

Battery Measurement IC for Electric Vehicles using High-Resolution & High-Reliability Delta-Sigma Modulator

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INTRRODUCTION

- Recently, the importance of BMS (Battery Management System) for ensuring stability, life and performance of Li-ion batteries is increasing as demand for electric vehicles surges due to environmental problems and battery technology development.
- BMS is a key system that optimizes the safety and performance of the battery by monitoring 3-4.2V cell7 and controlling the voltage, current, and temperature of the battery. Among them, accurate detection of battery voltage plays a key role in evaluating the SOC (State of Charge), SOH (State of Health) and overall stability of electric vehicles.
- In this design, Battery Measurement IC (BMIC) is proposed to measure the voltage of the ³ battery. Since the proposed BMIC is for vehicles that are directly connected to human life, high-resolution and reliability interface circuits and ADC (Analog-to-Digital Converter) are ³ required to accurately measure the battery voltage in any environment such as temperature and supply voltage variations.



3 to 8

Decoder

Switch[2:0]

∖ SW[7:0]

SW[7:0]

Fig. 1. Conceptional block diagram of Battery Measurement IC

PROPOSED CIRCUIT DESIGN





Specifications			
Technology	DB 180nm BCD		
Chip area $[mm^2]$	3.52		
Supply Voltage [V]	5		
Signal bandwidth [kHz]	5		
Sampling frequency [MHz]	5.12		
Power consumption [mW]	15.1		
Analog Input Range [V]	0-33.6		
Max. Conversion error [uV]	140		
SNR (TT/FF/SS) [dB]	105.8 / 107.6 / 102.7		
SNDR (TT/FF/SS) [dB]	105.2 / 107.2 / 102.3		
ENOB [bits]	17.2 / 17.5 / 16.7		





Fig. 4. Schematic of switched-capacitor based level shifter



CELL1 CELL2 CELL3 CELL4 CELL5 CELL6 CELL7 CELL8

Battery Cell Number Fig. 5. Simulated HVMUX + level shifter output conversion error

Table 1. Simulated results of BMIC

Corner Specifications			
Corner	ТТ	FF	SS
Temperature [°C]	27	-40	150
Supply Voltage [V]	0	+10	-10

Table 2. Temperature and supply voltage variation at each corner







Fig. 6. Schematic of 2nd-order discrete-time delta-sigma modulator (DTDSM)



Fig. 8. Microchip photograph

CONCLUSION

- This design proposed a Battery Measurement IC to measure the Li-ion battery cell voltage of BMS for electric vehicles.
- The proposed interface circuit (HVMUX & level shifter) has a conversion error up to 140uV for 8-series Li-ion batteries cells
- The proposed DSM has peak SNR 107.6dB and SNDR 107.2dB at a sampling clock of 5.12MHz for a signal bandwidth of 5kHz.
- The chip fabricated was supported by the IC Design Education Center (IDEC), Korea.

