

Annex 1: Measurement diagrams to
TEST REPORT
No.: 18-1-0257101T93a-C2

According to:

Title 47
FCC Regulations Subpart 15C
§15.231

ISED-Regulations
RSS-Gen, Issue 5
RSS-210, Issue 9

for

Continental Advanced Antenna GmbH

Remote Keyless Entry RKE223E1

FCC-ID: 2ACC7RKE223E1
ISED: 11980A-RKE223E1

Laboratory Accreditation and Listings



Accredited EMC-Test Laboratory

accredited according to DIN EN ISO/IEC 17025

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1. Measurement diagrams

1.1. Fundamental field strength (15.231(b))

1.1.1. Measurements on antenna 1, ch1

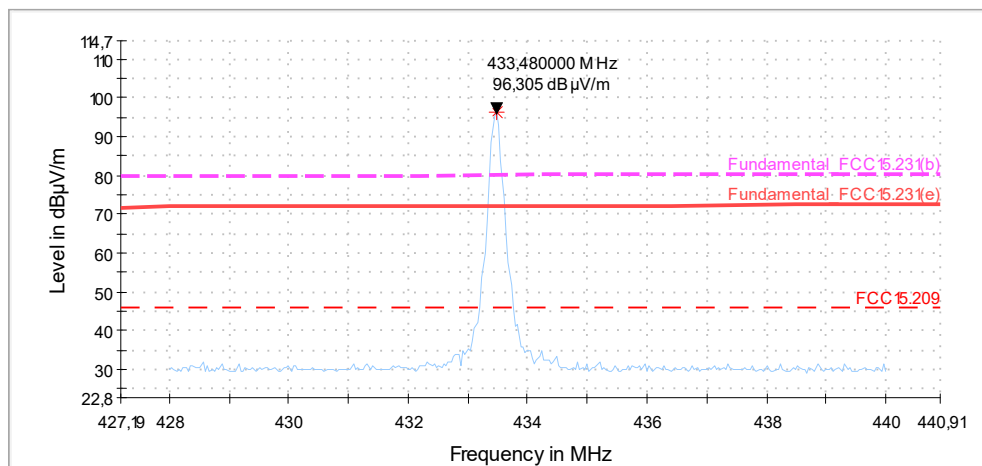


Diagram 3.11, X-Axis

AV-Value: $96.30 - 17.35 \text{ dB (Timing)} = 78.95 \text{ dB}\mu\text{V/m}@3\text{m}$

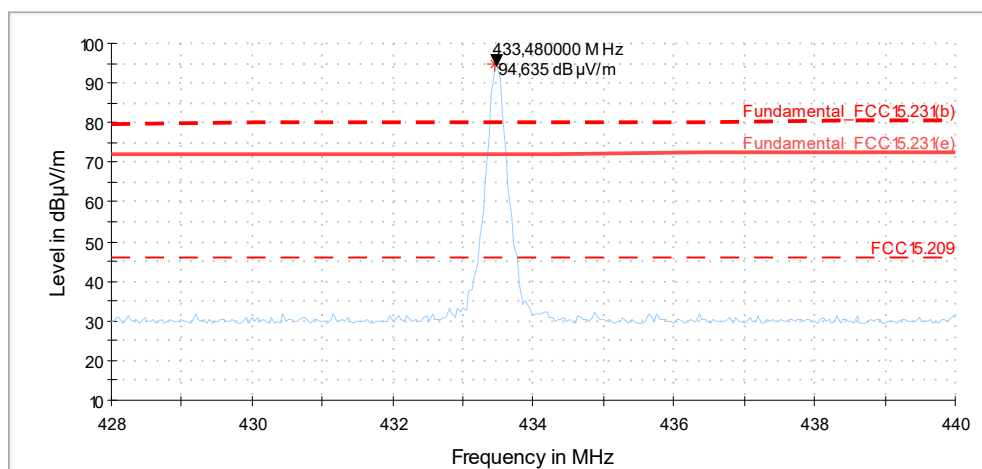


Diagram 3.12, Y-Axis

AV-Value: $94.63 - 17.35 \text{ dB (Timing)} = 77.28 \text{ dB}\mu\text{V/m}@3\text{m}$

1.1.2. Measurements on antenna 2, ch2

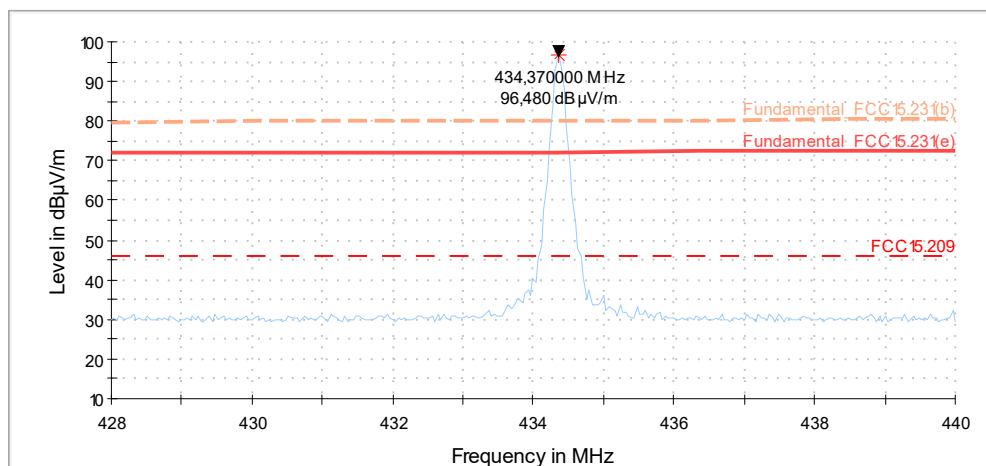


Diagram 3.14, X-Axis

AV-Value: 96.48 -17.35 dB (Timing) = 79.13 dBμV/m@3m

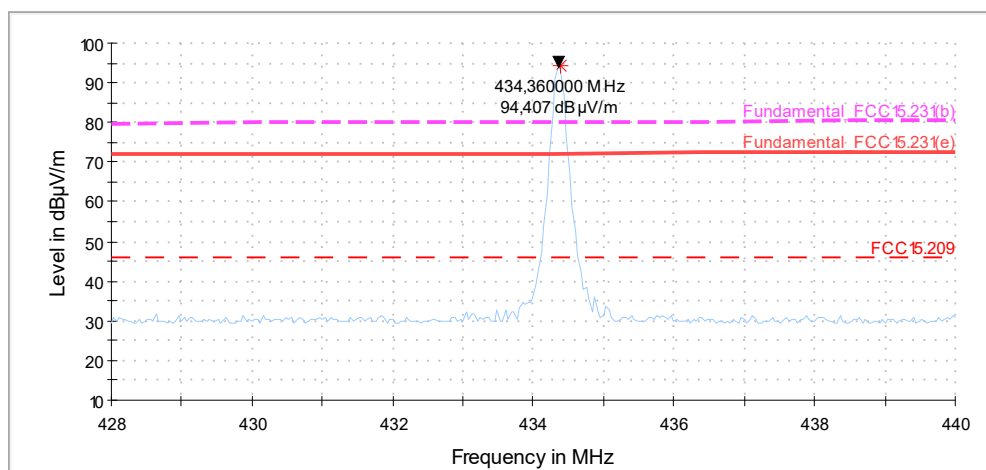


Diagram 3.15, Y-Axis

AV-Value: 94.40 -17.35 dB (Timing) = 77.05 dBμV/m@3m

1.2. Radiated magnetic field strength measurements (f < 30 MHz)

1.2.1. Measurements on antenna 1, ch3

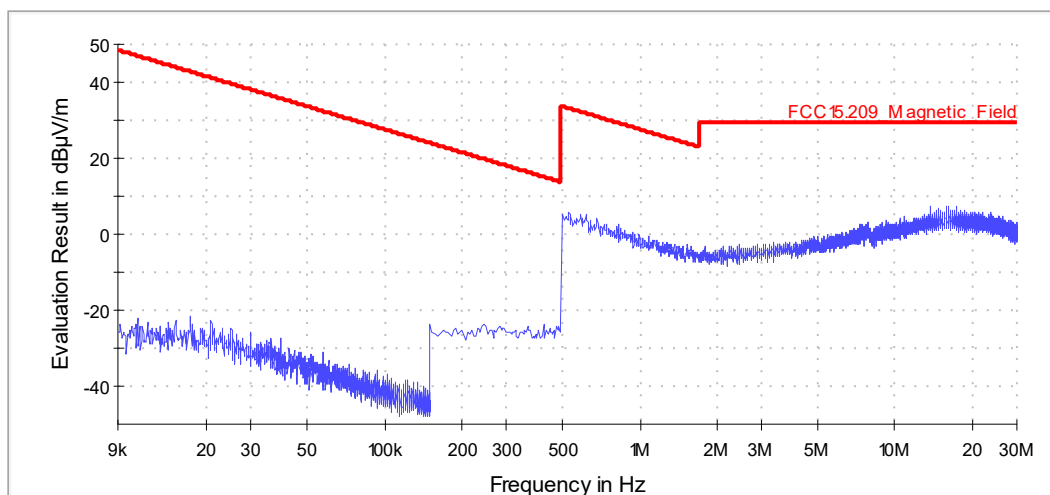
2.01_RSE_TX_Ch3_RF-Port1_x_Achse

Common Information

Test description:	Magnetic Field Strength Measurement related to 30/300 m distance
Test site and distance:	Ref.-Nr. 441 Semi Anechoic Room (SAR) with 3 m measurement distance
Version of Testsoftware:	EMC32 V9.25.0
Distance correction:	used accord. table, pls. see test report
Technical Data:	Please see page 2 for detailed data of measurement setup
Rec. antenna (pre-scan):	height 1.00 m, parallel and 90° to EUT polarization
Used filter:	bypass
Test specification:	FCC 15.209/RSS-Gen, Issue 5
Operator:	MSO
Operating Mode:	
Power during tests:	12 V DC
Comment 1:	Channel middle=433.92 MHz
Comment 2:	RF-Port 1 active, other Port 2 = 50 Ohm
Environmental Conditions::	Humidity : 54.4% rH; Temperature: 21.8 °C
EUT Setup:	Standing
Verdict:	Passed

EUT Information

EUT:	
Manufacturer:	Kathrein/Continental
Serial number:	S15+Antenna Sample 31



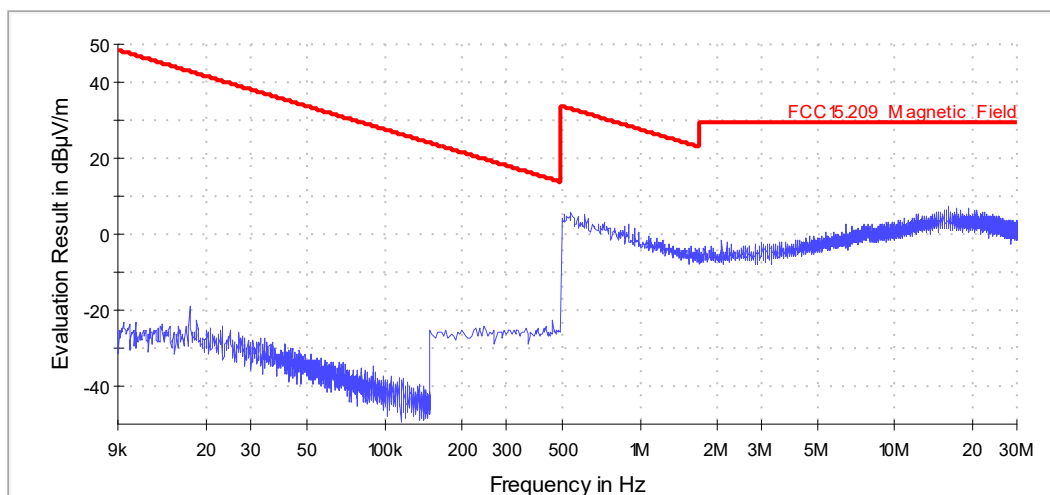
2.02_RSE_TX_Ch3_RF-Port1_y_Achse

Common Information

Test description:	Magnetic Field Strength Measurement related to 30/300 m distance
Test site and distance:	Ref.-Nr. 441 Semi Anechoic Room (SAR) with 3 m measurement distance
Version of Testsoftware:	EMC32 V9.25.0
Distance correction:	used accord. table, pls. see test report
Technical Data:	Please see page 2 for detailed data of measurement setup
Rec. antenna (pre-scan):	height 1.00 m, parallel and 90° to EUT polarization
Used filter:	bypass
Test specification:	FCC 15.209/RSS-Gen, Issue 5
Operator:	MSo
Operating Mode:	TX, Ch3
Power during tests:	12 V DC
Comment 1:	Channel middle 443.92 MHz
Comment 2:	RF-Port 1 active, other Port 2 = 50 Ohm
Environmental Conditions::	Humidity : 54.8% rH; Temperature: 22.0 °C
EUT Setup:	y-Achse
Verdict:	Passed

EUT Information

EUT:	
Manufacturer:	Kathrein/Continental
Serial number:	S15+Antenna Sample 31



1.2.2. Measurements on antenna 2, ch3

2.03_RSE_TX_Ch3_RF-Port2_x_Achse

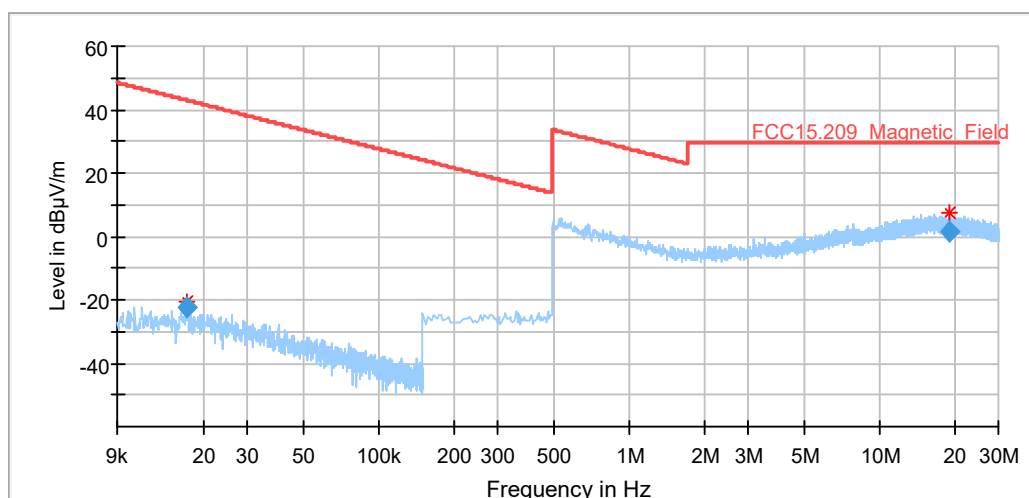
Common Information

Test description:	Magnetic Field Strength Measurement related to 30/300 m distance
Test site and distance:	Ref.-Nr. 441 Semi Anechoic Room (SAR) with 3 m measurement distance
Version of Testsoftware:	EMC32 V9.25.0
Distance correction:	used accord. table, pls. see test report
Technical Data:	Please see page 2 for detailed data of measurement setup
Rec. antenna (pre-scan):	height 1.00 m, parallel and 90° to EUT polarization
Used filter:	bypass
Test specification:	FCC 15.209/RSS-Gen, Issue 5
Operator:	TFra
Operating Mode:	TX, Ch3, RF-Port2
Power during tests:	12 V DC
Comment 1:	Channel middle = 433.92 MHz
Comment 2:	RF-Port 2 active, other Port1 = 50 Ohm
Environmental Conditions:	Humidity : 53.3% rH; Temperature: 22.6 °C
EUT Setup:	x-Achse
Verdict:	Passed

EUT Information

Manufacturer:	Continental Advanced Antenna GmbH
Product:	RKE-Modul
Model:	Application Mode 434 FCC
PMT Sample Number:	S15

Full Spectrum



Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB)	Comment
0.017180	-22.38	42.90	65.28	0.200	V	0.0	-64.5	17:16:51 - 17.07.2019
19.013400	1.64	29.54	27.90	9.000	V	144.0	-10.9	17:21:47 - 17.07.2019

2.04_RSE_TX_Ch3_RF-Port2_y_Achse

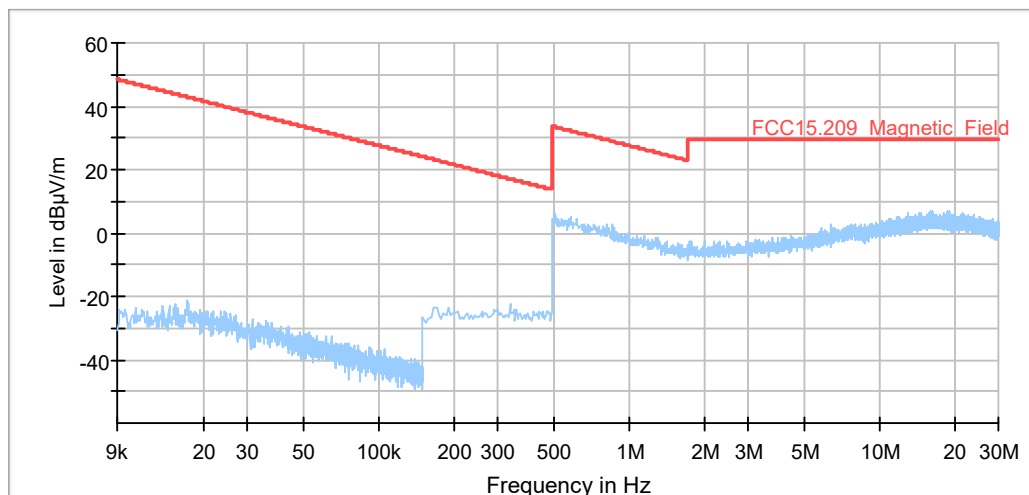
Common Information

Test description:	Magnetic Field Strength Measurement related to 30/300 m distance
Test site and distance:	Ref.-Nr. 441 Semi Anechoic Room (SAR) with 3 m measurement distance
Version of Testsoftware:	EMC32 V9.25.0
Distance correction:	used accord. table, pls. see test report
Technical Data:	Please see page 2 for detailed data of measurement setup
Rec. antenna (pre-scan):	height 1.00 m, parallel and 90° to EUT polarization
Used filter:	bypass
Test specification:	FCC 15.209/RSS-Gen, Issue 5
Operator:	TFra
Operating Mode:	TX, Ch3, RF-Port2
Power during tests:	12 V DC
Comment 1:	Channel middle = 433.92 MHz
Comment 2:	RF-Port 2 active, other Port1 = 50 Ohm
Environmental Conditions:	Humidity : 51.8% rH; Temperature: 22.7 °C
EUT Setup:	y-Achse
Verdict:	Passed

EUT Information

Manufacturer:	Continental Advanced Antenna GmbH
Product:	RKE-Modul
Model:	Application Mode 434 FCC
PMT Sample Number:	S15

Full Spectrum



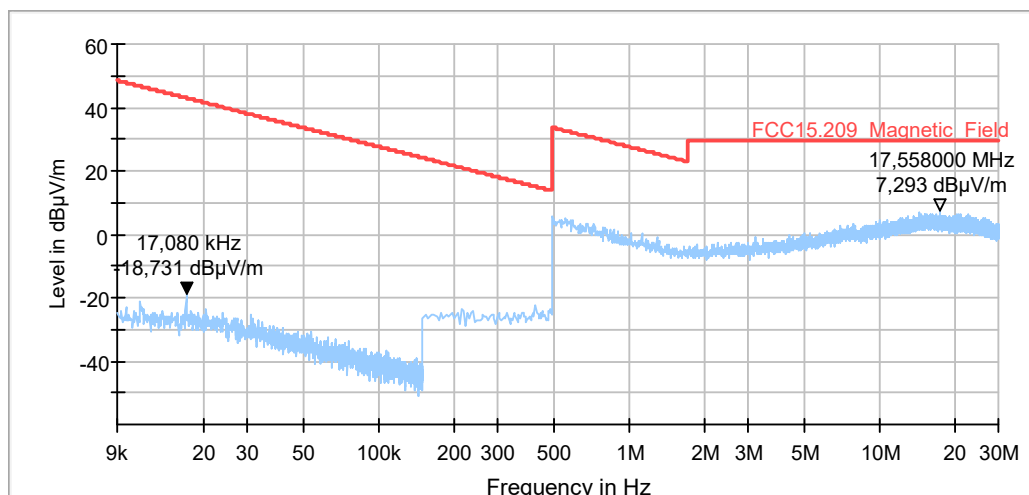
1.2.3. Measurements on antenna 1, ch1

2.06_RSE_TX_Ch1_RF-Port1_x_Achse_ohne_Ansteuerbox

Common Information

Test description:	Magnetic Field Strength Measurement related to 30/300 m distance
Test site and distance:	Ref.-Nr. 441 Semi Anechoic Room (SAR) with 3 m measurement distance
Version of Testsoftware:	EMC32 V9.25.0
Distance correction:	used accord. table, pls. see test report
Technical Data:	Please see page 2 for detailed data of measurement setup
Rec. antenna (pre-scan):	height 1.00 m, parallel and 90° to EUT polarization
Used filter:	bypass
Test specification:	FCC 15.209/RSS-Gen, Issue 5
Operator:	Lor
Operating Mode:	Ant1, Ch1
Power during tests:	12 V DC
Comment 1:	Channel 1
Comment 2:	Sample #18 + Antenna #31
Environmental Conditions::	Humidity : 57% rH; Temperature: 22 °C
EUT Setup:	x-Achse (Antenna vertical – top position up)
Verdict:	Initial

Full Spectrum



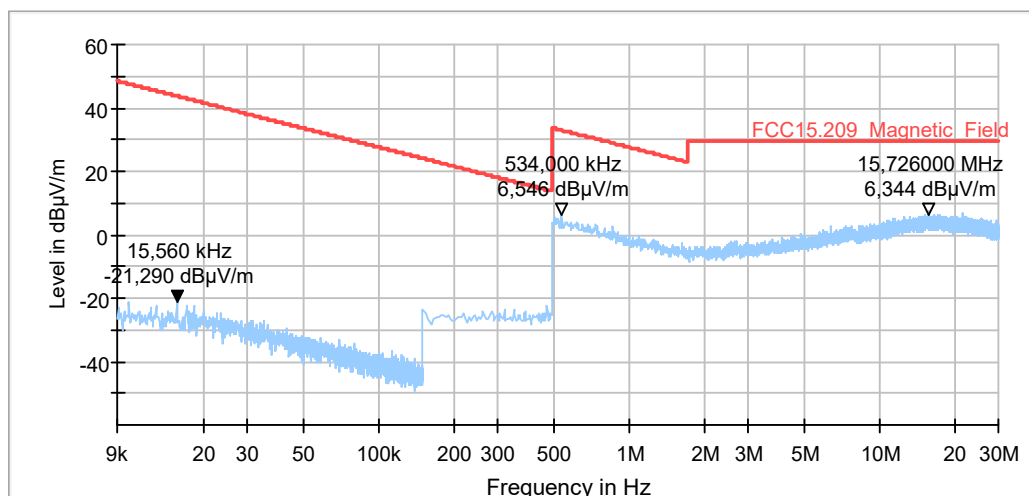
1.2.4. Measurements on antenna 2, ch2

2.05_RSE_TX_Ch2_RF-Port2_y_Achse_ohne_Ansteuerbox

Common Information

Test description:	Magnetic Field Strength Measurement related to 30/300 m distance
Test site and distance:	Ref.-Nr. 441 Semi Anechoic Room (SAR) with 3 m measurement distance
Version of Testsoftware:	EMC32 V9.25.0
Distance correction:	used accord. table, pls. see test report
Technical Data:	Please see page 2 for detailed data of measurement setup
Rec. antenna (pre-scan):	height 1.00 m, parallel and 90° to EUT polarization
Used filter:	bypass
Test specification:	FCC 15.209/RSS-Gen, Issue 5
Operator:	Lor
Operating Mode:	Ant2, Ch2
Power during tests:	12 V DC
Comment 1:	Channel 2
Comment 2:	Sample #17 + Antenna #31
Environmental Conditions::	Humidity : 57% rH; Temperature: 22 °C
EUT Setup:	y-Achse (EUT Horizontal antenna)
Verdict:	Initial

Full Spectrum



1.3. Radiated emissions in the frequency range 30 to 1000 MHz

Due emissions of AE1 and impossibility to shield it completely, tests without AE1 were performed.

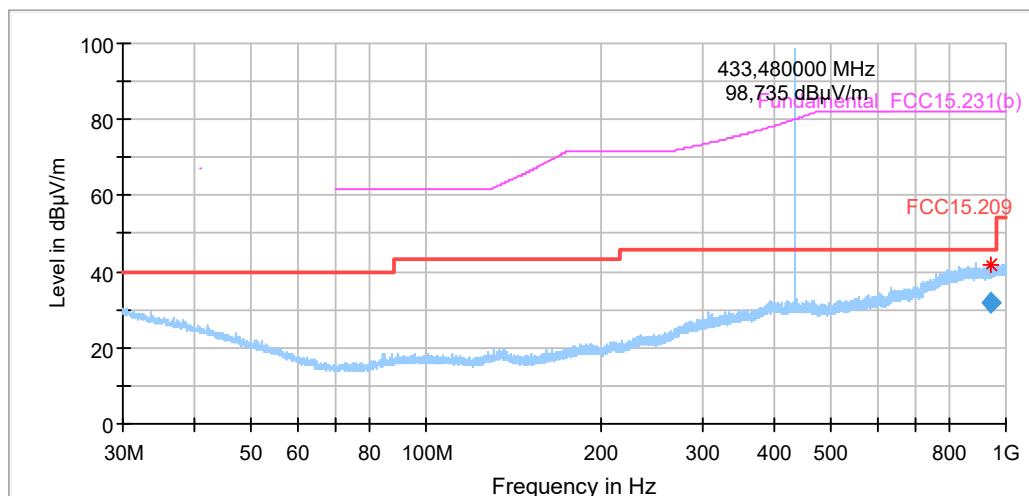
1.3.1. Measurements on antenna 1, ch1

3.05_RSE_Setup_TX_cont_Cont_Ant1Ch1_x_Achse

Common Information

Test description:	Electric Field Strength Measurement
Test site and distance:	Ref.-Nr. 441 Semi Anechoic Room (SAR) with 3 m measurement distance
Version of Testsoftware:	EMC32 V9.25.0
Distance correction:	not used
Used filter:	not used
Technical Data:	please see page 2 for detailed data of measurement setup
Test specification.:	FCC §15.209/§15.231 / RSS-210, Issue9, B.6 / RSS-Gen, Issue 5
Operator:	TFra
Operating Mode:	Ant1, Ch1
Power during tests:	12 V DC
Comment 1:	Continuous Transmissions
Environmental Conditions.:	Humidity : 57% rH; Temperature: 22 °C
EUT Setup:	EUT Sample no. 18 + Antenna Sample #31 , x-axis positioned, without Box
Verdict:	Passed

Full Spectrum



Final Result

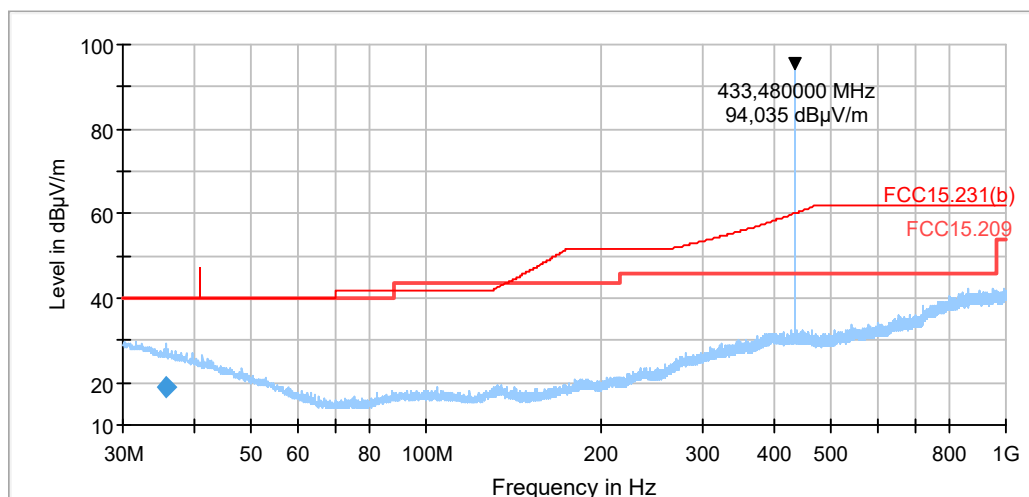
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
939.784000	31.61	46.00	14.39	120.000	290.0	H	337.0	26.8

3.06_RSE_Setup_TX_cont_Cont_Ant1Ch1_y_Achse

Common Information

Test description:	Electric Field Strength Measurement
Test site and distance:	Ref.-Nr. 441 Semi Anechoic Room (SAR) with 3 m measurement distance
Version of Testsoftware:	EMC32 V9.25.0
Distance correction:	not used
Used filter:	not used
Technical Data:	please see page 2 for detailed data of measurement setup
Test specification.:	FCC §15.209/§15.231 / RSS-210, Issue9, B.6 / RSS-Gen, Issue 5
Operator:	Lor
Operating Mode:	Ant1, Ch1
Power during tests:	12 V DC
Comment 1:	Continuos Transmissions
Environmental Conditions.:	Humidity : 57% rH; Temperature: 22 °C
EUT Setup:	EUT Sample no. 18 + Antenna Sample #31 , y-axis positioned, without Box
Verdict:	Passed

Full Spectrum



Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
35.604000	19.15	40.00	20.85	120.000	183.0	H	79.0	19.0

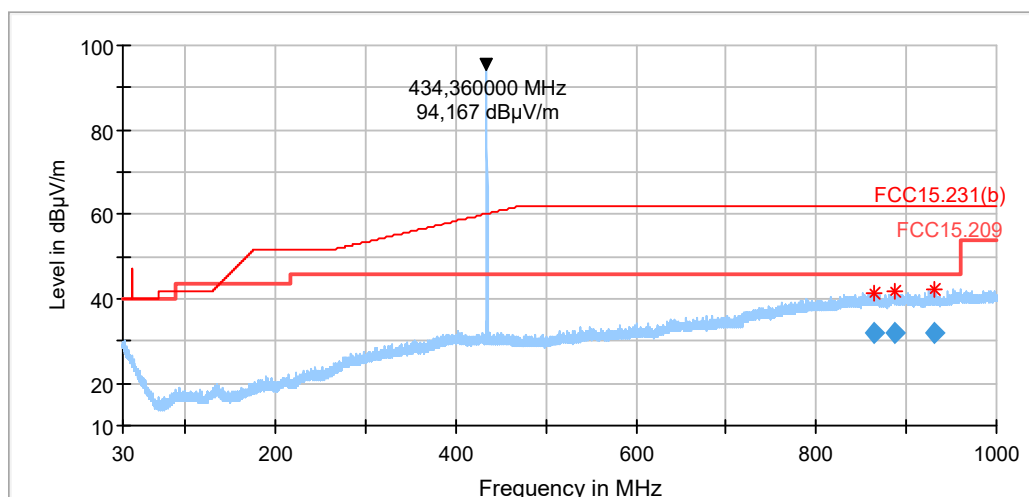
1.3.2. Measurements on antenna 2, ch2

3.07_RSE_Setup_TX_cont_Cont_Ant2Ch2_y_Achse

Common Information

Test description:	Electric Field Strength Measurement
Test site and distance:	Ref.-Nr. 441 Semi Anechoic Room (SAR) with 3 m measurement distance
Version of Testsoftware:	EMC32 V9.25.0
Distance correction:	not used
Used filter:	not used
Technical Data:	please see page 2 for detailed data of measurement setup
Test specification.:	FCC §15.209/§15.231 / RSS-210, Issue9, B.6 / RSS-Gen, Issue 5
Operator:	Lor
Operating Mode:	Ant2, Ch2
Power during tests:	12 V DC
Comment 1:	Continuos Transmissions
Environmental Conditions.:	Humidity : 57% rH; Temperature: 22 °C
EUT Setup:	EUT Sample no. 17 + Antenna Sample #31 , y-axis positioned, without Box
Verdict:	Passed

Full Spectrum



Final_Result

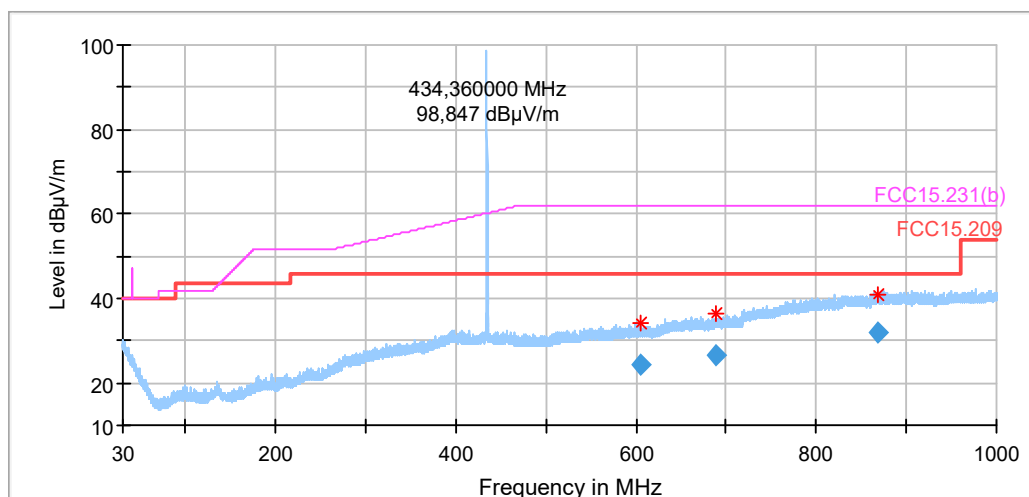
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
863.088000	32.11	46.00	13.89	120.000	183.0	H	234.0	26.6
887.376000	32.05	46.00	13.95	120.000	310.0	H	270.0	26.9
930.300000	31.86	46.00	14.14	120.000	318.0	V	179.0	27.0

3.08_RSE_Setup_TX_cont_Cont_Ant2Ch2_x_Achse

Common Information

Test description:	Electric Field Strength Measurement
Test site and distance:	Ref.-Nr. 441 Semi Anechoic Room (SAR) with 3 m measurement distance
Version of Testsoftware:	EMC32 V9.25.0
Distance correction:	not used
Used filter:	not used
Technical Data:	please see page 2 for detailed data of measurement setup
Test specification.:	FCC §15.209/§15.231 / RSS-210, Issue9, B.6 / RSS-Gen, Issue 5
Operator:	Lor
Operating Mode:	Ant2, Ch2
Power during tests:	12 V DC
Comment 1:	Continuous Transmissions
Environmental Conditions.:	Humidity : 57% rH; Temperature: 22 °C
EUT Setup:	EUT Sample no. 17 + Antenna Sample#31, x-axis , without Box
Verdict:	Passed

Full Spectrum



Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
605.128000	24.31	46.00	21.69	120.000	174.0	H	325.0	22.1
689.132000	26.36	46.00	19.64	120.000	218.0	H	39.0	23.4
868.388000	32.05	46.00	13.95	120.000	345.0	H	216.0	26.8

1.4. Radiated emissions in the frequency range above 1000MHz

1.4.1. Measurements on antenna 1, ch3

4.01_RSE_TX_RF-Port1_Ch3_x_Achse

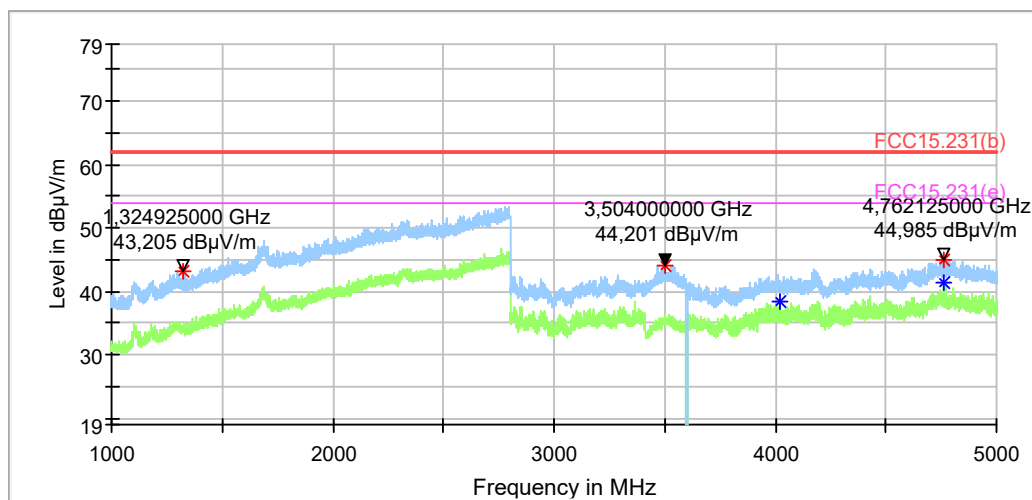
Common Information

Test Description:	Radiated field strength emission in 3m distance
Test Site:	CETECOM GmbH Essen
Test Standard:	FCC 15.231
Antenna polarization:	horizontal/vertical
Test specification.:	FCC §15.209/§15.231 / RSS-210, Issue9, B.6 / RSS-Gen, Issue 5
Operating Mode:	Ant1Ch3
Operator:	Lor
Comment:	FCC Antenna x-Position (top-standing) EUT Sample 15 (Appl. Mode)
Environmental Conditions.:	Humidity : 55% rH; Temperature: 21 °C
EUT Setup:	1 Tnom, Vnom
Verdict:	Pass

EUT Information

PMT Sample Number:	S15 (TX) + Antenna (S31)
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Full Spectrum



4.04_RSE_TX_RF-Port1_Ch3_y_Achse

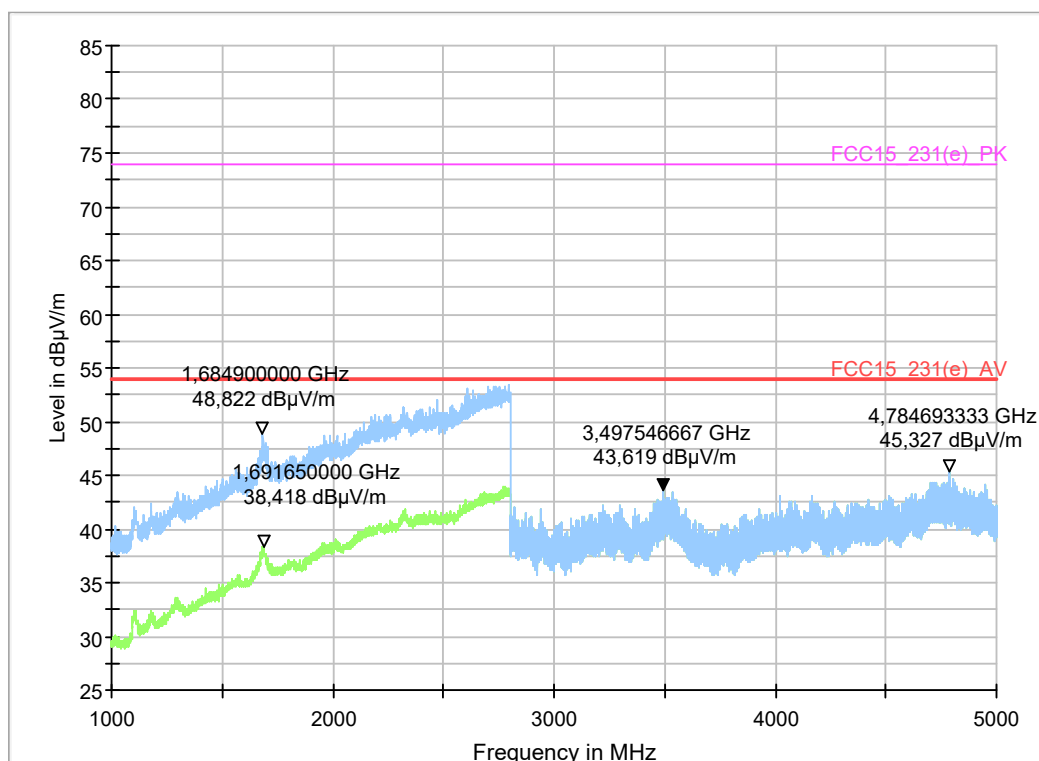
Common Information

Test Description:	Radiated field strength emission in 3m distance
Test Site:	CETECOM GmbH Essen
Test Standard:	FCC 15.109 Unintentional Radiator
Antenna polarization:	horizontal/vertical
Test specification.:	FCC §15.209/§15.231 / RSS-210, Issue9, B.6 / RSS-Gen, Issue 5
Operating Mode:	Ant1Ch3
Operator:	Lor
Comment:	FCC Antenna (Sample31) y-Position EUT Sample 15 (Appl. Mode)
Environmental Conditions.:	Humidity : 55% rH; Temperature: 20 °C
EUT Setup:	1
Verdict:	Tnom, Vnom Pass

EUT Information

PMT Sample Number:	S15 (TX) + Antenna (S31)
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Full Spectrum



1.4.2. Measurements on antenna 2, ch3

4.02_RSE_TX_RF-Port2_Ch3_x_Achse

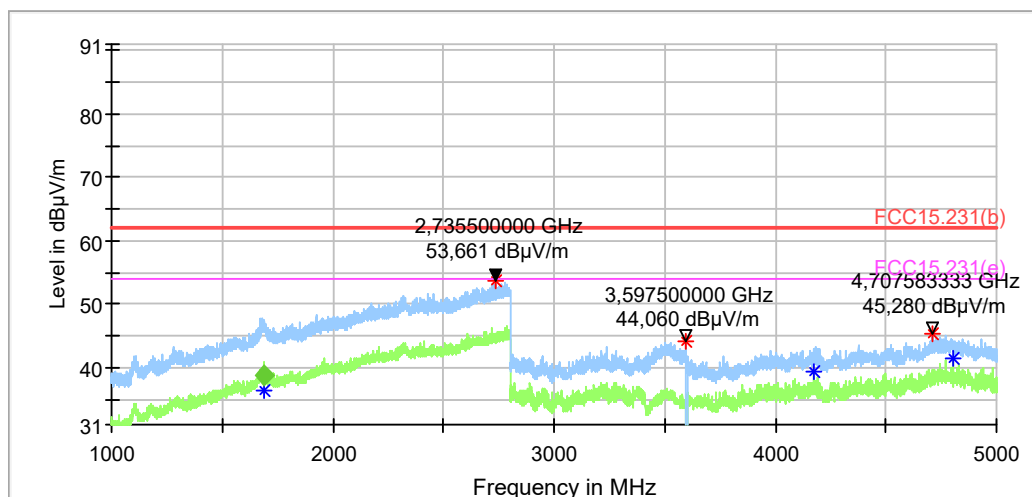
Common Information

Test Description:	Radiated field strength emission in 3m distance
Test Site:	CETECOM GmbH Essen
Test Standard:	FCC 15.231
Antenna polarization:	horizontal/vertical
Test specification.:	FCC §15.209/§15.231 / RSS-210, Issue9, B.6 / RSS-Gen, Issue 5
Operating Mode:	Ant2Ch3
Operator:	Lor
Comment:	FCC Antenna (Sample31) x-Position (top-standing) EUT Sample 15 (Appl. Mode)
Environmental Conditions.:	Humidity : 55% rH; Temperature: 20 °C
EUT Setup:	2 Tnom, Vnom
Verdict:	Pass

EUT Information

PMT Sample Numbwe:	S12 (TX) + Antenna (S31)
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Full Spectrum



Final Result

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)	Corr. (dB/m)	Sig Path (dB)
1690.000000	---	54.00	15.15	100.0	1000.000	H	118.0	34	5

(continuation of the "Final_Result" table from column 18 ...)

Frequency (MHz)	Trd Corr. (dB/m)	Raw Rec (dBµV)	Comment
1690.000000	29	5	20:13:19 - 16.07.2019

4.03_RSE_TX_RF-Port2_Ch3_y_Achse

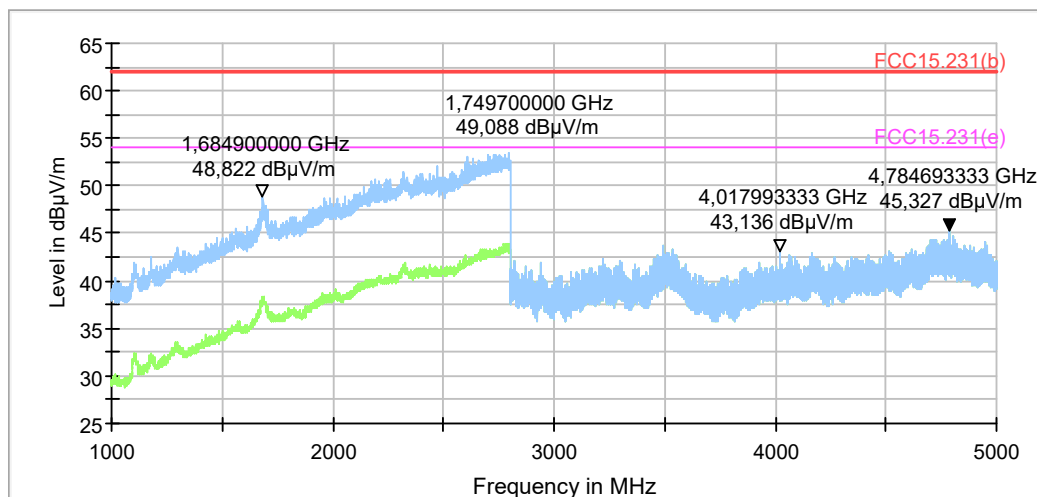
Common Information

Test Description:	Radiated field strength emission in 3m distance
Test Site:	CETECOM GmbH Essen
Test Standard:	FCC 15.231
Antenna polarization:	horizontal/vertical
Test specification.:	FCC §15.209/§15.231 / RSS-210, Issue9, B.6 / RSS-Gen, Issue 5
Operating Mode:	Ant2Ch3
Operator:	Lor
Comment:	FCC Antenna (Sample31) y-Position EUT Sample 15 (Appl. Mode)
Environmental Conditions::	Humidity : 55% rH; Temperature: 21 °C
EUT Setup:	2 Tnom, Vnom
Verdict:	Pass

EUT Information

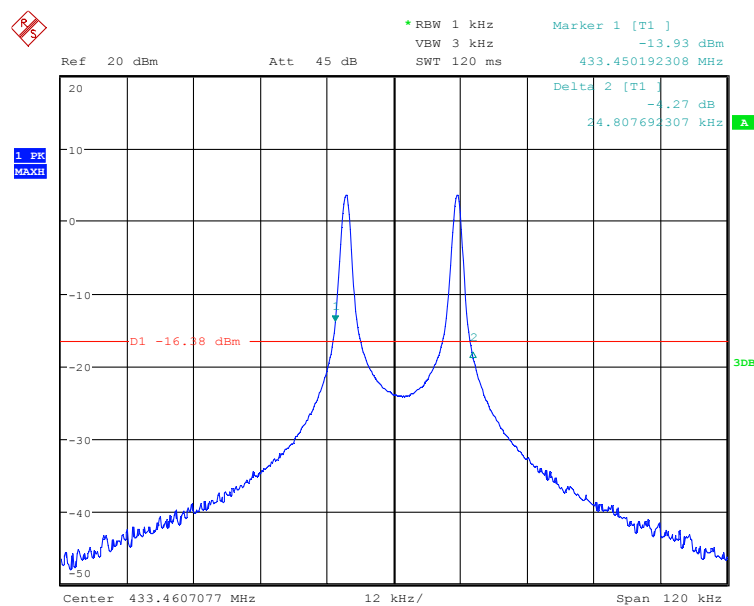
PMT Sample Numbwe: S15 (TX) + Antenna (S31)

Full Spectrum



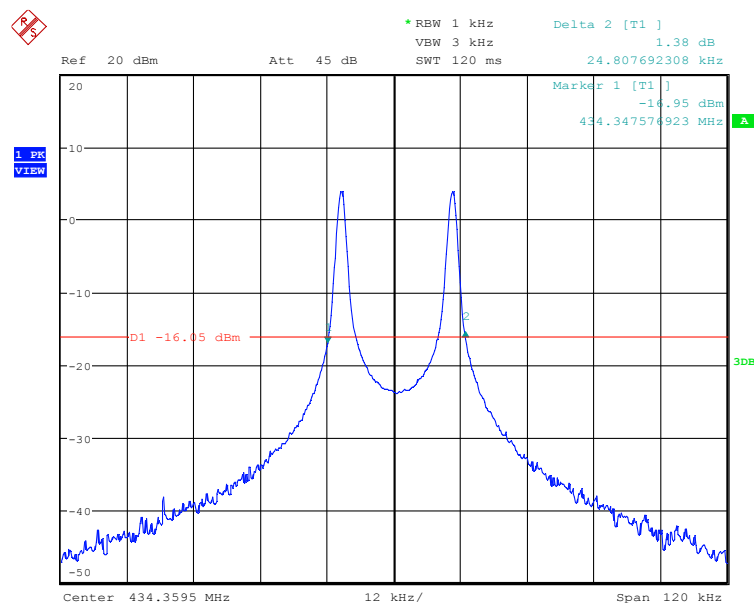
1.5. 20dB bandwidth

1.5.1. Measurements on set-up1, antenna 1, ch1



Date: 25.JUL.2019 16:11:35

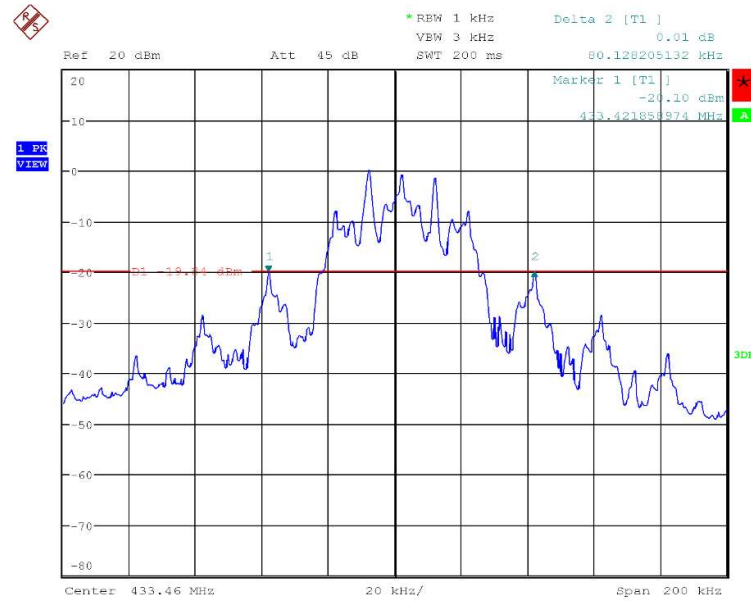
1.5.2. Measurements on set-up2, antenna 2, ch2



Date: 25.JUL.2019 15:58:39

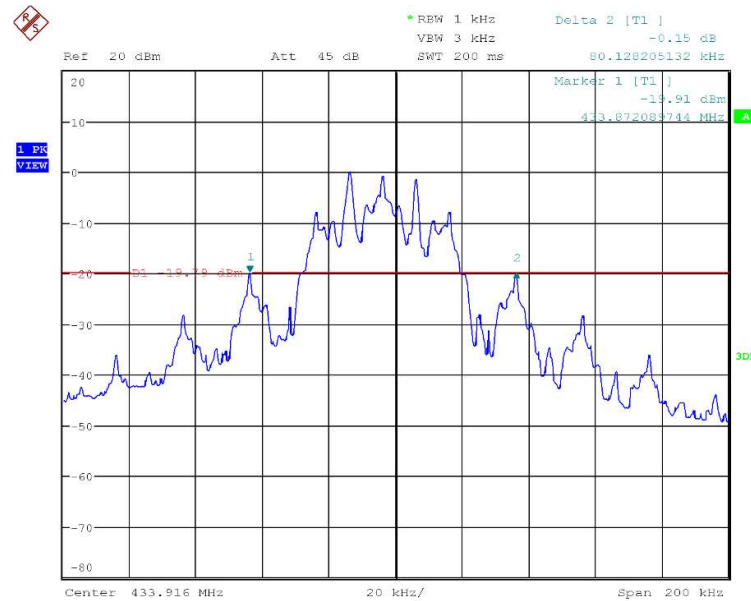
1.5.3. Measurements on set-up 3

1.5.3.1. Measurements on antenna 1, Ch1 (low)



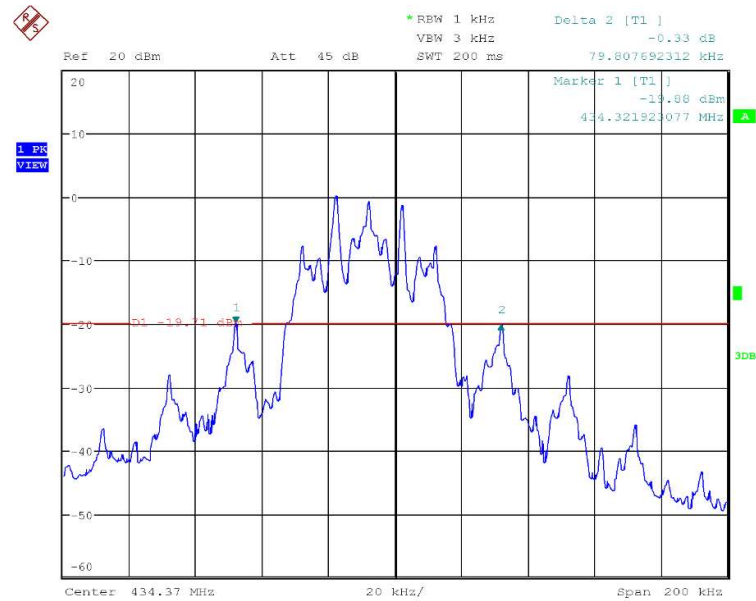
Date: 25.JUL.2019 18:23:21

1.5.3.2. Measurements on antenna 1, Ch3 (middle)



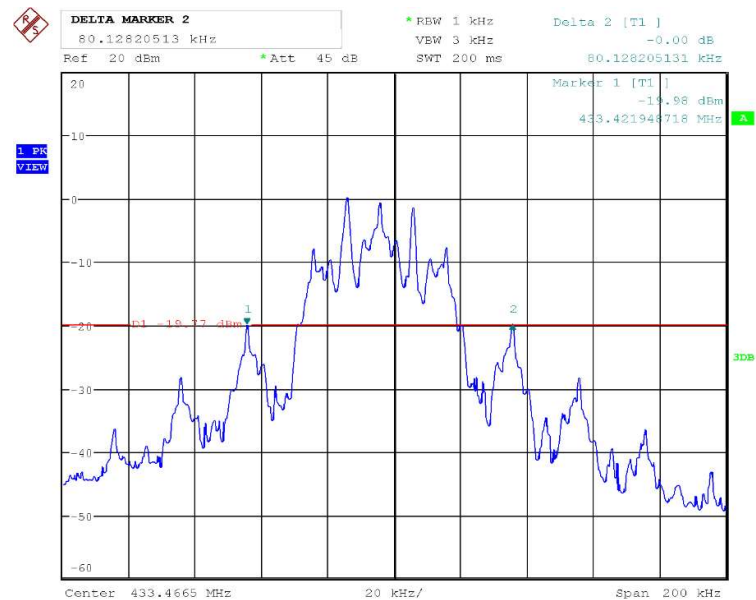
Date: 25.JUL.2019 18:47:44

1.5.3.3. Measurements on antenna 1, Ch2 (high)



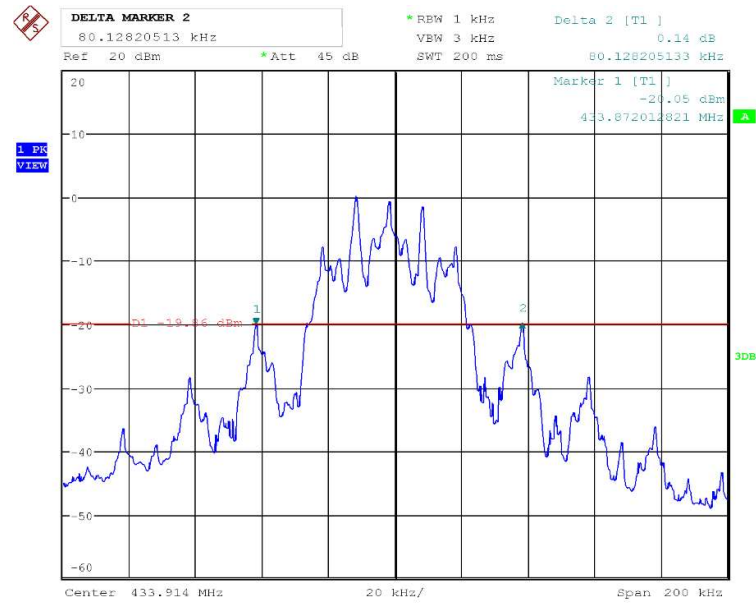
Date: 25.JUL.2019 18:39:07

1.5.3.4. Measurements on antenna 2, Ch1 (low)



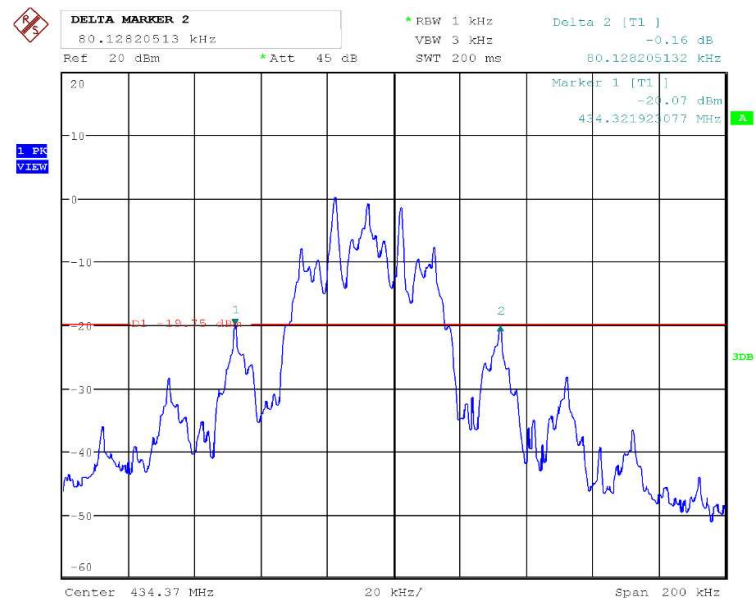
Date: 25.JUL.2019 17:33:03

1.5.3.5. Measurements on antenna 2, Ch3 (middle)



Date: 25.JUL.2019 17:45:20

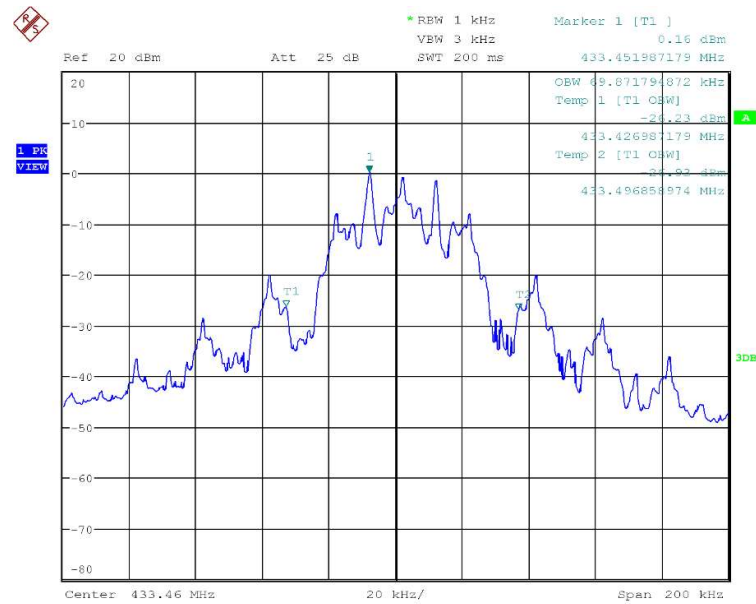
1.5.3.6. Measurements on antenna 2, Ch2 (high)



Date: 25.JUL.2019 17:41:06

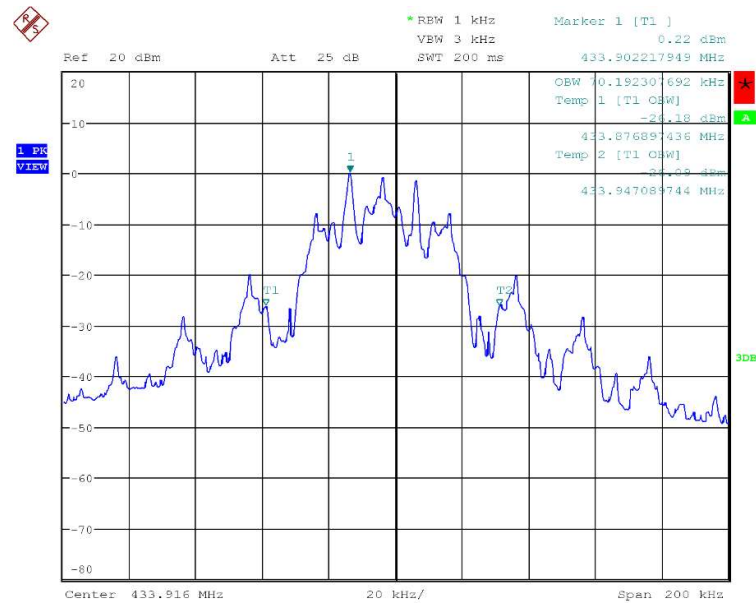
1.6. 99% Occupied bandwidth

1.6.1. Measurements on antenna 1, Ch1 (low)



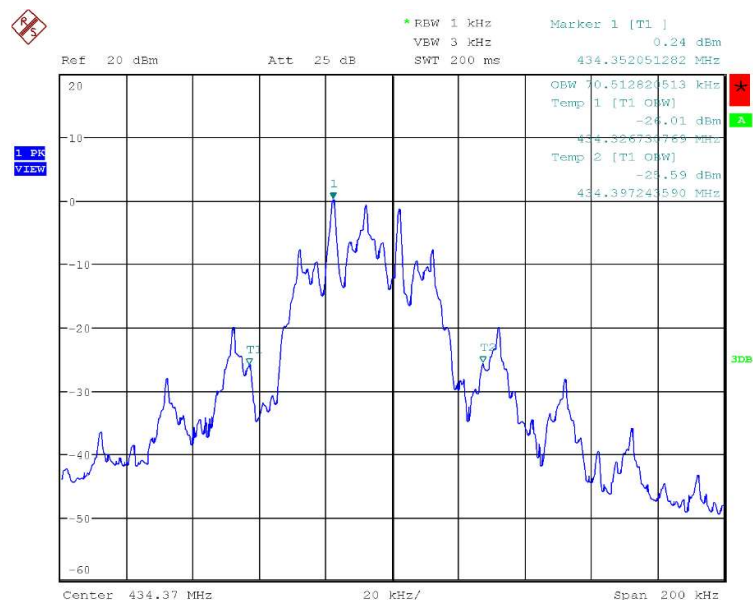
Date: 25.JUL.2019 18:21:14

1.6.2. Measurements on antenna 1, Ch3 (middle)



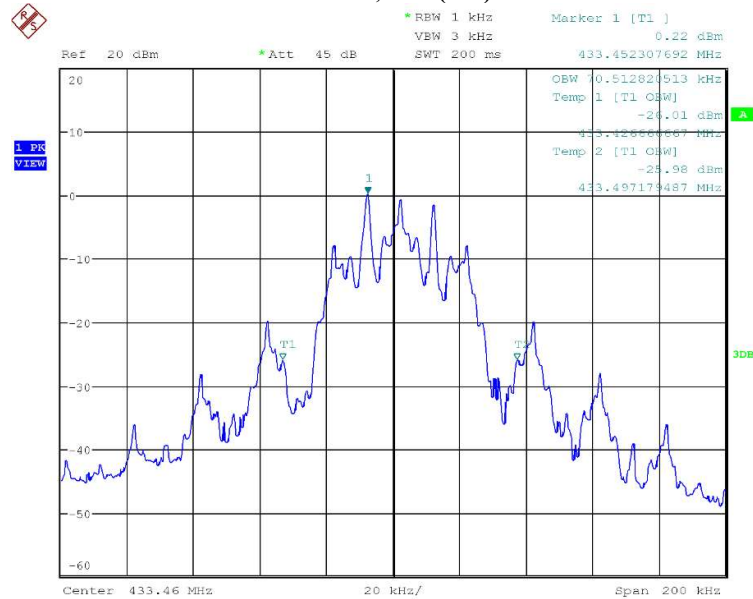
Date: 25.JUL.2019 18:52:22

1.6.3. Measurements on antenna 1, Ch2 (high)



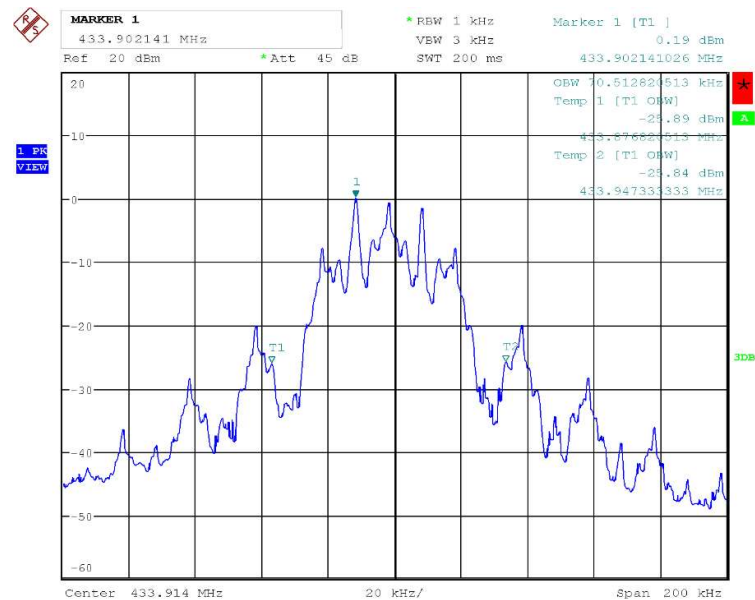
Date: 25.JUL.2019 18:42:45

1.6.4. Measurements on antenna 2, Ch1 (low)



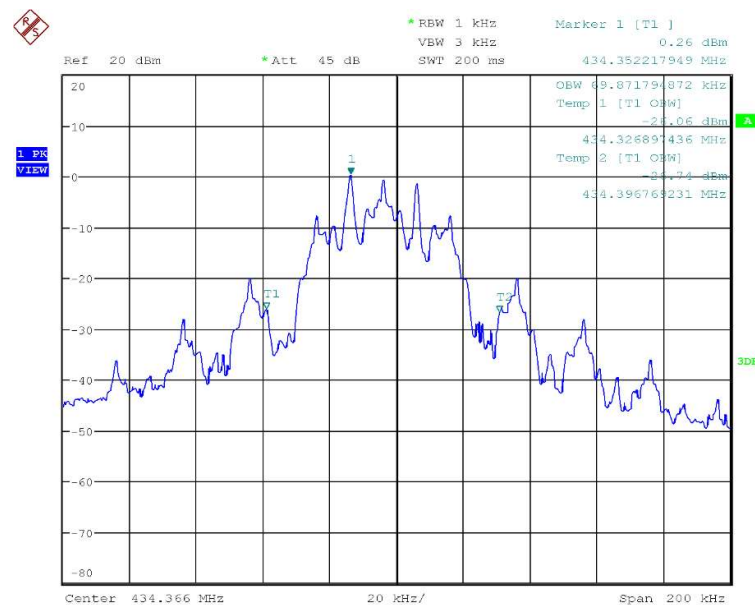
Date: 25.JUL.2019 17:52:51

1.6.5. Measurements on antenna 2, Ch3 (middle)



Date: 25.JUL.2019 17:47:48

1.6.6. Measurements on antenna 2, Ch2 (high)



Date: 25.JUL.2019 18:07:13

1.7. Duty-Cycle correction

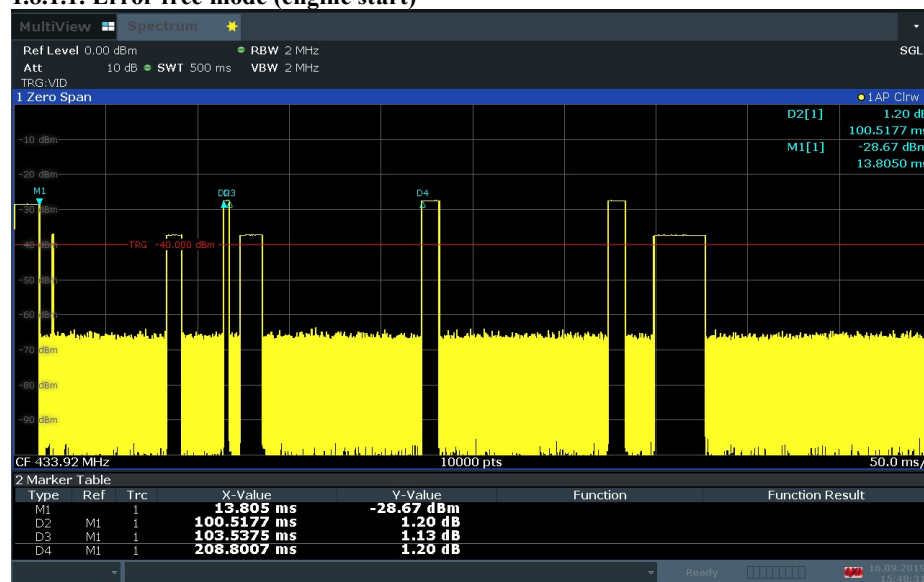
A duty-cycle Peak to AV applies since the transmitter is not 100% on during a 100 ms time unit. Pls. see below diagrams showing the behavior of the pulses and calculations performed

Worst-Case Duty-Cycle correction = -17.35dB (Chapter 1.8.1.1)

1.8. Transmission characteristics

1.8.1. Deactivation of transmitter (§15.231(a)(1))

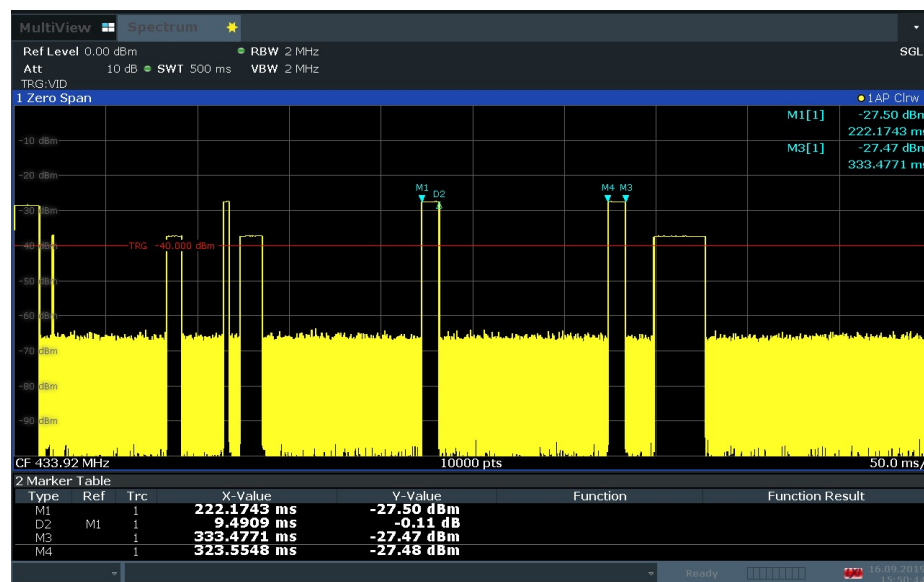
1.8.1.1. Error free mode (engine start)



15:48:32 16.09.2019

Diagram 40.03a -

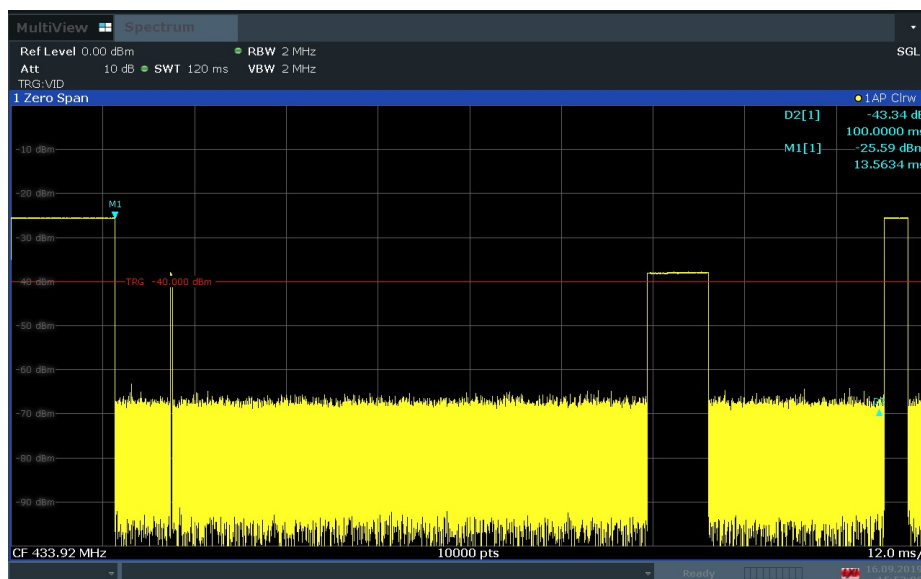
- ➔ 4 Pulses in totally, constant cycle time, no repetition
- ➔ Lower power pulses are response from counterpart (Key)



15:50:44 16.09.2019

Diagram 40.03b – Overview Pulse 3 and 4 (Pulse width/duration)

- ➔ Lower power pulses are response from counterpart (Key)



15:53:06 16.09.2019

Diagram 40.03c – Pulse length/duration

➔ Lower power pulses are response from counterpart (Key)

Pulse no.	Length [ms]	Remark:
1	13.5634	Diagram 40.03c (direct read) -> Worst-Case Pulse length
2	3.01979	From Diagram 40.03b (calculated)
3	9.4909	From Diagram 40.03b (direct read)
4	9.9223	From Diagram 40.03b (calculated)

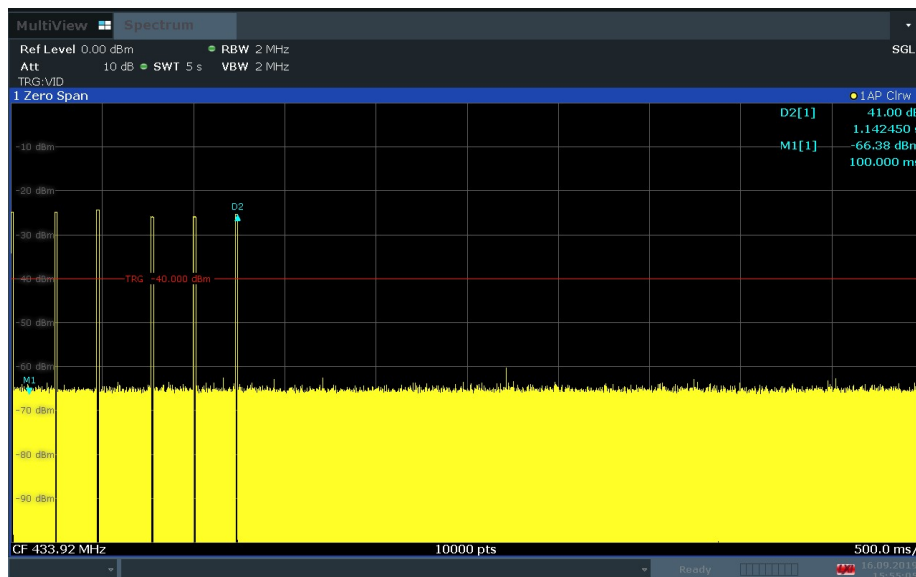
Cycle Time: $TX_{ON}\text{-Pulse1} + TX_{OFF}$ 13.5634 ms + 100.5177 ms = 114.3227 ms

Only one Pulse can be observed during a period of 100 ms:

Therefore: Duty-Cycle [dB] related to 100 ms = $20 \cdot \log_{10}(13.5634 \text{ ms}/100 \text{ ms}) = -17.35 \text{ dB}$

For Peak to AV correction of measured field strength: -17.35 dB apply for averaging the peak emission values.

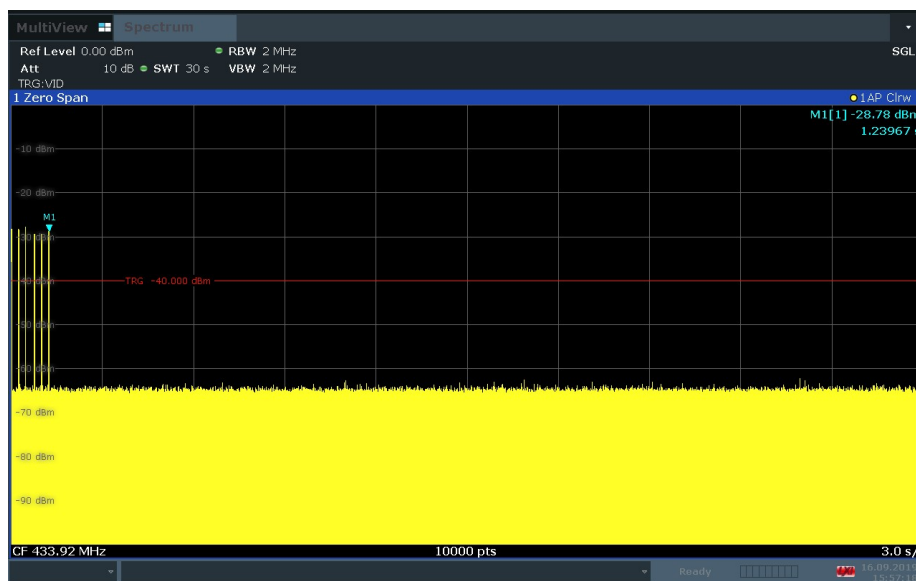
1.8.1.2. Error mode (engine start)



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Diagram 40.04a - Overview

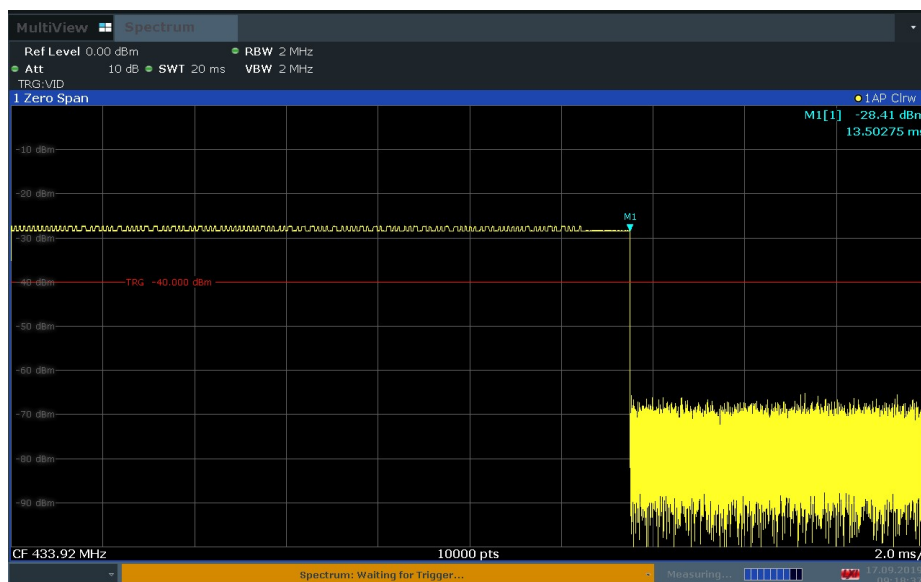
➔ Maximum Pulse time: 1.14245 s lower than 5 seconds §15.231(a)(1) -> pass



15:57:18 16.09.2019

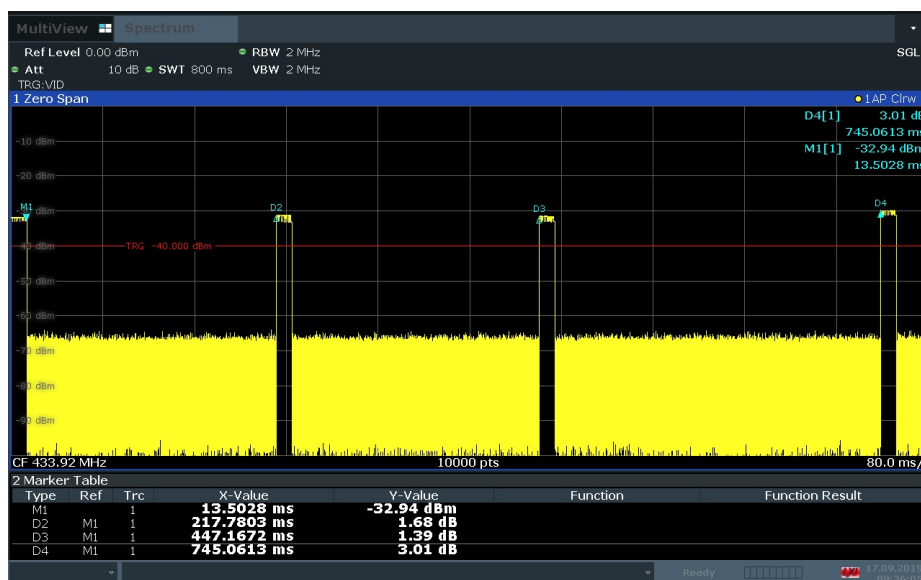
Diagram 40.04b – Overview about single pulses

➔ No repetition can be determined after last pulse train, §15.231(a)(3) -> pass



09:18:46 17.09.2019

Diagram 40.04d – Pulse length/duration: 13.50275 ms



09:36:05 17.09.2019

Diagram 40.04e – Pulse cycle times

TX_{OFF} Cycle-Times:

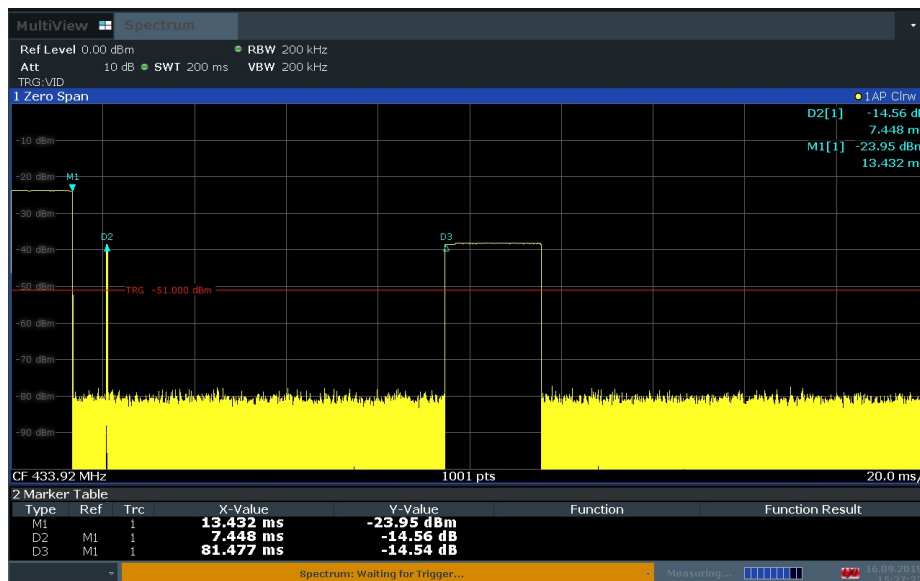
- Pulse 1-2: 217.7803 ms (direct read)
- Pulse 2-3: 215.884 ms (calculated)
- Pulse 3-4: 284.39139 (calculated - longer)

One Pulse can be observed during a period of 100ms:

Therefore: Duty-Cycle [dB] related to 100ms= $20 \cdot \log_{10}(13.50275\text{ms}/100\text{ms}) = -17.35\text{dB}$

For Peak to AV correction of measured field strength: -17.39 dB apply for averaged values

1.8.1.3. Error free mode (car access/entrance)

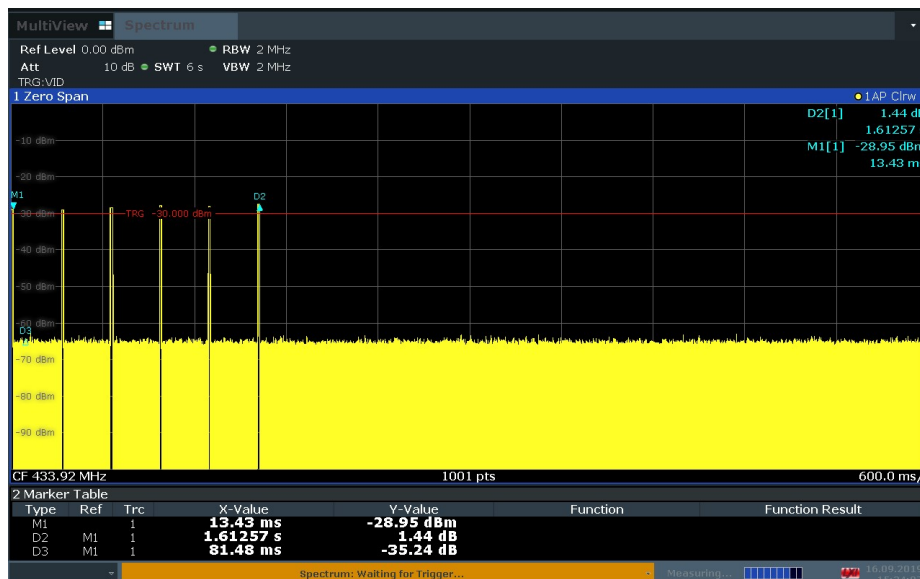


15:27:22 16.09.2019

Diagram 40.01 – Pulse length (duration)

- ➔ One pulse can be observed
- ➔ Pulse-Length: 13.432 ms < 5 seconds
- ➔ Lower power burst from counterpart (Key - Marker on D2&D3)

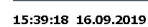
1.8.1.4. Error mode (car access/entrance)



15:34:08 16.09.2019

Diagram 40.02 – Pulse train (6 Pulses)

- ➔ Pulse train ends after 1.61257 seconds < 5seconds (§15.231(a)(1)) -> Pass
- ➔ Equal spaced > 300 ms



➔ No repetition

1.8.2. Periodical operation (§15.231(a)(3))

Not visible/detectable