Much of the material in this note is based upon the excellent information provided by Grenville Hancock of the Moody Owners Association.

**Background**

On yachts with inboard engines and therefore alternators, multiple battery banks are now accepted practice and the many yachts now have a separate battery dedicated to engine starting. This introduces the question of how to charge both battery banks from a single source?

You can choose either a manual system, based on a rotary switch allowing you to select 'either' or 'both' batteries. This works perfectly well, is 100% efficient and inexpensive. The only downside is that you have to remember to keep a charged battery 'in reserve' so that you can start the engine if the service battery becomes overly discharged.

Alternatively you can fit an automatic system, that keeps the starter battery charged, and automatically isolates it, so that you never have to worry about not being able to start the engine due to a flat starter battery.

Originally I had fitted a manual switch arrangement on 'Toodle Pip', but after installing a fridge requiring more 12 volt power, I decided to add a third battery purely for engine starting, and to install an automatic battery charge splitter.

**Split Charging Systems**

Automatic systems, that automatically isolate the engine starter battery, were traditionally of the split diode type. Many Leisure yachts with Volvo engines were fitted with a split diode charging plate on the back of the alternator; alternatively there are several separate split diode modules available.

Split diode systems work well, and are relatively inexpensive, but suffer one serious disadvantage. Due to the 0.5 to 0.7 volt drop in the diodes, the batteries can never reach a full state of charge, perhaps only reaching a maximum of 70% of optimum. Even the more complex systems with remote battery sensing can only ensure that one of the batteries is fully charged.

Given that you should not discharge service batteries (even deep discharge types) more than 50% if you want them to last a long time, this potentially gives you only 20% of usable capacity!

Another consideration is the type of battery used: ideally you want a relatively small (say 50 AH) engine starter battery, but one with high CCA (Cold Cranking Amps) rating, whilst you need a high capacity (say 110AH if you have the space) deep discharge (leisure type) battery for services.

There is a solution, which is to use a Voltage Sensitive Relay (VSR). The operating principle of a VSR is that it contains an embedded voltage detection circuit which accurately monitors the engine starter battery voltage (this being the highest priority). This circuit controls the relay and introduces controlled hysteresis such that the relay cuts in when the voltage rises above 13.7v and cuts out when the voltage falls below 12.8v. What this means in practice is that when the engine is first started, the alternator initially recharges the engine starter battery and only after the voltage of the engine starter battery rises above 13.7v does the system connect the two batteries together to form a single battery bank.

The VSR is essentially loss free, and has no voltage drop like the split diode arrangement.

VSR's come in two types, semiconductor, and mechanical relay. I chose a mechanical relay type as they are simpler, smaller, very robust and cheaper. The diagram on the left shows the basic arrangement:

The relay shown is a BEP Marine Voltage Sensitive Relay (see http://www.bepmarine.com/Voltage-Sensitive-Relays-166.html).

The relay comes in two main types, single or dual sensed.

Single sense types just monitor the engine starter battery, whilst the dual sense variety monitor both engine...
starter and service batteries; which allows the VSR to be used with a mains powered battery charger, as well as the engine alternator.

I actually used a BEP Dual Sense relay. The wiring diagram is unchanged, other than for the battery charger connection to the service battery.

For a basic installation you need simply to wire as shown, operation is fully automatic. A small red led glows on the BEP relay when it is energised, so that you can check on its operation.

**Installation on Toodle Pip**

The photo shows the relay installed on Toodle Pip on the Starboard side of the engine with the new rotary two way battery switch (A).

Unfortunately you cannot see the indicator on the BEP relay without removing the engine box cover. I did not want to have the relay mounted in the cabin, and this arrangement kept the cable lengths short with my battery arrangement. The unit has been totally reliable in service, so I do not believe this is a great compromise.

A good source of cable and terminals is Autosparks (www.autosparks.co.uk).

I used 61/0.90 battery cable and 120/0.30 60 amp cable for the connection to the VSR. You also need 8mm Straight Type Eyelet terminals to connect the 60amp cable to the VSR, and 10mm Straight Type Eyelet terminals to suit the battery cable. I can supply a complete parts breakdown on request. What you need will of course depend greatly on how you actually choose to do the wiring.

The BEP VSR's can be obtained from E C Smith, and many other yacht equipment suppliers.

The diagram (previous page) shows a basic installation, but on Toodle Pip I decided to include some 'extras' to allow more flexibility. I also had the space to install 2 110AH service batteries, as well as a 45AH engine starter battery. Obviously install the biggest batteries you can.

Some yacht owners I know use the motorcycle type 'high energy' batteries for engine starting. They are very compact, but are more expensive than regular car type batteries.

The diagram below shows the wiring on Toodle Pip.
Switch ‘A’ allows engine starting from either the engine starter battery (normal) or the services battery (in case of engine starter battery failure).

Switch ‘B’ allows either both service batteries to be in circuit, or one. Generally ‘both’ batteries are left in circuit, but the switch gives the ability to isolate one battery should it fail (it does happen!). An acquaintance of mine had 3 110AH batteries all wired together as a service battery bank and when one failed recently, the others discharged into it and it boiled. So the ability to isolate batteries can be useful!

Switch ‘C’ allows the main switch panel to be isolated when the boat is left, whilst leaving shore power connected and the batteries being float charged.

The single output battery charger is connected to the service battery. However because the VSR is the dual sense type, once the service battery has been charged to 13.7 volts, the VSR will close and will start to charge the engine starter battery also.

In my case Toodle Pip is permanently connected to shore power whilst in the marina, so I can be sure all the batteries are fully charged when we go sailing. The dual sense VSR is only an advantage if you have a charger installed, and have ready access to shore power. If you rely on the engine starter to charge your batteries, or only have occasional access to shore power, then the single sense VSR is fine, and it is slightly cheaper.

**Battery Locations**

The two 110 AH service batteries are located in the original battery box under the navigators seat, and in a moulded battery box mounted in the aft end of the Port side settee berth.

The space under the galley ice box was empty on Toodle Pip (some boats will have a fridge unit in this position).

I was able to make up a cradle for the starter battery to fit neatly in this space (alongside the pots and pans).

Note that the positive battery terminal was fitted with a clip on cover, and a battery tie down strap was fitted, after the photograph was taken.

Getting the battery in and out is a bit of a fiddle, but at least having the weight on the Starboard side helps to offset the list to Port all M28’s tend to have!

Some owners have fitted starter batteries under the aft cabin floor, but there was no space on Toodle Pip to install anything but a high energy battery there, and I wanted to use a regular car starter battery if I could.

**Experience to Date**

This arrangement has been in use throughout the 2009 season, as has proven to be 100% reliable. In practice I have found that the relay ‘clicks in’ almost immediately after the engine is started, as my old Volvo 2002 starts very easily, and very little capacity is used up starting the engine.

When the engine is stopped, the relay ‘clicks out’ after a few minutes, as the system voltage slowly drops to its steady state around 12.6 volts. This obviously depends on the service load at the time.

The VSR draws only a very small (a few milliamps) of current from the batteries when ‘off’, which is insignificant. Nonetheless you will want to disconnect the batteries completely in the winter if you do not have shore power charging.

When the VSR is ‘on’ it draws about 250 milliamps, but this is not an issue because the VSR is only ‘on’ when the batteries are being charged, either by the alternator, or if using a dual sense unit - from the shore power charging.

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