Test data, continued

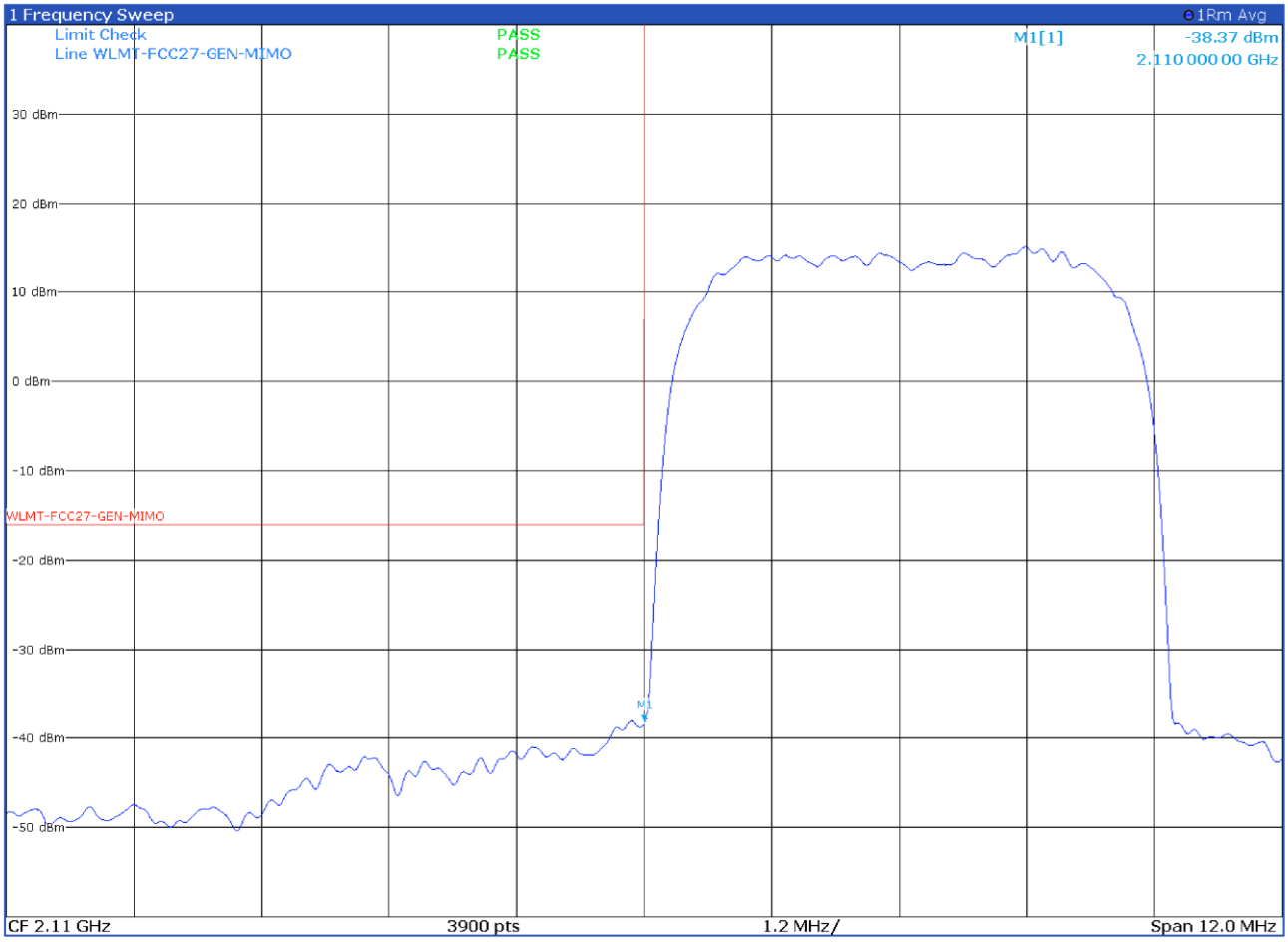


Figure 8.5-15: *Antenna port 2 single carrier lower block edge with input signal at AGC threshold*

Test data, continued

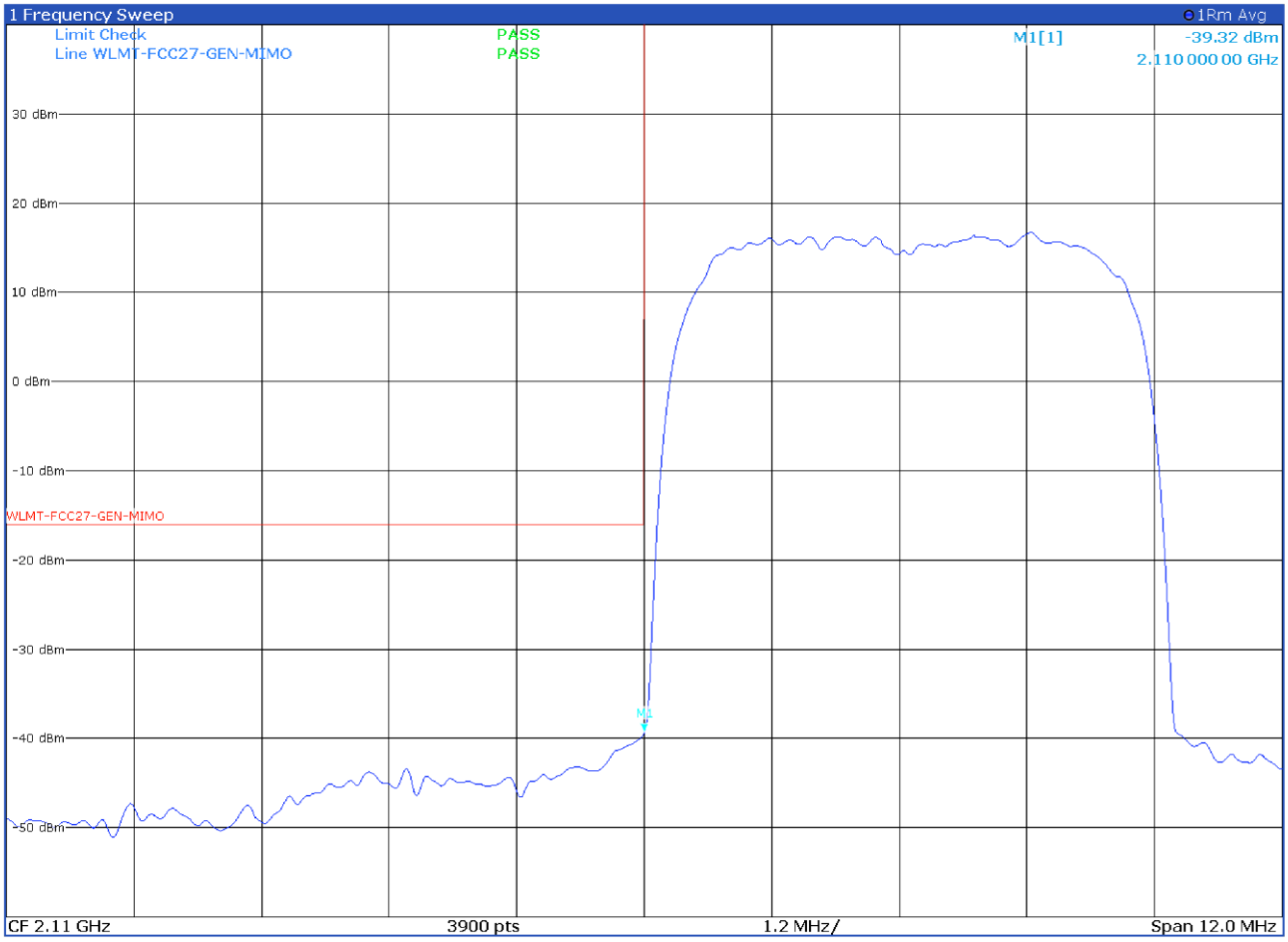


Figure 8.5-16: *Antenna port 2 single carrier lower block edge with input signal at AGC threshold +3 dB*

8.6 Spurious emissions conducted measurements

8.6.1 References, definitions and limits

FCC §27.53(h):

AWS emission limits

(1) General protection levels. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB.

(2) Additional protection levels. Notwithstanding the foregoing paragraph (h)(1) of this section:

(i) Operations in the 2180-2200 MHz band are subject to the out-of-band emission requirements set forth in § 27.1134 for the protection of federal government operations operating in the 2200-2290 MHz band.

(ii) For operations in the 2000-2020 MHz band, the power of any emissions below 2000 MHz shall be attenuated below the transmitter power (P) in watts by at least 70 + 10 log10(P) dB.

(iii) For operations in the 1915-1920 MHz band, the power of any emission between 1930-1995 MHz shall be attenuated below the transmitter power (P) in watts by at least 70 + 10 log10(P) dB.

(iv) For operations in the 1995-2000 MHz band, the power of any emission between 2005-2020 MHz shall be attenuated below the transmitter power (P) in watts by at least 70 + 10 log10(P) dB

(3) Measurement procedure

(i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(ii) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges, both upper and lower, as the design permits.

(iii) The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.

(4) Private agreements.

(i) For AWS operations in the 2000-2020 MHz and 2180-2200 MHz bands, to the extent a licensee establishes unified operations across the AWS blocks, that licensee may choose not to observe the emission limit specified in paragraph (h)(1), above, strictly between its adjacent block licenses in a geographic area, so long as it complies with other Commission rules and is not adversely affecting the operations of other parties by virtue of exceeding the emission limit.

(ii) For AWS operations in the 2000-2020 MHz band, a licensee may enter into private agreements with all licensees operating between 1995 and 2000 MHz to allow the 70 + 10 log10(P) dB limit to be exceeded within the 1995-2000 MHz band.

(iii) An AWS licensee who is a party to a private agreement described in this section (4) must maintain a copy of the agreement in its station files and disclose it, upon request, to prospective AWS assignees, transferees, or spectrum lessees and to the Commission.

RSS-131, Clause 5.2

Industrial zone enhancers

Industrial Zone Enhancers, including DASs, shall employ a gain control feature and shall comply with all the requirements in the RSS which applies to the equipment with which the zone enhancer is to be used. In addition, the equipment shall comply with the requirements specified in this section.

RSS-139, Clause 6.6

Transmitter Unwanted Emissions

(i) In the first 1.0 MHz bands immediately outside and adjacent to the equipment's smallest operating frequency block,2 which can contain the equipment's occupied bandwidth, the emission power per any 1% of the emission bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least 43 + 10 log10 p (watts) dB.

(ii) After the first 1.0 MHz outside the equipment's smallest operating frequency block, which can contain the equipment's occupied bandwidth, the emission power in any 1 MHz bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least 43 + 10 log10 p (watts) dB.

8.6.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	February 2, 2022

8.6.3 Observations, settings and special notes

The spectrum was searched from 9 kHz to the 10th harmonic.
All measurements were performed using peak detector according to note 4 of 935210 D05 Indus Booster Basic Meas v01r04 paragraph 3.6.3.
Limit line (43 + 10 $\log_{10}$ (P) or −13 dBm) was adjusted for MIMO operation by 3 dB*: −13 dBm – 3 dB = −16 dBm
*MIMO correction factor for 2 antenna ports: 10 × Log_{10}(2) = 3.01 dB

Spectrum analyser settings:

Resolution bandwidth:	Reference bandwidth in the applicable rule section for the supported frequency band
Video bandwidth:	VBW ≥ 3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

Input signal frequency

Low channel	2112.5 MHz
Middle channel	2145.0 MHz
High channel	2177.5 MHz

8.6.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.		
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767		
EMI Receiver	Rohde & Schwarz	ESU8	100202	2021-09	2
RF Vector Signal Generator	Rohde & Schwarz	SMBV100A	263254		
RF Vector Signal Generator	Rohde & Schwarz	SMBV100A	263397		

Notes: NCR - no calibration required, VOU - verify on use

8.6.5 Test data

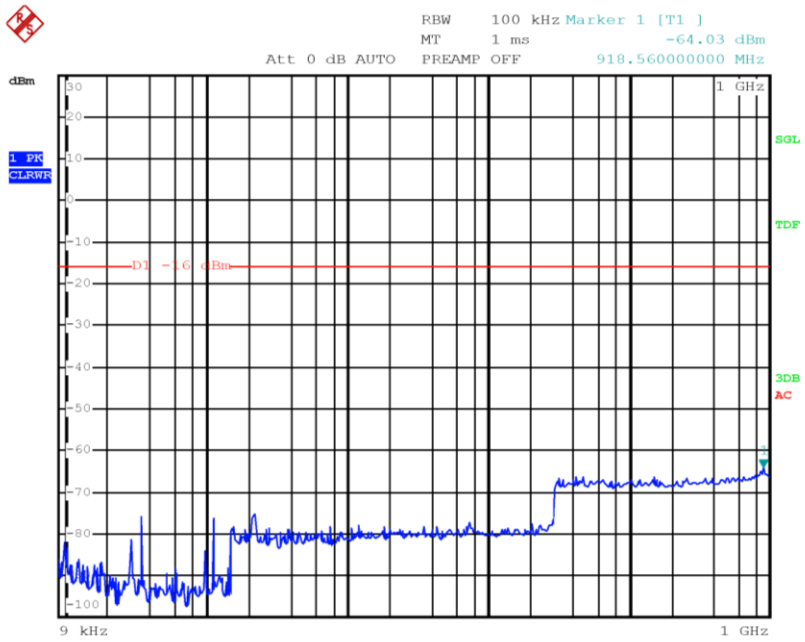


Figure 8.6-1: *Conducted spurious emissions of low channel, antenna port 1 – Range 9 kHz to 1000 MHz*

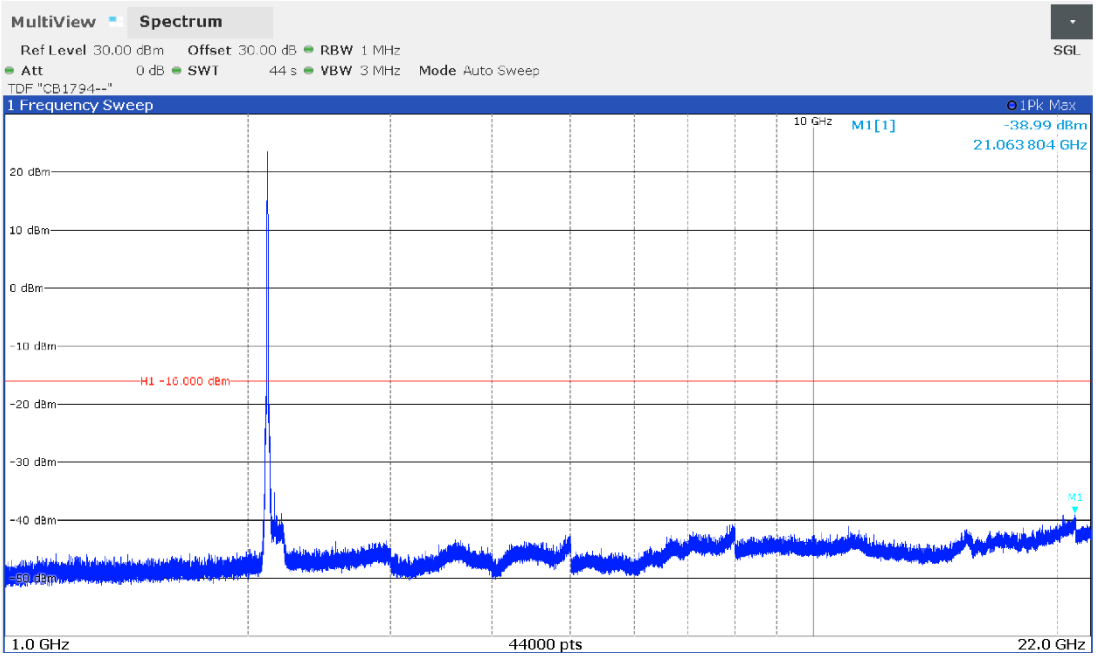


Figure 8.6-2: *Conducted spurious emissions of low channel, antenna port 1 – Range 1000 MHz to 10th harmonic*

Test data, continued

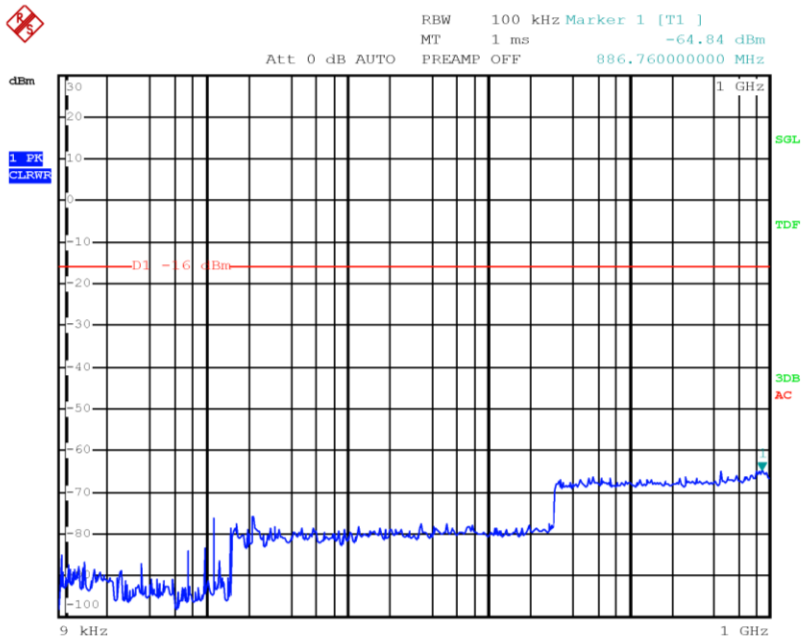


Figure 8.6-3: *Conducted spurious emissions of middle channel, antenna port 1 – Range 9 kHz to 1000 MHz*

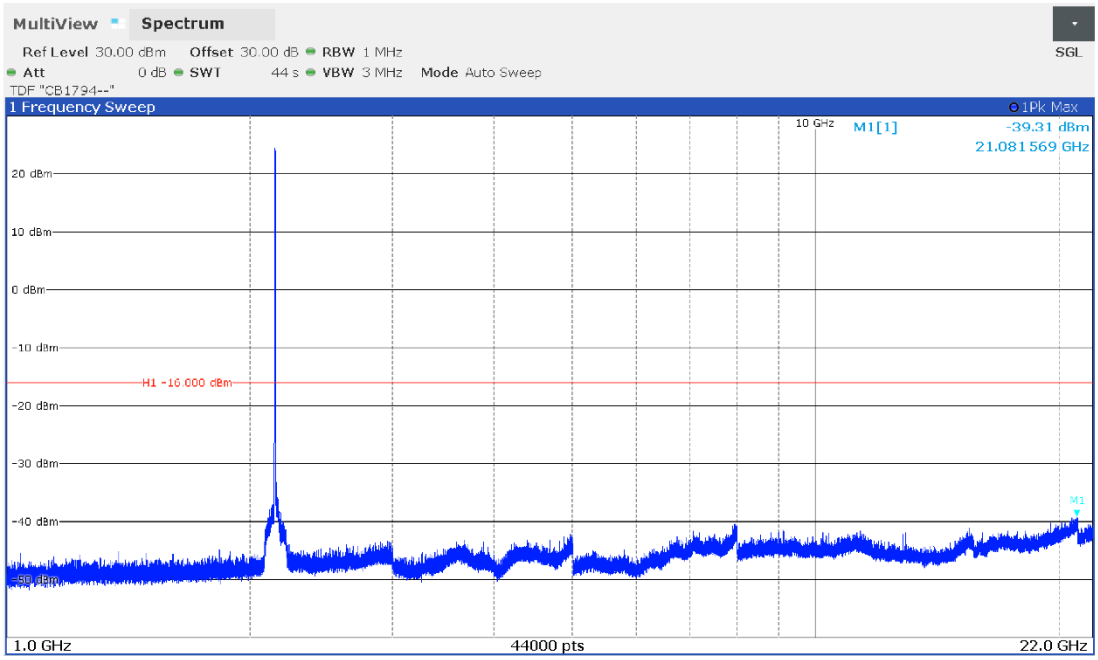


Figure 8.6-4: *Conducted spurious emissions of middle channel, antenna port 1 – Range 1000 MHz to 10th harmonic*

Test data, continued

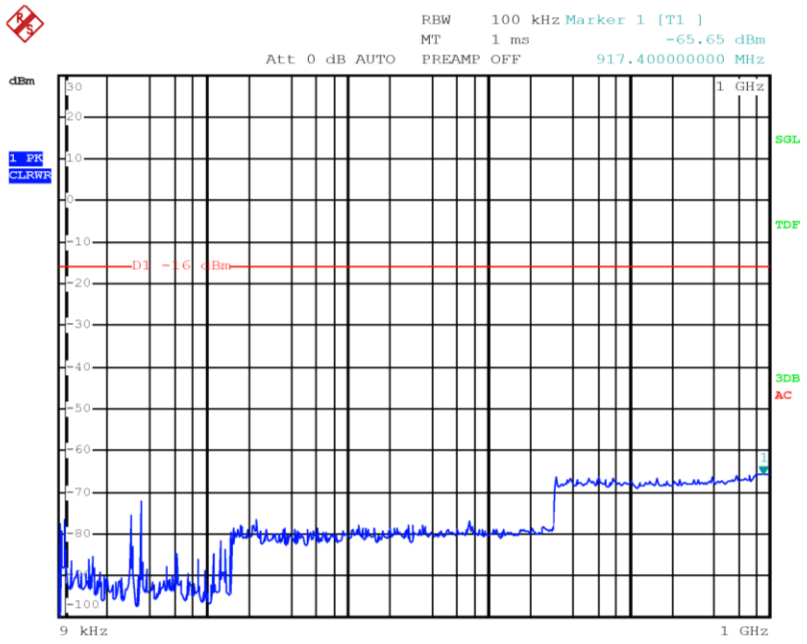


Figure 8.6-5: *Conducted spurious emissions of high channel, antenna port 1 – Range 9 kHz to 1000 MHz*

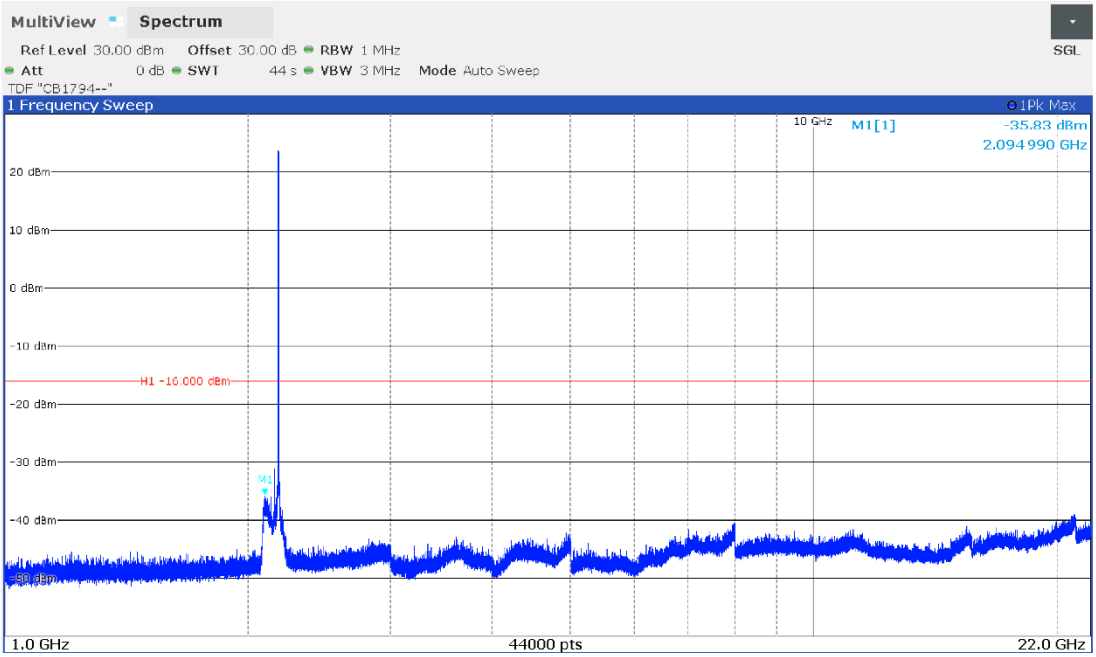


Figure 8.6-6: *Conducted spurious emissions of high channel, antenna port 1 – Range 1000 MHz to 10th harmonic*

8.6.1 Test data

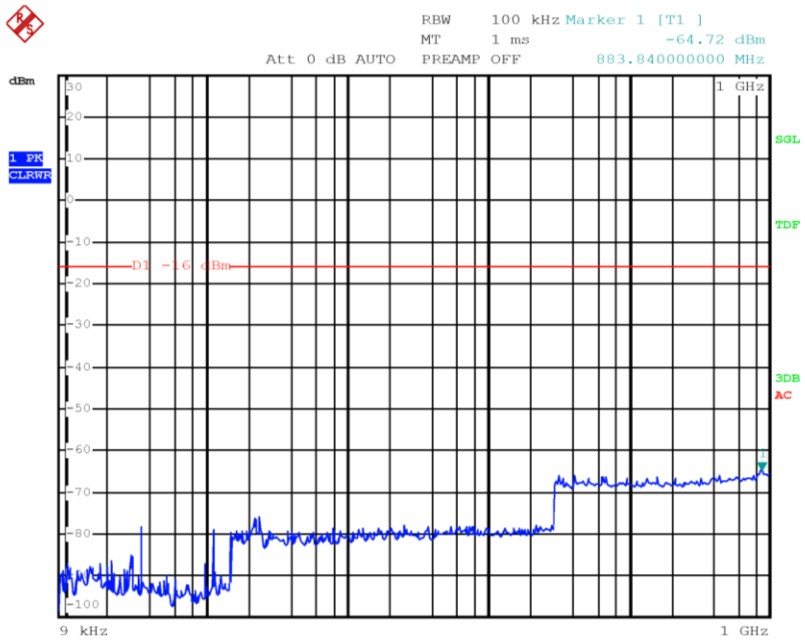


Figure 8.6-7: *Conducted spurious emissions of low channel, antenna port 2 – Range 9 kHz to 1000 MHz*

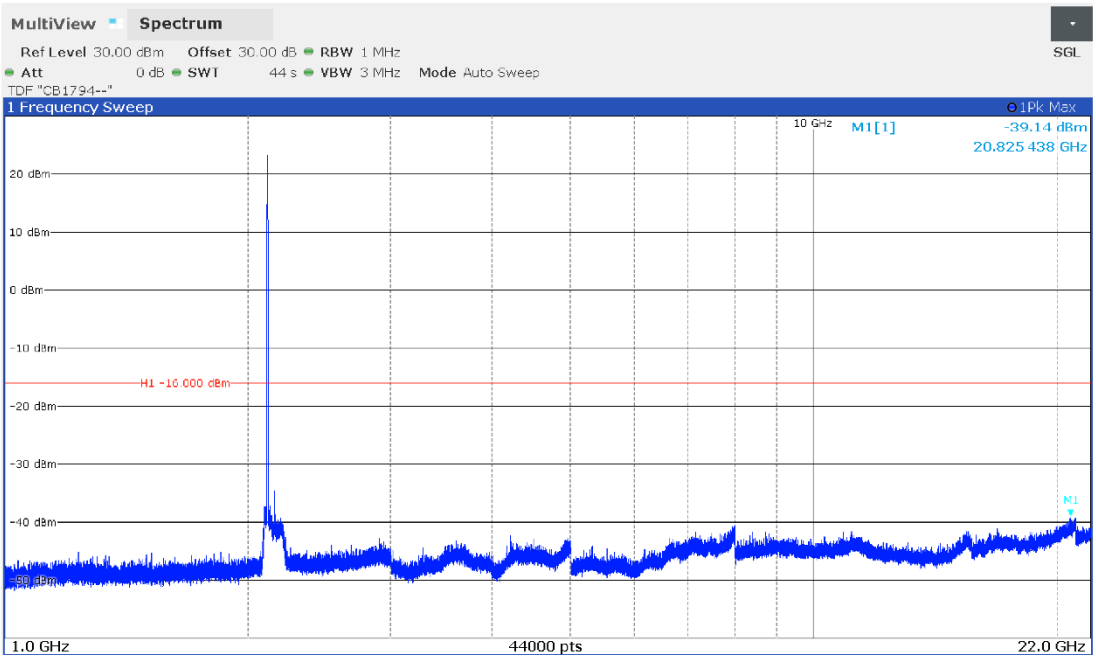


Figure 8.6-8: *Conducted spurious emissions of low channel, antenna port 2 – Range 1000 MHz to 10th harmonic*

Test data, continued

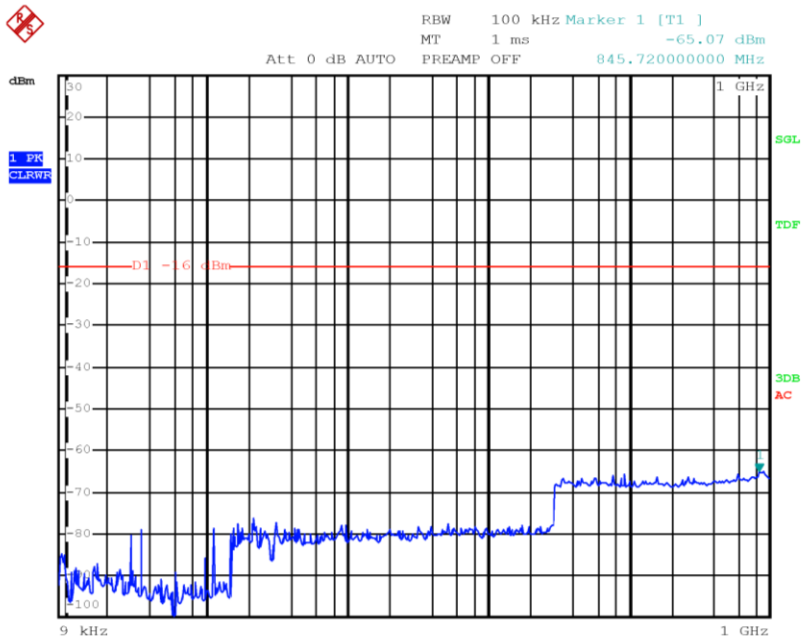


Figure 8.6-9: *Conducted spurious emissions of middle channel, antenna port 2 – Range 9 kHz to 1000 MHz*

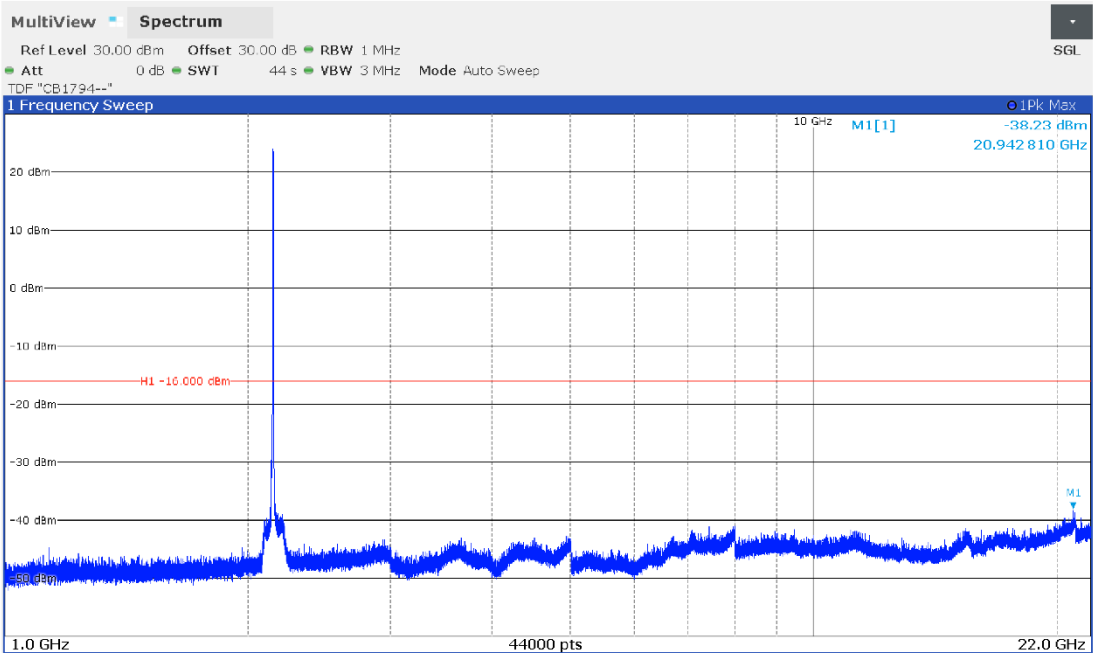


Figure 8.6-10: *Conducted spurious emissions of middle channel, antenna port 2 – Range 1000 MHz to 10th harmonic*

Test data, continued

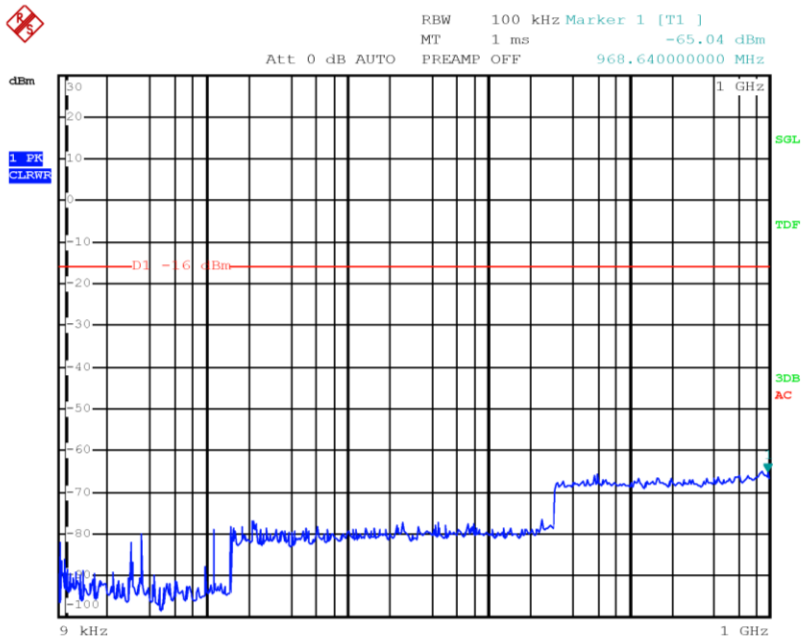


Figure 8.6-11: *Conducted spurious emissions of high channel, antenna port 2 – Range 9 kHz to 1000 MHz*

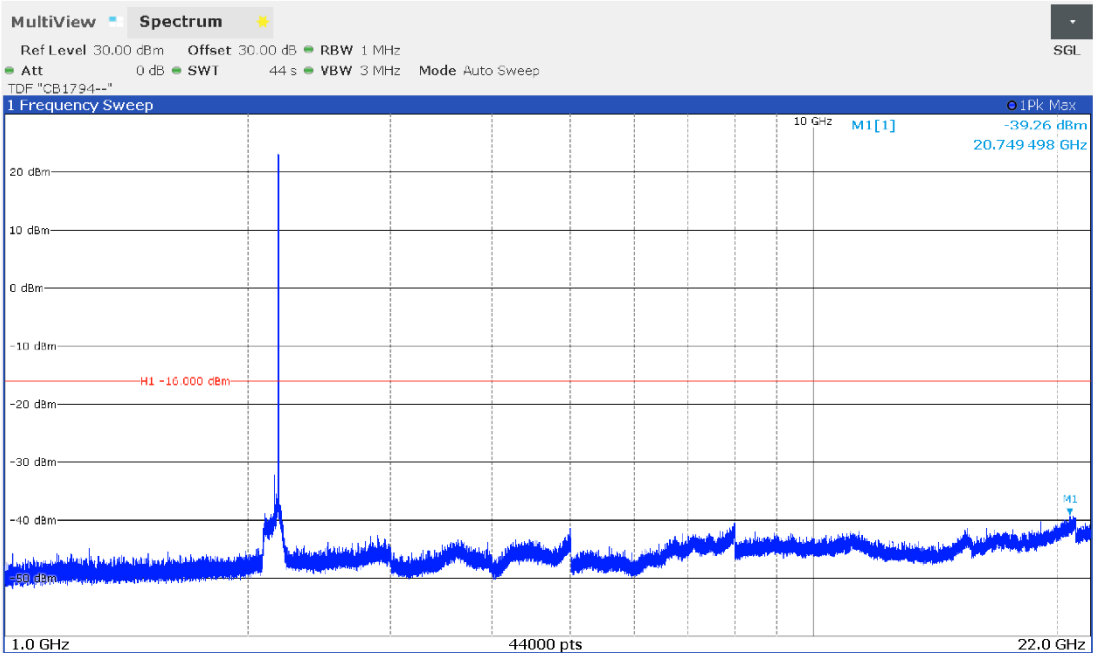


Figure 8.6-12: *Conducted spurious emissions of high channel, antenna port 2 – Range 1000 MHz to 10th harmonic*

8.7 Spurious emissions radiated measurements

8.7.1 References, definitions and limits

FCC §27.53(h):

AWS emission limits

(1) General protection levels. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB.

(2) Additional protection levels. Notwithstanding the foregoing paragraph (h)(1) of this section:

(i) Operations in the 2180-2200 MHz band are subject to the out-of-band emission requirements set forth in § 27.1134 for the protection of federal government operations operating in the 2200-2290 MHz band.

(ii) For operations in the 2000-2020 MHz band, the power of any emissions below 2000 MHz shall be attenuated below the transmitter power (P) in watts by at least 70 + 10 log10(P) dB.

(iii) For operations in the 1915-1920 MHz band, the power of any emission between 1930-1995 MHz shall be attenuated below the transmitter power (P) in watts by at least 70 + 10 log10(P) dB.

(iv) For operations in the 1995-2000 MHz band, the power of any emission between 2005-2020 MHz shall be attenuated below the transmitter power (P) in watts by at least 70 + 10 log10(P) dB

(3) Measurement procedure

(i) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(ii) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges, both upper and lower, as the design permits.

(iii) The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.

(4) Private agreements.

(i) For AWS operations in the 2000-2020 MHz and 2180-2200 MHz bands, to the extent a licensee establishes unified operations across the AWS blocks, that licensee may choose not to observe the emission limit specified in paragraph (h)(1), above, strictly between its adjacent block licenses in a geographic area, so long as it complies with other Commission rules and is not adversely affecting the operations of other parties by virtue of exceeding the emission limit.

(ii) For AWS operations in the 2000-2020 MHz band, a licensee may enter into private agreements with all licensees operating between 1995 and 2000 MHz to allow the 70 + 10 log10(P) dB limit to be exceeded within the 1995-2000 MHz band.

(iii) An AWS licensee who is a party to a private agreement described in this section (4) must maintain a copy of the agreement in its station files and disclose it, upon request, to prospective AWS assignees, transferees, or spectrum lessees and to the Commission.

RSS-131, Clause 5.2

Industrial zone enhancers

Industrial Zone Enhancers, including DASs, shall employ a gain control feature and shall comply with all the requirements in the RSS which applies to the equipment with which the zone enhancer is to be used. In addition, the equipment shall comply with the requirements specified in this section.

RSS-139, Clause 6.6

Transmitter Unwanted Emissions

(i) In the first 1.0 MHz bands immediately outside and adjacent to the equipment's smallest operating frequency block,2 which can contain the equipment's occupied bandwidth, the emission power per any 1% of the emission bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least 43 + 10 log10 p (watts) dB.

(ii) After the first 1.0 MHz outside the equipment's smallest operating frequency block, which can contain the equipment's occupied bandwidth, the emission power in any 1 MHz bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least 43 + 10 log10 p (watts) dB.

8.7.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	February 3, 2022

8.7.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
All measurements were performed using peak detector according to note 4 of 935210 D05 Indus Booster Basic Meas v01r04 paragraph 3.6.3.
Testing was performed with RF ports terminated with 50 Ohm load.
In the graphics below, no radiated spurious emission found and the limit is exceeded only by the carrier.

Spectrum analyser settings:

Resolution bandwidth:	100 kHz and 1 MHz
Video bandwidth:	VBW ≥ 3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

Input signal frequency

Low channel	2112.5 MHz
Middle channel	2145.0 MHz
High channel	2177.5 MHz

8.7.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767
EMI Receiver	Rohde & Schwarz	ESW44	101620
RF Vector Signal Generator	Rohde & Schwarz	SMBV100A	263254
RF Vector Signal Generator	Rohde & Schwarz	SMBV100A	263397
Antenna Trilog 25MHz - 8GHz	Schwarzbeck Mess-Elektronik	VULB9162	9162-025
Antenna 1 - 18 GHz	Schwarzbeck Mess-Elektronik	STLP9148	STLP 9148-152
Double Ridge Horn Antenna	RFSpin	DRH40	061106A40
Broadband Amplifier	Schwarzbeck Mess-Elektronik	BBV9718C	00121
Broadband Bench Top Amplifier	Sage	STB-1834034030-KFKF-L1	18490-01
Controller	Maturo	FCU3.0	10041
Tilt antenna mast	Maturo	TAM4.0-E	10042
Turntable	Maturo	TT4.0-5T	2.527
Semi-anechoic chamber	Nemko S.p.a.	10m semi-anechoic chamber	530

Notes: NCR - no calibration required, VOU - verify on use

8.7.5 Test data

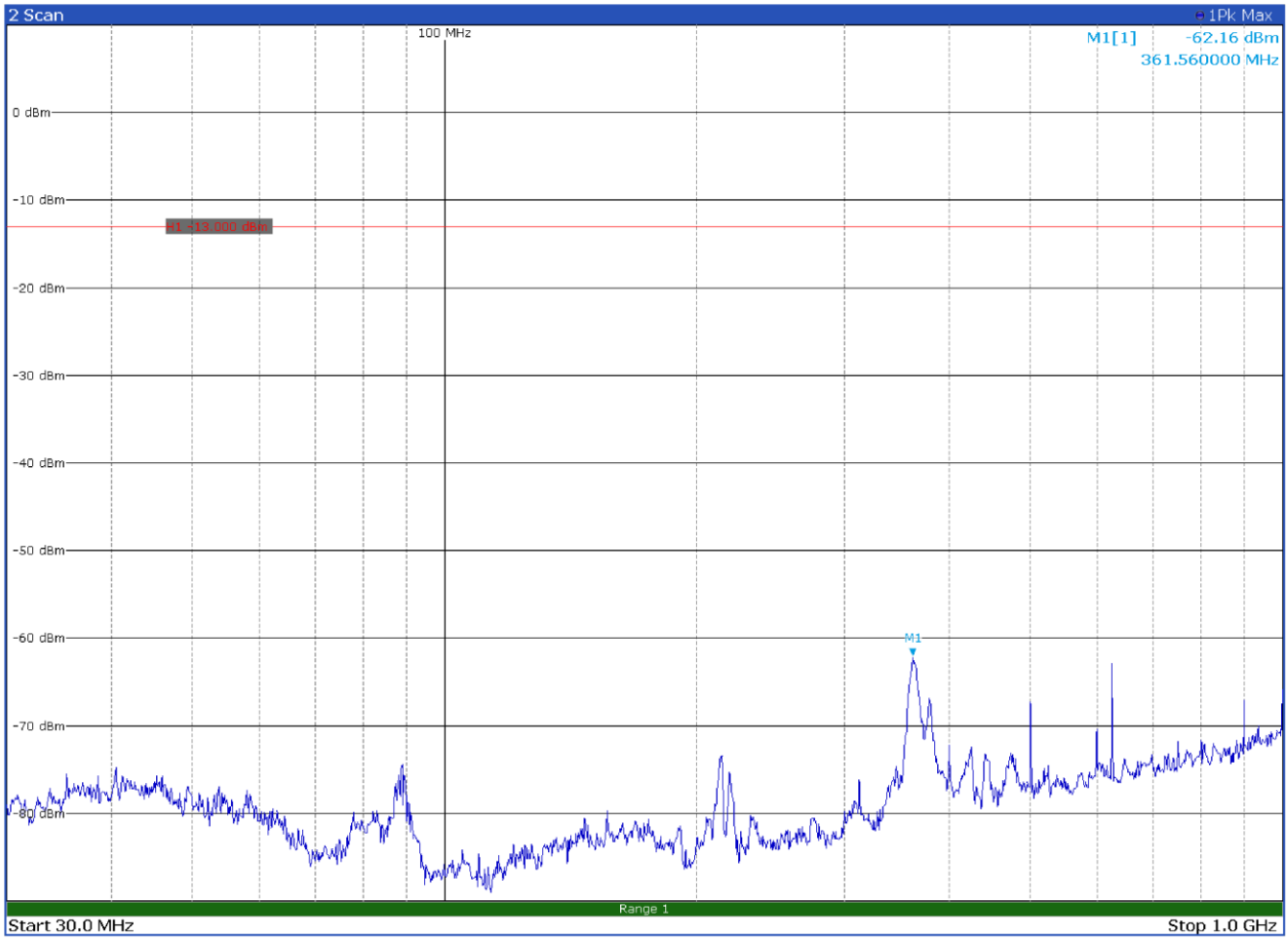


Figure 8.7-1: *Radiated spurious emissions below 1 GHz, low channel with antenna in horizontal polarization*

Test data, continued

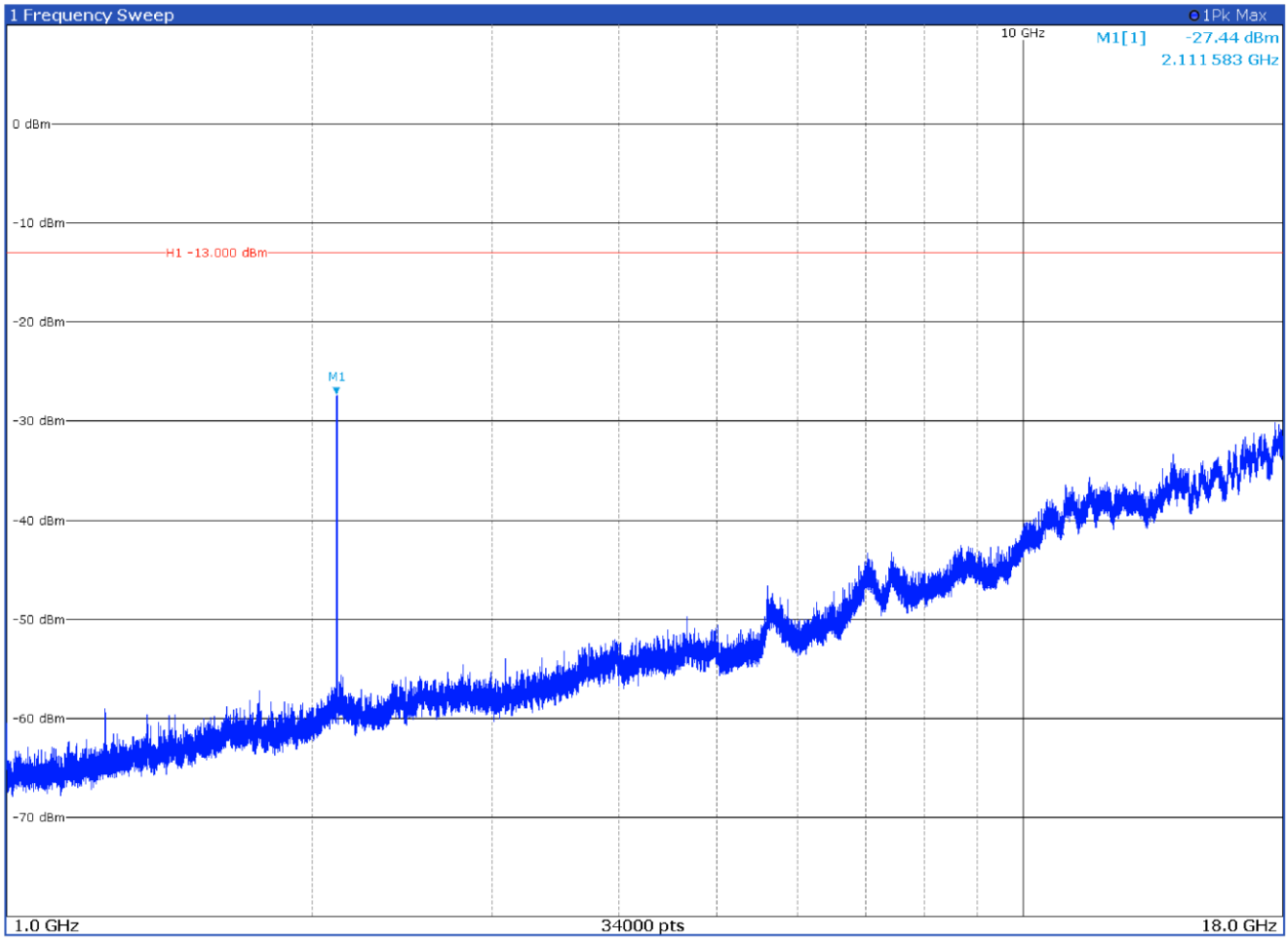


Figure 8.7-2: *Radiated spurious emissions from 1 GHz to 18 GHz, low channel with antenna in horizontal polarization*

Test data, continued

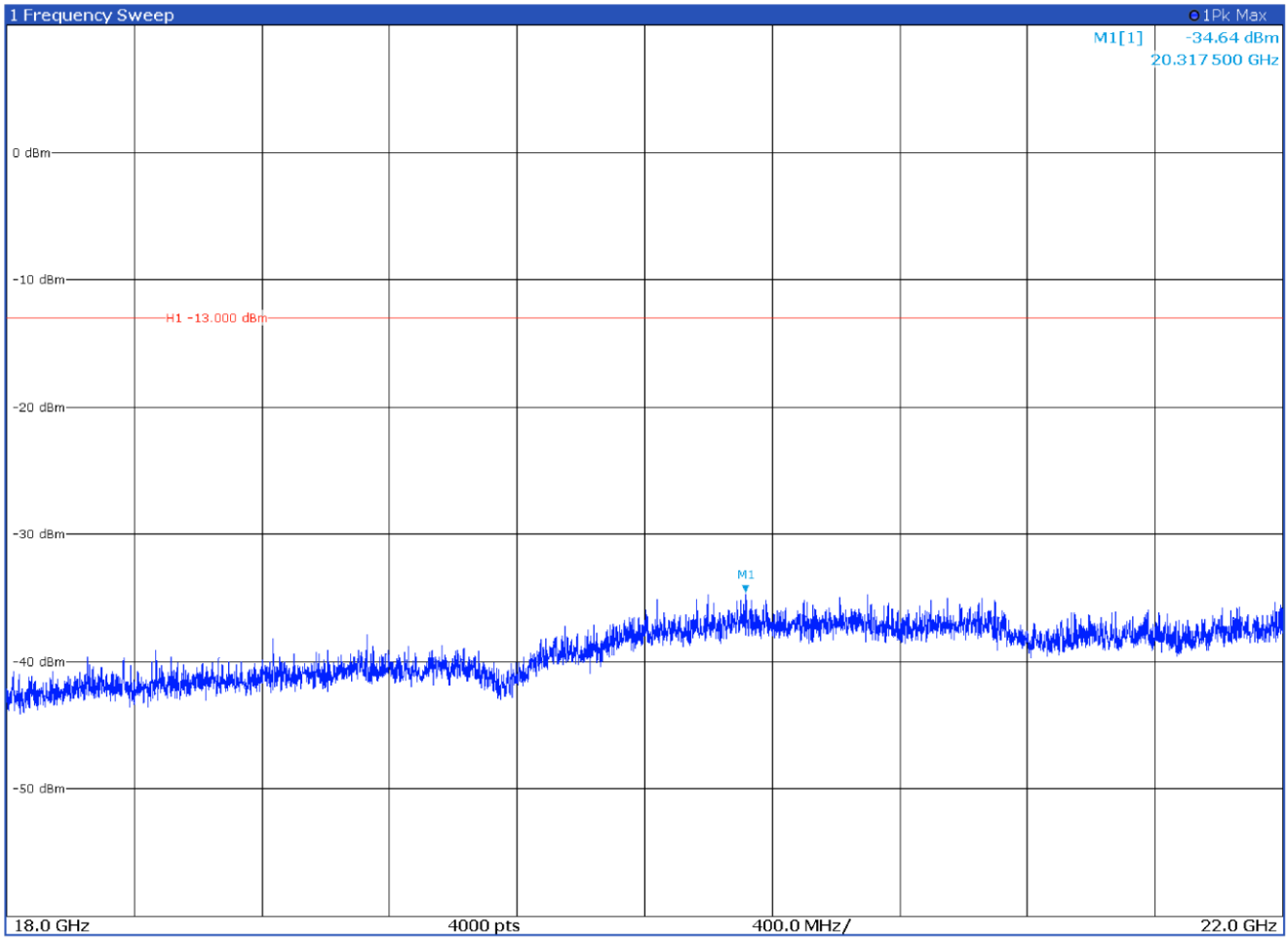


Figure 8.7-3: *Radiated spurious emissions from 18 GHz to to 10th harmonic, low channel with antenna in horizontal polarization*

Test data, continued

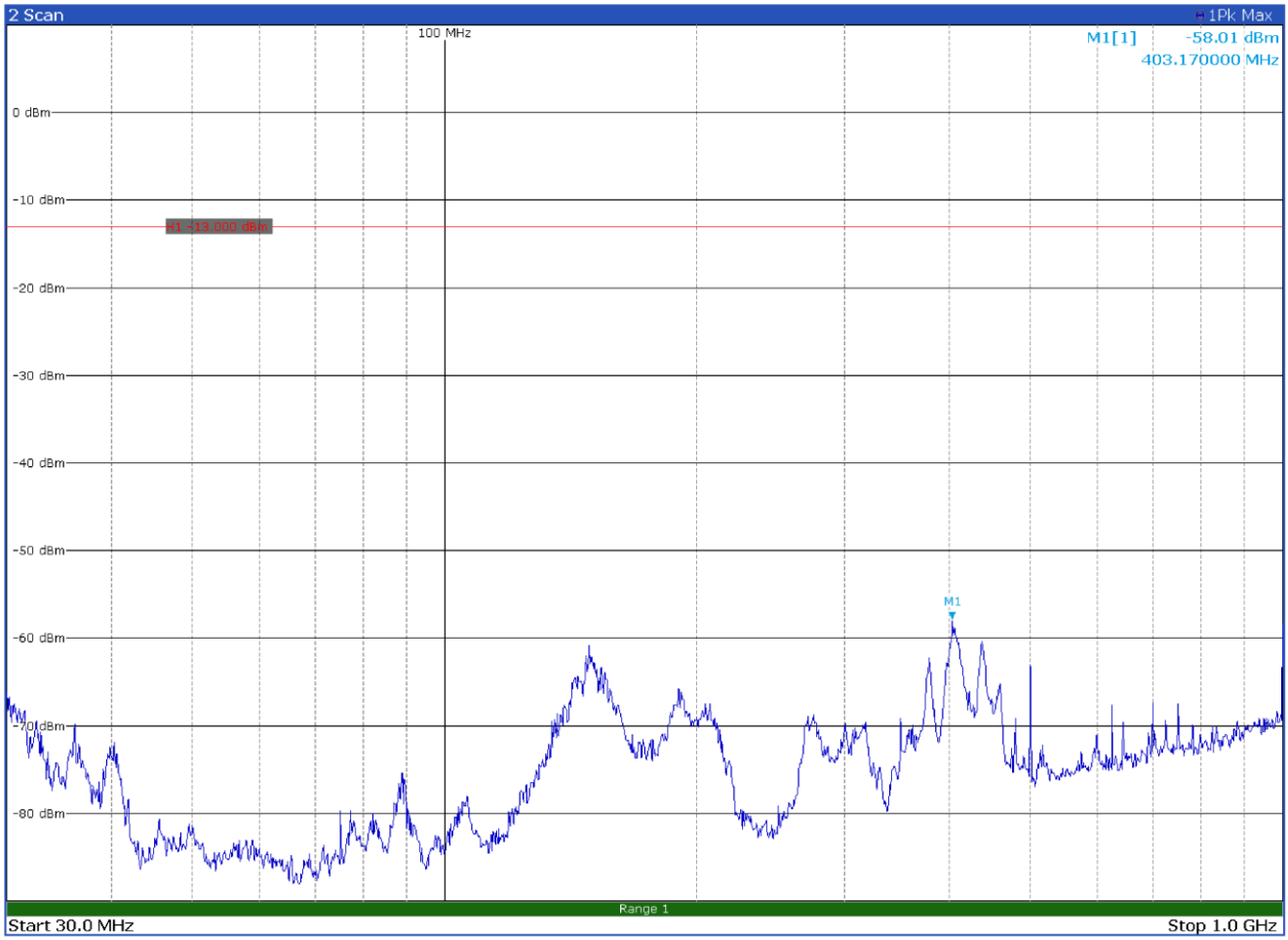


Figure 8.7-4: *Radiated spurious emissions below 1 GHz, low channel with antenna in vertical polarization*

Test data, continued

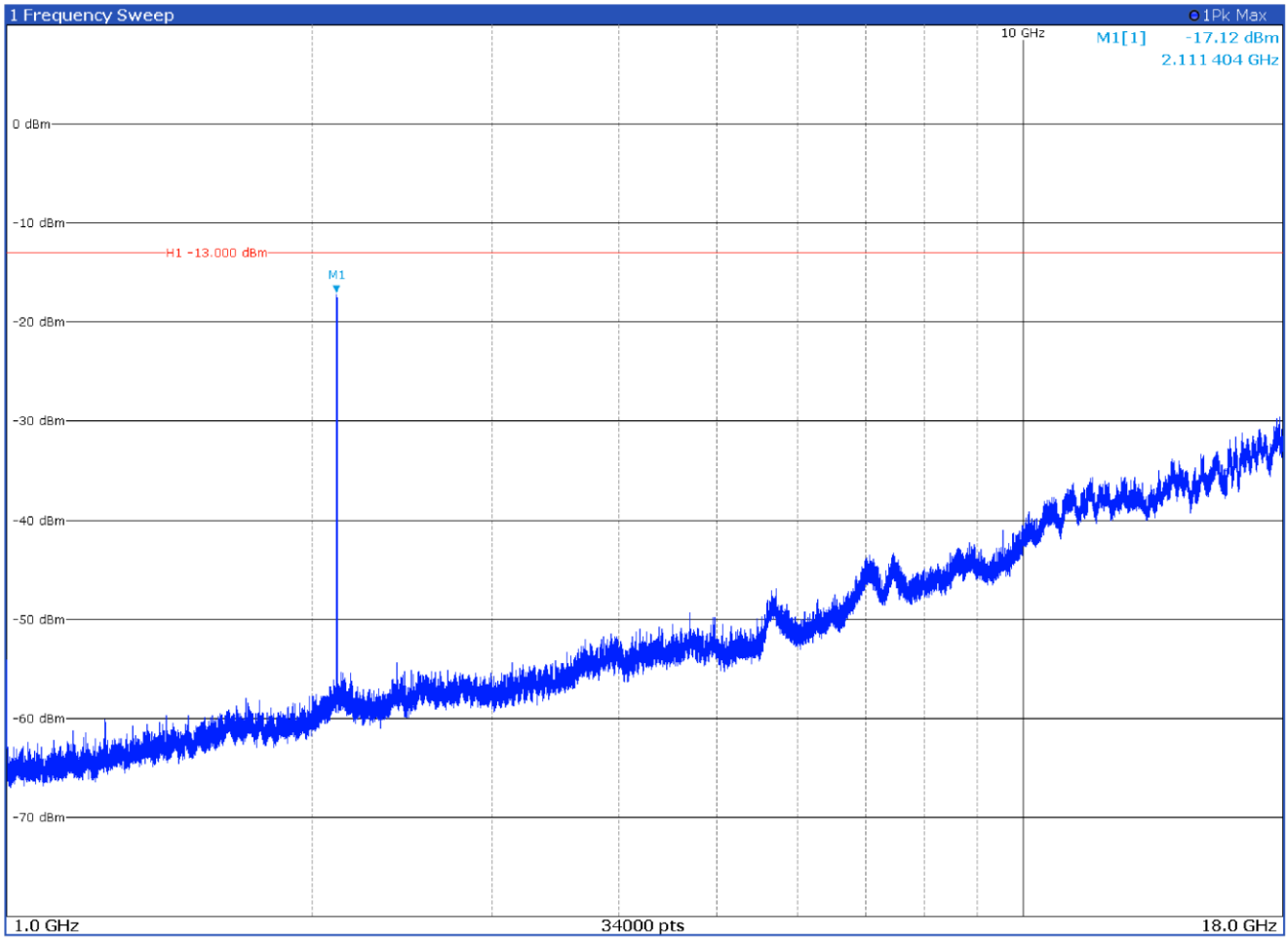


Figure 8.7-5: *Radiated spurious emissions from 1 GHz to 18 GHz, low channel with antenna in vertical polarization*

Test data, continued

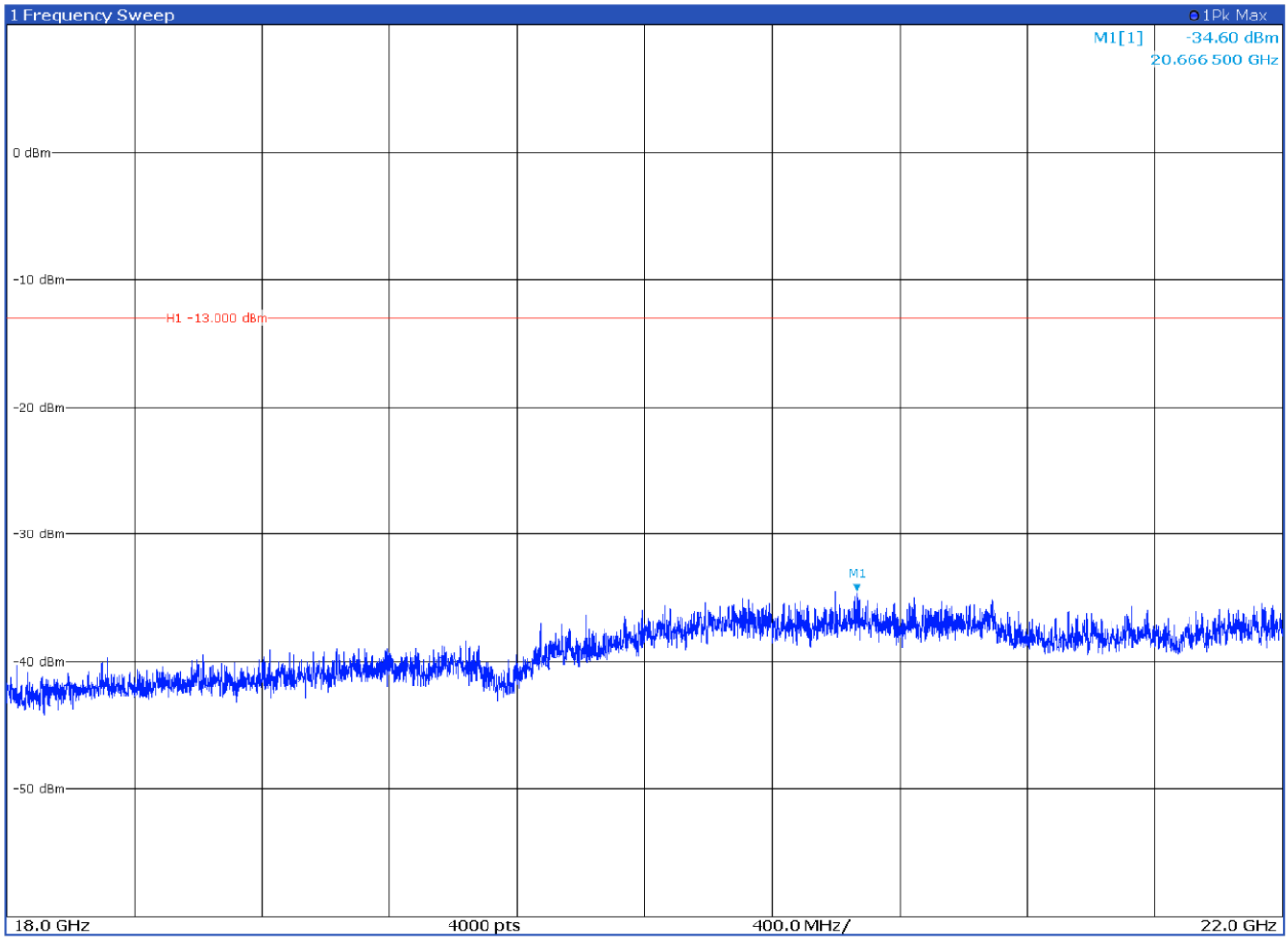


Figure 8.7-6: *Radiated spurious emissions from 18 GHz to to 10th harmonic, low channel with antenna in vertical polarization*

Test data, continued

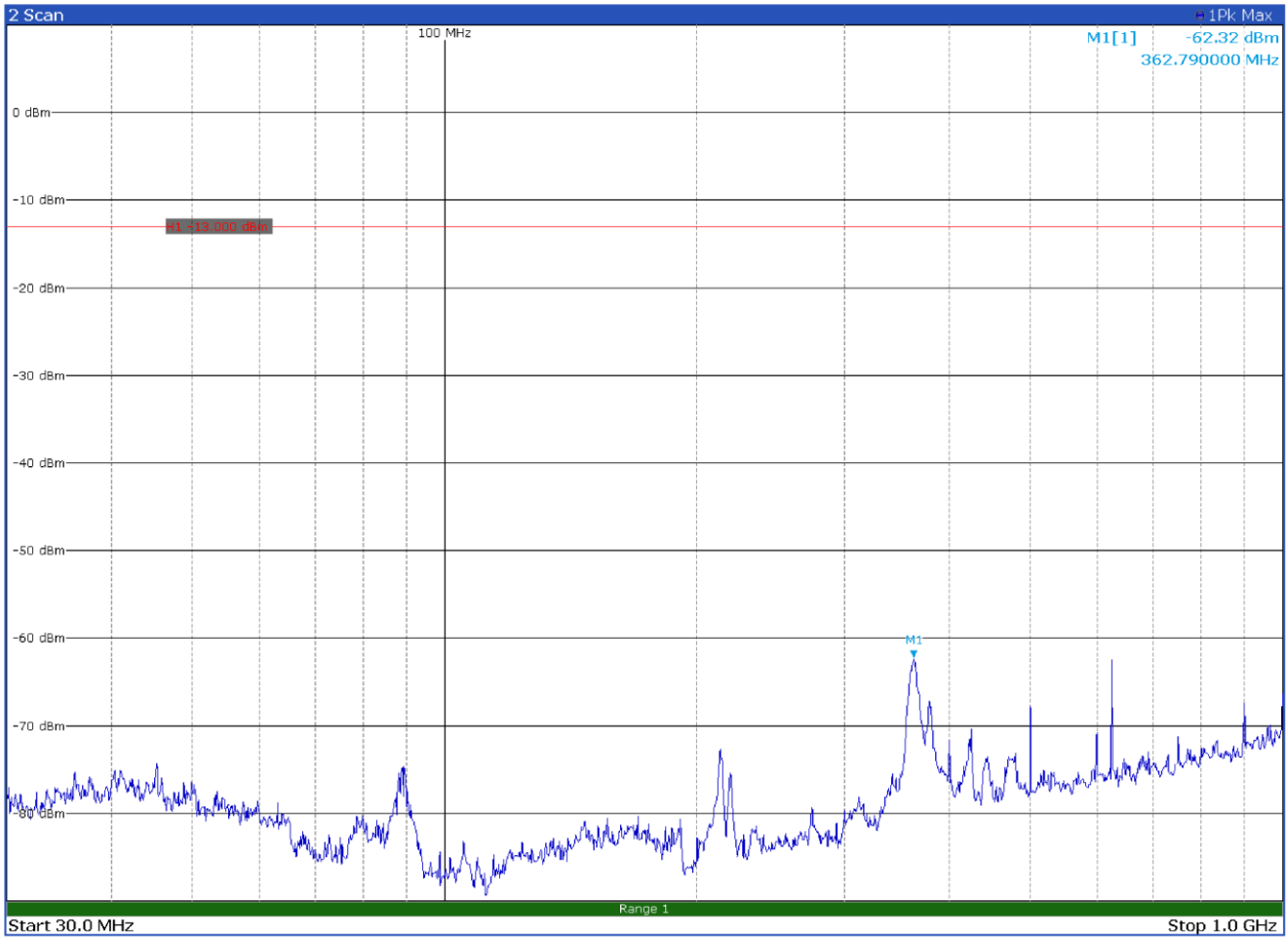


Figure 8.7-7: *Radiated spurious emissions below 1 GHz, middle channel with antenna in horizontal polarization*

Test data, continued

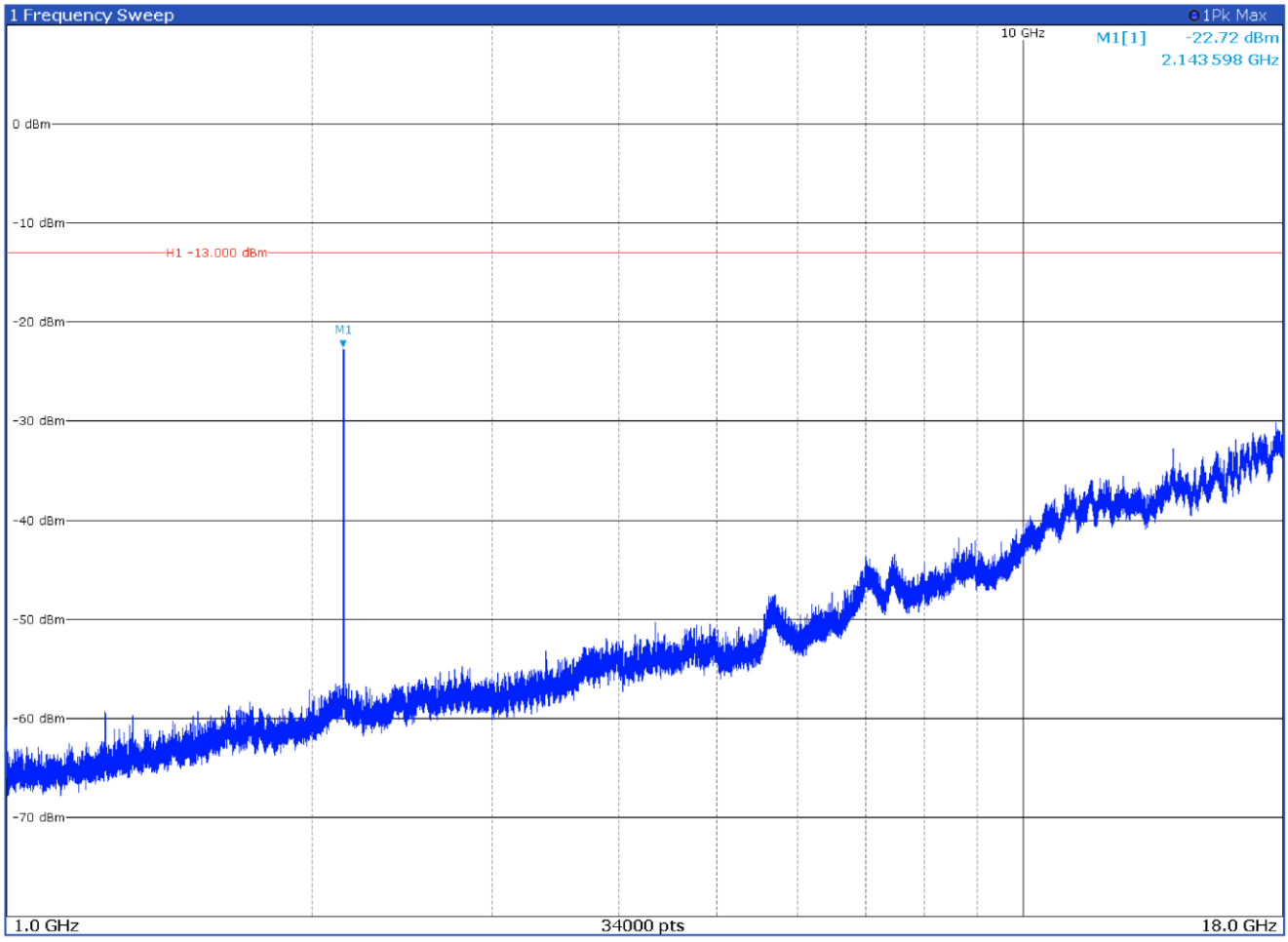


Figure 8.7-8: *Radiated spurious emissions from 1 GHz to 18 GHz, middle channel with antenna in horizontal polarization*

Test data, continued

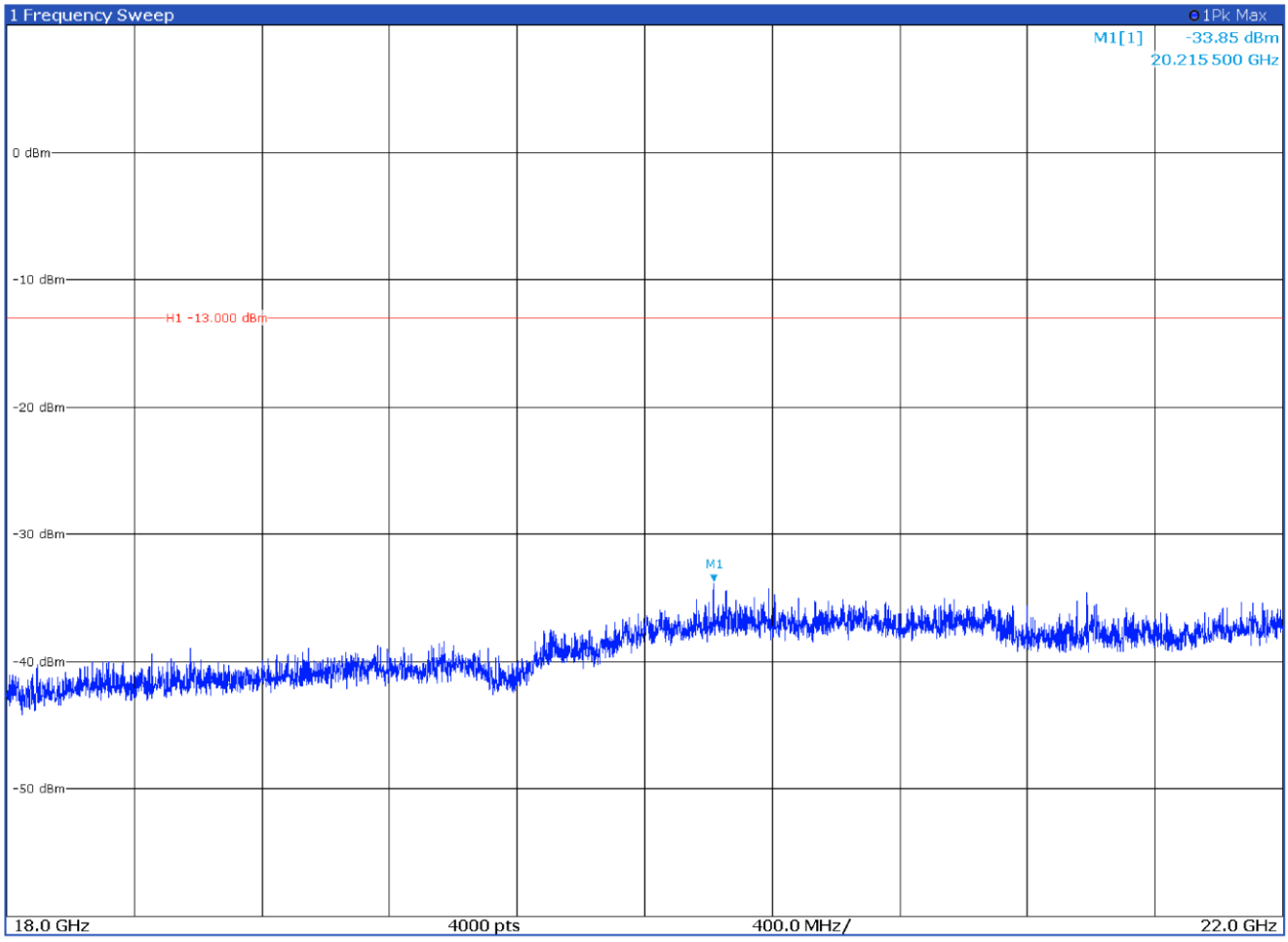


Figure 8.7-9: *Radiated spurious emissions from 18 GHz to to 10th harmonic, middle channel with antenna in horizontal polarization*

Test data, continued

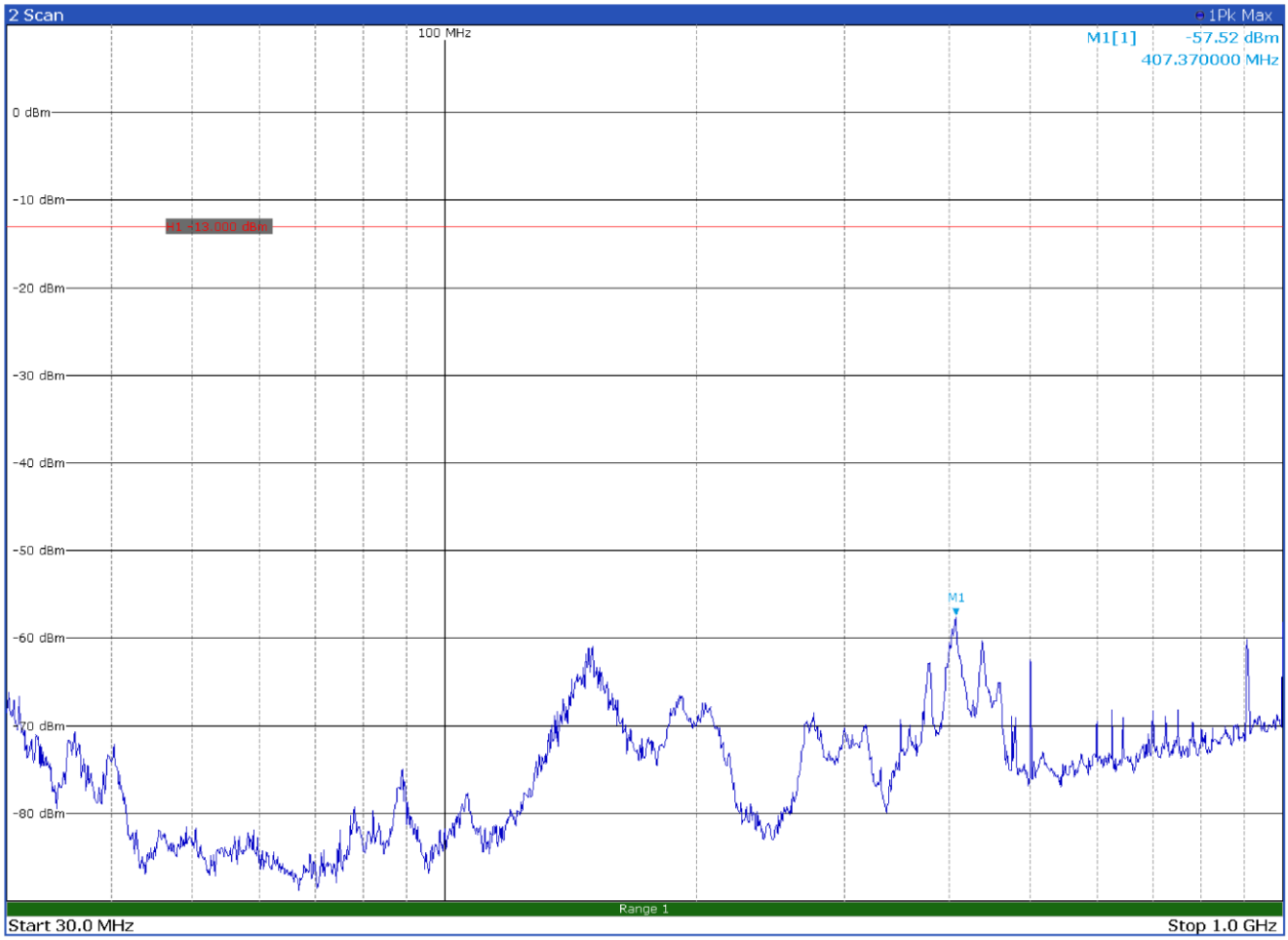


Figure 8.7-10: *Radiated spurious emissions below 1 GHz, middle channel with antenna in vertical polarization*

Test data, continued

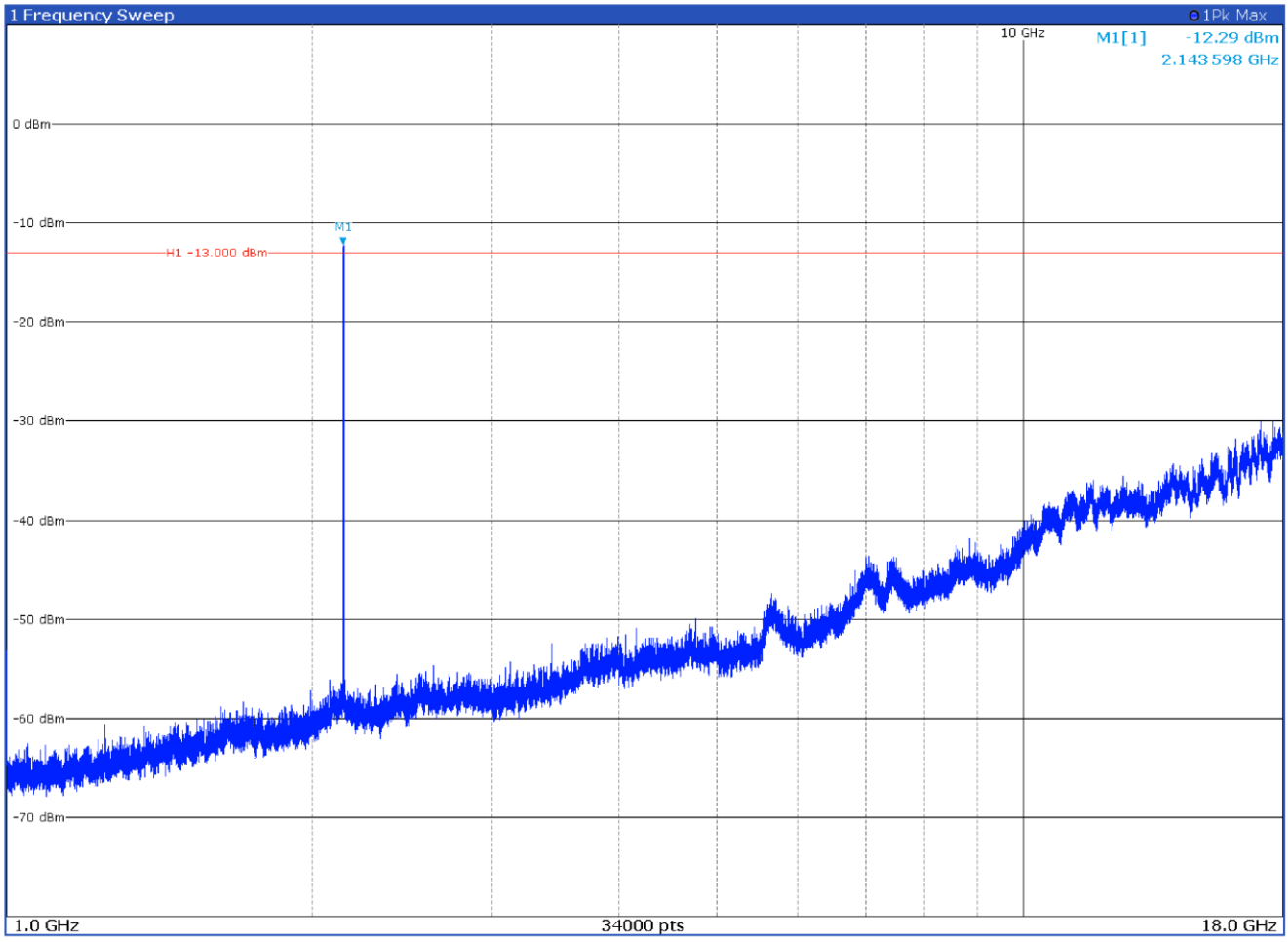


Figure 8.7-11: *Radiated spurious emissions from 1 GHz to 18 GHz, middle channel with antenna in vertical polarization*

Test data, continued

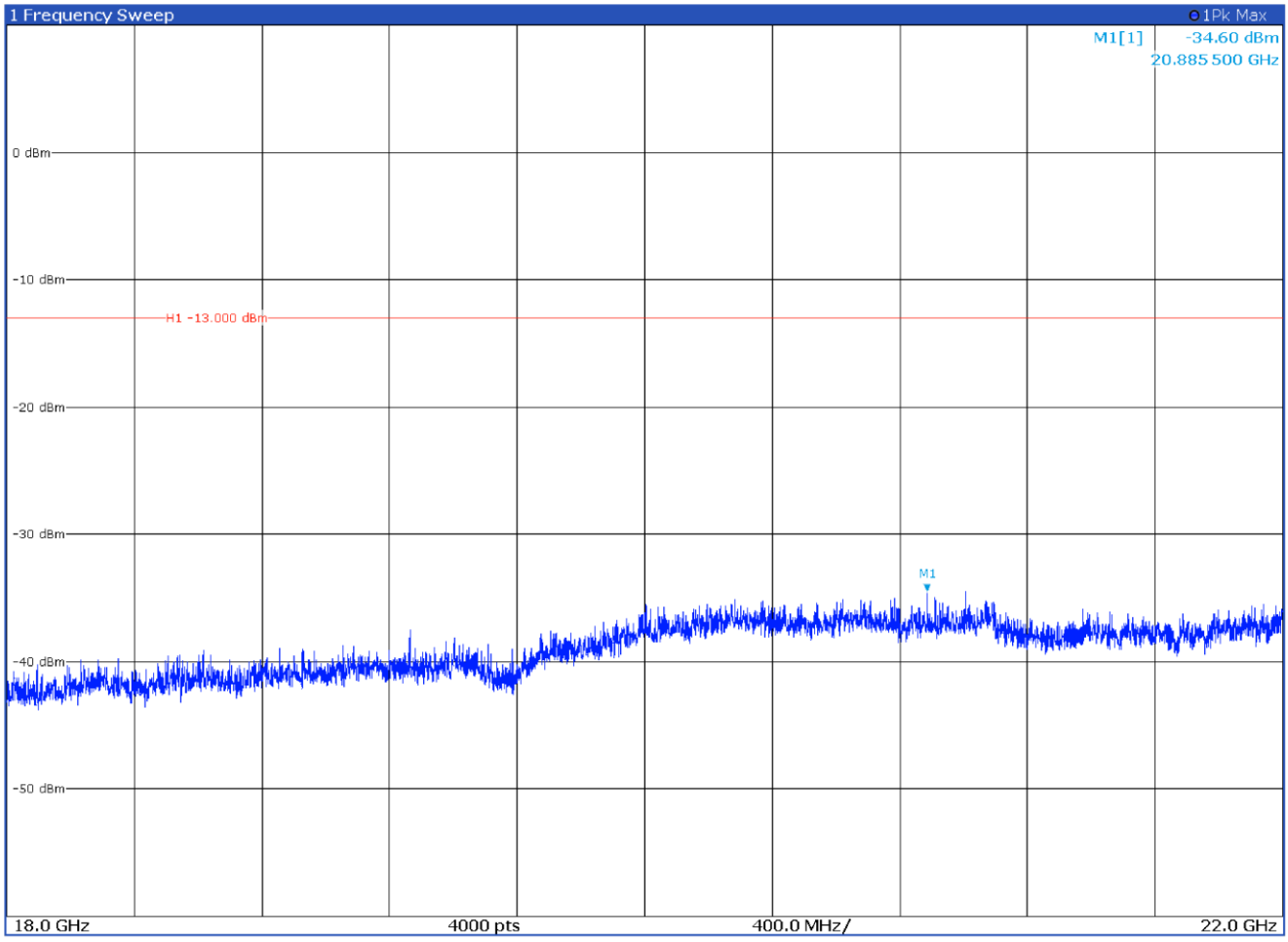


Figure 8.7-12: *Radiated spurious emissions from 18 GHz to to 10th harmonic, middle channel with antenna in vertical polarization*

Test data, continued

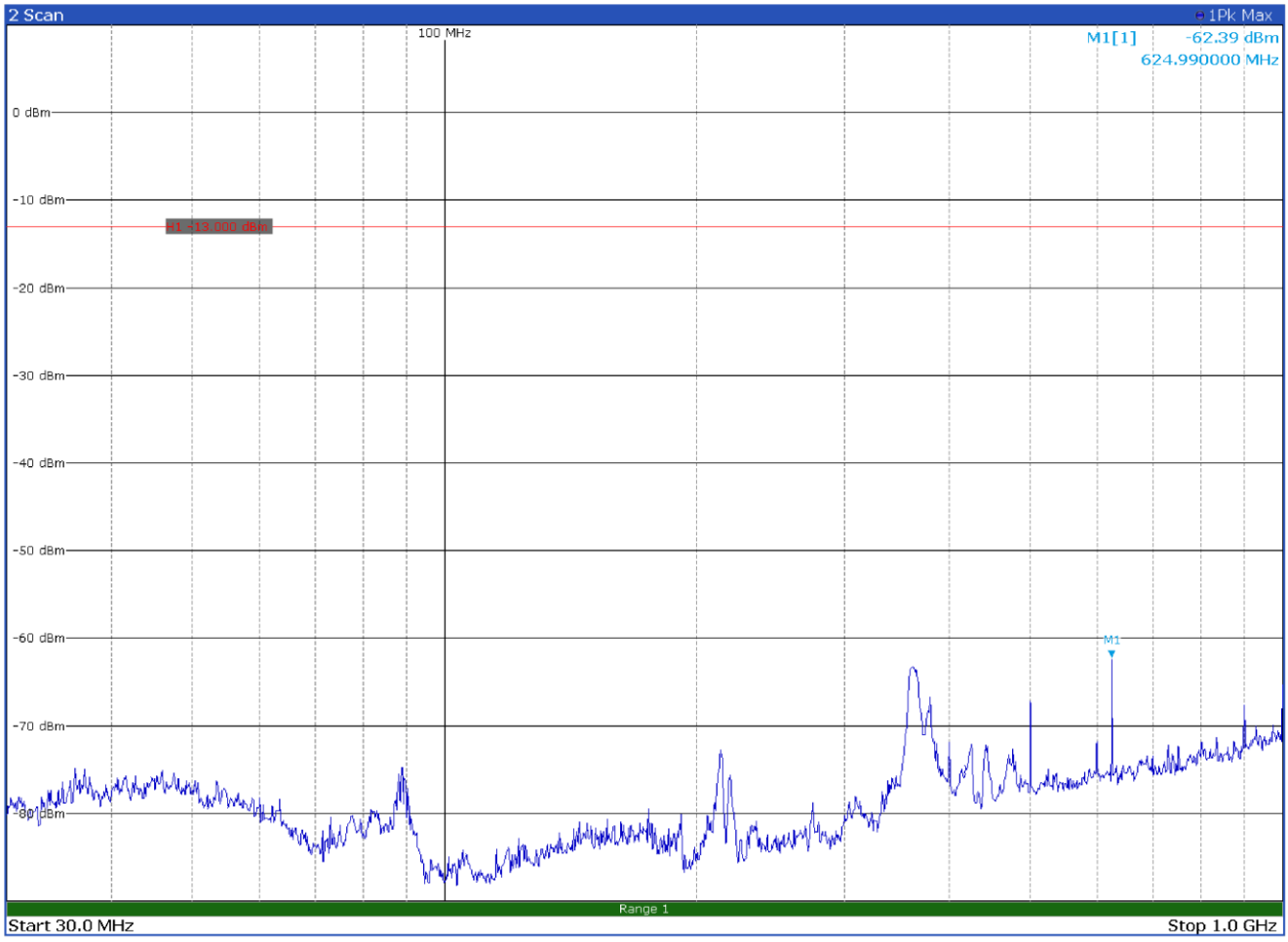


Figure 8.7-13: *Radiated spurious emissions below 1 GHz, high channel with antenna in horizontal polarization*

Test data, continued

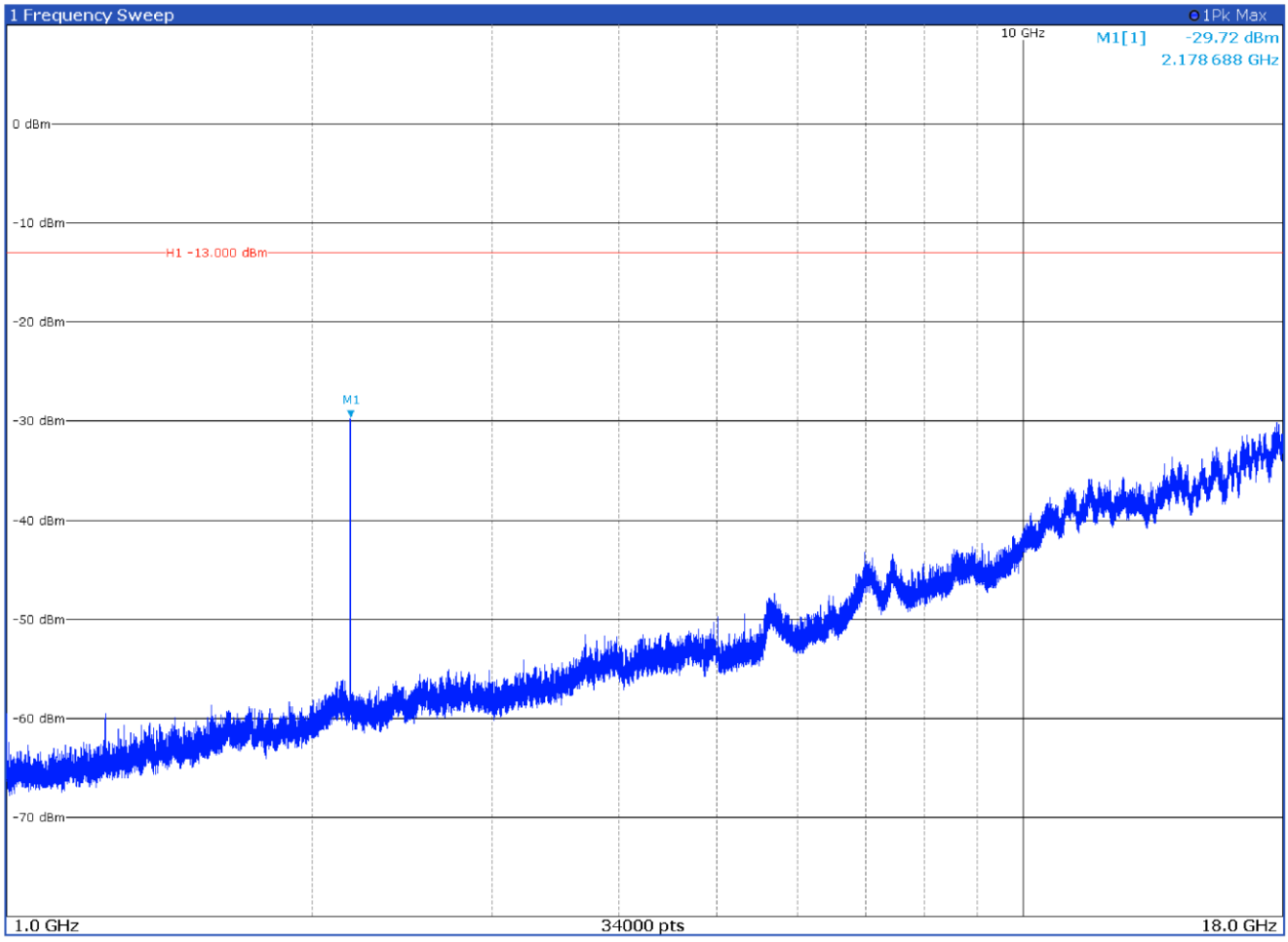


Figure 8.7-14: *Radiated spurious emissions from 1 GHz to 18 GHz, high channel with antenna in horizontal polarization*

Test data, continued

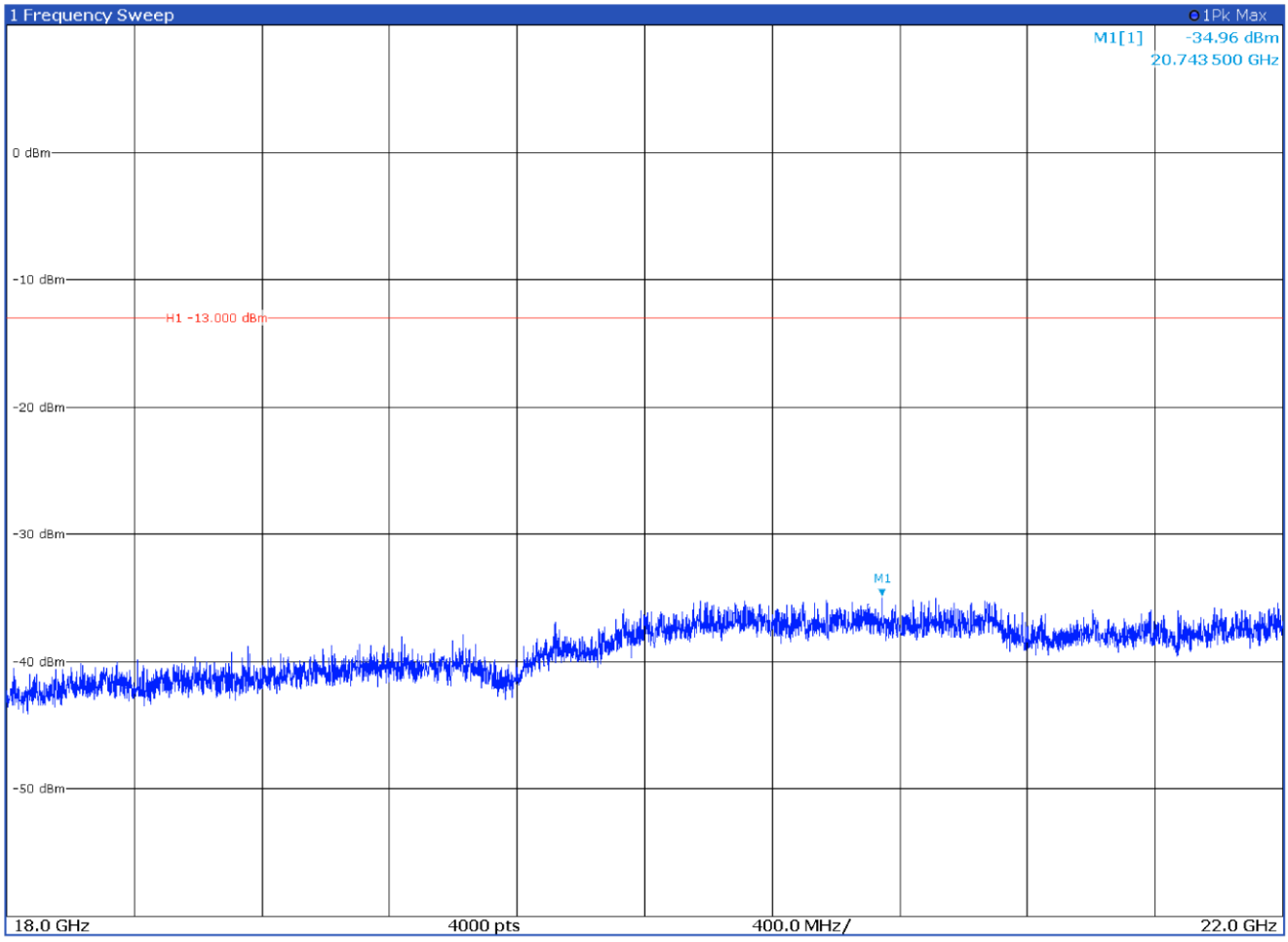


Figure 8.7-15: *Radiated spurious emissions from 18 GHz to to 10th harmonic, high channel with antenna in horizontal polarization*

Test data, continued

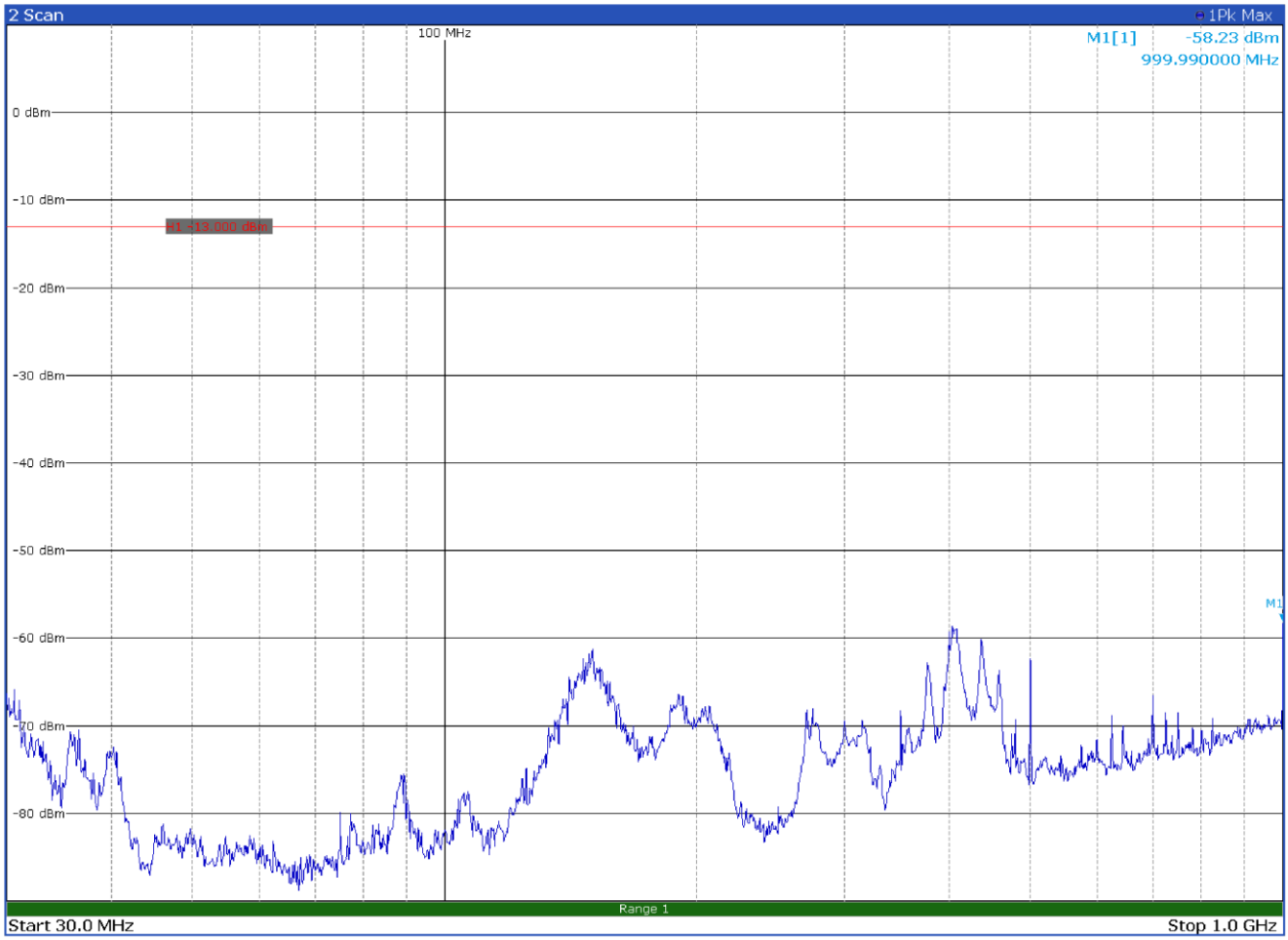


Figure 8.7-16: *Radiated spurious emissions below 1 GHz, high channel with antenna in vertical polarization*

Test data, continued

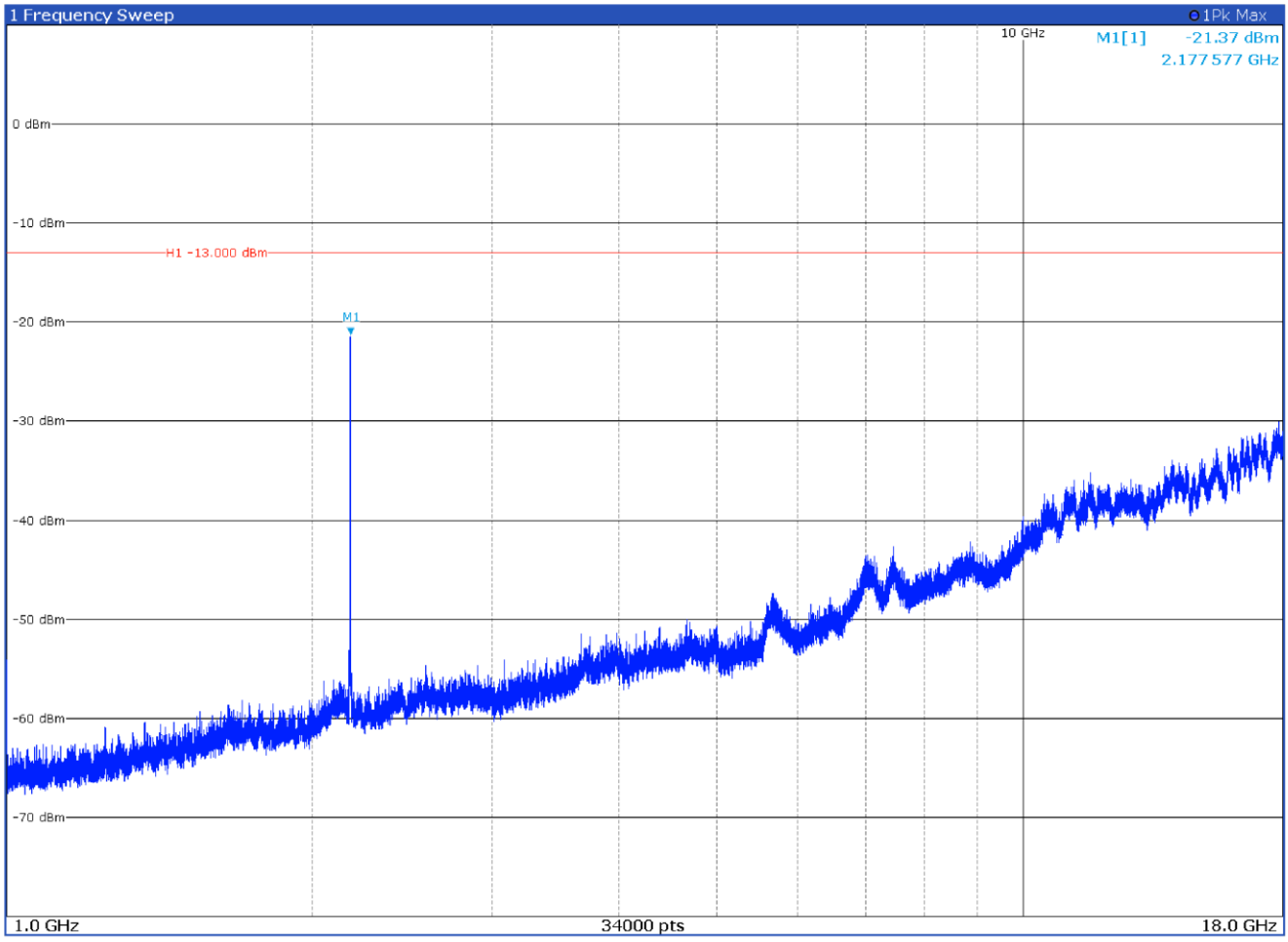


Figure 8.7-17: *Radiated spurious emissions from 1 GHz to 18 GHz, high channel with antenna in vertical polarization*

Test data, continued

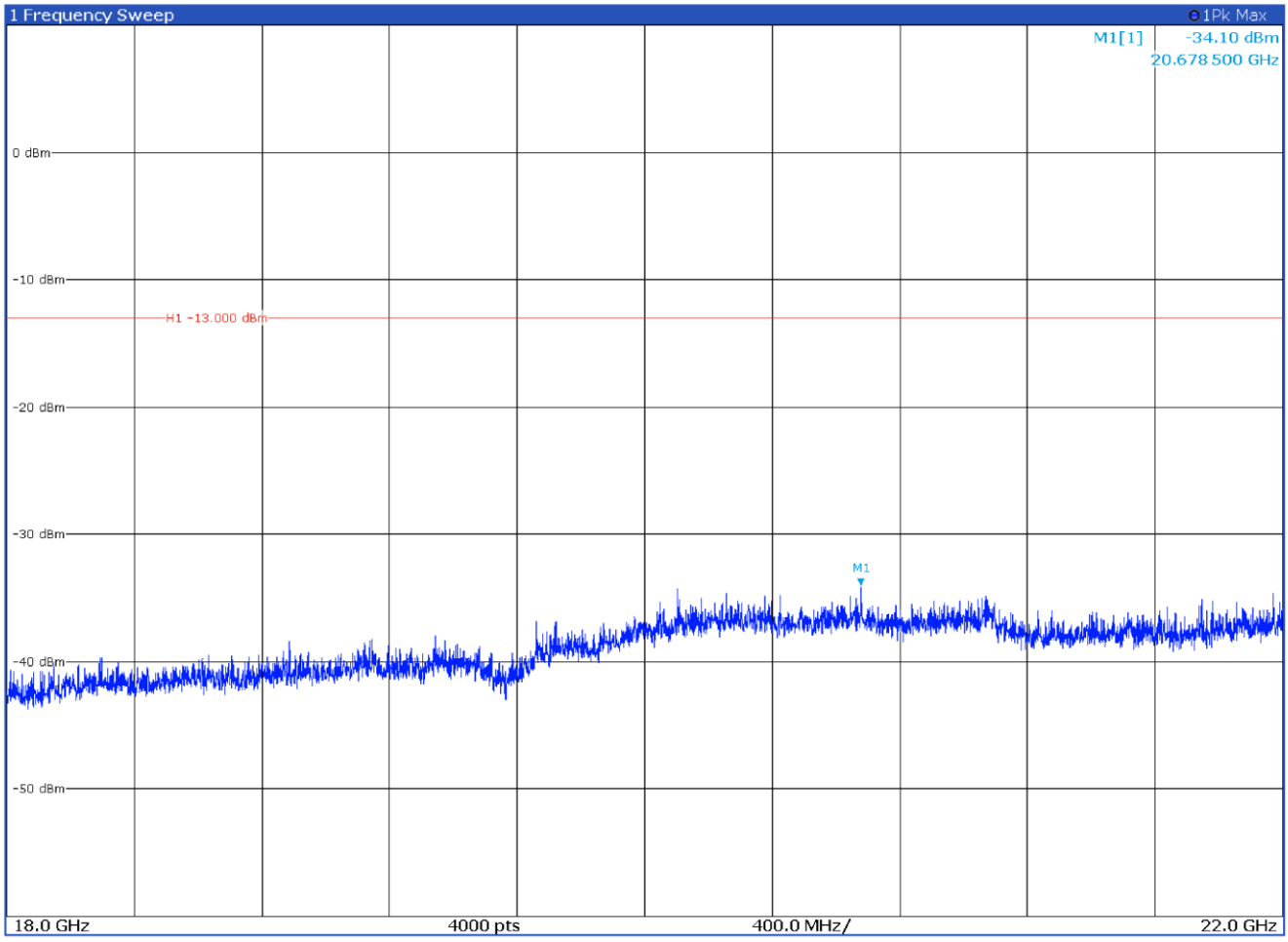


Figure 8.7-18: *Radiated spurious emissions from 18 GHz to to 10th harmonic, high channel with antenna in vertical polarization*

8.8 Frequency stability measurements

8.8.1 References, definitions and limits

FCC §27.54

The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

RSS-131, Clause 5.2.4

Industrial zone enhancers shall comply with the frequency stability given in the RSS that applies to the equipment with which the zone enhancer is to be used. In cases where the frequency stability limit is not given in the applicable RSS, the equipment shall comply with a frequency stability of ± 1.5 ppm.

For zone enhancers with no input signal processing capability, the frequency stability measurement in this section is not required.

RSS-139, Clause 6.4

The frequency stability shall be sufficient to ensure that the occupied bandwidth stays within the operating frequency block when tested to the temperature and supply voltage variations specified in RSS-Gen.

RSS-Gen, Clause 6.11

Transmitter frequency stability

Frequency stability is a measure of frequency drift due to temperature and supply voltage variations, with reference to the frequency measured at an appropriate reference temperature and the rated supply voltage.

When the measurement method of transmitter frequency stability is not stated in the applicable RSS or reference standards, the following conditions apply:

a. The reference temperature for radio transmitters is +20°C (+68°F).
b. A hand-held device that is only capable of operating using internal batteries shall be tested at the battery's nominal voltage, and again at the battery's operating end-point voltage, which shall be specified by the equipment manufacturer. For this test, either a battery or an external power supply can be used.
c. The operating carrier frequency shall be set up in accordance with the manufacturer's published operation and instruction manual prior to the commencement of these tests. No adjustment of any frequency-determining circuit element shall be made subsequent to this initial set-up.

With the transmitter installed in an environmental test chamber, the unmodulated carrier frequency and frequency stability shall be measured under the conditions specified below for licensed and licence-exempt devices, unless specified otherwise in the applicable RSS. A sufficient stabilization period at each temperature shall be used prior to each frequency measurement.

For licensed devices, the following measurement conditions apply:

a. at the temperatures of -30°C (-22°F), +20°C (+68°F) and +50°C (+122°F), and at the manufacturer's rated supply voltage
b. at the temperature of +20°C (+68°F) and at ±15% of the manufacturer's rated supply voltage

8.8.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	February 2, 2022

8.8.3 Observations, settings and special notes

Testing was performed per ANSI C63.26 Paragraphs 5.6.3, 5.6.4 and 5.6.5 methods.

8.8.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
EMI Receiver	Rohde & Schwarz	ESU8	100202
RF Vector Signal Generator	Rohde & Schwarz	SMBV100A	263254
RF Vector Signal Generator	Rohde & Schwarz	SMBV100A	263397
Climatic Chamber	MSL	EC500DA	15022

Notes: NCR - no calibration required, VOU - verify on use

8.8.5 Test data

Table 8.8-1: *Transmitter frequency stability results for antenna port 1*

Test conditions	Frequency, Hz	Drift, Hz	Drift, ppm	Limit ±ppm	Margin, ±ppm
+50 °C, Nominal	2144999095.0	16.9	0.00788	1.5	1.49
+40 °C, Nominal	2144999094.0	15.9	0.00741	1.5	1.49
+30 °C, Nominal	2144999089.0	10.9	0.00508	1.5	1.49
+20 °C, -15% voltage	2144999077.9	-0.2	-0.00009	1.5	1.50
+20 °C, Nominal	2144999078.1	Reference	Reference	Reference	Reference
+20 °C, +15% voltage	2144999081.4	3.3	0.00154	1.5	1.50
+10 °C, Nominal	2144999059.4	-18.7	-0.00872	1.5	1.49
0 °C, Nominal	2144999048.5	-29.6	-0.01380	1.5	1.49
−10 °C, Nominal	2144999024.8	-53.3	-0.02485	1.5	1.48
−20 °C, Nominal	2144999020.9	-57.2	-0.02667	1.5	1.47
−30 °C, Nominal	2144998952.0	-126.1	-0.05879	1.5	1.44

Table 8.8-2: *Transmitter frequency stability results for antenna port 2*

Test conditions	Frequency, Hz	Drift, Hz	Drift, ppm	Limit ±ppm	Margin, ±ppm
+50 °C, Nominal	2144999092.8	17.3	0.00807	1.5	1.49
+40 °C, Nominal	2144999091.6	16.1	0.00751	1.5	1.49
+30 °C, Nominal	2144999087.1	11.6	0.00541	1.5	1.49
+20 °C, -15% voltage	2144999075.7	0.2	0.00009	1.5	1.50
+20 °C, Nominal	2144999075.5	Reference	Reference	Reference	Reference
+20 °C, +15% voltage	2144999078.6	3.1	0.00145	1.5	1.50
+10 °C, Nominal	2144999056.9	-18.6	-0.00867	1.5	1.49
0 °C, Nominal	2144999046.4	-29.1	-0.01357	1.5	1.49
−10 °C, Nominal	2144999020.2	-55.3	-0.02578	1.5	1.47
−20 °C, Nominal	2144999016.1	-59.4	-0.02769	1.5	1.47
−30 °C, Nominal	2144998952.9	-122.6	-0.05716	1.5	1.44

Section 9 EUT photos

9.1 Set-up photos

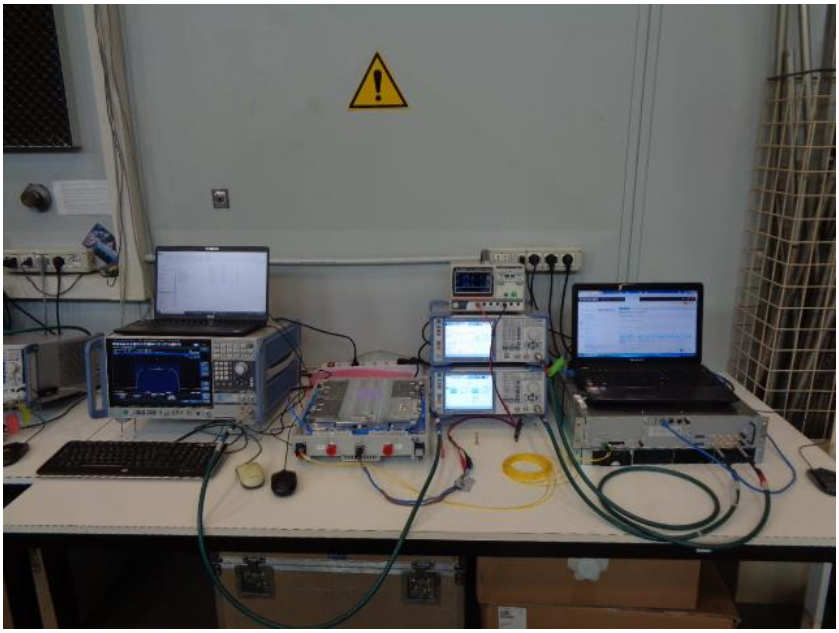


Figure 9.1-1: *Antenna port testing set-up*

Figure 9.1-2: *Antenna port testing set-up in climatic chamber*

Figure 9.1-3: *Radiated emissions set-up for frequencies below 1 GHz*

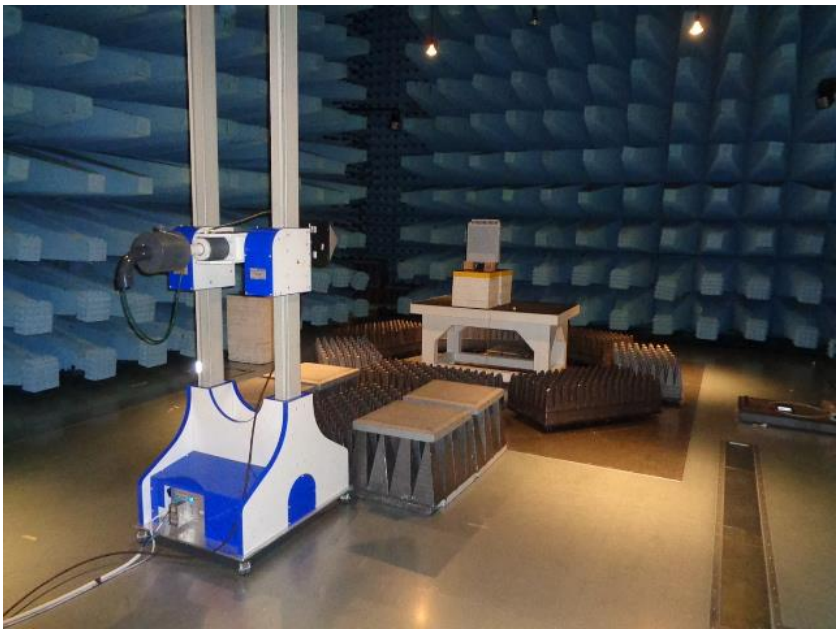


Figure 9.1-4: *Radiated emissions set-up for frequencies above 1 GHz*

9.2 External photos

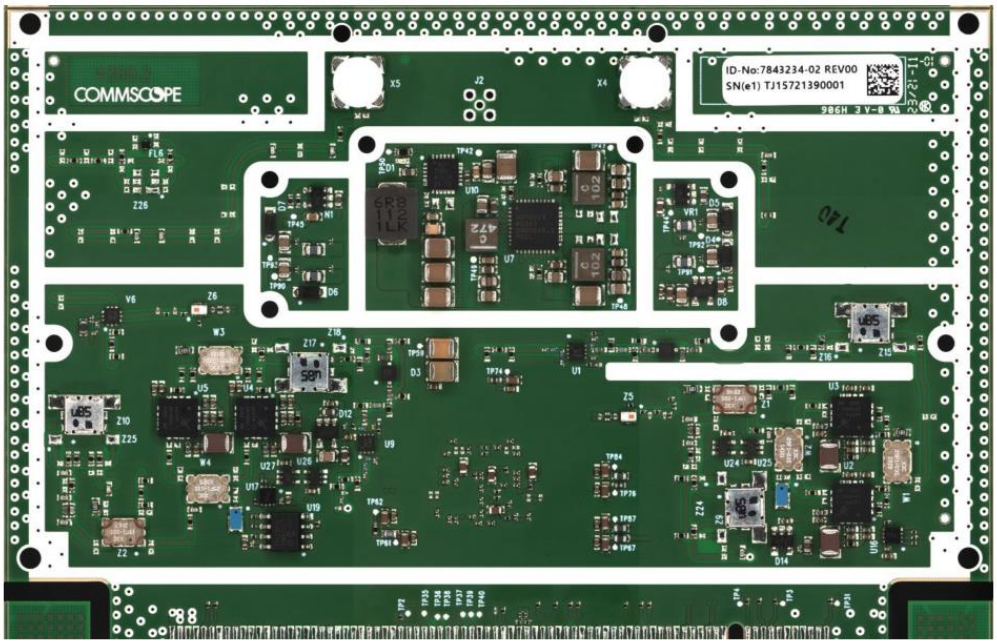
TOP View

BOTTOM View

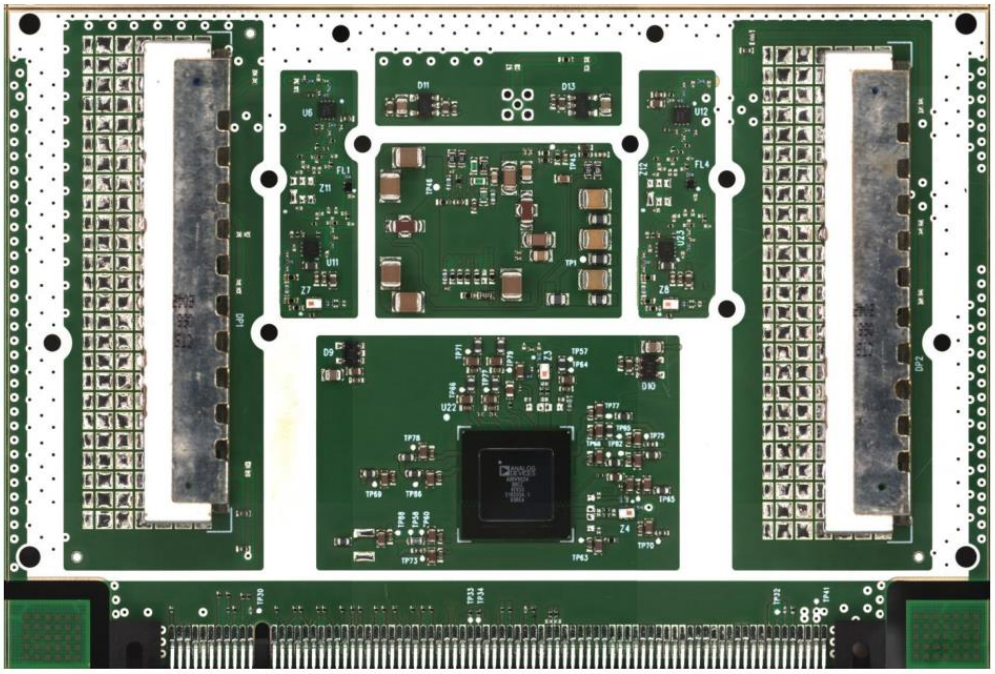
Connector side view

Rear side View

Left and Right side view



TOP View



BOTTOM View

End of the test report