T E S T R E P O R T

ISO 7779:2010 *Acoustics -- Measurement of airborne noise emitted by information technology and telecommunications equipment*

Orfield Laboratories Inc

Design Research Testing
Acoustics / Vibration / Vision / Lighting / Architecture / Market Research

DEVICES

- Fractal Design R5 solid panel case
- Fractal Design R5 window panel case

Report Date: 06/25/2015
Test Date: 12/17/2014

TEST SPONSOR
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METHODS
ISO 7779: 2010
ISO 3744: 2010
ISO 11201: 2010
ECMA-74: 2012

The information included in the following report presents the results of sound pressure and sound power testing.

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METHODS

This report presents the results of sound emission testing in accordance with international standards, as follows:

Referenced Standards

ISO 7779: 2010 *Acoustics -- Measurement of airborne noise emitted by information technology and telecommunications equipment*

ISO 3744: 2010 *Acoustics -- Determination of sound power levels and sound energy levels of noise sources using sound pressure – Engineering methods for an essentially free field over a reflecting plane.*

ECMA-74: 2012 *Measurement of Airborne Noise emitted by Information Technology and Telecommunications Equipment*

ISO 11201: 2010 *Acoustics -- Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections*

Sound Power Methods

The sound power testing was performed in full conformance with ISO 7779:2010 and ISO 3744:2010. For the sound power testing, the measurement surface selected was the hemispherical surface described in Annex B of ISO 3744:2010. The microphone positions used those with coordinates described in Table B.1. The measurement hemi-sphere radius was 1 meter resulting in a measurement surface area of 6.28 m^2. A diagram of the hemispherical array used is found in Appendix B of this document.

All sound measurements are time-averaged over a period of 30 seconds. Measured values in this report are for use in planning or in determining declared values. They are not to be confused with the declared values.

Operator Sound Pressure Methods

The operator sound pressure testing was performed in full conformance with ISO 7779 and other referenced standards. For the sound pressure testing, the operator position was selected to represent a user seated at a computer keyboard/screen with the central CPU (device under test) placed on the floor next to the device. This arrangement is described in ECMA-74 § C.15.2 and specifically in ECMA-74 figure C.4c. A diagram of the set up is found in Appendix B of this document. An additional bystander position was located at 1 meter out from the front panel of the device under test at a height of 1 meter above the floor (device placed on reflecting plane). This location was selected as the test sponsor indicated that this is a common microphone test location used in the quiet PC industry.

All sound measurements are time-averaged over a period of 30 seconds. Measured values in this report are for use in planning or in determining declared values. They are not to be confused with the declared values.

Measurement Uncertainty

The uncertainty declared for the measurement is based on information in the referenced standards. Since we have no prior knowledge of the standard deviation of reproducibility (σ_{omc}) for the family of machines under consideration, the values for σ_{omc} will be assigned as 0.5 dB. This value is suggested as appropriate for machines with "small variations in time" according to § 9.2 of ISO 3744:2010. The standard deviation of the method (σ_{ro}) is expressed as 1.5 dB in ISO 7779:2010 § 7.2 for the –weighted values measured. The total standard deviation (σ_{tot}), is calculated from equation 25 in ISO 3744:2010, § 9.1

$$\sigma_{tot} = \sqrt{\sigma^2{}_{RO} + \sigma^2{}_{omc}}$$

where: σ_{ro} = 1.5 dB

σ_{omc} = 0.5 dB

The total expanded uncertainty (U), in decibels is expressed as:

$$U = k\ \sigma_{tot}$$

where: k = 2.0 dB[1]

σ_{tot} = 1.6 dB

Expanded Uncertainty: U = 3.2 dB

SPECIMEN DESCRIPTION

Two devices were tested. The devices were personal computers cases. The following is the abbreviated description of the devices tested:

- Fractal Design R5 Case with solid side panel
- Fractal Design R5 Case with window side panel

Detailed specimen descriptions are found in Appendix A at the end of this document.

[1] The coverage factor k=2 gives a level of confidence of 95% for the expanded uncertainty

OPERATING CONDITIONS

The cases were tested at idle only. The devices (cases only) contained no CPU's or other operating electronics. The devices were connected to a standard 120 VAC, 60 Hz power receptacles.

In accordance with the sound power test method ISO 3744, the device was placed on the center of the reflecting plane.

For operator sound pressure level testing, the device was placed on the floor next to a "standard test table" as specified in ECMA-71 figure C.4c.

RESULT SUMMARY: SOUND PRESSURE LEVELS

OPERATOR POSITION (CASE ONLY)			
MEASURED SOUND PRESSURE LEVEL VALUES IN ACCORDANCE WITH ISO 7779:2010			
		Fractal Design R5 Case with solid side	Fractal Design R5 Case with window side
Measured A-weighted sound pressure level in decibels (0 dB=20μPascals)	dBA @ operator idle	0.0*	-0.2*

***** SPL at operator and 1m was within 6dB of background noise. Therefore value is "upper bounds" of sound pressure level

The reported operator locations value were measured as described in ECMA-74 § C.15.2 and specifically in ECMA-74 figure C.4c.

NOTE: The sum of a measured noise emission value and its associated uncertainty represents an upper boundary of the range of values that are likely to occur in measurements (measured value +/- U). The expanded uncertainty for these measurements is estimated at U=3.2 dB.

RESULT SUMMARY: SOUND PRESSURE LEVELS (cont.)

1M OUT, 1M UP (CASE ONLY)			
MEASURED SOUND PRESSURE LEVEL VALUES IN ACCORDANCE WITH ISO 7779:2010			
		Fractal Design R5 Case with solid side	Fractal Design R5 Case with window side
Measured A-weighted sound pressure level in decibels (0 dB=20μPascals)	dBA @ operator idle	0.5*	-0.1*

***** SPL at operator and 1m was within 6dB of background noise. Therefore value is "upper bounds" of sound pressure level

The reported operator locations value were measured as described in ECMA-74 § C.15.2 and specifically in ECMA-74 figure C.4c.

NOTE: The sum of a measured noise emission value and its associated uncertainty represents an upper boundary of the range of values that are likely to occur in measurements (measured value +/- U). The expanded uncertainty for these measurements is estimated at U=3.2 dB.

RESULT SUMMARY: SOUND POWER LEVELS

CASE ONLY			
MEASURED SOUND POWER LEVEL VALUES IN ACCORDANCE WITH ISO 7779:2010			
		Fractal Design R5 Case with solid side	Fractal Design R5 Case with window side
Measured A-weighted sound power level, L_{WA} (0 dB=1ρW), in decibels	dBA @ operator idle	12.8*	13.4*

* Measured sound power was within 6dB of background noise. Therefore value is "upper bounds" of sound power level

The reported sound power values were measured in accordance with ISO 7779:2010 and ISO 3744:2010.

NOTE: The sum of a measured noise emission value and its associated uncertainty represents an upper boundary of the range of values that are likely to occur in measurements (measured value +/- U). The expanded uncertainty for these measurements is estimated at U=3.2 dB.

CASE ONLY			
MEASURED SOUND POWER LEVEL VALUES IN ACCORDANCE WITH ISO 7779:2010			
		Fractal Design R5 Case with solid side	Fractal Design R5 Case with window side
Measured A-weighted sound power level, L_{WA} (0 dB=1ρW), in decibels	dBA @ operator idle	12.8*	13.4*

* Measured sound power was within 6dB of background noise. Therefore value is "upper bounds" of sound power level

The reported sound power values were measured in accordance with ISO 7779:2010 and ISO 3744:2010.

NOTE: The sum of a measured noise emission value and its associated uncertainty represents an upper boundary of the range of values that are likely to occur in measurements (measured value +/- U). The expanded uncertainty for these measurements is estimated at U=3.2 dB.

ACOUSTICAL ENVIRONMENT

Anechoic Chamber Dimensions = 5.4 x 4.8 x 4.2 meters wall to wall
= 3.7 x 3.1 x 3.5 meters wedge tip to tip

Anechoic Chamber Construction:

Structure	Material
walls and ceiling	prefabricated steel panels w/.85 meter fiberglass wedges
floor	25mm (2 x 12.5mm) OSB sandwich w/damping compound

The chamber meets the requirements of anechoic and hemi-anechoic precision grade sound power measurement. Therefore, no environmental k factor is applied (k_2 = 0dB) to measurements in this report, as indicated in Annex A of ISO 3744:2010. The test chamber was qualified per ISO 3745:2012 Annex A[2]. Documentation is available upon request*. The frequency range of qualification is 100Hz to 10,000 Hz.

Background noise levels below 0dBA were documented at the beginning and end of the test session. A-weighted measurements were handled in accordance with the corresponding standards regarding background noise. In all cases background noise criteria were met or exceeded.

[2] *Orfield Laboratories, Inc. has been accredited by the U.S. Department of Commerce, National Institute of Standards and Technology (NIST) under their National Voluntary Laboratory Accreditation Program (NVLAP) for the ISO 3745 procedure. This report shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the U.S. Government.*

The following environmental conditions were present in the hemi-anechoic chamber during the test.

Environmental Conditions

date	December 17, 2014
temperature	20°C (68°F)
relative humidity	40%
barometric pressure	102.125 kPa (30.12" Hg)

INSTRUMENTATION

Description	Manufacturer	Model#	Serial #
Analyzer	Norsonic	121	31185
Sound Level Calibrator	Brüel & Kjær	4230	1103933
Low Noise 1" Condenser Microphone	Brüel & Kjær	4179	1097574
Low Noise 1" Condenser Microphone	Brüel & Kjær	4179	1865152
Low Noise Microphone Preamplifier	Brüel & Kjær	2660	1097406
Low Noise Microphone Preamplifier	Brüel & Kjær	2660	1885025
Microphone Power Supply	Brüel & Kjær	WB 1057	none

Copies of current calibration logs and certificates are kept on file at the laboratory. All calibrations used are traceable to NIST (the National Institute of Standards and Technology) and were performed at Scantek, Inc. in Columbia, MD.

Before and after the testing, the equipment was calibrated using the reference sound level calibrator, and no irregularities were found.

REMARKS

The test results contained in this report pertain only to the sample submitted for testing and not necessarily to all similar products.

The test sponsor has full control over this information and any release of information will be only to the test sponsor. The specific testing results are deemed to be confidential exclusively for the test sponsor's use. Reproduction of this report, except in full, requires written approval by Orfield Laboratories, Inc.

APPENDIX A: DETAILED DEVICE DESCRIPTIONS

The following detailed descriptive data were provided by the test sponsor.

Test Subjects:

1. **Fractal Design Define R5 Case – Solid Side Panel Version**

Description: This test unit is a desktop midtower ATX computer case/chassis. This product is designed for computer system integrators, builders and consumer DIY'ers that prefer a quiet-focused computer housing.
Manufacturers Description: The Fractal Design Define R5 is the next evolution in the widely popular Define Series. Packed with intelligently designed enthusiast-oriented features delivering a silent case with powerful and expansive air and liquid cooling support, presented in a stunning Scandinavian inspired construction.

The Define R5 case reaches the highest level of silent computing through strategically placed dense sound-absorbing material, ModuVent™ fan vent covers and finely tuned Dynamic Series fans.

The Define R5 was designed with configurability in mind, accommodating up to 8 hard drives and all modern graphics card. Should you wish to expand your system with water cooling components or more fans the layout can easily be configured to meet your demand.

*Note: This test unit is identical to the Fractal Design Define R5 Case – Window Side Panel Version listed below with the exception that this unit features a SOLID side panel as opposed to the window side panel on the unit below.

Purpose with regards to testing:

A.) Illustrate the Sound level of the Fractal Design Define R5 Midtower ATX Computer Case at stock (no modifications from manufacturers factory configuration) configuration. To provide an "out of the box" experience relative to what a consumer would experience with product.
B.) Comparative noise level readings between the Solid Panel and Window Panel variants of the Fractal Design Define R5 Midtower ATX PC case.

Case: Fractal Design Define R5 Solid Side Panel variant (Model Number: FD-CA-DEF-R5-BK)
Power Supply: Fractal Design Newton R3 1000W (Model Number: FD-PSU-NT3W-1000W)
Intake Fan: Fractal Design GP14 Dynamic 140mm Fan (Model Number: FD-FAN-DYN-GP14-WT)

Exhaust Fan: Fractal Design GP14 Dynamic 140mm Fan (Model Number: FD-FAN-DYN-GP14-WT)
Fan control setting (for all tests): 5v via case-integrated fan controller

2. Fractal Design Define R5 Case – Window Side Panel Version

Description: This test unit is a desktop midtower ATX computer case/chassis. This product is designed for computer system integrators, builders and consumer DIY'ers that prefer a quiet-focused computer housing.
Manufacturers Description: The Fractal Design Define R5 is the next evolution in the widely popular Define Series. Packed with intelligently designed enthusiast-oriented features delivering a silent case with powerful and expansive air and liquid cooling support, presented in a stunning Scandinavian inspired construction.

The Define R5 case reaches the highest level of silent computing through strategically placed dense sound-absorbing material, ModuVent™ fan vent covers and finely tuned Dynamic Series fans.

The Define R5 was designed with configurability in mind, accommodating up to 8 hard drives and all modern graphics card. Should you wish to expand your system with water cooling components or more fans the layout can easily be configured to meet your demand.

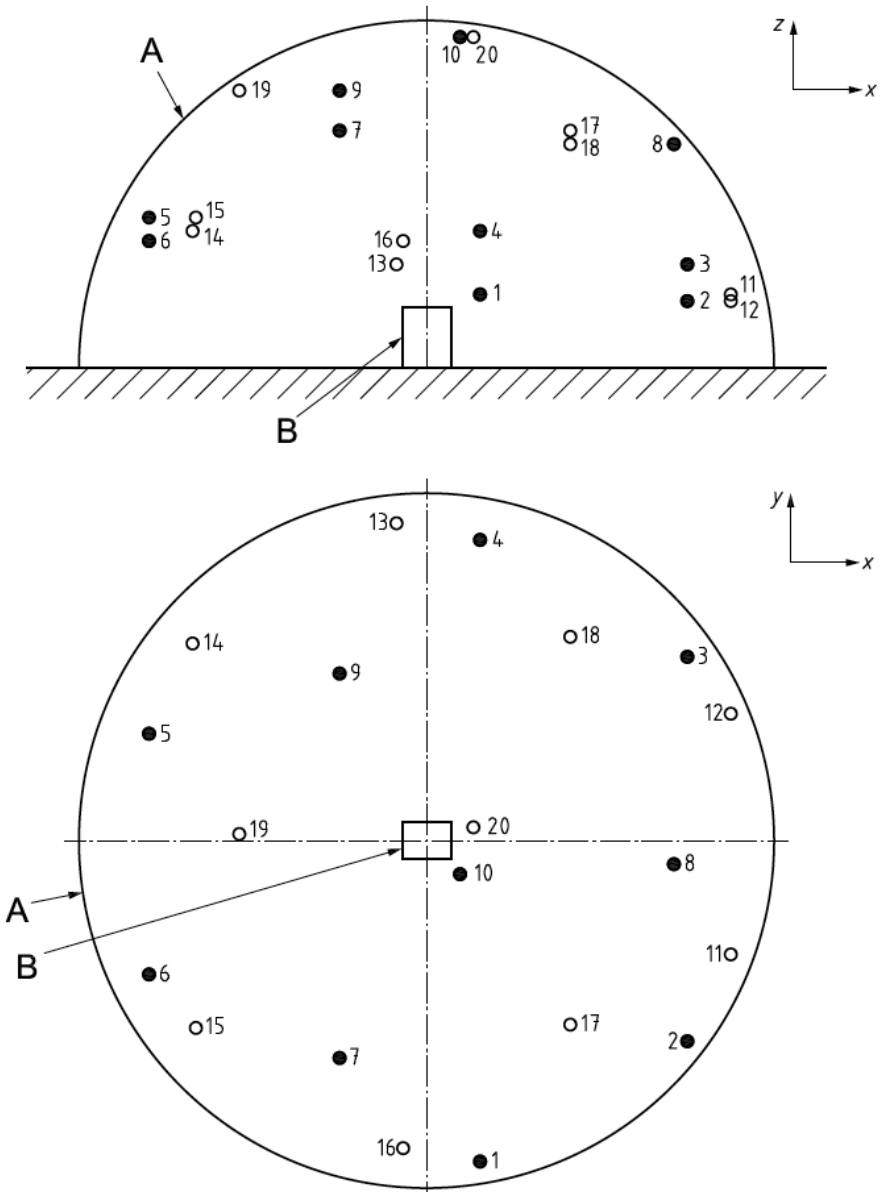
*Note: This test unit is identical to the Fractal Design Define R5 Case – Window Side Panel Version listed above with the exception that this unit features a WINDOW side panel as opposed to the solid side panel on the unit above.
Purpose with regards to testing:

A.) Illustrate the Sound level of the Fractal Design Define R5 Midtower ATX Computer Case at stock (no modifications from manufacturers factory configuration) configuration. To provide an "out of the box" experience relative to what a consumer would experience with product.
B.) Comparative noise level readings between the Solid Panel and Window Panel variants of the Fractal Design Define R5 Midtower ATX PC case.

Case: Fractal Design Define R5 Window Side Panel variant (Model Number: FD-CA-DEF-R5-BK-W)
Power Supply: Fractal Design Newton R3 1000W (Model Number: FD-PSU-NT3W-1000W)
Intake Fan: Fractal Design GP14 Dynamic 140mm Fan (Model Number: FD-FAN-DYN-GP14-WT)
Exhaust Fan: Fractal Design GP14 Dynamic 140mm Fan (Model Number: FD-FAN-DYN-GP14-WT)
Fan control setting (for all tests): 5v via case-integrated fan controller

APPENDIX B: TEST SETUP DIAGRAMS

Microphone positions for sound power tests (pos. 1-10 used) From ISO 3744:2010 Figure B.1



Microphone positions for sound power tests: From ISO 3744:2010 Table B.1

Table B.1 — Preferred microphone positions for all noise sources

Position number	*x*/*r*	*y*/*r*	*z*/*r*
1	0.16	– 0.96	0.22
2	0.78	– 0.60	0.20
3	0.78	0.55	0.31
4	0.16	0.90	0.41
5	– 0.83	0.32	0.45
6	– 0.83	– 0.40	0.38
7	– 0.26	– 0.65	0.71
8	0.74	– 0.07	0.67
9	– 0.26	0.50	0.83
10	0.10	– 0.10	0.99

Operator microphone location (top view) for sound pressure tests. From ECMA-74 Figure C.4c. Microphone height is 1.2 meters above reflecting plane