DingoTone.com

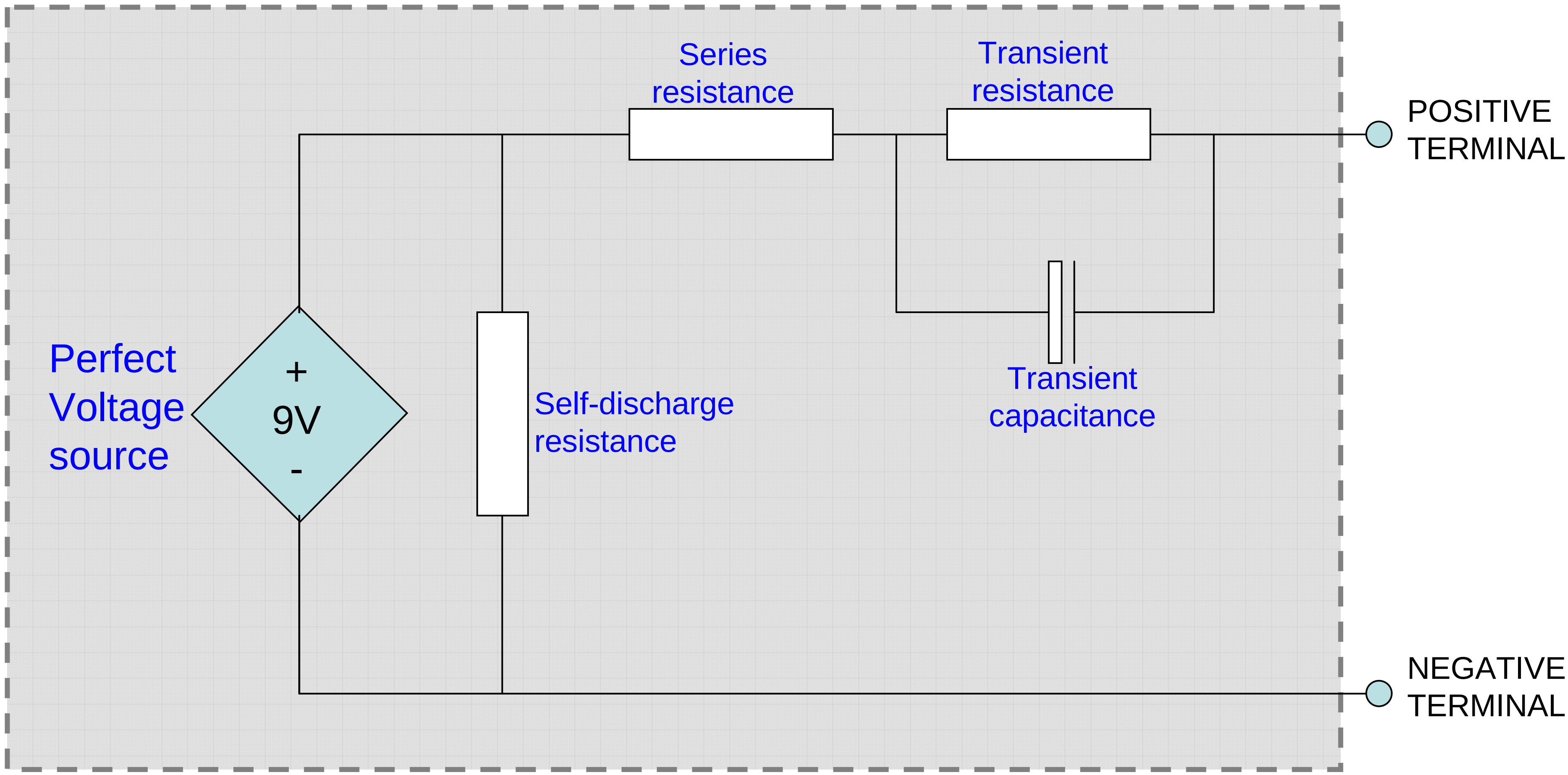
Effect pedals. Reinvented.

A discussion paper about why a cheap carbon battery is best to power your fuzz face pedal

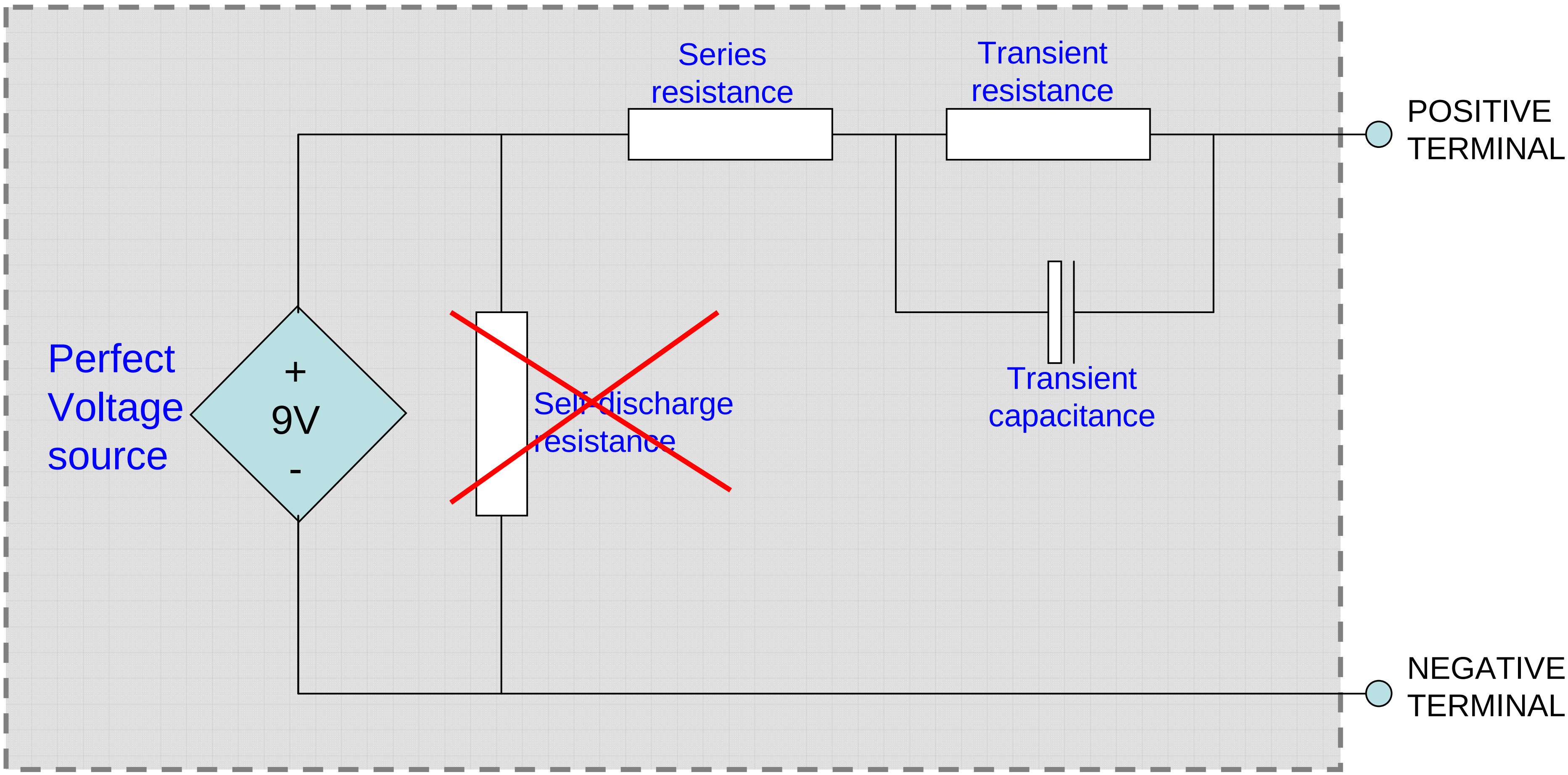
- In most applications it is convenient to think of a 9V battery as a perfect voltage source. You connect it to the pedal and it provides current until “goes flat”.
- For many pedal applications this is “close enough” to reality.
- What’s actually happening is far more complex….

- How we usually think of a battery:

- Something closer to what's actually going on (Thevenin based model):

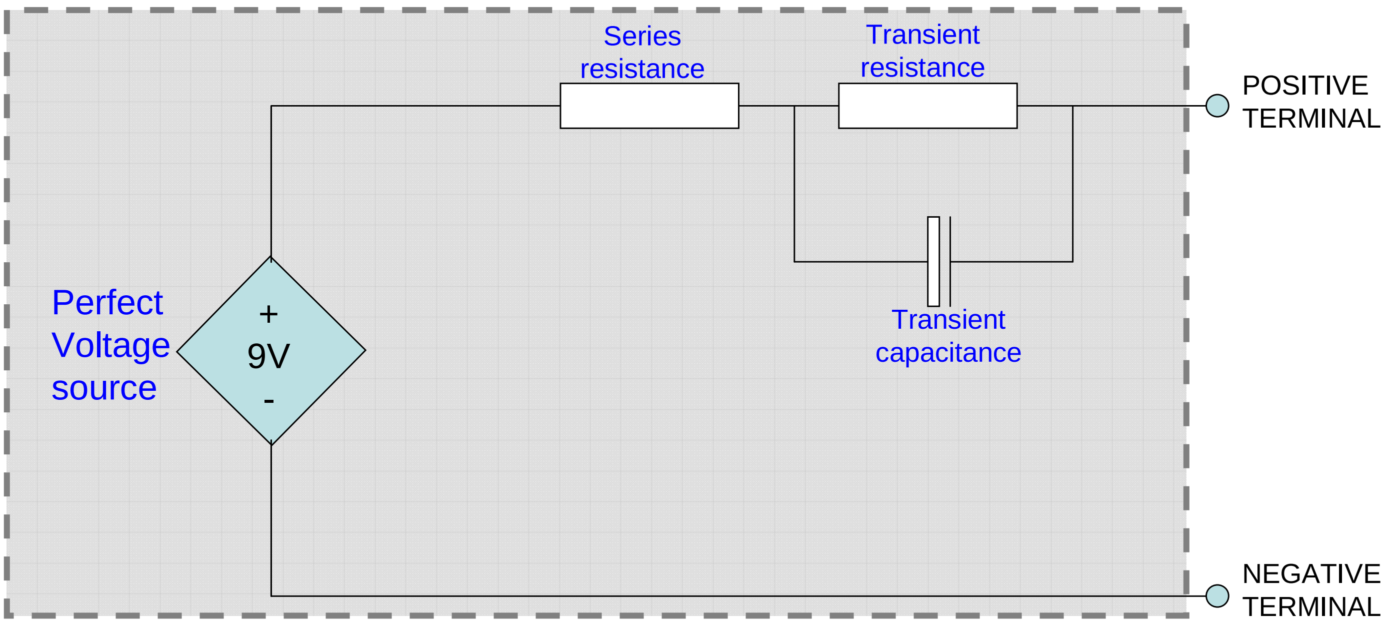


- This is only an approximation of what's really going on in the battery's chemical reaction, but it is close enough to be a useful model.
- Let's ignore the "self-discharge resistance"… it has much less effect than the others on tone.



- Every battery will have a different ***Series resistance***, ***Transient resistance***, and ***Transient capacitance***.
- More importantly, these characteristics are dependent on how "full" the battery is and they will change over time.

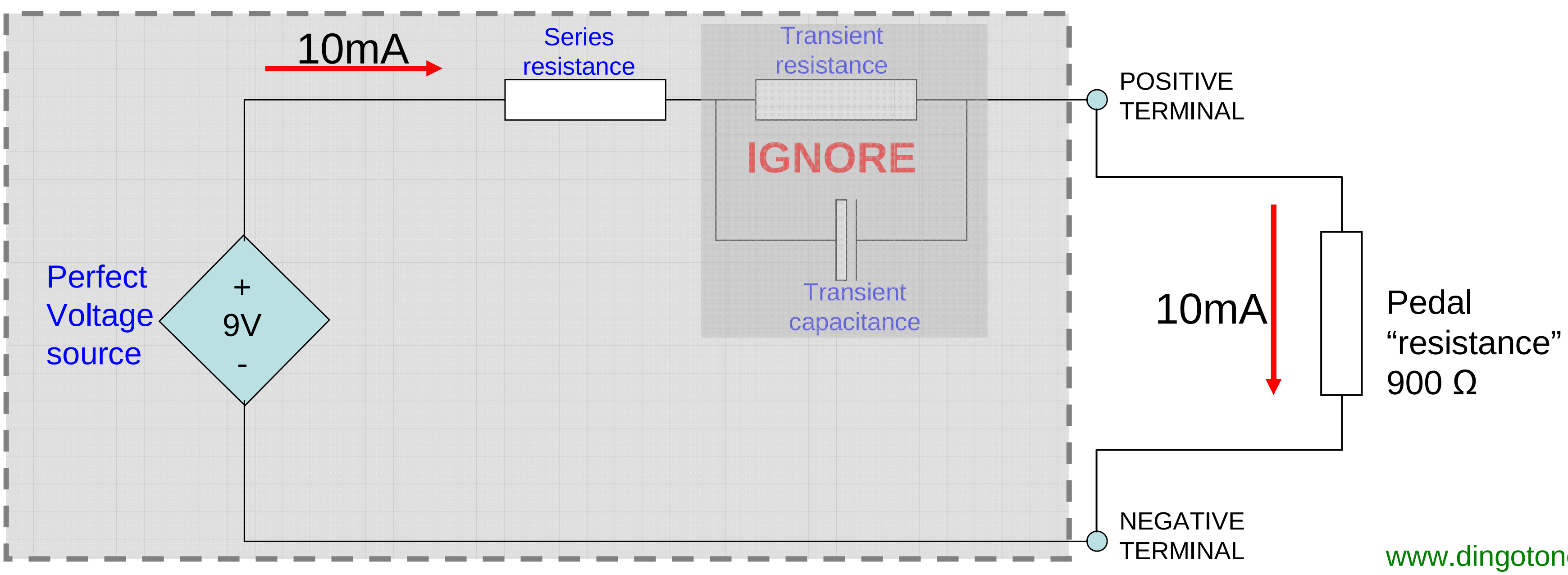
- Broadly speaking, a carbon battery will have higher ***Series resistance***, ***Transient resistance***, and ***Transient capacitance*** than an alkaline battery. I'll come back to that…



DingoTone

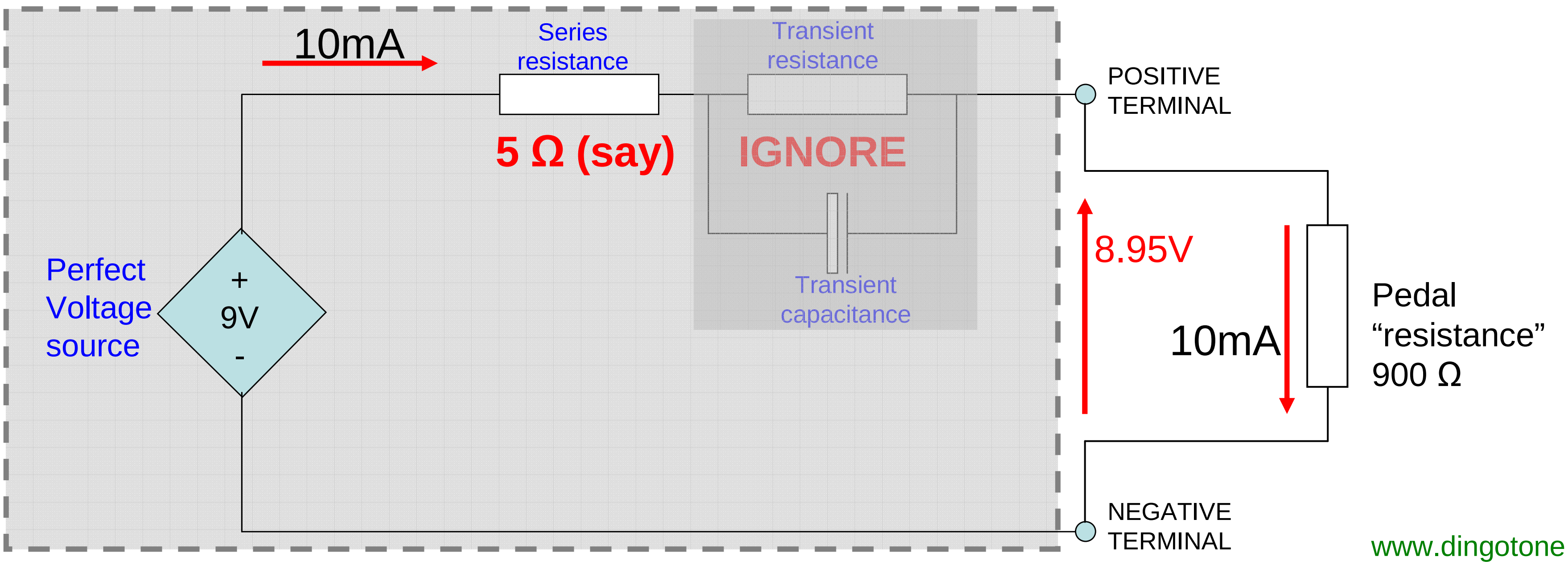
- Let’s see what connecting the battery to a pedal does.

- Ignore the Transient resistance for a moment and imagine you have a pedal connected with a steady current draw of 10mA.
- 10mA at 9V gives an effective “resistance” of the pedal power circuit of 9/0.01 or 900 Ohms (Ω).

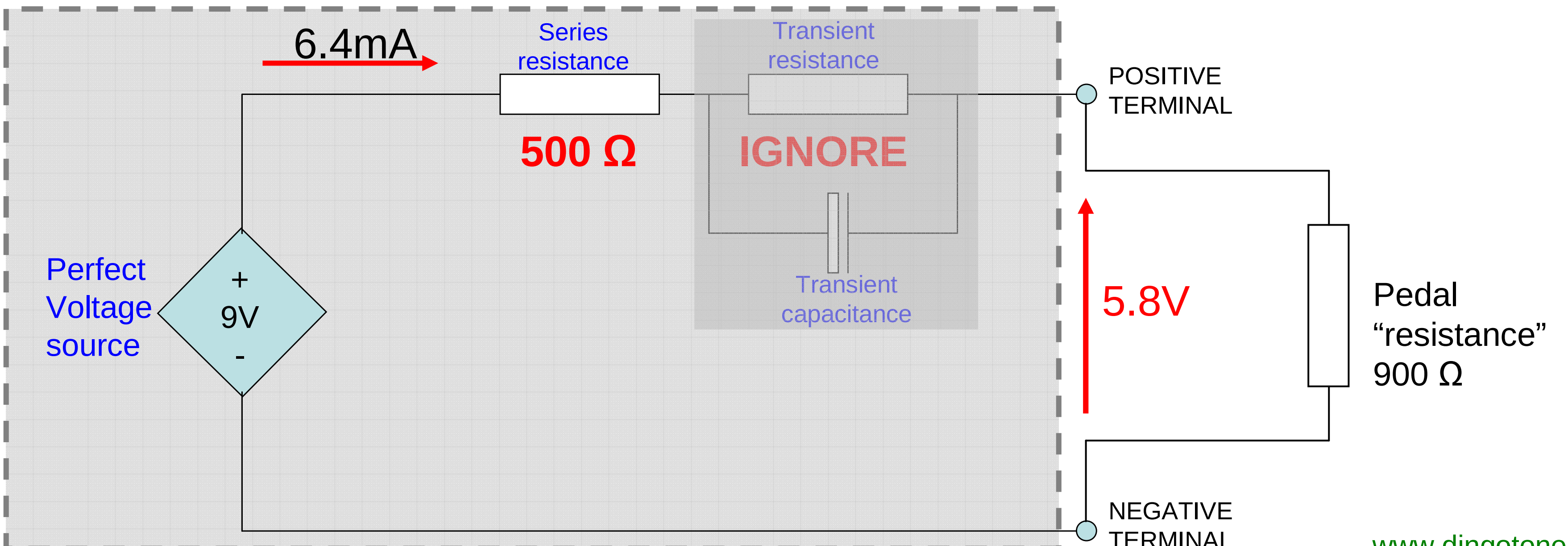


- This works out just fine if the battery is full.
- By definition, the battery being "full" means that the ***Series resistance*** is very low – usually in the order of a few Ohms.

- Let's say the ***Series resistance*** is 5Ω . 10mA going through 5Ω will cause a voltage drop inside the battery of 5x0.01 or 0.05V. Leaving the pedal powered with 8.95V. All good.



- As the battery discharges, the ***Series resistance*** goes up – in fact, this is the electrical definition of a battery discharging… it's not that the voltage goes away, it's that the ***Series resistance*** gets so large the battery can't do anything useful.
- Imagine the ***Series resistance*** is now up to 500Ω instead of 5Ω. Everything changes. The 9V is now going across a total of 900+500Ω. Giving a current through the pedal of 9/1400 or 6.4mA. This gives 0.0064x900 or about 5.8V to the pedal. Ouch. Flat battery!



- Now, this isn't all completely accurate from an engineering viewpoint. The pedal doesn't stay at 900 Ohms as the voltage drops and the ***Series resistance*** isn't strictly linear, but it is close enough to illustrate a point.

- The point is this – the battery ***Series resistance*** will mess with voltage provided to the pedal, and the bigger the ***Series resistance*** the larger the effect.

- If you add the effects of the ***Transient resistance***, and ***Transient capacitance*** the overall effect is even larger.

- Let's talk about ***Transient resistance***, and ***Transient capacitance*** for a moment. These are a measure of how much "inertia" the battery has to changing load. The smaller they are, the less effect there is on the voltage that ends up on the battery terminals.

- To summarize:
  - Higher ***Series resistance***, ***Transient resistance***, and ***Transient capacitance*** will have a greater effect on the battery terminal voltage.
  - Lower ***Series resistance***, ***Transient resistance***, and ***Transient capacitance*** will have a smaller effect on the battery terminal voltage.

- Now, messing with the battery terminal voltage… messes with your tone. Higher ***Series resistance***, ***Transient resistance***, and ***Transient capacitance*** is a bit like putting a "dynamic starve" control on the pedal.

- This is bad for many types of pedal. You wouldn't want it for your delay pedal, for example.

- BUT. The tone of your fuzzface actually relies on it. Let me state that again. For a fuzzface to sound like a fuzzface, the pedal needs a power source that has high ***Series resistance***, ***Transient resistance***, and ***Transient capacitance***.

- For a fuzzface to sound like a fuzzface, the pedal needs a power source that has high ***Series resistance***, ***Transient resistance***, and ***Transient capacitance***.

- You are probably one step ahead of me by now and have worked out that cheap carbon batteries have high ***Series resistance***, ***Transient resistance***, and ***Transient capacitance***. So the pedal sounds like it should if you use one.

- It's no coincidence that when the circuit for the pedal was developed cheap carbon batteries were the only thing available…

- Alkaline batteries have very low ***Series resistance***, ***Transient resistance***, and ***Transient capacitance*** (bad, for a fuzzface). Regulated power supplies are even lower (worse, for a fuzzface).

- Can you hear the difference? ABSOLUTELY.