Appendix D. Test Report of Rule 2.1046 – 2.1055

D.1 EUT Overview

Job Number:	06014
Doc Path:	V:\EMC Result.Data\2006\ 06014
Project Title:	QC SDM FCC Pre-Cert
Completion date:	March 1, 2006
EUT:	SDM stand alone with J8700 board
P/N:	10-J8728-1 on J8700-1 Rev A
S/N:	Unit: 100000546S
Temperature:	24 ^{o}C
Relative Humidity:	57%
Barometric Pressure:	754mm
Tested by	Suzy Galati, Fang Han

D.2 List of Test Equipment

Table D–1. Test equipment for radiated emission

No.	Manufacturer/ Type No.	Part/Model No.	Serial No.	Cal Date & Cal Due Date
1	R&S EMI Test Receiver 9 kHz to 2.5 GHz	ESPC	DE14759/845296/020	18 Oct 05 18 Oct 06
2	HP Pre Amp.	8447D OPT 010	2944A09692	28 Oct 05 28 Oct 06
4	Chase X-Wing Antenna 20 to 2000 MHz	CBL6140A	1151	21 Apr 05 21 Apr 06
7	Gore Coax Cables	N-type	#10, 12,14	30 June 05 30 June 06
8	Agilent Spectrum Analyzer 3Hz to 25 GHz	E4440A	MY44022417	2 Aug 05 2 Aug 06
9	CSZ Dimension Temperature Chamber	ZP-8	R-404A	20 July 05 20 July 06

D.3 Rule 2.1051/25.204 – Conducted RF Power Output

D.3.1 Test procedure

Definition - The output power rating of the transmitter is the power available at the output terminal of the transmitter when the terminal is connected to the normal load.

Minimum Standard - The nominated transmitter output power is 30 dBm and shall be maintained within range of 28.5 dBm to 32.5 dBm at extreme temperature.

Method of Measurement - The conducted RF power output is measured per Part 2.1046(a). The transmitter output carrier power with MSK modulation mode or CW mode can measured using a spectrum analyzer. The measurement setup diagram is shown in Figure D-1.

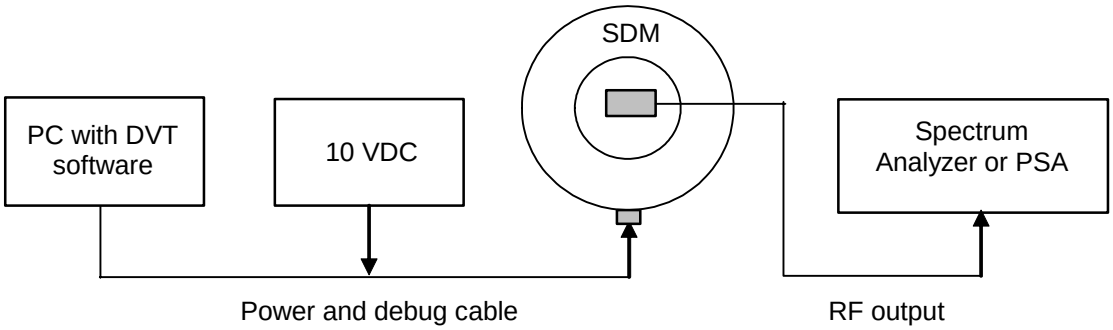


Figure D–1. Measurement setup for conducted RF power

Using the above setup, the conducted RF power output, emission mask and spurious emission can be measured simultaneously by the following steps:

1. Conducted Tx RF power output and emission mask

a) Connect the waveguide to SDM antenna port and then connect the waveguide to PSA via a low loss co-ax cable.

b) At initial Tx mode setup, select the CW mode and low channel selection. Note: once the MSK is enabled, it cannot be turned back to CW by the DVT software unless the EUT is rebooted.

c) At V-pol, Set CENTER FREQUENCY of PSA to the current Tx frequency (at low, mid or high channel). Set the frequency span to 5 MHz and RBW to 4 kHz.

d) Under trace 1, set necessary attenuation and reference level to avoid overloading. Then, align the beam, maximize the carrier emission and mark

the peak with marker 1. Then PEAK HOLD for seconds and turn to VIEW to stabilize trace 1 as V-pol CW emission.

e) While keep Trace 1 on, activate trace 2. Then enable MSK at the DVT setup.

f) PEAK HOLD trace 2 for seconds and turn it to VIEW to stabilize trace 2. Mark the peak of the first side lobe with Marker 2.

g) Turn full display and take a plot (Power and emission mask plot).

h) Enable the MARKER TABLE and take a full plot again. (Power and emission mask plot with marker data).

2. Spurious emission

a) Blank trace 2 above and clear trace 1.

b) Change the RBW to 100 kHz, and take full plot of emission profile for 1-10 GHz, 10-14 GHz, 14-14.5 GHz, and 14.5 to 18 GHz. Always put the marker on the peak of the emission profiles.

c) Repeat step 1b) through 1h) above for mid channel.

d) Repeat step 1b) through 2c) above for high channel.

D.3.2 Measurement result

The antenna port of the equipment is terminated to a 50 ohms resistive load of the PSA. The nominal power from the antenna port is 1 W (30 dBm). The carrier power was measured at CW state. The PAS setup is shown in Table D–2.

Table D–2. Spectrum setup for conducted emission

Frequency (GHz)	Internal att (dB)	Ref level (dB)	Level Offset (dB)	RBW (kHz)	Carrier type	External att (dB)
1-10	10	10	10	100	MSK	10
10-14	26	26	10	100	MSK	10
14-14.5	30	30	10	100	MSK	10
14.5-18	26	26	10	100	MSK	10

Table D–3. Conducted RF power output (W)

Channel in Ku-band	Carrier frequency (MHz)	Specs (dBm)	Max level (dBm)	PWR density (dBm/4kH)	FCC limit (dBm/4kH)
Low	14005 (LO/IF=12920/1085)	30±2	29.73	4.13	70
Mid	14250 (LO/IF=13160/1095)	30±2	30.02	4.43	70
High	14495 (LO/IF=13400/1095)	30±2	28.55	2.96	70

Table D-3 and Figure D-2 to Figure D-4 shows the measured data and waveform.

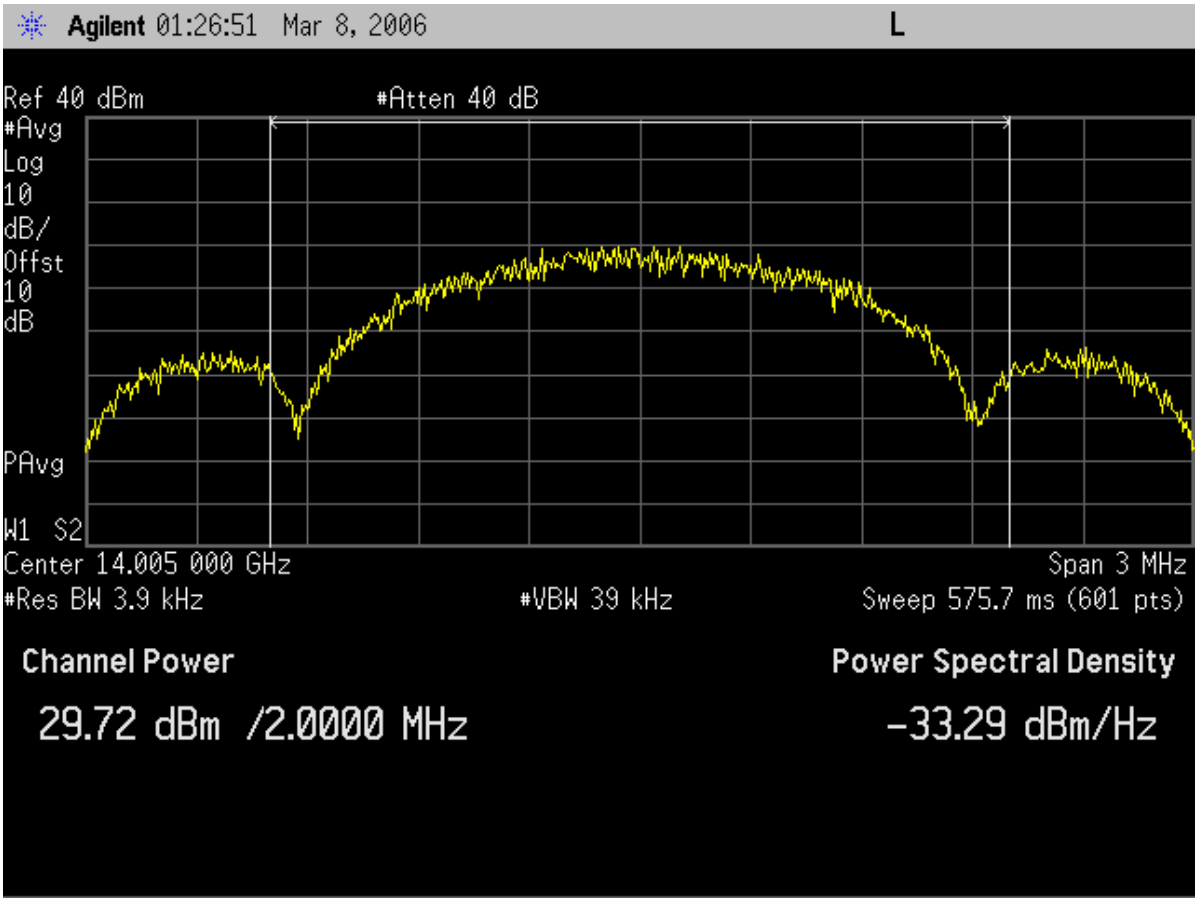


Figure D–2. Conducted RF power at antenna flange, low band

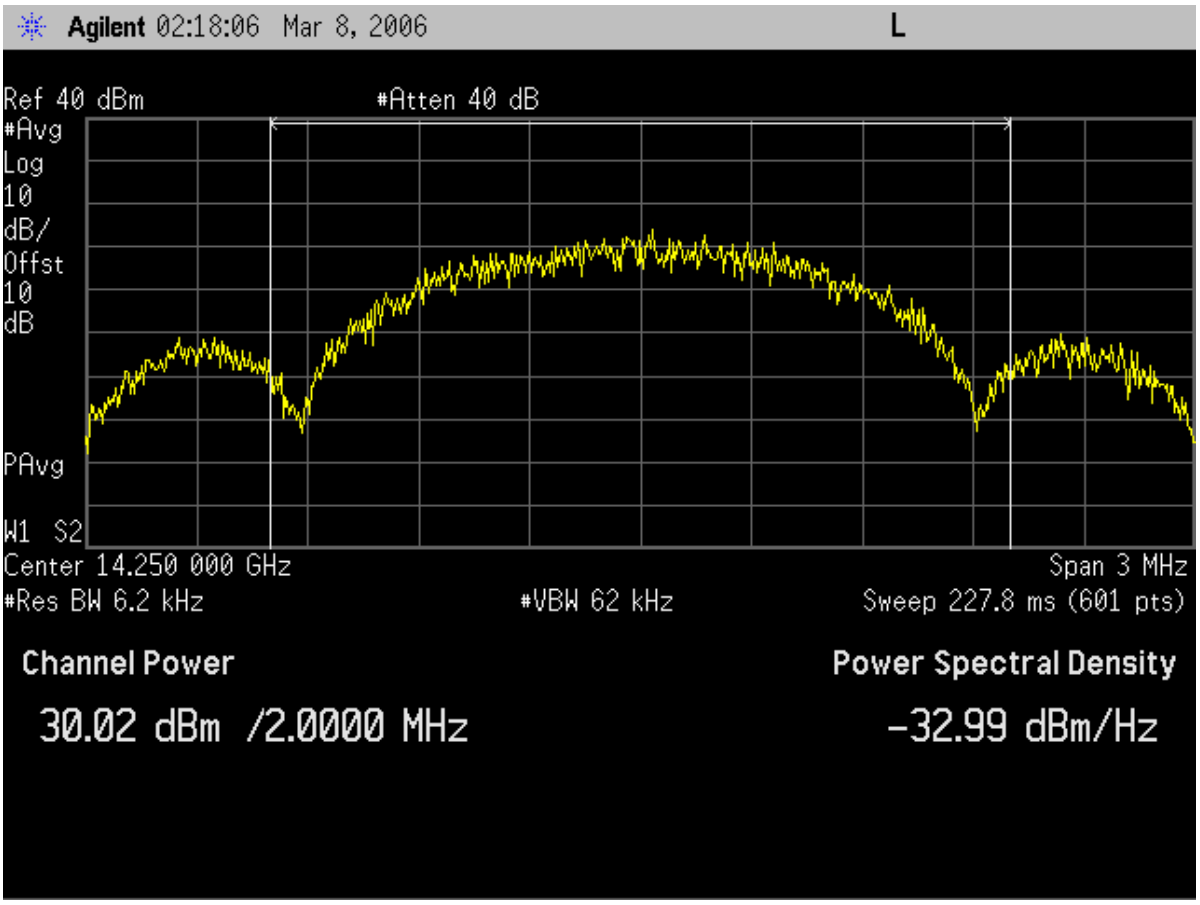


Figure D–3. Conducted RF power from antenna flange, mid band

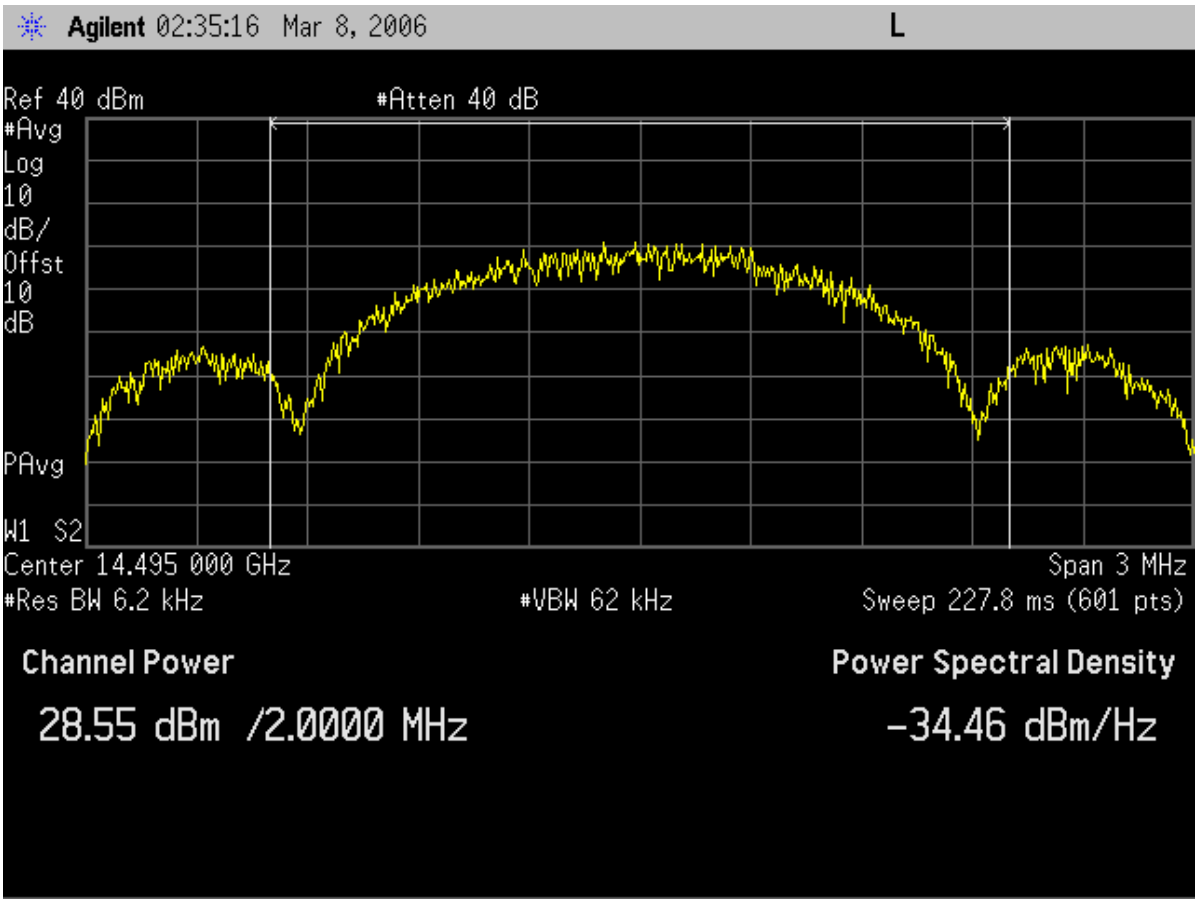


Figure D–4. Conducted RF power from antenna flange, high band

D.4 Rule 2.1046/25.204 – Radiated RF Power Output

D.4.1 Test procedure

Definition - The radiated power is the EIRP from the transmitter antenna.

Minimum Standard - The transmitter output power shall be maintained within 50 dBm which is below the power limit of 40 dBW by FCC rule 25.204.

Method of Measurement - The EIRP with CW and MSK modulation can be measured in an anechoic chamber. The measurement setup diagram is shown in Figure D-5.

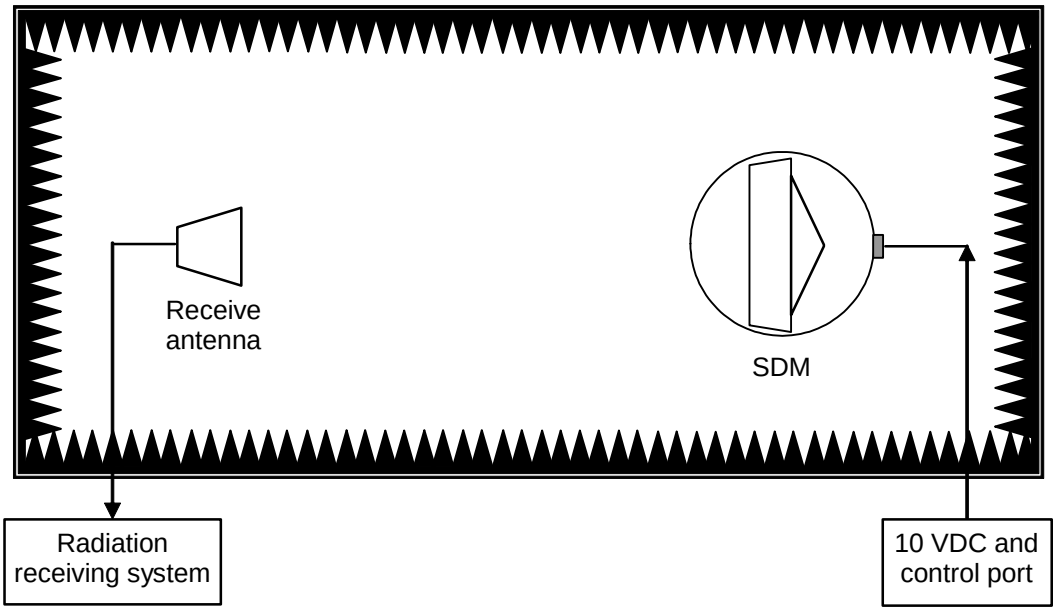


Figure D–5. Measurement setup for radiated emission and EIRP

The radiated RF power output, emission mask and spurious emission can be measured simultaneously by the following steps:

1. Radiated Tx RF power output and emission mask

a) At initial Tx mode setup, select the CW mode and low channel selection. Note: once the MSK is enabled, it cannot be turned back to CW by the DVT software unless the EUT is rebooted.

b) At V-pol, Set CENTER FREQUENCY of PSA to the current Tx frequency (at low, mid or high channel). Set the frequency span to 5 MHz and RBW to 4 kHz.

c) Under trace-1, set necessary attenuation and reference level to avoid overloading. Then, align the beam, maximize the carrier emission and mark the peak with marker 1. Then PEAK HOLD for seconds and turn to VIEW to stabilize trace 1 as V-pol CW emission.

d) While keep Trace-1 on, activate trace-2. Then enable MSK at the DVT setup.

e) PEAK HOLD trace-2 for seconds and turn it to VIEW to stabilize trace-2. Mark the peak of the first side lobe with Marker 2.

f) Turn full display and take a plot (Power and emission mask plot).

g) Enable the MARKER TABLE and take a full plot again. (Power and emission mask plot with marker data).

2. Radiated spurious emission

a) Clear trace-2 above.

b) Change the RBW to 1 MHz, and take full plot of emission profile for 1-14 GHz, 14-14.5 GHz, and 18 GHz. Always put the marker on the peak of the emission profiles.

c) Clear Trace-2 and maximize emission for H-pol

d) Repeat step 1e) through 2b).

e) Repeat step 1a) through 1g) for mid channel.

f) Repeat step 1a) through 2c) above for high channels.

D.4.2 Measurement result

The radiated RF power output can be converted by electric field by using the following (EIRP) equations

$$P = \frac{d^2}{30}\left(E_\theta^2 + E_\varphi^2\right) \qquad \text{(D-1)}$$

where P represents the EIRP power output. E_θ and E_φ are measured vertical electric field strength and horizontal electric field strength, respectively. d is the distance of 3 meters between the EUT source and measurement point.

Table D-4 shows the EIRP power level obtained by equation (D-1). Emission profiles are shown in Figure D–6 through Figure D–11.

Table D–4. Measured EIRP output SDM

Ku-band Channel	Carrier frequency (MHz)	Meas. E-field (dBuV/m)	SA factor (dB)	Max EIRP (dBm)	Limit@25.204(a) (dBm/4kHz)
Low	14005 (LO/IF=12920/1085)	131.26	14.13	50.16	70
Mid	14255 (LO/IF=13160/1095)	138.17	6.14	49.09	70
High	14495 (LO/IF=13400/1095)	136.05	5.75	46.57	70
Note: SA factor is obtained by substitute antenna					

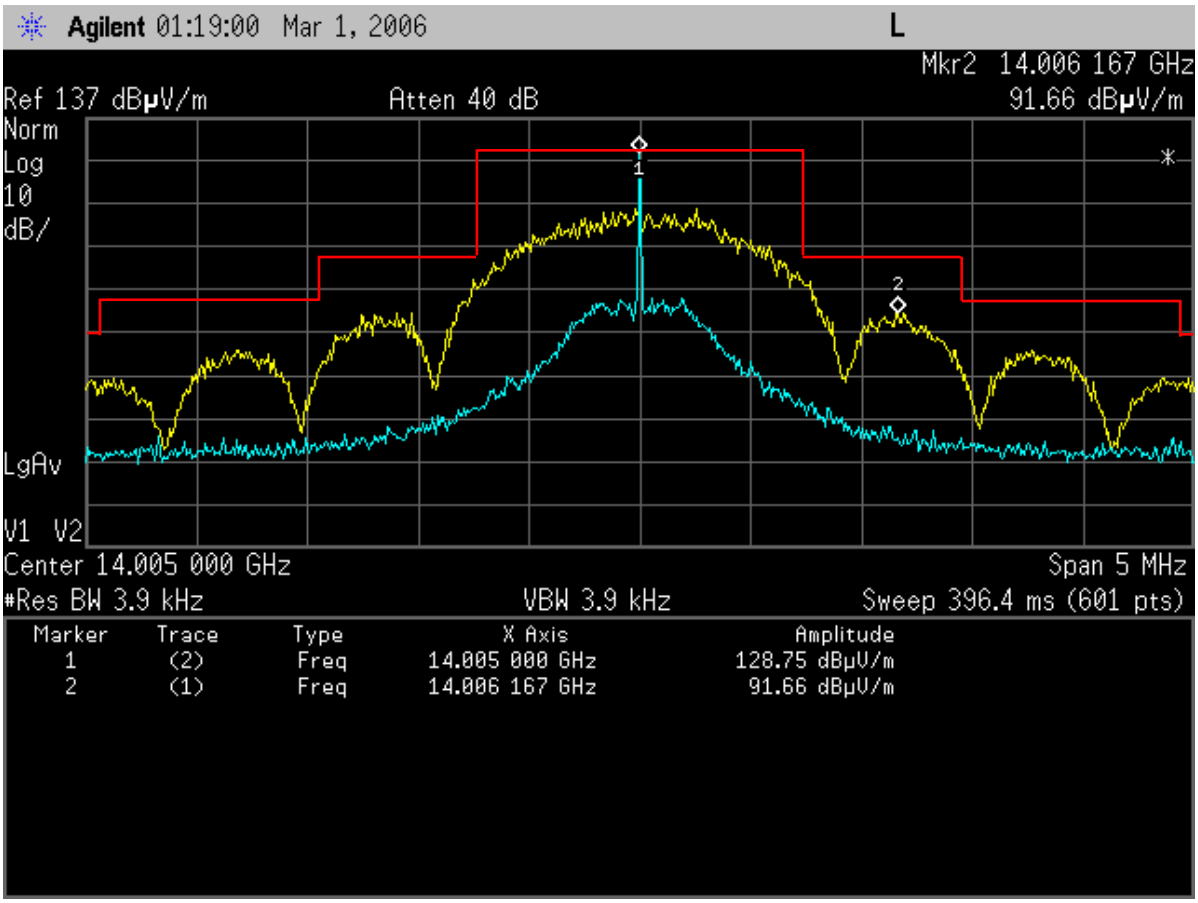


Figure D–6. 3-meter E-field of RF power in V-pol at low band

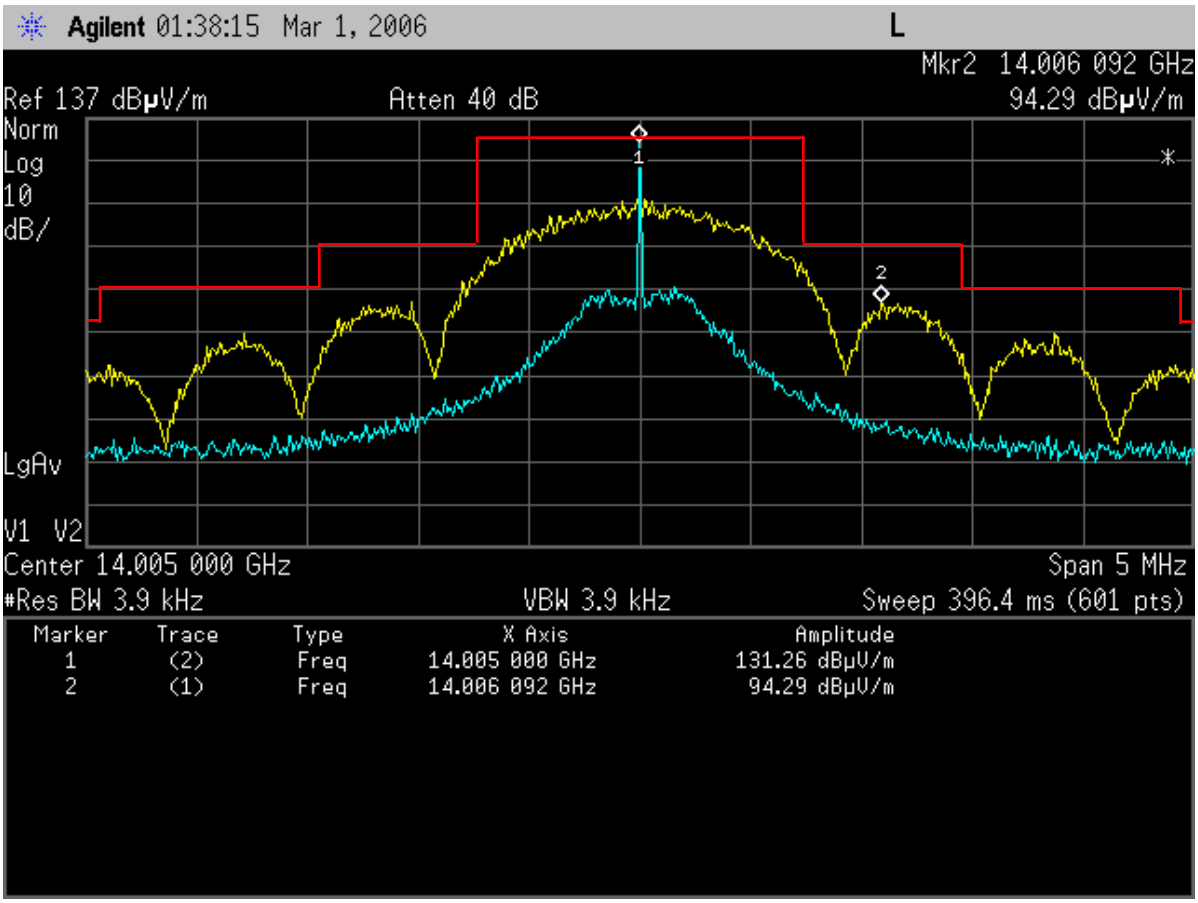


Figure D–7. 3-meter E-field of RF power in H-pol at low band

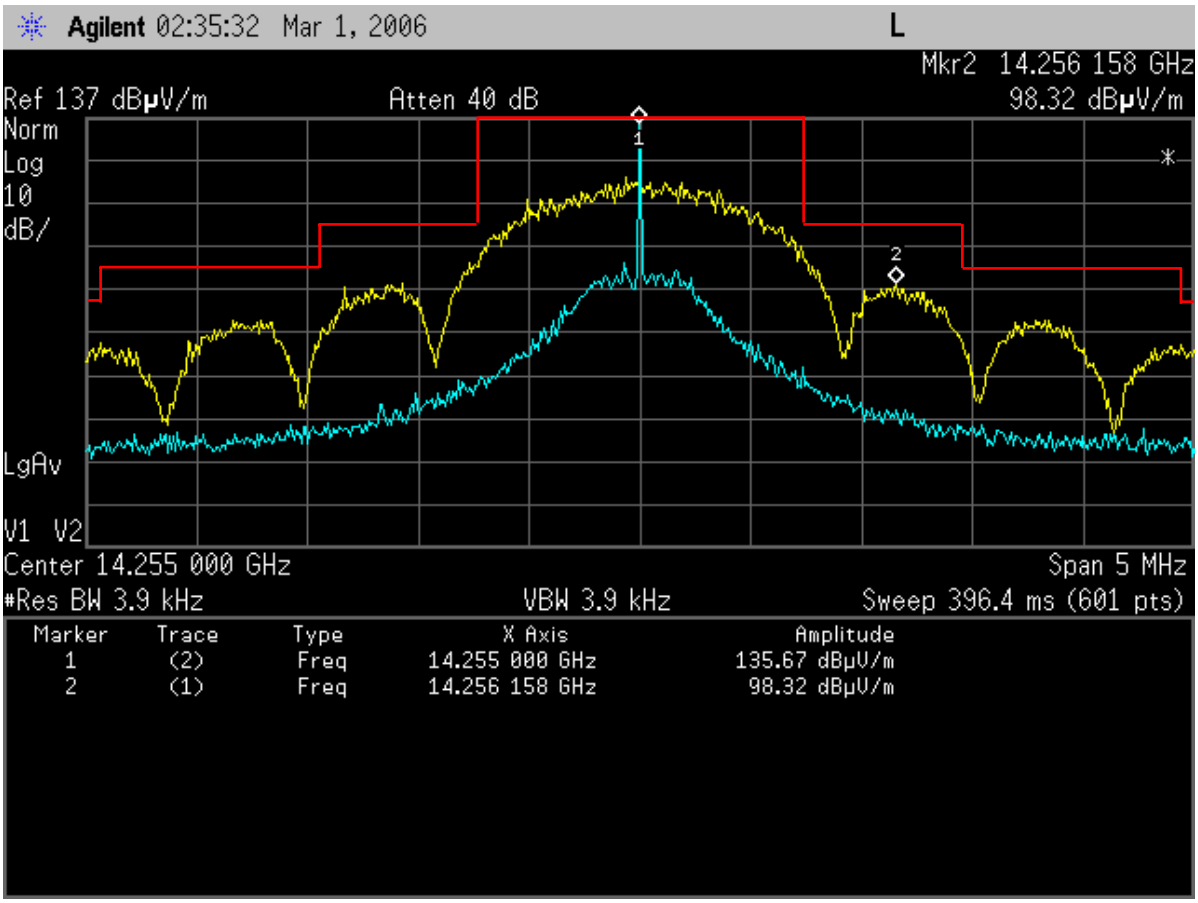


Figure D–8. 3-meter E-field of RF power in V-pol at mid band

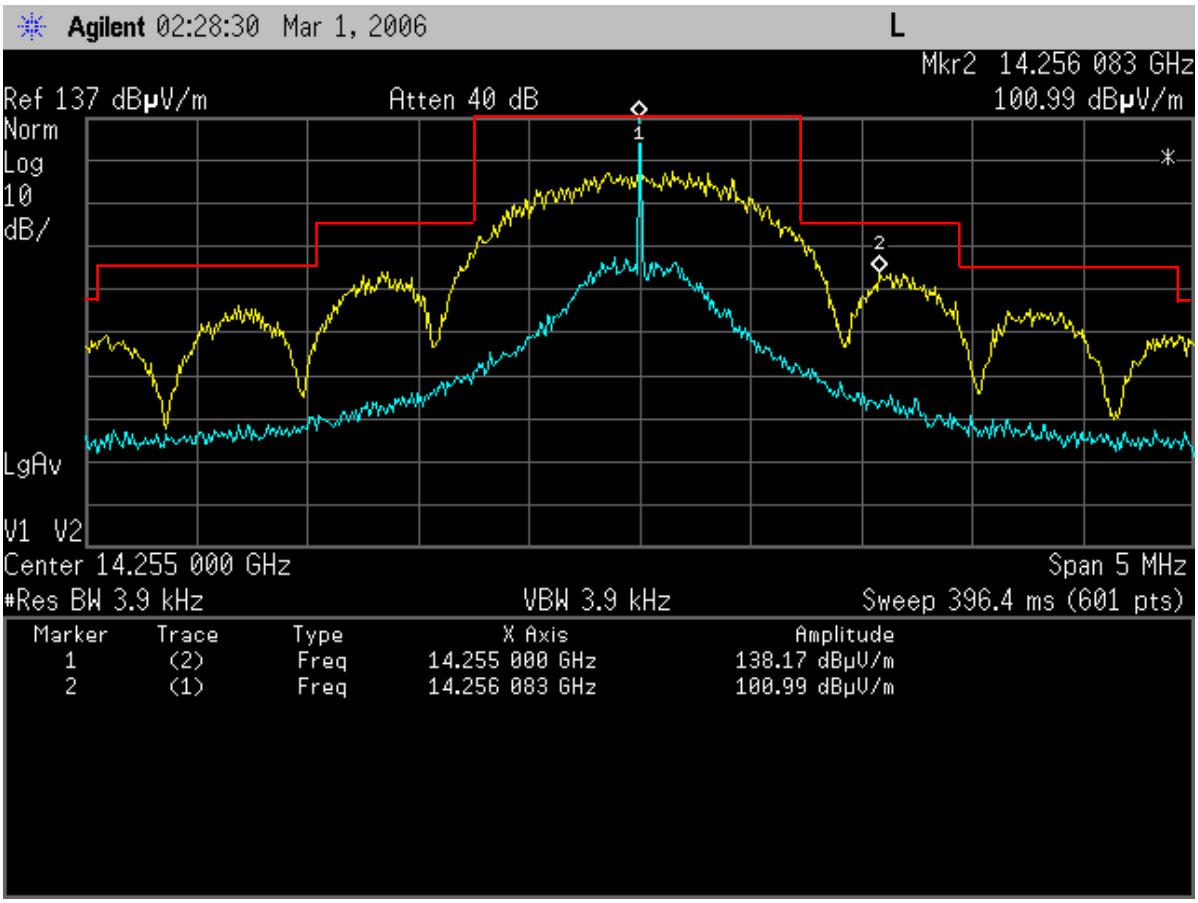


Figure D–9. 3-meter E-field of RF power in H-pol at mid band

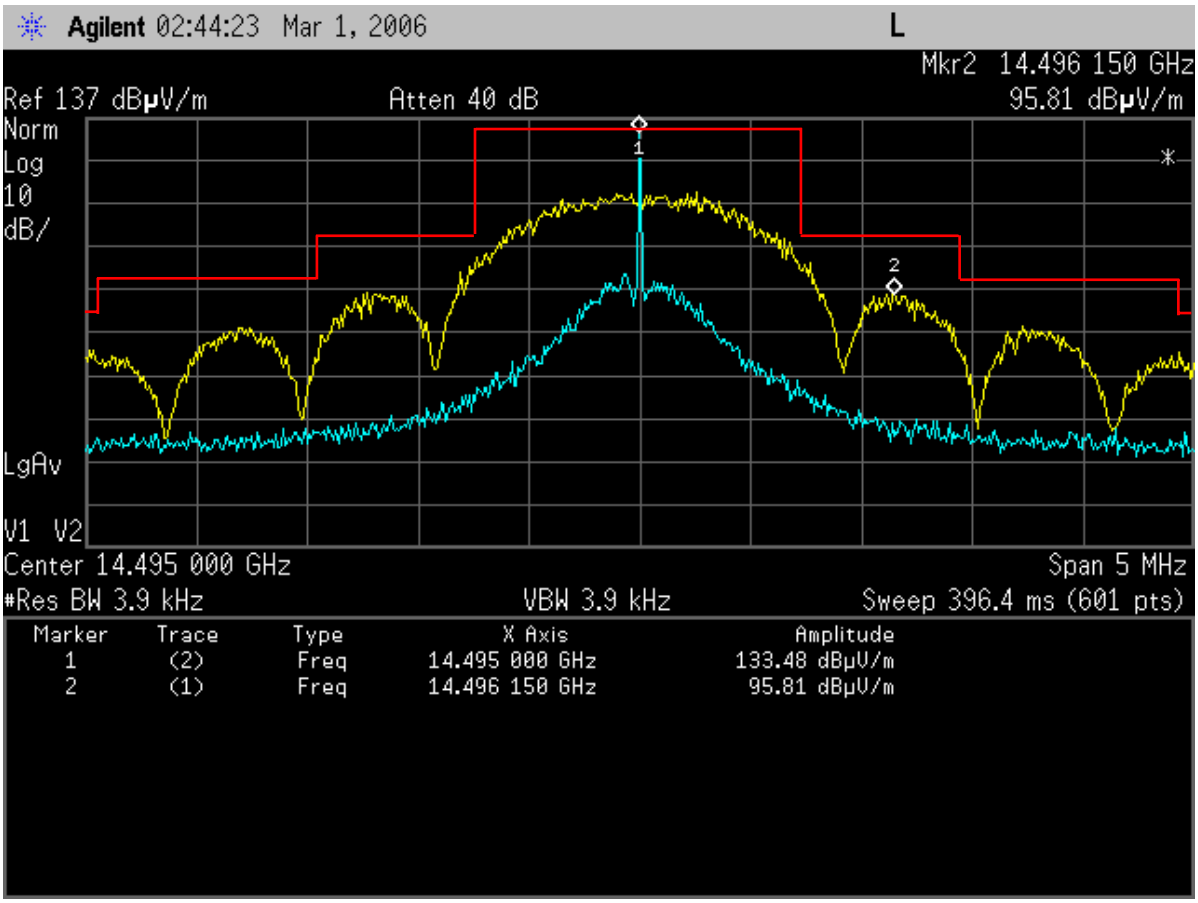


Figure D–10. 3-meter E-field of RF power in V-pol at high band

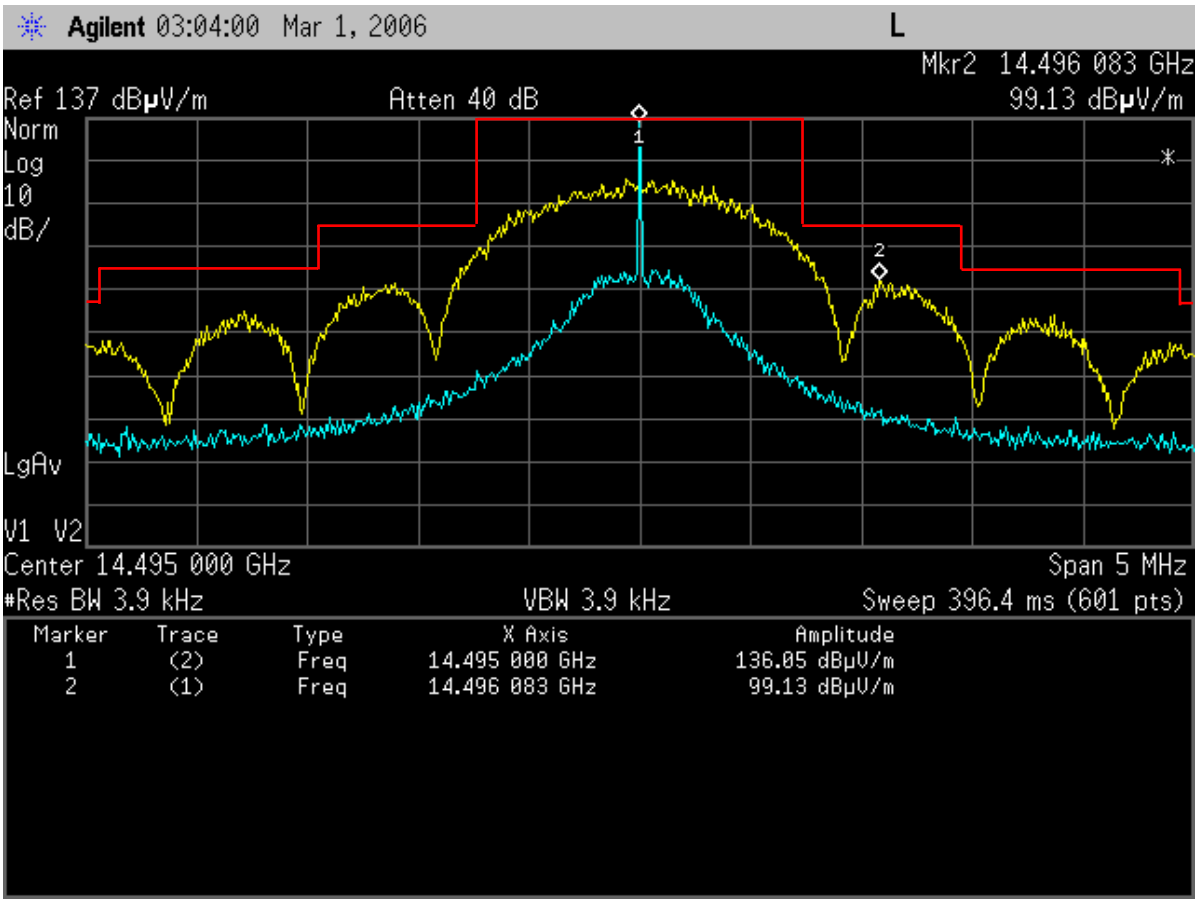


Figure D–11. 3-meter E-field of RF power in H-pol at high band

D.5 Rule 2.1049 – Occupied Bandwidth

D.5.1 Test procedure

D.5.1.1 Instantaneous carrier in factory test mode

Definition – The occupied bandwidth is defined as the spectrum noise produced at discrete frequency separations from the carrier due to all sources of unwanted noise within the transmitter in a modulated condition.

Minimum Standard – The mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:

(1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;

(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;

(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts; which is equivalent to an absolute limit of -13 dBm.

Method of Measurement – Since the occupied bandwidth of the system relies on the transponder bandwidth assigned by the operator and authorized by the regulatory agency, the actual occupied bandwidth can only be measured with an operational satellite system which would require a bandwidth of 36 MHz for operation. However, the occupied bandwidth of a modulated carrier can be measured in the lab environment with the DVT software. Since the necessary bandwidth of a modulated charier is 1.45 MHz, the occupied bandwidth of the instantaneous carrier can be measured and its emission mask can be used to justify the compliance of the occupied bandwidth for an operational system. The measurement setup diagram is shown in Figure D-1.

D.5.1.2 Hopping carrier in system operation mode

The occupied bandwidth of a hopping carrier can be measured under the system operation state using a spectrum analyzer with peak hold when measuring the RF output from the antenna port.

D.5.2 Measurement result

D.5.2.1 Instantaneous carrier in factory test mode

Occupied Bandwidth of the equipment was tested pursuant to FCC Part 2.1049. The measurement was conducted using spectrum analyzer with the OBW test feature. The measured data is shown in Table D-5 and Figure D-12 through Figure D-14.

Table D–5. Occupied Bandwidth (99%)

Ku-band Channel	Carrier frequency (MHz)	Occupied bandwidth (MHz)
Low	14005 (LO/IF=12920/1085)	1.41<OBW<1.45
Mid	14250 (LO/IF=13160/1090)	1.40<OBW <1.45
High	14495 (LO/IF=13400/1095)	1.40<OBW <1.45

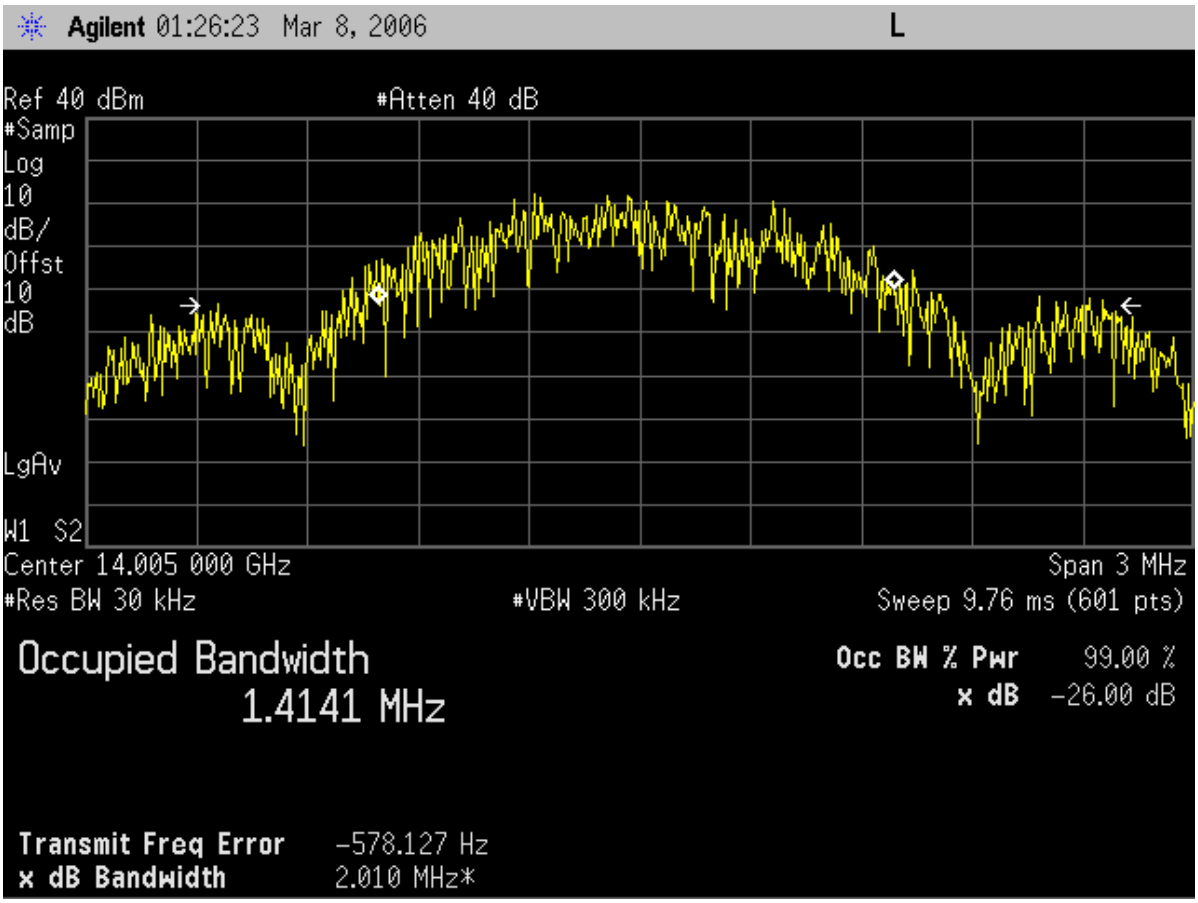


Figure D–12. Occupied bandwidth in low band

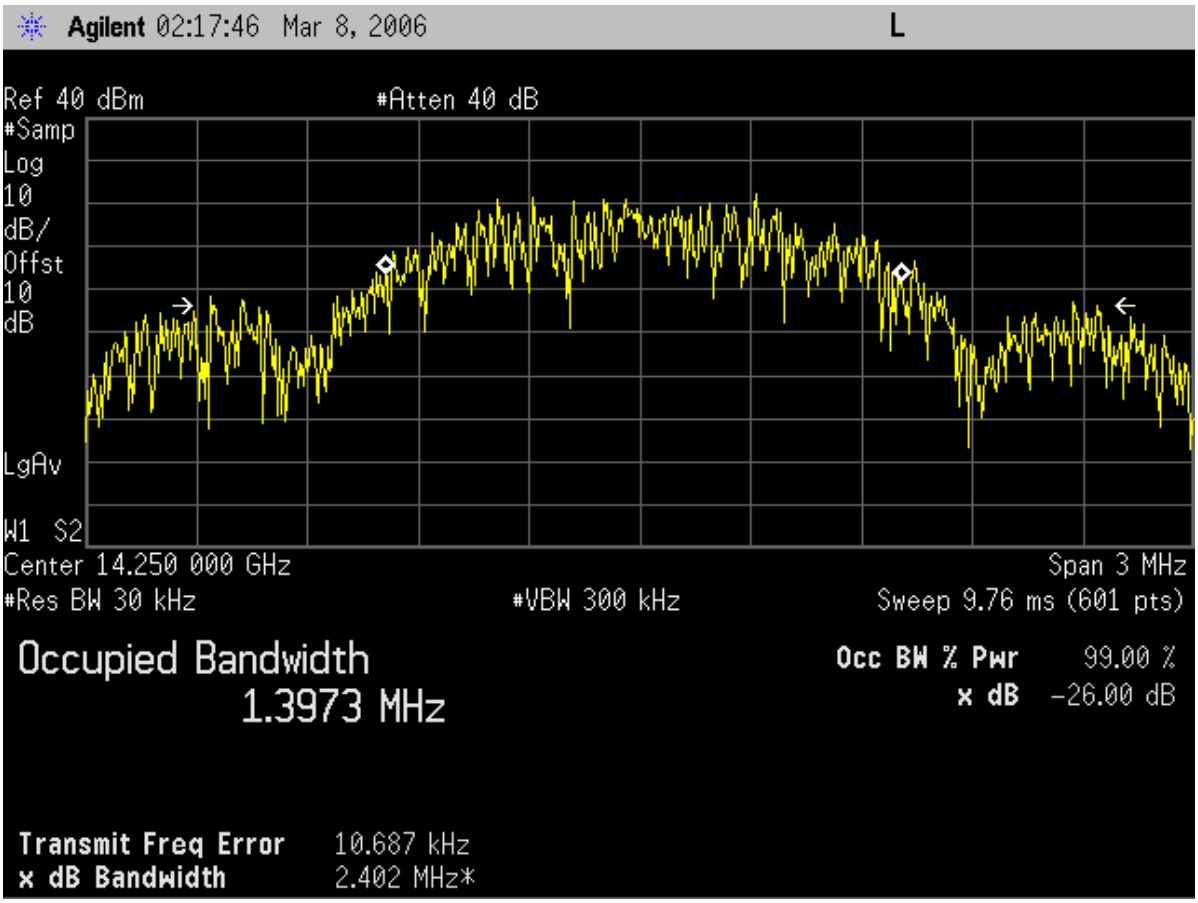


Figure D–13. Occupied bandwidth in mid band

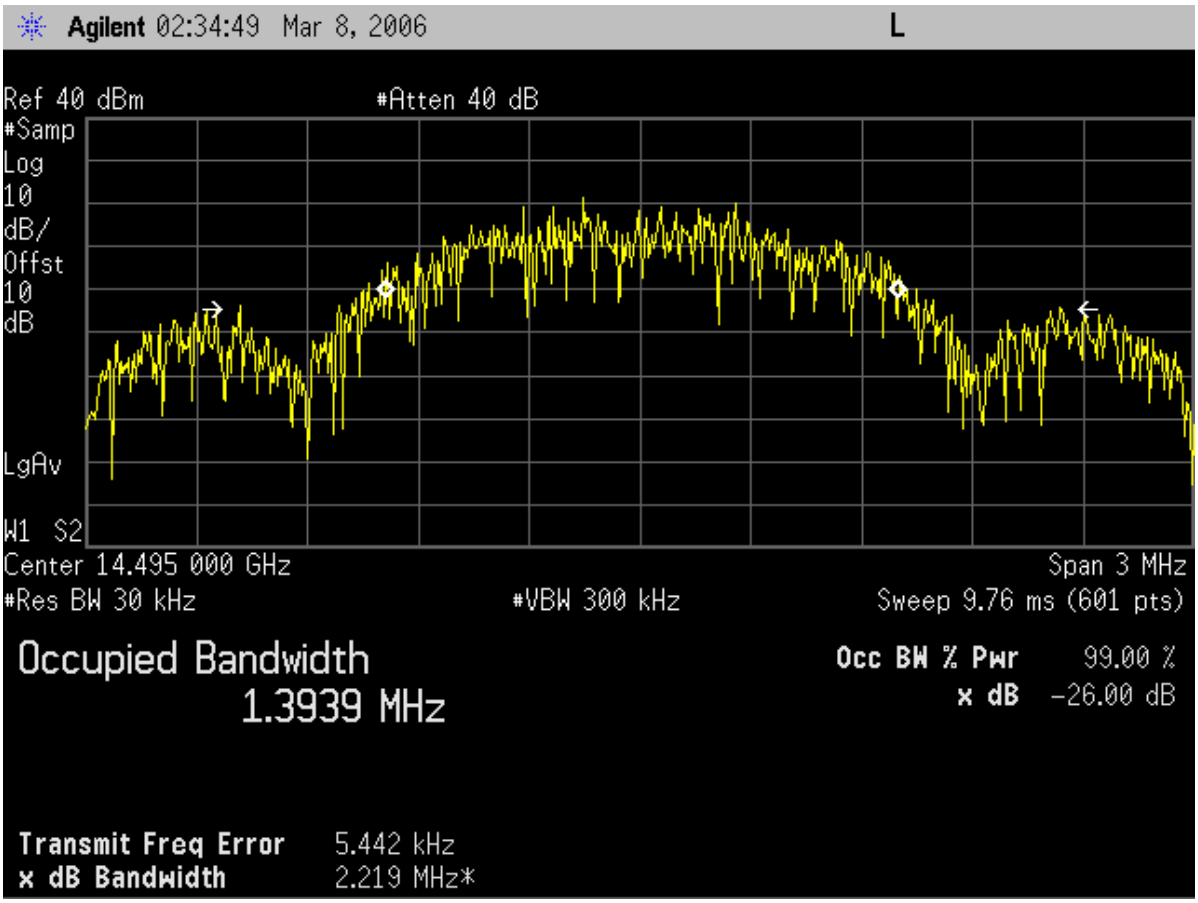


Figure D–14. Occupied bandwidth in high band

D.5.2.2 Hopping carrier in system operation mode

Occupied bandwidth of the hopping carrier in system operation mode are shown

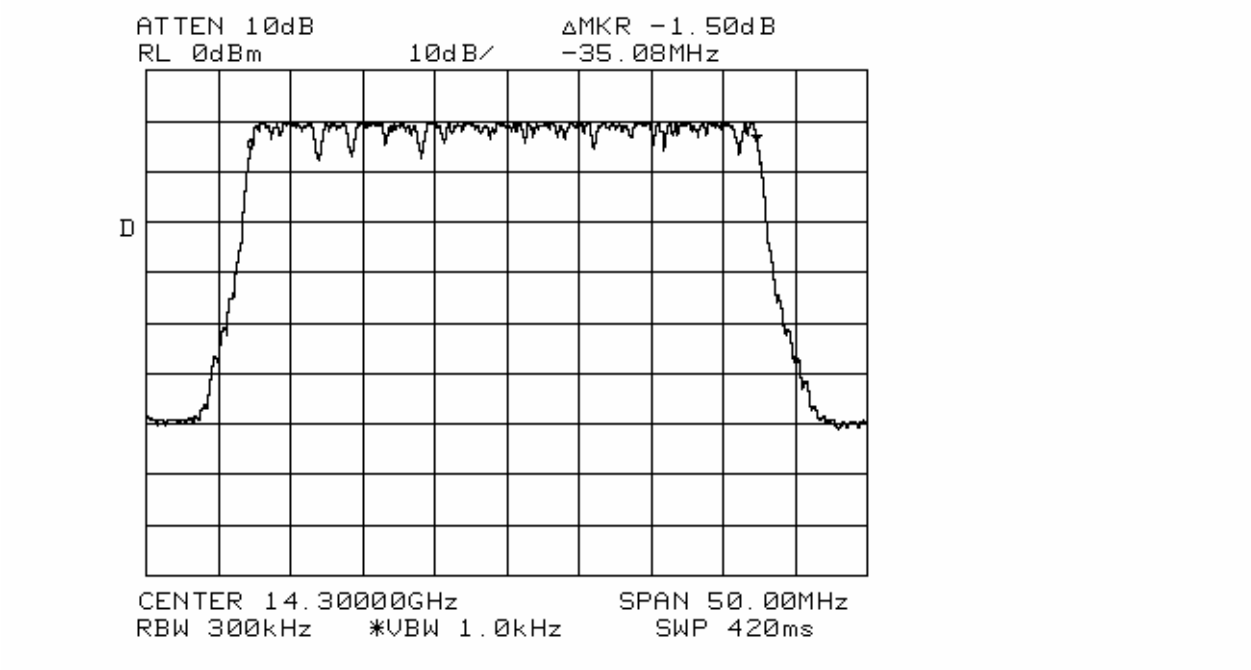


Figure D–15. Occupied bandwidth in system op-mode, zoom-in view

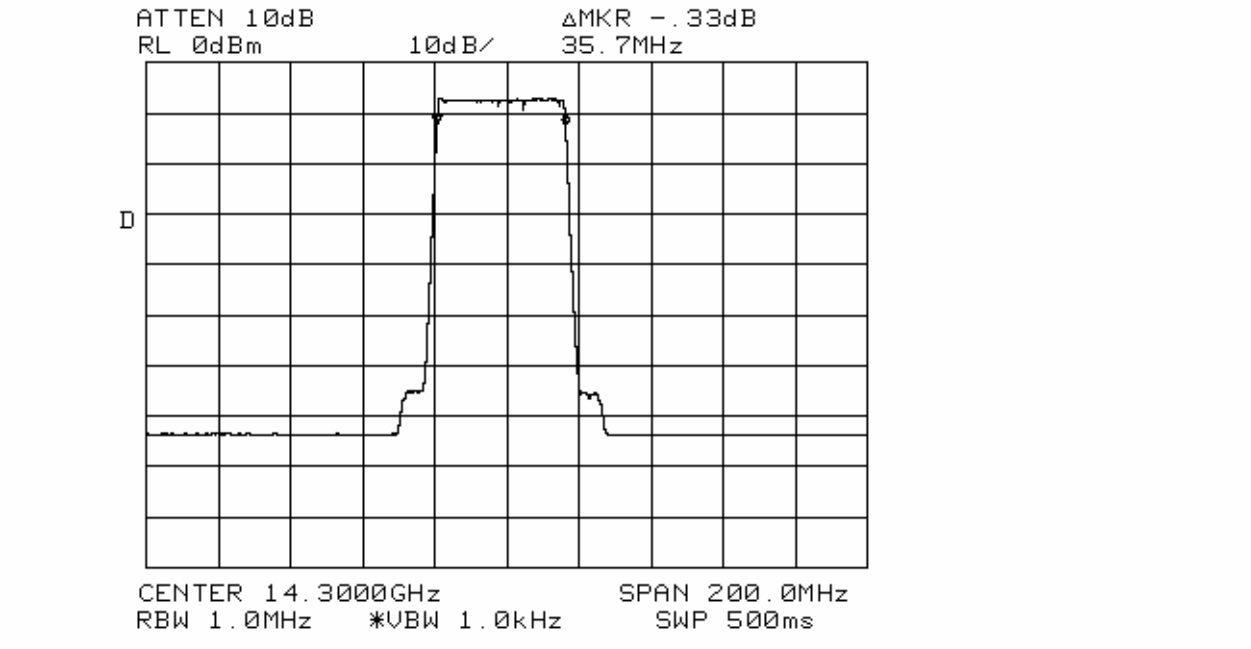


Figure D–16. Occupied bandwidth in system op-mode, zoom out view

D.6 Rule 2.1053/25.202(f) – Conducted Spurious Emission

D.6.1 Test procedure

Definition - The conducted harmonic and spurious emissions are emissions at the antenna ports at a frequency or frequencies that are outside the authorized bandwidth of the transmitter.

Minimum Standard - Conducted harmonic and spurious emissions shall be attenuated below the emission mask specified by rule 25.202(f), which is detailed in session D.5.

Method of Measurement - The measurement shall be made with a spectrum analyzer from the lowest radio frequency generated in the equipment to the 5th harmonic of the carrier, i.e., 72.5 GHz. The measurement setup diagram is shown in Figure D-1.

D.6.2 Measurement results

Conducted emission from the equipment was tested pursuant to FCC Part 2.1046. Measurement was conducted using the PSA.

D.6.2.1 Conducted harmonic emissions

The measurement results are shown in the Table D-6 through Table D-8.

Table D–6. Conducted harmonic emission at low-band

Harmonics	Frequency (MHz)	Measured level (dBm)	Limit (dBm/4kHz)
1	14,005	29.73	70
2	28,010	-34.33	-13.00
3	42,015		-13.00
4	56,020		-13.00
5	70,025		-13.00

Table D–7. Conducted harmonic emission at mid-band

Harmonics	Frequency (MHz)	Measured level (dBm)	Limit (dBm/4kHz)
1	14,250	30.02	70
2	28,500	-41.50	-13.00
3	42,750		-13.00
4	57,000		-13.00
5	71,250		-13.00

Table D–8. Conducted harmonic emission at high-band

Harmonics	Frequency (MHz)	Measured level (dBm)	Limit (dBm/4kHz)
1	14,500	28.55	70
2	29,000	-47.00	-13.00
3	43,500		-13.00
4	58,000		-13.00
5	72,500		-13.00

D.6.2.2 Conducted spurious emissions at low channel state

The measurement results are shown in Figure D-17 through Figure D-22.

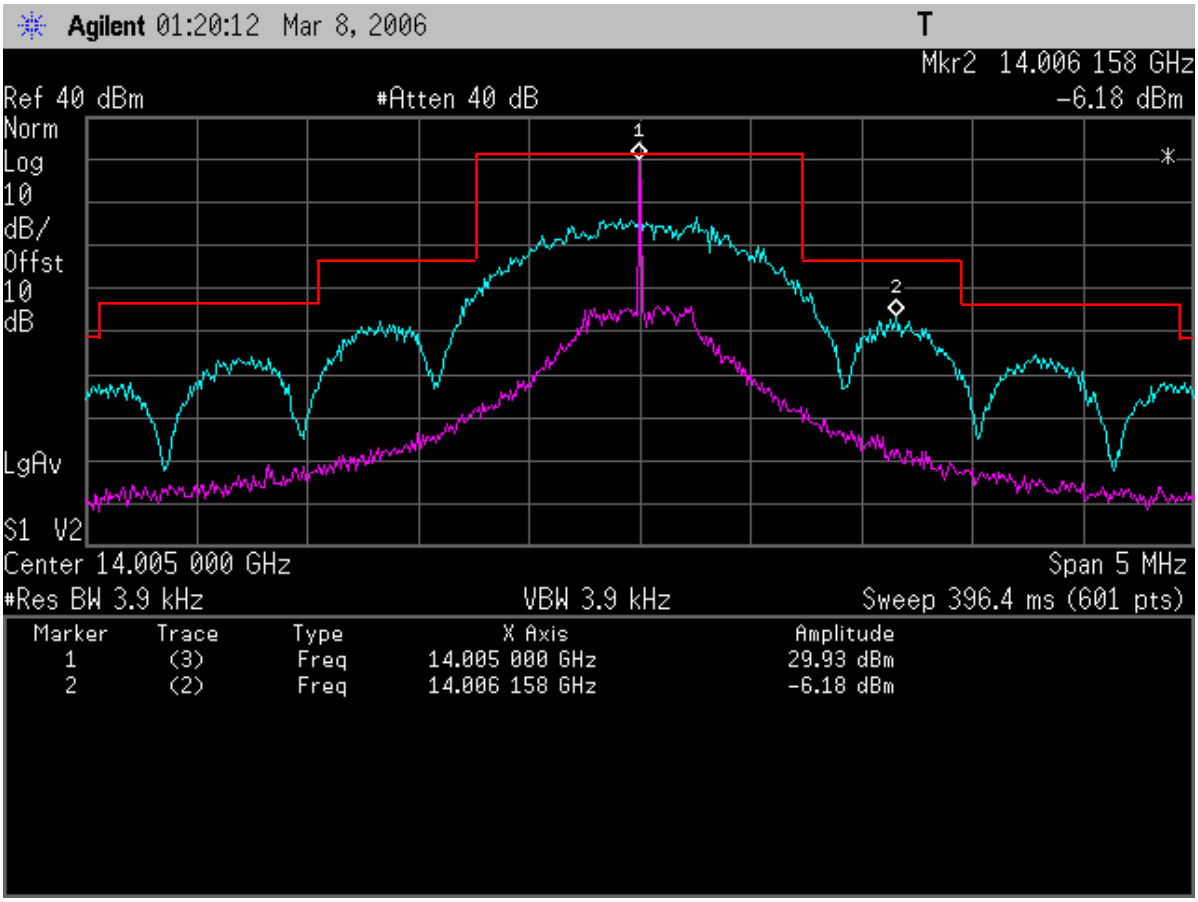


Figure D–17. Conducted emission mask

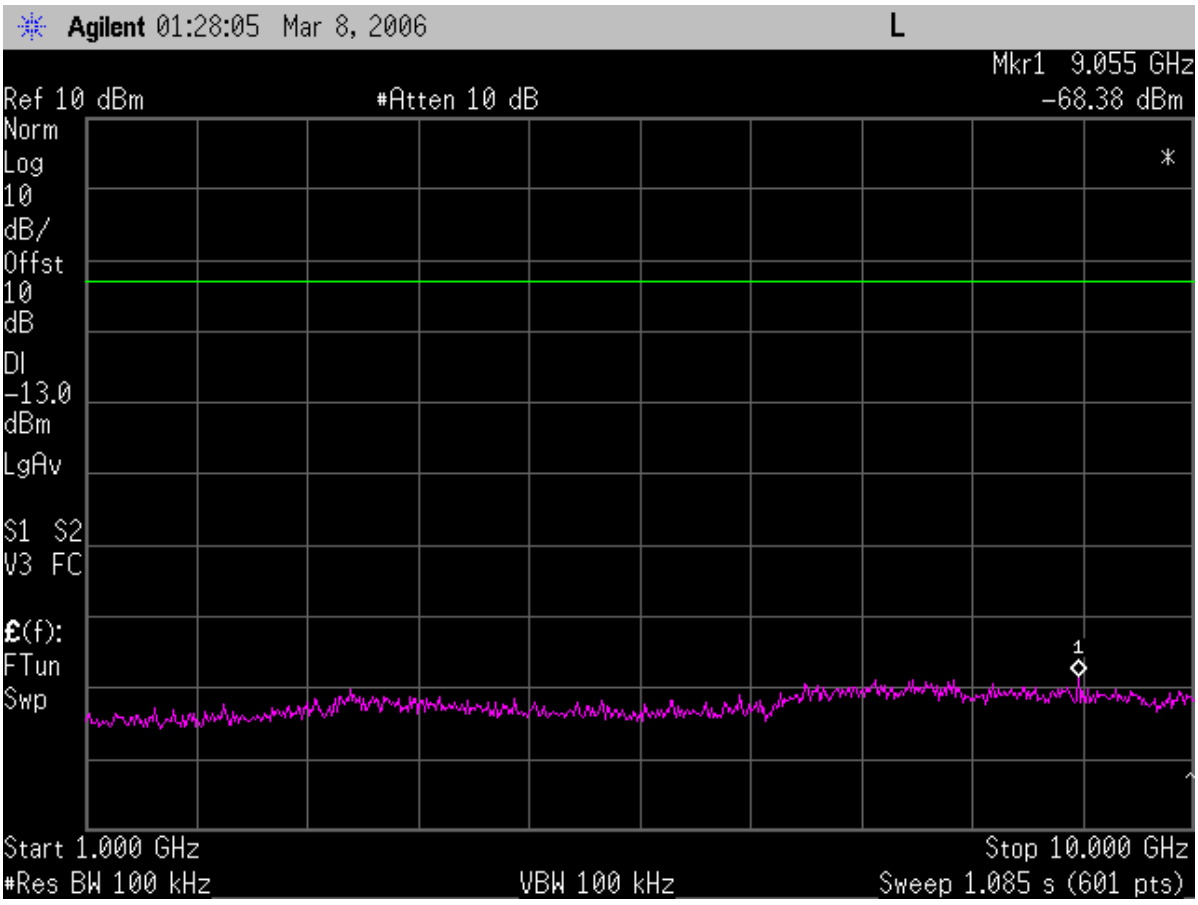


Figure D–18. Conducted spurious emission in 1 – 10 GHz

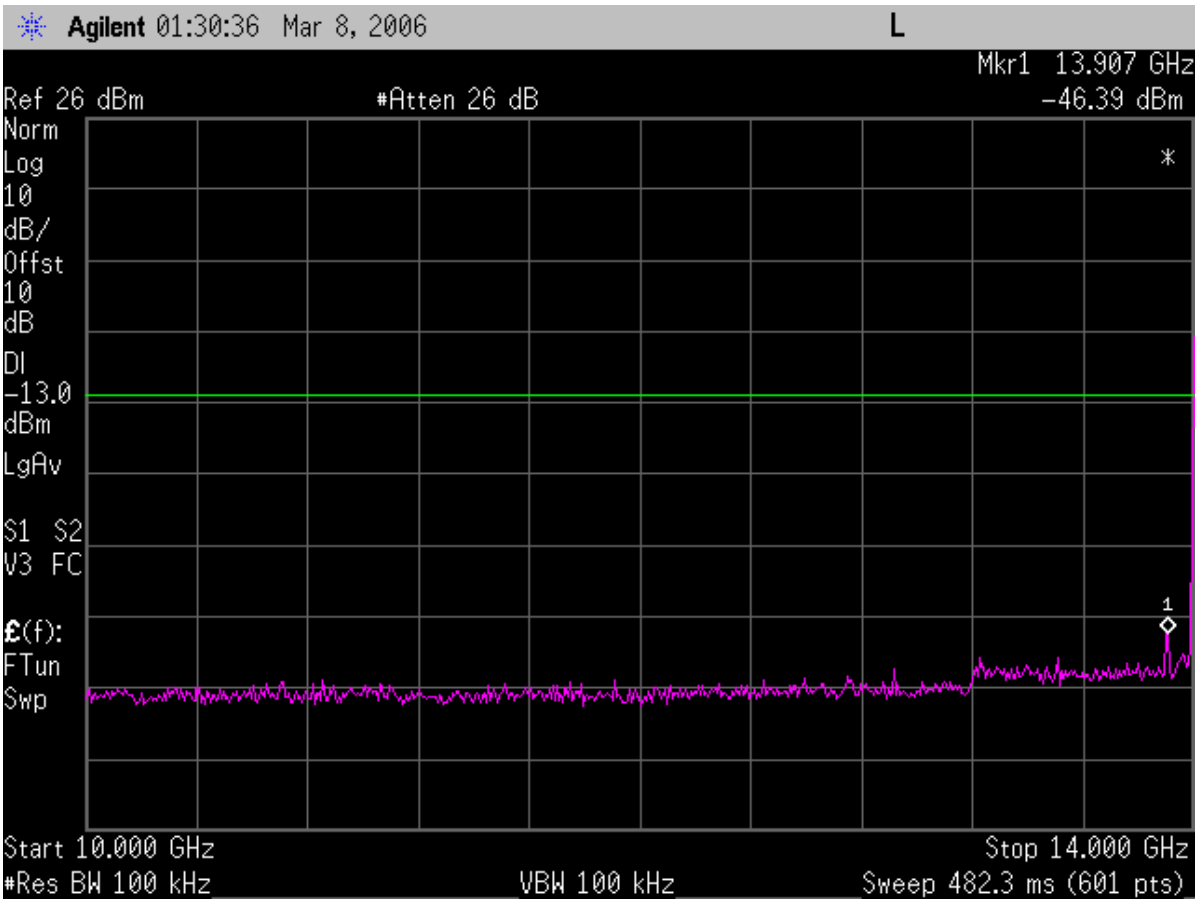


Figure D–19. Conducted spurious emission, in 10 – 14 GHz

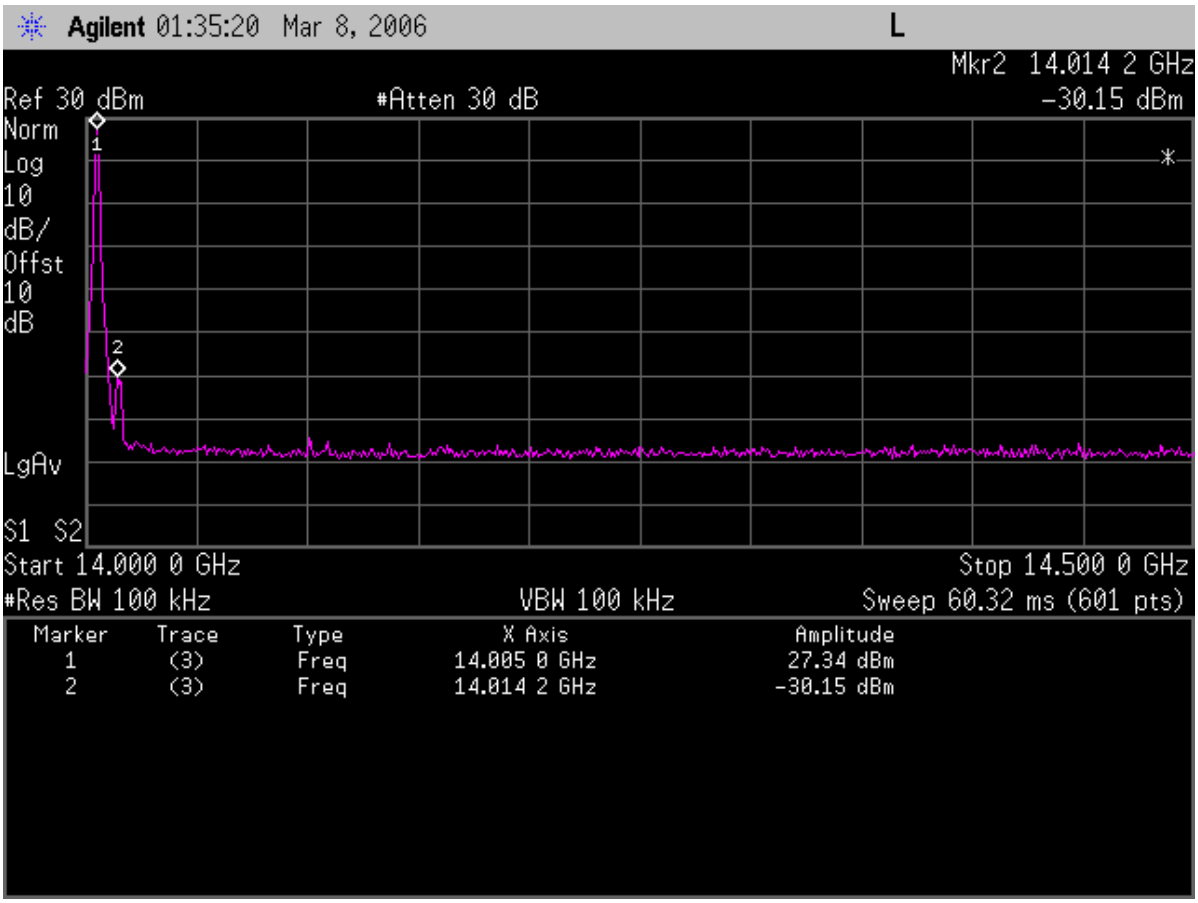


Figure D–20. Conducted spurious emission, in Ku-band

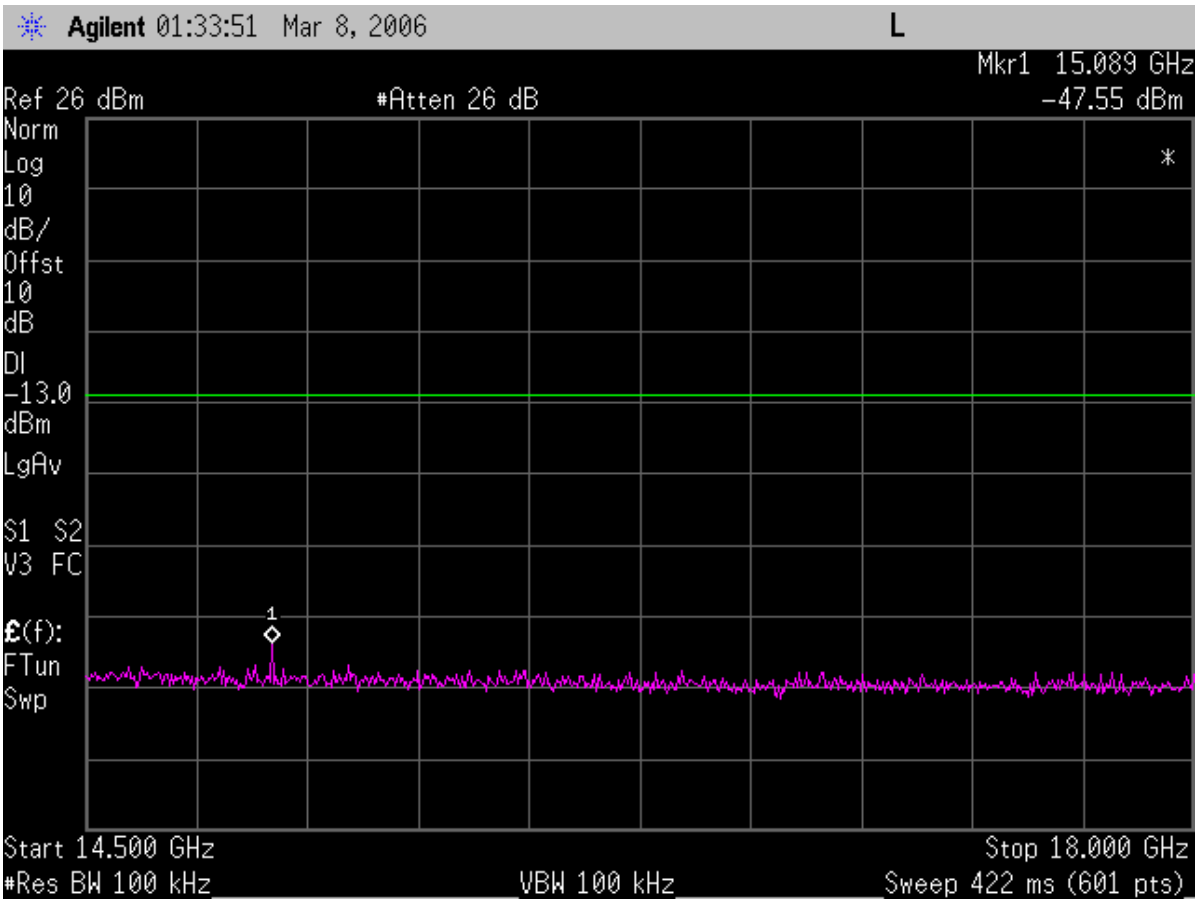


Figure D–21. Conducted spurious emission, in 14.5 – 18 GHz

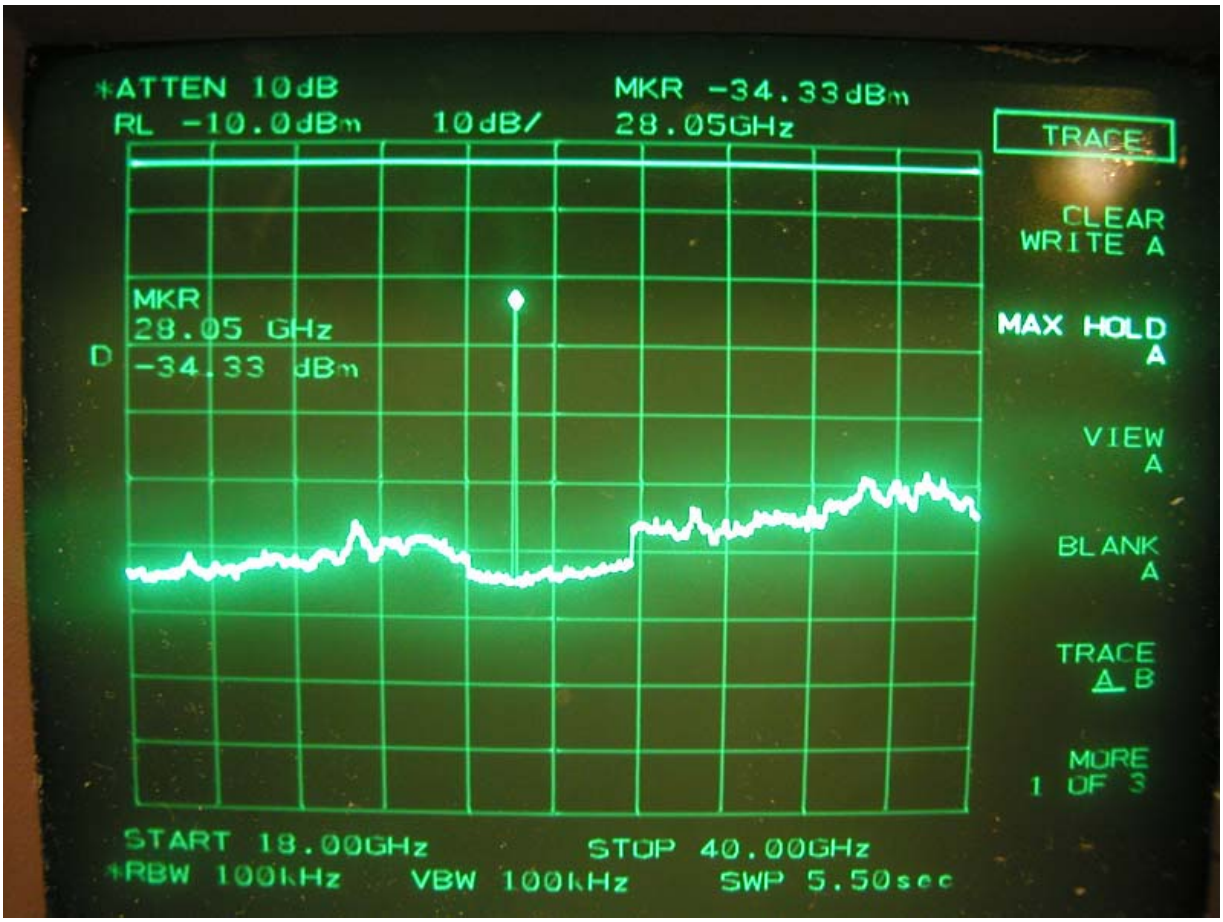


Figure D–22. Conducted spurious emission, in 14.5 – 18 GHz

D.6.2.3 Conducted spurious emissions at high channel state

The measurement results are shown in Figure D-23 through Figure D-28.

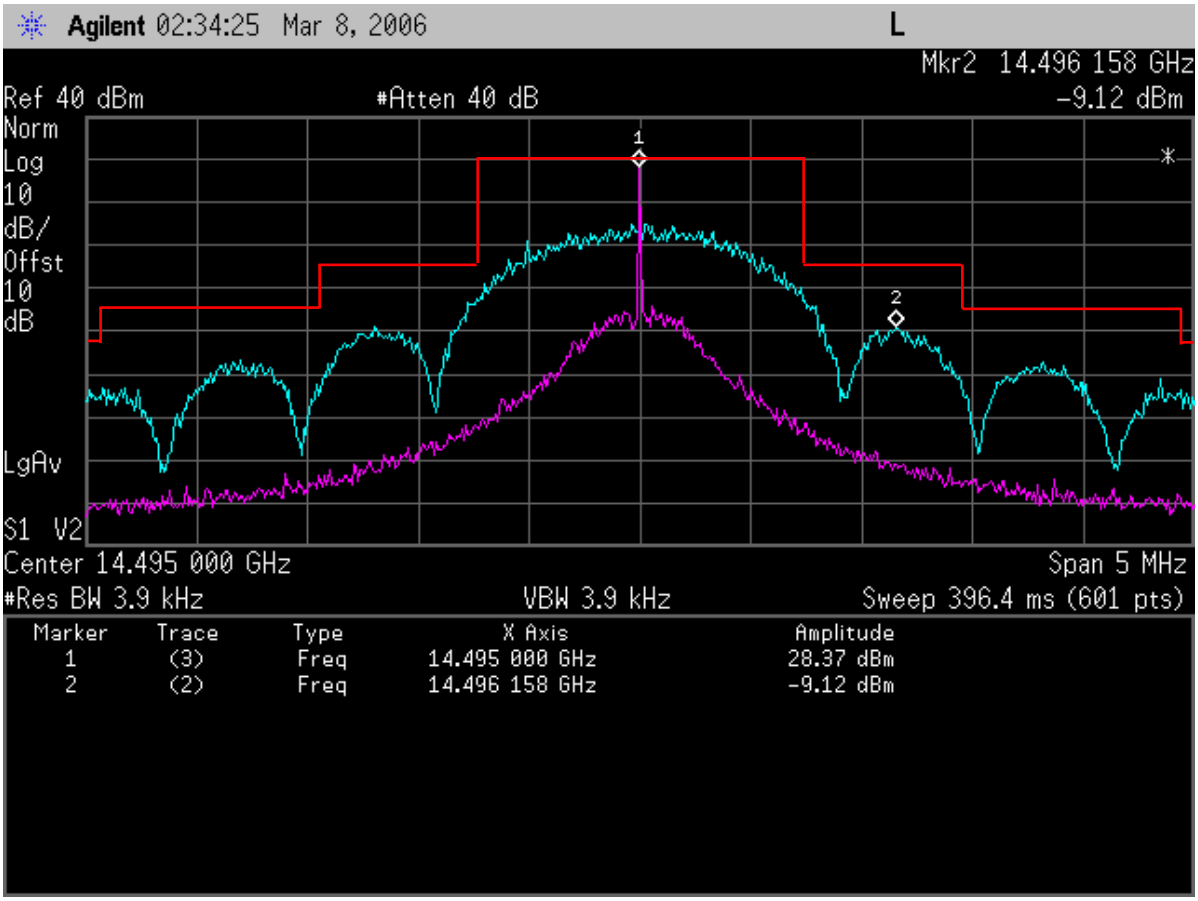


Figure D–23. Conducted emission mask

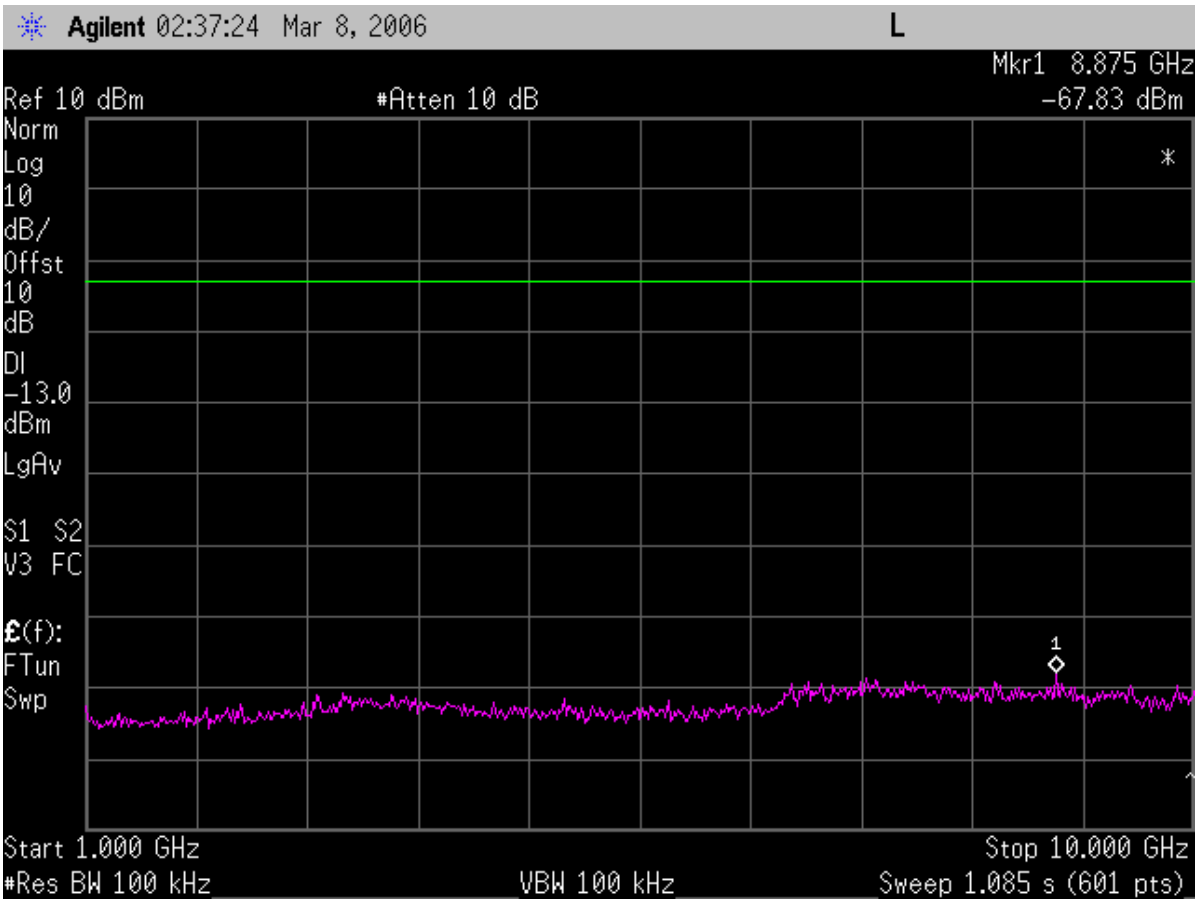


Figure D–24. Conducted spurious emission, in 1 – 10 GHz

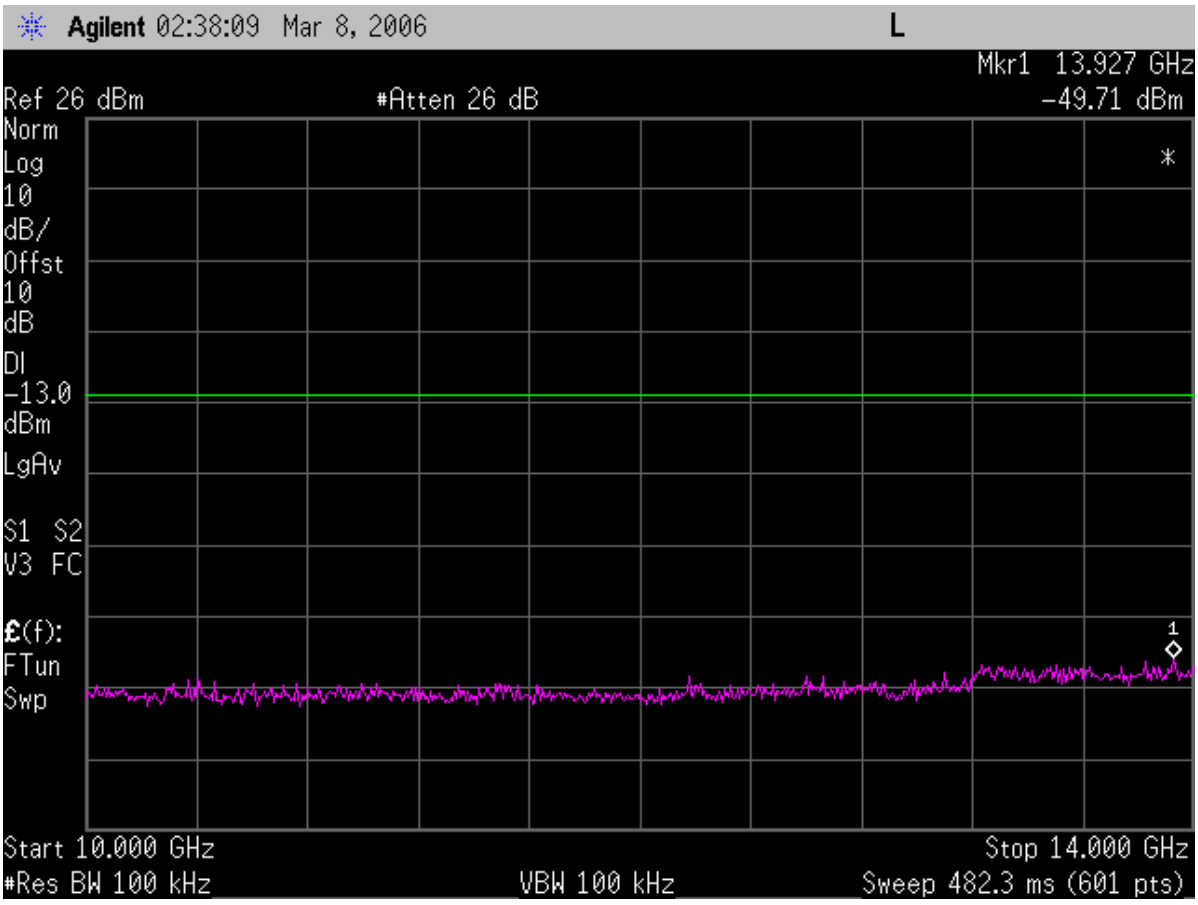


Figure D–25. Conducted spurious emission, in 10 – 14 GHz

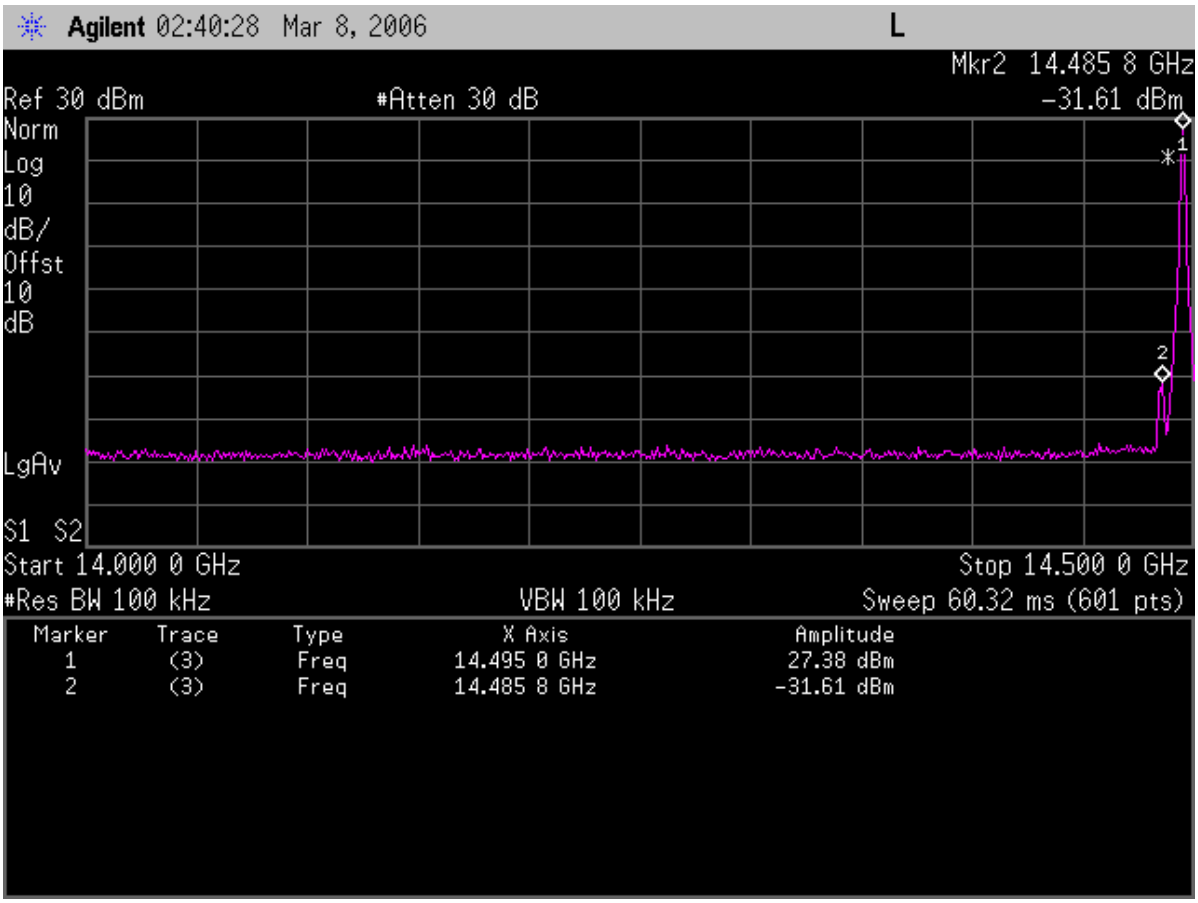


Figure D–26. Conducted spurious emission, in Ku-band

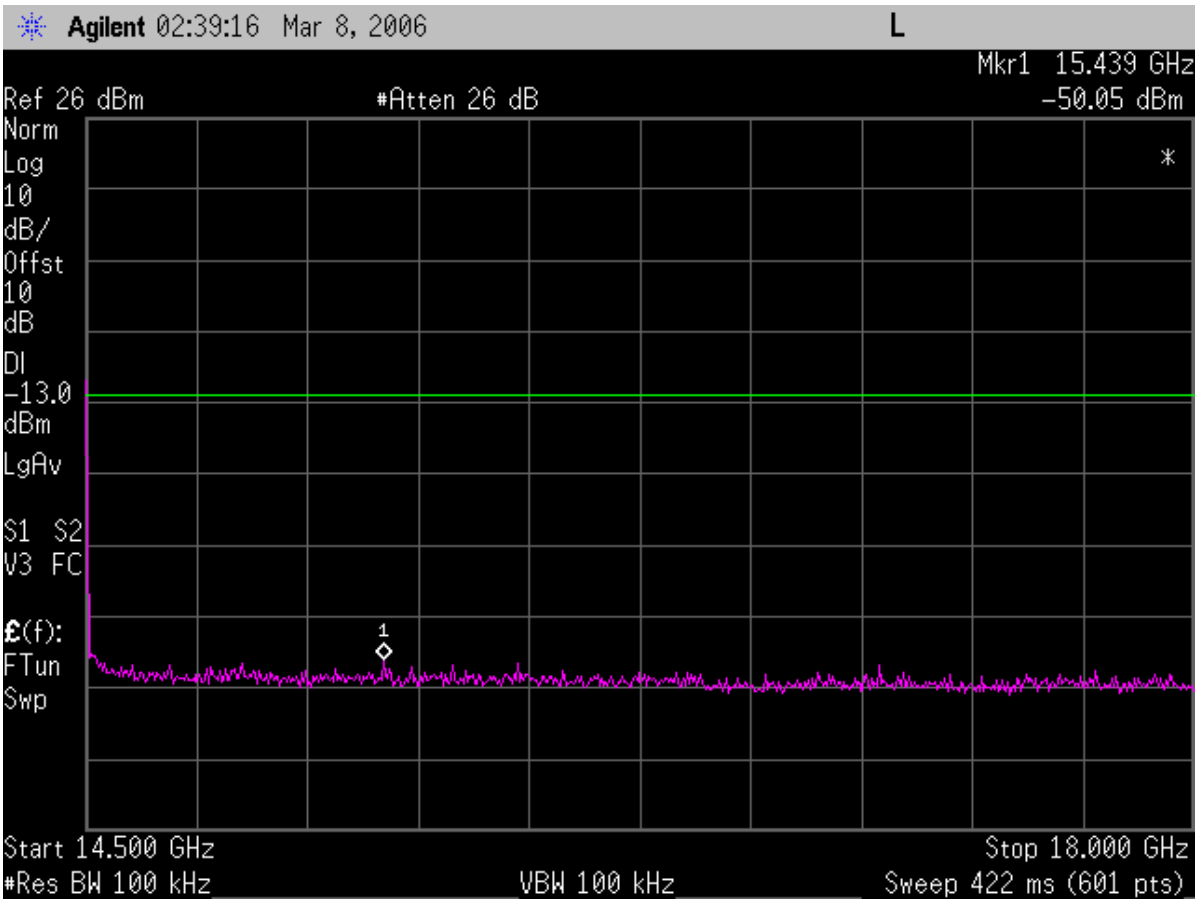


Figure D–27. Conducted spurious emission, in 14.5 – 18 GHz

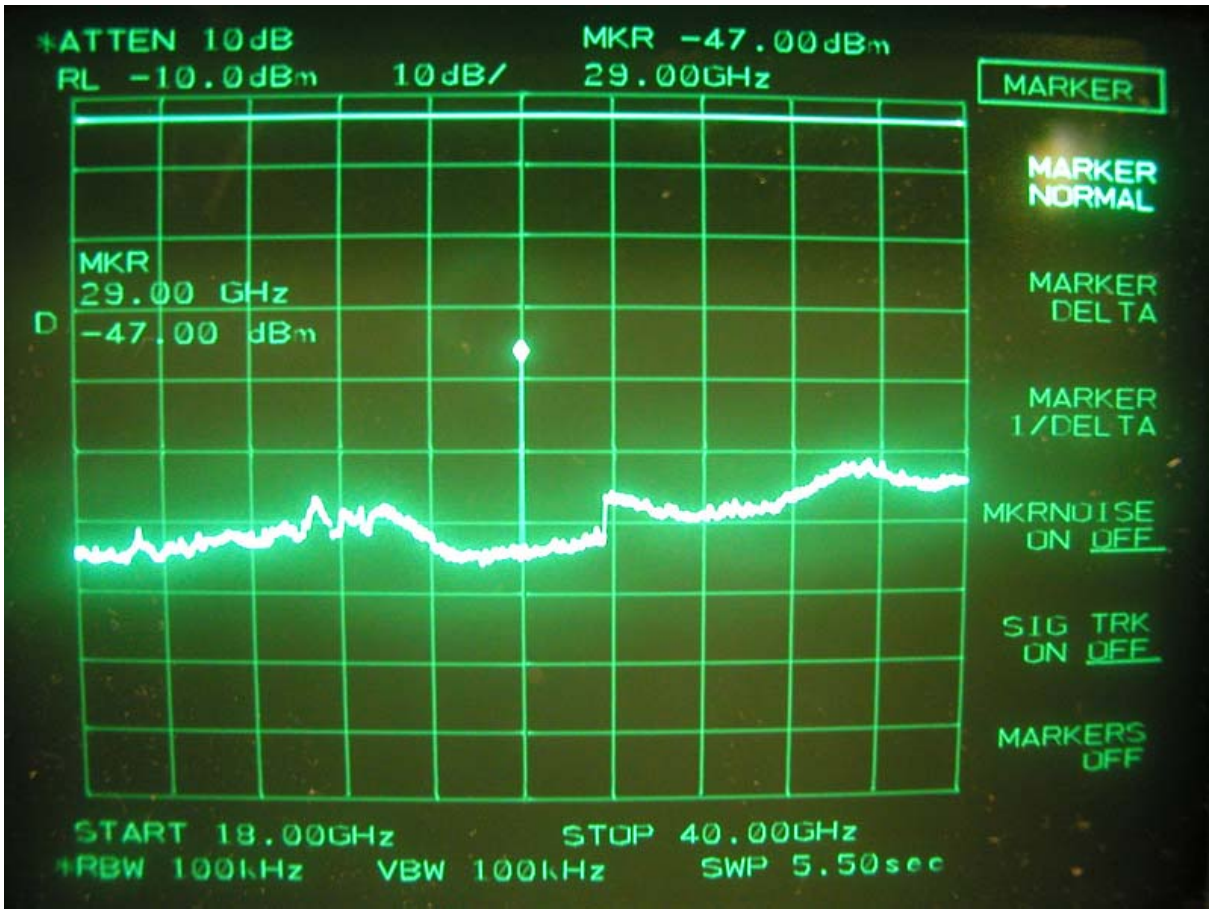


Figure D–28. Conducted spurious emission, in 14.5 – 18 GHz

D.7 Rule 2.1053/25.202(f) – Radiated Spurious Emissions

D.7.1 Test procedure

Definition - The radiated spurious emissions are emissions from the EUT with the attached antenna fully extended. The radiated spurious emissions include those emissions radiated from the attached antenna as well as the equipment cabinet and attached cables.

Minimum Standard - Radiated spurious emissions shall not exceed -13 dBm for EIRP or 82.23 dBμV/m for electric field at 3 meter.

Method of Measurement - The radiated emissions measurements can be conducted in accordance with American National Standards Institute ANSI C63.4 - American National Standard for Methods of Measurement of Radio-Noise Emissions form Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. The radiated emission measurements were performed using an

automated emission measurement system, in which, the EUT can be rotated in azimuth of 360° and the height of the measurement antenna, either vertically or horizontally polarized, can be adjusted between 1-4 meters. Maximization under each polarization was carried out at frequencies where the emission has low margins. The measurement setup diagram is shown in Figure D-1.

D.7.2 Measurement results

Conducted emission from the equipment was tested pursuant to FCC Part 2.1046. Measurement was conducted using the PSA.

D.7.2.1 Radiated harmonic emissions

The measurement results are shown in the Table D-9 through Table D-11.

Table D–9. Radiated harmonic emission at low-band

Harmonics	Frequency (MHz)	Meas. reading (dBuV/m)	SA factor (dB)	Meas. level (dBuV/m)	Limit (dBuV/m)
1	14,005	131.26	14.13	145.39	165.23
2	28,010				82.23
3	42,015				82.23
4	56,020				82.23
5	70,025				82.23
Note: SA factor is obtained by substitute antenna					

Table D–10. Radiated harmonic emission at mid-band

Harmonics	Frequency (MHz)	Meas. reading (dBuV/m)	SA factor (dB)	Meas. level (dBuV/m)	Limit (dBuV/m)
1	14,250	138.17	6.14	144.32	165.23
2	28,500				82.23
3	42,750				82.23
4	57,000				82.23
5	71,250				82.23
Note: SA factor is obtained by substitute antenna					

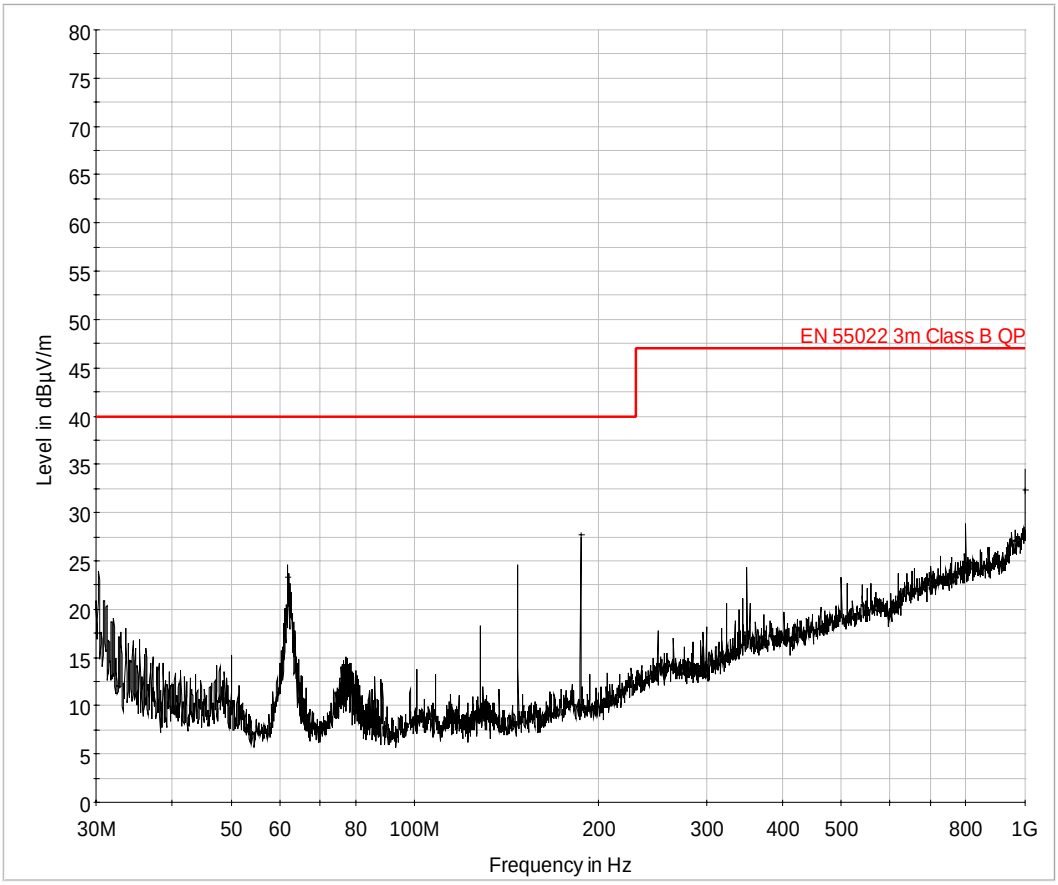
Table D–11. Radiated harmonic emission at high-band

Harmonics	Frequency (MHz)	Meas. reading (dBuV/m)	SA factor (dB)	Meas. level (dBuV/m)	Limit (dBuV/m)
1	14,500	136.05	5.75	141.80	165.23
2	29,000				82.23
3	43,500				82.23
4	58,000				82.23
5	72,500				82.23
Note: SA factor is obtained by substitute antenna					

D.7.2.2 Radiated spurious emissions at low channel state

The measurement results are shown in Figure D-29 through Figure D-38.

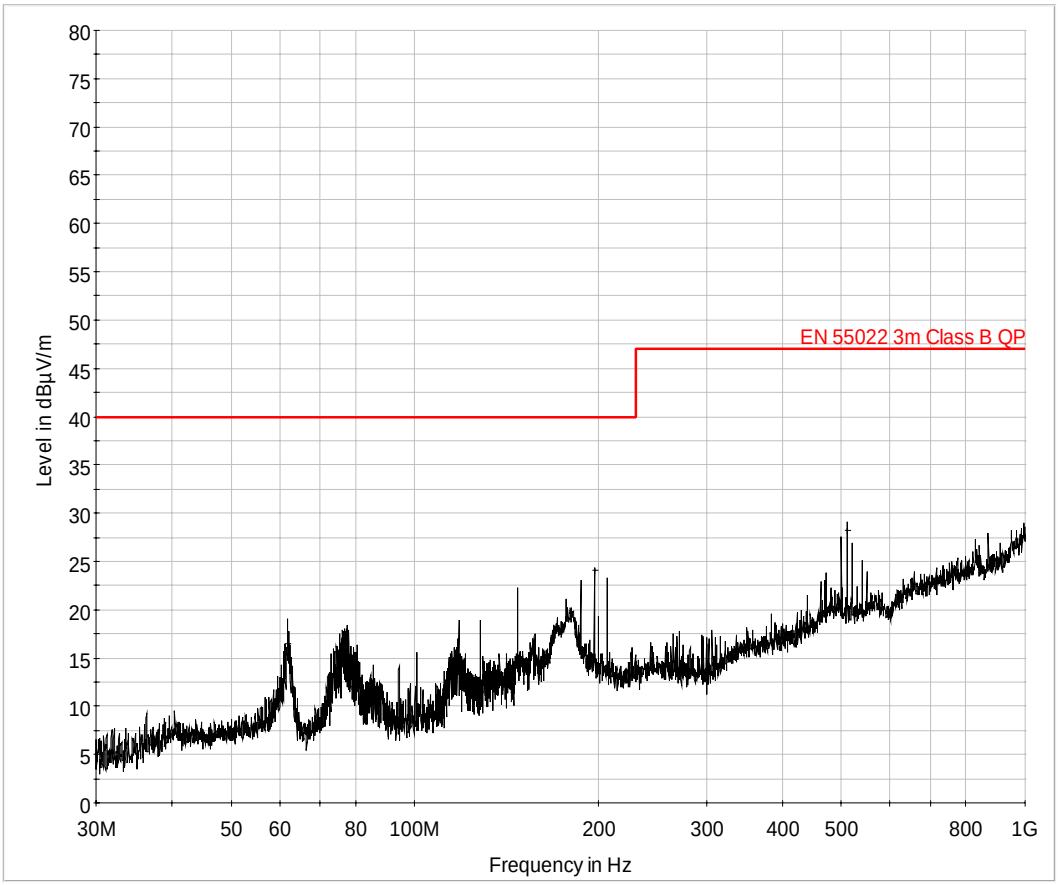
Meas. setup:	RE, Vertical polarization 2.15m, 80 degrees azimuth, least margin worst case.
EUT setup:	Power on 10 V_{DC}, 1.11 A. EUT set up TX low channel 14005 MHz, LO 12920 MHz, IF 1085 MHz, MSK on.
Configuration:	SDM standalone
Graph:	



Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dB)
61.80	23.30	40.00	16.70
186.85	27.70	40.00	12.30
1000.00	32.30	47.00	14.70

Figure D–29. Radiated spurious emission, V-pol, 30 – 1000 MHz

Meas. setup:	RE, Horizontal polarization 2.10m, 270 degrees azimuth, least margin worst case.
EUT setup:	Power on 10 V_{DC}, 1.11 A. EUT set up TX low channel 14005 MHz, LO 12920 MHz, IF 1085 MHz, MSK on.
Configuration:	SDM standalone
Graph:	



Frequency (MHz)	QP Level (dBuV/m)	QP Limit (dBuV/m)	QP Margin (dB)
61.80	16.40	40.00	23.60
196.62	24.10	40.00	15.90
511.21	28.30	47.00	18.70

Figure D–30. Radiated spurious emission, H-pol, 30 – 1000 MHz

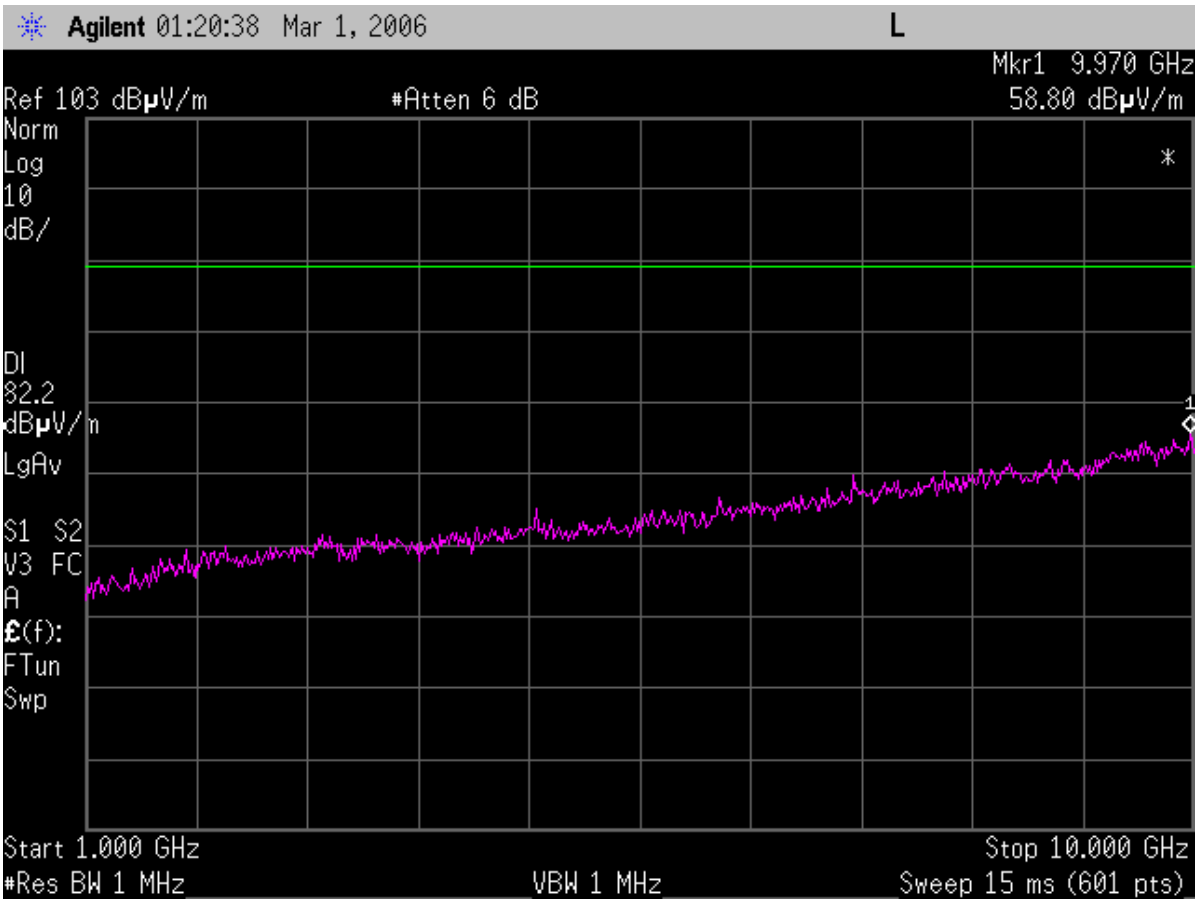


Figure D–31. Radiated spurious emission, V-pol, 1 – 10 GHz

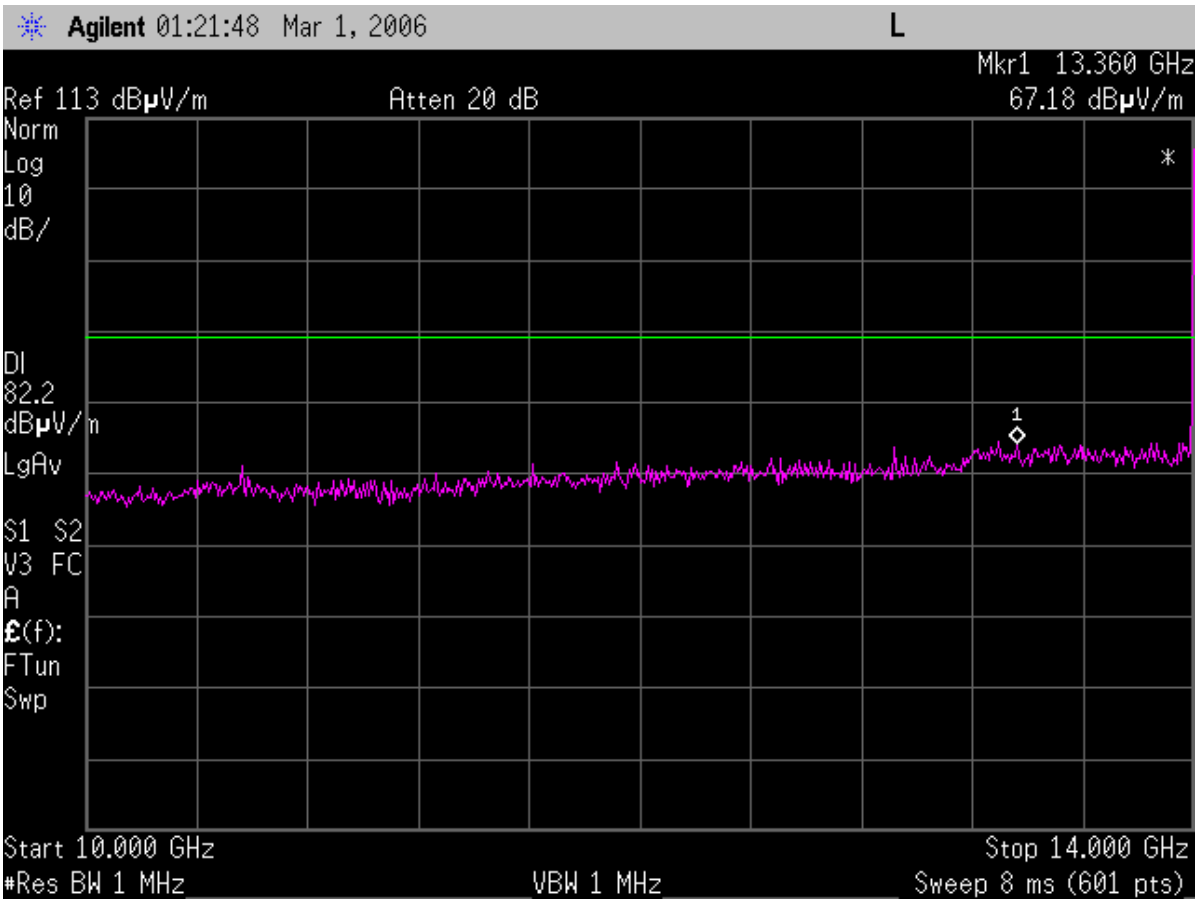


Figure D–32. Radiated spurious emission, V-pol, 10 – 14 GHz

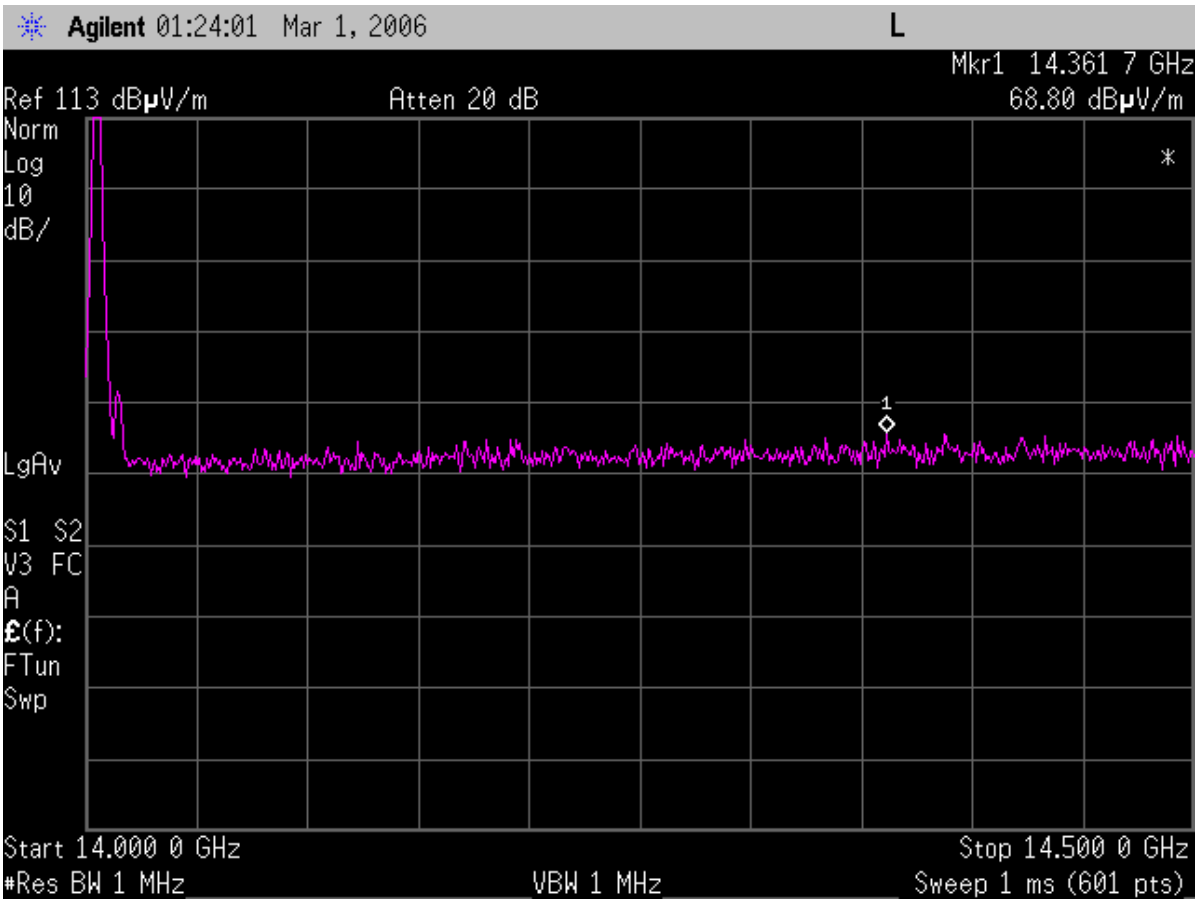


Figure D–33. Radiated spurious emission, V-pol, 14 – 14.5 GHz

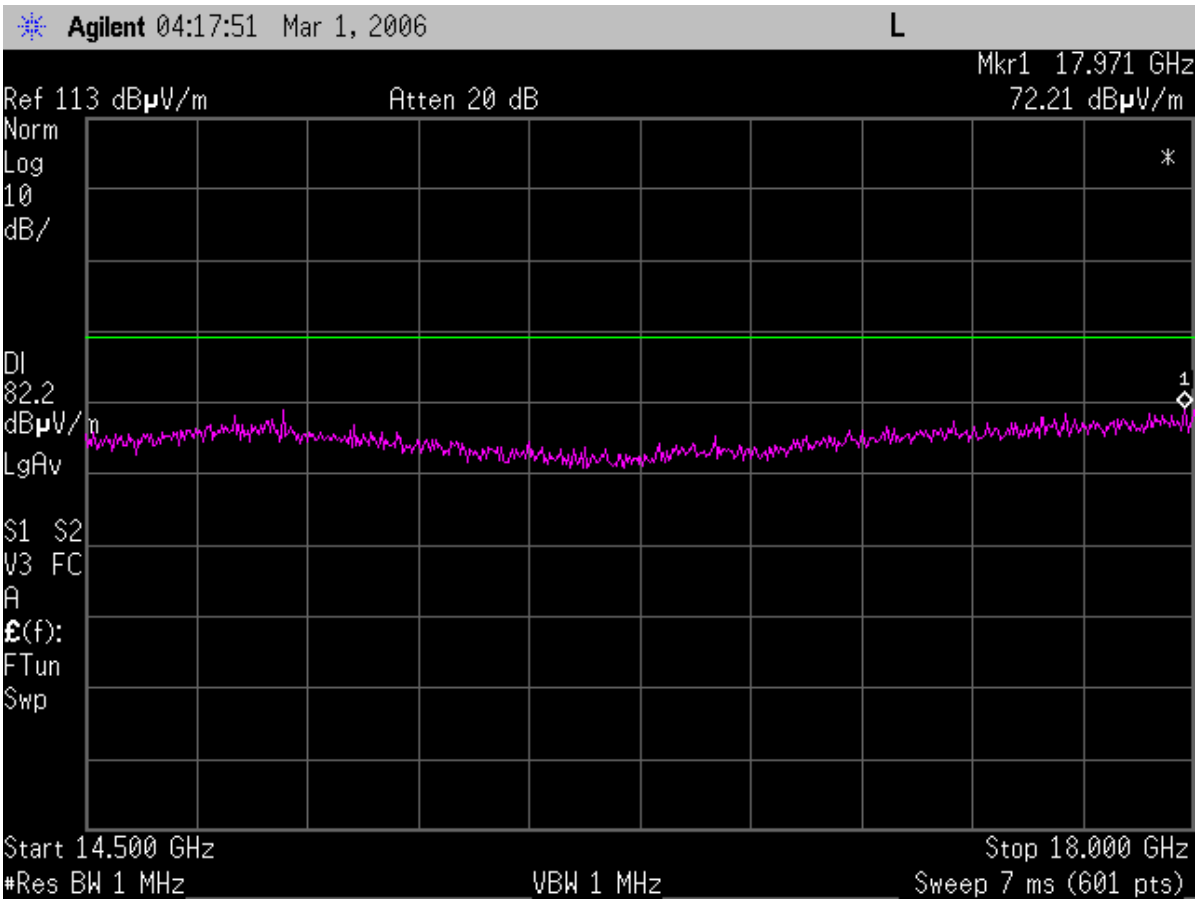


Figure D–34. Radiated spurious emission, V-pol, 14.5 – 18 GHz

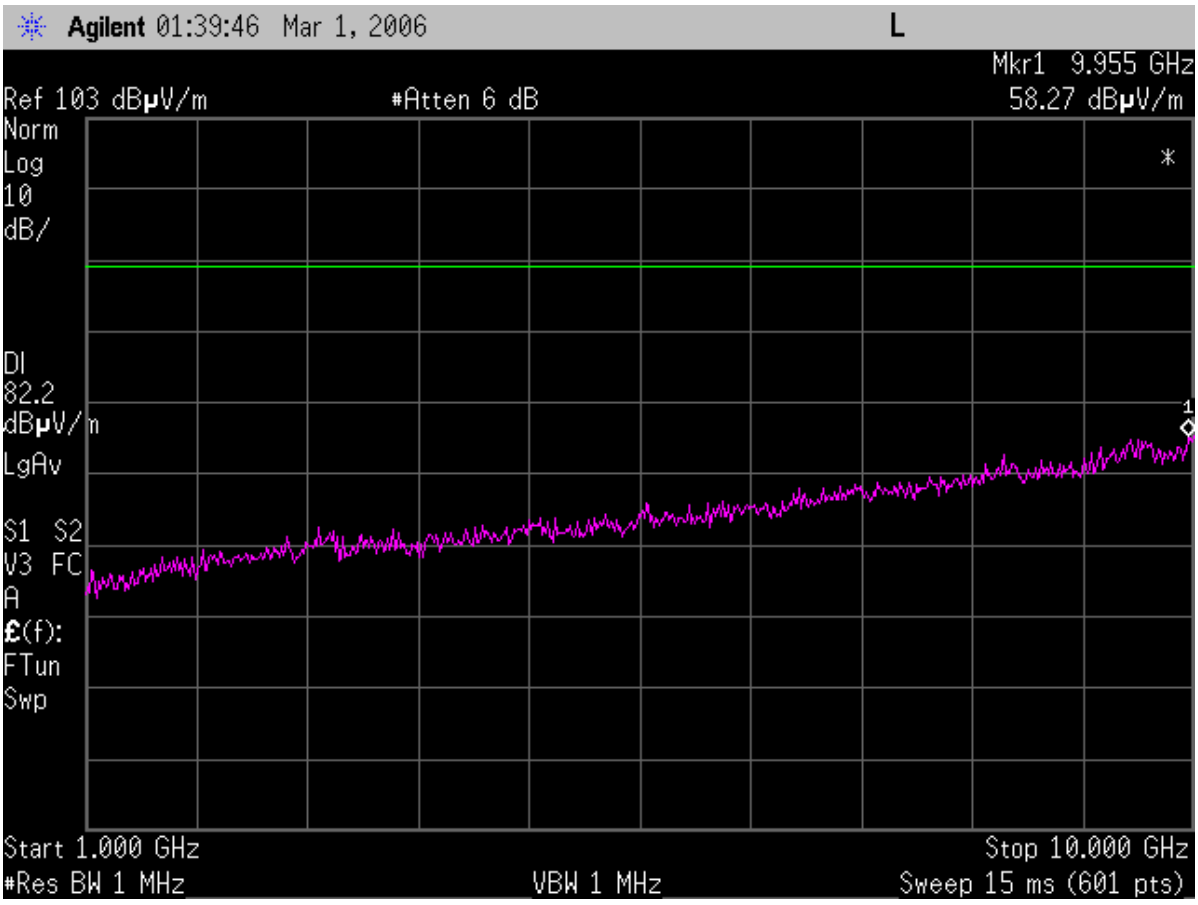


Figure D–35. Radiated spurious emission, H-pol, 1 – 10 GHz

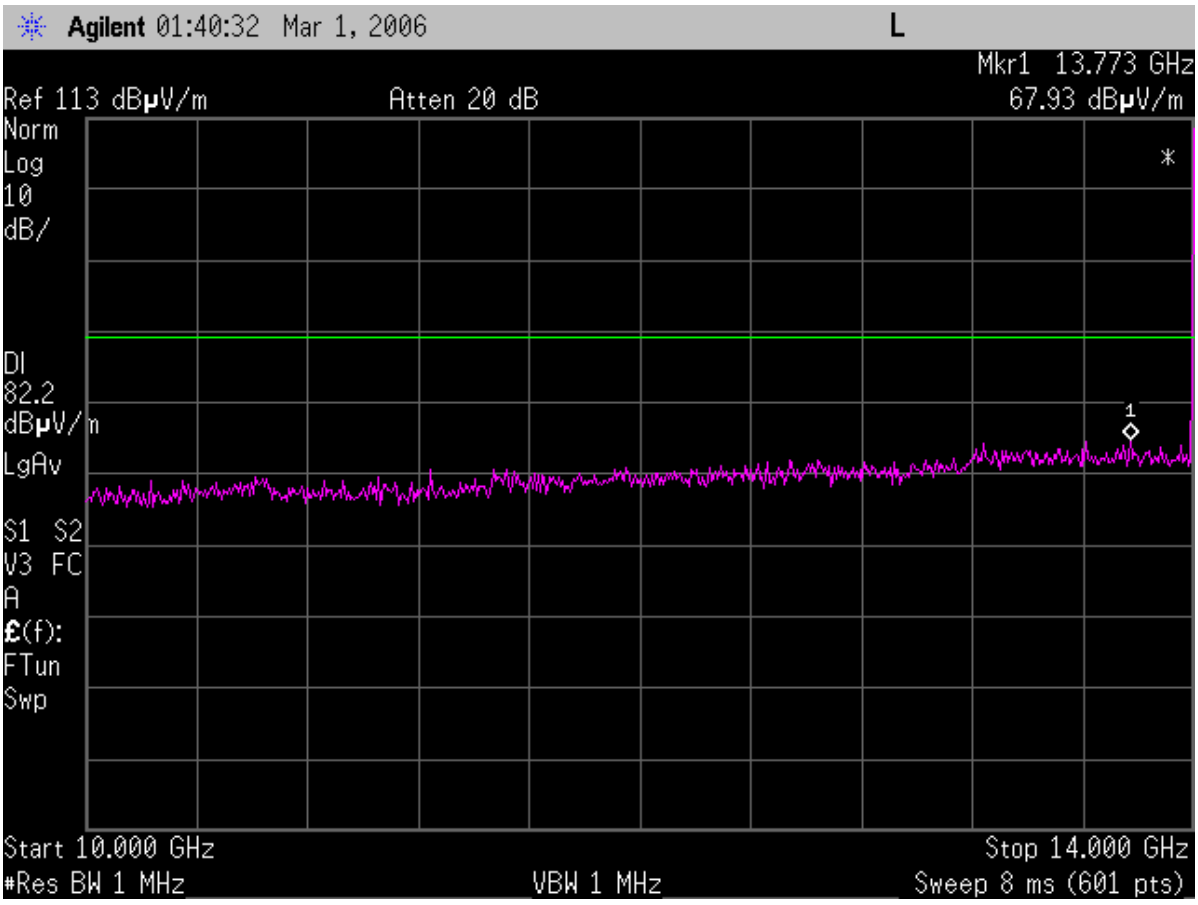


Figure D–36. Radiated spurious emission, H-pol, 10 – 14 GHz

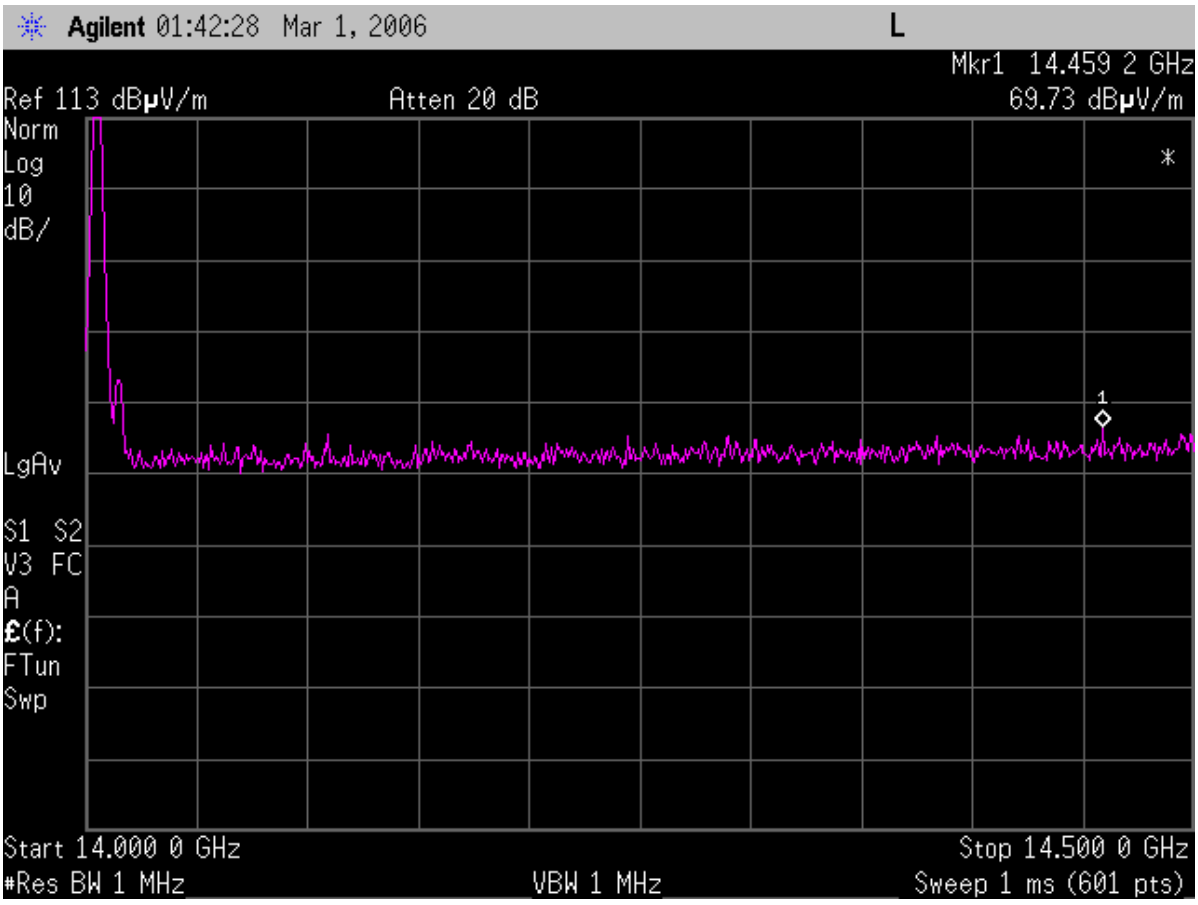


Figure D–37. Radiated spurious emission, H-pol, 14 – 14.5 GHz

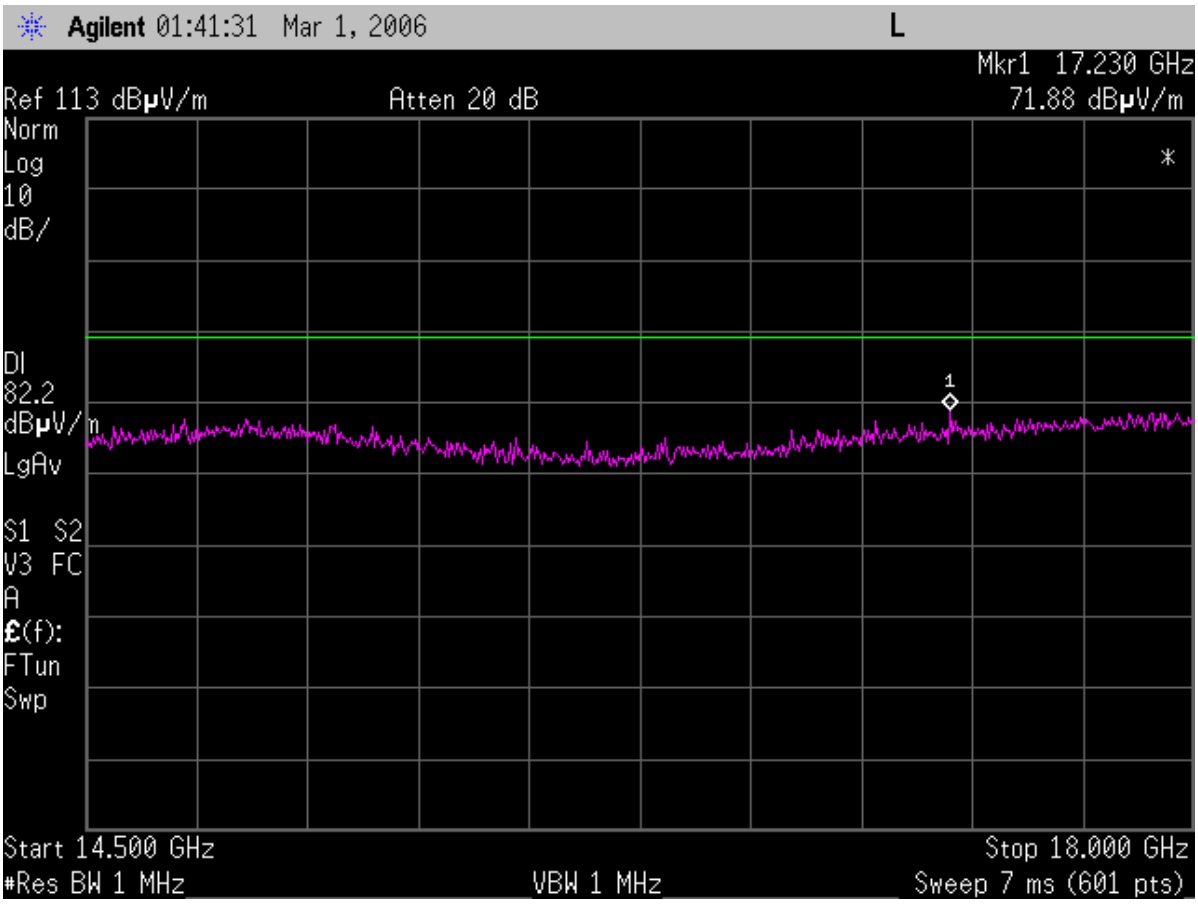


Figure D–38. Radiated spurious emission, H-pol, 14.5 – 18 GHz

D.7.2.3 Radiated spurious emissions at high channel state

The measurement results are shown in Figure D-39 through Figure D-46.

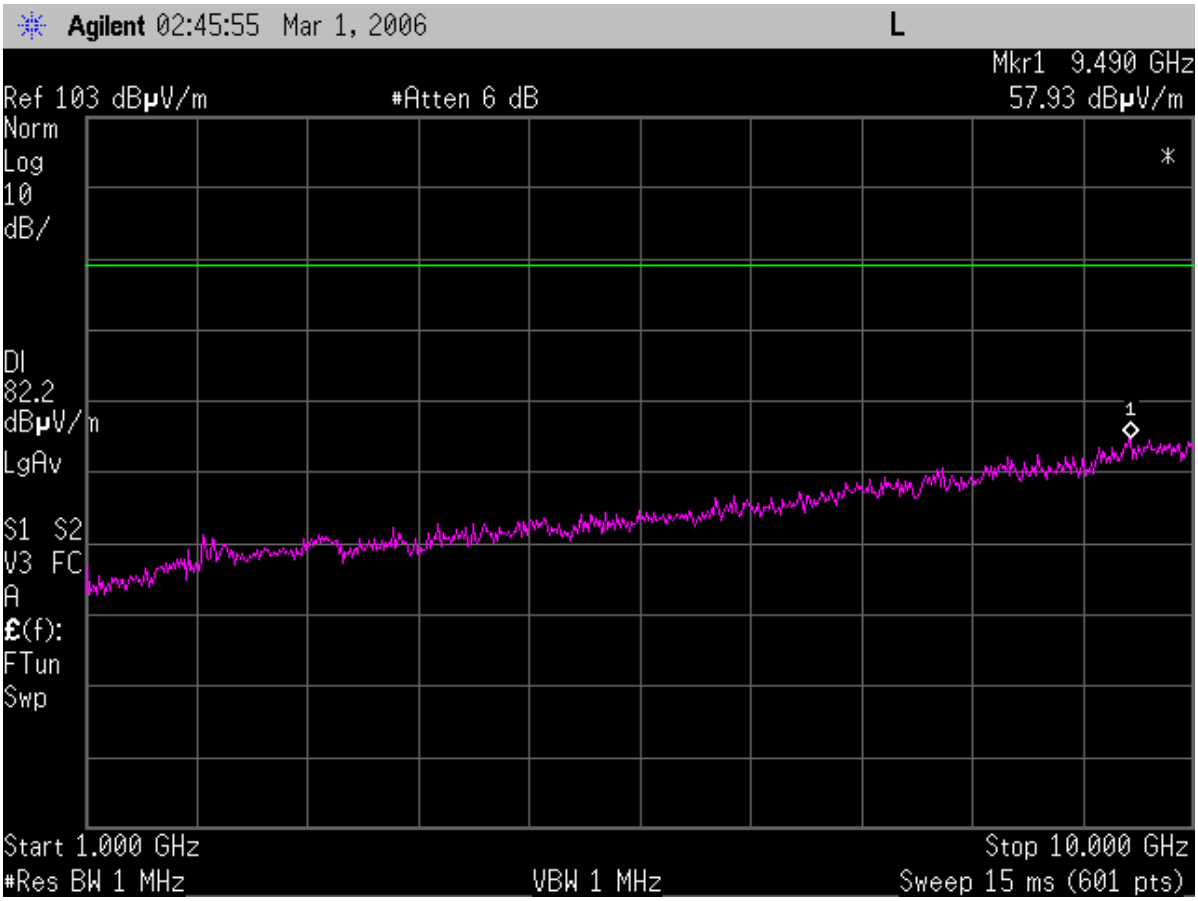


Figure D–39. Radiated spurious emission, V-pol, 1 – 10 GHz

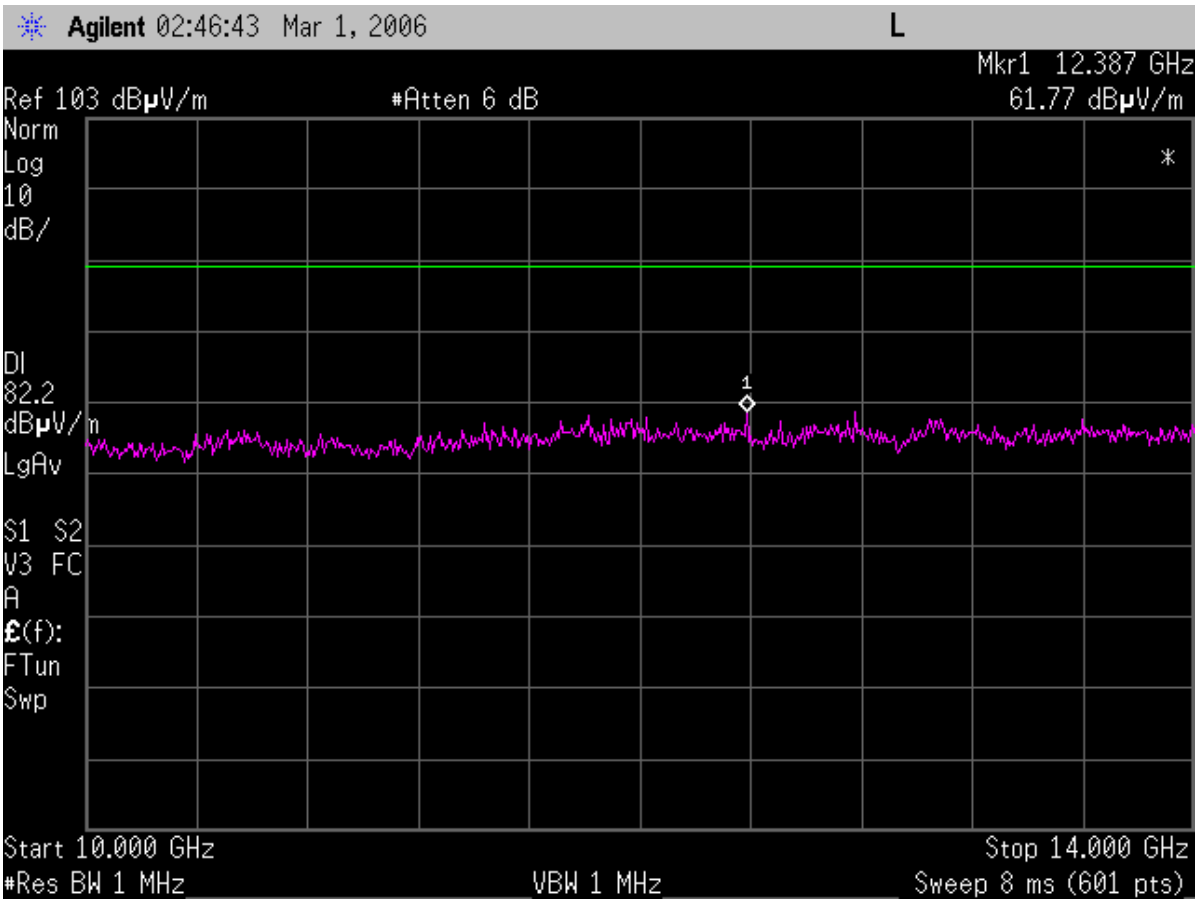


Figure D–40. Radiated spurious emission, V-pol, 10 – 14 GHz

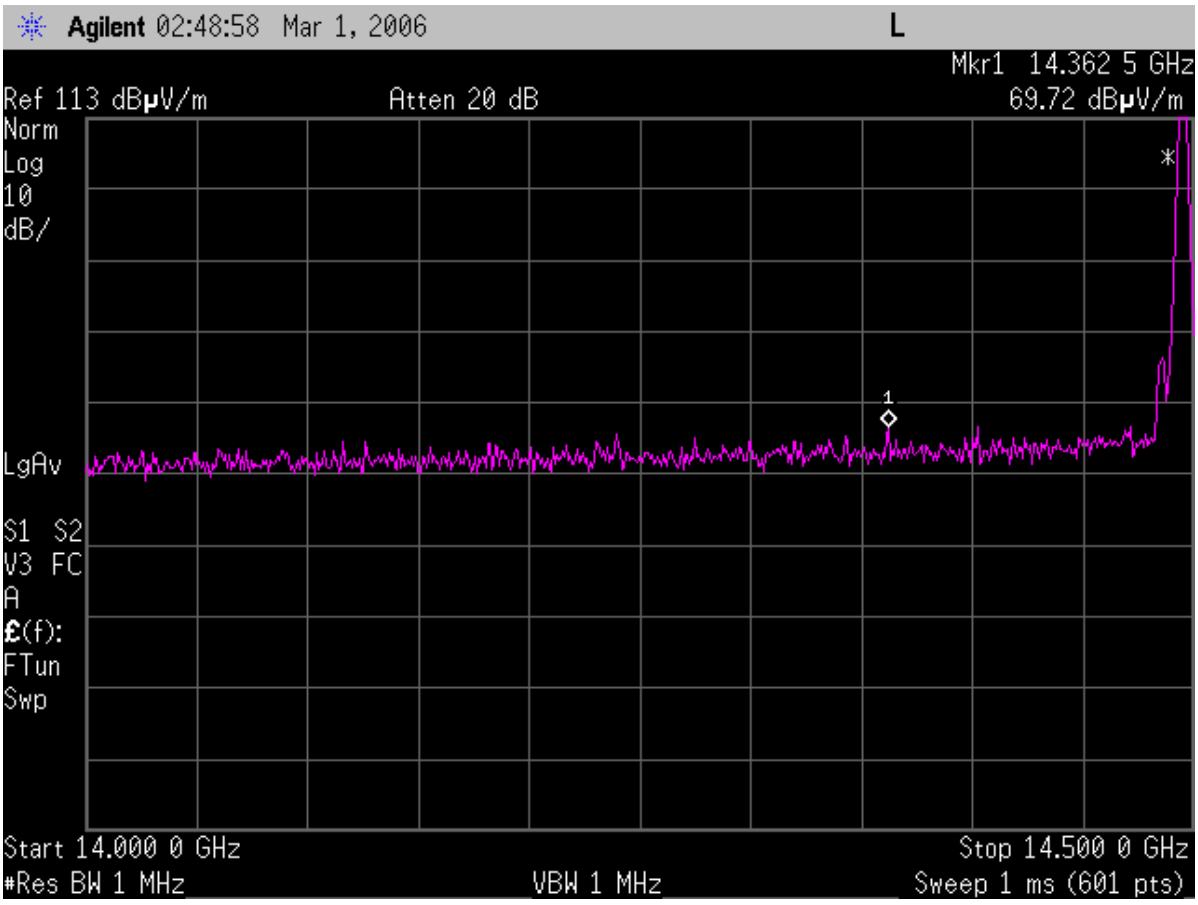


Figure D–41. Radiated spurious emission, V-pol, 14 – 14.5 GHz

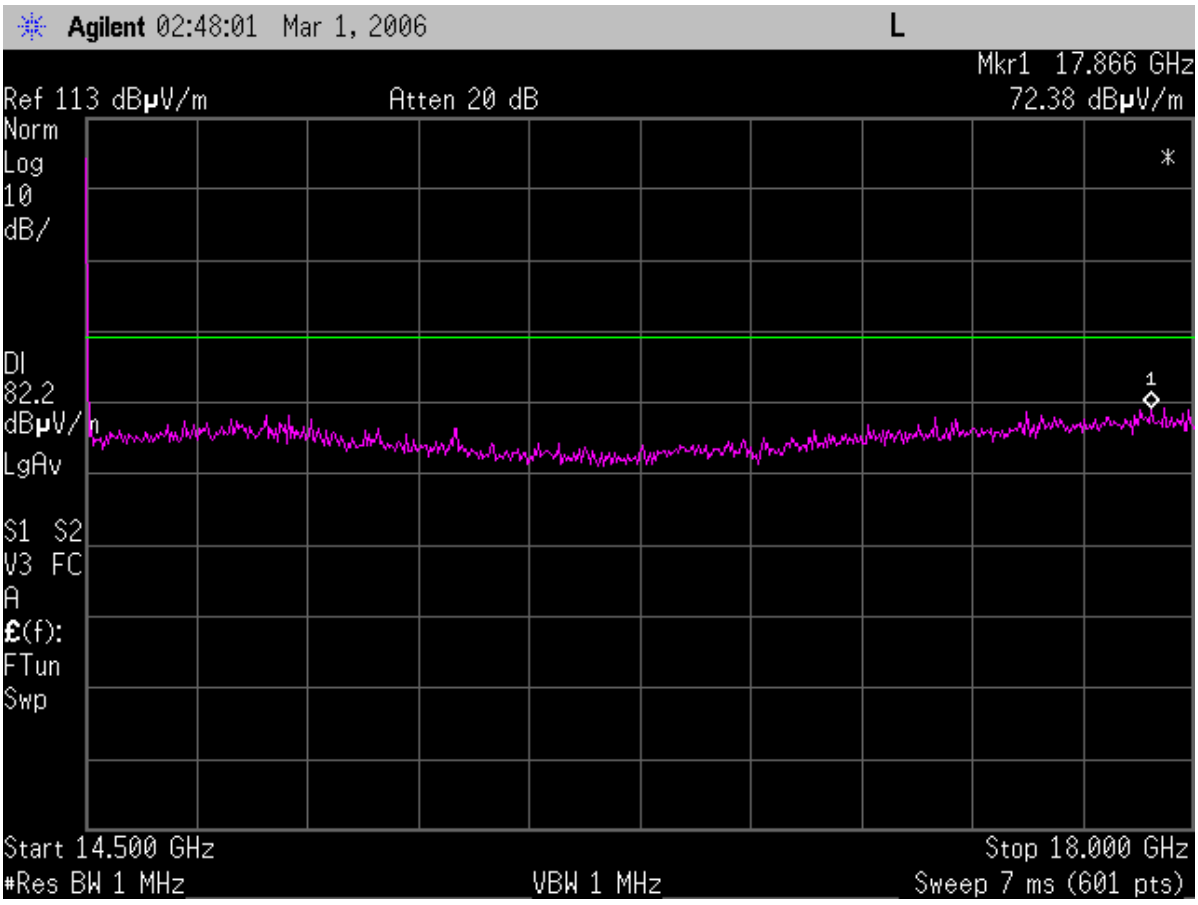


Figure D–42. Radiated spurious emission, V-pol, 14.5 – 18 GHz

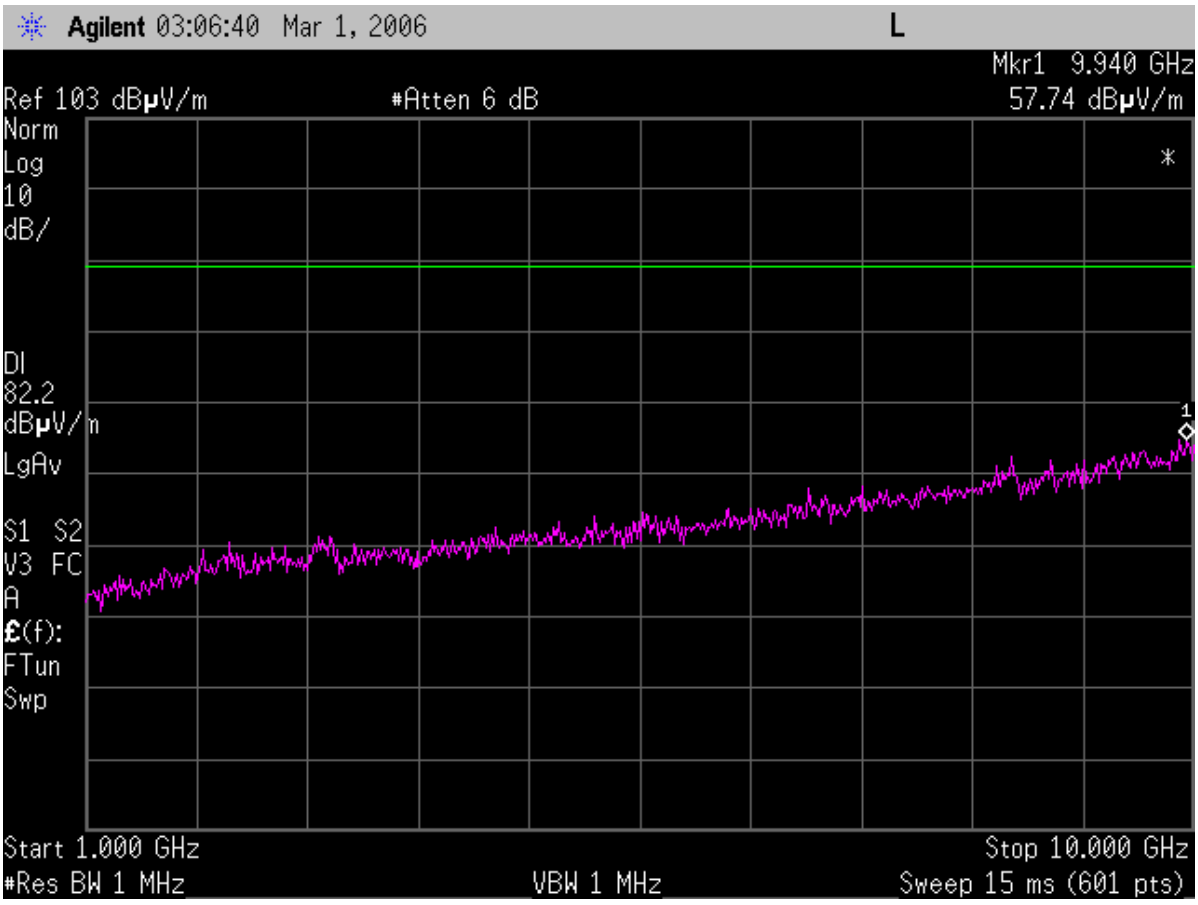


Figure D–43. Radiated spurious emission, H-pol, 1 – 10 GHz

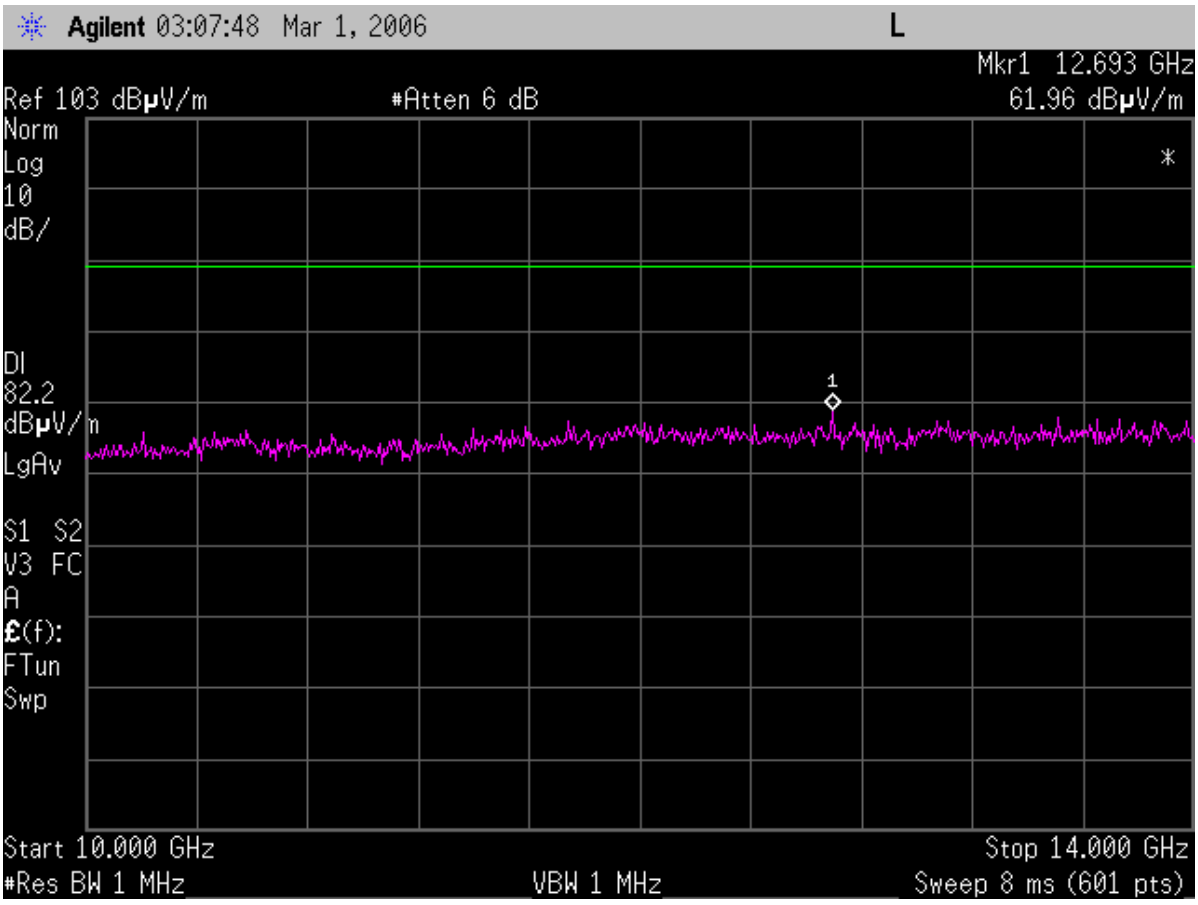


Figure D–44. Radiated spurious emission, H-pol, 10 – 14 GHz

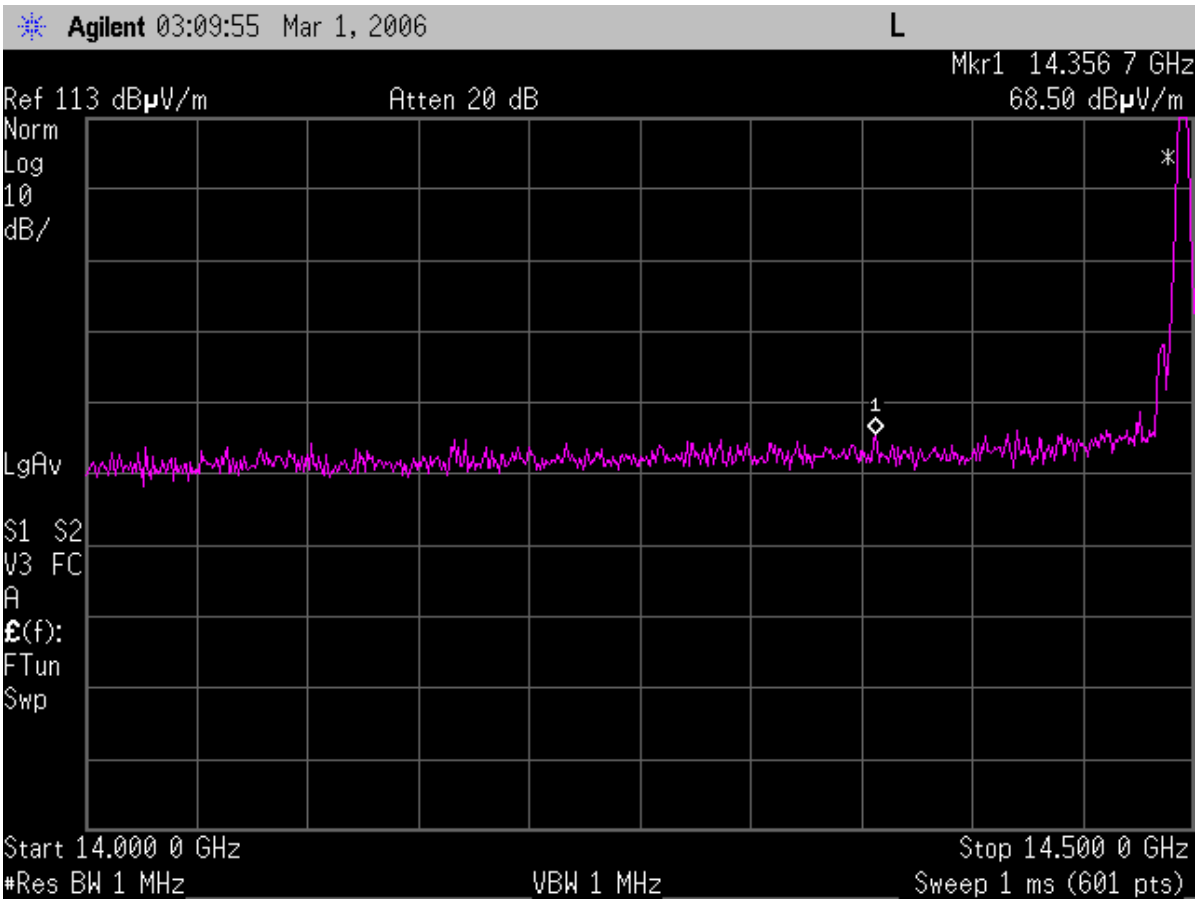


Figure D–45. Radiated spurious emission, H-pol, 14 – 14.5 GHz

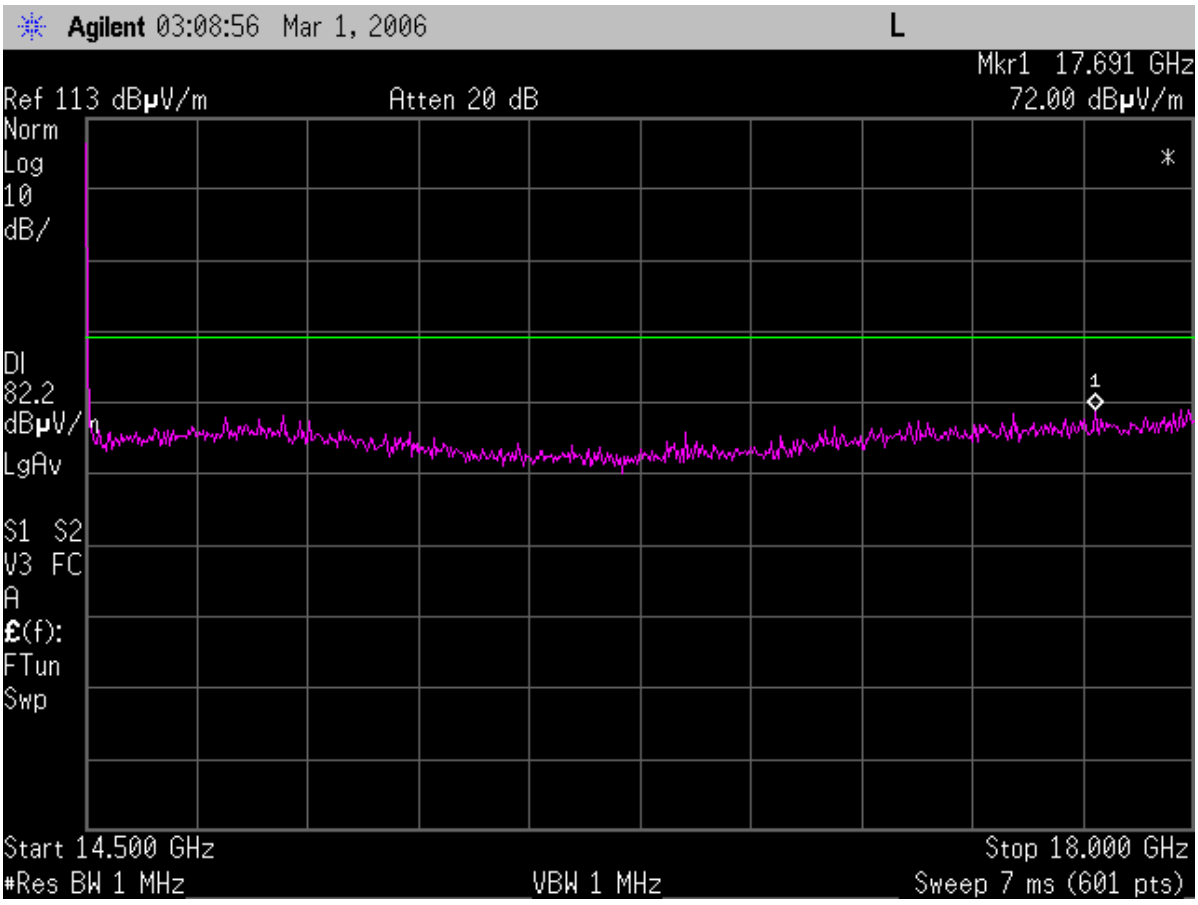


Figure D–46. Radiated spurious emission, H-pol, 10 – 18 GHz

D.8 Rule 2.1055/25.202(d) – Frequency Stability

D.8.1 Test procedure

Definition - The frequency stability is the ability of the transmitter to maintain an assigned carrier frequency against variation in ambient temperature and power supply.

Minimum Standard - The transmitter carrier frequency shall be maintained within ±10 ppm.

Method of Measurement - Use the spectrum analyzer to sample the transmitter RF output signal and measure its frequency under each specific temperature and power supply condition. Change the ambient temperature from –20°C to +60°C by step of 10°C, and vary the DC supply voltage to the equipment from 8.5, 10, to 11.5 V at each temperature. The measurement setup diagram is shown in Figure D-3.

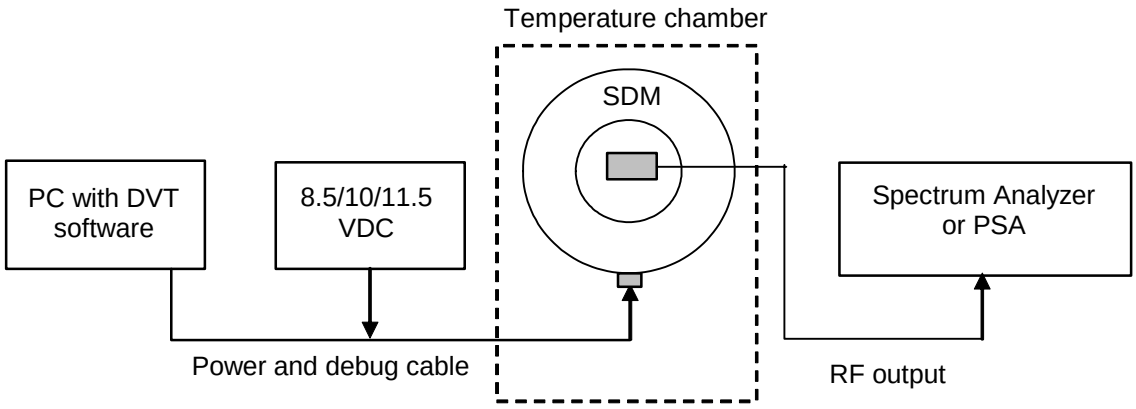


Figure D–47. Measurement setup for frequency stability

D.8.2 Measurement result

Frequency stability of the equipment versus changes in power supply (8.5V, 10V, 11.5V) and temperature (-40 °C to 80 °C) tested pursuant to FCC Part 2.1055. Measurement was conducted in CW mode. CSZ Dimension Series 60 Chamber was used to stabilize a specific temperature and HP 8563E spectrum analyzer was used to monitor frequency stability.

Table D–12. Offset (kHz) from carrier frequency of channel 14005 Mhz

Temperature (°C)	Current (A)	RF output (dBm)	Carrier offset (kHz) from 14,000 MHz			
			85% of PS (8.5V)	100% of PS (10V)	115% of PS (11.5V)	FCC limit (kHz)
-40	1.36	30.00	14.52	14.58	14.52	N/A
-30	1.20	28.40	9.22	9.25	9.20	±140
-20	1.40	27.90	4.20	4.18	4.70	±140
-10	1.20	28.20	3.10	3.08	3.30	±140
0	1.32	29.20	1.00	1.08	1.10	±140
10	1.36	29.70	1.20	1.33	1.40	±140
20	1.36	29.90	0.30	0.25	0.33	±140
30	1.36	30.10	-1.30	-1.50	-1.40	±140
40	1.37	30.30	-3.30	-3.20	-3.20	±140
50	1.37	30.10	-8.70	-7.80	-7.90	±140
60	1.37	30.20	-9.90	11.92	-11.00	N/A
70	1.37	30.30	-12.20	-12.40	-12.33	N/A
80	1.37	30.30	-16.80	-16.83	-16.55	N/A

Table D–13. Offset (kHz) from carrier frequency of channel 14495 Mhz

Temperature (°C)	Current (A)	RF output (dBm)	Carrier offset (kHz) from 14,500 MHz			
			85% of PS (8.5V)	100% of PS (10V)	115% of PS (11.5V)	FCC limit (kHz)
-40	1.36	24.60	12.17	12.67	12.37	N/A
-30	1.20	25.00	9.37	9.17	9.37	±140
-20	1.40	27.50	4.77	4.80	4.88	±140
-10	1.20	28.20	3.18	3.17	3.13	±140
0	1.32	28.90	1.58	1.50	1.53	±140
10	1.36	29.12	2.47	2.42	2.43	±140
20	1.36	29.20	0.37	0.33	0.37	±140
30	1.36	29.40	-0.87	-0.80	-0.87	±140
40	1.37	29.30	-4.13	-4.17	-4.27	±140
50	1.37	29.30	-8.83	-8.17	-8.87	±140
60	1.37	29.20	-12.37	-12.23	-12.23	N/A
70	1.37	29.10	-15.57	-15.42	-15.67	N/A
80	1.37	29.10	-16.97	-17.50	-17.97	N/A