RFTECH: ENCLOSURE

How Big Can the Enclosure Be?

Tech Tips

Measure the available space in your vehicle, making sure to draw out your design first, and ensure the enclosure will fit through any openings.

Things to Remember

There are no special size limits. (You do, however, want to avoid long, round enclosures in excess of 72" - if the airspace in the enclosure is long and stretched out, the woofer cannot couple to all of the air. When this happens, the air at the end of the enclosure becomes its own separate moving mass and can mistune the enclosure dramatically.)

Re-measure the area you're loading the enclosure into, and make sure the box will fit in through any openings. Nothing is more frustrating than building the perfect enclosure only to find it won't fit through the trunk opening.

Do you want to take up all the available space inside your car/truck/van/sport-utility? Or are you looking for something that is compact enough to be removed easily when necessary? These are important questions you must answer before beginning your project.

First, measure out the area you're interested in placing the subwoofer enclosure. Use a good-quality measuring tape (not your mom's cloth tape from her sewing kit) to determine the MAXIMUM height, width, and depth of your area. Height is the measurement up-and-down, width is the measurement from side-to-side, and depth is the measurement back-to-front. (We'll assume you're using English standards (inches, feet, yards) when measuring, and our example calculations will be done using these standards.)

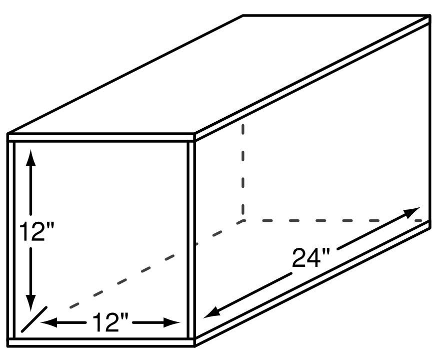
Once you've determined your maximum external dimensions, it is a good idea to start drawing out your enclosure on paper. If you make a mistake, you can simply erase it and start again, versus cutting the wood right away and discovering you have just made something resembling a large toy box.

Since you know what the external dimensions can be, we'll move to the next step!

How Do You Figure the Dimensions?

Tech Tips

Use the volume formula, (H X W X D) ÷ 1,728 to determine your enclosure's internal volume, allowing for displacements of wood, woofer, port(s), and bracing when applicable. (Use the manufacturer's recommended enclosure size.)



12 x 12 x 24 = 3456

3456 ÷ 1728 = 2.0 cu.ft.

Figure A **volume of an enclosure**

Things to Remember

All dimensions you calculate are interior dimensions, unless you specifically include the displacement of the wood used. Allow extra airspace for internal bracing, ports, and the speaker itself (called "displacements").

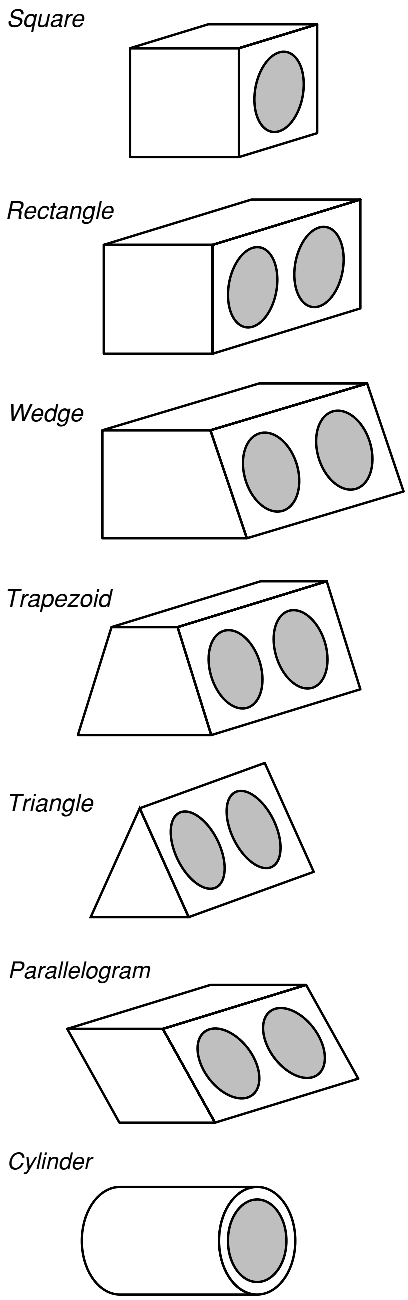
It is extremely important to know the internal volume necessary for the subwoofer you're using (also known as "box size"). Most manufacturers will tell you what the ideal-sized enclosure is for their woofers, and we're no exception. Since not all subwoofers require the same amount of airspace, different lines of the same brand of woofer can have completely different enclosure size requirements. As a general rule of thumb, making the enclosure too small will result in a lack of low-end bass response, and if it's too large, you won't have as much output as you could and the woofer's power handling will suffer. (If you're unsure of the recommended enclosure size for your Rockford Fosgate woofers, please visit the library section at www.rockfordfosgate.com.)

Calculating the correct box size is easy if you just remember a few simple formulas and calculations. The key to calculating internal box dimensions is a basic understanding of volume: Cubic volume is derived by multiplying each of an object's dimensions (height, width, depth) by each other.

For example: If you measure the internal dimensions of a rectangular object (like a subwoofer box) and its internal height is 12", its width is 24", and its depth is 12", and then multiply those dimensions together (12" X 24" X 12"), then you come up with a volume of 3,456 cubic inches. *(See Figure A)*

Enclosure volumes are never listed in cubic inches, so it is necessary to convert from cubic inches to cubic feet. (A cubic foot is no more than 12" X 12" X 12" or 1,728 cubic inches.) So, to convert from cubic inches to cubic feet, simply divide the volume in cubic inches by 1,728. In the case of our example above, this would be 3,456 divided by 1,728, or 2.0 cubic feet internal volume.

Since we know that the woofer will take up space in our enclosure, we will need to add for that volume, called its displacement. Woofers, ports, and internal bracing (covered in the Advanced section of our Enclosure pages) will all have a certain amount of volume they will take up in the enclosure. Their displacement will need to be accounted for in the enclosure, or the enclosure might not sound as good as it can.



Enclosure types

Rockford Fosgate carefully measures the total volume of all of the woofer's components (magnet, basket, cone, etc.) that displace air when loaded into an enclosure. This volume, called "Speaker Displacement," is included in your owner's manual or at www.rockfordfosgate.com. This volume will need to be considered when designing your enclosure if you want it to sound right, as it takes away from the available airspace you have in the enclosure. If you simply make the enclosure larger, it will compensate for how much volume the woofer takes up, and the enclosure will sound exactly the way it was meant to!

Using our example of 2.0 cubic feet, if we load the woofer into the enclosure it won't be 2.0 cubic feet anymore. Using our handy Rockford Fosgate Subwoofer Displacement Chart (See Woofer Displacement Formula Section), we can see that the Punch Power 12" DVC subwoofer displaces 0.21 cubic feet, so we subtract 0.21 cubic feet from the 2.0 cubic feet we have, and the enclosure is now 1.79 cubic feet. Since the recommended sealed enclosure for the Punch Power 12" DVC subwoofer is 1.25 cubic feet to 1.75 cubic feet, we're just about right on with the enclosure! However, if we were trying to make a ported enclosure that was 2.0 cubic feet, we'll need to make the enclosure slightly larger to accommodate for displacements of the woofer and the port! Simply adjust the dimensions of the enclosure (either Height, Width, or Depth) until you have reached the ideal size you're trying to achieve.

Calculating more complicated enclosures with triangular, circular, or wedge dimensions is simply a matter of breaking the dimensions of the enclosure down into basic formulas for calculation. These calculations can be found in **Enclosure Calculation Guide**.

Tech Tips

Use 3/4" Medium Density Fiberboard (MDF), measure out your wood completely before cutting, glue & screw all joints, and seal all joints with a silicone caulk to make the enclosure airtight.

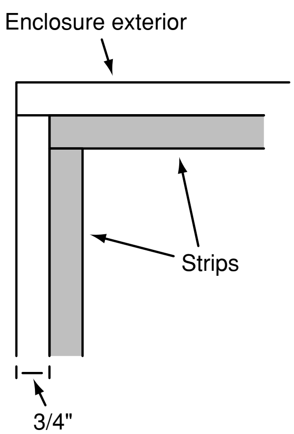


Figure B Butt Joint Example

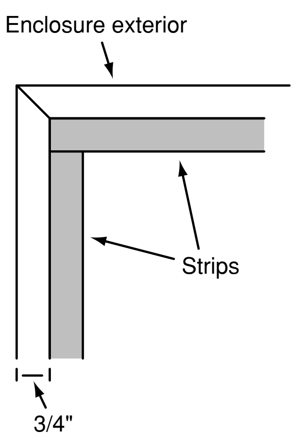


Figure C Miter Joint Example

Things to Remember

Measure twice, cut once!

Once the dimensions of the box are decided, and you know the enclosure will work well for you, the materials need to be selected. The following is a list of common enclosure construction materials:

Particle Board: Very inexpensive, however this board tends to come apart under the high stress of subwoofers, and is very susceptible to water damage! Not suitable for very large enclosures unless a great deal of internal bracing is added for extra rigidity.

Medium or High Density Fiber Board (MDF): The best overall material for speaker enclosures, fiberboard is extremely rigid, and will not come apart at even the highest pressure levels. However, fiberboard is hard to cut (requiring a carbide blade), and is not readily available in smaller stores.

Plywood (all types): A poor choice for car stereo subwoofer enclosures, as plywood tends to de-laminate under heat and weather ranges found in cars. It can also buzz at low frequencies when played at high volume.

Birch, Maple, Walnut (and other dense, natural woods):
Very good for all enclosures, although it is quite expensive.

The choice of materials should be made considering cost, availability, and the type of finish the box will eventually have, so don't spend the money for natural wood if you intend to cover it up with carpet! The thickness of material for the enclosure is governed by the overall size of the enclosure. The smallest of enclosures (1.0 cu ft or less) can use 5/8" or 1/2" material. Average size enclosures (1.0 cu ft to 4.0 cu ft) should use 3/4". Very large enclosures (over 4.0 cu ft) should use 1" material with braces to prevent enclosure flex.

Although there are many different ways to join the edges of enclosures together, the basic butt joint or the 45-degree miter joint are more than adequate for subwoofer enclosures *(See Figure B & C)*. When joined with carpenters glue such as Titebond or Elmer's wood glue and screws, the joints become stronger than the wood itself. Further strength can be added by using corner bracing made out of 1" strips at every inside edge. This will also ensure an air tight seal. The easiest way to put a enclosure together is to "glue and screw" it. *(See Figure D & E)*

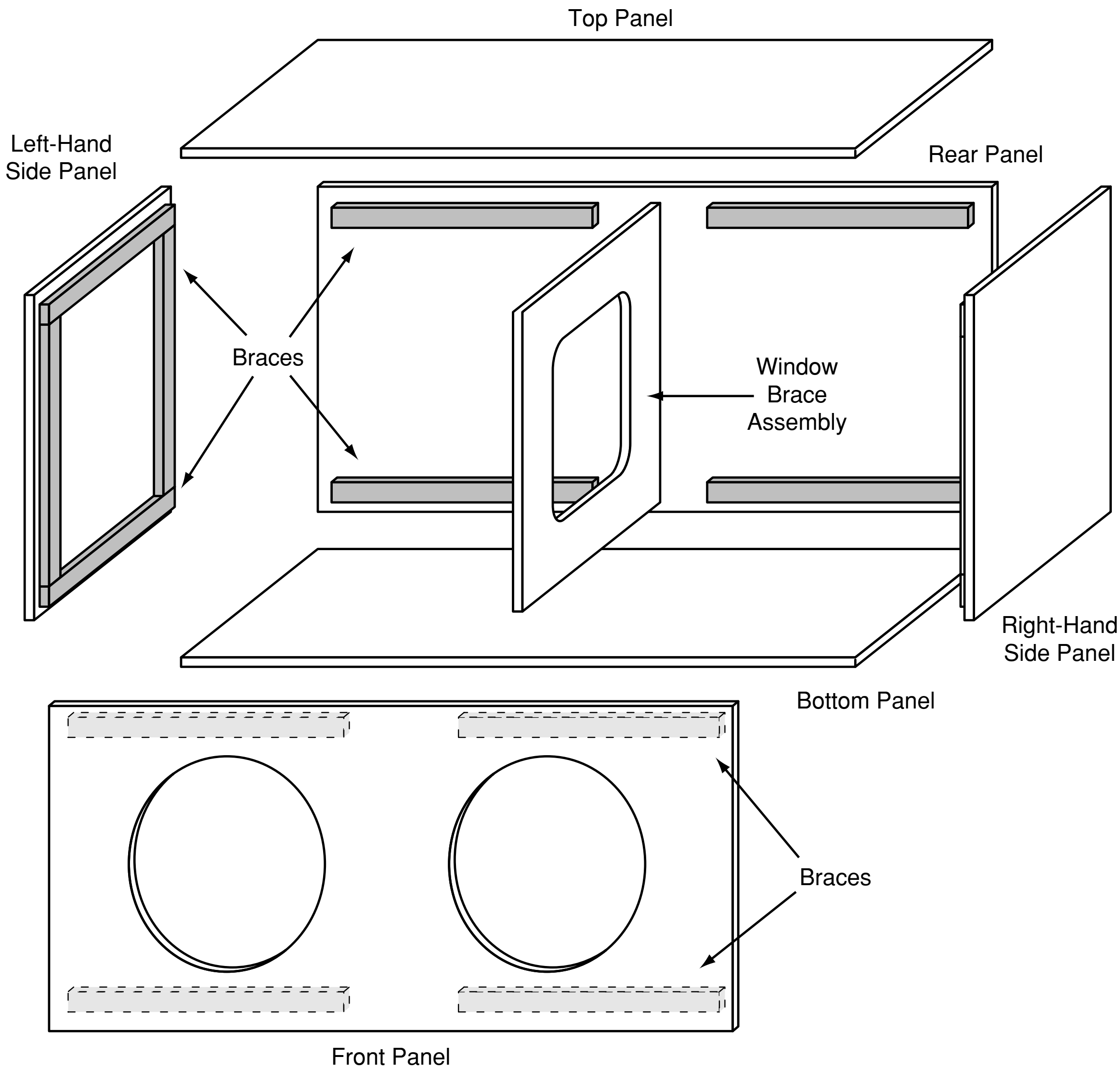


Figure D Parts and Assembly of Enclosure

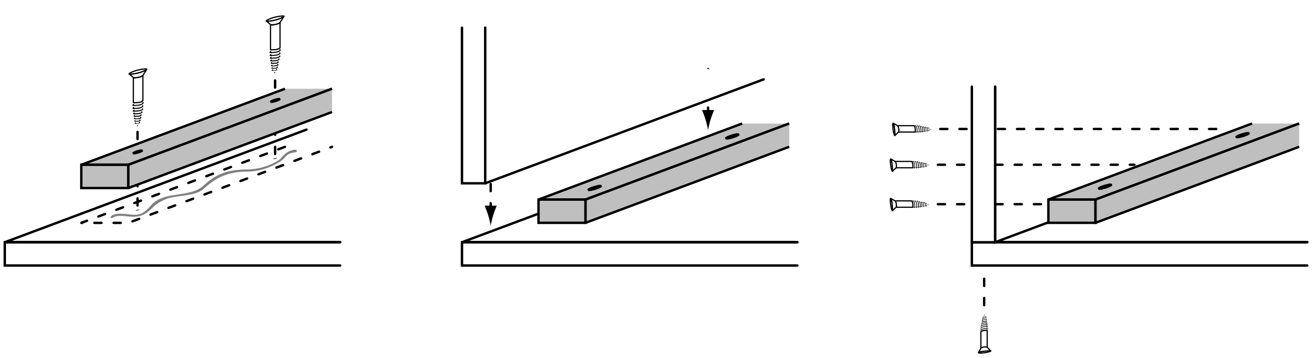
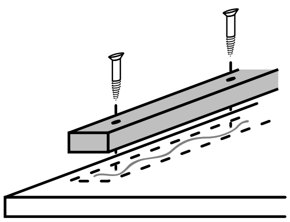
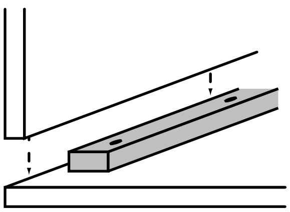


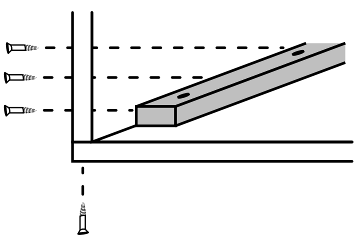
Figure E Corner Bracing Example



- Cut all of the enclosure sides and inner braces.
- Pre-drill and countersink the sides where they will attach to the braces.
- Lay a bead of glue on the brace and line it up with the appropriate edge.
- Screw one edge of the brace to a side, making sure that the edges line up. Remember to pre-drill your screw holes so the wood doesn't split when you put the screw in.
- Screw the opposite edge to the side, again making sure that the edges line up, then continue with the balance of the holes (screws should be placed at 3" intervals).



- Attach the rest of the braces.
- Apply a bead of glue to the edge of the brace and one side.
- Line up the attaching side and screw together the two pieces starting with the far edge.
- Continue with each screw in line, making sure that the edges stay flush. (This will take any warp out of the wood.)



- Continue the rest of the enclosure. In addition to the corner braces, it may be necessary to brace the enclosure from side-to-side, or top-to-bottom. In the case of such large surface areas, enclosures will tend to flex at the lower frequencies. This can cause distortion, a "boomy" box sound, and wastes energy that could be used to attain higher output levels. Anytime that you have an area larger than 1' X 2', you should put a brace in the middle. *(see window brace in Figure D)*
- Finally, remember to keep your enclosures airtight, even in the case of a vented system. All subwoofer systems can be mis-tuned dramatically from small amounts of leakage, so using a high-quality silicone (not latex) sealant from GE or DAP to seal all joints will make your enclosure work just right. The speaker itself may be sealed to the enclosure with foam gasket material or rope caulk to assist in preventing air leaks. Make sure to caulk around the holes cut for the ports as well, if your enclosure uses them.

Damping Enclosures

Adding damping material, such as lambs' wool, fiberglass, or Dacron polyester (pillow stuffing like Poly-Fil) to your subwoofer enclosure helps cancel any standing waves or resonances that form in the enclosure because of its particular dimensions. We recommend adding stuffing only if you need to, and only to sealed enclosures. It won't make up for a poorly-constructed enclosure or an enclosure that's built too small, but it can help make the enclosure play low frequencies with added emphasis.

It is possible to make your speaker think that it is in a larger box than it actually is by adding extra damping material, up to 75% of the entire enclosure volume. The general rule here is to add 1 pound of fill material (R-19 fiberglass, Dacron, or lamb's wool) per cubic foot of enclosure volume.

Naturally, you can vary the amount of fill you use to fit your personal taste. If you want to gradually change the way a sealed box sounds, add damping material to the enclosure beginning with about 10% fill, and adding up to 75% of the total enclosure volume according to the way you want the enclosure to sound. Don't compress the material, just loosely add fill to the enclosure. This works because the fibers of the material cause the sound waves to bend around them, slowing the waves down and taking longer to reach the enclosure's sides. As much as a 15% change in box volume/response can be achieved by this method.

Recommended Reading

Loudspeaker Design Cookbook, 5th Edition
Vance Dickason

Old Colony Sound Labs
Post Office Box 243
Peterborough, New Hampshire
03458-0243 U.S.A.

Building Speaker Systems, 2nd Edition
Gordon McComb, Alvis J. Evans, Eric J. Evans
Radio Shack part #62-1087

Master Publishing
14 Canyon Creek Village MS31
Richardson, Texas 75080 U.S.A.
214-907-8938

Advanced Speaker Systems
Ray Alden
Radio Shack part #62-2317

Master Publishing
14 Canyon Creek Village MS31
Richardson, Texas 75080 U.S.A.
214-907-8938

Enclosure Calculation Guide

TERMS

- H = Height
- W = Width
- D = Depth
- D_1 = Top Depth
- D_2 = Bottom Depth
- B = Base
- L = Length
- r = Radius

Enclosure Type	Calculation for Cubic Feet
Square	(H X W X D) ÷ 1,728
Rectangle	(H X W X D) ÷ 1,728
Wedge	((D_1 + D_2) X 0.5 X H X W) ÷ 1,728
Trapezoid	((D_1 + D_2) X 0.5 X H X W) ÷ 1,728
Triangle	((0.5 X B) X H X W) ÷ 1,728
Parallelogram	(H X W X D) ÷ 1,728
Cylinder	((3.14 X r X r) X L) ÷ 1,728

Woofer Displacement Formulas

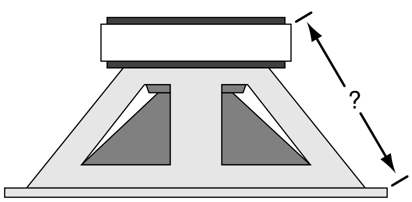


Figure F Speaker Displacement

Due to different manufacturing designs and materials used, the formula for calculating speaker displacement is not perfect but at least it works better than dipping the speaker into a bucket of water.

Speaker Displacement = 4 X 0.33 X 3.14 X the distance from the back of the mounting lip to the rear of the magnet ^ 3 X 0.5 X 0.6.

For example: using a Punch Power 12" DVC woofer, which has 6.03" inches from the back of the mounting lip to the rear of the magnet *(see Figure F)*.

4 X 0.33 X 3.14 X 6.03 ^ 3 X 0.5 X 0.6 = 273 cubic inches (0.16 cubic feet) displacement

CAUTION: Using this formula can result in up to 25% tolerance difference. For precise figures, please refer to the pre-calculated **Subwoofer Displacement Chart** in your Rockford Fosgate owner's manual or use the handy chart on the next page.

Woofer Displacement Chart

Model	Displacement (cubic feet)
Punch RFZ	
RFZ 2408/2808	.05
RFZ 2410/2810	.06
RFZ 2412/2812	.09
RFZ 2415/2815	.113
RFZ 3408/3808	.05
RFZ 3410/3810	.06
RFZ 3412/3812	.09
RFZ 3415/3815	.11
RFZ 1408/1808	.05
RFZ 1410/1810	.06
RFZ 1412/1812	.09
RFZ 1415/1815	.113

Model	Displacement (cubic feet)
Punch HE	
RFP 3408/3808	.035
RFP 3410/3810	.060
RFP 3412/3812	.085
RFP 3415/3815	.135
RFP 3406/3806	.018
Punch XLC	
RFP 2408/2808	.05
RFP 2410/2810	.06
RFP 2412/2812	.09
RFP 2415/2815	.113
RFP 2418/2818	.19

Model	Displacement (cubic feet)
Punch HX2	
RFD 1208	.041
RFD 1210	.055
RFD 1212	.069
RFD 1215	.109
RFD 2208	.041
RFD 2210	.055
RFD 2212	.069
RFD 2215	.109
RFD 1218	.300
RFD 2218	.300
RFD 3118	.244
RFD 3218	.244
RFD 2110	.055
RFD 2112	.069
RFD 2115	.109
Punch HE2	
RFP 3208	.031
RFP 2208	.031
RFP 2210	.050
RFP 3210	.050
RFP 2212	.066
RFP 3212	.066
RFP 2215	.103
RFP 3215	.103
Punch DVC	
RFP 1208	.035
RFP 1210	.06
RFP 1212	.085
RFP 1215	.135

Model	Displacement (cubic feet)
Punch Power HX2	
RFR 3110	.11
RFR 3112	.12
RFR 3115	.19
Punch Power	
RFR2210	.12
RFR2212	.21
RFR2215	.25

Vent Displacement Formulas

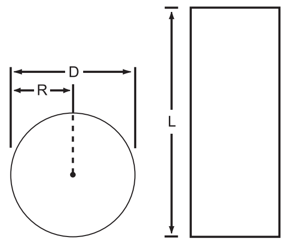


Figure G Vent Displacement

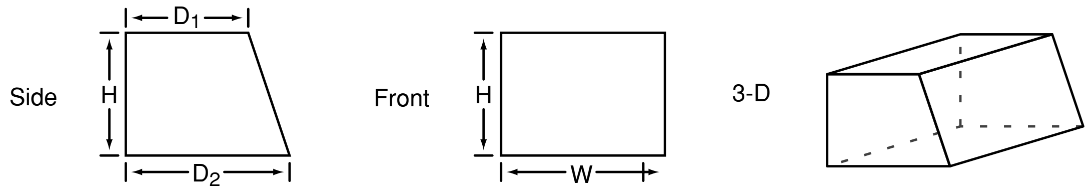
The formula for figuring displacement of a vent is as follows:

Vent Displacement = (1/2 the outside diameter X 2) X 3.14 X length of the vent

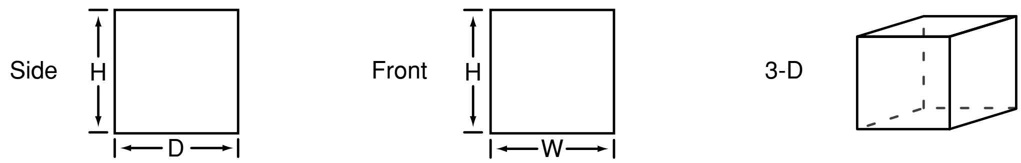
For example, a 4" port, 5" long would figure like this: (a typical 4" port has an outside diameter of 4.5"): 2.25 X 2.25 X 3.14 X 5.0 = 78.46 cubic inches of displacement!

	Port Diameter					
Port Length	2.0"	2.5"	3.0"	4.0"	5.0"	6.0"
2.0"	0.007	0.009	0.011	0.015	0.018	0.022
2.5"	0.009	0.011	0.014	0.018	0.023	0.027
3.0"	0.011	0.014	0.016	0.022	0.027	0.033
3.5"	0.013	0.016	0.019	0.025	0.032	0.038
4.0"	0.015	0.018	0.022	0.029	0.036	0.044
4.5"	0.016	0.020	0.025	0.033	0.041	0.049
5.0"	0.018	0.023	0.027	0.036	0.045	0.055
5.5"	0.020	0.025	0.030	0.040	0.050	0.060
6.0"	0.022	0.027	0.033	0.044	0.055	0.065
6.5"	0.024	0.030	0.035	0.047	0.059	0.071
7.0"	0.025	0.032	0.038	0.051	0.064	0.076
7.5"	0.027	0.034	0.041	0.055	0.068	0.082
8.0"	0.029	0.036	0.044	0.058	0.073	0.087
8.5"	0.031	0.039	0.046	0.062	0.077	0.093
9.0"	0.033	0.041	0.049	0.065	0.082	0.098
9.5"	0.035	0.043	0.052	0.069	0.086	0.104
10.0"	0.036	0.045	0.055	0.073	0.091	0.109
10.5"	0.038	0.048	0.057	0.076	0.095	0.114
11.0"	0.040	0.050	0.060	0.080	0.100	0.120
11.5"	0.042	0.052	0.063	0.084	0.104	0.125
12.0"	0.044	0.055	0.065	0.087	0.109	0.131
12.5"	0.045	0.057	0.068	0.091	0.114	0.136
13.0"	0.047	0.059	0.071	0.094	0.118	0.142
13.5"	0.049	0.061	0.074	0.098	0.123	0.147
14.0"	0.051	0.064	0.076	0.102	0.127	0.153
14.5"	0.053	0.066	0.079	0.105	0.132	0.158
15.0"	0.055	0.068	0.082	0.109	0.136	0.164
15.5"	0.056	0.070	0.084	0.113	0.141	0.169
16.0"	0.058	0.073	0.087	0.116	0.145	0.174

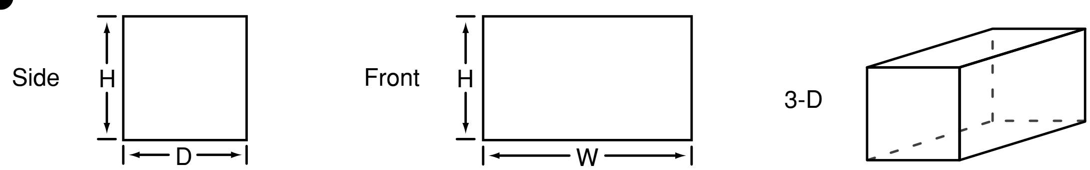
Wedge



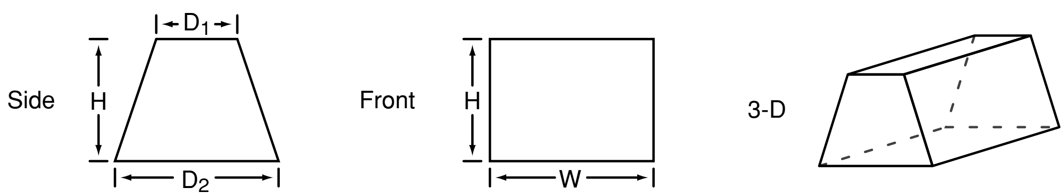
Square



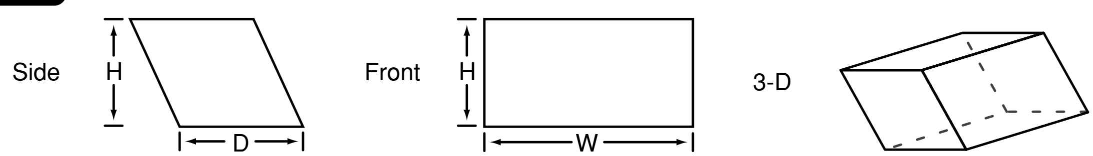
Rectangle



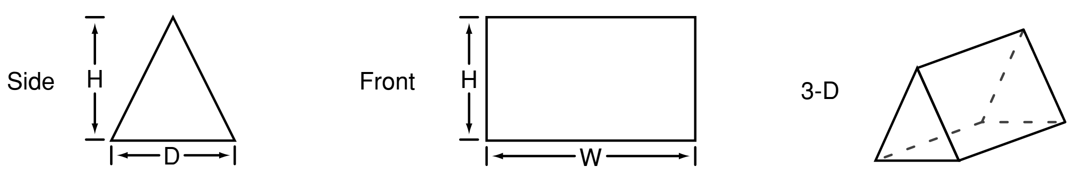
Trapezoid



Parallelogram



Triangle



Cylinder