ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 6, Special Issue 1, March 2019
"National Conference On Convergent Communication Technologies And Telemedicine Networking
(NC^2CT^2N–2019)"
27th March 2019
Organized by
Department of ECE & BME,Vinayaka Missions Kirupananda Variyar Engineering College, India

On Board Diagnostics for Hybrid Vehicles

Sanjay J S, Thirugnanaraman S V, Krishnamoorthi P, Agilan P,Barath Kumar V, Jagadeeshraja M

UG Student, Dept. of Electrical and Electronics Engineering, Knowledge Institute of Technology, Salem, Tamilnadu,
UG Student, Dept. of Electrical and Electronics Engineering, Knowledge Institute of Technology, Salem, Tamilnadu,
UG Student, Dept. of Electrical and Electronics Engineering, Knowledge Institute of Technology, Salem, Tamilnadu,
UG Student, Dept. of Electronics and Communication Engineering, Knowledge Institute of Technology, Salem, Tamilnadu
UG Student, Dept. of Electrical and Electronics Engineering, Knowledge Institute of Technology, Salem, Tamilnadu,
Assistant Professor, Dept. of Electrical and Electronics Engineering, Knowledge Institute of Technology, Salem, Tamilnadu, India

I. INTRODUCTION

The On Board Diagnostics (OBD) is a integral part of any automobile that we use in our day to day life and it is actually designed to reduce the emissions by means of monitoring and controlling the major components of engine. In the case of hybrid vehicle, it possesses both the gasoline and the electric part. In the normal case, Gasoline based system operates for the average power demand by the system and the battery operates for the average - peak power demand. Recent studies reveal that the gasoline vehicle operates more efficiently than the battery vehicle. It is because of the reason that the battery technology and other supporting technology for the emission reduction is not yet reached the optimum level. It is the fact that there is the requirement of technology that provide solution to the above problem.

II. LITERATURE REVIEW

A. BATTERY MANAGEMENT SYSTEM AND CONTROL STRATEGY FOR HYBRID AND ELECTRIC VEHICLE

B.P.Divakar, K.W.E.Cheng, H.W.Wu, J.Su, H.B.Ma, W. Ting, K.Ding, W.F.Choi, B.F.Huang, C.H.Leung et al described a Battery management system (BMS) on a electric vehicle that ensures that subjects to the conditions where they will be maintained under safe operating conditions. This enables safety to the device operator ie., customers . This literature provides preliminary work carried out to simulate a BMS for hybrid electrical vehicle. The functional blocks of the BMS are implemented with SIMULINK toolbox in MATLAB. The BMS proposed is designed with a battery model in which SOC is used as one of the states to overcome the limitation on the coulomb counting method for SOC estimation.

B. BATTERY MANAGEMENT SYSTEM WHITE PAPER BY RENESAS

In this White paper, Renesas listed out various functional blocks of BMS that are essential for such sophisticated embedded systems. They have provided information about cutoff FETS & FET driver for charging and discharging , Fuel gauge and cell current measurements. With the measurement, the estimation of cell voltage is done and then we

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 6, Special Issue 1, March 2019
"National Conference On Convergent Communication Technologies And Telemedicine Networking
(NC^{2}CT^{2}N–2019)"
27th March 2019
Organized by
Department of ECE & BME,Vinayaka Missions Kirupananda Variyar Engineering College, India

can use it to the extent so that we can get the efficient one finally and various state machine algorithms that could be followed.

C. BATTERIES AND BATTERY MANAGEMENT SYSTEM IN ELECTRIC VEHICLE

M.Grandl, H.Gall, M.Wenger, V.Lorentz, M.Giegerich, F.Baronti, G.Fantechi, L. Fanucci, R. Roncella, R. Saletti, S. Saponara, A. Thaler, M. Cifrain, W. Prochazka et al experimented the cell balancing strategies that could be implemented and issues associated with the design and the implementation of the battery management with the overview of main techniques of state of charge estimation and cell balancing schemes that includes both active and passive cell balancing.

D.BATTERY MANAGEMENT SYSTEM FOR LI - ION BATTERY

Fangfang Zhu, Guoan Liu, Cai Tao, Kangli Wang, Kai Jiang et al analyzed about the Li-ion batteries that are widely used in the field of electric vehicles and grid energy storage because of its high energy density, long life cycle, wider operating temperature range and low self-discharge rate. To ensure safety to personnel and prolong the service of battery packs, a battery management system (BMS) plays a major role. In this study, a state of charge (SOC) estimation and passive cell balancing based control are studied for LiCoO2 batteries. The experiment has the following functions: voltage and current measurements, SOC calculation, balance control, over charging and over discharging alarm and protection, battery status detection etc.

E.STUDY ON ENGINE MISFIRE DETECTION (EMD) USING SUPERVISE LEARNING ALGORITHM

Muhammad Zaim Mohamed Pauzi et al published a paper of Study on Engine Misfire Detection (EMD) using supervise learning algorithm in which they have described that vehicles that we use increases and it produces exhaust gas emissions and rising of demand lead to air pollution due to this misfire. The studies of supervised learning algorithm for misfire detection in internal combustion engine are reviewed to find efficient and reliable technique.
They have listed various detection metrics with supervised machine learning

F. MISFIRE DETECTION IN A DYNAMIC SKIP FIRE ENGINE

S Kevin Chen et al described the Misfire detection. The above proposed are not suitable for detecting misfires in a skip fire engine where a peak crankshaft angular acceleration may work well in conventional, all-cylinder firing engine, as it is expected that crankshaft acceleration will remain consistent for a given operating condition. In a skip fire engine, any cycle may be skipped. This is also observed in the vehicle with huge traction capability and there the Speed, mass, toque tradeoff need to be done and infact the duty and the frequency of the operation varies from time to time.

III. PROPOSED SYSTEM

A.ON BOARD DIAGNOSTICS FOR HYBRID VEHICLES

It is comprised of two segments and they are listed below.

- Battery Management System
- Misfire Detection System

ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 6, Special Issue 1, March 2019

"National Conference On Convergent Communication Technologies And Telemedicine Networking
(NC^2CT^2N–2019)"
27th March 2019

Organized by

Department of ECE & BME,Vinayaka Missions Kirupananda Variyar Engineering College, India

B. BATTERY MANAGEMENT SYSTEM

In Hybrid electric vehicle, Mostly lithium batteries are used and the reason why they are mostly used is because of the following features,

- Greatest electrochemical potential
- Largest energy density per weight
- High voltage
- Excellent capacity
- Remarkably high-energy density
- No Maintenance
- No Scheduled cycling
- No memory effect in the battery
- Discharge rate is minimum.

It also has some drawbacks and they are given below,

- Unstable, especially during charging
- Lithium ions are brittle

The reason why should we aware of overcharge and undercharge of the lithium batteries is that there is a risk of explosion and it may also cause irreversible damage to the battery as the failure of recombination of chemical decomposed.

Battery management system is necessary as they impart the following features like providing safety for the human operator, protecting battery from damage or failure cases or other abnormal cases. It increases the battery life and thereby providing high level performance. It also optimizes the tradeoff between battery and service life time.

Battery is normally composed of cell arranged in particular order ie., either in parallel or in series or the combination of both.

It includes the following segments,

- Sensing and high voltage control
- Protection circuitaries
- Interfacing systems
- SoC and Cell balancing
- SoH and SoL for Diagnostics action

C. SENSING AND HIGH VOLTAGE CONTROL

It consists of circuitry to measure voltage, current, temperature.It is used to control the system by sending proper signals to the triggering circuits. The sensing of the parameters like voltage and current of the every individual cell are necessary for performing any basic operations like cell balancing, over current, overvoltage and ground fault protection.

ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 6, Special Issue 1, March 2019

"National Conference On Convergent Communication Technologies And Telemedicine Networking (NC^2CT^2N–2019)"

27th March 2019

Organized by

Department of ECE & BME,Vinayaka Missions Kirupananda Variyar Engineering College, India

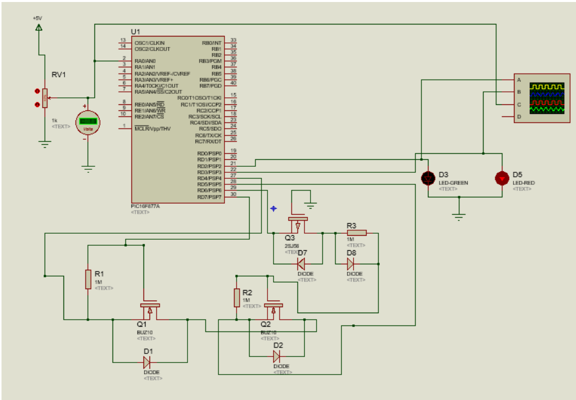


Fig 1: Charge Discharge Circuit

D.PROTECTION CIRCUITRIES

It provides protection against overcharging and over discharging of the individual cell. It is also necessary to provide isolation to each modules of the system.It is done with the help of combination of the MOSFET.

E.INTERFACING SYSTEMS

The Interfacing circuitry provides the range estimation details, communication for data recording and reporting. The communication protocols like I2C, SPI can be used based on the ASIC that we use for the Battery stack monitor.

F. STATE OF CHARGE (SOC) DETERMINATION

For the different capacities, the SoC measures the cell voltage by either of the methods given below.

- Direct measurement-Measure voltage
- Coulomb counting-Measure Current

The proposed System utilizes the Direct measurement technique though which the cell is isolated.

G.CELL BALANCING

A Battery may contain both weak cells and good cells usually the weak cell with charge slowly as it chemical compositions are bit different when compared with others.

During charging, weak cells have a possibility of fail, thereby it causes the battery to fail prematurely.

The proposed work involves the passive balancing through which the cell compensation is made.

- In active cell balancing, the charge from the stronger cells is diverted to the weaker cells.
- In passive balancing, dissipation occurs in case of higher cell voltages. In which the excess energy is removed through a bypass resistor until it reaches the optimum level required.

ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 6, Special Issue 1, March 2019

"National Conference On Convergent Communication Technologies And Telemedicine Networking
(NC^2CT^2N–2019)"
27th March 2019

Organized by

Department of ECE & BME,Vinayaka Missions Kirupananda Variyar Engineering College, India

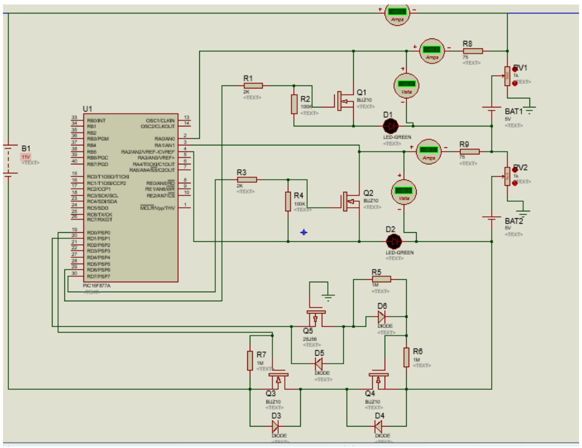


Fig 2 Cell balancing circuit

Passive balancing

The passive balancing removes excess charge in the form of heat through parallel shunt resistor.The passive balancing wastes energy and generates a good deal of heat which increases the difficulty of thermal management.

Active Balancing

- Active balancing, which diverts charge from auxiliary power (AP) and higher energy cells to lower ones.
    - Active balancing based on capacitor and inductor – low power Application
    - Active balancing based on transformer – reliability and stability is hard to control
    - Active balancing based on converter – efficiency high, Circuit and Control strategy complex.

H. SoH & SoL DETERMINATION

It effectively analyzes the power limit computation and other diagnostics such as Abuse Detection, State of Health (SoH) under both normal and abuse conditions and State of Life Estimation which involves supervised learning methodology for the effective calculation of lifetime of battery.

Table 1 Requirement of BMS

S No	Particular	Types / Quantity		
1	Controller Name	MSP430F R2355	PIC18 series	PIC18 series
2	No of cells	15	12	15

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 6, Special Issue 1, March 2019
"National Conference On Convergent Communication Technologies And Telemedicine Networking
(NC²CT²N–2019)"
27th March 2019
Organized by
Department of ECE & BME,Vinayaka Missions Kirupananda Variyar Engineering College, India

3	Battery Stack Monitor	bq72940	LTC6803HG-3	bq72940
4	MOSFET Required	Active	Active	Active
		17	14	17
		Passive	Passive	Passive
		3	3	3
5	Comm. Protocol	I2C	SPI	I2C
6	Resistor	27	32	27
7	Capacitor	28	20	28
8	Zener Diode	16	13	16
9	Diode	4	4	4

I. MISFIRE DETECTION IN GASOLINE ENGINE:

Misfire occurs if the engine skips any of the cycle during the running that is called misfiring. Misfiring occur due to many of reasons. The following factors are the reasons for misfiring in the engine,

- Spark plug
- Fuel injector
- Lean misfire
- Worn piston rings
- Leaking head gasket
- Transmission issue
- Chattering clutch
- Sticking brake pads

J. MAJOR REASON FOR MISFIRE:

Spark obscene in the spark plug is the major reason for the misfire.

The spark plugs have wires on them which are the reason for the ignition. If the wires are getting older or just not working as they should, we might notice the following signs: erratic idling, engine misfire, a 'check engine' light on the dash, radio interference and decreased fuel mileage.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 6, Special Issue 1, March 2019
"National Conference On Convergent Communication Technologies And Telemedicine Networking
(NC²CT²N–2019)"
27th March 2019
Organized by
Department of ECE & BME,Vinayaka Missions Kirupananda Variyar Engineering College, India

H. NEED FOR MISFIRE DETECTION:

Misfire detection is must because misfire leads to many problems in the engine. For example the following problems are occuring due to the misfire in the engine,

- Misfire can cause the air pollution due to the unburned fuel.
- It also affect the efficiency of the engine.
- Engine misfire can cause damage to other engine parts like the oxygen sensors or catalytic converter.

I. SENSORS USED FOR DETECT THE MISFIRE:

- CPS (Crankshaft Position Sensor)
- Current sensor

J. CPS (CRANKSHAFT POSITION SENSOR):

A crankshaft position sensor is an electronic device which used to monitor the position of the crankshaft in the motors that we use in the hybrid vehicle. Engine management system controls the fuel injection, the ignition system timing of triggering and other parameters of engine with the help of this sensor. This arrangement is made at the manufacturing of vehicle and most of the CPS works on the principle of hall effect through the multiple acquisition of information is possible.

K. TYPES OF CPS:

- Inductive sensor
- Hall Effect sensor,
- Magneto resistive sensor,
- Optical sensor.

L. CURRENT SENSOR:

A current sensor is a device that detects and converts current to an easily measured output voltage, which is proportional to the current through the measured path.

M. MISFIRE DETECTION SYSTEM

The main motive of the proposed system is to detect the misfire due to the ignition coil and spark plug failure. The spark plug should produce the sprk at the particular time. If that timing missed that is also called as misfire. Crankshaft Position Sensor is used to find the actual location of the piston. The current sensor detect to current flowing to the spark plug. The CPS signal and the current sensor output will be given to the comparator. If both the signal is positive then there is no misfire happen. If any of the signal is absent, then the MIL (Malfunction Indicator Lamp) indicate misfire happened. We have generated the CPS and current sensor signal by using PIC microcontroller.

ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 6, Special Issue 1, March 2019

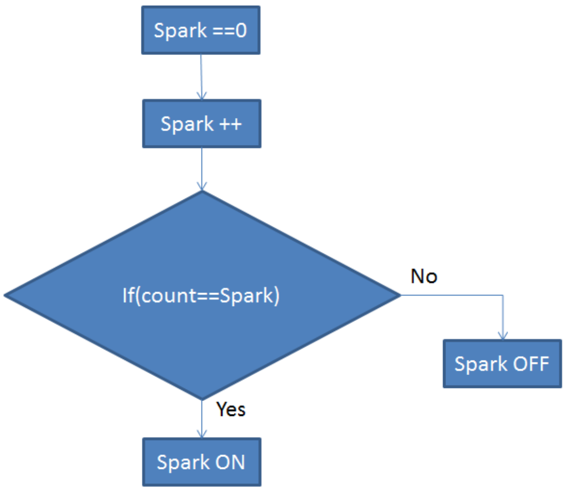
"National Conference On Convergent Communication Technologies And Telemedicine Networking (NC^{2}CT^{2}N–2019)"

27th March 2019

Organized by

Department of ECE & BME,Vinayaka Missions Kirupananda Variyar Engineering College, India

The flow chart is the steps for generating the spark plug using microcontroller. It is actually a software cycles that are programmed for the generation of the signals.



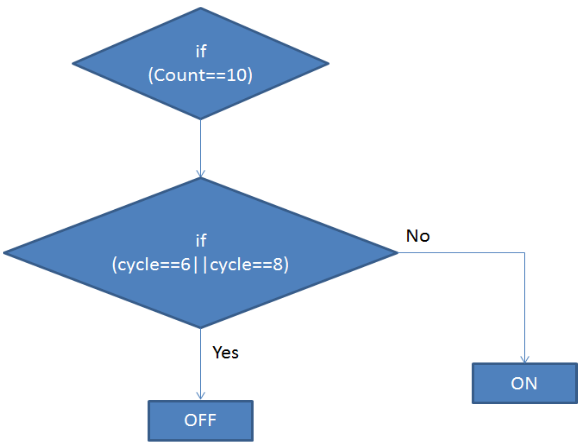


Fig 3 Block Diagram of Misfire Detection

ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 6, Special Issue 1, March 2019

"National Conference On Convergent Communication Technologies And Telemedicine Networking
(NC^{2}CT^{2}N–2019)"
27th March 2019

Organized by

Department of ECE & BME,Vinayaka Missions Kirupananda Variyar Engineering College, India

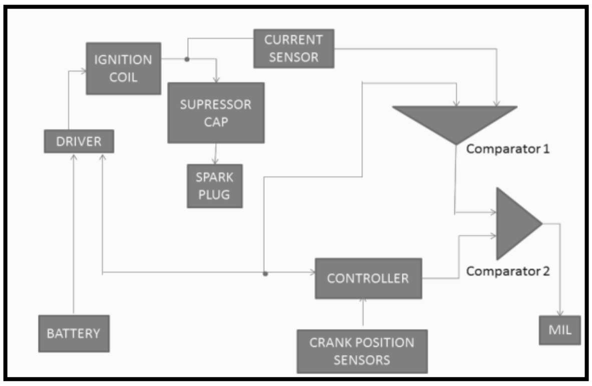


Fig 4 Flow of the Software Cycles

We have generated missing signal at every sixth and eighth pulse of the CPS signal. Whenever the missing pulse come the MIL indicate the misfire to the user. In this system we have stimulated the misfire detection using Proteus. In future it can be implemented in the hybrid vehicle. In next phase we can include the oxygen sensor also for indicate the misfire. If misfire happens the unburned fuel will be goes the exhaust. By measuring the oxygen level in the exhaust gas we can identify the misfire in the engine. We can't detect the misfire exactly by using only CPS and current sensor. So if the oxygen sensor included the efficiency of the system will increase.

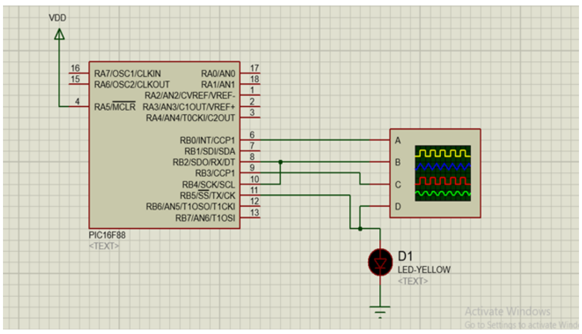


Fig 5 Misfiring Detector

The following diagram is the output of the proposed system. In this diagram the first waveform is the CPS output. The second pulse is the spark plug output. The third pulse is current sensor output. The fourth pulse is the comparator output. The comparator compare the CPS signal with current sensor value and give the output.

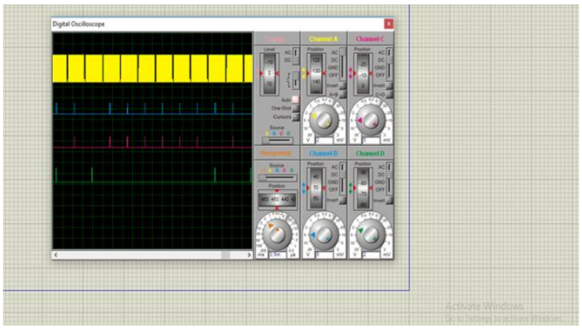


Fig 6 Simulation output that has CPS, Primary and Secondary current sensors output

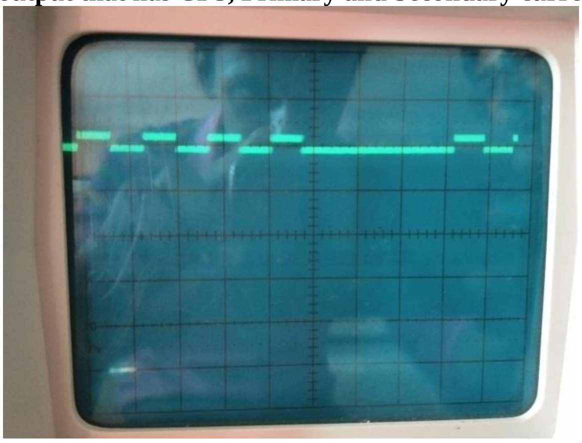


Fig 7 CPS Output Waveform

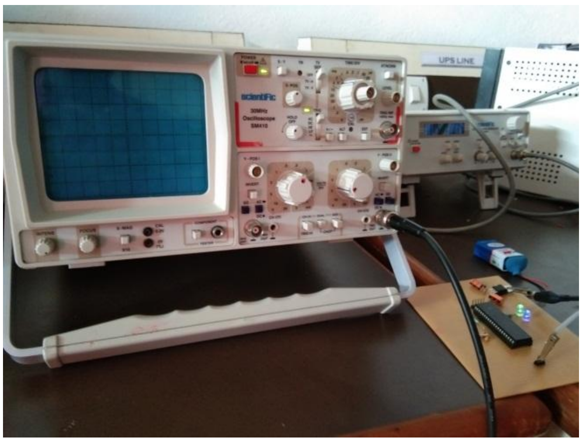


Fig 8 Misfiring Setup for Testing

ISSN: 2350-0328

International Journal of AdvancedResearch in Science, Engineering and Technology

Vol. 6, Special Issue 1, March 2019

"National Conference On Convergent Communication Technologies And Telemedicine Networking
(NC^2CT^2N–2019)"
27th March 2019

Organized by

Department of ECE & BME,Vinayaka Missions Kirupananda Variyar Engineering College, India

IV. CONCLUSION

The Battery Management system and the Misfire detection system proposed above can be implemented in the hybrid vehicles such that the emission can be reduced and we can operate the vehicles without any emissions to the environment and its implementation on the hybrid vehicles makes them environmentally reliable.

REFERENCES

[1] Battery University.com, Cadex Electronics Inc. http://www.batteryuniversity.com/

[2] Plett G L. Kalman-Filter SoC Estimation for LiPB HEV Cells.Proceedings of the 19th International Battery, Hybrid andFuel Cell Electric Vehicle Symposium & Exhibition (EVS19) Busan, Korea, 2002 pp. 527–538

[3] Hu, Rui, "Battery Management System For Electric Vehicle Applications" (2011). Electronic Theses and Dissertations. 5007.https://scholar.uwindsor.ca/etd/5007

[4] F. Baronti et al., "Design and Verification of Hardware Building Blocksfor High-Speed and Fault-Tolerant In-Vehicle Networks," *IEEE Trans.Ind. Electr.*, vol. 58, no. 3, pp. 792–801, Mar. 2011.

[5] J. Cao, N. Schofield, and A. Emadi, "Battery balancing methods: A comprehensive review," *in Proc. IEEE Conf. Vehicle Power andPropulsion*, 2008, pp. 1–6.

[6] F. Baronti, et al., "State–of–Charge Estimation Enhancing of Lithiumbatteries through a Temperature–Dependent Cell Model," *in Proc. IEEEApplied Electronics*, Sep. 2011, pp. 1-5