

Appendix B
To
FCC Correspondence Reference Number 7111

New Test Data

Bosch Telecom CPE Roof Unit Transceiver
FCC ID: NNS3214864
FCC Form 731 Confirmation Number: EA92818

April 23, 1999

Antenna Conducted Emissions Testing of the Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

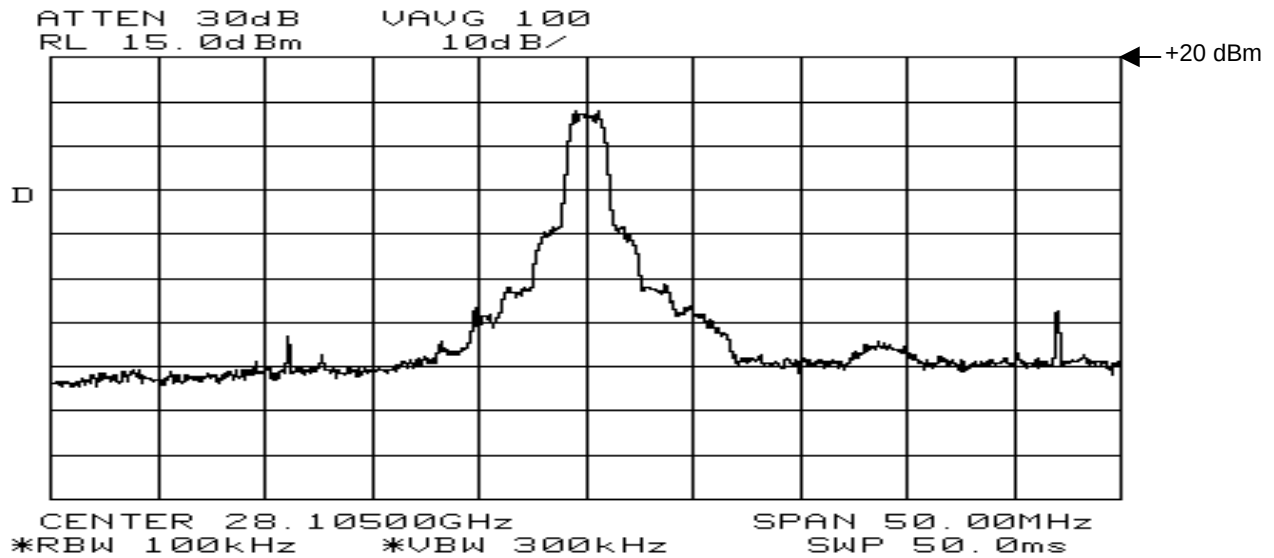


Figure 1a – Tuned Frequency = 28.107 GHz, Output Power = +20 dBm

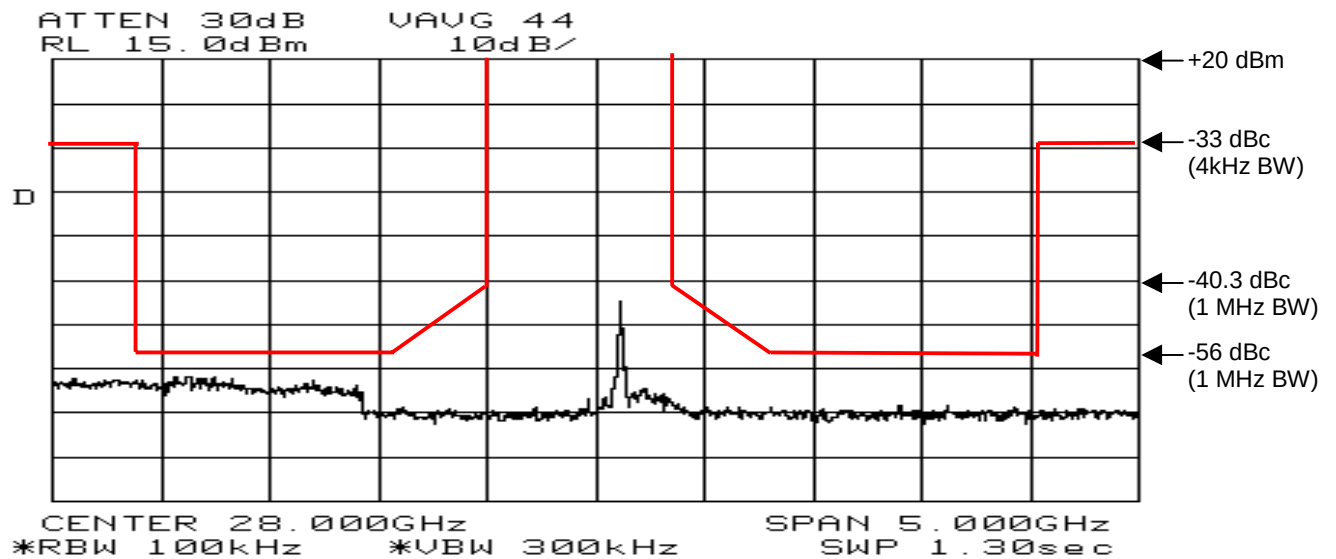


Figure 1b – Tuned Frequency = 28.107 GHz, Output Power = +20 dBm

Antenna Conducted Emissions Testing of the Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

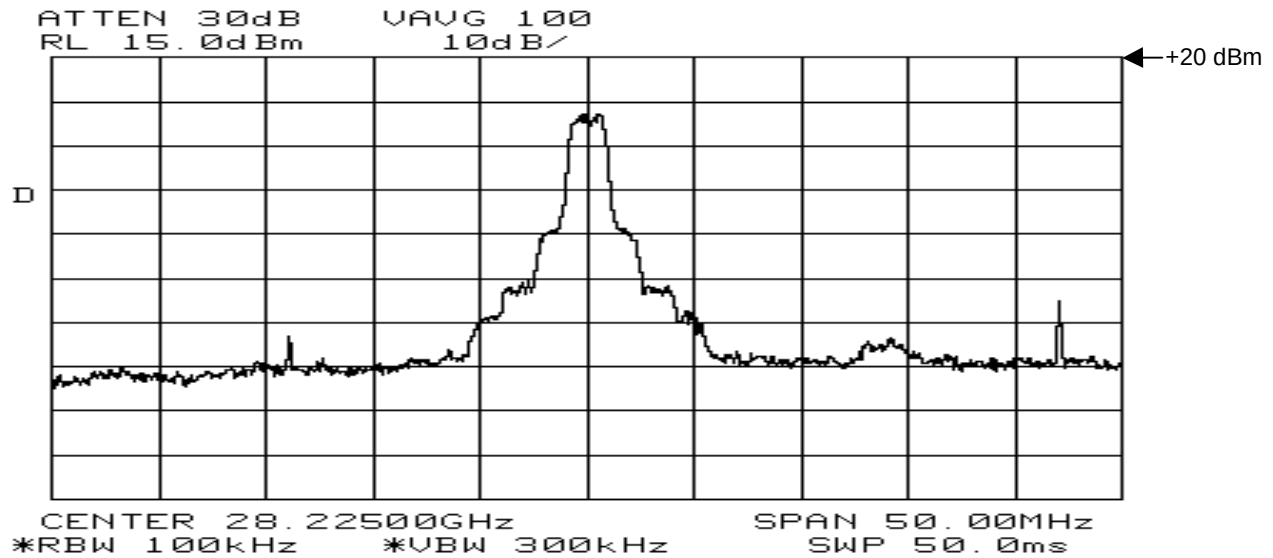


Figure 2a – Tuned Frequency = 28.225 GHz, Output Power = +20 dBm

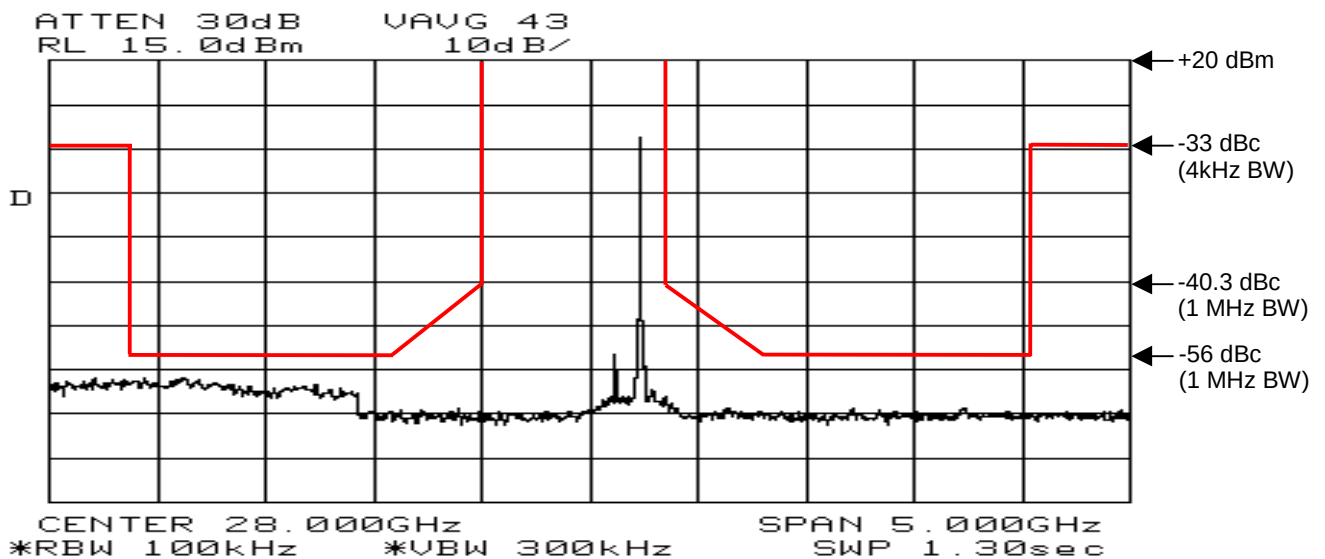


Figure 2b – Tuned Frequency = 28.225 GHz, Output Power = +20 dBm

Antenna Conducted Emissions Testing of the Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

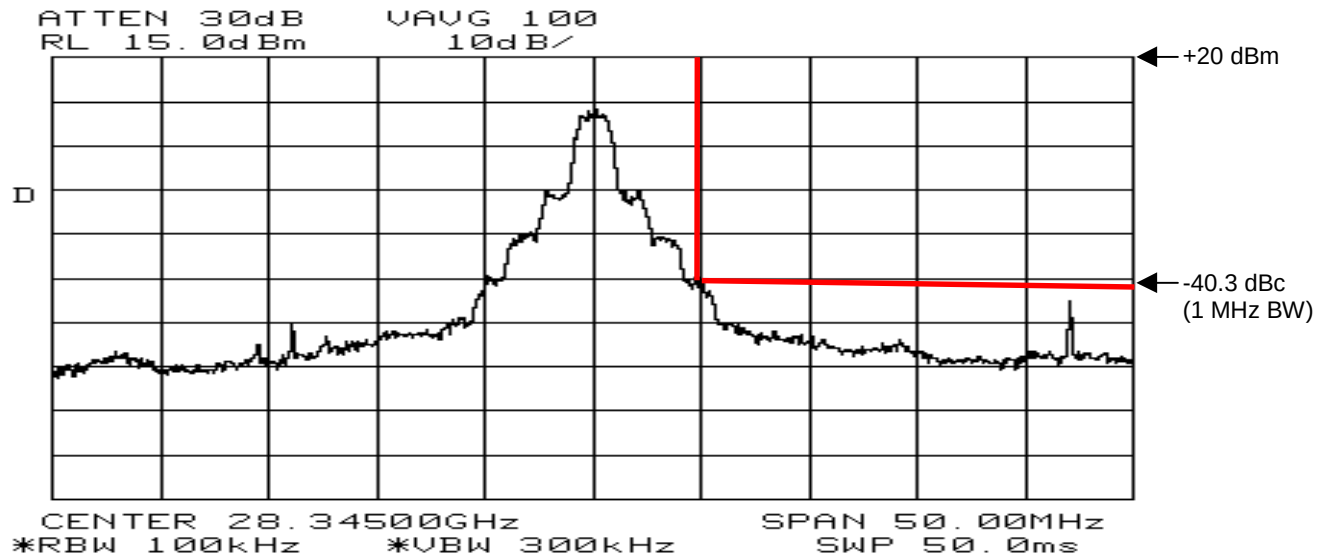


Figure 3a – Tuned Frequency = 28.345 GHz, Output Power = +20 dBm

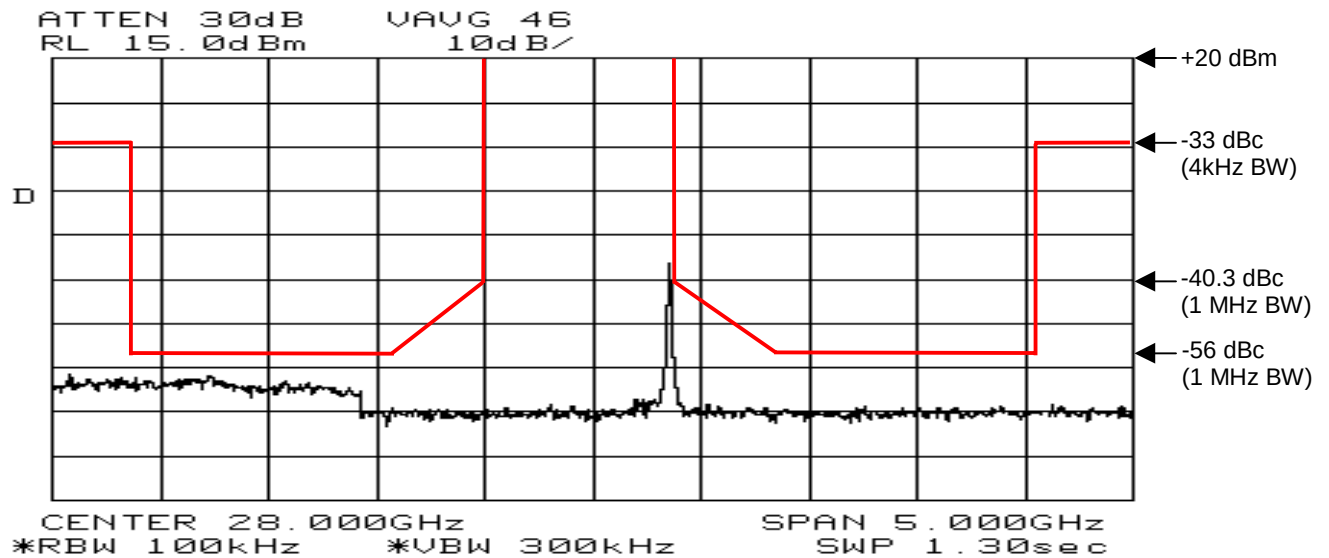


Figure 3a – Tuned Frequency = 28.345 GHz, Output Power = +20 dBm

Antenna Conducted Emissions Testing of the Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

Sample Calculations:

- a) General Limit per 101.111 (a) (2) (ii):

$$\begin{aligned} A &= 11 + 0.4 (P - 50) + 10 \log_{10} B & \text{where: } A &= \text{Attenuation} \\ &= 11 + 0 + 29.3 & B &= \text{Authorized} \\ &\text{Bandwidth} & & \\ &= 40.3 \text{ dB at } 27.500 \text{ GHz and } 28.350 \text{ GHz} & P &= \text{Percent of} \\ &\text{Bandwidth} & & \text{Removed from} \\ &\text{center} & & \text{Frequency} \end{aligned}$$
$$\begin{aligned} 56 &= 11 + 0.4 (P - 50) + 10 \log_{10} 850 \\ 56 &= 11 + 0.4 (P - 50) + 29.3 \\ P &= 15.7 / 0.4 + 50 = 89.25 \text{ Percent of } 850 \text{ MHz} \\ &= 758.625 \text{ MHz away from Bandcenter (i.e., } 27.166375 \text{ MHz and } 28.683625 \text{ MHz)} \end{aligned}$$

- b) Bandwidth Correction Factor for Broadband Signals within +/- 2.5 Bandwidths of Bandcenter:

Add $10 \log_{10} (1 \text{ MHz} / \text{Spectrum Analyzer RBW})$ to Attenuation

$$\text{BWCF} = 10 \log_{10} (1 \text{ MHz} / 100 \text{ kHz}) = 10 \text{ dB}$$

Therefore, the limit lines between 25.8 and 27.5 GHz and between 28.35 and 30.05 GHz are drawn 10 dB lower than calculations for Attenuation to compensate for Spectrum Analyzer Resolution Bandwidth (i.e., the limit line for – 56 dBc is shown 66 dB below the Reference Line and at Bandedge is shown 50.3 dB below the Reference Line).

- c) General Limit per 101.111 (a) (2) (iii):

$$\begin{aligned} A &= 43 + 10 \log_{10} (\text{Mean Output Power in Watts}) \\ &= 43 + 10 \log_{10} (0.1 \text{ Watts}) = 33 \text{ dB} \end{aligned}$$

- d) Bandwidth Correction Factor for Broadband Signals beyond +/- 2.5 Bandwidths from Bandcenter:

Add $10 \log_{10} (4 \text{ kHz} / \text{Spectrum Analyzer RBW})$ to Attenuation

$$\text{BWCF} = 10 \log_{10} (4 \text{ kHz} / 100 \text{ kHz}) = -14 \text{ dB}$$

Therefore, assuming the spectrum analyzer is setup for a Resolution Bandwidth (RBW) of 100 kHz, limit lines below 25.8 GHz and above 30.05 GHz are drawn 14 dB higher than calculations for Attenuation to compensate for Spectrum Analyzer Resolution Bandwidth (i.e., the limit line for this region is shown 19 dB below the Reference Line).

Also, limit lines between 25.8 and 30.05 GHz are drawn 10 dB lower than calculations for attenuation to compensate for the difference between the level of the trace with a 100 kHz RBW and the specification limit in terms of "per MHz".

Radiated Emissions Testing of the Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

Background:

In response to request for radiated emissions data from the Bosch CPE Roof Unit transceiver, the unit was tested under two conditions:

- 1) The Roof Unit was set up in the Bosch EMC Lab with the test (receiving) antenna location on the antenna boresight and at a test distance of 26 feet (7.92 meters) and operated at the low, midrange and upper frequencies of normal operation (28.105, 28.225 and 28.345 GHz). Measurements were performed over the –56 dB range of interest (25.8 to 30.05 GHz). This test distance was selected to insure measurements in the far-field. The test results are shown on Figures 4 through 7, pages B-10 through B-13.

Measurements of harmonics were performed over the –33 dB range of interest (33.05 to 100 GHz). Specific frequencies of interest were:

- Local Oscillator harmonics of 26.550 GHz: 53.100 and 79.650 GHz
- Harmonics of the Lowest tuned frequency of 28.107 GHz: 56.214 and 84.321 GHz
- Harmonics of the Mid-range frequency of 28.225 GHz: 56.450 and 84.675 GHz

The test results for harmonics are shown on page B-14.

- 2) The Roof Unit was set up in an indoor “open area” test range at the Rhein Texas in Plano, Texas, where measurements could be performed radially around the unit at a test distance of 3 meters. The unit was operated at the low, midrange and upper frequencies of normal operation (28.105, 28.225 and 28.345 GHz). Measurements were performed over the –56 dB range of interest (25.8 to 30.05 GHz). The test results are shown on pages B-15 to B-19.
- 3) The Roof Unit was set up in the Bosch EMC lab to evaluate RF radiated emissions from a modification to add a test connector (AGC Test Port Modification). The test antenna was positioned 3 meters from the rear of the unit; the unit was rotated to orient the unit for maximum indication radiation. The only observable indication was at the Local Oscillator frequency of 26.550 GHz. There was no observable change in level as a function of the tuned frequency. Test results are shown in Figure 12 on page B-20.

Sample calculations, determination of Specification limits and Spectrum Analyzer scans and are presented in this section.

Sample Calculations:

- 1) Reference Level for Carrier at test distance of 26 feet:

$$\begin{aligned} E &= (\text{Sq. Rt. } (49.2 * P)) / R & \text{where: } E &= \text{Field Intensity in V/m} \\ &= (\text{Sq. Rt. } (49.2 * 0.1)) / 7.92 & 49.2 &= 30 \times \text{Dipole gain over} \\ &= 0.280 \text{ V/m} & &\text{isotropic radiator} \\ &= 108.95 \text{ dB}\mu\text{V/m} & P &= \text{Output Power in Watts} \\ & & R &= \text{Distance to Test Antenna} \\ & & &\text{In meters} \end{aligned}$$

- 2) Reference Level for Carrier at test distance of 3 meters:

$$\begin{aligned} E &= (\text{Sq. Rt. } (49.2 * P)) / R \\ &= (\text{Sq. Rt. } (49.2 * 0.1)) / 3 \\ &= 0.739369 \text{ V/m} \\ &= 117.37 \text{ dB}\mu\text{V/m} \end{aligned}$$

- 3) Measurement of Radiated Emissions:

$$\text{Final Corrected Level} = \text{Measured Level (dB}\mu\text{V)} + (\text{Total Correction Factors})$$

$$\text{where: Total Correction Factors} = \text{Antenna Correction Factor (dB/m)} + \text{Cable Loss (dB)} - \text{Amplifier Gain (dB)}$$

Determination of Specification Limits for Compliance with FCC Part 101

The limit lines superimposed on the Spectrum Analyzer display scans have been converted to terms of “measured level” to facilitate direct comparison.

A further correction factor is required to compensate for the difference between “limit bandwidths” and Spectrum Analyzer resolution bandwidths. The limits of Part 101 paragraph 101.111 (a) (2) are in terms of “4 kHz bandwidth” for test frequencies below 25.8 GHz and above 30.05 GHz and in terms of “1 MHz bandwidth” for test frequencies between 25.8 and 30.05 GHz. Therefore a “Bandwidth Correction Factor” is necessary in these regions which has been applied in the limit line conversion of $10 \text{ Log}_{10} (100 \text{ kHz} / 1 \text{ MHz})$ and $10 \text{ Log}_{10} (100 \text{ kHz} / 4 \text{ kHz})$ respectively, where “100 kHz” is the resolution bandwidth of the Spectrum Analyzer.

- 1) In the region immediately below 25.8 GHz, the limit in terms of “measured level” is:

$$\begin{aligned} \text{Limit} &= \text{Reference Level} - 33 \text{ dB} - (\text{Total Correction Factors}) + 14 \text{ dB} \\ &= 108.95 \text{ dB}\mu\text{V} - 33 \text{ dB} - (-1.20) \text{ dB/m} + 14 \text{ dB} = 91.15 \text{ dB}\mu\text{V} \text{ for Test 1} \\ &= 117.37 \text{ dB}\mu\text{V} - 33 \text{ dB} - (-2.86) \text{ dB/m} + 14 \text{ dB} = 101.23 \text{ dB}\mu\text{V} \text{ for Test 2} \end{aligned}$$

- 2) In the region immediately above 25.8 GHz, the limit in terms of “measured level” is:

$$\begin{aligned} \text{Limit} &= \text{Reference Level} - 56 \text{ dB} - (\text{Total Correction Factors}) - 10 \text{ dB} \\ &= 108.95 \text{ dB}\mu\text{V} - 56 \text{ dB} - (-1.20) \text{ dB/m} - 10 \text{ dB} = 44.15 \text{ dB}\mu\text{V} \text{ for Test 1} \\ &= 117.37 \text{ dB}\mu\text{V} - 56 \text{ dB} - (-2.86) \text{ dB/m} - 10 \text{ dB} = 54.23 \text{ dB}\mu\text{V} \text{ for Test 2} \end{aligned}$$

- 3) At 27.17 GHz, the limit in terms of “measured level” is:

$$\begin{aligned} \text{Limit} &= \text{Reference Level} - 56 \text{ dB} - (\text{Total Correction Factors}) - 10 \text{ dB} \\ &= 108.95 \text{ dB}\mu\text{V} - 56 \text{ dB} - (-0.50) \text{ dB/m} - 10 \text{ dB} = 43.45 \text{ dB}\mu\text{V} \text{ for Test 1} \\ &= 117.37 \text{ dB}\mu\text{V} - 56 \text{ dB} - (-2.12) \text{ dB/m} - 10 \text{ dB} = 53.49 \text{ dB}\mu\text{V} \text{ for Test 2} \end{aligned}$$

4) At 27.50 GHz, the limit in terms of “measured level” is:

$$\begin{aligned}\text{Limit} &= \text{Reference Level} - 40.3 \text{ dB} - (\text{Total Correction Factors}) - 10 \text{ dB} \\ &= 108.95 \text{ dB}\mu\text{V} - 40.3 \text{ dB} - (-0.50) \text{ dB/m} - 10 \text{ dB} = 59.15 \text{ dB}\mu\text{V} \text{ for Test 1} \\ &= 117.37 \text{ dB}\mu\text{V} - 40.3 \text{ dB} - (-1.95) \text{ dB/m} - 10 \text{ dB} = 69.02 \text{ dB}\mu\text{V} \text{ for Test 2}\end{aligned}$$

5) At 28.35 GHz, the limit in terms of “measured level” is:

$$\begin{aligned}\text{Limit} &= \text{Reference Level} - 40.3 \text{ dB} - (\text{Total Correction Factors}) - 10 \text{ dB for Test 1} \\ &= 108.95 \text{ dB}\mu\text{V} - 40.3 \text{ dB} - (0.20) \text{ dB/m} - 10 \text{ dB} = 58.45 \text{ dB}\mu\text{V} \text{ for Test 1} \\ &= 117.37 \text{ dB}\mu\text{V} - 40.3 \text{ dB} - (-1.60) \text{ dB/m} - 10 \text{ dB} = 66.87 \text{ dB}\mu\text{V} \text{ for Test 2}\end{aligned}$$

6) At 28.66 GHz, the limit in terms of “measured level” is:

$$\begin{aligned}\text{Limit} &= \text{Reference Level} - 56 \text{ dB} - (\text{Total Correction Factors}) - 10 \text{ dB} \\ &= 108.95 \text{ dB}\mu\text{V} - 56 \text{ dB} - (0.90) \text{ dB/m} - 10 \text{ dB} = 42.05 \text{ dB}\mu\text{V} \text{ for Test 1} \\ &= 117.37 \text{ dB}\mu\text{V} - 56 \text{ dB} - (-1.50) \text{ dB/m} - 10 \text{ dB} = 50.47 \text{ dB}\mu\text{V} \text{ for Test 2}\end{aligned}$$

7) In the region immediately below 30.05 GHz, the limit in terms of “measured level” is:

$$\begin{aligned}\text{Limit} &= \text{Reference Level} - 56 \text{ dB} - (\text{Total Correction Factors}) - 10 \text{ dB} \\ &= 108.95 \text{ dB}\mu\text{V} - 56 \text{ dB} - (1.70) \text{ dB/m} - 10 \text{ dB} = 41.25 \text{ dB}\mu\text{V} \text{ for Test 1} \\ &= 117.37 \text{ dB}\mu\text{V} - 56 \text{ dB} - (-1.00) \text{ dB/m} - 10 \text{ dB} = 49.67 \text{ dB}\mu\text{V} \text{ for Test 2}\end{aligned}$$

8) In the region immediately above 30.05 GHz, the limit in terms of “measured level” is:

$$\begin{aligned}\text{Limit} &= \text{Reference Level} - 33 \text{ dB} - (\text{Total Correction Factors}) + 14 \text{ dB} \\ &= 108.95 \text{ dB}\mu\text{V} - 33 \text{ dB} - (1.70) \text{ dB/m} + 14 \text{ dB} = 88.25 \text{ dB}\mu\text{V} \text{ for Test 1} \\ &= 117.37 \text{ dB}\mu\text{V} - 33 \text{ dB} - (-1.00) \text{ dB/m} + 14 \text{ dB} = 96.67 \text{ dB}\mu\text{V} \text{ for Test 2}\end{aligned}$$

Radiated Emissions Testing of the Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

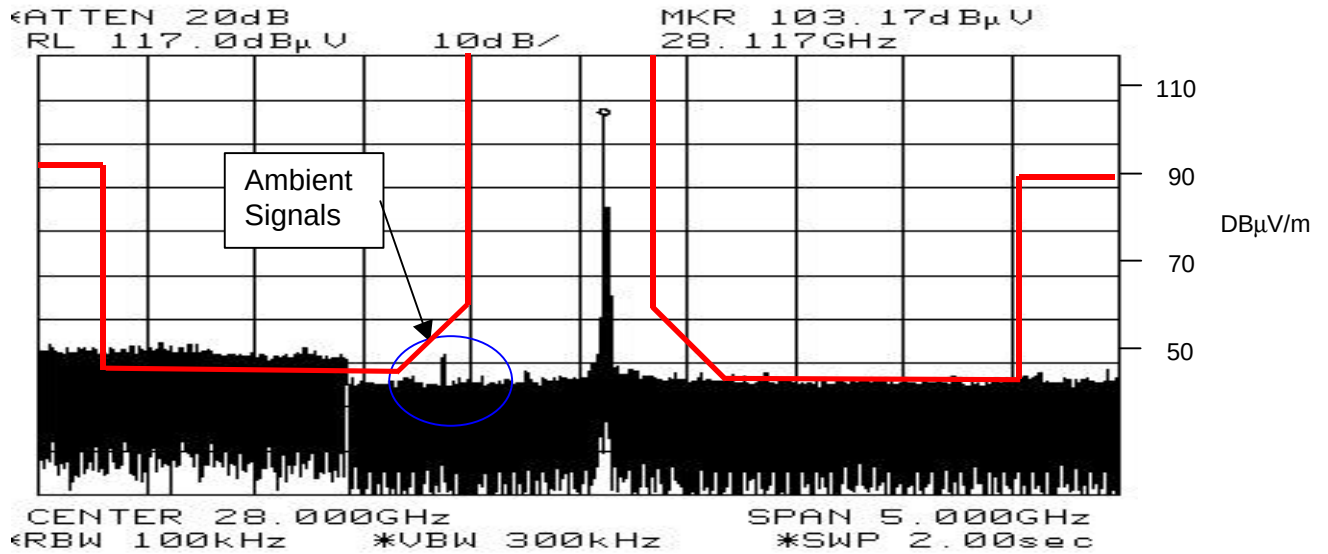


Figure 4a -- Test 1, Horizontally Polarized Test Antenna 26 Ft. from CPE Roof Unit, on Bore-site, Tuned Frequency = 28.105 GHz, +20 dBm Power Output

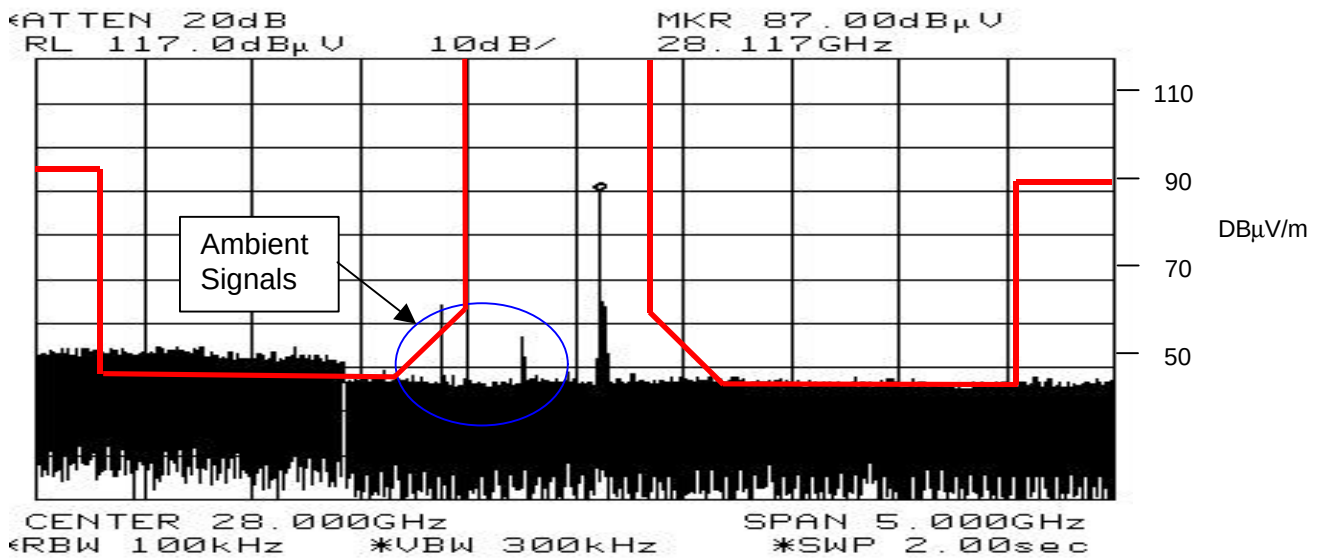


Figure 4b -- Test 1, Vertically Polarized Test Antenna 26 Ft. from CPE Roof Unit, on Bore-site, Tuned Frequency = 28.105 GHz, +20 dBm Power Output

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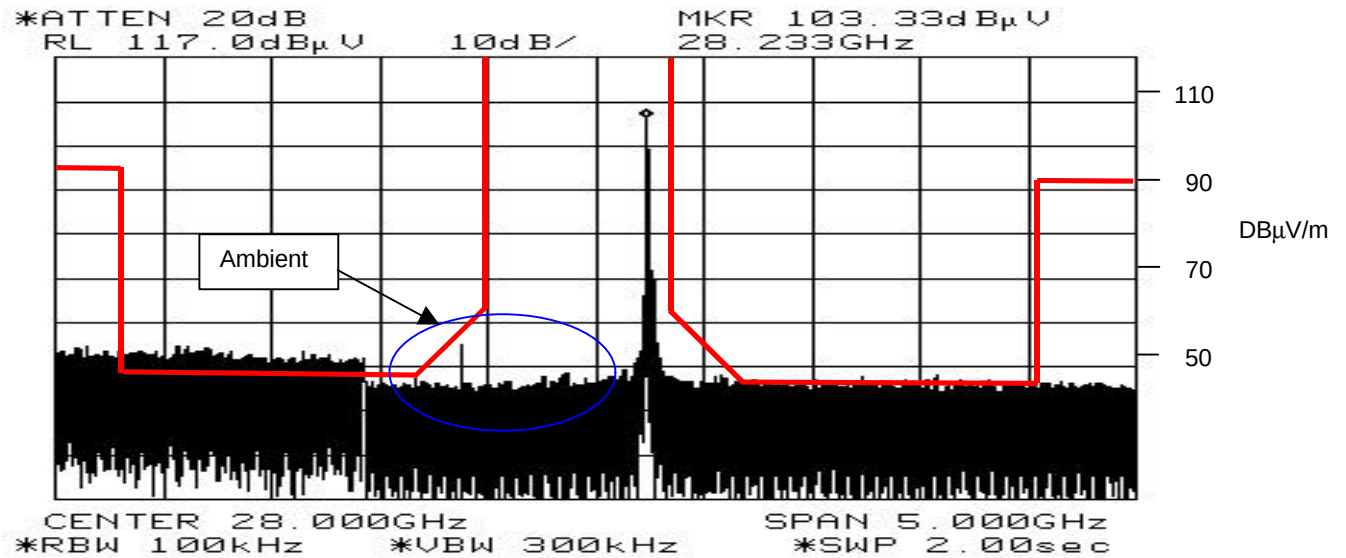


Figure 5a – Test 1, Vertically Polarized Test Antenna 26 Ft. from CPE Roof Unit, on Boresite, Tuned Frequency = 28.225 GHz, +20 dBm Power Output

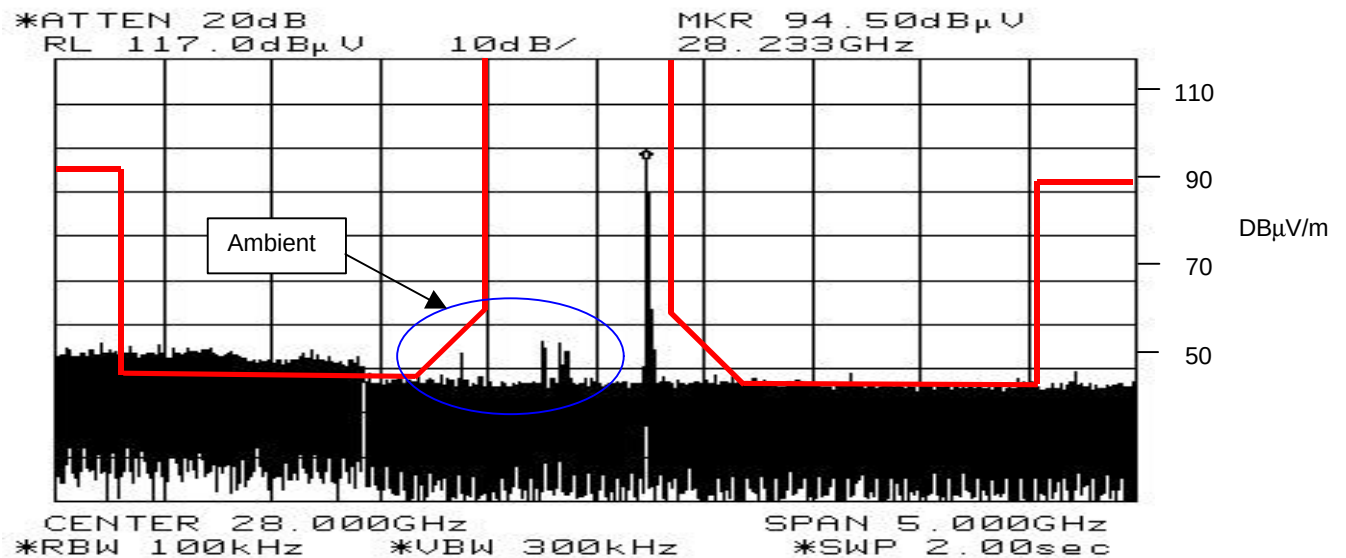


Figure 5b -- Test 1, Vertically Polarized Test Antenna 26 Ft. from CPE Roof Unit, on Boresite, Tuned Frequency = 28.225 GHz, +20 dBm Power Output

Radiated Emissions Testing of the Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

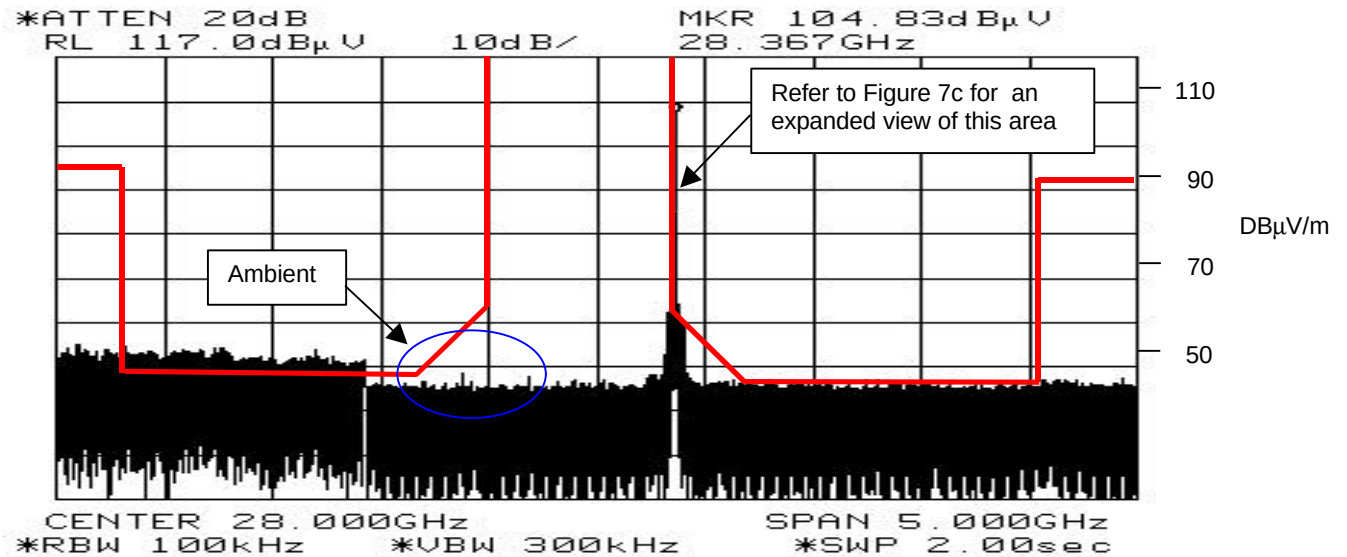


Figure 6a -- Test 1, Horizontally Polarized Test Antenna 26 Ft. from CPE Roof Unit, on Boresite, Tuned Frequency = 28.345 GHz, +20 dBm Power Output

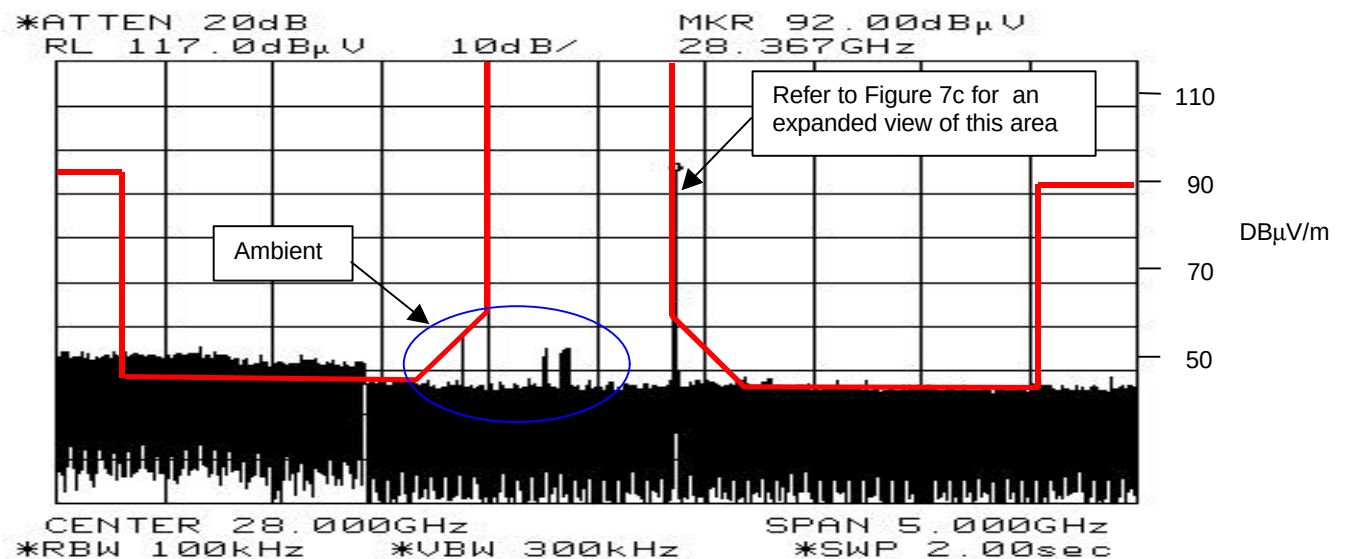


Figure 6b -- Test 1, Vertically Polarized Test Antenna 26 Ft. from CPE Roof Unit, on Boresite, Tuned Frequency = 28.345 GHz, +20 dBm Power Output

Radiated Emissions Testing of the Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

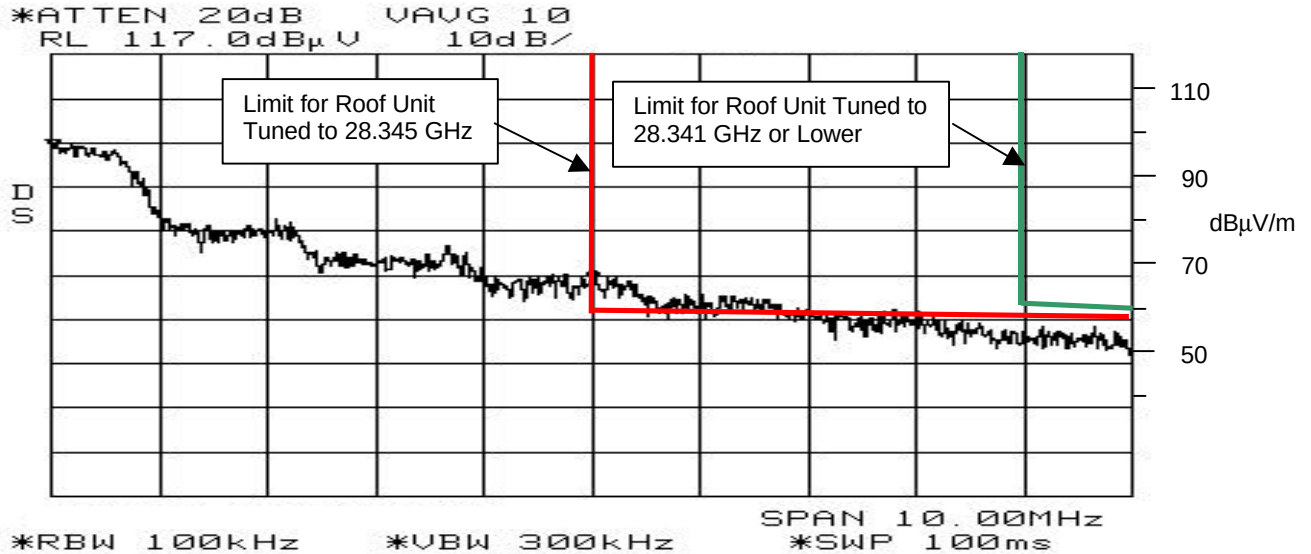


Figure 7c – Test 1, Horizontally Polarized Test Antenna 26 Ft. from CPE Roof Unit, on Boresite, Tuned Frequency = 28.345926 GHz, +20 dBm Power Output.

Restriction on Operation above 28.341926 GHz will insure that CPE Roof Unit is Fully Compliant with Part 101.111 Requirements.

Radiated Emissions Testing of the Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

Freq. (GHz)	Polarization (V or H)	Final Measured Level (dBμV/m/4kHz)	Attenuation (dBc)	FCC 2.993 Limit (dBc)	Margin (dB)	Comments
51.300	V	58.0	-50.94	-33	17.94	Noise Floor, 2 nd Harmonic of LO
56.214	V	58.3	-50.64	-33	17.64	Noise Floor, 2 nd Harmonic 28.107 GHz
56.450	V	58.4	-50.54	-33	17.54	Noise Floor, 2 nd Harmonic 28.225 GHz
56.690	V	58.8	-50.14	-33	17.14	Noise Floor, 2 nd Harmonic 28.345 GHz
79.650	V	65.3	-43.64	-33	10.64	Noise Floor, 3 rd Harmonic of LO
84.321	V	63.4	-45.54	-33	12.54	Noise Floor, 3 rd Harmonic 28.107 GHz
84.675	V	64.3	-44.64	-33	11.64	Noise Floor, 3 rd Harmonic 28.225 GHz
85.035	V	62.6	-43.34	-33	13.34	Noise Floor, 3 rd Harmonic 28.345 GHz
51.300	H	58.0	-50.94	-33	17.94	Noise Floor, 2 nd Harmonic of LO
56.214	H	58.3	-50.64	-33	17.64	Noise Floor, 2 nd Harmonic 28.107 GHz
56.450	H	60.4	-48.54	-33	15.54	Noise Floor, 2 nd Harmonic 28.225 GHz
56.690	H	59.0	-49.94	-33	16.94	Noise Floor, 2 nd Harmonic 28.345 GHz
79.650	H	63.6	-45.34	-33	12.34	Noise Floor, 3 rd Harmonic of LO
84.321	H	62.9	-46.04	-33	13.04	Noise Floor, 3 rd Harmonic 28.107 GHz
84.675	H	65.3	-43.64	-33	10.64	Noise Floor, 3 rd Harmonic 28.225 GHz
85.035	H	63.9	-45.04	-33	12.04	Noise Floor, 3 rd Harmonic 28.345 GHz

Radiated Emissions Testing of the Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

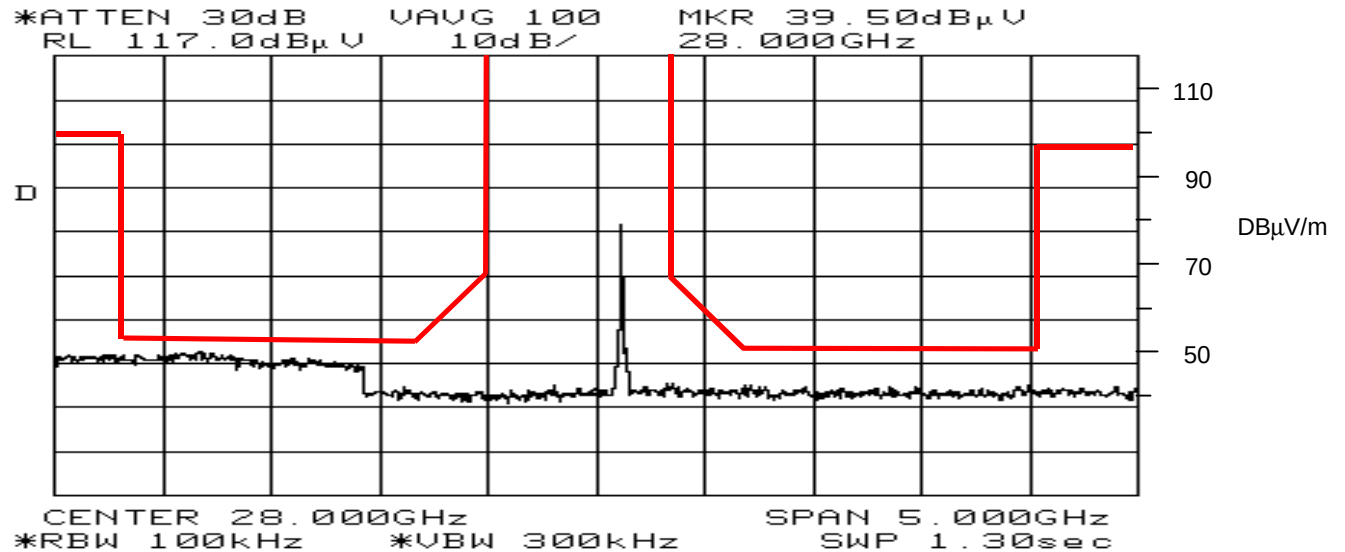


Figure 8a – Test 2, Vertically Polarized Test Antenna 3 meters from CPE Roof Unit, Tuned Frequency = 28.107 GHz, +20 dBm Power Output, Maximum Emission, Video Average On

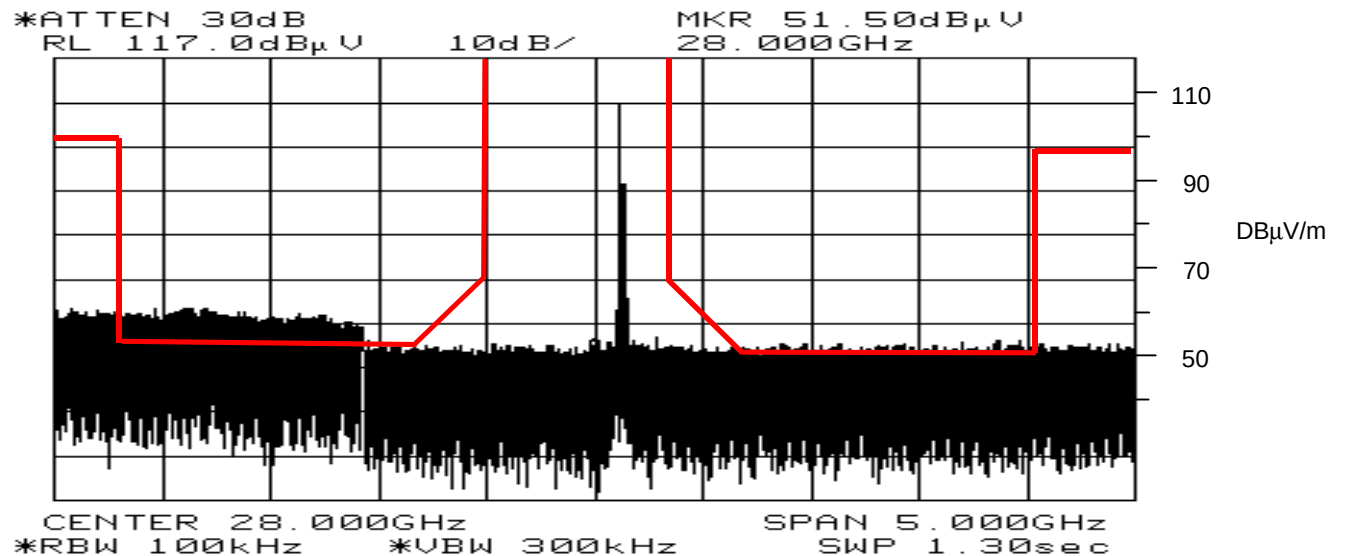


Figure 8b – Test 2, Vertically Polarized Test Antenna 3 meters from CPE Roof Unit, Tuned Frequency = 28.107 GHz, +20 dBm Power Output, Maximum Emission, Video Average Off

Radiated Emissions Testing of the Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

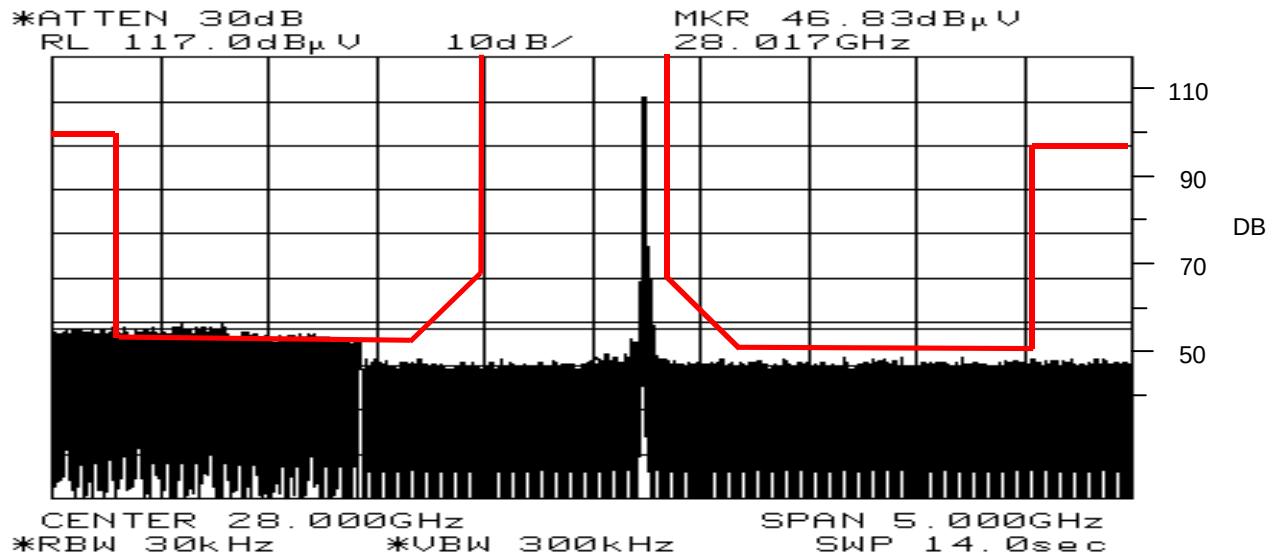


Figure 9a – Test 2: Horizontally Polarized Test Antenna 3 meters from CPE Roof Unit, Tuned Frequency = 28.225 GHz, +20 dBm Power Output, Maximum Emission, Video Average Off

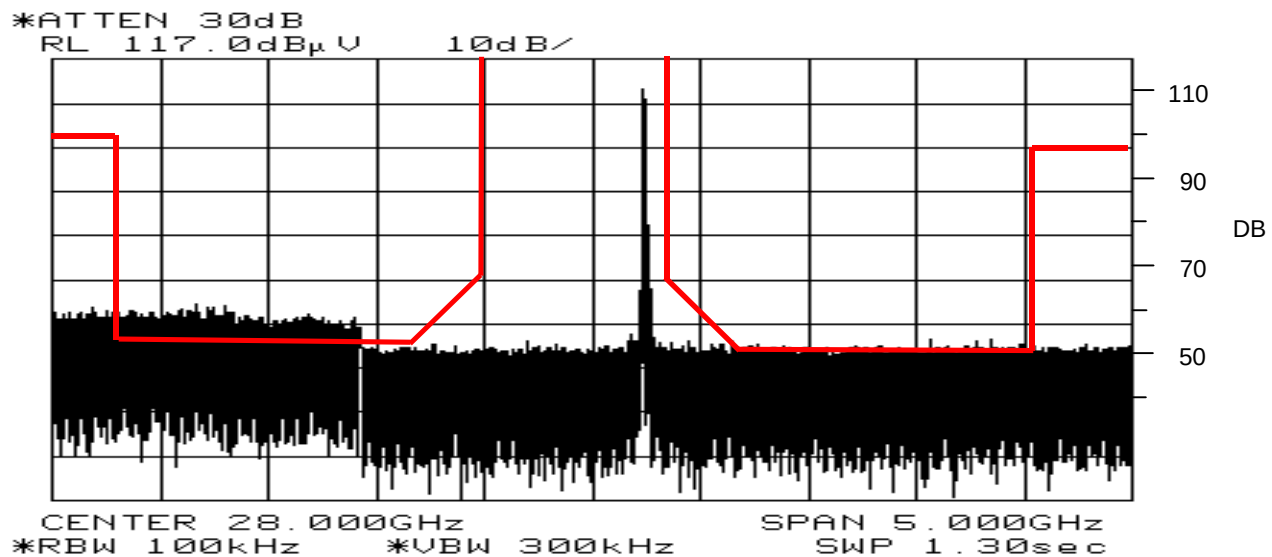


Figure 9b – Test 2: Vertically Polarized Test Antenna 3 meters from CPE Roof Unit, Tuned Frequency = 28.225 GHz, +20 dBm Power Output, Maximum Emission, Video Average Off

Radiated Emissions Testing of the Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

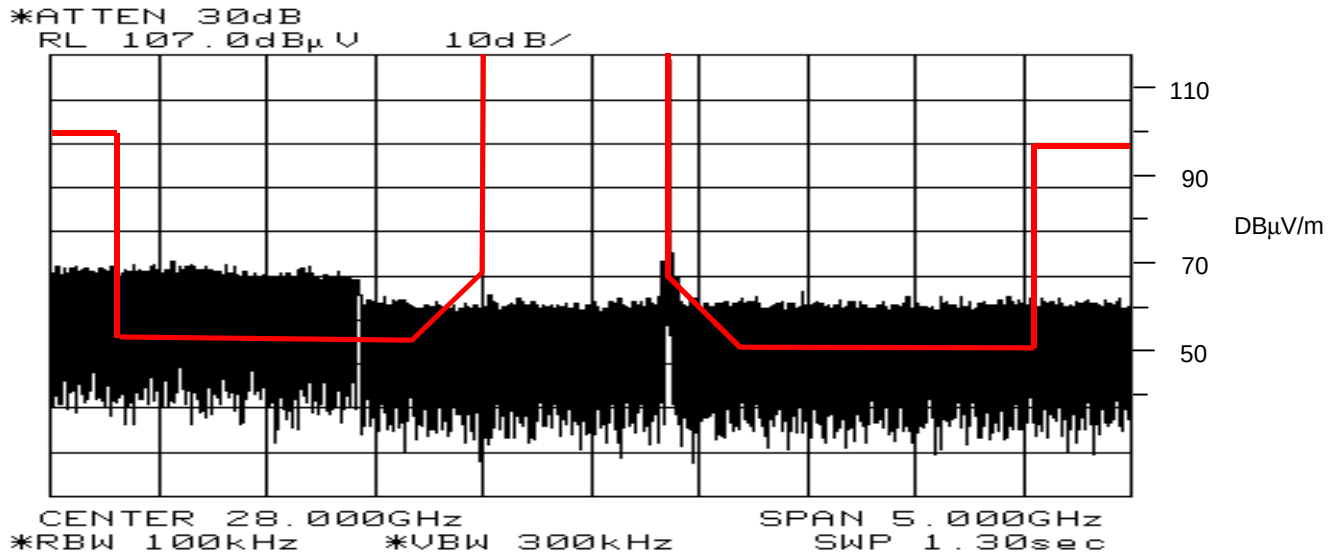


Figure 10a – Test 2: Vertically Polarized Test Antenna 3 meters from CPE Roof Unit, Tuned Frequency = 28.345 GHz, +20 dBm Power Output, Maximum Emission, Video Average Off

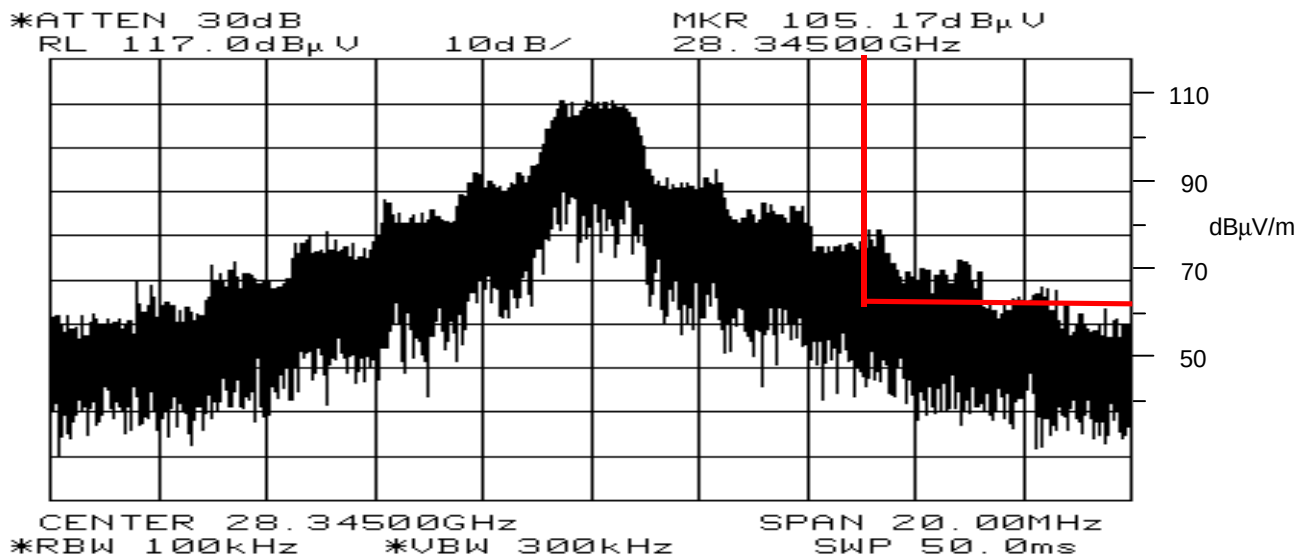


Figure 10b – Test 2: Vertically Polarized Test Antenna 3 meters from CPE Roof Unit, Tuned Frequency = 28.345 GHz, +20 dBm Power Output, Maximum Emission, Video Average Off

Radiated Emissions Testing of the Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

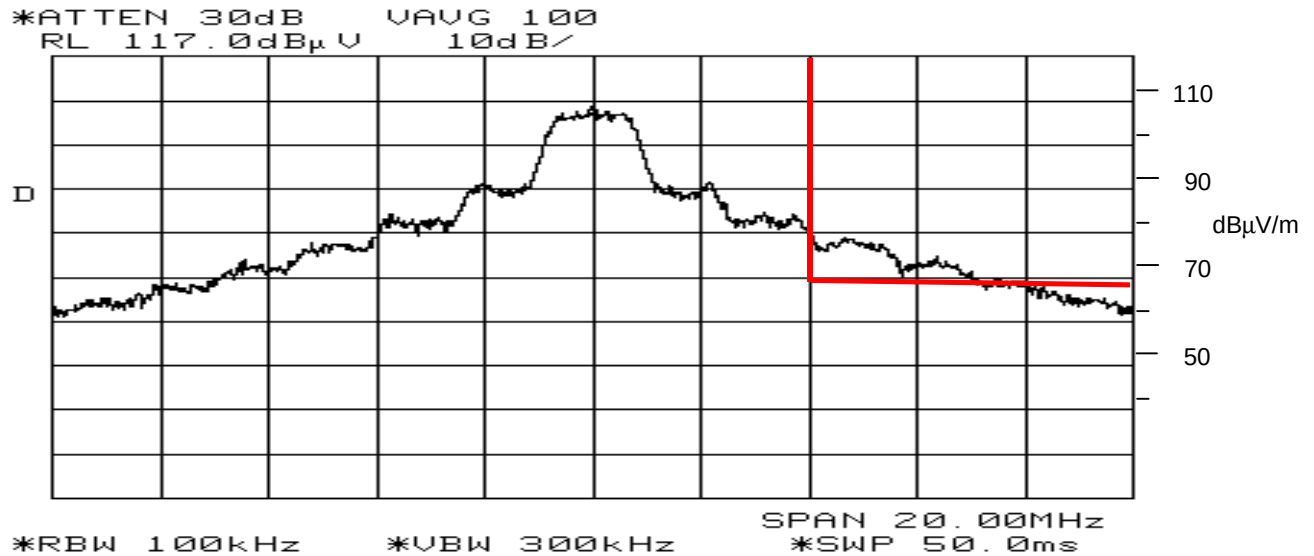


Figure 11a – Test 2: Vertically Polarized Test Antenna 3 meters from CPE Roof Unit, Tuned Frequency = 28.345926 GHz, +20 dBm Power Output, Maximum Emission, Video Average On

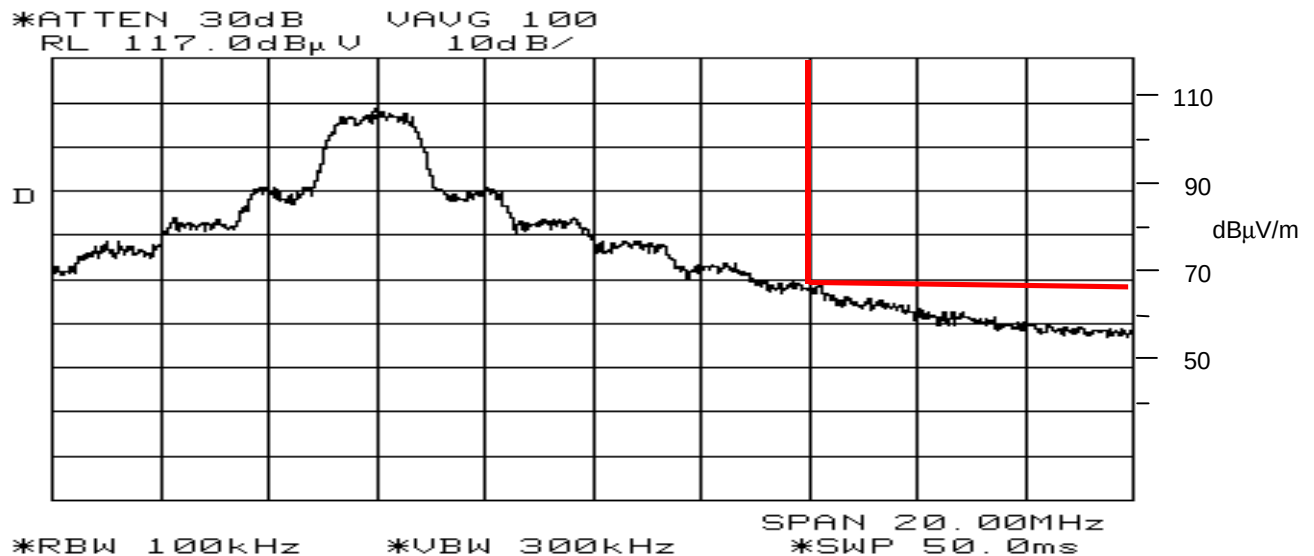


Figure 11b – Test 2: Vertically Polarized Test Antenna 3 meters from CPE Roof Unit, Tuned Frequency = 28.345926 GHz, +20 dBm Power Output, Maximum Emission, Video Average On

Effect of Not Transmitting on Highest Two “Channels” (28.343926 and 28.345926 GHz)

Radiated Emissions Testing
of the
Bosch CPE Roof Unit Transceiver, FCC ID NNS3214864

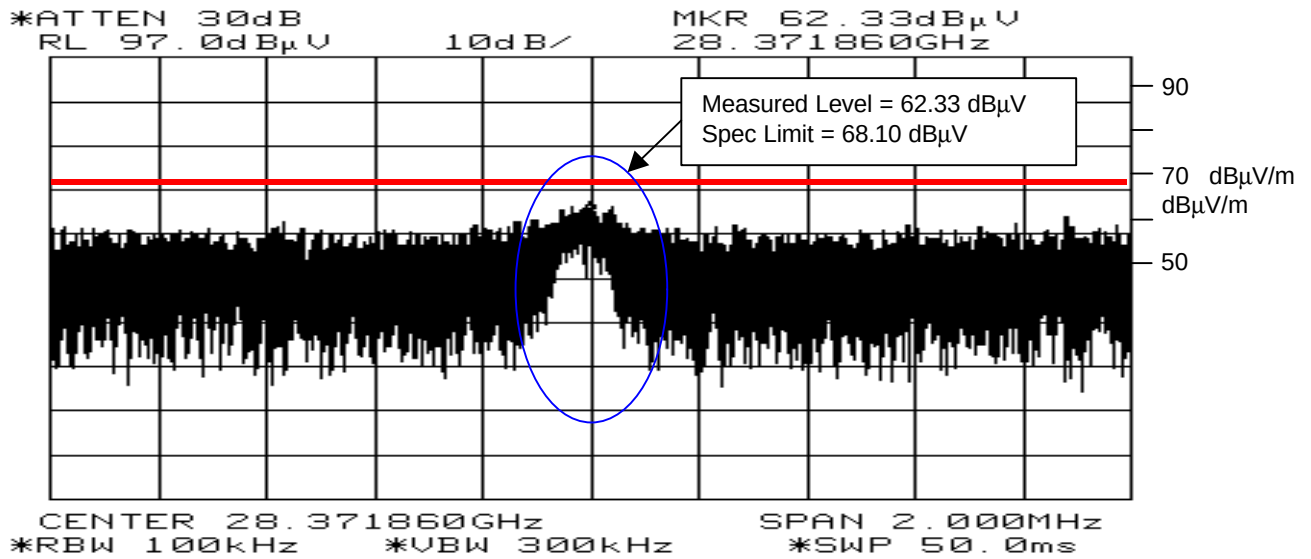


Figure 12 – Test 2, Vertically Polarized Test Antenna 3 meters from CPE Roof Unit, Tuned Frequency = 28.345 GHz, +20 dBm Power Output, Maximum Emission on Boresite, Video Average Off

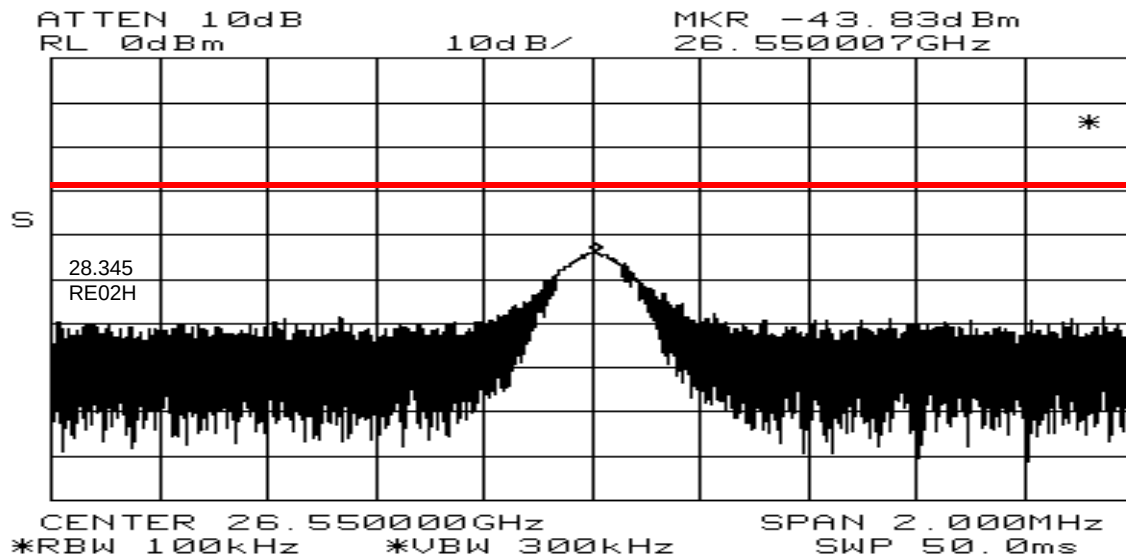


Figure 12a -- Test 3, Horizontally Polarized Test Antenna 3 meters from Rear of CPE Roof Unit, Tuned Frequency = 28.107 GHz, +20 dBm Power Output, Maximum Emission from Rear of CPE Roof Unit, Video Average Off

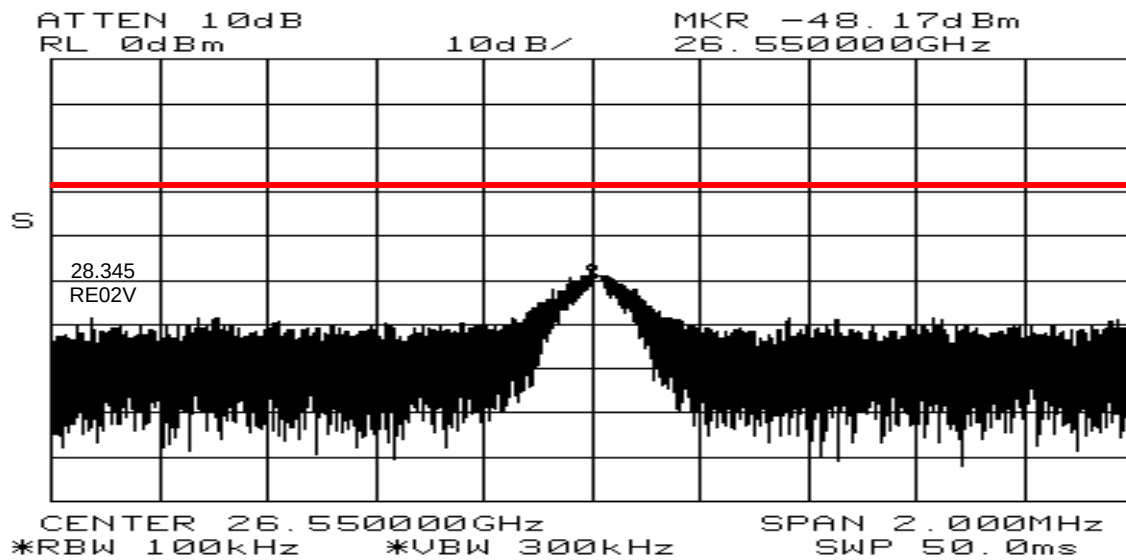


Figure 12b -- Test 3, Vertically Polarized Test Antenna 3 meters from Rear of CPE Roof Unit, Tuned Frequency = 28.107 GHz, +20 dBm Power Output, Maximum Emission from Rear of CPE Roof Unit, Video Average Off