FCC Test Report

FOR:

iRhythm Technologies

Model Name / Model No: ZIO SR / K102A5001

Product Description: ZIO SR ECG Gateway.

FCC ID: 2AFBP-SR15G

47 CFR Part 22, 24

TEST REPORT #: EMC-IRHYT-003-15001-FCC-22-24-Rev1
DATE: 2015-10-09

ACCREDITED
TESTING LABORATORY
Certificate #2135.01

FCC: Recognized

IC recognized #
3462B-1

***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 22 and 24 and No deviations were ascertained during the course of the tests performed.

Company	Description	Model #
iRhythm Technologies	ZIO SR ECG Gateway	K102A5001

Report reviewed by:

Date	Section	Name	Signature
2015-10-09	Compliance	Franz Engert Manager Compliance Services	Digitally signed by Franz Engert DN: cn=Franz Engert, c=US, o=CETECOM, ou=Complience, email=franz.engert@cetecom.com

Responsible for the Report:

Date	Section	Name	Signature
2015-10-09	Compliance	James Donnellan (Sr. EMC Engineer)	James Donnellan Digitally signed by James Donnellan DN: cn=James Donnellan, c=US, o=Cetecom Inc., ou=Compliance, email=james.donnellan@cetecom.com Date: 2015.10.09 19:03:33 -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	James Donnellan

2.2 Identification of the Client

Client Firm/Name:	iRhythm Technologies
Street Address:	650 Townsend St., Ste 380
City/Zip Code	San Francisco, CA 94103
Country	USA
Contact Person:	Matt Ho
Phone No.	415-632-5714
Fax:	415-632-5701
e-mail:	mho@irhythmtech.com

2.3 Identification of the Manufacturer

Manufacturer's Name:	Same as client.
Manufacturers Address:	
City/Zip Code	
Country	

2.4 Dates of Testing:

2015/05/25 – 2015/06/03

3 Equipment under Test (EUT)

3.1 Specification of the Equipment under Test

Marketing Name / Description:	SkyRunner Gateway
Model Number:	K102A5001
FCC-ID :	2AFBP-SR15G
Product Description:	ZIO SR ECG Gateway
Technology / Type(s) of Modulation:	CDMA 850/1900MHz
Operating Frequency Ranges (MHz) / Channels:	Incorporated integrated radio module: Telit, model CE910-DUAL FCC-ID: RI7CE910-DUAL IC ID: 5131A-CE910DUAL CDMA 850: 825.03-848.97; 800 channels CDMA 1900: 1850.05-1909.95; 1200 channels
Antenna info:	Internal Hexa-Band Cellular SMD Antenna from Toglas Product Name: Anam P/N PA.25a Documented Max Antenna Gain: 850MHz: 1.5 dBi, 1900MHz: 2.3 dBi
Rated Operating Voltage Range:	Low: 3.7 Nom: 3.9 High: 4.2
Rated Operating Temperature Range:	0ºC to 45ºC
Test Sample Status:	Production
Other Radios contained in the device:	A Bluetooth LE TiWi-uB1 Module from LS Research, LLC. FCC ID: TFB-BT2 IC ID: 5969A-BT2

3.2 Identification of the Equipment under Test (EUT)

EUT #	Serial Number	Sample	HW / SW Version
1	J152001511	Radiated	2 / CC2541_SmartRF_Host
2	J152001503	Conducted	2 / CC2541_SmartRF_Host

3.3 Identification of Accessory equipment

STE #	Type	Manufacturer	Model	Serial Number
2	3.6 V Battery Pack	House Of Batteries	NCA103450-PC-1 Rev. B	-

3.4 Identification of Ancillary equipment

STE #	Type	Manufacturer	Model	Serial Number
1	Gateway Programming Assembly	iRhythm	-	-
2	Laptop	Dell	Latitude E6430s	966X7W1

4 Summary of Measurement Results

CDMA 850MHz Band:

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§2.1046 §22.913 (a)	RF Output Power	Nominal	CDMA	■	☐	☐	☐	Complies
§2.1055 §22.355	Frequency Stability	Nominal	CDMA	☐	☐	☐	■	Note 1
§2.1049 §22.917(b)	Occupied Bandwidth	Nominal	CDMA	☐	☐	☐	■	Note 1
§2.1051 §22.917	Band Edge Compliance	Nominal	CDMA	☐	☐	☐	■	Note 1
§2.1051 §22.917	Conducted Spurious Emissions	Nominal	CDMA	☐	☐	☐	■	Note 1
§2.1053 §22.917	Radiated Spurious Emissions	Nominal	CDMA	■	☐	☐	☐	Complies

Note: NA= Not Applicable; NP= Not Performed.
Note 1: Leveraged from module certification. See Section 5.4

CDMA 1900 MHz Band:

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§2.1046 §24.232 (a)	RF Output Power	Nominal	CDMA	■	☐	☐	☐	Complies
§2.1055 §24.235	Frequency Stability	Nominal	CDMA	☐	☐	☐	■	Note 1
§2.1049 §24.238(b)	Occupied Bandwidth	Nominal	CDMA	☐	☐	☐	■	Note 1
§2.1051 §24.238	Band Edge Compliance	Nominal	CDMA	☐	☐	☐	■	Note 1
§2.1051 §24.238	Conducted Spurious Emissions	Nominal	CDMA	☐	☐	☐	■	Note 1
§2.1053 §24.238	Radiated Spurious Emissions	Nominal	CDMA	■	☐	☐	☐	Complies

Note: NA= Not Applicable; NP= Not Performed.
Note 1: Leveraged from module certification. See Section 5.4

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: 3.7 VDC(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 Telit UE910-NAD module (details see EUT spec in section 3.1)
Test Report No. : NK-12-R-098 for this integrated module issued on July 27, 2012 by Nemko Korea Co., Ltd. Results are leveraged in this report.

Taking into account guidance from FCC KDB 996369 (modular approval) and where relevant test procedures did not change conducted test results are leveraged.

This test report contains full radiated testing as per FCC 22H/24E

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 Digital Radio Communication Tester (R&S CMU200).
2. The EUT is tested on the low, mid and high 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 Power Output verification

6.1 References
FCC: CFR Part 2.1046, CFR Part 22.913, CFR Part 24.232

6.2 Limits:

ERP/EIRP (850 MHz Band)

FCC Part 22.913 (a)

FCC: ERP < 38.45 dBm (7W)
The effective radiated power (ERP) of mobile transmitters must not exceed 7 Watts.

EIRP (1900 MHz Band)

FCC Part 24.232 (c) (e) &

FCC: EIRP < 33 dBm (2W)
(b) Mobile/portable stations are limited to 2 Watts effective isotropic radiated power (EIRP).
(c) Peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms equivalent voltage. The measurement results shall be properly adjusted for any limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement over the full bandwidth of the channel.

6.4 Measurement Results Summary:

The measurements were made on the CMU 200 while connected directly to the device. The cable attenuations are accounted for in the measurements and using the appropriate gains from the antenna Specification document SPE-11-8-061/G we calculate the EIRP.

Conducted Measurement and EIRP Summary					
Band	Channel	Frequency [MHz]	Max Average power dBm	Antenna Gain	EIRP
BC0	1013	824.7	24.09	1.5	25.59
	384	836.6	23.96	1.5	25.46
	777	848.31	23.93	1.5	25.43
BC1	25	1851.25	23.76	2.3	26.06
	600	1880	23.99	2.3	26.29
	1175	1908.75	24.05	2.3	26.35

Given the conducted measurements above are in line with the FCC module report for the integrated module, I am using results from the integrated module report to calculate the PAPR below. Referencing KDB) 971168 section 5.7.2 Alternate procedure for PAPR I get the values indicated below for Peak to Average Power Ratio..

Conducted Measurement From FCC Module Report NK-12-R-098				
Band	Channel	Average power dBm	Peak power dBm	Peak to Average Power Ratio dB
Cellular	1013	24.65	29.05	4.40
	384	24.49	29.22	4.73
	777	24.10	28.88	4.78
PCS	25	24.08	27.33	3.25
	600	24.29	27.85	3.56
	1175	24.44	28.47	4.03

6.5 Test Verdic:

PASS: All ERP/EIRP are within the regulatory limits

7 Spurious Emissions Radiated

7.1 References:

FCC: CFR Part 2.1053, CFR Part 22.917, CFR Part 24.238, CFR Part 27.53

7.2 Limits:

(a) *Out of band emissions*. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

For all power levels +30dBm to 0dBm, this becomes a constant specification of -13dBm.

7.2.1 FCC 22.917 Emission limitations for cellular equipment.

The rules in this section govern the spectral characteristics of emissions in the Cellular Radiotelephone Service.

(b) *Measurement procedure.* Compliance with these provisions is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (*i.e.* 100 kHz of 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

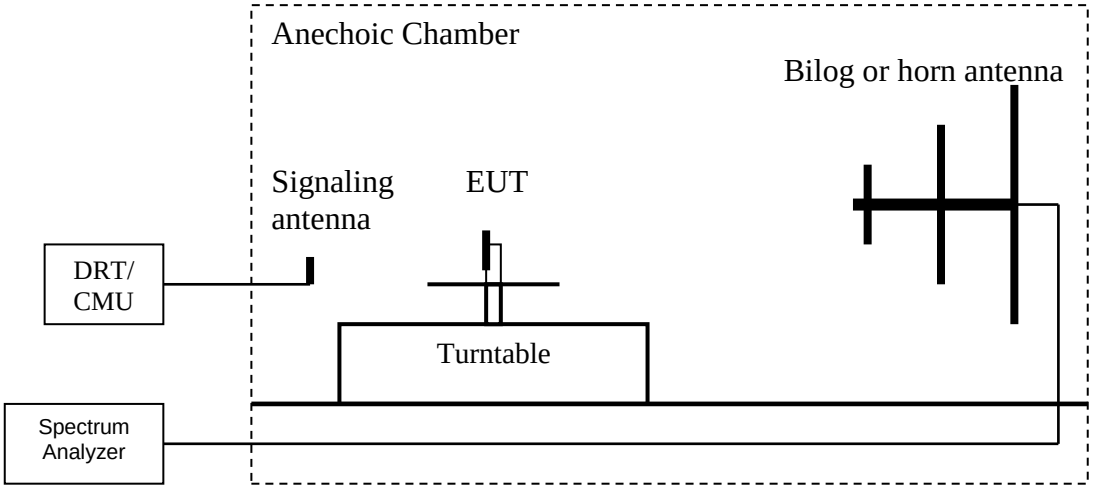
7.2.2 FCC 24.238 Emission limitations for Broadband PCS equipment.

The rules in this section govern the spectral characteristics of emissions in the Broadband Personal Communications Service.

(b) Measurement procedure. Compliance with these provisions is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (*i.e.* 100 kHz of 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

7.3 Radiated out of band measurement procedure:

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 22

	30MHz – 1 GHz	1 – 1.58 GHz	1.58 – 9 GHz
Resolution Bandwidth	100 kHz	1 MHz	1 MHz
Video Bandwidth	100 kHz	1 MHz	1 MHz
Detector	Peak	Peak	Peak
Trace Mode	Max Hold	Max Hold	Max Hold
Sweep Time	Auto	Auto	Auto

Settings for FCC 24

	30MHz – 1 GHz	1 – 2.7 GHz	2.7 – 18 GHz	18 – 19.1 GHz
Resolution Bandwidth	100 kHz	1 MHz	1 MHz	1 MHz
Video Bandwidth	100 kHz	1 MHz	1 MHz	1 MHz
Detector	Peak	Peak	Peak	Peak
Trace Mode	Max Hold	Max Hold	Max Hold	Max Hold
Sweep Time	Auto	Auto	Auto	Auto

7.4 Test Results

7.4.1 CDMA 850.

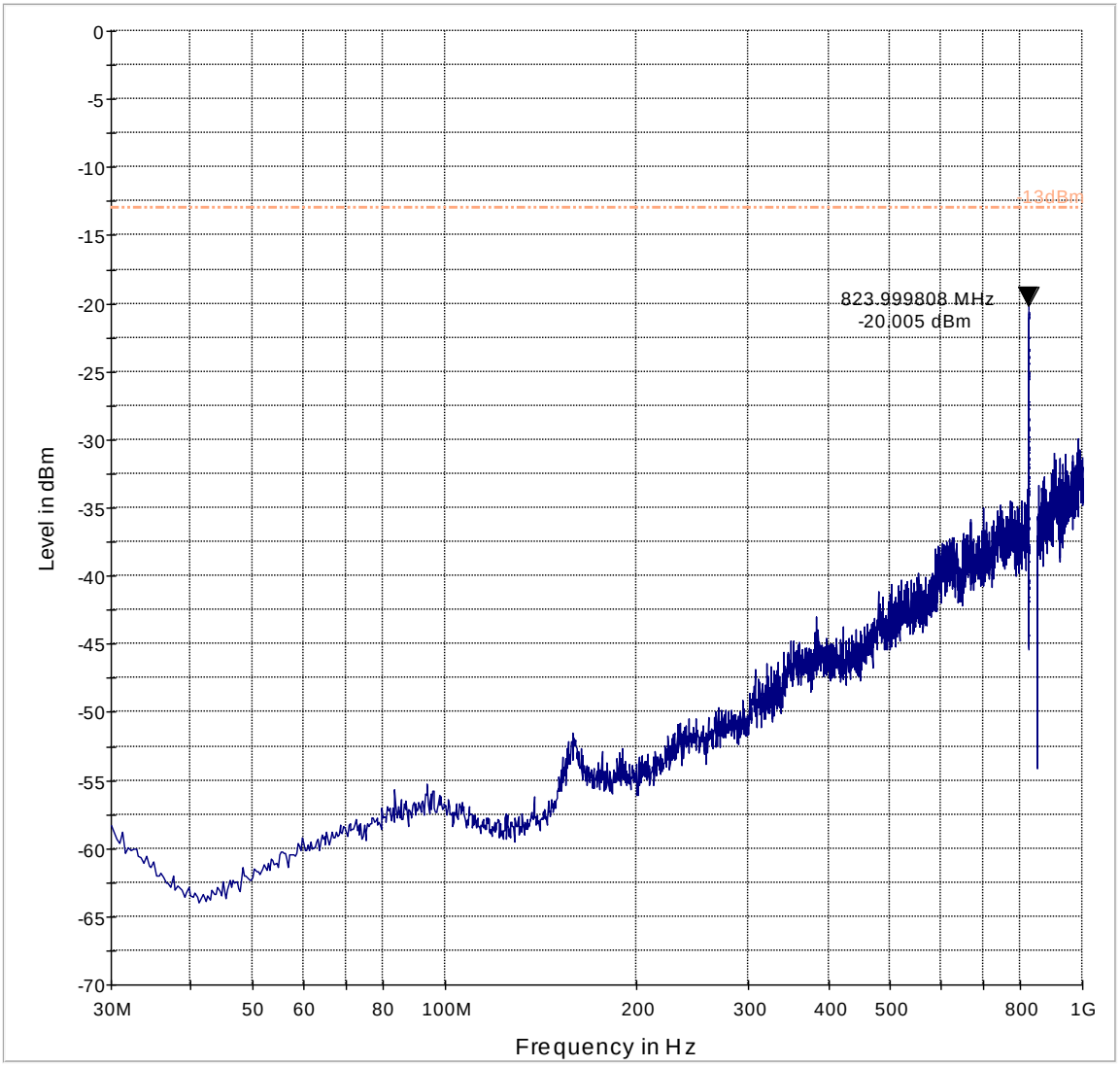
Harmonic	Tx ch-128 Freq. (MHz)	Level (dBm)	Tx ch-190 Freq. (MHz)	Level (dBm)	Tx ch-251 Freq. (MHz)	Level (dBm)	Limit FCC and IC (dBm)
2	1648.4	-38.8	1673.2	-43.1	1697.6	NF	-13
3	2472.6	NF	2509.8	NF	2546.4	NF	
4	3296.8	NF	3346.4	NF	3395.2	NF	
5	4121	NF	4183	NF	4244	NF	
6	4945.2	NF	5019.6	NF	5092.8	NF	
7	5769.4	NF	5856.2	NF	5941.6	NF	
8	6593.6	NF	6692.8	NF	6790.4	NF	
9	7417.8	NF	7529.4	NF	7639.2	NF	
10	8242	NF	8366	NF	8488	NF	
NF = Noise Floor Measurement Uncertainty: ±3dB							

7.4.2 CDMA 1900

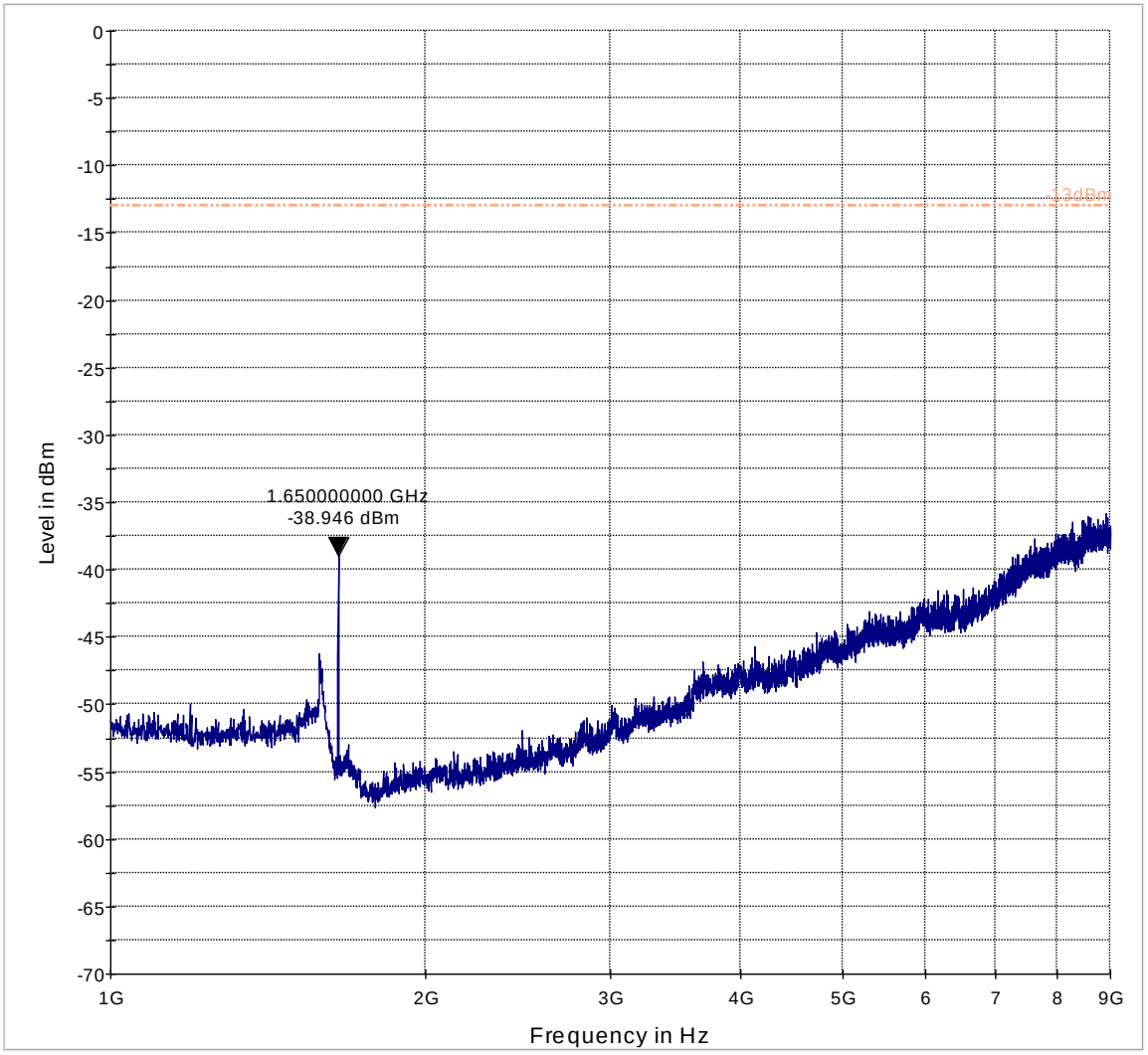
Harmonic	Tx ch-512 Freq. (MHz)	Level (dBm)	Tx ch-661 Freq. (MHz)	Level (dBm)	Tx ch-810 Freq. (MHz)	Level (dBm)	Limit FCC and IC (dBm)
2	3700.4	-29.7	3760	NF	3819.6	-35.0	-13
3	5550.6	NF	5640	NF	5729.4	NF	
4	7400.8	NF	7520	NF	7639.2	NF	
5	9251	NF	9400	NF	9549	NF	
6	11101.2	NF	11280	NF	11458.8	NF	
7	12951.4	NF	13160	NF	13368.6	NF	
8	14801.6	NF	15040	NF	15278.4	NF	
9	16651.8	NF	16920	NF	17188.2	NF	
10	18502	NF	18800	NF	19098	NF	
NF = Noise Floor Measurement Uncertainty: ±3dB							

7.5 BC0 Band Radiated Emission Plots:

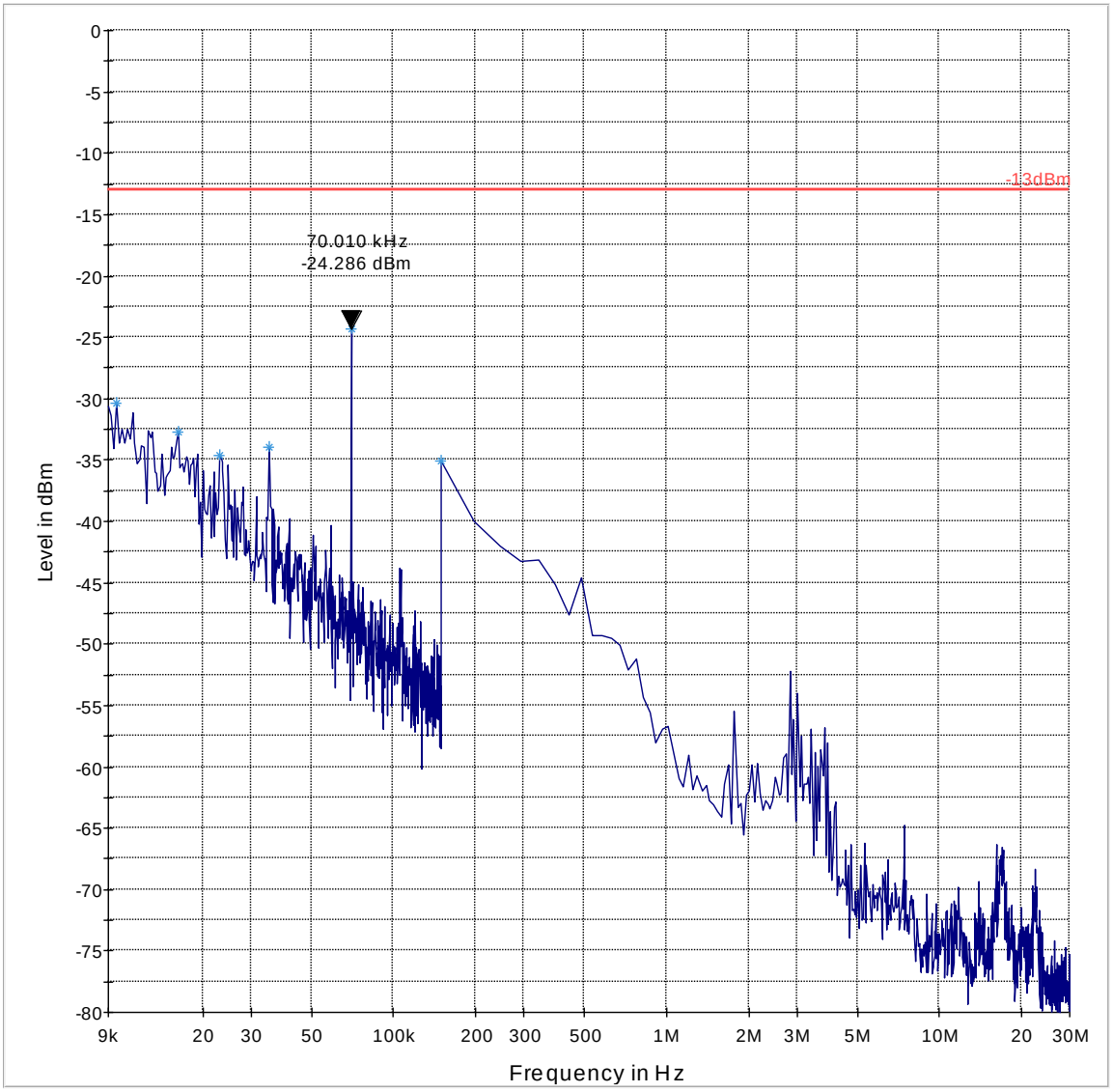
30 MHz – 1 GHz, CDMA 850, Tx: Ch. Low



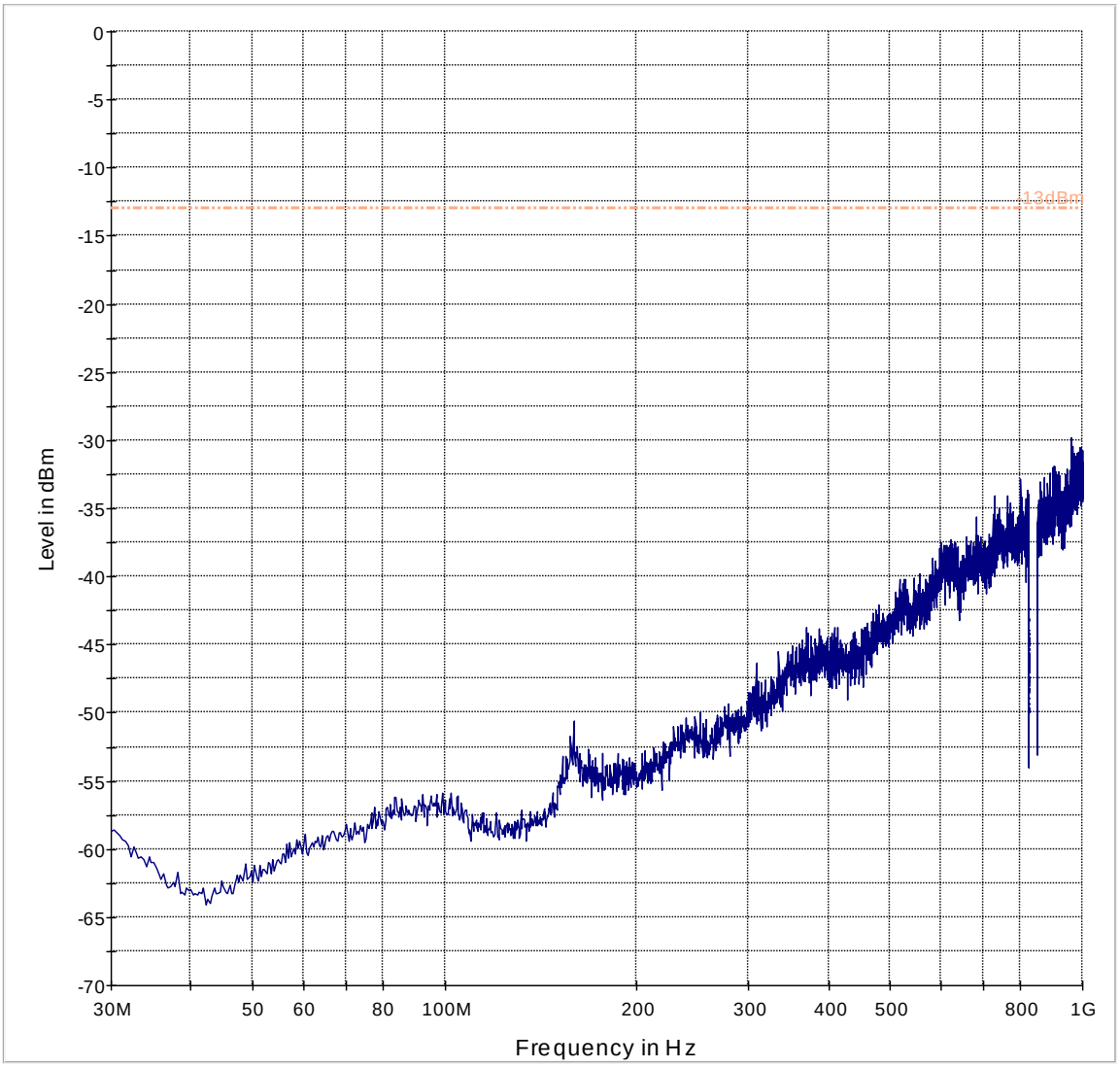
1 GHz – 9 GHz, CDMA 850, Tx: Ch. Low



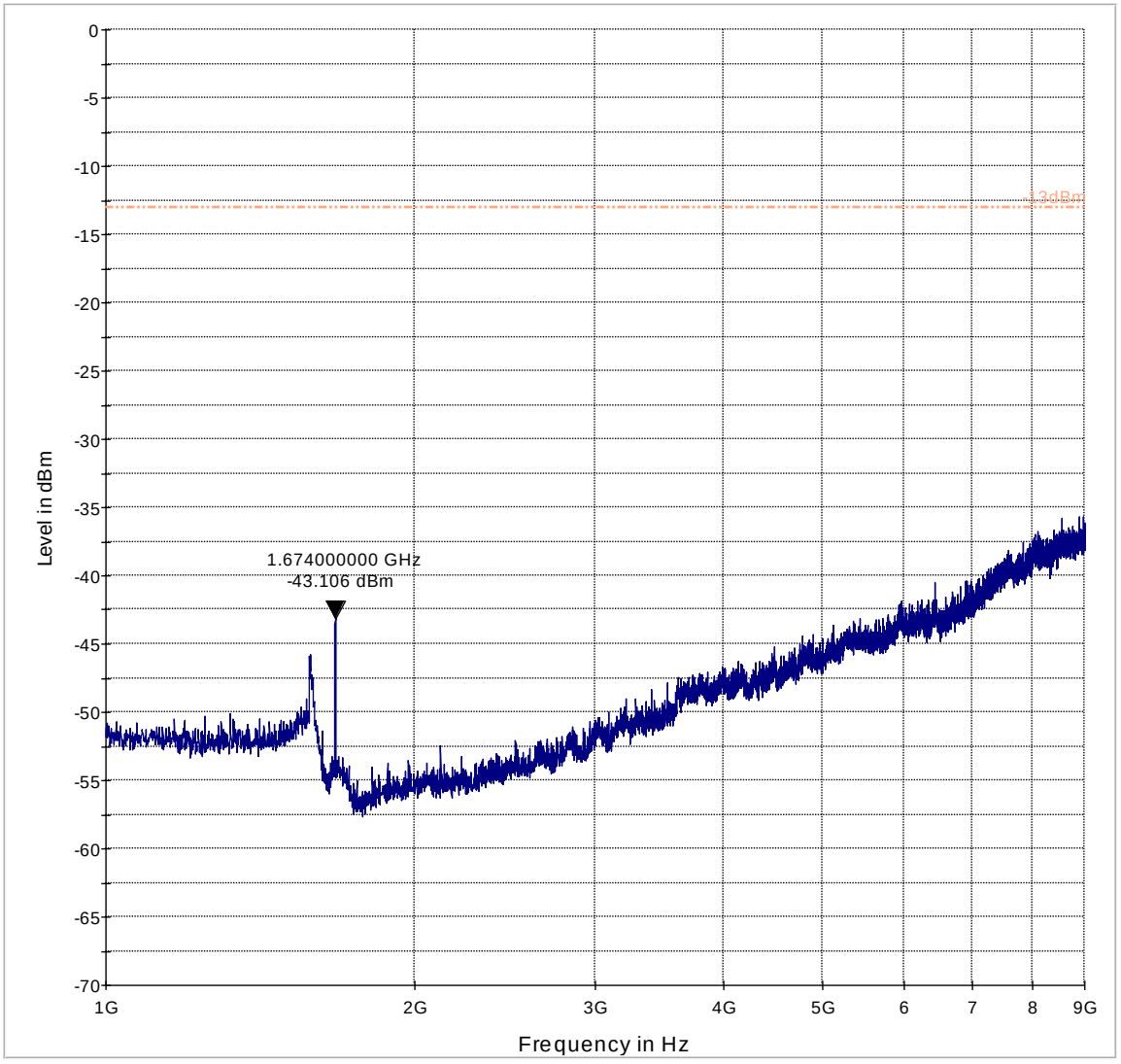
9 KHz – 30 MHz, CDMA 850, Tx: Ch. Mid



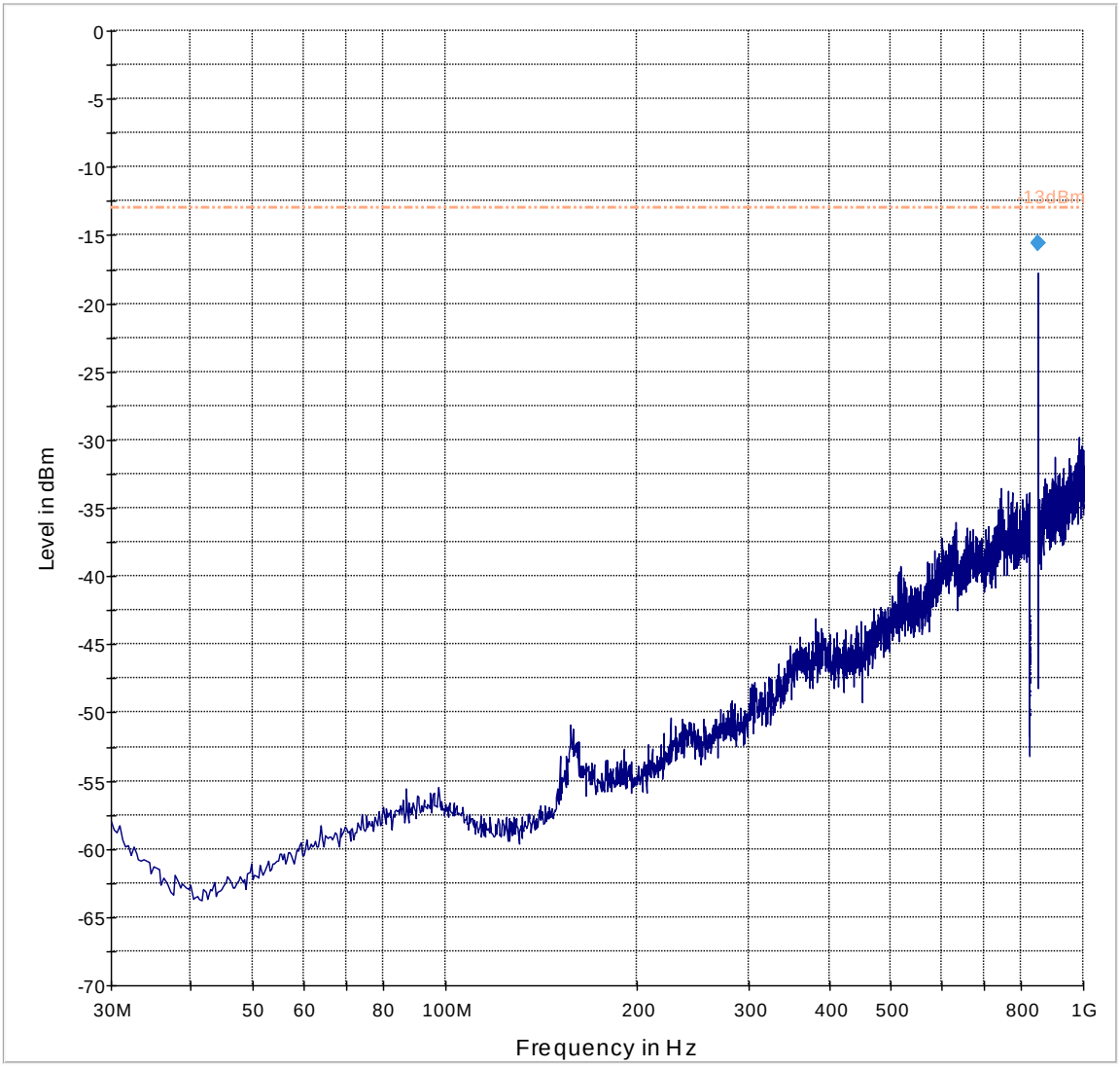
30 MHz – 1 GHz, CDMA 850, Tx: Ch. Mid



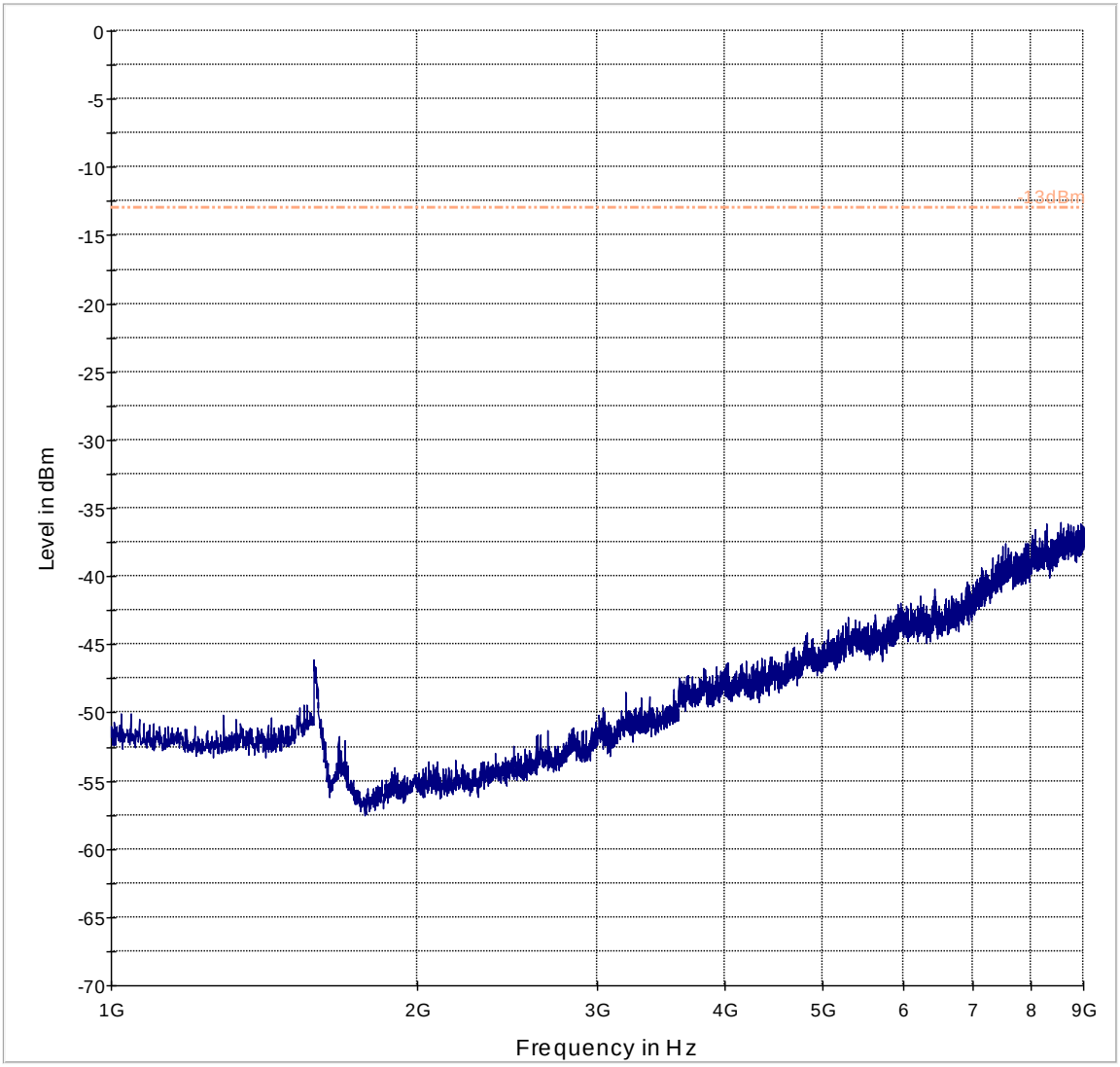
1 GHz – 9 GHz, CDMA 850, Tx: Ch. Mid



30 MHz – 1 GHz, CDMA 850, Tx: Ch. High

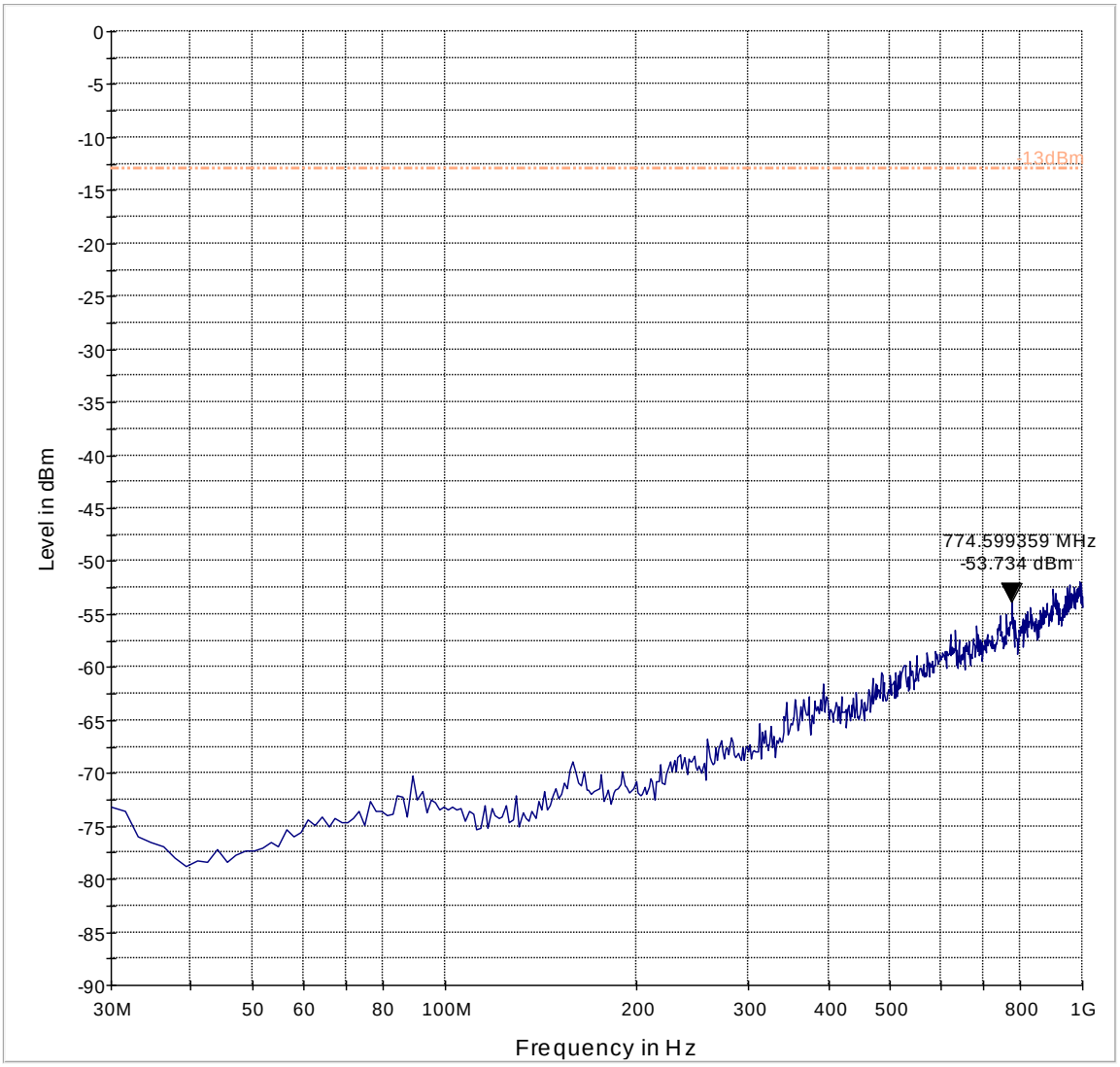


1 GHz – 9 GHz, CDMA 850, Tx: Ch. High

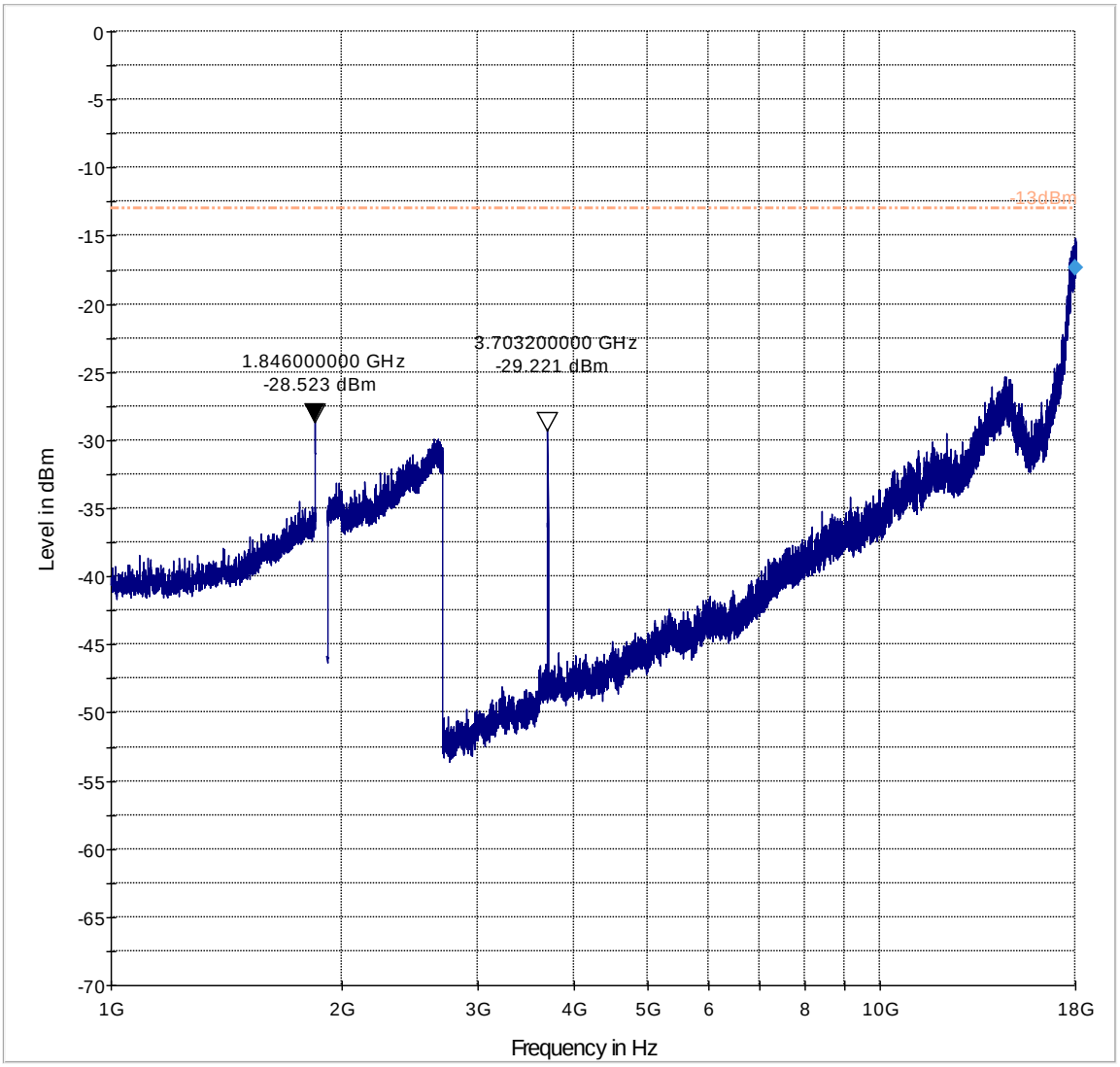


7.6 BC1 Band Radiated Emission Plots

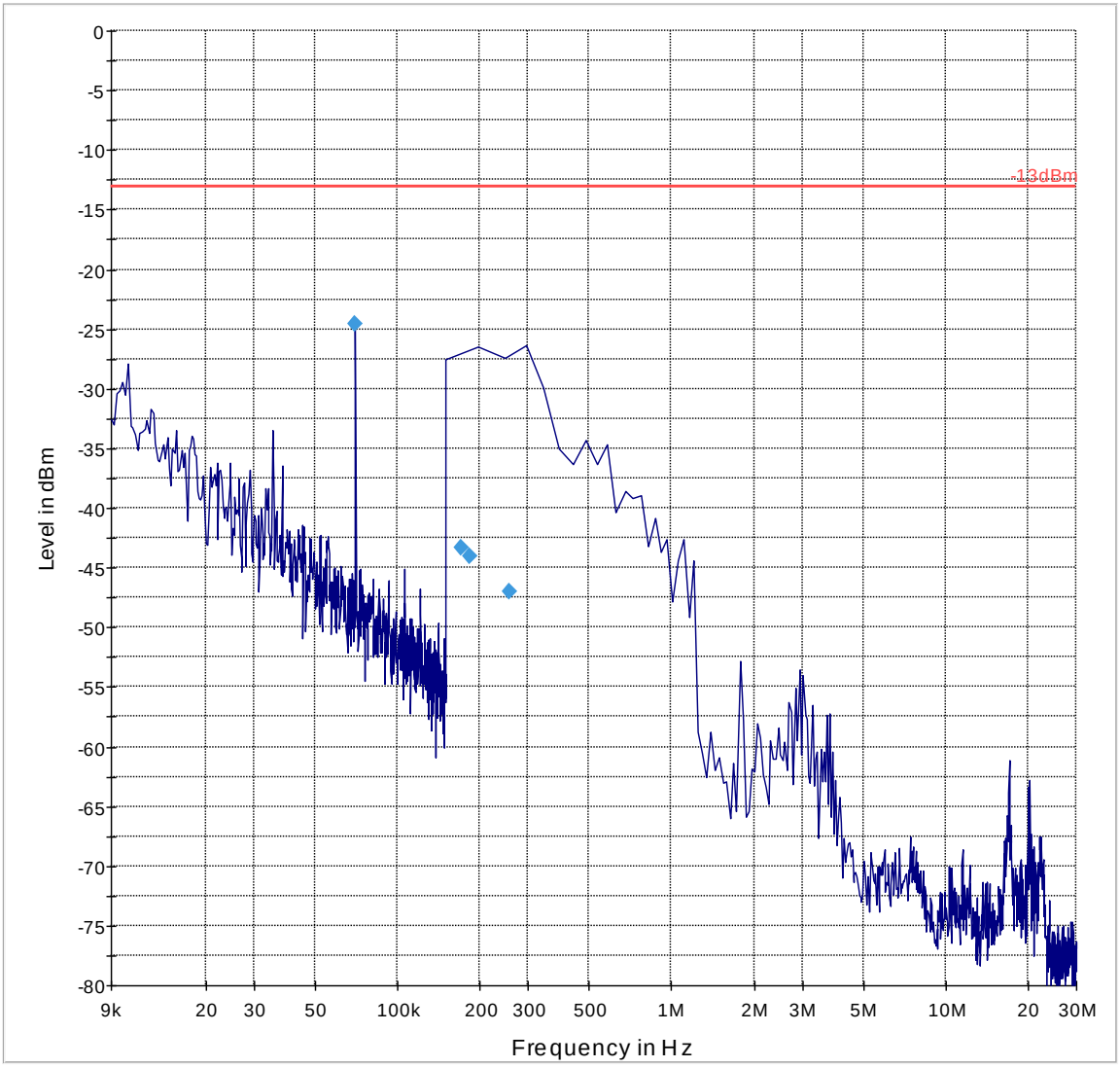
30 MHz – 1 GHz, CDMA 1900, Tx: Ch. Low



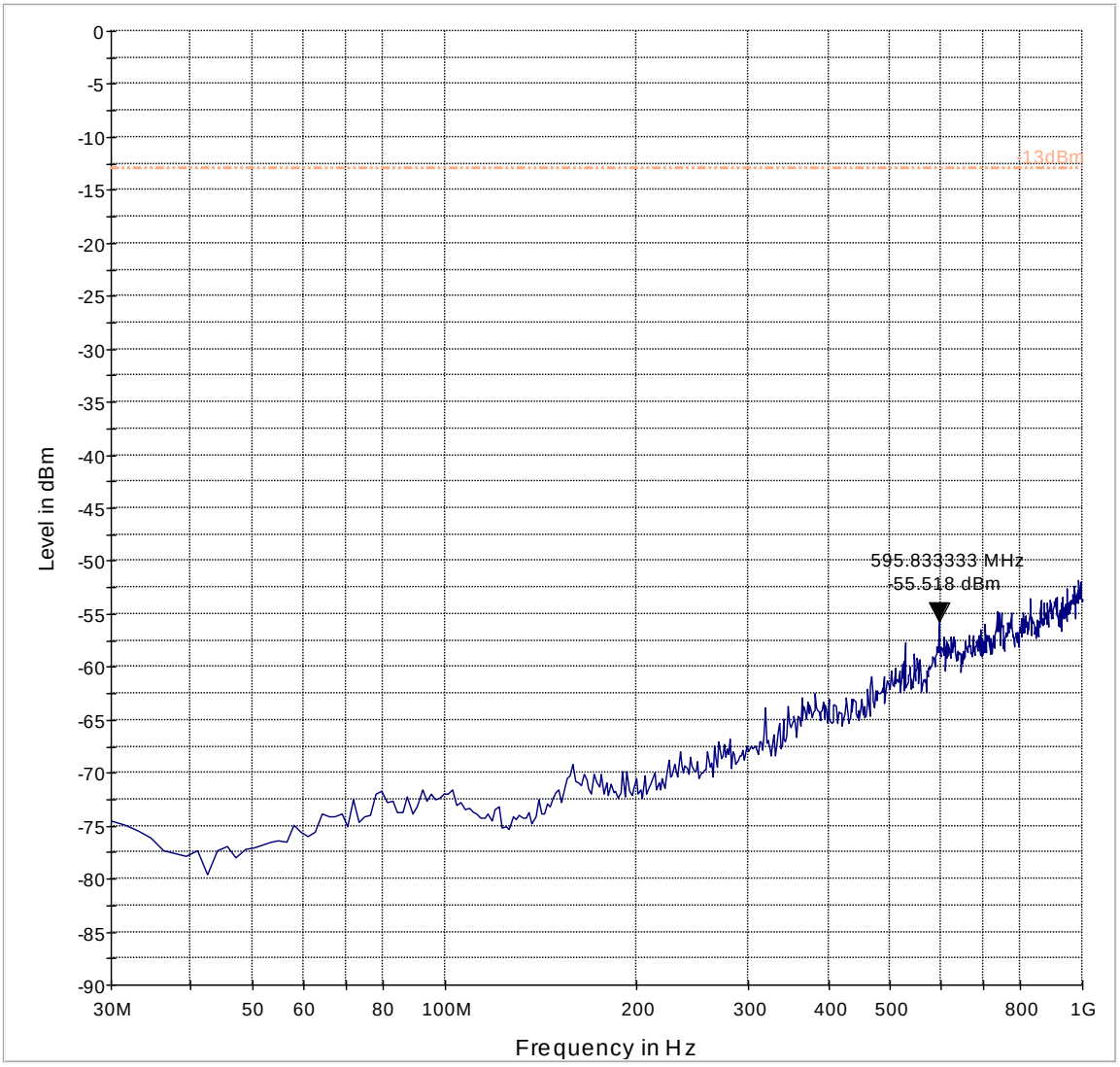
1 GHz – 18 GHz, CDMA 1900, Tx: Ch. Low



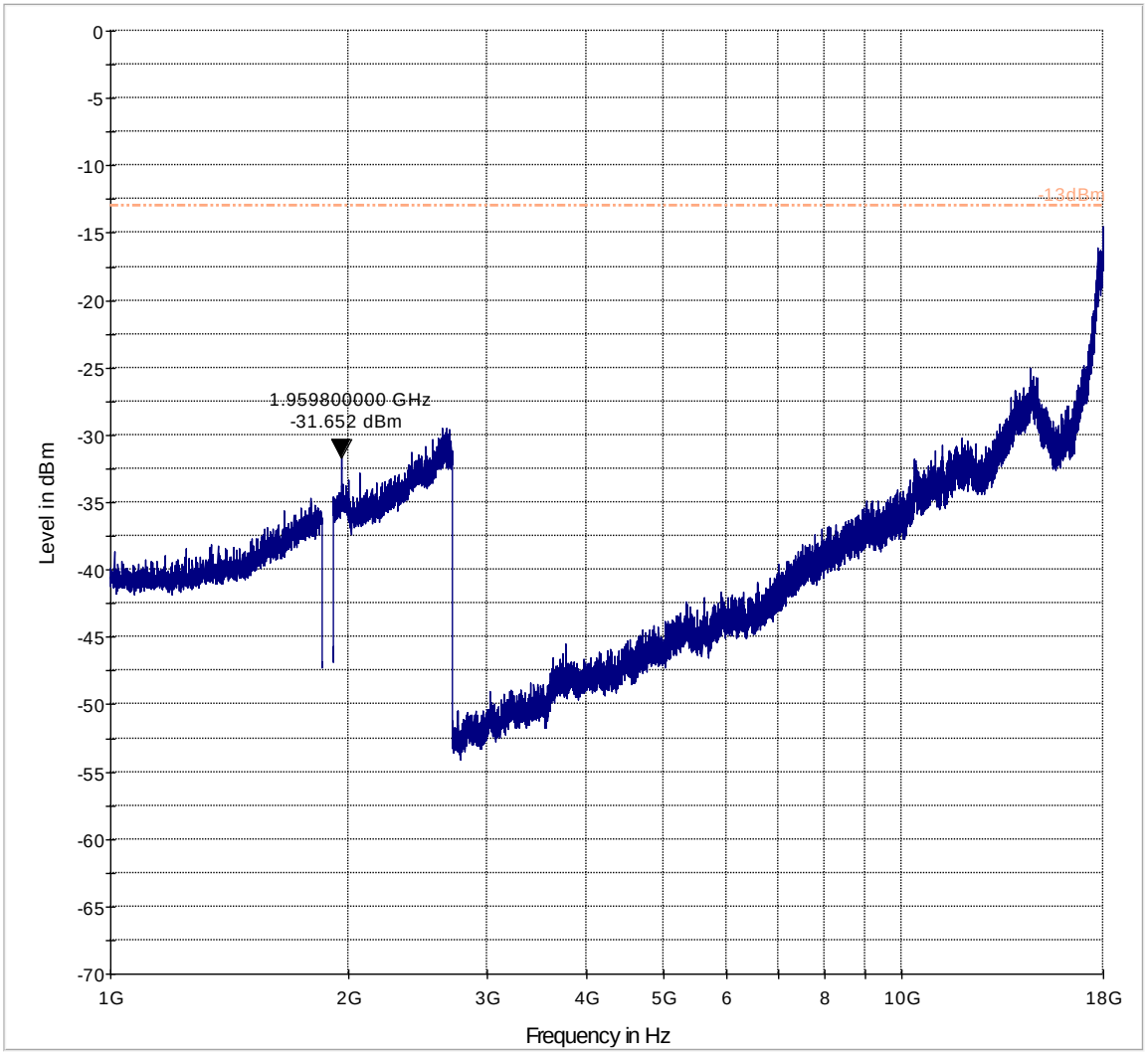
9 KHz – 30 MHz, CDMA 1900, Tx: Ch. Mid



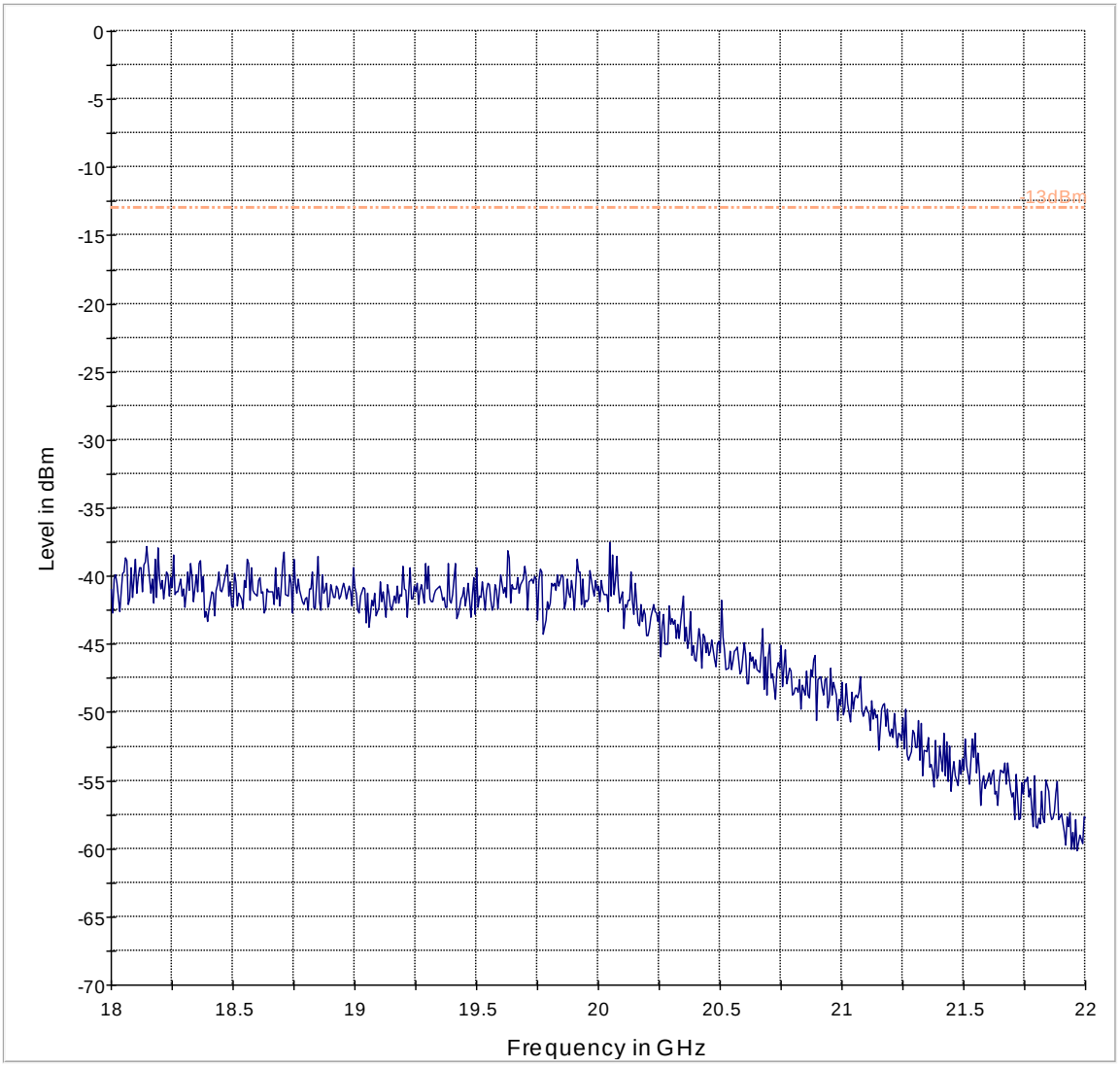
30 MHz – 1 GHz, CDMA 1900, Tx: Ch. Mid



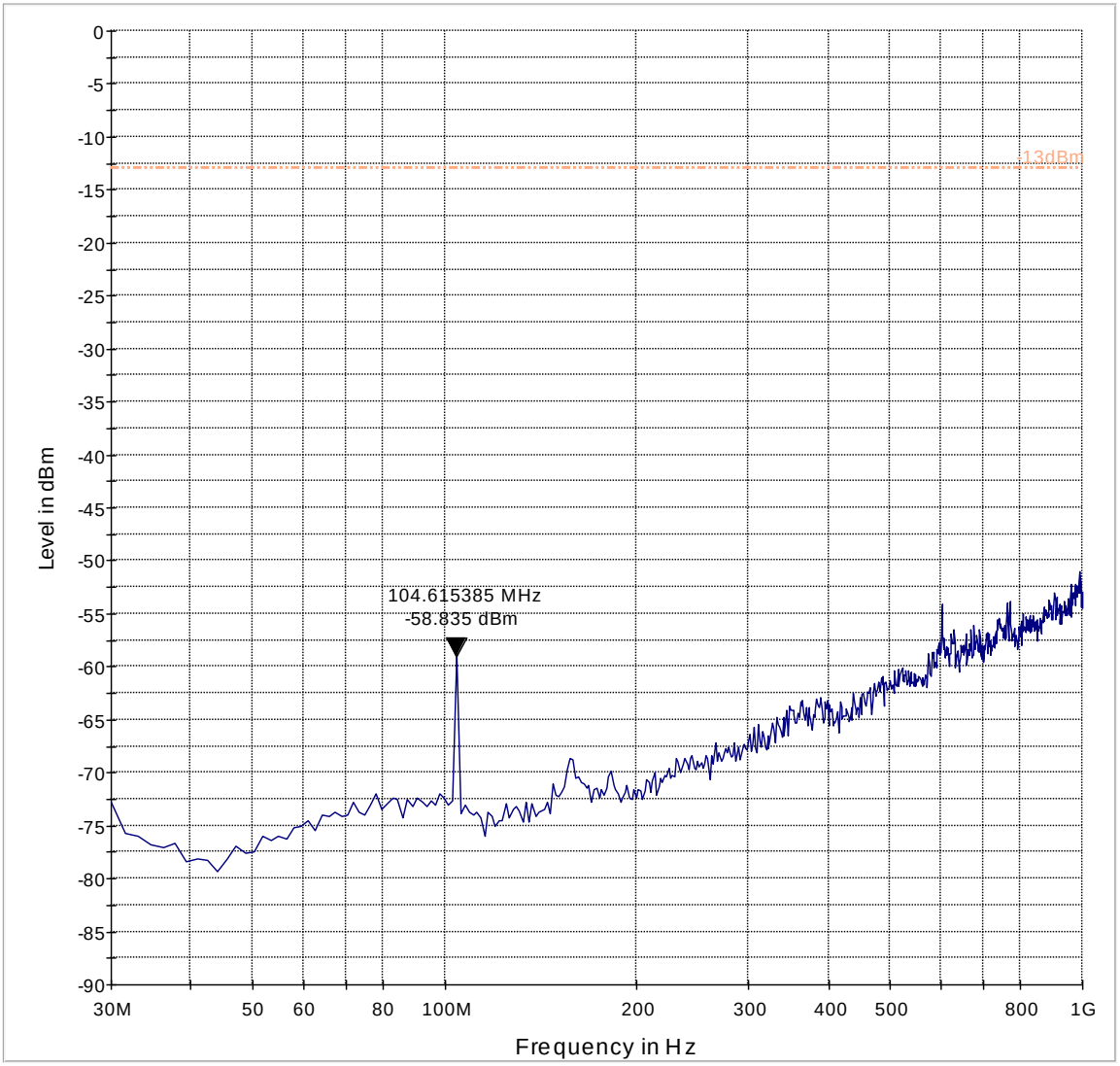
1 GHz – 18 GHz, CDMA 1900, Tx: Ch. Mid



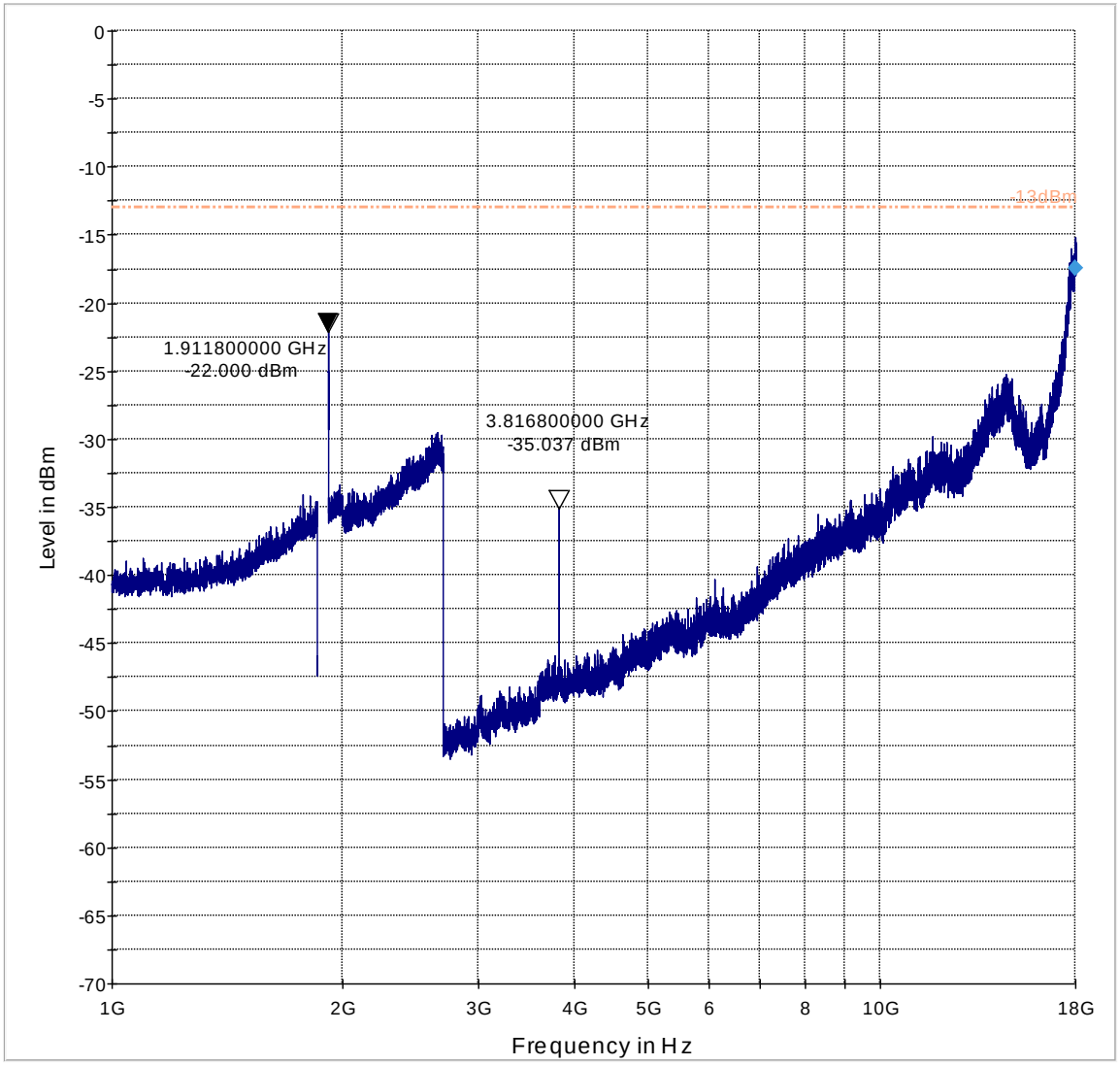
18 GHz - 22 GHz, CDMA 1900, Tx: Ch. Mid



30 MHz – 1 GHz, CDMA 1900, Tx: Ch. High



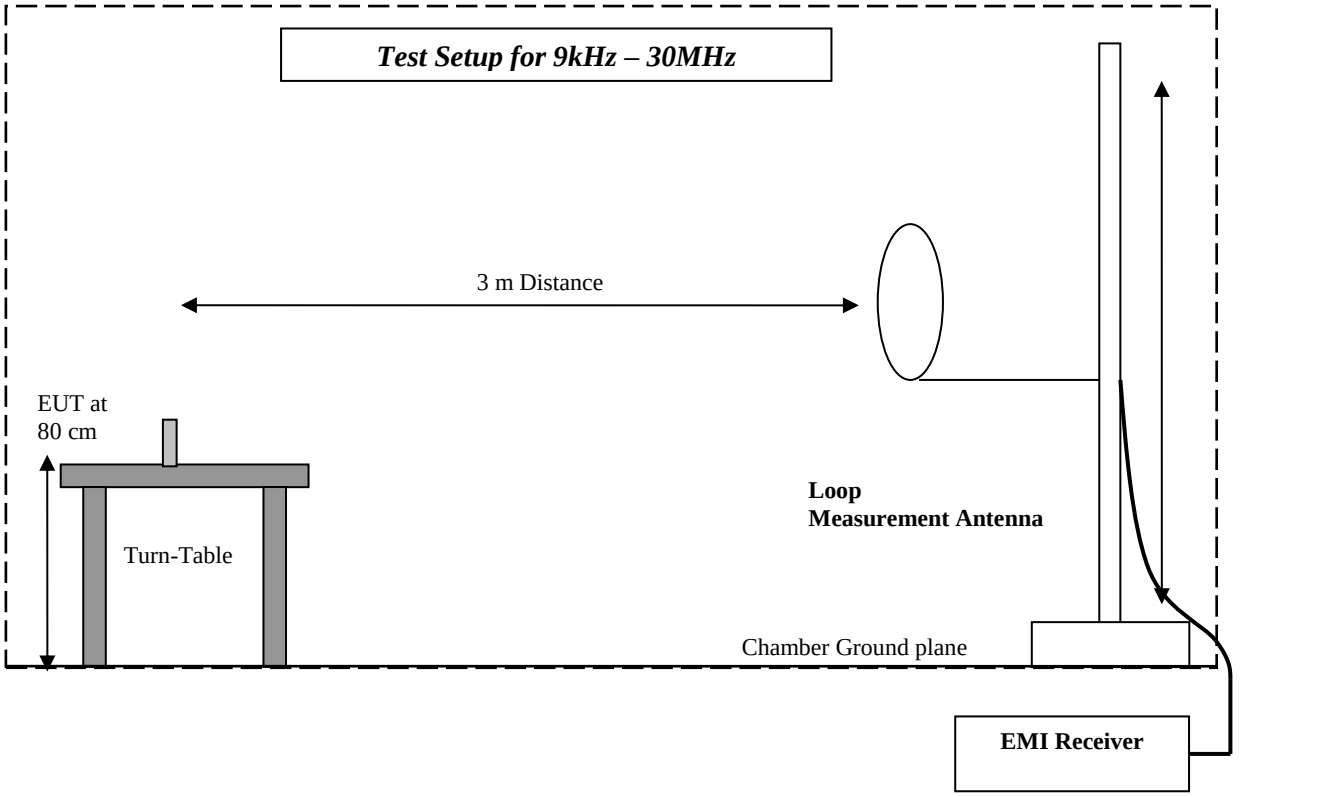
1 GHz – 18 GHz, CDMA 1900, Tx: Ch. High

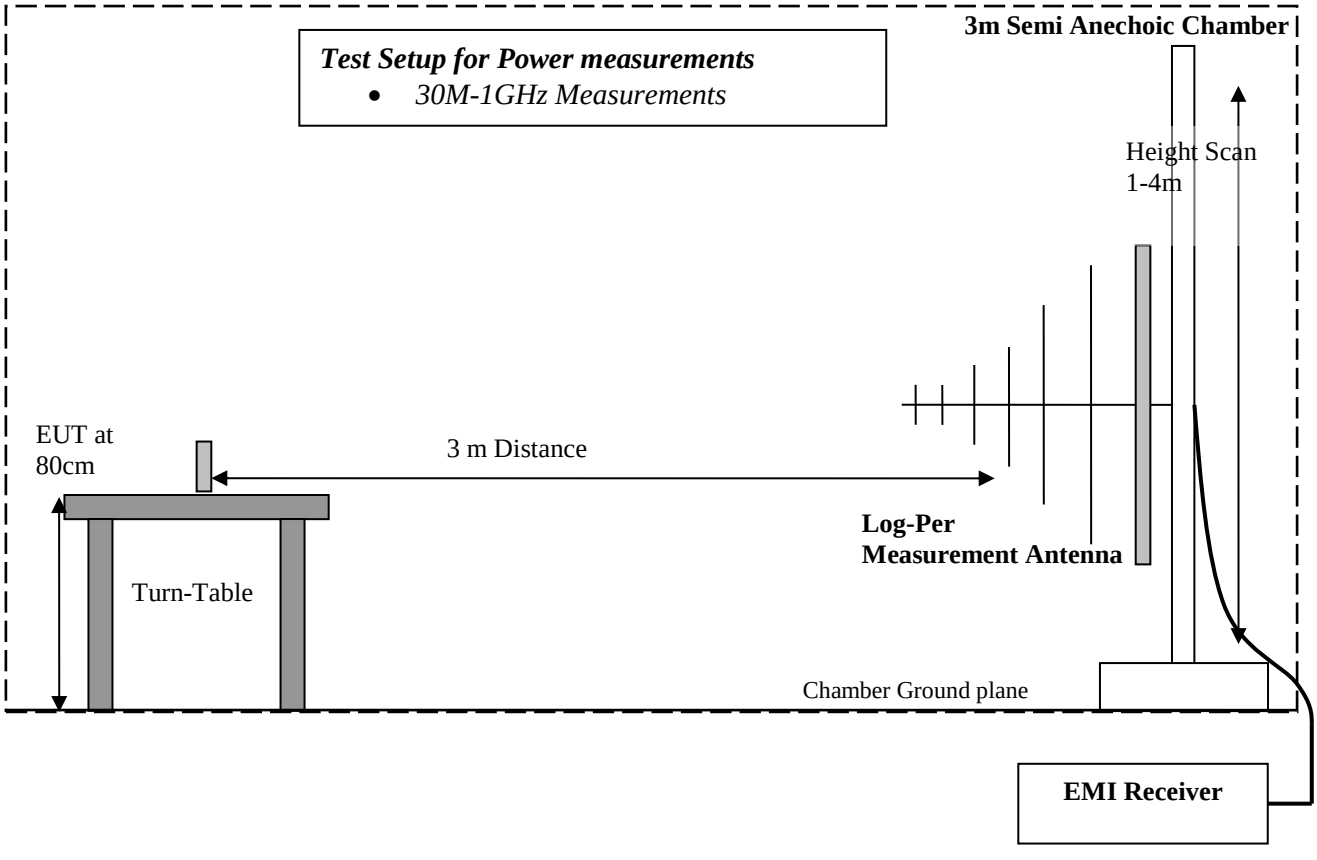


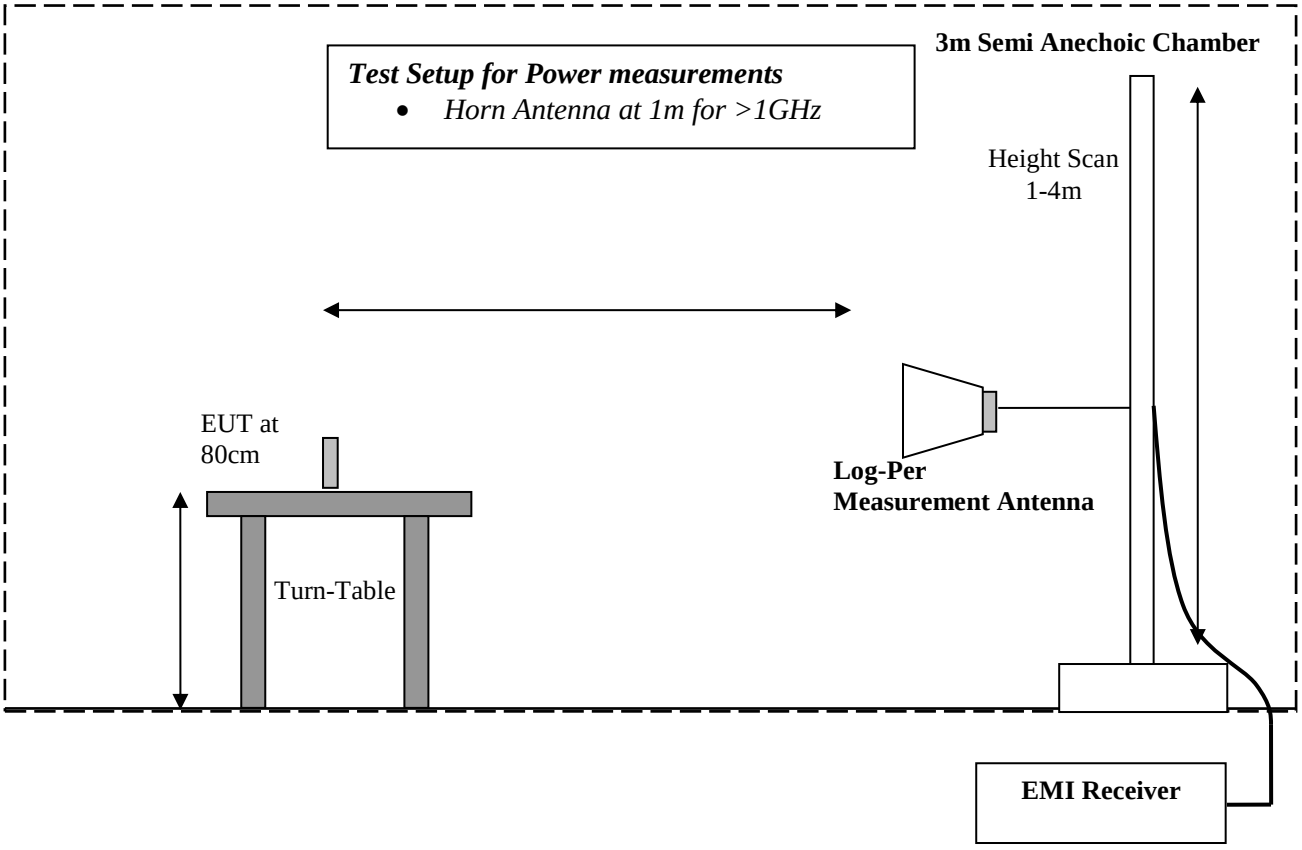
8 Test Equipment and Ancillaries used for tests.

No.	Equipment Name	Manufacturer	Type/model	Serial No.	Cal Date	Cal Interval
3m Semi- Anechoic Chamber:						
	Digital Radio Comm. Tester	Rohde&Schwarz	CMU 200	110759	Jul 2015	3 Years
	EMC32 Measurement Software	Rohde&Schwarz	8.52.0	N/A	N/A	N/A
	Turn table	EMCO	2075	N/A	N/A	N/A
	MAPS Position Controller	ETS Lindgren	2092	0004-1510	N/A	N/A
	Antenna Mast	EMCO	2075	N/A	N/A	N/A
	Relay Switch Unit	Rohde&Schwarz	RSU	338964/001	N/A	N/A
	EMI Receiver/Analyzer	Rohde&Schwarz	ESU 40	100251	Jul 2015	2 Year
	1500MHz HP Filter	Filtek	HP12/1700	14c48	N/A	N/A
	2800 MHz HP Filter	Filtek	HP12/2800	14C47	N/A	N/A
	Pre-Amplifier	Miteq	JS40010260	340125	N/A	N/A
	Binconilog Antenna	EMCO	3149	J000123908	Feb 2014	3 Years
	Horn Antenna	EMCO	3115	35114	Jul 2015	3 Years
	Spectrum Analyzer	Rohde&Schwarz	FSU	100189	Jul 2015	2 Years
	Loop Antenna 6512	ETS Lindgren	6507	161344	Feb 2015	3 Years
Ancillary equipment						
	Humidity Temperature Logger	Dickson	TM320	03280063	Apr 2015	2 Year
	Communication Antenna	IBP5-900/1940	Kathrein	N/A	N/A	N/A

9 Block Diagrams






Test Setup for Power measurements
Horn Antenna at 1m for >1GHz
3m Semi Anechoic Chamber
Height Scan
1-4m
EUT at
80cm
Log-Per
Measurement Antenna
Turn-Table
EMI Receiver

10 Revision History

Date	Report Name	Changes to Report	Report prepared by
2015-07-15	EMC-IRHYT-003-15001-FCC-22-24	Initial Report	James Donnellan
2015-10-09	EMC-IRHYT-003-15001-FCC-22-24-Rev1	Updated after Review.	James Donnellan