ZS6PTA PARC Club Project – 1/2008

Multipurpose 10 LED Monitor & Charger Controller

For 12 Volt Lead Acid (LA) Accumulators

1 Introduction

This device can be used to monitor the voltage of a 12V lead acid accumulator and control a battery charger via a solid state relay.

This project has three modules that can be used as a single integrated unit or as individual units with the appropriate breaks in tracks.

- **10 LED Monitor Module** – indicates battery voltage from 10.5 to 14.5 volts on a dot mode LED display based on the LM3914 display IC.
- **Control Module** – sets and resets the voltage used to control the state of the Solid State Relay **(SSR)**
- **SSR Module** – interfaces to and isolates the mains circuitry (battery charger) from the battery monitor and control circuitry

- ***Note 1*** – This project uses ***MAINS (230V AC)*** voltages and should not be constructed if you are unfamiliar in working with mains voltages.

- ***Note 2*** - If during operation of your equipment either the red or yellow LEDs are illuminated you should immediately disconnect the load (typically your expensive radio) as the battery and equipment is in danger of being permanently damaged due to OVER (yellow) or UNDER (red) voltage conditions.

Remember your battery should always be tested under loaded condition to obtain a real indication of the battery status. Testing under open circuit (or no load) conditions does not give a real indication of the battery charge condition.

2 Principle of operation

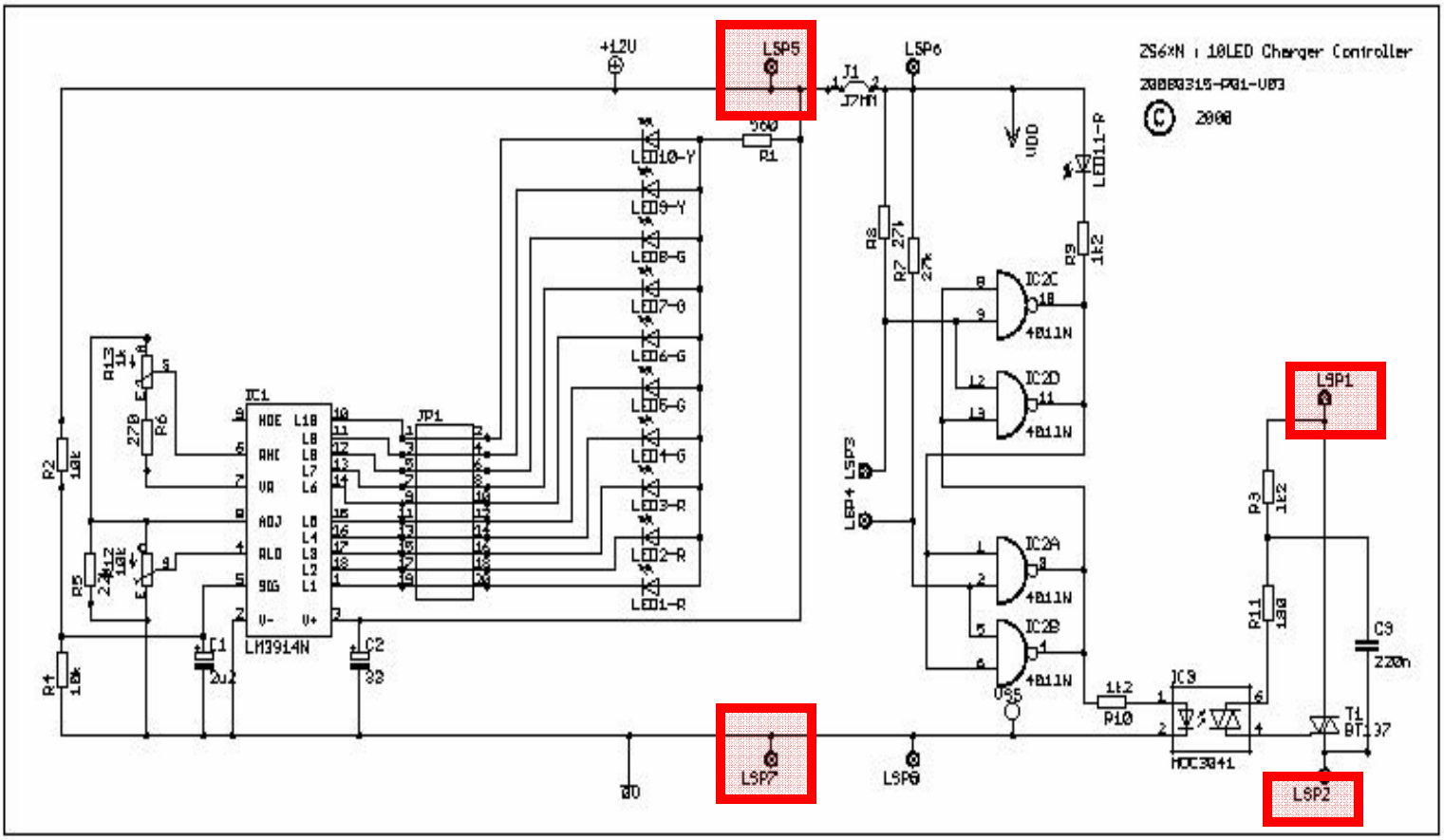
The battery monitor makes use of the LM3914 linear display IC which displays the preset voltage range in 10 steps of 0.5V for the circuit as described. The display is in **DOT** mode and ***SHOULD NOT BE SET TO BAR MODE*** if used as an integrated unit. (If the monitor portion **only** is used, BAR mode may be used – see the LM3914 data sheet for details.)

The monitor is followed by a control circuit that requires both a low voltage and a high voltage input. When the low voltage is reached (indicated by that LED illuminating) the SSR is activated switching the battery charger on. AS the battery charges the voltage will increase and so the appropriate LED will illuminate in sequence. When the battery voltage reaches the high voltage level (indicated by that LED illuminating) the control circuit senses this and the SSR is deactivated switching the battery charger off. The battery then discharges under normal operation until the low voltage level is again reached. The charge/discharge cycle then repeats.

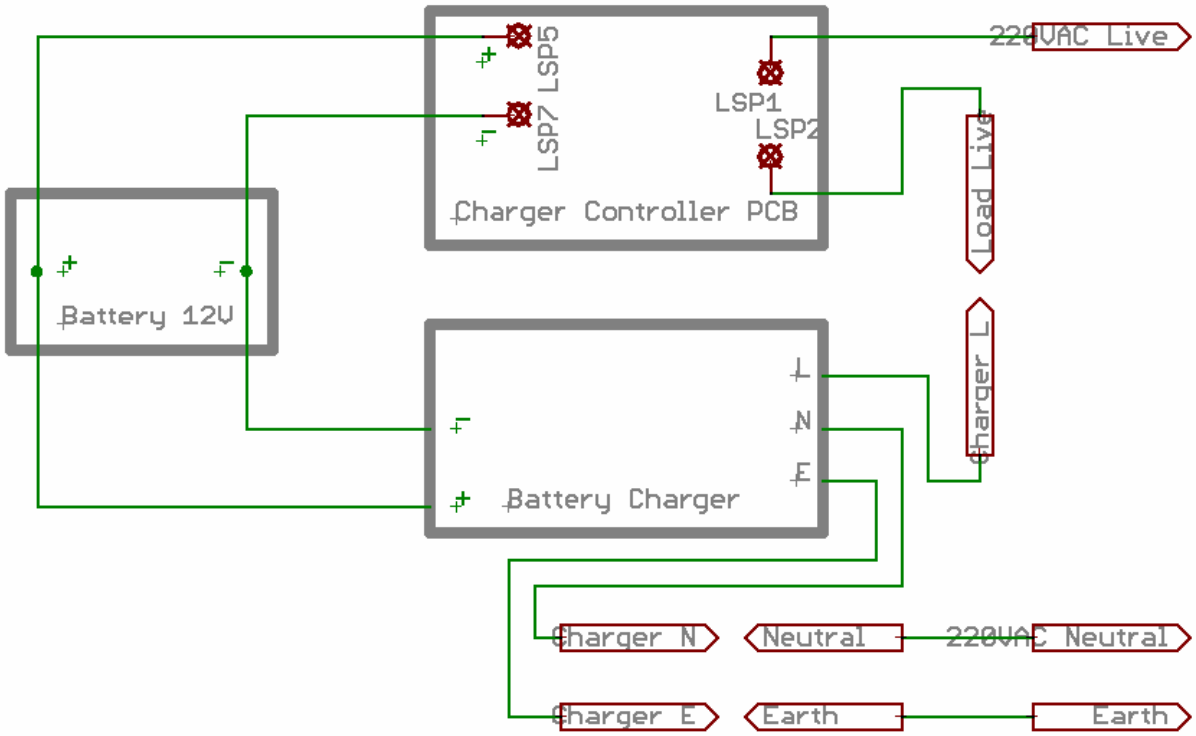
The SSR is optically isolated from the monitor/controller modules by the use of an opto-triac driver. This is a zero-crossing device allowing switch on only at the mains 0 volt points. This is incorporated to minimize mains interference effects common with non-zero crossing switching circuits.

Prepared by Roy Newton – ZS6XN / ZS5HX for the Pretoria Amateur Radio Club – ZS6PTA
Based on a design by K4GOK

3 Circuit Diagram



4 Installation Diagram



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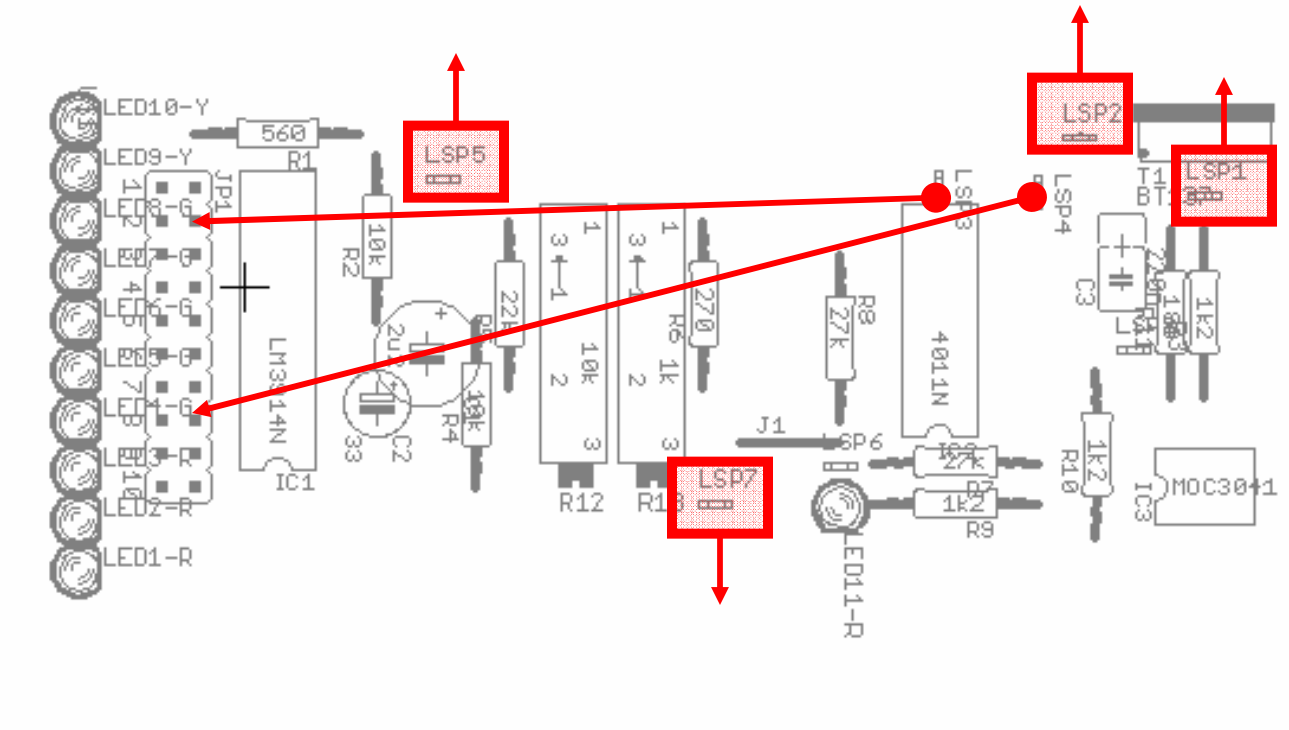
5 Component Overlay



6 Parts List

C1	2u2		R 1	560E
C2	33u		R 2,4	10k
C3	220n 250V		R 3,9,10	1k2
IC1	LM3914N		R 5	22k
IC2	4011N		R 6	270E
IC3	MOC3041		R 7,8	27k
T1	BT137		R 11	180E
LED1,2,3,11	3mm Red		R 12	10k multi-turn pot
LED4,5,6,7,8	3mm Green		R 13	1k multi-turn pot
LED9,10	3mm Yellow		J1, JP1	Jumper/Field

7 Recommended Construction Order

7.1 Decide if remote display is to be used?

7.1.1 If ***YES***, carefully cut off the LED display section from main board ***NOW***.

7.2 Insert jumper J1. (Only required if used as an integrated unit – leave out for separate units).

7.3 Insert and solder the eleven quarter watt resistors R1 – R11 in their correct positions.

7.4 Insert and solder the two multi-turn trim pots R12 – R13 in their correct positions.

7.5 Insert and solder the three capacitors C1-C3. Note polarities of C1, C2.

7.6 Insert and solder the three ICs, IC1-IC3. Note orientation of ICs.

7.7 Insert and solder the Triac T1. Note orientation.

7.8 Insert and solder the11 LEDs, LED1-LED11. Note orientation and colour positions of LEDs.

7.8.1 LED fly leads (LEDs display mounted remotely from PCB)

- Insert and solder 13 wires on the PCB. These wires should have sufficient length to allow the PCB and the LEDs to be mounted in their desired remote positions.
- It is recommended that different coloured wires be used for at least anode and cathode leads of the LEDs e.g. red for anodes and black for cathodes.

7.9 Insert and solder the battery supply fly leads ensuring they are long enough to route between the PCB mounting location and the battery measurement point.

- If desired use appropriate connectors if the PCB and measurement point are remote from each other

7.10 Insert and solder the AC Mains supply fly leads ensuring they are long enough to route between the PCB mounting location and the plug and socket for the battery charger. Use the SSR points LSP1 and LSP2 as an extra switch in the supply lead to the battery charger.

8 Pre-Test Check

WARNING NOTE – Mains voltages are present ON the circuit board under operational conditions. It is recommended that all testing and calibration is performed without the mains being connected. ONLY once calibration is completed can the mains be connected and the final testing of the solid state relay be completed.

8.1 ***Before*** powering up the circuit perform the following visual checks

- All components are in the correct positions
- All polarity sensitive components are soldered with the correct orientation
- All solder joints are well soldered (no dry joints)
- There are no solder bridges between tracks on the PCB creating short circuits
- All jumpers are in place
- The fly leads for the default voltage selection to the controller are installed
    - **High** - LSP3 to JP1 LED9
    - **Low** – LSP4 to JP1 LED3 (You can use other voltage settings to suit your battery as required)

9 Testing & Calibration

9.1 10 LED Monitor

- Ensuring that the power supply is turned off, connect the monitor to the output terminals of a variable output (0 – 15V) DC power supply making sure of the correct lead polarity – ***Note***: this circuit has ***no reverse voltage protection***.
- Set the output voltage to zero volt output.
- Switch on the power supply.
- No LEDs should be illuminated.
- Increase the voltage to approximately 4V – the first RED LED should illuminate dimly.
- Measure and make a note of this voltage – if you connect the monitor to a battery and no LEDs illuminate the battery has at least 5 dead cells and the battery voltage is below 4V.
- Slowly increase the voltage by 0,5V steps from 10V to 15V.
- The previous LED should turnoff and the next LED should illuminate in sequence.
- Set the PSU to 10V
- Adjust R12 until LED1 illuminates
- Set the PSU to 15V
- Adjust R13 until LED10 illuminates
- **Both these settings are interactive so repeat until the necessary calibration is achieved**.
- Measure and make a note of the voltage that turns the first LED on brightly – this is the minimum voltage level for the battery monitor.
- Measure and make a note of the voltage that turns the last LED on brightly – this is the maximum voltage level for the battery monitor.

Note 3 – Calibration is easier if you have two power supplies, one set to 10V and the other set to 15V, and you alternate the monitor input between the two supplies.

10 Summary

This project provides an inexpensive, easy to construct and use 12V LA battery monitor and charger control. It connects between your existing (manual) battery charger and the mains.

If the yellow or red LEDs are illuminated you are running great risk of damaging your battery and equipment and the total load, including the battery monitor (it also consumes power from the battery) should be disconnected until the problems are corrected.

If any of the green LEDs are illuminated your battery is operating within a **TYPICAL Lead Acid Battery VOLTAGE RANGE**.

Note 4 - If you require a simpler voltage measurement display it is recommended that you consider another ZS6PTA project the 3 LED voltage monitor (Project 2/2008).