Project 06486-10

iCAP Technologies
Release Headband

Certification
Electromagnetic Compatibility Test Report

Prepared for:

iCAP Technologies

6450A Mt. Madonna Road
Gilroy CA 95020

By

Professional Testing (EMI), Inc.
1601 FM 1460, Suite B
Round Rock, Texas 78664

10 JULY 2006

Reviewed by	Written by
Michael Royer	Eric Lifsey
EMC Department Manager	Test Engineer

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Certificate Of Compliance

Applicant: iCAP Technologies

Applicant's Address: 6450A Mt. Madonna Road
Gilroy CA 95020

Project Number: 06486-10

Test Dates: May 9th, 2006 and May 10th, 2006

I, Michael A. Royer, for Professional Testing (EMI), Inc., being familiar with the FCC rules and test procedures have reviewed the test setup, measured data and this report. I believe them to be true and accurate.

The **iCAP Technologies, Release Headband** was tested to and found to be in compliance with FCC Part 15 Subpart C for an Intentional Radiator.

The highest emissions generated by the above equipment are listed below:

	Frequency (MHz)	**Level (dBμV/m)**	**Limit (dBμV/m)**	**Margin (dB)**
Fundamental	904	82.5	94	-11.5
Harmonics	1809.7	61.8 (avg)	63.5 (avg)	-1.7
Spurious	960	41.6	46	-5.9

Occupied Bandwidth 1.04 MHz
Transmit Duty Cycle 100 %

Michael A. Royer, BSEE, NCE
EMC Department Manager

This report has been reviewed and accepted by iCAP Technologies. The undersigned is responsible for ensuring that **iCAP Technologies, Release Headband** will continue to comply with the FCC rules.

1.0 EUT Description

The Release Headband (EUT) is a relaxation feedback headband-worn device that acquires brainwave signals and transmits them at low power to a companion USB receiver where software presents feedback to the user. The EUT transmitter operates from a single AAA battery once manually activated by the user. After approximately 30 minutes of operation it automatically shuts down.

An analog sensor measures the wearer's EEG activity, which is digitized by the microcontroller and drives the IA4220 transmitter module.

The microcontroller data stream modulates the 904 MHz carrier using FSK modulation with a maximum input bit stream of 256 kbps and a maximum deviation of 240 kHz. The transmitter uses an integrated PLL with direct closed-loop modulation without LO or IF, driven by a 10MHz reference crystal. The integrated output amplifier of the transmitter module feeds into a balanced 200 Ohm loop antenna etched onto the PCB.

The transmit module is encapsulated in its entirety by an epoxy potting material and prevents user tampering with its construction.

The system tested consisted of the following:

Manufacturer	Description	FCC ID
iCAP Technologies	904 MHz Transmitter	T9MRMV106A

1.1 Modifications to Equipment

No modifications were made to the EUT.

1.2 Applicable Documents

The following guidelines apply to the operation of the EUT:

Guidelines	FCC Rule Parts Part 15
Transmitter Characteristics	15.249
Spurious Radiated Power	15.249
Occupied Bandwidth	15.249
Antenna Requirements	15.203
Averaging Calculations	15.35b

1.3 EUT Operation

The EUT was operated in continuous transmit mode at a fixed and maximum power.

2.0 Electromagnetic Emissions Testing

Professional Testing (EMI), Inc. (PTI), follows the guidelines of NIST for all uncertainty calculations, estimates and expressions thereof for EMC testing. See Appendix B for details.

2.1 Radiated Emissions Measurements

Emission measurements were made at the PTI open area test site designated Site 3, located in Round Rock, Texas. This site is registered with the FCC under Section 2.948 and is subsequently confirmed by laboratory accreditation (NVLAP).

Radiated emission measurements were made of the fundamental, spurious, and occupied bandwidth of the EUT. The fundamental emissions of the device were measured device placed in three orthogonal axes in each measuring antenna orientation.

2.1.1 Test Procedure

The EUT was placed at the center of a non-conductive remotely-rotated table 0.8 meters above the ground plane. Below 1 GHz the measurement antenna was placed at a distance of 3 meters as measured from the closest point of the EUT. Above 1 GHz emissions the antenna is placed at 1 meter distance. The radiated emissions were maximized by rotating the EUT. A drawing showing the test setup is given as Figure 1.

2.1.2 Test Criteria

Relevant FCC/IC & CISPR emission limits are listed below. Transmitter harmonics are measured up to the 10th harmonic. The lower limit shall apply at the transition frequency.

FCC/IC			
Frequency MHz	Test Distance (Meters)	Field Strength Limit	
		Distance 3 m (µV/m)	At Test Distance (dB µV/m)
Fundamental (peak)	3	50000	94.0
Harmonics (average)	1	500	63.5
Harmonics (peak)	1	-	83.5

FCC/IC		
Frequency (MHz)	Test Distance (Meters)	Field Strength Limit (dB µV/m)
30 to 88	3	40.0
88 to 216	3	43.5
216 to 960	3	46.0
960 and above	3	54.0

CISPR		
Frequency (MHz)	Test Distance (Meters)	Field Strength Limit (dB µV/m)
30 to 230	3	40.5
230 to 1000	3	47.5

2.1.3 Test Results

The radiated test data is included in Appendix A. Peak detection was used during the test for the fundamental and harmonics. Quasi-Peak or peak detection was used for spurious emissions below 1 GHz. The measured radiated emissions are below the applicable limits.

2.1.4 Radiated Emissions Test Equipment < 1 GHz

Asset #	Manufacturer	Model #	Description	Calibration Due
C005	None	None	Underground Coaxial Cable	March 17, 2007
0754	Compliance Design	B100	Biconical Antenna	June 3, 2006
0746	Tek	2706	RF Preselector	October 27, 2006
0084	HP	8566B	Spectrum Analyzer	March 13, 2007
0084	HP	8566B	Spectrum Analyzer Display	March 13, 2007
0085	HP	85650A	Quasi-peak Adapter	September 26, 2006
0483	HP	8447D	RF Preamplifier	January 12, 2007
0755	EMCO	3146	Log Periodic Dipole Array Antenna	June 8, 2006

2.1.5 Radiated Emissions Test Equipment > 1 GHz

Asset #	Manufacturer	Model #	Description	Calibration Due
C031	None	None	1.5 meter Coaxial RF Cable	November 23, 2006
0267	EMCO	3115	Ridge Guide Antenna	July 16, 2006
0950	HP	8566B	Spectrum Analyzer	March 13, 2007
0949	HP	8566B	Spectrum Analyzer Display	March 13, 2007
0897	Miteq	None	Microwave Preamplifier	May 16, 2006

3.0 Occupied Bandwidth Measurements

Measurements of the occupied bandwidth were made in a controlled indoor environment in a configuration which did not present measurement distortion or ambient interference.

3.1 Test Procedure

The EUT was placed on a non-conductive table 0.8 meters above the floor. The table was rotated to an angle which presented the highest signal level. The occupied bandwidth was based on a 20 dB criteria (20 dB down either side of the emission from the peak emission). A drawing showing the test setup is given as Figure 1.

3.2 Test Criteria

According to FCC Part 15.249, the fundamental emission must remain in the allocated band.

3.3 Test Results

The occupied bandwidth test data is included in Appendix A. The occupied bandwidth satisfies the criteria.

4.0 Burst Length, Pulse Width, Pulse Repetition Rate and Duty Cycle

The EUT transmitter operates continuously and does not burst data. Therefore these measurements are not applicable and the duty cycle is reported as 100 %.

5.0 Antenna Requirement

An analysis of the EUT was performed to determine compliance with FCC Section 15.203. This section requires specific handling and control of antennas used for devices subject to regulations.

5.1 Evaluation Procedure

The structure and application of the EUT was analyzed with respect to the rules.

5.2 Evaluation Criteria

Section 15.203 of the rules states that the subject device must meet at least one of the following criteria:

(a) Antenna must be permanently attached to the unit.

(b) Antenna must use a unique type of connector to attach to the EUT.

(c) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

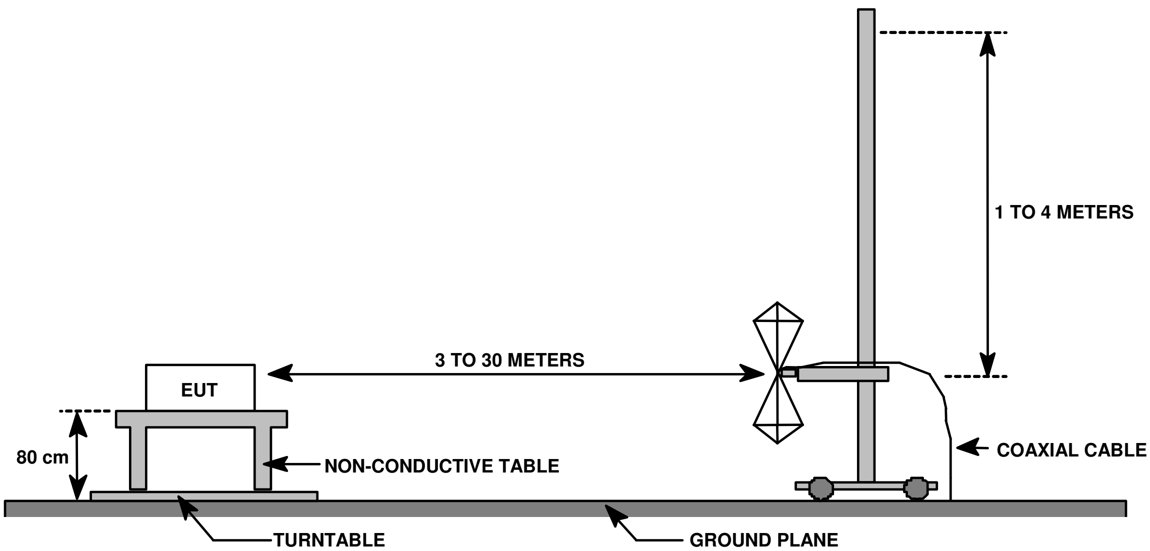
5.3 Evaluation Results

The EUT meets the criteria of this rule by virtue of having an internal antenna embedded into the printed circuit board. The EUT is potted at the factory which protects against any user tampering. The EUT satisfies the criteria.

6.0 Modifications

No modifications were required.

FIGURE 1: Radiated Emissions Test Setup



Fundamental Radiated Emissions Data Sheet
904 MHz Carrier

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
06486-10	10 May 2006	FCC B	3 m	Log	120 kHz	1 MHz	Peak

COMMENT	

ANTENNA POLARIZATION: Horizontal

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
904.943	90	1	39.8	0.0	22.6	10.1	72.6	94	-21.4
904.935	270	1	42.1	0.0	22.6	10.1	74.9	94	-19.1
904.935	0	1.5	44	0.0	22.6	10.1	76.8	94	-17.2

ANTENNA POLARIZATION: Vertical

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBµV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)
904.935	270	1	46.9	0.0	22.6	10.1	79.7	94	-14.3
904.935	180	1	49.7	0.0	22.6	10.1	82.5	94	-11.5
904.935	0	1	43.6	0.0	22.6	10.1	76.4	94	-17.6

Fundamental emissions are measured in all orthogonal orientations.

Test Engineer: Eric Lifsey

Radiated Emissions Data Sheet
Harmonics & Spurious
1 GHz ≤ f ≤ 9.05 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
06486-10	11 May 2006	CISPR B	1 m	Horn	1 MHz	1 MHz	Peak | Average

COMMENT	

ANTENNA POLARIZATION: Horizontal

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
904.86	F(o) for	reference								
1809.7	45	1	68.3	33.2	26.7	0.6	62.4	83.5	-21.1	Peak
1809.7	45	1	67.7	33.2	26.7	0.6	61.8	63.5	-1.7	Avg
2714.6	270	1	54	34.9	29.3	0.6	49.1	83.5	-34.4	Peak
3619.4	270	1	50.9	34.1	32.0	0.8	49.5	83.5	-34.0	Peak
4524.3	90	1	52.7	31.9	33.4	0.8	55.0	83.5	-28.5	Peak
5429.2	noise	floor	44.3	30.8	34.9	0.6	49.0	83.5	-34.5	Peak
6334.0	noise	floor	49.5	30.7	35.2	1.3	55.2	83.5	-28.3	Peak
7238.9	noise	floor	49.7	31.0	36.8	1.4	56.9	83.5	-26.6	Peak
8143.7	noise	floor	47.8	31.2	37.5	1.4	55.5	83.5	-28.0	Peak
9048.6	noise	floor	47.9	31.2	37.3	1.5	55.6	83.5	-27.9	Peak

ANTENNA POLARIZATION: Horizontal

Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
904.86	F(o) for	reference								
1809.7	90	1	68.1	33.2	26.7	0.6	62.2	83.5	-21.3	Peak
1809.7	45	1	66.9	33.2	26.7	0.6	61.0	63.5	-2.5	Avg
2714.6	180	1	50.3	34.9	29.3	0.6	45.4	83.5	-38.1	Peak
3619.4	0	1	48.4	34.1	32.0	0.8	47.0	83.5	-36.5	Peak
4524.3	0	1	46.9	31.9	33.4	0.8	49.2	83.5	-34.3	Peak
5429.2	noise	floor	44.6	30.8	34.9	0.6	49.3	83.5	-34.2	Peak
6334.0	noise	floor	48.9	30.7	35.2	1.3	54.6	83.5	-28.9	Peak
7238.9	noise	floor	48.2	31.0	36.8	1.4	55.4	83.5	-28.1	Peak
8143.7	noise	floor	48	31.2	37.5	1.4	55.7	83.5	-27.8	Peak
9048.6	noise	floor	47.8	31.2	37.3	1.5	55.5	83.5	-28.0	Peak

Test Engineer: Eric Lifsey

Spurious Radiated Emissions Data Sheet
30 MHz ≤ f ≤ 1 GHz

PROJECT #	DATE	CLASS	DISTANCE	ANTENNA	RBW	VBW	DETECTOR
06486-10	10 May 2006	CISPR B	3 m	Bicon | Log	CISPR 120 kHz	1 MHz	QP | Peak

COMMENT	

ANTENNA POLARIZATION: Horizontal

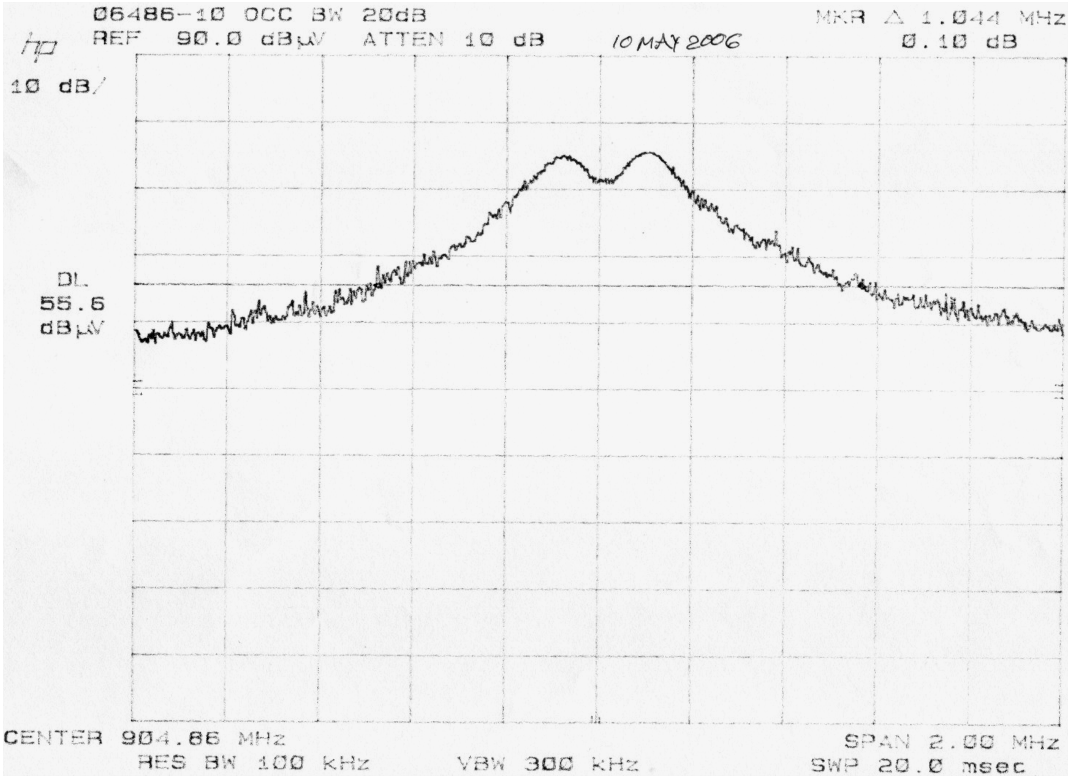
Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector Function
35	noise	floor	33.1	26.7	11.1	2.2	19.7	40.5	-20.8	Peak
77	noise	floor	33.4	26.7	6.9	2.9	16.6	40.5	-23.9	Peak
120	noise	floor	35.1	26.7	12.0	3.7	24.1	40.5	-16.4	Peak
170	noise	floor	33.3	26.7	14.9	4.9	26.5	40.5	-14.0	Peak
220	noise	floor	34.4	26.8	11.4	5.1	24.1	40.5	-16.4	Peak
320	noise	floor	34.8	27.1	15.1	6.2	29.1	47.5	-18.4	Peak
750	noise	floor	33.8	26.1	21.3	9.0	38.0	47.5	-9.5	Peak
920	noise	floor	33.8	26.3	22.7	10.1	40.3	47.5	-7.2	Peak
940	noise	floor	33	26.3	22.9	10.1	39.7	47.5	-7.8	Peak
960	noise	floor	32.9	26.4	23.5	10.0	40.0	47.5	-7.5	Peak

ANTENNA POLARIZATION: Vertical

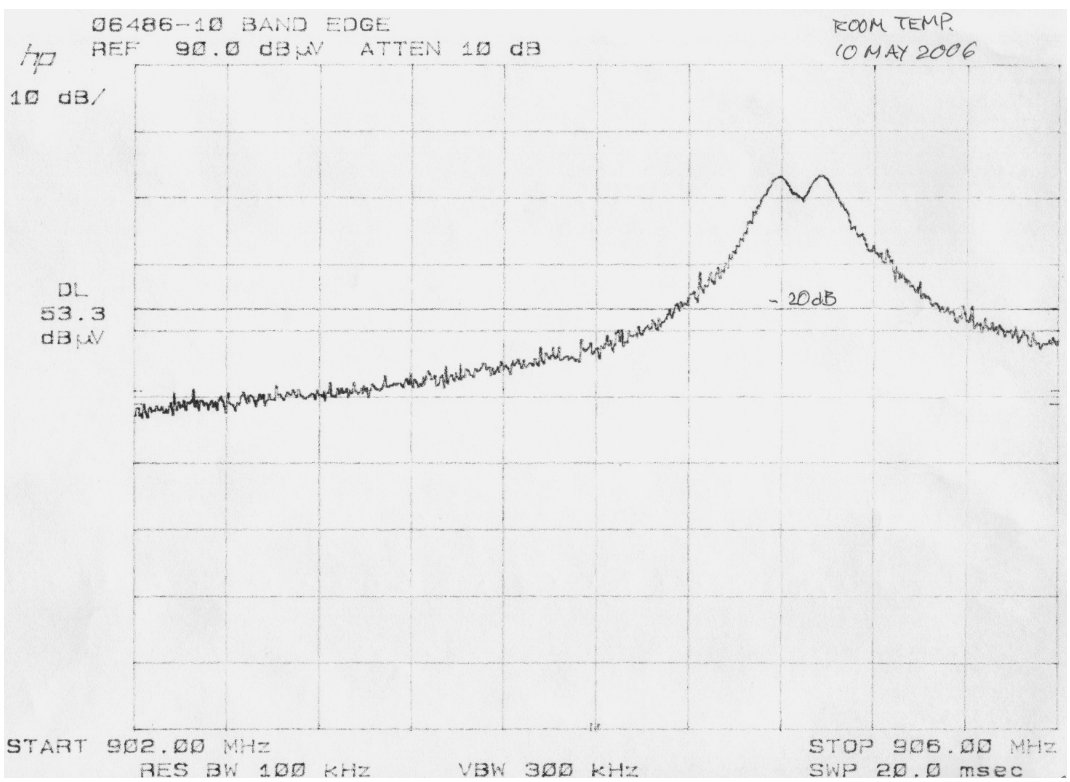
Frequency (MHz)	EUT Direction (degrees)	Antenna Elevation (Meters)	Recorded Level (dBμV)	Amplifier Gain (dB)	Antenna Factor (dB/m)	Cable Loss (dB)	Corrected Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector Function
77	noise	floor	36.2	26.7	6.9	2.9	19.4	40.5	-21.1	Peak
120	noise	floor	34.4	26.7	12.0	3.7	23.4	40.5	-17.1	Peak
170	noise	floor	33.9	26.7	14.9	4.9	27.1	40.5	-13.4	Peak
220	noise	floor	34.6	26.8	11.4	5.1	24.3	40.5	-16.2	Peak
320	noise	floor	36.2	27.1	15.1	6.2	30.5	47.5	-17.0	Peak
750	noise	floor	34	26.1	21.3	9.0	38.2	47.5	-9.3	Peak
920	noise	floor	32.4	26.3	22.7	10.1	38.9	47.5	-8.6	Peak
940	noise	floor	32.4	26.3	22.9	10.1	39.1	47.5	-8.4	Peak
960	noise	floor	34.5	26.4	23.5	10.0	41.6	47.5	-5.9	Peak

Test Engineer: Eric Lifsey

Occupied Bandwidth Datasheet



Band Edge Datasheet*



*Transmitter frequency is much closer to bottom of band than top. Top band edge not plotted.

Test Engineer: Eric Lifsey

Professional Testing (EMI) Inc. (PTI) Policy, Rationale and Evaluation of EMC Measurement Uncertainty

All uncertainty calculations, estimates and expressions thereof shall be in accordance with NIST policy stated in Appendix E to NIST Technical Communications Program, Subchapter 4.09 of the Administrative Manual, as reproduced in Appendix C of NIST Technical Note (TN) 1297, 1994 Edition [1][1]. The NIST policy is based on ISO Guide to the Expression of Uncertainty in Measurement [2] (herein after called the Guide), which shall take precedence in the event of disputes. The Guide is explained in TN 1297. Other notable explanations for the Guide are NAMAS Publications NIS 80 [3] and NIS 81 [4]; the latter being specifically for EMC measurements, and the easiest to understand. Since PTI operates in accordance with NIST (NVLAP) Handbook 150-11 [5], all instrumentation having an effect on the accuracy or validity of tests shall be periodically calibrated or verified traceable to national standards by a competent calibration laboratory. The certificates of calibration or verification on this instrumentation shall include estimates of uncertainty as required by NIST Handbook 150-11.

1. Rationale and Summary of Expanded Uncertainty.

Each piece of instrumentation at PTI that is used in making measurements for determining conformance to a standard (or limit), shall be assessed to evaluate its contribution to the overall uncertainty of the measurement in which it is used. The assessment of each item will be based on either a type A evaluation or a type B evaluation. Most of the evaluations will be type B, since they will be based on the manufacture's statements or specifications of the calibration tolerances or uncertainty will be stated along with a brief rationale for the type of evaluation and the resulting state uncertainties.

The individual uncertainties included in the combined standard uncertainty for a specific test result will depend on the configuration in which the item of instrumentation is used. The combination will always be based on the law of propagation of uncertainty discussed in TN 1297, NIS 81, and the Guide. Any systematic effects will be accommodated by including their uncertainties, in the calculation of the combined standard uncertainty; except that if the direction and amount of the systematic effect cannot be determined and separated from its uncertainty, the whole effect will be treated as uncertainty and combined along with the other elements of the test setup.

Type A evaluations of standard uncertainty will usually be based on calculating the standard deviation of the mean of a series of independent observations, but may be based on a least-squares curve fit or the analysis of variance for unusual situations. Type B evaluations of standard uncertainty will usually be based on manufacturer's specifications, data provided in calibration reports, and experience. The type of probability distribution used (normal, rectangular, a-priori, or u-shaped) will be stated for each Type B evaluation.

[1] Numbers in square brackets identify documents listed in the reference section.

In the evaluation of the uncertainty of each type of measurement, the uncertainty caused by the operator will be estimated. One notable operator contribution to measurement uncertainty is the manipulation of cables to maximize the measured values of radiated emissions. The operator contribution to measurement uncertainty is evaluated by having several operators independently repeat the same test. This results in a Type A evaluation of operator-contributed measurement uncertainty.

A summary of the expanded uncertainties of PTI measurements if shown is Table 1. These are the worst-case uncertainties considering all operative influence factors.

Table 1-1

Summary of Measurement Uncertainties

Type of Measurement	Frequency Range	Meas. Dist.	Expanded Uncertainty U, dB (k=2)
Conducted Emissions	150 kHz to 30 MHz	N/A	2.9
Radiated Emissions, Site #1	30 to 200 MHz	3 m	4.7
		10 m	4.4
	200 to 1000 MHz	3 m	4.6
		10 m	4.0
	1 to 2.5 GHz	1 m	2.5
	2.5 to 12.5 GHz	1 m	3.6
	12.5 to 18 GHz	1 m	4.0
Radiated Emissions, Site #2	30 to 200 MHz	3 m	3.5
		10 m	3.7
	200 to 500 MHz	3 m	3.5
		10 m	3.1
	500 to 1000 MHz	3 m	4.0
		10 m	3.9
Radiated Emissions, Site #3	30 to 200 MHz	3 m	3.9
	200 to 500 MHz	3 m	4.0
	500 to 1000 MHz	3 m	4.3