

Testing and Calibration of Energy Limiters

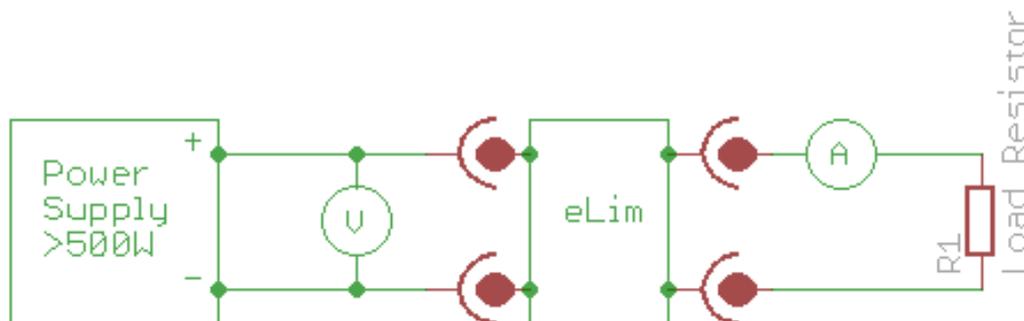
1 My Vision of Setup and Calibration at Race Meetings

Before I move on to how we move forward from where we are now, I would just like to explain my thoughts during the design process.

When I started my design, I was not aware of any other designs and so I started with a blank sheet of paper.

One of my early concerns was calibration. I was aware that as a relatively low cost item, not a laboratory instrument (and even they need recalibrating from time to time), I did not want the user to have to return them for this to be done. I therefore allowed for calibration by the race organisers.

As this put the responsibility on to the race organisers, I wanted this to be as simple and cheap as possible to do. I assumed a set up as shown in the diagram below.



The load resistor should draw a realistic current. I assumed about 35Amps.

It should also be at a realistic but convenient voltage. I assumed 12Volts.

This means that the load would need to dissipate $12 \times 35 = 420$ Watts and would have a resistance of $12/35 = 0.34$ Ohms. A cheap and effective method of achieving this is to use 8 or 9 domestic spotlights of 12V 50A rating which are readily available.

The power supply would therefore need to be approximately 12V and at least 500W capacity. This could most readily be achieved with a 3S LiPo although this is not ideal due to the need to constantly recharge it.

The voltmeter can be any bench meter of sufficient accuracy which are readily available.

The current meter is more difficult as most multi-meters only read up to about 10A with additional external hardware. However, it is my belief that the most important thing in a competition is not that the limiter is calibrated to international standards but rather that they are all identically calibrated in order to achieve fairness.

With that thought in mind, a standard 50A analogue meter could be used, which whilst not very accurate or linear, at a specific current they are very repeatable.

1.1 How to setup and calibrate at a meeting

Given the setup described above, all the race organisers have to do is:-

1. Connect the eLim into the rig
2. Plug in the eLim programmer
3. On the voltage calibration screen of the programmer, set the voltage to read the same as the voltmeter.
4. On the current calibration screen of the programmer, set the current to read the same as the ammeter.
5. On the general screen of the programmer, do a long press of the select key and all predefined settings are transferred to the eLim along with the security code.

This whole process takes less than one minute.

2 The Present Position

As of now (July 2017) there are three limiters that I am aware of. In order to help the discussion along I have compiled a comparison chart of the three limiters that I am aware of (see attached pdf).

As you will see from the table, my eLim is I believe, the only one which can display voltage and current values. It is also the only one which can be calibrated in the field.

If I am correct and neither the MDLE4 nor the KLV202/001 can be calibrated in the field, then there is nothing that the race organisers can do and they must therefore rely on the factory calibration being within a predefined tolerance. The benefit is that the race organisers will not require any test equipment and will only need a programmer for each limiter type in order to set the required ramp down time, limit time etc. For the eLim and the MDLE4 this would only appear to be done once per meeting but for the KLV202/001, as far as I can tell from the manual, it only has one stored energy limit and would therefore need to be reprogrammed if the entrant runs in a different energy band class.

3 Thoughts on Calibration

If my thoughts in section 2 are correct, there are only two alternatives I can see.

- 1) The individual manufacturers must calibrate the limiters at the factory using the same methods and to an agreed tolerance.
- 2) The calibration of all limiters must be done by an independent third party.

If alternative 1 is chosen, then I think that a simple reproducible technique is used. A/C waveforms and high frequency modulation of the supply should be avoided and something simpler as described in section 1 should be adopted measuring a DC voltage and static current. I have described above how the eLim is calibrated but as I do not know how the other two limiters are calibrated, I will have to wait to hear feedback from Miroslav and Klaudiusz.

As a suggestion to compare all three limiters, they could all be connected in series in a configuration similar to the diagram above and their energy readings compared after a period.