Test data, continued

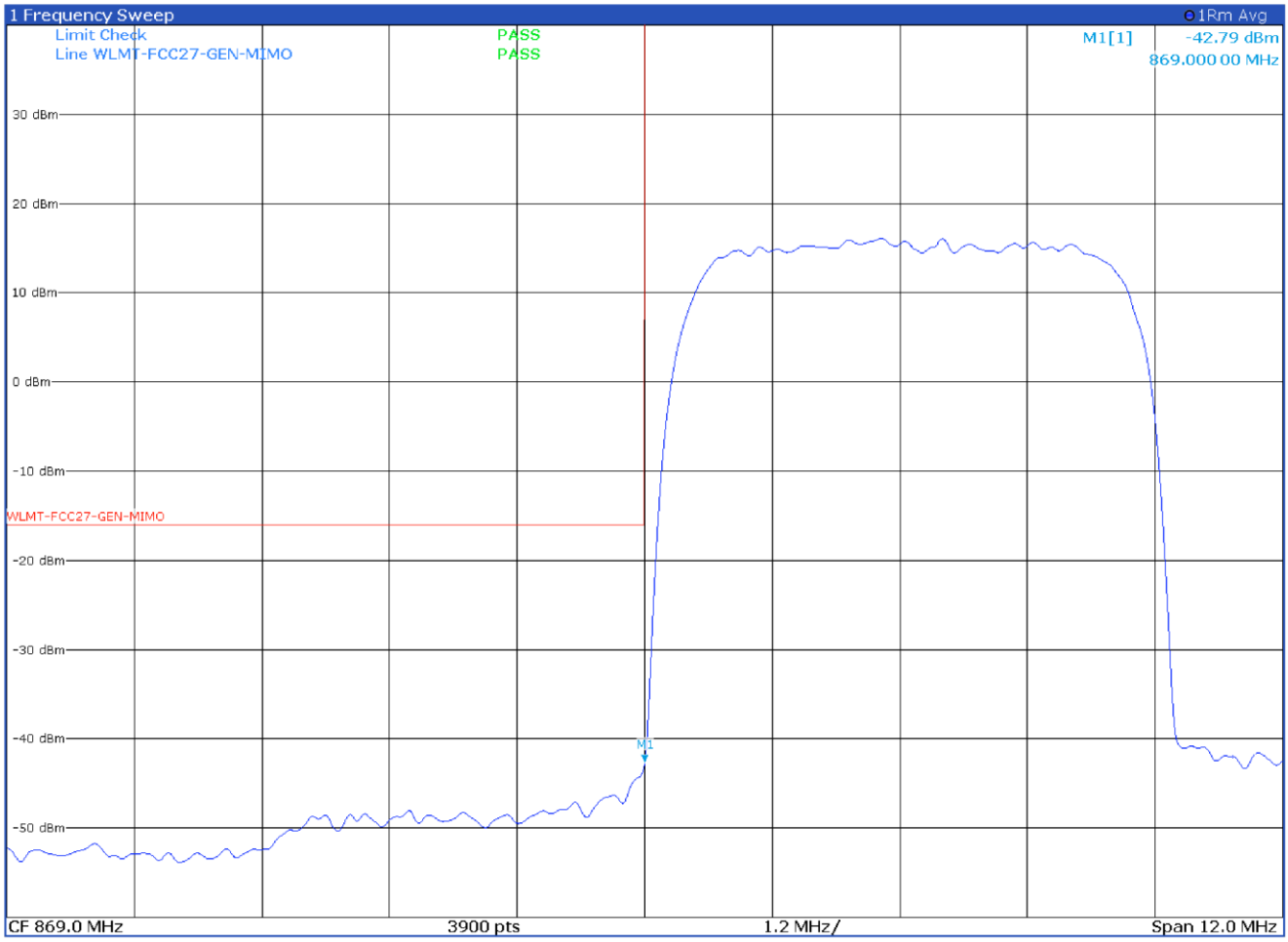


Figure 8.5-15: *Antenna port 2 single carrier lower block edge with input signal at AGC threshold*

Test data, continued

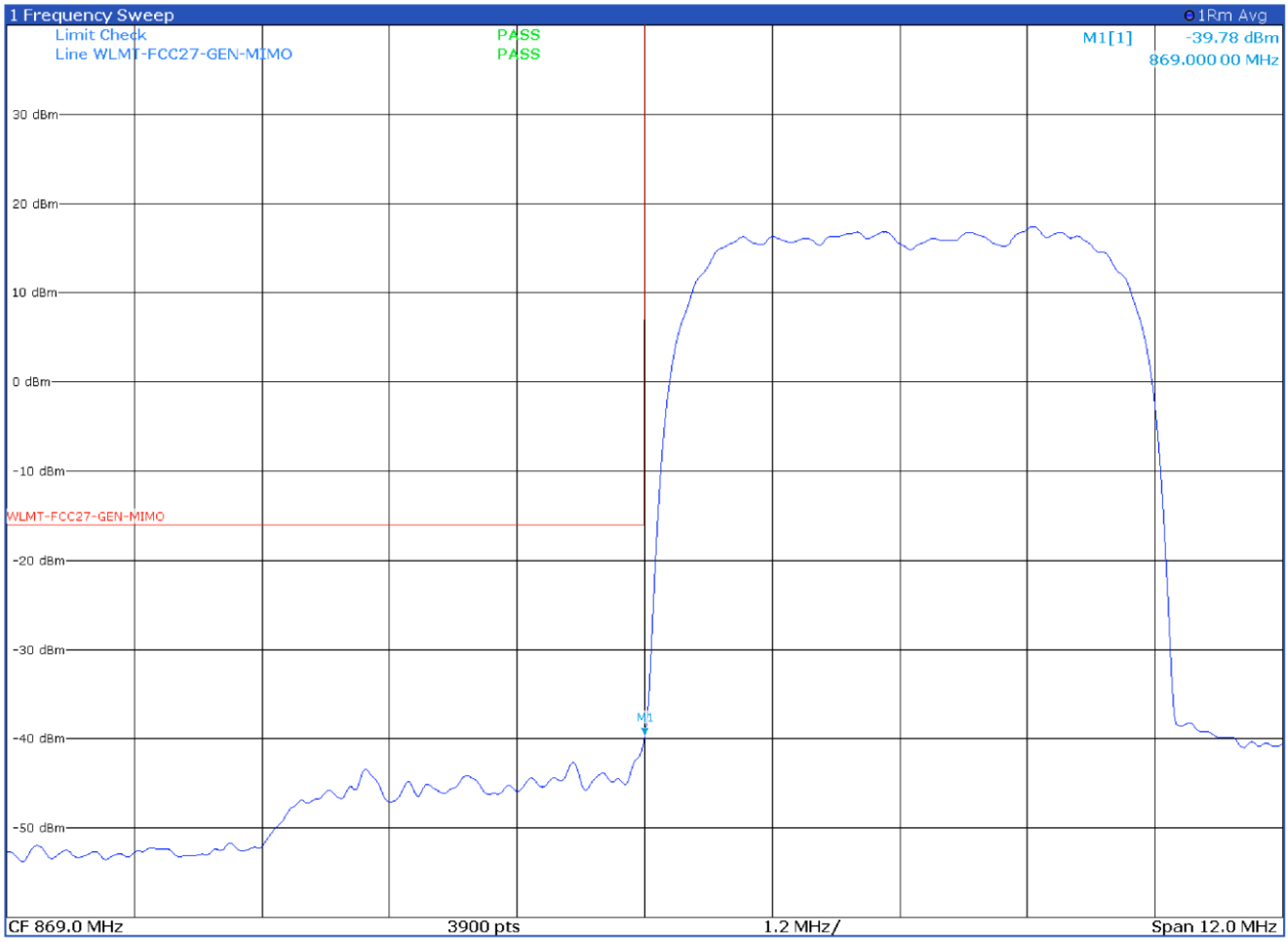


Figure 8.5-16: *Antenna port 2 single carrier lower block edge with input signal at AGC threshold +3 dB*

8.6 Spurious emissions conducted measurements

8.6.1 References, definitions and limits

FCC §22.917(a)

Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

RSS-131, Clause 5.2

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-132, Clause 5.5

Transmitter Unwanted Emissions

(i) In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10p (watts).

(ii) After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

8.6.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	January 28, 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

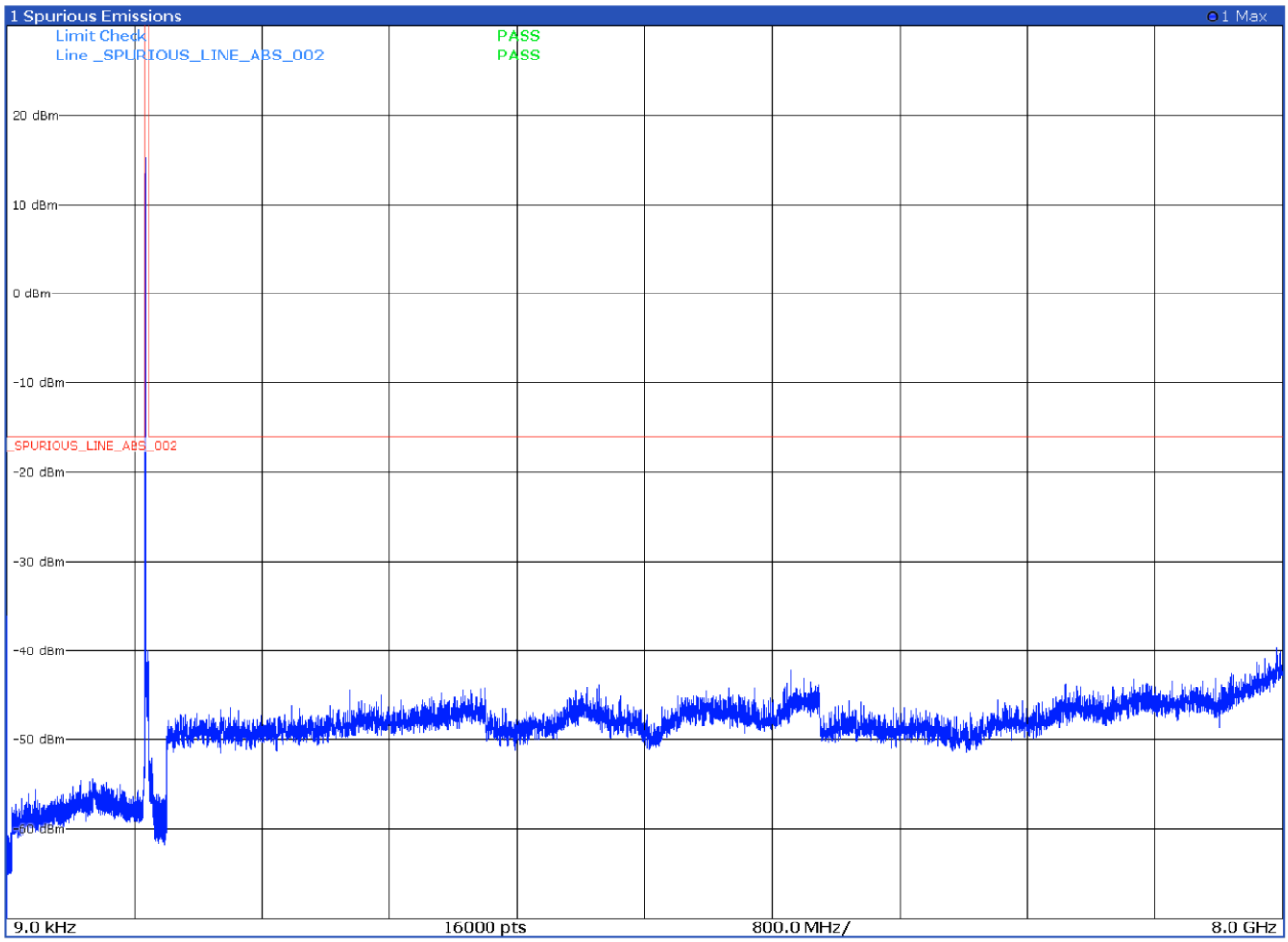
Low channel	871.5 MHz
Mid channel	881.5 MHz
High channel	891.5 MHz

8.6.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767
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

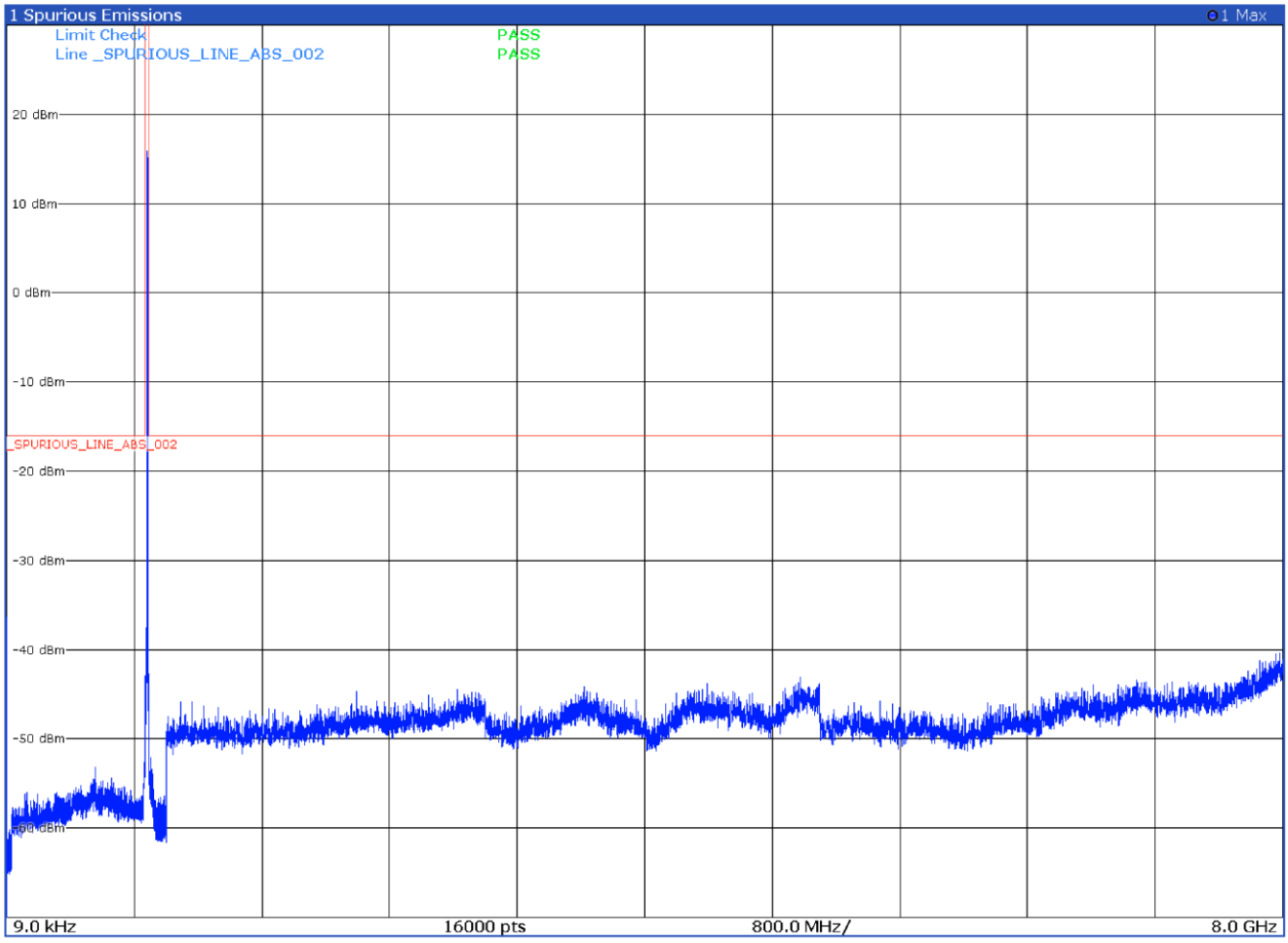


2 Result Summary

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
9.000 kHz	150.000 kHz	1.000 kHz	**11.467 50 kHz**	**-65.72 dBm**	**-49.72 dB**
150.000 kHz	30.000 MHz	10.000 kHz	**702.225 00 kHz**	**-36.15 dBm**	**-20.15 dB**
30.000 MHz	869.000 MHz	100.000 kHz	**868.790 25 MHz**	**-42.11 dBm**	**-26.11 dB**
869.000 MHz	894.000 MHz	100.000 kHz	**871.218 75 MHz**	**15.22 dBm**	**-34.78 dB**
894.000 MHz	1.000 GHz	100.000 kHz	**894.026 50 MHz**	**-48.27 dBm**	**-32.27 dB**
1.000 GHz	8.000 GHz	1.000 MHz	**7.966 31 GHz**	**-39.61 dBm**	**-23.61 dB**

Figure 8.6-1: *Conducted spurious emissions of low channel, antenna port 1*

8.6.1 Test data

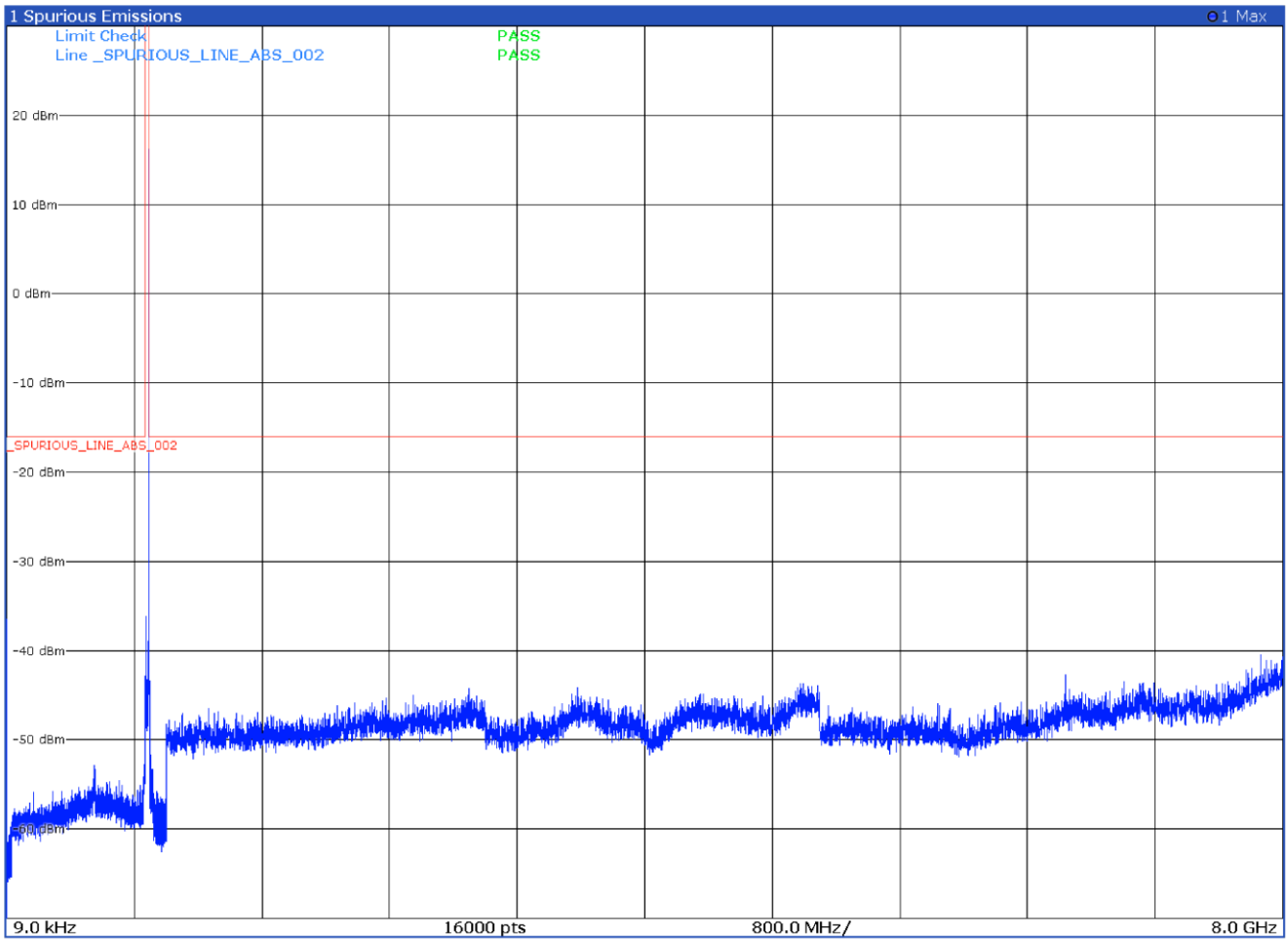


2 Result Summary

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
9.000 kHz	150.000 kHz	1.000 kHz	**10.339 50 kHz**	**-66.09 dBm**	**-50.09 dB**
150.000 kHz	30.000 MHz	10.000 kHz	**702.225 00 kHz**	**-36.34 dBm**	**-20.34 dB**
30.000 MHz	869.000 MHz	100.000 kHz	**868.790 25 MHz**	**-49.23 dBm**	**-33.23 dB**
869.000 MHz	894.000 MHz	100.000 kHz	**882.143 75 MHz**	**15.93 dBm**	**-34.07 dB**
894.000 MHz	1.000 GHz	100.000 kHz	**894.026 50 MHz**	**-48.26 dBm**	**-32.26 dB**
1.000 GHz	8.000 GHz	1.000 MHz	**7.982 06 GHz**	**-40.35 dBm**	**-24.35 dB**

Figure 8.6-2: *Conducted spurious emissions of mid channel, antenna port 1*

Test data, continued

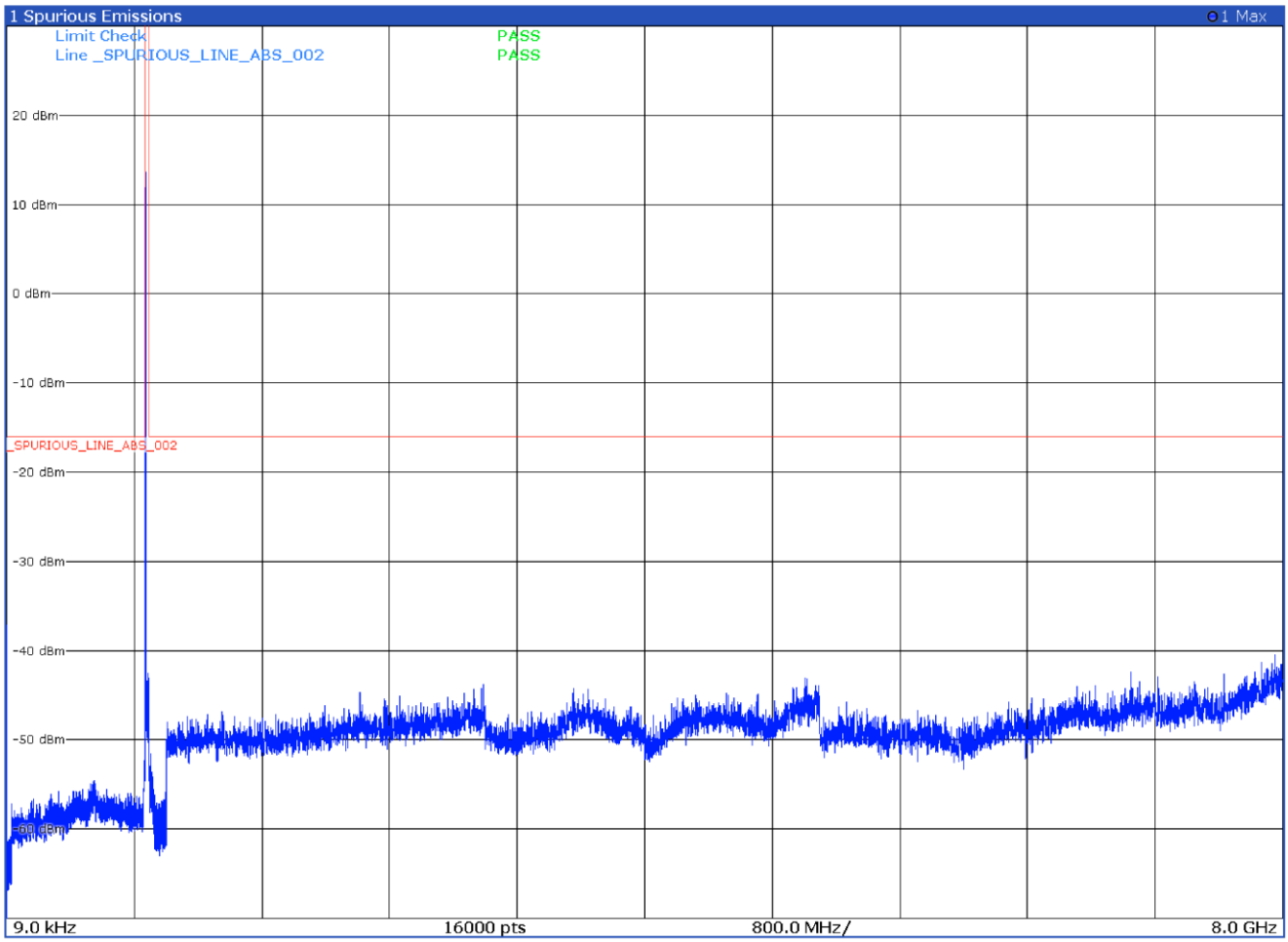


2 Result Summary

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
9.000 kHz	150.000 kHz	1.000 kHz	**9.493 50 kHz**	**-66.05 dBm**	**-50.05 dB**
150.000 kHz	30.000 MHz	10.000 kHz	**702.225 00 kHz**	**-36.45 dBm**	**-20.45 dB**
30.000 MHz	869.000 MHz	100.000 kHz	**868.790 25 MHz**	**-49.66 dBm**	**-33.66 dB**
869.000 MHz	894.000 MHz	100.000 kHz	**892.156 25 MHz**	**16.18 dBm**	**-33.82 dB**
894.000 MHz	1.000 GHz	100.000 kHz	**894.185 50 MHz**	**-40.43 dBm**	**-24.43 dB**
1.000 GHz	8.000 GHz	1.000 MHz	**7.863 06 GHz**	**-40.50 dBm**	**-24.50 dB**

Figure 8.6-3: *Conducted spurious emissions of high channel, antenna port 1*

8.6.1 Test data

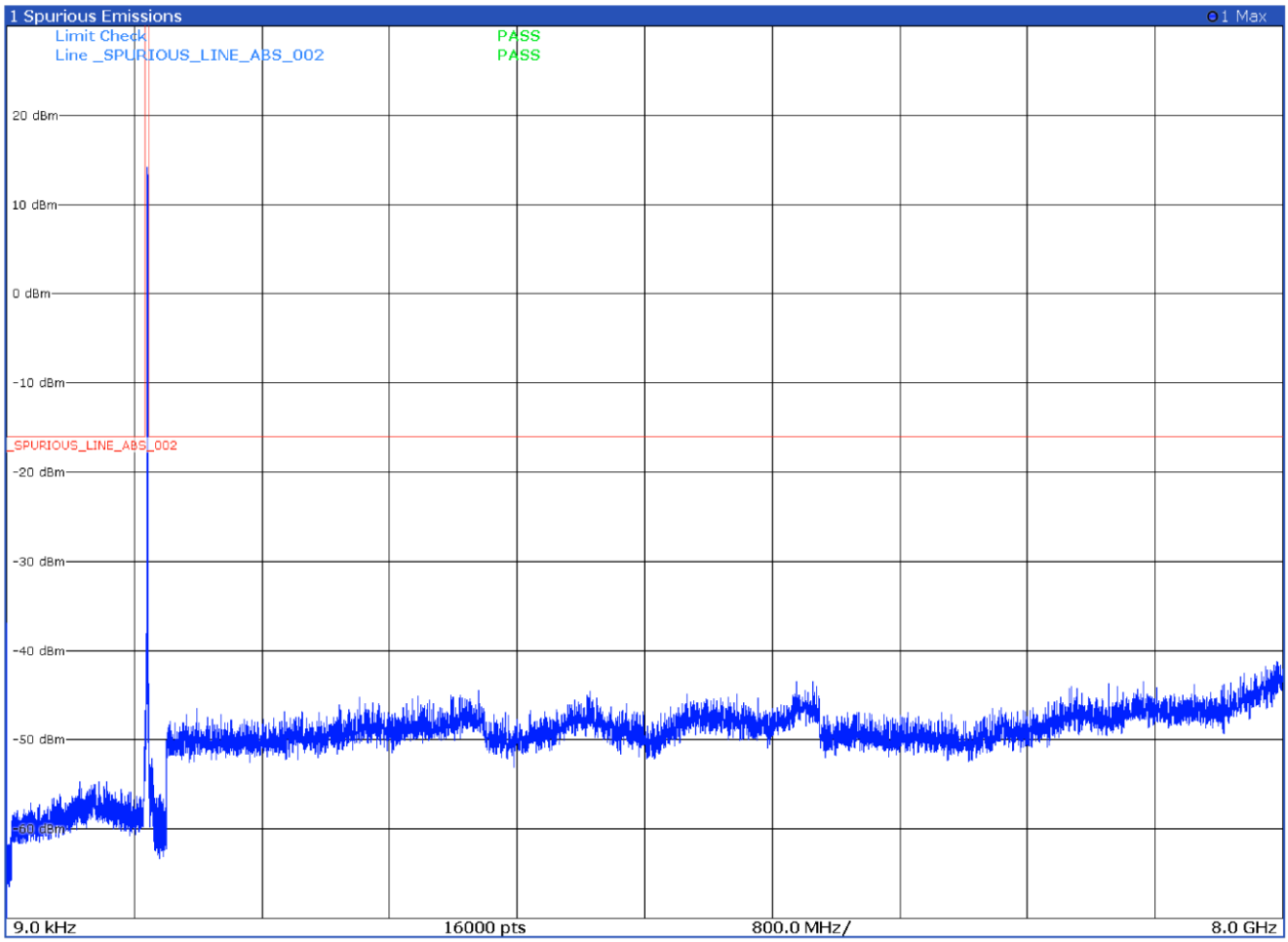


2 Result Summary

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
9.000 kHz	150.000 kHz	1.000 kHz	**11.749 50 kHz**	**-66.88 dBm**	**-50.88 dB**
150.000 kHz	30.000 MHz	10.000 kHz	**702.225 00 kHz**	**-37.08 dBm**	**-21.08 dB**
30.000 MHz	869.000 MHz	100.000 kHz	**868.790 25 MHz**	**-40.89 dBm**	**-24.89 dB**
869.000 MHz	894.000 MHz	100.000 kHz	**871.218 75 MHz**	**13.65 dBm**	**-36.35 dB**
894.000 MHz	1.000 GHz	100.000 kHz	**894.026 50 MHz**	**-49.18 dBm**	**-33.18 dB**
1.000 GHz	8.000 GHz	1.000 MHz	**7.951 44 GHz**	**-40.47 dBm**	**-24.47 dB**

Figure 8.6-4: *Conducted spurious emissions of low channel, antenna port 2*

8.6.1 Test data

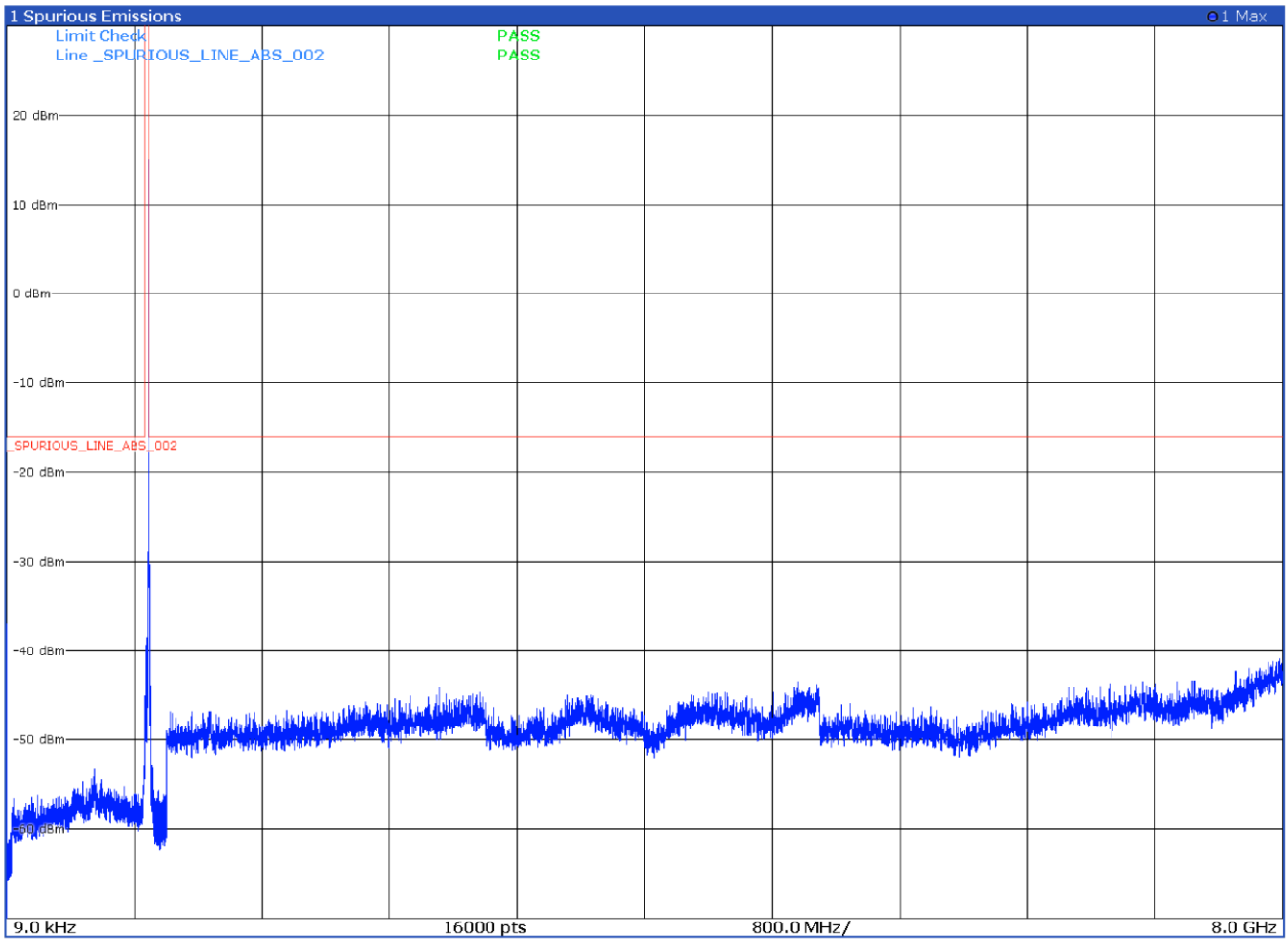


2 Result Summary

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
9.000 kHz	150.000 kHz	1.000 kHz	**10.621 50 kHz**	**-64.94 dBm**	**-48.94 dB**
150.000 kHz	30.000 MHz	10.000 kHz	**702.225 00 kHz**	**-36.93 dBm**	**-20.93 dB**
30.000 MHz	869.000 MHz	100.000 kHz	**864.175 75 MHz**	**-50.84 dBm**	**-34.84 dB**
869.000 MHz	894.000 MHz	100.000 kHz	**882.143 75 MHz**	**14.16 dBm**	**-35.84 dB**
894.000 MHz	1.000 GHz	100.000 kHz	**894.079 50 MHz**	**-49.61 dBm**	**-33.61 dB**
1.000 GHz	8.000 GHz	1.000 MHz	**7.965 44 GHz**	**-41.27 dBm**	**-25.27 dB**

Figure 8.6-5: *Conducted spurious emissions of mid channel, antenna port 2*

Test data, continued



2 Result Summary

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
9.000 kHz	150.000 kHz	1.000 kHz	**13.723 50 kHz**	**-65.45 dBm**	**-49.45 dB**
150.000 kHz	30.000 MHz	10.000 kHz	**702.225 00 kHz**	**-37.05 dBm**	**-21.05 dB**
30.000 MHz	869.000 MHz	100.000 kHz	**868.790 25 MHz**	**-50.49 dBm**	**-34.49 dB**
869.000 MHz	894.000 MHz	100.000 kHz	**892.131 25 MHz**	**15.00 dBm**	**-35.00 dB**
894.000 MHz	1.000 GHz	100.000 kHz	**894.185 50 MHz**	**-28.11 dBm**	**-12.11 dB**
1.000 GHz	8.000 GHz	1.000 MHz	**7.978 56 GHz**	**-40.87 dBm**	**-24.87 dB**

Figure 8.6-6: *Conducted spurious emissions of high channel, antenna port 2*

8.7 Spurious emissions radiated measurements

8.7.1 References, definitions and limits

FCC §22.917(a)

Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

RSS-131, Clause 5.2

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-132, Clause 5.5

Transmitter Unwanted Emissions

(i) In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10p (watts).

(ii) After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

8.7.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	January 28, 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	871.5 MHz
Middle channel	881.5 MHz
High channel	891.5 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

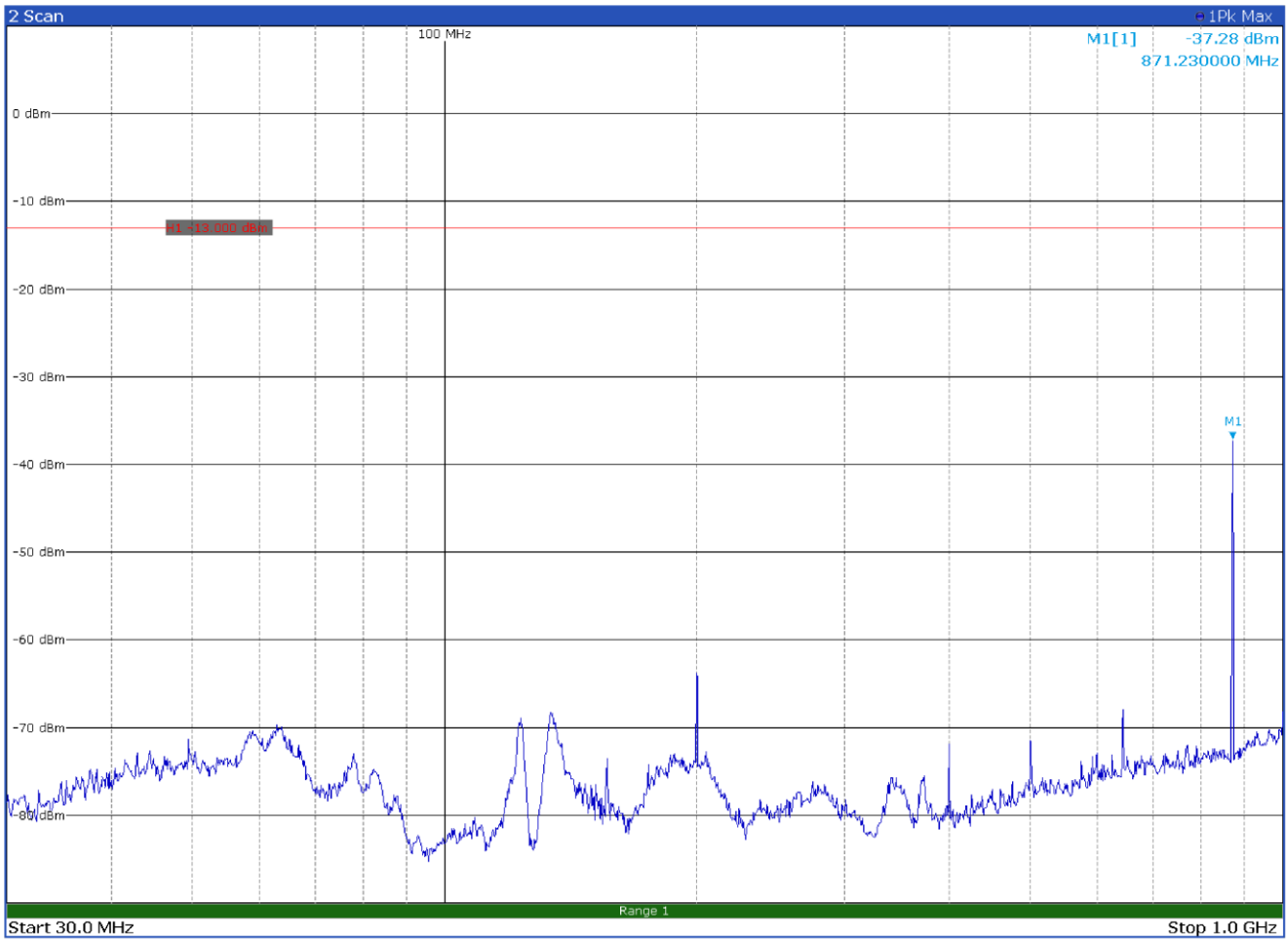


Figure 8.7-1: *Radiated spurious emissions below 1 GHz, low channel with antenna in horizontal polarization*

Test data, continued

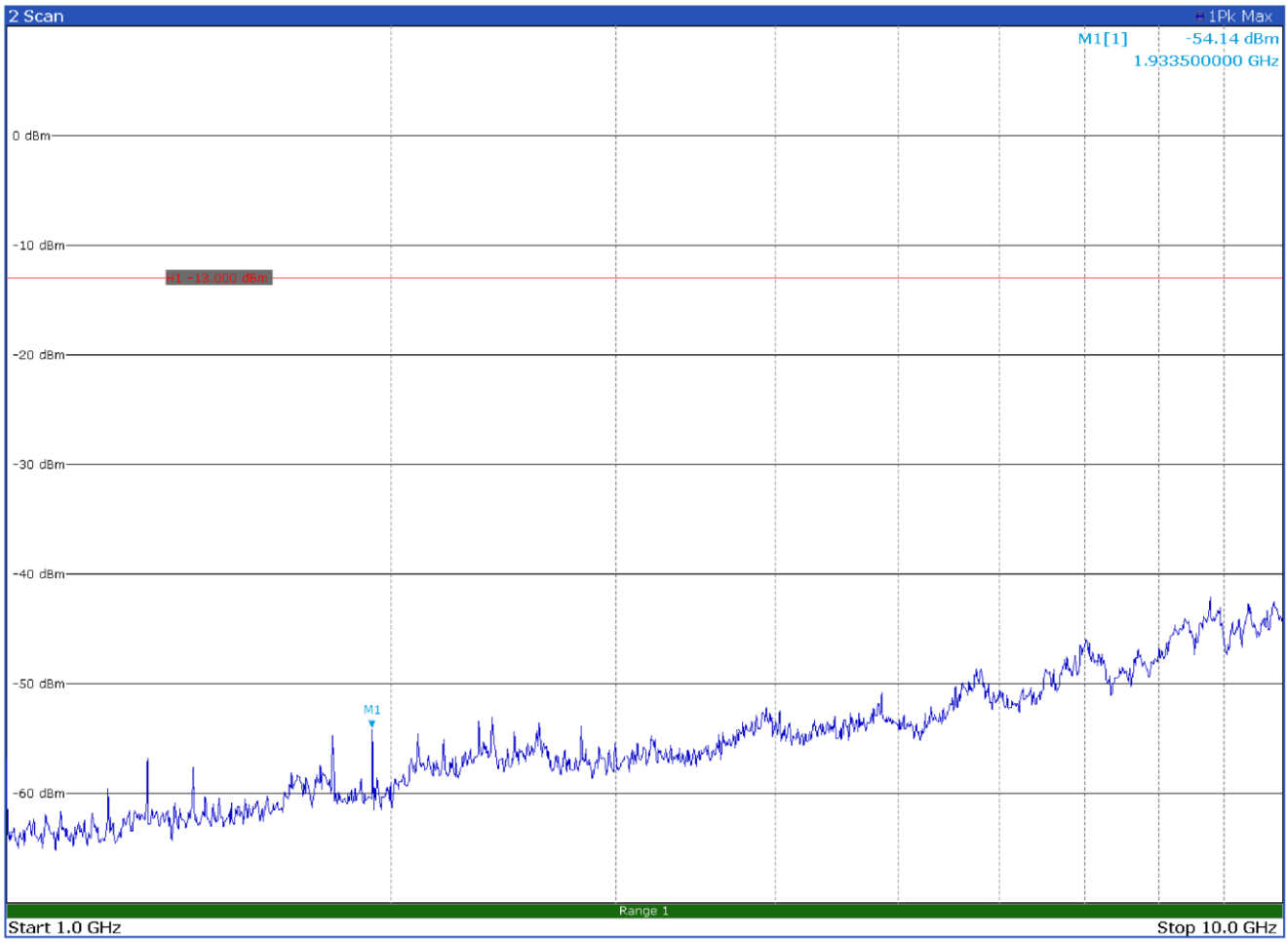


Figure 8.7-2: *Radiated spurious emissions from 1 GHz to 10 GHz, low channel with antenna in horizontal polarization*

Test data, continued

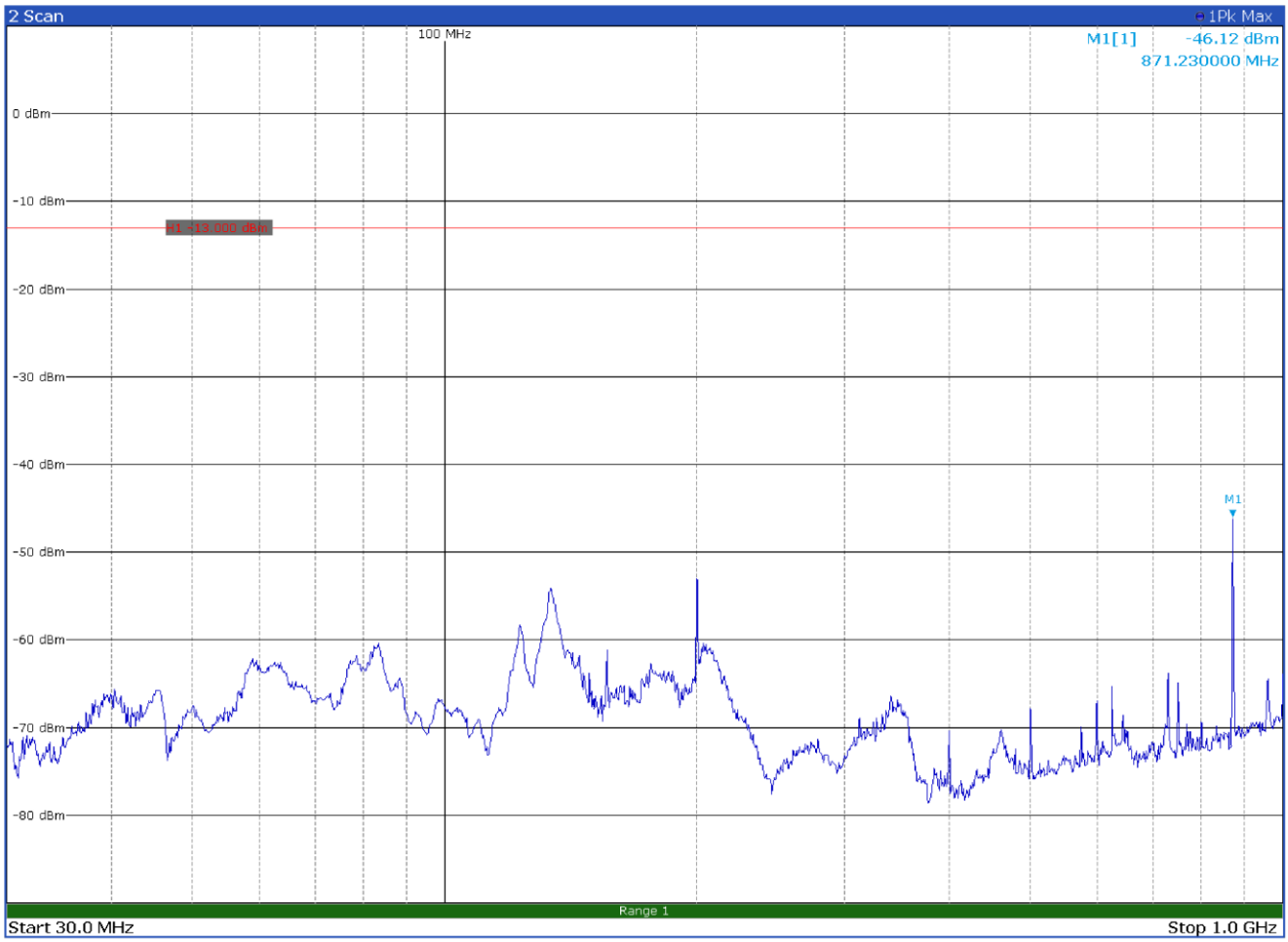


Figure 8.7-3: *Radiated spurious emissions below 1 GHz, low channel with antenna in vertical polarization*

Test data, continued

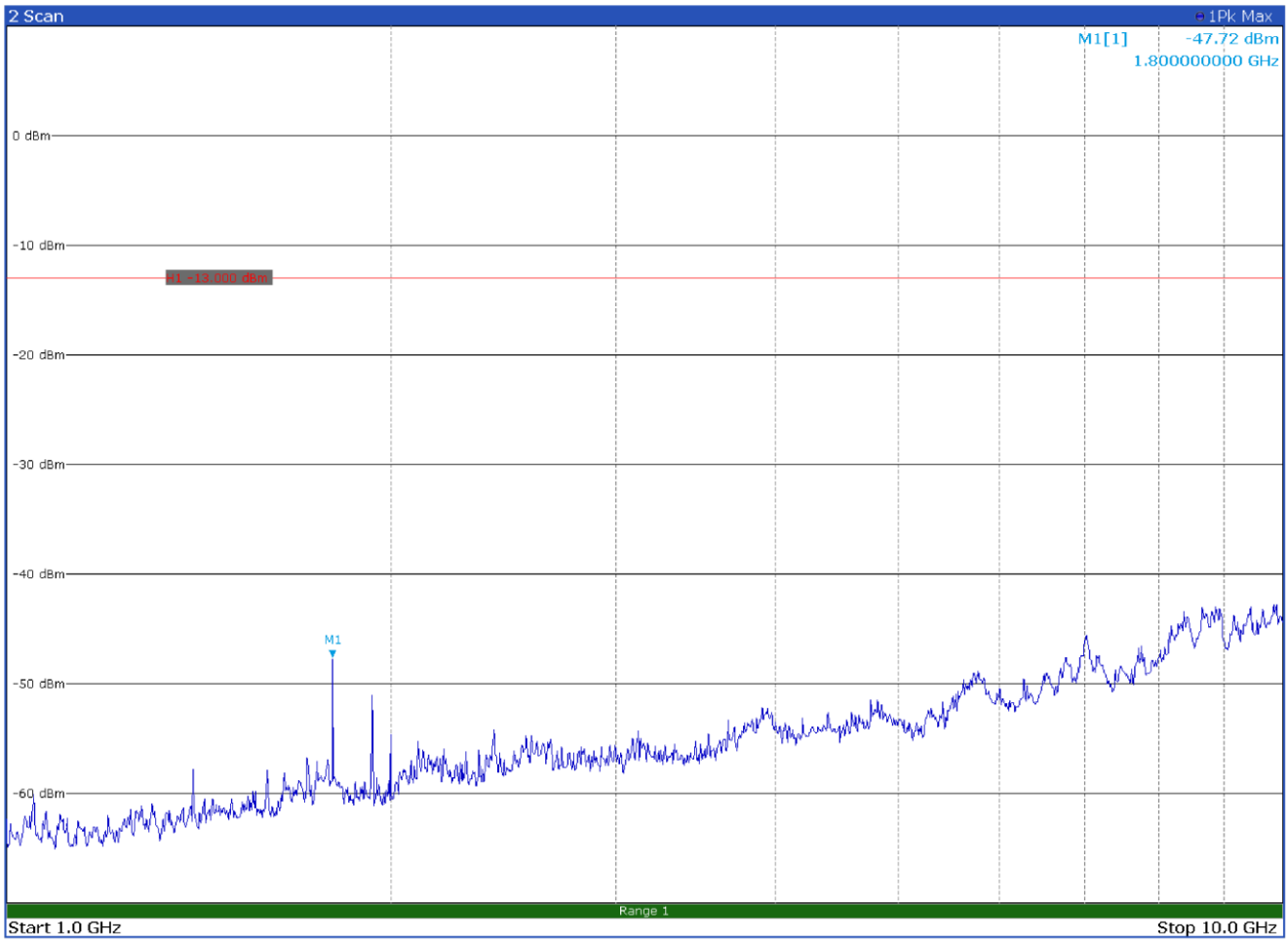


Figure 8.7-4: *Radiated spurious emissions from 1 GHz to 10 GHz, low channel with antenna in vertical polarization*

Test data, continued

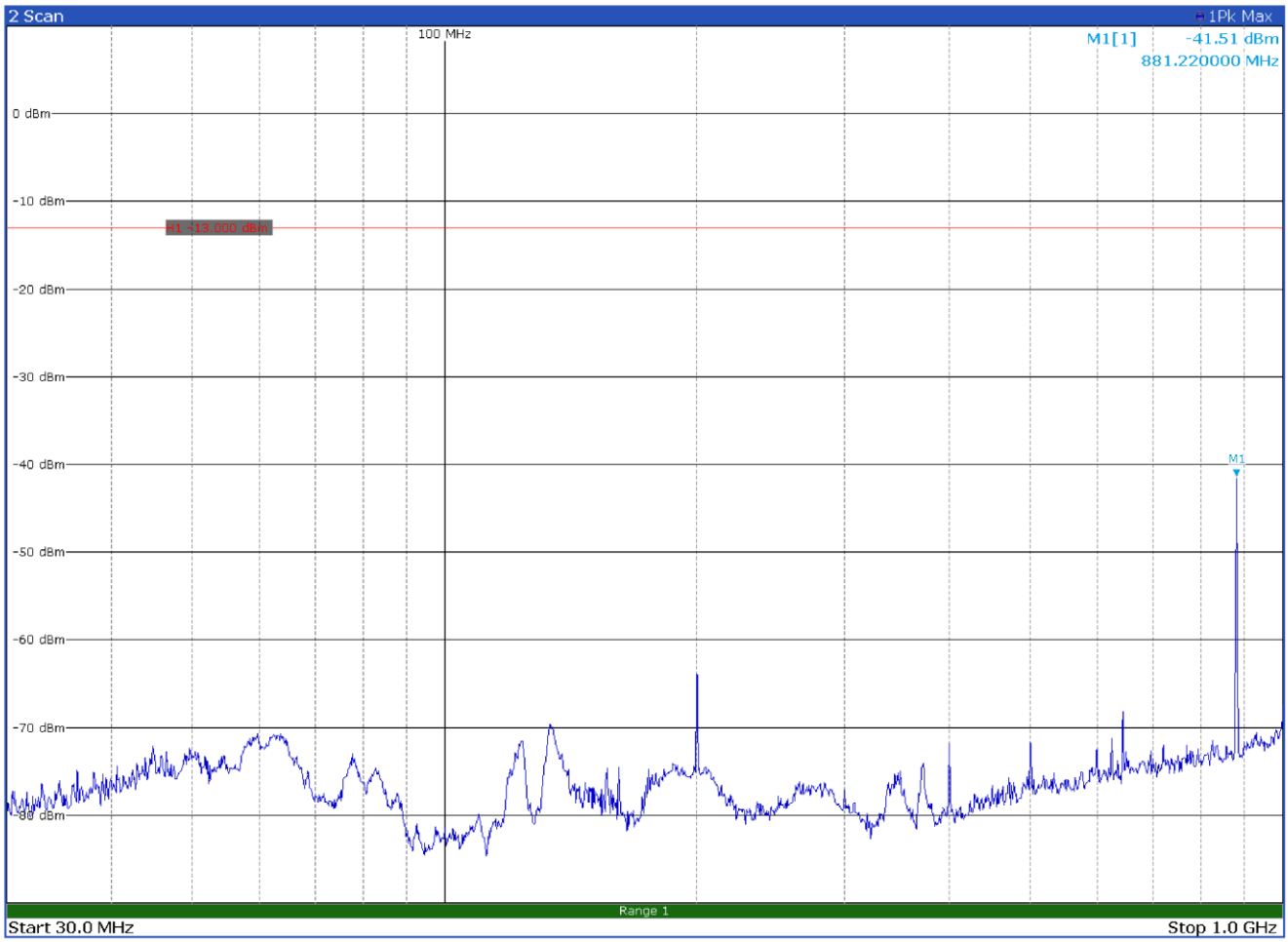


Figure 8.7-5: *Radiated spurious emissions below 1 GHz, mid channel with antenna in horizontal polarization*

Test data, continued

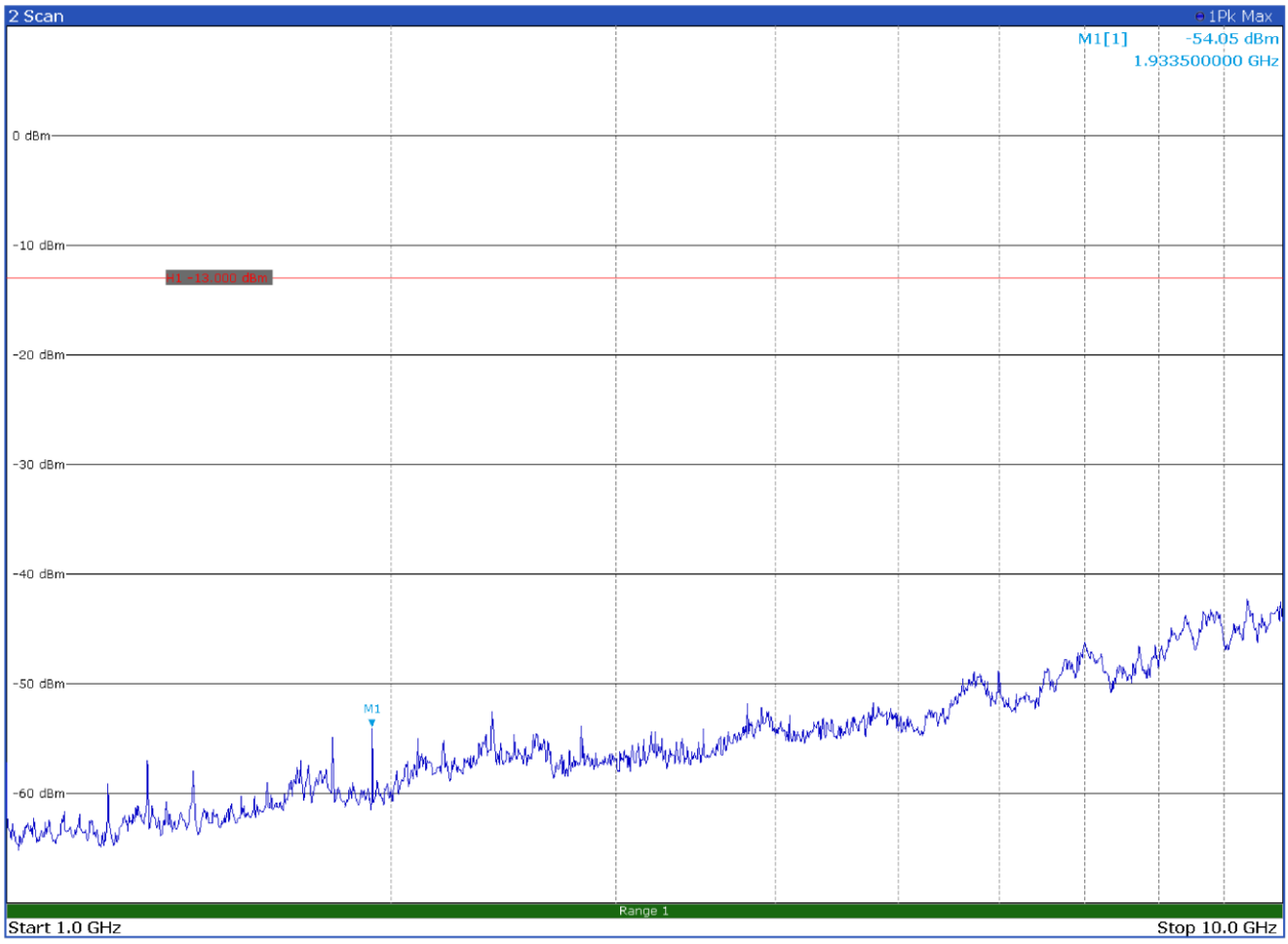


Figure 8.7-6: *Radiated spurious emissions from 1 GHz to 10 GHz, mid channel with antenna in horizontal polarization*

Test data, continued

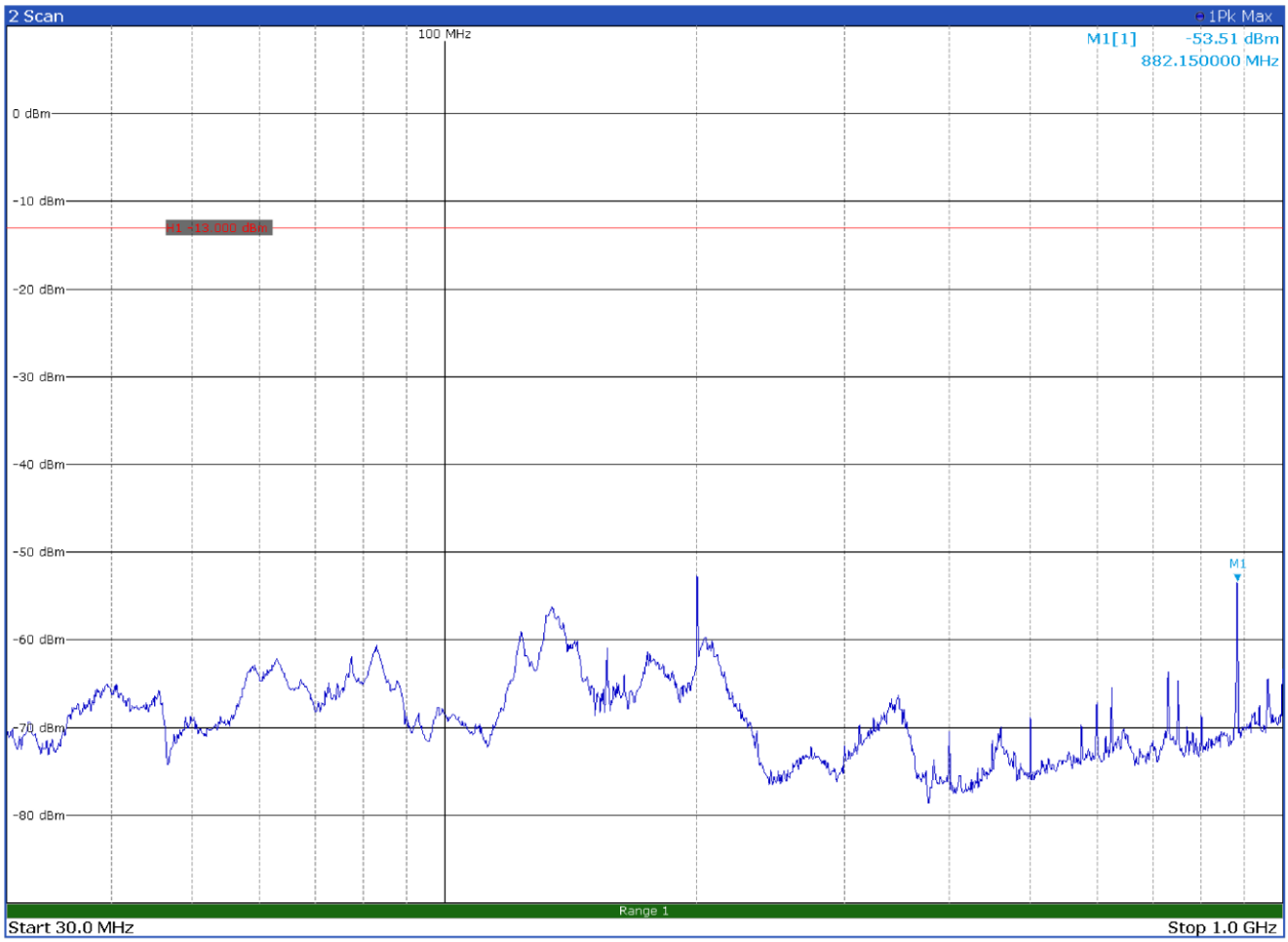


Figure 8.7-7: *Radiated spurious emissions below 1 GHz, mid channel with antenna in vertical polarization*

Test data, continued

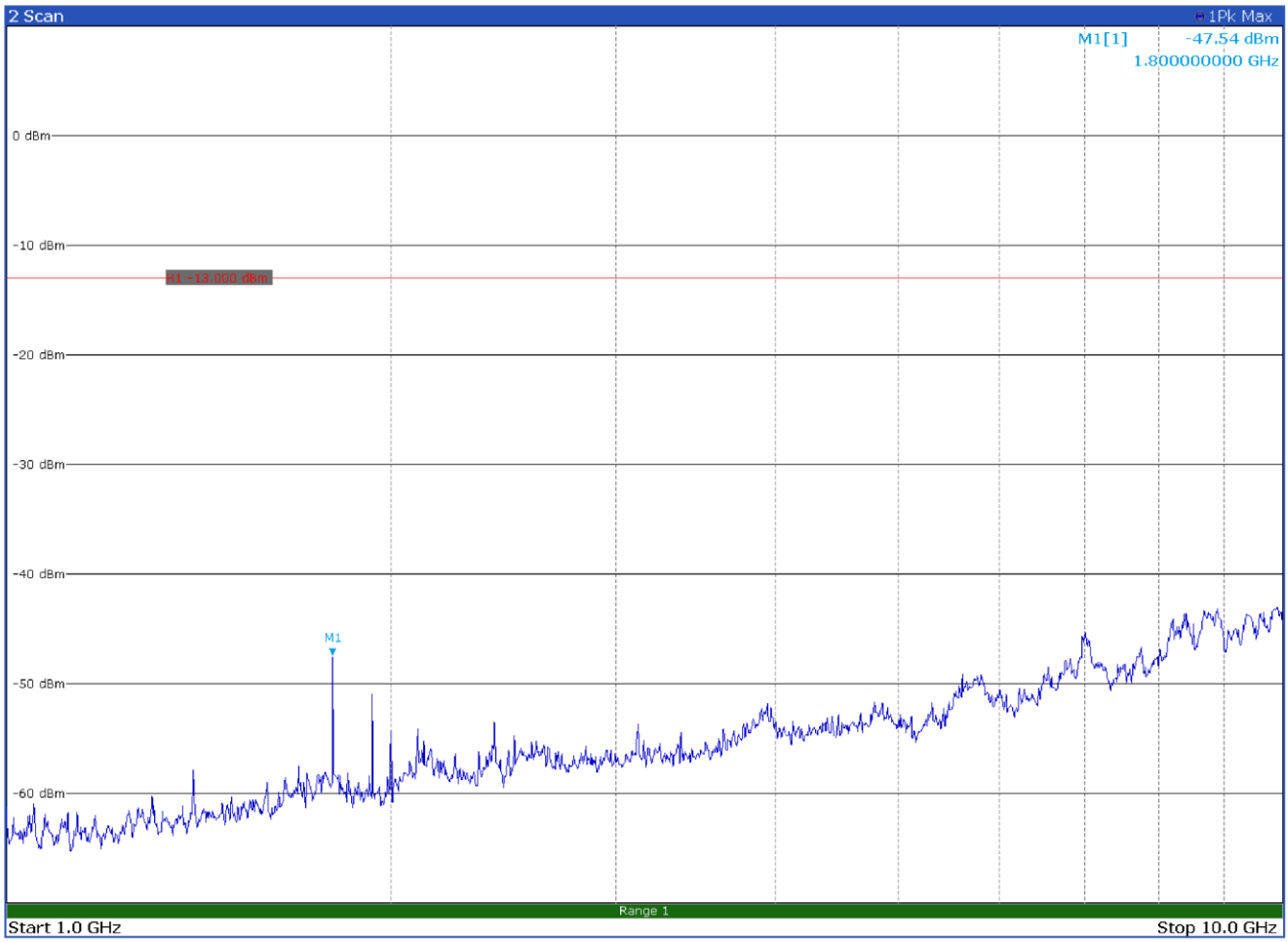


Figure 8.7-8: *Radiated spurious emissions from 1 GHz to 10 GHz, mid channel with antenna in vertical polarization*

Test data, continued

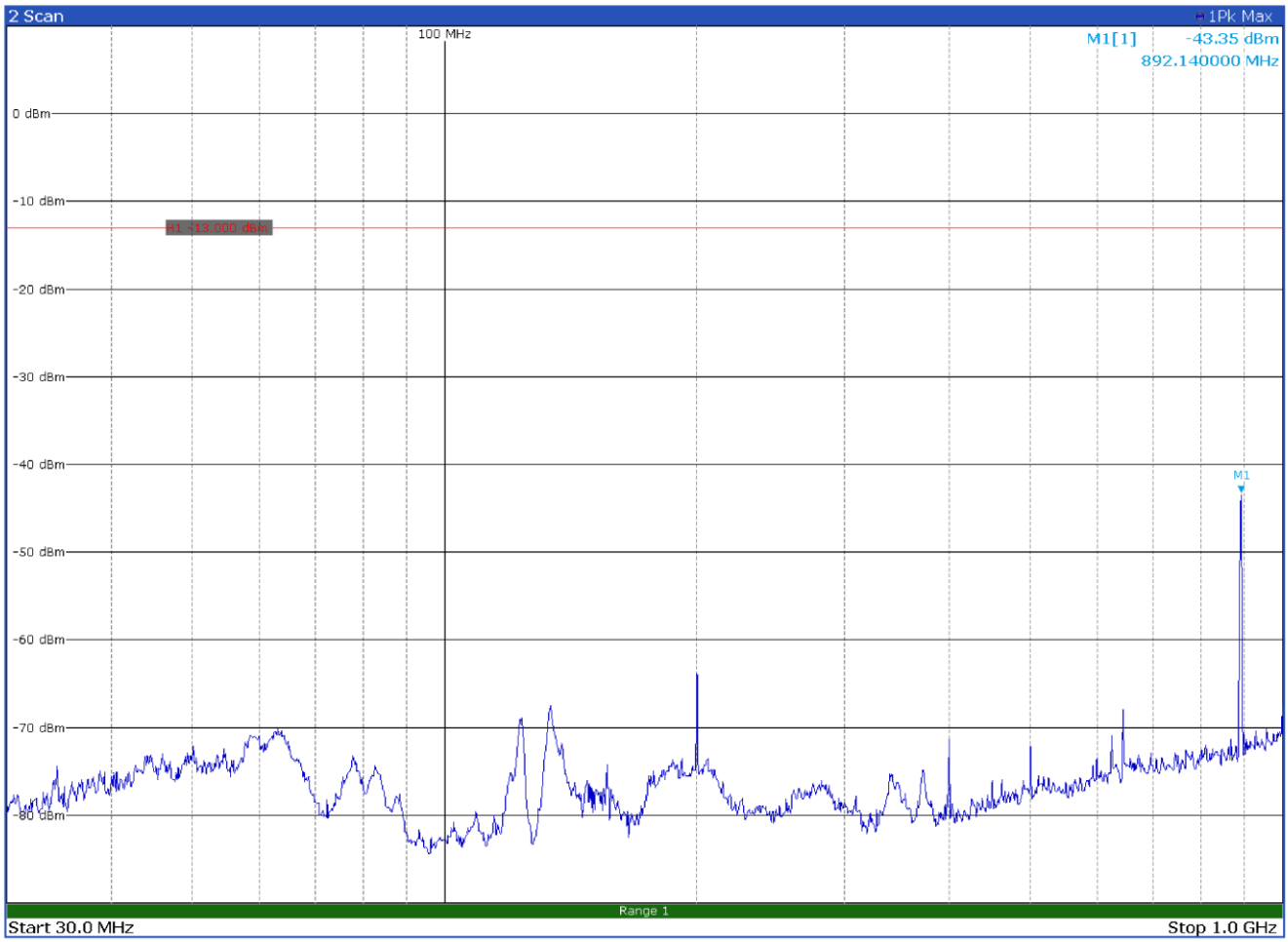


Figure 8.7-9: *Radiated spurious emissions below 1 GHz, high channel with antenna in horizontal polarization*

Test data, continued

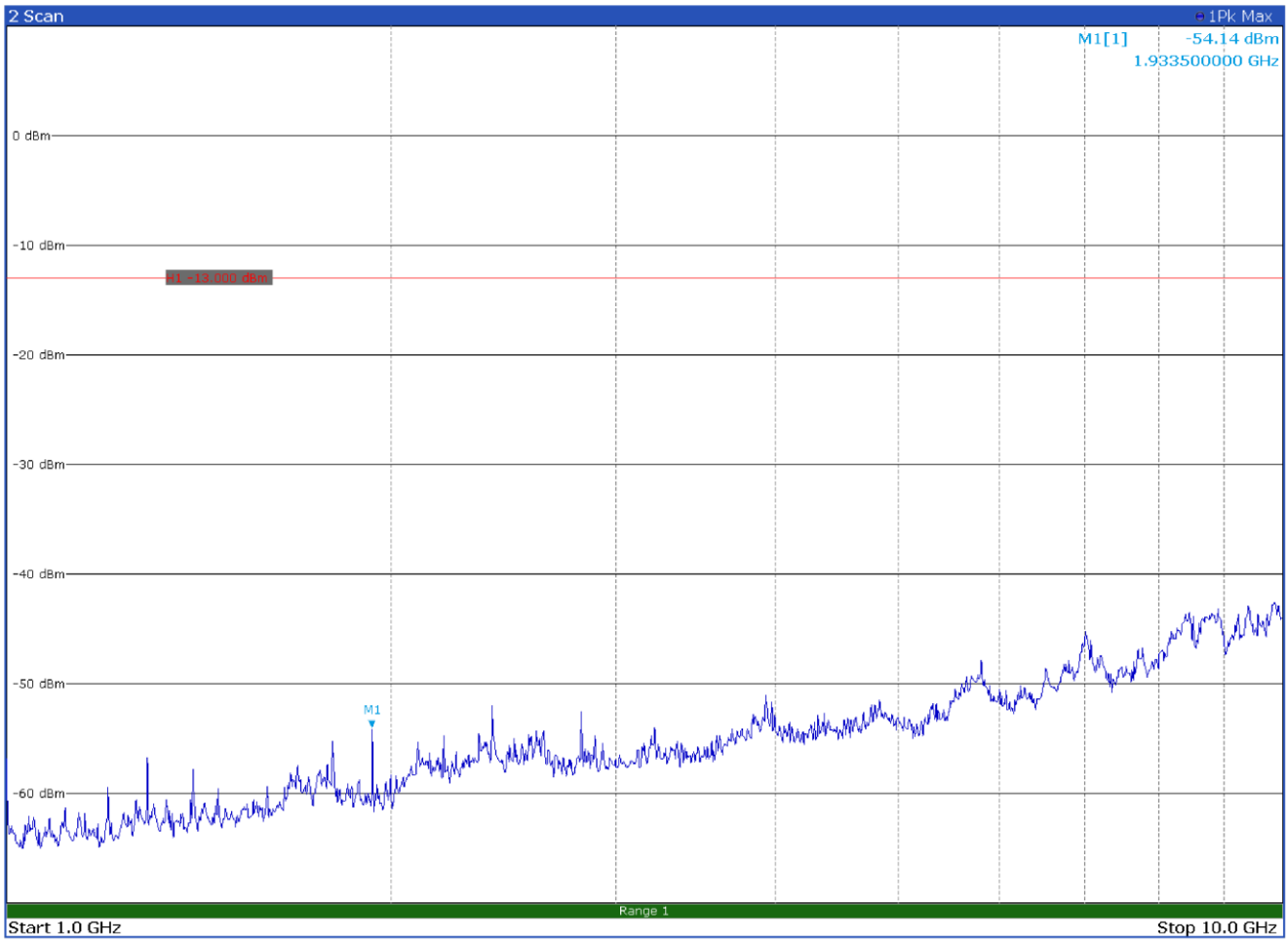


Figure 8.7-10: *Radiated spurious emissions from 1 GHz to 10 GHz, high channel with antenna in horizontal polarization*

Test data, continued

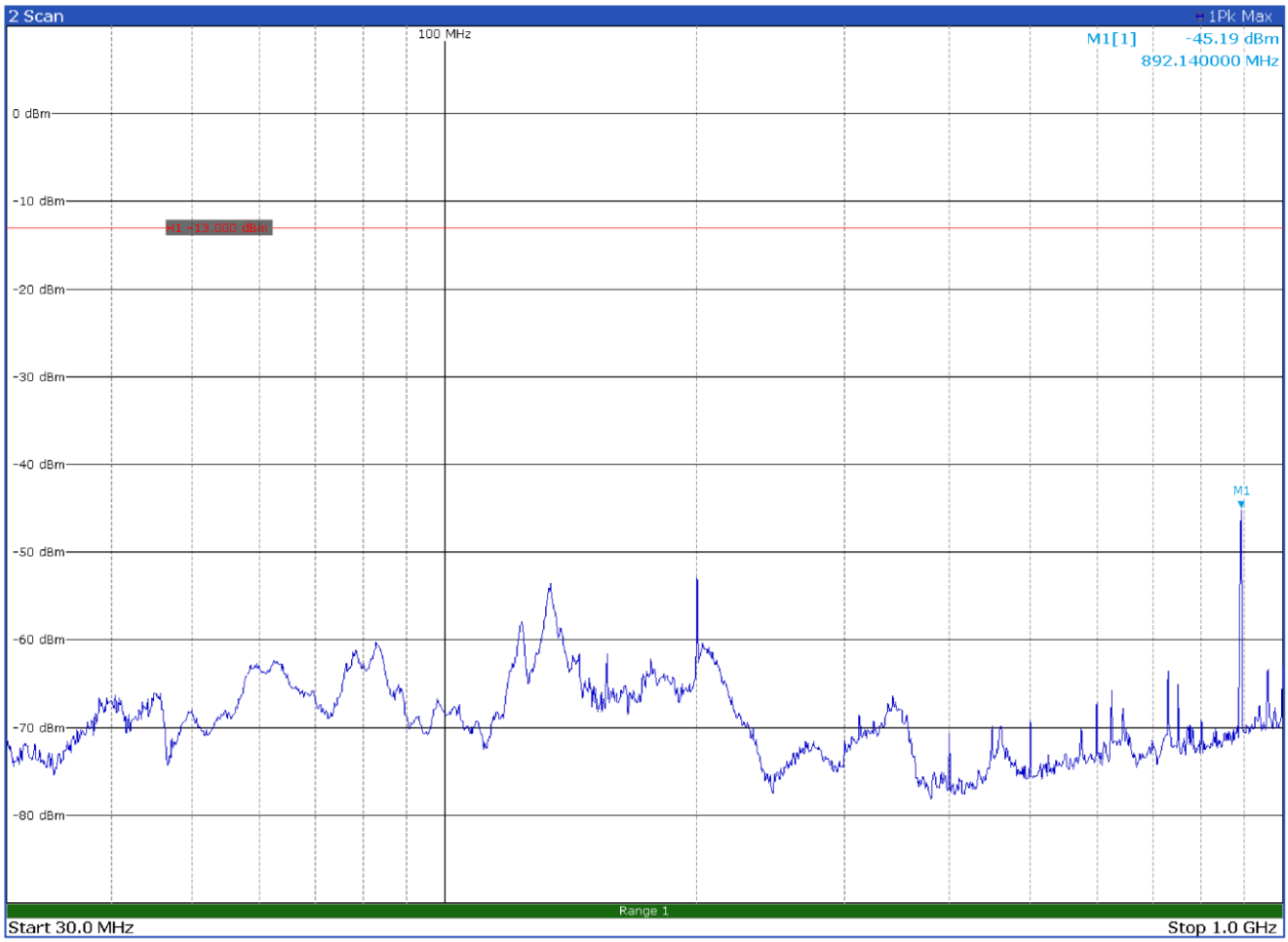


Figure 8.7-11: *Radiated spurious emissions below 1 GHz, high channel with antenna in vertical polarization*

Test data, continued

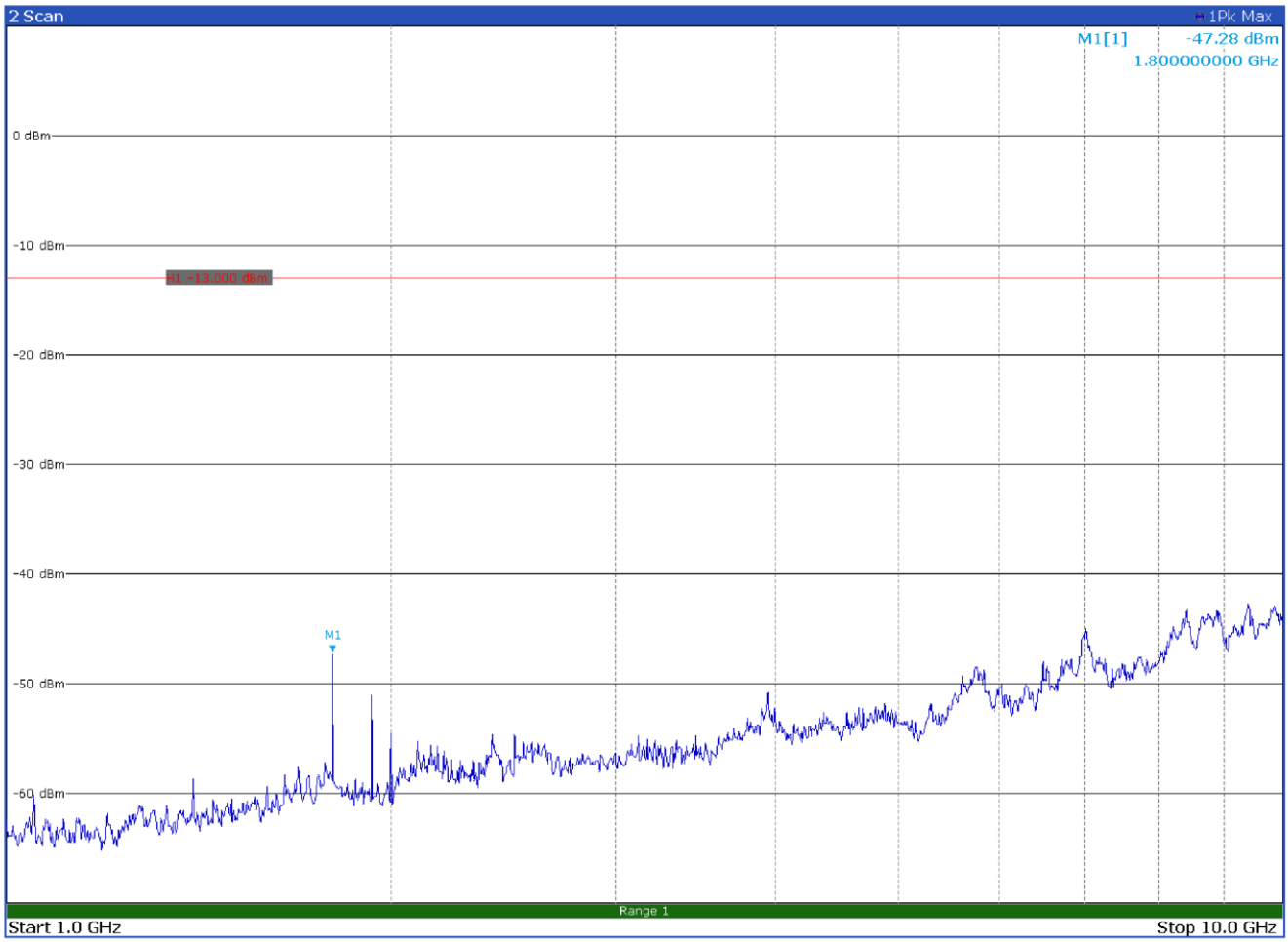


Figure 8.7-12: *Radiated spurious emissions from 1 GHz to 10 GHz, high channel with antenna in vertical polarization*

8.8 Frequency stability measurements

8.8.1 References, definitions and limits

FCC § 22.355

Except as otherwise provided in this part, the carrier frequency of each transmitter in the Public Mobile Services must be maintained within the tolerances given in Table C-1 of this section.

Table C-1 - Frequency Tolerance for Transmitters in the Public Mobile Services

Frequency range (MHz)	Base, fixed (ppm)	Mobile >3 watts (ppm)	Mobile ≤3 watts (ppm)
25 to 50	20.0	20.0	50.0
50 to 450	5.0	5.0	50.0
450 to 512	2.5	5.0	5.0
821 to 896	1.5	2.5	2.5
928 to 929	5.0	n/a	n/a
929 to 960	1.5	n/a	n/a
2110 to 2220	10.0	n/a	n/a

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-132, Clause 5.3

The carrier frequency shall not depart from the reference frequency in excess of ±2.5 ppm for mobile stations and ±1.5 ppm for base stations.

In lieu of meeting the above stability values, the test report may show that the frequency stability is sufficient to ensure that the occupied bandwidth stays within each of the sub-bands (see Section 5.1) 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 8, 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	881499798.8	20.6	0.02337	1.5	1.48
+40 °C, Nominal	881499795.8	17.6	0.01997	1.5	1.48
+30 °C, Nominal	881499791.7	13.5	0.01531	1.5	1.48
+20 °C, -15% voltage	881499780.8	2.6	0.00295	1.5	1.50
+20 °C, Nominal	881499778.2	Reference	Reference	Reference	Reference
+20 °C, +15% voltage	881499775.3	-2.9	-0.00329	1.5	1.50
+10 °C, Nominal	881499757.6	-20.6	-0.02337	1.5	1.48
0 °C, Nominal	881499745.8	-32.4	-0.03676	1.5	1.46
−10 °C, Nominal	881499722.5	-55.7	-0.06319	1.5	1.44
−20 °C, Nominal	881499715.9	-62.3	-0.07068	1.5	1.43
−30 °C, Nominal	881499647.7	-130.5	-0.14804	1.5	1.35

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	881499796.9	20.4	0.02314	1.5	1.48
+40 °C, Nominal	881499794.4	17.9	0.02031	1.5	1.48
+30 °C, Nominal	881499790.4	13.9	0.01577	1.5	1.48
+20 °C, -15% voltage	881499779.4	2.9	0.00329	1.5	1.50
+20 °C, Nominal	881499776.5	Reference	Reference	Reference	Reference
+20 °C, +15% voltage	881499773.5	-3.0	-0.00340	1.5	1.50
+10 °C, Nominal	881499755.6	-20.9	-0.02371	1.5	1.48
0 °C, Nominal	881499743.8	-32.7	-0.03710	1.5	1.46
−10 °C, Nominal	881499721.6	-54.9	-0.06228	1.5	1.44
−20 °C, Nominal	881499713.4	-63.1	-0.07158	1.5	1.43
−30 °C, Nominal	881499646.7	-129.8	-0.14725	1.5	1.35

Section 9 EUT photos

9.1 Set-up photos

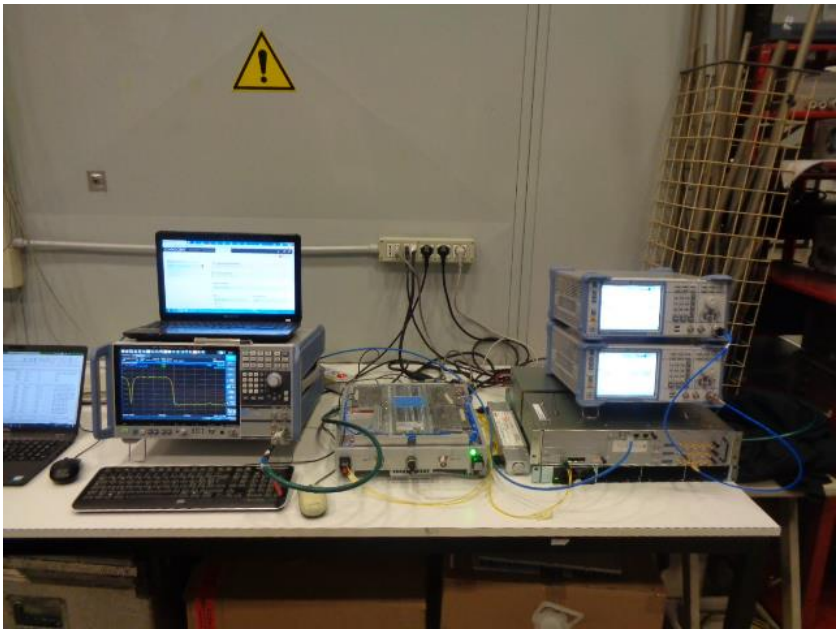


Figure 9.1-1: *Antenna port testing set-up*

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*

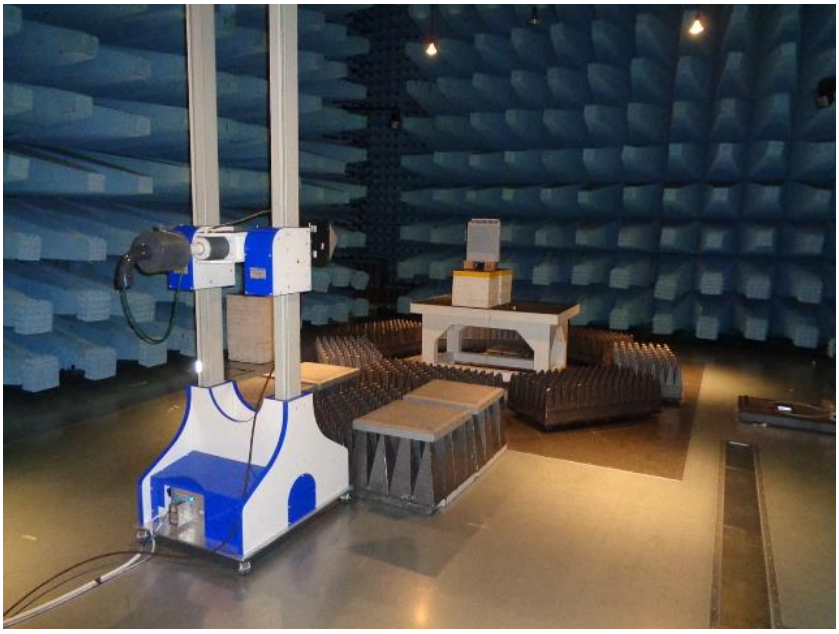


Figure 9.1-4: *Radiated emissions set-up for frequencies above 1 GHz*

9.2 External photos

Figure 9.2-1: *EUT photo*

End of the test report