

Test Report # 317161 A

Equipment Under Test: IRIS

Test Date(s): August 18-22 and September 12, 2017

Prepared for: Husqvarna
Attn: Matt Albinger
8825 Statesville Road
Charlotte, NC 28269

Report Issued by: Adam Alger, Quality Systems Engineer

Signature: 

Date: 12/20/2017

Report Reviewed by: Khairul Aidi Zainal, Laboratory Manager

Signature: 

Date: 12/20/2017

Report Constructed by: Adam Alger, Quality Systems Engineer

Signature: 

Date: 12/20/2017

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Laird Technologies Test Services in Review

The Laird Technologies, Inc. laboratory located at W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA is recognized through the following organizations:



A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope

A2LA Certificate Number: 1255.01

Scope of accreditation includes all test methods listed herein, unless otherwise noted.



Federal Communications Commission (FCC) – USA

Accredited recognition of two 3 meter Semi-Anechoic Chambers

Accredited Test Firm Registration Number: 953492



Innovation, Science and Economic Development Canada

ISED Site listing of two 3 meter Semi-Anechoic Chambers based on RSS-GEN – Issue 4

File Number: IC 3088A-2

File Number: IC 3088A-3

Company: Husqvarna	Page 3 of 23	Name: IRIS
Report: TR 317161 A		Model: 590568001
Job: C-2772		Serial: Engineering Sample

1 TEST REPORT SUMMARY

During **August to September 2017** the Equipment Under Test (EUT), **IRIS**, as provided by **Husqvarna** was tested to the following requirements:

Requirement	Description	Specification	Method	Compliant
15.247 (a)(2) RSS-247 5.2 (a)	Digital Modulation System 6 dB bandwidth	500 kHz	ANSI C63.10	Yes
2.1049 RSS-GEN 6.6	Occupied Bandwidth	Reported	ANSI C63.10	Yes
15.247 (b)(3) RSS-247 5.4 (d)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Yes
15.247 (e) RSS-247 5.2 (b)	Digital Modulation System Power Spectral Density	8 dBm / 3 kHz	ANSI C63.10	Yes
15.247 (d) RSS-247 5.5	RF Spurious Emissions at the Transmitter Antenna Terminal	20 dBc	ANSI C63.10	Yes
15.247 (d) RSS-GEN 8.10	Spurious Radiated Emissions in Restricted Bands	FCC 15.209	ANSI C63.10	Yes
2.1055 (d) RSS-GEN 6.11	Frequency Stability	Reported	ANSI C63.10	Yes
15.207 RSS-GEN 8.8	AC Power Line Conducted Emissions	0.150-30 MHz	ANSI C63.10	N/A

Note: AC Emissions not applicable. Battery operated device only.

Notice:

The results relate only to the item tested and described in this report. Any modifications made to the equipment under test after the specified test date(s) may invalidate the data herein.

If the resulting measurement margin is seen to be within the uncertainty value, as listed in this report, the possibility exists that this unit may not meet the required limit specification if subsequently tested.

2 CLIENT INFORMATION

Company Name	Husqvarna
Contact Person	Matthew Albinger
Address	8825 Statesville Road Charlotte, NC 28269

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	IRIS
Model Number	590568001
Serial Number	Engineering Sample
FCC / IC ID	2ANTT-IRIS01 / 23218-IRIS01

2.2 Product Description

Bluetooth low energy product with integral antenna

2.3 Modifications Incorporated for Compliance

None noted at time of test

2.4 Deviations and Exclusions from Test Specifications

None noted at time of test

2.5 Additional Information

Channels low (2402 MHz), middle (2440 MHz) and high (2480 MHz) with transmit selectable modulated or un-modulated programmed via hex files loaded by a computer connected to a programming board plugged into EUT for programming then removed for testing. Cypress PSoC Programmer 3.26.0.2791 loaded custom hex files for each channel and mode.

3 REFERENCES

Publication	Edition	Date
CFR 47 Part 15.247	-	2017
RSS-247	2	2017
CFR 47 Part 15.209	-	2017
ANSI C63.10	-	2013
RSS-GEN	4	2014

4 UNCERTAINTY SUMMARY

Using the guidance of the following publications the calculated measurement uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of $k = 2$.

References	Version / Date
CISPR 16-4-1	Ed. 2 (2009-02)
CISPR 16-4-2	Ed. 2 (2011-06)
CISPR 32	Ed. 1 (2012-01)
ANSI C63.23	2012
A2LA P103	February 4, 2016
A2LA P103c	August 10, 2015
ETSI TR 100-028	V1.3.1 (2001-03)

Measurement Type	Configuration	Uncertainty $\pm$
Radiated Emissions	Biconical Antenna	5.0 dB
Radiated Emissions	Log Periodic Antenna	5.3 dB
Radiated Emissions	Horn Antenna	4.7 dB
AC Line Conducted Emissions	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	4.9 dB
Disturbance Power Emissions	Absorbing Clamp	4.1 dB
Radiated Immunity	3 Volts/meter	2.2 dB
Conducted Immunity	CDN/EM/BCI	2.4/3.5/3.4 dB
EFT Burst/Surge	Peak pulse voltage	164 volts
ESD Immunity	15 kV level	1377 Volts

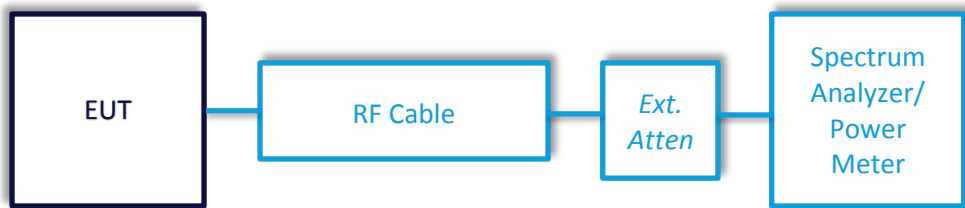
Parameter	ETSI U.C. $\pm$	U.C. $\pm$
Radio Frequency, from F0	1×10^{-7}	0.55×10^{-7}
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

5 TEST DATA

5.1 Antenna Port Conducted Emissions

Description of Measurement	The direct measurement of emissions at the antenna port of the EUT is achieved by use of a RF connection to a spectrum analyzer or power meter. The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.
Example Calculations	Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm) Margin (dB) = Limit (dBm) – Corrected Reading (dBm)

Block Diagram



5.1.1 Antenna Port Conducted Emissions

Operator	Adam Alger
QA	Zach Wilson
Test Date	8/19/2017
Location	Radio bench
Temp. / R.H.	68/60
Requirement	FCC 15.247 / RSS-247
Method	ANSI C63.10

Limits:

Type	Limit
Output Power	30 dBm
PSD	8 dBm / 3 kHz
Spurious	20 dBc
DTS BW	500 kHz

Test Parameters

Frequency	30-25000 MHz
RBW	100 kHz (spurious, PSD, DTS BW); RBW > DTS BW = 3 MHz (output power)
Detector	Peak Max Hold
EUT	12 VDC from bench supply (5.5-16.5 VDC for frequency stability)
EUT Channels	Low (2402 MHz), Mid (2440 MHz), High (2480 MHz)
Example Calculation	Spurious Limit = 100 kHz reference (PSD Plot) – 20 dB

Instrumentation



Date : 18-Aug-2017 Test : Antenna Port Conducted Emissions Job : C-2772
 PE : Adam Alger Customer : Husqvarna Quote : 317161

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	EMI Receiver	Agilent	N9038A	MY51210148	5/12/2017	5/12/2018	Active Calibration
2	EE 960081	DC Power Supply	Tenma	72-7700	1001514	11/14/2016	11/14/2017	Active Verification

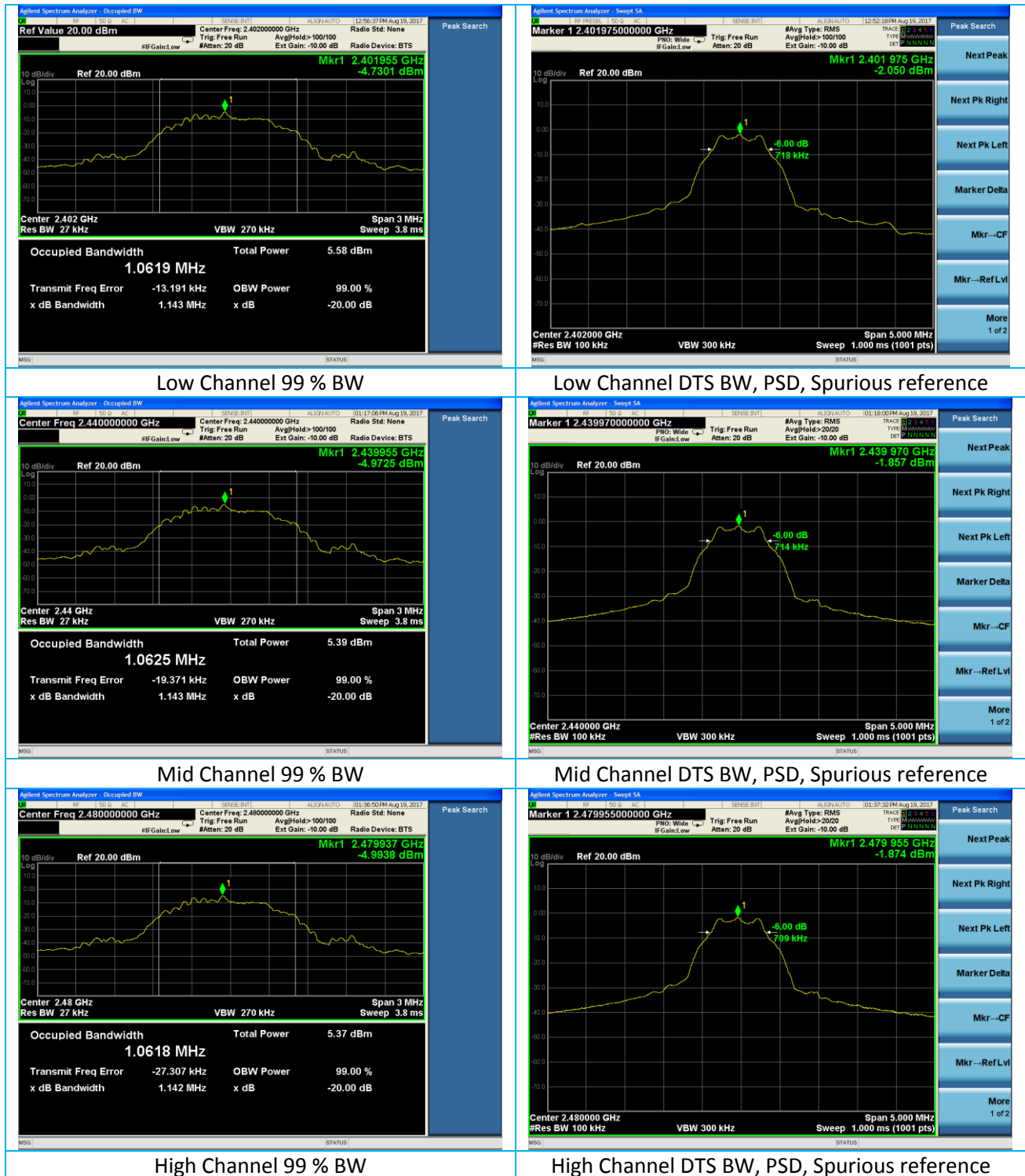
Table

Frequency (MHz)	99 % BW (MHz)	DTS BW (MHz)	PSD 100 kHz (dBm)	PSD 3 kHz limit (dBm)	PSD Margin (dB)	Output Power (dBm)	Output Power Limit (dBm)	Output Power Margin (dBm)
2402	1.06	0.718	-2.05	8.00	10.1	-1.53	30.00	31.5
2440	1.06	0.714	-1.86	8.00	9.9	-1.29	30.00	31.3
2480	1.06	0.709	-1.87	8.00	9.9	-1.32	30.00	31.3

Frequency (MHz)	Spurious Reference -20 dB
2402	-22.05
2440	-21.86
2480	-21.87

Channel	5.5 VDC (Hz)	12 VDC (Hz)	16.5 VDC (Hz)	Max Deviation (Hz)
Low	2401973697	2401974101	2401973854	404
Mid	2439973367	2439973178	2439973083	284
High	2479972807	2479972868	2479973059	252

Plots



Company: Husqvarna

Report: TR 317161 A

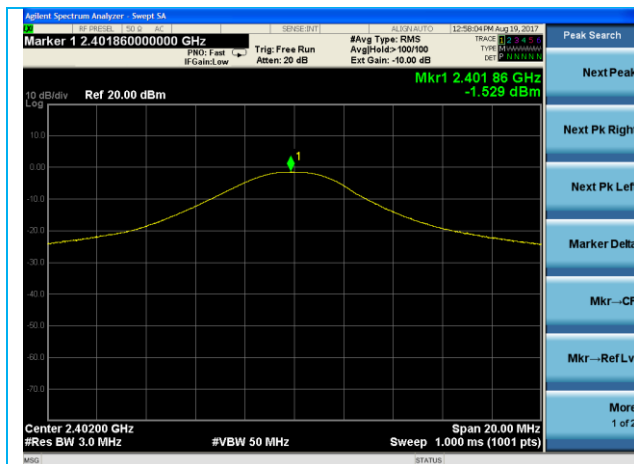
Job: C-2772

Name: IRIS

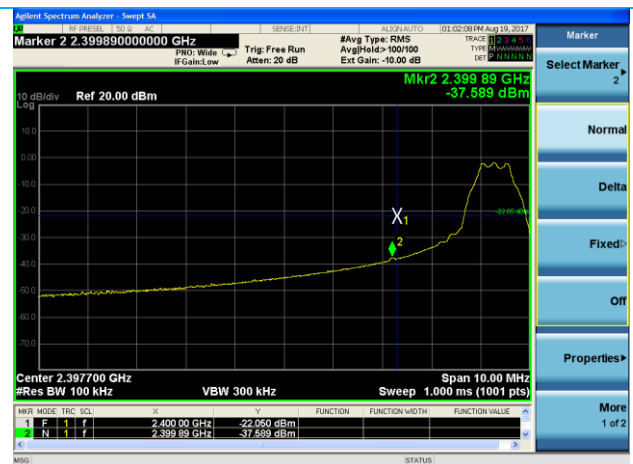
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Serial: Engineering Sample

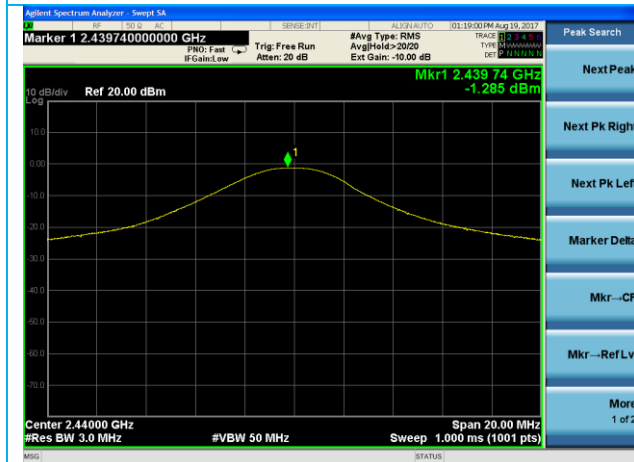
Plots



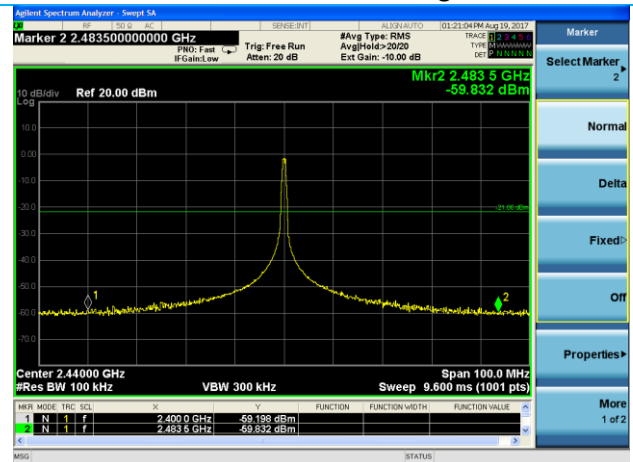
Low Channel Power



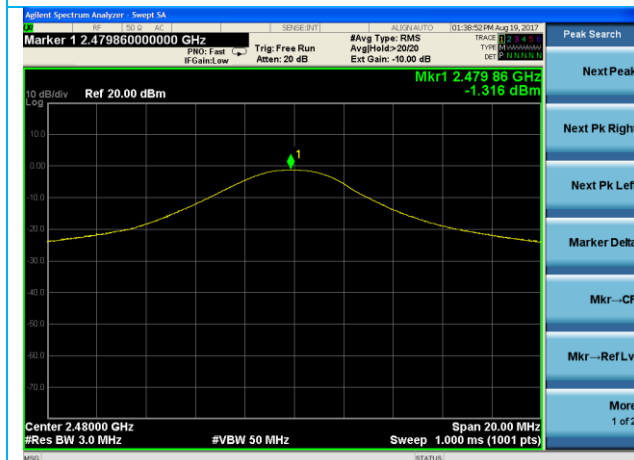
Low Channel Band-edge



Mid Channel Power



Mid Channel Band-edge



High Channel Power



High Channel Band-edge

Company: Husqvarna

Report: TR 317161 A

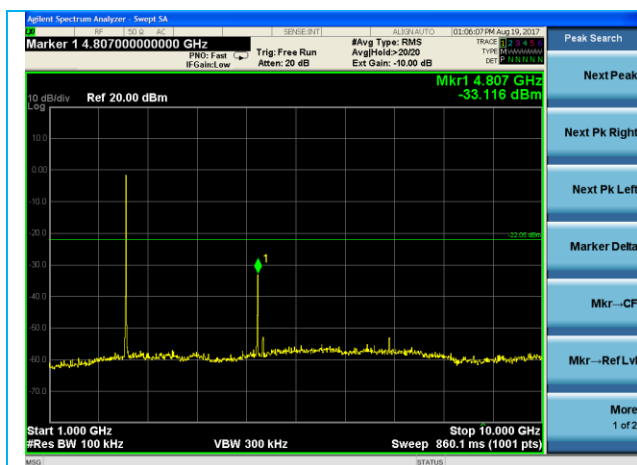
Job: C-2772

Name: IRIS

Model: 590568001

Serial: Engineering Sample

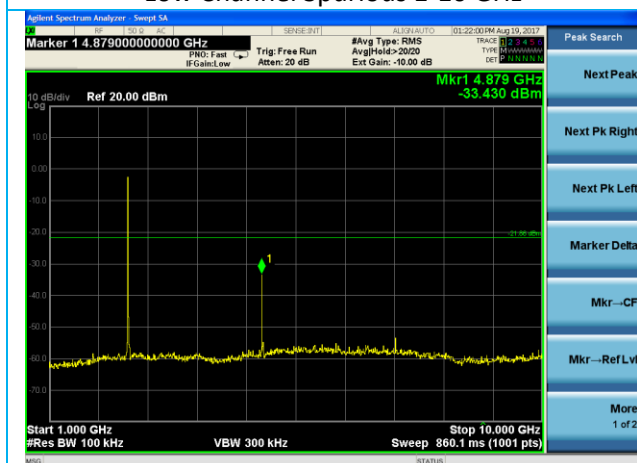
Plots



Low Channel Spurious 1-10 GHz



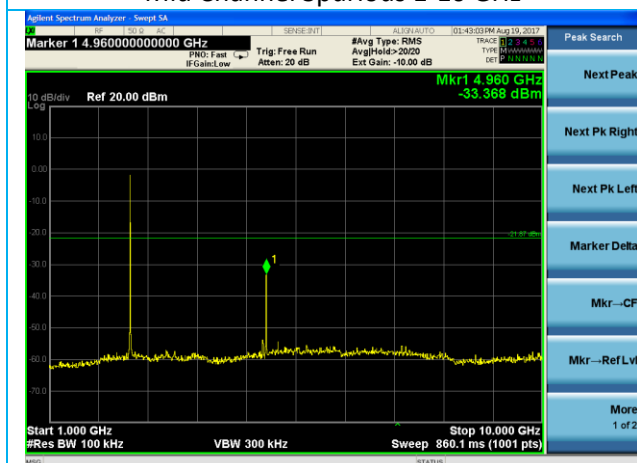
Low Channel Spurious 10-25 GHz



Mid Channel Spurious 1-10 GHz



Mid Channel Spurious 10-25 GHz



High Channel Spurious 1-10 GHz



High Channel Spurious 10-25 GHz

Company: Husqvarna

Report: TR 317161 A

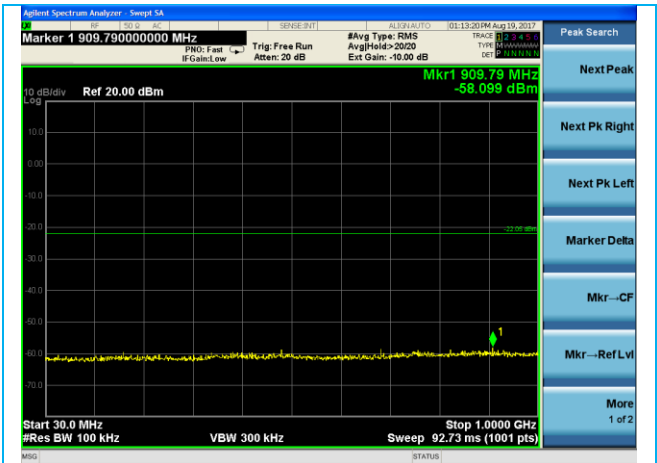
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Name: IRIS

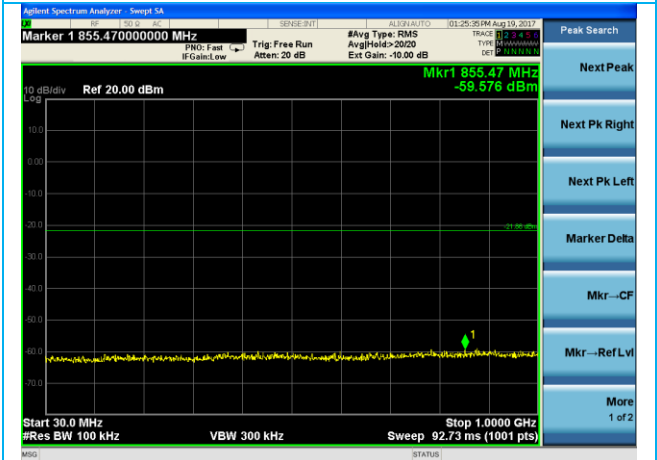
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Serial: Engineering Sample

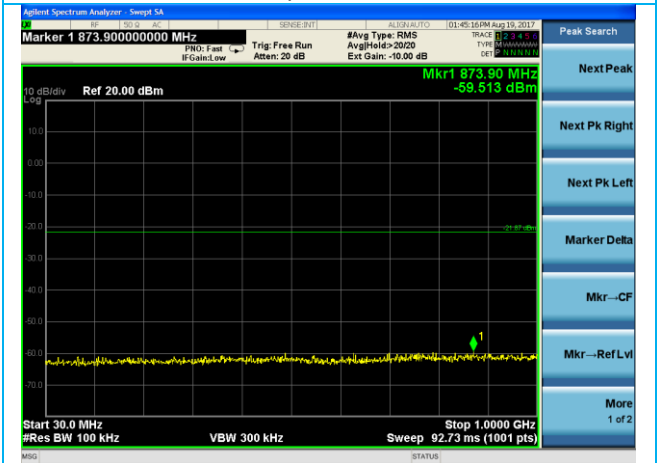
Plots



Low Channel Spurious 30-1000 MHz



Mid Channel Spurious 30-1000 MHz



High Channel Spurious 30-1000 MHz

5.2 Radiated Emissions

Description of Measurement	The frequency spectrum is investigated for intentional and / or unintentional signals emanating from the EUT by use of a standardized test site and measurement antenna. The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed allowing the data to be gathered and reported as corrected values. The maximum emissions from the EUT are determined by turn-table azimuth rotation (360°) and scanning of the measurement antenna. Maximized levels are noted at degree values of azimuth, measurement antenna height, and measurement antenna polarity.
Example Calculations	Measurement (dBμV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBμV/m) Margin (dB) = Limit (dBμV/m) - Corrected Reading (dBμV/m) Example at 4000 MHz: Reading = 40 dBμV + 3.4 dB + 0.9 dB + 6.5 dB/m = 50.8 dBμV/m Average Limit = 20 log (500) = 54 dBμV/m Margin = 54 dBμV/m - 50.8 dBμV/m = 3.2 dB

Block Diagram



5.2.1 Radiated Emissions 30-1000 MHz

Operator	Adam Alger
QA	Zach Wilson
Test Date	8/21/2017
Location	Chamber 5
Temp. / R.H.	68/65
Requirement	15.209 / RSS-247
Method	ANSI C63.10 Section 11.12, 6.3, 6.5, 6.6

Limits:

Frequency of emission (MHz)	Field strength (microvolts/meter)	Limit (dBμV/m) 3 meter	Limit Type
30-88	100	40.0	Quasi-Peak
88-216	150	43.5	
216-960	200	46.0	
Above 960	500	54.0	Average

Test Parameters

Frequency	30-1000 MHz
Distance	3m
Measurement Settings: RBW	120 kHz
Measurement Settings: VBW	1.2 MHz
Measurement Settings	Peak detector Max hold trace
Measurement Settings: Final	Peak compared to quasi-peak limit
EUT	12VDC from bench supply - Continuous transmit low, mid, high channel
Notes	Tested in three orthogonal orientations

Instrumentation



Date : 18-Aug-2017

Test : Radiated Emissions

Job : C-2772

PE : Adam Alger

Customer : Husqvarna

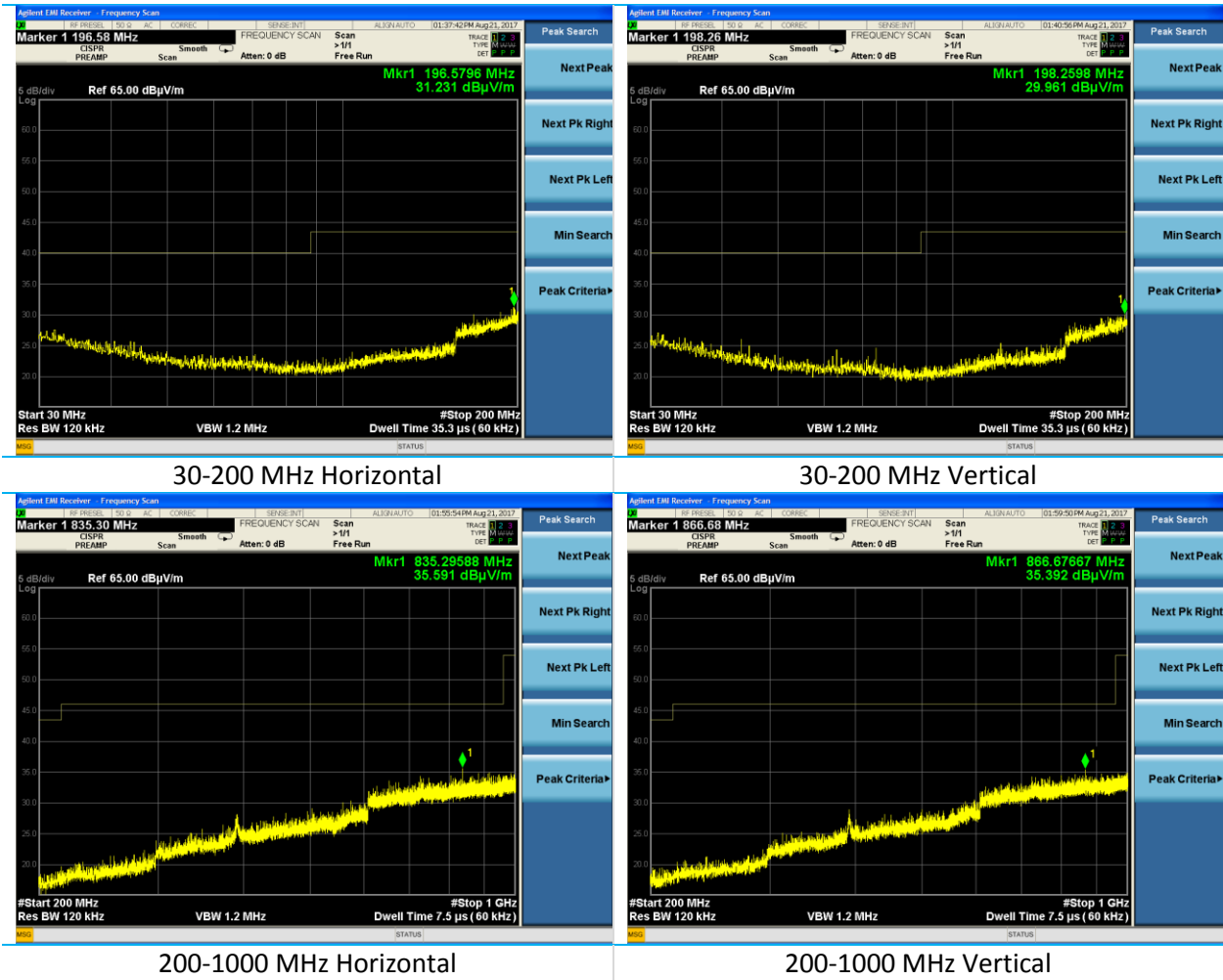
Quote : 317161

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	EMI Receiver	Agilent	N9038A	MY51210148	5/12/2017	5/12/2018	Active Calibration
2	AA 960176	Cable - low loss 6m	A.H. Systems, Inc	SAC-26G-6	395	5/15/2017	5/15/2018	Active Verification
3	AA 960153	High Pass Filter 2.4 GHz	KWM	HPF-L-14186	7272-04	5/2/2017	5/2/2018	Active Calibration
4	AA 960158	Double Ridge Horn Antenna	ETS Lindgren	3117	109300	10/13/2016	10/13/2017	Active Calibration
5	EE 960159	Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	462101702	4/12/2017	4/12/2018	Active Calibration
6	EE 960088	EMI Receiver	Agilent	N9038A	MY51210138	3/2/2017	3/2/2018	Active Calibration
7	AA 960150	Biconical Antenna	ETS Lindgren	3110B	0003-3346	3/3/2017	3/3/2018	Active Calibration
8	AA 960163	Log Periodic Antenna	A.H. Systems, Inc	SAS-512-2	500	3/28/2017	3/28/2018	Active Calibration

Table

Frequency (MHz)	EUT orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBμV/m)	Quasi-Peak Limit (dBμV/m)	Margin (dB)
196.58	Horizontal	Horizontal	100	0	31.231	43.50	12.27
198.26	Horizontal	Vertical	100	0	29.96	43.50	13.54
835.29	Vertical	Vertical	100	0	35.95	46.00	10.05
866.67	Vertical	Vertical	100	0	35.39	46.00	10.61

Plots



5.2.2 Radiated Emissions 1000-25000 MHz

Operator	Zach Wilson
QA	Adam Alger
Test Date	8/18, 8/22, 9/12
Location	Chamber 5
Temp. / R.H.	68/65
Requirement	15.209 / RSS-247
Method	ANSI C63.10 Section 11.12, 6.3, 6.5, 6.6

Limits:

Frequency of emission (MHz)	Field strength (microvolts/meter)	Limit (dBμV/m) 3 meter	Limit Type
30-88	100	40.0	Quasi-Peak
88-216	150	43.5	
216-960	200	46.0	
Above 960	500	54.0	Average

Test Parameters

Frequency	1000-25000 MHz
Distance	3m
Measurement Settings: RBW	1 MHz
Measurement Settings: VBW	3 MHz (peak) 3 kHz (average)
Measurement Settings	Peak detector Max hold trace
Measurement Settings: Final	Peak and Average
EUT	12VDC from bench supply - Continuous transmit low, mid, high channel
Notes	Tested in three orthogonal orientations

Instrumentation



Date : 18-Aug-2017

Test : Radiated Emissions

Job : C-2772

PE : Adam Alger

Customer : Husqvarna

Quote : 317161

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	EMI Receiver	Agilent	N9038A	MY51210148	5/12/2017	5/12/2018	Active Calibration
2	AA 960176	Cable - low loss 6m	A.H. Systems, Inc	SAC-26G-6	395	5/15/2017	5/15/2018	Active Verification
3	AA 960153	High Pass Filter 2.4 GHz	KWM	HPF-L-14186	7272-04	5/2/2017	5/2/2018	Active Calibration
4	AA 960158	Double Ridge Horn Antenna	ETS Lindgren	3117	109300	10/13/2016	10/13/2017	Active Calibration
5	EE 960159	Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	462101702	4/12/2017	4/12/2018	Active Calibration
6	EE 960088	EMI Receiver	Agilent	N9038A	MY51210138	3/2/2017	3/2/2018	Active Calibration
7	AA 960150	Biconical Antenna	ETS Lindgren	3110B	0003-3346	3/3/2017	3/3/2018	Active Calibration
8	AA 960163	Log Periodic Antenna	A.H. Systems, Inc	SAS-512-2	500	3/28/2017	3/28/2018	Active Calibration

Table

Restricted band-edge

Frequency (GHz)	EUT orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)
2.3890	Horizontal	Vertical	111	133.25	57.00	74.00	17.00
2.2694	Horizontal	Vertical	111	133.25	55.21	74.00	18.79
3.2236	Horizontal	Vertical	111	133.25	57.739	74.00	16.26
2.4835	Horizontal	Vertical	111	133.25	65.165	74.00	8.83
2.2956	Horizontal	Vertical	111	133.25	55.018	74.00	18.98
2.4835	Horizontal	Vertical	111	133.25	67.107	74.00	6.89

Frequency (GHz)	EUT orientation	Antenna Polarity	Height (cm)	Azimuth (degree)	Avg Reading (dBμV/m)	Avg Limit (dBμV/m)	Avg Margin (dB)
2.3668	Horizontal	Vertical	111	133.25	44.96	54.0	9.04
2.2720	Horizontal	Vertical	111	133.25	44.68	54.0	9.32
3.5951	Horizontal	Vertical	111	133.25	48.38	54.0	5.62
2.4837	Horizontal	Vertical	111	133.25	45.87	54.0	8.14
2.2733	Horizontal	Vertical	111	133.25	44.58	54.0	9.42
3.5921	Horizontal	Vertical	111	133.25	48.83	54.0	5.17

Company: Husqvarna

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Name: IRIS

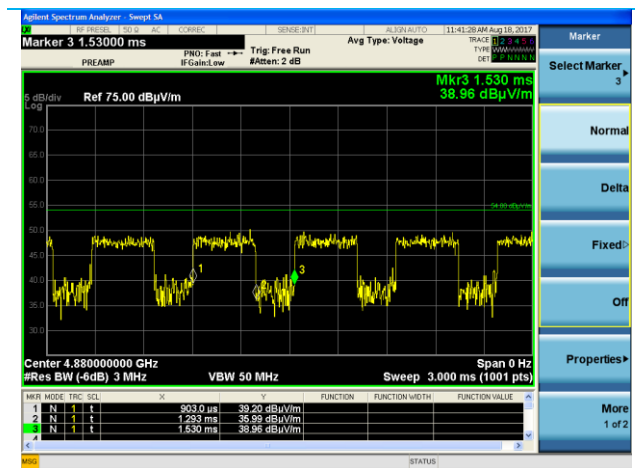
Model: 590568001

Serial: Engineering Sample

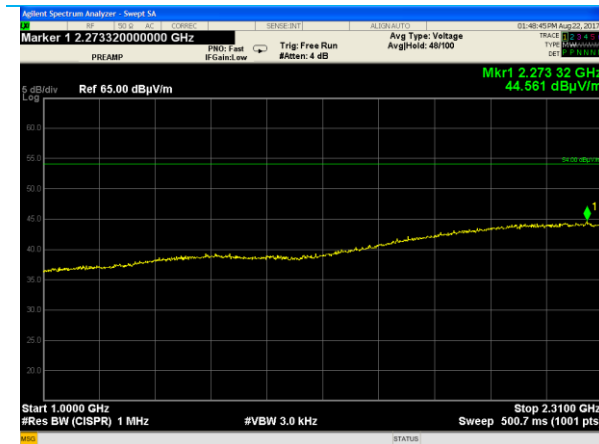
Restricted bands

Frequency (MHz)	EUT orientation	Channel	Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBμV/m)	Avg Reading (dBμV/m)	Peak Limit (dBμV/m)	Peak Margin (dB)	Avg Limit (dBμV/m)	Avg Margin (dB)
4880	Horizontal	Mid	Horizontal	190.0	161.0	47.94	43.13	74.00	26.06	54.0	10.88
4880	Horizontal	Mid	Vertical	117.0	243.0	47.69	42.57	74.00	26.31	54.0	11.43
4804	Horizontal	Low	Vertical	128.2	116.3	47.52	41.62	74.00	26.48	54.0	12.38
4804	Horizontal	Low	Horizontal	162.0	60.0	47.75	41.89	74.00	26.25	54.0	12.11
4960	Horizontal	High	Horizontal	204.5	220.8	48.74	43.01	74.00	25.26	54.0	10.99
4960	Horizontal	High	Vertical	120.0	122.0	48.36	43.10	74.00	25.64	54.0	10.90
4960	Flat	High	Vertical	224.2	232.8	48.43	43.06	74.00	25.57	54.0	10.94
4960	Flat	High	Horizontal	150.0	94.0	48.91	43.72	74.00	25.09	54.0	10.28
4880	Flat	Mid	Horizontal	163.6	90.0	47.43	41.96	74.00	26.58	54.0	12.04
4880	Flat	Mid	Vertical	216.9	234.5	48.27	42.88	74.00	25.73	54.0	11.12
4804	Flat	Low	Vertical	231.2	243.0	47.52	41.41	74.00	26.48	54.0	12.59
4804	Flat	Low	Horizontal	242.7	138.5	46.77	41.14	74.00	27.23	54.0	12.87
4804	Vertical	Low	Horizontal	150.0	129.5	46.51	40.20	74.00	27.49	54.0	13.80
4804	Vertical	Low	Vertical	314.5	194.0	47.89	41.89	74.00	26.11	54.0	12.11
4880	Vertical	Mid	Vertical	308.0	190.0	47.90	42.19	74.00	26.10	54.0	11.81
4880	Vertical	Mid	Horizontal	150.0	133.3	47.11	41.11	74.00	26.90	54.0	12.89
4960	Vertical	High	Horizontal	110.0	128.5	48.90	43.62	74.00	25.10	54.0	10.38
4960	Vertical	High	Vertical	278.0	213.8	48.60	43.28	74.00	25.40	54.0	10.72

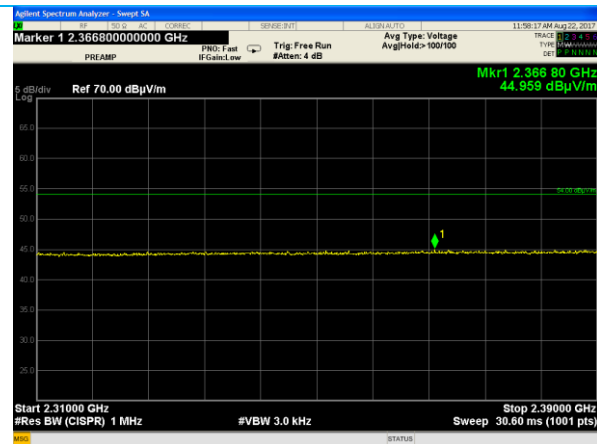
Plots



Duty cycle 90.3% = 3 kHz VBW for average meas.



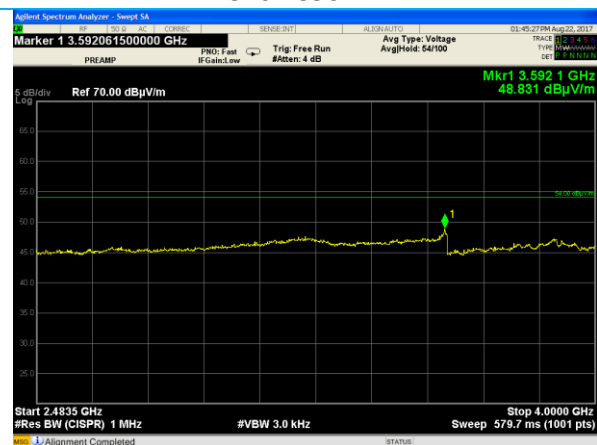
1000-2310 MHz



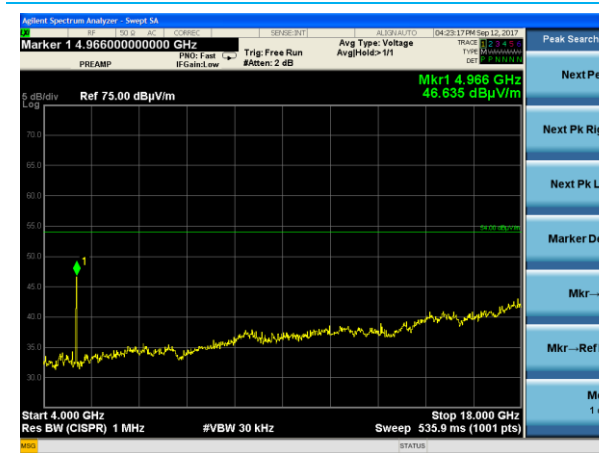
2310-2390 MHz



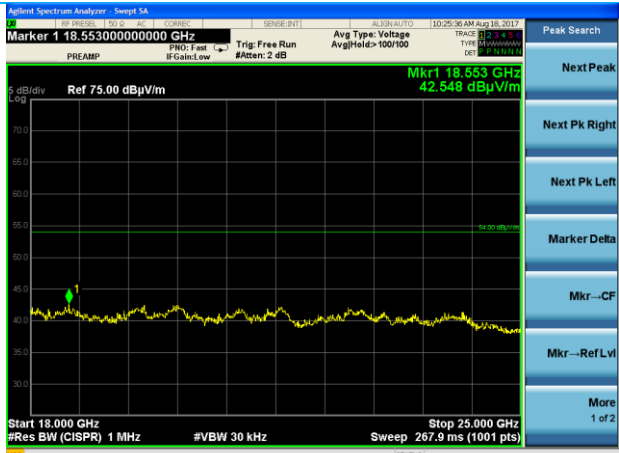
2483.5-2500 MHz



2483.5-4000 MHz



4000-18000 MHz



18000-25000 MHz

6 REVISION HISTORY

Version	Date	Notes	Person
V0	12/20/17	Customer Info Added and Draft Complete	Adam Alger
V1	12/20/2017	Internal Review and Final Version	Adam Alger

END OF REPORT