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Efficiency optimization and simulation towards the Design of Smart Batteries

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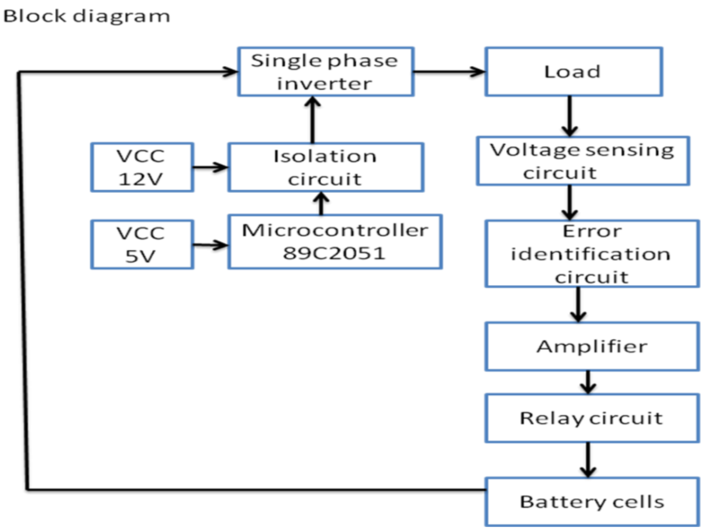
ABSTRACT: The existing multicell battery design usually employs a fixed configuration to connect multiple cells in series and in parallel during operation in order to achieve the required voltage and current.The proposed multicell battery can automatically configure itself according to the dynamic load or storage demand and the condition of each cell.The proposed design is validated by simulation and experiment by a smart cell polymer lithium-ion battery.The proposed design is universal and can be applied to any type and size of battery cells.

KEYWORDS: Multicell battery, self-healing, self-balance, self-reconfiguration

I. INTRODUCTION

This paper extends the work by proposing a novel self-X multicell battery design, where self-X stands for self-reconfiguration, self-balance, self-healing and self-optimization. A MOSFET is used as a Gate Driver Circuit.It acts with constant voltage source.[1] A Current Buffer is used for providing increased current level. A Gate Driver Circuit is used to isolate the Digital and Analog Circuit. It is also used for gatepulse Triggering. Consequently, the proposed battery system can dynamically configure itself according to the load/storage demand during operation, by self-healing.

II. BLOCK DIAGRAM



III. EXPLANATION OF COMPONENTS

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A.SMART BATTERY SYSTEM

Smart Battery System (SBS) is a specification for determining accurate battery capacity readings, usually for a portable computer.[2]It allows operating systems to perform power management operations based on remaining estimated run times. In principle, any battery operated product can use SBS, but in practice only laptop computers use the system. [3]The goal of the Smart Battery interface is to provide adequate information for power management and charge control regardless of the particular battery's chemistry of English units as identifiers in trade, such as "3.5-inch disk drive".

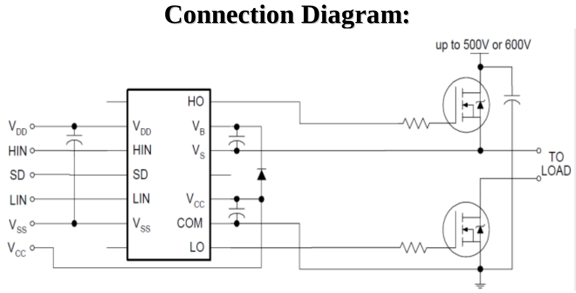
B. ISOLATION CIRCUIT

Isolation circuits are specially designed circuits to isolate the POWER CIRCUIT and CONTROLLER CIRCUIT. These circuits are used to provide ground. ICs are usually used to provide this isolation. **[4]**

C. FEATURES OF GATE DRIVER:

Gate drive has supply range from 10 to 20V and it has under voltage lockout for both channels.It has CMOS Schmitt-triggered inputs with pulldown and Matched propagation delay for both the channels.It has outputs in phase with inputs.[5]

Connection Diagram:



D.VOLTAGE REGULATOR:

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level.

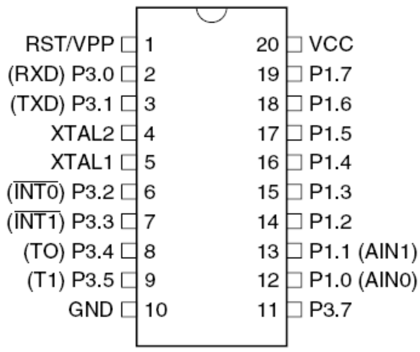
E.AT89C2051 MICROCONTROLLER:

The AT89C2051 is a low-voltage, high performance CMOS 8-bit microcomputer with 2K Bytes of Flash programmable and erasable read only memory. Features of AT89C2051:

It has supply voltage range from 2.7V to 6V and Fully Static Operation frequency from 0 Hz to 24 MHz. It has 15 Programmable I/O Lines and two 16-bit timer/counters. It has low-power idle and power-down Modes.

The Pin diagram is as follows

PIN DIAGRAM



IV. OVERALL CIRCUIT DI

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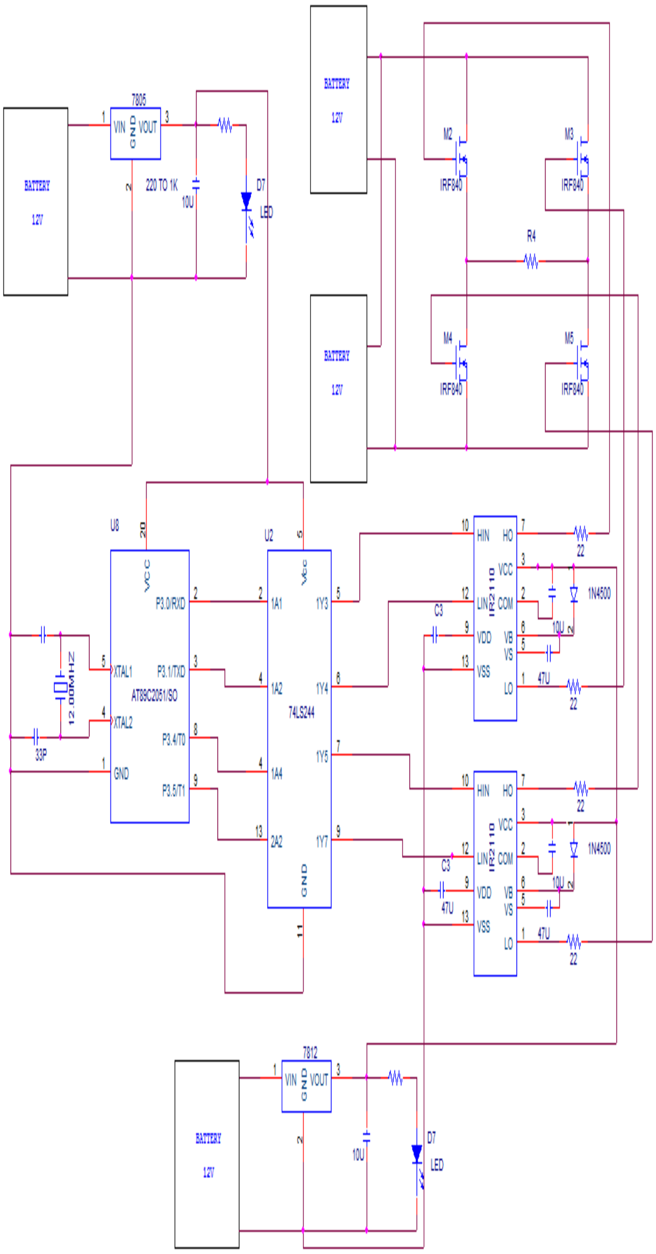
IV.CIRCUIT DIAGRAM



V. POWER SUPPLY CIRCUIT

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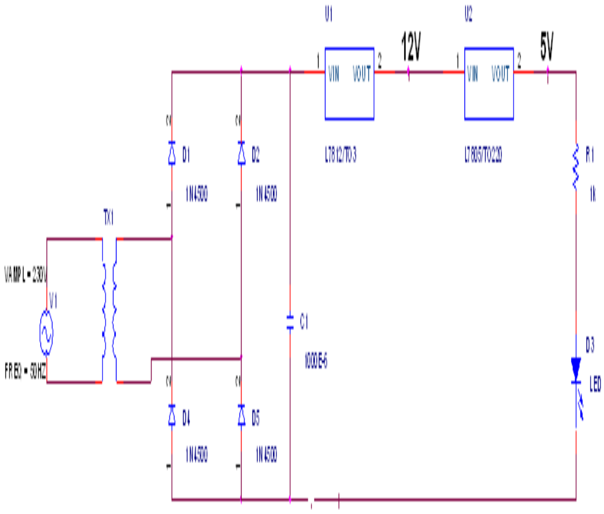

The working and power Supply of the circuit diagram are explained as follows:

A step-down transformer (230/15) V is used to give input supply to the power circuit. The 15V AC input is rectified into 15V pulsating DC with the help of full bridge rectifier circuit and the ripples in the pulsating DC are removed and pure DC is obtained by using a capacitor filter.The positive terminal of the capacitor is connected to the input pin of the 7812 regulator.An output voltage of 12V obtained from the output pin of 7812 is fed as the supply to the pulse amplifier.Output voltage of 5V obtained from the output pin of 7805 is fed as the supply to the micro controller.From the same output pin of the 7805, a LED is connected in series with the resistor to indicate that the power is ON.[6-7]

VI. HARDWARE CIRCUIT

VII. SIMULATION RESULTS

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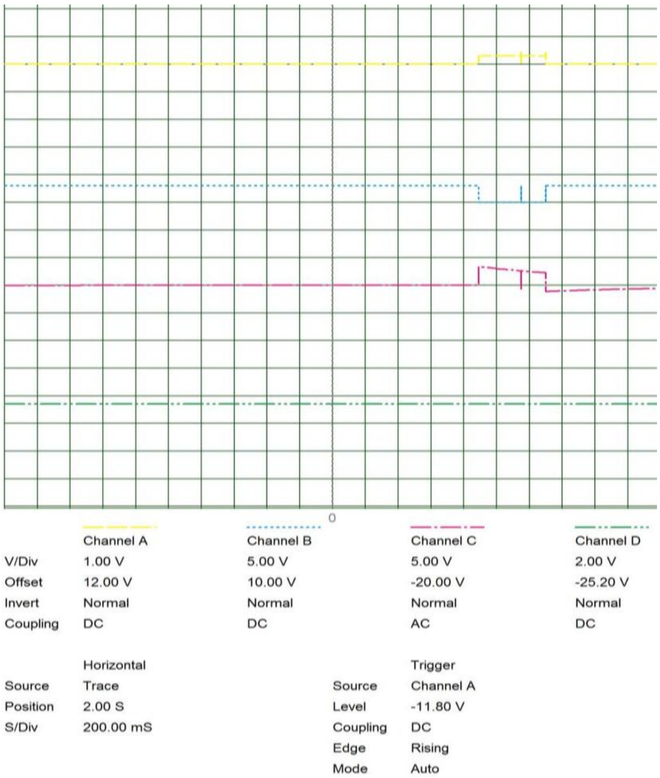

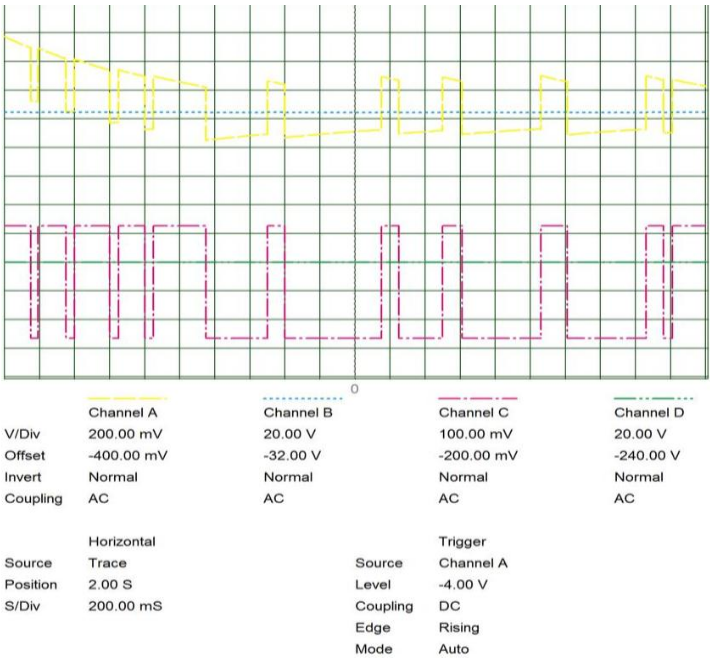

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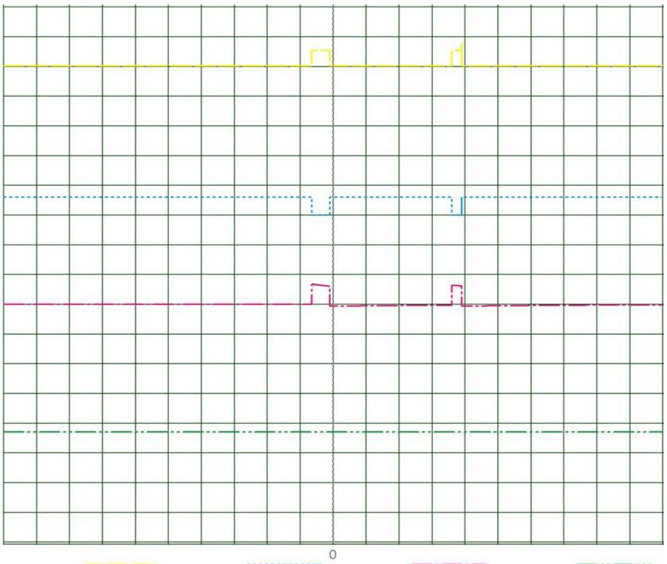
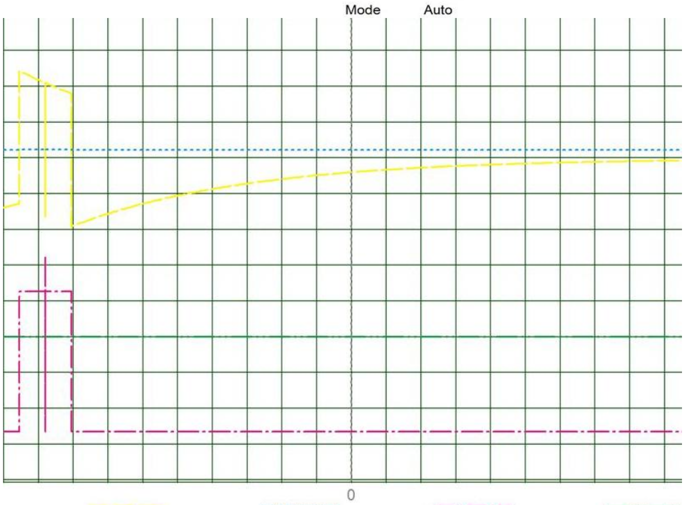


	Channel A	Channel B	Channel C	Channel D
V/Div	562.50 mV	5.00 V	5.00 V	2.00 V
Offset	6.75 V	10.00 V	-20.00 V	-25.20 V
Invert	Normal	Normal	Normal	Normal
Coupling	DC	DC	AC	DC

	Horizontal		Trigger
Source	Trace	Source	Channel A
Position	2.00 S	Level	-6.64 V
S/Div	200.00 mS	Coupling	DC
		Edge	Rising
		Mode	Auto



	Channel A	Channel B	Channel C	Channel D
V/Div	100.00 mV	20.00 V	100.00 mV	20.00 V
Offset	-200.00 mV	-32.00 V	-200.00 mV	-240.00 V
Invert	Normal	Normal	Normal	Normal
Coupling	AC	AC	AC	AC

	Horizontal		Trigger
Source	Trace	Source	Channel A
Position	2.00 S	Level	-2.00 V
S/Div	200.00 mS	Coupling	DC
		Edge	Rising
		Mode	Auto

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VIII. CONCLUSION

This paper has presented a novel power electronics–enabled self-X multicell battery design. By using the proposed design,additional monitoring, control ,protection, and optimization functions can be readily added to each cell and the overall battery system leading to a smart battery.

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