

ESL DIY-project 18

When 19-year old I ever bought 2 Solo-Sound 4-electrostatic elements with a central bass box. That was my first experience with electrostatic loudspeakers, also called ESL programs. Some years later I bought two Janszen Z-40 hybrid ESL's that after the technical problems were exchanged for dynamic 3-way speakers from the Focal brand. Years later anyway back longingly to the electrostatic noise, used Quad ESL-63 speakers and bought it with much pleasure listened. The last 12 years spent with the DIY ESL's. An interesting but time-consuming hobby.

EsL's self-build or buy:

Around 12 years ago I discovered the book: "Electrostatic loudspeakers self build or self-buying" Eddy Fikier. It was a well written book full of information about commercial esl's, explanation of technology and the possibilities of DIY. This book is very worthwhile to read and now free to download (see ESL Clubsite). Via the Internet I found out later in contact with builders of ESL programs, ESL club and Rob de Lugt Netherlands in The Hague. Building esl's is certainly not easy and requires thorough preparation, available machinery, technical skills and a good dose of free time. Is this an entirely new matter for you, my urgent advice to begin the book by E. Fikier you to read and properly orient the Internet, with other club members or commercial ESL manufacturers.

There are also pre-built electrostatic elements ready for sale that you can build yourself a frame. You then a good element to a successful outcome is assured. Take a look at: www.metrum-acoustics.nl or www.capaciti.eu here you'll find all sorts of things on sale of fine quality. Further information on the many ESL Clubsite: www.esl.hifi.nl **Realize that a esl high voltage work. Touching certain parts of active ESL can fatal!**

Full-range ESL Project 18:

Below is a brief description of my latest DIY project full-range 18. The pages then all sorts of information about the materials, construction, measurements, tips, tricks and construction experience. There is no blueprint available for Project 18. Your choices to the desired size, type and finish their ESL before his decisive.

Project 18 is a full-range segmented stator esl wire with outer dimensions of 164 x 37 cm. The front of the ESL tilted slightly backwards so that it remains in good standing and listening ear at a distance of about 3 meters in the middle of the ESL is. The wooden frame is made of solid hardwood. The ESL-wire stators are made of Trespa with the dimensions: 149 x 33 cm, the film size is: 140 x 27 cm and the foil stator wire distance 2.6 mm. Between the stator wire-center spacing is 3 mm and the stator wire openness about 50%. 86 per stator wires are used which are segmented into 7-fold the number of thread: 22-12-6-6-6-12-22. The thickness the Mylar ® film is 4 μ and is coated with high impedance coating of EC-esl-club member MartinJan from Utrecht. The stator wire is flexible, insulated PVC wire 0.5 mm ² with an outer diameter of 1.6 mm. The applied step-up transformer is the type of T-700 (see www.audio4.nl). The HS-voltage unit is a DIY Cockcroft-Walton HV generator.



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Stator Frames Trespa:

Stator Frames can I make the material Trespa. In most cases I use waste plastic strips with suppliers or www.markplaats.nl at a reasonable price for sale. Trespa is composed of thermosetting resins, homogeneously reinforced with wood and manufactures high-pressure and temperature. It is in many sizes, thicknesses and hardness in the market for sale. It is stable, insensitive to moisture and good electrical insulator. It depends on the thickness, relatively flexible so that the stator frames to create bent possibility. With a fine toothed blade can widia Trespa fine saw. Please note that you are not black or dark blue paint Trespa buys or delete this before you go there stator frames make. My experience is that this color paint HS-loading of the coating somewhat progressive and can cause problems.



Glue mold for stator frames:

For gluing together the parts Trespa stator is a stator frames glue mold used to be exactly the same get. Making a lijmmal takes time but it does get back in the quality of the stator frame. During the bonding the stator frames m.b.v. of spacers to the desired height glue mold obtained for the stator wire carriers. At the corners of the stator frames are countersunk M4 screws to reinforce the Trespa confirms frame. If you for the first time the stator frame flattens the taut wire stator, the forces on the frame is very large Trespa possible and may split and / or adhesive bonding cracks.



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Stator assembly of wires in the stator frames:

The stator wires for these stator frames in lengths of 3 meters and a cut loop (pair) through the top of the stator frame from the outside in the pre-drilled holes plugged by the Trespa. Then the stator wires "smoothed" between the fingers to spiral out irregularities and to remove the wires. Then the wires through the drilled holes in the bottom of the stator frame from inside to outside outlet. Because the Trespa stator frame remains somewhat flexible, you can bend it in eg a wooden frame and then fix the stator wires tightly to attract and retain soldering example segmentation a strip of printed material. Here you have consider the appropriate distribution of the stator wire segments. If all wires are soldered stator stator frame is inverted in the mold and placed carefully in steps opposite bent. This will be something about the stator wires and then pull the stator frame himself straight. This is depending on the number of stator wire, the wire tension and resilience of the stator frame itself. Make sure your stator wires are not stretched, they have to remain tense in the stator frame. There are limits to the efforts of the stator copper wires that simply because you stretch or break. The frame is dependent on the structure, constraints. If the stator wires to the stator carriers later glued remains stator frame plane. The greatest strength of the stator wires are then inside the stator frame because the stator wires are mounted slightly deepened. You can also wire the stator of solid copper wire make it constructive and has some advantages over acoustic smooth stator wiring. The stator frame itself can therefore different and / or lighter construction.



For project 18 to the stator wires soldered to a copper strip board with two jobs at the bottom of the stator frame. This page and all welds are after all work properly cleaned and covered with a Plastic Low-70 finish of the brand contact. It insulates well and prevents oxidation of the copper wires and / or soldering. Also all stator wires on the inside - especially where the stator wires through the holes to the outside stuck - with a layer of plastic-70 finish. This provides extra insulation. Segmentation of the copper strips on the strip you can print before or after welding the stator wires do so by road saws of copper on the gates. Note that no buyer sawdust behind the stator wires and / or holes. Thoroughly spraying with compressed air and insulated with plastic-70 finish is my opinion.

Stator wire type:

The stator wire used for Project 18 is flexible copper wire of 0.5 mm² with an outer diameter of 1.6 mm. It is buy from Farnell (article: 140 350) per spool of 500 meters. My experience with this wire are fine. You can use this thread good tension without stretching or breaking too fast. By Farnell is supplied to individuals, but then you have minimum of € 50, - and only buy mail order and pay for purchases in advance.

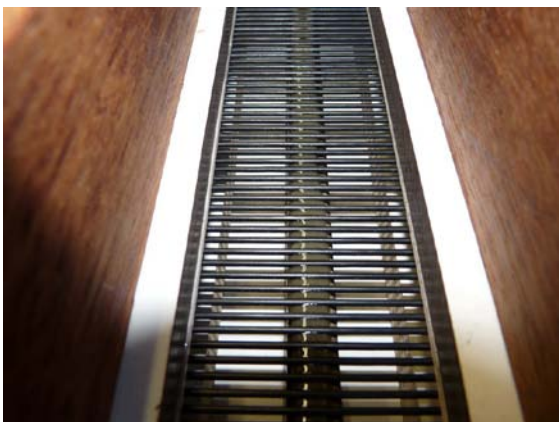
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Glue Mold for stator wires:

For bonding wires to the stator the stator is a cross girders glue mold used. This gives you the stator wire film distance Always neat, all equal and beautiful in a stator wires to the foil plane oriented to lie. Small thickness variations in the stator wires themselves and / or tolerances of the Trespa frame are thus also eliminated. For gluing the stator wires is (Brown) PU adhesive.



When gluing the stator wires to the stator Crossbars I use a hair dryer so that the PU glue the hot air is thinner and thus distributes better between the stator wires. Excess glue runs along the natural path stator cross girders. No excess glue on the stator wires wipe with a cloth or your fingers. This way you get possible adhesive residue on the stator wires. The glue is not too hot with the hair dryer and about 10 cm from the wire / glue holding and constant movement.

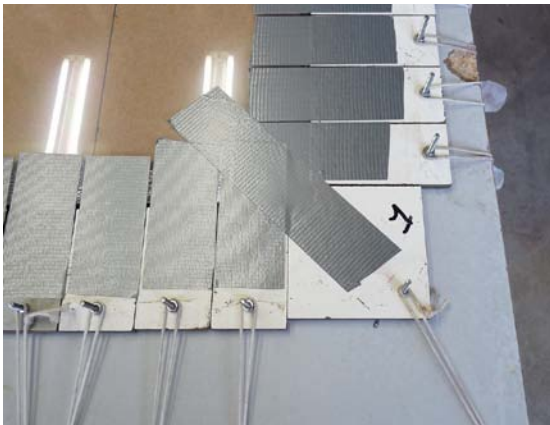


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Membrane foil efforts:



There are many ways to foil their efforts. Plastic bags are used by me filled with 1.5 kg of sand. The foil is glued around with DUC-tape 5 cm wide pieces Trespa. If all images have been stuck to the foil as the sand bags hung. This film is the beautiful tightened evenly around. This method can easily remain repeat without much stress differences in the foil. As the basis for the film A 5 mm thick MDF plate. It requires some experimenting with the weight of the sand bags. Use your thicker film or do you tighten the foil efforts than simply increase your weight of the bags with sand e.g. a 0.5 kg.



Membrane glue to a stator frame:

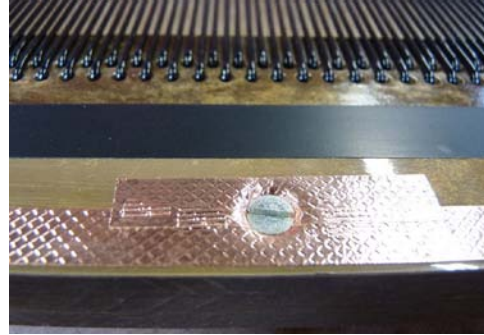
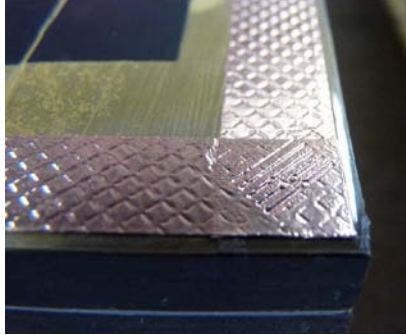
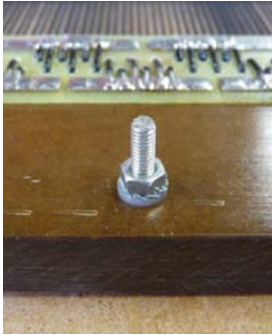
The foil is glued to a stator frame with (gray) Bison PU glue directly on the Trespa. This way you can both stator frames always dismantle the film is defective. This will enable the coated side of the foil strip and the HV contact accessible for servicing and / or adjustments. If the membrane is glued to the stator frame Trespa Here you can easily drill holes through it without you need to fear that the tear film. For cutting the foil I use a knife, so the film not catch or tear (see photo below).



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HV Connection:

For the HV connection with the coated side of the conductive foil I use 3M Scotch copper tape (type 1245). This is a thin copper foil adhesive tape with a honey comb, available in various widths. I use rolls of 16.5 m length and a width of 9 or 12 mm. It can be purchased from Farnell and various hobby shops. The copper foil tape around the stator frame attached so that a fast charge can arise from the high impedance coating. I paste the copper tape on the corners over each other and press the glued strips together using a pipe wrench on the edges firmly together to ensure contact. Copper tape and right through the stator frame of Trespa previously, I attach a flush-m4 bolt which functions as the HV connector (see photos).



Step-up Transformer:

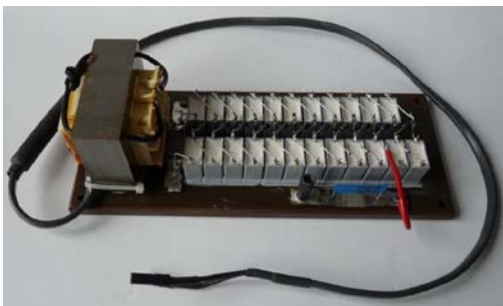


In Model 18 uses T-700 step-up transformers Rob on air from The Hague. To have a step-up ratio of 1:150. My experience with the T-700 step-up transformers are excellent! You can find more information on the step-up transformers at: www.audio4.nl. Rob wraps the transformers themselves and different step-up ratios are possible.

Mylar ® film:

There is some ESL film-club members for sale. I generally use tensilized Mylar ® foil MartinJan from Utrecht with a thickness of 4 mu and 80 cm wide. This can almost always be two frames in a time-esl adhesives. This is the safest both membrane film at exactly the same voltage gain. The thickness of 4 mu "sound" neutral but requires special care when handling them. The 6 mu film is also great for full-range ESL programs. This is more solid, and therefore has more strength if desired as loose tense.

High Voltage Unit:

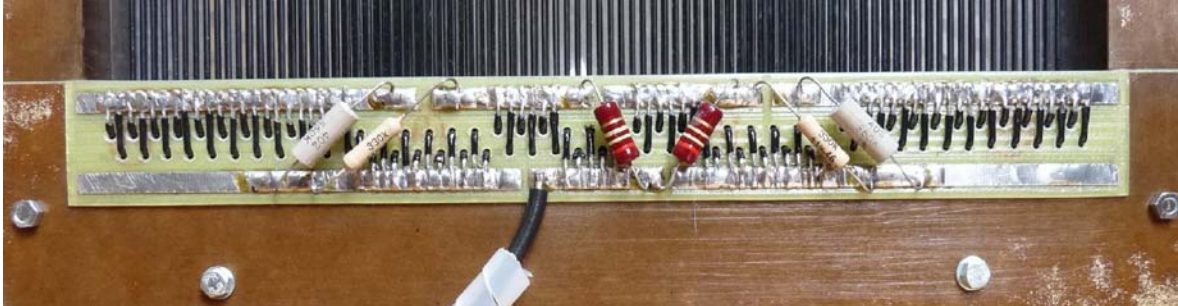


I'm using a Cockcroft-Walton high voltage cascade and glue them on the capacitors of 0.33 volts on a piece uF/600 Trespa m.b.v. silicon. Then there 1N-4007 diode directly the capacitor soldered connections. To HS-voltage slightly to settle, a mobile (red) wire used. There is also a resistor 10 applied kV/10MΩ between the PS unit and ESL unit. It is wise HV Unit easy to paint with plastic-70 finish for extra insulation and prevent oxidation.

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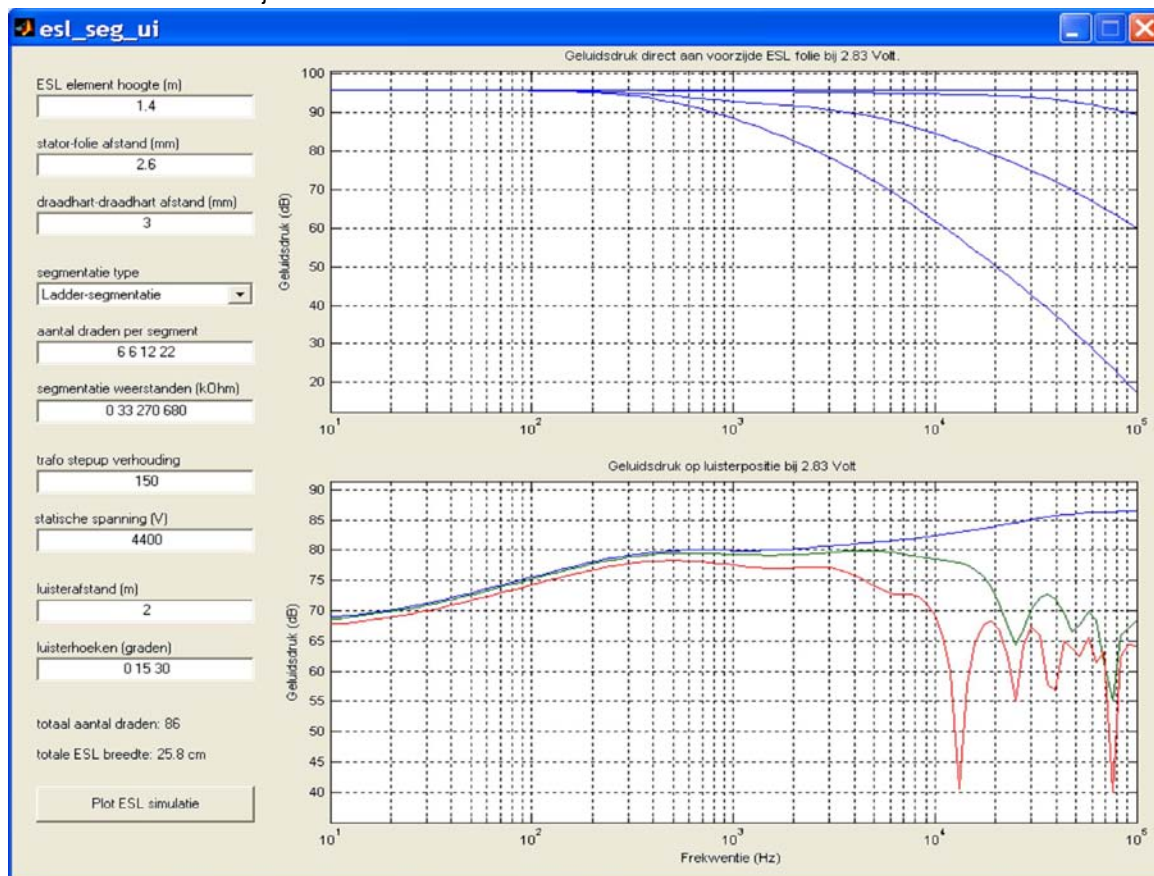
Segmented stator wires:

Broad elements will emit highly directional high frequencies. To the dispersion of higher frequencies promotion project in 18 wire segmentation applied. In Project 18, a stator frame 86 stator wires. These are seven sections divided from left to right on stator frame in the number of wires: 22-12-6-6-6-12-22. The middle six wires, the signal transformer connected. In the photo below shows the segmentation strip of epoxy, the segmentation resistors and the transformer connection. The resistors from left to right are: 680-270 - 33 - transformer connector - 33-270 - 680k Ω



ESL club member by Edo Hulsebos some time ago a convenient and free downloadable program created what `esl_seg_ui` enables import of the following: ESL altitude stator film distance wire center-center distance, number of legs per segment; segmentation resistors, transformers step-up ratio, static pressure and listening distance, the following charts generate.

Below the results of Project 18:

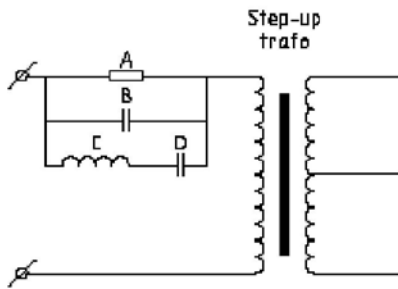


The rising curve is high d.m.v. an RC filter on the primary side of the step-up transformer corrected. This is not above calculations included and visible. The descending bass is partly offset by the influence of the damping material used on the back of the ESL and partly by the influence of the listening room itself. This is not included in the calculation and in practice can have peaks up to about 10 dB for certain low frequencies.

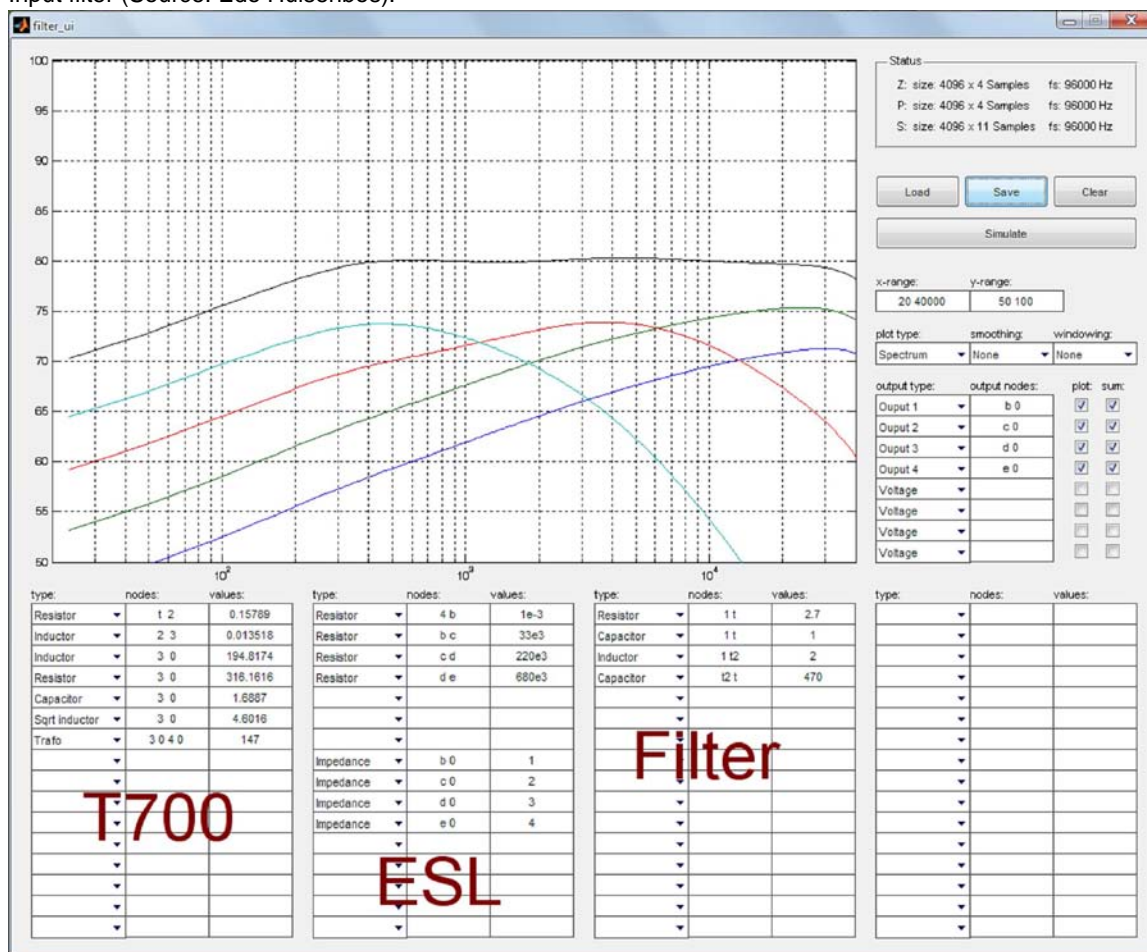
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Primary input filter:

Some time ago by Edo Hulsenbos the T-700 step-up transformer and the element of Project 1918 and measured separately introduced into the calculation program MATLAB. There is then an input filter which calculates the frequency response and primary impedance improves a lot. The impact on the whole sound is clearly audible and certainly positive. If you ESL programs are similar plans to build and use is of the T-700 step-up transformer is recommended that this input filter RCL values and related equipment to apply. Links Filter Project 18 signed with the RCL values: A = 2.7 ohm resistor, capacitor B (determines sound quality) = 1 uF, C = 2 mH and Rinse condenser D (composition and MKP bipolar) = 470 uF.



Below is the calculated results in the MATLAB program of the T-700 transformer, the element of Project 1918 and Input filter (Source: Edo Hulsenbos):



Widens sound even better:

If you choose a different stator wire distribution, segmentation film resistors and wire from the stator widens sound of ESL in overall better. It is best to wire the stator 86 can be divided into: 18-10-10-10-10-10-18; the segmentation resistance to change: 1200-560-390-0-390-560-1200kΩ and the input filter values: A = 3 Ohm B = 0.47 uF, C = 0.56 mH, D = 470 uF using the stator wire and foil 2 mm distance to choose. See results on the following page (calculated using MATLAB and esl_seg_ui: source Edo Hulsenbos).

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Frame ESL staters:



Confirm staters in a sturdy wooden or aluminum frame. This will improve the display quality the ESL certainly benefit. I make mostly wooden frames and attach the stator frame using Trespa 4 mm screws Trespa across the frame, into the hardwood. If desired, you can isolate the screws compared to the stator frame and film by applying heat shrink tubing or nylon spacers. This prevents unpleasant stimuli of the HS-load when touching the screws.

Attenuation of film:



If you do not apply rate-corrected direction of the ESL's film damping is the esl back of the resonances of the film needed to be eliminated. You can use all kinds damping material for use as fleece blankets, BAF-damping cloth, stone or glass wool. All materials have their own specific advantages and disadvantages, and some influence on the overall sound. Self-experimentation is the advice. At this time I experiment with T-77 screen printing mesh glued with PVC glue pierced Lexan plates of 8 mm thick. These pictures are directly against the stator wires mounted to minimize the reflectivity. You can use the T-77 mesh e.g. also on steel wire bonding. This Lexan has advantages over the pass because it is larger which in turn slightly lower hardness caused in the middle / high display (read: less reflection). The disadvantage is the weakness and the difficult confirmation of the T-77 on the steel mesh. The silkscreen mesh o.a. sale in Amsterdam in the Levant fa artists supplies, see: www.levant.nl. See also various information on the ESL-Clubsite.

PU-adhesive:



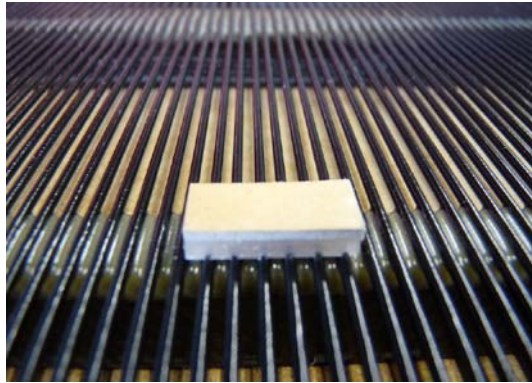
Trespa for gluing all parts and the foil on the stator frame (gray) Bison PU-adhesive. The advantage is that this adhesive after mixing the structure of the peanut butter making easily processed and runoff. And the adhesion strength of the glue is still slightly larger than the brown type polyurethane adhesive of Bison. The brown polyurethane adhesive used for bonding wires to the stator the stator cross girders. This glue has after mixing structure syrup, making it easy under the stator wires invloeit.

Application of fixation dots between film and stator wire:

The use of (thin) 4 mu film and the relatively wide span of 27 cm in 18 project "requires" the use of fixation dots between the foil and the stator wire. A total of 7 fixation dots used in Project 18. This is somewhat at the expense of overall mobility of the film but instead can increase the voltage on the membrane and louder with Playing without the film - with heavy bass / resonance - the staters touches. I make 2 layers of super fixation dots mounting tape and a layer of cardboard or plastic to stick together. The total thickness the fixation dot is determined by the desired stator wire-foil distance plus eg 2 mm extra for the film between the fixation dots to be securely when the stator frames are assembled together. The mounting tape itself is something which is resiliently.

The fixation dots are two frames on the stator wires stuck to its stator cross girders. In my case not to the film because I have dismantled the frames to keep. If the foil is glued to the stator and two stator halves together are assembled, the foil sandwiched between two fixation dots and slightly depressed. This gives the entire stator frame more rigidity. You can also fixation dots silicone dots are together with the glue of the film, which insulates the best!

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Film coating:

You can, in the book of E. Fikier bearings on all film coating. Also on the Internet or other ESL builders is much information available. I've been using EC-year high impedance coating MartinJan from Utrecht. It is easy processable, non-toxic, stable and adheres well to the film if it is properly installed. My experience is good for the film cleaned with pure alcohol using a clean cloth or paper towel. Then you summon the coating with a fine paint roller or soft longhair (wide) brush. The coating quickly and evenly but not too fat yield. However the force applied to the film, which promotes adhesion. Work in a clean, preferably dust-free environment where the stator frame is also 24 hours to dry. A shower is perfect for it.

Are there any improvements possible:

The high voltage unit can be improved, since I get to work. I am also looking for a better adhesive to the foil on the Trespa stators gluing. Since I now use (gray) Bison PU adhesive for bonding them but the film is not ideal. Who has the solution? Do you have any questions, ideas or comments?

I hear it like: @ piet.van.duijvenbode live.nl
Piet van Duijvenbode.