Measurement of RF Emissions from a Tire Patrol Transmitter

For	Danko MFG 624 Atchison Way #103 Castle Rock, CO 80109
P.O. Number	PO-10074
Date Tested	August 25, 2016
Test Personnel	Tylar Jozefczyk
Test Specification	FCC "Code of Federal Regulations" Title 47 Part15, Subpart C Industry Canada RSS-GEN Industry Canada RSS-210

Test Report By:

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EMC Engineer

Requested By: Brian Phillips
Danko MFG

Approved By:

Raymond J. Klouda
Registered Professional
Engineer of Illinois - 44894

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REVISION HISTORY

Revision	Date	Description
—	2 Sept 2016	Initial release

Measurement of RF Emissions from a Tire Patrol Transmitter

1. INTRODUCTION

1.1. Scope of Tests

This report presents the results of the RF emissions measurements performed on a Tire Patrol, (hereinafter referred to as the Equipment Under Test (EUT)). The EUT was designed to transmit at approximately 915 MHz using an internal antenna. The EUT was manufactured and submitted for testing by Danko MFG located in Castle Rock, CO.

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, Section 249 for Intentional Radiators. Testing was performed in accordance with ANSI C63.4-2014 and with ANSI C63.10-2013.

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 21^{o}C and the relative humidity was 50%.

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 2016
- ANSI C63.4-2014, "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"
- ANSI C63.10-2013, "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices"
- Industry Canada Radio Standards Specification, RSS-Gen, “General Requirements for Compliance of Radio Apparatus”, Issue 4, November 2014
- Industry Canada Radio Standards Specification, RSS-210, “License-Exempt Radio Apparatus: Category I Equipment”, Issue 9, August 2016

3. EUT SETUP AND OPERATION

3.1. General Description

The EUT is a Danko MFG Tire Patrol. A block diagram of the EUT setup is shown as Figure 1.

3.1.1. Power Input

The EUT was powered by a 3.2V DC internal battery.

3.1.2. Peripheral Equipment

The EUT had no peripheral equipment.

3.1.3. Signal Input/Output Leads

The EUT had no interconnect cables.

3.1.4. Grounding

The EUT was ungrounded during the tests.

3.2. Software

For all tests the EUT had Firmware Version A loaded onto the device to provide correct load characteristics. The EUT requires Software Version A to control the device during testing

3.3. Operational Mode

For all tests the EUT and all peripheral equipment were placed on an 80cm high non-conductive stand. The EUT was setup to transmit at 915 MHz.

3.4. EUT Modifications

No modifications were required for compliance to the FCC Title 47, Part 15, Subpart C, Section 15.249 for Intentional Radiators.

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 C63.4-2014 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 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 with a calibration interval not greater than two years. 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

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 has no connections for AC power, no conducted emissions tests are required.

5.2. Radiated Measurements

5.2.1. Requirements

The EUT must comply with the requirements of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C, Section 15.249(a) and Industry Canada Radio Standards Specification RSS-210 Annex 2, section A2.9 for transmitters:

Fundamental Frequency MHz	Field Intensity mV/m @ 3 meter	Field Strength of Harmonics uV/m @ 3 meter
902 - 928	50	500

Note: The limits shown in the above table are based on measurements using an average detector, except for the fundamental emission in the frequency band 902-928 MHz, which is based on measurements using a CISPR quasi-peak detector. In addition, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20 dB under any condition of modulation. Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits, whichever is the lesser attenuation.

5.2.2. 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 C63.4-2014 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 10.0GHz 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 10GHz. 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.

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.

5.2.3.Results

The preliminary plots, with the EUT transmitting at 915 MHz, are presented on pages 14 through 17. The plots are presented for a reference only, and are not used to determine compliance. The final data, with the EUT transmitting at 915 MHz, is presented on pages 18 and 19.

As can be seen from the data, all emissions measured from the EUT were within the specification limits. Photographs of the test configuration are shown on Figures 2 and 3.

5.3. Occupied Bandwidth Measurements

5.3.1.Requirement

In accordance with paragraph of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C, Section 15.249(d) and Industry Canada Radio Standards Specification RSS-210 Annex 2, section A 2.9(b), emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general field strength limits, whichever is less stringent.

5.3.1.Procedures

The EUT was placed on an 80cm high non-conductive stand. A bilog antenna was placed at a test distance of 3 meters from the EUT. The unit was set to transmit continuously. The EUT was maximized for worst case emissions at the low band-edge. The maximum meter reading was recorded using a quasi-peak (QP) detector with a 120 kHz resolution bandwidth.

5.3.2.Results

The occupied bandwidth data are shown on data page 20. As can be seen from this data page, the transmitter met the occupied bandwidth requirements. The 99% bandwidth was measured to be 3.7 MHz.

6. OTHER TEST CONDITIONS

6.1. Test Personnel and Witnesses

All tests were performed by qualified personnel from Elite Electronic Engineering Incorporated. The test series was witnessed by Danko MFG personnel.

6.2. Disposition of the EUT

The EUT and all associated equipment were returned to Danko MFG upon completion of the tests.

7. CONCLUSIONS

It was determined that the Danko MFG Tire Patrol did fully meet the conducted and radiated emission

requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.247 et seq. for Intentional Radiators, when tested per ANSI C63.4-2014 and ANSI C63.10-2013.

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 as operated by Danko MFG personnel. 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
APW11	PREAMPLIFIER	PMI	PE2-35-120-5R0-10-12-SFF	PL11685/1241	1GHZ-20GHZ	4/18/2016	4/18/2017
CDX8	COMPUTER	ELITE	WORKSTATION			N/A	
NTA3	BILOG ANTENNA	TESEQ	6112D	32853	25-1000MHz	3/23/2016	3/23/2017
NWQ0	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3117	66657	1GHZ-18GHZ	5/18/2016	5/18/2018
RBA1	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB26	100146	20HZ-26.5GHZ	2/12/2016	2/12/2017
SHC2	Power Supplies	HENGFU	HF60W-SL-24	A11372702	24V	NOTE 1	
WKA1	SOFTWARE, UNIVERSAL RCV EMI	ELITE	UNIV_RCV_EMI	1	---	I/O	
XPQ3	HIGH PASS FILTER	K&L MICROWAVE	4IH30-1804/T10000-0	4	1.8GHZ-10GHZ	9/22/2015	9/22/2016

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.

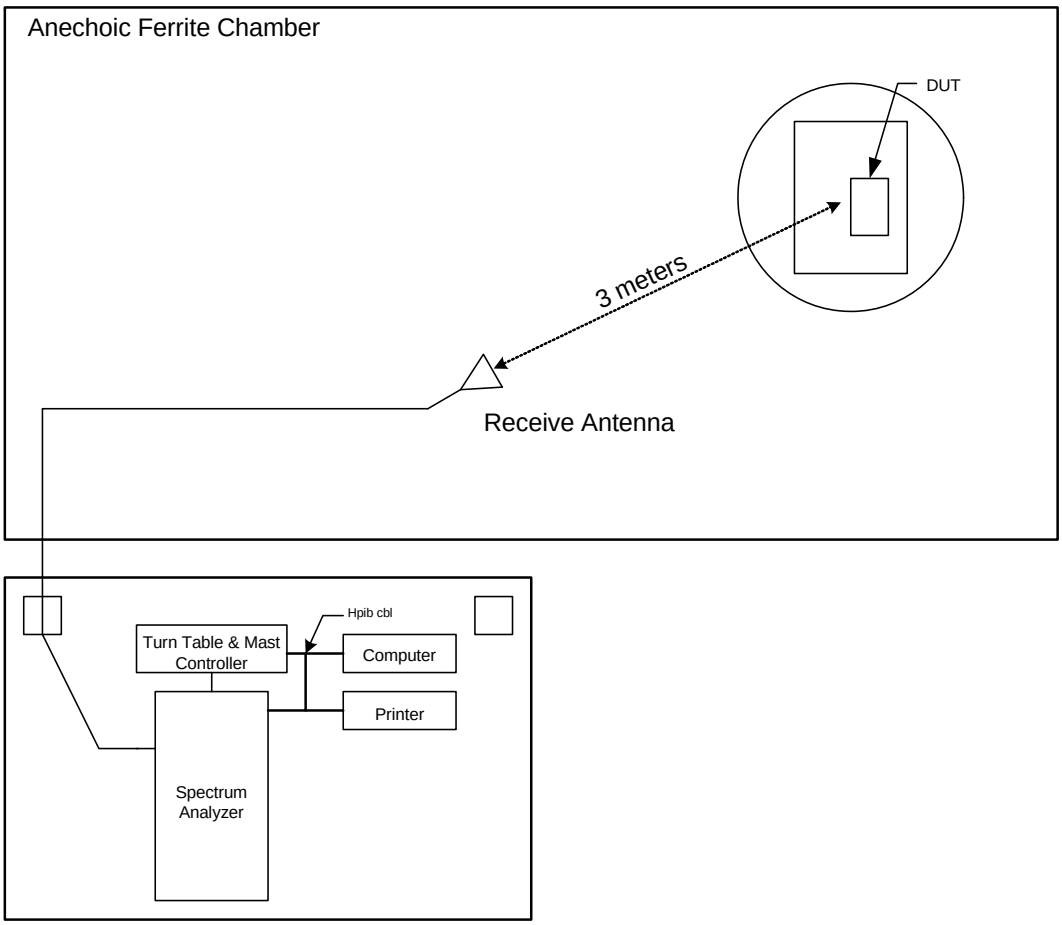


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

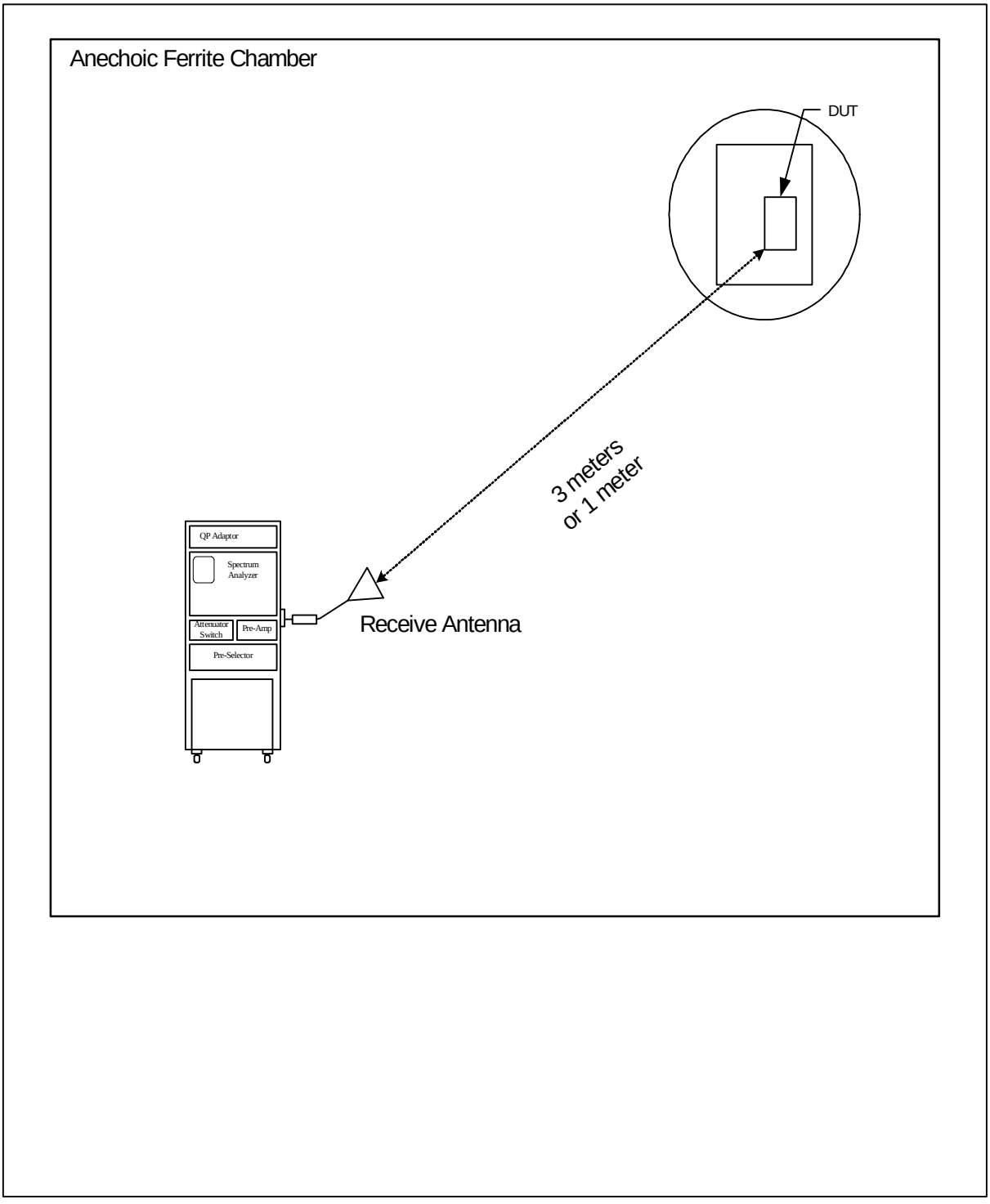
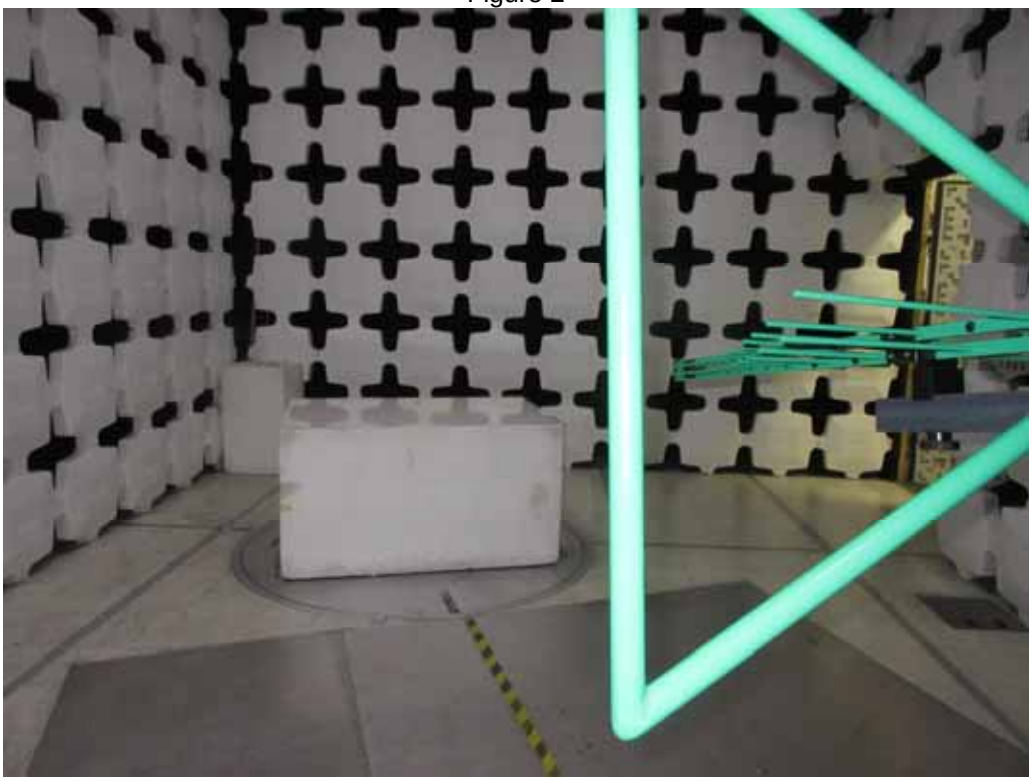
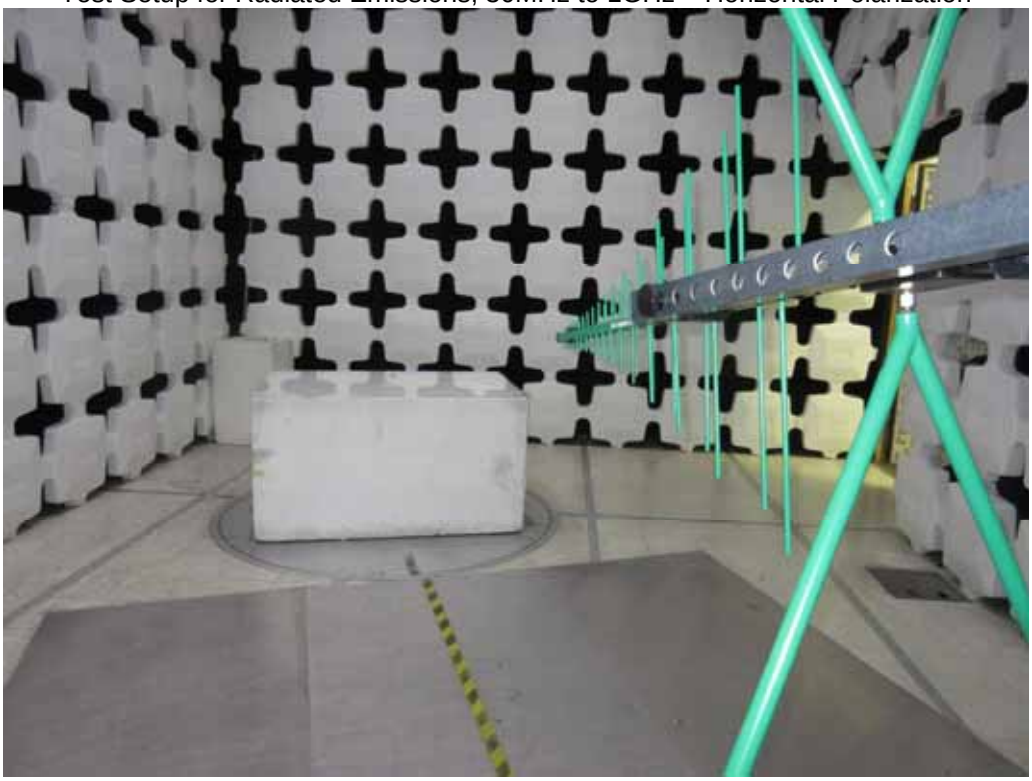

Anechoic Ferrite Chamber
DUT
3 meters
or 1 meter
QP Adaptor
Spectrum
Analyzer
Attenuator
Switch
Pre-Amp
Pre-Selector
Receive Antenna

Figure 2



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

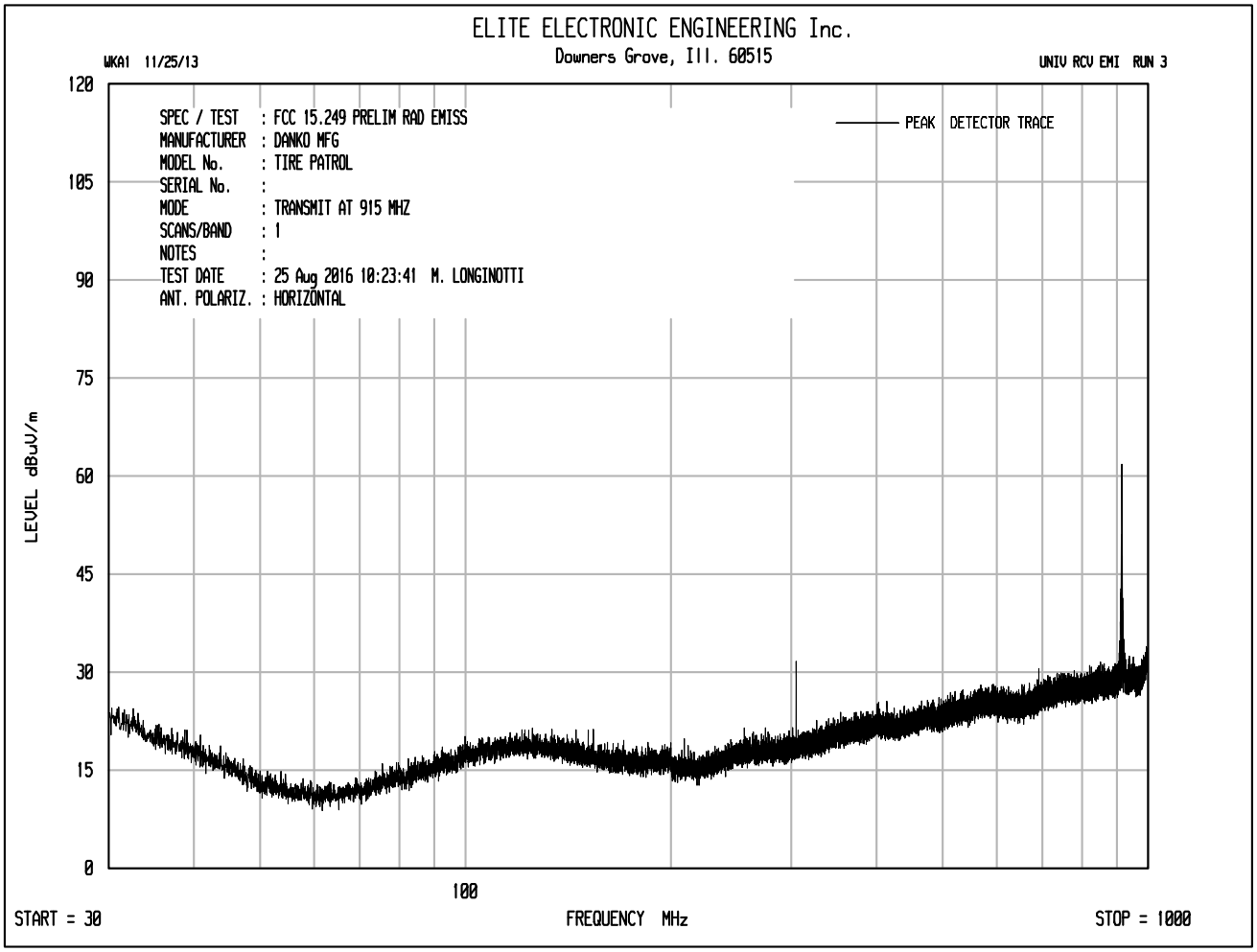


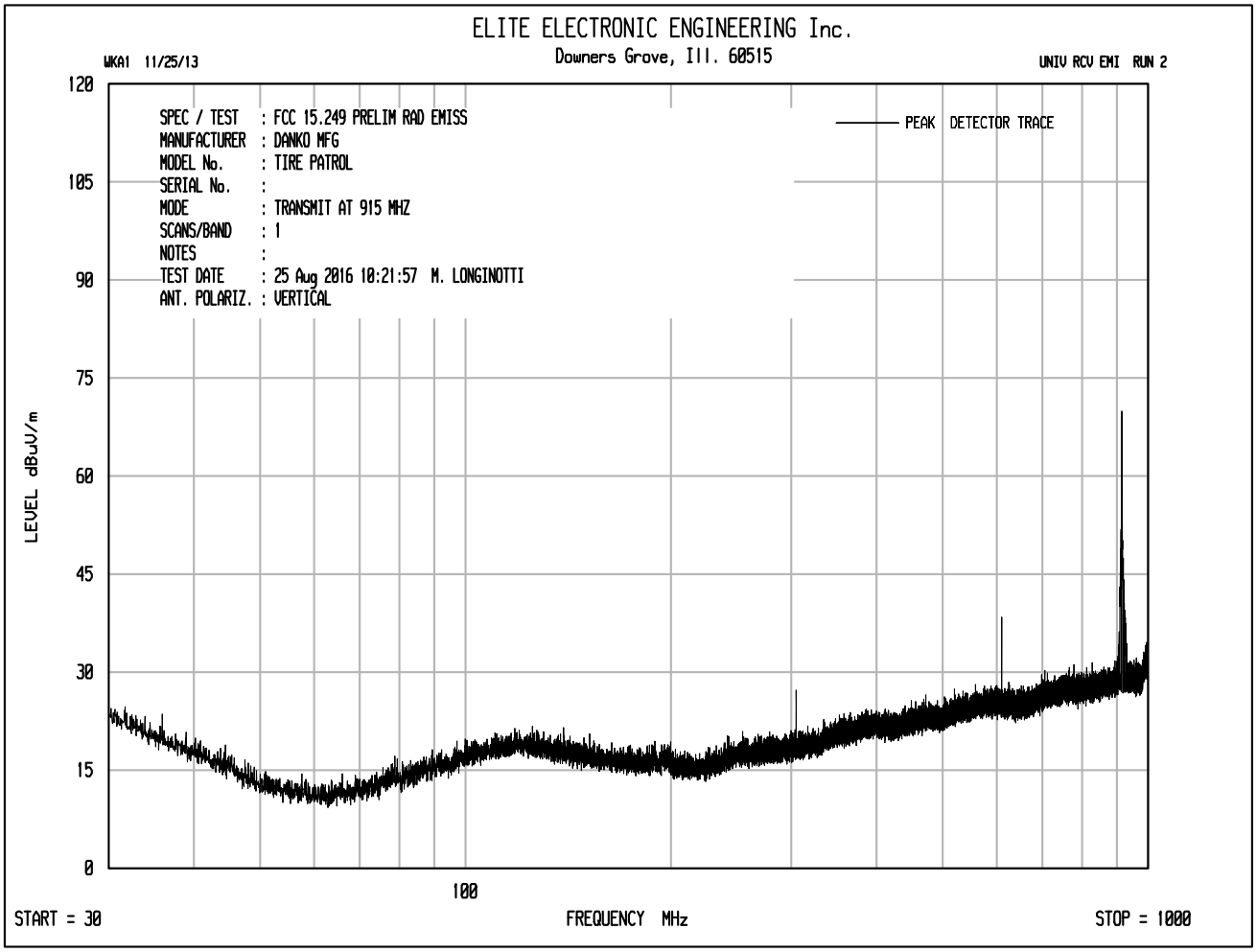
Test Setup for Radiated Emissions, 30MHz to 1GHz – Vertical Polarization

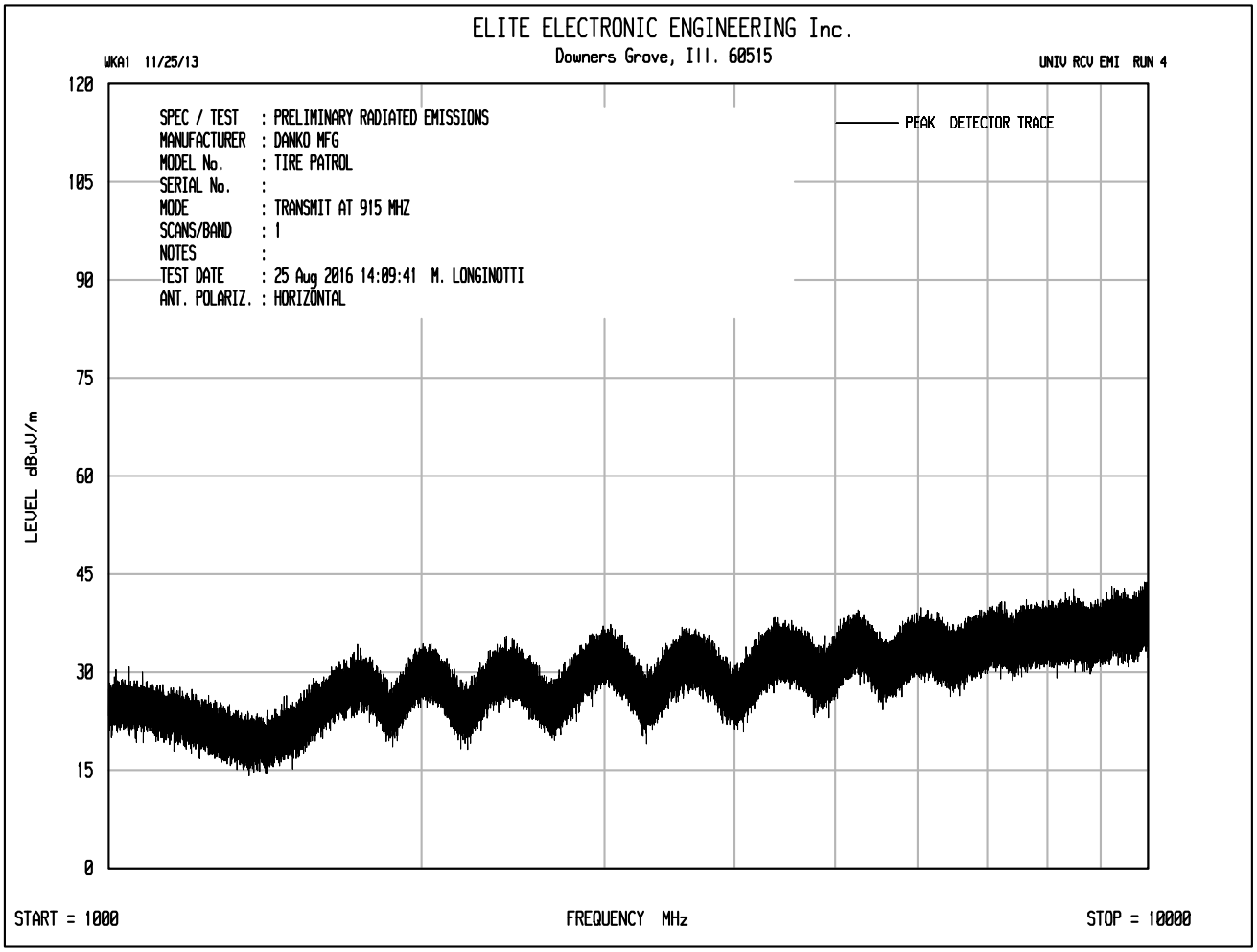
Figure 3

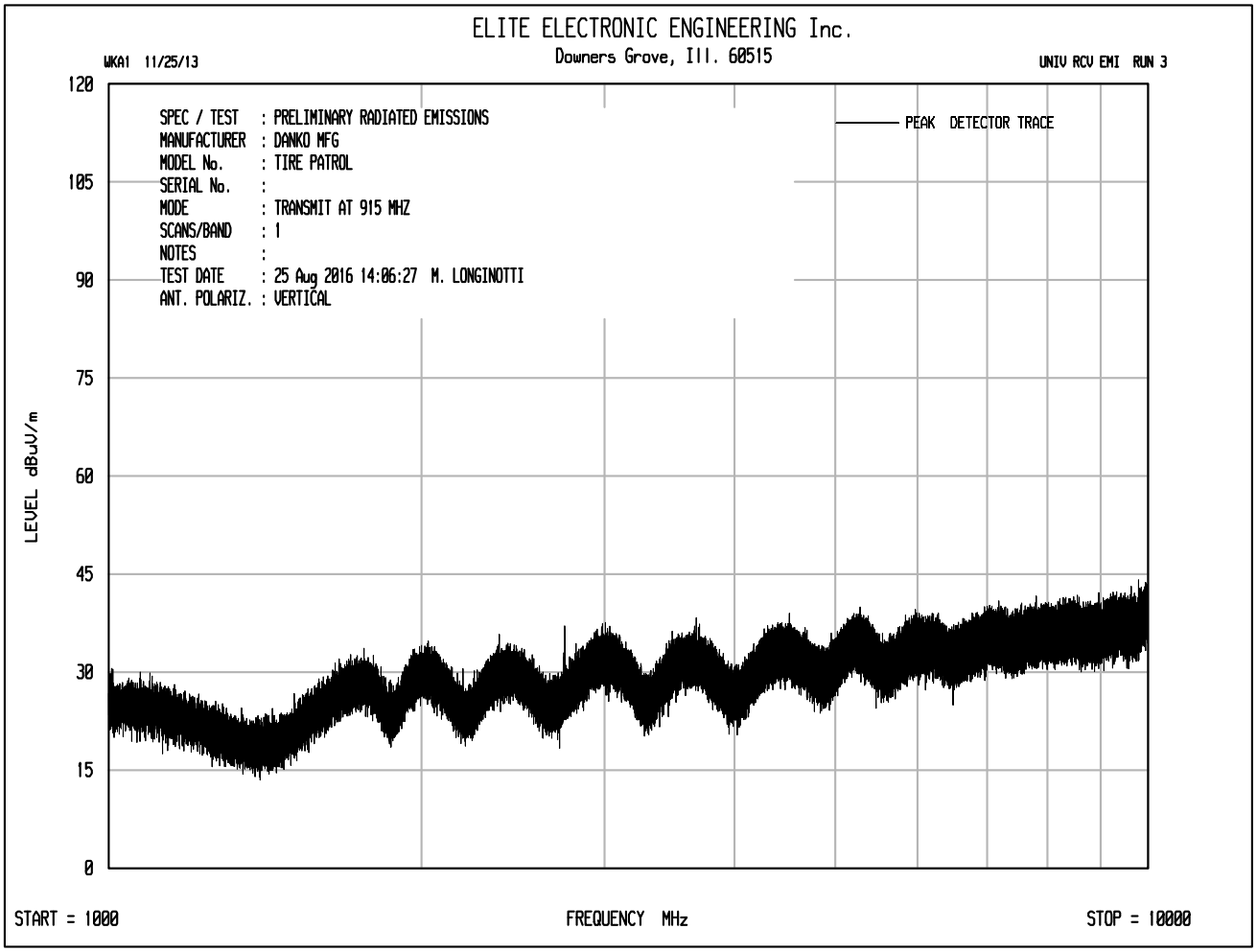
Test Setup for Radiated Emissions, 1GHz to 10GHz – Horizontal Polarization

Test Setup for Radiated Emissions, 1GHz to 10GHz – Vertical Polarization


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 3
SPEC / TEST : FCC 15.249 PRELIM RAD EMISS
MANUFACTURER : DANKO MFG
MODEL No. : TIRE PATROL
SERIAL No. :
MODE : TRANSMIT AT 915 MHZ
SCANS/BAND : 1
NOTES :
TEST DATE : 25 Aug 2016 10:23:41 M. LONGINOTTI
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
100
START = 30
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 2
SPEC / TEST : FCC 15.249 PRELIM RAD EMISS
MANUFACTURER : DANKO MFG
MODEL No. : TIRE PATROL
SERIAL No. :
MODE : TRANSMIT AT 915 MHZ
SCANS/BAND : 1
NOTES :
TEST DATE : 25 Aug 2016 10:21:57 M. LONGINOTTI
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
100
START = 30
FREQUENCY MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 4
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : DANKO MFG
MODEL No. : TIRE PATROL
SERIAL No. :
MODE : TRANSMIT AT 915 MHZ
SCANS/BAND : 1
NOTES :
TEST DATE : 25 Aug 2016 14:09:41 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 = 10000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA1 11/25/13
UNIV RCV EMI RUN 3
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : DANKO MFG
MODEL No. : TIRE PATROL
SERIAL No. :
MODE : TRANSMIT AT 915 MHZ
SCANS/BAND : 1
NOTES :
TEST DATE : 25 Aug 2016 14:06:27 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 = 10000

Manufacturer : Danko MFG
Model No. : Tire Patrol
Serial No. : S/N 1
Date Tested : August 25, 2016
Test Performed : Radiated Emissions
Mode : Transmit at 915 MHz
Test Distance : 3 meters
Notes : QP detector with 120kHz RBW used below 1GHz
: Peak detector with 1MHz RBW used above 1GHz

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	QP/Peak Total dBuV/m at 3m	QP/Peak Total uV/m at 3 m	QP/Peak Limit uV/m at 3 m	Margin (dB)
915.000	H	41.3		1.6	26.5	0.0	69.4	2937.9	50000.0	-24.6
915.000	V	42.1		1.6	26.5	0.0	70.2	3221.3	50000.0	-23.8
1830.000	H	49.4	Ambient	2.2	31.7	-40.0	43.3	146.9	5000.0	-30.6
1830.000	V	49.5	Ambient	2.2	31.7	-40.0	43.5	149.5	5000.0	-30.5
2745.000	H	46.7	Ambient	2.8	34.1	-39.7	43.9	156.2	5000.0	-30.1
2745.000	V	47.5	Ambient	2.8	34.1	-39.7	44.8	172.8	5000.0	-29.2
3660.000	H	51.7	Ambient	3.3	34.3	-39.2	50.1	318.4	5000.0	-23.9
3660.000	V	51.0	Ambient	3.3	34.3	-39.2	49.4	295.1	5000.0	-24.6
4575.000	H	50.5	Ambient	3.6	36.2	-39.2	51.0	355.5	5000.0	-23.0
4575.000	V	50.3	Ambient	3.6	36.2	-39.2	50.9	350.7	5000.0	-23.1
5490.000	H	48.1	Ambient	3.9	36.8	-39.4	49.4	295.8	5000.0	-24.6
5490.000	V	47.8	Ambient	3.9	36.8	-39.4	49.1	286.7	5000.0	-24.8
6405.000	H	48.5	Ambient	4.3	37.9	-39.4	51.3	367.9	5000.0	-22.7
6405.000	V	47.3	Ambient	4.3	37.9	-39.4	50.1	321.6	5000.0	-23.8
7320.000	H	48.3	Ambient	4.7	38.2	-39.4	51.8	387.6	5000.0	-22.2
7320.000	V	48.2	Ambient	4.7	38.2	-39.4	51.7	386.2	5000.0	-22.2
8235.000	H	49.3	Ambient	4.9	38.6	-39.4	53.4	470.0	5000.0	-20.5
8235.000	V	49.1	Ambient	4.9	38.6	-39.4	53.3	459.9	5000.0	-20.7
9150.000	H	49.8	Ambient	5.0	38.8	-39.3	54.3	519.1	5000.0	-19.7
9150.000	V	50.2	Ambient	5.0	38.8	-39.3	54.7	542.3	5000.0	-19.3

Total (dBuV/m) = Meter Reading (dBuV) + CBL Fac (dB) + Ant Fac (dB) + Pre Amp (dB)

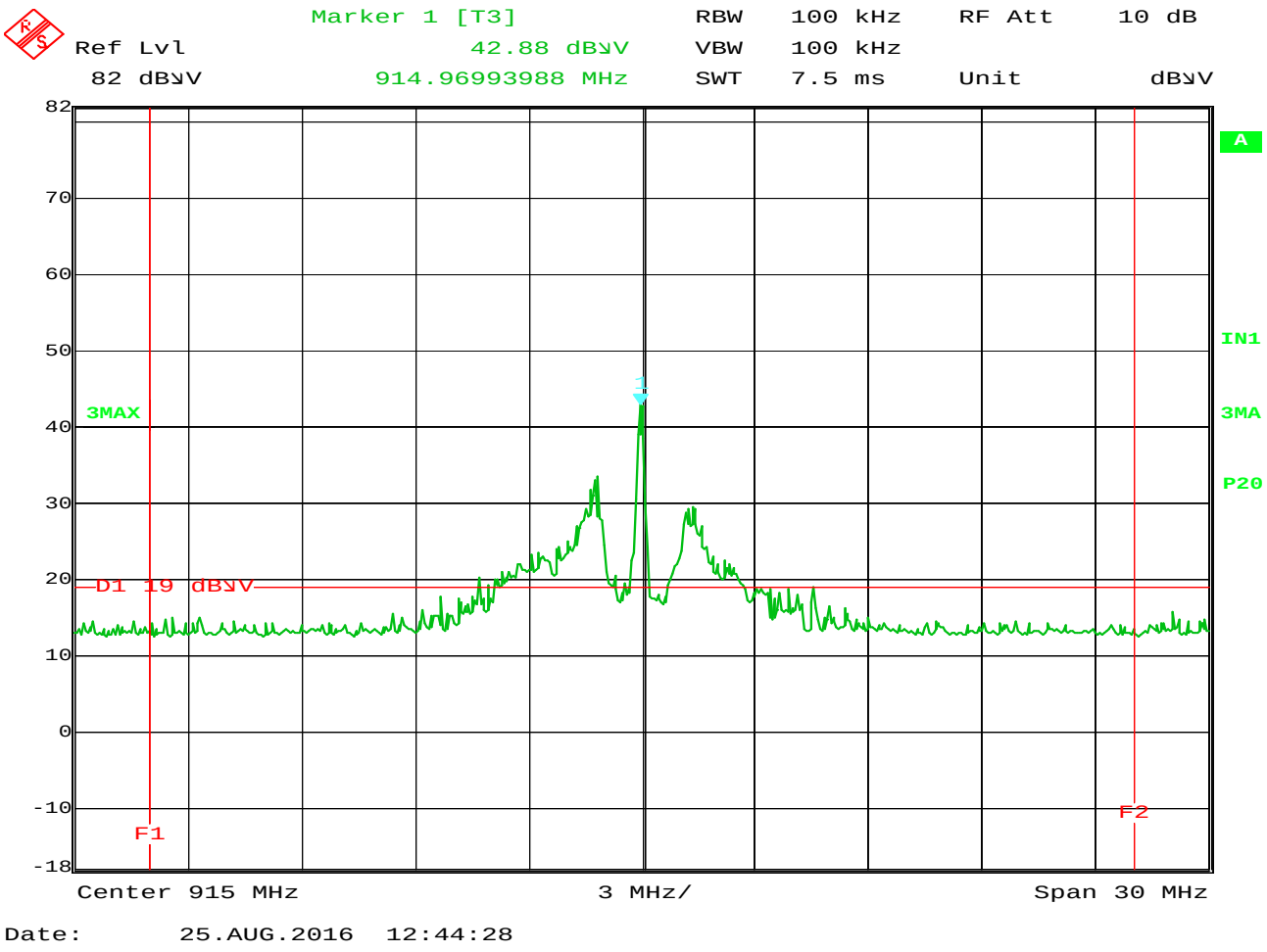
Total (uV/m) = 10^(Total (dBuV/m)/20)

Manufacturer : Danko MFG
Model No. : Tire Patrol
Serial No. : S/N 1
Date Tested : August 25, 2016
Test Performed : Radiated Emissions
Mode : Transmit at 915 MHz
Test Distance : 3 meters
Notes : Average Readings with a 1MHz RBW, 10Hz VBW

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dBuV/m at 3m	Average Total uV/m at 3 m	Average Limit uV/m at 3 m	Margin (dB)
1830.00	H	36.86	Ambient	2.2	31.7	-40.0	0.0	30.8	34.8	500.0	-23.2
1830.00	V	36.81	Ambient	2.2	31.7	-40.0	0.0	30.8	34.6	500.0	-23.2
2745.00	H	34.11	Ambient	2.8	34.1	-39.7	0.0	31.3	36.9	500.0	-22.6
2745.00	V	35.45	Ambient	2.8	34.1	-39.7	0.0	32.7	43.0	500.0	-21.3
3660.00	H	38.3	Ambient	3.3	34.3	-39.2	0.0	36.7	68.3	500.0	-17.3
3660.00	V	38.28	Ambient	3.3	34.3	-39.2	0.0	36.7	68.2	500.0	-17.3
4575.00	H	36.87	Ambient	3.6	36.2	-39.2	0.0	37.4	74.5	500.0	-16.5
4575.00	V	36.88	Ambient	3.6	36.2	-39.2	0.0	37.4	74.5	500.0	-16.5
5490.00	H	34.9	Ambient	3.9	36.8	-39.4	0.0	36.2	64.7	500.0	-17.8
5490.00	V	34.87	Ambient	3.9	36.8	-39.4	0.0	36.2	64.5	500.0	-17.8
6405.00	H	34.41	Ambient	4.3	37.9	-39.4	0.0	37.2	72.7	500.0	-16.7
6405.00	V	34.46	Ambient	4.3	37.9	-39.4	0.0	37.3	73.2	500.0	-16.7
7320.00	H	35.6	Ambient	4.7	38.2	-39.4	0.0	39.1	90.1	500.0	-14.9
7320.00	V	35.52	Ambient	4.7	38.2	-39.4	0.0	39.0	89.3	500.0	-15.0
8235.00	H	36.49	Ambient	4.9	38.6	-39.4	0.0	40.6	107.6	500.0	-13.3
8235.00	V	36.49	Ambient	4.9	38.6	-39.4	0.0	40.6	107.6	500.0	-13.3
9150.00	H	36.99	Ambient	5.0	38.8	-39.3	0.0	41.5	119.0	500.0	-12.5
9150.00	V	37	Ambient	5.0	38.8	-39.3	0.0	41.5	119.2	500.0	-12.5

Average Total (dBuV/m) = Meter Reading (dBuV) + CBL Fac (dB) + Ant Fac (dB) + Pre Amp (dB)

Average Total (uV/m) = 10^(Average Total (dBuV/m)/20)



MANUFACTURER : Danko MFG
MODEL NUMBER : Tire Patrol
TEST MODE : Transmitted at 915 MHz
TEST PARAMETERS : 15.249 - Occupied Bandwidth
EQUIPMENT USED : EMI Test Receiver, Bilog Antenna

NOTES: Display line F1 represents the band edge at 902 MHz and display line F2 represents the band edge at 928 MHz. Display line D1represents the general limits of 46 dBuV/m.