

Test report

331827-1R1TRFWL

Date of issue: July 18, 2017

Applicant: HM Electronics, Inc

Product: Advanced Vehicle Detection Board

Model: RFM100 Model variant: N/A

FCC ID: BYMRF100 IC Registration number: 1806A-RFM100

Specifications:

◆ **FCC 47 CFR Part 15 Subpart C, §15.209**

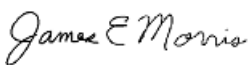
Radiated emission limits; general requirements.

◆ **RSS-310**

Licence-Exempt Radio Apparatus: Category II Equipment

Test location

Company name:	Nemko USA, Inc.
Address:	2210 Faraday Ave, Suite 150
City:	Carlsbad
State:	California
Postal code:	92008
Country:	USA
Telephone:	+1 760 444 3500
Website:	www.nemko.com
Site number:	FCC: US5058; IC: 2040B

Tested by:	Mark Phillips, EMC Test Engineer
Reviewed by:	James Morris, EMC and Wireless Divisions Manager
Date:	August 2, 2017
Signature:	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko USA's ISO/IEC 17025 accreditation.

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Section 1 Report summary

1.1 Applicant

Company name	HM Electronics, Inc.
Address	14110 Stowe Drive
City	Poway
Province/State	CA
Postal/Zip code	92064
Country	U.S.A.

1.2 Manufacturer

Company name	HM Electronics, Inc.
Address	14110 Stowe Drive
City	Poway
Province/State	CA
Postal/Zip code	92064
Country	U.S.A.

1.3 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.209	Radiated emission limits; general requirements.
RSS-310	Licence-Exempt Radio Apparatus: Category II Equipment

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued
R1TRF	Updated test specifications

Section 2 Summary of test results

2.1 FCC Part 15 Subpart C – general requirements, test results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass

Notes: None

2.2 FCC Part 15 Subpart C – Intentional Radiators, test results

Part	Test description	Verdict
§15.209	Radiated emission limits; general requirements.	Pass

Notes: None

2.3 RSS-310 Conducted emissions test results

Test description	Verdict
AC power lines conducted emission limits	Pass

Notes: None

2.4 RSS-310 Radiated emissions test results

Test description	Verdict
Transmitter emissions limits	Pass

Notes: None

Section 3 Equipment under test (EUT) details

3.1 Sample information

Receipt date	March 27, 2017
Nemko sample ID number	331827

3.2 EUT information

Product name	Advanced Vehicle Detection Board
Model	RFM100
Model variant	N/A
Serial number	N/A (prototype)

3.3 Technical information

Operating band	N/A
Operating frequency	12 – 75 kHz
Modulation type	N/A
Occupied bandwidth (99 %)	N/A
Emission designator	CW Swept Carrier
Power requirements	12 VDC
Antenna information	Underground Loop antenna for Vehicle Detection The EUT is professionally installed.

3.4 Product description and theory of operation

Model RFM100 is a module that when installed in other systems such as a timer or base station and used in conjunction with a ground loop, the RFM100 detects the presence or absence of vehicles on top of the ground loop. It operates as a swept CW signal from 11kHz to 75kHz. The RFM100 monitors and adjust certain health conditions of the ground loop. It also provides user alerts of changes on the ground loop's health status. These alerts are communicated through the Bluetooth communication link.

3.5 EUT exercise details

EUT was set for continuous operation.

3.6 EUT setup Figure

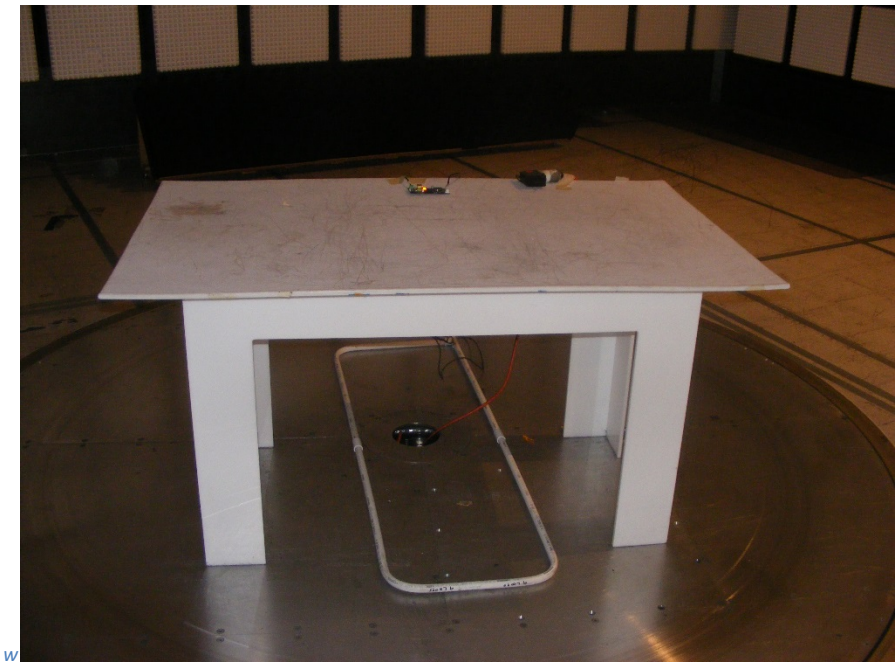


Figure 3.6-1: Setup Figure

3.7 EUT sub assemblies

Table 3.7-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number
Advanced Vehicle Detection Board	RFM100	G2997	N/A (prototype)

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5 Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages $\pm 5\%$, for which the equipment was designed.

Section 6 Measurement uncertainty

6.1 Uncertainty of measurement

Nemko USA Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 "Uncertainty in EMC measurements." Measurement uncertainty was calculated using the methods described in CISPR 16-4 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC measurements; as well as described in UKAS LAB34: The expression of Uncertainty in EMC Testing. Measurement uncertainty calculations assume a coverage factor of $K=2$ with 95% certainty.

Section 7 Test equipment

7.1 Test equipment list

Asset Tag	Description	Manufacturer	Model	Serial #	Next Cal
D1033	Antenna, DRWG	EMCO	3115	9609-4943	27-Jul-2017
809	Multimeter	Fluke	111	77790102	29-Jun-2017
E1019	Two Line V-Network	Rohde & Schwarz	ENV216	101045	15-Jun-2017
E1035	Variac (Variable Transformer) 3KVA	Shanghai China	TDGC	N/A	VOU
1480	Antenna, Bilog	Schaffner-Chase	CBL6111C	2572	21-Jul-2017
E1120	Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101395	25-May-2017
E1121	EMI Test Receiver	Rohde & Schwarz	ESU 40	100064	28-Apr-2017
N/A	10m Chamber Cable - HF	N/A	N/A	N/A	
N/A	10m Chamber Cable - LF	N/A	N/A	N/A	
N/A	RF Conducted Cables - HF	N/A	N/A	N/A	
317	Preamp	HP	8449B	N/A	
N/A	Attenuator	HP	8493A	05391	

Section 8 Testing data

8.1 FCC 15.207(a) and RSS-310 AC power line conducted emissions limits

8.1.1 Definitions and limits

FCC:

Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

IC:

The purpose of this test is to measure unwanted radio frequency currents induced in any AC conductor external to the equipment which could conduct interference to other equipment via the AC electrical network.

Except when the requirements applicable to a given device state otherwise, for any licence-exempt radiocommunication device equipped to operate from the public utility AC power supply, either directly or indirectly, the radio frequency voltage that is conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in Table 2. The tighter limit applies at the frequency range boundaries.

The conducted emissions shall be measured with a 50 Ω /50 μ H line impedance stabilization network (LISN).

Table 8.1-1: Conducted emissions limit

Frequency of emission, MHz	Conducted limit, dB μ V	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

Note: * - Decreases with the logarithm of the frequency.

8.1.2 Test summary

Test date:	May 23, 2017	Temperature:	21 °C
Test engineer:	Mark Phillips	Air pressure:	1002 mbar
Verdict:	Pass	Relative humidity:	56 %

8.1.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Receiver settings for preview measurements:

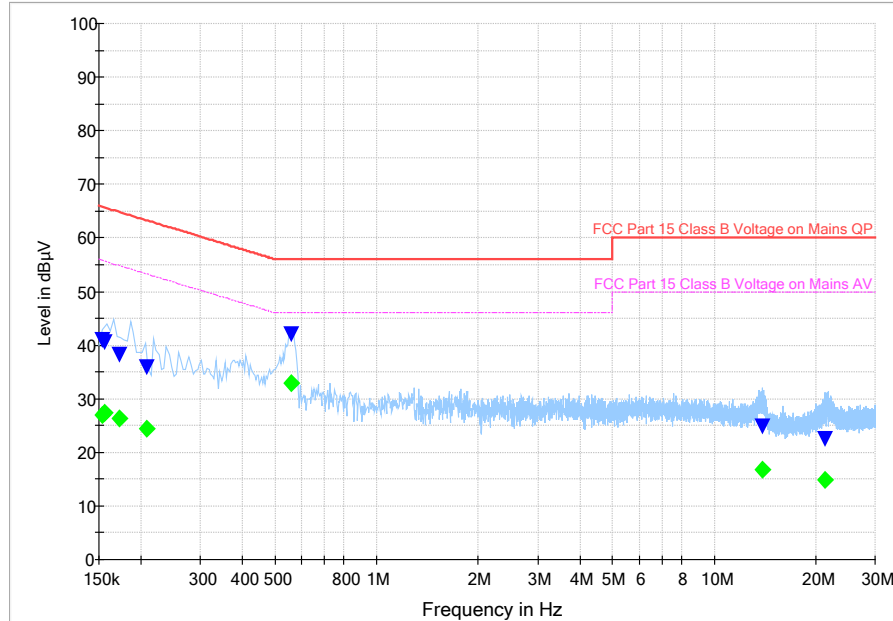
Resolution bandwidth:	9 kHz
Video bandwidth:	30 kHz
Detector mode:	Peak and Average
Trace mode:	Max Hold
Measurement time:	1000 ms

Receiver settings for final measurements:

Resolution bandwidth:	9 kHz
Video bandwidth:	30 kHz
Detector mode:	Quasi-Peak and Average
Trace mode:	Max Hold
Measurement time:	1000 ms

8.1.4 Test data

Full Spectrum



Plot 8.1-1: Conducted emissions on phase and neutral line

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line
0.154000	---	27.04	55.78	28.74	5000.0	9.000	L1
0.154000	40.98	---	65.78	24.80	5000.0	9.000	L1
0.156500	---	27.31	55.65	28.34	5000.0	9.000	N
0.156500	40.65	---	65.65	25.00	5000.0	9.000	N
0.172500	38.28	---	64.84	26.56	5000.0	9.000	N
0.172500	---	26.23	54.84	28.61	5000.0	9.000	N
0.208500	35.92	---	63.27	27.34	5000.0	9.000	L1
0.208500	---	24.40	53.27	28.87	5000.0	9.000	L1
0.556500	42.06	---	56.00	13.94	5000.0	9.000	L1
0.556500	---	32.89	46.00	13.11	5000.0	9.000	L1
13.852500	24.94	---	60.00	35.06	5000.0	9.000	L1
13.852500	---	16.73	50.00	33.27	5000.0	9.000	L1
21.288500	---	14.97	50.00	35.03	5000.0	9.000	N
21.288500	22.54	---	60.00	37.46	5000.0	9.000	N

Table 8.1-2: Quasi-Peak and Average conducted emissions results on phase and neutral line

Sample calculation:

Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)

Result (dBµV) = XX dBµV (reading from receiver) + XX dB (Correction factor)

Example:

43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

8.2 Clause 15.209 and RSS-310 Field strength of emissions

8.2.1 Definitions and limits

In addition to the provisions of §15.205 RSS-310 the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

Table 8.2-1: Field strength limits

Fundamental frequency (MHz)	Field strength of fundamental		Field strength of spurious emissions	
	(mV/m)	(dBμV/m)	(μV/m)	(dBμV/m)
902–928	50	94	500	54
2400–2483.5	50	94	500	54
5725–5875	50	94	500	54
24.0–24.25	250	108	2500	68

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For point-to-point operation under paragraph (b) of this section, the peak field strength shall not exceed 2500 millivolts/meter (128 dBμV/m) at 3 meters along the antenna azimuth.

8.2.2 Test summary

Test date:	May 23, 2017	Temperature:	21 °C
Test engineer:	Mark Phillips	Air pressure:	1002 mbar
Verdict:	Pass	Relative humidity:	56 %

8.2.3 Observations/special notes

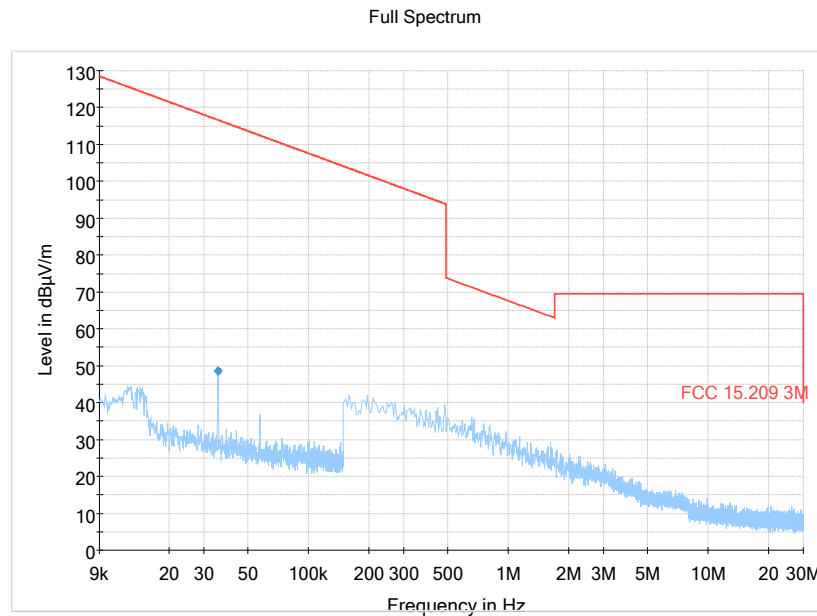
Table 8.2-2: §15.209 RSS Gen 7.2.5 – Radiated emission limits

Frequency (MHz)	Field strength		Measurement distance (m)
	(μV/m)	(dBμV/m)	
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

- The spectrum was searched from 30 MHz to the 10th harmonic.
- All measurements were performed at a distance of 3 m.
- All measurements were performed:
 - below 30 MHz: using a quasi-peak detector with 9 kHz/30 kHz RBW/VBW,
 - above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results

Transmit output power was measured while supply voltage was varied from 102 VAC to 138 VAC (85 % to 115 % of the nominal rated supply voltage). No change in transmit output power was observed.

8.2.4 Test data, continued



Plot 8.2-1: 9kHz – 30MHz

The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators) for determination of compliance. Limits have been adjusted to reflect 3 m requirements.

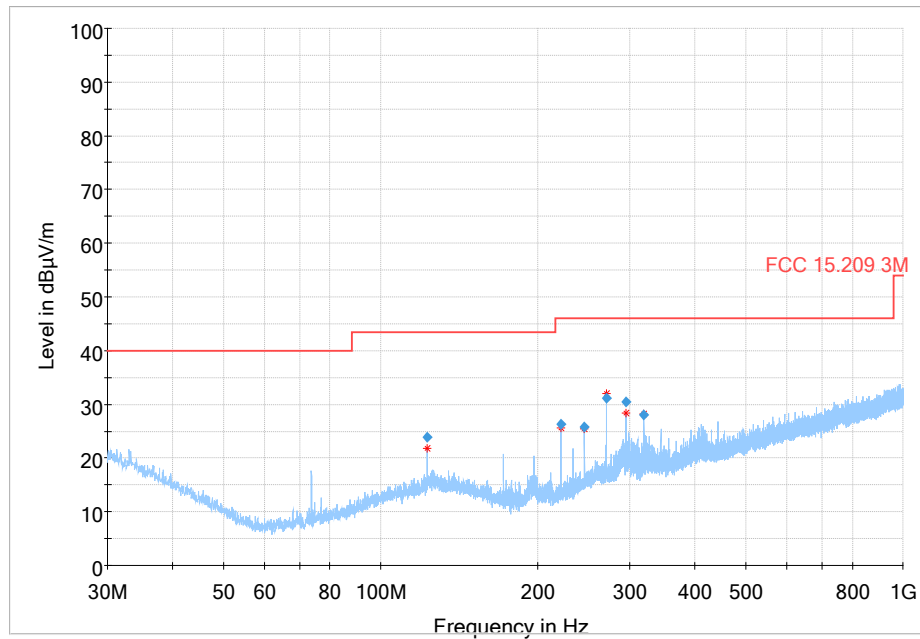
A preview measurement was generated with receiver in continuous scan or sweep mode while the EUT was rotated and antenna adjusted to maximize radiated emission. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Frequency (MHz)	QuasiPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Pol	Azimuth (deg)
0.035327	48.57	---	116.63	68.06	10000.0	0.200	N/A	188.0

Table 8.2-3: Field strength measurement results

Note: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Full Spectrum



Plot 8.2-2: 30MHz – 1000MHz

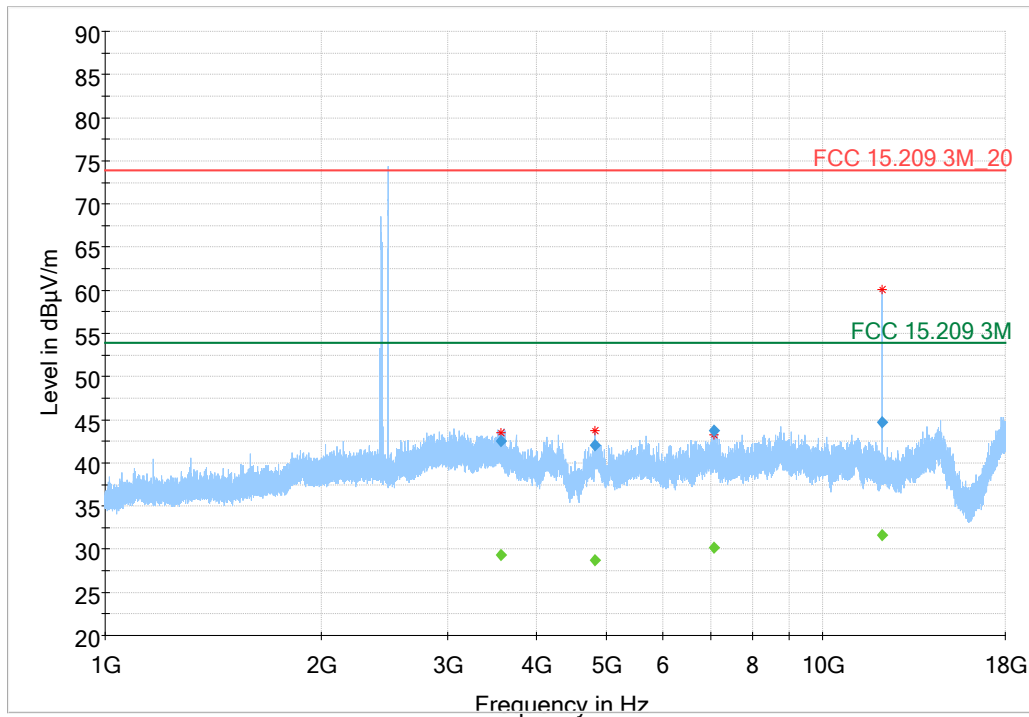
The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators) for determination of compliance. Limits have been adjusted to reflect 3 m requirements.

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
122.857500	23.84	43.50	19.66	5000.0	120.000	330.1	H	154.0
221.167000	26.24	46.00	19.76	5000.0	120.000	119.5	H	70.0
245.748000	25.71	46.00	20.29	5000.0	120.000	334.5	H	180.0
270.337500	31.14	46.00	14.86	5000.0	120.000	129.8	H	310.0
294.918500	30.44	46.00	15.56	5000.0	120.000	124.4	H	166.0
319.468000	27.95	46.00	18.05	5000.0	120.000	111.7	H	160.0

Table 8.2-4: Field strength measurement results

Note: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

Full Spectrum



Emissions in 2400 – 2483.5 band are Bluetooth transmitter.

Plot 8.2-3: 1 – 18GHz

The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators) for determination of compliance. Limits have been adjusted to reflect 3 m requirements.

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)
3564.620000	---	29.33	53.90	24.57	5000.0	1000.000	190.6	H	266.0
3564.620000	42.55	---	73.90	31.35	5000.0	1000.000	190.6	H	266.0
4822.760000	---	28.77	53.90	25.13	5000.0	1000.000	144.9	V	278.0
4822.760000	42.10	---	73.90	31.80	5000.0	1000.000	144.9	V	278.0
7066.920000	43.76	---	73.90	30.14	5000.0	1000.000	241.6	H	223.0
7066.920000	---	30.14	53.90	23.76	5000.0	1000.000	241.6	H	223.0
12130.040000	44.67	---	73.90	29.23	5000.0	1000.000	111.3	H	128.0
12130.040000	---	31.59	53.90	22.31	5000.0	1000.000	111.3	H	128.0

Table 8.2-5: Field strength measurement results

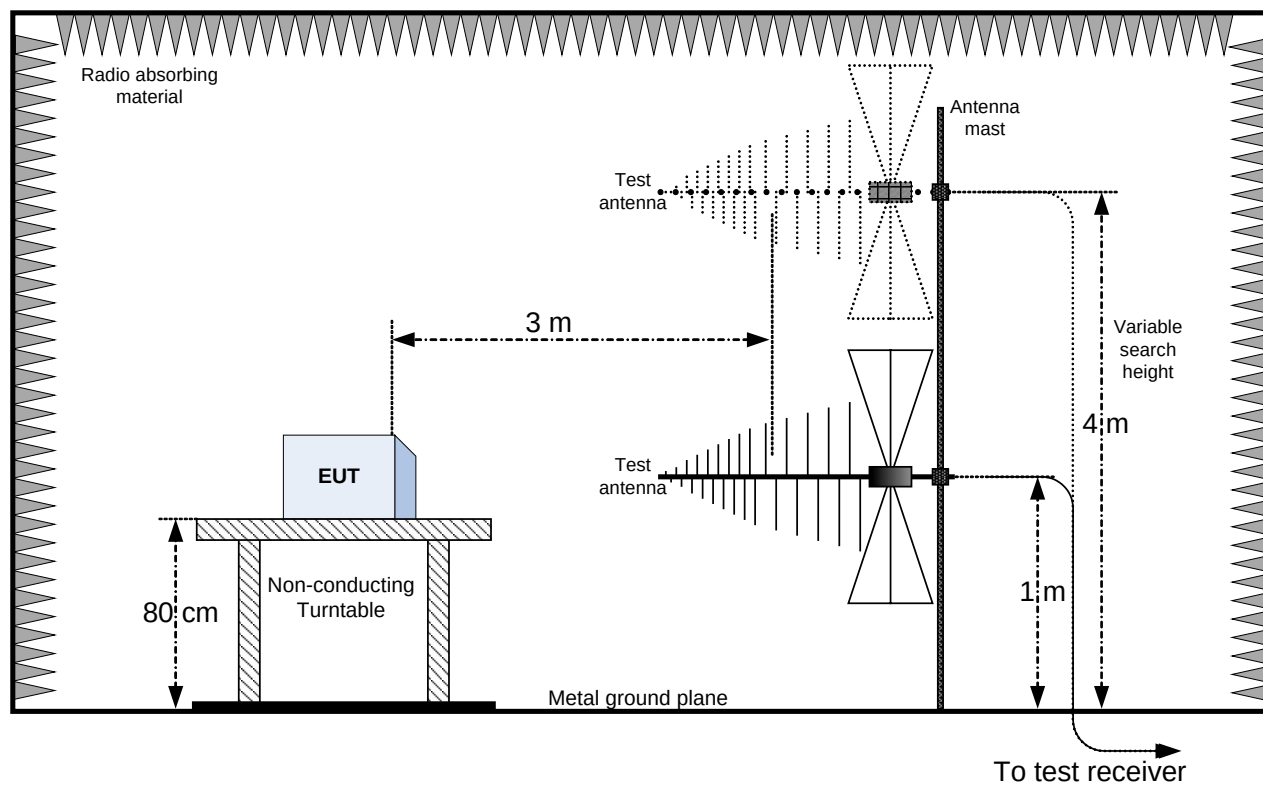
Note: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

8.2.5 Observations/special notes

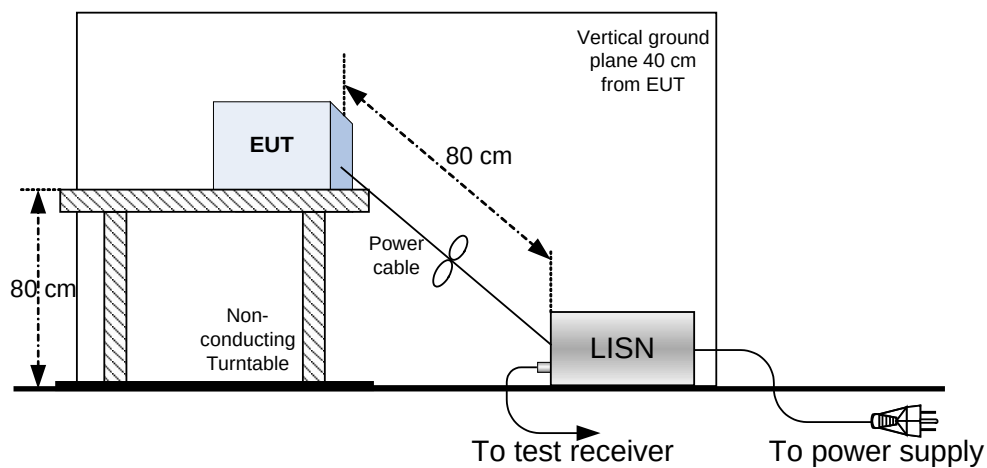
- The spectrum was searched from 30 MHz to the 10th harmonic.
- All measurements were performed at a distance of 3 m.
- All measurements were performed:
- below 30 MHz: using a quasi-peak detector with 9 kHz/30 kHz RBW/VBW,
- within 30–1000 MHz range: using a quasi-peak detector with 120 kHz/300 kHz RBW/VBW,
- above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results
- and using peak detector with 1 MHz/10 Hz RBW/VBW for average results.

Section 9 Block Figures of test set-ups

9.1 Radiated emissions set-up



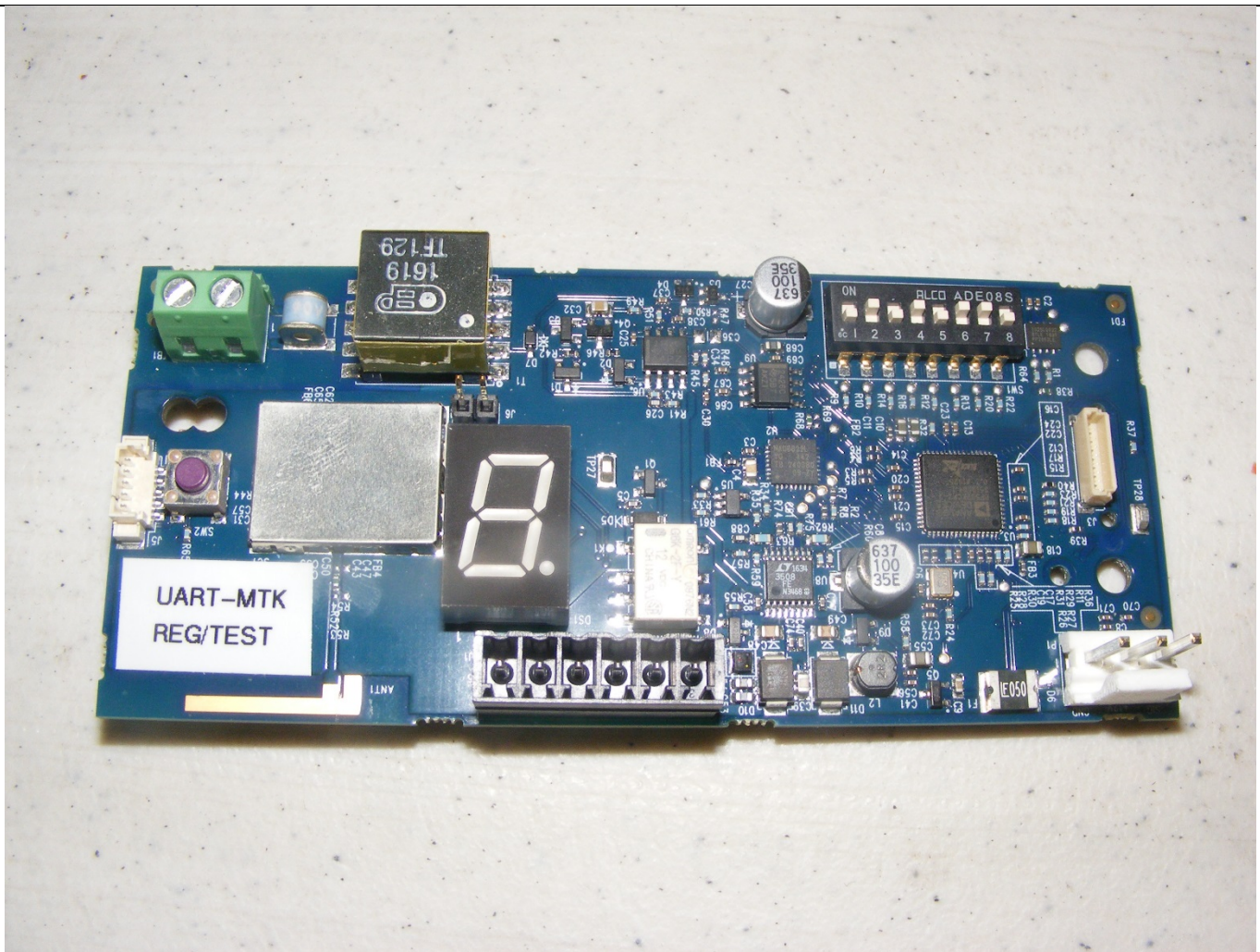
9.2 Conducted emissions set-up



Section 10 EUT photos

10.1 External photos

10.1.1 EUT front view



10.1.2 EUT rear view

