CHALLENGE BATTERIES WA

Technical Update

Auxiliary Battery Systems

The purpose of an auxiliary battery system is to supply power for devices connected to your vehicle (even when the engine is not running), ensuring the main starting battery is reserved for engine cranking and vehicle electrical requirements. Applications include campers, 4WD's, trucks (e.g. tailgate lift), tradesman vehicles and caravans. An auxiliary battery system can include multiple batteries connected in parallel to increase overall storage capacity.

In the past, an auxiliary battery could be connected to the vehicle's electrical system using a VSR (Voltage Sensitive Relay) to 'piggy back' the alternator (Fig.1) however this type of connection is no longer reliable as vehicle Battery Management Systems (BMS) have become more sophisticated. Modern BMS's are designed to only manage the starting battery, with a primary focus on optimising fuel consumption rather than maintaining a high SoC of the battery. The battery in this type of system is never fully charged. It is for this reason that we should not recommend using a VSR, especially in late model vehicles.

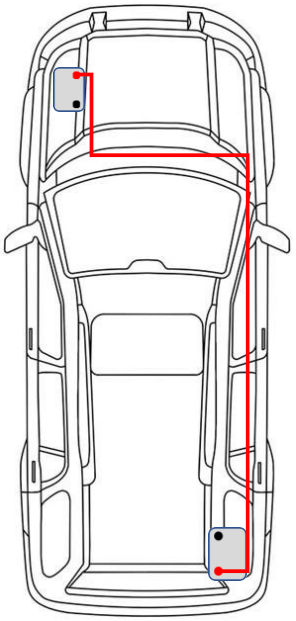

Fig.1.

These 'piggy back' style systems can also suffer from a significant voltage drop depending on the battery location. In a typical system installed in an SUV (Fig.1), the positive cable can easily be 5m long. If an 8-gauge cable is used for a 5m run to the auxiliary battery, the voltage drop at 25A will be 0.5V.

Although this doesn't sound like much, consider if the main battery charge voltage is 14.1V - the voltage at the auxiliary battery will be 13.6V. This is below the voltage required for effective charging and will extend the charging time significantly. The most likely outcome is an auxiliary battery which is only charged to 70% or 80% SoC instead of 100%.

Do It Once, Do It Right!

The only way to ensure an auxiliary battery is charged & managed correctly is to install its own BMS in the form of a DC-DC battery charger. This device will independently manage the auxiliary battery to ensure the battery (or batteries) are charged and managed correctly, maximising service life and reliability (Fig.2).

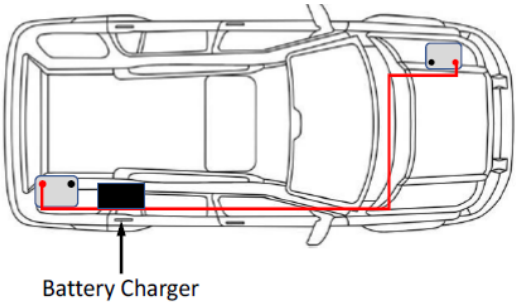

Fig. 2

Most DC-DC chargers include an input voltage sense function which ensures they do not operate until the engine is running to preserve the starting battery. Another benefit of using a DC-DC charger is that you will eliminate voltage drop issues for the battery by locating the charger as close as possible to the auxiliary battery.

If the auxiliary battery is located in a caravan, the DC-DC charger should be installed in the caravan adjacent to the battery to ensure the battery receives the correct charge voltage (Fig.3). Some DC-DC chargers can support multiple input power sources, which means that you can connect a solar panel to power the charger when in storage or not connected to the main vehicle.

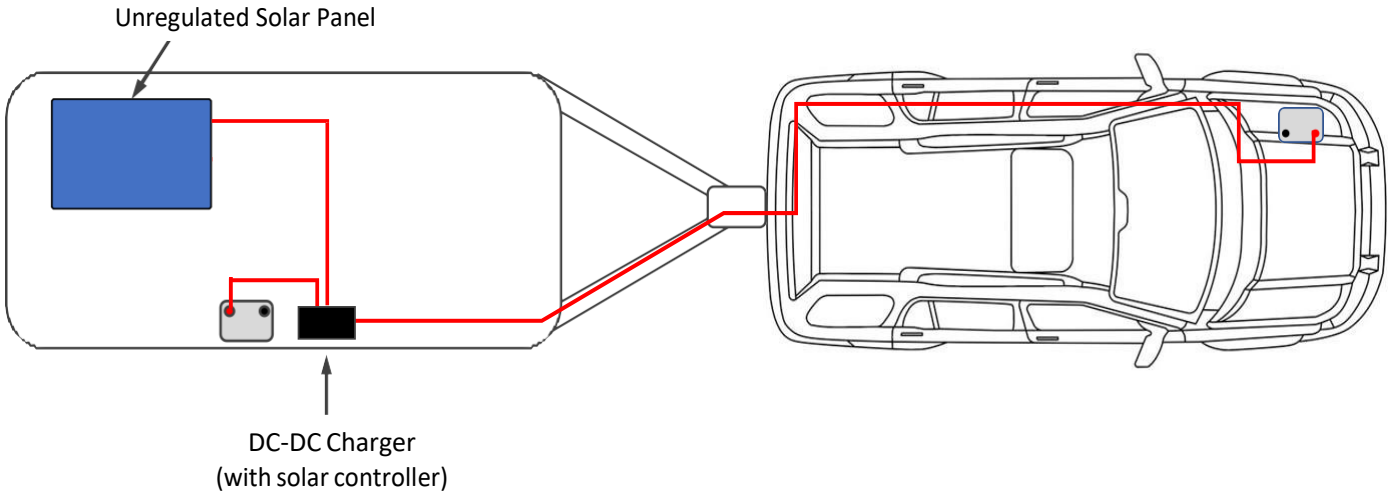

Fig.3

Battery Types

There are a number of different types of batteries which can be used in auxiliary systems. It is important that you select the correct battery which is suited to the location and application.

Design

Starting (or cranking) batteries are primarily designed to deliver short bursts of high current for engine starting – let's think of them as a greyhound. They are designed to always operate at a high SoC (>85%).

Cycling batteries are designed to deliver lower current over extended periods of time and can be discharged down to 50% SoC (Lead Acid) or even 100% SoC ($LiFePO_4$). Let's think of them as a draught horse.

Using a starting battery in an auxiliary power system is like using a greyhound to pull a trailer – neither of them are going to last very long! Conversely, entering a draught horse in a sprint race is going to be about as successful as installing a low CCA deep cycle battery in a starting application!

Case Material

Deep Cycle AGM and gel batteries with ABS cases (e.g. Fullriver, Predator ES, FTG & ED series) **must not be installed in an engine bay or near any heat source.** ABS softens at around 100°C - given that the coolant temperature in your vehicle is over 100°C, the hot air from your radiator is enough to soften the case before you consider the other heat sources in the engine bay. ABS can be identified by a high gloss finish and a number 9 inside the recycling triangle (Fig.4).

Fig.4

Deep cycle lithium batteries (e.g. ALLiON & RELiON) also have an ABS case which means they must also be kept out of the engine bay and away from heat sources.

Batteries which are designed to be installed in the engine bay will have a polypropylene (PP) case and will be identified by 'PP' or a number 5 inside the recycling triangle (Fig.5). PP normally has a matte or satin finish rather than full gloss. The majority of starting and marine batteries have PP cases. Another way to identify a PP case is the moulded in lead posts, where ABS cases will almost always have a threaded stud or boss terminal which is bonded or glued in (Fig.6).

Fig.5

There is always an exception to any rule. Fullriver HC batteries have a modified ABS case which can better handle the heat in an engine bay, and there are a couple of ABS cased batteries with moulded in lead posts. If you are unsure, please refer to the R&J Product Data Sheets or contact the Product & Technical Manager.

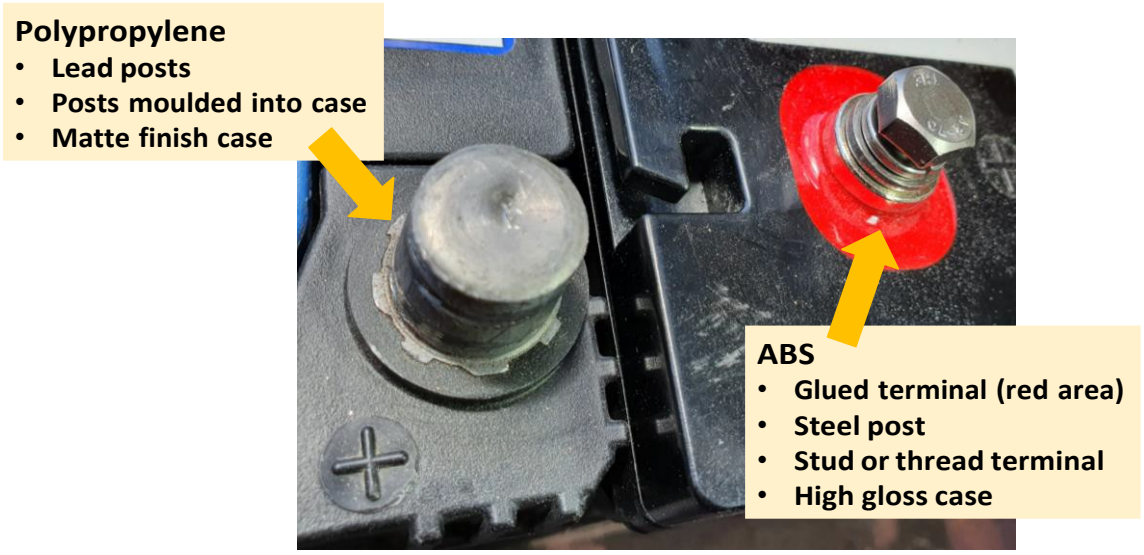

Fig.6

System Design & Installation Tips

Here are some tips for installing an auxiliary battery system which will help our Customers get it right first time:

- Always install the DC-DC charger as close as practical to the auxiliary battery (or batteries).
- Best practise is to use crimped connections for power wires – the mechanical retention of a crimp will ensure the wires are always positively retained (solder can melt!).
- Always install a fuse in a power cable. The fuse must be located as close as possible to the power source (i.e. battery or terminal block), not at the device. Fuses are installed to protect the wiring, not the device.
- To increase the storage capacity of an auxiliary battery system, connect multiple batteries in parallel. If there are more than 2 or 3 batteries in the parallel group, connecting the power and charging cables to opposite ends of the group will balance out any voltage drop when discharging or charging (Fig.7).

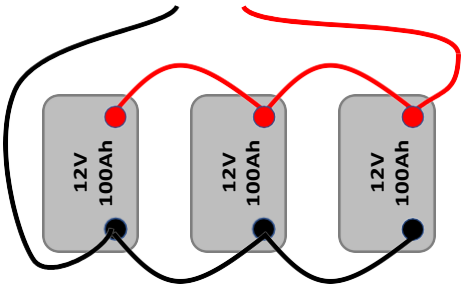

Fig.7

- To minimise the voltage drop in power wires, ensure you use wire which is large enough to carry the rated current – see the following section which discusses wire size selection.

Wire Size Selection

Wire size is measured using a number of different standards. One of the most common is American Wire Gauge (or AWG).

In this standard, the wire is rated by a number; interestingly the smaller the number, the larger the wire size. 2AWG wire can also be written as 2gauge, 2ga or 2G – you will normally see this printed on the outer insulation of the wire (Fig.8).

Fig.8

To select the correct wire size for a 12V system, you will need an AWG wire sizing table like the one shown in Figure 9 which lists the common wire sizes. These tables can easily be found by searching on the internet for “AWG wire size length”.

First, find the line which corresponds to the maximum expected current draw. Read along that line until you intersect with the column which equals the wire length (always round up to the next increment). Where these two numbers intersect, read off the wire size.

As an example, let’s consider a 75A max current and 5.5m wire length. First you round 75A up to 80A and follow across the 80A line until you reach the 6.1m column (rounded up from 5.5m). The recommended wire size for this application is 2 gauge. If you want to build in a safety factor and minimise voltage drop, you could use the next largest size wire which would be 1/0ga on this table. You could also use 1AWG and 0AWG if available.

Current in Amps	Wire Length in Metres													
	0.6	1.2	1.8	2.4	3	3.7	4.3	4.9	6.1	7.3	8.5	10	12.8	15.3
10A	16	16	16	14	14	14	12	12	10	10	10	8	8	4
15A	16	16	14	14	14	12	10	10	8	8	8	4	4	4
20A	16	14	14	12	12	10	10	8	8	8	4	4	4	4
25A	14	14	12	10	10	10	8	8	4	4	4	4	4	2
30A	14	14	12	10	10	8	8	8	4	4	4	2	2	2
40A	14	12	10	8	8	8	4	4	4	4	2	2	2	1/0
50A	12	12	10	8	4	4	4	4	4	2	2	2	1/0	1/0
60A	12	10	8	8	4	4	4	4	2	2	2	1/0	1/0	1/0
70A	12	10	8	4	4	4	2	2	2	2	1/0			
80A	12	8	8	4	4	2	2	2	2	1/0	1/0			
90A	12	8	4	4	2	2	2	2	1/0	1/0	1/0			
100A	10	8	4	4	2	2	2	2	1/0	1/0	1/0			
120A	10	8	4	2	2	2	1/0	1/0	1/0	1/0	3/0			
140A	10	4	4	2	2	2	1/0	1/0	1/0	3/0	3/0			
160A	8	4	2	2	2	1/0	1/0	1/0	3/0	3/0	3/0			
180A	8	4	2	2	1/0	1/0	1/0	1/0	3/0	3/0	3/0			
200A	8	4	2	2	1/0	1/0	1/0	3/0	3/0	3/0				
250A	4	2	2	1/0	1/0	1/0	3/0	3/0	3/0					

AWG Wire Specifications

AWG	16	14	12	10	8	4	2	1/0	3/0
Wire Diameter (mm)	1.29	1.63	2.05	2.59	3.26	5.19	6.54	8.25	10.4
Wire Area (mm^2)	1.31	2.08	3.31	5.26	8.37	21.2	33.6	53.5	85

Fig.9

Installing a DC-DC Charger

Installing & connecting a DC-DC Charger is not a complex task. Although they may vary a little between brands, the same main connections are required for all chargers. The key is to take your time and make sure every connection is high quality and low resistance. Figure 10 shows a schematic wiring diagram for a DC-DC charger.

Firstly, vehicles built in the last 50 years are configured with a negative earth. This means that the negative cable of the vehicle battery is connected directly to the vehicle's metal body. This simplifies connecting electrical devices because you only need to run a positive power wire. A negative power wire can be connected to the metal body anywhere in the vehicle.

Please note the following when reading the schematic in Fig.10:

- All positive power wires are fused to protect the wiring. Fuse size (in Amps) must be the **same or less than the maximum current capacity of the wire.**
- Make sure all ground connections are to bare metal. You may need to sand off paint to expose bare metal before installing the connection.
- If the DC-DC charger is installed in a separate vehicle (e.g. caravan or trailer), you must also add a negative wire (grounded to the body of the main vehicle) which is the same size as the positive wire. Both wires will transmit the same amount of power.
- The temperature sensor is attached to the top or side of the auxiliary battery.
- All connections should be made using crimp-based connectors to ensure wires are always positively retained.

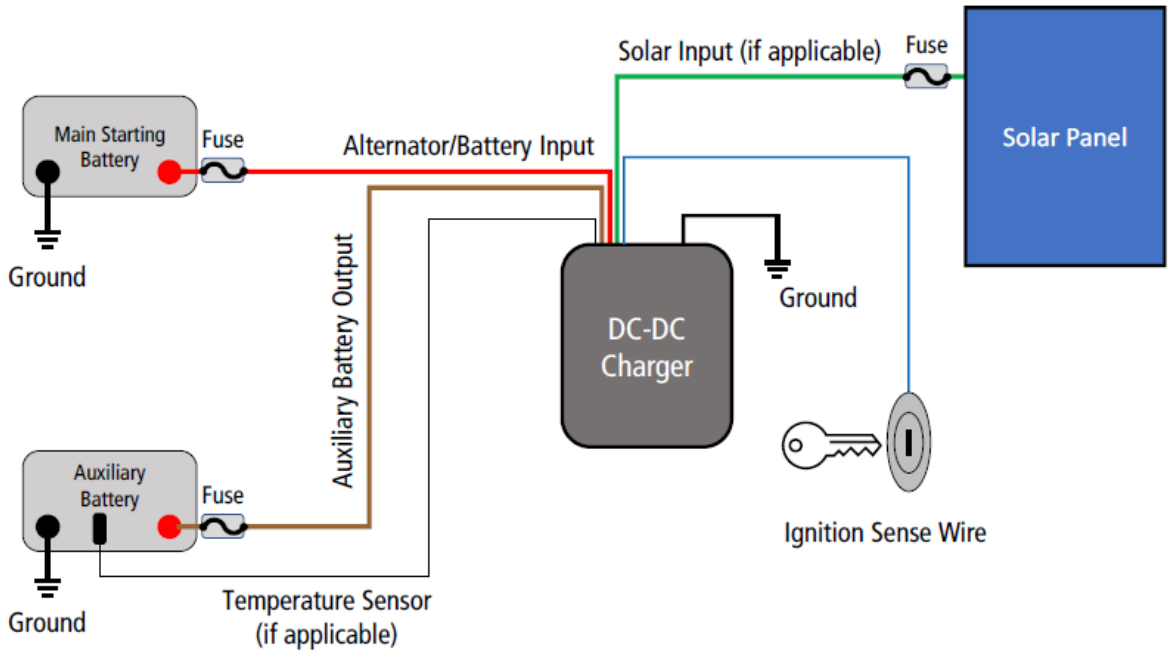

Fig.10