FCC TEST REPORT

INTENTIONAL RADIATOR

CFR 47 FCC, PART 15 SUBPART C 15.247

Company Name: Arcam Ltd

Product: ARCAM, irDAC-II

Test Report Number	ETS/V2253/Radio FCC
Issue Date:	09-08-2016
Applicable Standards	CFR 47 FCC, Part 15 Subpart C, 15.247

Revision Record

Revision	Date	Details
1.0	09-08- 2016	Issue Version 1

Note:

This Test Report consists of 67 pages. This report records the test results of the equipment submitted and does not imply conformance of the equipment manufactured. This report is issued in Adobe Acrobat document format (PDF). The report shall not be reproduced except in full, without the written approval of Electromagnetic Testing Services Limited.

REPORT ON EMC MEASUREMENT CARRIED OUT ON A ARCAM, irDAC-II

Produced on behalf of

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Cambridge
CB25 9PB

By

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This laboratory is:

- UKAS Accredited Testing Laboratory Number 4416
  Scope of Accreditation may be found at:
  http://www.ukas.org/testing/lab_detail.asp?lab_id=2806&location_id=&vMenuOption=3
- F.C.C. (Federal Communications Commission) listed as per the requirements of section 2.948 of the Code Of Federal Regulations CFR 47 for Parts 15 & 18 under Registration Number 90580
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- Approved by the Vehicle Certification Agency for testing Automotive Products
- International associate of Radio Technical Commission for Aeronautics (RTCA)
- Approved by VCCI for Japan - Membership Number 3322

Distribution:
01 Arcam Ltd
02 Electromagnetic Testing Services Limited

Tested By:	George Vassila / Conan Smith / Anthony Rogers
Approved and Authorised By:	George Vassila Technical Director
Prepared by:	Leigh Robinson

Radio Frequency measurements were carried out on a Arcam Ltd, Arcam, irDAC-II, to assess adherence to the requirements of the following standard:

CFR 47 FCC Part 15 Subpart C, 15.247
Radio Equipment and Services - 902-928 MHz, 2400-2483.5 MHz, 5725-5850 MHz

The results obtained indicate compliance with the test requirements of the above standards as follows:

FCC Rules	Emissions Tests	Status
15.247 (a) (1)	20 dB Emissions BW	Complied
15.247 (a) (1) (iii)	Minimum Hopping Channels	Complied
15.247 (b)	PK O/P Power	Complied
15.247 (a) (1) (iii)	Dwell Time	Complied
15.247 (d)	Spurious Emissions (Conduction)	Complied
15.247 (d)	Band Edge Measurements	Complied
15.209, 15.205, 15.247(d)	Spurious Radiated Emissions	Complied
15.207	Conducted Emissions	Complied

The Arcam Ltd, Arcam irDAC-II, is an Audio DAC with optical, coaxial, USB and Bluetooth inputs, , which is used for domestic audio reproduction.

The model tested was a irDAC-II.

The test results contained in this report refer to a single product supplied for testing. Tests were carried out for the purpose of demonstrating compliance.

The EUT was received on 16 December 2015. All tests were carried out between 16 December and 25 January 2016 at the Electromagnetic Testing Services Limited EMC Facilities, Stebbing, Essex, England. The work was carried out under ETS Test Number 12A15U394.

Additional testing carried out between 29 June and 08 July 2016, under Test Number 06A16V196.

The EUT was tested under normal laboratory conditions.

Client Information:

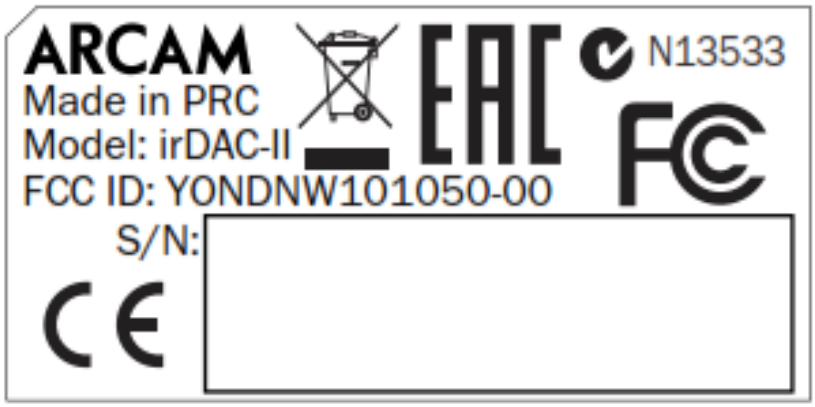
Contact: Peter Kuell

Company: Arcam Ltd

Tel.: 01223 203207

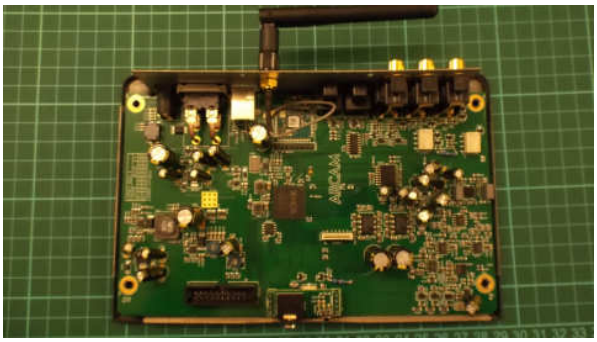
Email: peterk@arcam.co.uk

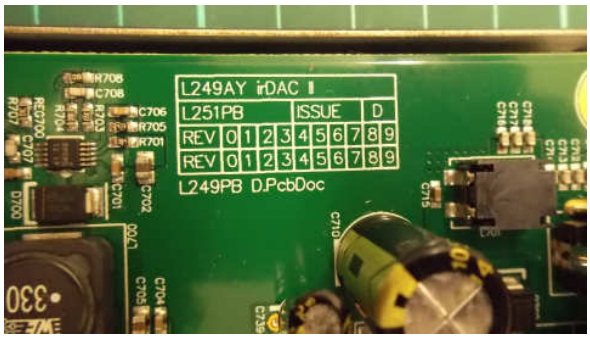
Some tests were carried out in the presence Peter Kuell, of Arcam Ltd.

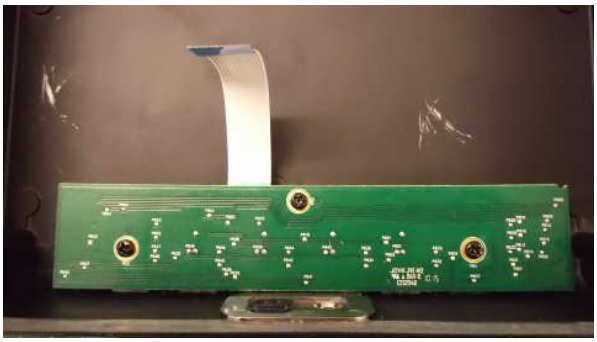


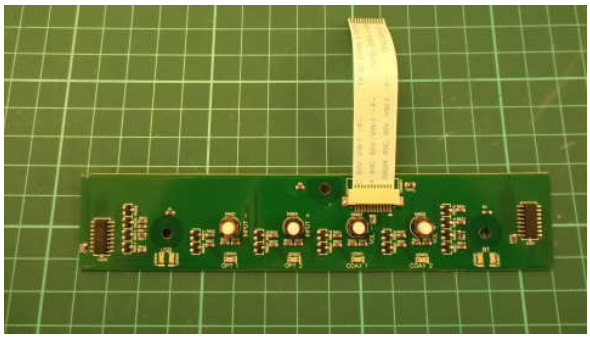
Labeling Requirements

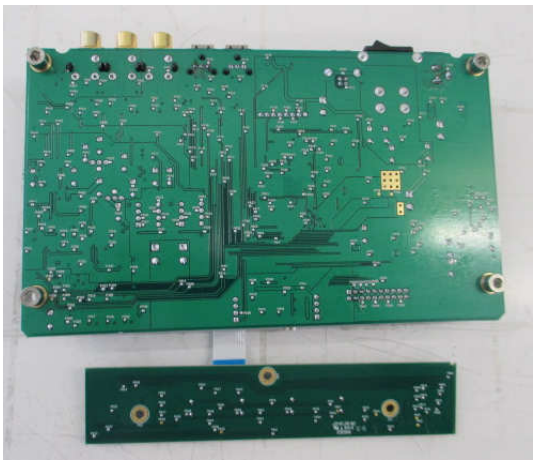
The device shall bear the following statement in a conspicuous location on the device :
This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.




L249AY irDAC II
L251PB ISSUE D
REV 0 1 2 3 4 5 6 7 8 9
REV 0 1 2 3 4 5 6 7 8 9
L249PB D.PcbDoc



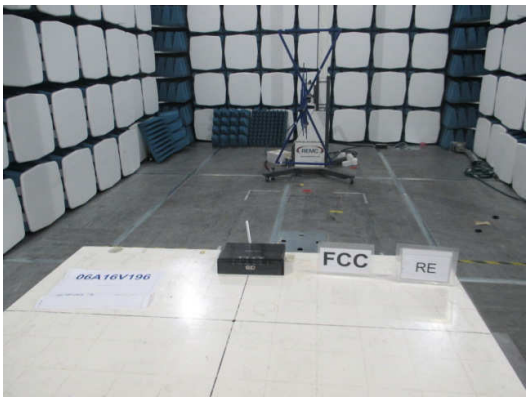


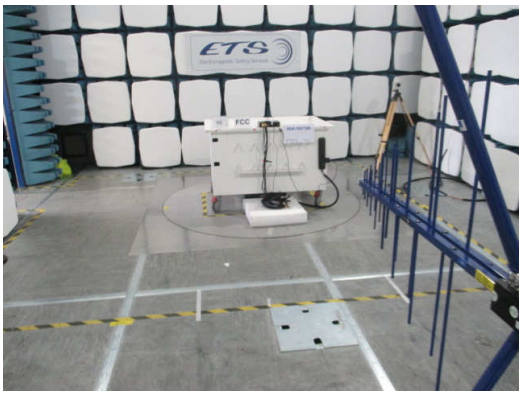



ARCAM

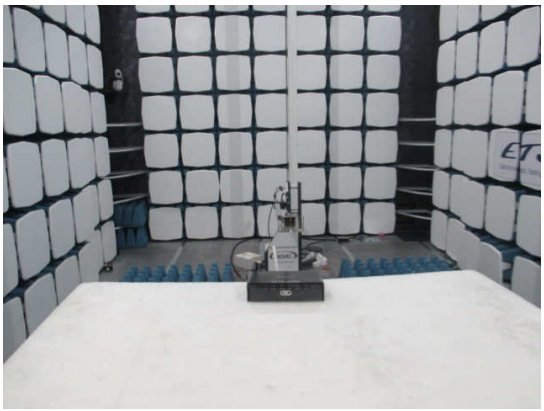
Conducted Emissions

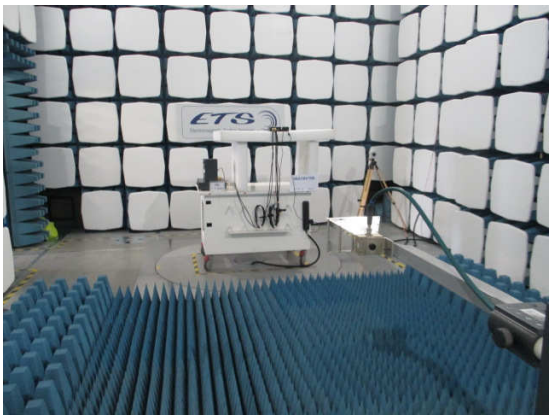
Radiated Emissions - Low Band

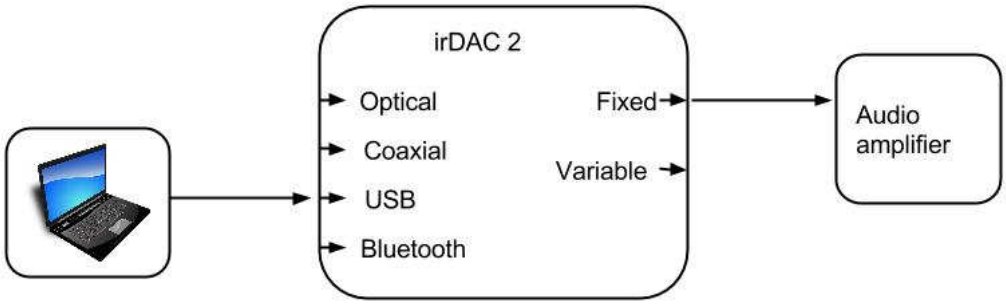




Radiated Emissions - High Band

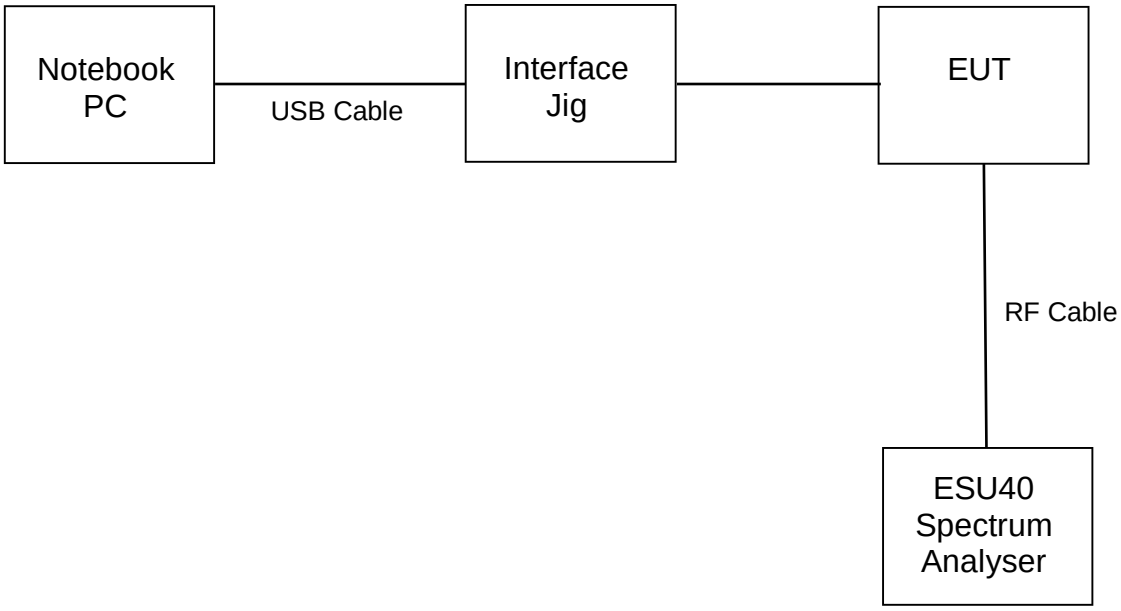






LIST OF CABLES

Ref.	Cable	Type	Length
1	PC to irDAC-II	USB type A-B	2m
2	irDAC-II to amplifier	Phono RCA	3m
3			
4			



8.1 Identification of Equipment

Nomenclature / Product Type	:	Audio DAC
Brand Name	:	Arcam
Model Number	:	irDAC-II
Serial Number	:	EDICB00902
Power Requirements	:	115 V 60 Hz
Manufacturer Name	:	Arcam Ltd
Manufacturer Address	:	Stirling House Waterbeach Cambridge CB25 9PB
Signatory's Name	:	
Signatory's Address	:	Stirling House Waterbeach Cambridge CB25 9PB

8.2	**Description of Apparatus:**	Audio DAC with optical, coaxial, USB and Bluetooth inputs.
8.3	**Intended Use of Apparatus:**	Domestic audio reproduction
8.4	**Physical Location of Installation:**	Domestic home environment
8.5	**Description of Variants:** **Important Note** The list of variants is identical to the unit submitted for testing and relate to features that could not have any bearing on the EMC status of the product as declared by the client. This list is under the authority and sole responsibility of the client.	N/A

Antenna Requirement

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to §15.247 (b), if Receiving antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Antenna Construction and Directional Gain

The antennas is a Dipole antenna. The peak gain of antenna used is 2.0 dBi.

8.6 Declared EUT Configuration:

Item	Description of board/sub assemblies	Part Number	Revision No.
01	Main Board : L249AY irDAC Issue D	L251PB	
02	Control board: JOVE JVE-M2	E232940	
03	Shenzhen Click Power Pack	CPS024120200U	
04	Antenna	-	

8.7 Declared Suppression Measures:

Item	Description of board/sub assemblies	Reason	Date & Time
0	EUT as supplied with no additional modifications		
01	Change of power Supply : Shenzhen Click Power Pack - CPS024120200U	CE	12/16/2015

I certify that sections 8.6 and 8.7 are correct and describes the equipment tested and will be manufactured as stated.

Signature Peter Kuell_____ Title Senior Design Engineer

Radio Equipment and Services - 902-928 MHz, 2400-2483.5 MHz, 5725-5850 MHz

Test Plan and check list Reference FCC Part 15.247 (template issue 001)

Test number:	**ETS/TP/U1844A**	Customer:	**Arcam**
Date:	**11/08/2015**	EUT:	**irDAC-II**

N.B.
Operation of unlicensed systems under section 15.247 of the FCC's rules is limited to frequency hopping and digitally modulated systems operating within the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands.

Port tested	Standard & Emission phenomenon	Test value	Test required
Hopping Channel Carrier Frequency Separation			
Antenna Port	FCC Part 15.247(a)(1)	Minimum carrier frequency separation of 25 kHz or the 20 dB BW of hopping channel.	X
Minimum Hopping Channels			
Antenna Port	FCC Part 15.247(a)(1)(iii)	Minimum 15 hopping frequencies	X
Occupied Bandwidth			
Antenna Port	FCC Part 15.247(a)(1)	Minimum carrier frequency separation of 25 kHz or the 20 dB BW of hopping channel. Separation of 25 kHz or two-thirds of 20 dB BW. For output power <125 mW	X
Dwell Time			
Antenna Port	FCC Part 15.247(a)(1)(iii)	Channel Occupancy < 0.4s with period 0.4s x no of hopping channels	X
Peak Output Power (conducted)			
Antenna Port	FCC Part 15.247(a)(1) FCC Part 15.247(b)(1) FCC Part 15.247(b)(3) FCC Part 15.247(b)(4)	Minimum carrier frequency separation of 25 kHz or the 20 dB BW of hopping channel. Separation of 25 kHz or two-thirds of 20 dB BW. For output power <125 mW	X

Port tested	Standard & Emission phenomenon	Test value	Test required
Spurious Emissions (Conducted)			
Antenna Port	FCC Part 15.247(d)	30 MHz to 25 GHz	X
Spurious Emissions (Radiated)			
Enclosure and Cables	FCC Parts 15.209, 15.205, 15.247(d)	30 MHz to 25 GHz	X
Antenna Requirements			
Antenna	FCC Part 15.203		X
Band Edge Measurements			
Antenna Port	FCC Part 15.247(d)	> 20 dBc	X

Tests not carried out

Reference	Reason

Comments

Operating Mode

During testing the EUT was powered up and operated with the aid of software to force the transmission channels and power levels in accordance with the manufacture's instructions and in a manner that represented worst case use.

9.1 20 dB Bandwidth and Channel Separation Requirements 15.247(a)(1) (Frequency Separation)

According to § 15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

TEST PROCEDURE

Place the EUT on the table and set it in transmitting mode.
Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Set center frequency of spectrum analyzer = middle of hopping channel.
Set the spectrum analyzer as RBW = 30kHz, VBW = 100kHz, Span = 3MHz, Sweep = auto. 5. Max hold, mark 3 peaks of hopping channel and record the 3 peaks frequency.
Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
The setup of the EUT as shown in figure below.
Turn on the EUT and connect it to measurement instrument. Then set it to any convenient frequency within its operating range.
Set a reference level on the measuring instrument equal to the highest peak value.
Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
Repeat above procedures until all frequencies measured were complete.

9.1 20 dB Bandwidth and Channel Separation Requirements 15.247(a)(1)

The powerline conducted emissions automatic scans are tabulated below.

Company	**Arcam**
Product	**irDAC-II**
Applicable Standard	**15.247(a)(1)**
Test Procedure	**ETS tpRDFcc**

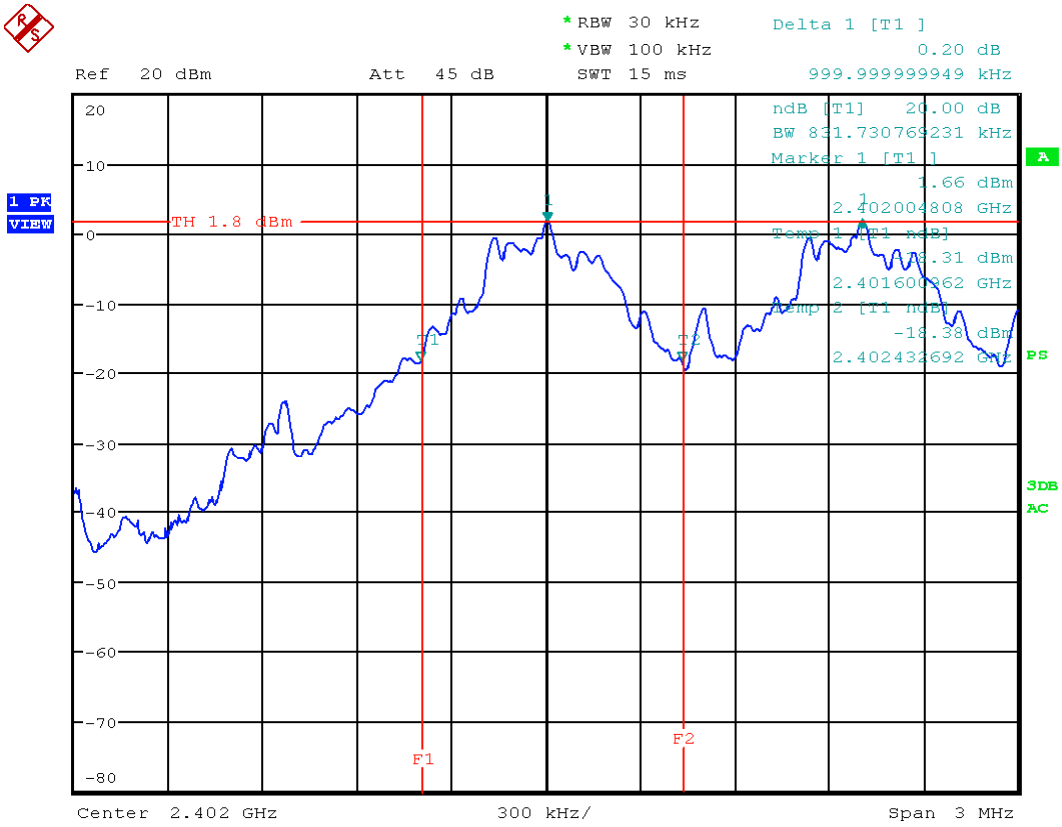
20 dB Bandwidth and Channel Separation

Plot No.	Test File	Channel	Frequency	CH Separation	20 dB Bandwidth		Result
			(MHz)	(MHz)	(kHz)	Limit	
Plot 1a	U394BW-0	0	2402	1.0	831.73	> 25 kHz	Pass
Plot 1b	U394BW39	39	2441	1.0	820.12		Pass
Plot 1c	U394BW78	78	2480	1.0	932.69		Pass

The EUT achieved compliance.

	Temp: º C	% RH	Pa mbar		Tested by:		
	22	46	971		GV		

Plot 1a - U394BW-0



Company	**Arcam**
Product	**irDAC-II**
Applicable Standard	**15.247(a)(1)**
Test Procedure	**ETS tpRDFcc**

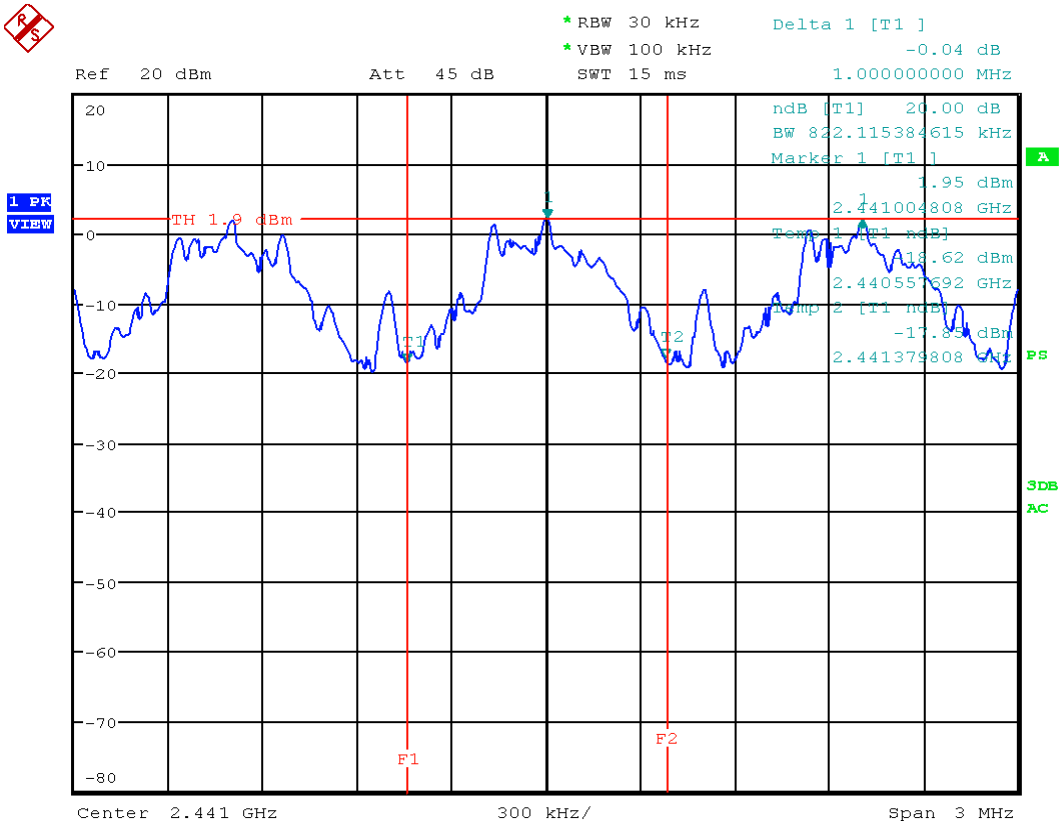
20 dB Bandwidth and Channel Separation - Channel 0

Test File	No	Frequency (MHz)	Level (dBm)
U394BW-0	1	2402.00	1.66
	T1	2401.60	-18.31
	T2	2402.43	-18.38

Delta Frequency (kHz)	Delta Level (dB)	Channel Separation (MHz)
831.73	0.07	1.0

Temp: ° C	% RH	Pa mbar	Tested by:
22	46	971	GV

Plot 1b - U394BW39



Company	**Arcam**
Product	**irDAC-II**
Applicable Standard	**15.247(a)(1)**
Test Procedure	**ETS tpRDFcc**

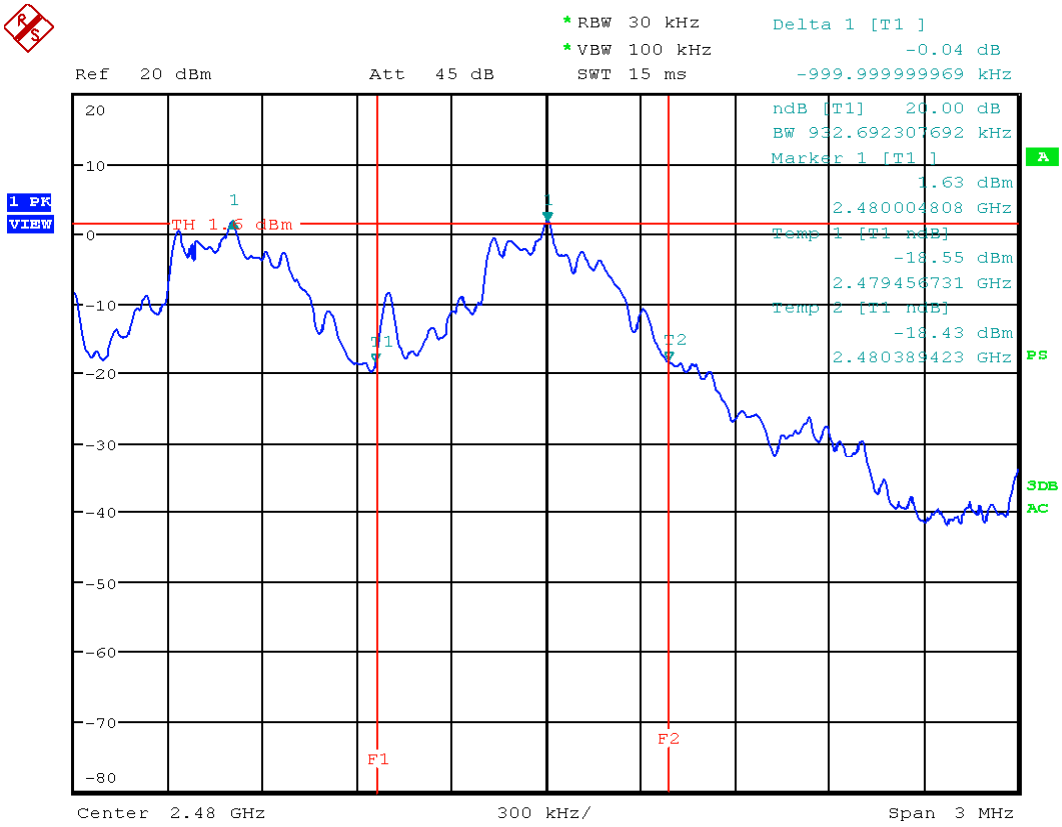
20 dB Bandwidth and Channel Separation - Channel 39

Test File	No	Frequency (MHz)	Level (dBm)
U394BW39	1	2441.00	1.95
	T1	2440.55	-18.62
	T2	2441.38	-17.85

Delta Frequency (kHz)	Delta Level (dB)	Channel Separation (MHz)
822.12	0.77	1.0

Temp: ° C	% RH	Pa mbar	Tested by:
22	46	971	GV

Plot 1c - U394BW78



Company	**Arcam**
Product	**irDAC-II**
Applicable Standard	**15.247(a)(1)**
Test Procedure	**ETS tpRDFcc**

20 dB Bandwidth and Channel Separation - Channel 78

Test File	No	Frequency (MHz)	Level (dBm)
U394BW78	1	2480.00	1.63
	T1	2479.46	-18.55
	T2	2480.39	-18.43

Delta Frequency (kHz)	Delta Level (dB)	Channel Separation (MHz)
932.69	0.12	1.0

Temp: ° C	% RH	Pa mbar	Tested by:
22	46	971	GV

9.2 Minimum Hopping Channels - 15.247(a)(1)(iii)

According to 15.247(a)(1)(iii), for frequency hopping systems, operating in the 2400-2483.5MHz band employing at least 75 hopping channels.

TEST PROCEDURE

I. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.

2. The setup of the EUT as shown in Section 6.0. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set EUT to hopping operating mode and set spectrum analyzer minimum to measure the number of hopping channels.

9.2 Minimum Hopping Channels - 15.247(a)(1)(iii)

The powerline conducted emissions automatic scans are tabulated below.

Company	**Arcam**
Product	**irDAC-II**
Applicable Standard	**15.247(a)(1)(iii)**
Test Procedure	**ETS tpRDFcc**

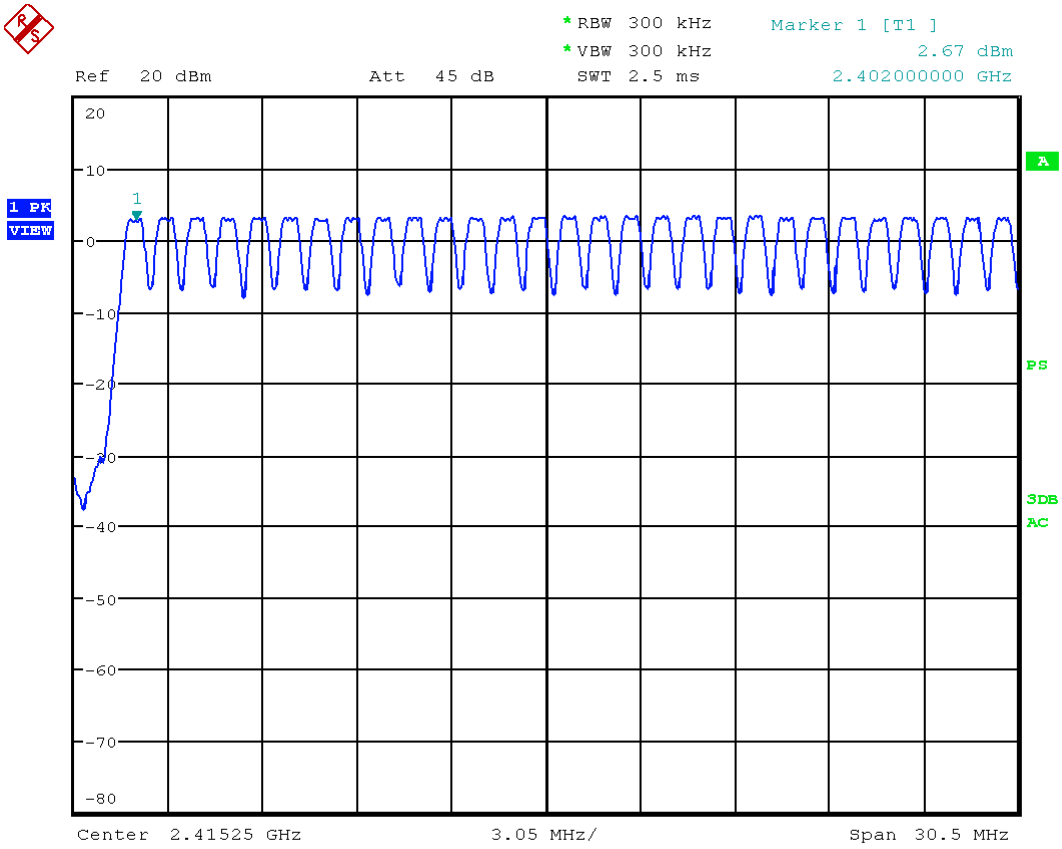
Minimum Hopping Channels

Plot No.	Test File	No Of Channels	Total No Of Channels	Limit	Result
Plot 2a	U394HC-1	29	79	>75	Pass
Plot 2b	U394HC-2	30			
Plot 2c	U394HC-3	20			

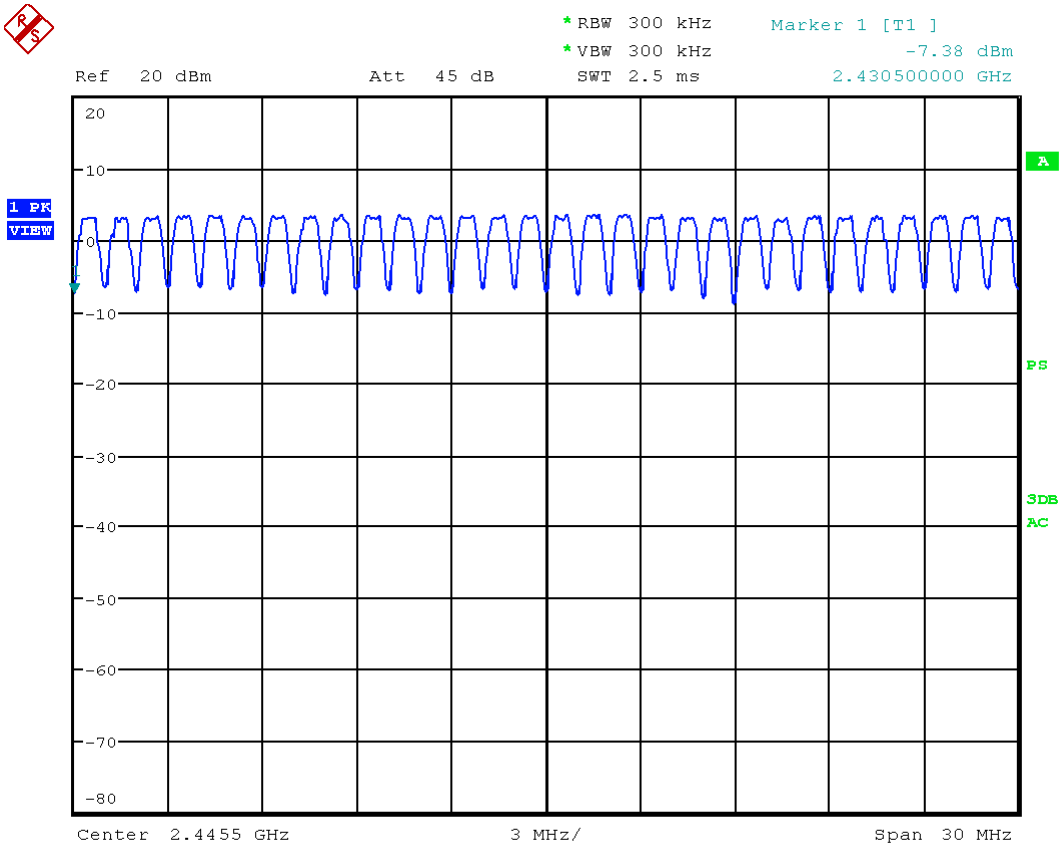
The EUT achieved compliance.

	Temp: º C	% RH	Pa mbar	Tested by:			
	22	46	971	GV			

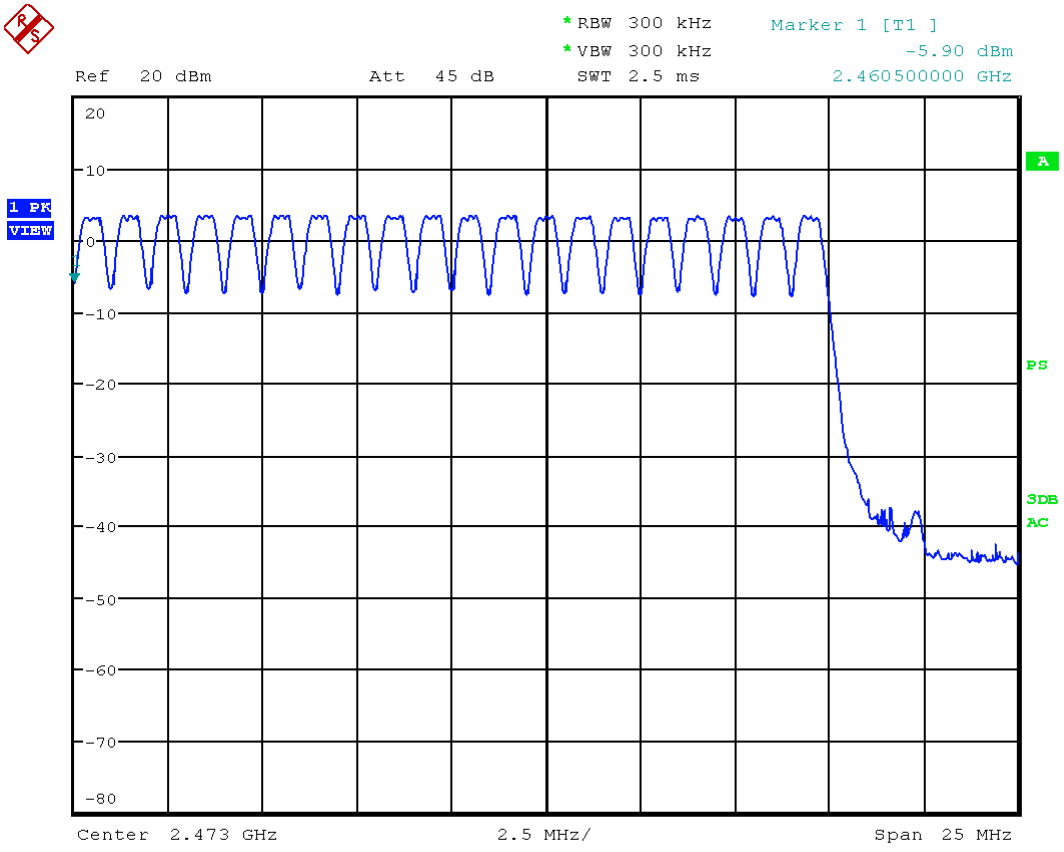
Plot 2a - U394HC-1



Plot 2b - U394HC-2



Plot 2c - U394HC-3



9.3 Peak Output Power , 15.247(b)(1)

For frequency hopping system, according to 15.247(b)(1), the maximum peak output power of the transmitter shall not exceed 1 Watt. if Receving antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

TEST PROCEDURE

Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.

The setup of the EUT as shown in Section 6.0. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any measured frequency within its operating range and make sure the instrument is operated in its linear range.

Set RBW of spectrum analyzer to 2 MHz and VBW to 2 MHz.

Measure the highest amplitude appearing on spectral display and record the level to calculate result data.

5. Repeat above procedures until all frequencies measured were complete.

9.3 Peak Output Power , 15.247(b)(1)

Company	**Arcam**
Product	**irDAC-II**
Applicable Standard	**15.247(b)(1)**
Test Procedure	**ETS tpRDFcc**

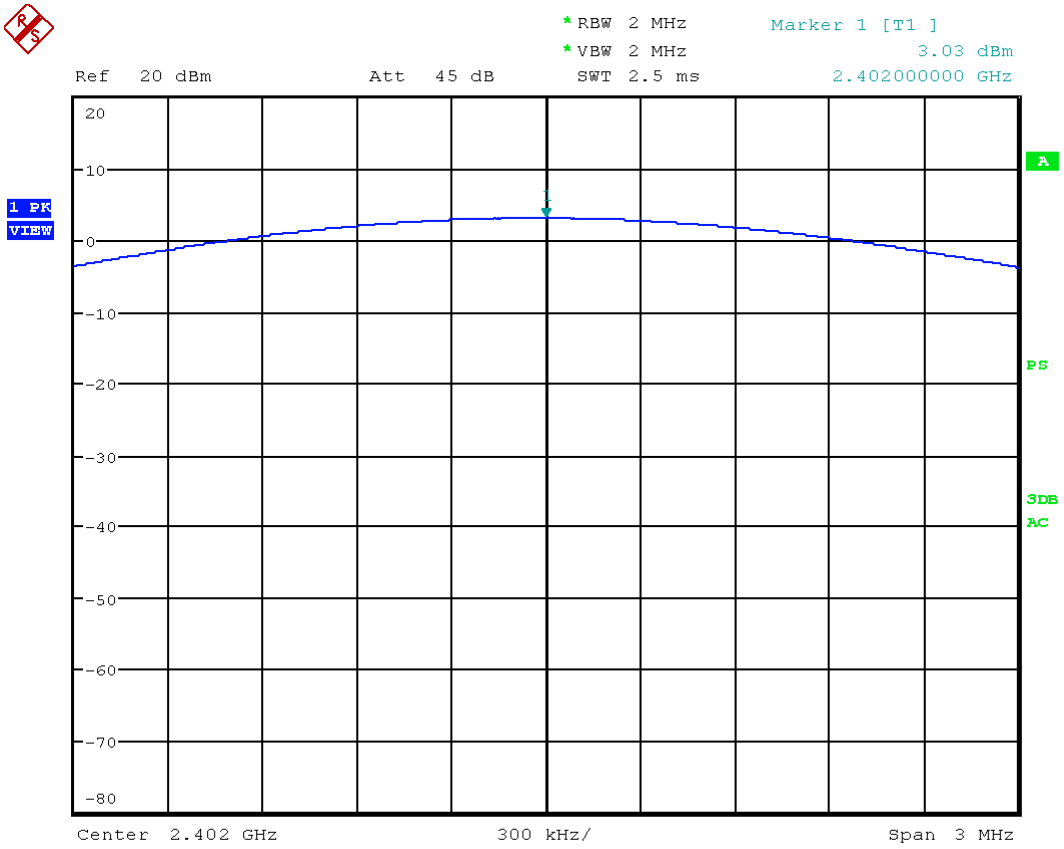
Peak Output Power

Plot No.	Test File	Channel	Peak Power dBm	Peak Power mW	Limit mW	Result
Plot 3a	U394PP-1	0 (2402 MHz)	3.03	2.01	1000	Pass
Plot 3b	U394PP-2	39 (2441 MHz)	3.45	2.21		Pass
Plot 3c	U394PP-3	78 (2480 MHz)	3.29	2.13		Pass

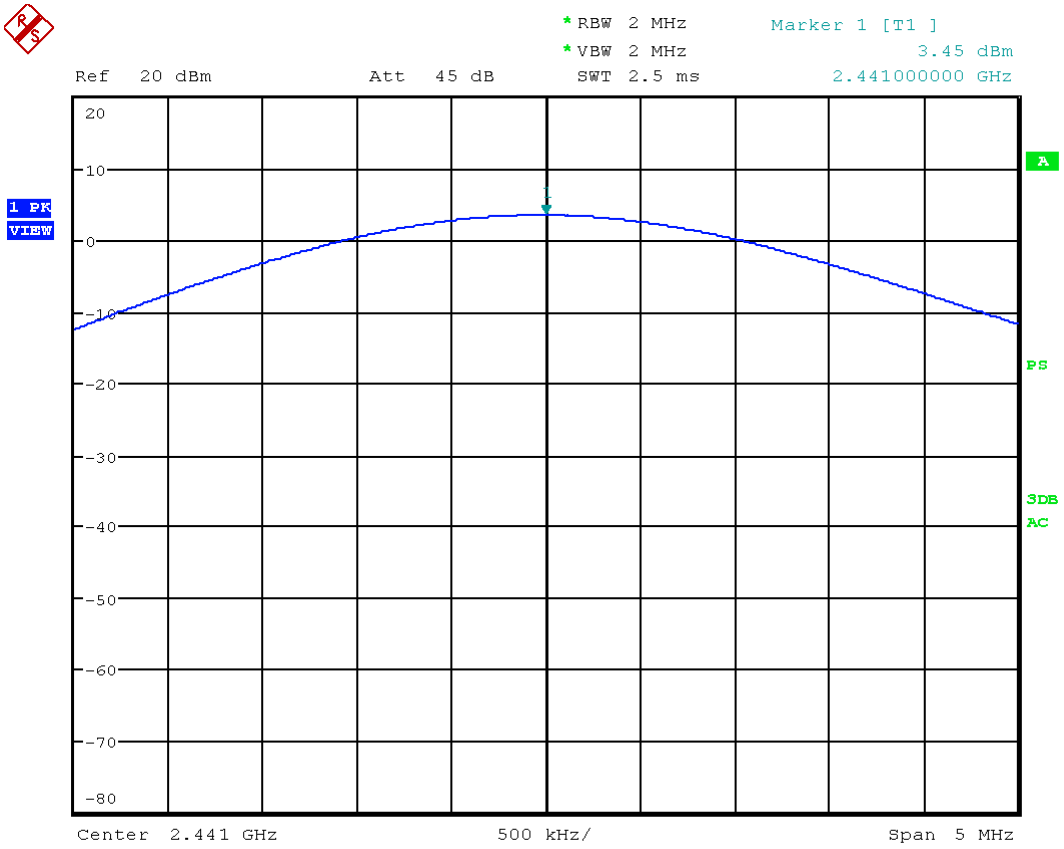
The EUT achieved compliance.

	Temp: º C	% RH	Pa mbar	Tested by:		
	22	46	971	GV		

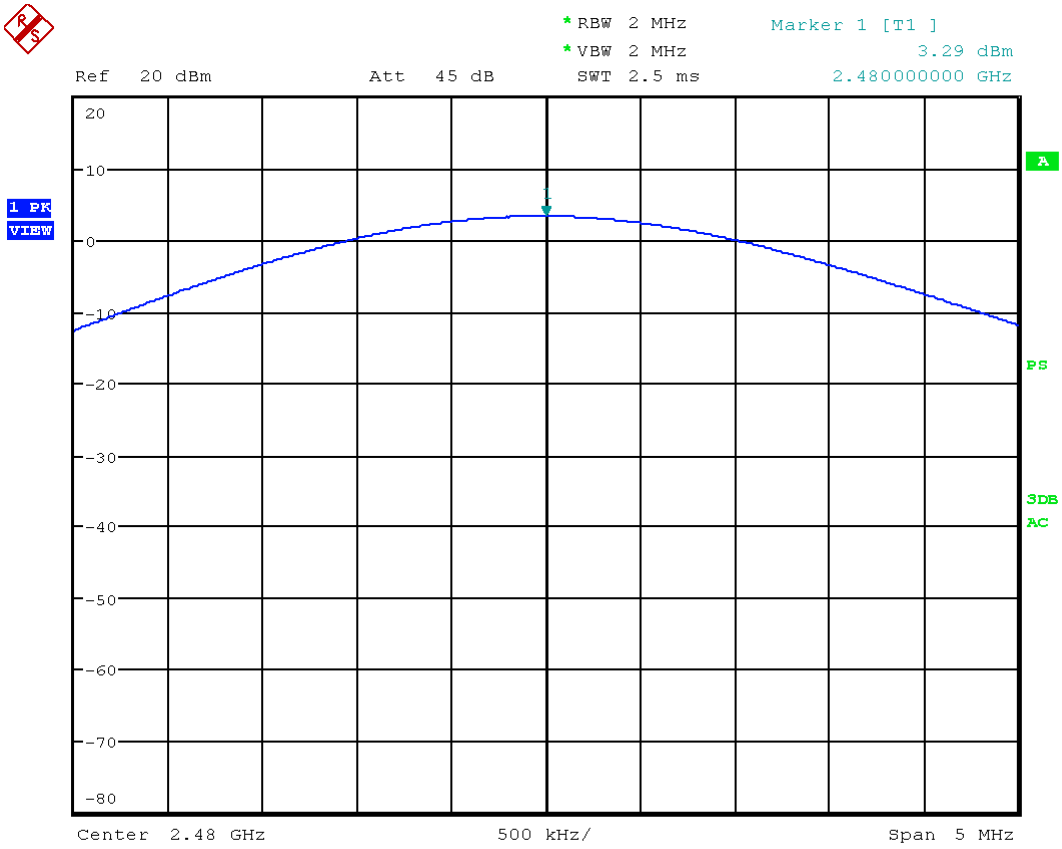
Plot 3a - U394PP-1



Plot 3b - U394PP-2



Plot 3c - U394PP-3



9.4 Dwell Time 15.247(a)(1)(iii)

According to 15.247(a)(1)(iii), frequency hopping system in the 2400-2483.5MHz band employing at least 15 non-overlapping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 second multiplied by the number of hopping channels employed.

TEST PROCEDURE

Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.

The setup of the EUT as shown in figure at section 6.0.

9.4 Dwell Time 15.247(a)(1)(iii)

Company	**Arcam**
Product	**irDAC-II**
Applicable Standard	**15.247(a)(1)(iii)**
Test Procedure	**ETS tpRDFcc**

Dwell Time

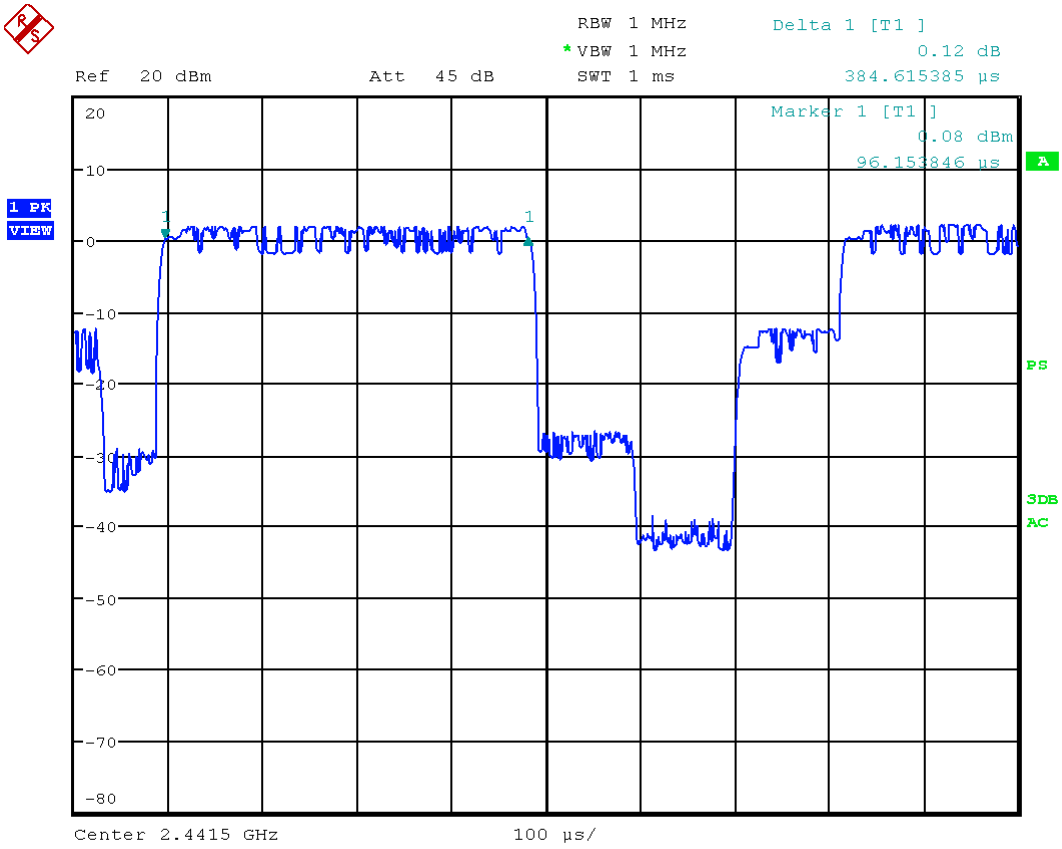
Plot No.	Test File	Channel	Pulse Width ms	Dwell Time ms	Limit ms	Result
Plot 4a	U394DT-2	0 (2402 MHz)	0.3846	130.7	400	Pass
Plot 4b	U394DT-3	39 (2441 MHz)	0.4967	168.9		Pass
Plot 4c	U394DT-4	78 (2480 MHz)	0.4663	158.5		Pass
Plot 4d	U394DT-1	100.5 ms between hop				

Test Period = 0.4(seconds per channel) x 79 channels = 31.6 s
Dwell Time = occupancy x No of Hopping Channels

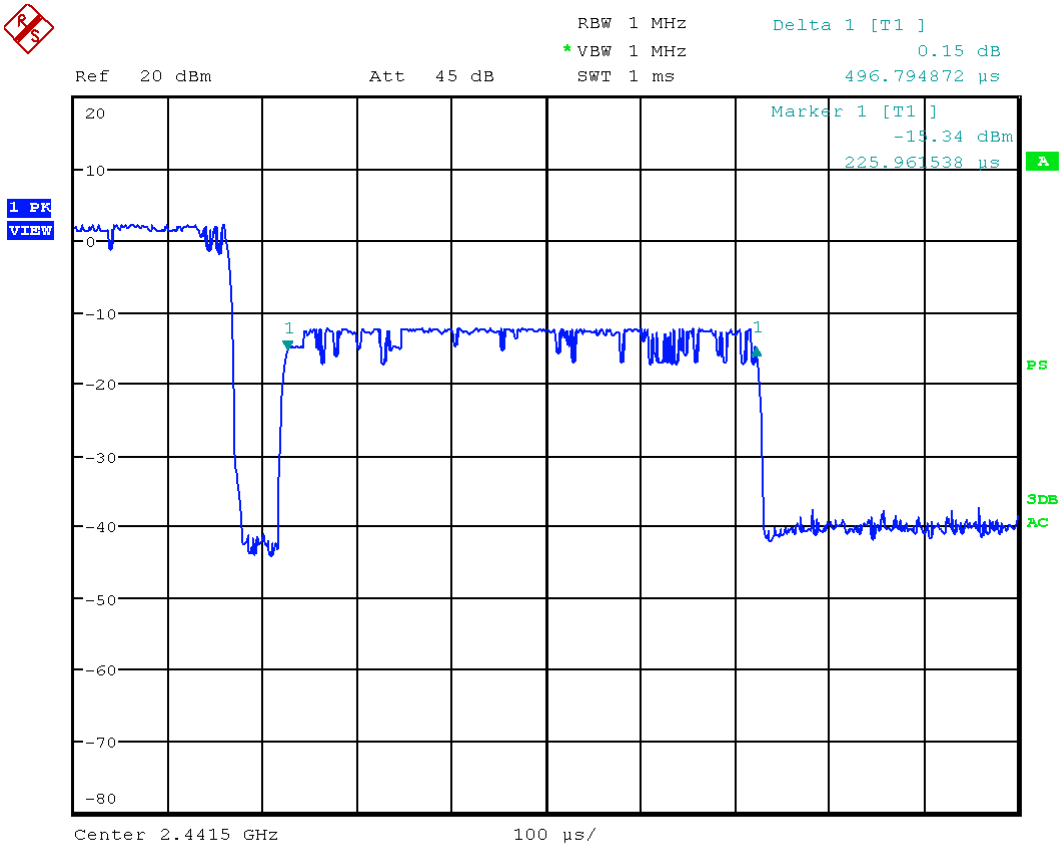
The EUT achieved compliance.

	Temp: º C	% RH	Pa mbar	Tested by:		
	22	46	971	GV		

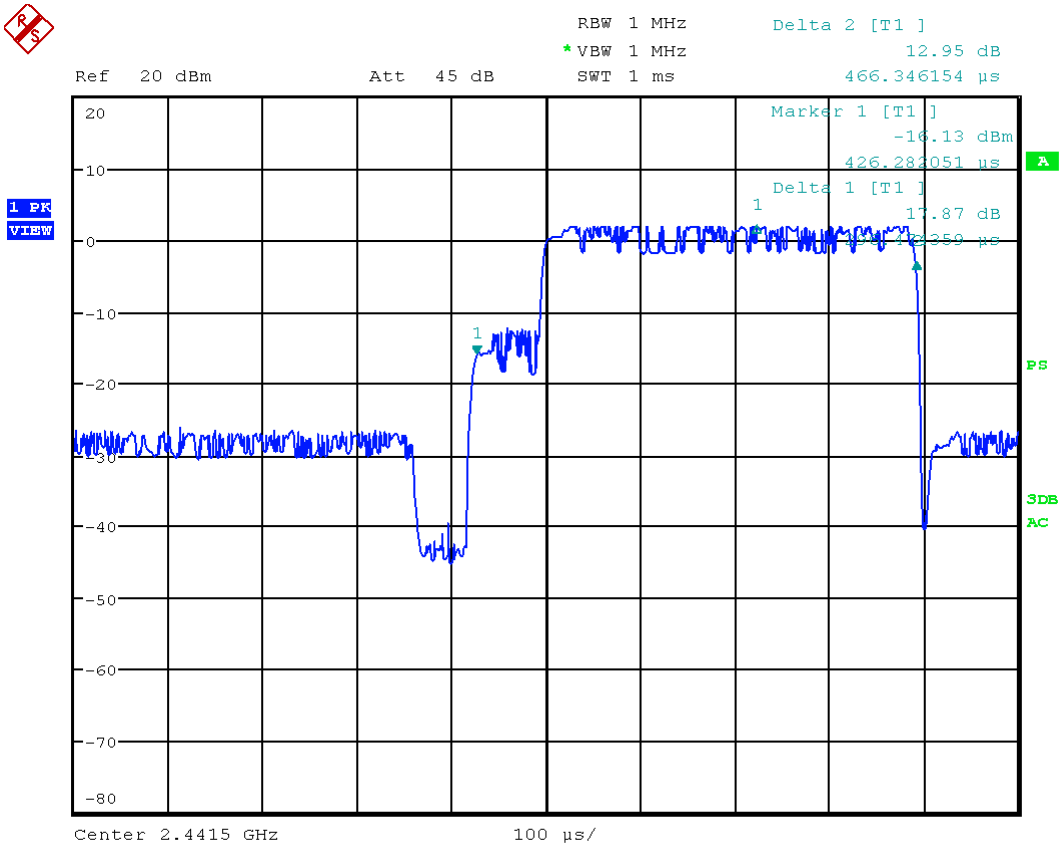
Plot 4a - U394DT-2



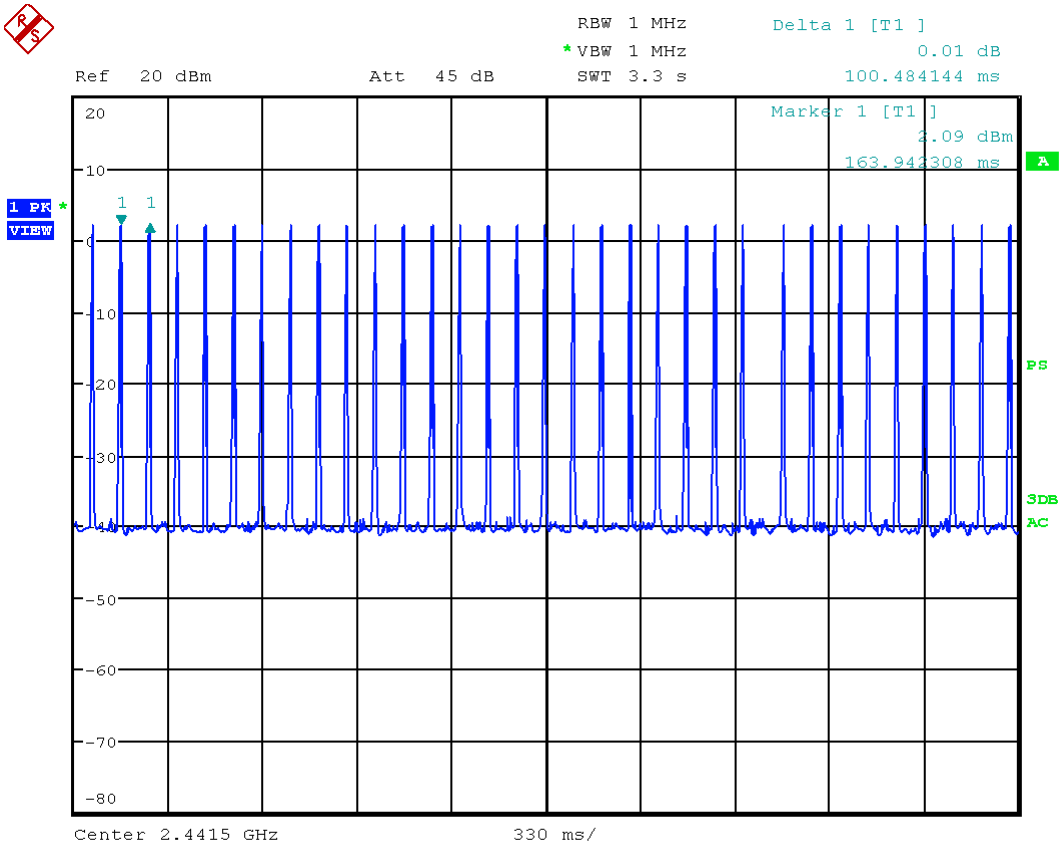
Plot 4b - U394DT-3



Plot 4c - U394DT-4



Plot 4d - U394DT-1



9.5 Spurious Emissions (Conducted), 15.247(d)

According to 15.247(d), if any 100 kHz bandwidth outside these frequency bands, the radio frequency power that is produced by the modulation products of the spreading sequence, the information sequence and the carrier frequency shall be either at least 20 dB below that in any 100 kHz bandwidth within the band that contains the highest level of the desired power or shall not exceed the general levels specified in §15.209(a), whichever results in the lesser attenuation.

TEST PROCEDURE

Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
The setup of the EUT as shown in Section 6.0. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any measured frequency within its operating range and make sure the instrument is operated in its linear range.
Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge.
Measure the highest amplitude appearing on spectral display and set it as a reference level.
Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

9.5 Spurious Emissions (Conducted), 15.247(d)

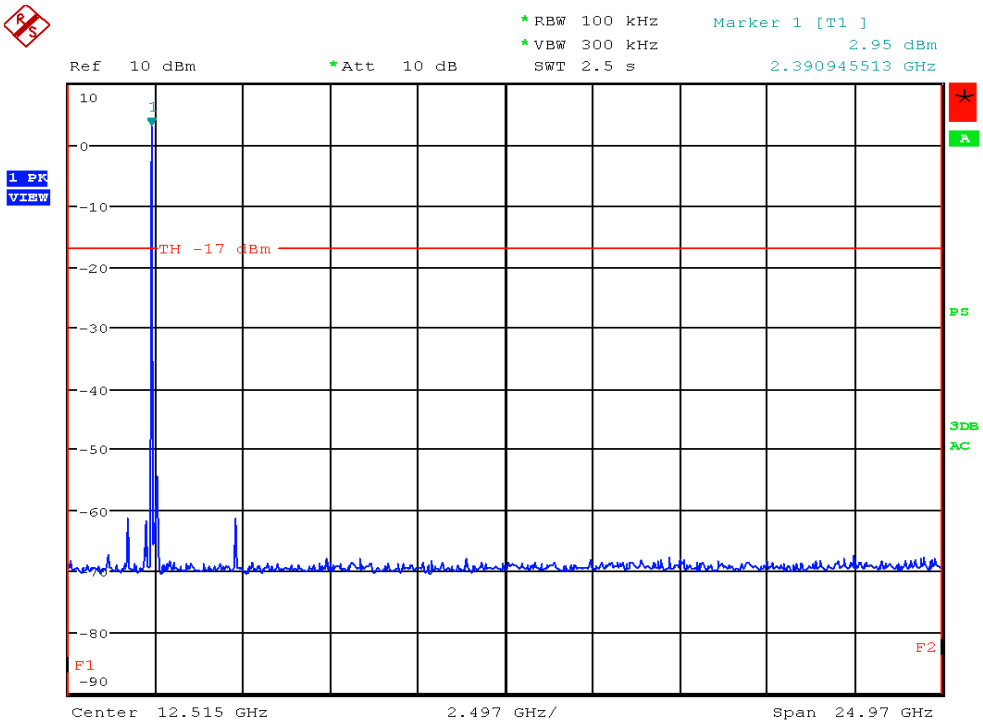
Company	**Arcam**
Product	**irDAC-II**
Applicable Standard	**15.247(d)**
Test Procedure	**ETS tpRDFcc**

Plot No.	Test File	Channel	Frequency Range MHz	Comments	Result
Plot 5a	U394SU00	0 (2402 MHz)	30 - 25000		Pass
Plot 5b	U394SU39	39 (2441 MHz)	30 - 25000		Pass
Plot 5c	U394SU78	78 (2480 MHz)	30 - 25000		Pass

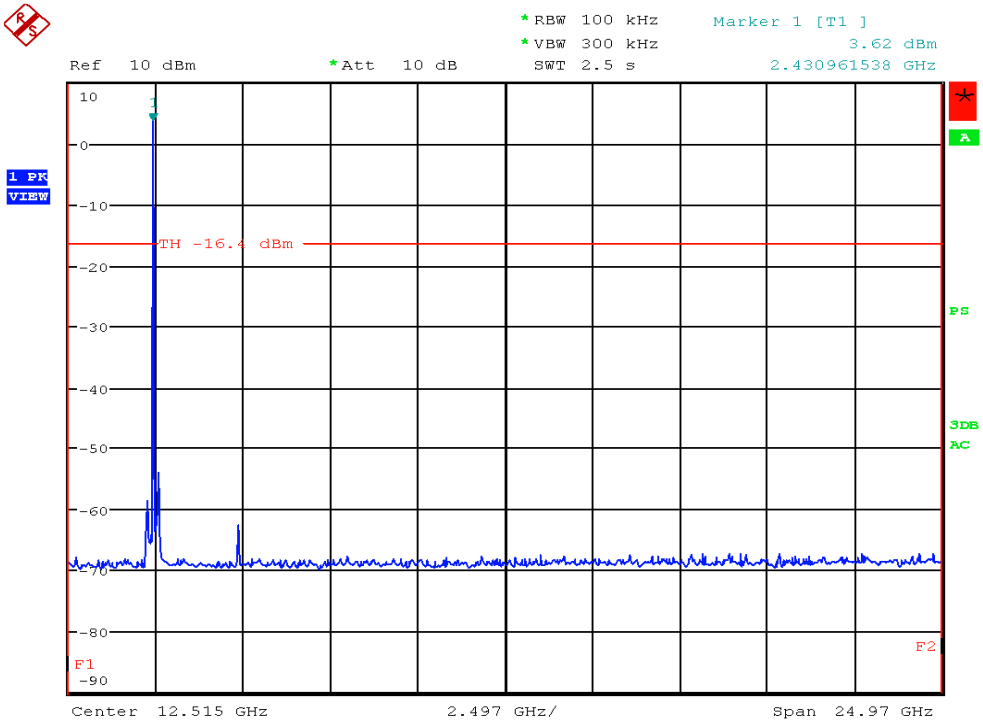
The EUT achieved compliance.

	Temp: º C	% RH	Pa mbar	Tested by:	
	22	46	971	GV	

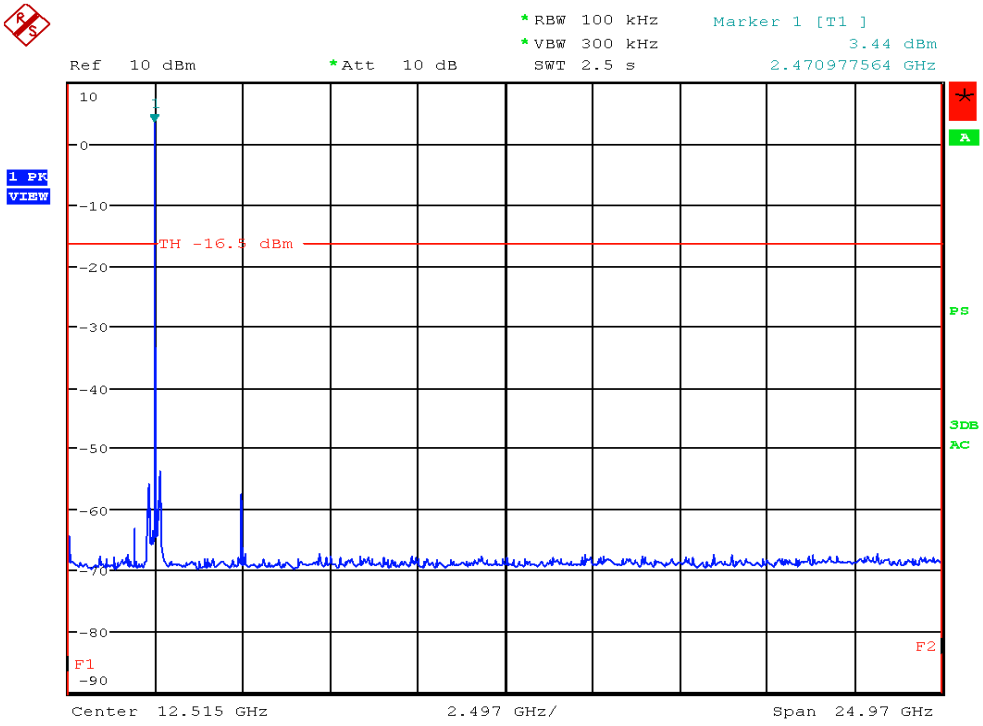
Plot 5a - U394SU00



Plot 5b - U394SU39



Plot 5c - U394SU78



9.6 Band Edge Measurements, 15.247(d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. In addition radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

TEST PROCEDURE

Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.

The setup of the EUT as shown in figure in section 6.0. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable.

Set the RBW 100kHz, VBW = 300kHz.

Detector = Peak, Sweep time = auto couple.

Trace mode = max hold, allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level.

9.6 Band Edge Measurements, 15.247(d)

Company	**Arcam**
Product	**irDAC-II**
Applicable Standard	**15.247(d)**
Test Procedure	**ETS tpRDFcc**

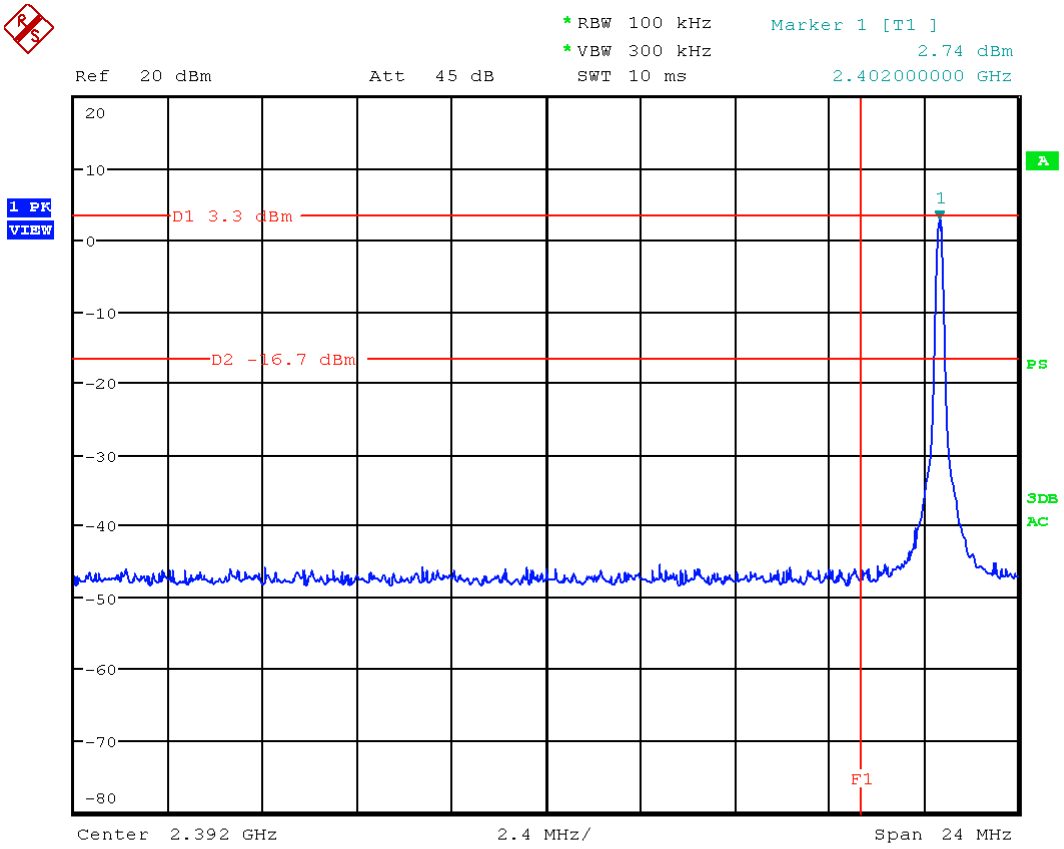
Band Edge Measurements

Plot No.	Test File	Channel	Comments	Result
Plot 6a	U394BE00	0 (2402 MHz)		Pass
Plot 6b	U394BE39	78 (2480 MHz)		Pass

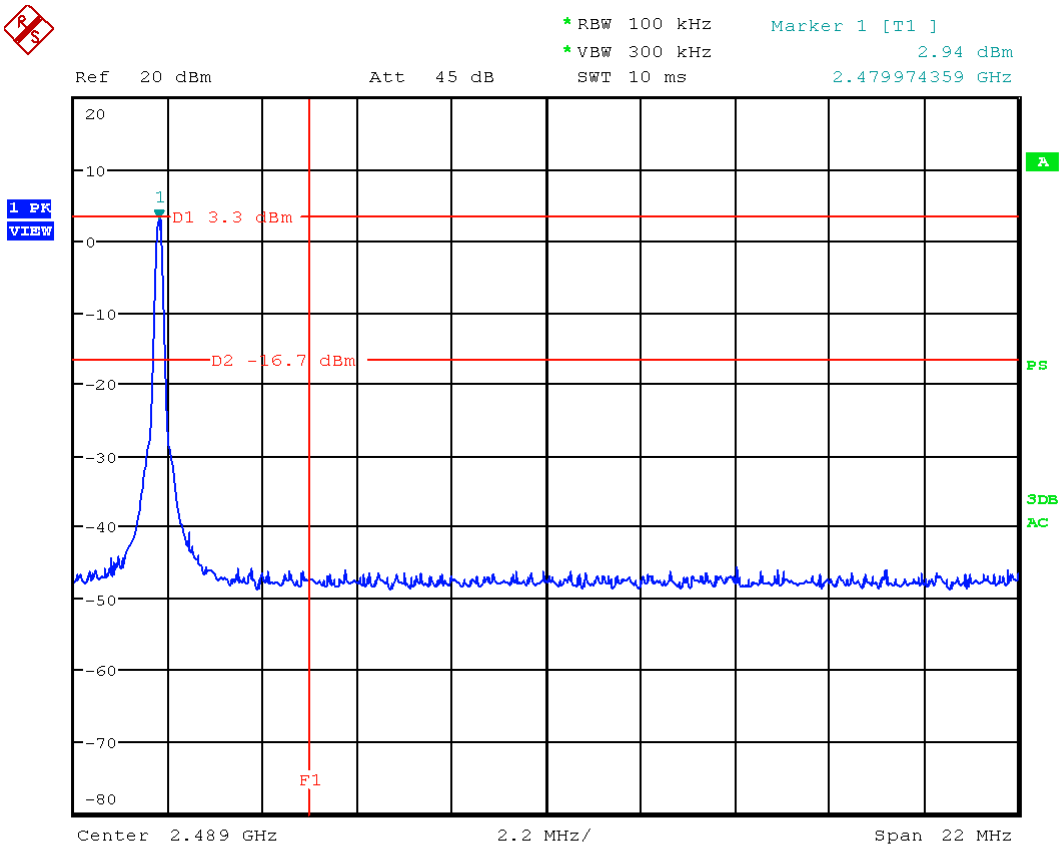
The EUT achieved compliance.

	Temp: º C	% RH	Pa mbar	Tested by:	
	22	46	971	GV	

Plot 6a - U394BE00



Plot 6b - U394BE78



9.7 Conducted Emissions, 15.247

For unintentional radiator, the conducted emission shall comply with §15.107(a).
For intentional radiators, according to §15.247 (a), operation under this provision is limited to frequency hopping and digitally modulated, and the out band emission shall be comply with § 15.107

9.7 Conducted Emissions, 15.207

The powerline conducted emissions automatic scans are tabulated below.

Company	**Arcam**
Product	**irDAC 2**
Applicable Standard	**FCC Part 15.207 Class B**

Plot No.	Test File	Detector	Port	Frequency (MHz)	Level (dBuV)	Margin (dB)	Result
Plot 7a	U394CALD	Average	Live	0.276	37.71	-13.23	Pass
Plot 7b	U394CAND	Average	Neutral	0.3165	37.21	-12.59	Pass
Plot 7c	U394CQLD	Quasi Peak	Live	0.159	47.82	-17.70	Pass
Plot 7d	U394CQND	Quasi Peak	Neutral	0.159	50.68	-14.84	Pass

The powerline conducted emissions automatic scans and tables of the most significant emissions are illustrated below. It illustrates the emissions from the EUT on the live and neutral conductors. These results can be compared directly with the FCC Part 15 Class B limit lines shown on the plot.

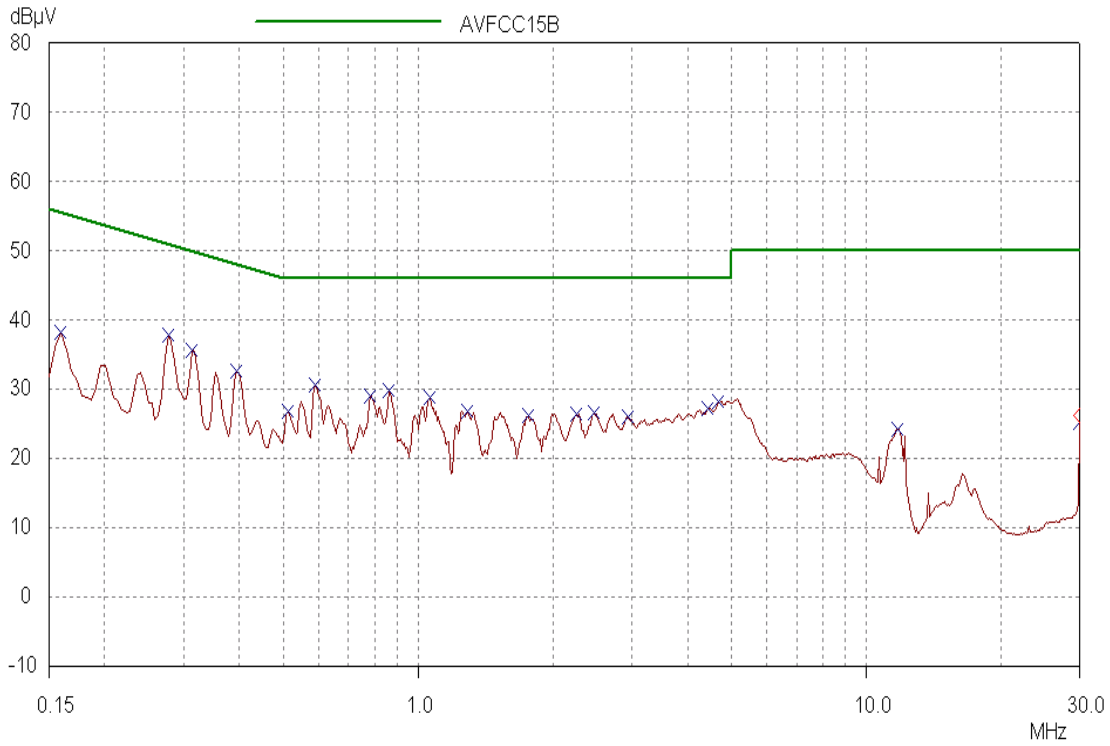
As it can be seen from plots 1a to 1d, all the emission levels from the EUT were below the FCC Part 15 Class B limit line.

The narrowest compliance margin was -12.59 dB at 0.3165 MHz where the measured level was 37.21 dBuV.

The EUT achieved compliance.

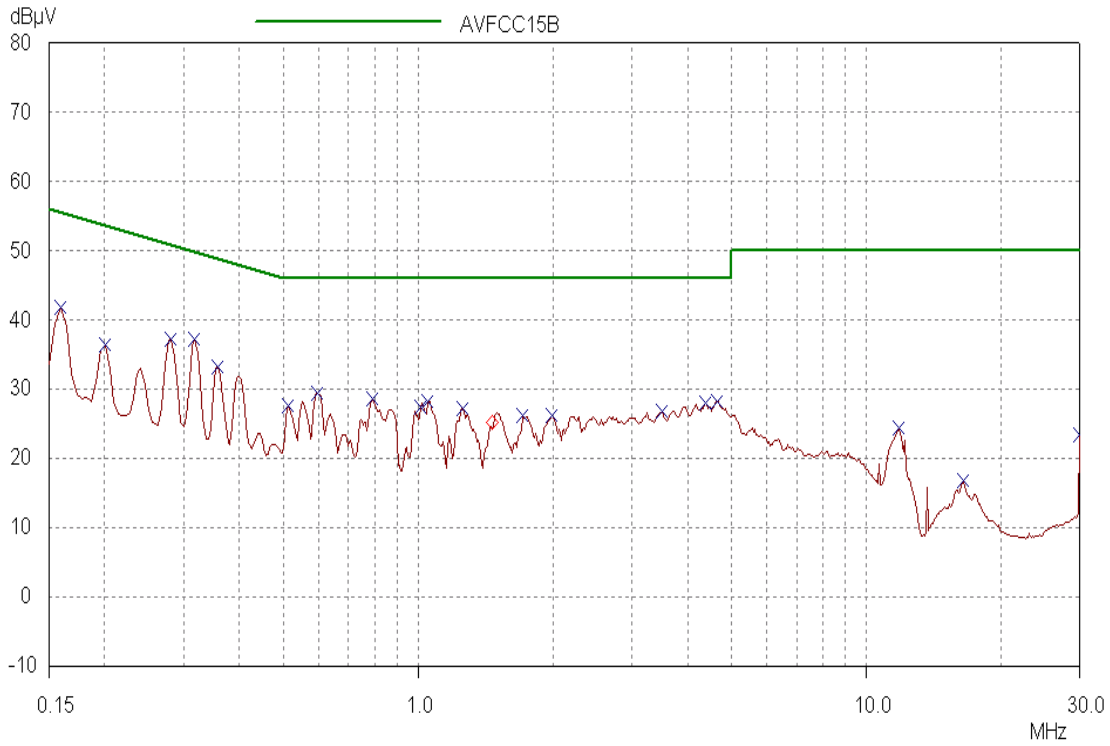
	Temp: º C	% RH	Pa mbar	Tested by:	Date:	
Site 09	22	43	983	AR	06/01/2016	

Plot 7a - U394CALD



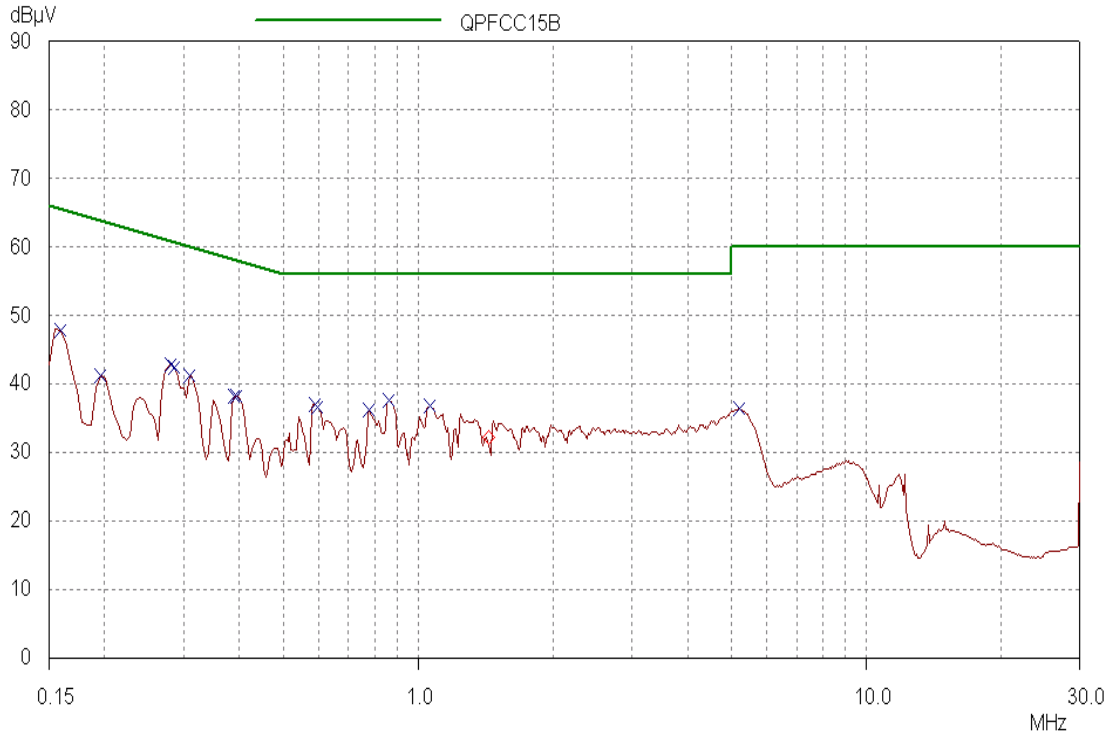
Frequency MHz	Level dBuV	Limit dB	QP Delta dB		
0.159	38.15	55.52	17.37	L1	gnd
0.276	37.71	50.94	13.23	L1	gnd
0.312	35.51	49.92	14.41	L1	gnd
0.393	32.68	48.00	15.32	L1	gnd
0.5865	30.55	46.00	15.45	L1	gnd
0.861	29.70	46.00	16.30	L1	gnd
0.78	29.04	46.00	16.96	L1	gnd
1.059	28.77	46.00	17.23	L1	gnd
4.6815	28.23	46.00	17.77	L1	gnd
4.434	27.27	46.00	18.73	L1	gnd
0.51	26.85	46.00	19.15	L1	gnd
1.284	26.80	46.00	19.20	L1	gnd
2.463	26.65	46.00	19.35	L1	gnd
2.247	26.48	46.00	19.52	L1	gnd
1.7565	26.18	46.00	19.82	L1	gnd
2.9445	26.00	46.00	20.00	L1	gnd
30.0	25.20	50.00	24.80	L1	gnd
11.7195	24.25	50.00	25.75	L1	gnd

Plot 7b - U394CAND



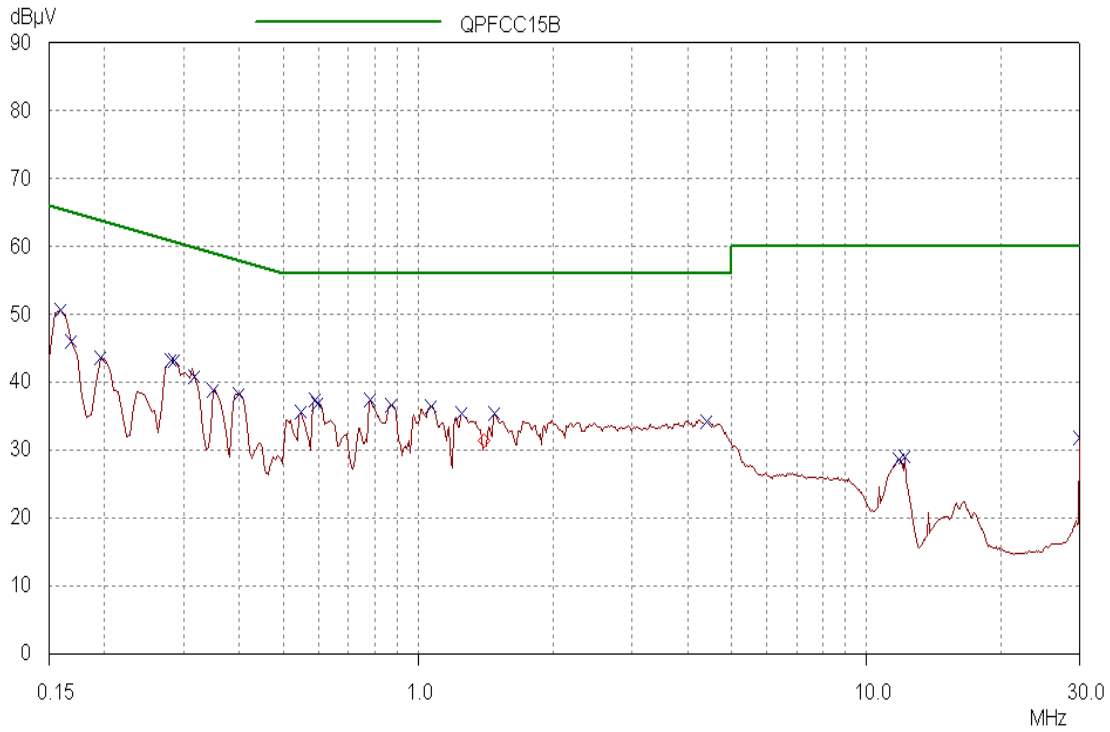
Frequency MHz	Level dBuV	Limit dB	QP Delta dB		
0.159	41.87	55.52	13.65	L1	gnd
0.3165	37.21	49.80	12.59	L1	gnd
0.2805	37.13	50.80	13.67	L1	gnd
0.1995	36.31	53.63	17.32	L1	gnd
0.357	33.25	48.80	15.55	L1	gnd
0.5955	29.39	46.00	16.61	L1	gnd
0.789	28.50	46.00	17.50	L1	gnd
4.6455	28.27	46.00	17.73	L1	gnd
1.05	28.16	46.00	17.84	L1	gnd
4.371	27.98	46.00	18.02	L1	gnd
0.51	27.61	46.00	18.39	L1	gnd
1.0095	27.37	46.00	18.63	L1	gnd
1.257	27.19	46.00	18.81	L1	gnd
3.4935	26.77	46.00	19.23	L1	gnd
1.986	26.28	46.00	19.72	L1	gnd
1.7115	26.19	46.00	19.81	L1	gnd
11.7915	24.43	50.00	25.57	L1	gnd
30.0	23.32	50.00	26.68	L1	gnd
16.503	16.77	50.00	33.23	L1	gnd

Plot 7c - U394CQLD



Frequency MHz	Level dBuV	Limit dB	QP Delta dB		
0.159	47.82	65.52	17.70	L1	gnd
0.2805	42.76	60.80	18.04	L1	gnd
0.285	42.36	60.67	18.31	L1	gnd
0.195	41.29	63.82	22.53	L1	gnd
0.3075	41.20	60.04	18.84	L1	gnd
0.3885	38.17	58.10	19.93	L1	gnd
0.393	38.17	58.00	19.83	L1	gnd
0.861	37.51	56.00	18.49	L1	gnd
0.5865	37.04	56.00	18.96	L1	gnd
1.0635	36.75	56.00	19.25	L1	gnd
0.5955	36.59	56.00	19.41	L1	gnd
5.2125	36.47	60.00	23.53	L1	gnd
0.7755	36.21	56.00	19.79	L1	gnd

Plot 7d - U394CQND



Frequency MHz	Level dBuV	Limit dB	QP Delta dB		
0.159	50.68	65.52	14.84	L1	gnd
0.168	46.01	65.06	19.05	L1	gnd
0.195	43.67	63.82	20.15	L1	gnd
0.2805	43.20	60.80	17.60	L1	gnd
0.285	43.20	60.67	17.47	L1	gnd
0.3165	40.89	59.80	18.91	L1	gnd
0.348	38.72	59.01	20.29	L1	gnd
0.3975	38.22	57.91	19.69	L1	gnd
0.5865	37.31	56.00	18.69	L1	gnd
0.78	37.30	56.00	18.70	L1	gnd
0.5955	36.85	56.00	19.15	L1	gnd
0.87	36.68	56.00	19.32	L1	gnd
1.068	36.38	56.00	19.62	L1	gnd
0.546	35.59	56.00	20.41	L1	gnd
1.4775	35.37	56.00	20.63	L1	gnd
1.248	35.36	56.00	20.64	L1	gnd
4.407	34.16	56.00	21.84	L1	gnd
30.0	31.83	60.00	28.17	L1	gnd
12.183	29.00	60.00	31.00	L1	gnd
11.823	28.56	60.00	31.44	L1	gnd

9.8 Spurious Radiated Emissions

TEST PROCEDURE

Spurious radiated emissions were carried out in the frequency range 30 MHz to 25 GHz in accordance with FCC part 15.209, 15.205 and 15.247(d) and ETS test procedure tpRE SAC and ANSI C63.10, 2013. The EUT was placed on a non conductive table 0.8m above ground plane for Emissions measurements below 1GHz and 1.5m above ground plane for Emissions measurements above 1 GHz. The measurement distance below 1GHz was 10m and above 1GHz was 3m..

All significant emissions were maximized by rotating the turntable by 360 degrees and scanning the receiving antenna from 1 m to 4 m.

Company	**ARCAM**
Product	**irDAC-II**
Applicable Standard	**FCC Part 15.209, 15.205 and 15.247(d)**

Plot No.	Test File	Frequency MHz	Pol.	Frequency (MHz)	Level (dBuV/m)	Margin (dB)	Result
Plot 8a	V196RV1T	30 to 1000	Vertical	107.550	25.00	-8.50	Pass
Plot 8b	V196RH1T	30 to 1000	Horizontal	107.550	23.32	-10.18	Pass

Measurement Bandwidth: 120 kHz, Detector : Quasi Peak

On all of the result plots the black trace represents the ambient noise and the red trace the emissions from the equipment under test (EUT). The green line illustrates the FCC applicable limit.

Emissions marked by ' X ' represent the maximised significant emissions from the EUT.

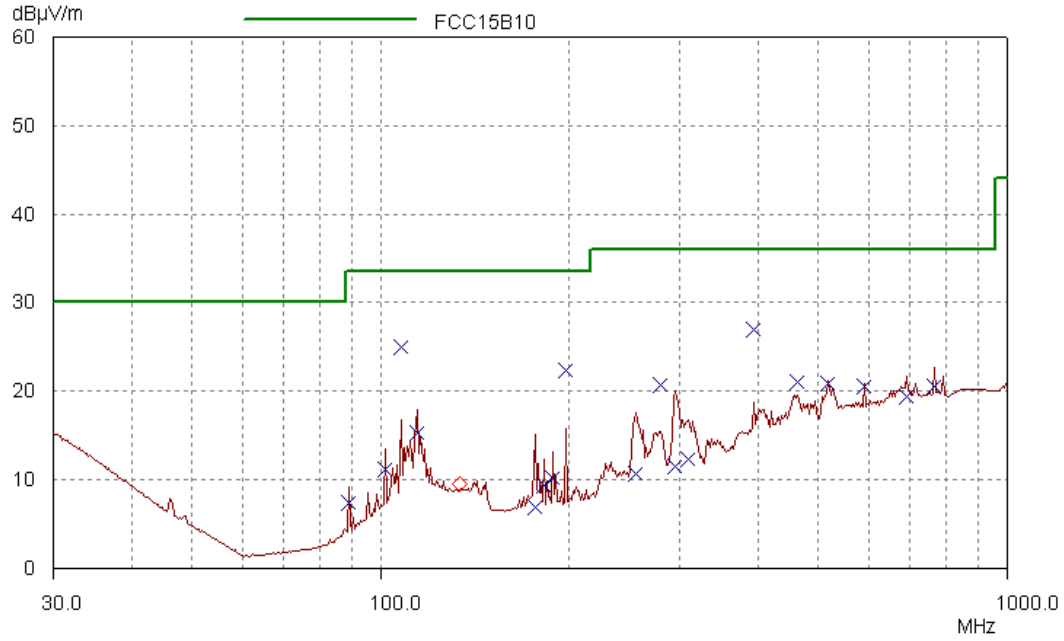
As it can be seen from plots 8a to 8b, all the emission levels from the EUT were below the applicable FCC limit line.

The narrowest compliance margin was –8.50 dB at 107.550 MHz where the measured level was 25.00 dBuV/m.

The EUT achieved compliance.

	Temp: º C	% RH	Pa mbar	Tested by:	Date:
Semi-Anechoic Room	22	55	997	CS	30/06/2016

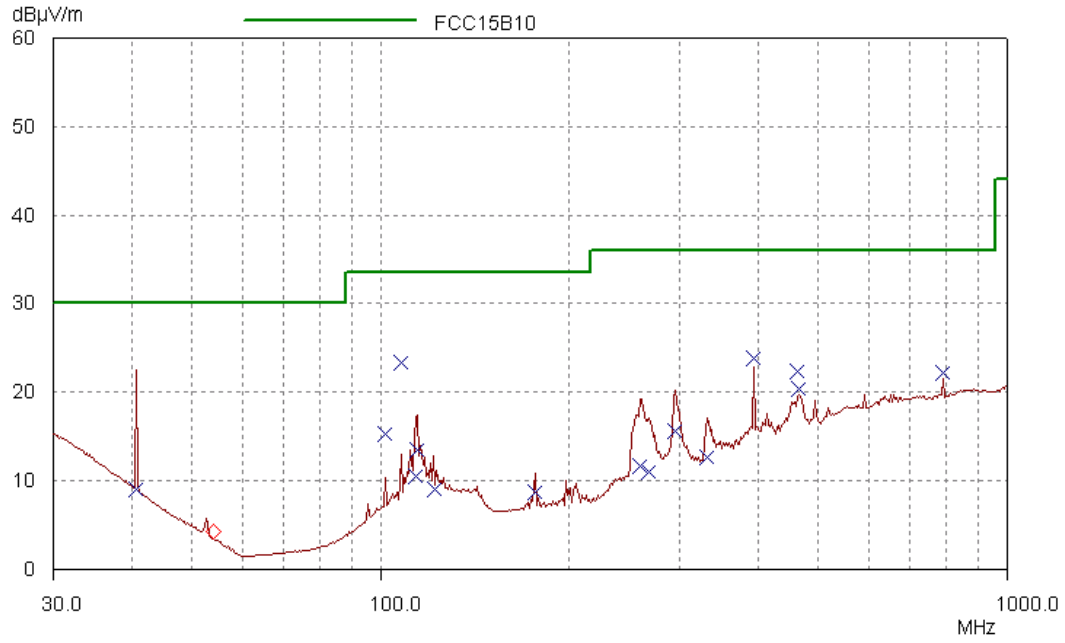
Plot 8a V196RV1T



ELECTROMAGNETIC TESTING SERVICES LTD 01/07/2016 08:27:01
Electric Field Radiated Emissions - SAC - Vertical Polarisation
Arcam - irDAC-II
Arcam - Test File V196RV1T
V196RV1T - ARCAM irDAC-II

Frequency MHz	QP Level dBuV/m	Limit dBuV/m	Margin dBuV/m	Angle °	Height m
89.070	7.42	33.50	26.08	237	1.02
101.390	11.16	33.50	22.34	114	3.20
107.550	25.00	33.50	8.50	5	1.06
114.370	15.31	33.50	18.19	357	1.06
175.090	6.90	33.50	26.60	245	2.65
181.250	9.32	33.50	24.18	317	1.15
187.410	10.18	33.50	23.32	229	1.03
196.650	22.37	33.50	11.13	10	1.00
254.400	10.59	36.00	25.41	269	1.05
278.270	20.64	36.00	15.36	307	1.02
294.110	11.45	36.00	24.55	38	2.78
308.740	12.20	36.00	23.80	359	2.48
393.220	26.99	36.00	9.01	162	2.38
459.770	21.05	36.00	14.95	360	1.39
516.090	20.87	36.00	15.13	169	1.36
589.790	20.54	36.00	15.46	90	1.95
688.130	19.39	36.00	16.61	246	1.34
761.830	20.50	36.00	15.50	221	1.32

Plot 8b V196RH1T



ELECTROMAGNETIC TESTING SERVICES LTD 01/07/2016 09:18:05
Electric Field Radiated Emissions - SAC - Horizontal Polarisation
Arcam - irDAC-II
Arcam - Test File V196RH1T
V196RH1T - ARCAM irDAC-II

Frequency MHz	QP Level dBuV/m	Limit dBuV/m	Margin dBuV/m	Angle °	Height m
40.670	8.91	30.00	21.09	72	3.41
101.390	15.16	33.50	18.34	358	2.94
107.550	23.32	33.50	10.18	169	3.97
113.710	10.53	33.50	22.97	190	3.69
114.370	13.43	33.50	20.07	172	2.65
122.180	9.02	33.50	24.48	92	1.52
175.090	8.70	33.50	24.80	328	1.22
258.360	11.66	36.00	24.34	165	2.18
266.280	10.97	36.00	25.03	359	1.90
294.110	15.51	36.00	20.49	123	1.24
331.180	12.64	36.00	23.36	198	1.80
393.220	23.79	36.00	12.21	147	2.32
459.770	22.35	36.00	13.65	27	2.12
463.730	20.27	36.00	15.73	191	1.08
786.470	22.18	36.00	13.82	124	1.09

Company	**ARCAM**
Product	**irDAC-II**
Applicable Standard	**FCC Part 15.209, 15.205 and 15.247(d)**

Plot No.	Test File	Frequency GHz	Pol.	Detector	Frequency (MHz)	Level (dBuV/m)	Margin (dB)	Result
Plot 8c	V196AVG1	1 to 18	Vertical	AV	Negligible Levels			Pass
Plot 8d	V196PVG1	1 to 18	Vertical	PK	Negligible Levels			Pass
Plot 8e	V196AHG1	1 to 18	Horizontal	AV	2667.0	42.43	-11.57	Pass
Plot 8f	V196PHG1	1 to 18	Horizontal	PK	4848.0	73.28	-0.72	Pass
Measurement Bandwidth: 1 MHz, Detector : Peak & Average								

On all of the result plots the black trace represents the ambient noise and the red trace the emissions from the equipment under test (EUT). The green line illustrates the FCC applicable limit.

Emissions marked by ' X ' represent the maximised significant emissions from the EUT.

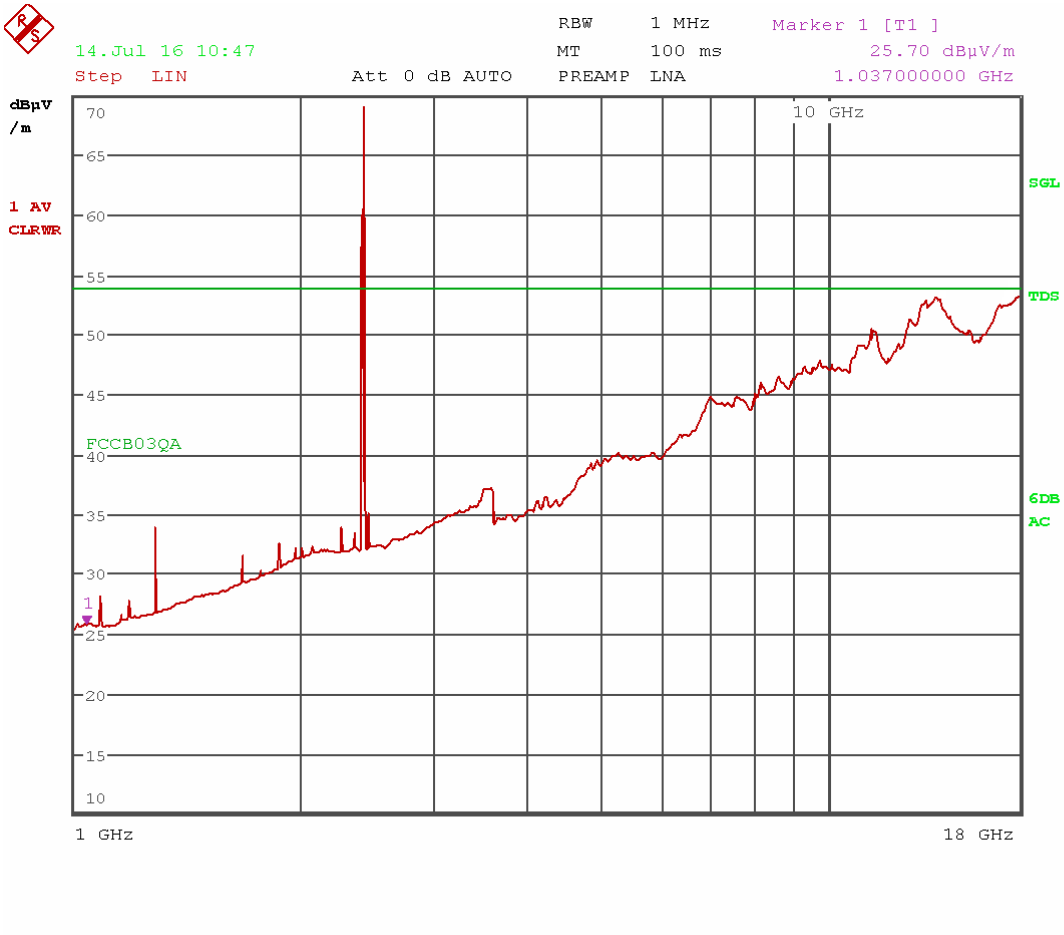
As it can be seen from plots 8c to 8f, all the emission levels from the EUT were below the applicable FCC limit line.

The narrowest compliance margin was –0.72 dB at 4848.0 MHz where the measured level was 73.28 dBuV/m.

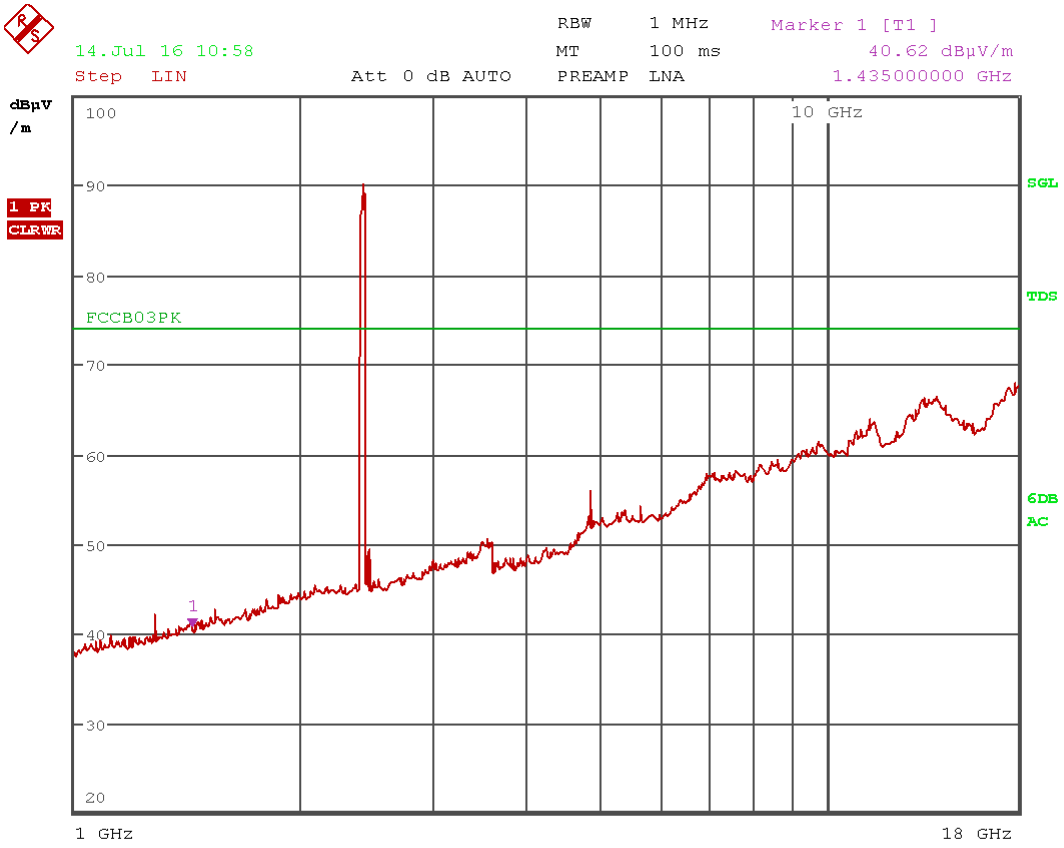
The EUT achieved compliance.

	Temp: º C	% RH	Pa mbar	Tested by:	Date:
Semi-Anechoic Room	22	46	999	CS	08/07/2016

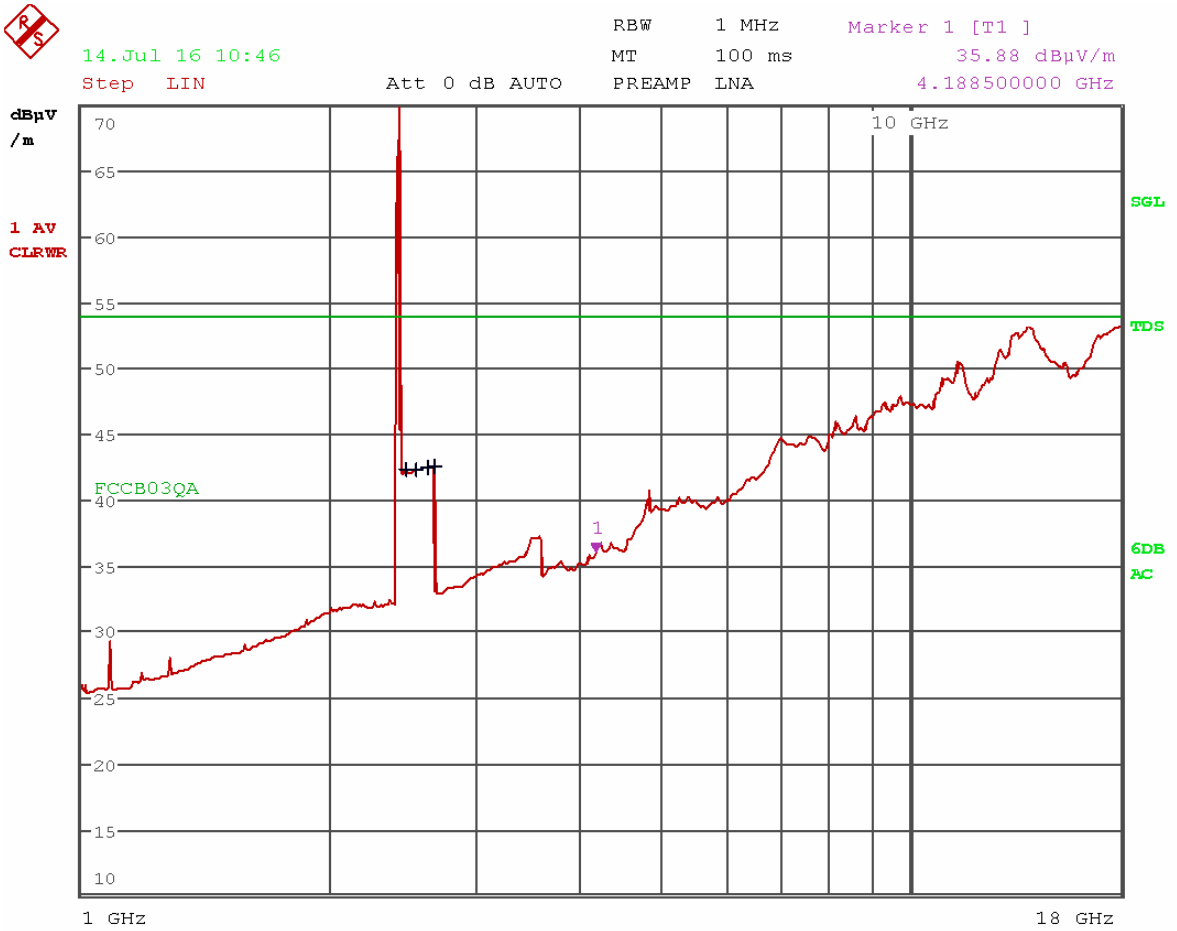
Plot 8c V196AVG1



Plot 8d V196PVG1



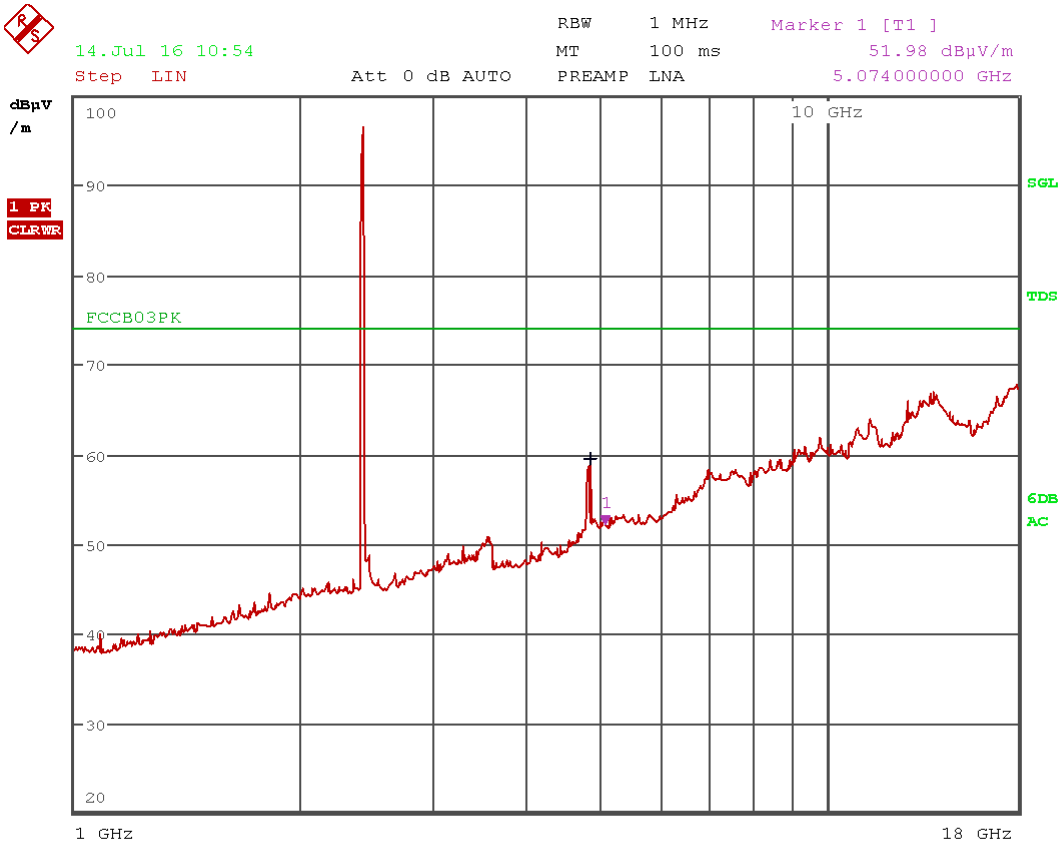
Plot 8e V196AHG1



V196AHG1 - ARCAM - irDAC-II

Frequency MHz	QP Level dBuV/m	Limit dBuV/m	Margin dBuV/m	Angle °	Height m
2467.500	41.91	54.00	12.09	6	1.41
2536.500	42.23	54.00	11.77	107	2.13
2623.500	42.36	54.00	11.64	74	2.30
2667.000	42.43	54.00	11.57	109	3.42

Plot 8f V196PHG1



V196PHG1 - ARCAM - irDAC-II

Frequency MHz	QP Level dBuV/m	Limit dBuV/m	Margin dBuV/m	Angle °	Height m
4848.000	73.28	74.00	0.72	187	1.22

Company	**ARCAM**
Product	**irDAC-II**
Applicable Standard	**FCC Part 15.209, 15.205 and 15.247(d)**

Plot No.	Test File	Frequency GHz	Pol.	Detector	Frequency (MHz)	Level (dBuV/m)	Margin (dB)	Result
Plot 8g	V196AVU2	18 to 25	Vertical	AV	Negligible Levels			Pass
Plot 8h	V196PVU2	18 to 25	Vertical	PK	Negligible Levels			Pass
Plot 8i	V196AHU2	18 to 25	Horizontal	AV	Negligible Levels			Pass
Plot 8j	V196PHU2	18 to 25	Horizontal	PK	Negligible Levels			Pass
Measurement Bandwidth: 1 MHz, Detector : Peak & Average								

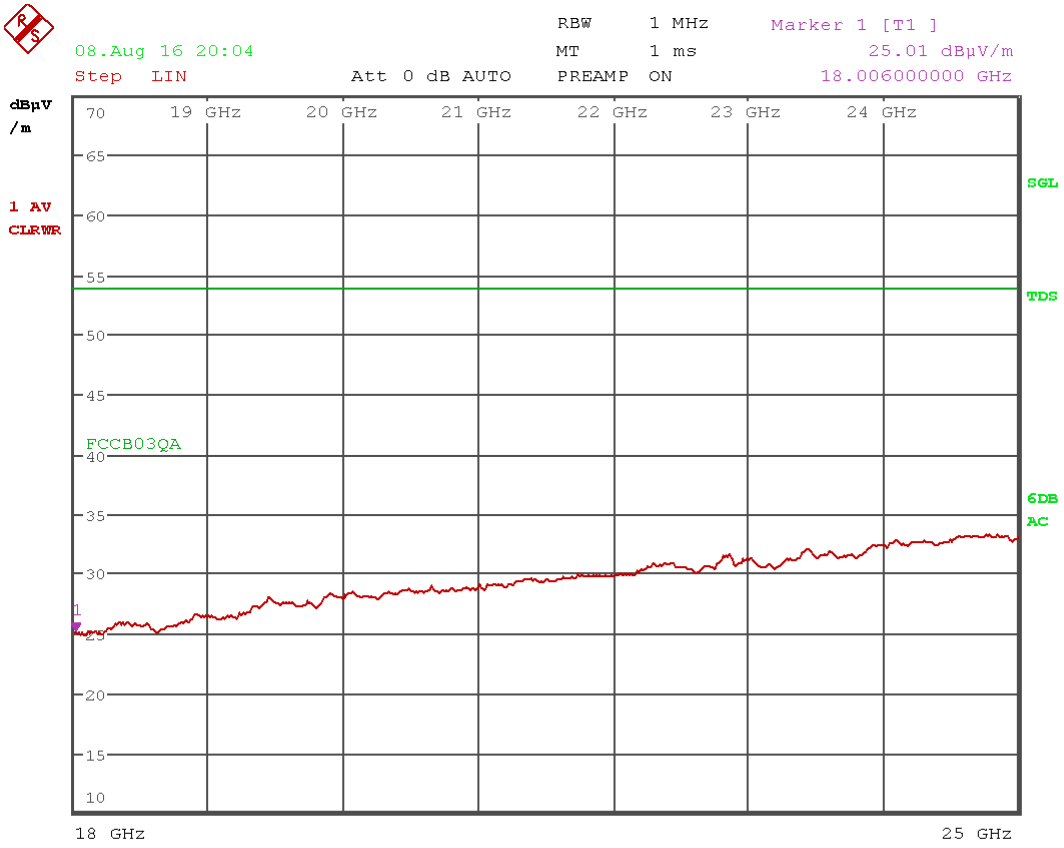
On all of the result plots the black trace represents the ambient noise and the red trace the emissions from the equipment under test (EUT). The green line illustrates the FCC applicable limit. Emissions marked by ' X ' represent the maximised significant emissions from the EUT.

As it can be seen from plots 8g to 8j, all the emission levels from the EUT were below the applicable FCC limit line.

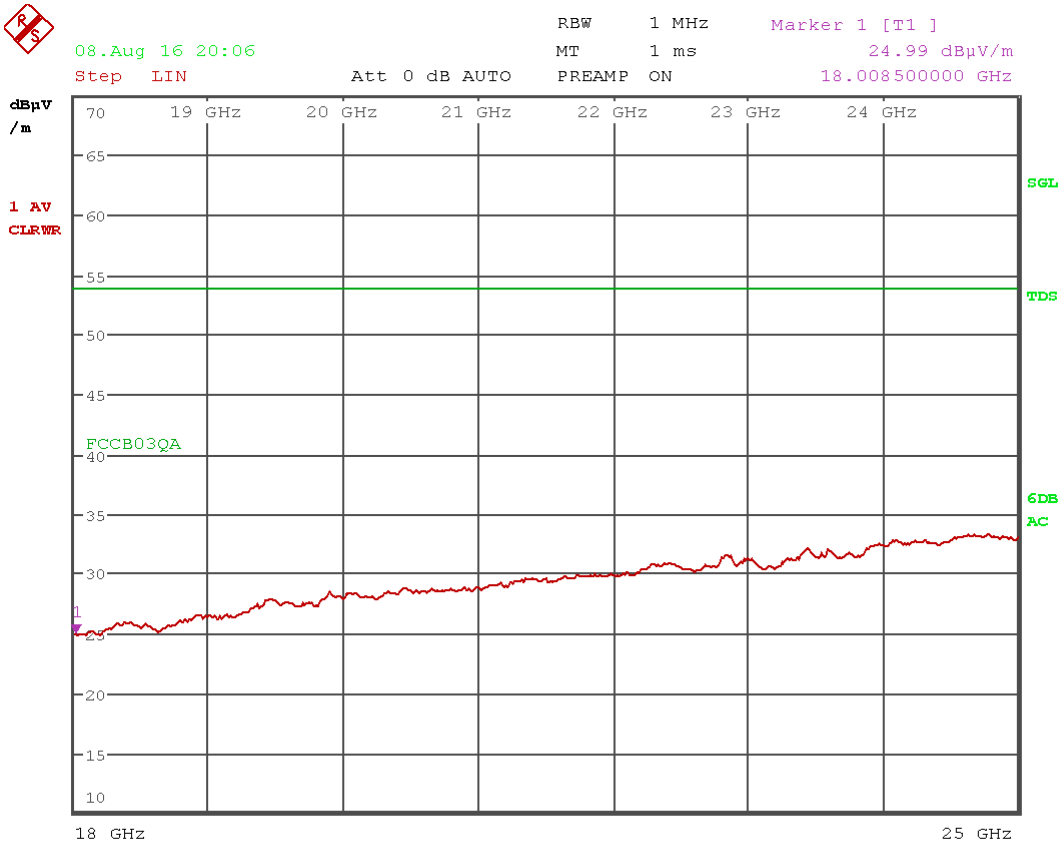
The EUT achieved compliance with negligible levels.

	Temp: º C	% RH	Pa mbar	Tested by:	Date:
Semi-Anechoic Room	22	46	999	CS	08/07/2016

Plot 8g V196AHU2



Plot 8h V196AVU2



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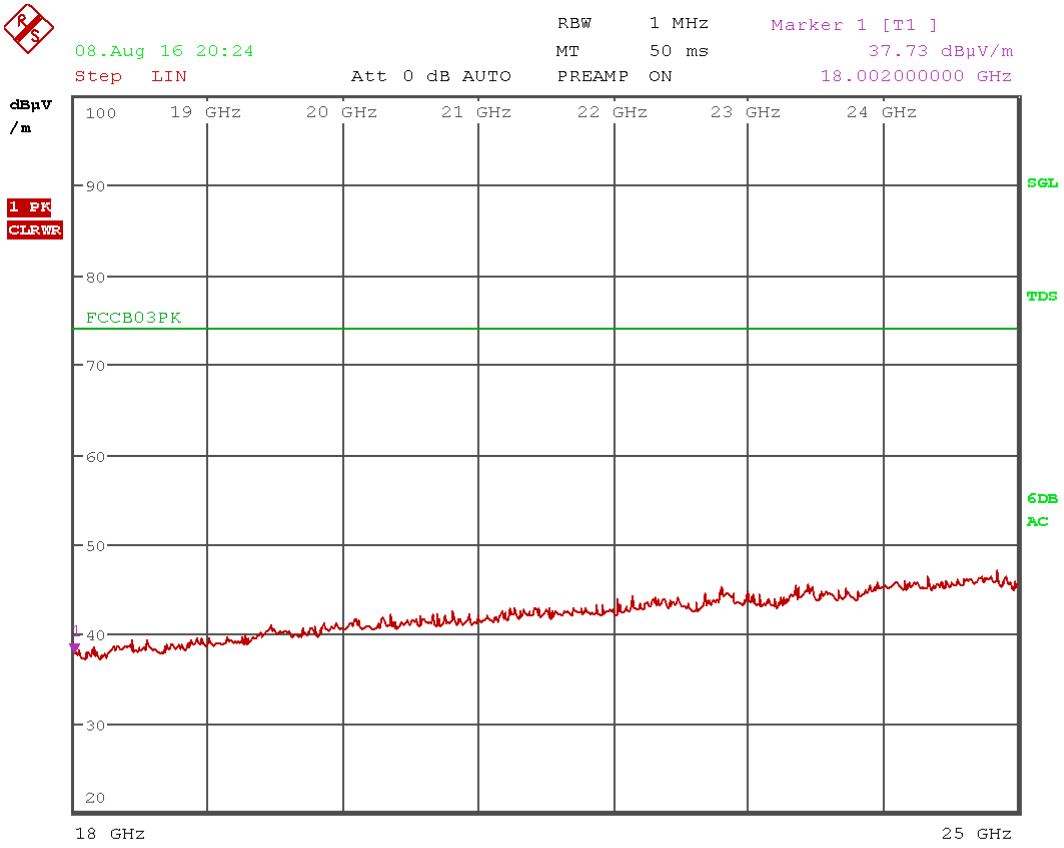

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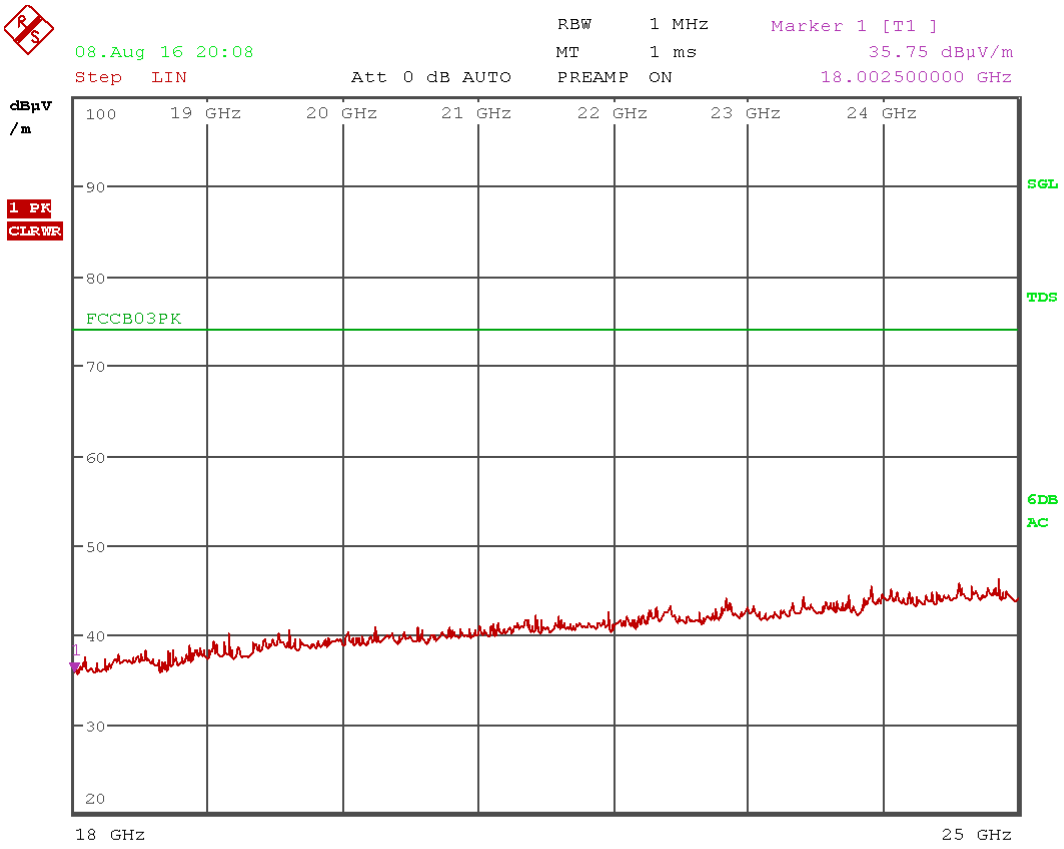

From the results obtained, the Arcam Ltd, Arcam irDAC-II system tested, was found to be compliant with the applicable FCC Pt 15.247 requirements as follows:

FCC Rules	Emissions Tests	Status
15.247 (a) (1)	20 dB Emissions BW	Complied
15.247 (a) (1) (iii)	Minimum Hopping Channels	Complied
15.247 (b)	PK O/P Power	Complied
15.247 (a) (1) (iii)	Dwell Time	Complied
15.247 (d)	Spurious Emissions (Conducted)	Complied
15.247 (d)	Band Edge Measurements	Complied
15.209, 15.205, 15.247(d)	Spurious Radiated Emissions	Complied

Appendix A	**User Information**
Appendix B	**Measurement Uncertainty**
Appendix C	**List of Equipment Used**
Appendix D	**Support Equipment**

User Information

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual.

The Federal Communications Commission Radio Frequency Interference Statement includes the following paragraph.

This equipment has been tested and found to comply with the limits for a Class B Digital Device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio / TV technician for help.

To comply with the FCC RF exposure compliance requirement, this device and its antenna must not be co-located or operating to conjunction with any other antenna or transmitter.

Measurement Uncertainty

The reported expanded measurement uncertainties are based on a standard uncertainty multiplied by a coverage factor of k = 2, providing a confidence level of approx. 95%. The uncertainty evaluation has been carried out in accordance with M3003 requirements.

The estimated combined standard measurement uncertainties are:

Measurement Uncertainty	***Ucispr***	***Ulab***
Conducted Measurements 9 kHz - 40 GHz	3.55	3.57

Traceability
All measurement equipment calibrations are traceable to national standards.

Calibration
Equipment requiring calibration is calibrated to Manufacturer's specifications. Additional verification tests are performed on a regular basis using in house standards and comparisons.

Test Equipment List

TG Number	Description	Model Number	Manufacturer	Serial Number		Software Firmware		Calibration due
Conducted RF Emissions								
3	Receiver (20 Hz to 40GHz)	ESU40	Rohde & Schwarz	100069	0	4.13 SP1	0	08/05/2017
Radiated RF Emissions								
3	Receiver (20 Hz to 40GHz)	ESU40	Rohde & Schwarz	100069				08/05/2017
13	Horn Antenna 1.0 GHz - 18 GHz	DRG-118A	ARA	ETS0801				04/04/2019
272	Big Chamber	N/A	Rainford	Chamber 1				08/01/2017
296	Camera Controller	CON4	Pontis	0				N/A
163	Antenna mast	1090	EMCO	0				N/A
293	Innco Controller	C03000	Innco Systems	0				N/A
164	Turntable	N/A	ETS	0				N/A
150	Double - Ridge Guide Antenna	SAS-571	AH Systems	516				27/05/2017
396	Bilog Antenna 30 MHz to 1 GHZ	CBL6111A	Chase	1536				06/08/2017
197	Pre Amplifier	AS5892	Atlantec RF	13616				11/01/2016
202	10 dB Attenuator	AN18-10	AtlanTecRF	0				11/01/2016

Support Equipment

The table below provides a list of all the support equipment used during the test.

Item	Description, Brand Name, Model	Serial Number	EMC Compliance
1	Laptop (ETS)		
2	Arcam A19 amplifier	Prototype 1	Y
3	Muso Speaker		
4	Arcam FMJ A29		