



Measurement of RF Emissions from a Model 8-73737A-6 Transmitter

For Snap On Tools
2801 80th Street
Kenosha, WI 53143

P.O. Number 130-1YC002125
Date Tested July 10 through 24, 2014
Test Personnel Dan Crowder
Test Specification FCC "Code of Federal Regulations" Title 47
Part15, Subpart C
Industry Canada RSS-GEN
Industry Canada RSS-210

Test Report By:

A handwritten signature in black ink, appearing to read "Dan Crowder".

Dan Crowder

Requested By:

Matthew Crass
Snap On Tools

Approved By:

A handwritten signature in black ink, appearing to read "Raymond J. Klouda".

Raymond J. Klouda
Registered Professional
Engineer of Illinois - 44894



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REVISION HISTORY

Revision	Date	Description
—	29 July 2014	Initial release

Measurement of RF Emissions from a Model 8-73737A-6 Transmitter

1. INTRODUCTION

1.1. Scope of Tests

This report presents the results of the RF emissions measurements performed on a Model 8-73737A-6 transmitter, (hereinafter referred to as the Equipment Under Test (EUT)). No serial number was assigned to the EUT. The EUT was designed to transmit at approximately 434MHz using an Integral antenna. The EUT was manufactured and submitted for testing by Snap On Tools located in Kenosha, WI.

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 15.231 and IC Radio Standards Specification RSS-210 and RSS-GEN. 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°C and the relative humidity was 41%.

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 2013
- 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 Licence-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 Snap On Tools, 8-73737A-6 transmitter. A block diagram of the EUT setup is shown as Figure 1.



3.1.1.Power Input

The EUT was powered by internal batteries.

3.1.2.Peripheral Equipment

The EUT does not have any ports for peripheral equipment.

3.1.3.Signal Input/Output Leads

The EUT does not have any ports for I/O leads.

3.1.4.Grounding

The EUT was ungrounded during the tests.

3.2. Software

For all tests the EUT had Firmware Version SPTP10NS loaded onto the device to provide correct load characteristics.

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.

3.4. EUT Modifications

No modifications were required for compliance to the requirements.

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.

Conducted and radiated emission measurements were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths and detector functions specified in the requirements. 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	1.06	-1.06



Expanded Uncertainty (95% confidence)	2.12	-2.12
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Radiated Emissions Measurements		
Combined Standard Uncertainty	2.09	-2.09
Expanded Uncertainty (95% confidence)	4.19	-4.19

5. TEST PROCEDURES

5.1. Powerline Conducted Emissions

5.1.1. Requirements

Since the EUT was powered by internal batteries and does not connect to AC power, the conducted emissions tests are not required.

5.2. Periodic Operation Measurements

5.2.1. Requirements

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released. Also, a transmitter activated automatically shall cease transmission within 5 seconds after activation.

5.2.2. Procedures

The spectrum analyzer was setup to display the time domain trace. The EUT was set to transmit normally. The spectrum analyzer was used to record the amount of time that the EUT remained active following activation.

5.2.3. Results

The plot of the periodic timing is shown on page 17. The data shows that the EUT ceases operation within the allotted time.

5.3. Duty Cycle Factor Measurements

5.3.1. Procedures

The duty cycle factor is used to convert peak detected readings to average readings. This factor is computed from the time domain trace of the pulse modulation signal.

With the transmitter set up to transmit for maximum pulse density, the time domain trace is displayed on the spectrum analyzer. This trace is obtained by tuning center frequency to the transmitter frequency and then setting a zero span width with 10msec/div. The amplitude settings are adjusted so that the on/off transitions clear the 4th division from the bottom of the display. The markers are set at the beginning and end of a word period. If the word period exceeds 100 msec the word period is set to 100 msec. The on-time and off-time are then measured. The on-time is total time signal level exceeds the 4th division. Off-time is time under for the word period. The duty cycle is then computed as the $(\text{On-time} / \text{word period})$ where the word period = $(\text{On-time} + \text{Off-time})$.

The duty cycle factor was calculated from information supplied by the manufacturer. Since this EUT utilizes a Manchester encoded modulation, the duty is calculated based on the worst case. The following procedure was used to measure a representative sample:

- a) With the transmitter set up to transmit for maximum pulse density, the time domain trace is displayed

on the spectrum analyzer.

- b) This trace is obtained by tuning center frequency to the transmitter frequency and then setting a zero span width with 10msec/div.
- c) The amplitude settings are adjusted so that the on/off transitions clear the 4th division from the bottom of the display. The markers are set at the beginning and end of a word period. If the word period exceeds 100 msec the word period is set to 100 msec.
- d) The on-time and off-time are then measured. The on-time is total time signal level exceeds the 4th division. Off-time is time under for the word period.
- e) The duty cycle is then computed as the (On-time/ word period) where the word period = (On-time + Off-time).
- f) The duty cycle factor is computed from the duty cycle

5.3.2.Results

The plot of the duty cycle is shown on pages 18 and 19. The duty cycle factor was computed to be -6.0 dB.

5.4. Radiated Measurements

5.4.1.Requirements

The EUT must comply with the requirements of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C, Section 15.205 et seq.

Paragraph 15.231(b) has the following radiated emission limits:

Fundamental Frequency MHz	Field Intensity uV/m @ 3 meters	Field Strength Harmonics and Spurious @ 3 meters
260 to 470	3,750 to 12,500*	375 to 1,250*

* - Linear Interpolation

For 434MHz, the limit at the fundamental is 10995.8uV/m @ 3m and the limit on the harmonics is 1099.5uV/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 open field emission tests were then manually performed over the frequency range of 30MHz to 5000MHz. Between 30MHz and 1000MHz, a broadband hybrid 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) In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer and the antenna cannot be raised to 4 meters. The measuring antenna is raised or lowered as much as the cable will allow and the EUT is rotated through all axes to ensure the maximum readings are recorded. See attached Figure.

5.4.3.Results

The preliminary plots, with the EUT transmitting at 434MHz, are presented on pages 20 through 23. The plots are presented for a reference only, and are not used to determine compliance.

The final open area radiated levels, with the EUT transmitting at 434MHz, are presented on page 24. As can be seen from the data, all emissions measured from the EUT were within the specification limits. Photographs of the test configuration which yielded the highest or worst case, radiated emission levels are shown on Figures 3 and 4.

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. The 99% bandwidth was measured to be 541kHz.

5.5.3.Results

The plot of the emissions near the fundamental frequency is presented on page 25. As can be seen from this data page, the transmitter met the occupied bandwidth requirements.

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 Snap On Tools upon completion of the tests.

7. CONCLUSIONS

It was determined that the Snap On Tools Transmitter, Model No. 8-72737A-6, Serial No. None Assigned, did



fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, and the IC Radio Standards Specification RSS-210 and RSS-GEN.

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 certification, approval, or endorsement by NVLAP, NIST or any agency of the Federal Government.



9. EQUIPMENT LIST

Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
CDX8	COMPUTER	ELITE	WORKSTATION			N/A	
NTA3	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	2/19/2014	2/19/2015
NWQ1	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS-LINDGREN	3117	66655	1GHZ-18GHZ	3/11/2014	3/11/2015
RBA0	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB26	100145	20HZ-26.5GHZ	3/7/2014	3/7/2015

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.

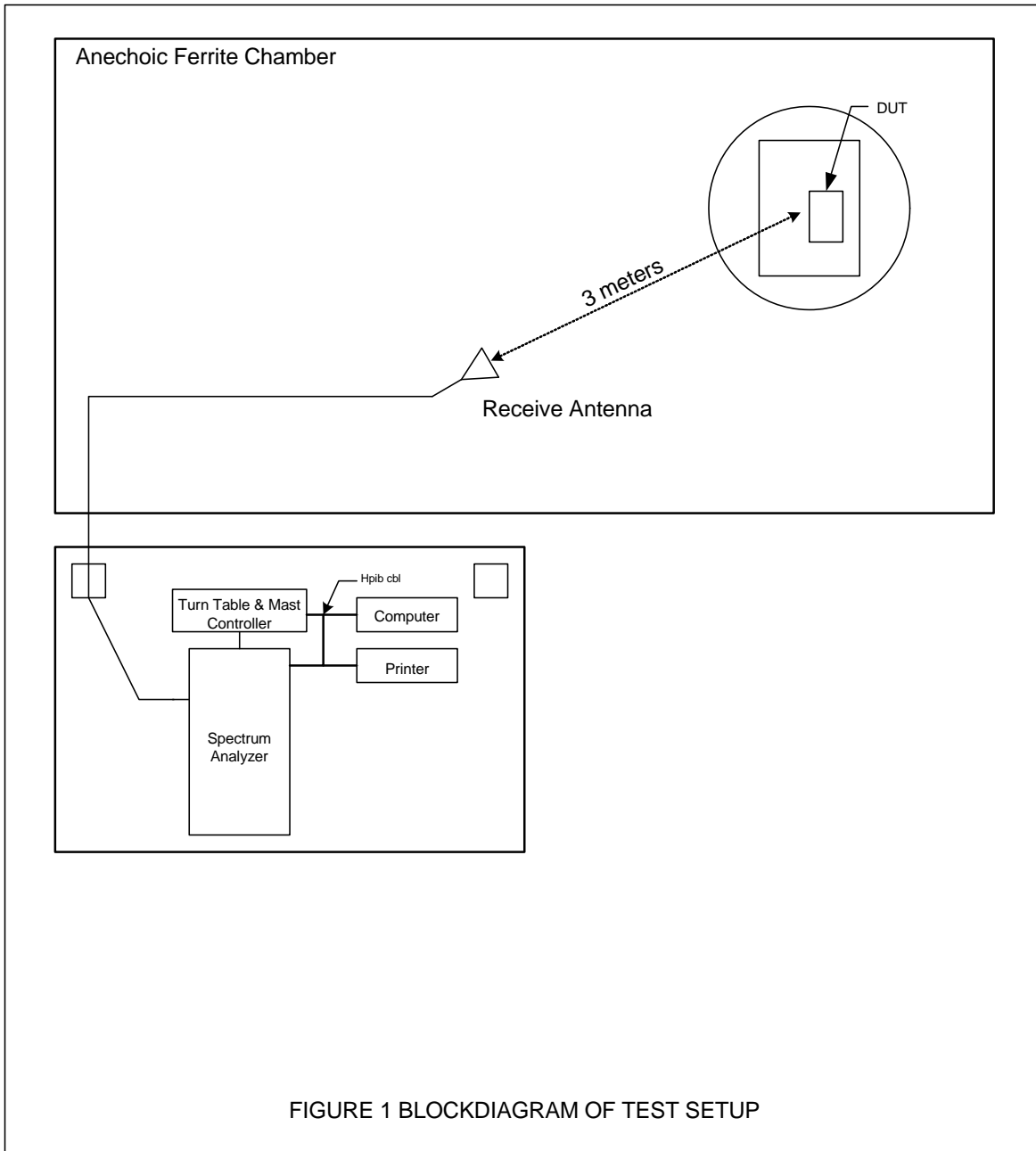


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

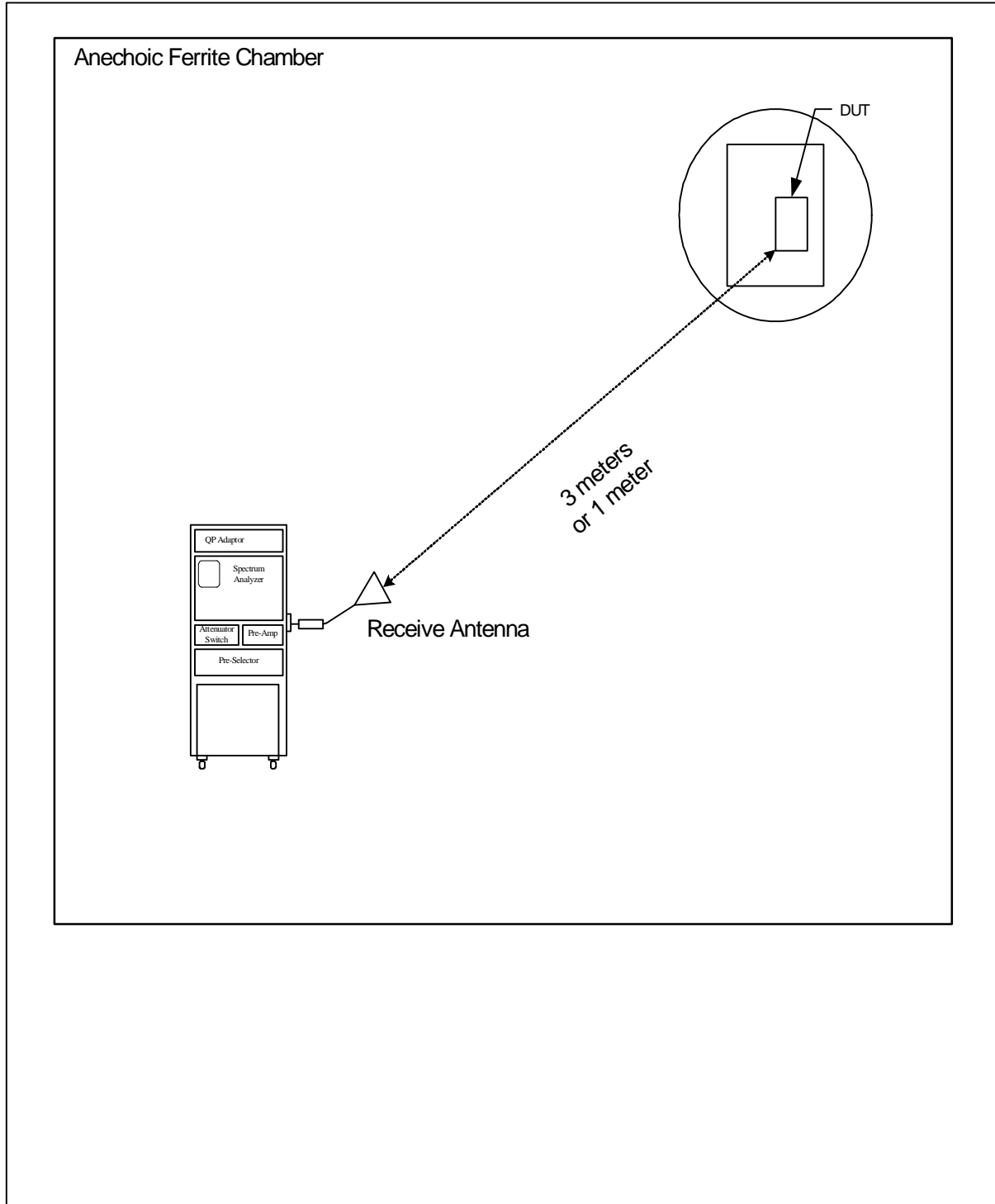
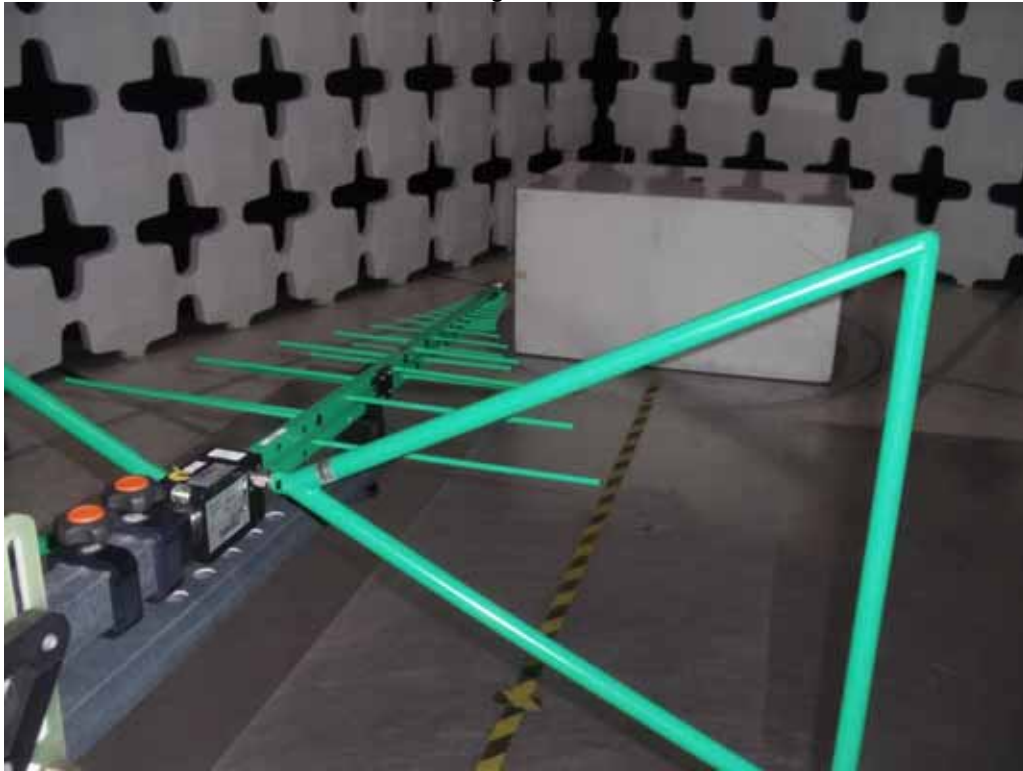


Figure 2

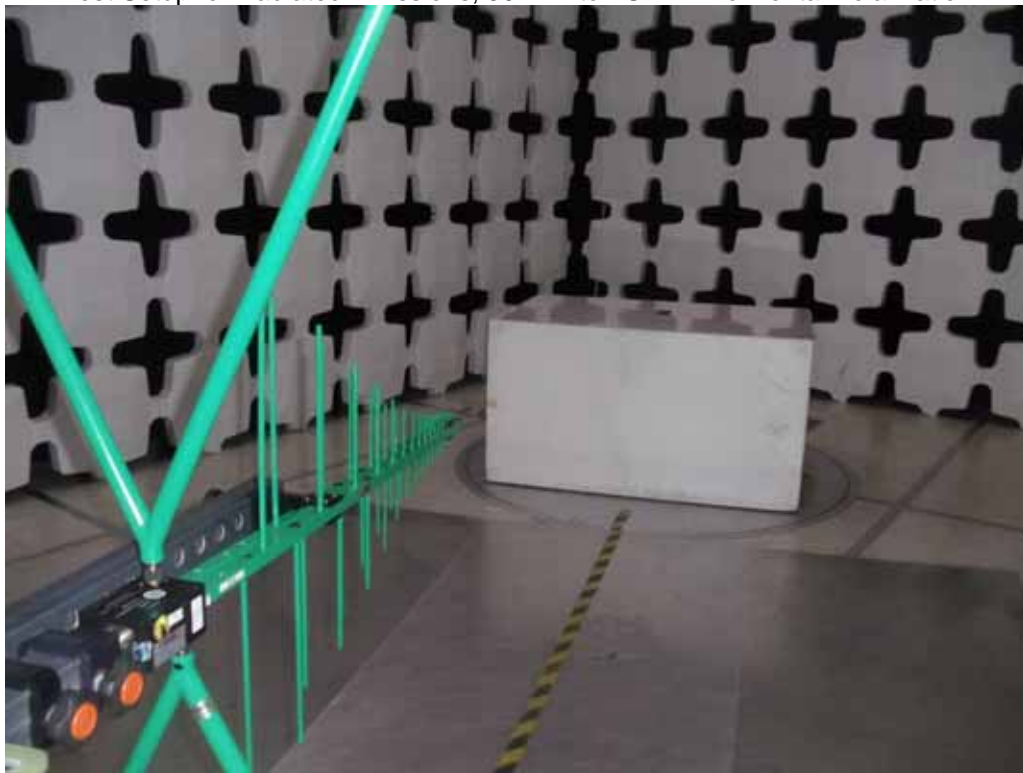


Test Setup

Figure 3



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



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

Figure 4



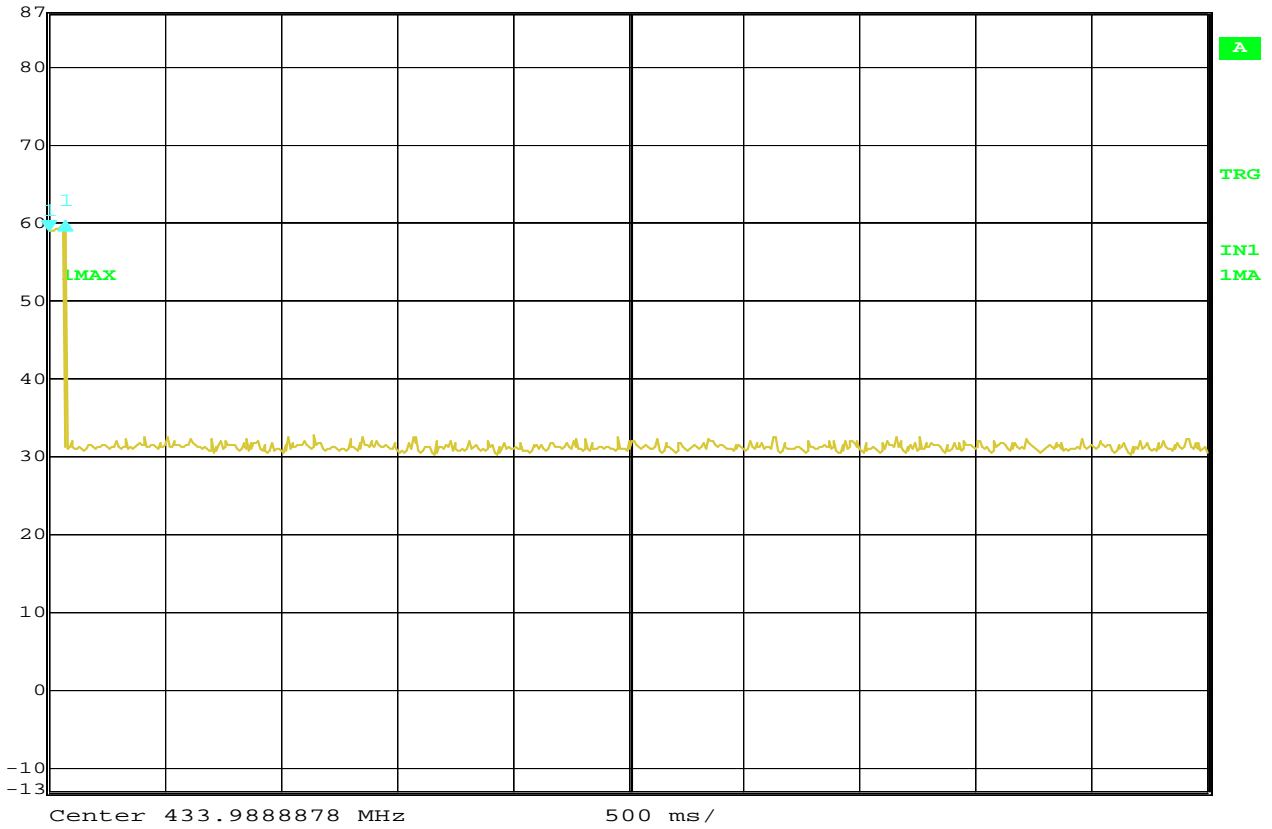
Test Setup for Radiated Emissions, 1GHz to 5GHz – Horizontal Polarization



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



	Delta 1 [T1]	RBW	1 MHz	RF Att	10 dB
Ref Lvl	1.10 dB	VBW	1 MHz		
87 dBμV	70.140281 ms	SWT	5 s	Unit	dBμV



Date: 24.JUL.2014 13:20:28

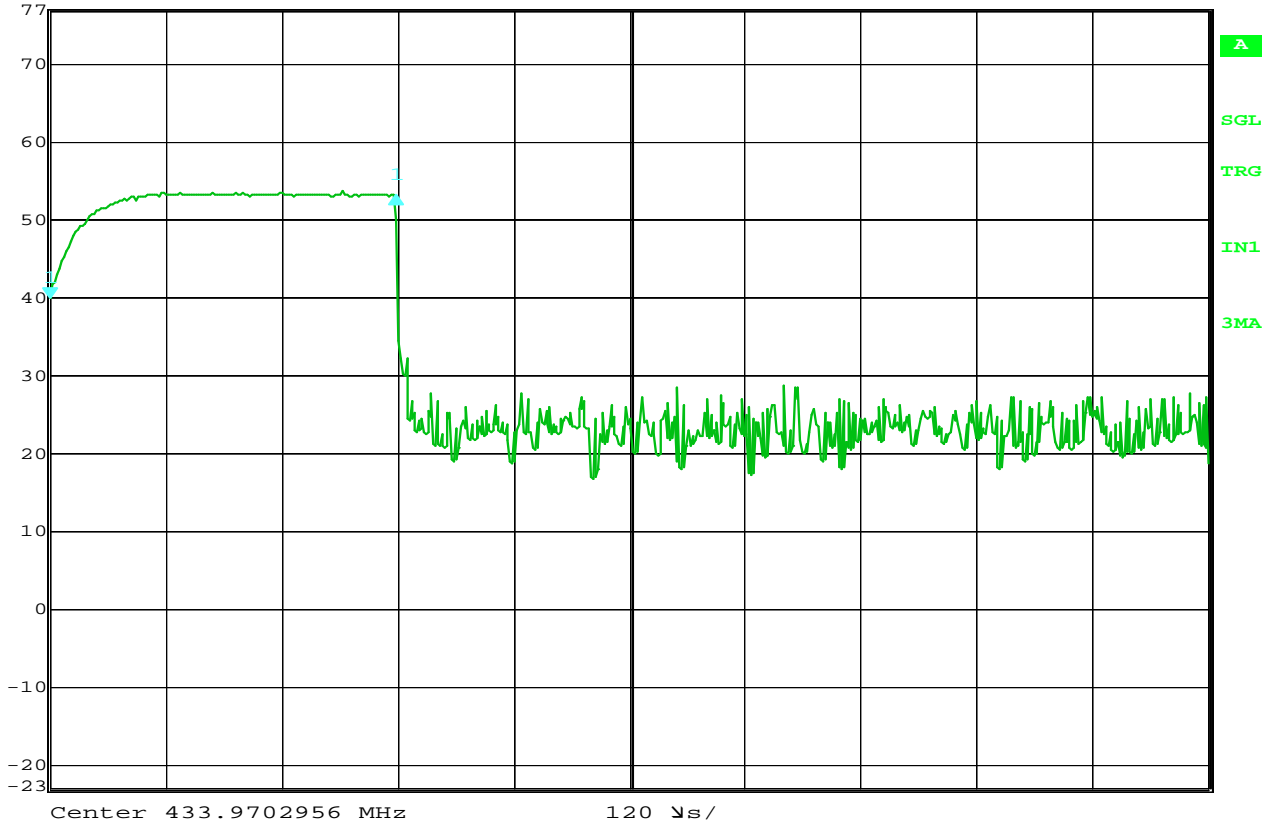
FCC 15.231 Periodic Operation

MANUFACTURER : Snap-On
 MODEL NUMBER : 8-72737A-6 Transmitter
 SERIAL NUMBER : None assigned
 TEST MODE : Tx at 434MHz
 NOTES :

NOTES



	Delta 1 [T3]	RBW	1 MHz	RF Att	10 dB
Ref Lvl	13.30 dB	VBW	1 MHz		
77 dB μ V	359.318637 μ s	SWT	1.2 ms	Unit	dB μ V



Date: 10.JUL.2014 07:15:18

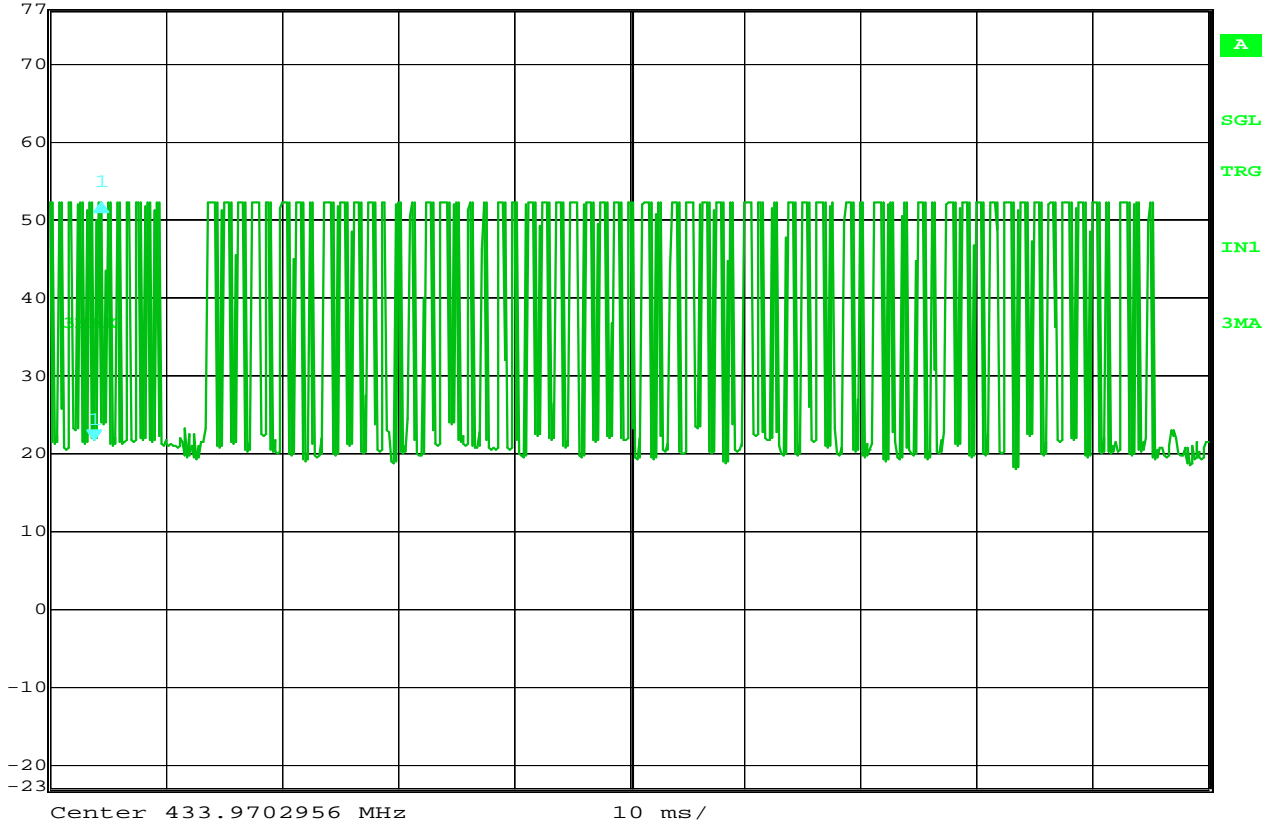
FCC 15.231 Duty Cycle

MANUFACTURER : Snap-On
 MODEL NUMBER : 8-72737A-6 Transmitter
 SERIAL NUMBER : None assigned
 TEST MODE : Tx at 434MHz
 NOTES : Pulse width is 360uSec

NOTES



	Delta 1 [T3]	RBW	100 kHz	RF Att	10 dB
Ref Lvl	30.33 dB	VBW	100 kHz		
77 dB μ V	752.104208 μ s	SWT	100 ms	Unit	dB μ V

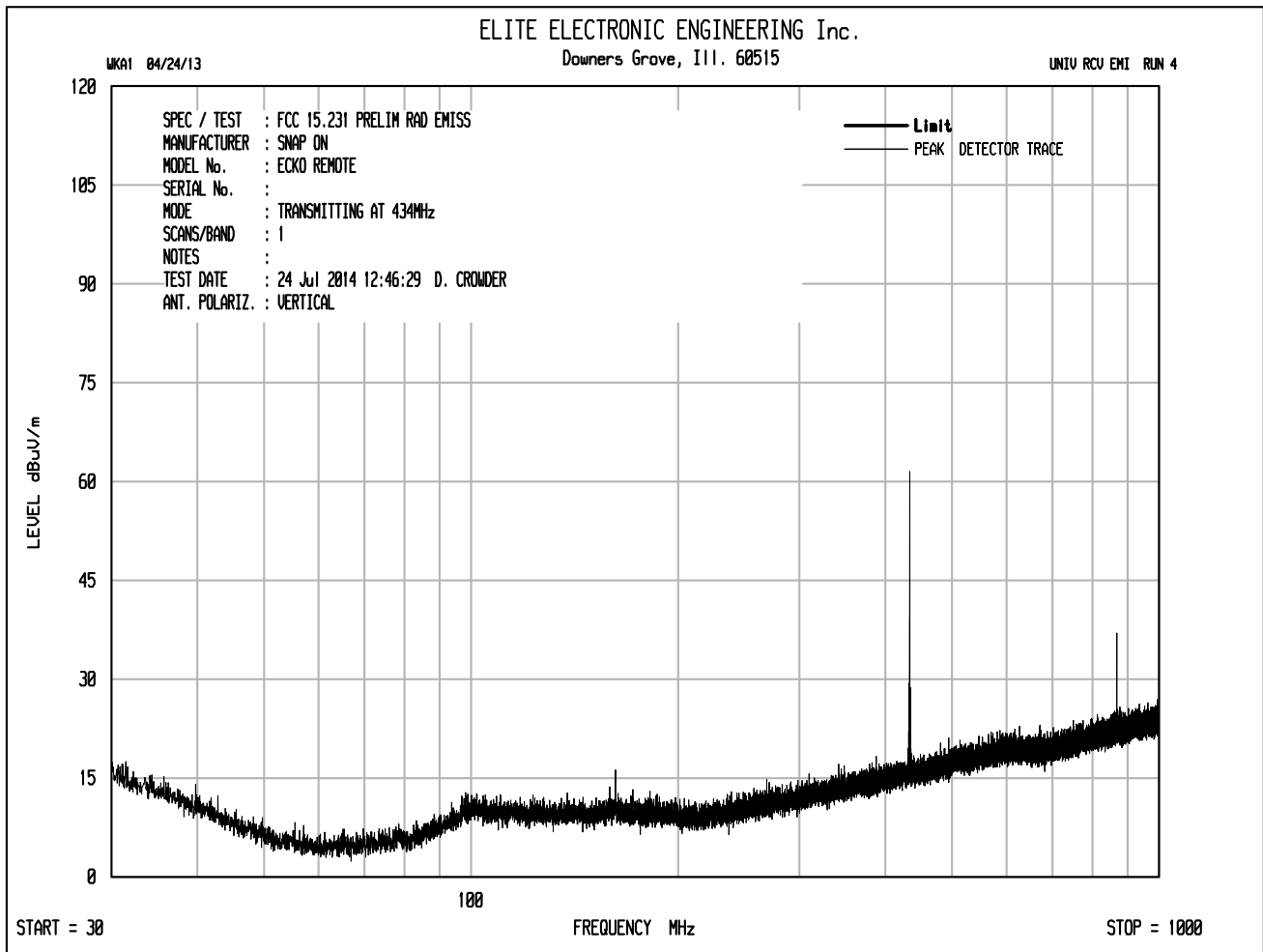


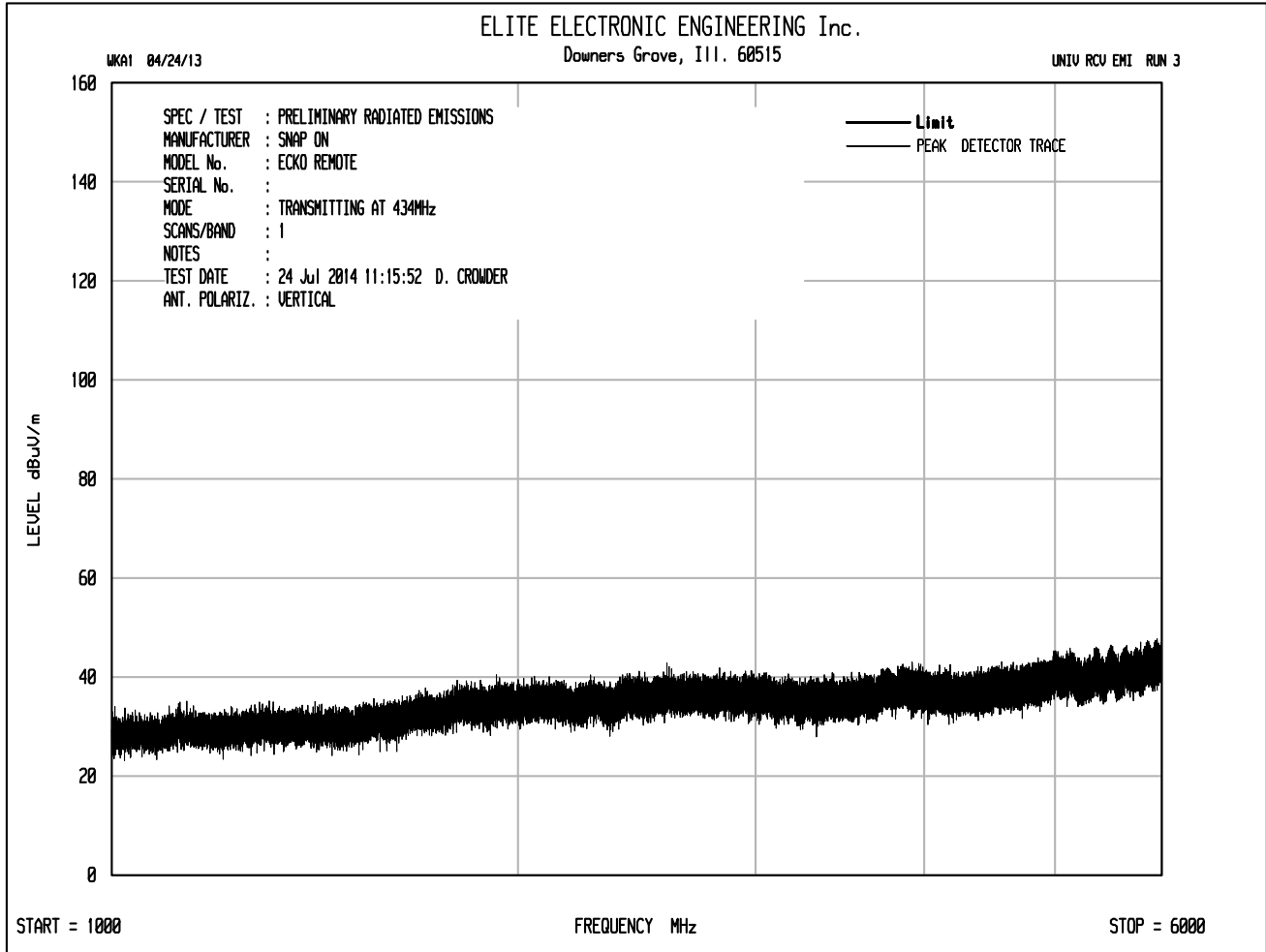
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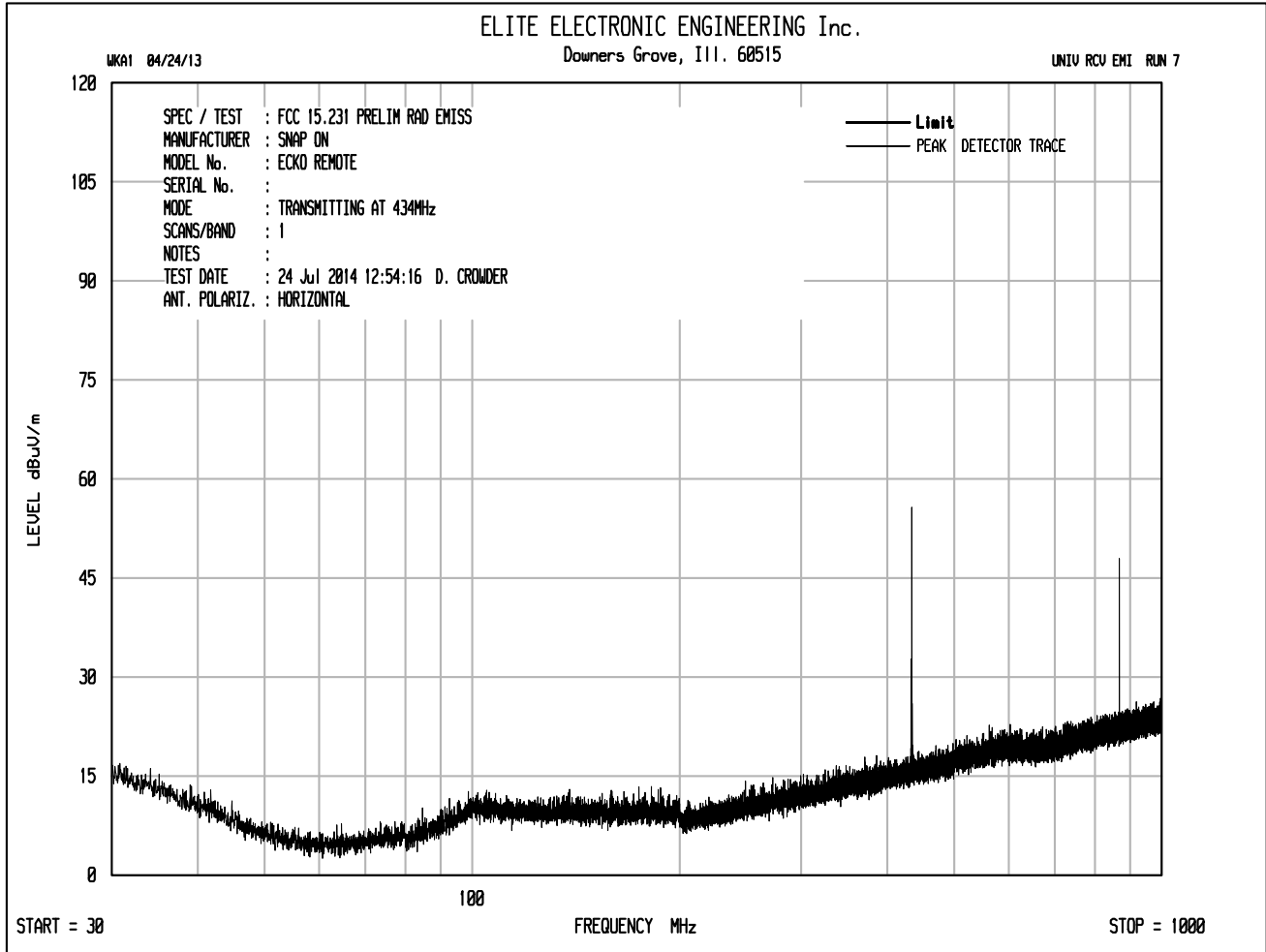
FCC 15.231 Duty Cycle

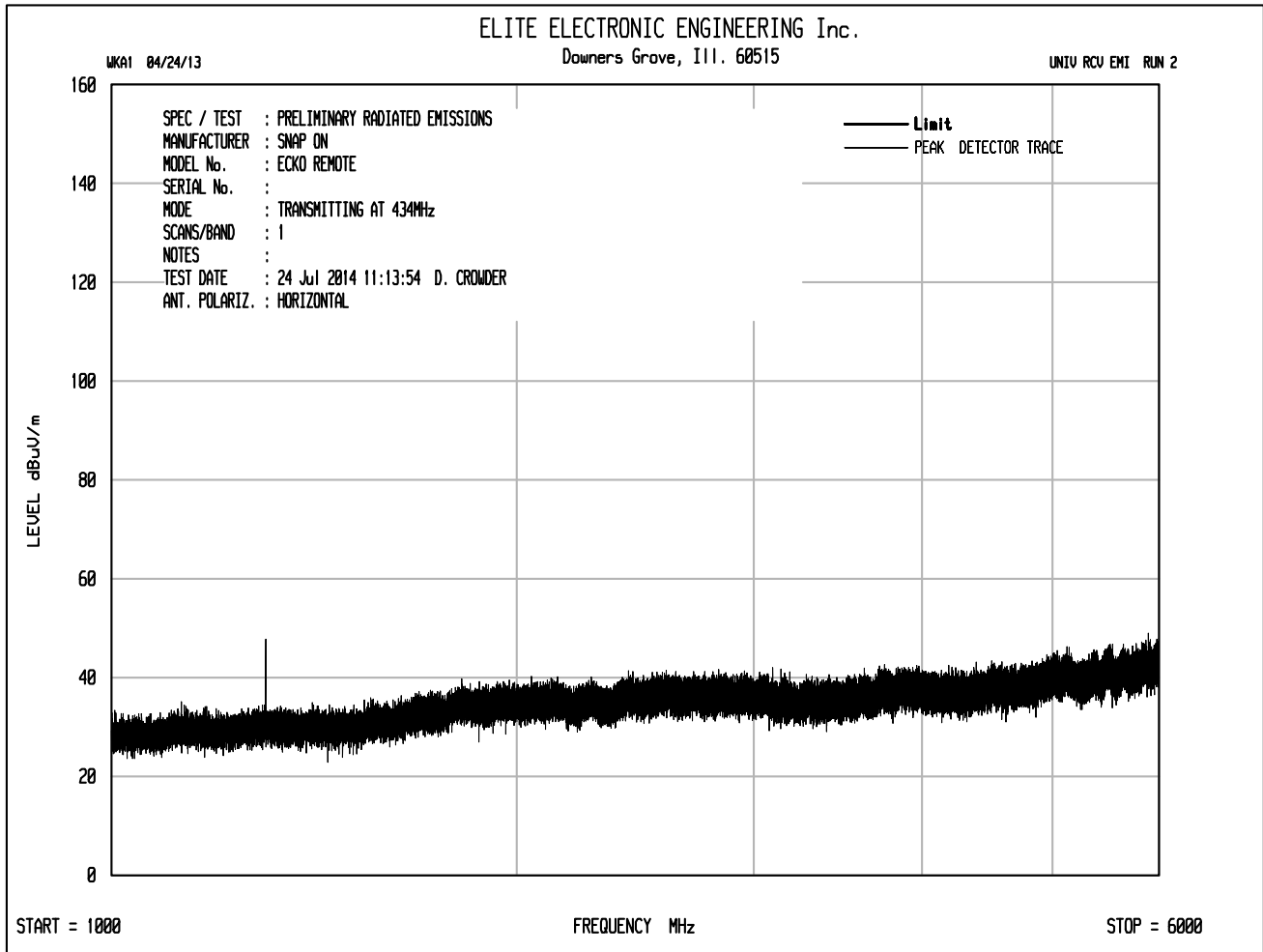
MANUFACTURER : Snap-On
 MODEL NUMBER : 8-72737A-6 Transmitter
 SERIAL NUMBER : None assigned
 TEST MODE : Tx at 434MHz
 NOTES : Pulse train.

NOTES











FCC 15.231 Final Radiated Emissions

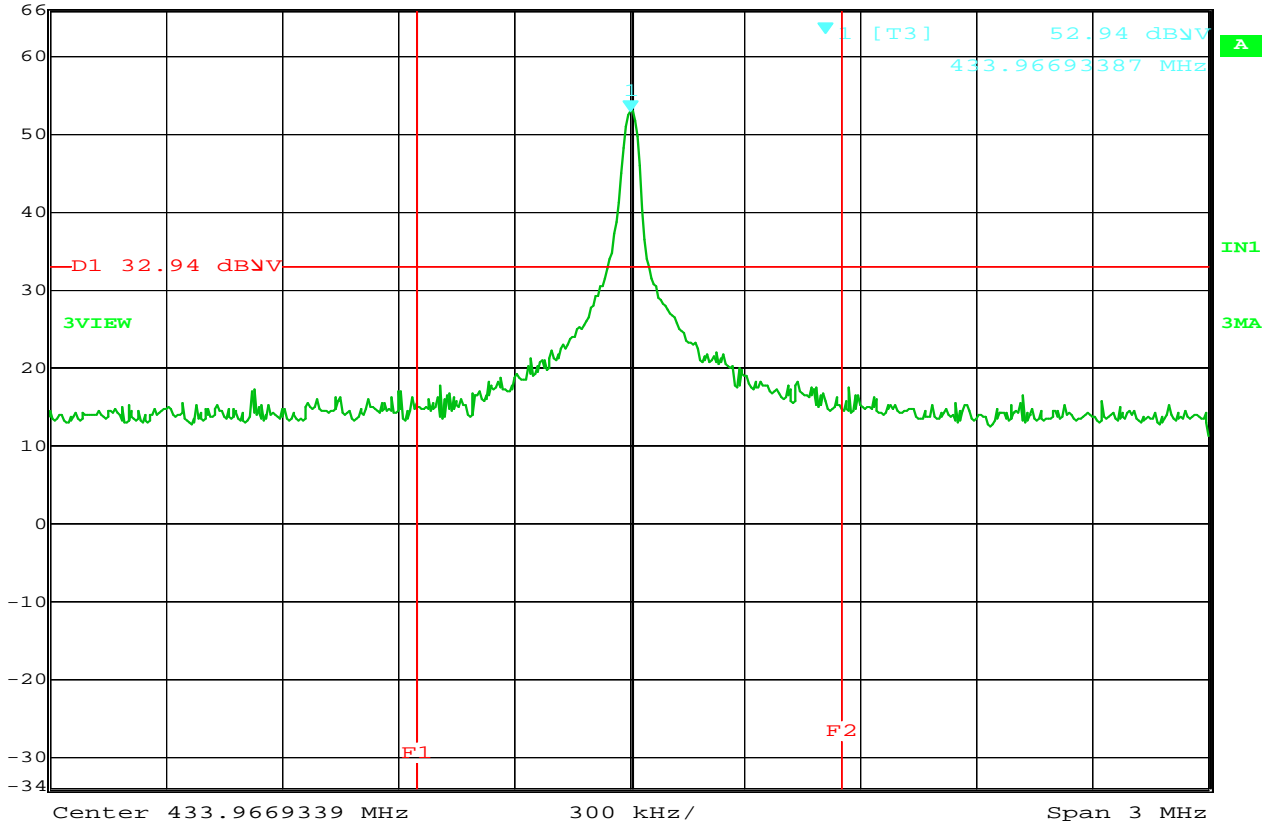
MANUFACTURER : Snap-On
 MODEL NUMBER : 8-72737A-6 Transmitter
 SERIAL NUMBER : None assigned
 TEST MODE : Tx at 434MHz
 NOTES : Since the Duty Cycle correction factor is less than 20dB the emissions level will also comply with the peak limits.

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Duty Cycle (dB)	Total (dBuV/m)	Total (uV/m)	Limit (uV/m)	Margin (dB)
433.900	H	45.1		1.1	16.3	-6.0	56.5	665.1	10995.8	-24.4
433.900	V	45.7		1.1	16.3	-6.0	57.1	712.7	10995.8	-23.8
867.800	H	32.3		1.5	20.0	-6.0	47.8	244.8	1099.6	-13.0
867.800	V	30.7		1.5	20.0	-6.0	46.2	203.6	1099.6	-14.6
1301.700	H	24.0		1.9	28.6	-6.0	48.5	265.3	500.0	-5.5
1301.700	V	25.0		1.9	28.6	-6.0	49.5	297.7	500.0	-4.5
1735.600	H	14.9	Ambient	2.2	30.3	-6.0	41.4	117.7	1099.6	-19.4
1735.600	V	16.0	Ambient	2.2	30.3	-6.0	42.5	133.6	1099.6	-18.3
2169.500	H	15.4	Ambient	2.5	31.5	-6.0	43.4	147.8	1099.6	-17.4
2169.500	V	15.7	Ambient	2.5	31.5	-6.0	43.7	153.0	1099.6	-17.1
2603.400	H	15.8	Ambient	2.7	32.5	-6.0	45.0	178.1	1099.6	-15.8
2603.400	V	15.8	Ambient	2.7	32.5	-6.0	45.0	178.1	1099.6	-15.8
3037.300	H	15.1	Ambient	3.0	32.8	-6.0	44.8	174.6	1099.6	-16.0
3037.300	V	15.1	Ambient	3.0	32.8	-6.0	44.8	174.6	1099.6	-16.0
3471.200	H	15.0	Ambient	3.2	33.0	-6.0	45.2	182.2	1099.6	-15.6
3471.200	V	14.5	Ambient	3.2	33.0	-6.0	44.7	172.0	1099.6	-16.1
3905.100	H	16.4	Ambient	3.4	33.6	-6.0	47.3	232.0	500.0	-6.7
3905.100	V	15.3	Ambient	3.4	33.6	-6.0	46.2	204.4	500.0	-7.8
4339.000	H	14.5	Ambient	3.5	34.3	-6.0	46.4	207.9	500.0	-7.6
4339.000	V	15.5	Ambient	3.5	34.3	-6.0	47.4	233.3	500.0	-6.6

Checked By: 



Ref Lvl	66 dBμV	Marker 1 [T3]	52.94 dBμV	433.96693387 MHz	RBW	30 kHz	RF Att	10 dB
					VBW	300 kHz		
					SWT	8.5 ms	Unit	dBμV



Date: 10.JUL.2014 07:07:43

FCC 15.231 0.25% Bandwidth

MANUFACTURER : Snap-On
 MODEL NUMBER : 8-72737A-6 Transmitter
 SERIAL NUMBER : None assigned
 TEST MODE : Tx at 434MHz
 NOTES :

NOTES