

Speaker Re-foaming (Surround Replacement)

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Introduction

The speaker surround can be found around the perimeter of the speaker cone, attaching it to the basket—the metal framing forming the exterior of the unit. It is often made of foam, though it is also sometimes made of rubber, or more exotic materials. The speaker surround serves two purposes. Firstly it supplies the returning spring force necessary for the speaker to be a harmonic oscillator. On larger speaker cones the surround works in conjunction with a spider. The spider can be found at the narrow end of the cone, near the voice coil. Secondly, the surround (and spider) also align the cone correctly in the basket, which entails keeping the voice coil correctly aligned in the gap—the optimal area in the permanent magnetic field where the coil is designed to sit.

The most common reason to replace the speaker surround is damage. If a speaker surround is partially torn it may provide inadequate or asymmetric spring force, which can cause diminished output, improper frequency response—discussed below—and possible damage to the voice coil if it scrapes the edges of the gap. A surround that is entirely torn should result in a completely non-functional speaker. Another reason to replace the surround, before any damage has occurred, is material deterioration such as stiffening. If the surround becomes brittle or stiff, it can diminish output, and will shift the resonance which will bring it out of design specifications and likely make it a poor match for the cabinet that was designed for it. The resultant frequency response may have undesirable peaks and roll-off.

Procedure

Luckily replacing the surround can be very affordable, does not require specialty tools, and can be done at home. It can also be done professionally. For a pair of JBL LE14A (14 inch) woofers, the cost of the kit was around \$25. Unfortunately it makes up for the aforementioned by being extremely tedious and delicate. In this case, the removal of old surround and adhesive was difficult, slow, and error-prone. One must be careful not to tear the cone, which is best accomplished by applying a shear force to remove the old adhesive, and possibly employing a small, somewhat-blunt “pick” such as a small standard-type screwdriver. (If too small of a pick is used, such as an eyeglass screwdriver, it will become too easy to puncture the cone surface and begin burrowing). Shear forces (as opposed to a lifting force, normal to the surface) are unfortunately harder to counter, and it is important to make sure there is not excessive torque on the cone, trying to twist against the spider, or tilting it such that the voice coil scrapes or becomes deformed. **SPEAKER RE-FOAMING SHOULD ONLY BE PERFORMED BY SOMEONE WITH MODERATE PATIENCE.** This removal took as much as three hours *per cone*.



The use of solvents has been suggested on some forums to aid in the adhesive removal. Some solvents mentioned were butanone (methyl ethyl ketone or just “MEK”) and acetone. In this case, MEK was also advised by the manufacturer, but nonetheless still reportedly had the ability to release the surface treatments on the cone. In this case, the removal was completed *without* solvent.

After removal is satisfactory, the installation of the new surround will begin. The LE14A is more than large enough to require a spider. The spider more or less keeps the voice coil positioned correctly in the gap, in a 2d planar sense. The voice coil can twist a bit (imagine a cylinder whose axis is no longer normal to a plane) as the front of the cone can jiggle in the basket without a surround present. As the face of the cone moves, and twists the coil, the spider also becomes warped instead of being symmetrically depressed or stretched. Luckily this means that there is a restoring force in the spider (which the factory hopefully installed to be flat for a correct coil alignment). So if the speaker assembly is laid on a table, face up, and is run with a low frequency (30Hz in this case) tone of moderate amplitude, the cone should nominally align itself. If the speaker is small and there is no spider, a more complicated technique for alignment is necessary, possibly involving shims and the cutting of the voice coil dust cap. That technique was not performed here, and can be read about at various audio forums online.

The procedure then is to first apply a prudent amount of glue to the perimeter of the cone face, and the mating surface of the basket, and then gently install the surround, gently pressing and tacking it to the cone surface. Then the tone should be played allowing the cone to slowly slide into centered-position while the glue is still wet. Everything should be more thoroughly pressed and tacked together after this step. Periodically, through the drying, the tone should be played again, perhaps at less volume—or even music with mixed tones and varied frequencies should be played—to listen for clicking or chatter, indicating that a portion of the surround is not glued down properly, and is free to vibrate and slap against the surface. A small, precise applicator such as a paper clip, or a pin should be used to drive glue between the surround and

surface where needed to tack down and eliminate buzzing or chatter. This may need to be repeated after the glue dries overnight.

Results

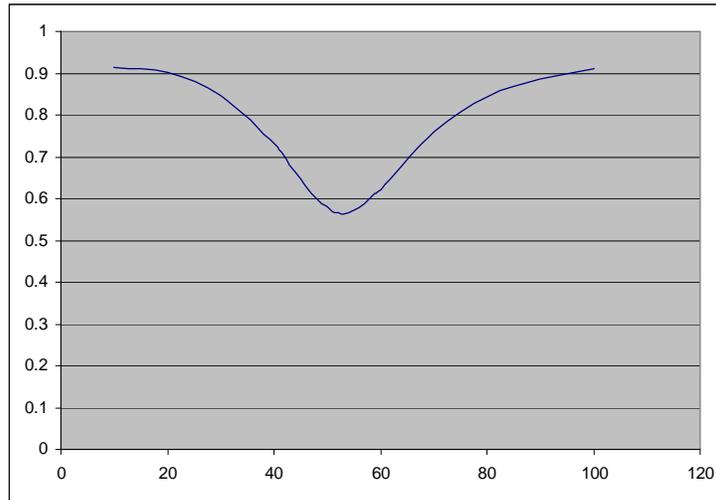


The replacement of the surrounds drastically improved the sound reproduction of the speakers, especially in the low range of frequencies. Qualitatively the SC99 Athena 2-way speakers that the LE14As were installed in retained much of their idiosyncratic sound—anemic reproduction of the high-midrange for example—but had an undeniable presence below 60Hz which was previously an undeniable absence. Some quantitative measurements corroborate this evaluation.

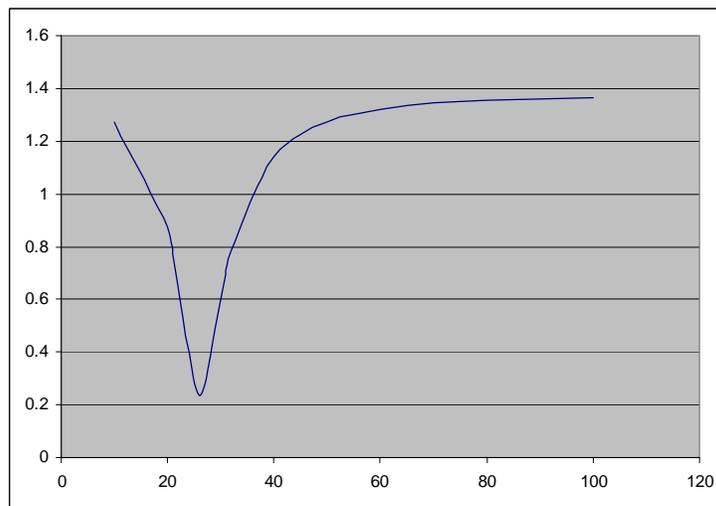
Of all the Thiele/Small parameters of a loudspeaker driver, the most relevant to this repair would be the free air resonance (F_s). The mass of the driver, and electrical properties likely have remained the same. The damping provided by a correctly-functioning surround should be minimal as compared to that provided by radiation to the air. So achieving correct F_s should ensure that all parameters are (nearly) correct. Achieving correct F_s then comes down only to choosing the correct surround for the driver. If the surround has the correct compliance, it will have a good F_s .

Before the repair was conducted, the free air resonance of one of the LE14A drivers was measured. It should be noted that this was after both surrounds sustained damage resultant from efforts to overcome the stiffness through equalization and high volume. Exercising the surrounds in this manner did loosen them up, but not as intended—they began tearing. Before

sustaining damage the surrounds were likely even stiffer. The free air resonance was measured by removing the drivers, placing them or hanging them such as to avoid proximity to any surface, and running them using an amplifier and a tone generator. A resistor (in this case 33 Ohm) was placed in series with the driver, and the AC voltage across that resistor measured, effectively measuring circuit current. The impedance of the driver is highest at resonance. Therefore the minimal current (and voltage across resistor) corresponds to resonance.



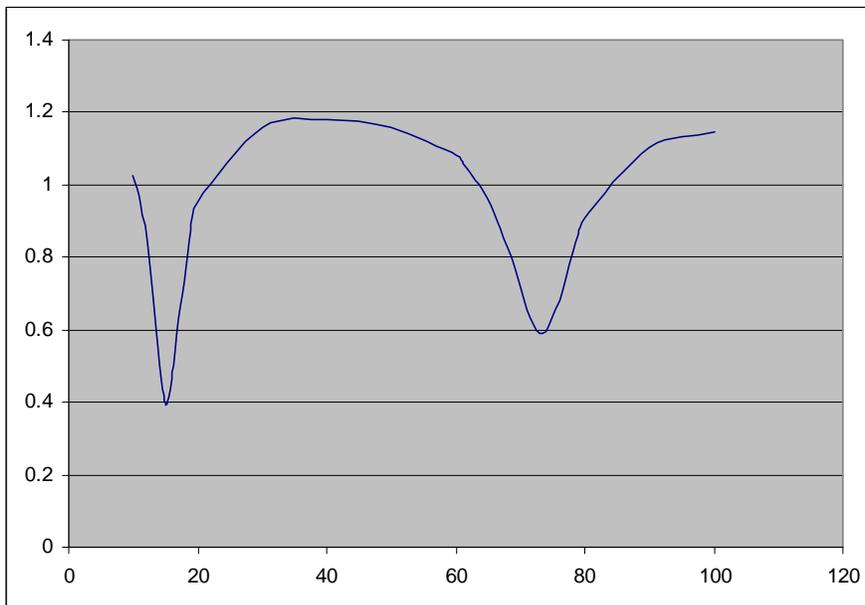
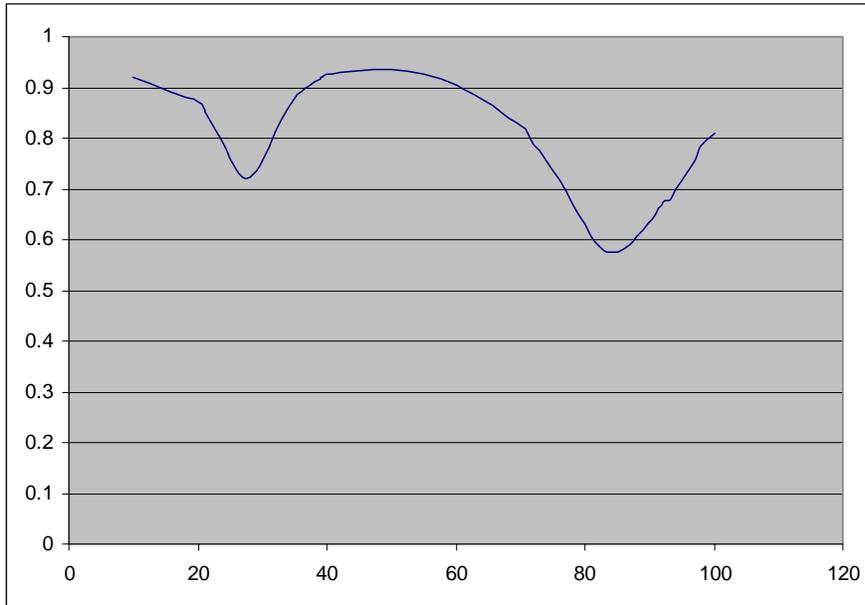
This measurement reveals a resonance of 53 Hz. This is far from the supplied Thiele/Small parameters from JBL which specify it as 28 Hz. A subsequent measurement after repairs indicates a resonance of 26 Hz, which is acceptably close.



It is also clear that the new resonance peak is much sharper. If the viscous damping coefficient of an oscillator were to remain the same while the resonance frequency increased, it would be expected that the Q-factor would increase proportionally, keeping the frequency-width of the resonance curve the same. Since it is narrower, there has been some reduction in the damping (which may also be frequency-dependant damping, along with the new material). Unfortunately the frequency was not measured with enough resolution to do a reasonable Q-

factor measurement, nor was the exact resistance of the resistor (a necessary quantity for the calculation).

The speaker cabinet's inner dimensions are (depth, width, height) of 23x35x57cm. The port is 18.5cm long with a diameter of 10.3cm. To model this as a Helmholtz resonator, the volume of air in the port must be subtracted from the overall cabinet volume. Furthermore we can treat the LE14A woofer as a cylinder of 30cm diameter and 15cm height (the basket, magnet etc. take up a significant volume, and the overall depth of the assembly is about 25cm). Finally, there is also a tweeter magnet, and fiberglass damping applied to the interior. To compensate for the roughly 2~3cm of wadding, each dimension can be reduced by 1cm, and the tweeter can be treated as a cylinder with a 10cm diameter and 10cm height. The Helmholtz resonance then calculates to about 68Hz. The following figure is the resonance curve of the driver and cabinet combination *before* repairs. And the next figure is after repair.



In a ported cabinet (as opposed to a sealed one) the peak resonance corresponds to minimal impedance rather than maximal. At resonance in a ported cabinet, the cone moves very little, and the port is excited maximally. This results in reduced back-EMF from the motion of the voice coil. In both curves the peak is around 40Hz, but in the repaired curve, the roll-off down near 30Hz is greatly reduced.