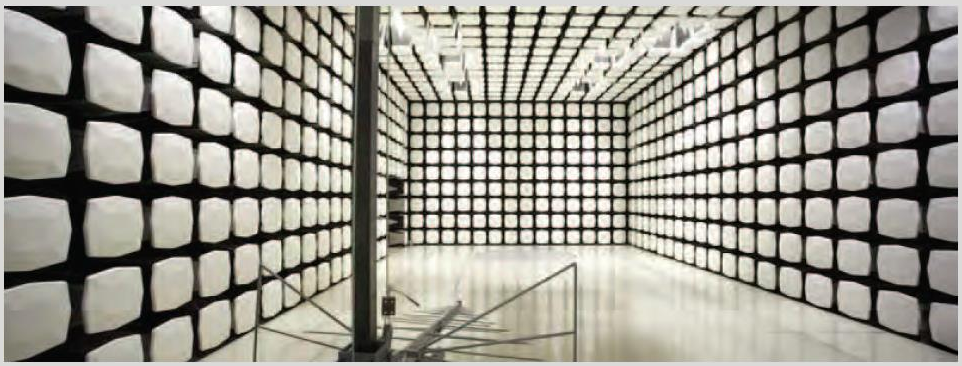
Preco, Inc.

SX97

FCC 15.249:2019

24.05-24.25 GHz Transceiver

Report # PRCO0103



NVLAP LAB CODE: 200630-0

CERTIFICATE OF TEST

Last Date of Test: October 8, 2019
Preco, Inc.
EUT: SX97

Radio Equipment Testing

Standards

Specification	Method
FCC 15.249:2019	ANSI C63.10:2013

Results

Method Clause	Test Description	Applied	Results	Comments
6.2	Powerline Conducted Emissions	No	N/A	Not requested.
6.5, 6.6	Field Strength of Harmonics and Spurious Radiated Emissions	Yes	Pass	
6.6	Field Strength of Fundamental	Yes	Pass	
7.5	Duty Cycle	No	N/A	Not requested.

Deviations From Test Standards

None

Approved By:

Kyle Holgate, Operations Manager

Product compliance is the responsibility of the client; therefore, the tests and equipment modes of operation represented in this report were agreed upon by the client, prior to testing. The results of this test pertain only to the sample(s) tested. The specific description is noted in each of the individual sections of the test report supporting this certificate of test. This report reflects only those tests from the referenced standards shown in the certificate of test. It does not include inspection or verification of labels, identification, marking or user information. As indicated in the Statement of Work sent with the quotation, Element's standard process is to always use the latest published version of the test methods even when earlier versions are cited in the test specification. Issuance of a purchase order was de facto acceptance of this approach. Otherwise, the client would have advised Element in writing of the specific version of the test methods they wanted applied to the subject testing.

REVISION HISTORY

Revision Number	Description	Date (yyyy-mm-dd)	Page Number
00	None		

ACCREDITATIONS AND AUTHORIZATIONS

United States

FCC - Designated by the FCC as a Telecommunications Certification Body (TCB). Certification chambers, Open Area Test Sites, and conducted measurement facilities are listed with the FCC.

A2LA - Accredited by A2LA to ISO / IEC 17065 as a product certifier. This allows Element to certify transmitters to FCC and IC specifications.

NVLAP - Each laboratory is accredited by NVLAP to ISO 17025

Canada

ISED - Recognized by Innovation, Science and Economic Development Canada as a Certification Body (CB) and as a CAB for the acceptance of test data.

European Union

European Commission – Within Element, we have a EU Notified Body validated for the EMCD and RED Directives.

Australia/New Zealand

ACMA - Recognized by ACMA as a CAB for the acceptance of test data.

Korea

MSIT / RRA - Recognized by KCC's RRA as a CAB for the acceptance of test data.

Japan

VCCI - Associate Member of the VCCI. Conducted and radiated measurement facilities are registered.

Taiwan

BSMI – Recognized by BSMI as a CAB for the acceptance of test data.

NCC - Recognized by NCC as a CAB for the acceptance of test data.

Singapore

IDA – Recognized by IDA as a CAB for the acceptance of test data.

Israel

MOC – Recognized by MOC as a CAB for the acceptance of test data.

Hong Kong

OFCA – Recognized by OFCA as a CAB for the acceptance of test data.

Vietnam

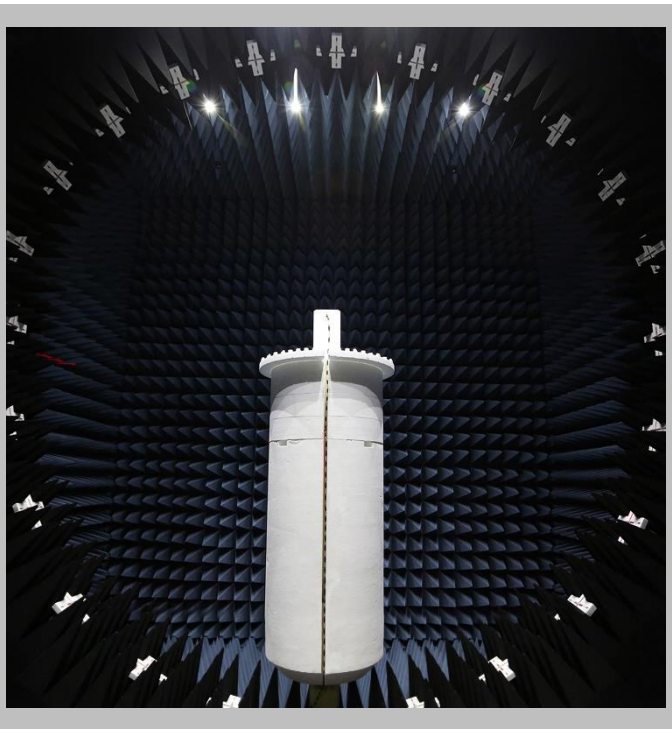
MIC – Recognized by MIC as a CAB for the acceptance of test data.

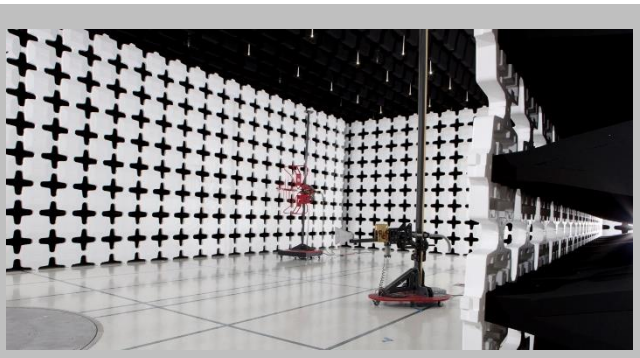
SCOPE

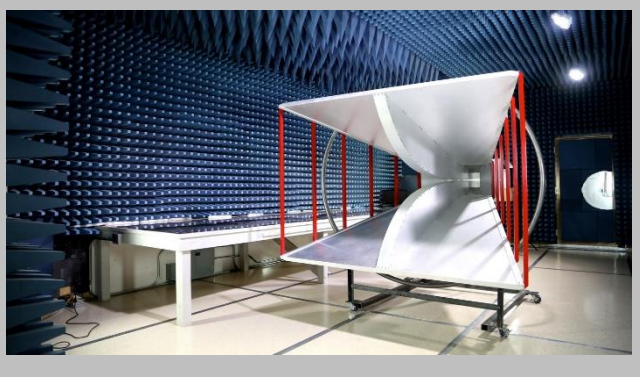
For details on the Scopes of our Accreditations, please visit:
https://www.nwemc.com/emc-testing-accreditations

FACILITIES

California	Minnesota	Oregon	Texas	Washington
Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Labs MN01-10 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	Labs EV01-12 6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Labs NC01-05 19201 120th Ave NE Bothell, WA 98011 (425)984-6600
NVLAP				
NVLAP Lab Code: 200676-0	NVLAP Lab Code: 200881-0	NVLAP Lab Code: 200630-0	NVLAP Lab Code:201049-0	NVLAP Lab Code: 200629-0
Innovation, Science and Economic Development Canada				
2834B-1, 2834B-3	2834E-1, 2834E-3	2834D-1	2834G-1	2834F-1
BSMI				
SL2-IN-E-1154R	SL2-IN-E-1152R	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI				
A-0029	A-0109	A-0108	A-0201	A-0110
Recognized Phase I CAB for ISED, ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA				
US0158	US0175	US0017	US0191	US0157







MEASUREMENT UNCERTAINTY

element
TMU.2015.07.10

Measurement Uncertainty

When a measurement is made, the result will be different from the true or theoretically correct value. The difference is the result of tolerances in the measurement system that cannot be completely eliminated. To the extent that technology allows us, it has been our aim to minimize this error. Measurement uncertainty is a statistical expression of measurement error qualified by a probability distribution.

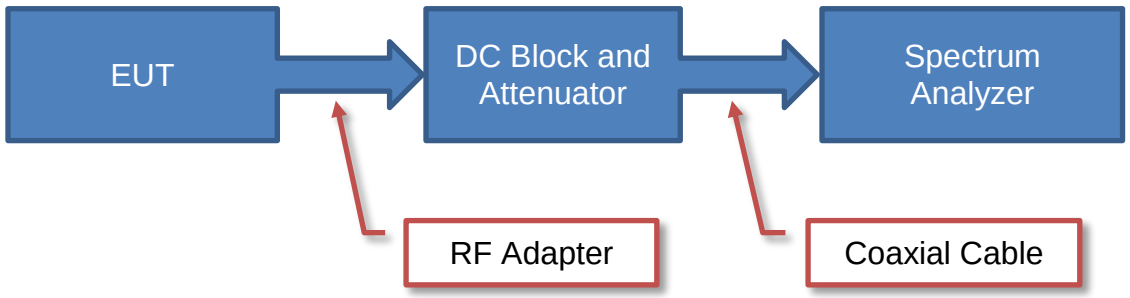
A measurement uncertainty estimation has been performed for each test per our internal quality document QM205.4.6. The estimation is used to compare the measured result with its "true" or theoretically correct value. The expanded measurement uncertainty (K=2) can be found included as part of the applicable test description page. Our measurement data meets or exceeds the measurement uncertainty requirements of the applicable specification; therefore, the test data can be compared directly to the specification limit to determine compliance. The calculations for estimating measurement uncertainty are based upon ETSI TR 100 028 (or CISPR 16-4-2 as applicable), and are available upon request.

The following table represents the Measurement Uncertainty (MU) budgets for each of the tests that may be contained in this report.

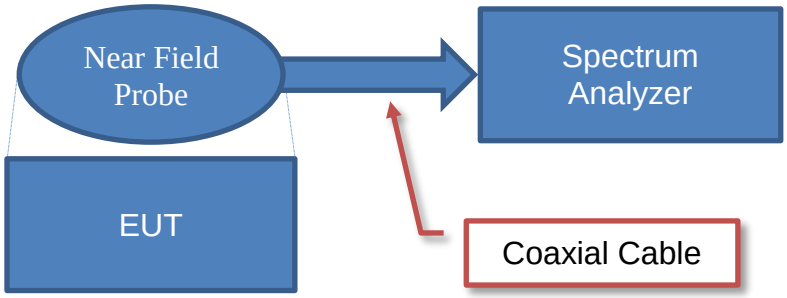
Test	+ MU	- MU
Frequency Accuracy	0.0007%	-0.0007%
Amplitude Accuracy (dB)	1.2 dB	-1.2 dB
Conducted Power (dB)	1.2 dB	-1.2 dB
Radiated Power via Substitution (dB)	0.7 dB	-0.7 dB
Temperature (degrees C)	0.7°C	-0.7°C
Humidity (% RH)	2.5% RH	-2.5% RH
Voltage (AC)	1.0%	-1.0%
Voltage (DC)	0.7%	-0.7%
Field Strength (dB)	5.2 dB	-5.2 dB
AC Powerline Conducted Emissions (dB)	2.4 dB	-2.4 dB

Test Setup Block Diagrams

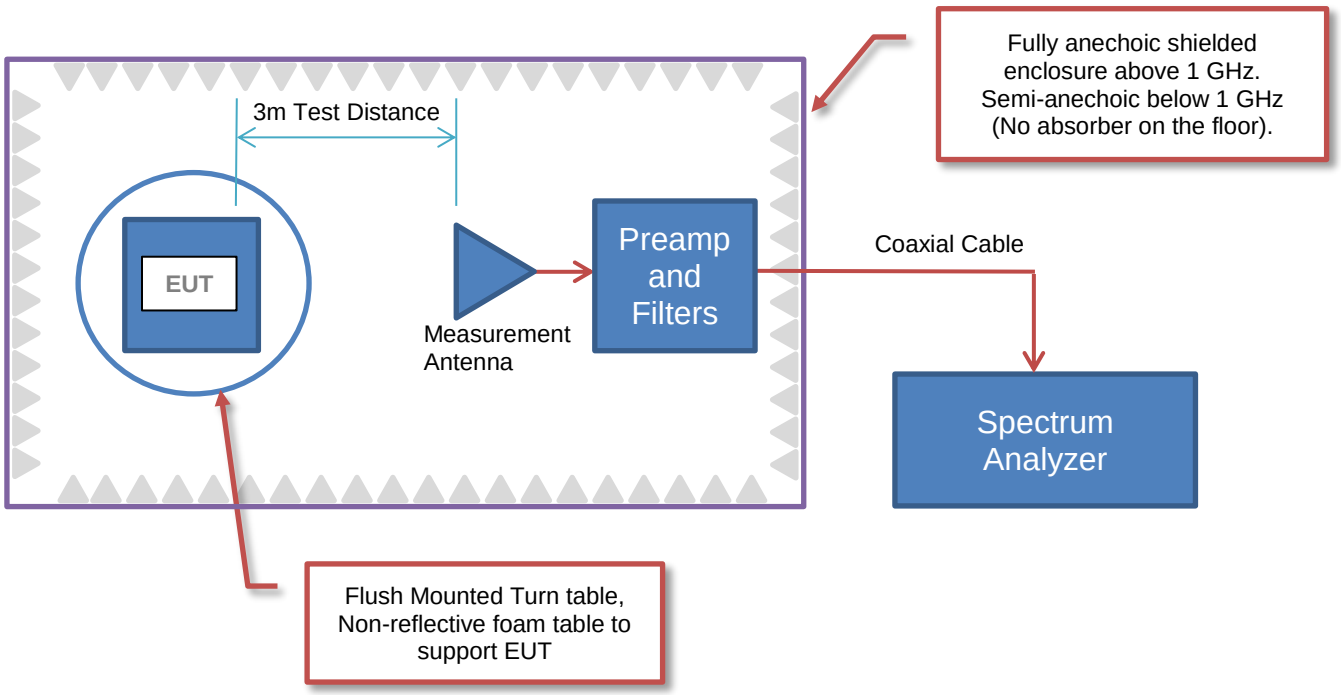
Antenna Port Conducted Measurements



Near Field Test Fixture Measurements



Spurious Radiated Emissions



PRODUCT DESCRIPTION

Client and Equipment Under Test (EUT) Information

Company Name:	Preco, Inc.
Address:	10335 West Emerald Street
City, State, Zip:	Boise, ID 83704
Test Requested By:	Donny LLoyd
EUT:	SX97
First Date of Test:	October 1, 2019
Last Date of Test:	October 8, 2019
Receipt Date of Samples:	October 1, 2019
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
Preco Narrow Sentry FOV - SX97 is a 24 GHz Frequency Modulated Continuous Waveform radar object detection system designed to alert equipment (vehicle, truck, machine) operators to the presence of obstacles.

Testing Objective:
Seeking to demonstrate compliance under FCC 15.249:2019 for operation in the 24.05-24.25 GHz Band.

CONFIGURATIONS

Configuration PRCO0103- 1

Software/Firmware Running during test	
Description	**Version**
Firmware	1.8

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
FMCW Radar	Preco, Inc.	SX97	None

Peripherals in test setup boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
Linear DC Power Supply	Topward	TPS-2000	0074

Remote Equipment Outside of Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
USB CAN Adapter	Peak	PEH002021	None
Remote Laptop	HP	Elitebook 820	5GG63636KL

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
Transition Harness	No	10.0 m	No	Sensor Pigtail	USB CAN Adapter
Sensor Pigtail	No	0.2 m	No	Transition Harness	FMCW Radar
USB	Yes	0.8 m	No	USB CAN Adapter	Remote Laptop
DC Power	No	1.0 m	No	Linear DC Power Supply	Transition Harness

CONFIGURATIONS

Configuration PRCO0103- 2

Software/Firmware Running during test	
Description	**Version**
Firmware	1.8

EUT			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
FMCW Radar	Preco, Inc.	SX97	None

Remote Equipment Outside of Test Setup Boundary			
Description	**Manufacturer**	**Model/Part Number**	**Serial Number**
USB CAN Adapter	Peak	PEH002021	None
Remote Laptop	HP	Elitebook 820	5GG63636KL
Linear DC Power Supply	Topward	TPS-2000	0074

Cables					
Cable Type	**Shield**	**Length (m)**	**Ferrite**	**Connection 1**	**Connection 2**
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Sensor Pigtail	No	0.2 m	No	Transition Harness	FMCW Radar
USB	Yes	0.8 m	No	USB CAN Adapter	Remote Laptop
DC Power	No	1.0 m	No	Linear DC Power Supply	Transition Harness

MODIFICATIONS

Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2019-10-01	Field Strength of Fundamental	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
2	2019-10-04	Field Strength of Harmonics	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	EUT remained at Element following the test.
3	2019-10-08	Spurious Radiated Emissions	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

FIELD STRENGTH OF HARMONICS

XMit 2017.12.13

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data.

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Cable	OML, Inc.	S119BFSS100390443	SUN	NCR	NCR
Diplexer	OML, Inc.	DPL26	DAA	NCR	NCR
Antenna	OML, Inc.	M08HWAX	AIL	18-Sep-19	18-Sep-22
Antenna	OML, Inc.	M12HWAX	AIK	19-Sep-19	19-Sep-22
Antenna	OML, Inc.	M19HWAX	AIJ	20-Sep-19	20-Sep-22
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	24-Mar-19	24-Mar-20

TEST DESCRIPTION

The measurement was made in a radiated configuration of the fundamental with the carrier fully maximized for its highest radiated power. The EUT was transmitting with an unmodulated carrier. The testing was done at distances closer than 3m as called out in the data sheets. While scanning, emissions from the EUT were maximized by rotating the EUT, adjusting the measurement antenna orientation and polarization, and manipulating the EUT and EUT antenna in 3 orthogonal planes (per ANSI C63.10:2009). The specifiation limit was adjusted for the closer test distances at 20 dB per decade as called out in the following table:

	Spec limit						
	3m	1m	50cm	20 cm	10 cm	5 cm	2 cm
Average	68	77.54	83.56	91.5	97.5	103.6	111.5
Peak	88	97.54	103.56	111.5	117.5	123.6	131.5

The analyzer display was offset with the value of the test equipment losses (mixers, duplexers, and cables) specific to each band and the antenna factor per the following tables:

Low Frequency (MHz): 24056

Freq (MHz)	Antenna Gain (dBi)	Antenna Factor (dB/m)	Mixer / Duplexer loss (dB)	Analyzer Offset (dB)
48112.00	24.00	39.87	31.13	71.00
72168.00	24.00	43.39	38.93	82.32
96224.00	24.00	45.89	36.14	82.03

Mid Frequency (MHz): 24152

Freq (MHz)	Antenna Gain (dBi)	Antenna Factor (dB/m)	Mixer / Duplexer loss (dB)	Analyzer Offset (dB)
48304.00	24.00	39.90	30.09	69.99
72456.00	24.00	43.42	38.99	82.41
96608.00	24.00	45.92	34.86	80.78

High Frequency (MHz): 24247

Freq (MHz)	Antenna Gain (dBi)	Antenna Factor (dB/m)	Mixer / Duplexer loss (dB)	Analyzer Offset (dB)
48494.00	24.00	39.93	29.81	69.74
72741.00	24.00	43.46	38.67	82.13
96988.00	24.00	45.95	33.82	79.77

FIELD STRENGTH OF HARMONICS

element

XMit 2019.09.05

EUT:	**SX97**			**Work Order:**	**PRCO0103**
Serial Number:	**None**			**Date:**	**4-Oct-19**
Customer:	**Preco, Inc.**			**Temperature:**	**20.3 °C**
Attendees:	**None**			**Humidity:**	**45.1% RH**
Project:	**None**			**Barometric Pres.:**	**1024 mbar**
Tested by:	**Jeff Alcoke**	**Power:**	**12 VDC via 110VAC/60Hz**	**Job Site:**	**EV01**

TEST SPECIFICATIONS	**Test Method**
FCC 15.249:2019	ANSI C63.10:2013

COMMENTS

Measurements were taken with EUT in the orientation that generated highest level of emissions.

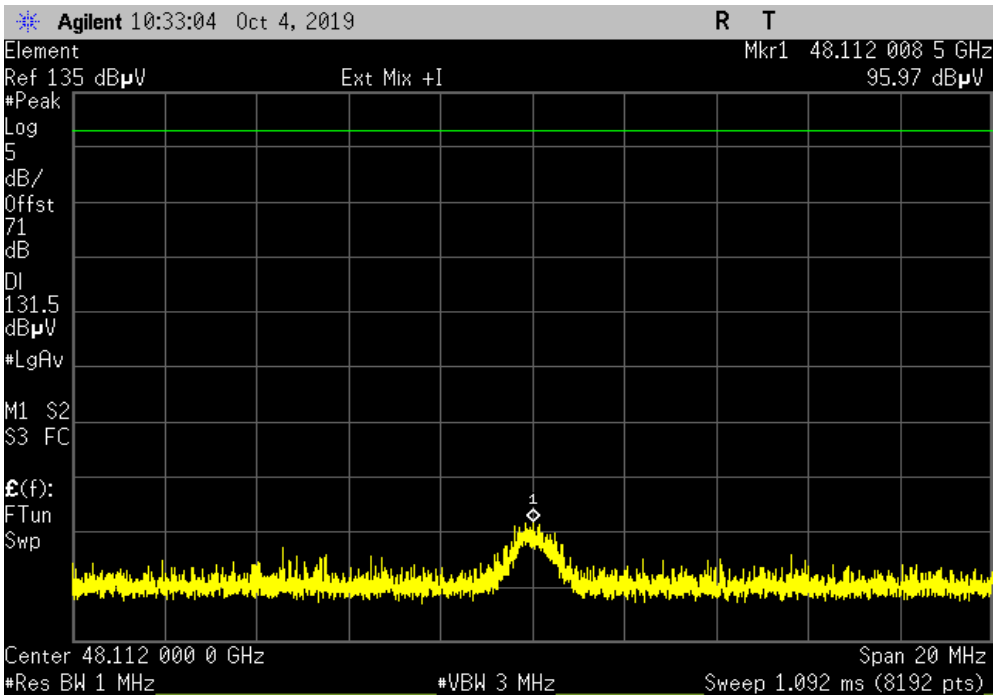
DEVIATIONS FROM TEST STANDARD

None

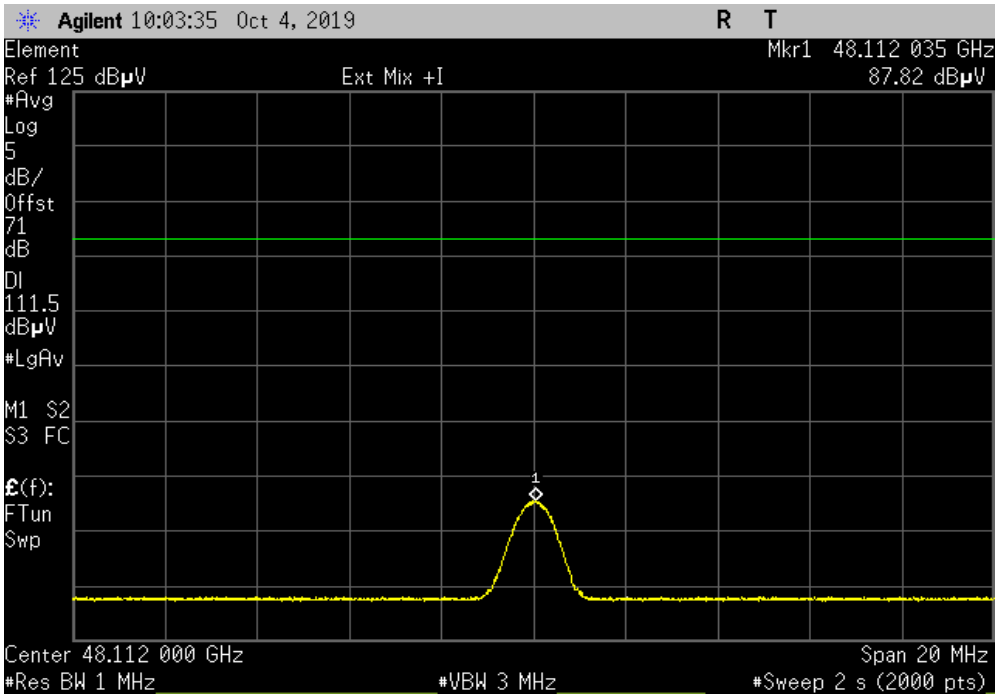
Configuration #	**2**	*Signature*

	Value (dBuV)	**Limit (dBuV)**	**Result**
Continuous TX, 24056 MHz - 24247 MHz			
2nd Harmonic			
Low Ch. 24056 MHz			
Peak	95.97	131.5 @ 2 cm	Pass
Average	87.82	111.5 @ 2 cm	Pass
Mid Ch. 24152 MHz			
Peak	95.47	131.5 @ 2 cm	Pass
Average	89.03	111.5 @ 2 cm	Pass
High Ch. 24247 MHz			
Peak	93.38	131.5 @ 2 cm	Pass
Average	85.28	111.5 @ 2 cm	Pass
3rd Harmonic			
Low Ch. 24056 MHz			
Peak	106.21	131.5 @ 2 cm	Pass
Average	91.80	111.5 @ 2 cm	Pass
Mid Ch. 24152 MHz			
Peak	105.13	131.5 @ 2 cm	Pass
Average	91.34	111.5 @ 2 cm	Pass
High Ch. 24247 MHz			
Peak	104.57	131.5 @ 2 cm	Pass
Average	91.22	111.5 @ 2 cm	Pass
4th Harmonic			
Low Ch. 24056 MHz			
Peak	106.01	131.5 @ 2 cm	Pass
Average	93.49	111.5 @ 2 cm	Pass
Mid Ch. 24152 MHz			
Peak	104.90	131.5 @ 2 cm	Pass
Average	92.47	111.5 @ 2 cm	Pass
High Ch. 24247 MHz			
Peak	102.94	131.5 @ 2 cm	Pass
Average	89.83	111.5 @ 2 cm	Pass

Continuous TX, 24056 MHz - 24247 MHz, 2nd Harmonic, Low Ch. 24056 MHz, Peak							
					Value (dBuV)	Limit (dBuV)	Result
					95.97	131.5 @ 2 cm	Pass



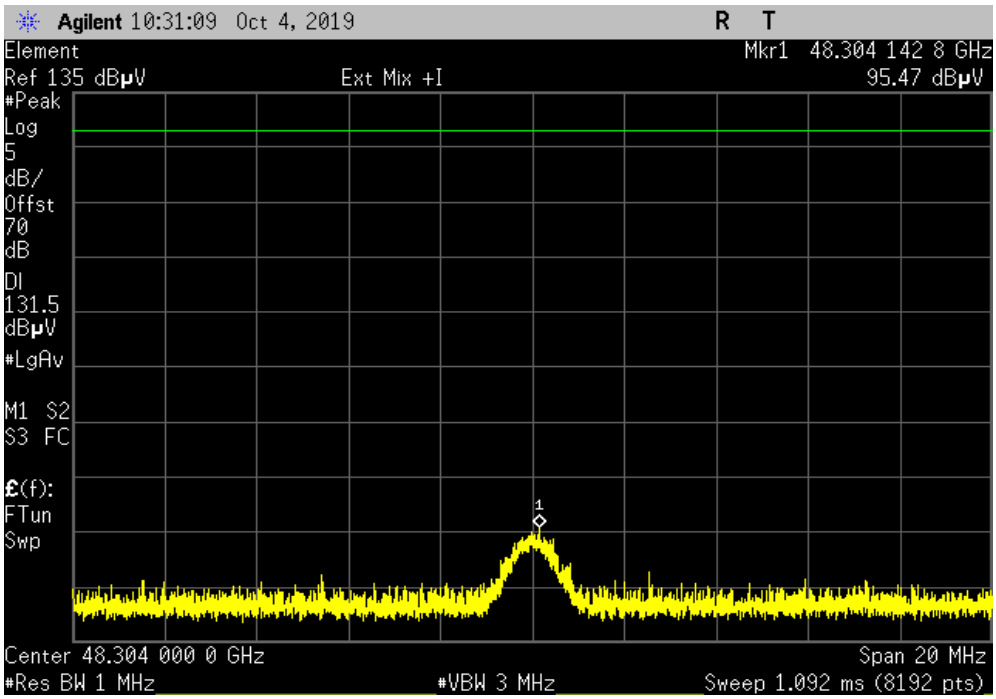
Continuous TX, 24056 MHz - 24247 MHz, 2nd Harmonic, Low Ch. 24056 MHz, Average							
					Value (dBuV)	Limit (dBuV)	Result
					87.82	111.5 @ 2 cm	Pass



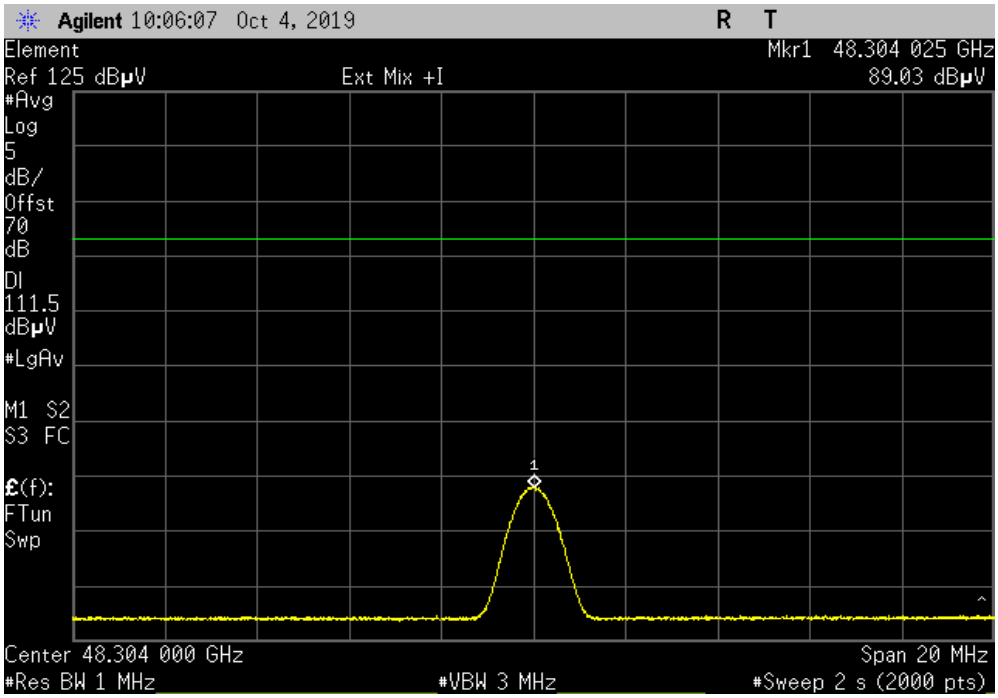
FIELD STRENGTH OF HARMONICS

XMit 2019.09.05

Continuous TX, 24056 MHz - 24247 MHz, 2nd Harmonic, Mid Ch. 24152 MHz, Peak							
					Value (dBuV)	Limit (dBuV)	Result
					95.47	131.5 @ 2 cm	Pass



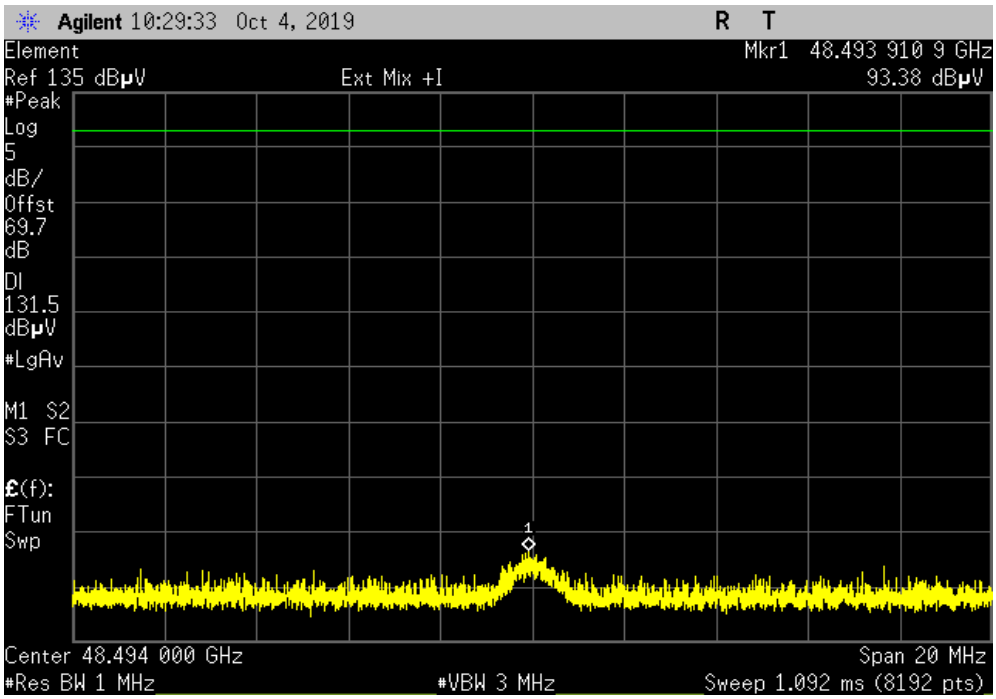
Continuous TX, 24056 MHz - 24247 MHz, 2nd Harmonic, Mid Ch. 24152 MHz, Average							
					Value (dBuV)	Limit (dBuV)	Result
					89.03	111.5 @ 2 cm	Pass



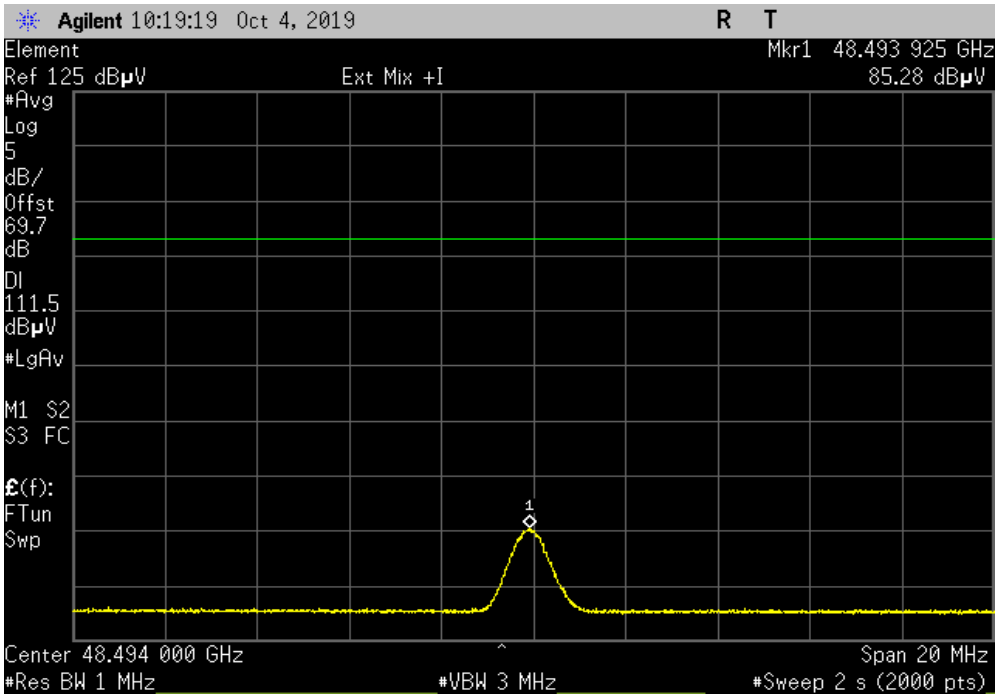
FIELD STRENGTH OF HARMONICS

XMit 2019.09.05

Continuous TX, 24056 MHz - 24247 MHz, 2nd Harmonic, High Ch. 24247 MHz, Peak						
				Value (dBuV)	Limit (dBuV)	Result
				93.38	131.5 @ 2 cm	Pass



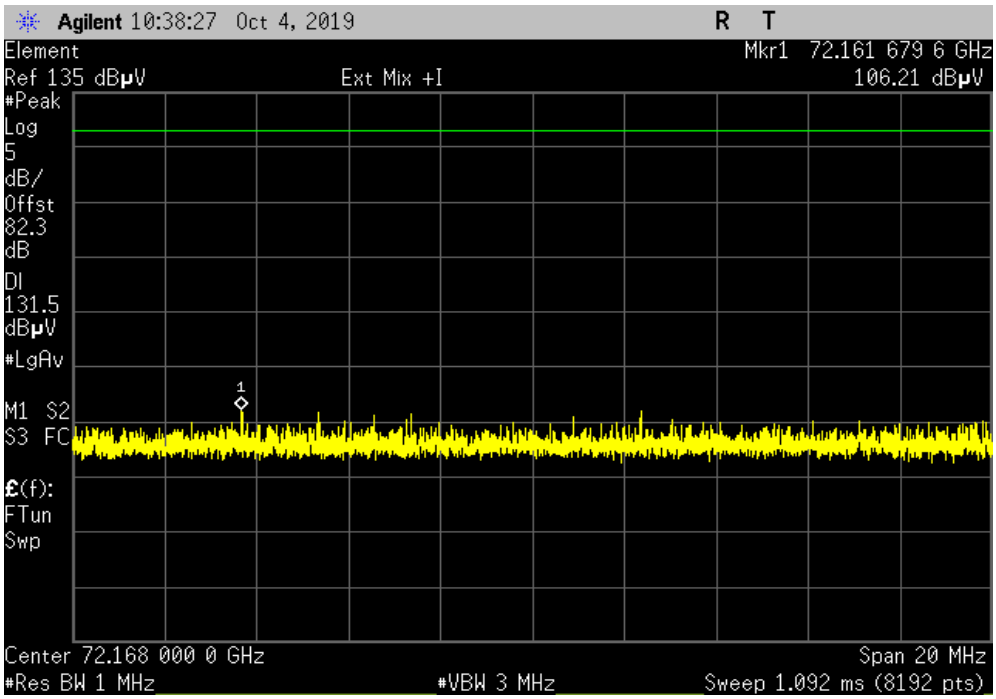
Continuous TX, 24056 MHz - 24247 MHz, 2nd Harmonic, High Ch. 24247 MHz, Average						
				Value (dBuV)	Limit (dBuV)	Result
				85.28	111.5 @ 2 cm	Pass



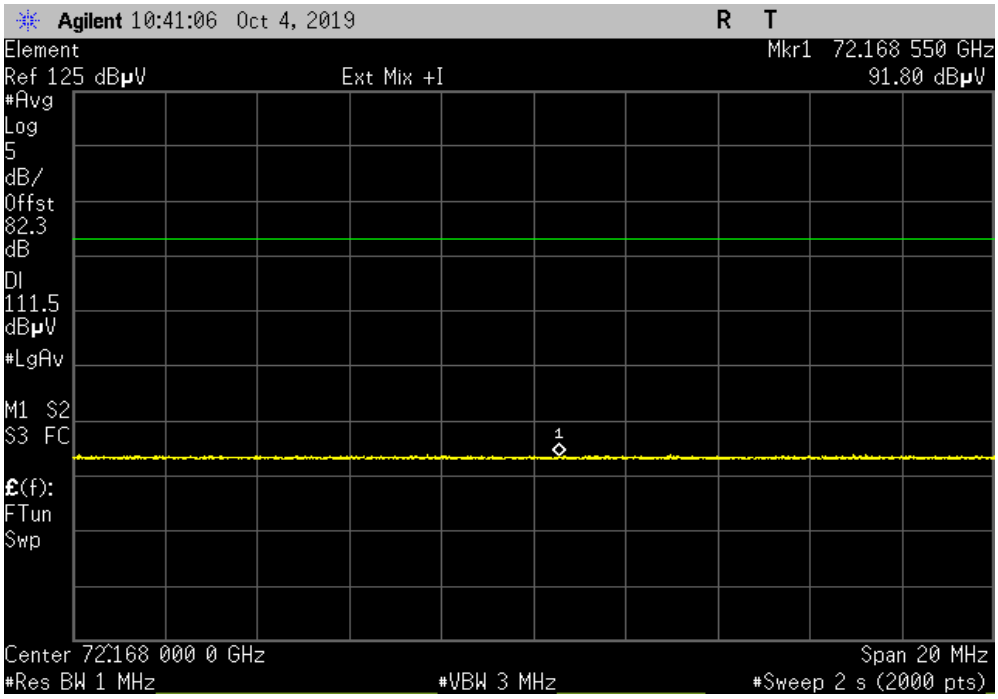
FIELD STRENGTH OF HARMONICS

XMit 2019.09.05

Continuous TX, 24056 MHz - 24247 MHz, 3rd Harmonic, Low Ch. 24056 MHz, Peak							
					Value (dBuV)	Limit (dBuV)	Result
					106.21	131.5 @ 2 cm	Pass



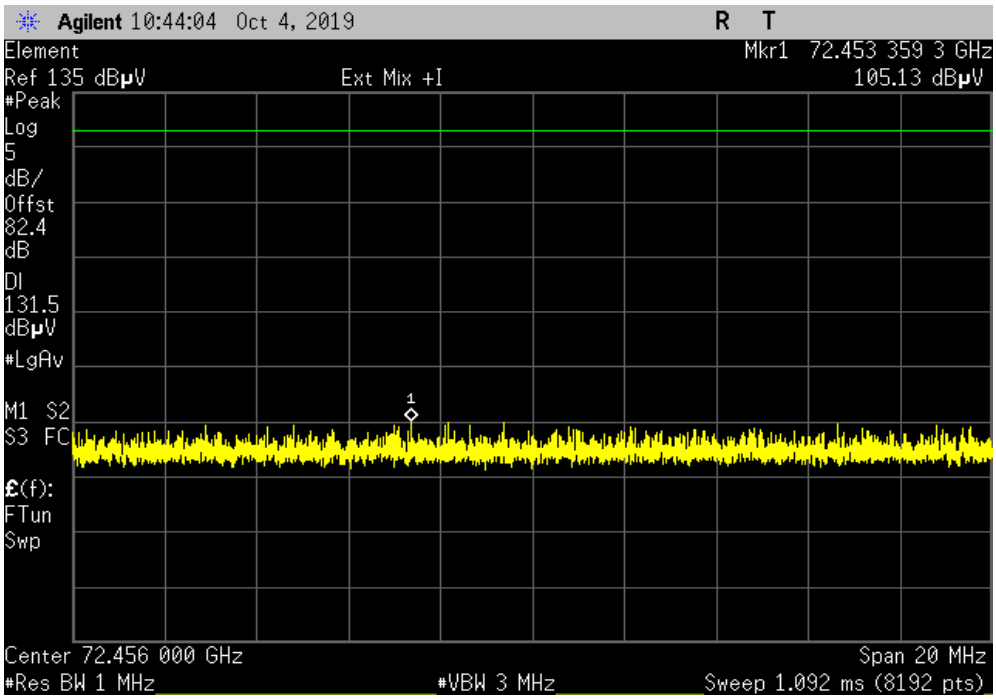
Continuous TX, 24056 MHz - 24247 MHz, 3rd Harmonic, Low Ch. 24056 MHz, Average							
					Value (dBuV)	Limit (dBuV)	Result
					91.80	111.5 @ 2 cm	Pass



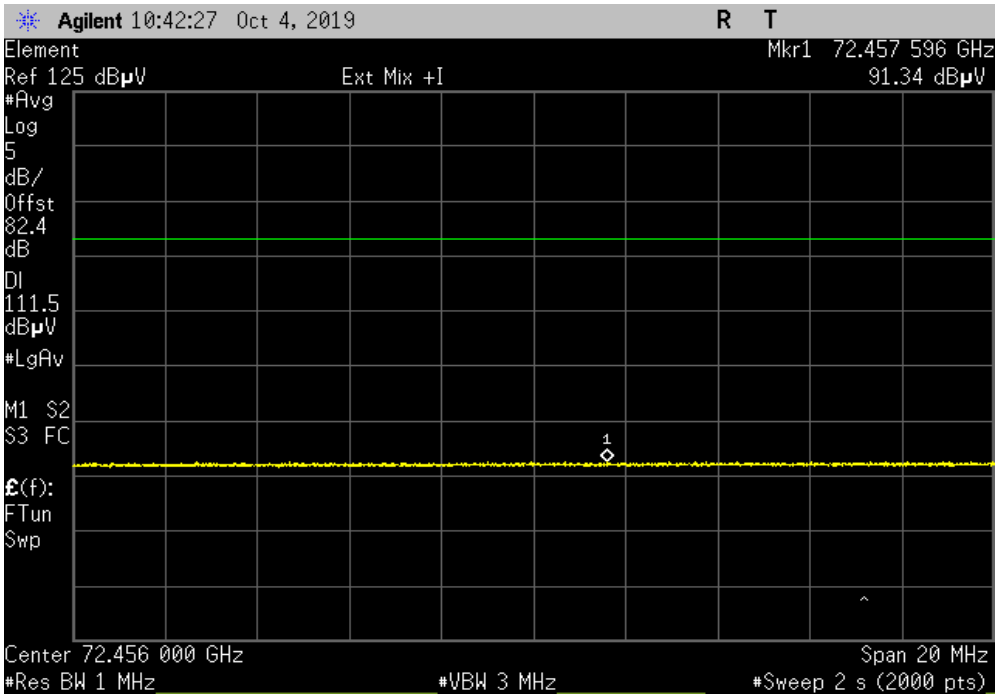
FIELD STRENGTH OF HARMONICS

XMit 2019.09.05

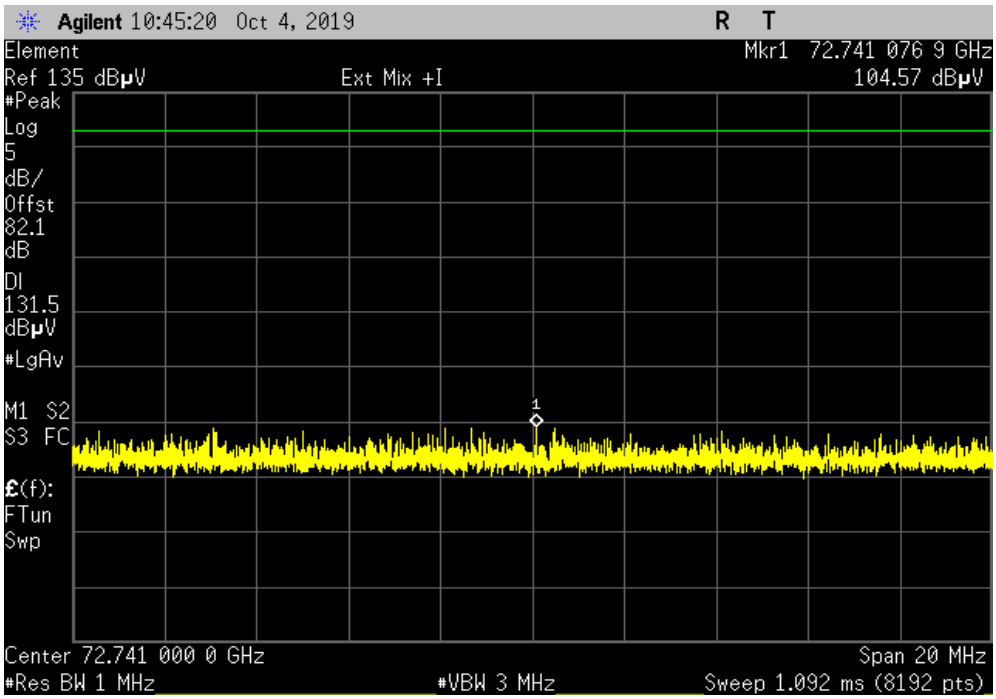
Continuous TX, 24056 MHz - 24247 MHz, 3rd Harmonic, Mid Ch. 24152 MHz, Peak						
				Value (dBuV)	Limit (dBuV)	Result
				105.13	131.5 @ 2 cm	Pass



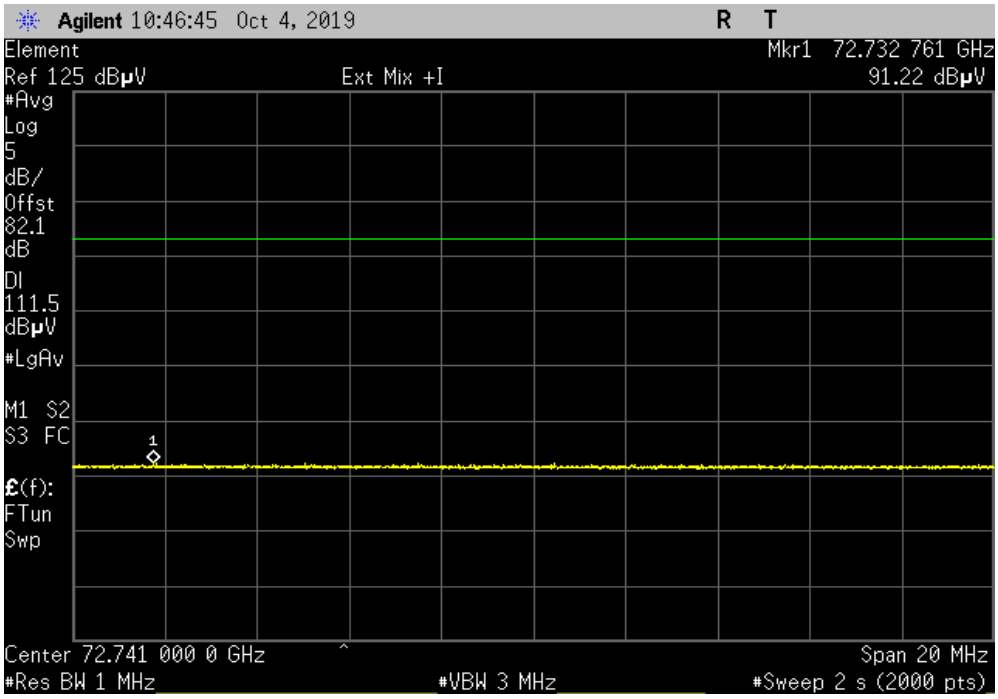
Continuous TX, 24056 MHz - 24247 MHz, 3rd Harmonic, Mid Ch. 24152 MHz, Average						
				Value (dBuV)	Limit (dBuV)	Result
				91.34	111.5 @ 2 cm	Pass



Continuous TX, 24056 MHz - 24247 MHz, 3rd Harmonic, High Ch. 24247 MHz, Peak						
				Value (dBuV)	Limit (dBuV)	Result
				104.57	131.5 @ 2 cm	Pass



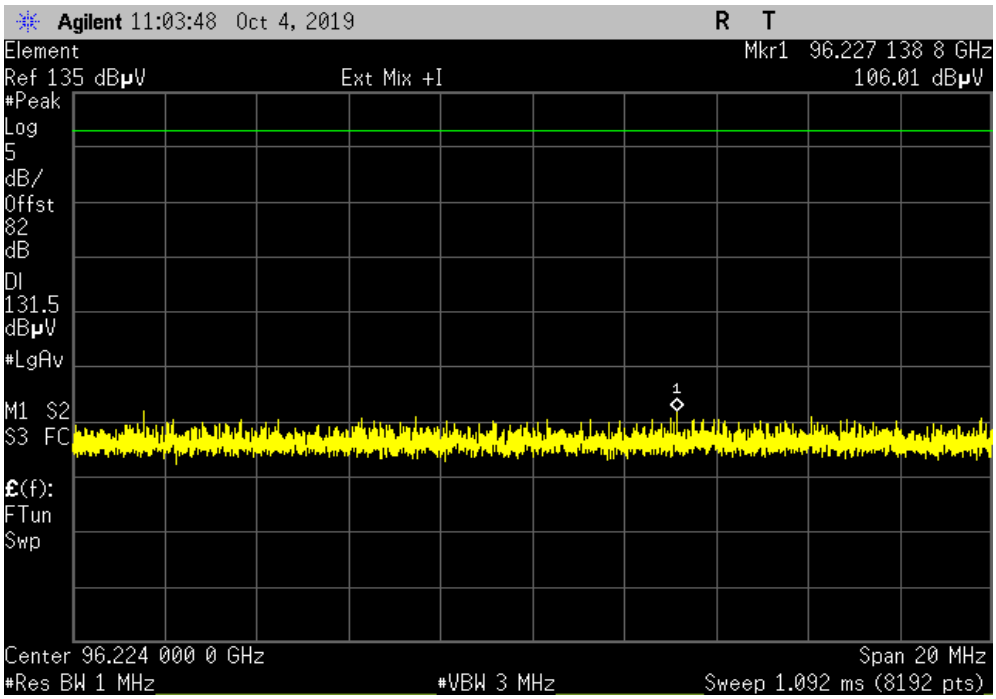
Continuous TX, 24056 MHz - 24247 MHz, 3rd Harmonic, High Ch. 24247 MHz, Average						
				Value (dBuV)	Limit (dBuV)	Result
				91.22	111.5 @ 2 cm	Pass



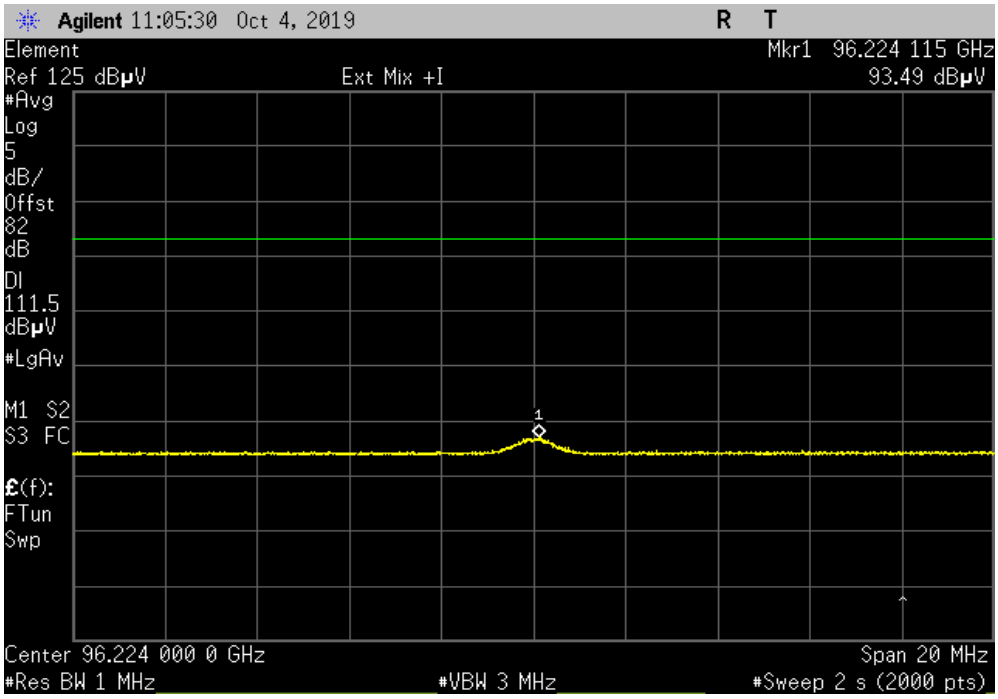
FIELD STRENGTH OF HARMONICS

XMit 2019.09.05

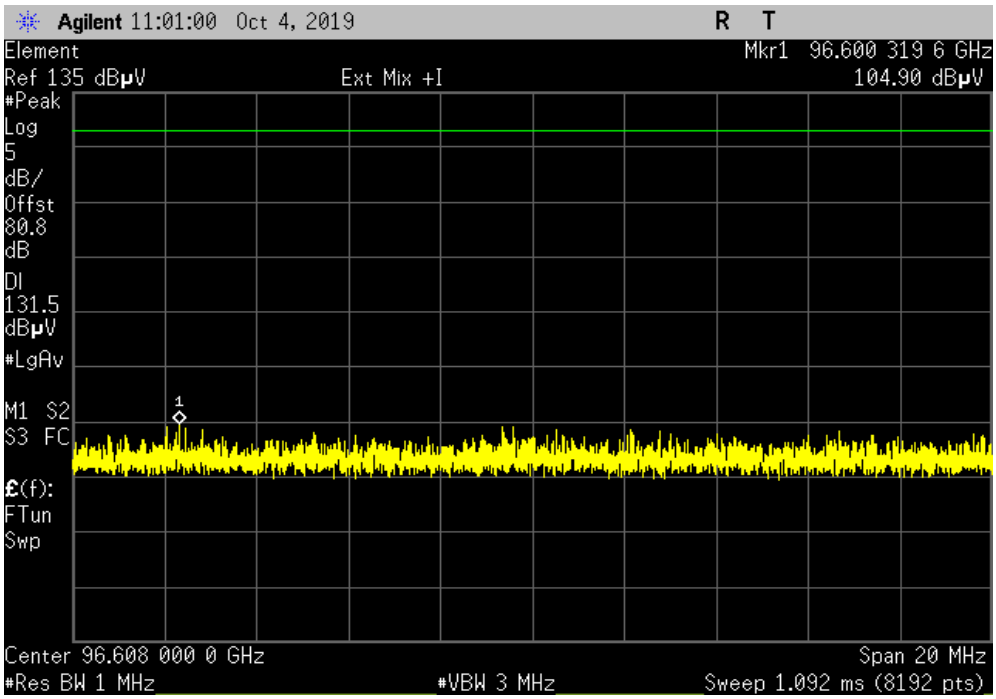
Continuous TX, 24056 MHz - 24247 MHz, 4th Harmonic, Low Ch. 24056 MHz, Peak						
				Value (dBuV)	Limit (dBuV)	Result
				106.01	131.5 @ 2 cm	Pass



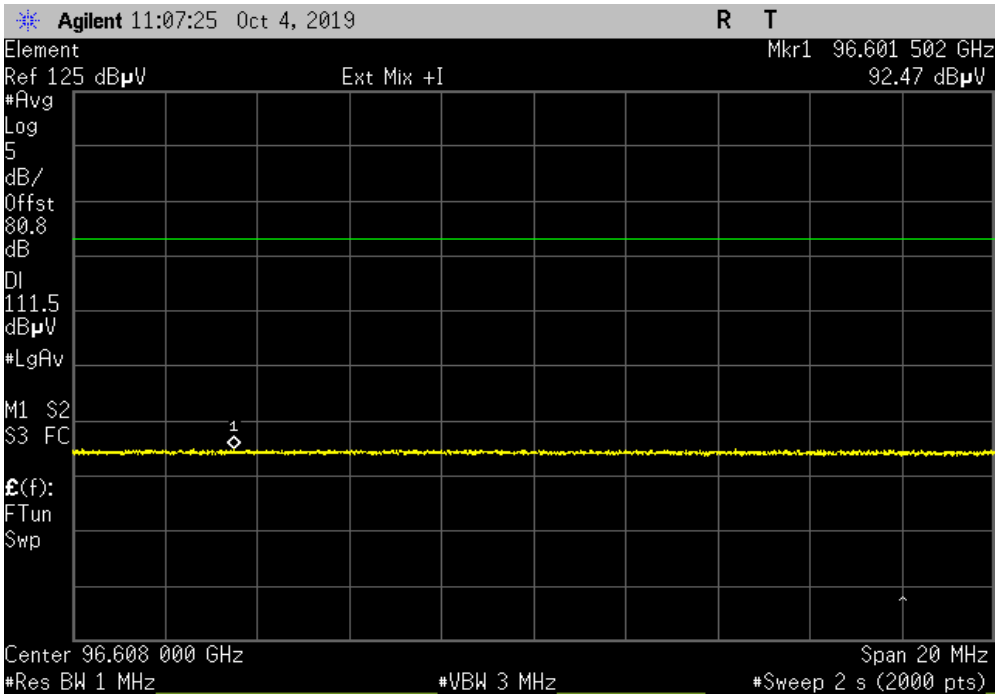
Continuous TX, 24056 MHz - 24247 MHz, 4th Harmonic, Low Ch. 24056 MHz, Average						
				Value (dBuV)	Limit (dBuV)	Result
				93.49	111.5 @ 2 cm	Pass



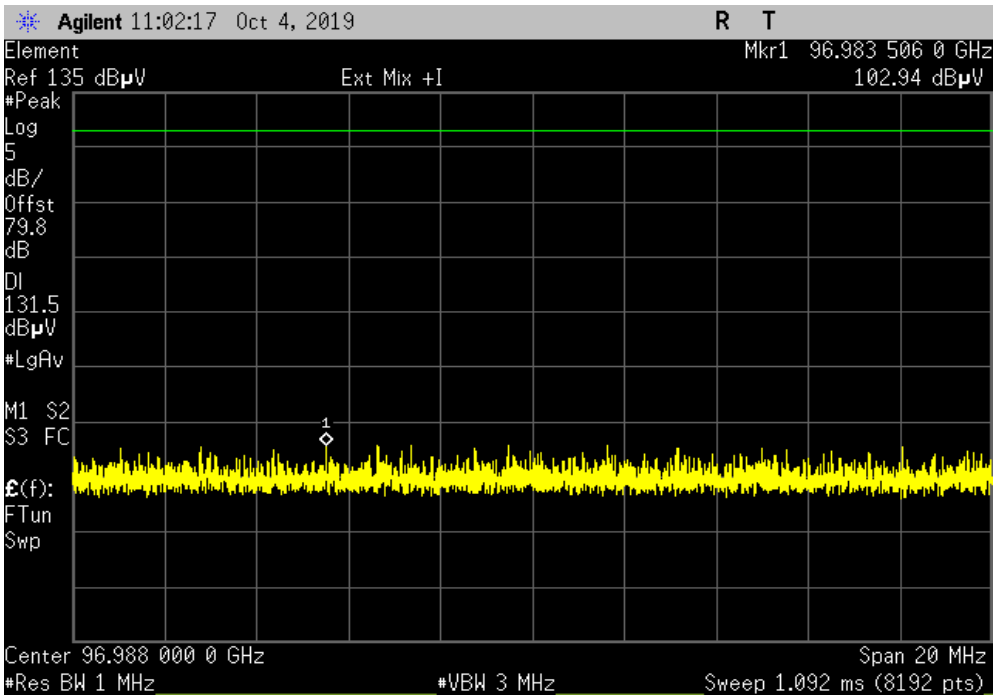
Continuous TX, 24056 MHz - 24247 MHz, 4th Harmonic, Mid Ch. 24152 MHz, Peak							
					Value (dBuV)	Limit (dBuV)	Result
					104.90	131.5 @ 2 cm	Pass



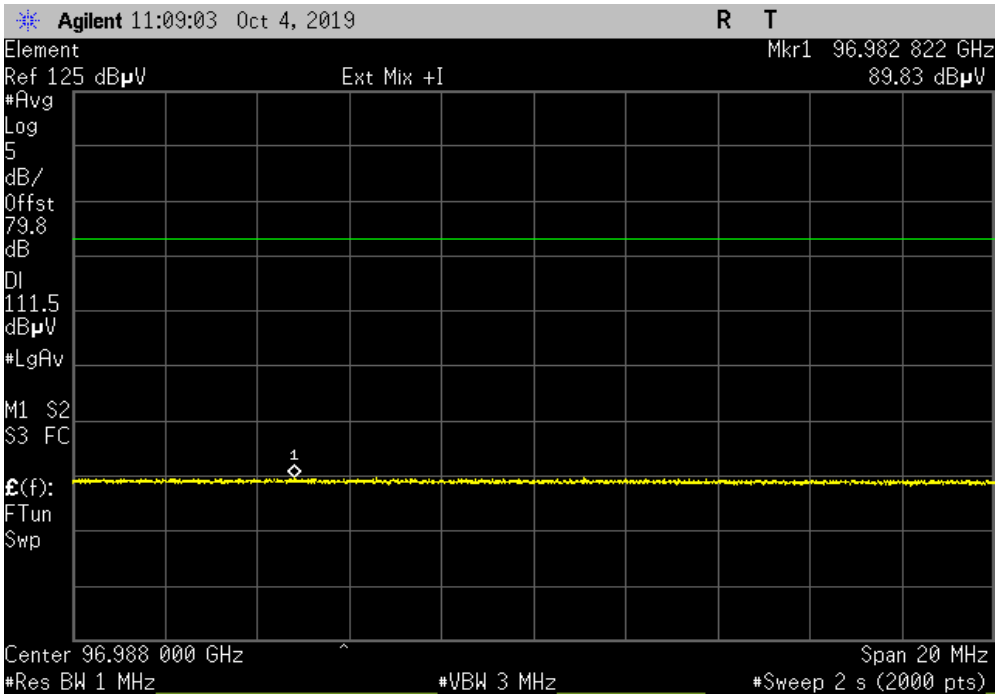
Continuous TX, 24056 MHz - 24247 MHz, 4th Harmonic, Mid Ch. 24152 MHz, Average							
					Value (dBuV)	Limit (dBuV)	Result
					92.47	111.5 @ 2 cm	Pass



Continuous TX, 24056 MHz - 24247 MHz, 4th Harmonic, High Ch. 24247 MHz, Peak							
					Value (dBuV)	Limit (dBuV)	Result
					102.94	131.5 @ 2 cm	Pass



Continuous TX, 24056 MHz - 24247 MHz, 4th Harmonic, High Ch. 24247 MHz, Average							
					Value (dBuV)	Limit (dBuV)	Result
					89.83	111.5 @ 2 cm	Pass



SPURIOUS RADIATED EMISSIONS

PSA-ESCI 2019.05.10

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

MODES OF OPERATION

Continuous Tx, CW, Low Ch. = 24056 MHz, Mid Ch = 24152 , High Ch 24247

POWER SETTINGS INVESTIGATED

12 VDC via 110VAC/60Hz

CONFIGURATIONS INVESTIGATED

PRCO0103 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	30 MHz	Stop Frequency	40 GHz

SAMPLE CALCULATIONS

Radiated Emissions: Field Strength = Measured Level + Antenna Factor + Cable Factor - Amplifier Gain + Distance Adjustment Factor + External Attenuation

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Amplifier - Pre-Amplifier	Miteq	JSW45-26004000-40-5P	PAE	23-Apr-2019	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-6F-12001800-30-10P	AVD	24-Nov-2018	12 mo
Amplifier - Pre-Amplifier	L-3 Narda-MITEQ	AMF-6F-08001200-30-10P	PAO	24-Nov-2018	12 mo
Amplifier - Pre-Amplifier	Miteq	AMF-3D-00100800-32-13P	PAG	24-Nov-2018	12 mo
Amplifier - Pre-Amplifier	Miteq	AM-1616-1000	AOL	24-Nov-2018	12 mo
Attenuator	Weinschel Corp	54A-10	RBK	19-Nov-2018	12 mo
Cable	ESM Cable Corp.	KNKN-72 SMA Cable	EVZ	23-Apr-2019	12 mo
Cable	Micro-Coax	UFD150A-1-0720-200200	EVH	28-Mar-2019	12 mo
Cable	None	Standard Gain Horns Cable	EVF	24-Nov-2018	12 mo
Cable	N/A	Double Ridge Horn Cables	EVB	24-Nov-2018	12 mo
Cable	N/A	Bilog Cables	EVA	24-Nov-2018	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-10	AIW	NCR	0 mo
Antenna - Standard Gain	ETS Lindgren	3160-09	AHY	NCR	0 mo
Antenna - Standard Gain	ETS Lindgren	3160-08	AHV	NCR	0 mo
Antenna - Standard Gain	ETS Lindgren	3160-07	AHU	NCR	0 mo
Antenna - Double Ridge	ETS Lindgren	3115	AIZ	7-Feb-2018	24 mo
Antenna - Biconilog	Teseq	CBL 6141B	AXR	2-Oct-2018	24 mo
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	24-Mar-2019	12 mo

TEST DESCRIPTION

The EUT was transmitting and while set at the lowest channel, a middle channel, and the highest channel available. While scanning, emissions from the EUT were maximized by rotating the EUT, adjusting the measurement antenna height and polarization, and manipulating the EUT and EUT antenna in 3 orthogonal planes.

The average values were calculated as per FCC KDB 890966 - Measurement Procedure for Level Probing Radars, Section 9. The steps for the calculation are as follows:

1. Calculate the dwell time, T_C, of the sweep frequency signal per MHz of the sweep frequency span.

   T_D = Ts/ΔF, Where:

   Ts is the signal sweep frequency time in seconds
   ΔF is the signal sweep frequency span in MHz

2. Calculate the Average Factor:

   Average Factor = (T_D) / Cycle Time, Where:

   Cycle Time is the total time for a complete cycle of the signal including retrace and any other latency times.

3. Calculate the Duty Cycle Correction Factor (DCCF):

   DCCF = 10*log(Average Factor)

4. Apply the DCCF to the PK measurements to determine the AVG values.

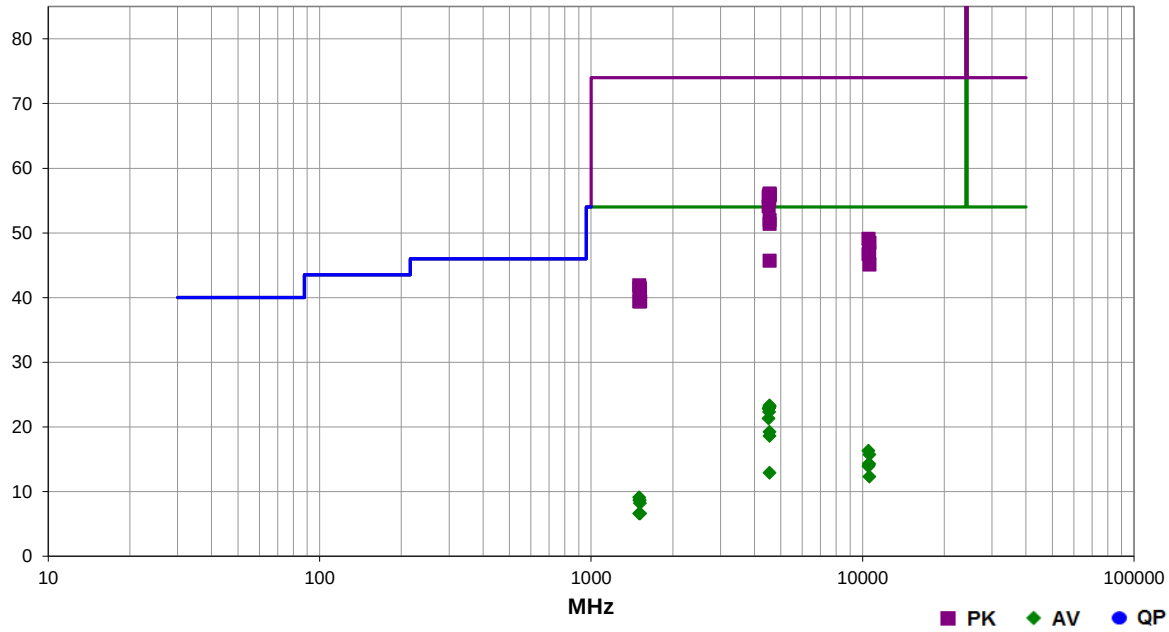
SPURIOUS RADIATED EMISSIONS

EmiR5 2019.08.01 PSA-ESCI 2019.05.10

Work Order:	PRCO0103	**Date:**	2-Oct-2019		
Project:	None	**Temperature:**	19.8 °C		
Job Site:	EV01	**Humidity:**	37.7% RH		
Serial Number:	None	**Barometric Pres.:**	1021 mbar	**Tested by:**	Jeff Alcoke
EUT:	SX97				
Configuration:	1				
Customer:	Preco, Inc.				
Attendees:	Donny Lloyd				
EUT Power:	12 VDC via 110VAC/60Hz				
Operating Mode:	Continuous Tx, CW, Low Ch. = 24056 MHz, Mid Ch = 24152 , High Ch 24247				
Deviations:	None				
Comments:	See comments below for Channel and EUT orientation. The radio employs FMCW modulation, the AVG values were derived from PK measurements as per FCC KDB 890966 Section F. The radio has a dwell time (T_D) of 5.86*10^-6 s and Cycle Time of 0.01119 s. The Average Factor = T_D/Cycle Time = 5.24*10^-4. The DCCF used to derive the AVG value is 10*log(Average Factor) = -32.8 dB				

Test Specifications	**Test Method**
FCC 15.249:2019	ANSI C63.10:2013

Run #	9	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
4546.467	52.3	3.8	2.4	292.0		0.0	Horz	PK	0.0	56.1	74.0	-17.9	High Ch, EUT on Side
4546.517	52.1	3.8	1.3	278.0		0.0	Vert	PK	0.0	55.9	74.0	-18.1	High Ch, EUT Horz
4546.483	52.1	3.8	1.0	165.0		0.0	Vert	PK	0.0	55.9	74.0	-18.1	High Ch, EUT Vert
4528.433	51.8	3.9	2.4	287.0		0.0	Horz	PK	0.0	55.7	74.0	-18.3	Mid Ch, EUT on Side
4510.442	51.6	4.0	2.5	281.0		0.0	Horz	PK	0.0	55.6	74.0	-18.4	Low Ch, EUT on Side
4528.567	51.2	3.9	2.3	282.0		0.0	Vert	PK	0.0	55.1	74.0	-18.9	Mid Ch, EUT Horz
4510.475	50.1	4.0	1.5	279.0		0.0	Vert	PK	0.0	54.1	74.0	-19.9	Low Ch, EUT Horz
4546.458	48.2	3.8	1.2	251.0		0.0	Horz	PK	0.0	52.0	74.0	-22.0	High Ch, EUT Vert
4546.433	47.6	3.8	2.2	203.0		0.0	Horz	PK	0.0	51.4	74.0	-22.6	High Ch, EUT Horz
10524.620	50.1	-1.0	2.0	325.0		0.0	Horz	PK	0.0	49.1	74.0	-24.9	Low Ch, EUT on Side
10607.900	49.1	-0.6	1.9	213.0		0.0	Horz	PK	0.0	48.5	74.0	-25.5	High Ch, EUT on Side
10566.620	47.9	-0.8	1.9	251.0		0.0	Vert	PK	0.0	47.1	74.0	-26.9	Mid Ch, EUT Horz
10566.650	47.7	-0.8	1.5	346.0		0.0	Horz	PK	0.0	46.9	74.0	-27.1	Mid Ch, EUT on Side
10524.580	47.7	-1.0	2.0	244.0		0.0	Vert	PK	0.0	46.7	74.0	-27.3	Low Ch, EUT Horz
4546.067	41.9	3.8	1.2	355.0		0.0	Vert	PK	0.0	45.7	74.0	-28.3	High Ch, EUT on Side
10608.170	45.7	-0.6	1.5	87.0		0.0	Vert	PK	0.0	45.1	74.0	-28.9	High Ch, EUT Horz
4546.467	52.3	3.8	2.4	292.0	-32.8	0.0	Horz	AV	0.0	23.3	54.0	-30.7	High Ch, EUT on Side

Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
4546.517	52.1	3.8	1.3	278.0	-32.8	0.0	Vert	AV	0.0	23.1	54.0	-30.9	High Ch, EUT Horz
4546.483	52.1	3.8	1.0	165.0	-32.8	0.0	Vert	AV	0.0	23.1	54.0	-30.9	High Ch, EUT Vert
4528.433	51.8	3.9	2.4	287.0	-32.8	0.0	Horz	AV	0.0	22.9	54.0	-31.1	Mid Ch, EUT on Side
4510.442	51.6	4.0	2.5	281.0	-32.8	0.0	Horz	AV	0.0	22.8	54.0	-31.2	Low Ch, EUT on Side
4528.567	51.2	3.9	2.3	282.0	-32.8	0.0	Vert	AV	0.0	22.3	54.0	-31.7	Mid Ch, EUT Horz
1503.583	49.1	-7.2	1.4	117.0		0.0	Horz	PK	0.0	41.9	74.0	-32.1	Low Ch, EUT on Side
1509.558	48.7	-7.2	2.8	101.0		0.0	Vert	PK	0.0	41.5	74.0	-32.5	Mid Ch, EUT Horz
1509.500	48.6	-7.2	2.3	121.0		0.0	Horz	PK	0.0	41.4	74.0	-32.6	Mid Ch, EUT on Side
4510.475	50.1	4.0	1.5	279.0	-32.8	0.0	Vert	AV	0.0	21.3	54.0	-32.7	Low Ch, EUT Horz
1515.192	48.2	-7.2	1.6	123.0		0.0	Horz	PK	0.0	41.0	74.0	-33.0	High Ch, EUT on Side
1515.467	46.6	-7.2	1.5	51.0		0.0	Vert	PK	0.0	39.4	74.0	-34.6	High Ch, EUT Horz
1503.325	46.6	-7.2	1.5	249.0		0.0	Vert	PK	0.0	39.4	74.0	-34.6	Low Ch, EUT Horz
4546.458	48.2	3.8	1.2	251.0	-32.8	0.0	Horz	AV	0.0	19.2	54.0	-34.8	High Ch, EUT Vert
4546.433	47.6	3.8	2.2	203.0	-32.8	0.0	Horz	AV	0.0	18.6	54.0	-35.4	High Ch, EUT Horz
10524.620	50.1	-1.0	2.0	325.0	-32.8	0.0	Horz	AV	0.0	16.3	54.0	-37.7	Low Ch, EUT on Side
10607.900	49.1	-0.6	1.9	213.0	-32.8	0.0	Horz	AV	0.0	15.7	54.0	-38.3	High Ch, EUT on Side
10566.620	47.9	-0.8	1.9	251.0	-32.8	0.0	Vert	AV	0.0	14.3	54.0	-39.7	Mid Ch, EUT Horz
10566.650	47.7	-0.8	1.5	346.0	-32.8	0.0	Horz	AV	0.0	14.1	54.0	-39.9	Mid Ch, EUT on Side
10524.580	47.7	-1.0	2.0	244.0	-32.8	0.0	Vert	AV	0.0	13.9	54.0	-40.1	Low Ch, EUT Horz
4546.067	41.9	3.8	1.2	355.0	-32.8	0.0	Vert	AV	0.0	12.9	54.0	-41.1	High Ch, EUT on Side
10608.170	45.7	-0.6	1.5	87.0	-32.8	0.0	Vert	AV	0.0	12.3	54.0	-41.7	High Ch, EUT Horz
1503.583	49.1	-7.2	1.4	117.0	-32.8	0.0	Horz	AV	0.0	9.1	54.0	-44.9	Low Ch, EUT on Side
1509.558	48.7	-7.2	2.8	101.0	-32.8	0.0	Vert	AV	0.0	8.7	54.0	-45.3	Mid Ch, EUT Horz
1509.500	48.6	-7.2	2.3	121.0	-32.8	0.0	Horz	AV	0.0	8.6	54.0	-45.4	Mid Ch, EUT on Side
1515.192	48.2	-7.2	1.6	123.0	-32.8	0.0	Horz	AV	0.0	8.2	54.0	-45.8	High Ch, EUT on Side
1515.467	46.6	-7.2	1.5	51.0	-32.8	0.0	Vert	AV	0.0	6.6	54.0	-47.4	High Ch, EUT Horz
1503.325	46.6	-7.2	1.5	249.0	-32.8	0.0	Vert	AV	0.0	6.6	54.0	-47.4	Low Ch, EUT Horz

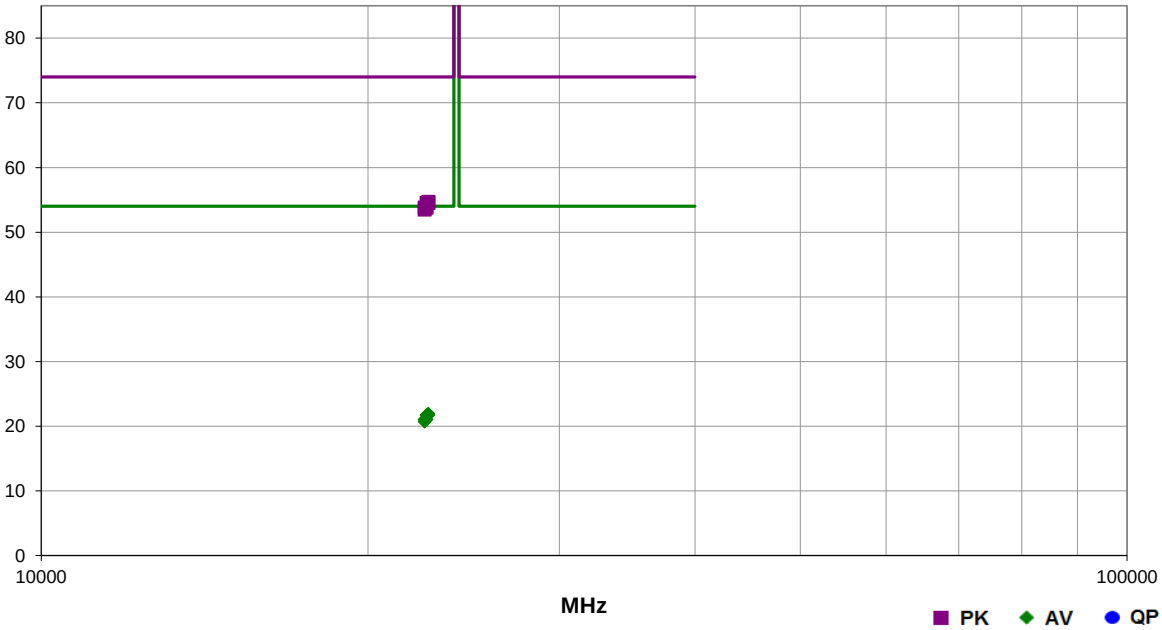
SPURIOUS RADIATED EMISSIONS

EmiR5 2019.08.01 PSA-ESCI 2019.05.10

Work Order:	PRCO0103	**Date:**	8-Oct-2019		
Project:	None	**Temperature:**	21.7 °C		
Job Site:	EV01	**Humidity:**	46.3% RH		
Serial Number:	None	**Barometric Pres.:**	1018 mbar	**Tested by:**	Jeff Alcoke
EUT:	SX97				
Configuration:	1				
Customer:	Preco, Inc.				
Attendees:	None				
EUT Power:	12 VDC via 110VAC/60Hz				
Operating Mode:	Continuous Tx, CW, Low Ch. = 24056 MHz, Mid Ch = 24152 , High Ch 24247				
Deviations:	None				
Comments:	See comments below for Channel and EUT orientation. The radio employs FMCW modulation, the AVG values were derived from PK measurements as per FCC KDB 890966 Section F. The radio has a dwell time (T_D) of 5.86*10^-6 s and Cycle Time of 0.01119 s. The Average Factor = T_D/Cycle Time = 5.24*10^-4. The DCCF used to derive the AVG value is 10*log(Average Factor) = -32.8 dB				

Test Specifications	**Test Method**
FCC 15.249:2019	ANSI C63.10:2013

Run #	14	**Test Distance (m)**	0.1	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
22731.820	41.1	43.1	1.6	10.0		0.0	Horz	PK	-29.5	54.7	74.0	-19.3	High Ch, EUT Horz
22731.480	40.9	43.1	1.6	10.0		0.0	Vert	PK	-29.5	54.5	74.0	-19.5	High Ch, EUT on Side
22642.370	40.9	43.1	1.6	10.0		0.0	Horz	PK	-29.5	54.5	74.0	-19.5	Mid Ch, EUT Horz
22642.730	40.2	43.1	1.6	10.0		0.0	Vert	PK	-29.5	53.8	74.0	-20.2	Mid Ch, EUT on Side
22552.800	40.2	43.1	1.6	10.0		0.0	Vert	PK	-29.5	53.8	74.0	-20.2	Low Ch, EUT on Side
22552.780	39.9	43.1	1.6	10.0		0.0	Horz	PK	-29.5	53.5	74.0	-20.5	Low Ch, EUT Horz
22731.820	41.1	43.1	1.6	10.0	-32.8	0.0	Horz	AV	-29.5	21.9	54.0	-32.1	High Ch, EUT Horz
22731.480	40.9	43.1	1.6	10.0	-32.8	0.0	Vert	AV	-29.5	21.7	54.0	-32.3	High Ch, EUT on Side
22642.370	40.9	43.1	1.6	10.0	-32.8	0.0	Horz	AV	-29.5	21.7	54.0	-32.3	Mid Ch, EUT Horz
22642.730	40.2	43.1	1.6	10.0	-32.8	0.0	Vert	AV	-29.5	21.0	54.0	-33.0	Mid Ch, EUT on Side
22552.800	40.2	43.1	1.6	10.0	-32.8	0.0	Vert	AV	-29.5	21.0	54.0	-33.0	Low Ch, EUT on Side
22552.780	39.9	43.1	1.6	10.0	-32.8	0.0	Horz	AV	-29.5	20.7	54.0	-33.3	Low Ch, EUT Horz

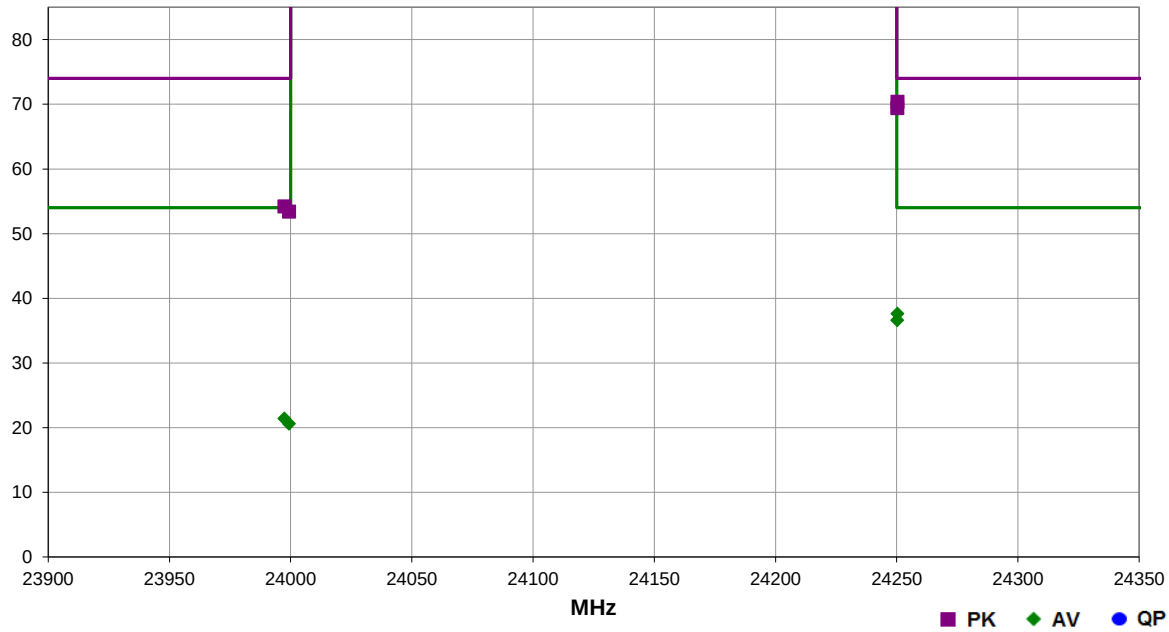
SPURIOUS RADIATED EMISSIONS

EmiR5 2019.08.01 PSA-ESCI 2019.05.10

Work Order:	PRCO0103	**Date:**	8-Oct-2019		
Project:	None	**Temperature:**	21.7 °C		
Job Site:	EV01	**Humidity:**	46.3% RH		
Serial Number:	None	**Barometric Pres.:**	1018 mbar	**Tested by:**	Jeff Alcoke
EUT:	SX97				
Configuration:	1				
Customer:	Preco, Inc.				
Attendees:	None				
EUT Power:	12 VDC via 110VAC/60Hz				
Operating Mode:	Continuous Tx, CW, Low Ch. = 24056 MHz, Mid Ch = 24152 , High Ch 24247				
Deviations:	None				
Comments:	See comments below for Channel and EUT orientation. The radio employs FMCW modulation, the AVG values were derived from PK measurements as per FCC KDB 890966 Section F. The radio has a dwell time (T_D) of 5.86*10^-6 s and Cycle Time of 0.01119 s. The Average Factor = T_D/Cycle Time = 5.24*10^-4. The DCCF used to derive the AVG value is 10*log(Average Factor) = -32.8 dB				

Test Specifications	**Test Method**
FCC 15.249:2019	ANSI C63.10:2013

Run #	16	**Test Distance (m)**	0.1	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
24250.330	56.5	43.4	1.6	10.0		0.0	Horz	PK	-29.5	70.4	74.0	-3.6	High Ch, EUT Horz
24250.230	55.5	43.4	1.6	10.0		0.0	Vert	PK	-29.5	69.4	74.0	-4.6	High Ch, EUT on Side
24250.330	56.5	43.4	1.6	10.0	-32.8	0.0	Horz	AV	-29.5	37.6	54.0	-16.4	High Ch, EUT Horz
24250.230	55.5	43.4	1.6	10.0	-32.8	0.0	Vert	AV	-29.5	36.6	54.0	-17.4	High Ch, EUT on Side
23997.410	40.4	43.3	1.6	10.0		0.0	Vert	PK	-29.5	54.2	74.0	-19.8	Low Ch, EUT on Side
23999.320	39.6	43.3	1.6	10.0		0.0	Horz	PK	-29.5	53.4	74.0	-20.6	Low Ch, EUT Horz
23997.410	40.4	43.3	1.6	10.0	-32.8	0.0	Vert	AV	-29.5	21.4	54.0	-32.6	Low Ch, EUT on Side
23999.320	39.6	43.3	1.6	10.0	-32.8	0.0	Horz	AV	-29.5	20.6	54.0	-33.4	Low Ch, EUT Horz

FIELD STRENGTH OF FUNDAMENTAL

PSA-ESCI 2019.05.10

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

MODES OF OPERATION

Continuous Tx, CW, Low Ch. = 24056 MHz, Mid Ch = 24152 MHz, High Ch 24247 MHz

POWER SETTINGS INVESTIGATED

12 VDC via 110VAC/60Hz

CONFIGURATIONS INVESTIGATED

PRCO0103 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	24056 MHz	Stop Frequency	24247 MHz

SAMPLE CALCULATIONS

Radiated Emissions: Field Strength = Measured Level + Antenna Factor + Cable Factor - Amplifier Gain + Distance Adjustment Factor + External Attenuation

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Interval
Cable	Micro-Coax	UFD150A-1-0720-200200	EVH	28-Mar-2019	12 mo
Antenna - Standard Gain	ETS Lindgren	3160-09	AIV	NCR	0 mo
Analyzer - Spectrum Analyzer	Agilent	E4446A	AAQ	24-Mar-2019	12 mo

TEST DESCRIPTION

The antennas to be used with the EUT were tested. The EUT was transmitting and while set at the lowest channel, a middle channel, and the highest channel available. While scanning, emissions from the EUT were maximized by rotating the EUT, adjusting the measurement antenna height and polarization, and manipulating the EUT and EUT antenna in 3 orthogonal planes.

The average values were calculated as per FCC KDB 890966 - Measurement Procedure for Level Probing Radars, Section 9. The steps for the calculation are as follows:

1. Calculate the dwell time, T_C, of the sweep frequency signal per MHz of the sweep frequency span.

   T_D = Ts/ΔF, Where:

   Ts is the signal sweep frequency time in seconds
   ΔF is the signal sweep frequency span in MHz

2. Calculate the Average Factor:

   Average Factor = (T_D) / Cycle Time, Where:

   Cycle Time is the total time for a complete cycle of the signal including retrace and any other latency times.

3. Calculate the Duty Cycle Correction Factor (DCCF):

   DCCF = 10*log(Average Factor)

4. Apply the DCCF to the PK measurements to determine the AVG values.

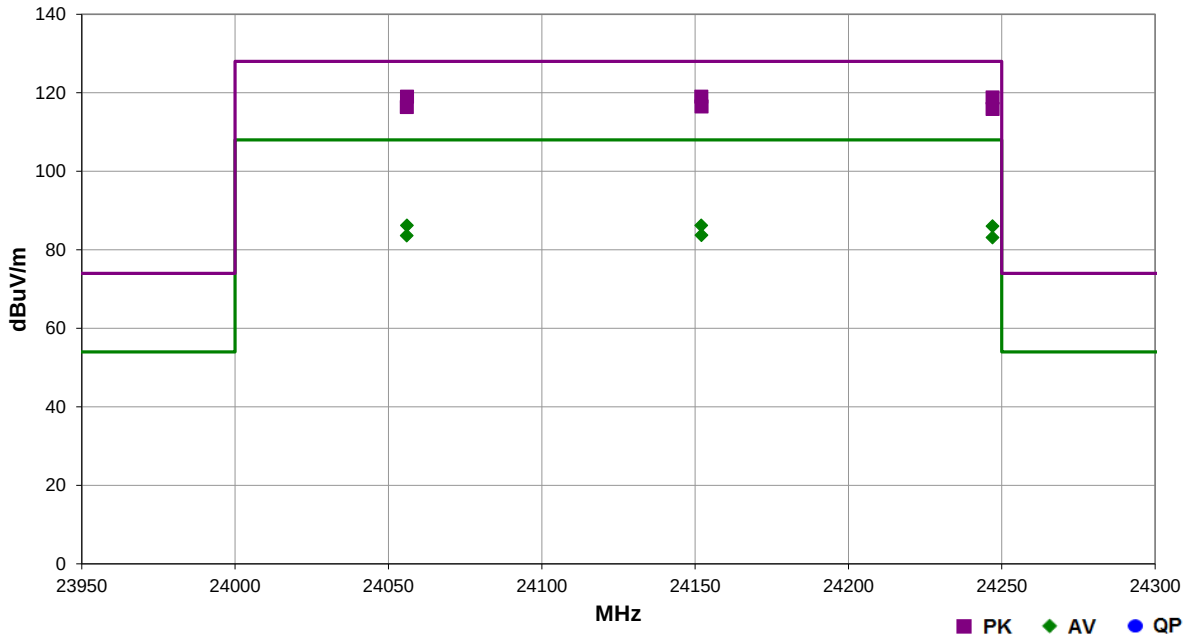
FIELD STRENGTH OF FUNDAMENTAL

EmiR5 2019.08.01 PSA-ESCI 2019.05.10

Work Order:	PRCO0103	**Date:**	1-Oct-2019		
Project:	None	**Temperature:**	21.9 °C		
Job Site:	EV01	**Humidity:**	37.4% RH		
Serial Number:	None	**Barometric Pres.:**	1023 mbar	**Tested by:**	Jeff Alcoke
EUT:	SX97				
Configuration:	1				
Customer:	Preco, Inc.				
Attendees:	Donny Lloyd				
EUT Power:	12 VDC via 110VAC/60Hz				
Operating Mode:	Continuous Tx, CW, Low Ch. = 24056 MHz, Mid Ch = 24152 MHz, High Ch 24247 MHz				
Deviations:	None				
Comments:	See comments below for Channel and EUT orientation. The radio employs FMCW modulation, the AVG values were derived from PK measurements as per FCC KDB 890966 Section F. The radio has a dwell time (T_D) of 5.86*10^-6 s and Cycle Time of 0.01119 s. The Average Factor = T_D/Cycle Time = 5.24*10^-4. The DCCF used to derive the AVG value is 10*log(Average Factor) = -32.8 dB				

Test Specifications	**Test Method**
FCC 15.249:2019	ANSI C63.10:2013

Run #	0	**Test Distance (m)**	3	**Antenna Height(s)**	1 to 4(m)	**Results**	Pass



Freq (MHz)	Amplitude (dBuV)	Factor (dB)	Antenna Height (meters)	Azimuth (degrees)	Duty Cycle Correction Factor (dB)	External Attenuation (dB)	Polarity/ Transducer Type	Detector	Distance Adjustment (dB)	Adjusted (dBuV/m)	Spec. Limit (dBuV/m)	Compared to Spec. (dB)	Comments
24056.030	75.6	43.4	1.6	3.0		0.0	Vert	PK	0.0	119.0	128.0	-9.0	Low Ch, EUT on Side
24152.020	75.6	43.4	1.6	3.0		0.0	Vert	PK	0.0	119.0	128.0	-9.0	Mid Ch, EUT on Side
24247.020	75.4	43.4	1.6	4.0		0.0	Vert	PK	0.0	118.8	128.0	-9.2	High Ch, EUT on Side
24152.070	73.1	43.4	1.7	7.0		0.0	Horz	PK	0.0	116.5	128.0	-11.5	Mid Ch, EUT Horz
24056.000	73.0	43.4	1.8	8.0		0.0	Horz	PK	0.0	116.4	128.0	-11.6	Low Ch, EUT Horz
24246.980	72.5	43.4	1.7	9.0		0.0	Horz	PK	0.0	115.9	128.0	-12.1	High Ch, EUT Horz
24056.030	75.6	43.4	1.6	3.0	-32.8	0.0	Vert	AV	0.0	86.2	108.0	-21.8	Low Ch, EUT on Side
24152.020	75.6	43.4	1.6	3.0	-32.8	0.0	Vert	AV	0.0	86.2	108.0	-21.8	Mid Ch, EUT on Side
24247.020	75.4	43.4	1.6	4.0	-32.8	0.0	Vert	AV	0.0	86.0	108.0	-22.0	High Ch, EUT on Side
24152.070	73.1	43.4	1.7	7.0	-32.8	0.0	Horz	AV	0.0	83.7	108.0	-24.3	Mid Ch, EUT Horz
24056.000	73.0	43.4	1.8	8.0	-32.8	0.0	Horz	AV	0.0	83.6	108.0	-24.4	Low Ch, EUT Horz
24246.980	72.5	43.4	1.7	9.0	-32.8	0.0	Horz	AV	0.0	83.1	108.0	-24.9	High Ch, EUT Horz