Radio Frequency Exposure Evaluation Report

For:

Xirgo Technologies Inc.

Model Number:
XT4970D

Product Description:
Vehicle Solar harvesting GPS/Cellular Tracker with BT/ZGB Tech

FCC ID: GKM-XT4970D
IC ID: 10281A-XT4970D

Per:
CFR Part Part 1 (1.1307 &1.1310), Part 2 (2.1091),
FCC KDB 447498 D01 General RF Exposure Guidance v06

Report number: EMC_XIRGO-111-15001_FCC_MPE_v1.2
DATE: February 19, 2016

***CETECOM* Inc.**
411 Dixon Landing Road ◆ Milpitas, CA 95035 ◆ U.S.A.
Phone: + 1 (408) 586 6200 ◆ Fax: + 1 (408) 586 6299 ◆ E-mail: info@cetecom.com ◆
http://www.cetecom.com
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4 Contents

1 Assessment

This RF Exposure evaluation report provides information about compliance of the below identified device with the RF Exposure limits for mobile devices as defined in FCC CFR Part 1 (1.1307 &1.1310), Part 2 (2.1091) and IC standard RSS-102 issue 5 under given conditions (measured or rated RF output power, antenna gain, distance towards human body, multiple transmitter information as presented by the applicant).
In addition, maximum antenna gain or minimum distance towards the human body is calculated, respectively, where relevant.

The device meets the limits as stipulated by the above given FCC and IC rule parts based on available specifications.

Company	Description	Model #
Xirgo Technologies Inc.	Vehicle Solar harvesting GPS/Cellular Tracker with BT/ZGB Tech	XT4970D

Responsible for the Test Laboratory:

Date	Section	Name	Signature
February 19, 2016	Compliance	Heiko Strehlow (VP RC&EMC)	Digitally signed by Heiko Strehlow Date: 2016.02.21 22:44:50 -08'00'

Responsible for the Report:

Date	Section	Name	Signature
February 19, 2016	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

2 Administrative Data

1.1 Identification of the Testing Laboratory Issuing the Test Report

Company Name:	CETECOM Inc.
Department:	Compliance
Address:	6370 Nancy Ridge Drive San Diego, CA 92121 U.S.A.
Telephone:	+1 (858) 362 2400
Fax:	+1 (858) 687-4809
Compliance Manager:	Franz Engert
Project Engineer:	Tony Planinac

2.1 Identification of the Client / Manufacturer

Clients Name:	Xirgo Technologies Inc.
Clients Address:	188 Camino Ruiz
City/Zip Code	Camarillo, CA 93012
Country	USA
Contact Person:	Johnny Chen
Phone No.	805-338-2204
Fax:	
e-mail:	Jchen@xirgotech.com

3 Equipment under Assessment

Model #:	XT4970D
Product Description:	Vehicle Solar harvesting GPS/Cellular Tracker with BT/ZGB Tech
FCC-ID:	GKM-XT4970D
IC certification number, HVIN, PMN, FVIN:	10281A-XT4970D, XT4970D, CXT4970D, NA
Technology/ Type(s) of Modulation:	UMTS/HSPA; LTE SC-FDMA: (Module ublox TOBY-L201, FCC ID: XPYTOBYL201, IC: 8595A-TOBYL201) Bluetooth 4.0 with BT-LE and BT-BDR/EDR (TI CC2564) ZigBee (TI CC2530 with CC2591 LNA/PA)
Operating Frequency Ranges (MHz)/ Channels:	UMTS FDD II / LTE Band 2 (1800MHz): 1850 MHz – 1910 MHz LTE Band 4 (1700 MHz): 1710 -1755 MHz UMTS FDD V / LTE Band 5 (800MHz): 824 MHz – 849 MHz LTE Band 13 (700 MHz): 777 MHz – 787 MHz LTE Band 17 (700 MHz): 704 MHz – 716 MHz BT and ZigBee: ISM band 2.4GHz – 2.4835GHz
Antenna info:	cellular radio: SMD dielectric antenna peak gain: 3.05dBi @ Band 4 -0.21dBi @ Band 13,17 0.77dBi @ Band 5 2.92dBi @ Band 2 BT and ZigBee: SMD ceramic antenna 1.5dBi @ 2.45GHz
Co-located Transmitters/ Antennas?	☐Yes ■ No
Device Category:	■ Fixed Installation ☐ Mobile ☐Portable ☐ Mixed Mobile and Portable
Exposure Category:	☐ Occupational/ Controlled ■ General Population/ Uncontrolled
Power Supply/ Rated Operating Voltage Range:	Vmin: 8.0V dc/ Vnom: 12.0V dc / Vmax: 24.0V dc
operating temperature range	-40 ºC to 70 ºC
Test Sample Status:	Pre-production

4 RF Exposure Limits - EMC (ERP/EIRP) Limits - FCC and IC Basic Rules

For the specific described radio apparatus the following basic limits and rules apply:

4.1 Power Density Limits acc. to FCC 1.1310(e) / IC RSS-102 i5, cl. 4:

FCC

Frequency Range (MHz)	Power density (mW/cm²)	Averaging time (minutes)
300 – 1500	f (MHz) /1500	30
1500 – 100.000	1.0	30

IC

Frequency Range (MHz)	Power density (W/m²)	Averaging time (minutes)
300 – 6000	$0.02619 \times f(MHz)^{0.6834}$	6

4.2 FCC Categorical Exclusion and IC Routine Environmental Evaluation Exemption Thresholds

FCC § 2.1091(c)
operating frequency < 1.5GHz: excluded if ERP < 1.5W / 31.8dBm (EIRP: 33.9);
operating frequency > 1.5GHz: excluded if ERP < 3.0W / 34.8dBm (EIRP: 36.9);

IC RSS-102, cl. 2.5
300MHz < = operating frequency < 6 GHz: exempted if EIRP < $0.0131 \times f(MHz)^{0.6834}$ W

When a device (mobile or fixed application) qualifies for the FCC categorical exclusion provision of § 2.1091(c) estimation of RF exposure compliance for example per plane wave power density formula (see below) is permitted. Otherwise, further MPE evaluation (measurement or simulation) would be required for TCB approval.

Industry Canada RSS-102 does generally not require further RF exposure evaluation for fixed or mobile applications which stay below the above given exemption limits.

Note that the thresholds for FCC categorical exclusion and IC routine evaluation exemption are no compliance limits but determine the ERP/EIRP limit above which further MPE evaluation (e.g. E or H field measurement) or simulation would be required to show compliance.

4.3 EMC Output Power Limits (ERP/EIRP)

In any case, the EMC ERP/EIRP limits of the relevant FCC / IC rule parts must be respected.

FCC part 22/24 / IC RSS-132, RSS-133 (to be additionally taken into account for maximum antenna gain considerations)

FCC part 22: 7W ERP / 38.5dBm / IC RSS-132: 11.5W EIRP / 40.6dBm
FCC part 24: 2W EIRP / 33.0dBm / IC RSS 133: same as FCC part 24
FCC Part 27.50 (d) (4) (6) / RSS-139 Section 6.5

4.4 RF Exposure Estimation (MPE Estimation)

Having available the source based average output power and peak antenna gain or the ERP/EIRP of the specified device and for a known minimum distance of its radiating structures from the body of persons according to its use cases (at least 20cm) the power density at that distance can be estimated by the following formula for plane-wave equivalent conditions (far-field conditions), when ground reflection is neglected.

$$S = \frac{PG}{4\pi R^2}$$

where: S = power density (mW/cm^2 or W/m^2)
P = power input to the antenna (mW or W)
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna (cm or m)

5 Evaluations

5.1 Routine Environmental Evaluation Applicability - Categorical Exclusion per FCC § 2.1091(c)

EIRP for cellular is based on measured results under 6. in this report as these results were higher than maximum conducted power + tune up tolerance + declared antenna gain would suggest.
EIRP for BT and Zig Bee is based on maximum declared conducted output power + declared gain as this was slightly higher than the verification measurement.

Transmission Mode	Duty Cycle (%)	Maximum EIRP [dBm]	FCC / IC Limits for Routine Environmental Evaluation Applicability, EIRP (dBm)	Exempt from Routine evaluation (Yes/No)
LTE 2	100	27.7	36.9 / 33.5	Yes
UMTS FDD II	100	29.1	36.9 / 33.5	Yes
LTE4	100	29.4	36.9 / 33.3	Yes
LTE 5	100	26.3	33.9 / 31.1	Yes
UMTS FDD V	100	30.7	33.9 / 31.1	Yes
LTE 13	100	28.4	33.9 / 30.9	Yes
LTE 17	100	26.6	33.9 / 30.7	Yes
BT	100	13.5	36.9 / 34.3	Yes
ZigBee	100	13.5	36.9 / 34.3	Yes

(1) max. cellular oputput powers as measured under 6.
(2) the cellular and either BT or ZigBee may transmit simultaneously, but not BT and ZigBee, acc. to documentation;
(3) powers for ZigBee and BT were measured with peak detector so no duty cycle correction required.

Conclusion:

- **For operation of a single transmitter the equipment qualifies for the categorical exclusion provision of FCC § 2.1091(c) and is exempted from further RF exposure routine evaluation acc. to IC RSS-102 section 2.5.2.**

5.2 Compliance with FCC and IC Plane Wave Power Density Limits - single transmitters

Power Density Calculation for a distance between the transmitter and the human body of 20cm				
Band of Operation (MHz)	**max EIRP (dBm)**	**Power Density (mW/cm^2)**	**FCC/IC Limit (mW/cm^2)**	**Verdict**
LTE 2	27.7	0.1171	1.00 / 0.45	Pass
UMTS FDD II	29.1	0.1617	1.00 / 0.45	Pass
LTE4	29.4	0.1733	1.00 / 0.43	Pass
LTE 5	26.3	0.0849	0.55 / 0.26	Pass
UMTS FDD V	30.7	0.2337	0.55 / 0.26	Pass
LTE 13	28.4	0.1376	0.52 / 0.25	Pass
LTE 17	26.6	0.0909	0.47 / 0.23	Pass
BT	13.5	0.0045	1.00 / 0.54	Pass
ZigBee	13.5	0.0045	1.00 / 0.54	Pass

note: comparison with IC limits is provided for information only but not required according to the result of section 5.1

Conclusion:

- **The equipment respects the FCC and IC Plane Wave Power Density Limits for the minimum distance between the antenna and the human body of 20cm, and above.**

5.3 Maximum allowed Antenna Gain – Gmax

- not applicable since fixed internal antenna is used in the product;

5.4 Simultaneous Transmission Evaluation

Simultaneous transmission does not occur between BT and ZigBee, only between one of the unlicensed radios and one of the licensed radios.

Power Density Calculation for a distance between the transmitter and the human body of 20cm						
Band of Operation (MHz)	**Power Density (mW/cm^2)**	**IC Limit worst case (mW/cm^2)**	**Single transmitter MPE ratio**	**simultaneous transmitter MPE ratio**	**FCC/IC Limit ratio**	**Verdict**
LTE 2	0.1171	0.45	0.26	0.27	1.00	Pass
UMTS FDD II	0.1617	0.45	0.36	0.37	1.00	Pass
LTE4	0.1733	0.43	0.40	0.41	1.00	Pass
LTE 5	0.0849	0.26	0.33	0.34	1.00	Pass
UMTS FDD V	0.2337	0.26	0.90	**0.91**	1.00	Pass
LTE 13	0.1376	0.25	0.55	0.56	1.00	Pass
LTE 17	0.0909	0.23	0.40	0.41	1.00	Pass
BT	0.0045	0.54	0.01	0.25	1.00	Pass
ZigBee	0.0045	0.54	0.01	0.25	1.00	Pass

Conclusion:

- **The equipment qualifies for the exclusion from further simultaneous transmission MPE evaluation (measurement or simulation as appropriate and agreed on with FCC/IC)**

6 Effective Isotropic Radiated Power measurements for the licensed radios

FCC 2.1046: RF power output
Power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on circuit elements as specified. The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.
RSS-Gen 6.12: RF power output.
Transmitter output power measurements shall be carried out before the unwanted emissions test. The transmitter output power value, obtained from this test, serves as the reference level used to determine the unwanted emissions.

6.1 References

FCC: CFR Part 2.1046, CFR Part 22.913, CFR Part 24.232, CFR Part 27.50
IC: RSS-Gen Section 6.12; RSS-132 Section 5.4; RSS-133 Section 6.4, RSS-139 Section 6.5

6.2 Limits:

ERP/EIRP (850 MHz Band)
FCC Part 22.913 (a) & RSS-132 Section 5.4

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

IC: Average EIRP < 40.60 dBm (11.5W)
The transmitter output power shall be measured in terms of average power. The equivalent isotropically radiated power (e.i.r.p.) for mobile equipment shall not exceed 11.5 watts.

EIRP (1900 MHz Band)
FCC Part 24.232 (c) (e) & RSS-133 Section 6.4

FCC: Peak 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.

IC: Average EIRP < 33 dBm (2W)
The transmitter output power shall be measured in terms of average power. The equivalent isotropically radiated power (e.i.r.p.) for mobile equipment shall not exceed 2 watts.

EIRP (1700 MHz Band)
FCC Part 27.50 (d) (4) (6) & RSS-139 Section 6.5

FCC: Peak EIRP < 30 dBm (1W)
Fixed, mobile and portable (handheld stations) operating in the 1710-1755 MHz band are limited to 1 watt EIRP

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 instrument 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 for the emission in question over the full bandwidth of the channel

IC: Average EIRP < 30 dBm (1W)

The average equivalent isotropically radiated power (e.i.r.p.) for fixed, mobile and portable transmitters in the 1710-1755 MHz shall not exceed 1 watt.

6.3 Measurement Procedure:

The EIRP measurements were performed in a fully anechoic chamber at a measurement distance to the EUT of 1.65m. The chamber is calibrated by substitution method according to TIA-603C 2004.

For LTE 1 uplink resource block has been used with a nominal bandwidth of 10MHz as this depicts the highest power for LTE.

For UMTS powers have been tested in Rel. 99 mode as this depicts the highest powers for UMTS.

An RMS detector was used for the measurements in all cases.

6.4 Test Conditions:

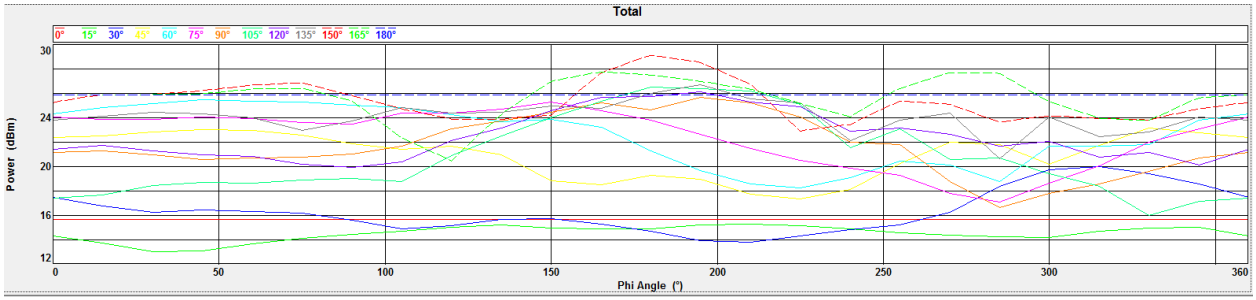
Tnom: 22°C; Vnom: 3.9 V

6.5 Test Results

UMTS II WCDMA Dual channel QPSK

Channel	Frequency (MHz)	TRP (dBm) Free Space	EIRP (dBm) Free Space
9262	1852.4	22.8	29.1
9400	1880.0	22.4	28.7
9538	1907.6	22.8	28.8

Ch 9262



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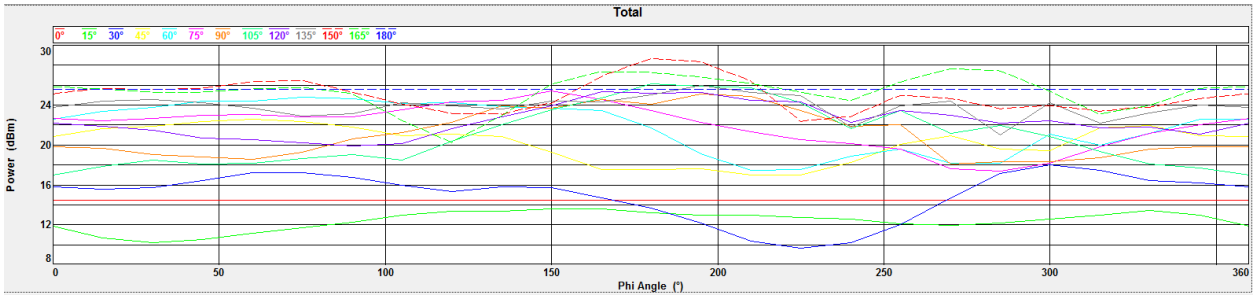

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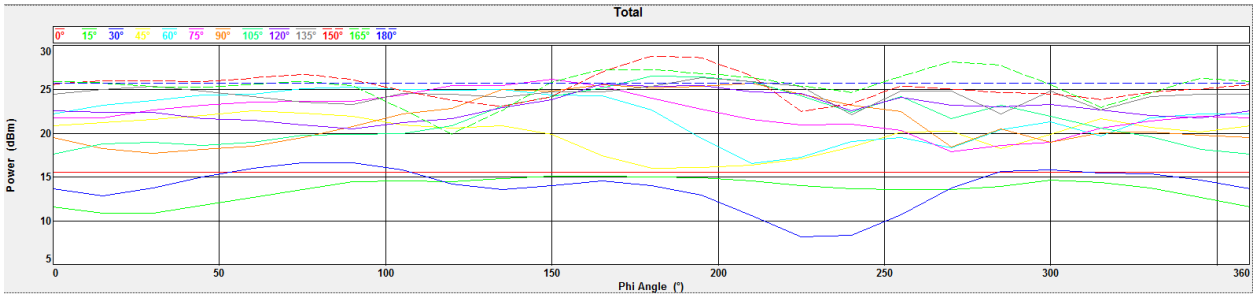
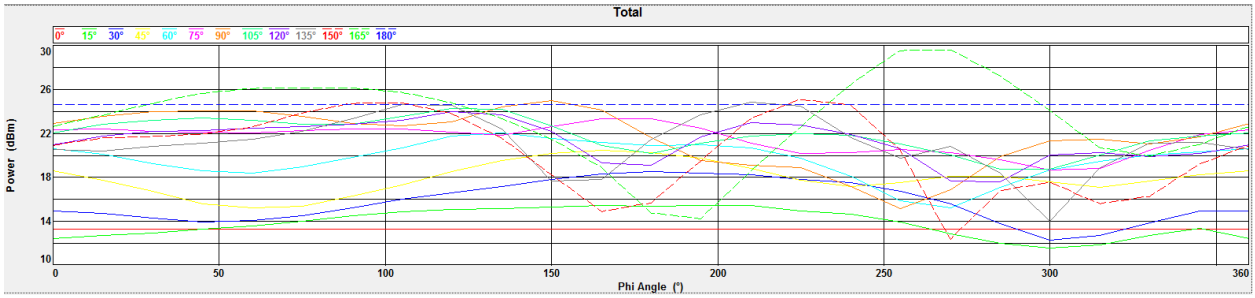


UMTS V WCDMA Dual channel QPSK

Channel	Frequency (MHz)	TRP (dBm) Free Space	EIRP (dBm) Free Space
4132	826.4	21.2	29.5
4183	836.6	22.1	30.7
4233	846.6	20.9	29.7

Ch 4132



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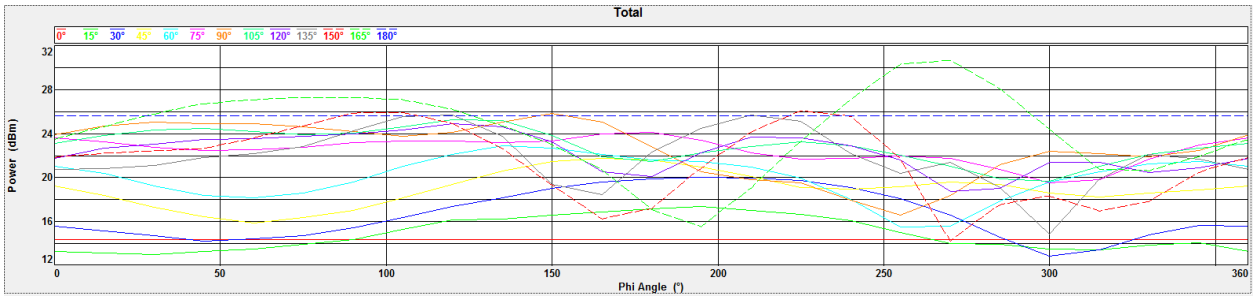

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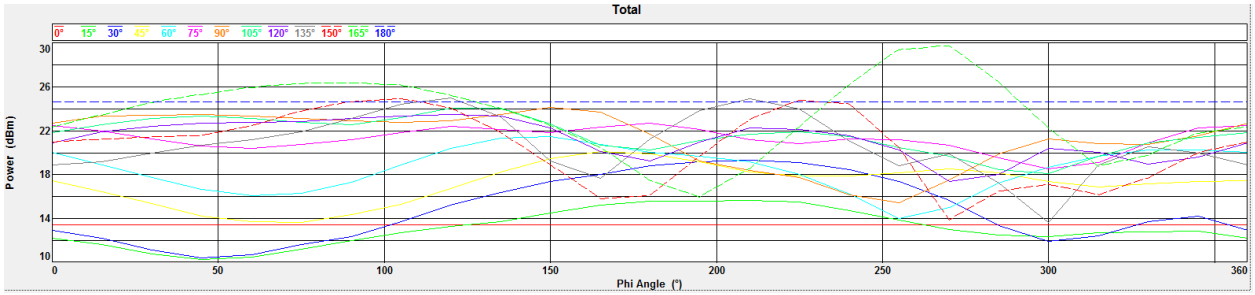
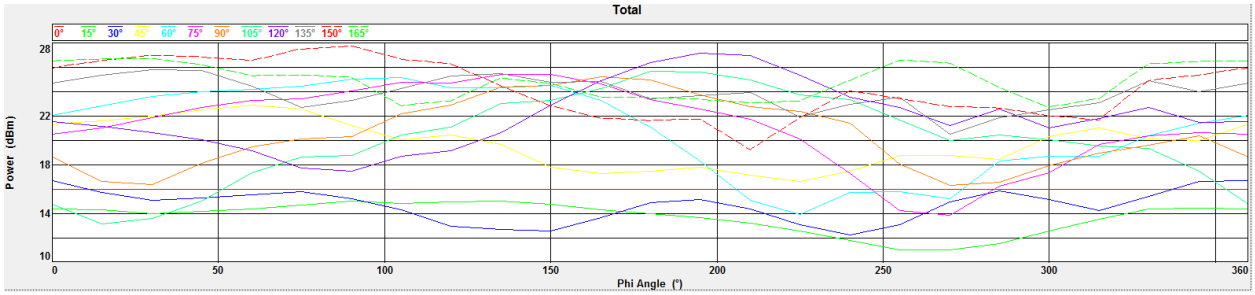


LTE 2 SC-FDMA with QPSK

Channel	Frequency (MHz)	TRP (dBm) Free Space	EIRP (dBm) Free Space
18650	1851.6	22.00	27.7
18900	1880.0	21.14	27.0
19150	1908.4	21.94	27.6

Ch 18650



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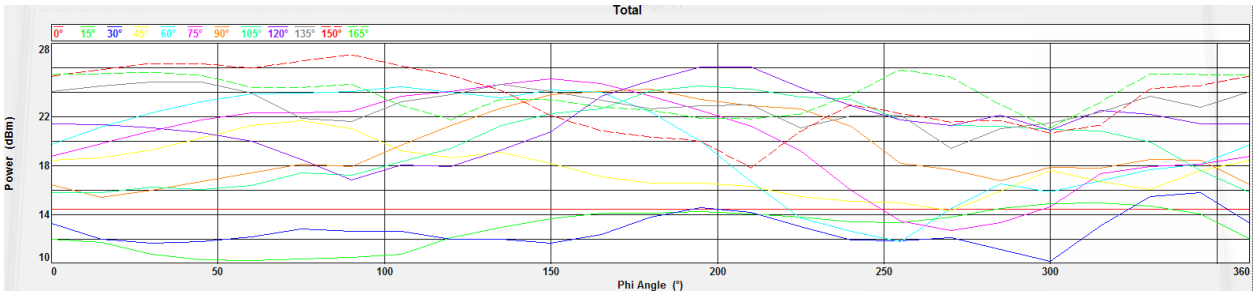

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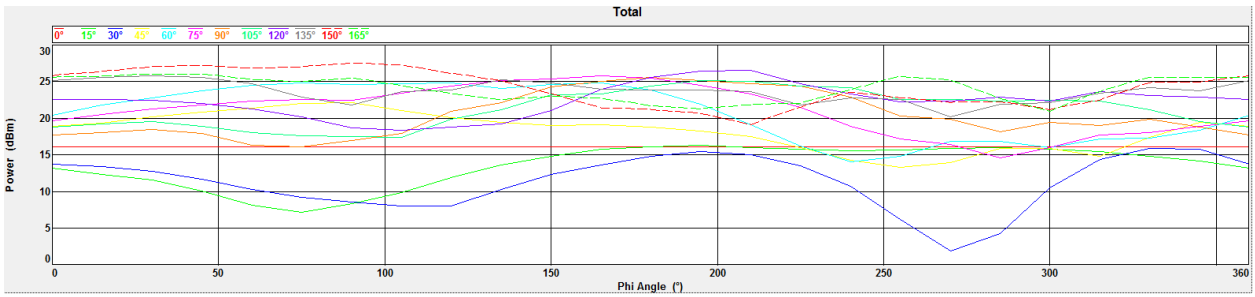
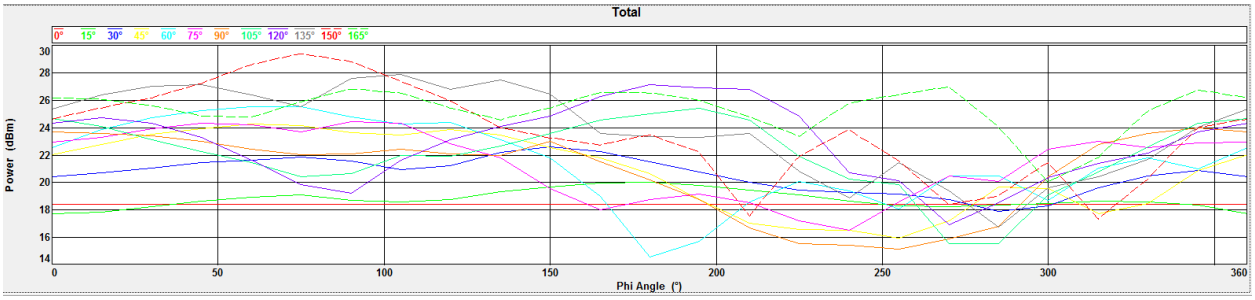


LTE 4 SC-FDMA with QPSK

Channel	Frequency (MHz)	TRP (dBm) Free Space	EIRP (dBm) Free Space
20000	1715.0	22.65	29.4
20175	1732.5	22.31	29.0
20350	1750.0	22.87	29.1

Ch 20000



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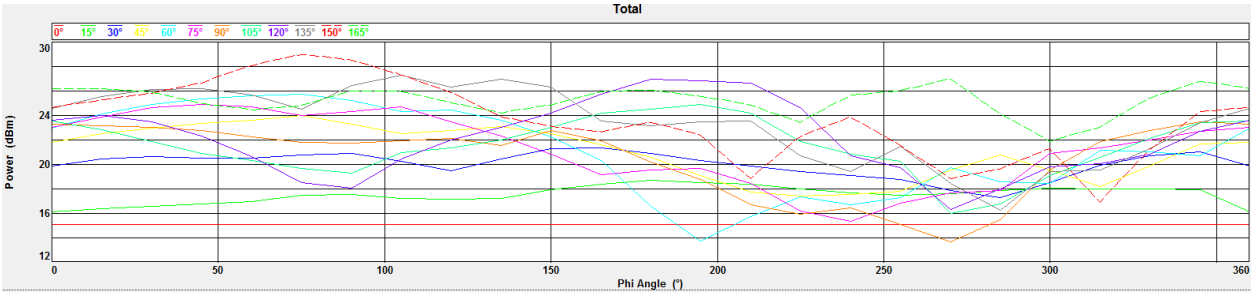

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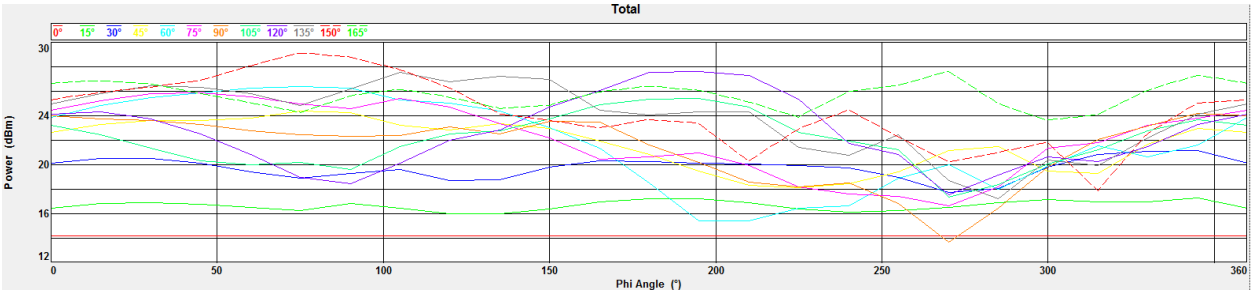
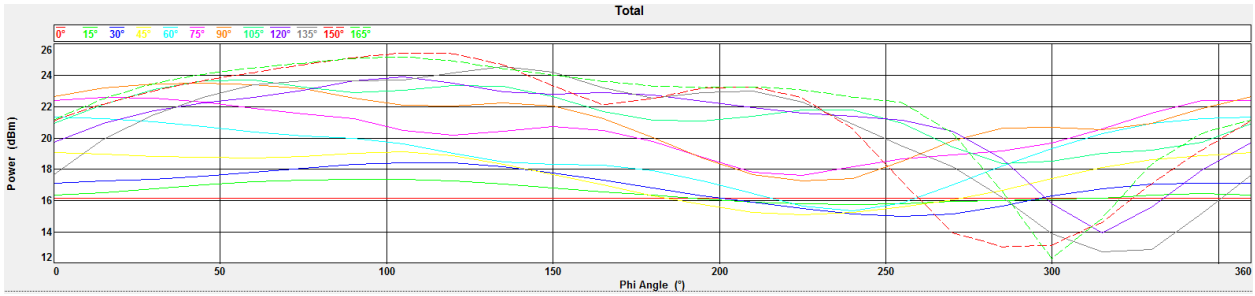


LTE 5 SC-FDMA with QPSK

Channel	Frequency (MHz)	TRP (dBm) Free Space	EIRP (dBm) Free Space
20450	825.58	20.68	25.4
20525	836.50	21.31	26.3
20600	847.42	20.15	25.3

Ch 20450



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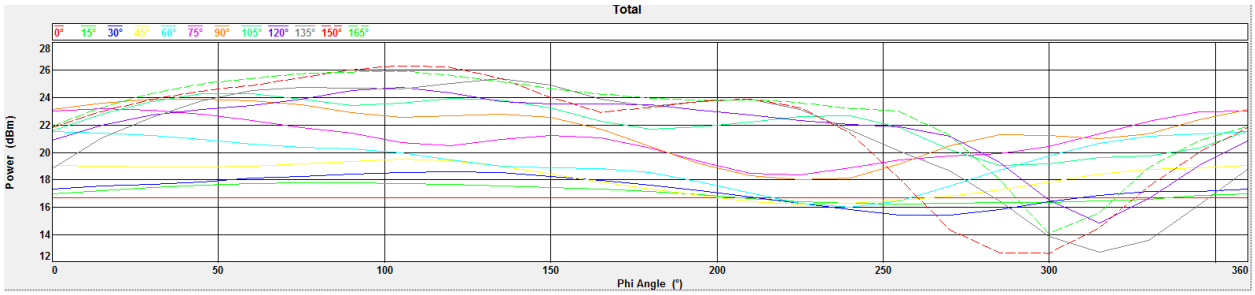

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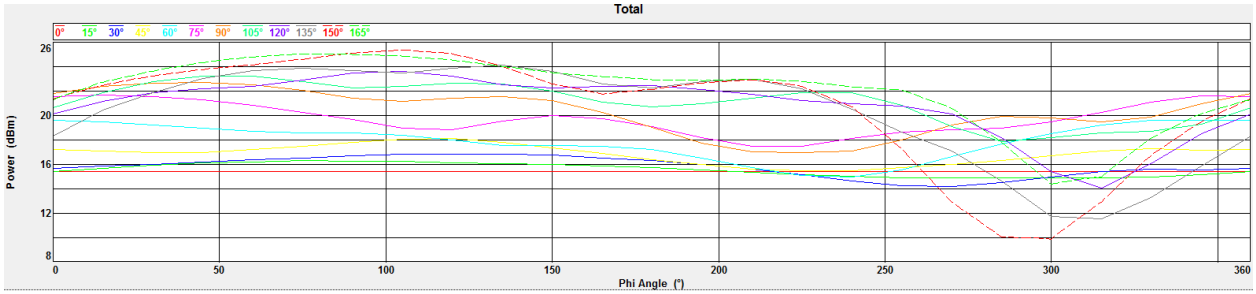
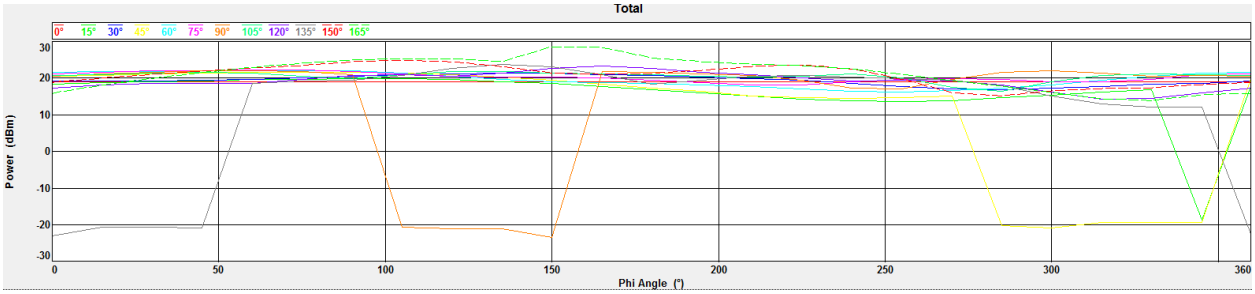


LTE 13 SC-FDMA with QPSK

Channel	Frequency (MHz)	TRP (dBm) Free Space	EIRP (dBm) Free Space
23230	778.58	20.01	28.4
23230	782.00	20.48	25.1
23230	785.42	19.87	25.6

Ch 20450



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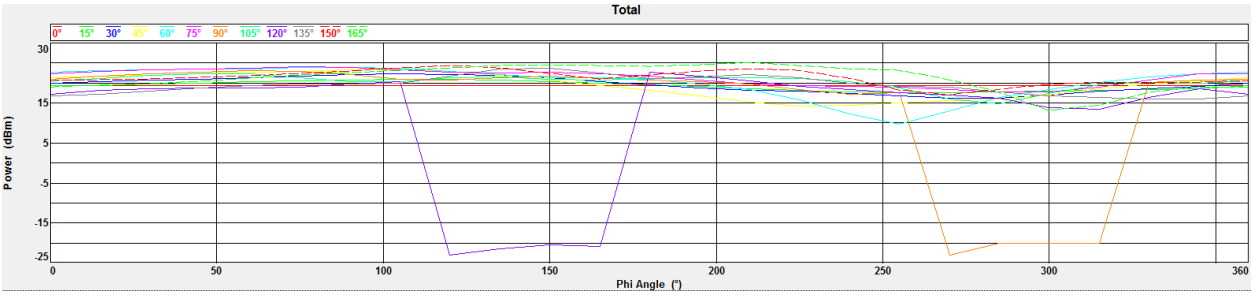

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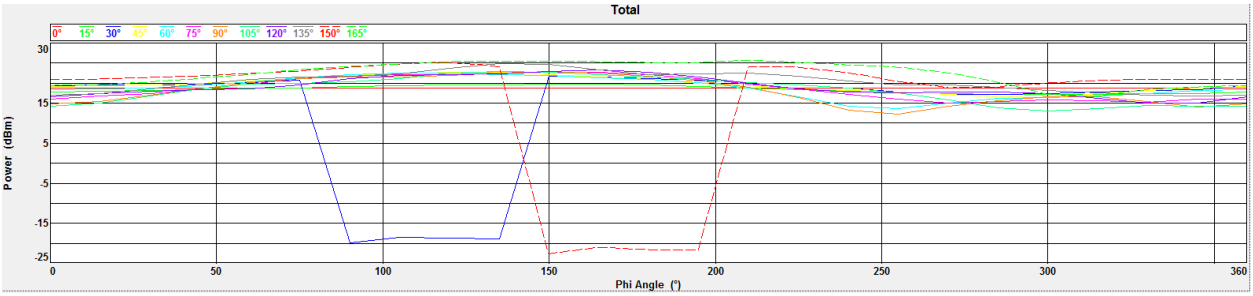
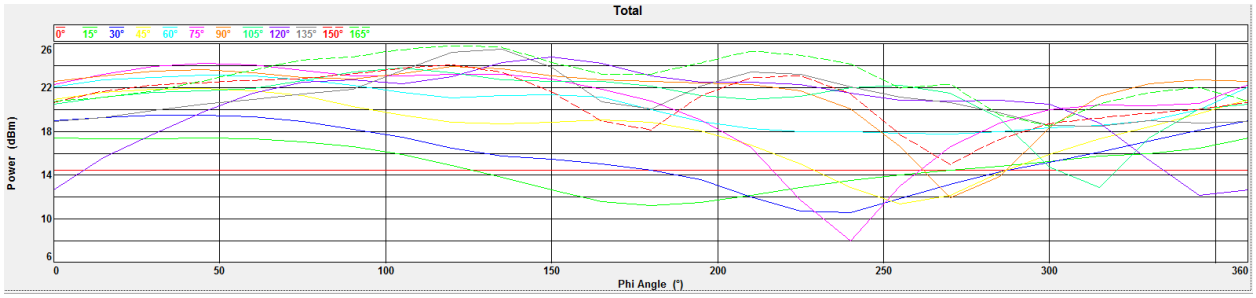


LTE 17 SC-FDMA with QPSK

Channel	Frequency (MHz)	TRP (dBm) Free Space	EIRP (dBm) Free Space
23780	705.58	20.95	25.8
23790	710.00	21.69	26.6
23800	714.42	20.90	25.7

Ch 23780



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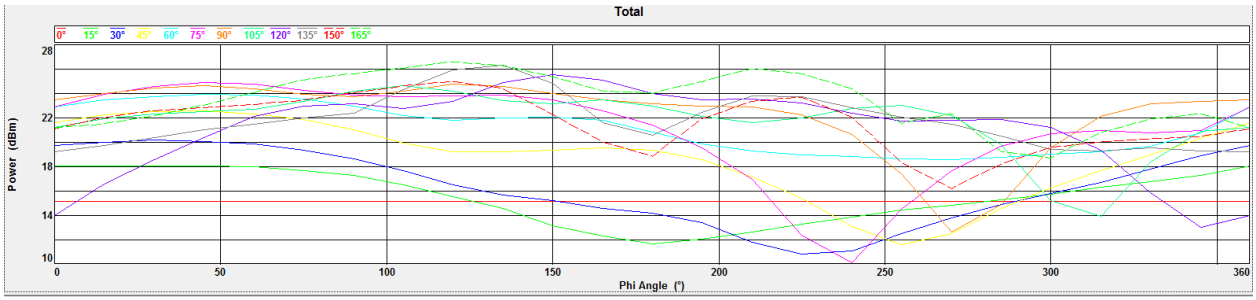

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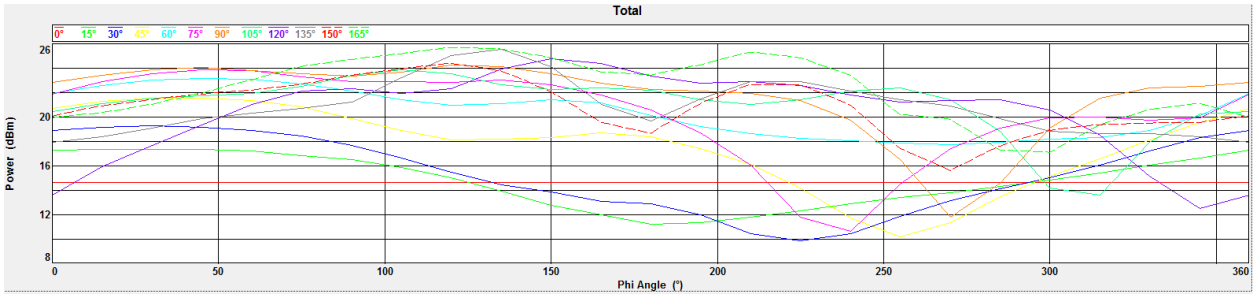

6.6 Anechoic Chamber OTA2 used for EIRP measurements

TYPE OF EQUIPMENT	MODEL NUMBER	MANUFACTURER	SN	CALIBRATION DUE DATE
Rectangular Anechoic Chamber	DR S 201 4x7 RH	ETS-Lindgren	N/A	Aug 2016
Quad-Ridge Horn Antenna 400MHz-6GHz	EMCO3164	ETS-Lindgren	00069447	N/R
Circularly Polarized Communication Antenna	EMCO3102	ETS-Lindgren	00078664	N/A
Circularly Polarized Communication Antenna	EMCO3102	ETS-Lindgren	00069033	N/A
Antenna Position Controller	EMCO2090	ETS-Lindgren	00078764	N/A
Dual Axis Positioner	None	The Howland Company	N/A	N/A
Low loss RF Cables	N/A	Huber & Suhner	N/A	N/R
Desktop Test Computer	Optiplex745	Dell Computer	N/A	N/A
Pattern Measurement Software	EMQuest	ETS-Lindgren	1013	N/A
Base Station Emulator	CMU-200	Rohde & Schwarz	110230	July 2017
Power Meter	NRVD	Rohde & Schwarz	849708 / 005	July 2017
Power Meter	NRVD	Rohde & Schwarz	849708 / 005	July 2017
Spectrum Analyzer	FSP	Rohde & Schwarz	100837	July 2017

7 Revision History

Date	Report Name	Changes to report	Report prepared by
February 09, 2016	EMC_XIRGO-111-15001_FCC_MPE	First Version	Franz Engert
February 17, 2016	EMC_XIRGO-111-15001_FCC_MPE_v1.1	Use measured EIRPs because they are much higher than conducted power + gain. Clarify wording on categorical exclusion.	Franz Engert
February 19, 2016	EMC_XIRGO-111-15001_FCC_MPE_v1.2	Added EIRP measurement results	Franz Engert