EMC EMISSIONS - TEST REPORT (Full)

Test Report No.	**3173742DEN-001**	Issue Date:	**Monday 23/Mar/2009**
Model / Serial No.	**MN: Awave /SN: A7**		
Product Type	**802.15.4 Transceiver**		
Client	**Phase IV Engineering.**		
Manufacturer	**Phase IV Engineering.**		
License holder	**Phase IV Engineering.**		
Address	**2820 Wilderness Place Suite C**		
	Boulder CO 80301		
Test Criteria Applied	**FCC 47 CFR Part 15.249**		
Test Result	**PASS**		Title 47 CFR 15: RADIO FREQUENCY DEVICES Subpart C – Intentional Radiators
Test Project Number	3173742		
References			
Total Pages Including Appendices:	**33**		

Tested By: Michael Spataro

Reviewed By : Randy Thompson

REVISION SUMMARY - The following changes have been made to this Report:

Rev.	Revision Statement	Author	Revision Date	Reviewer
	Initial Release of Document	See above	See above	

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STATEMENT OF MEASUREMENT UNCERTAINTY

The data and results referenced in this document are true and accurate. The measurement uncertainty for Conducted Emissions in the frequency range of 150kHz – 30MHz is calculated to be ±3.14dB and for Radiated Emissions is calculated to be ±4.4dB in the frequency range of 10kHz – 1000MHz at 3m and ±4.9dB in the frequency range of 1 – 18GHz at 3m. For testing at 10m ±4.8dB in the frequency range of 30 – 1000MHz. For Disturbance Power, ±3.3dB in the frequency range of 30 – 1000MHz. For Flicker and Harmonics testing the equipment used is calibrated by the manufacture and is with in the tolerances specified in 61000-3-2/3. These uncertainties have been calculated using CISPR 16-4-2:2003 and represent a 95% confidence level (k=2).

EUT Received Date: 25-February-2009

Testing Start Date: 25-February-2009

Testing End Date: 2-March-2009

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The tests were performed according to following regulations:

1. **FCC CFR47 Part 15 subpart C**

Emission Test Results:

Conducted Emissions 15.207 - NA

Test Result

Minimum limit margin 0.0 dB at 0.0 MHz

Remarks: EUT is battery powered

Radiated Unintentional and Spurious Emissions 15.249(d)/15.205/209 - PASS

Test Result

Minimum limit margin -12.1 dB at 18000.0 MHz

Remarks:

Field Strength of the Fundamental 15.249(a) - PASS

Test Result

Minimum limit margin -14.3 dB at 2405.48 MHz

Remarks: Emission from Channel 1 Axis 1.

Field Strength of Harmonics of the Fundamental 15.249(a) - PASS

Test Result

Minimum limit margin -8.5 dB at 14432.9 MHz

Remarks: Emission from Channel 1 Axis 1.

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GENERAL REMARKS:

The following remarks are to be considered as "where applicable" and are taken into account while completing any FCC/IC/ETSI radio tests at Intertek.

Testing was performed in 3 different orthogonal axis to determine the worst case emissions from the device. The worst case emissions measurements are shown in this report.

FCC CFR47 Part 15.31: Measurement Standards: In any case where the device is powered off a battery, a fresh battery was used during test. In cases where the device is powered off an AC supply, voltage was varied per Part 15.31 to find worst case emissions.

FCC CFR47 Part 15.35: Measurement Detector Functions and Bandwidths: FCC Part 15.35 was utilized when performing the measurements within this report.

Sample:
☒Production ☐Prototype ☐See Appendix B

Modifications required to pass: None

Test Specification Deviations: Additions to or Exclusions from: None

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Test-setup photo(s):
Radiated Intentional Emissions: Axis 1

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Test-setup photo(s):
Radiated Intentional Emissions: Axis 2

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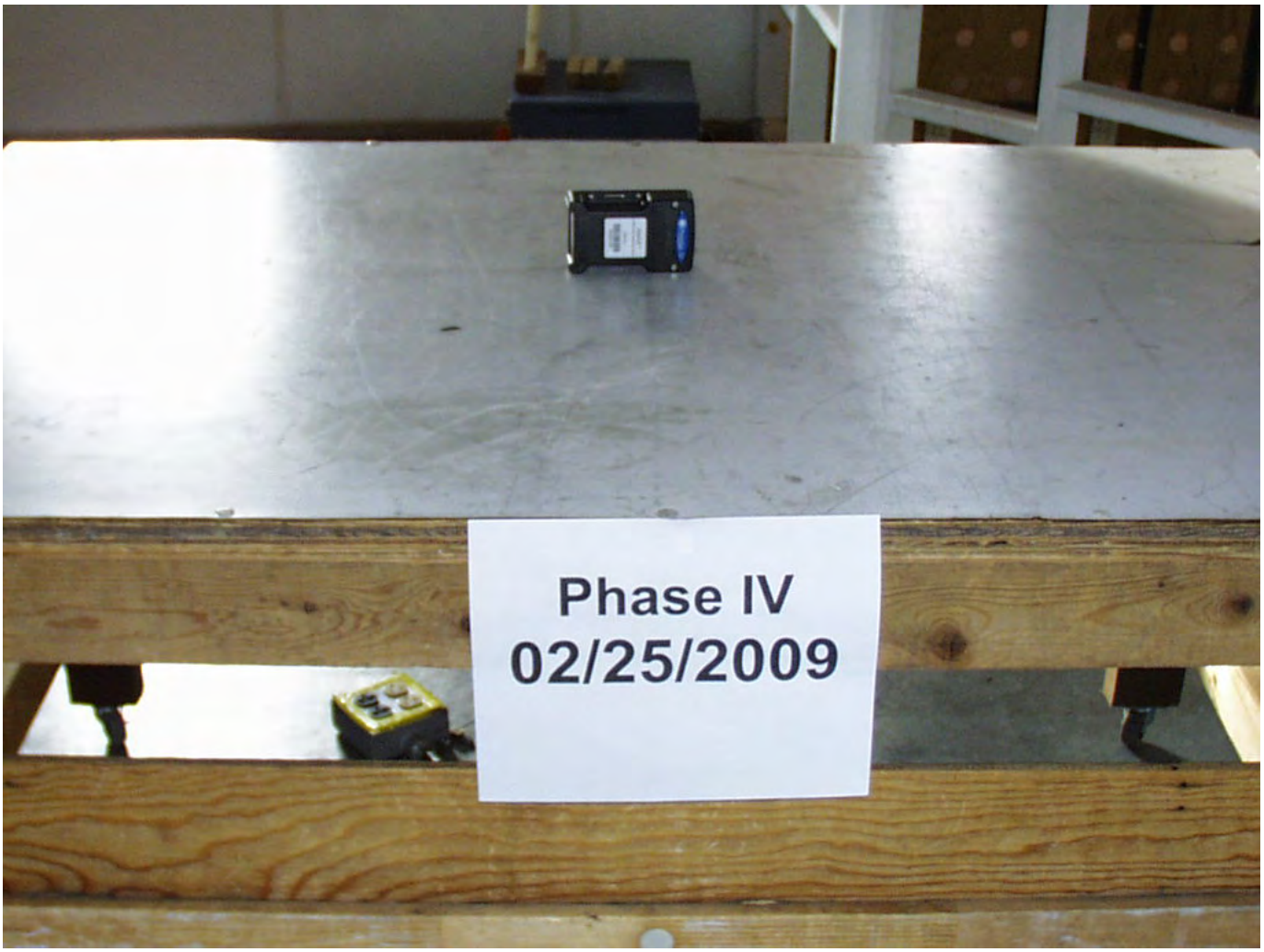
Test-setup photo(s):
Radiated Intentional Emissions: Axis 3



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Test-setup photo(s):
Radiated Unintentional Emissions:

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Test-setup photo(s):
Radiated Unintentional Emissions:

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Appendix A

Test Data Sheets

and

Test Equipment Used

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Spurious Emissions
And
Unintentional Emissions

15.249(d) and 15.205/209

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Radiated Electromagnetic Emissions

Test Report #:	**3173742**	Test Area:	Pinewood Site 1 (3m)	Temperature:	23.7	°C
Test Method:	FCC Part 15.209	Test Date:	02-Mar-2009	Relative Humidity:	36.5	%
EUT Model #:	Awave	EUT Power:	Battery	Air Pressure:	80	kPa
EUT Serial #:	A7					
Manufacturer:	Phase IV					
EUT Description:	802.15.4 Transceiver					
Notes:						

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av – Average	

FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dB\m) (dB)	(dBuV)	(m) (DEG)	15.209 <1GHz	15.209 >1GHz
EUT operating on channel 12.						
No emission found: 200 – 1000MHz Vertical.						
The following are noise floor.						
200.00	37.0 Qp	1.5 / 11.3 / 27.3	22.4	V / 1.0 / 270.0	-21.1	N/A
500.00	30.2 Qp	2.6 / 21.3 / 28.2	26.0	V / 1.0 / 270.0	-20.0	N/A
990.00	20.9 Qp	3.7 / 23.0 / 27.3	20.4	V / 1.0 / 270.0	-33.6	N/A
No emissions found: 200 – 1000MHz Horizontal.						
The following are noise floor.						
250.00	27.4 Qp	1.7 / 11.6 / 27.2	13.5	H / 2.0 / 270.0	-32.5	N/A
605.04	22.1 Qp	2.9 / 18.7 / 28.4	15.4	H / 2.0 / 270.0	-30.6	N/A
900.00	21.4 Qp	3.6 / 22.3 / 27.6	19.8	H / 2.0 / 270.0	-26.2	N/A
38.85	33.1 Qp	0.6 / 11.6 / 28.3	17.1	V / 1.0 / 0.0	-22.9	N/A
51.03	34.6 Qp	0.7 / 9.8 / 28.2	17.0	V / 1.0 / 0.0	-23.0	N/A
48.00	34.0 Qp	0.7 / 10.3 / 28.2	16.8	V / 1.0 / 0.0	-23.2	N/A
64.00	36.7 Qp	0.8 / 8.2 / 28.2	17.5	V / 1.0 / 0.0	-22.5	N/A
160.00	29.2 Qp	1.4 / 12.3 / 27.7	15.1	V / 1.0 / 0.0	-28.4	N/A
38.85	32.6 Qp	0.6 / 11.6 / 28.3	16.6	V / 1.0 / 90.0	-23.4	N/A
64.00	38.6 Qp	0.8 / 8.2 / 28.2	19.4	V / 1.0 / 90.0	-20.6	N/A
48.00	33.6 Qp	0.7 / 10.3 / 28.2	16.5	V / 1.0 / 180.0	-23.5	N/A
38.85	32.2 Qp	0.6 / 11.6 / 28.3	16.2	V / 1.0 / 270.0	-23.8	N/A
The following were maximized between 30 and 200 MHz.						
38.85	35.4 Qp	0.6 / 11.6 / 28.3	19.3	V / 1.0 / 340.0	-20.7	N/A
51.03	35.6 Qp	0.7 / 9.9 / 28.2	18.0	V / 1.0 / 15.0	-22.0	N/A
No higher emissions found: 30 to 200 MHz Horizontal.						

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FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dB\m) (dB)	(dBuV)	(m) (DEG)	15.209 <1GHz	15.209 >1GHz
The following are noise floor.						
30.00	23.9 Qp	0.5 / 13.0 / 28.2	9.2	H / 2.0 / 270.0	-30.8	N/A
80.00	33.9 Qp	0.9 / 6.9 / 28.1	13.6	H / 2.0 / 270.0	-26.4	N/A
190.00	29.4 Qp	1.4 / 13.0 / 27.5	16.4	H / 2.0 / 270.0	-27.1	N/A
No emissions found: 32kHz to 30MHz.						
The following are noise floor.						
0.0320	31.3 Qp	0.0 / 12.4 / 0.0	43.7	V / 1.0 / 270.0	-73.8	N/A
1.00	24.2 Qp	0.1 / 10.6 / 0.0	34.9	V / 1.0 / 270.0	-32.7	N/A
25.00	5.6 Qp	0.5 / 9.1 / 0.0	15.2	V / 1.0 / 270.0	-54.3	N/A
0.100	26.9 Qp	0.1 / 10.9 / 0.0	38.0	H / 1.0 / 270.0	-69.6	N/A
10.00	6.7 Qp	0.2 / 10.7 / 0.0	17.6	H / 1.0 / 270.0	-51.9	N/A
20.00	5.8 Qp	0.4 / 10.2 / 0.0	16.4	H / 1.0 / 270.0	-53.1	N/A
No emissions found: 1 to 4 GHz Vertical.						
Noise floor.						
1000.00	35.0 Av	3.7 / 23.2 / 38.2	23.7	V / 1.0 / 270.0	N/A	-30.3
2500.00	35.9 Av	3.2 / 27.5 / 38.5	28.1	V / 1.0 / 270.0	N/A	-25.9
No emissions found: 1 to 4 GHz Horizontal.						
Noise floor.						
2000.00	32.7 Av	3.0 / 26.9 / 38.1	24.5	H / 1.0 / 270.0	N/A	-29.5
3000.00	35.9 Av	3.8 / 29.7 / 38.1	31.2	H / 1.0 / 270.0	N/A	-22.8
No emissions found: 4 to 8 GHz Horizontal.						
Noise floor.						
4000.00	32.5 Av	4.8 / 31.4 / 39.9	28.8	H / 1.0 / 270.0	N/A	-25.2
6000.00	32.9 Av	6.2 / 34.2 / 39.9	33.4	H / 1.0 / 270.0	N/A	-20.6
No emissions found: 4 to 8 GHz Vertical.						
Noise floor.						
5000.00	33.5 Av	5.8 / 32.5 / 40.1	31.7	V / 1.0 / 270.0	N/A	-22.3
7000.00	29.6 Av	7.1 / 35.0 / 40.9	30.8	V / 1.0 / 270.0	N/A	-23.2
No emissions found: 8 to 18 GHz Vertical.						
Noise floor.						
10000.0	44.2 Av	8.8 / 37.2 / 49.3	40.9	V / 1.0 / 270.0	N/A	-13.1
17000.0	36.7 Av	11.6 / 40.3 / 47.8	40.8	V / 1.0 / 270.0	N/A	-13.2
No emissions found: 8 to 18 GHz Horizontal.						
Noise floor.						
16000.0	36.1 Av	11.3 / 37.3 / 47.7	37.0	H / 1.0 / 270.0	N/A	-17.0
18000.0	34.1 Av	12.0 / 42.0 / 46.3	41.9	H / 1.0 / 270.0	N/A	-12.1
No emissions found: 18 – 25 GHz, using harmonic mixers.						
25000.0	11.9 Pk	0.0 / 21.8 / 0.0	33.7	V / 1.0 / 0.0	N/A	-20.3

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FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dB\m) (dB)	(dBuV)	(m) (DEG)	15.209 <1GHz	15.209 >1GHz
20000.0	11.2 Pk	0.0 / 21.8 / 0.0	33.0	V / 1.0 / 0.0	N/A	-21.0

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FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	DELTA1 (dB)	DELTA2 (dB)
(MHz)	(dBuV)	(dB) (dB\m) (dB)	(dBuV)	(m) (DEG)	15.209 <1GHz	15.209 >1GHz
********** Measurement Summary **********						
18000.0	34.1 Av	12.0 / 42.0 / 46.3	41.9	H / 1.0 / 270.0	N/A	-12.1
10000.0	44.2 Av	8.8 / 37.2 / 49.3	40.9	V / 1.0 / 270.0	N/A	-13.1
17000.0	36.7 Av	11.6 / 40.3 / 47.8	40.8	V / 1.0 / 270.0	N/A	-13.2
16000.0	36.1 Av	11.3 / 37.3 / 47.7	37.0	H / 1.0 / 270.0	N/A	-17.0
500.00	30.2 Qp	2.6 / 21.3 / 28.2	26.0	V / 1.0 / 270.0	-20.0	N/A
25000.0	11.9 Pk	0.0 / 21.8 / 0.0	33.7	V / 1.0 / 0.0	N/A	-20.3
64.00	38.6 Qp	0.8 / 8.2 / 28.2	19.4	V / 1.0 / 90.0	-20.6	N/A
6000.00	32.9 Av	6.2 / 34.2 / 39.9	33.4	H / 1.0 / 270.0	N/A	-20.6
38.85	35.4 Qp	0.6 / 11.6 / 28.3	19.3	V / 1.0 / 340.0	-20.7	N/A
20000.0	11.2 Pk	0.0 / 21.8 / 0.0	33.0	V / 1.0 / 0.0	N/A	-21.0
200.00	37.0 Qp	1.5 / 11.3 / 27.3	22.4	V / 1.0 / 270.0	-21.1	N/A
51.03	35.6 Qp	0.7 / 9.9 / 28.2	18.0	V / 1.0 / 15.0	-22.0	N/A
5000.00	33.5 Av	5.8 / 32.5 / 40.1	31.7	V / 1.0 / 270.0	N/A	-22.3
3000.00	35.9 Av	3.8 / 29.7 / 38.1	31.2	H / 1.0 / 270.0	N/A	-22.8
48.00	34.0 Qp	0.7 / 10.3 / 28.2	16.8	V / 1.0 / 0.0	-23.2	N/A
7000.00	29.6 Av	7.1 / 35.0 / 40.9	30.8	V / 1.0 / 270.0	N/A	-23.2
4000.00	32.5 Av	4.8 / 31.4 / 39.9	28.8	H / 1.0 / 270.0	N/A	-25.2
2500.00	35.9 Av	3.2 / 27.5 / 38.5	28.1	V / 1.0 / 270.0	N/A	-25.9
900.00	21.4 Qp	3.6 / 22.3 / 27.6	19.8	H / 2.0 / 270.0	-26.2	N/A
80.00	33.9 Qp	0.9 / 6.9 / 28.1	13.6	H / 2.0 / 270.0	-26.4	N/A
190.00	29.4 Qp	1.4 / 13.0 / 27.5	16.4	H / 2.0 / 270.0	-27.1	N/A
160.00	29.2 Qp	1.4 / 12.3 / 27.7	15.1	V / 1.0 / 0.0	-28.4	N/A
2000.00	32.7 Av	3.0 / 26.9 / 38.1	24.5	H / 1.0 / 270.0	N/A	-29.5
1000.00	35.0 Av	3.7 / 23.2 / 38.2	23.7	V / 1.0 / 270.0	N/A	-30.3
605.04	22.1 Qp	2.9 / 18.7 / 28.4	15.4	H / 2.0 / 270.0	-30.6	N/A
30.00	23.9 Qp	0.5 / 13.0 / 28.2	9.2	H / 2.0 / 270.0	-30.8	N/A
250.00	27.4 Qp	1.7 / 11.6 / 27.2	13.5	H / 2.0 / 270.0	-32.5	N/A
1.00	24.2 Qp	0.1 / 10.6 / 0.0	34.9	V / 1.0 / 270.0	-32.7	N/A
990.00	20.9 Qp	3.7 / 23.0 / 27.3	20.4	V / 1.0 / 270.0	-33.6	N/A
10.00	6.7 Qp	0.2 / 10.7 / 0.0	17.6	H / 1.0 / 270.0	-51.9	N/A
20.00	5.8 Qp	0.4 / 10.2 / 0.0	16.4	H / 1.0 / 270.0	-53.1	N/A
25.00	5.6 Qp	0.5 / 9.1 / 0.0	15.2	V / 1.0 / 270.0	-54.3	N/A
0.100	26.9 Qp	0.1 / 10.9 / 0.0	38.0	H / 1.0 / 270.0	-69.6	N/A
0.0320	31.3 Qp	0.0 / 12.4 / 0.0	43.7	V / 1.0 / 270.0	-73.8	N/A

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Fundamental field strength
And
Harmonics of the Fundamental

15.249(d)

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Field Strength Measurements
Fundamental and Spurious of the Transmitter

Test Report #:	**3173742**	Test Area:	Pinewood Site 1 (3m)	Temperature:	22.7	°C
Test Method:	FCC Part 15.249	Test Date:	25-Feb-2009	Relative Humidity:	41	%
EUT Model #:	Awave	EUT Power:	Battery	Air Pressure:	80	kPa
EUT Serial #:	A7					
Manufacturer:	Phase IV					
EUT Description:	802.15.4 Transceiver					
Notes:						

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	

FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Duty Cycle Correction	Final Corrected	Limit	DELTA
(MHz)	(dBuV)	(dB) (dB\m) (dB)	(dBuV)	(m) (DEG)	(dB)	(dBuV/m)	(dBuV/m)	(dB)
The following duty cycle was Measured.								
3.75%								
Averaging method for pulsed signals and calculation in accordance to FCC CFR47 Part 15.35 utilized to calculate field strength emissions.								
The testing performed in accordance to FCC CFR47 Part 15.205 (restricted bands of operation) and 15.249 emissions and delta limits were calculated as follows:								
Final Corrected Peak Measurement – Duty Cycle Correction Factor* = Final Calculated Emission								
The Final Calculated Emission was then compared to the Limits in CFR47 Part 15.209 and 15.249 and the emission/limit delta was calculated.								
the DTCF is calculated as follows $20*\log_{10}$(duty cycle in 100mS) “not to exceed 20dB”								
Channel 1								
Axis 1 EUT is vertical on the table.								
2405.48	68.8 Pk	3.2 / 27.7 / 0.0	99.7	H / 1.3 / 15.0	-20	79.7	94	-14.3
2405.48	65.2 Pk	3.2 / 27.7 / 0.0	96.1	V / 1.4 / 315.0	-20	76.1	94	-17.9
4810.97	52.6 Pk	5.6 / 32.2 / 40.4	49.9	V / 1.1 / 5.0	-20	29.9	54	-24.1
4810.97	56.6 Pk	5.6 / 32.2 / 40.4	53.9	H / 1.3 / 15.0	-20	33.9	54	-20.1
7216.45	37.0 Pk	7.3 / 35.9 / 39.9	40.3	V / 1.5 / 5.0	-20	20.3	54	-33.7
7216.45	37.6 Pk	7.3 / 35.9 / 39.9	41.0	H / 1.6 / 15.0	-20	21.0	54	-33.0
9621.94	50.1 Pk	8.6 / 37.0 / 48.9	46.9	H / 1.3 / 255.0	-20	26.9	54	-27.1
9621.94	44.0 Pk	8.6 / 37.0 / 48.9	40.7	V / 1.0 / 0.0	-20	20.7	54	-33.3
Axis 2 EUT is flat on the table.								
2405.48	66.3 Pk	3.2 / 27.7 / 0.0	97.2	V / 1.8 / 0.0	-20	77.2	94	-16.8
2405.48	64.5 Pk	3.2 / 27.7 / 0.0	95.4	H / 1.3 / 205.0	-20	75.4	94	-18.6
4810.97	51.1 Pk	5.6 / 32.2 / 40.4	48.4	H / 1.8 / 14.2	-20	28.4	54	-25.6
4810.97	54.0 Pk	5.6 / 32.2 / 40.4	51.3	V / 1.4 / 10.0	-20	31.3	54	-22.7
7216.46	36.0 Pk	7.3 / 35.9 / 39.9	39.3	H / 1.7 / 120.0	-20	19.3	54	-34.7
7216.46	37.8 Pk	7.3 / 35.9 / 39.9	41.1	V / 1.8 / 75.5	-20	21.1	54	-32.9
9621.94	43.4 Pk	8.6 / 37.0 / 48.9	40.1	V / 1.0 / 0.0	-20	20.1	54	-33.9
9621.94	45.2 Pk	8.6 / 37.0 / 48.9	42.0	H / 1.0 / 0.0	-20	22.0	54	-32.0
Axis 3 EUT is vertical on the table rotated 90 degrees.								
2405.48	66.0 Pk	3.2 / 27.7 / 0.0	96.9	H / 1.3 / 31.0	-20	76.9	94	-17.1
2405.48	66.4 Pk	3.2 / 27.7 / 0.0	97.3	V / 1.4 / 0.0	-20	77.3	94	-16.7
4810.97	52.8 Pk	5.6 / 32.2 / 40.4	50.1	H / 1.2 / 132.0	-20	30.1	54	-23.9
4810.97	53.2 Pk	5.6 / 32.2 / 40.4	50.5	V / 1.4 / 10.0	-20	30.5	54	-23.5
7216.45	38.4 Pk	7.3 / 35.9 / 39.9	41.7	V / 1.0 / 221.0	-20	21.7	54	-32.3
7216.45	37.0 Pk	7.3 / 35.9 / 39.9	40.3	H / 1.8 / 343.0	-20	20.3	54	-33.7
9621.94	46.9 Pk	8.6 / 37.0 / 48.9	43.6	V / 1.0 / 0.0	-20	23.6	54	-30.4
9621.94	44.5 Pk	8.6 / 37.0 / 48.9	41.2	H / 1.0 / 0.0	-20	21.2	54	-32.8

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FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Duty Cycle Correction	Final Corrected	Limit	DELTA
(MHz)	(dBuV)	(dB) (dB\m) (dB)	(dBuV)	(m) (DEG)	(dB)	(dBuV/m)	(dBuV/m)	(dB)
No Higher emissions found, the following are noise floor.								
12027.4	41.1 Pk	0.5 / 39.6 / 46.2	35.1	V / 1.0 / 0.0	0	35.1	54	-18.9
12027.4	40.4 Pk	0.5 / 39.6 / 46.2	34.3	H / 1.0 / 0.0	0	34.3	54	-19.7
14432.9	41.4 Pk	0.9 / 51.2 / 48.0	45.5	V / 1.0 / 0.0	0	45.5	54	-8.5
14432.9	41.3 Pk	0.9 / 51.2 / 48.0	45.4	H / 1.0 / 0.0	0	45.4	54	-8.6
16838.4	42.8 Pk	1.3 / 39.4 / 48.2	35.3	V / 1.0 / 0.0	0	35.3	54	-18.7
16838.4	41.5 Pk	1.3 / 39.4 / 48.2	34.1	H / 1.0 / 0.0	0	34.1	54	-19.9
19243.8	10.9 Pk	0.0 / 22.4 / 0.0	33.3	V / 1.0 / 0.0	0	33.3	54	-20.7
21649.3	11.5 Pk	0.0 / 21.3 / 0.0	32.8	V / 1.0 / 0.0	0	32.8	54	-21.2
24054.8	11.3 Pk	0.0 / 21.3 / 0.0	32.6	V / 1.0 / 0.0	0	32.6	54	-21.4
Channel 8								
Axis 1 EUT is vertical on the table.								
2440.49	68.2 Pk	3.2 / 27.6 / 0.0	99.0	H / 1.3 / 10.0	-20	79.0	94	-15.0
2440.49	63.6 Pk	3.2 / 27.6 / 0.0	94.4	V / 1.3 / 240.0	-20	74.4	94	-19.6
4880.94	53.6 Pk	5.6 / 32.3 / 40.4	51.2	H / 1.8 / 345.0	-20	31.2	54	-22.8
4880.98	51.6 Pk	5.6 / 32.3 / 40.4	49.1	V / 1.8 / 105.0	-20	29.1	54	-24.9
7321.43	37.0 Pk	7.4 / 36.2 / 40.3	40.2	V / 1.7 / 105.0	-20	20.2	54	-33.8
7321.43	37.7 Pk	7.4 / 36.2 / 40.3	40.9	H / 1.5 / 10.0	-20	20.9	54	-33.1
9761.94	48.5 Pk	8.7 / 36.9 / 49.1	45.0	V / 1.4 / 150.0	-20	25.0	54	-29.0
9761.94	51.3 Pk	8.7 / 36.9 / 49.1	47.8	H / 1.4 / 243.0	-20	27.8	54	-26.2
Axis 2 EUT is flat on the table.								
2440.48	66.0 Pk	3.2 / 27.6 / 0.0	96.9	V / 1.4 / 0.0	-20	76.9	94	-17.1
2440.48	64.8 Pk	3.2 / 27.6 / 0.0	95.6	H / 1.3 / 346.0	-20	75.6	94	-18.4
4880.94	51.4 Pk	5.6 / 32.3 / 40.4	48.9	H / 1.8 / 18.2	-20	28.9	54	-25.1
4880.95	53.8 Pk	5.6 / 32.3 / 40.4	51.3	V / 1.4 / 185.0	-20	31.3	54	-22.7
7321.44	36.0 Pk	7.4 / 36.2 / 40.3	39.2	H / 1.7 / 250.0	-20	19.2	54	-34.8
7321.44	35.9 Pk	7.4 / 36.2 / 40.3	39.1	V / 1.6 / 180.0	-20	19.1	54	-34.9
9761.94	43.1 Pk	8.7 / 36.9 / 49.1	39.6	H / 1.4 / 243.0	-20	19.6	54	-34.4
9761.94	45.3 Pk	8.7 / 36.9 / 49.1	41.8	V / 1.4 / 0.0	-20	21.8	54	-32.2
Axis 3 EUT is vertical on the table rotated 90 degrees.								
2440.48	66.2 Pk	3.2 / 27.6 / 0.0	97.0	H / 1.0 / 27.0	-20	77.0	94	-17.0
2440.48	67.8 Pk	3.2 / 27.6 / 0.0	98.6	V / 1.0 / 330.0	-20	78.6	94	-15.4
4880.96	53.8 Pk	5.6 / 32.3 / 40.4	51.3	H / 1.8 / 109.0	-20	31.3	54	-22.7
4880.97	51.0 Pk	5.6 / 32.3 / 40.4	48.6	V / 1.2 / 313.0	-20	28.6	54	-25.4
7321.44	36.6 Pk	7.4 / 36.2 / 40.3	39.9	V / 1.0 / 15.0	-20	19.9	54	-34.1
7321.44	37.4 Pk	7.4 / 36.2 / 40.3	40.6	H / 1.8 / 345.0	-20	20.6	54	-33.4
9761.94	45.1 Pk	8.7 / 36.9 / 49.1	41.6	H / 1.0 / 0.0	-20	21.6	54	-32.4
9761.94	44.4 Pk	8.7 / 36.9 / 49.1	40.9	V / 1.0 / 0.0	-20	20.9	54	-33.1
No Higher emissions found, the following are noise floor.								
12202.4	39.3 Pk	0.5 / 40.8 / 46.1	34.6	H / 1.0 / 0.0	0	34.6	54	-19.4
12202.4	40.4 Pk	0.5 / 40.8 / 46.1	35.7	V / 1.0 / 0.0	0	35.7	54	-18.3
14642.9	42.4 Pk	0.9 / 45.9 / 48.0	41.3	H / 1.0 / 0.0	0	41.3	54	-12.7
14642.9	43.2 Pk	0.9 / 45.9 / 48.0	42.1	V / 1.0 / 0.0	0	42.1	54	-11.9
17083.4	41.8 Pk	1.3 / 41.0 / 47.7	36.4	H / 1.0 / 0.0	0	36.4	54	-17.6
17083.4	42.2 Pk	1.3 / 41.0 / 47.7	36.8	V / 1.0 / 0.0	0	36.8	54	-17.2
19523.9	10.5 Pk	0.0 / 22.1 / 0.0	32.6	V / 1.0 / 0.0	0	32.6	54	-21.4
21964.4	11.2 Pk	0.0 / 21.3 / 0.0	32.5	V / 1.0 / 0.0	0	32.5	54	-21.5
24404.8	11.6 Pk	0.0 / 21.7 / 0.0	33.3	V / 1.0 / 0.0	0	33.3	54	-20.7
Channel 16								
Axis 1 EUT is vertical on the table.								
2480.49	66.2 Pk	3.2 / 27.5 / 0.0	97.0	H / 1.2 / 0.0	-20	77.0	94	-17.0
2480.49	63.1 Pk	3.2 / 27.5 / 0.0	93.9	V / 1.5 / 20.0	-20	73.9	94	-20.1
4960.96	50.8 Pk	5.7 / 32.4 / 40.4	48.5	V / 1.3 / 185.0	-20	28.5	54	-25.5
4960.96	49.5 Pk	5.7 / 32.4 / 40.4	47.3	H / 1.3 / 286.0	-20	27.3	54	-26.7
7441.44	38.4 Pk	7.5 / 36.1 / 39.8	42.1	V / 1.3 / 185.0	-20	22.1	54	-31.9
7441.44	37.1 Pk	7.5 / 36.1 / 39.8	40.9	H / 1.3 / 135.0	-20	20.9	54	-33.1
9921.93	53.5 Pk	8.7 / 37.2 / 49.3	50.2	H / 1.4 / 140.0	-20	30.2	54	-23.8

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FREQ	LEVEL	CABLE / ANT / PREAMP	FINAL	POL / HGT / AZ	Duty Cycle Correction	Final Corrected	Limit	DELTA
(MHz)	(dBuV)	(dB) (dB\m) (dB)	(dBuV)	(m) (DEG)	(dB)	(dBuV/m)	(dBuV/m)	(dB)
9921.93	46.5 Pk	8.7 / 37.2 / 49.3	43.2	V / 1.7 / 245.0	-20	23.2	54	-30.8
Axis 2 EUT is flat on the table.								
2480.49	64.0 Pk	3.2 / 27.5 / 0.0	94.8	V / 1.4 / 345.0	-20	74.8	94	-19.2
2480.49	60.9 Pk	3.2 / 27.5 / 0.0	91.7	H / 1.6 / 210.0	-20	71.7	94	-22.3
4960.96	51.3 Pk	5.7 / 32.4 / 40.4	49.1	V / 1.3 / 360.0	-20	29.1	54	-24.9
4960.97	48.7 Pk	5.7 / 32.4 / 40.4	46.5	H / 1.2 / 138.0	-20	26.5	54	-27.5
7441.44	38.0 Pk	7.5 / 36.1 / 39.8	41.8	H / 1.7 / 138.0	-20	21.8	54	-32.2
7441.44	37.4 Pk	7.5 / 36.1 / 39.8	41.1	V / 1.9 / 175.0	-20	21.1	54	-32.9
9921.93	46.6 Pk	8.7 / 37.2 / 49.3	43.3	V / 1.6 / 230.0	-20	23.3	54	-30.7
9921.93	46.0 Pk	8.7 / 37.2 / 49.3	42.6	H / 1.7 / 25.0	-20	22.6	54	-31.4
Axis 3 EUT is vertical on the table rotated 90 degrees.								
2480.48	62.5 Pk	3.2 / 27.5 / 0.0	93.3	H / 1.2 / 17.0	-20	73.3	94	-20.7
2480.48	65.8 Pk	3.2 / 27.5 / 0.0	96.5	V / 1.0 / 334.0	-20	76.5	94	-17.5
4960.96	50.5 Pk	5.7 / 32.4 / 40.4	48.2	V / 1.1 / 96.0	-20	28.2	54	-25.8
4960.96	53.0 Pk	5.7 / 32.4 / 40.4	50.8	H / 1.8 / 268.0	-20	30.8	54	-23.2
7441.45	38.0 Pk	7.5 / 36.1 / 39.8	41.8	V / 1.0 / 299.0	-20	21.8	54	-32.2
7441.45	36.4 Pk	7.5 / 36.1 / 39.8	40.2	H / 1.9 / 18.0	-20	20.2	54	-33.8
9921.93	47.4 Pk	8.7 / 37.2 / 49.3	44.1	V / 1.8 / 334.0	-20	24.1	54	-29.9
9921.93	48.1 Pk	8.7 / 37.2 / 49.3	44.8	H / 1.4 / 180.0	-20	24.8	54	-29.2
No Higher emissions found, the following are noise floor.								
12402.4	42.0 Pk	0.6 / 41.3 / 46.3	37.6	V / 1.0 / 0.0	0	37.6	54	-16.4
12402.4	40.2 Pk	0.6 / 41.3 / 46.3	35.8	H / 1.0 / 0.0	0	35.8	54	-18.2
14882.9	40.4 Pk	1.0 / 43.1 / 48.4	36.0	V / 1.0 / 0.0	0	36.0	54	-18.0
14882.9	40.5 Pk	1.0 / 43.1 / 48.4	36.2	H / 1.0 / 0.0	0	36.2	54	-17.8
17363.4	40.0 Pk	1.4 / 43.9 / 46.5	38.8	V / 1.0 / 0.0	0	38.8	54	-15.2
17363.4	40.2 Pk	1.4 / 43.9 / 46.5	39.0	H / 1.0 / 0.0	0	39.0	54	-15.0
19843.9	11.3 Pk	0.0 / 21.8 / 0.0	33.1	V / 1.0 / 0.0	0	33.1	54	-20.9
22324.4	11.1 Pk	0.0 / 21.0 / 0.0	32.1	V / 1.0 / 0.0	0	32.1	54	-21.9
24804.9	11.5 Pk	0.0 / 21.8 / 0.0	33.3	V / 1.0 / 0.0	0	33.3	54	-20.7

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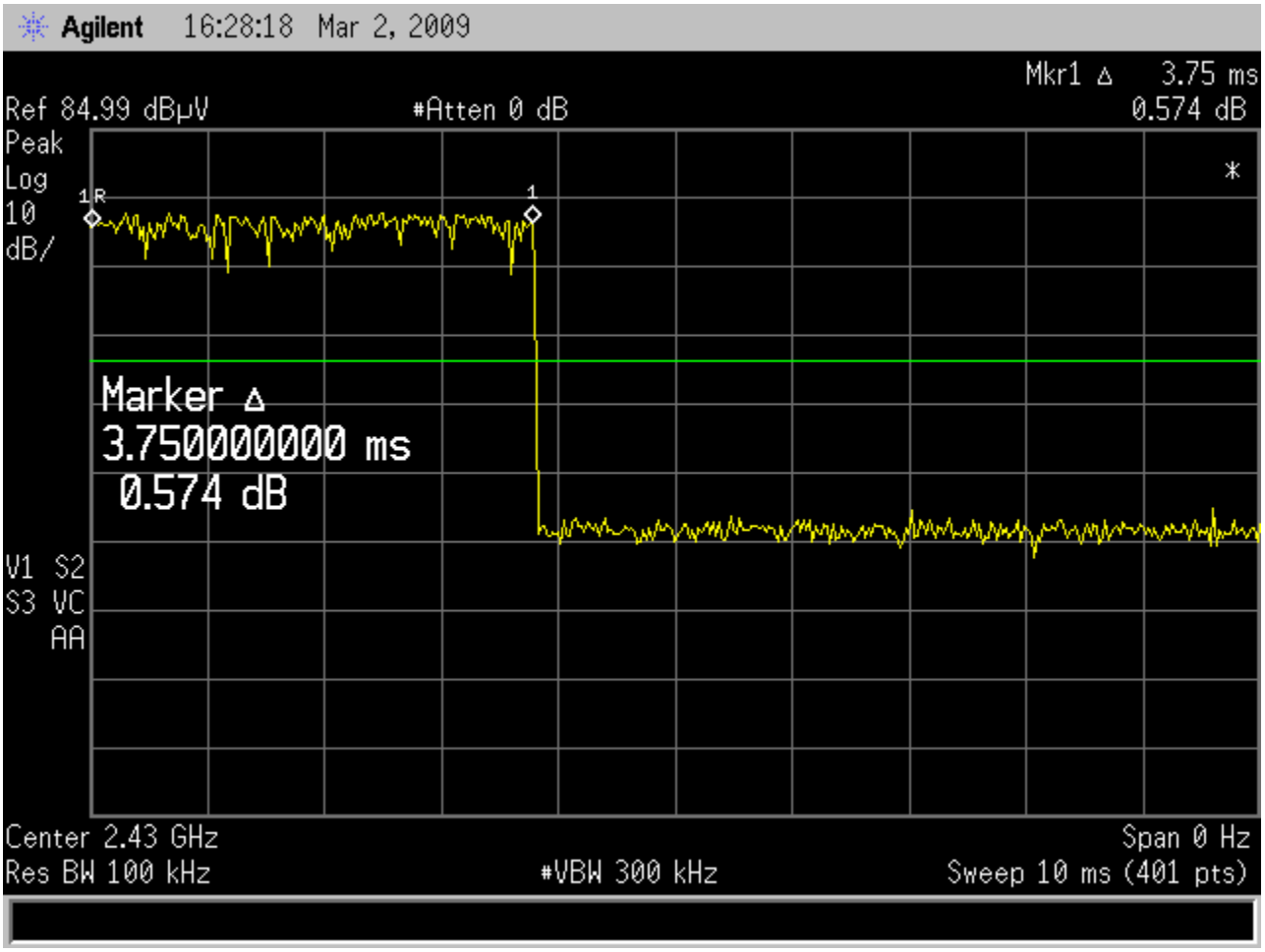
Duty Cycle Justification

Test Report #:	**3173742**	Test Area:	Pinewood Site 1 (3m)	Temperature:	22.7	°C
Test Method:	FCC Part 15.249	Test Date:	25-Feb-2009	Relative Humidity:	41	%
EUT Model #:	Awave	EUT Power:	Battery	Air Pressure:	80	kPa
EUT Serial #:	A7					
Manufacturer:	Phase IV					
EUT Description:	802.15.4 Transceiver					
Notes:						

Level Key	
Pk – Peak	Nb – Narrow Band
Qp – QuasiPeak	Bb – Broad Band
Av - Average	



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Level Key	
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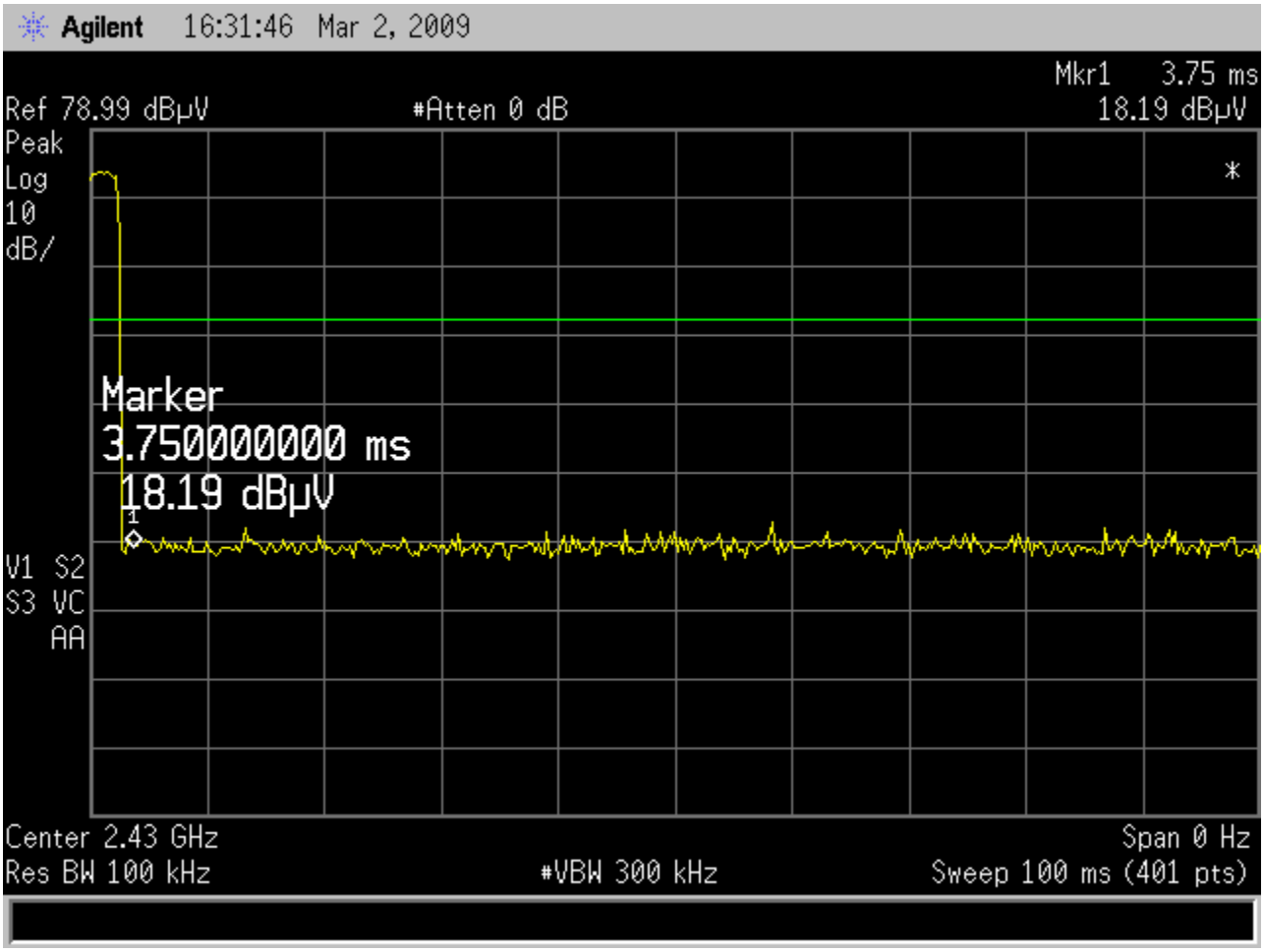

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List of Equipment Utilized for Final Test

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Project Report

Begin Date: 2/25/2009 **End Date:** 3/2/2009

Technician Mike Spataro **Project:** 3173742

Capital Asset ID	Manufacturer	Model #	Serial #	Description	Test Performed	Service Type	Service Date	Service Due
18880	Hewlett-Packard	85650A	2811A01300	Q.P Adapter	R Radiated Emissions	For Cal	12/11/2008	12/11/2009
18882	Hewlett-Packard	8566B	2410A00154	Spectrum Analyzer (dc-22 GHz)	R Radiated Emissions	For Cal	12/10/2008	12/10/2009
18888	EMCO	3146	9402-3775	Log Periodic Antenna (200-1000MHz)	R Radiated Emissions	For Cal	10/21/2008	10/21/2009
18889	EMC TEST SYSTEMS	3109	3142	Biconical Antenna 30-300MHz	R Radiated Emissions	For Cal	2/22/2009	2/22/2010
18897	EMCO	6502	9205-2738	Magnetic loop	R Radiated Emissions	For Cal	10/2/2008	10/2/2009
18900	Avantek	AFT97-8434-10F	1007	RF Pre-Amplifier (4-8 GHz)	R Radiated Emissions	For Ver	5/2/2008	5/2/2009
18901	Avantek	AWT-18037	1002	RF Pre-Amplifier (8-18 GHz)	R Radiated Emissions	For Ver	5/2/2008	5/2/2009
18906	Mini-Circuits Lab	ZHL-42	N052792-2	Amplifier	R Radiated Emissions	For Ver	5/2/2008	5/2/2009
18912	Hewlett-Packard	8447F	3113A05545	9 kHz- 1.3GHz Pre Amp	R Radiated Emissions	For Ver	5/2/2008	5/2/2009
18913	Hewlett-Packard	E7405A	My44211889	Spectrum Analyzer	R Radiated Emissions	For Cal	3/22/2008	3/22/2009
18805	Hewlett-Packard	11970K	2332A01280	Harmonic Mixer	R Radiated Emissions	For Cal	3/12/2008	3/12/2010
18886	TENSOR	4105	2020	Ridged Guide Antenna 1-18GHz	R Radiated Emissions	For Cal	3/6/2008	3/6/2009

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Appendix B

Test Plan

and

Constructional Data Form

Intertek Testing Services NA, Inc.
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PRODUCT COMPLIANCE TEST PLAN

for the:

AWAVE™ WSN
Wireless Sensing Node

Manufactured by:

Phase IV Engineering, Inc.
2820 Wilderness Place, Unit C
Boulder, Colorado 80301

HTC Document No.: 2009600101, Rev. A

Confidential and Proprietary

HIGHTEC CONSULTING, INC.
2997 SHALE COURT, SUPERIOR, COLORADO 80027
303-633-5444
WWW.HIGHTECCONSULTING.COM

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CUSTOMER INFORMATION:

Representative:	**HIGHTec Consulting, Inc.**
Address:	2997 Shale Court
	Superior, Colorado 80027
Contact:	Kevin J. Hight – President
Telephone:	(303) 633-5444
Email:	Kevin@HIGHTecConsulting.com
Manufacturer:	**Phase IV Engineering**
Address:	2820 Wilderness Place, Unit C
	Boulder, Colorado 80301
Contact:	Randy Engle
Telephone:	(303) 443-6611
Fax:	(303) 443-8379
Email:	rengle@phaseivengr.com

EQUIPMENT UNDER TEST (EUT):

Model Number:	AWAVE™
Part Number:	WSN (Wireless Sensing Node)
Serial Number:	12141018
Environment:	Field Use
Voltage:	3.6 V Li-$SOCl_2$ Battery

PROJECT REQUIREMENTS:

- 47 CFR 15, Subpart B, Unintentional Radiators, Class B
- 47 CFR 15, Subpart C, Intentional Radiators, Section 15.247
  - IEEE 802.15.4 (ZigBee)

CONFIGURATION OF EUT DURING TESTING:

EUT Internal Components:

Description	Manufacturer	Part/ Model Number	Clock Frequency/ Data Rate
Single Board WSN	Phase IV Engineering, Inc.	45-100133-00 Rev 2.1	See below
8-bit AVR Microcontroller	Atmel	ATmega1281V-8AU	32.768 kHz, 7.37 MHz
2.4 GHz Transceiver for ZigBee, IEEE 802.15.4	Atmel	AT86RF230	16 MHz, 2405 – 2480 MHz

EUT OPERATION DURING TESTING:

During the Intentional Radiator testing, the AWAVE WSN was programmed to transmit a CW signal on Channel 11 (2405 MHz), then on Channel 18 (2445 MHz) and finally on Channel 26 (2480 MHz).
During the Unintentional Radiator testing, the AWAVE WSN was programmed to transmit a PRBS signal on Channel 11 2405 MHz.

TEST CONFIGURATION:

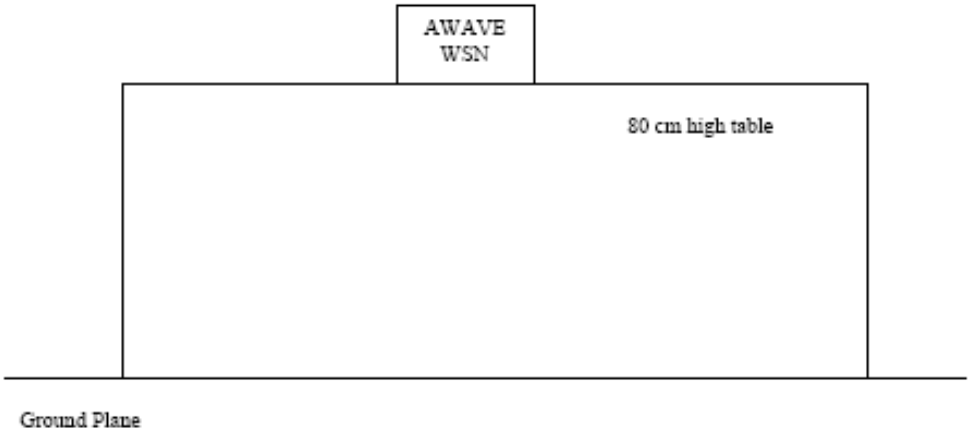

Figure 1: AWAVE WSN Test Configuration

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Appendix C

Measurement Protocol

And

Test Procedures

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MEASUREMENT PROTOCOL

GENERAL INFORMATION

Intertek Testing Services NA, Inc. facilities located in Boulder CO and Pinewood Springs CO are ISO 17025:2005 accredited for EMC/EMI testing. See scope of accreditation for standards and restrictions.

Test Methodology

Conducted and radiated emission testing is performed according to the procedures in ANSI C63.4 & CNS13438.

Justification

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral into it's characteristic impedance or left unterminated. When appropriate, the cables are manually manipulated with respect to each other to obtain maximum emissions from the unit.

CONDUCTED EMISSIONS

The final level, expressed in dBμV, is arrived at by taking the reading directly from the EMI receiver. This level is compared directly to the applicable limit.

To convert between dBμV and μV, the following conversions apply:

- dBμV = 20(log μV)
- μV = Inverse log(dBμV/20)

RADIATED EMISSIONS

The final level, expressed in dBμV/m, is arrived at by taking the reading from the spectrum analyzer (Level dBμV) and adding the antenna correction factor and cable loss factor (Factor dB) to it. This result then has the applicable limit subtracted from it to provide the Delta which gives the tabular data as shown in the data sheets in Attachment B.

Example: At a Test Frequency of 30 MHz, with a peak reading on the spectrum analyzer or measuring receiver of 14 dBμV:

Measured Level	+	Transducer & Cable Loss factor	=	Corrected Reading	Specification Limit	-	Corrected Reading	=	Delta Specification
(dBμV)		(dB)		(dBμV/m)	(dBμV/m)		(dBμV/m)		
14.0		**14.9**		**28.9**	**40.0**		**28.9**		**-11.1**

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DETAILS OF TEST PROCEDURES

General Standard Information

The test methods used comply with ANSI C63.4-2003 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz."

Conducted Emissions

Conducted emissions on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection, and a Line Impedance Stabilization Network (LISN), with 50 Ω/50 μH (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimeters above the floor and is positioned 40 centimeters from the vertical ground plane (wall) of the screen room. In some cases, a pre-scan using a spectrum analyzer is initially performed on the units comprising the system under test to locate the highest emissions. If the minimum passing margin appears to be less than 20 dB with a peak mode measurement, the emissions are re-measured using a tuned receiver or spectrum analyzer with quasi-peak and average detection and recorded on the data sheets.

Radiated Emissions

Radiated emissions from the EUT are measured in the frequency range of 30 to 22GHz using a spectrum analyzer and appropriate broadband linearly polarized antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection and measurements above 1000 MHz are made with a 1 MHz/6 dB bandwidth and peak detection. Table top equipment is placed on a 1.0 X 1.5 meter non-conducting table 80 centimeters above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. Interface cables that are closer than 40 centimeters to the ground plane are bundled in the center in a serpentine fashion so they are at least 40 centimeters from the ground plane. Cables to simulators/testers (if used in this test) are routed through the center of the table and to a screen room located outside the test area. The antenna is positioned 3, 10 or 30 meters horizontally from the EUT. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 meters, measurement scans are made with both horizontal and vertical antenna polarizations and the EUT are rotated 360 degrees.

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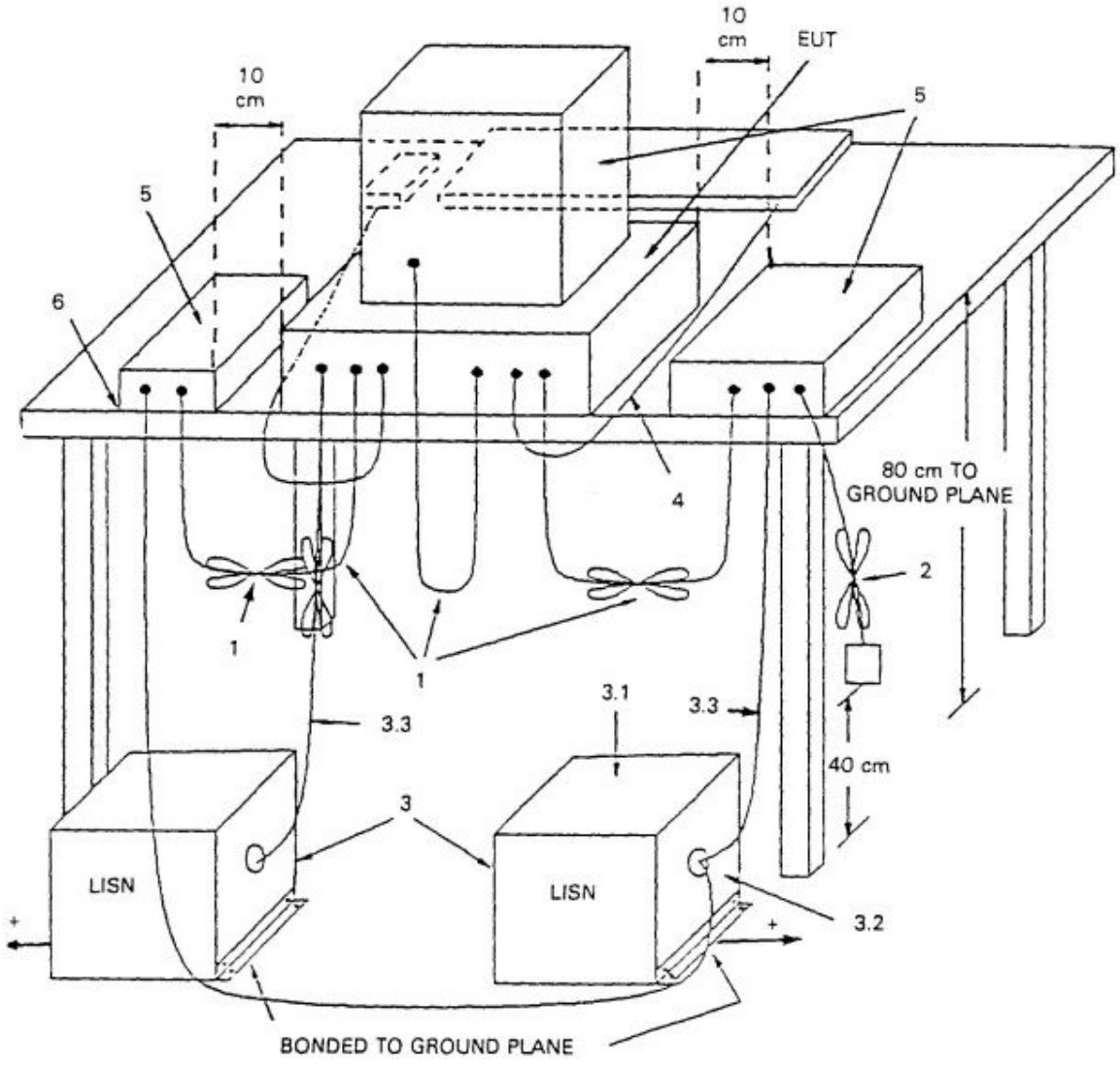
Conducted Emissions Diagram:



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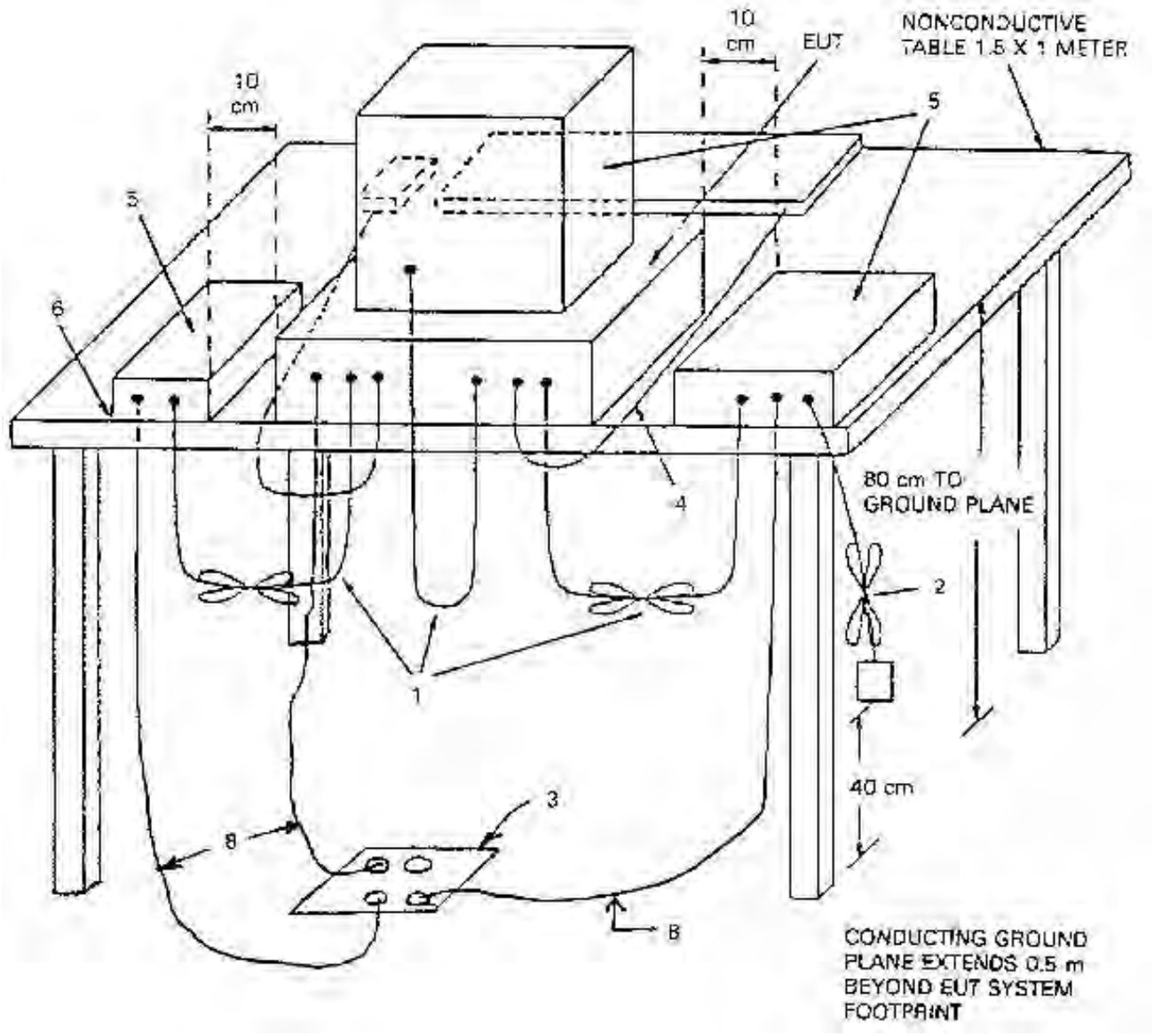
Radiated Emissions Diagram:



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