dB616TL

For anybody looking for the original dB61TL, you won't find it here. The single woofer version has been replaced by this MTM version with a new, simpler crossover.

As an experimental modification to the original dB61TL, the dB616TL proved to be better in several respects. The original traits remained, but addition of the second woofer allowed baffle step compensation to be built in and provided a closer match with the tweeter's output. The result is that, despite the added cost of a second woofer, the cost remains almost the same, and the sound is improved with more bass and a cleaner midrange. Plus, you get a cheaper price if you buy four woofers!

The build process that follows is just a recommendation. Many other techniques can be used.

Notice: The shielded versions of the woofer and tweeter are now recommended as direct replacements for the unshielded versions. You can see the SPL response comparison below.

However, If you're contemplating building the dB616TL using the new shielded drivers, you will need to adjust the location of the upper/first reflector.

Make it 7 5/16" long instead of the 8 1/32" shown on the drawing. This will allow it to be moved back about 1/2" which should provide the clearance needed for the shielded woofer's larger magnet.

Photos by Barry Waldron. Barry is well known for his expertise and promotion of electrostatic loudspeakers. Check out his web site: http://www.eslinformation4u.com

Comments or Questions, e-mail: mailto:dbrown_removethis_@d-web.com

Note to potential builders: I've received some feedback and questions recently about the dB616TL. Before you decide to build this speaker, here are a couple of comments:

1. The enclosure is not as easy to construct as it might look at first glance. It is helpful to have access to a table saw/radial arm saw and to have some experience using a router -- or have somebody helping who has. There is also some work involved in getting the stuffing and acoustic foam installed and it may need to be adjusted by listening.

2. The design goal of this, and most transmission line speakers is, to produce bass which is non-resonant and smooth. If you're looking for loud or hard kicking bass, this isn't the correct design.

3. If you have any questions about building the dB616TL, please e-mail me.

The idea for this design was inspired by a visit to the home of Nelson Pass, owner, CEO, and chief designer at Pass Labs. Nelson is well known for his current line extraordinary Pass Labs amplifiers but many will recall his Zen amp, Son of Zen, the A40 and many more designs which have been published over the years. Nelson is also a fanatic DIYer and strong supporter of audio hobbyists as is evidenced by the plethora of DIY amplifier projects available on his website http://www.passlabs.com/. When I visited Nelson's home, he demonstrated a speaker with a 9 ft. line and, if I recall, a 6 inch woofer. The most I remember is that the design was very simple – basically a box with two dividers to create the line. It's hard to remember because of all the other projects he had built and was in the process of building throughout his house and workshop. Mind boggling to say the least!

A note about transmission line bass: The goal of a t-line system is to produce bass which is totally free of port and box resonances. The result should be a very natural sound which is full but not boomy. You may find that you prefer louder bass with more kick or punch. If so, a vented design may be more to your liking and there are several available which use the same drivers as the dB616TL. Also, the bass response of the dB616TL is not perfectly smooth, that is, there are some response anomalies. Part of this is controlled by stuffing, but some ripples remain. Nonetheless, I have found the sound to be pleasant and very listenable.

I'd been playing around with the Parts Express/Dayton 6 ½ inch woofer for several projects. One was a vented two-way project designed for and built as an employee project for at work. This evolved into a W-T-W two-way floor standing design I built for my son. These designs also used a new tweeter from Parts Express – a 1 1/8 inch silk dome tweeter. Both the woofer and tweeter worked extremely well in those speakers and are still much in favor in an almost cult-like following on the Parts Express discussion forum at http://www.partsexpress.com/.

To the right is a pic of a dB616TL sent to me by Paul Ogglesby who built this design. His craftsmanship is obviously outstanding. He used cherry veneer and some very advanced finishing techniques using cherry veneer, natural antique cherry analine dye & hand rubbed paste varnish finish.

Zach Condi took his pair of speakers to the DIY Dayton get together in October 2003. Pics from the show are to the right. A summary of comments by listeners at the function were posted on the PartsExpress Tech Talk forum by PJay and I am listing them here verbatim to help you possibly decide if you want to undertake the project. It should be noted that the crossover Zach used was the earlier dB616TL version. The current version of the crossover actually addresses comments made about the need for increased baffle step compensation and midrange forwardness. I also believe the sibilance noted is further reduced, although part of it is the inherent sound of the Dayton tweeter.

> "DB616 TL Dayton 6.5"/silky
> Slight sibilance, great speaker, esp. for the money.
> Crisp highs, mids a little shallow. Good bass, nice speaker.
> Good sounding speakers. Good imaging.
> Best bang for the buck of the day.
> Forward perspective, strong mids, probably needs more baffle step comp.
> Slightly forward, good overall, trumpet good and not edgy. Nice speaker."

Zach received many excellent comments for his craftsmanship and his use of Formica laminate. That technique has a lot of advantages. I believe the laminate is relatively inexpensive, comes in a multitude of colors, and requires zero staining, sanding, sealing, etc.

Here's a link to Dave Case's website which includes, among other very interesting things, his trials and tribulations during the construction of his pair of 616TLs. Lessons learned in Dave's project -- lots of bandaids and sharp router bits!

Here's a pic of dB616TLs Aaron Scalise is building for a friend. Still unfinished, but the craftsmanship looks excellent. Click on the pic for a close in image.

DRIVERS

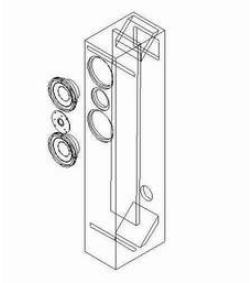
Parts Express Part Number 275-070

Parts Express Part Number 295-305

Parts Express Part Number 275-075

Parts Express Part Number 295-306

See the SPL response below which shows a comparison between the shielded and unshielded versions of these drivers. For the most part, the differences are minimal.



Here is a rough 3D drawing to show the relative locations of the main parts. The transmission line is 94 inches long -- from the upper woofer to the terminus at the rear. If we include another 12" from the rear to the front it makes the total acoustic line distance 106". The line tapers from 35 sq. in to 26 sq. in. -- a taper ratio of 75%.

The following tables and drawings show the parts list, enclosure part dimensions, and crossover layout and parts list. The drivers, crossover components and accessories are available from www.partsexpress.com.

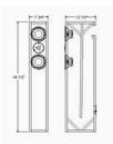
Parts and Cost for One Speaker			
Item	Quantity	Cost/Each	Price
6 1/2" Woofer	2	$15.20	$30.40
1 1/8" Silk Dome Tweeter	1	15.50	15.50
3/4" MDF, 4' by 8' Sheet	1	18.55	18.55
Polyfil Stuffing, 20 Ounce Bag	1	2.89	2.89
Terminal/Binding Posts Bi-Amp	1	4.35	4.35
Crossover Parts			
C1 (027-427, Dayton MPP)	1	2.15	2.15
C2 (027-420, Dayton MPP)	1	1.77	1.77
Ce (027-358, Non-Polarized Electrolytic)	1	1.80	1.80
L1 (266-814, 18 ga. AirCore)	1	2.90	2.90
L2 (266-816, 18 ga. Air Core)	1	3.75	3.75
Req (016-6, 10W)*	1	.39	.39
Rs (016-2, 10W)	1	.39	.39
Rp (016-12, 10W)	1	.39	.39
Grille Cloth	1/2 Yard	7.50	3.75
Grille Guides, Small	8	1.90	1.90
Glue	1/2 Bottle	4.00	2.00
Rope caulk, Ace 52515	1 roll	1.79	.90
		Total	$93.78
* 016-6 is no longer available at Partsexpress. You can substitute two 12 ohm resistors (016-12) paralleled or use the non-inductive version (004-6).			

Construction is basically easy, but there are a couple of tools and techniques that will make it easier. A router with a setup for cutting holes for the drivers, i.e. a circle cutting jig, makes for a very smooth cutout, although I used a 3 1/2" hole saw for the tweeter. 1/2 inch and 3/8 inch rabbeting bits will help to cut the flush mount rabbets. The technique for that is to cut a hole 1 inch or ¾ inches smaller than the diameter of the overall diameter of the speaker flange, then use the rabbeting bit to cut the flush mount portion to the flange diameter. Set the depth to correspond to the thickness of the speaker flange and the gasket or sealant you'll use to mount the drivers.

Another technique for cutting holes that I like best of all involves the use of templates. I cut the template so that it looks just like the hole I'm trying to make in the speaker. Use 1/8" or 1/4" hardboard and a jigsaw to cut the shape. Make sure to cut carefully and sand smooth since the hole you cut in the speaker will be exactly like the template. Attach the template to the baffle with a couple of screws and, using a 1/4" router bit with bearing on the end, cut the hole. The bearing rides on the edge of the template. Note, that this must be done before the speaker is assembled. Also, it's almost a necessity to use a router table for this since there won't be much surface for the router to ride on near the edge of the baffle.

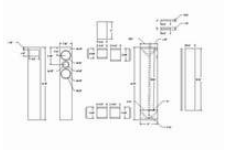
Another very useful technique is to cut the front, back, top, and bottom slightly oversize (about 1/8" on each edge), then trim the overhang after assembly. For this, a straight bit with bearing is needed.

I assembled the box using drywall screws and glue, but since have gone to using finishing nails instead of screws. It takes a little getting used to, but you don't have to pre-drill and counter sink and you don't have the big holes to fill. Really careful parts cutting can result in the need to use no fasteners. You'll know if this is something you can do.

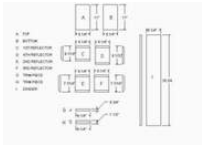


Here's a drawing showing the overall size and layout.

Here are the parts with dimensions.

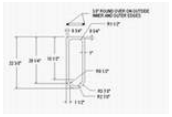


The reflectors, top/bottom, and miscellaneous parts. When using the shielded drivers, cut the first reflector (D) to a length of 7 5/16" instead of 8 1/32" so it can be moved back about 1/2".



Baffle and rear panel. These go over the top/bottom/sides.

The grille shown is made of 3/4" MDF and can be covered with black grille cloth. Width of the grille should be slightly narrower (approximately 1/8") than the finished cabinet to allow for the thickness of the cloth.



An important tweak. Paul Ogglesby provided the following and I tried it with my prototype pair of dB616TLs. I heard a smoother presentation, reduced grain, improved detail, and maybe (?) more, smooth bass. Here are Paul's remarks:

"Just thought I'd send a pic of my latest tweak. I picked up some
caulking cord at my local Home Depot & covered all of the mid's frame &
magnet. I also covered the back of the tweeter. It made a huge
difference in the smoothness & over all definition of the speakers. They
are, for a lack of a better description, more musical. Even my teenage
kids noticed the difference. I don't know if you have ever tried this
tweak but in my opinion it is a high value - low cost mod.
I am still looking forward to trying the new crossovers but this should
keep me going until then....LOL."

I bought a package of rope caulk at my local Ace Hardware -- one package was just enough since I didn't put any on the magnet like Paul did -- for $1.79. This is definitely a cost effective improvement!

There are two other modifications that Paul has done to his speakers which he says provide even more improvement in bass and overall definition. The first is to brace the woofers using blocks between the woofer magnet and the divider. Between the brace, Paul used some butyl caulk he had (I think you could use the black bituminous sealant that Parts Express ships with their woofers). Since it's virtually impossible to make the block a perfect fit between the woofer and divider, leave a small gap between the block and the woofer magnet which will be filled with the caulk. When you install the woofers, the caulk will compress and maintain the connection with the woofer.

The blocks Paul used were "U" shaped to fit the bumped back plate and the block for the upper woofer is angled at 45 degrees to match the first reflector.

The second modification is to epoxy 1/4" steel plates inside the transmission line cavity. Paul says this mod makes a major improvement. You can buy the plate from a fabrication/machine shop and it's not too expensive. It comes in 4" wide stock which you can cut to various lengths to fit. They'll charge something like $2 a cut.

Here's a building sequence to use:

Cut out all parts.

Cut driver openings and flush mount recesses in baffle. If you're using a Jasper jig, you probably need to cut the flush mount recess first. For other methods, you can either cut the flush mount recesses now or wait until the veneer is applied.

Cut hole for terminal cup in rear panel.

Lay out in pencil the locations of the four reflectors and the divider on both side panels.

Glue the divider, top, and bottom in place between the two sides.

Glue the four reflectors in place.

Install triangular piece "G" to top of reflector "C".

Install piece "H" onto rear panel centered horizontally and at a point which will be 4 1/4" below the lower edge of piece "G". Note, these last two steps are done now so that the terminus can be cutout with a router using "G", "H", and the sides as guides.

Glue the front baffle and rear panel in place.

Cut out the terminus opening.

Paint or apply veneer as desired.

Install wiring from terminal cup to drivers.

Install acoustic foam behind the drivers on the front side of the divider.

Install poly-fil stuffing.

Install drivers.

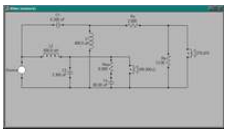
Stuffing procedure: start with about 3/4 of a bag (bags I buy are 20 oz, so that would be around 15 oz). Play music and listen with your ear at the terminus. If you hear midrange, add more stuffing...but, be conscious of adding too much and cutting off the bass. If you have access to impedance measurments, adjust the stuffing to attain a single hump in the low frequency range. I will try to come up with a more definitve method, but, since your poly fil material may differ from what I have, it may be hard to do.

The terminus. This is easily created with a router straight cutting bit with bearing. The bearing guides on the sides of the box and the triangular pieces attached to the rear panel.

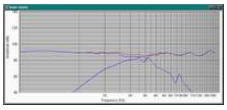
The terminal cup. Inexpensive but works well. The cutout shown in the drawings is for this.

CROSSOVER

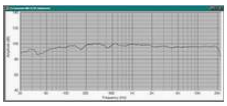
Note: Here is a link to the crossover I originally designed for the dB616TL. Paul Ogglesby commented that he prefers this version to the new one and you may prefer it as well. The old version provides a flatter response such that the midrange will be slightly more open at the expense of a bit less warmth in the midbass.



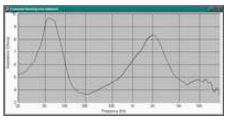
The crossover design is to the right. Feel free to upgrade components as you see fit.



Crossover simulation from SpeakerWorkshop.

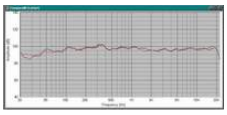


Here is the SPL response taken at 0.5 meters using SpeakerWorkshop.



And here is an impedance curve taken using my Woofer Tester. Note the single hump low frequency response indicating the transmission line behavior. The minimum impedance is a bit less than 4 ohms at 220 Hz.

Depending on your listening room, and your taste and hearing acuity, you may want to adjust the tweeter level. Below is a table of resistor values for various attenuation values. Feel free to try them. Rs goes between where L1 attaches to C1 and the tweeter. Rp goes across the tweeter, i.e., from the + to the - terminal of the tweeter.



This chart shows the response comparison between the shielded and unshielded drivers. The measurements were taken with the same mic location and settings. A slightly lower response in the 1700 Hz range can be, but it should not be audible. The difference in the bass response below 70 Hz is probably a difference in stuffing between the two speakers tested which occured when I did some adjustments. So, as for now, I recommend using the shielded drivers as a direct "drop in replacement" and no changes to the crossover. Just don't forget to move the first reflector to clear the big magnet cup!

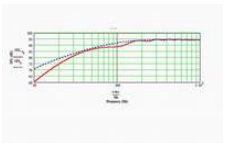
L-Pad Resistor Values

(for adjusting tweeter level)

Desired Attenuation, dB	*Rs*	*Rp*
1	0.65	55.0
2	1.2	24.2
3	1.7	14.9
4	2.2	10.4
5	2.6	7.8
6	3.0	6.0

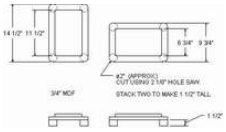
7	3.3	4.8
8	3.6	4.0
9	3.8	3.3
10	4.1	2.8

Martin King has developed some exciting simulations using MathCad which allow us to look at predicted transmission line behavior based on driver parameters, line geometry and line stuffing density. His web site is http://www.quarter-wave.com/ where he provides extensive theory on various line types, some of his designs, and information on how to download MathCad and run his simulations.



The graph to the right shows the far field spl response (red trace) and infinite baffle response (blue) of the dB616TL. It should be noted that this response may not represent accurately the behavior of a two woofer line. Martin's simulation is for a single driver. I entered the net parameters (Sd, Re, Vas, and Le) for two woofers connected in parallel. Since the woofers are not coincident, ie, they're located with the second driver 11 3/4" downstream of the first, there will be a difference in the location and amplitude of the ripple effect. The difference could be such that the ripple is smoothed, however that is only speculation. I hope to complete some ground plane bass measurements to get a more accurate view of these effects. (There are some similarities between the MathCad simulation and the measured response shown in the charts above, but the response below 100 Hz for the measurement is definitely not valid, and above that, room reflections come into play.

These pics are of a pair (single woofer version) I built for Beverly, a friend of Barry's. We also included a dB10tit -- Titanic 10 Mk II subwoofer -- which helps with the bass in her large room.



The base is a design created by Dan "Lefty" Carroll. Dan came up with the idea of using the inner part left after cutting a hole using a hole saw as disks for feet on a speaker base. After the disks are cut out and attached to the base, they are used as guides to router a round corner on the base. The design shown uses two disks stacked to make feet 1 1/2" tall. Also, a spacer plate is added between the speaker bottom and the base -- just for looks. This idea came from Barry Waldron. You can paint the bases as you like. I used spray on Truck Bed Coating.

If desired, you can install spikes into the feet for improved coupling to carpeted floors.

That's it. Good Luck!