

Annex 1: Measurement diagrams 21-1-0039901T01a-A1-C2

Number of pages:	65	Date of Report:	2021-Nov-11
Testing company:	CETECOM GmbH Im Teelbruch 116 45219 Essen Germany Tel. + 49 (0) 20 54 / 95 19-0 Fax: + 49 (0) 20 54 / 95 19-150	Applicant:	IMST GmbH
Product: Model:	LoRa radio module iM980B		
FCC ID:	Q9B-IM980B	IC:	10740A-IM980B
Testing has been carried out in accordance with:	Title 47 CFR, Chapter I FCC Regulations, Subchapter A §15.247 (DTS & FHSS) ISED-Regulations RSS-247, Issue 2 (DTS & FHSS) RSS-Gen., Issue 5 Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method and limit".		

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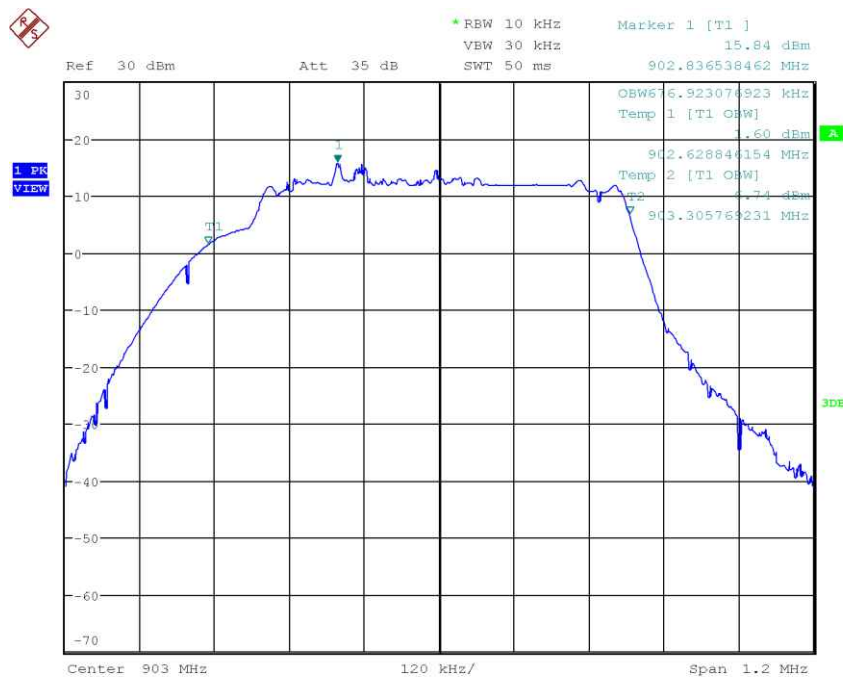
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1 Measurement diagrams

1.1 DTS mode

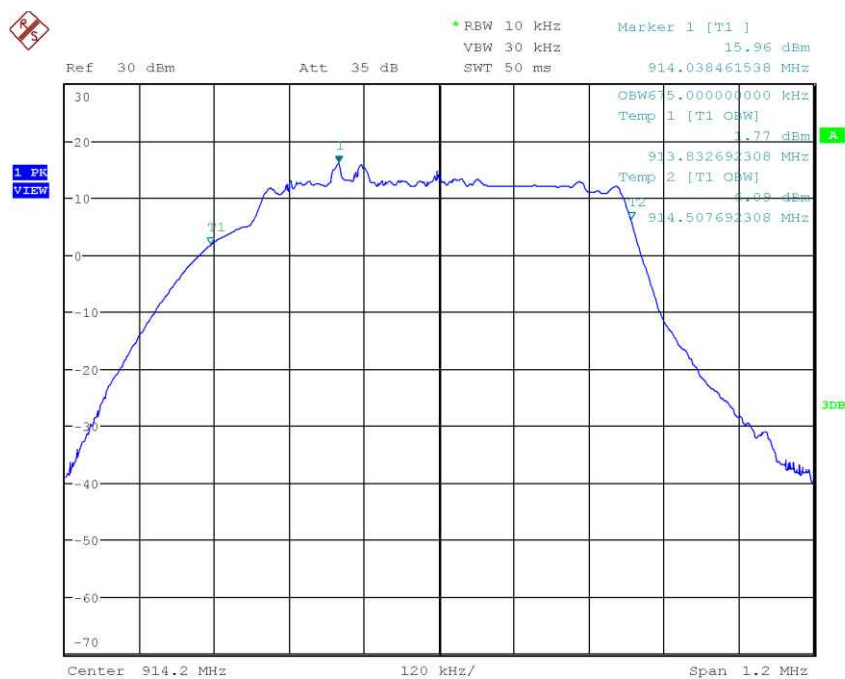
Remark: If the EUT operates under DTS mode, the lowest channel is at 903 MHz, the middle channel is chosen to be 914.2 MHz and the highest channel is at 927.1 MHz.

1.1.1 99% Occupied bandwidth (99%OBW)



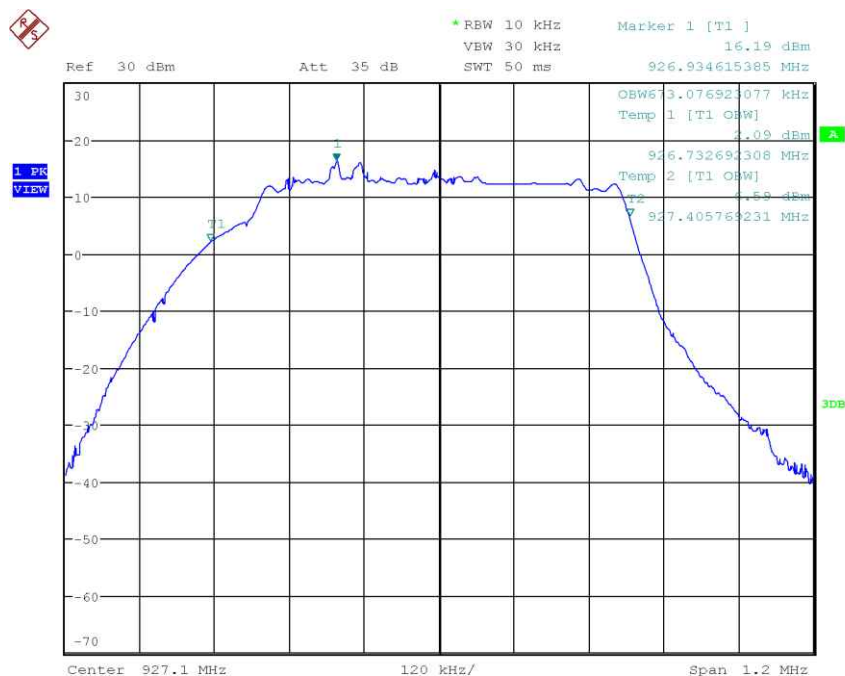
Date: 3.AUG.2021 12:15:47

Diagram 1. 99% OBW, channel low, SF = 8



Date: 3.AUG.2021 12:11:52

Diagram 2. 99% OBW, channel middle, SF = 8

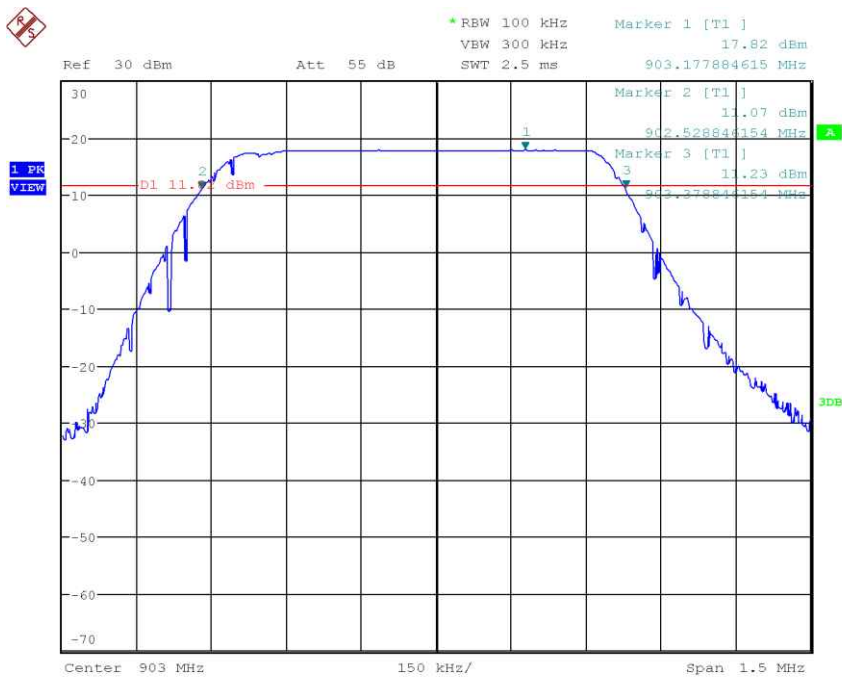


Date: 19.JUL.2021 16:51:36

Diagram 3. 99% OBW, channel high, SF = 8

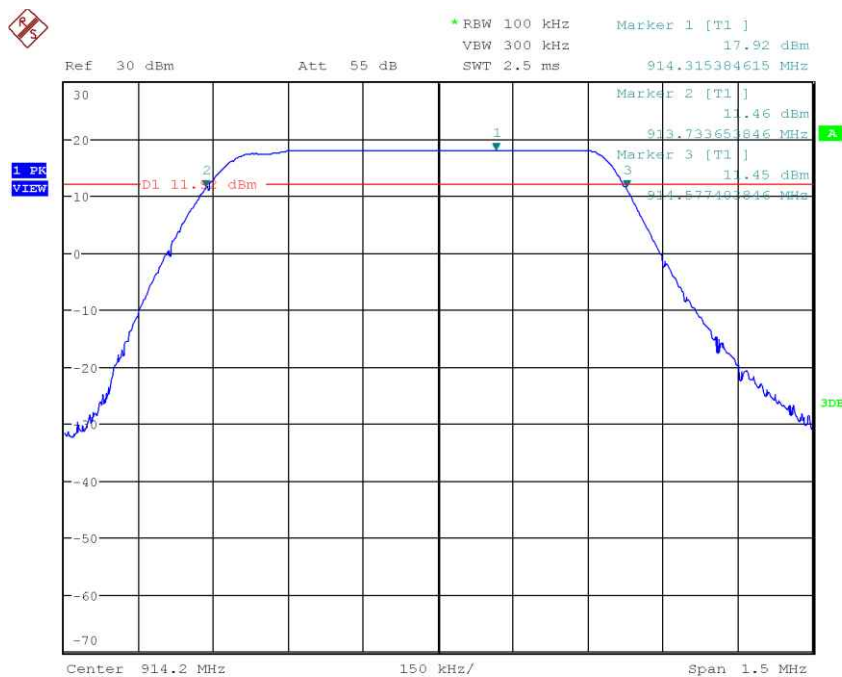


1.1.2 6 dB bandwidth



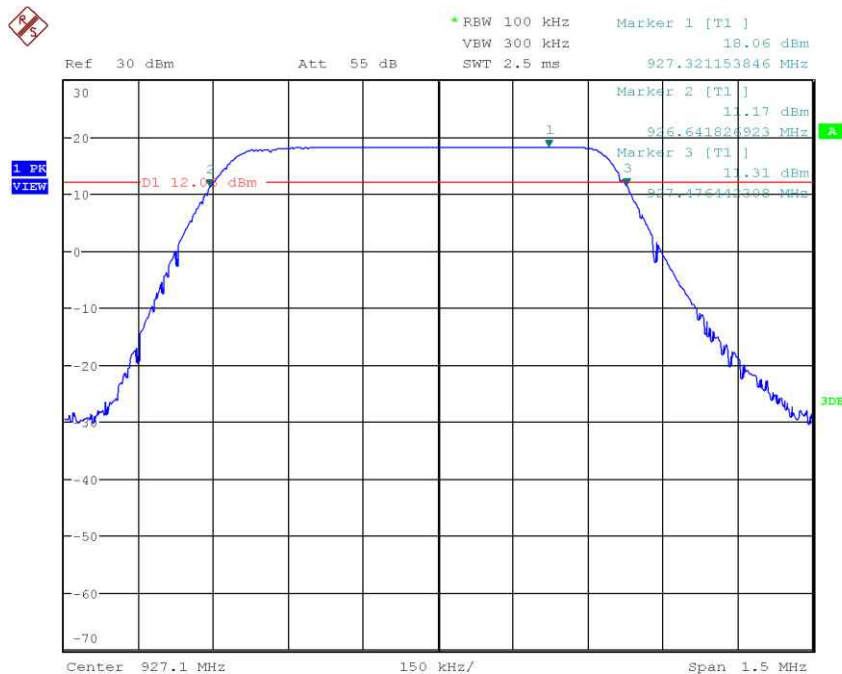
Date: 3.AUG.2021 13:48:38

Diagram 4. 6 dB bandwidth, channel low, SF = 8



Date: 3.AUG.2021 13:58:52

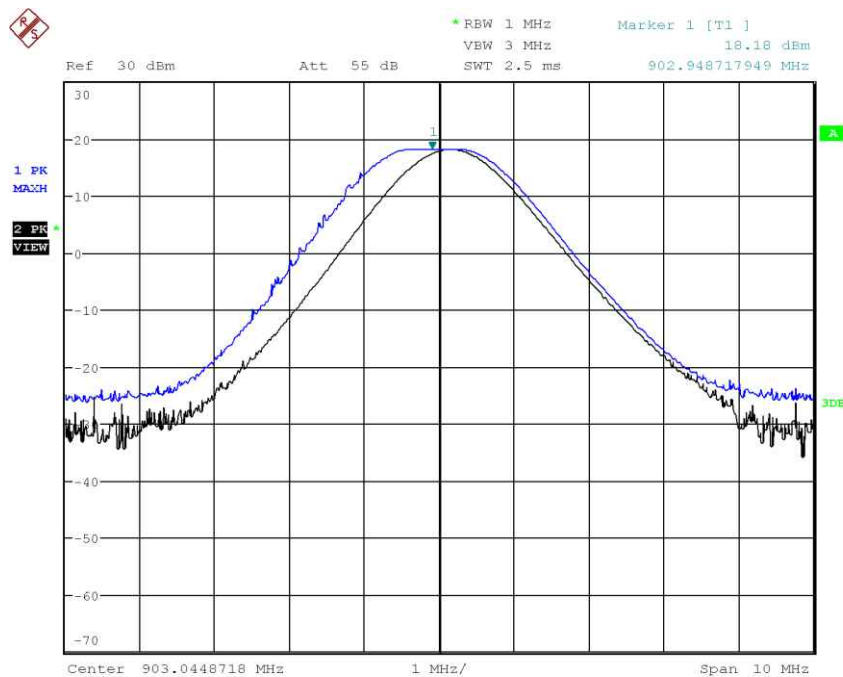
Diagram 5. 6 dB bandwidth, channel middle, SF = 8



Date: 3.AUG.2021 14:04:59

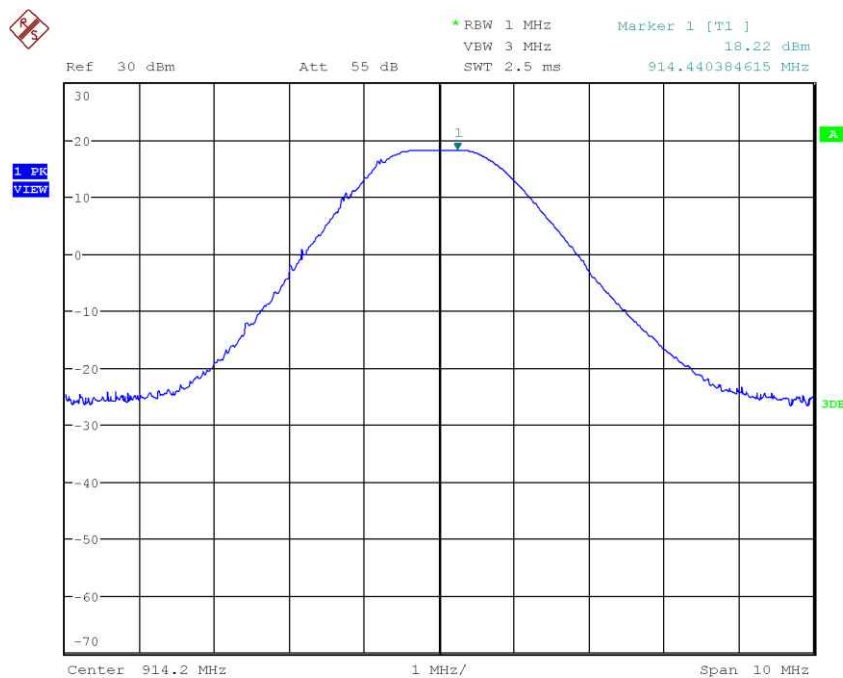
Diagram 6. 6 dB bandwidth, channel high, SF = 8

1.1.3 Max peak output power conducted



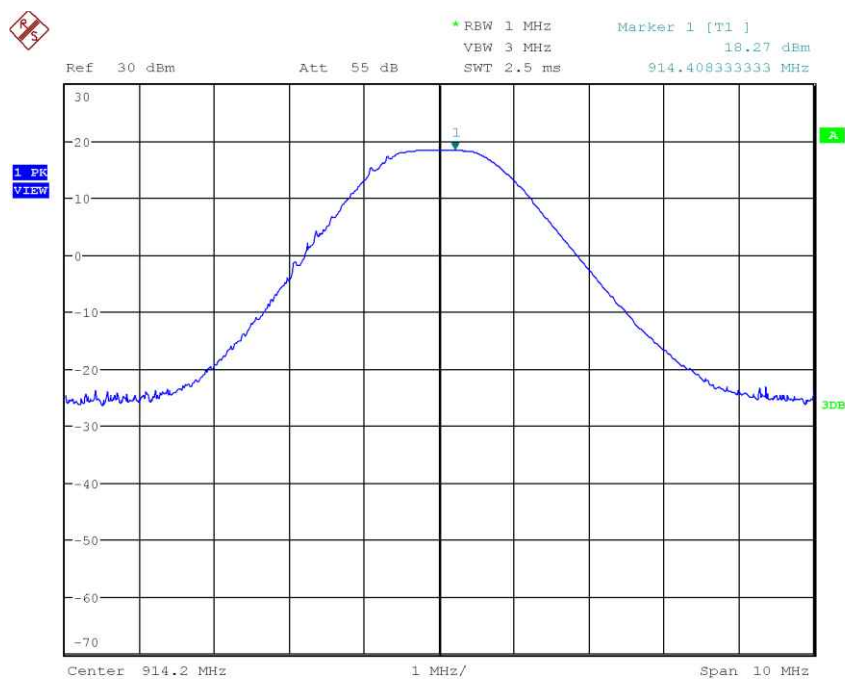
Date: 8.JUL.2021 16:54:23

Diagram 7. conducted power, channel low



Date: 9.JUL.2021 15:46:12

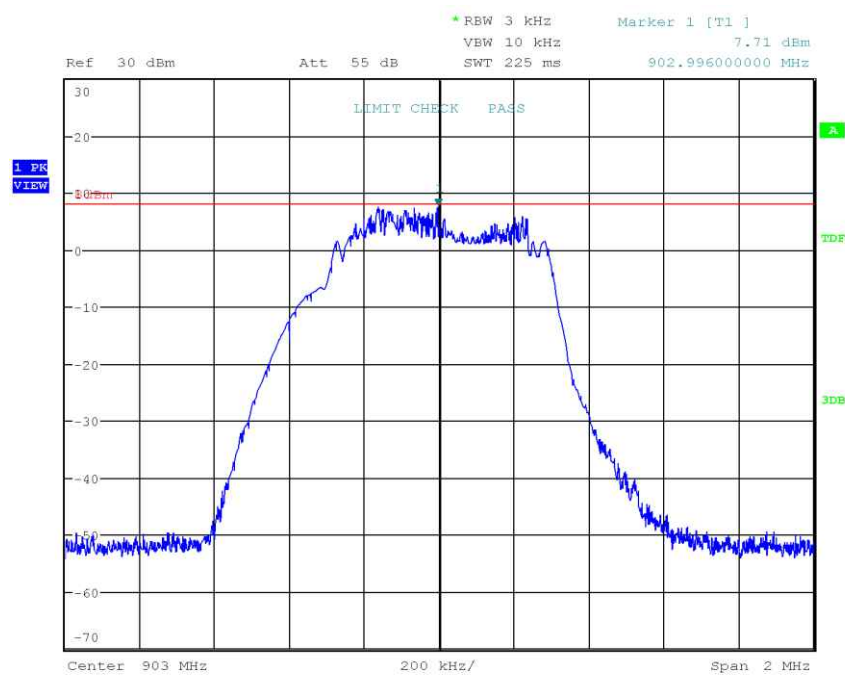
Diagram 8. conducted power, channel middle



Date: 8.JUL.2021 16:58:20

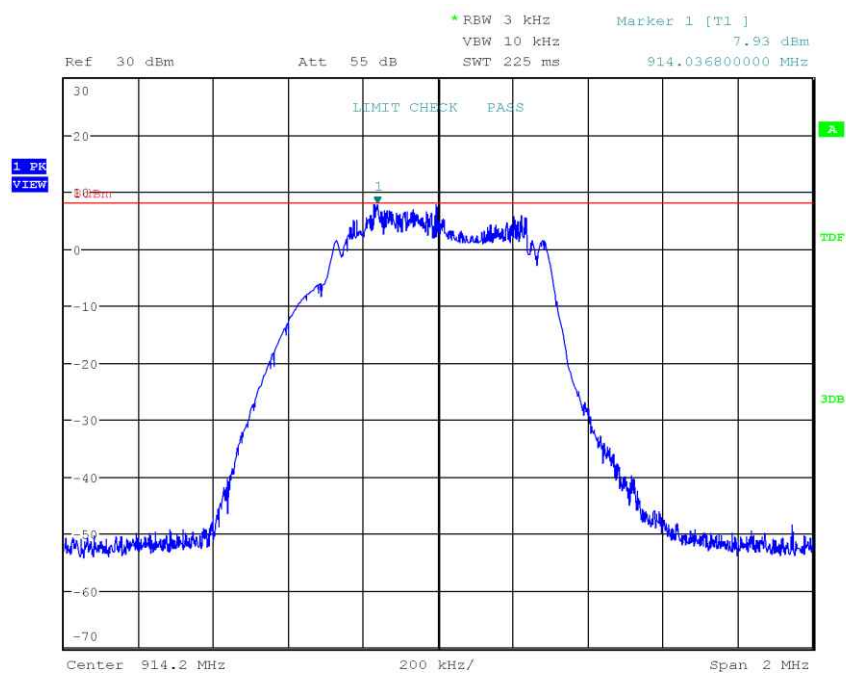
Diagram 9. conducted power, channel high

1.1.4 Power spectral density



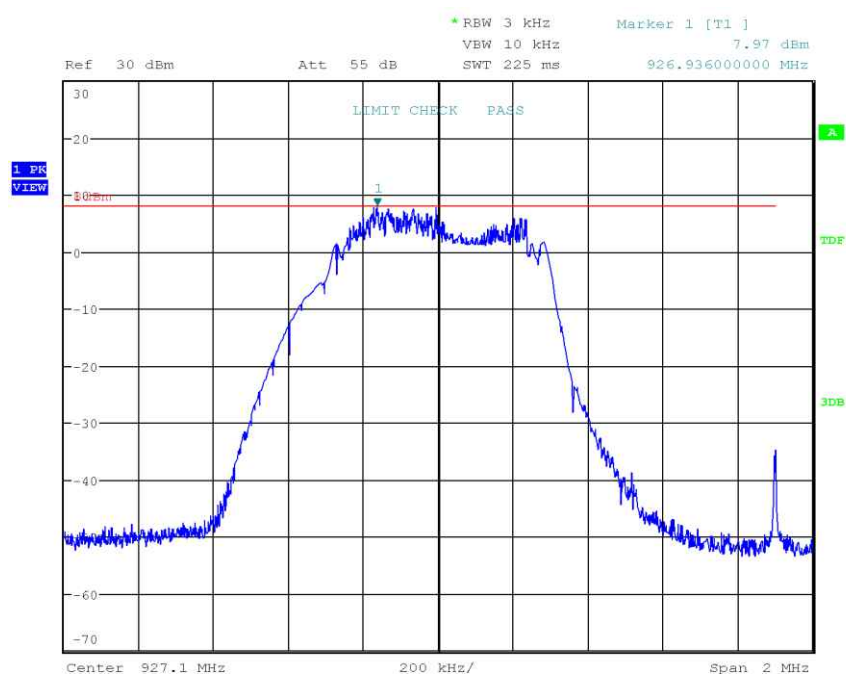
Date: 5.OCT.2021 15:22:51

Diagram 10. PSD, channel low



Date: 5.OCT.2021 15:25:39

Diagram 11. PSD, channel middle



Date: 5.OCT.2021 15:31:21

Diagram 12. PSD, channel high

Ref 30 dBm Att 55 dB RBW 100 kHz VBW 300 kHz SWT 5 ms

Marker 1 [T1] 903.178000000 MHz -33.86 dBm

Marker 2 [T1] 902.000000000 MHz -33.86 dBm

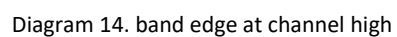
1 PK VIEW

D1 -2 dBm

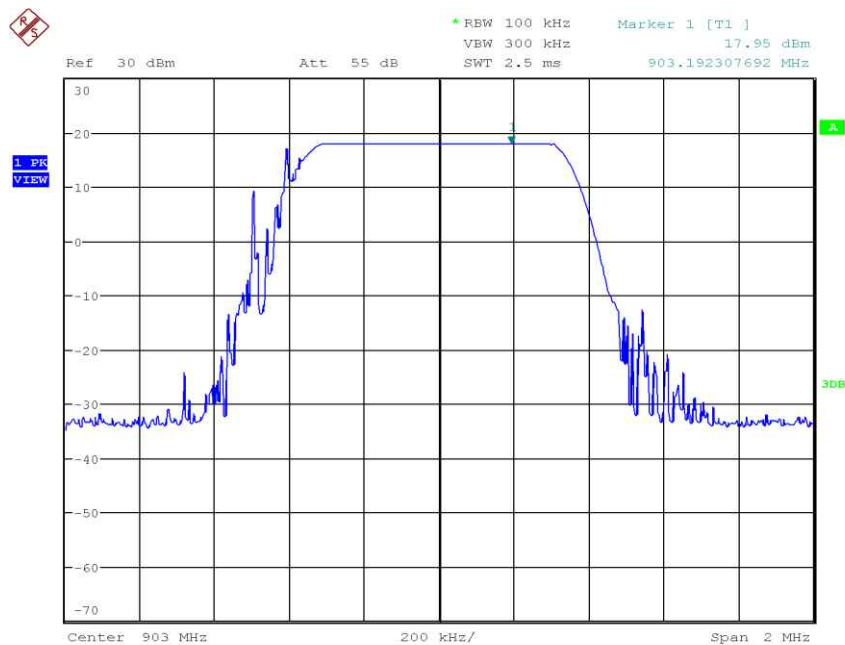
F1

Start 901 MHz 300 kHz/ Stop 904 MHz

Diagram 13. band edge at channel low

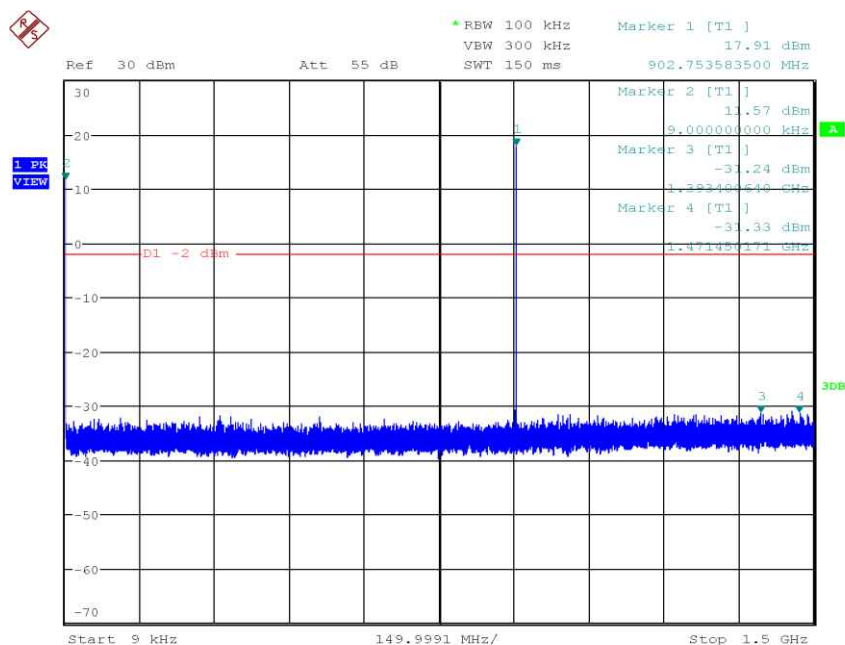


1.1.6 Conducted spurious emission



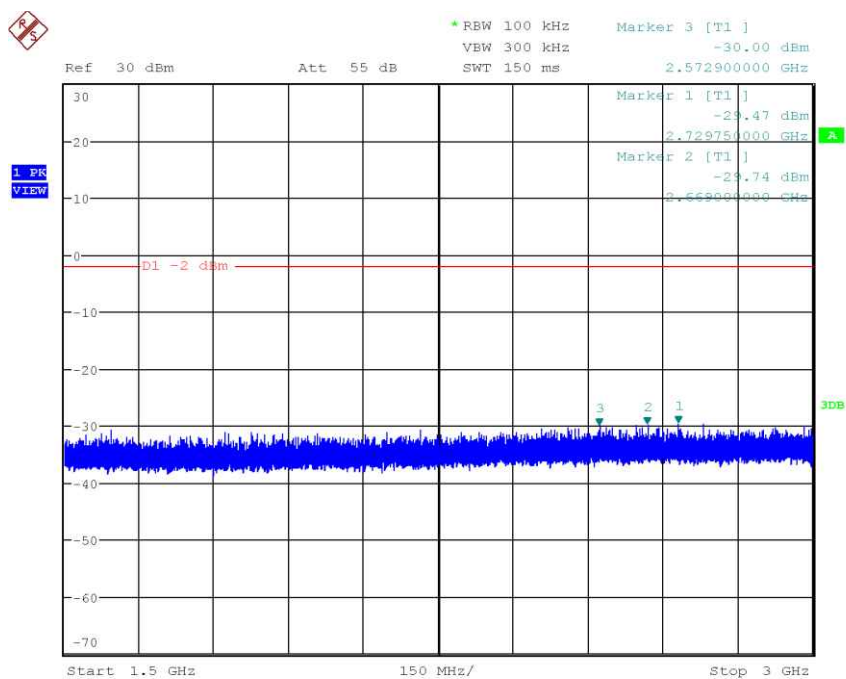
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Diagram 15. The fundamental emission level is at 18 dBm, thus the spurious emissions must be beneath -2 dBm, if the peak detector is applied.



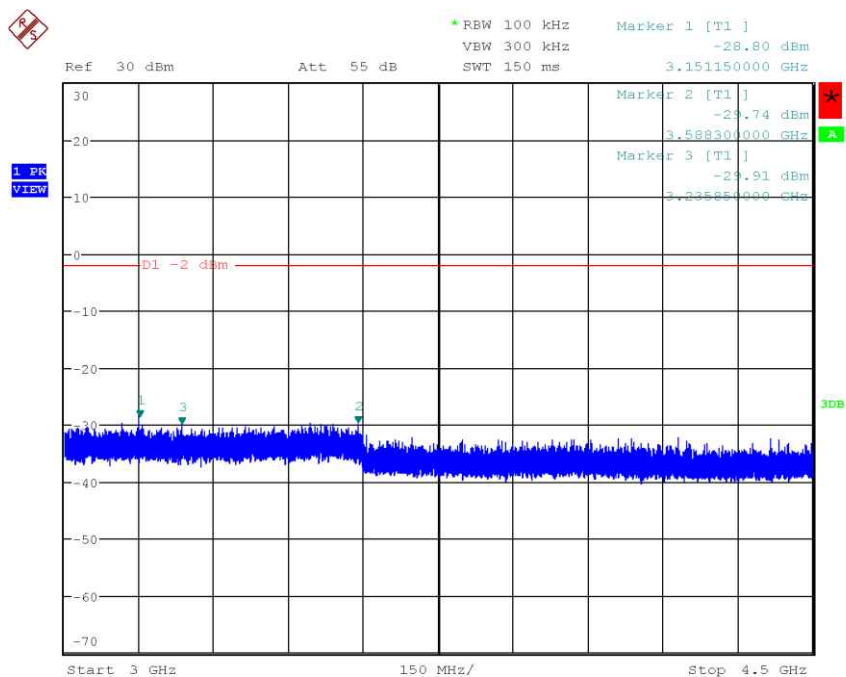
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Diagram 16. conducted spurious for channel low, from 9 kHz to 1.5 GHz. The peak at Marker 1 is intrinsic from the spectrum analyzer, which is irrelevant to the limit.



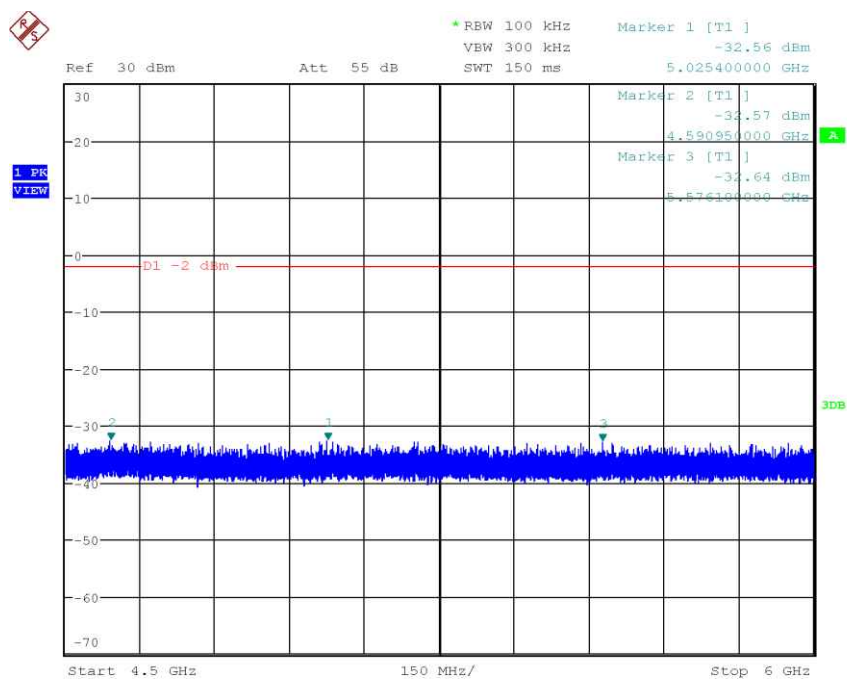
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Diagram 17. conducted spurious for channel low, from 1.5 GHz to 3 GHz.



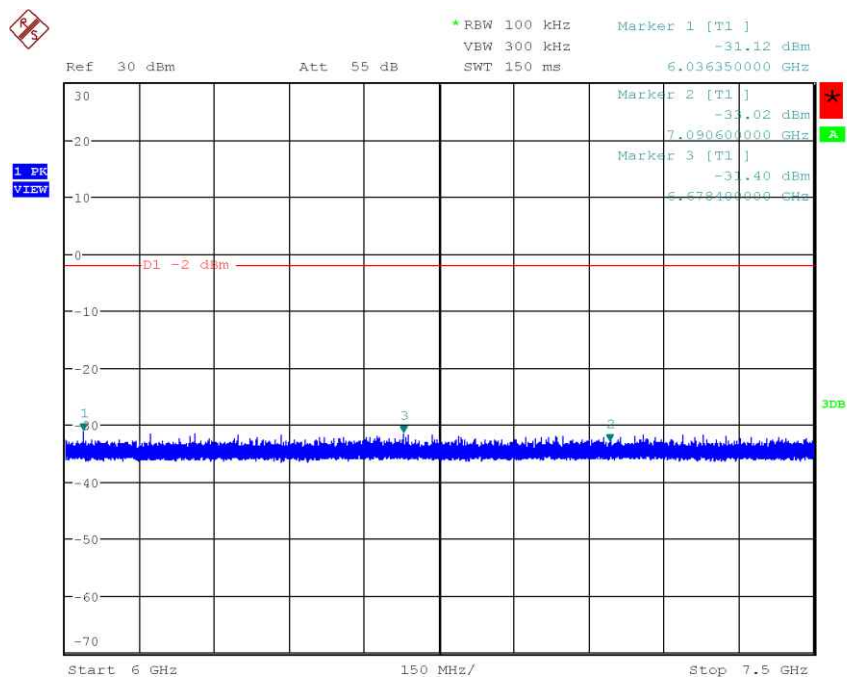
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Diagram 18. conducted spurious for channel low, from 3 GHz to 4.5 GHz.



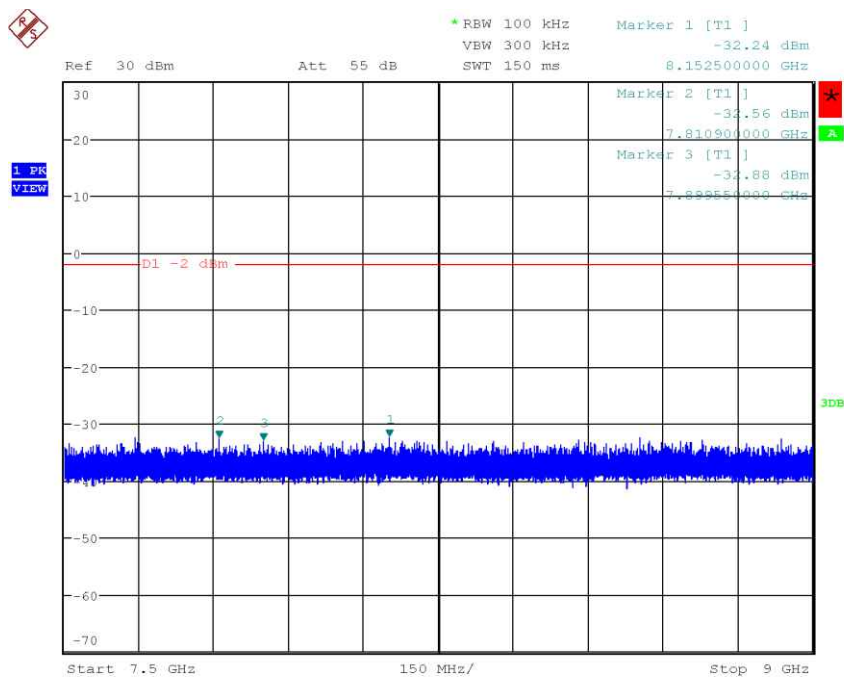
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Diagram 19. conducted spurious for channel low, from 4.5 GHz to 6 GHz.



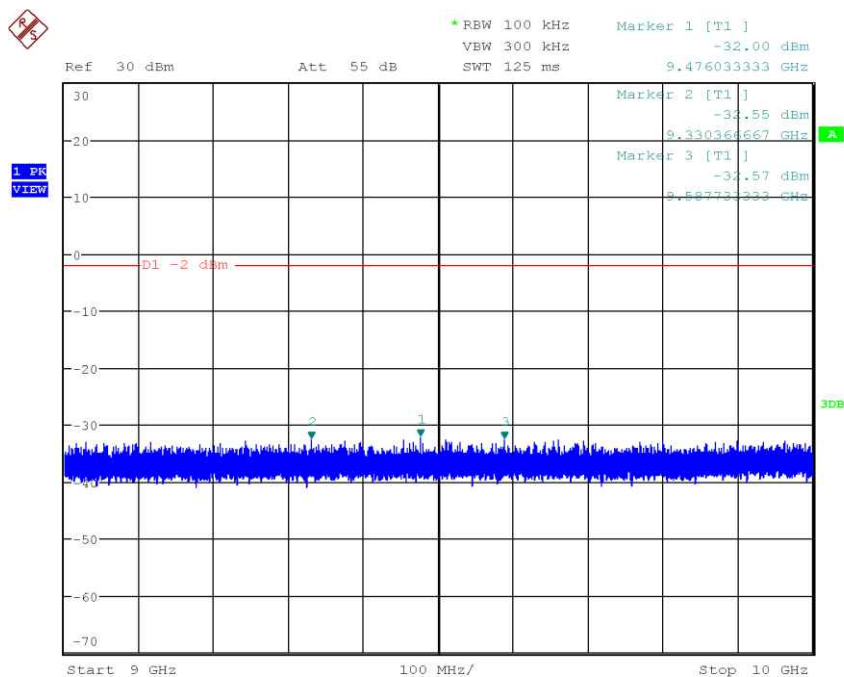
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Diagram 20. conducted spurious for channel low, from 6 GHz to 7.5 GHz



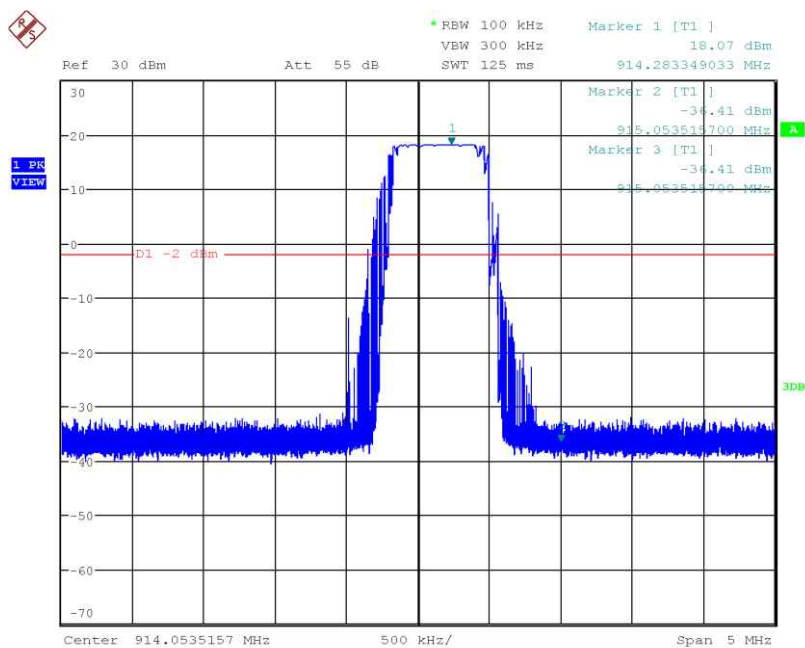
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Diagram 21. conducted spurious for channel low, from 7.5 GHz to 9 GHz



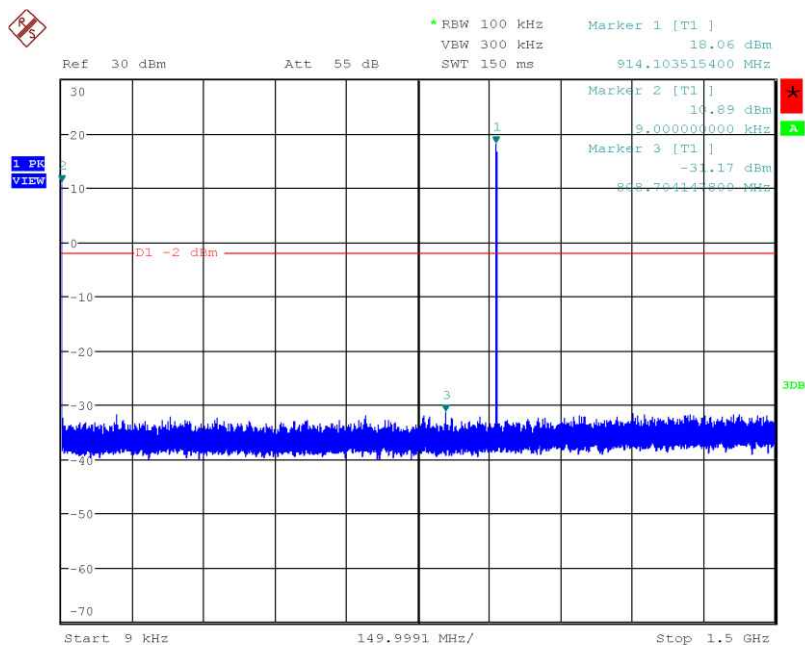
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Diagram 22. conducted spurious for channel low, from 9 GHz to 10 GHz



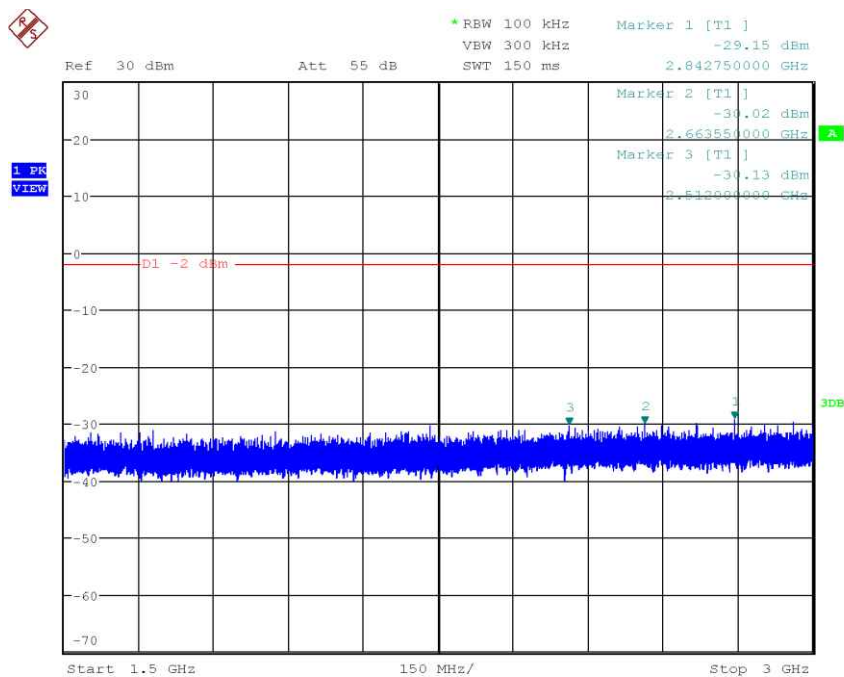
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Diagram 23. The fundamental emission level is at 18 dBm, thus the spurious emissions must be beneath -2 dBm, if the peak detector is applied.



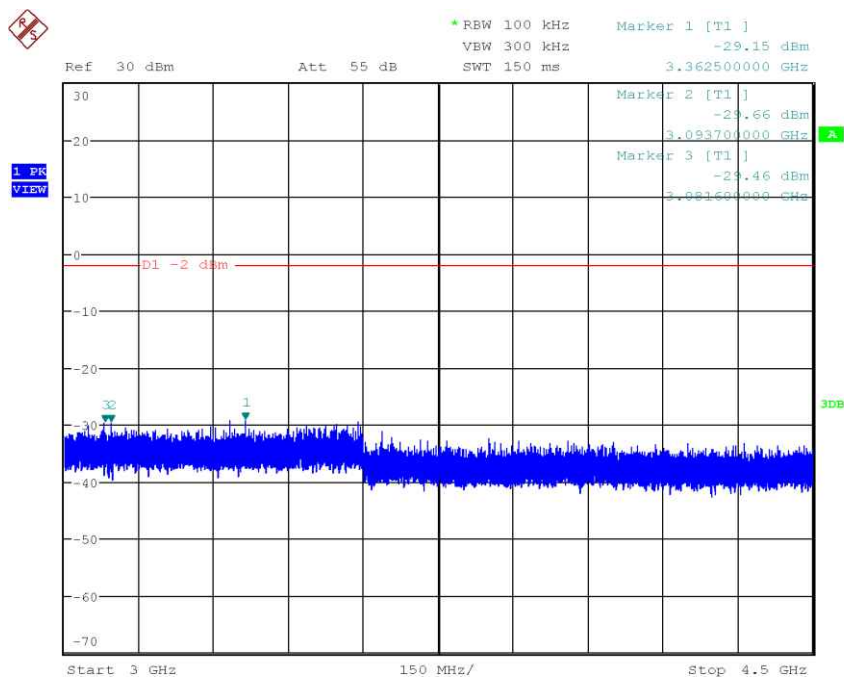
Date: 9.JUL.2021 17:01:00

Diagram 24. conducted spurious for channel middle, from 9 kHz to 1.5 GHz. The peak at Marker 2 is intrinsic from the spectrum analyzer, which is irrelevant to the limit.



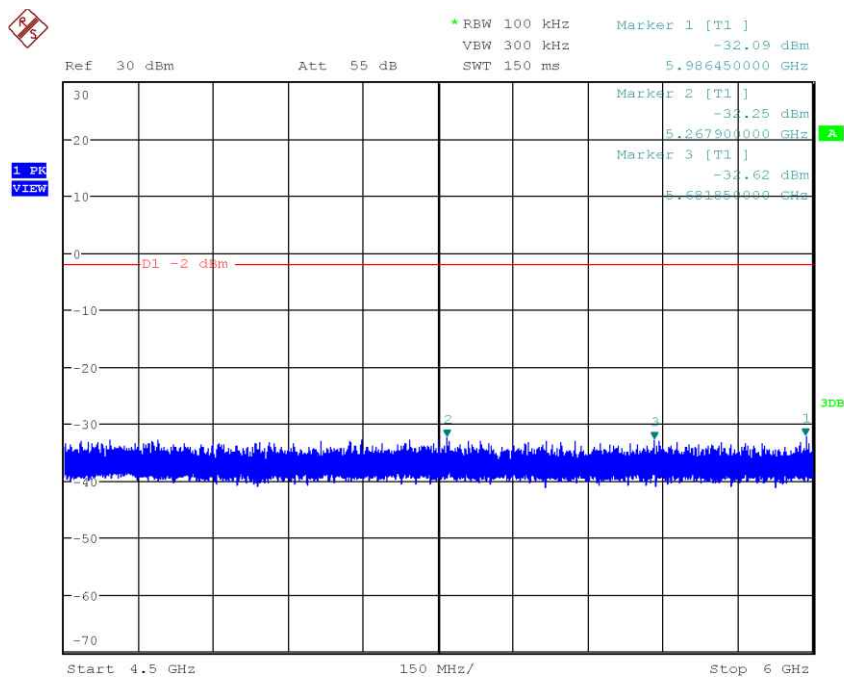
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Diagram 25. conducted spurious for channel middle, from 1.5 GHz to 3 GHz.



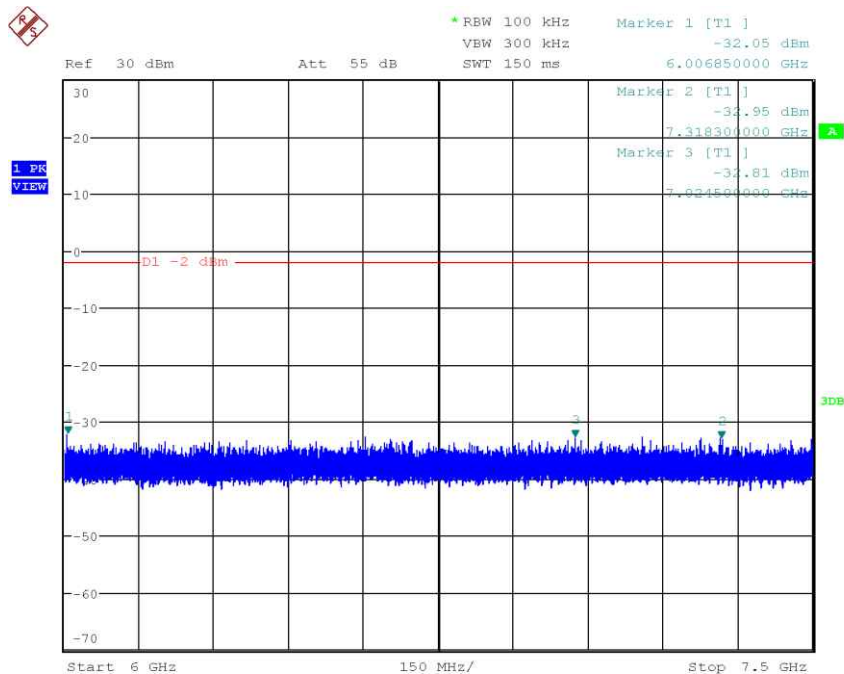
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Diagram 26. conducted spurious for channel middle, from 3 GHz to 4.5 GHz.



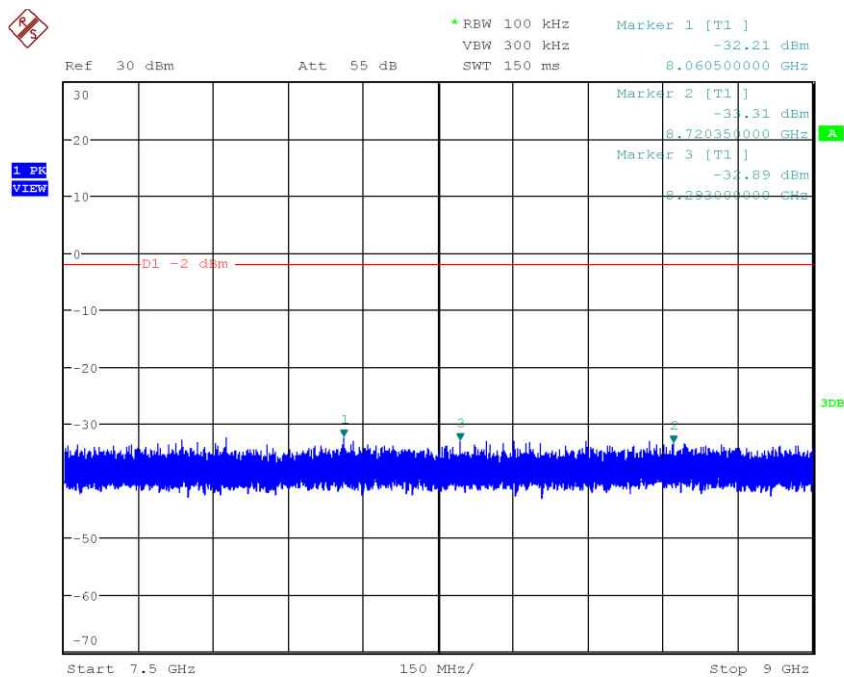
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Diagram 27. conducted spurious for channel middle, from 4.5 GHz to 6 GHz



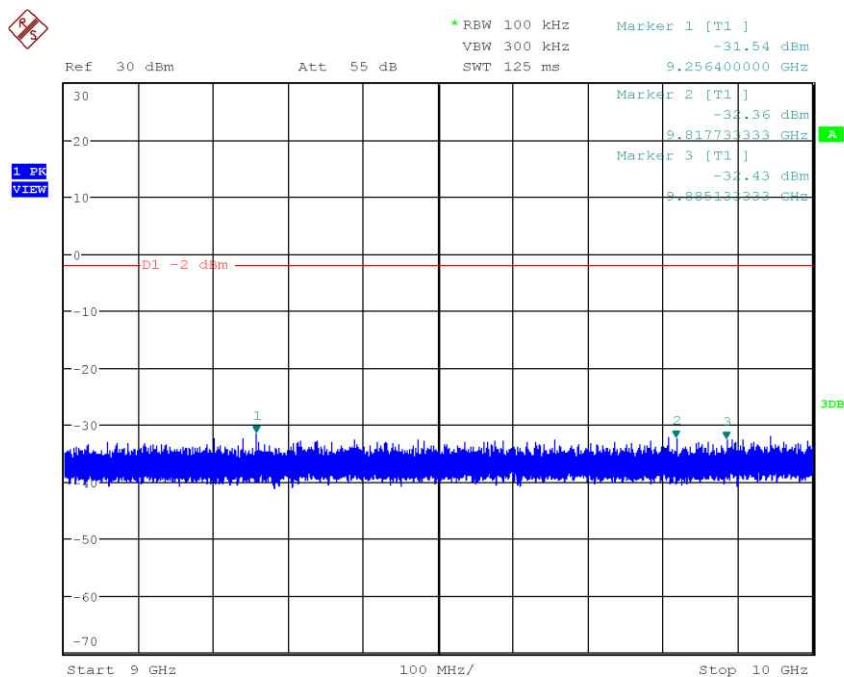
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Diagram 28. conducted spurious for channel middle, from 6 GHz to 7.5 GHz



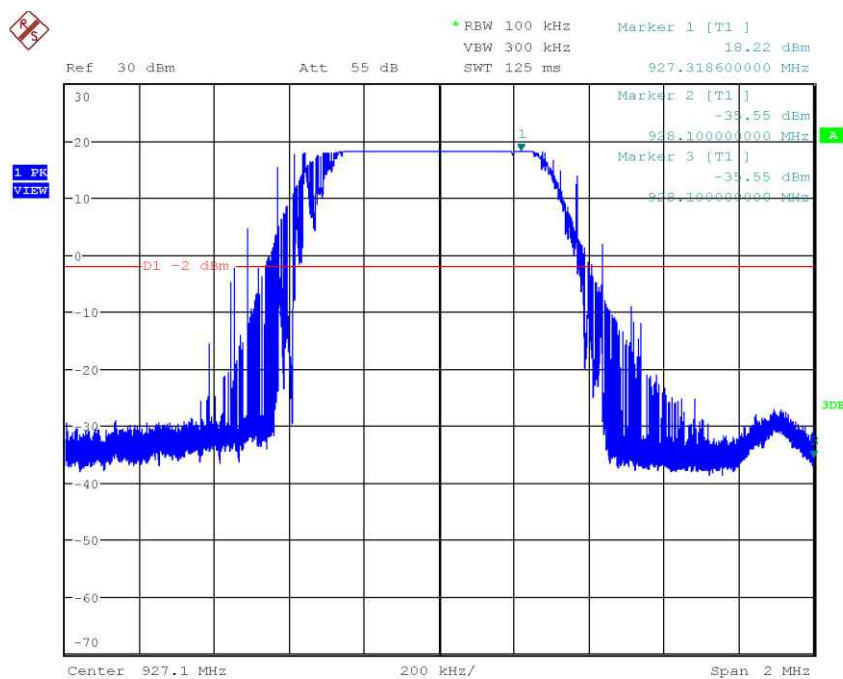
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Diagram 29. conducted spurious for channel middle, from 7.5 GHz to 9 GHz



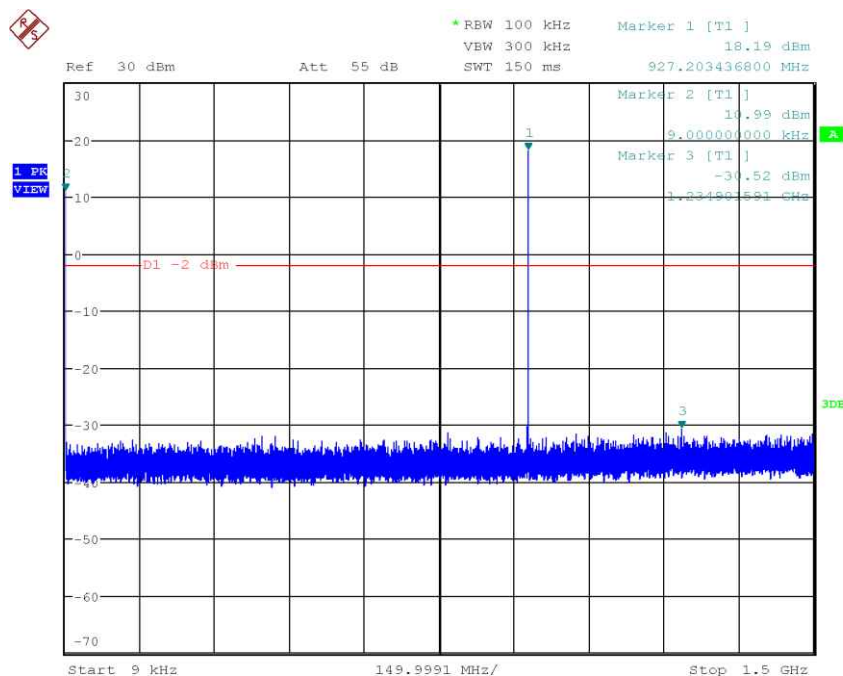
Date: 9.JUL.2021 17:07:17

Diagram 30. conducted spurious for channel middle, from 9 GHz to 10 GHz



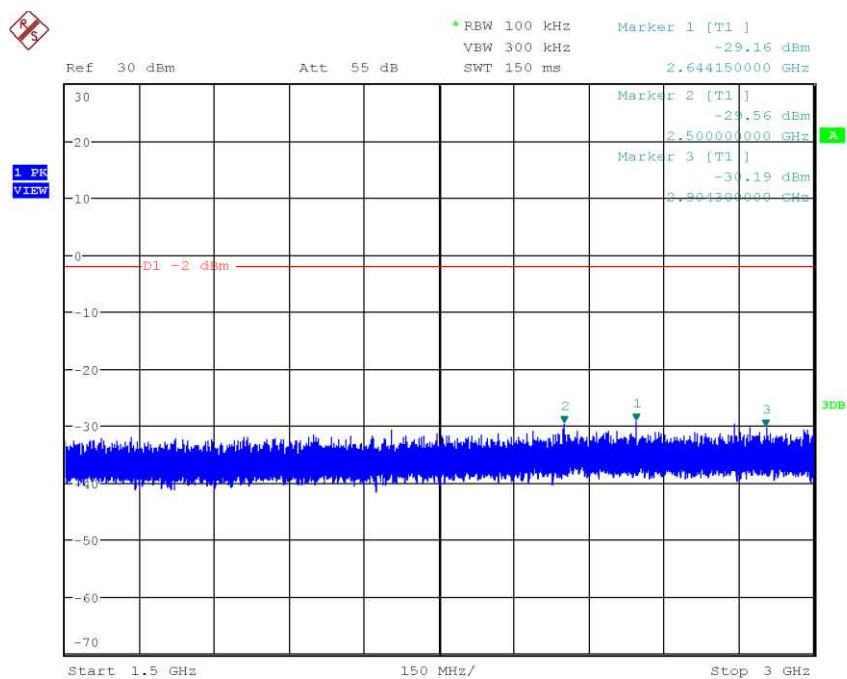
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Diagram 31. The fundamental emission level is at 18 dBm, thus the spurious emissions must be beneath -2 dBm, if the peak detector is applied.



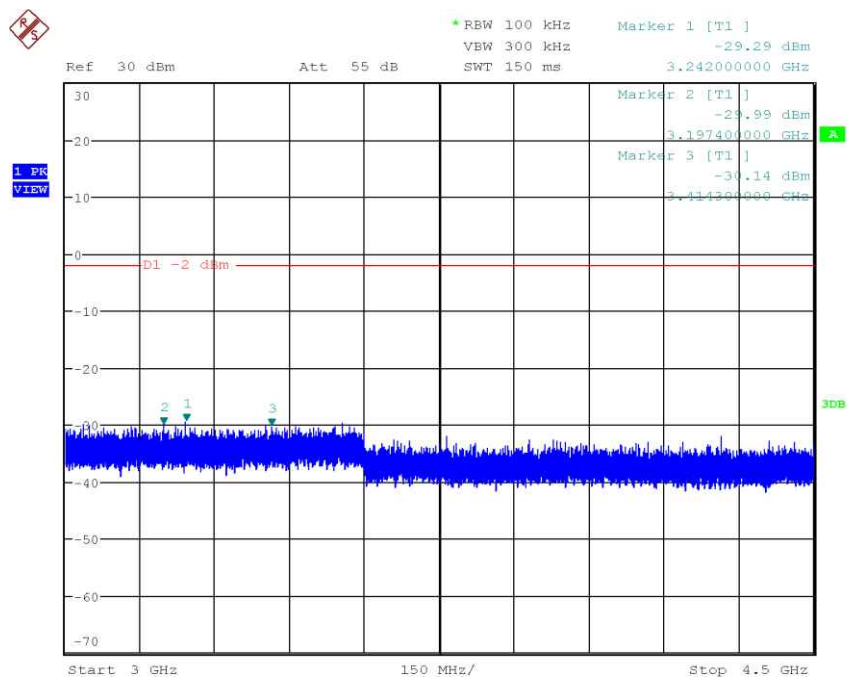
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Diagram 32. conducted spurious for channel high, from 9 kHz to 1.5 GHz. The peak at Marker 2 is intrinsic from the spectrum analyzer, which is irrelevant to the limit.



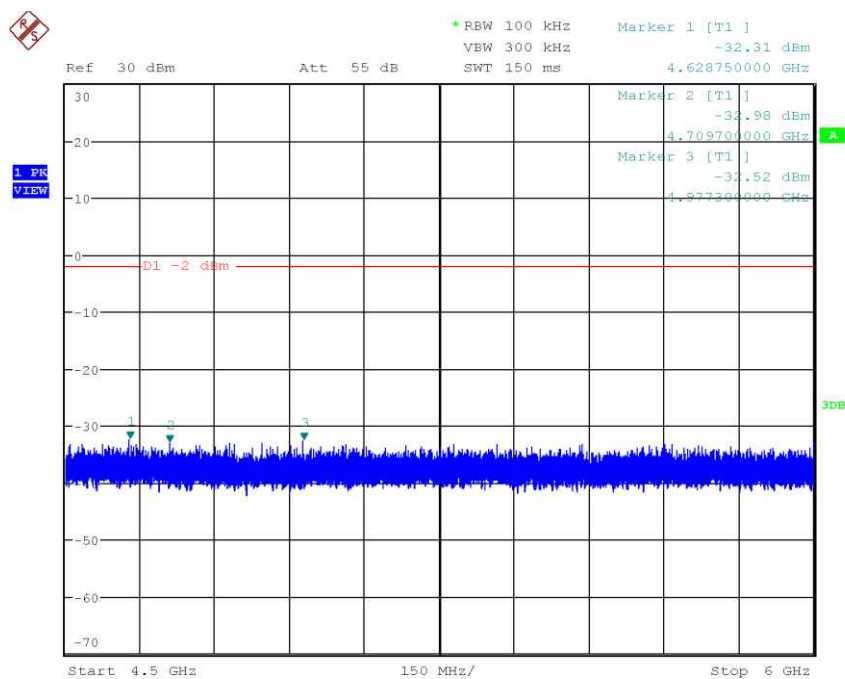
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Diagram 33. conducted spurious for channel high, from 1.5 GHz to 3 GHz.



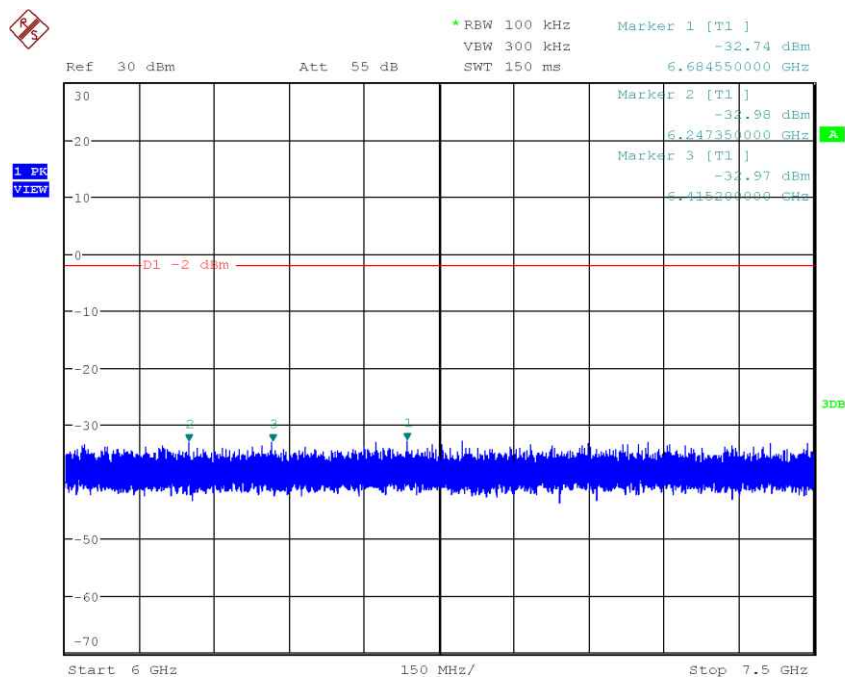
Date: 9.JUL.2021 17:11:49

Diagram 34. conducted spurious for channel high, from 3 GHz to 4.5 GHz.



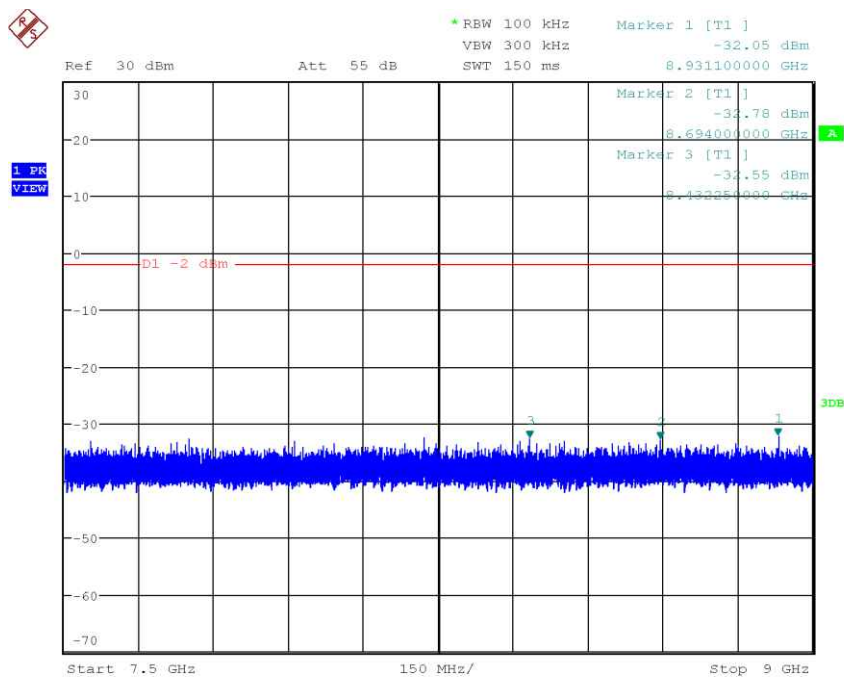
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Diagram 35. conducted spurious for channel high, from 4.5 GHz to 6 GHz



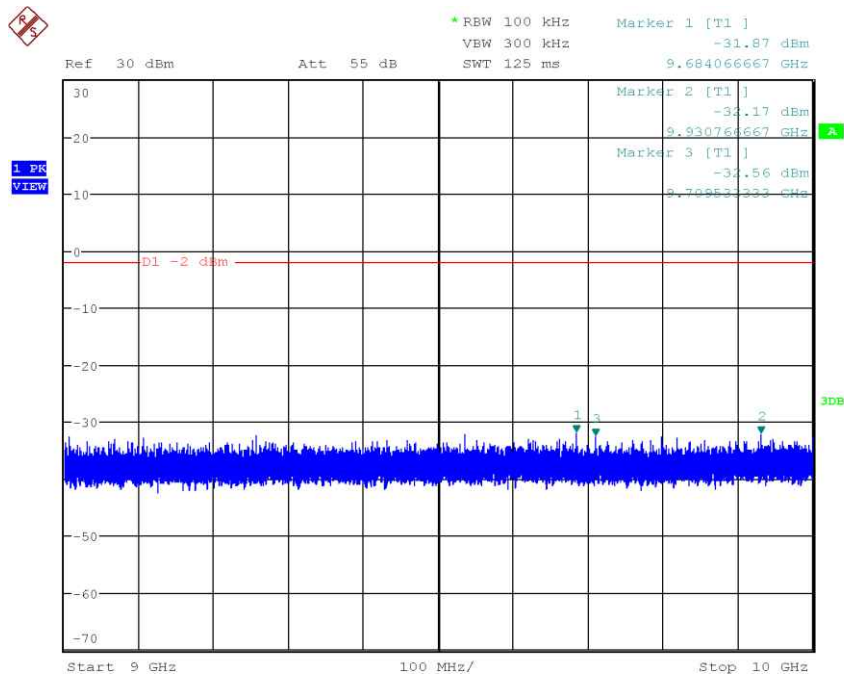
Date: 9.JUL.2021 17:14:08

Diagram 36. conducted spurious for channel high, from 6 GHz to 7.5 GHz



Date: 9.JUL.2021 17:15:20

Diagram 37. conducted spurious for channel high, from 7.5 GHz to 9 GHz



Date: 9.JUL.2021 17:16:27

Diagram 38. conducted spurious for channel high, from 9 GHz to 10 GHz

1.1.7 Radiated spurious emission

1.1.7.1 Frequency range 9 kHz – 30 MHz

Diagram 2.04_RSE_DTS_Flow_lying

Common Information

Test Description:	Magnetic Field Strength Measurement related to 30/300 m distance
Test Site Location:	Ref.-Nr. 441 Semi Anechoic Chamber (SAC1) with 3 m measurement distance
Version of Testsoftware:	EMC32 V10.50.0
Distance correction:	used accord. table, pls. see test report
Rec. antenna (pre-scan):	height 1.00 m, parallel and 90° to EUT polarisation
Used Filter:	bypass
Test Standard:	FCC § 15.209; RSS-Gen: Issue 5
Operator:	GHu/PGrundmann
Operating Mode:	TX DTS mode, channel low
Power during tests:	Battery
Environmental Conditions::	Humidity : 60%rH; Temperature: 21°C
Verdict:	Passed
Comment:	The EUT is tested at lying position only, which is the worst case position.

Full Spectrum

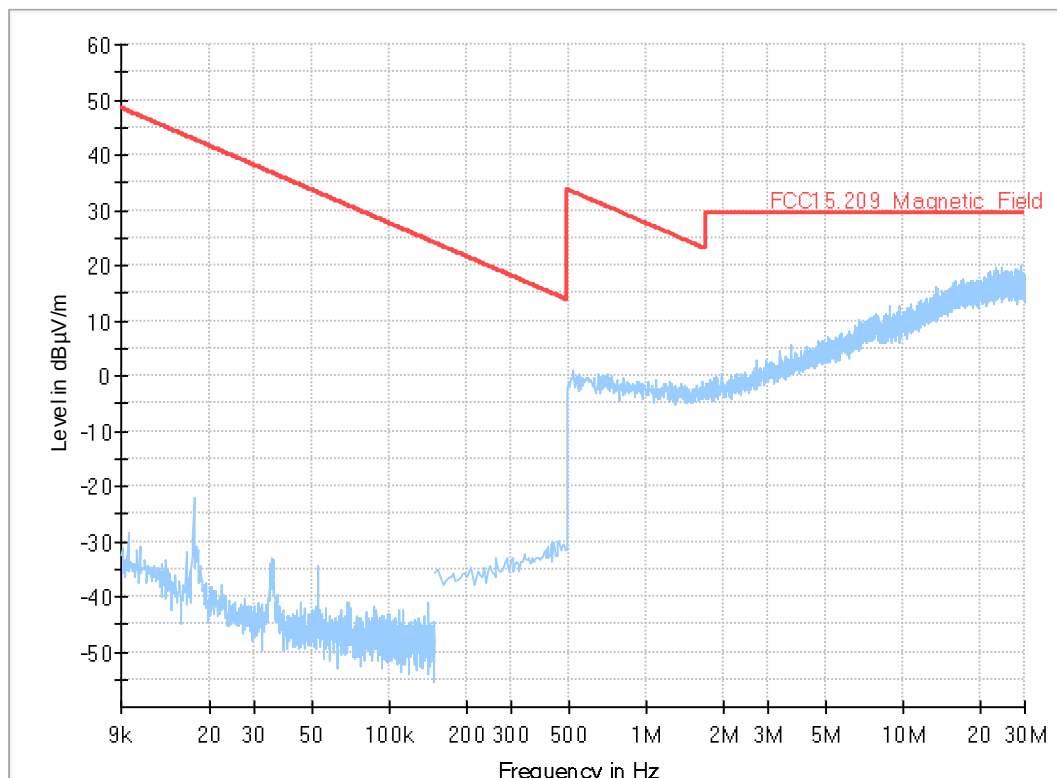


Diagram 2.05_RSE_DTS_Fmid_lying

Common Information

Test Description:	Magnetic Field Strength Measurement related to 30/300 m distance
Test Site Location:	Ref.-Nr. 441 Semi Anechoic Chamber (SAC1) with 3 m measurement distance
Version of Testsoftware:	EMC32 V10.50.0
Distance correction:	used accord. table, pls. see test report
Rec. antenna (pre-scan):	height 1.00 m, parallel and 90° to EUT polarisation
Used Filter:	bypass
Test Standard:	FCC § 15.209; RSS-Gen: Issue 5
Operator:	GHu/PGrundmann
Operating Mode:	TX DTS mode, channel middle
Power during tests:	Battery
Environmental Conditions:	Humidity : 60%RH; Temperature: 21°C
Verdict:	Passed
Comment:	The EUT is tested at lying position only, which is the worst case position.

Full Spectrum

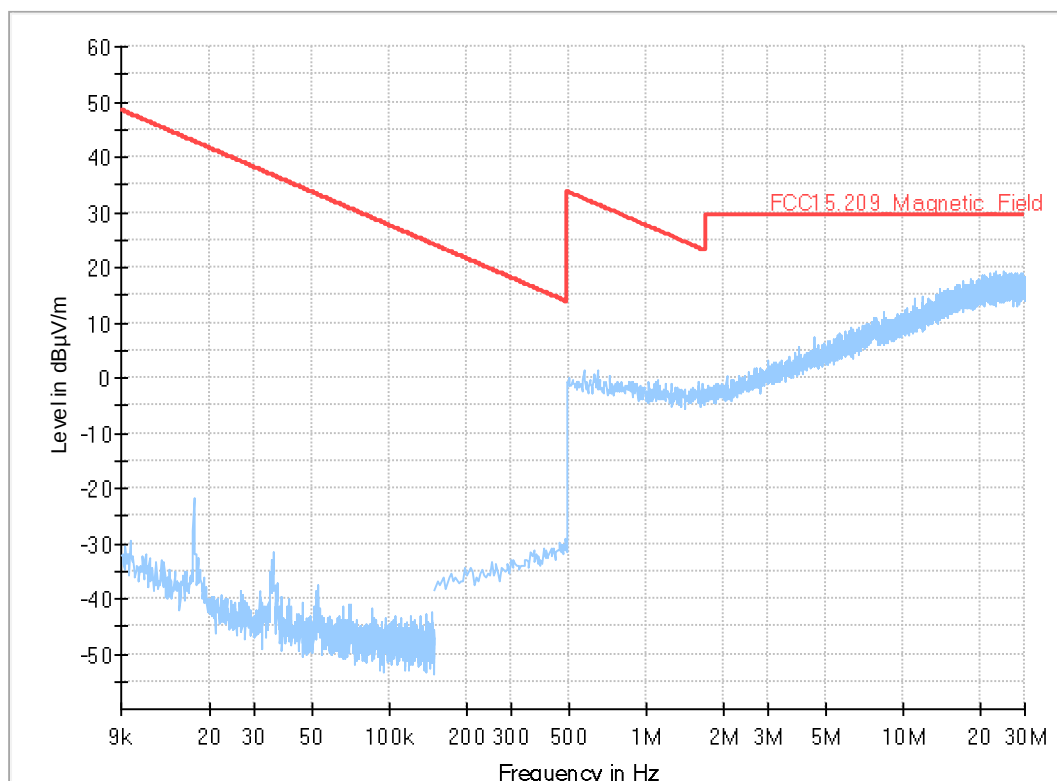
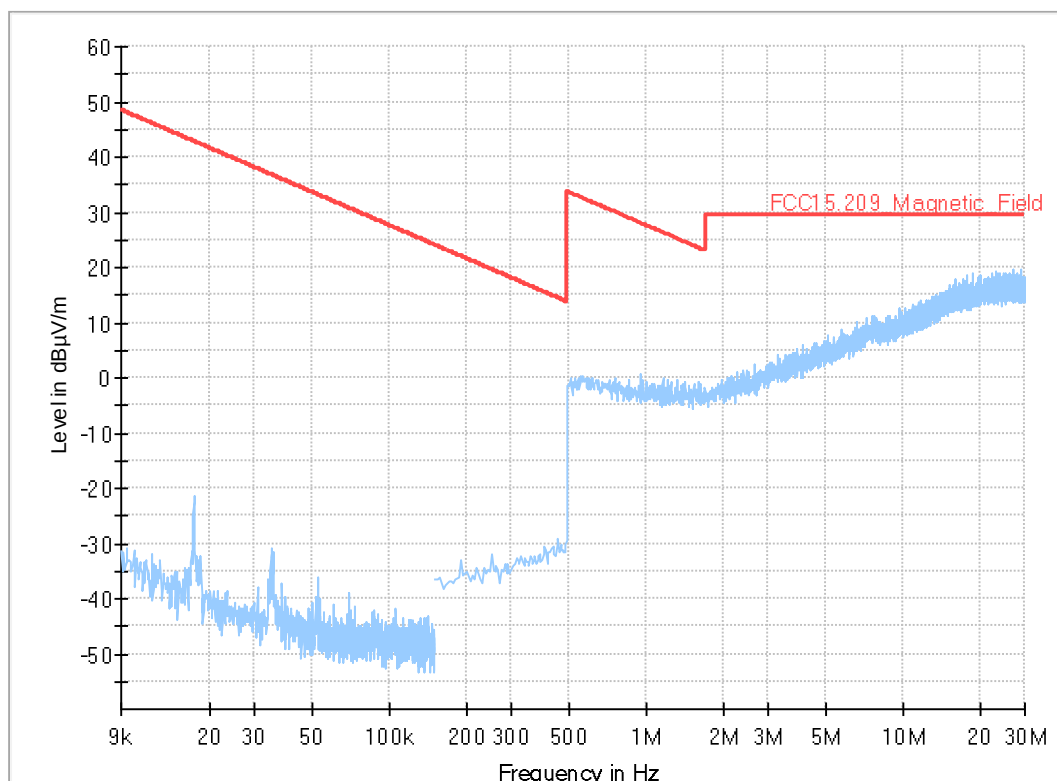


Diagram 2.06_RSE_DTS_Fhigh_lying

Common Information

Test Description:	Magnetic Field Strength Measurement related to 30/300 m distance
Test Site Location:	Ref.-Nr. 441 Semi Anechoic Chamber (SAC1) with 3 m measurement distance
Version of Testsoftware:	EMC32 V10.50.0
Distance correction:	used accord. table, pls. see test report
Rec. antenna (pre-scan):	height 1.00 m, parallel and 90° to EUT polarisation
Used Filter:	bypass
Test Standard:	FCC § 15.209; RSS-Gen: Issue 5
Operator:	GHu/PGrundmann
Operating Mode:	TX DTS mode, channel high
Power during tests:	Battery
Environmental Conditions::	Humidity : 60%rH; Temperature: 21°C
Verdict:	Passed
Comment:	The EUT is tested at lying position only, which is the worst case position.

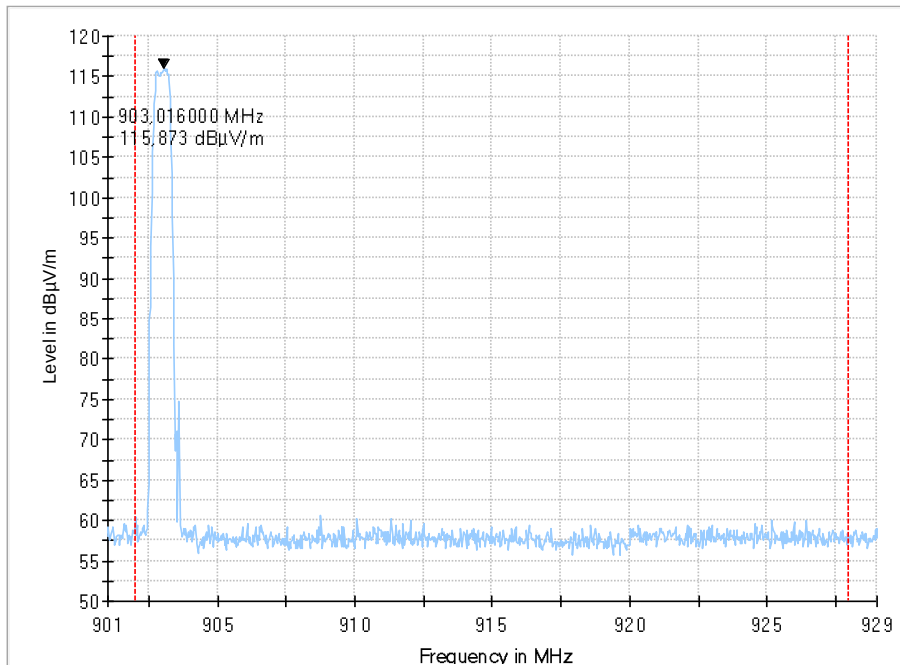
Full Spectrum



1.1.7.2 Frequency range 30 MHz – 1 GHz

Diagram 3.05_fundamental_DTS_Flow_lying

Full Spectrum

**Diagram 3.06_fundamental_DTS_Fmid_lying**

Full Spectrum

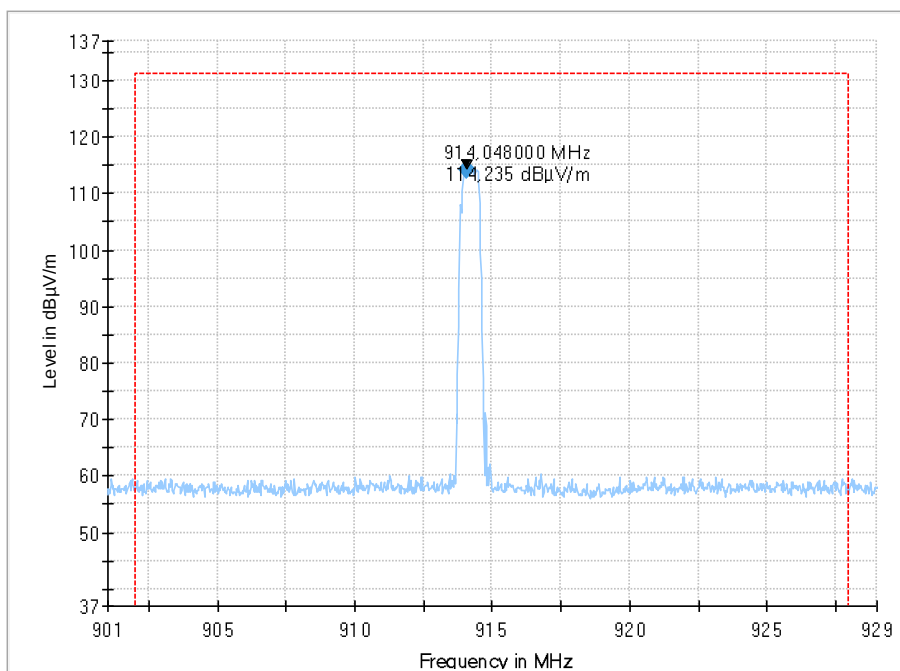


Diagram 3.07_fundamental_DTS_Fhigh_lying

Full Spectrum

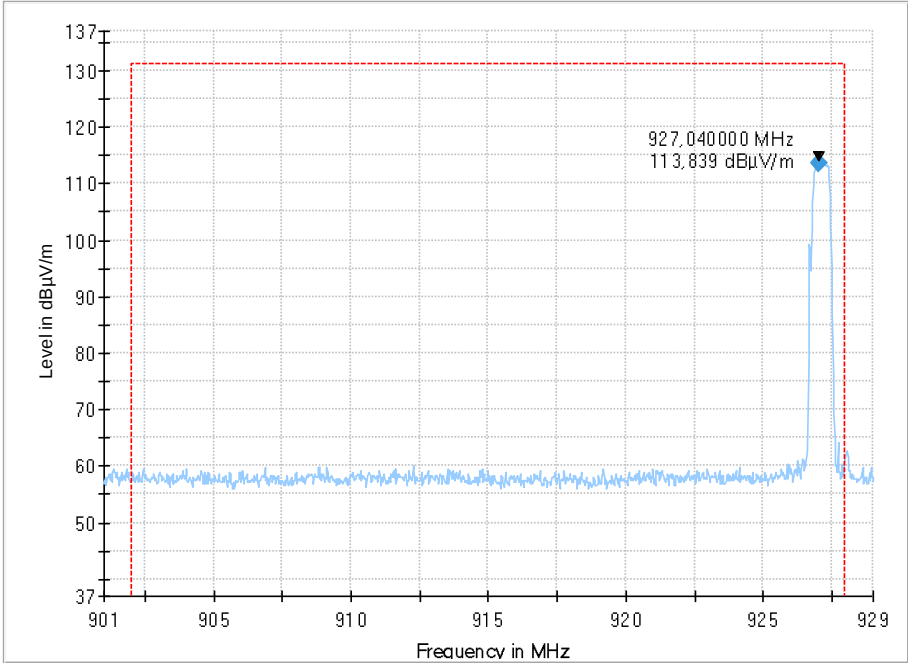


Diagram 3.13_RSE_DTS_Flow_lying

Full Spectrum

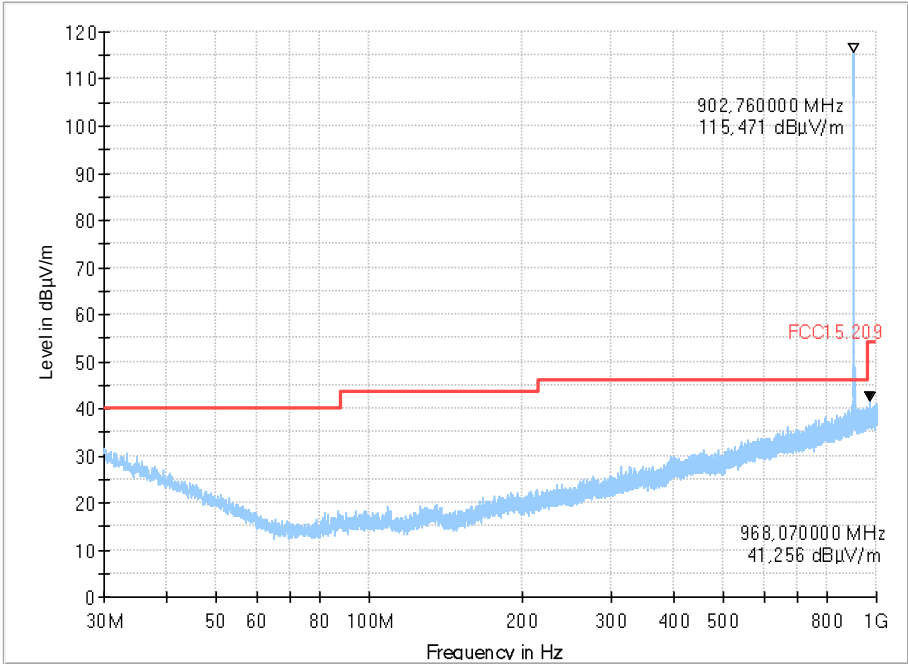


Diagram 3.14_RSE_DTS_Fmid_lying

Full Spectrum

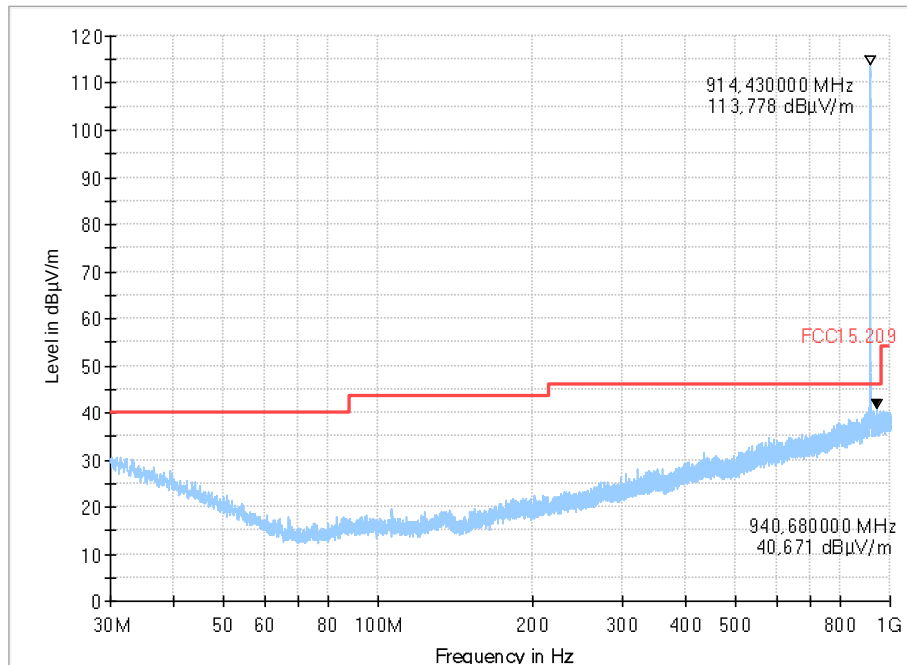
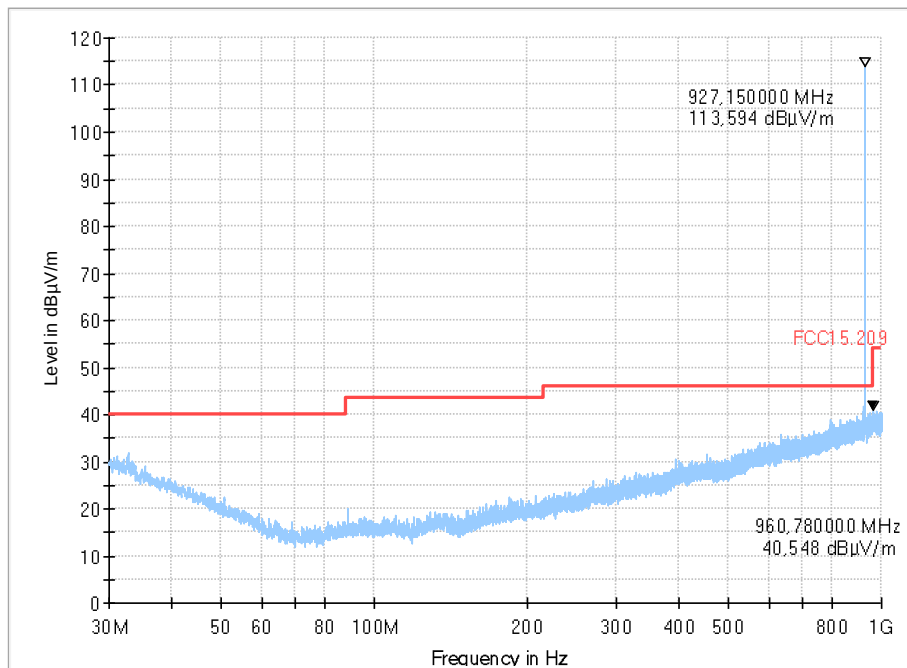


Diagram 3.15_RSE_DTS_Fhigh_lying

Full Spectrum



1.1.7.3 Frequency range 1 GHz – 9.5 GHz

Diagram 8.04a_RSE_DTS_Flow_1-2.8GHz

Full Spectrum

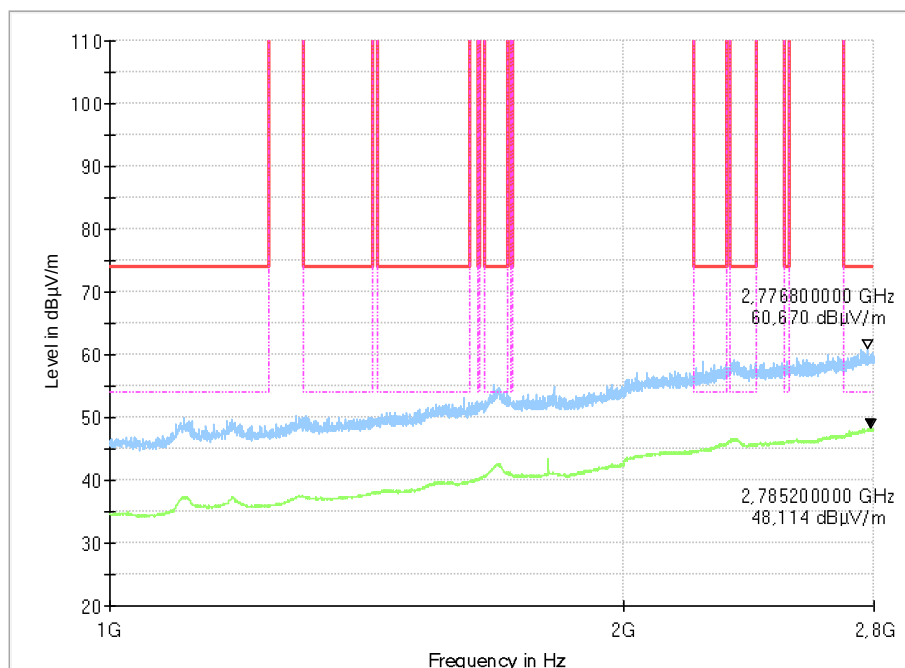
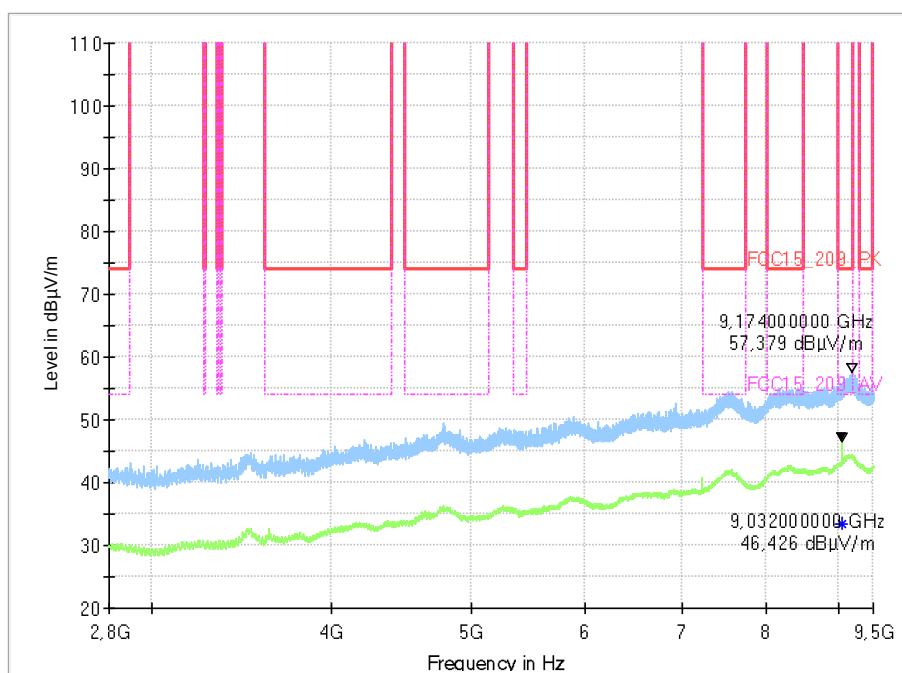


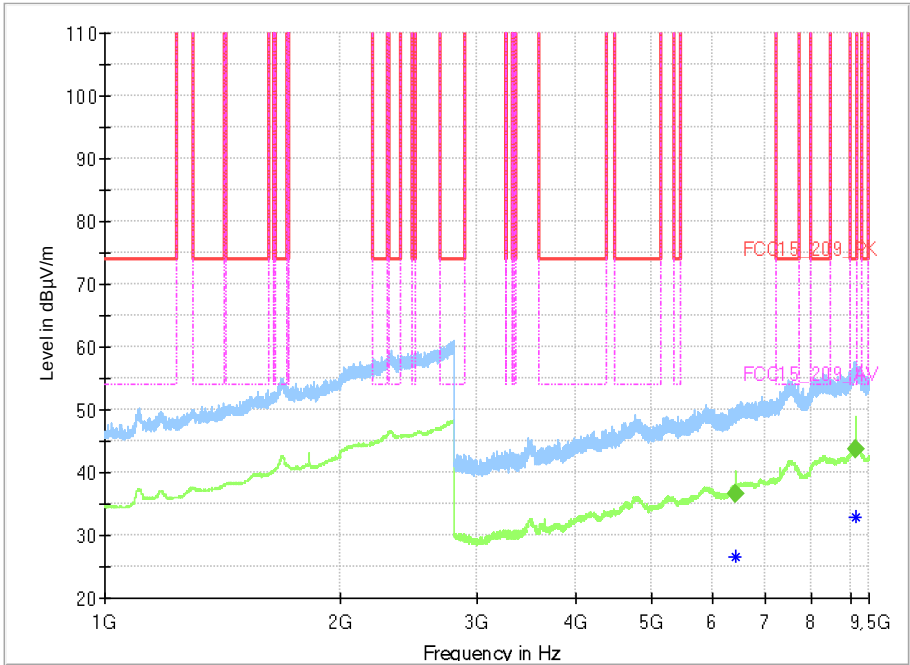
Diagram 8.04b_RSE_DTS_Flow_2.8-9.5GHz

Full Spectrum



8.06_RSE_DTS_Fmid_1-9.5GHz

Full Spectrum

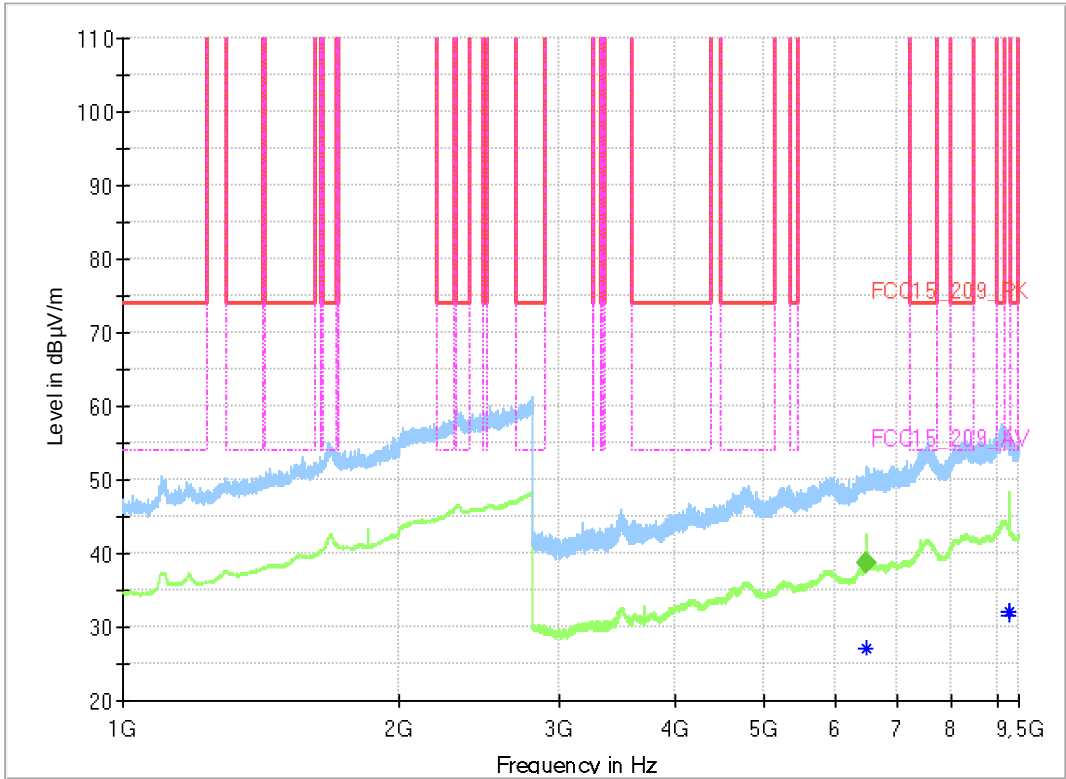


Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Elevation	Corr. (dB/m)
6401.010000	---	36.64	150.00	113.36	100.0	1000.000	155.0	V	303.0	45.0	11
9142.370000	---	43.79	54.00	10.21	100.0	1000.000	155.0	H	306.0	90.0	18

Diagram 8.05_RSE_DTS_Fhigh_1-9.5GHz

Full Spectrum



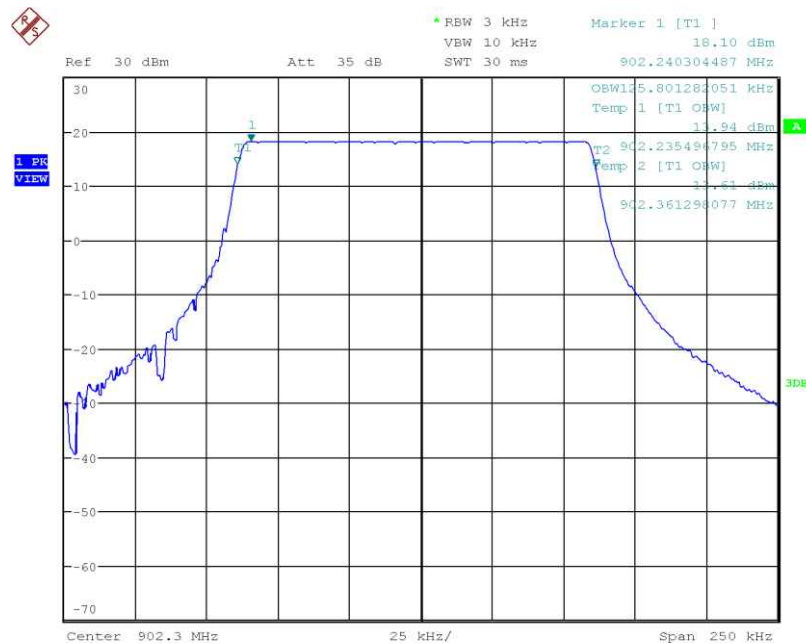
Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth (h)	Height	Pol	Azimuth	Elevation	Corr. (dB/m)
6489.090000	---	38.61	150.00	111.39	100.0	1000.000	155.0	H	194.0	90.0	11

1.2 FHSS mode

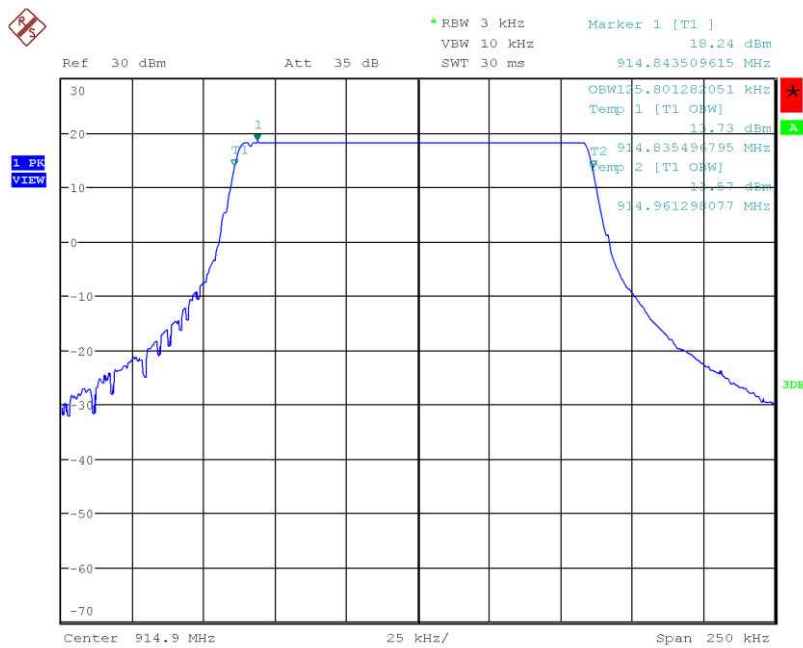
Remark: If the EUT operates under DTS mode, the lowest channel is at 902.3 MHz, the middle channel is chosen to be 914.9 MHz and the highest channel is at 927.8 MHz.

1.2.1 99% Occupied bandwidth (99%OBW)



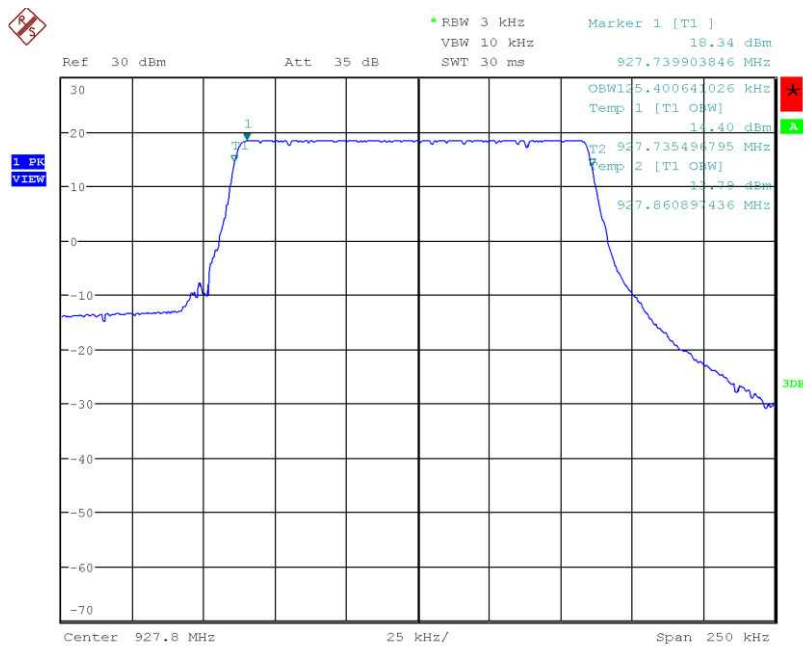
Date: 9.JUL.2021 15:02:08

Diagram 39. 99%OBW, channel low, SF = 10



Date: 9.JUL.2021 15:04:59

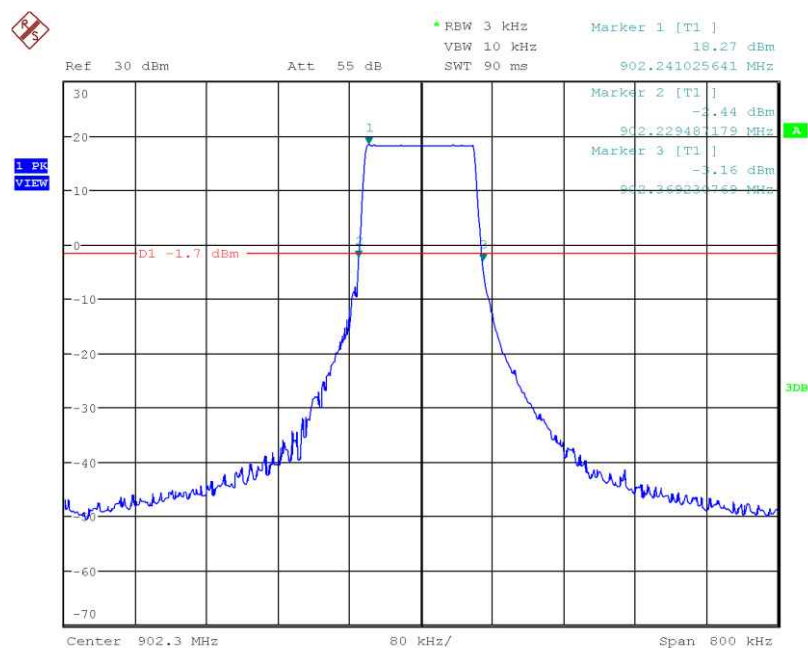
Diagram 40. 99%OBW, channel middle, SF = 10



Date: 9.JUL.2021 15:06:10

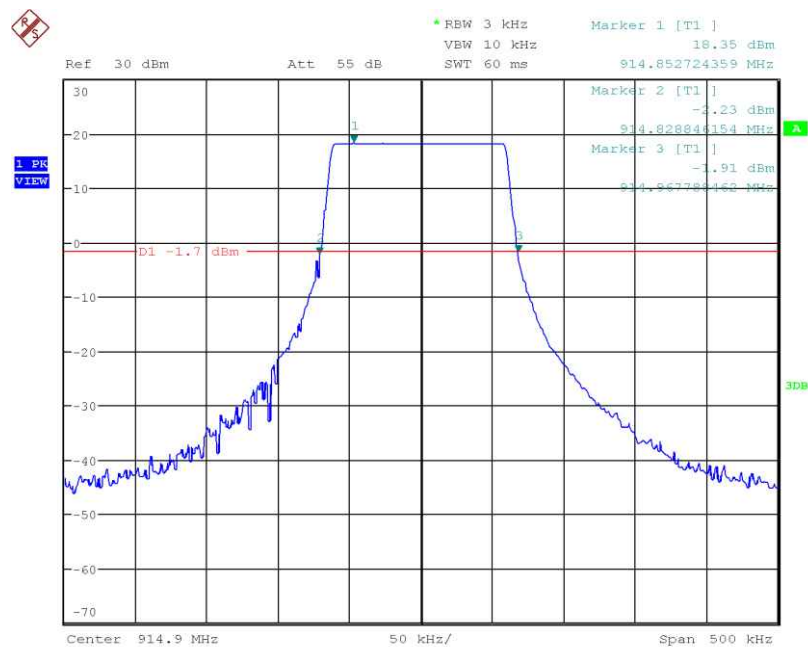
Diagram 41. 99%OBW, channel high, SF = 10

1.2.2 20 dB bandwidth



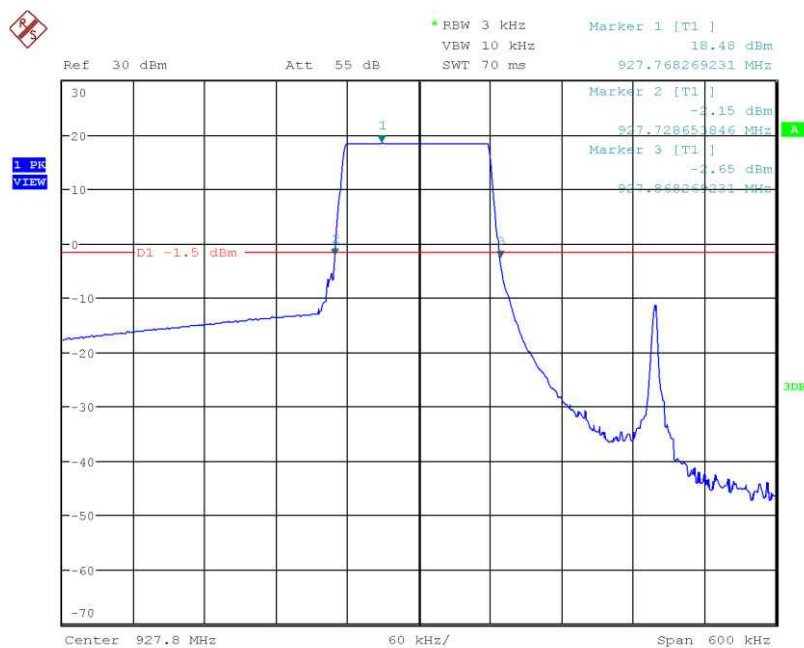
Date: 6.AUG.2021 13:34:15

Diagram 42. 20 dB BW, channel low, SF = 10



Date: 6.AUG.2021 13:42:41

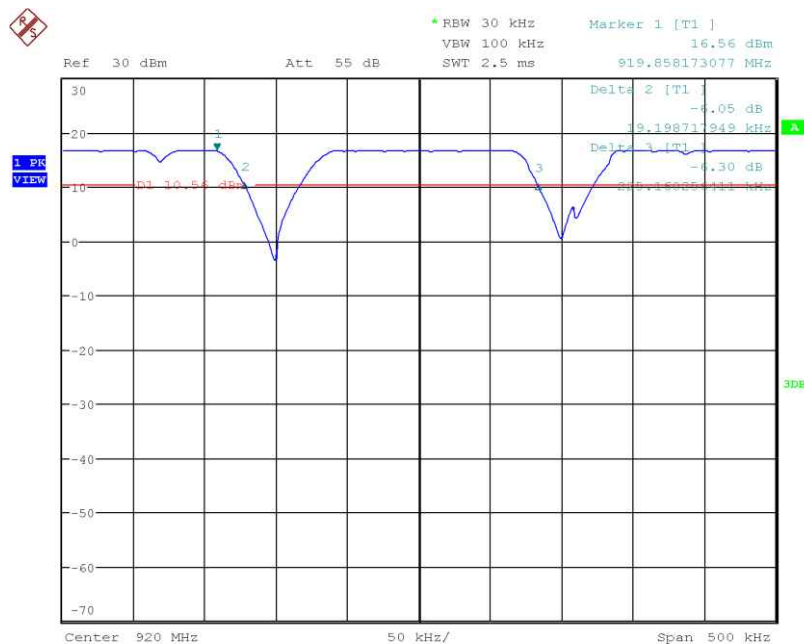
Diagram 43. 20 dB BW, channel middle, SF = 10



Date: 6.AUG.2021 13:46:21

Diagram 44. 20 dB BW, channel high, SF = 10

1.2.3 Minimum channel separation



Date: 4.AUG.2021 14:19:05

Diagram 45. channel separation between two adjacent channels. The reference points are set to -6 dB relative to the peak level, which leads to a channel separation of 205.961 kHz.