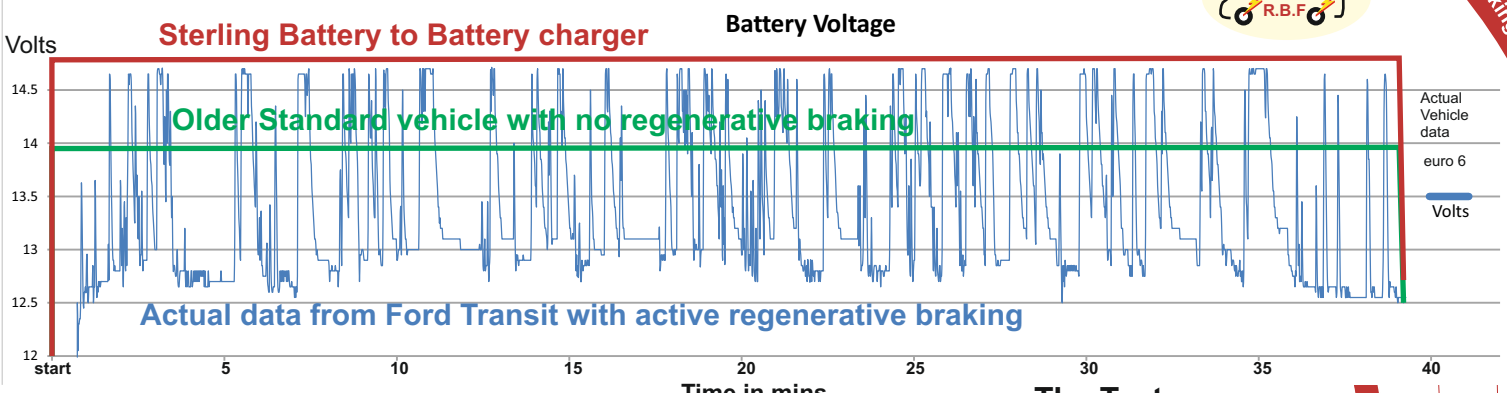
Regenerative Braking - Introduction to the problem and the solution.

Voltage variations associated with vehicle regenerative braking / smart alternator Systems (Energy Recovery System) and what a Sterling Battery to Battery Charge does to rectify this problem.



What is Smart Alternator / Regenerative Braking?

The initiative behind the introduction of smart alternators / regenerative braking is to lower CO_2 emissions and to improve miles per gallon / KM per litre for EU regulations. These smart alternators are installed on modern European Vehicles (Euro 5, Euro 6 + and newer engine models).

The object of this new system is to utilise a vehicles wasted kinetic energy during braking / deceleration cycles experienced in every day motoring and rapidly convert as much of that energy (which is usually wasted as braking heat) into useful electricity and store this energy in the starter battery. Then, during acceleration and cruising release this energy back into the vehicles running system as "free electrical energy" thus reducing the time where a alternator loads the main engine. This increases MPG/KPL and lowers CO_2 emissions.

However, in order for this system to be effective, the starter battery must have 'free space' to boost the energy into the battery, this requires the battery to be about 20% depleted (low enough to allow more power to be boosted into it but not too low as to prevent the engine from restarting when switched off). To replenish this 'free space', during deceleration or braking events, the voltage on the alternator shoots up to approximately 15V+. This higher voltage fast charges the starter battery to replenish its capacity. As you are using the inertia of the vehicle to charge the battery, rather than fuel, it is seen as 'free energy'. Then the voltage drops to about 12.4V to allow the free energy to be consumed by the vehicle allowing the battery to deplete itself by about 20% ready for the next speed reduction and so on and so forth. Albeit an improvement in terms of emissions, there are knock on effects regarding the auxiliary charging systems on board commercial vehicles, read on:

Problems with Smart Alternator / Regenerative Braking

The system requires a 20% empty starter battery for the system to work. It needs the space to "dump" the fast energy build up during braking. This is in direct conflict with the auxiliary charging system requirements, why?

1) No charge going into the batteries during the 12.2-12.4V phase (which is totally by primary system design). Therefore, if a simple relay charging system was used to charge the auxiliary system it would not be charged during this time frame. This will be a problem if you require a charged auxiliary battery during travel or at location to location.

2) Very high battery charge rate during vehicle deceleration / braking due to alternator high voltage. This is relatively problem free for the starter battery as its relatively full. However, a large empty auxiliary bank could experience high currents at high voltages (much higher than their recommended level) which would be detrimental to the battery (especially sealed, AGM and Gel) leading to premature destruction.

Problem with using voltage sensitive/controlled relays?

1) Most VSR / VCRs have 2-3 minute time delays before activating.

2) Even when the relay engages then at low voltages the batteries do not charge but at high voltage the aux batteries will get damaged due to massive current in rushes. **Also remember that the inherent software control system prevents the battery from being over 80% charged, so even when the battery is charging it will prematurely stop charging due to the software limitations which must leave that 20% space for the unit to be able to dump the breaking power, so you can never fully charge a battery using a relay or fet controller you must use a active power product .**

The Solution Sterling Batt. to Batt. chargers 20-180A

Sterling's Battery to Battery Charger: The battery to battery charger range is an active power device and is designed to be connected between the starter battery and the auxiliary system. This unit will increase the vehicle's voltage to the auxiliary battery when it is low and reduce the vehicles voltage to the auxiliary battery when it is high. It will also NOT permit high current inrush beyond the rating of the product (even under high demand loads) and so delivers the auxiliary battery system the correct voltage for different battery types (programmable) regardless off the main system voltage swings, thus, protecting the auxiliary batteries from unnecessary damage. It ensures a constant, safer and much faster charge from the system **which is not effected by the 80% charge restrictions on the primary battery system as such this product will fully charge you Aux battery bank almost doubling your battery power** .

It should also be noted that even on older vehicles or vehicles without smart alternators / Regenerative braking system, the Battery to Battery charger will charge auxiliary batteries much faster than conventional non active products such as relays. This product also has the ability to compensate for cable voltage drops over distance which will still result in up to a 10 times + faster charge rate.

The Test

Vehicle used in test (use graph for illustration)

Vehicle tested was a new (2013) Ford Transit van. Most, if not all vans and cars are now operating on this principle (no inditement to the Transit).

Route chosen:

The route involved some urban, then town, then motorway driving over about 40 minutes.

Graph / Voltage measured.

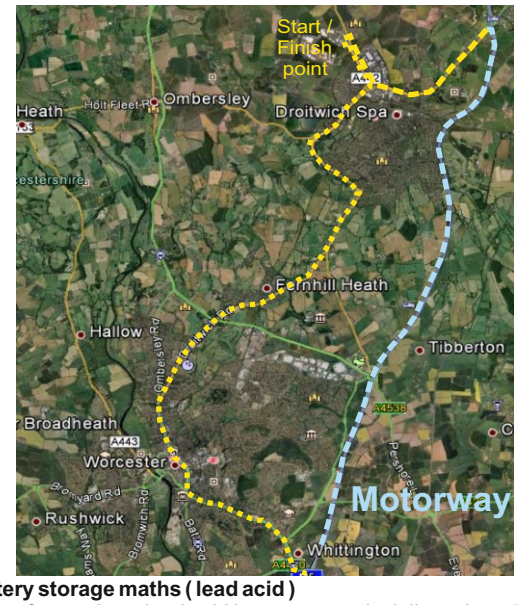
Blue line: Is the voltage measured at the battery from the Ford Transit using the regenerative system over the journey (acquired on actual journey).

Green line: Is the typical voltage one would see from a standard older vehicle not operation under regenerative braking control.

Red line: This is the voltage on the auxiliary battery sustained by the Sterling Battery to Battery charger regardless of the voltage on the input to the unit (or what ever voltage the unit is set for depending on the aux battery chemistry). The important thing to glean from this is that the Sterling unit is still boosting to 14.8V even when the input voltage drops to 12.6V. It also reduces the high 15V+ (not on the Ford sample) down to the correct 14.4V or 14.8V.

Conclusion: One can clearly see the voltage swing associated with the regenerative braking. Swing from 12.6V - 15.0V. this presents 2 major problems: When at 12.6V the auxiliary charging would simply be useless and at 15.0V it would destroy Gel / AGM batteries. Voltage swings with other manufactures have been in the order of 12.2V-15.4V. There are also massive current fluctuations which adversely affects fuse and cable sizes.

The Vehicle's Route



Battery storage maths (lead acid)

After a few cycles a lead acid battery can only deliver about 50% of its Ah rating as an affective power draw. As such, a 100Ah battery can only deliver about 50Ah affective, however, if the battery is limited to 80% charge capacity (Euro 6 engine restriction) then you only have about 30Ah affective. If you can fully charge the battery you have about 30% extra power storage in the battery.

Warning: Some vehicle dealers are using the workshop re-gen breaking override (for servicing) and using the vehicle on a day to day basis with this feature disabled in effect overriding the vehicles management system in regard to the re-gen braking aspect, this is totally illegal and will void the euro emission test certification for that vehicle as the re-gen braking aspect is part of the engine's emission certification standard. If in doubt about this then simply contact Volkswagen and ask them how bye passing the engine approved certified software and running on a non approved set of software is working out for them.