

Powerwave Technologies, Inc.

TEST REPORT FOR

800MHz Band Remote Radio Head, LRS08-T5022-100

Tested To The Following Standards:

FCC Part 90 Subpart S

Report No.: 92116-7

Date of issue: August 4, 2011



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:

Powerwave Technologies, Inc.
1801 E. St. Andrew Place
Santa Ana, CA 92705

REPORT PREPARED BY:

Joyce Walker
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

REPRESENTATIVE: Sean Doan
Customer Reference Number: 144378

Project Number: 92116

DATE OF EQUIPMENT RECEIPT:

July 27, 2011

DATE(S) OF TESTING:

July 27 - August 2, 2011

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.

A handwritten signature in black ink, reading "Steve Behm", is written over a horizontal line.

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

In-Situ Testing:
Powerwave Technologies
1801 E. St. Andrew Place
Santa Ana, CA 92705

Site Registration & Accreditation Information

Location	CB #	JAPAN	CANADA	FCC
Brea A	US0060	R-2945, C-3248 & T-1572	3082D-1	90473

SUMMARY OF RESULTS

Standard / Specification: FCC Part 90 Subpart S

Description	Test Procedure/Method	Results
Emission Mask / Block Edge	FCC 90.691	Pass
RF Power Output	FCC 2.1033(c)(14)/2.1046/90.635	Pass
Modulation Characteristics – Audio Frequency Response	FCC 2.1033(c)(14)/2.1047(a)	NA
Modulation Characteristics – Modulation Limiting Response	FCC 2.1033(c)(14)/2.1047(b)	NA
Occupied Bandwidth	FCC 2.1033(c)(14)/2.1049(l)	Pass
Spurious Emissions at Antenna Terminal	FCC 2.1033(c)(14)/2.1051/90.691(a)	Pass
Field Strength of Spurious Radiation	FCC 2.1033(c)(14)/2.1053/90.691(a)	Pass
Frequency Stability	FCC 2.1033(c)(14)/2.1055(a)&(d)/90.543(a)	Pass

Conditions During Testing

This list is a summary of the conditions noted for or modifications made to the equipment during testing.

Summary of Conditions
Temperature testing was performed In-situ to utilize the manufacturer's large temperature chamber. However, all testing was performed utilizing CKC Laboratories test equipment.

EQUIPMENT UNDER TEST (EUT)

EQUIPMENT UNDER TEST

The EUT is a 800MHz Band Remote Radio Head (RRH). The main functions of RRH are modulating, demodulating, up-down converting and amplifying the signals which are transmitted from a channel card and received from antennas.

800MHz Band Remote Radio Head

Manuf: Powerwave Technologies, Inc.

Model: LRS08-T5022-100

Serial: S3XB501014

PERIPHERAL DEVICES

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

Mouse

Manuf: HP

Model: M-S34

Serial: LZA7130868

Keyboard

Manuf: HP

Model: KB-9970

Serial: 9L21401134B

Monitor

Manuf: HP

Model: M-S34

Serial: LZA71340868

TDP Test Fixture

Manuf: Powerwave Technologies, Inc.

Model: Selhurst

Serial: NA

Computer

Manuf: HP

Model: 2UA5380LIC

Serial: NA

Power Supply

Manuf: HP

Model: 6654A

Serial: US36391129

ESG

Manuf: Agilent

Model: E4443B

Serial: US40052164

FCC PART 90 SUBPART S

This report contains EMC emissions test results under United States Federal Communications Commission (FCC) requirements for licensed devices.

FCC 90.691 - Emission Mask / Block Edge

Test Conditions / Setup

The EUT, containing two identical RF circuits with independent RF output ports, was placed on the test bench. The Optical port was connected to a remote TDP Test Fixture. USB port was connected to remote computer. The EUT was set in full, constant transmit power mode.

The RF evaluation was performed at the antenna port with a spectrum analyzer. External attenuators used were verified and the offset was entered into the spectrum analyzer.

The EUT was rated at 50W+ 50W for 5 channels and 20W+20W for a single channel.

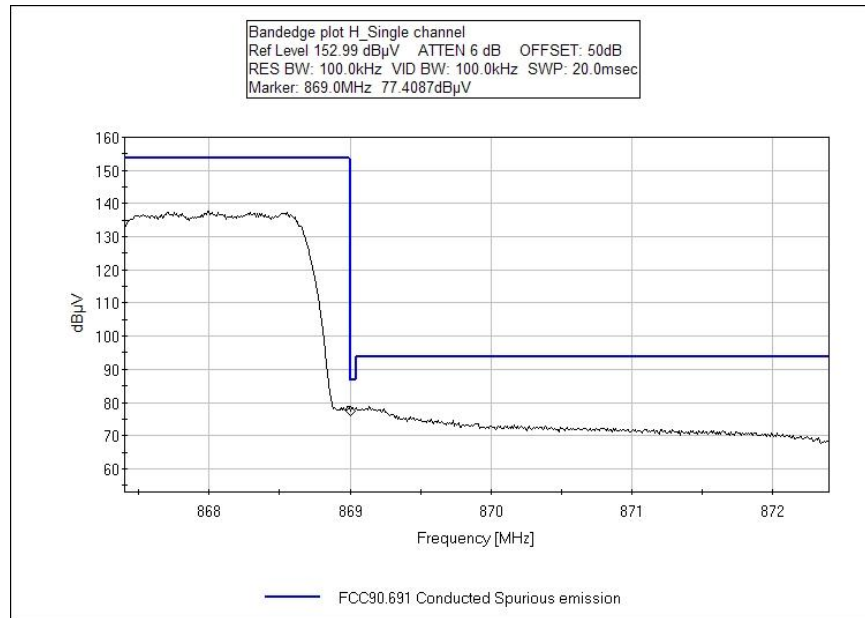
Frequency range: 862 -869MHz

Modulation: CDMA

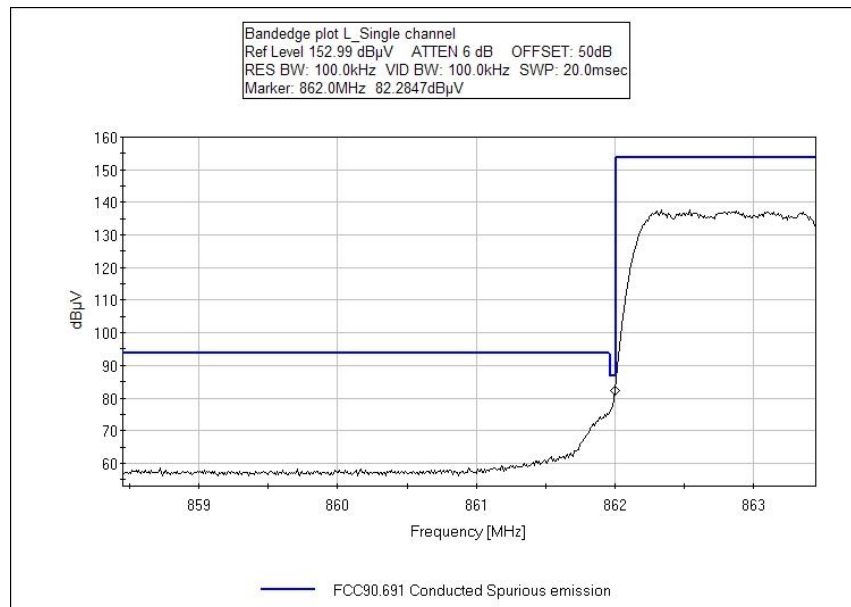
Engineer Name: E. Wong

Test Equipment					
Asset/Serial #	Description	Model	Manufacturer	Cal Date	Cal Due
02672	Spectrum Analyzer	E4446A	Agilent	8/9/2010	8/9/2012
03174	Cable	16301	AstroLab	10/28/2009	10/28/2011

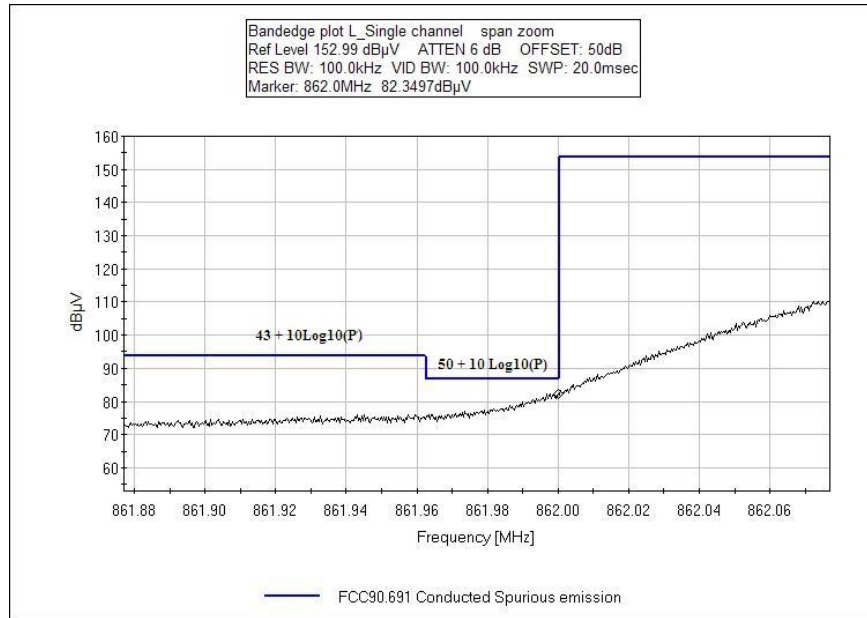
Test Data



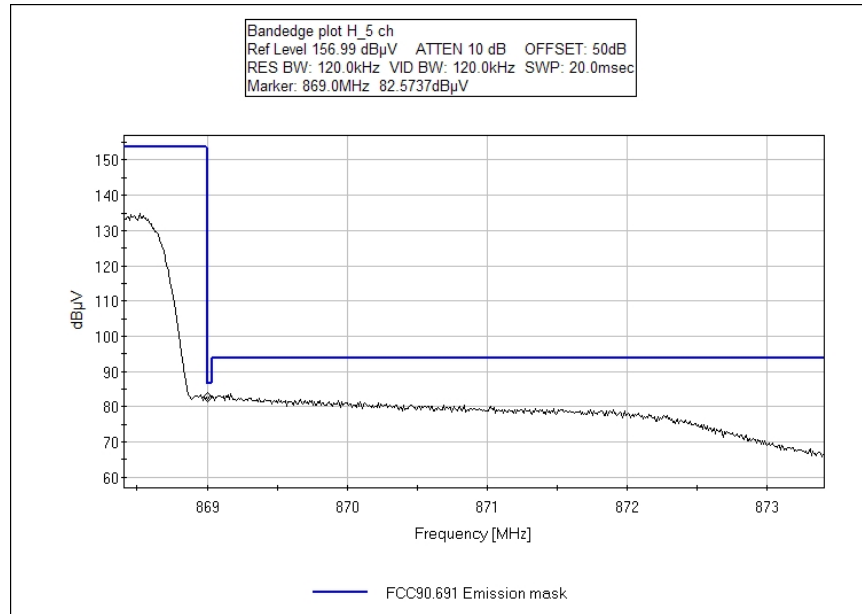
Single Channel 2 – High



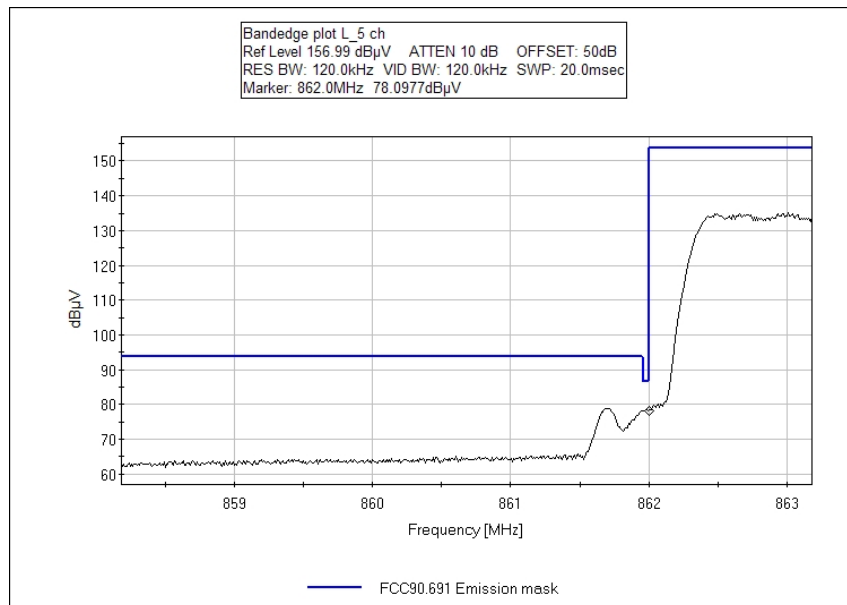
Single Channel 2 – Low



Single channel 2 – Low (zoom)



Five Channels - High



Five Channels - Low

Test Setup Photos



2.1033(c)(14)/2.1046/90.635 - RF Power Output

Test Conditions / Setup

The EUT, containing two identical RF circuits with independent RF output ports, was placed on the test bench. The Optical port was connected to a remote TDP Test Fixture. Both RF ports of identical RF circuitries were connected to a RF load. USB port was connected to a remote computer. The EUT was set in full, constant transmit power.

The RF evaluation was performed at the antenna port with a RF power meter. The RF Output power from both antenna ports were evaluated.

The EUT is designed to transmit all 5 channels simultaneously from each antenna port at 10 watts per channel (total of 50 watts) or a single channel at 20 watts at each antenna port.

Frequency range: 862 -869MHz
Modulation: CDMA

Multi-channel

Frequencies: 862.9 MHz, 864.15MHz, 865.4MHz, 866.65MHz 867.9 MHz
Power= 50W+ 50W (10W per channel)

Single channel

Frequency: 862.9 MHz, 868.1 MHz
Power= 20W+ 20W (20W per channel)

Engineer Name: E. Wong

Test Equipment					
Asset/Serial #	Description	Model	Manufacturer	Cal Date	Cal Due
02778	Power Meter	E4418A	HP	1/26/2010	1/26/2012

Test Data

Antenna port A		
Frequency	Power (dBm)	Power (Watt)
Single channel		
862.90	43	20
868.10	43	20
5 Channel		
862.90 864.15 865.40 866.65 867.90	47	50

Antenna port B		
Frequency	Power (dBm)	Power (Watt)
Single channel		
862.90	43	20
868.10	43	20
5 Channel		
862.90 864.15 865.40 866.65 867.90	47	50

DC Voltage was varied $\pm 15\%$ with no change in RF output power.

Test Setup Photos



2.1033(c)(14)/2.1049(I)/ - Occupied Bandwidth

Test Conditions / Setup

The EUT, containing two identical RF circuits with independent RF output ports, was placed on the test bench. The Optical port was connected to a remote TDP Test Fixture. USB port was connected to remote computer. The EUT was set in full, constant transmit power mode.

The RF evaluation was performed at the antenna port with a spectrum analyzer. External attenuators used were verified and the offset was entered into the spectrum analyzer.

The EUT was rated at 50W+ 50W for 5 channels and 20W+20W for a single channel.

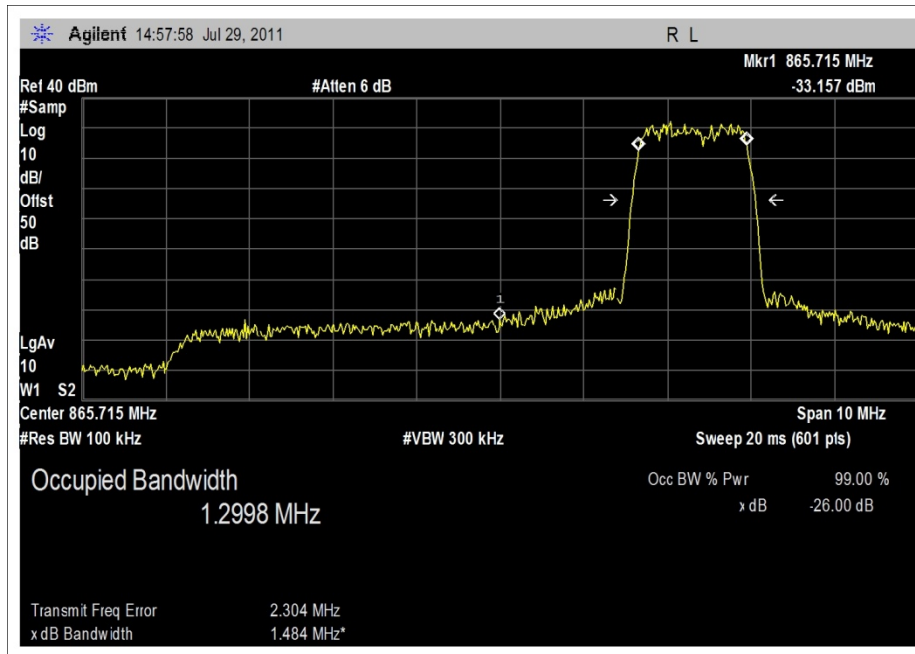
Frequency range: 862 -869MHz

Modulation: CDMA

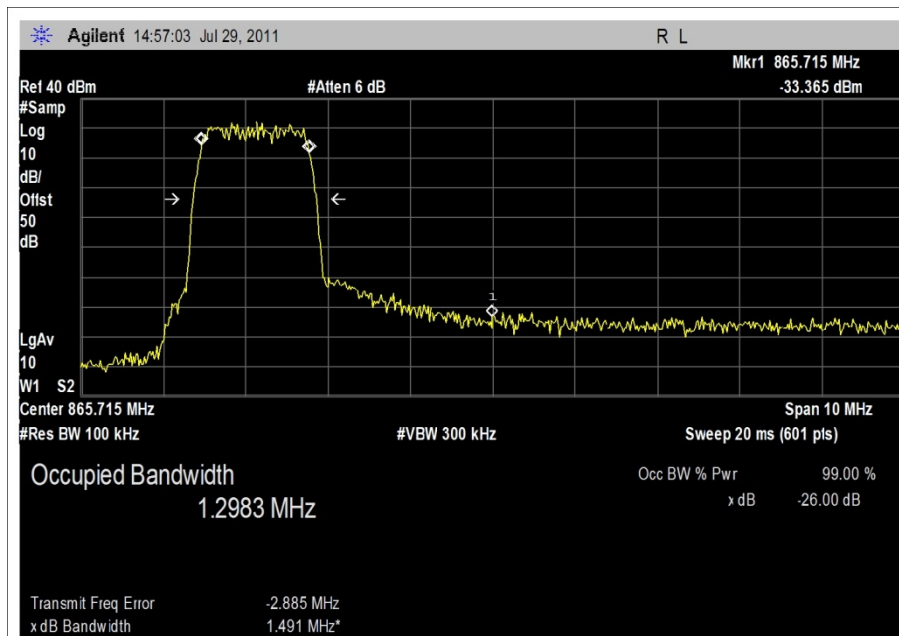
Engineer Name: E. Wong

Test Equipment					
Asset/Serial #	Description	Model	Manufacturer	Cal Date	Cal Due
02672	Spectrum Analyzer	E4446A	Agilent	8/9/2010	8/9/2012
03174	Cable	16301	AstroLab	10/28/2009	10/28/2011

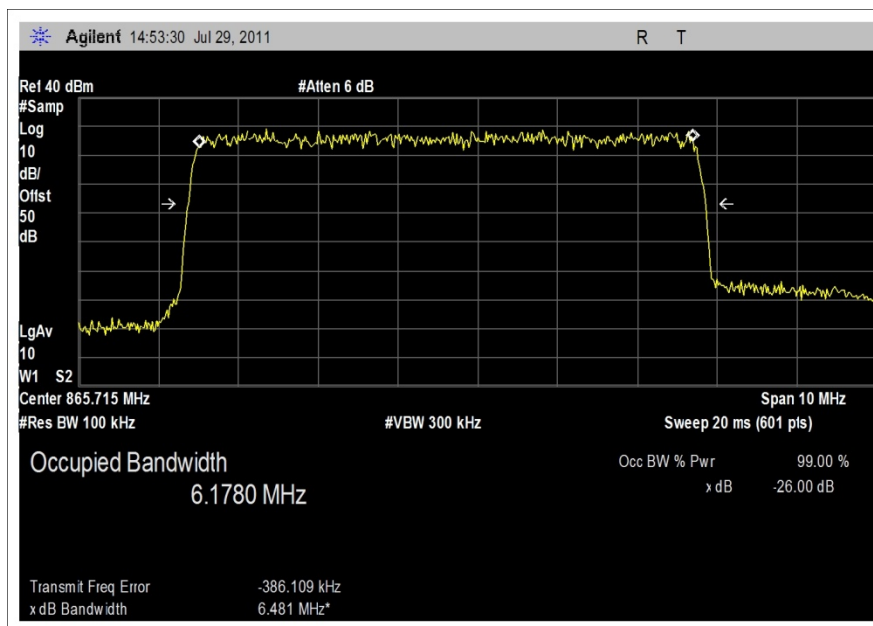
Test Data



High



Low



5MHz

Test Setup Photos



2.1033(c)(14)/2.1051/90.691(a) - Spurious Emissions at Antenna Terminal

Test Data

Limit line for Spurious Conducted Emission

$$\text{Required Attenuation} = 43 + 10 \log P \text{ dB}$$

$$\text{Limit line (dBuV)} = V_{\text{dBuV}} - \text{Attenuation}$$

$$\begin{aligned} V_{\text{dBuV}} &= 20 \log \frac{V}{1 \times 10^{-6}} \\ &= 20 (\log V - \log 1 \times 10^{-6}) \\ &= 20 \log V - 20 \log 1 \times 10^{-6} \\ &= 20 \log V - 20(-6) \\ &= 20 \log V + 120 \end{aligned}$$

$$\begin{aligned} \text{Attenuation} &= 43 + 10 \log P \\ &= 43 + 10 \log \frac{V^2}{R} \\ &= 43 + 10 (\log V^2 - \log R) \\ &= 43 + 10 (2 \log V - \log R) \\ &= 43 + 20 \log V - 10 \log R \end{aligned}$$

$$\begin{aligned} \text{Limit line} &= V_{\text{dBuV}} - \text{Attenuation} \\ &= 20 \log V + 120 - (43 + 20 \log V - 10 \log R) \\ &= 20 \log V + 120 - 43 - 20 \log V + 10 \log R \\ &= 20 \log V + 120 - 43 - 20 \log V + 10 \log R \\ &= 120 - 43 + 10 \log 50 \quad \text{Note : } R = 50 \Omega \\ &= 120 - 43 + 16.897 \\ &= 94 \text{ dBuV at any power level} \end{aligned}$$

Test Location: CKC Laboratories, Inc. • 110 N. Olinda Place • Brea, CA 92823 • (714) 993-6112

Customer: **Powerwave Technologies, Inc.**
 Specification: **FCC90.691 Conducted Spurious Emission**
 Work Order #: **92116** Date: 7/29/2011
 Test Type: **Conducted Emissions** Time: 14:25:31
 Equipment: **800MHz Band Remote Radio Head** Sequence#: 5
 Manufacturer: Powerwave Technologies, Inc. Tested By: E. Wong
 Model: LRS08-T5022-100 48Vdc
 S/N: S3XB501014

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02672	Spectrum Analyzer	E4446A	8/9/2010	8/9/2012
T1	AN03174	Cable	16301	10/28/2009	10/28/2011
T2	AN03169	High Pass Filter	HM1155-11SS	9/14/2009	9/14/2011

Equipment Under Test (* = EUT):

Function	Manufacturer	Model #	S/N
800MHz Band Remote Radio Head*	Powerwave Technologies, Inc.	LRS08-T5022-100	S3XB501014

Support Devices:

Function	Manufacturer	Model #	S/N
Mouse	HP	M-S34	LZA7130868
Keyboard	HP	KB-9970	9L21401134B
Monitor	HP	M-S34	LZA71340868
TDP Test Fixture	Powerwave Technologies, Inc.	Selhurst	NA
Computer	HP	2UA5380LIC	NA
Power Supply	HP	6654A	US36391129
ESG	Agilent	E4443B	US40052164

Test Conditions / Notes:

The EUT containing two identical RF circuits with independent RF output ports were placed on the test bench. The Optical port was connected to a remote TDP Test Fixture. Both RF ports of identical RF circuitries were connected to a RF load. The USB port was connected to a remote computer. The EUT was set in full, constant transmit power.

RF evaluation performed at antenna port A

The EUT is rated at 50W+50W for 5 channels and 20W+20W for a single channel.

Frequency: 862 -869MHz

Modulation: CDMA

Multi-channels

Frequency: 862.9 MHz, 864.15MHz, 865.4MHz, 866.65MHz 867.9 MHz

Power= 50W+ 50W (10W Per Channel)

Single channel

Frequency: 862.9 MHz, 868.1 MHz

Power= 20W+ 20W (20W Per Channel)

Frequency range of measurement = 9 kHz- 9 GHz.

9 kHz -150 kHz;RBW=200 Hz,VBW=200 Hz;150 kHz-30 MHz;RBW=9 kHz,VBW=9 kHz;30 MHz-1000 MHz;RBW=120 kHz,VBW=120 kHz,1000 MHz-9000 MHz;RBW=1 MHz,VBW=1 MHz.

21°C, 65% relative humidity

48V DC Power obtained from support DC power supply

Ext Attn: 0 dB

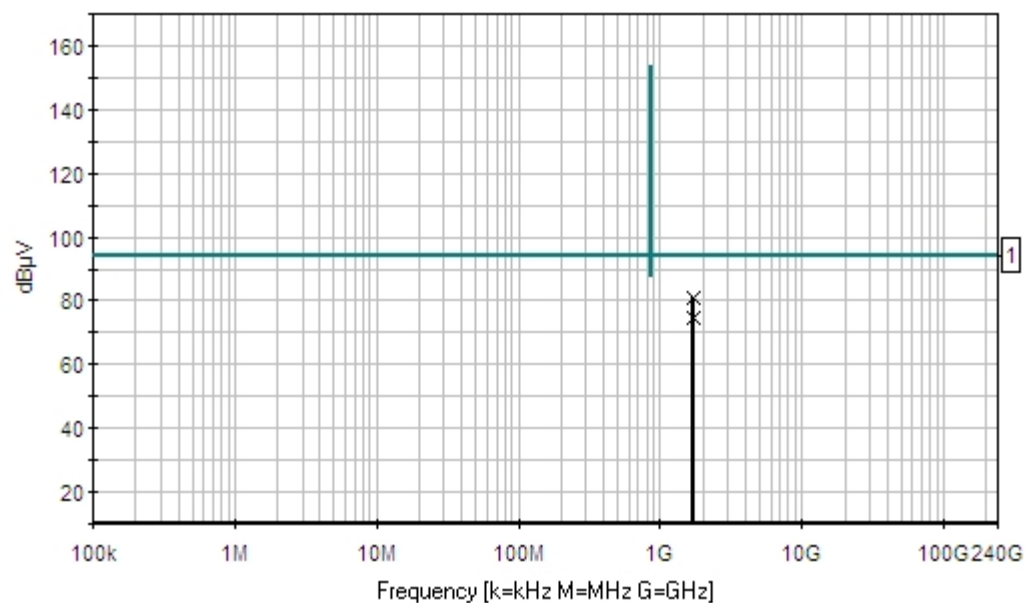
Measurement Data:

Reading listed by margin.

Test Lead: Antenna port

#	Freq MHz	Rdng dBμV	T1 dB	T2 dB		Dist Table	Corr dBμV	Spec dBμV	Margin dB	Polar Ant
1	1725.878M	80.2	+0.4	+0.3		+0.0	80.9	94.0	-13.1	Anten
2	1736.664M	74.2	+0.4	+0.3		+0.0	74.9	94.0	-19.1	Anten

CKC Laboratories, Inc. Date: 7/29/2011 Time: 14:25:31 Powerwave Technologies, Inc. WO#: 92116
 FCC90.691 Conducted Spurious emission Test Lead: Antenna port 48Vdc Sequence#: 5 Ext ATTN: 0 dB



— Readings — 1 - FCC90.691 Conducted Spurious emission × Peak Readings

Test Setup Photos



2.1033(c)(14)/2.1053/90.691(a) - Field Strength of Spurious Radiation

Test Conditions / Setup

The EUT, containing two identical RF circuits with independent RF output ports, was placed on the test bench. The Optical port was connected to a remote TDP Test Fixture. Both RF ports of identical RF circuitries were connected to a RF load. USB port was connected to a remote computer. The EUT was set in full, constant transmit power.

The EUT was rated at 50W+50W for 5 channels and 20W+20W for a single channel.

Frequency: 862 -869MHz

Modulation: CDMA

Multi-channel

Frequency: 862.9 MHz, 864.15MHz, 865.4MHz, 866.65MHz 867.9 MHz

Power= 50W+ 50W (10W Per Channel)

Single channel

Frequency: 862.9 MHz, 868.1 MHz

Power= 20W+ 20W (20W Per Channel)

Frequency range of measurement = 9 kHz- 9 GHz.

9 kHz -150 kHz;RBW=200 Hz,VBW=200 Hz;150 kHz-30 MHz;RBW=9 kHz,VBW=9 kHz;30 MHz-1000 MHz;RBW=120 kHz,VBW=120 kHz;1000 MHz-9000 MHz;RBW=1 MHz,VBW=1 MHz.

21°C, 65% relative humidity

48V DC Power obtained from support DC power supply

No emission within 20dB of the limit line found. Recorded data represents noise floor level.

Test Setup Photos



2.1033(c)(14)/2.1055/90.543(c) - Frequency Stability

Test Conditions / Setup

The EUT, containing two identical RF circuits with independent RF output ports, was placed on the test bench. The Optical port was connected to a remote TDP Test Fixture. USB port was connected to remote computer. The EUT was set in full, constant transmit power mode.

The RF evaluation was performed at the antenna port with a spectrum analyzer. External attenuators used were verified and the offset was entered into the spectrum analyzer.

The EUT was rated at 50W+ 50W for 5 channels and 20W+20W for a single channel.

Frequency range: 862 -869MHz

Modulation: CDMA

Note: Tested In-situ; CKC Laboratories NIST traceable test equipment was used.

Engineer Name: E. Wong

Test Equipment					
Asset/Serial #	Description	Model	Manufacturer	Cal Date	Cal Due
02672	Spectrum Analyzer	E4446A	Agilent	8/9/2010	8/9/2012
03174	Cable	16301	AstroLab	10/28/2009	10/28/2011
01830	Multimeter	45	Fluke	22/2/2010	22/2/2011
Cust	Temperature chamber	AST-35-LN2	NA	NCR	NCR
5947	K/J Thermometer	51	Fluke	11/09/2009	11/09/2011

NCR = No calibration required because the temperature of the chamber was maintained at the temperature readings recorded with K/J Thermometer AN P05947.

Test Data

Frequency Stability

Customer: Powerwave Technologies, Inc
WO#: 92116
Date: 2-Aug-11
Test Engineer: E. Wong
Device Model #: LRS08-T5022-100
Operating Voltage: 48 Vdc
Frequency Limit: 1.50E+00 ppm

Temperature Variations

Channel Frequency:		20W (L)	Dev (ppm)	20W (H)	Dev (ppm)	50W (L)	Dev (ppm)
		862.2373		867.3663		862.2573	
Temp (C)	Voltage						
-30	48	862.2363	1.159774	867.3658	0.576458	862.2569	0.463899
-20	48	862.2367	0.695864	867.3660	0.345875	862.2568	0.579873
-10	48	862.2364	1.043796	867.3661	0.230583	862.2565	0.927797
0	48	862.2374	-0.115977	867.3655	0.922332	862.2576	-0.347924
10	48	862.2376	-0.347932	867.3655	0.968449	862.2570	0.347924
20	48	862.2373	0.000000	867.3663	0.000000	862.2573	0.000000
30	48	862.2383	-1.159774	867.3661	0.230583	862.2582	-1.043772
40	48	862.2379	-0.695864	867.3673	-1.152915	862.2580	-0.811823
50	48	862.2380	-0.811841	867.3663	0.000000	862.2572	0.115975

Voltage Variations ($\pm 15\%$)

Temp (C)	Voltage	20W (L)	Dev. (MHz)	20W (H)	Dev. (MHz)	50W (L)	Dev. (MHz)
20	40.8	862.2373	0.000000	867.3663	0.000000	862.2573	0.000000
20	48.0	862.2373	0.000000	867.3663	0.000000	862.2573	0.000000
20	55.2	862.2373	0.000000	867.3663	0.000000	862.2573	0.000000

Max Deviation (ppm)	+	1.15977
Max Deviation (ppm)	-	1.15977
PASS		

	+	0.96845
	-	1.15292
PASS		

	+	0.92780
	-	1.04377
PASS		

Test Setup Photos



SUPPLEMENTAL INFORMATION

Measurement Uncertainty

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

The reported measurement uncertainties are calculated based on the worst case of all laboratory environments from CKC Laboratories, Inc. test sites. Only those parameters which require estimation of measurement uncertainty are reported. The reported worst case measurement uncertainty is less than the maximum values derived in CISPR 16-4-2. Reported uncertainties 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

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 $\text{dB}\mu\text{V}/\text{m}$, the spectrum analyzer reading in $\text{dB}\mu\text{V}$ was corrected by using the following formula. This reading was then compared to the applicable specification limit.

SAMPLE CALCULATIONS		
	Meter reading	(dB μ V)
+	Antenna Factor	(dB)
+	Cable Loss	(dB)
-	Distance Correction	(dB)
-	Preamplifier Gain	(dB)
=	Corrected Reading	(dB μ V/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. For testing emissions, an appropriate reference level and a vertical scale size of 10 dB per division were used.

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 "Peak" mode. Whenever a "Quasi-Peak" or "Average" reading is listed as one of the highest readings, this is indicated as a "QP" or an "Ave" on the appropriate rows of the data sheets. 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/receiver readings recorded all emissions at their peak value as the frequency band selected was scanned. By combining this function with another feature of the measuring device called "peak hold," the measuring device had the ability to measure transients 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

When the true peak values exceeded or were within 2 dB of the specification limit, quasi-peak measurements were taken using the quasi-peak detector.

Average

For certain frequencies, average measurements may be made using the spectrum analyzer/receiver. 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.