FAQ: Loudspeaker
ElMod FusionX, ElMod 4WD, ElMod Fusion ECO/PRO

This document collects frequently asked questions (FAQ) about Loudspeakers.

Question: Is it possible to connect an extern amplifier for louder sounds?

Answer: It is not possible and there also is no profit in that. The used amplifier in most ElMod modules is the optimum already.

As a basic principle: it's physics law that the maximum power is limited by the battery voltage. Someone who claims his amplifier produces 50 W out of 7 V either lies or has no idea about physics. (in car hifi sector there are audio amplifiers that actually may provide 500W and more. But internally the amplifiers convert the 12 V of the vehicle to a much higher voltage, usually 50 V and more. These amplifiers are quite expensive and definitely too big for 1:16 tanks)

The physically possible power can be calculated under http://www.sengpielaudio.com/Rechner-ohm.htm. (The theory behind it is explained there too. Sorry, it's a german page)

a rule of thumb for 8 Ohm loudspeakers :
7.2 V -> maximal theoretical power 6,5 W
10 V -> maximal theoretical power 12,5 W
12 V -> maximal theoretical power 18 W

At this it should be noted that the power is only achieved for DC voltage. But since sound is an AC-signal, the mean power is distinctly below the listed value (around 30%). Furthermore amplifiers may have a considerable power loss (amount of energy that is converted into heat) that influence the actual power output additionally.

In order to achieve higher performance, for example in the automotive sector, the 12V on-board voltage is transformed upwards. Audio amplifiers with 50V and more are common in higher price ranges. With this, power up to approx. 300W would be possible. In model making, these are not found because of large dimensions and high prices.

Question: Does that mean that the sound is twice as loud with a 10 V battery (after the list above 12,5 W instead of 6,5 W are reached)?

Answer: I'm afraid not. We need a 10-times stronger power to hear a sound twice as loud. The cause is the logarithmic behavior of our brain. I won't go into detail (you may check on http://www.sengpielaudio.com/Rechner-pegelaenderung.htm).
Just a few facts:
- the psychoacustic loudness a subjective item and cannot be defined exactly. Though it doubles with around 10 dB. That means if the acoustic level is at 10 dB, most people perceive it as twice as loud.
- the doubling of the power corresponds to the change of the acoustic level by 3 dB.
- cause the dB-scale is a logarithmic scale, 3 dB makes no more than 23% more perceptible sound change. Thus the sound is just 1/4 louder. The required 10 dB are achieved by a 10 times stronger power. The amplifier would have to provide over 60 W rather than 6 W. With an 8 Ohm loudspeaker a 22 V battery would be necessary therefore. For a 4-times louder perception even 20 dB are required, meaning a 100-times stronger power! Which means 600 W power and a battery voltage of 70 V.

Question: can a 4 ohm speaker be used with ElMod products?

Answer: no. The amplifier module used only allows 8 ohms (or more). If a 4 Ohm speaker is connected, the amplifier may be destroyed. This is more likely the higher the battery voltage is.
However, it is possible to connect two 4 Ohm speakers in series and then connect them to an ElMod central unit. It is then advantageous if the membrane size is larger compared to a single loudspeaker.

Question: Which/How much power must the loudspeaker have?

Answer: The power declaration of the loudspeaker has a passive character only. It declares how much power the loudspeaker bears until it is destroyed. It doesn't say anything about how loud it is or how it sounds. You make the safe choice with a 10W loudspeaker (for small control units like the 3to or M16 1-2W are sufficient).

Question: Which loudspeaker is the best?

Answer: This is one of the most difficult questions that can only be answered superficially at this point.
- broadly defined: a bad loudspeaker in a reasonable box sounds better than a good loudspeaker without box.
- for a rich sound and good deep frequencies the loudspeaker needs volume. Volume means as much distance as possible between the air in front of the loudspeaker and the air behind the loudspeaker (yes, a loudspeaker makes noise with its rear side, too!!) Therefor it needs a box which seperates the both sides of the speaker.
- the problem: in 1:16 vehicles there is far too little space for a reasonable box. The loudspeakers of the leading producers are delivered with suggestions for a appropriate box. All of them are ways too big for the vehicles.
- but: the worst thing is to run a loudspeaker entirely without a box. The consequence is a so called acoustic short cut: the acoustic waves of the loudspeaker's front side meet the acoustic waves of the rear side as soon as they leave the membrane. Both waves cancel each other because they amplitude is contrary. The consequence is a thin, bass-less, distorted sound at moderate level.
- compromise: We need a preferably big box to get the optimal sound under the given conditions.
- most simple solution: a box which is
-- as big as possible
-- seal air-tight (e.g. seal with silicone!)
-- coated with sound absorbing material (acoustic insulant or lambs wool)
-- with a high quality loudspeaker with a preferably big diameter.
You don't only get a better but also a louder sound (because no acoustic short cut and no canceling of the acoustic waves occur).

To evaluate the quality of a loudspeaker on the basis of its technical characteristics is nearly impossible for a non-professional. The best thing is to hear the sound of the loudspeaker. A point of reference is the acoustic pressure that tells you how loud or soft a loudspeaker is. If you have one with 75 dB and an second with 85 dB acoustic pressure then the second one is approximately twice as loud than the first (see question about the doubling of loudness above). With small loudspeakers a high acoustic pressure is reached by a stiff membrane which has a negative effect on the frequency response however. They are louder but have no depth. So you have to decide on your own.

To put it simply. From my experience I recommend:
- loud: Visaton FRS7-8 plus a good box
- deep/boomy: Visaton FRS8-8 plus a good box

For experts: the bigger the membrane surface the better the low frequencies (reason: the lower the frequency the more energy you need to render it, the more air must be moved therefor. This is easier if as much air as possible is compressed). To achieve that you can take an elongated box and assemble two loudspeakers. I use one with 2x Visaton FRS8-4, that are connected in series (the FRSB-4 is a 4 Ohm type. Two of them in series result in 8 Ohm, too). But

careful: the negative pole of one loudspeaker has to be connected with the positive pole of the other! Otherwise it would sound as old tin buckets.

Supplement: dB list

dB or Decibel is no real physical unit. dB describes the difference between two levels. To make a comparison between levels that differs greatly, the scale of comparison is logarithmic. By the difference of the values (e.g. two loudspeakers with different acoustic pressures, see above) we are able to make a statement about how much louder the loudspeaker with the higher acoustic pressure is.

The first column is the difference (e.g loudspeaker 1 has 80 dB, loudspeaker 2 has 83 dB. That makes a difference of 3 dB and according to the table, loudspeaker 2 is around 23% louder).
These are not absolute values! As described above the loudness is a psychoacoustic item. It depends not just on the subjective sense but also on the spectral composition of the sound (which frequencies are intensively involved) and many other factors.

dB...Factor
1....1,07
2....1,14
3....1,23 (3dB means double power. There are only few people who can hear the difference of 3 dB or less.)
5....1,41
7....1,62
10...2,00 (tenfold power. ca. double loudness, thus perceptible volume)
16...3,00 (fortyfold power. threefold loudness)
20...4,00 (hundredfold power. fourfold loudness)

ElMod Thomas Kusch
Seebuckweg 9
D-78054 Villingen-Schwenningen, Germany