Test Report

**(FCC Rules 47 CFR,
2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, 80.873,
80.213, 80.211, 80.217, and 80.874)**

For

Trade name: Furuno
Model: VHF RADIOTELEPHONE
Type: FM-8900S

Report No.: FLI 12-12-070

Date of Issue: 23 May 2012

Furuno Labotech International Co., Ltd.

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Report Summary

FLI project number:	FLI 04-12-0105		
Test report number of initial issue:	FLI 12-12-070	Date of initial issue	23 May 2012
Test report number of revised/replaced issue:	---	Date of revised/replaced issue	---
Test report revision/ replacement history:	---		
Test standard(s)/ Test specifications:	FCC 47 CFR, Sections: 2.1046 and 80.873 - RF Power Output, 2.1047 and 80.213 - Modulation Characteristics, 2.1049 and 80.211 - Occupied Bandwidth, 2.1051 and 80.211 - Spurious Emissions at Antenna Terminal, 2.1053 - Field Strength of Spurious Radiation, 2.1055 - Frequency Stability, 80.217 - Suppression of Interference Aboard Ships, 80.874 - Maximum Usable Sensitivity for the Receiver. (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:	VHF RADIOTELEPHONE		
Type:	FM-8900S		
Product function and intended use:	For Maritime Radiocommunication		
Number of samples tested:	One		
Serial number:	4500-0018		
Power rating:	24 VDC, 4.7 A		
Product status:	Pre-production model		
Modifications made to samples during testing:	None.		
Date of receipt of samples:	2 April 2012		
Test period:	From 2 April 2012 to 26 April 2012		
Place of test:	Furuno Labotech International Co., Ltd. - Nishinomiya Lab. 9-52, Ashihara-cho, Nishinomiya-shi, Hyogo, 662-8580 Japan - Nishinomiya-Hama Lab. 2-20, Nishinomiya-Hama, Nishinomiya-shi, Hyogo, 662-0934 Japan Anechoic Chamber used for the test has been registered by FCC. **(File number: 90607)** **Test firm Designation Number: JP2007,** **Test Firm Registration #: 838049**		
Test results/ Compliance:	Passed. The test results of this report relate only to the samples tested.		
Tested by:	Katsumi Imamura, Yasuharu Nakamura, and Akira Inoue		
Written by:	Akiko Inoue		
Verified by:	Yoshihiro Ishii		
Approved by:	Date: 23 May 2012 Name: Yoshihiro Ishii Title: Senior 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) 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

(2) BSH Recognized Testing Laboratory:
- recognized by Bundesamt für Seeschifffahrt und Hydrographie, 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

(3) 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.

(4) RMRS Recognized Testing Laboratory:
- recognized by Russian Maritime Register of Shipping, 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 Elecrtrical 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)

TABLE OF CONTENTS

1 General Information

1.1 Specifications

1.1.1 Outline

(a) Manufacturer: Furuno Electric Co., Ltd.
Ahihara-cho 9-52, Nishinomiya-city,
662-8580 Japan

(b) Model: FM-8900S
(for Simplex and semi-duplex operation with DSC Class A)

Name	Type	Serial Number
VHF Radiotelephone	FM-8900S	4500-0018

(c) Number of Channel: INTL: 57,
USA: 50,
Weather: 10,
Canada: 57,
Inland waterway: 57,
Private: 20.
MEMORY CH: 50.

(d) Frequency Stability: Within ±1.5 kHz

(e) Communication System: Simplex/ Semi-duplex

(f) Class of Emission: 16K0G3E (Radiotelephone)
16K0G2B (DSC)

(f) Antenna Impedance: 50 ohms

1.1.2 Transmitter functions

(a) Frequency range:

Simplex/ Semi-duplex	155.000 to 161.475 MHz

(b) Output Power: High: Max. 25 W, Low: Not exceed 1 W.
US version: Manual override for 25 W available on CH13, CH67 and CH77.

(c) Frequency Stability: Within ±1.5 kHz

(d) TX Timeout: Deactivates the transmitter after uninterrupted transmission of more than 5 minutes.

(e) Frequency Deviation: Within ±5 kHz (maximum peak)

1.1.3 Receiver

(a) Frequency range:

Simplex	155.000 to 161.475 MHz
Semi-duplex	159.600 to 164.200 MHz

(b) Receiving system: Double-conversion super-heterodyne.
1st IF: 51.1375 MHz
2nd IF: 62.5 kHz

(c) Sensitivity: less than 6 dBμV at SINAD 20 dB

(d) Adjacent channel selectivity: 70 dB or more

(e) Spurious response: 70 dB or more

(f) AF output power: Built-in speaker: 3 W (4 Ω. THD 10% or less.)
Handset earphone receiver: 2 mW (150 Ω)

(g) Audio Response De-emphasis of 6 dB/oct +1/-3 dB

1.1.4 DSC modem

(a) Protocol: ITU-R M.493-13 (Class A), M.541-9 and M.689-2.

(b) Class of emission: 16K0G2B

(c) Baud rate: 1200 baud ±30 ppm max.

(d) Frequency shift: 1700 ±400 Hz
Mark: 1300 Hz
Space: 2100 Hz

(e) Message Log: Receive: 50 distress massages and 50 non-distress Messages
Transmit: 50 messages

(f) Navigational data interface: IEC 61162-1, Ed. 4
INPUT sentence & priority: GNS > GGA > RMC > GLL.
OUTPUT sentence: DSC, DSE, TLL.

(g) Printer interface: Centronics-compatible.

(h) Alarm Audible and visual on receipt of a DSC call.

1.1.5 CH70 Watch Receiver

(a) Receiving Frequency: 156.525 MHz

(b) Receiving system: Double-conversion super-heterodyne.
1st IF: 38.3625 MHz
2nd IF: 37.5 kHz

(c) Sensitivity: Less than 0 dBμV (Symbol error rate (SER) < 1%)

(d) Adjacent channel selectivity: 70 dB or more

(e) Spurious response: 70 dB or more

1.1.6 Power Requirements

(a) Power supply: 24 VDC (-10%/+30%)

(b) Power consumption:

mode	Current consumption
Standby	typ. 0.6 A at 24.0 VDC
Receive	typ. 0.8 A at 24.0 VDC
Transmit	max. 4.7 A at 24.0 VDC

1.1.7 Environment

(a) Temperature: -15°C to 55°C

(b) Relative humidity: 93% (at 40°C)

(c) Waterproofing (IEC 60529):

Transceiver Unit FM-8900S: IP20 (IP22 with option)

Handset/Hanger HS-2003/FP05-05510: IP24

(d) Dimensions & Mass:

	Type	Width (mm)	Height (mm)	Depth (mm)	Weight (kg)
Transceiver unit	FM-8900S	258	108	240	4.2
Handset/ Hanger	HS-2003/ FP05-05510	55/ 65	35/ 60	200/ 208	0.2/ 0.5

1.2 Observation and comments

None.

2 Test Results Summary

Clause no. of this report	47 CFR Section	Item	Result	Test Engineer
3.1	2.1046 & 80.873	RF Power Output	---	---
3.1.1		RF Power Output	Passed.	K. Imamura
3.1.2		Output Power Variation	Passed.	Y. Nakamura
3.2	2.1047 & 80.213	Modulation Characteristics	---	---
3.2.1		Audio Frequency Response	Passed.	K. Imamura
3.2.2		Modulation Limiting	Passed.	K. Imamura
3.3	2.1049 & 80.211	Occupied Bandwidth	Passed.	K. Imamura
3.4	2.1051 & 80.211	Spurious Emissions at Antenna Terminal	Passed.	K. Imamura
3.5	2.1053	Field Strength of Spurious Radiation	Passed.	K. Imamura and A. Inoue
3.6	2.1055	Frequency Stability	Passed.	Y. Nakamura
3.7	80.217	Suppression of Interference Aboard Ships	Passed.	K. Imamura
3.8	80.874	Maximum Usable Sensitivity for the Receiver	Passed.	K. Imamura

3 Test Results

3.1 RF Power Output (FCC Rules Part 80.873 (c) & 2.1046)

3.1.1 RF Power Output

3.1.1.1 Method of Measurement

(a) The DC voltages applied to and DC currents into the final RF output module of the EUT (Equipment Under Test) will be measured.

(b) Carrier power will be measured at the EUT RF output terminal with 50 Ω load attached for both HI and LO Power positions.
See Fig. 3.1.1 below.

(c) Power Supply Voltages applied to the EUT will be set to 24 VDC ±15%.

(d) TX frequencies will be set to CH180 (155.000 MHz), CH16 (156.800 MHz) and CH179 (161.475 MHz).

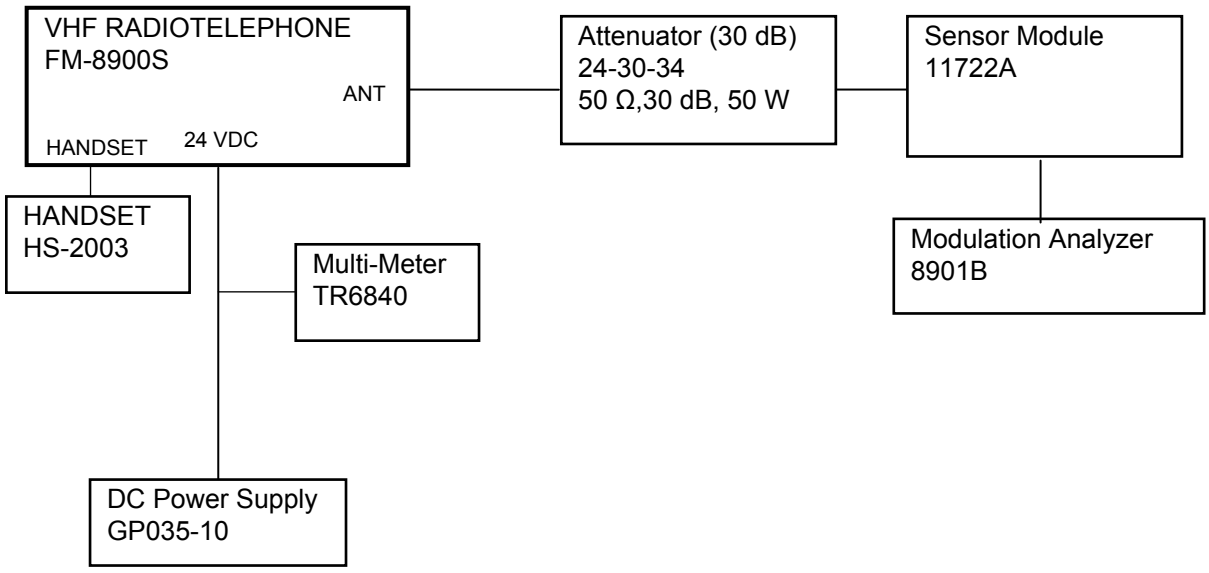


Fig. 3.1.1 Test set-up

3.1.1.2 List of Measuring/Test Equipment

See Clause 4 of this report.

3.1.1.3 Test Result

Passed.

Results are shown below.

CH	Power Supply (VDC)	Output (High power)			Output (Low power)		
		Carrier Power (W)	DC Volt (VDC)	DC Current (A)	Carrier Power (W)	DC Volt (VDC)	DC Current (A)
180	20.4	21.06	14.90	3.07	0.67	14.92	0.52
	24.0	21.15	14.90	3.07	0.67	14.92	0.52
	27.6	21.12	14.90	3.07	0.67	14.92	0.52
16	20.4	20.84	14.90	3.03	0.67	14.92	0.51
	24.0	20.94	14.90	3.03	0.67	14.92	0.51
	27.6	20.93	14.90	3.03	0.67	14.92	0.51
179	20.4	20.14	14.90	3.29	0.67	14.92	0.54
	24.0	20.23	14.90	3.29	0.67	14.92	0.54
	27.6	20.20	14.90	3.29	0.67	14.92	0.54

Environmental conditions observed: On 16 April 2012, 27°C to 27°C, 42% to 42%RH, 24.0 VDC to 24.0 VDC.

3.1.2 Output Power Variation

3.1.2.1 Setup for measurement

The EUT will be placed in the climatic chamber and transmitter output (Carrier power) will be measured at ambient temperatures of -20, -10, 0, +10, +20, +30, +40 and +50°C on Channel 180 (155.000 MHz),16 (156.800 MHz) and 179 (161.475 MHz).
Test set-up is shown below (Fig. 3.1.2).

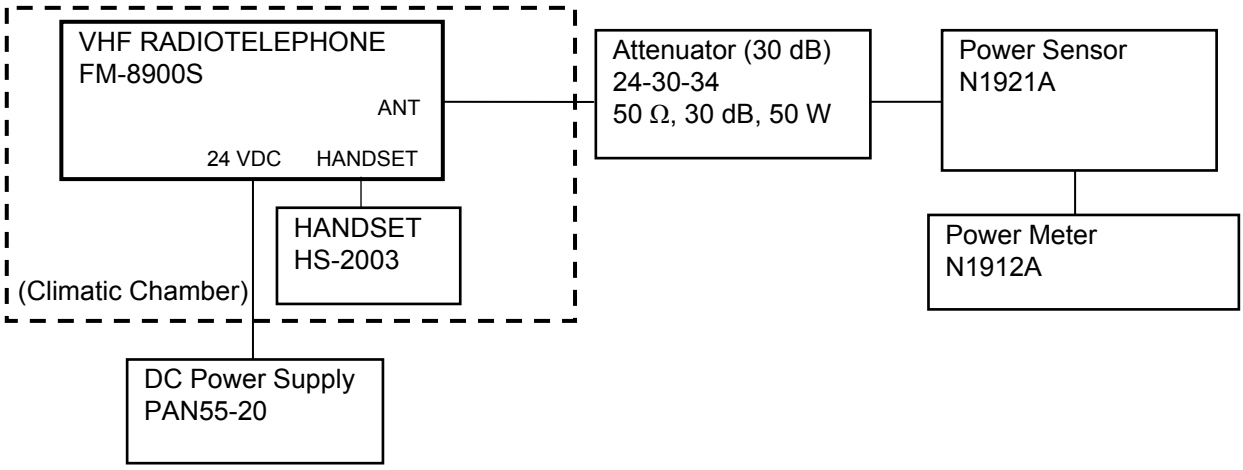


Fig. 3.1.2 Test set-up

3.1.2.2 List of Measuring/Test Equipment

See Clause 4 of this report.

3.1.2.3 Test Result

Passed.

Temp.	Power Supply (VDC)	Carrier power (W)					
		Channel 180		Channel 16		Channel 179	
		High power	Low power	High power	Low power	High power	Low power
-20°C	20.4	22.4	0.92	22.2	0.93	21.4	0.93
	24.0	22.3	0.94	22.1	0.94	21.4	0.94
	27.6	22.1	0.91	22.0	0.91	21.3	0.91
-10°C	20.4	22.0	0.89	21.9	0.91	21.3	0.93
	24.0	22.2	0.90	21.9	0.88	21.2	0.89
	27.6	22.1	0.88	21.9	0.90	21.1	0.87
0°C	20.4	21.9	0.84	21.8	0.85	21.1	0.83
	24.0	21.9	0.85	21.7	0.83	21.0	0.84
	27.6	21.8	0.82	21.7	0.83	21.0	0.81
+10°C	20.4	21.7	0.77	21.5	0.78	21.0	0.79
	24.0	21.8	0.79	21.6	0.80	20.9	0.78
	27.6	21.7	0.81	21.6	0.81	21.0	0.83
+20°C	20.4	21.6	0.74	21.3	0.73	20.7	0.73
	24.0	21.6	0.74	21.3	0.74	20.7	0.74
	27.6	21.5	0.74	21.4	0.73	20.7	0.73
+30°C	20.4	21.4	0.71	21.3	0.72	20.6	0.71
	24.0	21.4	0.72	21.3	0.71	20.6	0.72
	27.6	21.5	0.72	21.3	0.73	20.6	0.74
+40°C	20.4	21.4	0.69	21.0	0.68	20.4	0.69
	24.0	21.3	0.68	21.2	0.68	20.4	0.68
	27.6	21.2	0.67	21.1	0.67	20.5	0.67
+50°C	20.4	21.3	0.66	21.0	0.66	20.4	0.67
	24.0	21.2	0.66	21.0	0.67	20.5	0.67
	27.6	21.3	0.67	21.0	0.68	20.4	0.68

Environmental conditions observed: On 2 April 2012, 22°C to 22°C, 50% to 50%RH, 24.0 VDC to 24.0 VDC.

On 3 April 2012, 21°C to 21°C, 53% to 53%RH, 24.0 VDC to 24.0 VDC.

On 4 April 2012, 20°C to 20°C, 48% to 48%RH, 24.0 VDC to 24.0 VDC.

3.2 Modulation Characteristics (FCC Rule Part 2.1047)

3.2.1 Audio Frequency Response (FCC Rules Part 2.1047 (a) & 80.213)

3.2.1.1 Method of Measurement

(1) The EUT will be connected with measuring equipment as shown in Fig. 3.2.1.1.

(2) A modulation signal at a frequency of 1 kHz will be applied to the transmitter and the deviation will be measured at the output. The audio input level will be adjusted so that the frequency deviation is ±1 kHz. This is the reference point in Fig. 3.2.1.2 (1 kHz corresponds to 0 dB).
The modulation frequency will then be varied between 100 Hz and 40 kHz, with the level of the audio frequency signal being kept constant and equal to the value specified above.

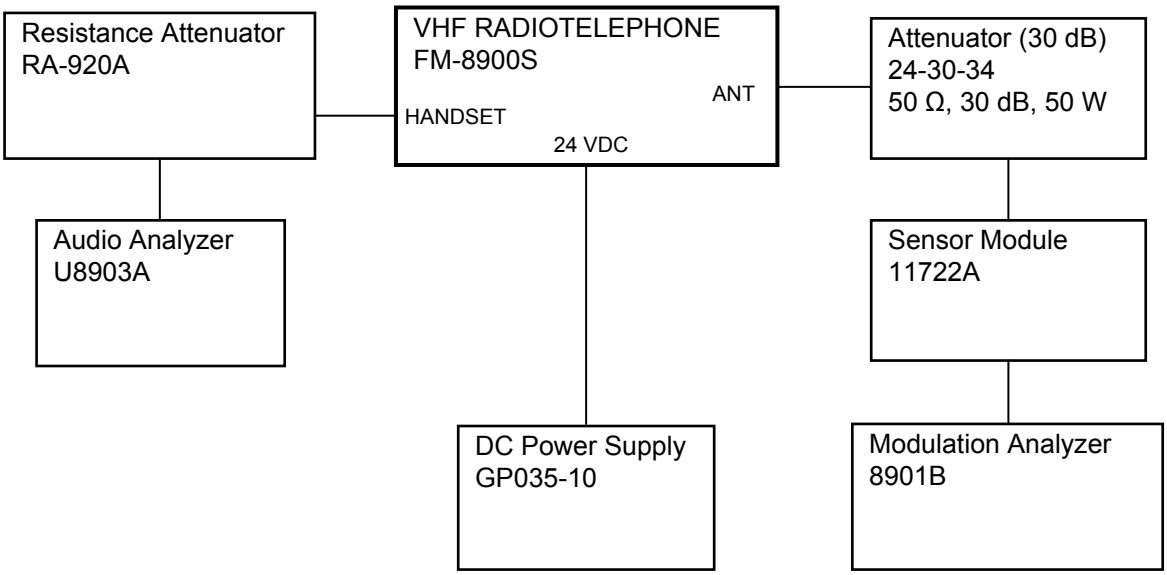


Fig. 3.2.1.1 Setup for measurement

3.2.1.2 List of Measuring/Test Equipment

See Clause 4 of this report.

3.2.1.3 Test Result

Passed.

(1) Overall modulation characteristics:

Results are shown in Fig.3.2.1.2.

(2) Audio Low-Pass filter characteristics:
The characteristics of Audio Low-pass filter are generated by the software used for DSP (Digital Signal Processor).

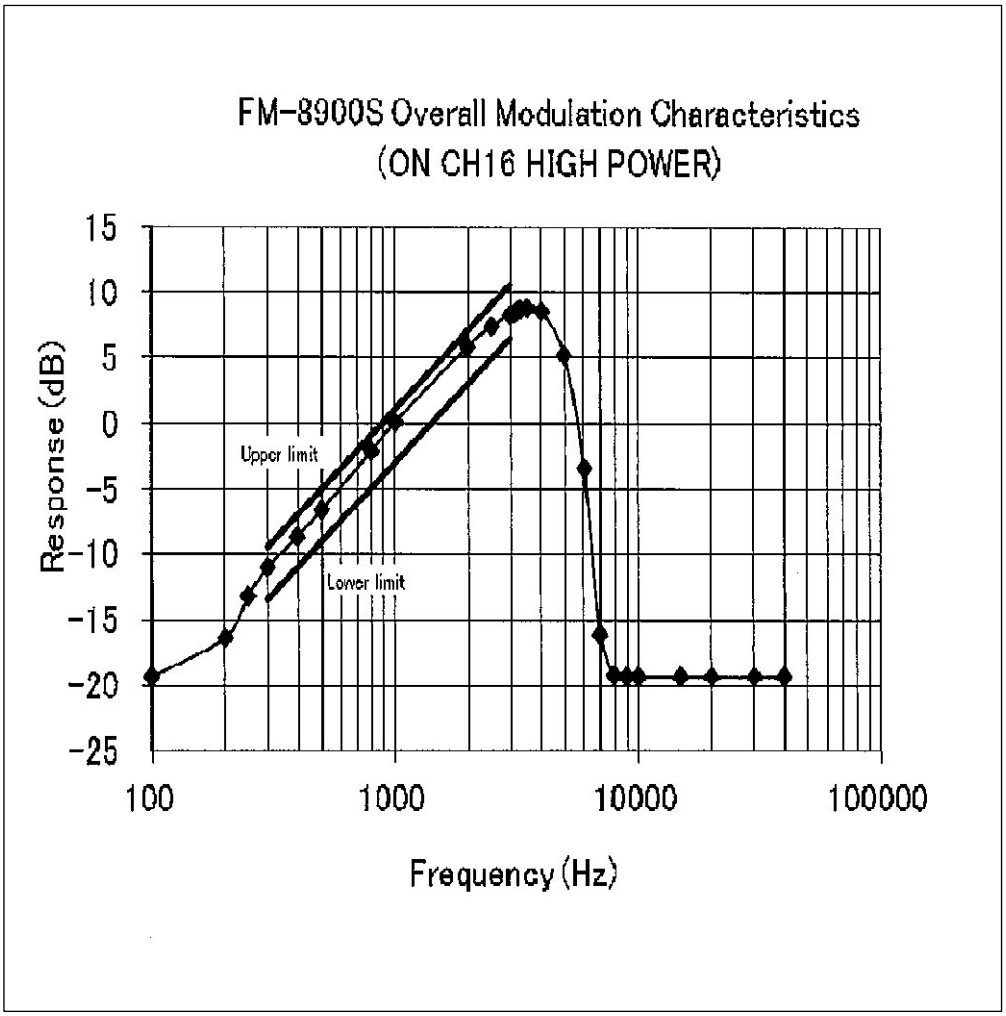


Fig. 3.2.1.2 Audio Frequency Response

Environmental conditions observed: On 17 April 2012, 28°C to 28°C, 36% to 33%RH, 24.0 VDC to 24.0 VDC.

3.2.2 Modulation Limiting (FCC Rule Part 2.1047 (b))

3.2.2.1 Method of Measurement

A modulation signal at a frequency of 1 kHz will be applied to the transmitter, and its level adjusted so that the frequency deviation becomes to ±1 kHz. The level of the modulation signal will then be increased by 20 dB and the deviation will again be measured.
The deviation will be also measured with the modulation signal at 300 Hz and 3 kHz.

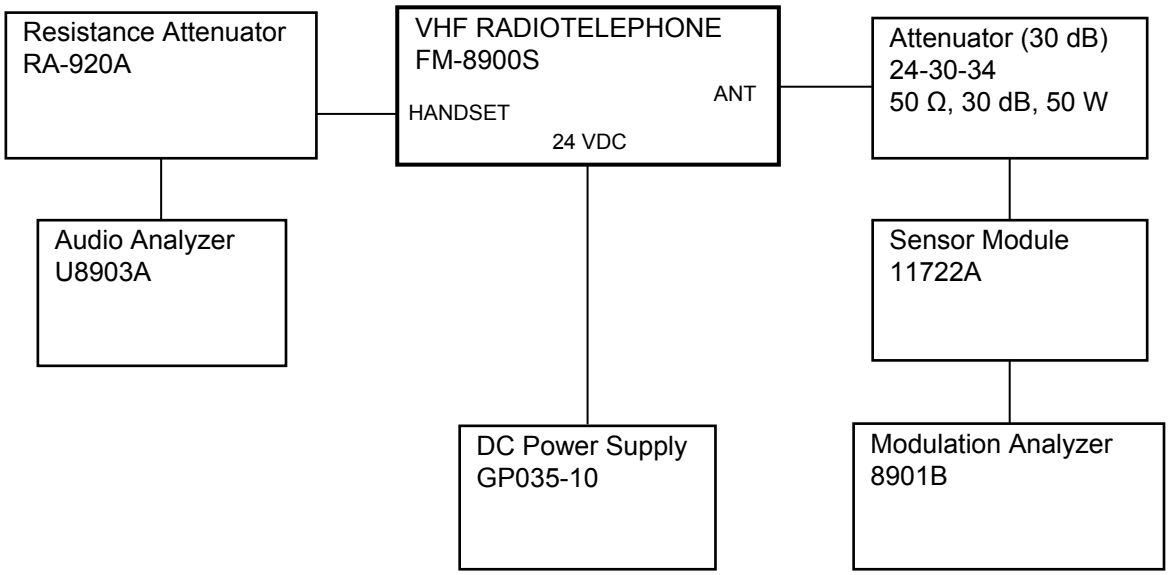


Fig. 3.2.2.1 Setup for measurement

3.2.2.2 List of Measuring/Test Equipment

See Clause 4 of this report.

3.2.2.3 Test Result

Passed.

The results are shown in Fig. 3.2.2.3

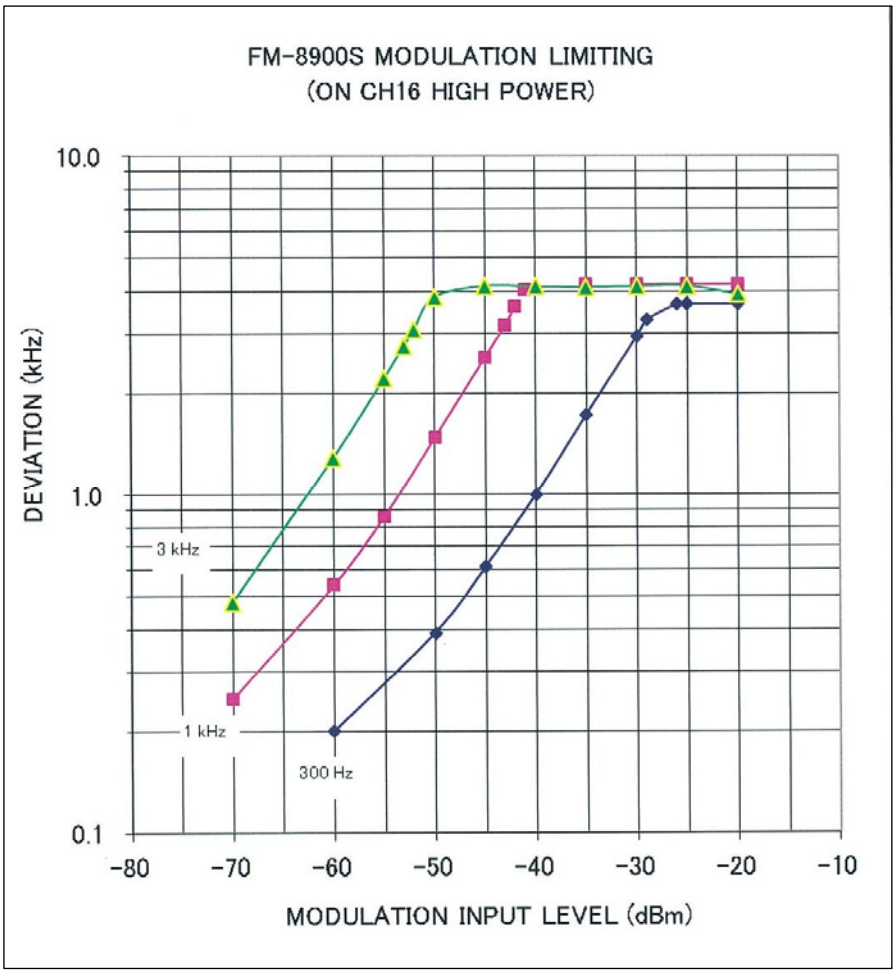


Fig. 3.2.2.3

Environmental conditions observed: On 17 April 2012, 28°C to 28°C, 33% to 33%RH, 24.0 VDC to 24.0 VDC.

3.3 Occupied Bandwidth (FCC Rules Part 2.1049 & 80.211)

3.3.1 Method of Measurement

(1) The EUT will be connected with measuring equipment as shown in Fig. 3.3.1.

(2) Test Channel: CH180, CH16 and CH179.

Tests will be done with modulation by a 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation.

(3) CH70:

Tests will be done with modulation by a 1300 Hz and 2100 Hz tone.

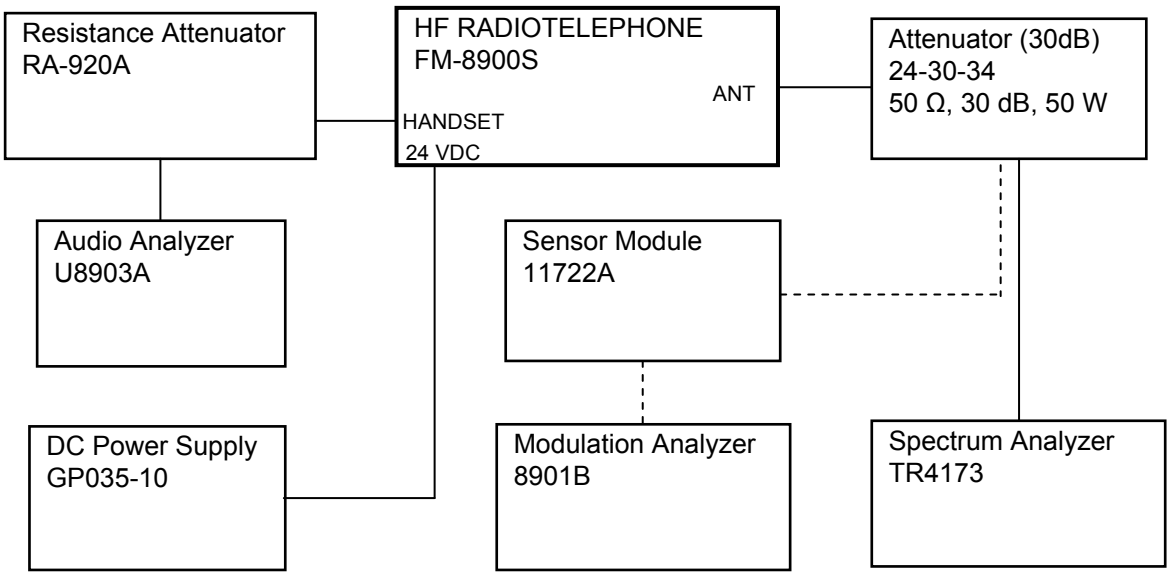


Fig. 3.3.1

3.3.2 List of Measuring/Test Equipment

See Clause 4 of this report.

3.3.3 Test Result

Passed.

Results are shown in Fig. 3.3.2 to 3.3.11

Output Power	Modulation	Occupied Bandwidyh (kHz)	Limit (kHz)
High	1300 Hz (MARK)	7.90	≤ 16
	2100 Hz (SPACE)	12.70	≤ 16
Low	1300 Hz (MARK)	7.95	≤ 16
	2100 Hz (SPACE)	12.70	≤ 16

Environmental conditions observed: On 18 April 2012, 28°C to 28°C, 34% to 36%RH, 24.0 VDC to 24.0 VDC.

On 19 April 2012, 27°C to 28°C, 37% to 36%RH, 24.0 VDC to 24.0 VDC.

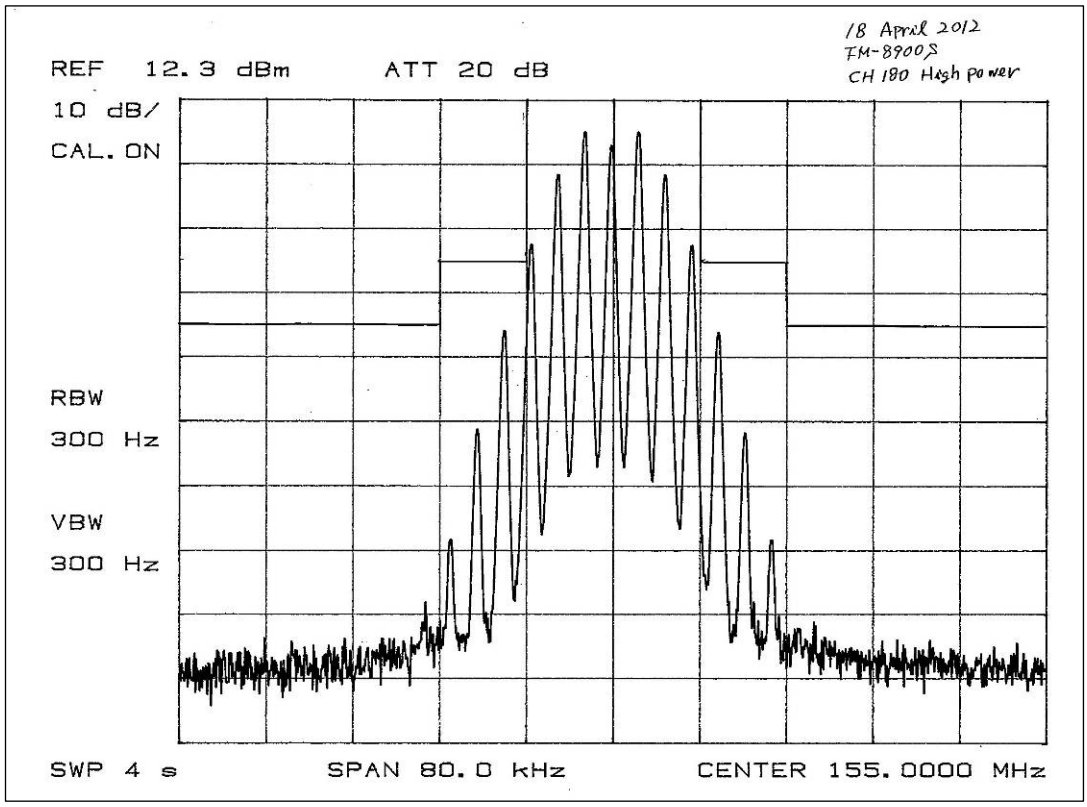


Fig. 3.3.2 - (CH180, High power)

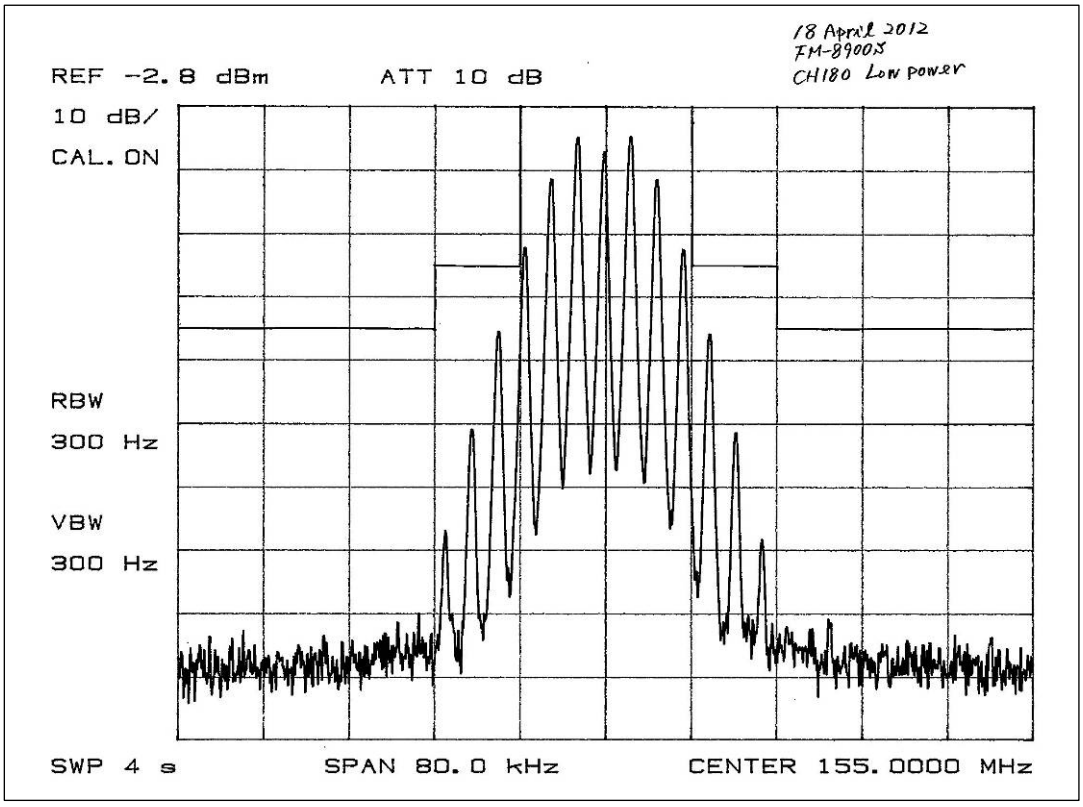


Fig. 3.3.3 - (CH180, Low power)

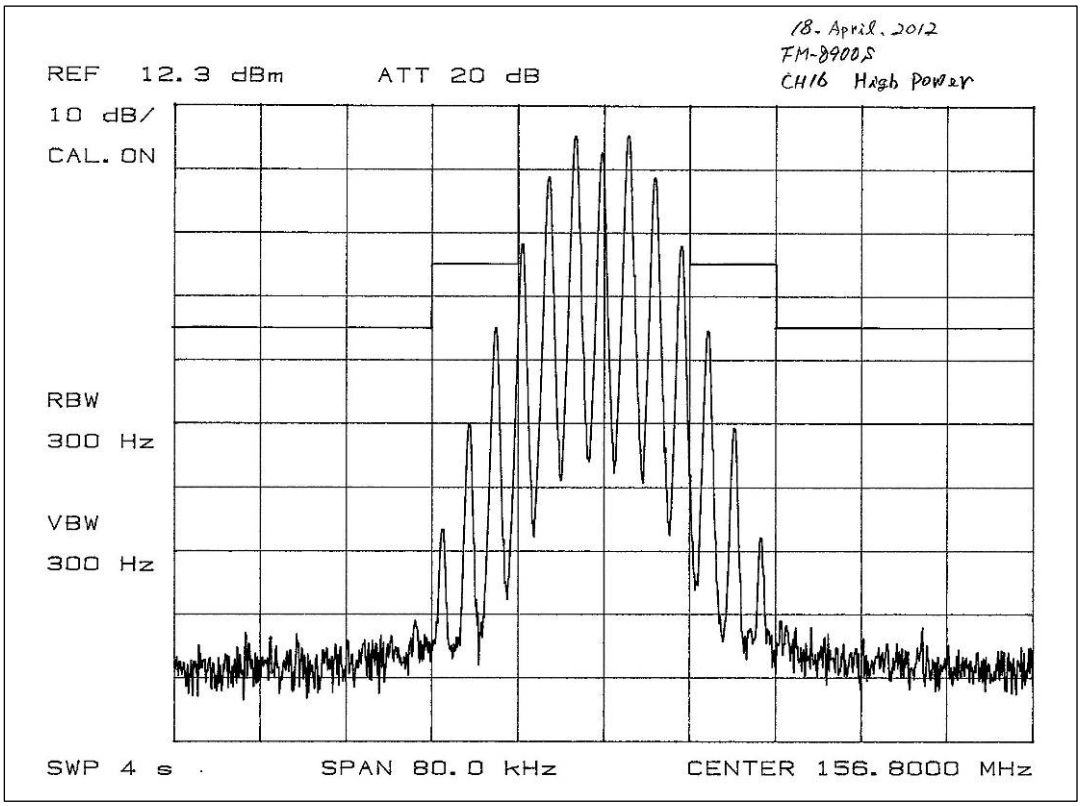


Fig. 3.3.4 - (CH16, High power)

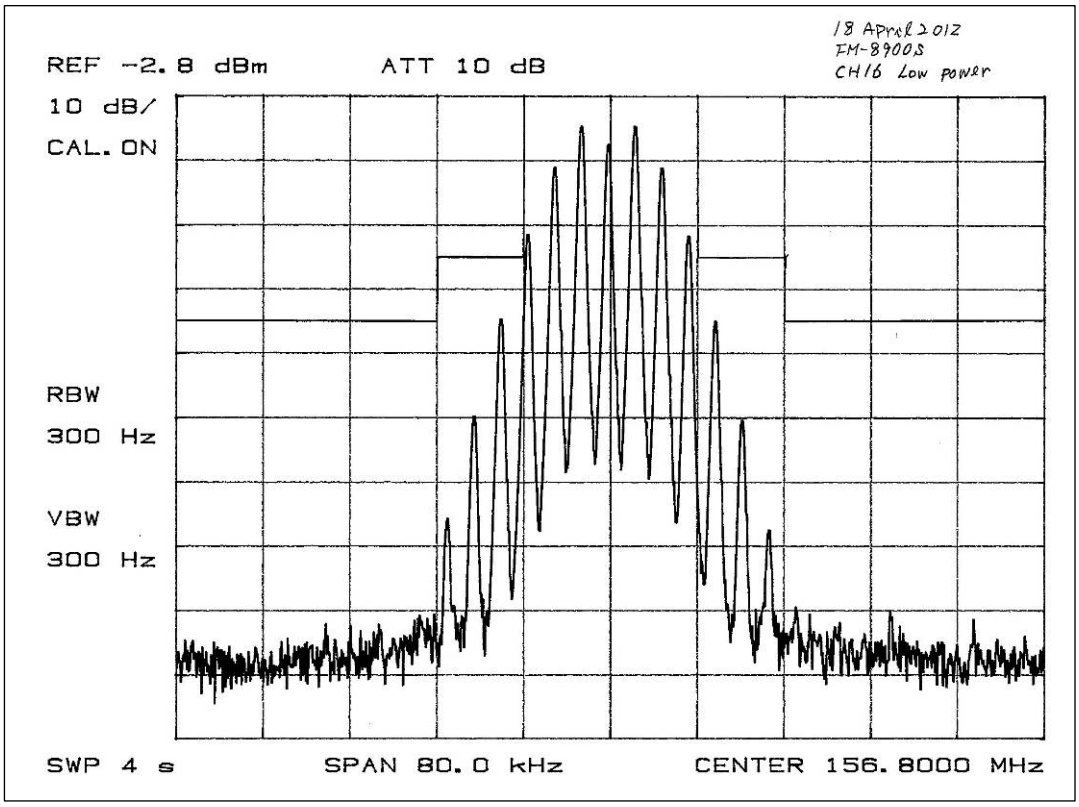


Fig. 3.3.5 - (CH16, Low power)

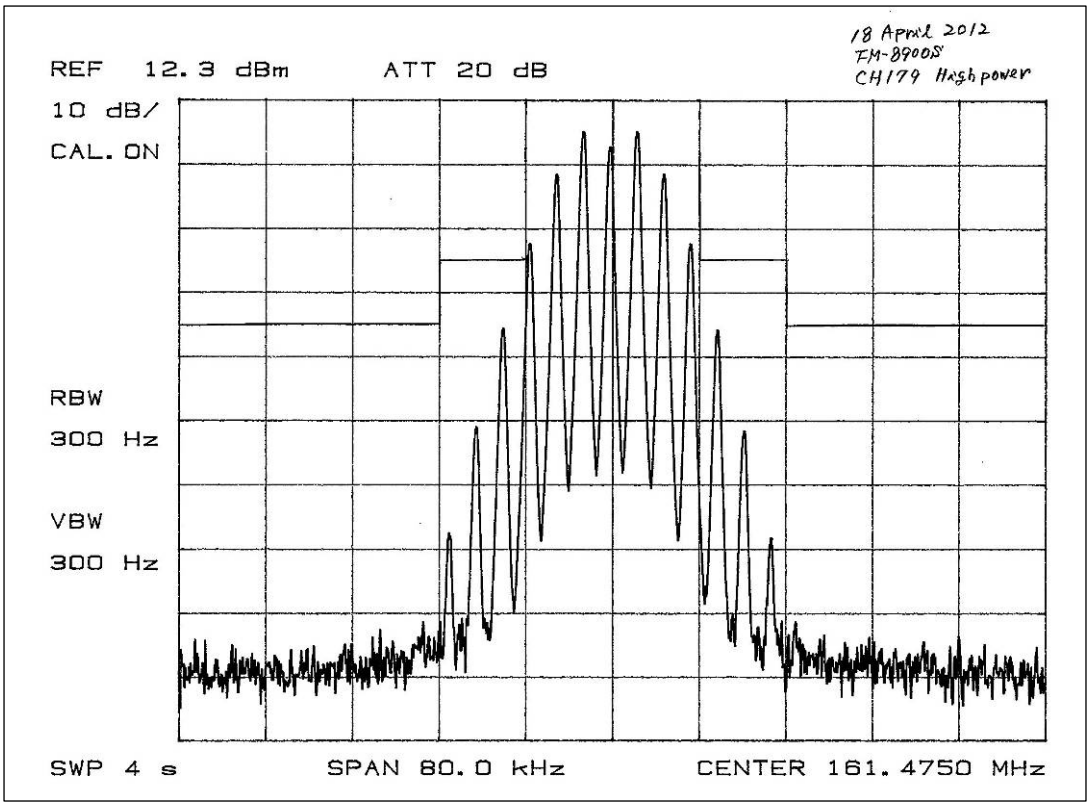


Fig. 3.3.6 - (CH179, High power)

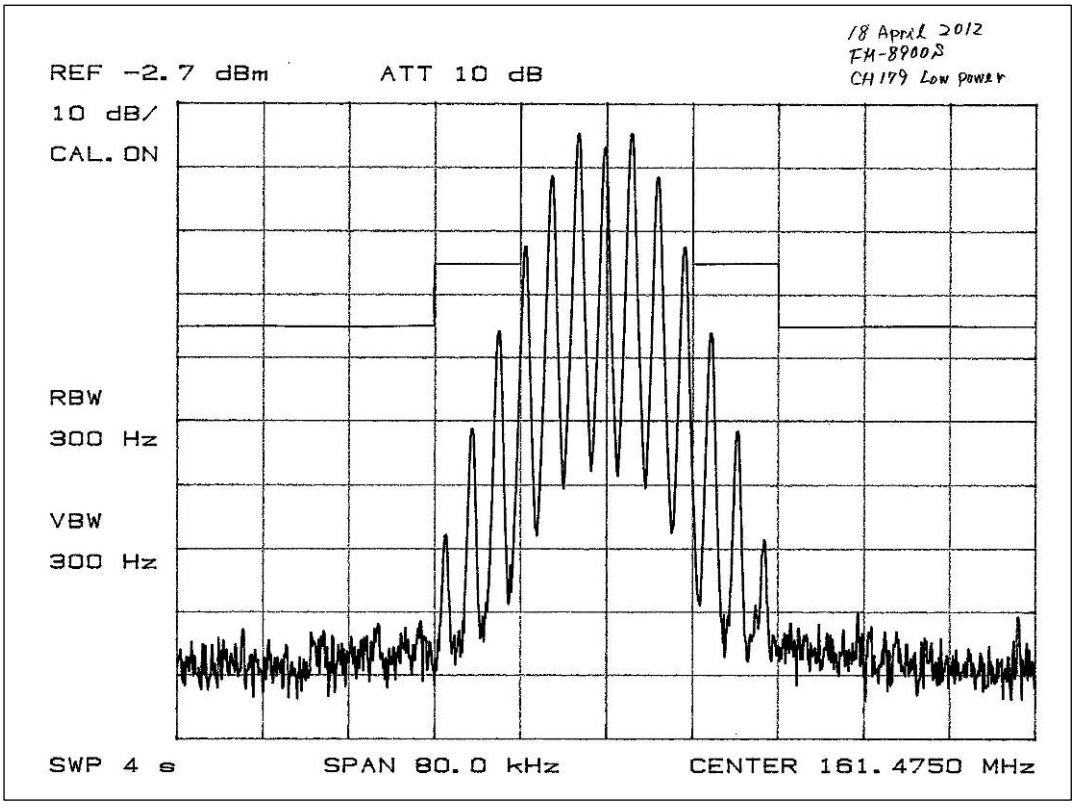


Fig. 3.3.7 - (CH179, Low power)

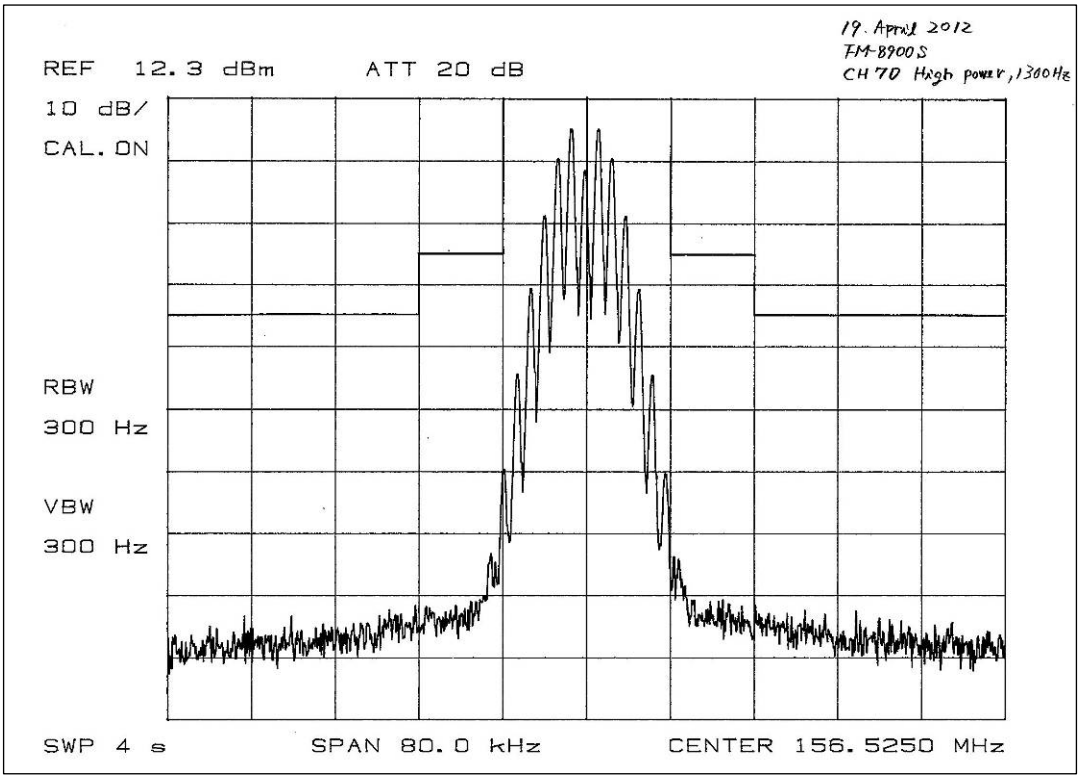


Fig. 3.3.8 - (CH70, High power, 1300 Hz)

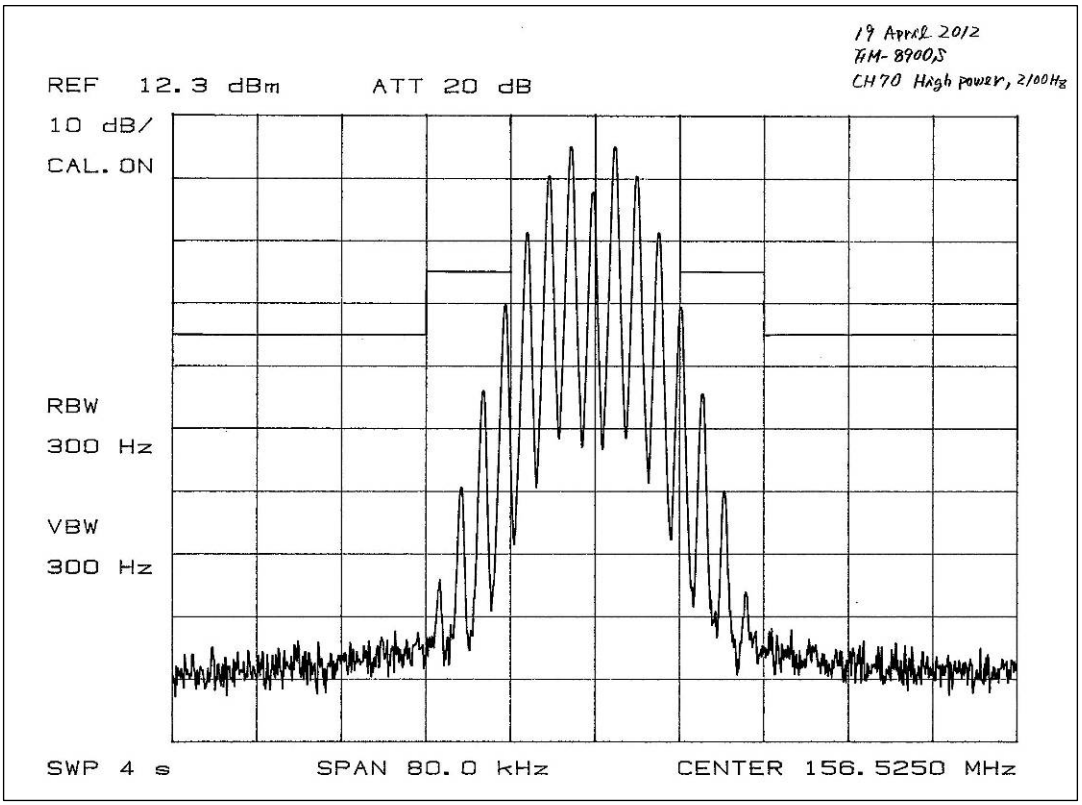


Fig. 3.3.9 - (CH70, High power, 2100 Hz)

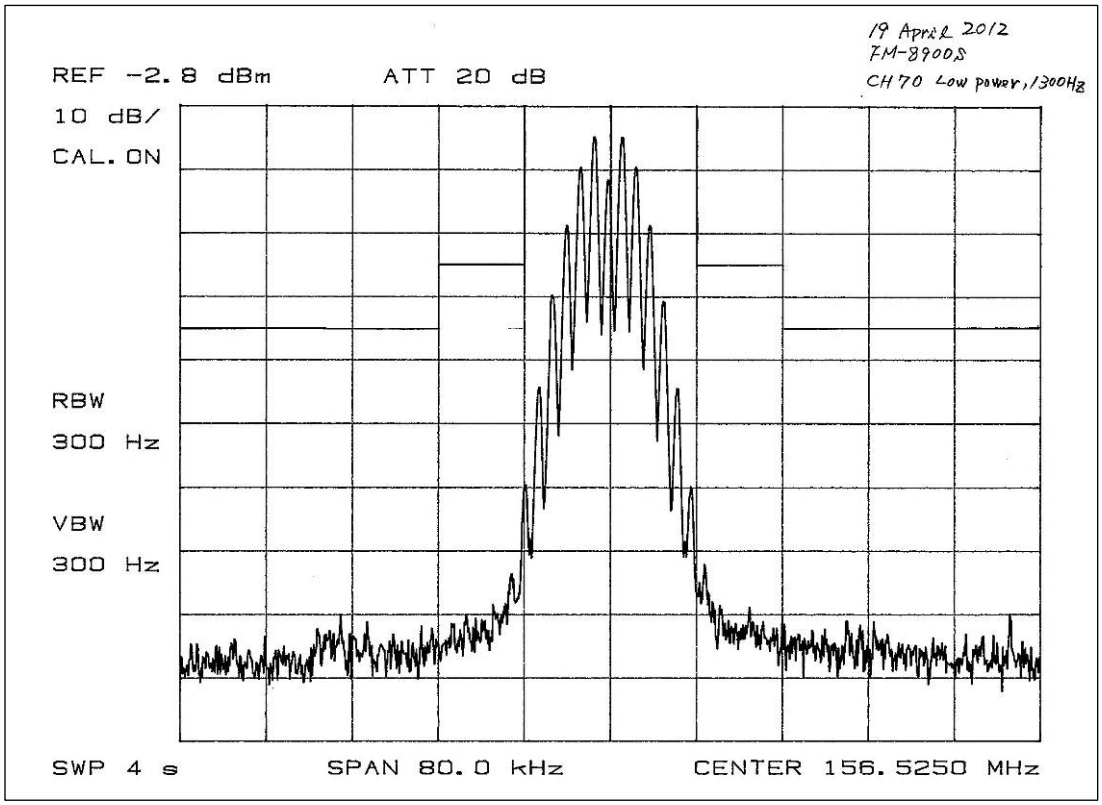


Fig. 3.3.10 - (CH70, Low power, 1300 Hz)

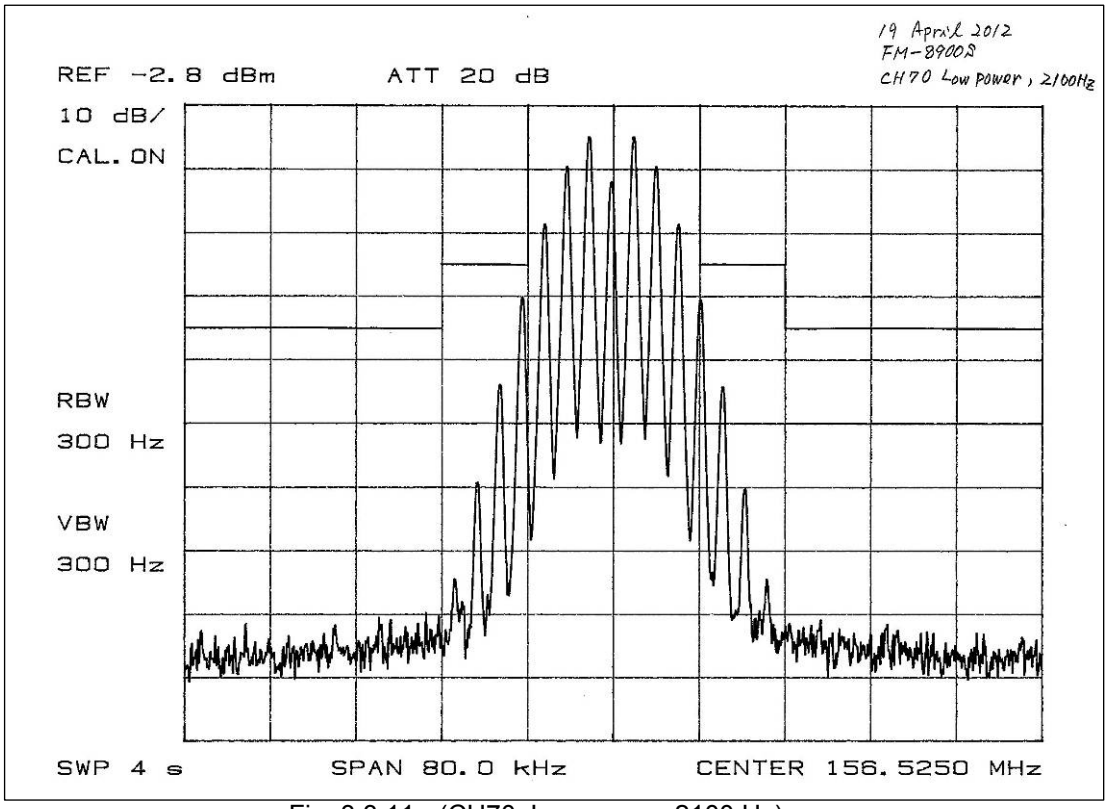


Fig. 3.3.11 - (CH70, Low power, 2100 Hz)

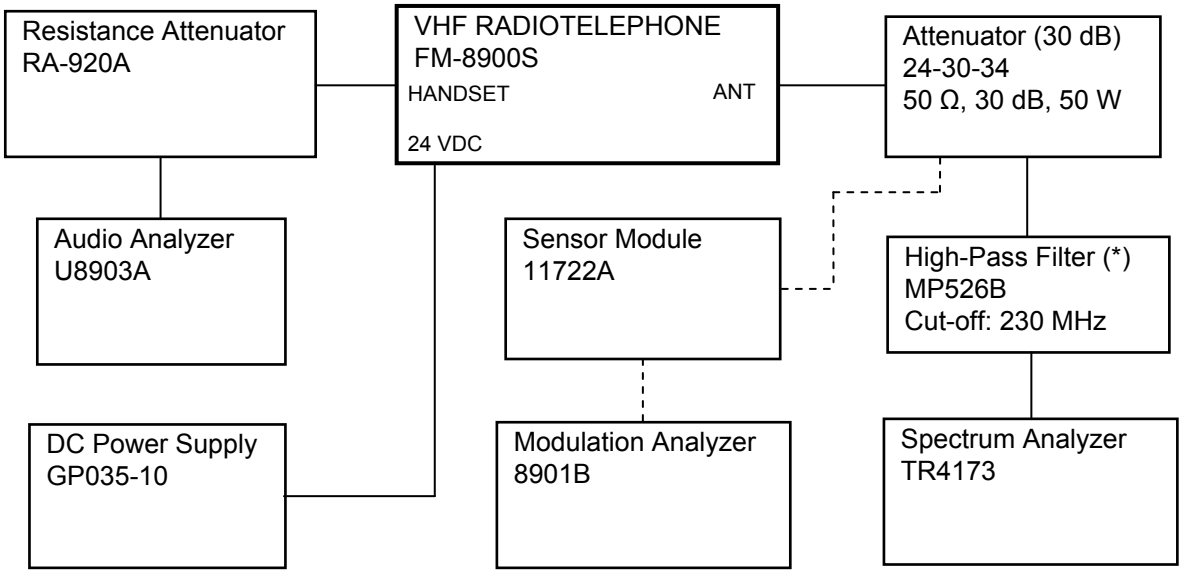
3.4 Spurious Emissions at Antenna Terminal (FCC Rules Part 2.1051 & 80.211)

3.4.1 Method of Measurement

(1) The EUT will be connected with measuring equipment as shown in Fig.3.4.1.

(2) Radio frequency voltage generated within the EUT and appearing on a spurious frequency was measured at the output terminal when loaded with 50-ohm artificial antenna.

(3) Modulation input level:
16 dB greater than that necessary to produce 50% modulation when modulated by a 2500 Hz tone.



(*): This High-Pass Filter was used for 200 MHz to 500 MHz.

Fig. 3.4.1

3.4.2 List of Measuring/Test Equipment

See Clause 4 of this report.

3.4.3 Emission limits

< -57 dB below carrier at High power,
< -43 dB below carrier at Low power

3.4.4 Test results

Passed.

The spurious emissions at antenna terminal of EUT were found lower than the specified limits.

Environmental conditions observed: On 19 April 2012, 27°C to 28°C, 37% to 36%RH,
24.0 VDC to 24.0 VDC.

Frequency	CH180 (155.000 MHz)			
	High power	Limit	Low power	Limit
15.9 MHz	Not found	-57 dBc	-70.4 dBc	-43 dBc
153.6 MHz	-78.6 dBc	-57 dBc	Not found	-43 dBc
171.9 MHz	-78.8 dBc	-57 dBc	Not found	-43 dBc
172.8 MHz	Not found	-57 dBc	-65.8 dBc	-43 dBc
2 × fc (*)	Not found	-57 dBc	Not found	-43 dBc
3 × fc	Not found	-57 dBc	Not found	-43 dBc
4 × fc	Not found	-57 dBc	Not found	-43 dBc
5 × fc	Not found	-57 dBc	Not found	-43 dBc
6 × fc	Not found	-57 dBc	Not found	-43 dBc

(*) fc: carrier frequency

Frequency	CH16 (156.800 MHz)			
	High	Limit	Low	Limit
15.6 MHz	Not found	-57 dBc	-71.3 dBc	-43 dBc
169.2 MHz	-79.7 dBc	-57 dBc	Not found	-43 dBc
174.0 MHz	Not found	-57 dBc	-66.8 dBc	-43 dBc
2 × fc (*)	Not found	-57 dBc	Not found	-43 dBc
3 × fc	Not found	-57 dBc	Not found	-43 dBc
4 × fc	Not found	-57 dBc	Not found	-43 dBc
5 × fc	Not found	-57 dBc	Not found	-43 dBc
6 × fc	Not found	-57 dBc	Not found	-43 dBc

(*) fc: carrier frequency

Frequency	CH179 (161.475 MHz)			
	High	Limit	Low	Limit
14.7 MHz	Not found	-57 dBc	-72.3 dBc	-43 dBc
153.9 MHz	Not found	-57 dBc	-67.6 dBc	-43 dBc
173.1 MHz	Not found	-57 dBc	-67.7 dBc	-43 dBc
174.3 MHz	-80.5 dBm	-57 dBc	Not found	-43 dBc
2 × fc (*)	Not found	-57 dBc	Not found	-43 dBc
3 × fc	Not found	-57 dBc	Not found	-43 dBc
4 × fc	Not found	-57 dBc	Not found	-43 dBc
5 × fc	Not found	-57 dBc	Not found	-43 dBc
6 × fc	Not found	-57 dBc	Not found	-43 dBc

(*) fc: carrier frequency

Spurious emission plots are shown in Fig.3.4.4.1 to Fig.3.4.4.18.

Fig. No.	Test Channel	Frequency range	Output Power
3.4.4.1	180	9 kHz to 300 MHz	High
3.4.4.2		200 MHz to 500 MHz	
3.4.4.3		500 MHz to 2 GHz	
3.4.4.4		9 kHz to 300 MHz	Low
3.4.4.5		200 MHz to 500 MHz	
3.4.4.6		500 MHz to 2 GHz	
3.4.4.7	16	9 kHz to 300 MHz	High
3.4.4.8		200 MHz to 500 MHz	
3.4.4.9		500 MHz to 2 GHz	
3.4.4.10		9 kHz to 300 MHz	Low
3.4.4.11		200 MHz to 500 MHz	
3.4.4.12		500 MHz to 2 GHz	
3.4.4.13	179	9 kHz to 300 MHz	High
3.4.4.14		200 MHz to 500 MHz	
3.4.4.15		500 MHz to 2 GHz	
3.4.4.16		9 kHz to 300 MHz	Low
3.4.4.17		200 MHz to 500 MHz	
3.4.4.18		500 MHz to 2 GHz	

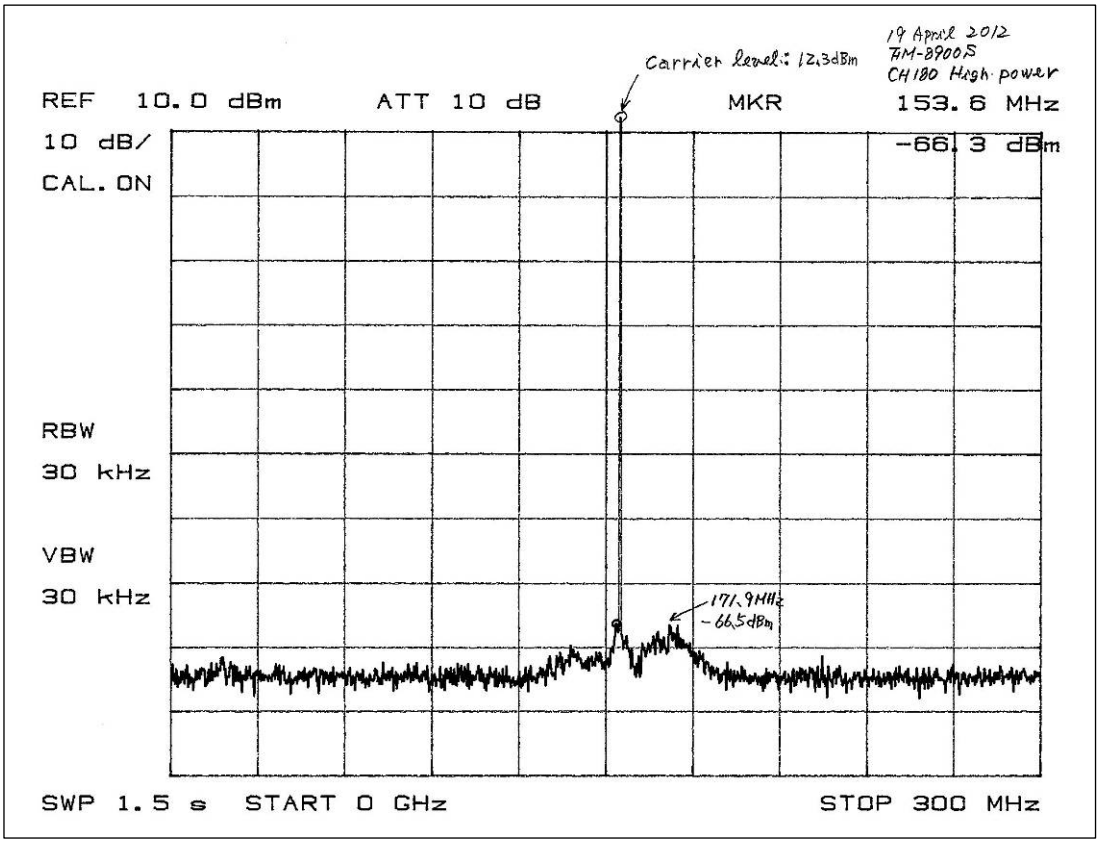


Fig. 3.4.4.1 - (CH180, High power)

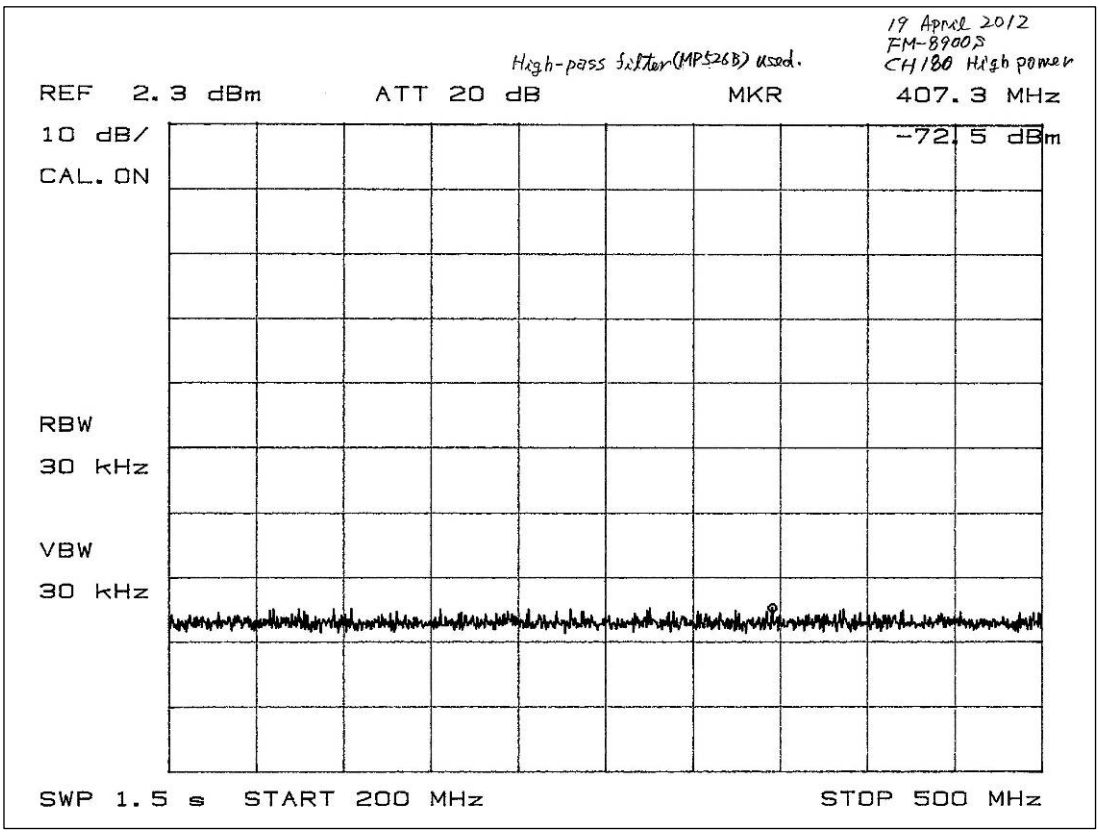


Fig. 3.4.4.2 - (CH180, High power)

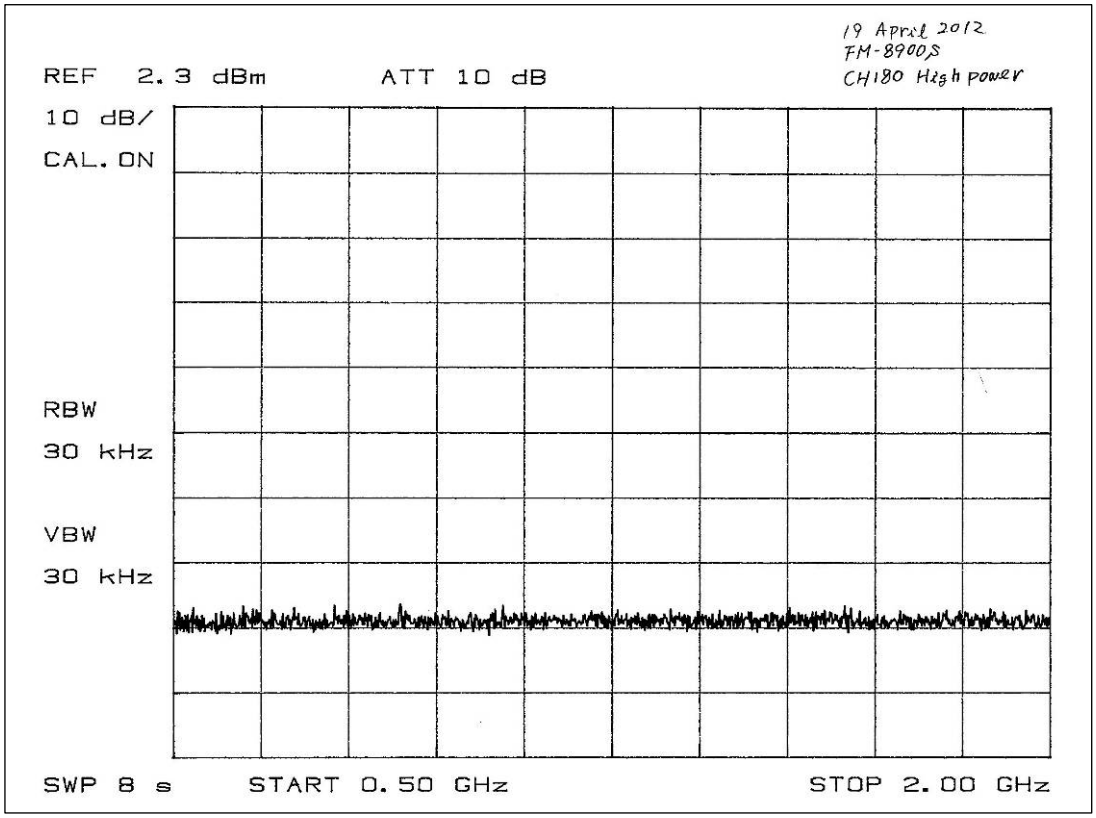


Fig. 3.4.4.3 - (CH180, High power)

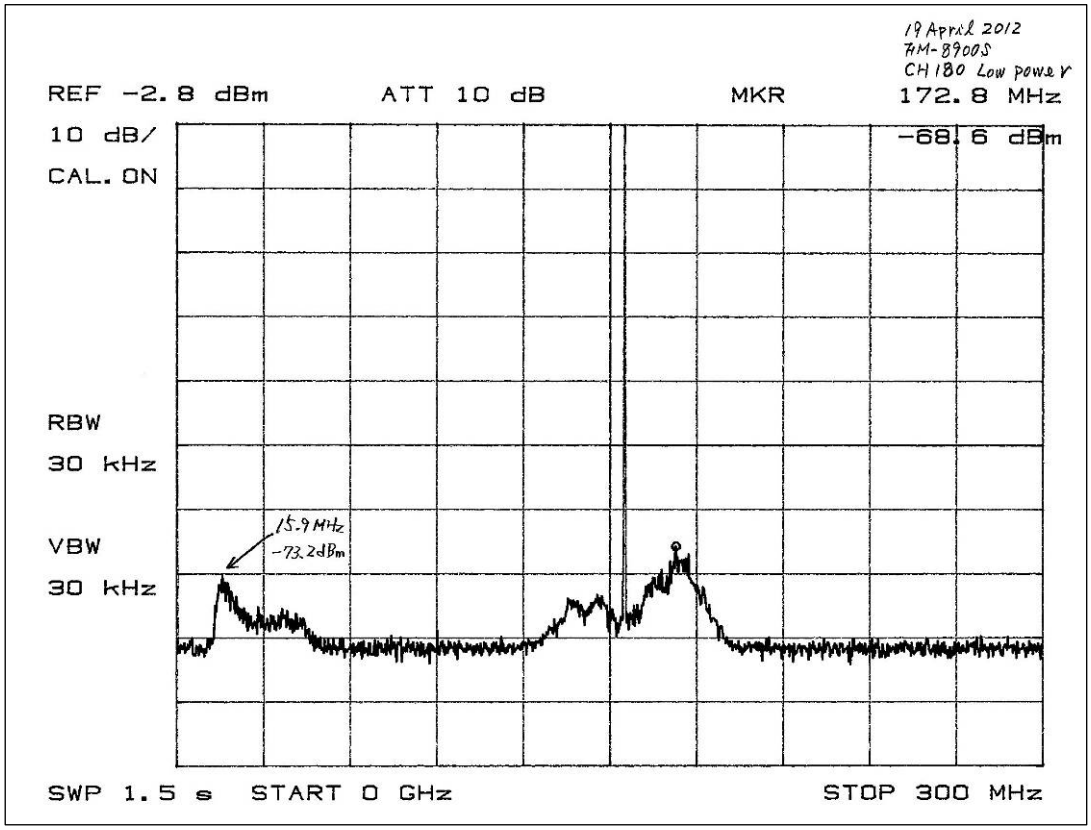


Fig. 3.4.4.4 - (CH180, Low power)

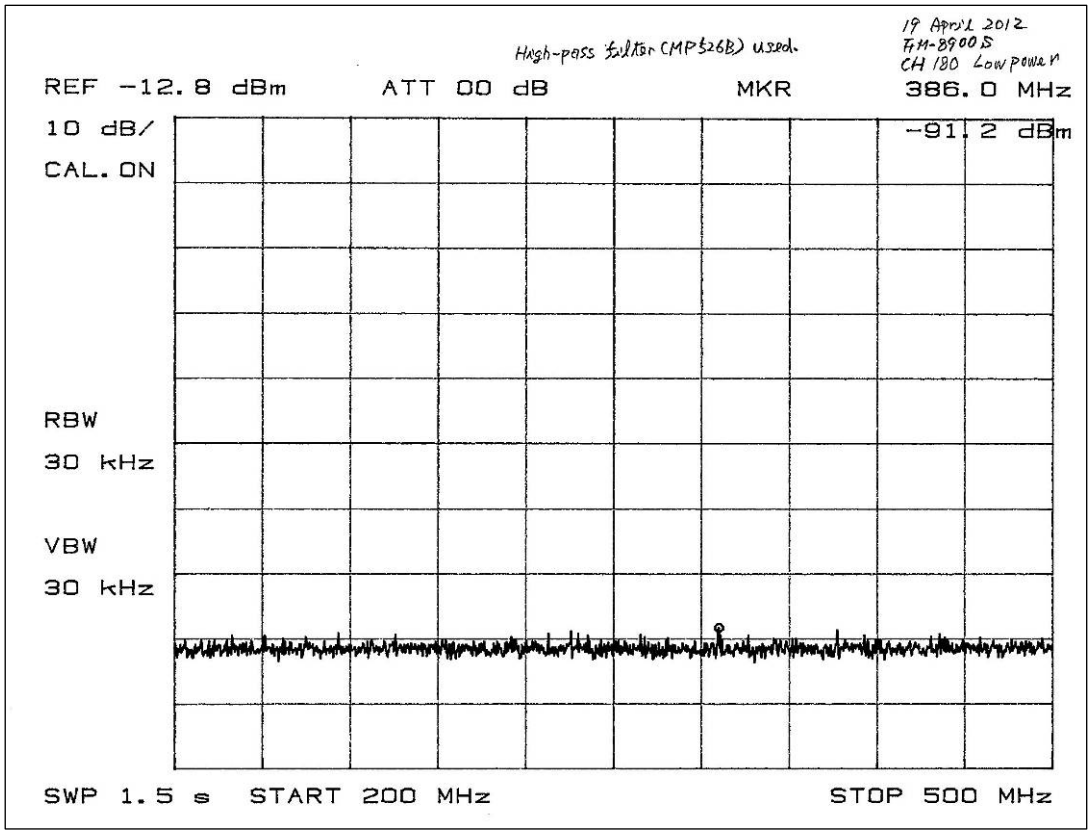


Fig. 3.4.4.5 - (CH180, Low power)

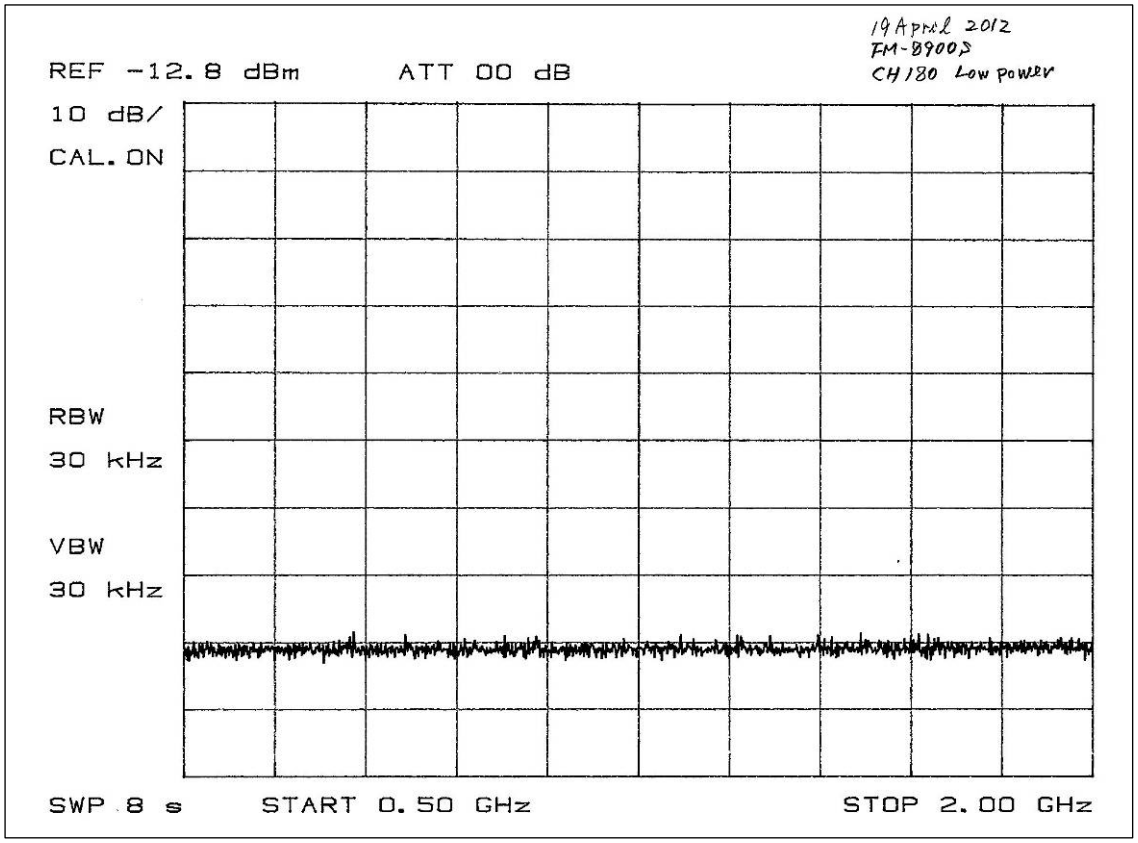


Fig. 3.4.4.6 - (CH180, Low power)

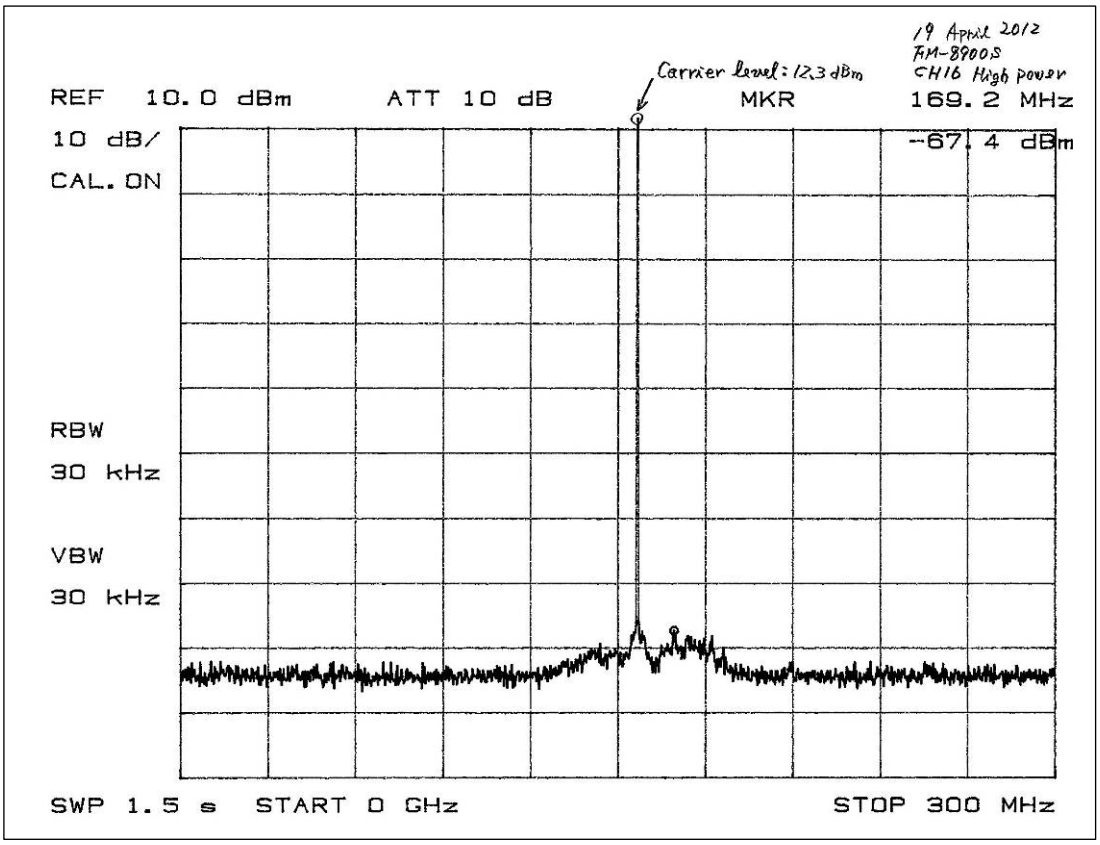


Fig. 3.4.4.7 - (CH16, High power)

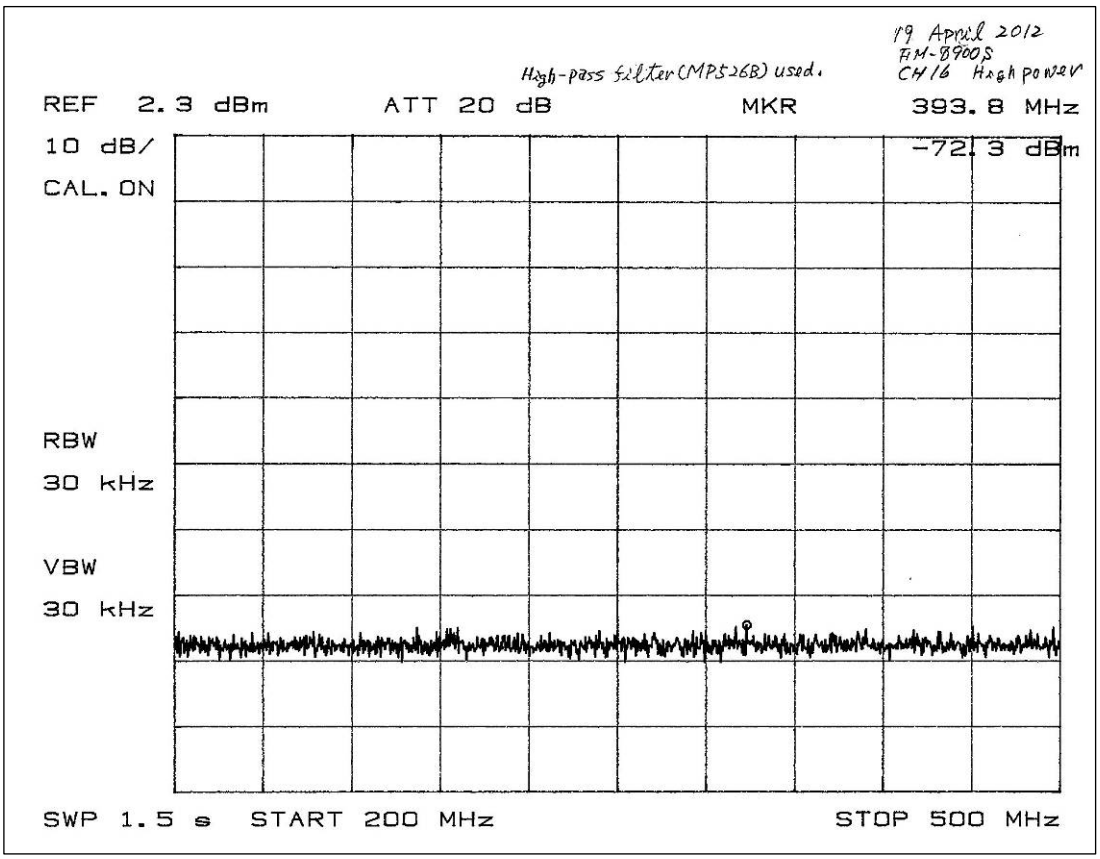


Fig. 3.4.4.8 - (CH16, High power)

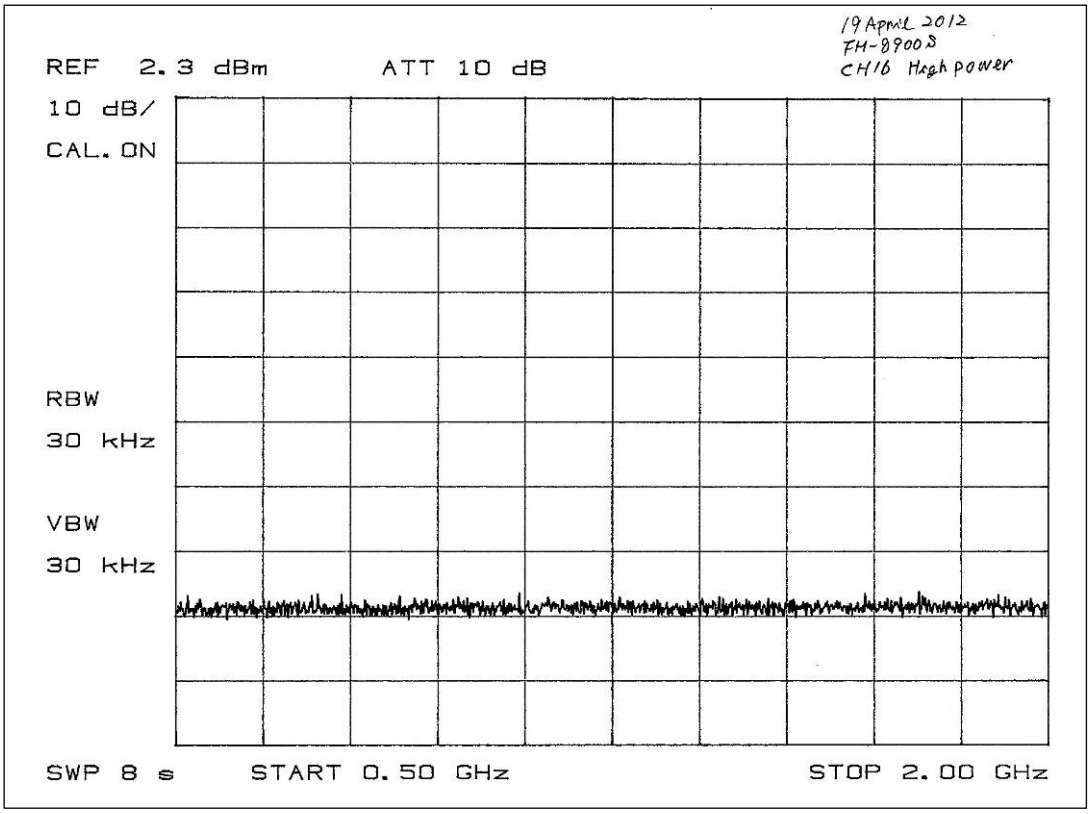


Fig. 3.4.4.9 - (CH16, High power)

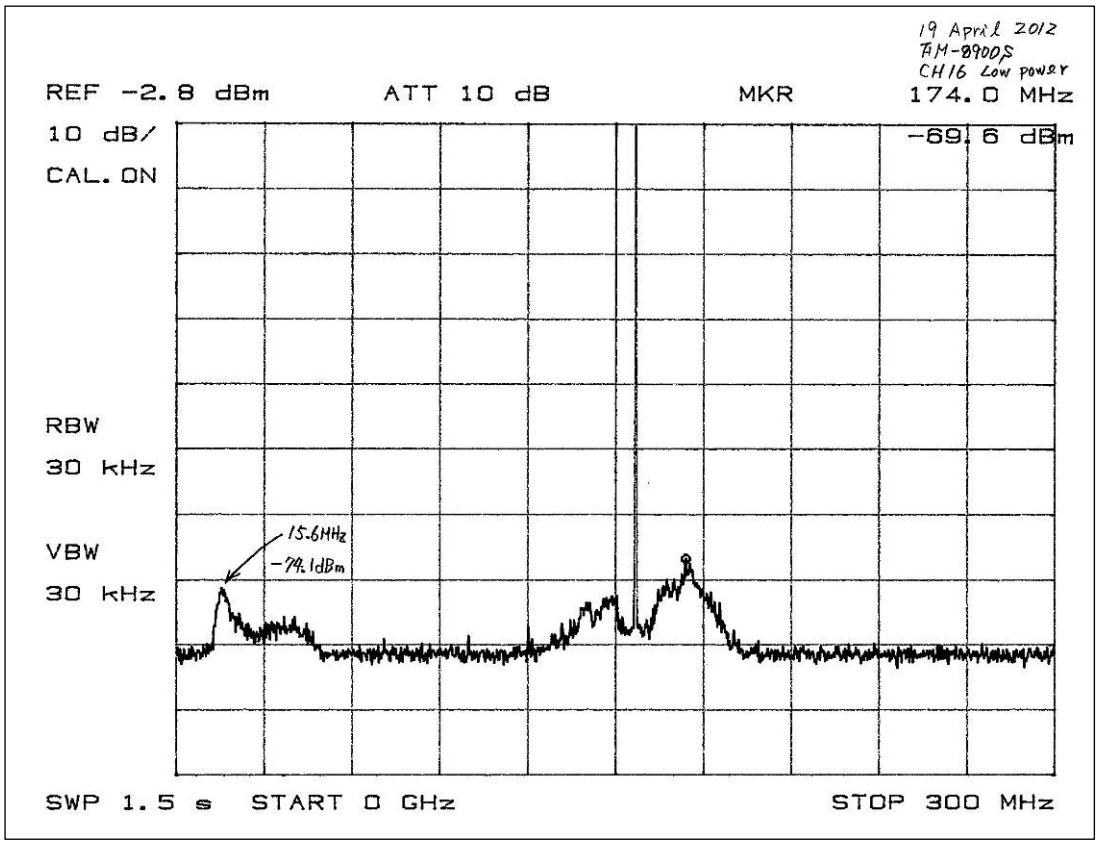


Fig. 3.4.4.10 - (CH16, Low power)

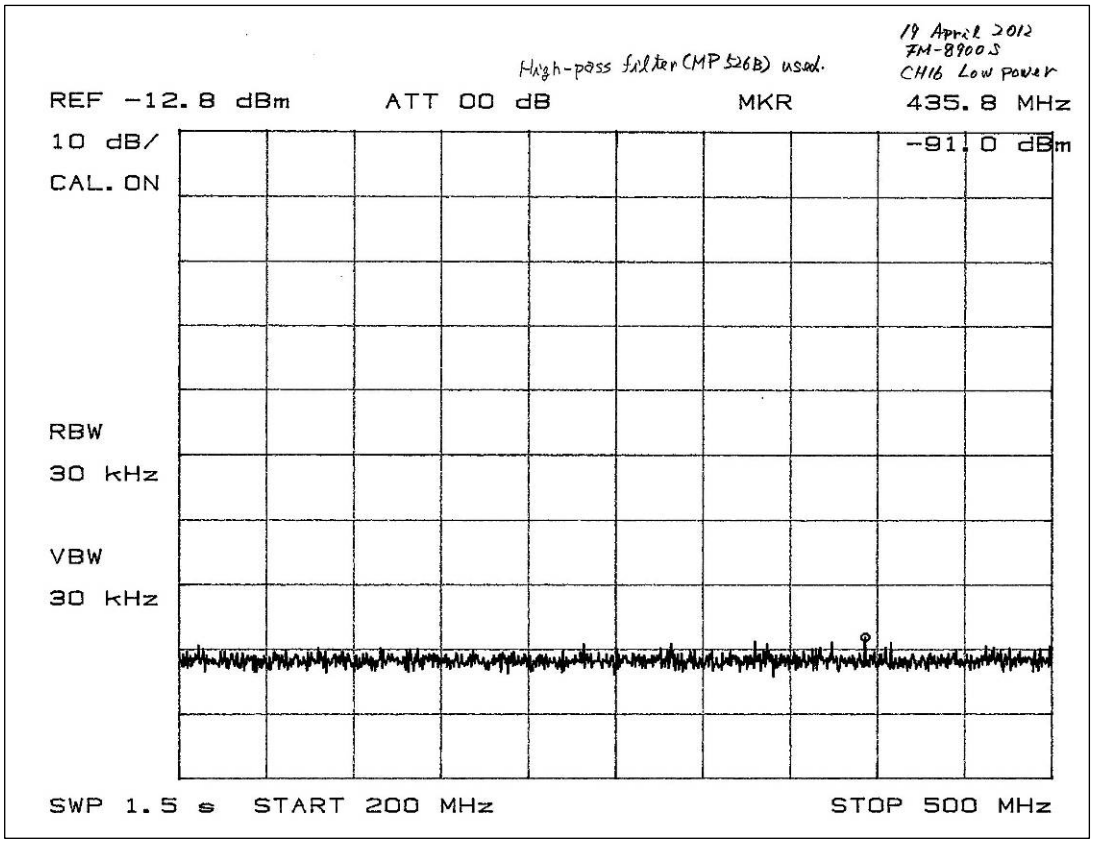


Fig. 3.4.4.11 - (CH16, Low power)

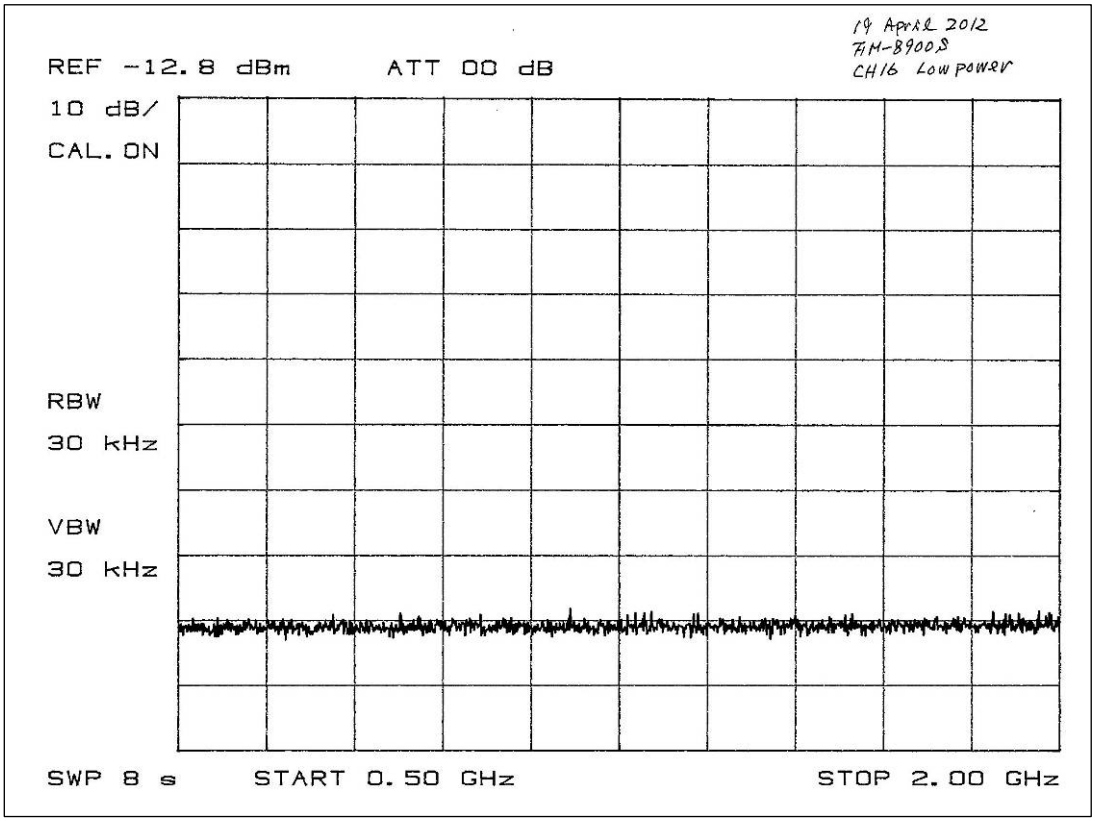


Fig. 3.4.4.12 - (CH16, Low power)

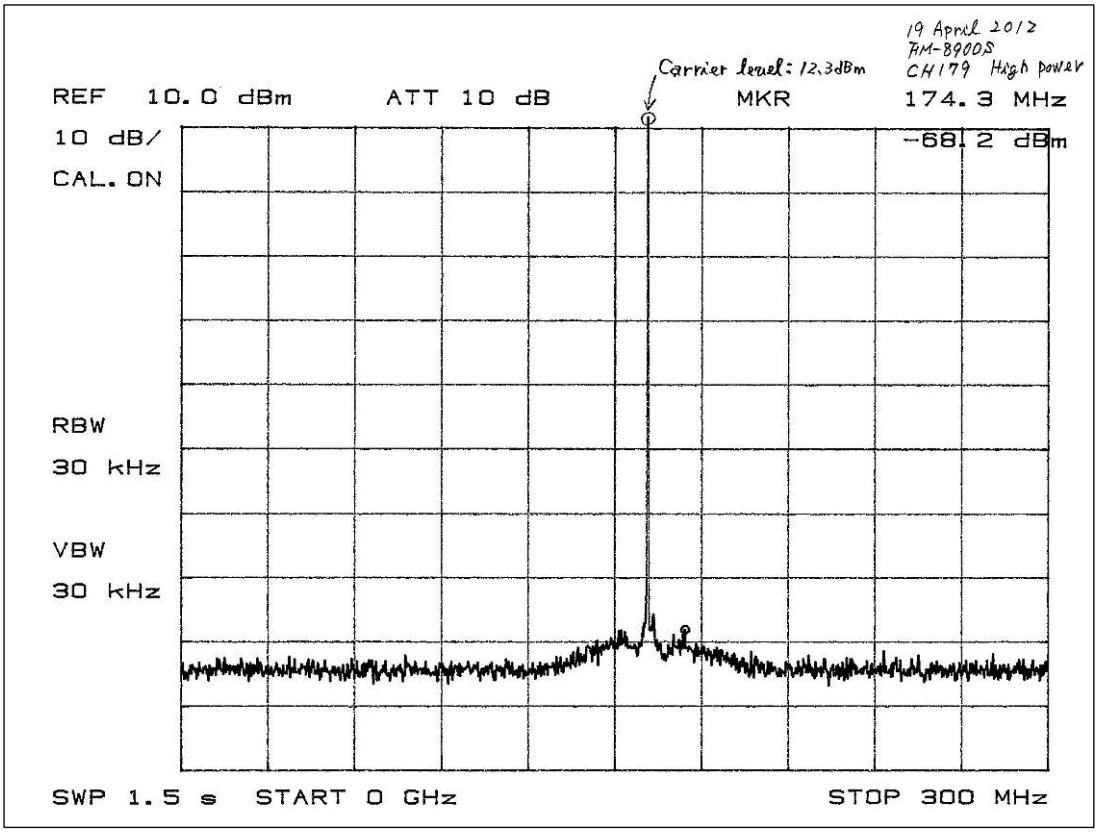


Fig. 3.4.4.13 - (CH179, High power)

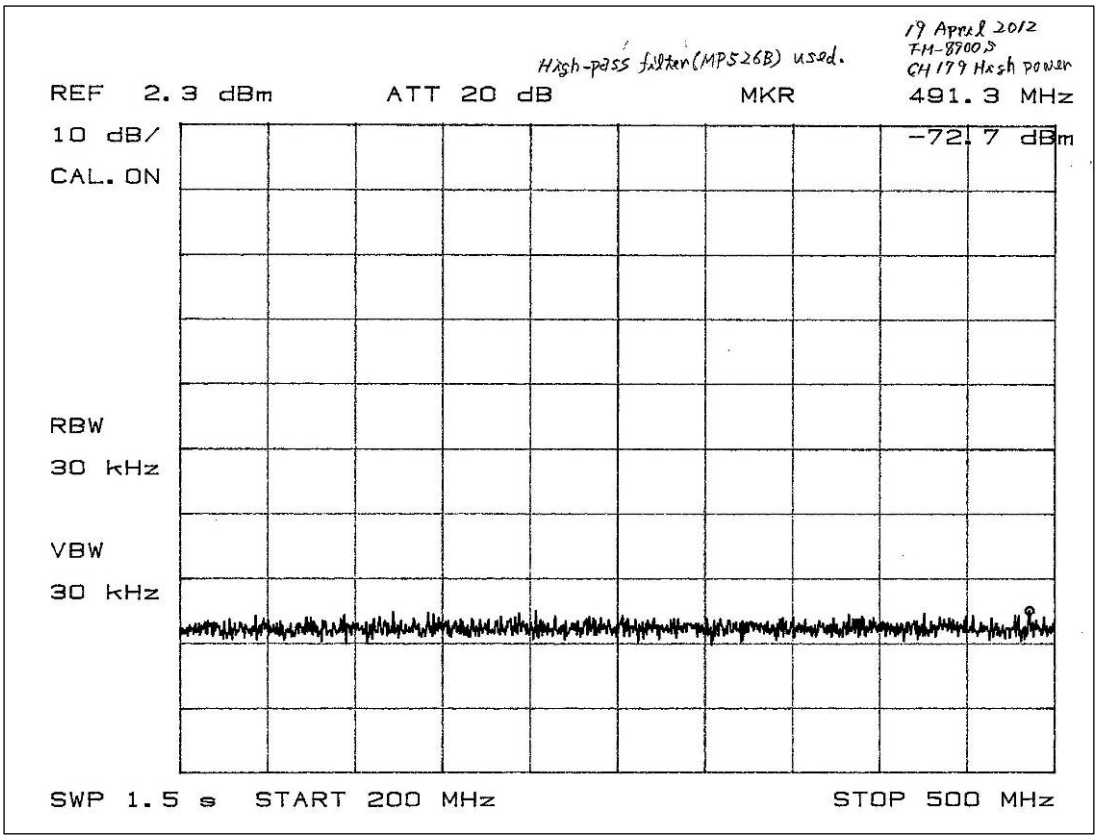


Fig. 3.4.4.14 - (CH79, High power)

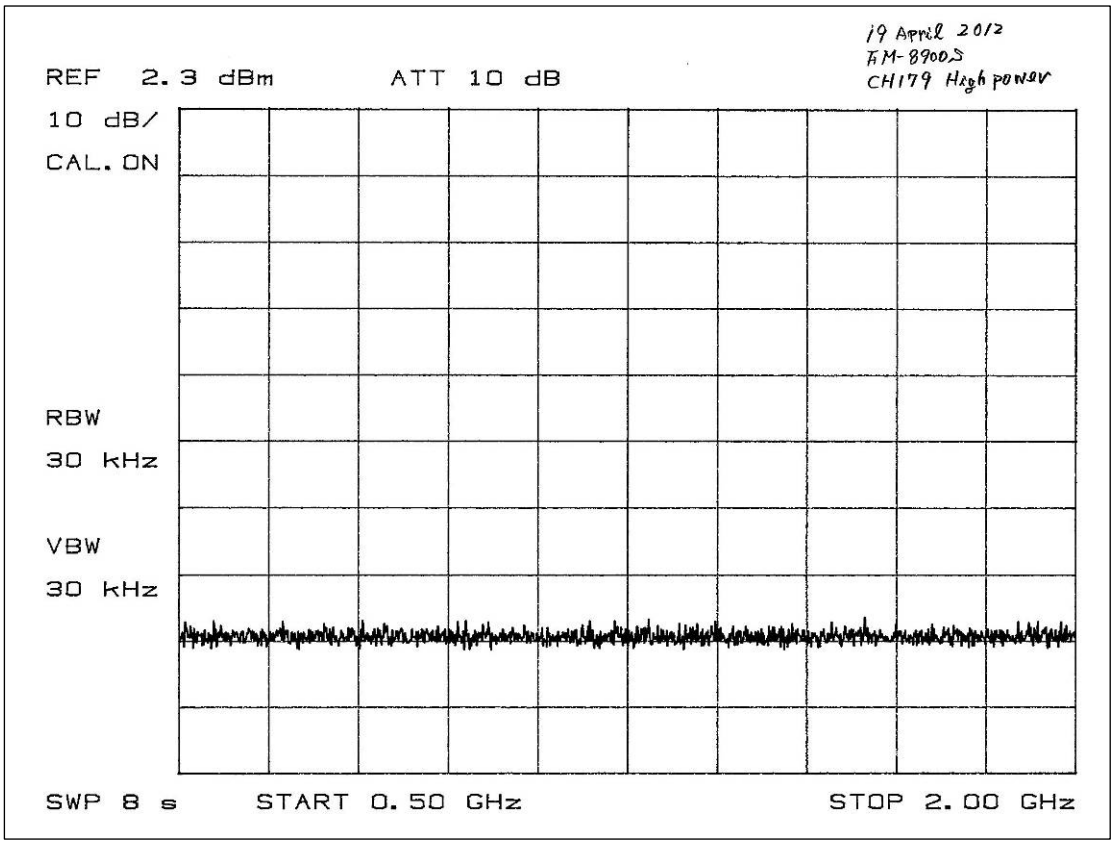


Fig. 3.4.4.15 - (CH179, High power)

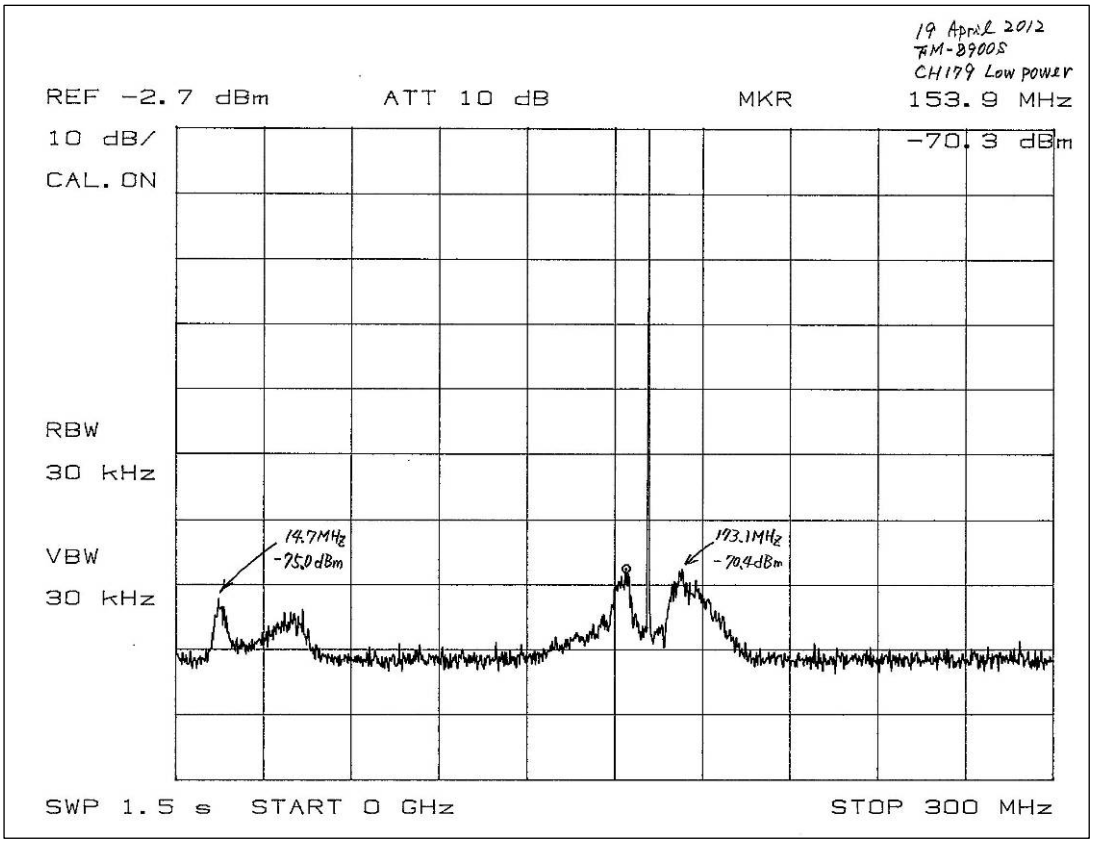


Fig. 3.4.4.16 - (CH179, Low power)

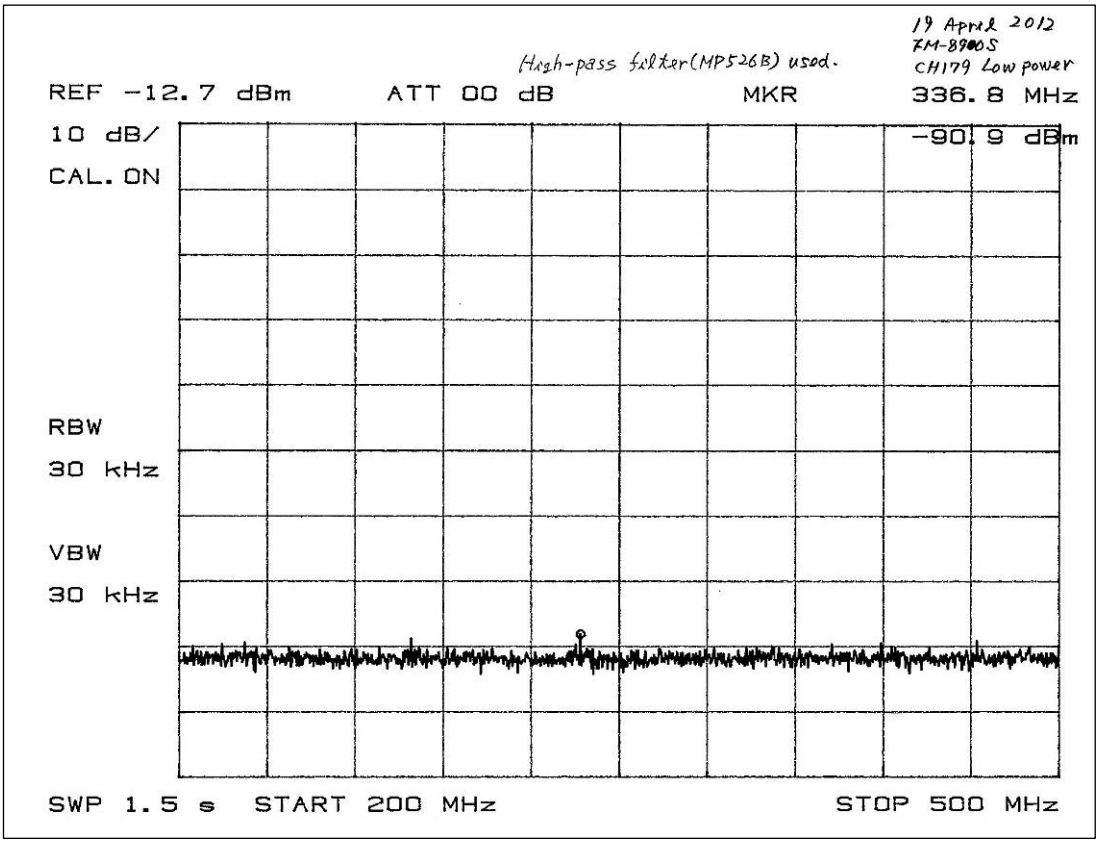


Fig. 3.4.4.17 - (CH79, Low power)

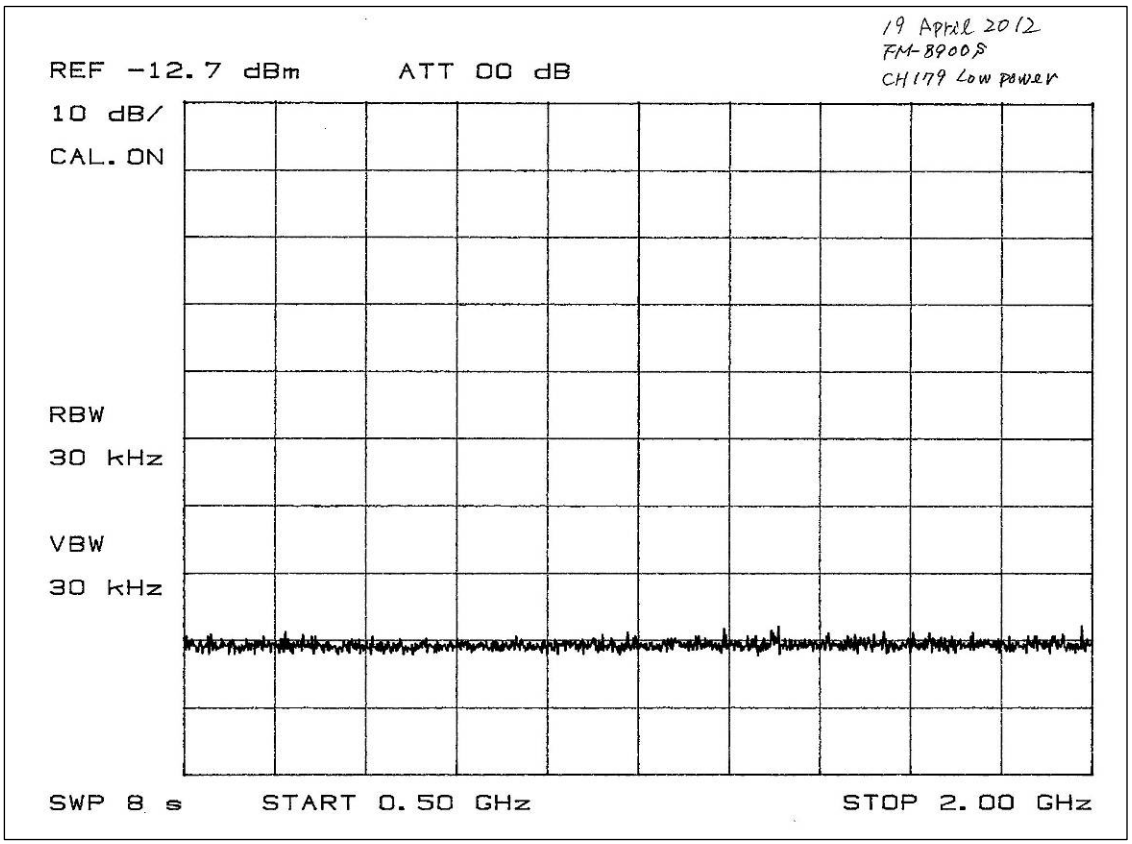


Fig. 3.4.4.18 - (CH179, Low power)

3.5 Field Strength of Spurious Radiation (FCC Rule Part 2.1053)

3.5.1 Method of Measurement

The EUT will be connected with measuring equipment as in Fig. 3.5.1.

The transmitter (supplied with 24 VDC) will be modulated with 2500 Hz.

Limit at High power: = 43 + 10 log (Transmission average power) = 43 + 10 log (25) = 57 dBc.
Limit at Low power: = 43 + 10 log (Transmission average power) = 43 + 10 log (1) = 43 dBc.

The spurious radiation measurement will be performed in the 3 m Anechoic Chamber and the limit values will be converted into electric field strength by the substitution method.

Anechoic Chamber used for the test has been registered by FCC.
(File number: 90607)

The resolution bandwidth of the spectrum analyzer was set as follows:

Frequency range	Resolution bandwidth
9 kHz to 100 kHz	1 kHz
100 kHz to 30 MHz	10 kHz
30 MHz to 2000 MHz	100 kHz

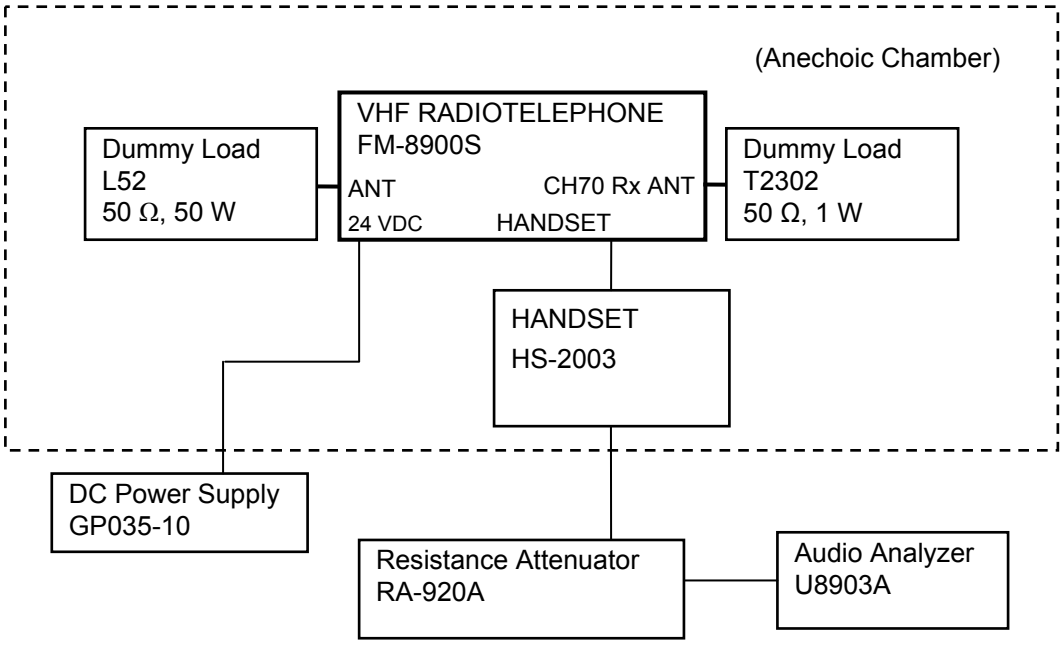
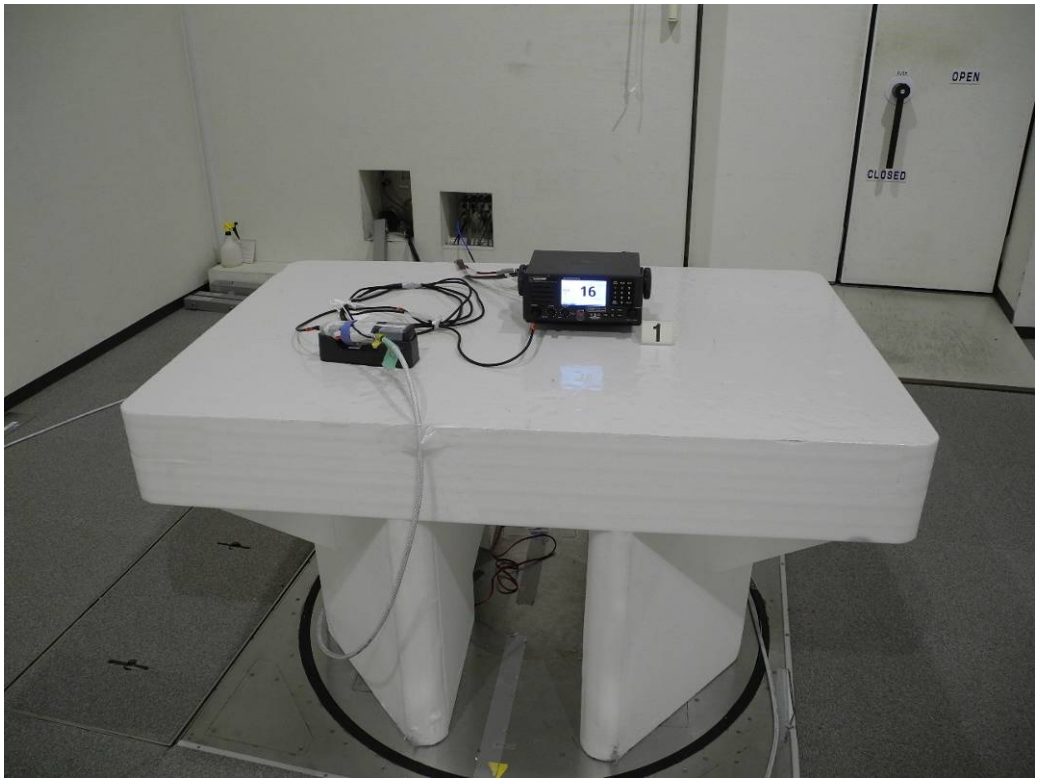


Fig. 3.5.1

Environmental conditions observed: On 10 April 2012, 22°C to 22°C, 66% to 66%RH, 24.0 VDC to 24.0 VDC.
On 25 April 2012, 20°C to 22°C, 64% to 66%RH, 24.0 VDC to 24.0 VDC.
On 26 April 2012, 20°C to 21°C, 68% to 65%RH, 24.0 VDC to 24.0 VDC.

Photo showing the Test Setup:

Anechoic Chamber used for the test has been registered by FCC.
(File number: 90607)



3.5.2 Test Results

Passed.

Spurious Emissions that were prominent are listed in Table 3.5.1 to 3.5.6

Table 3.5.1 Spurious emissions of CH180 (155.000 MHz) High power.

Spurious frequency	Antenna Polarization	Power of spurious emission (dBc)	Limit (dBc) (*2)	Margin (dB)
0.031 MHz	0 degree	Not found	-57	N.A.
	90 degree	-66.5	-57	9.5
0.063 MHz	0 degree	Not found	-57	N.A.
	90 degree	-63.2	-57	6.2
2 × Fc (*1)	Horizontal	-109.4	-57	52.4
	Vertical	-112.7	-57	52.7
3 × Fc	Horizontal	-112.0	-57	55.0
	Vertical	-110.1	-57	53.1
4 × Fc	Horizontal	-106.3	-57	49.3
	Vertical	-107.0	-57	50.0
5 × Fc	Horizontal	-93.8	-57	36.8
	Vertical	-94.3	-57	37.3
6 × Fc	Horizontal	Not found	-57	N.A.
	Vertical	Not found	-57	N.A.
7 × Fc	Horizontal	-105.1	-57	48.1
	Vertical	-104.7	-57	47.7
8 × Fc	Horizontal	Not found	-57	N.A.
	Vertical	Not found	-57	N.A.
9 × Fc	Horizontal	Not found	-57	N.A.
	Vertical	Not found	-57	N.A.
10 × Fc	Horizontal	Not found	-57	N.A.
	Vertical	Not found	-57	N.A.

(*1) Fc: Carrier frequency
(*2) Limit: 43 + 10 log (Transmission average power) = 43 + 10 log (25) = 57 dBc
Note: N.A.- Not applicable.

Table 3.5.2 Spurious emissions of CH180 (155.000 MHz) Low power.

Spurious frequency	Antenna Polarization	Power of spurious emission (dBc)	Limit (dBc) (*2)	Margin (dB)
0.031 MHz	0 degree	Not found	-43	N.A.
	90 degree	-52.3	-43	9.3
0.064 MHz	0 degree	Not found	-43	N.A.
	90 degree	-48.7	-43	5.7
2 × Fc (*1)	Horizontal	-99.3	-43	56.3
	Vertical	-101.9	-43	58.9
3 × Fc	Horizontal	-98.3	-43	55.3
	Vertical	-96.3	-43	53.3
4 × Fc	Horizontal	-97.0	-43	54.0
	Vertical	-97.2	-43	54.2
5 × Fc	Horizontal	-84.9	-43	41.9
	Vertical	-84.7	-43	41.7
6 × Fc	Horizontal	Not found	-43	N.A.
	Vertical	Not found	-43	N.A.
7 × Fc	Horizontal	-94.2	-43	51.2
	Vertical	-94.0	-43	51.0
8 × Fc	Horizontal	Not found	-43	N.A.
	Vertical	Not found	-43	N.A.
9 × Fc	Horizontal	Not found	-43	N.A.
	Vertical	Not found	-43	N.A.
10 × Fc	Horizontal	Not found	-43	N.A.
	Vertical	Not found	-43	N.A.

(*1) Fc: Carrier frequency
(*2) Limit: 43 + 10 log (Transmission average power) = 43 + 10 log (1) = 43 dBc
Note: N.A.- Not applicable.

Table 3.5.3 Spurious emissions of CH16 (156.800 MHz) High power.

Spurious frequency	Antenna Polarization	Power of spurious emission (dBc)	Limit (dBc) (*2)	Margin (dB)
0.030 MHz	0 degree	Not found	-57	N.A.
	90 degree	-66.7	-57	9.7
0.063 MHz	0 degree	Not found	-57	N.A.
	90 degree	-63.2	-57	6.2
2 × Fc (*1)	Horizontal	-108.9	-57	51.9
	Vertical	-112.8	-57	55.8
3 × Fc	Horizontal	-108.7	-57	51.7
	Vertical	-107.8	-57	50.8
4 × Fc	Horizontal	-104.5	-57	47.5
	Vertical	-104.5	-57	47.5
5 × Fc	Horizontal	-94.0	-57	37.0
	Vertical	-95.2	-57	38.2
6 × Fc	Horizontal	Not found	-57	N.A.
	Vertical	Not found	-57	N.A.
7 × Fc	Horizontal	-108.0	-57	51.0
	Vertical	-107.9	-57	50.9
8 × Fc	Horizontal	Not found	-57	N.A.
	Vertical	Not found	-57	N.A.
9 × Fc	Horizontal	Not found	-57	N.A.
	Vertical	Not found	-57	N.A.
10 × Fc	Horizontal	Not found	-57	N.A.
	Vertical	Not found	-57	N.A.

(*1) Fc: Carrier frequency
(*2) Limit: 43 + 10 log (Transmission average power) = 43 + 10 log (25) = 57 dBc
Note: N.A.- Not applicable.

Table 3.5.4 Spurious emissions of CH16 (156.800 MHz) Low power.

Spurious frequency	Antenna Polarization	Power of spurious emission (dBc)	Limit (dBc) (*2)	Margin (dB)
0.032 MHz	0 degree	Not found	-43	N.A.
	90 degree	-52.6	-43	9.6
0.064 MHz	0 degree	Not found	-43	N.A.
	90 degree	-49.3	-43	6.3
2 × Fc (*1)	Horizontal	-98.7	-43	55.7
	Vertical	-101.7	-43	58.7
3 × Fc	Horizontal	-95.6	-43	52.6
	Vertical	-94.2	-43	51.2
4 × Fc	Horizontal	-97.6	-43	54.6
	Vertical	-97.2	-43	54.2
5 × Fc	Horizontal	-84.5	-43	41.5
	Vertical	-85.6	-43	42.6
6 × Fc	Horizontal	Not found	-43	N.A.
	Vertical	Not found	-43	N.A.
7 × Fc	Horizontal	-93.6	-43	50.6
	Vertical	-93.8	-43	50.8
8 × Fc	Horizontal	Not found	-43	N.A.
	Vertical	Not found	-43	N.A.
9 × Fc	Horizontal	Not found	-43	N.A.
	Vertical	Not found	-43	N.A.
10 × Fc	Horizontal	Not found	-43	N.A.
	Vertical	Not found	-43	N.A.

(*1) Fc: Carrier frequency
(*2) Limit: 43 + 10 log (Transmission average power) = 43 + 10 log (1) = 43 dBc
Note: N.A.- Not applicable.

Table 3.5.5 Spurious emissions of CH179 (161.475 MHz) High power.

Spurious frequency	Antenna Polarization	Power of spurious emission (dBc)	Limit (dBc) (*2)	Margin (dB)
0.030 MHz	0 degree	Not found	-57	N.A.
	90 degree	-66.0	-57	9.0
0.063 MHz	0 degree	Not found	-57	N.A.
	90 degree	-62.9	-57	5.9
2 × Fc (*1)	Horizontal	-106.4	-57	49.4
	Vertical	-111.6	-57	54.6
3 × Fc	Horizontal	-107.6	-57	50.6
	Vertical	-102.4	-57	45.4
4 × Fc	Horizontal	-106.4	-57	49.4
	Vertical	-106.1	-57	49.1
5 × Fc	Horizontal	Not found	-57	N.A.
	Vertical	Not found	-57	N.A.
6 × Fc	Horizontal	-109.7	-57	52.7
	Vertical	-107.5	-57	50.5
7 × Fc	Horizontal	-100.8	-57	43.8
	Vertical	-102.6	-57	45.6
8 × Fc	Horizontal	Not found	-57	N.A.
	Vertical	Not found	-57	N.A.
9 × Fc	Horizontal	Not found	-57	N.A.
	Vertical	Not found	-57	N.A.
10 × Fc	Horizontal	Not found	-57	N.A.
	Vertical	Not found	-57	N.A.

(*1) Fc: Carrier frequency
(*2) Limit: 43 + 10 log (Transmission average power) = 43 + 10 log (25) = 57 dBc
Note: N.A.- Not applicable.

Table 3.5.6 Spurious emissions of CH179 (161.475 MHz) Low power.

Spurious frequency	Antenna Polarization	Power of spurious emission (dBc)	Limit (dBc) (*2)	Margin (dB)
0.033 MHz	0 degree	Not found	-43	N.A.
	90 degree	-53.1	-43	10.1
0.064 MHz	0 degree	Not found	-43	N.A.
	90 degree	-49.4	-43	6.4
2 × Fc (*1)	Horizontal	-94.3	-43	51.3
	Vertical	-100.0	-43	57.0
3 × Fc	Horizontal	-97.7	-43	54.7
	Vertical	-91.5	-43	48.5
4 × Fc	Horizontal	-101.0	-43	58.0
	Vertical	-100.0	-43	57.0
5 × Fc	Horizontal	-90.9	-43	47.9
	Vertical	-91.8	-43	48.8
6 × Fc	Horizontal	-95.9	-43	52.9
	Vertical	-93.0	-43	50.0
7 × Fc	Horizontal	-93.1	-43	50.1
	Vertical	-94.7	-43	51.7
8 × Fc	Horizontal	Not found	-43	N.A.
	Vertical	Not found	-43	N.A.
9 × Fc	Horizontal	Not found	-43	N.A.
	Vertical	Not found	-43	N.A.
10 × Fc	Horizontal	Not found	-43	N.A.
	Vertical	Not found	-43	N.A.

(*1) Fc: Carrier frequency
(*2) Limit: 43 + 10 log (Transmission average power) = 43 + 10 log (1) = 43 dBc
Note: N.A.- Not applicable.

3.6 Frequency Stability (FCC Rule Part 2.1055)

3.6.1 Method of Measurement

The EUT will be connected with the measuring equipment as shown in Fig.3.6.1
Frequency variation will be measured on CH180 (155.000 MHz), CH16 (156.800 MHz) and CH179 (161.475 MHz).
Power Supply Voltages applied to the EUT will be set to 24 VDC ±15%.

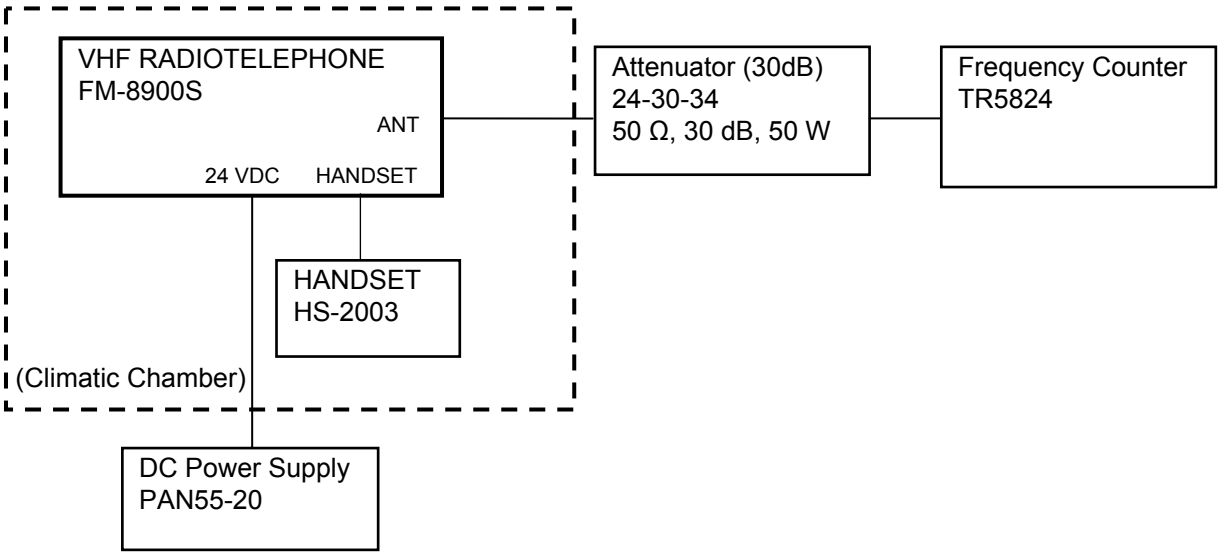


Fig.3.6.1 Setup for Measurement

3.6.2 List of Measuring/Test Equipment

See Clause 4 of this report.

3.6.3 Frequency Tolerance Limits

10 ppm (Ship stations)

3.6.4 Test results

Passed.

Test results are shown in Fig. 3.6.4.1 to 3.6.4.6

Environmental conditions observed: On 2 April 2012, 22°C to 22°C, 50% to 50%RH, 24.0 VDC to 24.0 VDC.
On 3 April 2012, 21°C to 21°C, 53% to 53%RH, 24.0 VDC to 24.0 VDC.
On 4 April 2012, 20°C to 20°C, 48% to 48%RH, 24.0 VDC to 24.0 VDC.

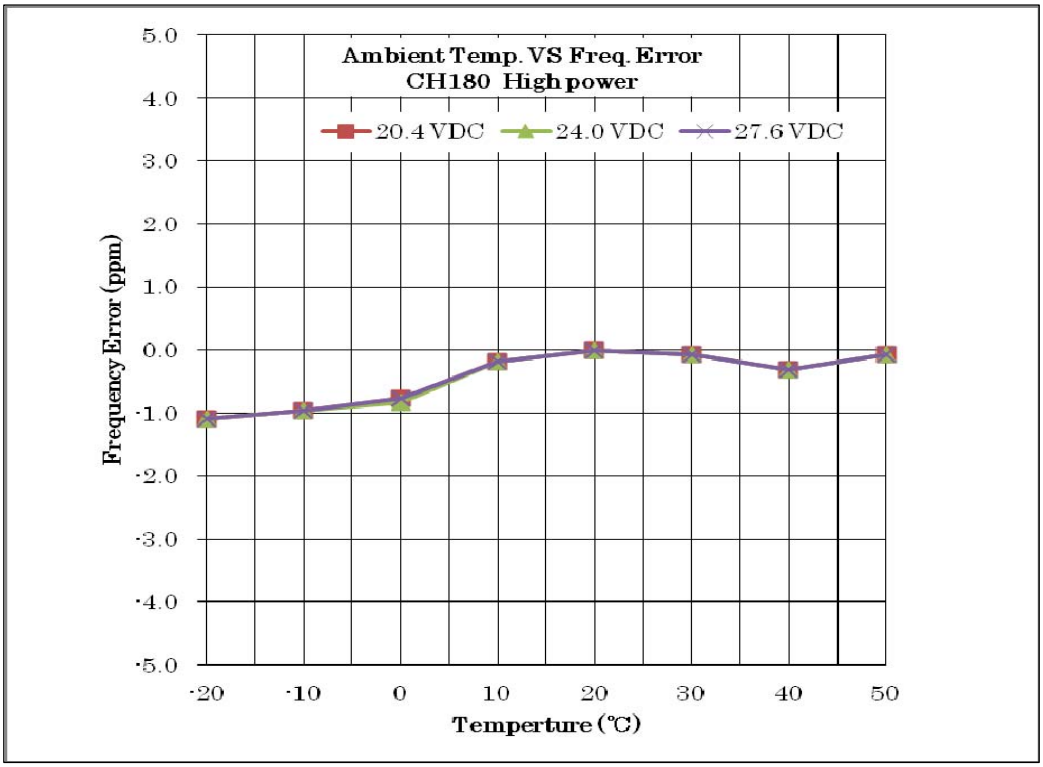


Fig. 3.6.4.1. Frequency stability (CH180, High power)

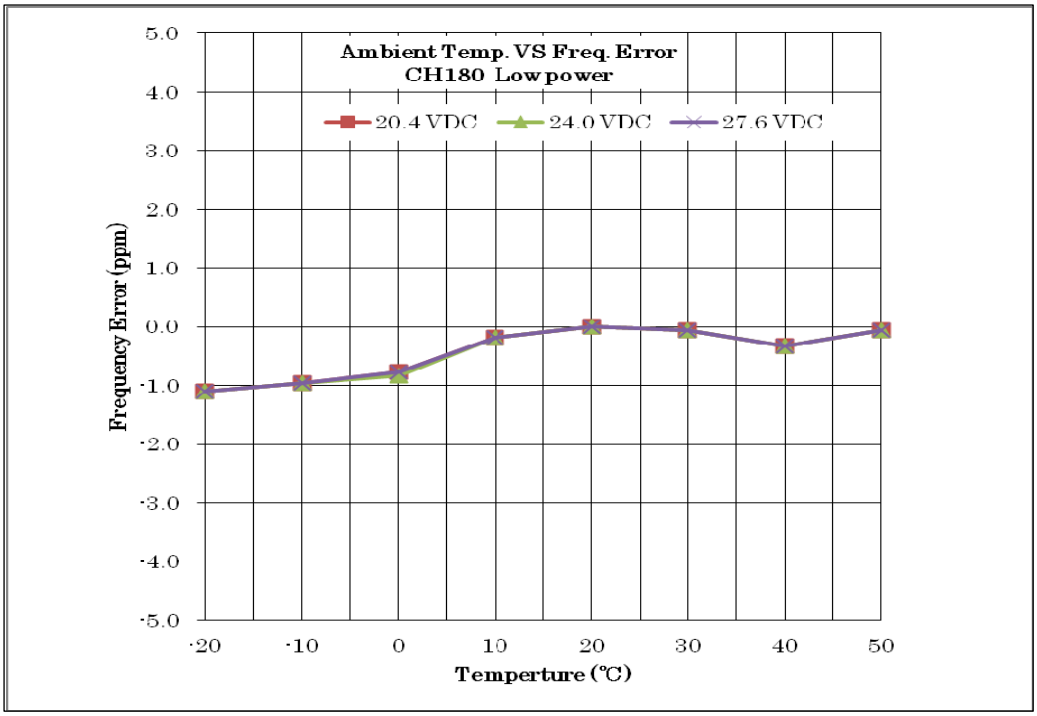


Fig. 3.6.4.2. Frequency stability (CH180, Low power)

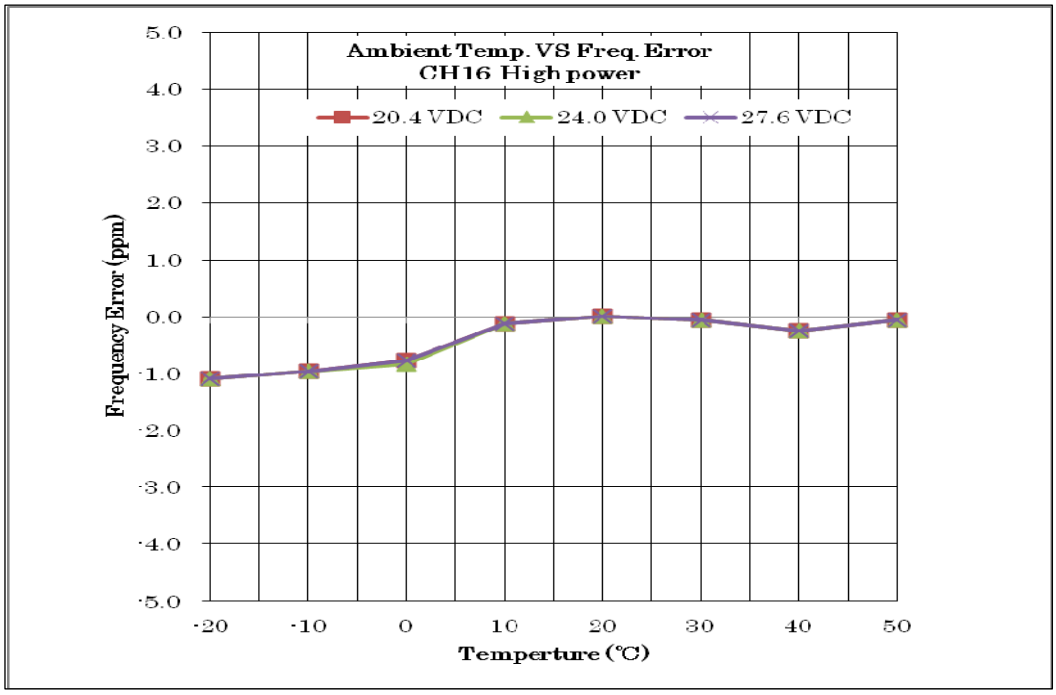


Fig. 3.6.4.3. Frequency stability (CH16, High power)

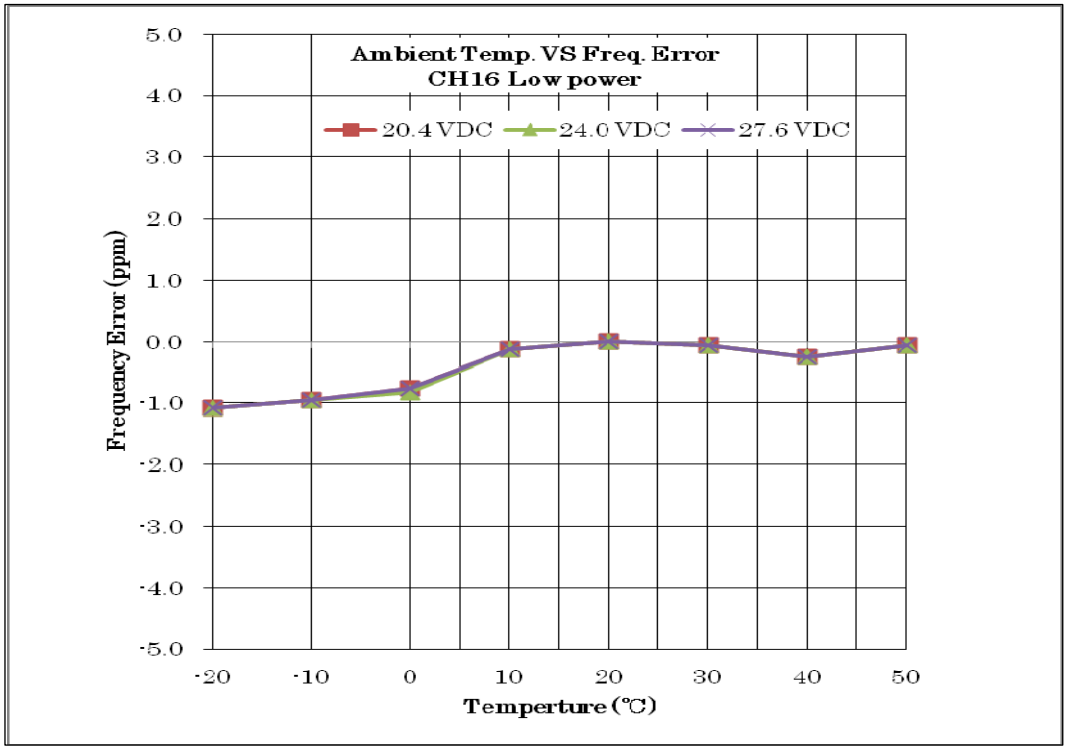


Fig. 3.6.4.4. Frequency stability (CH16, Low power)

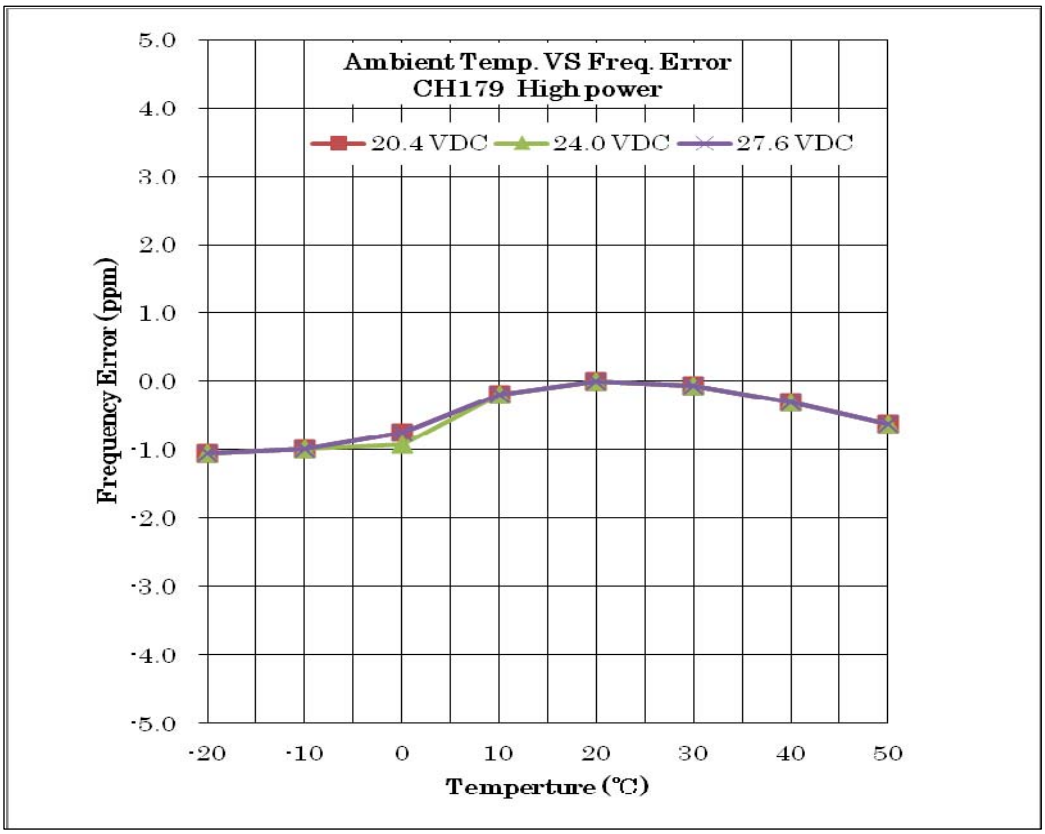


Fig. 3.6.4.5. Frequency stability (CH179, High power)

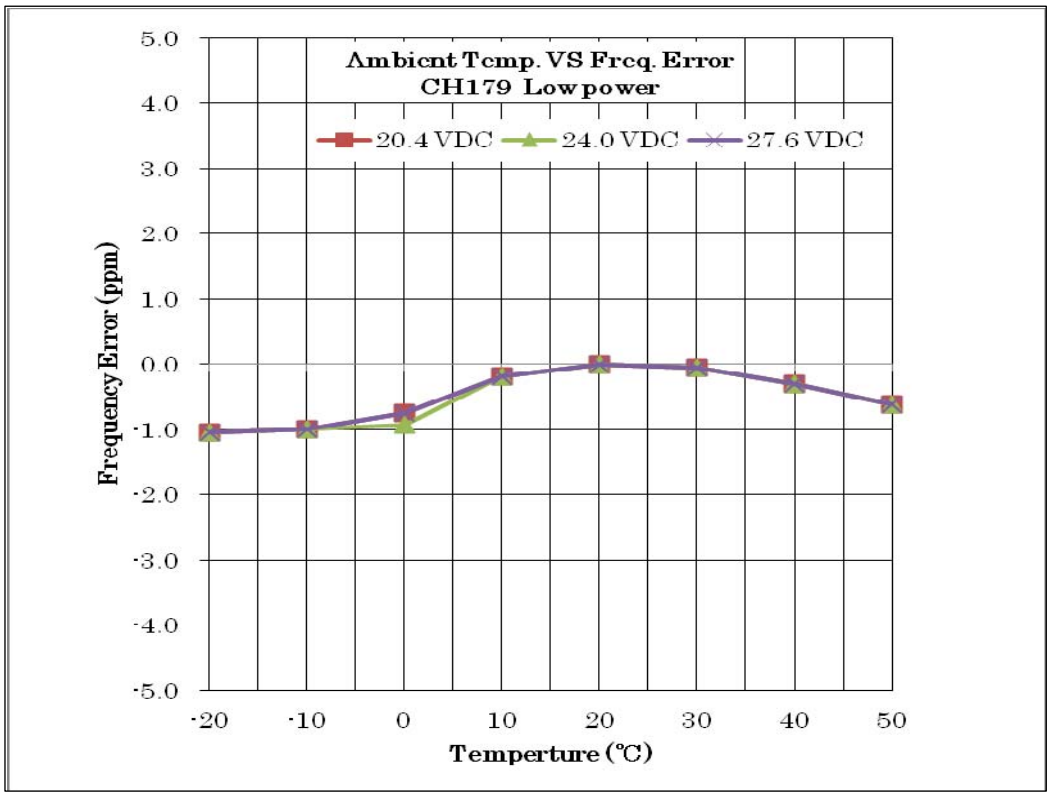


Fig. 3.6.4.6. Frequency stability (CH179, Low power)

3.7 Suppression of Interference Aboard Ships (FCC Rule Part 80.217)

3.7.1 Method of Measurement

The EUT will be connected with the measuring equipment as shown in Fig.3.7.1
Test mode: CH16 (156.800 MHz), Receiving.

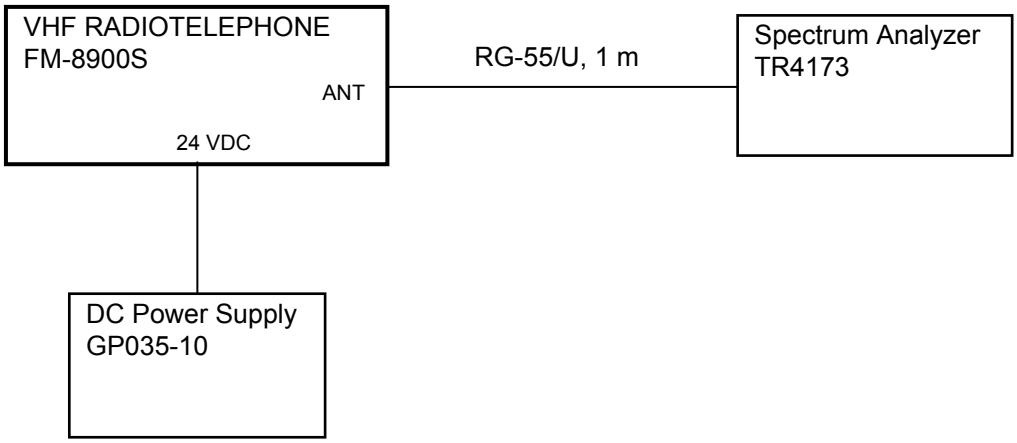


Fig.3.7.1 Setup for Measurement

3.7.2 List of Measuring/Test Equipment

See Clause 4 of this report.

3.7.3 Limits

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 - 2 GHz			1 MHz

3.7.4 Test results

Passed.

Test results are shown in Fig. 3.7.4.1 to 3.7.4.6

Environmental conditions observed: On 19 April 2012, 27°C to 27°C, 37% to 37%RH,
24.0 VDC to 24.0 VDC.

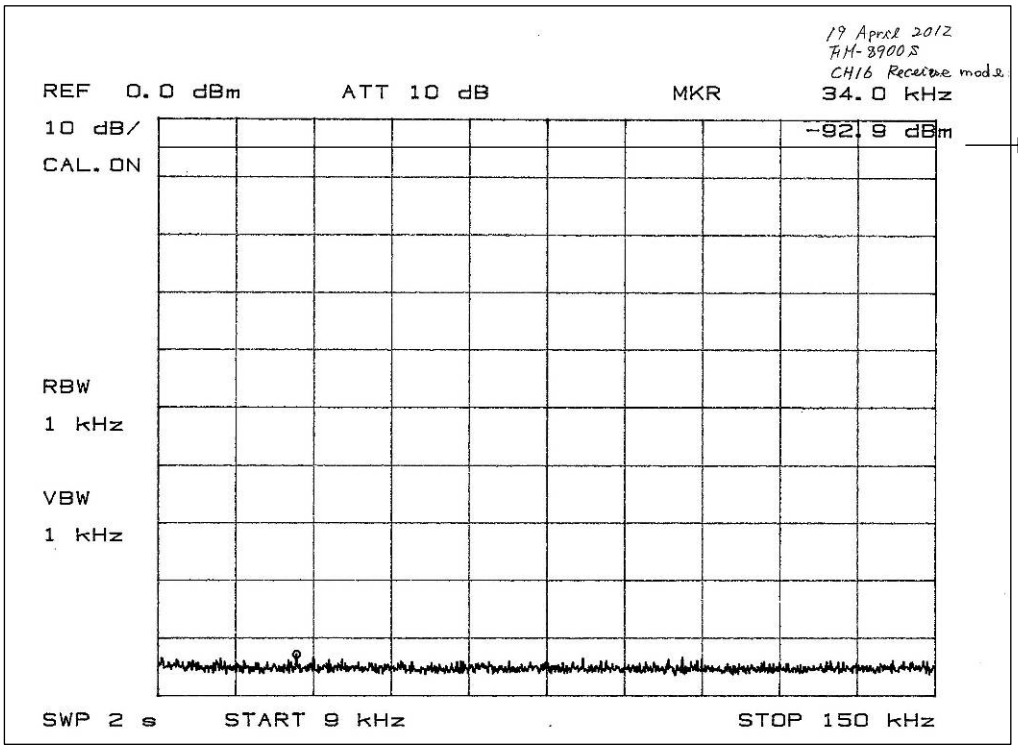


Fig. 3.7.4.1 - 9 kHz - 150 kHz (Limit: 400 µW = -4 dBm)

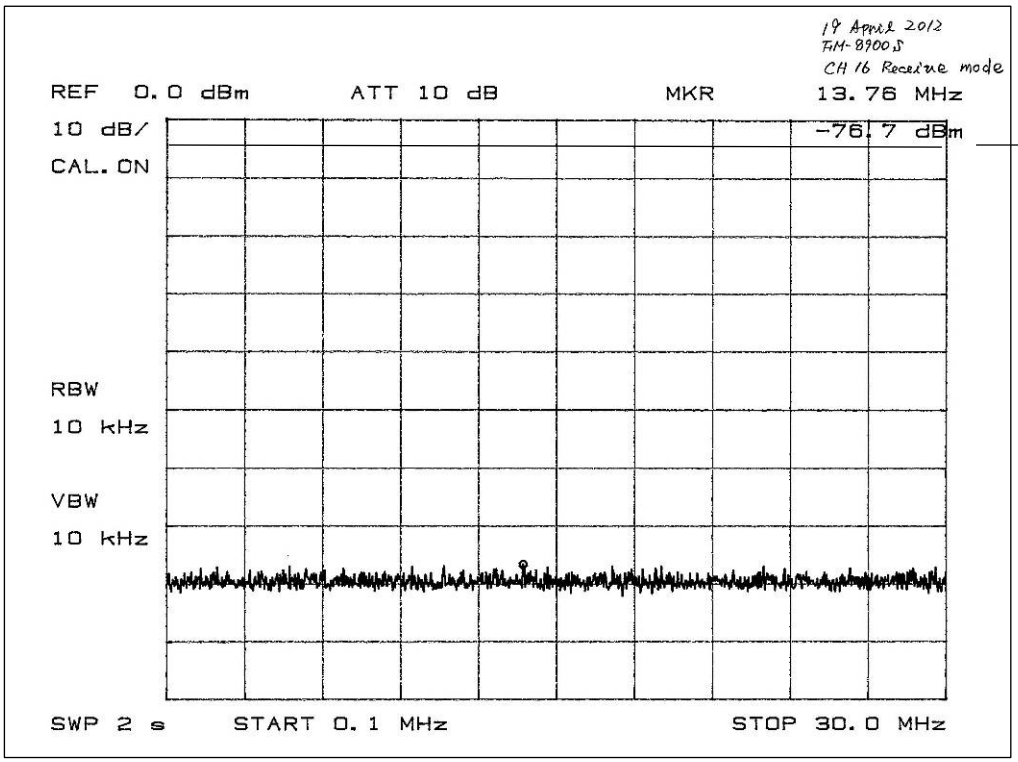


Fig. 3.7.4.2 - 150 kHz - 30 MHz (Limit: 400 µW = -4 dBm)

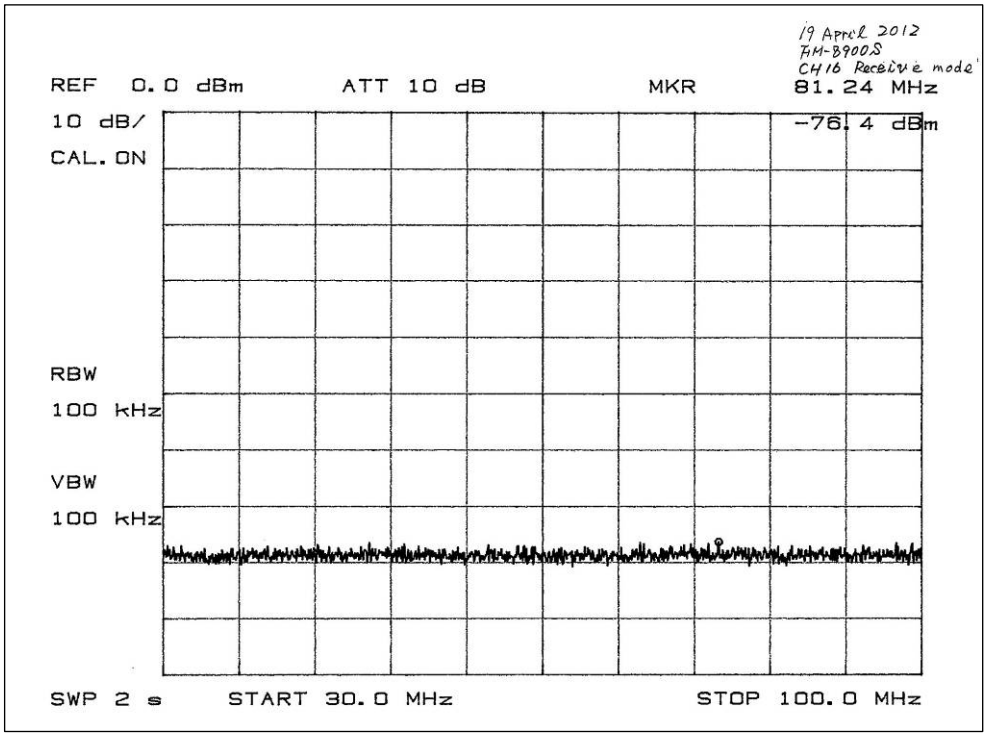


Fig. 3.7.4.3 - 30 MHz - 100 MHz (Limit: 4000 µW = +6 dBm)

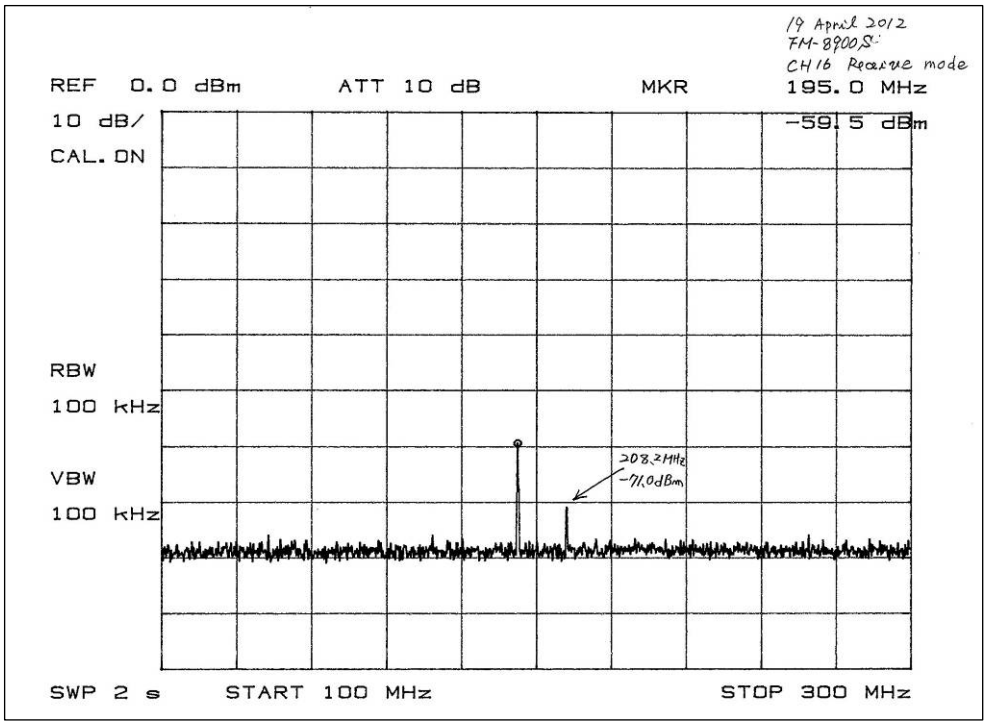


Fig. 3.7.4.4 - 100 MHz – 300 MHz (Limit: 40000 µW = +16 dBm)

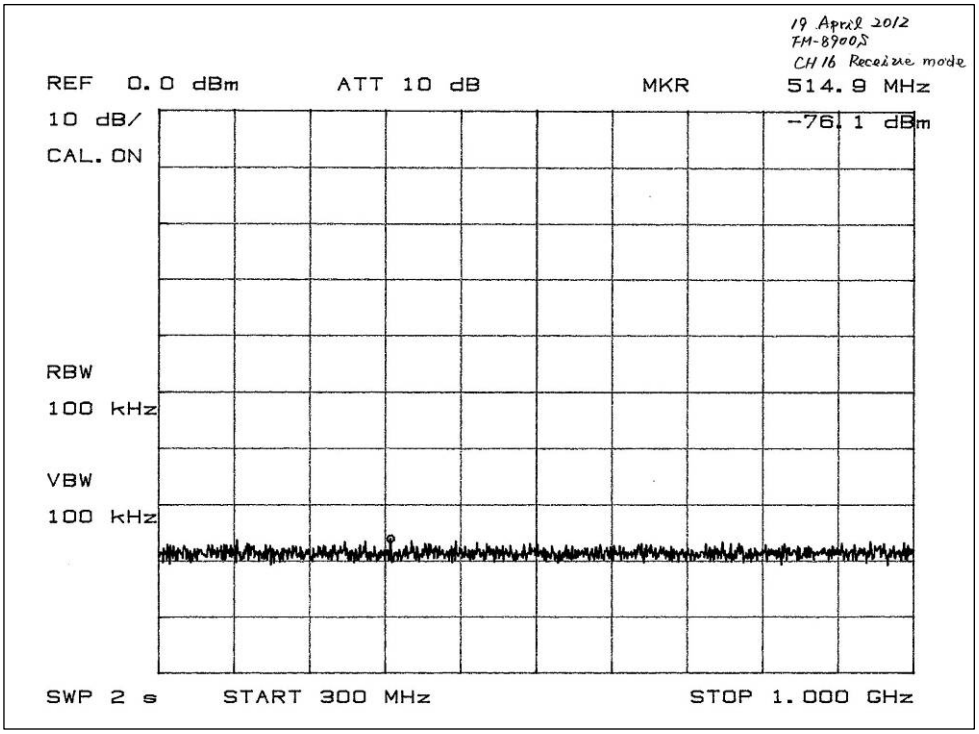


Fig. 3.7.4.5 - 300 MHz – 1 GHz (Limit: 400000 µW = +26 dBm)

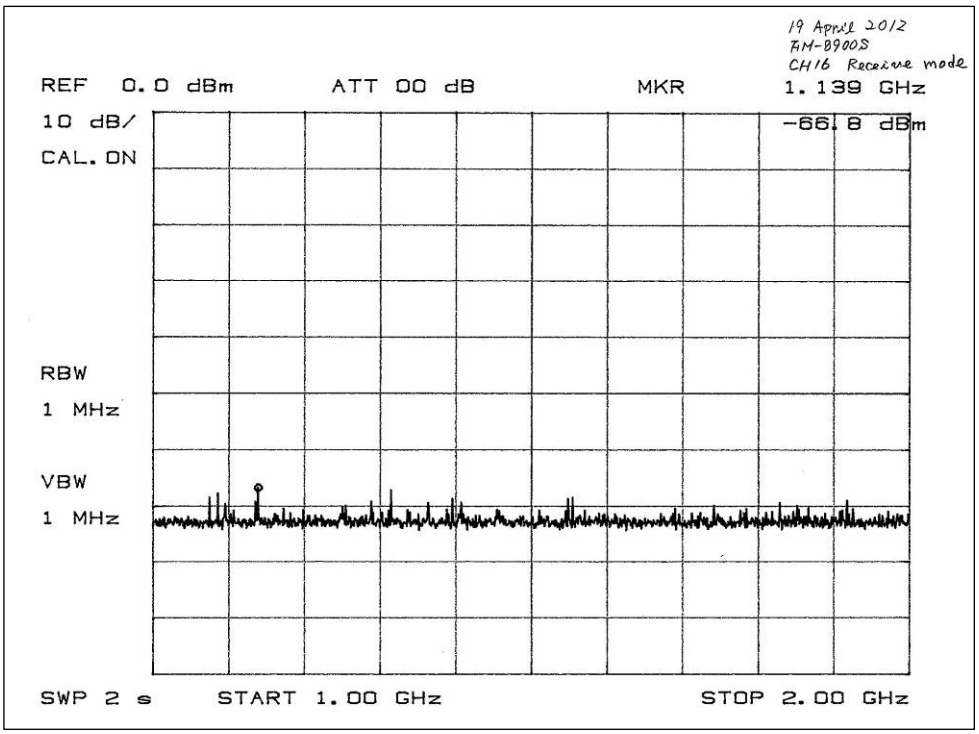


Fig. 3.7.4.6 - 1 GHz – 2 GHz (Limit: 400000 µW = +26 dBm)

3.8 Maximum Usable Sensitivity for the Receiver (FCC Rule Part 80.874)

3.8.1 Method of Measurement

(1) The EUT will be connected with measuring equipment as shown in Fig. 3.8.1.

(2) An Input test signal at a Carrier frequency equal to the nominal frequency of the receiver, will be modulated by the normal test modulation.

(3) Normal test modulation:

Modulation frequency: 1 kHz
Frequency deviation: ±3.5 kHz.

(4) The level of the Input test signal will be adjusted so that a SINAD ratio of 12 dB is obtained.

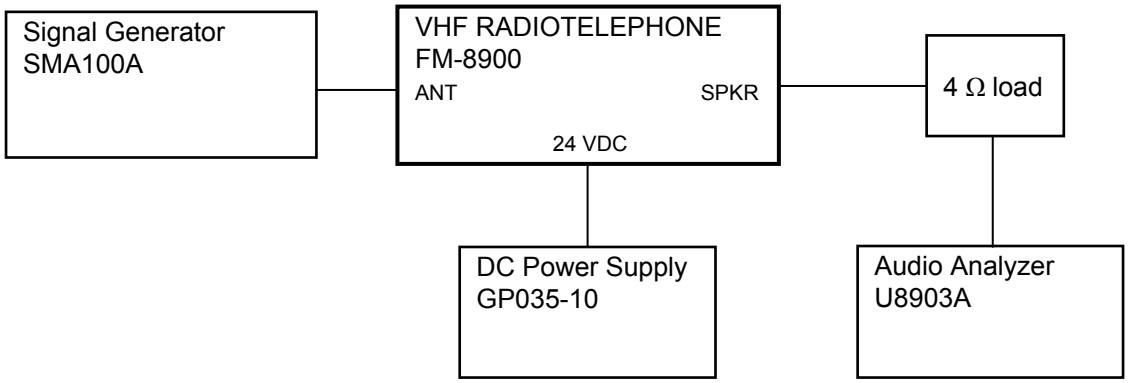


Fig. 3.8.1

3.8.2 List of Measuring/Test Equipment

See Clause 4 of this report.

3.8.3 Limits

Less than 0.5 μV.

3.8.4 Test results

Passed.

	Power Supply		
Test channel	20.4 VDC	24.0 VDC	27.6 VDC
CH180: 155.000 MHz	0.45 μV	0.45 μV	0.45 μV
CH16: 156.800 MHz	0.45 μV	0.45 μV	0.45 μV
CH224: 164.200 MHz	0.45 μV	0.45 μV	0.45 μV

Environmental conditions observed: On 19 April 2012, 26°C to 28°C, 38% to 38%RH, 24.0 VDC to 24.0 VDC.

4 List of Measuring/Test Equipment Used

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.

4.1 Temperature and Voltage Extremes

Instrument	Type	S/N	Manufacturer
Climatic chamber (Nishinomiya-S)	PL-4KP	14004204	Tabai Espec
DAQSTATION FX100	FX106-4-1	S5JA01450	Yokogawa
DC power supply	PAN55-20	AK003307	Kikusui

4.2 Receiver Spurious Emission

Instrument	Type	S/N	Manufacturer
Spectrum analyzer (9 kHz to 3 GHz)	R3132	110401654	Advantest
Loop antenna (0.15 MHz to 30 MHz)	HFH2-Z2	100093	Rohde & Schwarz
Amplifier (for Loop antenna)	310N	250607	Sonoma Instrument
Biconical antenna (30 MHz to 300 MHz)	VBA6106A	1296	Schaffner
Pre-amplifier (30 MHz to 2 GHz)	87405A	3207A01643	Agilent
Semi-anechoic Chamber	3mSAC	D-002	Riken
DC power supply	GP035-30	1014396080	Takasago

4.3 Measuring/Test Instruments submitted by the customer for evaluating the EUT performance

Instrument	Type	Serial No.	Manufacture	Calibration Due date
Audio Analyzer	U8903A	MY50070005	Agilent	30 April 2013
Sensor Module	11722A	2716A01531	HP	31 August 2012
Modulation Analyzer	8901B	3028A03046	HP	31 January 2013
Multi-Meter	TR6840	30340715	ADVANTEST	31 August 2012
Resistance Attenuator	RA-920A	1090014	KENWOOD	30 November 2012
Spectrum Analyzer	TR4173	85580030	ADVANTEST	31 January 2013
Signal Generator	SMA100A	103683	R & S	30 June 2012
Frequency Counter	TR5824	41930036	ADVANTEST	31 August 2012
Attenuator (30 dB)	24-30-34	BT6391	Aeroflex/Weinschel	31 July 2012
High-Pass Filter	MP526B	M83048	ANRITSU	30 April 2013
DC Power Supply	GP035-10	1013895093	TAKASAGO	CNR (*)
Power Meter	N1912A	MY45101876	Agilent	31 January 2013
Power Senser	N1921A	MY45242388	Agilent	31 January 2013

(*): calibration not required.