InterLab®

FCC Measurement/Technical Report on

Radio Identification Device
IDGNG1

Report Reference: MDE_HELLA_1201_FCCa

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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: 10-1-11

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			10-1-11 Edition
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_a01	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 2	Setup_a01	Enclosure	passed
op-mode 2	Setup_b01	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_a01	Enclosure	passed

FCC Part 15, Subpart C		**§ 15.231**	
Occupied Bandwidth			
The measurement was performed according to FCC § 15.31			10-1-11 Edition
OP-Mode	**Setup**	**Port**	**Final Result**
op-mode 1	Setup_a01	Enclosure	passed

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

Responsible for Accreditation Scope: M. Kullik

Responsible for Test Report:

[M. Kullik] 7layers

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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. Carsten Steinröder
Date of Test(s):	2013-01-21 to 2013-02-14
Date of Report:	2013-02-15

1.3 Applicant Data

Company Name:	Hella KGaA Hueck & Co.
Address:	Rixbecker Str.75 59552 Lippstadt Germany
Contact Person:	Dipl.-Ing. (FH) Jürgen Baier

1.4 Manufacturer Data

Company Name:	Hella Shanghai Electronics Co., Ltd. (HSE)
Address:	No. 411 Jianye Road, Pudong, Shanghai 201201 China
Company Name:	Hella KGaA Hueck & Co.
Address:	Römerstrasse 66 59075 Hamm Germany

2 Test object Data

2.1 General EUT Description

Equipment under Test	Radio Identification Device
Type Designation:	IDGNG1
Kind of Device:	433 MHz transceiver
Voltage Type:	DC battery
Voltage level:	3.0 V
Repeated Operation:	Manually
The EUT is part of a security or safety system:	No

General product description:

The EUT is a wireless handheld remote control unit consisting of transmitter and receiver (non-periodic operation in the band above 70 MHz).
The operating frequencies are: Ch. 1 = 433.20 MHz and Ch. 2 = 434.64 MHz

Specific product description for the EUT:

The EUT is a Radio Identification Device - RKE (remote keyless entry) and PKE (passive keyless entry) transceiver, which uses Manchester coded FSK modulation. The transmitter is activated manually by a switch and is deactivated automatically within less than 5 seconds after release of the switch.

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	Customer Series	HW Status	SW Status	Date of Receipt
EUT A (Code: V0020a01)	Radio Identification Device	IDGNG1	Mini	8.3	7.5	2013-01-21
EUT B (Code: V0020b01)	Radio Identification Device	IDGNG1	Mini	8.3	7.5	2013-01-21
EUT C (Code: V0010a01)	Radio Identification Device	IDGNG1	MCV	8.3	7.5	2013-01-21

Remark: EUT A, B and C are equipped with an integral antenna (gain= 2.15 dBi).

Note: Pre-measurements have been performed to identify the worst case EUT of the customer Series Mini, MCV, XNF. The pre-measurements have shown that all test results were inside the measurement tolerance. The Customer Series "Mini" has been used as representative EUT for the final measurements, which are documented in this test report. All EUTs are electrically identical (same PCB) and only differ in the housing (form factor and material).

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

2.2 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.

2.3 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.

2.4 EUT Setups

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

Setup No.	Combination of EUTs	Description
Setup_a01	EUT A	setup for RF and TX Spurious emissions measurements
Setup_a02	EUT B	setup for RF and RX Spurious emissions measurements
Setup_a03	EUT C	setup for Duty Cycle measurements

2.5 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 telegrams sequences of RKE and PKE type. Special operating mode for test purpose only.
op-mode 2	continuous operation	Transmitter is sending a CW signal continuously. Special operating mode for test purpose only.
op-mode 3	real operation	Transmitter is sending only the telegram sequence provided to be used in a normal operation.

2.6 Product labelling

2.6.1 FCC ID label

FCC ID: NBGIDGNG1

2.6.2 Location of the label on the EUT

The FCC ID is placed behind the backside cover of the EUT.

3 Test Results

3.1 Duty cycle measurement (based on dwell time measurement)

Standard FCC Part 15, 10-1-11 Edition 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 activated function of the EUT, different paragraphs of FCC §15.231 apply:

(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,

(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.

3.1.3 Test Protocol

Temperature: 22° C
Air Pressure: 1004 hPa
Humidity: 35 %

Op. Mode	Setup	Port
op-mode 3	Setup_a03	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]

RKE mode, Telegram type 2.

Step 1	Holdover time	Less than 5s
Step 2	Cycle to determine the on/off ratio within a cycle (period T)	743 ms
Step 3	Sweep of a data word to determine the on time within a data word (L1-LN).	L1 = 43 ms
Step 4	Determine the number of pulses (N1-NN). First range (trigger delay = 0 ms).	N1 = 8

Duty cycle = ((L1*N1) + (L2*N2) + ... + (Ln*Nn)) / 100 ms or T, whichever is less

Correction factor = 20 * LOG (Duty cycle) [dB]

Calculation of Duty Cycle / Correction Factor:
If T > 100 ms => T:= 100 ms; L1 = 43 ms; N1 = 1;
Duty cycle = 43 * 1 / 100 = **0.43**
Correction factor = 20 * LOG (0.43) = **-7.33 dB**

b) Determine the period of periodic re-transmission, if any, or cease (deactivation) time:
Period of re-transmission T_R = n/a.

Note: The device sends one pulse (Telegram Code) of 43 ms duration on f_1 frequency. In case of reception error, it sends a second pulse with the same content of data and duration, but on the f_2 frequency. If there is a reception error again, the device sends the same pulse on f_1 again. The worst case scenario is a repetition of a maximal number of 8 pulses pack which is transmitted once. No repetition provided.

Deactivation (worst case scenario) after T_C = 0.743 s, Limit: ≤ 5 s

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, 10-1-11 Edition 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

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	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

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) + 30 dB	78.5 – 46.8
0.49 – 1.705	24000/F (kHz)	30	(48.9 – 23.0) + 10 dB	58.9 – 33.0
1.705 – 30	30	30	29.5 + 10 dB	39.5

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.

3.2.3 Test Protocol

3.2.3.1 Measurement up to 30 MHz

Temperature: 22 °C
Air Pressure: 1009 hPa
Humidity: 32 %

Op. Mode	Setup	Port
op-mode 2	Setup_a01	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: No spurious emissions in the range 20 dB below the limit found therefore step 2 was not performed.

3.2.3.2 Measurement 30 MHz – 1 GHz

Temperature: 23 °C
Air Pressure: 1005 hPa
Humidity: 35 %

Op. Mode	Setup	Port
op-mode 2	Setup_a01	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
Channel 2 = 434.640000 MHz									
Vertical	30.18000	23.80	–	–	40.0	–	–	16.2	–
Horizontal	440.70000	35.10	–	–	46.0	–	–	10.9	–
Horizontal	446.76000	35.60	–	–	46.0	–	–	10.4	–
Horizontal	924.50000	23.70	–	–	46.0	–	–	22.3	–
Channel 1 = 433.200000 MHz									
Vertical	31.20000	23.40	–	–	40.0	–	–	16.6	–
Horizontal	439.26000	34.50	–	–	46.0	–	–	11.5	–
Horizontal	445.32000	34.30	–	–	46.0	–	–	11.7	–
Horizontal	930.00000	23.70	–	–	46.0	–	–	22.3	–

Remark: No further spurious emissions in the range 20 dB below the limit found. The test was performed in the frequency range from 30 MHz to 1 GHz. For this test a EUT sending a CW signal was used.
The values listed above include the correction factor of the test system and the duty cycle determined by the test "Duty cycle measurement (based on dwell time measurement)".

3.2.3.3 Measurement above 1 GHz

Temperature: 22 °C
Air Pressure: 1009 hPa
Humidity: 32 %

Op. Mode	Setup	Port
op-mode 2	Setup_a01	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
		–			–				

Remark: No spurious emissions in the range 20 dB below the limit found. The test was performed in the frequency range from 1 GHz to 5.0 GHz. For this test a EUT sending a CW signal was used. The values listed above include the correction factor of the test system and the duty cycle determined by the test "Duty cycle measurement (based on dwell time measurement)".

3.2.4 Test result: Spurious radiated emissions

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

3.3 Peak power output

Standard FCC Part 15, 10-1-11 Edition 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: 24.5 °C
Air Pressure: 1005 hPa
Humidity: 37 %

Op. Mode	Setup	Port
op-mode 2	Setup_a01	Enclosure

Output power dBµV/m	Frequency MHz	Remarks
Channel - 1 f = 433,2 MHz		
77.4	433.200	Maximum radiated field strength at fundamental frequency
Channel - 2 f = 434,64 MHz		
77.7	434.640	Maximum radiated field strength at fundamental frequency

3.3.4 Test result: Peak power output

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

3.4 Occupied bandwidth

Standard FCC Part 15, 10-1-11 Edition 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 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: 22.2°C
Air Pressure: 1010 hPa
Humidity: 35.7%

Op. Mode	Setup	Port
op-mode 1	Setup_a01	Enclosure

20 dB bandwidth kHz	Limit kHz	Remarks
168.71	1086.6	The limit is calculated as 434.64 MHz * 0.25% = 1086.6 kHz.

Remarks: Please see annex for the measurement plots. The widest Occupation Bandwidth of 168.71 kHz is measured on Channel 2, PKE mode and the message type of Telegram 2.

For information: The 99% Bandwidth is 114.23 kHz.

3.4.4 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 1**
Manufacturer:	Frankonia
Description:	Anechoic Chamber for radiated testing
Type:	10.58x6.38x6.00 m³

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	none	Frankonia	
	Calibration Details		*Last Execution*	*Next Exec.*
	FCC listing 96716 3m Part15/18		2011/01/11	2014/01/10
	IC listing 3699A-1 3m		2011/02/07	2014/02/06
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 Radiated emissions

Lab ID:	**Lab 1**
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	AS 620 P	620/37	HD GmbH	
Biconical dipole	VUBA 9117	9117-108	Schwarzbeck	
	Calibration Details		*Last Execution*	*Next Exec.*
	Standard Calibration		2008/10/27	2013/10/26
	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

Single Devices for Auxiliary Equipment for Radiated emissions (continued)

Single Device Name	*Type*	*Serial Number*	*Manufacturer*	
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	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
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 1, Lab 2**
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		2011/10/19 2013/10/18
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
Vector Signal Generator	SMIQ 03B	832492/061	Rohde & Schwarz GmbH & Co.KG

Test Equipment Digital Signalling Devices

Lab ID: **Lab 1, Lab 2**
Description: Signalling equipment for various wireless technologies.

Single Devices for Digital Signalling Devices

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Bluetooth Signalling Unit CBT	CBT	100589	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2011/11/24 2014/11/23
CMW500	CMW500	107500	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution* *Next Exec.*
	Initial factory calibration		2012/01/26 2014/01/25
Universal Radio Communication Tester	CMU 200	102366	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2011/05/26 2013/05/25
	HW/SW Status		*Date of Start* *Date of End*
	Hardware: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B56V14, B68 3v04, PCMCIA, U65V04 Software: K21 4v21, K22 4v21, K23 4v21, K24 4v21, K42 4v21, K43 4v21, K53 4v21, K56 4v22, K57 4v22, K58 4v22, K59 4v22, K61 4v22, K62 4v22, K63 4v22, K64 4v22, K65 4v22, K66 4v22, K67 4v22, K68 4v22, K69 4v22 Firmware: µP1 8v50 02.05.06 ---		2007/07/16
Universal Radio Communication Tester	CMU 200	837983/052	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2011/12/07 2014/12/06
	HW/SW Status		*Date of Start* *Date of End*
	HW options: B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B54V14, B56V14, B68 3v04, B95, PCMCIA, U65V02 SW options: K21 4v11, K22 4v11, K23 4v11, K24 4v11, K27 4v10, K28 4v10, K42 4v11, K43 4v11, K53 4v10, K65 4v10, K66 4v10, K68 4v10, Firmware: µP1 8v40 01.12.05 ---		2007/01/02
	SW: K62, K69		2008/11/03

Test Equipment Emission measurement devices

Lab ID:	**Lab 1**
Description:	Equipment for emission measurements
Serial Number:	see single devices

Single Devices for Emission measurement devices

Single Device Name	*Type*	*Serial Number*	*Manufacturer*
Personal Computer	Dell	30304832059	Dell
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2012/05/22 2013/05/21
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2012/05/21 2013/05/20
Signal Generator	SMR 20	846834/008	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	standard calibration		2011/05/12 2014/05/11
Spectrum Analyzer	ESIB 26	830482/004	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard Calibration		2011/12/05 2013/12/04
	HW/SW Status		*Date of Start* *Date of End*
	Firmware-Update 4.34.4 from 3.45 during calibration		2009/12/03

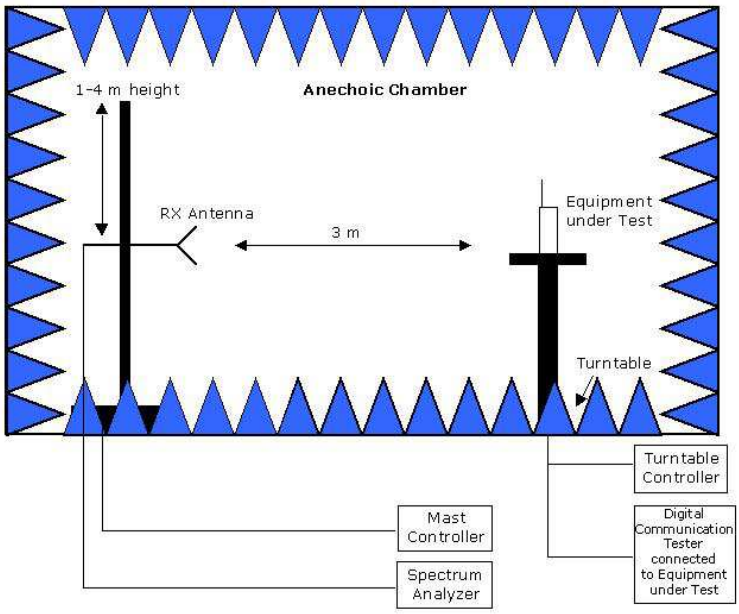
Test Equipment Radio Lab Test Equipment

Lab ID: **Lab 2**
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		Rosenberger Micro-Coax
Coax Cable Rosenberger Micro Coax FA210A0010003030 SMA/SMA 1,0m	FA210A0010003030	54491-2	Rosenberger Micro-Coax
Power Meter	NRVD	828110/016	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2012/05/22 2013/05/21
RF Step Attenuator RSP	RSP	833695/001	Rohde & Schwarz GmbH & Co.KG
Rubidium Frequency Standard	Datum, Model: MFL	2689/001	Datum-Beverly
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2012/06/21 2013/06/20
Sensor Head A	NRV-Z1	827753/005	Rohde & Schwarz GmbH & Co.KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2012/05/21 2013/05/20
Signal Generator	SMY02	829309/018	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2011/11/04 2014/11/03
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
Spectrum Analyser	FSIQ26	840061/005	Rohde & Schwarz GmbH & Co. KG
	Calibration Details		*Last Execution* *Next Exec.*
	Standard calibration		2011/02/10 2013/02/09
Temperature Chamber Vötsch 03	VT 4002	58566002150010	Vötsch
	Calibration Details		*Last Execution* *Next Exec.*
	Customized calibration		2012/03/12 2014/03/11

5 Setup Drawings



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

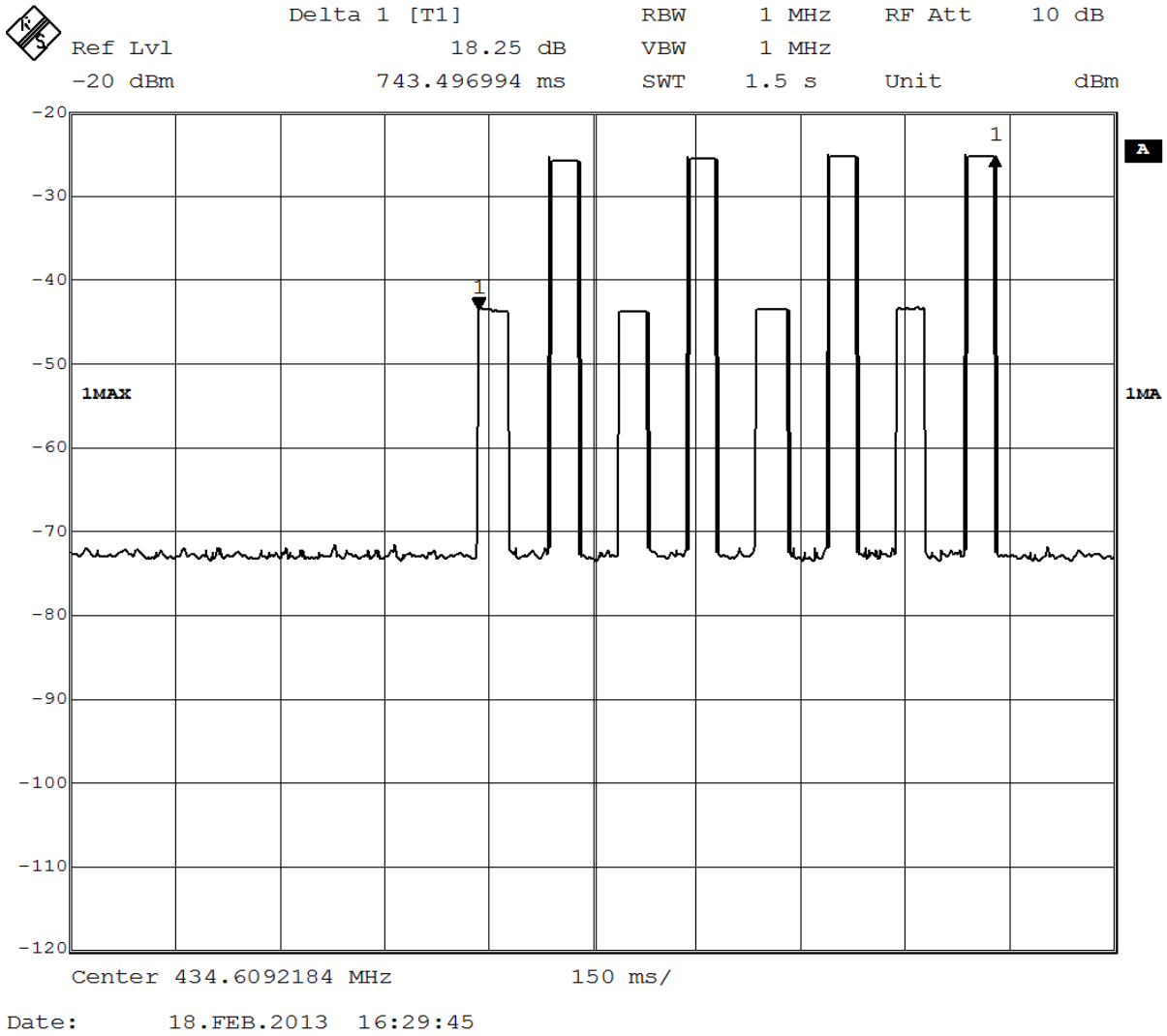
6 Annex measurement plots

6.1 Duty cycle measurement (based on dwell time measurement)

Op. Mode

Op-mode 1

The plots depend on the modulation pattern, plots for pulse coding and burst.



RKE mode, Telegram type 2.
Frequency hopping.
Note: Every next pulse (Telegram Code type) is sent on different frequency.

Step 1: Holdover time, T_C = 743 ms. Telegram 2 RKE mode. (▼1 - ▲1).

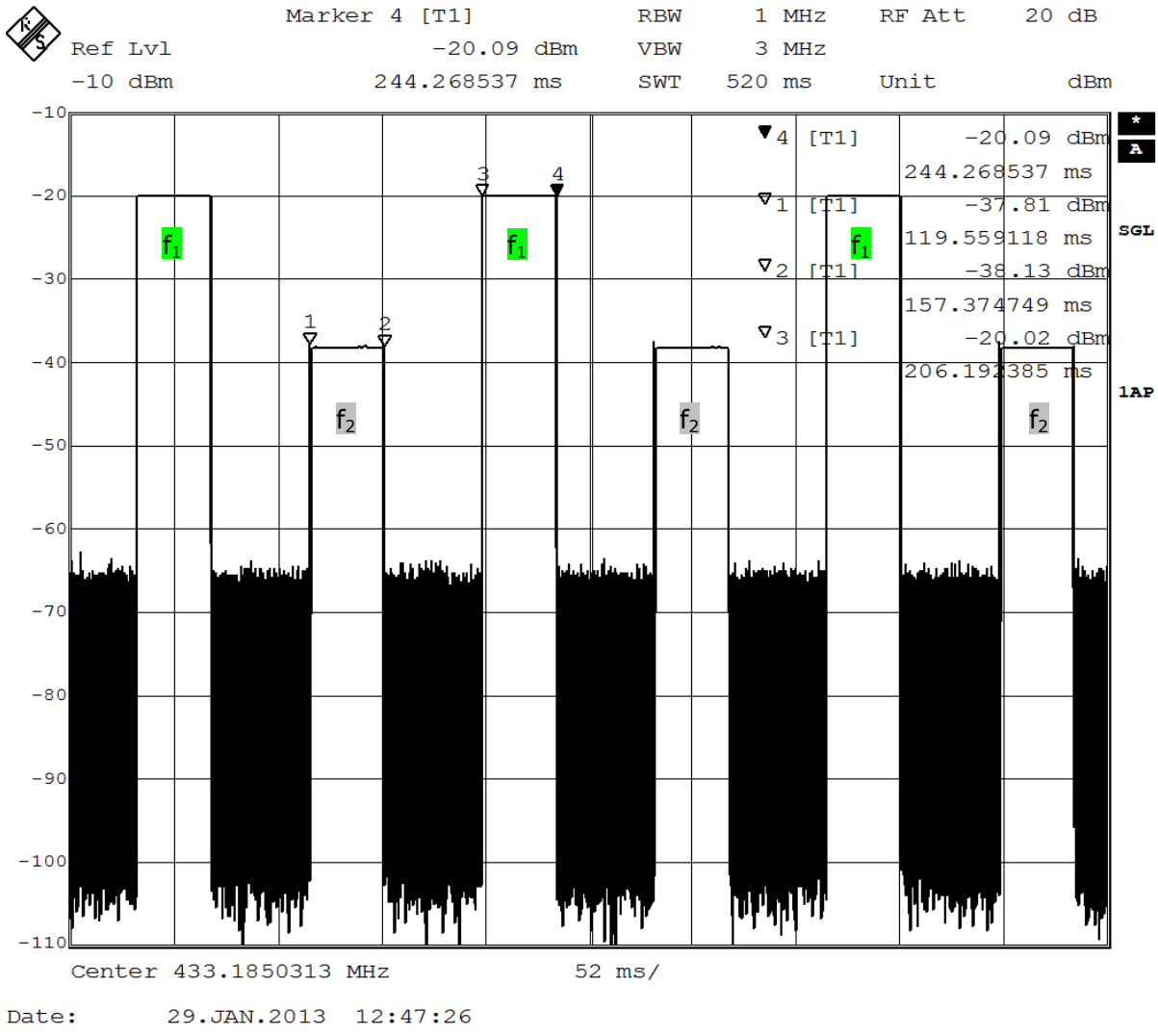
Step 2: Determine the on/off ratio within a cycle (period T).
$R_{on/off}$ = 8 * 43 ms/ 8 * 100 ms = 0.43

Step 3: Sweep of a data word to determine the on time within a data word (L1 to LN).

(∇2 - ∇1) = (∇4 - ∇3) = 43 ms. (Please see the plot bellow)

T_{on} = 8 * 43 = 364 ms.

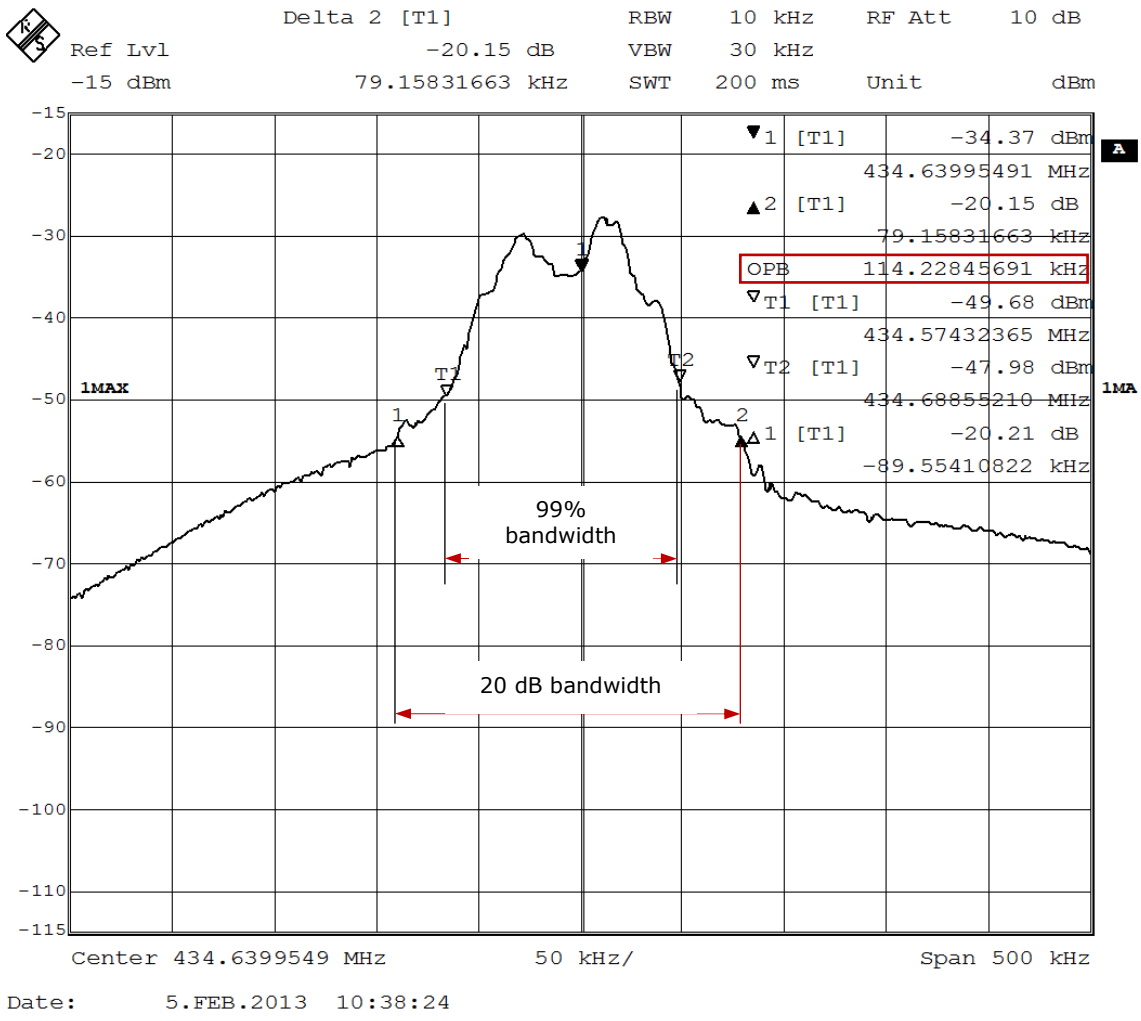
Step 4: Determine the number of pulses (N1-NN). First range (trigger delay=0 ms).
N1 = 8;



RKE mode, Telegram type 2. Frequency hopping.
Note: Every next pulse (Telegram Code type) is sent on different frequency.

6.2 Occupied bandwidth

Op. Mode	20 dB bandwidth
op-mode 1	168.71 kHz*



*Note: This bandwidth is the worst case (most wide).
All measured bandwidths are shown in the table below:

Mode	Telegram type	RF Channel	20 dB BW	99% BW
PKE	2	2	168.71*	114.23
PKE	1	2	162.70	119.24
PKE	1	1	105.81	111.82
PKE	2	1	105.81	110.62
RKE	1	1	70.44	77.15
RKE	2	1	70.44	75.15
RKE	1	2	69.14	75.75
RKE	2	2	69.14	73.95