EMISSION TEST REPORT

Report Number: 3137752BOX-001b

Project Number: 3137752

Duty Cycle Testing performed on the

908MHz Z-Wave Motion Sensor

Model: US

To Support

FCC Part 15 Subpart C 15.249

For

Express Controls

Test Performed by:	Test Authorized by:
Intertek – ETL SEMKO	Express Controls
70 Codman Hill Road	74A Averill Road
Boxborough, MA 01719	Brookline, NH 03033

Prepared by: ______________________ Date: 07/02/09
Nicholas Abbondante

Reviewed by: ______________________ Date: 07/06/09
Jeff Goulet

1.0 Job Description

1.1 Client Information:

This equipment under test (EUT) has been tested at the request of:

Company:	Express Controls 74A Averill Road Brookline, NH 03033
Contact:	Eric Ryherd
Telephone:	603-930-8822
Fax:	Not Available
Email:	Eric@EpressControls.com

1.2 Equipment Under Test:

Equipment Type:	908MHz Z-Wave Motion Sensor
Model Number(s):	US
Serial number(s):	3
Manufacturer:	Express Controls
EUT receive date:	July 02, 2009
EUT received condition:	A production unit was received with no visible damage.
Test start date:	July 02, 2009
Test end date:	July 02, 2009

1.3 Test Plan Reference:

Tested according to the standards listed and ANSI C63.4:2003

1.4 Test Configuration:

1.4.1 EUT Voltage Range:

The EUT is powered from three AAA batteries.

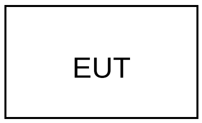
1.4.2 Cables:

None

1.4.3 Support Equipment:

None

1.4.4 Block Diagram:



1.5 Mode(s) of Operation:

The EUT was transmitting normally during testing.

1.6 Modifications Required For Compliance:

None

2.0 Test Summary:

TEST STANDARD	RESULTS	
FCC Part 15 Subpart C 15.249		
SUB-TEST	**TEST PARAMETER**	**COMMENT**
Duty Cycle FCC 15.35	There is no limit on duty cycle	No Limit

REVISION SUMMARY – The following changes have been made to this Report:

Date	Project No.	Project Handler	Page(s)	Item	Description of Change

3.0 Sample Calculations:

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG

Where FS = Field Strength in dBµV/m
RA = Receiver Amplitude (including preamplifier) in dBµV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows:

Assume a receiver reading of 52.0 dBµV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBµV/m. This value in dBµV/m was converted to its corresponding level in µV/m.

RA = 52.0 dBµV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBµV/m

Level in µV/m = [10(32 dBµV/m)/20] = 39.8 µV/m

The following is how net line-conducted readings were determined:

NF = RF + LF + CF + AF
Where NF = Net Reading in dBµV
RF = Reading from receiver in dBµV
LF = LISN Correction Factor in dB
CF = Cable Correction Factor in dB
AF = Attenuator Loss Factor in dB

To convert from dBµV to µV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in µV

Example:

NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 dBµV
$UF = 10^{(48.1\ dB\mu V / 20)}$ = 254 µV/m

4.0 Measurement Uncertainty:

Compliance of the product is based on the measured value. However, the measurement uncertainty is included for informational purposes.
The expanded uncertainty (k = 2) for radiated emissions from 30 to 1000 MHz has been determined to be:

±3.5 dB at 10m and ±3.8 dB at 3m

The expanded uncertainty (k = 2) for mains conducted emissions from 150 kHz to 30 MHz has been determined to be:

±2.6 dB

The expanded uncertainty (k = 2) for telecom port conducted emissions from 150 kHz to 30 MHz has been determined to be:

±3.2 for ISN and voltage probe measurements
±3.1 for current probe measurements

5.0 Site Description:

Test Site(s): 2

Our OATS are 3m and 10m sheltered emissions measurement ranges located in a light commercial environment in Boxborough, Massachusetts. They meet the technical requirements of ANSI C63.4-2003 and CISPR 22:1993/EN 55022:1994 for radiated and conducted emission measurements. The shelter structure is entirely fiberglass and plastic, with outside dimensions of 33 ft x 57 ft. The structure resembles a quonset hut with a center ceiling height of 16.5 ft.

The testing floor is covered by a galvanized sheet metal groundplane that is earth-grounded via copper rods around the perimeter of the site. The joints between individual metal sheets are bridged with a 2 inch wide metal strips to provide low RF impedance contact throughout. The sheets are screwed in place with stainless steel, round-head screws every three inches. Site illumination and HVAC are provided from beneath the ground reference plane through flush entry ports, the port covers are electrically bonded to the ground plane.

A flush metal turntable with 12 ft. diameter and 5000 lb. load capacity (12,000 lb. in Site 3) is provided for floor-standing equipment. A wooden table 80 cm high is used for table-top equipment. The turntable is electrically connected to the ground plane with three copper straps. The straps are connected to the turntable at the center of it with ground braid. The copper strap is directly connected to the groundplane at the edges of the turntable. The turntable is located on the south end of the structure and the antennas are mounted 3 and 10 meters away to the north. The antenna mast is a non-conductive with remote control of antenna height and polarization. The antenna height is adjustable from 1 to 4 meters.

All final radiated emission measurements are performed with the testing personnel and measurement equipment located below the ground reference plane. The site has a full basement underneath the turntable where support equipment may be remotely located. Operation of the antenna, turntable and equipment under test is controlled by remote controls that manipulate the antenna height and polarization and with a turntable control. Test personnel are located below the ellipse when measurements are performed, however the site maintains the ability of having personnel manipulate cables while monitoring test equipment. Ambient radiated emissions are 6 dB or more below the relevant FCC emission limits.

AC mains power is brought to the equipment under test through a power line filter, to remove ambient conducted noise. 50 Hz (240 VAC single phase), 60 Hz power (120 VAC single phase, 208 VAC three phase), and 60 Hz (480 VAC three phase) are available. Conducted emission measurements are performed with a Line Impedance Stabilization Network (LISN) or Artificial Mains Network (AMN) bonded to the ground reference plane. A removable vertical groundplane (2 meter X 2 meter area) is used for line-conducted measurements for table top equipment. The vertical groundplane is electrically connected to the reference groundplane.

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Test Results: No limits

Test Standard: FCC 15.35, 15.249

Test: Duty Cycle

Performance Criterion: Not Applicable

EUT Operating Voltage: Three fully charged AAA batteries

Test Environment:

Environmental Conditions During Testing:		Ambient (°C):	22	Humidity (%):	77	Pressure (hPa):	1000
Pretest Verification Performed		Yes		Equipment under Test:		US	
Test Engineer(s):	Nicholas Abbondante			EUT Serial Number:		3	
Engineer's Initials:	NNA	Date Test Performed:	07/02/2009	Reviewer's Initials:	[illegible]	Date Reviewed:	07/06/09

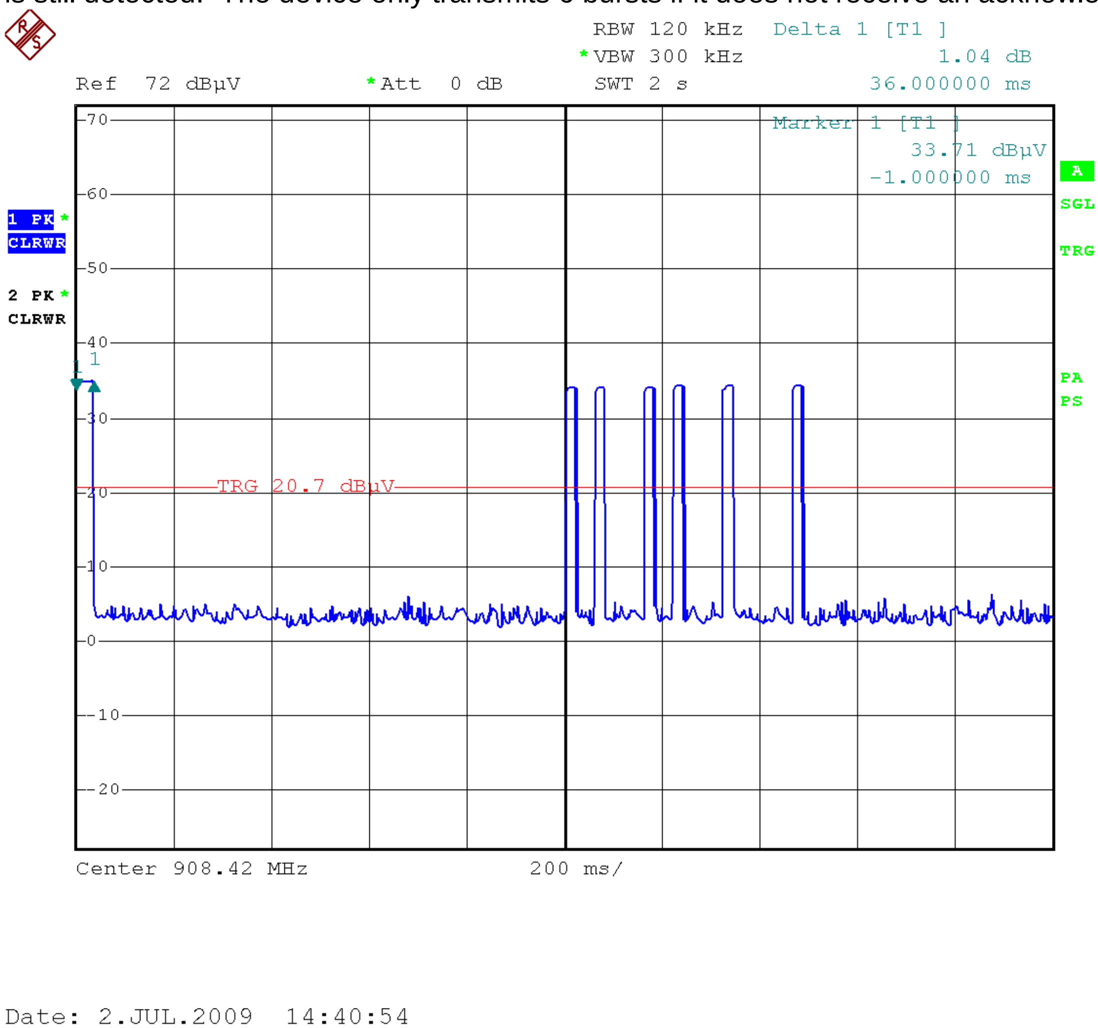
Test Equipment Used:

TEST EQUIPMENT LIST					
Item	**Equipment Type**	**Make**	**Model No.**	**Serial No.**	**Next Cal. Due**
1	Weather Station	Davis Instruments	7400	PE80529A39A	06/10/2010
2	9kHz to 3GHz EMI Test Receiver	Rohde & Schwartz	ESCI 1166.5950K03	100067	02/17/2010
3	10 Meter in floor cable for site 2	ITS	RG214B/U	S2 10M FLR	02/20/2010
4	ANTENNA	EMCO	3142	9711-1224	12/12/2009

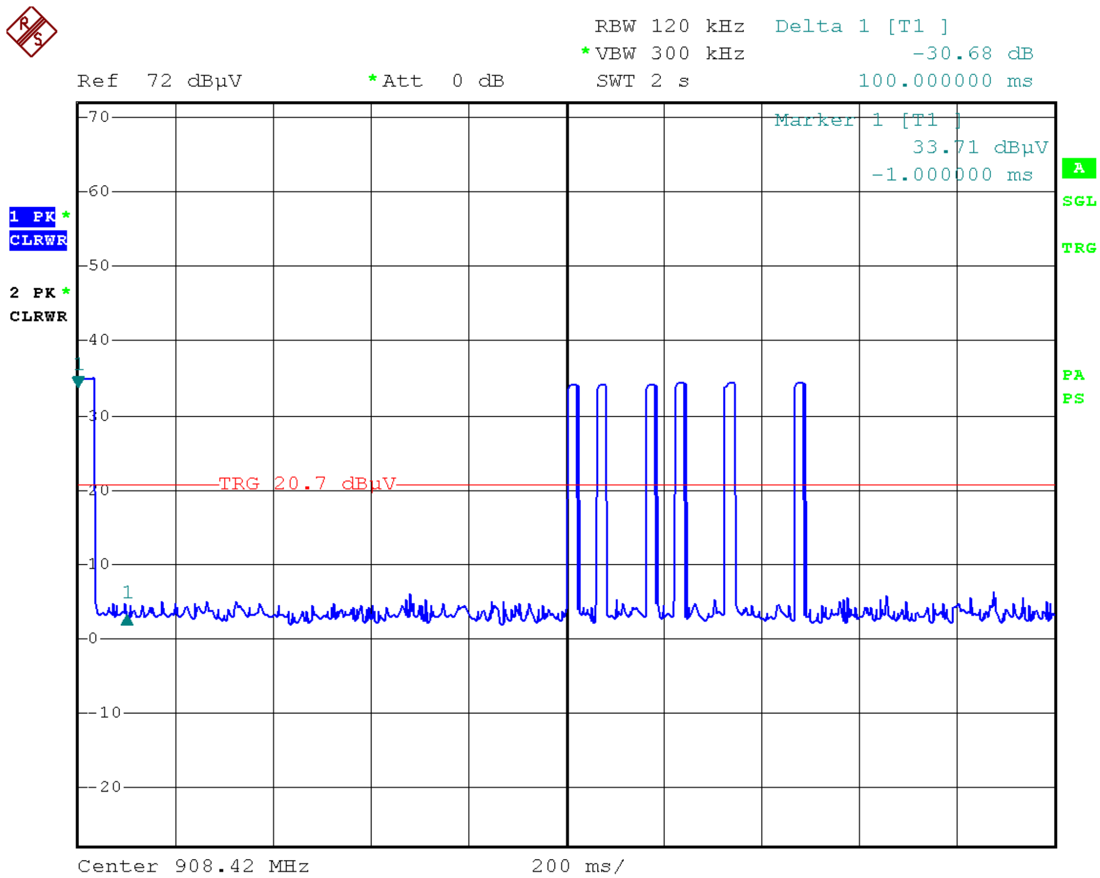
Test Results:

Notes: The typical worst-case duty cycle is 48%, yielding a duty cycle correction factor of 20*LOG(0.48)=6.38 dB. Worst case is based on two 24 ms bursts which occur in a 100 ms period, as part of the motion detection signal which is longer than 100 ms. This sequence only occurs when motion is detected and the radio does not receive an acknowledgement to its first burst. When an acknowledgement is not received, the radio retries several times before going to sleep. If an acknowledgement is received, the radio stops transmitting and goes to sleep. Testing occurred without a device present to give an acknowledgement in order to force worst-case operation.

Following is a 2 second plot of transmissions from the EUT. This shows an initial wakeup signal which was ~36 ms long. This is a broadcast which occurs every few minutes where the device says "I'm here". The device then sleeps unless motion is detected, at which point it broadcasts the 6-burst pulse seen in the plot below and then goes to sleep again for several minutes, even if motion is still detected. The device only transmits 6 bursts if it does not receive an acknowledgement.



Wakeup followed by a motion detection burst, wakeup burst length is 36 ms



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Plot of the 100ms span starting from the wakeup transmission. Note that with a wakeup burst length of 36 ms, generally the duty cycle for a wakeup transmission would be 36%.

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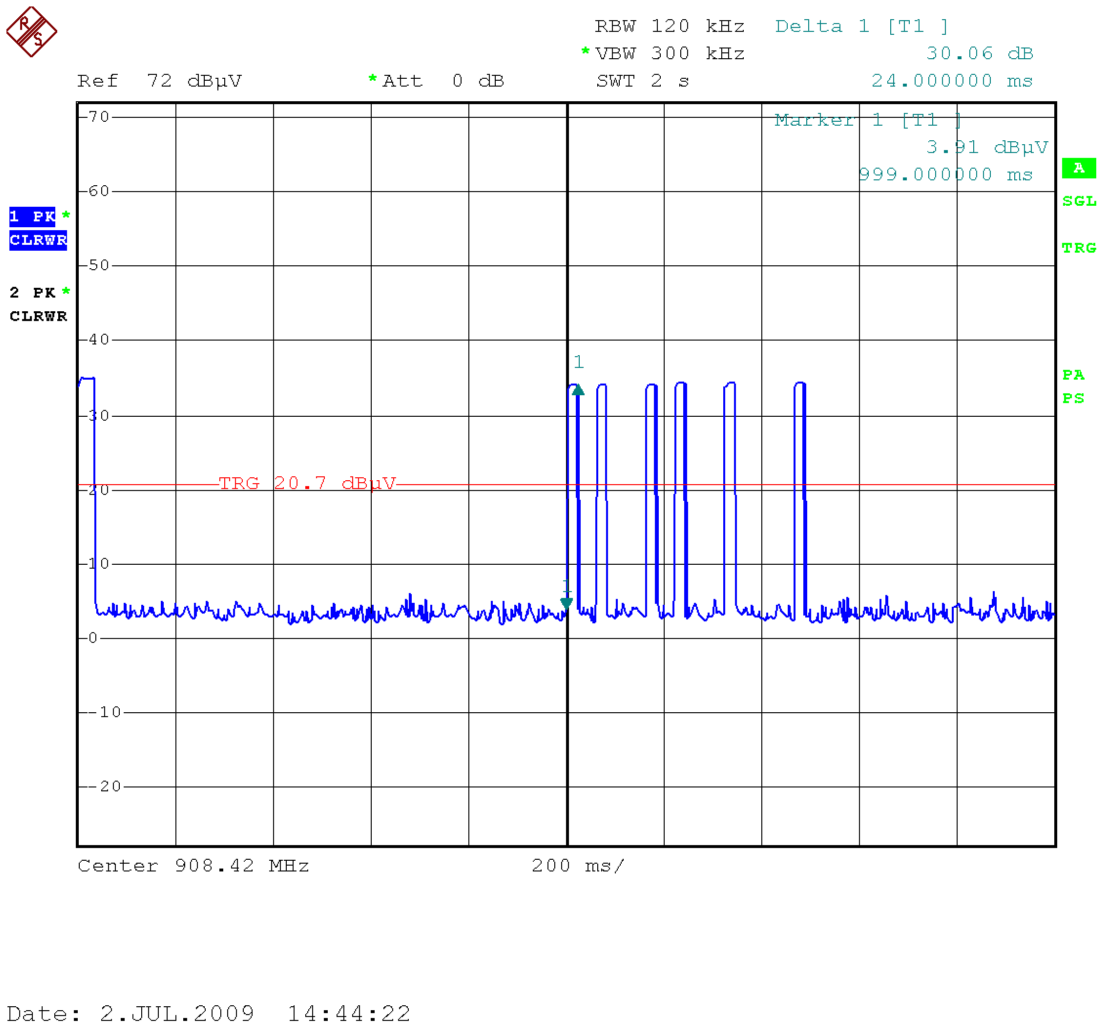
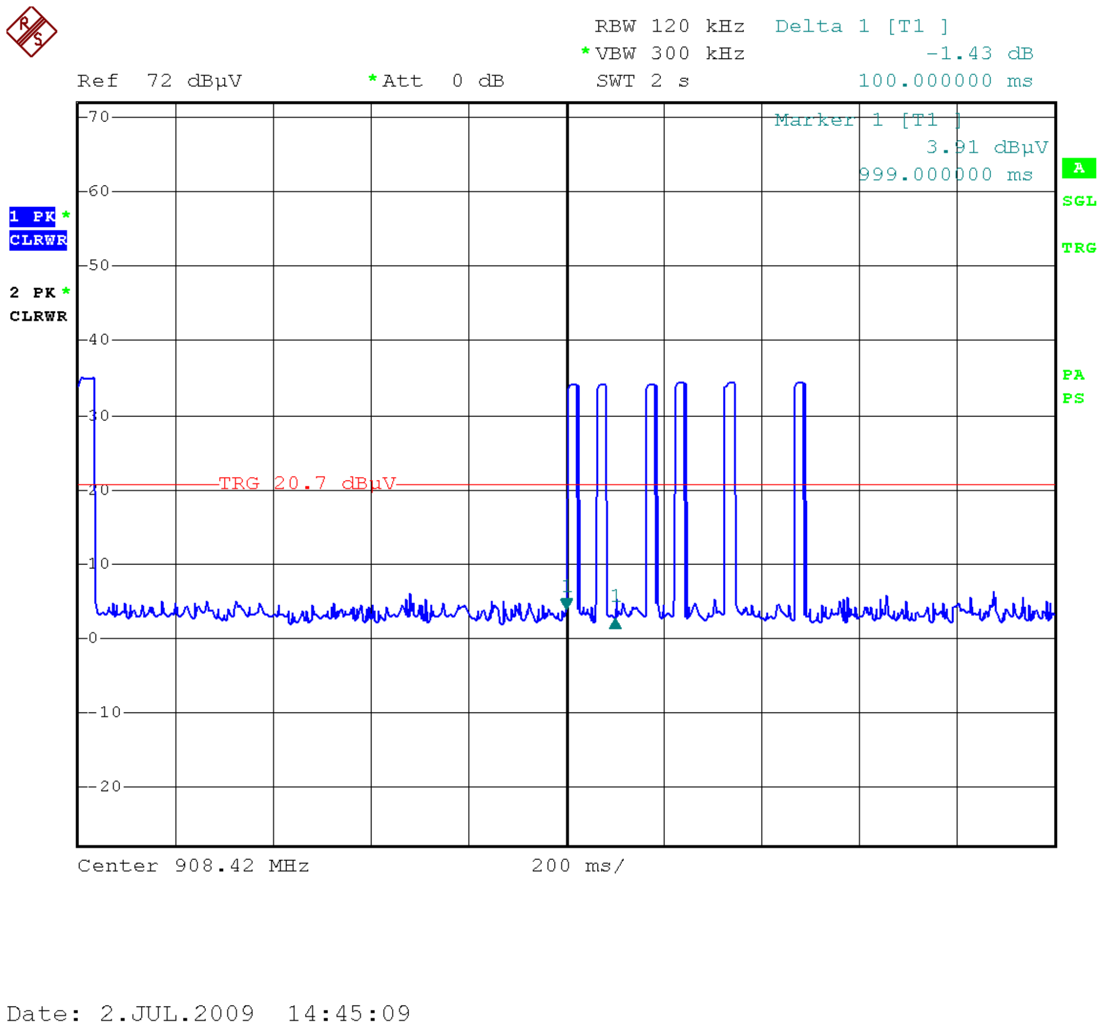


First motion burst length, 24 ms



100ms span after the start of the first motion detection burst, note that only two 24 ms bursts occur in a 100 ms timeframe (48% duty cycle)

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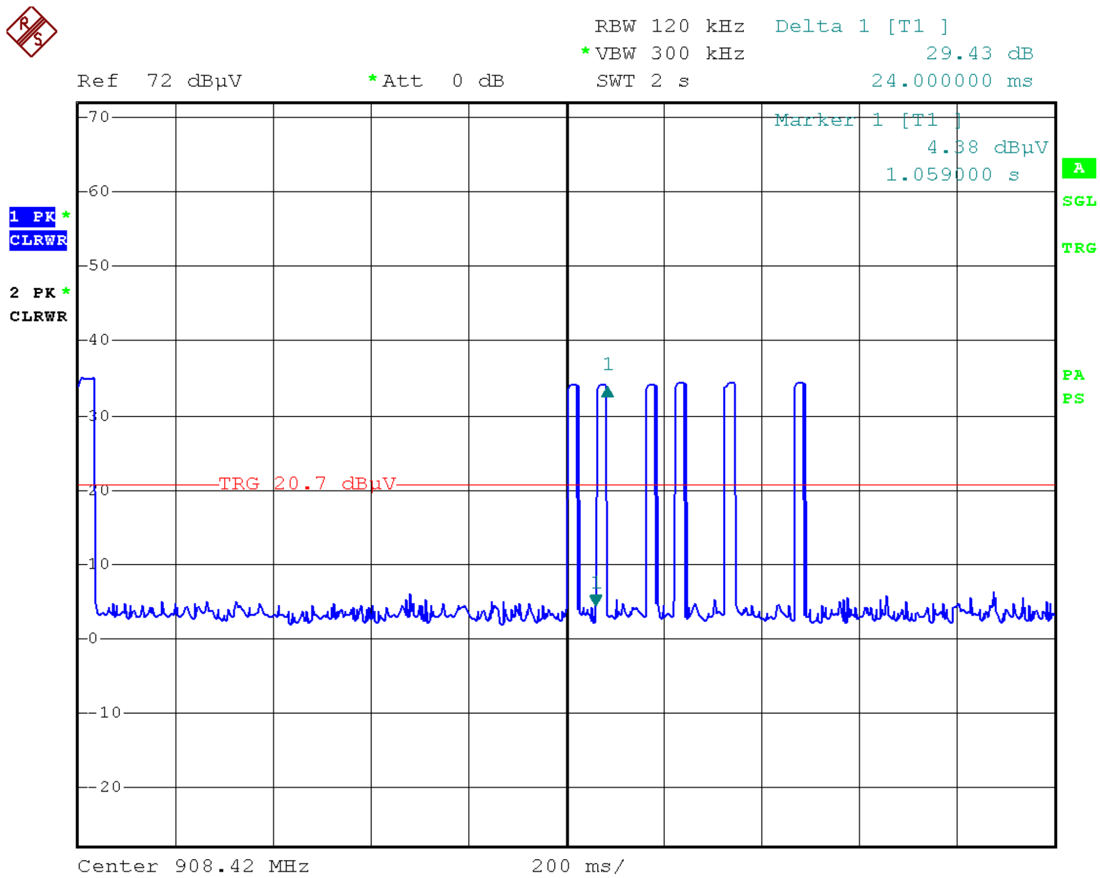

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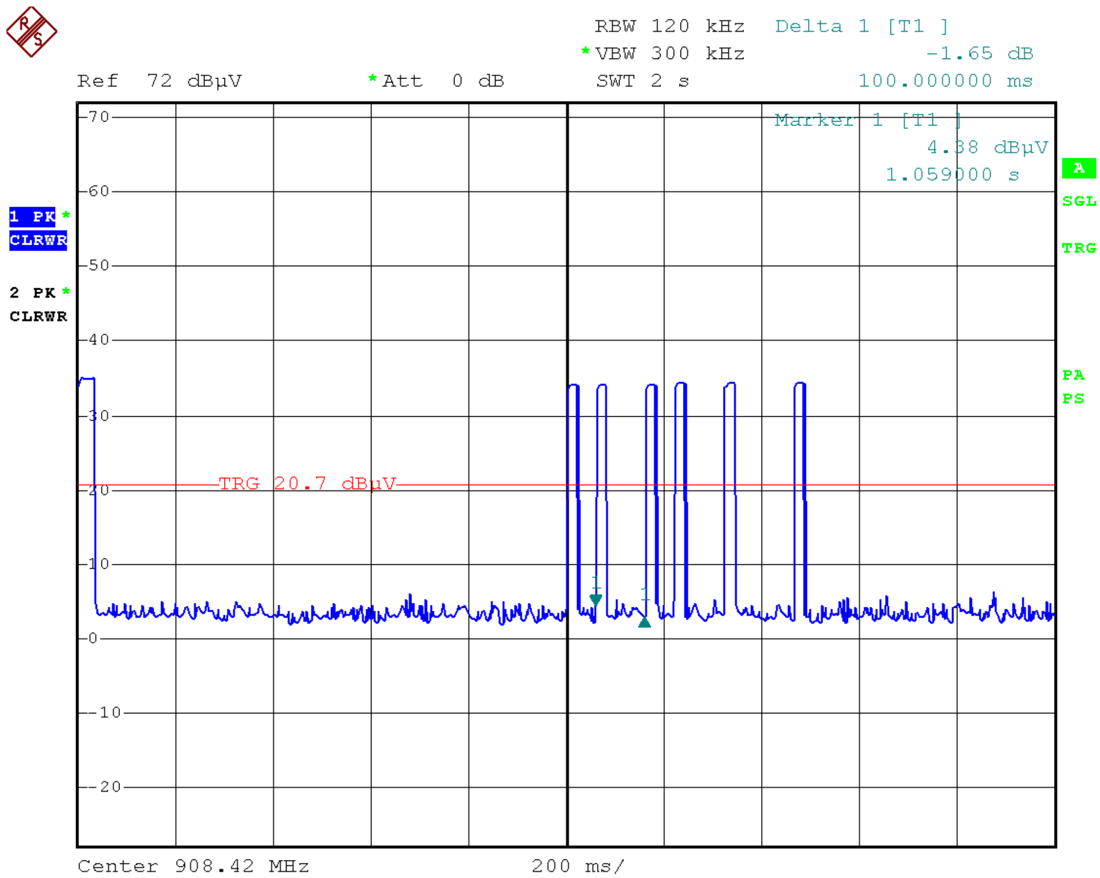
Second motion burst length, 24 ms



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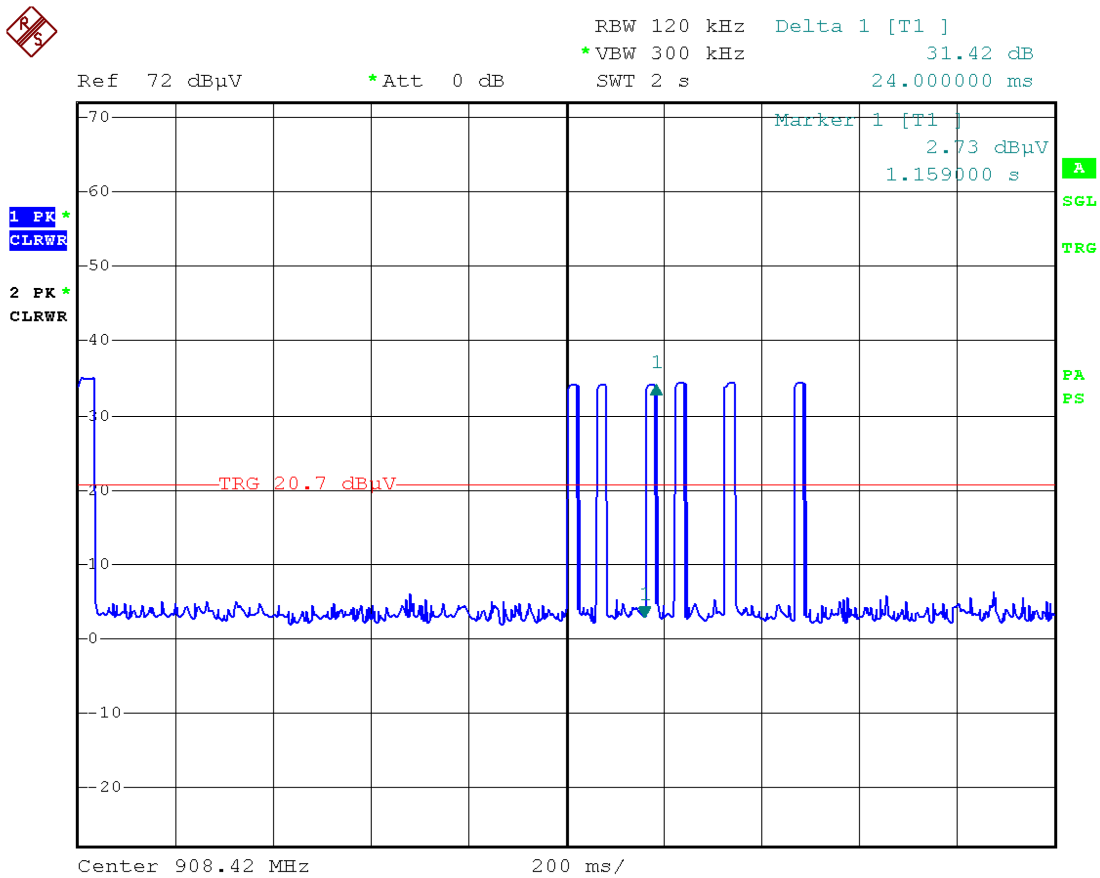
100ms span after the start of the second motion detection burst, note that only one 24 ms burst occurs in a 100ms timeframe (24% duty cycle)



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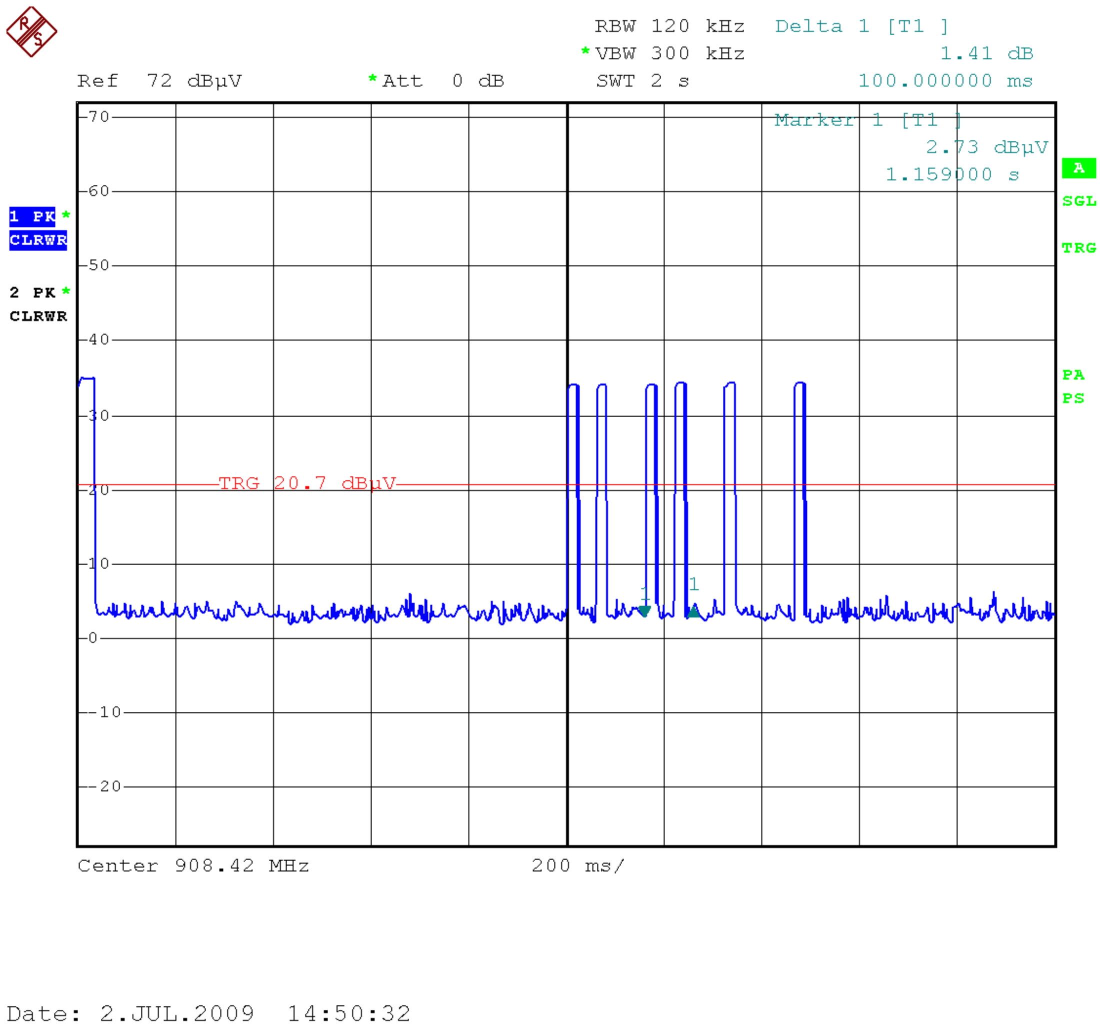
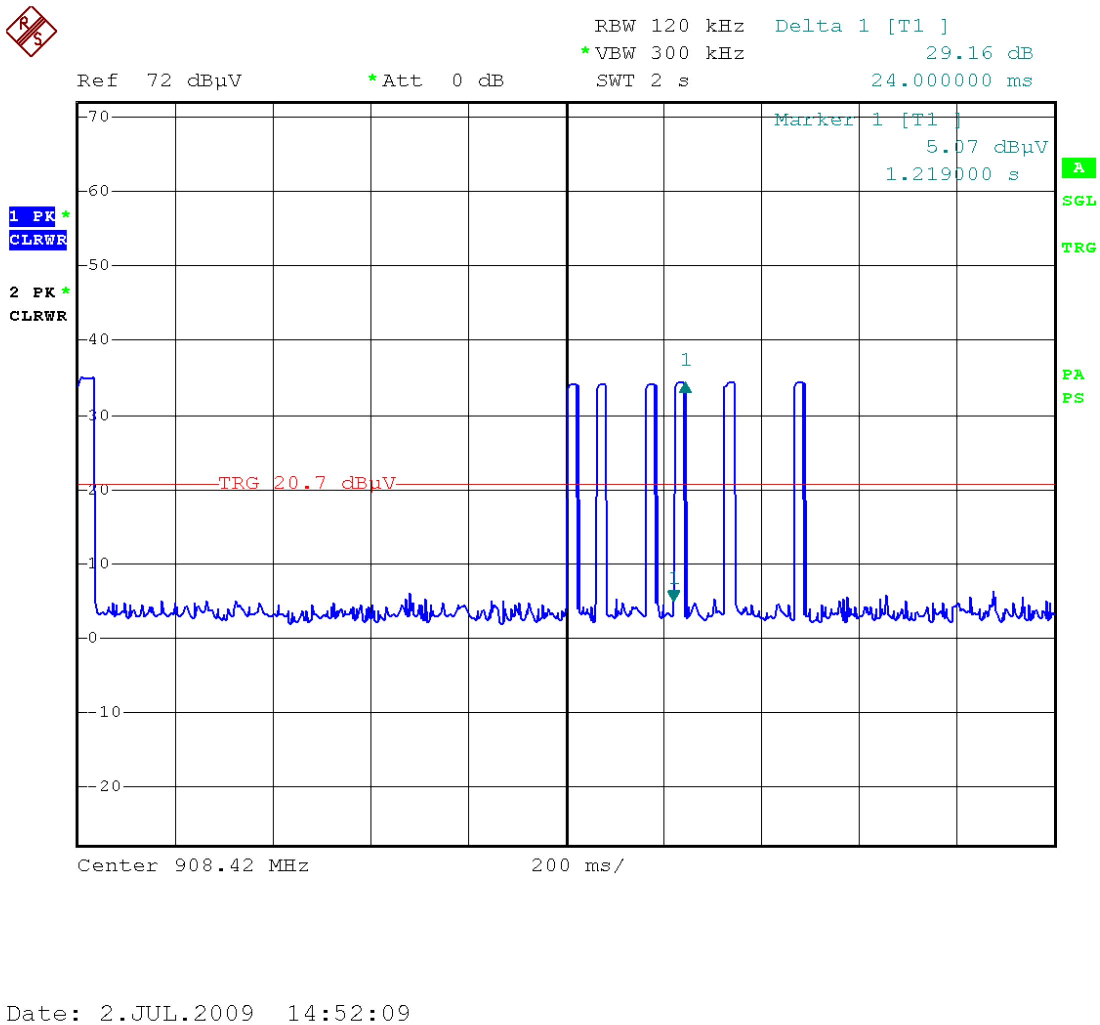
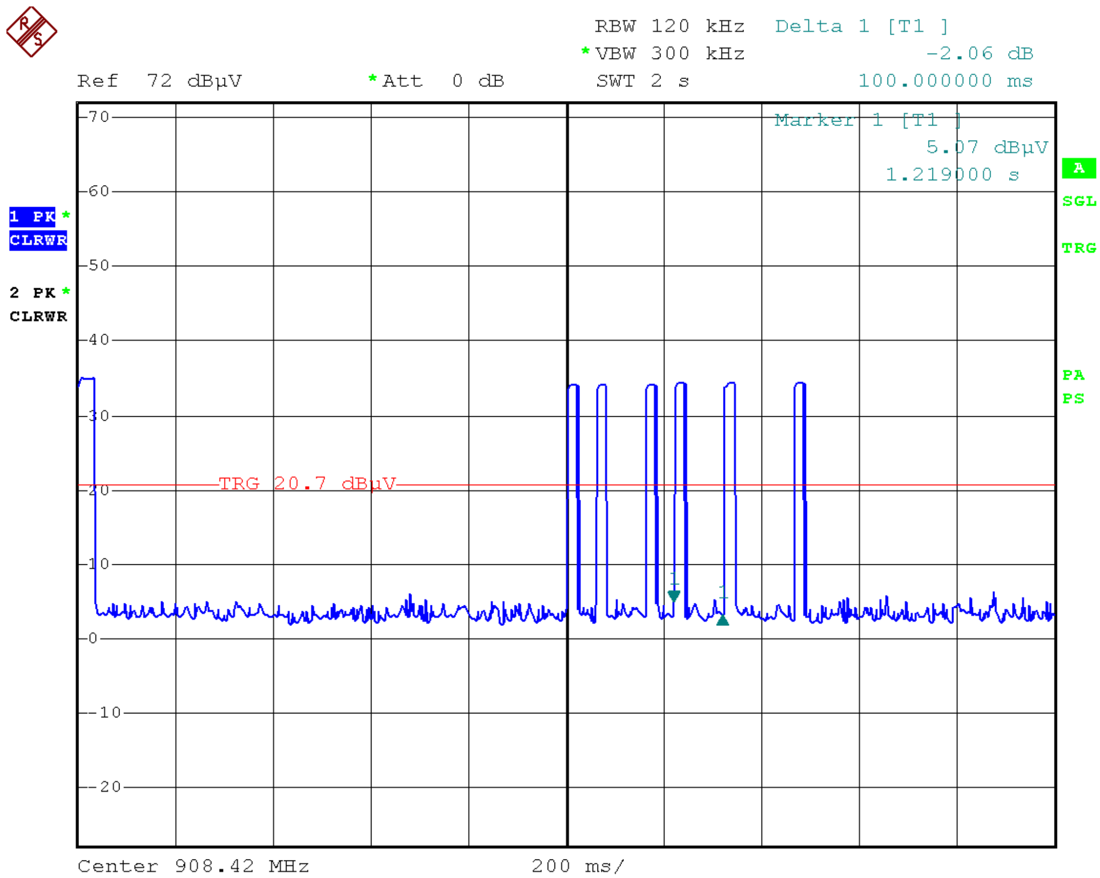
Third motion burst length, 24 ms



100ms span after the start of the third motion detection burst, note that only two 24 ms bursts occur in a 100 ms timeframe (48% duty cycle)



Fourth motion burst length, 24 ms



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100ms span after the start of the fourth motion detection burst, note that only one 24 ms burst occurs in a 100ms timeframe (24% duty cycle)

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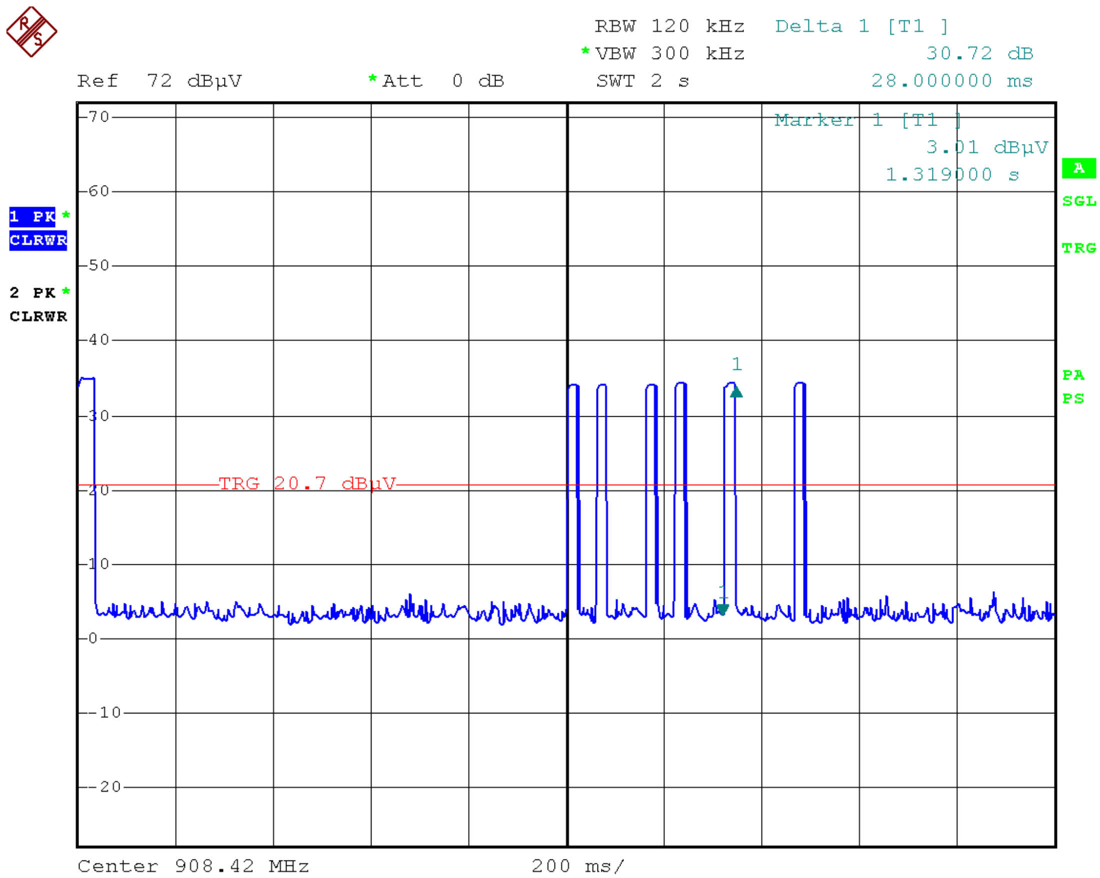

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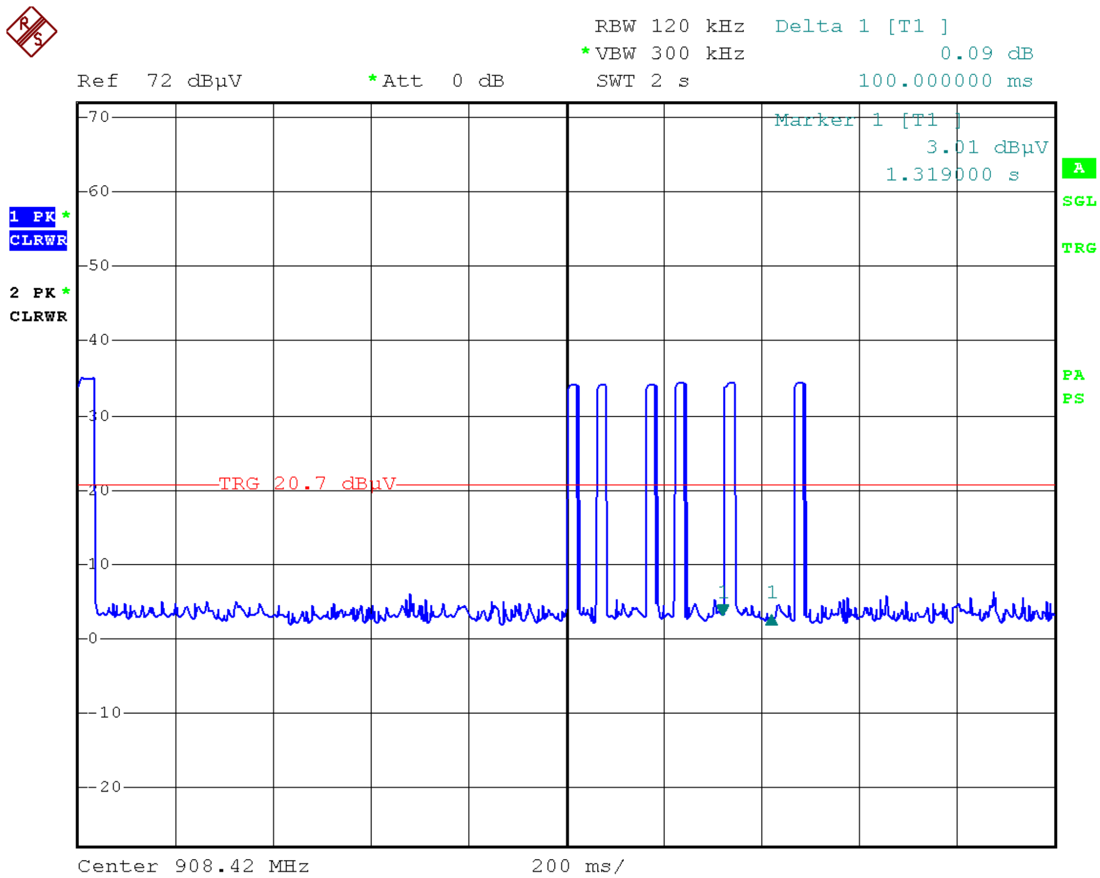
Fifth motion burst length, 28 ms



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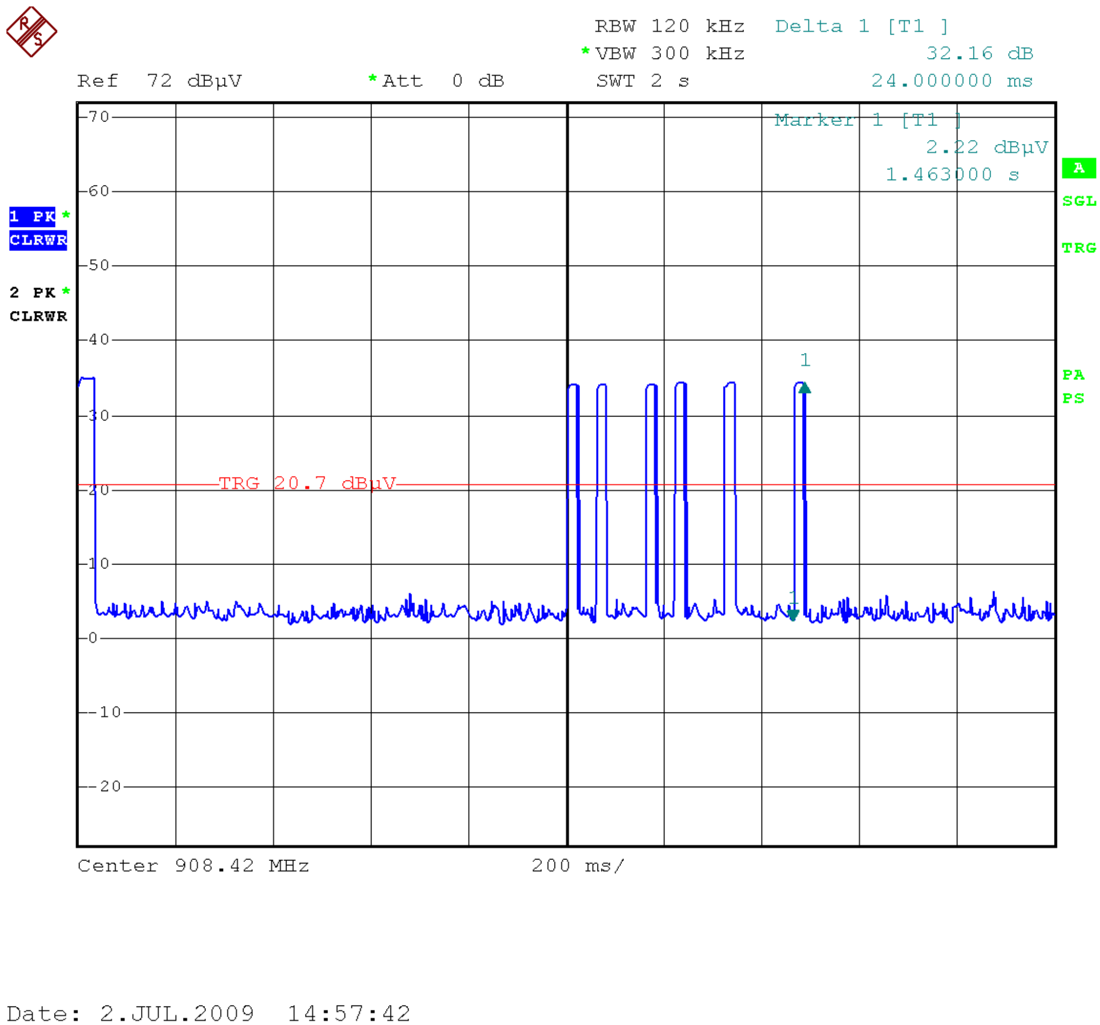
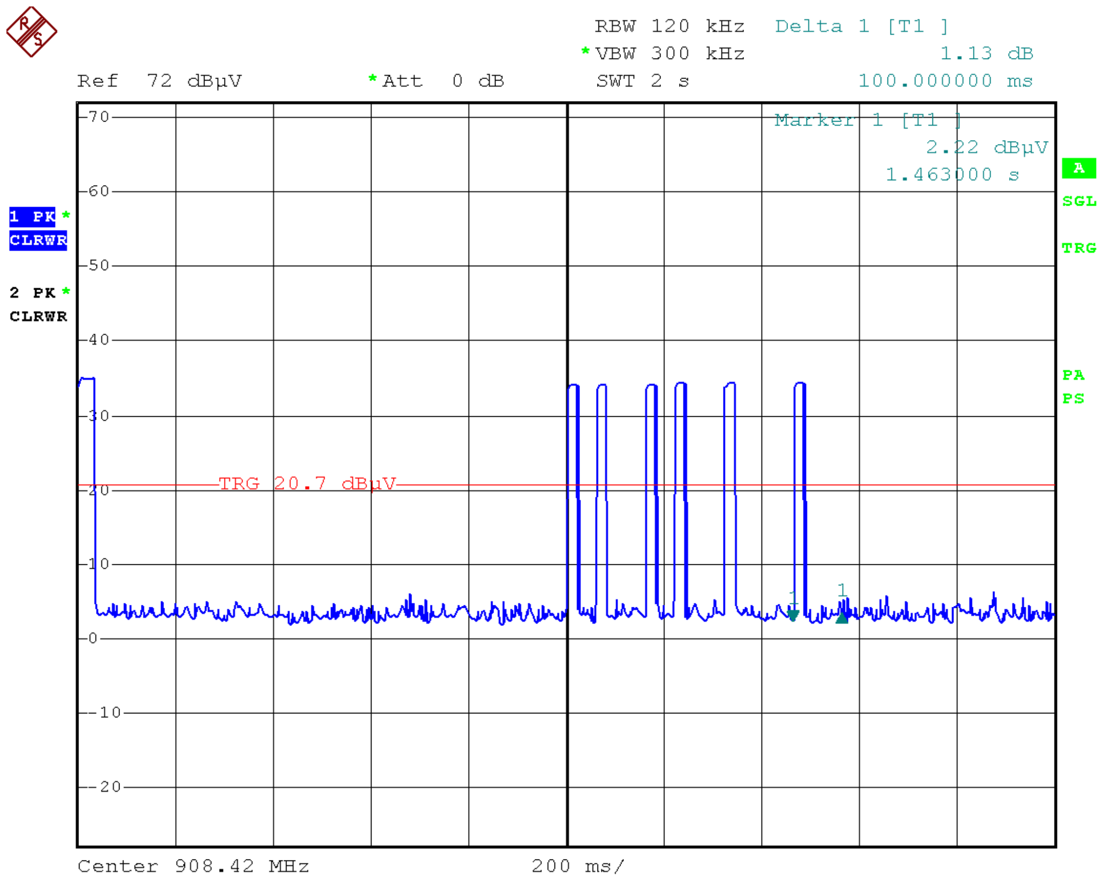
100ms span after the start of the fifth motion detection burst, note that only one 28 ms burst occurs within a 100 ms timeframe from the start of the fifth burst (28% duty cycle)



Sixth motion burst length, 24 ms



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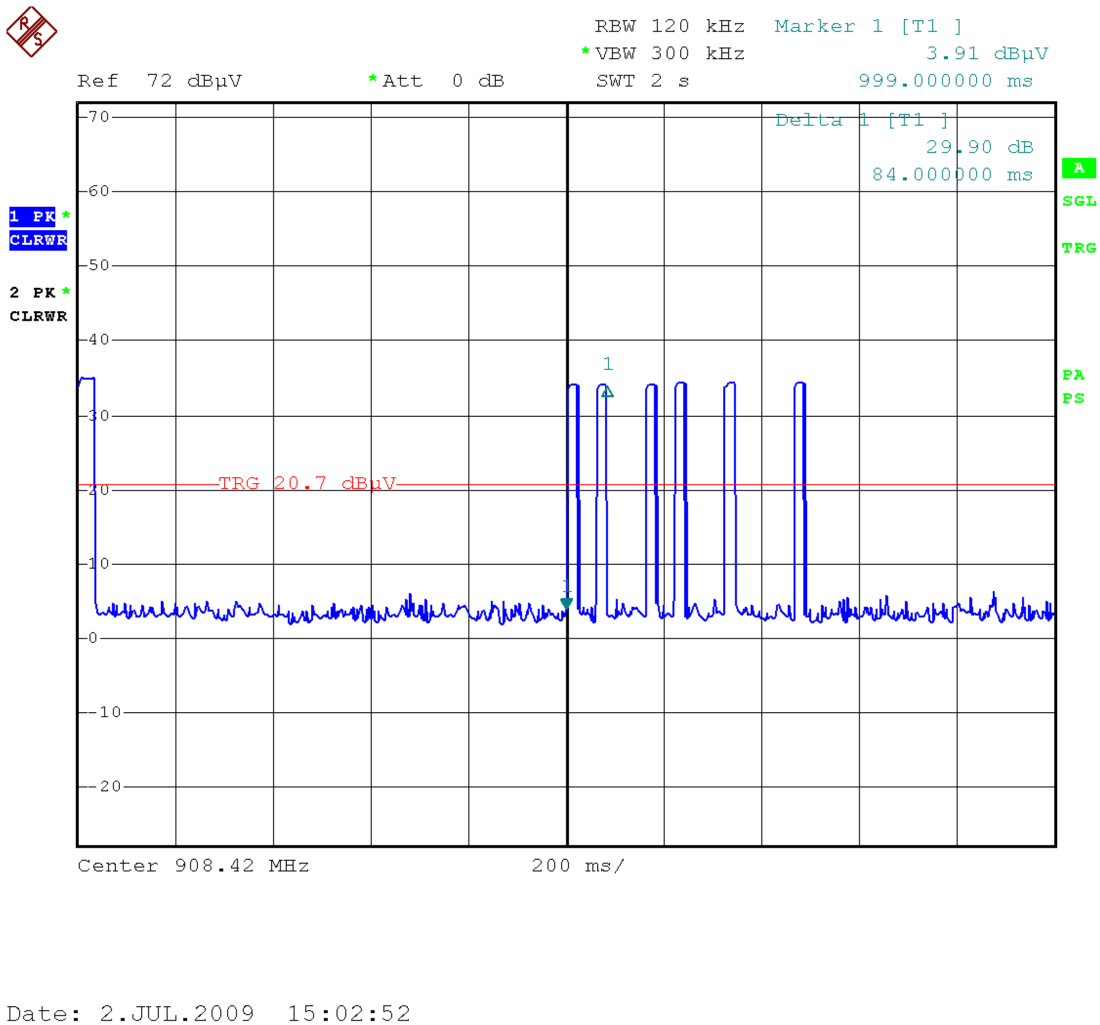
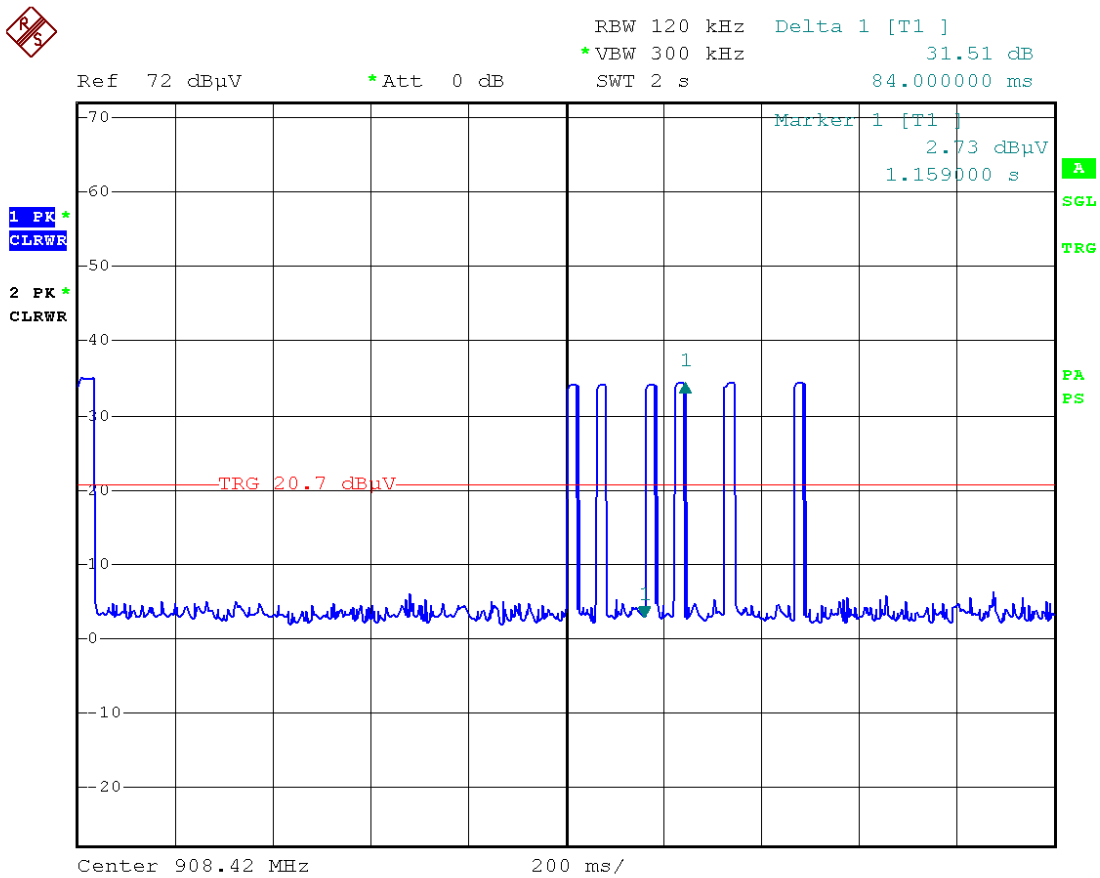
100ms span after the start of the Sixth motion detection burst, note that no additional transmissions occur in the 100 ms timeframe after the sixth burst, or in a longer timeframe (24% duty cycle)



The time from the start of the 1st burst to the stop of the 2nd burst is 84ms. It does not appear that this is a valid interval for duty cycle determination, as it is part of a longer set of bursts which is longer than 100 ms. If this would be considered a valid interval, then the duty cycle would be ~57.2% and the duty cycle averaging factor would be 4.9 dB.



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The time from the start of the 3rd burst to the stop of the 4th burst is 84ms. It does not appear that this is a valid interval for duty cycle determination, as it is part of a longer set of bursts which is longer than 100 ms. If this would be considered a valid interval, then the duty cycle would be ~57.2% and the duty cycle averaging factor would be 4.9 dB.

Final Note: It *may* be possible, if the software even allows it, for a motion detection burst to occur directly after a wakeup transmission. This is an unlikely scenario, but stipulating that it is possible, then the worst case duty cycle would be comprised of a 36 ms wakeup burst immediately followed by a 24 ms motion detection burst, followed by an off-time of 84-(24*2)=36 ms, followed by a second 24 ms motion detection burst. In this case, 96 ms would have passed between the start of the wakeup burst to the start of the second motion detection burst. This would mean that the on-time would be 36+24+4= 64ms in a 100 ms timeframe, yielding a 64% duty cycle and a duty cycle averaging factor of 3.9 dB.