InterLab®

FCC Measurement/Technical Report on

Remote Control Transceiver 433MHz

Cobra100RxCR2S

Report Reference: MDE_SCHMI_1301_FCCb_Rev01

FCC ID: 2AB65COBRA100RXCR2S

Test Laboratory:
7Layers AG
Borsigstrasse 11
40880 Ratingen
Germany

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

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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: 10-1-13

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 should be performed acc. to ANSI C63.4			2009
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 4	Setup_02	AC Port (power line)	passed

FCC Part 15, Subpart C	**§ 15.231**		
Duty cycle measurement (based on dwell time measurement)			
The measurement was performed according to FCC § 15.31			10-1-13 Edition
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_01	Enclosure	no verdict*

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 2	Setup_01 (>30M) Setup_02 (<30M)	Enclosure	passed

FCC Part 15, Subpart C	**§ 15.231**		
Peak power output			
The measurement was performed according to ANSI C63.4			2009
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 2	Setup_01	Enclosure	passed

FCC Part 15, Subpart C	**§ 15.231**		
Occupied Bandwidth			
The measurement was performed according to FCC § 15.31			10-1-13 Edition
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_01	Enclosure	passed

*) The test was only performed to determine the duty cycle correction factor. No limits are defined and consequently no verdict is given.

0.3 Report revision

Version	**Release date**	**Changes**	**Version validity**
initial	2014-08-08	--	invalid
Revision 01	2014-09-30	AC conducted emissions test added; clarification about worst case configuration added	valid

Responsible for Accreditation Scope: _____ Responsible for Test Report: _____

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:	2012-03-14

1.2 Project Data

Responsible for testing and report:	Dipl.-Ing. Dobrin Dobrinov
Date of Test(s):	2014-05-05 to 2014-09-30
Date of Report:	2014-09-30

1.3 Applicant Data

Company Name:	Schmidiger GmbH
Address:	Gutenegg 6125 Menzberg Switzerland
Contact Person:	Mr. Fabian Kugler

1.4 Manufacturer Data

Company Name:	please see applicants data
Address:	

2 Test object Data

2.1 General EUT Description

Equipment under Test	Master module (Transceiver) with four relays
Type Designation:	Cobra100RxCR2S
Kind of Device:	Remote Control Transceiver 433MHz
Voltage Type:	DC
Voltage level:	12.0 to 24.0 V
Repeated Operation:	Manually
The EUT is part of a security or safety system:	No

General product description:

The EUT is a wireless transceiver for industrial automation and commercial use. According to its technical specification FCC Rule Part 15.231 (Periodic operation in the band 40.66-40.70 MHz and above 70 MHz) applies. The transceiver is part of the bidirectional Cobra 100 radio control system. The system has 14 channels with channel spacing of 100 kHz between 433.125 (channel 1) and 434.725 MHz (channel 14).

The product name which is used by the manufacturer in the user manual and in the internal documentation is "Receiver", since its main function within the Cobra 100 radio control system is receiving data and switching relays.

The master module contains the transceiver and provides 4 relays (basic version). It can be extended with up to seven slave modules. Each slave module adds 4 relays but there is no radio functionality integrated. Thus the maximum configuration provides 32 relays.

In order to find the worst case configuration a comparison measurement was performed. This investigation showed that the master module in combination with one slave module produces higher emissions than the master module stand alone. Thus the full testing was performed using the master module in combination with one slave module. In this test report only the test results for this worst case configuration are provided.

The EUT provides the following ports:

Ports
Enclosure
DC power supply (master module)
Data interface (master module)
4 relays (master module)
4 relays (slave module)

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: DE1033000ba01)	Master Module (Transceiver) with 4 relays + Slave Module providing 4 additional relay ports	Cobra100Rx CR2S + Slave	Test sample ba01	Master: A 15 14 Slave: B 14 14	Master: 10 51 12 Slave: 10 46 12	2014-04-07
Remark: EUT A is equipped with an integral antenna.						
EUT B (Code: DE1033000bb01)	Master Module (Transceiver) with 4 relays + Slave Module providing 4 additional relay ports	Cobra100Rx CR2S + Slave	Test sample bb01	Master: A 15 14 Slave: B 14 14	Master: 10 51 12 Slave: 10 46 12	2014-04-07
Remark: EUT B is equipped with an integral antenna.						
EUT C (Code: DE1033000bc01)	Master Module (Transceiver) with 4 relays "stand alone"	Cobra100Rx CR2S	Test sample bc01	Master: A 15 14	Master: 10 51 12	2014-04-07
Remark: EUT C is equipped with an integral antenna.						

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.
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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	Serial no.	HW Status	SW Status	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	Master module + slave module
Setup_02	EUT B	Master module + slave module
Setup_03	EUT C	Master module "stand alone" only used for comparison 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	periodic operation	Transmitter is sending multiple telegram sequences with 12 ms pulse and 56 ms pause (normal operation)
op-mode 2	continuous operation, modulated	Transmitter is sending continuously. The carrier is modulated (Continuous Modulation - CM) (special operating mode for test purpose only)
op-mode 3	continuous operation, unmodulated	Transmitter is sending continuously. The carrier is unmodulated (Continuous Wave - CW) (special operating mode for test purpose only)
op-mode 4	continuous operation, modulated, data traffic	Transmitter is sending continuously. The carrier is modulated (Continuous Modulation - CM) + data traffic on RS232 interface (special operating mode for test purpose only)

2.7 Product labelling

2.7.1 FCC ID label

FCC ID: 2AB65COBRA100RXCR2S

2.7.2 Location of the label on the EUT

Please refer to separate documentation.

3 Test Results

3.1 Conducted emissions (AC power line)

Standard FCC Part 15, 10-1-13 Edition Subpart C

The test was performed according to: ANSI C 63.4, 2003

3.1.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C 63.4-2003. The Equipment Under Test (EUT) was setup in a shielded room to perform the conducted emissions measurements in a typical installation configuration. The EUT was powered from 50µH || 50 Ohm Line Impedance Stabilization Network (LISN). The LISN's unused connections were terminated with 50 Ohm loads.

The measurement procedure consists of two steps. It is implemented into the EMI test software ES-K1 from R&S.

Step 1: Preliminary scan
Intention of this step is, to determine the conducted EMI-profile of the EUT.
EMI receiver settings:
- Detector: Peak - Maxhold
- Frequency range: 150 kHz – 30 MHz
- Frequency steps: 5 kHz
- IF–Bandwidth: 9 kHz
- Measuring time / Frequency step: 20 ms
- Measurement on phase + neutral lines of the power cords

On basis of this preliminary scan the highest amplitudes and the corresponding frequencies relative to the limit are identified. Emissions above the limit and emissions which are in the 10 dB range below the limit are considered.

Step 2: Final measurement
Intention of this step is, to determine the highest emissions with the settings defined in the test specification for the frequencies identified in step 1.
EMI receiver settings:
- Detector: Quasi-Peak
- IF - Bandwidth: 9 kHz
- Measuring time: 1 s / frequency

At each frequency determined in step 1, four measurements are performed in the following combinations:
1) Neutral lead - reference ground (PE grounded)
2) Phase lead - reference ground (PE grounded)
3) Neutral lead - reference ground (PE floating)
4) Phase lead - reference ground (PE floating)

The highest value is reported.

3.1.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.207

Frequency Range (MHz)	QP Limit (dBµV)	AV Limit (dBµV)
0.15 – 0.5	66 to 56	56 to 46
0.5 – 5	56	46
5 – 30	60	50

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

3.1.3 Test Protocol

Temperature: 23°C
Air Pressure: 1009 hPa
Humidity: 37%

Op. Mode	Setup	Port
op-mode 4	Setup_02	DC power supply

Power line	Frequency MHz	Measured value dBµV	Delta to limit dBµV	Remarks
N	–	–	–	–
L1	–	–	–	–

Remark: No final measurement was performed because no frequencies (peaks) were found within the offset for acceptance analysis during the preliminary scan. Please see annex for the measurement plot.

3.1.4 Test result: Conducted emissions (AC power line)

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 4	passed

3.2 Duty cycle measurement (based on dwell time measurement)

Standard FCC Part 15, 10-1-13 Edition Subpart C

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

3.2.1 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.

3.2.2 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 Peak power output.

3.2.3 Test Protocol

Temperature: 22 °C
Air Pressure: 1010 hPa
Humidity: 38 %

Op. Mode	Setup	Port
op-mode 1	Setup_01	Enclosure

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 5 s
Step 2	Cycle to determine the on/off ratio within a cycle (period T)	68.8 ms
Step 3	Determine the number of pulses (N1-NN). First range (trigger offset = -2 ms).	N1 = 1 L1 = 12.3 ms

The longest transmission period within the transmitter is "on" is the worst case. According to the measured values, the pulse with 12.1 ms length is the worst case.

Calculation of Duty Cycle / Correction Factor:
If T > 100 ms => T:= 100 ms;

Duty Cycle = L1*N1/T = 12.3/68.8 = 0.179

Correction factor = 20*LOG(0.179) = 20*(-0.74768) = -14.95

The worst case duty cycle correction factor is rounded to: **-15.0 dB.**

3.2.4 Test result: Duty cycle / correction factor

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	no verdict*

*) The test was only performed to determine the duty cycle correction factor. No limits are defined and consequently no verdict is given.

3.3 Spurious radiated emissions

Standard FCC Part 15, 10-1-13 Edition Subpart C

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

3.3.1 Test Description

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.
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
- 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 with QP detector.
- 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 4a: final measurement with QP detector in case of non-pulsing signals
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

Step 4b: applying a duty cycle correction factor in case of pulsing signals

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 = 10 MHz
- Sweeptime = 100 ms / per 100 MHz sweep
In case of pulsing signals the average value is derived by applying a duty cycle correction factor to the measured peak value instead of using the average detector.

3.3.2 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	67.0	47.0
130 – 174	67.0 – 71.5 *)	47.0 – 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 – 77.9
0.49 – 1.705	24000/F (kHz)	30	(48.9 – 23.0) + 19.1 dB	68.0 – 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 last 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.

3.3.3 Test Protocol

3.3.3.1 Measurement up to 30 MHz

Temperature: 24 °C
Air Pressure: 1006 hPa
Humidity: 38 %

Op. Mode	Setup	Port
op-mode 2	Setup_02	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°	–	–	–	–	–	–	–	–	–

Remarks:

- 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.

3.3.3.2 Measurement 30 MHz – 1 GHz

Temperature: 24 °C
Air Pressure: 1006 hPa
Humidity: 38 %

Op. Mode	Setup	Port
op-mode 2	Setup_01	Enclosure

channel 1									
Antenna 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	Peak	AV
vertical	482.88	-	35.3	20.3	-	66	46	30.7	25.7
vertical	843.24	-	41.6	26.6	-	66	46	24.4	19.4
channel 14									
Antenna 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	Peak	AV
horizontal	456.6	–	37.6	22.6	–	66	46	28.5	23.5

Remarks:

- Maximum radiated spurious emissions. All three axis (X,Y,Z) of the device and both antenna polarizations (H/V) were considered.
- The Transmitter is sending continuously (special operating mode for test purpose only). The carrier is modulated.
- The values given in the columns “AV” represent the peak values corrected with the Duty Cycle Correction Factor of -15 dB, calculated in 3.1.3. It was checked by the laboratory that the corresponding emissions are pulsed in the same manner as the wanted signal.
- Only the highest emissions are reported.

3.3.3.3 Measurement above 1 GHz

Temperature: 24 °C
Air Pressure: 1006 hPa
Humidity: 38 %

Op. Mode	Setup	Port
op-mode 2	Setup_01	Enclosure

channel 1									
Antenna 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**	**Peak**	**AV**
horiz+vert	1.733	–	47.3	–	-	74	54	26.7	21.7
horiz+vert	2.166	–	53.3	–	-	74	54	20.7	15.7
horiz+vert	2.599	–	52.5	–	-	74	54	21.6	16.6
horiz+vert	3.032	–	52.1	–	-	74	54	21.9	16.9
channel 14									
Antenna 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**	**Peak**	**AV**
horiz+vert	1.739	–	49.0	34.0	-	74	54	25.0	20.0
horiz+vert	2.174	–	53.4	38.4	-	74	54	20.6	15.6
horiz+vert	2.609	–	57.6	42.6	-	74	54	16.4	11.4
horiz+vert	3.043	–	54.9	39.9	-	74	54	19.1	14.1

Remarks:

- Maximum radiated spurious emissions. All three axis (X,Y,Z) of the device and both antenna polarizations (H/V) were considered.
- The Transmitter is sending continuously (special operating mode for test purpose only). The carrier is modulated.
- The values given in the columns "AV" represent the peak values corrected with the Duty Cycle Correction Factor of -15 dB, calculated in 3.1.3. It was checked by the laboratory that the corresponding emissions are pulsed in the same manner as the wanted signal.
- Only the highest emissions are reported.
- The test was performed in the frequency range from 1 GHz to 4.5 GHz.

3.3.4 Test result: Spurious radiated emissions

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

3.4 Peak power output

Standard FCC Part 15, 10-1-13 Edition Subpart C

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

3.4.1 Test Description

Please refer to sub-clause 3.3.1.

3.4.2 Test Limits

Please refer to sub-clause 3.3.2.

3.4.3 Test Protocol

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

Op. Mode	Setup	Port
op-mode 2	Setup_01	Enclosure

Channel	Frequency MHz	Output power dBµV/m (Peak)	Output Power dBµV/m (AV)	Limit dBµV/m (AV)	Margin dB
1	433.125	69.4	54.4	80.8	26.4
14	434.725	68.1	53.1	80.8	27.7

Remarks:

- Maximum radiated field strength at fundamental frequency. All three axis (X,Y,Z) of the device and both antenna polarizations (H/V) were considered.
- The Transmitter is sending continuously (special operating mode for test purpose only). The carrier is modulated.
- The measured peak values are corrected in order to obtain the AV value using the Duty Cycle Correction Factor = -15.0 dB, calculated in 3.1.3.

3.4.4 Test result: Peak power output

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

3.5 Occupied bandwidth

Standard FCC Part 15, 10-1-13 Edition Subpart C

The test was performed according to: FCC §15.231

3.5.1 Test Description

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

3.5.2 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

3.5.3 Test Protocol

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

Op. Mode	Setup	Port
op-mode 1	Setup_01	Enclosure

20 dB bandwidth kHz	Limit kHz	Remarks
channel 1		
35.5	1086.875	The limit is calculated as 434.725 MHz * 0.25% = 1086.875 kHz.
channel 14		
37.1	1086.875	The limit is calculated as 434.725 MHz * 0.25% = 1086.875 kHz.

Remark: Please see annex for the measurement plots.
For information: The 99% Bandwidth for channel 1 is 35.9 kHz.
The 99% Bandwidth for channel 14 is 35.5 kHz.

3.5.4 Test result: Occupied bandwidth

FCC Part 15, Subpart C	Op. Mode	Result
	op-mode 1	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 ENY41	100002	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard calibration		2013/03/01	2015/03/31
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
Two-Line V-Network	ESH 3-Z5	828304/029	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standart Calibration		2013/03/01	2015/02/28
Two-Line V-Network	ESH 3-Z5	829996/002	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2013/03/01	2015/02/28

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		2012/01/18	2015/01/17
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		2011/10/27	2014/10/26

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		2013/07/29	2014/07/28
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		2011/11/25	2014/11/24
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
Spectrum Analyser	FSIQ26	840061/005	Rohde & Schwarz GmbH & Co. KG	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2013/02/12	2015/02/11
Temperature Chamber Vötsch 03	VT 4002	58566002150010	Vötsch	
	Calibration Details		*Last Execution*	*Next Exec.*
	Customized calibration		2012/03/12	2014/03/11
	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

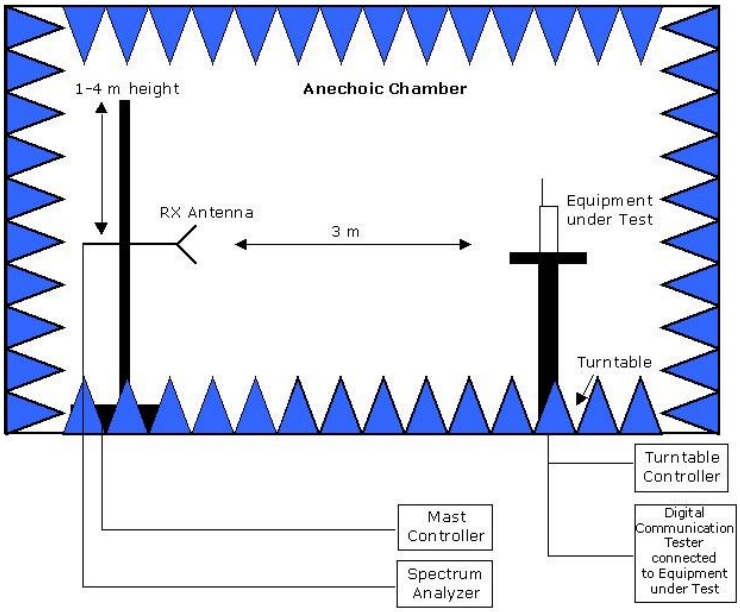
Single Devices for Temperature Chamber 01

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		2012/03/12	2014/03/11
	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 table 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 3: 7.2.4
Transmitter spurious radiated emissions	§ 15.231 (b) / (e)	RSS Gen Issue 3: 7.2.3, 7.2.5; 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
Peak power output	§ 15.231 (b) / (e)	RSS-210 Issue 8: A1.1.2, A1.1.5; RSS Gen Issue 3: 7.2.3
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 3: 7.1.2
Receiver spurious emissions	–	RSS-210 Issue 8: 2.3 RSS Gen Issue 3: 6 *)

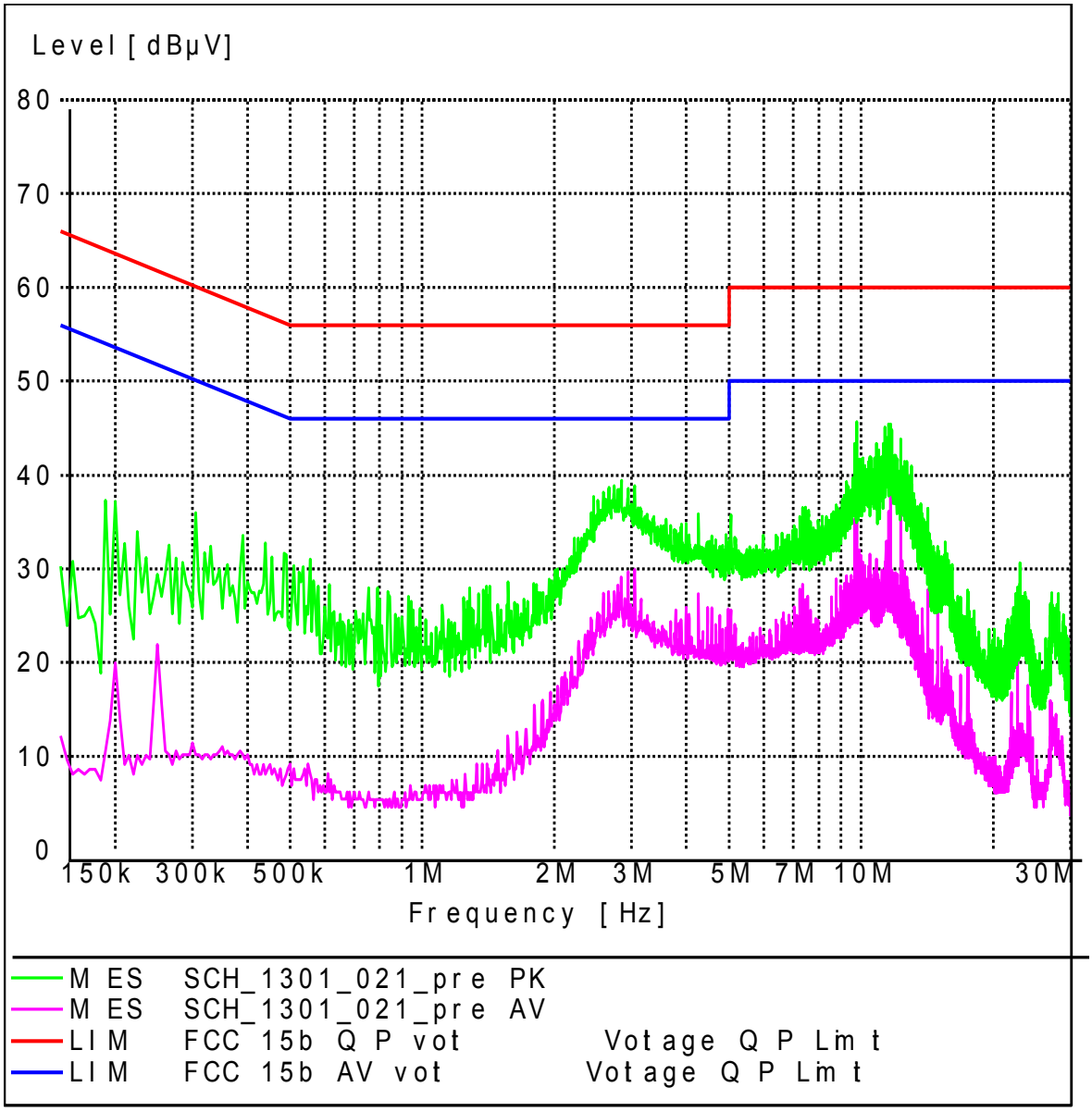
*) Receivers which are part of Transceivers are exempted with respect to Notice 2012-DRS0126.

8 Annex measurement plots

8.1 Conducted emissions (AC power line)

Short Description: FCC Voltage

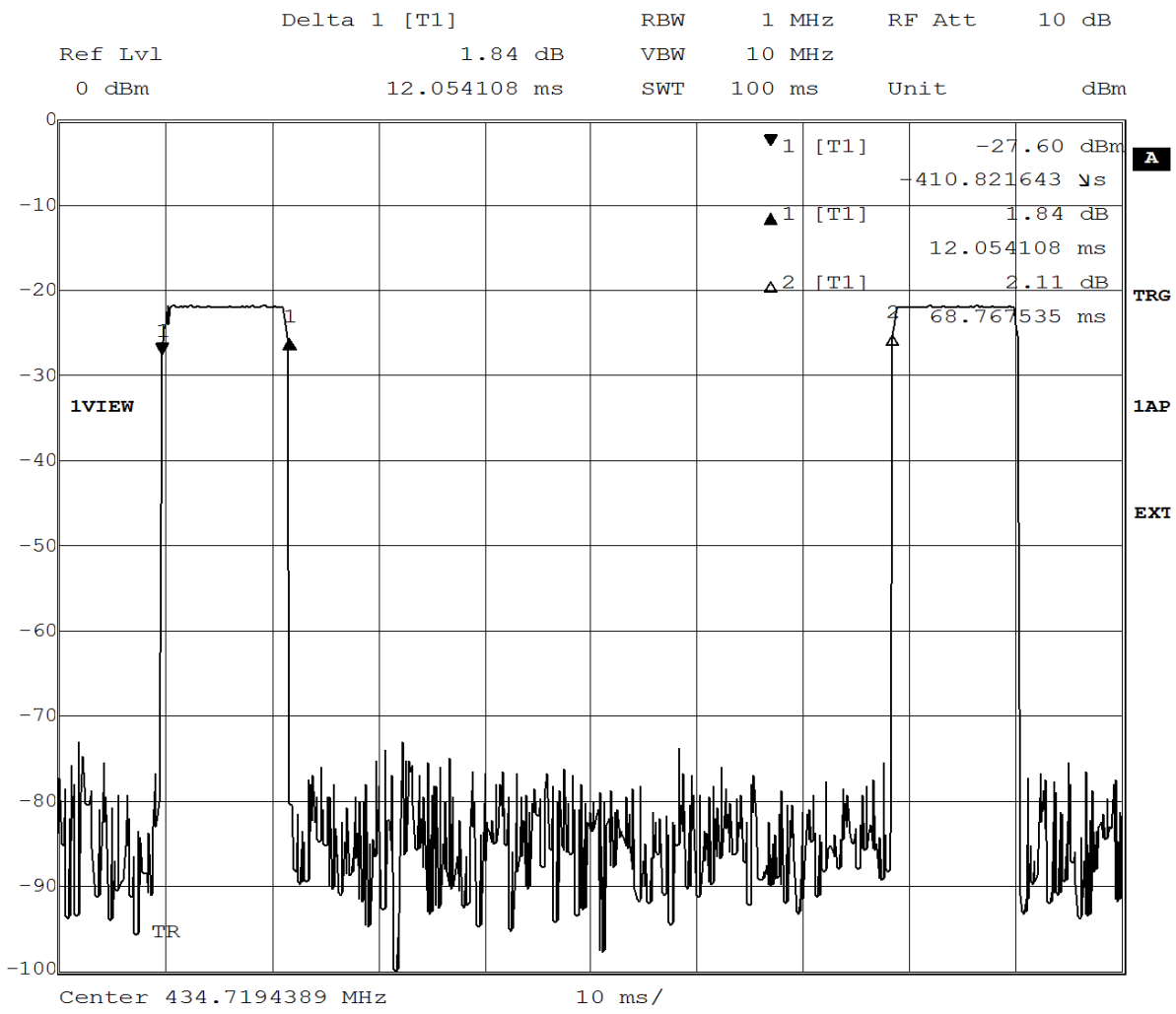
Start Frequency	Stop Frequency	Step Width	Detector	Meas. Time	IF Bandw.	Transducer
150.0 kHz	30.0 MHz	5.0 kHz	MaxPeak Average	20.0 ms	9 kHz	ESH3-Z5



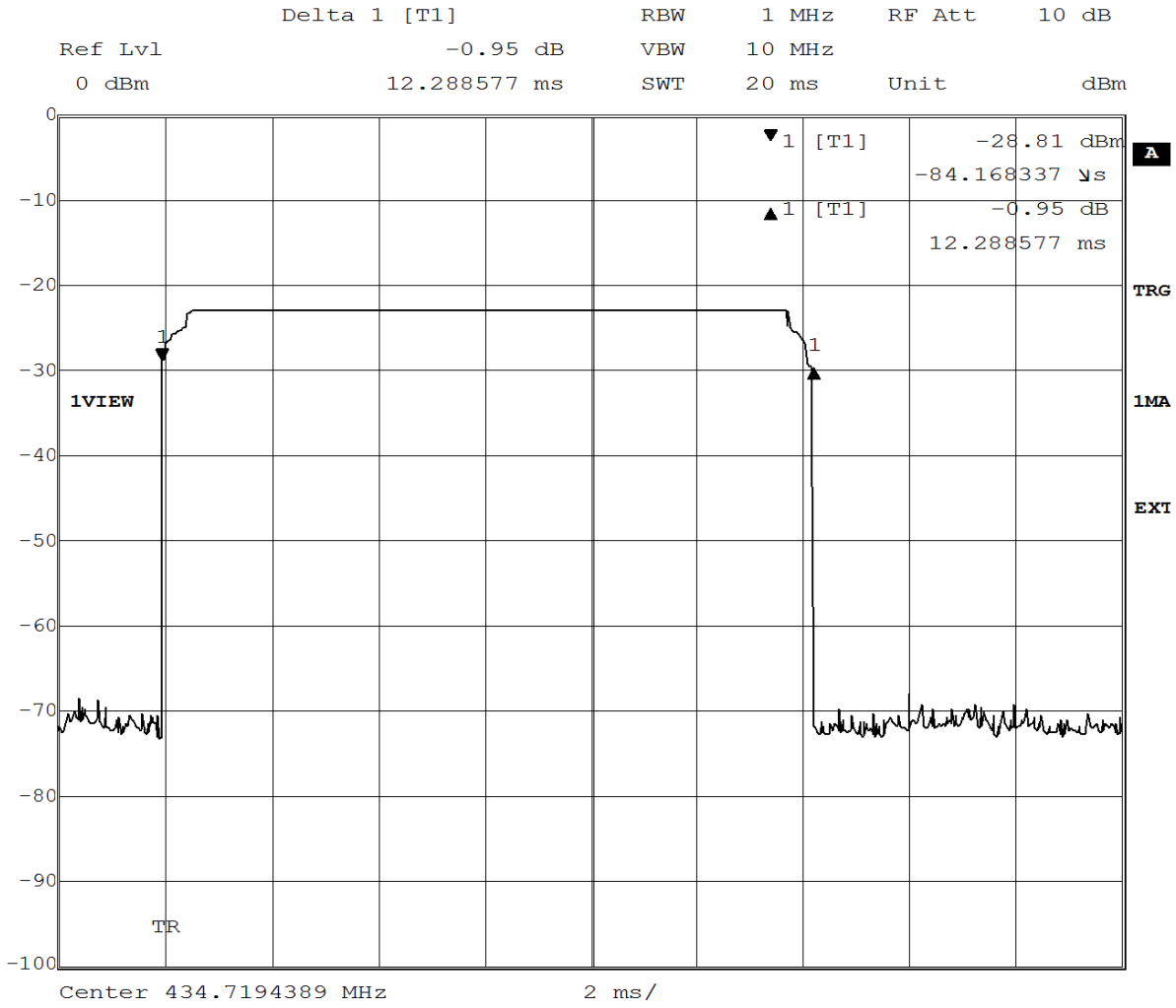
8.2 Duty cycle measurement (based on dwell time measurement)

Op. Mode

Op-mode 1



Step 1: Holdover time, T_C = 68.8 ms.

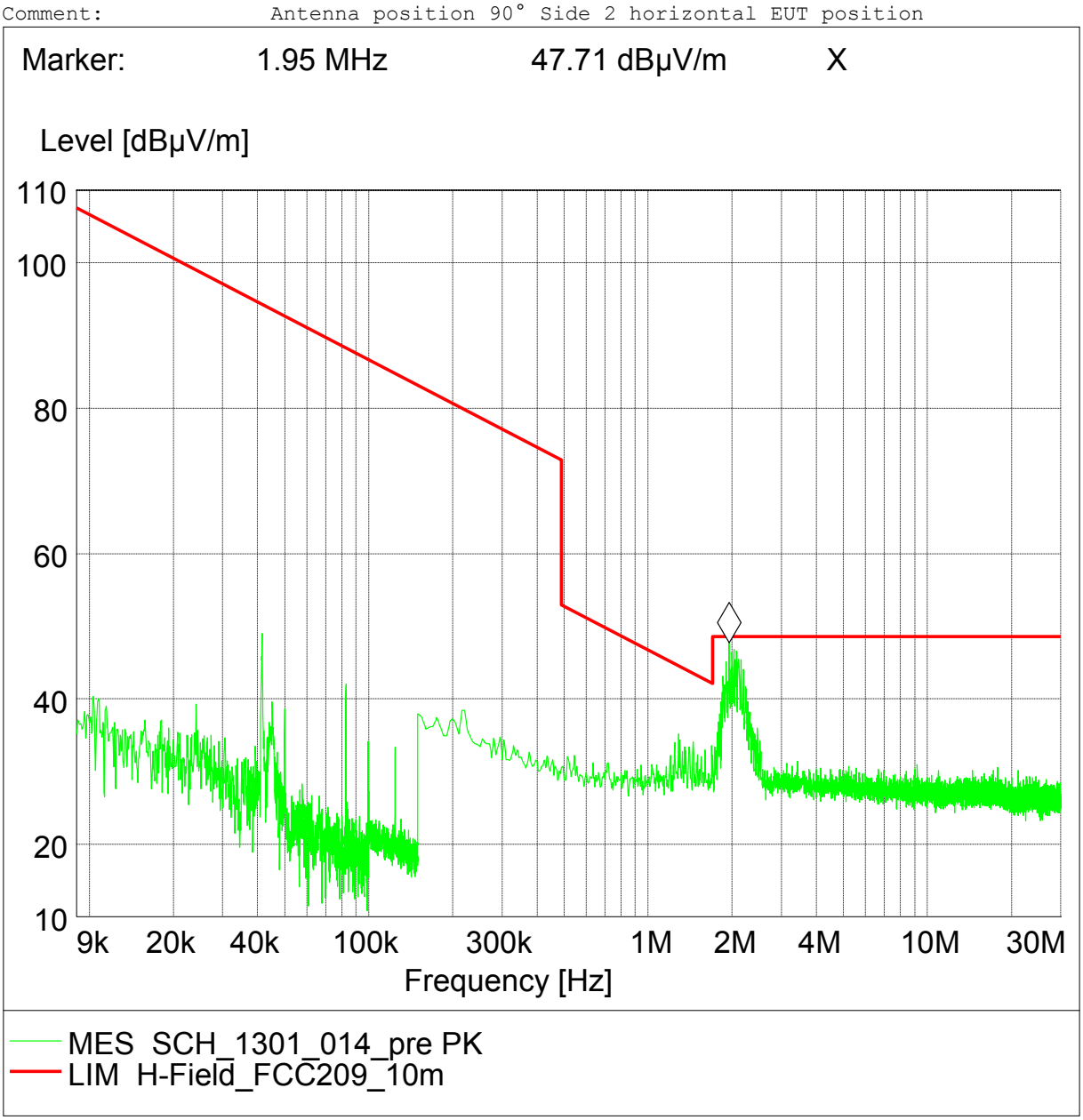


Step 2: 20 ms sweep, cycle to determine the on/off ratio within a period of 68.8 ms.
T_{on} = 12.3 ms

8.3 Spurious radiated emissions

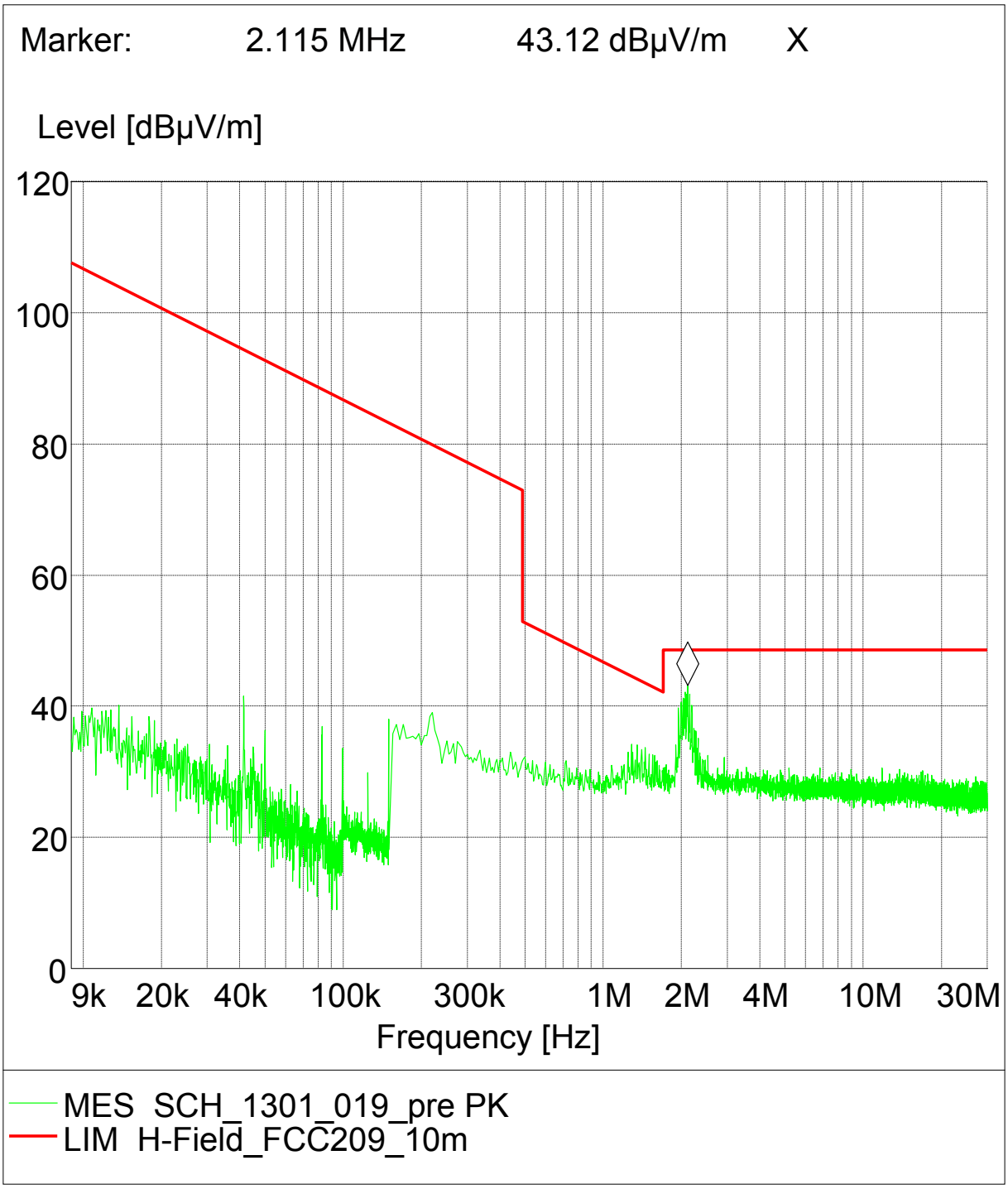
8.3.1 TX spurious radiated emissions for f < 30 MHz channel 1, worst case position/configuration

```
EUT:                    (DE1033000bb01)
Manufacturer:           Schmidiger
Operating Condition:    TX on 433.1250 MHz
Test Site:              7 layers, Ratingen
Test Specification:     FCC 15.321
Comment:                Antenna position 90° Side 2 horizontal EUT position
```



Spurious radiated emissions for f < 30 MHz
channel 14, worst case position/configuration

```
EUT:                  (DE1033000bb01)
Manufacturer:         Schmidiger
Operating Condition:  TX on 434.725 MHz
Test Site:            7 layers, Ratingen
Test Specification:   FCC 15.321
Comment:              Antenna position 90° Side 2 horizontal EUT position 90°
```

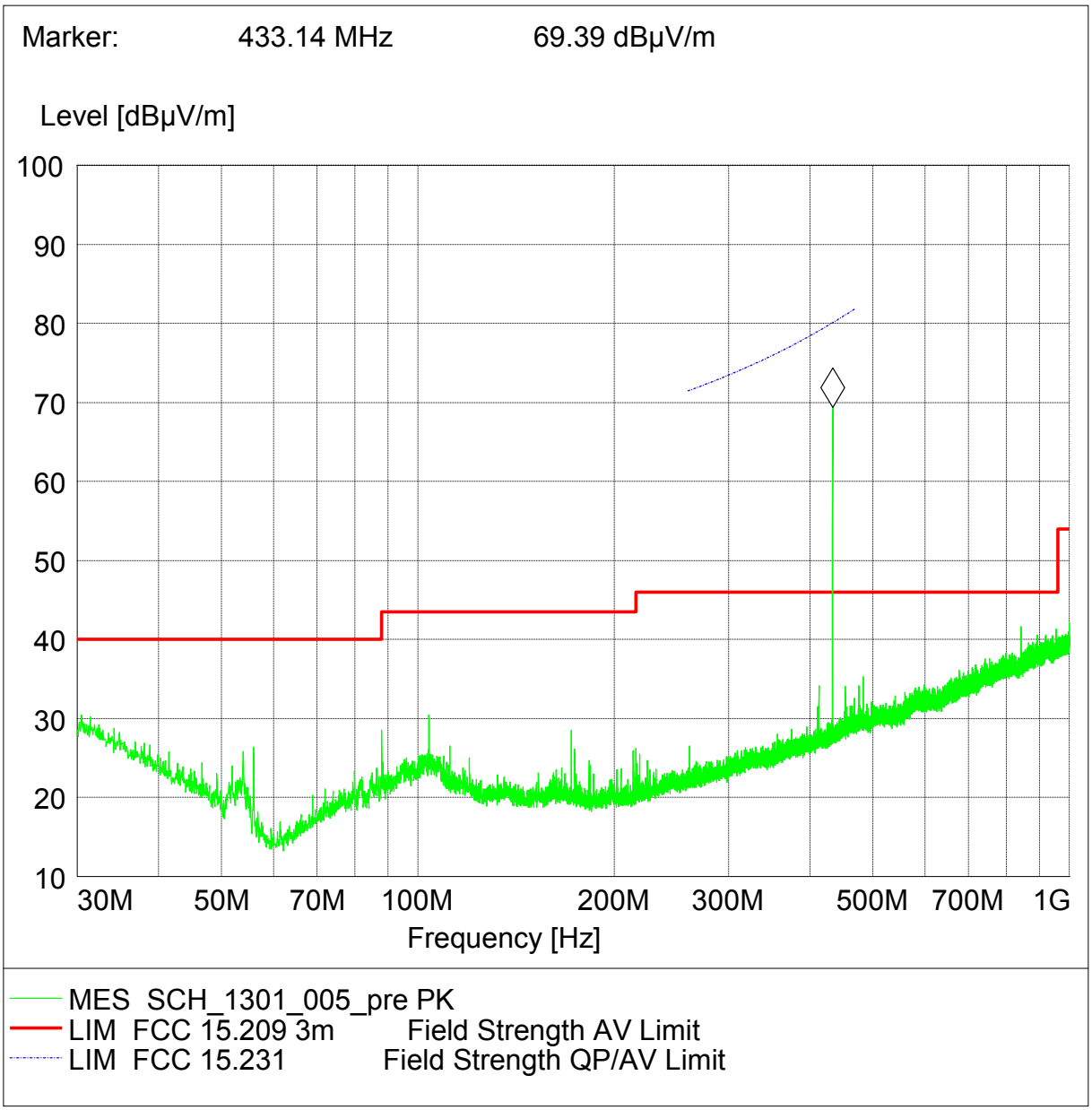


8.3.2 Spurious radiated emissions for 30 MHz < f < 1 GHz

worst case plot
channel 1 - values are not corrected by duty cycle correction factor

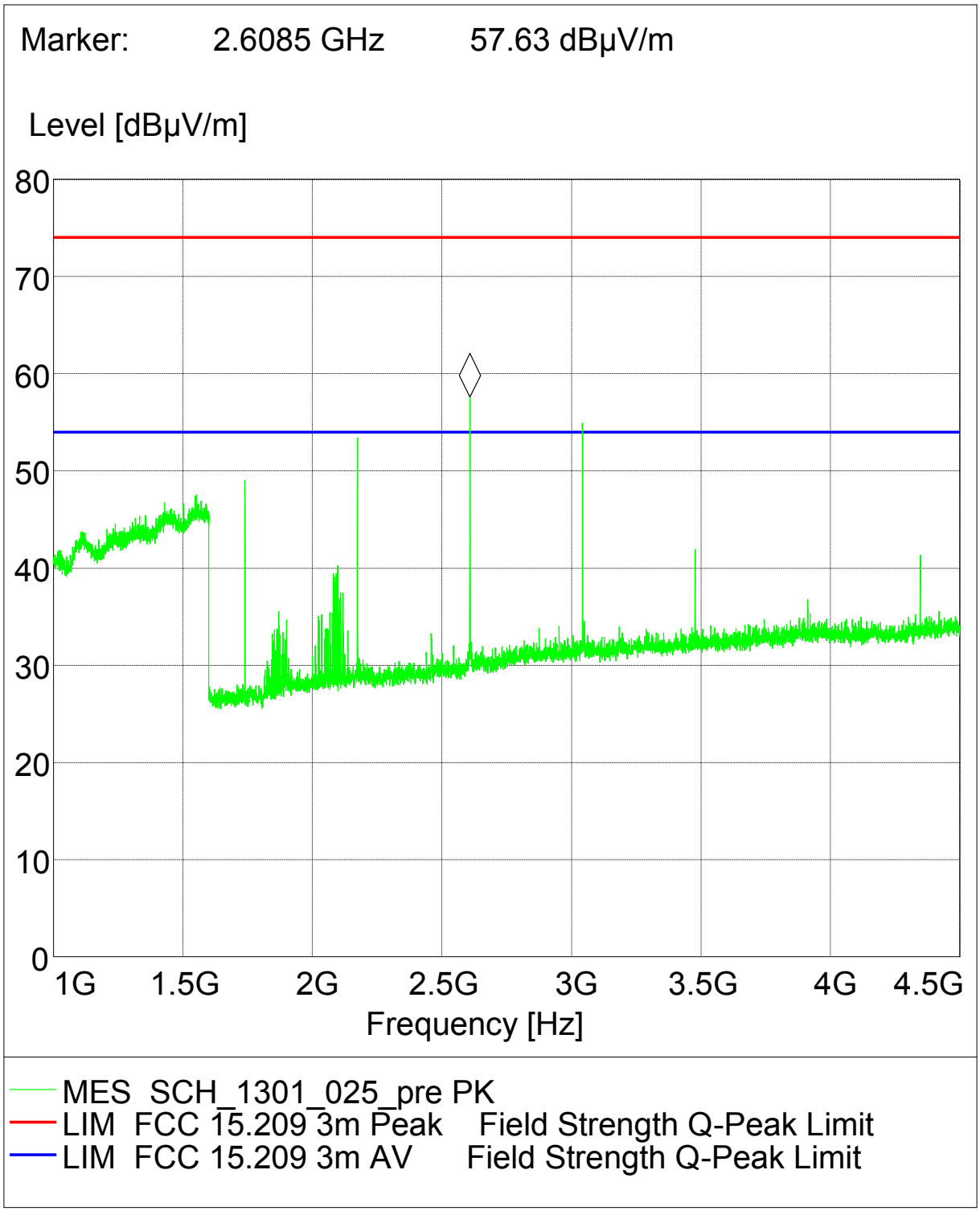
SCAN TABLE: "FCC 15.231 C F433MHz"

```
Short Description:              FCC ClassA Field Strength
  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
```



8.3.3 Spurious radiated emissions for 1 GHz < f < 4.5 GHz

worst case plot
channel 14 - values are not corrected by duty cycle correction factor

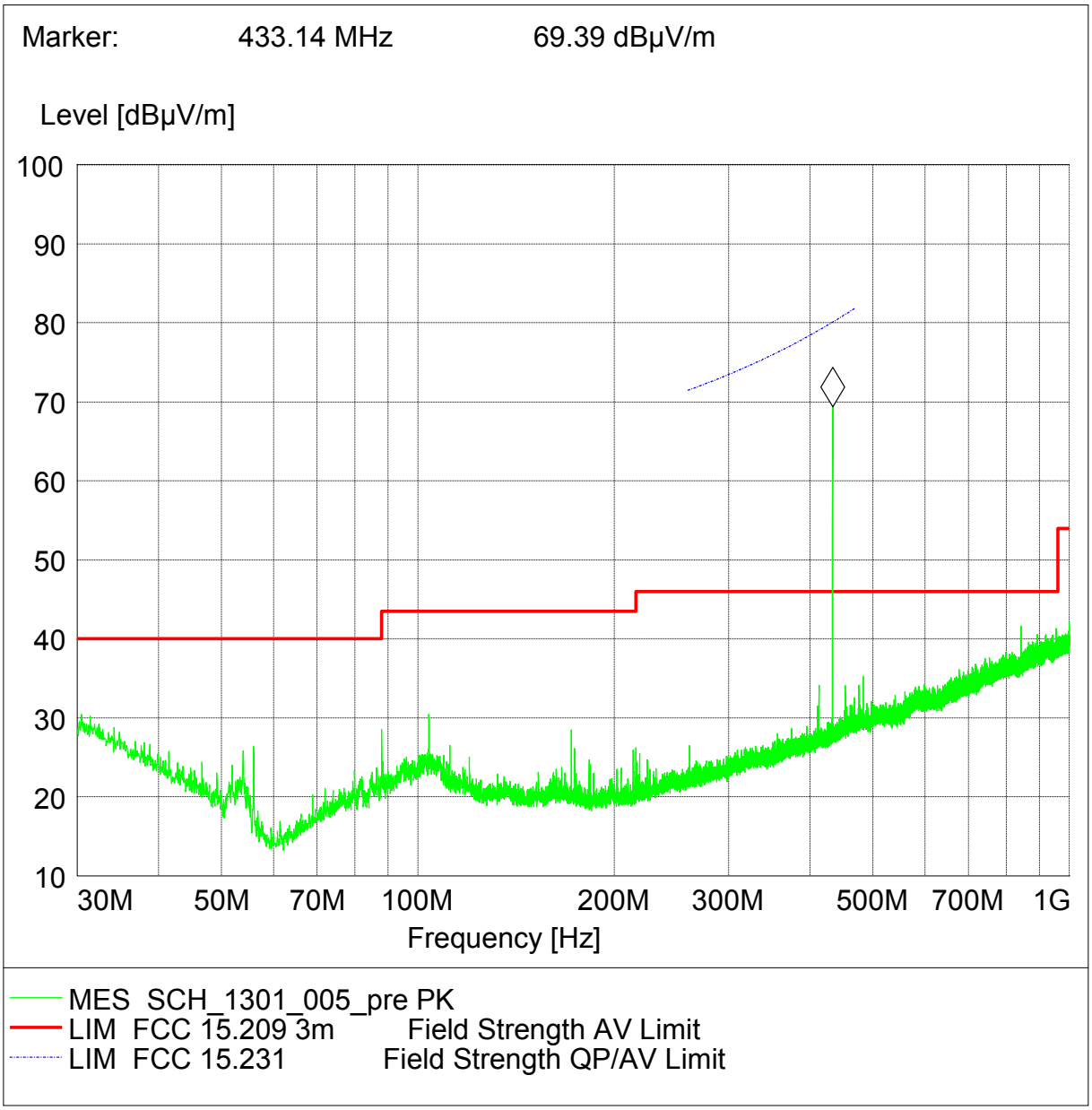


8.4 Peak power output

worst case plot
channel 1 - values are not corrected by duty cycle correction factor

SCAN TABLE: "FCC 15.231 C F433MHz"

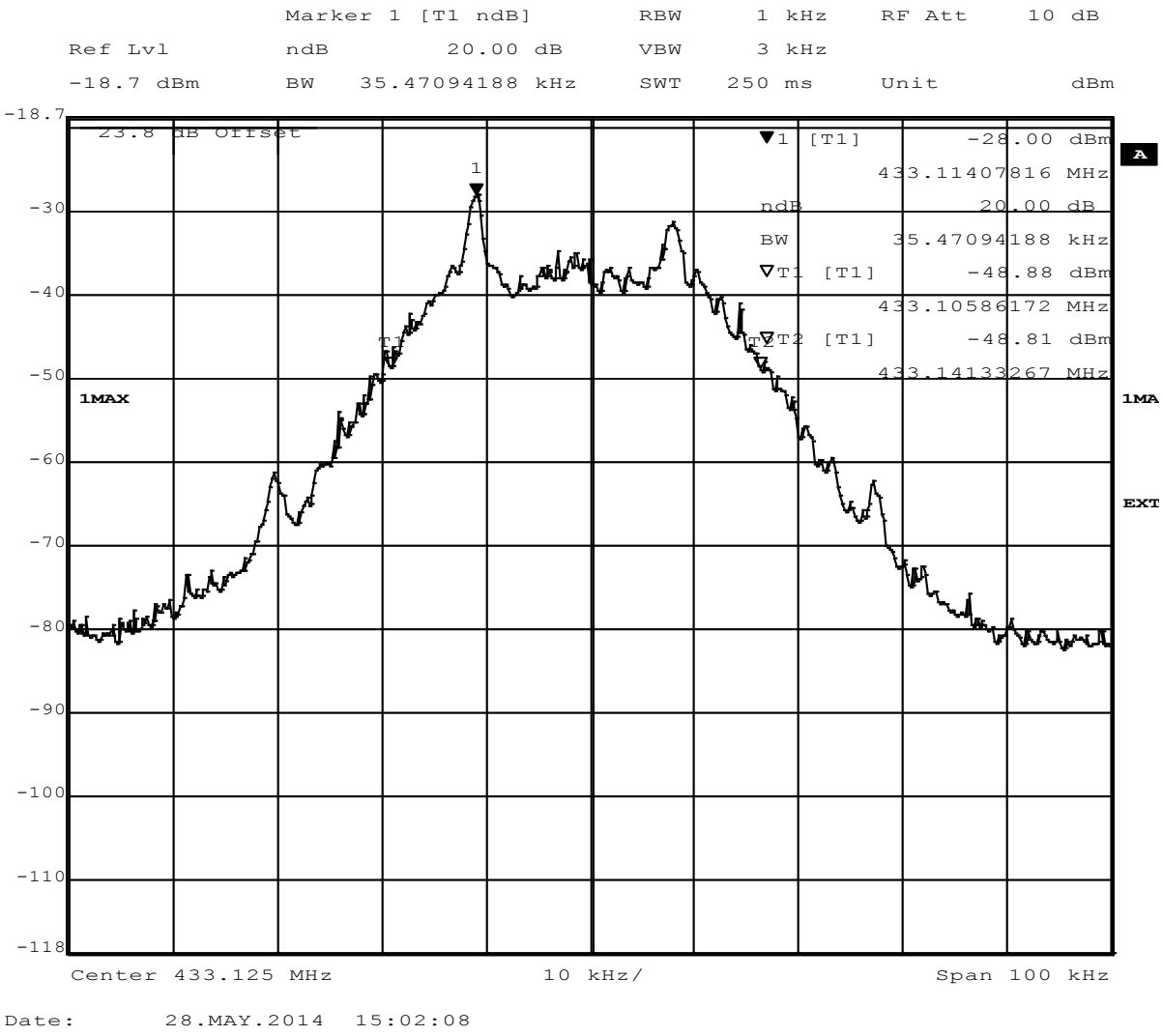
```
Short Description:              FCC ClassA Field Strength
  Start      Stop       Step       Detector  Meas.     IF       Transducer
  Frequency  Frequency  Width                Time      Bandw.
  30.0 MHz   1.0 GHz    60.0 kHz   MaxPeak   1.0 ms    120 kHz  HL562
```



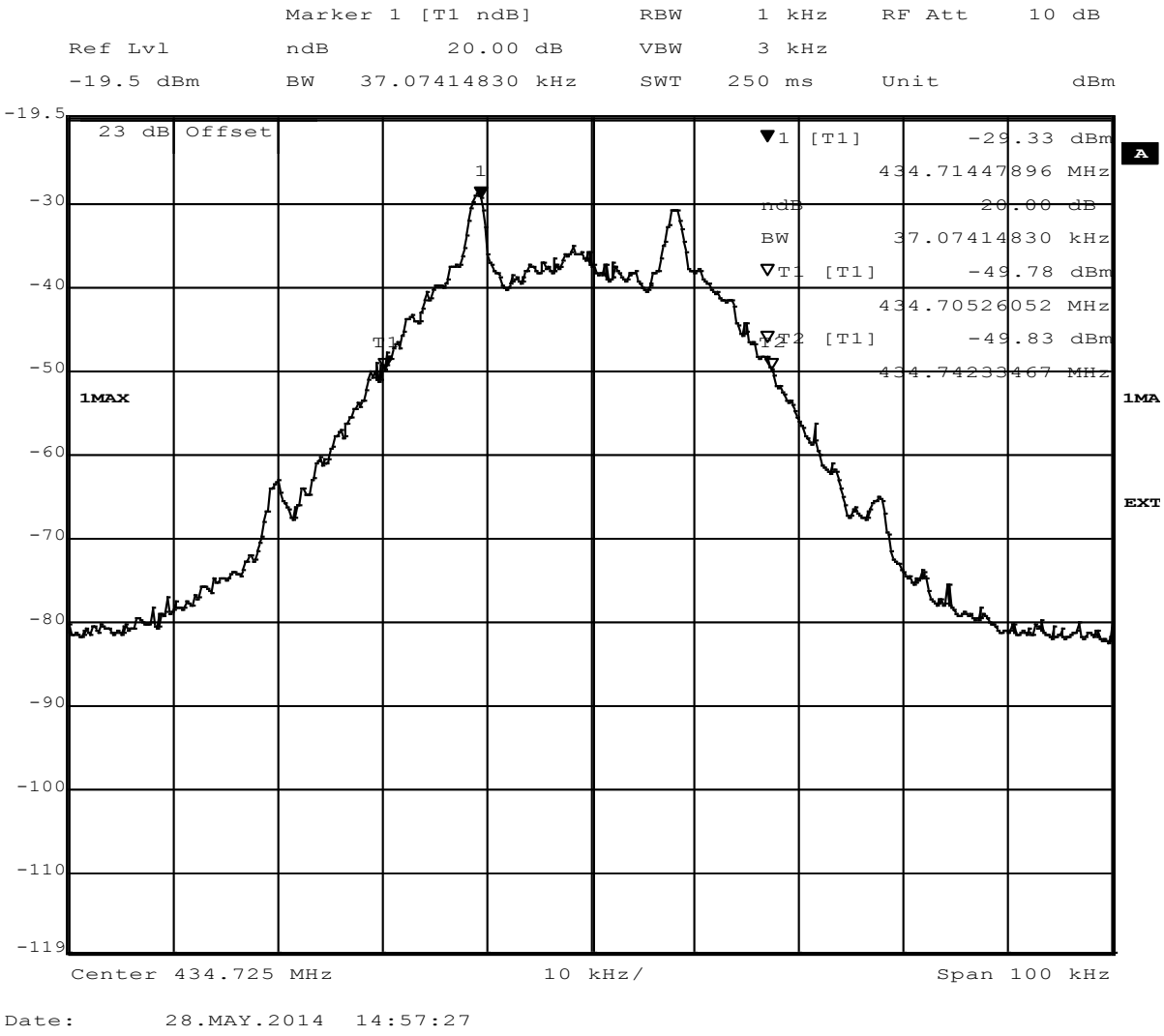
8.5 Occupied bandwidth

8.5.1 Occupied bandwidth operating mode 1

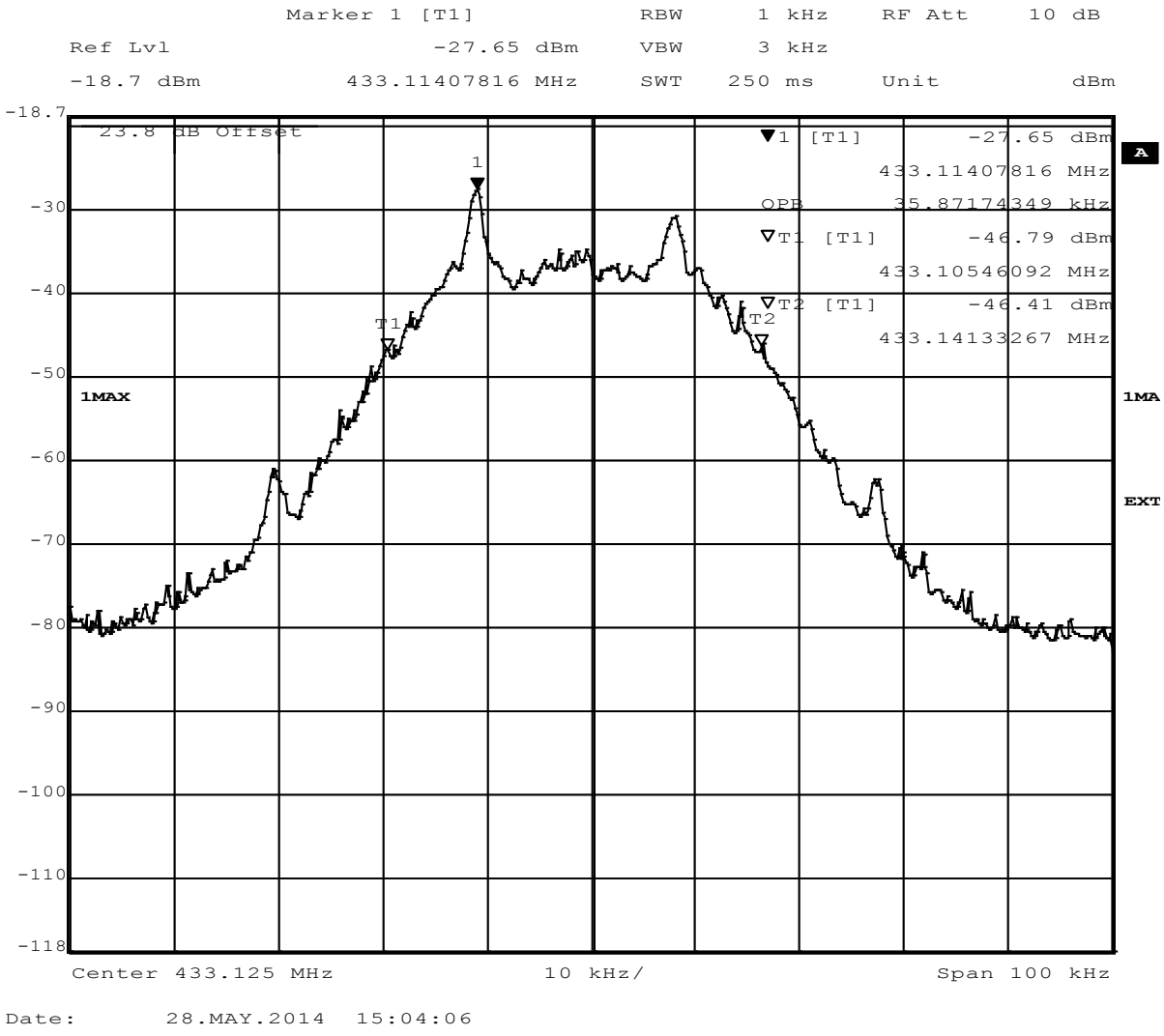
20 dB Occupied bandwidth channel 1



20 dB Occupied bandwidth channel 2



99% occupied bandwidth channel 1



99% Occupied bandwidth channel 2