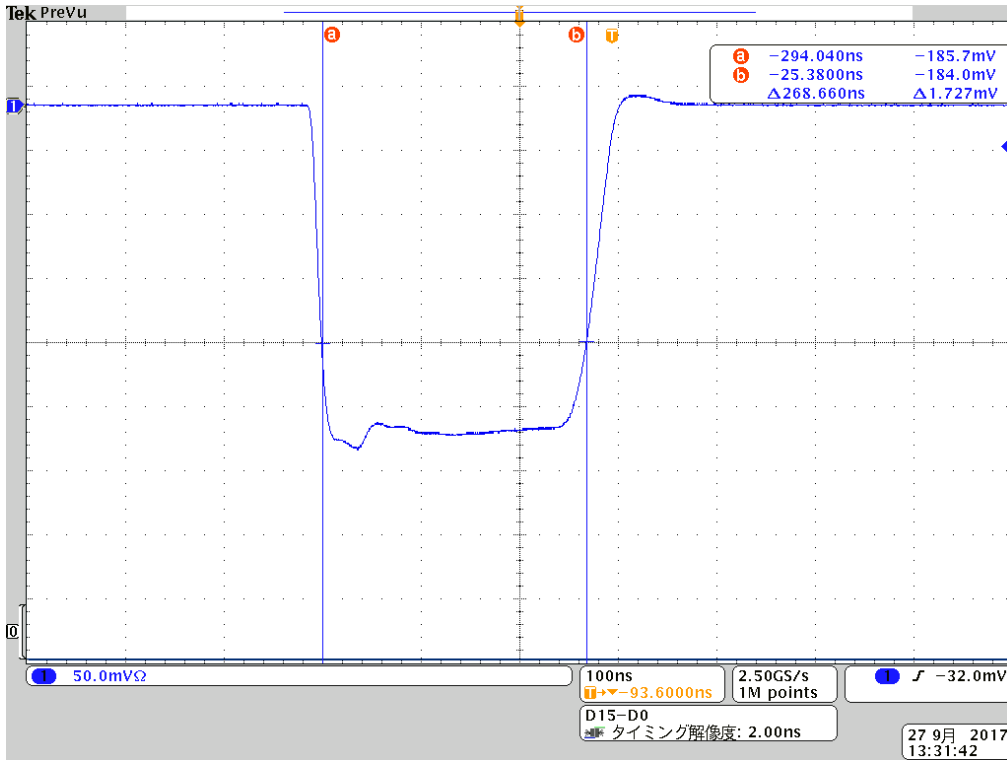


Fig. 7.3 M2 Pulse Envelope

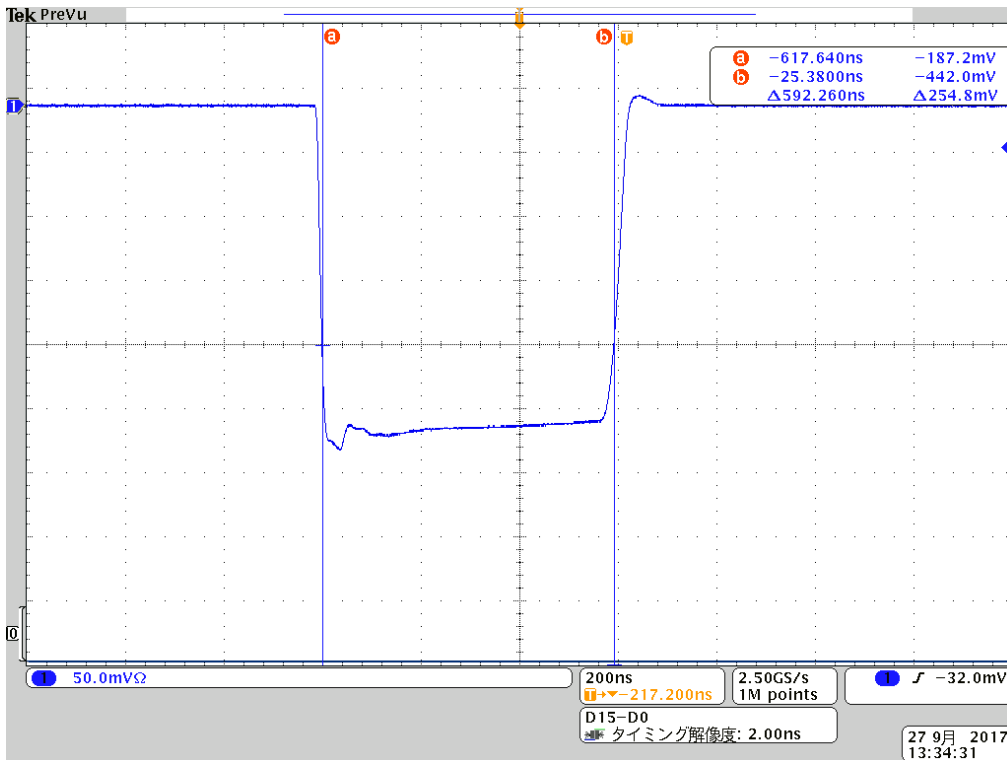


Fig. 7.4 L Pulse Envelope

