

Test Report

FCC Testing for the SX1126 UNII Customer Premise Equipment Transceiver

No. 3 Additional Antennas June 25, 2001

Jay Kruse WJ Communications
 Alberto Campos WJ Communications
 Tom Cokenias Consultant

This document presents the latest results for the WJ Communication's SX1126 transceiver.

Customer requirements have required the addition of new antennas. The FCC specifications as a function of antenna gain are listed in Table 1.

Table 1. FCC limits based on antenna gain.

Antenna	Antenna Gain (dBi)	Maximum Allowed PSD (dBm/MHz)	Maximum Allowed Peak Transmit Power BW=6 MHz (dBm)	Maximum Allowed Band edge PSD (dBm/MHz)	Maximum Allowed Band edge ± 10 MHz PSD (dBm/MHz)
Integrated	22.5	17.0	24.8	-39.5	-49.5
2' Dish	28.0	12.0	19.8	-45.0	-55.0
3' Dish	31.0	9.0	16.8	-48.0	-58.0
4' Dish	34.0	6.0	13.8	-51.0	-61.0

In the initial testing with the integrated antenna, special attention was not placed on maximizing the dynamic range of the spectrum analyzer. A typical SX1126 transceiver was tested at the maximum output power (14 dBm) for the three bandwidths to determine the worse case band edge emissions. The lowest channel dominates the band-edge PSD specifications. At the middle and highest channels the noise floor of the spectrum analyzer limits the bandedge emissions as shown in Figure 2 for the 6 MHz bandwidth signal.

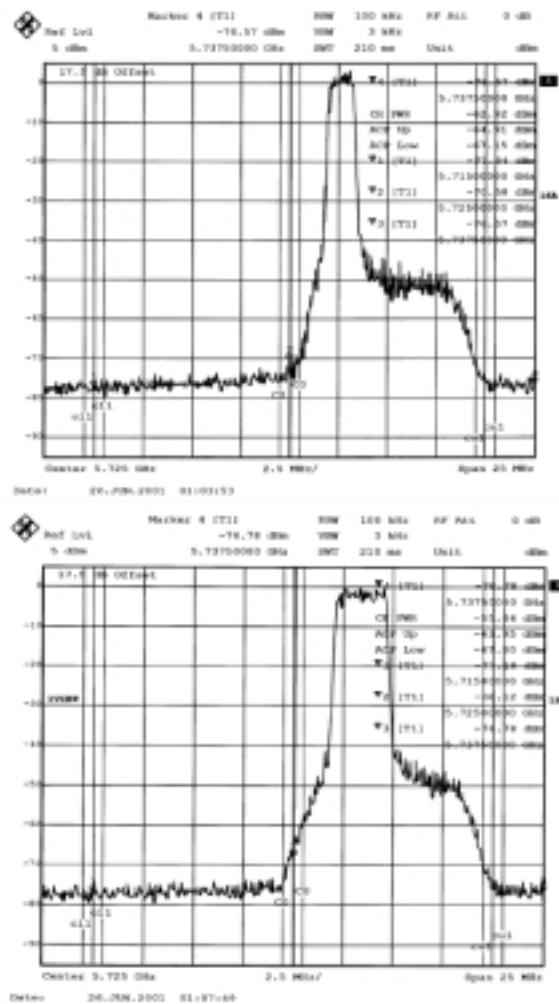
Table 2. Measured band-edge PSD data

Bandwidth (MHz)	Output Power (dBm)	Maximum Allowed Band edge PSD (dBm/MHz)	Maximum Measured Band edge PSD (dBm/MHz)	Maximum Allowed Band edge ± 10 MHz PSD (dBm/MHz)	Maximum Measured Band edge ± 10 MHz PSD (dBm/MHz)
1.5	14.0	-51.0	-62.9	-61.0	-67.2
3.0	14.0	-51.0	-55.0	-61.0	-67.8
6.0	14.0	-51.0	-51.5	-61.0	-68.3

Included in the manual will be the maximum output power for a given antenna and signal bandwidth (Table 3).

Table 3. Maximum transceiver output power as a function of signal bandwidth and antenna gain.

Antenna	Antenna Gain (dBi)	Po (dBm) 1.5 MHz	Po (dBm) 3.0 MHz	Po (dBm) 6.0 MHz
Integrated	22.5	14.0	14.0	14.0
2' Dish	28.0	13.8	14.0	14.0
3' Dish	31.0	10.8	13.8	14.0
4' Dish	34.0	7.8	10.8	13.8



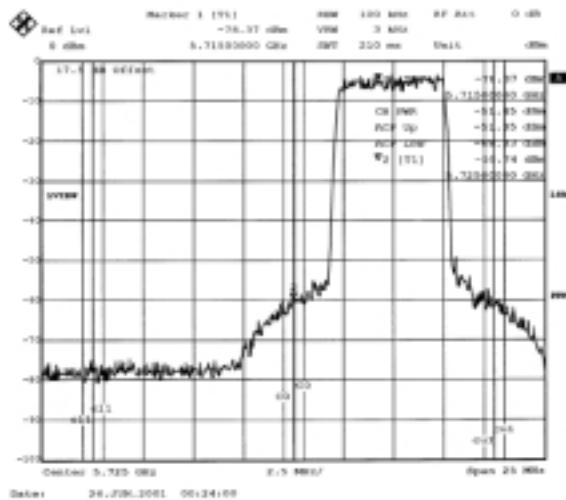


Figure 1. Low-band emmission plots for 1.5, 3.0 and 6.0 MHz. The output power was 14.0 dBm. All signal bandwidths passed the 34 dBi antenna bandedge emission requirements at this output power level.

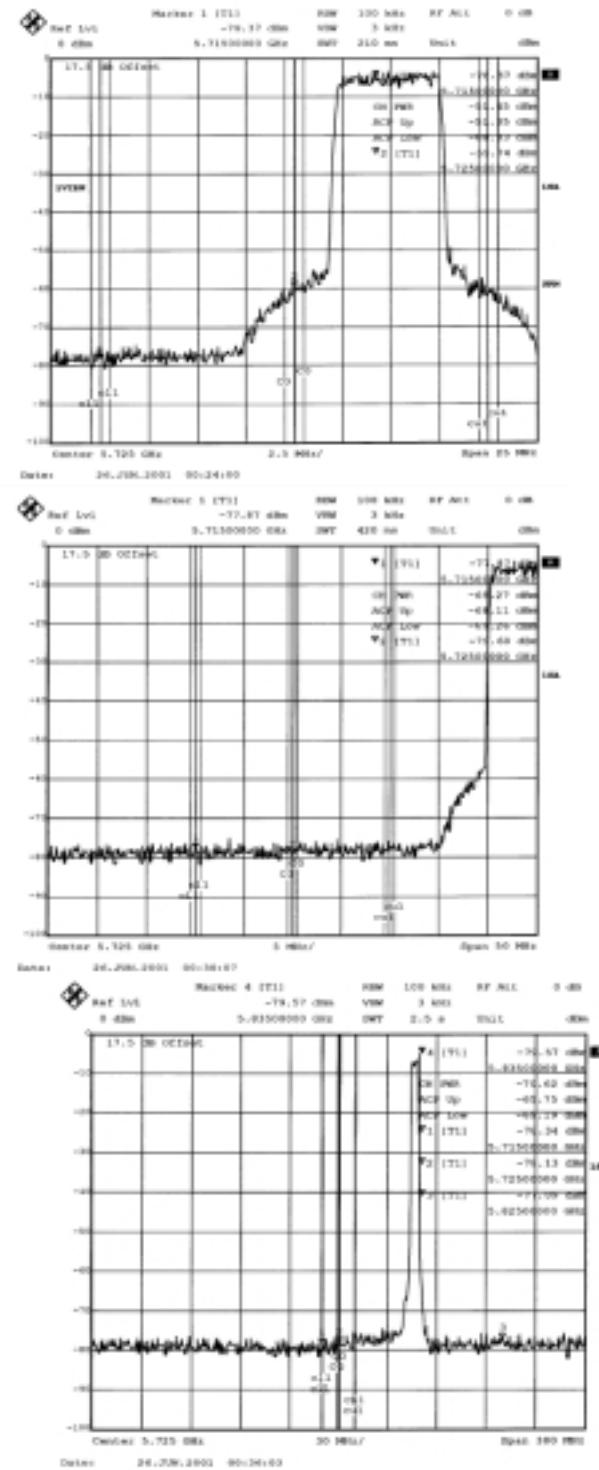


Figure 2. Emmision plots for low, middle and high channels. The output power was 14.0 dBm and the bandwidth was 6 MHz. The noise floor of the spectrum analyzer determines the bandedge PSD for all but the low channel.

Amendment 1 Test Methods for determining UNII parameters.

Peak Power Spectral Density 17 dBm/MHz

Resolution Bandwidth = 1MHz

Video Bandwidth = 1 MHz

Average = 100 sweeps

Peak Search

Measure Peak

Peak Transmit Power $17 \text{ dBm/MHz} + 10 \cdot \log(\text{Bandwidth in MHz})$

Resolution Bandwidth ~ 1% Emission Bandwidth

Video Bandwidth = Resolution Bandwidth

Set Channel Bandwidth = Emission Bandwidth

View Trace

Measure Power in Channel Bandwidth

Band Edge $-17 \text{ dBm/MHz} - \text{Antenna Gain (Bandedge)}$

$-27 \text{ dBm/MHz} - \text{Antenna Gain (Bandedge} \pm 10 \text{ MHz)}$

Resolution Bandwidth ~ 1% Emission Bandwidth

Video Bandwidth = Resolution Bandwidth/30

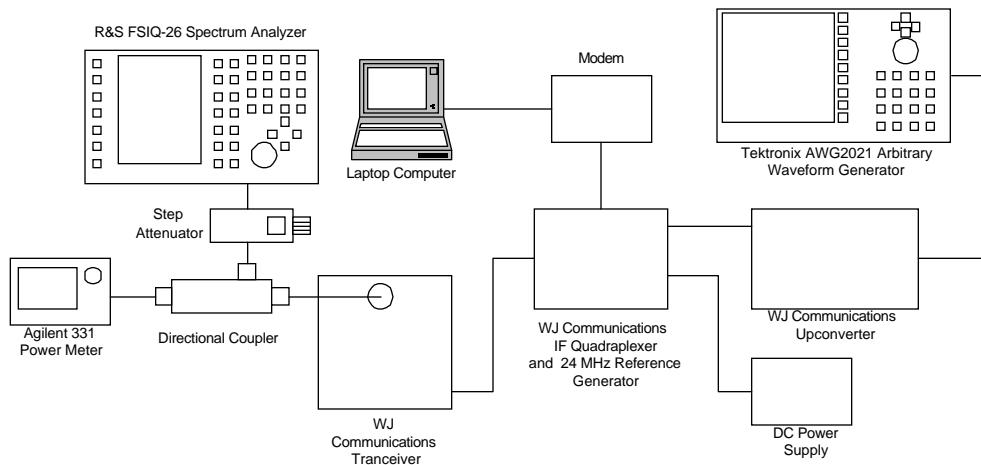
Center Frequency = Band Edge

Set Adjacent Channel Bandwidth = 1 MHz

View Trace

Measure Power in Adjacent Channel d Bandwidth

Test Setup



15.407(f) RF Exposure

NOTE: User manual will have instructions to maintain a minimum separation distance of 1.5 m from all persons, to keep in compliance with 15 November 2000 TCB Exclusions.

15.407(c)6 Field Strength of Spurious and Harmonic Radiation

Radiated tests for unwanted out of band transmitter emissions were performed at three different operating frequencies.

5730 MHz (LOW)

5754 MHz (MID)

5772 MHz (HIGH)

The SX1126 will be deployed with an integral antenna. The correct mounting hardware for this antenna was not available at time of test. The antenna was placed next to the radio (instead of being mounted on top covering the circuit board) and was connected to the RF output port by the type and length cable that will be used on production units.

The test set-up is a worst-case configuration as emissions directly off the board are not blocked or shielded as they would be under actual conditions. However, test data shows the unit meets the 15.205 and 15.209 limits for radiated emissions above 1 GHz.

Summary of the test results is presented in the table below:

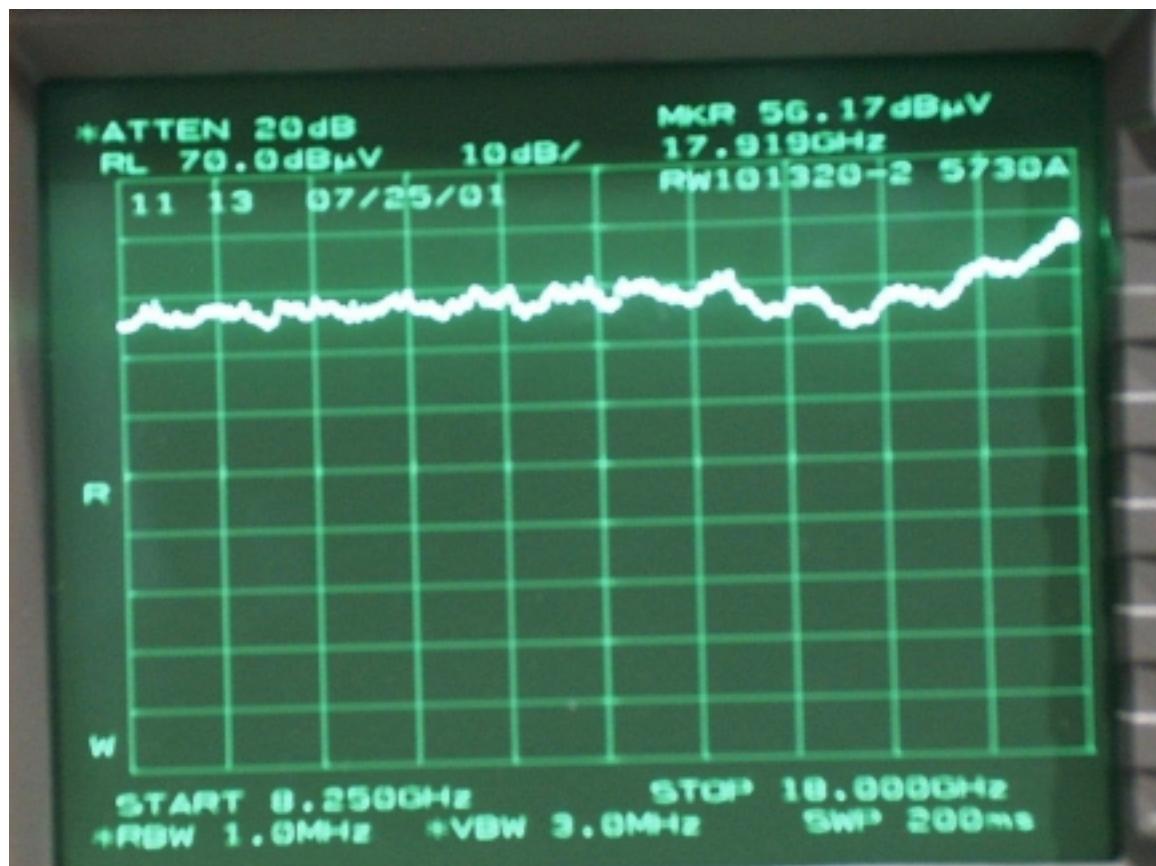
fo MHz	Emission GHz	Reading dBuV/m	Meas.dist, m	3 m Corr dBuV/m	Limit dBuV/m	Notes
				pk av	Pk Av	
5730	16.050	59.8	1.0	50.3	74 54	LOCAL OSC
	21.4	61.3	0.5	45.8	74 54	LOCAL OSC
	26.77	67.5	0.5	51.96	NONE	LOCAL OSC not 15.205
5754	17.25	59.3	1.0	49.8	NONE	3 rd harmonic not 15.205
	21.7	59.2	0.5	43.7	NONE	LOCAL OSC not 15.205
5772	16.13	54.7	1.0	45.2	74 54	LOCAL OSC
	21.76	57.7	0.5	42.2	NONE	LOCAL OSC not 15.205

Dist correction, 1m to 3m: -9.54 dB

Distance correction, 0.5m to 3m -15.54 dB

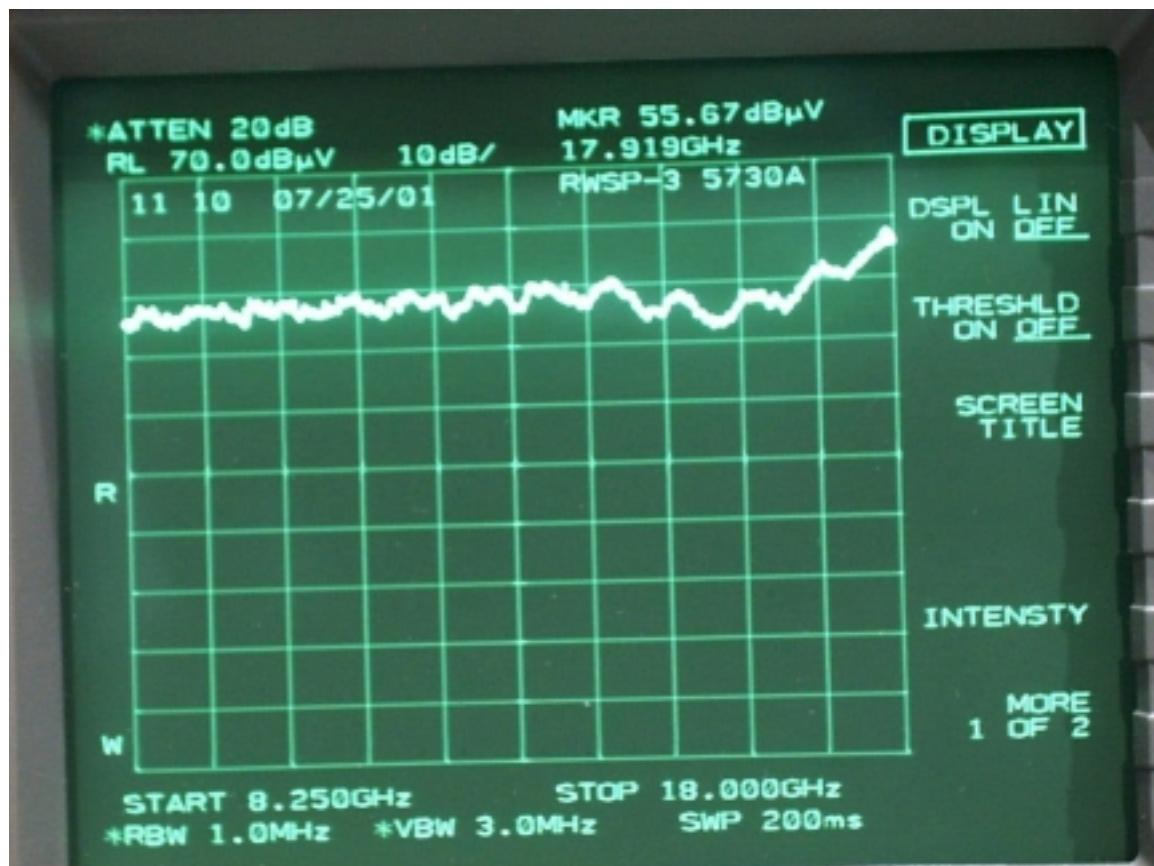
NTTSX1126 Radiated Emissions, Radiowaves 2 ft dish
fo = 5730 MHz

Emissions: 8.25 - 18 GHz



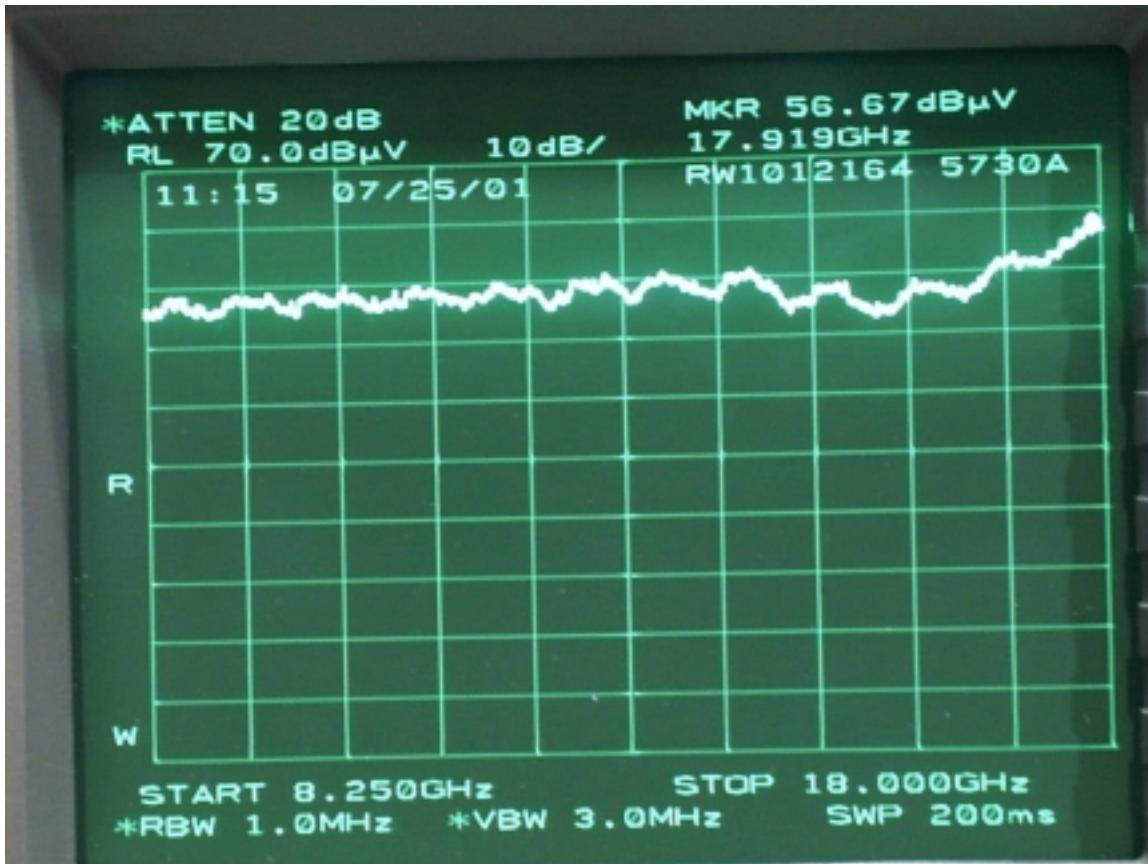
NTTSX1126 Radiated Emissions, Radiowaves 3 ft dish
fo = 5730 MHz

Emissions: 8.25 - 18 GHz



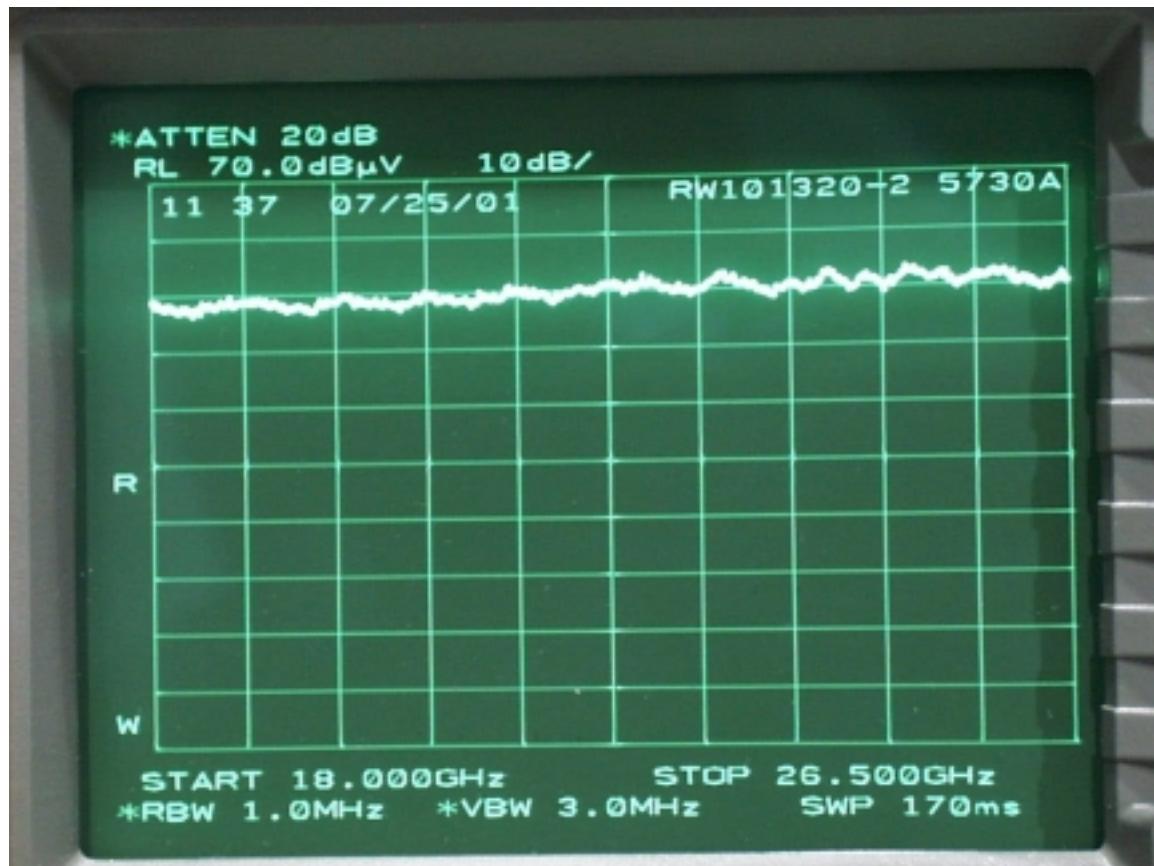
NTTSX1126 Radiated Emissions, Radiowaves 4 ft dish
fo = 5730 MHz

Emissions: 8.25 - 18 GHz



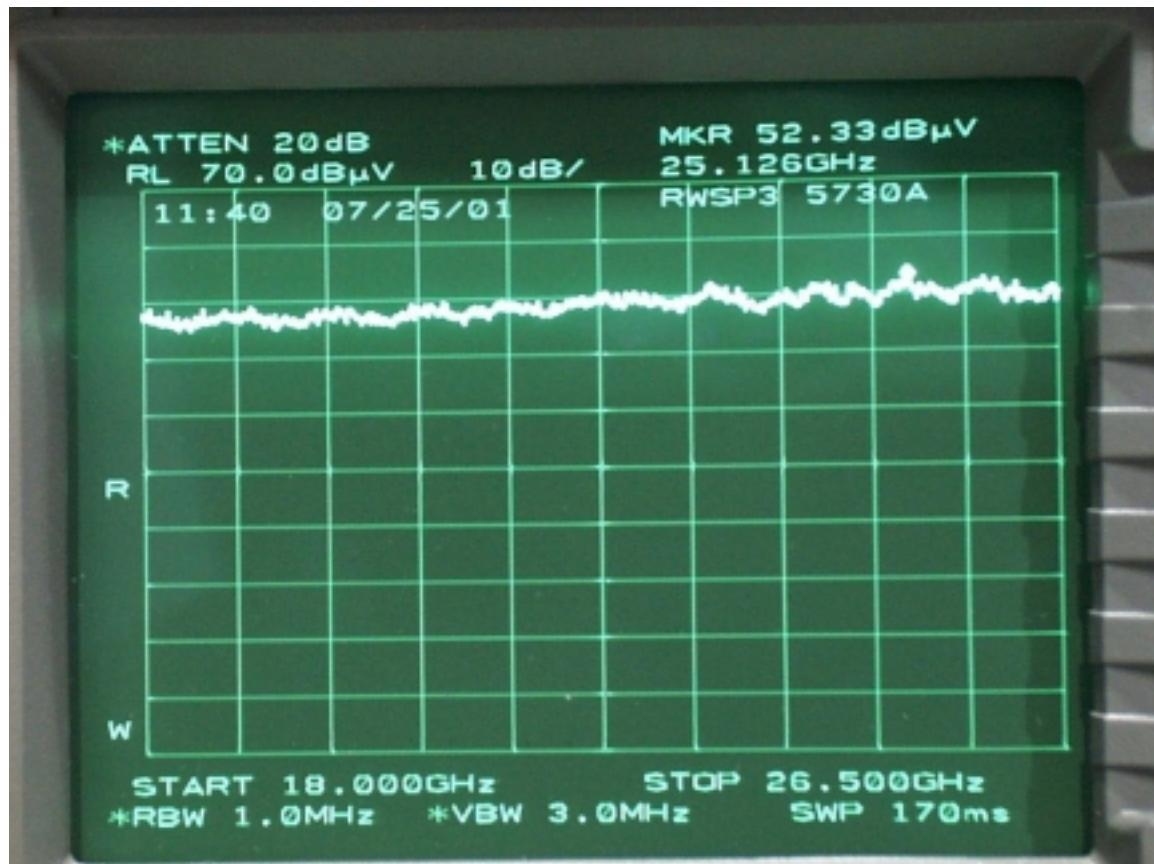
NTTSX1126 Radiated Emissions
fo = 5730 MHz

Emissions: 18 - 26.5 GHz Radiowaves 2ft dish



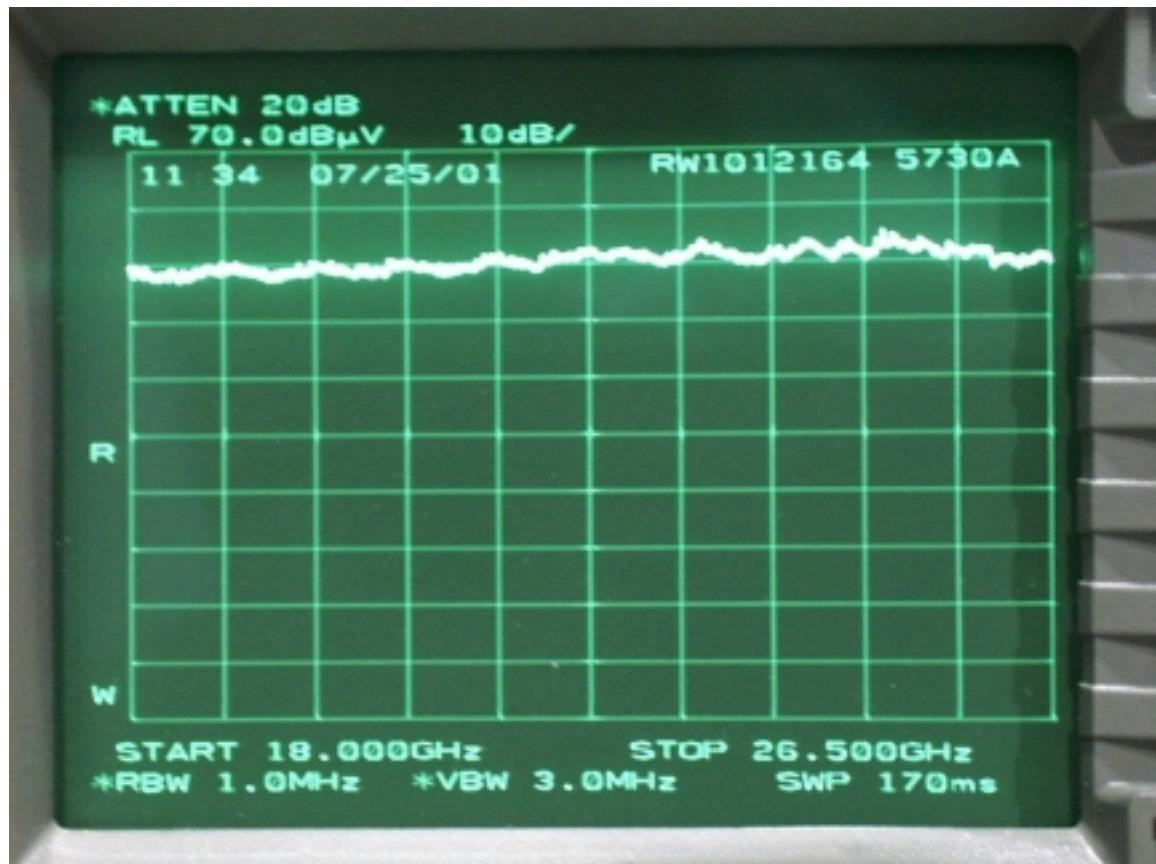
NTTSX1126 Radiated Emissions
fo = 5730 MHz

Emissions: 18 - 26.5 GHz Radiowaves 3ft dish



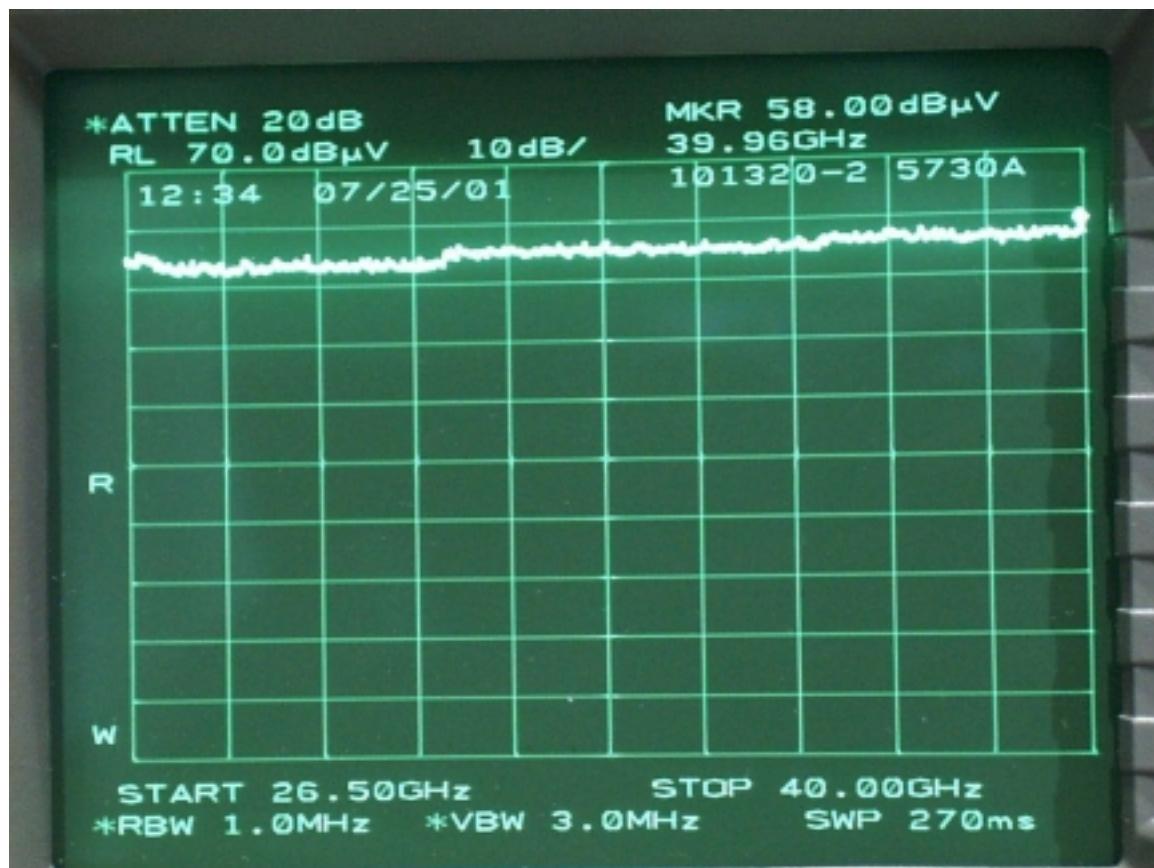
fo = 5730 MHz

Emissions: 18 - 26.5 GHz Radiowaves 4ft dish



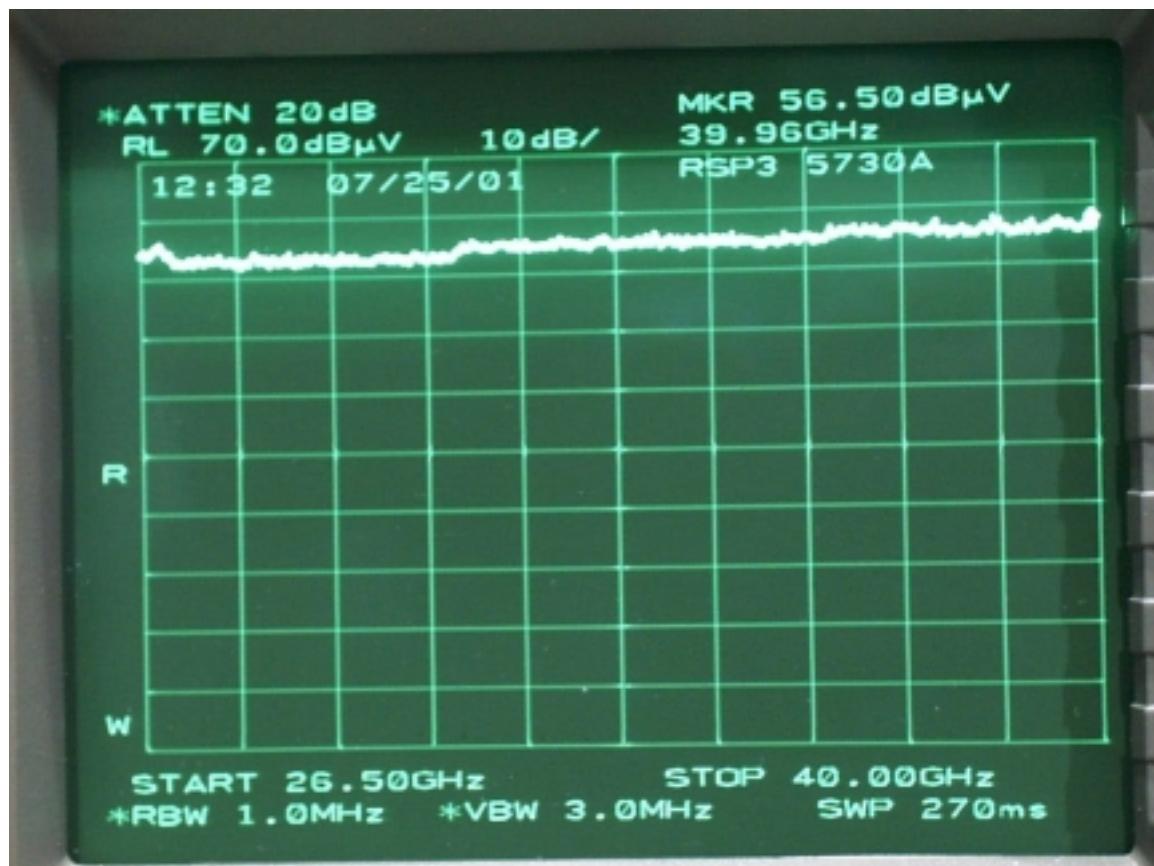
NTTSX1126 Radiated Emissions
fo = 5730 MHz

Emissions 26.5 - 40 GHz Radiowaves 2ft dish



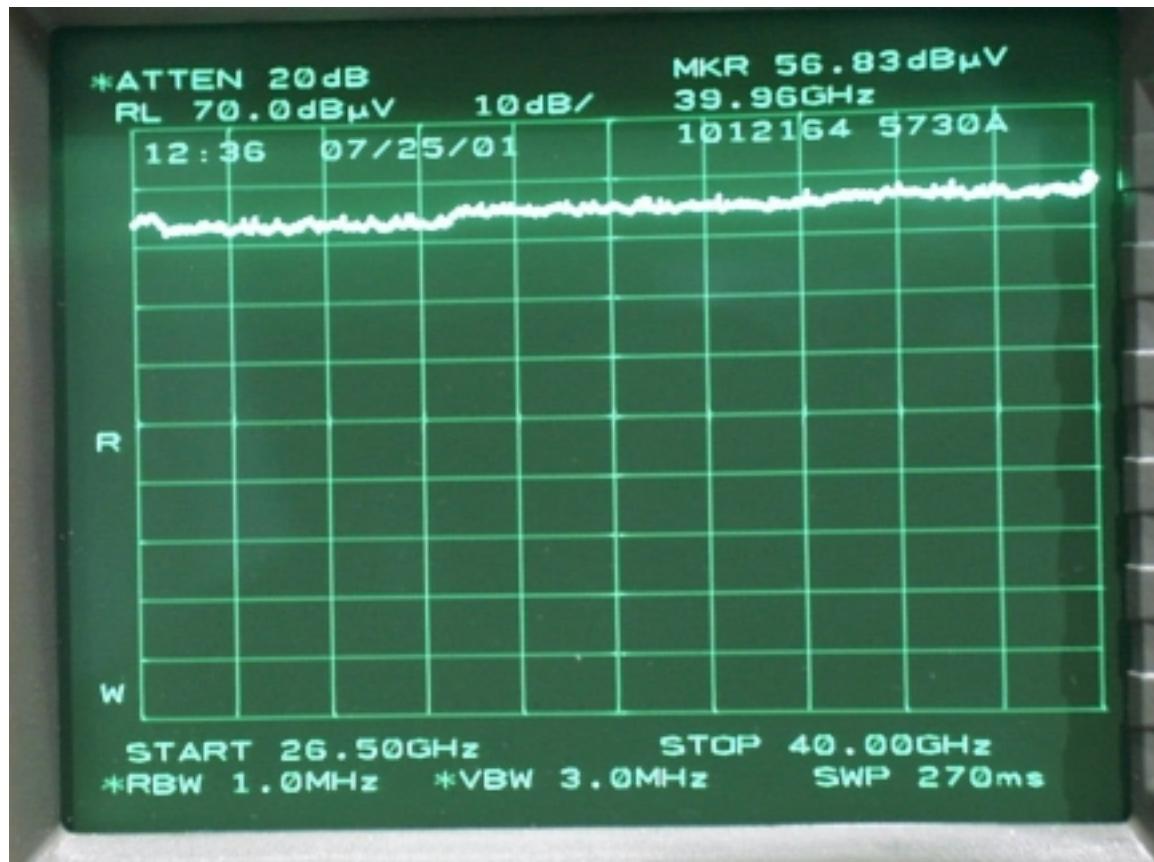
NTTSX1126 Radiated Emissions fo = 5730 MHz

Emissions: 26 - 40 GHz Radiowaves 3ft dish



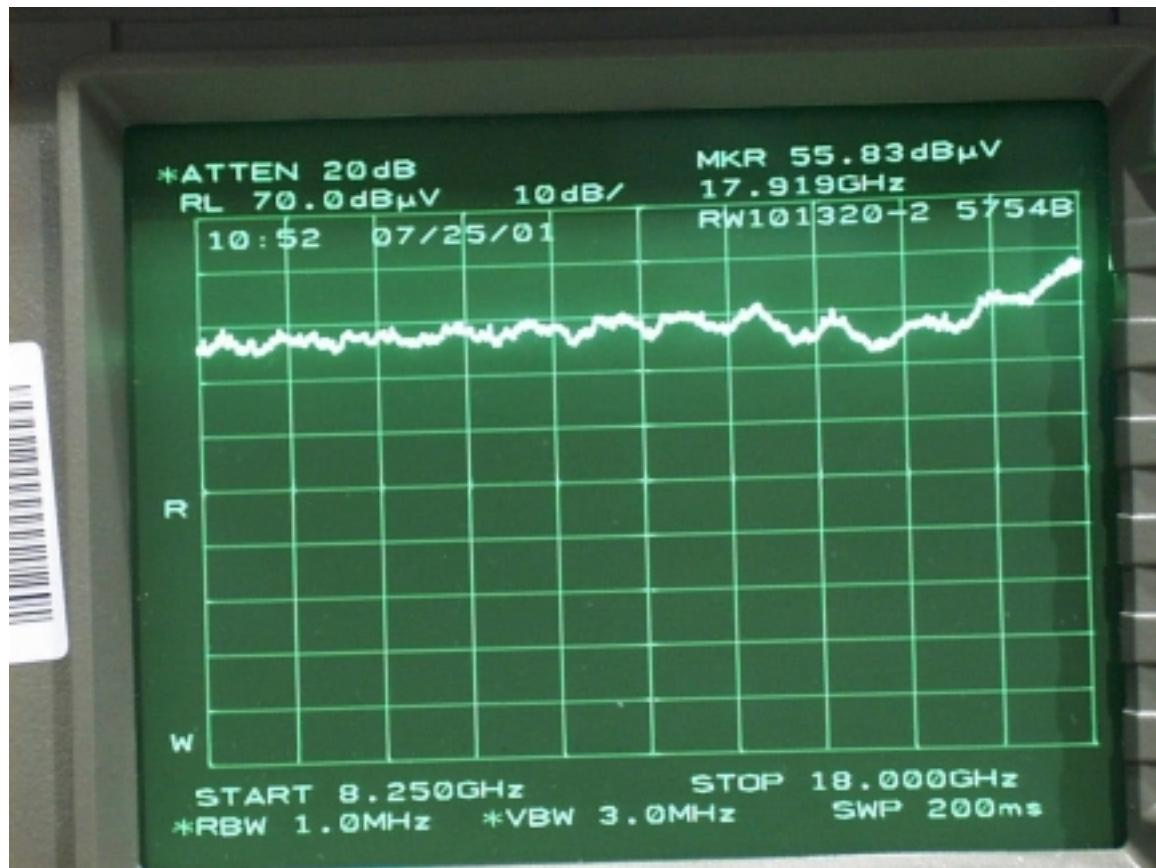
fo = 5730 MHz

Emissions: 26.5 - 40GHz Radiowaves 4ft dish



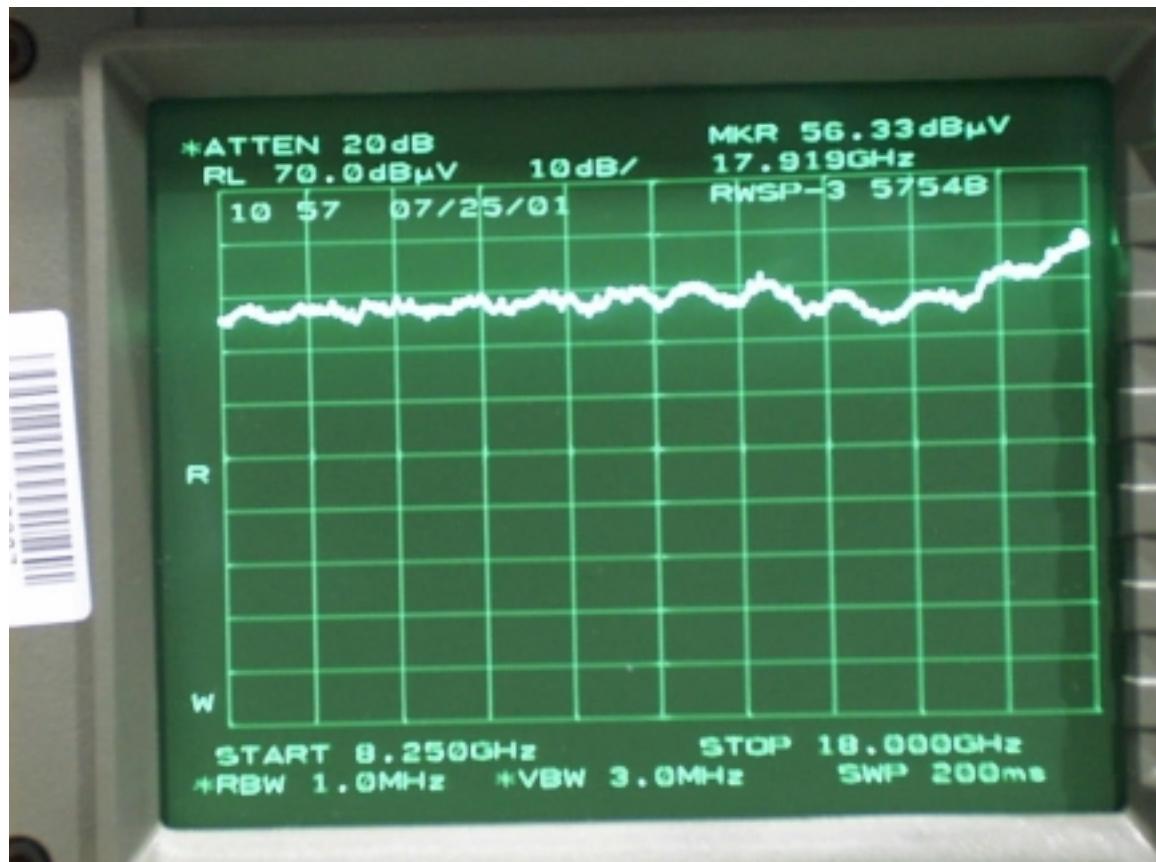
NTTSX1126 Radiated Emissions
fo = 5754 MHz

Emissions 8.25 - 18 GHz Radiowaves 2ft dish



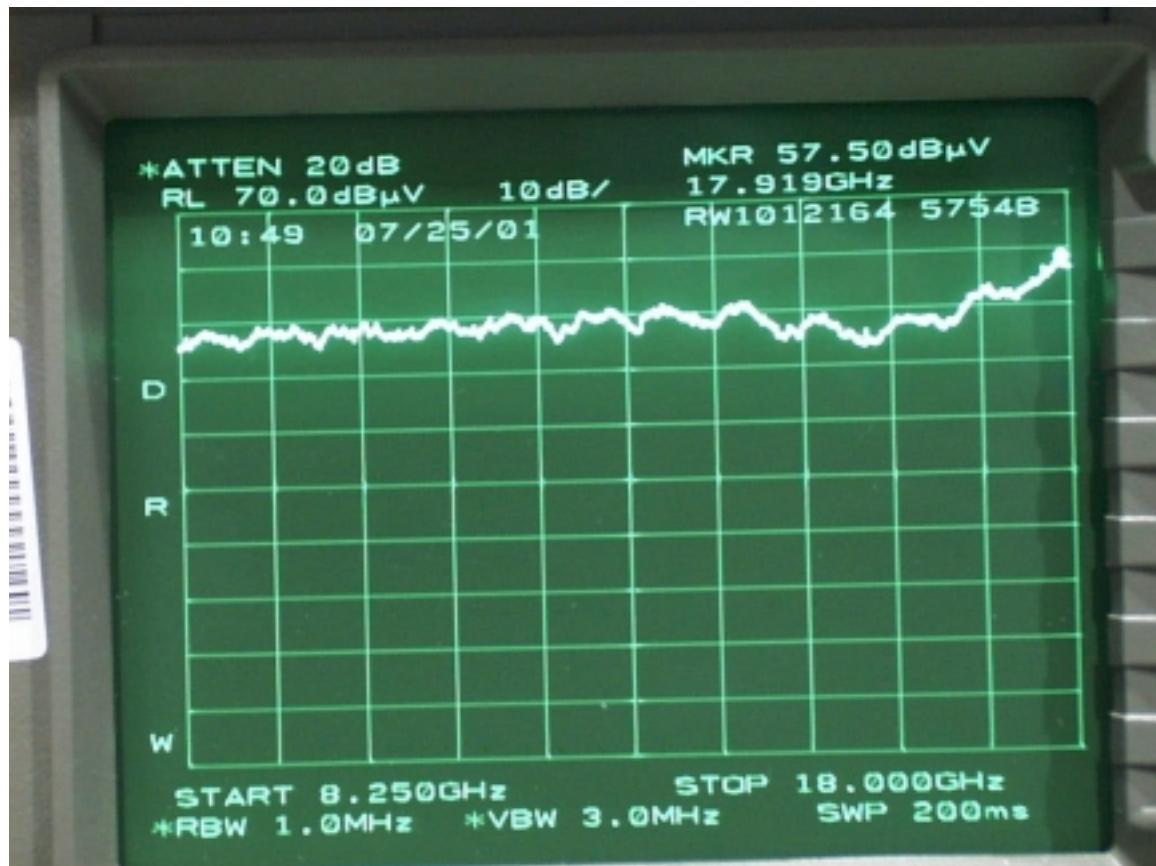
NTTSX1126 Radiated Emissions
fo = 5754 MHz

Emissions 8.25 - 18 GHz, Radiowaves 3 ft dish



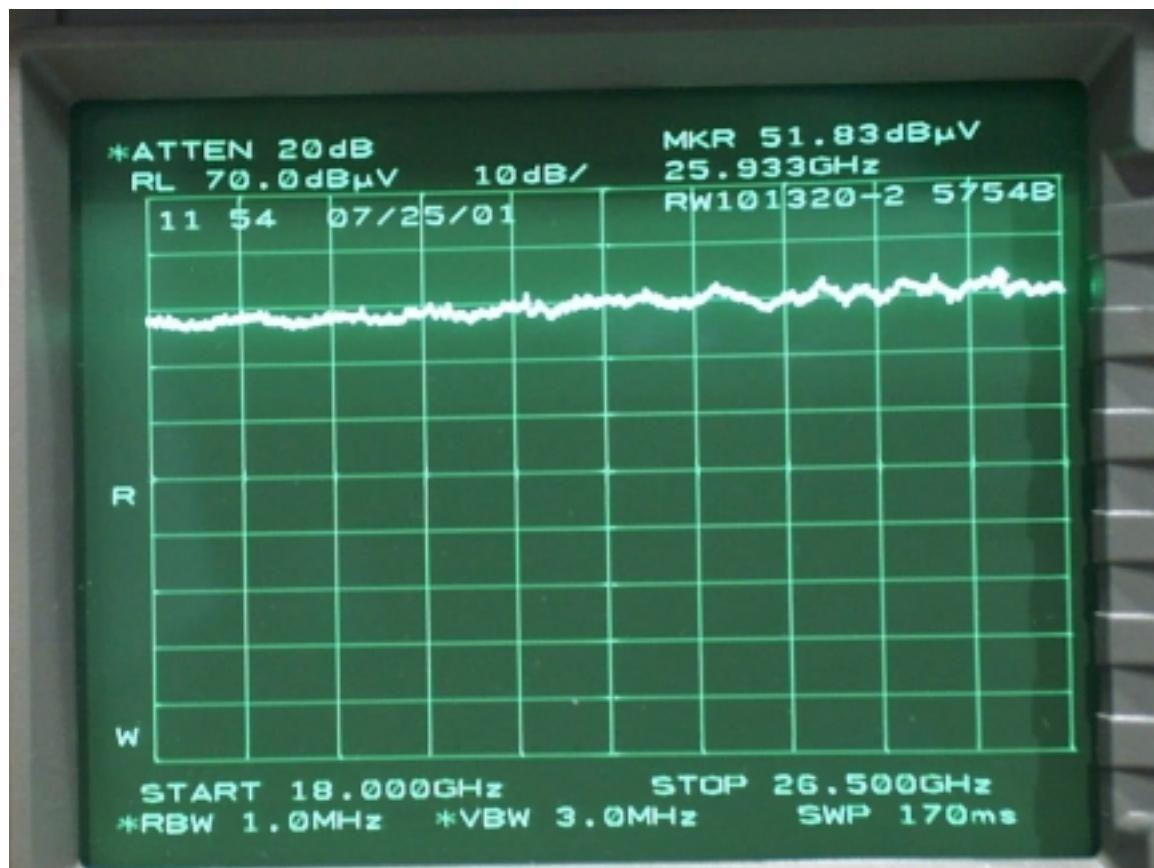
NTTSX1126 Radiated Emissions
fo = 5754 MHz

Emissions 8.25 - 18 GHz Radiowaves 4ft dish



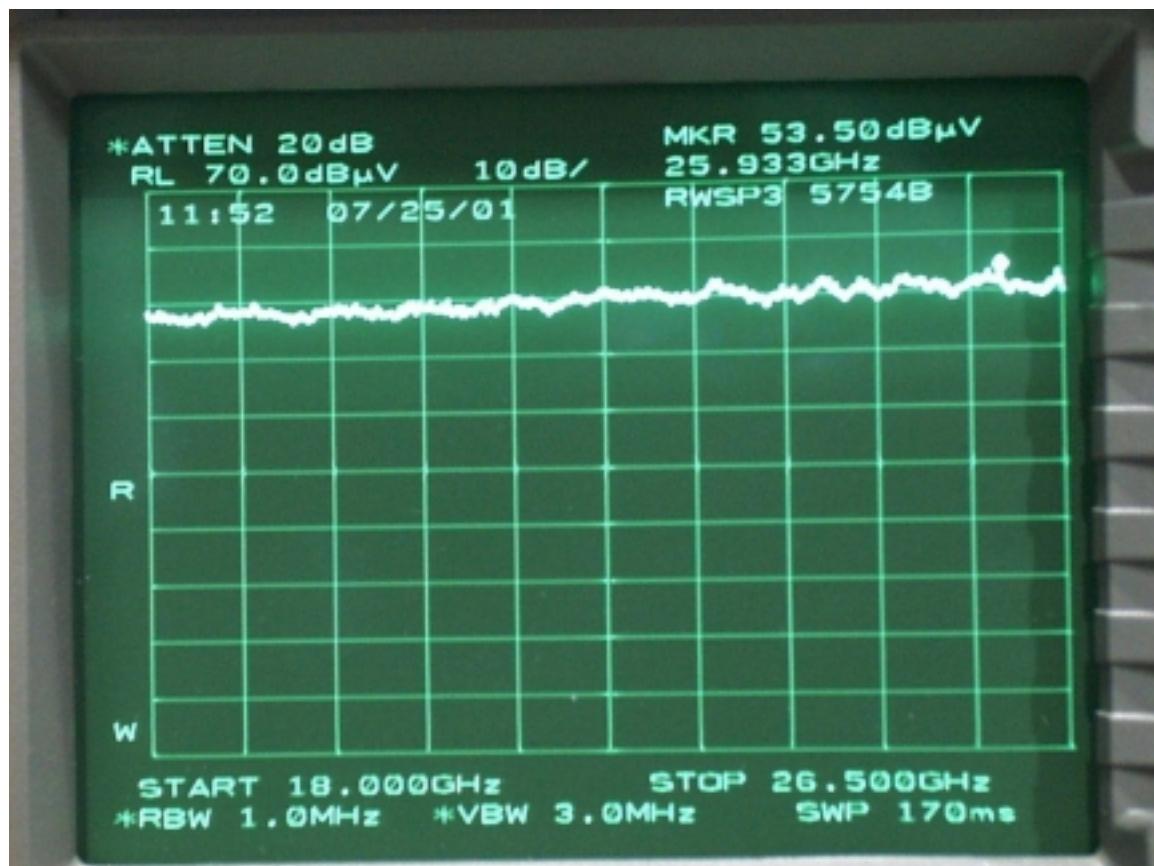
NTTSX1126 Radiated Emissions
fo = 5754 MHz

Emissions 18 - 26.5 GHz Radiowaves 2ft dish



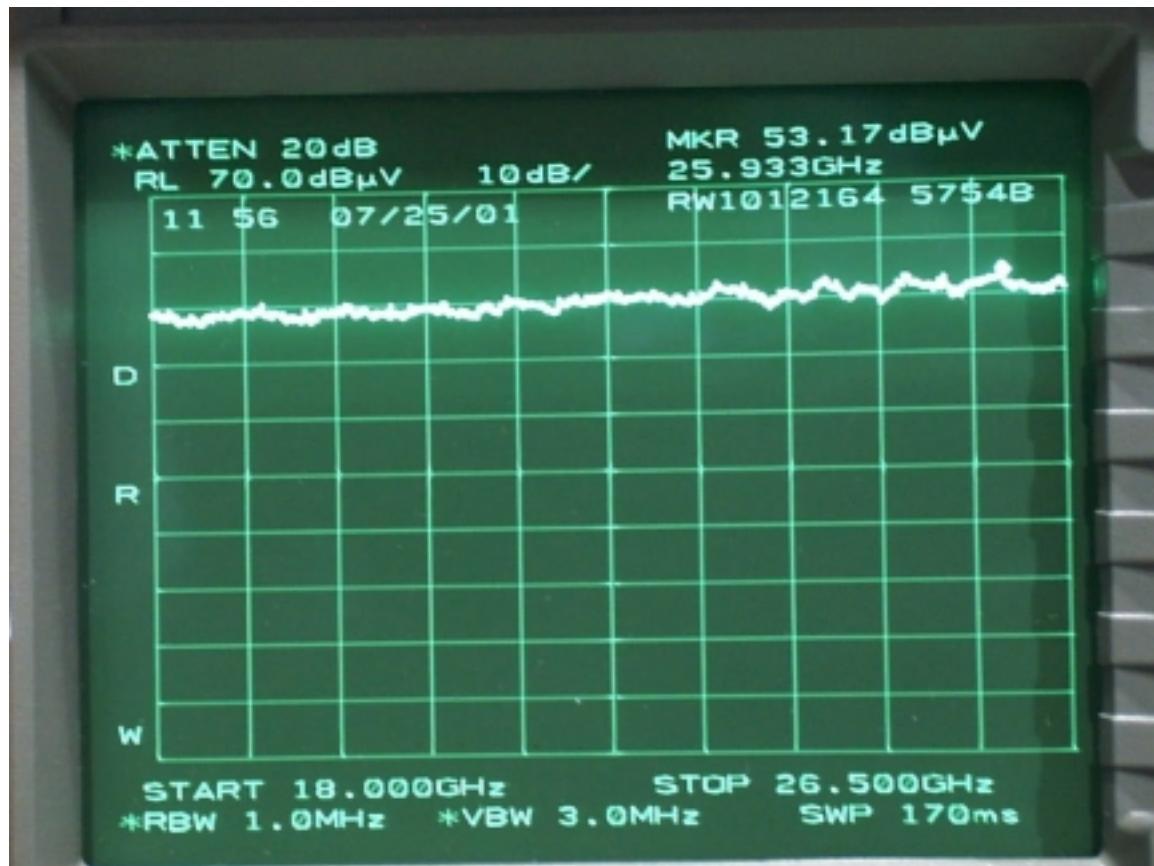
NTTSX1126 Radiated Emissions
fo = 5754 MHz

Emissions 18 - 26.5 GHz Radiowaves 3ft dish



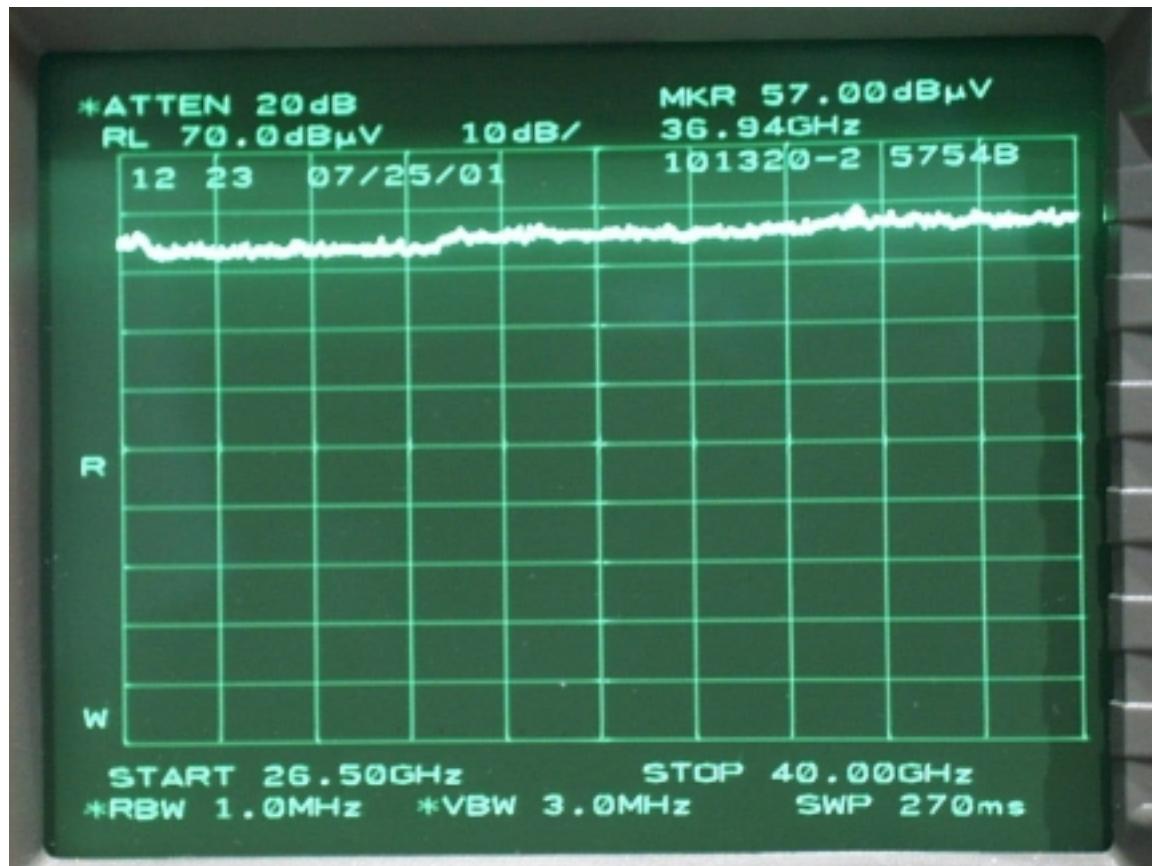
NTTSX1126 Radiated Emissions
fo = 5754 MHz

Emissions 18 - 26.5GHz Radiowaves 4ft dish



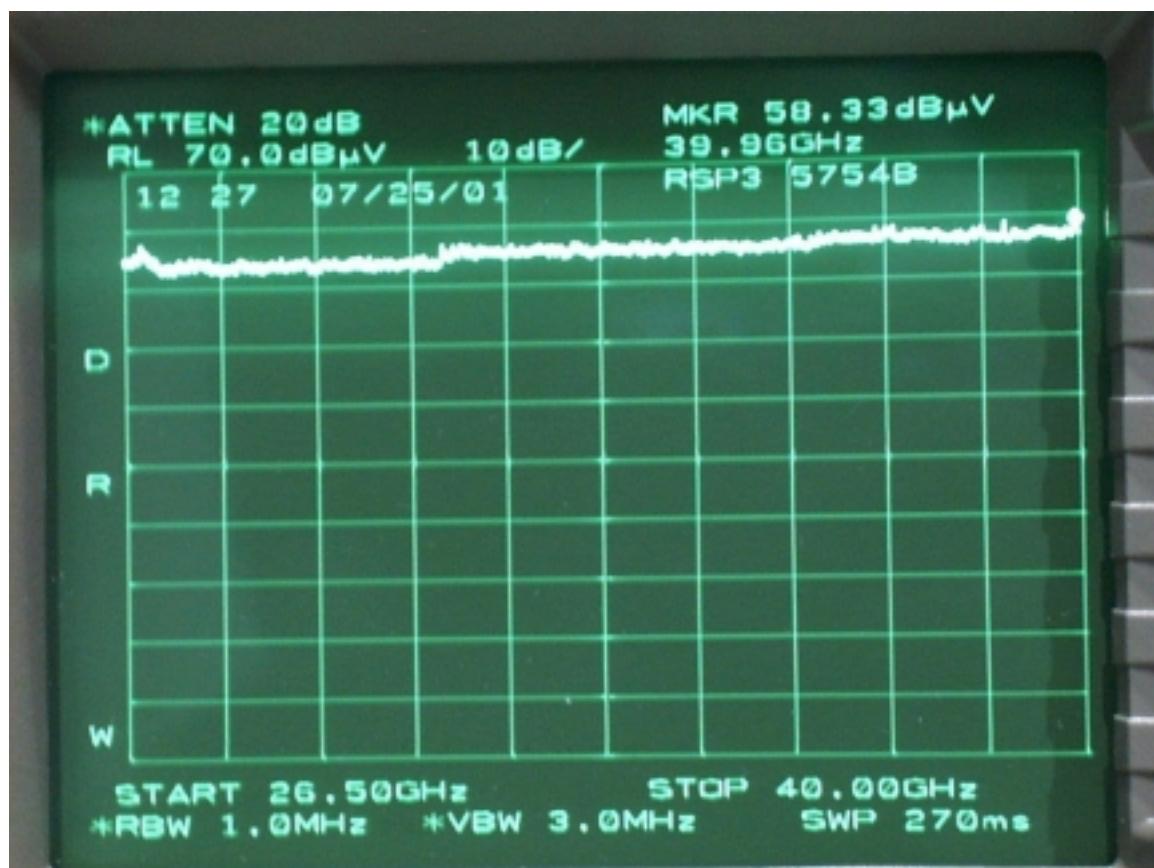
NTTSX1126 Radiated Emissions fo = 5754 MHz

Emissions 26.5 - 40 GHz Radiowaves 2ft dish



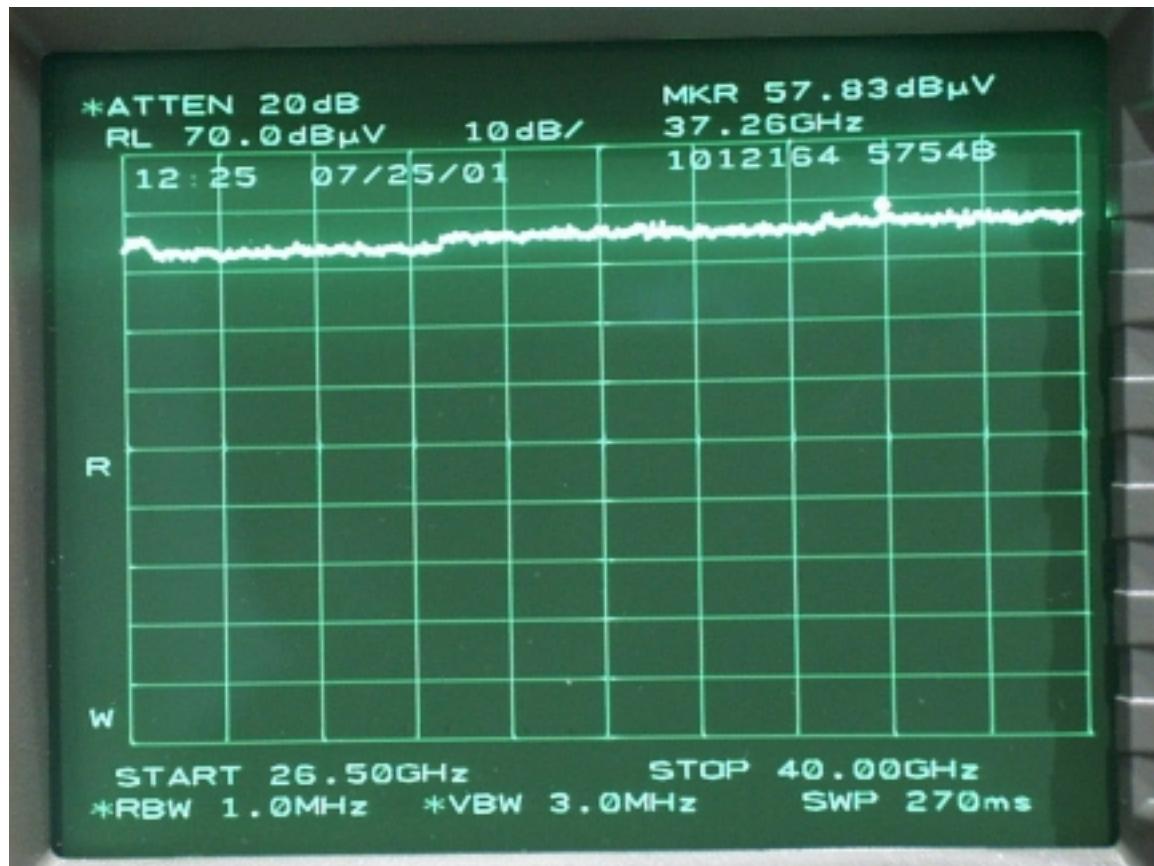
NTTSX1126 Radiated Emissions
fo = 5754 MHz

Emissions 26.5 - 40 GHz Radiowaves 3 ft dish



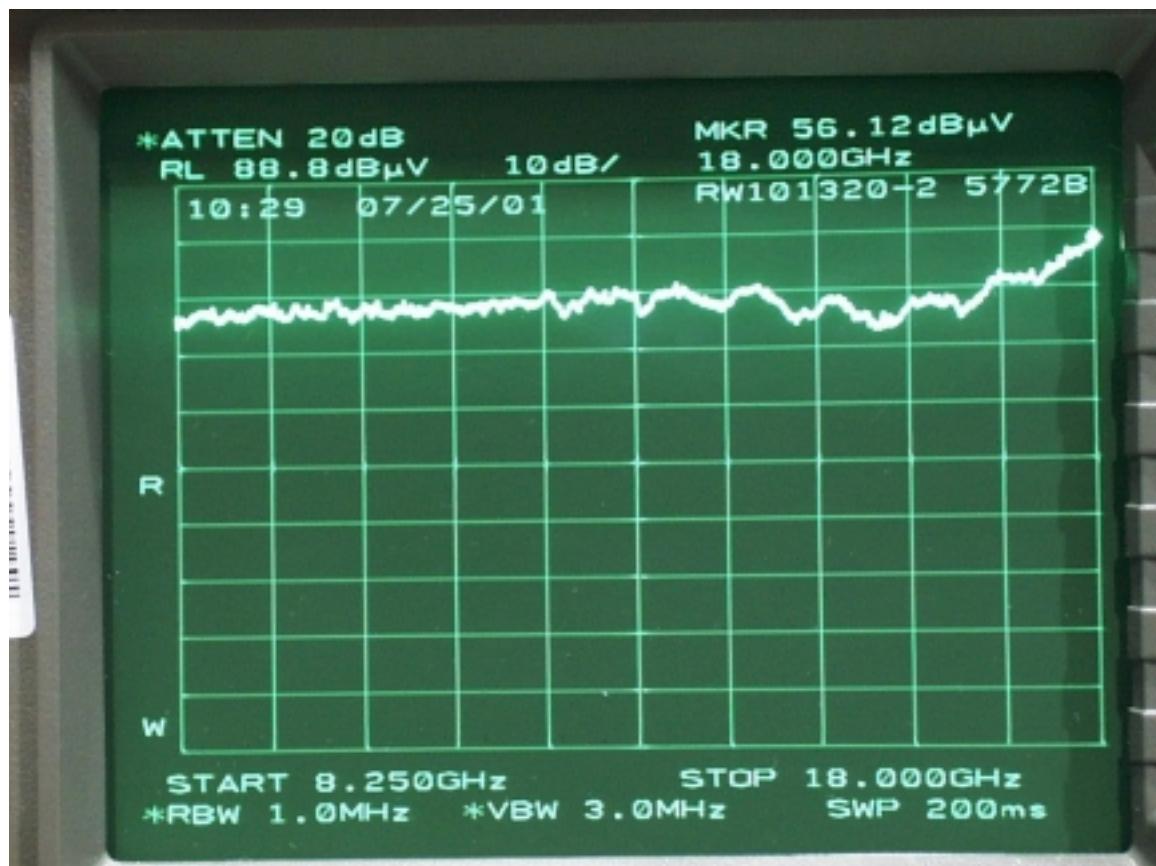
NTTSX1126 Radiated Emissions
fo = 5754 MHz

Emissions 26.5 - 40 GHz Radiowaves 4 ft dish



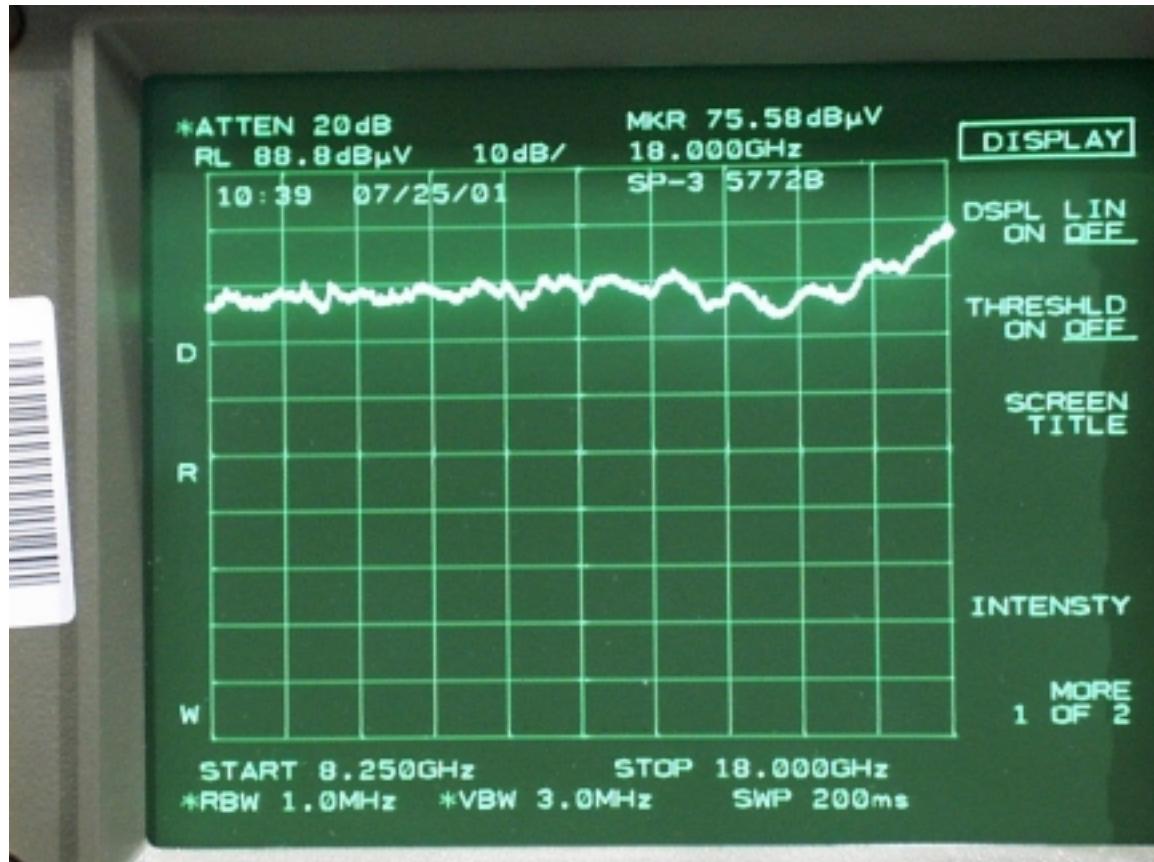
NTTSX1126 Radiated Emissions
fo = 5772MHz

Emissions 8.25 - 18 GHz, 2ft dish



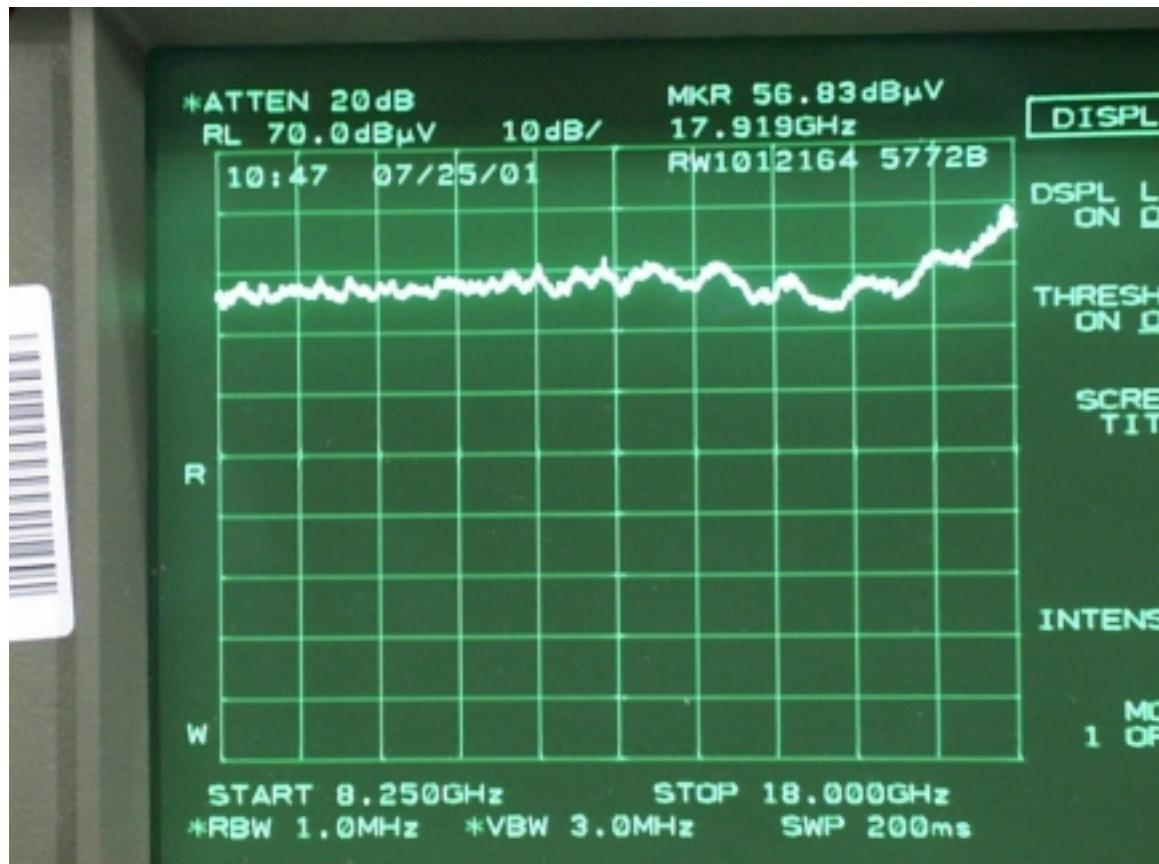
NTTSX1126 Radiated Emissions
fo = 5772 MHz

Emissions 8.25 - 18 GHz, 3ft dish



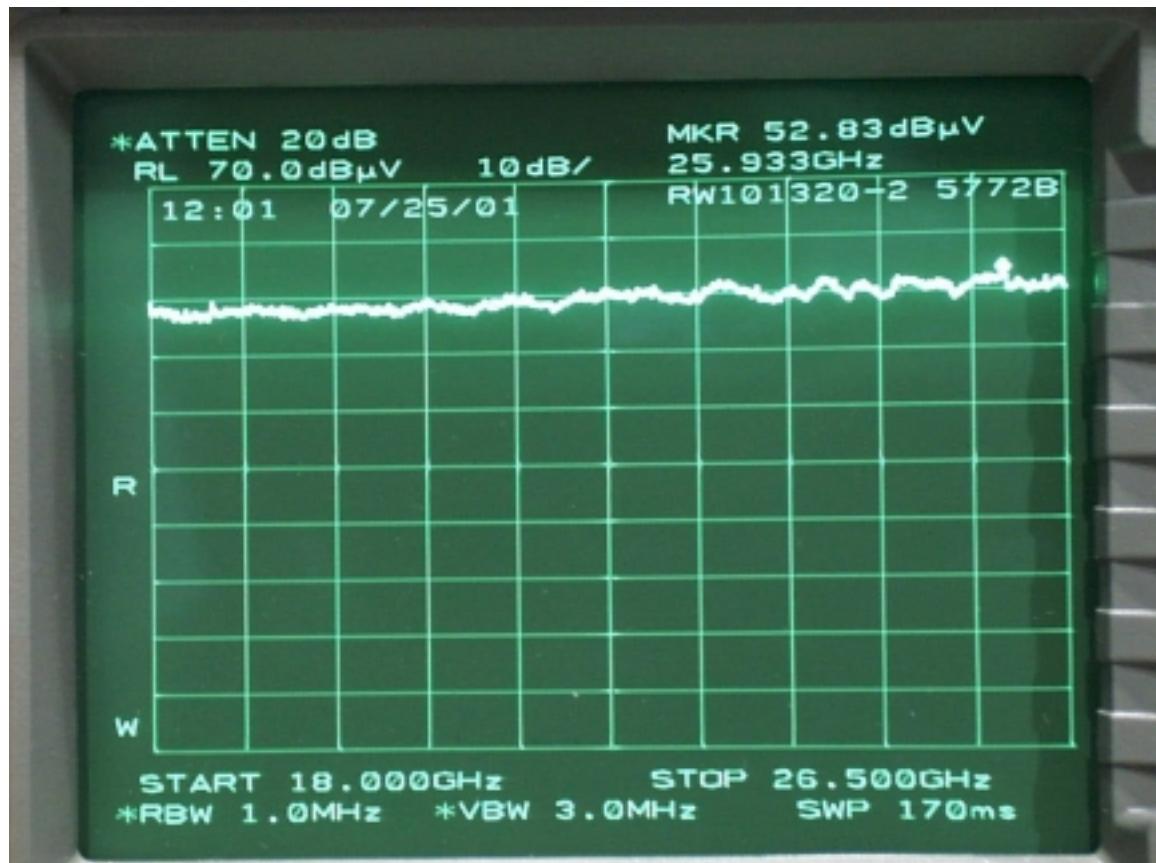
NTTSX1126 Radiated Emissions
fo = 5772 MHz

Emissions 8.25 - 18 GHz, 4ft dish



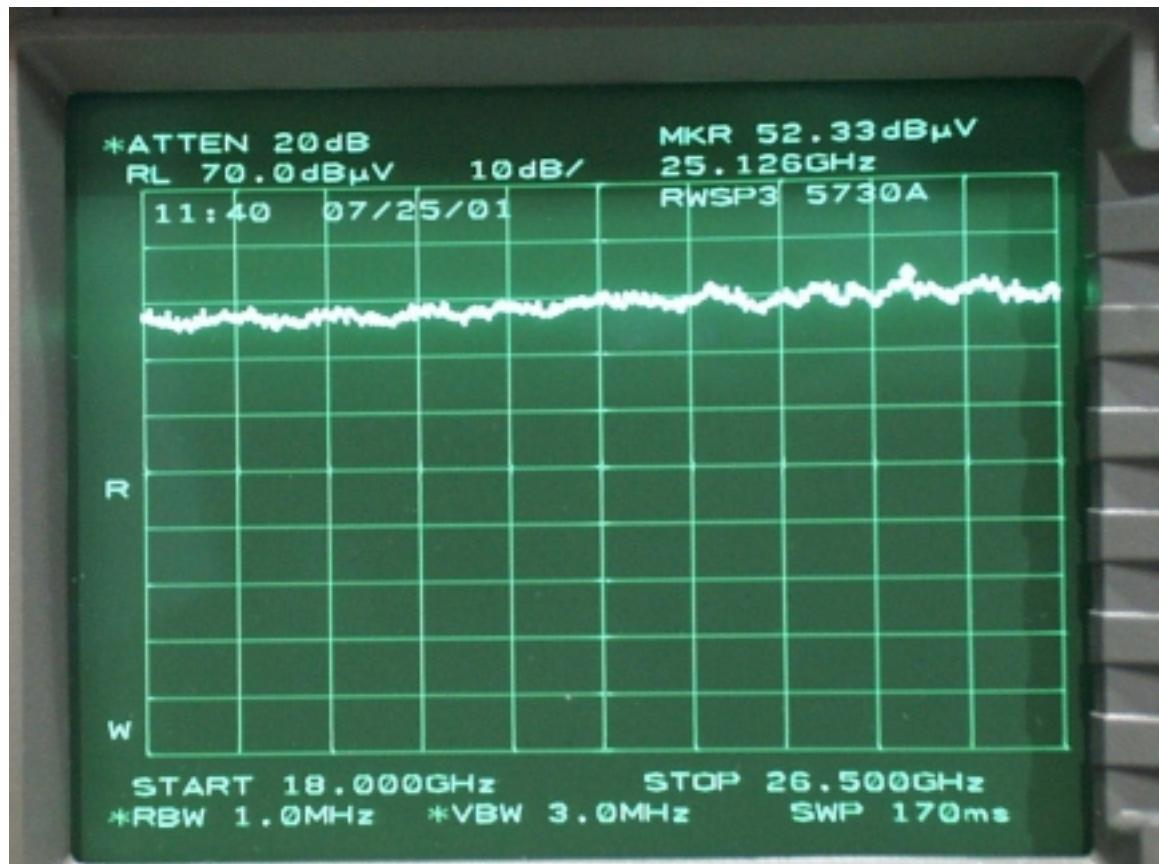
NTTSX1126 Radiated Emissions
fo = 5772 MHz

Emissions 18-26.5 GHz Radiowaves 2ft dish



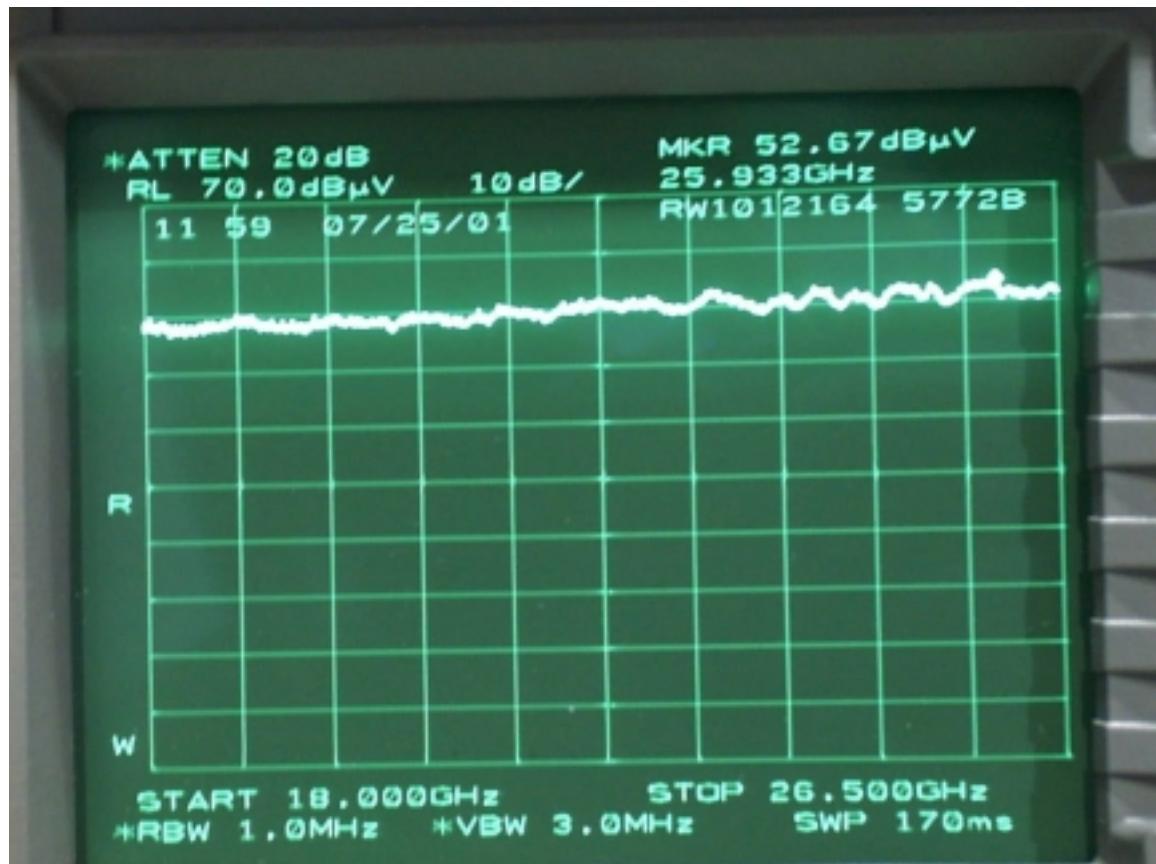
NTTSX1126 Radiated Emissions
fo = 5772 MHz

Emissions 18 - 26.5 GHz Radiowaves 3ft dish



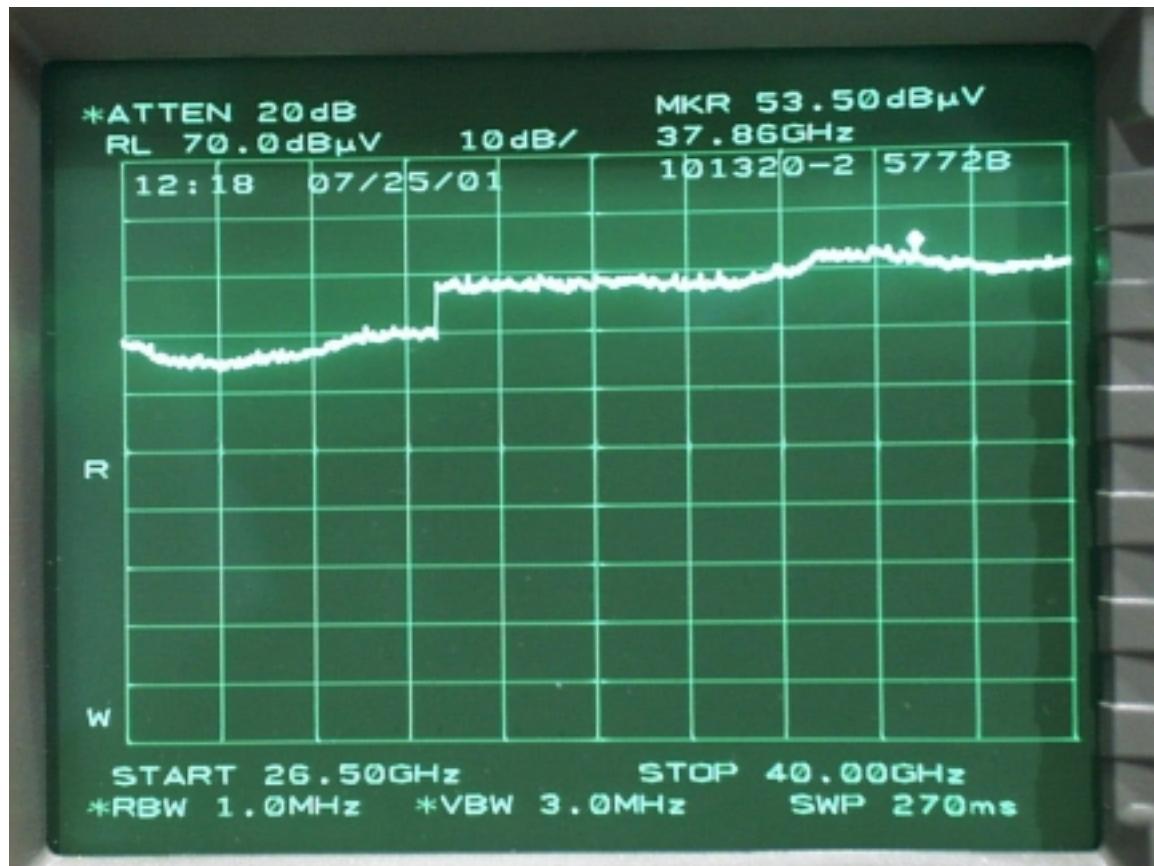
NTTSX1126 Radiated Emissions
fo = 5772 MHz

Emissions 18 - 26.5 GHz Radiowaves 4ft dish



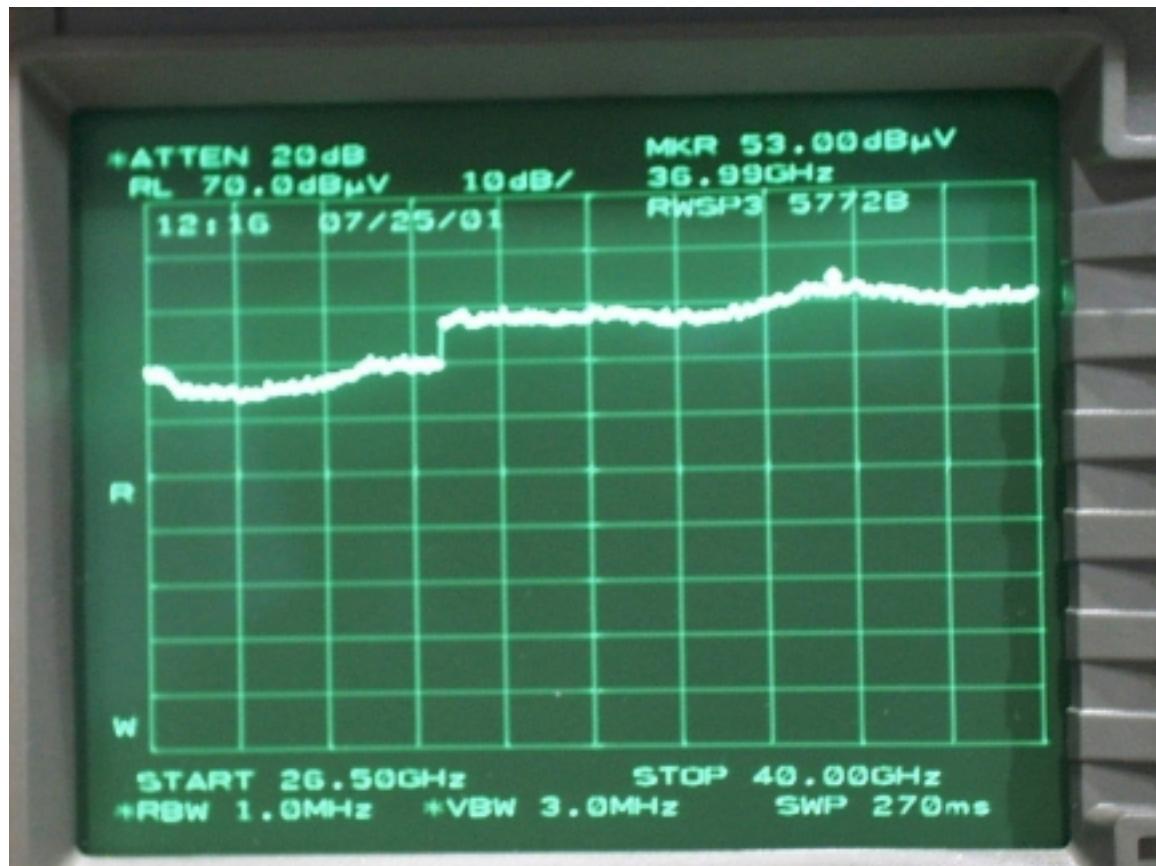
NTTSX1126 Radiated Emissions
fo = 5772 MHz

Emissions 26.5 - 40 GHz Radiowaves 2ft dish



NTTSX1126 Radiated Emissions
fo = 5772 MHz

Emissions 26.5 - 40 GHz Radiowaves 3 ft dish



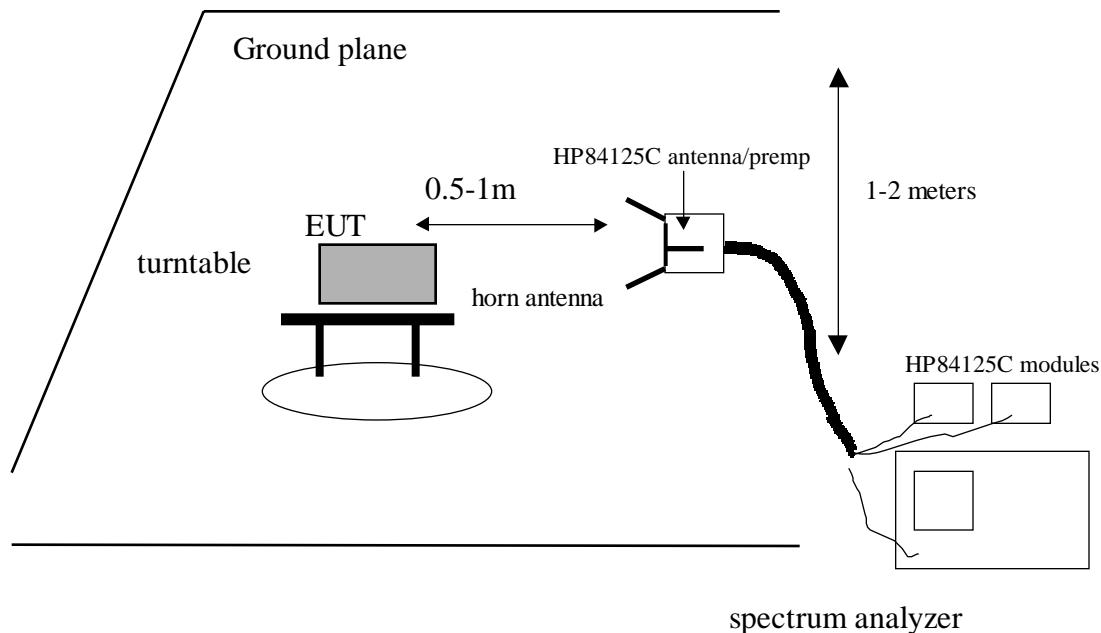
NTTSX1126 Radiated Emissions
fo = 5772 MHz

Emissions 26.5 - 40 GHz Radiowaves 4 ft dish



Measurement Equipment Used:

HP 8565E Spectrum Analyzer
HP 84125C Microwave EMI Measurement System

Test Set-Up**Requirement**

For restricted band emissions listed in 15.205 that are above 1 GHz, the limit of each spurious and harmonic emission detected shall be no more than

54 dBuV/m at 3m separation, using an average detector

74 dBuV/m at 3m separation, using a peak detector

Test Method

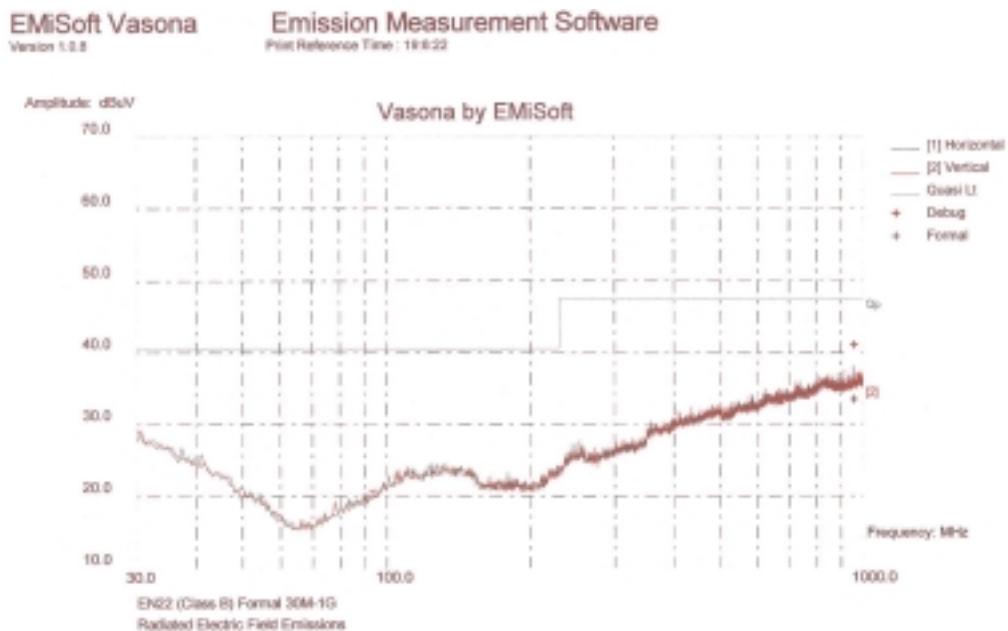
With the transmitter operating at full power, the EUT was rotated 360° and the search antenna was slowly raised and lowered by hand in both polarities, all in an attempt to maximize the levels of the received emission for each harmonic and spurious emission up to 40 GHz.

Test Results

The HP84125C, when used with the memory card, applies all corrections such as cable loss, antenna factor, and amplifier gains to the received signal and displays a corrected

field strength level on the spectrum analyzer screen. System operation is verified per user manual by connecting a signal generator to where the antenna port would normally connect, and comparing the displayed emission level with the theoretical level calculated for the system loss/gain parameters.

ITE Radiated Emissions, 30 – 1000 MHz



Results Title : EN22 (Class B) Formal 30M-1G

Test Laboratory : Building 7

Engineer/User : Peter Liljequist

Equipment [EUT]: W.J. SX1126 3-29-01

Details

Transverter on the table powered up with 24
volts D.C.

Configuration

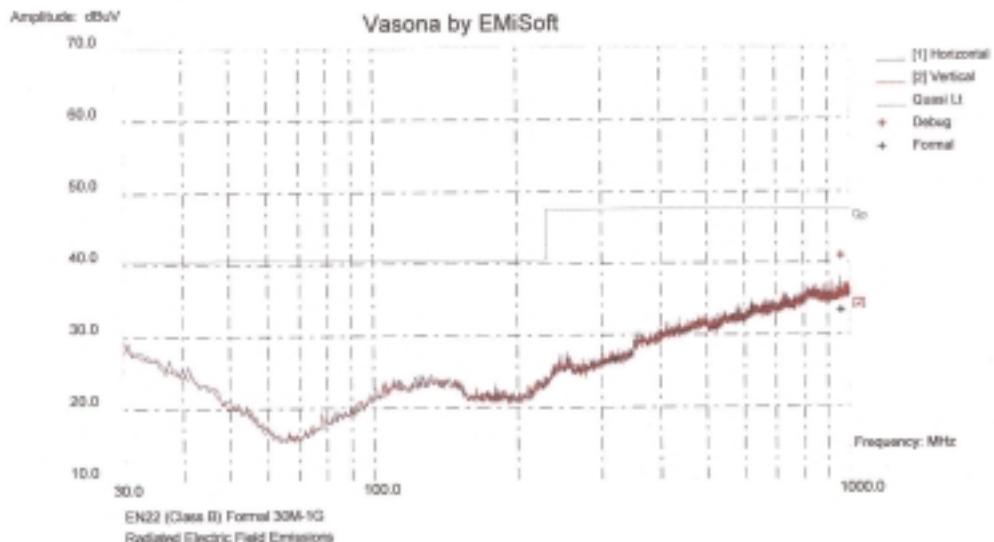
Case open with load connected to antenna port.

Current time : 29 Mar 01 at 19:6:22

Vasona is a trademark of EMiSoft Ltd.
Another test and assessment product from EMiSoft !

Debug Data

No	Frequency MHz	Raw dBuV	Cable Loss dB	AF dB	Level dBuV	Emission Type	Pol	Hgt cm	AzL Deg	Limit dBuV	Margin dB	Pass /Fail	Comments
1	963.925	13.3	2.41	22.33	38.04	Preview	H	300	0	47.5	-9.46	Pass	

EMiSoft Vasona
Version 1.0.8Emission Measurement Software
Print Reference Time : 19:14:24

Results Title : EN22 (Class B) Formal 30M-1G

Test Laboratory : Building 7

Engineer/User : Peter Liljequist

Equipment [EUT]: W.J. SX1126 3-29-01

Details

Transverter on the table powered up with 24
volts D.C.

Configuration Case open with load connected to antenna port.

Current time : 29 Mar 01 at 19:14:24

Vasona is a trademark of EMiSoft Ltd
Another test and assessment product from EMiSoft !

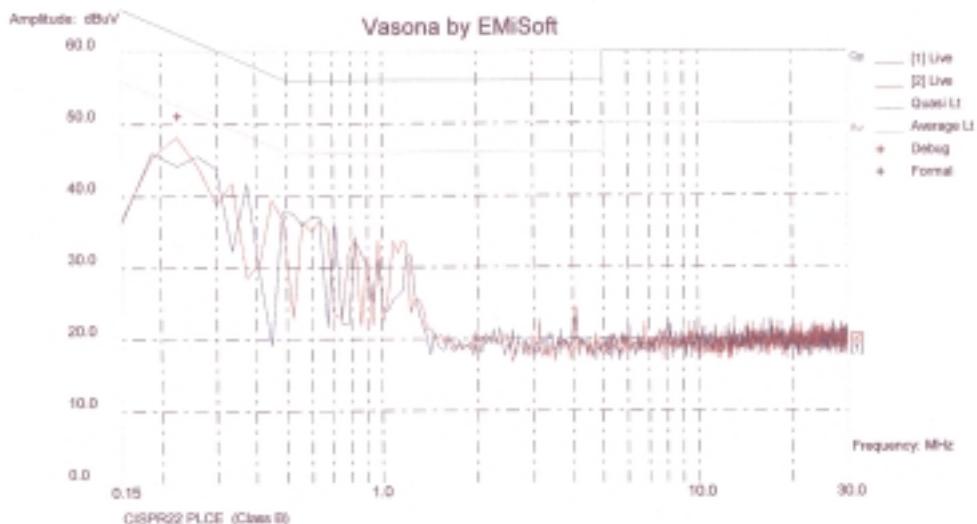
Formal Data

No	Frequency MHz	Raw dBuV	Cable Loss dB	AF dB	Level dBuV	Emission Type	Pol	Hgt cm	Azt Deg	Limit dBuV	Margin dB	Pass if Fall	Comments
1	.000	.0	.0	.0	.0	Preview		0	0	.0	.0	Pass	
2	654.122	5.73	2.41	22.33	30.47	Quasi Max	V	232	231	47.5	-17.03	Pass	

15.207 AC Line Conducted Tests

The EUT uses DC voltage only. During radiated emissions tests, the EUT was powered by a laboratory power supply plugged into a LISN AC receptable located on the turntable floor. The LISN is mounted underneath the turntable.

Test results show no detectable emissions within 15 dB of limits in the 0.45 - 30 MHz.

EMiSoft Vasona
Version 1.0.8Emission Measurement Software
Point Reference Time : 17:36:23

Results Title : CISPR22 PLCE (Class B)
 Test Laboratory : Building 7
 Engineer/User : Peter Ullqvist
 Equipment (EUT): SX1126 3-29-01
 Details

HL P Power supply mdl. 6002 powering EUT with 24
 volts. Transistor on table w transmitter on.
 Both sides of the line.

Configuration : Case open with load connected.

Current time : 29 Mar 01 at 17:36:23 Vasona is a trademark of EMiSoft Ltd
 Another test and assessment product from EMiSoft !

Debug Data

No	Frequency MHz	Raw dBuV	Cable Loss dB	Factors dB	Level dBuV	Emission Type	Line	Limit dBuV	Margin dB	Pass if Fail	Comments
1	.225	27.54	19.99	.66	40.19	Preview	Live	52.66	-4.46	Pass	

Test Site

All radiated testing was performed at Cisco Systems by me or under my supervision. Antenna conducted RF emissions were performed at Watkins Johnson and at Cisco. Conducted and radiated emissions were performed using test equipment with calibration traceable to NIST, and following test procedures accepted by the industry.

THOMAS N. COKENIAS
Consultant, EMC&Radio Type Approvals