

Test Report # 318196 B

Equipment Under Test: Digilance V

Test Date(s): 9/19/18 – 10/31/18

Prepared for: Jason Black
Heraeus Electro-Nite
541 Industrial Drive
Hartland, WI 53029

Report Issued by: Shane Dock, EMC Engineer

Signature:



Date: 12/20/2018

Report Reviewed by: Adam Alger, Quality Manager

Signature: 

Date: 11/11/2018

Report Constructed by: Shane Dock, EMC Engineer

Signature:



Date: 12/20/2018

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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



**Government
of Canada**

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: Heraeus Electro-Nite	Page 3 of 29	Name: Digilance V
Report: 318196 B		Model: DL5W
Job: C-3073		Serial: DL5WTD A24180006

1 TEST REPORT SUMMARY

During **9/19/18 – 10/31/18** the Equipment Under Test (EUT), **Digilance V**, as provided by **Heraeus Electro-Nite** was tested to the following requirements:

Requirement	Description	Specification	Method	Result
FCC: 15.247 (a)(1) IC: RSS-247 5.1	Channel Separation, Number of Hopping frequencies, Time of Occupancy	FHS	ANSI C63.10	Pass
FCC: 2.1049 IC: RSS-GEN 6.6	Occupied Bandwidth	Reported	ANSI C63.10	Pass
FCC: 15.247 (b)(1) IC: RSS-247 5.4 (b)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Pass
FCC: 15.247 (d) IC: RSS-247 5.5	RF Spurious Emissions at the Transmitter Antenna Terminal	20 dBc	ANSI C63.10	Pass
FCC: 15.247 (d) IC: RSS-GEN 8.10	Spurious Radiated Emissions in Restricted Bands	FCC 15.209 RSS-GEN 8.9	ANSI C63.10	Pass
FCC: 15.207 IC: RSS-GEN 8.8	AC Power Line Conducted Emissions	0.150-30 MHz	ANSI C63.10	N/A

Note: Radio cannot function while charger is connected to the EUT.

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	Heraeus Electro-Nite
Contact Person	Jason Black
Address	541 Industrial Drive Hartland, WI 53029

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	Digilance V
Model Number	DL5W
Serial Number	DL5WTDA24180006
FCC/IC ID	FCC: OSW-DL5W IC: 24510-DL5W

2.2 Product Description

The Digilance V is a hand-held instrument for the measurement of molten metal temperatures. Used with disposable thermocouples the instrument can measure temperatures from 300°C to 2300°C. Housed in a robust Aluminum case, the precision electronics are protected from the difficult environmental conditions encountered in the molten metals industry. The instrument has the option to connect to a wireless receiver box, which enables communication and data storage possibilities using Heraeus Electro-Nite software. The instrument also stores measurement results internally for downloading via the wireless interface.

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

EUT programmed via button presses to switch channel and mode. Low, Mid, and High Channels set to approximately 2404 MHz, 2435.5, and 2466.9 MHz, respectively. RM024 set to Tx or Rx Mode by switching between a "Server" and "Client" module (the former for Tx, the latter for Rx). EUT uses the firmware file "DL5FCC_01.PAC". EUT powered by a 7.2V battery, and can be charged

Company: Heraeus Electro-Nite	Page 5 of 29	Name: Digilance V
Report: 318196 B		Model: DL5W
Job: C-3073		Serial: DL5WTDA24180006

with a charger powered by 120 VAC, 60 Hz. Antenna used is an ANT-2.4-WRT-MON-RPS monopole antenna with a peak gain of 0.8 dBi.

3 REFERENCES

Publication	Edition	Date	AMD 1
CFR 47 Part 15	-	2018	
ANSI C63.10	-	2013	2017
RSS-247	2	2017	
RSS GEN	5	2018	

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

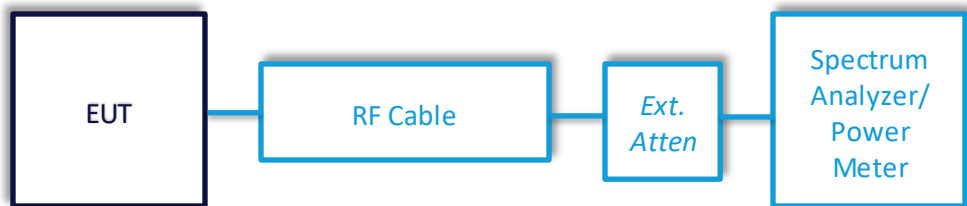
Parameter	ETSI U.C. $\pm$	U.C. $\pm$
Radio Frequency, from F0	1×10^{-7}	0.55×10^{-7}
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9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

Operator	Shane Dock
Test Date	10/31/18
Location	Conducted RF Area
Temp. / R.H.	22.2 deg C/46.6%
Requirement	FCC: 15.247 (a)(1) IC: RSS-247 5.1
Method	ANSI C63.10 Sections 7.8.2, 7.8.3, 7.8.4

Limits:

Frequency Separation	Number of Hopping Channels	Maximum Occupancy Time
>25 kHz or 20 dB Bandwidth	>15	0.4 seconds per 17.2 second period

Test Parameters

Frequency	2404-2466.9 MHz
Settings	Low, Mid, and High Checked
EUT	Hopping mode Utilized on EUT

Instrumentation



Date : 13-Sep-2018

Test : Conducted RF

Job : C-3073

PE : Shane Dock

Customer : Heraeus Electro-Nite

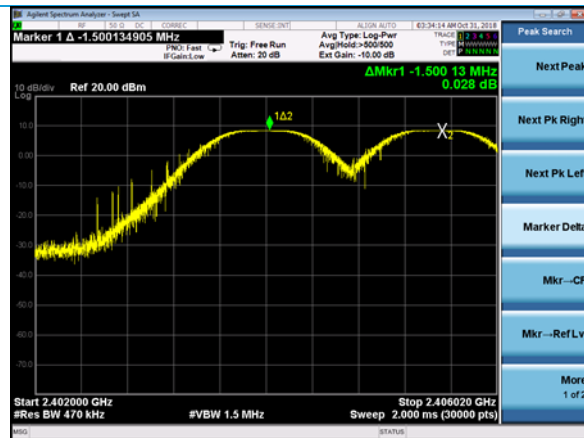
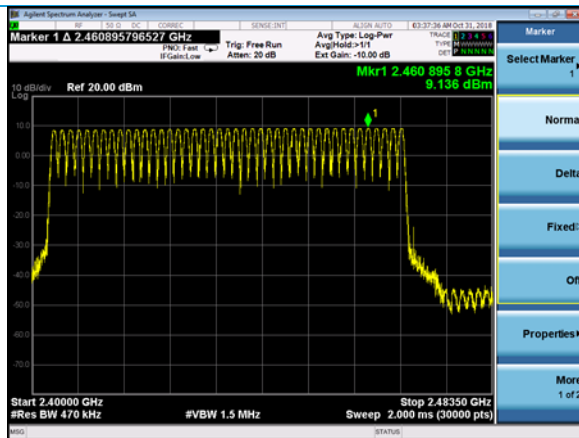
Quote : 318196

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960160	Cable	Micro-Coax	UFC142A-0-0720-20C	218652-001	11/15/2017	11/15/2018	Active Verification
3	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/15/2017	11/15/2018	Active Verification

Table

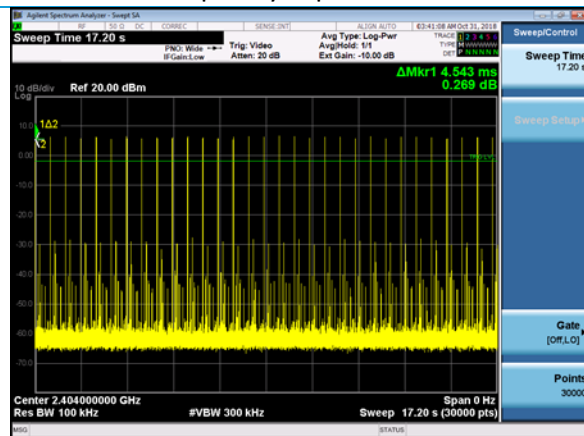
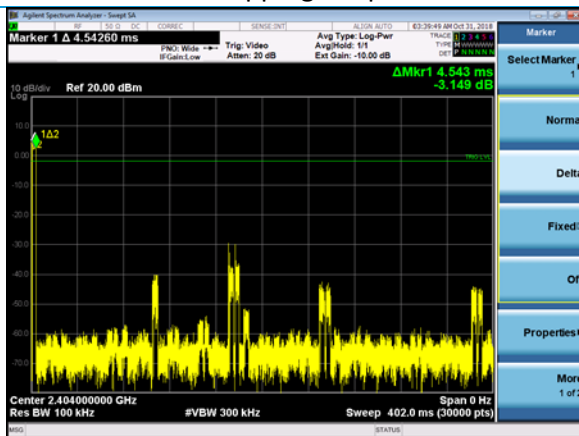
Channel	Occupancy Time (ms)	Number of Transmissions	Occupancy time per 20s (ms)
Low	4.543	31	140.833
Mid	4.516	31	139.996
High	4.516	31	139.996

Plots



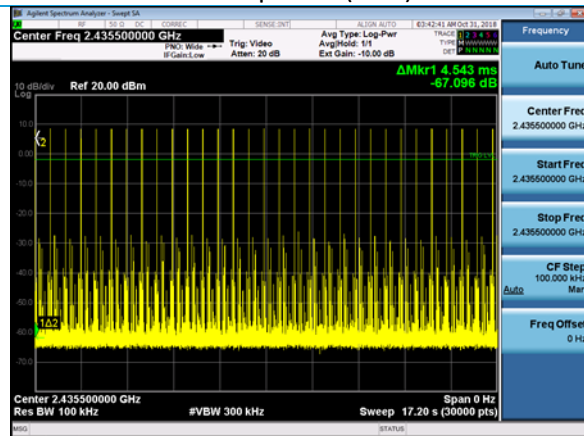
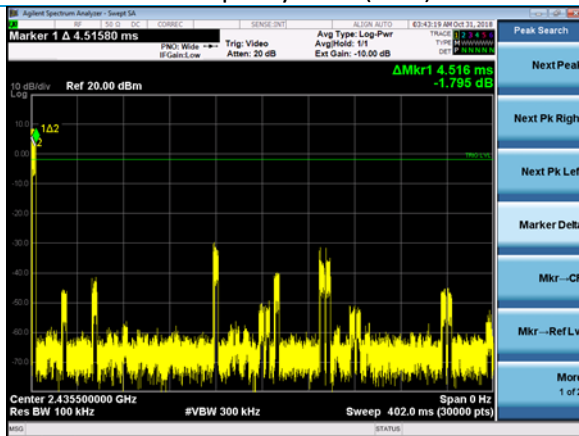
Number of Hopping Frequencies = 43

Carrier Frequency Separation = 1.5 MHz



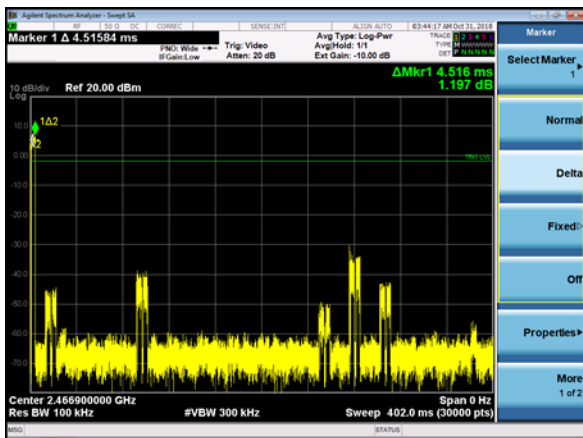
Occupancy Time (Low)

17.2s period (Low)

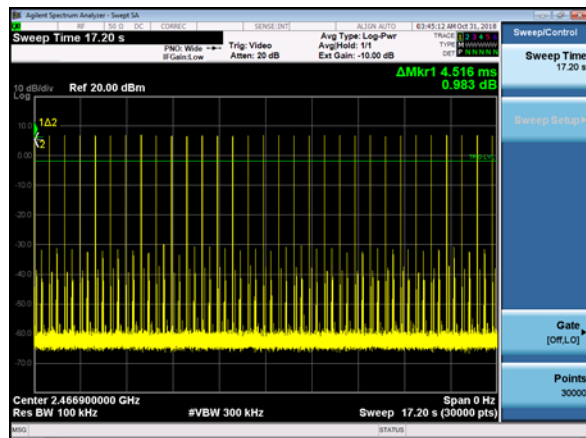


Occupancy Time (Mid)

17.2 period (Mid)



Occupancy Time (High)



17.2s period (High)

5.1.2 Antenna Port Conducted Emissions – Occupied Bandwidth

Operator	Shane Dock
Test Date	10/25/18 – 10/31/18
Location	Conducted RF Area
Temp. / R.H.	22.2 deg C/46.6% RH
Requirement	FCC: 2.1049 IC: RSS-GEN 6.6
Method	ANSI C63.10 Section 7.8.7

Limits:

20 dB BW (MHz)
< 500

Test Parameters

Channels	Low, Mid, High Channels Checked
Settings	99% and 20 dB BW recorded

Table

Channel	Low	Mid	High
20 dB BW (kHz)	830	830	934
99% BW (kHz)	791.59	847.10	853.40

Plots – Occupied Bandwidth



Low



Mid



High

Plots – 20 dB Bandwidth



Low



Mid



High

5.1.3 Antenna Port Conducted Emissions – Maximum Conducted Output Power

Operator	Shane Dock
Test Date	9/23/18
Location	Conducted RF Area
Temp. / R.H.	20.2 deg C/ 55.4% RH
Requirement	FCC: 15.247 (b)(1) IC: RSS-247 5.4 (b)
Method	ANSI C63.10 Section 7.8.5

Limits:

Maximum Conducted Output Power (watts)	Maximum Conducted Output Power (dBm)
1	30

Test Parameters

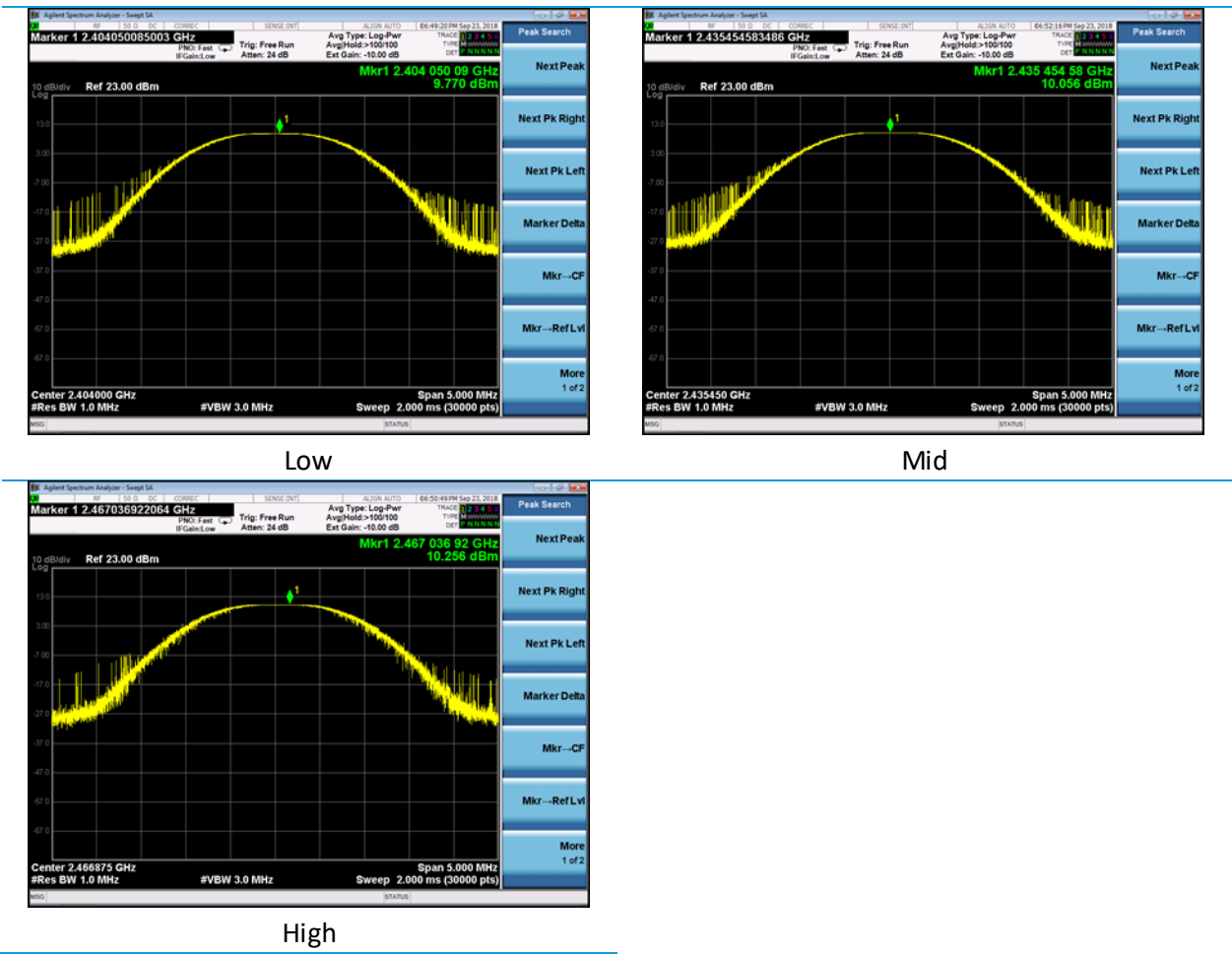
Channels	Low, Mid, High
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Table

Channel	Low	Mid	High
Pout Conducted (dBm)	10.256	10.056	9.770

Worst Case Margin = 30.000 dBm – (10.256 dBm) = 19.744 dB

Plots



5.1.4 Antenna Port Conducted Emissions – RF Spurious Emissions

Operator	Shane Dock
Test Date	10/25/18, 10/31/18
Location	Conducted RF Area
Temp. / R.H.	22.2 degrees C/ 46.6 %RH
Requirement	FCC: 15.247 (d) IC: RSS-247 5.5
Method	ANSI C63.10 Sections 7.8.6 and 7.8.8

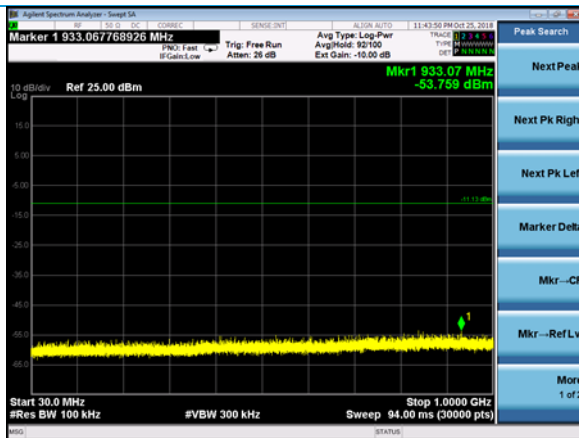
Limits:

RF Spurious Limit
20 dBc

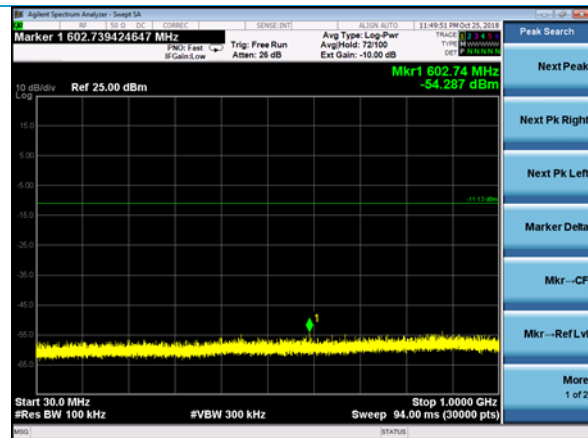
Test Parameters

Frequency	30-25000 MHz
Channels	Low, Mid, High
Notes	All emissions are >25 dB below the limit.

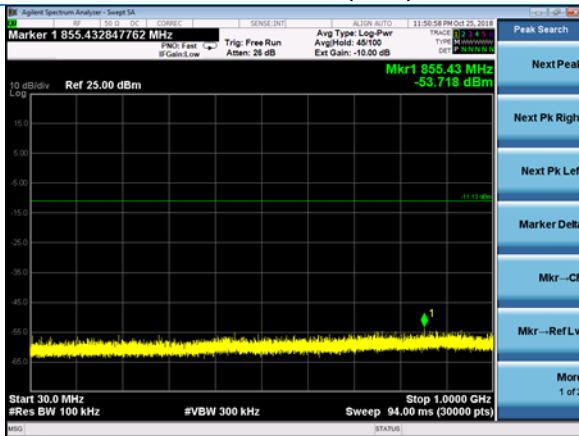
Plots



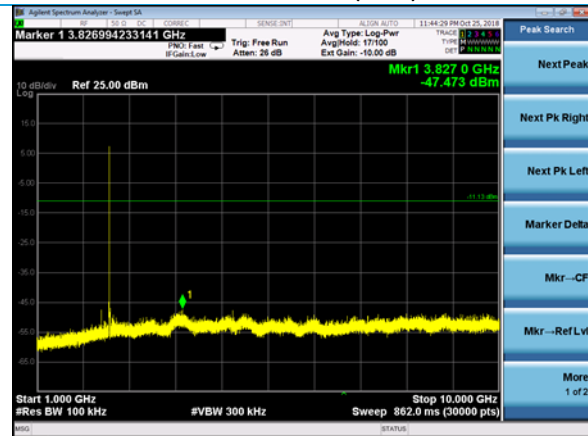
30-1000 MHz (Low)



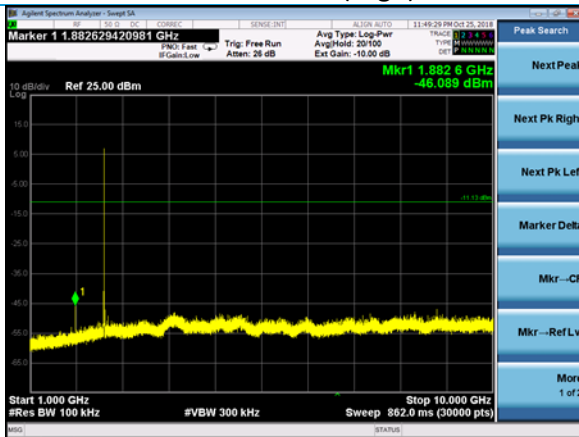
30-1000 MHz (Mid)



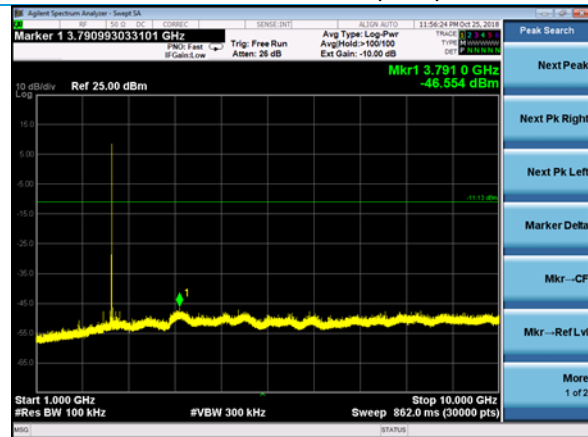
30-1000 MHz (High)



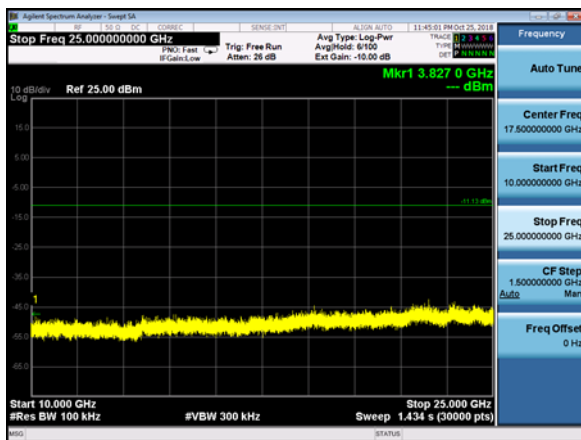
1000-10000 MHz (Low)



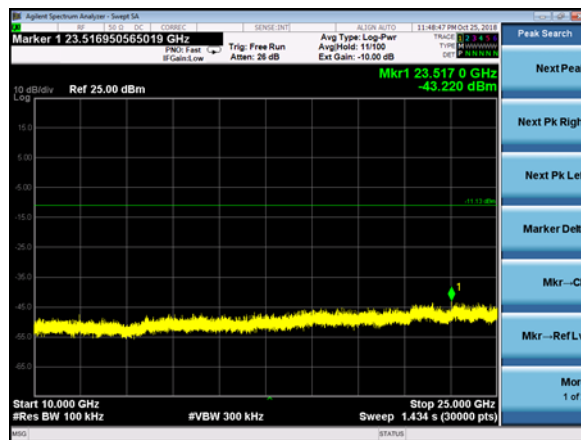
1000-10000 MHz (Mid)



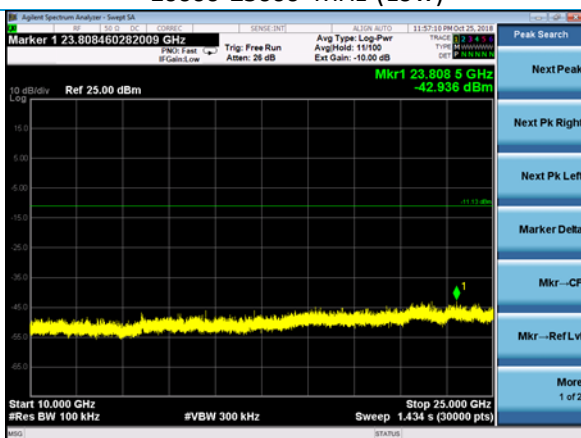
1000-10000 MHz (High)



10000-25000 MHz (Low)

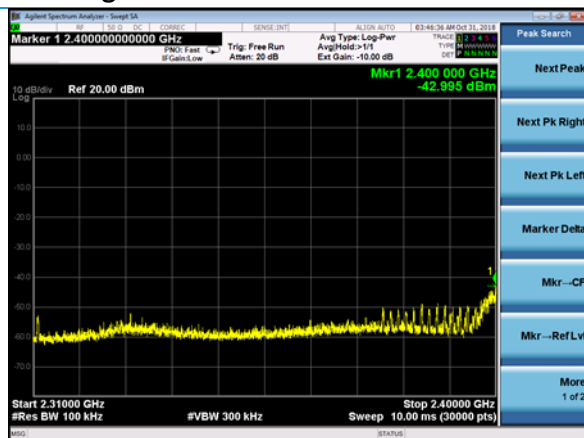


10000-25000 MHz (Mid)

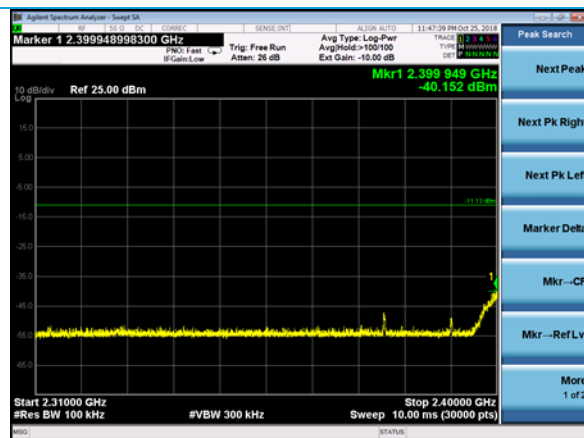


10000-25000 MHz (High)

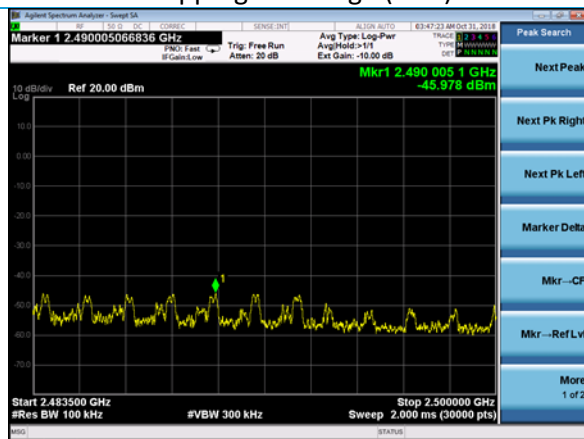
Band Edges



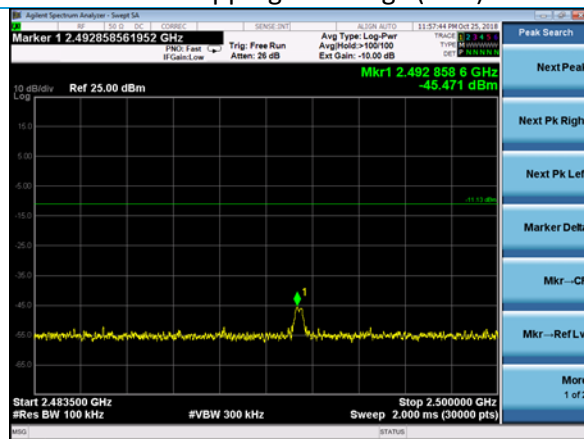
Hopping Band Edge (Low)



Non-Hopping Band Edge (Low)



Hopping Band Edge (High)



Non-Hopping Band Edge (High)

5.1.5 Antenna Port Conducted Emissions – Frequency Stability

Operator	Shane Dock
Test Date	10/30/18
Location	Conducted RF Area
Temp. / R.H.	22.2 deg C/ 46.6% RH
Requirement	FCC: 2.1055 (d) IC: RSS-GEN 6.11
Method	ANSI C63.10 Section 6.8

Test Parameters

Channels	Low, Mid, High
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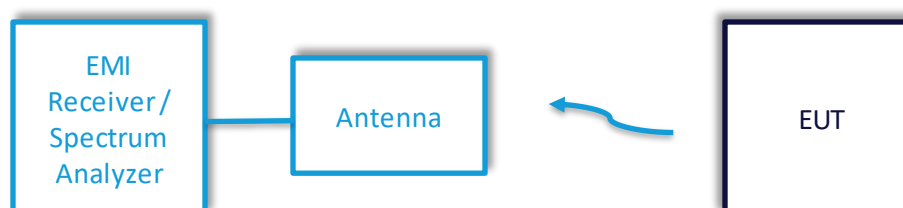
Table (Values below listed in Hz at the given voltages)

Channel	6.1 VDC	7.2 VDC	8.3 VDC	Deviation (Hz)
Low	2403993737	2403995637	2403993953	1900
Mid	2435451173	2435450307	2435453340	3033
High	2466906209	2466908842	2466911159	4950

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

Operator	Jon Dilley, Zach Wilson
QA	Shane Dock, Laura Zehnder
Test Date	9/19/18-10/31/18
Location	Chamber 5, Chamber 3
Temp. / R.H.	22.9 deg. C/ 50.9% RH
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	Quasi Peak (<1 GHz)

Note: Above 1 GHz, the limit applies to an average detector, with a peak limit 20 dB greater.

Frequency	30-25000 MHz
Distance	3m
Measurement Settings: RBW	1 MHz
Measurement Settings: VBW	3 MHz (peak), 1.6 kHz (average)
Measurement Settings	Peak detector Max hold trace
Notes	Tested in three orthogonal orientations. EUT tested without charger connected, as the unit cannot function while charging

Instrumentation



Date : 30-Oct-2018

Test : FCC Tx

Job : C-3073

PE : Shane Dock

Customer : Heraeus Electro-Nite

Quote : 318196

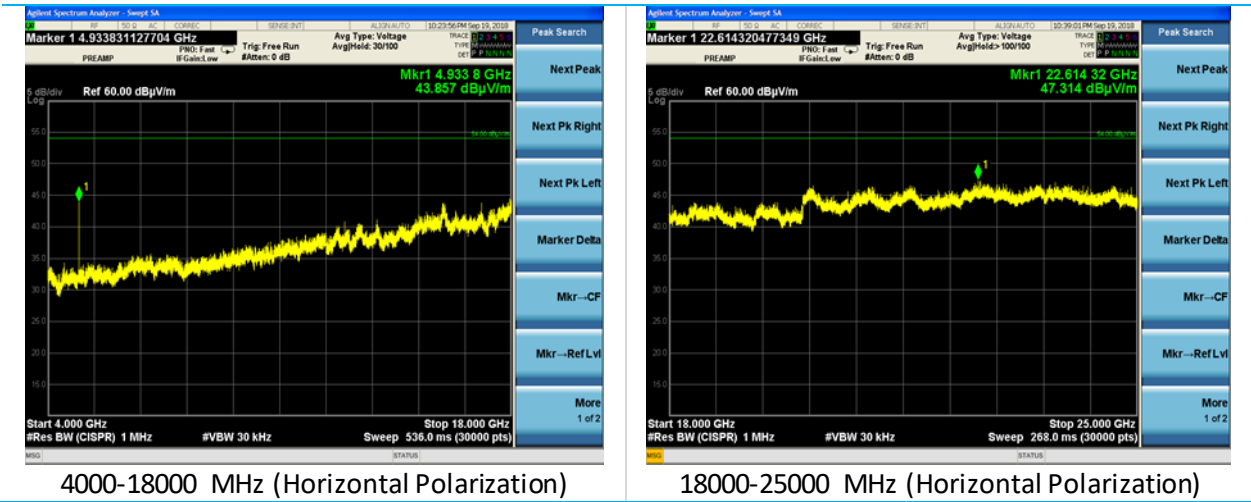
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960088	Analyzer - EMI Receiver	Agilent	N9038A	MY51210138	4/24/2018	4/24/2019	Active Calibration
2	AA 960158	Antenna - Double Ridge Horn	ETS Lindgren	3117	109300	3/26/2018	3/26/2019	Active Calibration
3	AA 960154	Filter - High Pass 2.4 GHz	KWM	HPF-L-14186	7272-02	4/25/2018	4/25/2019	Active Calibration
4	AA 960174	Antenna - Small Horn	ETS Lindgren	3116C-PA	00206880	5/15/2018	5/15/2019	Active Calibration
5	EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	4/24/2018	4/24/2019	Active Calibration
6	AA 960150	Antenna - Biconical	ETS Lindgren	3110B	0003-3346	4/20/2018	4/20/2019	Active Calibration
7	AA 960195	Antenna - Log Periodic	A.H. Systems, Inc	SAS-512-2	557	1/30/2018	1/30/2019	Active Calibration
8	AA 960171	Cable	A.H. Systems, Inc	SAC-26G-6	386	11/15/2017	11/15/2018	Active Verification
9	AA 960176	Cable	A.H. Systems, Inc	SAC-26G-6	395	6/4/2018	6/4/2019	Active Verification

Table - Tx

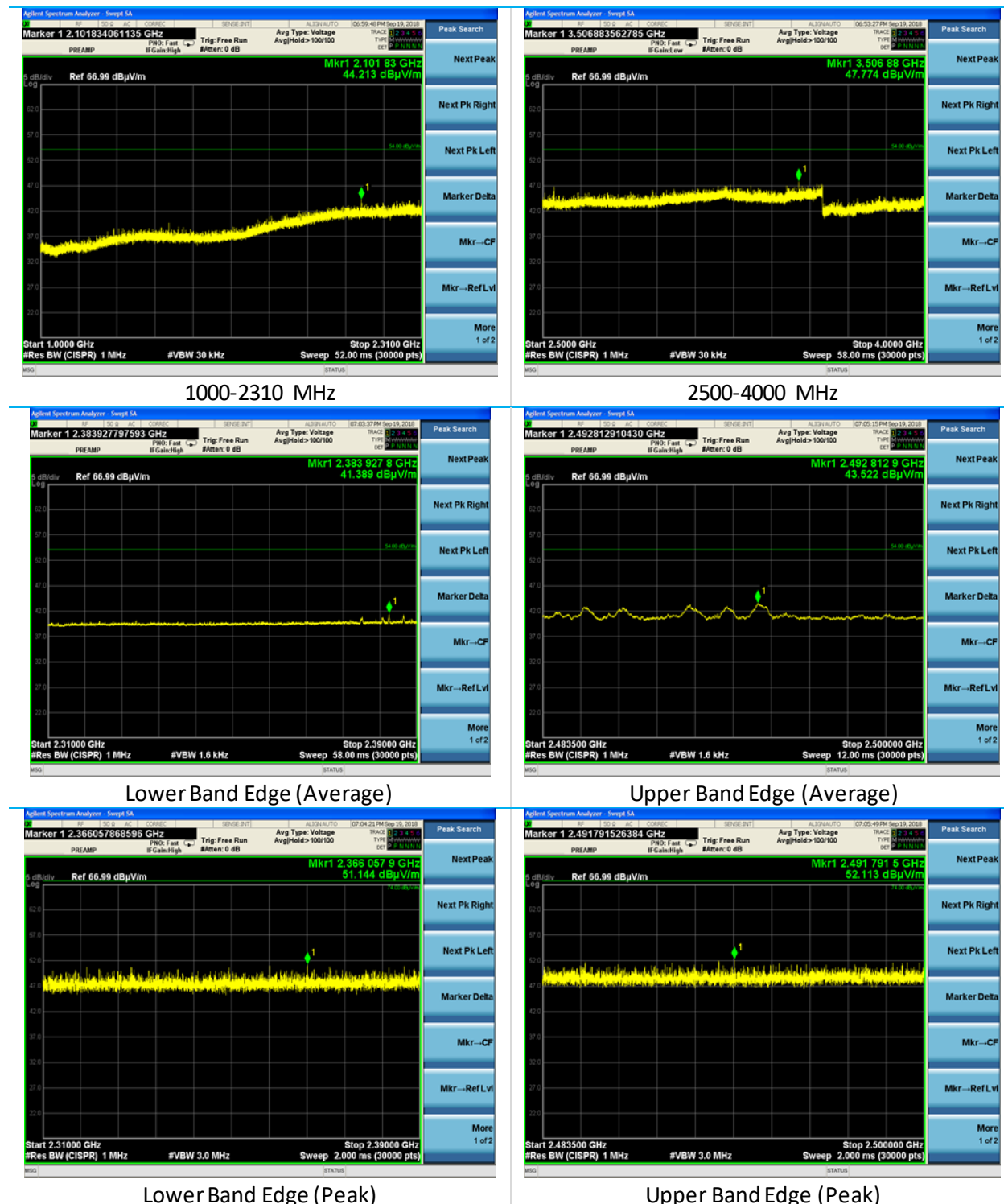
Channel	Frequency (GHz)	Orientation	Polarity	Azimuth (deg)	Height (cm)	Average Measurement (dBuV/m)	Average Limit (dBuV/m)	Average Margin (dB)	Peak Measurement (dBuV/m)	Peak Limit (dBuV/m)	Peak Margin (dB)
High	4.934	Vertical	H	0.0	189.5	42.9	54.0	11.1	46.8	74.0	27.2
High	4.934	Vertical	V	0.0	350.0	37.0	54.0	17.0	43.5	74.0	30.5
High	4.934	Horizontal	V	0.0	100.0	36.9	54.0	17.1	43.1	74.0	30.9
High	4.934	Horizontal	H	7.0	225.0	39.1	54.0	14.9	44.8	74.0	29.2
High	4.934	Flat	H	57.0	200.0	38.5	54.0	15.5	44.5	74.0	29.5
High	4.934	Flat	V	75.0	180.0	41.9	54.0	12.1	46.4	74.0	27.6
Mid	4.871	Vertical	H	0.0	189.5	42.0	54.0	12.0	46.0	74.0	28.0
Low	4.808	Vertical	H	0.0	189.5	34.2	54.0	19.8	44.0	74.0	30.0

Channel	Frequency (MHz)	EUT Orientation	Polarity	Azimuth (deg)	Height (cm)	Quasi-peak Measurement (dBuV/m)	Quasi-peak Limit (dBuV/m)	Quasi-peak Margin (dB)
Low	270.3	Vertical	Horizontal	47.5	100.0	40.9	46.0	5.1
Low	614.4	Vertical	Vertical	34.0	100.0	33.4	46.0	12.6
Mid	180.3	Vertical	Horizontal	278.7	100.0	29.6	43.5	13.9
Mid	182.3	Vertical	Vertical	56.3	100.0	26.0	43.5	17.5

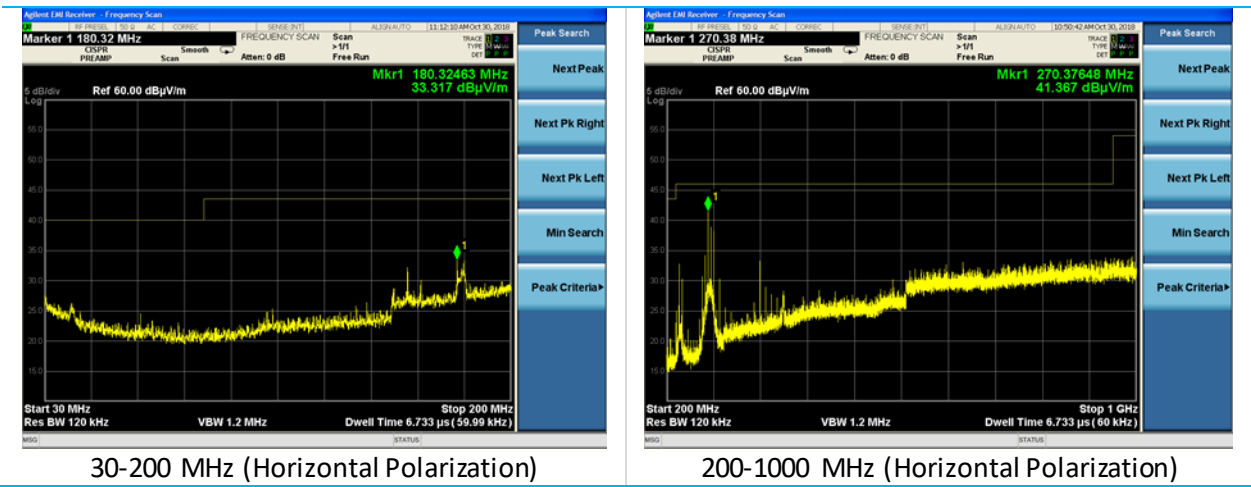
Plots – Tx Harmonics



Plots – Tx 1-4 GHz (Horizontal Polarization, Vertical Orientation)



Plots – Tx < 1GHz



6 REVISION HISTORY

Version	Date	Notes	Person
V0	11/5/18	First Draft	Shane Dock
V1	11/12/18	Second Draft	Shane Dock
V2	12/18/18	Final Draft	Shane Dock

END OF REPORT