

FCC PART 90 TYPE APPROVAL EMI MEASUREMENT AND TEST REPORT

For

Pacific Crest Corporation

990 Richard Avenue, Suite 110
Santa Clara, CA 95050, U.S.A.

FCC ID: KEATNL450I

Model no: TNL450I

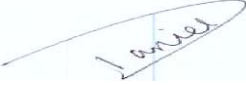
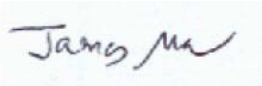
This Report Concerns: ☒ Original Report		Product Type: UHF Radio
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Report No.:	R0604242	
Report Date:	2006-08-13	
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GENERAL INFORMATION

Product Description for Equipment Under Test (EUT)

The *Pacific Crest Corporation's* product, FCC ID: KEATNL450I or the "EUT" as referred in this report is an UHF radio, which measures approximately 16.0cmL x 6.0cmW x 3.5cmH.

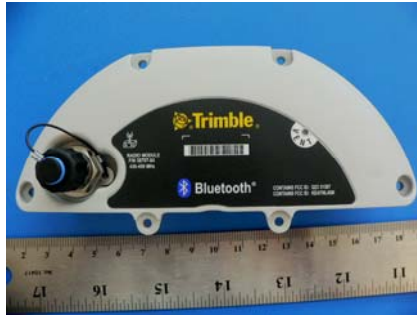
The EUT is a half duplex, 410-470 MHz, 12.5 KHz and 25 KHz channel spacing, 0.5W UHF transceiver module designed for use inside a Trimble R8 GPS receiver. The R8 GPS receiver incorporates this UHF radio transceiver and an ASIC, which has a built-in GMSK and 4LFSK modem. The EUT (Midas radio) does not have an on board microcontroller and uses the R8 receiver's host microcontroller.

**The test data gathered are from production samples, serial numbers 06287880, 06287846, 06287884 provided by the manufacturer.*

EUT Photo



410-430 MHz



430-450 MHz



450-470 MHz

Additional photos in Exhibit C

Objective

This type approval report is prepared on behalf of *Pacific Crest Corporation* in accordance with Part 2 and Part 90 of the Federal Communication Commissions rules.

The objective of the manufacturer is to determine compliance with FCC rules for output power, occupied bandwidth (emission mask), spurious emission at antenna terminal, frequency stability, spurious radiated emissions and transient frequency behavior

Related Submittal(s)/Grant(s)

No Related Submittals

Test Methodology

All tests and measurements indicated in this document were performed in accordance with the Code of Federal Regulations Title 47 Part 2, Sub-part J as well as the following individual parts:

Part 90 – Private Land Mobile Radio Service

Applicable Standards: TIA/EIA-603-C, ANSI 63.4-2003, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.

All radiated and conducted emissions measurement was performed at Bay Area Compliance Laboratory, Corp. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Test Facility

The Test site used by BACL Corp. to collect radiated and conducted emissions measurement data is located at it's facility in Sunnyvale, California, USA.

Test site at BACL has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports has been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997 and Article 8 of the VCCI regulations on December 25, 1997. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2003.

The Federal Communications Commission, Industry Canada, and Voluntary Control Council for Interference have the reports on file and are listed under FCC file 31040/SIT 1300F2, IC registration number: 3062A, and VCCI Registration No.: C-1298 and R-1234. The test site has been approved by the FCC, IC, and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL is a National Institute of Standards and Technology (NIST) accredited laboratory, under the National Voluntary Laboratory Accredited Program (Lab Code 200167-0). The current scope of accreditations can be found at <http://ts.nist.gov/ts/htdocs/210/214/scopes/2001670.htm>

SYSTEM TEST CONFIGURATION

Justification

The host system was configured for testing according to TIA/EIA 603-C

The EUT was tested in the normal (native) operating mode to represent *worst*-case results during the final qualification test, the test software was provided by the client.

Block Diagram

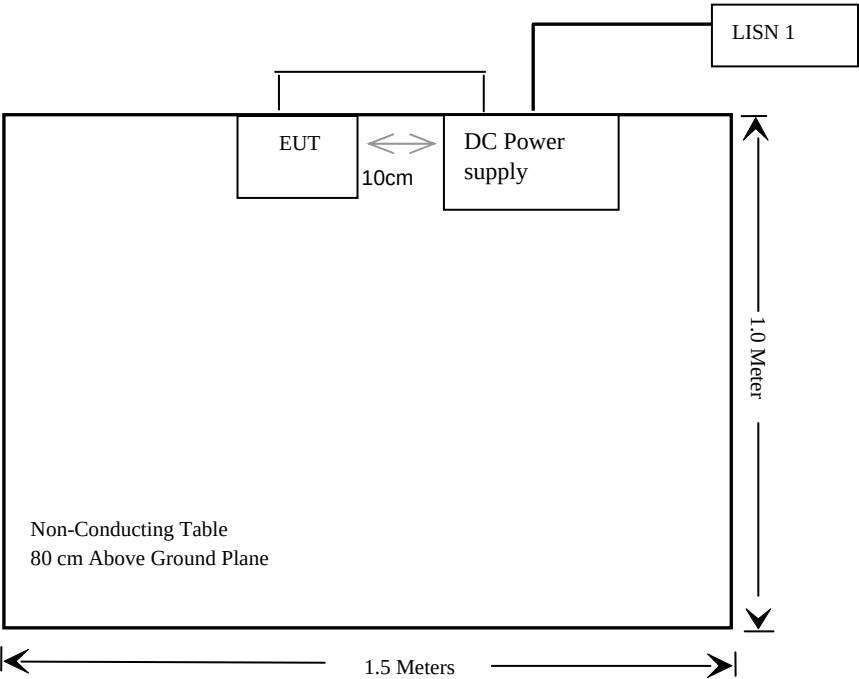
Please refer to Appendix A.

Equipment Modifications

No modifications were made to the EUT.

Test Setup Block Diagram

The EUT is a standalone device.



SUMMARY OF TEST RESULTS

FCC Rule	Description	Result
§ 2.1046, § 90.205	RF Output Power	Compliant
§ 2.1049 § 90.209	Emission mask, Occupied Bandwidth	Compliant
§ 2.1051 § 90.210	Spurious emissions at antenna terminals	Compliant
§ 2.1053 § 90.210	Field strength of spurious radiation	Compliant
§ 2.1055 § 90.213	Frequency stability vs. temperature Frequency stability vs. voltage	Compliant
§ 90.214	Transient Frequency Behavior	Compliant
§ 2.1091	RF Exposure	Compliant

§2.1091 – RF Exposure

Provision Applicable

According to §2.1091 and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to §1.1310 and §2.1091 RF exposure is calculated.

Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

MPE Prediction

Predication of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2$$

Where: S = power density

P = power input to antenna

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna

Maximum peak output power at antenna input terminal: 27.17 (dBm)

Maximum peak output power at antenna input terminal: 521.2 (mw)

Prediction distance: 20 (cm)

Predication frequency: 450 (MHz)

Antenna Gain (typical): 2.14 (dBi)

Maximum antenna gain: 1.637 (numeric)

Power density at predication frequency at 20 cm: 0.17 (mw/cm²)

MPE limit for uncontrolled exposure at prediction frequency: 0.3 (mw/cm²)

Result

The predicted power density level at 20 cm is 0.17 mw/cm². This is below the uncontrolled exposure limit of 0.3mw/cm² at 450 MHz. The EUT is used at least 20cm away from user's body. It is defined as mobile equipment.

§2.1046 – Conducted Output Power

Provision Applicable

Per FCC §2.1046 and §90.205: maximum ERP is dependent upon the station's antenna HAAT and required service area.

Test Procedure

The RF output of the transceiver was connected to a spectrum analyzer through appropriate attenuator.

Test Equipment

Manufacturer	Description	Model	S/N	Cal. Due Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2006-03-06
Agilent	Power Meter	E4419B	MY4121511	2006-09-08
Agilent	Power Sensor	E4412A	US38488542	2005-08-31
Agilent	Spectrum Analyzer	8562EC	3946A00288	2006-12-22

* **Statement of Traceability:** BACL attests that all calibrations have been performed per the NVLAP requirements, traceable to NIST.

Environmental Conditions

Room Temperature:	22° C
Relative Humidity:	75%
Pressure:	1021 mbar

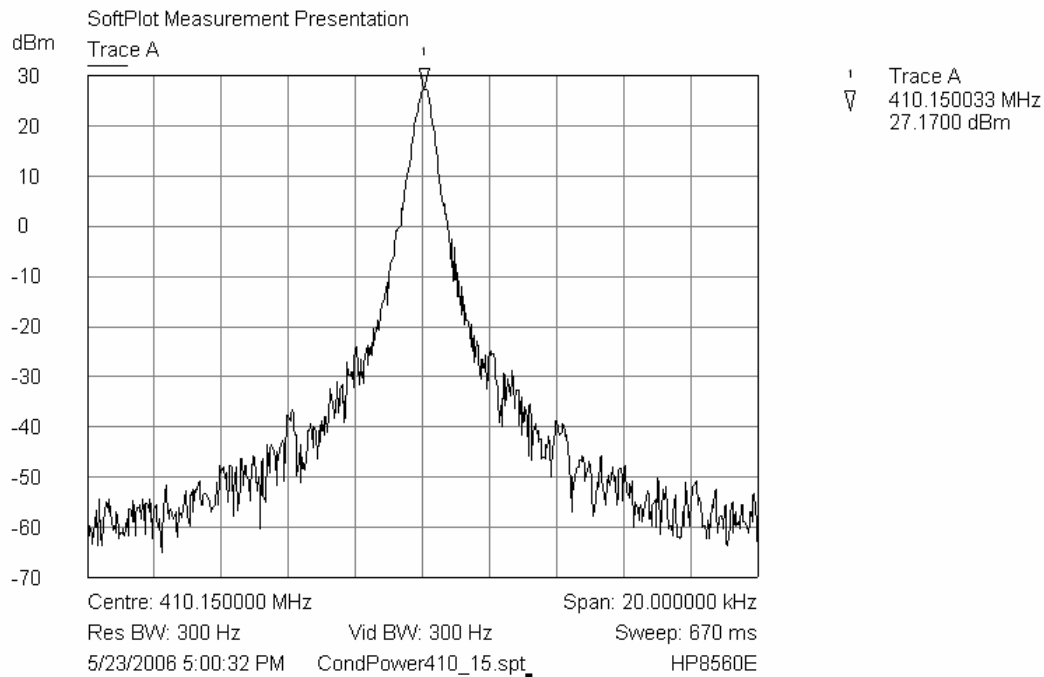
*Testing was performed by Daniel Deng 2006-05-05 and Dmitry Tadenev on 2006-05-22.

Test Results

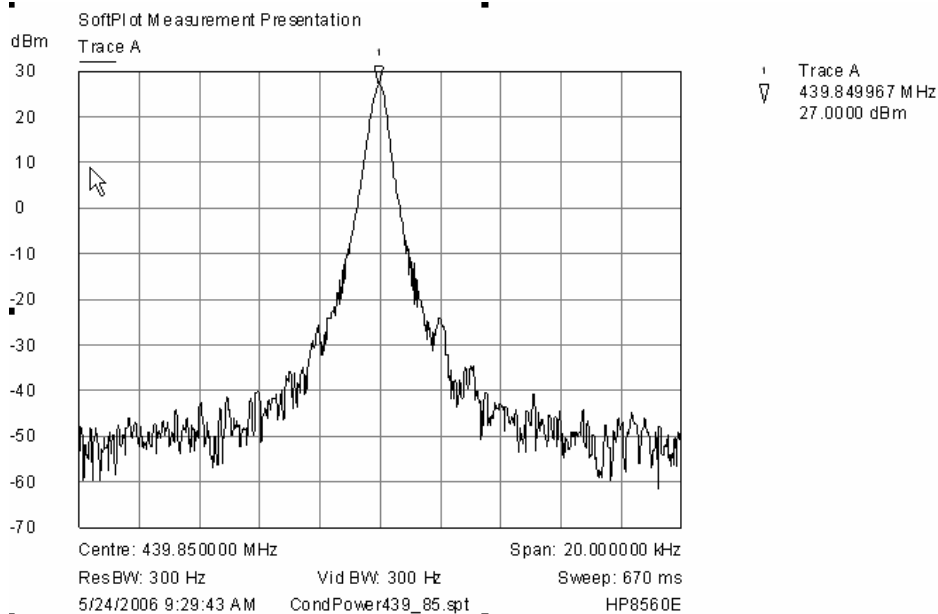
Band (MHz)	Frequency (MHz)	Output Power in dBm	Output Power in Watts
410-430	410.15	27.17	0.521
430-450	439.85	27.00	0.500
450-470	459.85	27.05	0.507

Please refer to the plots in following pages:

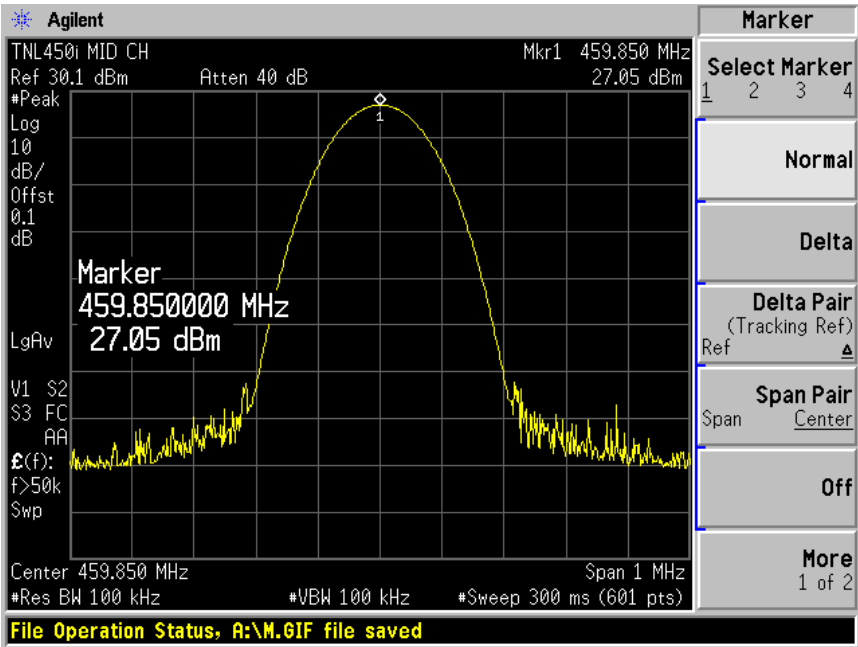
410-430 MHz Band:



430-450 MHz Band:



450-470 MHz Band:



§2.1049, and § 90.209 – Occupied Bandwidth and Emission Mask

Applicable Standard

§2.1049, §90.210

12.5 kHz bandwidth:

For any frequency removed from the center of the authorized bandwidth f_0 to 5.625kHz removed from f_0 , 0dB.

On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.626kHz but no more than 12.5kHz, at least $7.27 (f_d - 2.88\text{kHz})$ dB.

On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5kHz at least:

$50 + 10\log P$ or 70 dB.

25 kHz bandwidth:

On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5kHz but not more than 10kHz, at least $83 \log (f_d / 5)$ dB.

On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10kHz but not more than 250% of the authorized bandwidth, at least $29 \log (f_d^2 / 11)$ dB or 50 dB.

On any frequency removed from the center of the authorized bandwidth by more than 250% of the authorized bandwidth: least $43 + 10 \log (P)$.

Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

The resolution bandwidth of the spectrum analyzer was set at 100 Hz and the spectrum was recorded in the frequency band ± 50 KHz or ± 25 kHz from the carrier frequency.

Test Equipment

Manufacturer	Description	Model	S/N	Cal. Due Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2007-03-06
Agilent	Spectrum Analyzer	8562EC	3946A00288	2006-12-22

* **Statement of Traceability:** BACL attests that all calibrations have been performed per the NVLAP requirements, traceable to NIST.

Environmental Conditions

Room Temperature:	22° C
Relative Humidity:	75%
Pressure:	1021mbar

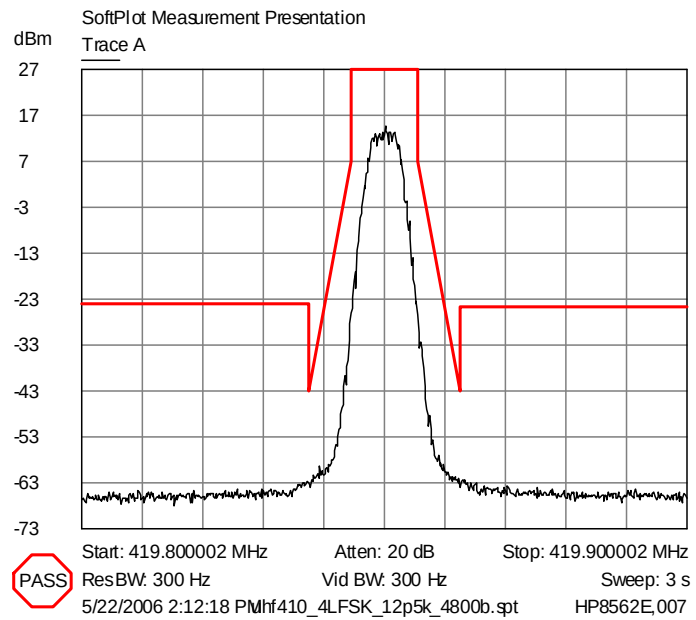
**Testing was performed by Daniel Deng on 2006-05-05 and Dmitry Tadenev on 2006-05-22.*

Test Results

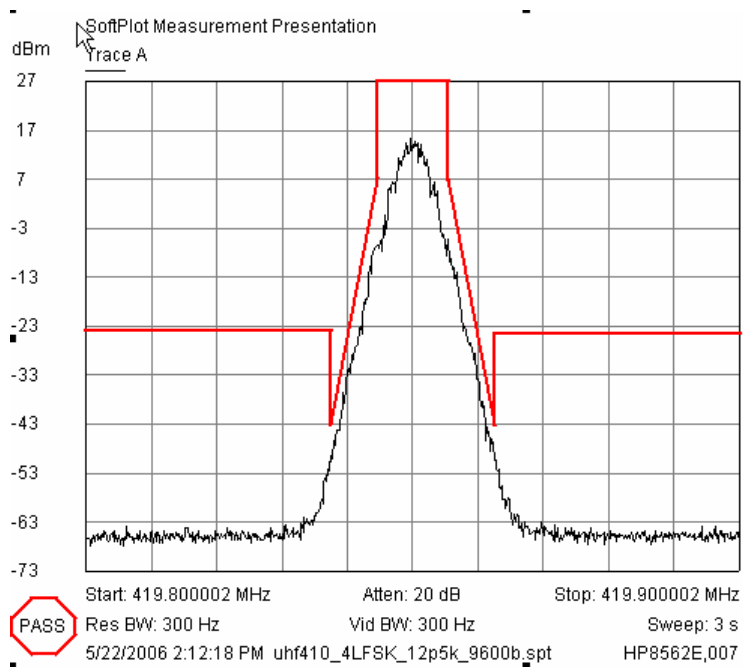
Please refer to the hereinafter plots.

410-430 MHz Band:

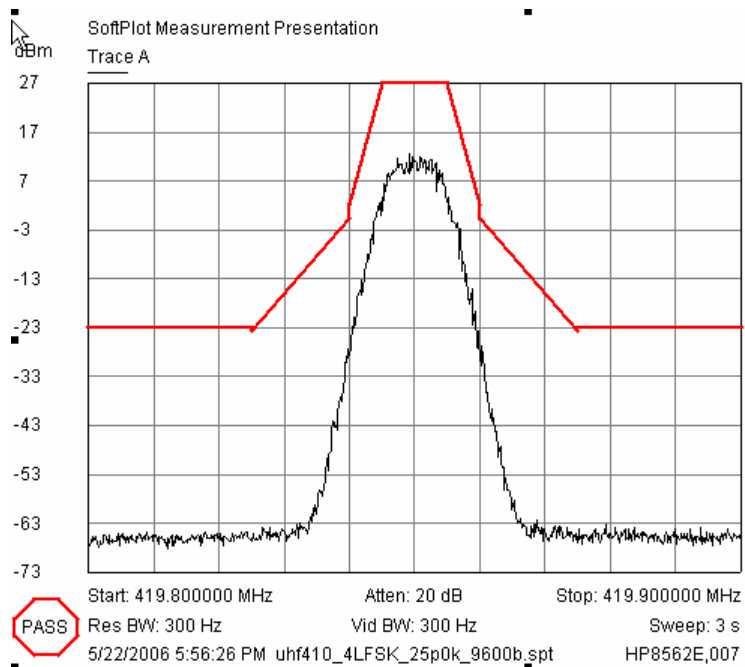
12.5 KHz Channel spacing 4800 Baud rate:



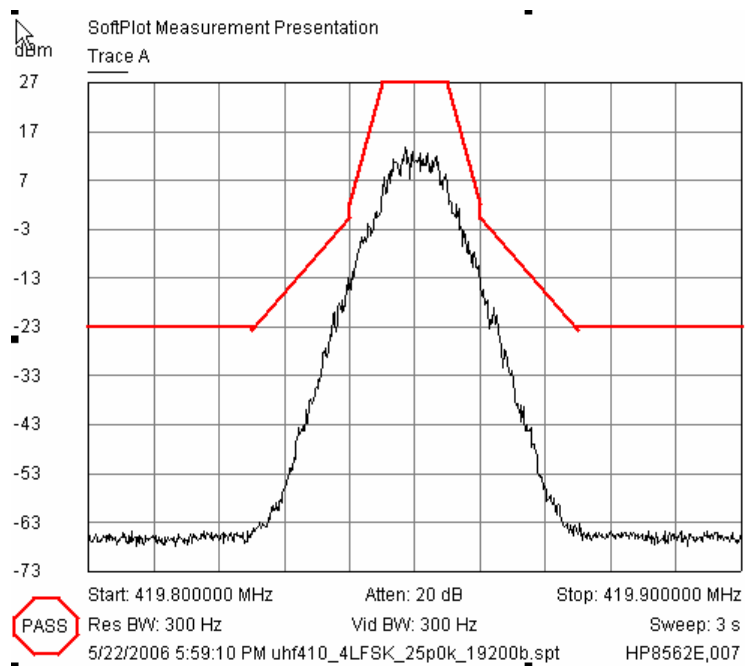
12.5 KHz Channel spacing, 9600 Baud rate:



25 KHz Channel Spacing, 9600 Baud rate:

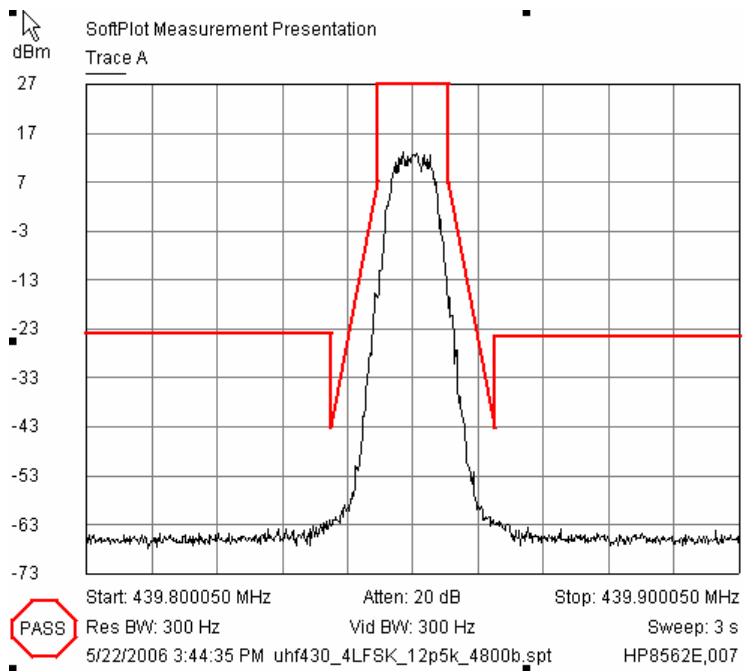


25 KHz Channel Spacing, 19200 Baud rate:

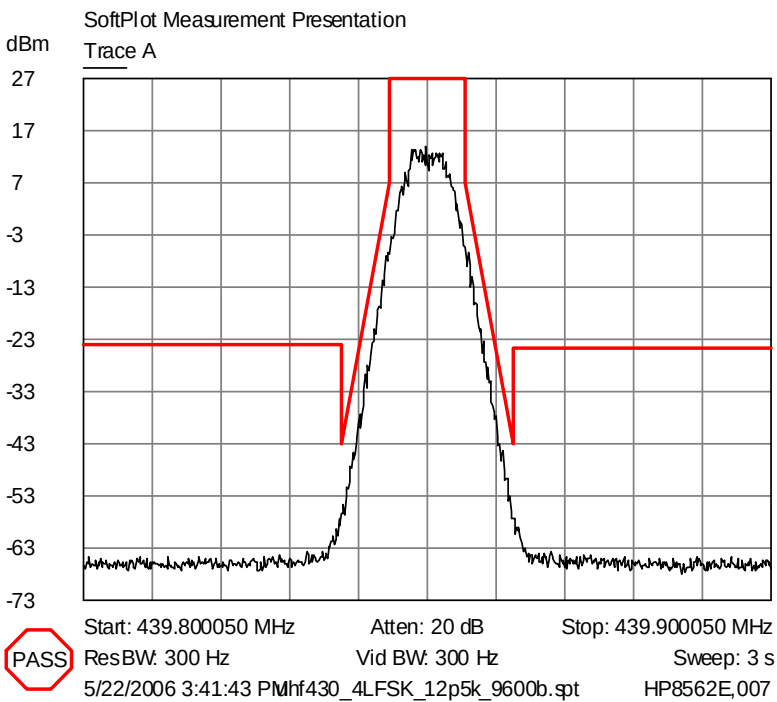


430-450 MHz Band:

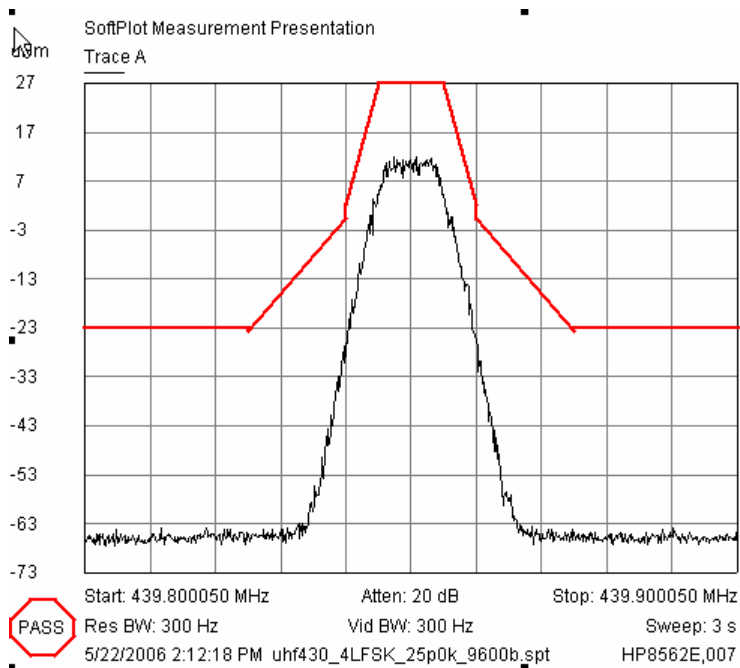
12.5 KHz Channel spacing 4800 Baud rate:



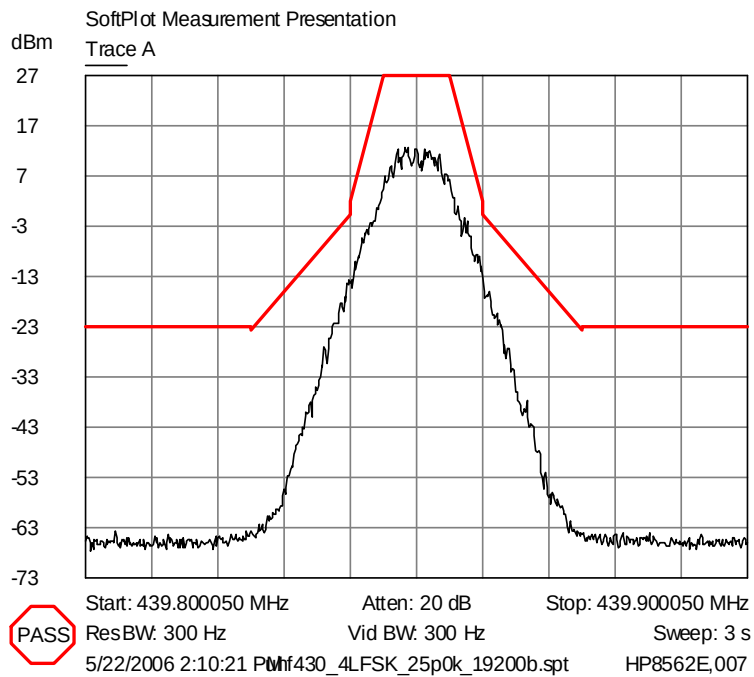
12.5 KHz Channel spacing 9600 Baud rate:



25 KHz Channel spacing 9600 Baud rate:

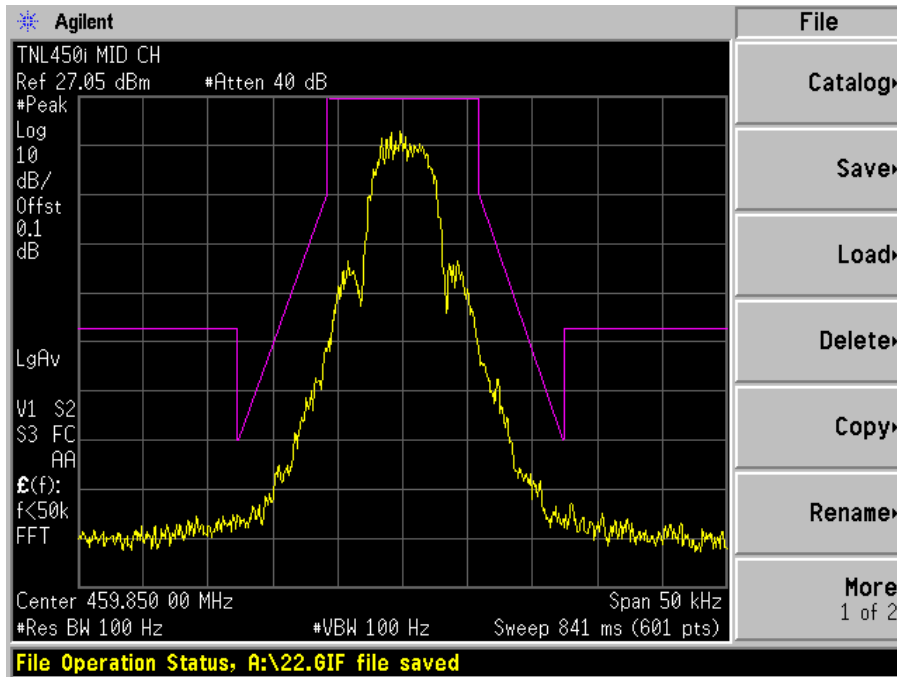


25 KHz Channel spacing 19200 Baud rate:

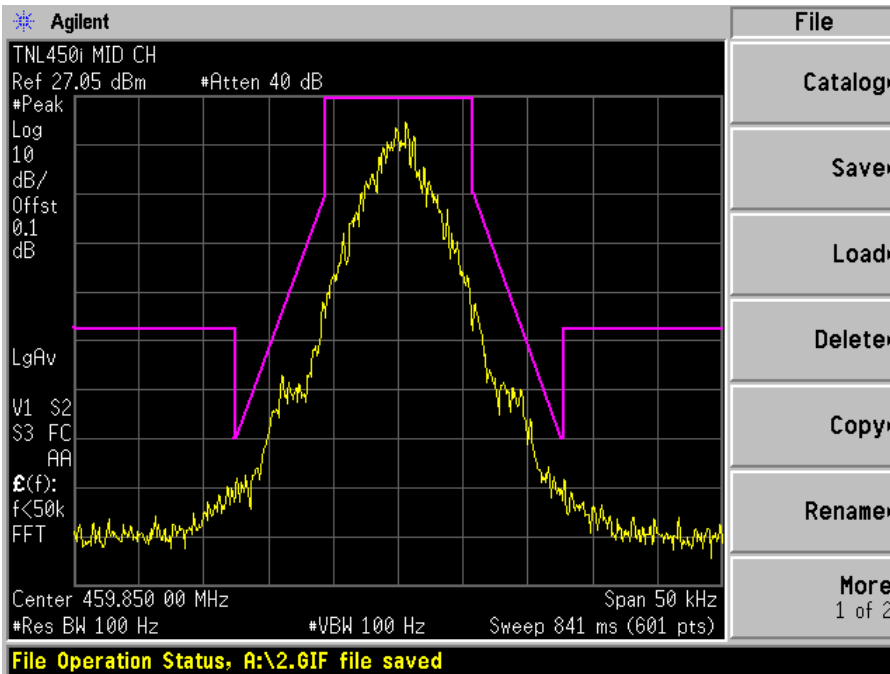


450-470 MHz Band:

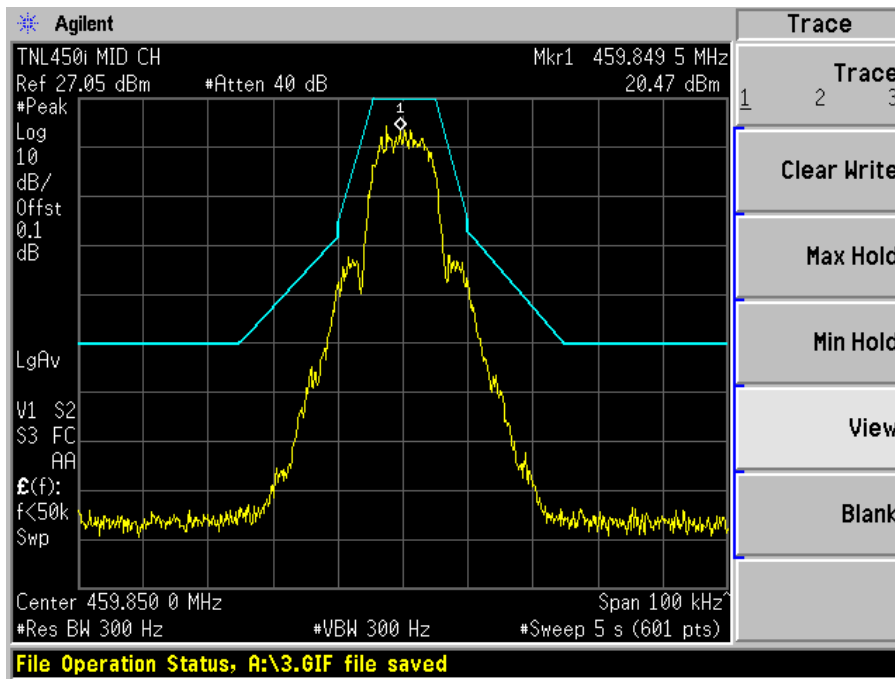
12.5 KHz Channel spacing 4800 Baud rate:



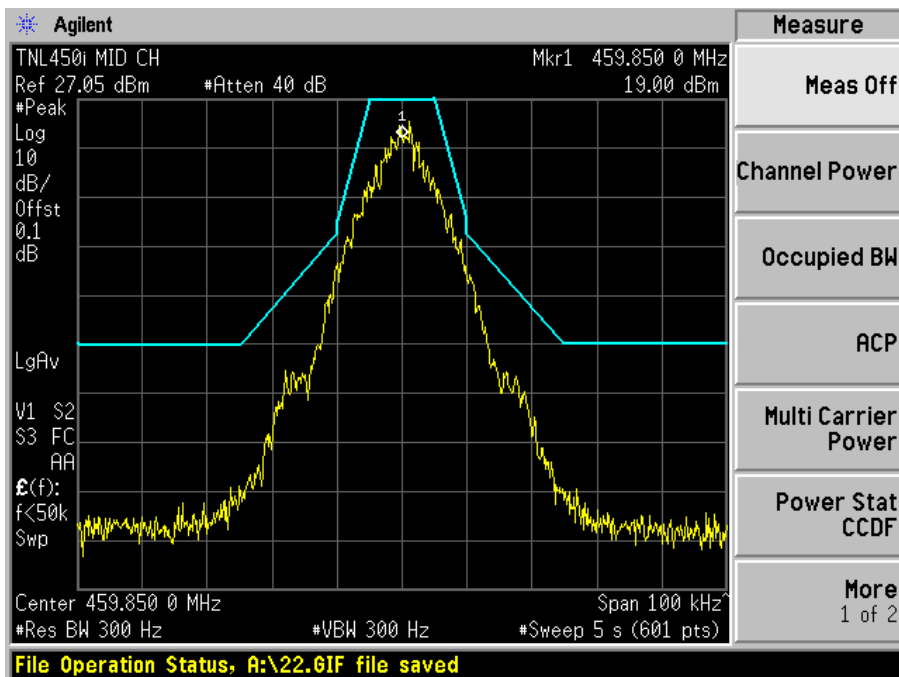
12.5 KHz Channel spacing, 9600 Baud rate:



25 KHz Channel spacing, 9600 Baud rate:



25 KHz Channel spacing, 19200 Baud rate:



§2.1051 and §90.210 – Spurious Emissions at Antenna Terminals

Applicable Standard

§2.1051 and §90.210.

On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz at least:

$50 + 10 \log P$ or 70 dB.

On any frequency removed from the center of the assigned channel by more than 250 percent at least:

$43 + 10 \log (P)$

Test Procedure

The RF output of the transceiver was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.

Test Equipment

Manufacturer	Description	Model	S/N	Cal. Due Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2007-03-06
Agilent	Spectrum Analyzer	8562EC	3946A00288	2006-12-22

* **Statement of Traceability:** BACL attests that all calibrations have been performed per the NVLAP requirements, traceable to NIST.

Environmental Conditions

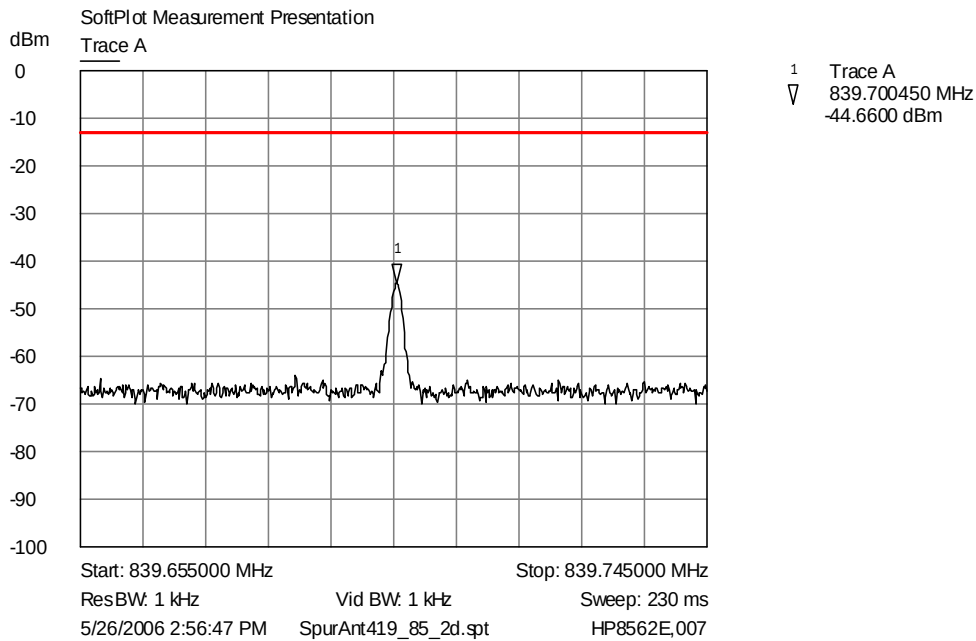
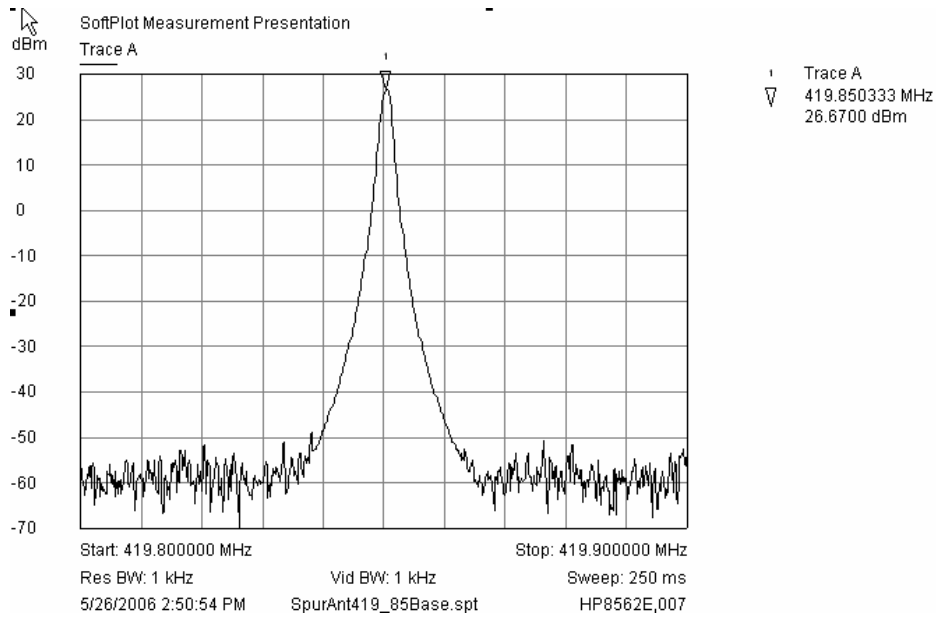
Room Temperature:	22° C
Relative Humidity:	75%
Pressure:	1021 mbar

**Testing was performed by Daniel Deng on 2006-05-05 and Dmitry Tadenev on 2006-05-26.*

Test Results

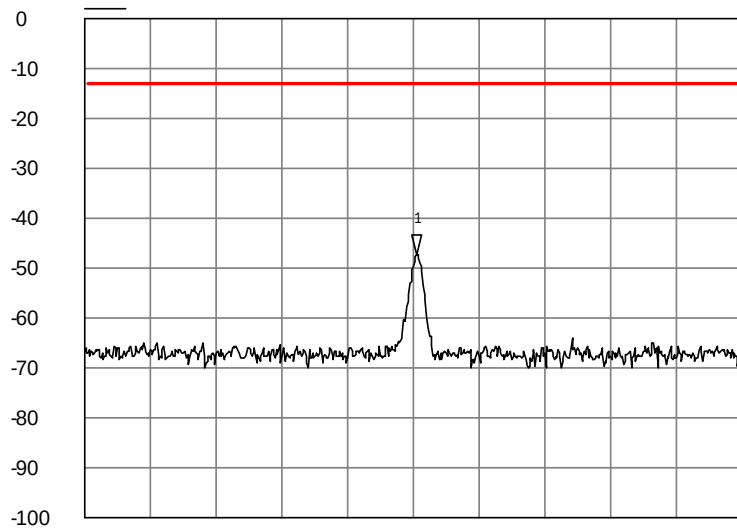
Please refer to the hereinafter plots.

410-430 MHz Band:



SoftPlot Measurement Presentation

Trace A



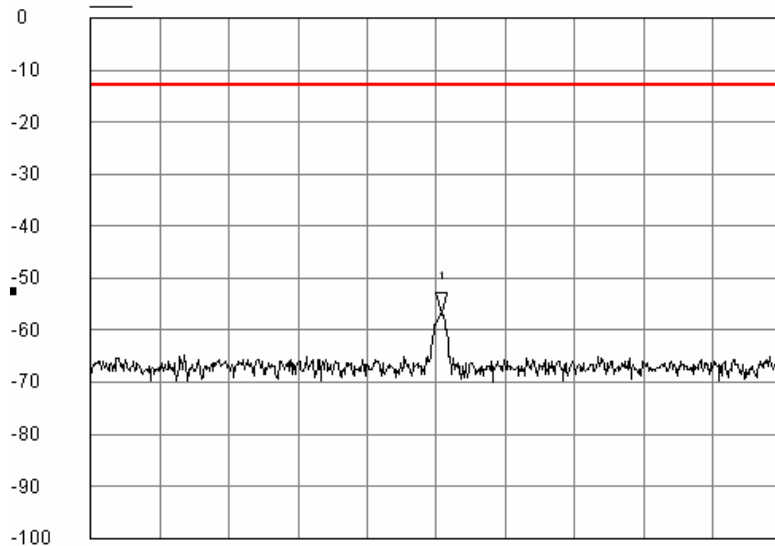
1 Trace A
1.259550 GHz
-47.3300 dBm

Start: 1.259510 GHz Stop: 1.259591 GHz
ResBW: 1 kHz Vid BW: 1 kHz Sweep: 210 ms
5/26/2006 3:00:25 PM SpurAnt419_85_3d.spt HP8562E,007



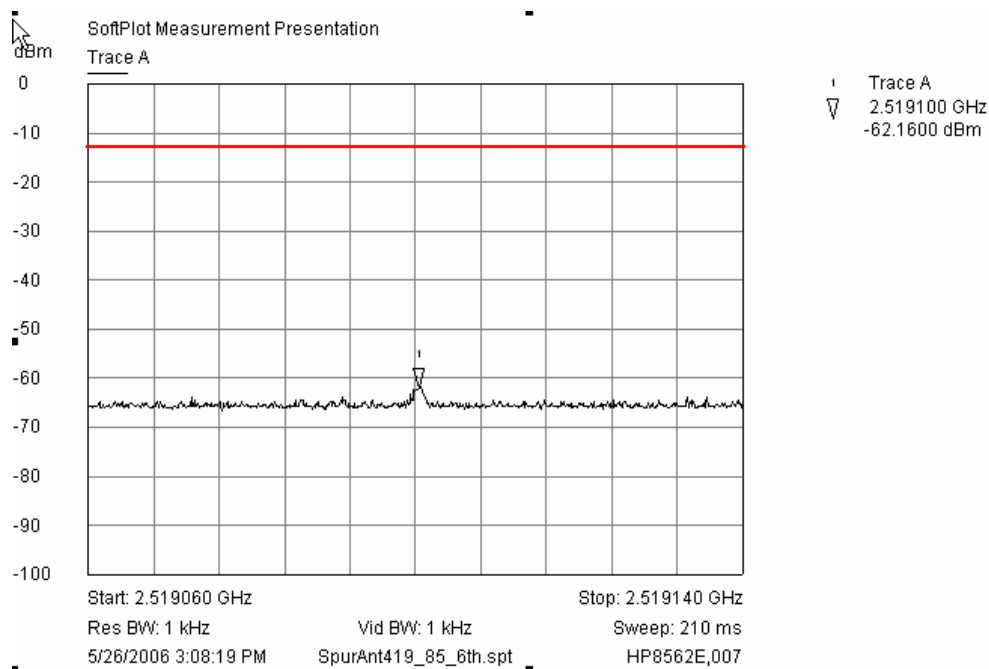
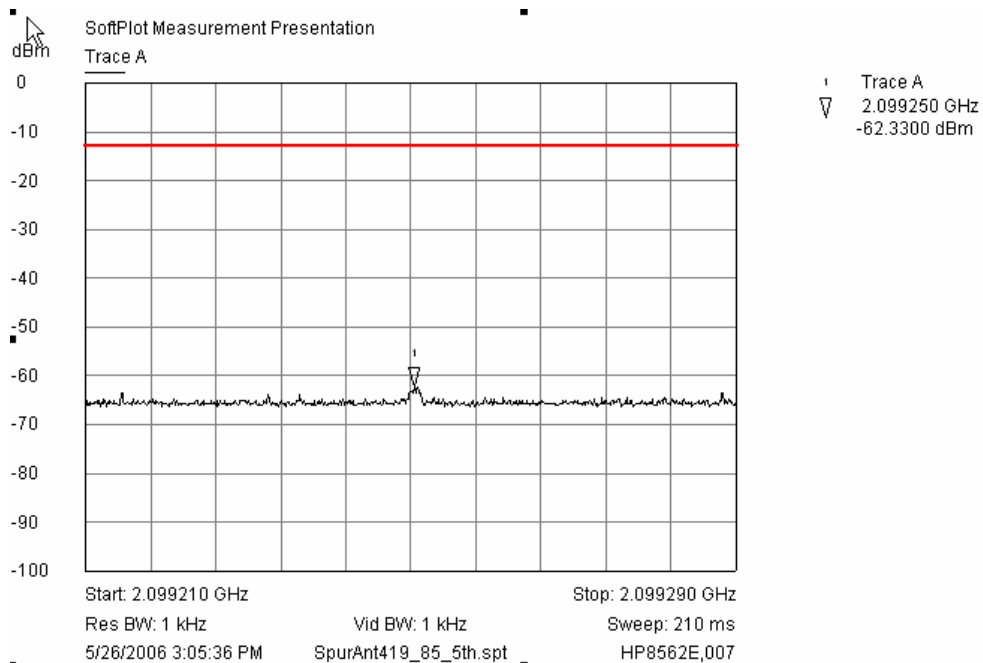
SoftPlot Measurement Presentation

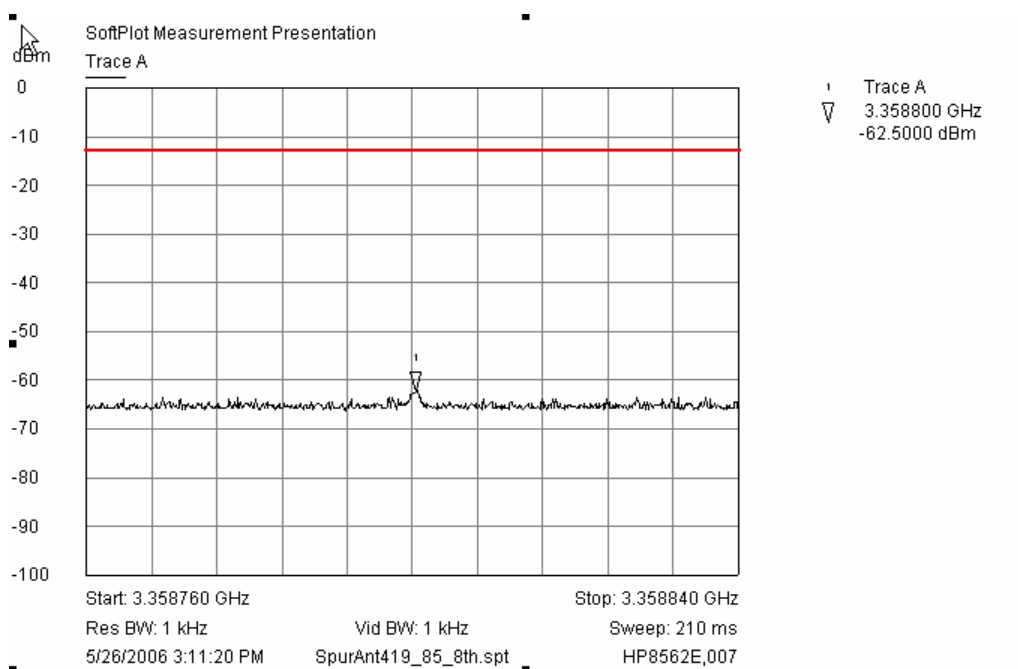
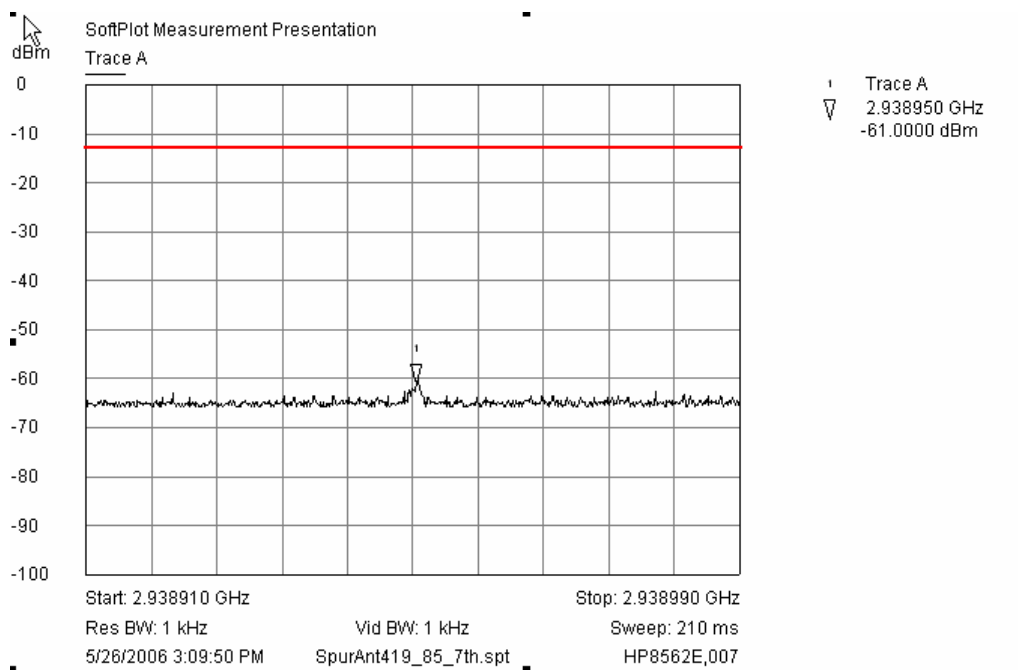
Trace A

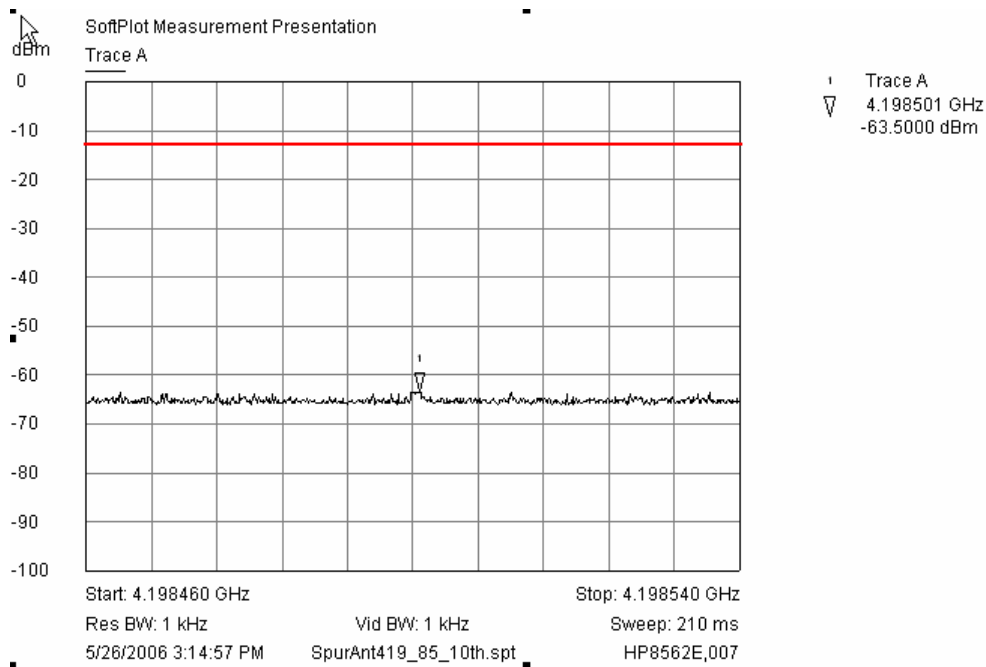
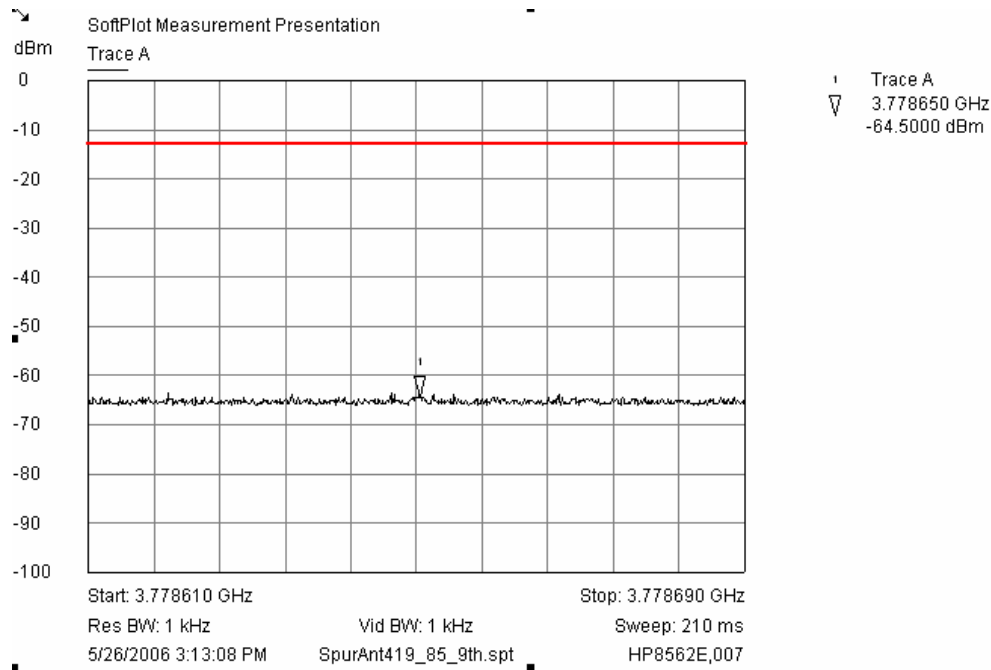


1 Trace A
1.679401 GHz
-56.6600 dBm

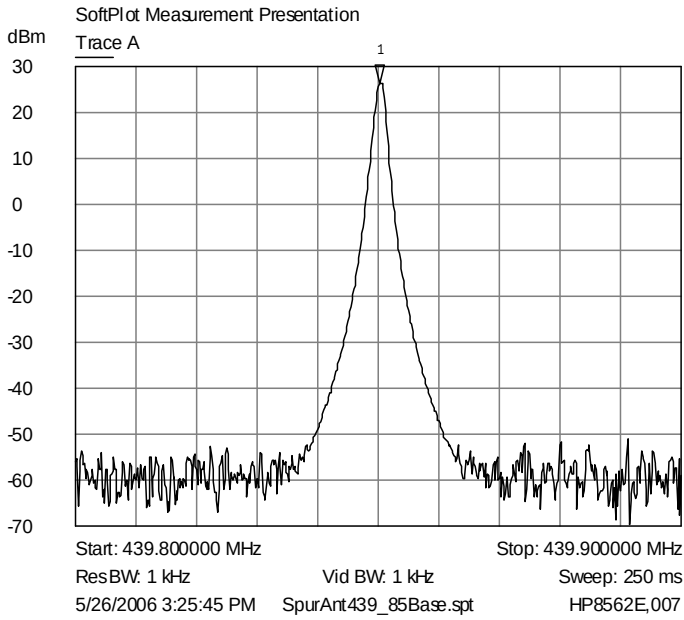
Start: 1.679360 GHz Stop: 1.679441 GHz
Res BW: 1 kHz Vid BW: 1 kHz Sweep: 210 ms
5/26/2006 3:02:24 PM SpurAnt419_85_4th.spt HP8562E,007



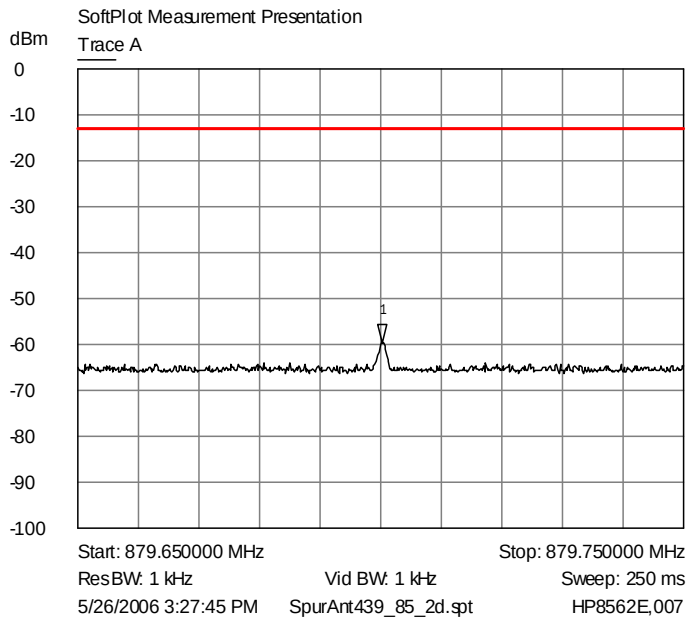




430-450 MHz Band:



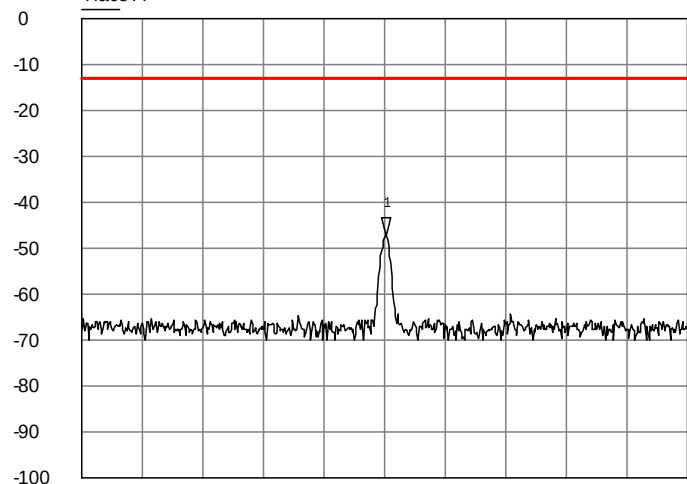
1 Trace A
439.850333 MHz
26.5000 dBm



1 Trace A
879.700333 MHz
-59.5000 dBm

SoftPlot Measurement Presentation

Trace A

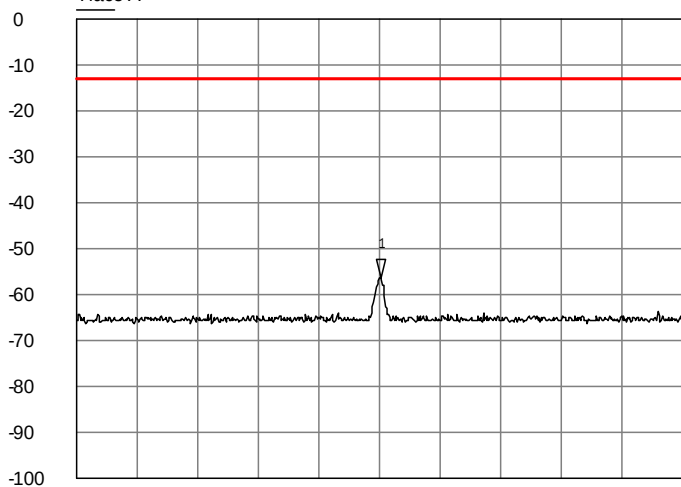


1 Trace A
1.319550 GHz
-47.3300 dBm

Start: 1.319500 GHz Stop: 1.319600 GHz
ResBW: 1 kHz Vid BW: 1 kHz Sweep: 250 ms
5/26/2006 3:29:14 PM SpurAnt439_85_3d.spt HP8562E,007

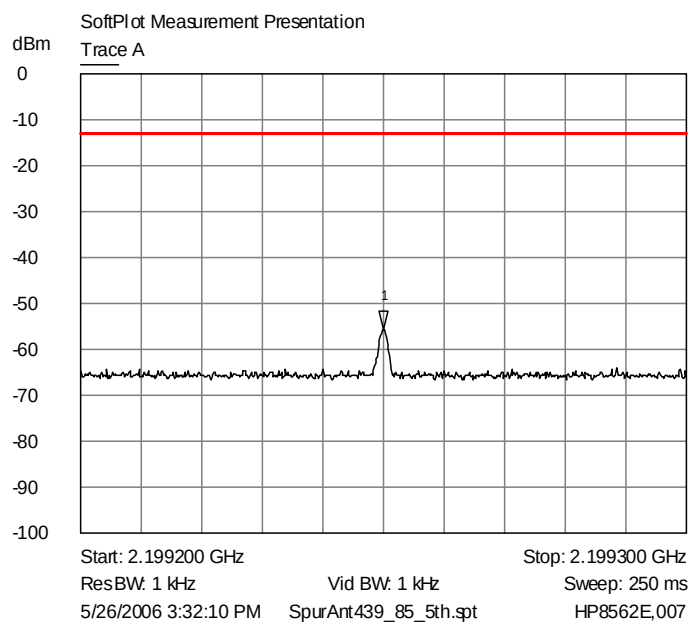
SoftPlot Measurement Presentation

Trace A

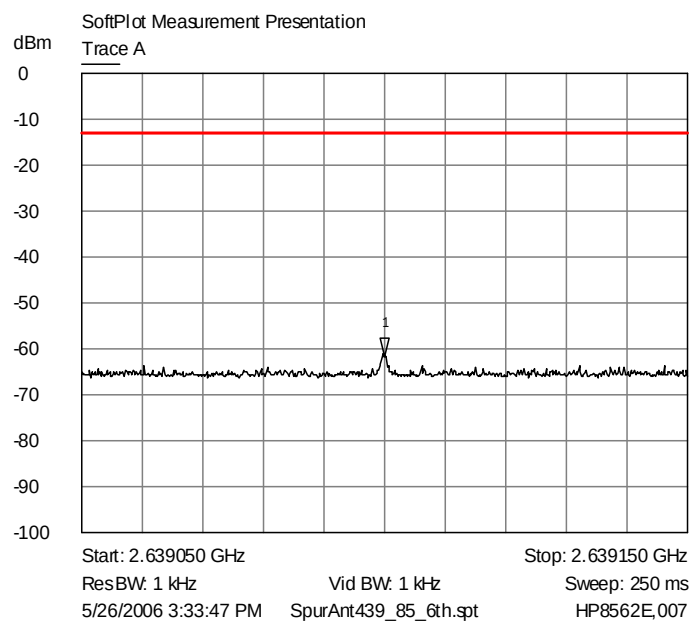


1 Trace A
1.759400 GHz
-56.5000 dBm

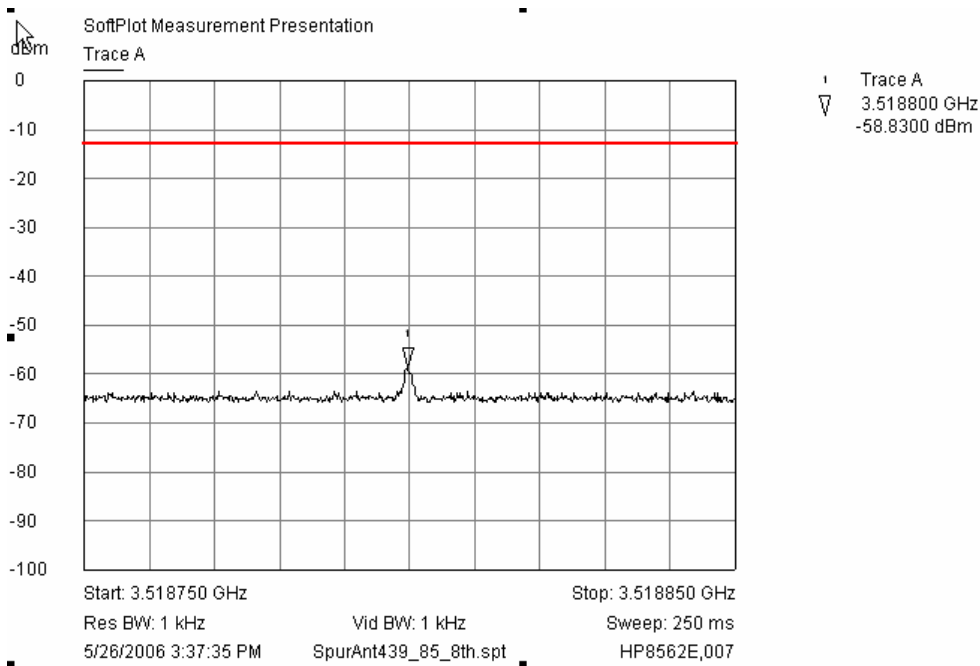
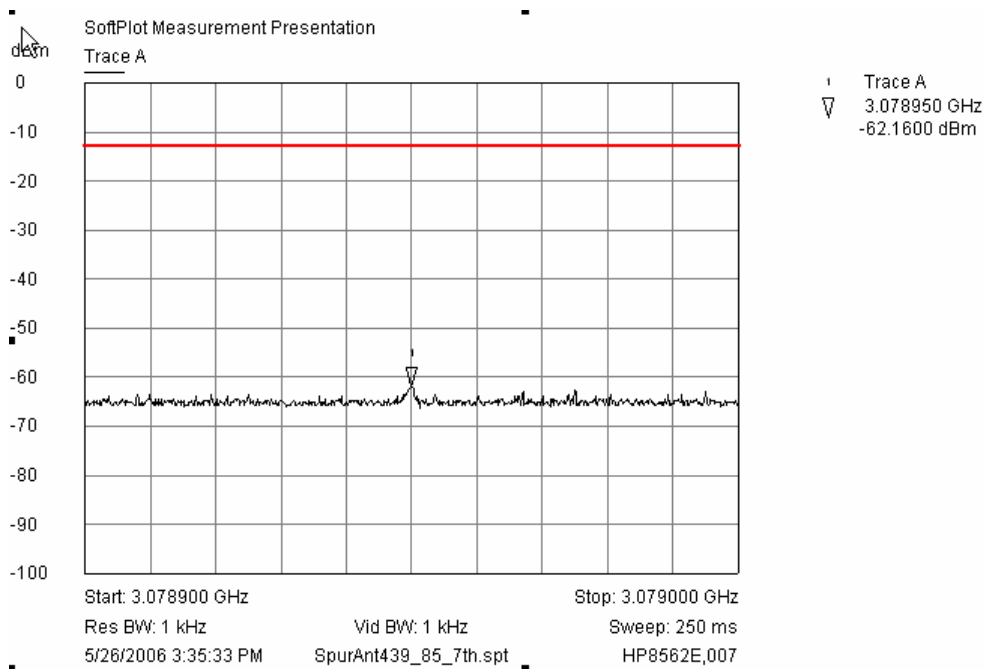
Start: 1.759350 GHz Stop: 1.759450 GHz
ResBW: 1 kHz Vid BW: 1 kHz Sweep: 250 ms
5/26/2006 3:30:38 PM SpurAnt439_85_4th.spt HP8562E,007

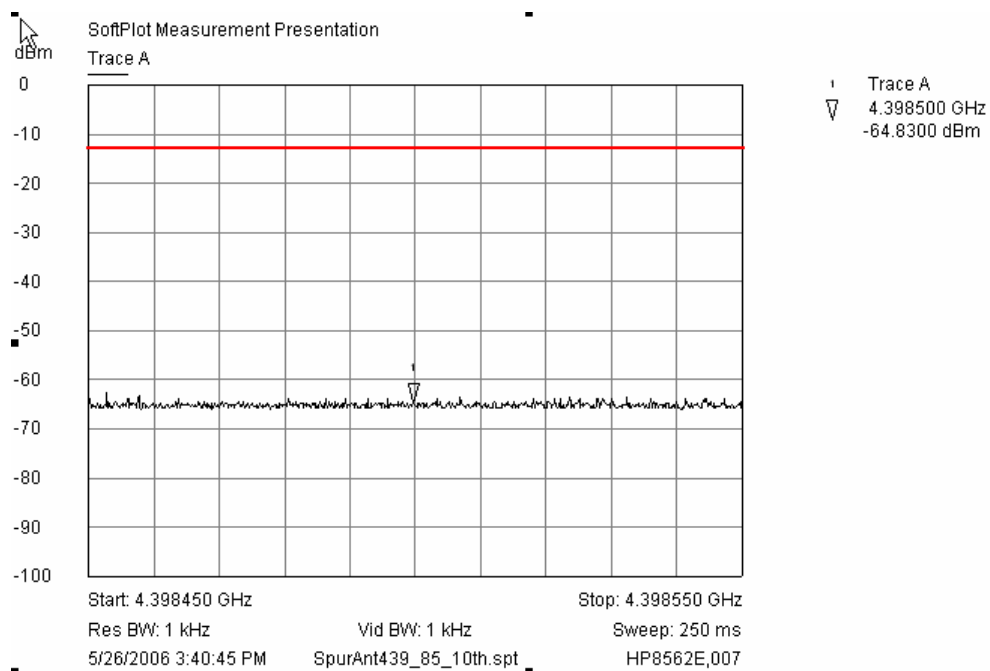
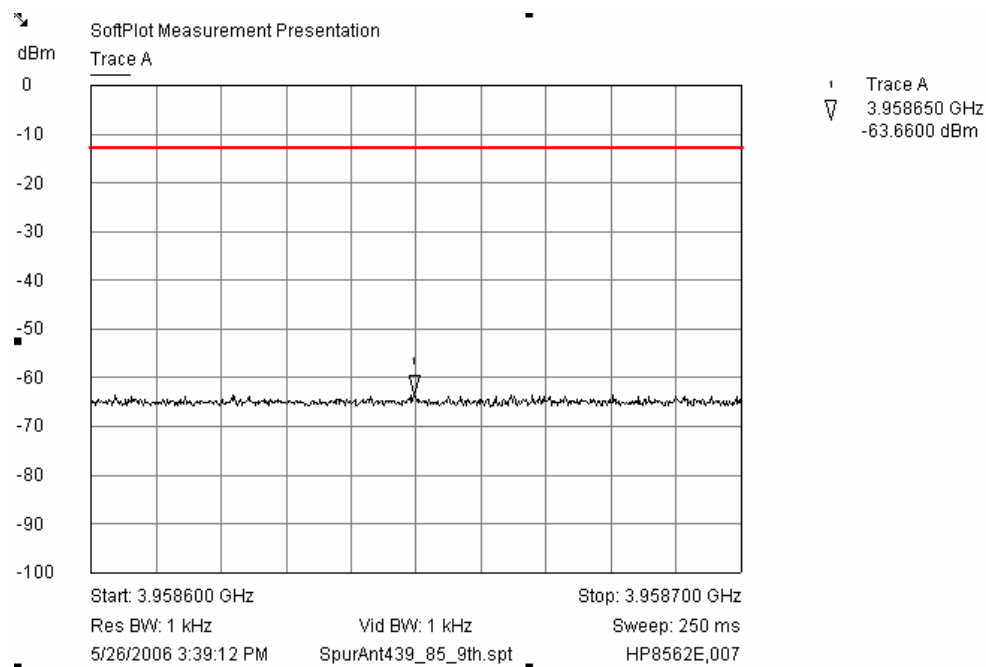


1 Trace A
▽ 2.199250 GHz
-55.6600 dBm

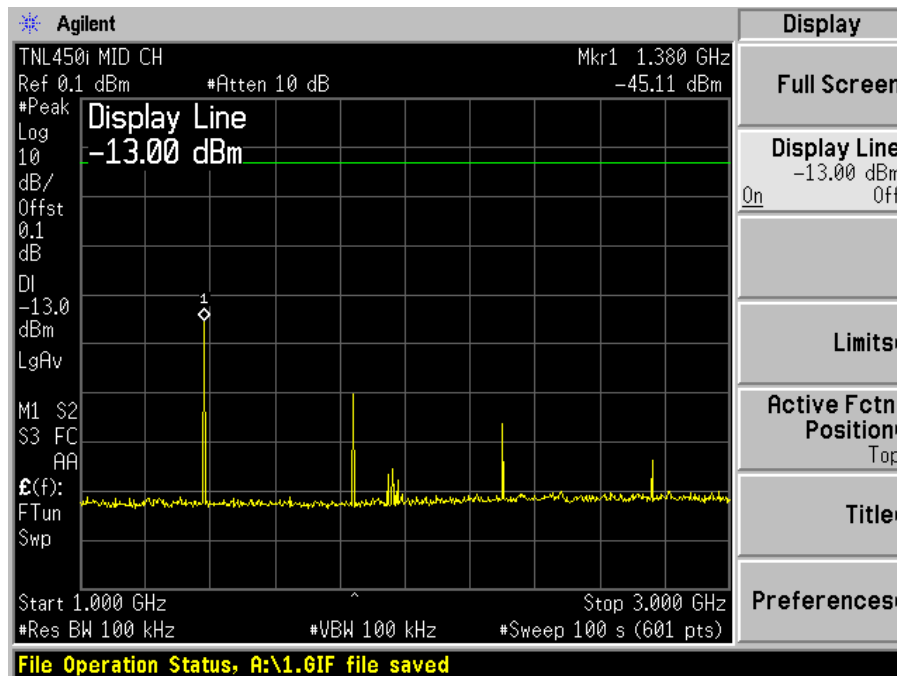
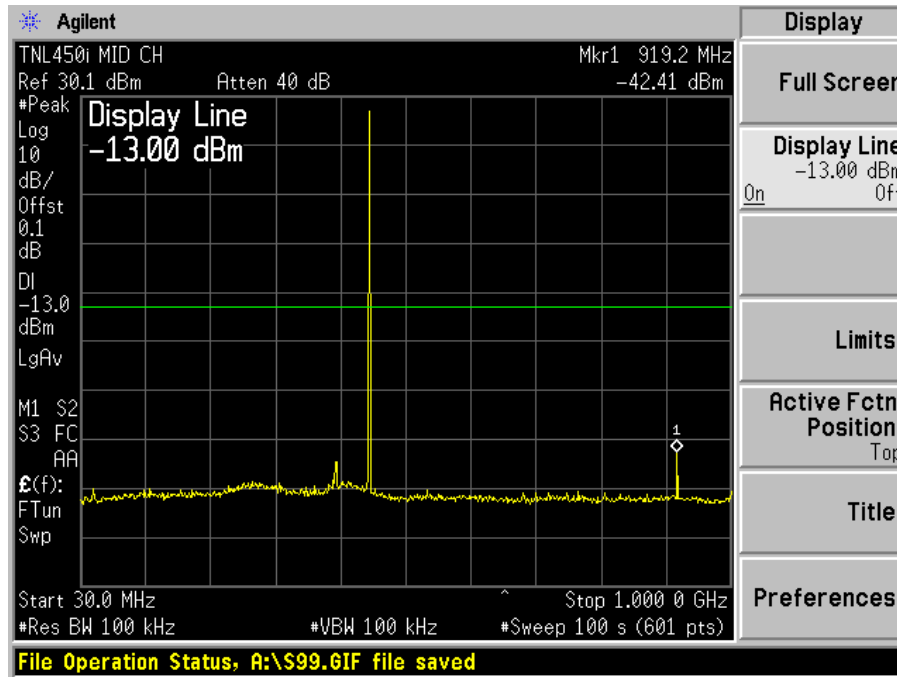


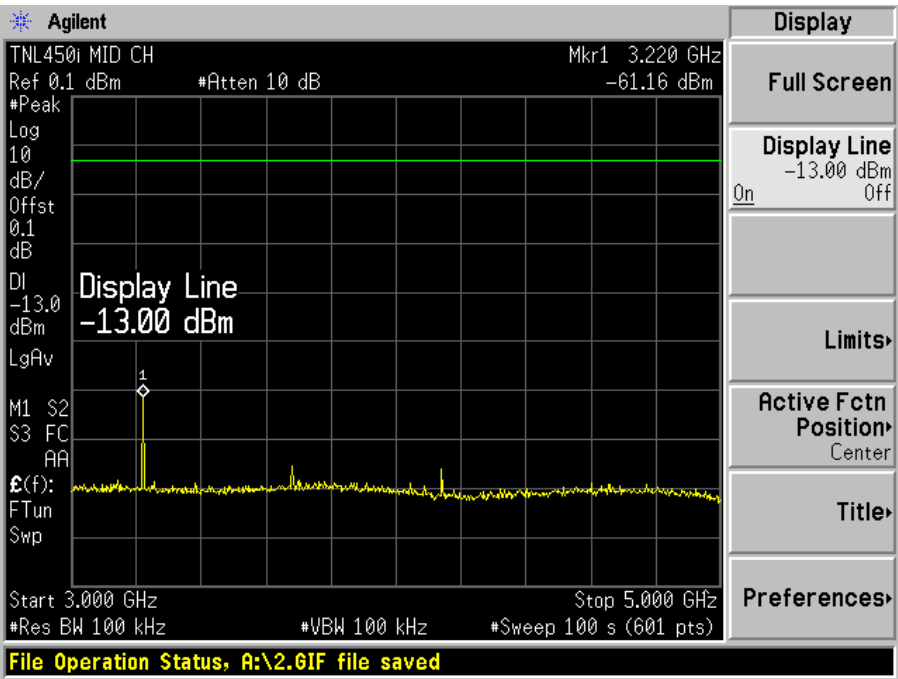
1 Trace A
▽ 2.639100 GHz
-61.5000 dBm





450-470 MHz Band:





§2.1053 and §90.210 - Radiated Spurious Emissions

Applicable Standard

§2.1053 and §90.210

Test Procedure

The transmitter was placed on a wooden turntable, and it was transmitting into a non-radiating load which was also placed on the turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3-orthogonal axis.

The frequency range up to tenth harmonic of the fundamental frequency was investigated.

Remove the EUT and replace it with substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

Spurious emissions in dB = $10 \lg (\text{TXpwr in Watts}/0.001)$ – the absolute level

Spurious attenuation limit in dB = $43 + 10 \log_{10} (\text{power out in Watts})$ for EUT with a 25KHz channel bandwidth.

Spurious attenuation limit in dB = $50 + 10 \log_{10} (\text{power out in Watts})$ for EUT with a 12.5KHz channel bandwidth.

Test Equipment

Manufacturer	Description	Model	S/N	Cal. Due Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2007-03-06
R & S	Signal Generator	SMIQ03	849192	2007-05-02
Sonoma Instrument	Pre amplifier	317	260408	2007-02-03
Agilent	Pre amplifier	8449B	3147A00400	2006-08-10
HP	Signal Generator	83650B	3614A00276	2007-05-10
A.R.A	Horn antenna	DRG-118/A	1132	2006-08-17
Sunol Science	Antenna	JB3	A020106-3 / S006628	2007-03-12

* **Statement of Traceability:** BACL attests that all calibrations have been performed per the NVLAP requirements, traceable to NIST.

Environmental Conditions

Room Temperature:	22° C
Relative Humidity:	75%
Pressure:	1021 mbar

**Testing was performed by Daniel Deng on 2006-05-05.*

Test Result

Indicated Frequency MHz	Amp. dBuV	Table Angle Degree	Test Antenna		Substituted				Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Height	Polar	Frequency	Level	Antenna	Cable Loss dB			
			Meter	H/V	MHz	(dBm)	Gain				
3220.00	40.75	20	2.45	V	3220.00	-55.10	9.6	1.7	-47.2	-13	-34.2
3220.00	35.88	21	1.67	H	3220.00	-59.60	9.6	1.7	-51.7	-13	-38.7
1380.00	47.18	55	1.56	H	1380.00	-64.50	6.3	0.9	-59.1	-13	-46.1
920.00	50.17	51	1.01	H	920.00	-60.20	0	0.8	-61.0	-13	-48.0
1840.00	36.64	27	1.1	V	1840.00	-72.60	8.8	1.1	-64.9	-13	-51.9
1840.00	33.94	75	2.97	H	1840.00	-74.10	8.8	1.1	-66.4	-13	-53.4
1380.00	37.61	0	1.07	V	1380.00	-75.20	6.3	0.9	-69.8	-13	-56.8
2300.00	29.25	101	2.25	H	2300.00	-77.80	8.3	1.5	-71.0	-13	-58.0
920.00	38.66	108	1.1	V	920.00	-71.00	0	0.8	-71.8	-13	-58.8
216.00	39.20	70	1.64	H	216.00	-72.50	0	0.3	-72.8	-13	-59.8
2300.00	27.71	190	1.12	V	2300.00	-80.20	8.3	1.5	-73.4	-13	-60.4
216.00	32.75	285	2.38	V	216.00	-77.90	0	0.3	-78.2	-13	-65.2

§2.1055 (d) and §90.213- Frequency Stability

Applicable Standard

§2.1055 (d)

§90.213 for output power < 2 watts, the limit is 5.0 ppm.

Test Procedure

Frequency Stability vs. Temperature: The equipment under test was connected to an external DC power supply and the RF output was connected to a frequency counter via feed-through attenuators. The EUT was placed inside the temperature chamber. The DC leads and RF output cable exited the chamber through an opening made for the purpose.

After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the counter.

Frequency Stability vs. Voltage: An external variable DC power supply was connected to the equipment under test. The voltage was set to 110% of the nominal value and was then decreased until the transmitter light no longer illuminated; i.e., the end point. The output frequency was recorded for each voltage.

Test Equipment

Manufacturer	Description	Model	S/N	Cal. Due Date
Agilent	Spectrum Analyzer	E4446A	US44300386	2007-03-06
Tenney	Temperature Oven	VersaTenn	12.222-193	2006-06-27
HP	Frequency Counter	5342A	2232A06380	2006-12-12

* **Statement of Traceability:** BACL attests that all calibrations have been performed per the NVLAP requirements, traceable to NIST.

Environmental Conditions

Room Temperature:	22° C
Relative Humidity:	75%
Pressure:	1021mbar

*Testing was performed by Daniel Deng on 2006-05-05 and Dmitry Tadenev on 2006-05-26.

Test Results

410-430 MHz Band:

1) Frequency Vs. Temperature			
Reference Frequency 419.85 MHz			
Test Condition		Frequency Measure with Time Elapsed	
Temperature (°C)	Power Supply (VDC)	Measured Frequency (MHz)	ppm Error
60	7.4	419.85007	0.17
50	7.4	419.85007	0.17
40	7.4	419.85	0.00
30	7.4	419.85	0.00
20	7.4	419.850077	0.18
10	7.4	419.85003	0.07
0	7.4	419.84999	-0.02
-10	7.4	419.84998	-0.05
-20	7.4	419.84998	-0.05
-30	7.4	419.84993	-0.17
2) Frequency Vs. Voltage			
Reference Frequency 419.85 MHz			
Test Condition		Frequency Measure with Time Elapsed	
Temperature (°C)	Power Supply (VDC)	Measured Frequency (MHz)	ppm Error
20	6.66	419.85001	0.02
20	8.14	419.850015	0.04

430-450 MHz Band:

1) Frequency Vs. Temperature			
Reference Frequency 439.85 MHz			
Test Condition		Frequency Measure with Time Elapsed	
Temperature (°C)	Power Supply (VDC)	Measured Frequency (MHz)	ppm Error
60	7.4	439.85017	0.39
50	7.4	439.85008	0.18
40	7.4	439.85008	0.18
30	7.4	439.85	0.00
20	7.4	439.85008	0.18
10	7.4	439.85008	0.18
0	7.4	439.84992	-0.18
-10	7.4	439.84973	-0.61
-20	7.4	439.84973	-0.61
-30	7.4	439.84977	-0.52
2) Frequency Vs. Voltage			
Reference Frequency 439.85 MHz			
Test Condition		Frequency Measure with Time Elapsed	
Temperature (°C)	Power Supply (VDC)	Measured Frequency (MHz)	ppm Error
20	6.66	439.850007	0.02
20	8.14	439.85001	0.02

450-470 MHz Band:

1) Frequency Vs. Temperature			
Reference Frequency 459.85 MHz			
Test Condition		Frequency Measure with Time Elapsed	
Temperature (°C)	Power Supply (VDC)	Measured Frequency (MHz)	ppm Error
60	7.4	459.850125	0.27
50	7.4	459.850116	0.25
40	7.4	459.849994	-0.01
30	7.4	459.849981	-0.04
20	7.4	459.849975	-0.05
10	7.4	459.850165	0.36
0	7.4	459.850059	0.13
-10	7.4	459.849889	-0.24
-20	7.4	459.849829	-0.37
-30	7.4	459.849991	-0.02
2) Frequency Vs. Voltage			
Reference Frequency 459.85 MHz			
Test Condition		Frequency Measure with Time Elapsed	
Temperature (°C)	Power Supply (VDC)	Measured Frequency (MHz)	ppm
20	6.66	459.850128	0.28
20	8.14	459.850135	0.29

§90.214 – Transient Frequency Behavior

Standard Applicable

§90.214, Transmitters designed to operate in the 150–174 MHz and 421–512 MHz frequency bands must maintain transient frequencies within the maximum frequency difference limits.

Test Method

TIA/EIA-603 2.2.19

Test Equipment

Manufacturer	Description	Model	Cal. Due Date
Agilent	Spectrum Analyzer	8562EC	2006-12-22
HP	RF Communications Test Set	8920A	2006-12-15
HP	Signal Generator	8648A	2006-12-14
Tektronix	Oscilloscope	TDS220	2006-12-14

* **Statement of Traceability:** BACL attests that all calibrations have been performed per the NVLAP requirements, traceable to NIST.

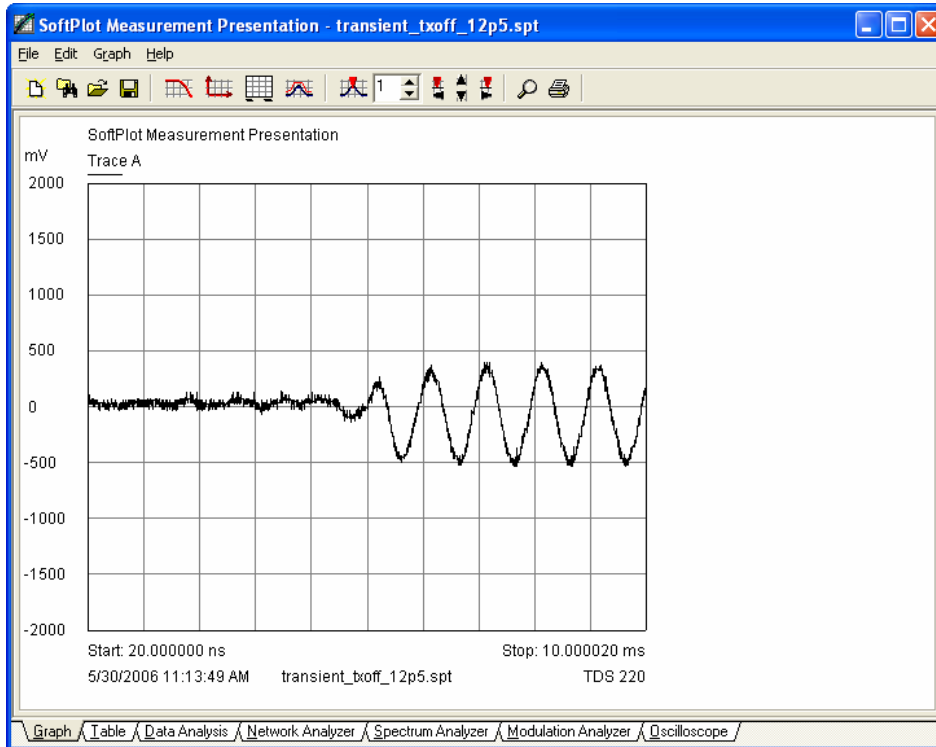
Environmental Conditions

Room Temperature:	20° C
Relative Humidity:	50%
Pressure:	1021 mbar

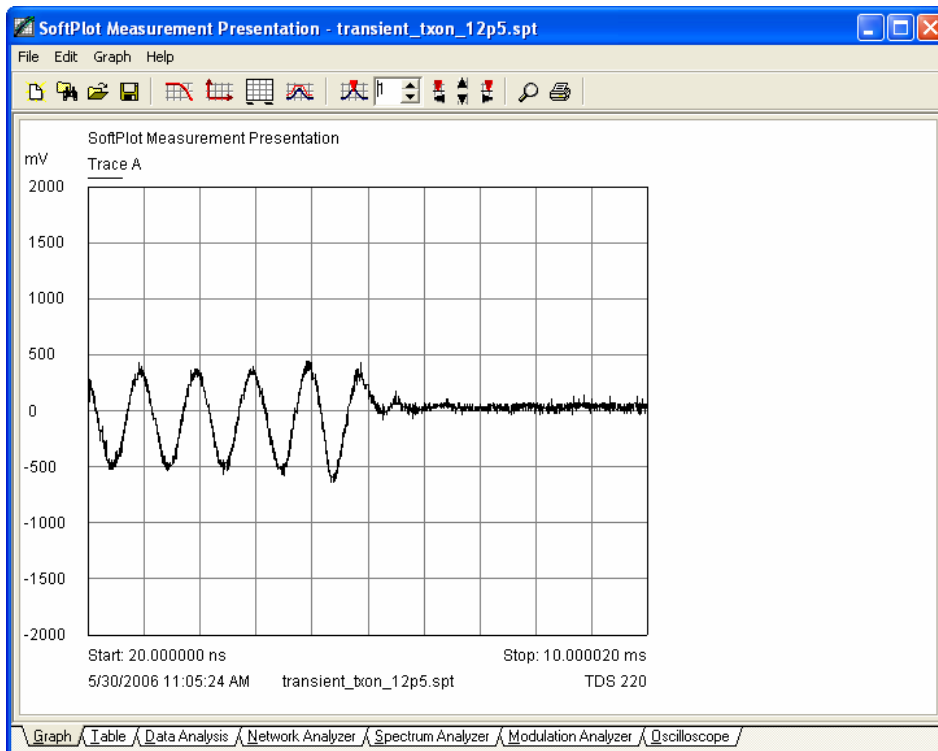
Test Result

Please refer to the plot hereinafter.

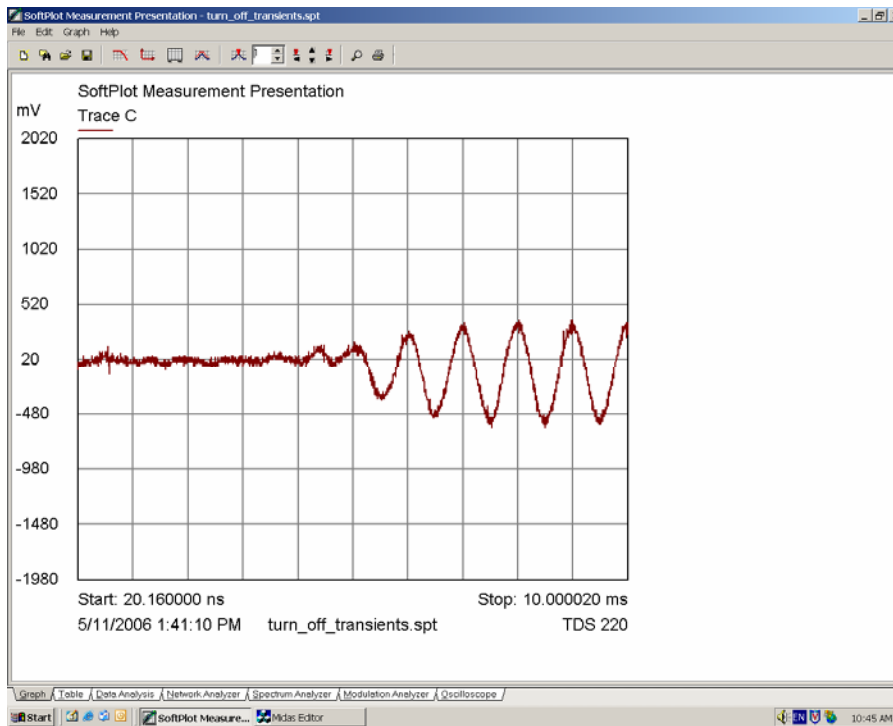
1. Turn off transience channel spacing 12.5 kHz



2. Turn on transience channel spacing 12.5 kHz



3. Turn off transience channel spacing 25 kHz



4. Turn on transience channel spacing 25 kHz

