InterLab®

FCC Measurement/Technical Report on

Tire Pressure Generation 1C wheel unit
Type TIS-01

Report Reference: MDE_CONTI_1506_FCCa_rev_1

FCC ID: KR5TIS-01
IC: 7812D-TIS01

Test Laboratory:
7Layers AG
Borsigstrasse 11
40880 Ratingen
Germany

DAkkS Deutsche Akkreditierungsstelle D-PL-12140-01-01

Table of Contents

0 Summary

0.1 Technical Report Summary

Type of Authorization
Certification for an Intentional Radiator (Periodic operation in the band above 70 MHz)

Applicable FCC Rules

Edition of FCC Rules: October 1, 2014

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 15. The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C – Intentional Radiators

§ 15.201 Equipment authorization requirement

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.231 Periodic operation in the band 40.66-40.70 MHz, above 70 MHz

Note:
none

Summary Test Results:

The EUT complied with all performed tests as listed in chapter 0.2 Measurement Summary.

0.2 Measurement Summary

FCC Part 15, Subpart C		**§ 15.207**	
Conducted emissions (AC power line)			
The measurement was performed according to ANSI C63.4			2009
OP-Mode	**Setup**	**Port**	**Final Result**
		AC Port (power line)	N/A

FCC Part 15, Subpart C		**§ 15.231**	
Duty cycle measurement (based on dwell time measurement)			
The measurement was performed according to FCC § 15.31			10-1-14 Edition
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 3	Setup_01	Enclosure	passed

FCC Part 15, Subpart C		**§ 15.231**	
Spurious Radiated Emissions			
The measurement was performed according to ANSI C63.4			2009
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_01	Enclosure	passed

FCC Part 15, Subpart C		**§ 15.231**	
Maximum radiated field strength at fundamental frequency			
The measurement was performed according to ANSI C63.4			2009
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_01	Enclosure	passed

FCC Part 15, Subpart C		**§ 15.231**	
Occupied Bandwidth			
The measurement was performed according to FCC § 15.31			10-1-14 Edition
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 2	Setup_01	Enclosure	passed

N/A not applicable (the EUT is powered by DC internal battery)

Revision History

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2015-04-09	-	invalid
rev1	2015-04-16	- Added remark to 3.3.3 for the EUT compliance according to Part 15.231 (e) - Changed IC ID to 7812D-TIS01 - EUT antenna gain value changed	valid

Responsible for Accreditation Scope: MARCO KULLIK 2015.04.16 15:51:43 +02'00'

Responsible for Test Report: Dobrin Dobrinov 2015.04.16 15:49:45 +02'00'

1 Administrative Data

1.1 Testing Laboratory

Company Name:	7Layers AG
Address	Borsigstr. 11 40880 Ratingen Germany

This facility has been fully described in a report submitted to the FCC and accepted under the registration number 96716.

The test facility is also accredited by the following accreditation organisation:

Laboratory accreditation no.:	DAkkS D-PL-12140-01-01
Responsible for Accreditation Scope:	Dipl.-Ing. Bernhard Retka Dipl.-Ing. Robert Machulec Dipl.-Ing. Andreas Petz Dipl.-Ing. Marco Kullik
Report Template Version:	2014-04-02

1.2 Project Data

Responsible for testing and report:	Dipl.-Ing. Dobrin Dobrinov
Date of Test(s):	2015-04-02 to 2015-04-06
Date of Report:	2015-04-16

1.3 Applicant Data

Company Name:	Continental Automotive GmbH
Address:	Siemensstrasse 12 93055 Regensburg, Germany
Contact Person:	Mr. Josef Lohr

1.4 Manufacturer Data

Company Name:	Continental Automotive
Address:	1 Avenue Paul Ourliac 31100 Toulouse, France
Contact Person:	Mr. Josef Lohr

2 Test object Data

2.1 General EUT Description

Equipment under Test	Tire Pressure Generation 1C wheel unit
Type Designation:	Type TIS-01
Kind of Device:	433 MHz transmitter
(optional)	
Voltage Type:	DC internal battery
Voltage level:	3.0 V
Repeated Operation:	Automatic
The EUT is part of a security or safety system:	No

General product description:

The Equipment Under Test (EUT) is a wireless transmitter for non-periodic operation in the band above 70 MHz. The operating frequency is in the 433 MHz ISM band.

Specific product description for the EUT:

The transmitter, together with its DC supply battery, is encapsulated into the vehicles wheel valve stem. Every 64 seconds when set in drive mode, the transmitter sends the tire pressure, acceleration and temperature data.

The sample used for tests contains a new battery.

The EUT provides the following ports:

Ports
- Enclosure

The main components of the EUT are listed and described in Chapter 2.2.

2.2 EUT Main components

Type, S/N, Short Descriptions etc. used in this Test Report

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status	Date of Receipt
EUT A (Code: DE10 24000aa01)	Tire Pressure wheel unit Generation 1C	TIS-01	-	TIS-01	test SW	–
Remark: EUT A is equipped with an integral antenna (gain = -22.1 dBi).						

NOTE: The short description is used to simplify the identification of the EUT in this test report.

2.3 Ancillary Equipment

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	HW Status	SW Status	Serial no.	FCC ID
–	–	–	–	–	–	–

2.4 Auxiliary Equipment

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Auxiliary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	HW Status	SW Status	Serial no.	FCC ID
–	–	–	–	–	–	–

2.5 EUT Setups

This chapter describes the combination of EUTs and ancillary equipment used for testing.

Setup No.	Combination of EUTs	Description
Setup_01	EUT A	setup for radiated measurements

2.6 Operating Modes

This chapter describes the operating modes of the EUTs used for testing.

Op. Mode	Description of Operating Modes	Remarks
op-mode 1	CW mode	transmitter sends CW signal
op-mode 2	Burst script mode	Transmitter sends continuously modulated signal
op-mode 3	Single burst mode	Transmitter sends single modulated signal

Remark: The special test software provided by applicant was used.

The test software sends command to switch EUT in different operational modes as following:

Test mode	Description	Transmission duration
Continuous CW	EUT sends CW signal	3 min 55 s
Continuous burst script	EUT sends continuously a normal burst pattern	2 min 52 s
Single burst	EUT sends single normal burst	0.4284 s

2.7 Product labelling

2.7.1 FCC ID label

KR5TIS-01

2.7.2 IC ID Label

7812D-TIS01

2.7.3 Location of the label on the EUT

Please refer to the documentation of the applicant.

3 Test Results

3.1 Duty cycle measurement (based on dwell time measurement)

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.35, §15.231

3.1.1 Test Description

The Equipment Under Test (EUT) was setup in a shielded room to perform the dwell time measurements. For analyzer settings please see measurement plots in annex.

3.1.2 Test Limits

Depending on the function of the EUT different paragraphs of FCC §15.231 apply:

Either
(a)(1): A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

Or
(a)(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

And
(a)(3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

Otherwise
(e) Intentional radiators may operate at a periodic rate exceeding that specified in paragraph (a) of this section and may be employed for any type of operation [...].
In addition, [...] the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

This test is also performed to determine the pulse train of the transmitter and calculate the correction factor for pulse modulated transmitters according to FCC §15.35. This factor is used as a correction factor for the field strength measurements, both for Spurious radiated emissions and Maximum radiated field strength at fundamental frequency.

3.1.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1009 hPa
Humidity: 38 %

Op. Mode	Setup	Port
op-mode 3	Setup_01	Enclosure

a) Determine the total duration of a transmission within 100 ms:

Duty cycle = ((L1*N1) + (L2*N2) + ... + (Ln*Nn)) / 100 ms or T, whichever is less
Correction factor = 20 * LOG (Duty cycle) [dB]

Step 1	Holdover time	Less than 5s
Step 2	Cycle to determine the on/off ratio within a cycle (period T)	428.4 ms
Step 3	Sweep of a data word to determine the on time within a data word (L1-LN).	L1 = 41.6 ms L2 = 10.1 ms
Step 4	Determine the number of pulses (N1-NN). First range (trigger delay = -10 ms).	N1 = 1 N2 = 3

Calculation of Duty Cycle / Correction Factor:
If T > 100 ms => T:= 100 ms; L1 = 41.6 ms; L2 = 10.1 ms; N1 = 2;
In 100 ms T_{on} = 1*41.6 ms = 41.6 ms
Duty cycle = 41.6 / 100 = 0.416
Correction factor = 20*LOG(0.416) = **–7.6 dB**

b) Determine the period of periodic re-transmission, if any, or cease (deactivation) time:

Working mode	Period of retransmission [s]	Structure of the transmitted burst
Driving	**T_R = 64 s**	single L1 pulse followed by one 10.1 ms pulse at every next 64 ms
Parking	**T_R = 46800**	L1 + 3*L3 pulses

Deactivation after **T_C = 0.4284 s** (worst case scenario), **Limit: ≤ 5 s**

c) Determine the total duration of periodic transmissions within 1 hour, if any:

Duration t_d of all pulses/bursts during T_R ("on-time"):

Working mode	t_d [s]
Driving	**0.997325**
Parking	**0.033**

Worst case scenario is: **t_d = 0.997325 s**, **Limit: ≤ 2 s**

d) If the result of c) exceeds 2 seconds/hour then paragraph (e) applies:

Determine the duration of each transmission (one complete pulse train) and silent time:
Duration t_{PT}, Limit: ≤ 1 s (Remark: t_{PT} is identical to t_d if T ≤ 100 ms)
Silent time between transmissions t_S = , Limit: ≤ Maximum(10 s and 30*t_{PT}).

3.1.4 Test result: Duty cycle / correction factor

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 3	passed

3.2 Spurious radiated emissions

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31, ANSI C 63.4, 2009

3.2.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C 63.4-2009. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m in the semi-anechoic chamber. The test was performed at the distance of 3 m between the EUT and the receiving antenna.
The radiated emissions measurements were made in a typical installation configuration.
The measurement procedure is implemented into the EMI test software ES-K1 from R&S.

1. Measurement up to 30 MHz
The test set-up was made in accordance to the general provisions of ANSI C 63.4-2009. The Equipment Under Test (EUT) was set up on a non-conductive table in the anechoic chamber.
The radiated emissions measurements were made in a typical installation configuration.
The measurement procedure is implemented into the EMI test software ES-K1 from R&S.
The Loop antenna HFH2-Z2 is used.
Step 1: pre measurement
- Anechoic chamber
- Antenna distance: 10 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 – 0.15 and 0.15 – 30 MHz
- Frequency steps: 0.1 kHz and 5 kHz
- IF–Bandwidth: 0.2 kHz and 10 kHz
- Measuring time / Frequency step: 10 ms

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.
Step 2: final measurement
For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is to find the maximum emission level.
- Open area test side
- Antenna distance: according to the Standard
- Detector: Quasi-Peak
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF–Bandwidth: 200 Hz - 10 kHz
- Measuring time / Frequency step: 100 ms

2. Measurement above 30 MHz and up to 1 GHz
Step 1: Preliminary scan
Preliminary test to identify the highest amplitudes relative to the limit.
Settings for step 1:
- Detector: Peak-Maxhold
- Frequency range: 30 – 1000 MHz
- Frequency steps: 60 kHz
- IF–Bandwidth: 120 kHz

- Measuring time / Frequency step: 100 µs
- Turntable angle range: –180 to 180°
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: second measurement

For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is, to find out the approximate turntable angle and antenna height for each frequency.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: –180 to 180°
- Turntable step size: 45°
- Height variation range: 1 – 4 m
- Height variation step size: 0.5 m
- Polarisation: horizontal + vertical

After this step the EMI test system has determined the following values for each frequency (of step 1):

- Frequency
- Azimuth value (of turntable)
- Antenna height

The last two values have now the following accuracy:

- Azimuth value (of turntable): 45°
- Antenna height: 0.5 m

Step 3: final measurement

In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.

For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will be slowly varied by +/- 22.5° around this value. During this action the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position the antenna height is also slowly varied by +/- 25 cm around the antenna height determined. During this action the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: –22.5° to + 22.5° around the determined value
- Height variation range: –0.25 m to +0.25 m around the determined value

Step 4: final measurement with QP detector

With the settings determined in step 3, the final measurement will be performed:
EMI receiver settings for step 4:

- Detector: Quasi-Peak(< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

3. Measurement above 1 GHz

The following modifications apply to the measurement procedure for the frequency range above 1 GHz:

The measurement distance was reduced to 1 m. The results were extrapolated by the extrapolation factor of 20 dB/decade (inverse linear distance for field strength measurements, inverse linear-distance squared for the power reference level measurements). Due to the fact that in this frequency range a double ridged wave guided horn antenna (up to 18 GHz) and a horn antenna (18-25 GHz) are used, the steps 2-4 are omitted. Step 1 was performed with one height of the receiving antenna only.

Important EMI receiver settings:

- Detector: Peak, Average
- RBW = 1 MHz, VBW = 3 MHz
- Sweep time = 100 ms / per 100 MHz sweep

3.2.2 Test Requirements / Limits

1) A radiated emission test is relating to the fundamental frequency.

a) Either for "non-periodic" operation of the EUT as defined in §15.231(a) the limits for the average field strength apply according to FCC Part 15, Subpart C, §15.231(b):

For fundamental frequency (MHz)	Limit Fundamental (dBµV/m)	Limit Spurious (dBµV/m)
40.66 – 40.70	67.0	47.0
70 – 130	62.0	42.0
130 – 174	62.0 – 71.5	42.0 – 51.5 *)
174 – 260	71.5	51.5
260 – 470	71.5 – 81.9	51.5 – 61.9 *)
above 470	81.9	61.9

b) Or for "periodic" operation of the EUT the limits for the average field strength apply according to FCC Part 15, Subpart C, §15.231(e):

For fundamental frequency (MHz)	Limit Fundamental (dBµV/m)	Limit Spurious (dBµV/m)
40.66 – 40.70	60.0	40.0
70 – 130	54.0	34.0
130 – 174	54.0 – 63.5	34.0 – 43.5 *)
174 – 260	63.5	43.5
260 – 470	63.5 – 74.0	43.5 – 54.0 *)
above 470	74.0	54.0

*) linear interpolation

(1) The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.

2) A radiated emission test applies to harmonic/spurs that fall in the restricted bands as listed in § 15.205(a). The maximum permitted QP (< 1 GHz) and Average (> 1GHz) field strength is listed in § 15.209(a):
Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Calculate Limit(dBµV/m @10m)	Limit (dBµV/m) @10m
0.009 – 0.49	2400/F (kHz)	300	(48.5 – 13.8) + 59.1 dB	107.6 – 72.9
0.49 – 1.705	24000/F (kHz)	30	(33.8 – 23.0) + 19.1 dB	52.9 – 42.1
1.705 – 30	30	30	29.5 + 19.1 dB	48.6

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limit (dBµV/m
30 – 88	100	3	40.0
88 – 216	150	3	43.5
216 – 960	200	3	46.0
above 960	500	3	54.0

§15.35(b) ..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit ... .

Used conversion factor: Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)

§15.35(c):
[...] when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds.
As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted [...].

§15.231(b)(3)
The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator.
Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in §15.209, whichever limit permits a higher field strength.

Interpretation of the test laboratory:
The lats subordinate clause of §15.231(b)(3) is overruled by §15.205/209, therefore within the restricted bands the limits defined at §15.205/209 and outside the restricted bands the limits defined at §15.231(b) resp. §15.231(e) are applied.

3.2.3 Test Protocol

3.2.3.1 Measurement up to 30 MHz

Temperature: 24 °C
Air Pressure: 1009 hPa
Humidity: 38 %

Op. Mode	Setup	Port
op-mode 2	Setup_01	Enclosure

Polari-sation	Frequency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Margin to limit dB	Margin to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
0°	–	–	–	–	–	–	–	–	–
90°	–	–	–	–	–	–	–	–	–

Remark: In step 1 no spurious emissions above the limit were found using a peak detector, therefore step 2 (using a QP-detector) was not performed. For this test an EUT sending a CW signal was used. Please see the measurement plots in annex.

All three axis (Y,Y,Z) of the device and both antenna polarizations (H/V) were considered.

3.2.3.2 Measurement 30 MHz – 1 GHz

Temperature: 24 °C
Air Pressure: 1006 hPa
Humidity: 42 %

Op. Mode	Setup	Port
op-mode 2	Setup_01	Enclosure

Polarisation of the antenna and the EUT	Frequency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Margin to limit dB	Margin to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
–	–	–	–	–	–	–	–	–	–

Remark: No spurious emissions in the range 15 dB below the limit found. The test was performed in the frequency range from 30 MHz to 1 GHz. For this test an EUT sending a CW signal was used. Please see measurement plot.

All three axis (Y,Y,Z) of the device and both antenna polarizations (H/V) were considered.

3.2.3.3 Measurement above 1 GHz

Temperature: 24 °C
Air Pressure: 1006 hPa
Humidity: 42 %

Op. Mode	Setup	Port
op-mode 2	Setup_01	Enclosure

Polarisation	Frequency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Margin to limit dB	Margin to limit dB
		QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
vert./horiz.	3471	–	45.5	41.8	–	74.0	54.0	28.5	12.2

Remarks: - The test was performed in the frequency range from 1 GHz to 4.5 GHz. For this test an EUT sending a CW signal was used. Please see measurement plots.

All three axis (Y,Y,Z) of the device and both antenna polarizations (H/V) were considered.

3.2.4 Test result: Spurious radiated emissions

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	passed

3.3 Maximum radiated field strength at fundamental frequency

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31, §15.231, ANSI C 63.4, 2009

3.3.1 Test Description

Please refer to sub-clause 3.2.1.

3.3.2 Test Limits

Please refer to sub-clause 3.2.2.

3.3.3 Test Protocol

Temperature: 24 °C
Air Pressure: 1009 hPa
Humidity: 38 %

Op. Mode	Setup	Port
op-mode 2	Setup_01	Enclosure

channel	Output power dBµV/m	Frequency MHz	Limit dBµV/m	Remarks
1	68.3	433.86	80.83	Maximum radiated field strength at fundamental frequency

Notes: - The value shown in the table above is corrected by using the Duty Cycle Correction Factor, calculated in 3.1.3.
- Because the EUT could be subject to interpretation in the specific case of Part 15.231 (e), the results according the provisions of Part 15.231 (e) are shown in the table below:

channel	Output power dBµV/m	Frequency MHz	Limit dBµV/m	Remarks
1	68.3	433.86	72.20	Maximum radiated field strength at fundamental frequency

3.3.4 Test result: Maximum radiated field strength at fundamental frequency

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	passed

3.4 Occupied bandwidth

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.231

3.4.1 Test Description

The Equipment Under Test (EUT) was setup in a shielded room to perform the occupied bandwidth measurements.
For analyzer settings please see the measurement plots in annex.

3.4.2 Test Limits

FCC Part 15, Subpart C, §15.231(c)
The maximum 20 dB bandwidth of a transmitter operating at a frequency range:
70 to 900 MHz is 0.25% of the centre frequency
above 900 MHz is 0.5% of the centre frequency

3.4.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1009 hPa
Humidity: 42 %

Op. Mode	Setup	Port
op-mode 2	Setup_01	Enclosure

Channel	20 dB bandwidth kHz	99% bandwidth kHz	Limit kHz	Remarks
1	192.5	164.978	1084.8	The limit is calculated as: 433.92 MHz (declared by applicant) * 0.25% = 1084.8 kHz.

Remark: The analyser settings are consistent with the recommendations of ANSI C63.10-2013 section 6.9.2 where is stated, that the resolution bandwidth should be between 1% and 5% of the actual signal bandwidth.

As an actual signal bandwidth the limit of 1086.75 kHz is considered. According to ANSI C63.10-2013 section 6.9.2, the analyser RBW should be between 10.868 kHz and 54.338 kHz. The RBW of 30 kHz was chosen.

Please see annex for the measurement plots.

3.4.4 Test result: Occupied bandwidth

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 2	passed

4 Test Equipment

The calibration, hardware and software states are shown for the testing period.

Test Equipment Anechoic Chamber

Lab ID:	**Lab 2**		
Manufacturer:	Frankonia		
Description:	Anechoic Chamber for radiated testing		
Type:	10.58x6.38x6.00 m³		
	NSA (FCC)	2014/01/09	2017/01/09

Single Devices for Anechoic Chamber

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Air compressor	none	-	Atlas Copco	
Anechoic Chamber	10.58 x 6.38 x 6.00 m³ FCC listing 96716 3m Part15/18	none	Frankonia 2014/01/09	2017/01/08
Controller Maturo	MCU	961208	Maturo GmbH	
EMC camera	CE-CAM/1	-	CE-SYS	
EMC camera Nr.2	CCD-400E	0005033	Mitsubishi	
Filter ISDN	B84312-C110-E1		Siemens&Matsushita	
Filter Universal 1A	BB4312-C30-H3	-	Siemens&Matsushita	

Test Equipment Auxiliary Equipment for Conducted emissions

Lab ID:	**Lab 1**
Manufacturer:	Rohde & Schwarz GmbH & Co.KG
Description:	EMI Conducted Auxiliary Equipment

Single Devices for Auxiliary Equipment for Conducted emissions

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Cable "LISN to ESI"	RG214	W18.03+W48.03	Huber&Suhner	
Impedance Stabilization Network	ISN T800	36159	Teseq GmbH	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2014/02/06	2016/02/28
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN ST08	36292	Teseq GmbH	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2014/01/10	2016/01/31
Impedance Stabilization Network, Coupling Decoupling Network	ISN/CDN T8-Cat6	32187	Teseq GmbH	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2014/01/08	2016/01/31

Single Devices for Auxiliary Equipment for Conducted emissions (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
One-Line V-Network	ESH 3-Z6	100489	Rohde & Schwarz GmbH & Co. KG
One-Line V-Network	ESH 3-Z6	100570	Rohde & Schwarz GmbH & Co. KG

Calibration Details	*Last Execution*	*Next Exec.*
Standard Calibration	2013/11/25	2016/11/24

Test Equipment Auxiliary Equipment for Radiated emissions

Lab ID:	**Lab 2**
Description:	Equipment for emission measurements
Serial Number:	see single devices

Single Devices for Auxiliary Equipment for Radiated emissions

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Antenna mast	AM 4.0	AM4.0/180/11920513	Maturo GmbH	
Antenna mast	AS 620 P	620/37	HD GmbH	
Biconical dipole	VUBA 9117	9117-108	Schwarzbeck	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2012/05/18	2015/05/17
Broadband Amplifier 18MHz-26GHz	JS4-18002600-32-5P	849785	Miteq	
Broadband Amplifier 1GHz-4GHz	AFS4-01000400-1Q-10P-4	-	Miteq	
Broadband Amplifier 30MHz-18GHz	JS4-00101800-35-5P	896037	Miteq	
Cable "ESI to EMI Antenna"	EcoFlex10	W18.01-2+W38.01-2	Kabel Kusch	
Cable "ESI to Horn Antenna"	UFB311A+UFB293C	W18.02-2+W38.02-2	Rosenberger Micro-Coax	
Double-ridged horn	HF 906	357357/001	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2012/05/18	2015/05/17
Double-ridged horn	HF 906	357357/002	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2012/06/26	2015/06/25
High Pass Filter	4HC1600/12750-1.5-KK	9942011	Trilithic	
High Pass Filter	5HC2700/12750-1.5-KK	9942012	Trilithic	
High Pass Filter	5HC3500/12750-1.2-KK	200035008	Trilithic	
High Pass Filter	WHKX 7.0/18G-8SS	09	Wainwright	
Horn Antenna Schwarzbeck 15-26 GHz BBHA 9170	BBHA 9170			
Log.-per. Antenna	HL 562 Ultralog	100609	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2012/12/18	2015/12/17
Log.-per. Antenna	HL 562 Ultralog	830547/003	Rohde & Schwarz GmbH & Co. KG	
Loop Antenna	HFH2-Z2	829324/006	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2011/11/27	2017/11/27

Single Devices for Auxiliary Equipment for Radiated emissions (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Pyramidal Horn Antenna 26,5 GHz	3160-09	00083069	EMCO Elektronik GmbH
Pyramidal Horn Antenna 40 GHz	3160-10	00086675	EMCO Elektronik GmbH
Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	TD1.5-10kg/024/3790709	Maturo GmbH

Test Equipment Auxiliary Test Equipment

Lab ID:	**Lab 2, Lab 3**
Manufacturer:	see single devices
Description:	Single Devices for various Test Equipment
Type:	various
Serial Number:	none

Single Devices for Auxiliary Test Equipment

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Broadband Power Divider N (Aux)	1506A / 93459	LM390	Weinschel Associates	
Broadband Power Divider SMA	WA1515	A855	Weinschel Associates	
Digital Multimeter 03 (Multimeter)	Fluke 177	86670383	Fluke Europe B.V.	
	Calibration Details		*Last Execution*	*Next Exec.*
	Customized calibration		2013/12/04	2015/12/03
Fibre optic link Satellite (Aux)	FO RS232 Link	181-018	Pontis	
Fibre optic link Transceiver (Aux)	FO RS232 Link	182-018	Pontis	
Isolating Transformer	LTS 604	1888	Thalheimer Transformatorenwerke GmbH	
Notch Filter Ultra Stable (Aux)	WRCA800/960-6EEK	24	Wainwright	
Signal Analyzer	FSV30	103005	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard		2014/02/10	2016/02/09
Spectrum Analyser	FSP3	836722/011	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard		2012/06/13	2015/06/12
Spectrum Analyser	FSU26	200418	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2014/07/29	2015/07/28
Vector Signal Generator	SMIQ 03B	832492/061	Rohde & Schwarz GmbH & Co.KG	

Test Equipment Radio Lab Test Equipment

Lab ID: **Lab 3**
Description: Radio Lab Test Equipment

Single Devices for Radio Lab Test Equipment

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Broadband Power Divider SMA	WA1515	A856	Weinschel Associates	
Coax Attenuator 10dB SMA 2W	4T-10	F9401	Weinschel Associates	
Coax Attenuator 10dB SMA 2W	56-10	W3702	Weinschel Associates	
Coax Attenuator 10dB SMA 2W	56-10	W3711	Weinschel Associates	
Coax Cable Huber&Suhner	Sucotest 2,0m		Huber&Suhner	
Coax Cable Rosenberger Micro Coax FA210A0010003030 SMA/SMA 1,0m	FA210A0010003030	54491-2	Rosenberger Micro-Coax	
Signal Generator SME	SME03	827460/016	Rohde & Schwarz GmbH & Co.KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2014/12/02	2017/12/01
Signal Generator SMP	SMP02	836402/008	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2013/05/06	2016/05/05
Signal Analyser	FSV30	103005	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2014/02/10	2016/02/09
Temperature Chamber Vötsch 03	VT 4002	58566002150010	Vötsch	
	Calibration Details		*Last Execution*	*Next Exec.*
	Customized calibration		2014/03/11	2016/03/10

Test Equipment Temperature Chamber 01

Lab ID:	**Lab 4**
Manufacturer:	see single devices
Description:	Temperature Chamber KWP 120/70
Type:	Weiss
Serial Number:	see single devices

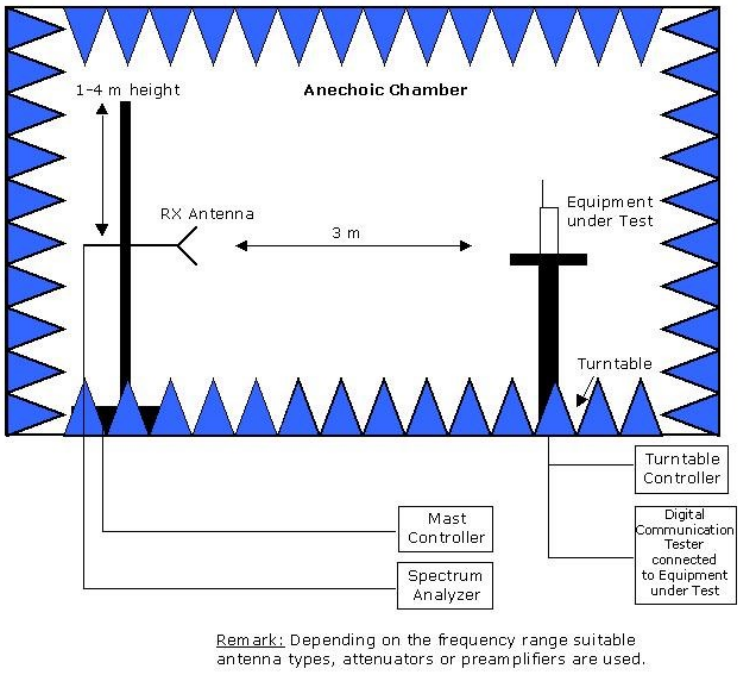
Single Devices for Temperature Chamber 01

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
Temperature Chamber Weiss 01	KWP 120/70	59226012190010	Weiss Umwelttechnik GmbH	
	Calibration Details		*Last Execution*	*Next Exec.*
	Customized calibration		2014/03/12	2016/03/11

5 Photo Report

Photos are included in an external report.

6 Setup Drawings



Drawing 1: Setup in the Anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting ground plane.

7 Correlation table FCC-IC

Correlation of measurement requirements for Momentarily (incl. Periodically) Operated Devices and Remote Control from FCC and IC

Radio equipment

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 4: 8.8
Transmitter spurious radiated emissions	§ 15.231 (b) / (e)	RSS Gen Issue 4: 6.10/6.13/8.9/8.10; RSS-210 Issue 8: A1.1.2, A1.1.5
Duty cycle measurement (based on dwell time measurement)	§ 15.231 (a)	RSS-210 Issue 8: A1.1.1, A1.1.5
Maximum radiated field strength at fundamental frequency	§ 15.231 (b) / (e)	RSS-210 Issue 8: A1.1.2, A1.1.5; RSS Gen Issue 4: 6.12
Occupied bandwidth	§ 15.231 (c)	RSS-210 Issue 8: A1.1.3
Frequency Stability	§ 15.231 (d)	RSS-210 Issue 8: A1.1.4
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 4: 8.3
Receiver spurious emissions	–	RSS-210 Issue 8: 2.3 RSS Gen Issue 4: 5/7 *)

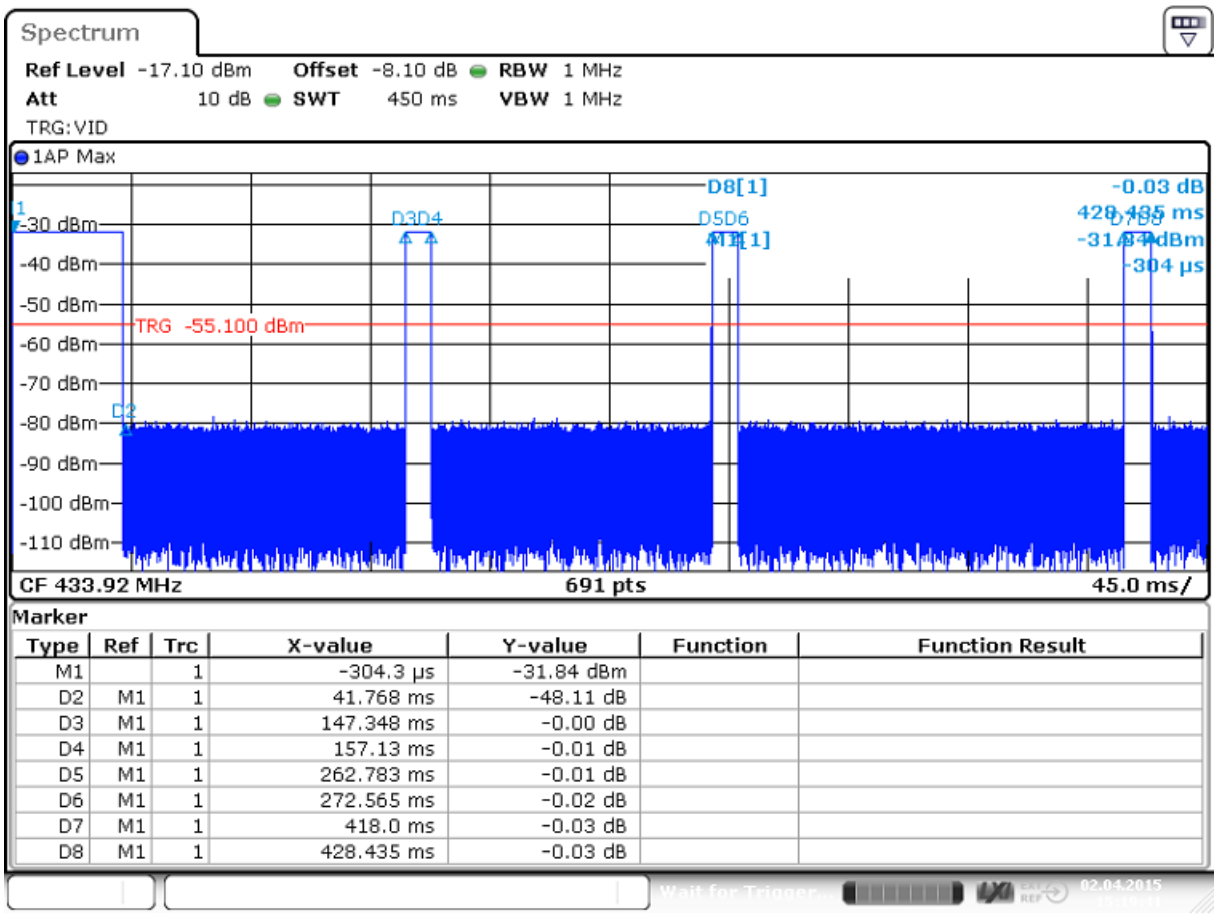
*) Receivers are exempted from certification besides if operating in stand-alone mode in the frequency range 30–960 MHz or if these are scanner receivers.

8 Annex measurement plots

8.1 Duty cycle measurement (based on dwell time measurement)

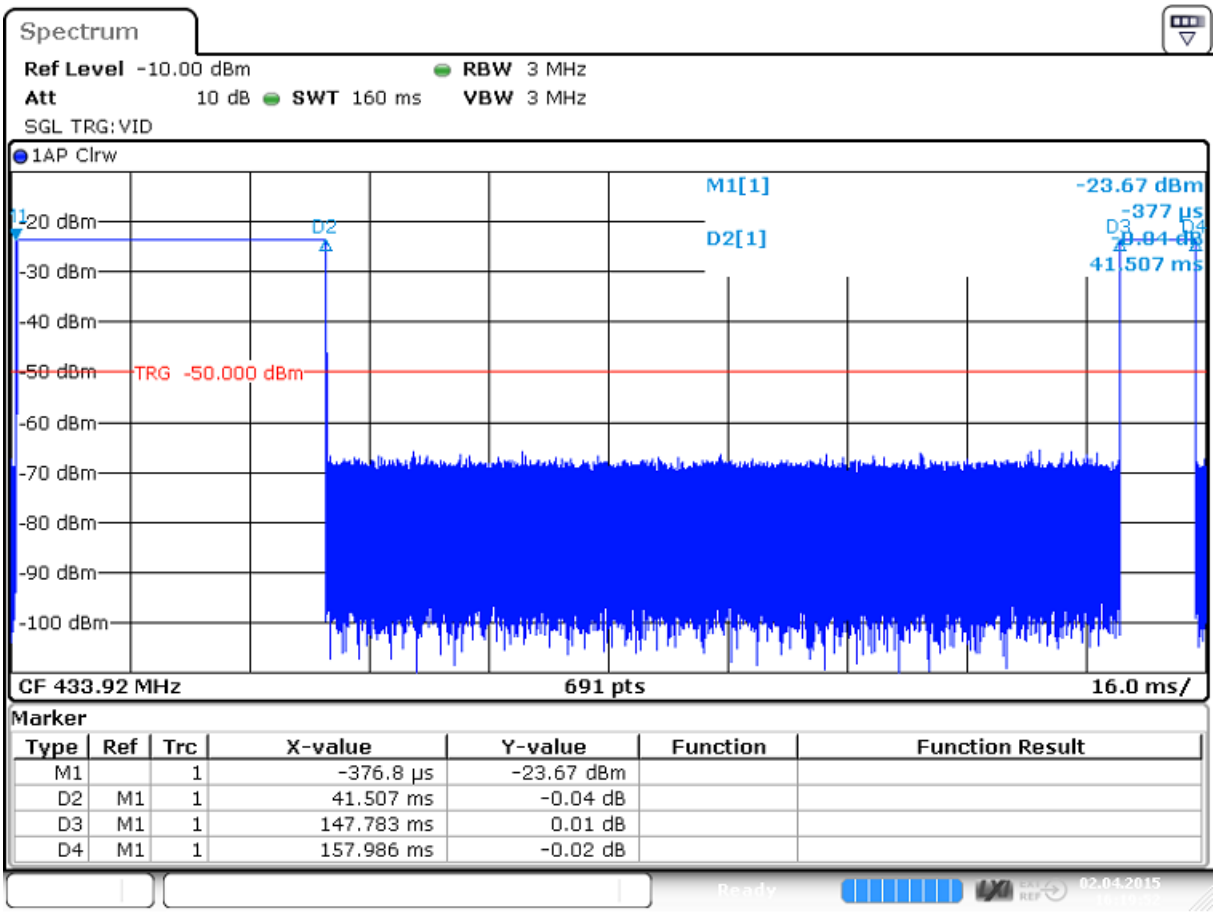
Op. Mode

op-mode 3 Setup_02 enclosure



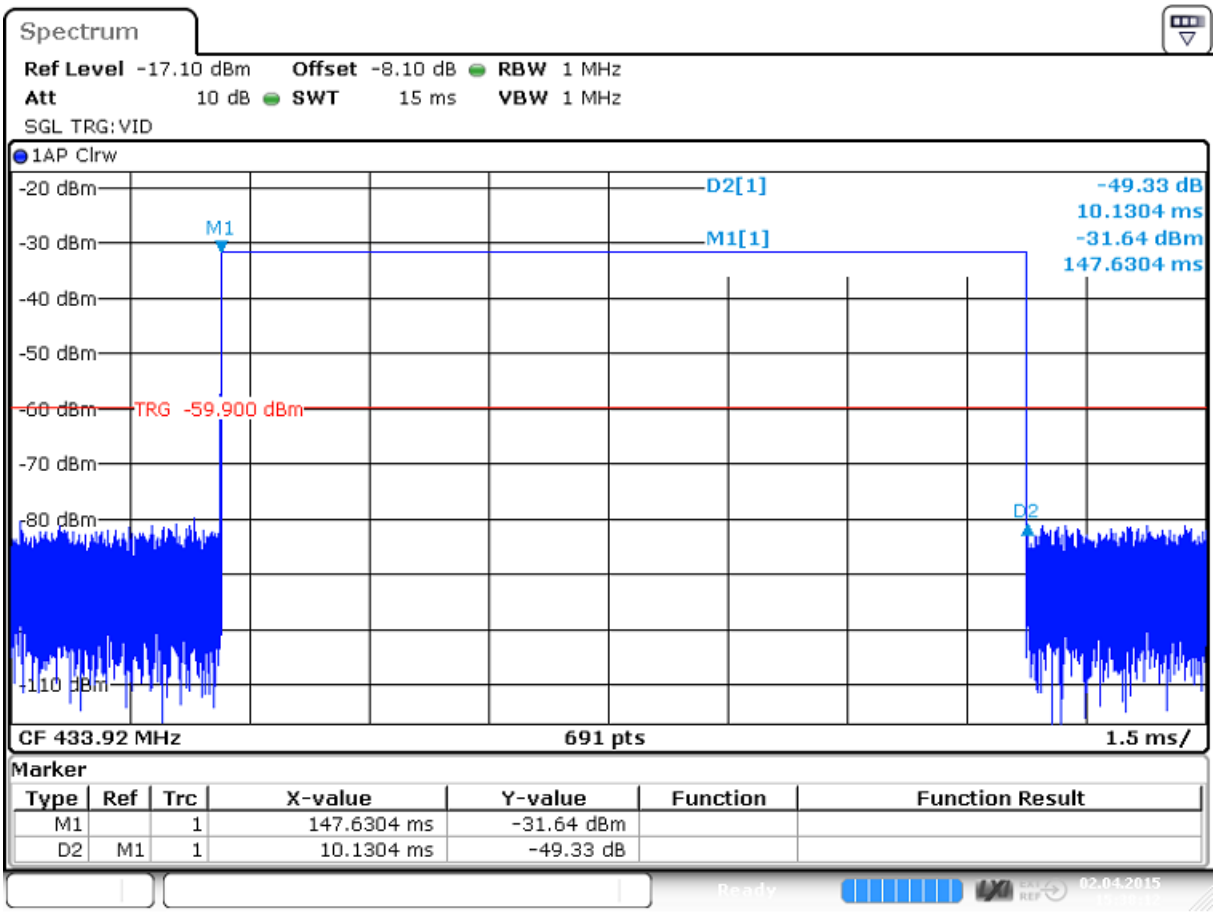
Date:2.APR.2015 15:19:41

The pulse Burst of one period T_R = 429.2 ms



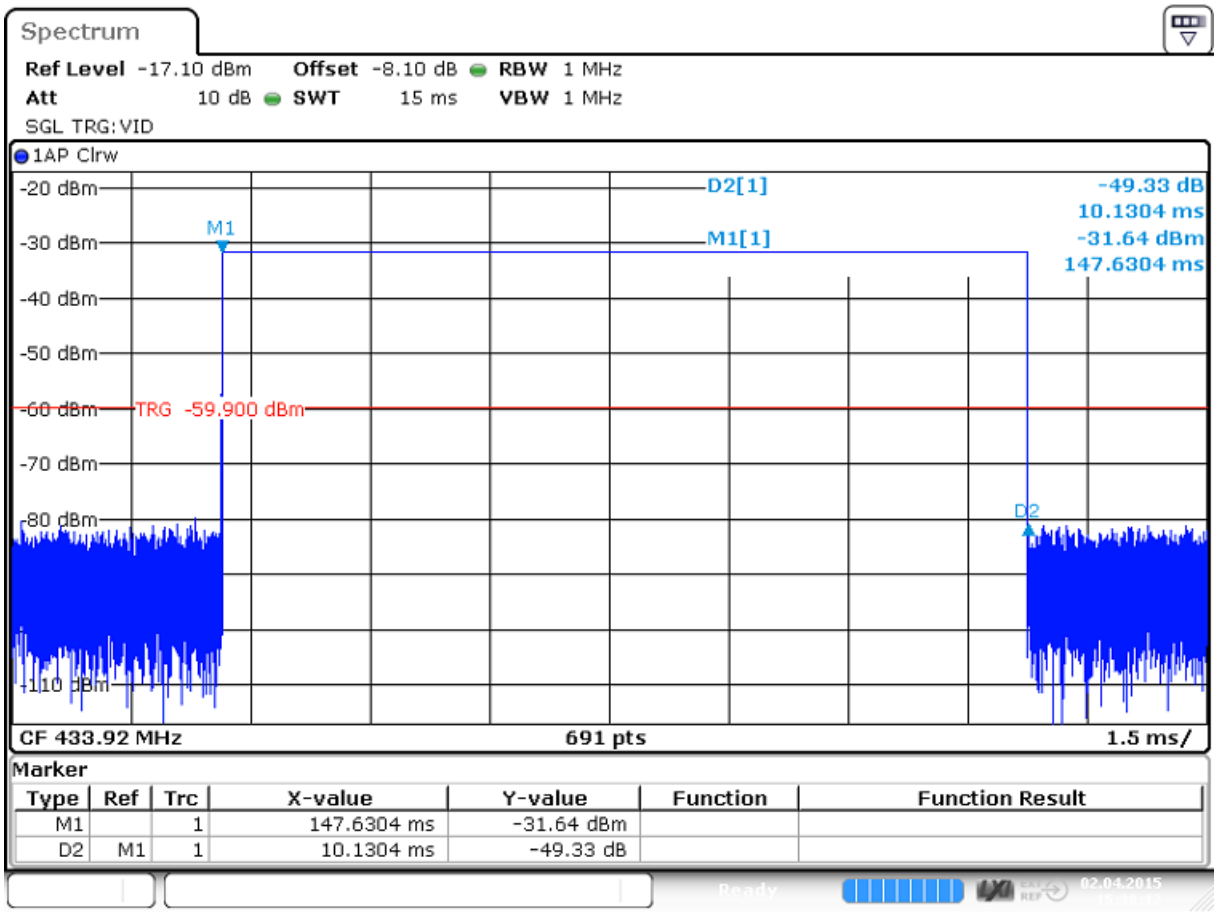
Date: 2.APR.2015 16:19:53

First 2 pulses. In 100 ms period is only N1 pulse contained.



Date:2.APR.2015 15:38:12

The N1 pulse.



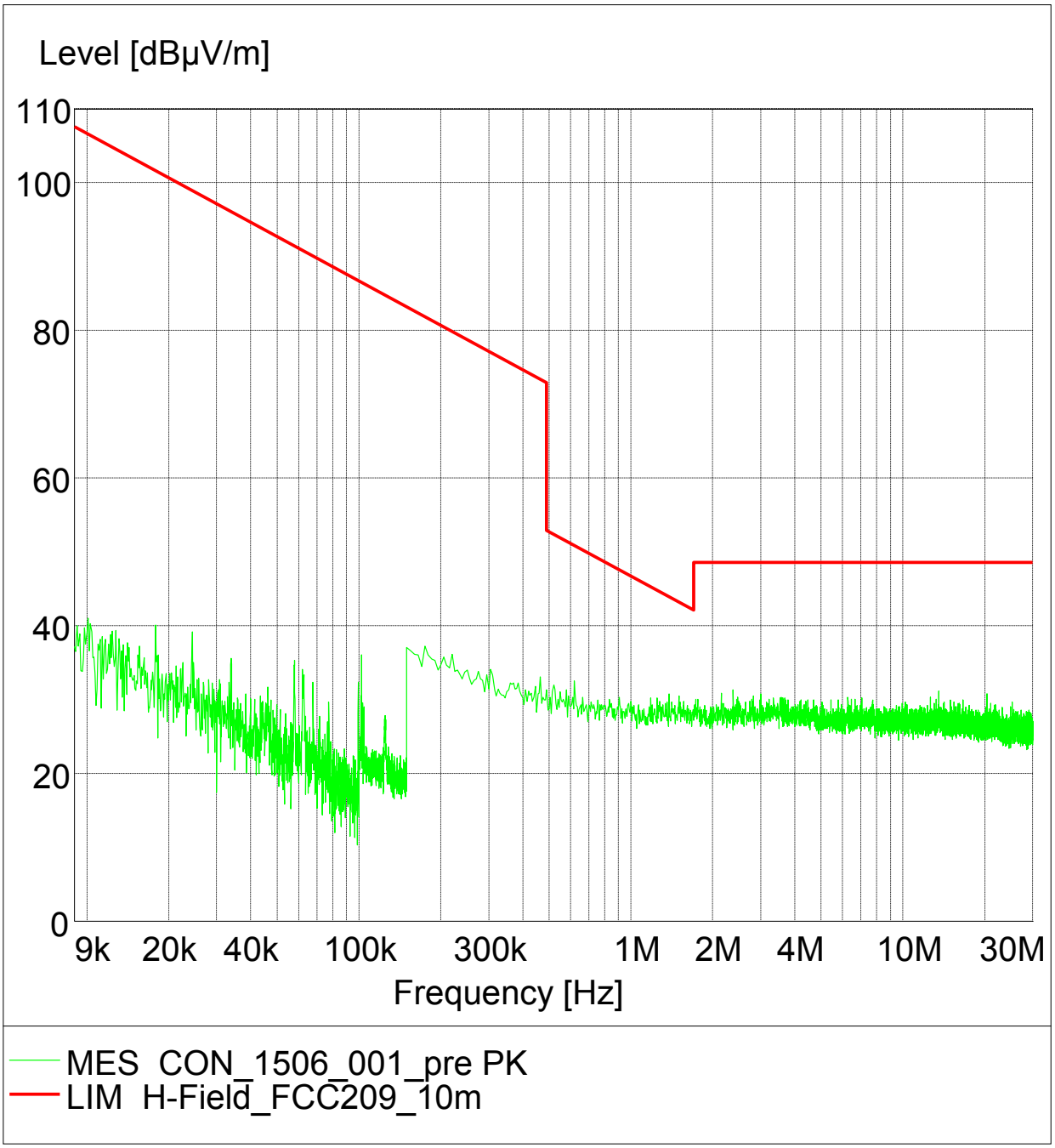
Date: 2.APR.2015 15:38:12

The N2 pulse.

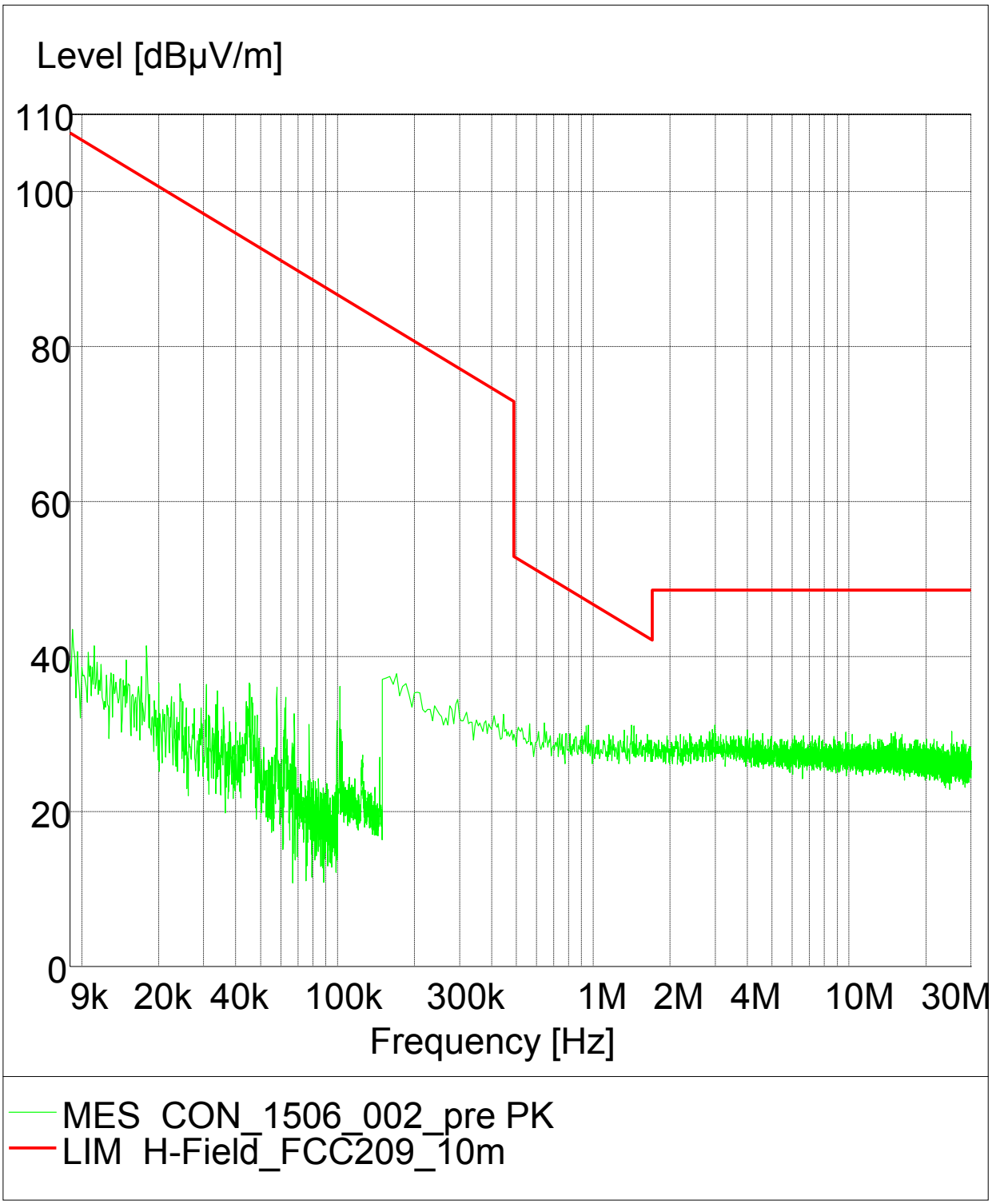
8.2 Radiated emissions

8.2.1 Radiated emissions (f < 30 MHz)

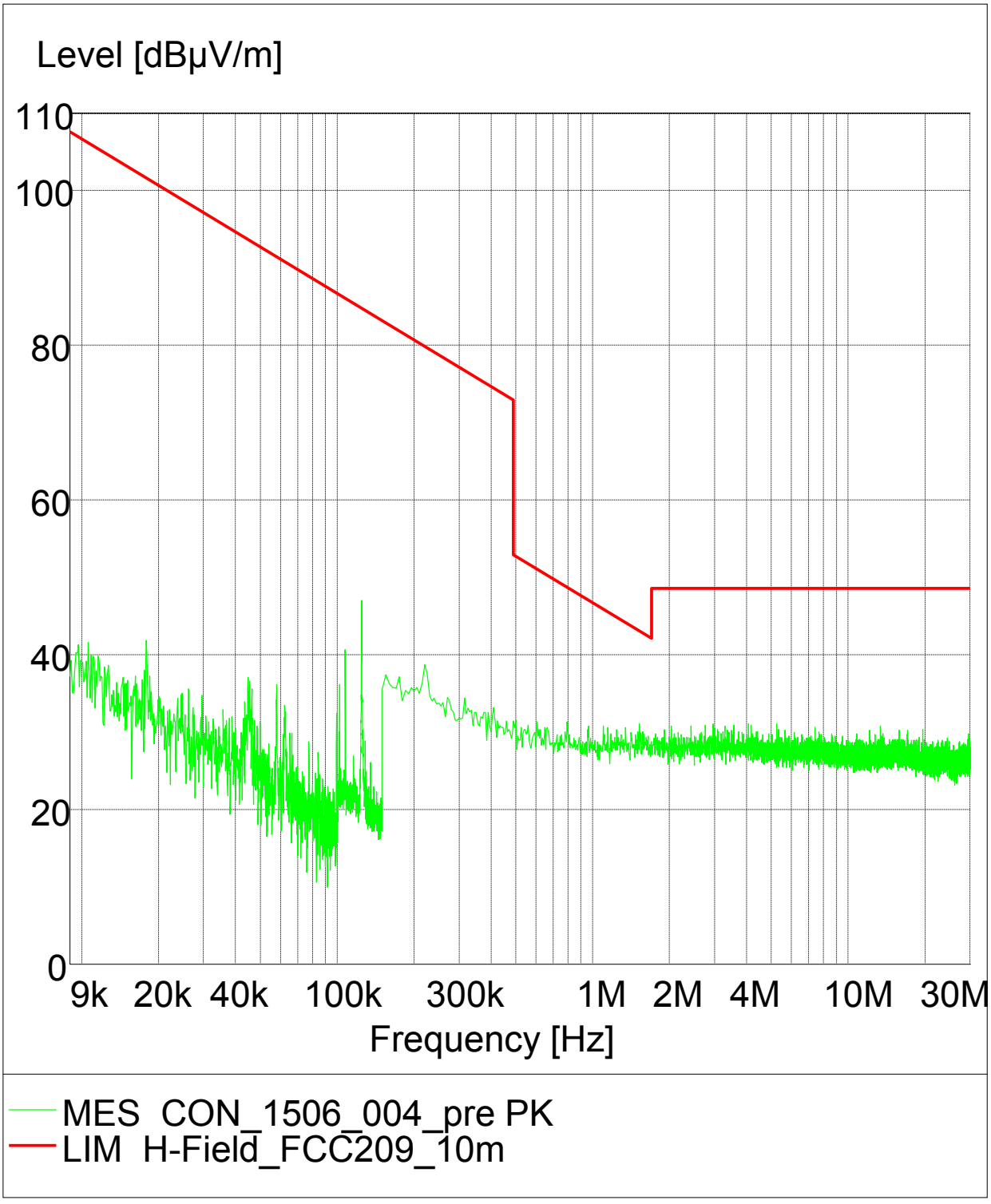
EUT: DE1024004aa01)
Manufacturer: Continental Corporation GmbH
Operating Condition: TX on 433,88 MHz; max output power
Test Site: 7 layers, Ratingen
Test Specification: FCC 15.231
Comment: Antenna position 0°
Side 1 horizontal EUT position



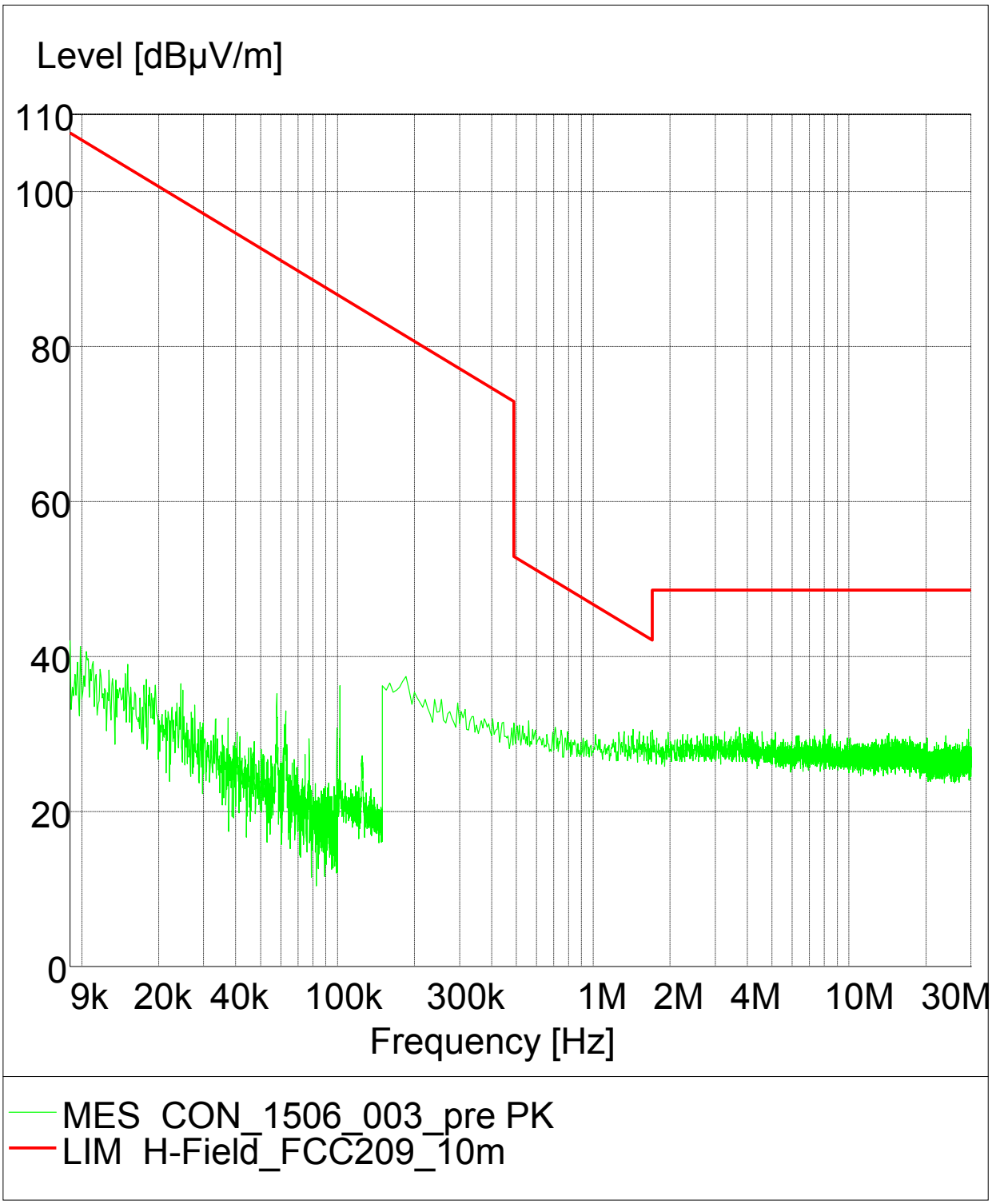
Antenna position 90° Side 1 horizontal EUT position



Antenna position 90° Side 2 horizontal EUT position



Antenna position 0° Side 2 horizontal EUT position

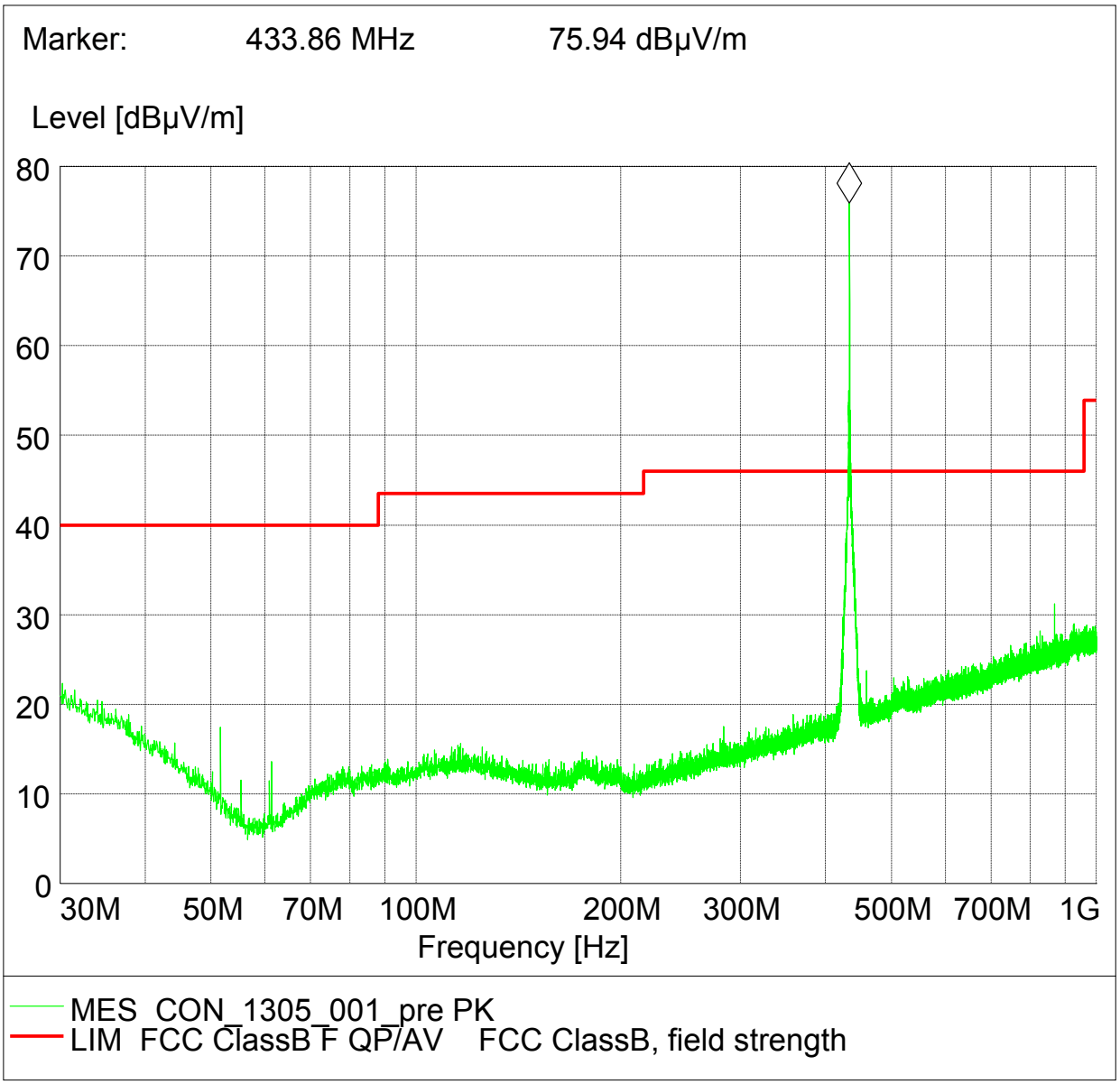


8.2.2 Radiated emissions 30 MHz < f < 1 GHz

```
EUT:                    (DE1024004aa01)
Manufacturer:           Continental Automotive GmbH
Operating Condition:    TX on 433,92 MHz
Test Site:              7 layers, Ratingen
Test Specification:     FCC 15.231
Comment:                Horizontal EUT position, Horiz.+Vert. antenna polarization
Start of Test:          02.04.2015 / 10:03:15
```

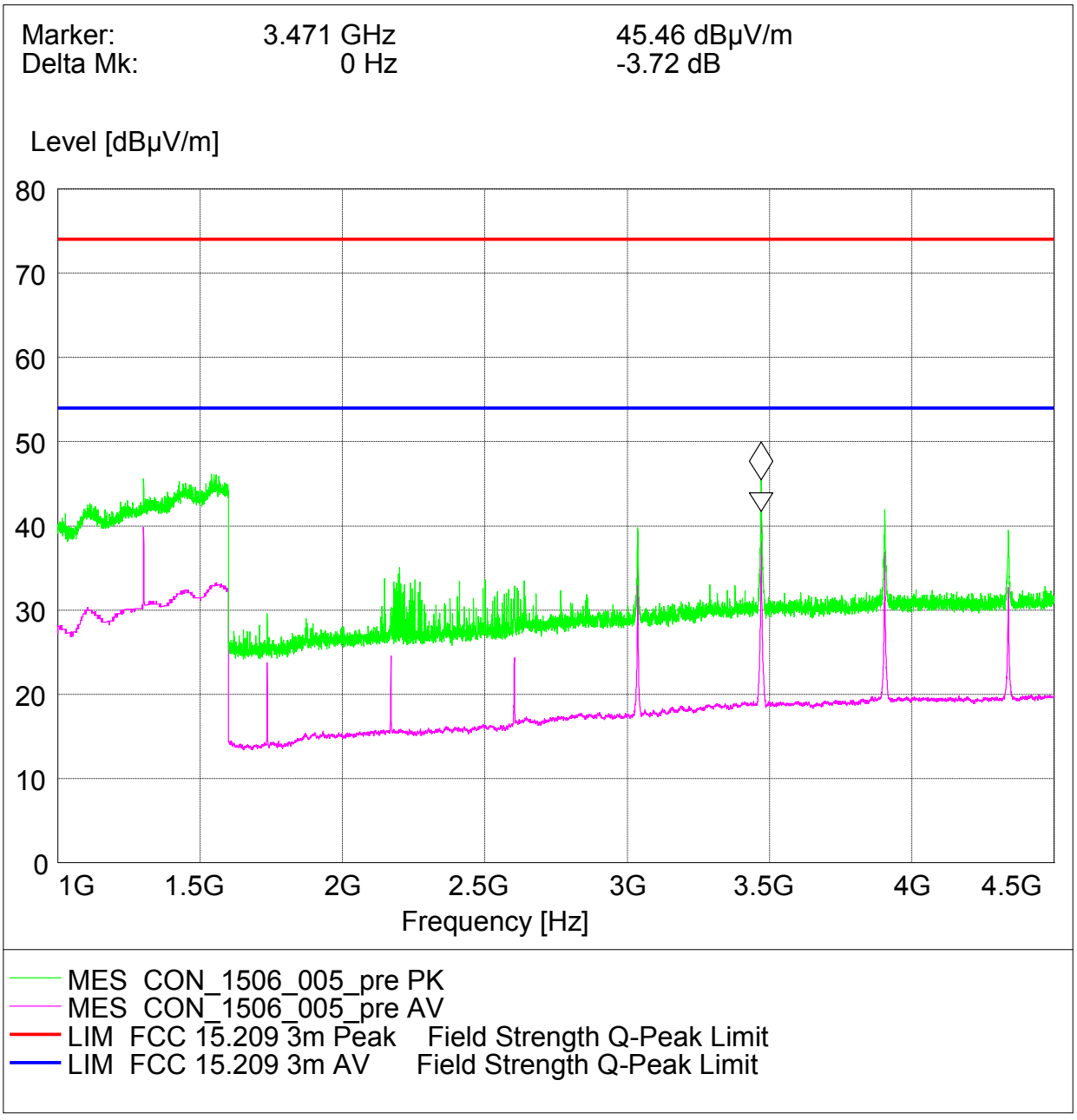
SCAN TABLE: "FCC 15.231"

```
  Short Description:              FCC part 15 b
  Start      Stop       Step       Detector  Meas.     IF       Transducer
  Frequency  Frequency  Width                Time      Bandw.
  30.0 MHz   1.0 GHz    60.0 kHz   MaxPeak   1.0 ms    120 kHz  HL562
```

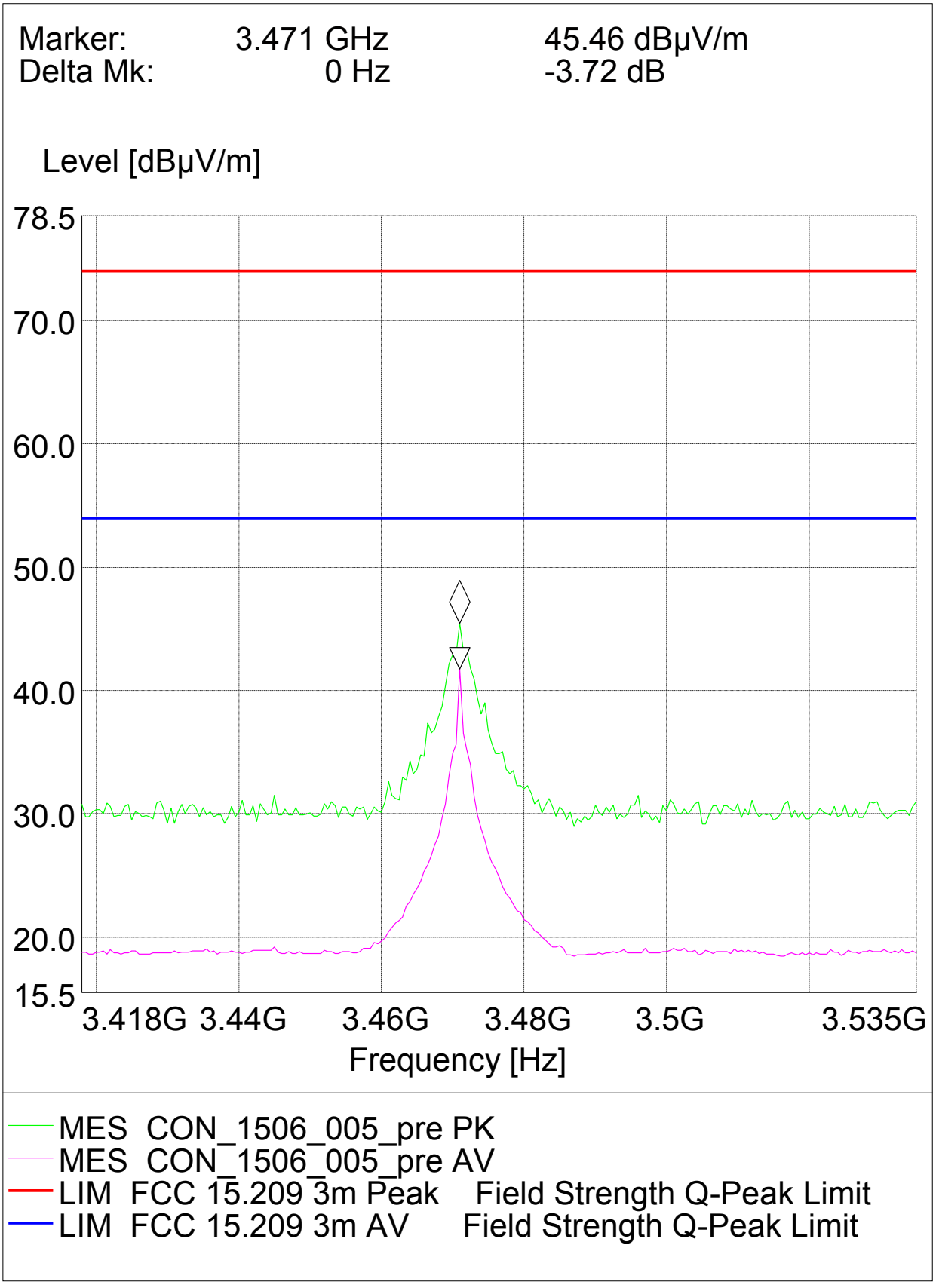


8.2.3 Radiated emissions f > 1 GHz

EUT: (DE1024004aa01)
Manufacturer: Continental Automotive GmbH
Operating Condition: TX on 433,88 MHz; max output power
Test Site: 7 layers Ratingen
Test Specification: FCC 15.231
Comment: vertical + horizontal antenna pol.; vertical EUT pos.
Horizontal EUT position



Detailed view of the pick area is shown on the next page.

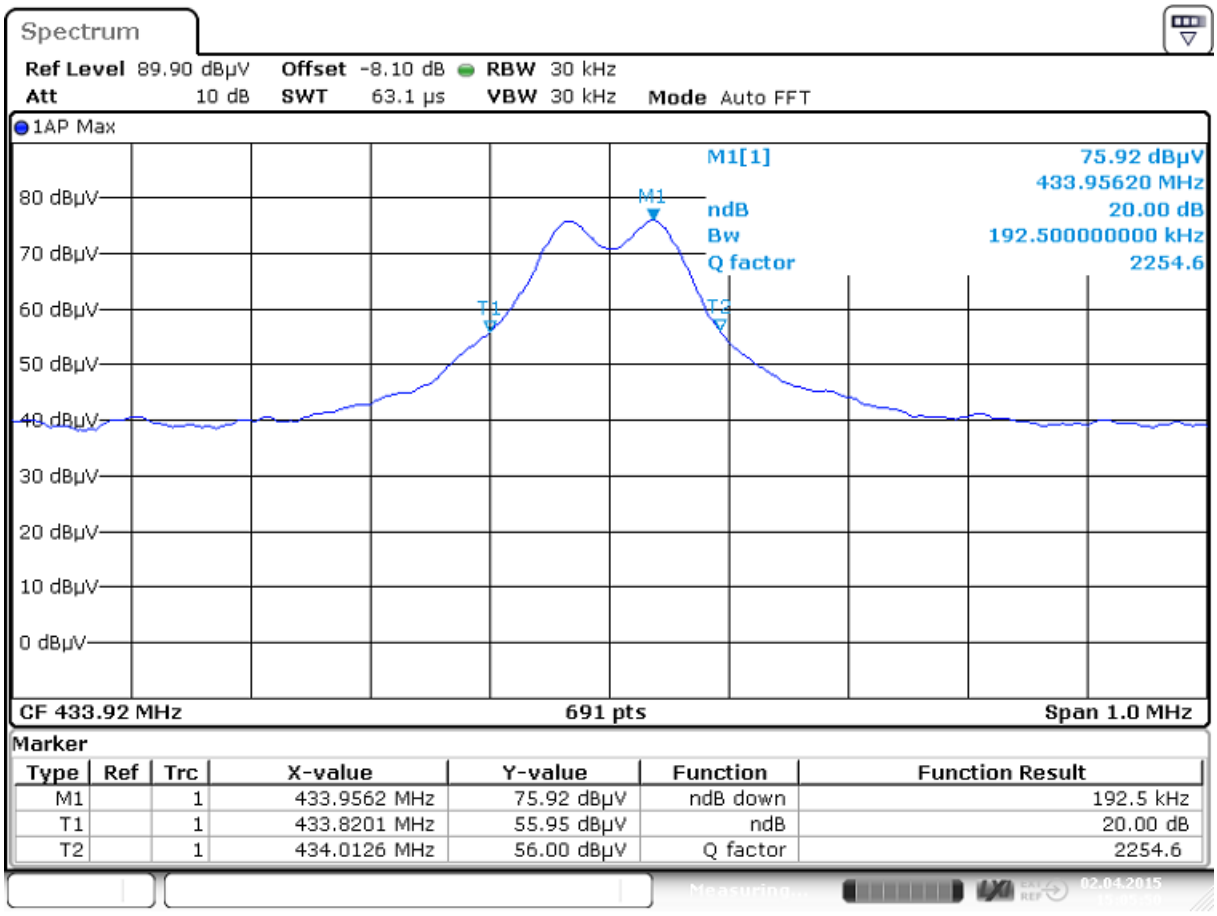

Marker: 3.471 GHz 45.46 dBµV/m
Delta Mk: 0 Hz -3.72 dB
Level [dBµV/m]
78.5
70.0
60.0
50.0
40.0
30.0
20.0
15.5
3.418G 3.44G 3.46G 3.48G 3.5G 3.535G
Frequency [Hz]
MES CON_1506_005_pre PK
MES CON_1506_005_pre AV
LIM FCC 15.209 3m Peak Field Strength Q-Peak Limit
LIM FCC 15.209 3m AV Field Strength Q-Peak Limit

8.3 Occupation bandwidth

8.3.1 20 dB bandwidth

Op. Mode

op-mode 2



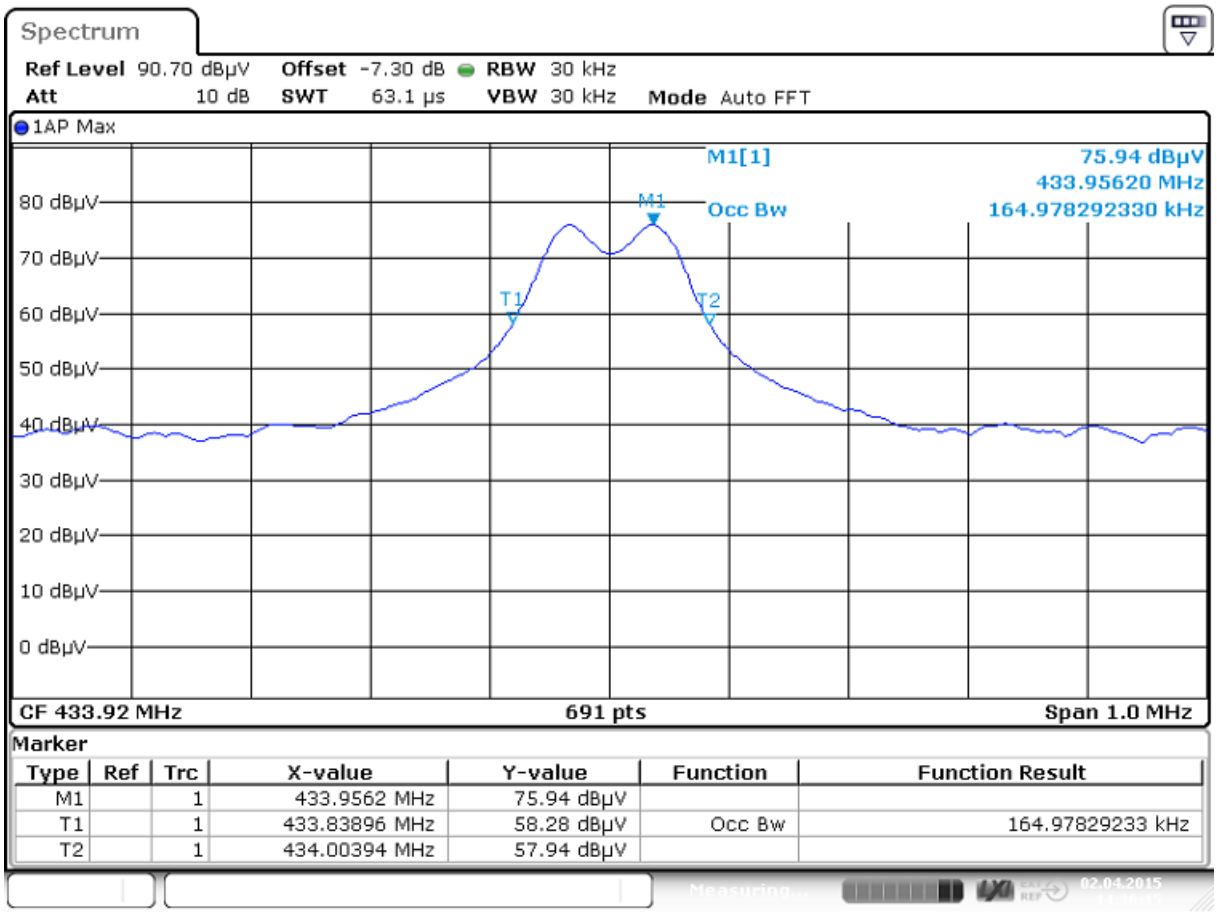
Date: 2.APR.2015 15:05:50

20 dB occupied bandwidth

8.3.2 99 % bandwidth

Op. Mode

op-mode 2



Date: 2.APR.2015 14:36:15

99% bandwidth.