Rothenbuhler Engineering

TEST REPORT FOR

Carriage Transmitter, Model: 1100-3
Yarder Transmitter, Model: 1100-5

Tested To The Following Standards:

FCC Part 90I

Report No.: 96354-8

Date of issue: January 23, 2015

ACCREDITED
Testing Certificates:
803.01, 803.02, 803.05, 803.06

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 EMC 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.

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ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

Rothenbuhler Engineering
524 Rhodes Rd.
Sedro Woolley, WA 98284-0708

Representative: Tom Jacobson
Customer Reference Number: 25535

REPORT PREPARED BY:

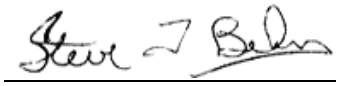
Morgan Tramontin
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 96354

DATE OF EQUIPMENT RECEIPT: December 10, 2014
DATE(S) OF TESTING: December 10, 2014 - January 9, 2015

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the sample equipment 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.
22116 23rd Drive S.E., Suite A
Bothell, WA 98021-4413

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.00.14
Immunity	5.00.07

Site Registration & Accreditation Information

Location	CB #	TAIWAN	CANADA	FCC	JAPAN
Bothell	US0081	SL2-IN-E-1145R	3082C-1	318736	A-0148

SUMMARY OF RESULTS

Standard / Specification: FCC Part(s) 2 / 90I

Test Procedure	Description	Modifications*	Results
2.1046 / 90.205(d)	RF Power Output	NA	Pass
2.1049 / 90.209(b)(5)	Bandwidth Limitations	NA	Pass
2.1051 / 90.210(d)	Spurious Emissions at Antenna Terminals	NA	Pass
2.1053 / 90.210(d)	Field Strength of Spurious Radiation	MOD #1	Pass
2.1055 / 90.213	Frequency Stability	NA	Pass
2.1055 / 90.214	Transient Frequency Behavior	NA	Pass

Modifications* During Testing

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

Summary of Conditions
MOD #1: The EUT has modified copper tape around the battery box.

***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
Note: EUT models 1100-3 and 1100-5 both have the same transmitter circuitry. Model 1100-3 is representative for all tests except Radiated Spurious Emissions, RF Power and Frequency Stability.

EQUIPMENT UNDER TEST (EUT)

EQUIPMENT UNDER TEST

Carriage Transmitter
Manuf: Rothenbuhler Engineering
Model: 1100-3
Serial: 0102

Carriage Transmitter
Manuf: Rothenbuhler Engineering
Model: 1100-3
Serial: 0103

Smart Box
Manuf: Rothenbuhler Engineering
Model: 1079-6
Serial: SXXX

Yarder Transmitter
Manuf: Rothenbuhler Engineering
Model: 1100-5
Serial: 0001

Carriage Control Receiver
Manuf: Rothenbuhler Engineering
Model: 1100-4
Serial: 00001

Programmer/Remote Monitor
Manuf: Rothenbuhler Engineering
Model: 1100-6
Serial: 0001

PERIPHERAL DEVICES

The EUT was tested with the following peripheral device(s):

Programmer/Remote Monitor
Manuf: Rothenbuhler Engineering
Model: 1100-6
Serial: 0001

RFD Programmer
Manuf: Rothenbuhler Engineering
Model: 1670-10
Serial: 00101

Load Box
Manuf: Rothenbuhler Engineering
Model: NA
Serial: NA

Laptop
Manuf: Dell
Model: Latitude D810
Serial: NA

Magnetic Mount Antenna
Manuf: Larsen
Model: Magnetic Mount
Serial: NA

12V Battery
Manuf: SuperStart
Model: 34/78EXTJ
Serial: NA

FCC PART(S) 2 / 90I

This report contains EMC emissions test results under United States Federal Communications Commission (FCC) requirements for 47 CFR Part 2: Frequency Allocations and Radio Treaty Matters, General Rules and Regulations and Licensed Device falling under Part 90: Private Land Mobile Radio Services.

2.1046 / 90.205(d) RF Power Output

Test Equipment					
Asset #	**Description**	**Model**	**Manufacturer**	**Cal Date**	**Cal Due**
02872	Spectrum Analyzer	E4440A	Agilent	07/19/2013	07/19/2015
P05747	Attenuator	PE7004-20	Pasternack	02/13/2014	02/13/2016
P06124	Attenuator	18N-6	Aeroflex	05/13/2013	05/13/2015
P06505	Cable	32026-29080-29080-84	Astrolab	10/18/2013	10/18/2015

Test Conditions / Setup

Temp: 23°C
Humidity: 41%
Pressure: 103.3kPa
Frequency Range: 150-174MHz

Test Date: 1/5/2015
Test Engineer: Steven Pittsford

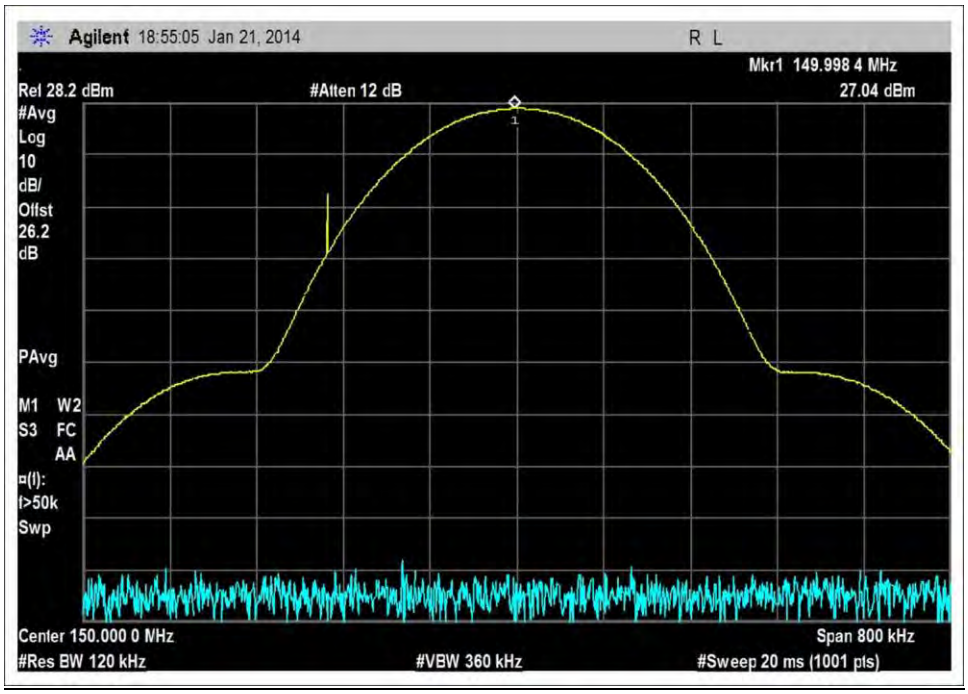
The EUT's RF output is connected to the Spectrum analyzer through 26dB of attenuation.
The EUT is connected to the RFD Programmer to interface to the laptop.
The 1100-5 Smart Box and 13VDC power and the 1100-3 are powered by a fresh battery.
The EUT is in operational mode.
The EUT will be transmitting at LOW (150MHz), MID (161MHz), and HIGH (174MHz) Channels.

Test Data

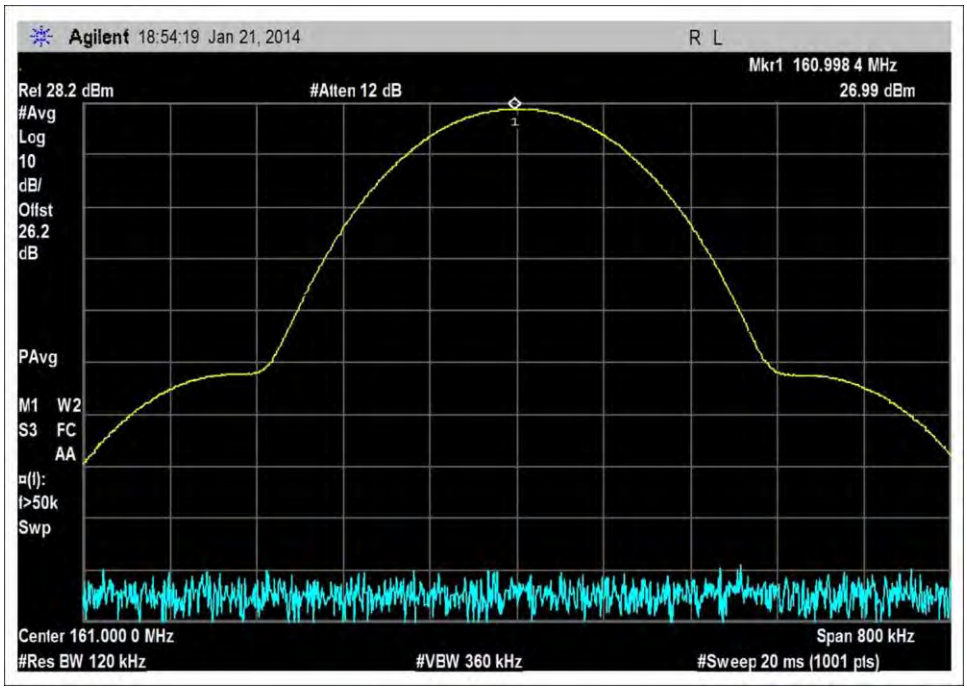
Equipment	Manufacturer	Model Number	Serial Number
Carriage Transmitter	Rothenbuhler Engineering	1100-3	0103
Frequency (MHz)	**RF Output Power (dBm)**	**90.205 Limit**	**Result**
150.00	27.0	30dBm	Pass
161.00	27.0	30dBm	Pass
174.00	27.0	30dBm	Pass

Equipment	Manufacturer	Model Number	Serial Number
Yarder Transmitter	Rothenbuhler Engineering	1100-5	0001
Frequency (MHz)	**RF Output Power (dBm)**	**90.205 Limit**	**Result**
150.00	27.0	30dBm	Pass
161.00	26.9	30dBm	Pass
174.00	27.0	30dBm	Pass

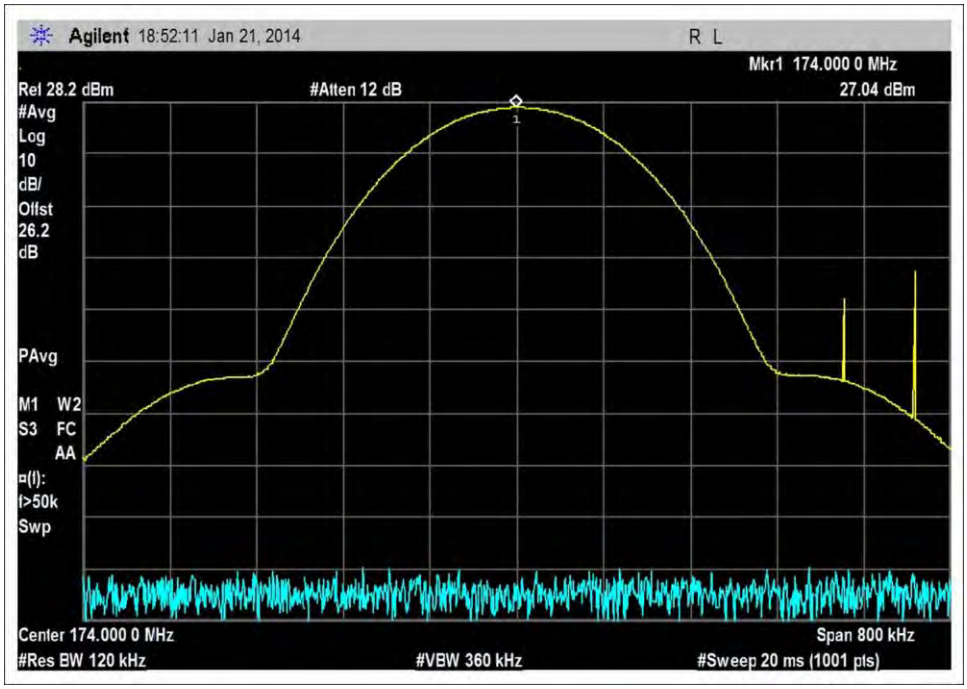
Test Plots



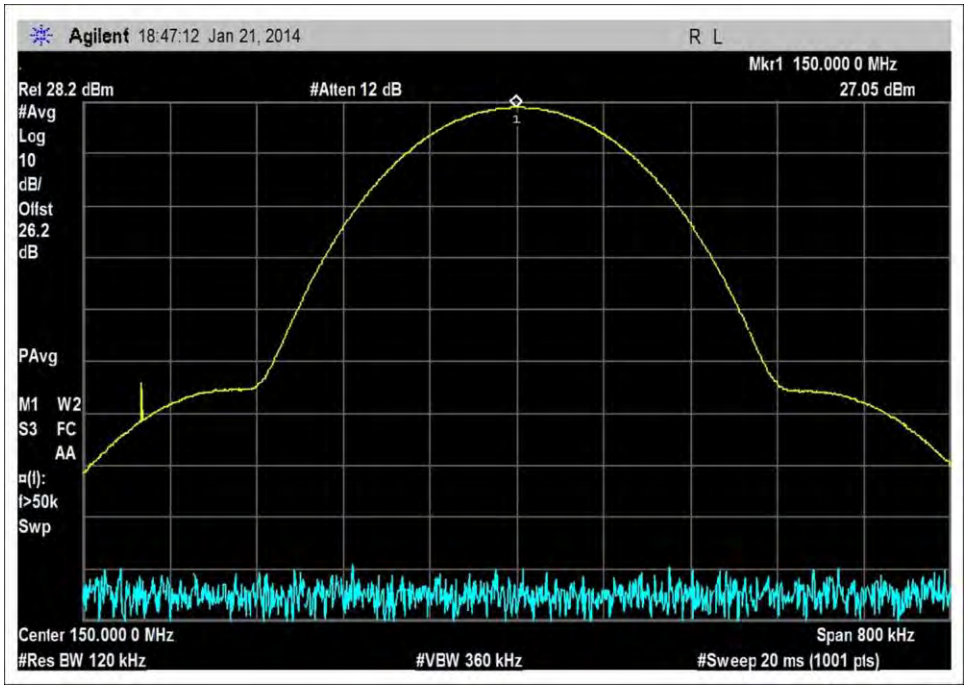
Low Frequency (150MHz) - Carriage Transmitter, 1100-3



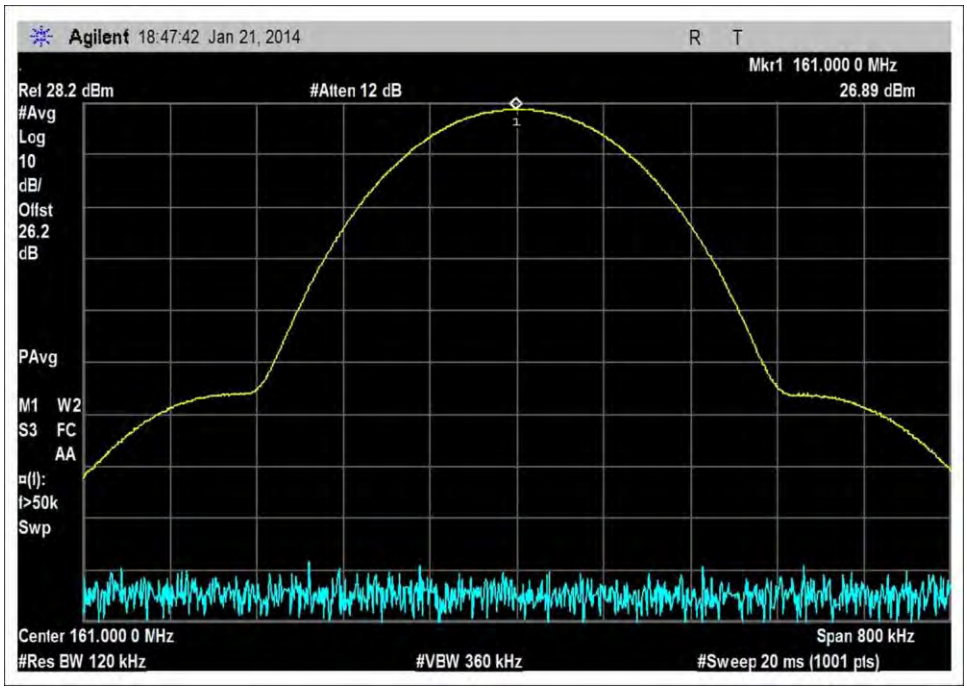
Middle Frequency (161MHz) - Carriage Transmitter, 1100-3



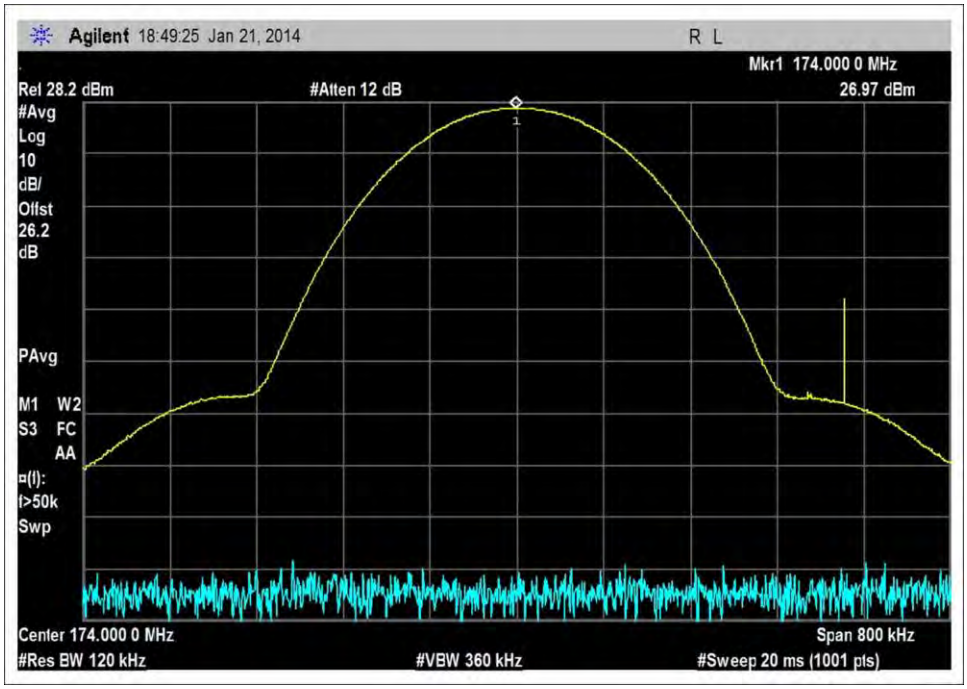
High Frequency (174MHz) - Carriage Transmitter, 1100-3



Low Frequency (150MHz) - Yarder Transmitter, 1100-5



Middle Frequency (161MHz) - Yarder Transmitter, 1100-5



High Frequency (174MHz) - Yarder Transmitter, 1100-5

Test Setup Photo(s)

Carriage Transmitter, 1100-3, View #1

Carriage Transmitter, 1100-3, View #2

Yarder Transmitter, 1100-5, View #1

Yarder Transmitter, 1100-5, View #2

2.1049 / 90.209(b)(5) Bandwidth Limitations

Test Equipment					
Asset #	**Description**	**Model**	**Manufacturer**	**Cal Date**	**Cal Due**
02872	Spectrum Analyzer	E4440A	Agilent	07/19/2013	07/19/2015
P05747	Attenuator	PE7004-20	Pasternack	02/13/2014	02/13/2016
P06124	Attenuator	18N-6	Aeroflex	05/13/2013	05/13/2015
P06505	Cable	32026-29080-29080-84	Astrolab	10/18/2013	10/18/2015

Test Conditions / Setup

Temp: 23°C
Humidity: 41%
Pressure: 103.3kPa
Frequency Range: 150-174MHz

Test Date: 12/10/14
Test Engineer: Steven Pittsford

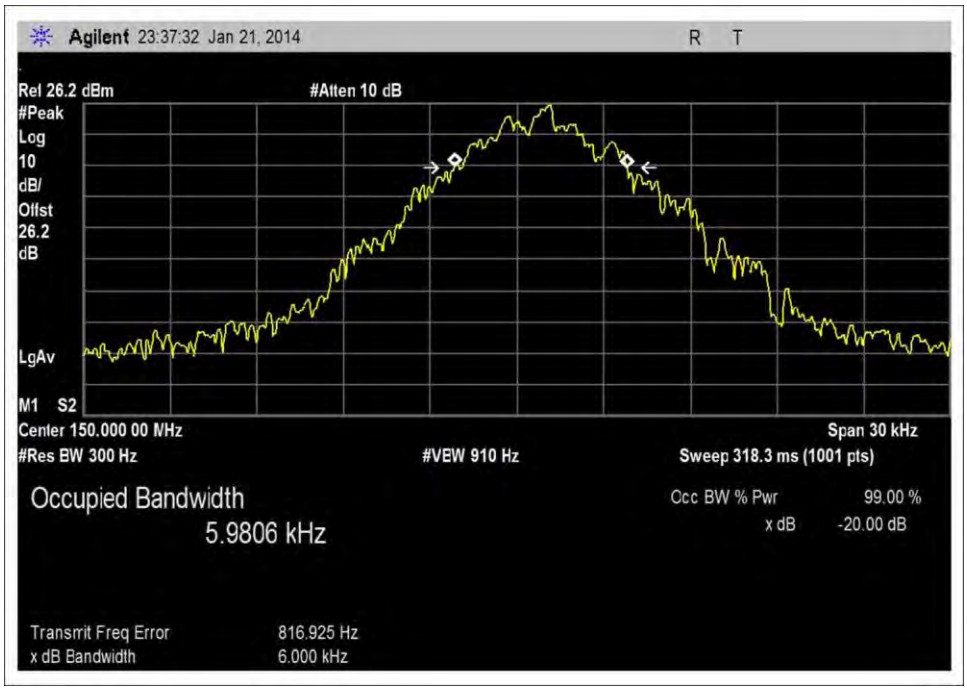
The EUT's RF output is connected to the Spectrum analyzer through 26dB of attenuation.
The EUT is connected to the RFD Programmer to interface to the laptop.
The 1100-3 is powered by a fresh battery.
The EUT is in operational mode.
The EUT will be transmitting at LOW (150MHz), MID (161MHz), and HIGH (174MHz) Channels.

Note: Model: 1100-3 is tested and is representative of Model: 1100-5.

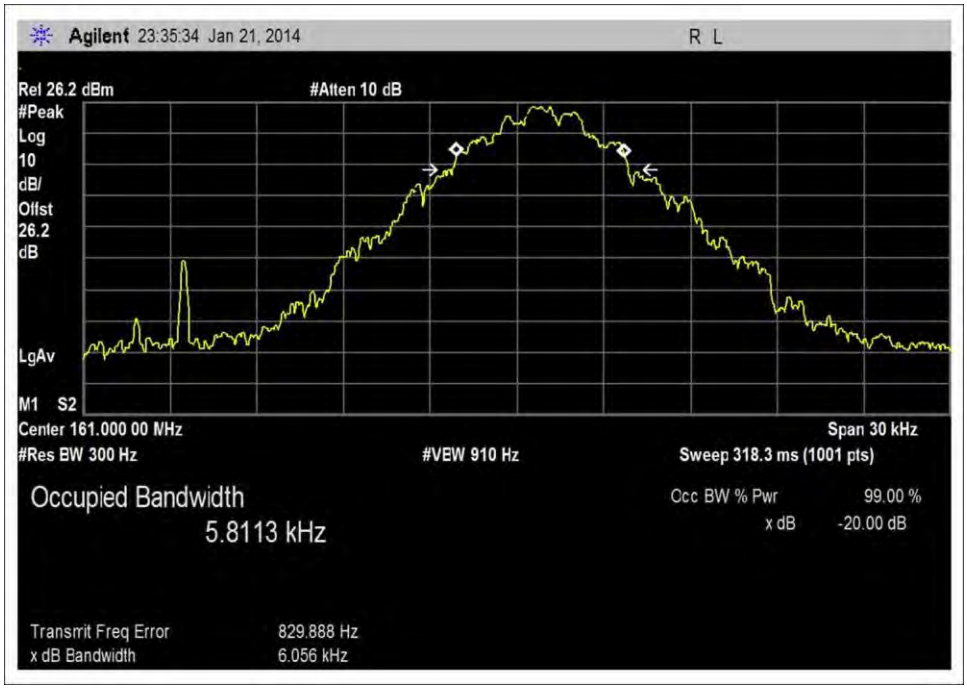
Test Data

Frequency (MHz)	-20dB BW	90.209 Limit	Result
150.00	6.00kHz	11.25kHz	Pass
161.00	6.06kHz	11.25kHz	Pass
174.00	6.26kHz	11.25kHz	Pass

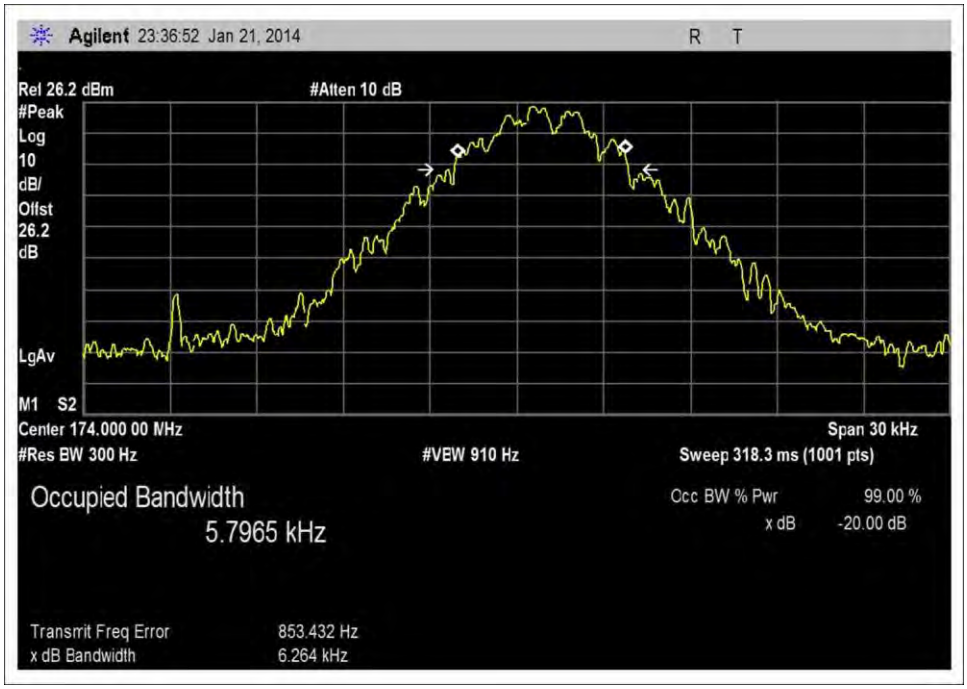
Test Plots



Low Frequency (150MHz)



Middle Frequency (161MHz)



High Frequency (174MHz)

Note: At the time of testing, the date stamp on the above plots was set on a default setting and should read 12/10/2014.

Test Setup Photo(s)

Carriage Transmitter, 1100-3, View #1

Carriage Transmitter, 1100-3, View #2

2.1051 / 90.210(d) Spurious Emissions at Antenna Terminals

Conducted Emissions Mask

Test Equipment					
Asset #	**Description**	**Model**	**Manufacturer**	**Cal Date**	**Cal Due**
02872	Spectrum Analyzer	E4440A	Agilent	07/19/2013	07/19/2015
P05747	Attenuator	PE7004-20	Pasternack	02/13/2014	02/13/2016
P06124	Attenuator	18N-6	Aeroflex	05/13/2013	05/13/2015
P06505	Cable	32026-29080-29080-84	Astrolab	10/18/2013	10/18/2015

Test Conditions / Setup

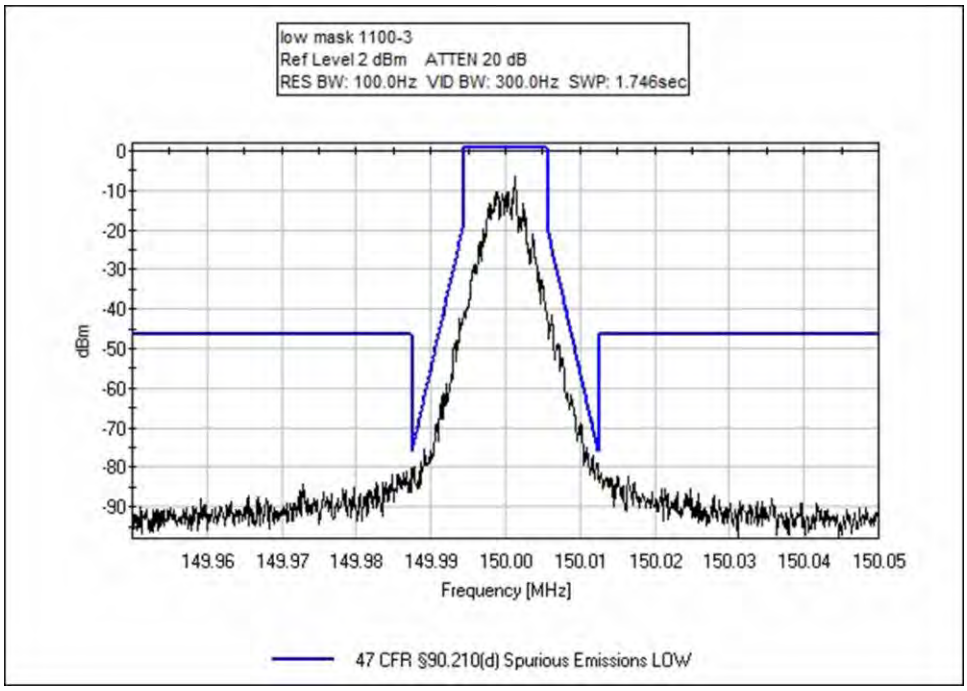
Temp: 23°C
Humidity: 41%
Pressure: 103.3kPa
Frequency Range: 150-174MHz

Test Date: 12/22/14
Test Engineer: Steven Pittsford

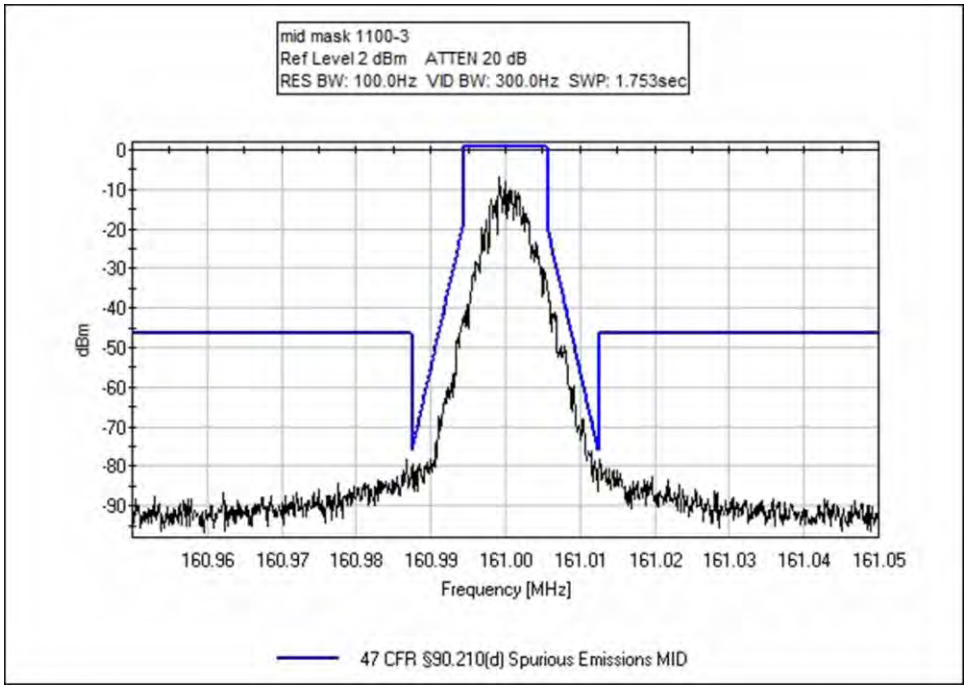
The EUT's RF output is connected to the Spectrum analyzer through 26dB of attenuation.
The EUT is connected to the RFD Programmer to interface to the laptop.
The 1100-3 is powered by a fresh battery.
The EUT is in operational mode.
The EUT will be transmitting at LOW (150MHz), MID (161MHz), and HIGH (174MHz) Channels.

Note: Model: 1100-3 is tested and is representative of Model: 1100-5.

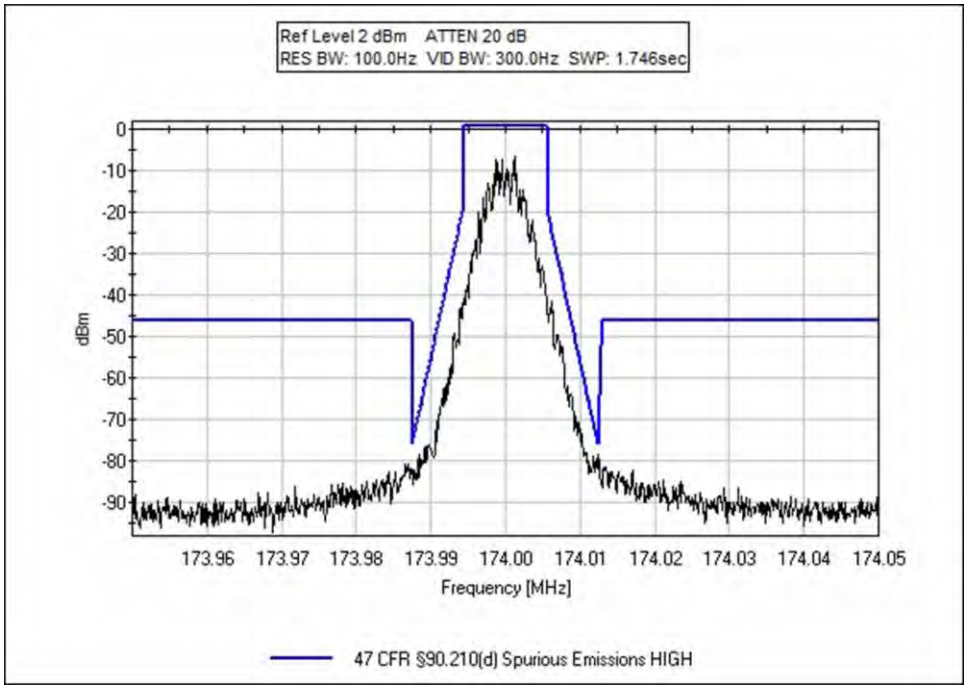
Test Data



Low Mask - Carriage Transmitter, 1100-3



Middle Mask - Carriage Transmitter, 1100-3



High Mask - Carriage Transmitter, 1100-3

Conducted Spurious Emissions

Test Data

Test Location: CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • (425) 402-1717

Customer: **Rothenbuhler Engineering**
Specification: **47 CFR §90.210(d) Spurious Emissions LOW**
Work Order #: **96354** Date: 12/22/2014
Test Type: **Conducted Emissions** Time: 11:33:40
Equipment: **Carriage Transmitter** Sequence#: 8
Manufacturer: Rothenbuhler Engineering Tested By: Michael Atkinson
Model: 1100-3 Battery
S/N: 0102

***Test Equipment*:**

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	ANP05747	Attenuator	PE7004-20	2/13/2014	2/13/2016
T2	ANP06124	Attenuator	18N-6	5/13/2013	5/13/2015
T3	ANP06505	Cable	32026-29080-29080-84	10/18/2013	10/18/2015
	AN02872	Spectrum Analyzer	E4440A	7/19/2013	7/19/2015

***Equipment Under Test* (* = EUT):**

Function	Manufacturer	Model #	S/N
Carriage Transmitter*	Rothenbuhler Engineering	1100-3	0102

Support Devices:

Function	Manufacturer	Model #	S/N
Programmer/Remote Monitor	Rothenbuhler Engineering	1100-6	0001
Laptop	Dell	Latitude D810	
RFD Programmer	Rothenbuhler Engineering	1670-10	00101

Test Conditions / Notes:

Temperature: 20°C
Pressure: 103.0kPa
Humidity: 41%
Frequency: 9k-2GHz

The EUT's RF output is connected to the Spectrum analyzer through 26dB of attenuation.
The EUT is connected to the RFD Programmer to interface to the laptop.
The EUT is in operational mode.
The EUT will be transmitting at Low, Mid and High.

Model #: 1100-3 is being tested, running off of a fresh battery and is representative of 1100-5.

1) Resolution Bandwidth = 10 kHz for spurious emissions below 1 GHz, and 1 MHz for spurious emissions above 1 GHz.
2) Video Bandwidth .3 times the resolution bandwidth.
3) Sweep Speed .2000 Hz per second.
4) Detector Mode = mean or average power.
Sweep: Auto

Ext Attn: 0 dB

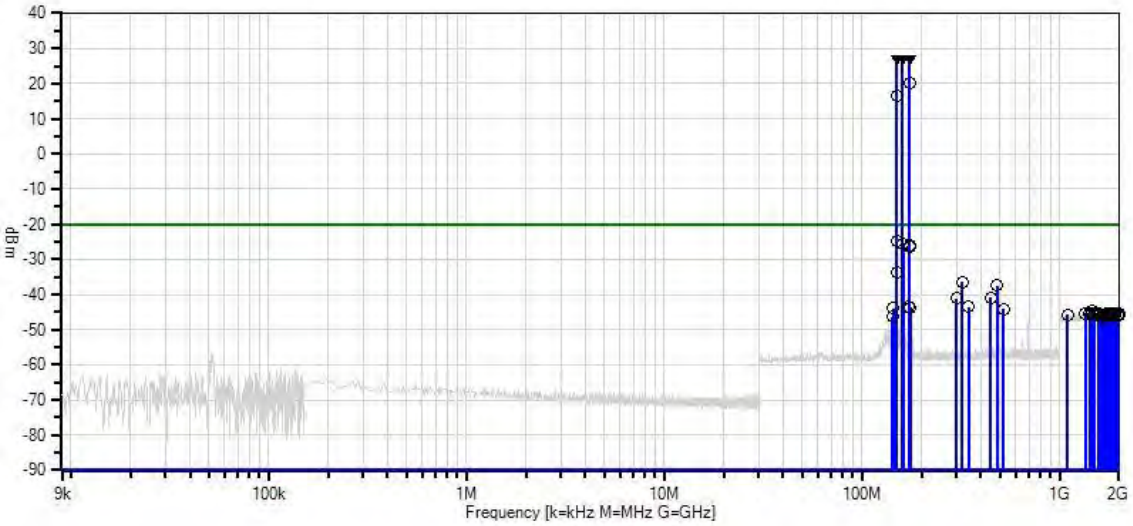
Measurement Data: Reading listed by margin. Test Lead: Antenna

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBm	Spec dBm	Margin dB	Polar Ant
1	161.000M	0.8	+20.0	+5.8	+0.4		+0.0	27.0	27.0	+0.0	Anten
	Ambient								Fund		
2	174.000M	0.8	+20.0	+5.8	+0.4		+0.0	27.0	27.0	+0.0	Anten
	Ambient								Fund		
3	149.999M	0.7	+20.0	+5.8	+0.4		+0.0	26.9	27.0	-0.1	Anten
	Ambient								Fund		
4	149.738M	-50.8	+20.0	+5.8	+0.4		+0.0	-24.6	-20.0	-4.6	Anten
5	150.264M	-51.0	+20.0	+5.8	+0.4		+0.0	-24.8	-20.0	-4.8	Anten
6	160.732M	-51.8	+20.0	+5.8	+0.4		+0.0	-25.6	-20.0	-5.6	Anten
7	161.265M	-52.0	+20.0	+5.8	+0.4		+0.0	-25.8	-20.0	-5.8	Anten
8	174.269M	-52.3	+20.0	+5.8	+0.4		+0.0	-26.1	-20.0	-6.1	Anten
9	173.731M	-52.7	+20.0	+5.8	+0.4		+0.0	-26.5	-20.0	-6.5	Anten
10	174.001M	-6.1	+20.0	+5.8	+0.4		+0.0	20.1	27.0	-6.9	Anten
11	150.001M	-9.6	+20.0	+5.8	+0.4		+0.0	16.6	27.0	-10.4	Anten
12	150.261M	-59.8	+20.0	+5.8	+0.4		+0.0	-33.6	-20.0	-13.6	Anten
13	322.012M	-62.7	+20.0	+5.8	+0.5		+0.0	-36.4	-20.0	-16.4	Anten
14	482.973M	-64.0	+20.0	+5.8	+0.7		+0.0	-37.5	-20.0	-17.5	Anten

15	450.060M	-67.3	+20.0	+5.8	+0.6	+0.0	-40.9	-20.0	-20.9	Anten
16	300.030M	-67.4	+20.0	+5.8	+0.5	+0.0	-41.1	-20.0	-21.1	Anten
17	172.823M	-69.5	+20.0	+5.8	+0.4	+0.0	-43.3	-20.0	-23.3	Anten
18	347.958M	-70.0	+20.0	+5.8	+0.6	+0.0	-43.6	-20.0	-23.6	Anten
19	175.225M	-69.9	+20.0	+5.8	+0.4	+0.0	-43.7	-20.0	-23.7	Anten
20	143.994M	-70.1	+20.0	+5.8	+0.4	+0.0	-43.9	-20.0	-23.9	Anten
21	522.012M	-70.6	+20.0	+5.8	+0.7	+0.0	-44.1	-20.0	-24.1	Anten
22	1450.000M	-71.9	+20.1	+5.8	+1.2	+0.0	-44.8	-20.0	-24.8	Anten
23	1499.000M	-72.4	+20.1	+5.8	+1.2	+0.0	-45.3	-20.0	-25.3	Anten
24	1344.000M	-72.3	+20.1	+5.8	+1.1	+0.0	-45.3	-20.0	-25.3	Anten
25	1898.000M	-72.4	+20.1	+5.8	+1.2	+0.0	-45.3	-20.0	-25.3	Anten
26	1589.000M	-72.5	+20.1	+5.8	+1.2	+0.0	-45.4	-20.0	-25.4	Anten
27	1882.000M	-72.5	+20.1	+5.8	+1.2	+0.0	-45.4	-20.0	-25.4	Anten
28	1857.000M	-72.5	+20.1	+5.8	+1.2	+0.0	-45.4	-20.0	-25.4	Anten
29	1568.000M	-72.5	+20.1	+5.8	+1.2	+0.0	-45.4	-20.0	-25.4	Anten
30	1832.000M	-72.5	+20.1	+5.8	+1.2	+0.0	-45.4	-20.0	-25.4	Anten
31	1914.000M	-72.5	+20.1	+5.8	+1.2	+0.0	-45.4	-20.0	-25.4	Anten
32	1716.000M	-72.5	+20.1	+5.8	+1.2	+0.0	-45.4	-20.0	-25.4	Anten
33	1755.000M	-72.6	+20.1	+5.8	+1.2	+0.0	-45.5	-20.0	-25.5	Anten
34	1853.000M	-72.6	+20.1	+5.8	+1.2	+0.0	-45.5	-20.0	-25.5	Anten
35	1463.000M	-72.6	+20.1	+5.8	+1.2	+0.0	-45.5	-20.0	-25.5	Anten
36	1810.000M	-72.6	+20.1	+5.8	+1.2	+0.0	-45.5	-20.0	-25.5	Anten
37	1987.000M	-72.7	+20.1	+5.8	+1.3	+0.0	-45.5	-20.0	-25.5	Anten
38	1413.000M	-72.6	+20.1	+5.8	+1.1	+0.0	-45.6	-20.0	-25.6	Anten
39	1771.000M	-72.7	+20.1	+5.8	+1.2	+0.0	-45.6	-20.0	-25.6	Anten
40	1814.000M	-72.7	+20.1	+5.8	+1.2	+0.0	-45.6	-20.0	-25.6	Anten

41	1093.000M	-72.6	+20.1	+5.8	+1.0	+0.0	-45.7	-20.0	-25.7	Anten
42	1957.000M	-72.9	+20.1	+5.8	+1.3	+0.0	-45.7	-20.0	-25.7	Anten
43	1576.000M	-72.8	+20.1	+5.8	+1.2	+0.0	-45.7	-20.0	-25.7	Anten
44	1500.000M	-72.8	+20.1	+5.8	+1.2	+0.0	-45.7	-20.0	-25.7	Anten
45	1846.000M	-72.8	+20.1	+5.8	+1.2	+0.0	-45.7	-20.0	-25.7	Anten
46	1656.000M	-72.9	+20.1	+5.8	+1.2	+0.0	-45.8	-20.0	-25.8	Anten
47	1676.000M	-72.9	+20.1	+5.8	+1.2	+0.0	-45.8	-20.0	-25.8	Anten
48	1717.000M	-72.9	+20.1	+5.8	+1.2	+0.0	-45.8	-20.0	-25.8	Anten
49	1819.000M	-72.9	+20.1	+5.8	+1.2	+0.0	-45.8	-20.0	-25.8	Anten
50	1997.000M	-73.2	+20.1	+5.8	+1.3	+0.0	-46.0	-20.0	-26.0	Anten
51	1901.000M	-73.1	+20.1	+5.8	+1.2	+0.0	-46.0	-20.0	-26.0	Anten
52	1677.000M	-73.3	+20.1	+5.8	+1.2	+0.0	-46.2	-20.0	-26.2	Anten
53	143.393M	-72.6	+20.0	+5.8	+0.4	+0.0	-46.4	-20.0	-26.4	Anten

CKC Laboratories, Inc. Date: 12/22/2014 Time: 11:33:40 Rothenbuhler Engineering WO#: 96354
Test Lead: Antenna Battery Sequence#: 8 Antenna
Rothenbuhler Engineering Carriage Transmitter P/N: 1100-3



Sweep Data
Peak Readings
Average Readings
1 - 47 CFR §90.210(d) Spurious Emissions LOW
Readings
QP Readings
Ambient

Test Setup Photo(s)

Carriage Transmitter, 1100-3, View #1

Carriage Transmitter, 1100-3, View #2

2.1053 / 90.210(d) Field Strength of Spurious Radiation

Test Conditions / Setup

Test Location: CKC Laboratories, Inc. • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • (425) 402-1717

Customer: **Rothenbuhler Engineering**
Specification: **47 CFR §90.210(d) Spurious Emissions**
Work Order #: **96354** Date: 1/9/2015
Test Type: **Radiated Scan** Time: 13:11:07
Equipment: **Yarder Transmitter** Sequence#: 16
Manufacturer: Rothenbuhler Engineering Tested By: Steven Pittsford
Model: 1100-5
S/N: 0001

***Test Equipment*:**

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02307	Preamp	8447D	3/14/2014	3/14/2016
T2	AN01996	Biconilog Antenna	CBL6111C	7/16/2014	7/16/2016
T3	ANP05963	Cable	RG-214	2/21/2014	2/21/2016
T4	ANP06505	Cable	32026-29080-29080-84	10/18/2013	10/18/2015
T5	AN02872	Spectrum Analyzer	E4440A	7/19/2013	7/19/2015
T6	ANP05360	Cable		12/1/2014	12/1/2016
T7	ANP05747	Attenuator	PE7004-20	2/13/2014	2/13/2016
T8	AN03209	Preamp	83051A	3/5/2013	3/5/2015
T9	AN01467	Horn Antenna-ANSI C63.5 Calibration	3115	9/16/2013	9/16/2015
T10	ANP05305	Cable	ETSI-50T	2/20/2014	2/20/2016
	AN00052	Loop Antenna	6502	5/20/2014	5/20/2016

***Equipment Under Test* (* = EUT):**

Function	Manufacturer	Model #	S/N
Yarder Transmitter*	Rothenbuhler Engineering	1100-5	0001

Support Devices:

Function	Manufacturer	Model #	S/N
Smart Box	Rothenbuhler Engineering	1079-6	SXXX

Test Conditions / Notes:

Temperature: 20°C
Pressure: 103.3kPa
Humidity: 41%
Frequency: 9k-2GHz

The EUT is sitting on a foam test bench.
The antenna port is terminated into a 50 Ohm Load on the 1100-5 and into integral antenna on the 1100-3
The EUT is in operational mode.
The EUT will be transmitting at Low Mid and High Channels.
The 1100-3 supplied 13.2V and the 1100-3 has a fresh battery installed.

1) Resolution Bandwidth = 10 kHz for spurious emissions below 1 GHz, and 1 MHz for spurious emissions above 1GHz.
2) Video Bandwidth = 300 kHz for spurious emissions below 1 GHz, and 3 MHz for spurious emissions above 1 GHz.
3) Sweep Speed slow enough to maintain measurement calibration.
4) Detector Mode = Positive Peak.

Test Method TIA-603 D
NOTE: The EUT has modified copper tape around the battery box.

Test Data

Operating Frequency(ies):	150, 161, 174 MHz	
Operational Mode(s):	Transmit Low, Mid, High	
Highest Measured Power:	27	dBm
Measurement Distance:	3	meters

Limit Definition:

Frequency Range	Limit (dBc)	Limit Calculation
9kHz - 2GHz	47	50+10*LOG(P)

Frequency (MHz)	Reference Level (dBm)	Measured (dBc)	Margin	Antenna Polarity
348.004	-24.3	51.3	-4.3	Vertical
300.000	-29.6	56.6	-9.6	Vertical
600.003	-30.7	57.7	-10.7	Vertical
695.997	-31.5	58.5	-11.5	Vertical
173.738	-35.0	62.0	-15.0	Vertical
749.995	-35.1	62.1	-15.1	Vertical
522.004	-35.3	62.3	-15.3	Vertical
174.269	-36.3	63.3	-16.3	Vertical
450.000	-39.2	66.2	-19.2	Vertical

161.264	-39.5	66.5	-19.5	Vertical
644.004	-40.1	67.1	-20.1	Vertical
322.002	-40.3	67.3	-20.3	Vertical
160.733	-40.7	67.7	-20.7	Vertical
1739.908	-41.7	68.7	-21.7	Horizontal
483.004	-43.3	70.3	-23.3	Vertical
1770.939	-45.0	72.0	-25.0	Vertical
965.977	-45.2	72.2	-25.2	Vertical
899.994	-45.9	72.9	-25.9	Horizontal
805.002	-48.9	75.9	-28.9	Vertical
1199.890	-49.9	76.9	-29.9	Vertical

Note: The above table applies to: Carriage Transmitter, 1100-3.

Operating Frequency(ies):	150, 161, 174 MHz	
Operational Mode(s):	Transmit Low, Mid, High	
Highest Measured Power:	27	dBm
Measurement Distance:	3	meters

Limit Definition:

Frequency Range	Limit (dBc)	Limit Calculation
9kHz - 2GHz	47	50+10*LOG(P)

Frequency (MHz)	Reference Level (dBm)	Measured (dBc)	Margin	Antenna Polarity
299.998	-39.9	66.9	-19.9	Horizontal
322.000	-28.0	55.0	-8.0	Horizontal
347.999	-31.1	58.1	-11.1	Horizontal
348.004	-32.7	59.7	-12.7	Horizontal
449.998	-40.8	67.8	-20.8	Vertical
450.000	-33.2	60.2	-13.2	Horizontal
483.000	-42.2	69.2	-22.2	Horizontal
522.001	-45.3	72.3	-25.3	Horizontal
644.003	-44.4	71.4	-24.4	Horizontal
696.002	-46.9	73.9	-26.9	Horizontal
1500.000	-42.7	69.7	-22.7	Vertical
1740.050	-40.9	67.9	-20.9	Vertical
1771.000	-40.2	67.2	-20.2	Vertical

Note: The above table applies to: Yarder Transmitter, 1100-5.

Test Setup Photo(s)

Carriage Transmitter, 1100-3

Yarder Transmitter, 1100-5

2.1055 / 90.213 Frequency Stability

Test Equipment					
Asset #	**Description**	**Model**	**Manufacturer**	**Cal Date**	**Cal Due**
02872	Spectrum Analyzer	Agilent	E4440A	07/19/2013	07/19/2015
P05747	Attenuator	Pasternack	PE7004-20	02/13/2014	02/13/2016
P06124	Attenuator	Aeroflex	18N-6	05/13/2013	05/13/2015
P06505	Cable	Astrolab	32026-29080-29080-84	10/18/2013	10/18/2015
02757	Temperature Chamber	Bemco	F100/350-8	01/22/2013	01/22/2015
P05362	Cable	Beldon	RG-214	02/21/2014	02/21/2016
P05371	Cable	Pasternack	RG214/U	04/14/2014	04/14/2016

Test Conditions / Setup

Test Date: 1/6/2015
Test Engineer: Steven Pittsford

Both EUTs are located inside the temperature chamber with all support located outside of the temperature chamber.
The EUT's RF output is connected to the Spectrum analyzer through 26dB of attenuation.
The EUTs are connected to the RFD Programmer to interface to the laptop.
The 1100-5 and the 1100-3 will be power by nominal voltage and also at extreme voltages.
The EUT is in operational mode.
The EUT will be transmitting at LOW (150MHz), MID (161MHz), and HIGH (174MHz) Channels.

Test Data

Frequency Stability

Customer:	Rothenbuhler Engineering
WO#:	96354
Date:	6-Jan-15
Test Engineer:	S. Pittsford
Test Specification	90.213
Device Model #:	1100-3
Operating Voltage:	14.4 VDC
Frequency Limit:	5 PPM

Temperature Variations

		Channel 1 (MHz)	Dev. (PPM)	Channel 2 (MHz)	Dev. (PPM)	Channel 3 (MHz)	Dev. (PPM)
Channel Frequency:		150		161		174	
Temp (C)	Voltage						
-30	14.4	149.99996	0.25333	160.99999	0.09317	173.99998	0.10345
-20	14.4	149.99995	0.32667	160.99998	0.15528	173.99999	0.04598
-10	14.4	149.99994	0.39333	160.99996	0.24845	173.99996	0.21839
0	14.4	149.99994	0.38667	160.99996	0.25466	173.99995	0.28161
10	14.4	149.99994	0.38667	161.00002	0.11180	174.00002	0.09195
20	14.4	150.00022	1.46667	161.00005	0.32919	174.00009	0.53448
30	14.4	150.00000	0.02000	161.00001	0.08075	174.00001	0.06897
40	14.4	149.99998	0.12000	161.00000	0.01863	174.00001	0.06897
50	14.4	149.99999	0.04667	161.00000	0.01242	173.99999	0.04023

Voltage Variations (±15%)

20	12.2	150.00001	0.05333	161.00004	0.25466	174.00005	0.31034
20	14.4	150.00002	0.14667	161.00005	0.32919	174.00009	0.53448
20	16.6	150.00002	0.14667	161.00007	0.45342	174.00009	0.51149
Max Deviation (PPM)			**1.46667**		**0.45342**		**0.53448**
			PASS		**PASS**		**PASS**

Note: The above table applies to: Carriage Transmitter, 1100-3.

Frequency Stability

Customer:	Rothenbuhler Engineering
WO#:	96354
Date:	6-Jan-15
Test Engineer:	S. Pittsford
Test Specification	90.213
Device Model #:	1100-5
Operating Voltage:	13.2 VDC
Frequency Limit:	5 PPM

Temperature Variations

		Channel 1 (MHz)	Dev. (PPM)	Channel 2 (MHz)	Dev. (PPM)	Channel 3 (MHz)	Dev. (PPM)
Channel Frequency:		150		161		174	
Temp (C)	Voltage						
-30	13.2	149.99990	0.70000	160.99988	0.77019	173.99986	0.80460
-20	13.2	149.99993	0.46667	160.99991	0.54658	173.99991	0.54598
-10	13.2	150.00000	0.03333	160.99998	0.13665	173.99996	0.22989
0	13.2	150.00003	0.21333	161.00003	0.16770	174.00002	0.10920
10	13.2	150.00002	0.10000	161.00000	0.02484	174.00000	0.02874
20	13.2	150.00001	0.04667	160.99999	0.05590	173.99998	0.13218
30	13.2	150.00001	0.06000	161.00000	0.01863	173.99998	0.10345
40	13.2	150.00002	0.16000	161.00002	0.09938	174.00001	0.04598
50	13.2	150.00008	0.52667	161.00007	0.43478	174.00005	0.29310

Voltage Variations (±15%)

20	11.2	150.00000	0.02667	160.99999	0.06211	173.99998	0.13218
20	13.2	150.00001	0.04667	160.99999	0.05590	173.99998	0.13218
20	15.2	150.00001	0.03333	160.99999	0.04969	173.99998	0.12069
Max Deviation (PPM)			**0.70000**		**0.77019**		**0.80460**
			PASS		**PASS**		**PASS**

Note: The above table applies to: Yarder Transmitter, 1100-5.

Test Setup Photo(s)

Temperature Chamber, View #1

Temperature Chamber, View #2

2.1055 / 90.214 Transient Frequency Behavior

Test Equipment					
Asset #	**Description**	**Model**	**Manufacturer**	**Cal Date**	**Cal Due**
02872	Spectrum Analyzer	E4440A	Agilent	07/19/2013	07/19/2015
02072	RF Characteristics Analyzer	8901A	HP	04/11/2013	04/11/2015
01316	Preamp	8447D	HP	08/28/2014	08/28/2016
01706	Attenuator	8495B	HP	01/27/2014	01/27/2016
01496	RF Generator	2022-0003X	Marconi	01/20/2014	01/20/2016
03052	Oscilloscope	54615B	HP	02/26/2014	02/26/2016
P01313	Splitter, 4-Way	NA	Motorola	04/11/2014	04/11/2016

Test Conditions / Setup

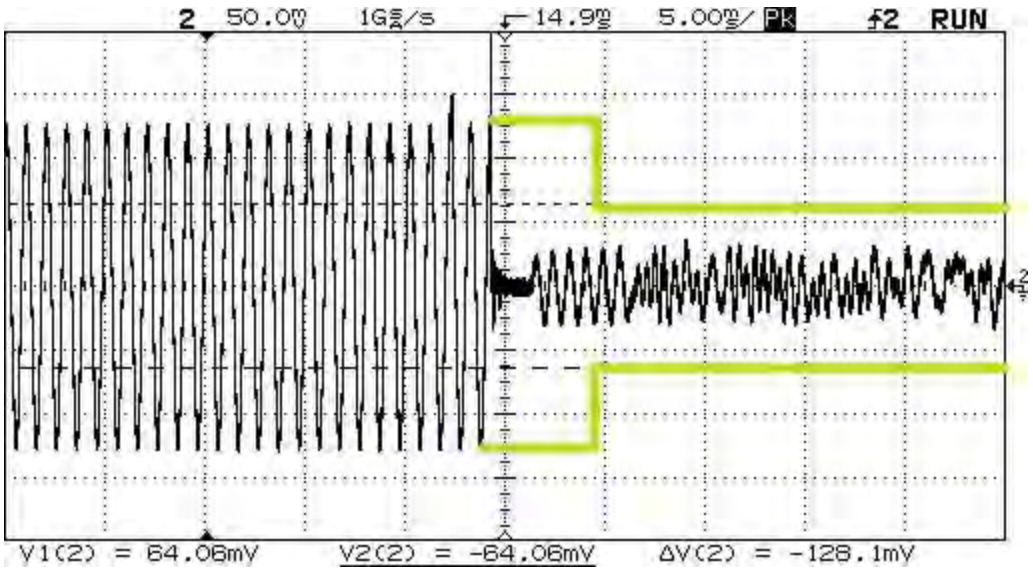
Test Conditions

Temp: 21°
Humidity: 41%
Pressure: 103.3kPa
Frequency Range: 150-174MHz

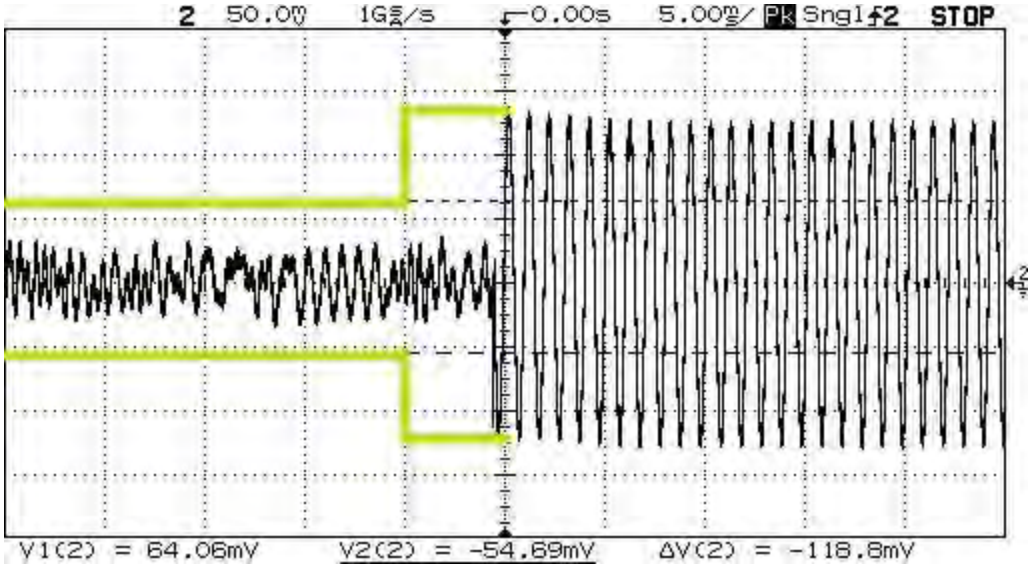
Test Date: 1/5/2015
Test Engineer: Steven Pittsford

The EUT's RF output and Signal Generator output are connected to the 4 port splitter.
The Output of the splitter is connected to a pre-amp and the output of the pre-amp is connected to the demodulator input and the PSA through a step attenuator.
The PSA is only being used to be sure that the sig-gen output is 20dB lower that the EUT's output. The output of the demodulator is connected to an oscilloscope.
The EUT is connected to a laptop.
The EUT is in operational mode.
The EUT will be transmitting at LOW (150MHz), MID (161MHz), and HIGH (174MHz) Channels.
Note: Model: 1100-3 was tested and it is representative of Model: 1100-5.

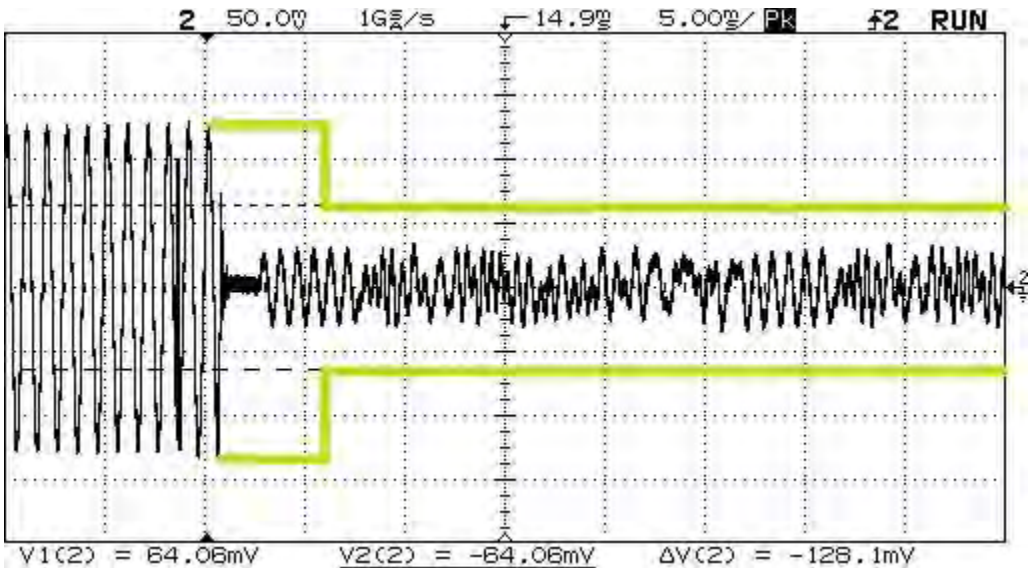
Test Data



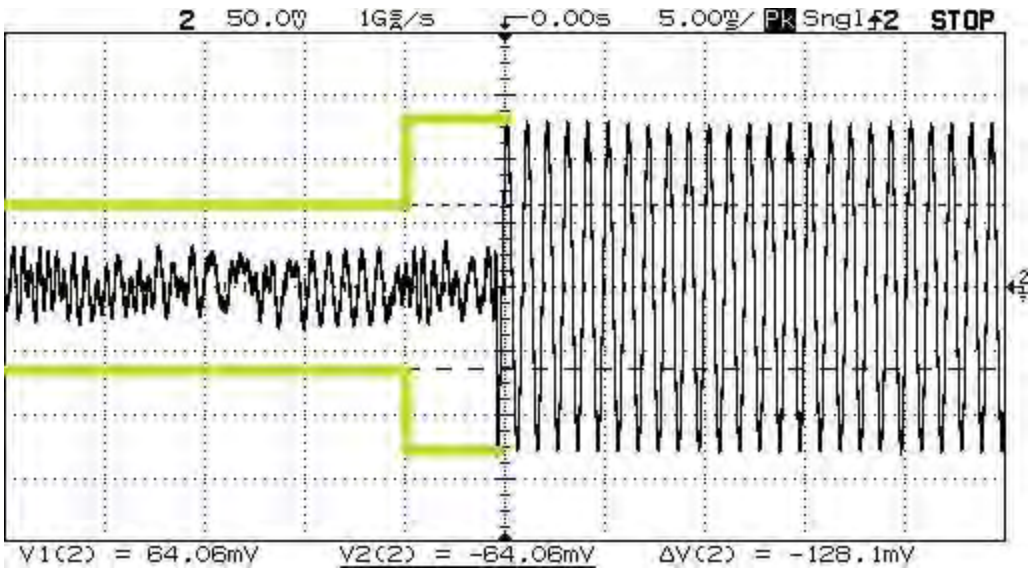
ON Time, 150MHz



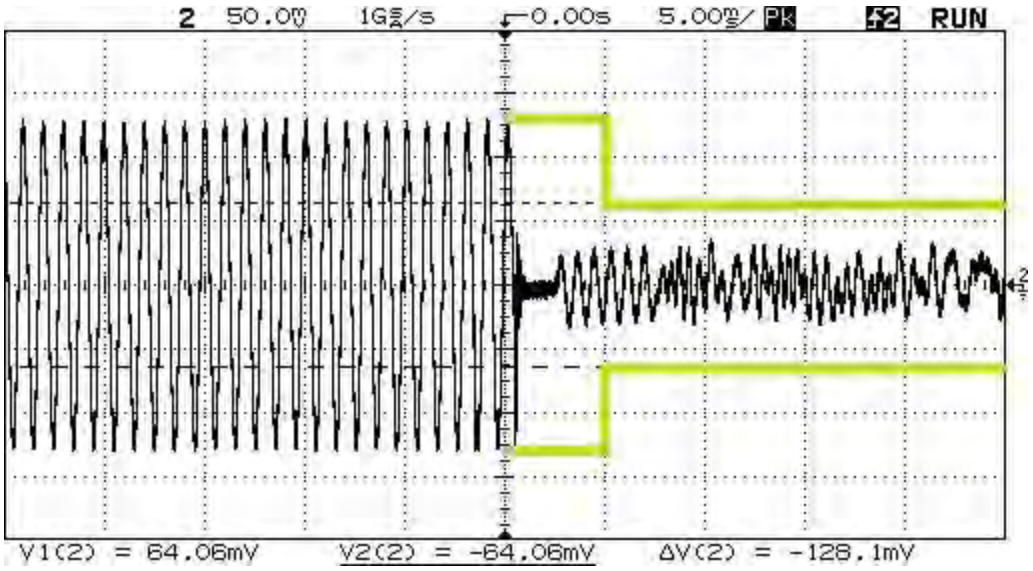
OFF Time, 150MHz



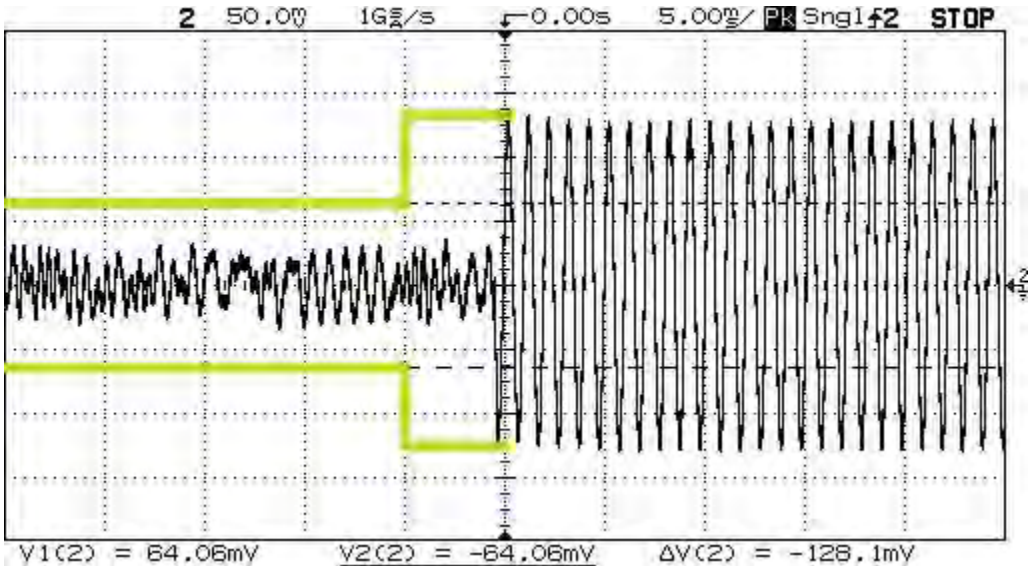
ON Time, 161MHz



OFF Time, 161MHz



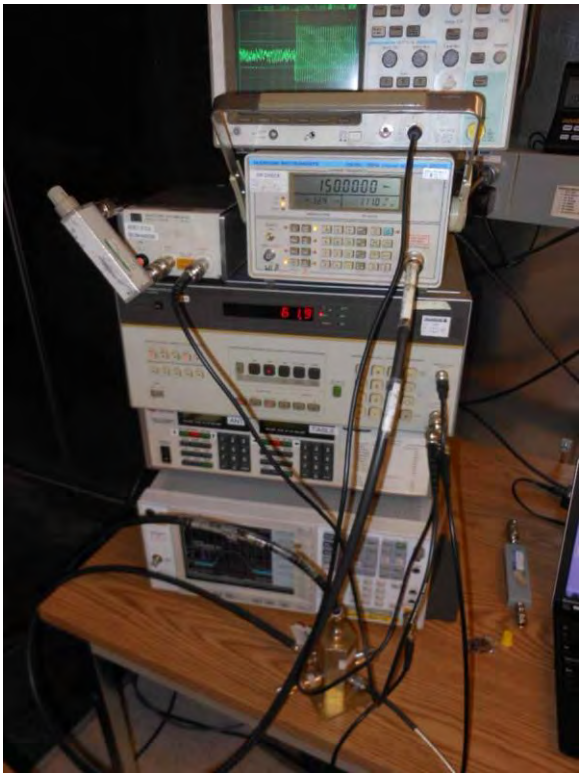
ON Time, 174MHz



OFF Time, 174MHz

Test Setup Photo(s)

Test Setup, View #1



Test Setup, View 2

SUPPLEMENTAL INFORMATION

Measurement Uncertainty

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

Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2.

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.

SAMPLE CALCULATIONS		
	Meter reading	(dBµV)
+	Antenna Factor	(dB)
+	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 carrot ("^") 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.