Certification Test Report

For a

EasyTorque Model CS5-25 Torque Wrench
FCC ID: V9S929TX-US

Manufacturer:

SEEG
6, rue Léonard de Vinci
Brie-Comte-Robert
France, 77170

Testing Laboratory:

F-Squared Laboratories
16740 Peters Road
Middlefield, Ohio 44062
United States of America

The EasyTorque, model CS5-25 Torque Wrench, was tested and was found to comply with the requirements of the Federal Communications Commission outlined in the Federal Register CFR 47, Part 15.207 and Part 15.249.

The product was received on April 4, 2008 and the testing was completed on July 23, 2008.

Evaluation Conducted By:

Kenneth P. Klann
EMC Engineer

Report Reviewed By:

for
Wendy Fuster
President

F-Squared Laboratories
success thru compliance

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Table of Contents

1. ENGINEERING STATEMENT

This report has been prepared on behalf of Stanley Assembly Technologies/Facom/SEEG to provide documentation for the testing described herein. This equipment has been tested and found to comply with Part 15.207 and Part 15.249 of the FCC Rules using ANSI C63.4 2003 standards. The test results found in this test report relate only to the items tested.

1.1. Equipment Under Test:

EasyTorque Torque Wrench
5-25 Nm Wrench, Short Deflection
FCC ID: V9S929TX-US

1.2. Trade Name:

EasyTorque

1.3. Model:

CS5-25

1.4. Power Supply:

Batteries – 3 AAA, Ni-MH Rechargeable
AC-Battery Charger (Torque Wrench is operational with charger connected)

1.5. Applicable Rules:

CFR 47, FCC Part 15.207(a)(c), FCC Part 15.249(a)(c)(d)

1.6. Equipment Category:

Radio Transmitter-DXX Low Power Communications Device
50 Channels-Narrow Band FSK Modulation
Frequency Range: 915.40-916.91 MHz

1.7. Antenna:

Internal-Wire monopole housed in plastic end cap 7.7 cm length

1.8. Measurement Location:

F-Squared Laboratories in Middlefield, Ohio. Site description and attenuation data are on file with the FCC's Sampling and Measurement Branch at the FCC Laboratory in Columbia, MD**.**

1.9. Measurement Procedure:

All measurements were performed according to the 2003 version of ANSI C63.4 and FCC Parts 15.31, 15.33 and 15.35. A list of the measurement equipment can be found in Section 2.

1.10. Uncertainty Budget:

Conducted Emissions - Combined Uncertainty ±1.13 dB; Expanded Uncertainty ±2.26 dB
Radiated Emissions - Combined Uncertainty ±2.24 dB; Expanded Uncertainty ±4.48 dB

1.11. Engineering Certification:

The undersigned of this report hereby state that the measurements shown in this application were made in accordance with the procedures indicated, and that the energy emitted by this equipment was found to be within the limits. The undersigned assume full responsibility for the accuracy and completeness of these measurements and further state that, on the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 15.247 and Part 15.249 of the FCC Rules under normal use and maintenance.

2. LIST OF MEASUREMENT INFORMATION

Equipment Type	Manufacturer	Model	Serial Number	Calibration Due Date
Shield Room	Shielding Resources	3 Meter	001	May 14, 2009
Temp/Hum. Recorder	Extech	RH520	H005869	Aug. 21, 2008
OATS	Compliance Labs	N/A	001	Aug. 16, 2008
Receiver	Rohde & Schwarz	Display, EASI-0-804-8932-52; RF Unit, ESMI-RF 1032-5640-53	84982/015; 849152/005	July 31, 2008
Antenna 1-Chamber	ETS/EMCO	3142B	9811-1330	June 29, 2009
Antenna 2-OATS	Sunol Sciences	JB1	A101101	June 29, 2009
Horn Antenna	Emco	3115	9809-5580	Sept. 26, 2009
Horn Antenna	AH Systems	SAS-572	237	June 15, 2009
Transient Limiter	Hewlett Packard	11947A	3107A03325	Oct. 23, 2008
Pre-Amplifier	Hewlett Packard	83006A	310A00500	Apr. 4, 2009
LISN 2	Solar	8028-50-TS-24-BNC	1128	Oct. 23, 2008
LISN 4	Solar	8028-50-TS-24-BNC	1127	Oct. 23, 2008
Active 18” Loop Antenna	A.H. Systems, Inc.	SAS-562B	241	Aug. 23, 2009

3. EQUIPMENT UNDER TEST (EUT) INFORMATION AND DATA

3.1 Test Item Condition:

The equipment to be tested was received in good condition.

3.2 Testing Algorithm:

The EasyTorque Torque Wrench was configured using software (EasyTorque V1.19 by Atcom Telemetrie) to permit frequency changes from low (Channel 01, 915.40 MHz) to high (Channel 50, 916.91 MHz). FCC test firmware was provided to allow continuous transmission using FSK modulation. All measurements were performed at maximum power output (Level 13).

3.3 Conducted Emissions:

Since the EasyTorque Torque Wrench will operate (transmit) with the AC battery charger connected, measurements were performed to demonstrate compliance with Conducted Emissions limits. The Wrench was placed on a 1.0 x 1.5m non-conductive table, 0.8m above a horizontal ground plane and 0.4m from a vertical ground plane. Power was provided to the EUT (battery charger) through a LISN bonded to the horizontal ground plane. The LISN was supplied power through a filtered AC source. The RF output port of the LISN was connected to the input of measuring receiver via a transient limiter and emissions in the 150 kHz to 30 MHz were measured. The final measurements were recorded using Quasi-Peak and Average detectors, with the resolution bandwidth set to 9 kHz. The raw measurements were corrected to allow for LISN, coax and transient limiter loss. Conducted emissions were measured with the Wrench operating on both Channel 01 and Channel 50. Data for the conducted emissions can be found in Section 6.0.

3.4 Radiated Emission Testing on Open Area Test Site (OATS):

The Wrench was initially characterized in a semi-anechoic chamber over a frequency range of 1.7 MHz to 5 GHz. Magnetic field emissions were measured below 30 MHz and electric field emissions were examined above 30 MHz. The Wrench was characterized operating on both Channel 01 and Channel 50, with a fully charged battery and with the battery charger connected.

The final radiated emissions measurements were performed on an Open Area Test Site (OATS). The Wrench was tested at 3.0 meter distance below 5 GHz and 1 meter distance above 5 GHz. The emissions were maximized by rotating the Wrench mounted on the 0.8 meter high test stand while raising/lowering the antenna mounted on a 4.0 meter mast. Additionally, the Wrench was examined in three orthogonal positions to ensure maximization of emissions. Both horizontal and vertical field components were measured above 30 MHz. A resolution bandwidth of 9 kHz was used between 1.7 to 30 MHz, 120 kHz between 30 to 1000 MHz, and 1 MHz between 1 to 20 GHz. On frequencies at or below 1 GHz, the detector function was set to Quasi-Peak mode and above 1 GHz, the detector was set to Average mode. The raw measurements were corrected to allow for antenna factor, cable loss and preamplifier gain. Radiated emissions were measured with the Wrench operating on both Channel 01 and Channel 50, with a fully charged battery and with the battery charger connected. All radiated emissions measurements can be found in Section 7.0. Varying the input power to the battery charger between 85% and 115% of the rated supply voltage demonstrated no measurable change in the level of emissions.

4. EUT CONFIGURATION AND CABLES

4.1. Equipment Under Test (EUT):

Device	Manufacturer	Model Number	Serial Number
Torque Wrench	SEEG	CS5-25	F0120012

4.2. Accessories (Support Equipment):

Device	Manufacturer	Model Number	Serial Number
Battery Charger	Mascot	Type 2116 (SEEG p/n CS-ALIM-C)	None Specified

4.3. Cables:

Cable Function	Length	Shielded (Yes/No)
DC Power Cable (from Charger)	1.8 meters	No

5. PRODUCT DESCRIPTION

The EasyTorque Torque Wrench is based on an Analog Devices ADμ #814 (8051 based) control coupled with a Chipcon SmartRF CC1070 single chip, low power RF transmitter. The transmitter incorporates PLL frequency control based on a 14.7 MHz crystal. The firmware is set to provide fifty 25 kHz channels between 915.40 to 916.91 MHz. The transmitted data is impressed on the RF carrier using frequency shift keying (FSK). The maximum power output is 8dBm.

The torque Wrench is battery operated, using 3 AAA Ni-MH rechargeable batteries. The Wrench is supplied with a Mascot type 2116 Ni-MH charger (SEEG p/n CS-ALIM-C). The Wrench is operable both on battery and with the charger connected. Hence, conducted and radiated emissions measurements were performed with the charger connected. Additional radiated emissions measurements were performed without the charger connected.

Since the Wrench is able to transmit over 915.40 to 916.91 MHz (1.5 MHz span), the transmitter was evaluated with the frequency set to Channel 01 (915.40 MHz) and Channel 50 (916.91 MHz) per requirements of FCC Part 15.31(m).

6. FCC PART 15.207(a) – CONDUCTED EMISSIONS

6.1. Requirements

The Wrench/battery charger shall not conduct radio frequency voltage back onto the AC power line in excess of the limits stated in FCC Part 15.207(a).

The conducted emissions measurements were made with the transmitter set at Channel 01 (915.40 MHz) and at Channel 50 (916.91 MHz). The basic test setup is shown in Pictorial 1.

6.2. Results

The measured conducted emissions (peak readings) with the Wrench operating on Channel 01 (915.40 MHz) are shown in the Spectral Plots of Figures 1 and 2. The worst case emissions were re-measured separately, using quasi-peak and average detectors. The results of these measurements are summarized in Tables 1 and 2.

Table 1
Conducted Emissions – AC Mains, Line 1
Transmitting on Channel 01

Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBµV)	Adjustment (dB)	Results (dBµV)	Limit (dBµV)	Margin (dB)
1	Line 1	0.174000	Quasi-Peak	43.5	11.1	54.6	64.8	-10.2
			Average	30.4	11.1	41.5	54.8	-13.3
2	Line 1	0.217000	Quasi-Peak	44.2	10.8	55.0	62.9	-7.9
			Average	34.0	10.8	44.8	52.9	-8.1
3	Line 1	0.259000	Quasi-Peak	32.5	10.6	43.1	61.5	-18.4
			Average	25.1	10.6	35.7	51.5	-15.8
4	Line 1	0.304000	Quasi-Peak	35.3	10.5	45.8	60.1	-14.3
			Average	33.0	10.5	43.5	50.1	-6.6
5	Line 1	0.346000	Quasi-Peak	25.5	10.4	35.9	59.1	-23.2
			Average	23.1	10.4	33.5	49.1	-15.6

Table 2
Conducted Emissions – AC Mains, Line 2
Transmitting on Channel 01

Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBµV)	Adjustment (dB)	Results (dBµV)	Limit (dBµV)	Margin (dB)
1	Line 2	0.174000	Quasi-Peak	43.2	11.1	54.3	64.8	-10.5
			Average	31.6	11.1	42.7	54.8	-12.1
2	Line 2	0.217000	Quasi-Peak	44.0	10.8	54.8	62.9	-8.1
			Average	34.4	10.8	45.2	52.9	-7.7
3	Line 2	0.259000	Quasi-Peak	31.4	10.6	42.0	61.5	-19.5
			Average	24.2	10.6	34.8	51.5	-16.7
4	Line 2	0.304000	Quasi-Peak	33.8	10.5	44.3	60.1	-15.8
			Average	30.8	10.5	41.3	50.1	-8.8
5	Line 2	3.700000	Quasi-Peak	23.2	10.2	33.4	56.0	-22.6
			Average	10.4	10.2	20.6	46.0	-25.4

The conducted emissions found with the Wrench operating on Channel 50 (916.91 MHz) are shown in Figures 3 and 4, with the worst case discrete emissions measurements shown in Tables 3 and 4.

Table 3
Conducted Emissions – AC Mains, Line 1
Transmitting on Channel 50

Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBµV)	Adjustment (dB)	Results (dBµV)	Limit (dBµV)	Margin (dB)
1	Line 1	0.174000	Quasi-Peak	44.1	11.1	55.2	64.8	-9.6
			Average	30.3	11.1	41.4	54.8	-13.4
2	Line 1	0.217000	Quasi-Peak	44.3	10.8	55.1	62.9	-7.8
			Average	33.5	10.8	44.3	52.9	-8.6
3	Line 1	0.259000	Quasi-Peak	33.3	10.6	43.9	61.5	-17.6
			Average	25.8	10.6	36.4	51.5	-15.1
4	Line 1	0.304000	Quasi-Peak	35.8	10.5	46.3	60.1	-13.8
			Average	33.3	10.5	43.8	50.1	-6.3
5	Line 1	0.346000	Quasi-Peak	26.0	10.4	36.4	59.1	-22.7
			Average	23.6	10.4	34.0	49.1	-15.1

Table 4
Conducted Emissions – AC Mains, Line 2
Transmitting on Channel 50

Top Discrete Measurements								
No.	Conductor	Frequency (MHz)	Detector	Level (dBµV)	Adjustment (dB)	Results (dBµV)	Limit (dBµV)	Margin (dB)
1	Line 2	0.174000	Quasi-Peak	43.6	11.1	54.7	64.8	-10.1
			Average	31.6	11.1	42.7	54.8	-12.1
2	Line 2	0.217000	Quasi-Peak	43.8	10.8	54.6	62.9	-8.3
			Average	34.1	10.8	44.9	52.9	-8.0
3	Line 2	0.259000	Quasi-Peak	32.1	10.6	42.7	61.5	-18.8
			Average	24.5	10.6	35.1	51.5	-16.4
4	Line 2	0.304000	Quasi-Peak	33.6	10.5	44.1	60.1	-16.0
			Average	30.4	10.5	40.9	50.1	-9.2
5	Line 2	0.346000	Quasi-Peak	23.0	10.4	33.4	59.1	-25.7
			Average	18.7	10.4	29.1	49.1	-20.0

The measured conducted emissions remain below the limits stated in FCC Part 15.207(a). The Wrench/Battery Charger satisfied the FCC requirements for suppression of conducted emissions.

7. FCC PART 15.249 – RADIATED EMISSIONS

7.1. Requirements:

The field strength of the emissions (measured at 3 meters) from the Wrench shall not exceed 50 mV/M (94 dBµV/m) at the fundamental frequency and 500µV/m (54 dBµV/m) at the harmonic frequencies per FCC Part 15.249(a). Additionally, spurious emissions outside the 902-928 MHz band shall be suppressed by at least 50 dB or to the FCC Part 15.209(a) limits, whichever is lesser.

The radiated emissions measurements were initially performed in a semi-anechoic chamber to profile the emissions characteristics of the Wrench. These measurements were performed transmitting on Channel 01 (915.40 MHz) and Channel 50 (916.91 MHz) with and without the battery charger connected. The test setups used in the chamber are shown in Pictorials 2-4.

The final compliance measurements were performed on the OATS at a 3 meter distance for frequencies below 5 GHz and at 1 meter above 5 GHz. All spurious, harmonic, fundamental and band-edge measurements were made on the OATS. The Wrench was evaluated transmitting on Channel 01 and Channel 50, with and without the charger. The typical test setups used on the OATS are shown in Pictorials 5-10.

7.2. Results:

The characterization measurements performed in the semi-anechoic chamber are organized as follows:

Figures 5-9 Transmitter Operating on Channel 01, Without Charger
Figures 10-14 Transmitter Operating on Channel 50, Without Charger
Figures 15-19 Transmitter Operating on Channel 01, With Charger
Figures 20-24 Transmitter Operating on Channel 50, With Charger

The compliance measurements performed on the OATS are organized as follows:

Table 5 Transmitter Operating on Channel 01, Without Charger
Table 6 Transmitter Operating on Channel 50, Without Charger
Table 7 Transmitter Operating on Channel 01, With Charger
Table 8 Transmitter Operating on Channel 50, With Charger

Table 5
Radiated Emissions
Transmitter Operating on Channel 01 (915.40 MHz), Without Charger

Frequency (MHz)	Antenna Polarization	Reading[1] (dBuV)	Correction[2] Factor (dB)	Emissions Level (dBuV/m)	Measurement Distance (m)	Emission Extrapolation Factor 1 to 3m (dB)	Emissions Level at 3 meters (dBuV/m)	Limit at 3m (dBuV/m)	Margin (dB)	Orthogonal Positon maximizing emissions	Emisssion Type
167.77	V	7.9	15.2	23.1	3.0	0.0	23.1	43.5	-20.4	2	spurious[3]
167.77	H	12.6	15.0	27.6	3.0	0.0	27.6	43.5	-15.9	2	spurious[3]
915.40	V	41.8	28.7	70.5	3.0	0.0	70.5	94.0	-23.5	2	f_0
915.40	H	45.5	29.2	74.7	3.0	0.0	74.7	94.0	-19.3	2	f_0
1830.76	V	43.6	3.2	46.8	3.0	0.0	46.8	54.0	-7.2	2	f_2
1830.76	H	42.7	3.2	45.9	3.0	0.0	45.9	54.0	-8.1	1	f_2
2746.04	V	34.3	7.5	41.8	3.0	0.0	41.8	54.0	-12.2	2	f_3
2746.04	H	32.4	7.5	39.9	3.0	0.0	39.9	54.0	-14.1	2	f_3
3661.56	V	39.1	11.2	50.3	3.0	0.0	50.3	54.0	-3.7	1	f_4
3661.56	H	35.3	11.2	46.5	3.0	0.0	46.5	54.0	-7.5	2	f_4
4576.96	V	27.6	12.6	40.2	3.0	0.0	40.2	54.0	-13.8	3	f_5
4576.96	H	25.6	12.6	38.2	3.0	0.0	38.2	54.0	-15.8	2	f_5
5492.40	V	27.5	14.8	42.3	1.0	-9.5	32.8	54.0	-21.2	1	f_6
5492.40	H	28.2	14.8	43.0	1.0	-9.5	33.5	54.0	-20.5	1	f_6
6407.80	V	24.3	16.0	40.3	1.0	-9.5	30.8	54.0	-23.2	noise floor	f_7
6407.80	H	24.2	16.0	40.2	1.0	-9.5	30.7	54.0	-23.3	noise floor	f_7
7323.20	V	33.3	18.8	52.1	1.0	-9.5	42.6	54.0	-11.4	2	f_8
7323.20	H	34.0	18.8	52.8	1.0	-9.5	43.3	54.0	-10.7	1	f_8
8238.60	V	23.8	21.4	45.2	1.0	-9.5	35.7	54.0	-18.3	noise floor	f_9
8238.60	H	23.7	21.4	45.1	1.0	-9.5	35.6	54.0	-18.4	noise floor	f_9
9154.00	V	23.1	23.5	46.6	1.0	-9.5	37.1	54.0	-16.9	noise floor	f_{10}
9154.00	H	23.3	23.5	46.8	1.0	-9.5	37.3	54.0	-16.7	noise floor	f_{10}

Notes:

[1] At frequencies below 1 GHz detector function set to Quasi-Peak, above 1 GHz detector function set to Linear Average. Measurements above 1 GHz were also checked with a peak detector but demonstrated no measurable change in the level of emissions.

[2]Correction Factor is the summation of antenna factor, coax factor, and preamplifier gain.

[3]The spurious emissions appear related to the microcontroller.

Table 6
Radiated Emissions
Transmitter Operating on Channel 50 (916.91 MHz), Without Charger

Frequency (MHz)	Antenna Polarization	Reading[1] (dBuV)	Correction[2] Factor (dB)	Emissions Level (dBuV/m)	Measurement Distance (m)	Emission Extrapolation Factor 1 to 3m (dB)	Emissions Level at 3 meters (dBuV/m)	Limit at 3m (dBuV/m)	Margin (dB)	Orthogonal Positon maximizing emissions	Emisssion Type
167.76	V	5.6	15.2	20.8	3.0	0.0	20.8	43.5	-22.7	3	spurious[3]
167.76	H	7.9	15.0	22.9	3.0	0.0	22.9	43.5	-20.6	1	spurious[3]
916.91	V	42.6	28.7	71.3	3.0	0.0	71.3	94.0	-22.7	2	f_0
916.91	H	45.7	29.2	74.9	3.0	0.0	74.9	94.0	-19.1	2	f_0
1833.76	V	41.2	3.2	44.4	3.0	0.0	44.4	54.0	-9.6	2	f_2
1833.76	H	44.0	3.2	47.2	3.0	0.0	47.2	54.0	-6.8	1	f_2
2750.60	V	34.3	7.5	41.8	3.0	0.0	41.8	54.0	-12.2	2	f_3
2750.60	H	34.8	7.5	42.3	3.0	0.0	42.3	54.0	-11.7	2	f_3
3667.56	V	39.9	11.2	51.1	3.0	0.0	51.1	54.0	-2.9	1	f_4
3667.56	H	38.6	11.2	49.8	3.0	0.0	49.8	54.0	-4.2	1	f_4
4584.52	V	28.8	12.6	41.4	3.0	0.0	41.4	54.0	-12.6	3	f_5
4584.52	H	27.0	12.6	39.6	3.0	0.0	39.6	54.0	-14.4	2	f_5
5501.50	V	29.1	14.8	43.9	1.0	-9.5	34.4	54.0	-19.6	2	f_6
5501.50	H	27.1	14.8	41.9	1.0	-9.5	32.4	54.0	-21.6	1	f_6
6418.40	V	24.4	16.0	40.4	1.0	-9.5	30.9	54.0	-23.1	noise floor	f_7
6418.40	H	24.4	16.0	40.4	1.0	-9.5	30.9	54.0	-23.1	noise floor	f_7
7335.30	V	35.1	18.8	53.9	1.0	-9.5	44.4	54.0	-9.6	2	f_8
7335.30	H	35.4	18.8	54.2	1.0	-9.5	44.7	54.0	-9.3	2	f_8
8252.20	V	23.8	21.4	45.2	1.0	-9.5	35.7	54.0	-18.3	noise floor	f_9
8252.20	H	23.7	21.4	45.1	1.0	-9.5	35.6	54.0	-18.4	noise floor	f_9
9169.10	V	23.8	23.5	47.3	1.0	-9.5	37.8	54.0	-16.2	noise floor	f_{10}
9169.10	H	23.9	23.5	47.4	1.0	-9.5	37.9	54.0	-16.1	noise floor	f_{10}

Notes:

[1] At frequencies below 1 GHz detector function set to Quasi-Peak, above 1 GHz detector function set to Linear Average. Measurements above 1 GHz were also checked with a peak detector but demonstrated no measurable change in the level of emissions.

[2]Correction Factor is the summation of antenna factor, coax factor, and preamplifier gain.

[3]The spurious emissions appear related to the microcontroller.

Table 7
Radiated Emissions
Transmitter Operating on Channel 01 (915.40 MHz), With Charger

Frequency (MHz)	Antenna Polarization	Reading[1] (dBuV)	Correction[2] Factor (dB)	Emissions Level (dBuV/m)	Measurement Distance (m)	Emission Extrapolation Factor 1 to 3m (dB)	Emissions Level at 3 meters (dBuV/m)	Limit at 3m (dBuV/m)	Margin (dB)	Orthogonal Positon maximizing emissions	Emisssion Type
35.49	V	6.4	17.0	23.4	3.0	0.0	23.4	40.0	-16.6	3	spurious[3]
39.46	V	11.8	14.2	26.0	3.0	0.0	26.0	40.0	-14.0	3	spurious[3]
43.41	V	20.3	11.5	31.8	3.0	0.0	31.8	40.0	-8.2	3	spurious[3]
46.45	V	22.5	9.9	32.4	3.0	0.0	32.4	40.0	-7.6	3	spurious[3]
47.39	V	25.9	9.6	35.5	3.0	0.0	35.5	40.0	-4.5	3	spurious[3]
47.39	H	12.9	10.4	23.3	3.0	0.0	23.3	40.0	-16.7	3	spurious[3]
50.32	V	28.1	8.9	37.0	3.0	0.0	37.0	40.0	-3.0	3	spurious[3]
50.32	H	14.3	9.4	23.7	3.0	0.0	23.7	40.0	-16.3	3	spurious[3]
51.33	V	29.1	8.7	37.8	3.0	0.0	37.8	40.0	-2.2	3	spurious[3]
51.33	H	15.4	9.2	24.6	3.0	0.0	24.6	40.0	-15.4	3	spurious[3]
55.27	V	25.4	8.8	34.2	3.0	0.0	34.2	40.0	-5.8	2	spurious[3]
55.27	H	16.8	9.1	25.9	3.0	0.0	25.9	40.0	-14.1	3	spurious[3]
55.21	V	22.8	9.1	31.9	3.0	0.0	31.9	40.0	-8.1	3	spurious[3]
63.16	H	19.2	9.1	28.3	3.0	0.0	28.3	40.0	-11.7	3	spurious[3]
117.49	V	10.4	16.0	26.4	3.0	0.0	26.4	43.5	-17.1	3	spurious[3]
134.22	V	6.8	15.8	22.6	3.0	0.0	22.6	43.5	-20.9	3	spurious[3]
150.99	V	11.3	15.1	26.4	3.0	0.0	26.4	43.5	-17.1	3	spurious[3]
150.99	H	10.2	14.9	25.1	3.0	0.0	25.1	43.5	-18.4	2	spurious[3]
167.77	V	20.6	15.2	35.8	3.0	0.0	35.8	43.5	-7.7	1	spurious[3]
184.55	V	11.0	14.4	25.4	3.0	0.0	25.4	43.5	-18.1	2	spurious[3]
167.77	H	21.0	15.0	36.0	3.0	0.0	36.0	43.5	-7.5	3	spurious[3]
915.40	V	47.0	28.7	75.7	3.0	0.0	75.7	94.0	-18.3	2	f_0
915.40	H	50.3	29.2	79.5	3.0	0.0	79.5	94.0	-14.5	2	f_0
1830.76	V	41.8	3.2	45.0	3.0	0.0	45.0	54.0	-9.0	2	f_2
1830.76	H	43.7	3.2	46.9	3.0	0.0	46.9	54.0	-7.1	1	f_2
2746.04	V	32.6	7.5	40.1	3.0	0.0	40.1	54.0	-13.9	2	f_3
2746.04	H	30.8	7.5	38.3	3.0	0.0	38.3	54.0	-15.7	2	f_3
3661.56	V	37.7	11.2	48.9	3.0	0.0	48.9	54.0	-5.1	1	f_4
3661.56	H	37.4	11.2	48.6	3.0	0.0	48.6	54.0	-5.4	1	f_4
4576.96	V	26.2	12.6	38.8	3.0	0.0	38.8	54.0	-15.2	1	f_5
4576.96	H	25.6	12.6	38.2	3.0	0.0	38.2	54.0	-15.8	3	f_5
5492.40	V	27.5	14.8	42.3	1.0	-9.5	32.8	54.0	-21.2	1	f_6
5492.40	H	27.0	14.8	41.8	1.0	-9.5	32.3	54.0	-21.7	2	f_6
6407.80	V	24.3	16.0	40.3	1.0	-9.5	30.8	54.0	-23.2	noise floor	f_7
6407.80	H	24.1	16.0	40.1	1.0	-9.5	30.6	54.0	-23.4	noise floor	f_7
7323.20	V	31.6	18.8	50.4	1.0	-9.5	40.9	54.0	-13.1	2	f_8
7323.20	H	33.2	18.8	52.0	1.0	-9.5	42.5	54.0	-11.5	2	f_8
8238.60	V	23.9	21.4	45.3	1.0	-9.5	35.8	54.0	-18.2	noise floor	f_9
8238.60	H	23.8	21.4	45.2	1.0	-9.5	35.7	54.0	-18.3	noise floor	f_9
9154.00	V	23.3	23.5	46.8	1.0	-9.5	37.3	54.0	-16.7	noise floor	f_{10}
9154.00	H	23.2	23.5	46.7	1.0	-9.5	37.2	54.0	-16.8	noise floor	f_{10}

Notes:

[1] At frequencies below 1 GHz detector function set to Quasi-Peak, above 1 GHz detector function set to Linear Average. Measurements above 1 GHz were also checked with a peak detector but demonstrated no measurable change in the level of emissions.

[2] Correction Factor is the summation of antenna factor, coax factor, and preamplifier gain.

[3] The spurious emissions appear related to the microcontroller.

Table 8
Radiated Emissions
Transmitter Operating on Channel 50 (916.91 MHz), With Charger

Frequency (MHz)	Antenna Polarization	Reading[1] (dBuV)	Correction[2] Factor (dB)	Emissions Level (dBuV/m)	Measurement Distance (m)	Emission Extrapolation Factor 1 to 3m (dB)	Emissions Level at 3 meters (dBuV/m)	Limit at 3m (dBuV/m)	Margin (dB)	Orthogonal Positon maximizing emissions	Emisssion Type
35.52	V	6.6	15.8	22.4	3.0	0.0	22.4	40.0	-17.6	3	spurious[3]
39.49	V	9.2	14.2	23.4	3.0	0.0	23.4	40.0	-16.6	3	spurious[3]
43.45	V	22.7	11.4	34.1	3.0	0.0	34.1	40.0	-5.9	3	spurious[3]
44.45	V	20.6	10.9	31.5	3.0	0.0	31.5	40.0	-8.5	3	spurious[3]
47.39	V	24.5	9.5	34.0	3.0	0.0	34.0	40.0	-6.0	1	spurious[3]
47.43	H	14.0	10.3	24.3	3.0	0.0	24.3	40.0	-15.7	2	spurious[3]
50.33	V	28.6	8.9	37.5	3.0	0.0	37.5	40.0	-2.5	3	spurious[3]
50.33	H	15.5	9.4	24.9	3.0	0.0	24.9	40.0	-15.1	3	spurious[3]
51.33	V	29.5	8.7	38.2	3.0	0.0	38.2	40.0	-1.8	3	spurious[3]
51.33	H	18.0	9.2	27.2	3.0	0.0	27.2	40.0	-12.8	2	spurious[3]
55.28	V	25.5	8.8	34.3	3.0	0.0	34.3	40.0	-5.7	1	spurious[3]
55.28	H	15.6	9.1	24.7	3.0	0.0	24.7	40.0	-15.3	2	spurious[3]
59.22	V	22.9	9.1	32.0	3.0	0.0	32.0	40.0	-8.0	2	spurious[3]
63.17	V	19.5	9.1	28.6	3.0	0.0	28.6	40.0	-11.4	2	spurious[3]
117.56	V	10.4	16.0	26.4	3.0	0.0	26.4	43.5	-17.1	3	spurious[3]
134.21	V	6.8	15.8	22.6	3.0	0.0	22.6	43.5	-20.9	3	spurious[3]
150.99	V	11.8	15.1	26.9	3.0	0.0	26.9	43.5	-16.6	3	spurious[3]
150.99	H	9.2	14.9	24.1	3.0	0.0	24.1	43.5	-19.4	1	spurious[3]
167.77	V	21.5	15.2	36.7	3.0	0.0	36.7	43.5	-6.8	1	spurious[3]
167.77	H	20.6	15.0	35.6	3.0	0.0	35.6	43.5	-7.9	1	spurious[3]
184.55	V	10.6	14.4	25.0	3.0	0.0	25.0	43.5	-18.5	1	spurious[3]
916.91	V	47.8	28.7	76.5	3.0	0.0	76.5	94.0	-17.5	2	f_0
916.91	H	51.4	29.2	80.6	3.0	0.0	80.6	94.0	-13.4	2	f_0
1833.76	V	42.8	3.2	46.0	3.0	0.0	46.0	54.0	-8.0	2	f_2
1833.76	H	38.3	3.2	41.5	3.0	0.0	41.5	54.0	-12.5	1	f_2
2750.60	V	33.5	7.5	41.0	3.0	0.0	41.0	54.0	-13.0	2	f_3
2750.60	H	33.7	7.5	41.2	3.0	0.0	41.2	54.0	-12.8	1	f_3
3667.56	V	39.2	11.2	50.4	3.0	0.0	50.4	54.0	-3.6	1	f_4
3667.56	H	36.9	11.2	48.1	3.0	0.0	48.1	54.0	-5.9	2	f_4
4584.52	V	26.3	12.6	38.9	3.0	0.0	38.9	54.0	-15.1	3	f_5
4584.52	H	25.5	12.6	38.1	3.0	0.0	38.1	54.0	-15.9	1	f_5
5501.50	V	29.0	14.8	43.8	1.0	-9.5	34.3	54.0	-19.7	1	f_6
5501.50	H	26.8	14.8	41.6	1.0	-9.5	32.1	54.0	-21.9	1	f_6
6418.40	V	24.5	16.0	40.5	1.0	-9.5	31.0	54.0	-23.0	noise floor	f_7
6418.40	H	24.3	16.0	40.3	1.0	-9.5	30.8	54.0	-23.2	noise floor	f_7
7335.30	V	33.7	18.8	52.5	1.0	-9.5	43.0	54.0	-11.0	2	f_8
7335.30	H	34.7	18.8	53.5	1.0	-9.5	44.0	54.0	-10.0	1	f_8
8252.20	V	23.8	21.4	45.2	1.0	-9.5	35.7	54.0	-18.3	noise floor	f_9
8252.20	H	23.7	21.4	45.1	1.0	-9.5	35.6	54.0	-18.4	noise floor	f_9
9169.10	V	23.6	23.5	47.1	1.0	-9.5	37.6	54.0	-16.4	noise floor	f_{10}
9169.10	H	23.8	23.5	47.3	1.0	-9.5	37.8	54.0	-16.2	noise floor	f_{10}

Notes:

[1] At frequencies below 1 GHz detector function set to Quasi-Peak, above 1 GHz detector function set to Linear Average. Measurements above 1 GHz were also checked with a peak detector but demonstrated no measurable change in the level of emissions.

[2] Correction Factor is the summation of antenna factor, coax factor, and preamplifier gain.

[3] The spurious emissions appear related to the microcontroller.

The band-edge analysis performed on the OATS used the EUT orthogonal position, turntable and antenna placement that maximizd the field strength of the fundamental. With the modulated transmitter operating on Channels 01 and 50, the resultant spectrum was recorded over the 902-928 MHz band. The spectral plots are presented as follows:

Figure 25 Band-edge Characteristic – Channel 01
Figure 26 Band-edge Characteristic – Channel 50

Reviewing the OATS data, it is evident that the Wrench operating with or without the battery charger meets FCC Part 15.249(a)(d) requirements. The worst case spurious emissions appear below 200 MHz and are related to the microcontroller. The amplitude of these emissions increase with connection of the battery charger. The transmitter portion of the Wrench generates a fundamental emission well below the FCC 94 dBµV/m limit (typically less than 80.5 dBµV/m). The transmitter exhibits maximum harmonic radiation on the second and fourth overtones they remain 6.8 and 2.9 dB below the limit, respectively.

The band-edge measurements show that the transmitter is free of spurious modulation products. The transmitter meets FCC Part 15.249(d) requirements).

Based on these measurements, the Wrench/Battery Charger meets FCC part 15.249 requirements for suppression of radiated emissions.

8. FIGURES – SPECTRAL DATA PLOTS

Figure 1: Conducted Emissions, Line 1 – Peak Reading
Transmitting on Channel 01

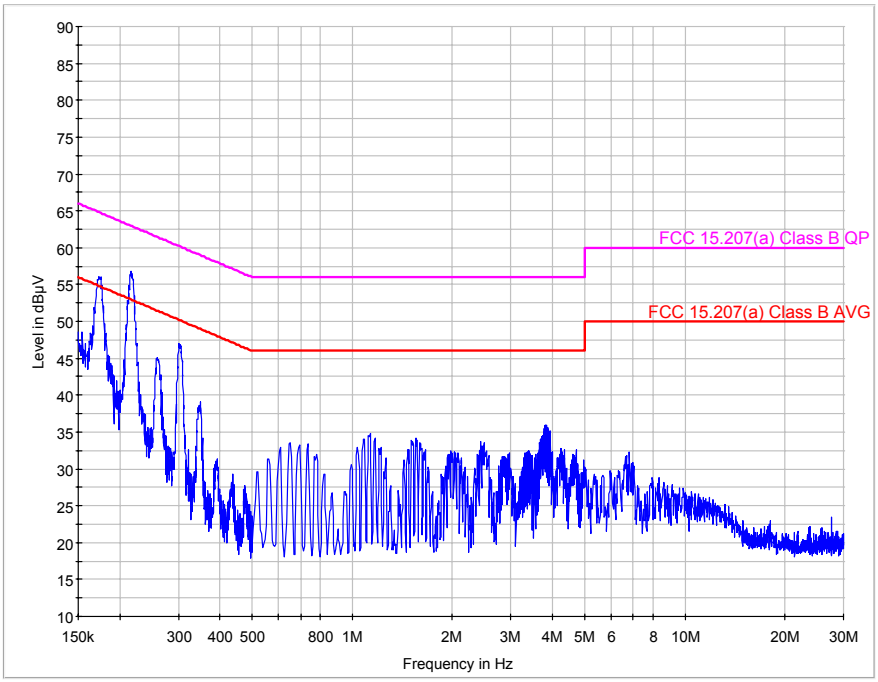


Figure 2: Conducted Emissions, Line 2 – Peak Reading
Transmitting on Channel 01

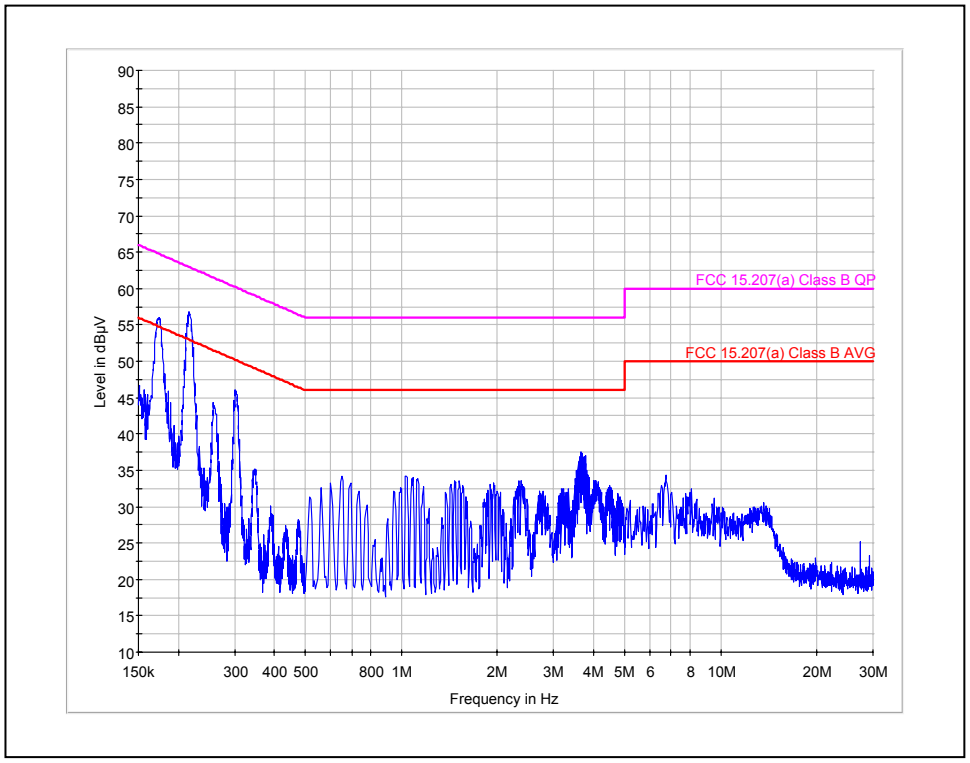


Figure 3: Conducted Emissions, Line 1 – Peak Reading
Transmitting on Channel 50

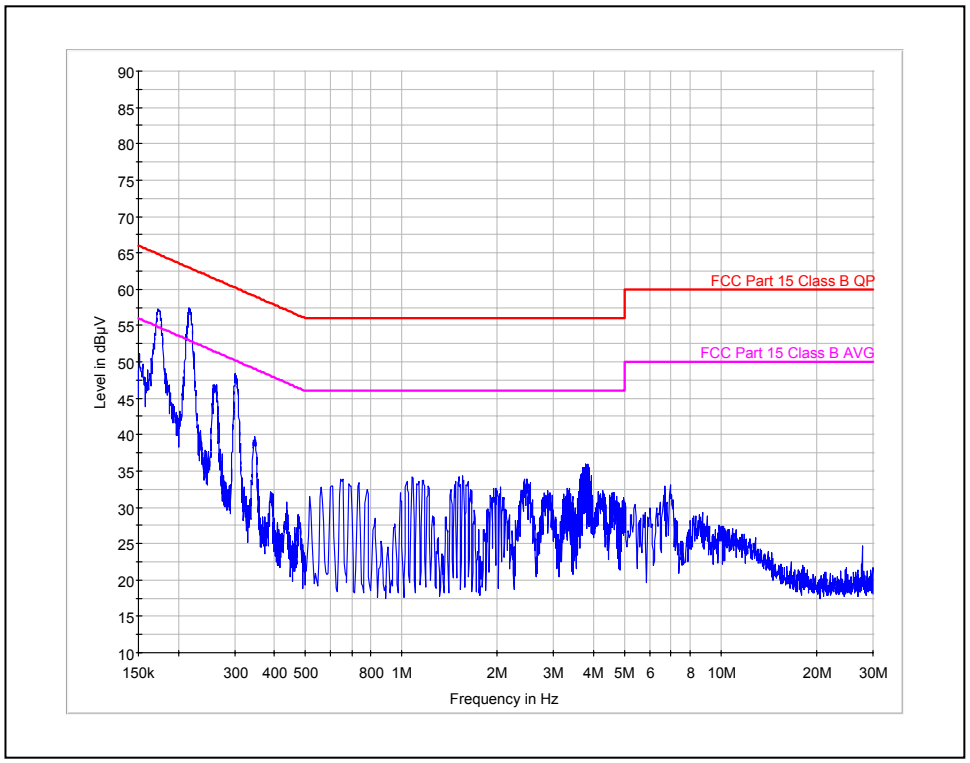


Figure 4: Conducted Emissions, Line 2 – Peak Reading
Transmitting on Channel 50

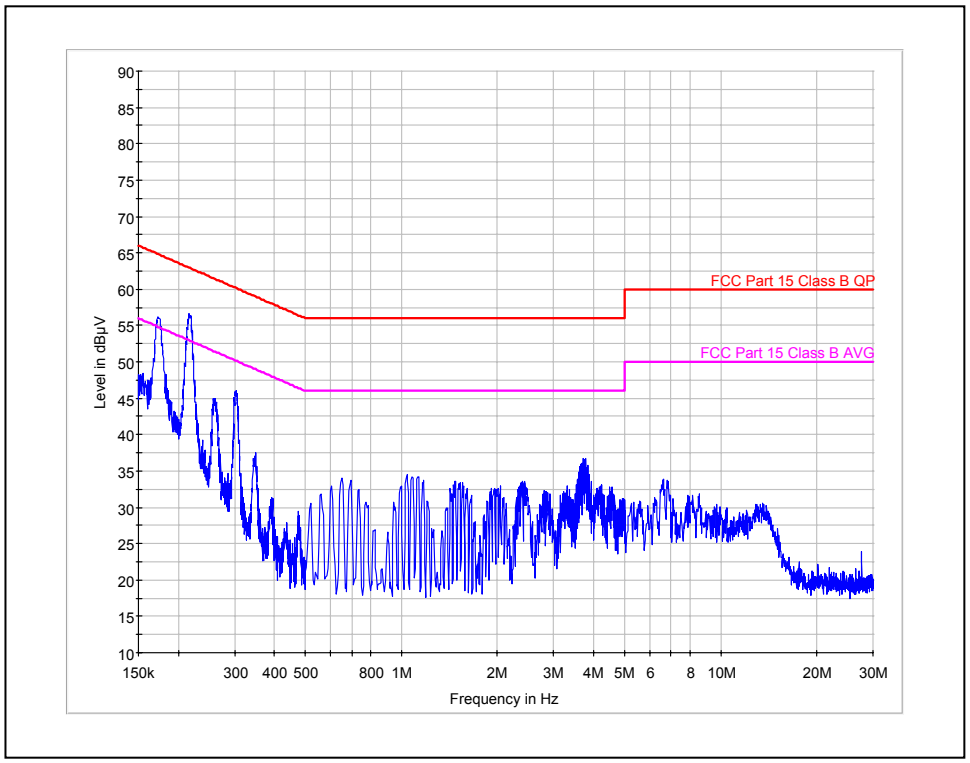


Figure 5: Radiated Emissions, Characterization, 1.7-30 MHz
H-Field Loop Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 01, Without Charger

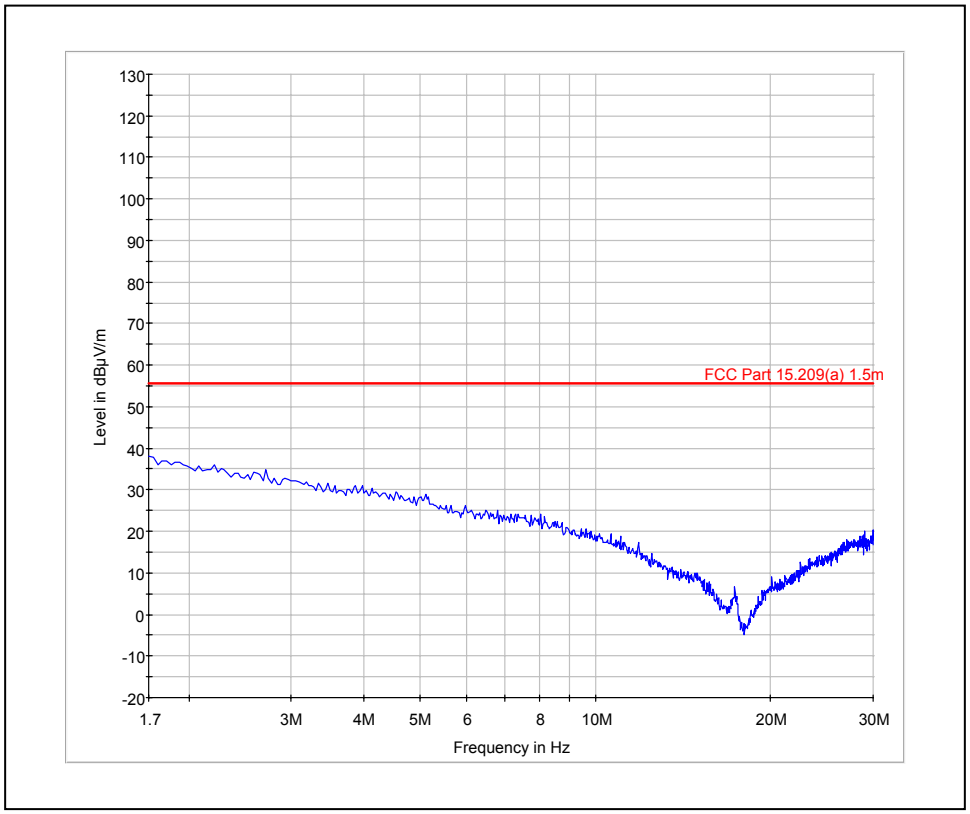


Figure 6: Radiated Emissions, Characterization, 30-1000 MHz
E-Field Vertical Bilog Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 01, Without Charger

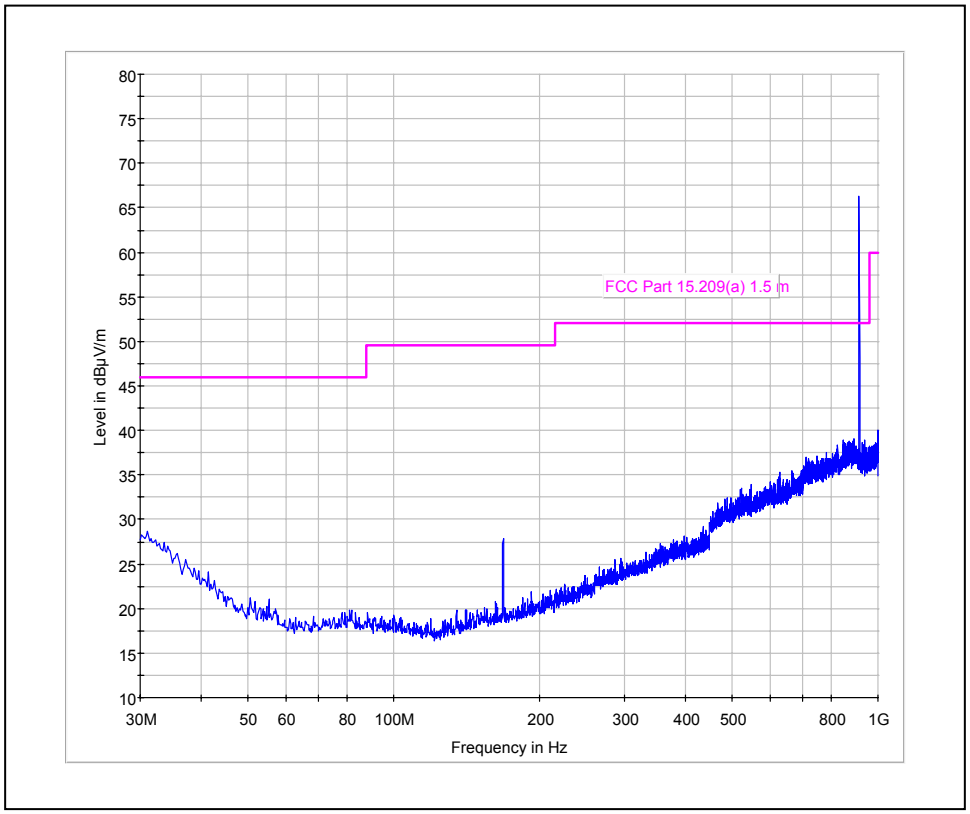


Figure 7: Radiated Emissions, Characterization, 30-1000 MHz
E-Field Horizontal Bilog Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 01, Without Charger

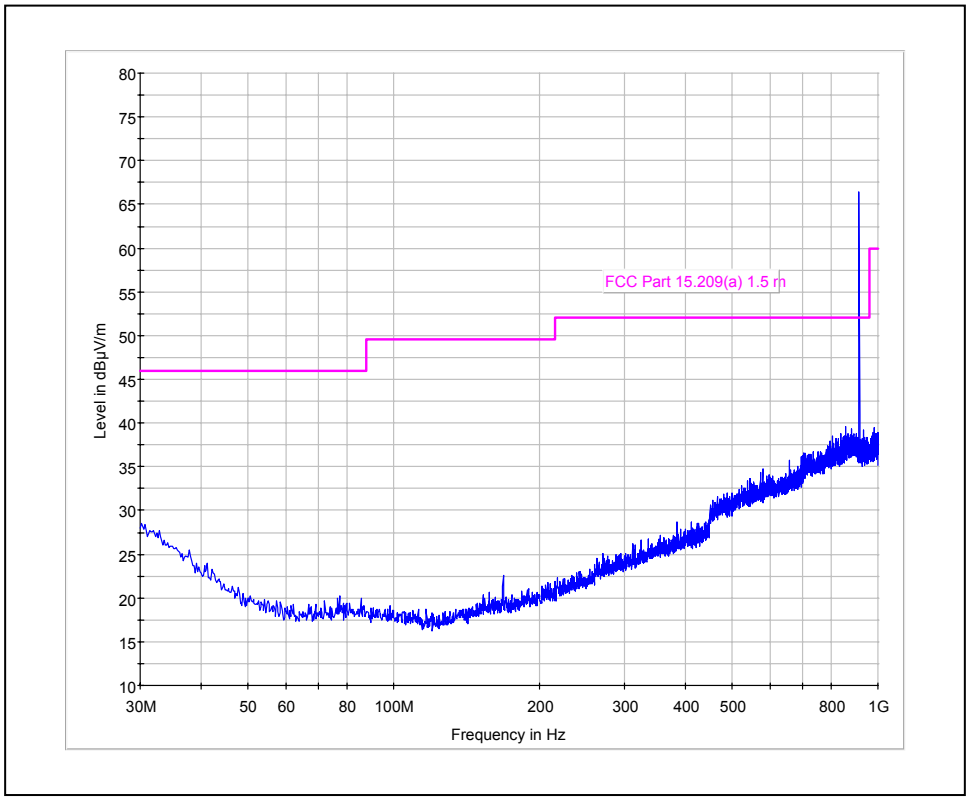


Figure 8: Radiated Emissions, Characterization, 1000-5000 MHz
E-Field Vertical Horn Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 01, Without Charger

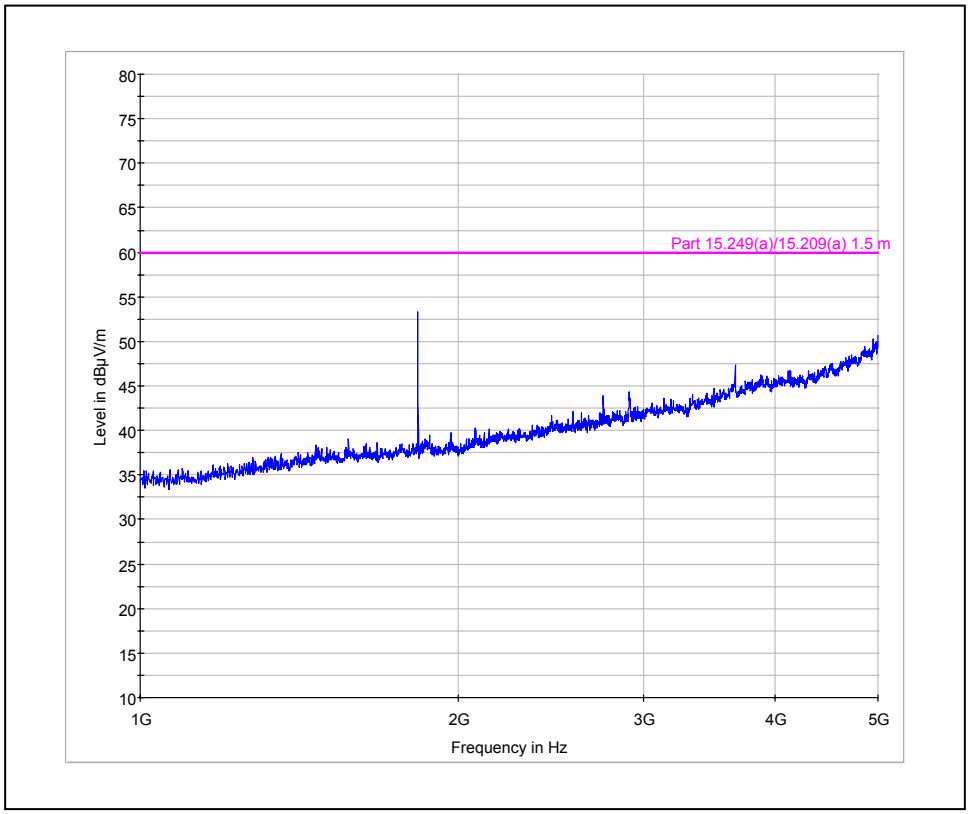


Figure 9: Radiated Emissions, Characterization, 1000-5000 MHz
E-Field Horizontal Horn Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 01, Without Charger

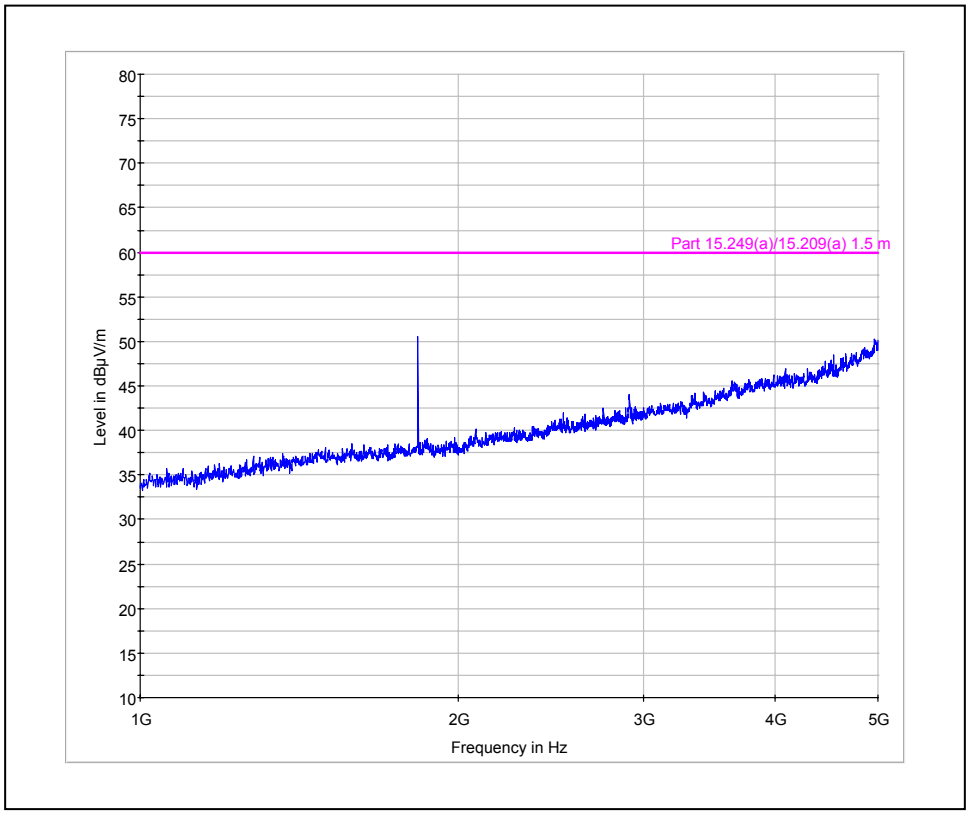


Figure 10: Radiated Emissions, Characterization, 1.7-30 MHz
H-Field Loop Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 50, Without Charger

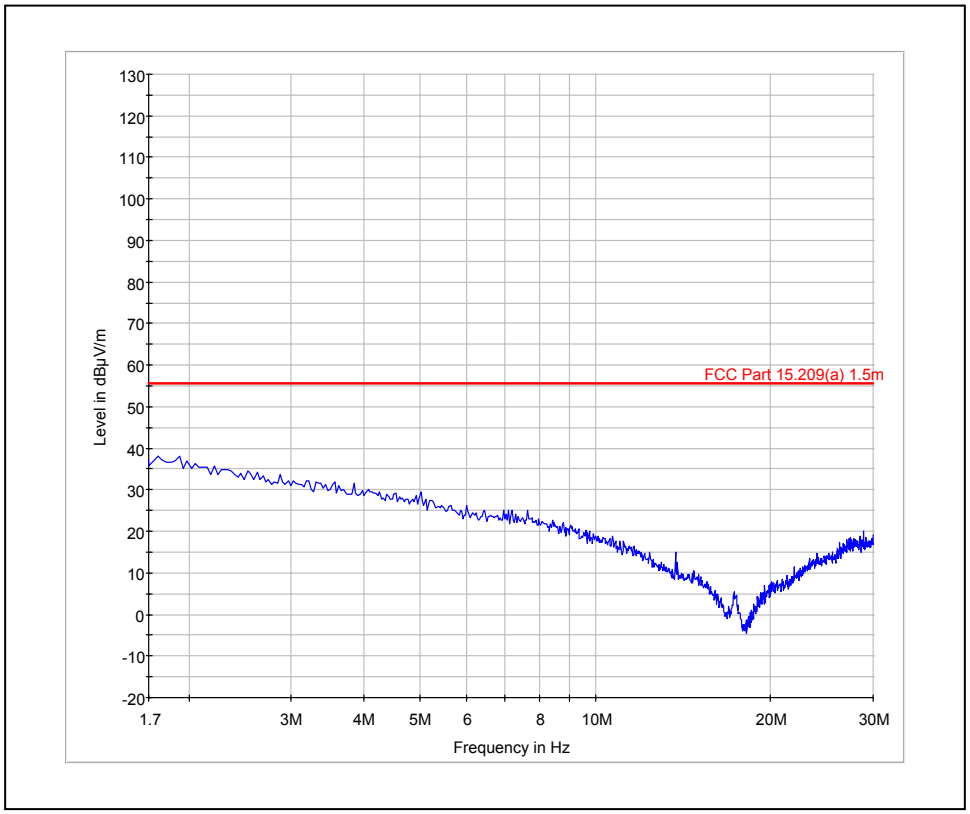


Figure 11: Radiated Emissions, Characterization, 30-1000 MHz
E-Field Vertical Bilog Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 50, Without Charger

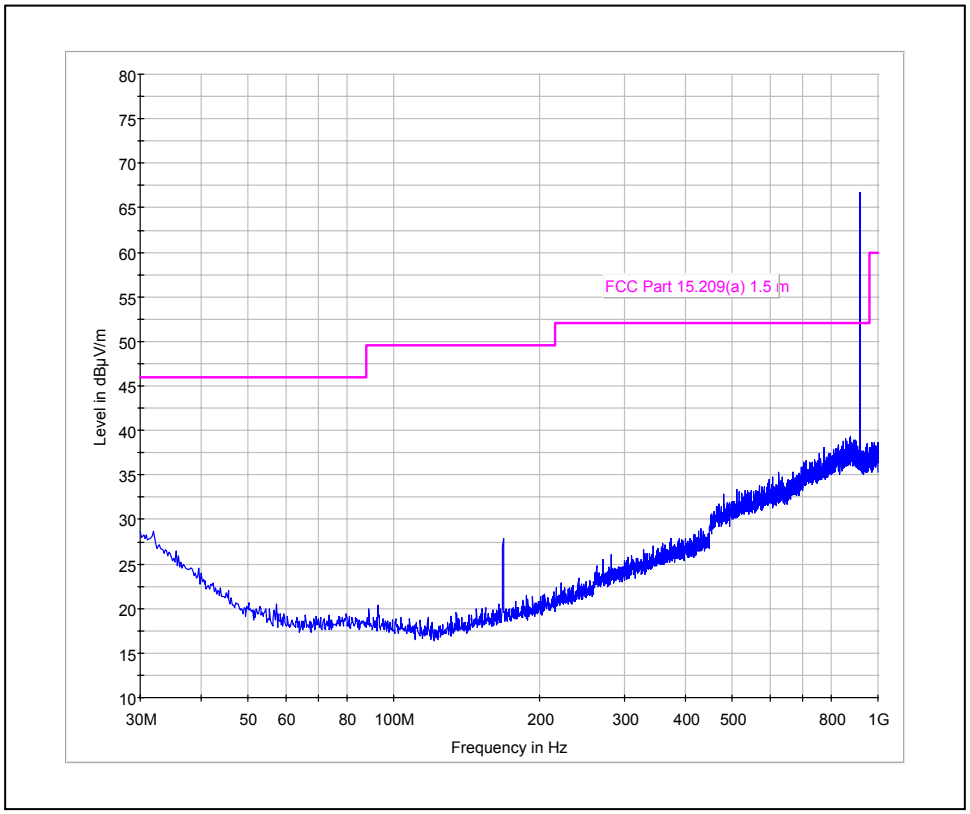


Figure 12: Radiated Emissions, Characterization, 30-1000 MHz
E-Field Horizontal Bilog Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 50, Without Charger

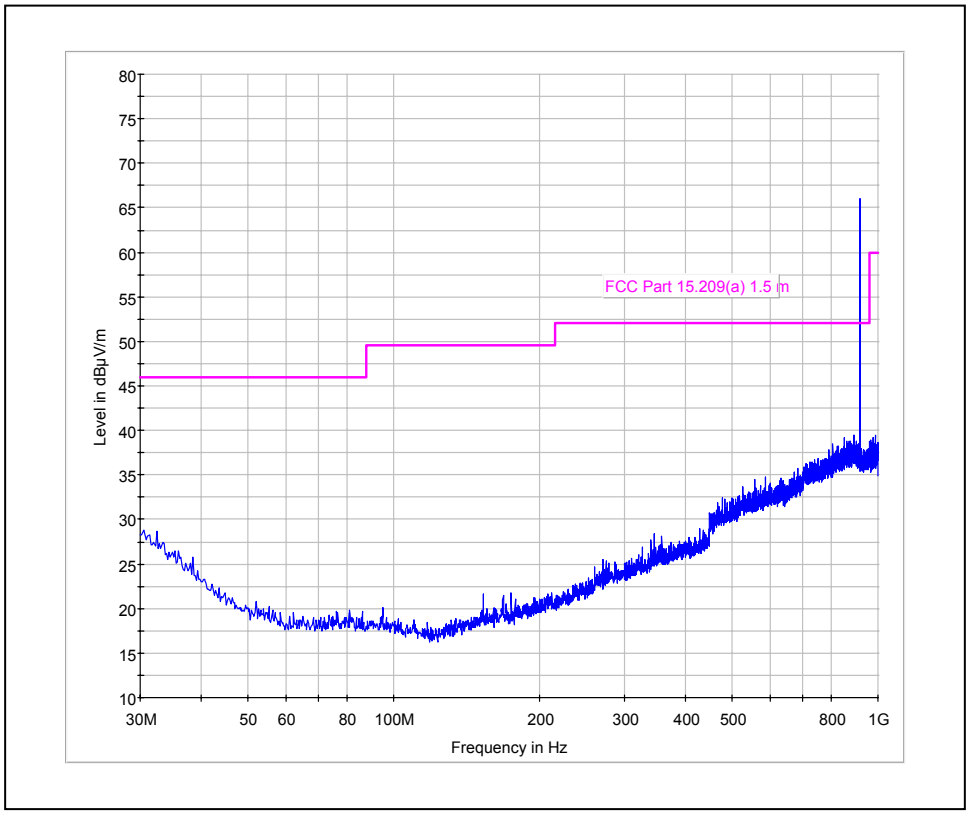


Figure 13: Radiated Emissions, Characterization, 1000-5000 MHz
E-Field Vertical Horn Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 50, Without Charger

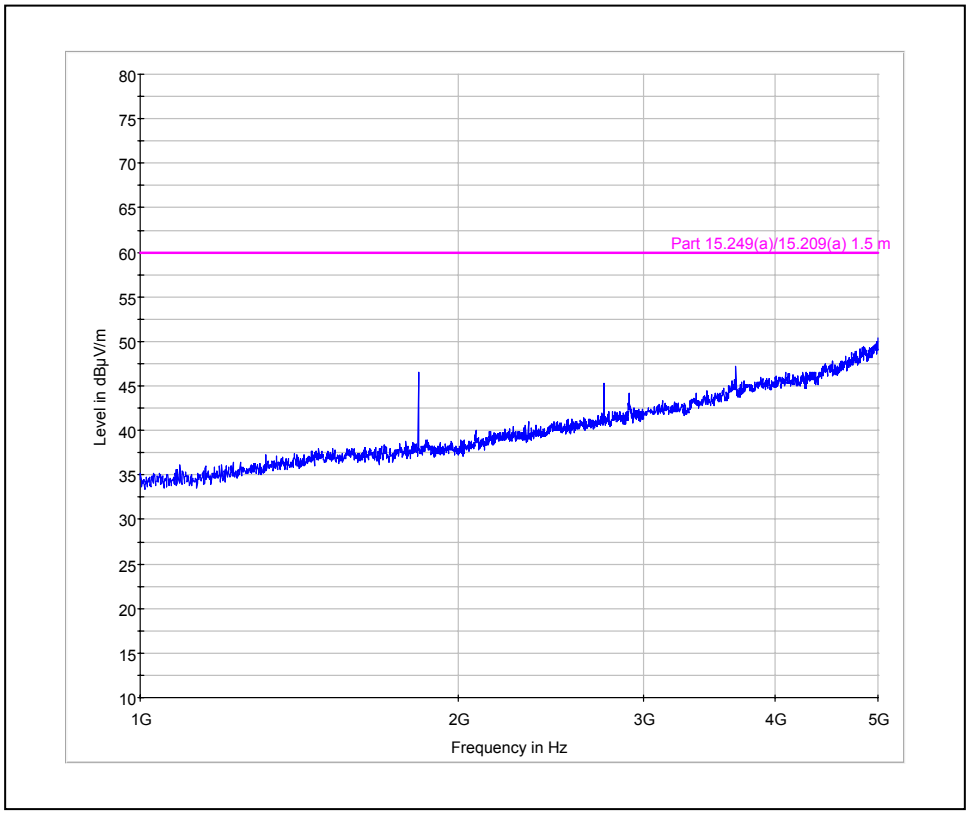


Figure 14: Radiated Emissions, Characterization, 1000-5000 MHz E-Field Horizontal Horn Antenna, 1.5m Distance – Peak Reading Transmitting on Channel 50, Without Charger

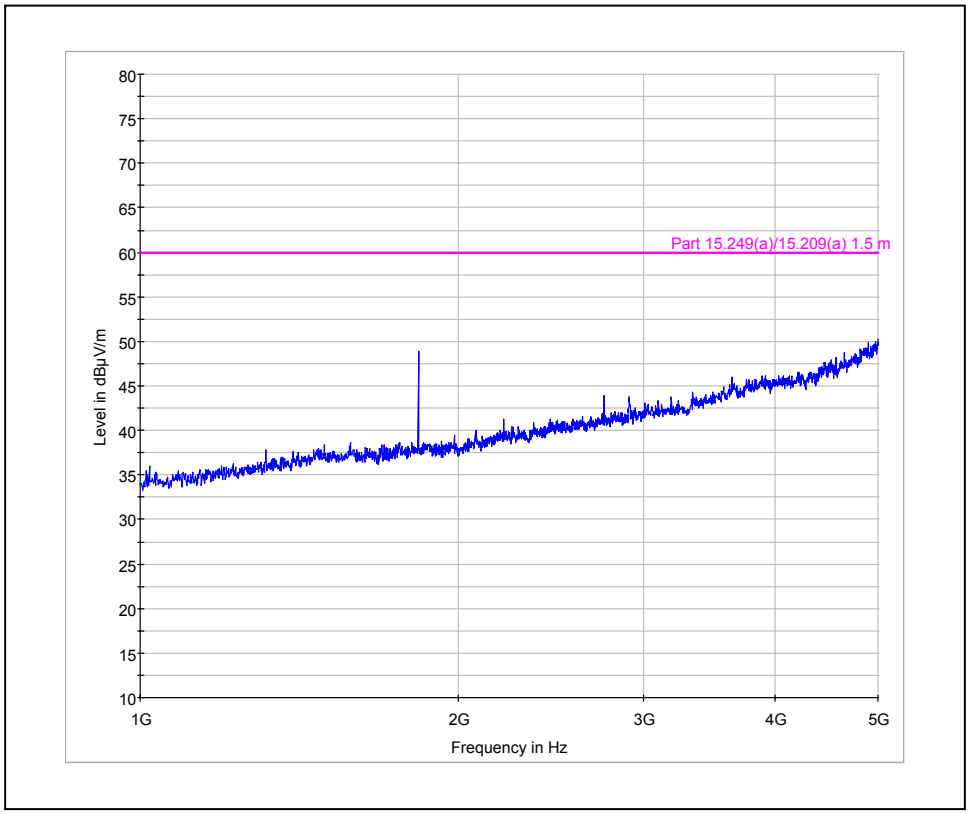


Figure 15: Radiated Emissions, Characterization, 1.7-30 MHz
H-Field Loop Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 01, With Charger

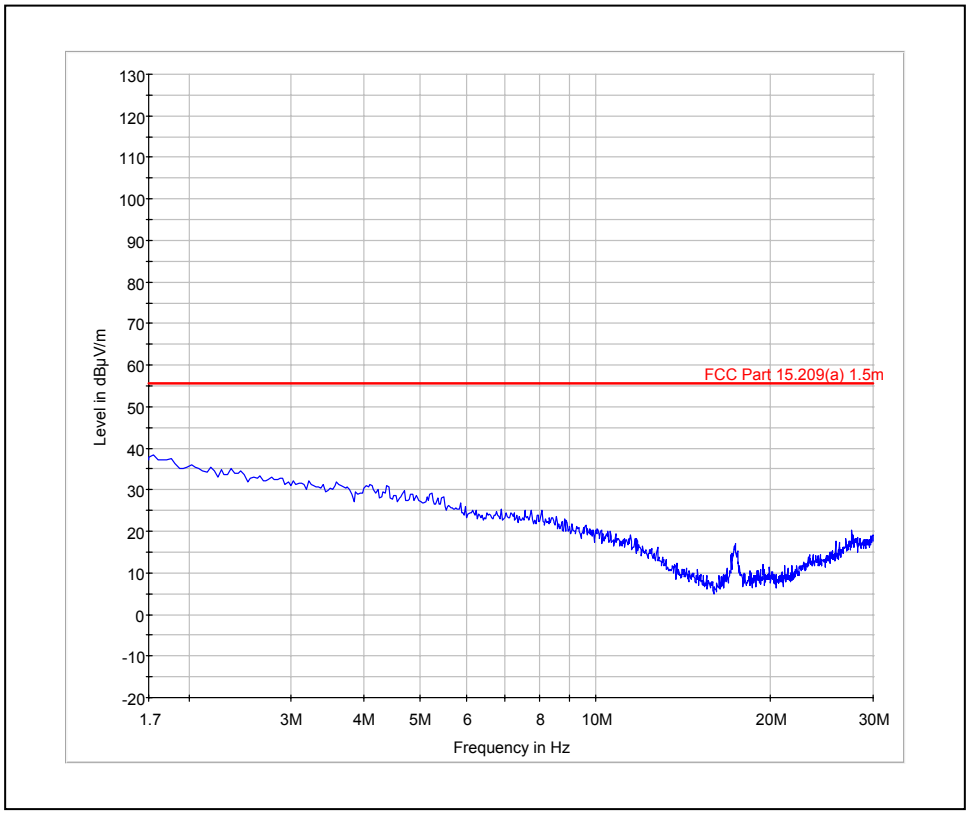


Figure 16: Radiated Emissions, Characterization, 30-1000 MHz
E-Field Vertical Bilog Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 01, With Charger

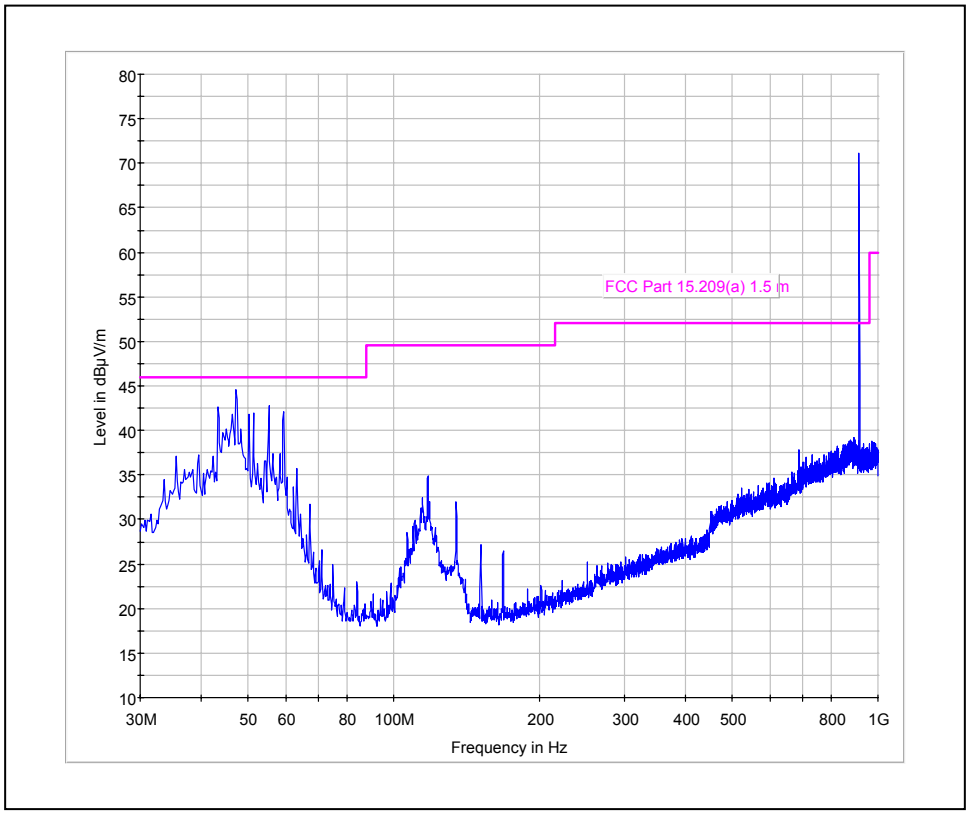


Figure 17: Radiated Emissions, Characterization, 30-1000 MHz
E-Field Horizontal Bilog Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 01, With Charger

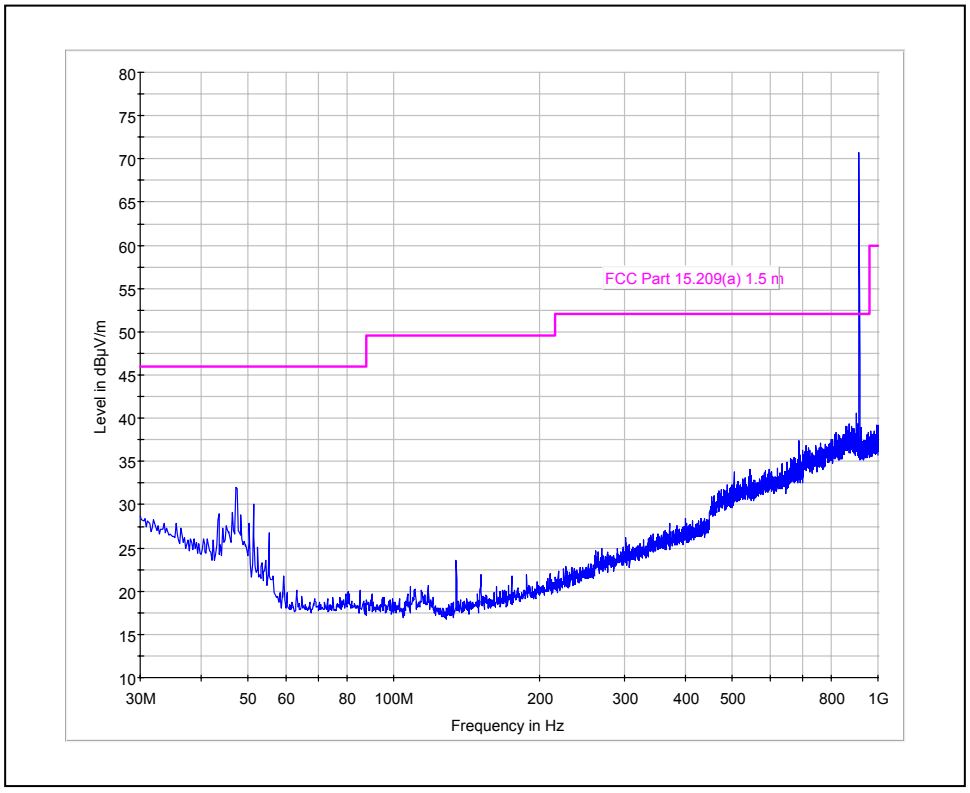


Figure 18: Radiated Emissions, Characterization, 1000-5000 MHz
E-Field Vertical Horn Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 01, With Charger

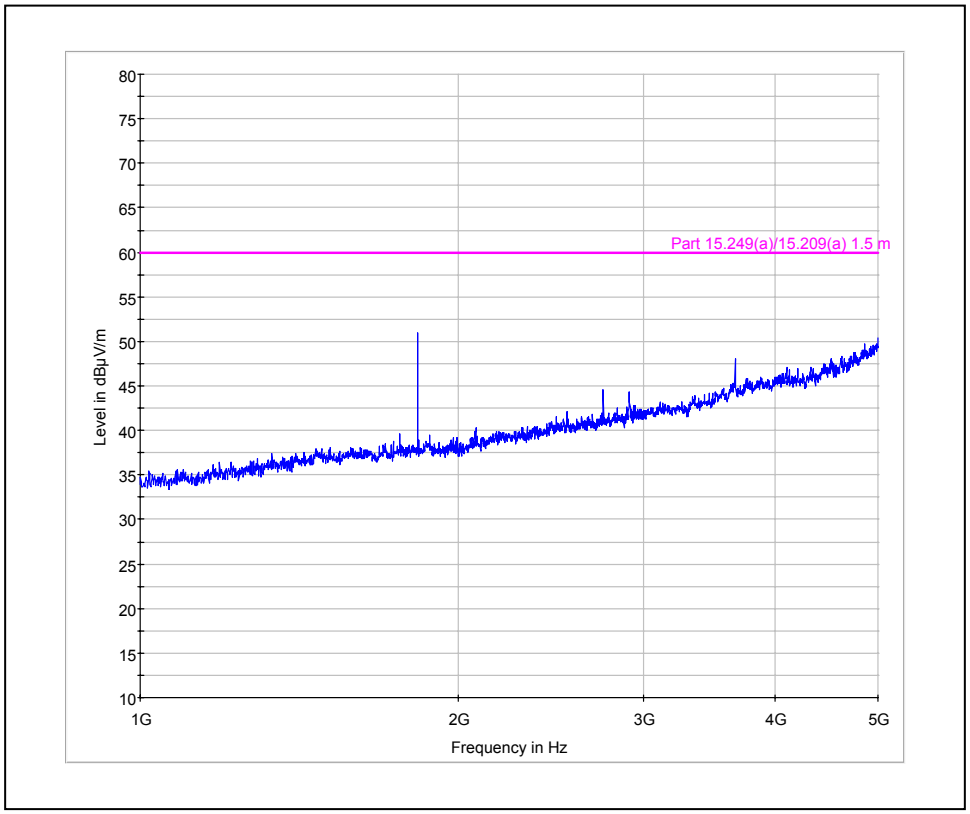


Figure 19: Radiated Emissions, Characterization, 1000-5000 MHz E-Field Horizontal Horn Antenna, 1.5m Distance – Peak Reading Transmitting on Channel 01, With Charger

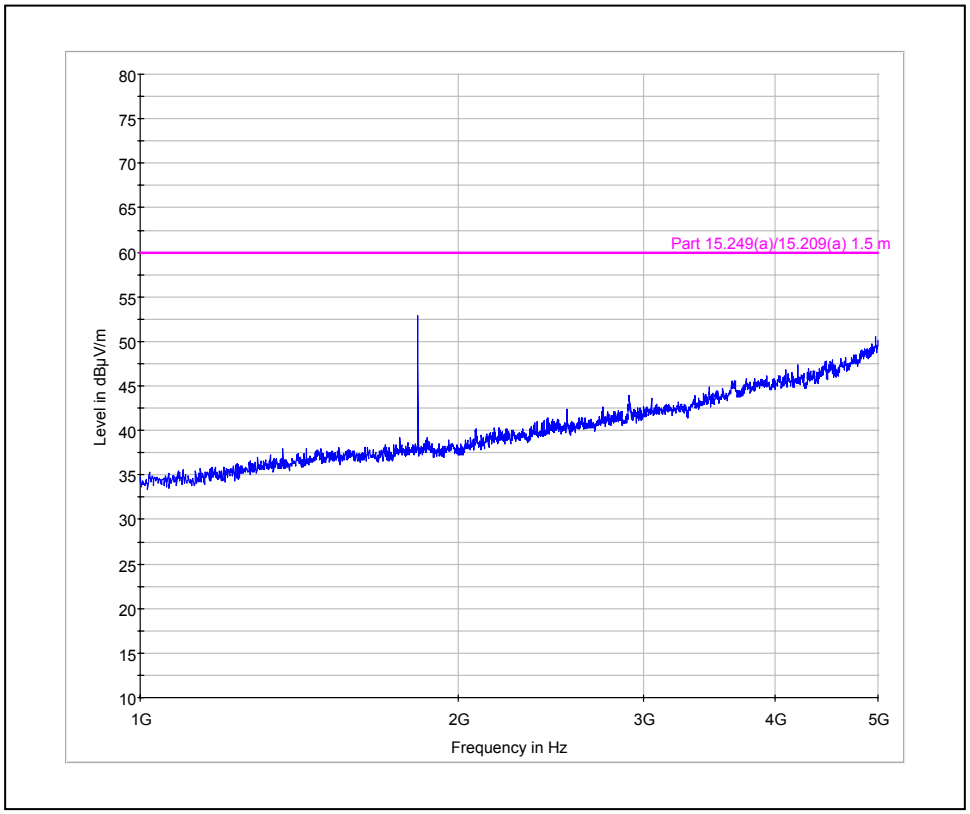


Figure 20: Radiated Emissions, Characterization, 1.7-30 MHz
H-Field Loop Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 50, With Charger

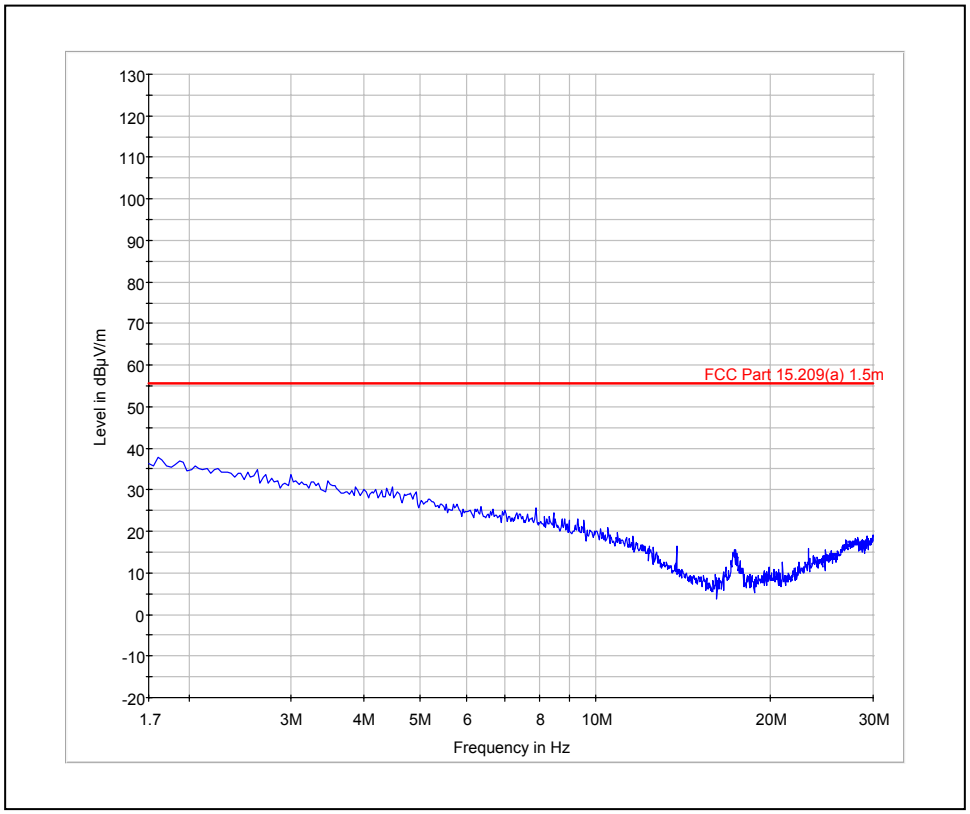


Figure 21: Radiated Emissions, Characterization, 30-1000 MHz
E-Field Vertical Bilog Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 50, With Charger

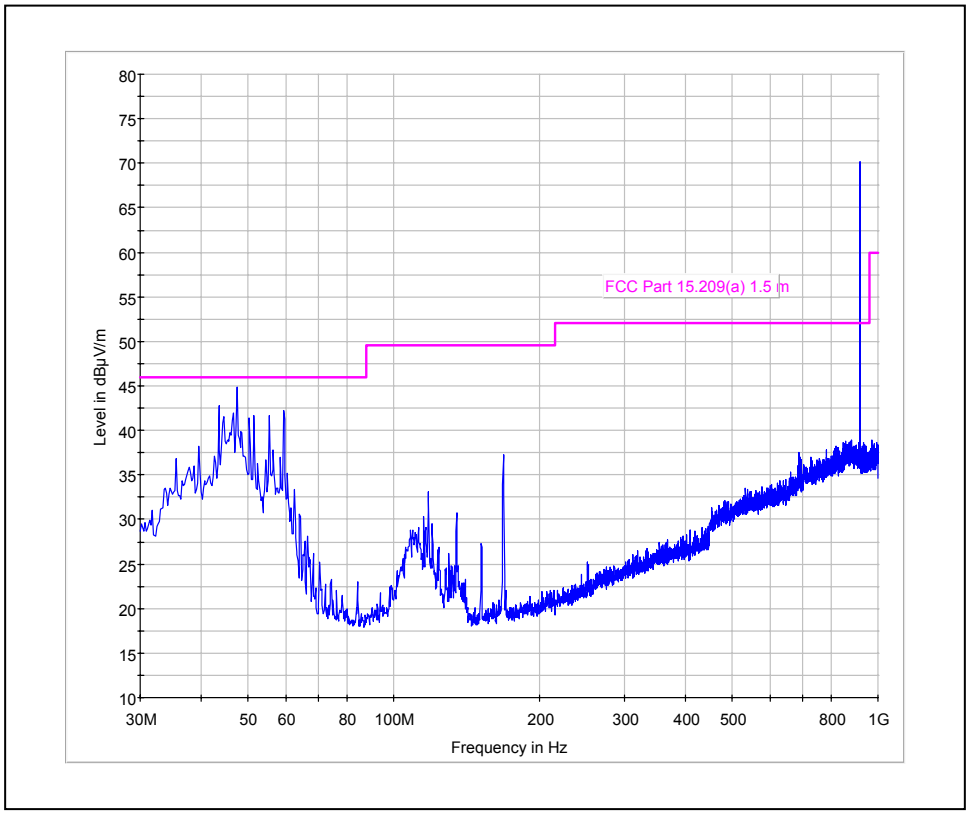


Figure 22: Radiated Emissions, Characterization, 30-1000 MHz
E-Field Horizontal Bilog Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 50, With Charger

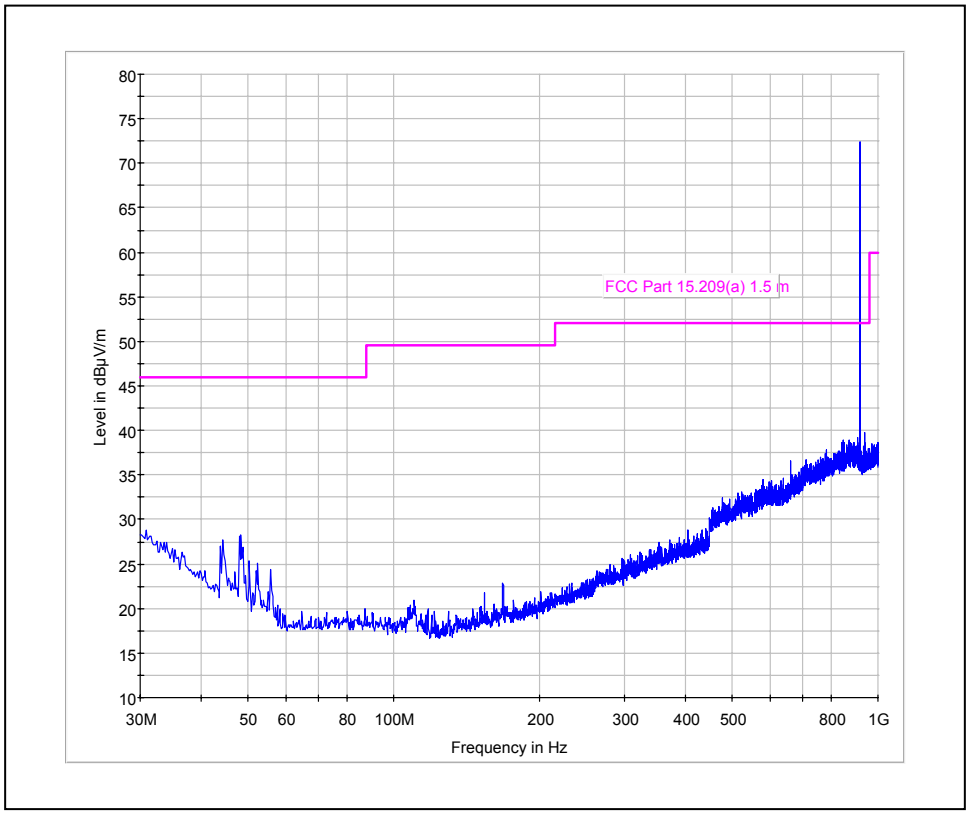


Figure 23: Radiated Emissions, Characterization, 1000-5000 MHz
E-Field Vertical Horn Antenna, 1.5m Distance – Peak Reading
Transmitting on Channel 50, With Charger

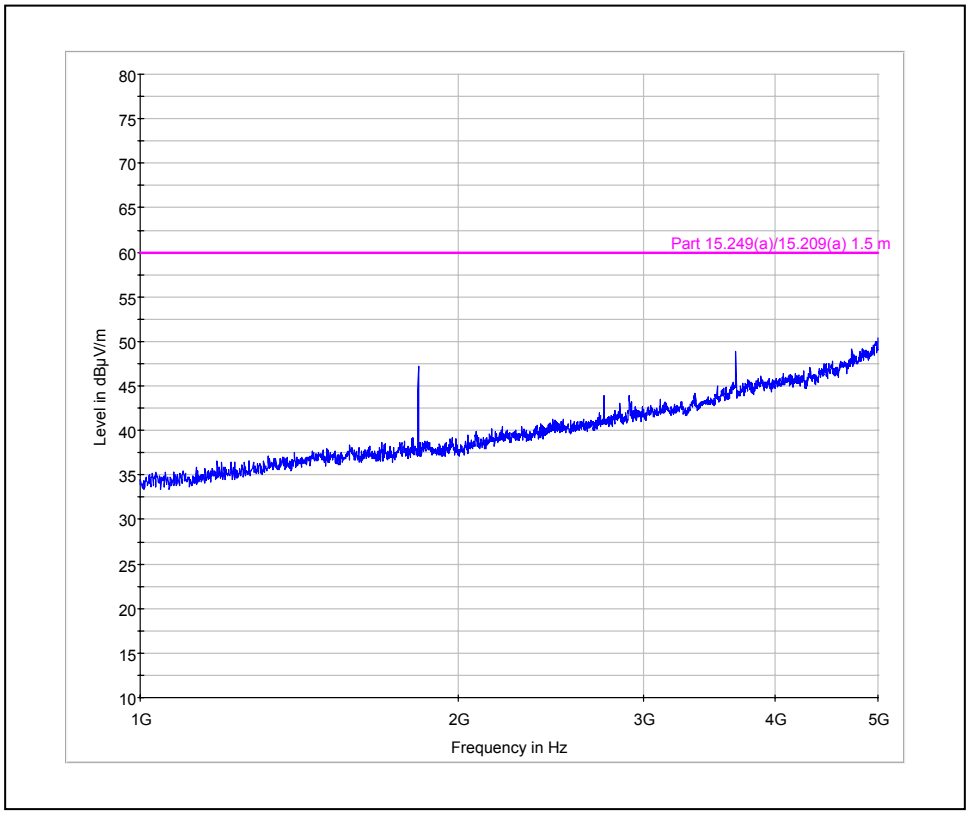


Figure 24: Radiated Emissions, Characterization, 1000-5000 MHz E-Field Horizontal Horn Antenna, 1.5m Distance – Peak Reading Transmitting on Channel 50, With Charger

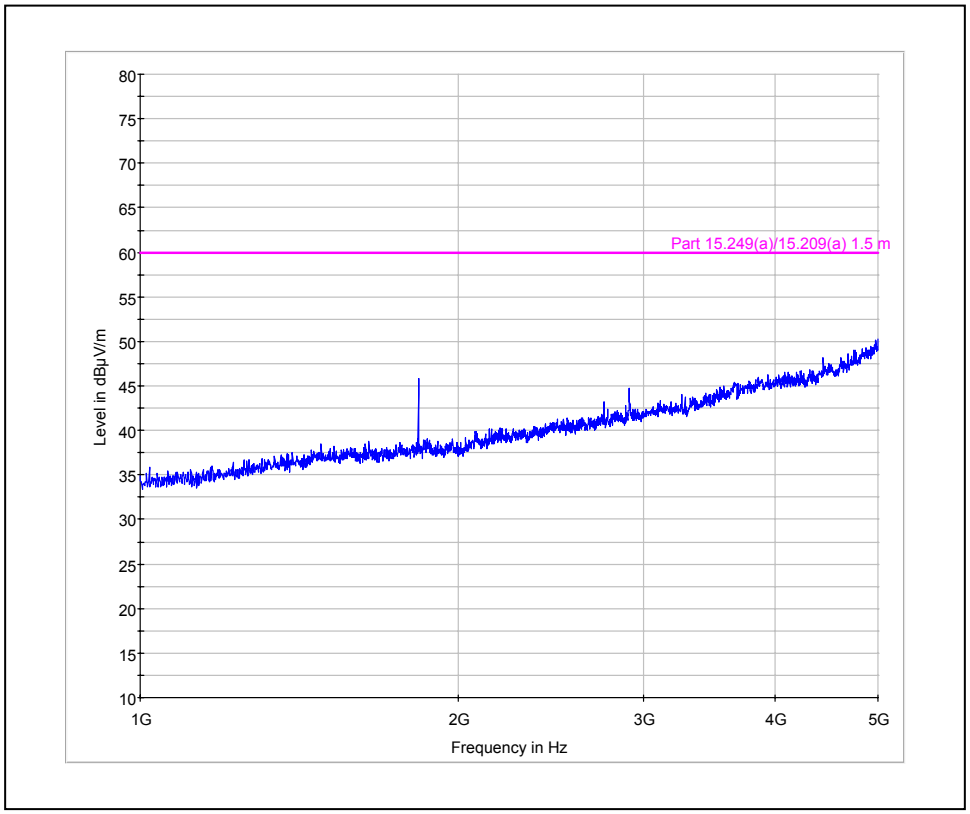
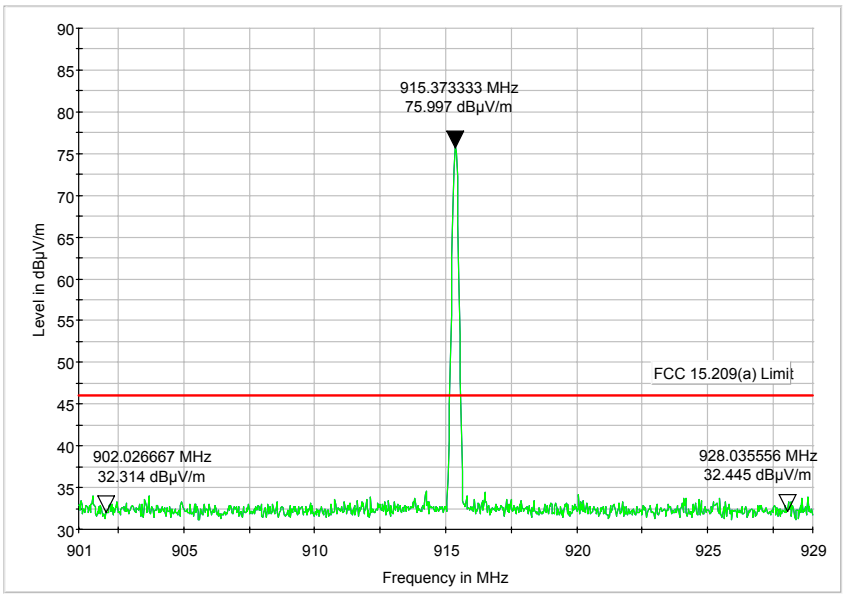
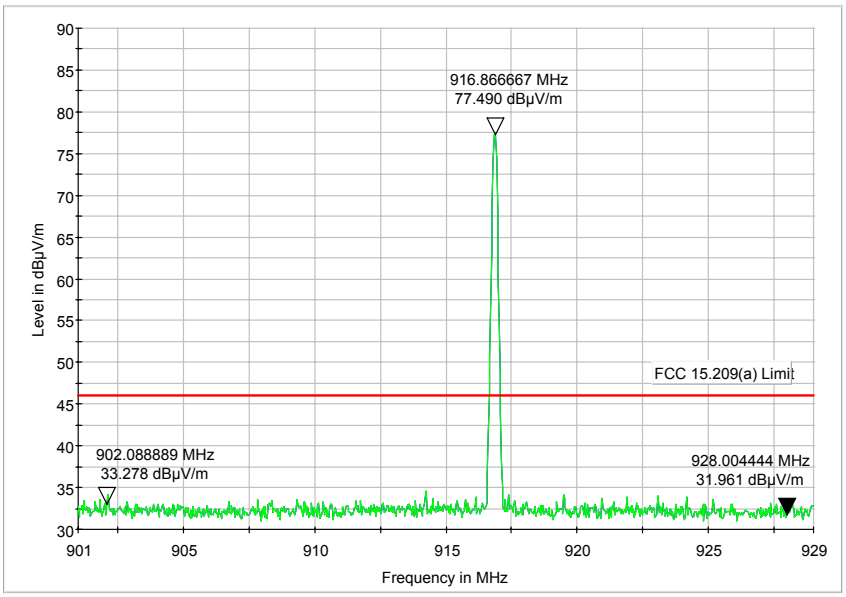


Figure 25: Band-Edge Characteristic – Channel 01
Plot Corrected for Antenna & Coax Factors



Band Edge Characteristic
Stanley C5-25 Wrench Operating on CH01
3 meter OATS at maximum field strength orientation
Peak Reading, 120 KHz RBW

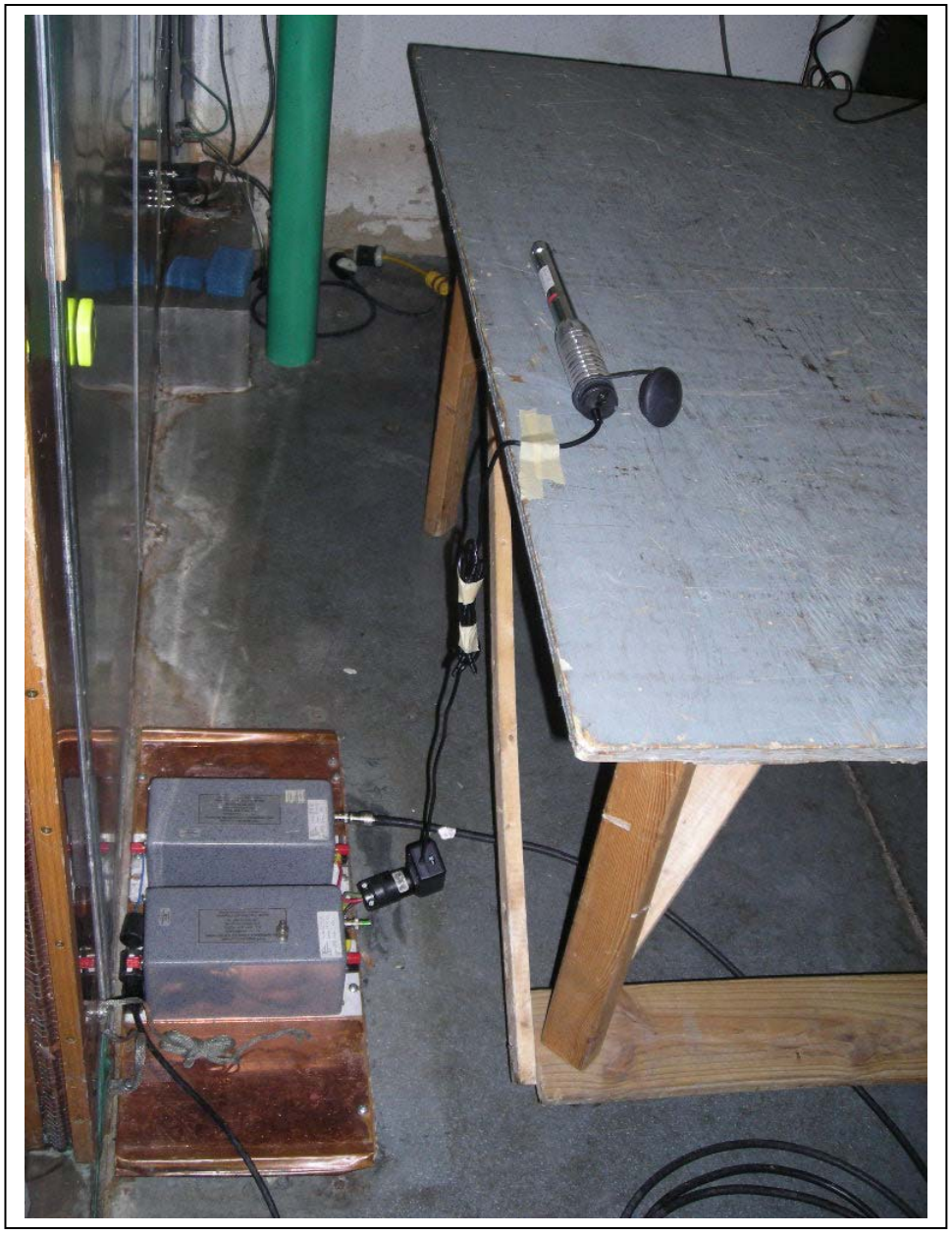
Figure 26: Band-Edge Characteristic – Channel 50
Plot Corrected for Antenna & Coax Factors



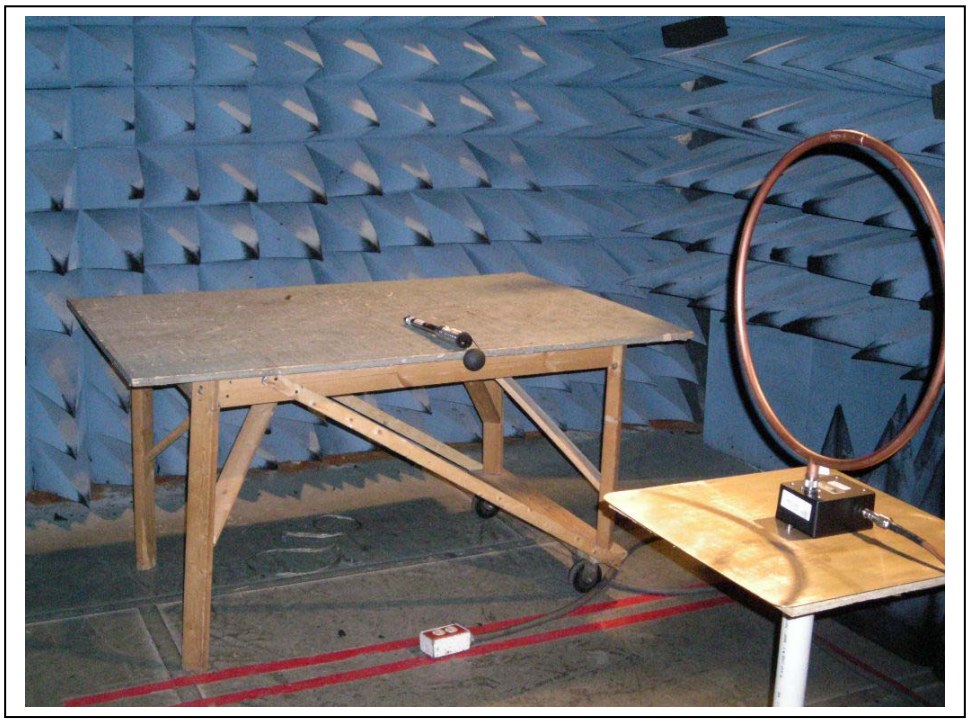
Band Edge Characteristic
Stanley C5-25 Wrench Operating on CH50
3 meter OATS at maximum field strength orientation
Peak Reading, 120 KHz RBW

9. PICTORIALS – TEST SETUP

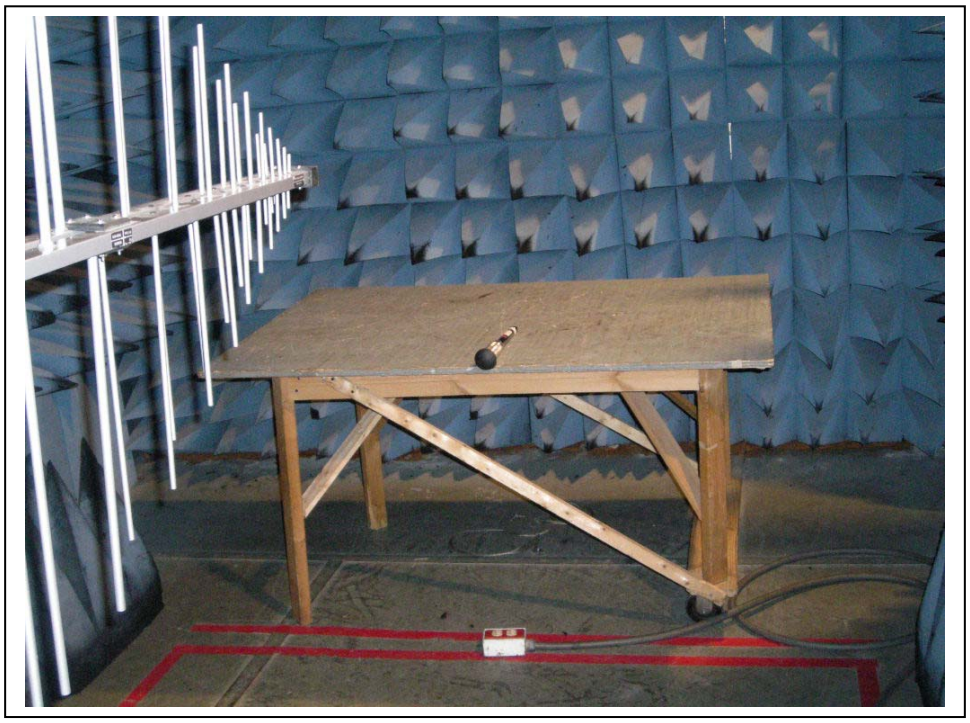
Pictorial #1: Conducted Emissions Test Setup
Wrench With Battery Charger



Pictorial #2: Radiated Emissions Test Setup – Chamber
H-Field Loop Antenna, 1.5m Distance



Pictorial #3: Radiated Emissions Test Setup – Chamber
E-Field, Bilog Antenna, 1.5m Distance

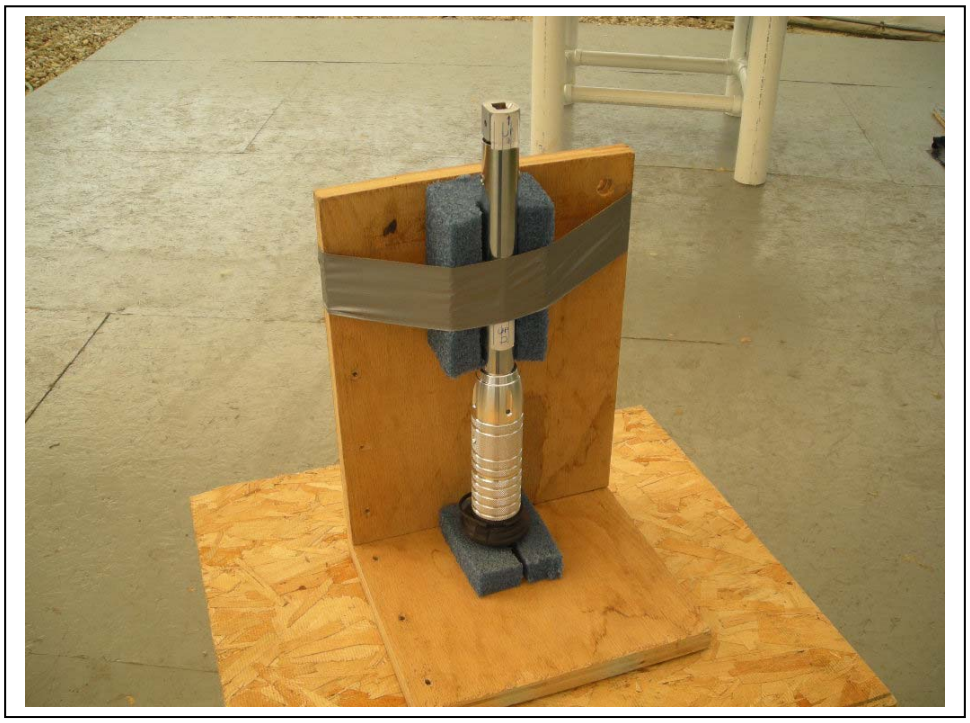


Pictorial #4: Radiated Emissions Test Setup – Chamber
E-Field, Horn Antenna, 1.5m Distance

Pictorial #5: Radiated Emissions Test Setup – OATS
Orthogonal Position 1

Pictorial #6: Radiated Emissions Test Setup – OATS
Orthogonal Position 2

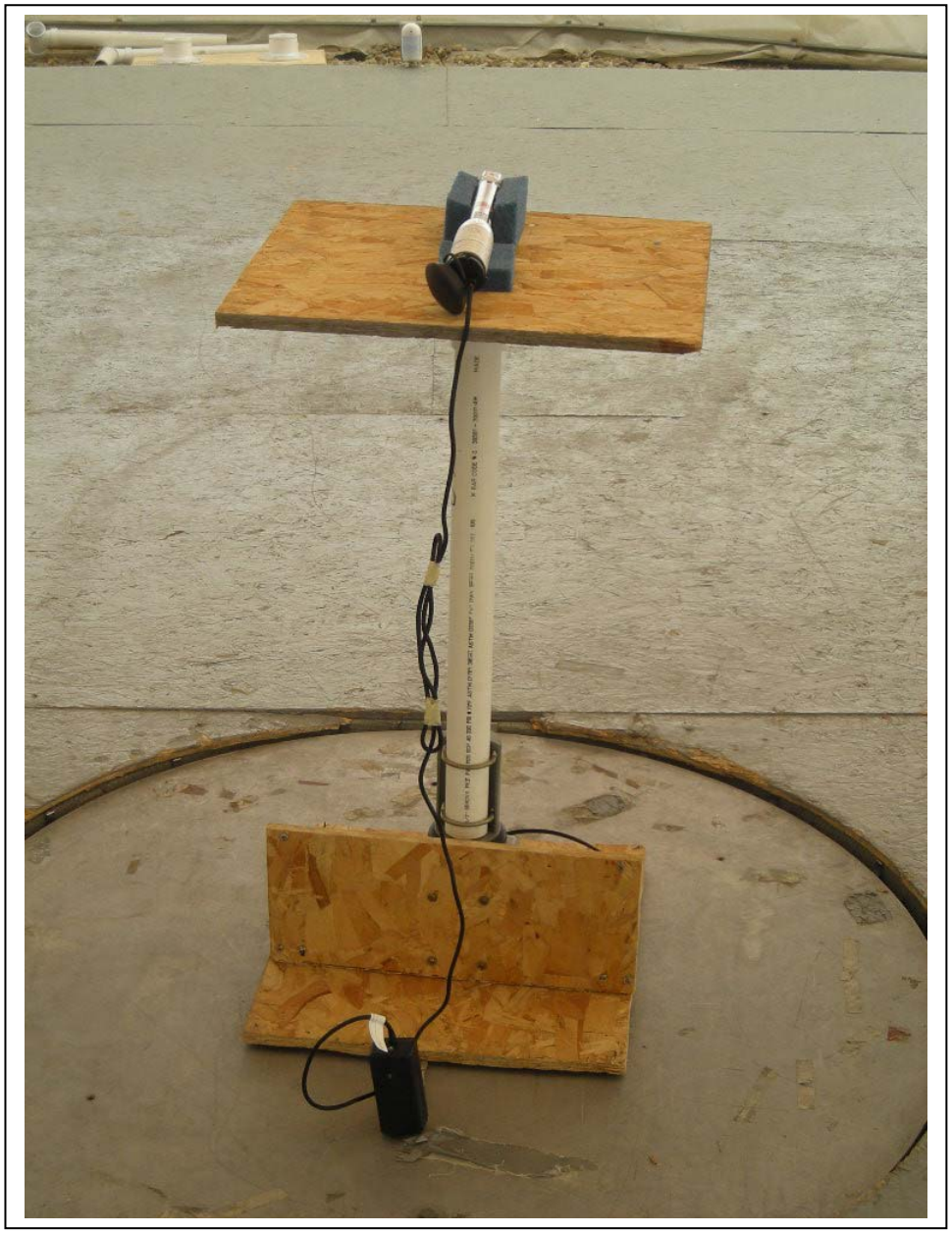
Pictorial #7: Radiated Emissions Test Setup – OATS
Orthogonal Position 3



Pictorial #8: Radiated Emissions Test Setup – OATS
Bilog Antenna, 3m Distance

Pictorial #9: Radiated Emissions Test Setup – OATS
Horn Antenna, 1m Distance

Pictorial #10: Radiated Emissions Test Setup – OATS
Wrench With Charger Connected



10. PICTORIALS – EUT

External View of CS5-25 Torque Wrench

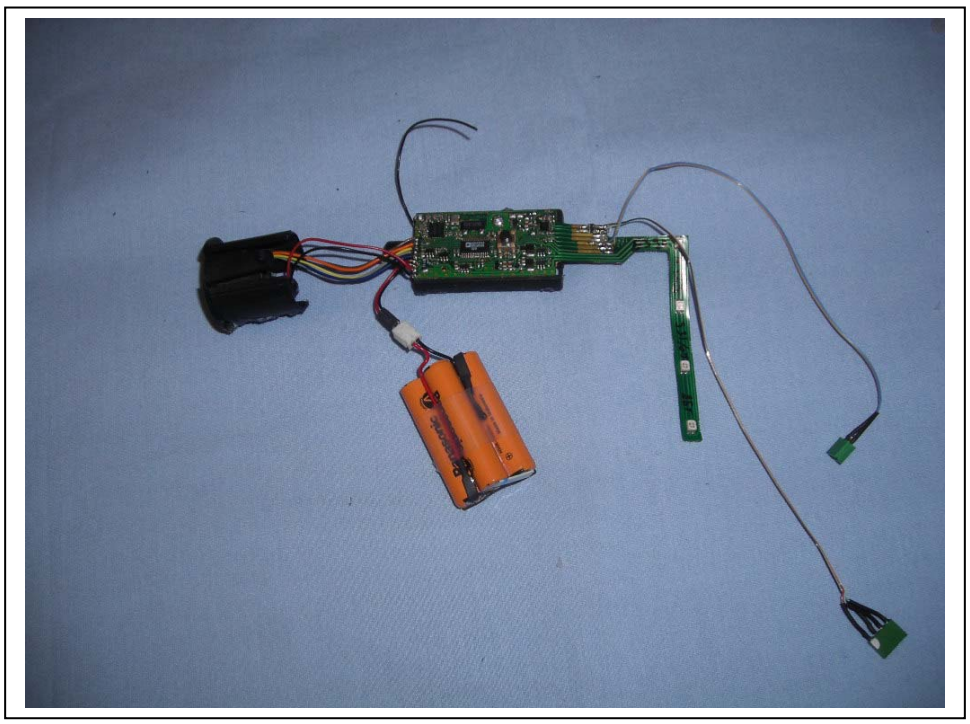
Handle Assembly of Wrench Containing Transmitter & Battery Pack

Handle Assembly of Wrench
Bottom cap removed, exposing programming connector and charger port (antenna wire is placed in circular groove of end cap).

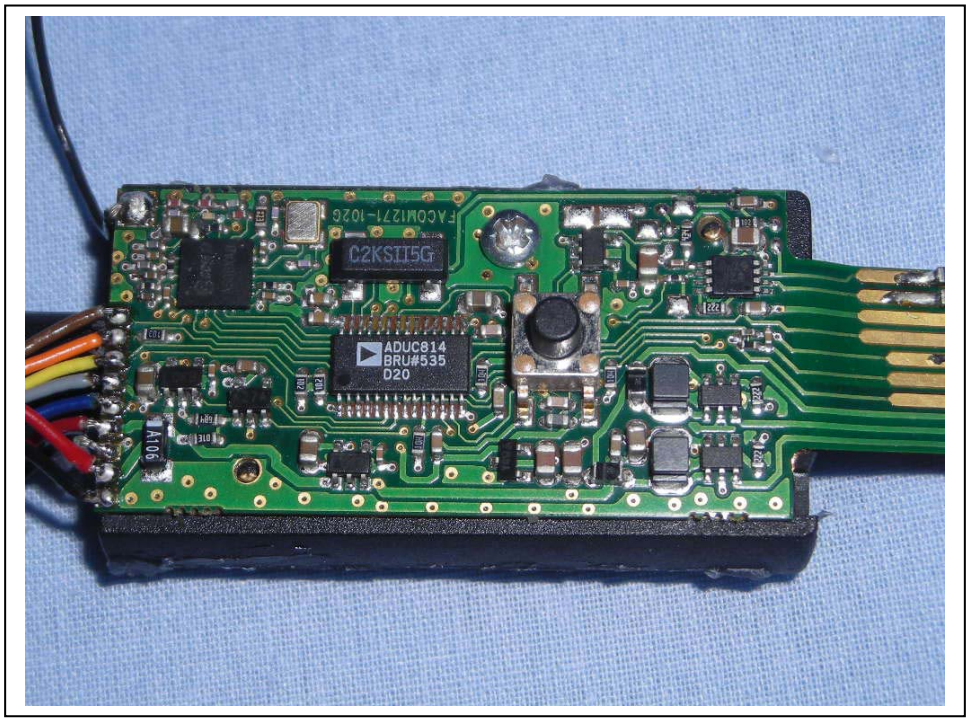
Handle Assembly of Wrench
Metal cover removed, exposing battery compartment and transmitter housing.

Handle Assembly of Wrench
Metal cover removed, with battery removed.

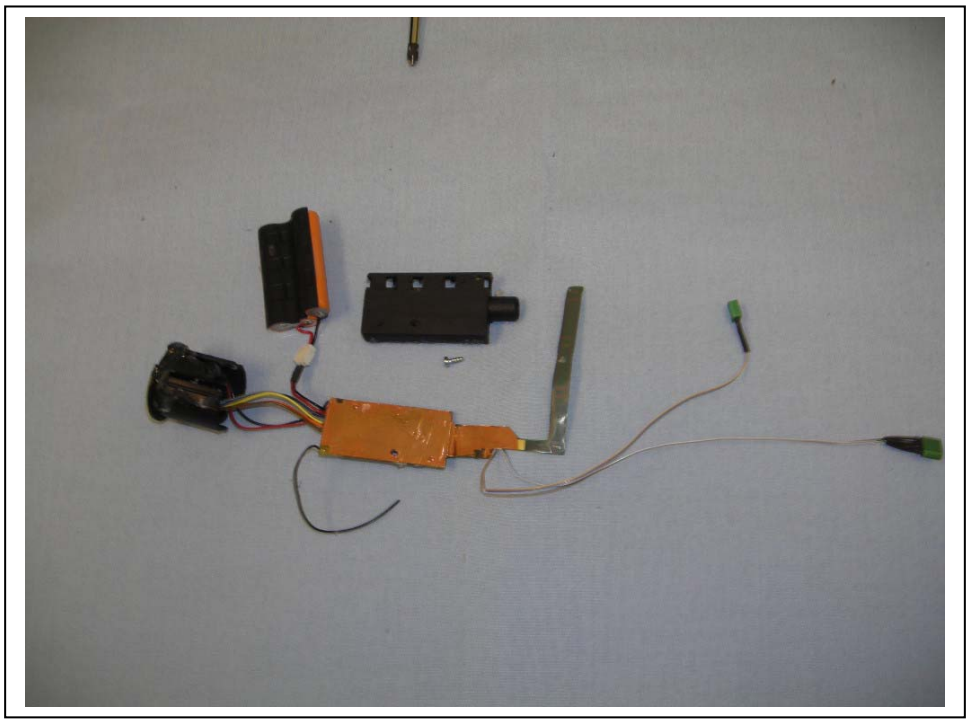
Transmitter/Controller Unit Removed From Wrench



Transmitter/Controller Unit – Close-up of Component Side of PCB



Transmitter/Controller Unit
Reverse side of PCB after removal from plastic housing.



Transmitter/Controller Unit
Close-up of Reverse Side of PCB

Battery Charger Unit – Mascot Type 2116 (SEEG p/n CS-ALIM-C)

Battery Charger Unit – Product Label