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Wireless test report – REP020953

Type of assessment:

Transmitters co-location

2hire s.r.l.

Via Mantova 52, 00198 - Roma, Italy

Product:

Automotive Telematics Unit

Model:

ESP32-C3-MINI-1

FCC ID:

2BDMD-2HBM2

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.209

  Radiated emission limits; general requirements.

Transmitter Emission Limits

Date of issue: December 13, 2023

D. Guarnone — Tested by — Signature

P. Barbieri — Reviewed by — Signature

Test location(s)

Company name	Nemko Spa
Address	Via del Carroccio, 4
City	Biassono
Province	MB
Postal code	20853
Country	Italy
Telephone	+39 039 220 12 01
Facsimile	+39 039 220 12 21
Website	www.nemko.com
Site number	FCC: 682159; IC: 9109A (10 m semi anechoic chamber)

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report. This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Spa ISO/IEC 17025 accreditation.

Copyright notification

Table of contents

Section 1. Report summary

1.1 Applicant and manufacturer

Company name	2hire S.r.l.
Address	Via Mantova 52, 00198 Roma - Italy

1.2 Test specifications

FCC 47 CFR Part 15 Subpart C, §15.209	Radiated emission limits; general requirements.
RSS-GEN, Issue 5, section 8.9	Transmitter Emission Limits for Licence-Exempt Radio Apparatus

1.3 Test methods

ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.4 Statement of compliance

In the configuration tested, the EUT was found non-compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.5 below. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Exclusions

As per quote, the purpose of this report is verification of transmitters colocation. Only inter-modulation products within restricted bands were assessed, other requirements were excluded from the scope of this report.

1.6 Test report revision history

Revision #	Date of issue	Details of changes made to test report
REP020953	December 12, 2023	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.209	Radiated emission limits; general requirements.	Pass

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	December 12, 2023
Nemko sample ID number	PRJ00459760005 assigned by Nemko S.p.A

3.2 EUT information

Product name	Telematics unit
Model	2hire box 2.0
Serial number	PRJ00459760005 assigned by Nemko S.p.A

3.3 Technical information

Frequency band	BLE:2400–2483.5 MHz band GSM850 824 to 849 MHz GSM1900 1850 to 1910 MHz UMTS BAND II 1850 to 1910 MHz UMTS BAND IV 1710 to 1755 MHz UMTS BAND V 824 to 849 MHz LTE BAND 2 1850 to 1910 MHz LTE BAND 4 1710 to 1755 MHz LTE BAND 5 824 to 849 MHz LTE BAND 7 2500 to 2570 MHz LTE BAND 12 699 to 716 MHz LTE BAND 13 777 to 787 MHz LTE BAND 25 1850 to 1915MHz LTE BAND 26 814 to 824MHz LTE BAND 26 (824 to 849 MHz LTE BAND 38 2570 to 2620MHz LTE BAND 41 2500 to 2690MHz
EUT power requirements	12 Vdc
Antenna information	The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 EUT setup diagram

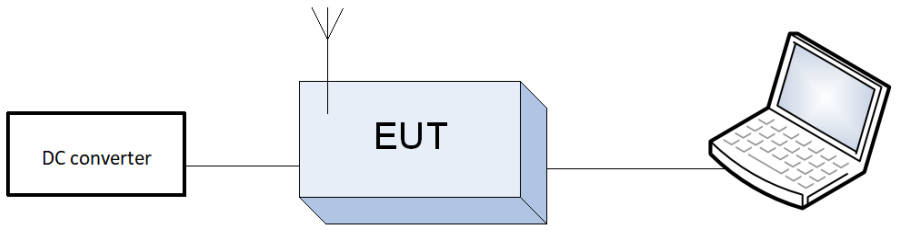


Figure 3.4-1: *Setup diagram*

3.5 Product description and theory of operation

2hire Box 2.0 is an innovative IoT device designed by the 2hire team. Improve monitoring capabilities and vehicle management by connecting to the vehicle's OBD-II port, CAN-bus or internal connectors of the actuator. This connection allows you to retrieve data and enables various interactions with the vehicle, such as closing and opening doors. The device has cellular connectivity with global coverage across all 4G/3G/2G networks, secure communication protocols, Bluetooth technology for offline commands and profiles customizable for different makes and models of vehicles. Thanks to the dedicated GPS module, it is possible to have a vehicle tracking with high precision.

3.6 EUT exercise details

To set the EUT is continuous transmission AT commands (provided by the applicant) have been used.

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

The EUT uses a Espressi type ESP32C3MINI1 Espressif radio module with BLE standard and radio module Quectel model 06232021_YF0022AA-24510 Quectel

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

In the laboratory, the following ambient conditions are respected for each test reported below:

Temperature	18 – 33 °C
Relative humidity	25 – 70 %
Air pressure	860 – 1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

The following instruments are used to monitor the environmental conditions:

Equipment	Manufacturer	Model no.	Asset no.	Cal date	Next cal.
Thermo-hygrometer data loggers	Testo	175-H2	20012380/305	12/2022	12/2024
Thermo-hygrometer data loggers	Testo	175-H2	38203337/703	12/2022	12/2024
Barometer	Castle	GPB 3300	072015	05/2023	05/2024

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

The measurement uncertainty was calculated for each test and quantity listed in this test report, according to CISPR 16-4-2, ETSI TR 100 028-1, ETSI TR 100 028-2 and other specific test standards and is documented in Nemko Spa working manuals WML1002 and WML0078. The assessment of conformity for each test performed on the equipment is performed not taking into account the measurement uncertainty. The two following possible verdicts are stated in the report:

P (Pass) - The measured values of the equipment respect the specification limit at the points tested. The specific risk of false accept is up to 50% when the measured result is close to the limit.

F (Fail) - One or more measured values of the equipment do not respect the specification limit at the points tested. The specific risk of false reject is up to 50% when the measured result is close to the limit.

Hereafter Nemko's measurement uncertainties are reported:

EUT	Type	Test	Range	Measurement Uncertainty	Notes
Transmitter	Conducted	Frequency error	0.001 MHz ÷ 40 GHz	0.08 ppm	(1)
		Carrier power RF Output Power Power Density	0.009 MHz ÷ 30 MHz	1.1 dB	(1)
			30 MHz ÷ 18 GHz	1.5 dB	(1)
			18 MHz ÷ 40 GHz	3.0 dB	(1)
			40 MHz ÷ 140 GHz	5.0 dB	(1)
		Adjacent channel power	1 MHz ÷ 18 GHz	1.4 dB	(1)
		Conducted spurious emissions	0.009 MHz ÷ 18 GHz	3.0 dB	(1)
			18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 dB	(1)
		Intermodulation attenuation	1 MHz ÷ 18 GHz	2.2 dB	(1)
		Attack time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Attack time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Release time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Release time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Transient behaviour of the transmitter– Transient frequency behaviour	1 MHz ÷ 18 GHz	0.2 kHz	(1)
		Transient behaviour of the transmitter – Power level slope	1 MHz ÷ 18 GHz	9%	(1)
		Frequency deviation - Maximum permissible frequency deviation	0.001 MHz ÷ 18 GHz	1.3%	(1)
		Frequency deviation - Response of the transmitter to modulation frequencies above 3 kHz	0.001 MHz ÷ 18 GHz	0.5 dB	(1)
		Dwell time	-	3%	(1)
		Hopping Frequency Separation	0.01 MHz ÷ 18 GHz	1%	(1)
		Occupied Channel Bandwidth	0.01 MHz ÷ 40 GHz	2%	(1)
		Modulation Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
	Radiated	Radiated spurious emissions	0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
		Effective radiated power transmitted, Power density	10 kHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
Receiver	Radiated	Radiated spurious emissions	0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
		Sensitivity measurement	1 MHz ÷ 18 GHz	6.0 dB	(1)
	Conducted	Conducted spurious emissions	0.009 MHz ÷ 18 GHz	3.0 dB	(1)
			18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 dB	(1)

NOTES:
(1) The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95 %

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI receiver (20 Hz ÷ 8 GHz)	Rohde & Schwarz	ESU8	100202	2023-09	2024-09
EMI receiver (2 Hz ÷ 44 GHz)	Rohde & Schwarz	ESW44	101620	2023-09	2024-09
Trilog Antenna (30 MHz ÷ 7 GHz)	Schwarzbeck	VULB 9162	9162-025	2021-07	2024-07
Bilog antenna (1 ÷ 18 GHz)	Schwarzbeck	STLP 9148	9148-123	2021-09	2024-09
Horn Antenna (4 ÷ 40 GHz)	RFSpin	DRH40	061106A40	2023-05	2026-05
Preamplifier (1 ÷ 18 GHz)	Schwarzbeck	BBV 9718C	00121	2023-03	2024-03
Preamplifier (18 ÷ 40 GHz)	Sage	STB-1834034030-KFKF-L1	18490-01	2023-05	2024-05
Controller	Maturo	FCU3.0	10041	NCR	NCR
Tilt antenna mast	Maturo	TAM4.0-E	10042	NCR	NCR
Turntable	Maturo	TT4.0-5T	2.527	NCR	NCR
Semi-anechoic chamber	Nemko	10m semi-anechoic chamber	530	09/2019	09/2021
Shielded room	Siemens	10m control room	1947	NCR	NCR
3m Semi anechoic chamber	Comtest	SAC-3	1711-150	2022-09	2024-09

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

Section 8. Testing data

8.1 FCC 15.209 and RSS-GEN section 8.9 Radiated emission limits; general requirements

8.1.1 Definitions and limits

FCC:
(f) In accordance with §15.33(a), in some cases the emissions from an intentional radiator must be measured to beyond the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator because of the incorporation of a digital device. If measurements above the tenth harmonic are so required, the radiated emissions above the tenth harmonic shall comply with the general radiated emission limits applicable to the incorporated digital device, as shown in §15.109 and as based on the frequency of the emission being measured, or, except for emissions contained in the restricted frequency bands shown in §15.205, the limit on spurious emissions specified for the intentional radiator, whichever is the higher limit. Emissions which must be measured above the tenth harmonic of the highest fundamental frequency designed to be emitted by the intentional radiator and which fall within the restricted bands shall comply with the general radiated emission limits in §15.109 that are applicable to the incorporated digital device.

ISED:
Except when the requirements applicable to a given device state otherwise, emissions from licence‑exempt transmitters shall comply with the field strength limits shown in Table below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 8.1-1: *FCC §15.209 – Radiated emission limits*

Frequency, MHz	Field strength of emissions		Measurement distance, m
	µV/m	dBµV/m	
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

Table 8.1-2: *FCC restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

8.1.2 Test summary

Test start date	December 13, 2023
Test engineer	D. Guarnone

8.1.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to 25.0 GHz.
EUT's LTE and WIFI transmitters were set to transmit continuously, different channel setting has been investigated as per provided by client's setup, only the worst-case is presented.

Spectrum analyzer settings for frequencies below 30 MHz:

Detector mode	Quasi-Peak
Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Trace mode	Max Hold
Measurement time	100 ms

Spectrum analyser settings for radiated measurements within restricted bands 30 MHz to 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyzer settings for average radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	10 Hz
Detector mode:	Peak
Trace mode:	Max Hold

8.1.4 Test data

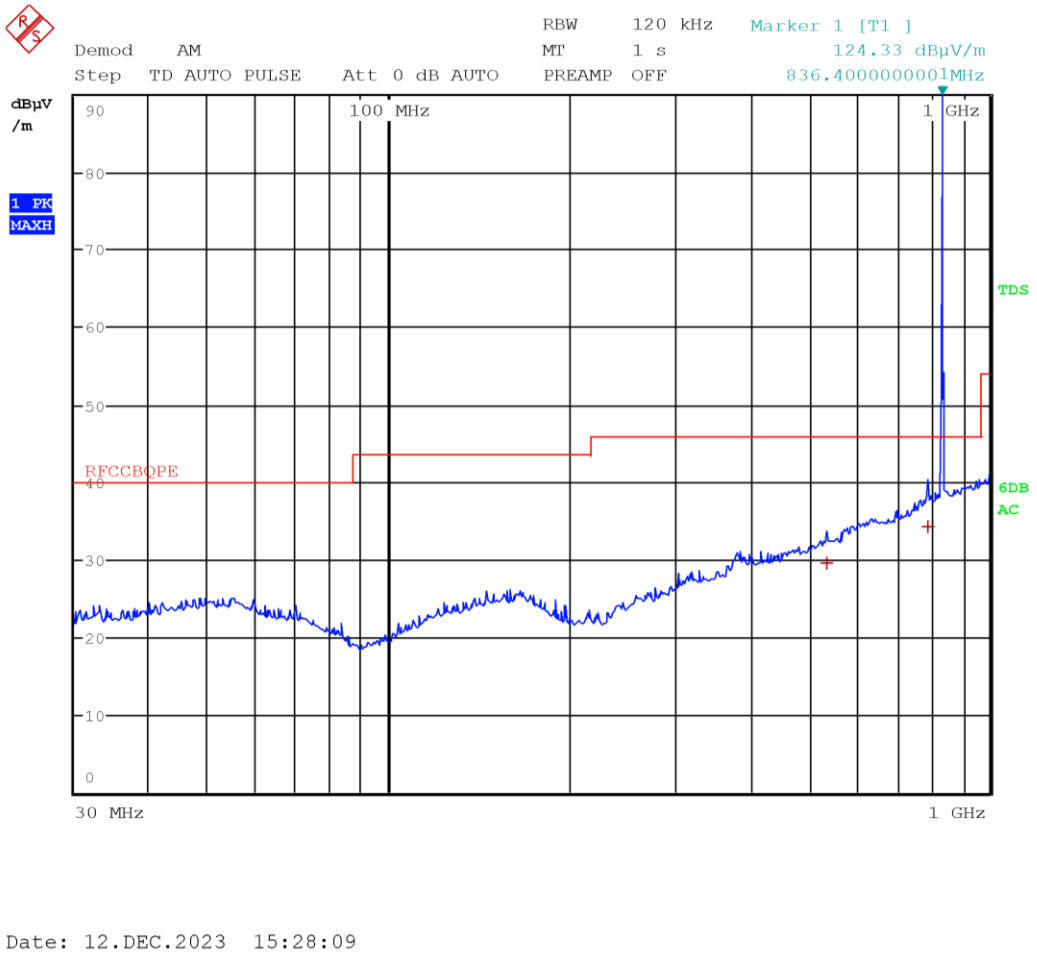


Figure 8.1-1: *Radiated spurious emissions with GSM 850 at mid channel and BLE at mid channel – antenna in horizontal polarization*

Note: Limit exceeded by carrier

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
536.5500	29.7	46.0	-16.3	QP
790.2000	34.4	46.0	-11.6	QP

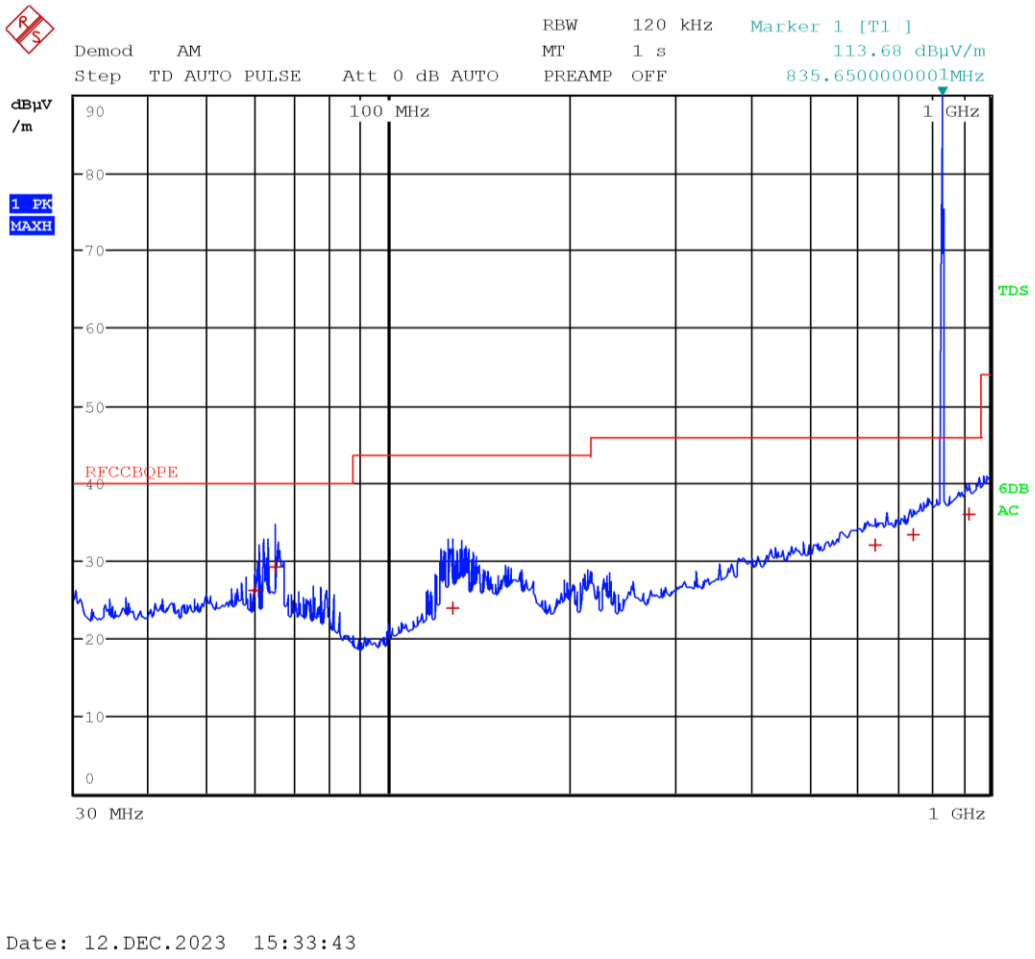


Figure 8.1-2: *Radiated spurious emissions with GSM 850 at mid channel and BLE at mid channel – antenna in vertical polarization*

Note: Limit exceeded by carrier

Emissions above the limit were from intentional emissions. No intermodulation emissions were detected

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
59.8800	26.3	40.0	-13.7	QP
64.8000	29.3	40.0	-10.7	QP
128.1000	24.0	43.5	-19.5	QP
646.6200	32.1	46.0	-13.9	QP
748.0200	33.3	46.0	-12.7	QP
922.2300	36.1	46.0	-9.9	QP

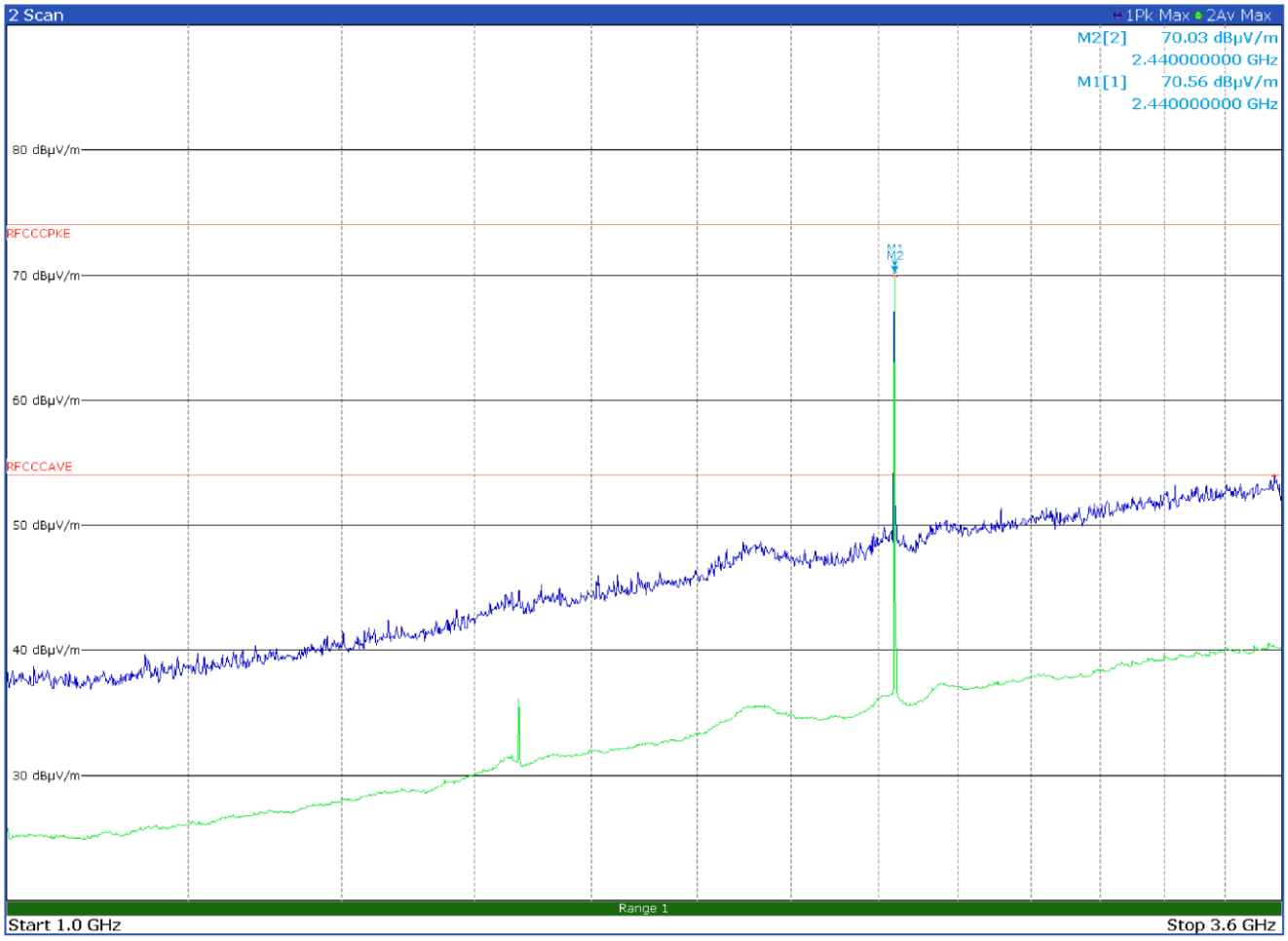


Figure 8.1-3: *Radiated spurious emissions with GSM 850 at mid channel and BLE at mid channel – antenna in horizontal polarization*

Note: Emissions above the limit were intentional. No intermodulation emissions were detected

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
2440.0000	70.6	--	--	Pk
2440.0000	70.0	--	--	Av

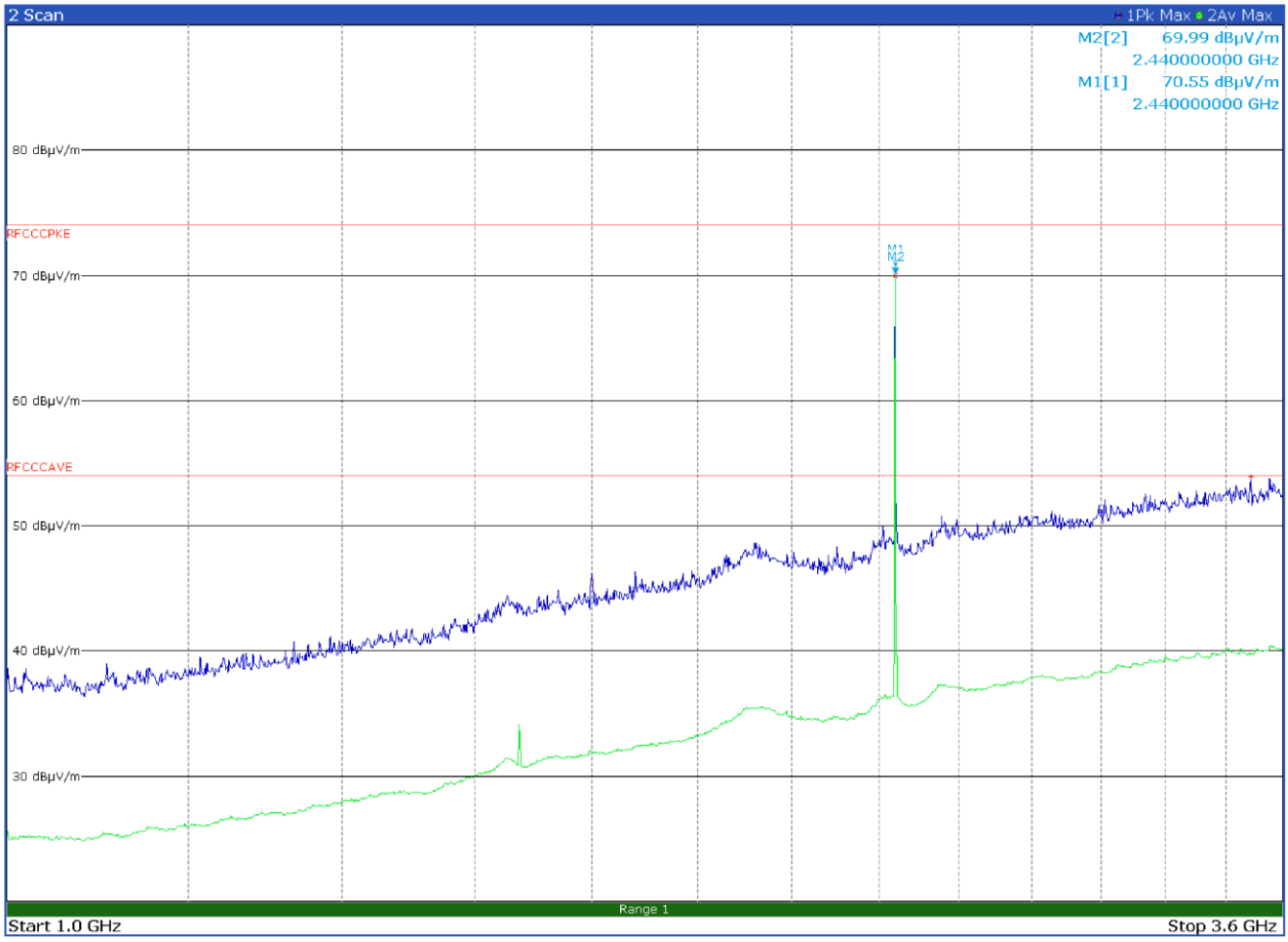
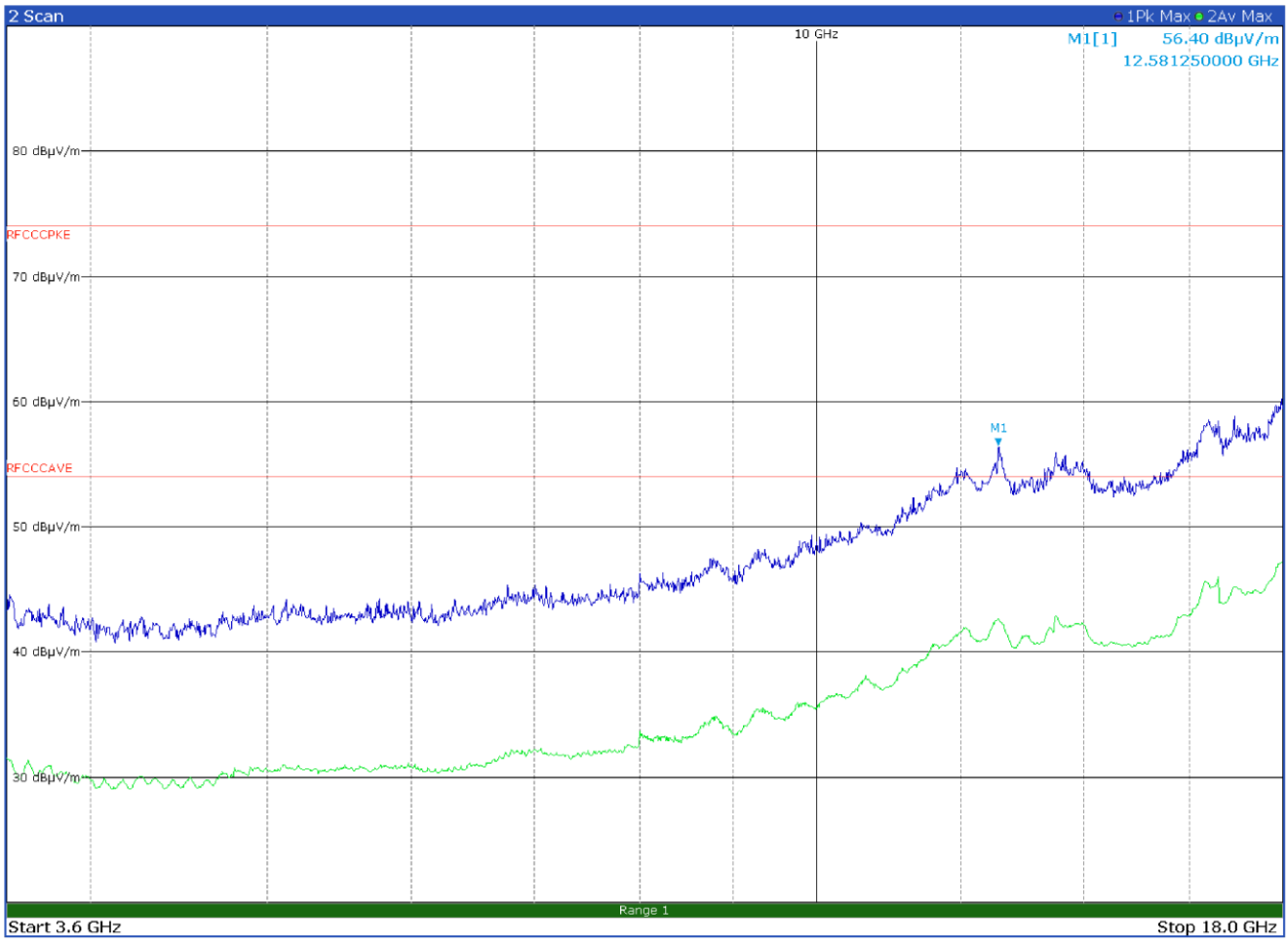


Figure 8.1-4: *Radiated spurious emissions with GSM 850 at mid channel and BLE at mid channel – antenna in vertical polarization*

Note: Emissions above the limit were from intentional emissions.

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
2440.0000	70.6	--	--	Pk
2440.0000	70.0	--	--	Av
3487.0000	54.0	74.0	-20.0	Pk



Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
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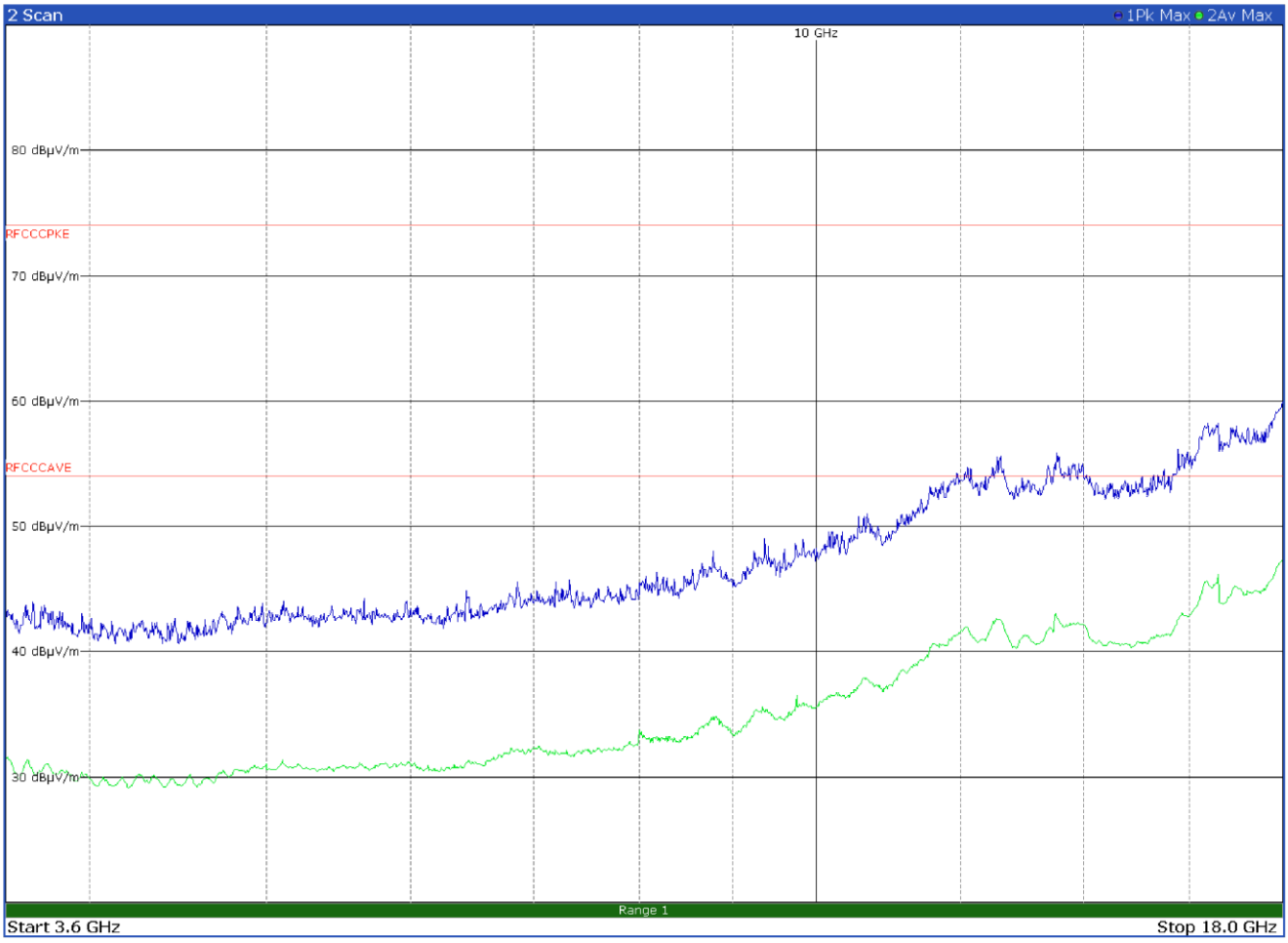
Figure 8.1-5: *Radiated spurious emissions with GSM 850 at mid channel and BLE at mid channel – antenna in horizontal polarization*



Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
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Figure 8.1-6: *Radiated spurious emissions with GSM 850 at mid channel and BLE at mid channel – antenna in vertical polarization*

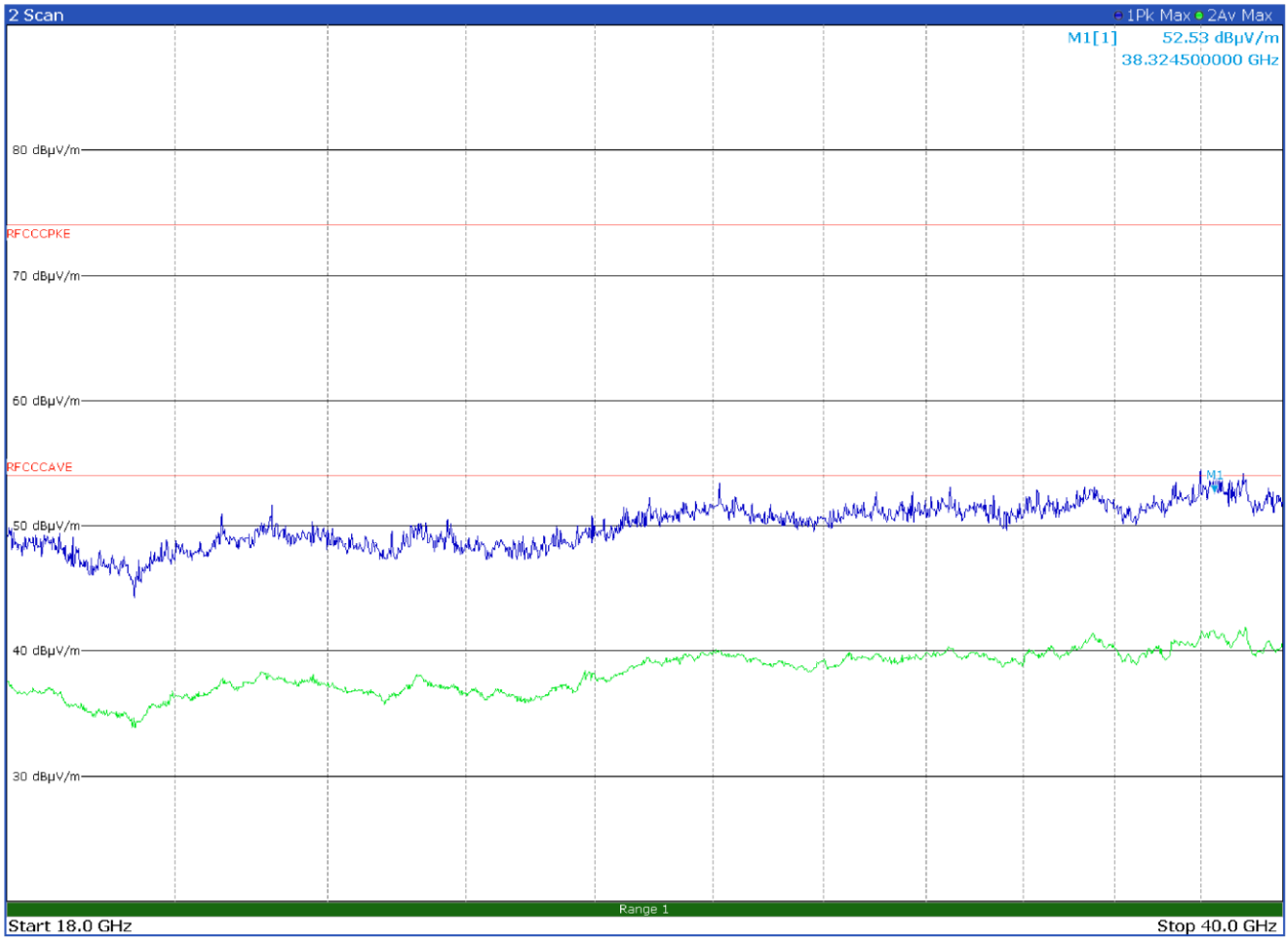

Figure 8.1-7: *Radiated spurious emissions with GSM 850 at mid channel and BLE at mid channel – antenna in horizontal polarization*

Peak level under the average limit – no additional measures need. No intermodulation emissions were detected

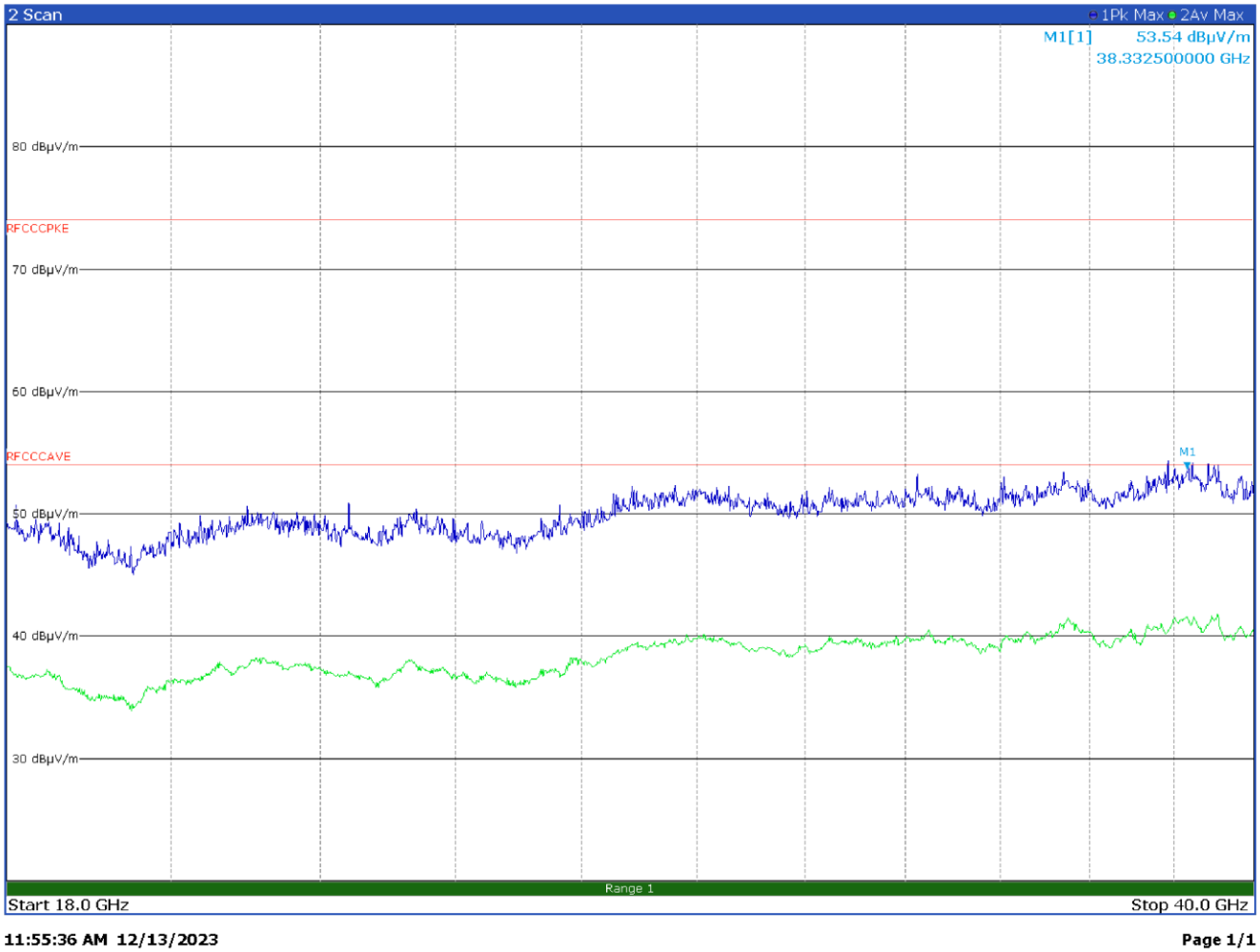

Figure 8.1-8: *Radiated spurious emissions with GSM 850 at mid channel and BLE at mid channel – antenna in vertical polarization*

Peak level under the average limit – no additional measures need. No intermodulation emissions were detected

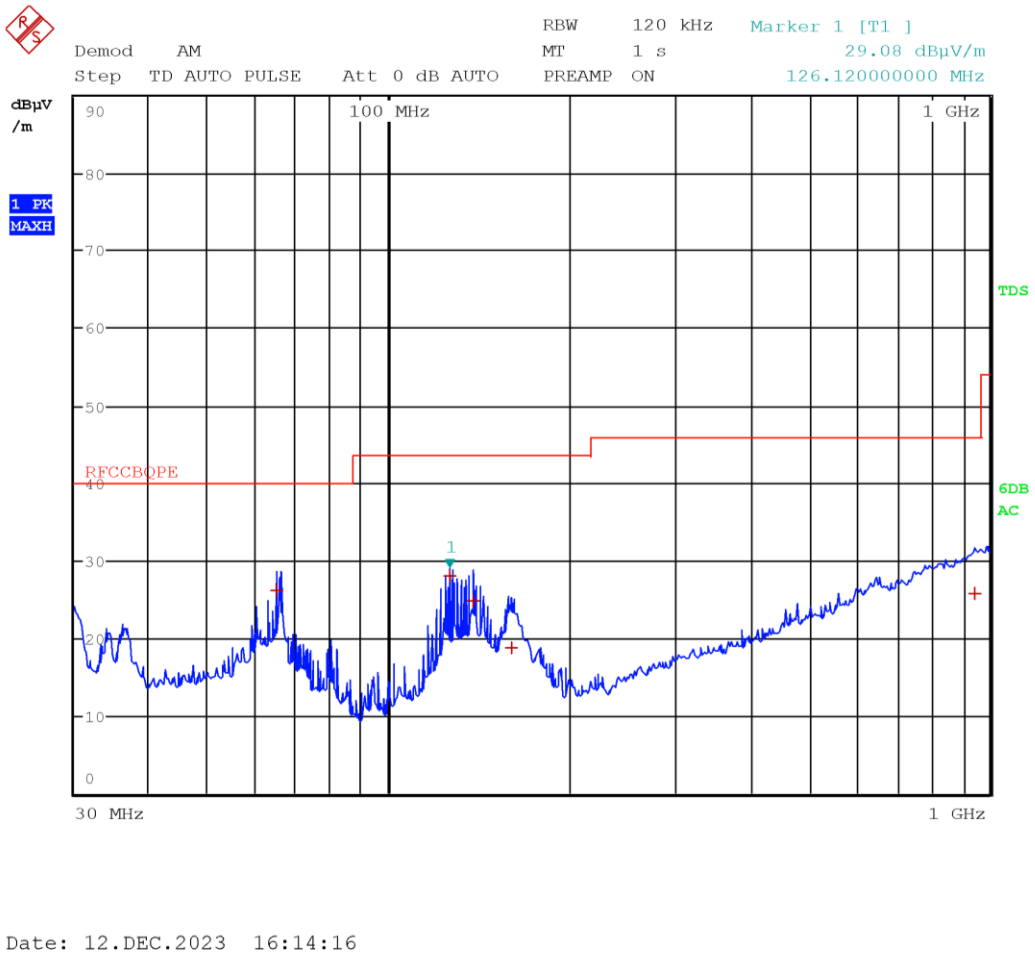

Figure 8.1-9: *Radiated spurious emissions with GSM 1900 at mid channel and BLE at mid channel – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
65.0700	26.3	40.0	-13.7	QP
126.1200	28.2	43.5	-15.3	QP
138.1800	24.9	43.5	-18.6	QP
160.2300	18.9	43.5	-24.6	QP
942.9000	25.8	46.0	-20.2	QP

No intermodulation emissions were detected

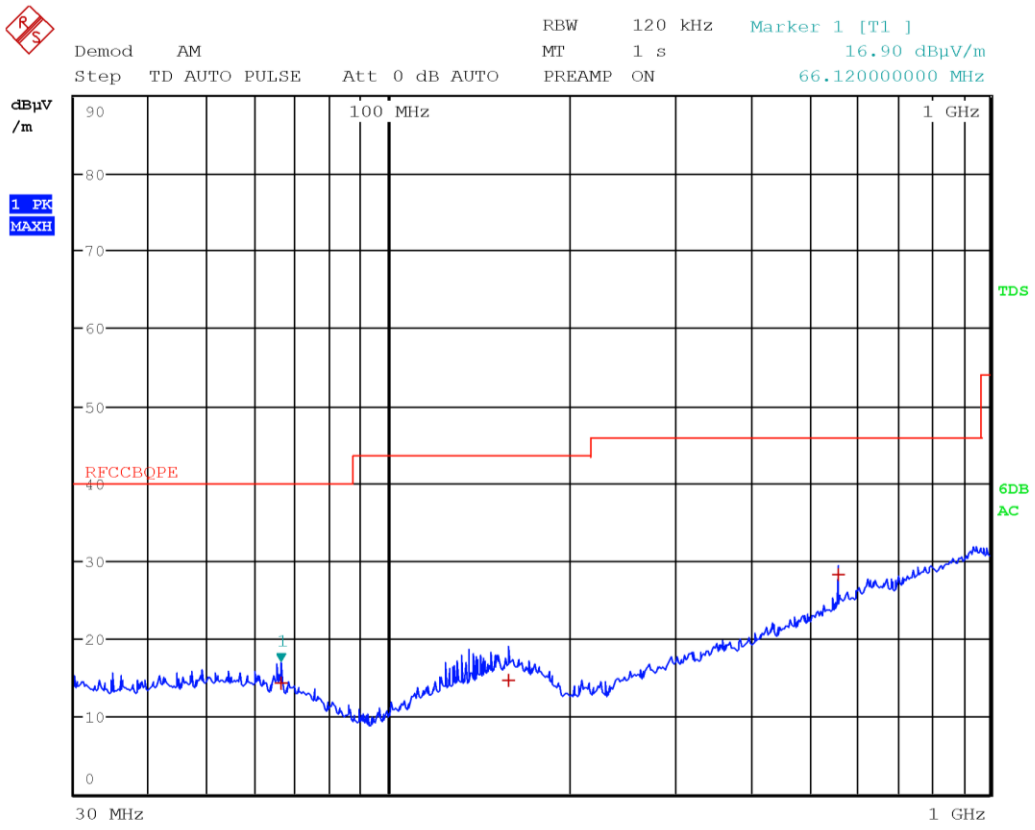

Figure 8.1-10: *Radiated spurious emissions with GSM 1900 at mid channel and BLE at mid channel – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
66.1200	14.4	40.0	-25.6	QP
158.3100	14.7	43.5	-28.8	QP
559.9800	28.4	46.0	-17.6	QP

No intermodulation emissions were detected

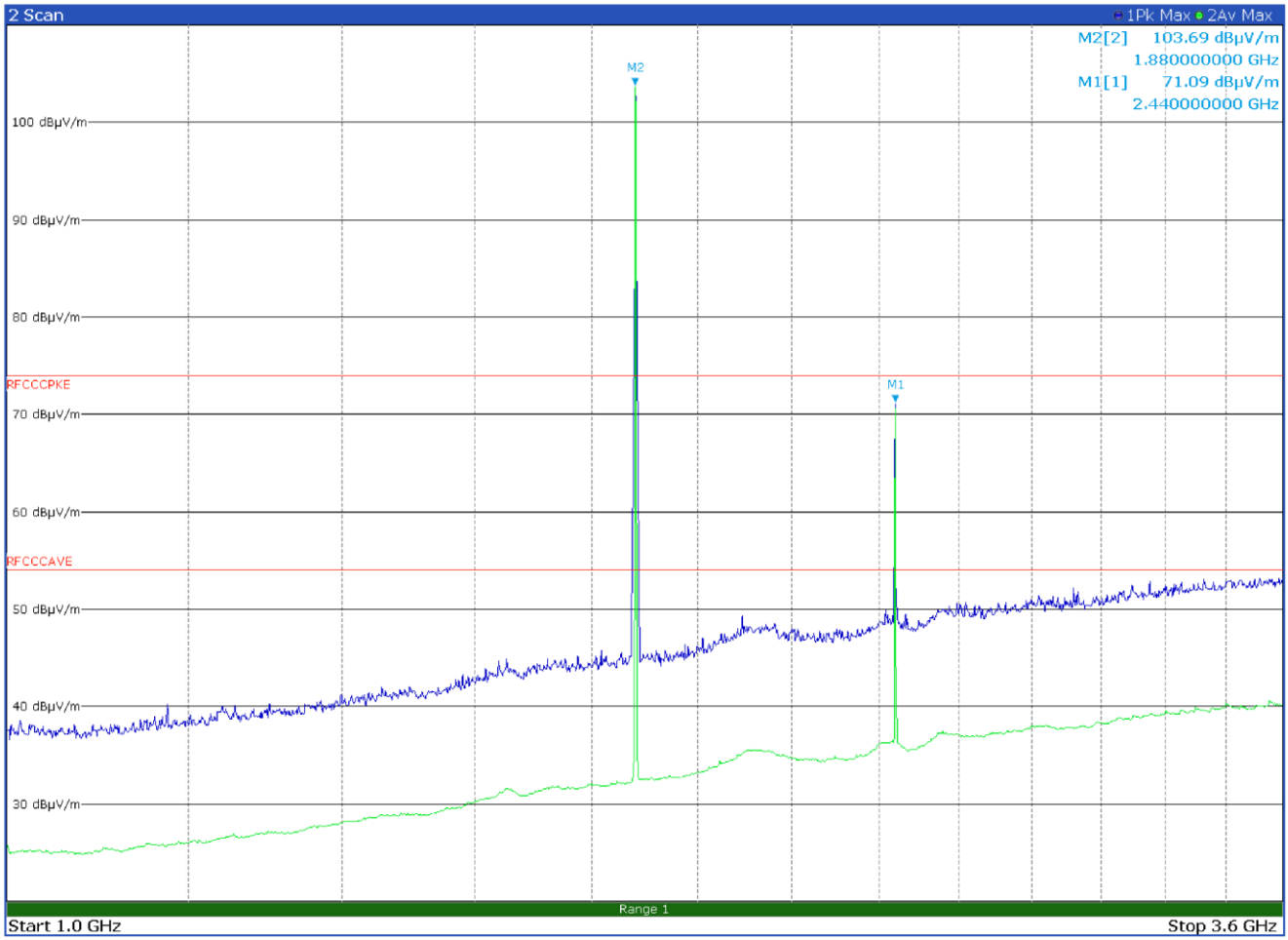

Figure 8.1-11: *Radiated spurious emissions with GSM 1900 at mid channel and BLE at mid channel – antenna in horizontal polarization*

Note:

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
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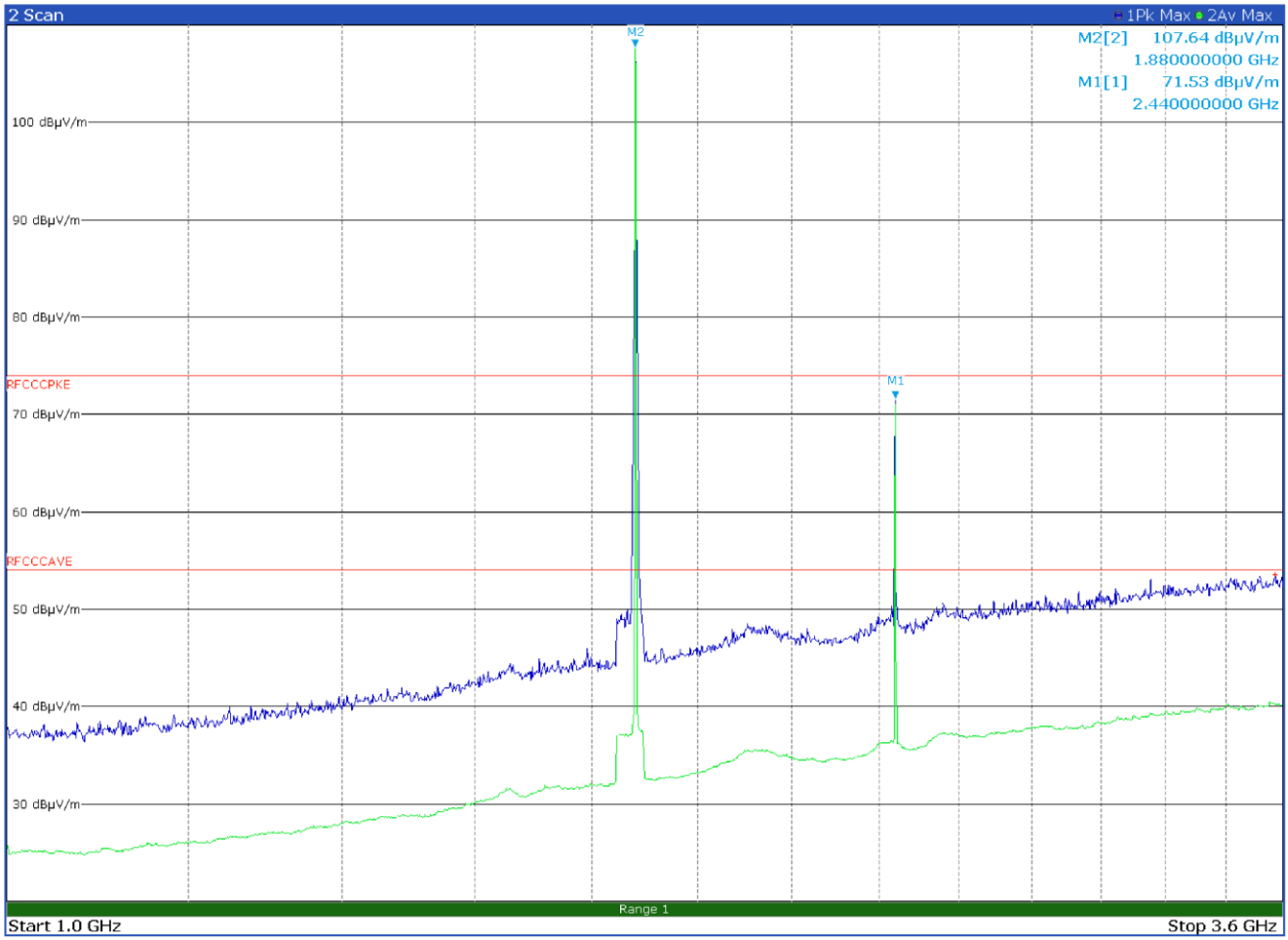
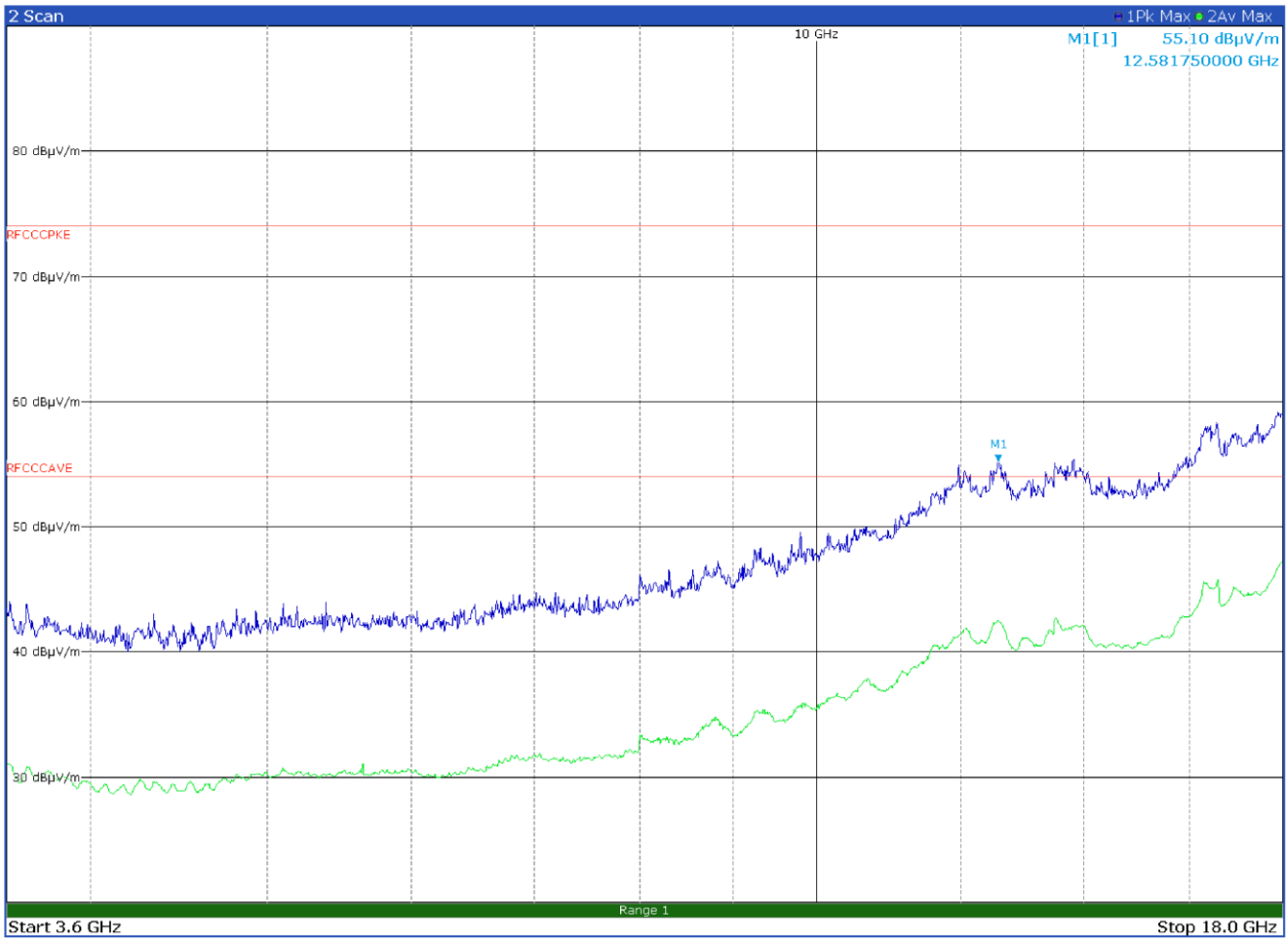


Figure 8.1-12: *Radiated spurious emissions with GSM 1900 at mid channel and BLE at mid channel – antenna in vertical polarization*

Note:

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
3573.7500	53.6	74.0	-20.4	Pk



Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
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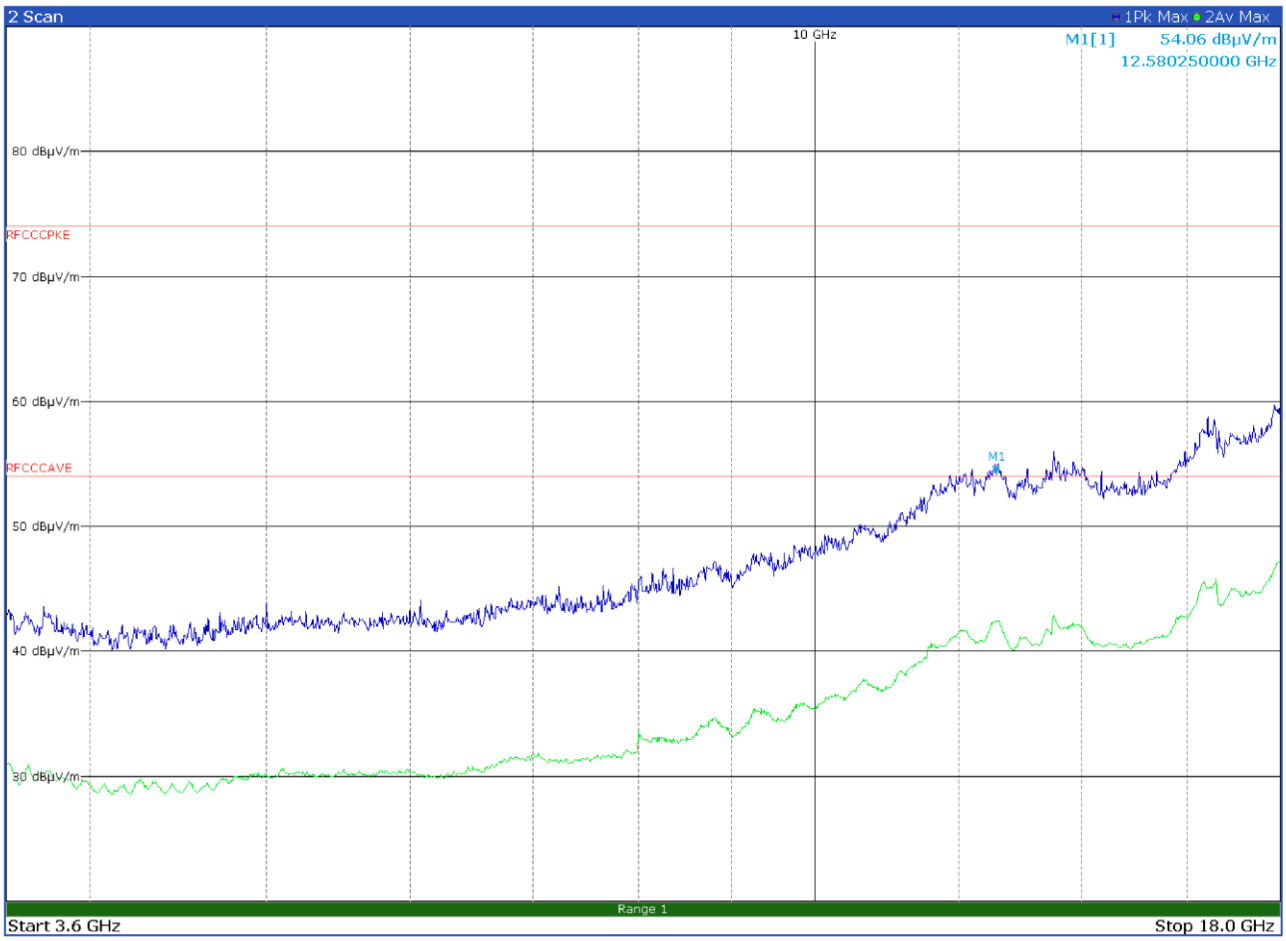
Figure 8.1-13: *Radiated spurious emissions with GSM 1900 at mid channel and BLE at mid channel – antenna in horizontal polarization*

Limits exceed by the GSM 1900 spurious emission.



Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
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Figure 8.1-14: *Radiated spurious emissions with GSM 1900 at mid channel and BLE at mid channel – antenna in vertical polarization*

Limits exceed by the GSM 1900 spurious emission.

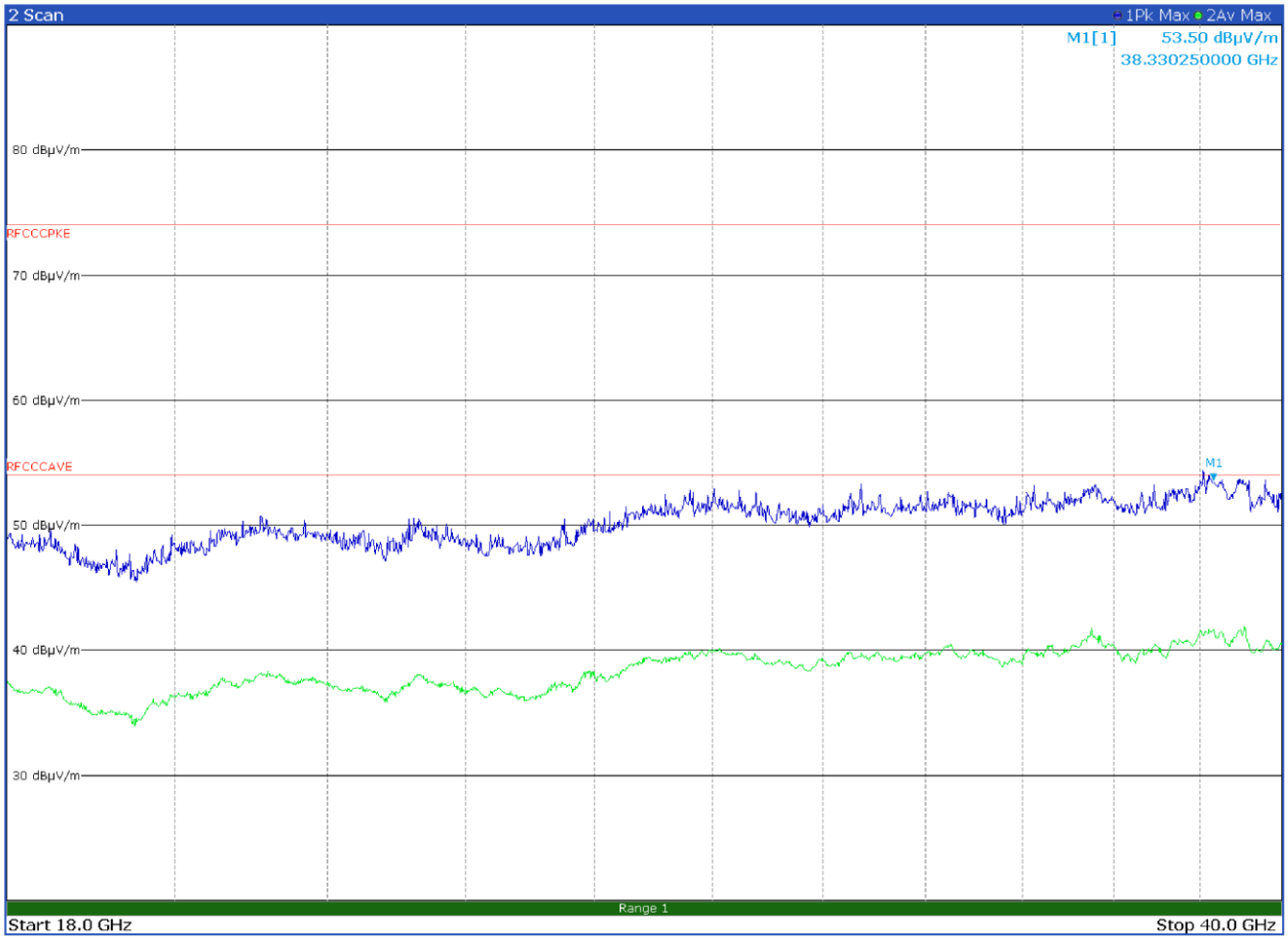


Figure 8.1-15: *Radiated spurious emissions with GSM 1900 at mid channel and BLE at mid channel – antenna in horizontal polarization*

Peak level under the average limit – no additional measures need. No intermodulation emissions were detected

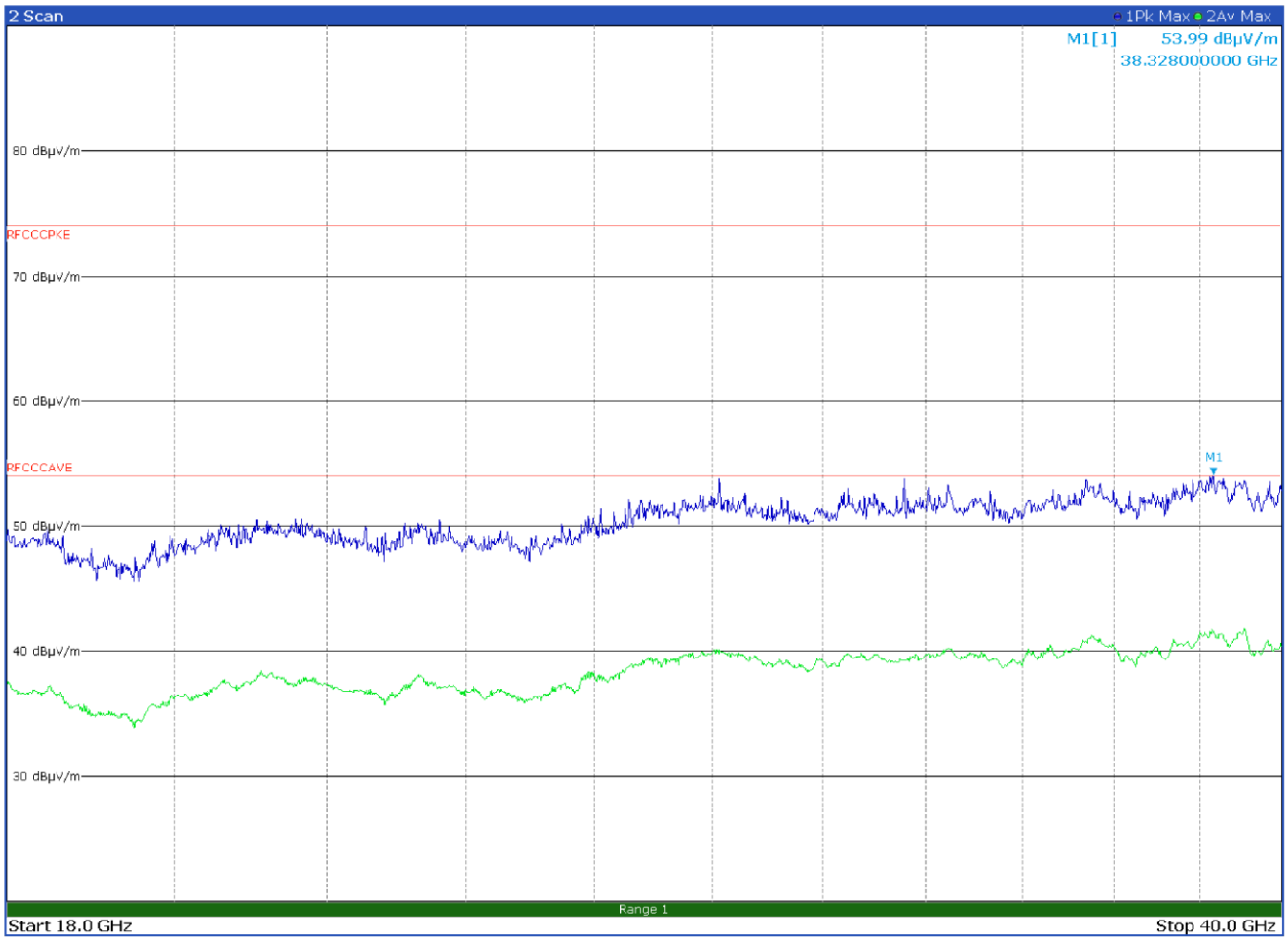


Figure 8.1-16: *Radiated spurious emissions with GSM 1900 at mid channel and BLE at mid channel – antenna in vertical polarization*

Peak level under the average limit – no additional measures need. No intermodulation emissions were detected

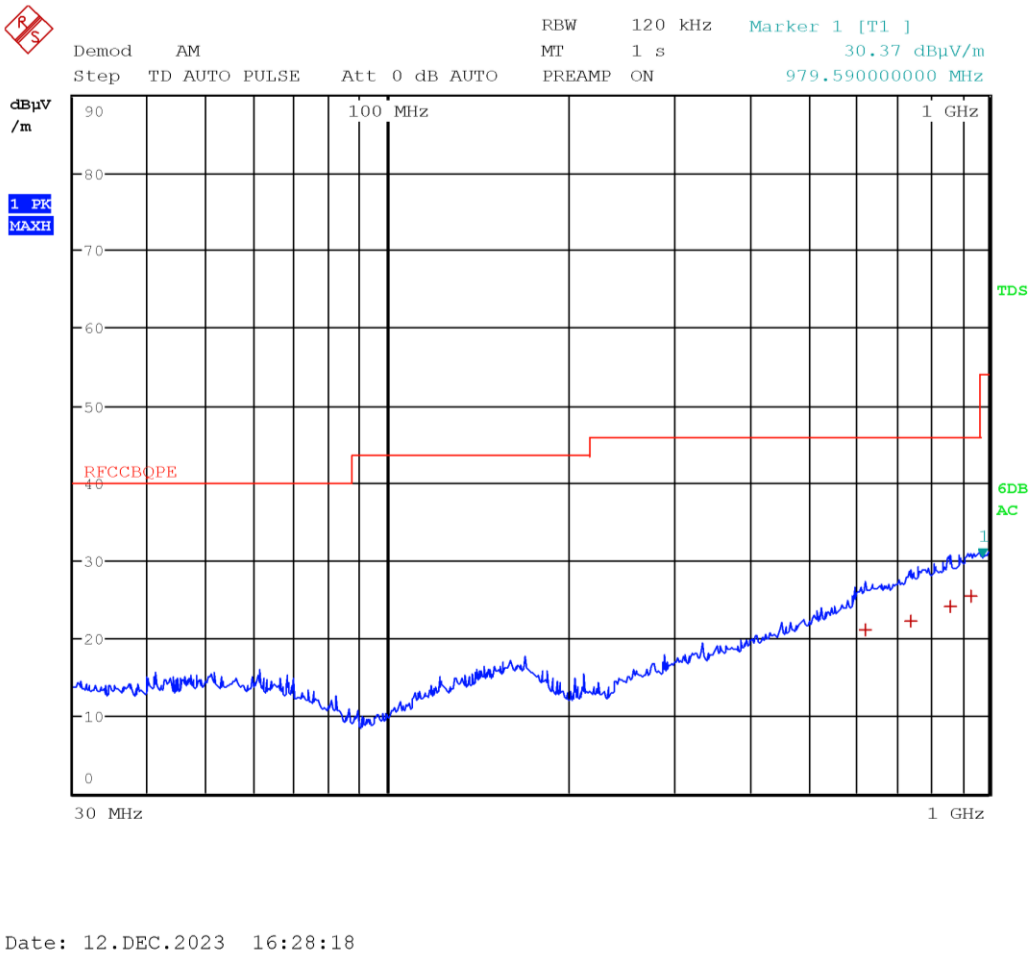


Figure 8.1-17: *Radiated spurious emissions with UMTS IV at mid channel and BLE at mid channel – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
536.5500	29.7	46.0	-16.3	QP
790.2000	34.4	46.0	-11.6	QP

No intermodulation emissions were detected

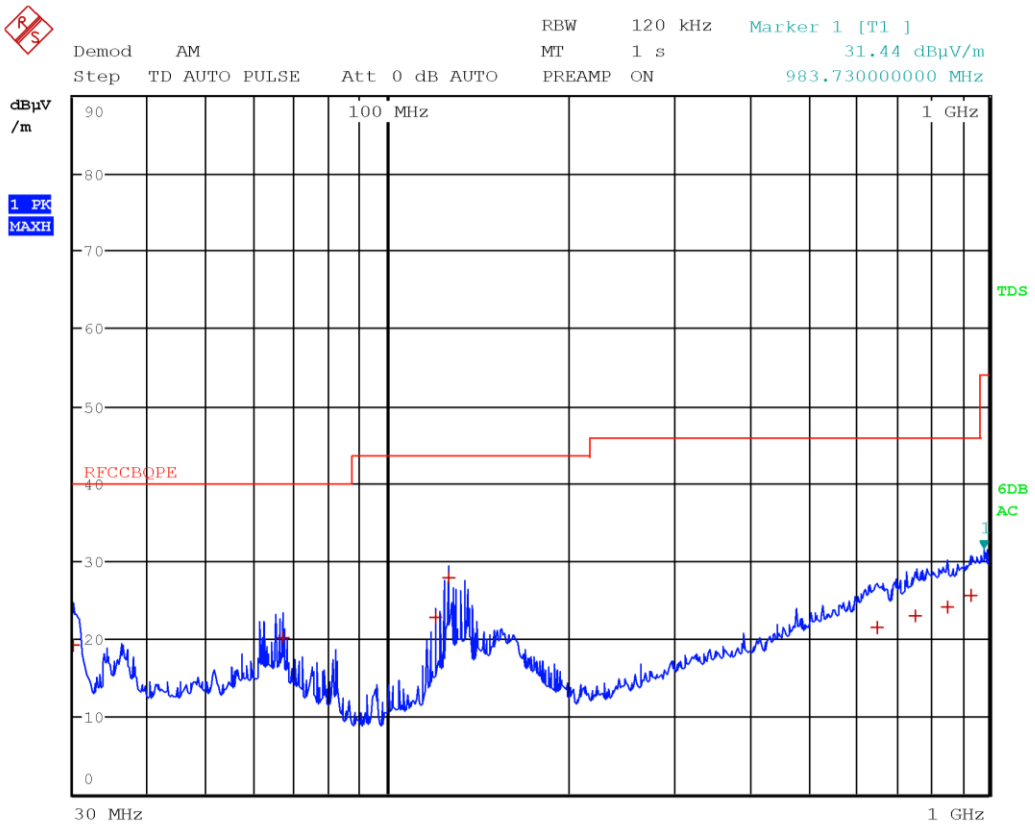
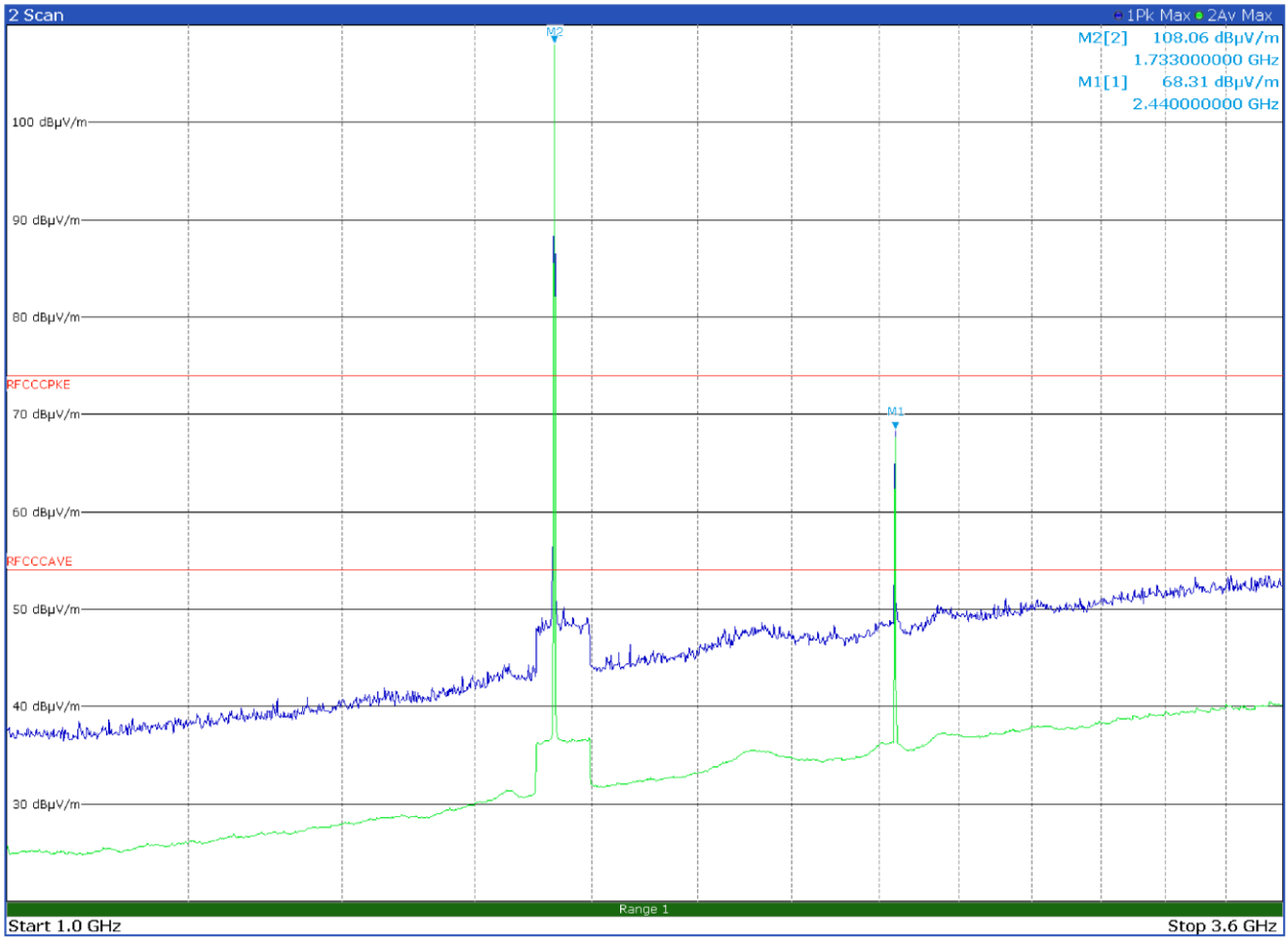


Figure 8.1-18: *Radiated spurious emissions with UMTS IV at mid channel and BLE at mid channel – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
30.0000	19.3	40.0	-20.7	QP
67.1100	20.1	40.0	-19.9	QP
120.2400	22.7	43.5	-20.8	QP
126.2100	27.9	43.5	-15.6	QP
652.1700	21.5	46.0	-24.5	QP
755.3700	23.0	46.0	-23.0	QP
856.3500	24.1	46.0	-21.9	QP
936.3300	25.6	46.0	-20.4	QP

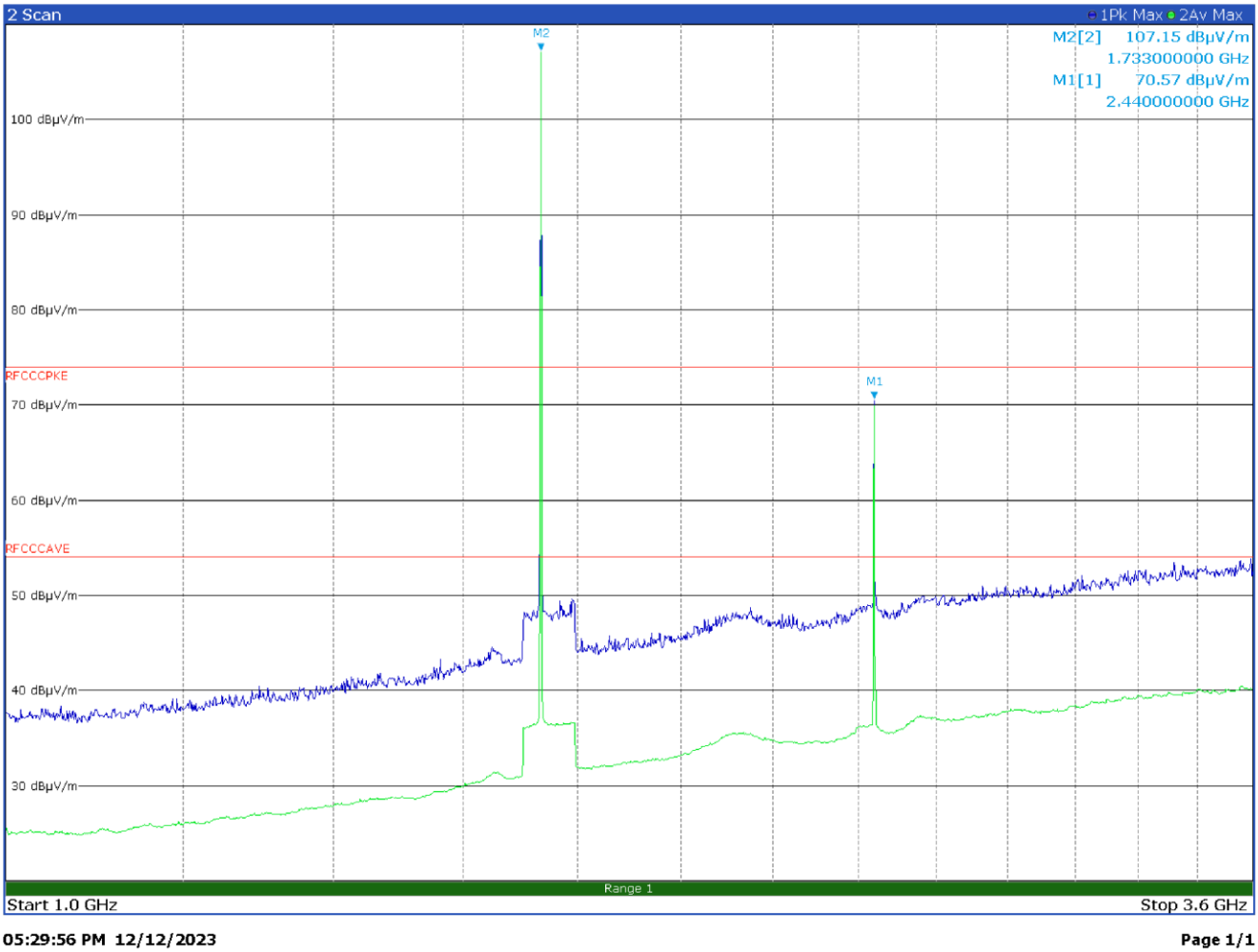
No intermodulation emissions were detected



Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
--	--	--	--	--

Figure 8.1-19: *Radiated spurious emissions with UMTS IV at mid channel and BLE at mid channel – antenna in horizontal polarization*

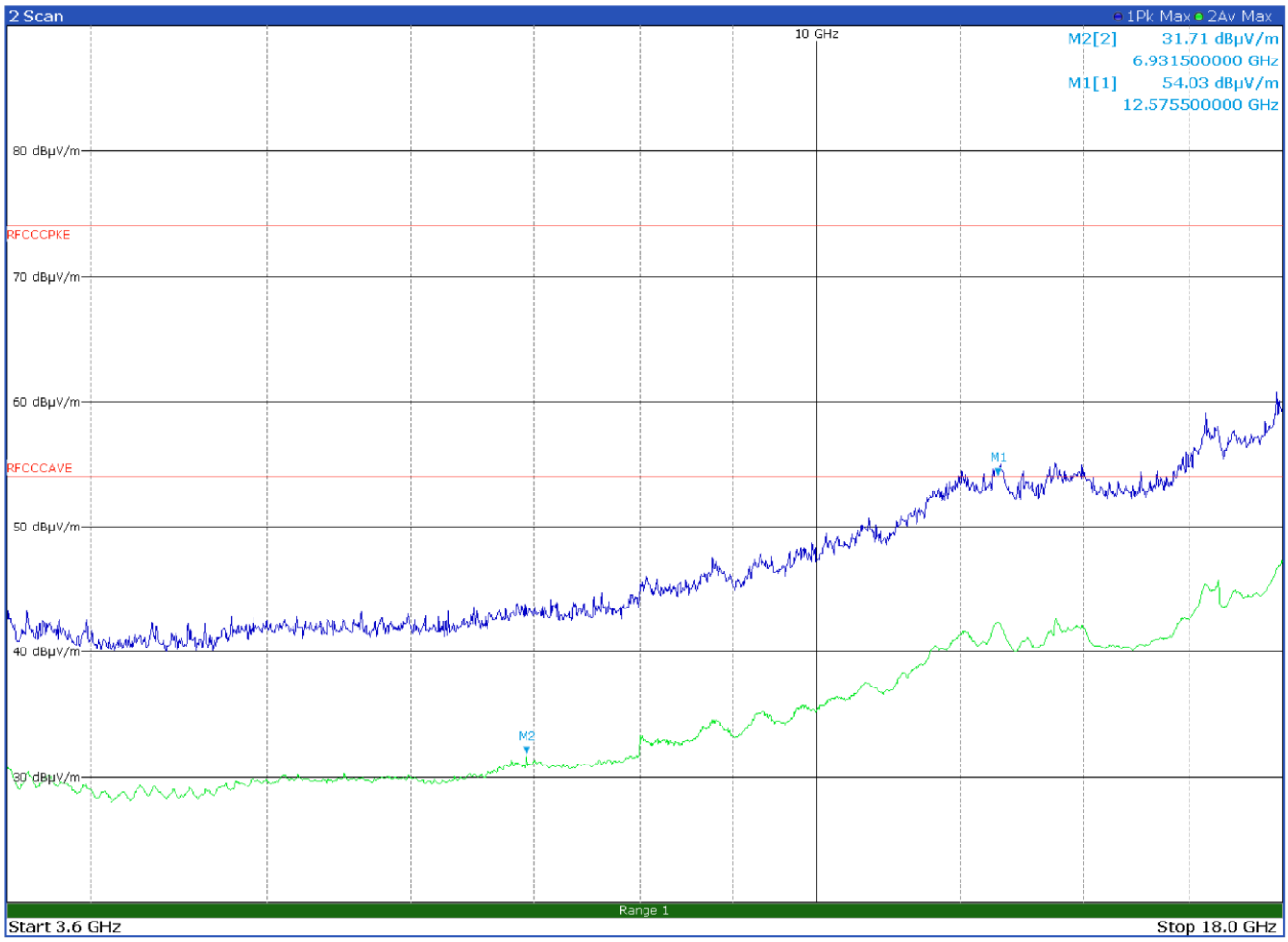
Note: Emissions above the limit were from intentional emissions. intermodulation emissions were detected:



Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
--	--	--	--	--
Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.				

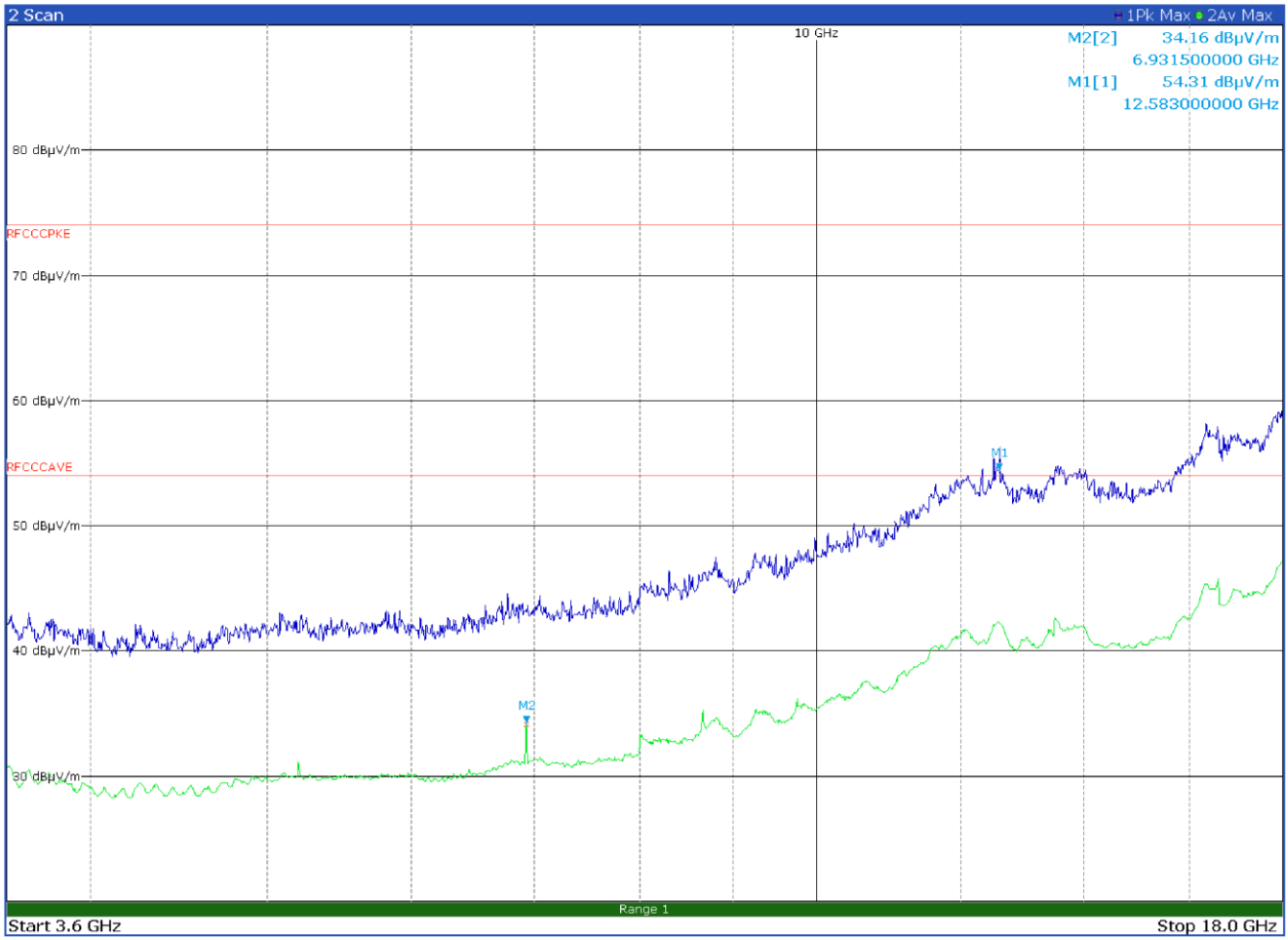
Figure 8.1-20: Radiated spurious emissions with UMTS IV: Radiated spurious emissions with UMTS IV at mid channel and BLE at mid channel – antenna in vertical polarization

Note:



Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
--	--	--	--	PK

Figure 8.1-21: *Radiated spurious emissions with UMTS IV at mid channel and BLE at mid channel – antenna in horizontal polarization*



Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
6931.5000	34.2	54.0	-19.8	Av

Figure 8.1-22: *Radiated spurious emissions with UMTS IV at mid channel and BLE at mid channel – antenna in vertical polarization*

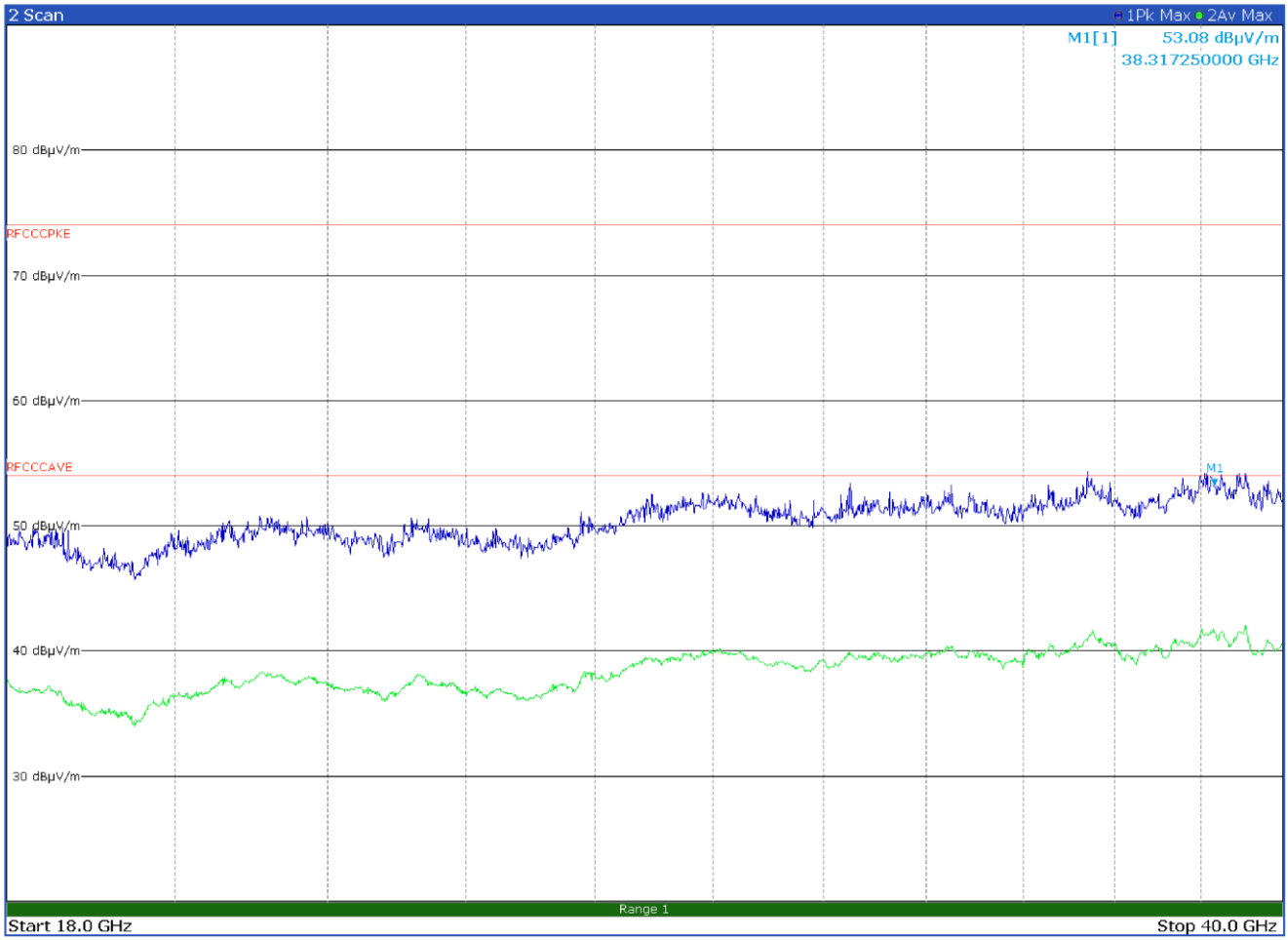


Figure 8.1-23: *Radiated spurious emissions with UMTS IV at mid channel and BLE at mid channel – antenna in horizontal polarization*

Peak level under the average limit – no additional measures need. No intermodulation emissions were detected

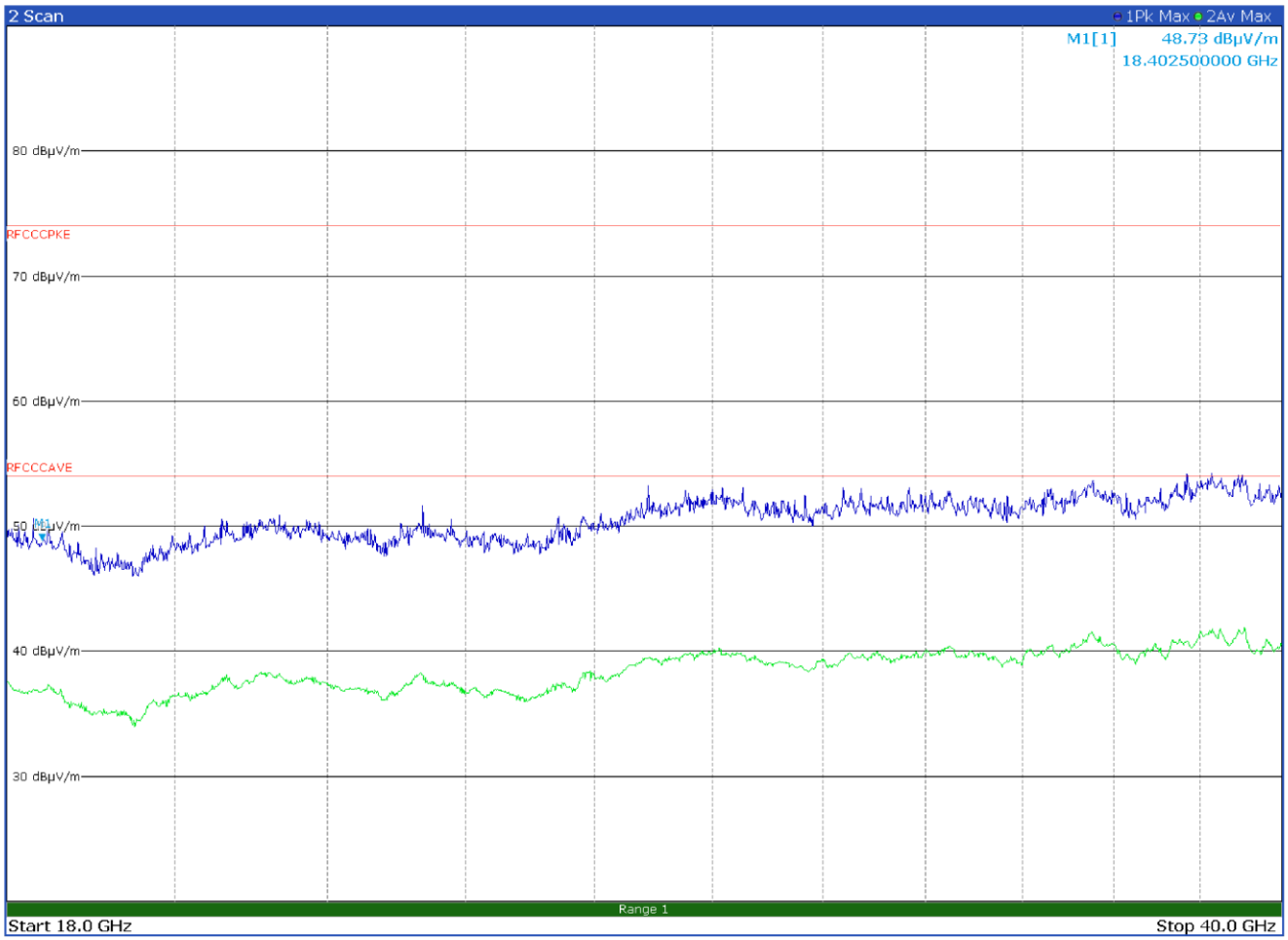


Figure 8.1-24: *Radiated spurious emissions with UMTS IV at mid channel and BLE at mid channel – antenna in vertical polarization*

Peak level under the average limit – no additional measures need. No intermodulation emissions were detected

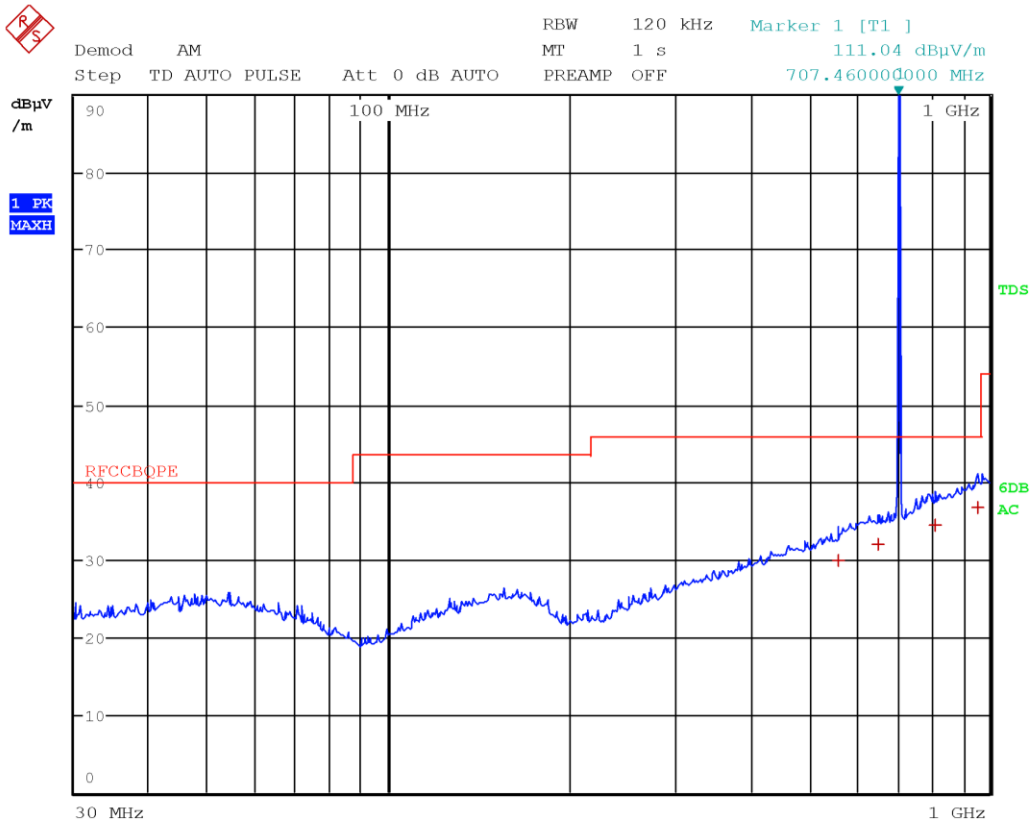


Figure 8.1-25: *Radiated spurious emissions with LTE B12 at mid channel and BLE at mid channel – antenna in horizontal polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
560.4300	30.1	46.0	-15.9	QP
651.3900	32.1	46.0	-13.9	QP
811.5000	34.6	46.0	-11.4	QP
956.4000	36.8	46.0	-9.2	QP

No intermodulation emissions were detected
Limit exceeded by carrier

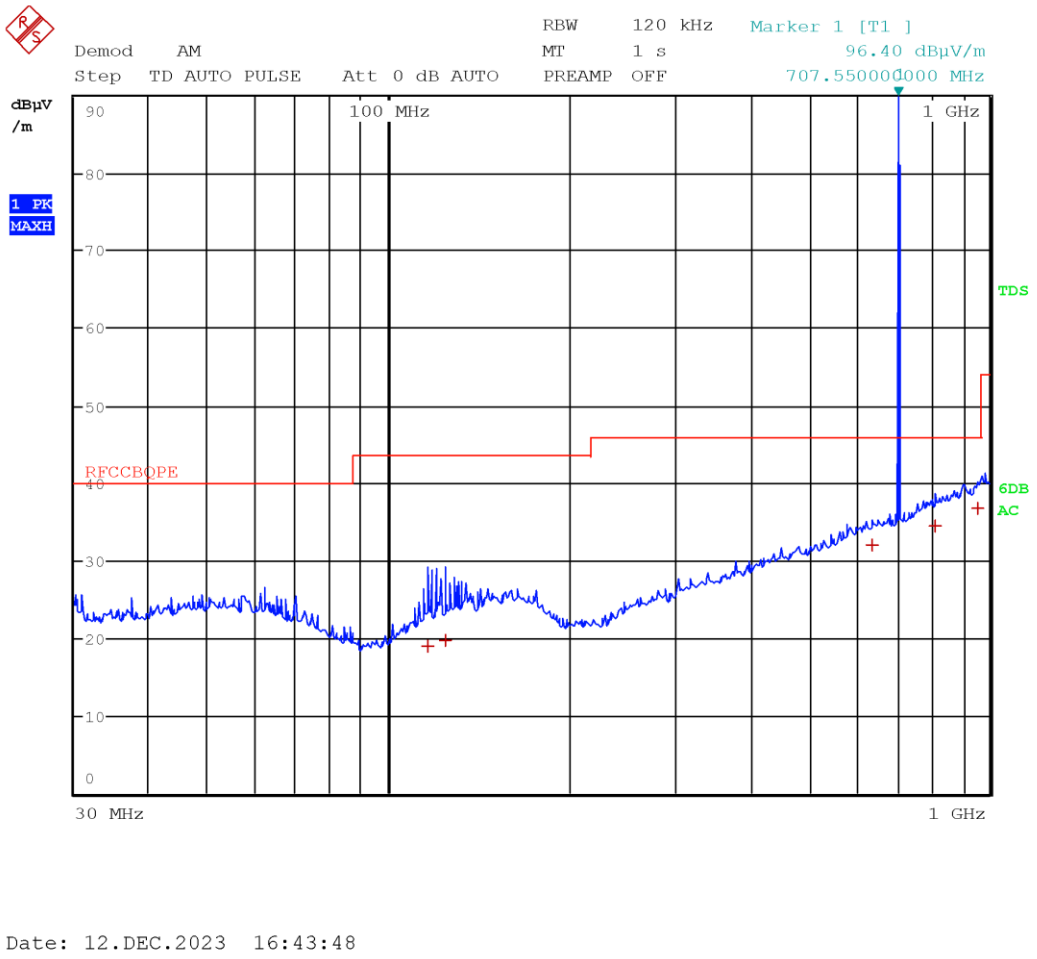


Figure 8.1-26: *Radiated spurious emissions with LTE B12 at mid channel and BLE at mid channel – antenna in vertical polarization*

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
116.3100	19.1	43.5	-24.4	QP
124.4100	19.8	43.5	-23.7	QP
637.7100	32.1	46.0	-13.9	QP
812.2200	34.6	46.0	-11.4	QP
956.6400	36.8	46.0	-9.2	QP

No intermodulation emissions were detected

Limit exceeded by carrier

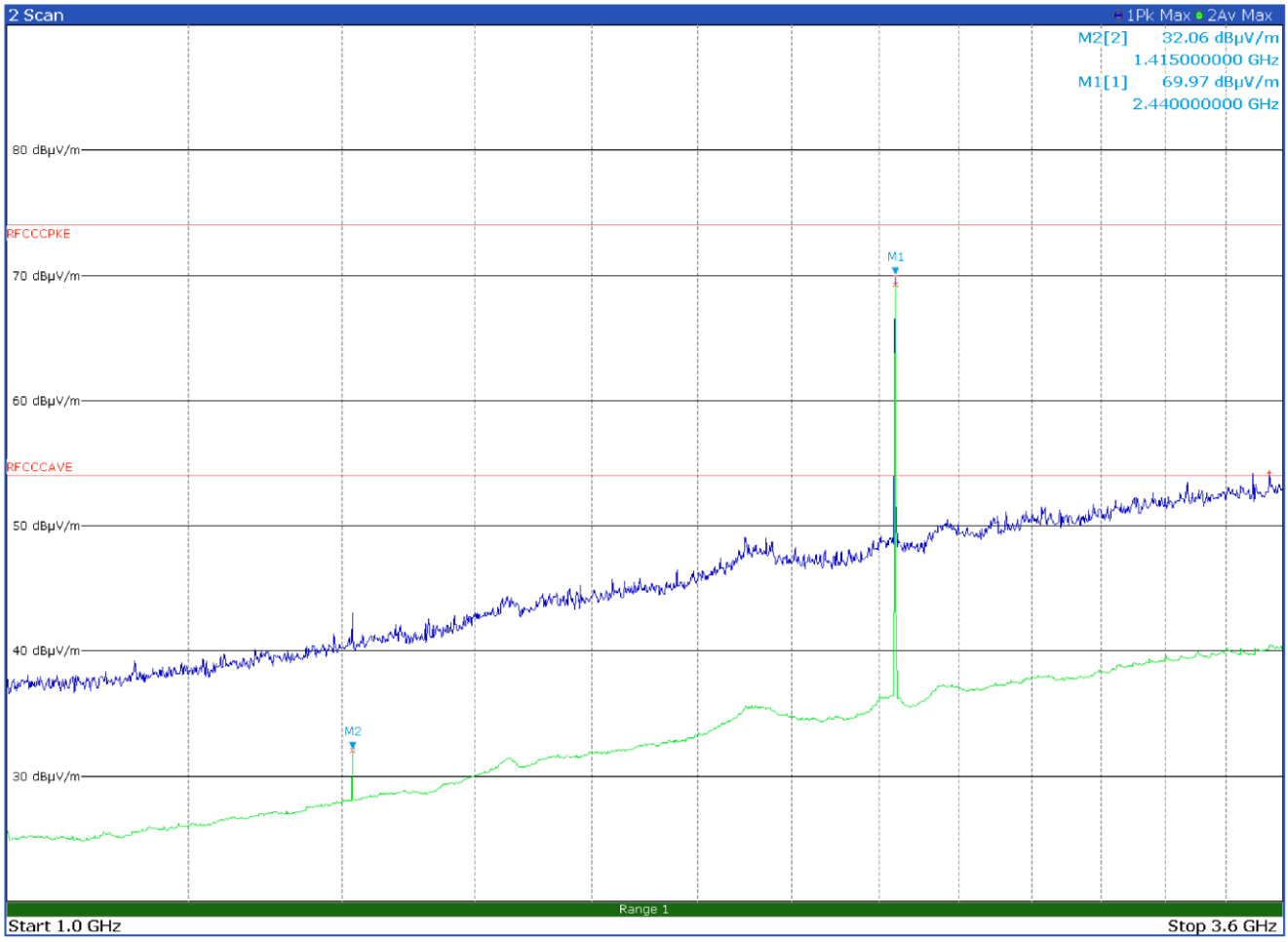


Figure 8.1-27: *Radiated spurious emissions with LTE B12 at mid channel and BLE at mid channel – antenna in horizontal polarization*

Note: Emissions above the limit were from intentional emissions. intermodulation emissions were detected:

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1415.0000	32.1	54.0	-21.9	Av
2440.0000	--	--	--	Pk
2440.0000	--	--	--	Av
3552.0000	54.3	74.0	-19.7	Pk

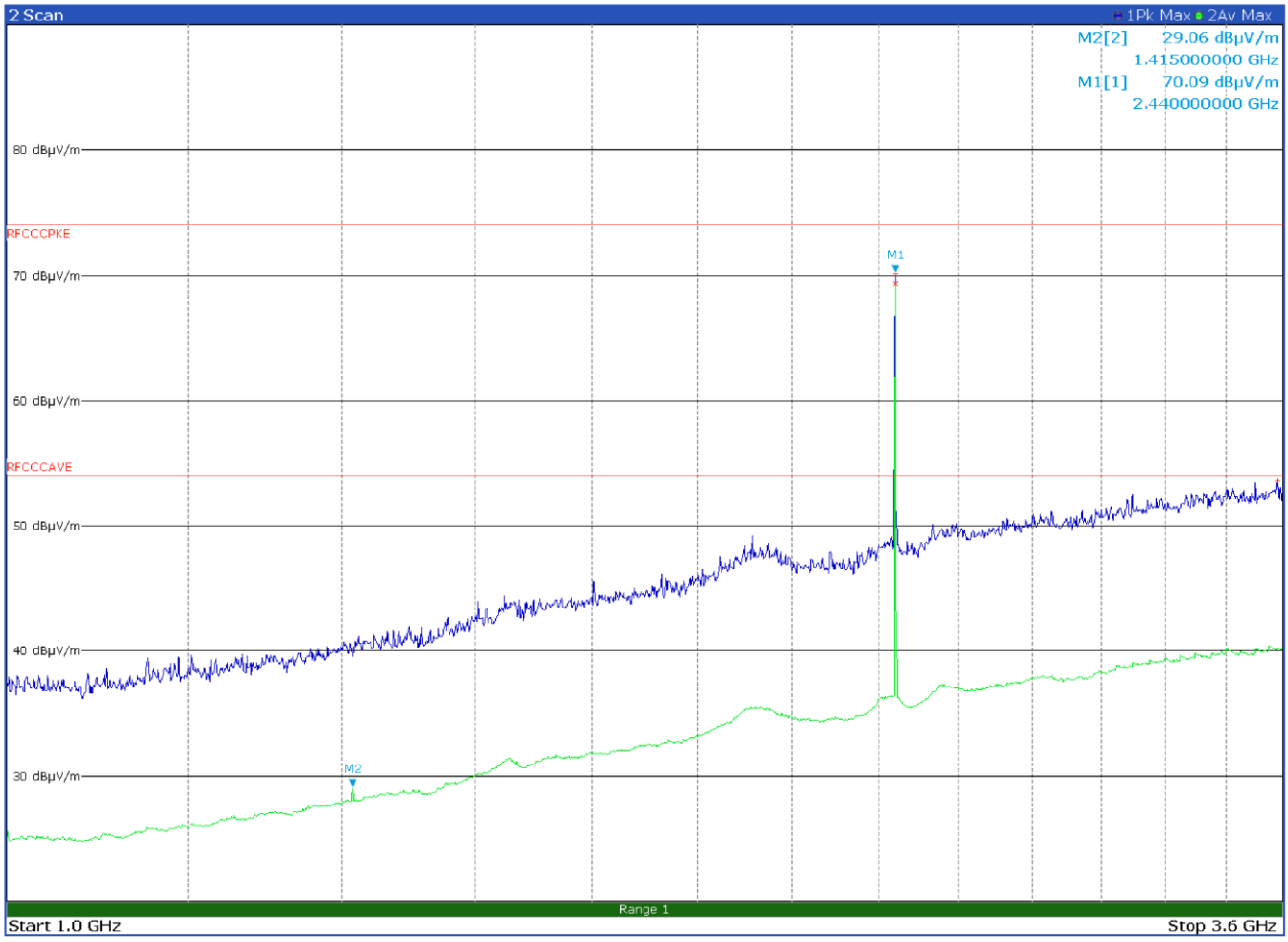
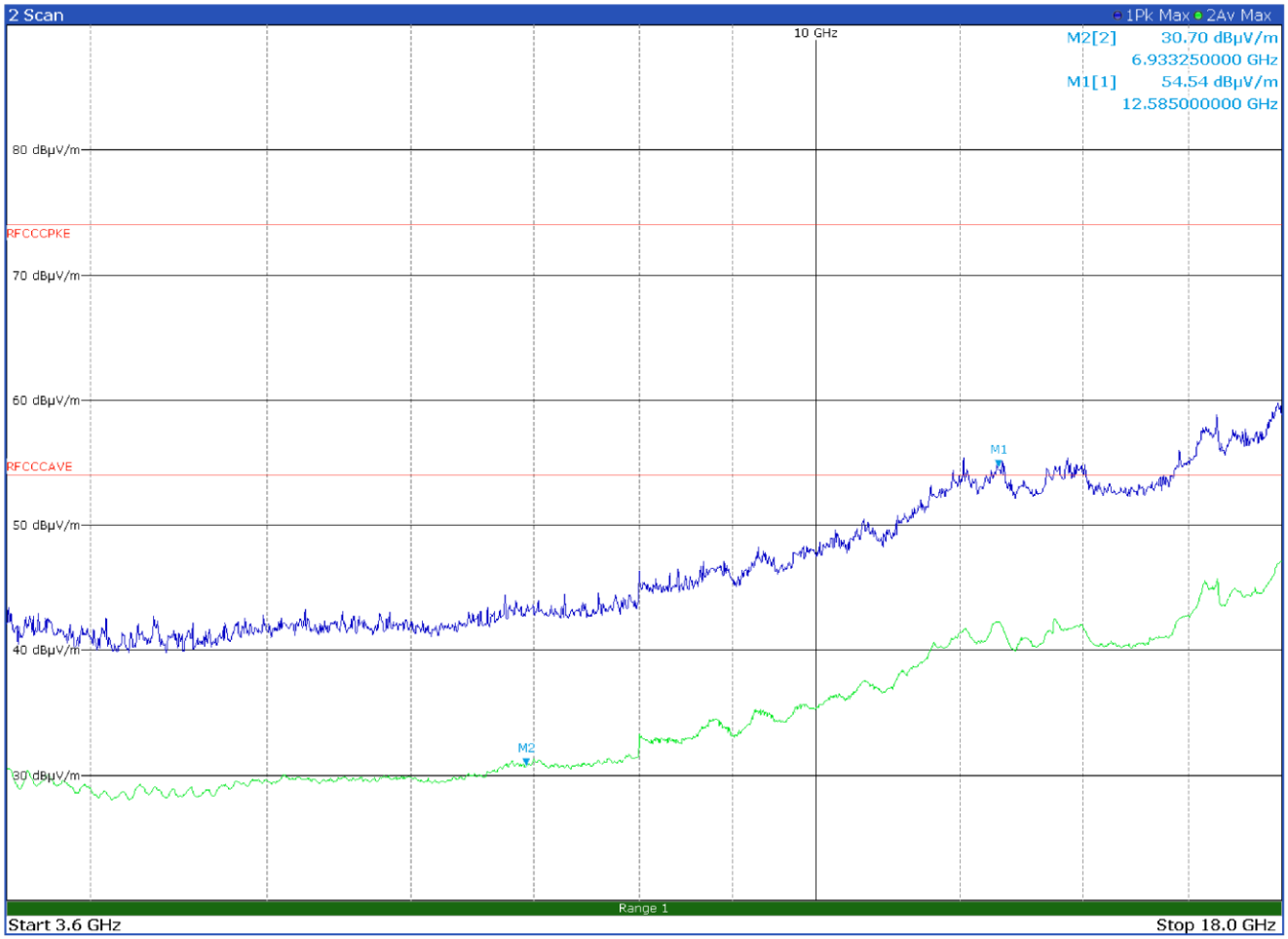


Figure 8.1-28: *Radiated spurious emissions with LTE B12 at mid channel and BLE at mid channel – antenna in vertical polarization*

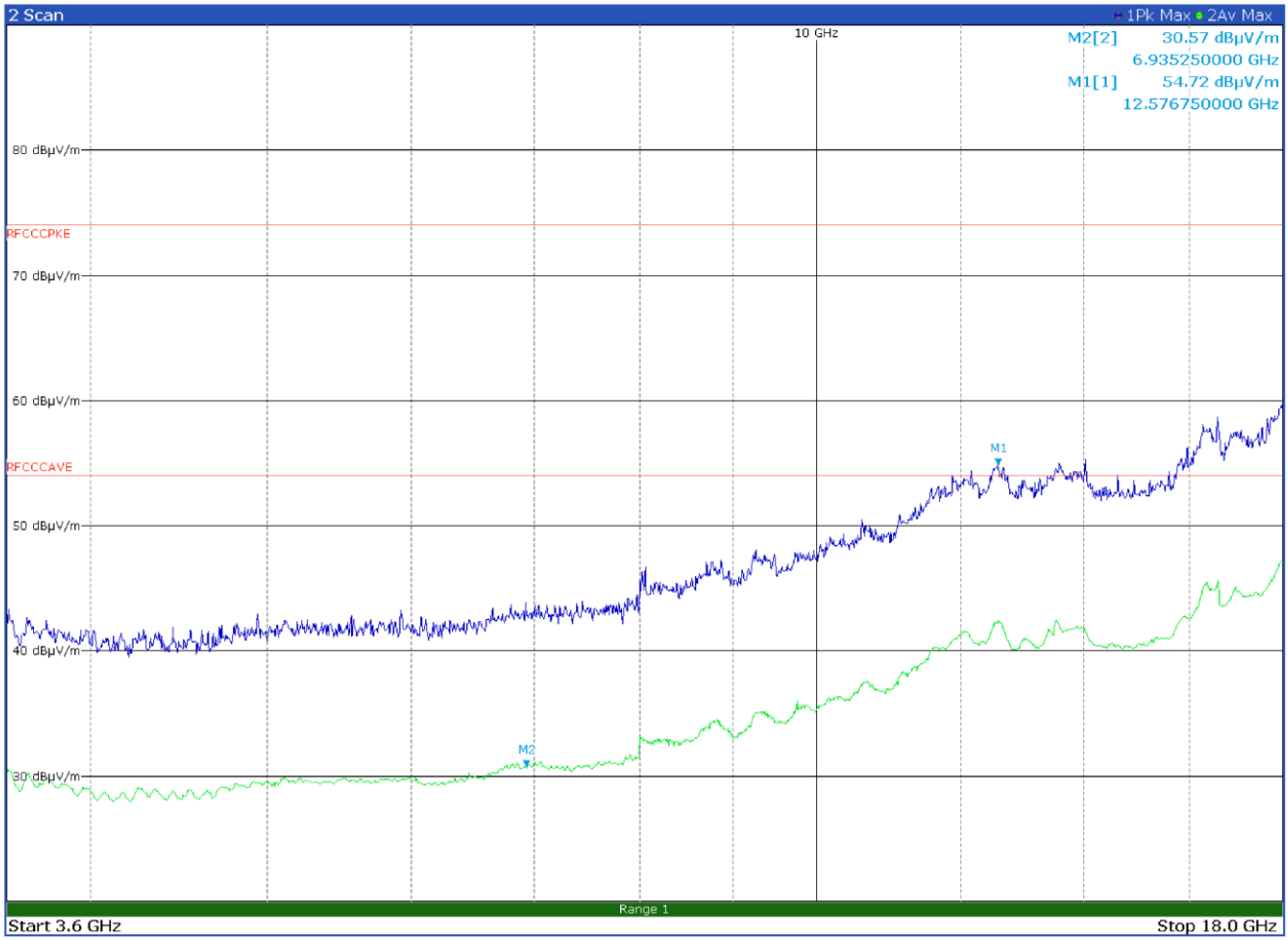
Note: Emissions above the limit were from intentional emissions. intermodulation emissions were detected:

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
2440.0000	--	--	--	Pk
2440.0000	---	--	--	Av
3581.5000	53.7	74.0	-20.3	Pk



Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
--	--	--	--	--

Figure 8.1-29: *Radiated spurious emissions with LTE B12 at mid channel and BLE at mid channel – antenna in horizontal polarization*



Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
--	---	--	--	--

Figure 8.1-30: *Radiated spurious emissions with LTE B12 at mid channel and BLE at mid channel – antenna in vertical polarization*

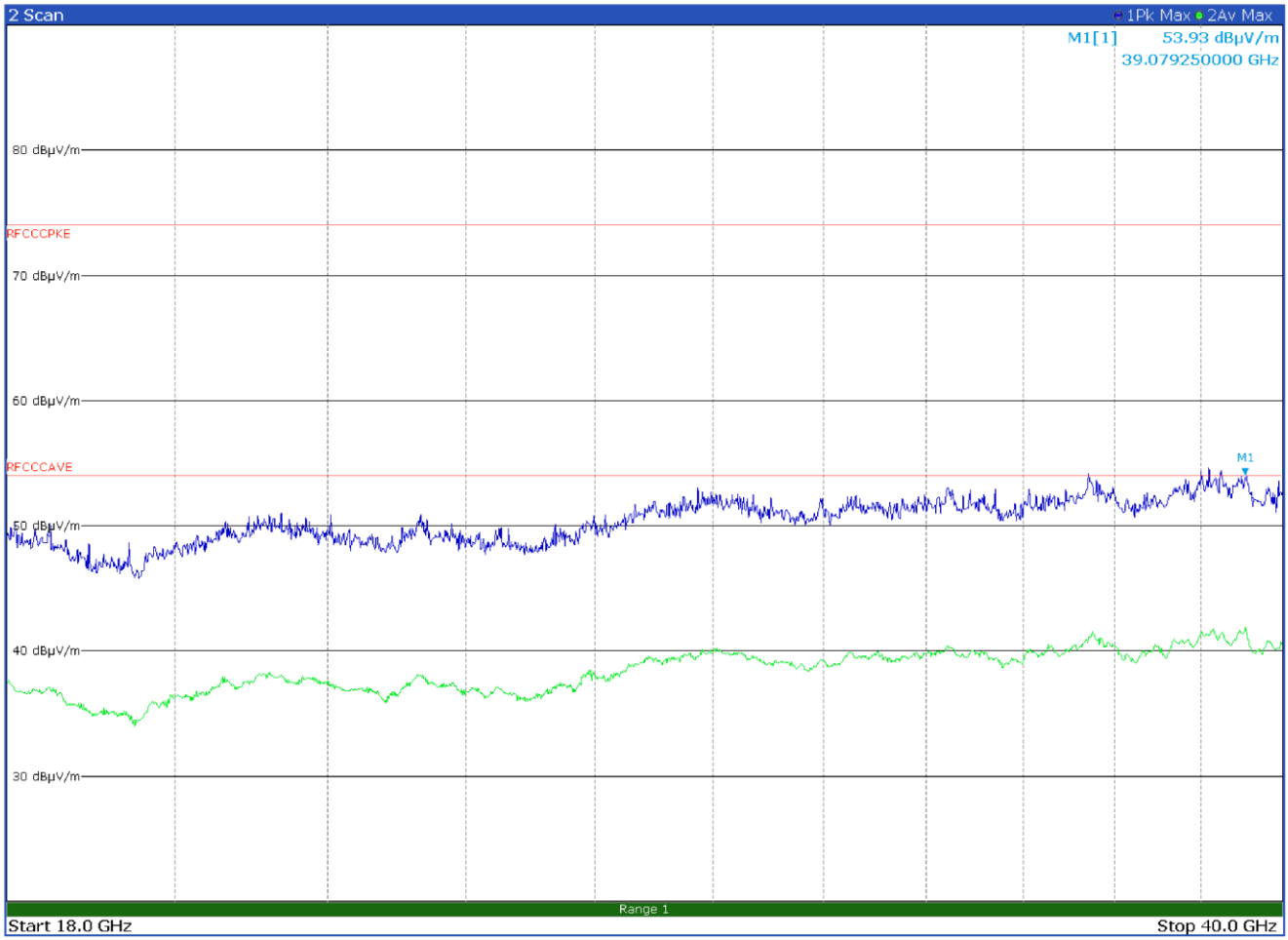


Figure 8.1-31: *Radiated spurious emissions with LTE B12 at mid channel and BLE at mid channel – antenna in horizontal polarization*

Peak level under the average limit – no additional measures need. No intermodulation emissions were detected

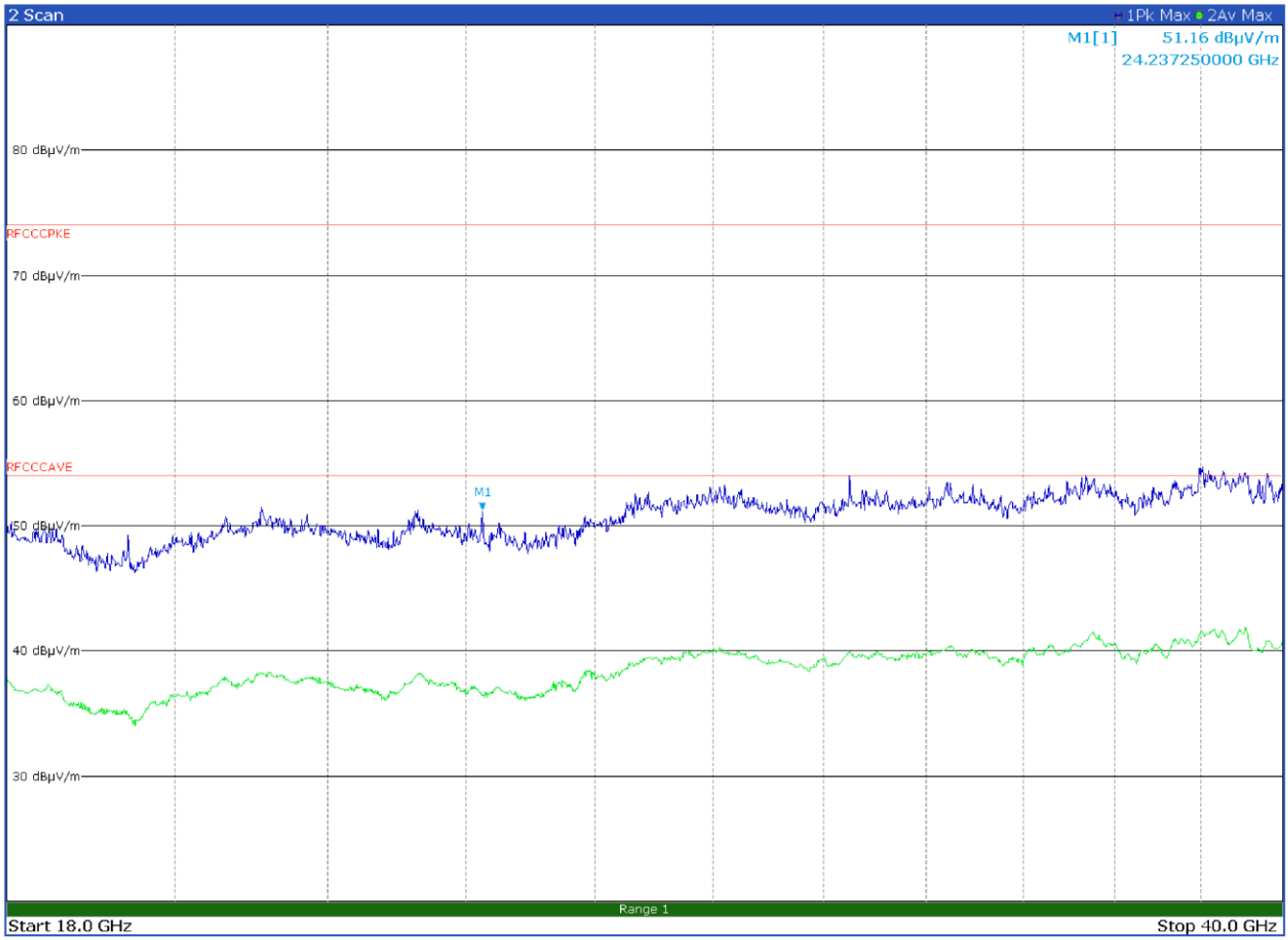


Figure 8.1-32: *Radiated spurious emissions with LTE B12 at mid channel and BLE at mid channel – antenna in vertical polarization*

Peak level under the average limit – no additional measures need. No intermodulation emissions were detected

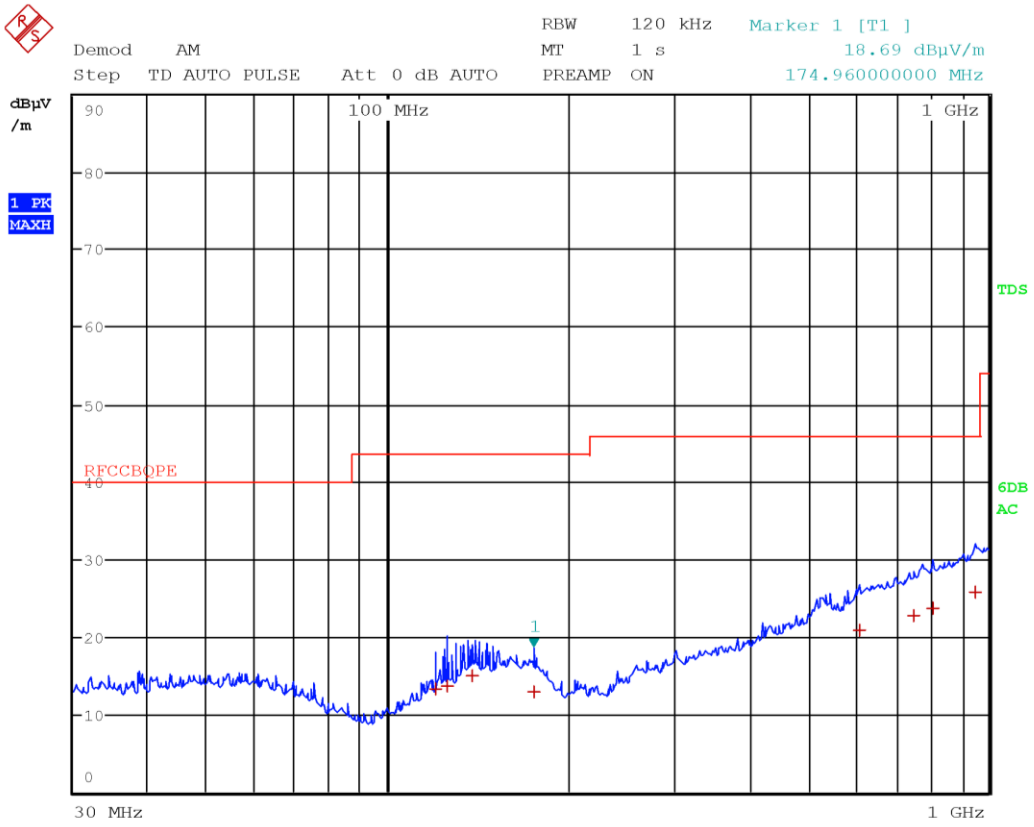


Figure 8.1-33: Radiated spurious emissions with LTE B41 at mid channel and BLE at mid channel – antenna in horizontal polarization

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
119.9700	13.3	43.5	-30.2	QP
126.0000	13.7	43.5	-29.8	QP
137.9700	15.1	43.5	-28.4	QP
174.9600	13.1	43.5	-30.4	QP
611.0100	20.9	46.0	-25.1	QP
748.9800	22.8	46.0	-23.2	QP
807.1200	23.7	46.0	-22.3	QP
951.8400	25.9	46.0	-20.1	QP

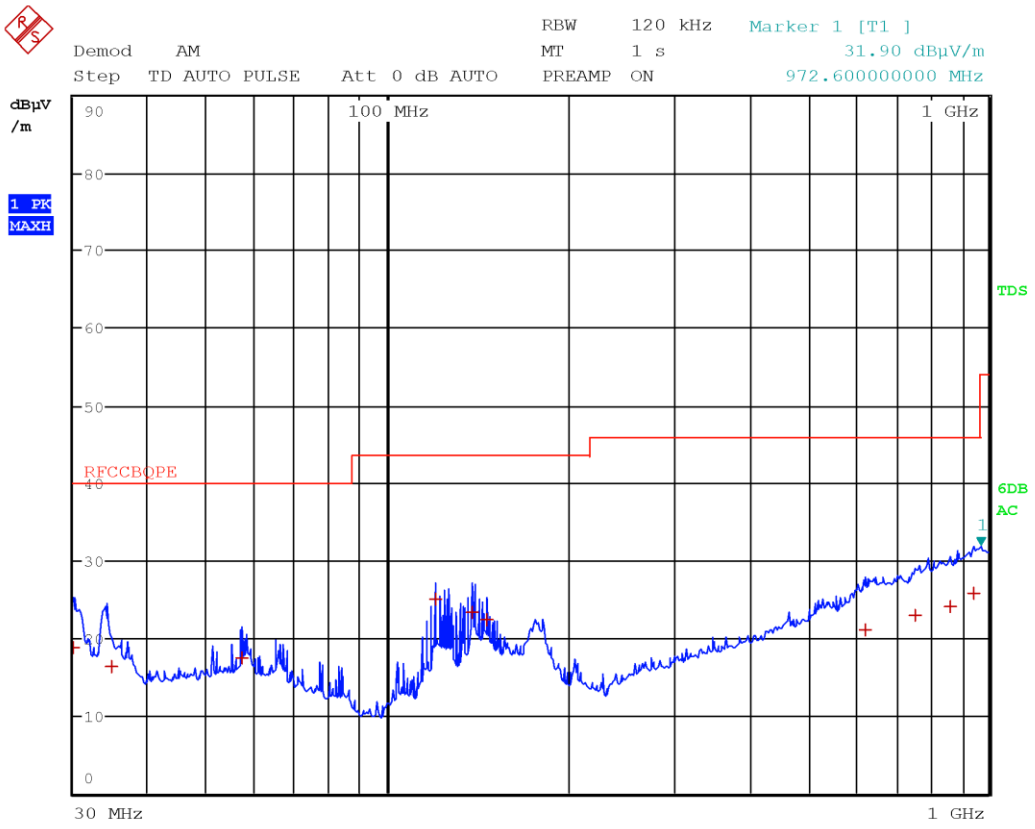


Figure 8.1-34: Radiated spurious emissions with LTE B41 at mid channel and BLE at mid channel – antenna in vertical polarization

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
30.0600	18.9	40.0	-21.1	QP
34.5300	16.4	40.0	-23.6	QP
57.0600	17.5	40.0	-22.5	QP
120.0900	25.0	43.5	-18.5	QP
138.1200	23.4	43.5	-20.1	QP
146.1000	22.5	43.5	-21.0	QP
621.9600	21.1	46.0	-24.9	QP
755.1900	23.0	46.0	-23.0	QP
864.8400	24.2	46.0	-21.8	QP
946.9200	25.8	46.0	-20.2	QP
215.2800	23.5	43.5	-20.0	QP

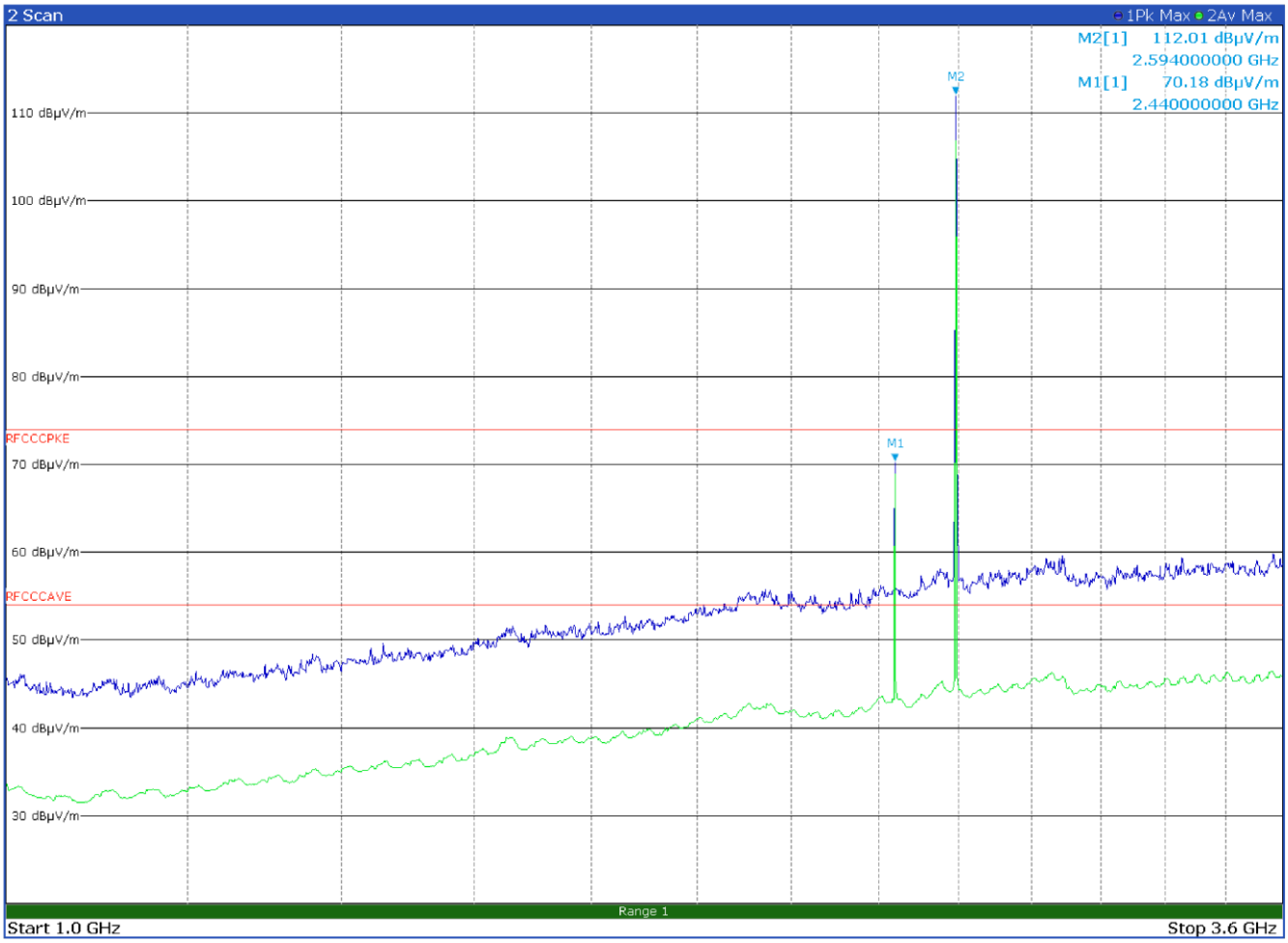


Figure 8.1-34: Radiated spurious emissions with LTE B41 at mid channel and BLE at mid channel – antenna in horizontal polarization

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
--	--	--	--	--

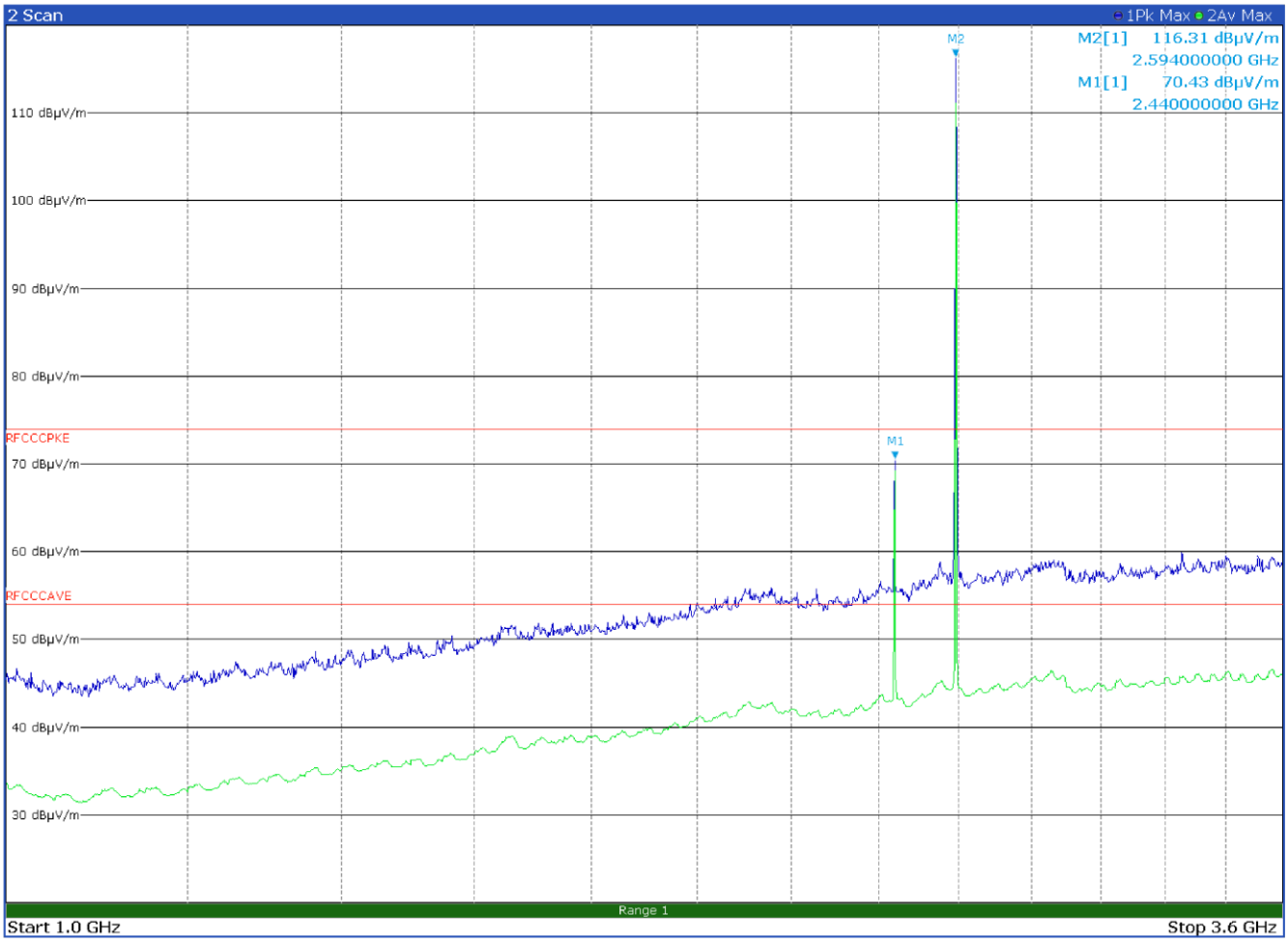
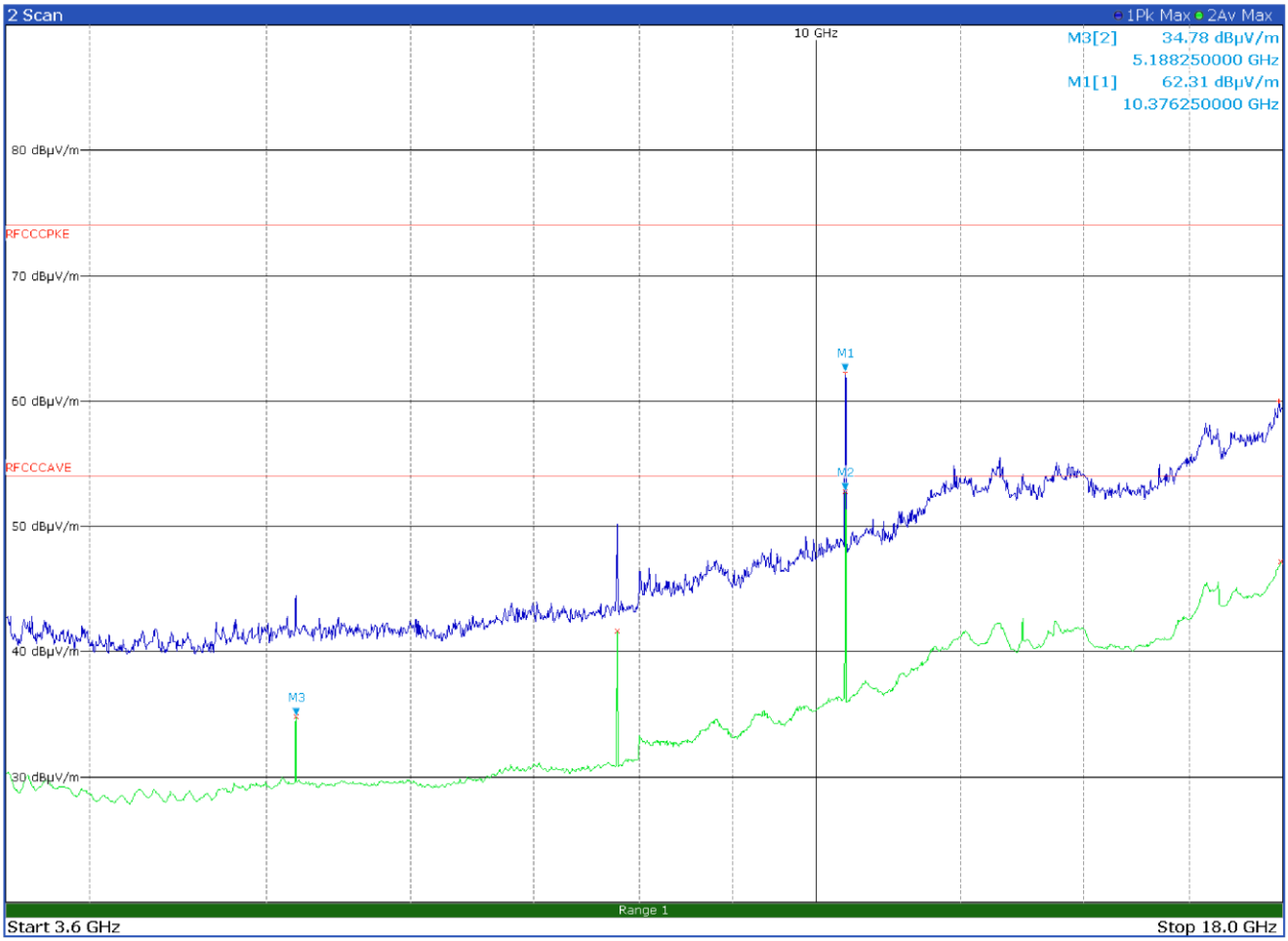


Figure 8.1-34: Radiated spurious emissions with LTE B41 at mid channel and BLE at mid channel – antenna in vertical polarization

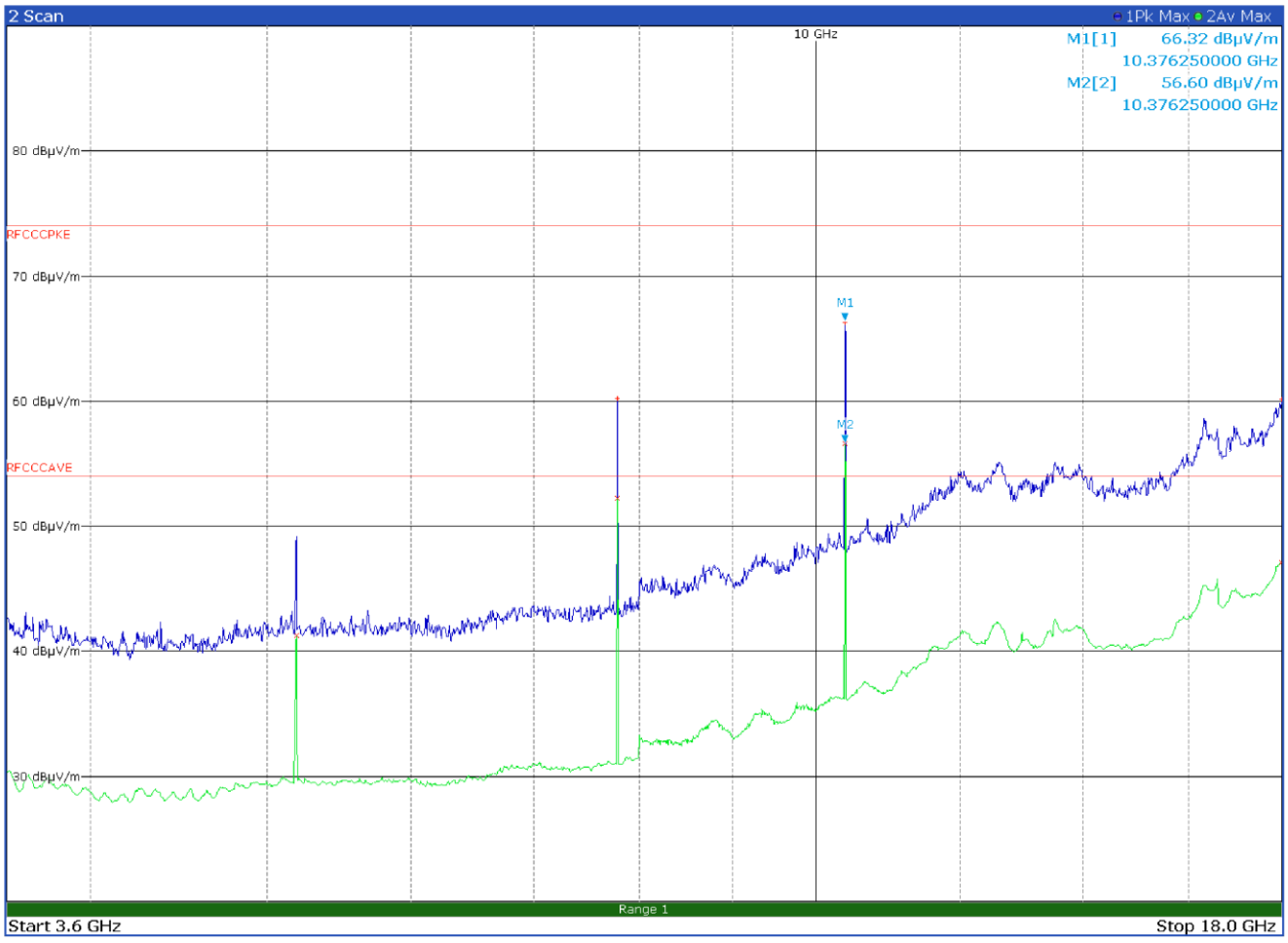
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
--	--	--	--	--



Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
5188.2500	34.8	--	--	Av
7782.2500	41.7	--	--	Av
10376.2500	62.4	82.2	-19.8	Pk
10376.2500	52.8	--	--	Av
17917.0000	60.1	74.0	--	Pk
17959.0000	47.2	54.0	--	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

Figure 8.1-34: *Radiated spurious emissions with LTE B41 at mid channel and BLE at mid channel – antenna in horizontal polarization*



10:53:14 AM 12/13/2023 **Page 1/1**

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
5188.2500	41.3	--	--	Av
7782.2500	60.3	82.2	-21.9	Pk
7782.2500	52.3	--	--	Av
10376.2500	66.4	82.2	-15.8	Pk
10376.2500	56.6	--	--	Av
17999.2500	60.2	--	--	Pk
17999.2500	47.2	54.0	-6.8	Av

The limit for LTE is -13 dBm. Limit (dBµV/m) = limit (dBm) + 95.23 = 82.2 dBµV/m

Figure 8.1-35: *Radiated spurious emissions with LTE B41 at mid channel and BLE at mid channel – antenna in vertical polarization*

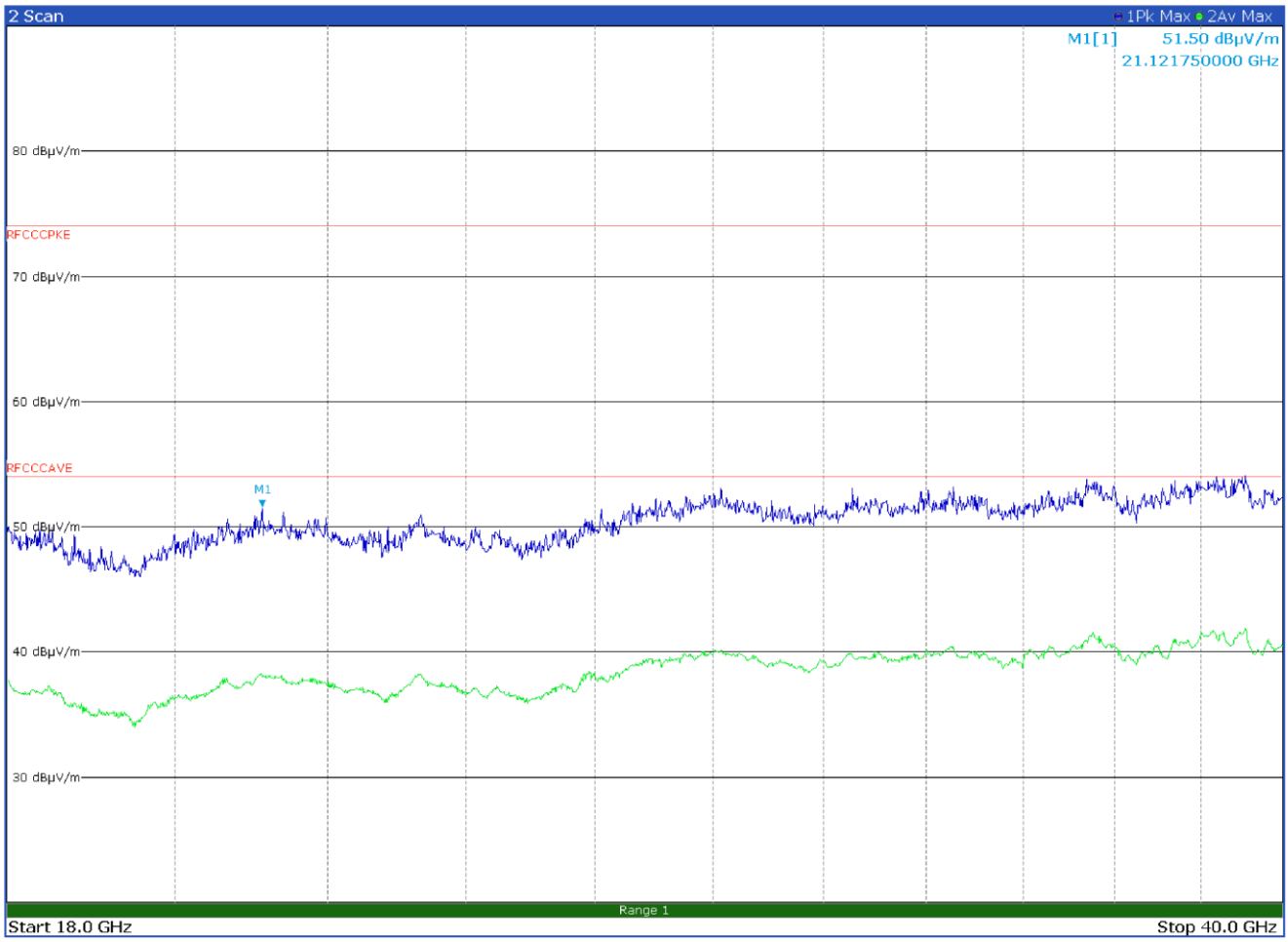


Figure 8.1-36: *Radiated spurious emissions with LTE B4 at mid channel and BLE at mid channel – antenna in vertical polarization*

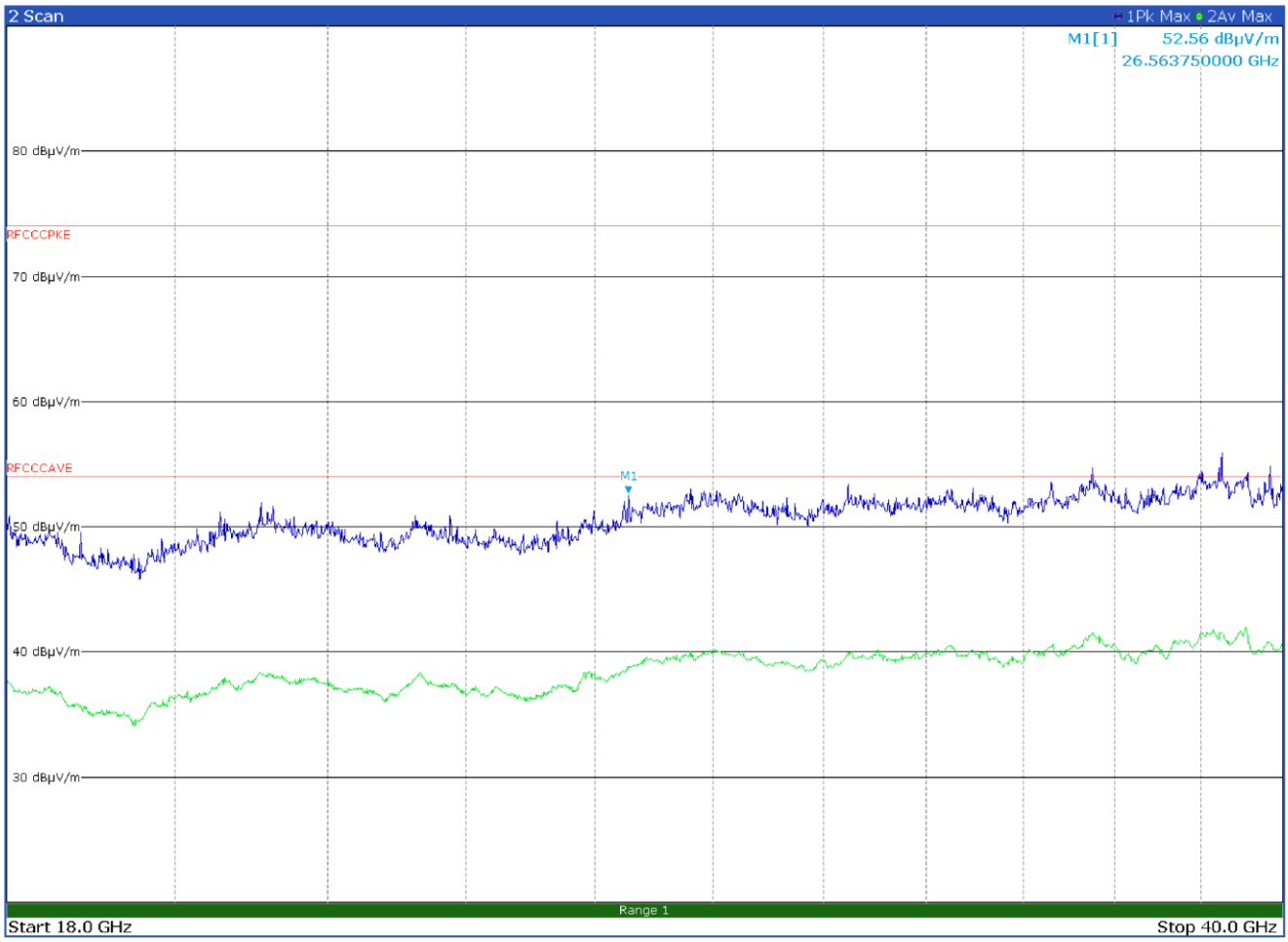
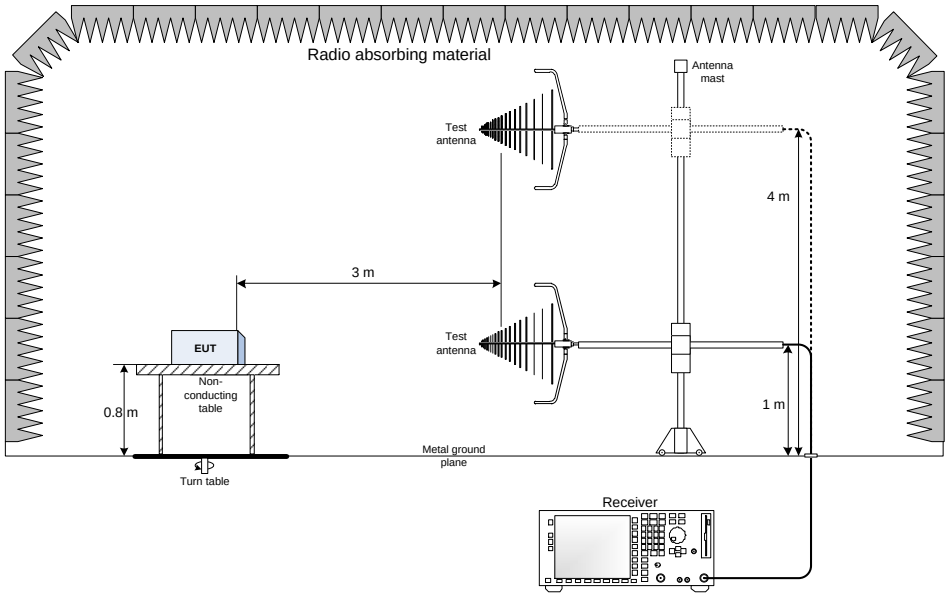


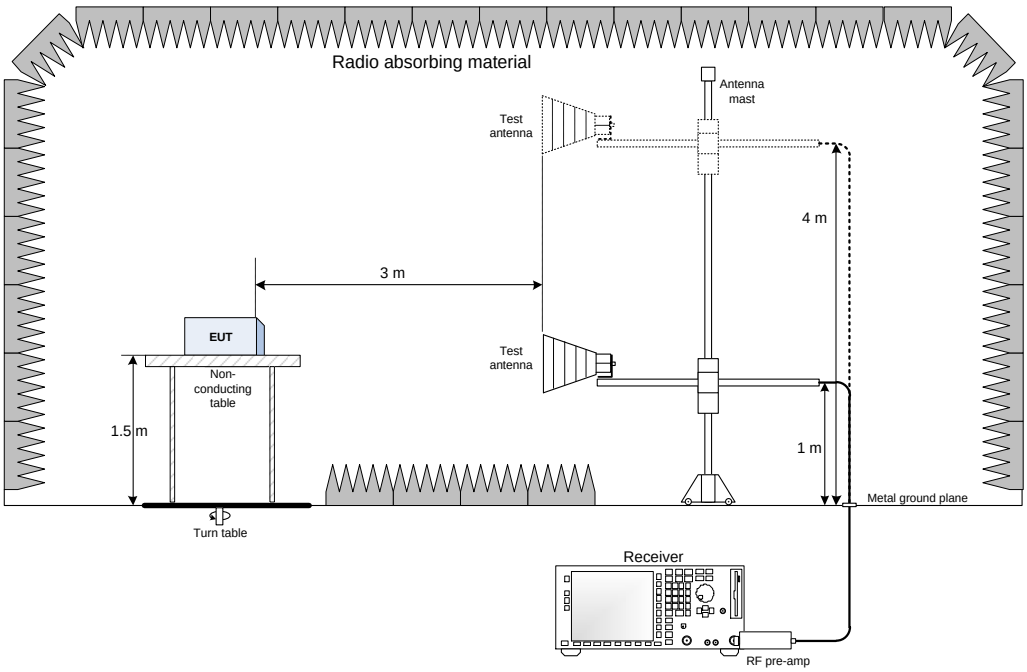
Figure 8.1-37: *Radiated spurious emissions with LTE B4 at mid channel and BLE at mid channel – antenna in horizontal polarization*

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz

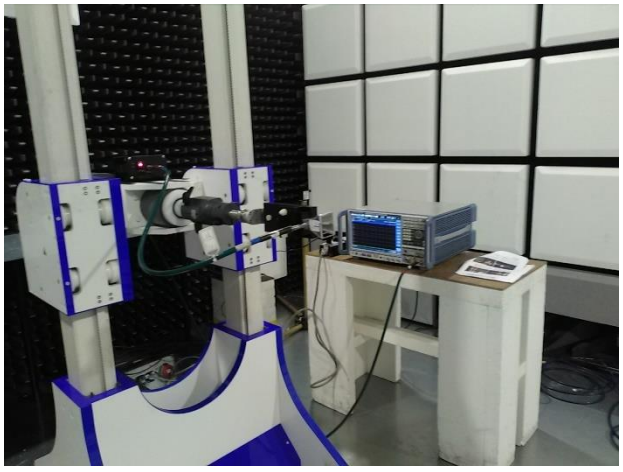


Section 10. Photos

10.1 Photos of the test set-up


Radiated emission below 1 GHz



Radiated emission above 1 GHz

10.2 Photos of the EUT

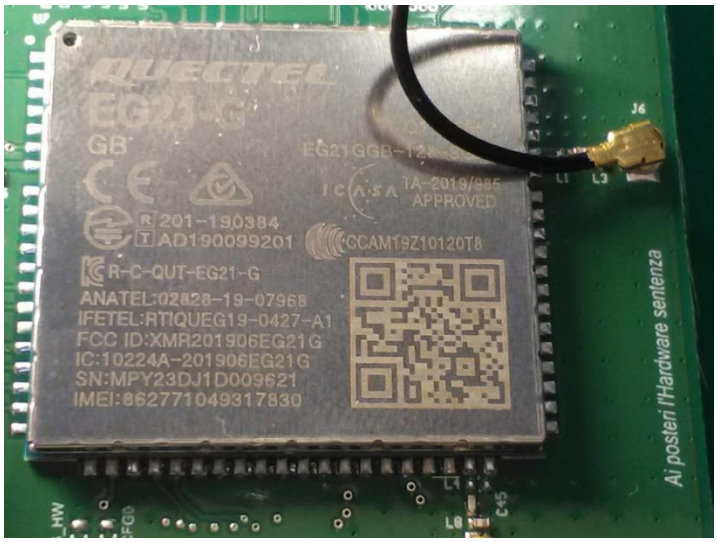
Top view photo

Connector view photo

Bottom view photo

Lateral view photo

Internal view photo



Internal view photo

(End of report)