Electrics Ma Belle

There are several separate diagrams of the electrics/wiring of Ma Belle:

1. Battery, Alternator, Starter, Engine wiring and main user connections
2. Switch/breaker panel, fuses and user connections
3. MPPT and solar wiring
4. Detail wiring LiFePO4 V-level monitor and alarms
5. Detail wiring Alternator regulator (Wally100)
6. Detail wiring Start battery/engine via relay A
7. Detail wiring DC-DC charger and charge control box for start battery

General
The LiFePO4 batteries are charged directly by the 85A alternator. Charge current is regulated by the alternator regulator (Wally 100) by varying Field-current. Inputs used for regulation are battery voltage, alternator charge current, alternator temperature and alternator RPM.
All parameters are configurable.
A manual field current regulator is available for emergencies.

No BMS is used. Instead, a cell voltage monitor, 4 cell over-voltage alarms and a total battery voltage under-voltage alarm are present. The cell monitor also has an under-voltage alarm. Furthermore an active cell balancer is being used with far greater balancing currents than the balancing function of a BMS. This all provides sufficient protection and leaves the skipper in full control over LFP battery power supply switching, usage and charging. The advantage of not using a BMS on a boat is that no unexpected power source disconnects can take place which can be dangerous if critical equipment is being used at the time of the disconnect (e.g. anchor winch, critical navigation equipment or a hot air diesel heater which needs a cool-off cycle before power can be switched off). By conservative setting of the LFP battery under-voltage alarm, the skipper gets an advance warning and can take action to reduce or switch off power usage before a dangerous under-voltage is reached which can damage the LFP batteries or it may be decided to start the engine to start charging by the alternator.
The battery charge state is monitored by a no-nonsense battery monitor/coulomb counter.
The Wally100 alternator charge controller displays Voltage, Amperage, RPM, temperature and currenct parameter settings. Parameter settings can be changed in the running system.
In case of an emergency charging can be stopped by a long-press of the display selection button which forces the regulator into Wait mode.

An important advantage of this setup is that the house batteries are charged directly via a heavy-gauge cable between alternator and batteries without any electronics in between, thus minimizing risk of faults.

The start battery is charged by a small max 10A 14.2V DC-DC (adjustable) converter which is powered by the LFP batteries. The charger starts when the alternator starts producing charge current to the LFP batteries. A selector-switch also allows start battery charging when the engine is not running or switching off charging altogether.
The start battery is also kept topped-up by a dedicated solar panel with 3-stage MPPT controller for L/A batteries.

Solar charging of the LFP batteries is provided by 2 100A solar panels mounted on the

bimini. The panels are connected in parallel to the Epever MPPT Tracer AN solar MPPT controller with MT50 display.
Both the panel-side and the battery-side of the Epever connections can be switched by high current switches mounted under the controller. In an emergency, the battery-side switch can be used to isolate the LFP batteries if over-charging of one or more LFP cells takes place (alarm goes off). Like most MPPT controllers, The Epever controller only monitors total battery voltage, so in case of a significant cell-unbalance one or more cells can reach undesirable high voltages (>3.65V) while total voltage is still below the set absorption or boost voltage.
This is an exceptional situation that is normally avoided by a conservative absorption voltage setting and the activation of the active cell balancer.

Alternator regulator (Wally100)
The alternator regulator is powered by the house batteries and powers on automatically (via a FET) when the start battery main switch is on and the power switch on the engine instrument panel is switched on. However, an override switch has been installed to power the regulator without automatic on/off control, so that regulator parameter settings can be changed without the need of switching on engine electrics.

Settings are:
1. Maximum charge current for 3 alternator RPMs (2000, 3500, 5000). For in-between RPMs max charge currents are calculated by interpolation.
2. Maximum Volts (absorption Volts). Default 13.8
3. Voltage for re-start charging LFP when in wait mode.
4. Maximum alternator temperature. Default 60
5. Cool-off time if alternator temp has reached max.
6. Absorption time.
7. Calibration Voltage

There are also similar separate settings for L/A batteries, but the alternate L/A - LFP charging feature is currently not being used.

The regulator controls (limits) charge current and monitors voltage and alternator temperature during the bulk charge stage. When the absorption voltage is reached, the voltage is regulated (CV-stage) while charging is limited to a low amperage. This stage is timed and allows charging to 100% SOC. This also allows the active balancer to balance cells with several amps of balance current. When the absorption time is up, the regulator switches to “Wait” mode, whereby just enough field current is supplied to keep the W output of the alternator active for the tachometer.
The regulator returns to bulk mode when the LFP voltage drops to the (settable) restart voltage.

The regulator does not have a “float” stage for LFP mode (it has for L/A mode).

Operational parameters can be changed quickly and easily by plugging in a small separate box in a mini-stereo connector on the regulator and selecting “config” mode by repeatedly pressing the display select button until the config on/off screen is displayed. The box contains a potentiometer and by varying voltage, turning the potentiometer, parameter values can be changed. For example, to change the absorption voltage, push the display selection button repeatedly to go to the absorption voltage setting display. The present absorption voltage is displayed and next to it the new required value can be chosen by turning the potentiometer. When the required value is displayed, it can be applied and

saved by a long press of the display selection button. The same applies to all other parameter settings.
The parameter setting procedure can also be executed in the running system, during charging.

As a backup for the regulator a simple plug-compatible manual field current regulator is available. By choosing a conservative charge amperage, alternator charging can continue unattendedly if the Wally100 smart regulator fails. A thermostat and voltage switch will stop charging if max alternator temperature or absorption voltage is reached.
This emergency regulator has not been necessary during the years the Wally100 has been in use.

Main battery switches and change over switch.
The battery switches isolate the LFP and start batteries from all electrical wiring with the following exceptions:
LFP batteries: The cell monitor, high voltage alarms, low voltage alarm and active balancer are in close proximity of the batteries and are permanently connected. The active balancer can be switched off. The cell monitor and alarms are all fused, so during long absence from the boat the blade fuses can be taken out for complete isolation. There is also a (fused) connector for low-current voltage sense. The voltage sense wires of alternator regulator, battery monitor and V-alarm are connected to this.
The MPPT solar controller output is also connected directly to the LFP batteries, but this can be isolated with a high current switch. During absence from the boat, no charging of the LFP batteries takes place.
L/A start battery: The L/A start battery has a dedicated MPPT controller connected (via fuse) with 80W solar panel. This stays connected also during absence from the boat for trickle charging to keep the start battery topped up.

The change over switch is used in an emergency if the start battery or LFP batteries are faulty or flat. The start battery can be used for powering essential users such as navigation lighting and minimum navigation electronics and the LFP battries can be used for engine starting. Parallel switching of start and LFP batteries is not possible.

Positive and negative distribution of LFP batteries. (often called bus bars)
The positive distribution point (behind the main battery switch) is used for connection of:

1. The user breaker panel (switch board for lighting, nav equipment, etc.)
2. A few users for which it is impractical to be connected via the breaker panel because it would require long heavy gauge wiring.
   a. Anchor winch (with own breaker)
   b. Inverter (with own switch and fuse)
   c. Auto pilot (with switch and fuse)

The same applies to the negative distribution point, but in addition any ground connections for the engine electrics are connected here.