

Dust Networks

TEST REPORT FOR

**802.15.4 Wireless Mesh Mote
Model: ETERNA2**

Tested To The Following Standards:

**ETSI EN 300 328 V1.8.1
Partial Testing**

Report No.: 93692-27

Date of issue: April 18, 2014



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.

TABLE OF CONTENTS

Administrative Information	3
Test Report Information	3
Report Authorization	3
Test Facility Information	4
Software Versions	4
Summary of Results	5
Conditions During Testing	5
Equipment Under Test	6
Peripheral Devices	6
Equipment Details	6
ETSI EN 300 328 V1.8.1	7
4.3.1 Technical Requirements	7
4.3.1.1 RF Power Output	7
4.3.1.2 Duty Cycle / Tx Sequence / Tx-gap	10
4.3.1.3 Dwell Time, Minimum Frequency Occupation & Hopping Sequence	12
4.3.1.4 Hopping Frequency Separation	14
4.3.1.5 Medium Utilisation (MU) Factor	16
4.3.1.6 Adaptivity	18
4.3.1.7 Occupied Channel Bandwidth	20
4.3.1.8 Transmitter Unwanted Emissions in the OOB Domain	22
4.3.1.11 Receiver Blocking	25
Appendix A: Measurement uncertainty	27

ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

Dust Networks
30695 Huntwood Avenue
Hayward, CA 94544

Representative: Gordon Charles
Customer Reference Number: DX10479F

DATE OF EQUIPMENT RECEIPT:**DATE(S) OF TESTING:****REPORT PREPARED BY:**

Dianne Dudley
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

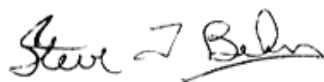
Project Number: 93692

April 7, 2014

April 7-11, 2014

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 that reads "Steve Behm". The signature is written in a cursive style and is positioned above 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.
22116 23rd Drive S.E.
Bothell, WA 98021-4413

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.00.14
Immunity	5.00.07

SUMMARY OF RESULTS

Standard / Specification: ETSI EN 300 328 V1.8.1

Test Procedure/Method	Description	Results
Technical Requirements	Sub clause 4.3.1	
Sub clause 4.3.1.1	RF Power Output	Pass
Sub clause 4.3.1.2	Duty Cycle, Tx Sequence, Tx-gap	Pass
Sub clause 4.3.1.3	Dwell Time, Minimum Frequency Occupation & Hopping Sequence	Pass
Sub clause 4.3.1.4	Hopping Frequency Separation	Pass
Sub clause 4.3.1.5	Medium Utilisation (MU) Factor	Pass
Sub clause 4.3.1.6	Adaptivity	Pass
Sub clause 4.3.1.7	Occupied Channel Bandwidth	Pass
Sub clause 4.3.1.8	Transmitter Unwanted Emissions in the OOB Domain	Pass
Sub clause 4.3.1.9	Transmitter Unwanted Emissions in the Spurious Domain	NA*
Sub clause 4.3.1.10	Receiver Spurious Emissions	NA*
Sub clause 4.3.1.11	Receiver Blocking	Pass

NA* = A different standard applies; see applicable test report.

Conditions During Testing

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

Summary of Conditions
None

EQUIPMENT UNDER TEST

EQUIPMENT UNDER TEST

802.15.4 Wireless Mesh Mote

Manuf: Dust Networks

Model: ETERNA2

Serial: NA

PERIPHERAL DEVICES

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

Eterna Serial Programmer

Manuf: Dust Networks

Model: NA

Serial: NA

Laptop

Manuf: Lenovo

Model: X61

Serial: 7675CTO

EQUIPMENT DETAILS

Equipment Type:	802.11.4
Modulation Type:	FHSS
Adaptive Modes:	Adaptive and Non-Adaptive modes
Adaptive Mode Type:	LBT based DAA

ETSI EN 300 328 V1.8.1

4.3.1 TECHNICAL REQUIREMENTS

4.3.1.1 RF Power Output

Ambient Temperature: 22°C

Relative Humidity: 37 %

Test Setup / Conditions

The EUT is located inside the temperature chamber during all conditions and is connected through a measurement cable.

Test Engineer: Steven Pittsford

Test Equipment					
Asset #	Description	Model	Manufacturer	Cal Date	Cal Due
03287	Power Sensor	Agilent	U2000A	4/25/2012	4/25/2014
02757	Temperature Chamber	Bemco	F100/350-8	1/22/2013	1/22/2015
03029	Thermometer, Digital Infrared	Fluke	566	2/1/2013	2/1/2015
P06505	Cable	Astrolab	32026-29080-29080-84	10/18/2013	10/18/2015

Test Data

TEST CONDITIONS		TRANSMITTER EIRP POWER (dBm)		
		2405MHz	2440MHz	2475MHz
T_{nom}(25)°C	V_{nom} (3.0)V	12.05	12.03	12.04
	V_{min} (2.1)V	11.41	11.6	11.53
	V_{Max} (3.76)V	11.75	11.85	11.79
T_{min}(-45)° C	V_{nom} (3.0)V	10.41	10.44	10.36
	V_{min} (2.1)V	10.34	9.96	10.18
	V_{Max} (3.76)V	9.71	10.3	10.12
T_{max}(85)° C	V_{nom} (3.0)V	10.96	10.67	10.8
	V_{min} (2.1)V	10.48	10.27	10.46
	V_{Max} (3.76)V	10.74	10.53	10.72
Limit		EIRP≤20dBm		

Note: Reported transmitter power is EIRP, where EIRP = measured conducted power +Antenna gain of 4.8dBi. During extreme temperature measurements 1.4dB is added to correct for cable loss.

Test Setup Photos



4.3.1.2 Duty Cycle / Tx Sequence / Tx-gap

Ambient Temperature: 25°C

Relative Humidity: 35 %

Test Setup / Conditions

The EUTs antenna port is directly connected to the spectrum analyzer.

Nonconformity: Power Sensor is unable to perform measurements at 1MS/s for the required observation Period.

Method Used:

Spectrum Analyzer

Frequency: Centered on Transmit channel

Span: 0Hz

Detector Type: RMS

RBW: 2MHz

VBW: 6MHz

Sweep Time: 1 Second

Sweep Points: 8192

Engineer Name: Steven Pittsford

Test Equipment					
Asset #	Description	Model	Manufacturer	Cal Date	Cal Due
02872	Spectrum Analyzer	Agilent	E4440A	7/19/2013	7/19/2015

Test Data

TESTS	Duty Cycle / Tx Sequence / Tx-gap		
	2405MHz	2440MHz	2475MHz
Duty Cycle	20.31%	19.98%	20.31%
TX Sequence	4.52ms	4.52ms	4.52ms
TX Gap	5.00ms	5.00ms	5.00ms
Limit	Maximum Tx-Sequence Time=Minimum Tx-Gap = 3.5-10ms		

Test Setup Photos



4.3.1.3 Dwell Time, Minimum Frequency Occupation & Hopping Sequence

Ambient Temperature: 22°C

Relative Humidity: 35%

Test Setup / Conditions

The EUTs antenna port is directly connected to the spectrum analyzer.

Test Engineer: S. Pittsford

Test Equipment					
Asset #	Description	Model	Manufacturer	Cal Date	Cal Due
02872	Spectrum Analyzer	Agilent	E4440A	7/19/2013	7/19/2015

Test Data

TESTS	Dwell Time & Minimum Frequency Occupation		
	2420MHz	2470MHz	Limit
Dwell Time	4.52ms	4.52ms	Not Greater than 15ms within 15ms multiplied by number of hopping channels
Minimum Frequency Occupation	4.52ms	4.52ms	= Dwell time

TESTS	Hopping Sequence	
	Number Hopping Frequencies (N)	Limit
Hopping Sequence	15	N=15 or 15 divided by the minimum hopping frequency separation in MHz, Whichever is greater
Hopping Sequence Span (-20dBc)	89.4%	Minimum 70%

Test Setup Photos



4.3.1.4 Hopping Frequency Separation

Ambient Temperature: 22°C

Relative Humidity: 35%

Test Setup / Conditions

The EUTs antenna port is directly connected to the spectrum analyzer.

Test Engineer: S. Pittsford

Test Equipment					
Asset #	Description	Model	Manufacturer	Cal Date	Cal Due
02872	Spectrum Analyzer	Agilent	E4440A	7/19/2013	7/19/2015

Test Data

	Frequency Separation		
Test	Measurement	Limit	Result
Frequency Separation (F_{HS}) Adaptive Mode	4.99MHz	$F_{HS} > 100\text{kHz}$	Pass
Frequency Separation (F_{HS}) Non- Adaptive Mode	4.99MHz	$F_{HS} > BW_{chan}$	Pass

Using Option 1 Frequency Separation (F_{HS}) must be Greater than or equal to -20dB channel Bandwidth (BW_{CHAN}) of 2.60MHz.

Test Setup Photos



4.3.1.5 Medium Utilisation (MU) Factor

Ambient Temperature: 25°C

Relative Humidity: 34 %

Test Setup / Conditions

The EUT's antenna port is directly connected to the spectrum analyzer.

Nonconformity: Power Sensor is unable to perform measurements at 1MS/s for the required observation Period.

Method Used:

Spectrum Analyzer

Frequency: Centered on Transmit channel

Span: 0Hz

Detector Type: RMS

RBW: 2MHz

VBW: 6MHz

Sweep Time: 1 Second

Sweep Points: 8192

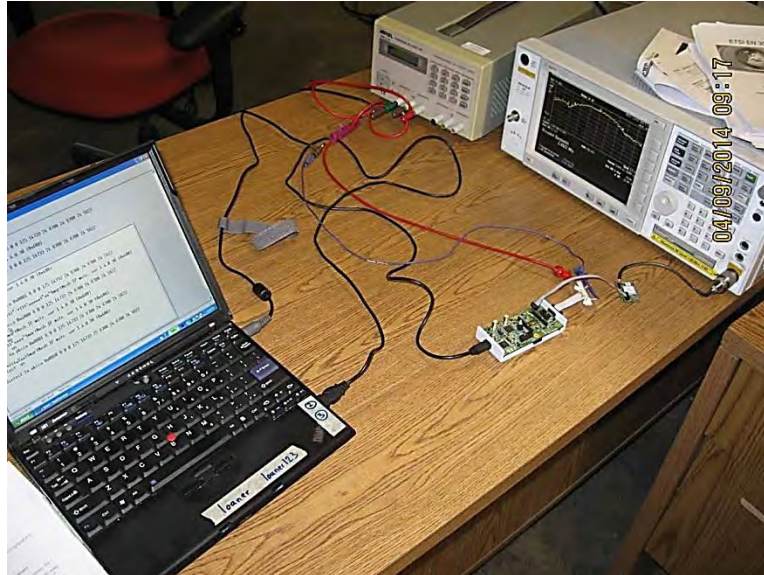
Engineer Name: Steven Pittsford

Test Equipment					
Asset #	Description	Model	Manufacturer	Cal Date	Cal Due
02872	Spectrum Analyzer	Agilent	E4440A	7/19/2013	7/19/2015

Test Data

TESTS	MU=(P/100mW)* Duty Cycle		
	2405MHz	2440MHz	2475MHz
Medium Utilisation (MU) Factor	3.26%	3.19%	3.25%
Limit	MU<10%		

Test Setup Photos



4.3.1.6 Adaptivity

Ambient Temperature: 25°C

Relative Humidity: 35%

Test Setup / Conditions

The EUTs antenna port is directly connected to the spectrum analyzer.
VBW is not able to meet 3x RBW spec so highest available setting used.

Engineer Name: Steven Pittsford

Test Equipment					
Asset #	Description	Model	Manufacturer	Cal Date	Cal Due
02872	Spectrum Analyzer	Agilent	E4440A	7/19/2013	7/19/2015
03394	RF Generator	Anritsu	68369B	5/17/2013	5/17/2015
P05304	Directional Coupler	ATM	C223E-20	1/14/2013	1/14/2015
P01313	Splitter, 4-Way	Motorola		NCR	NCR
02875	RF Generator	Agilent	E4437B	1/18/2013	1/18/2015

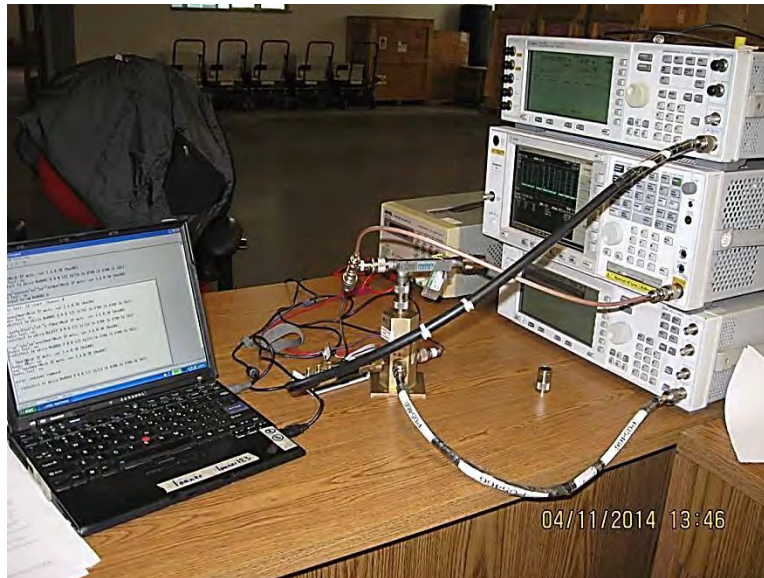
NCR = No Calibration Required

Test Data

TESTS	Transmission Stop Time		
	2405MHz	2440MHz	2475MHz
Transmission Stop Time	4.80ms	5.15ms	5.84ms
Limit	Transmission stops within period \leq Channel Occupancy Time (35ms)		

TESTS	Short Controlling Signal Length		
	2405MHz	2440MHz	2475MHz
Short Controlling Signal Duty Cycle within 50ms	8.61%	8.59%	8.77%
Limit	Max Duty cycle of 10% within 50ms period		

Test Setup Photos



4.3.1.7 Occupied Channel Bandwidth

Ambient Temperature: 26°C

Relative Humidity: 34%

Test Setup / Conditions

The EUT's antenna port is directly connected to the spectrum analyzer.

Test Engineer: Steven Pittsford

Test Equipment					
Asset #	Description	Model	Manufacturer	Cal Date	Cal Due
02872	Spectrum Analyzer	Agilent	E4440A	7/19/2013	7/19/2015

Test Data

TESTS	Occupied Channel Bandwidth		
	2405MHz	2440MHz	2475MHz
99% OBW	2.43MHz	2.43MHz	2.48MHz
Limit	≤20MHz		

4.3.1.8 Transmitter Unwanted Emissions in the OOB Domain

Ambient Temperature: 26°C

Relative Humidity: 34%

Test Setup / Conditions

The EUT's antenna port is directly connected to the spectrum analyzer. The EUT is located inside the temperature chamber during extreme temperature conditions and is connected through a cable. All readings are adjusted for cable loss.

Note: Reported transmitter power is EIRP, where EIRP= measured conducted power +Antenna gain of 4.8dBi.

Test Engineer: Steven Pittsford

Test Equipment					
Asset #	Description	Model	Manufacturer	Cal Date	Cal Due
02872	Spectrum Analyzer	Agilent	E4440A	7/19/2013	7/19/2015
02757	Temperature Chamber	Bemco	F100/350-8	1/22/2013	1/22/2015
03029	Thermometer, Digital Infrared	Fluke	566	2/1/2013	2/1/2015
P06505	Cable	Astrolab	32026-29080-29080-84	10/18/2013	10/18/2015

Test Data

Low Channel					
Frequency	Measurement (dBm/MHz EIRP)			Limit (dBm/MHz EIRP)	Pass/Fail
	Normal Temperature	-45°C	+85°C		
2394.7	-38.8	-32.7	-37.1	-11.76	Pass
2395.6	-37.4	-32.7	-35.8	-11.76	Pass
2396.6	-36.9	-28.8	-34	-11.76	Pass
2397.6	-34.5	-25.2	-32.2	-0.76	Pass
2398.5	-33.3	-22.3	-29.4	-0.76	Pass
2399.5	-30.8	-18	-27	-0.76	Pass
2484	-54.5	-52.2	-50.4	-0.76	Pass
2485	-54.1	-51.8	-50	-0.76	Pass
2485.9	-54.5	-51.6	-50.3	-0.76	Pass
2486.4	-54.5	-51.7	-50.2	-11.76	Pass
2487.4	-54.3	-51.7	-50.2	-11.76	Pass
2488.3	-54.6	-52.2	-50	-11.76	Pass

High Channel					
	Measurement (dBm/MHz EIRP)				
Frequency	Normal Temperature	-45°C	+85°C	Limit (dBm/MHz EIRP)	Pass/Fail
2394.7	-54.2	-51.9	-50.9	-11.76	Pass
2395.6	-54.3	-51.5	-51	-11.76	Pass
2396.6	-54.4	-49.7	-50.7	-11.76	Pass
2397.6	-54.5	-49.5	-50.5	-0.76	Pass
2398.5	-54.2	-50.4	-50.7	-0.76	Pass
2399.5	-54.4	-51.2	-51	-0.76	Pass
2484	-36.3	-34.3	-36.3	-0.76	Pass
2485	-38	-38.1	-38	-0.76	Pass
2485.9	-38	-36.9	-38.7	-0.76	Pass
2486.4	-39.2	-39.7	-39.1	-11.76	Pass
2487.4	-40.2	-40.5	-40.8	-11.76	Pass
2488.3	-40.7	-41	-41.2	-11.76	Pass

Test Setup Photos



4.3.1.11 Receiver Blocking

Ambient Temperature: 25°C

Relative Humidity: 35%

Test Setup / Conditions

The EUT's antenna port is directly connected to the spectrum analyzer.
VBW is not able to meet 3x RBW spec so highest available setting used.

Test Engineer: Steven Pittsford

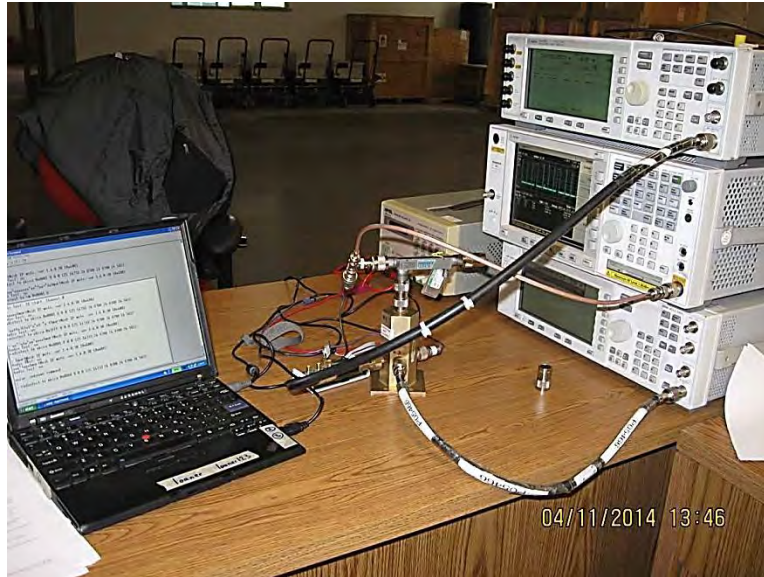
Test Equipment					
Asset #	Description	Model	Manufacturer	Cal Date	Cal Due
02872	Spectrum Analyzer	Agilent	E4440A	7/19/2013	7/19/2015
03394	RF Generator	Anritsu	68369B	5/17/2013	5/17/2015
P05304	Directional Coupler	ATM	C223E-20	1/14/2013	1/14/2015
P01313	Splitter, 4-Way	Motorola		NCR	NCR
02875	RF Generator	Agilent	E4437B	1/18/2013	1/18/2015

NCR = No Calibration Required.

Test Data

TESTS	Transmission Stop Time		
	2405MHz	2440MHz	2475MHz
Transmission Stop Time	5.80ms	6.78ms	8.31ms
Limit	Transmission stops within period \leq Channel Occupancy Time (35ms)		

Test Setup Photos



APPENDIX A: MEASUREMENT UNCERTAINTY

MEASUREMENT UNCERTAINTY			
Parameter Uncertainty	Actual	Limit	
Occupied Channel Bandwidth	1	5	%
RF Output Power, Conducted	0.67	1.5	dB
Power Spectral Density, Conducted	0.67	3	dB
Unwanted Emissions, conducted	0.67	3	dB
All Emissions, Radiated	3.73	6	dB
Temperature	1	1	°C
Humidity	2.5	5	%
DC and Low Frequency Voltages	2	3	%
Time	1.1	5	%
Duty Cycle	1.1	5	%