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Intelligent LED lamp ballast for a solar powered bollard

By

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CONTENTS

AIMS & OBJECTIVE

- To design an intelligent charger capable of monitoring rate of charging and discharge of a lead acid battery of solar powered bollard .

- Understanding depth of discharge and battery capacity of a solar powered charger for lead-acid battery

- Design, Build and Test the intelligent LED lamp ballast using a micro-controller

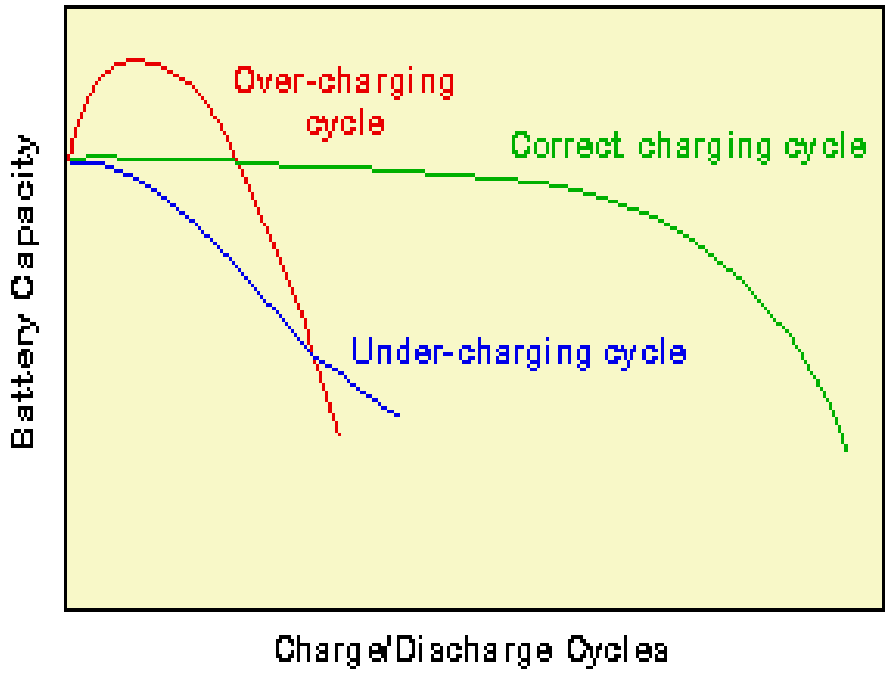
INTRODUCTION

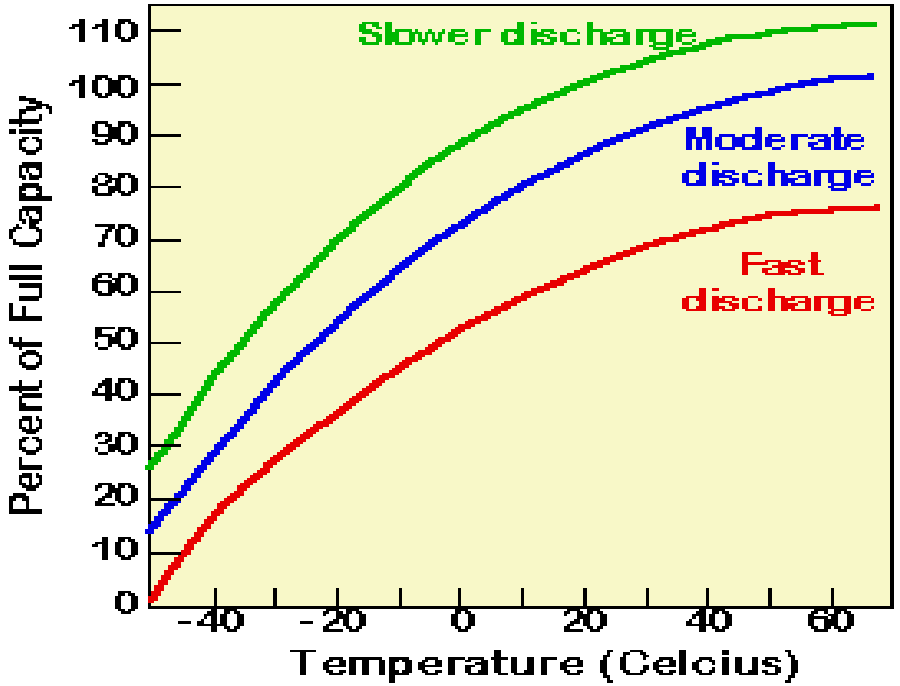
Over time, battery capacity degrades due to sulfation of the battery and shedding of active material. The degradation of battery capacity depends most strongly on the interrelationship between the following parameters:

- The charging/discharging regime of the battery.
- The Depth of discharge of the battery over its life.
- Its exposure to prolonged periods of low discharge.
- The average temperature of the battery over its lifetime.

Lead-acid battery charging/characteristic

The charging regime plays an important part in determining battery lifetime. Overcharging or undercharging the battery results in either the shedding of active material or the sulfation of the battery, thus greatly reducing battery life.

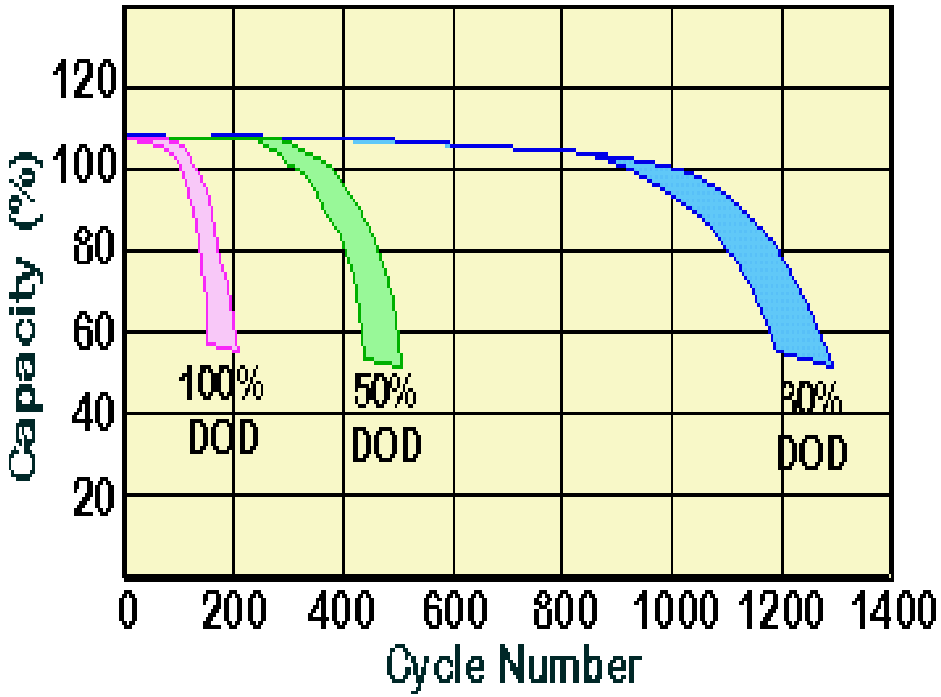


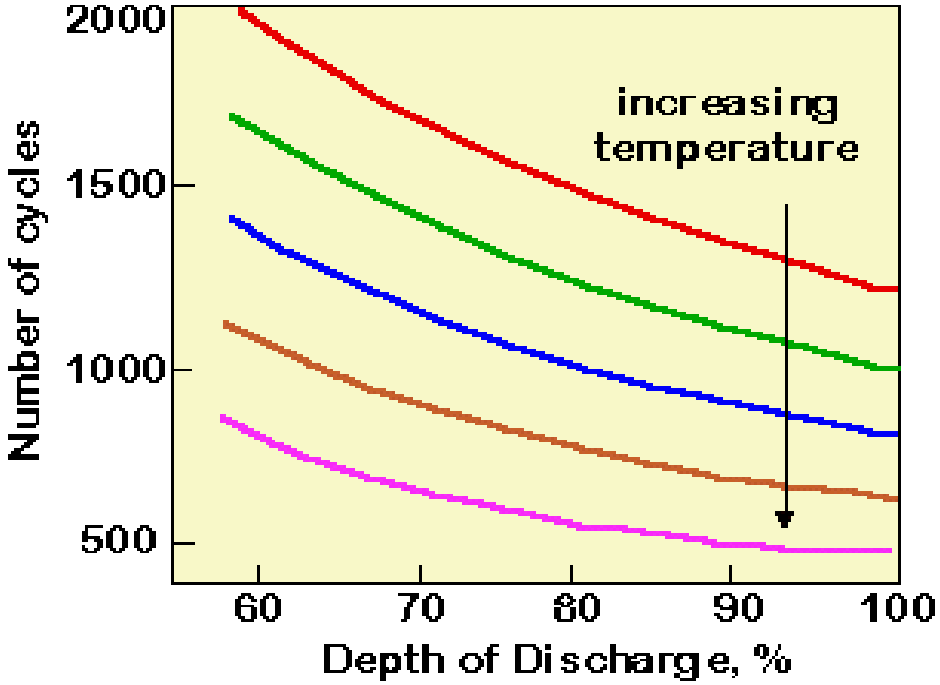


Relationship between battery capacity, temperature and lifetime for a deep-cycle battery.

Lead-acid battery charging/characteristic

Relationship between battery capacity, temperature and lifetime for a shallow & deep-cycle battery.

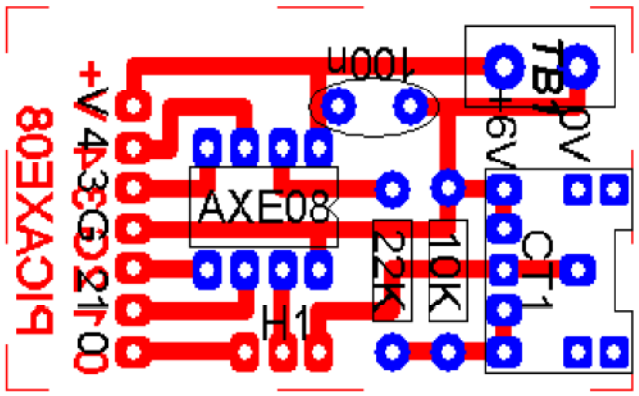




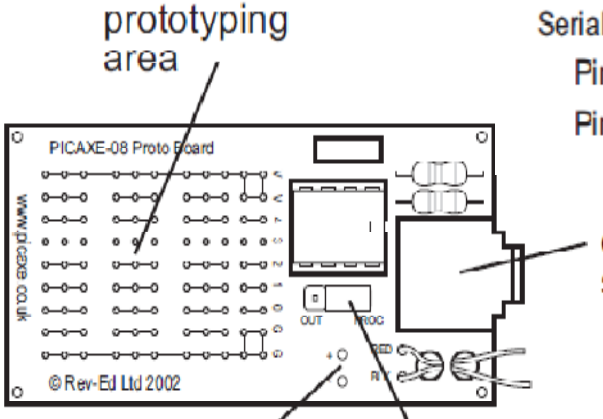
The capacity of a lead acid battery is reduced at low temperature operation; high temperature operation increases the aging rate of the battery. The impact on battery charging relates to the temperature of the battery.

Circuit Designing & Constructing

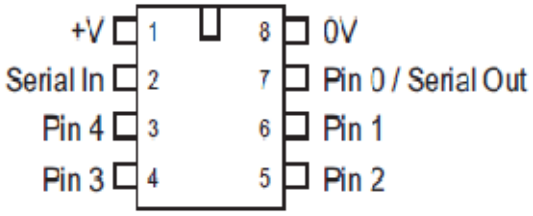
The circuit was developed and test on printed circuit board (PCB), the PCB bottom and top layer are shown below.



Bottom layer PCB

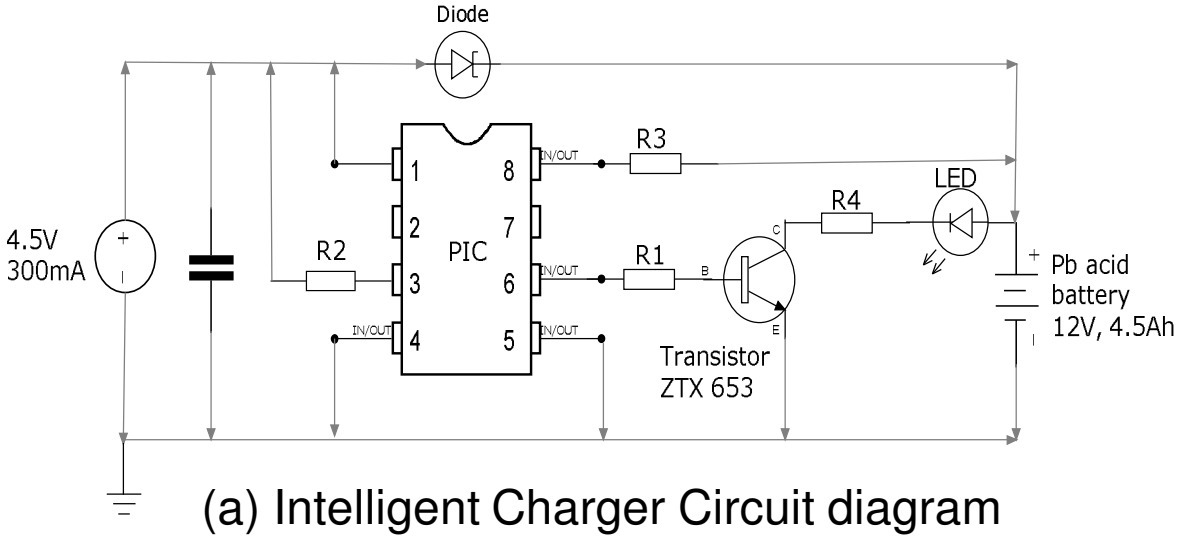


Top layer PCB

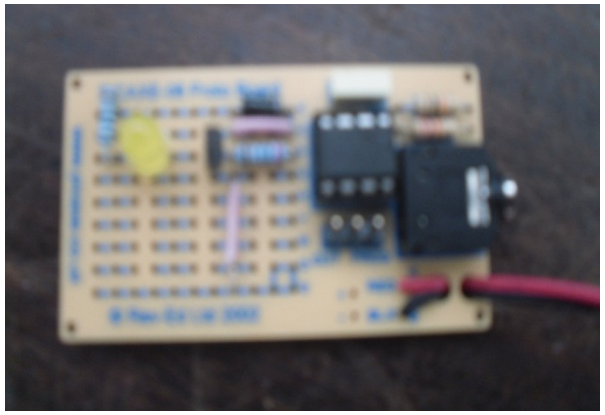


The PICAXE-08 proto board provides a rapid development system for the 8pin microcontroller system. It provides the basic download circuit beside a small proto typing area for connection of input / output circuits to the PICAXE-08 pins as shown above.

Circuit Designing & Constructing



(a) Intelligent Charger Circuit diagram



(b) Built Circuit on PCB

The features are: Download socket, USB download cable, 3-pin header and jumper link, Resistors (R1-R4), Capacitor, Diode, Transistor (NPN), Light Emitting Diode (LED), 8-pin micro-controller (PIC12F683).

The circuit design was relatively straight forward to build. However a number of the electronic components are polarised, care was taken to ensure these components are fitted the correct way around before soldering them on the PCB.

Operating principle & Testing

- The micro-controller monitor the battery voltage and internally uses an analog to digital converter to read the battery voltage and displays the current charging status on the LED.

- The IC cannot supply large output current so it was necessary to use a NPN transistor ZTX653 to switch the large current, 150mA required to power the LED.

- Resistor R_1 is required to limit the current flowing into the base of the transistor and preventing it from being damaged.

- The circuit consists of capacitor to reduce the ripple under a full 1.5A load to 1V.

- The diode (IN4001) ensures that the circuit charges the battery during forward bias operation.

CONCLUSION

- The intelligent battery charger determines the amount of energy left in the lead-acid battery during discharging and controlling state of charge will prevent overcharging, complete discharge, and degradation in order to keep the battery within safe operating window and to ensure a long cycle life.

- The circuit design uses the voltage of the battery cell as the basis for calculating state of charging and remaining capacity.

ACKNOWLEDGEMENT

I would like to thank my supervisor Dr. Dave Stone for his time, support and guidance during the mini-project. It's a pleasure working with him.

Thanks also to electrical & electronic Department for providing me access to all equipment and information required to build and test the circuit design successfully.

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Thank you for Listen

Any Questions