Spartan Radar

EMC TEST REPORT FOR

Sensor
Model: HSENIXX

Tested to The Following Standards:

FCC Part 95 Subpart M
The 76–81 GHz Band Radar Service

Report No.: 108943-3

Date of issue: October 24, 2023

This test report bears the accreditation symbol indicating that the testing performed herein meets the test and reporting requirements of ISO/IEC 17025 under the applicable scope of testing for CKC Laboratories, Inc.

We strive to create long-term, trust based relationships by providing sound, adaptive, customer first testing services. We embrace each of our customers' unique EMC challenges, not as an interruption to set processes, but rather as the reason we are in business.

Test Certificate # 803.01

TABLE OF CONTENTS

ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

Spartan Radar
10541 Calle Lee, Unit 125
Los Alamitos, CA 90720

Representative: Eugene Adams

REPORT PREPARED BY:

Viviana Prado
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 108943

DATE OF EQUIPMENT RECEIPT: September 19, 2023
DATE(S) OF TESTING: September 19 and 20, 2023

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the equipment provided by the client, tested in the agreed upon operational mode(s) and configuration(s) as identified herein. Compliance assessment remains the client's responsibility. This report may not be used to claim product endorsement by A2LA or any government agencies. This test report has been authorized for release under quality control from CKC Laboratories, Inc.
.

Steve Behm
Director of Quality Assurance & Engineering Services
CKC Laboratories, Inc.

Test Facility Information

Our laboratories are configured to effectively test a wide variety of product types. CKC utilizes first class test equipment, anechoic chambers, data acquisition and information services to create accurate, repeatable, and affordable test results.

TEST LOCATION(S):
CKC Laboratories, Inc.
110 Olinda Place
Brea, CA 92823

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.20
EMITest Immunity	5.03.10

Site Registration & Accreditation Information

Location	*NIST CB #	FCC	Canada	Japan
Canyon Park, Bothell, WA	US0103	US1024	3082C	A-0136
Brea, CA	US0103	US1024	3082D	A-0136
Fremont, CA	US0103	US1024	3082B	A-0136
Mariposa, CA	US0103	US1024	3082A	A-0136

*CKC's list of NIST designated countries can be found at: https://standards.gov/cabs/designations.html

SUMMARY OF RESULTS

Standard / Specification: FCC Part 95 Subpart M – 95.3301

Test Procedure	Description	Modifications	Results
2.1049	Occupied Bandwidth	NA	NP
2.1046/95.3367 (a), (b)	Power Output : 76–81 GHz Band Radar Service radiated power limits	NA	Pass
2.1055 /95.3379 (b)	Frequency Stability	NA	NP
2.1053/95.3379 (a)(1), (a)(2)	Radiated Spurious Emissions: 76–81 GHz Band Radar Service unwanted emissions limits	NA	Pass

NA = Not Applicable
NP = NP: Not Performed. This test was not performed because the only change to the original EUT was the firmware. The firmware change increased the duty cycle only. There were no hardware changes to the EUT.

ISO/IEC 17025 Decision Rule
The equipment sample utilized for testing is selected by the manufacturer. The declaration of pass or fail herein is a binary statement for simple acceptance rule (ILAC G8) based upon assessment to the specification(s) listed above, without consideration of measurement uncertainties. For performance related tests, equipment was monitored for specified criteria identified in that section of testing.

Modifications During Testing

This list is a summary of the modifications made to the equipment during testing.

Summary of Conditions
No modifications were made during testing.

Modifications listed above must be incorporated into all production units.

Conditions During Testing

This list is a summary of the conditions noted to the equipment during testing.

Summary of Conditions
None

EQUIPMENT UNDER TEST (EUT)

During testing numerous configurations may have been utilized. The configurations listed below support compliance to the standard(s) listed in the Summary of Results section.

Configuration 1

Equipment Tested:

Device	Manufacturer	Model #	S/N
Sensor	Spartan Radar	HSENIXX	HSENIXX-2332-20014

Support Equipment:

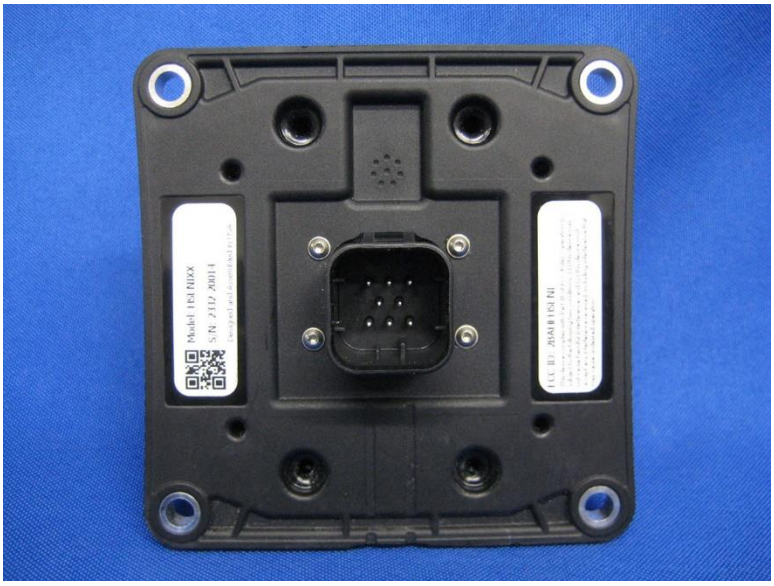
Device	Manufacturer	Model #	S/N
HMI	Spartan Radar	HLCD	HLCD-2330-20915
Power Supply	Topward	6306D	9885614
Multimeter	Fluke	8845A/G	3947018
Laptop Computer	MSi	MS-17E9	K2010N1000392

General Product Information:

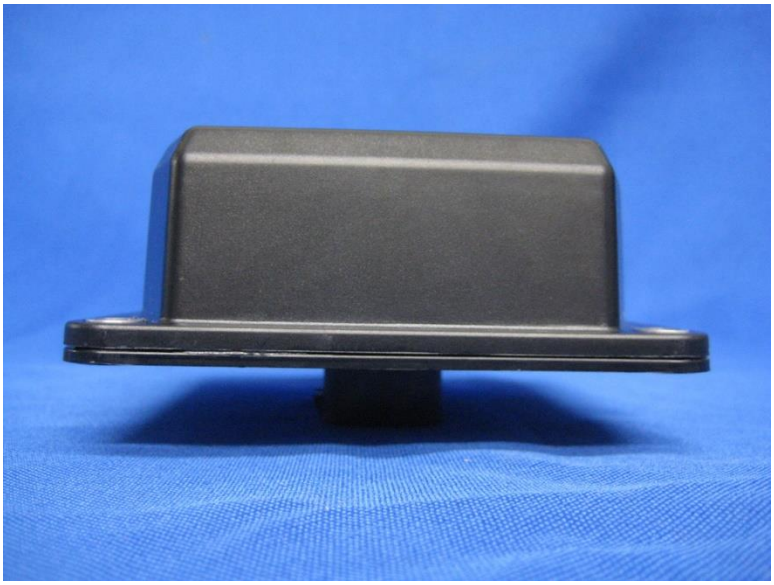
Product Information	Manufacturer-Provided Details
Equipment Type:	Stand-Alone Equipment
Type of Transmission System:	Modulated CW Radar
Operating Frequency Range(s):	77.37GHz to 79.97GHz
Modulation Type(s):	Linear FMCW
Maximum Duty Cycle:	9% (98% or better for the entire band of operation)
Number of TX Chains:	3
Antenna Type(s) and Gain:	Microstrip Patch Antenna / 12dBi
Beamforming Type:	NA
Antenna Connection Type:	Integral
Nominal Input Voltage:	12.0VDC
Firmware used for test:	v1.0.0.8
The validity of results is dependent on the stated product details, the accuracy of which the manufacturer assumes full responsibility.	

EUT and Accessory Photo(s)

Front View



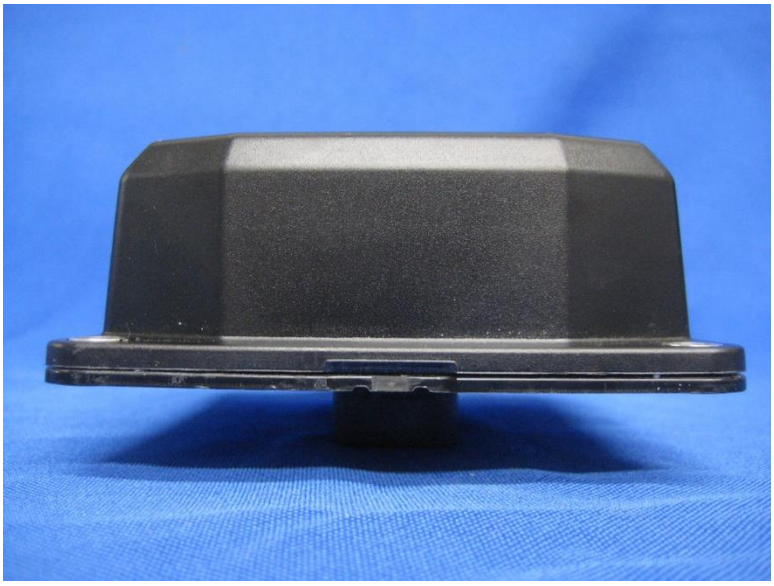
Back View



Left View

Right View

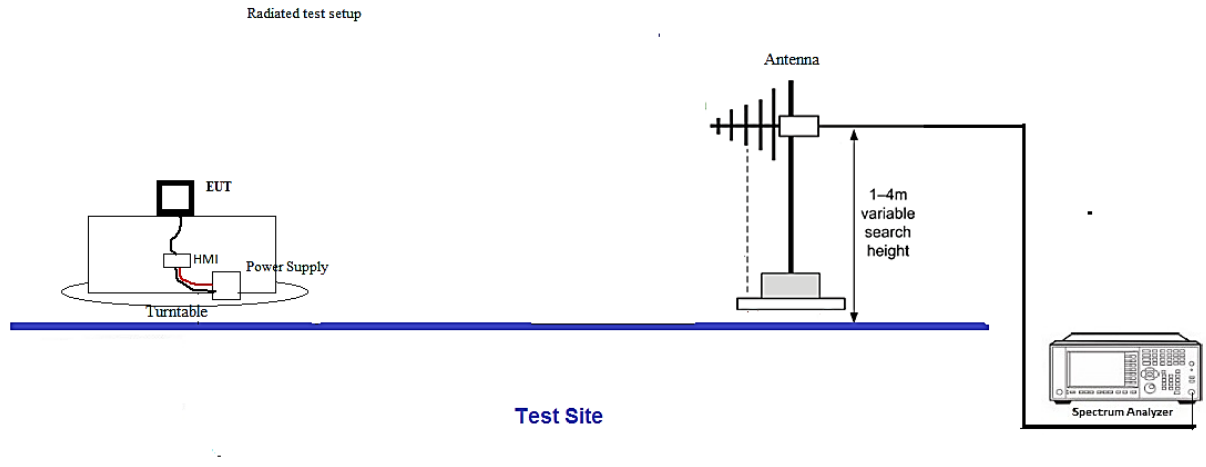
Top View



Bottom View

Support Equipment Photo(s)

Block Diagram of Test Setup(s)



FCC Part 95 Subpart M

2.1046/95.3367 (a), (b) Output Power

Test Setup/Conditions			
Test Location:	Brea Lab A	Test Engineer:	S. Yamamoto
Test Method:	ANSI C63.26 (2015) KDB 653005 D01 76-81 GHz Radars v01r02	Test Date(s):	9/19/2023
Configuration:	1		
Test Setup:	The equipment under test (EUT) is placed on the Styrofoam tabletop on the test site. The EUT is connected to a support DC power supply set at 1.1 % of the target battery bank of the EUT and monitor. The EUT is powered on and running in its normal operational mode. TX frequency : 77.37 GHz , 78.65GHz, 79.97GHz RBW=1MHz,VBW=3 MHz. Peak = Peak Ave = RMS detector for Fundamental power Peak EIRP , measured at 1 meter test distance due to low signal strength. Integrated RMS EIRP measured 10 cm test distance due to low signal strength. No signal detected with the receiving antenna placed in horizontal polarity.		

Environmental Conditions			
Temperature (ºC)	25	Relative Humidity (%):	53

Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
02672	Spectrum Analyzer	Agilent	E4446A	5/9/2022	5/9/2024
02348	Horn Antenna	OML	M12HWA	2/14/2023	2/14/2025
07659	Cable	Astrolab, Inc.	32022-29094K-29094K-24TC	6/22/2022	6/22/2024
07660	Cable	Astrolab, Inc.	32022-29094K-29094K-24TC	6/22/2022	6/22/2024

Test Data Summary - RF Radiated Measurement					
Peak **					
Frequency (GHz)	**Modulation**	**Ant. Type / Gain (dBi)**	***Measured EIRP (dBm)**	**Limit (dBm)**	**Results**
77.350	Linear FMCW	Microstrip Patch Antenna / 12	7.0	55	Pass
77.915	Linear FMCW	Microstrip Patch Antenna / 12	9.0	55	Pass
78.793	Linear FMCW	Microstrip Patch Antenna / 12	6.5	55	Pass

Test Data Summary - RF Radiated Measurement					
Power Average (RMS)					
Frequency (GHz)	**Modulation**	**Ant. Type / Gain (dBi)**	***Measured EIRP (dBm)**	**Limit (dBm)**	**Results**
77.99	Linear FMCW	Microstrip Patch Antenna / 12	4.8	50	Pass
78.805	Linear FMCW	Microstrip Patch Antenna / 12	4.7	50	Pass
79.76	Linear FMCW	Microstrip Patch Antenna / 12	4.1	50	Pass

(a) The maximum power (EIRP) within the 76–81 GHz band shall not exceed 50 dBm based on measurements employing a power averaging detector with a 1 MHz Resolution Bandwidth (RBW). (Integrated power IAW KDB)

(b) The maximum peak power (EIRP) within the 76–81 GHz band shall not exceed 55 dBm based on measurements employing a peak detector with a 1 MHz RBW.

* Conversion: EIRP = E(dBuV/m) + 20LOG(d) -G-104.77, for EIRP, G=0

** No Pulse desensitizing correction factor (PDCF) applied as investigation with various sweep time, and using simulated signal according to the signal parameter shows the peak emission remains unchanged.

Note: For reference only as a possible worst-case scenario the Agilent application note 5952-1039, P15 indicates PCDF for the PSA series instrument used would be

K = 1.479
α p dB = 20 Log (Teff k rbw)

T eff = 32.68kHz
PRF= 1/32.38kHz
Rbw=1000kHz
† eff = 1/ 32.32 kHz= 0.0309ms

PDCF α p dB = 20 Log (0.0309 x 1.476 x 1000) = 33.2dB

Test Data Summary - RF Radiated Measurement					
Peak with worse case correction					
Frequency (GHz)	**Modulation**	**Ant. Type / Gain (dBi)**	**For reference only *Measured EIRP with PDCF of 33.2dB applied. (dBm)**	**Limit (dBm)**	**Results**
77.350	Linear FMCW	Microstrip Patch Antenna / 12	40.2	55	Pass
77.915	Linear FMCW	Microstrip Patch Antenna / 12	42.2	55	Pass
78.793	Linear FMCW	Microstrip Patch Antenna / 12	39.7	55	Pass

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 110 North Olinda Place • Brea, CA 92823 • (714) 993-6112		
Customer:	**Spartan Radar**		
Specification:	**95.3367 Radiated Emissions (RMS)**		
Work Order #:	**108943**	Date:	9/19/2023
Test Type:	**Maximized Emissions**	Time:	14:33:04
Tested By:	S. Yamamoto	Sequence#:	1
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The equipment under test (EUT) is placed on the Styrofoam tabletop on the test site. The EUT is connected to a support DC power supply set at 1.1 % of the target battery bank of the EUT and monitor. The EUT is powered on and running in its normal operational mode.

TX Frequency: 77.37 GHz , 78.65GHz, 79.97GHz

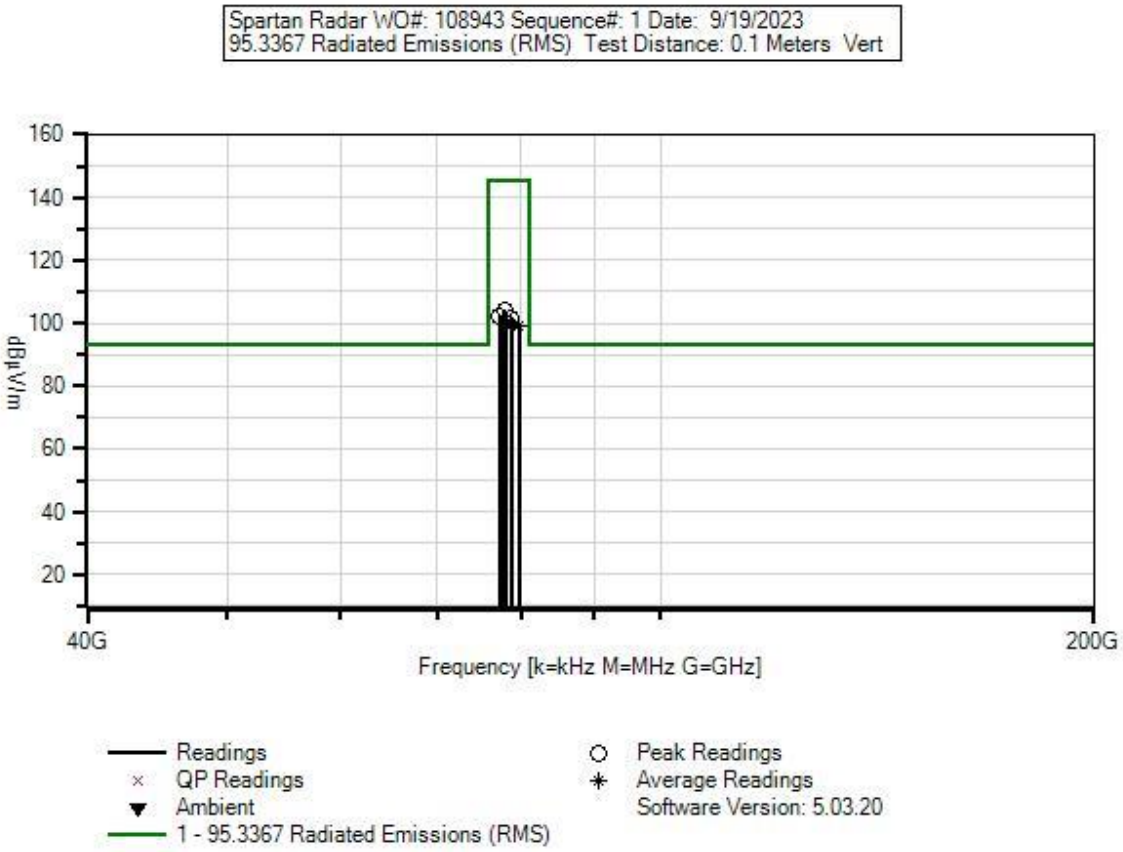
Frequency Range of Measurement: Fundamental TX Frequency
RBW=1MHz,VBW=3 MHz.

Test Environment Conditions:
Temperature: 25°C
Humidity: 53%
Pressure: 99kPa

Test Method: ANSI C63.26 (2015), 653005 D01 76-81 GHz Radars v01r02

Site A

Peak = Peak
Ave = RMS detector for Fundamental integrated power



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02672	Spectrum Analyzer	E4446A	5/9/2022	5/9/2024
T1	ANP07659-B	Cable	32022-29094K-29094K-24TC	6/22/2022	6/22/2024
T2	ANP07660-B	Cable	32022-29094K-29094K-24TC	6/22/2022	6/22/2024
T3	AN02348	Horn Antenna	M12HWA	2/14/2023	2/14/2025

Measurement Data: Reading listed by margin. Test Distance: 0.1 Meters

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
1	77990.000 M Ave	43.6	+0.6	+0.6	+84.7		-29.5	100.0	145.2 Low_New_DC_	-45.2	Vert
2	78805.000 M Ave	44.5	+0.6	+0.6	+83.7		-29.5	99.9	145.2 Mid_New_DC_	-45.3	Vert
3	79760.000 M Ave	43.5	+0.6	+0.6	+84.1		-29.5	99.3	145.2 High_New_DC_	-45.9	Vert
4	77915.000 M	27.8	+0.6	+0.6	+84.7		-9.5	104.2	150.2 Mid_New_DC_	-46.0	Vert
5	77350.000 M	26.1	+0.6	+0.7	+84.3		-9.5	102.2	150.2 Low_New_DC_	-48.0	Vert
6	78793.000 M	26.3	+0.6	+0.6	+83.7		-9.5	101.7	150.2 High_New_DC_	-48.5	Vert

Test Setup Photo(s)

Test Setup, View 1

Test Setup, View 2

2.1053/95.3379 (a)(1), (a)(2) Radiated Emissions

Test Setup/Conditions			
Test Location:	Brea Lab D	Test Engineer:	S.Yamamoto
Test Method:	ANSI C63.26 (2015) KDB 653005 D01 76-81 GHz Radars v01r02	Test Date(s):	9/20/2023
Configuration:	1		
Test Setup:	The equipment under test (EUT) is placed on the Styrofoam tabletop on the test site. The EUT is connected to a support DC power supply set at 1.1 % of the target battery bank of the EUT and monitor. The EUT is powered on and running in its normal operational mode. TX Frequency : 77.37 GHz , 78.65GHz, 79.97GHz Frequency Range of Measurement: 9kHz-231GHz 9 kH -150 kHz;RBW=200 Hz,VBW=600 Hz; 150 kHz-30 MHz;RBW=9 kHz,VBW=27 kHz; 30 MHz-1000 MHz;RBW=120 kHz,VBW=360 kHz, 1000 MHz-231 000 MHz;RBW=1MHz,VBW=3 MHz. Peak = Peak Ave = RMS detector for Fundamental power, Average detector for spurious emission.		

Environmental Conditions			
Temperature (ºC)	24	Relative Humidity (%):	54

Test Equipment					
Asset#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
00314	Loop Antenna	EMCO	6502	3/29/2022	3/29/2024
02672	Spectrum Analyzer	Agilent	E4446A	5/9/2022	5/9/2024
P06978	Cable	Huber & Suhner Inc	Sucoflex 104A	3/4/2022	3/4/2024
00010	Preamp	HP	8447D	1/3/2022	1/3/2024
P04382	Cable	andrew	LDF-50	5/18/2022	5/18/2024
P05569	Cable	Pasternack	RG-214/U	12/31/2022	12/31/2024
01994	Antenna	Chase	CBL6111C	6/1/2022	6/1/2024
P07655	Cable	Astrolab, Inc.	32022-29094K-29094K-24TC	6/22/2022	6/22/2024
P07656	Cable	Astrolab, Inc.	32022-29094K-29094K-24TC	6/22/2022	6/22/2024
P07659	Cable	Astrolab, Inc.	32022-29094K-29094K-24TC	6/22/2022	6/22/2024
P07660	Cable	Astrolab, Inc.	32022-29094K-29094K-24TC	6/22/2022	6/22/2024
P07691	Cable	CommScope	LDF1-50	9/9/2022	9/9/2024
P07657	Cable	Astrolab, Inc.	32022-29094K-29094K-24TC	6/22/2022	6/22/2024
02347	Antenna	OML	M19HWA	2/14/2023	2/14/2025
02348	Antenna	OML	M12HWA	2/14/2023	2/14/2025
02349	Antenna	OML	M08HWA	2/14/2023	2/14/2025
02350	Antenna	OML	M05HWA	2/14/2023	2/14/2025
03763	Mixer	OML Inc.	M03HWD	2/14/2023	2/14/2025
03158A	Antenna	Dorado	GH-28-25	7/7/2023	7/7/2025
01413	Antenna	HP	84125-80008	10/3/2022	10/3/2024
00787	Preamp	HP	83017A	6/27/2023	6/27/2025
01646	Antenna	Emco	3115	3/21/2022	3/21/2024
03367	Antenna	Dorado	62-GH-62-25.	8/10/2023	8/10/2025

Test Data Summary					
Frequency (MHz)	**Polarity**	**Pk/Ave/QP**	**Measured (dBuV/m)**	**Limit (dBuV/m)**	**Results**
28799.52	Horizontal	Ave	52.7	54.0	Pass
28799.52	Horizontal	Pk	54.2	74.0	Pass
150.000	Vertical	QP	41.3	43.5	Pass
150.000	Horizontal	QP	40.5	46.0	Pass

* See appendix B for limit conversion

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 110 North Olinda Place • Brea, CA 92823 • (714) 993-6112		
Customer:	**Spartan Radar**		
Specification:	**95.3379(a) Radiated Emissions**		
Work Order #:	**108943**	Date:	9/20/2023
Test Type:	**Maximized Emissions**	Time:	14:46:34
Tested By:	S. Yamamoto	Sequence#:	2
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The equipment under test (EUT) is placed on the Styrofoam tabletop on the test site. The EUT is connected to a support DC power supply set at 1.1 % of the target battery bank of the EUT and monitor. The EUT is powered on and running in its normal operational mode.

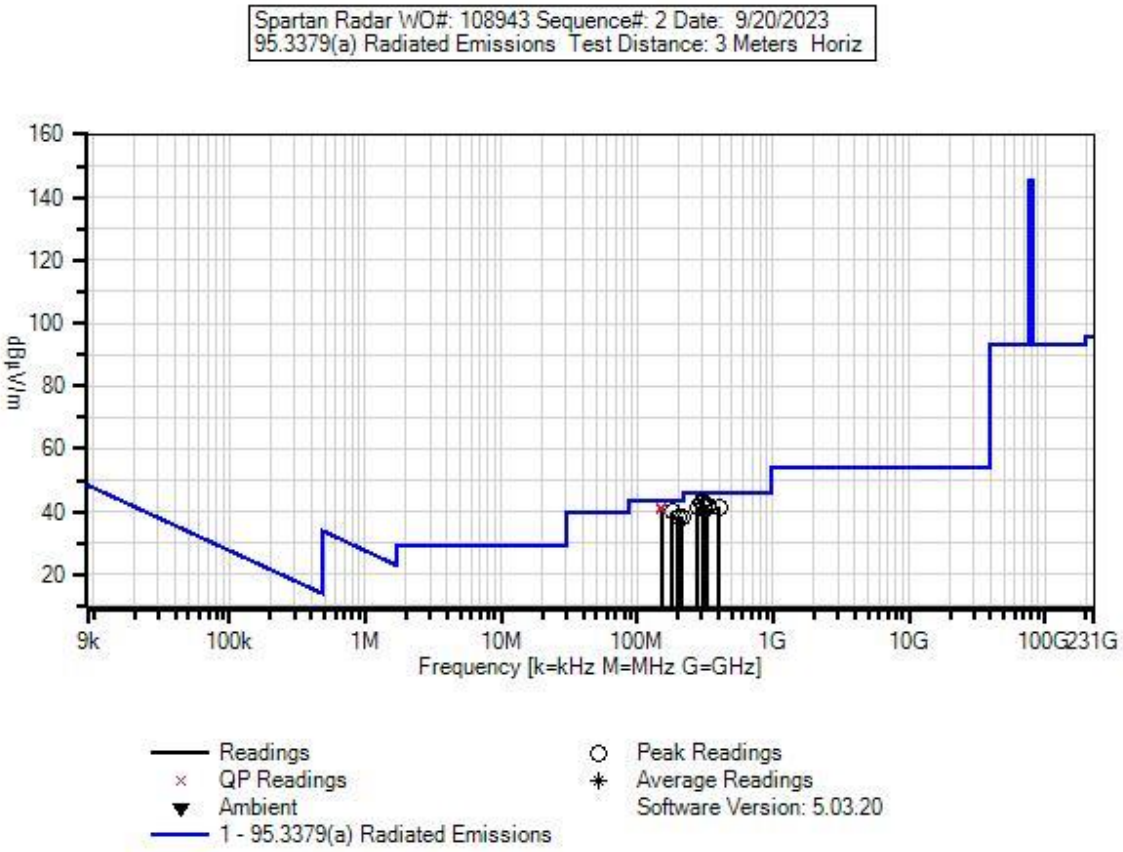
TX Frequency: Low 77.37GHz, Middle 78.65GHz, High 79.97GHz

Frequency Range of Measurement: 9kHz-1GHz
9kHz to 150kHz;RBW=200Hz,VBW=600Hz;
150kHz to 30MHz;RBW=9kHz,VBW=27kHz;
30MHz to 1000MHz;RBW=120kHz,VBW=360kHz,

Test Environment Conditions:
Temperature: 24°C
Humidity: 54%
Pressure: 99kPa

Test Method: ANSI C63.26 (2015), KDB 653005 D01 76-81 GHz Radars v01r02

Site D



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	12/13/2022	12/13/2023
T1	ANP06978	Cable	Sucoflex 104A	3/4/2022	3/4/2024
T2	AN00010	Preamp	8447D	1/3/2022	1/3/2024
T3	ANP04382	Cable	LDF-50	5/18/2022	5/18/2024
T4	ANP05569	Cable-Amplitude +15C to +45C (dB)	RG-214/U	12/31/2022	12/31/2024
T5	AN01994	Biconilog Antenna	CBL6111C	6/1/2022	6/1/2024

Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq	Rdng	T1 T5	T2	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	150.000M QP	48.5	+0.2 +16.8	-26.9	+1.4	+1.3	+0.0	41.3	43.5	-2.2	Vert
^	150.000M	55.5	+0.2 +16.8	-26.9	+1.4	+1.3	+0.0	48.3	43.5	+4.8	Vert
3	150.000M QP	47.7	+0.2 +16.8	-26.9	+1.4	+1.3	+0.0	40.5	43.5	-3.0	Horiz
^	150.000M	54.6	+0.2 +16.8	-26.9	+1.4	+1.3	+0.0	47.4	43.5	+3.9	Horiz
5	304.032M	46.2	+0.2 +19.2	-26.5	+2.0	+1.9	+0.0	43.0	46.0	-3.0	Vert
6	304.314M	46.0	+0.2 +19.2	-26.5	+2.0	+1.9	+0.0	42.8	46.0	-3.2	Horiz
7	182.666M	49.1	+0.2 +14.6	-26.8	+1.5	+1.4	+0.0	40.0	43.5	-3.5	Horiz
8	312.357M	45.1	+0.2 +19.3	-26.6	+2.0	+2.0	+0.0	42.0	46.0	-4.0	Horiz
9	328.691M	44.6	+0.2 +19.6	-26.7	+2.1	+2.0	+0.0	41.8	46.0	-4.2	Vert
10	401.756M	42.0	+0.3 +21.9	-27.3	+2.3	+2.3	+0.0	41.5	46.0	-4.5	Horiz
11	328.707M	44.2	+0.2 +19.6	-26.7	+2.1	+2.0	+0.0	41.4	46.0	-4.6	Horiz
12	312.320M	44.3	+0.2 +19.3	-26.6	+2.0	+2.0	+0.0	41.2	46.0	-4.8	Horiz
13	280.130M	44.9	+0.2 +18.7	-26.5	+2.0	+1.8	+0.0	41.1	46.0	-4.9	Vert
14	214.935M	47.0	+0.2 +14.6	-26.6	+1.7	+1.6	+0.0	38.5	43.5	-5.0	Vert
15	198.797M	47.1	+0.2 +14.8	-26.7	+1.6	+1.5	+0.0	38.5	43.5	-5.0	Vert

Test Location:	CKC Laboratories, Inc. • 110 North Olinda Place • Brea, CA 92823 • (714) 993-6112		
Customer:	**Spartan Radar**		
Specification:	**95.3379(a) Radiated Emissions**		
Work Order #:	**108943**	Date:	9/20/2023
Test Type:	**Maximized Emissions**	Time:	16:11:24
Tested By:	S. Yamamoto	Sequence#:	3
Software:	EMITest 5.03.20		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The equipment under test (EUT) is placed on the Styrofoam tabletop on the test site. The EUT is connected to a support DC power supply set at 1.1 % of the target battery bank of the EUT and monitor. The EUT is powered on and running in its normal operational mode.

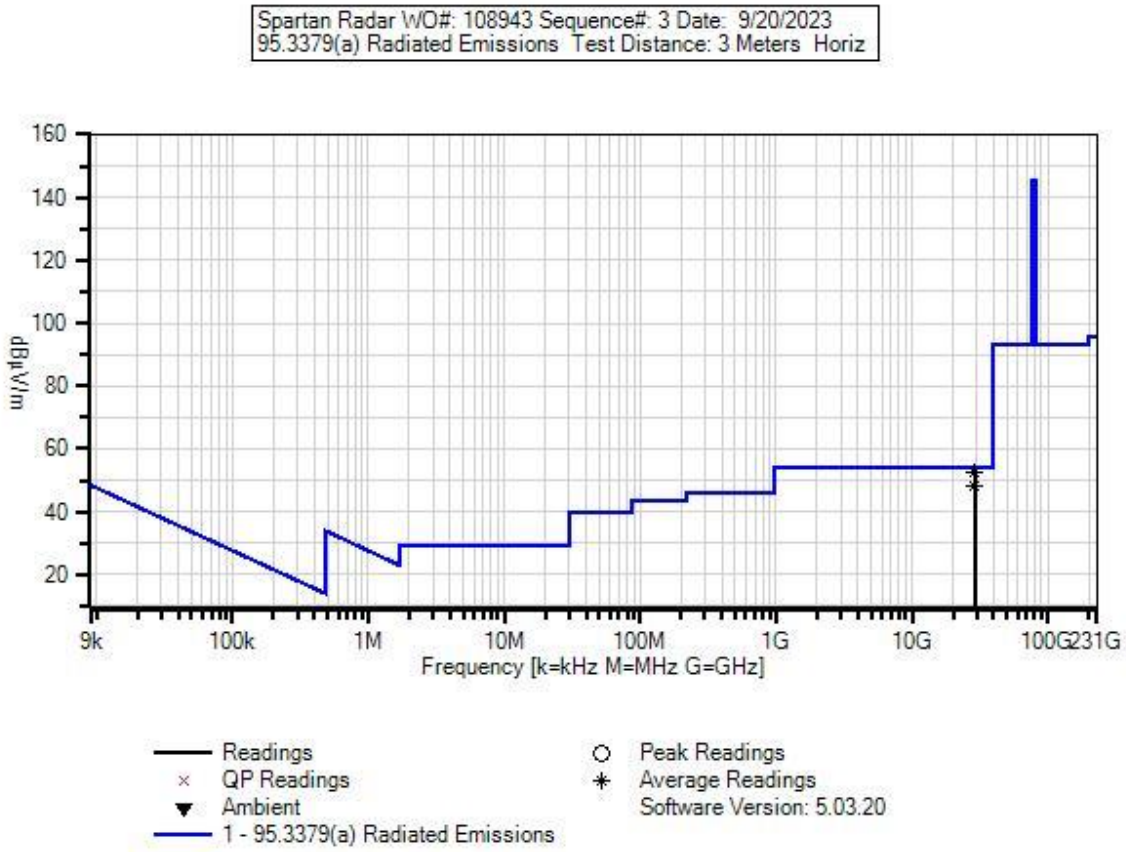
TX Frequency: Low 77.37GHz , Middle 78.65GHz, High 79.97GHz

Frequency Range of Measurement: 1GHz-243GHz
1GHz to 243GHz;RBW=1MHz,VBW=3 MHz.

Test Environment Conditions:
Temperature: 24°C
Humidity: 54%
Pressure: 99kPa

Test Method: ANSI C63.26 (2015), KDB653005 D01 76-81 GHz Radars v01r02

Site D



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02672	Spectrum Analyzer	E4446A	5/9/2022	5/9/2024
T1	ANP07660	Cable	32022-29094K-29094K-24TC	6/22/2022	6/22/2024
	ANP07655	Cable	32022-29094K-29094K-24TC	6/22/2022	6/22/2024
	ANP07656	Cable	32022-29094K-29094K-24TC	6/22/2022	6/22/2024
T2	ANP07659	Cable	32022-29094K-29094K-24TC	6/22/2022	6/22/2024
T3	AN03158A	Horn Antenna	GH-28-25	7/17/2023	7/17/2025

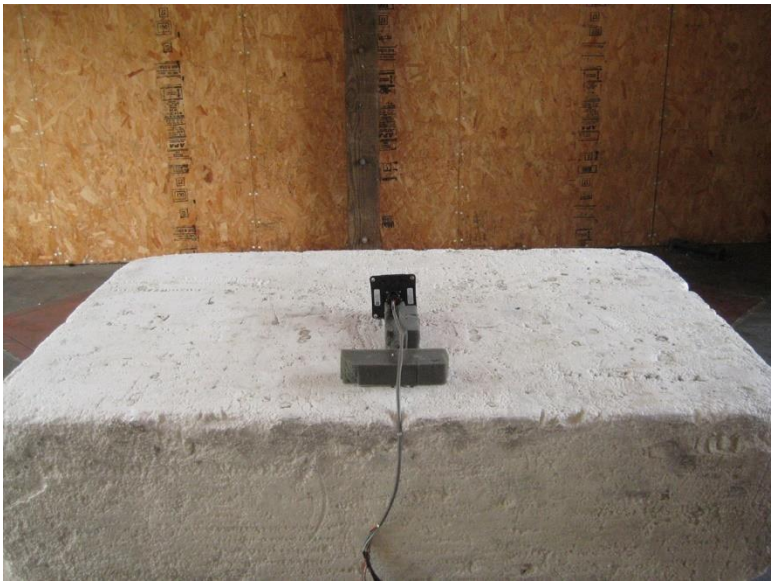
Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
1	28799.520 M Ave	45.4	+1.8	+1.7	+3.8		+0.0	52.7	54.0	-1.3	Horiz
^	28799.520 M	46.9	+1.8	+1.7	+3.8		+0.0	54.2	54.0	+0.2	Horiz
3	28799.520 M Ave	41.0	+1.8	+1.7	+3.8		+0.0	48.3	54.0	-5.7	Vert
^	28799.520 M	42.7	+1.8	+1.7	+3.8		+0.0	50.0	54.0	-4.0	Vert

Test Setup Photo(s)

Test Setup

Front View



Back View

APPENDIX A: DATA CONVERSION

Calculation of dBuV/m from pW/cm^2 or uW/cm^2
Useful for unit conversions such as FCC Part 95M or FCC Part 30 mmWave measurements

From Frii's equation for free space path loss:

$$P(dBm) = E(dBuV/m) + 20LOG(d) - G\ - 104.77$$

Where G=0 dBi since this is included in the definition of P (EIRP); in other words: we want to find the EIRP, not the conducted power. Solve for E:

$$E(dBuV/m) = P(dBm) - 20LOG(d) + 104.77$$

Now, convert pW/cm^2 or uW/cm^2 into power units, which in linear terms is (d is in meters):

$$mW = \frac{pW}{cm^2} * 4\pi d^2 * 10^{-9}(mw/pW) * 10^4(cm^2/m^2)$$

And

$$mW = \frac{uW}{cm^2} * 4\pi d^2 * 10^{-3}(mw/uW) * 10^4(cm^2/m^2)$$

Substituting for pW:

$$E(dBuV/m) = 10LOGP(\mathrm{pW/cm^2}) + 10LOG(4\pi d^2) - 50 - 20LOG(d) + 104.77$$

Note that the distance terms cancel; 20Logd -20Logd=0

$$E(dBuV/m) = 10LOGP(\mathrm{pW/cm^2}) + 65.76$$

And consequently:

$$E(dBuV/m) = 10LOGP(\mathrm{uW/cm^2}) + 125.76$$

Therefore:

Specification Limit	Equivalent E-Field Measurand
60 uW/cm2 @ 3m	143.5 dBuV/m @ 3m
600 pW/cm^2 @ 3m	93.5 dBuV/m @ 3m
1000 pW/cm^2 @ 3m	95.8 dBuV/m @ 3m

SUPPLEMENTAL INFORMATION

Measurement Uncertainty

Uncertainty Value	Parameter
4.73 dB	Radiated Emissions
3.34 dB	Mains Conducted Emissions
3.30 dB	Disturbance Power

Uncertainties reported are worst case for all CKC Laboratories' sites and represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2. Compliance is deemed to occur provided measurements are below the specified limits.

Emissions Test Details

TESTING PARAMETERS

Unless otherwise indicated, the following configuration parameters are used for equipment setup: The cables were routed consistent with the typical application by varying the configuration of the test sample. Interface cables were connected to the available ports of the test unit. The effect of varying the position of the cables was investigated to find the configuration that produced maximum emissions. Cables were of the type and length specified in the individual requirements. The length of cable that produced maximum emissions was selected.

The equipment under test (EUT) was set up in a manner that represented its normal use, as shown in the setup photographs. Any special conditions required for the EUT to operate normally are identified in the comments that accompany the emissions tables.

The emissions data was taken with a spectrum analyzer or receiver. Incorporating the applicable correction factors for distance, antenna, cable loss and amplifier gain, the data was reduced as shown in the table below. The corrected data was then compared to the applicable emission limits. Preliminary and final measurements were taken in order to ensure that all emissions from the EUT were found and maximized.

CORRECTION FACTORS

The basic spectrum analyzer reading was converted using correction factors as shown in the highest emissions readings in the tables. For radiated emissions in dBµV/m, the spectrum analyzer reading in dBµV was corrected by using the following formula. This reading was then compared to the applicable specification limit. Individual measurements were compared with the displayed limit value in the margin column. The margin was calculated based on subtracting the limit value from the corrected measurement value; a positive margin represents a measurement exceeding the limit, while a negative margin represents a measurement less than the limit.

SAMPLE CALCULATIONS		
	Meter reading	(dBµV)
+	Antenna Factor	(dB/m)
+	Cable Loss	(dB)
-	Distance Correction	(dB)
-	Preamplifier Gain	(dB)
=	Corrected Reading	(dBµV/m)

TEST INSTRUMENTATION AND ANALYZER SETTINGS

The test instrumentation and equipment listed were used to collect the emissions data. A spectrum analyzer or receiver was used for all measurements. Unless otherwise specified, the following table shows the measuring equipment bandwidth settings that were used in designated frequency bands. For testing emissions, an appropriate reference level and a vertical scale size of 10 dB per division were used.

MEASURING EQUIPMENT BANDWIDTH SETTINGS PER FREQUENCY RANGE			
TEST	BEGINNING FREQUENCY	ENDING FREQUENCY	BANDWIDTH SETTING
CONDUCTED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	9 kHz	150 kHz	200 Hz
RADIATED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	30 MHz	1000 MHz	120 kHz
RADIATED EMISSIONS	1000 MHz	>1 GHz	1 MHz

SPECTRUM ANALYZER/RECEIVER DETECTOR FUNCTIONS

The notes that accompany the measurements contained in the emissions tables indicate the type of detector function used to obtain the given readings. Unless otherwise noted, all readings were made in the "positive peak" detector mode. Whenever a "quasi-peak" or "average" reading was recorded, the measurement was annotated with a "QP" or an "Ave" on the appropriate rows of the data sheets. In cases where quasi-peak or average limits were employed and data exists for multiple measurement types for the same frequency then the peak measurement was retained in the report for reference, however the numbering for the affected row was removed and an arrow or caret ("^") was placed in the far left-hand column indicating that the row above takes precedence for comparison to the limit. The following paragraphs describe in more detail the detector functions and when they were used to obtain the emissions data.

Peak

In this mode, the spectrum analyzer or receiver recorded all emissions at their peak value as the frequency band selected was scanned. By combining this function with another feature called "peak hold," the measurement device had the ability to measure intermittent or low duty cycle transient emission peak levels. In this mode the measuring device made a slow scan across the frequency band selected and measured the peak emission value found at each frequency across the band.

Quasi-Peak

Quasi-peak measurements were taken using the quasi-peak detector when the true peak values exceeded or were within 2 dB of a quasi-peak specification limit. Additional QP measurements may have been taken at the discretion of the operator.

Average

Average measurements were taken using the average detector when the true peak values exceeded or were within 2 dB of an average specification limit. Additional average measurements may have been taken at the discretion of the operator. If the specification or test procedure requires trace averaging, then the averaging was performed using 100 samples or as required by the specification. All other average measurements are performed using video bandwidth averaging. To make these measurements, the test engineer reduces the video bandwidth on the measuring device until the modulation of the signal is filtered out. At this point, the measuring device is set into the linear mode and the scan time is reduced.