



FCC CFR47 PART 90
CERTIFICATION TEST REPORT
FOR
COMPACT SURVEILLANCE RADAR
MODEL NUMBER: C40
FCC ID: C06-C40-LIC
REPORT NUMBER: 12U14653-1, REVISION B
ISSUE DATE: FEBRUAY 4, 2013

Prepared for
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709 E. TECHNOLOGY AVE. BLDG E 3100
OREM, UTAH 84097 USA

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NVLAP[®]
NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
	10/31/12	Initial	T. LEE
A	11/28/12	Updated Report: TIA reference, RF Power measurement procedure; photos, deleted AC Conducted; added RF Exposure	T. LEE
B	2/4/13	Updated Frequency units from MHz to GHz	T. LEE

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: SPOTTERRF LLC
709 E. TECHNOLOGY AVE. BLDG E 3100
OREM, UTAH 84097 USA

EUT DESCRIPTION: COMPACT SURVEILLANCE RADAR

MODEL: C40

SERIAL NUMBER: PROTO 1496941

DATE TESTED: OCTOBER 28 AND 29, 2012

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 90	Pass

UL CCS tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL CCS based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

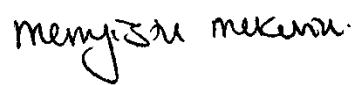
Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL CCS and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL CCS will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For UL CCS By:



TIMOTHY K. LEE
STAFF ENGINEER
UL CCS

Tested By:



MENGISTU MEKURIA
EMC TECHNICIAN
UL CCS

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 90, RSS-GEN Issue 3, and TIA 603.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 Benicia Street, Fremont, California, USA.

UL CCS is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at <http://www.ccsemc.com>.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \\ &\text{Cable Loss (dB)} - \text{Preamp Gain (dB)} \\ 36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} &= 28.9 \text{ dBuV/m} \end{aligned}$$

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Conducted Disturbance, 0.15 to 30 MHz	3.52 dB
Radiated Disturbance, 30 to 1000 MHz	4.94 dB

Uncertainty figures are valid to a confidence level of 95%.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is 10 GHz medium range Compact Surveillance Radar (CSR). The unit operates only between channel 2 through 9 (10.0670 GHz to 10.4154 GHz)

The radio module is manufactured by SpotterRF LLC.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

Frequency (GHz)	Channel	Output Power (dBm)	Output Power (mW)
10.0670	2	26.21	417.83
10.2660	5	26.02	399.94
10.4154	9	26.38	434.51

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes a patch antenna, with a maximum gain of 14 dBi.

5.4. SOFTWARE AND FIRMWARE

The EUT driver software installed during testing was Spotter RF C40 SP0003 v3.0.0-alpha.00502 (2012-10-16_12-19).

5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emission was performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

All final radiated testing was performed with the EUT in upright orientation as indicated by the installation instructions.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Toshiba	PT324U03900R	2C165037H	DoC
AC Adapter	Toshiba	PA3714U-1ACA	T0412032003150A	DoC
Power Over Ethernet Adapter	APC	AP9302-WM	--	--
AC Adapter	V-infinity	ETSA200200UD	--	--

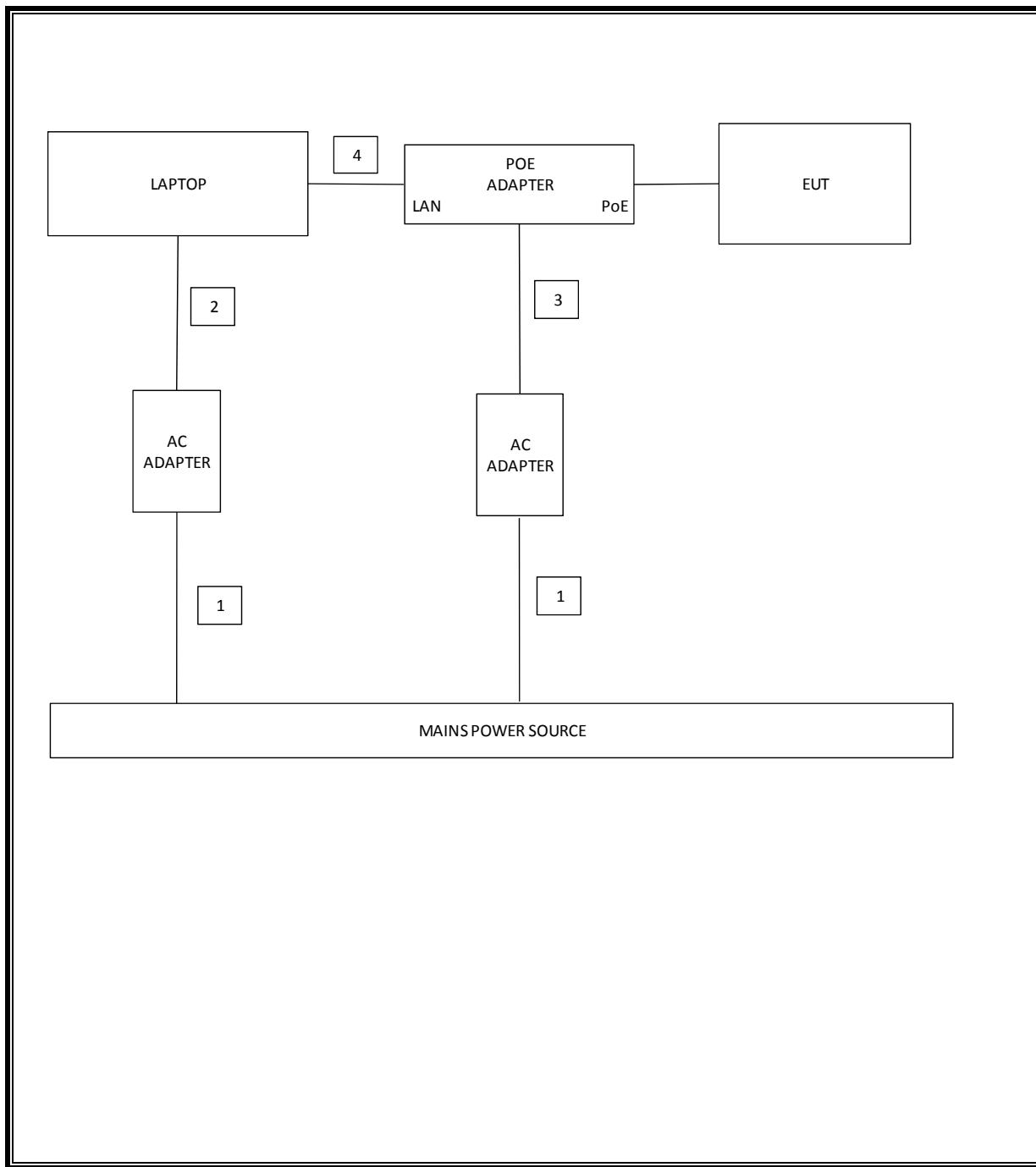
I/O CABLES

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	2	AC 2P	Unshielded	1.8m	None
2	DC	1	DC	Shielded	1.8m	Ferrite on Laptop end
3	DC	1	DC	Unshielded	1.8m	Ferrite on Adapter end
4	LAN	1	CAT5	Unshielded	2m	None
5	LAN	1	CAT5	Shielded	7.5m	Screw on weatherproof connector for EUT side

TEST SETUP

The EUT is powered via the POE adapter. Test software exercised using the Laptop controlled through the Ethernet cables.

SETUP DIAGRAM FOR TESTS



6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment List				
Description	Manufacturer	Model	Asset	Cal Due
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C00996	5/11/2013
Spectrum Analyzer, 44 GHz	Agilent / HP	E4446A	C00986	3/22/2013
Antenna, Bilog, 30MHz-1 GHz	Sunol Sciences	JB1	C01011	3/23/2013
Antenna, Horn, 18 GHz	EMCO	3115	C01218/10006	11/1/2012
Antenna, Horn, 26.5 GHz	ARA	MWH-1826/B	C00980	11/28/2012
Antenna, Horn, 40 GHz	ARA	MWH-2640/B	C00981	6/14/2013
Harmonic Mixer, 50 GHz	Agilent / HP	11970Q	C00769	5/11/2013
Harmonic Mixer, 75 GHz	Agilent / HP	11970V	C00768	01/31/14
Preamplifier, 1300 MHz	Agilent / HP	8447D	C00885	11/11/12
Preamplifier, 26.5 GHz	Agilent / HP	8449B	C01063	11/07/12
Preamplifier, 40 GHz	Miteq	NSP4000-SP2	C00990	8/2/2013
Temperature / Humidity Chamber	Thermotron	SE 600-10-10	C00930	11/1/2013
Down Converter, 67 GHz	Agilent / HP	MT-463	C01188	CNR
Analog Signal Generator, 40 GHz	Agilent / HP	E8257D	C01177	9/9/2013

7. ANTENNA PORT TEST RESULTS

7.1. 99% BANDWIDTH

LIMITS

FCC § 90.209(b)(5)

None; for reporting purposes only. Bandwidth for radiolocation stations will be reviewed and authorized on a case-by-case basic.

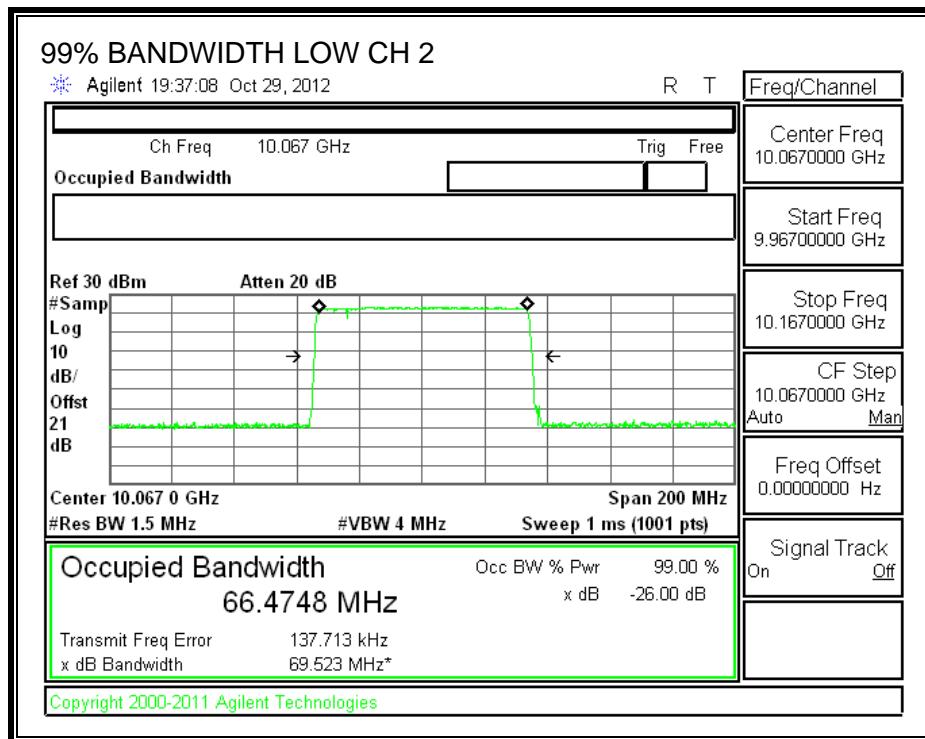
TEST PROCEDURE

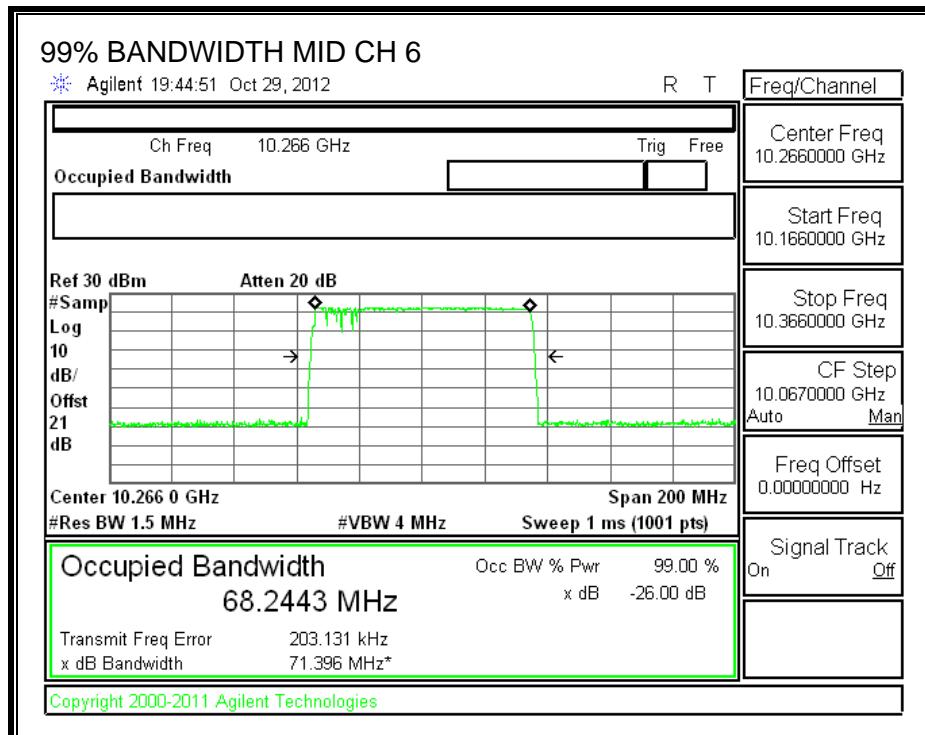
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

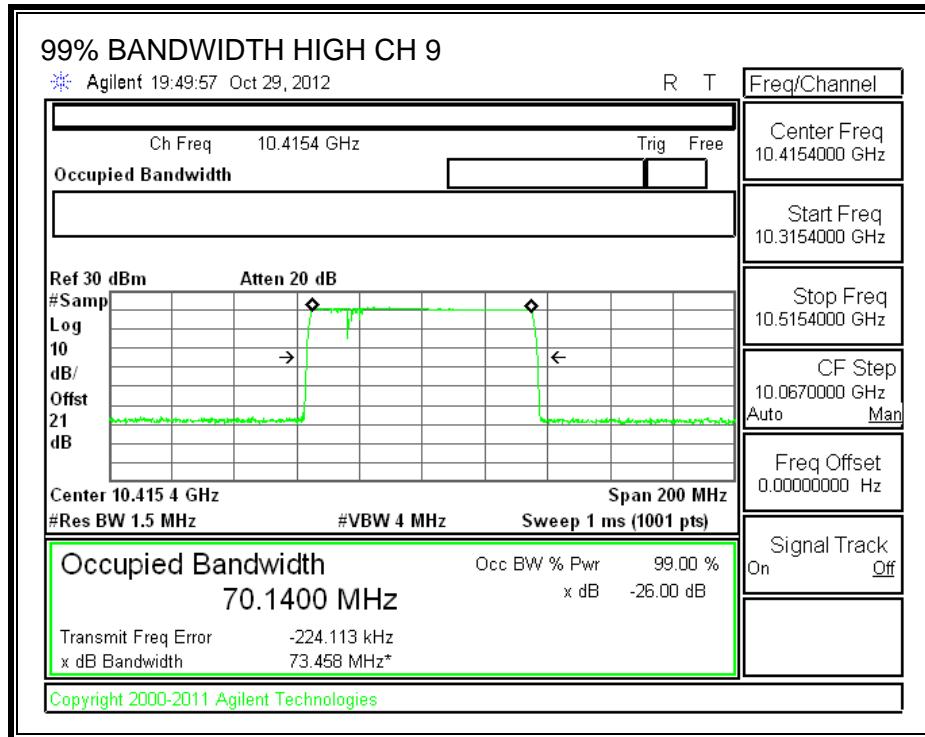
RESULTS

Channel	Frequency (GHz)	99% Bandwidth (MHz)
2	10.0670	66.4748
6	10.2660	68.2443
9	10.4154	70.1400

99% BANDWIDTH







7.2. OUTPUT POWER

LIMITS

FCC §90.103(c) (13)

The maximum power into the antenna port shall be less than 5 W.

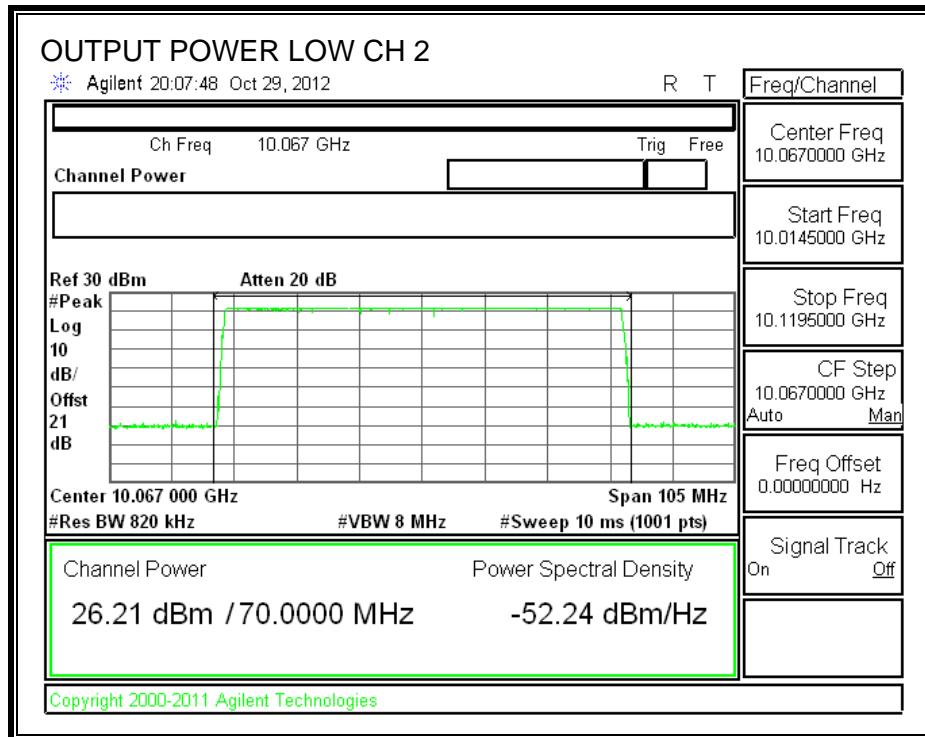
TEST PROCEDURE

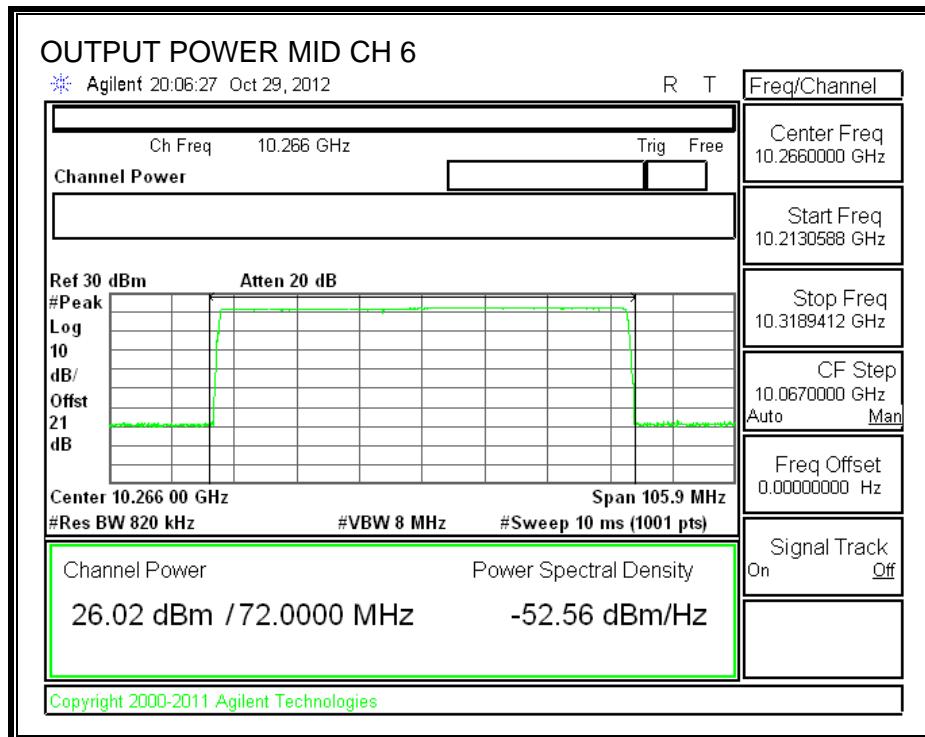
The transmitter output was connected to the input terminal via calibrated coaxial cable. The output power was measured with the spectrum analyzer at the low, middle and high channel in each band.

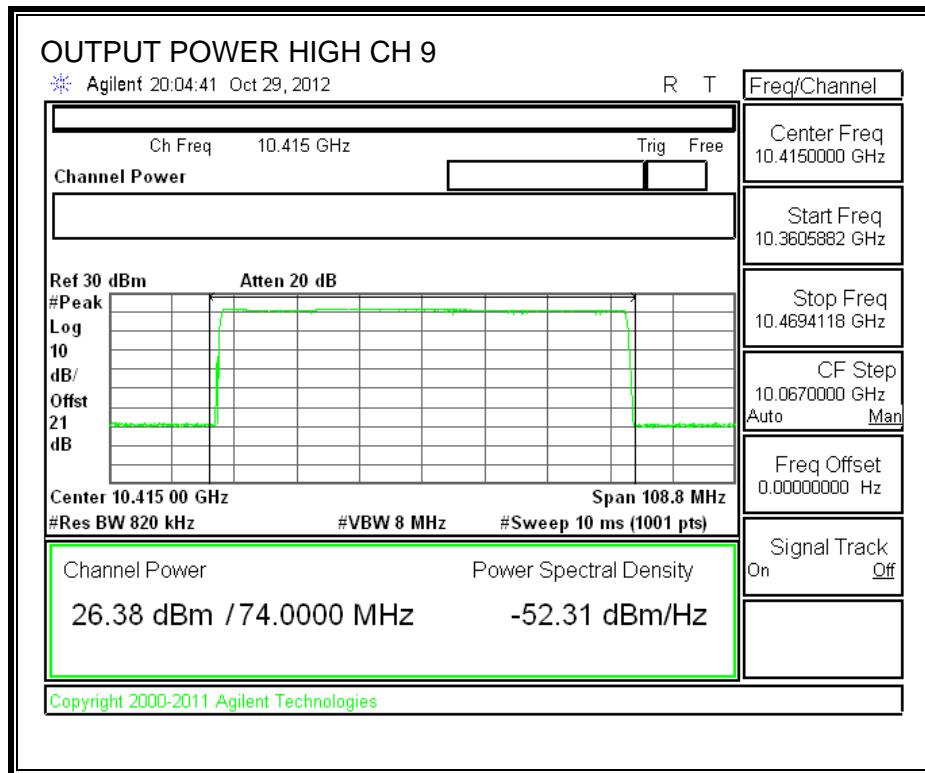
RESULTS

Channel	Frequency (GHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
2	10.0670	26.210	37	-10.790
6	10.2660	26.020	37	-10.980
9	10.4154	26.380	37	-10.620

OUTPUT POWER







7.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a power meter.

RESULTS

The cable assembly insertion loss of 22 dB (including 20dB pad and 2 dB cable) was entered as an offset in the power meter to allow for direct reading of power.

Channel	Frequency (GHz)	AV power (dBm)
2	10.0670	20.63
6	10.2660	20.96
9	10.4154	20.27

7.4. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §90.210

Attenuation below carrier of $43 + 10 \log (P)$ dB or -13dBm

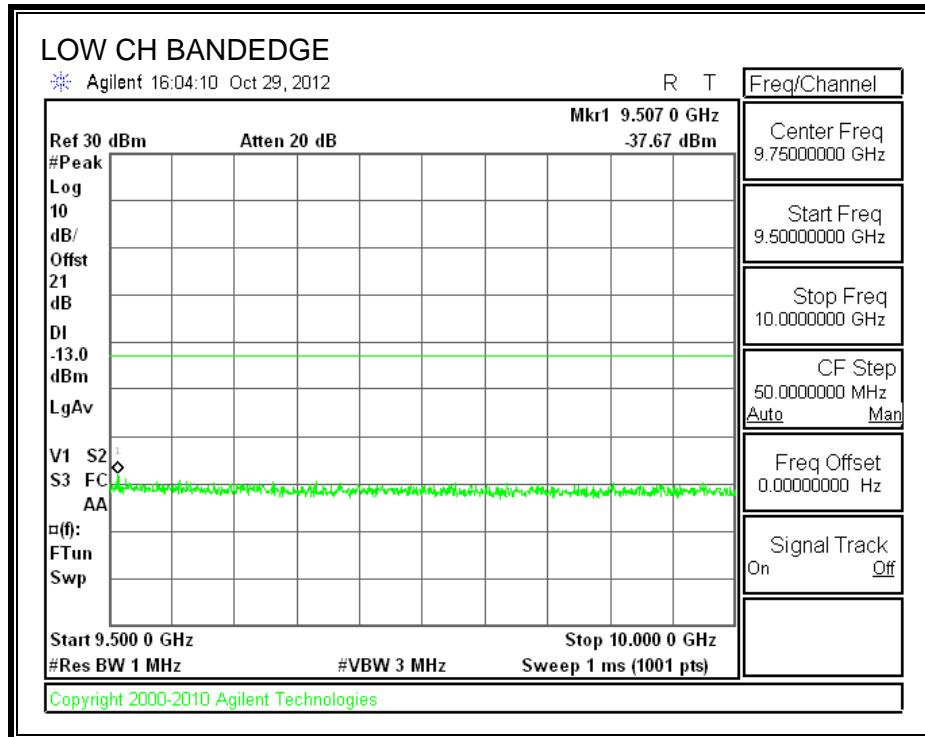
TEST PROCEDURE

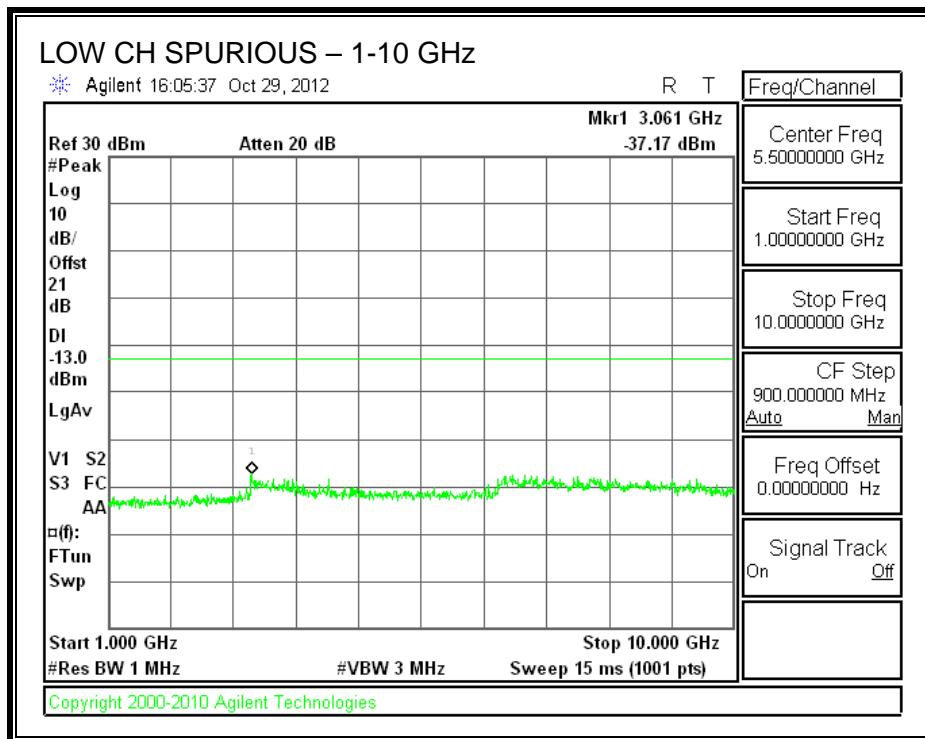
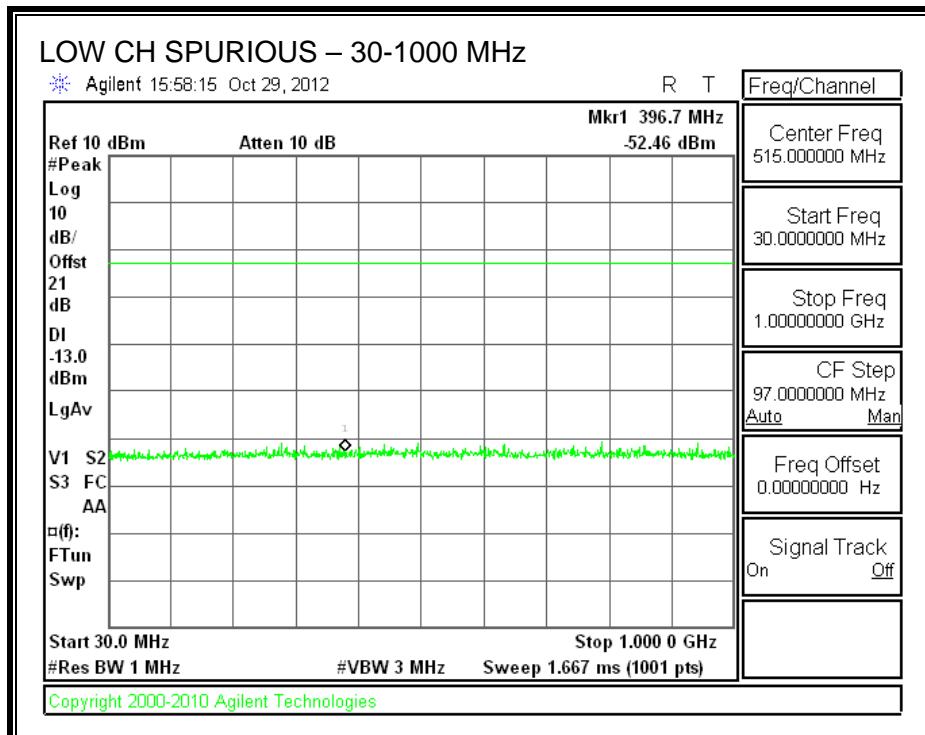
The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

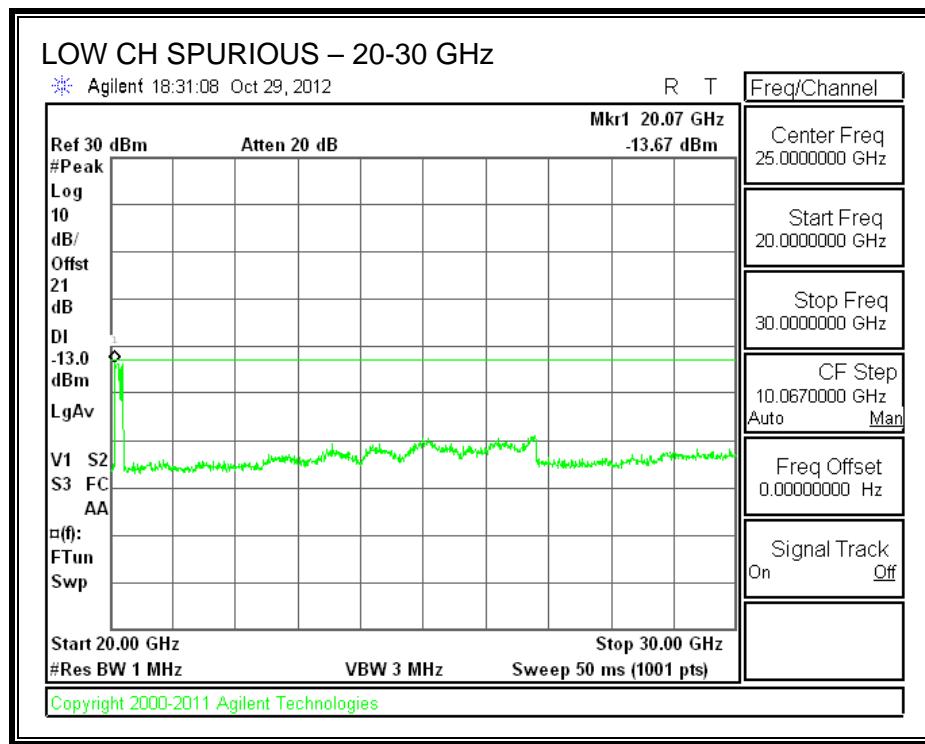
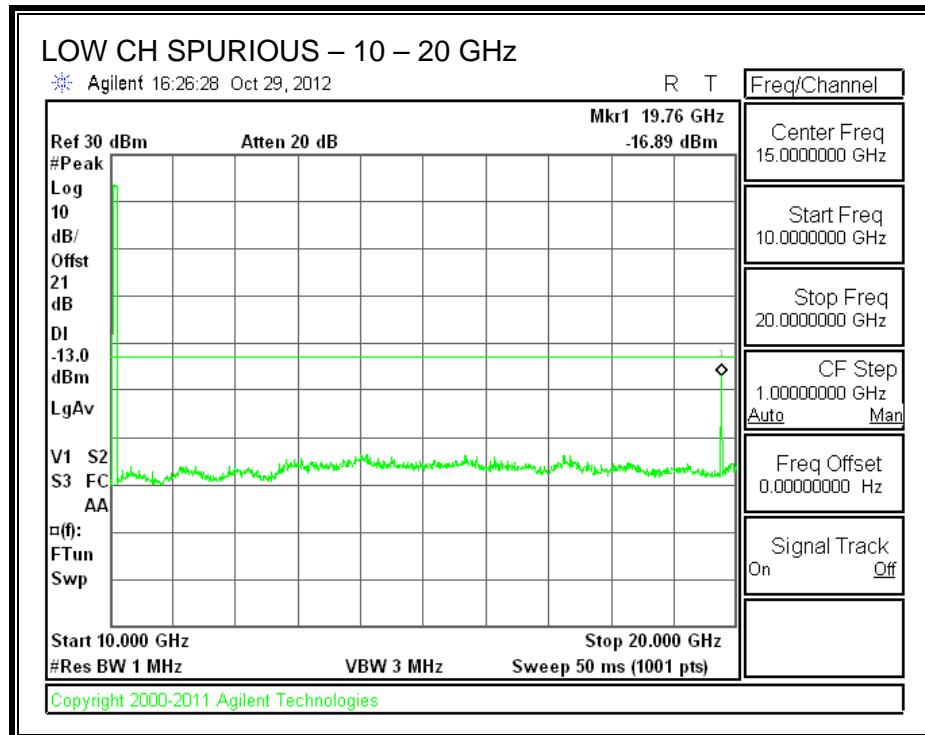
The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

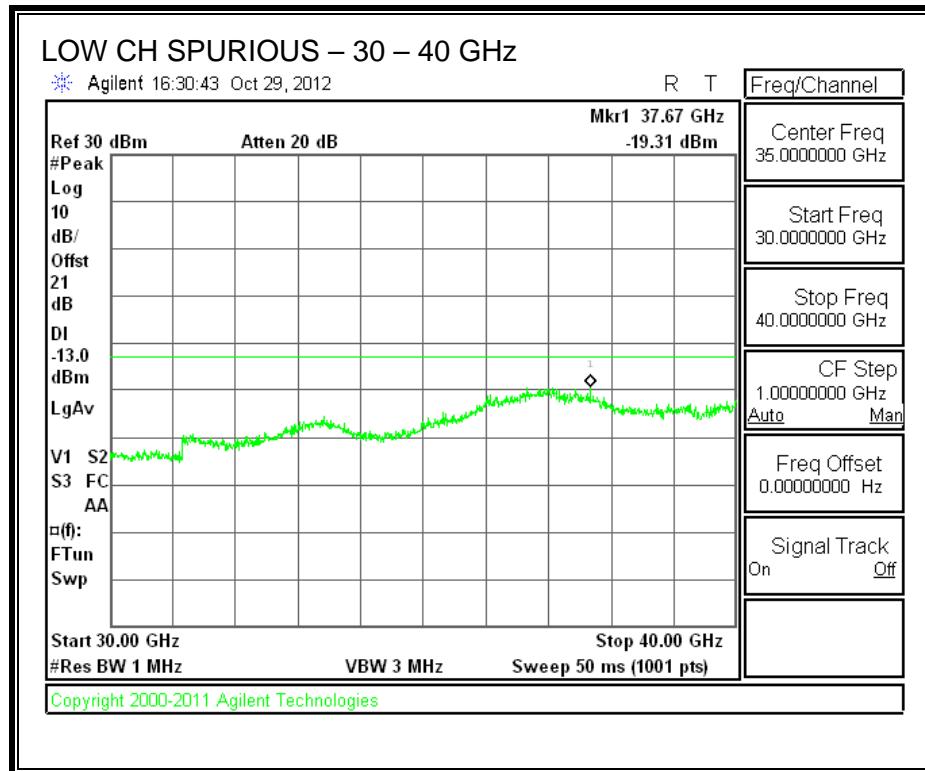
RESULT

SPURIOUS EMISSIONS, LOW CHANNEL

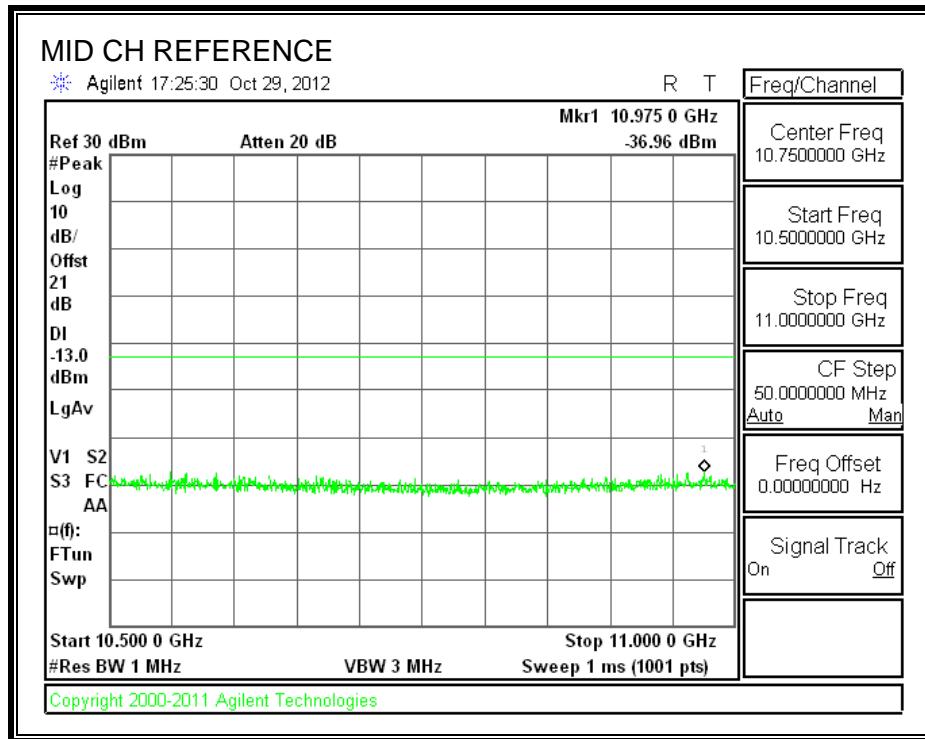


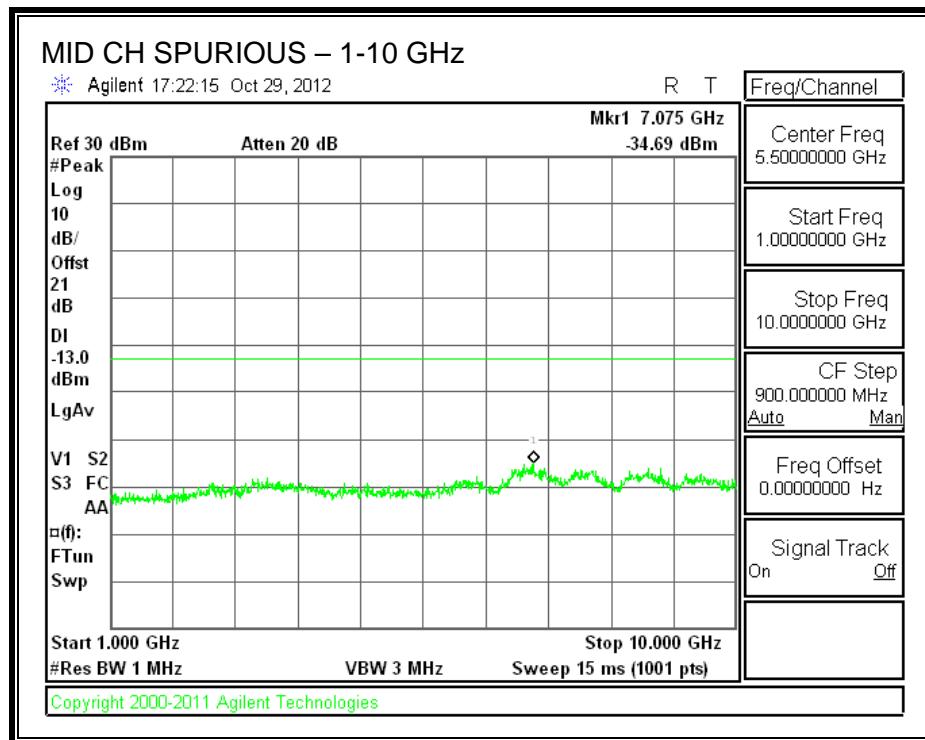
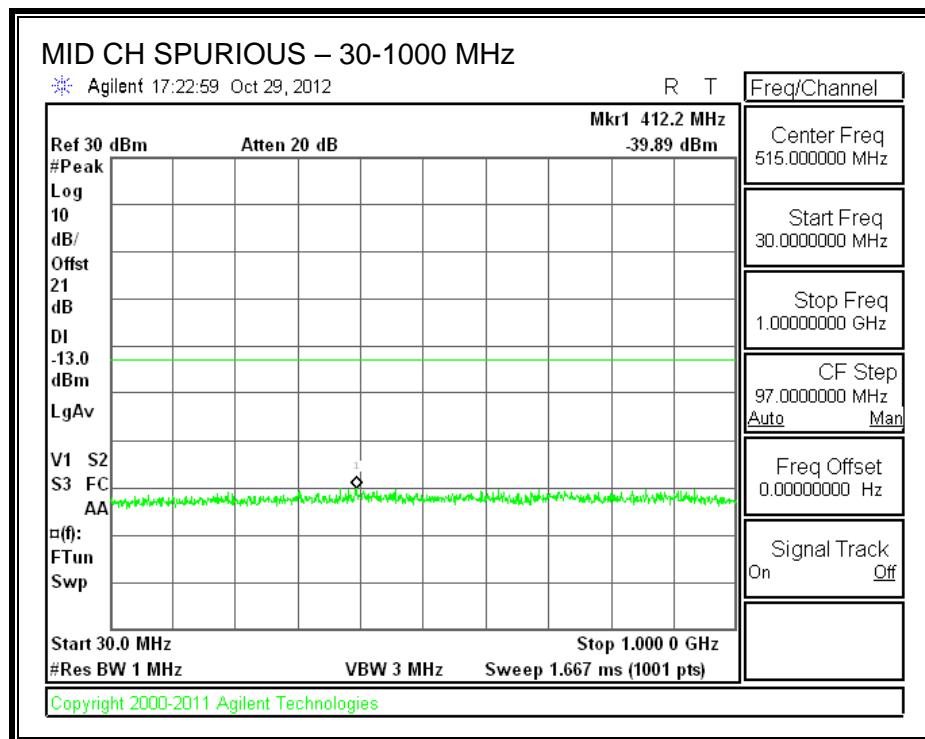


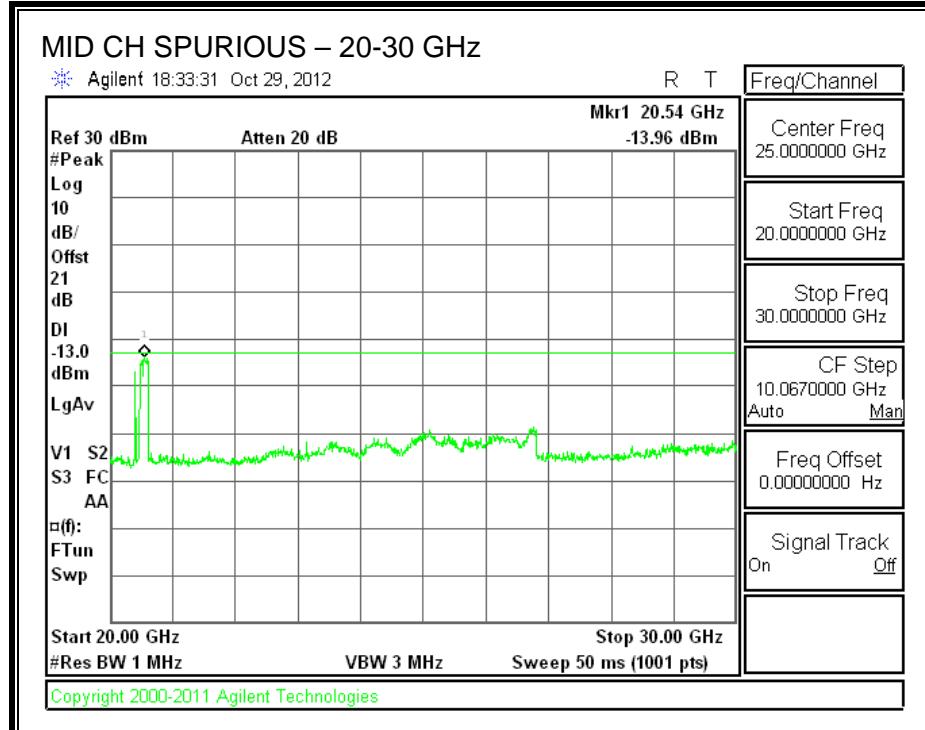
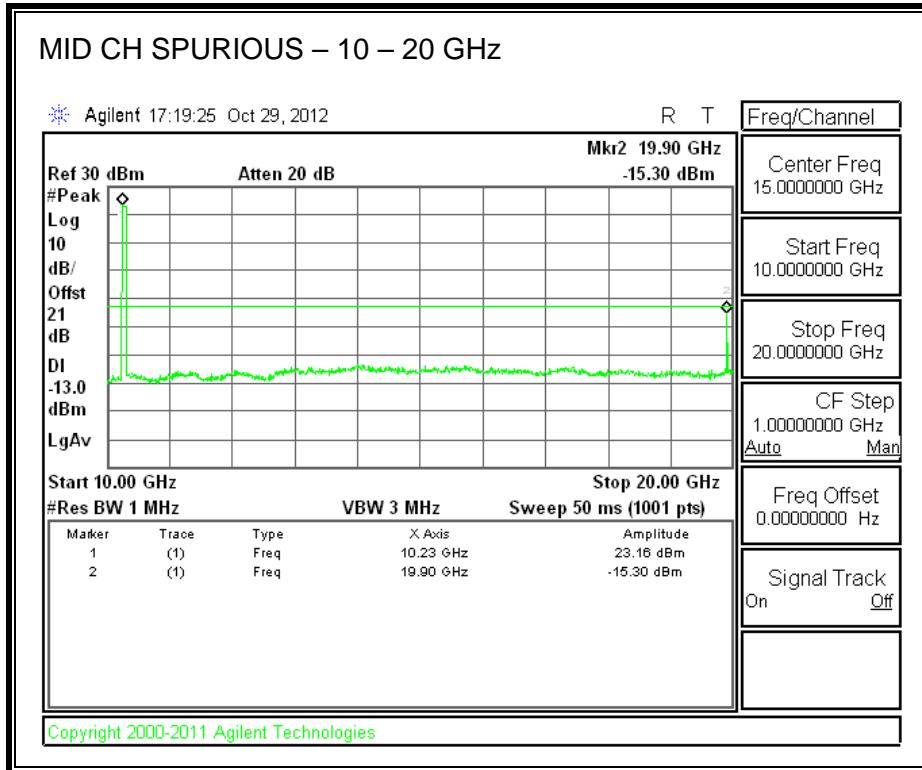


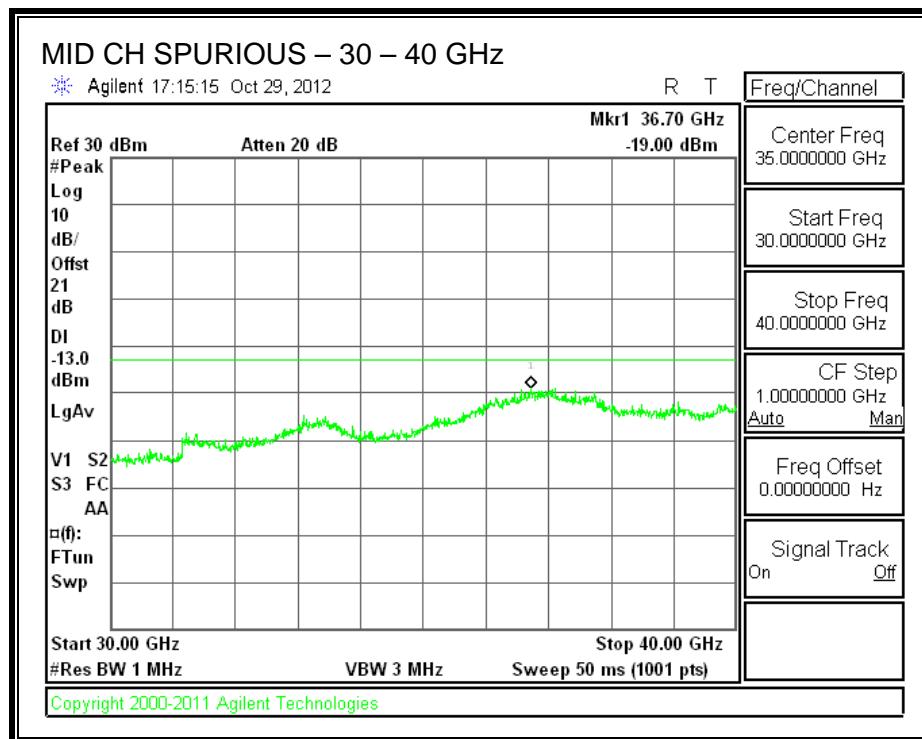


SPURIOUS EMISSIONS, MID CHANNEL

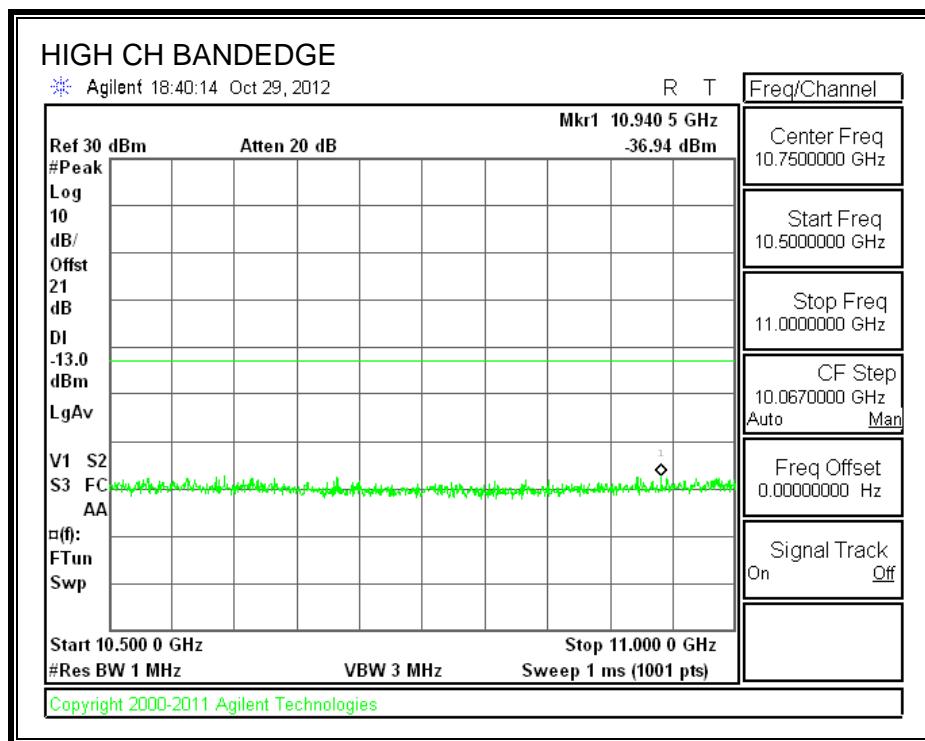


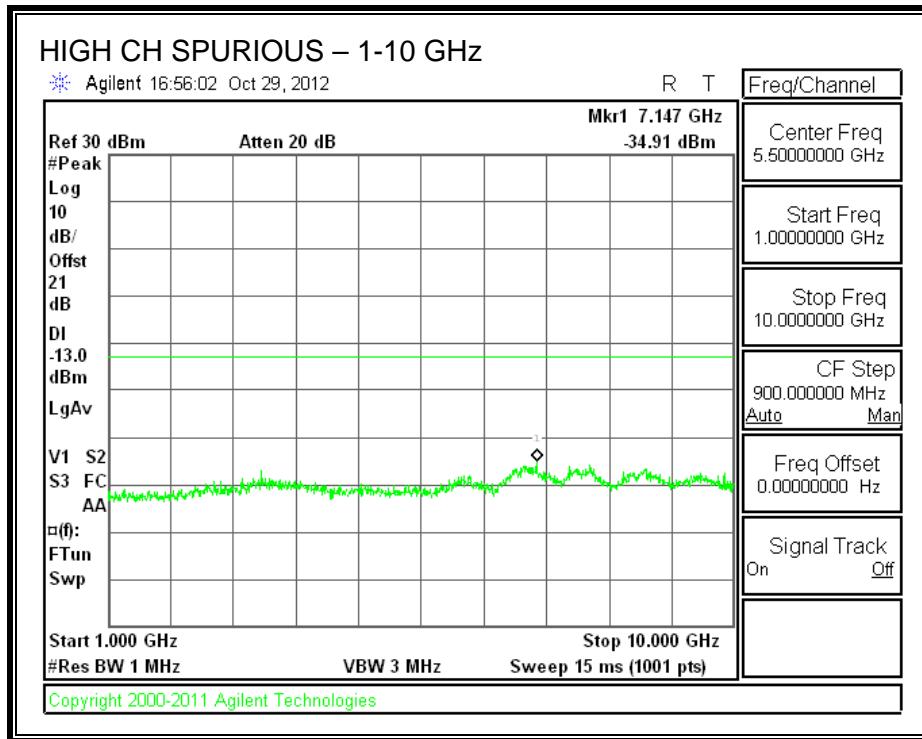
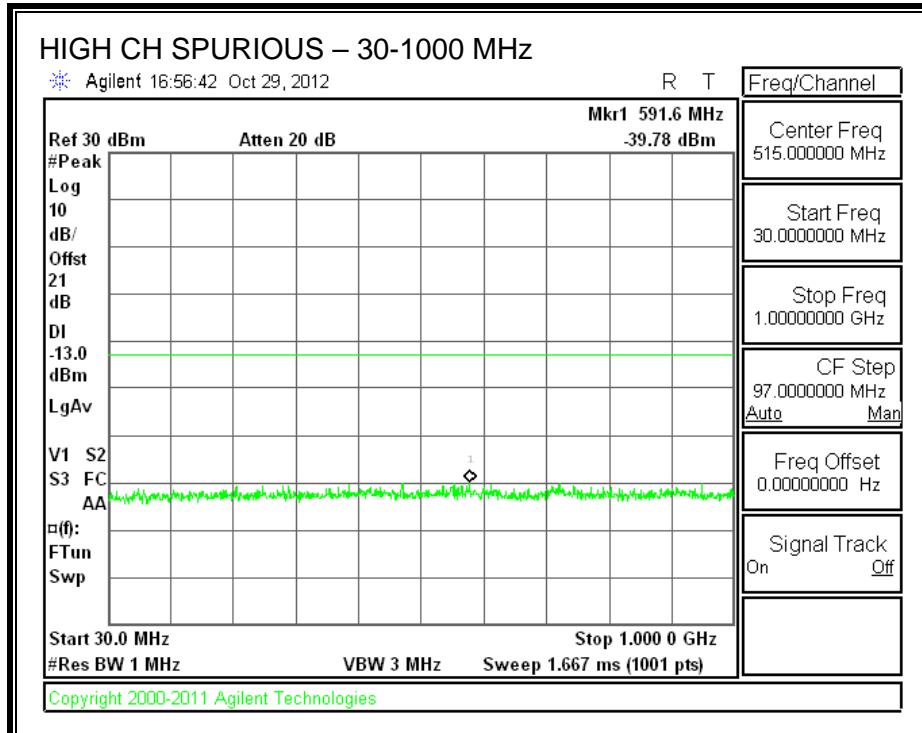


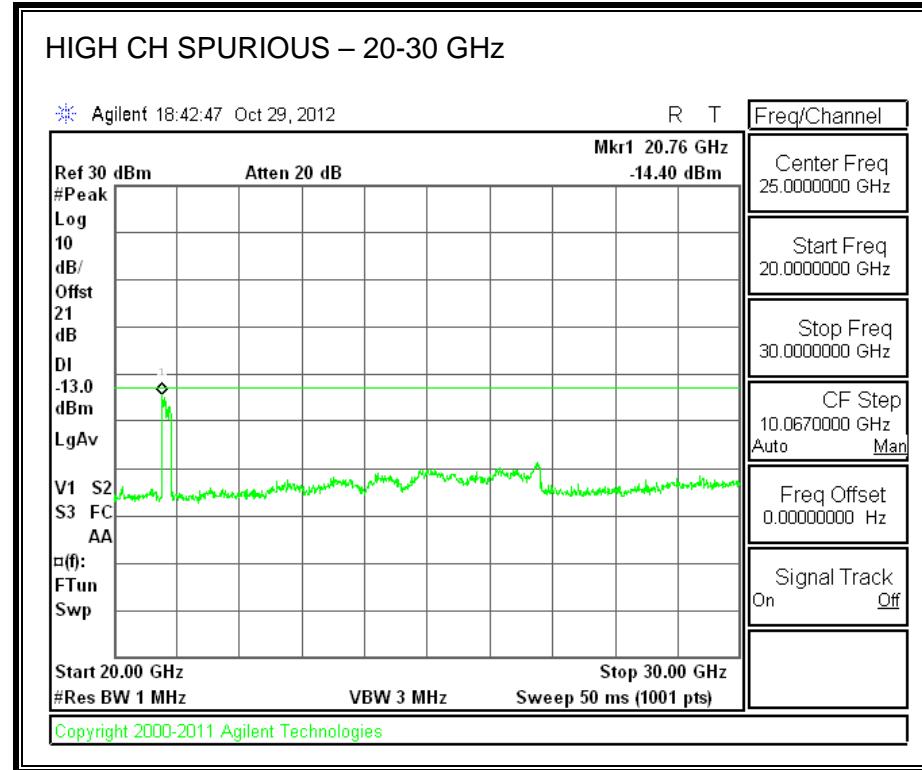
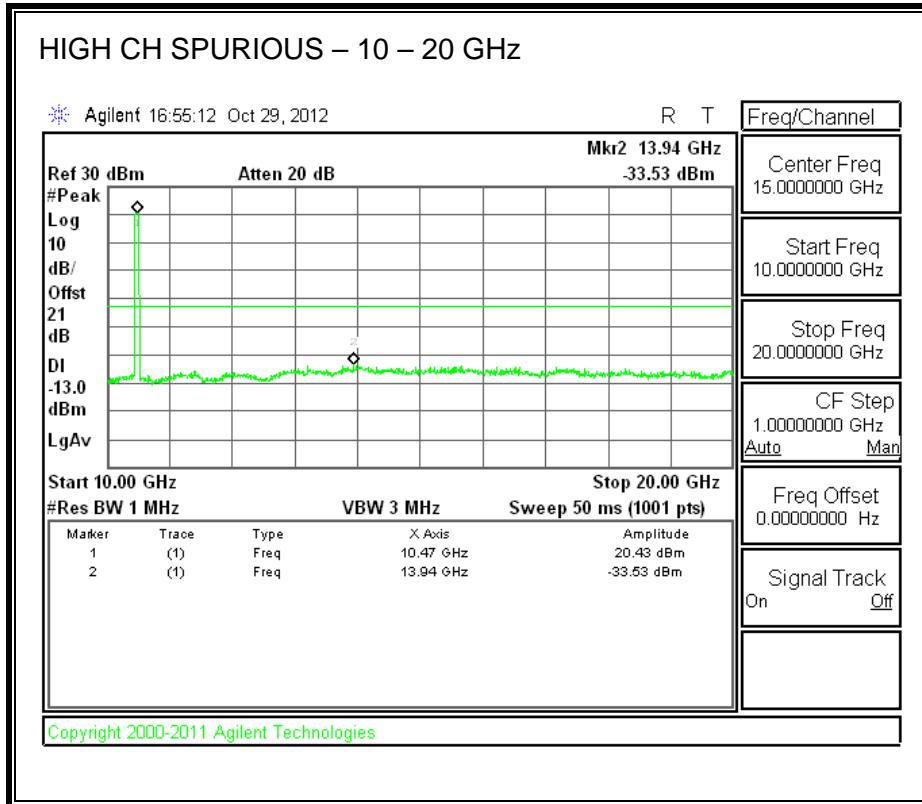


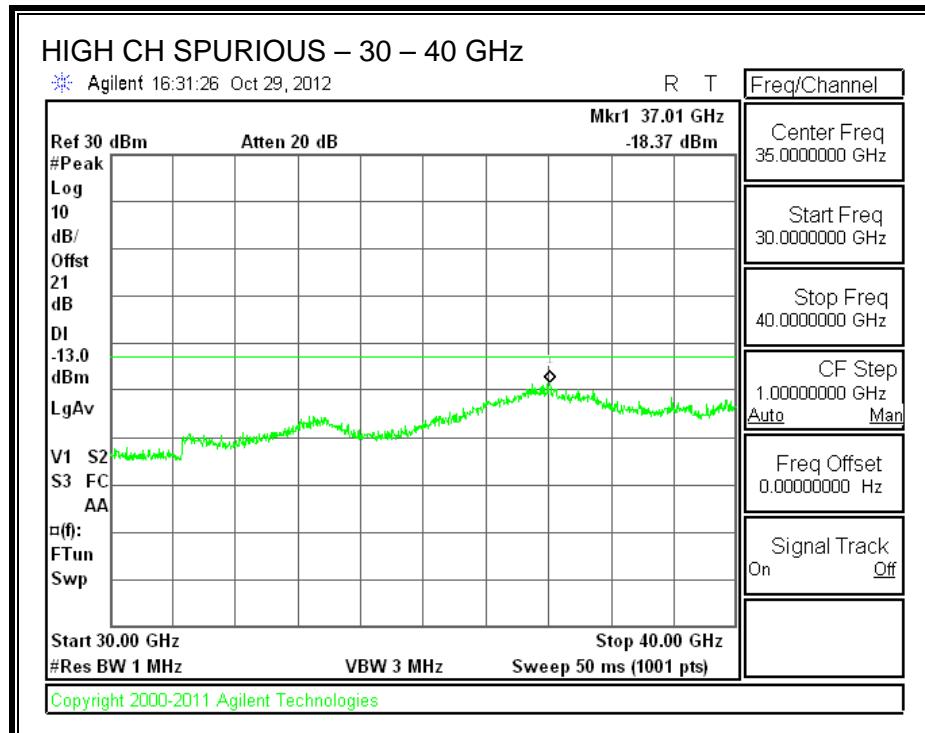


SPURIOUS EMISSIONS, HIGH CHANNEL









7.5. FREQUENCY STABILITY

LIMIT

§90.213 (a) The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency, over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

TEST PROCEDURE

ANSI / TIA / EIA 603 Clause 2.3.1 and 2.3.2

RESULTS

Reference Frequency: EUT Mid Channel @ 20°C Limit: ± 100 ppm = 102748.632 kHz				
Power Supply (Vac)	Environment Temperature (°C)	Frequency Deviation Measured with Time Elapse		
		(MHz)	Delta (ppm)	Limit (ppm)
115.00	60	10274.8802923	-0.017	± 100
115.00	50	10274.8627320	0.000	± 100
115.00	40	10274.8518686	0.011	± 100
115.00	30	10274.8375478	0.025	± 100
115.00	20	10274.8632139	0.000	± 100
115.00	10	10274.8828166	-0.019	± 100
115.00	0	10274.9168166	-0.052	± 100
115.00	-10	10274.9548166	-0.089	± 100
115.00	-20	10274.9929281	-0.126	± 100

8. RADIATED TEST RESULTS

8.1. LIMITS AND PROCEDURE

LIMITS

FCC §90.210

13dBm (~ 82dBuV/m)

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.4. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

The spectrum from 30 MHz to 55 GHz is investigated with the transmitter set at the worst case channel.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

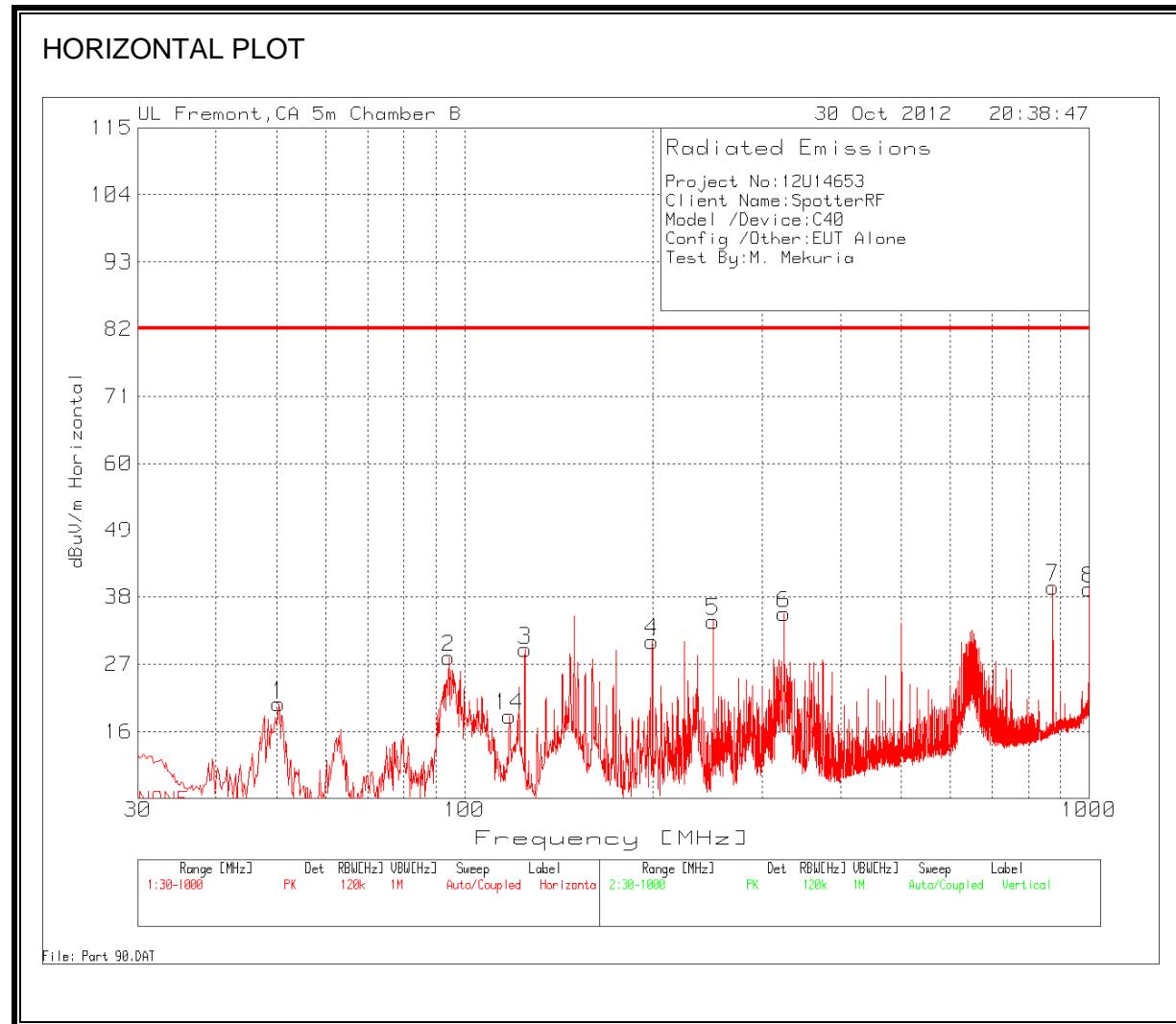
8.2. TRANSMITTER ABOVE 1 GHz

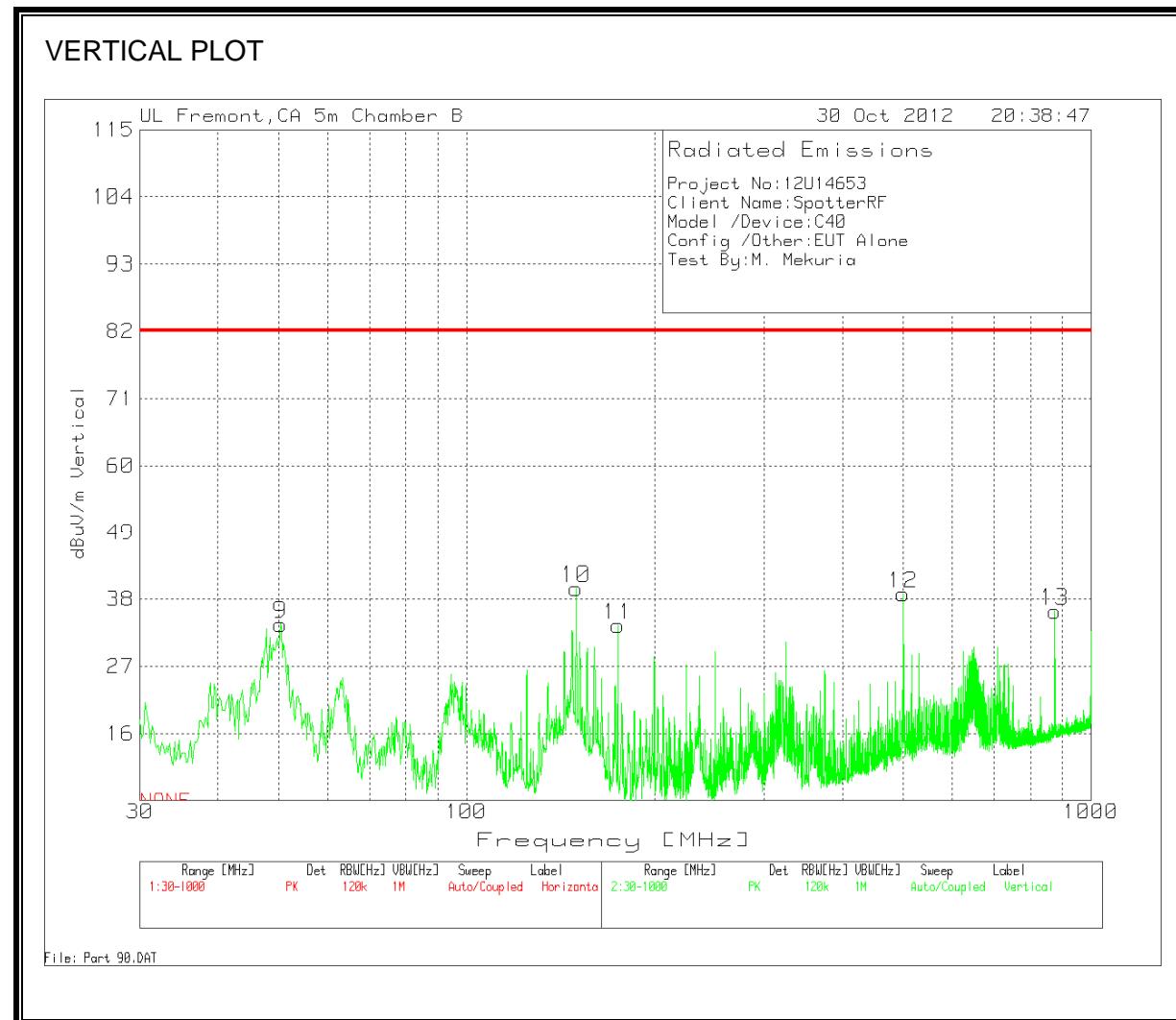
Compliance Certification Services Above 1GHz High Frequency Substitution Measurement									
Company:	SpotterRF								
Project #:	12U14653								
Date:	10/29/12								
Test Engineer:	MENGISTU MEKURIA								
Configuration:	EUT ALONE (ANTENNA PORT TERMINATED)								
Mode:	TX MODE								
Chamber		Pre-amplifier		Filter		Limit			
5m Chamber B		T145 8449B				Part 90			
f GHz	SG reading (dBm)	Ant. Pol. (H/V)	Distance (m)	Preamp (dB)	Filter (dB)	EIRP (dBm)	Limit (dBm)	Delta (dB)	Notes
Low Channel (Channel 2)									
1.128	-22.5	V	3.0	36.2		-58.6	-13.0	-45.6	
5.025	10.8	V	3.0	35.3		-24.5	-13.0	-11.5	
15.132	-5.1	V	3.0	33.5		-38.6	-13.0	-25.6	
20.146	-3.4	V	3.0	32.0		-35.5	-13.0	-22.5	
1.128	-23.4	H	3.0	36.2		-59.5	-13.0	-46.5	
5.025	9.1	H	3.0	35.3		-26.2	-13.0	-13.2	
15.132	-9.1	H	3.0	33.5		-42.6	-13.0	-29.6	
20.146	-1.9	H	3.0	32.0		-34.0	-13.0	-21.0	
Mid Channel (Channel 6)									
1.126	-23.9	V	3.0	36.2		-60.0	-13.0	-47.0	
5.113	9.4	V	3.0	35.3		-26.0	-13.0	-13.0	
15.380	0.6	V	3.0	33.4		-32.8	-13.0	-19.8	
20.500	-3.1	V	3.0	32.1		-35.2	-13.0	-22.2	
1.126	-24.0	H	3.0	36.2		-60.1	-13.0	-47.1	
5.113	8.5	H	3.0	35.3		-26.8	-13.0	-13.8	
15.428	-10.1	H	3.0	33.3		-43.5	-13.0	-30.5	
20.050	-2.6	H	3.0	32.0		-34.6	-13.0	-21.6	
High Channel (Channel 9)									
1.126	-22.7	V	3.0	36.2		-58.8	-13.0	-45.8	
5.212	7.7	V	3.0	35.3		-27.7	-13.0	-14.7	
15.585	-1.4	V	3.0	33.3		-34.7	-13.0	-21.7	
20.800	-1.6	V	3.0	32.1		-33.7	-13.0	-20.7	
1.126	-24.0	H	3.0	36.2		-60.2	-13.0	-47.2	
5.041	-3.2	H	3.0	35.3		-38.5	-13.0	-25.5	
5.221	9.4	H	3.0	35.3		-26.0	-13.0	-13.0	
15.585	-8.0	H	3.0	33.3		-41.2	-13.0	-28.2	
20.800	-3.1	H	3.0	32.1		-35.2	-13.0	-22.2	

Rev. 03.03.09
 Note: No other emissions were detected above the system noise floor.

8.3. WORST-CASE BELOW 1 GHz

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION,)





HORIZONTAL AND VERTICAL DATA

Project No:12U14653											
Client Name:SpotterRF											
Model /Device:C40											
Config /Other:EUT Alone											
Test By:M. Mekuria											
Horizontal 30 - 1000MHz											
Test Frequency	Meter Reading	Detector	T122 Sunol Bilog.TXT (dB)	5mB Amp Path 30-1000MHz (dB)	to 3m Conversion (dB)	dBuV/m	NONE	Margin	Height [cm]	Polarity	
50.3537	51.98	PK	8	-29	-10.5	20.48	82	-61.52	300	Horz	
94.3565	58.48	PK	8.7	-28.6	-10.5	28.08	82	-53.92	300	Horz	
124.984	53.96	PK	14.2	-28.3	-10.5	29.36	82	-52.64	200	Horz	
199.8082	56.03	PK	12.8	-27.6	-10.5	30.73	82	-51.27	100	Horz	
250.014	60.27	PK	11.5	-27.2	-10.5	34.07	82	-47.93	100	Horz	
325.032	58.65	PK	13.9	-26.8	-10.5	35.25	82	-46.75	100	Horz	
875.1639	52.96	PK	22.1	-25	-10.5	39.56	82	-42.44	100	Horz	
1000	50.77	PK	23.2	-24.2	-10.5	39.27	82	-42.73	100	Horz	
118.1994	43.45	PK	13.9	-28.3	-10.5	18.55	82	-63.45	300	Horz	
Vertical 30 - 1000MHz											
Test Frequency	Meter Reading	Detector	T122 Sunol Bilog.TXT (dB)	5mB Amp Path 30-1000MHz (dB)	10m to 3m Conversion (dB)	dBuV/m	NONE	Margin	Height [cm]	Polarity	
50.3537	65.42	PK	8	-29	-10.5	33.92	82	-48.08	100	Vert	
149.99	65.61	PK	12.6	-28	-10.5	39.71	82	-42.29	100	Vert	
174.8022	60.58	PK	11.4	-27.8	-10.5	33.68	82	-48.32	100	Vert	
500.0739	58.63	PK	17.7	-27	-10.5	38.83	82	-43.17	100	Vert	
875.1639	49.4	PK	22.1	-25	-10.5	36	82	-46	100	Vert	

9. MAXIMUM PERMISSIBLE RF EXPOSURE

9.1. FCC RULES

§1.1310 The criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f ²)	6
30–300	61.4	0.163	1.0	6
300–1500	.....	.....	f/300	6
1500–100,000	.....	.....	5	6
(B) 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

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)—Continued

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
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

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

9.2. IC RULES

IC Safety Code 6, Section 2.2.1 (a) A person other than an RF and microwave exposed worker shall not be exposed to electromagnetic radiation in a frequency band listed in Column 1 of Table 5, if the field strength exceeds the value given in Column 2 or 3 of Table 5, when averaged spatially and over time, or if the power density exceeds the value given in Column 4 of Table 5, when averaged spatially and over time.

Table 5
Exposure Limits for Persons Not Classed As RF and Microwave Exposed Workers (Including the General Public)

1 Frequency (MHz)	2 Electric Field Strength; rms (V/m)	3 Magnetic Field Strength; rms (A/m)	4 Power Density (W/m ²)	5 Averaging Time (min)
0.003–1	280	2.19		6
1–10	$280/f$	$2.19/f$		6
10–30	28	$2.19/f$		6
30–300	28	0.073	2*	6
300–1 500	$1.585f^{0.5}$	$0.0042f^{0.5}$	$f/150$	6
1 500–15 000	61.4	0.163	10	6
15 000–150 000	61.4	0.163	10	$616\ 000/f^{1.2}$
150 000–300 000	$0.158f^{0.5}$	$4.21 \times 10^{-4}f^{0.5}$	$6.67 \times 10^{-5}f$	$616\ 000/f^{1.2}$

* Power density limit is applicable at frequencies greater than 100 MHz.

Notes:

1. Frequency, f , is in MHz.
2. A power density of 10 W/m² is equivalent to 1 mW/cm².
3. A magnetic field strength of 1 A/m corresponds to 1.257 microtesla (μ T) or 12.57 milligauss (mG).

9.3. EQUATIONS

POWER DENSITY

Power density is given by:

$$S = \text{EIRP} / (4 * \pi * D^2)$$

Where

S = Power density in mW/cm²

EIRP = Equivalent Isotropic Radiated Power in mW

D = Separation distance in cm

Power density in units of mW/cm² is converted to units of W/m² by multiplying by 10.

DISTANCE

Distance is given by:

$$D = \sqrt{(\text{EIRP} / (4 * \pi * S))}$$

Where

D = Separation distance in cm

EIRP = Equivalent Isotropic Radiated Power in mW

S = Power density in mW/cm²

SOURCE-BASED DUTY CYCLE

Where applicable (for example, multi-slot cell phone applications) a duty cycle factor may be applied.

$$\text{Source-based time-averaged EIRP} = (\text{DC} / 100) * \text{EIRP}$$

Where

DC = Duty Cycle in %, as applicable

EIRP = Equivalent Isotropic Radiated Power in W

10. RF EXPOSURE RESULTS

In the table(s) below, Power and Gain are entered in units of dBm and dBi respectively and conversions to linear forms are used for the calculations.

Band	Mode	Separation Distance (cm)	Output Power (dBm)	Antenna Gain (dBi)	Duty Cycle (%)	EIRP (mW)	FCC Power Density (mW/cm^2)	IC Power Density (W/m^2)
10 GHz	Transmit	20	20.96	14.00	100.0	3133.3	0.624	6.24

FCC Limit = 1 mW/cm²
IC Limit = 10 W/m²