Spectralux Corporation

EMC TEST REPORT FOR

Envoy Datalink
PN: 15000-10-000-02*
***See Appendix for Manufacturers Declaration**

Tested to The Following Standards:

FCC Part 87 Subpart D

Report No.: 100887-2

Date of issue: March 4, 2020

Test Certificate # 803.01

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.

Testing the Future
CKC LABORATORIES, INC.

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ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

Spectralux Corporation
12335 134th Court NE
Redmond, WA 98052

Representative: Brian DeHart
Customer Reference Number: 120630

REPORT PREPARED BY:

Morgan Tramontin
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 100887

DATE OF EQUIPMENT RECEIPT: November 27, 2019
DATE(S) OF TESTING: November 27, 2019 & January 6, 2020

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.

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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.
Canyon Park
22116 23rd Drive S.E., Suite A
Bothell, WA 98021

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.12
EMITest Immunity	5.03.10

Site Registration & Accreditation Information

Location	*NIST CB #	FCC	Japan
Canyon Park, Bothell, WA	US0081	US1022	A-0136
Brea, CA	US0060	US1025	A-0136
Fremont, CA	US0082	US1023	A-0136
Mariposa, CA	US0103	US1024	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 2 / 87 Subpart D

Test Procedure	Description	Modifications	Results
2.1046 / 87.131	RF Output Power	NA	Pass
2.1053 / 87.139	Field Strength of Spurious Emissions/Emissions Mask	NA	Pass

NA = Not Applicable

Note: The tests listed above are the only tests contracted by the manufacturer. Testing for permissive change purposes.

Purpose of Testing: To validate RF parameters remain compliant following change to receiver portion of the equipment. The manufacturer declares no changes were made to the RF transmit circuitry.

ISO/IEC 17025 Decision Rule
The declaration of pass or fail herein is based upon assessment to the specification(s) listed above, including where applicable, assessment 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.

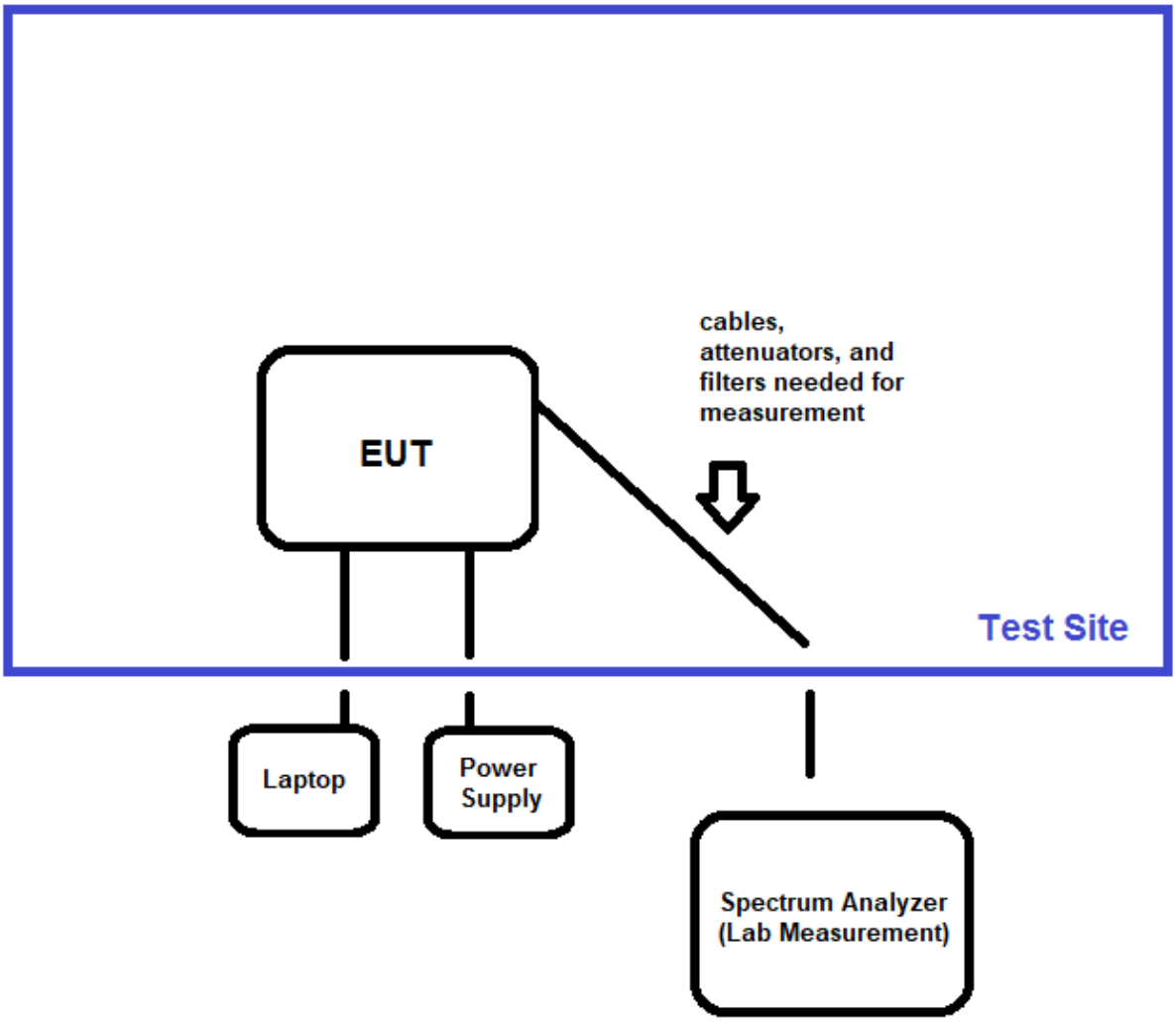
Modifications listed above must be incorporated into all production units.

Conditions During Testing

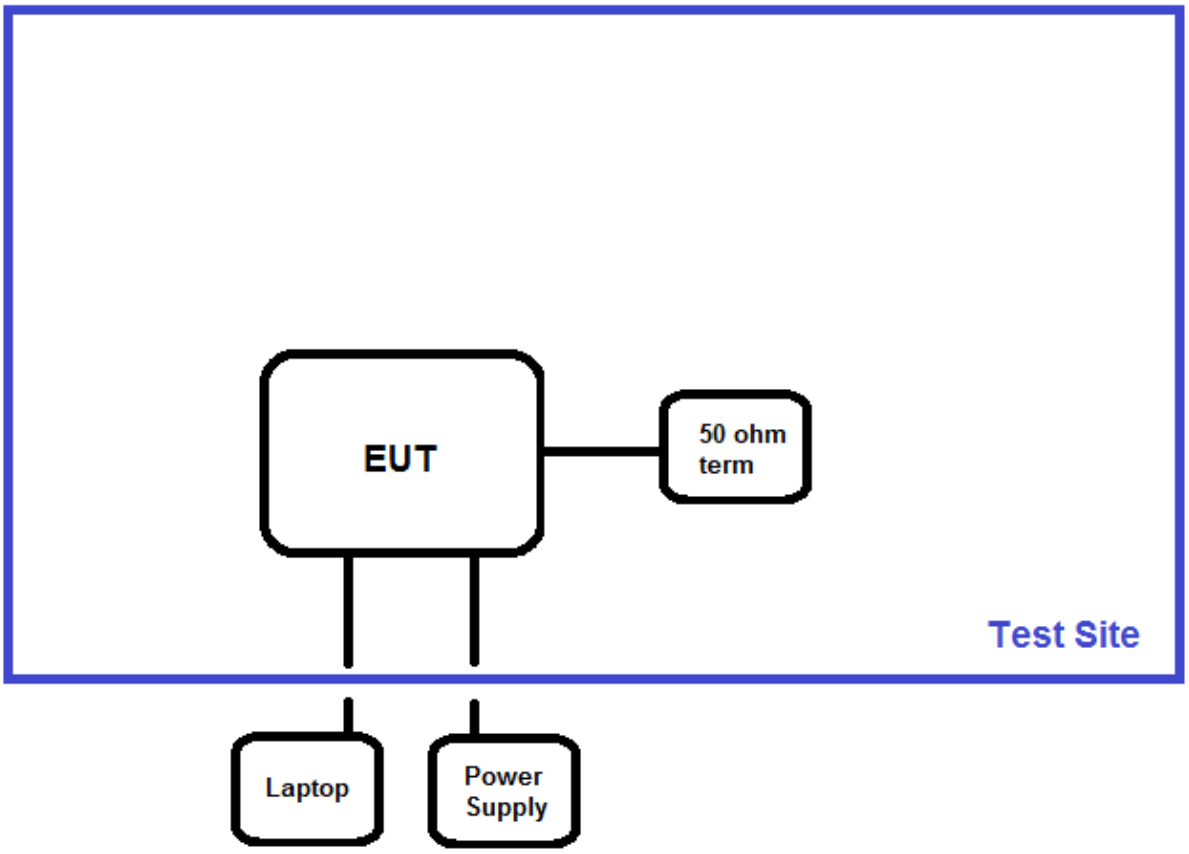
This list is a summary of the conditions noted to the equipment during testing.

Summary of Conditions
None

Test Setup Block Diagram (Conducted)



Test Setup Block Diagram (Radiated)



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	Part #	S/N
Envoy Datalink	Spectralux Corporation	15000-10-000-02	1039

Support Equipment:

Device	Manufacturer	Model #	S/N
Power Supply	Power Ten	3100A-4010	P06998
Laptop	Dell	XPS 15 9570	Asset #101324

General Product Information:

Product Information	Manufacturer-Provided Details
Equipment Type:	Stand Alone Equipment
Modulation Type(s):	A2D (Mode A), G1D (Mode 2)
Antenna Type(s) and Gain:	Omnidirectional, 0dBi
Antenna Connection Type:	External
Nominal Input Voltage:	28VDC
Firmware / Software used for Test:	Program on PC: DTS for Envoy 2.3.24 Software on Envoy (Flight Code): SAM Bootloader CRC: 9B347333 VER: 00.57 SAM Application CRC: 548BAF0D VER: 00.57 DUKB Bootloader CRC: 9DB4620B VER: 00.44 DUKB Application CRC: 1506D4DC VER: 00.44 VDL A CRC: 720A VER: 00.24 VDL 2 CRC: 9C06 VER: 00.26
Temperature Range	-15C to 55C
Manufacturer description of the operation	The Envoy data link product contains a radio transceiver capable of receiving and transmitting in the 118-136.975MHz VHF frequency range. The transmitter is a dual-mode radio that transmits data messages in Mode 2 (G1D), using D8PSK, and in Mode A (A2D), using AM-MSK. The transmitter output power is 15-17 watts in G1D and 10-17 watts in A2D. The Envoy transmitter employs a direct-conversion architecture that converts baseband modulation directly to the VHF carrier with no intermediate frequency. The modulation signals are fed to the modulator, which drives the HPA. The output from the HPA includes a feedback path back to the modulator. In Mode 2 operation, this feedback signal operates in real-time to help linearize the output and maintain constant output power.

	Several transmitter parameters are factory set, or tuned using digital potentiometers and constants stored in memory. These parameters include transmitter HPA bias current, as well as several receiver operating points, transmitter gain, modulation levels, phase offsets, DC offset and VSWR calibration. The software uses some of these stored parameters to provide the desired transmitter output.

FCC PART(S) 2 / 87

2.1046 / 87.131 RF Power Output

Test Setup/Conditions			
Test Location:	Bothell Lab C3	Test Engineer:	M. Atkinson
Test Method:	FCC CFR 47 Part 87.131, TIA-603E	Test Date(s):	11/27/2019
Configuration:	1		
Test Setup:	Frequency Range: Fundamental EUT is connected to a laptop through an Ethernet cable. EUT is continuously transmitting with modulation. Spectrum analyzer is connected to the EUT's RF port through appropriate cables and attenuators. Spectrum analyzer's built in RF power measurement suite used to perform the measurements. Values were then input into EMI test to account for the losses in the attenuator and cable.		

Environmental Conditions			
Temperature (ºC)	22	Relative Humidity (%):	30

Test Equipment					
Asset# / Serial#	**Description**	**Manufacturer**	**Model**	**Cal Date**	**Cal Due**
02673	Spectrum Analyzer	Agilent	E4446A	2/22/2019	2/22/2021
P07226	Attenuator	Pasternack	PE7004-6	10/2/2019	10/2/2021
P06540	Cable	Andrews	Heliax	8/23/2019	8/23/2021
P06515	Cable	Andrews	Heliax	6/29/2018	6/29/2020
P07496	Attenuator	Pasternack	PE7389-20	9/26/2018	9/26/2020

Test Data

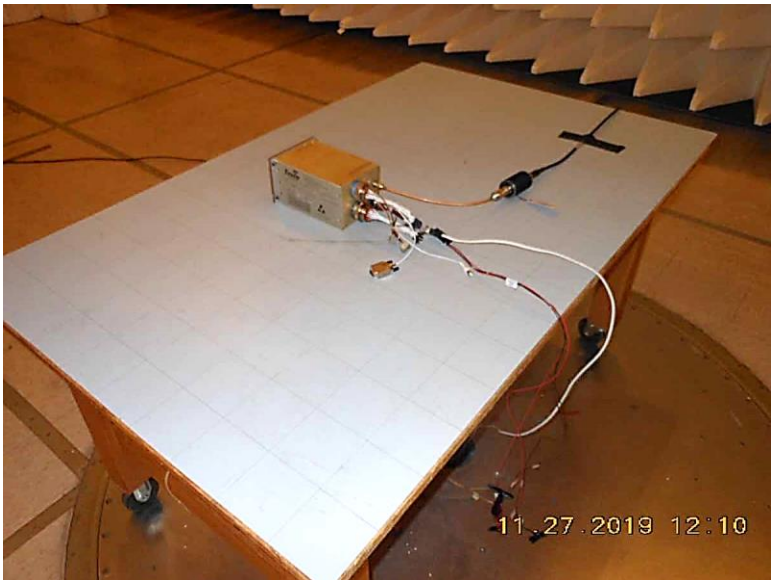
Test Data Summary Mode A

Channel	Frequency (MHz)	Measured Power (dBm)	Power Watts	Limit Watts	Results
Low	118	41.9	15.49	55	Pass
Mid	128	41.7	14.79	55	
High	136	41.7	14.76	55	

Test Data Summary Mode 2

Channel	Frequency (MHz)	Measured Power (dBm)	Power Watts	Limit Watts	Results
Low	118	42.1	16.22	55	Pass
Mid	128	42.3	16.98	55	
High	136	42.3	16.98	55	

Test Setup Photo



2.1053 / 87.139 Field Strength of Spurious / Emissions Mask

Conducted Spurious Emissions

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • (425) 402-1717		
Customer:	**Spectralux Corporation**		
Specification:	**87.139 Conducted Spurious Emissions Mask K**		
Work Order #:	**100877**	Date:	1/6/2020
Test Type:	**Conducted Emissions**	Time:	11:48:24
Tested By:	Michael Atkinson	Sequence#:	2
Software:	EMITest 5.03.12		28VDC

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Frequency Investigated: 9kHz-1.5GHz
Temperature: 20-22°C
Relative Humidity: 30-40%

EUT is connected to a laptop through an Ethernet cable.

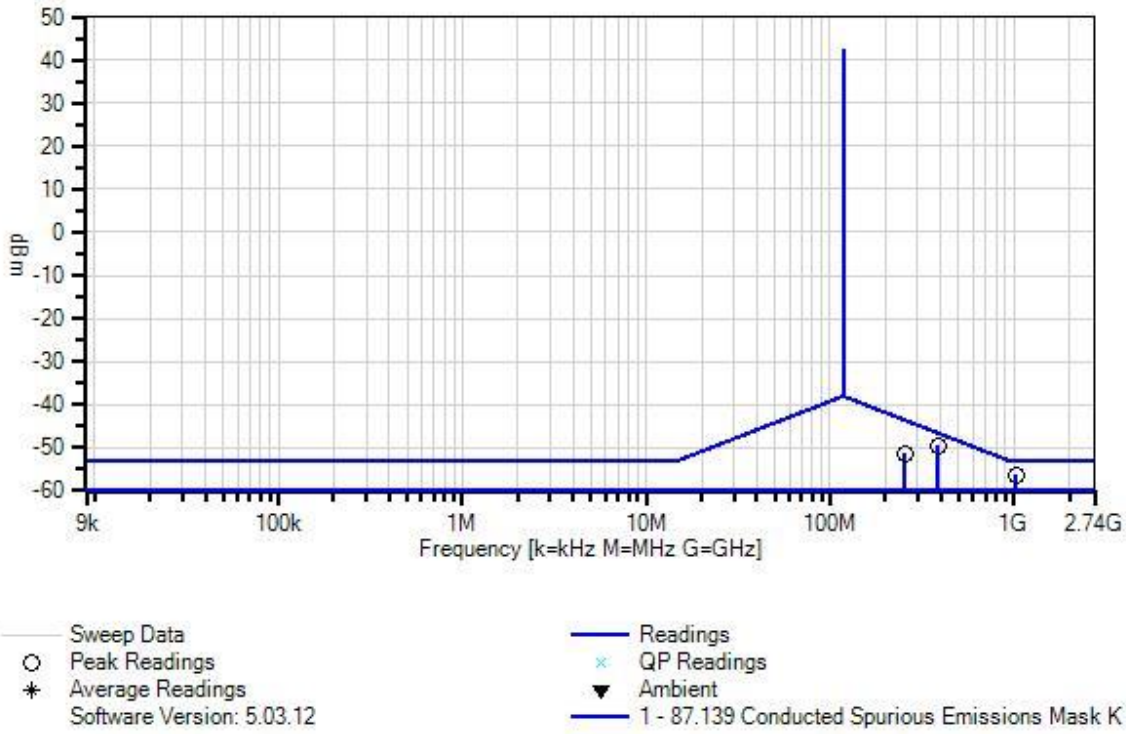
Spectrum analyzer is connected to the EUT's RF port through appropriate cables/attenuators/filters. EUT is continuously transmitting with modulation on Middle Channel (128MHz) in Mode 2 (G1D).

Note: Several different cable/attenuator/filter setups were used to investigate the emissions. It appears the autotuning function of the EUT was producing harmonics depending on the combination of the load connected to the antenna port (which includes the measurement cables, attenuators, and filter). After different configurations were investigated, the final data set was collected using the following configuration which produced passing results:
EUT antenna port -> 3dB pad->10dB pad-> ~ 6 foot heliax cable->20dB pad->200MHz high pass filter->Spectrum Analyzer.

Test Location: Bothell Lab C3
Test Method: FCC CFR 47 Part 87.139, TIA-603E
For mode A, the appropriate limit selected is 87.139 (d)
For mode 2, the appropriate limit selected is 87.139 (k). The mask limit was built from the worst case of the following, centered on mid channel:
87.139 (k) (1)
87.139 (k) (2) installed after January 1, 2002 (i) (ii) (iii)
87.139 (3)

Data collected is for spurious emissions only, no fundamental or fundamental mask measurement performed in this dataset, the mask shown is just provided to show the margin for harmonics and other spurious emissions.

CKC Laboratories, Inc. Date: 1/6/2020 Time: 11:48:24 Spectralux Corporation WO#: 100877
87.139 Conducted Spurious Emissions Mask K Test Lead: Antenna Port Antenna Port Sequence#: 2 Ext ATTN: 0 dB



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02871	Spectrum Analyzer	E4440A	10/15/2019	10/15/2021
T2	ANP07496	Attenuator	PE7389-20	9/26/2018	9/26/2020
T3	ANP05503	Attenuator	766-10	7/30/2019	7/30/2021
T4	ANNHP	High Pass Filter		1/6/2020	1/6/2022
T5	ANP07495	Attenuator	PE7389-3	9/26/2018	9/26/2020
T6	ANP05238	Cable	Heliax	6/7/2018	6/7/2020

Measurement Data: Reading listed by margin. Test Lead: Antenna Port

#	Freq	Rdng	T1 T5	T2 T6	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBm	dB	dB	dB	dB	Table	dBm	dBm	dB	Ant
1	384.000M	-82.6	+0.0 +2.9	+19.8 +0.1	+10.1	+0.3	+0.0	-49.4	-46.5	-2.9	Anten
2	1024.000M	-89.7	+0.0 +3.0	+19.8 +0.2	+10.1	+0.3	+0.0	-56.3	-53.0	-3.3	Anten
3	256.000M	-84.7	+0.0 +2.9	+19.8 +0.1	+10.1	+0.5	+0.0	-51.3	-43.6	-7.7	Anten

Test Location:	CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • (425) 402-1717		
Customer:	**Spectralux Corporation**		
Specification:	**87.139 Conducted Spurious Emissions Mask D**		
Work Order #:	**100887**	Date:	11/27/2019
Test Type:	**Conducted Emissions**	Time:	13:19:57
Tested By:	Michael Atkinson	Sequence#:	1
Software:	EMITest 5.03.12		28VDC

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Frequency Investigated: 9kHz-1.5GHz
Temperature: 20-22°C
Relative Humidity: 30-40%

EUT is connected to a laptop through an Ethernet cable. The EUT is continuously transmitting with modulation on Middle Channel (128MHz).

Spectrum analyzer is connected to the EUT's RF port through appropriate cables/attenuators/filters.
EUT is continuously transmitting with modulation on Middle Channel (128MHz) in Mode A (A2D).

The manufacturer declares the previous report CKC 91600-10, 2 modes of operation are Mode A (A2D) with an ABW of ~6kHz (13kHz limit) and Mode 2 (G1D) with an ABW of ~13.5kHz (14kHz limit).

For mode A, the appropriate limit selected is 87.139 (d)
For mode 2, the appropriate limit selected is 87.139 (k)
The mask limit was built from the worst case of the following, centered on mid channel:
87.139 (k) (1)
87.139 (k) (2) installed after January 1, 2002 (i) (ii) (iii)
87.139 (3)

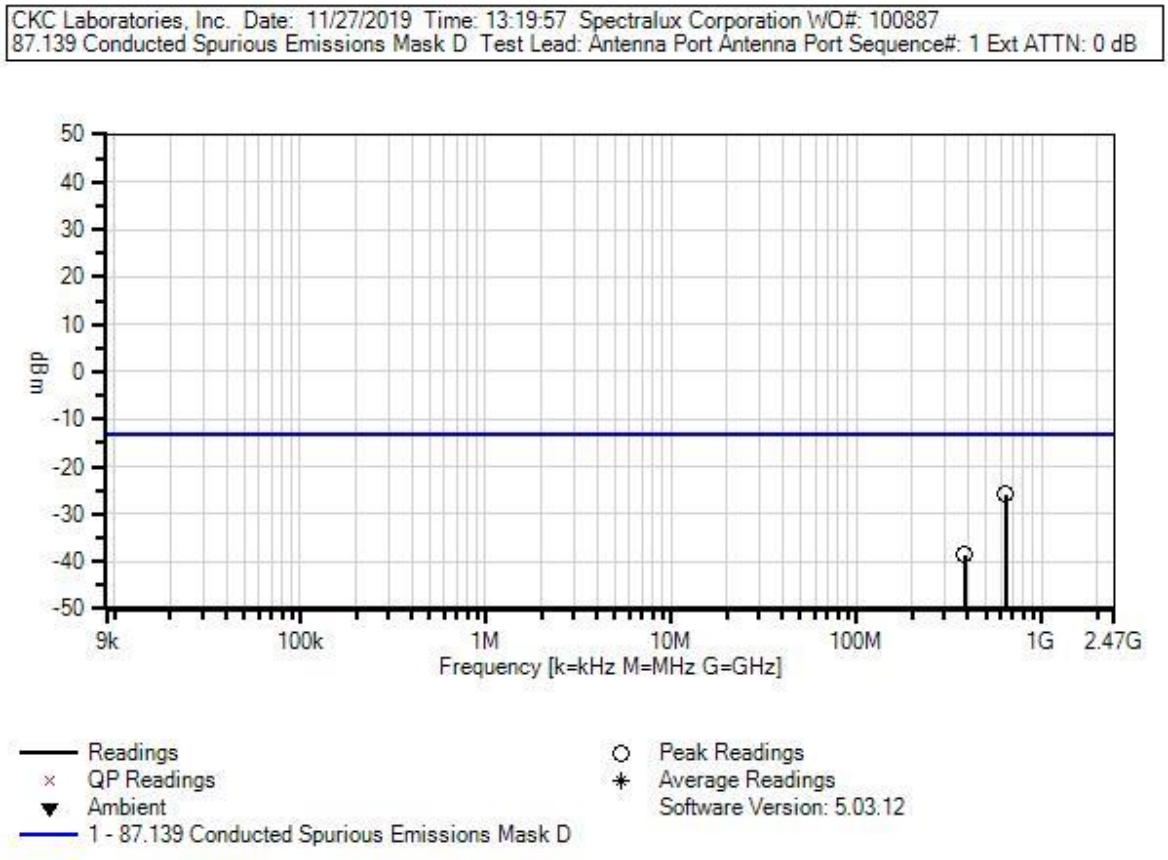
Note: The following configuration was used to measure the conducted emissions to produce passing results. No additional configurations were used:

EUT antenna port->manufacturer provided adapter cable->20dB pad-> ~ 20 foot RG-214 cable-> ~20 foot heliax -> chamber bulkhead -> ~ 6 foot heliax cable -> 6dB pad -> Spectrum Analyzer.

All equipment insertion loss accounted for with exception of manufacturer provided adapter cable, it was found to have less than 1dB loss at worst case frequencies.

Test Location: Bothell Lab C3

Test Method: FCC CFR 47 Part 87.139, TIA-603E



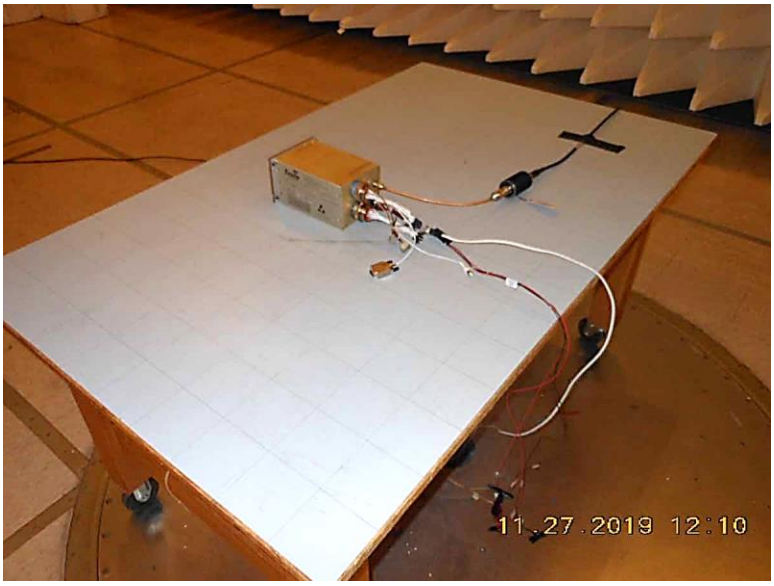
Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02673	Spectrum Analyzer	E4446A	2/22/2019	2/22/2021
T1	ANP07226	Attenuator	PE7004-6	10/2/2019	10/2/2021
T2	ANP05959	Cable	Heliax	4/11/2018	4/11/2020
T3	ANP06540	Cable	Heliax	8/23/2019	8/23/2021
T4	ANP06515	Cable	Heliax	6/29/2018	6/29/2020
T5	ANP07496	Attenuator	PE7389-20	9/26/2018	9/26/2020
T6	ANP07619	High Pass Filter	NHP-250+	1/6/2020	1/6/2022

Measurement Data: Reading listed by margin. Test Lead: Antenna Port

#	Freq	Rdng	T1 T5	T2 T6	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBm	dB	dB	dB	dB	Table	dBm	dBm	dB	Ant
1	640.000M	-53.8	+5.8 +19.8	+0.5 +0.3	+0.3	+1.3	+0.0	-25.8	-13.0	-12.8	Anten
2	384.000M	-66.1	+5.8 +19.8	+0.4 +0.3	+0.2	+1.0	+0.0	-38.6	-13.0	-25.6	Anten
3	256.000M	-81.5	+5.8 +19.8	+0.3 +0.5	+0.2	+0.8	+0.0	-54.1	-13.0	-41.1	Anten

Test Setup Photo(s)



Radiated Spurious Emissions

Test Setup / Conditions / Data

Test Location:	CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • (425) 402-1717		
Customer:	**Spectralux Corporation**		
Specification:	**87.139 Radiated Spurious Emissions Mask K**		
Work Order #:	**100887**	Date:	11/27/2019
Test Type:	**Maximized Emissions**	Time:	15:40:52
Tested By:	Michael Atkinson	Sequence#:	3
Software:	EMITest 5.03.12		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Frequency Investigated: 9kHz-1.5GHz
Temperature: 20-22°C
Relative Humidity: 25-30%

EUT is connected to a laptop through an Ethernet cable.

EUT is continuously transmitting with modulation on Middle Channel (128MHz) in Mode 2 (G1D). EUT antenna port is terminated into 50ohm load. 3 x orthogonal measurement antenna axes investigated below 30MHz, for above 30MHz horizontal and vertical antenna polarities investigated, worst case reported.

The manufacturer declares the previous report CKC 91600-10, 2 modes of operation are Mode A (A2D) with an ABW of ~6kHz (13kHz limit) and Mode 2 (G1D) with an ABW of ~13.5kHz (14kHz limit).

For mode A, the appropriate limit selected is 87.139 (d)
For mode 2, the appropriate limit selected is 87.139 (k)
The mask limit was built from the worst case of the following, centered on mid channel:
87.139 (k) (1)
87.139 (k) (2) installed after January 1, 2002 (i) (ii) (iii)
87.139 (3)

Test Location: Bothell Lab C3

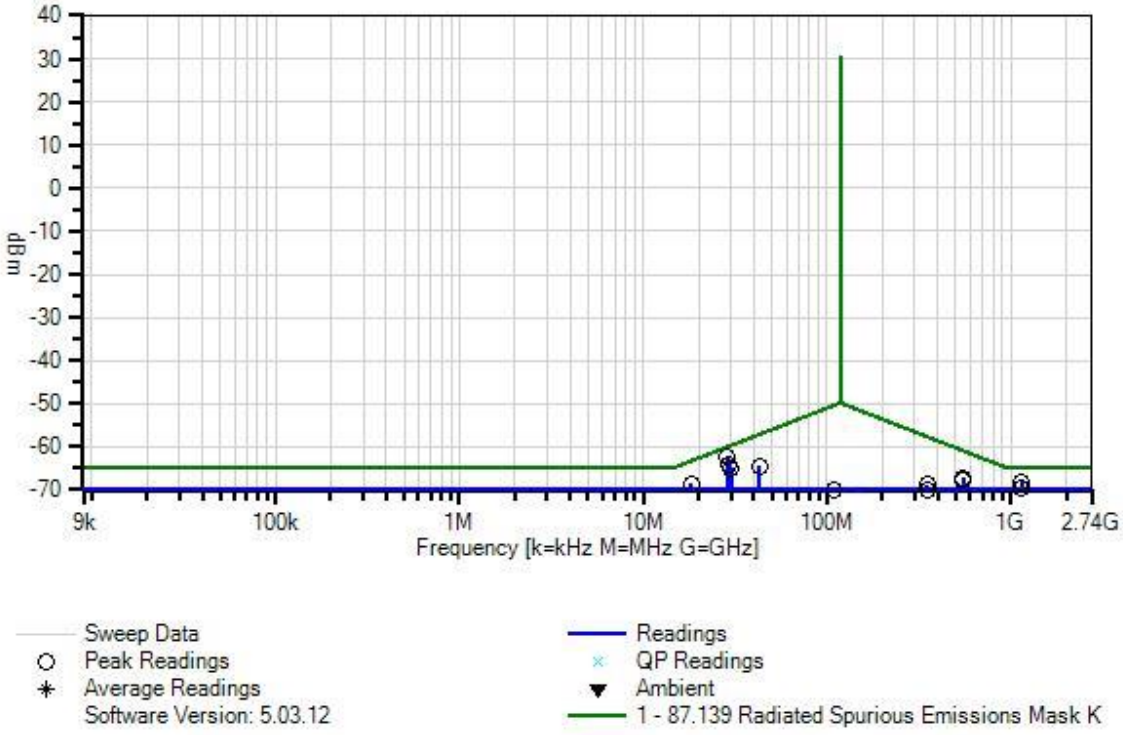
Test Method: FCC CFR 47 Part 87.139, TIA-603E

The radiated emission limit is built by converting to EIRP limit of dBm at 3m. The following equation is used (where d=3m, G=1):
E(dBµV/m) = P(dBm) - 20LOG(d) + G + 104.77

This was then converted to dBm/m with the following equation: E(dBm/m) = E(dBµV)/m) – 107

Data collected is for spurious emissions only, no fundamental or fundamental mask measurement performed in this dataset, the mask shown is just provided to show the margin for harmonics and other spurious emissions.

CKC Laboratories, Inc. Date: 11/27/2019 Time: 15:40:52 Spectralux Corporation WO#: 100887
87.139 Radiated Spurious Emissions Mask K Test Distance: 3 Meters Various Sequence#: 3 Ext ATTN: 0 dB



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02673	Spectrum Analyzer	E4446A	2/22/2019	2/22/2021
T1	ANP06540	Cable	Heliax	8/23/2019	8/23/2021
T2	ANP06515	Cable	Heliax	6/29/2018	6/29/2020
T3	AN01467	Horn Antenna-ANSI C63.5 Calibration	3115	7/5/2019	7/5/2021
T4	ANP06503	Cable	32026-29801-29801-36	3/13/2018	3/13/2020
T5	AN03540	Preamp	83017A	5/13/2019	5/13/2021
T6	AN00052	Loop Antenna	6502	5/7/2018	5/7/2020
T7	ANP05305	Cable	ETSI-50T	9/6/2019	9/6/2021
T8	ANP05360	Cable	RG214	1/31/2018	1/31/2020
T9	ANP06123	Attenuator	18N-6	4/5/2019	4/5/2021
T10	AN03628	Biconilog Antenna	3142E	6/11/2019	6/11/2021

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

#	Freq	Rdng	T1 T5 T9	T2 T6 T10	T3 T7	T4 T8	Dist	Corr	Spec	Margin	Polar
	MHz	dBm	dB	dB	dB	dB	Table	dBm	dBm	dB	Ant
1	28.680M	-68.8	+0.1 +0.0 +0.0	+0.3 +5.9 +0.0	+0.0 +0.0	+0.0 +0.0	+0.0	-62.5	-60.0	-2.5	Para
2	1149.600M	-59.2	+0.4 -36.5 +0.0	+1.8 +0.0 +0.0	+24.9 +0.0	+0.6 +0.0	+0.0	-68.0	-64.8	-3.2	Vert
3	29.220M	-70.2	+0.1 +0.0 +0.0	+0.3 +5.8 +0.0	+0.0 +0.0	+0.0 +0.0	+0.0	-64.0	-59.9	-4.1	Groun
4	1150.400M	-60.6	+0.4 -36.5 +0.0	+1.8 +0.0 +0.0	+24.9 +0.0	+0.6 +0.0	+0.0	-69.4	-64.8	-4.6	Horiz
5	18.244M	-77.2	+0.1 +0.0 +0.0	+0.2 +8.4 +0.0	+0.0 +0.0	+0.0 +0.0	+0.0	-68.5	-63.3	-5.2	Para
6	30.000M	-71.0	+0.1 +0.0 +0.0	+0.3 +5.6 +0.0	+0.0 +0.0	+0.0 +0.0	+0.0	-65.0	-59.7	-5.3	Perp
7	549.736M	-95.4	+0.3 +0.0 +5.8	+0.0 +0.0 +19.7	+0.0 +1.1	+0.0 +1.4	+0.0	-67.1	-60.9	-6.2	Horiz
8	549.736M	-96.1	+0.3 +0.0 +5.8	+0.0 +0.0 +19.7	+0.0 +1.1	+0.0 +1.4	+0.0	-67.8	-60.9	-6.9	Vert
9	43.090M	-81.5	+0.1 +0.0 +5.8	+0.0 +0.0 +10.6	+0.0 +0.3	+0.0 +0.3	+0.0	-64.4	-57.1	-7.3	Vert

10	350.000M	-92.3	+0.2 +0.0 +5.8	+0.0 +0.0 +15.5	+0.0 +0.9	+0.0 +1.1	+0.0	-68.8	-57.6	-11.2	Horiz
11	349.900M	-93.3	+0.2 +0.0 +5.8	+0.0 +0.0 +15.5	+0.0 +0.9	+0.0 +1.1	+0.0	-69.8	-57.6	-12.2	Horiz
12	449.872M	-98.6	+0.2 +0.0 +5.8	+0.0 +0.0 +18.0	+0.0 +1.0	+0.0 +1.3	+0.0	-72.3	-59.4	-12.9	Vert
13	501.848M	-100.9	+0.3 +0.0 +5.8	+0.0 +0.0 +18.5	+0.0 +1.1	+0.0 +1.3	+0.0	-73.9	-60.2	-13.7	Horiz
14	5.614M	-88.3	+0.0 +0.0 +0.0	+0.1 +9.6 +0.0	+0.0 +0.0	+0.0 +0.0	+0.0	-78.6	-64.8	-13.8	Para
15	107.800M	-85.0	+0.1 +0.0 +5.8	+0.0 +0.0 +8.1	+0.0 +0.5	+0.0 +0.6	+0.0	-69.9	-50.4	-19.5	Vert
16	350.000M	-100.6	+0.2 +0.0 +5.8	+0.0 +0.0 +15.5	+0.0 +0.9	+0.0 +1.1	+0.0	-77.1	-57.6	-19.5	Vert
17	98.880M	-89.1	+0.1 +0.0 +5.8	+0.0 +0.0 +8.0	+0.0 +0.5	+0.0 +0.5	+0.0	-74.2	-51.1	-23.1	Vert
18	107.800M	-89.1	+0.1 +0.0 +5.8	+0.0 +0.0 +8.1	+0.0 +0.5	+0.0 +0.6	+0.0	-74.0	-50.4	-23.6	Horiz
19	98.880M	-89.6	+0.1 +0.0 +5.8	+0.0 +0.0 +8.0	+0.0 +0.5	+0.0 +0.5	+0.0	-74.7	-51.1	-23.6	Horiz
20	155.500M	-94.2	+0.2 +0.0 +5.8	+0.0 +0.0 +9.6	+0.0 +0.6	+0.0 +0.7	+0.0	-77.3	-51.8	-25.5	Horiz
21	85.440M	-92.9	+0.1 +0.0 +5.8	+0.0 +0.0 +6.9	+0.0 +0.4	+0.0 +0.5	+0.0	-79.2	-52.1	-27.1	Horiz
22	148.100M	-94.8	+0.2 +0.0 +5.8	+0.0 +0.0 +8.9	+0.0 +0.6	+0.0 +0.7	+0.0	-78.6	-51.4	-27.2	Vert
23	124.900M	-97.3	+0.1 +0.0 +5.8	+0.0 +0.0 +7.8	+0.0 +0.5	+0.0 +0.6	+0.0	-82.5	-50.2	-32.3	Horiz

Test Location:	CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • (425) 402-1717		
Customer:	**Spectralux Corporation**		
Specification:	**87.139 Radiated Spurious Emissions Mask D**		
Work Order #:	**100887**	Date:	11/27/2019
Test Type:	**Maximized Emissions**	Time:	15:32:33
Tested By:	Michael Atkinson	Sequence#:	4
Software:	EMITest 5.03.12		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Frequency Investigated: 9kHz-1.5GHz
Temperature: 20-22°C
Relative Humidity: 25-30%

EUT is connected to a laptop through an Ethernet cable.

EUT is continuously transmitting with modulation Middle Channel (128MHz) in Mode A (A2D). EUT antenna port is terminated into 50ohm load. 3 x orthogonal measurement antenna axes investigated below 30MHz, for above 30MHz horizontal and vertical antenna polarities investigated, worst case reported.

Per previous report CKC 91600-10, 2 modes of operation are Mode A (A2D) with an ABW of ~6kHz (13kHz limit) and Mode 2 (G1D) with an ABW of ~13.5kHz (14kHz limit).

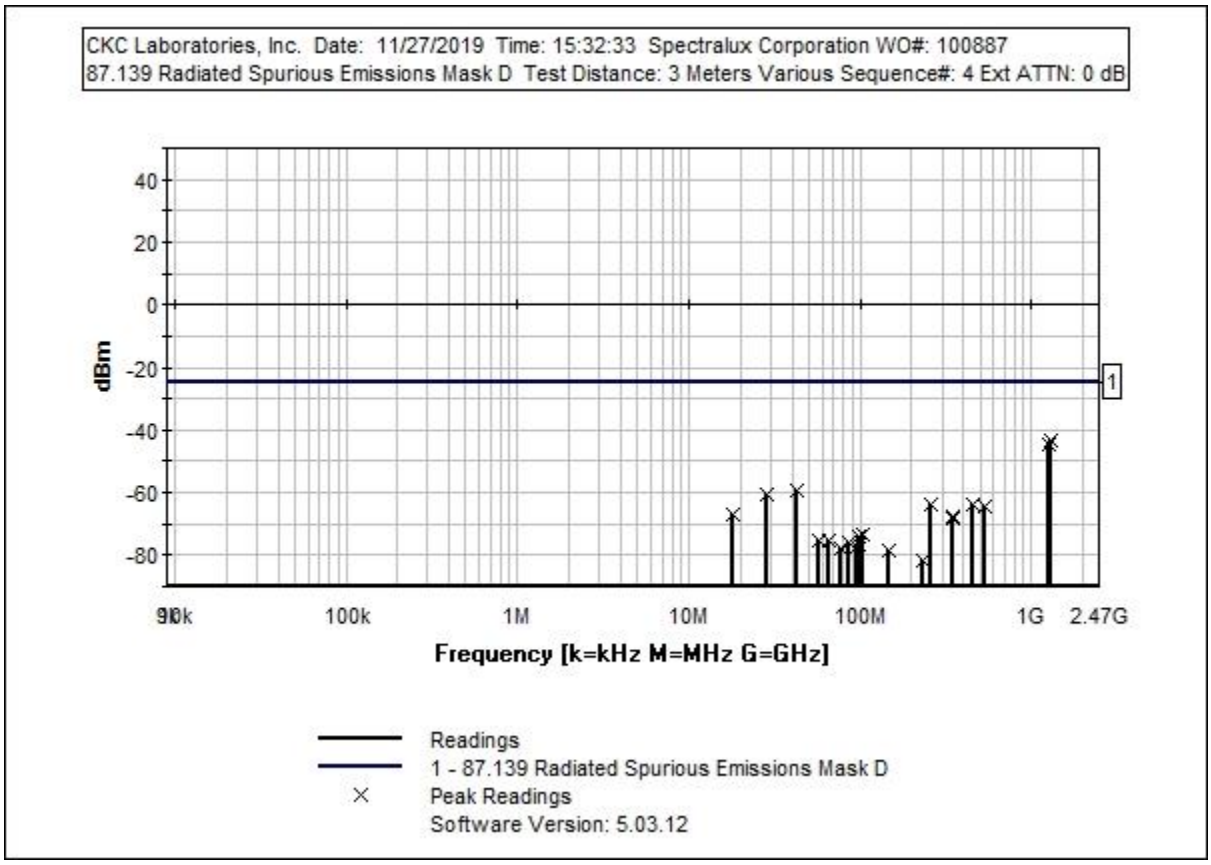
For mode A, the appropriate limit selected is 87.139 (d)
For mode 2, the appropriate limit selected is 87.139 (k)
The mask limit was built from the worst case of the following, centered on mid channel:
87.139 (k) (1)
87.139 (k) (2) installed after January 1, 2002 (i) (ii) (iii)
87.139 (3)

Test Location: Bothell Lab C3

Test Method: FCC CFR 47 Part 87.139, TIA-603E

The radiated emission limit is built by converting to EIRP limit of dBm at 3m. The following equation is used (where d=3m, G=1):
E(dBµV/m) = P(dBm) - 20LOG(d) + G + 104.77

This was then converted to dBm/m with the following equation: E(dBm/m) = E(dBµV)/m) - 107


CKC Laboratories, Inc. Date: 11/27/2019 Time: 15:32:33 Spectralux Corporation WO#: 100887
87.139 Radiated Spurious Emissions Mask D Test Distance: 3 Meters Various Sequence#: 4 Ext ATTN: 0 dB
40
20
0
-20
-40
-60
-80
dBm
1
100k
1M
10M
100M
1G
2.47G
Frequency [k=kHz M=MHz G=GHz]
Readings
1 - 87.139 Radiated Spurious Emissions Mask D
Peak Readings
Software Version: 5.03.12

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02673	Spectrum Analyzer	E4446A	2/22/2019	2/22/2021
T2	ANP06540	Cable	Heliax	8/23/2019	8/23/2021
T3	ANP06515	Cable	Heliax	6/29/2018	6/29/2020
T4	AN01467	Horn Antenna-ANSI C63.5 Calibration	3115	7/5/2019	7/5/2021
T5	AN00052	Loop Antenna	6502	5/7/2018	5/7/2020
T6	ANP05305	Cable	ETSI-50T	9/6/2019	9/6/2021
T7	ANP05360	Cable	RG214	1/31/2018	1/31/2020
T8	ANP06123	Attenuator	18N-6	4/5/2019	4/5/2021
T9	AN03628	Biconilog Antenna	3142E	6/11/2019	6/11/2021

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

#	Freq	Rdng	T1 T5 T9	T2 T6	T3 T7	T4 T8	Dist	Corr	Spec	Margin	Polar
	MHz	dBm	dB	dB	dB	dB	Table	dBm	dBm	dB	Ant
1	1307.300M	-71.0	+0.0 +0.0 +0.0	+0.4 +0.0	+1.9 +0.0	+25.2 +0.0	+0.0	-43.5	-24.8	-18.7	Horiz
2	1258.000M	-71.8	+0.0 +0.0 +0.0	+0.4 +0.0	+1.8 +0.0	+25.2 +0.0	+0.0	-44.4	-24.8	-19.6	Vert
3	43.160M	-76.7	+0.0 +0.0 +10.6	+0.1 +0.3	+0.0 +0.3	+0.0 +5.8	+0.0	-59.6	-24.8	-34.8	Vert
4	28.680M	-67.0	+0.0 +5.9 +0.0	+0.1 +0.0	+0.3 +0.0	+0.0 +0.0	+0.0	-60.7	-24.8	-35.9	Para
5	449.872M	-90.1	+0.0 +0.0 +18.0	+0.2 +1.0	+0.0 +1.3	+0.0 +5.8	+0.0	-63.8	-24.8	-39.0	Horiz
6	256.000M	-83.8	+0.0 +0.0 +12.3	+0.2 +0.8	+0.0 +0.9	+0.0 +5.8	+0.0	-63.8	-24.8	-39.0	Horiz
7	529.296M	-92.2	+0.0 +0.0 +19.2	+0.3 +1.1	+0.0 +1.4	+0.0 +5.8	+0.0	-64.4	-24.8	-39.6	Vert
8	18.244M	-76.0	+0.0 +8.4 +0.0	+0.1 +0.0	+0.2 +0.0	+0.0 +0.0	+0.0	-67.3	-24.8	-42.5	Para
9	350.000M	-91.0	+0.0 +0.0 +15.5	+0.2 +0.9	+0.0 +1.1	+0.0 +5.8	+0.0	-67.5	-24.8	-42.7	Horiz
10	350.000M	-91.8	+0.0 +0.0 +15.5	+0.2 +0.9	+0.0 +1.1	+0.0 +5.8	+0.0	-68.3	-24.8	-43.5	Vert

11	103.700M	-88.7	+0.0 +0.0 +8.1	+0.1 +0.5	+0.0 +0.6	+0.0 +5.8	+0.0	-73.6	-24.8	-48.8	Vert
12	98.880M	-88.8	+0.0 +0.0 +8.0	+0.1 +0.5	+0.0 +0.5	+0.0 +5.8	+0.0	-73.9	-24.8	-49.1	Horiz
13	64.790M	-89.7	+0.0 +0.0 +7.6	+0.1 +0.4	+0.0 +0.4	+0.0 +5.8	+0.0	-75.4	-24.8	-50.6	Vert
14	56.810M	-89.8	+0.0 +0.0 +7.6	+0.1 +0.4	+0.0 +0.4	+0.0 +5.8	+0.0	-75.5	-24.8	-50.7	Vert
15	85.440M	-89.4	+0.0 +0.0 +6.9	+0.1 +0.4	+0.0 +0.5	+0.0 +5.8	+0.0	-75.7	-24.8	-50.9	Vert
16	98.880M	-91.2	+0.0 +0.0 +8.0	+0.1 +0.5	+0.0 +0.5	+0.0 +5.8	+0.0	-76.3	-24.8	-51.5	Vert
17	95.800M	-92.0	+0.0 +0.0 +7.7	+0.1 +0.5	+0.0 +0.5	+0.0 +5.8	+0.0	-77.4	-24.8	-52.6	Vert
18	77.180M	-91.8	+0.0 +0.0 +6.9	+0.1 +0.4	+0.0 +0.5	+0.0 +5.8	+0.0	-78.1	-24.8	-53.3	Vert
19	148.100M	-95.0	+0.0 +0.0 +8.9	+0.2 +0.6	+0.0 +0.7	+0.0 +5.8	+0.0	-78.8	-24.8	-54.0	Vert
20	229.700M	-100.6	+0.0 +0.0 +11.3	+0.2 +0.7	+0.0 +0.9	+0.0 +5.8	+0.0	-81.7	-24.8	-56.9	Vert

Test Setup Photo

Appendix A: Manufacturer Declaration

The following part number has been tested by CKC Laboratories: **15000-10-000-02**

The manufacturer declares that the following additional part numbers are identical electrically or any differences between them do not affect their EMC characteristics, and therefore meets the level of testing equivalent to the tested model.

15000-10-000-00 Black, FED-STD-595 #37038, BAC 706
15000-10-000-01 GRAY, BAC 703
15000-10-000-02 MEDIUM BROWN, BAC8328
15000-10-000-03 LIGHT GRAY, BAC 705
15000-10-000-04 GRAY, FED-STD-595 #36118
15000-10-000-05 BLUE/GRAY, FED-STD-595 #35164 (AIRBUS)
15000-10-000-06 GRAY, FED-STD-595 #36076
15000-10-000-07 GRAY, FED-STD-595 #36176
15000-10-000-08 GRAY, FED-STD-595 #36492
15000-10-000-09 GRAY, FED-STD-595 #36173
15000-10-000-10 GRAY, FED-STD-595 #36320
15000-10-000-11 GRAY, FED-STD-595 #36231

Per the manufacturer, more options may be added in the future.

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.