

Diffusion - Diffraction - Scattering - Reflection

Toll-Free Number:



The most important information about an acoustic device, such as a 'diffuser', is how that device affects sound. With technological advances accelerating at a staggering rate, we believed it would be advantageous to compile all of the measurable acoustic parameters of these devices, in order to develop an operating profile for each.

Sound absorption and sound reflection can both be measured with great accuracy; however, in the absence of a universally excepted diffusion standard, Acoustics First is presenting this data in good faith as we believe it represents the best of what is currently available.

Please note that we are using the word "diffusion", in the broadest possible context as it relates to Diffusion, Diffraction, Scattering and Reflection.



Left: A single Diffuse Reflection.

Right: Multiple Diffuse Reflections contributing to a Diffuse Field.

Excerpt from "Diffuse Reflections in Room Acoustics Modelling." - Heli Nironen. 2004 *Courtesy of Tapio Lokki*, Used by Permission.

"In room acoustics the term diffusion denotes two conceptually different things. On one hand diffusion is a property of a sound field. It describes an isotropy of directional uniformity of sound propagation. Secondly, diffusion is an ability of a surface to scatter incident sound into non-specular directions. Although sound field diffusion may be a consequence of diffusely reflecting boundaries, both items must be well distinguished. The term scattering is somewhere used in connection with diffraction and elsewhere in connection with diffuse reflection. Others have considered different concepts used in context of diffuse reflection.

They have defined and grouped applied terms in the following way:

Diffraction. In a microscopic wave-theoretical view diffraction is one of the causes of diffuse reflection. In applied acoustics diffraction most often means edge diffraction from reflectors and similar objects.

Scattering. Often used in general linear acoustics for the result of diffraction. In applied acoustics this term is used for reflection from a surface with roughness in a more general way.

Diffuse reflection. The most appropriate term to describe the process of reflection from a diffusor or from a diffusive surface."





Binary Array / Angled Cap Design

Some Low Frequency Absorption Moderate Phase Grating & Scattering

Operational Parameters:

Diffusion: Mid to High band Primary: 1K- 4k (extended to 16+K)

Hemispheric Pattern (2D)

Art Diffusor® Model C Diffusor

A patented, two dimensional, quadratic, binary array diffuser. This diffuser improves sound clarity and ambience while increasing the overall perceived space of the room. The range of the Model C is extended over other designs by its unique angled end caps to further control specular reflections above 4 kHz.

Construction: Class A Thermoformed plastic with natural white finish.

Nominal Size: 2'x2'

Depth: 4.5"

Mounting: Direct mount to wall/ceiling **– OR –** Fit into standard T-bar grids.



Sound Absorption Coefficients – Art Diffusor® – Model C Performance										
Mounting	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC			
Type A	0.32	0.20	0.10	0.29	0.20	0.16	0.20			
E400	0.20	0.12	0.12	0.31	0.23	0.22	0.20			







A patented, two dimensional, organic quadratic diffuser; this diffuser provides an asymmetric diffusion pattern to help you tune your acoustic space. A combination of QRD, Bicubic Interpolation, MLS and Boolean systems went into the unique organic curvature, and wide frequency control of this design.

Construction: Class A Thermoformed plastic with natural white finish.

Nominal Size: 2'x2'

Depth: 4.1"

Mounting: Direct mount to wall/ceiling **– OR –** Fit into standard T-bar grids.

Organic 2D Quadratic Diffuser Proprietary Asymmetric Diffusion

Operational Parameters: Diffusion: Mid to High band Primary: 1KHz- 20KHz Wideband Asymmetric Diffusion (2D) Low Frequency Absorption & Scatter Intense Phase Diffusion & Scatter

Ceiling or Wall Mountable



Sound Absorption Coefficients - Art Diffusor® – Model D Performance										
Test	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC			
Туре А	0.23	0.08	0.05	0.19	0.20	0.11	0.15			
E400	0.34	0.14	0.06	0.14	0.14	0.06	0.10			





Art Diffusor® Model F Diffusor A patented, two dimensional, quadratic, binary array diffuser. This diffuser improves sound clarity through the control of distracting, high-frequency, flutter echoes. The range of the Model F is extended over other designs by its unique angled end caps to further control specular reflections above 8 kHz. Modified 2D Quadratic Diffuser Binary Array / Angled Cap Design Construction: Class A Thermoformed plastic with natural white finish. **Operational Parameters:** Nominal Size: 2'x2' Diffusion: Upper Mid to High band Primary: 2K- 8k (extended to 16+K) Depth: 2" Hemispheric Pattern (2D) Mounting: Direct mount to wall/ceiling Some Low Frequency Absorption Moderate Phase Grating & Scattering - OR - Fit into standard T-bar grids. Ceiling or Wall Mountable 500 Hz 125 Hz 1 kHz 31.5 Hz 63 Hz 250 Hz 2 kHz 4 kHz 8 kHz 16 kHz [dB] Full Spectrum Response – Horizontal (180°- Left to Right) 10 90 (Left) 90 (Left) 60 -5 30 0 (Front) 0 (Front) 10 -30 -15 -60 -90 (Right) -90 (Right) 4 kHz 63 Hz 125 Hz 500[']Hz 2 kHz 31.5 Hz 250 Hz 1 kHz 16 kHz 8 kHz -20 31.5 Hz 63 Hz 125 Hz 250 Hz 500 Hz 1 kHz 2 kHz 4 kHz 8 kHz 16 kHz Spectrum Response – Vertical (180°– Top to Bottom). 90 (Top) 90 (Top) 60 -25 30 30 -30 0 (Front) 0 (Front) -30 -35 -60 -60 Full -90 (Bottom) -90 (Bottom) 40 31.5 Hz 63 Hz 125 Hz 250 Hz 500 Hz 2 kHz 4 kHz 8 kHz 16 kHz 1 kHz

Sound Absorption Coefficients – Art Diffusor® – Model F Performance										
Mounting	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC			
Туре А	0.05	0.60	0.07	0.09	0.07	0.13	0.20			
E400	0.20	0.10	0.06	0.05	0.06	0.14	0.05			



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Art Diffusor® Model Q

Art Diffusor® Model Q Diffusor



A one-dimensional, quadratic, well diffuser. This diffuser improves sound by incorporating quadratic residue number sequences to provide uniform broadband scattering. The range of the Model Q is extended over other designs by its unique angled well bottoms to further control specular reflections.

Construction: Class A Thermoformed plastic with natural white finish.

Nominal Size: 2'x2'

Depth: 4" (Nominal)

Mounting: Fit into standard T-bar grids. – **OR** – Recessed mount to wall/ceiling Operational Parameters: Diffusion: Mid to Upper Mid band Primary: Below 1K- 4k (ext. 16+K) 180° Scatter Pattern (1D) Some Low Frequency Absorption Moderate Phase Grating & Scattering

Prime 7 / Angled Well Design

Ceiling Grid or Recessed Wall Mount



Sound Absorption Coefficients – Art Diffusor® – Model Q Performance										
Mounting	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC			
E400	0.35	0.40	0.45	0.30	0.14	0.19	0.30			
E400 ^w /Insulation	0.38	0.39	0.45	0.31	0.13	0.16	0.30			





Aeolian[™] Diffuser



Sound Absorption Coefficients – Aeolian [™] Performance										
Mounting	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC			
Туре А	0.55	0.24	0.22	0.16	0.10	0.13	0.20			
E400 (No Insulation)	0.40	0.26	0.26	0.25	0.17	0.15	0.25			
E400 (Insulated)	0.41	0.24	0.25	0.25	0.17	0.15	0.25			



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Depth: 4"

Mounting: Direct mount to wall/ceiling

Aeolian™Mini Diffuser

Aeolian™ Mini Diffuser (Array of 4 tested-as shown)



A patented, two-dimensional, organic quadratic diffuser. Edge height variation is less than the flange width, creating an "implied edge" while maintaining a complete asymmetry which reduces acoustic lobing associated with some symmetrical designs.

Construction: Class A Thermoformed plastic with natural white finish. **Nominal Size:** 1'x1' Asymmetric Organic Quadratic Operational Parameters: Diffusion: Mid to High-Mid band Primary: 1.5K- 5k Hemispheric Pattern (2D -170°H/V) Wide Phase & Directional Diffusion

Modified 2D Quadratic Diffuser

Ceiling or Wall Mountable Asymmetric Distribution





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QuadraPyramid™ Diffuser

A patented, low-profile, geometric array diffuser. This diffuser is a proprietary array of 4 low-profile, offset pyramids, each quadrant rotated 90°. This provides a wide frequency range with a smooth and predictable response – without sacrificing the space of a larger diffuser.

Construction: Class A Thermoformed plastic with natural white finish.

Nominal Size: 2'x2'

Depth: 2.75"

Mounting: Direct mount to wall/ceiling **– OR –** Fit into standard T-bar grids.

Modified 2D Geometric Diffuser Proprietary Offset Pyramid Array

Operational Parameters: Diffusion: Wide Mid - High band Primary: 1.5KHz- 16+KHz Asymmetric Scatter Pattern (2D) Some Low Frequency Absorption Moderate Phase Scattering

Ceiling or Wall Mountable



Sound Absorption Coefficients – QuadraPyramid™ Diffuser Performance										
Mounting	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	NRC			
Туре А	0.23	0.58	0.05	0.04	0.04	0.11	0.20			
E400	0.28	0.17	0.09	0.07	0.10	0.14	0.10			



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(Note: Test data from a 2'x2' model.)

Modified 2D Geometric Diffuser

Asymmetric Scatter Pattern (2D) Varied Low Frequency Absorption

Asymmetric Offset Pyramid

Operational Parameters: Diffusion: Below <1KHz – 16+KHz

Radical Phase Scattering

Ceiling or Wall Mountable

2'X2' Pyramidal Diffuser



Pyramidal diffusers quickly and easily eliminate floor to ceiling standing waves. They reduce flutter echo while maintaining a warm room sound. Molded in a one-piece pyramid shape, their offset apex provides four different angles of reflection.

Construction: Class A Thermoformed plastic with natural white finish.

Nominal Sizes: 2'x2', 2'x4', 4'x4'

Depth: 8" - 13" (nominal)

Mounting: L-Bracket for Direct mount to wall/ceiling - OR - Manufactured to Fit into standard T-bar grids.

Internal cavity can be lined with a 11/2" thick layer of glass fiber batting to increase absorption and prevent resonance.



Sound Absorption Coefficients – Standard Pyramidal Diffuser											
Size	Mounting	Weight	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	NRC		
2'x2'	D-5	3.58lbs	0.22	0.22	0.17	0.08	0.08	0.06	0.15		
2'x2'	E-400	3.58lbs	0.24	0.22	0.16	0.11	0.10	0.11	0.15		
2'x2' w/insulation	D-5	4.23lbs	0.57	0.41	0.38	0.21	0.16	0.16	0.30		
2'x2' w/insulation	E-400	4.23lbs	0.35	0.28	0.23	0.14	0.11	0.16	0.20		



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Symmetric Design

Operational Parameters:

Smooth Phase Response

Ceiling or Wall Mountable

Diffusion: <500Hz – 16+KHz

Wide 180° Scatter Pattern (1D) Varied Low Frequency Absorption

Various Sizes/Proportions/Options.

(Note: Test data from a 2'x2' model.)

2'x2' Double Duty™ Diffuser



Polycylindrical (barrel shaped) diffusers act to scatter sound in any location. Bass absorption will vary with size. A 2' X 4' has maximum absorption at 125 Hz. Increasing size to 4' X 8' lowers the point of maximum absorption to 63 Hz. Mid to high frequency absorption is typically 0.10 to 0.25.

Construction: Class A Thermoformed plastic with natural white finish.

Nominal Sizes: 2'x2', 2'x4', 4'x4' and *4'x8' (*Molded Fiberglass only).

Depth: 7"

Mounting: L-Bracket for direct mount to wall/ceiling – OR – Manufactured to fit into standard T-bar grids.

Internal cavity can be lined with a $1\frac{1}{2}$ " thick layer of glass fiber batting to increase absorption and prevent resonance.



Sound Absorption Coefficients – Standard Double Duty™ Diffuser											
Size	Mounting	Weight	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	NRC		
2'x2'	D-5	4 lbs.	0.41	0.22	0.19	0.15	0.12	0.05	0.15		
2'x2'	E-400	4 lbs.	0.33	0.27	0.19	0.15	0.11	0.11	0.20		
2'x2' ^w /insulation	D-5	4.7 lbs.	0.64	0.28	0.26	0.18	0.11	0.15	0.20		
2'x2' ^w /insulation	E-400	4.7 lbs.	0.33	0.24	0.21	0.16	0.10	0.15	0.20		





The information within this booklet is only part of the data currently available on the materials that were tested. An electronic component is also available upon request. This electronic data allows for access to the raw test results, enabling further refinement, including previously absent data describing the phase of the reflections, attenuation, and directionality with a granularity exceeding all prior published data.

This electronic data has been compiled for Acoustics First by NWAA Labs in Elma, WA.

Acoustics First is offering this data without warranty, upon request, as no universally accepted standard currently exists.

Contact us for more information. Additional test data and product configurations appear on the web site. More information will be added as it becomes available.



Above: Virtual Test Lab developed by Acoustics First using particle modeling to illustrate the scattering of energy after impacting a surface - Inset (top): Real-World test mangitude data for comparison.

Right: Real-world testing rig at NWAA Labs in Elma, WA, which collected much of the data contained in this work.



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