Canadus One – System Battery Solution

Commercial Vehicle Fleet Battery Problem

Commercial Vehicle fleets, including sleeper-cabs, day-cabs, delivery trucks and vans all have a higher than needed replacement of lead acid batteries. Parked trucks using necessary "hotel load" amps for overnight service, liftgates, reefer trailers or frequently started and stopped delivery truck operations prevent batteries from proper charging while in service. Millions of dollars are spent annually for replacement batteries on equipment in the field which are not available to auxiliary charging. A better battery management system must be considered.

Figure 1: Battery Failure is Expensive, Unscheduled Lost Production

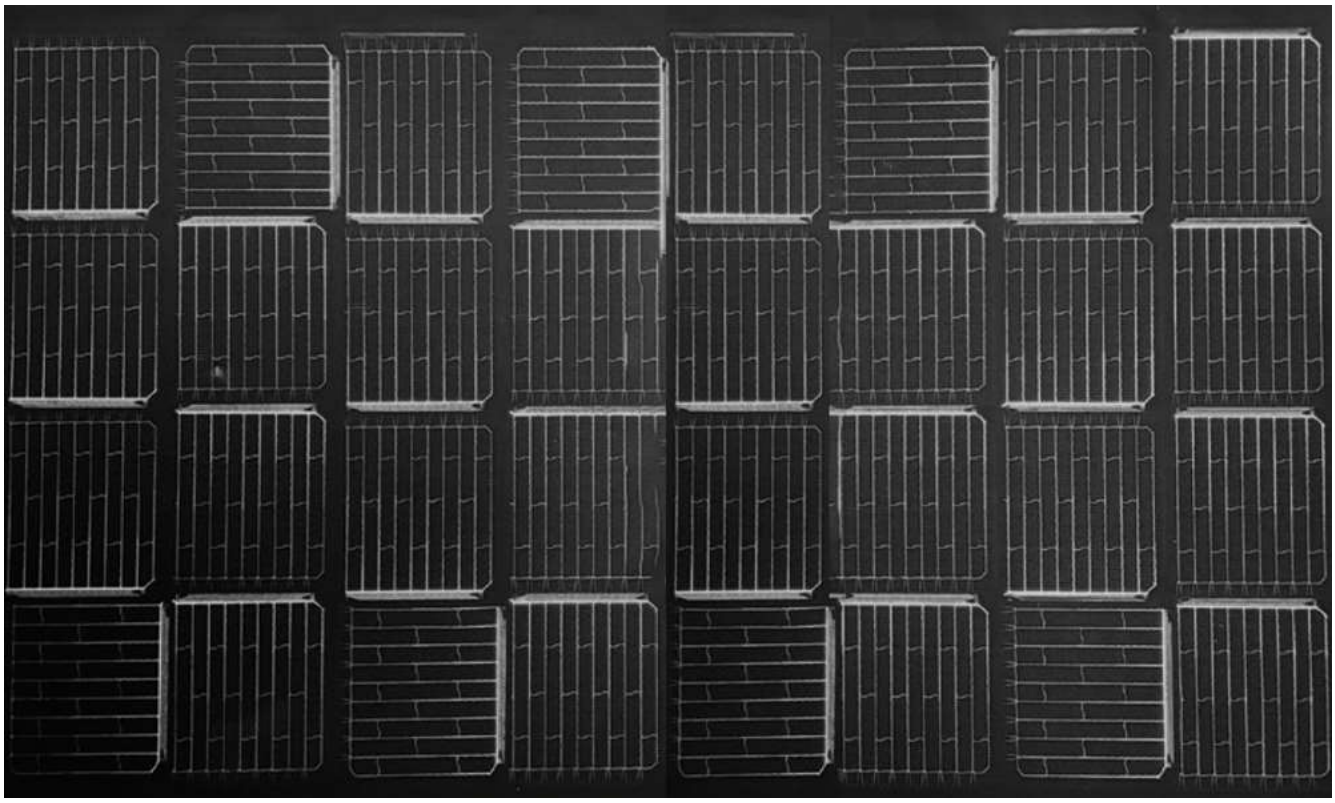
Available Solution

The Canadus One – System Battery Solution for Commercial Vehicles integrates two proven technologies to create a new method of maintaining batteries in the best possible condition. This design includes highly efficient and durable solar technology to provide supplemental battery charging with an electronic desulfator to provide balanced battery chemistry. The result is the ability to maintain full charge capacity and longer battery life.

About the Solar Advantage

This specific solar technology was developed and patented by Merlin Solar, San Jose CA. Merlin's panels consist of an innovative pair of metal grids that serve as intra-cell and inter-cell interconnections (see panel design in Figure 2) and enabled panels to continue working if physically damaged in a way that stops similarly sized glass – buss bar panels. The Merlin monocrystalline design assures the highest charging efficiency with the least amount of space requirement on the vehicle. These panels are flexible, rugged and easily attached. When a vehicle is equipped with the appropriate size solar panel for its specific duty, the additional charging capacity added to the standard alternator charging can maintain full battery capacity.

Figure 2: Merlin Solar Patented Panel



Battery Charging on a Truck:

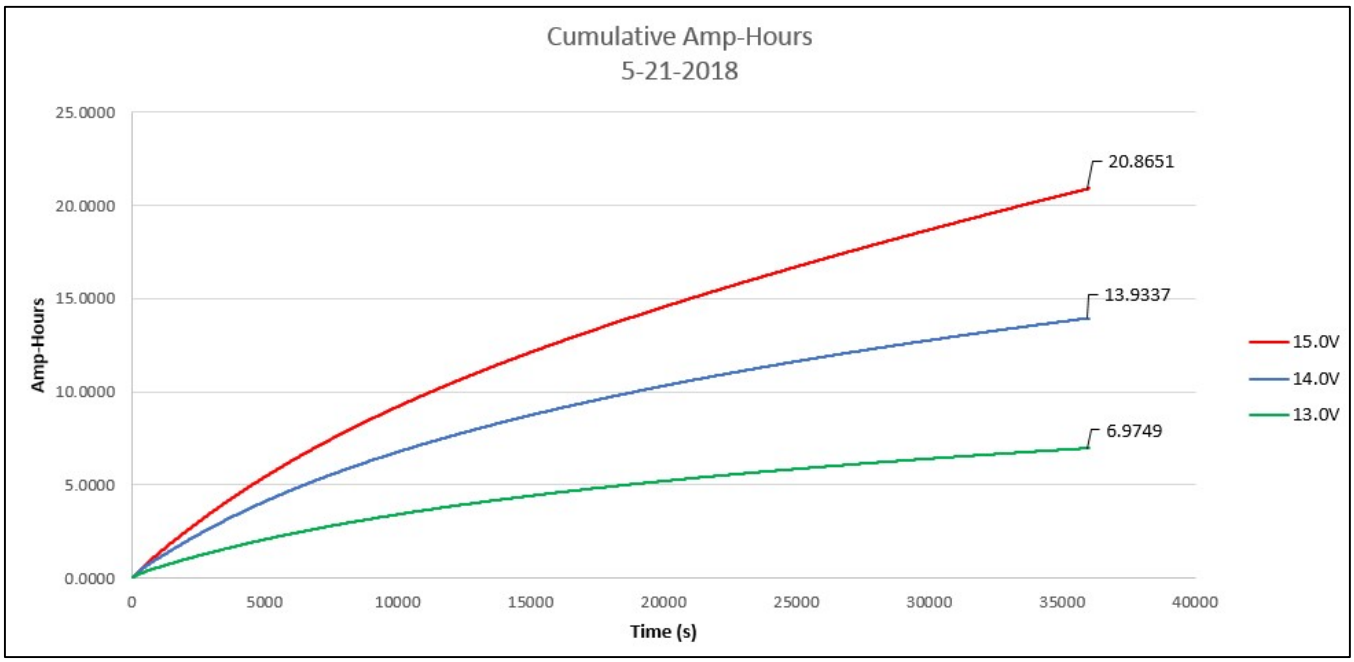
(NOTE: Examples listed in this report will be based on a typical North American, 12V electrical system)

Two conditions are needed to bring a battery to full charge; a voltage above 14.8V (which initiates gassing) and ample time. Neither of these conditions exists on today's commercial vehicles. At best, the voltage available to a vehicle's batteries under normal conditions is 14.2V. There is not enough time, nor is the voltage high enough to achieve a full charge within the vehicle's daily cycle.

Why is the vehicle set up to charge this way? Simply put, it is a compromise required by a single output alternator and a wide temperature operating range. 14.2V is as high as the voltage can be without water loss due to excessive gassing, which would occur at high temperatures.

As a battery is being cycled its available capacity will normalize based on how it is charged. Figure 4 shows three batteries that were discharged to 0% state-of-charge. Each battery was then charged at a different voltage ranging from 13V to 15V for a limited time of 10 hours. The current was accumulated to show the total amp-hours put back into the battery over time.

Figure 3: The effect of charging voltage on charge acceptance



As seen in Figure 3, there is a direct correlation between charging voltage and the number of amp-hours that can be put back into the battery during charging. Because charge efficiency is not 100%, we can expect to extract slightly less than was put in during the previous charging event.

In actual field applications, appropriately sized solar panels can be added to supplement the mechanical charging of the alternator to maintain battery capacity. Figure 4 below was developed for commercial vehicles:

Figure 4: Solar Panel Usage Application Matrix

By maintaining charge capacity and preventing batteries from sitting idle in a discharged state, the life of the batteries will be extended because "sulfation" crystals will not interfere with the battery chemistry. When the batteries are discharged, the Canadus HD-1224 Battery Desulfator will apply micro second charge pulses to destroy sulfation crystals while recharging either by the alternator or by solar.

About Sulfation

The formation of hardened lead-sulfate crystals on the battery plates is a leading cause for battery failures. Lead-sulfate is the product of discharge in a lead acid battery. As a battery is discharged, lead (Pb) from the plate combines with sulfate (SO_4) from the sulfuric acid (H_2SO_4) to create the compound lead-sulfate ($PbSO_4$), water (H_2O), and usable electricity. This is illustrated in the equation below with the discharge reaction moving from the left side of the equation to the right side.

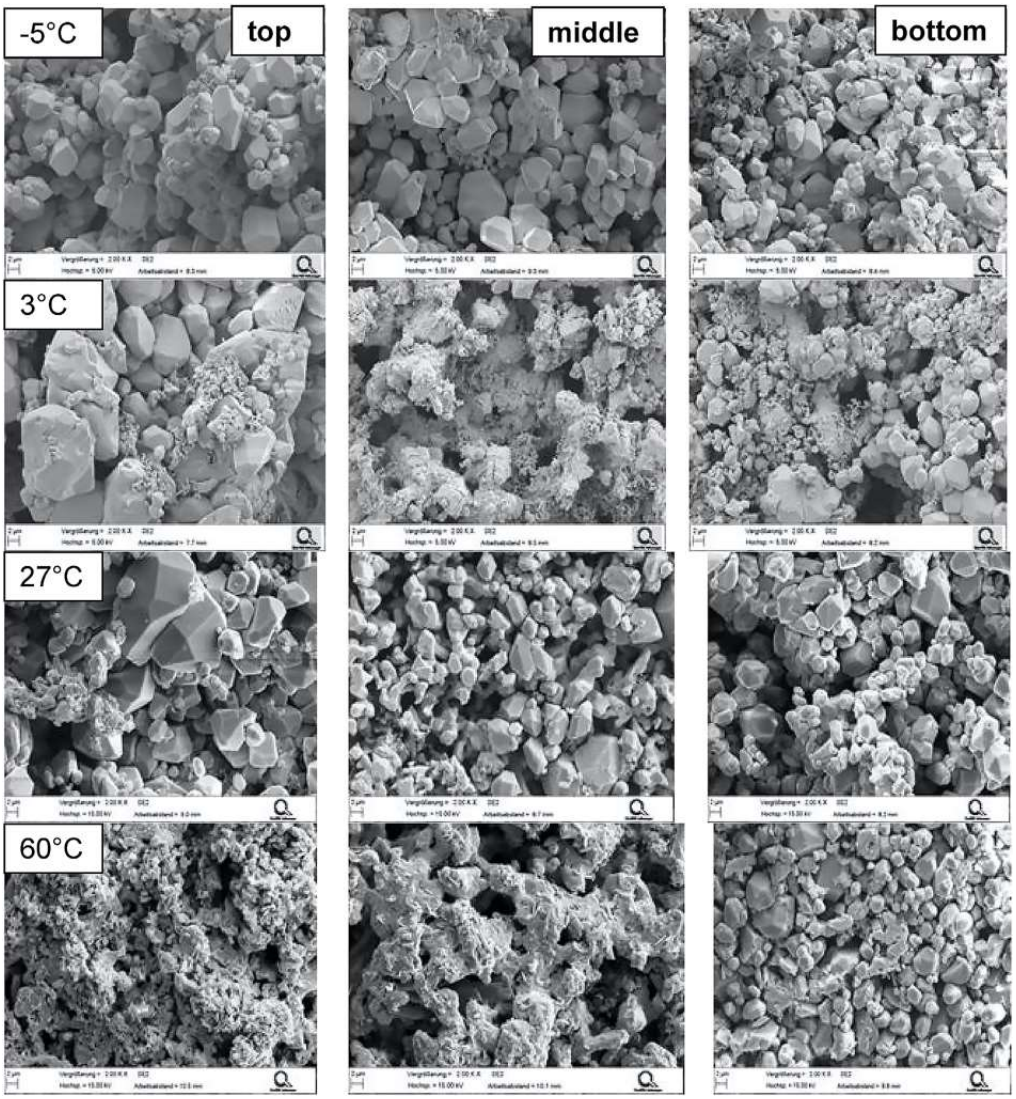
$$Pb + Pb0_2 + 2H_2SO_4 \rightleftharpoons Electricity + 2PbSO_4 + 2H_20$$

Lead + Lead Oxide + Sulfuric Acid ⇌ Electricity + Lead Sulfate + Water

A charging current reverses this reaction, pushing the lead (Pb) and sulfate (SO_4), as sulfuric acid, back to the left of the equation. The process is simple, reliable, and efficient until you want to convert all the

lead sulfate back to the left to full charge. In practice, it is impossible to do this on a truck with an alternator-based charging system. This condition of never being able to fully charge the battery leads to a failure mechanism called sulfation, where lead-sulfate crystals grow progressively larger resulting in what many people believe is a permanent loss of capacity. Figure 5 below illustrates the formation of sulfation crystals and temperature sensitivity.

Figure 5: Sulfation Crystals on Battery Plates vs. Temperature



Source:

Temperature-dependent formation of vertical concentration gradients in lead-acid-batteries under pSoC operation - Part 2: Sulfate analysis

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Sulfation Is Reversible:

As introduced earlier, small crystals of reactive lead-sulfate immediately form when a battery is discharged. These crystals are a required reactant for a battery during recharge. However, some of this material turns into large, stable crystals over time (sometimes referred to as hardened lead sulfate crystals), thereby reducing the available battery capacity. The following is a review of a simpler method to reverse sulfation without the negative effects of high voltage charging described earlier.

Canadus HD-1224 Desulfation Devices Explained:

In all the examples above, voltage in the 15V to 16V range was used to both fully charge a battery and reverse sulfation by breaking down some of the large, stable lead-sulfate crystals. Lost capacity was restored, thereby extending the useful life of batteries. Unfortunately, these higher voltages are not compatible with commercial vehicle charging for the reasons already listed, mainly excessive gassing. That's where desulfation devices can complement applications suffering from imperfect charging resulting in sulfation.

Figure 6: One HD-1224 can protect up to eight 12V Group 31 batteries in parallel configuration.

The Canadus HD-1224 provides the battery and the lead-sulfate crystals with the voltage needed to prevent and reverse sulfation. These pulses with peak amplitudes in the 17V to 18V range are of very short duration. These pulses do not cause gassing, water loss, loss of active material from the plates, or generate heat, but they do improve charge acceptance by dissolving large, stable lead-sulfate crystals if they are present.

The Canadus HD-1224 has been used as a standard component on commercial vehicles in both Europe and USA since 2015. Presently, more than 400,000 commercial heavy trucks have been OEM outfitted with the HD-1224 to prevent sulfation from forming and extending the life of the batteries.

Figure 7: Mack Makes Battery Refresher Standard

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Mack Makes Battery Refresher Standard

Industry experience has illustrated that the addition of the HD-1224 with new batteries prevents sulfation crystals from initiating in the battery. However, in service batteries can be treated with the HD-1224 to dissolve lead sulfate crystals that naturally occur over time as illustrated in Figure 8.

Figure 8: 17V to 18V micro pulses/sec dissolve lead sulfate from plates to improve battery capacity

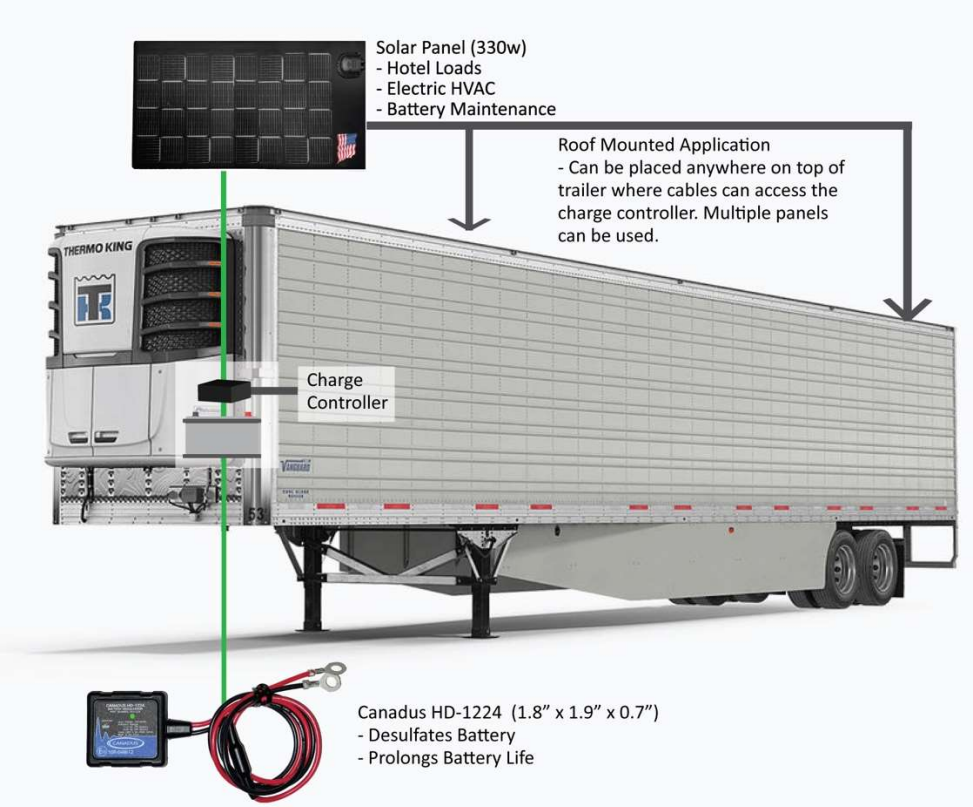
Summary

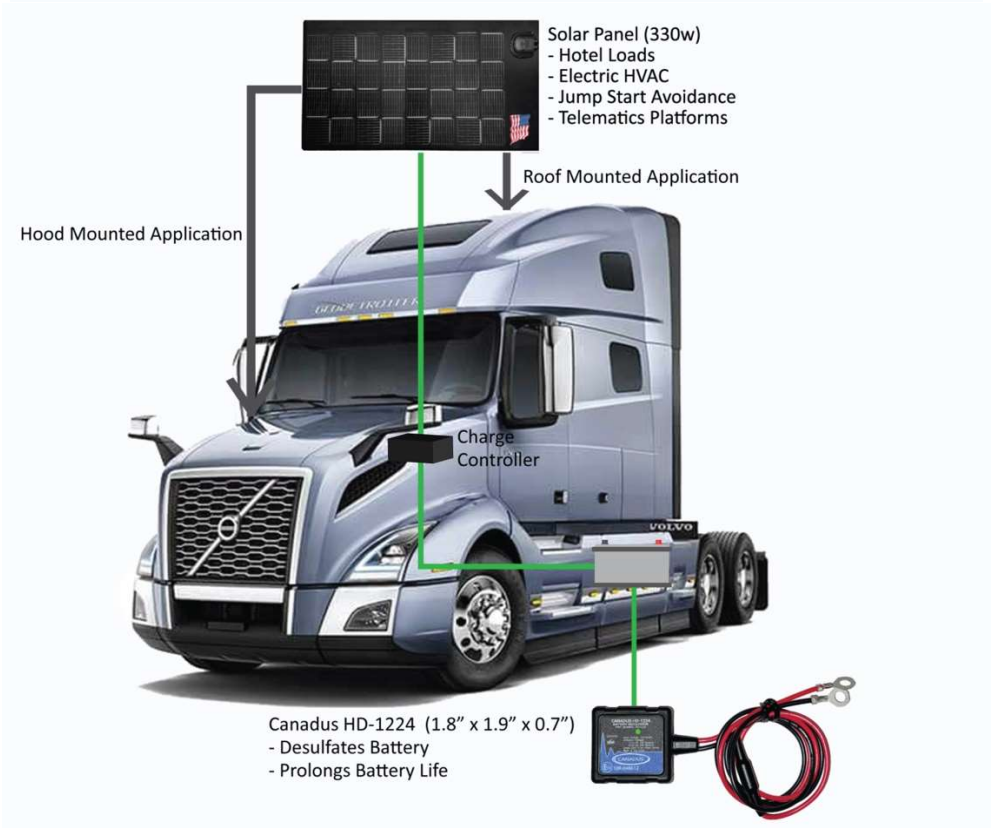
A lead acid battery's usable capacity is a direct result of how it has been charged. In most field applications, without auxiliary assistance, the usable capacity is significantly lower than a batteries potential capacity. The lost capacity is tied up in lead sulfate crystals, which over time grow progressively larger and more stable until they cannot be easily recovered through normal vehicle charging. A standard 14.2V charging system alone is not adequate to prevent sulfation from occurring.

Applying the Canadus One-System Battery Solution to Commercial Vehicle Fleets can keep batteries that are often over discharged and maximum readiness by using improved solar technology along with the industry proven HD-1224 electronic desulfator (see Figure 9).

Direct results of this practice will reduce no-starts, improve electrical system performance, extend battery life and lower replacement cost. Other benefits include the reduction in environmental liabilities, including less lead and sulfuric acid, and the reduction of fuel from necessary logistical movements of new and used batteries.

Figure 9: The Canadus One – System Battery Solution Illustrated Trucking





About Canadus Power Systems

Canadus Power Systems is a leader of lead acid battery technology since 2001. Canadus is involved in many design features to extend battery life and communicate battery health in 12, 24, 36 and 48-volt systems. Canadus manufactures its products in the USA.