FCC Test Report

FOR:

HAP Innovations

Model Name:

Spencer

Product Description:

Smart In-Home Medication Dispenser

FCC ID: 2AIA7-SPN01

Per:

47 CFR Part 27

Test Report #: EMC_HAPIN-001-16501_FCC_27_rev2
Date: August 30, 2016

***CETECOM* Inc.**
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CETECOM Inc. is a Delaware Corporation with Corporation number: 2905571

Table of Contents

1 Assessment

The following equipment as further described in section 3 of this test report was evaluated against the applicable criteria specified in FCC CFR47 Parts 27. No deviations were ascertained during the course of the tests performed.

Company	Description	Model #
HAP Innovations	Smart In-Home Medication Dispenser	Sp.01

Report reviewed by:

Date	Section	Name	Signature
August 30, 2016	Compliance	Franz Engert (Compliance Manager)	Digitally signed by Franz Engert DN: cn=Franz Engert, c=US, o=CETECOM, ou=Compliance, email=franz.engert@cetecom.com

Responsible for the Report:

Date	Section	Name	Signature
August 30, 2016	Compliance	Douglas Antioco (EMC Engineer)	Douglas Antioco 2016.08.30 17:32:30 -07'00'

The test results of this test report relate exclusively to the test item specified in Section3.
CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM Inc. USA.

2 Administrative Data

2.1 Identification of the Testing Laboratory Issuing the Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Address:	CETECOM Inc. 411 Dixon Landing Rd Milpitas, CA 95035
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
Compliance Manager:	Franz Engert
Responsible Project Leader	Douglas Antioco

2.2 Identification of the Client

Client Firm/Name:	Device Solutions
Street Address:	1004 Copeland Oaks Dr.
City/Zip Code	Morrisville, NC 27560
Country	USA

2.3 Identification of the Manufacturer

Manufacturer's Name:	HAP Innovations
Manufacturers Address:	4220 Apex Highway, Suite 200
City/Zip Code	Durham, NC 27713
Country	USA

2.4 Dates of Testing:

May 9, 2016 – August 16, 2016

3 Equipment under Test (EUT)

3.1 Specification of the Equipment under Test

Model #:	sp.01
HW Version :	1.0
SW Version :	1.0
FCC-ID :	2AIA7-SPN01
HVIN:	Sp.01
PMN:	spencer
Product Description:	Smart In-Home Medication Dispenser
Module Information:	Manufacturer: Gemalto M2M GmbH Module: Cinterion ELS31-V FCC-ID: QIPELS31-V
Technology / Type(s) of Modulation:	LTE 4,13 (QPSK, 16QAM)
Operating Frequency Ranges (MHz) / Channels:	LTE Band 4: 1710 - 1755 MHz; LTE Band 13: 777 - 787 MHz;
Maximum Output Power (See Note)	LTE Band 4 (1710 - 1755 MHz)= 22.94 dBm RMS, 27.98 dBm Peak (Conducted) LTE Band 13 (777 - 787 MHz)= 23.78 dBm RMS, 28.61 dBm Peak (Conducted)
Maximum E.I.R.P (Calculated with Antenna Gain)	LTE Band 4 (1710 - 1755 MHz)= 26.94 dBm LTE Band 13 (777 - 787 MHz)= 25.28 dBm
Antenna info:	Internal Manufacturer Declared Maximum Gain: 1710 - 1755 MHz; 4 dBi 777 - 787 MHz; 1.5 dBi
Rated Operating Voltage Range:	Vmin: 11.5V dc/ Vnom: 12.0V dc / Vmax: 16.8V dc
Rated Operating Temperature Range:	Tlow: 5° C/ Tnom: 22° C/ Tmax: 40° C
Other Radios included in the Device:	Bluetooth 4.0 Bluetooth EDR/BDR 802.11 b/g/n (2.4GHz)
Sample Revision:	■Prototype; ☐Production; ☐Pre-Production

Note: LTE Band 4 Power measurements obtained from section 6.2.5.7 the module report referenced in Section 5.4.
LTE Band 13 Power measurements obtained from section 6.2.5.10.1 the module report referenced in Section 5.4.

3.2 Identification of the Equipment under Test (EUT)

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	010C0319160300002E	1.0	1.0	Radiated Sample

3.3 Identification of Accessory equipment

AE #	Type	Model	Manufacturer	Serial Number
1	N/A	N/A	N/A	N/A

4 Summary of Measurement Results

LTE Band 4 (1700MHz):

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§2.1046 §27.50(d)(4)	RF Output Power	Nominal	QPSK	☐	☐	☐	■	Note 1
§27.50(d)(5)	Peak-to-Average Ratio	Nominal	QPSK	☐	☐	☐	■	Note 1
§2.1055 §27.54	Frequency Stability	Extreme	QPSK	☐	☐	☐	■	Note 1
§2.1049 §27.53(h)	Occupied Bandwidth	Nominal	QPSK	☐	☐	☐	■	Note 1
§2.1051 §27.53(h)	Band Edge Compliance	Nominal	QPSK	☐	☐	☐	■	Note 1
§2.1053 §27.53(h)	Radiated Spurious Emissions	Nominal	QPSK	■	☐	☐	☐	Complies

Note: NA= Not Applicable; NP= Not Performed.
Note 1: Leveraged from module certification. See Section 5.4
Note 2: Referencing the module certification, it has been confirmed that QPSK modulation delivers the highest output power. Thus QPSK has been chosen to represent worst case for all measurements in this report.

LTE Band 13:

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§2.1046 §27.50(d)(4)	RF Output Power	Nominal	QPSK	☐	☐	☐	■	Note 1
§27.50(d)(5)	Peak-to-Average Ratio	Nominal	QPSK	☐	☐	☐	■	Note 1
§2.1055 §27.54	Frequency Stability	Extreme	QPSK	☐	☐	☐	■	Note 1
§2.1049 §27.53(h)	Occupied Bandwidth	Nominal	QPSK	☐	☐	☐	■	Note 1
§2.1051 §27.53(h)	Band Edge Compliance	Nominal	QPSK	☐	☐	☐	■	Note 1
§2.1053 §27.53(h)	Radiated Spurious Emissions	Nominal	QPSK	■	☐	☐	☐	Complies

Note: NA= Not Applicable; NP= Not Performed.
Note 1: Leveraged from module certification. See Section 5.4
Note 2: Referencing the module certification, it has been confirmed that QPSK modulation delivers the highest output power. Thus QPSK has been chosen to represent worst case for all measurements in this report.

5 Measurements

5.1 Measurement Uncertainty

	Uncertainty in dB radiated <30MHz	Uncertainty in in dB radiated 30MHz - 1GHz	Uncertainty in dB radiated > 1GHz	Uncertainty in dB Conducted measurement
standard deviation k=1	2.48	1.94	2.16	0.64
95% confidence interval in dB	4.86	3.79	4.24	1.25
95% confidence interval in dB in delta to Result	+-2.5 dB	+-2.0 dB	+- 2.3dB	+-0.7dB

5.2 Nominal Environmental Conditions

- Ambient Temperature: 20-25 °C
- Relative humidity: 40-60%

5.3 Nominal Environmental Test Conditions

- Test Temperature: 20°C (nominal);
- Test Voltage: 120 VAC (nominal);

Deviating test conditions are indicated at individual test description where applicable.

5.4 Inheriting Test Results from Incorporated Module Certification:

The EUT integrates the certified module Gemalto Cinterion ELS31-V (details see EUT spec in section 3.1)

Taking into account guidance from FCC KDB 996369 (modular approval) and where relevant test procedures did not change conducted test results are leveraged Gemalto Cinterion ELS31-V given by Cetecom, inc, dated December 3, 2015 with Report Number: EMC_CETEC_139_15001_FCC27_LTE_V1.0; FCC ID: QIPELS31-V.

This test report contains full radiated testing as per FCC 27C.

5.5 Nominal Cellular Test Conditions

1. The different cellular operation modes of the EUT as required for testing are controlled through the link with the Wideband Radio Communication Tester (R&S CMW500).
2. The EUT is tested with QPSK Modulation, 5 MHz Bandwidth full resource block allocation on the mid channel of each of the supported cellular operation modes.

5.6 Additional Test Information.

Testing is performed according to the guidelines provided in FCC publication (KDB) 971168 D01 v02r02, *Measurement Guidance for Certification of Licensed Digital Transmitters* and according to relevant parts of TIA-603C 2004 as detailed below.

6 RF Output Power Verification

6.1 Conducted Measurement according to: FCC: CFR 47 Part 2.1046; CFR Part 22.913; Part 24.232; Part 27.50; RSS-132 5.4; RSS-133 6.4; RSS-139 6.5, utilizing KDB 971168 D01 Power Meas License Digital Systems v02r02 - Section 5.2.1

Equipment numbers 16 and 18 in section 8 of this report was used for this test case.

Spectrum Analyzer settings for CCDF procedure for conducted output power / PAPR measurements:

- RBW ≥ OBW
- Number of counts = 10000
- Sweep time ≥ 1ms
- Record the Mean Power level
- Record the maximum PAPR level associated with a probability of 0.1%

6.2 Limits:

- The measured output power shall be within +0.2dB and -1dB from the modular report power.
- The power measured on the mid channel of each RF band of operation will be compared to the Max. Output Power from the modular reports as indicated in the table below:

RF Band	Test Lab	Report Number	Report Date
LTE B4	Cetecom, inc	EMC_CETEC_139_15001_FCC27_LTE_V1.0	12/03/2015
LTE B13	Cetecom, inc	EMC_CETEC_139_15001_FCC27_LTE_V1.0	12/03/2015

6.3 Test conditions and setup:

Ambient Temperature (C)	EUT operating mode	Power Input	Measurement Path Correction (dB)
22	Full RB, 5 MHz Bandwidth, QPSK Modulation	120V AC	12.9 up to 1GHz 14.4 up to 2 GHz

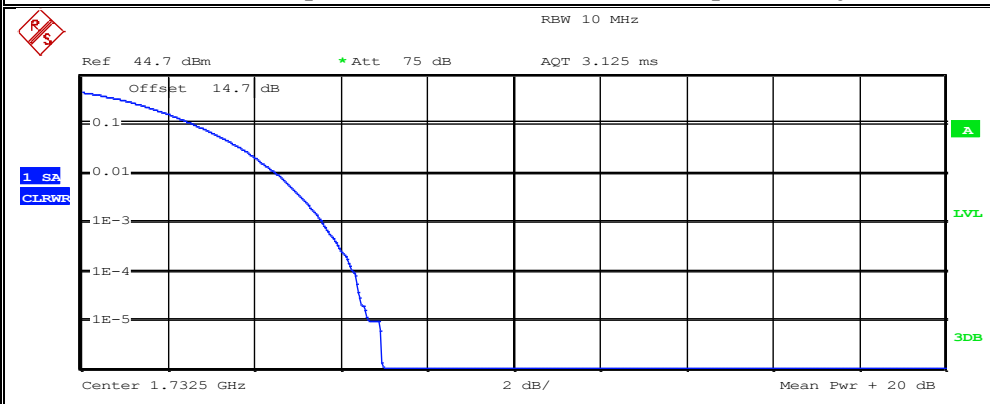
Note 1: Measurement Path accounts for the attenuation of the affixed temporary RF connector to the module output as well as any external attenuation as a result of the test fixure.

6.4 Measurement result ERP / EIRP:

Plot #	LTE Band	Channel #	Frequency (MHz)	Measured Maximum AVG Conducted Output Power (dBm)	AVG Conducted Output Power From Modular Report (dBm)	Output Power Delta (dB)	Result
1	4	20175	1732.5	21.5	21.6	-0.1	Pass
2	13	23230	782	21.3	21.7	-0.4	Pass

1.1.1 Measurement Plots:

Plot #1 Conducted Output Power / PAPR level at 0.1% probability



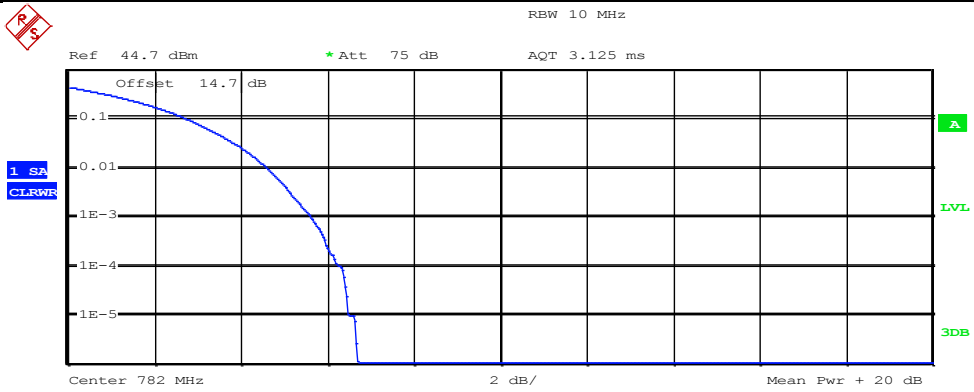
Complementary Cumulative Distribution Function (100000 samples)

	Trace 1
Mean	21.80 dBm
Peak	28.76 dBm
Crest	6.95 dB
10 %	2.60 dB
1 %	4.49 dB
.1 %	5.58 dB
.01 %	6.28 dB

Date: 16.AUG.2016 17:03:46

Note: Offset in this measurement should be 14.4 dBm which is reflected in the data table of section 6.4. Output power after accounting for external attenuation is 21.5 dBm.

Plot #2 Conducted Output Power / PAPR level at 0.1% probability



Complementary Cumulative Distribution Function (100000 samples)

	Trace 1
Mean	23.14 dBm
Peak	29.81 dBm
Crest	6.67 dB
10 %	2.72 dB
1 %	4.55 dB
.1 %	5.58 dB
.01 %	6.25 dB

Date: 16.AUG.2016 17:09:02

Note: Offset in this measurement should be 12.9 dBm which is reflected in the data table of section 6.4. Output power after accounting for external attenuation is 21.3 dBm.

7 Spurious Emissions Radiated

7.1 References:

FCC: CFR Part 2.1053, CFR Part 27.53 (h)

7.2 Limits:

CFR Part 27.53 (h)

(h) AWS emission limits—(1) General protection levels. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log_{10} (P) dB.

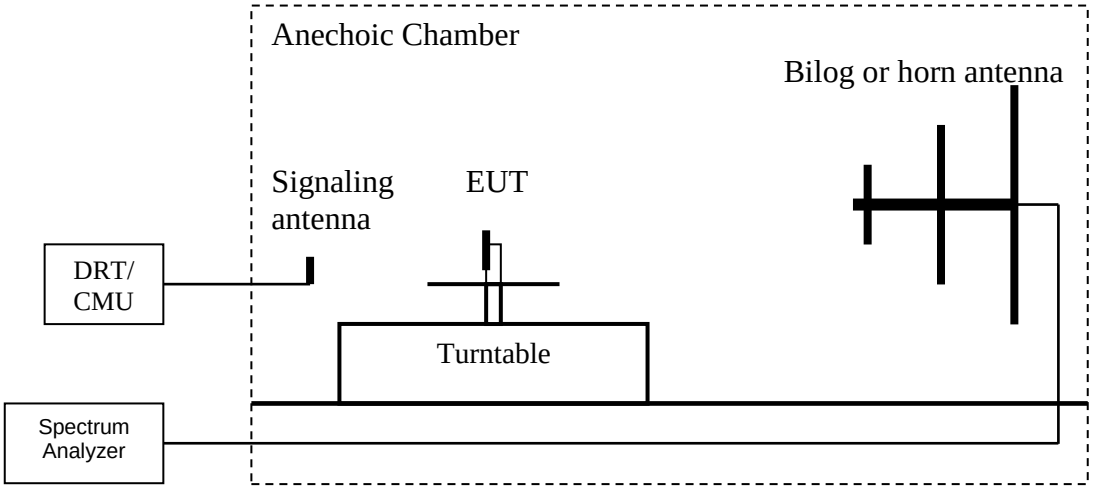
7.3 Radiated out of band measurement procedure:

Please see Section 5.5 for the Cellular

Please see section 9 for test setup diagrams. Equipment numbers 1-17 in section 9 of this report were used for this test case in a semi-anechoic chamber.

Only mid channel was tested as the difference in output power between the mid channel and low and high channels of the module certification report referenced in section 6.4 is within the measurement uncertainty for conducted measurements.

Ref: TIA-603C 2004- 2.2.12 Unwanted emissions: Radiated Spurious



1. Connect the equipment as shown in the above diagram with the EUT's antenna in a horizontal orientation.
2. Adjust the settings of the Digital Radio Communication Tester (DRT) to set the EUT to its maximum power at the required channel.
3. Set the spectrum analyzer to measure peak hold with the required settings.
4. Place the measurement antenna in a horizontal orientation. Rotate the EUT 360°. Raise the measurement antenna up to 4 meters in 0.5 meters increments and rotate the EUT 360° at each height to maximize all emissions. Measure and record all spurious emissions (**LVL**) up to the tenth harmonic of the carrier frequency.
5. Replace the EUT with a horizontally polarized half wave dipole or known gain antenna. The center of the antenna should be at the same location as the center of the EUT's antenna.
6. Connect the antenna to a signal generator with known output power and record the path loss in dB (**LOSS)**. **LOSS** = Generator Output Power (dBm) – Analyzer reading (dBm).
7. Determine the level of spurious emissions using the following equation:
   Spurious (dBm) = **LVL** (dBm) + **LOSS** (dB):
8. Repeat steps 4, 5 and 6 with all antennas vertically polarized.
9. Determine the level of spurious emissions using the following equation:
   Spurious (dBm) = **LVL** (dBm) + **LOSS** (dB):
10. Measurements are to be performed with the EUT set to the low, middle and high channel of each frequency band.
    (N**ote:** Steps 5 and 6 above are performed prior to testing and **LOSS** is recorded by test software. Steps 3, 4 and 7 above are performed with test software.)

7.3.1 Sample Calculations for Radiated Measurements:
Power Measurements using Substitution Procedure:

The measurement on the Spectrum Analyzer is used as a basis for the Substitution procedure.
The EUT is replaced with a Signal Generator and an antenna. The setting on the Signal Generator is varied until the Spectrum Analyzer displays the original reading. EIRP is calculated as-

EIRP (dBm)= Signal Generator setting (dBm)- Cable Loss (dB)+ Antenna Gain (dBi). Example below.

Frequency (MHz)	Measured SA (dBµV)	Signal Generator setting (dBm)	Antenna Gain (dBi)	Dipole Gain (dBd)	Cable Loss (dB)	EIRP (dBm)
1000	95.5	24.5	6.5	0	3.5	27.5

7.3.2 Spectrum Analyzer Settings

Settings for FCC 27 (Band 13)

	9-150KHz	150KHz-30MHz	30MHz – 1 GHz	1 – 9GHz
Resolution Bandwidth	200 Hz	9 KHz	100 kHz	1 MHz
Video Bandwidth	200 Hz	9 KHz	100 kHz	1 MHz
Detector	Peak	Peak	Peak	Peak
Trace Mode	Max Hold	Max Hold	Max Hold	Max Hold
Sweep Time	Auto	Auto	Auto	Auto

Settings for FCC 27 (Band 4)

	9-150KHz	150KHz-30MHz	30MHz – 1 GHz	1 – 3 GHz	3 – 18 GHz	18 – 22 GHz
Resolution Bandwidth	200 Hz	9 KHz	100 kHz	1 MHz	1 MHz	1 MHz
Video Bandwidth	200 Hz	9 KHz	100 kHz	1 MHz	1 MHz	1 MHz
Detector	Peak	Peak	Peak	Peak	Peak	Peak
Trace Mode	Max Hold	Max Hold	Max Hold	Max Hold	Max Hold	Max Hold
Sweep Time	Auto	Auto	Auto	Auto	Auto	Auto

7.4 Test Results

7.4.1 LTE Band 13

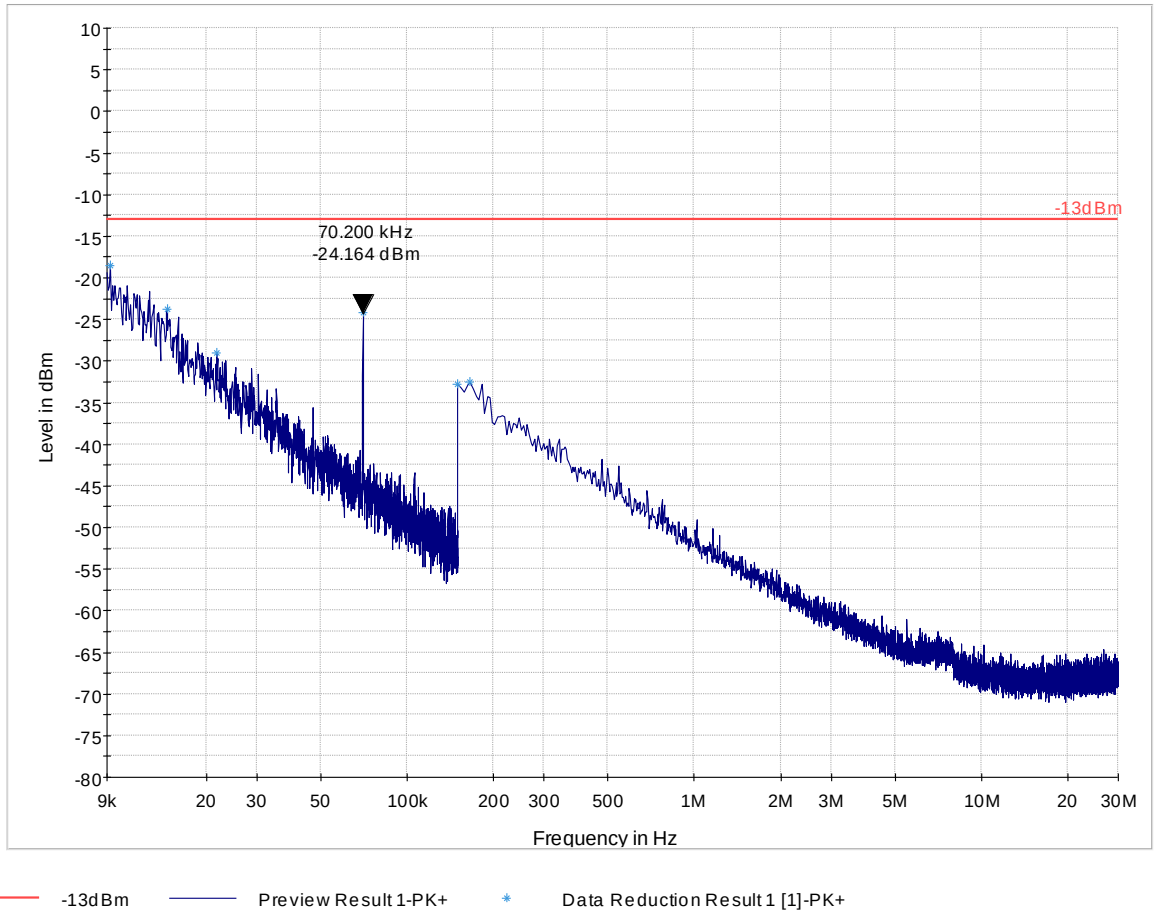
Pass, no emissions within 6 dB of the limit.

7.4.2 LTE Band 4

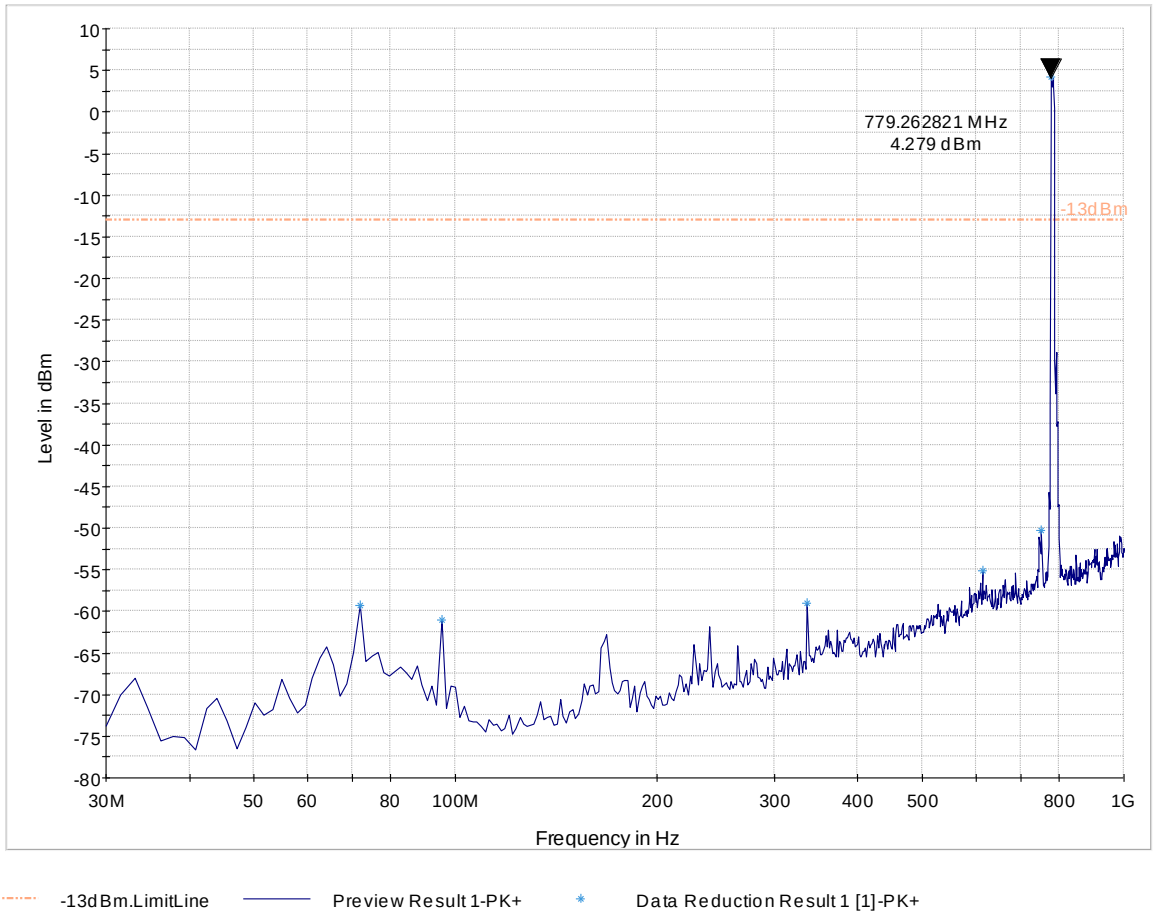
Pass, no emissions within 6 dB of the limit.

7.5 Measurement Plots:

7.5.1 LTE Band 13, Tx: Ch. Mid, 9 KHz – 30 MHz

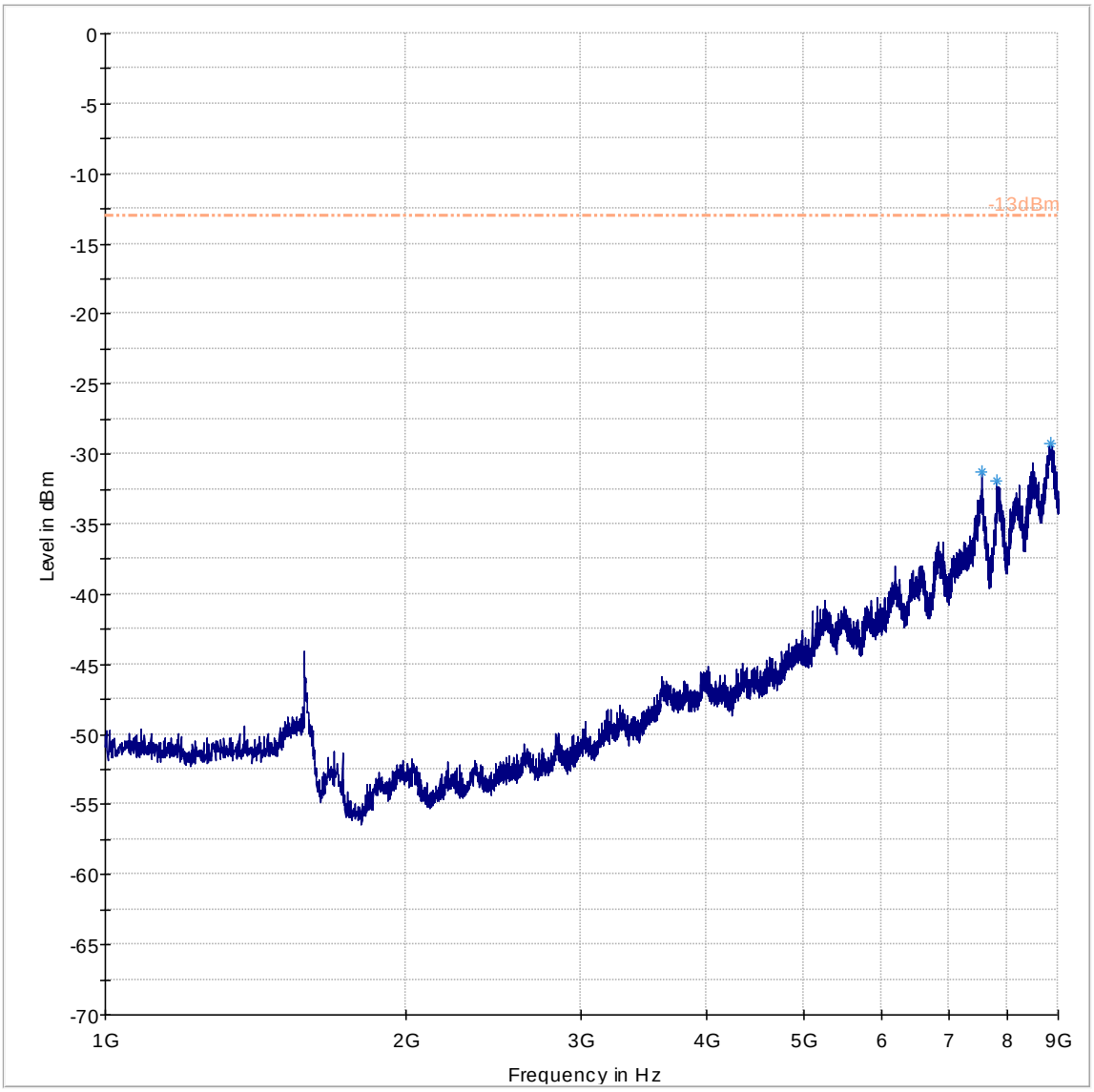


7.5.2 LTE Band 13, Tx: Ch. Mid, 30 MHz – 1 GHz

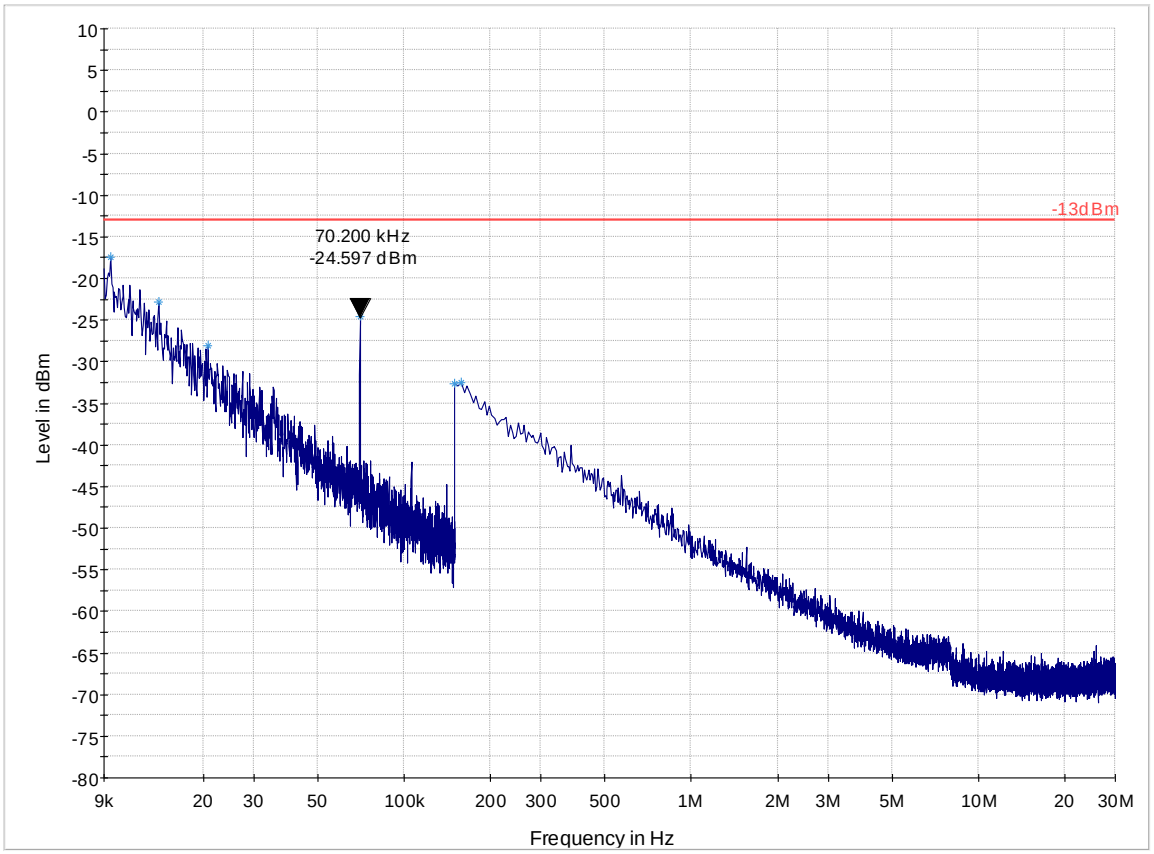


Note: Emission above limit is the Tx Signal.

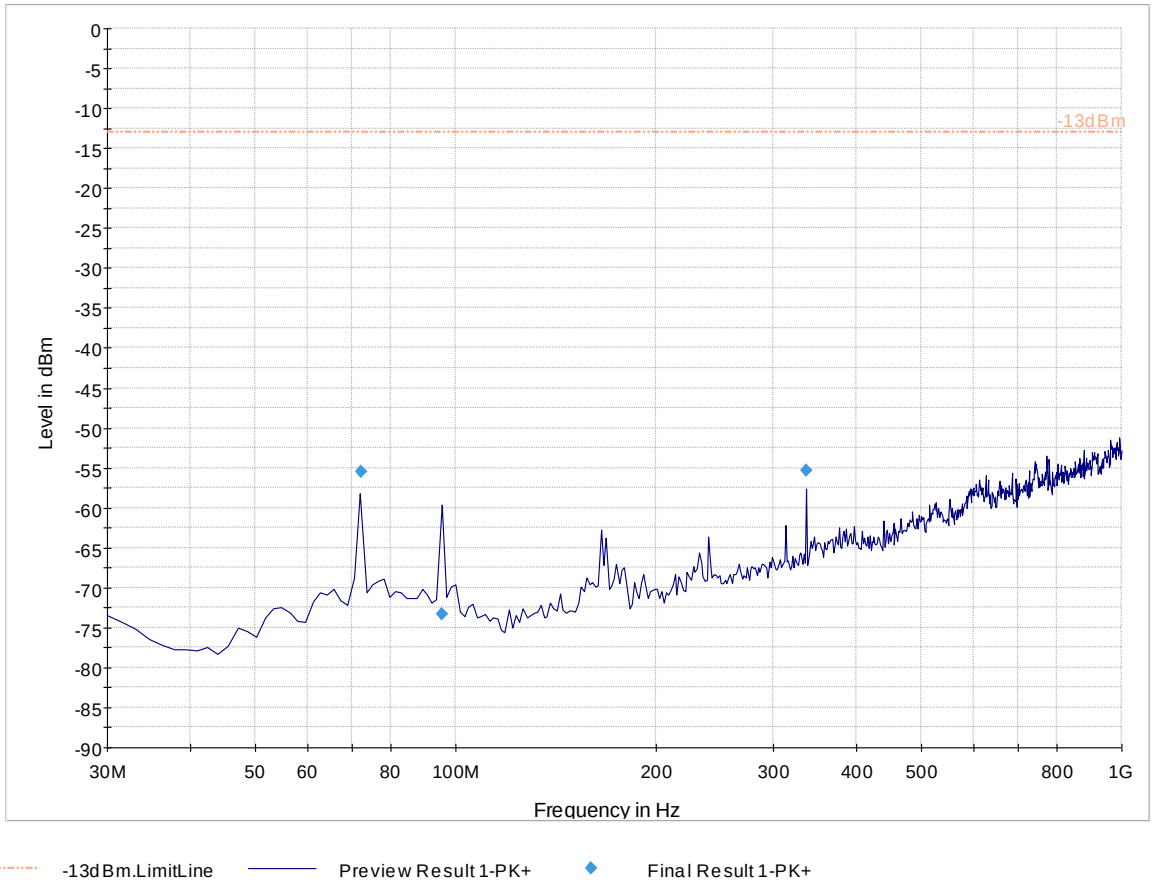
7.5.3 LTE Band 13, Tx: Ch. Mid, 1 GHz – 9 GHz



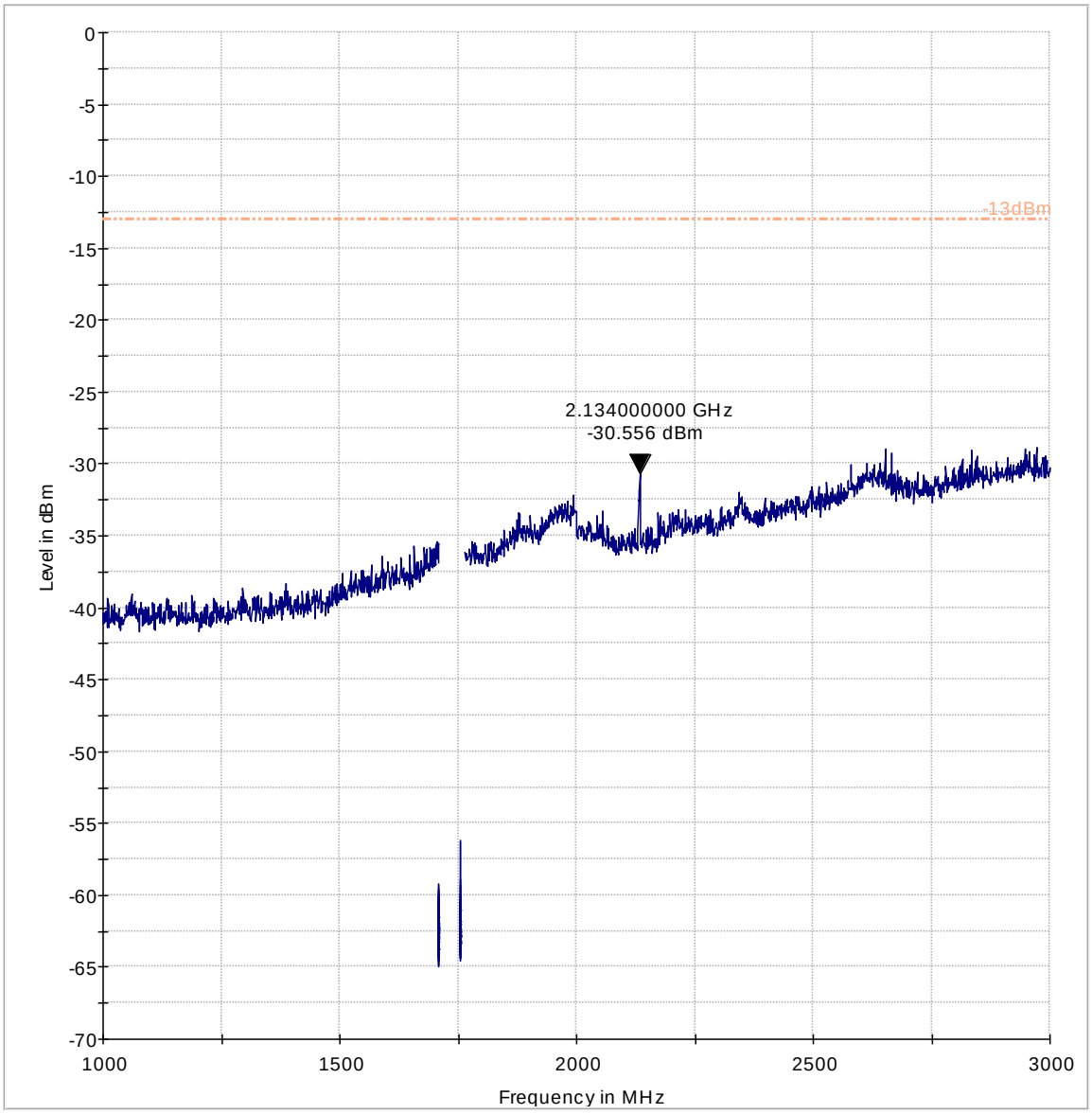
7.5.4 LTE Band 4, Tx: Ch. Mid, 9 KHz – 30 MHz



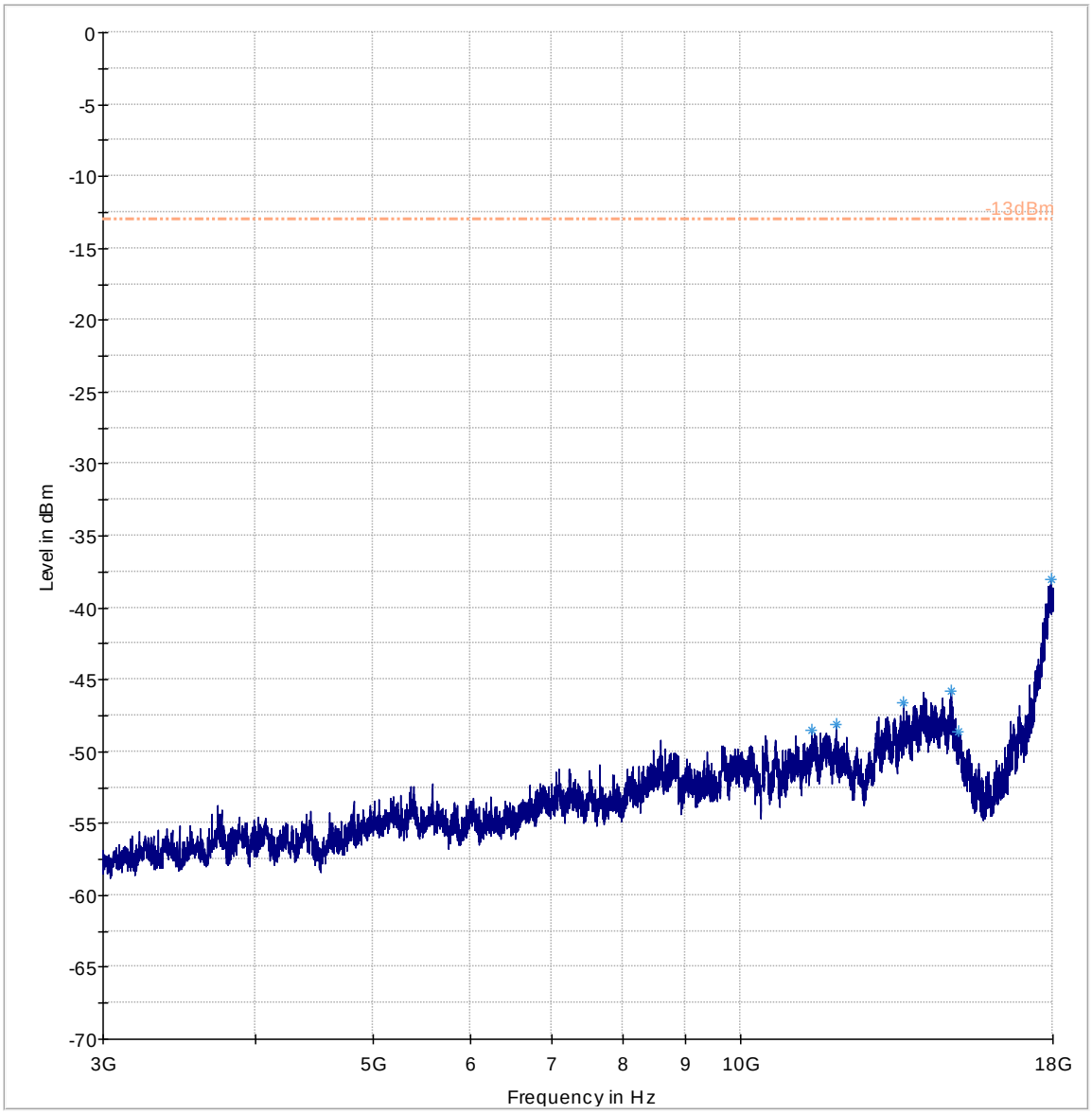
7.5.5 LTE Band 4, Tx: Ch. Mid, 30 MHz – 1 GHz



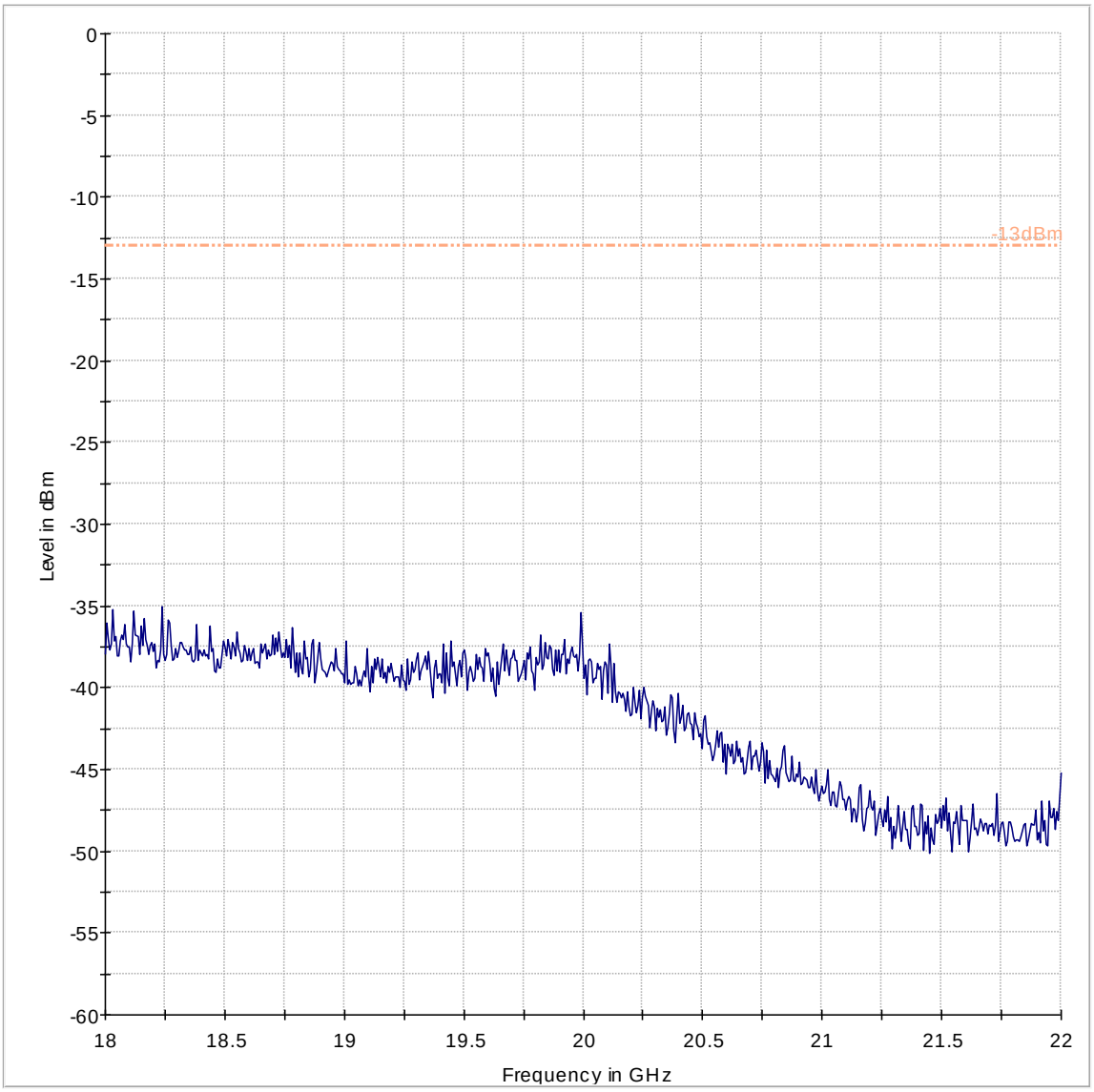
7.5.6 LTE Band 4, Tx: Ch. Mid, 1 GHz – 3 GHz



7.5.7 LTE Band 4, Tx: Ch. Mid, 3 GHz – 18 GHz



7.5.8 LTE Band 4, Tx: Ch. Mid, 18 GHz – 22 GHz

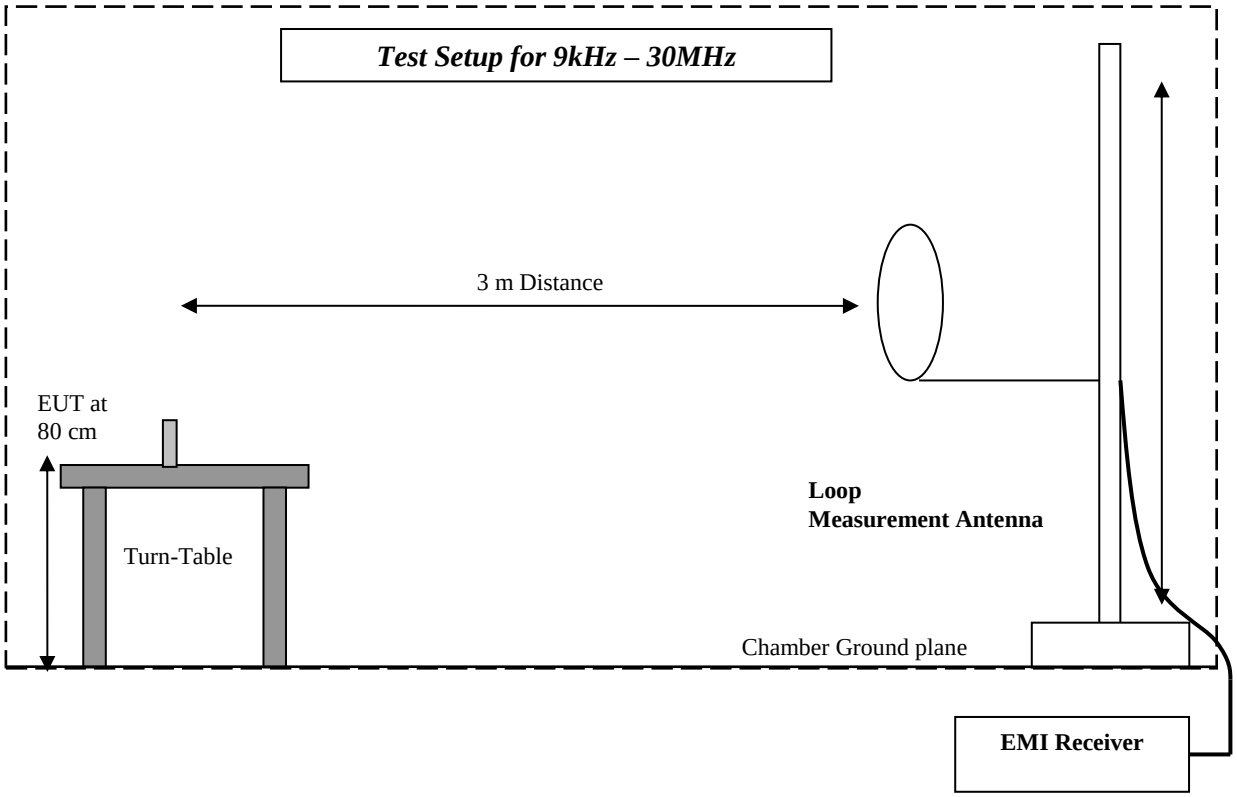


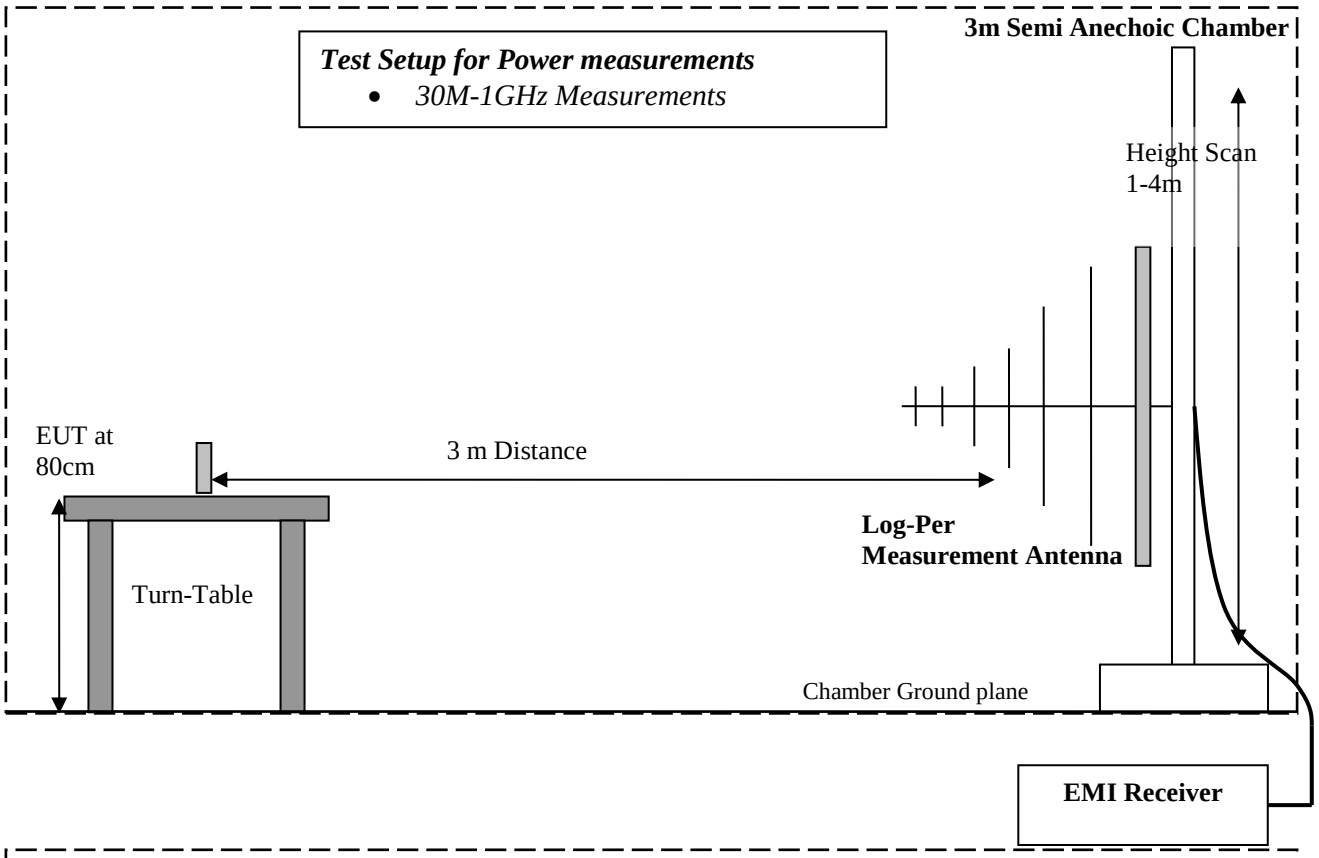
8 Test Equipment and Ancillaries used for tests.

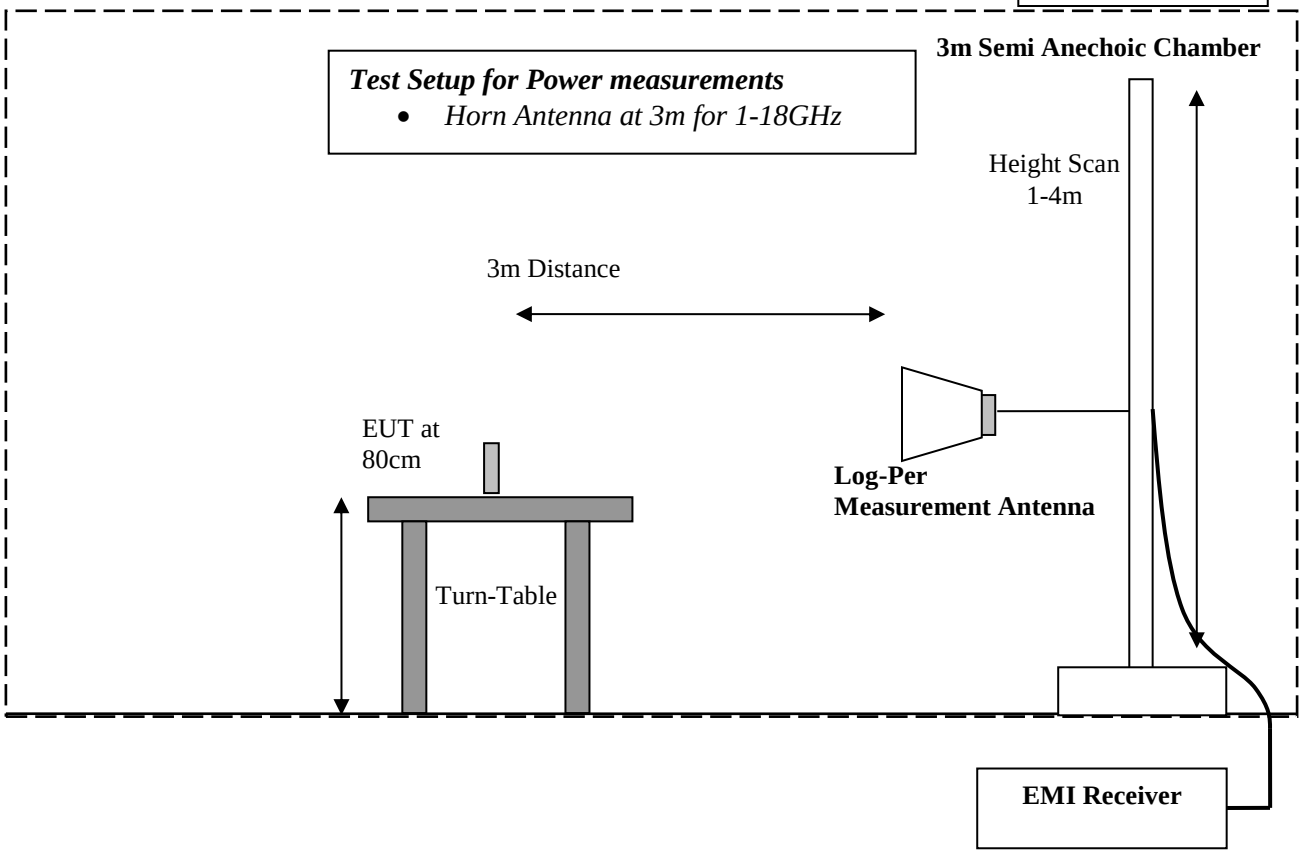
No.	Equipment Name	Manufacturer	Type/model	Serial No.	Cal Date	Cal Interval
1	Turn table	EMCO	2075	N/A	N/A	N/A
2	MAPS Position Controller	ETS Lindgren	2092	0004-1510	N/A	N/A
3	Antenna Mast	EMCO	2075	N/A	N/A	N/A
4	High Pass Filter	5HC2700	Trilithic Inc.	9926013	Part of system calibration	
5	High Pass Filter	4HC1600	Trilithic Inc.	9922307	Part of system calibration	
6	6GHz High Pass Filter	HPM50106	Microtronics	001	Part of system calibration	
7	Pre-Amplifier	JS4-00102600	Miteq	00616	Part of system calibration	
8	Relay Switch Unit	Rohde&Schwarz	RSU	338964/001	N/A	N/A
9	EMI Receiver/Analyzer	Rohde&Schwarz	ESU 40	100251	June 2015	3 Years
10	1500MHz HP Filter	Filtek	HP12/1700	14c48	N/A	N/A
11	2800 MHZ HP Filter	Filtek	HP12/2800	14C47	N/A	N/A
12	Pre-Amplifier	Miteq	JS40010260	340125	N/A	N/A
13	Binconilog Antenna	ETS	3142E	166067	Jun 2014	3 years
14	Horn Antenna	EMCO	3115	35111	Jul 2015	3 Years
15	Horn Antenna	EMCO	3116	00070497	Jul 2015	3 Years
16	WIDEB. RADIO COMM. TESTER	Rohde and Schwarz	CMW 500	127068	Mar 2015	3 years
17	Loop Antenna	EMCO	6512	00049838	Mar 2014	3 years
18	Spectrum Analyzer	Rohde&Schwarz	FSU-8	200256	Jul 2015	2 Years

Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels.
Calibration due dates, unless defined specifically, falls on the last day of the month.
Items indicated "N/A" for cal status either do not specifically require calibration or is internally characterized before use.

9 Block Diagrams




3m Semi Anechoic Chamber
Test Setup for Power measurements
30M-1GHz Measurements
Height Scan
1-4m
EUT at
80cm
3 m Distance
Log-Per
Measurement Antenna
Turn-Table
Chamber Ground plane
EMI Receiver


3m Semi Anechoic Chamber
Test Setup for Power measurements
Horn Antenna at 3m for 1-18GHz
Height Scan
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3m Distance
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Measurement Antenna
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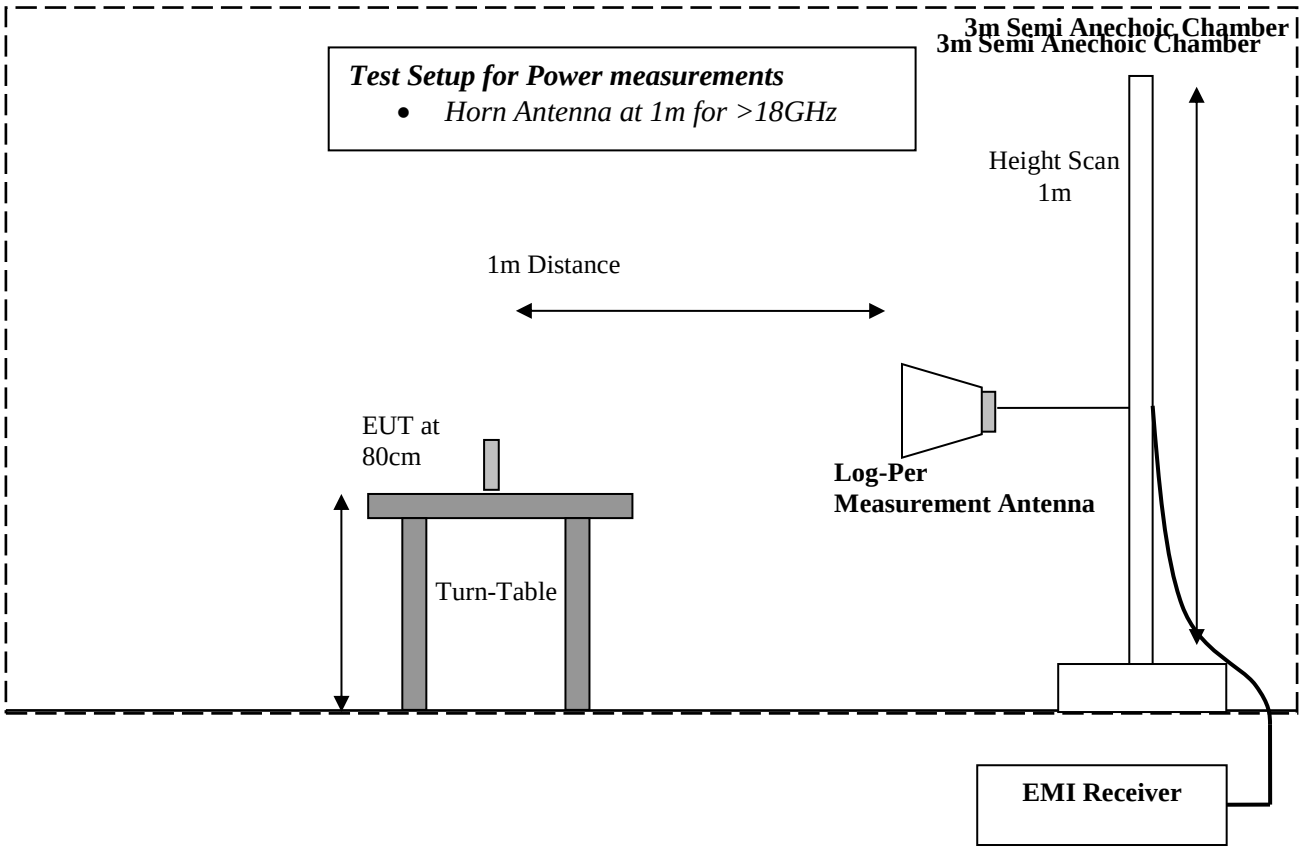
3m Semi Anechoic Chamber
3m Semi Anechoic Chamber
Test Setup for Power measurements
Horn Antenna at 1m for >18GHz
Height Scan
1m
1m Distance
EUT at
80cm
Log-Per
Measurement Antenna
Turn-Table
EMI Receiver

10 Revision History

Date	Report Name	Changes to Report	Report prepared by
July 27, 2016	EMC_HAPIN-001-16501_FCC_27	Initial Version	Douglas Antioco
August 18, 2016	EMC_HAPIN-001-16501_FCC_27_rev1	Added RF output power Verification (Section 6.1), Updated Sections 3.1, 7.3, 8 and 9.	Douglas Antioco
August 30, 2016	EMC_HAPIN-001-16501_FCC_27_rev2	Replaces previous versions. Updated sections 3.1 and 6.4	Douglas Antioco