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Test report

REP017308

Date of issue: October 6, 2023

Applicant:
Vega Srl
Via degli Appennini, 11-13 – 63845 Ponzano di Fermo (FM) – Italy

Product:
Lift door control system

Model:
3D-SENSOR-VG

FCC ID:
2BC5H-3DSENS

Specifications:

- FCC 47 CFR Part 15.255 Subpart C

Operation within the band 57 – 71 GHz.

P. Barbieri	
Tested by	Signature
D. Guarnone	
Reviewed by	Signature

Lab and test locations

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	682159 (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 USA's ISO/IEC 17025 accreditation.
This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

Copyright notification

Table of Contents

Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15.255, Subpart C	Title 47: Telecommunication; Part 15C— Operation within the band 57 – 71 GHz
ANSI C63.10-2013	American National Standard of procedures for compliance testing of unlicensed wireless devices

1.2 Exclusions

None

1.3 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard. 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.

1.4 Test report revision history

Table 1.4-1: *Test report revision history*

Revision #	Details of changes made to test report
REP017308	Original report issued

Notes: None

Section 2 Summary of test results

2.1 Emissions Test results

Table 2.1-1: *FCC 47 CFR Part 15 Subpart C general requirement, results*

Part	Test description	Verdict
§15.31 (e)	Variation of power source	Pass
§15.203	Antenna requirement	Pass
§15.207	Conducted limits	Pass

Notes: --

Table 2.1-2 *FCC 47 CFR Part 15.255 results*

Part	Test description	Verdict
§15.255 (c)	Radiated Power and conducted output power	Pass
§15.255 (d)	Transmitter spurious emissions	Pass
§15.255 (e)	Occupied Bandwidth	Pass
§15.255 (f)	Frequency stability	Pass

Notes: --

Section 3 Equipment under test (EUT) details

3.1 Applicant

Company name	Vega Srl
Address	Via degli Appennini, 11-13 – 63845 Ponzano di Fermo (FM) – Italy

3.2 Manufacturer

Company name	Vega Srl
Address	Via degli Appennini, 11-13 – 63845 Ponzano di Fermo (FM) – Italy

3.3 Sample information

Receipt date	October 3, 2023
Nemko sample ID number	PRJ0041053

3.4 EUT information

Product name	Lift door control system
Model	3D-SENSOR
Model variant	None
Serial number	PRJ00410530003 (Number assigned by Nemko Spa)
Power requirements	5 V DC – 700 mA – 3.5 W
Description/theory of operation	The EUT is a door protection system that provides enhanced 3D detection in the landing zone. The system uses microwave radar technology for 3D detection.
Operational frequencies	57-71 GHz (4 GHz OBW)
Min frequency	60 GHz
Max frequency	64 GHz
Software details	Firmware version 0.17

3.5 EUT exercise and monitoring details

The EUT has been tested in normal working condition supplied by its dedicated controller. For frequency stability the FMCW modulation has been switched off (CW mode).

3.6 EUT setup details

Table 3.6-1: Support equipment

Description	Brand name	Model/Part number	Serial number	Rev.
Controller	Vega Srl	3D-CONTROLLER-D	N/A	N/A

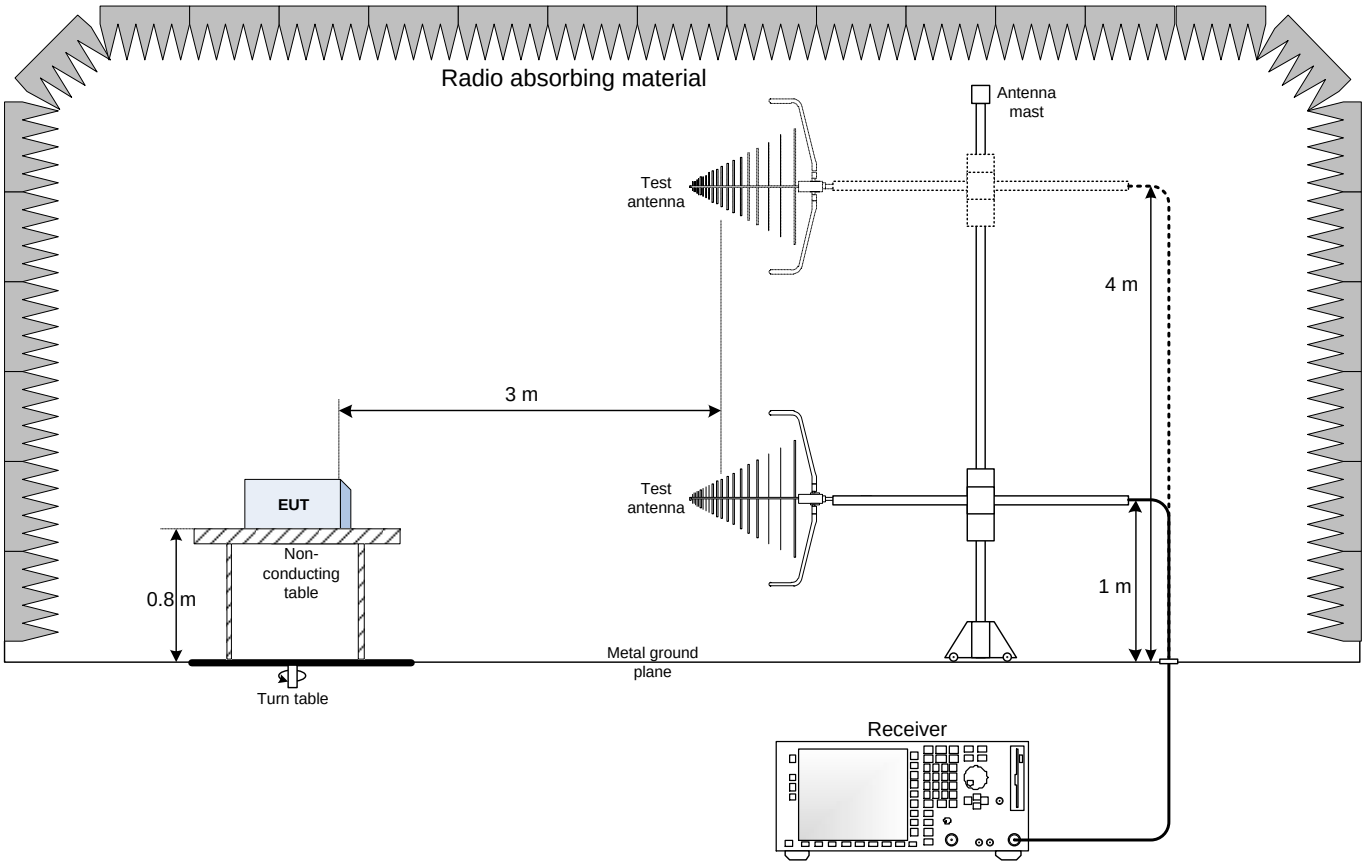


Figure 3.6-1: Radiated testing below 1 GHz block diagram

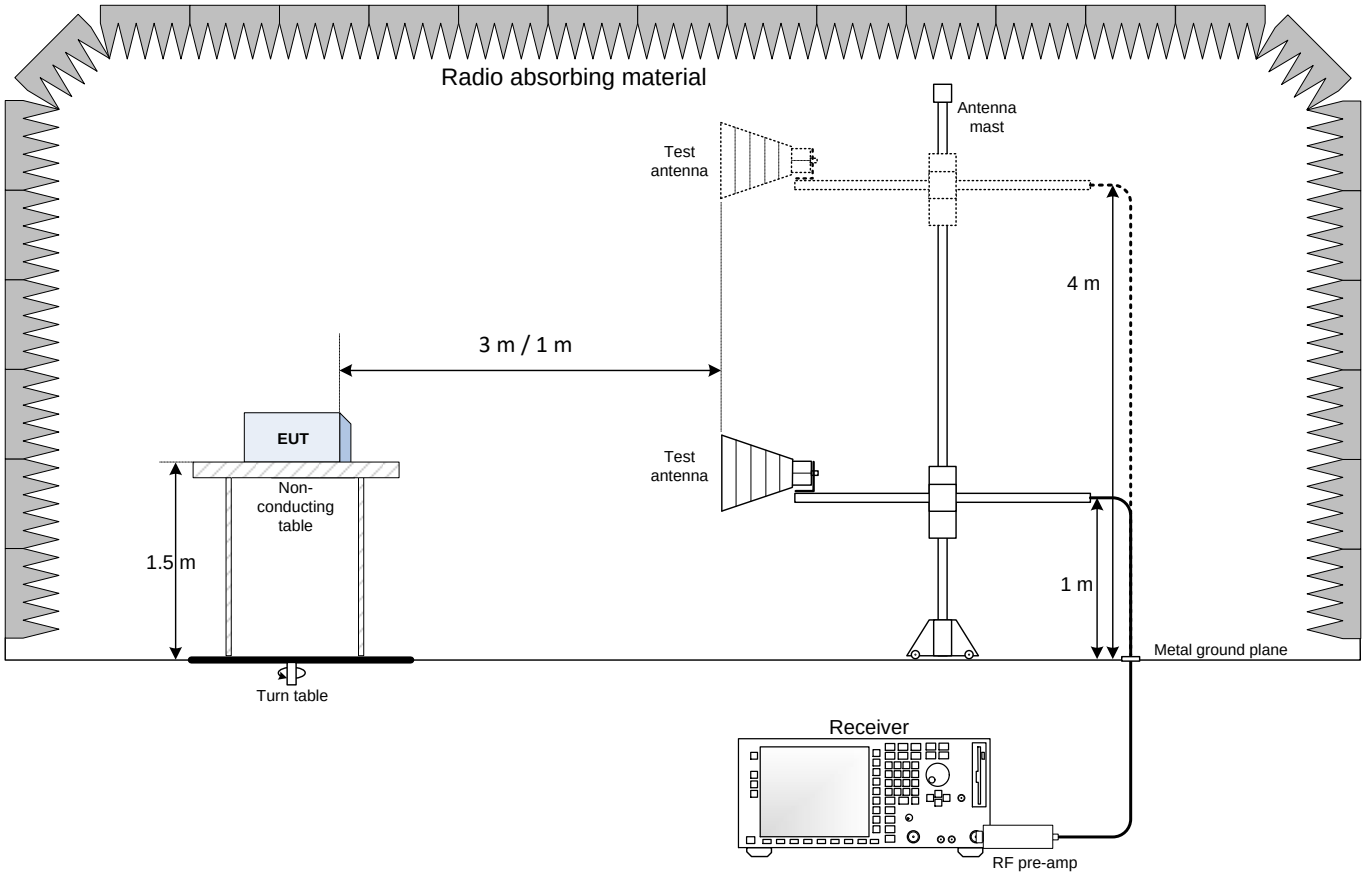


Figure 3.6-2: Radiated testing above 1 GHz block diagram

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

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5 Test conditions

5.1 Atmospheric conditions

Temperature	15 °C – 35 °C
Relative humidity	20 % – 75 %
Air pressure	86 kPa (860 mbar) – 106 kPa (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.
Barometer	Castle	GBP 3300	072015	2023-05	2024-05
Data logger con diagnosi in campo	Testo	175-H2	20012380/305	2022-12	2024-12
Data logger con diagnosi in campo	Testo	175-H2	38203337/703	2022-12	2024-12

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 and other specific test standard and is documented in Nemko Spa working manual WML1002.
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	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 ÷ 18 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 transmitter	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)

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 Testing data

7.1 Equivalent Isotropically Radiated Power (E.I.R.P.) and Peak conducted output power

7.1.1 References

§ 15.255 (c)

Radiated power limits. Within the 57–71 GHz band, emission levels shall not exceed the following equivalent isotropically radiated power (EIRP):

(1) Devices other than field disturbance sensors shall comply with one of the following power limits, as measured during the transmit interval:

(i) The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm; or

(ii) For fixed point-to-point transmitters located outdoors, the average power of any emission shall not exceed 82 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The peak power of any emission shall not exceed 85 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi.

(A) The provisions in this paragraph (c) for reducing transmit power based on antenna gain shall not require that the power levels be reduced below the limits specified in paragraph (c)(1)(i) of this section.

(B) The provisions of § 15.204(c)(2) and (4) that permit the use of different antennas of the same type and of equal or less directional gain do not apply to intentional radiator systems operating under this provision. In lieu thereof, intentional radiator systems shall be certified using the specific antenna(s) with which the system will be marketed and operated. Compliance testing shall be performed using the highest gain and the lowest gain antennas for which certification is sought and with the intentional radiator operated at its maximum available output power level. The responsible party, as defined in § 2.909 of this chapter, shall supply a list of acceptable antennas with the application for certification.

(2) Field disturbance sensors/radars shall not exceed −10 dBm peak conducted output power and 10 dBm peak EIRP except that field disturbance sensors/radars that limit their operation to all or part of the specified frequency band may operate without being subject to a transmitter conducted output power limit if they operate in compliance with paragraph (b)(3) of this section or with one or more of the provisions below:

(i) 57.0–59.4 GHz: the peak EIRP level shall not exceed 20 dBm for indoor operation or 30 dBm for outdoor operation;

(ii) 57.0–61.56 GHz: the peak EIRP shall not exceed 3 dBm except that the peak EIRP shall not exceed 20 dBm if the sum of continuous transmitter off-times of at least two milliseconds equals at least 16.5 milliseconds within any contiguous interval of 33 milliseconds;

(iii) 57.0–64.0 GHz:

(A) The peak EIRP shall not exceed 14 dBm, and the sum of continuous transmitter off-times of at least two milliseconds shall equal at least 25.5 milliseconds within any contiguous interval of 33 milliseconds, except as specific in paragraph (c)(2)(iii)(B) of this section;

(B) The peak EIRP shall not exceed 20 dBm, and the sum of continuous transmitter off-times of at least two milliseconds shall equal at least 16.5 milliseconds within any contiguous interval of 33 milliseconds when operated outdoors:

(1) As part of a temporary or permanently fixed application; or

(2) When being used in vehicular applications to perform specific tasks of moving something or someone, except for in-cabin applications;

(iv) A field disturbance sensor may operate in any of the modes in the above sub-sections so long as the device operates in only one mode at any time and does so for at least 33 milliseconds before switching to another mode.

(v) 61.0–61.5 GHz: For field disturbance sensors/radars that occupy 500 MHz bandwidth or less that are contained wholly within the frequency band 61.0–61.5 GHz, the average power of any emission, measured during the transmit interval, shall not exceed 40 dBm, and the peak power of any emission shall not exceed 43 dBm. In addition, the average power of any emission outside of the 61.0–61.5 GHz band, measured during the transmit interval, but still within the 57–71 GHz band, shall not exceed 10 dBm, and the peak power of any emission shall not exceed 13 dBm.

(3) For pulsed field disturbance sensors/radars operating in the 57–64 GHz band that have a maximum pulse duration of 6 ns, the average EIRP shall not exceed 13 dBm and the transmit duty cycle shall not exceed 10% during any 0.3 µs time window. In addition, the average integrated EIRP within the frequency band 61.5–64.0 GHz shall not exceed 5 dBm in any 0.3 µs time window. Peak emissions shall not exceed 20 dB above the maximum permitted average emission limit applicable to the equipment under test. The radar bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna.

(4) The provisions in § 15.35(b) and (c) that require emissions to be averaged over a 100 millisecond period and that limits the peak power to 20 dB above the average limit do not apply to devices operating under paragraphs (c)(2) and (3) of this section.

7.1.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	October 3, 2023

7.1.3 Notes

This test performed using the procedure described in ANSI C63.10-2013, section 9.10

7.1.4 Setup details

Receiver/spectrum analyzer settings

Resolution bandwidth	10 MHz
Video bandwidth	10 MHz
Detector mode	Peak / RMS
Trace mode	Max Hold

7.1.5 Test equipment used

Table 7.1-1: *Test equipment used*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Receiver	Rohde & Schwarz	ESW44	101620	2023-09	2024-09
Harmonic Mixer	Radiometer Physics	FS-Z90	101670	2021-01	2024-01
Pyramidal Horn Antenna 60-90 GHz	Sage	SAR-2013-121F-E2	17383.01	2021-07	2024-07
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
3m Semi anechoic chamber	Comtest	SAC-3	1711-150	2022-09	2024-09

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

7.1.6 Test data

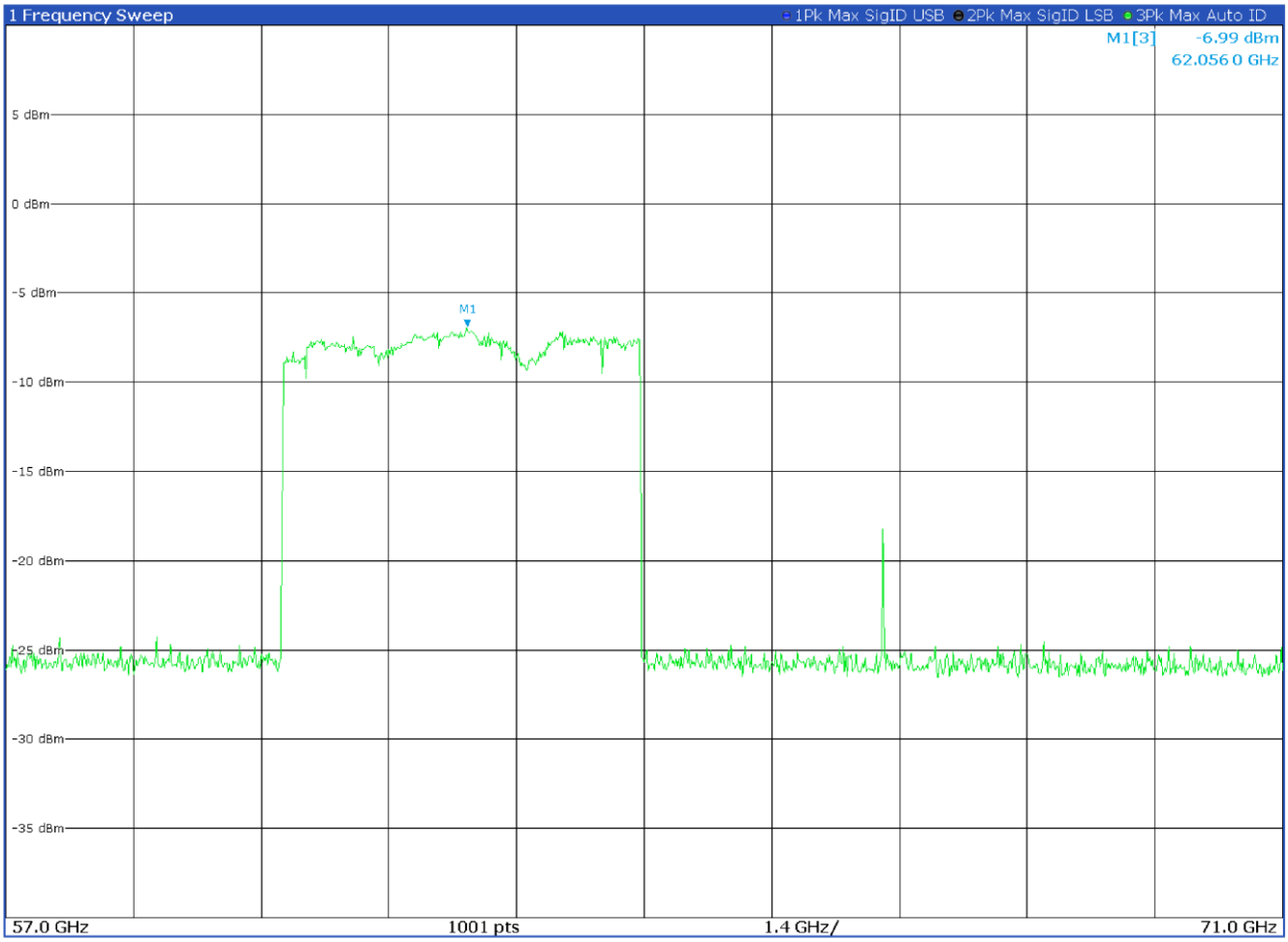


Figure 7.1-1: *Peak EIRP*

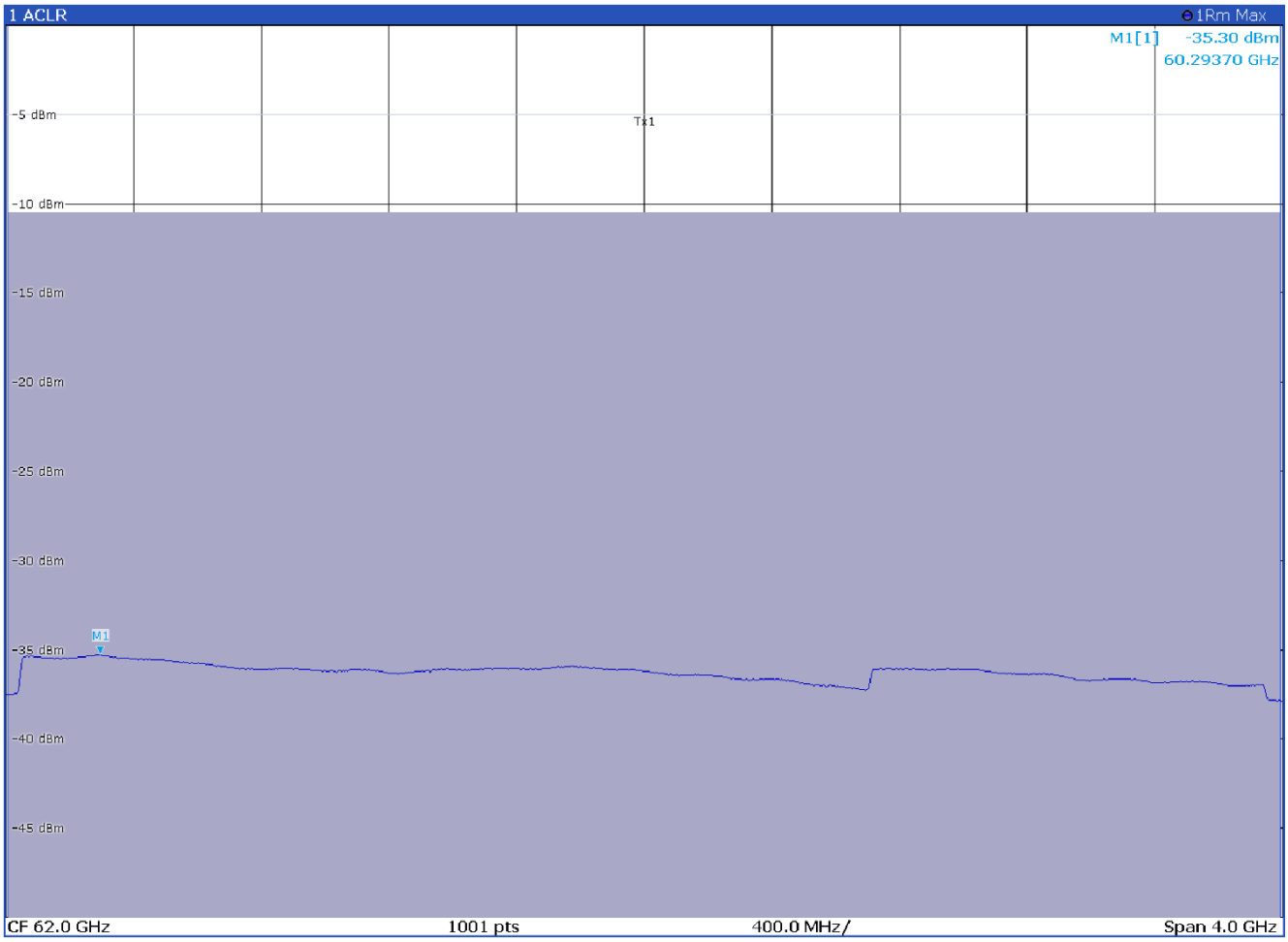
Frequency range, GHz	Peak EIRP, dBm	Limit, dBm	Margin, dB	Peak conducted power, dBm	Limit, dBm	Margin, dB
57 to 61	-6.7	10.0	-16.7	-11.7	-10.0	-1.7

Table 7.1-2: *EIRP Results*

Note: Peak conducted power = Peak EIRP – antenna gain = -6.7 dBm – 5 dB = -11.7 dBm

The antenna gain declared by manufacturer is 5 dBi.

Test data, continued



2 Result Summary — None

Channel	Bandwidth	Offset	Power
Tx1 (Ref)	3.990 GHz		**-10.51 dBm**
Tx Total			**-10.51 dBm**

Figure 7.1-2: *Average power*

7.2 Occupied bandwidth

7.2.1 References

§ 15.255 (e)

(2) Devices other than field disturbance sensors/radars with an emission bandwidth of less than 100 megahertz must limit their peak transmitter conducted output power to the product of 500 mW times their emission bandwidth divided by 100 megahertz. For the purposes of this paragraph, emission bandwidth is defined as the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kilohertz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g., for frequency hopping devices).

7.2.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	October 4, 2023

7.2.3 Notes

This is a radiated test due a conducted port is not available. Measurement was done with a fix antenna heigh and at 0.5 meters of distance.

7.2.4 Setup details

Receiver/spectrum analyzer settings:

Resolution bandwidth	100 kHz (6 dB OBW) and 10 MHz[1] (99% OBW)
Video bandwidth	300 kHz (6 dB OBW) and 40 MHz[1] (99% OBW)
Detector mode	Peak
Trace mode	Max Hold

Note: [1]This value is the maximum RBW supported by used equipment.

7.2.5 Test equipment used

Table 7.2-1: *Test equipment used*

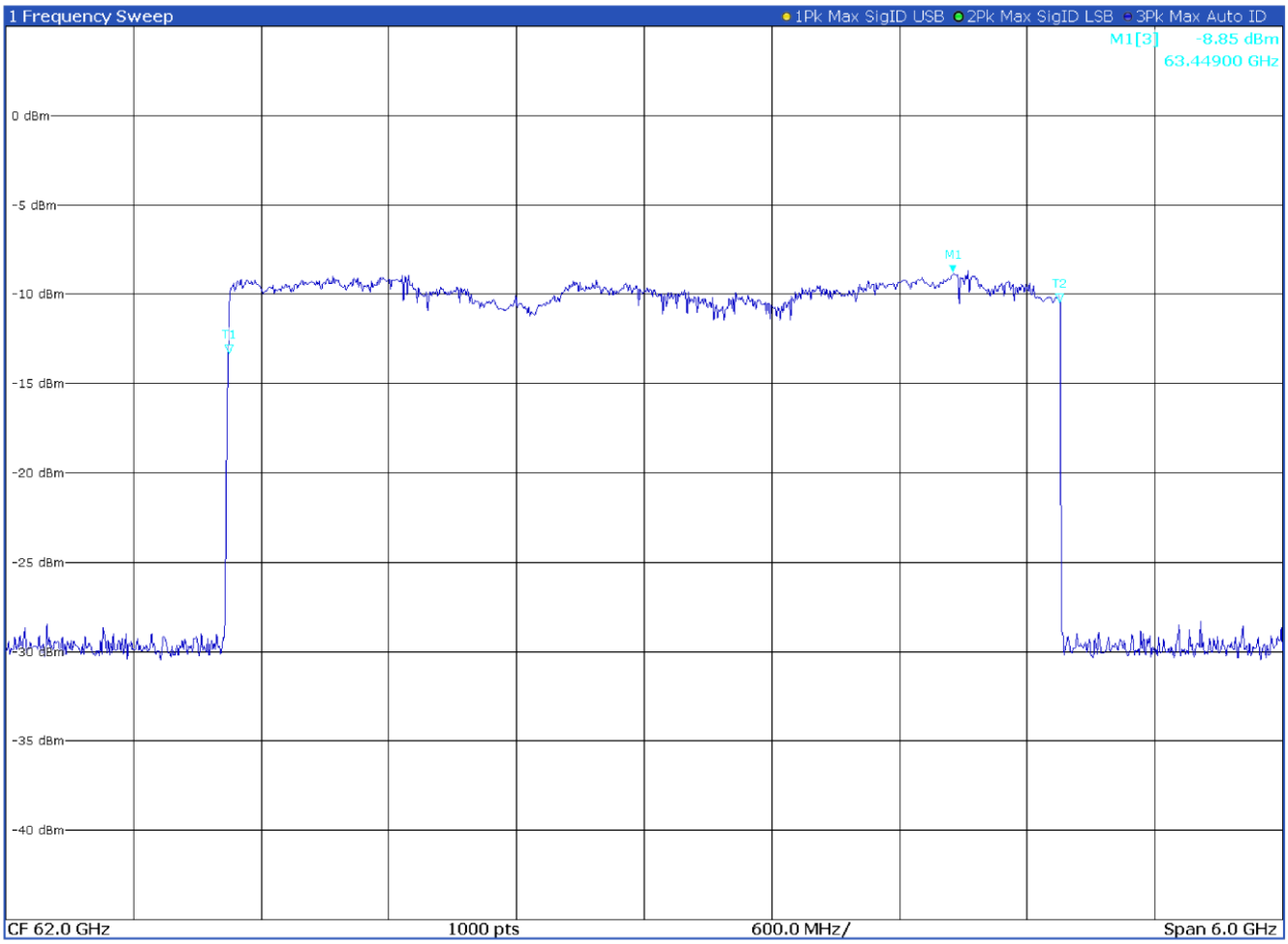
Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Receiver	Rohde & Schwarz	ESW44	101620	2023-09	2024-09
Harmonic Mixer	Radiometer Physics	FS-Z90	101670	2021-01	2024-01
Pyramidal Horn Antenna 60-90 GHz	Sage	SAR-2013-121F-E2	17383.01	2021-07	2024-07
Controller	Maturo	FCU3.0	10041	NCR	NCR
Tilt antenna mast	Maturo	TAM4.0-E	10042	NCR	NCR
Turntable	Maturo	TT4.0-5T	2.527	NCR	NCR
3m Semi anechoic chamber	Comtest	SAC-3	1711-150	2022-09	2024-09

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

7.2.6 Test data

Center Frequency (GHz)	Bandwidth (GHz)	6 dB BW (GHz)	99% BW (GHz)
62.0	4.0	3.91	3.91

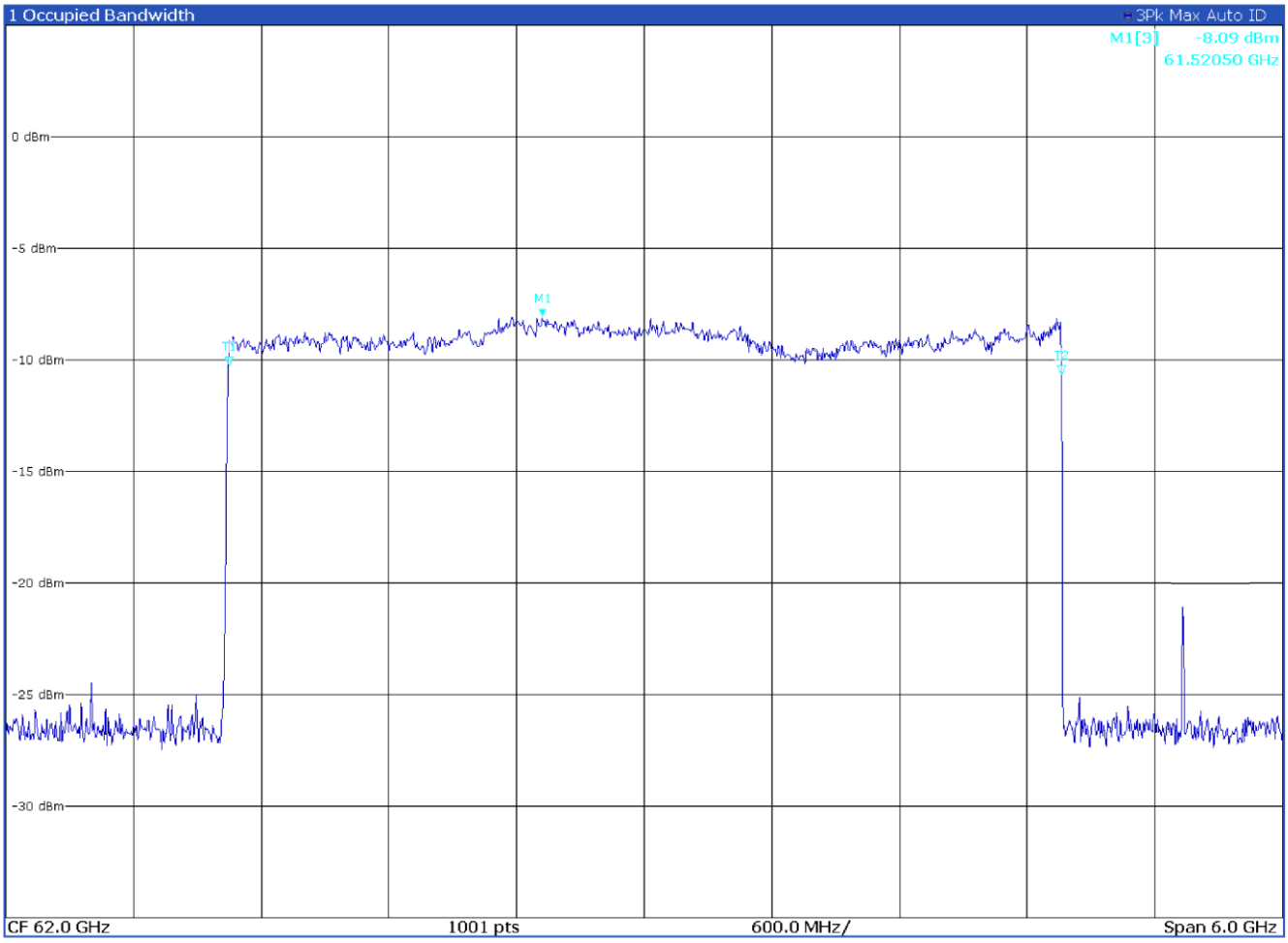
Table 7.2-2: *Occupied Bandwidth Results.*



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		3	**63.449 GHz**	**-8.85 dBm**	ndB	6.0 dB
T1		3	60.047 GHz	-13.32 dBm	ndB down BW	**3.91 GHz**
T2		3	63.953 GHz	-10.49 dBm	Q Factor	16.2

Figure 7.2-1: *6 dB OBW*



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		3	**61.5205 GHz**	**-8.09 dBm**	Occ Bw	**3.915852589 GHz**
T1		3	60.04629 GHz	-10.28 dBm	Occ Bw Centroid	62.004211788 GHz
T2		3	63.96214 GHz	-10.63 dBm	Occ Bw Freq Offset	4.211788398 MHz

Figure 7.2-2: *99% OBW*

7.3 Transmitter spurious emissions

7.3.1 References

§ 15.255 (d)
Limits on spurious emissions.
(1) The power density of any emissions outside the 57–71 GHz band shall consist solely of spurious emissions.
(2) Radiated emissions below 40 GHz shall not exceed the general limits in § 15.209.
(3) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm2 at a distance of 3 meters.
(4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

7.3.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	October 5, 2023

7.3.3 Notes

This test was done at a 3m measurement distance using the maximum radiated energy from the EUT. The spectrum was explored from 30 MHz to 220 GHz. Calculation from limit line for this test:

$$PD = \frac{EIRP_{Linear}}{4\pi d^2}$$

Where:

PD = Power density at the distance specified by the limit, in w/cm^2
$EIRP_{Linear}$ = Equivalent Isotropically Radiated Power, in watts.
d = Distance at which the power density limit is specified, in cm
$EIRP_{Linear} = (PD)(4\pi)(d^2)$
$EIRP_{Linear} = (90x10^{-12})(4\pi)(300^2)$
$EIRP_{Linear} = 0.10178\ mw \approx 85.31$ dBµV/m @ 3m

This limit was used from 40 GHz to 140 GHz. From 140 GHz to 220 GHz, the noise floor is less than 6 dB below the limit calculated at 3m. To compensate this problem, an extrapolation to a shorter distance was done. The new distance is 1 m and the new limit line is:

$$E_{SpecLimit} = E_{Meas} + 20\ Log\left(\frac{d_{Meas}}{d_{SpecLimit}}\right)$$

$$E_{SpecLimit} = 85.31 + 20\ Log\left(\frac{3}{1}\right) \approx 94.85\ dB\mu v/m\ @\ 1\ m$$

7.3.4 Setup details

Receiver/spectrum analyzer settings for frequencies below 1 GHz:

Resolution bandwidth	120 kHz
Detector mode	Peak (Preview measurement) Quasi-peak (Final measurement)
Trace mode	Max Hold

Receiver/spectrum analyzer settings for frequencies from 1 GHz to 40 GHz:

Resolution bandwidth	1 MHz
Detector mode	Peak and Average
Trace mode	Max Hold

Receiver/spectrum analyzer settings for frequencies above 40 GHz:

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

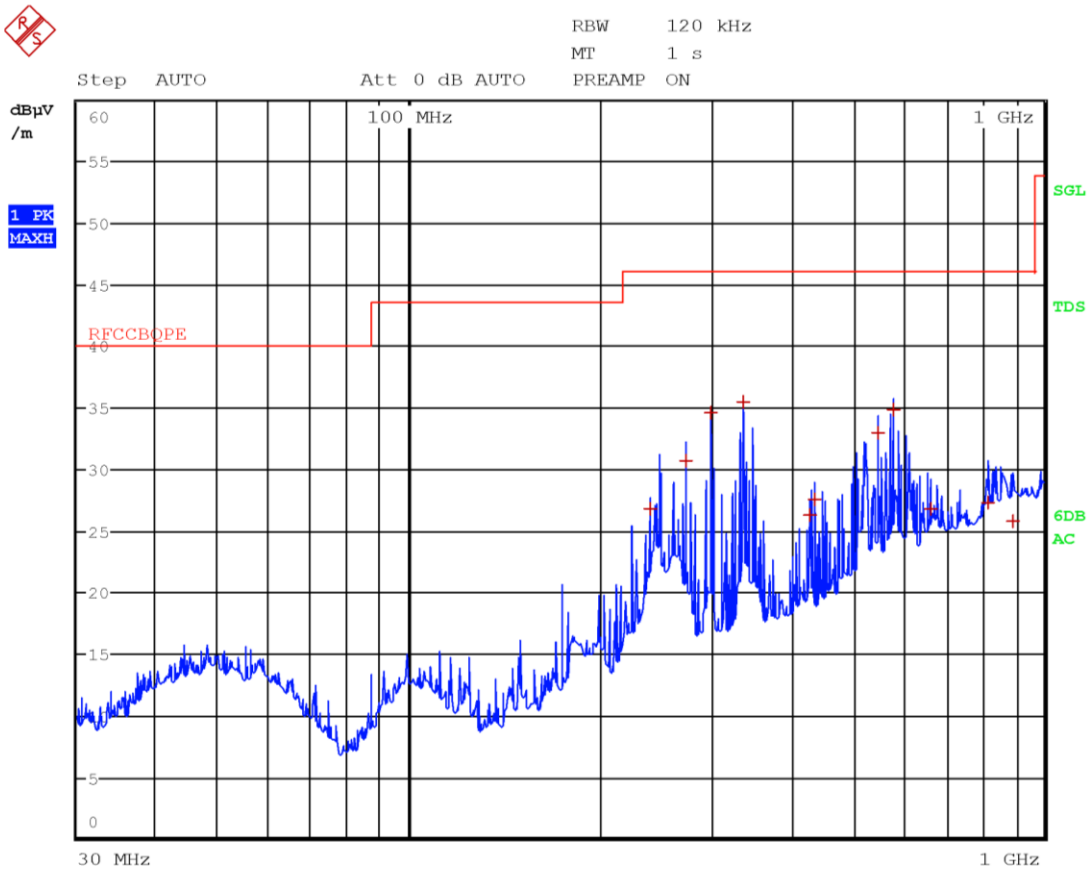
7.3.5 Test equipment used

Table 7.3-1: *Test equipment used*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Receiver	Rohde & Schwarz	ESW44	101620	2023-09	2024-09
Antenna Trilog 25-2000 MHz	Schwarzbeck	VULB9168	9168-242	2021-06	2024-06
Antenna 1 - 18 GHz	Schwarzbeck	STLP9148	STLP 9148-152	2021-09	2024-09
Double Ridge Horn Antenna	RFSpin	DRH40	061106A40	2023-05	2026-05
Pyramidal Horn Antenna 40-60 GHz	Sage	SAR-2507-19VF-R2	15715-01	2021-06	2024-06
Pyramidal Horn Antenna 60-90 GHz	Sage	SAR-2013-121F-E2	17383.01	2021-07	2024-07
Pyramidal Horn Antenna 90-140 GHz	Sage	SAZ-2410-08-S1	17383.01	NCR	NCR
Pyramidal Horn Antenna 140-220 GHz	Sage	SAZ-2410-05-S1	18490-01	NCR	NCR
Broadband Amplifier	Schwarzbeck	BBV9718C	00121	2023-03	2024-03
Broadband Bench Top Amplifier	Sage	STB-1834034030-KFKF-L1	18490-01	2023-05	2024-05
Harmonic Mixer	Radiometer Physics	FS-Z60	100988	2021-01	2024-01
Harmonic Mixer	Radiometer Physics	FS-Z90	101670	2021-01	2024-01
Harmonic Mixer	Radiometer Physics	FS-Z140	101138	2019-04	2024-04
Harmonic Mixer	Radiometer Physics	FS-Z220	101034	2019-11	2024-11
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
3m Semi anechoic chamber	Comtest	SAC-3	1711-150	2022-09	2024-09

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

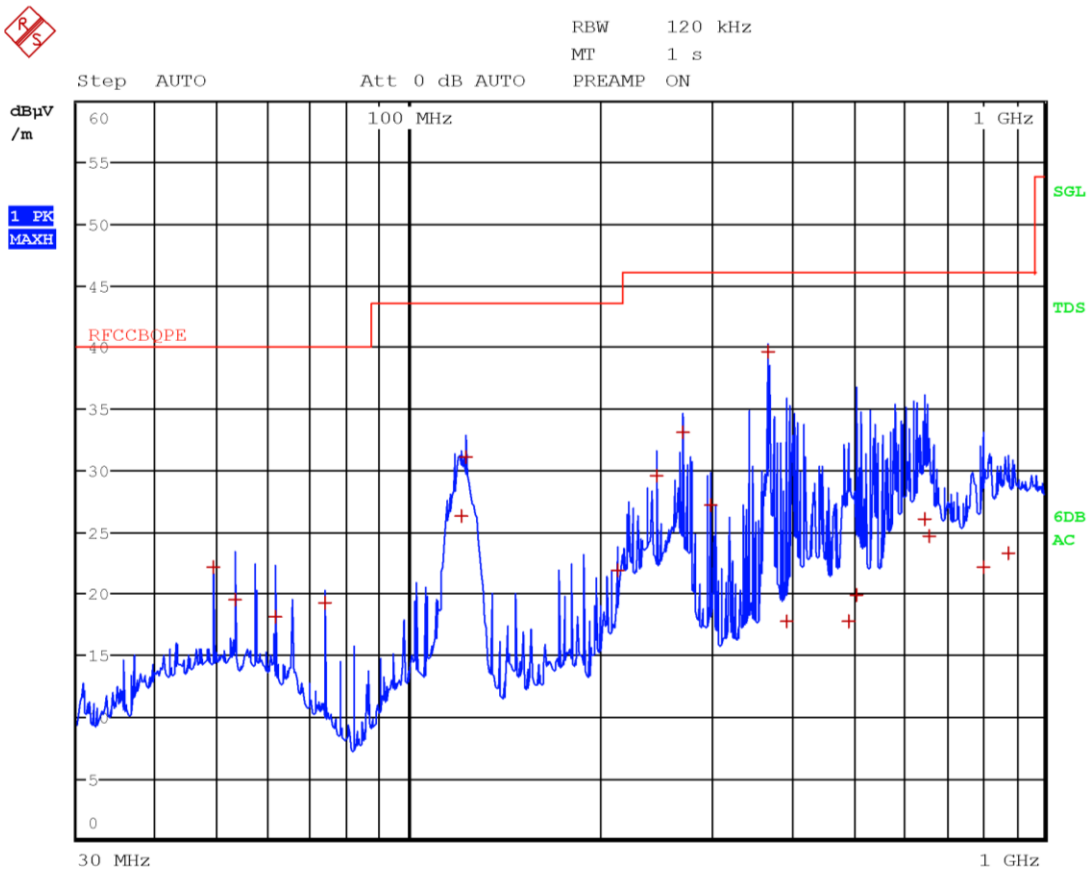
7.3.6 Test data



Range 30 to 1000 MHz with antenna in horizontal polarization

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
240.5200	26.8	46.0	-19.2	QP
273.6800	30.7	46.0	-15.3	QP
298.5600	34.7	46.0	-11.3	QP
335.8800	35.6	46.0	-10.4	QP
427.1200	26.4	46.0	-19.6	QP
435.4000	27.6	46.0	-18.4	QP
547.3600	33.0	46.0	-13.0	QP
580.5200	34.9	46.0	-11.1	QP
663.4800	26.8	46.0	-19.2	QP
816.8800	27.4	46.0	-18.6	QP
891.4800	25.8	46.0	-20.2	QP

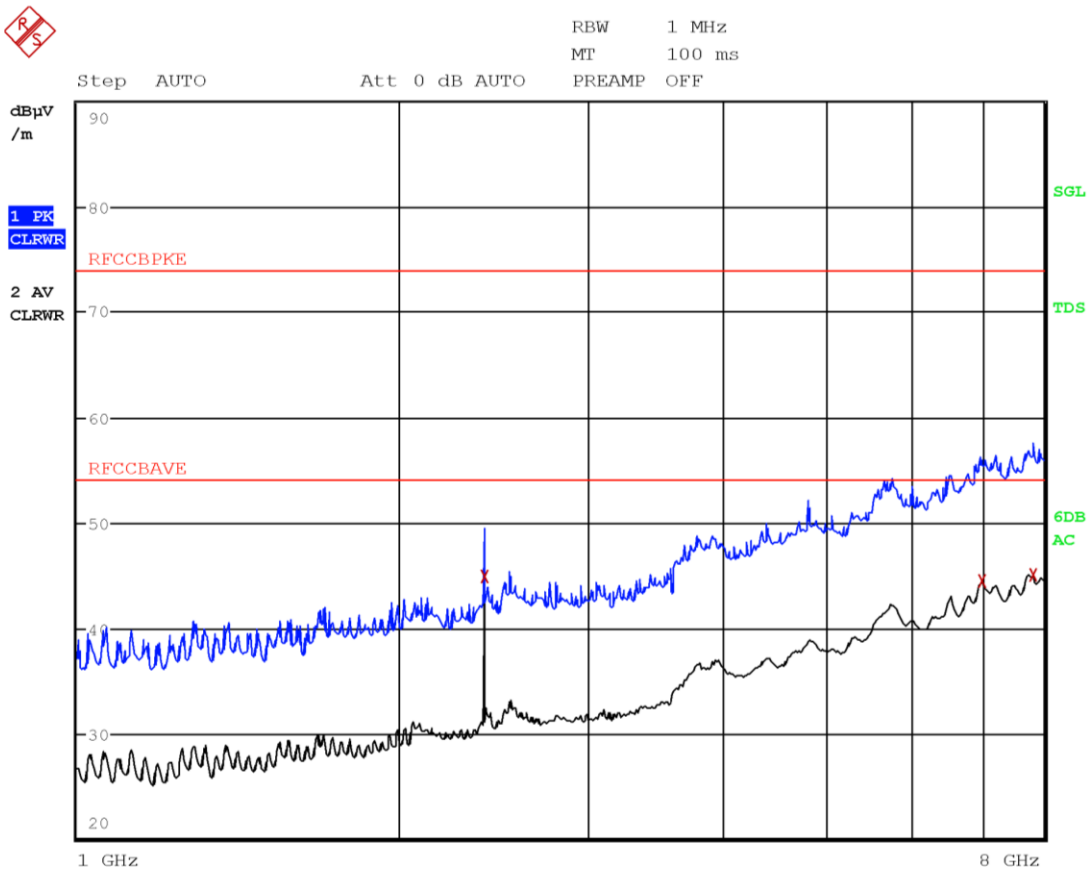
Test data, continued



Range 30 to 1000 MHz with antenna in horizontal polarization

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
49.1600	22.2	40.0	-17.8	QP
53.2800	19.6	40.0	-20.4	QP
61.4800	18.1	40.0	-21.9	QP
73.7200	19.3	40.0	-20.7	QP
120.9200	26.3	43.5	-17.2	QP
122.8800	31.1	43.5	-12.4	QP
212.9600	21.9	43.5	-21.6	QP
245.7600	29.6	46.0	-16.4	QP
270.3200	33.2	46.0	-12.8	QP
299.0000	27.2	46.0	-18.8	QP
368.6000	39.7	46.0	-6.3	QP
393.2400	17.8	46.0	-28.2	QP
491.4800	17.8	46.0	-28.2	QP
507.7600	19.9	46.0	-26.1	QP
647.0800	26.1	46.0	-19.9	QP
659.2800	24.7	46.0	-21.3	QP
802.7600	22.2	46.0	-23.8	QP
876.5600	23.2	46.0	-22.8	QP

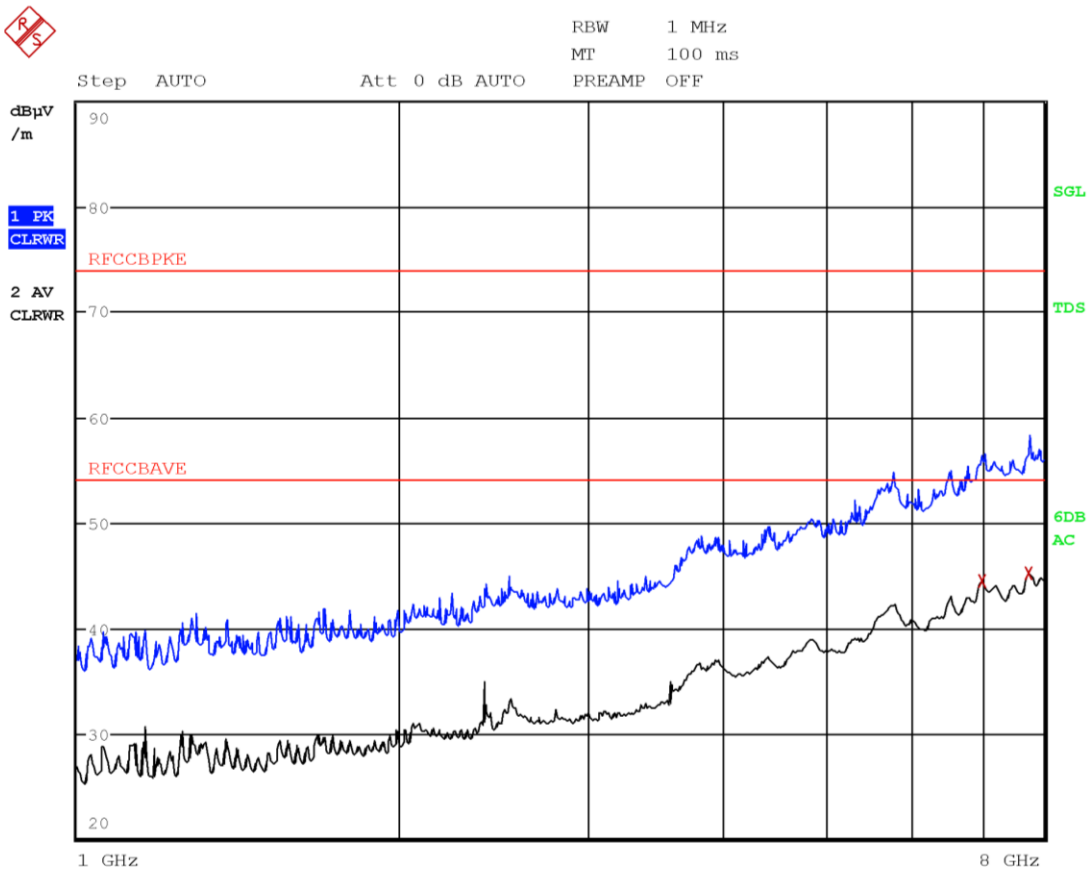
Test data, continued



Range 1 to 8 GHz with antenna in horizontal polarization

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
2400.0000	44.9	54.0	-9.1	Av
6991.6000	44.5	54.0	-9.5	Av
7826.8000	45.1	54.0	-8.9	Av

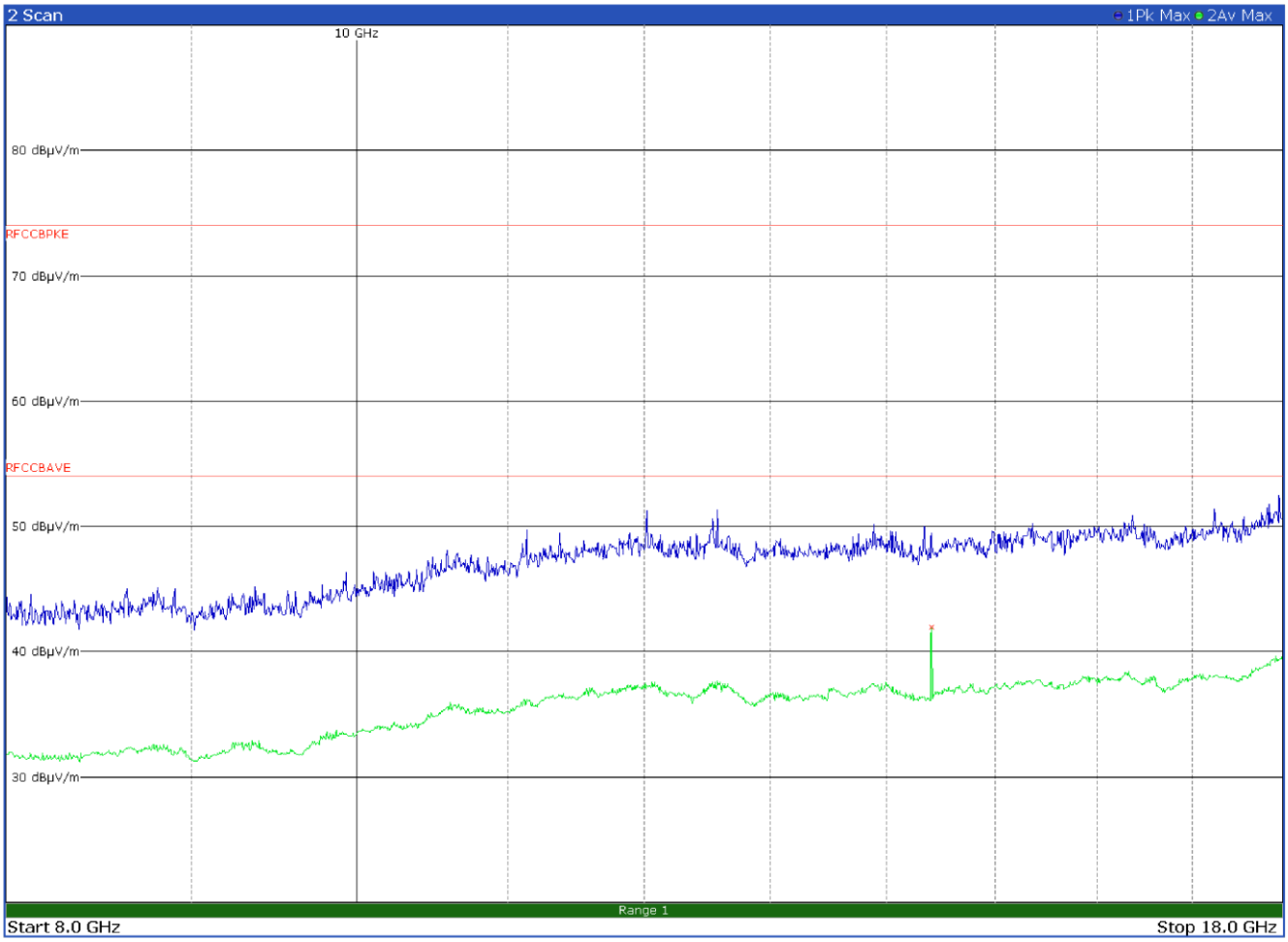
Test data, continued



Range 1 to 8 GHz with antenna in horizontal polarization

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
6999.6000	44.5	54.0	-9.5	Av
7734.4000	45.2	54.0	-8.8	Av

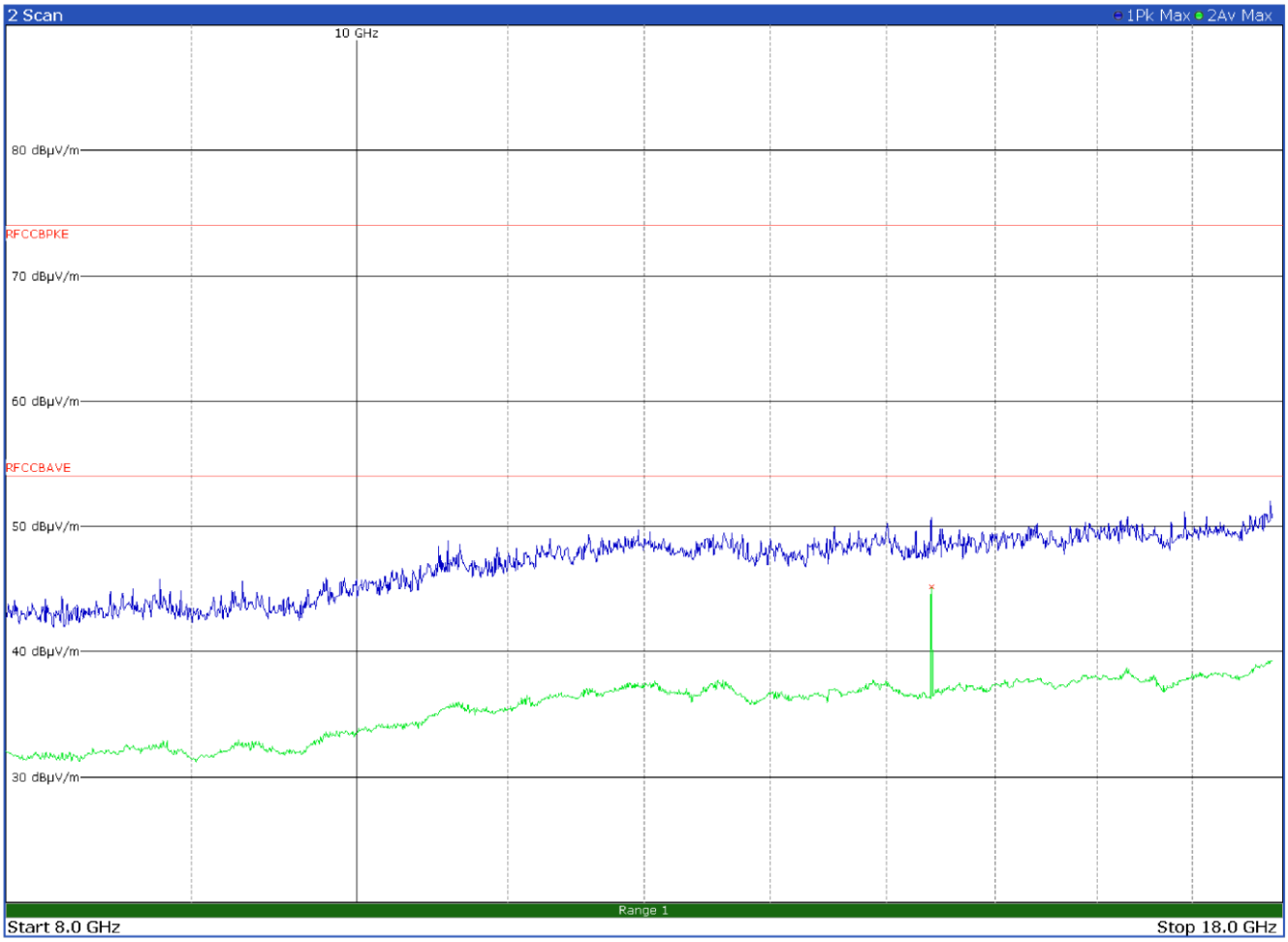
Test data, continued



Range 8 to 18 GHz with antenna in horizontal polarization

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
14400.0000	42.0	54.0	-12.0	Av

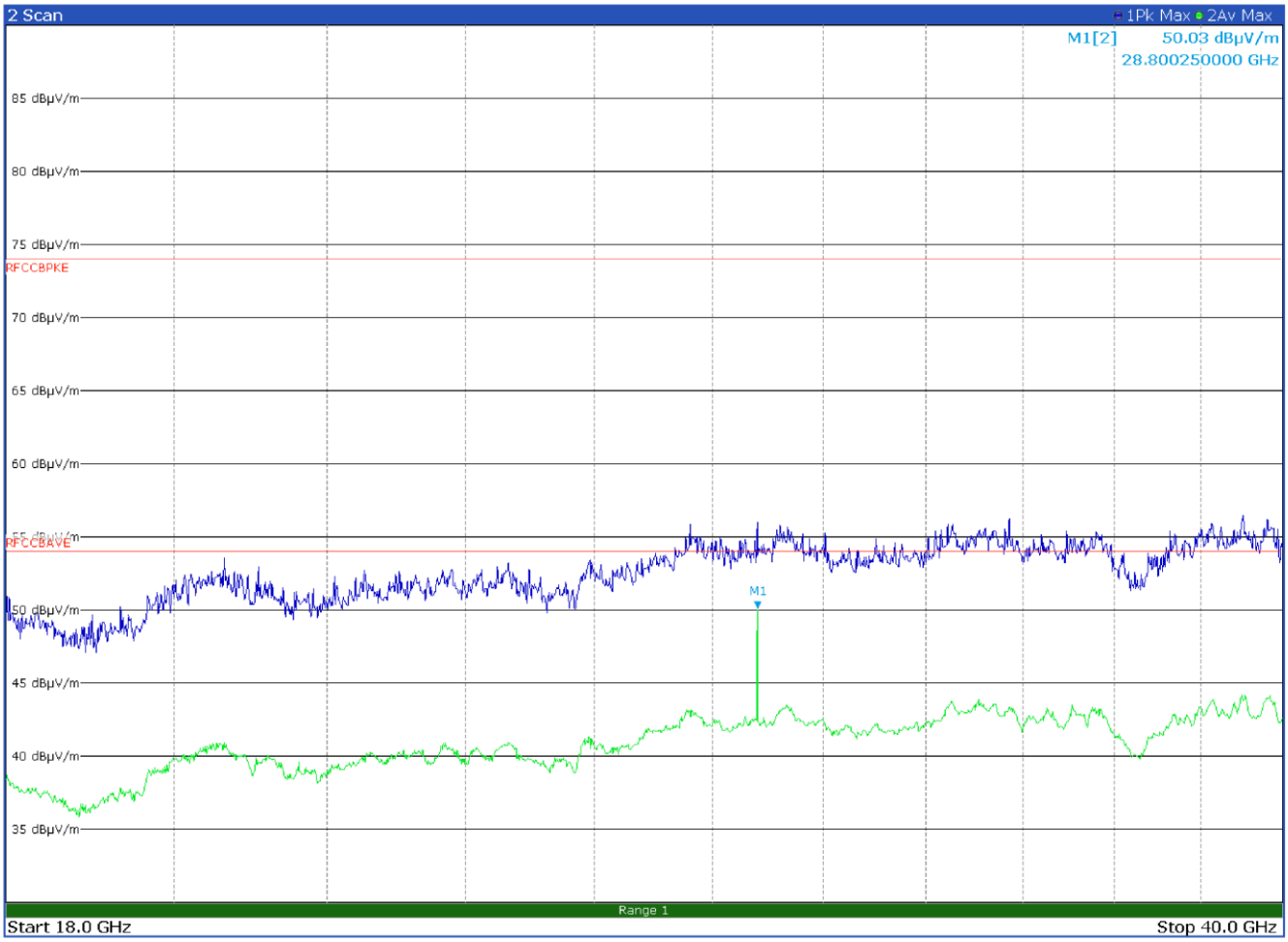
Test data, continued



Range 8 to 18 GHz with antenna in horizontal polarization

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
14400.0000	45.2	54.0	-8.8	Av

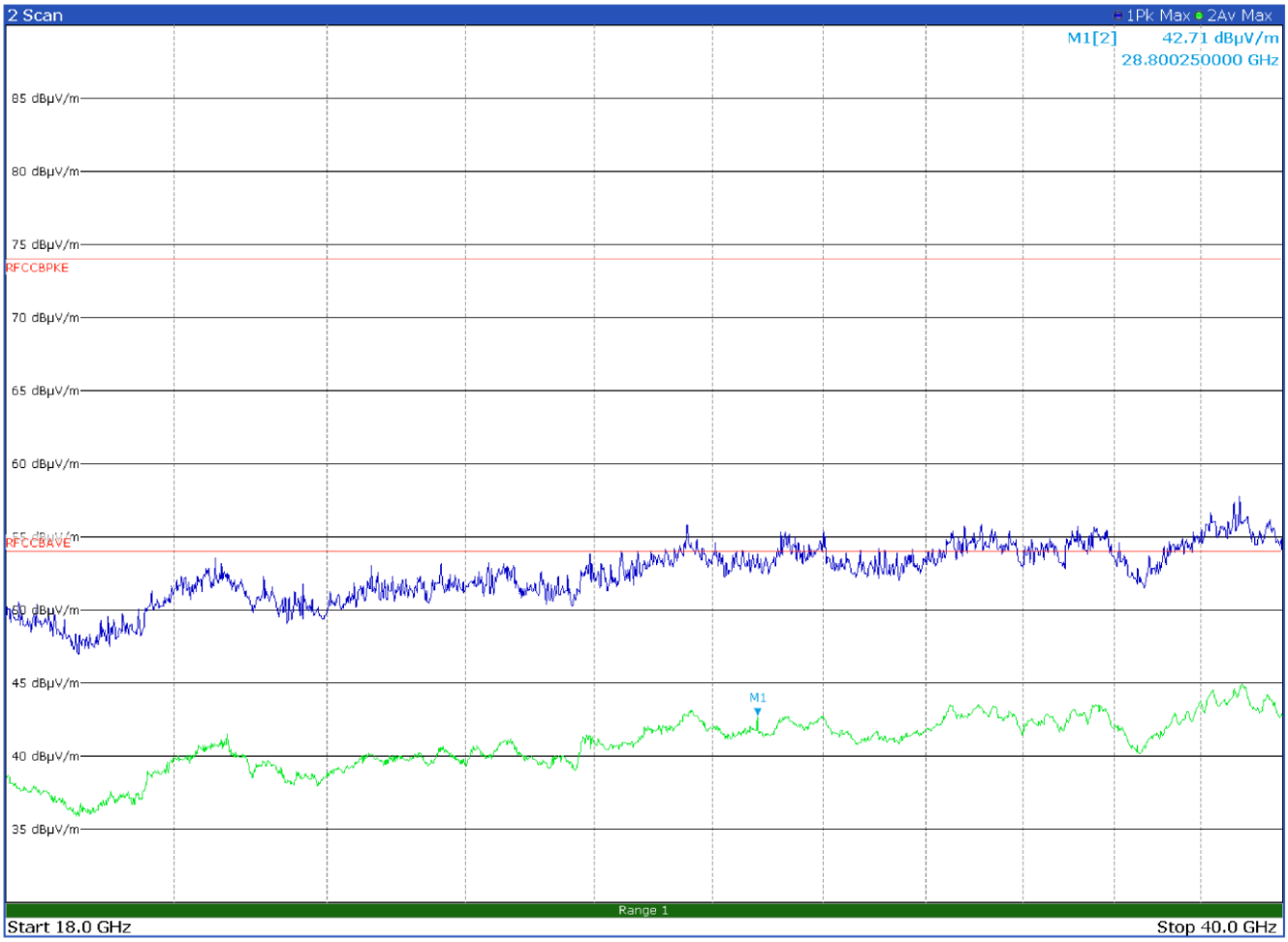
Test data, continued



Range 18 to 40 GHz with antenna in horizontal polarization

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
28800.2500	50.0	54.0	-4.0	Av

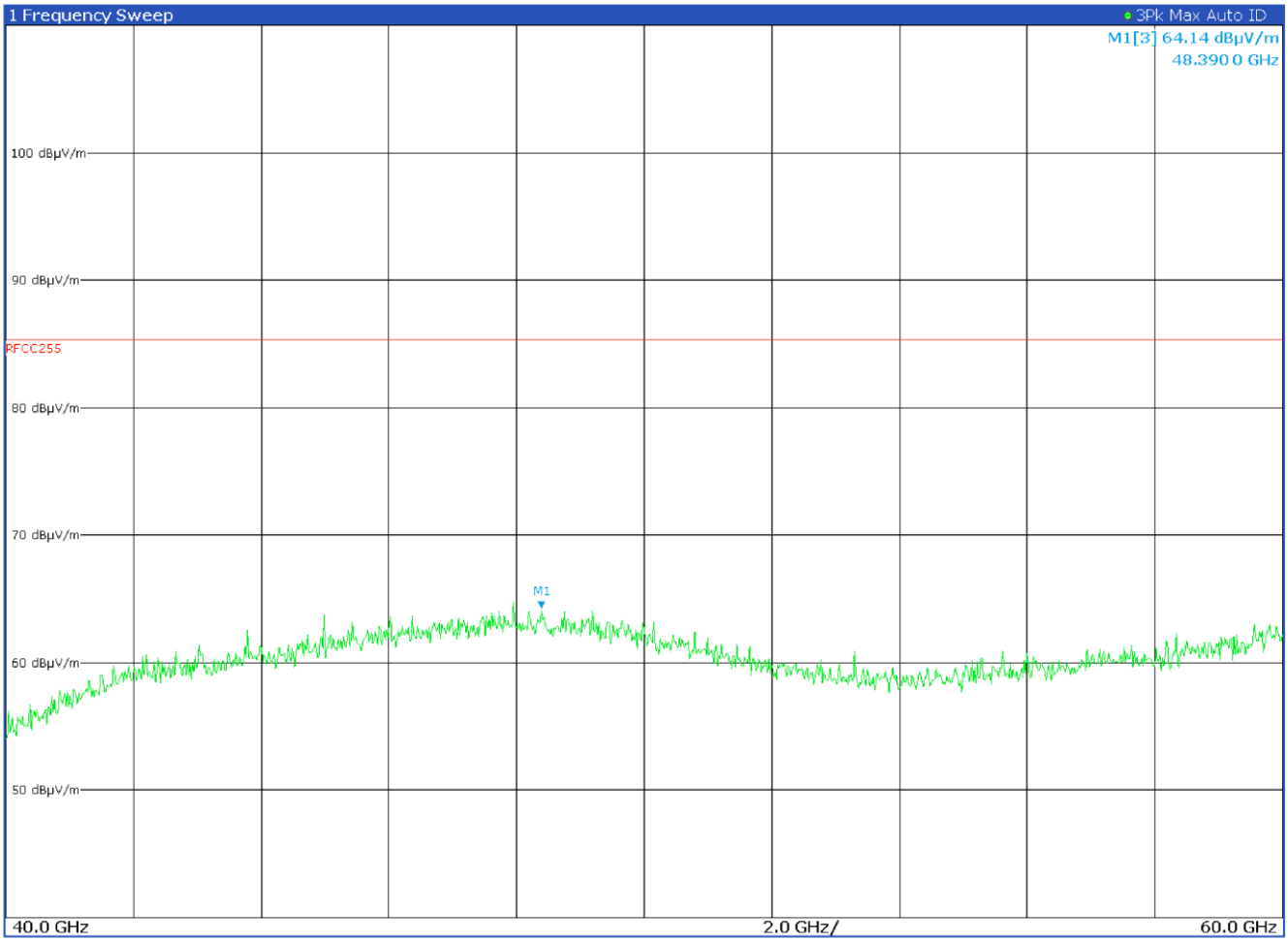
Test data, continued



Range 18 to 40 GHz with antenna in horizontal polarization

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
28800.2500	42.7	54.0	-11.3	Av

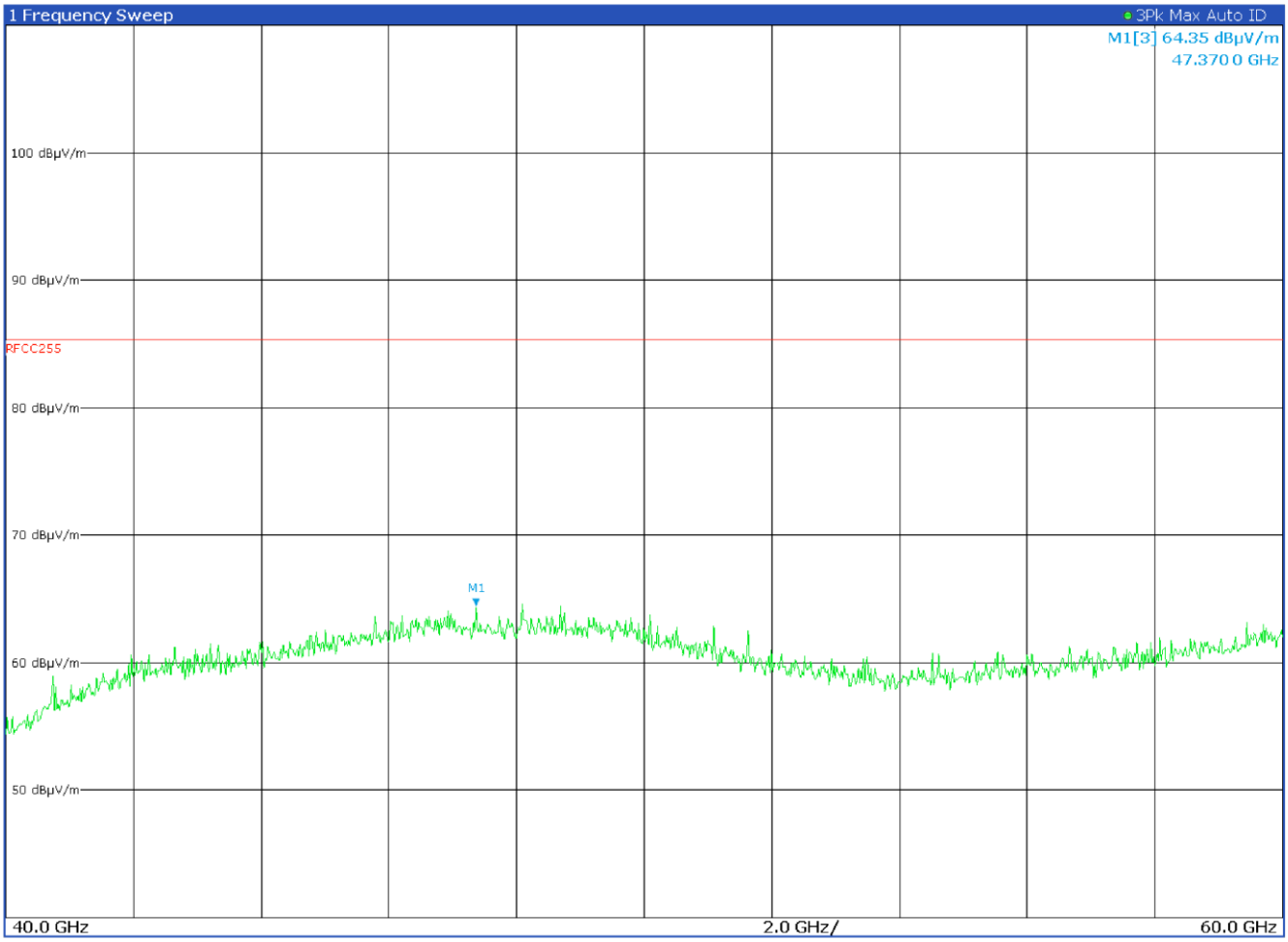
Test data, continued



Range 40 to 60 GHz with antenna in horizontal polarization

No spurious emission found

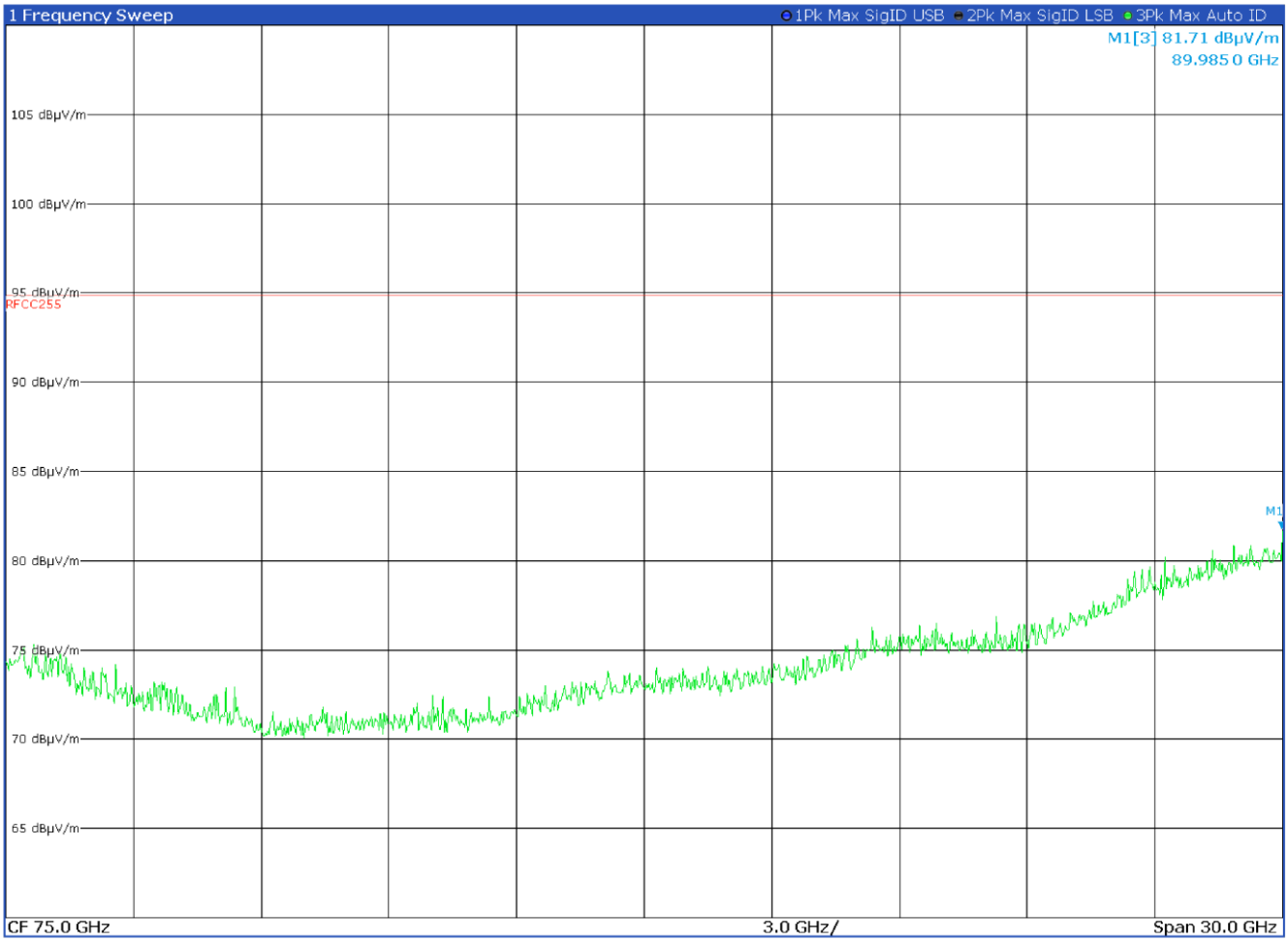
Test data, continued



Range 40 to 60 GHz with antenna in horizontal polarization

No spurious emission found

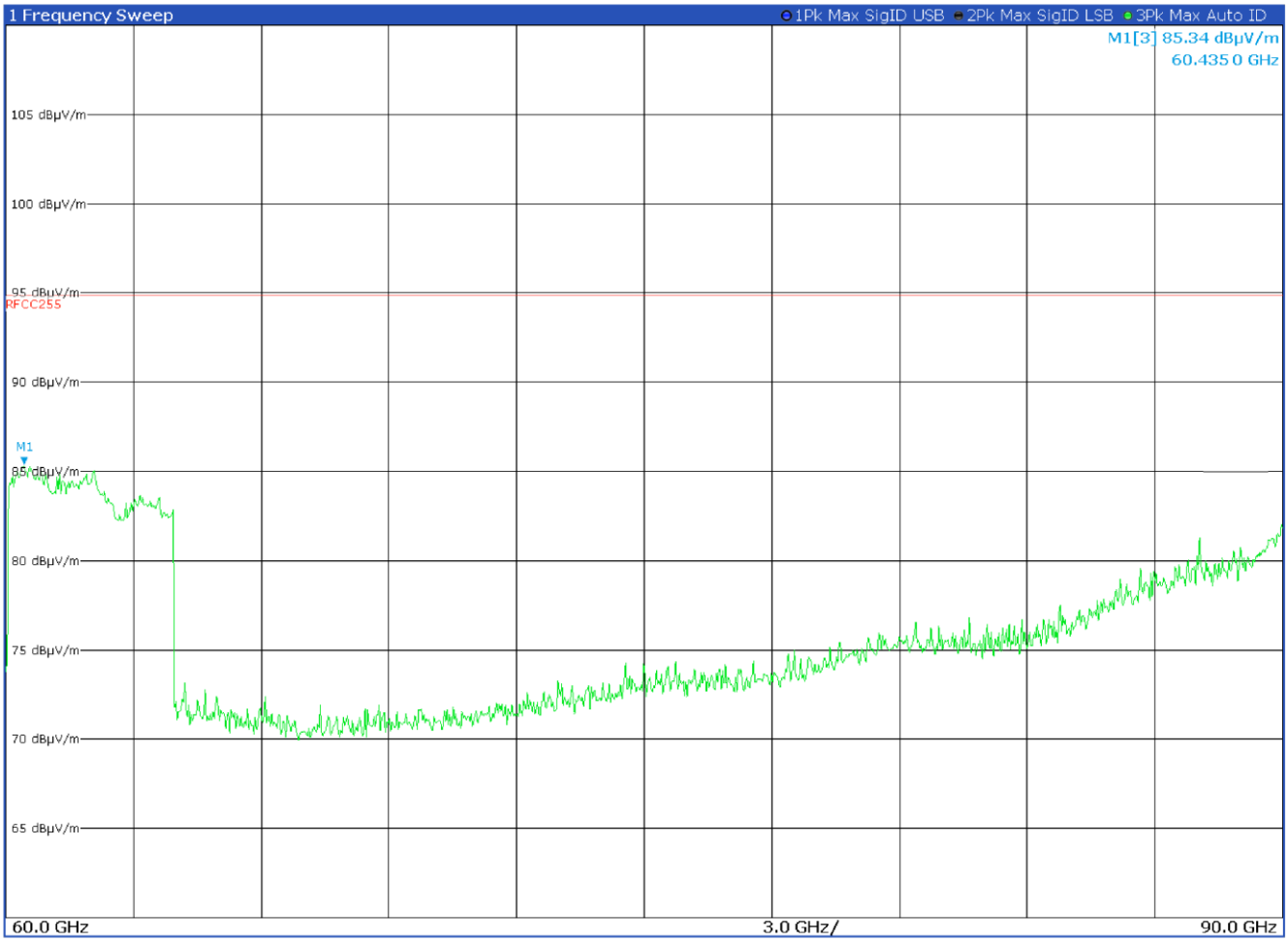
Test data, continued



Range 60 to 90 GHz with antenna in horizontal polarization

No spurious emission found

Test data, continued



Range 60 to 90 GHz with antenna in horizontal polarization

No spurious emission found

Test data, continued

Range 90 to 140 GHz with antenna in horizontal polarization

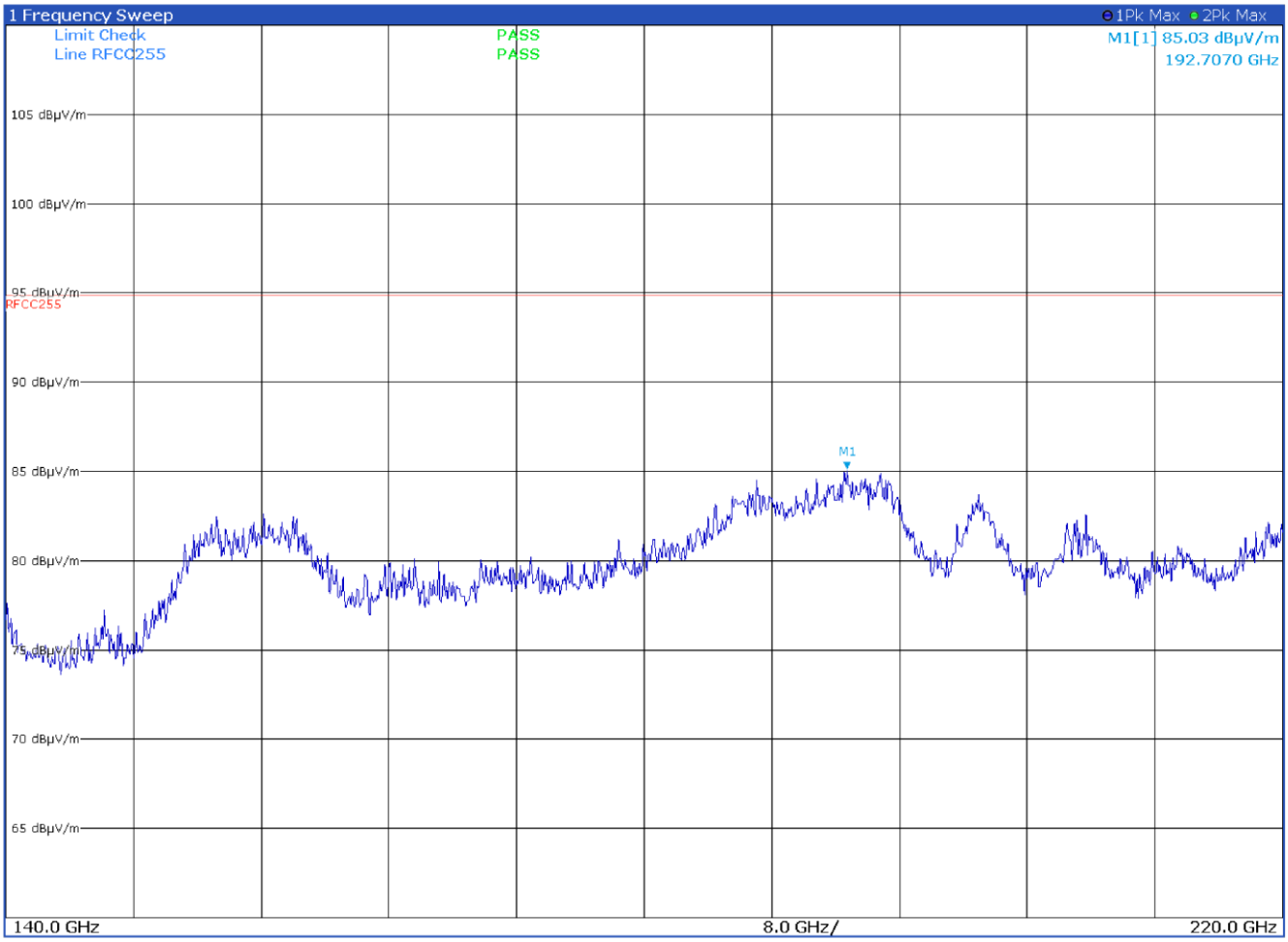
No spurious emission found

Test data, continued

Range 90 to 140 GHz with antenna in horizontal polarization

No spurious emission found

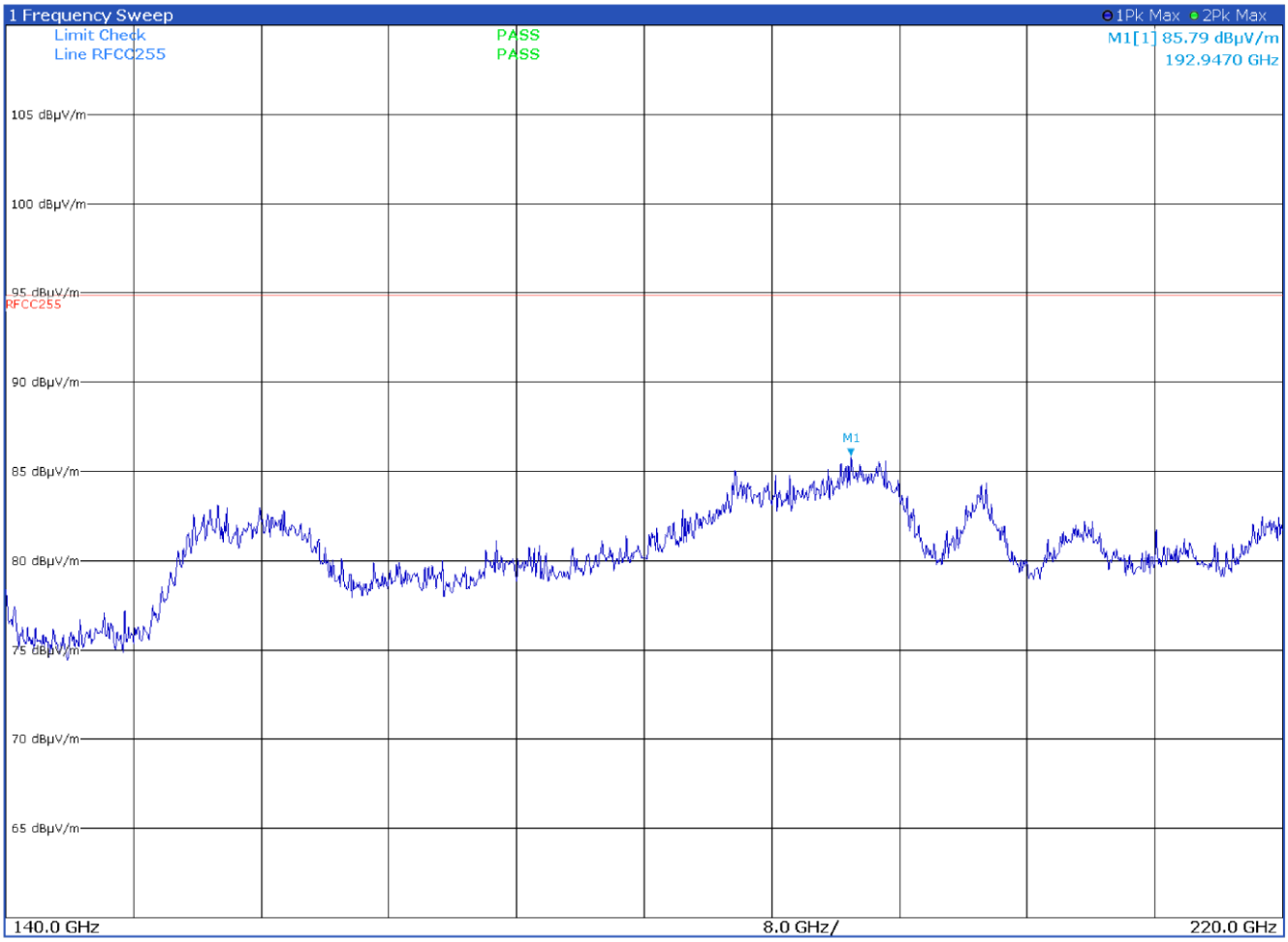
Test data, continued



Range 140 to 220 GHz with antenna in horizontal polarization

No spurious emission found

Test data, continued



Range 140 to 220 GHz with antenna in horizontal polarization

No spurious emission found

7.4 Frequency Stability

7.4.1 References

§ 15.255 (f)
Frequency stability.
Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to + 50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

7.4.2 Test summary

Verdict	Pass		
Test date	March 30, 2020	Temperature	26 °C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	999 mbar
Test location	Wireless Bench	Relative humidity	53 %

7.4.3 Notes

The test has been performed without modulation (CW mode)

7.4.4 Setup details

Receiver/spectrum analyzer settings for frequencies above 1 GHz:

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

7.4.5 Test equipment used

Table 7.4-1: *Frequency stability equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Receiver	Rohde & Schwarz	ESW44	101620	2023-09	2024-09
Harmonic Mixer	Radiometer Physics	FS-Z90	101670	2021-01	2024-01
Pyramidal Horn Antenna 60-90 GHz	Sage	SAR-2013-121F-E2	17383.01	2021-07	2024-07
Climatic Chamber	MSL	EC500DA	15022	2022-02	2024-02

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

7.4.6 Test data

Test conditions	Frequency, Hz	Frequency drift, Hz
+50 °C, Nominal	62000291545	-263.721
+40 °C, Nominal	62000354550	-200.716
+30 °C, Nominal	62000479321	-75.945
+20 °C, +15 %	62000555266	0
+20 °C, Nominal	62000555266	*Reference*
+20 °C, −15 %	62000555266	0
+10 °C, Nominal	62000742957	187.691
−0 °C, Nominal	62000793528	238.262
−10 °C, Nominal	62000834709	279.443
−20 °C, Nominal	62000953726	398.460

Note: frequency drift was calculated as follows:

Frequency drift (ppm) = $((F_{measured} - F_{reference}) \div F_{reference}) \times 1 \times 10^{6}$

This standard does not specify a ppm value as a limit. This table is just for reference and the only requirement by standard is the fundamental emission must to be inside to the band assigned.

7.5 AC Line conducted emissions

7.5.1 References

§ 15.207

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Table 7.5-1: Conducted emissions limit

Frequency of emission, MHz	Conducted limit, dBµV	
	Quasi-peak	Average**
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

Note: * - The level decreases linearly with the logarithm of the frequency.
** - A linear average detector is required.

7.5.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	October 3, 2023

7.5.3 Notes

None

7.5.4 Setup details

Receiver settings:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	– Peak and Average (Preview measurement) – Quasi-peak and Average (Final measurement)
Trace mode	Max Hold
Measurement time	– 10 ms (Peak and Average preview measurement) – 1000 ms (Quasi-peak final measurement) – 1000 ms (CAverage final measurement)

7.5.5 Test equipment used

Table 7.5-2: *Frequency stability equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Receiver	Rohde & Schwarz	ESU8	100202	2023-09	2024-09
LISN	Rohde & Schwarz	ENV432	101714	2023-09	2024-09
Shielded room	Siemens	Conducted emission test room	1862	NCR	NCR

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

7.5.6 Test data

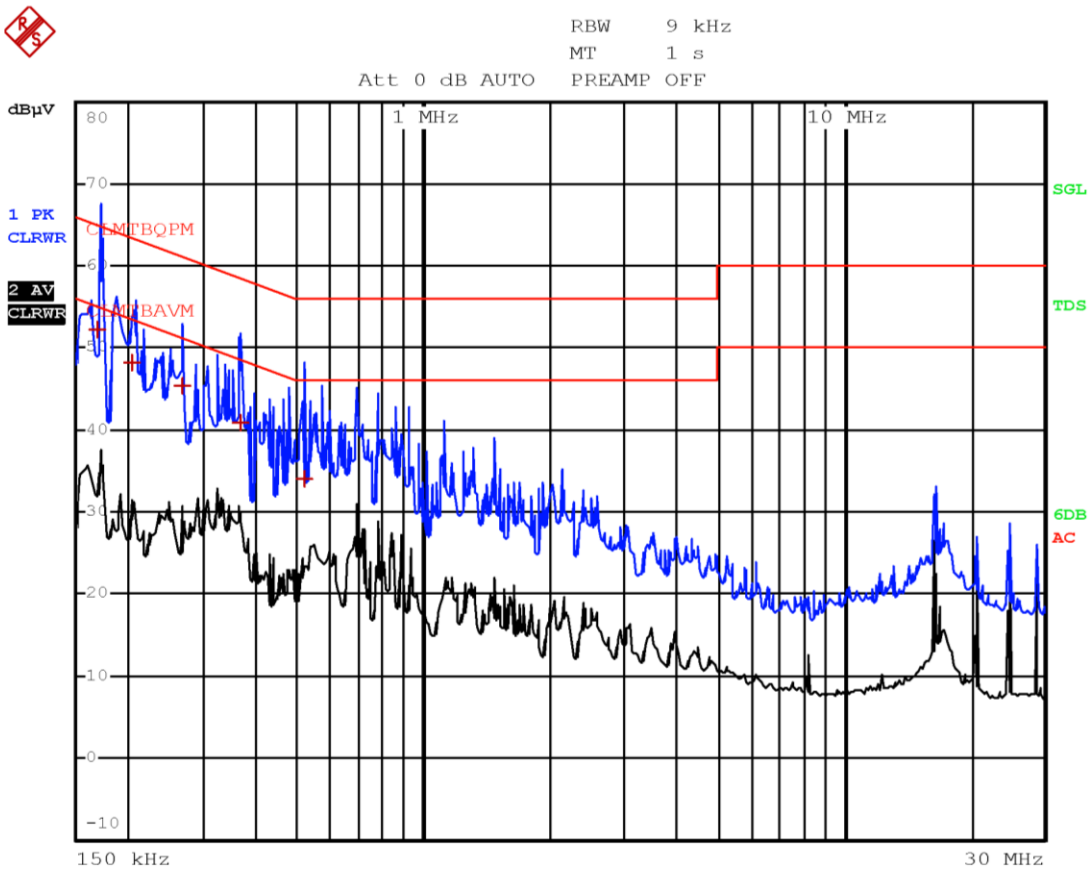


Figure 7.5-1: *Conducted disturbance at mains port spectral plot – phase line*

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.1700	52.2	65.0	-12.8	QP
0.2060	48.4	63.4	-15.0	QP
0.2660	45.5	61.2	-15.7	QP
0.3660	40.9	58.6	-17.7	QP
0.5180	34.0	56.0	-22.0	QP

Test data, continued

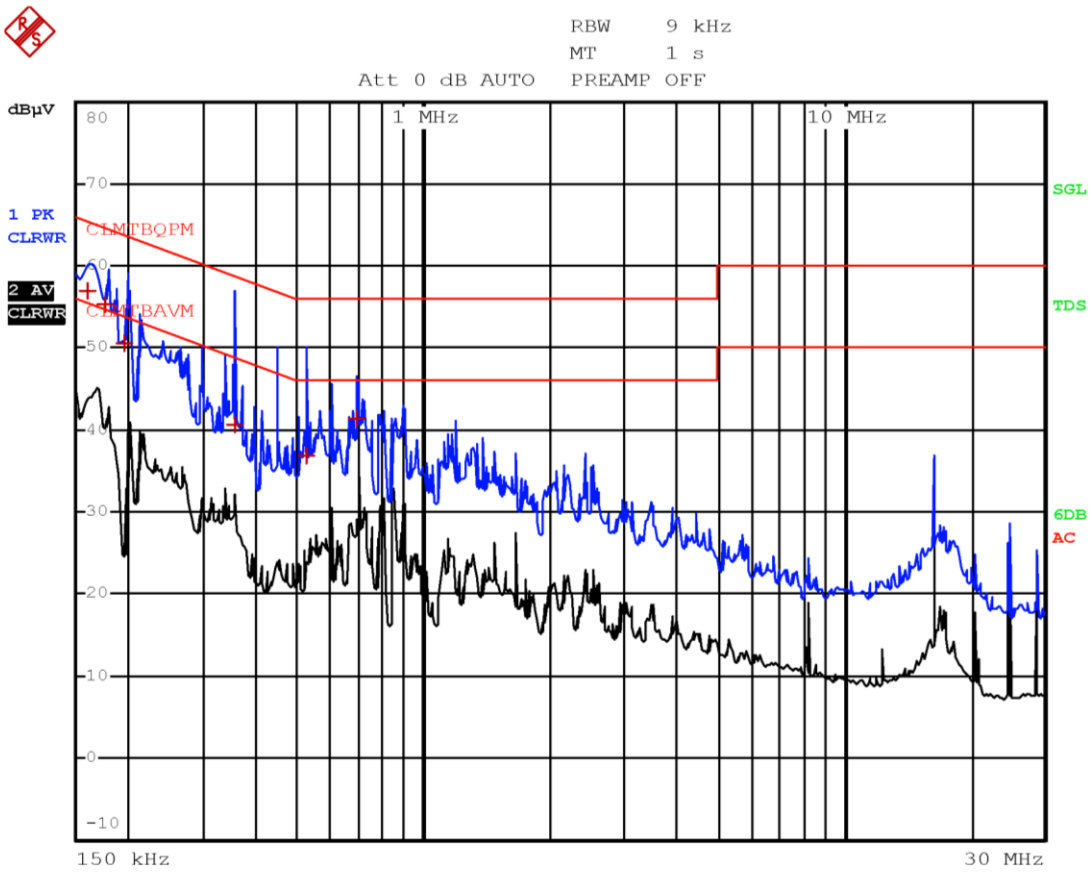
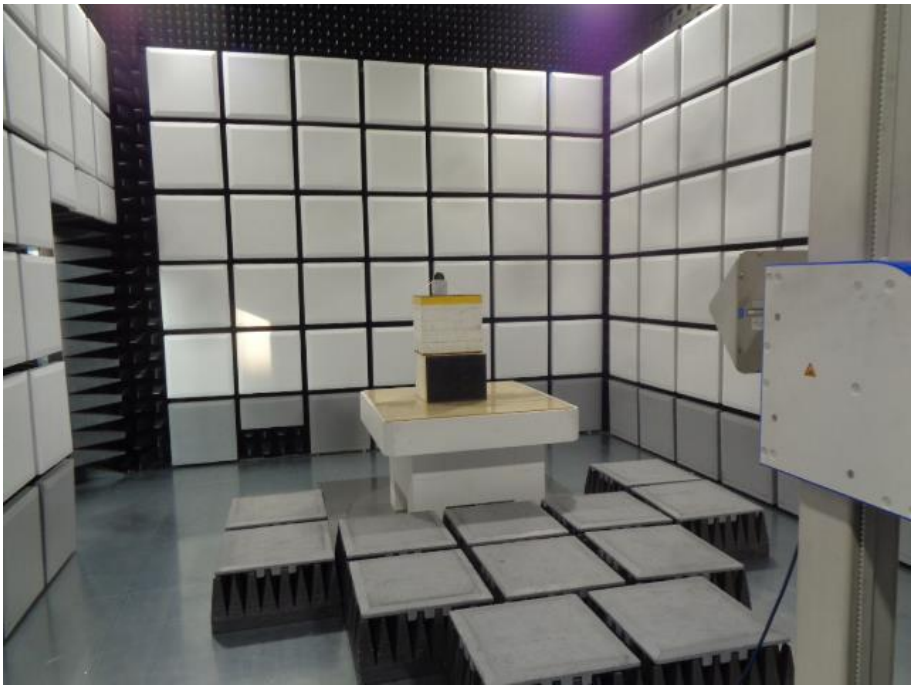


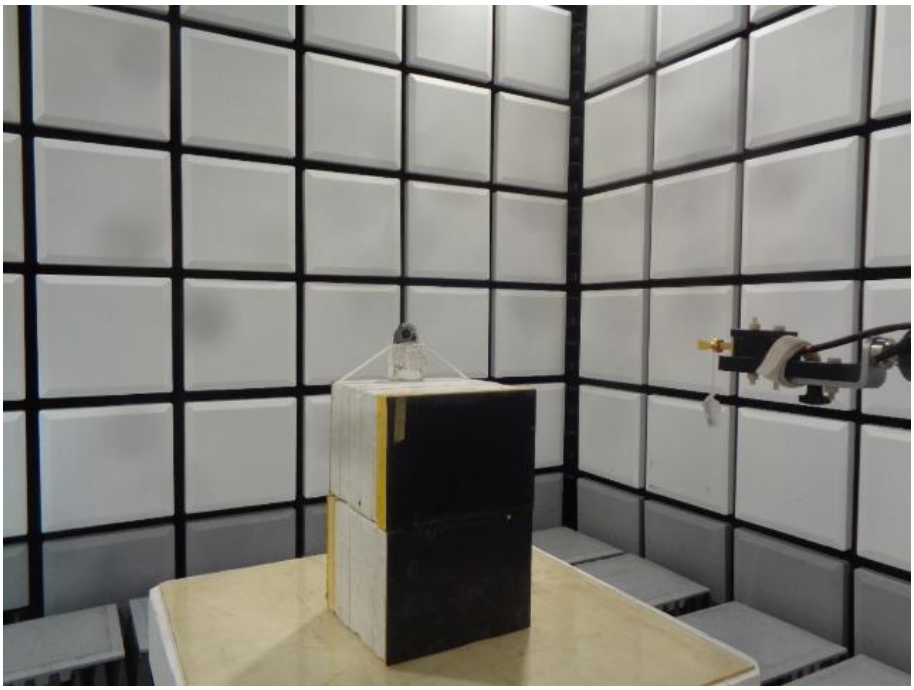
Figure 7.5-2: *Conducted disturbance at mains port spectral plot – neutral line*

Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Margin (dB)	Detector
0.1620	56.9	65.4	-8.5	QP
0.1780	55.5	64.6	-9.1	QP
0.1980	50.5	63.7	-13.2	QP
0.3540	40.8	58.9	-18.1	QP
0.5260	36.9	56.0	-19.1	QP
0.6940	41.5	56.0	-14.5	QP

Section 8 Photos

8.1 Set-up photos





8.2 EUT photos

End of report