Measurement of RF Emissions from a 225816-122 TPMS Transmitter

For	TRW Automotive Electronics, Inc. 24175 Research Drive Farmington Hills, MI 48335
P.O. Number	E273134517
Date Tested	May 29, 2013
Test Personnel	Mark Longinotti
Test Specification	FCC "Code of Federal Regulations" Title 47 Part15, Subpart C, Section 15.231 Industry Canada RSS-GEN Industry Canada RSS-210

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TRW Automotive Electronics, Inc.

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TABLE OF CONTENTS

PARAGRAPH	DESCRIPTION OF CONTENTS	PAGE NO.
1.	Introduction	5
1.1.	Scope of Tests	5
1.2.	Purpose	5
1.3.	Deviations, Additions and Exclusions	5
1.4.	EMC Laboratory Identification	5
1.5.	Laboratory Conditions	5
2.	Applicable Documents	5
3.	EUT Setup and Operation	6
3.1.	General Description	6
3.1.1.	Power Input	6
3.1.2.	Peripheral Equipment	6
3.1.3.	Signal Input/Output Leads	6
3.1.4.	Grounding	6
3.2.	Software	6
3.3.	Operational Mode	6
3.4.	EUT Modifications	6
4.	Test Facility and Test Instrumentation	6
4.1.	Shielded Enclosure	6
4.2.	Test Instrumentation	7
4.3.	Calibration Traceability	7
4.4.	Measurement Uncertainty	7
5.	Test Procedures	7
5.1.	Powerline Conducted Emissions	7
5.1.1.	Requirements	7
5.2.	Periodic Operation Measurements	7
5.2.1.	Requirements	7
5.2.2.	Procedures	7
5.2.3.	Results	7
5.3.	Duty Cycle Factor Measurements	8
5.3.1.	Requirements	8
5.3.2.	Procedures	8
5.3.3.	Results	9
5.4.	Radiated Measurements	9
5.4.1.	Requirements	9
5.4.2.	Procedures	9
5.4.3.	Results	10
5.5.	Occupied Bandwidth Measurements	10
5.5.1.	Requirement	10
5.5.2.	Procedures	10
5.5.3.	Results	10
6.	Other Test Conditions	10

TABLE OF CONTENTS

PARAGRAPH	DESCRIPTION OF CONTENTS	PAGE NO.
6.1.	Test Personnel and Witnesses	10
6.2.	Disposition of the EUT	10
7.	Conclusions	10
8.	Certification	11
9.	Equipment List	12

REVISION HISTORY

Revision	Date	Description
—	June 18, 2013	Initial release

Measurement of RF Emissions from a TPMS, Model No. 225816-122 Transmitter

1. INTRODUCTION

1.1. Scope of Tests

This report presents the results of the RF emissions measurements performed on a TPMS, Model No. 225816-122, (hereinafter referred to as the Equipment Under Test (EUT)). Serial Number 4002087 was assigned to the EUT used to perform radiated emissions tests and bandwidth measurements. Serial Number 04001F9F was assigned to the EUT used to perform the duty cycle measurements. The EUT was designed to transmit at approximately 433.92MHz using an internal antenna. The EUT was manufactured and submitted for testing by TRW Automotive Electronics, Inc. located in Farmington Hills, MI.

1.2. Purpose

The test series was performed to determine if the EUT meets the conducted and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.231 for Intentional Radiators.

The test series was also performed to determine if the EUT meets the conducted and radiated RF emission requirements of the Industry Canada Radio Standards Specification, RSS-Gen, Section 7.2.4 and RSS-210 Annex 1, Section A1.1 for transmitters.

Testing was performed in accordance with ANSI C63.4-2009.

1.3. Deviations, Additions and Exclusions

There were no deviations, additions to, or exclusions from the test specification during this test series.

1.4. EMC Laboratory Identification

This series of tests was performed by Elite Electronic Engineering Incorporated of Downers Grove, Illinois. The laboratory is accredited by The American Association for Laboratory Accreditation (A2LA). A2LA Certificate Number: 1786.01.

1.5. Laboratory Conditions

The temperature at the time of the test was 23^{o}C and the relative humidity was 48%.

2. APPLICABLE DOCUMENTS

The following documents of the exact issue designated form part of this document to the extent specified herein:

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15, Subpart C, dated 1 October 2012
- ANSI C63.4-2009, "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"
- Industry Canada Radio Standards Specification, RSS-Gen, “General Requirements and Information for the Certification of Radiocommunication Equipment”, Issue 3, December 2010
- Industry Canada Radio Standards Specification, RSS-210, “Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment”, Issue 8, December 2010

3. EUT SETUP AND OPERATION

3.1. General Description

The EUT is a TRW Automotive Electronics, Inc., TPMS, Model No. 225816-122. A block diagram of the EUT setup is shown as Figure 1.

3.1.1. Power Input

The EUT received 3.0VDC from an internal battery. The TRW TPM Generic Test Box received 12VDC from an external power supply. The TRW TPM Generic Test Box was used to provide 12VDC power to the Low Frequency Initiator.

3.1.2. Peripheral Equipment

The EUT was submitted for testing with a low frequency (LF) initiator. The LF initiator was connected to a TRW TPM Generic Test Box via a 3 wire cable. The K-Line output of the test box was connected to a MOXA CAN Port Powered High Speed RS-232 Mutimode Fiber Optic Converter. The Optical Output was converted back via another MOXA CAN Port Powered High Speed RS-232 Mutimode Fiber Optic Converter. The second MOXA CAN Port Powered High Speed RS-232 Mutimode Fiber Optic Converter was connected to a laptop computer via an RS-232 to USB converter. The Generic Tx tester software was run on the laptop computer. The software was used to place the EUT in the RF carrier enabled mode.

The laptop computer was external to the test chamber for all tests.

3.1.3. Signal Input/Output Leads

The EUT had no signal input/output leads.

3.1.4. Grounding

The EUT was ungrounded during the tests.

3.2. Software

For all tests the EUT used software version 1.0, (ASSY;SENSOR;TPM;CORE_PRESSURE_RBG;450kPa; Mask_Hybrid_HKMC).

3.3. Operational Mode

For all tests the EUT and all peripheral equipment were placed on an 80cm high non-conductive stand. The EUT and all peripheral equipment were energized.

The laptop computer that was connected to the TRW TPM Generic Test Box was used to place the EUT in the RF carrier enabled mode. In the RF carrier enabled mode, the transmitter is set to transmit the RF carrier frequency for 5 minutes upon command from the TPM initiator. The software will enable the user to select and set the transmit signal to unmodulated or modulated with FSK modulation.

3.4. EUT Modifications

No modifications were required for compliance.

4. TEST FACILITY AND TEST INSTRUMENTATION

4.1. Shielded Enclosure

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. With the exception of the floor, the reflective surfaces of the shielded chamber are lined with ferrite tiles on the walls and ceiling. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2009 for site attenuation.

4.2. Test Instrumentation

The test instrumentation and auxiliary equipment used during the tests are listed in Table 9-1. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

Conducted and radiated emission measurements were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths and detector functions specified by the FCC. The receiver bandwidth was 120kHz for the 30MHz to 1000MHz radiated emissions data and 1MHz for the 1000MHz to 5000MHz radiated emissions data.

4.3. Calibration Traceability

Test equipment is maintained and calibrated on a regular basis. All calibrations are traceable to the National Institute of Standards and Technology (NIST).

4.4. Measurement Uncertainty

All measurements are an estimate of their true value. The measurement uncertainty characterizes, with a specified confidence level, the spread of values which may be possible for a given measurement system.

The measurement uncertainty for these tests is presented below:

Conducted Emissions Measurements		
Combined Standard Uncertainty	1.07	-1.07
Expanded Uncertainty (95% confidence)	2.1	-2.1

Radiated Emissions Measurements		
Combined Standard Uncertainty	2.26	-2.18
Expanded Uncertainty (95% confidence)	4.5	-4.4

5. TEST PROCEDURES

5.1. Powerline Conducted Emissions

5.1.1. Requirements

Since the EUT was powered by internal batteries, no conducted emissions tests were required.

5.2. Periodic Operation Measurements

5.2.1. Requirements

Per the requirements of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C, Section 15.231(e) and Industry Canada Radio Standards Specification, RSS-210 Annex 1, Section A1.5, intentional radiators operating at a periodic rate shall be provided with a means for automatically limiting operation so that the duration of each transmission shall be at least 30 times the duration of the transmission but in no case less than 10 seconds. In addition a transmitter activated automatically shall cease transmission within 5 seconds after activation.

5.2.2. Procedures

All information was provided by TRW Automotive Electronics, Inc. personnel.

5.2.3. Results

Page 16 lists the modes of operation for the EUT. The plot of the periodic timing is shown on data page 19.

In the localization mode, the EUT transmits 8 each 7.6msec frames every 12-15 seconds. For this mode, the total transmission time is 60.8msec (8 frames x 7.6msec/frame). Each frame is separated by pseudo random delays. Based on the pseudo random delays, all 8 frames are transmitted within approximately 360msec and 382msec. Therefore the localization mode of the EUT meets the requirements of 15.231(e) for periodic transmissions which states that each transmission shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

In the normal mode, the EUT transmits 8 each 7.6msec frames every 60 seconds. For this mode, the total transmission time is 60.8msec (8 frames x 7.6msec/frame). Each frame is separated by pseudo random delays. Based on the pseudo random delays, all 8 frames are transmitted within approximately 360msec and 382msec. Therefore the normal mode of the EUT meets the requirements of 15.231(e) for periodic transmissions which states that each transmission shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

In the alert mode, the EUT transmits 8 each 7.6msec frames every 4 seconds. For this mode, the total transmission time is 60.8msec (8 frames x 7.6msec/frame). Each frame is separated by pseudo random delays. Based on the pseudo random delays, all 8 frames are transmitted within approximately 360msec and 382msec. In this mode, the periodic transmissions exceed the minimum of 10 seconds required by 15.231(e). However, per 15.231(a)(4), intentional radiators which are employed for control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

When the EUT is activated by the TPM diagnostic tool, the EUT transmits 4 each 7.6msec frames. Each frame is separated by pseudo random delays. Based on the pseudo random delays, all 4 frames are transmitted within approximately 138msec and 150msec. This meets the requirements of 15.231(a)(2) which states that a transmitter activated automatically shall cease transmission within 5 seconds after activation.

5.3. Duty Cycle Factor Measurements

5.3.1.Requirements

Unless otherwise specified, 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 with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification

5.3.2.Procedures

a. The EUT was placed on the non-conductive stand and set to transmit continuously with hopping enabled.
b. A bilog antenna was positioned at a 3 meter distance from the EUT. The output of the antenna was connected to the input of a spectrum analyzer.
c. The center frequency of the spectrum analyzer was set to the transmit frequency of the EUT.
d. The frequency span of the spectrum analyzer was set to 0Hz so that the time domain trace of the transmitted pulse of the EUT was displayed on the spectrum analyzer.
e. The sweep time of the spectrum analyzer was adjusted so that the beginning and end of a single pulse could be seen on the display of the spectrum analyzer.
f. The single sweep function of the spectrum analyzer was used multiple times to determine the maximum pulse width of the EUT.
g. The maximum pulse width display of the spectrum analyzer was recorded and then plotted using a 'screen dump' utility.

h. The sweep time of the spectrum analyzer was then adjusted to 100msec.
i. The single sweep function of the spectrum analyzer was used multiple times to determine the maximum number of transmitted pulses that occurred in a 100msec time period.
j. The maximum number of pulses transmitted in a 100msec time period was recorded and then plotted using a 'screen dump' utility.
k. The duty cycle correction was calculated using the following equation:

Duty Cycle Correction Factor (dB) = D.C. (dB)
D.C. (dB) = 20 x log [((pulse width (msec)) x (#pulses in a 100msecperiod)) / 100msec]

5.3.3.Results

The plots of the duty cycle are shown on data pages 18 and 19. The duty cycle factor was computed to be -16.34dB.

5.4. Radiated Measurements

5.4.1.Requirements

Per the requirements of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C, Section 15.231(e) and Industry Canada Radio Standards Specification, RSS-210 Annex 1, Section A1.1, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

Fundamental Frequency MHz	Field Strength of Fundamental uV/m @ 3 meters	Field Strength of Spurious Emissions uV/m @ 3 meters
260 to 470	1,500 to 5,000*	150 to 500*

* - Linear Interpolation

Spurious emissions shall be attenuated to the average (limits shown in this table) or to the general limits shown in § 15.209, whichever limit permits a higher field strength.

For 433.92MHz, the limit at the fundamental is 4398.7uV/m @ 3m and the limit on the harmonics is 439.9uV/m @ 3m.

In addition, emissions appearing in the Restricted Bands of Operation listed in paragraph 15.205(a) shall not exceed the general requirements shown in paragraph 15.209.

5.4.2.Procedures

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. The walls and ceiling of the shielded chamber are lined with ferrite tiles. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2009 for site attenuation.

The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

A preliminary radiated emissions test was performed to determine the emission characteristics of the EUT. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the EUT. The entire frequency range from 30MHz to 5.0GHz was investigated using a peak detector function. The data was then processed by the computer to calculate equivalent field intensity.

The final emission tests were then manually performed over the frequency range of 30MHz to 5000MHz. Between 30MHz and 1000MHz, a bilog antenna was used as the pick-up device. A broadband double ridged waveguide antenna was used as the pick-up device for all frequencies above 1GHz. All significant broadband

and narrowband signals were measured and recorded. The peak detected levels were converted to average levels using a duty cycle factor which was computed from the pulse train.

To ensure that maximum or worst case, emission levels were measured, the following steps were taken:

1) The EUT was rotated so that all of its sides were exposed to the receiving antenna.
2) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
3) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.
4) For hand-held or body-worn devices, the EUT was rotated through three orthogonal axes to determine which orientation produces the highest emission relative to the limit.

5.4.3.Results

The preliminary plots, with the EUT transmitting at 433.92MHz, are presented on data pages 20 through 23. The plots are presented for a reference only, and are not used to determine compliance.

The final radiated levels, with the EUT transmitting at 433.92MHz, are presented on data page 24. As can be seen from the data, all emissions measured from the EUT were within the specification limits. The emissions level closet to the limit (worst case) occurred at 433.92MHz. The emissions level at this frequency was 15.5dB within the limit. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 2 and Figure 3.

5.5. Occupied Bandwidth Measurements

5.5.1.Requirement

In accordance with paragraph 15.231(c), all emissions within 20dB of the peak amplitude level of the center frequency are required to be within a band less than 0.25% of the center frequency wide.

5.5.2.Procedures

The EUT was placed on an 80cm high non-conductive stand. The unit was set to transmit continuously. With an antenna positioned nearby, occupied bandwidth emissions were displayed on the spectrum analyzer. The resolution bandwidth was set to 30 kHz and span was set to 2 MHz. The frequency spectrum near the fundamental was plotted.

5.5.3.Results

The plot of the emissions near the fundamental frequency is presented on data page 25. As can be seen from this data page, the transmitter met the occupied bandwidth requirements. The 99% bandwidth was measured to be 127.3kHz.

6. OTHER TEST CONDITIONS

6.1. Test Personnel and Witnesses

All tests were performed by qualified personnel from Elite Electronic Engineering Incorporated.

6.2. Disposition of the EUT

The EUT and all associated equipment were returned to TRW Automotive Electronics, Inc. upon completion of the tests.

7. CONCLUSIONS

It was determined that the TRW Automotive Electronics, Inc. TPMS, Model No. 225816-122, Serial No. S/N 1, *did/did not fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.205 et seq. for Intentional Radiators, when tested per

ANSI C63.4-2009.

8. CERTIFICATION

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specifications.

The data presented in this test report pertains to the EUT at the test date. Any electrical or mechanical modification made to the EUT subsequent to the specified test date will serve to invalidate the data and void this certification.

This report must not be used to claim product endorsement by NVLAP or any agency of the US Government.

9. EQUIPMENT LIST

Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
NTA3	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	2/15/2013	2/15/2014
NWQ1	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS-LINDGREN	3117	66655	1GHZ-18GHZ	3/18/2013	3/18/2014
RBA0	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB26	100145	20HZ-26.5GHZ	3/12/2013	3/12/2014

I/O: Initial Only
N/A: Not Applicable
Note 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

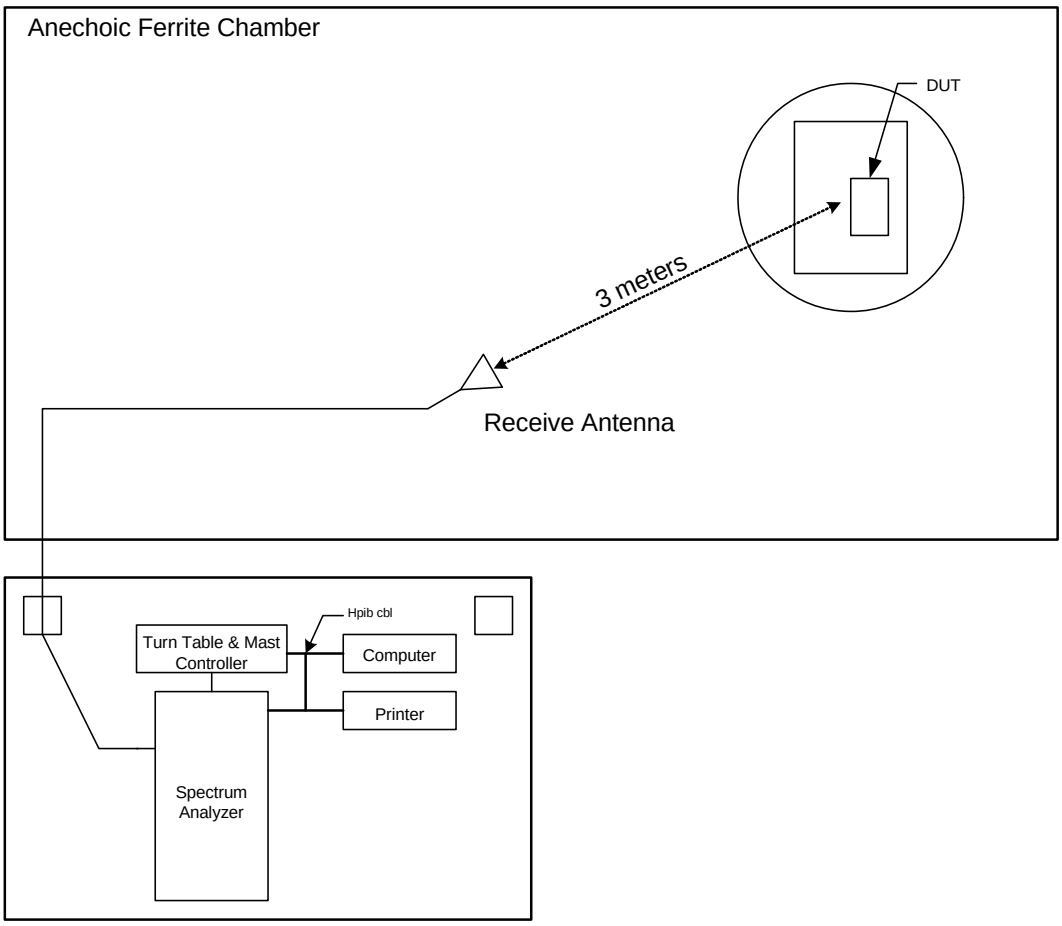
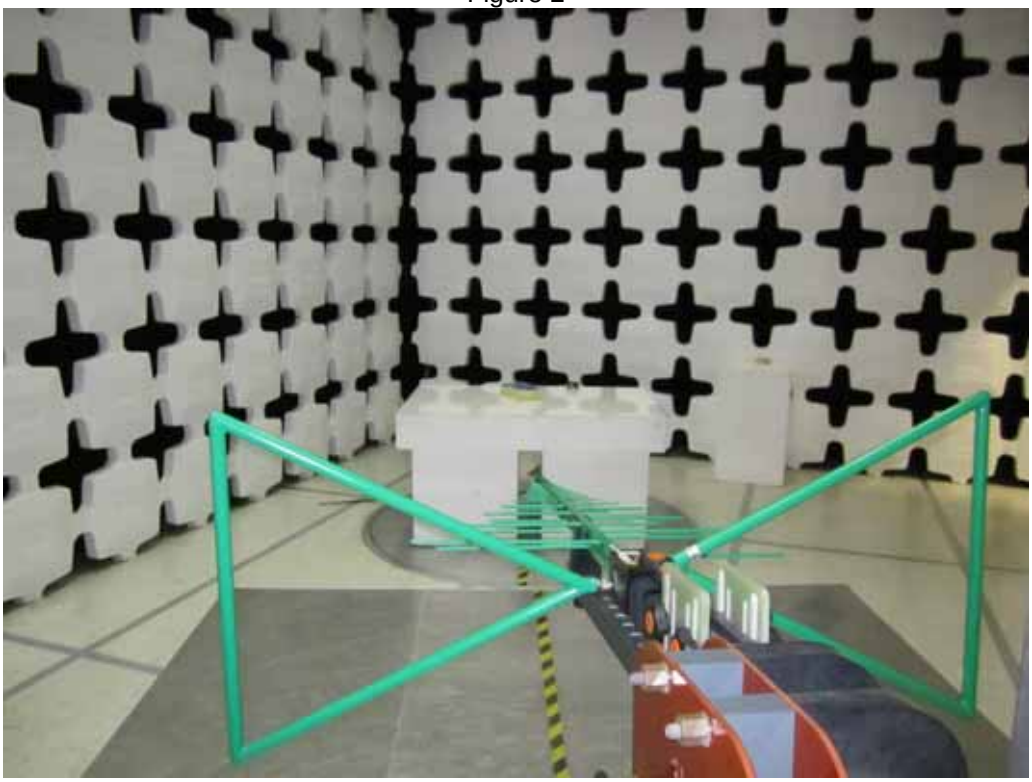
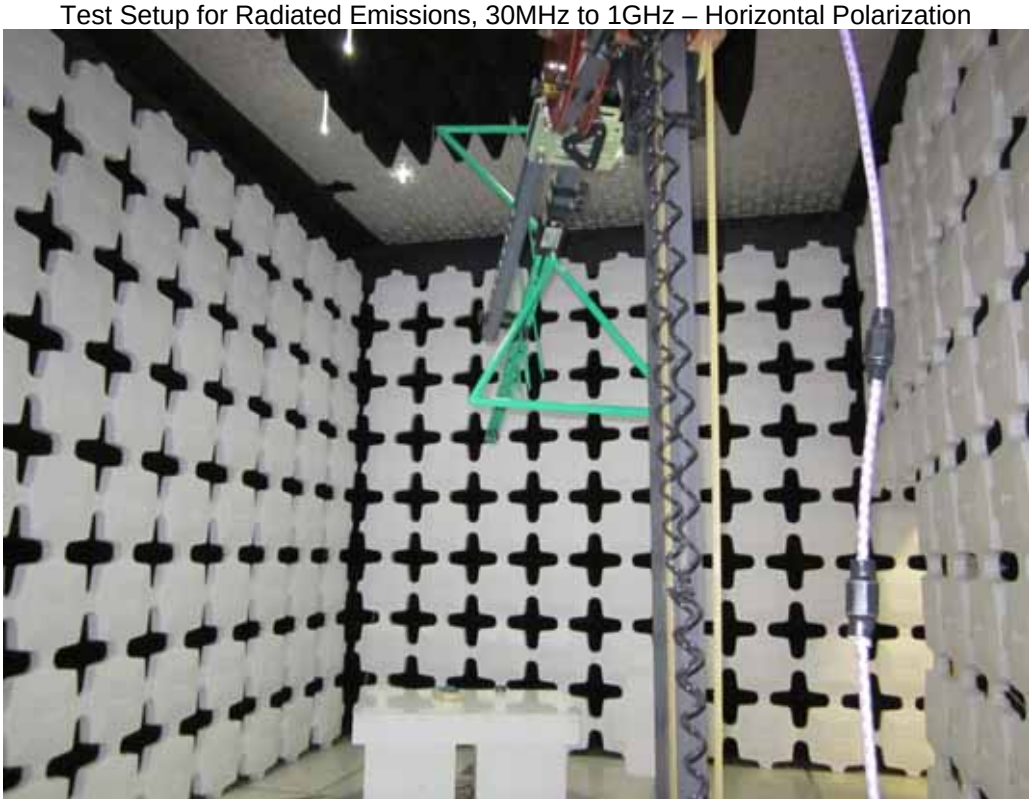


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

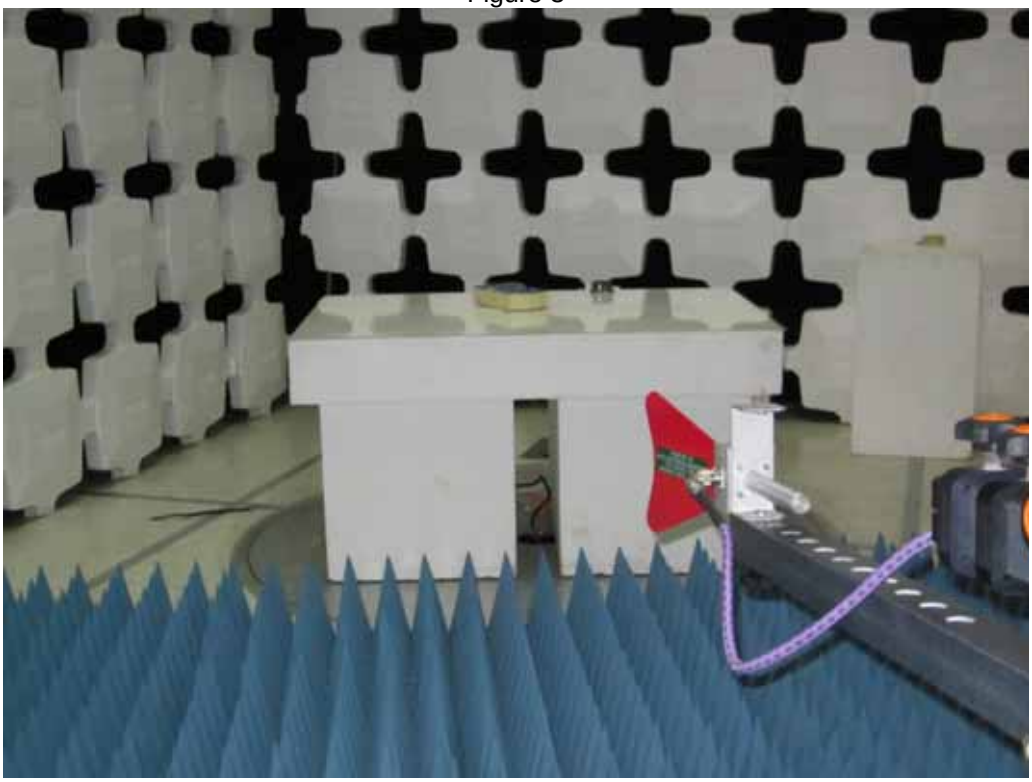


Test Setup for Radiated Emissions, 30MHz to 1GHz – Horizontal Polarization

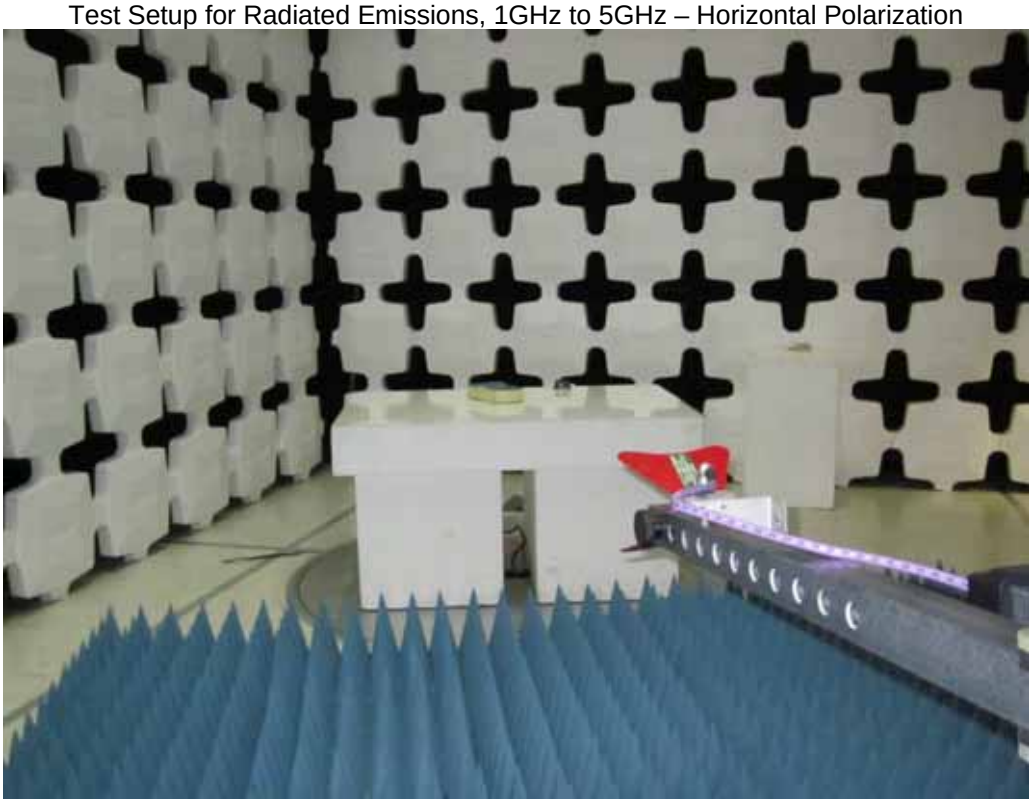


Test Setup for Radiated Emissions, 30MHz to 1GHz – Vertical Polarization

Figure 3

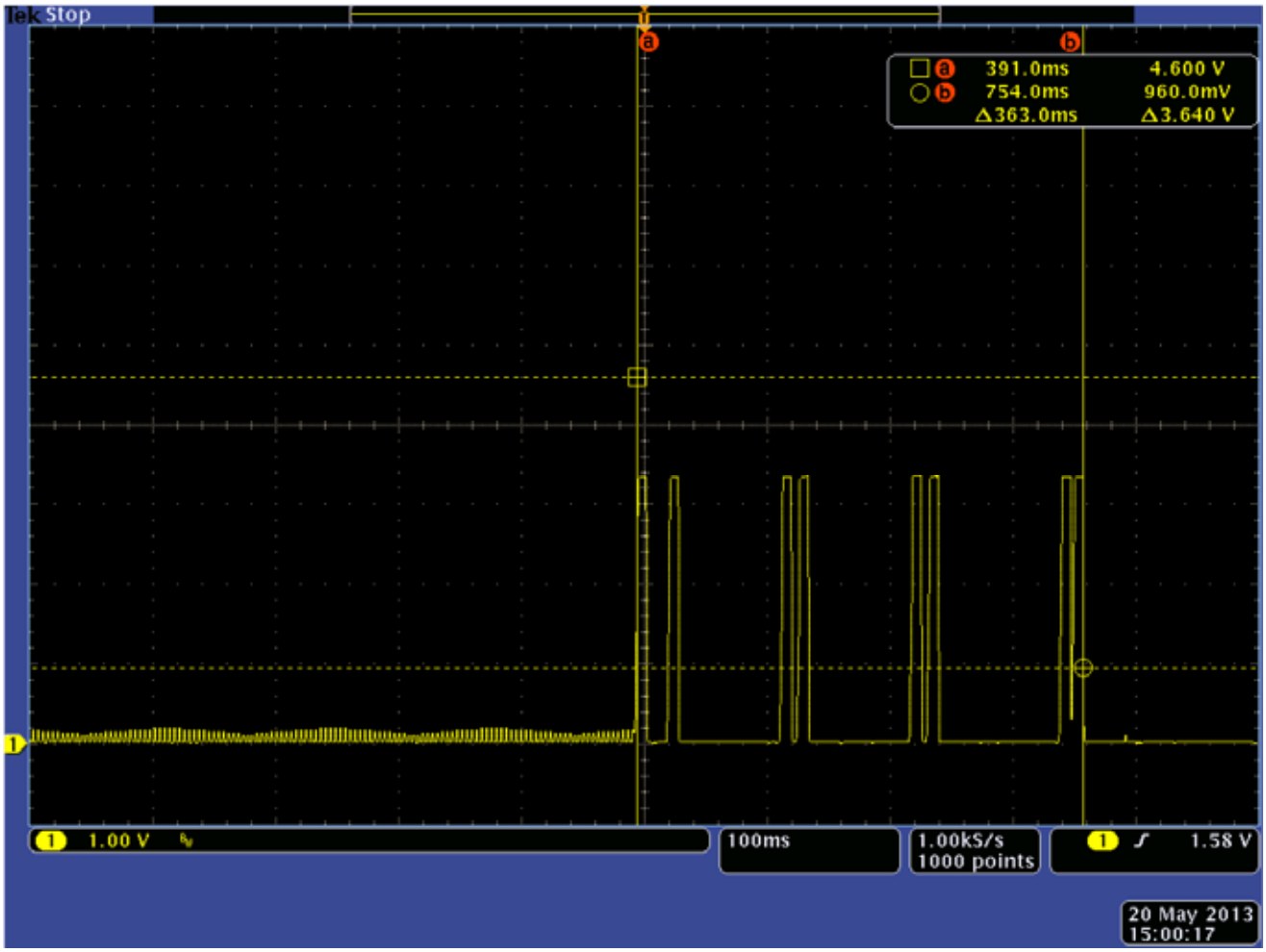


Test Setup for Radiated Emissions, 1GHz to 5GHz – Horizontal Polarization



Test Setup for Radiated Emissions, 1GHz to 5GHz – Vertical Polarization

Mode of Operation	Explanation	Frequency of Transmission
Storage Mode	No transmission. Measures temperature & pressure.	4 words when activation occurs with TPM diagnostic tool
Sleep State	Measures temperature, pressure, and motion. Enters this mode/state when: 1. Pressure goes above pressure threshold in Storage Mode or 2. No motion is detected for 15 minutes in Normal Mode/Rest State.	4 words when activation occurs with TPM diagnostic tool
Localization	Measures temperature, pressure, and motion. Transmits periodically. Enters this state when motion is detected in Sleep State.	• 8 Local Z words every 12-16 seconds • 4 words when activation occurs with TPM diagnostic tool
Normal State	Measures temperature, pressure, & motion. Transmits periodically. Enters this state when: 1. Localization is complete or	• 8 pressure/temperature words every 60 seconds • 4 words when activation occurs with TPM diagnostic tool
Rest State	Measures temperature, pressure, & motion. Enters this state after no motion is detected in Normal Mode/Normal State.	4 words when activation occurs with TPM diagnostic tool
Alert Mode	Transmits periodically. Enters this mode when: 1. Significant pressure delta detected	• 8 pressure/temperature words every 4 seconds for 1 minute • 4 words when activation occurs with TPM diagnostic tool



TPM Sensor enters Local Z mode (1 timed TX @, 8 packets per transmission)
Timed messages ~ every 12.5 seconds

CALCULATION

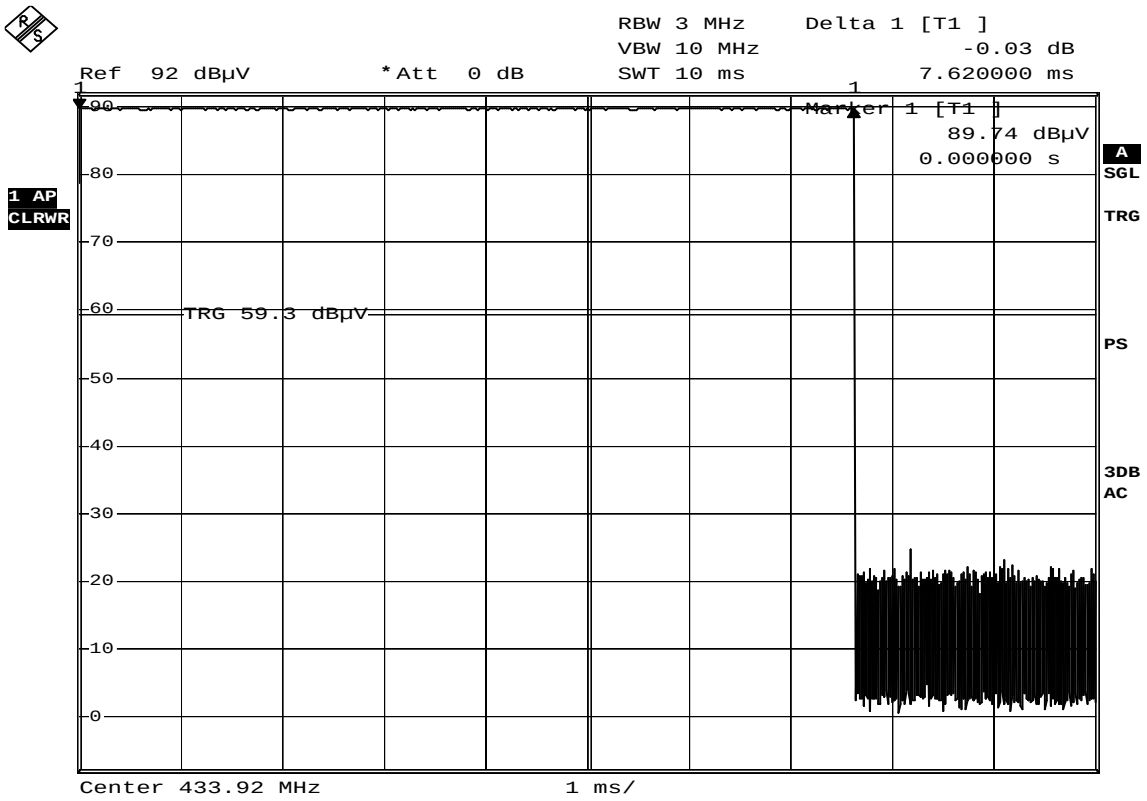
Per Title 47: Telecommunication Part 15 – Radio Frequency Devices Subpart C – Intentional Radiators

15.231 Periodic Operation in the band 40.66-40.70 MHz and above 70 MHz

1 Linear Interpolation

In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that 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.

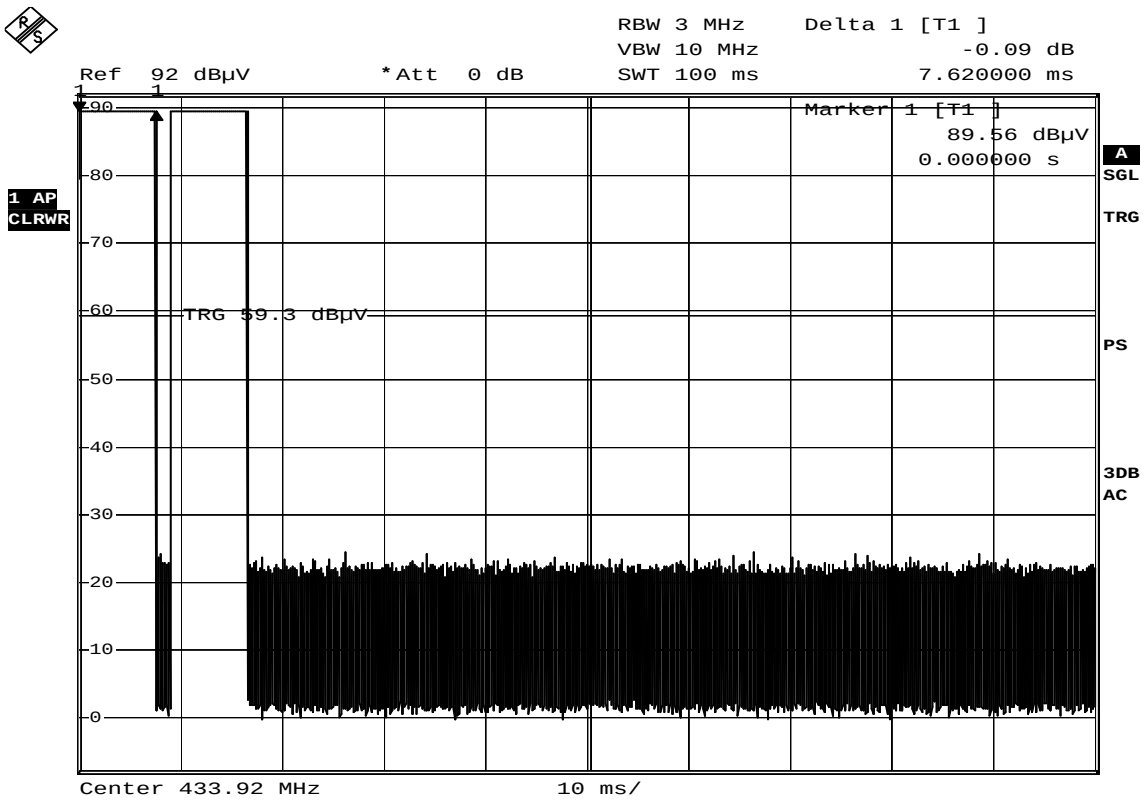
30 X 0.363sec = 10.89 sec.
Average Delay time is 12.596 sec.



Date: 30.MAY.2013 07:57:20

Duty Cycle

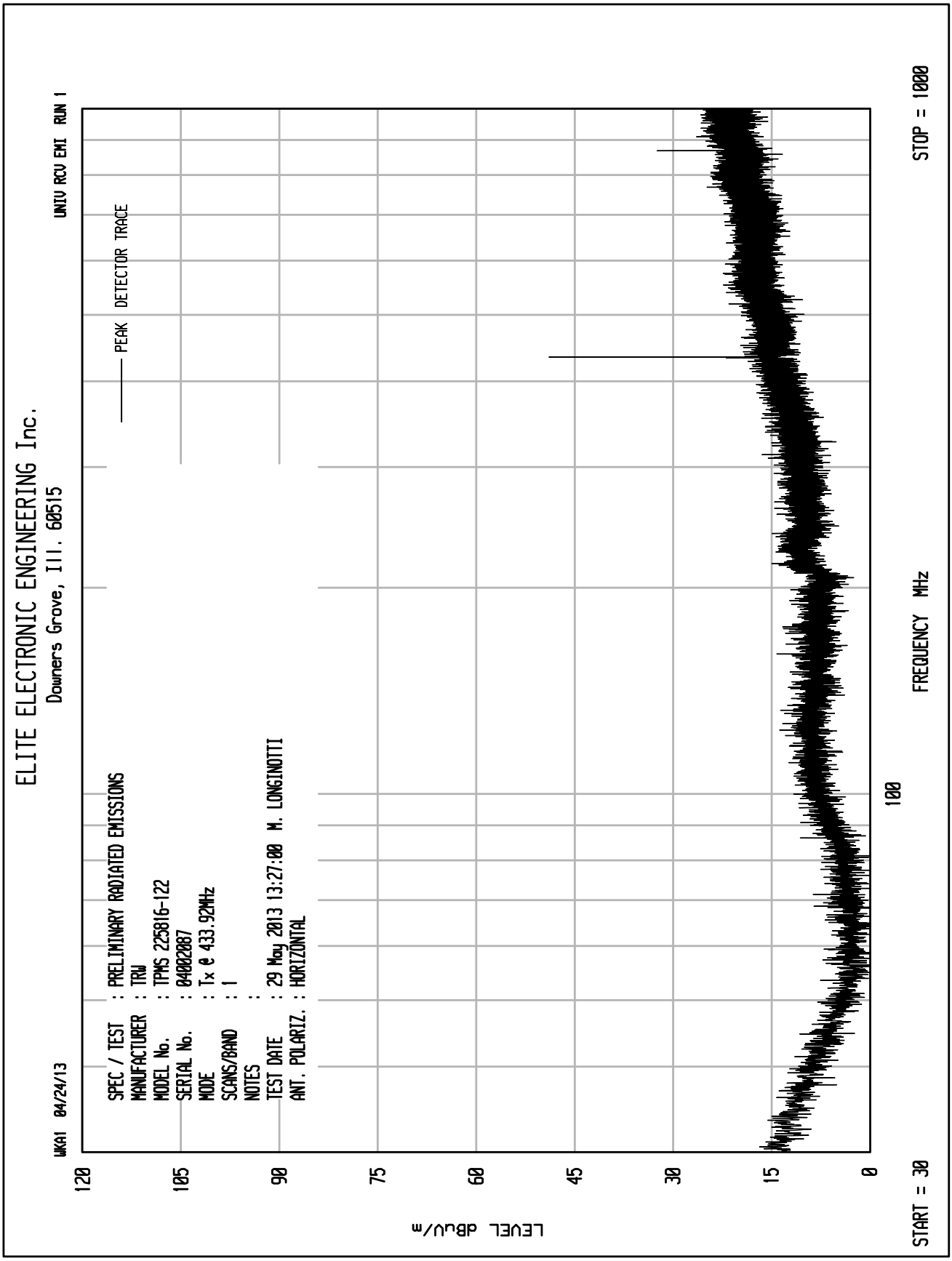
MANUFACTURER	: TRW
MODEL NUMBER	: TPMS
PART NUMBER	: 225816-122
SERIAL NUMBER	: 04001F9F
TEST MODE	: Tx @ 433.92MHz
TEST DATE	: May 29, 2013
TEST PARAMETERS	: Pulse width is 7.62msec
EQUIPMENT USED	: RBC0, PHA0

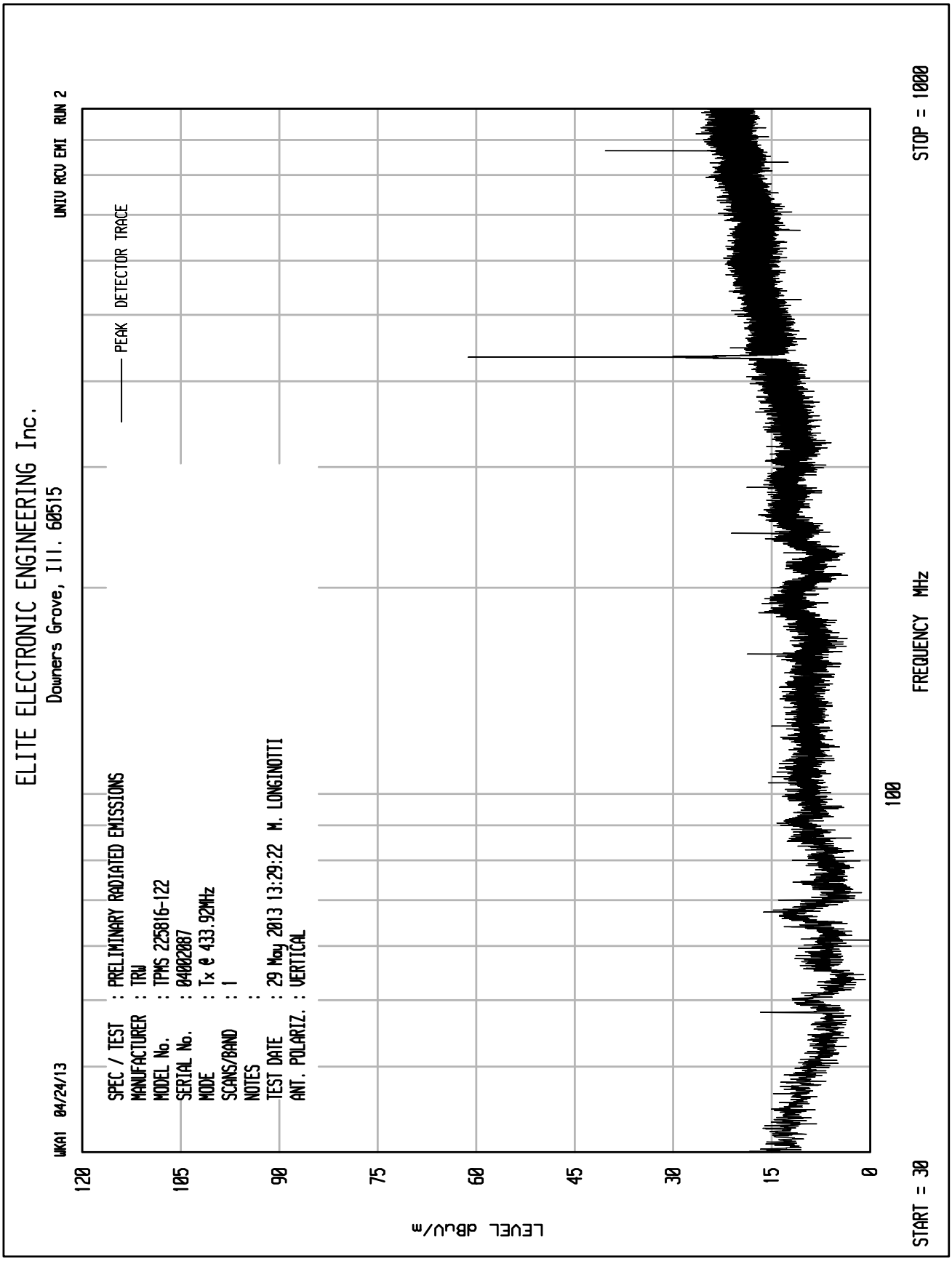


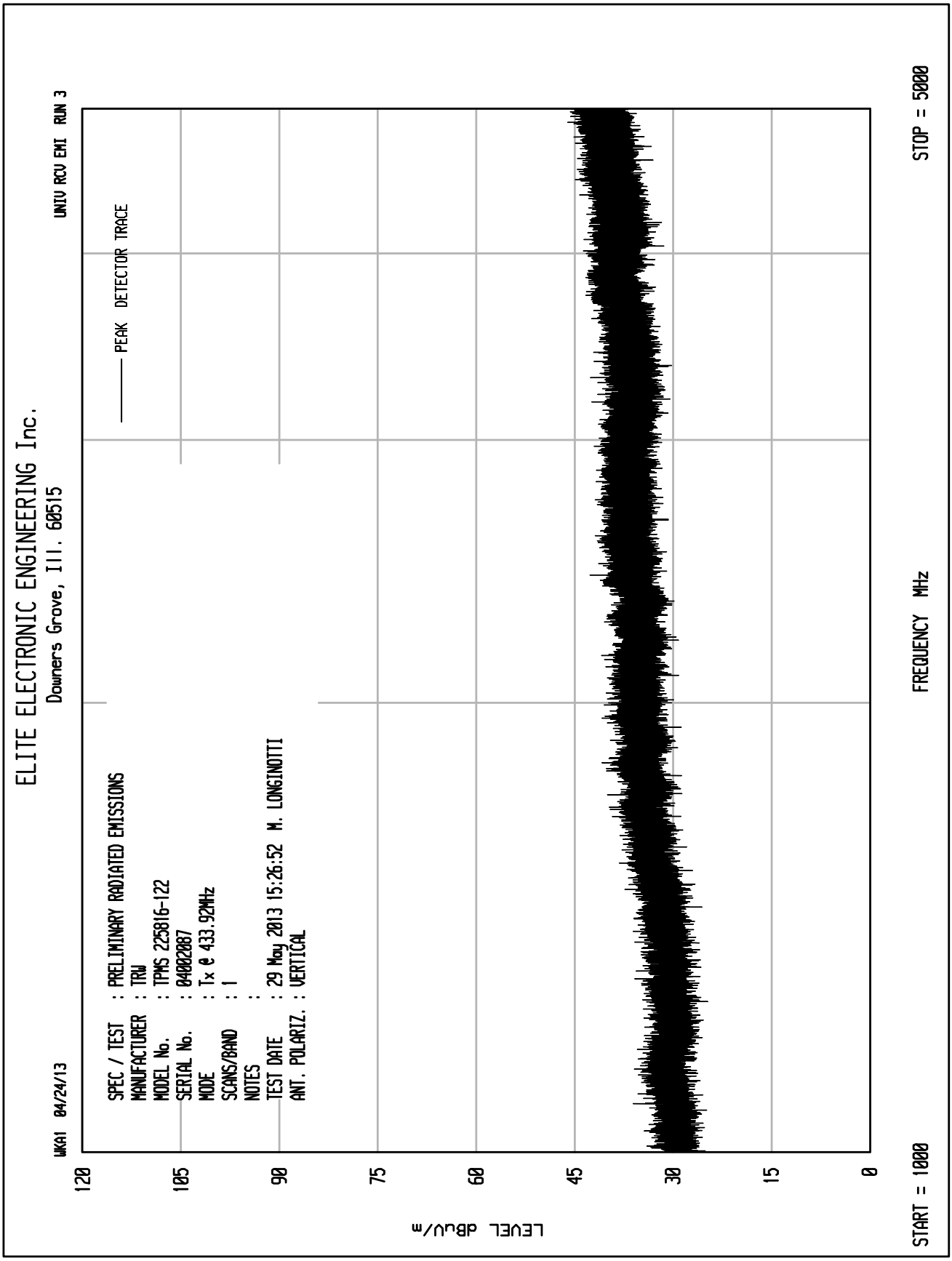
Date: 30.MAY.2013 07:59:07

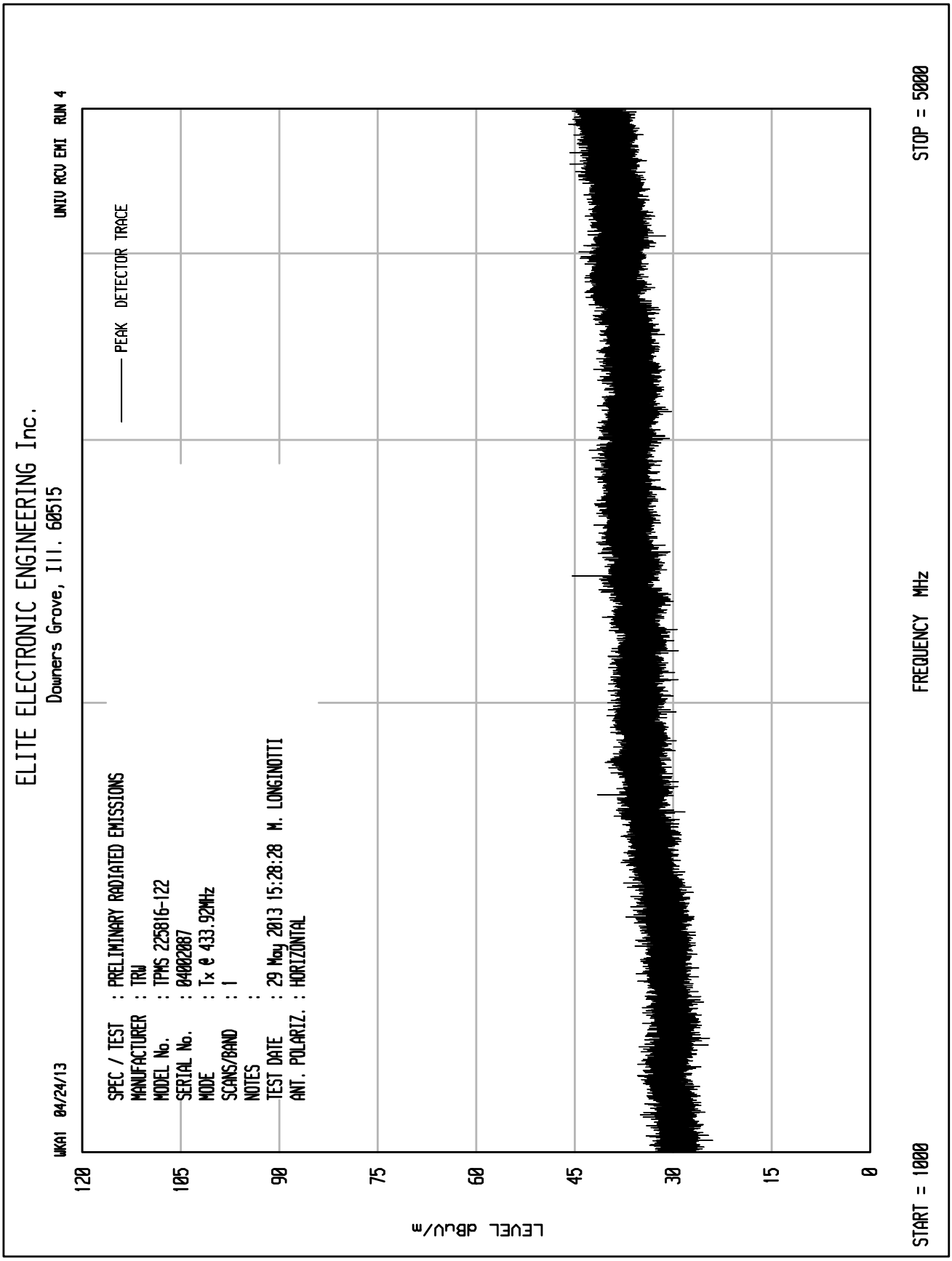
Duty Cycle

MANUFACTURER	:	TRW
MODEL NUMBER	:	TPMS
PART NUMBER	:	225816-122
SERIAL NUMBER	:	04001F9F
TEST MODE	:	Tx @ 433.92MHz
TEST DATE	:	May 29, 2013
TEST PARAMETERS	:	Pulse width is 7.62msec, 2 pulses in 100msec period
	:	Duty Cycle = 20 x log (on time/100msec)
	:	Duty Cycle = 20 x log (7.62msec/pulse x 2 pulses/ 100m sec)
	:	Duty Cycle = 20 x log (.1524)
	:	Duty Cycle = -16.34dB
EQUIPMENT USED	:	RBC0, NTA3


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 1
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : TRW
MODEL No. : TPMS 225816-122
SERIAL No. : 04002087
MODE : Tx @ 433.92MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 29 May 2013 13:27:00 M. LONGINOTTI
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : TRW
MODEL No. : TPMS 225816-122
SERIAL No. : 04002087
MODE : Tx @ 433.92MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 29 May 2013 13:29:22 M. LONGINOTTI
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 30
100
FREQUENCY MHz
STOP = 1000

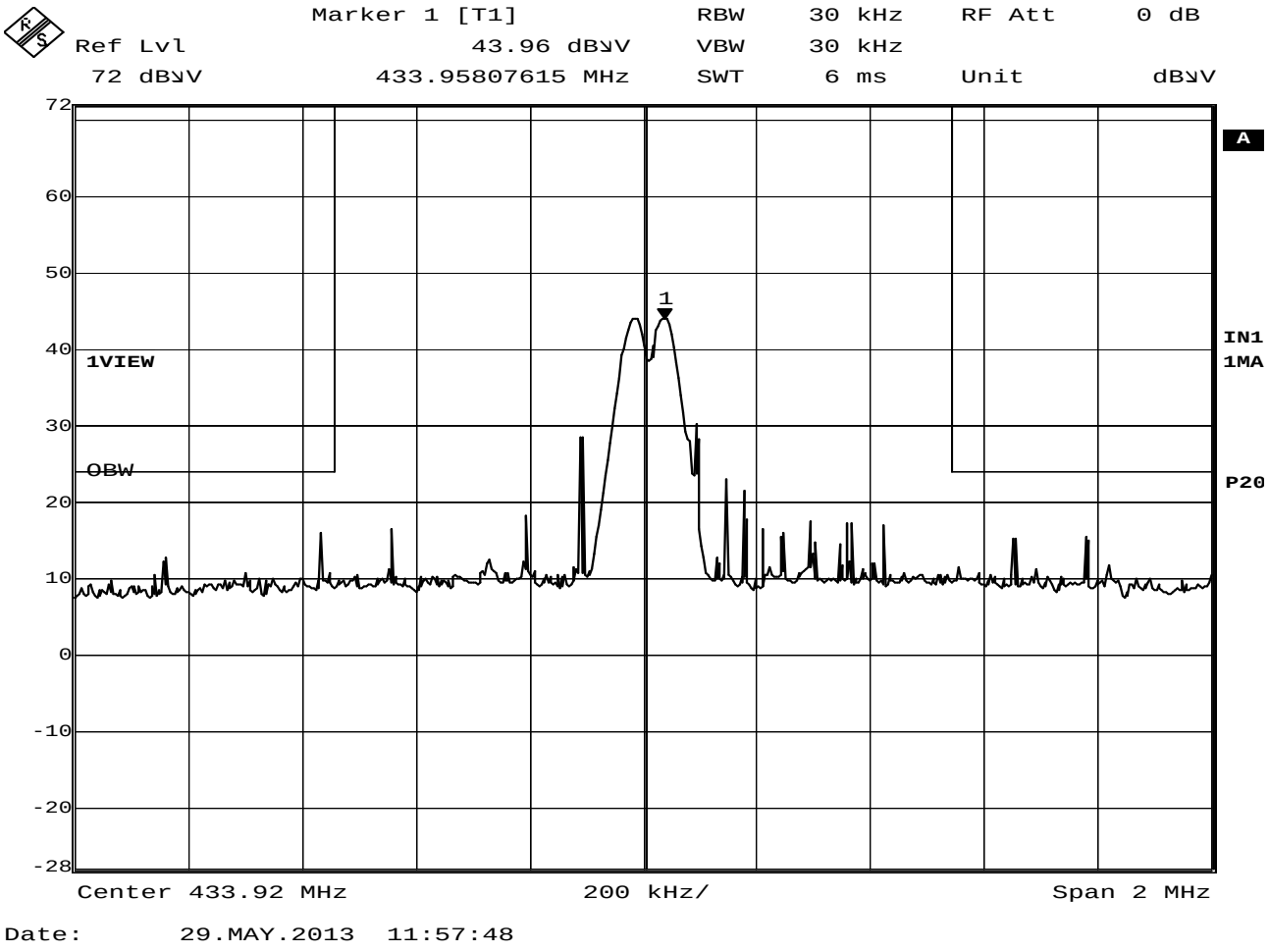

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 3
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : TRW
MODEL No. : TPMS 225816-122
SERIAL No. : 04002087
MODE : Tx @ 433.92MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 29 May 2013 15:26:52 M. LONGINOTTI
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 5000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 4
WKA1 04/24/13
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : TRW
MODEL No. : TPMS 225816-122
SERIAL No. : 04002087
MODE : Tx @ 433.92MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 29 May 2013 15:28:28 M. LONGINOTTI
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 5000

MANUFACTURER : TRW Automotive Electronics, Inc.
EUT : TPMS Transmitter
MODEL NUMBER : 225816-122
SERIAL NUMBER : 4002087
TEST MODE : Transmit at 433.92MHz
TEST DATE : May 29, 2013
TEST PARAMETERS : FCC CFR Title 47 Part 15, Subpart C, Section 15.231(e)
: Industry Canada RSS-210 Annex 1, Section A1.1, Table B, Spurious Radiated
: Emissions
TEST EQUIPMENT : RBA0, NTA3, NWQ1
NOTES : Average Detector

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Total (dBuV/m)	Total (uV/m)	Limit (uV/m)	Margin (dB)
433.920	H	55.8		1.4	16.5	0.0	-16.3	57.4	737.9	4398.7	-15.5
433.920	V	41.2		1.4	16.5	0.0	-16.3	42.8	137.4	4398.7	-30.1
867.840	H	13.2		2.0	19.9	0.0	-16.3	18.8	8.7	439.9	-34.1
867.840	V	22.9		2.0	19.9	0.0	-16.3	28.5	26.5	439.9	-24.4
1301.760	H	15.6	Ambient	2.5	28.6	0.0	-16.3	30.3	32.9	500.0	-23.6
1301.760	V	16.4	Ambient	2.5	28.6	0.0	-16.3	31.1	36.0	500.0	-22.8
1735.680	H	16.8	Ambient	2.9	30.3	0.0	-16.3	33.7	48.2	500.0	-20.3
1735.680	V	17.1	Ambient	2.9	30.3	0.0	-16.3	34.0	49.9	500.0	-20.0
2169.600	H	16.7	Ambient	3.2	31.5	0.0	-16.3	35.1	57.1	500.0	-18.8
2169.600	V	17.2	Ambient	3.2	31.5	0.0	-16.3	35.6	60.5	500.0	-18.3
2603.520	H	16.8	Ambient	3.6	32.5	0.0	-16.3	36.5	67.1	500.0	-17.4
2603.520	V	17.1	Ambient	3.6	32.5	0.0	-16.3	36.8	69.5	500.0	-17.1
3037.440	H	16.8	Ambient	3.9	32.8	0.0	-16.3	37.1	72.0	500.0	-16.8
3037.440	V	16.3	Ambient	3.9	32.8	0.0	-16.3	36.6	67.9	500.0	-17.3
3471.360	H	16.2	Ambient	4.2	33.0	0.0	-16.3	37.1	71.4	500.0	-16.9
3471.360	V	15.5	Ambient	4.2	33.0	0.0	-16.3	36.4	65.9	500.0	-17.6
3905.280	H	16.8	Ambient	4.4	33.6	0.0	-16.3	38.4	83.5	500.0	-15.5
3905.280	V	17.1	Ambient	4.4	33.6	0.0	-16.3	38.7	86.4	500.0	-15.2
4339.200	H	16.7	Ambient	4.6	34.3	0.0	-16.3	39.3	92.6	500.0	-14.6
4339.200	V	17.0	Ambient	4.6	34.3	0.0	-16.3	39.6	95.8	500.0	-14.3

Total (dBuV/m) = Meter Reading (dBuV) + Cable Factor (dB) + Antenna Factor (dB) + Duty Cycle (dB)



15.231(c) Occupied Bandwidth

MANUFACTURER	:	TRW
MODEL NUMBER	:	TPMS
PART NUMBER	:	225816-122
SERIAL NUMBER	:	04002087
TEST MODE	:	Tx @ 433.92MHz
TEST DATE	:	May 29, 2013
TEST PARAMETERS	:	The display lines represent the 0.25% of the center frequency and the 20dB down level from the peak of the modulated carrier.
EQUIPMENT USED	:	RBA0, NTA3