TÜV SÜD Canada
EMC & RF Test Report

As per

RSS 247 Issue 1: 2015
&
FCC Part 15 Subpart C: 2016

For

Unlicensed Intentional Radiators

Frequency Hopping Systems Operating in the 902-928 MHz band

on the

ARMOUR ANTENNA UNIT

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Testing produced for

SCAN-LINK

See *Appendix A* for full customer & EUT details.

Industry Canada
Registration # 6844A-3

Testing Laboratory Certificate #2955.02

Registration # CA6844

R-4023, G-506 T-1246, C-4498

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Report Scope

This report addresses the EMC certification testing and test results of the **Armour Antenna Unit** from **Scan~Link Technologies Inc.** This unit is herein referred to as EUT (Equipment Under Test) performed at TÜV SÜD Canada Labs.

The EUT was tested for compliance against the following standards:

RSS 247 Issue 1:2015
FCC Part 15 Subpart C 15.247:2016

Test procedures, results, justifications, and engineering considerations, if any, follow later in this report.

The results contained in this report relate only to the item(s) tested.

This report does not imply product endorsement by A2LA or any other accreditation agency, any government, or TÜV SÜD Canada.

Opinions/interpretations expressed in this report, if any, are outside the scope of TÜV SÜD Canada accreditation. Any opinions expressed do not necessarily reflect the opinions of TÜV SÜD Canada, unless otherwise stated.

Client	Scan~Link Technologies Inc.	
Product	Armour Antenna Unit	
Standard(s)	RSS 247 Issue 1 / FCC Part 15 Subpart C 15.247	

Summary

The results contained in this report relate only to the item(s) tested.

FCC Certification # (FCC ID):	YUU-SLAU270NB
ISED Certification # (IC):	9283A-SLAU270NB
EUT passed all tests performed.	Yes
Tests conducted by	Raymond Lee Au

Client	Scan~Link Technologies Inc.
Product	Armour Antenna Unit
Standard(s)	RSS 247 Issue 1 / FCC Part 15 Subpart C 15.247

Results Summary

Standard/Method	Description	Limit/Requirement	Result
FCC 15.203	Antenna requirement	Unique	Pass [α]
FCC 15.205 RSS-Gen (Table 6)	Restricted bands of operation	QuasiPeak Average	Pass
FCC 15.209 RSS- Gen (Table 4)	Spurious Radiated emissions	QuasiPeak Average	Pass
FCC 15.247(a)(1) RSS-247 5.1(2)	Channel separation & 20 dB bandwidth	Channel carrier frequency separation ≥ 20 dB bandwidth	Pass
FCC 15.247(a)(1)(i) RSS-247 5.1(3)	Number of hopping frequencies	≥ 50	Pass
	Time of occupancy per channel	≤ 0.4 s within 20 s period	Pass
FCC 15.247(b)2 RSS-247 5.4(1)	Max peak conducted output power	≤ 1 W (≤ 30 dBm)	Pass
RSS-247 5.4(1)	Max peak E.I.R.P output	≤ 4 W (≤ 36 dBm)	Pass
FCC 15.247(b)4	Max peak conducted output power (For this EUT with antenna gain > 6 dBi)	≤ 0.427 W (≤ 26.3 dBm)	Pass
FCC 15.247(d) RSS-247 5.5	Unwanted emissions (Antenna Spurious Conducted Emissions)	≤ 20 dBc in 100 kHz bandwidths outside transmission band	Pass
FCC 15.247(i) RSS-102	Maximum RF exposure	> 20 cm separation.	Pass [α]
FCC 15.247(a)2 RSS-247 5.2(1)	6 dB Bandwidth	≥ 500 kHz	Pass
FCC 15.247(e) RSS-247 5.2(2)	Power spectral density	≤ 8 dBm per 3 kHz bandwidth	Pass
Overall Result			**PASS**

[α] See *Notes, Justifications, or Deviations* section.

All tests were performed by Raymond Lee Au.

If the product as tested or evaluated complies with the specification, the EUT is deemed to comply with the requirement, and is allotted a result of “Pass.” If not, a “Fail” will be issued. Note that a “Pass” or “Fail” status is independent of any measurement uncertainties.

Notes, Justifications, or Deviations

The following justifications for tests not performed or deviations from the above listed specifications apply:

The EUT is part of a supplementary safety system for installation on heavy mobile equipment (such as vehicles used on construction sites) which can detect the presence of ground workers or other entities outfitted with the appropriate RFID tag. It is also known as the "Antenna Unit" The RFID system operates using the 902 – 928 MHz frequency band. All other communication with the EUT is done using the 2.4 – 2.4835 GHz band. If entities are detected by this "Antenna Unit," communication is done using the 2.4 GHz frequency band to a "Display Unit" which will give an audible and visual warning. However, these two frequency bands are never utilized at the same time, (i.e. only 1 transmitter will be on at a time, and will never be used simultaneously). Therefore, testing is only done with 1 transmitter operating at a time. The unit is to be powered using the vehicle's power supply, and does not have a means to connect to mains power.

The 2.4 GHz communication is provided using a Synapse Wireless Inc. SM220 module, which had been modularly approved with FCC ID: U9O-SM220, and IC: 7084A-SM220. However, for usage in the EUT, an Ethertronics Prestta WLAN Embedded Antenna Part Number 1000423, is used in place of the approved antenna. Therefore FCC Part 15 Subpart C 15.247 and RSS 247 testing has been repeated.

The "Display Unit" uses the Synapse wireless module mentioned above unaltered. As such, no further certification is required.

This report (*TUV-FCCIC-7169000926AR1*) contains testing of the 900 MHz transmitter portion only. See report number *TUV-FCCIC-7169000926BR1* for testing of the 2.4 GHz portion.

For the antenna requirement specified in FCC 15.203, the antenna used for the 900 MHz transmission is a custom PCB trace antenna. The 2.4 GHz antenna is a stamped metal antenna on a PCB. Both are completely enclosed within the unit's enclosure, and is not accessible or replaceable by the end user.

The antenna gain for the 900 MHz is > 6 dBi. Limits have been adjusted according to FCC 15.247(b)(4).

The EUT is not a hybrid system; FCC 15.247 (f) does not apply.

The EUT was tested positioned in the 3 orthogonal axis for 900 MHz and 2.4 GHz. Worst case results are presented. (Worst cases are upright for 900 MHz, flat for 2.4 GHz. See test photos).

The EUT's 900 MHz output level is set to "25" as this is the maximum output setting that will be used by the manufacturer.

The EUT is to be used at a distance of at least 20 cm from any personnel during normal operation.

The EUT meets exposure limits for FCC General Population/Uncontrolled exposure, and IC Controlled Environments.

See photo exhibits for photos showing the test set-up

Applicable Standards, Specifications and Methods

ANSI C63.4:2014	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 for testing unlicensed wireless devices
CFR 47 FCC 15:2016	Code of Federal Regulations – Radio Frequency Devices
CISPR 22:2008	Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
ISO 17025:2005	General Requirements for the competence of testing and calibration laboratories
RSS-Gen Issue 4:2014	General Requirements and Information for the Certification of Radio Apparatus
RSS 102 Issue 5:2015	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
RSS-247 Issue 1:2015	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Sample calculation(s)

Margin = limit – (received signal + antenna factor + cable loss – pre-amp gain)
Margin = 50.5dBuV/m – (50dBuV + 10dB + 2.5dB – 20dB)
Margin = 8.5 dB

Document Revision Status

Release 1 - August 12, 2016
Initial release

Definitions and Acronyms

The following definitions and acronyms are applicable in this report.
See also ANSI C63.14.

AE – Auxiallary Equipment.

BW – Bandwidth.

DTSs – Digital Transmission Systems.

E.I.R.P. – Equivalent Isotropically Radiated Power.

EMC – Electro-Magnetic Compatibility

EMI – Electro-Magnetic Immunity

EUT – Equipment Under Test

FHSs – Frequency Hopping Systems

ITE – Information Technology Equipment with a primary function(s) of entry, storage, display, retrieval, transmission, processing, switching, or control, of data.

LISN – Line impedance stabilization network

NCR – No Calibration Required

RF – Radio Frequency

Testing Facility

Testing for EMC on the EUT was carried out at TÜV SÜD Canada near Toronto, Ontario, Canada. The testing lab consists of a 3m semi-anechoic chamber calibrated to be able to allow measurements on an EUT with a maximum width or length of up to 2m and height up to 3m. The chamber is equipped with a turn table that is capable of testing devices up to 3300lb in weight. This facility is capable of testing products that are rated for a variety of input voltages, including 120 and 240 Vac single phase, and 208 Vac 3 phase. DC capability is also available. The chamber is equipped with an antenna mast that controls polarization and height from the control room adjoining the shielded chamber. Radiated emissions measurements are performed using Loop, Bilog, or Horn antennas as applicable. Conducted emissions, unless otherwise stated, are performed using a LISN.

Calibrations and Accreditations

The 3m semi-anechoic chamber is registered with Federal Communications Commission (FCC, CA6844), Industry Canada (IC, 6844A-3) and VCCI (R-4023, G-506, T-1246, and C-4498). This semi-anechoic chamber complies with the requirements of EN55016-2-3:2006, section 7.5 and the site attenuation requirements of EN55016-1-4. This chamber was additionally calibrated for Normalized Site Attenuation (NSA) using test procedures outlined in ANSI C63.4 “Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz”. The chamber is lined with ferrite tiles and absorption cones to minimize any undesired reflections. The NSA data is kept on file at TÜV SÜD Canada. For radiated susceptibility testing, a 16 point field calibration has been performed on the chamber. The field uniformity data is kept on file at TÜV SÜD Canada. TÜV SÜD Canada is accredited to ISO 17025 by A2LA with Testing Certificate #2955.02. The laboratories current scope of accreditation listing can be found as listed on the A2LA website. All measuring equipment is calibrated on an annual or bi-annual basis as listed for each respective test.

Testing Environmental Conditions and Dates

Following are the environmental conditions in the facility during time of testing.

Date	Test(s)	Init.	Temperature (ºC)	Humidity (%)	Pressure (kPa)
June 24, 2016	20 dB bandwidth. Max peak conducted output power.	RA	20-24ºC	39 - 50%	96 -102kPa
July 4, 2016	Max peak E.I.R.P output. Radiated emissions. Restricted bands of operation. Spurious Radiated emissions.	RA	20-24ºC	39 - 50%	96 -102kPa
July 5, 2016	Time of occupancy per channel. Unwanted emissions in 100 kHz bandwidths outside transmission band.	RA	20-24ºC	39 - 50%	96 -102kPa
July 8, 2016	Channel separation. Number of hopping frequencies.	RA	20-24ºC	39 - 50%	96 -102kPa

Detailed Test Results Section

20dB Bandwidth, Time of Occupancy, and Number of Channels

Purpose

The purpose of these tests is to find the 20dB bandwidth occupied by a hopping channel, and ensure efficient used of the frequency spectrum. They help ensure the utilization of the frequency allocation is sufficiently narrow and not occupying excessive spectrum, which facilitates usage of the band by others. It also helps to prevent corruption of data by ensuring adequate data separation to distinguish the reception of the intended information

Limits & Method

The limits and requirements are as specified in FCC 15.247(a)(1)i & RSS-247 5.1(2)).

These include the following:

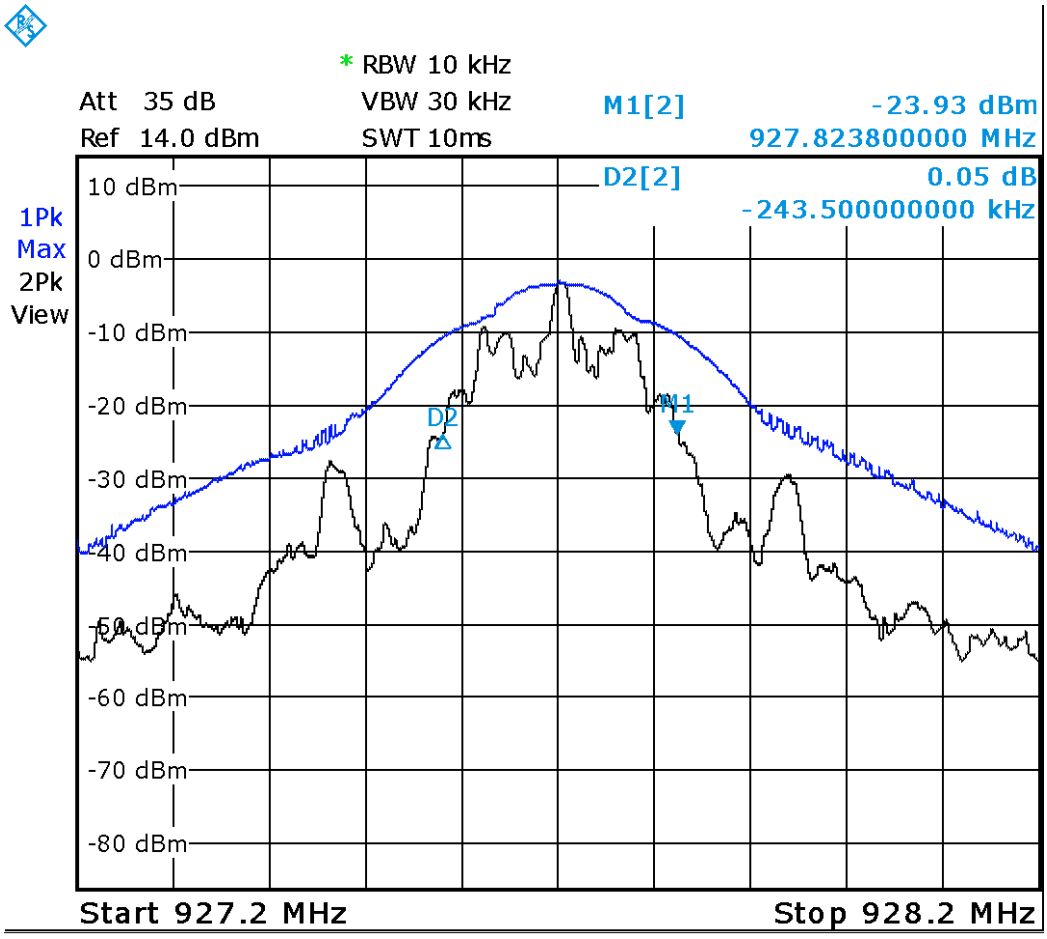
1. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.
2. For frequency hopping systems operating in the 902-928 MHz band:
    a. If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies.
    b. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies.
3. For frequency hopping systems operating in the 902-928 MHz band:
    a. If the 20 dB bandwidth of the hopping channel is less than 250 kHz, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period.
    b. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

The method is described in ANSI C63.10, 6.9.1.

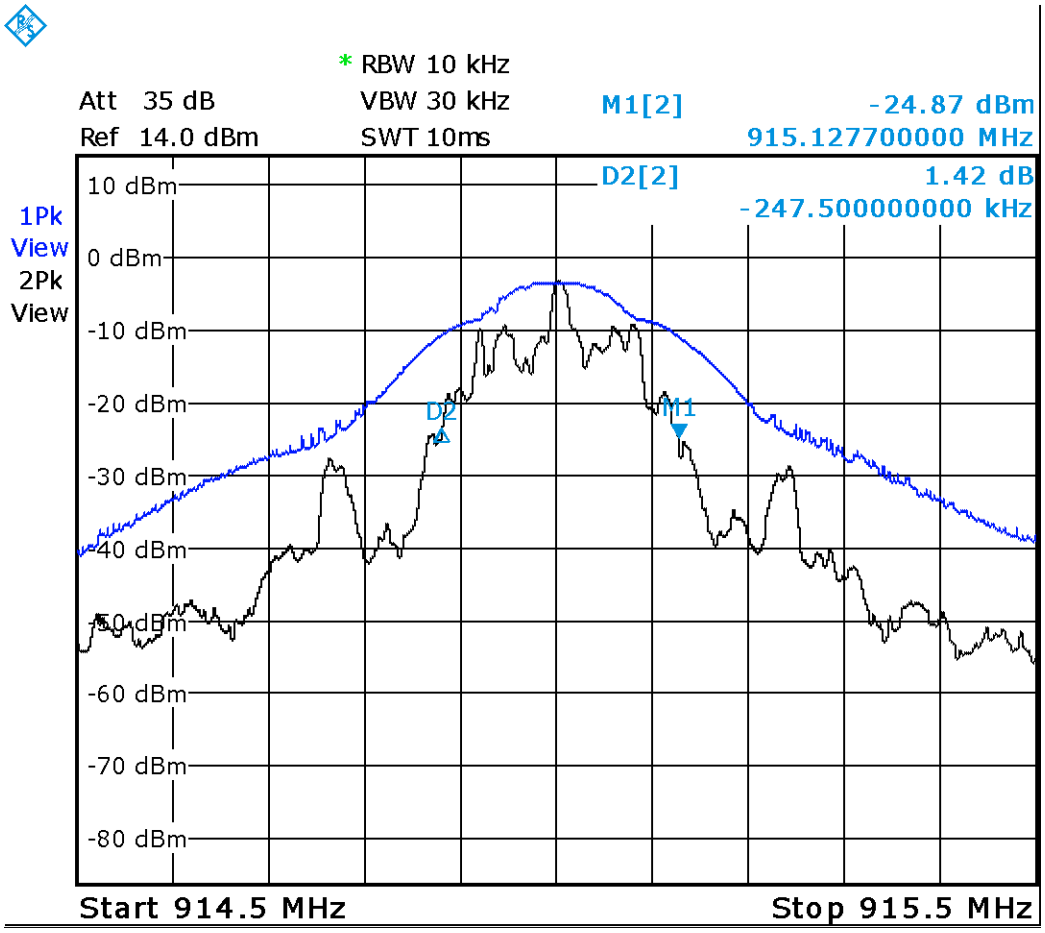
20dB Bandwidth

The graphs below show the 20dB bandwidth during the operation of the device. This is measured by a max hold on the spectrum analyzer and a video bandwidth at least 3x the resolution bandwidth. Bandwidths are shown for low, middle and high channels. These measurements are peak measurements. The EUT is set to transmit continuous modulated data at the maximum output settings.

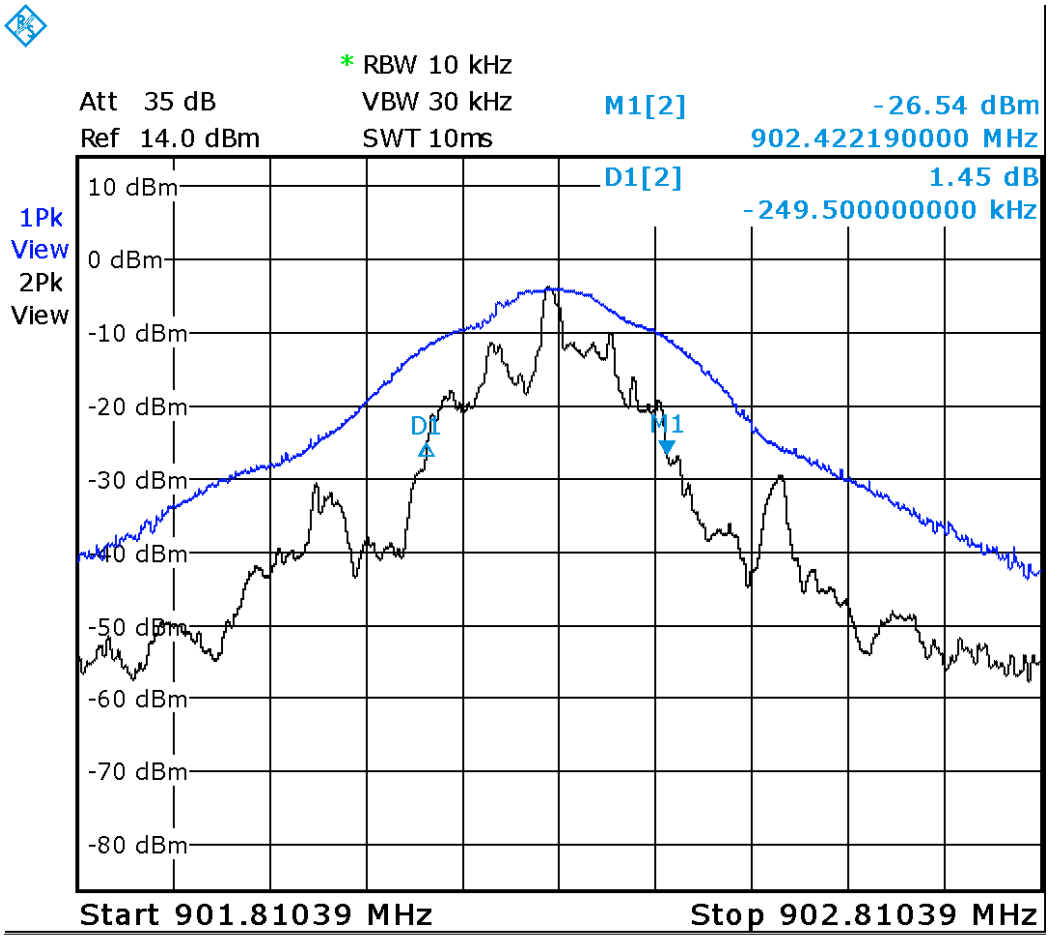
High Channel
20 dB Bandwidth = 243.5 kHz



Mid Channel
20 dB Bandwidth = 247.5 kHz



Low Channel
20 dB Bandwidth = 249.5 kHz



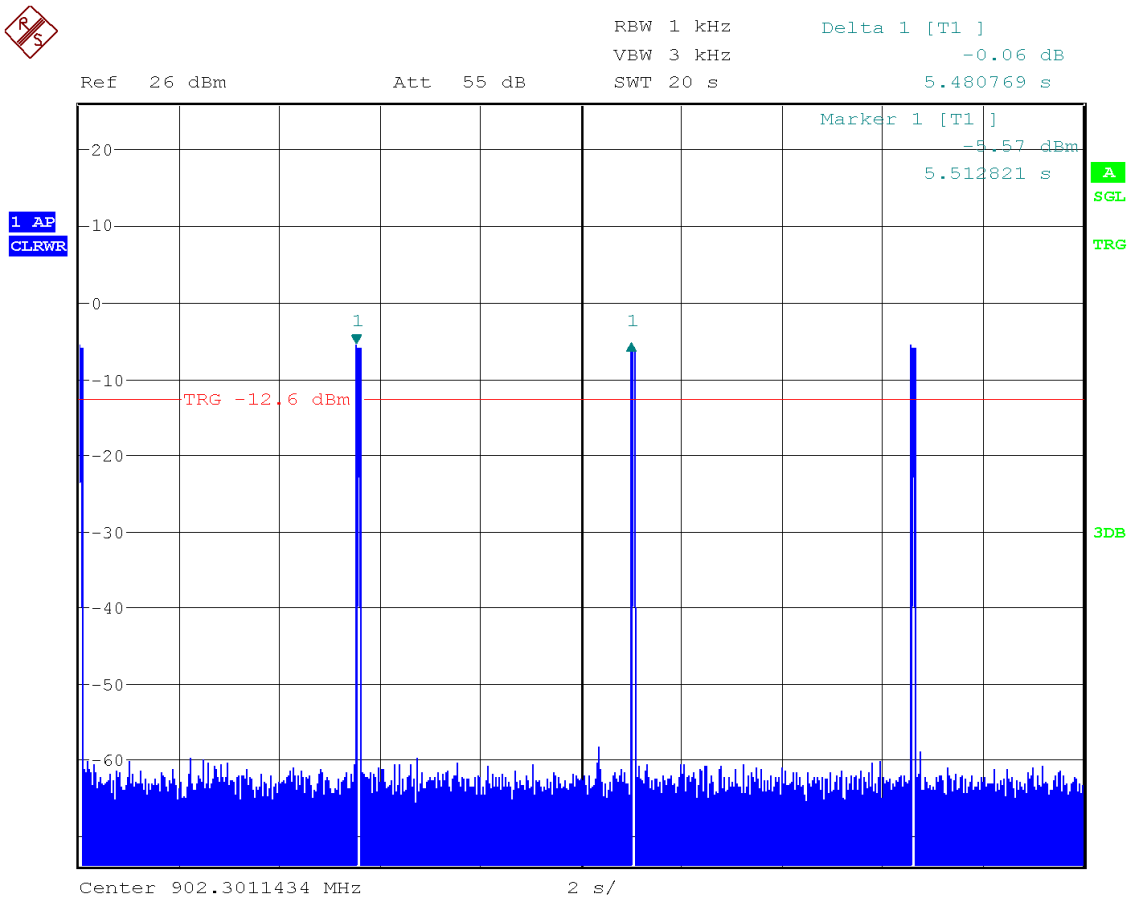
Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL6	Rohde & Schwarz	Nov. 25, 2015	Nov. 25, 2017	GMEC 160

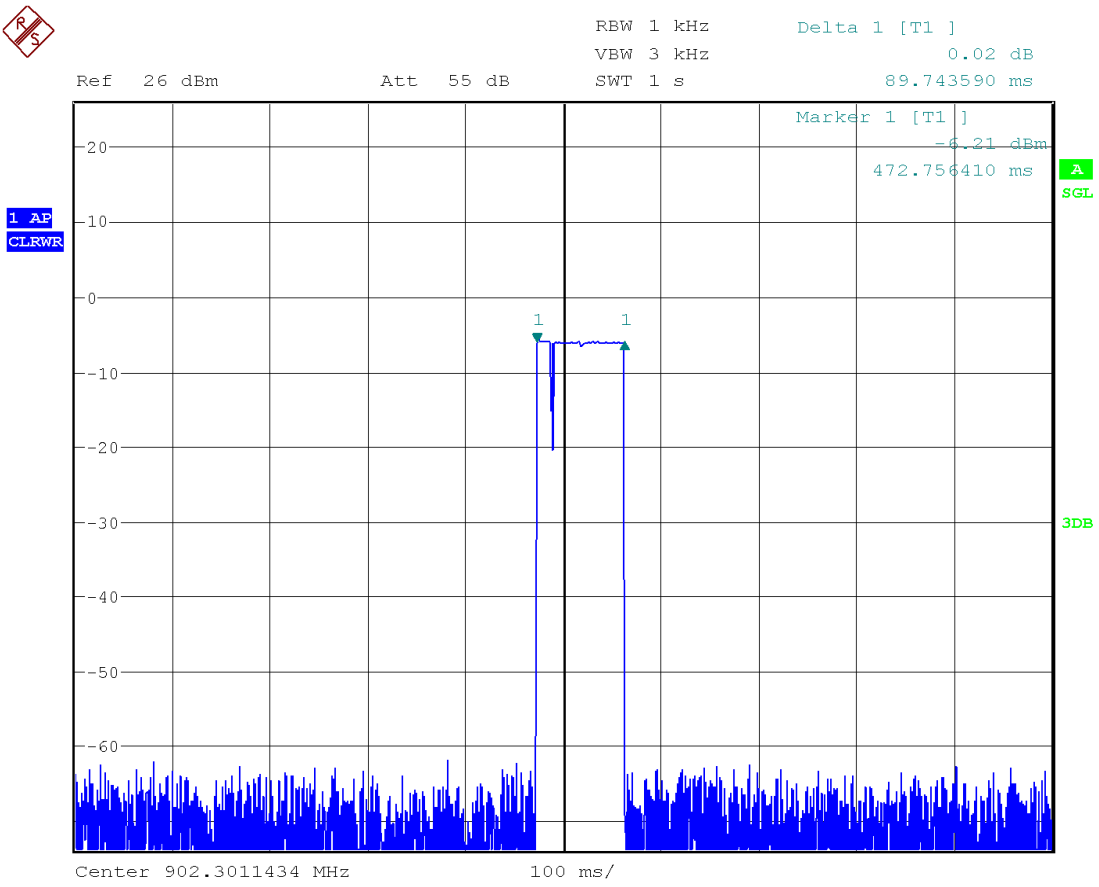
Time of Occupancy

The following plots show the time of occupancy in a channel.

Transmissions in a channel within a 20s time window.
Transmissions are 5.48 s apart.
Maximum number of transmissions in 20s = 4



Transmission on time.
Each transmission pulse = 89.74ms



(On time for each transmission) x (Maximum number of transmissions in 20s)
= 89.74ms x 4 = 358.96ms = 0.359s < 0.4s.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	FSU	Rohde & Schwarz	Jan. 19, 2015	Jan. 19, 2017	GMEC 198

Number of Channels

The EUT will use 50 hopping channels. As per the manufacturer, each individual unit of the product will be configured to use a set of 50 sequential channels within the 902.3 – 927.7 MHz range (inclusive) before it is sold. All units will use a 300 kHz channel spacing between carrier frequencies.

Results

The EUT passed. The maximum 20 dB BW measured was 249.5 kHz. The EUT uses 50 hopping frequencies, and the time of occupancy on a channel is not greater than 0.4 seconds within a 20 second period.

Maximum Peak Conducted Output Power

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element does not exceed the limits specified. This ensures that if the end-user replaces the antenna, that the maximum power does not exceed an amount which may create an excessive power level.

Limits

The limits are defined in FCC Part 15.247(b)2 and RSS-247 5.4(1).

1. For frequency hopping systems operating in the 902-928 MHz band:

    a. For systems employing at least 50 hopping channels: 1 Watt (30 dBm)

    b. For systems employing less than 50 hopping channels, but at least 25 hopping channels: 0.25 Watts (24 dBm)

1.a. Applies for the EUT.

Results

The EUT passed. The peak power measured is 26.1 dBm (407.4mW).

Table(s)

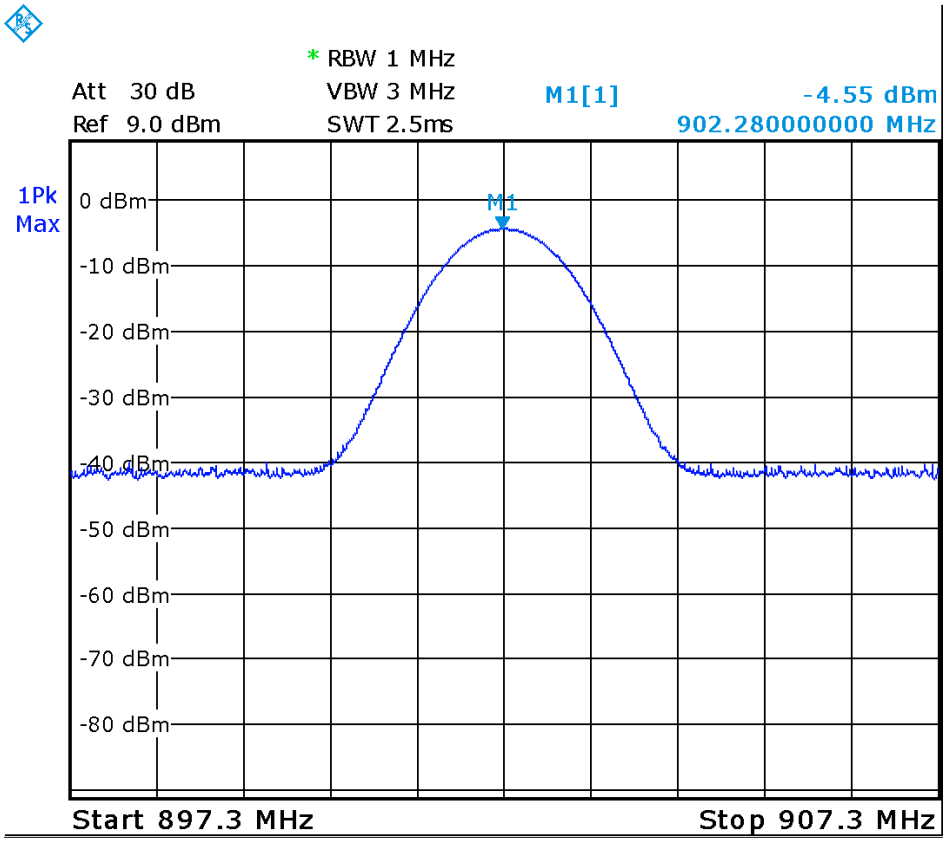
The table below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT. Peak detector was used with max hold. The EUT was transmitting continuous modulated data at the maximum output power used by the manufacturer.

Table 1 – Max peak conducted output power

Test Frequency (MHz)	Channel	Received Reading (dBm)	External Attenuator (dB)	Output Power (dBm)	Output Limit (dBm)	Margin (dB)	Result
902.3	Low	-4.55	30.0	25.5	30.0	4.6	Pass
915.0	Middle	-4.19	30.0	25.8	30.0	4.2	Pass
927.7	High	-3.87	30.0	**26.1**	30.0	3.9	Pass

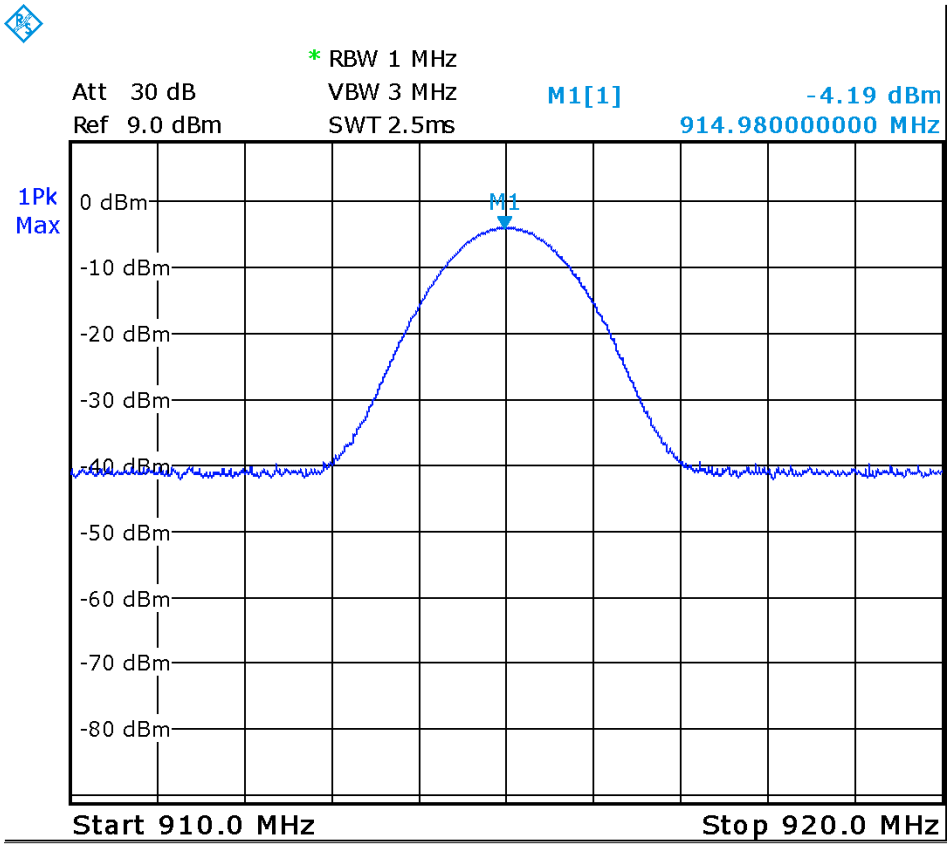
Low Channel

Note: 30 dB attenuator was used to make the measurements shown below.



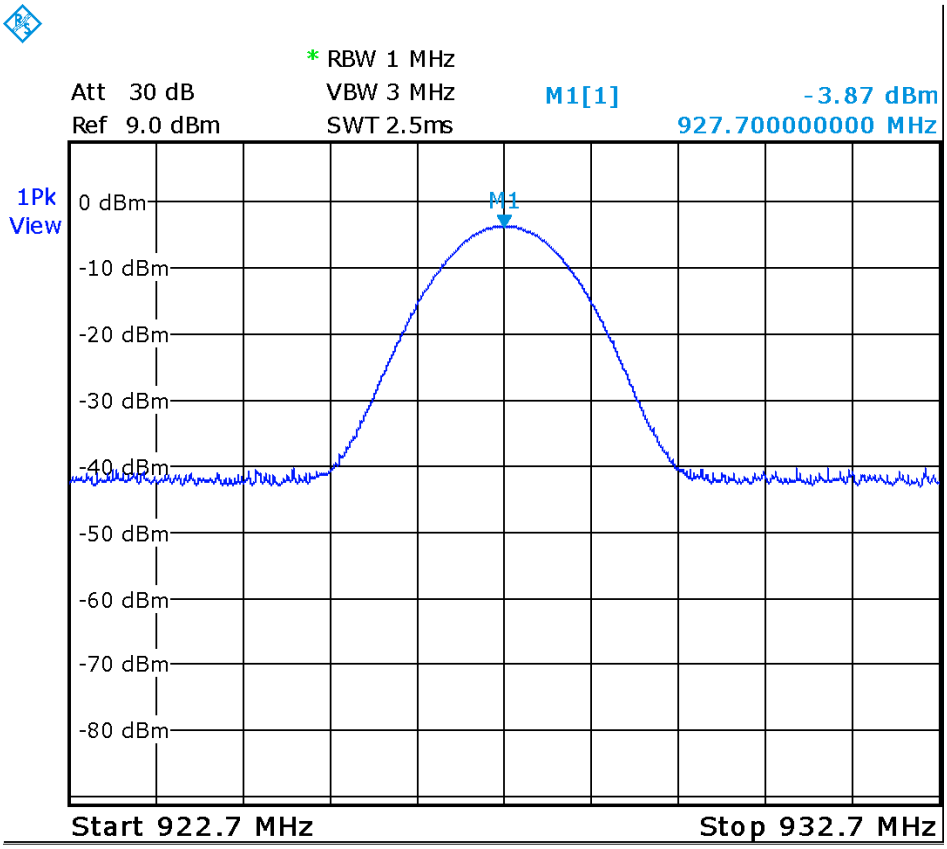
Middle Channel

Note: 30 dB attenuator was used to make the measurements shown below.



High Channel

Note: 30 dB attenuator was used to make the measurements shown below.



Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL6	Rohde & Schwarz	Nov. 25, 2015	Nov. 25, 2017	GMEC 160
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

Maximum Peak E.I.R.P Output

Purpose

The purpose of this test is to ensure that the maximum power output does not exceed the limits specified when used with the antenna, which may provide gain. This ensures that the maximum power does not exceed an amount which may create an excessive power level.

Limits

The limits are defined in RSS-247 5.4(1).
For FHSs operating in the 902-928 MHz band, the peak E.I.R.P. limit is 4 Watts (or 36 dBm = 131.2 dBµV at a 3m distance).

Results

The EUT passed. The peak E.I.R.P. is 34.8 dBm (3.0 W, or 130.0 dBµV/m at 3 m).

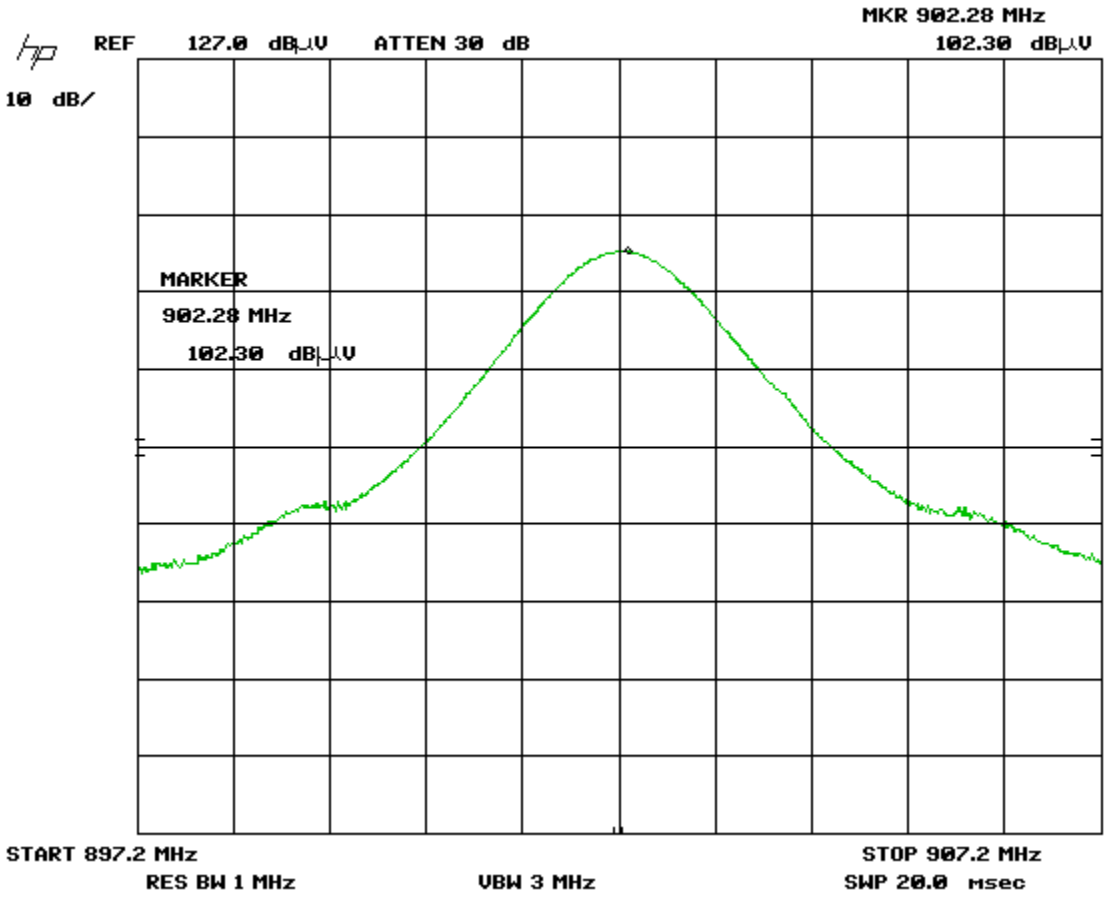
Table(s)

The table below shows the measured peak power output of the device. Peak measurements were made during transmit operation of the EUT with continuous modulated data at the maximum output power used by the manufacturer. Worst case plots are shown.

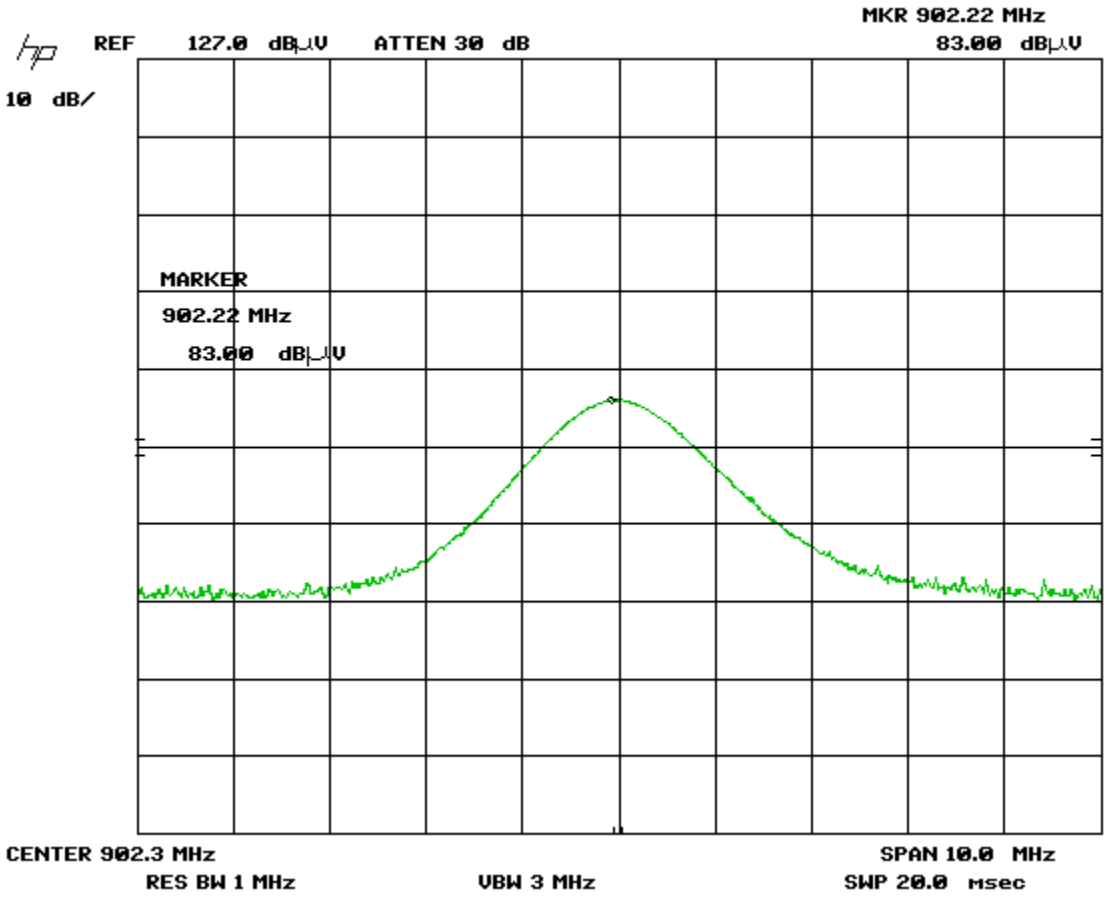
Table 2 – Max peak E.I.R.P. output

Test Frequency (MHz)	Channel	Antenna polarity	Received Reading dB(µV)	Antenna factor (dB)	Cable Loss (dB)	External Attenuator (dB)	Received signal at 3m (dBµV)	Emission limit dB(µV)	Margin dB(µV)	Result
902.3	Low	Vertical	102.3	22.4	2.2	3.0	129.9	131.20	1.3	Pass
902.2	Low	Horizontal	83.0	23.8	2.4	3.0	112.2	131.20	19.0	Pass
914.9	Middle	Vertical	102.5	22.1	2.2	3.0	129.8	131.20	1.4	Pass
914.9	Middle	Horizontal	82.6	23.8	2.5	3.0	111.9	131.20	19.3	Pass
927.6	High	Vertical	102.2	22.5	2.3	3.0	**130.0**	131.20	1.2	Pass
927.6	High	Horizontal	84.0	23.9	2.6	3.0	113.5	131.20	17.7	Pass

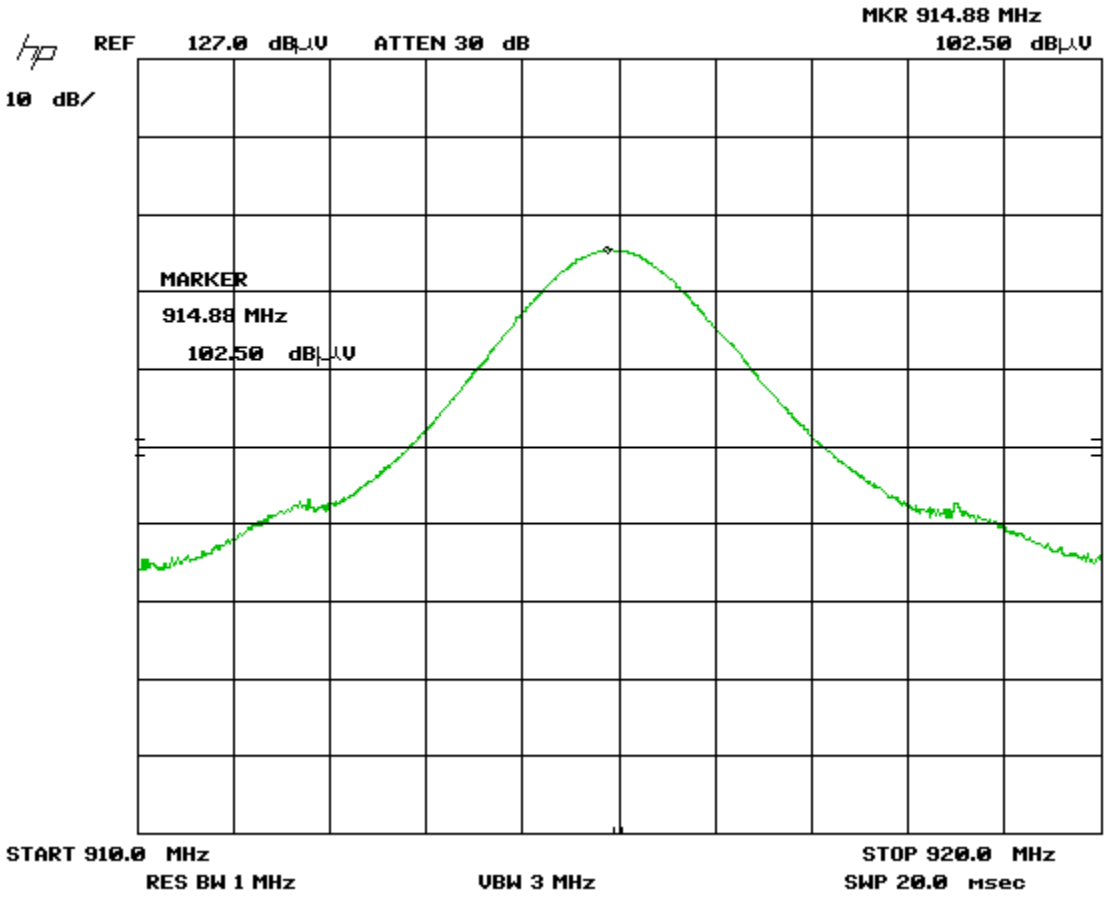
Low Channel
Vertical Antenna Polarity



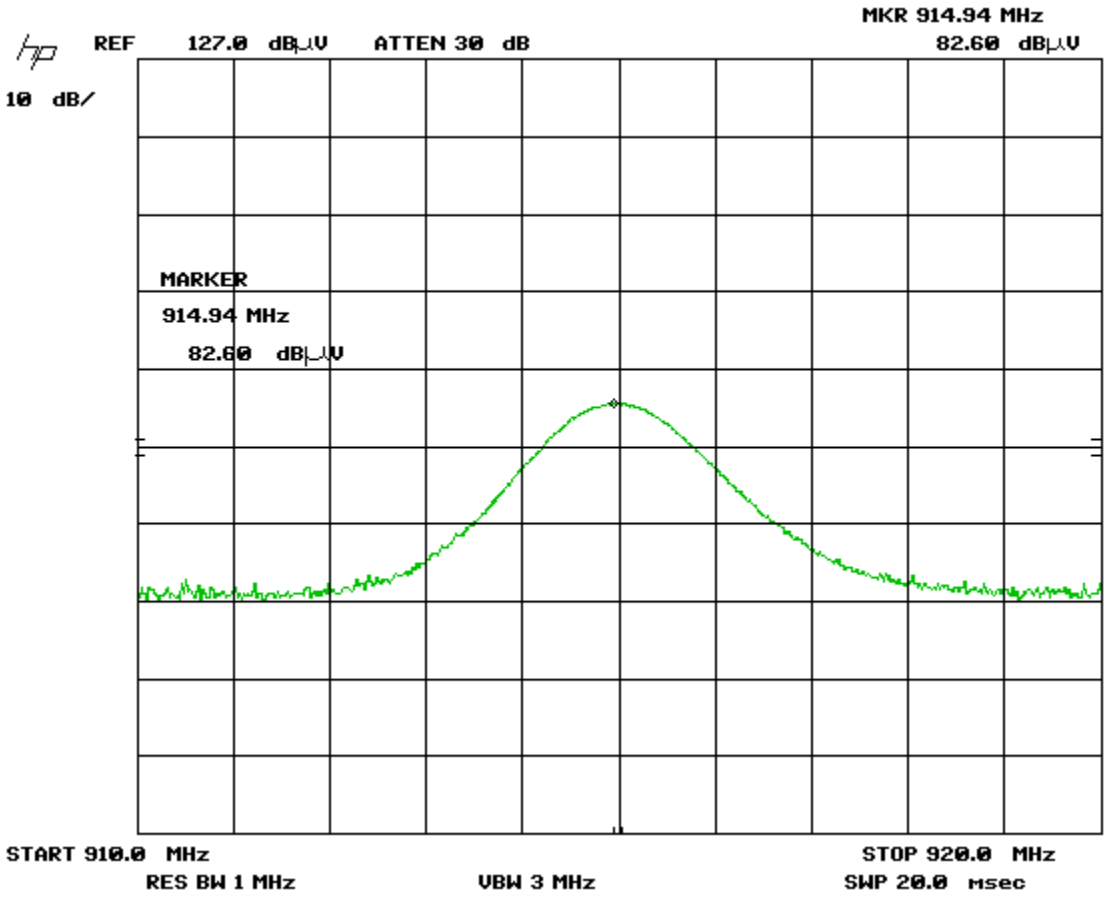
Low Channel
Horizontal Antenna Polarity



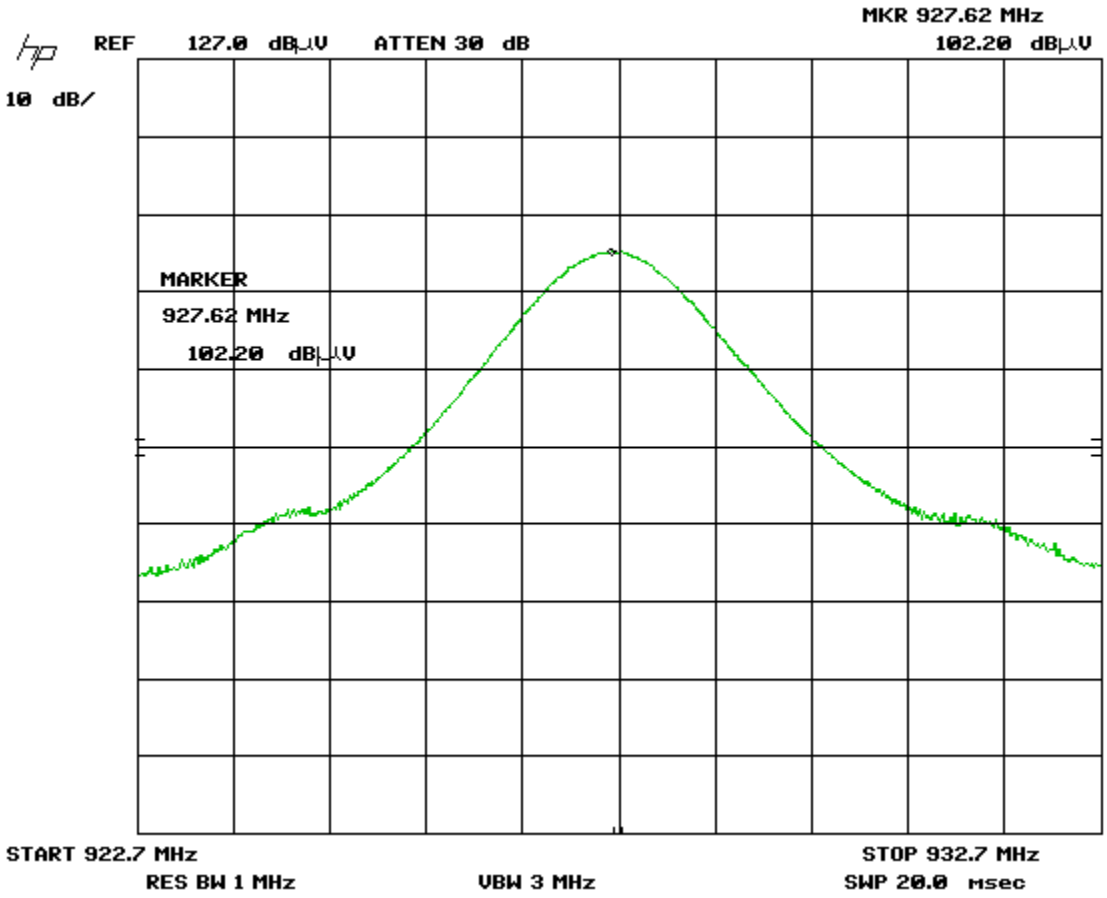
Middle Channel
Vertical Antenna Polarity



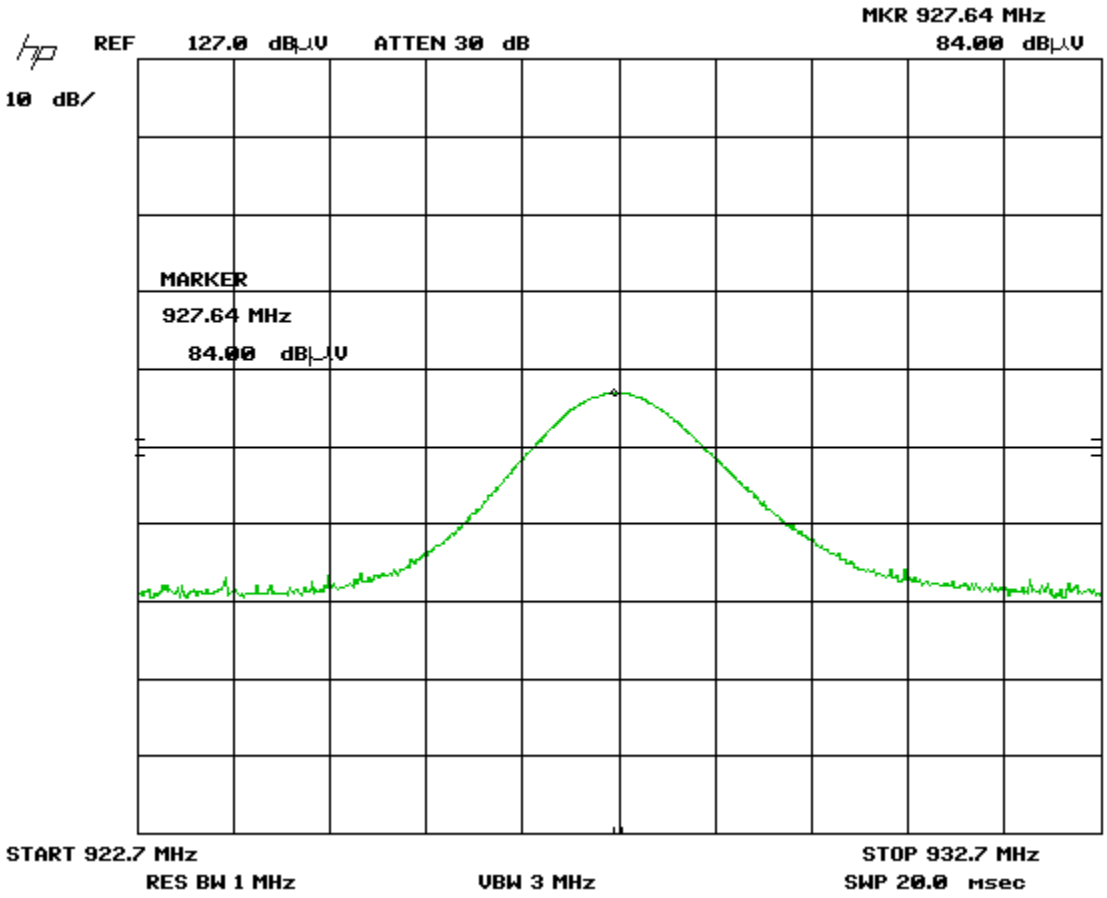
Middle Channel
Horizontal Antenna Polarity



High Channel
Vertical Antenna Polarity



High Channel
Horizontal Antenna Polarity



Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	Nov. 27, 2015	Nov. 27, 2017	GEMC 190
Quasi-Peak Adapter	85650A	HP	Nov. 27, 2015	Nov. 27, 2017	GEMC 191
BiLog Antenna	3142-C	ETS	Sept. 8, 2014	Sept. 8, 2016	GEMC 8
3 dB attenuator	612-03-1	Meca Electronics Inc.	NCR	NCR	GEMC 222
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

Maximum Peak Conducted Output Power (For Antenna Gain > 6 dBi)

Purpose

The purpose of this test is to ensure that the maximum power output does not exceed the limits specified when used with an antenna with a gain > 6 dBi. This ensures that the maximum power does not reach an excessive level when used with such an antenna.

Limits

The limits are defined in FCC Part 15.247(b)4.

For devices operating in the 902-928 MHz band, if a transmitting antenna with gain > 6 dBi is used, the conducted output power from the intentional radiator shall be reduced below the values stated in FCC Part 15.247(b)2, by the amount in dB that the gain of the antenna exceeds 6 dBi.

Results

As per the results shown in the section *Maximum Peak Conducted Output Power*, the peak conducted power output is 26.1 dBm (0.407 W).
As per the results shown in the section *Maximum E.I.R.P.*, the peak E.I.R.P output is 34.8 dBm.

Calculated antenna gain = (Peak E.I.R.P) – (Peak Conducted Power Output) = 8.7 dBi

Amount in dB that antenna gain is over 6 dBi = 2.7 dB
Peak conducted power limit = 30 dBm – 2.7 dB = 27.3 dBm = 0.537 W

Therefore, the EUT passes this test.

Antenna Spurious Conducted Emissions (-20 dBc)

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element at frequencies outside of the authorized spectrum does not exceed the limits specified. This ensures that the only the intended signal is delivered to the radiating element.

Limits

The limits are defined in FCC Part 15.247(d) and RSS-247 5.5. In any 100 kHz band outside the frequency band in which the intentional radiator is operating, the peak spurious harmonics emissions must be at least 20 dB below the fundamental. Spurious conducted emissions are to be evaluated up to the 10^{th} harmonic. This -20 dBc requirement also applies at the 'band edge' or 902 MHz and 928 MHz.

Results

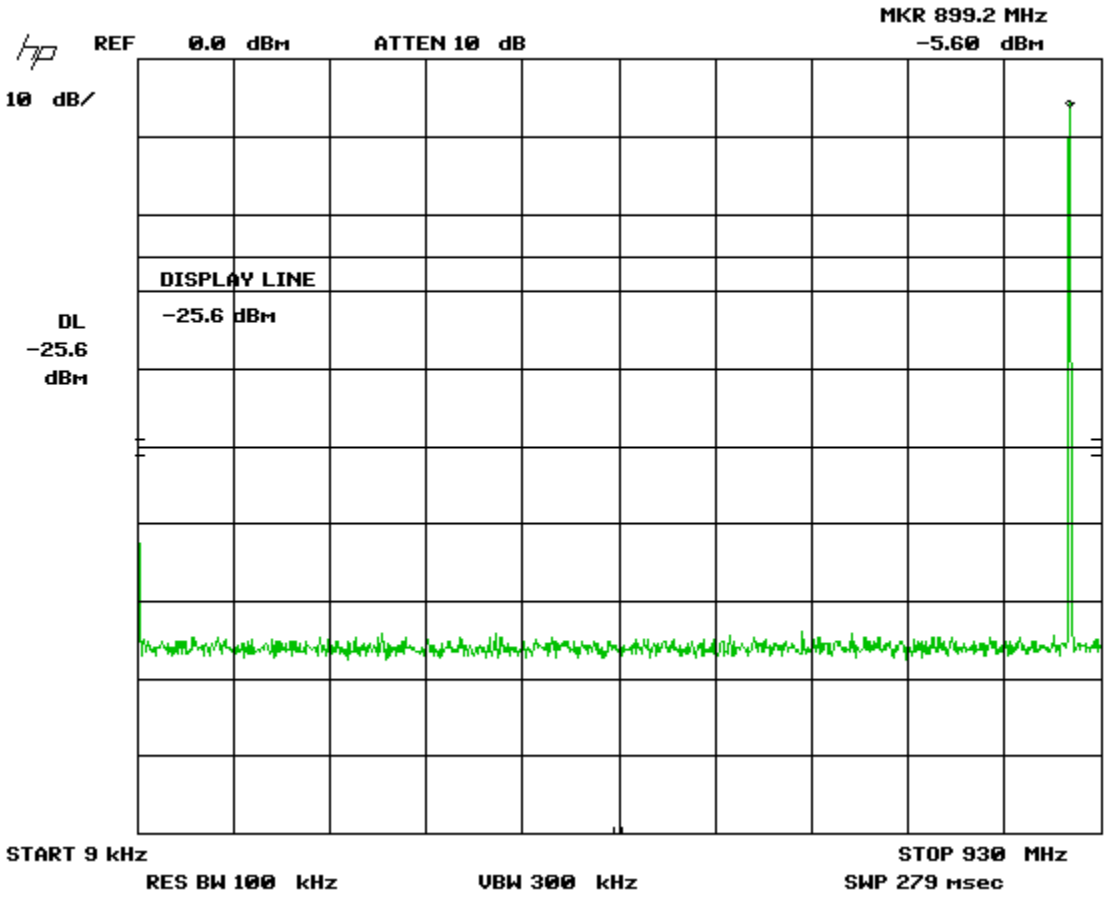
The EUT passes. Low, middle and high channels were measured. The worst case is presented as a graph for the spectrum. The -20 dBc requirement is shown for the lower band edge at 902 MHz in the low band, and for the high band edge at 928 MHz in the high band.

Graph(s)

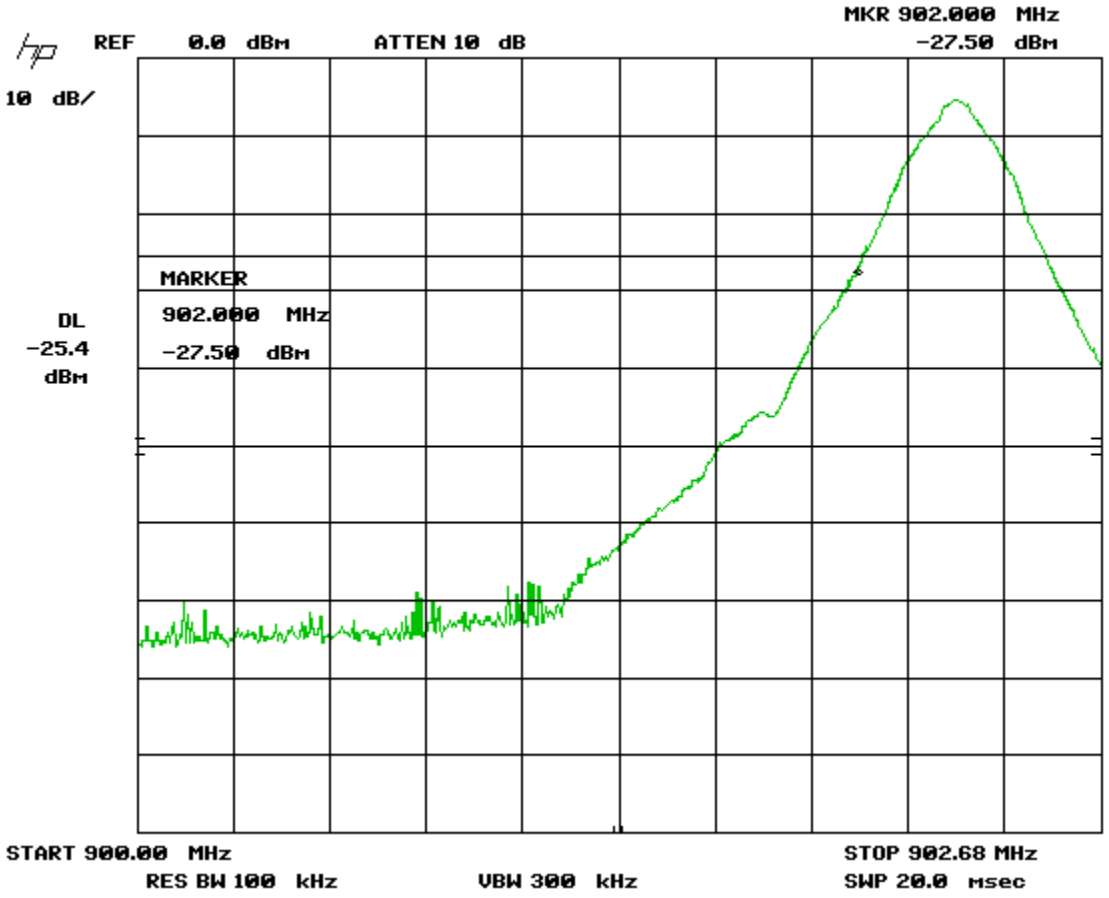
The EUT passes. Low, middle and high channels were measured. The worst case is presented as a graph for the spectrum. The -20 dBc requirement is shown for the lower band edge at 902 MHz in the low band, and for the high band edge at 928 MHz in the high band

Note that 30 dB of external attenuation was used during these measurements.

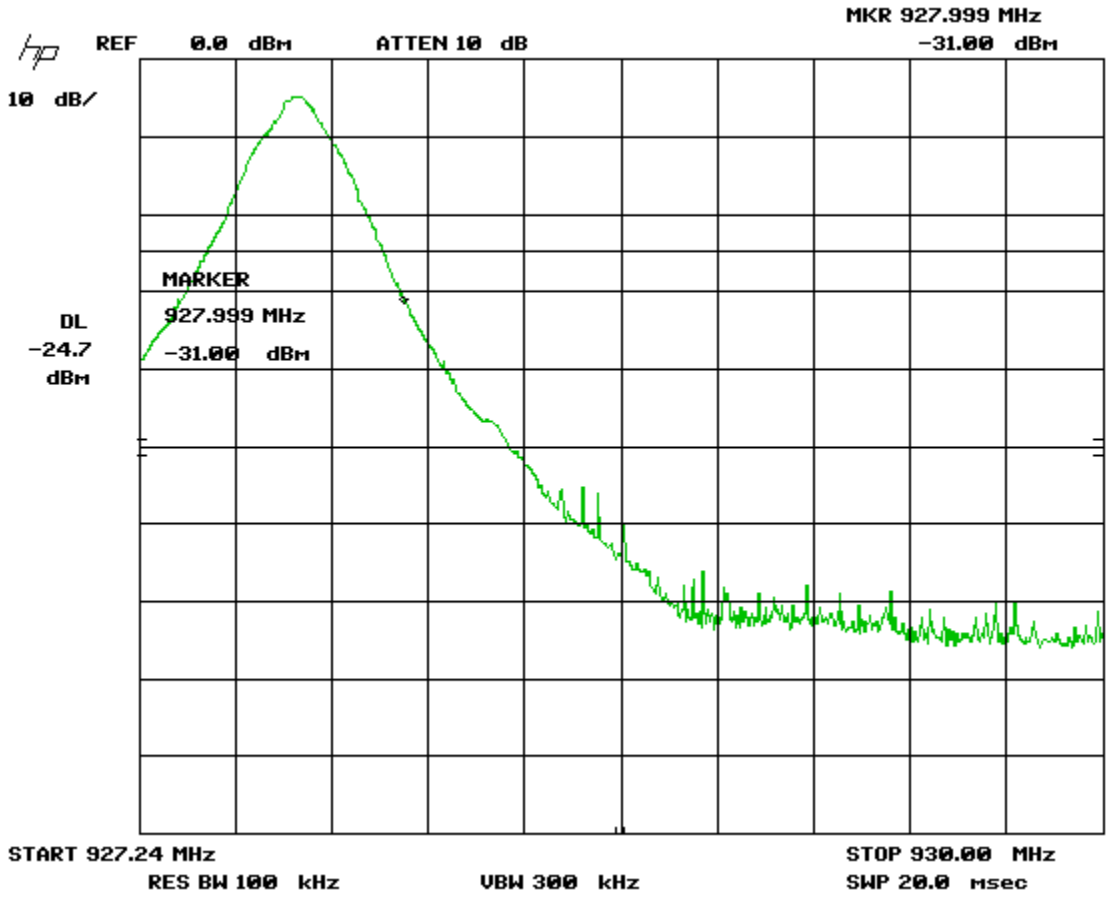
9 kHz – 930 MHz, Low Channel



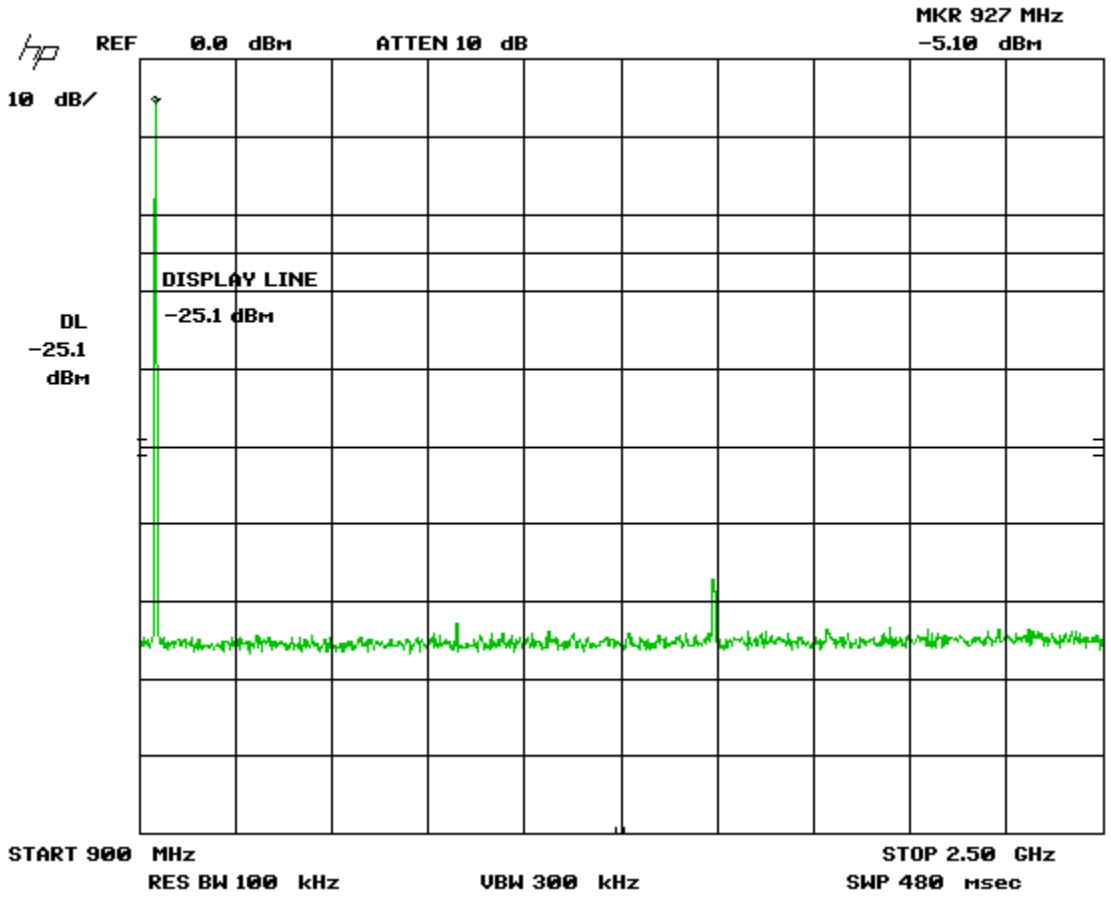
900 MHz – 902.68 MHz, Low Channel
Lower Band Edge



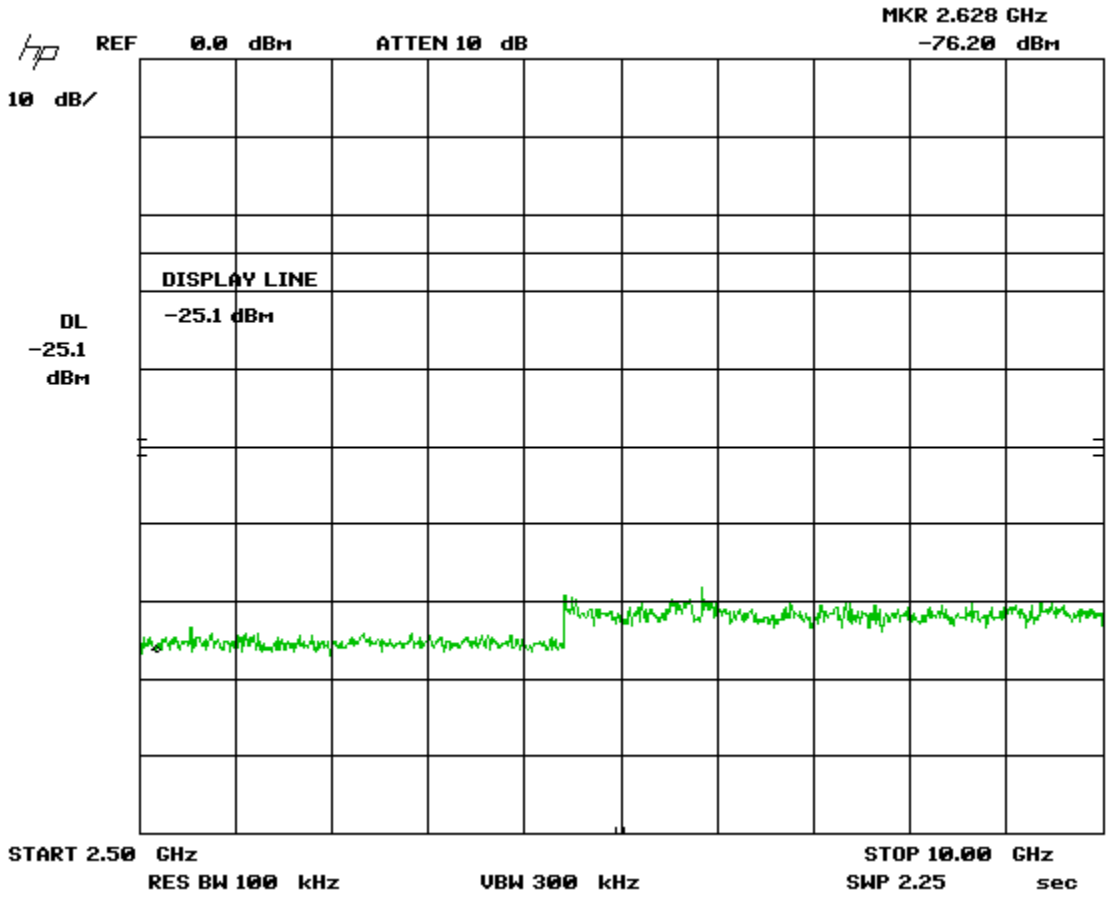
927.24 MHz – 930 MHz, High Channel
Upper Band Edge



900 MHz – 2.5 GHz, High Channel



2.5 GHz – 10 GHz, High Channel



Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	Nov. 27, 2015	Nov. 27, 2017	GEMC 190
Quasi-Peak Adapter	85650A	HP	Nov. 27, 2015	Nov. 27, 2017	GEMC 191
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

Channel Carrier Separation and Number of Hopping Frequencies

Purpose

The purpose of this test is to ensure that the RF energy of frequency hopping systems is sufficiently spread over a spectrum and that the radio energy is not overly dense. This limit helps allow for other spread spectrum devices to co-exist in the same frequency spectrum. This also helps prevent corruption of data by ensuring adequate channel separation to distinguish the reception of the intended information. It also confirms the number of hopping channels used.

Limits

The limits are as defined in 47 CFR FCC Part 15 Section FCC 15.247(a)(1), and RSS-247 5.1(2).

1. Frequency hopping systems in the 902 MHz - 928 MHz band shall have hopping channel carrier frequencies separated by a minimum of:

The greater value of:

a. 25 kHz,

or

b. The 20 dB bandwidth of the hopping channel,

As per the section titled *20dB Bandwidth, Time of Occupancy, and Number of Channels*, The 20 dB BW of the system was measured to be 249.5 kHz max. Channels must be separated by at least 249.5 kHz.

Additionally, the EUT must use at least 50 hopping channels as specified by FCC 15.247(a)(1)(i) and RSS-247 5.1(3).

Results

The EUT passed the requirements of channel carrier separation, and exceeds the 20 dB BW of the EUT. The device has a channel spacing of at least 293.4 kHz. The EUT will 50 hopping frequencies.

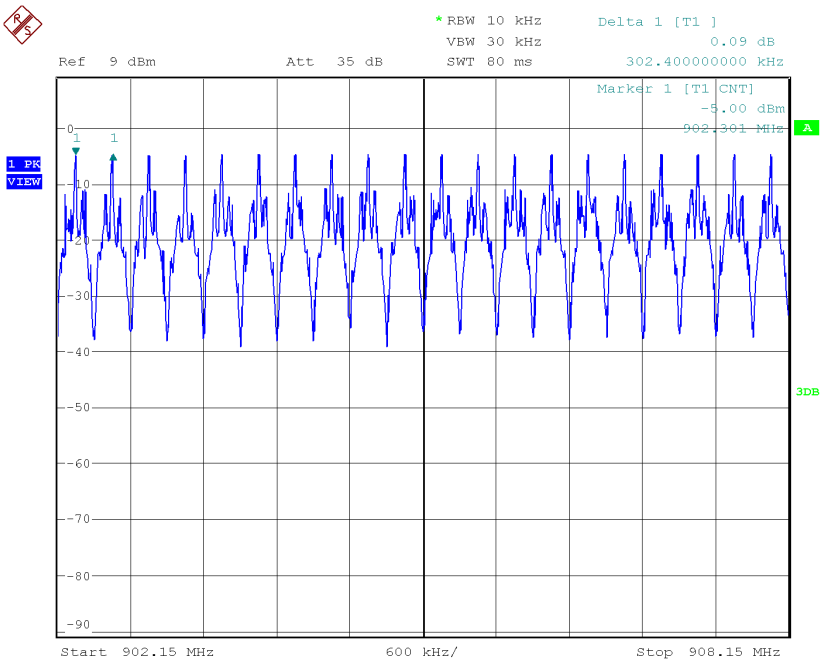
Graph(s)

The graphs shown below shows the channel spacing during the operation of the device. This is measured by a max hold on the spectrum analyzer with peak detector function. 30 dB of external attenuation is used at the spectrum analyzer input. Max hold is performed for a duration of not less than 1 minute. The EUT is transmitting at maximum output power with frequency hopping enabled.

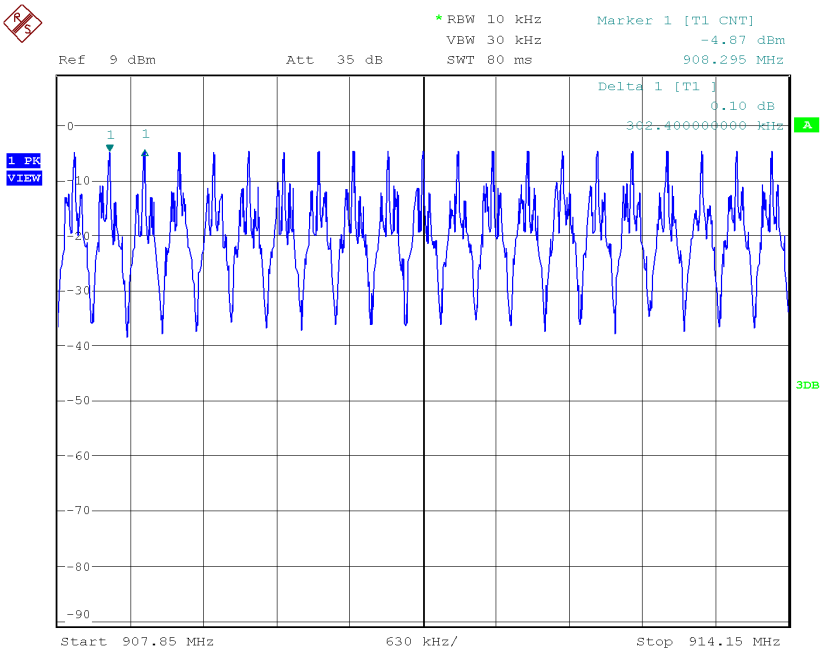
As per the manufacturer, each individual unit will be set to use 50 channels from a continuous subset of the full range of available channels shown below ranging from 902.3 – 927.7 MHz, with a channel spacing of 300 kHz. To verify channel spacing, the EUT is set to transmit on all the available channels, and the spacing between all adjacent channels are measured to ensure compliance.

Markers in the following plots are set between the closest adjacent channels in the plot.

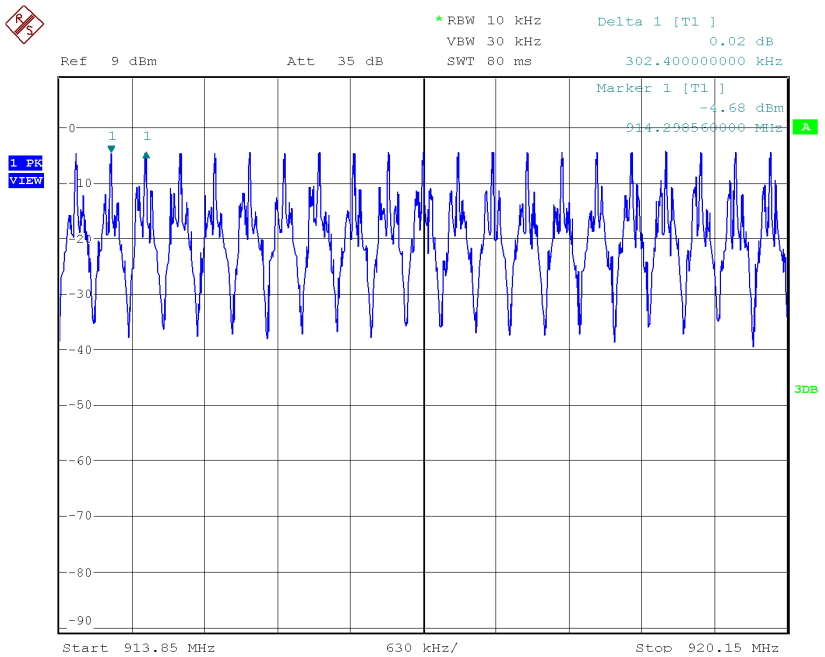
902.15 MHz – 908.15 MHz



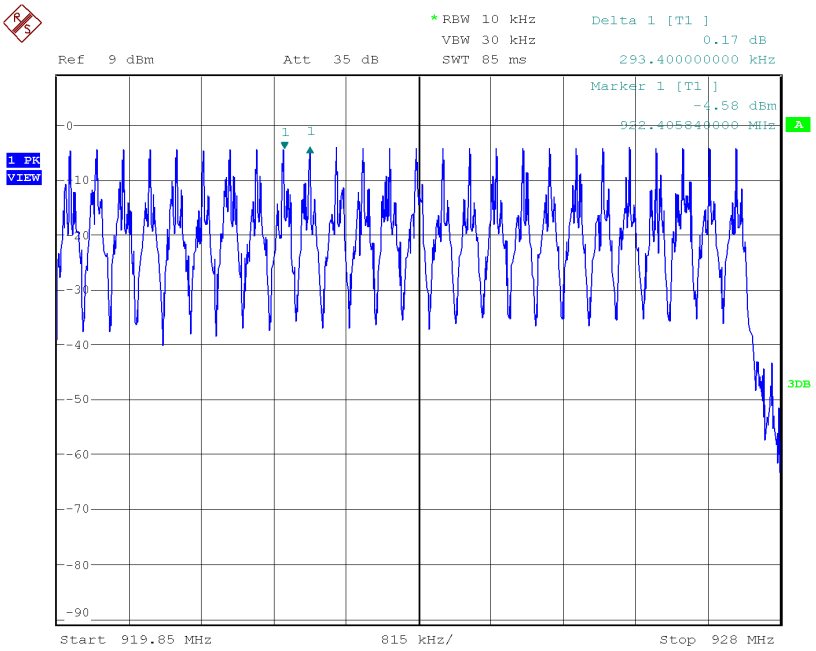
907.85 MHz – 914.15 MHz



913.85 MHz – 920.15 MHz



919.85 MHz – 928 MHz



Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL6	Rohde & Schwarz	2013-11-15	2015-11-15	GMEC 160
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

Spurious Radiated Emissions & Restricted Bands

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference.

Limit(s) and Method

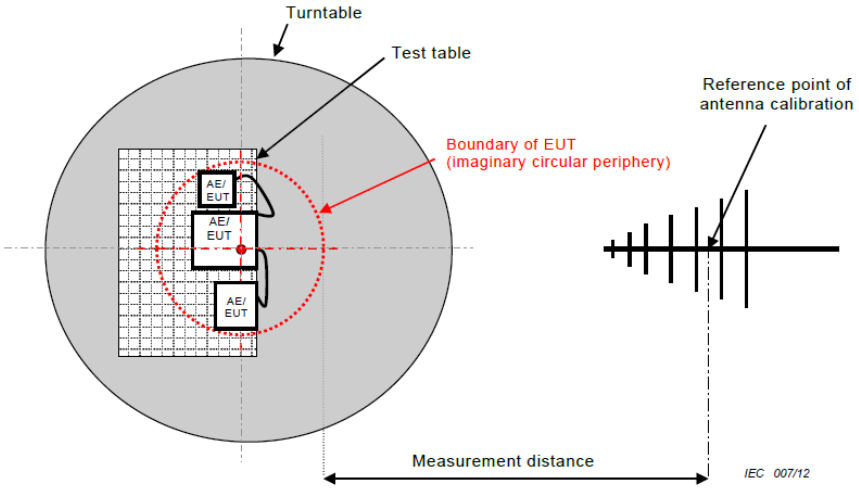
The method is as defined in ANSI C63.4.
The restricted bands are defined in 47 CFR FCC Part 15.205 and RSS-Gen (Table 6).
The limits are as defined in 47 CFR FCC Part 15.209 and RSS- Gen (Table 4).
The requirement is stated in 47 CFR FCC Part 15 Section FCC 15.247(d), and RSS-247 5.5.

The limits for unintentional radiated emissions apply for those emissions that fall in the restricted bands. These limits are as follows:

0.009 MHz – 0.490 MHz, 2400/F(kHz) uV/m at 300 m [1]
0.490 MHz – 1.705 MHz, 24000/F(kHz) uV/m at 30 m [1]
1.705 MHz – 30 MHz, 30 uV/m at 30 m [1]
30 MHz – 88 MHz, 100 uV/m (40.0 dBuV/m [1]) at 3 m
88 MHz – 216 MHz, 150 uV/m (43.5 dBuV/m [1]) at 3 m
216 MHz – 960 MHz, 200 uV/m (46.0 dBuV/m[1]) at 3 m
Above 960 MHz, 500 uV/m (54.0 dBuV/m [1]) at 3 m
Above 1000 MHz, 500 uV/m (54 dBuV/m [2]) at 3m
Above 1000 MHz, 5011.9 uV/m (74 dBuV/m [3]) at 3m

[1]Limit is with Quasi Peak detector with bandwidths as defined in CISPR-16-1-1.
[2]Limit is with 1 MHz measurement bandwidth and using an Average detector.
[3]Limit is with 1 MHz measurement bandwidth and using a Peak detector.

Typical Radiated Emissions Setup



Measurement Uncertainty

The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is +/-4.4 dB with a 'k=2' coverage factor and a 95% confidence level.

Preliminary Graphs

Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector, please refer to the final measurement table where applicable. The graphs shown below are maximized peak measurement graphs, measured with a resolution bandwidth greater than or equal to, the final required detector and over a full 0-360° rotation. This peaking process is done as a worst case measurement. This process enables the detection of frequencies of concern for final measurement, and provides considerable time savings.

In accordance with FCC Part 15, Subpart A, Section 15.33, the device was scanned to the 10^{th} harmonic.

Devices scanned may be scanned at alternate test distances, and in accordance with FCC Part 15, Subpart A, Section 15.31, an extrapolation factor of 20 dB/decade was used above 30 MHz and 40 dB/decade below 30 MHz. For example for 1 meter measurements, an extrapolation factor 9.5 dB from 20 Log (1m/3m) is applied.

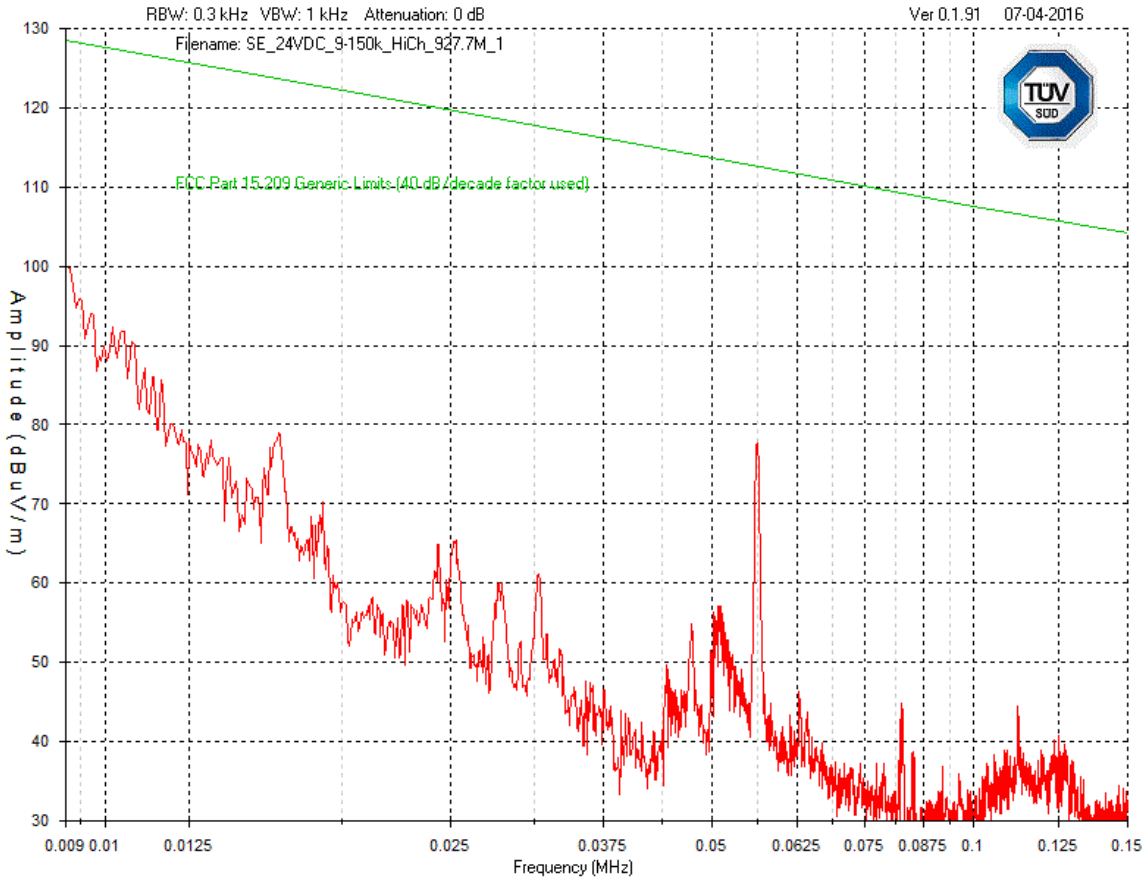
See *Final Measurements* section for measurement data.

EUT was scanned at low, middle, and high channels. Worst case data is presented.

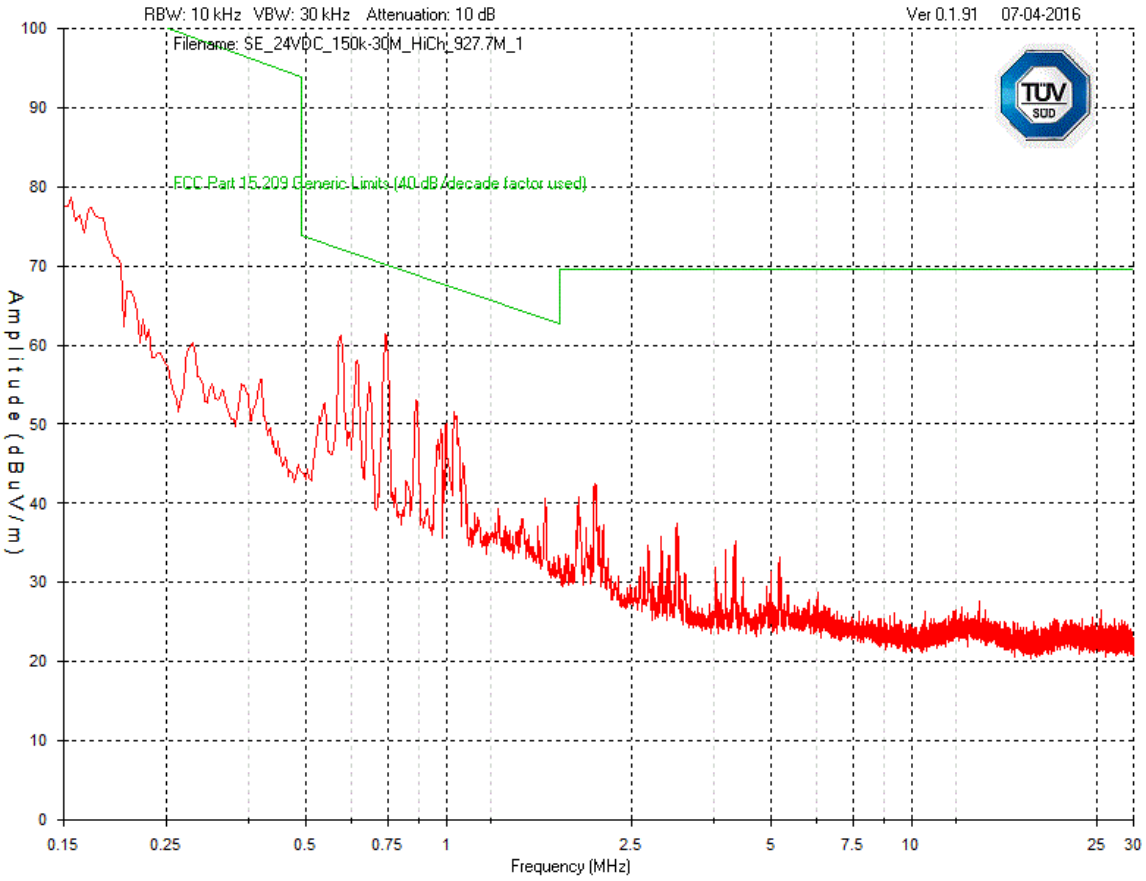
All transmitters in EUT are on and transmitting continuous modulated data at maximum power setting used by the manufacturer.

The measurement distance is 3m.

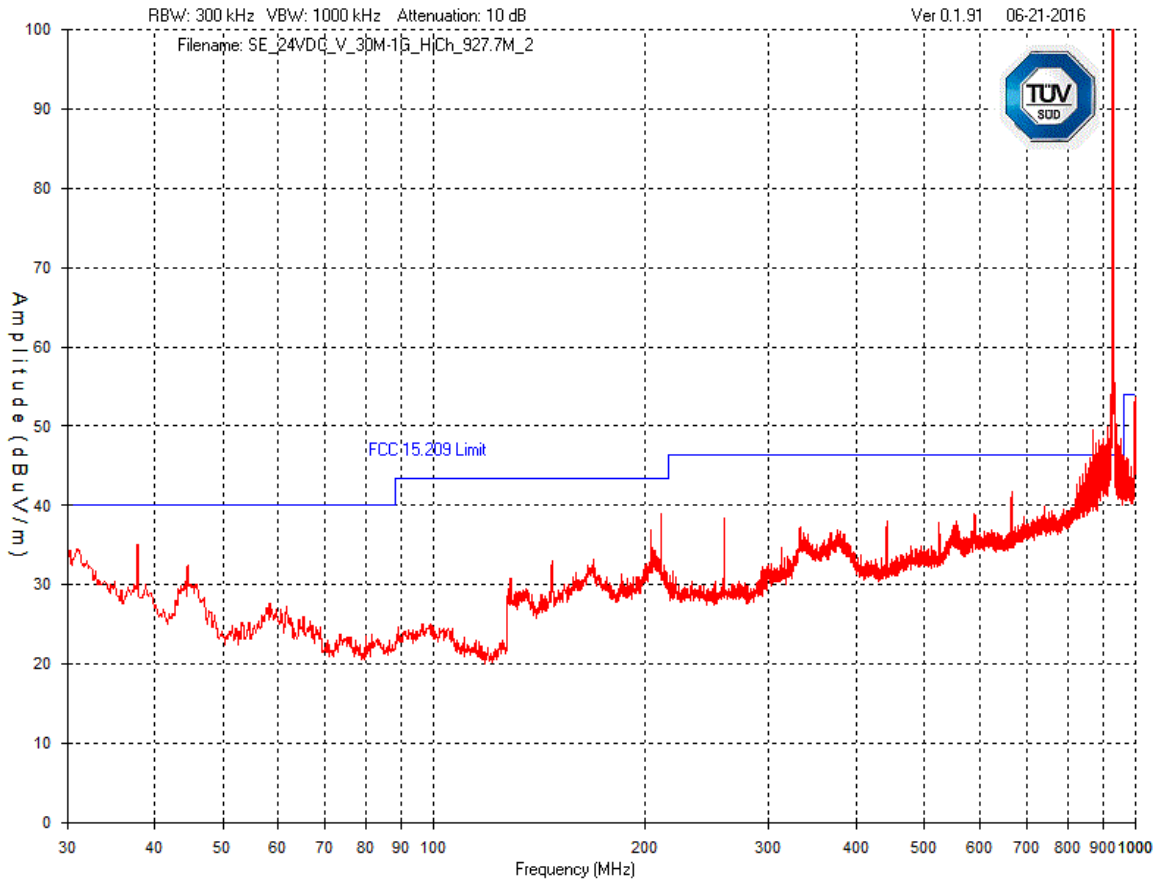
Peak Emissions Graph
9 kHz to 150 kHz



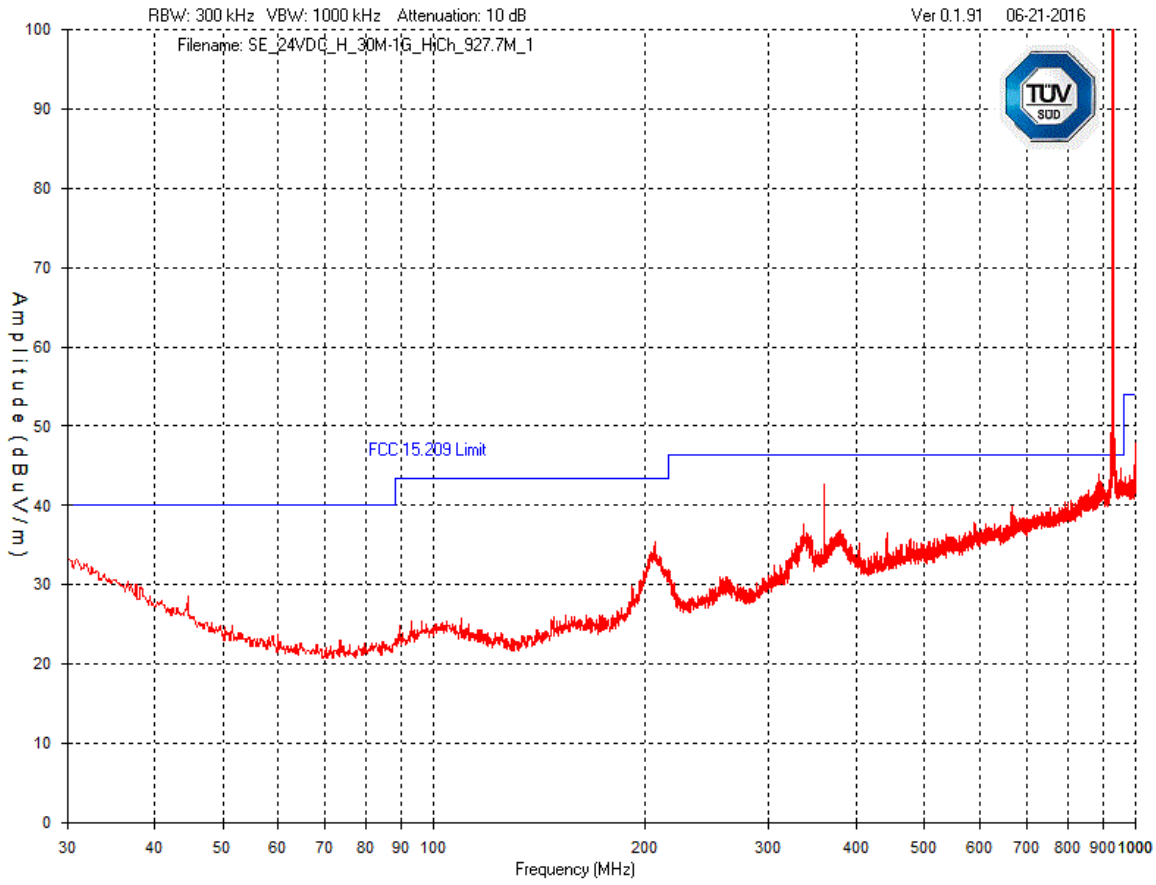
Peak Emissions Graph
150 kHz to 30 MHz



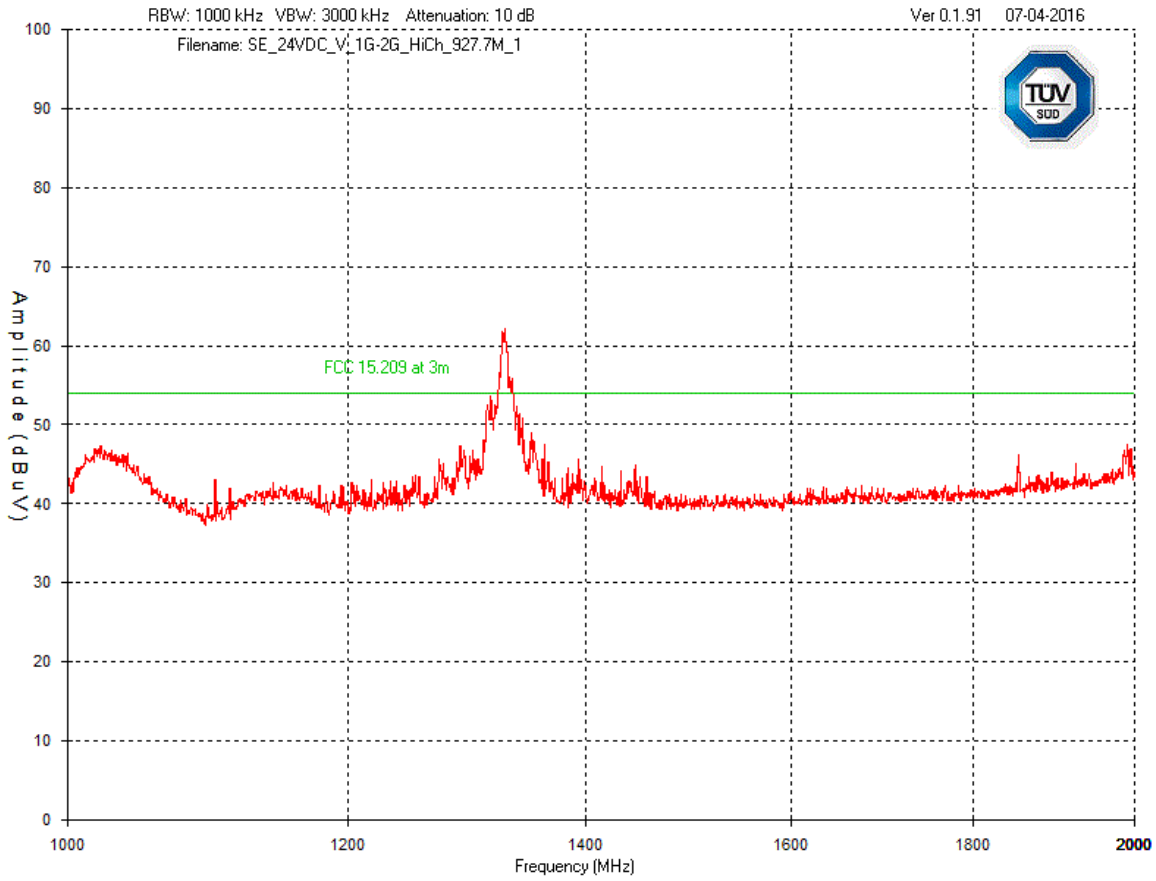
Peak Emissions Graph
Vertical Antenna Polarity
30 MHz to 1 GHz



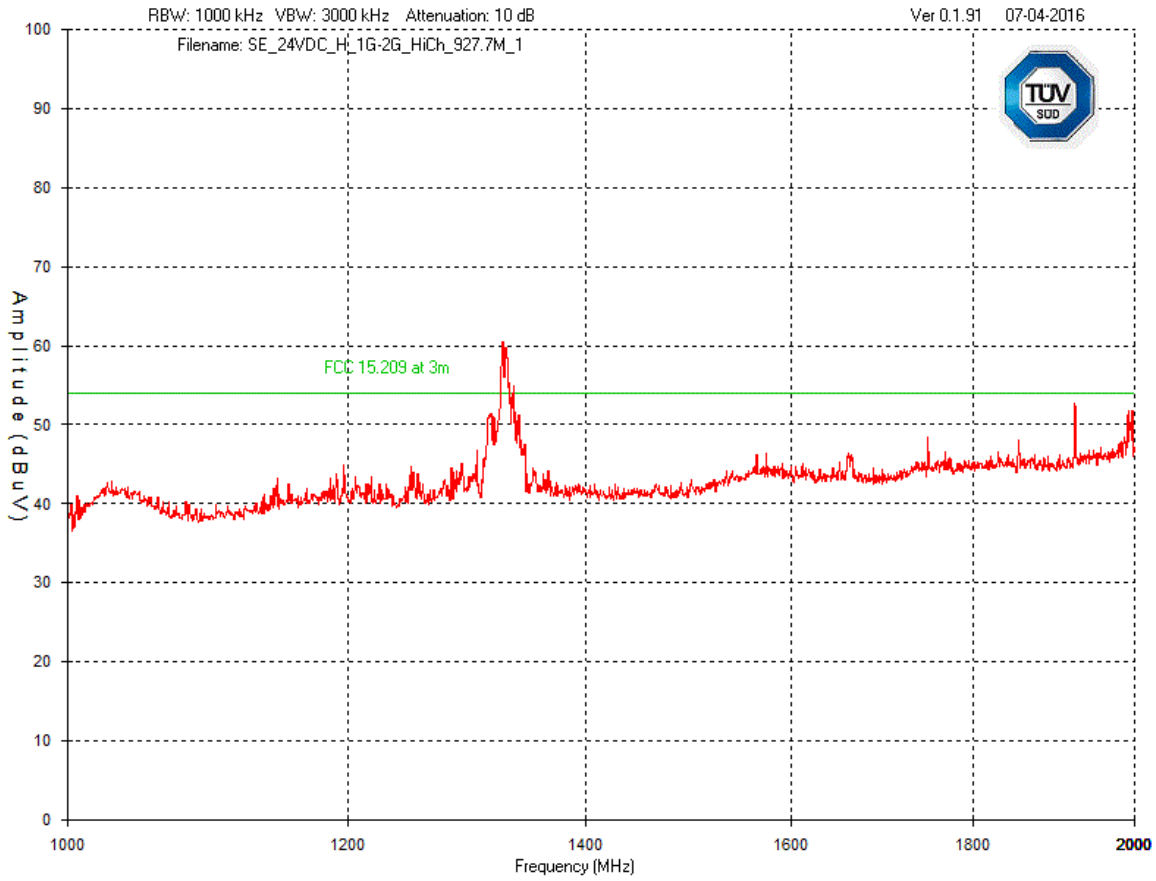
Peak Emissions Graph
Horizontal Antenna Polarity
30 MHz to 1 GHz



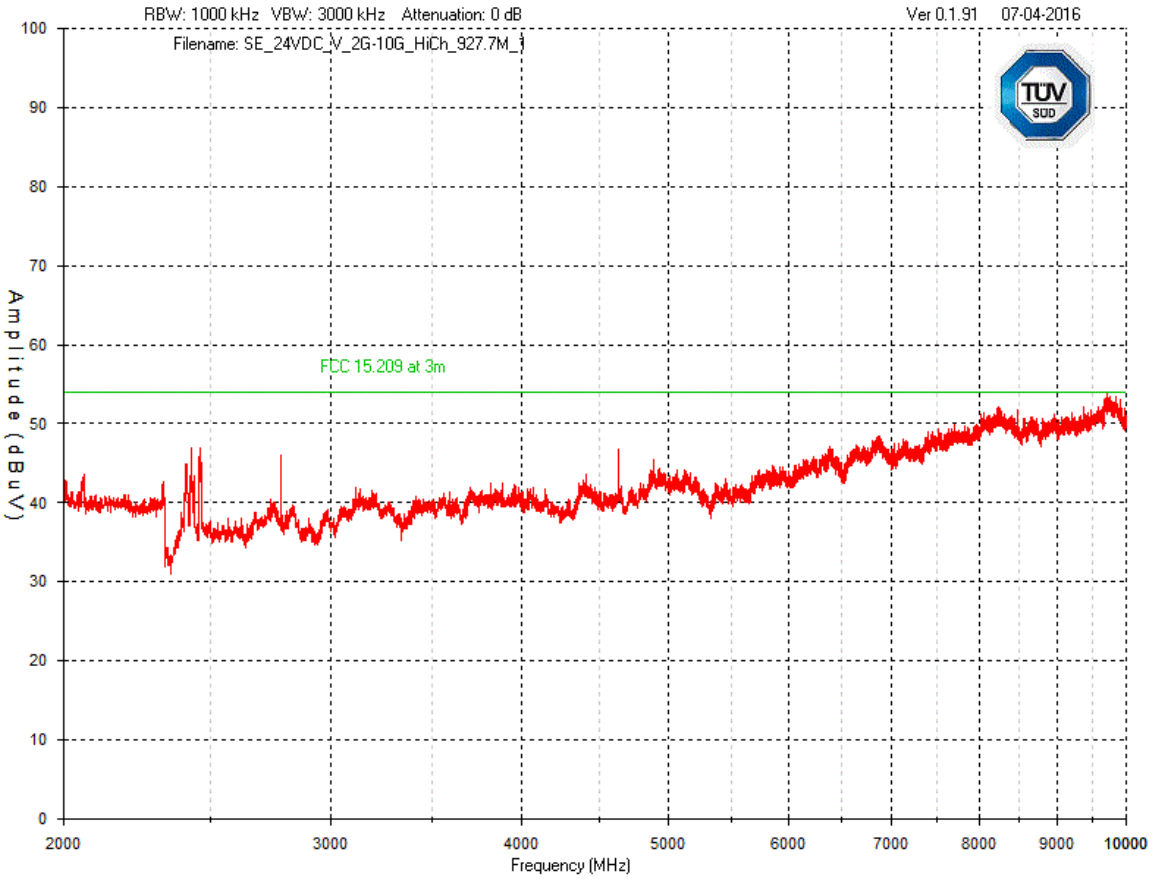
Peak Emissions Graph
Vertical Antenna Polarity
1 GHz to 2 GHz



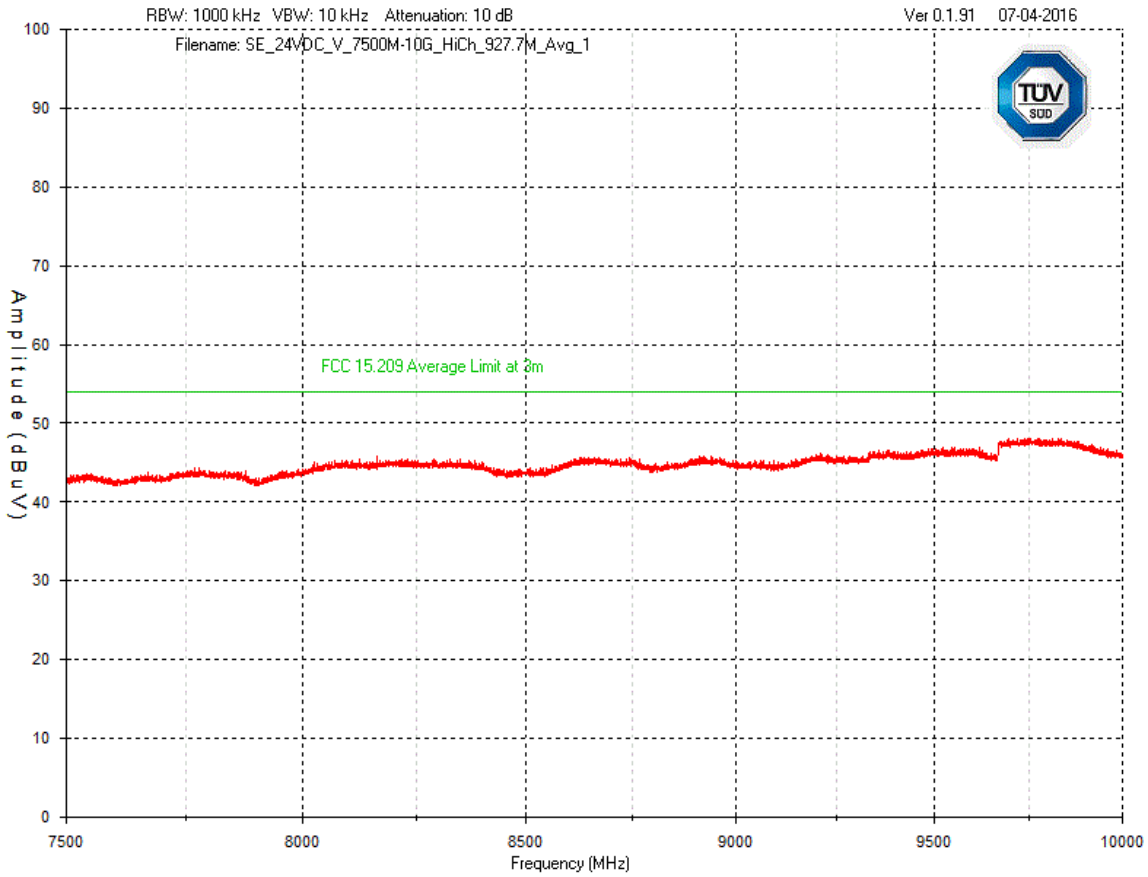
Peak Emissions Graph
Horizontal Antenna Polarity
1 GHz to 2 GHz



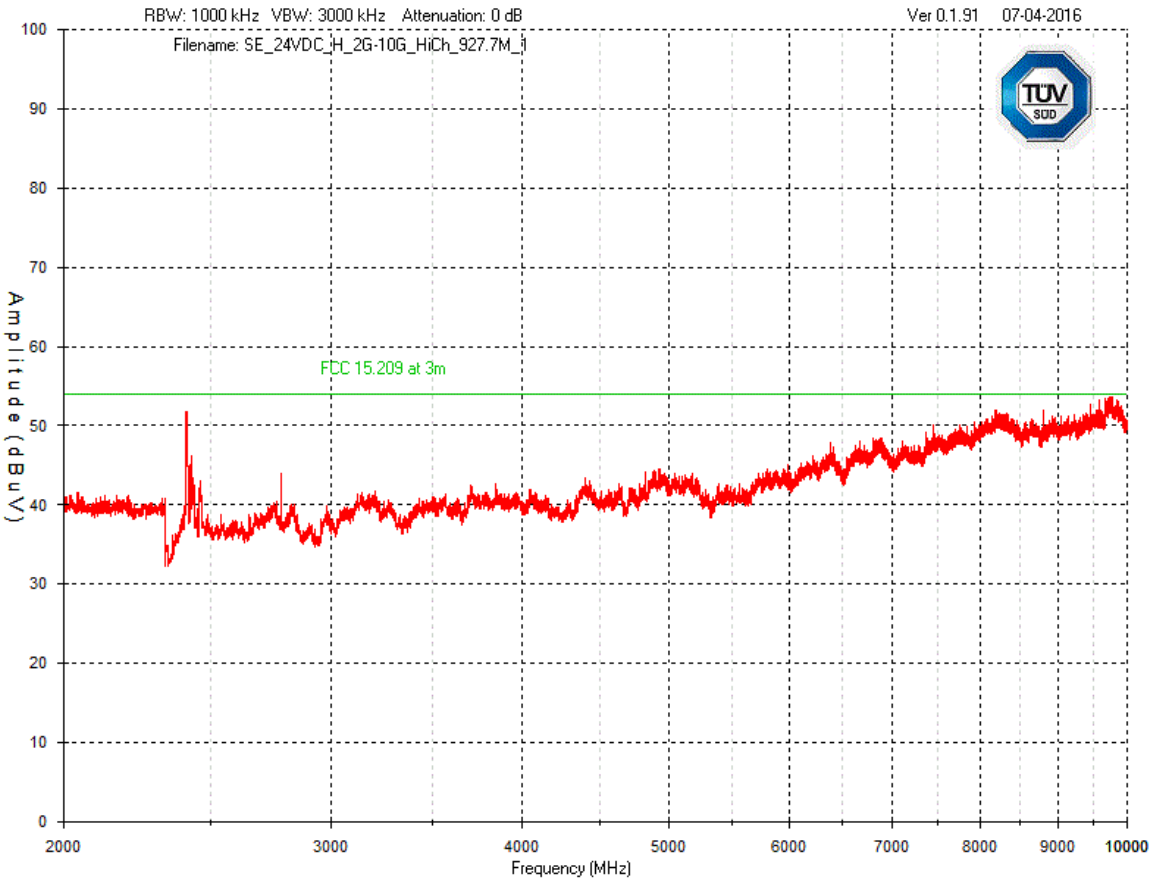
Peak Emissions Graph
Vertical Antenna Polarity
2 GHz to 10 GHz



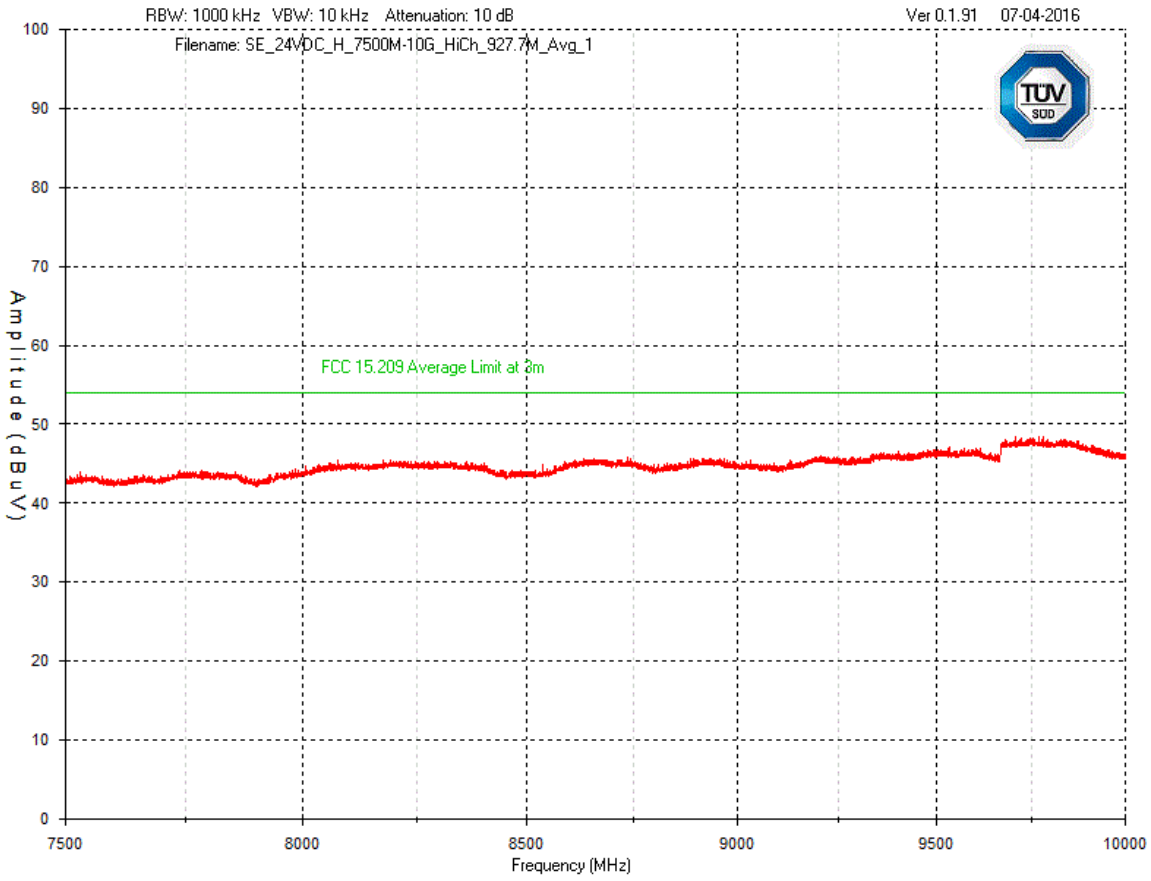
Average Emissions Graph
Vertical Antenna Polarity
7.5 GHz to 10 GHz



Peak Emissions Graph
Horizontal Antenna Polarity
2 GHz to 10 GHz



Average Emissions Graph
Horizontal Antenna Polarity
7.5 GHz to 10 GHz



Final Measurements

Table 3: Spurious Radiated Emissions
15.209 Limits

Test Frequency MHz	Detection mode	Measured signal dB(µV)	Antenna factor dB	Attenuator dB	Cable loss + Pre-selector dB	Pre-Amp Gain dB	Received signal dB(µV/m)	Emission limit dB(µV/m)	Margin dB(µV)	Result
Vertical Antenna Polarity										
868.3	QP	30.4	21.7	10	2.2	-32.1	32.2	46.4	14.2	Pass
997.8	QP	33.89	22.8	10	2.5	-31.2	37.99	54	16.01	Pass
210.9	Peak	50.3	11.1	10	0.9	-33.5	38.8	43.5	4.7	Pass
665.3	Peak	43.7	19.8	10	1.7	-33.5	41.7	46.4	4.7	Pass
37.8	Peak	45.7	12.1	10	0.4	-33.1	35.1	40	4.9	Pass
31.0	Peak	41.4	15.8	10	0.3	-33.1	34.4	40	5.6	Pass
1328.7	Peak	68.4	25.4	0	3	-34.7	62.1	74	11.9	Pass
1328.7	Avg	48.8	25.4	0	3	-34.7	42.5	54	11.5	Pass
Horizontal Antenna Polarity										
997.0	QP	29.67	23.9	10	2.5	-31.2	34.87	54	19.13	Pass
359.5	Peak	49.6	15.7	10	1.2	-33.9	42.6	46.4	3.8	Pass
31.0	Peak	37.9	18	10	0.3	-33.1	33.1	40	6.9	Pass
207.0	Peak	47	11	10	0.9	-33.4	35.5	43.5	8	Pass
1326.3	Peak	65.6	26.7	0	3	-34.7	60.6	74	13.4	Pass
1326.3	Avg	46.9	26.7	0	3	-34.7	41.9	54	12.1	Pass
1923.7	Peak	52.8	30.2	0	3.5	-33.8	52.7	74	21.3	Pass
1923.7	Avg	42.6	30.2	0	3.5	-33.8	42.5	54	11.5	Pass
1996.7	Peak	50.8	31.1	0	3.6	-33.7	51.8	74	22.2	Pass
1996.7	Avg	41.2	31.1	0	3.6	-33.7	42.2	54	11.8	Pass

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	Nov 27, 2015	Nov 27, 2017	GEMC 190
Quasi-Peak Adapter	85650A	HP	Nov 27, 2015	Nov 27, 2017	GEMC 191
Loop Antenna 9 – 150 kHz	EM 6871	Electro-Metrics	Feb. 3, 2015	Feb. 3, 2017	GEMC 70
Loop Antenna 150 kHz – 30 MHz	EM 6872	Electro-Metrics	Feb. 3, 2015	Feb. 3, 2017	GEMC 71
BiLog Antenna 30 MHz – 2 GHz	3142-C	ETS	Feb. 10, 2015	Feb. 10, 2017	GEMC 137
Horn Antenna 2 – 10 GHz	WBH218HN	Q-par	Feb. 12, 2016	Feb. 12, 2018	GEMC 6375
Preamp 9 kHz - 1 GHz	CPA9231A	Chase	Sept. 9, 2014	Sept. 9, 2016	GEMC 6403
Pre-amp 1 – 10 GHz	HP 8449B	HP	Sept. 9, 2014	Sept. 9, 2016	GEMC 6351
Attenuator 10 dB	612-10-1	Meca Electronics, Inc	NCR	NCR	GEMC 223
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

Appendix A – EUT Summary

For further details for filing purposes, refer to filing package.

General EUT Description

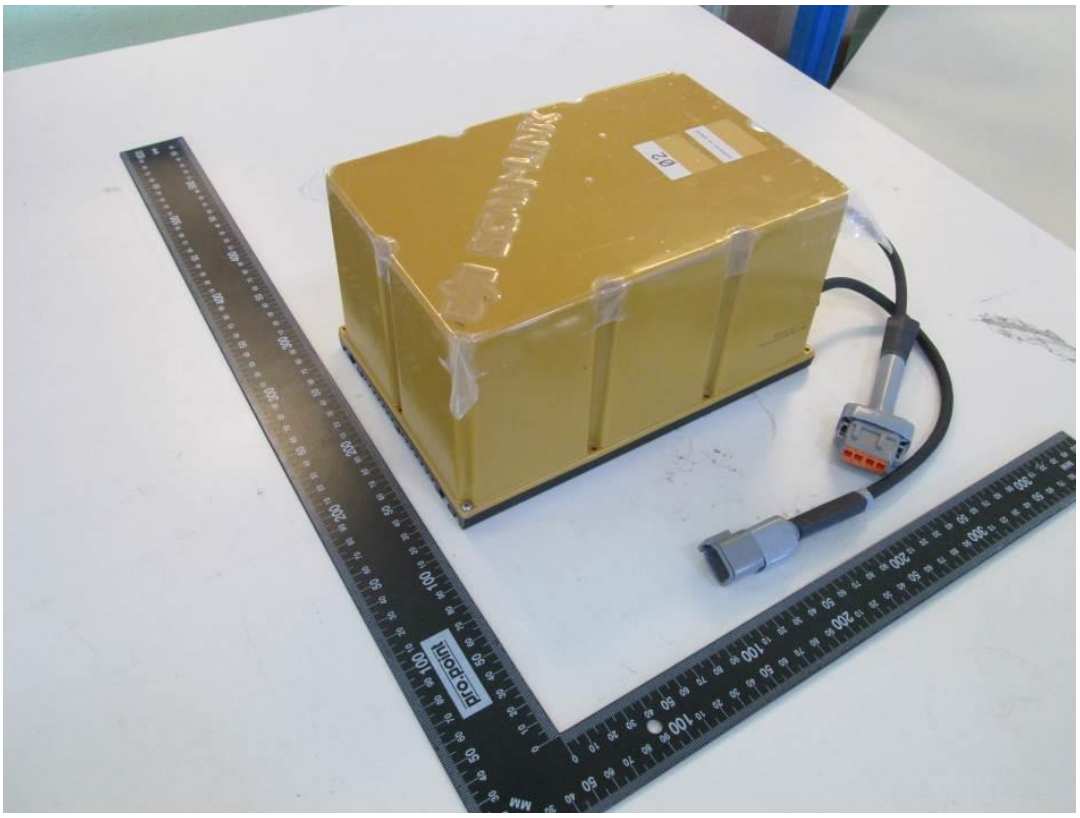
Client Details	
Organization / Address	SCAN~LINK Technologies Inc. 602 Tradewind Dr. Ancaster, Ontario Canada L9G 4V5
Contact	Uwe Schaible
Phone	905-304-6208 x222
Email	uschaible@scan-link.com
EUT (Equipment Under Test) Details	
EUT Name / Model	ARMOUR ANTENNA UNIT / SLAU-270NB
Input voltage	24 VDC (supplied by vehicle)
Transmit Frequencies	902.7 – 927.3 MHz 2.4 – 2.4835 GHz
Basic EUT functionality description	The EUT is typically mounted on the back of a vehicle to detect the presence of ground workers wearing an Armour equipped Safety Vest and/or Hard Hat. This is accomplished using the 900 MHz range. When a tagged ground worker is detected, the Antenna Unit sends a message to the Display Unit mounted inside the cab which then alerts the operator through an audible and visual alarm. This is accomplished through the 2.4 GHz range.
Modes of operation	On mode.
Available connectors on EUT	Power harness Relay
Dimensions of product (approx.)	L: 246mm, W: 165mm, H: 133mm
Separation distance from operator	20cm
EUT Configuration	- See *Appendix B* for pictures of the unit. - The wireless was configured to transmit data continuously, at the highest output power setting used by the manufacturer (25). - EUT is powered with 24 VDC. - A PC is connected to the EUT via USB and the cable harness to program the unit's test settings. The PC is auxiliary equipment and not covered in the scope of this report.

Note the EUT is considered to have been received the date of the commencement of the first test, unless otherwise stated.

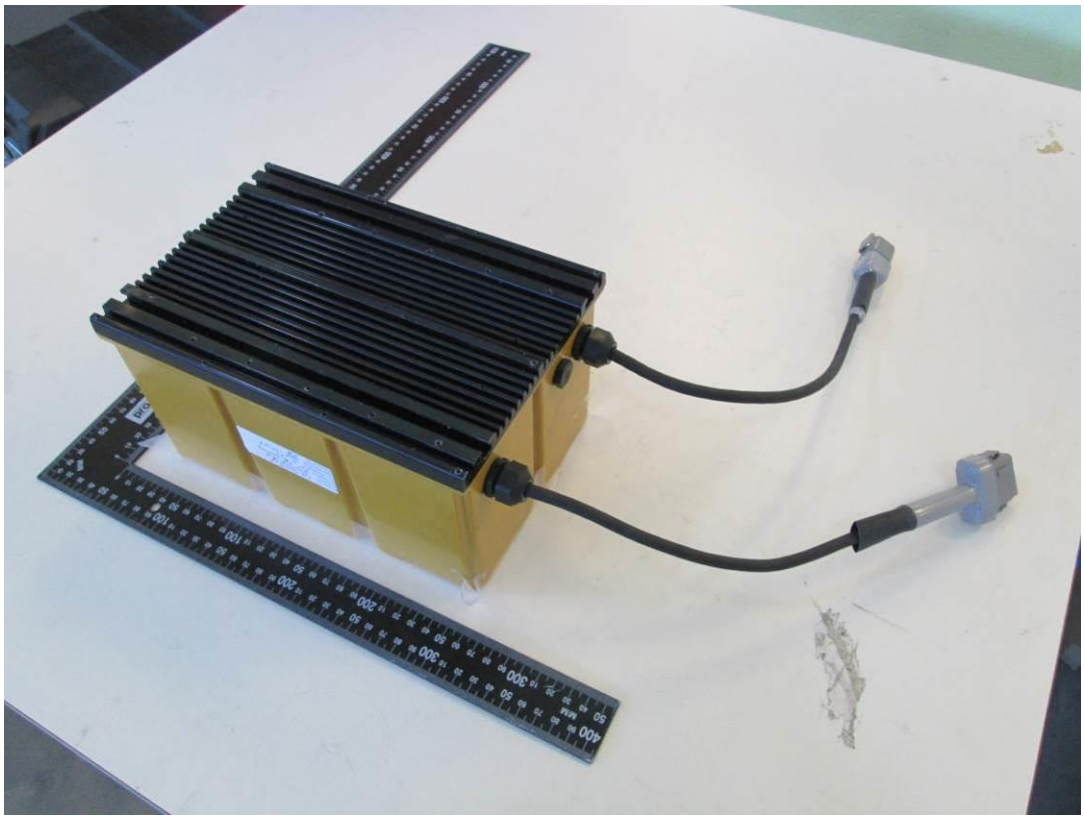
Appendix B – EUT and Test Setup Photographs

Note: These photos are for information purposes only.
Also refer to submitted files that are separate from this test report.

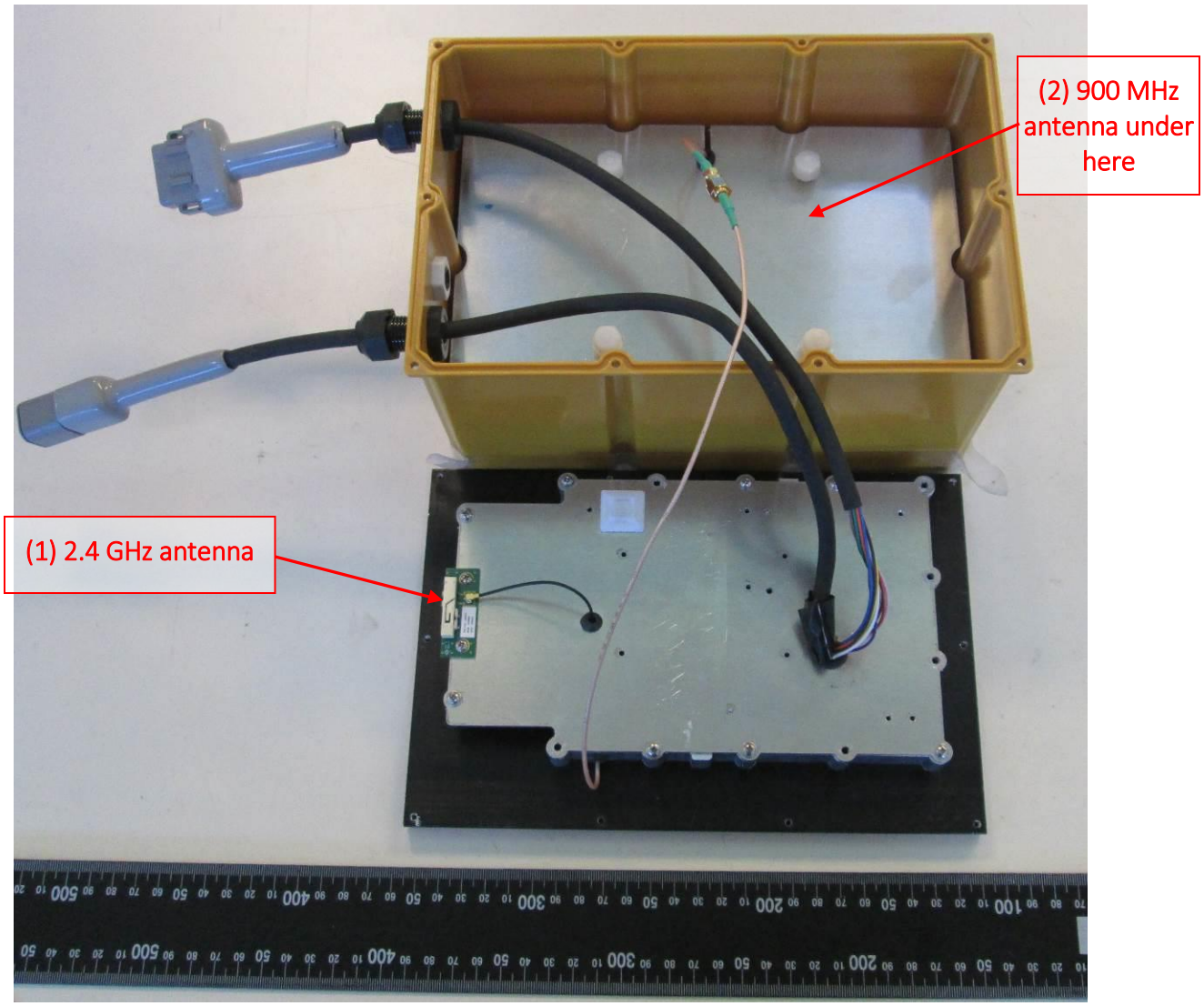
Note the numbers in **red text** are used to reference the same part in subsequent photos.



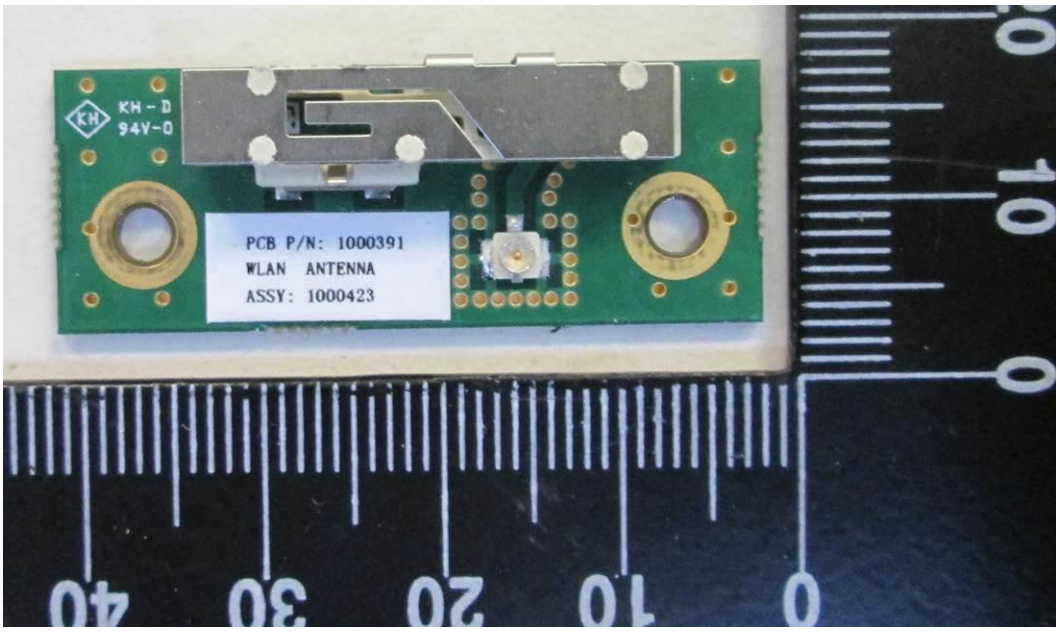
EUT – External view 1



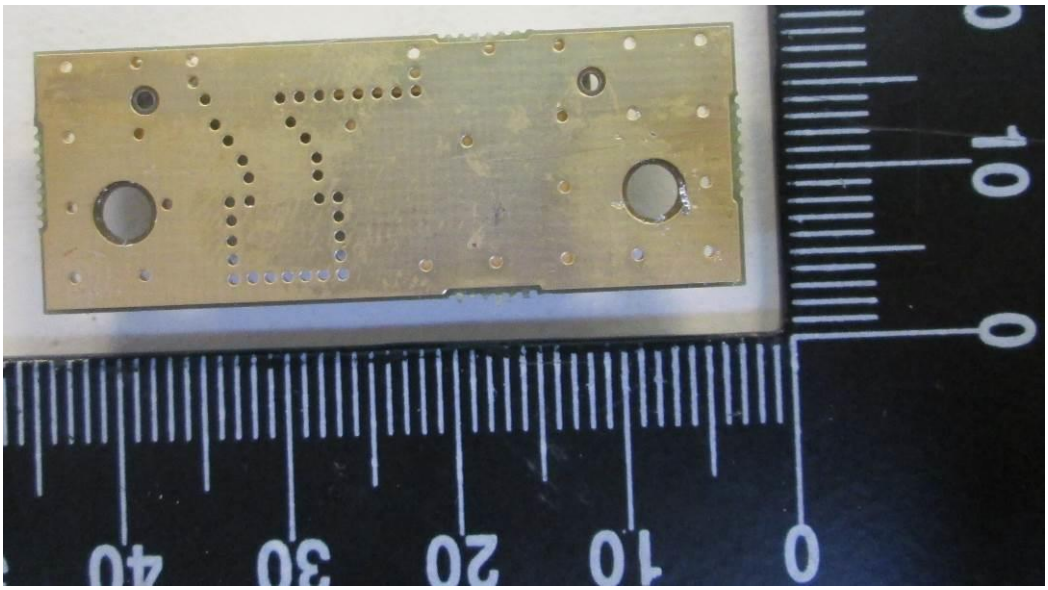
EUT – External view 2



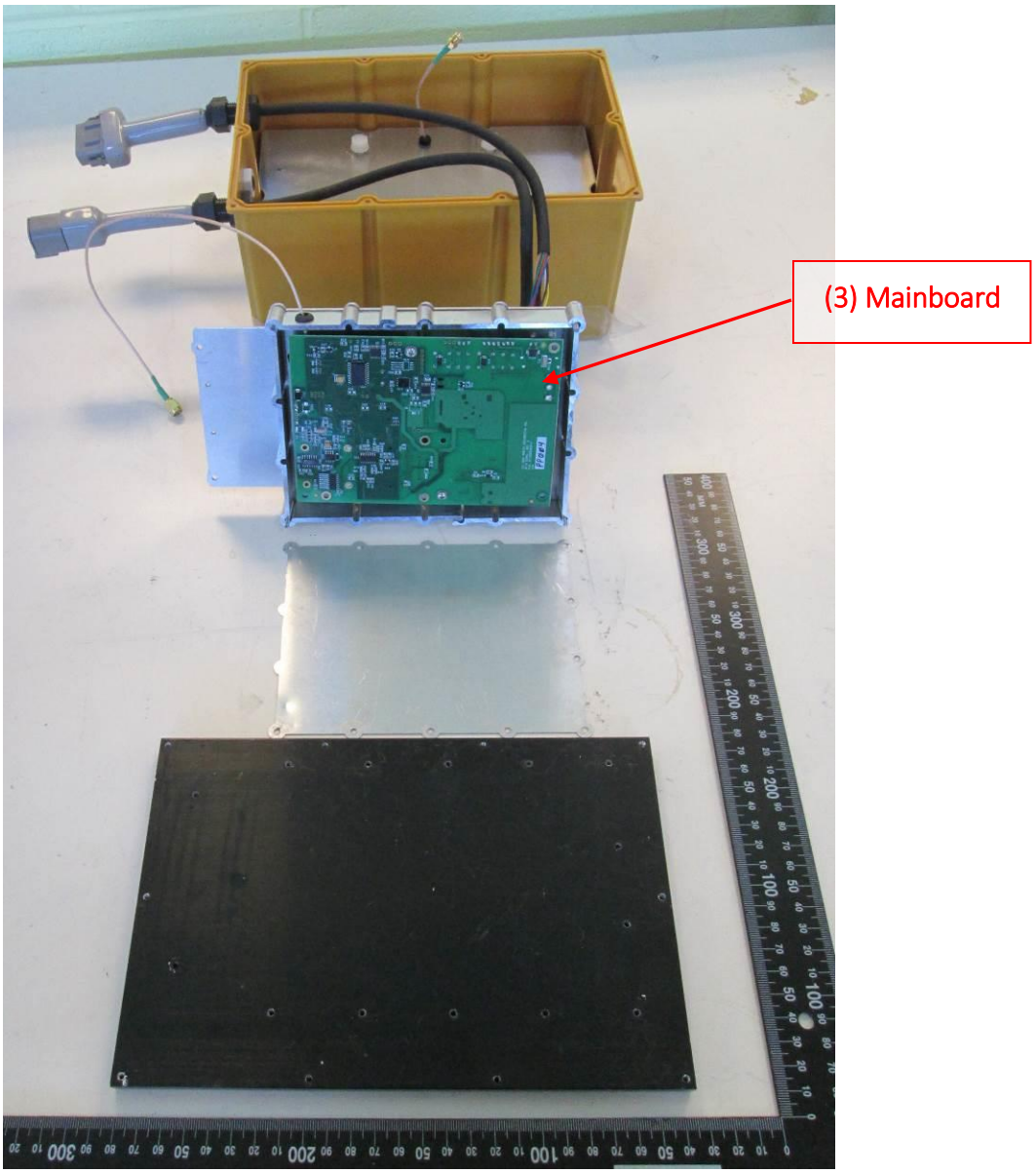
EUT – Internal view 1



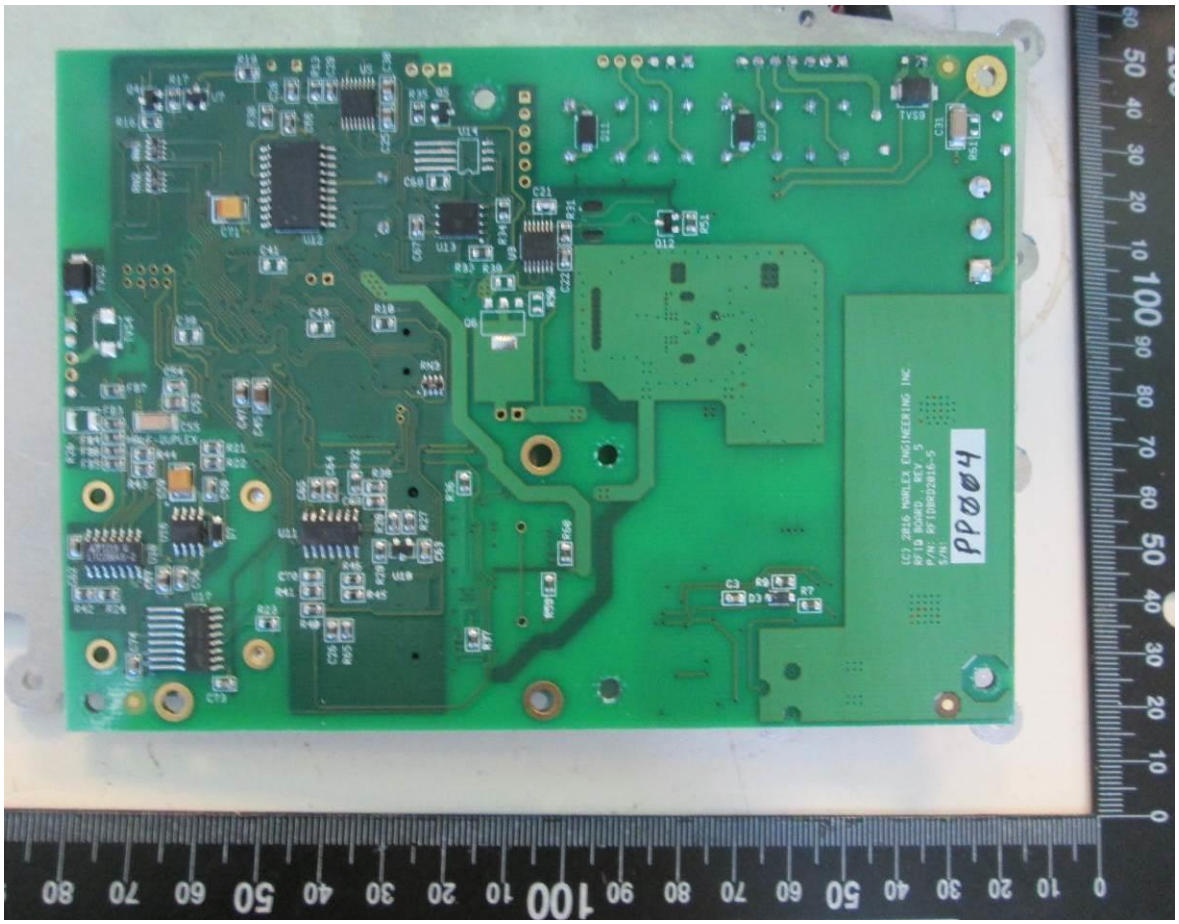
EUT – Internal view 2
Part (1) – 2.4 GHz antenna close-up, view 1



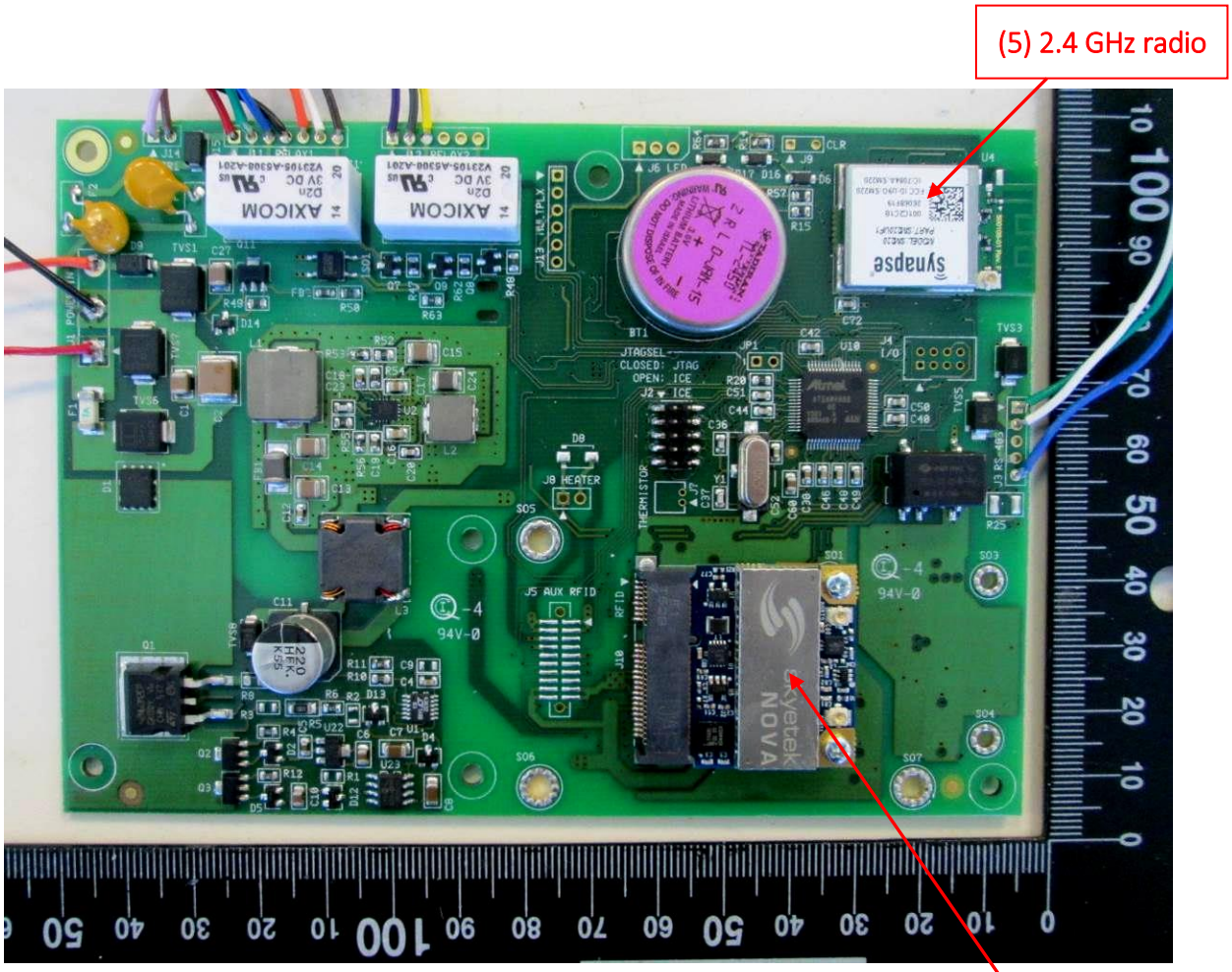
EUT – Internal view 3
Part (1) – 2.4 GHz antenna close-up, view 2



EUT – Internal view 4

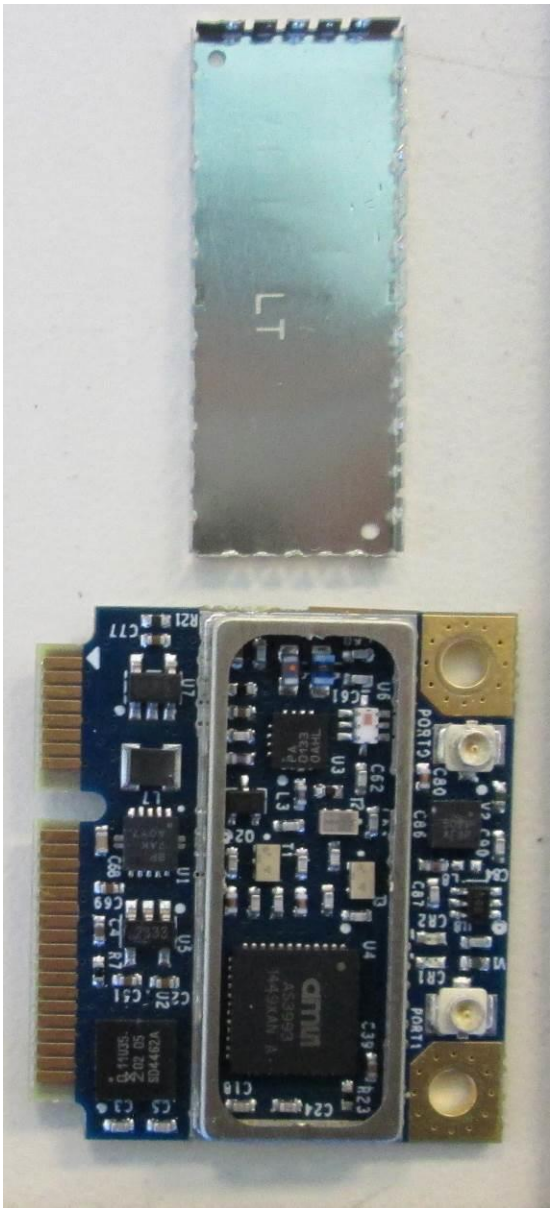


EUT – Internal view 5
Mainboard, view 1

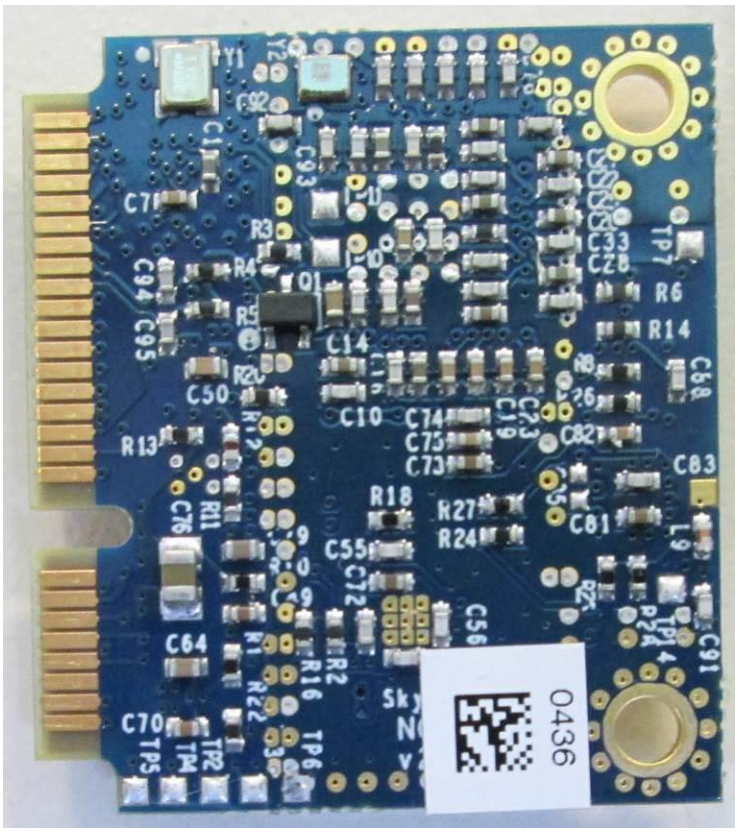


EUT – Internal view 6
Mainboard, view 2

EUT – Internal view 7
900 MHz radio close-up, view 1

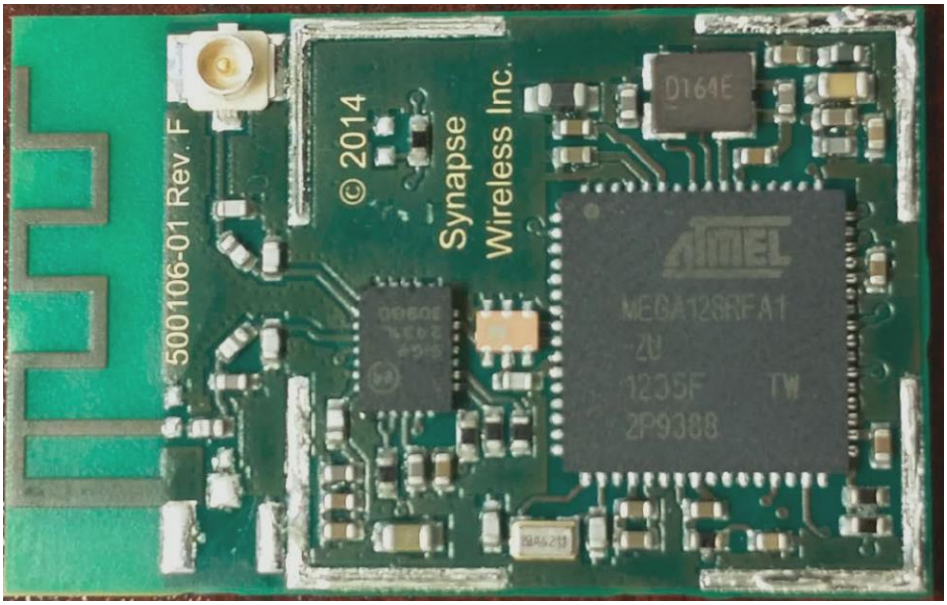


EUT – Internal view 8
900 MHz radio close-up, view 2, shield off

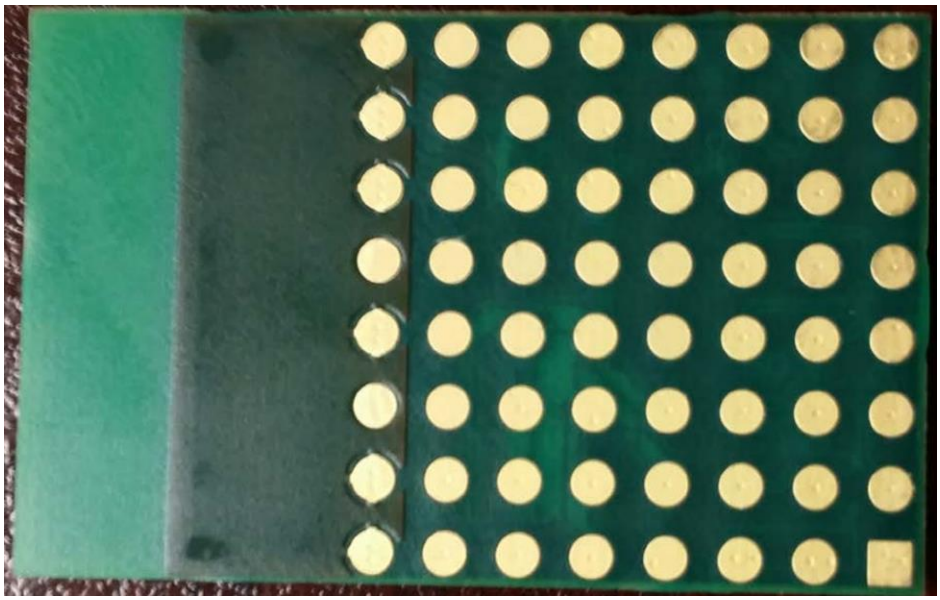


EUT – Internal view 9
900 MHz radio close-up, view 3

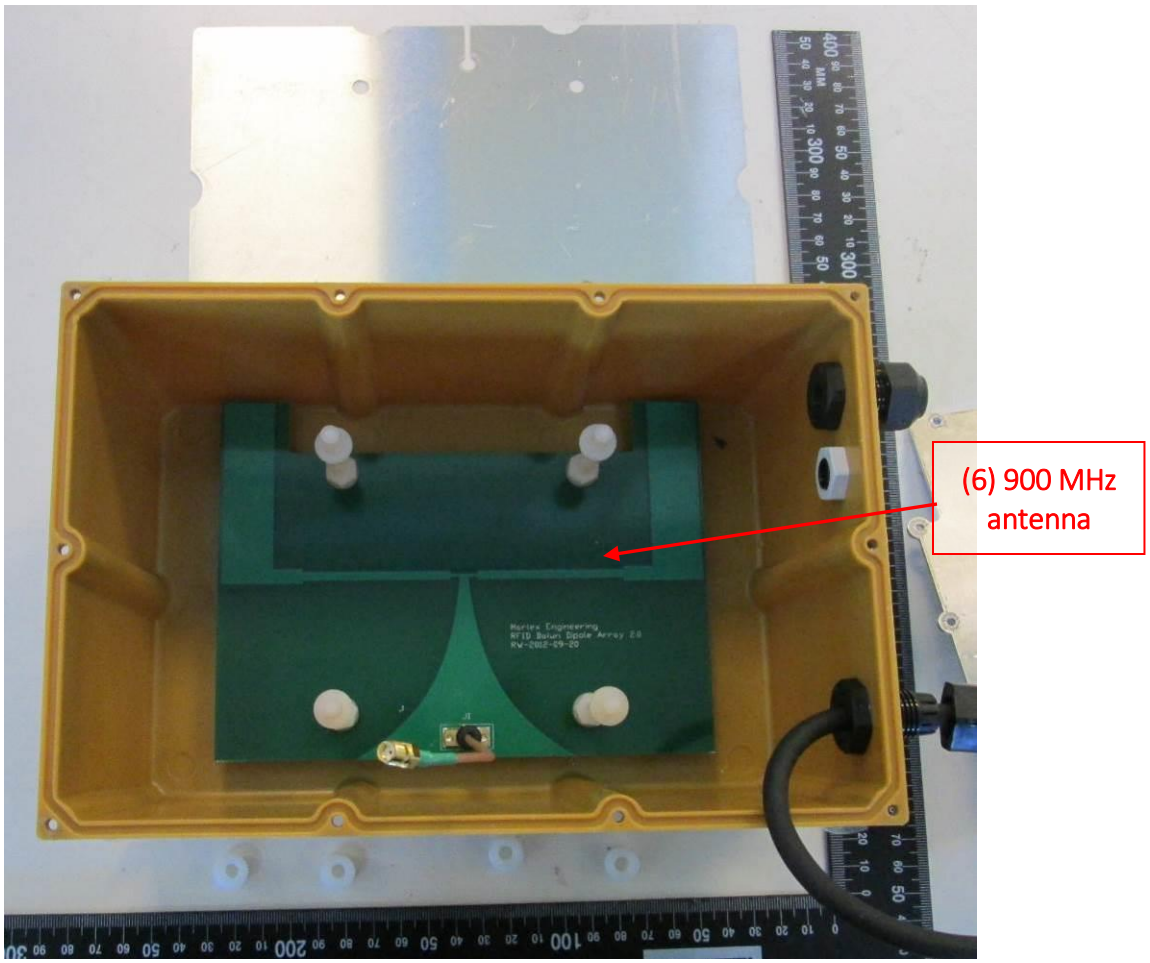
EUT – Internal view 10
2.4 GHz radio close-up, view 1



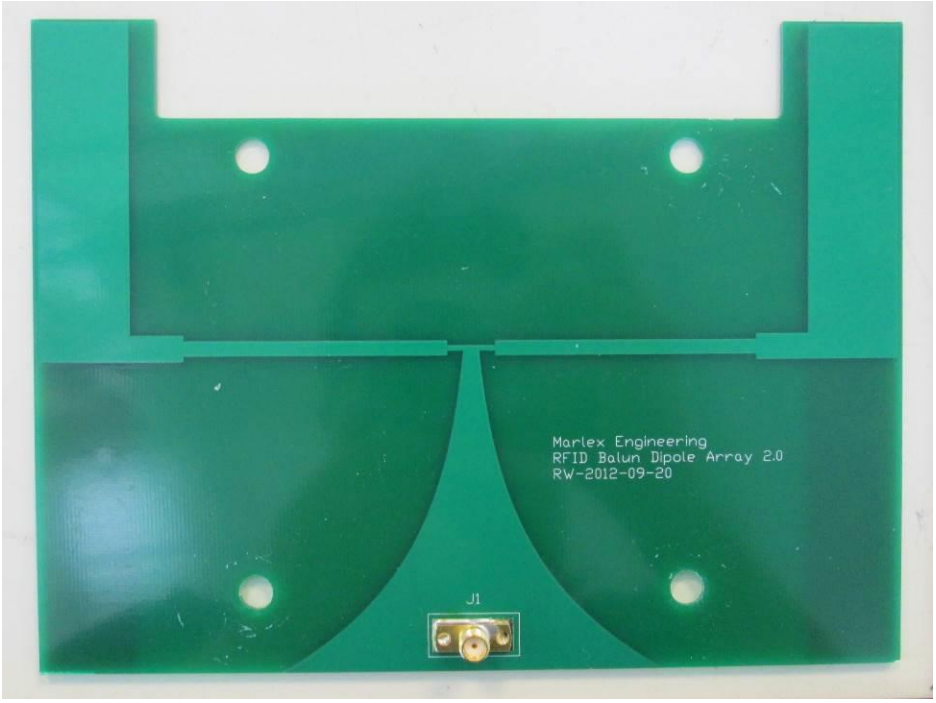
EUT – Internal view 11
2.4 GHz radio close-up, view 2, shield off



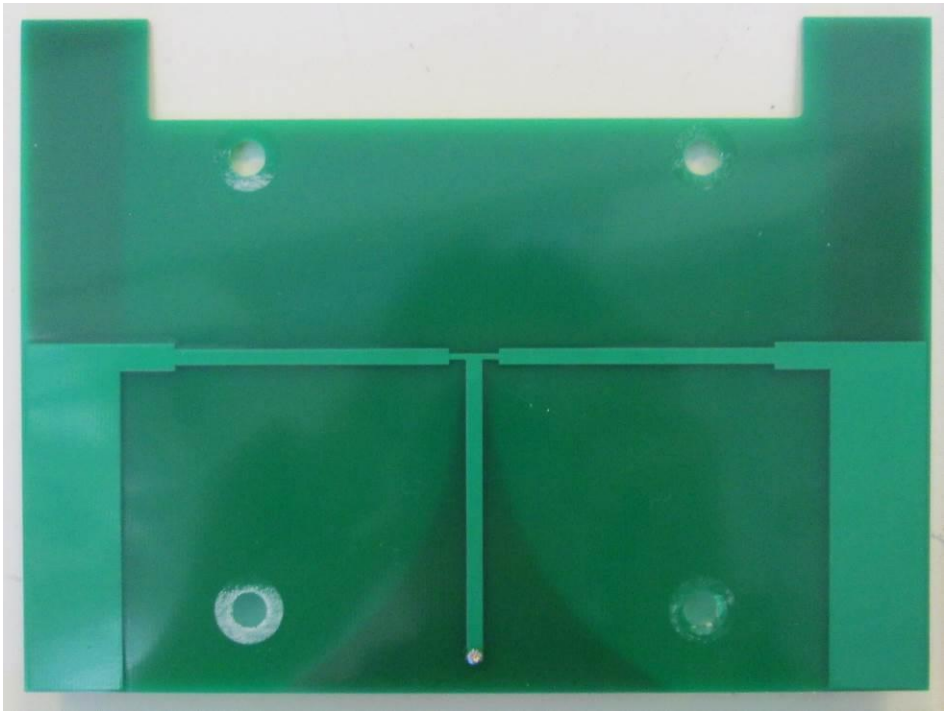
EUT – Internal view 12
2.4 GHz radio close-up, view 3



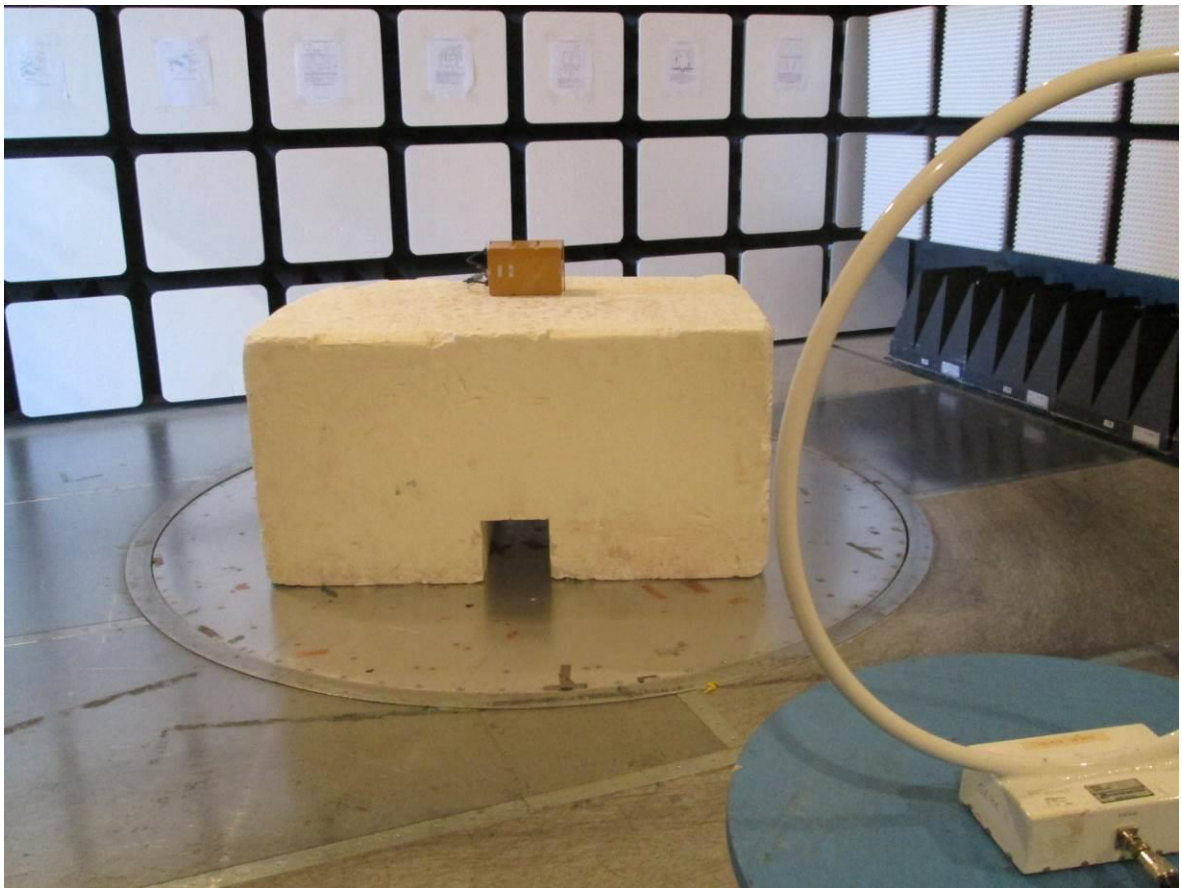
EUT – Internal view 13
900 MHz antenna, within enclosure



EUT – Internal view 14
900 MHz antenna, view 1

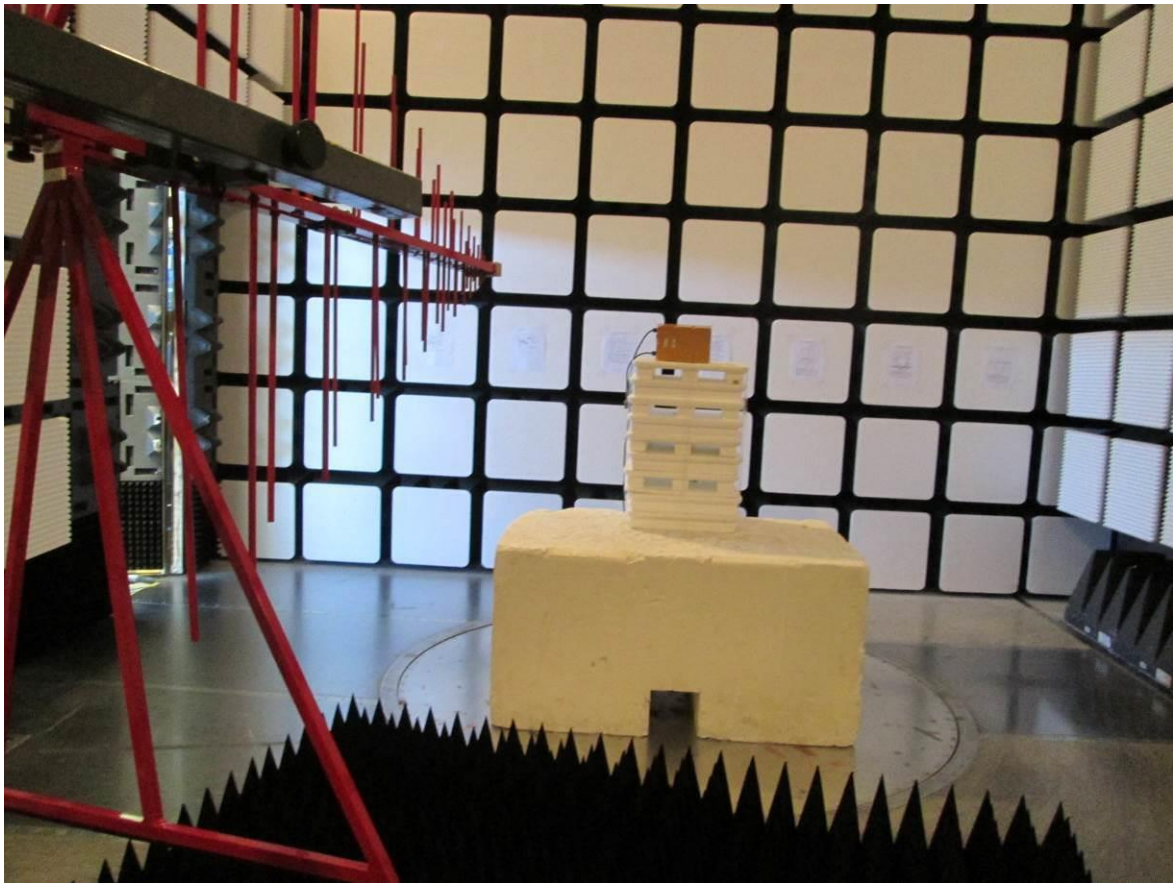


EUT – Internal view 15
900 MHz antenna, view 2

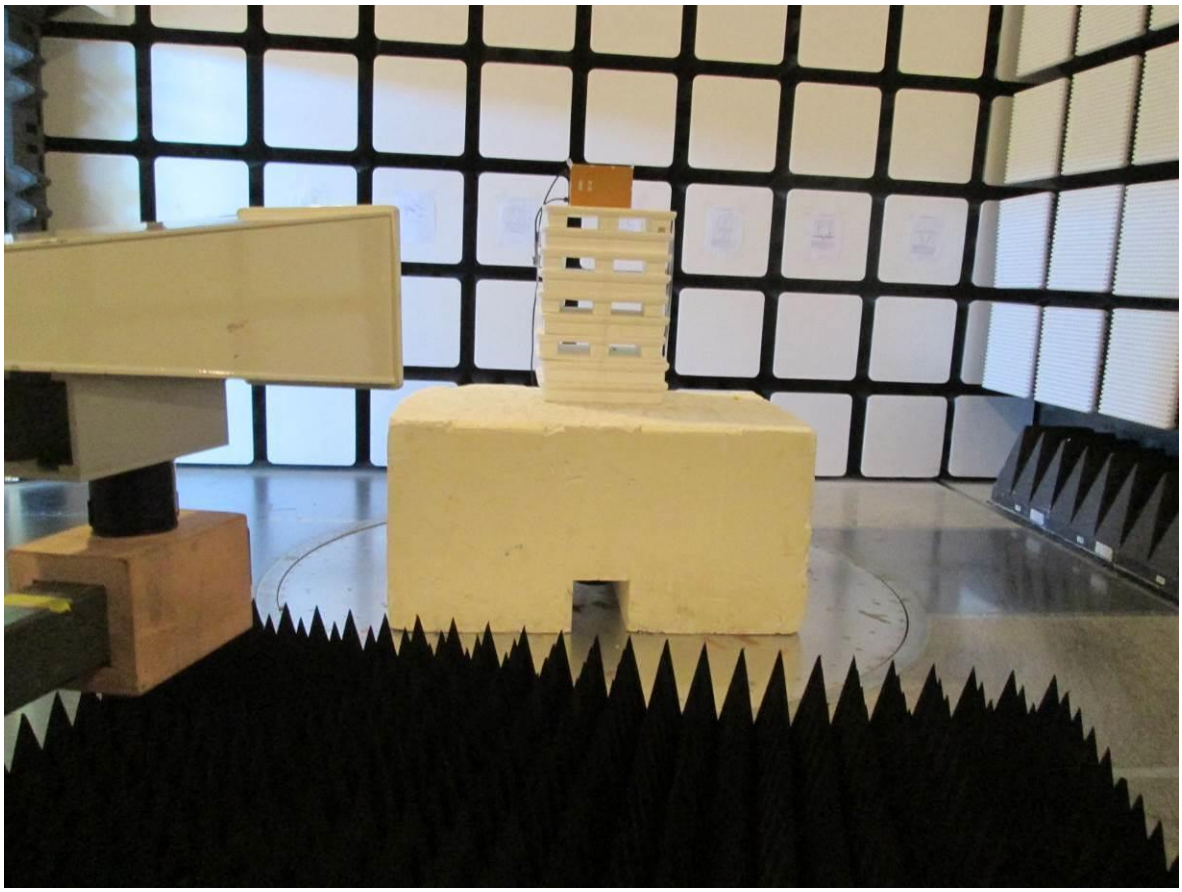


Test setup photo 1
Radiated measurements, 9 kHz – 30 MHz

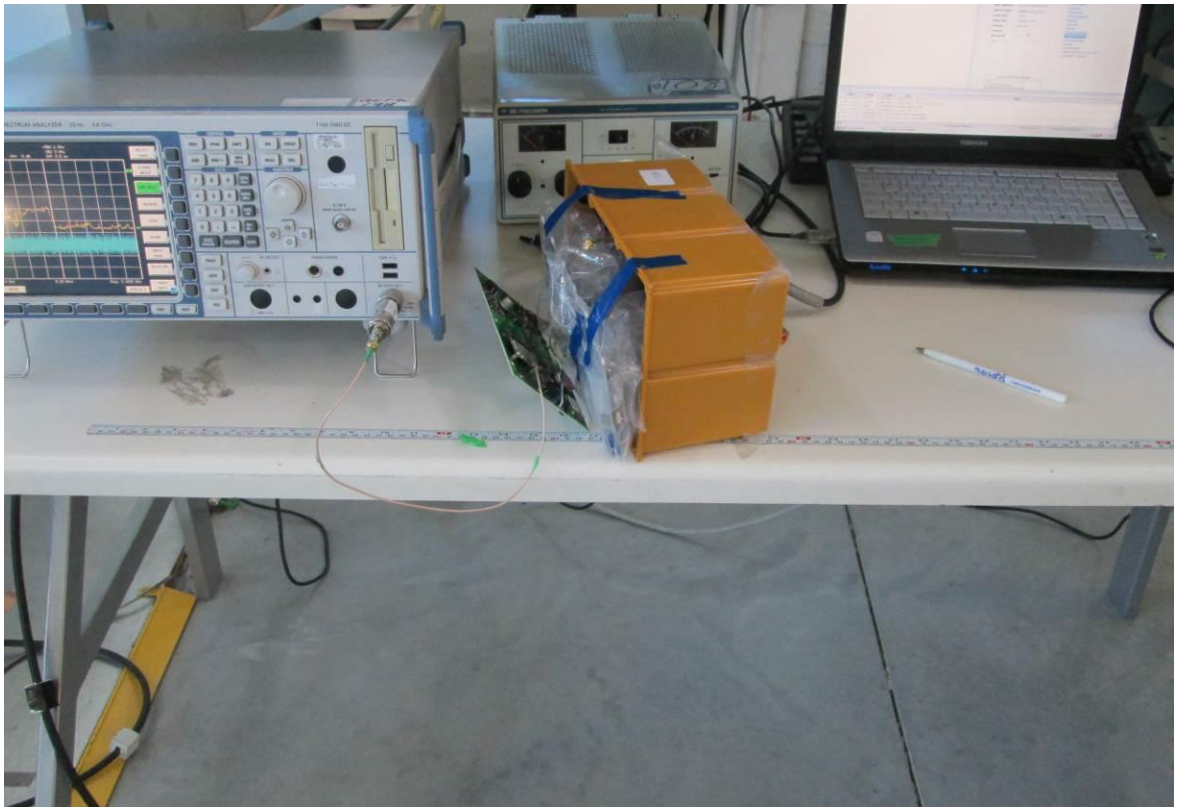
Test setup photo 2
Radiated measurements, 30 MHz – 1 GHz



Test setup photo 3
Radiated measurements, 1 GHz – 2 GHz



Test setup photo 4
Radiated measurements, 2 GHz – 10 GHz



Test setup photo 5
Conducted measurements