



EMI – TEST REPORT

- FCC Part 15.209 -

Type / Model Name : WT41u-E

Product Description : Bluetooth module

Applicant : MSC Technologies GmbH

Address : Ludwig-Erhard-Str. 10c

85375 NEUFAHRN; GERMANY

Manufacturer : Silicon Laboratories Finland Oy

Address : Alberga Business Park, Bertel Jungin aukio 3

ESPOO, 02600, FINLAND

Test Result according to the standards
listed in clause 1 test standards:

POSITIVE

Test Report No. : **T44711-00-00JP**

23. April 2019

Date of issue



Deutsche
Akkreditierungsstelle
D-PL-12030-01-01
D-PL-12030-01-02

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test results
without the written permission of the test laboratory.

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1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 15, Subpart A - General (September, 2018)

FCC Rules and Regulations Part 15, Subpart C - Intentional Radiators (September, 2018)

Part 15, Subpart C, Section 15.209	Radiated emission limits, general requirements
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ANSI C63.10: 2013	Testing Unlicensed Wireless Devices
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ETSI TR 100 028 V1.3.1: 2001-03,	Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the Measurement of Mobile Radio Equipment Characteristics—Part 1 and Part 2
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2 EQUIPMENT UNDER TEST

2.1 Photo documentation of the EUT – Detailed photos see ATTACHMENT A

2.2 Equipment type, category

Bluetooth device, portable equipment.

2.3 Short description of the equipment under test (EUT)

The EUT is a part 15C certificated Bluetooth V2.1 + EDR module with an U.FL antenna connector.

Items	Description
BT Chip set	WT41u-E
Modulation	FHSS (GFSK / $\pi/4$ -DQPSK / 8DPSK)
Frequency range	2402 MHz to 2480 MHz
Channel numbers	79
Data rate (Mbps)	1 (GFSK), 2 ($\pi/4$ -DQPSK), 3 (8DPSK)
Bluetooth version	V2.1+EDR
Bluetooth conformance test	approved

Number of tested samples: 1
Serial number: none

EUT configuration:

(The CDF filled by the applicant can be viewed at the test laboratory.)

2.4 Variants of the EUT

There are no variants.

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2.5 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

Channel plan IEEE-Standard 802.15.1:

Channel	Frequency	Channel	Frequency	Channel	Frequency
1	2402	28	2429	55	2456
2	2403	29	2430	56	2457
3	2404	30	2431	57	2458
4	2405	31	2432	58	2459
5	2406	32	2433	59	2460
6	2407	33	2434	60	2461
7	2408	34	2435	61	2462
8	2409	35	2436	62	2463
9	2410	36	2437	63	2464
10	2411	37	2438	64	2465
11	2412	38	2439	65	2466
12	2413	39	2440	66	2467
13	2414	40	2441	67	2468
14	2415	41	2442	68	2469
15	2416	42	2443	69	2470
16	2417	43	2444	70	2471
17	2418	44	2445	71	2472
18	2419	45	2446	72	2473
19	2420	46	2447	73	2474
20	2421	47	2448	74	2475
21	2422	48	2449	75	2476
22	2423	49	2450	76	2477
23	2424	50	2451	77	2478
24	2425	51	2452	78	2479
25	2426	52	2453	79	2480
26	2427	53	2454		
27	2428	54	2455		

Note: the marked frequencies are determined for final testing.

2.6 Transmit operating modes

- synchronous mode (SCO or eSCO traffic, for HV, DV or DM packets) for transmitting voice or data,
- asynchronous mode (ACL traffic, for DM or DH packets) for transmitting data,
- mixed transfer mode (for voice and data,

The most important mode is the ACL mode at a data rate of 3 Mbps for the worst case.

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Packets:

A summary of the packets in ACL mode and their characteristics is shown in the following table:

Modulation types:

For the DH1 packet the pay load modulation GFSK, for 2-DH1 the modulation $\pi/4$ -DQPSK, for 3-DH1 the modulation 8DPSK is used. The packet 3-DH1 shows most of modulation side bands and means the worst case.

Type	Payload Header (bytes)	User Payload (bytes)	FEC	CRC	Symmetric Max. Rate (kb/s)	Asymmetric Max. Rate (kb/s)	
						Forward	Reverse
DM1	1	0 - 17	2/3	yes	108.8	108.8	108.8
DH1	1	0 - 27	no	yes	172.8	172.8	172.8
DM3	2	0 - 121	2/3	yes	258.1	387.2	54.4
DH3	2	0 - 183	no	yes	390.4	585.6	86.4
DM5	2	0 - 224	2/3	yes	286.7	477.8	36.3
DH5	2	0 - 339	no	yes	433.9	723.2	57.6
AUX1	1	0 - 29	no	no	185.6	185.6	185.6
2-DH1	2	0 - 54	no	yes	345.6	345.6	345.6
2-DH3	2	0 - 367	no	yes	782.9	1174.4	172.8
2-DH5	2	0 - 679	no	yes	869.1	1448.5	115.2
3-DH1	2	0 - 83	no	yes	531.2	531.2	531.2
3-DH3	2	0 - 552	no	yes	1177.6	1766.4	235.6
3-DH5	2	0 - 1021	no	yes	1306.9	2178.1	177.1

2.7 Antenna

The following antenna shall be used with the EUT:

Number	Characteristic	Certification name	Plug	f-range (GHz)	Gain (dBi)
1	SMD	WE-MCA (7488910245)	PCB-Soldered	2.4 - 2.5	3.0

2.8 Power supply system utilised

Power supply voltage, V_{nom} : 3.0 V – 3.6 V
Power supply voltage (alternative) : ---

2.9 Peripheral devices and interface cables

The following peripheral devices and interface cables are connected during the measurements:

- Cable harness Model : NT01 DV6 supply cable
- Motherboard Model : NT01 DV6 mainboard
- Laptop Model : Fujitsu Lifebook
- Power supply Model : 12 VDC battery

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2.10 Determination of worst case conditions for final measurement

Measurements are made in all three orthogonal axes and the settings of the EUT are changed to locate at which position and at what setting of the EUT produce the maximum of the emissions. For the further measurement the EUT is set in X position.

The tests are carried out in the following frequency band:

2400 MHz – 2483.5 MHz

Preliminary tests are performed to find the worst case mode from all possible combinations between available modulations and data rates. The output power is set to maximum.

For the final test the following channels and test modes are selected:

Packet type	Available channel	Tested channels	Power setting	Modulation	Modulation type	Data rate
DH1	1 to 79	1, 39, 79	max.	DSSS	GFSK	Mbps
2-DH1	1 to 79	1, 39, 79	max.	DSSS	$\pi/4$ -DQPSK	Mbps
3-DH1	1 to 79	1, 39, 79	max.	DSSS	8DPSK	Mbps

- TX mode, GFSK
- TX mode, $\pi/4$ -DQPSK
- TX mode, 8DPSK

2.10.1 Test jig

The module is inserted into the motherboard.

2.10.2 Test software

The test software for the EUT provides TX continuous mode, modulated. The EUT was set with test modulation to transmit data during the tests from an internal packet generator.

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3 TEST RESULT SUMMARY

Bluetooth device using frequency hopping:

Operating in the 2400 MHz – 2483.5 MHz band:

FCC Rule Part	Description	Result
15.209	Radiated emission limits; general requirements	passed

3.1 Final assessment

The equipment under test fulfills the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 12 April 2019

Testing concluded on : 16 April 2019

Checked by:

Tested by:



Klaus Gegenfurtner
2019.04.23 15:48:26
+02'00'

Klaus Gegenfurtner
Teamleader Radio



Juergen Pessinger
2019.04.23 15:43:08
+02'00'

Jürgen Pessinger
Radio Team

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4 TEST ENVIRONMENT

4.1 Address of the test laboratory

CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15-35 ° C

Humidity: 30-60 %

Atmospheric pressure: 86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor $k = 2$. The true value is located in the corresponding interval with a probability of 95 %. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Measurement Type	Range	Confidence Level	Calculated Uncertainty
AC power line conducted emissions	0.15 MHz to 30 MHz	95%	$\pm 3.29 \text{ dB}$
EBW and OBW	2400 MHz to 30000 MHz	95%	$\pm 2.5 \times 10^{-7}$
Output power ERP, radiated	1000 MHz to 7000 MHz	95%	$\pm 2.71 \text{ dB}$
Field strength of the fundamental	1000 MHz to 7000 MHz	95%	$\pm 2.71 \text{ dB}$
Power spectral density	2400 MHz to 3000 MHz	95%	$\pm 0.62 \text{ dB}$
Spurious Emissions, conducted	9 kHz to 10000 MHz	95%	$\pm 2.15 \text{ dB}$
Spurious Emissions, conducted	10000 MHz to 40000 MHz	95%	$\pm 3.47 \text{ dB}$
Spurious Emissions, radiated	9 kHz to 30 MHz	95%	$\pm 3.53 \text{ dB}$
Spurious Emissions, radiated	30 MHz to 1000 MHz	95%	$\pm 4.44 \text{ dB}$
Spurious Emissions, radiated	1000 MHz to 30000 MHz	95%	$\pm 2.34 \text{ dB}$
Spurious Emissions, radiated	30000 MHz to 40000 MHz	95%	$\pm 5.13 \text{ dB}$

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4.4 Measurement protocol for FCC and ISED

4.4.1 General information

CSA Group Bayern GmbH is recognized as wireless testing laboratory under the CAB identifier:

FCC: DE 0011

ISED: DE0009

4.4.2 General Standard information

The test methods used comply with ANSI C63.10 - "Testing Unlicensed Wireless Devices".

4.4.2.1 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.4.2.2 Radiated emission (electrical field 30 MHz - 1 GHz)

Spurious emissions from the EUT are measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is established in accordance with ANSI C63.10. The interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so that they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. The antenna is positioned 3, 10 or 30 metres horizontally from the EUT and is repeated vertically. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees. The final level in dBμV/m is calculated by taking the reading from the EMI receiver (Level dBμV) and adding the correction factors and cable loss factor (dB). The FCC or CISPR limit is subtracted from this result in order to provide the limit margin listed in the measurement protocol.

The resolution bandwidth setting:

30 MHz – 1000 MHz: RBW: 120 kHz

Example:

Frequency Delta (MHz)	Level (dBμV)	+	Factor (dB)	=	Level (dBμV/m)	-	CISPR Limit (dBμV/m)	=	(dB)
719.0	75.0	+	32.6	=	107.6	-	110.0	=	-2.4

FCC ID: QOQWT41U**4.4.2.3 Radiated emission (electrical field 1 GHz - 40 GHz)**

Radiated emissions from the EUT are measured in the frequency range 1 GHz up to the maximum frequency as specified in 47 CFR Part 15, Subpart A, Section 15.33, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a 1.0 X 1.5 metre non-conducting table, 1.5 metre above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The setup of the equipment under test is following set out in ANSI C63.10. The interface cables that are closer than 40 centimetres to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screened room located outside the test area. Measurements are made in both the horizontal and vertical polarization planes in a fully anechoic room using a spectrum analyzer set to max peak detector function and a resolution 1 MHz and video bandwidth 3 MHz for peak measurement. The conditions determined as worst case will then be used for the final measurements. When the EUT is larger than the beam width of the measuring antenna it will be moved over the surface for the four sides of the equipment. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty and are calculated at the specified test distance.

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5 TEST CONDITIONS AND RESULTS

5.1 Radiated emission < 1 GHz (electric field)

For test instruments and accessories used see section 6 Part SER 2.

Legend for tables:

Level vert. QuasiPeak reading including correction factor for vertically polarised antenna
 Level hor. QuasiPeak reading including correction factor for horizontally polarised antenna
 Limit Limit referred to the appropriate standard
 DLimit... Delta between limit and result (margin)
 Noise Characteristic of disturbance (narrowband or broadband)

5.1.1 Description of the test location

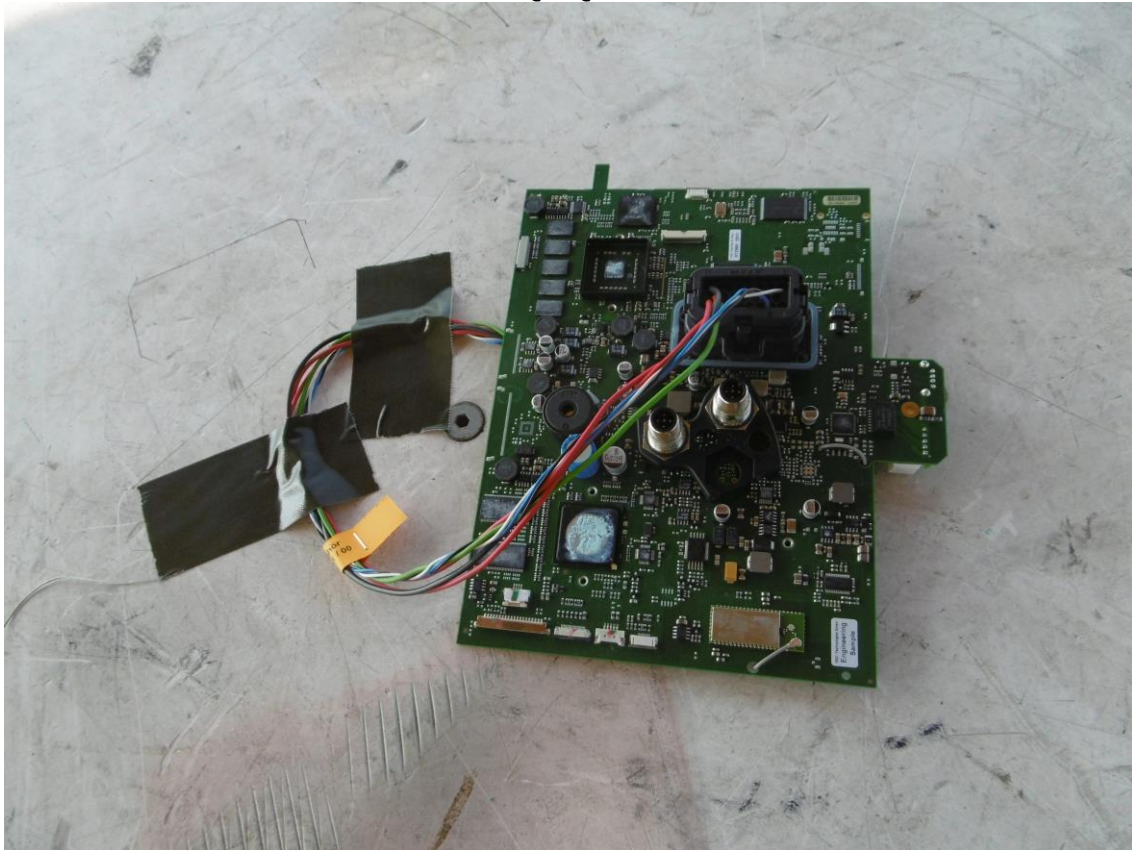
Test location: OATS 1

Test distance: 3 metres

5.1.2 Photo documentation of the test setup



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5.1.3 Test result

Frequency range: 30 MHz - 1000 MHz

Min. limit margin by 7.1 dB at 65.90 MHz

The requirements are **FULFILLED**.

Remarks: For detailed results, please see the following page(s).

For description of the measurement see 4.6.4.

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5.1.4 Test protocol

Operation mode: continuous Tx CH1 DH1
 Remarks: none
 Date: 16.04.2019
 Tested by: Franz-Xaver Schrettenbrunner

Result: passed

Frequency (MHz)	Reading Vert. (dBµV)	Reading Hor. (dBµV)	Correct. Vert. (dB)	Correct. Hor. (dB)	Level Vert. (dBµV/m)	Level Hor. (dBµV/m)	Limit (dBµV/m)	Dlimit (dB)
45.06	3.1	5.8	15.2	14.0	18.3	19.8	40.0	-20.2
65.90	18.6	6.7	14.3	13.5	32.9	20.2	40.0	-7.1
153.00	-1.6	0.2	14.1	14.9	12.5	15.1	43.5	-28.4
283.00	1.6	10.5	15.8	15.6	17.4	26.1	46.0	-19.9
538.00	1.4	5.6	23.6	23.4	25.0	29.0	46.0	-17.0
663.10	-0.3	-2.4	26.4	26.0	26.1	23.6	46.0	-19.9

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5.2 Radiated emission > 1 GHz (electric field)

For test instruments and accessories used see section 6 Part SER 3.

5.2.1 Description of the test location

Test location: Anechoic Chamber A1

Test distance: 3 metres for 1 GHz – 18 GHz
1 metres for 18 GHz – 26 GHz

ETS Lindgren 3117:

Dimension of the line tangent to the EUT according to CISPR 16-2-3:2010

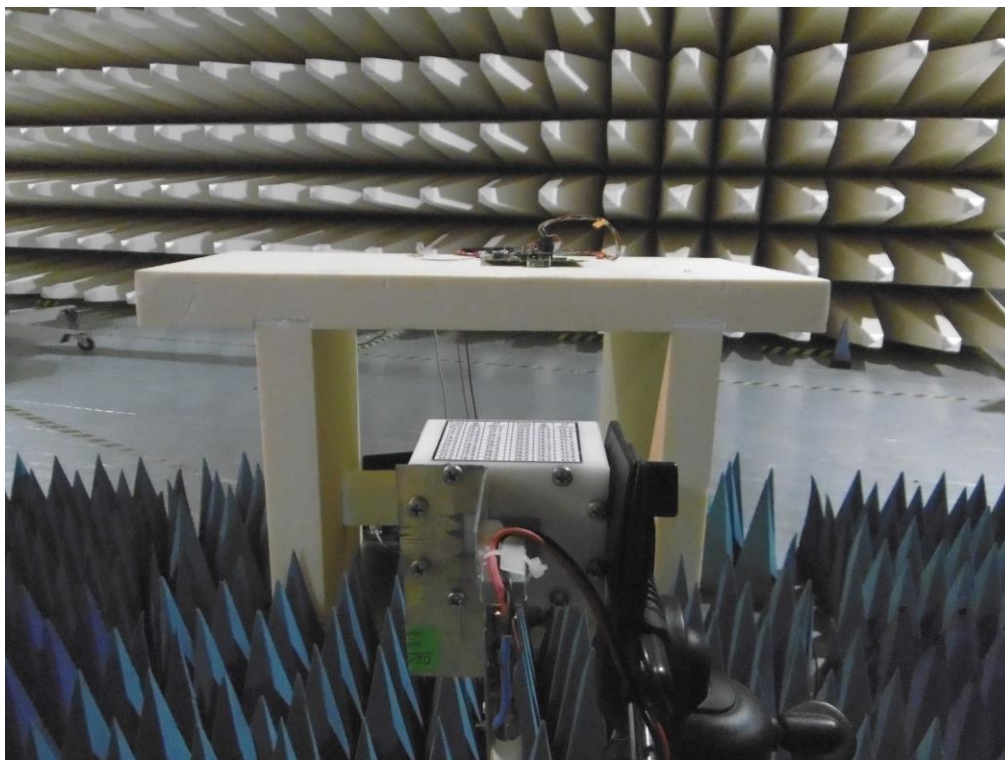
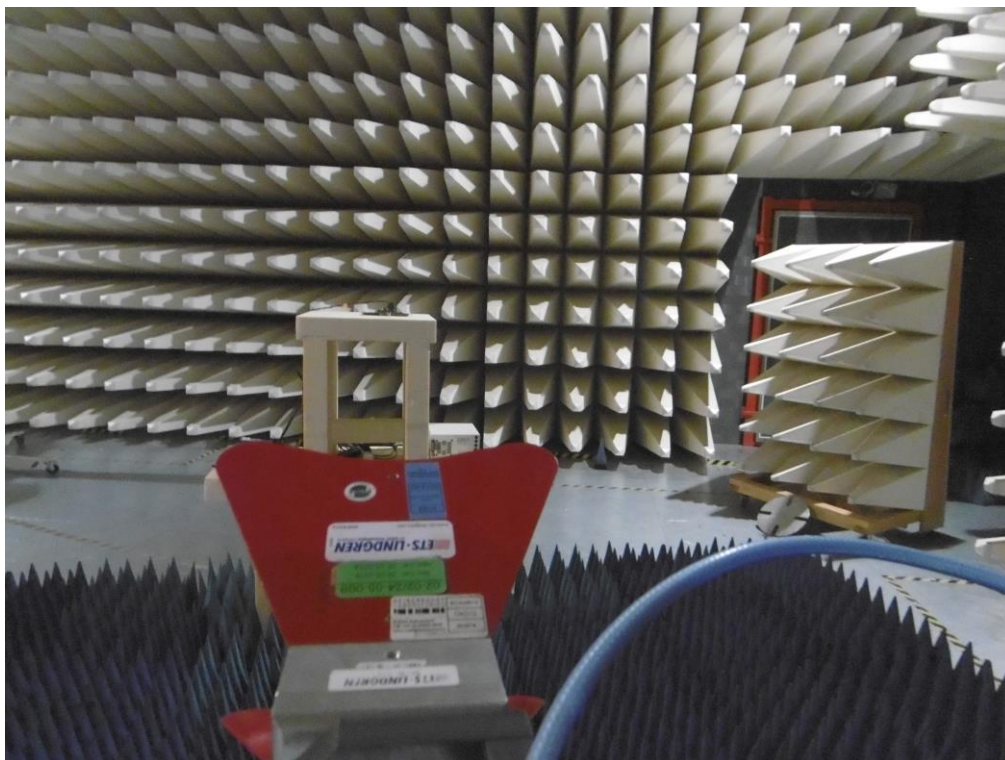
Note: The $\ominus$ 3dB min values were given by the antenna manufacturer

Frequenz GHz	$\ominus$ 3dB min	Measurement distance	w min
1	88	3 m	5.79 m
2	67	3 m	3.97 m
4	69	3 m	4.12 m
6	53	3 m	2.99 m
10	40	3 m	2.18 m
18	36	3 m	1.95 m

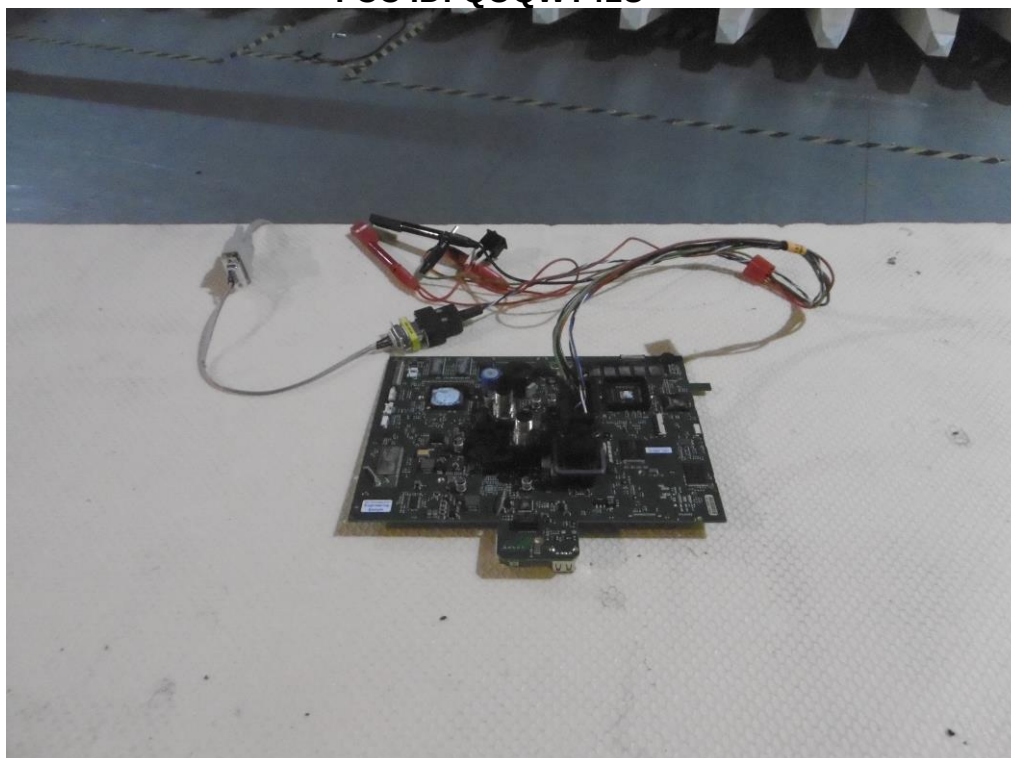
Frequenz GHz	$\ominus$ 3dB min	Measurement distance	w min
18	18.0	1 m	0.32 m
20	17.0	1 m	0.30 m
25	14.5	1 m	0.25 m
30	13.0	1 m	0.23 m
35	13.0	1 m	0.23 m
40	17.0	1 m	0.30 m

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5.2.2 Photo documentation of the test setup



FCC ID: QOQWT41U



5.2.3 Test result

Frequency range: 1000 MHz - 26000 MHz

Min. limit margin by 0.1 dB at 9609 MHz

The requirements are **FULFILLED**.

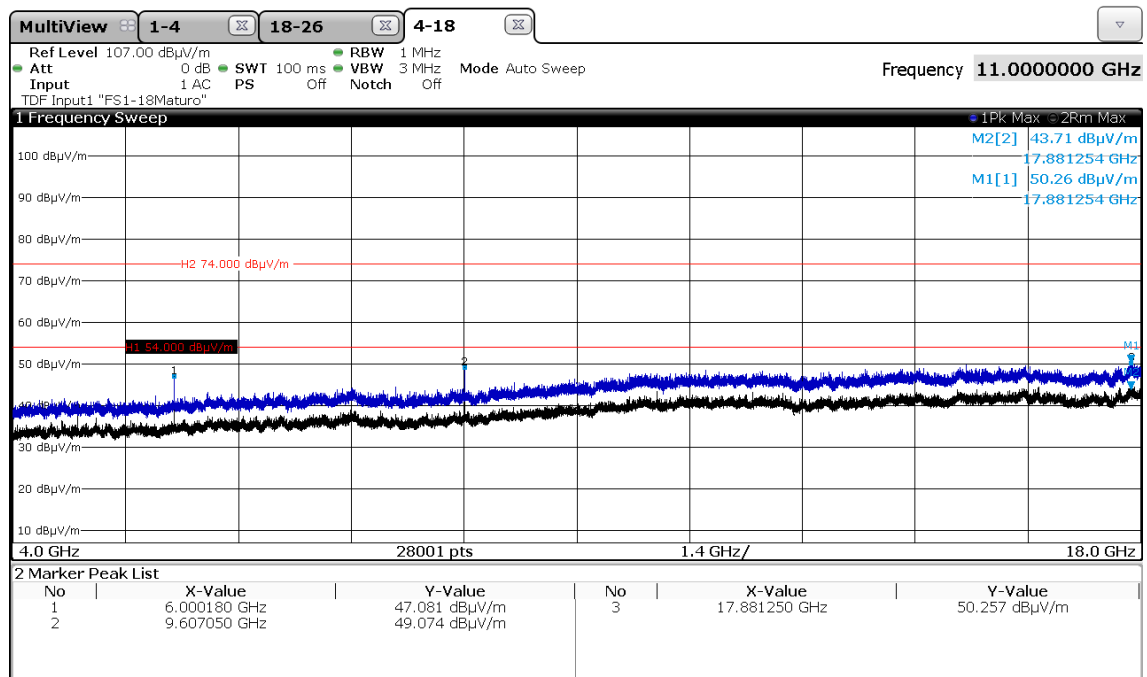
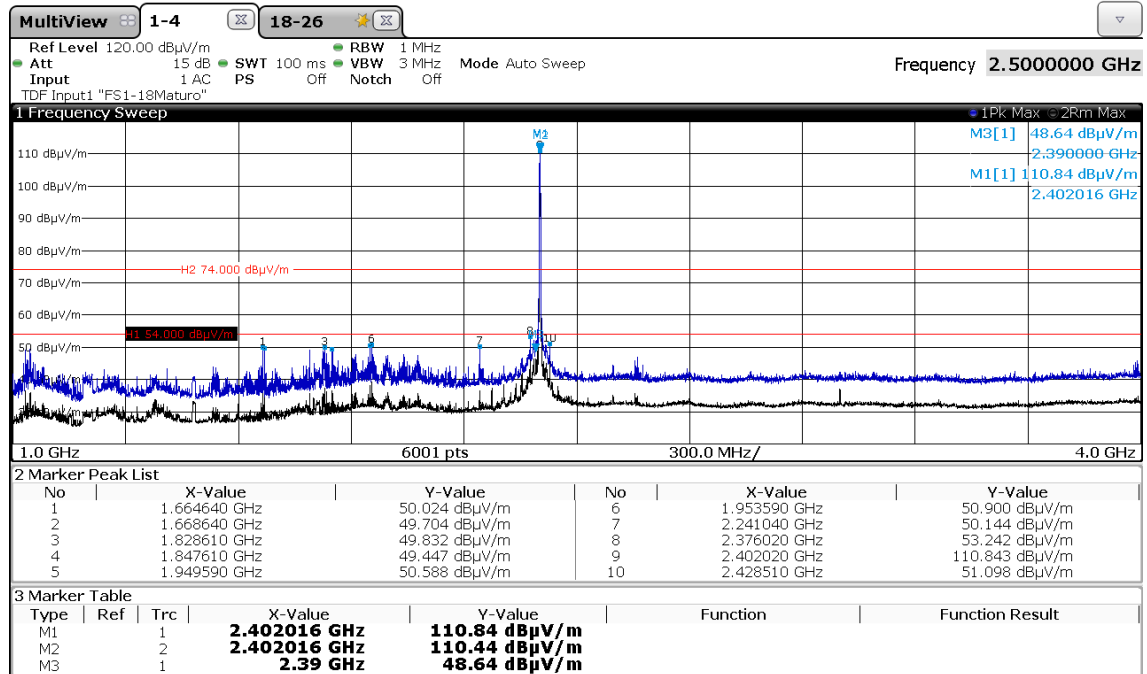
Remarks: For detailed results, please see the following page(s).

FCC ID: QOQWT41U

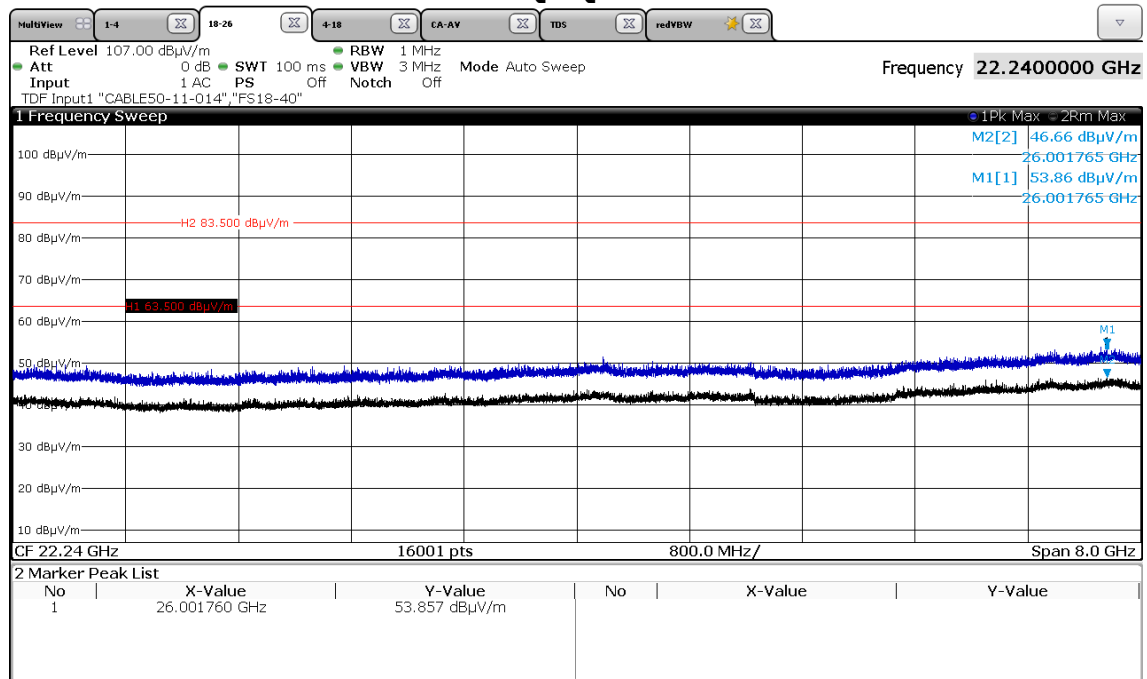
5.2.4 Test protocol

5.2.4.1 GFSK modulation

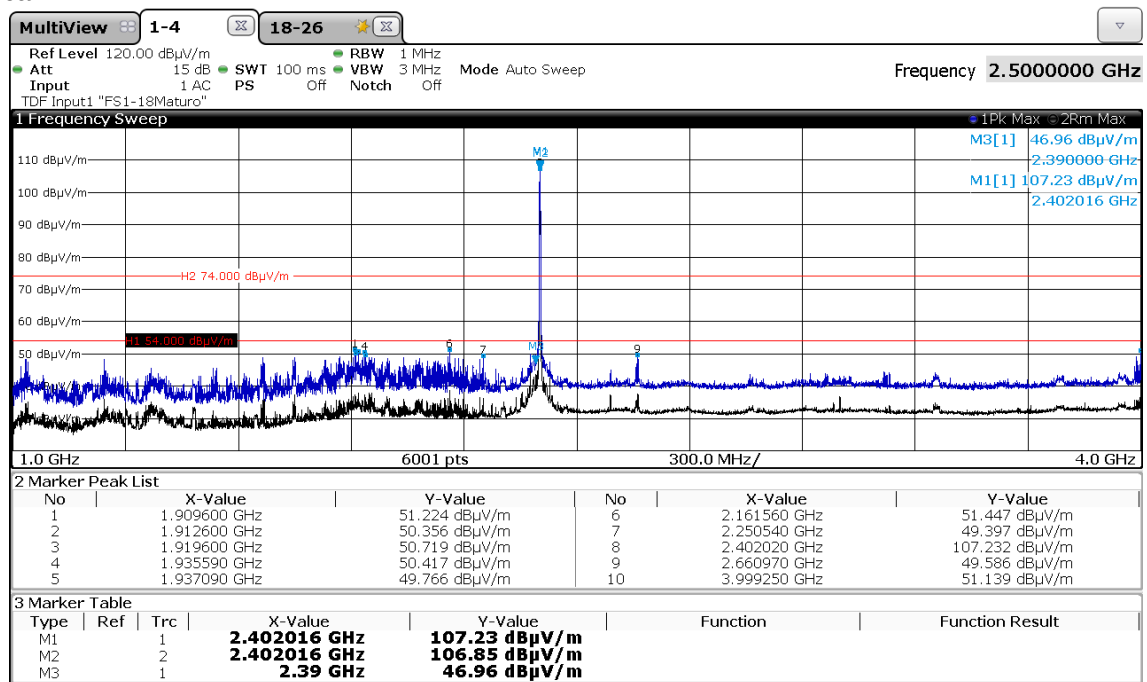
CH1 horizontal



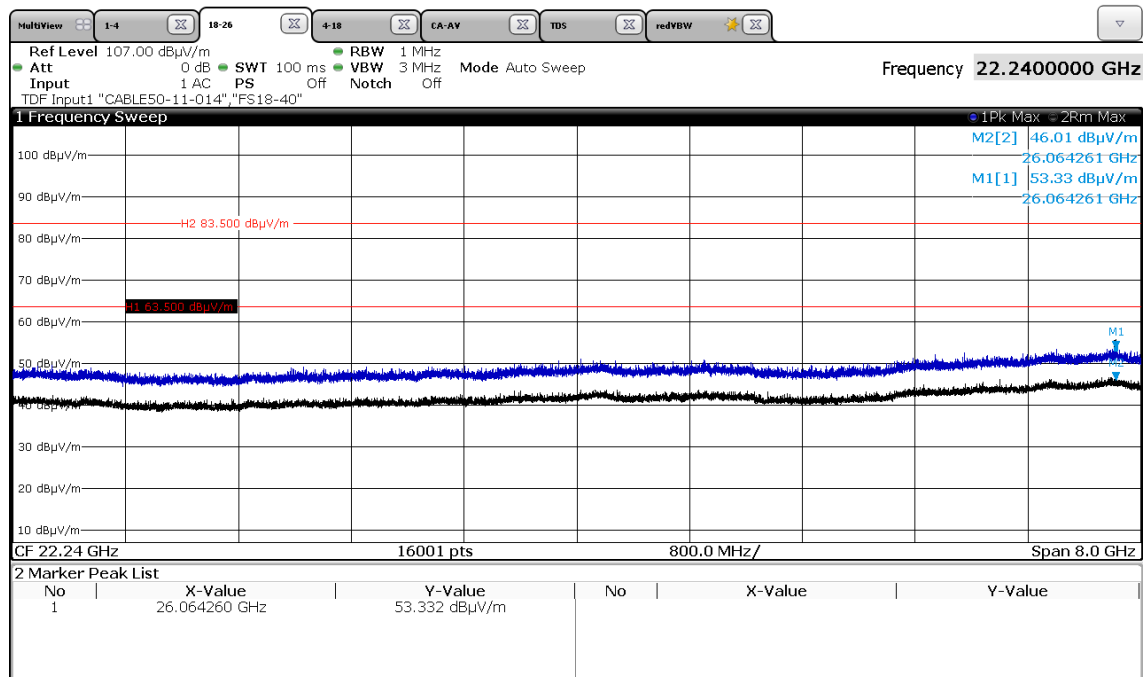
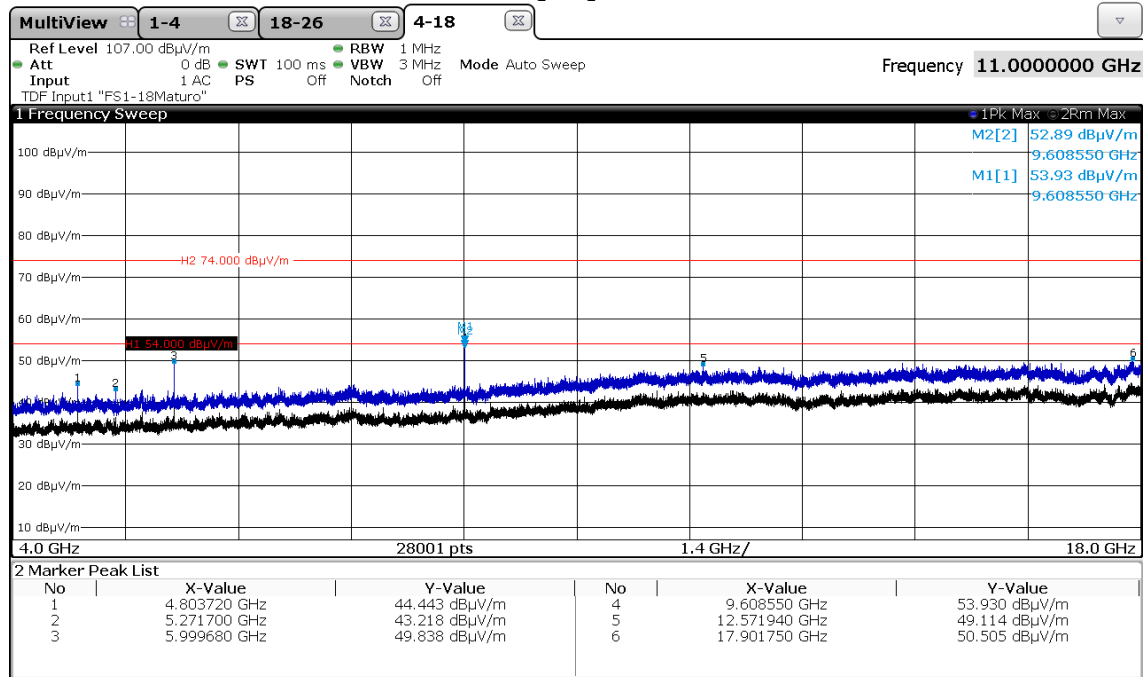
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CH1 vertical

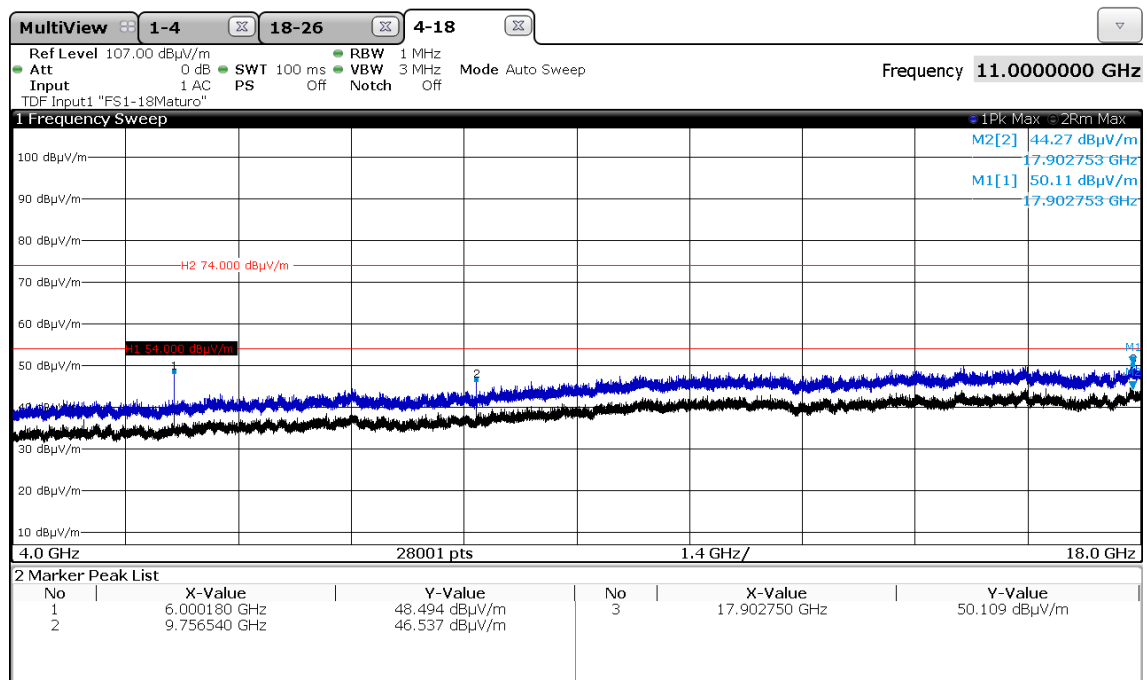
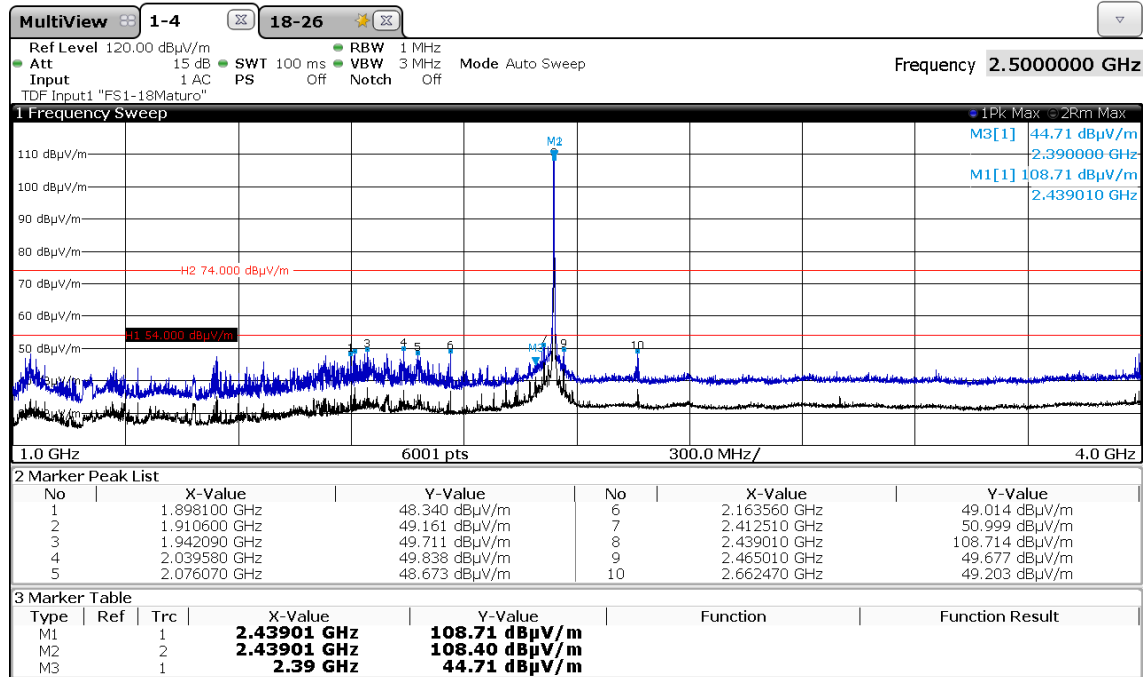


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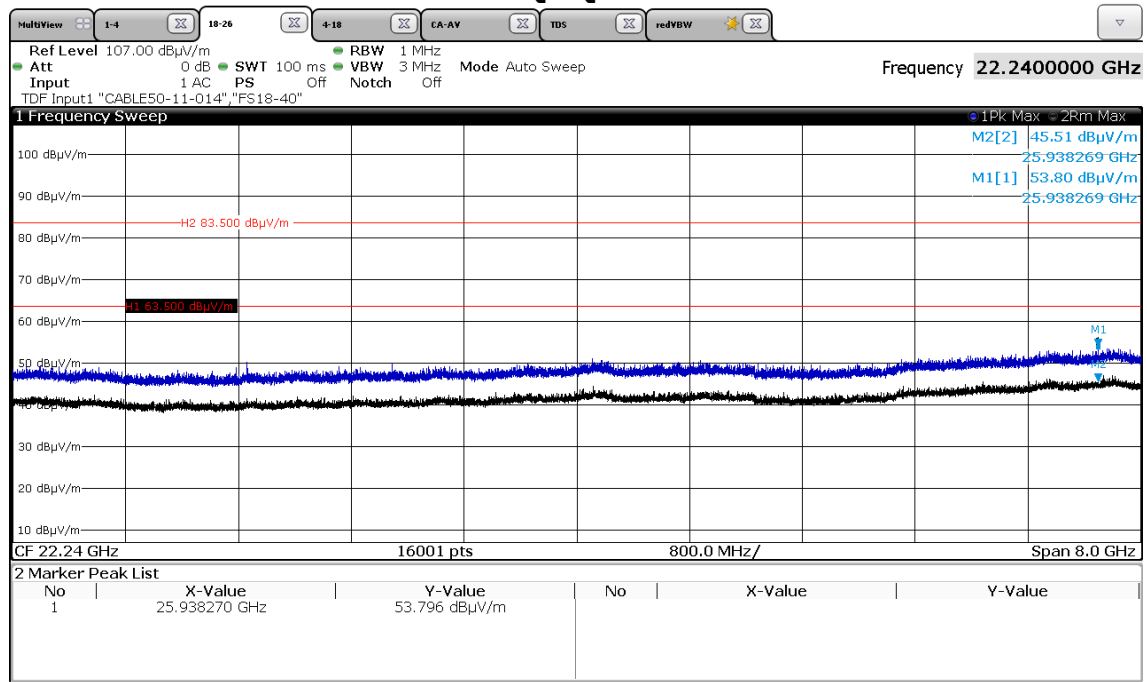


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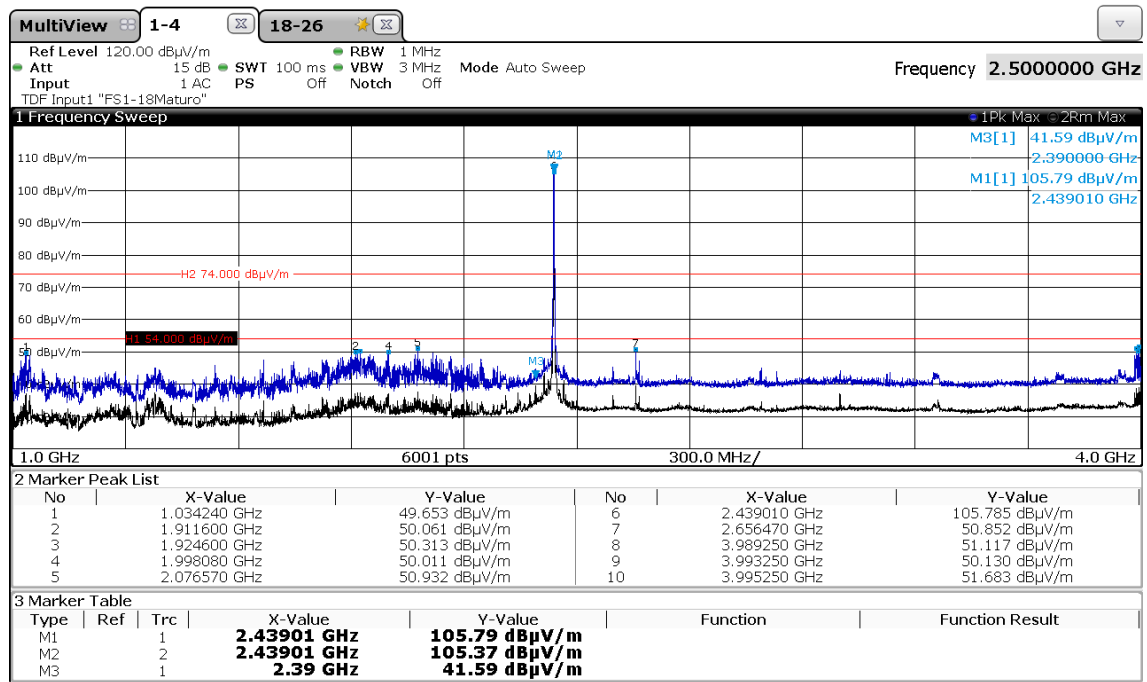
CH38 horizontal



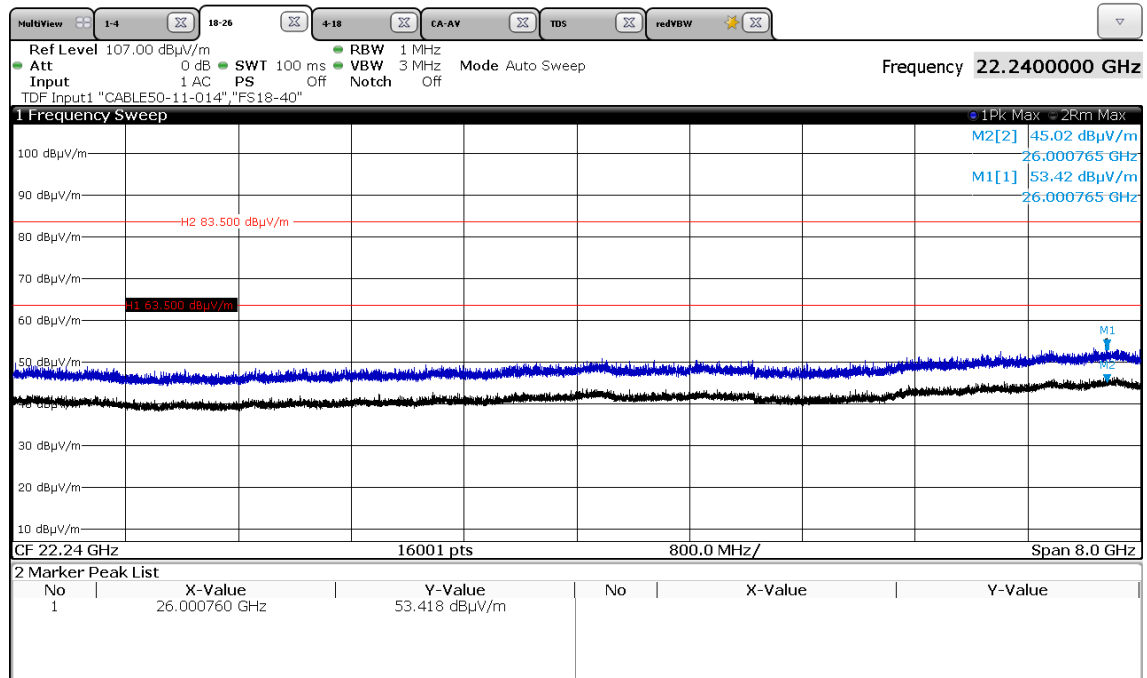
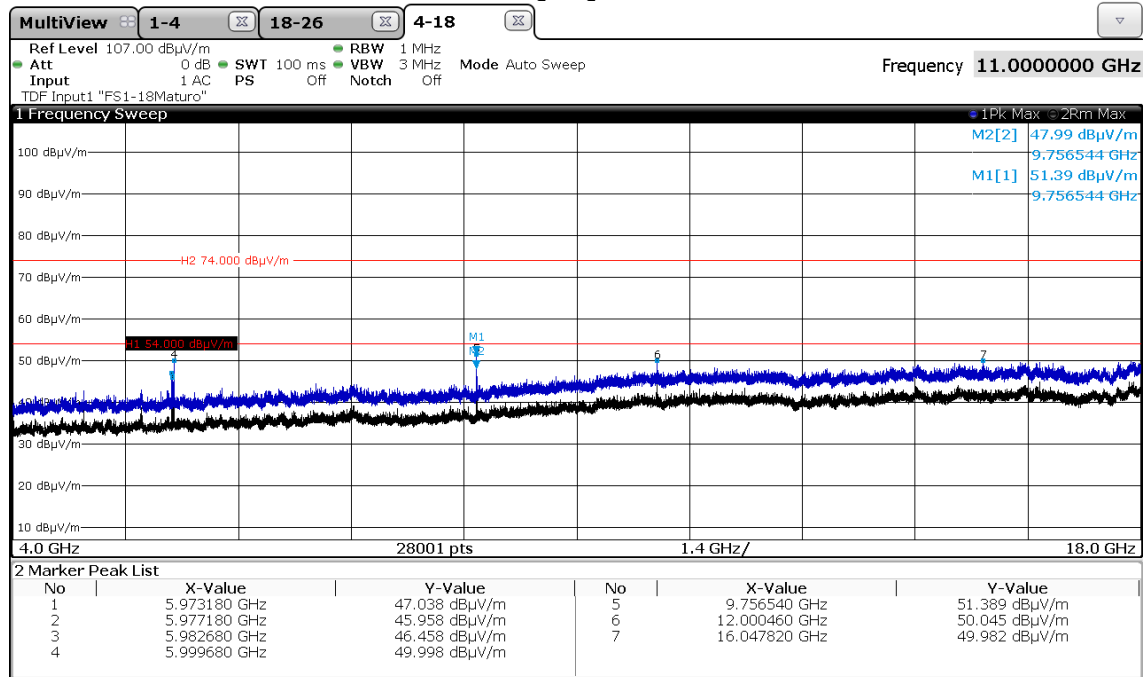
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CH 38 vertical

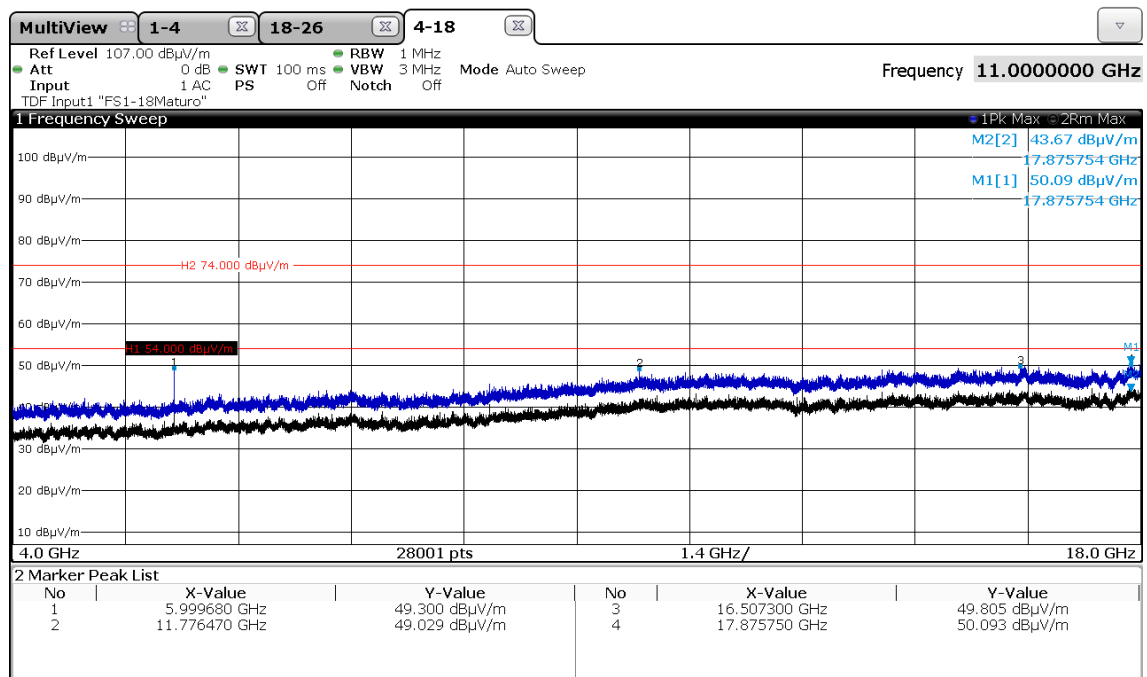
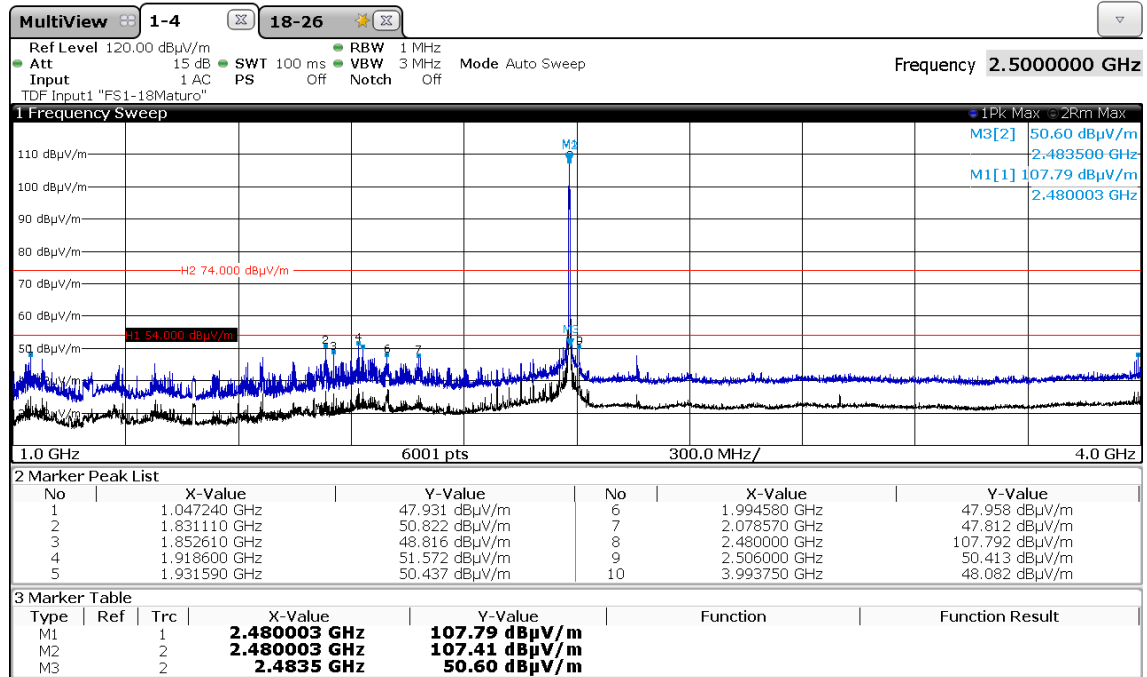


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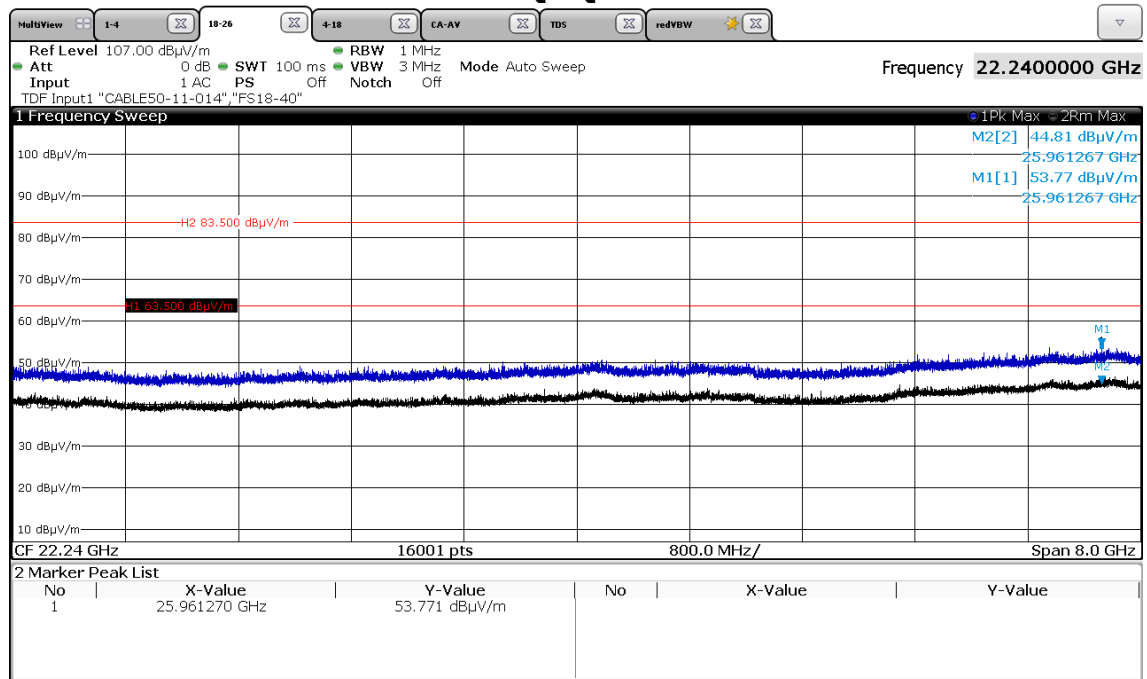


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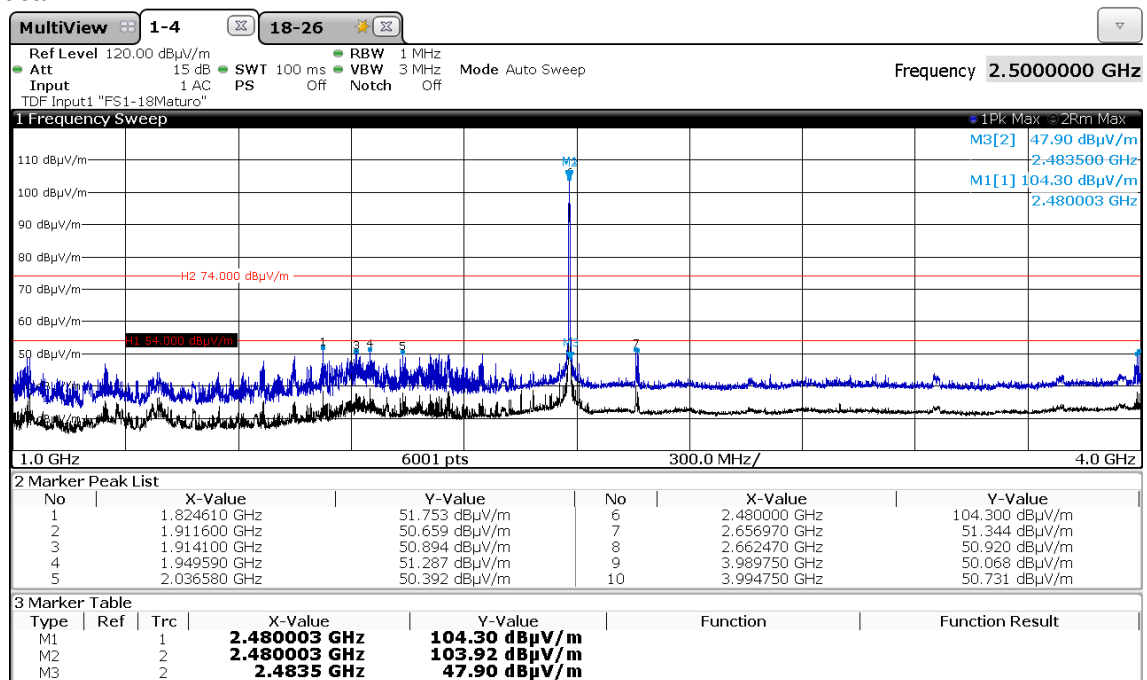
CH79 horizontal



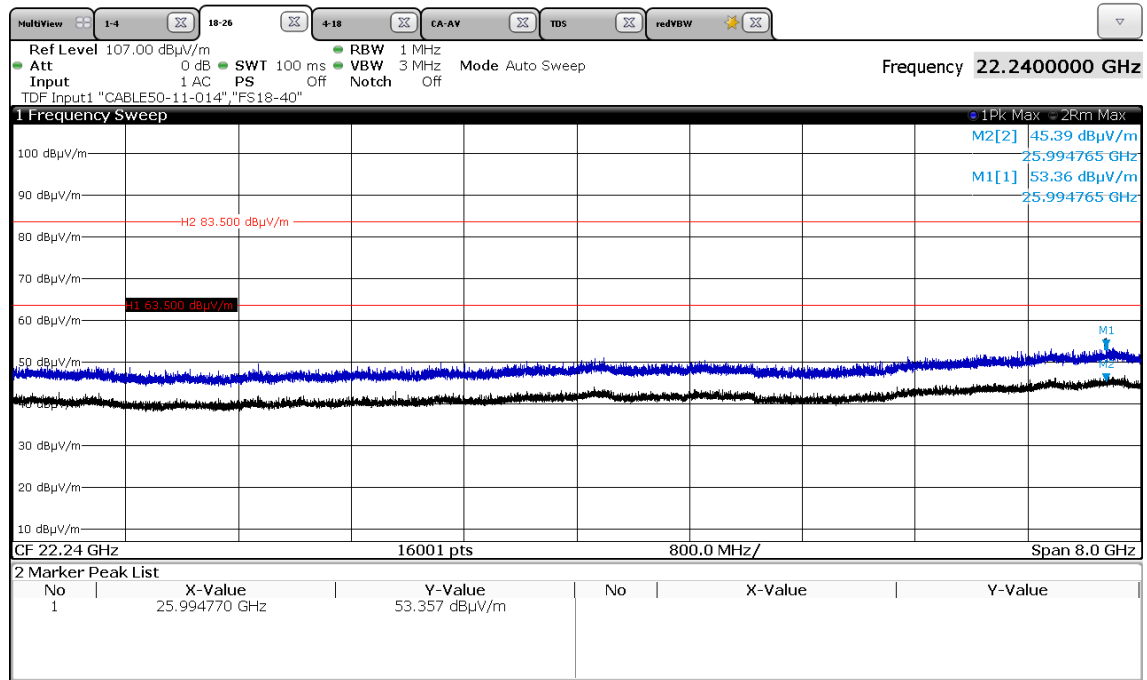
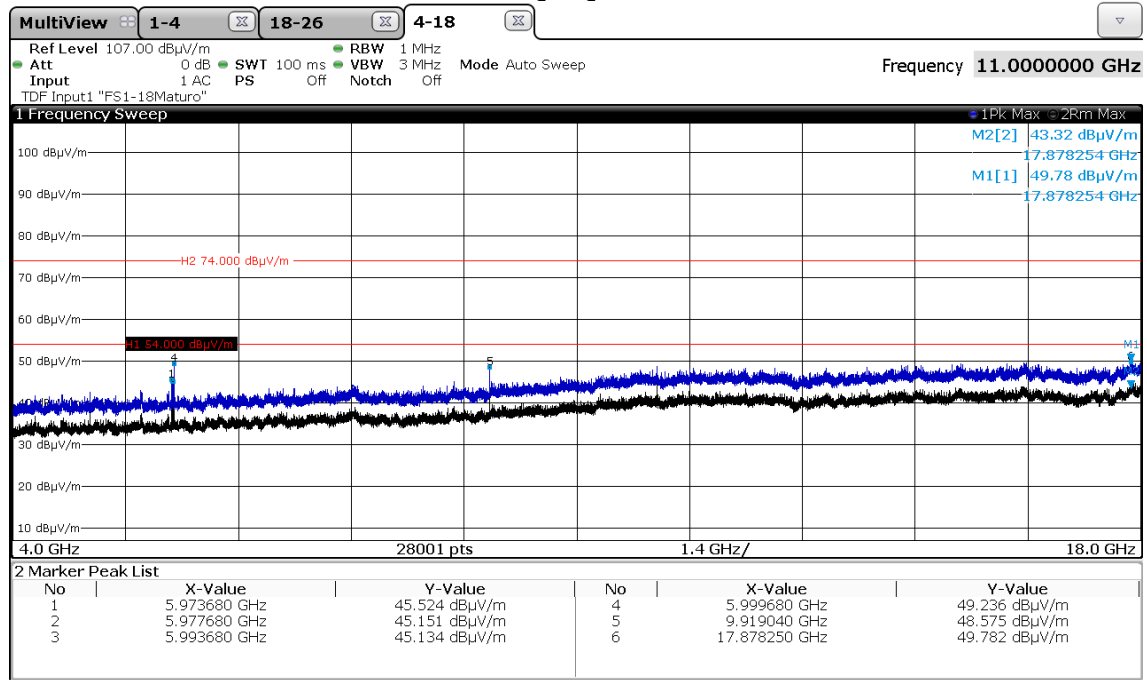
FCC ID: QOQWT41U



CH79 vertical



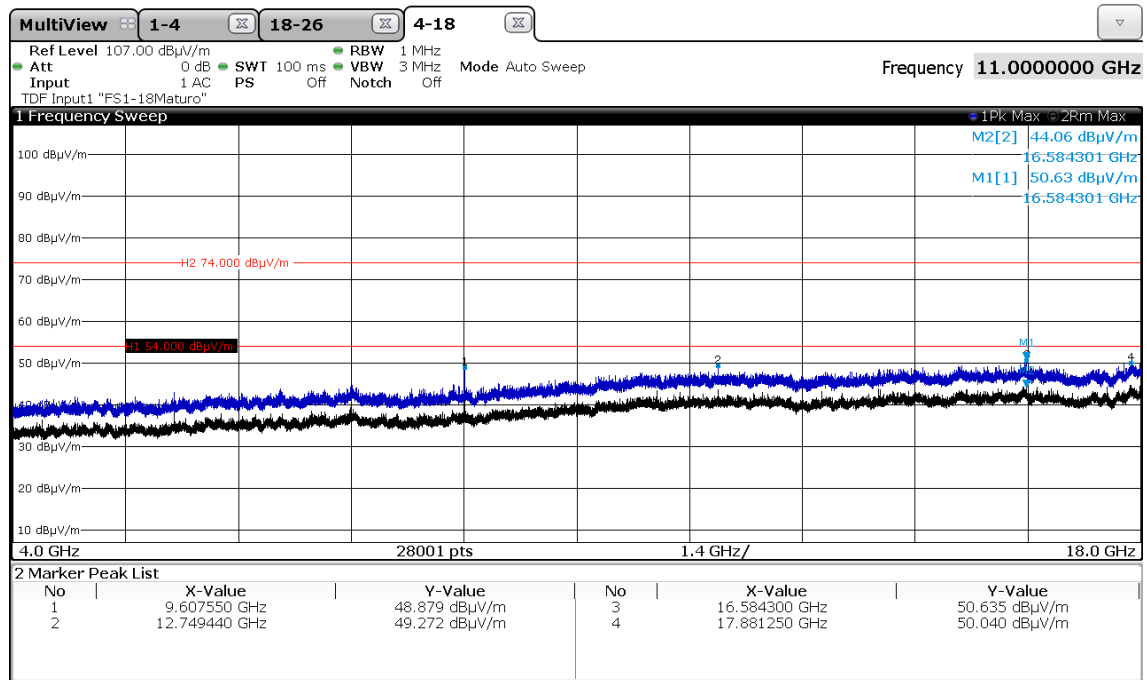
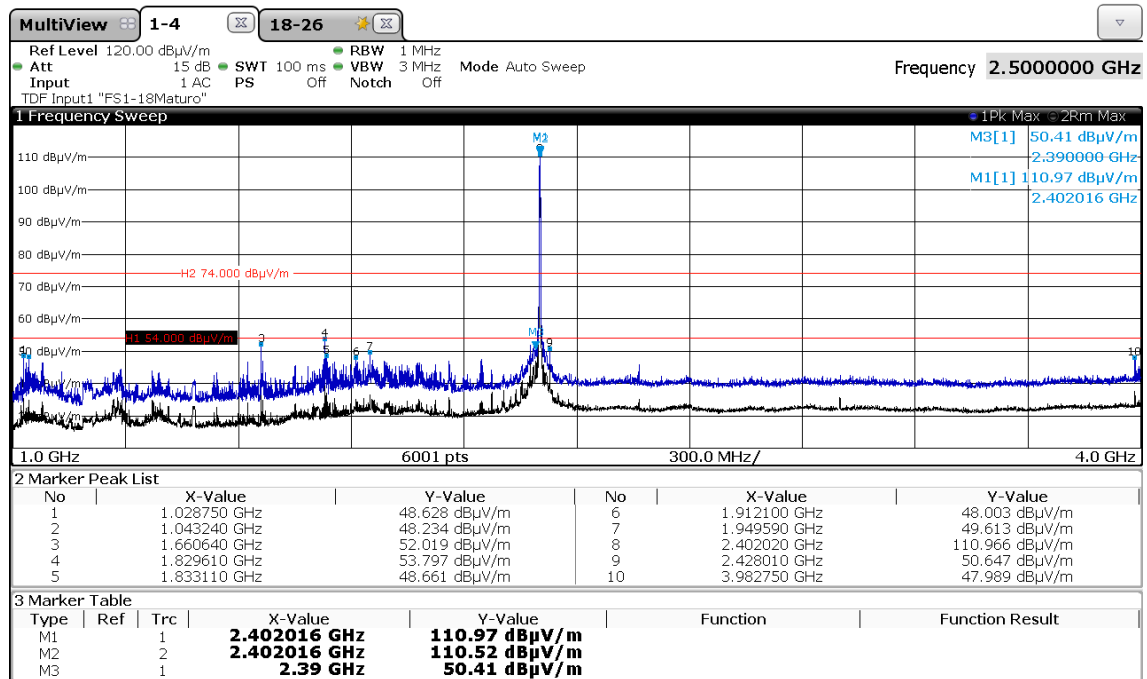
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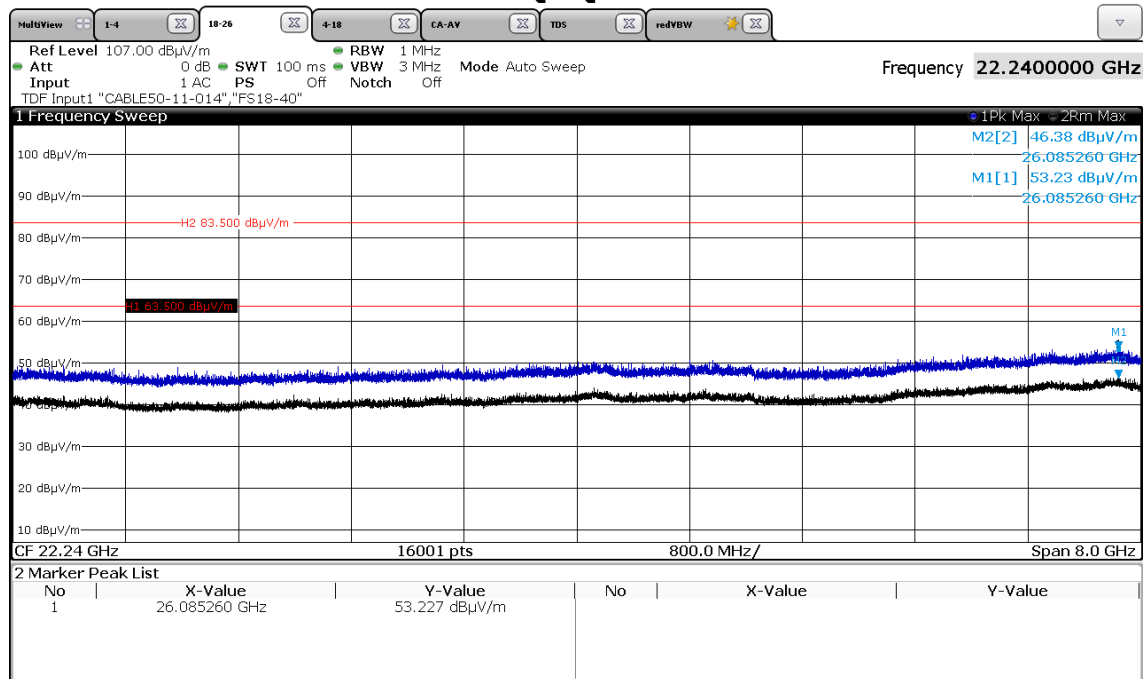
FCC ID: QOQWT41U

5.2.4.2 $\pi/4$ -DQPSK modulation

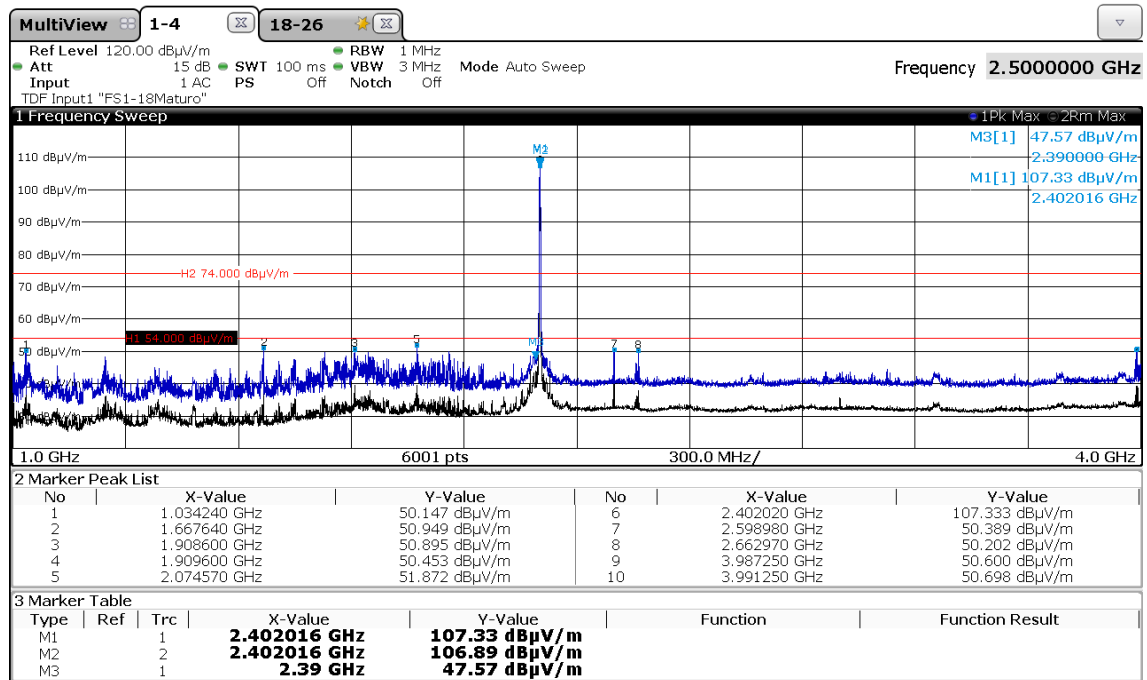
CH1 horizontal

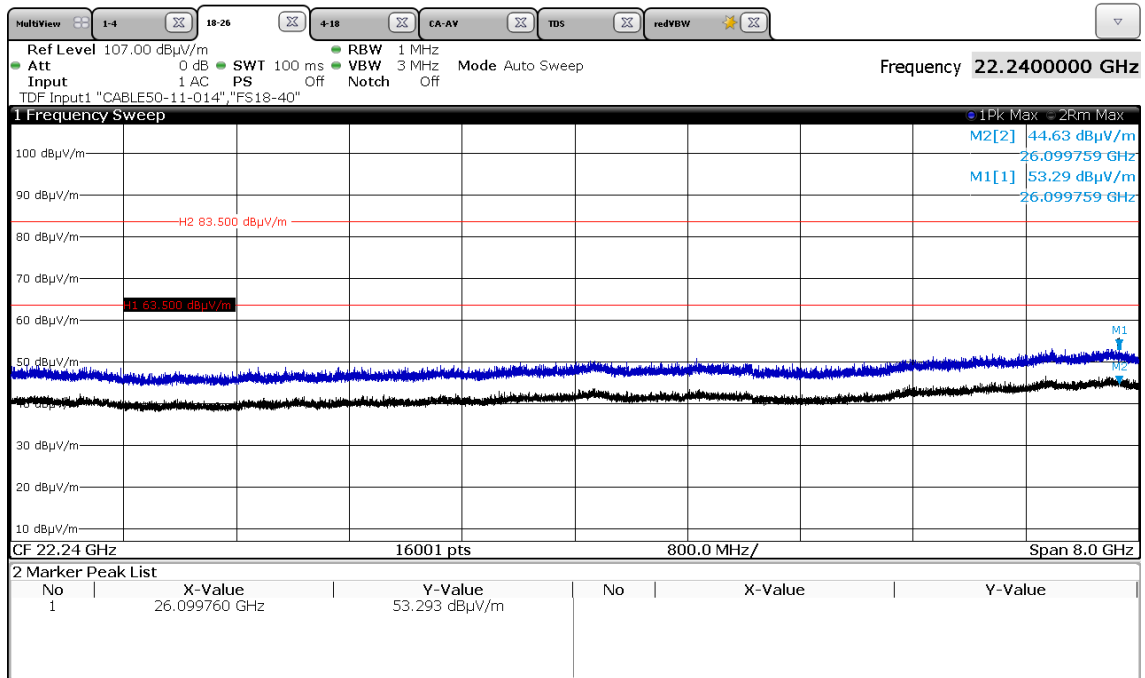
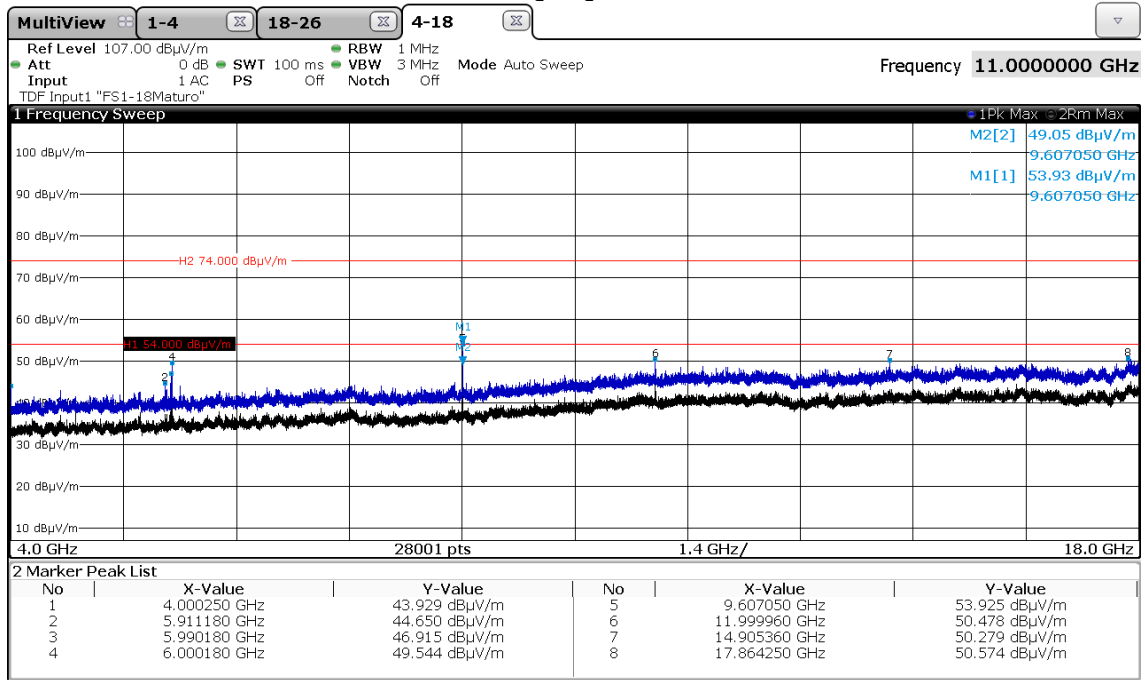


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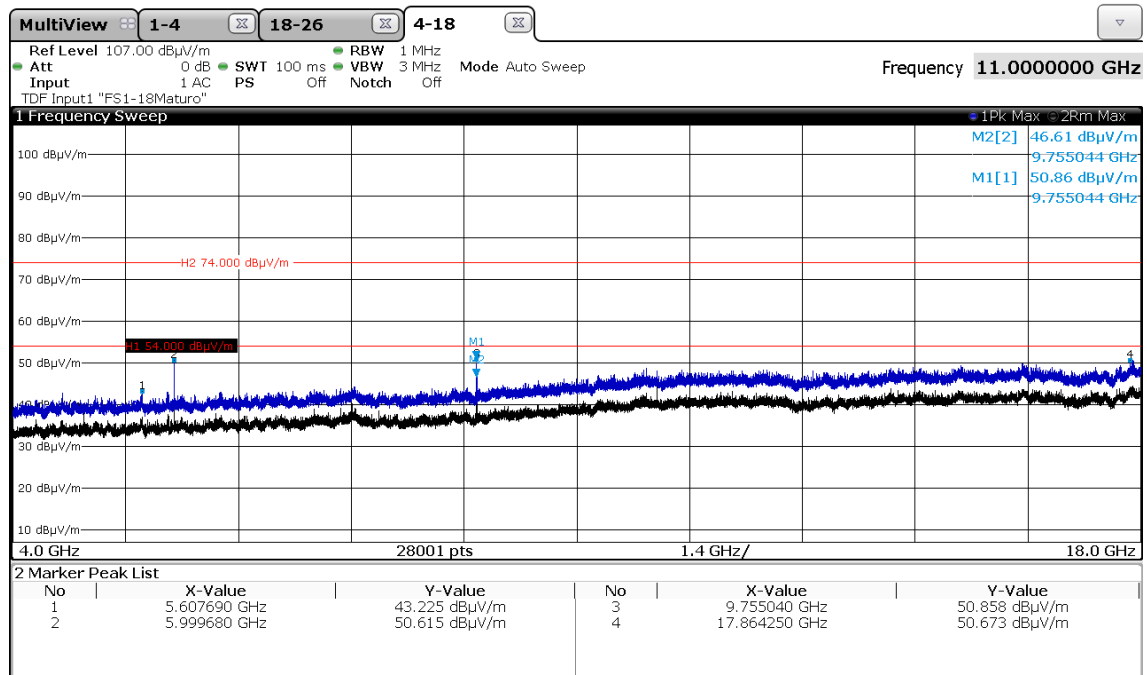
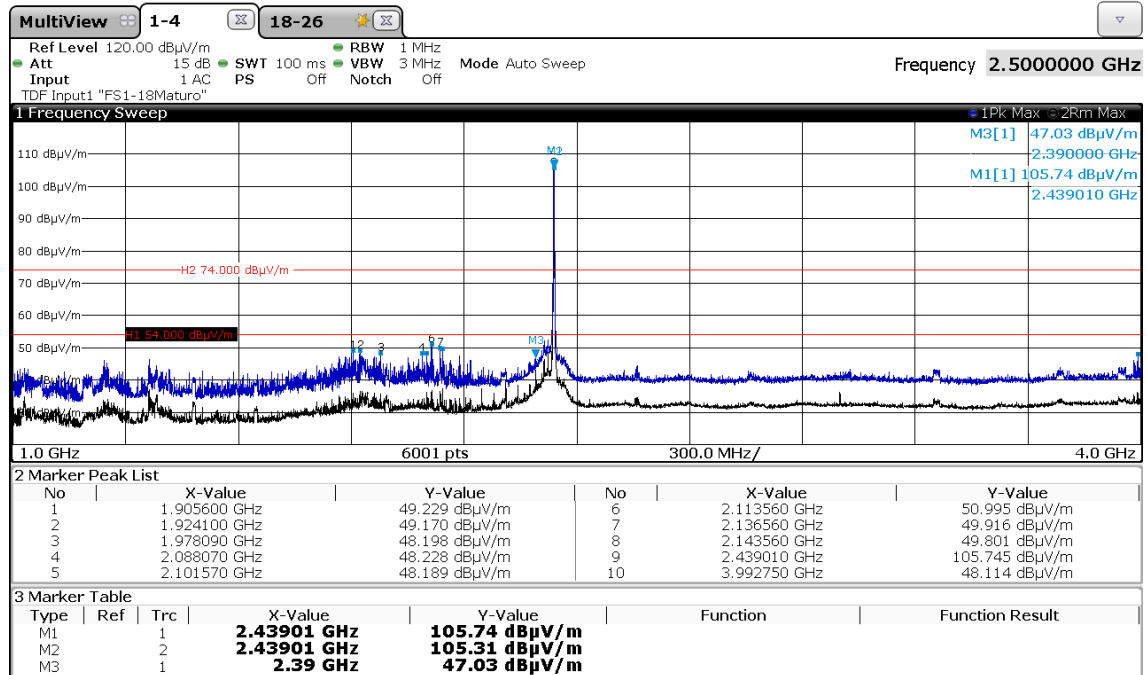
CH1 vertical



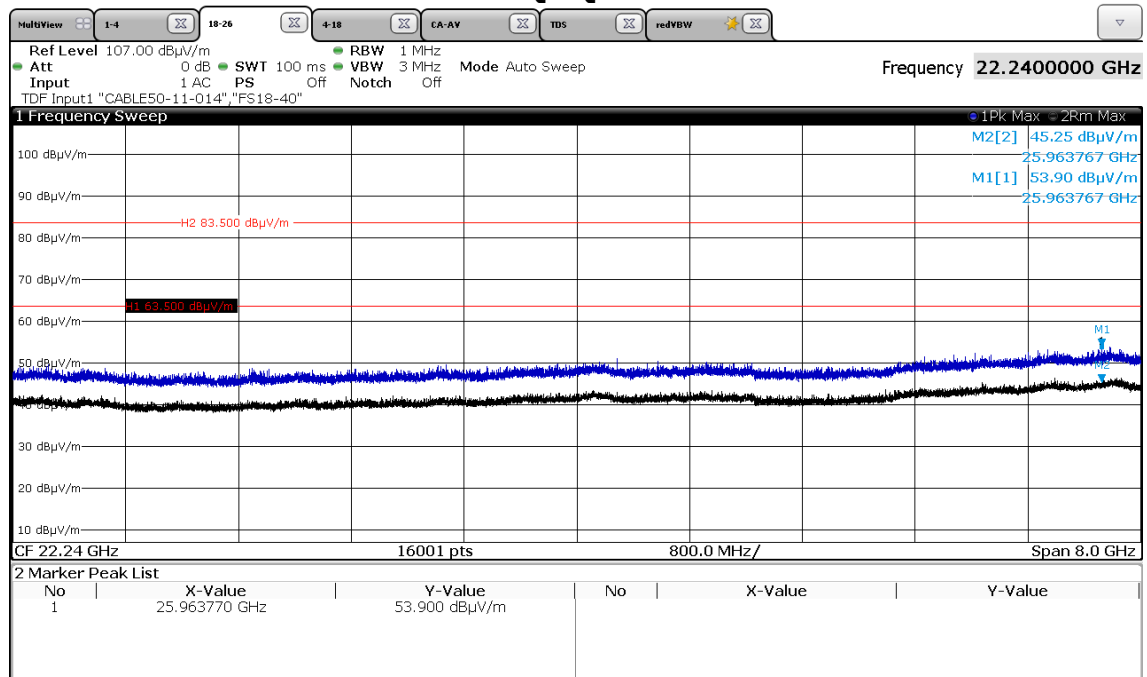
FCC ID: QOQWT41U


FCC ID: QOQWT41U

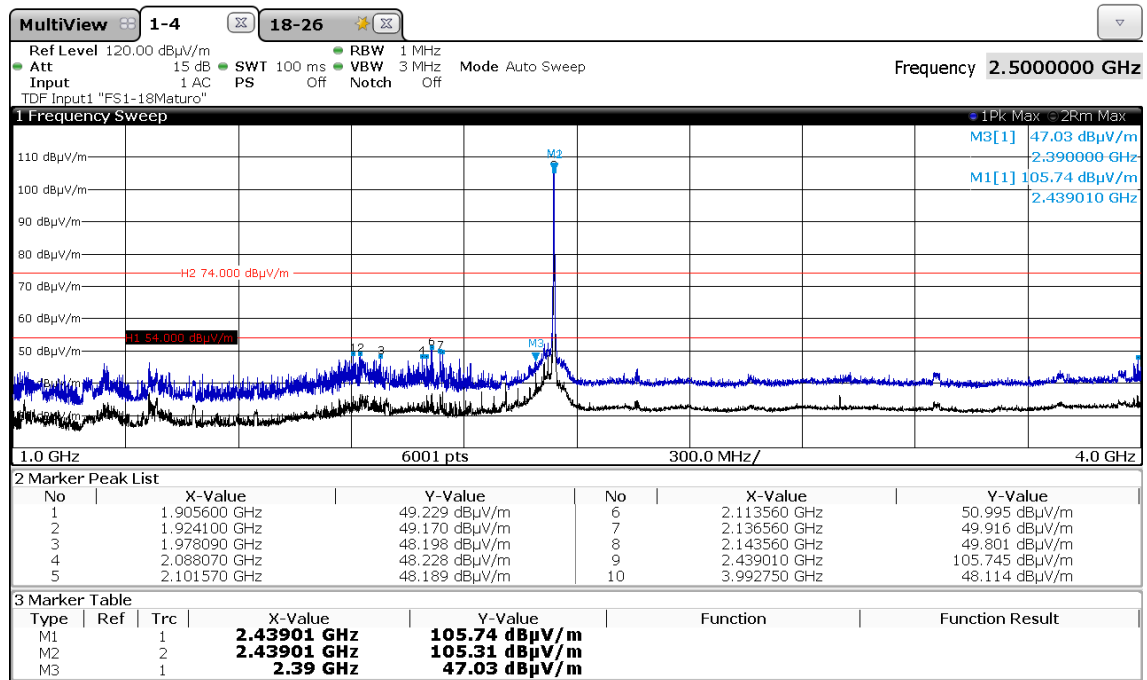
CH38 horizontal



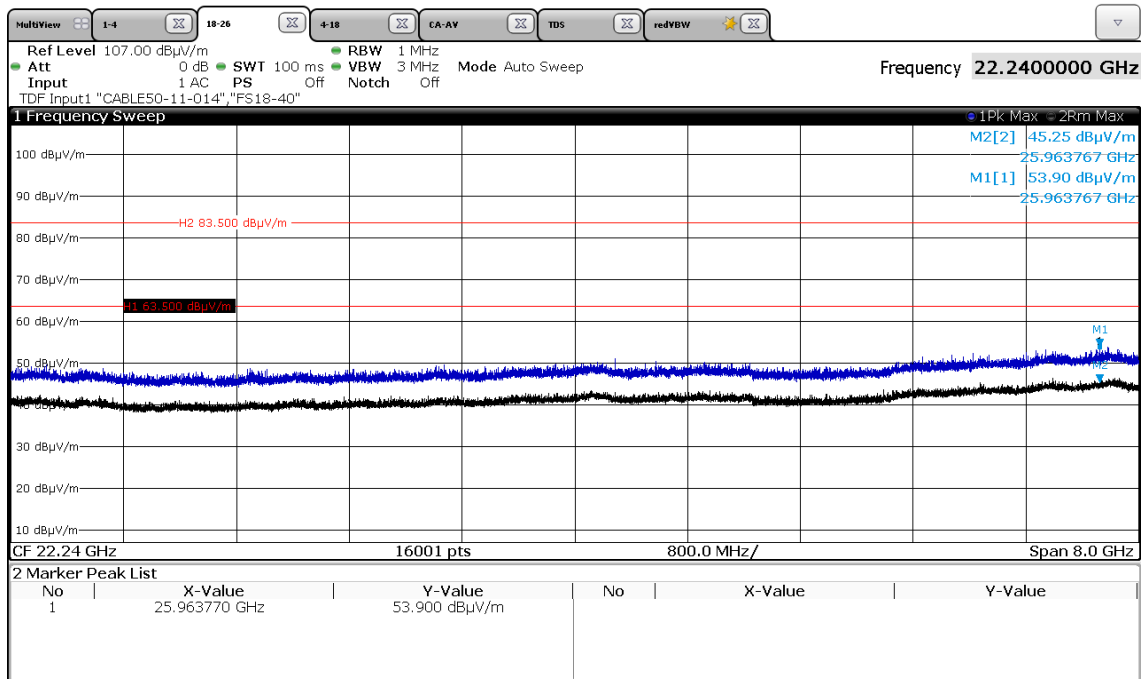
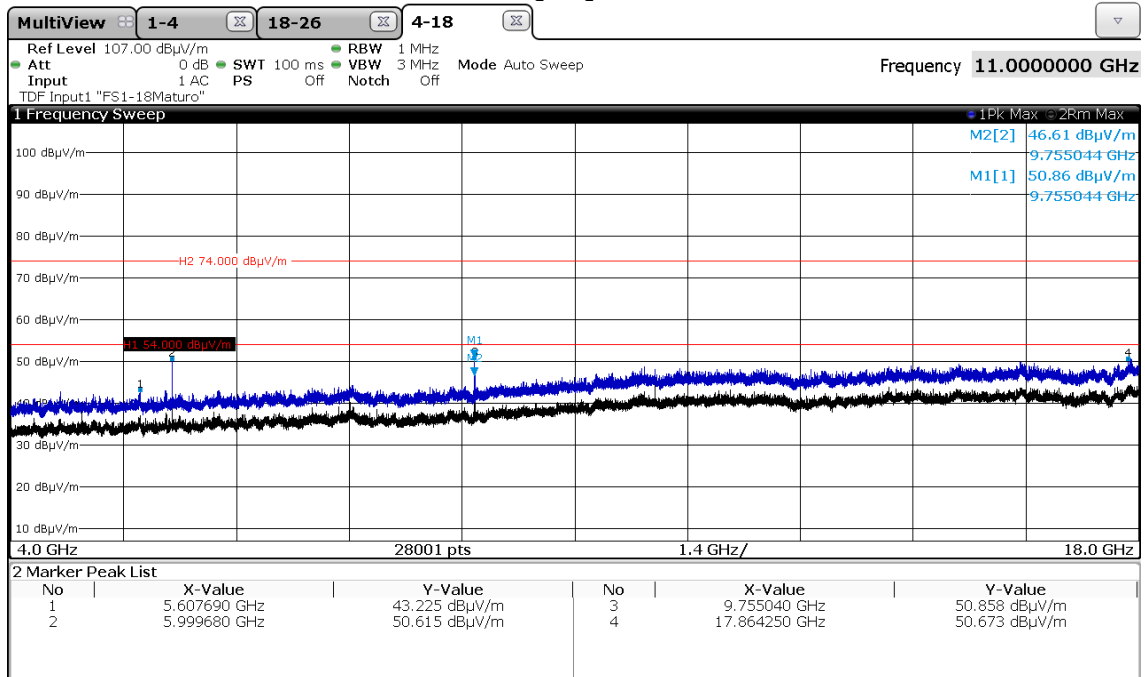
FCC ID: QOQWT41U



CH38 vertical

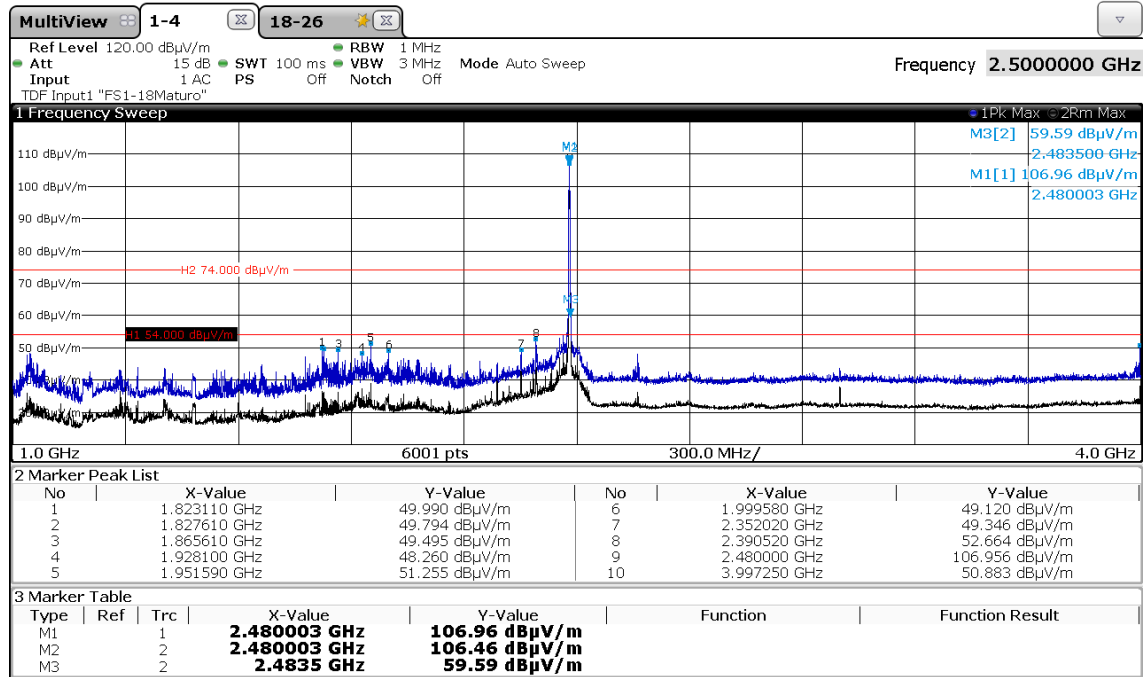


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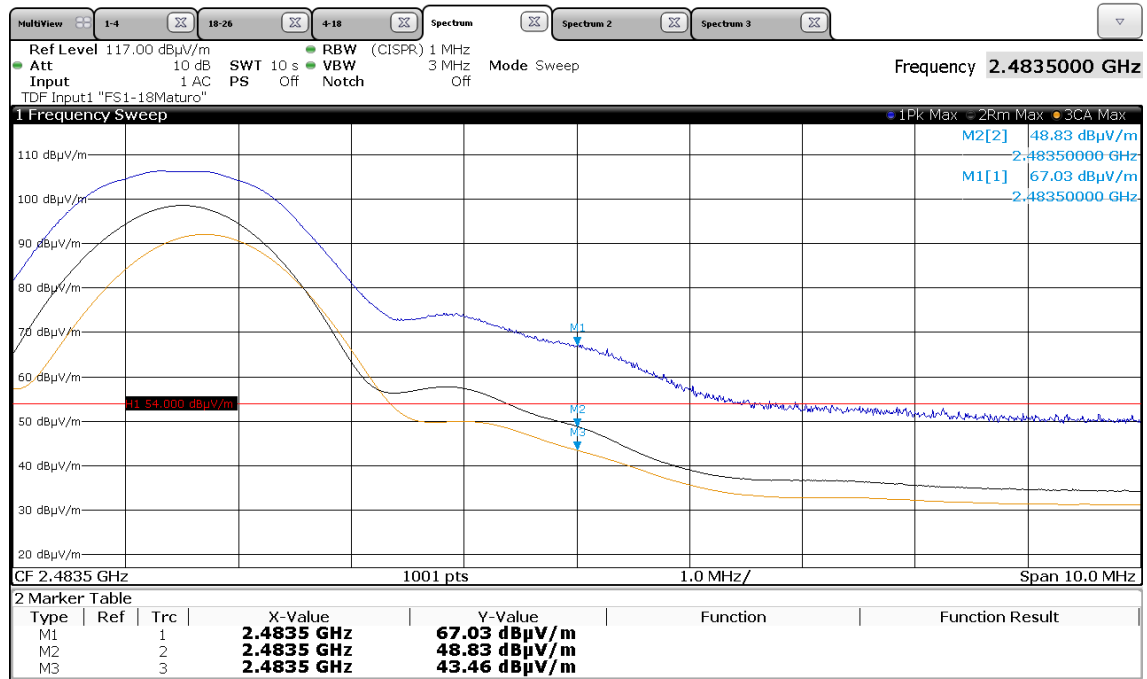


FCC ID: QOQWT41U

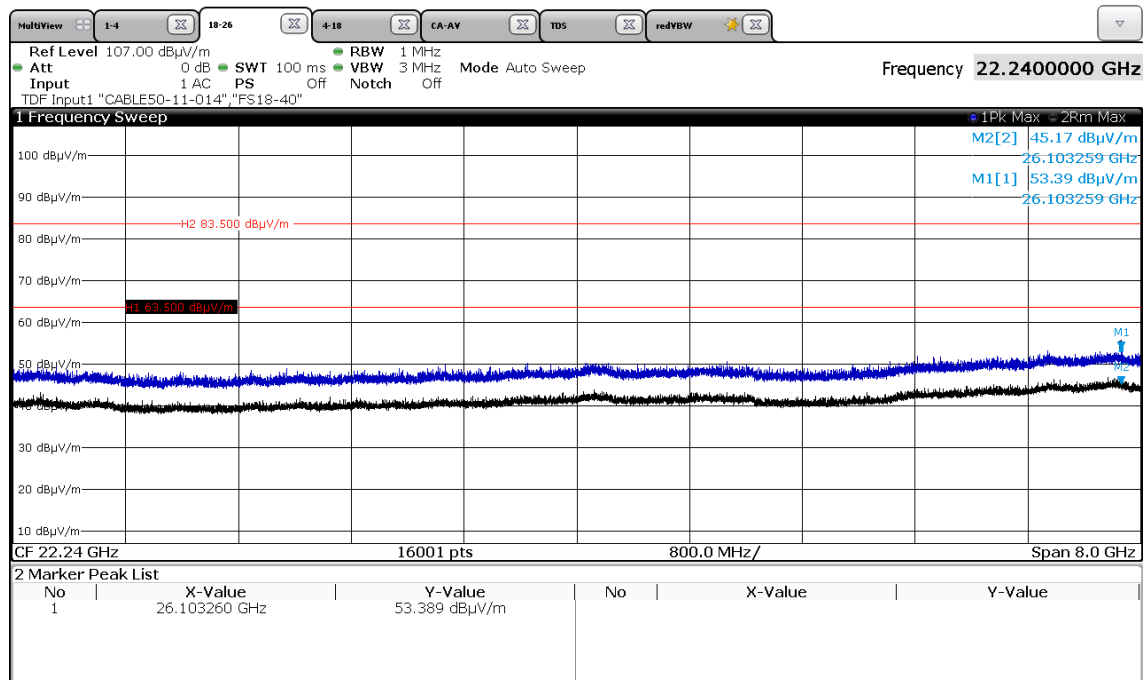
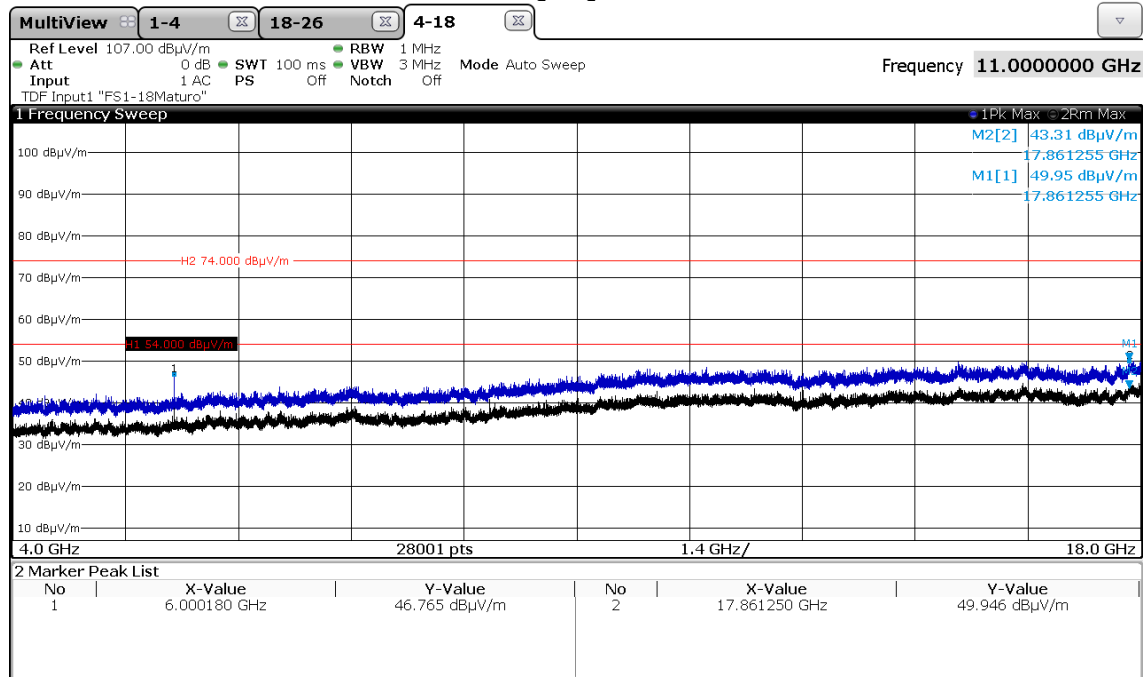
CH79 horizontal



Additional measurement with CISPR 16 detector

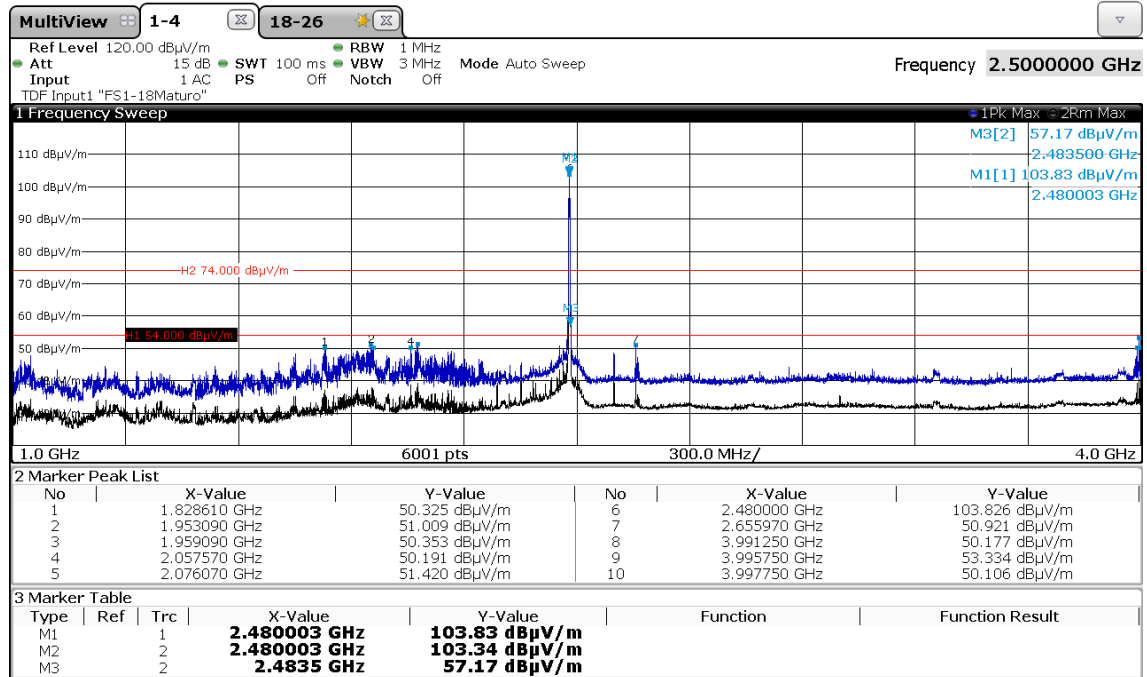


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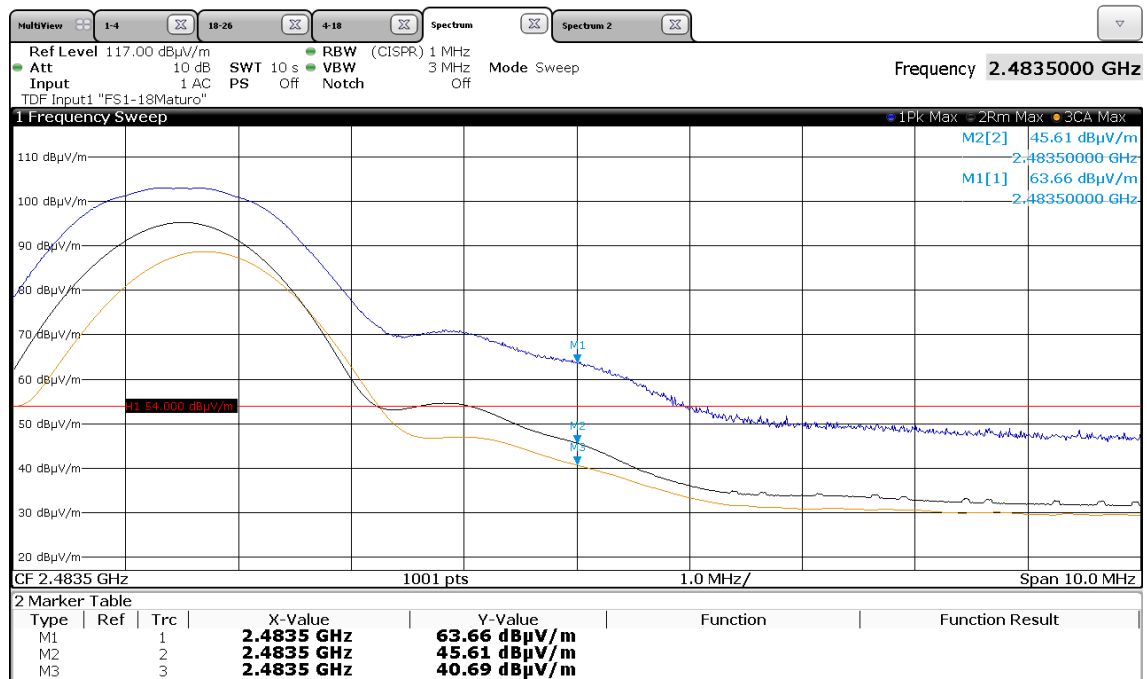


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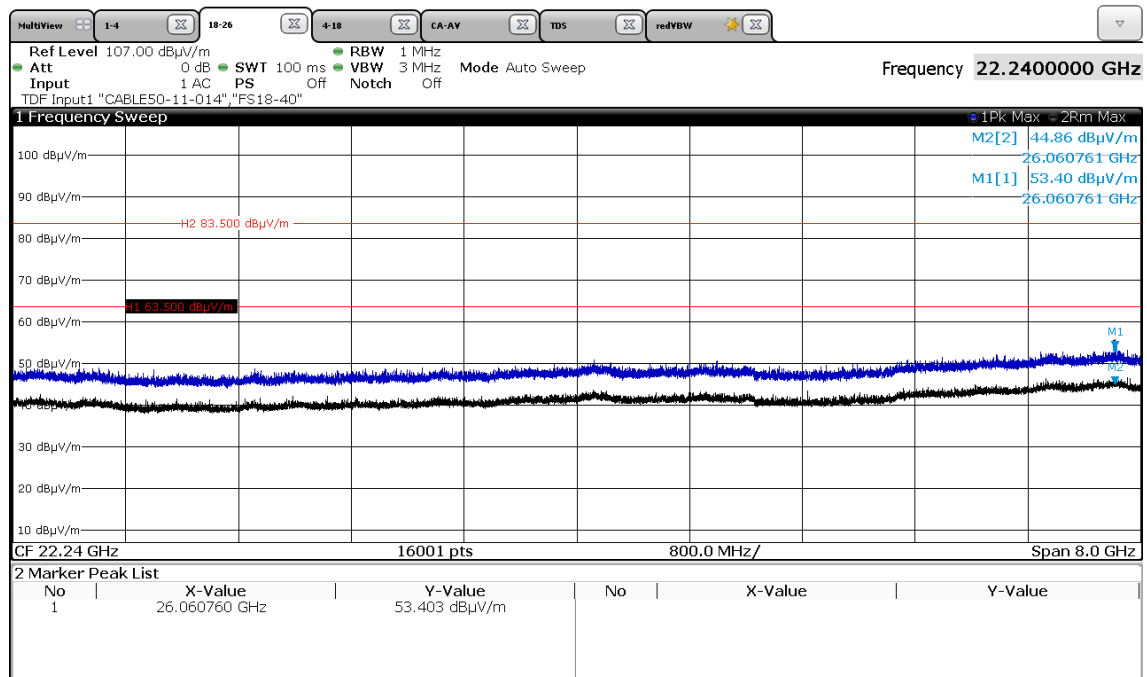
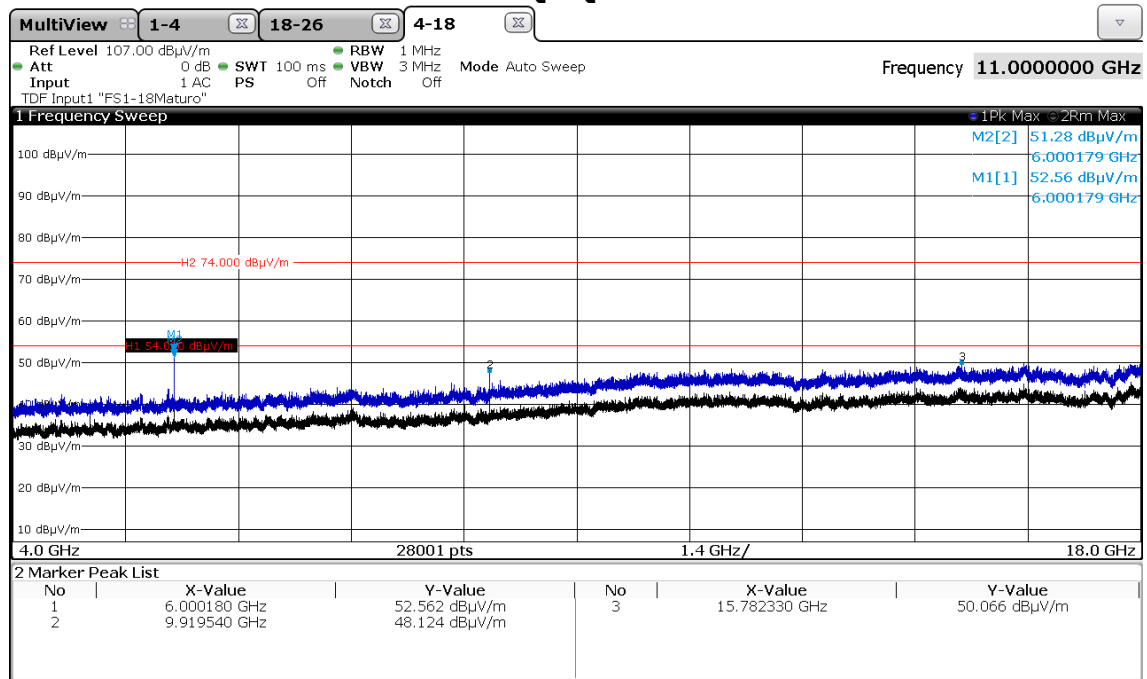
CH79 vertical



Additional measurement with CISPR 16 detector



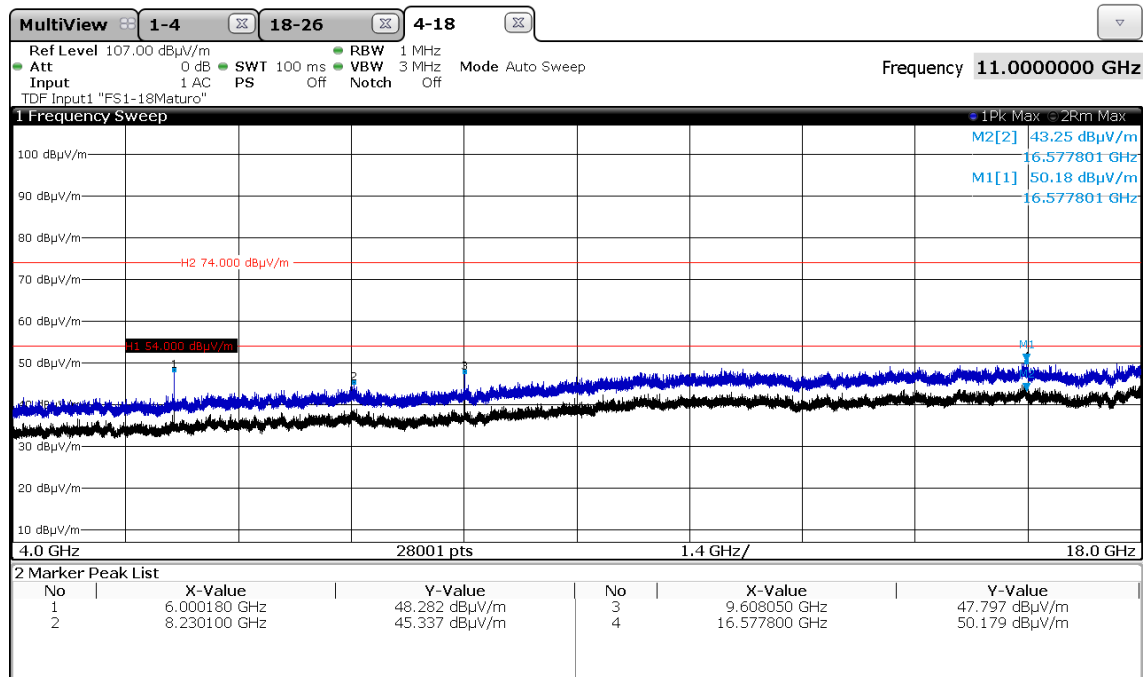
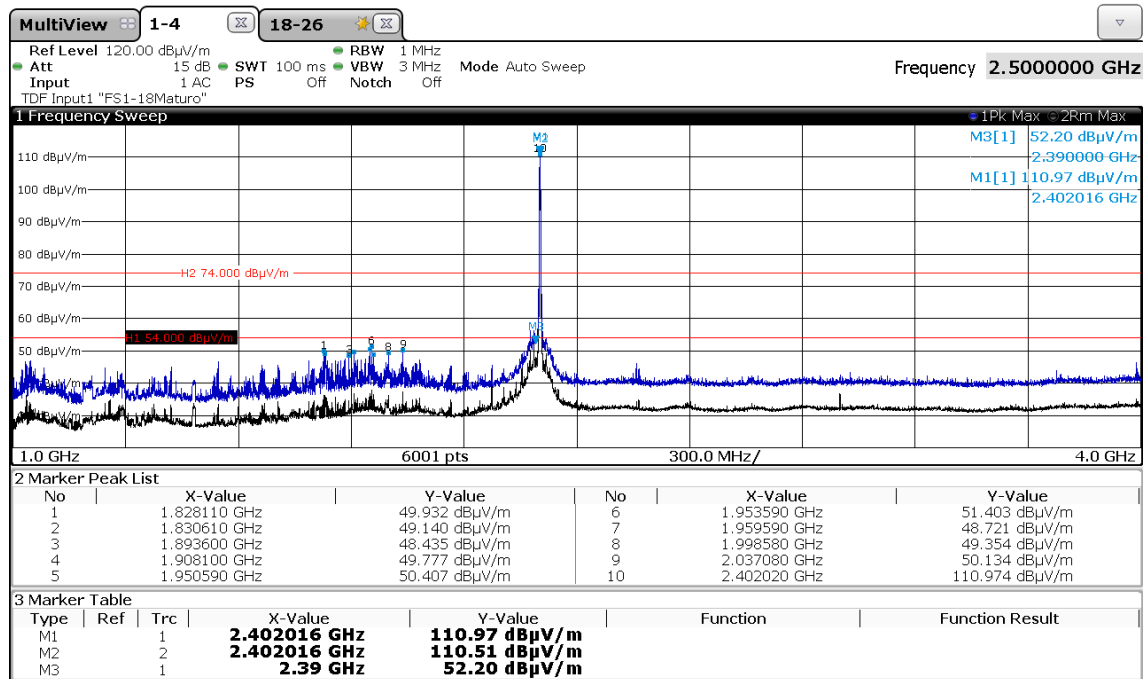
FCC ID: QOQWT41U



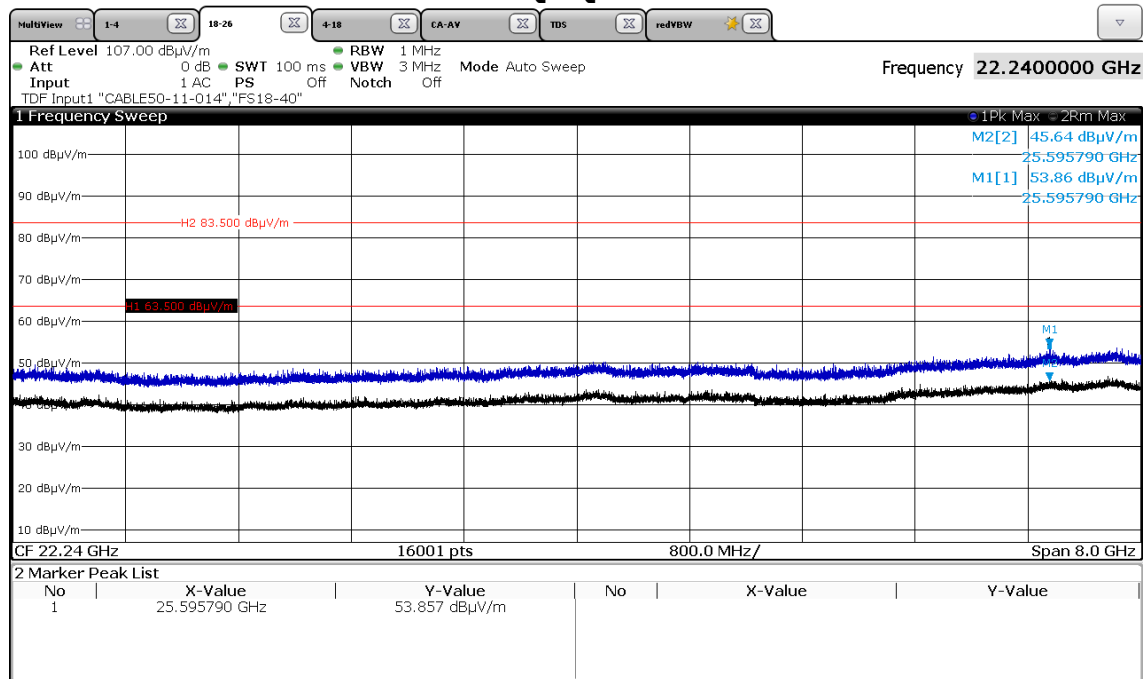
FCC ID: QOQWT41U

5.2.4.3 8DPSK modulation

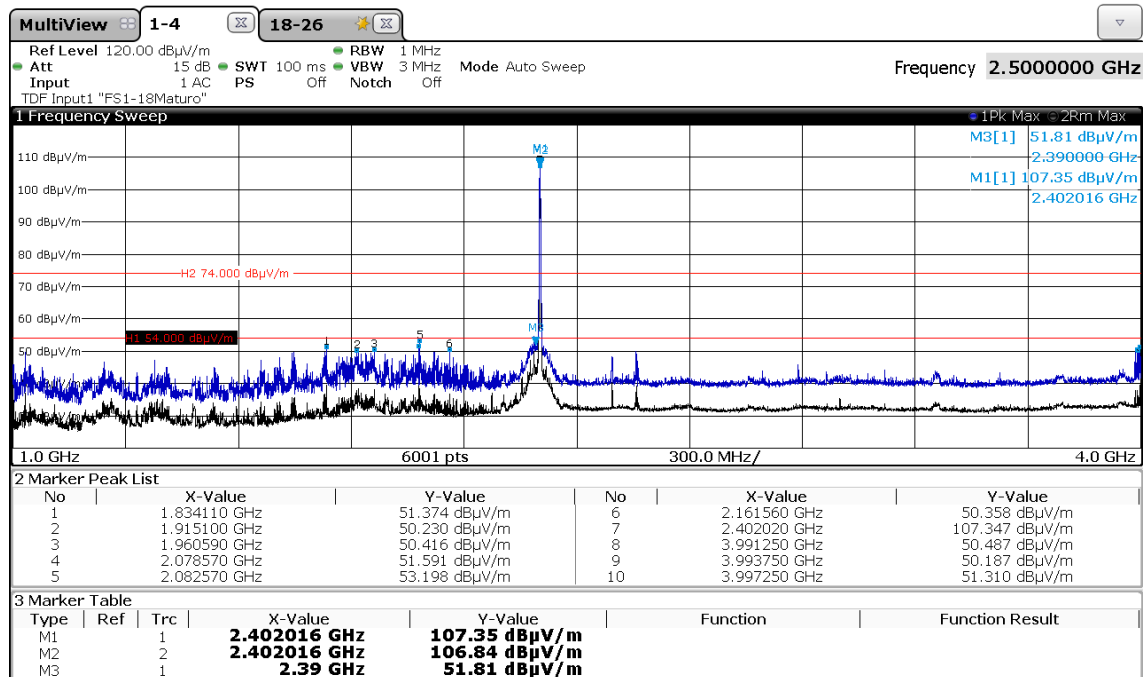
CH1 horizontal



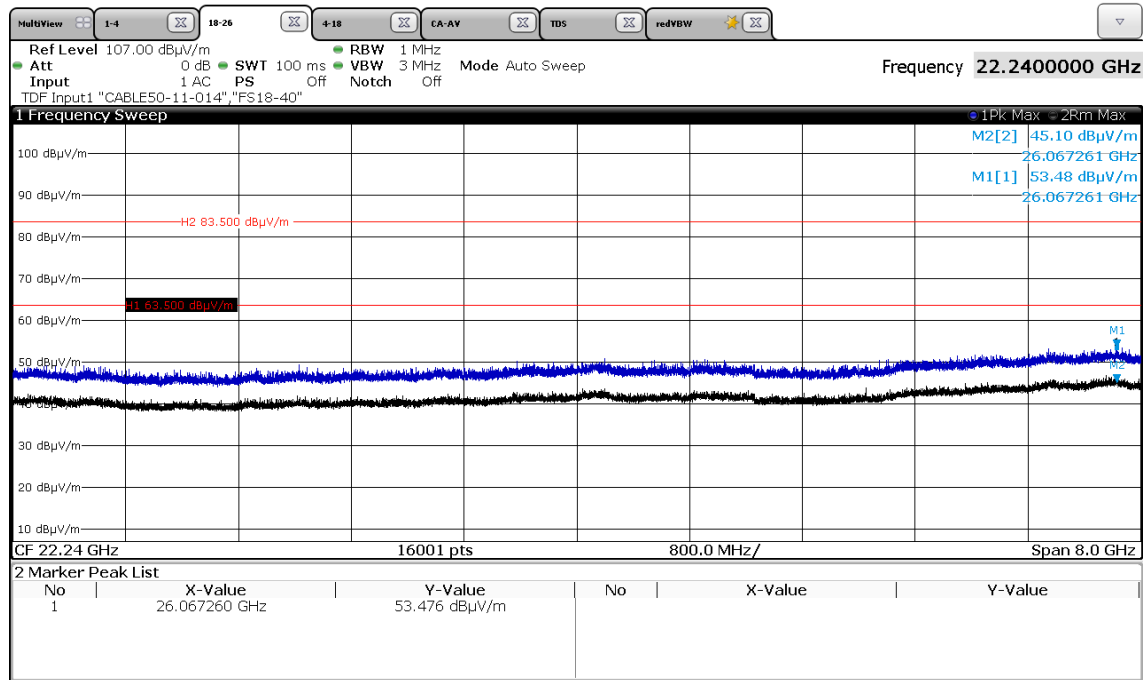
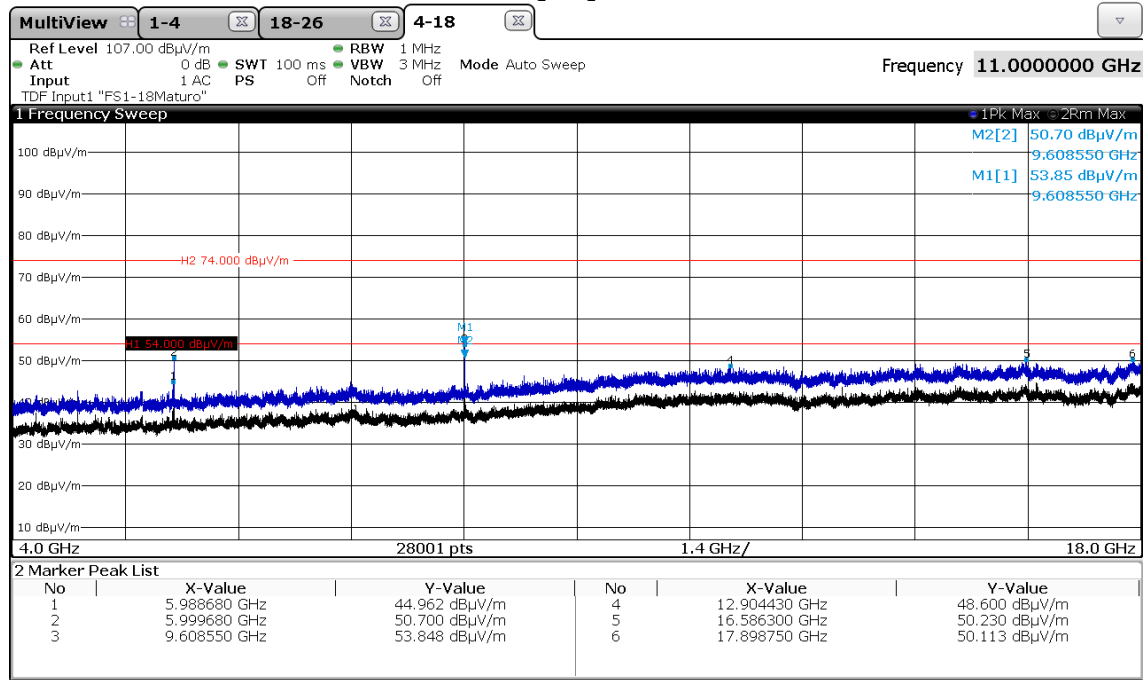
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CH1 vertical

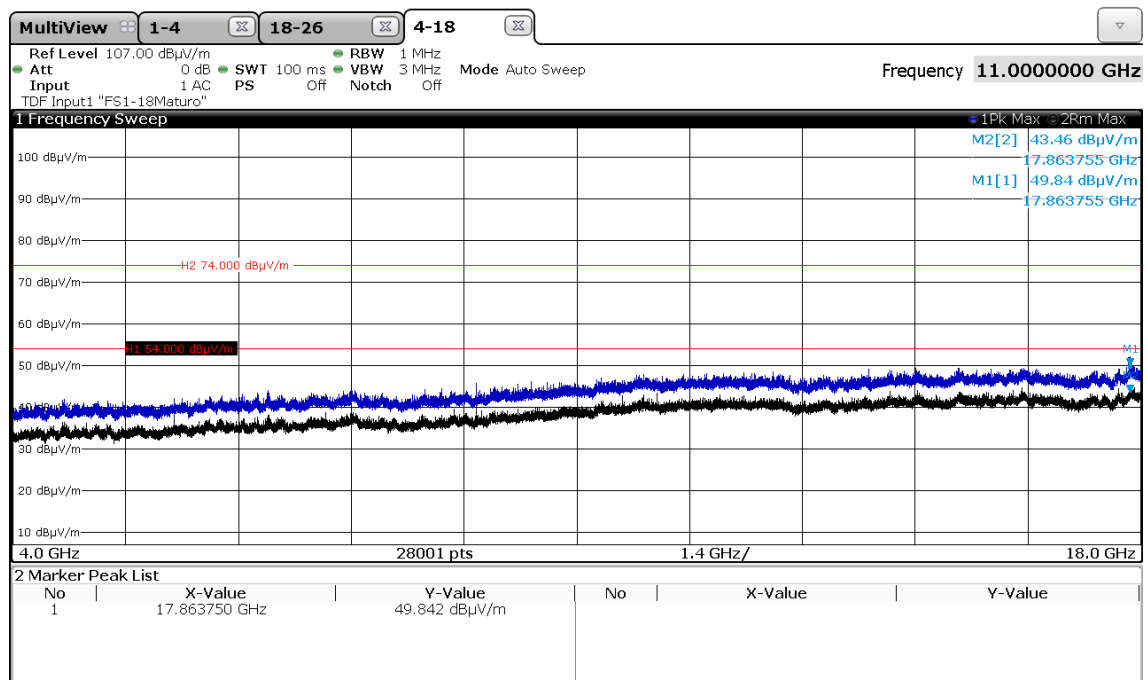
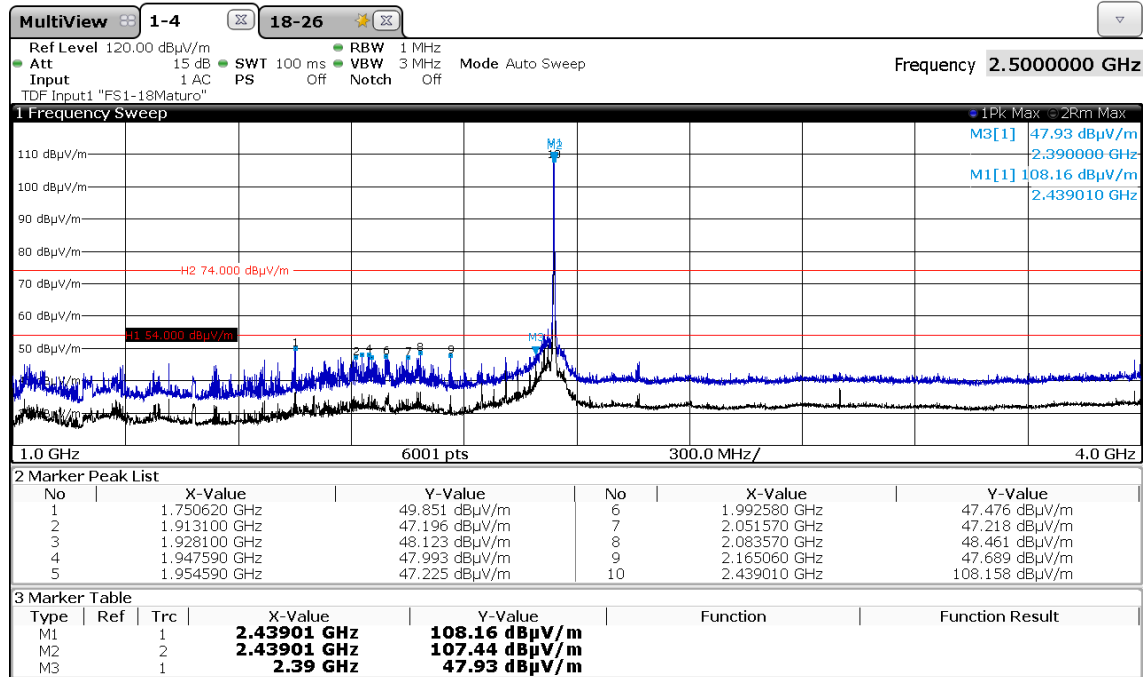


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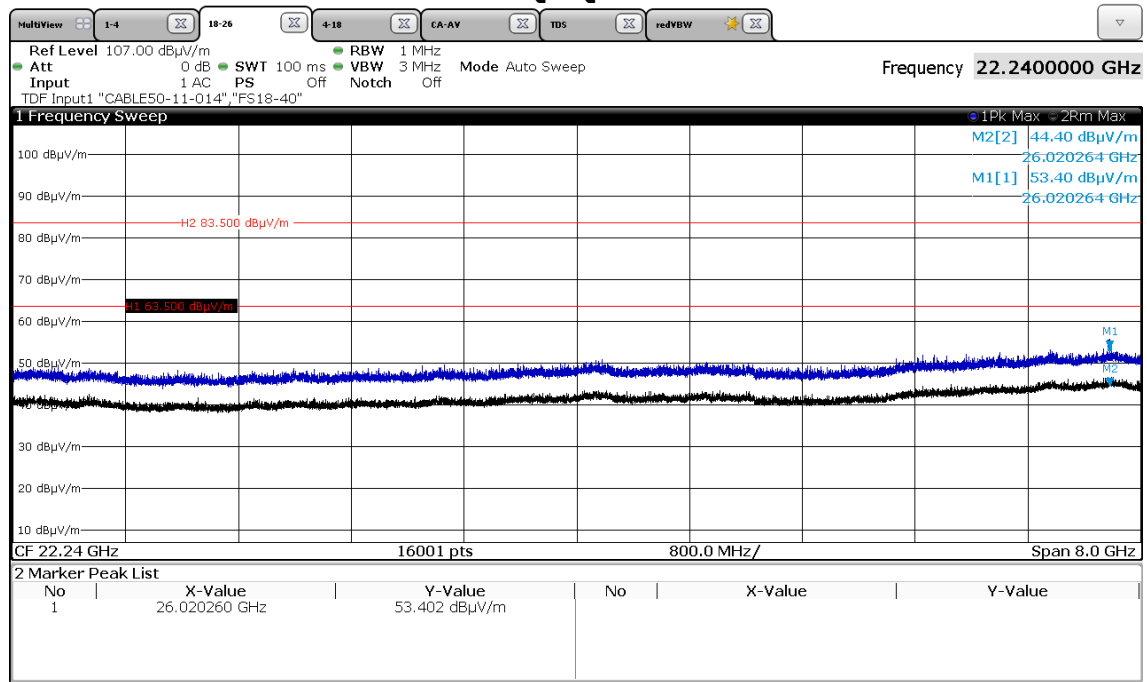


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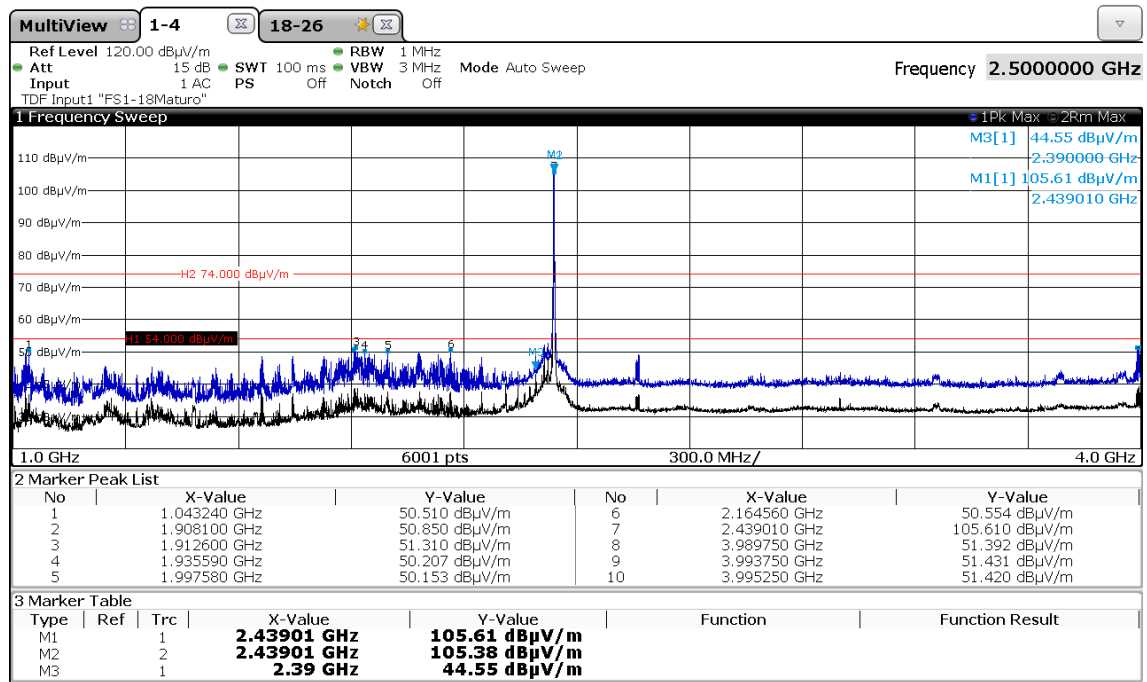
CH38 horizontal



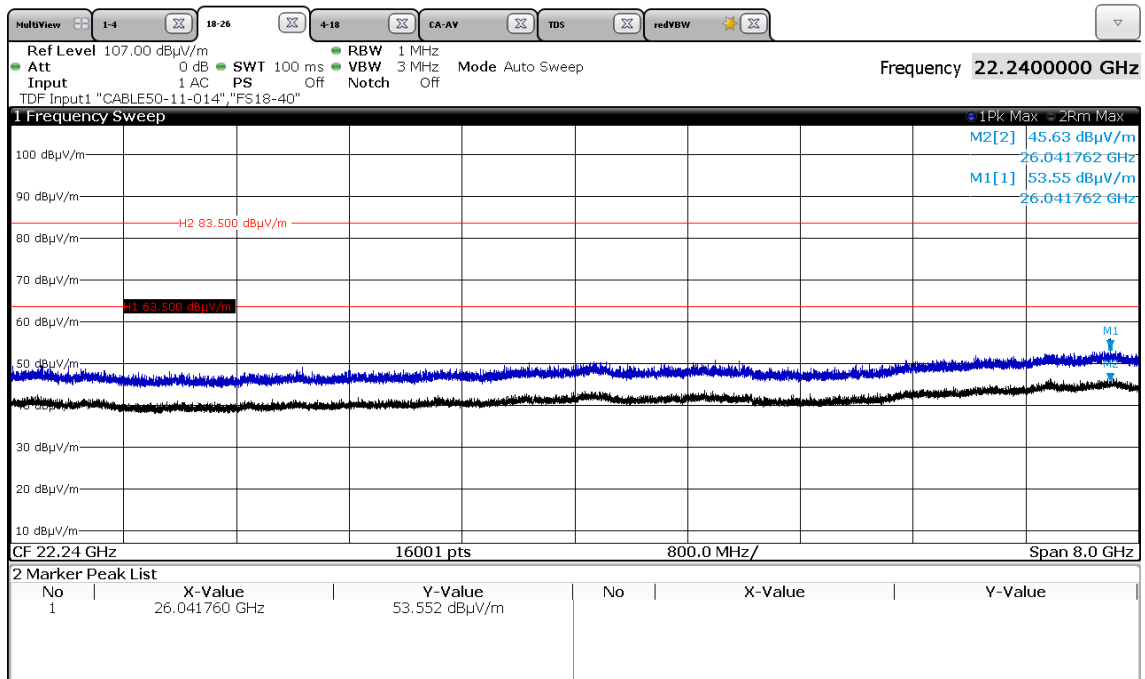
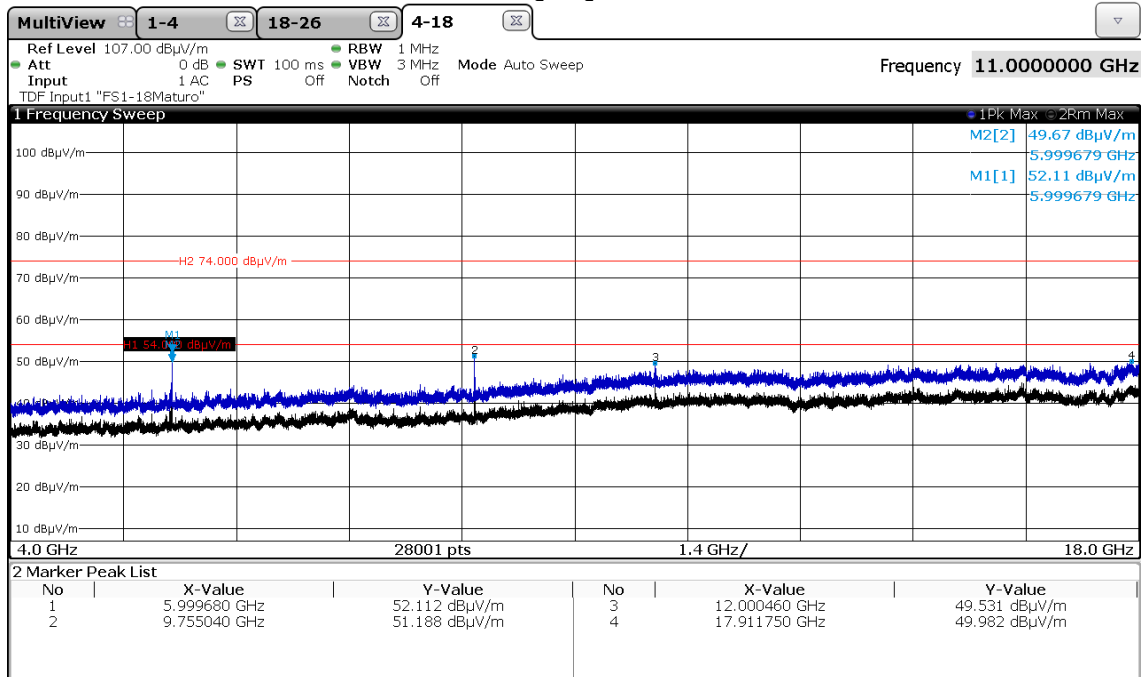
FCC ID: QOQWT41U



CH38 vertical

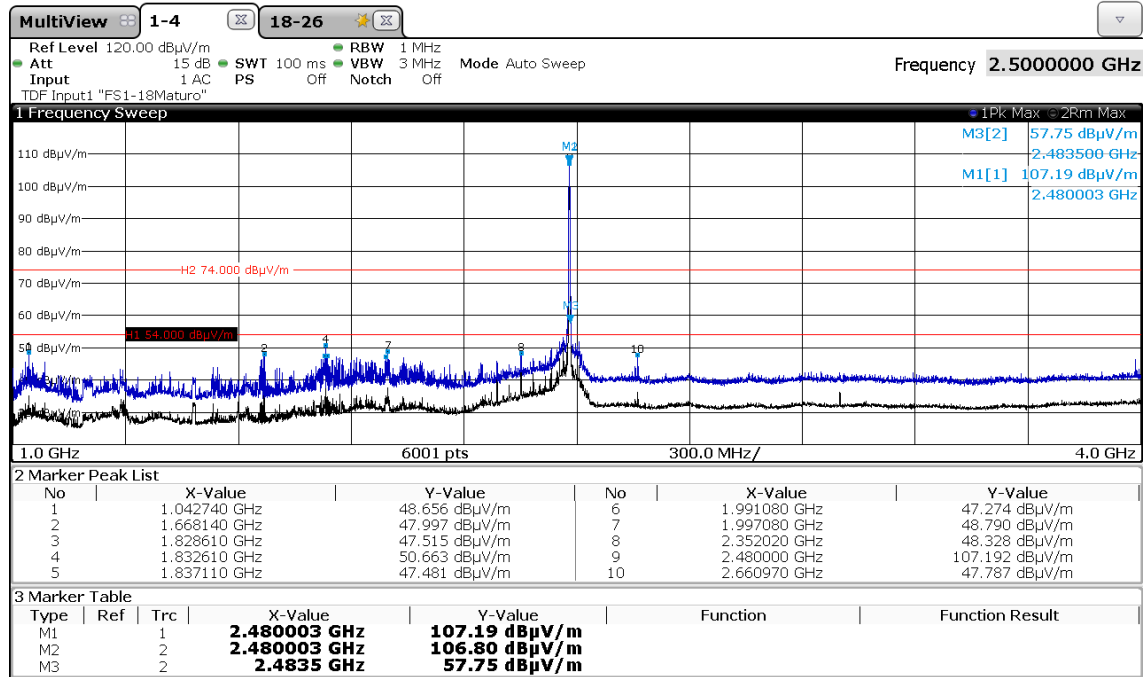


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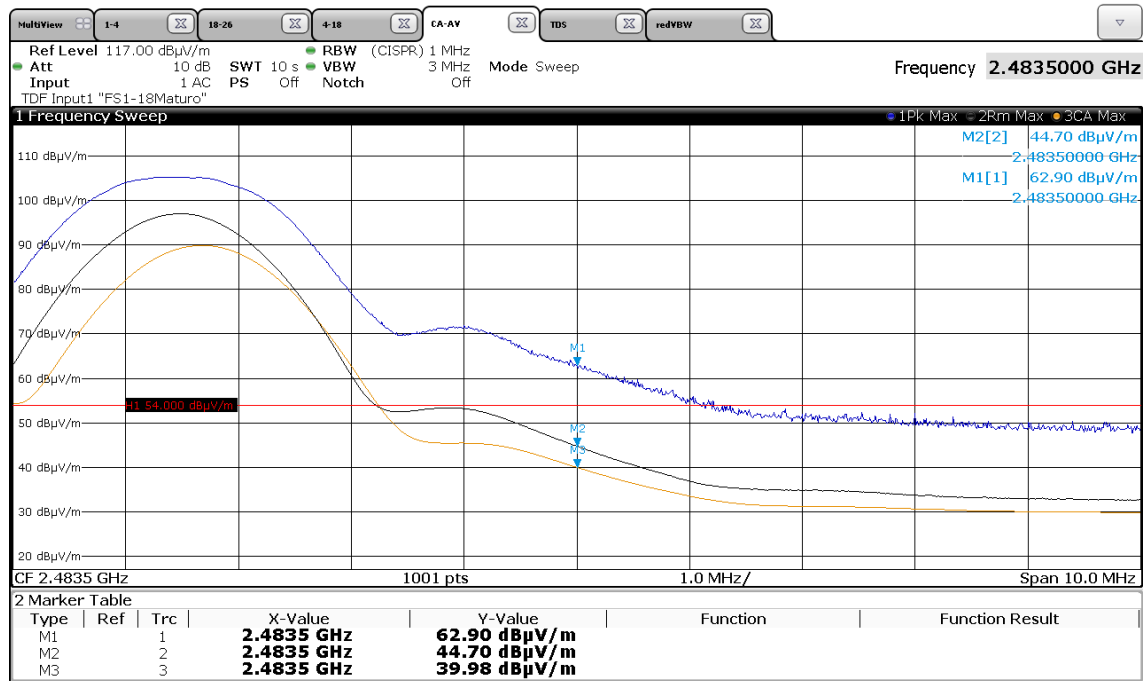


FCC ID: QOQWT41U

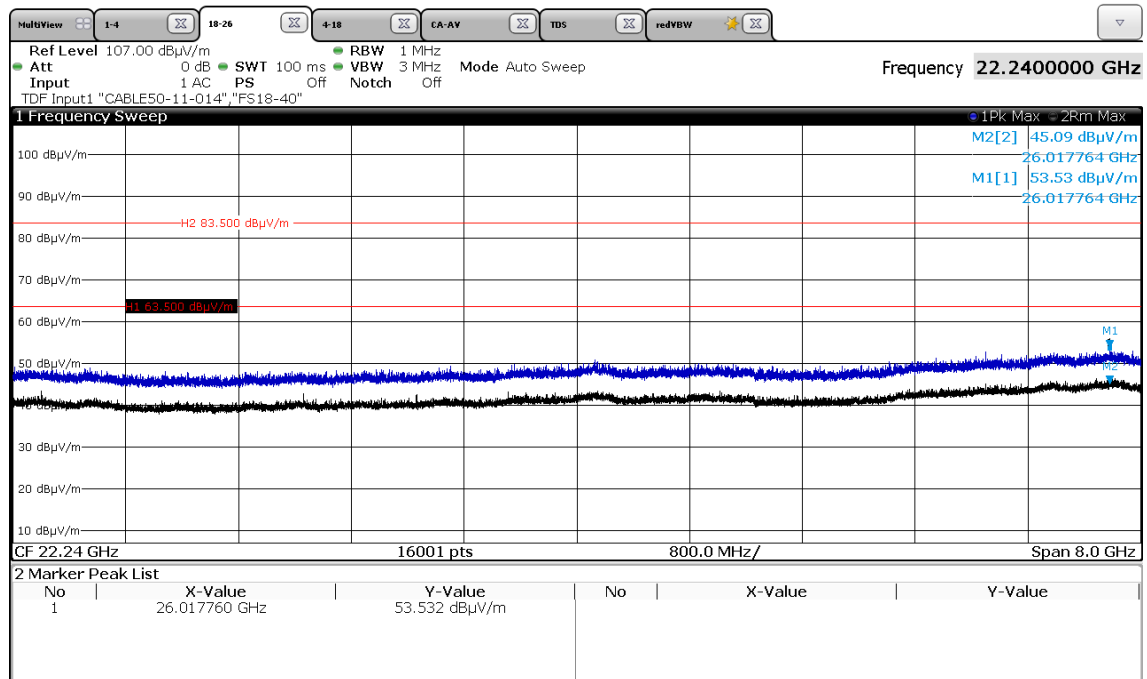
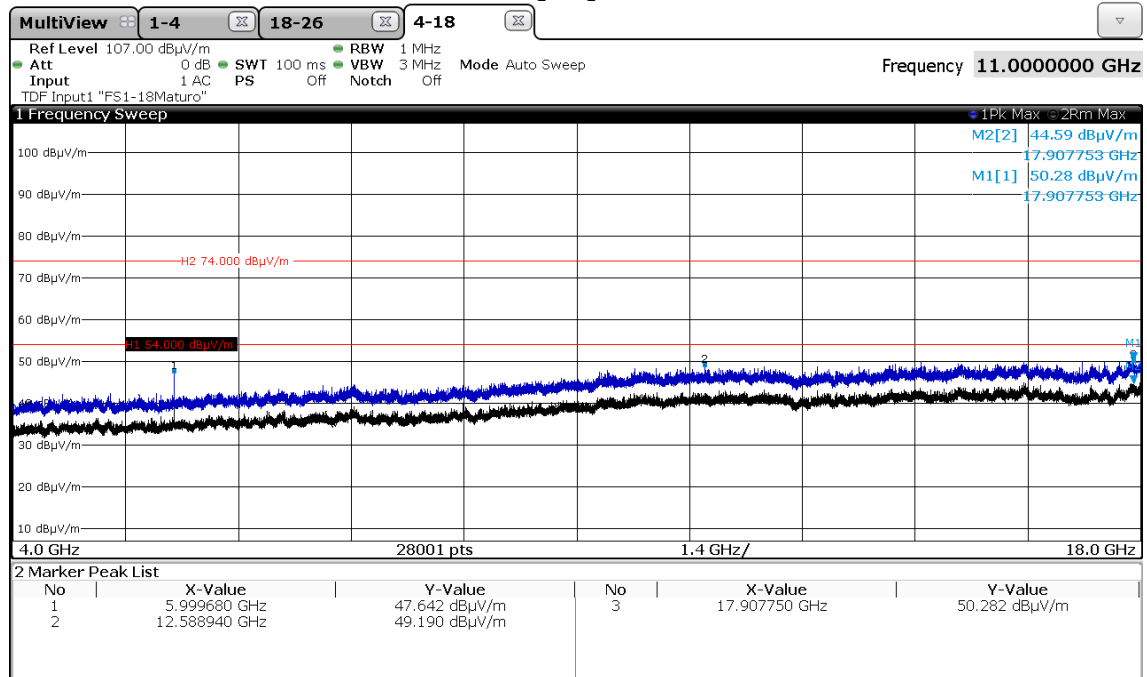
CH79 horizontal



Additional measurement with CISPR 16 detector

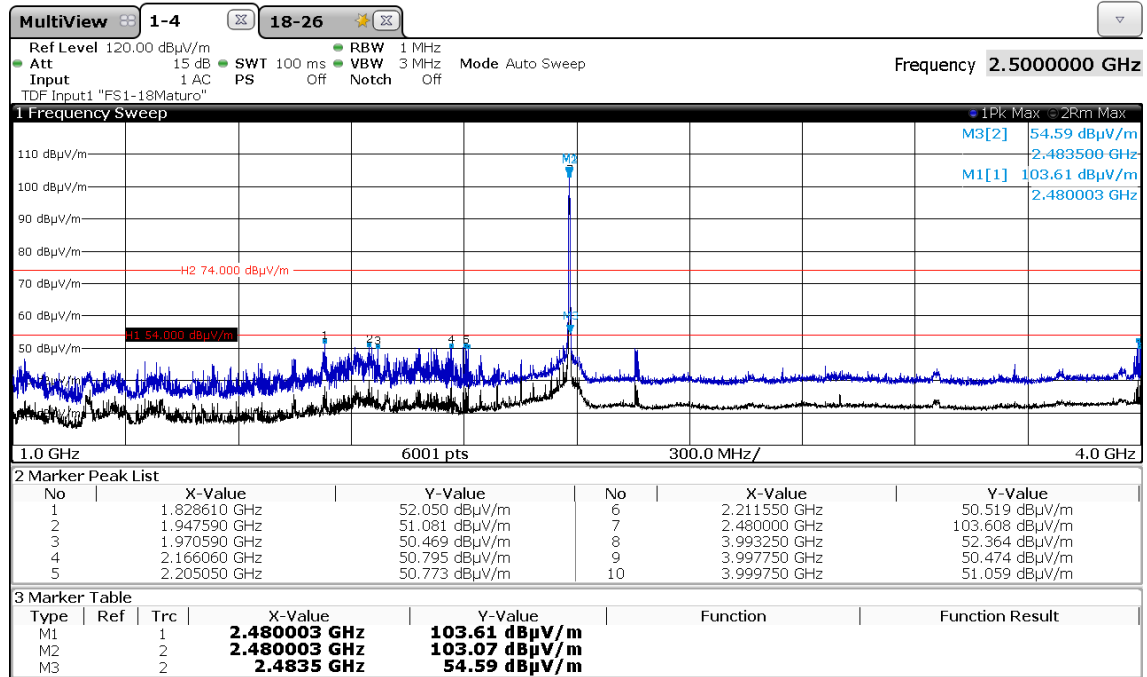


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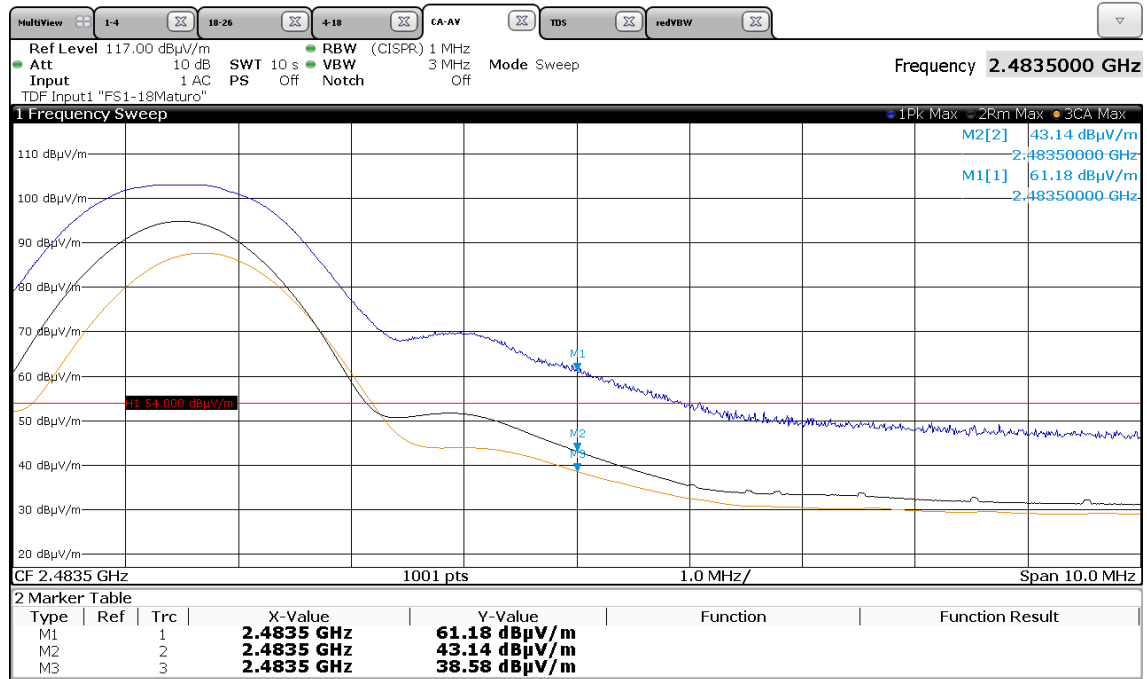


FCC ID: QOQWT41U

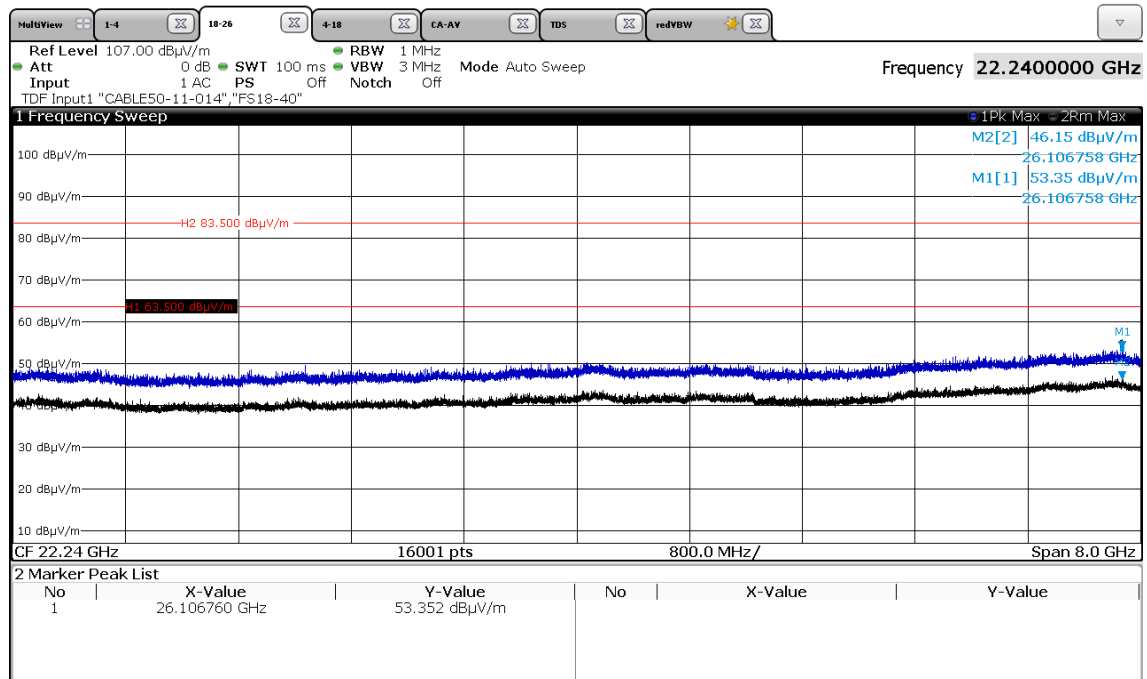
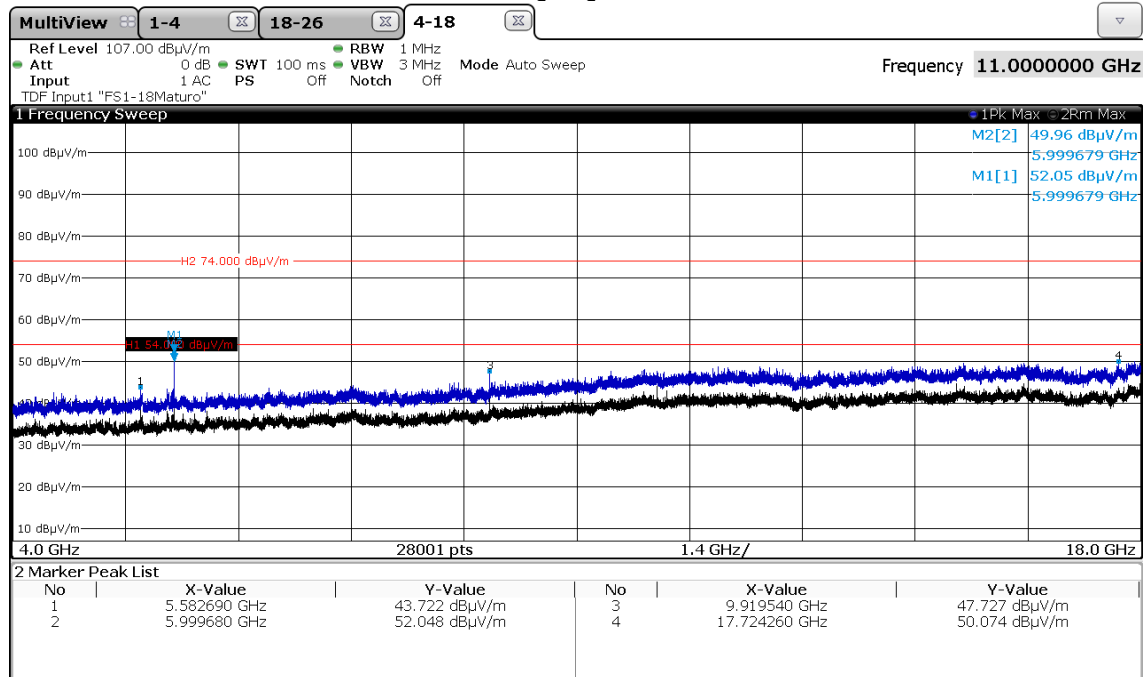
CH79 vertical



Additional measurement with CISPR 16 detector



FCC ID: QOQWT41U



FCC ID: QOQWT41U

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

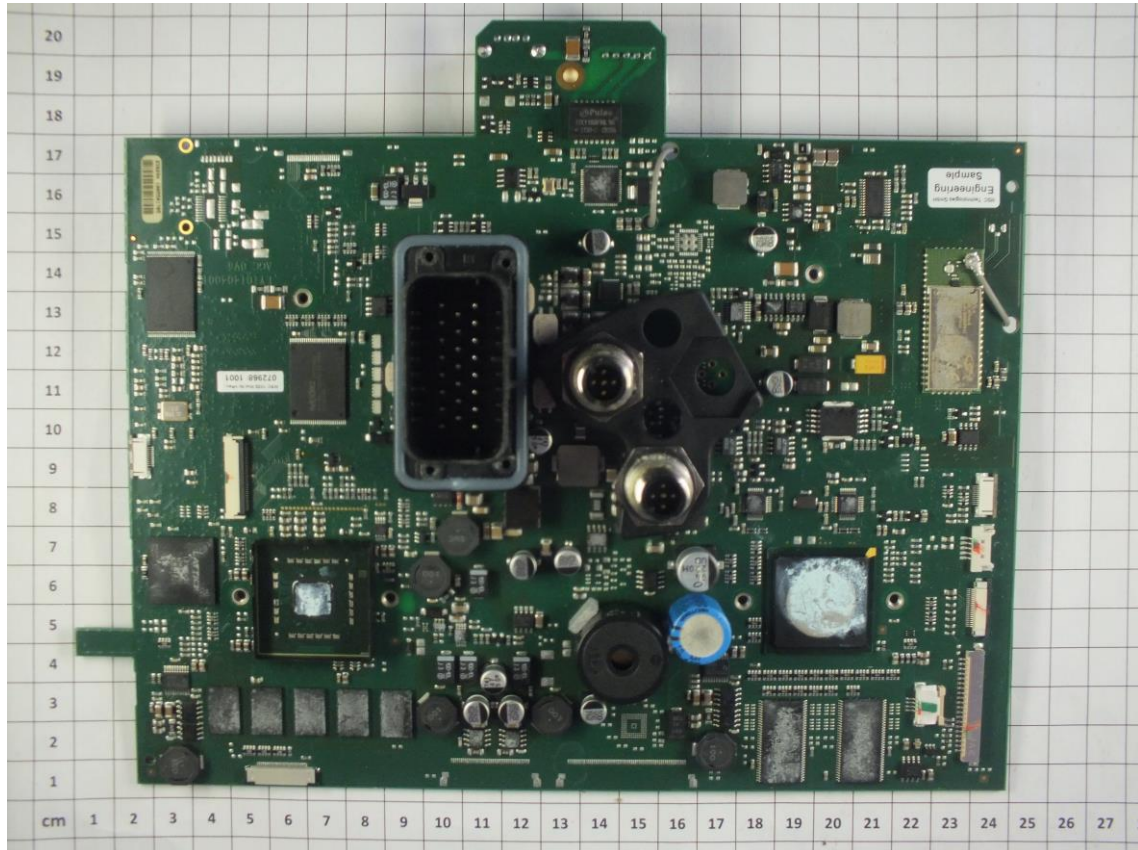
Test ID	Model Type	Kind of Equipment	Manufacturer	Equipment No.
SER 2	ESVS 30	EMI Test Receiver	Rohde & Schwarz München	02-02/03-05-006
	VULB 9168	Trilog Broadband Antenna	Schwarzbeck Mess-Elektronik	02-02/24-05-005
	NW-2000-NB	RF Cable	Huber + Suhner	02-02/50-05-113
	KK-EF393/U-16N-21N20 m	RF Cable 20m	Huber + Suhner	02-02/50-12-018
	KK-SD_7/8-2X21N-33,0M	RF Cable 33 m	Huber + Suhner AG	02-02/50-15-028
SER 3	ESW26	EMI Test Receiver	Rohde & Schwarz München	02-02/03-17-002
	JS4-18004000-30-5A	RF Amplifier 18 - 40 GHz	PARZICH GMBH	02-02/17-05-017
	AMF-6D-01002000-22-10P	RF Amplifier	MITEQ, Inc.	02-02/17-15-004
	3117	Horn Antenna 1 - 18 GHz	EMCO Elektronik GmbH	02-02/24-05-009
	BBHA 9170	SHF-EHF Horn Antenna	Schwarzbeck Mess-Elektronik	02-02/24-05-014
	WHK 3.0/18G-10EF	High Pass Filter	Wainwright Instruments GmbH	02-02/50-05-180
	KMS102-0.2 m	RF Cable	Tactron Elektronik	02-02/50-11-020
	18N-20	Coax Attenuator 20dB	Tactron Elektronik	02-02/50-17-003
	NMS111-GL200SC01-NMS11	RF Cable	GigaLane Co., Ltd.	02-02/50-17-012
	BAM 4.5-P	Antenna Mast	maturo GmbH	02-02/50-17-024
	NCD	Controller for Antenna Mast	maturo GmbH	02-02/50-17-025
	KK-SF106-2X11N-6,5M	RF Cable	Huber + Suhner	02-02/50-18-016

FCC ID: QOQWT41U

ATTACHMENT A

A1) Photo documentation of the EUT

External view:



FCC ID: QOQWT41U

