How to set up your ESU v4 decoder back EMF by Steve Weeks

Before we begin, these guidelines are aimed at the DCC user with programming experience. A DCC system that allows both Read & Write of CV's would be nice, but not essential.

Back **E**lectro **M**otive **F**orce as it is known to the DCC modeller is one of the most difficult motor features to set up, yet one of the most rewarding once mastered.   I have tried to use a common approach to my preferred method, **option 2** allowing the motor setup to be achieved. Be patient READ the following guidelines, as this can take time due to trial & error.

Introduction

5th generation load compensation enables LokSound decoders to execute precise motor control, even with the default settings, most locomotives run perfectly. Should you find after doing the initial test that the locomotive does not run smoothly, particularly at low speed or, that the locomotive jerks a little after having stopped or, if you are simply unsatisfied with the driving performance, then you should adjust the load compensation of your LokSound decoder.

Firstly, check if the irregular performance is due to either:

1) Poor electrical contact with dirty track, wheels or pick-ups. Cleanliness is essential for smooth low speed running.

2) Mechanical faults. Bent driving rods are one common cause. If you turn off load compensation (See CV 56) and the problem persists then it is likely there is a mechanical fault.

Adjusting Load Compensation

Load compensation (back emf) can be influenced with CVs (51 – 56). However due to the large number of different types of motors and drive systems, there is no single setting that suits all. Different manufacturers use different motor / gearbox combinations. Therefore the only way to accurately set up the decoder for smooth running is after it has been installed in the model.

CV 51   (I slow)

Here you can adjust the inertia of the motor separately for slow speeds and starting from a stop. The desired value is to be entered into CV 51. The parameters "K slow" and "I slow" jointly influence the behaviour at speed steps 1 and 2 while the parameters CV 54 ("K") and CV 55 ("I") are responsible for the remaining speed steps. The decoder computes a speed curve in order to avoid any abrupt changes.

CV 52   (K slow)

With the LokSound V4.0 decoder an additional CV 52 has been introduced which separately determines the gain control considerably for the whole slow driving sector in speed step 1.

If you are not satisfied with the driving behaviour when the locomotive drives slowly or starts, while everything is fine with the medium and high speed steps, you should increase the value of CV 52 by

5 - 10 than the value set in CV 54.

CV 53   (Reference Voltage)

In CV 53, you set the EMF reference voltage generated by the motor at maximum revs. This parameter may have to be adapted subject to the track voltage and the efficiency of the motor.

If the locomotive reaches maximum speed when the throttle is set to about three-quarter and the top third of the throttle has no influence on the speed, then you should reduce the value of CV 53. Reduce the value by 5 – 8 and test the locomotive again. Repeat this process until the locomotive just reaches its maximum speed when the throttle is fully open.

On the other hand, if the locomotive moves too slowly at full throttle then you should increase the value of CV 53 step by step until the maximum speed is reached.

CV 54   (K)

Parameter „K", stored in CV 54, influences how strongly load control will affect the driving performance. The higher the value, the more load control will respond to any changes and try to adjust the revs of the motor.

Parameter „K" needs adjustment if the locomotive runs unevenly (jerks).

Reduce the value of CV 54 by 5 and test-run the locomotive to see if there are any improvements. Repeat these steps until the locomotive runs smoothly at speed step 1.

CV 55   (I)

Parameter „I", stored in CV 55, provides important information to the decoder on how much inertia the motor has. Motors with large flywheels naturally have more inertia than smaller ones or coreless motors.

Adjust parameter „I" if the locomotive jerks somewhat just before it stops or „jumps" at lower speeds (lower third of the speed step range) or simply does not run smoothly.

Increase the value by 5 starting with the default value for motors • with very small or no flywheels.

Reduce the value by 5 starting with the default value for motors • with large flywheels.

Test again and repeat this procedure until you arrive at the desired result.

CV 56   (Load Compensation)

Dynamic Drive Control of your LokSound decoder enables you to adapt load control, as you may desire. Full control over the entire speed range (constant speed, if enough power is available) is not always prototypical. Therefore you can set the degree to which load control will be effective between 0 (no load control) and 100% (load compensation over the full range).

At low speeds it is advisable to have 100% load compensation in order to prevent the locomotive form „getting stuck" or from „running away" without any load. The impact of load control should recede with increasing speed in order to have the full „unharnessed" power of the motor available when the throttle is fully open. Thus, the locomotive will respond to certain changes in the main line such as gradients. The locomotive will run faster downhill and become slower climbing the hill.

The desired degree of load control influence is set in CV 56.

It is particularly meaningful to reduce the influence of load control whenever you run consists. This allows for better driving properties of all locomotives in the consist.

The operating range of load control is 0 – 100 %. (CV value 1 – 255). This defines up to which speed in % load control will be active.

A CV value of 128 indicates that load control will be switched off after reaching half speed.

You can also switch off load compensation by writing the value 0 in CV 56.

With load control turned off, the starting voltage in CV 2 should be increased until the locomotive starts moving at speed step 1 or 2.

Note:

CV 49   bit 1 (Adapting Load Control Frequency)

The LokSound decoders load control works normally with 40 kHz. Sometimes it can be useful to reduce this frequency by half.

To change the PWM frequency from 40 KHz to 20 kHz, set bit 1 in CV 49 to zero.

(Reduce the default value by 2) so CV49 now = 17

CV 124   bit 4 (Regulation Frequency)

The decoder operates ex works with a mutable **(constant)** regulation frequency to drive the motor as precisely as possible. However, as a result some motors might show a nasty buzzing noise.

For such motors you are able to set the regulation frequency for a **(adaptive)** value.

Set bit 4 to zero in CV 124.

(Reduce the default value by 16) so CV 124 now = 5

Loco	Notes	CV 's									
		2	5	49	51	52	53	54	55	56	124

Option 1

Automatic calibration of the motor

Note: Please read this section before, not after you pick your model up off the floor.

LokSound V4.0 decoders offer a feature for automatic calibration of the motor. In most cases this procedure leads to excellent load compensation characteristics. However, due to the infinite number of possible combinations of motors and gear boxes a good result cannot be guaranteed, but it is certainly worth a try.

Proceed as follows:

Set the vehicle onto a piece of straight and preferably level track. The track must be at least 2/3M long as to allow the locomotive to run at full speed for about two seconds. This movement takes place automatically during calibration. Provide buffer stops or something similar to prevent the locomotive from running off the track!

1. **Write the value 0 into CV 54 (either on the programming track or with POM).**
2. **Call up the locomotive on your throttle and make sure that F1 is switched OFF and the throttle is set to speed step 0.**
3. **Set the direction of travel and re-check.**
4. **Pressing F1 will cause the locomotive to start running at full speed automatically. During this time about 2.0 seconds you will not be able to control this locomotive!**
5. **The locomotive will automatically stop and the identified load compensation parameters will be saved in CVs 51, 52, 53, 54 and 55.**
6. **Retest the locomotive.**

If you wish you can now fine tune the load control parameters starting from these calibrated settings.

Adjustments for Fine Tuning

Unfortunately, the motors available in the market have considerable variations due to tolerances. This is even true for the same type. If the Auto values above do not lead to acceptable results, you can further optimise them.

For the slow driving sector (speed step 1) CV 51 and CV 52 will change the gain control. This helps to avoid any jerking while driving slowly. However, before doing this you must make sure that there are no capacitors wired between the motor terminals and the chassis.

The commutator of the motor must be clean and the drive system should run freely. The wheel contacts and other contact plates of the locomotive must also be clean and make reliable contact.

Note:

I have tried this method but get different results every time.

Option 2

My preferred method

1) Set the decoder Max speed with CV5 or if using a speed table from throttle steps 21 - 28 to 75%. This will result in more prototypical running and significantly increase the range available for slower speed performance. Remember, these are back emf decoders, so reducing the maximum speed does not reduce the maximum power available.

2) Set the back EMF CVs with the following values to begin with:

Load control / back EMF

☑ Enable load control / back EMF [CV49.0]

Regulation reference [CV53]

140   14V

Regulation parameter "K slow" [CV52]

0

Regulation parameter "I slow" [CV51]

0   0s

Regulation parameter "K" [CV54]

10

Regulation parameter "I" [CV55]

10   0.01s

Regulation influence [CV56]

255   100%

3) Test Run the loco at throttle values 10, 30, & 50. I would expect juddering at this stage.

4) Increase the K value CV 54 in 10s and re test the loco at the same throttle values, until the motor almost stops juddering and becomes quieter, where upon more precise values can be adjusted.

5) Now increase the I value CV 55 in small amounts until the motor is running smoothly, again test run the loco with the same throttle values. If when you stop, the loco lurches, reduce this value. One final test to make sure. This value can be higher than CV 54 with some Motor / Gearbox combinations.

6) Now run the loco with a throttle value of <5 and adjust K or I slow, only if necessary.

Remember if you re adjust the Max speed values after setting up the back EMF, you will have to start again.

Operating a back EMF decoder is different than a normal decoder. With a normal decoder minor throttle adjustments must be made to maintain the speed of your locomotive over turnouts and through minor shunting operations. With a back EMF decoder, the decoder will maintain the speed and increase the force necessary to overcome these minor obstacles, allowing any throttle changes made to actually control the speed of the locomotive.

Note:

If you are using a Sound decoder you can now set up the chuff rate with CVs 57 / 58.