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LAPIS SEMICONDUCTOR

Li-ion Battery Monitoring LSI

21th, August. 2017

Battery Monitoring LSI Development Team
LAPIS Semiconductor Co., Ltd.

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1．Lapis Strategy for LIB Market

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- Focuses on growing industrial market
- Targets middle to high voltage applications such as power tools, cordless vacuums, E-assist bikes, UPS and ESS

Number of battery cells

200 cells
16 cells
4 cells
1 cells

Target Application

Cordless Cleaner
Electrical Power tools

Electric Assist Bicycles
Lite Electric Vehicle

UPS

Electrical
Storage System

EV/HEV/PHV

Energy Storage System

※1cell：about 2～4V

Mobile consumer use

2. Industrial BMIC Roadmap

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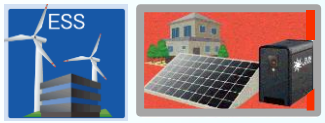
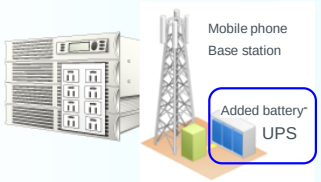
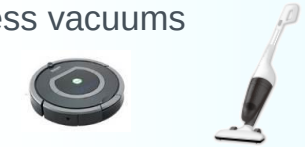
- Stand-alone(MCU less) and AFE(MCU control) products are ready to offer using analog-digital mixed signal technology on a high voltage wafer process.
- Developing battery protection ICs of 3 to 5 cells for Power tools and 4 to 7 cells for cordless cleaners.

Application	CY 2016	CY 2017	CY 2018
ESS 	MP ML5239 16cells, stackable, ADC built –in, cell-balance		
UPS 	MP ML5238 16cells, FET driver , analog I/F, cell-balance		
	MP ML5236 14cells, FET driver at high-side, ADC built-in, cell-balance		
	MP ML5232 14cells, OV protector		
E-bike, E-assisted bike 	MP ML5235 13cells, voltage/current detection, FET driver		
		MP ML5245 13cells, voltage/current/temperature FET driver	
Cordless vacuums 	MP ML5233 10cells, voltage/current/temperature detection, stackable		
	MP ML5203 7cells, voltage/current detection, FET driver		
Power tools 		MP ML5204 5cells (SC* detection, FET driver)	
		45V MP ML5248 Develop ML5246/7 46/7/8 7cells	
		30V ES/develop ML5240/1/2 5cells	

Start of Production, *SC detection: short current detection

3-1. Industrial BMIC Products (Stand-alone)

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	Type	Stand-alone							
	Part number	ML5240	ML5241	ML5242	ML5203	ML5233	ML5235	ML5245	ML5232
Basics	Operating voltage	5 V ～ 25 V	5 V ～ 25 V	5 V ～ 25 V	5 V ～ 42 V	5 V ～ 60 V	7 V ～ 80 V	7 V ～ 80 V	7 V ～ 80 V
	Operating temperature	-20℃～+85℃	-20℃～+85℃	-20℃～+85℃	-40℃～+85℃	-40℃～+85℃	-40℃～+85℃	-40℃～+85℃	-40℃～+105℃
	Supported cells	3 ～ 5	3 ～ 5	3 ～ 5	4 ～ 7	4 ～ 10	5 ～ 13	5 ～ 13	5 ～ 14
	Cell detection accuracy	±25mV(Typ)	±25mV(Typ)	±25mV(Typ)	±25mV(Typ)	±15mV(Typ)	±25mV(Typ)	±15mV(Typ)	±20mV(Typ)
	Operating current	1μA(typ.)	1μA(typ.)	1μA(typ.)	30 μA (typ.)	25 μA (typ.)	25 μA (typ.)	25 μA (typ.)	2.5 μA (typ.)
	Power down current	0.1 μA (typ.)	0.1 μA (typ.)	0.1 μA (typ.)	0.1 μA (typ.)	0.1 μA (typ.)	0.1 μA (typ.)	0.1 μA (typ.)	-
Monitoring	Cell voltage monitor	-	-	-	✓	-	✓	✓	-
	Pack current monitor	-	-	-	✓	-	-	-	-
Protection	Overvoltage	✓	✓	✓	✓	✓	✓	✓	✓
	Undervoltage	-	-	✓	✓	✓	✓	✓	-
	Overcurrent	-	-	-	✓	✓	✓	✓	-
	Over temperature	-	-	-	-	✓	-	✓	-
	Short-circuit	-	-	-	-	✓	-	✓	-
	Cell open wire	✓	✓	✓	-	-	-	-	-
	Cell balance switch	-	-	-	✓By MCU Control	-	-	-	-
	Output Pin C-/D-FET Gate Drive	NMOS/PMOS open drain or CMOS	NMOS/PMOS open drain or CMOS	NMOS/PMOS open drain or CMOS	Low-side NMOS GD.	Low-side NMOS GD.	Low-side NMOS GD.	Low-side NMOS GD.	NMOS open drain, CMOS
Others	Sleep	-	✓	✓	-	-	-	-	-
	Stackable	-	-	-	-	✓	-	-	-
	Threshold setting	Optional mask	Optional mask	Optional mask	Optional mask	Optional mask	Optional mask	Optional mask	Optional mask
	Package	8 VSSOP	10 SON	10 SON	30 SSOP	32 LQFP	30 SSOP	30 SSOP	20 TSSOP
	Product status	ES	ES	Developoing	MP	MP	MP	MP	MP

3-2. Industrial BMIC Products (Analog-Front-End)

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	Type	Analog Front End					
	Part number	ML5204	ML5247	ML5248	ML5236	ML5238	ML5239
Basics	Operating voltage	3.3 V ～ 42 V	4 V ～ 42 V	5 V ～ 31.5 V	8 V ～ 64V	7 V ～ 80 V	10V ～72V
	Operating temperature	-40℃～+85℃	-40℃～+85℃	-40℃～+85℃	-40℃～+85℃	-40℃～+85℃	-40℃～+85℃
	Supported cells	4 ～ 5	3 ～ 7	3 ～ 7	5 ～ 14	5 ～ 16	5 ～ 16
	Cell voltage accuracy	±25mV(Typ)	±25mV(Typ)	±20mV(Typ)	±15mV(typ.)	±20mV(typ.)	±10mV（Typ)
	Operating current	14 μA (typ.)	20μA(typ.)	32μA(typ.)	330μA (typ.)	50μA (typ.)	1.2mA (typ.)
	Power down current	0.1 μA (typ.)	0.1 μA (typ.)	0.1 μA (typ.)	0.1μA (typ.)	0.1 μA (typ.)	0.1 μA (typ.)
Monitoring	Cell voltage monitor	✓	✓	✓	✓	✓	✓
	Pack current monitor	✓	✓	✓	✓	✓	-
	Temperature monitor	-	-	-	✓ x2	-	✓ x4
	Digital output	-	-	-	✓12bit SAR ADC	-	✓12bit SAR ADC
	Analog Output	✓	✓	✓	-	✓	-
Protection	Overvoltage	✓	-	-	✓	-	-
	Undervoltage	✓	-	-	-	-	-
	C-/D-FET Gate Drive	NMOS Open Drain	Low-side NMOS GD.	High-side NMOS GD.	High-side NMOS GD.	Low-side NMOS GD.	-
	Short-circuit	✓	✓	✓	✓	✓	-
	Cell open wire	-	-	-	-	-	✓
	Cell balance switch	✓ internal	✓ internal	✓ internal	✓ internal	✓ internal	✓ external
Others	Stackable	-	-	-	-	-	✓
	Power supply LDO	-	✓	✓	✓	✓	✓
	Threshold setting	Optional mask	MCU control	MCU control	MCU control	MCU control	MCU control
	Package	20 TSSOP	20 WQFN	30 SSOP	44 TQFP	44 QFP	64 TQFP
	Product status	MP	Planning	MP	MP	MP	MP

4-6. ML5245 : Stand-alone LIB protector

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13-cell voltage/current/temperature/short detection, Voltage monitor

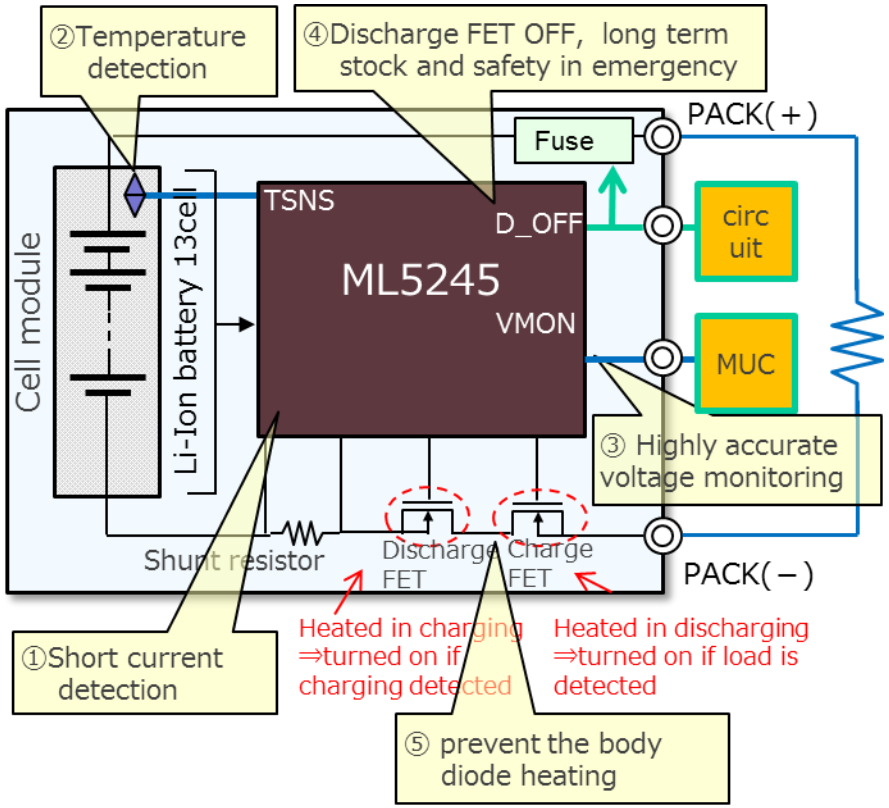
Features

- Connected cells= 5 to 13 cells(*)
- Highly accurate over/undervoltage detection function
  Overvoltage/Undervoltage detection accuracy
  : ±15mV/ ±50mV (25℃)
- Charge / discharge overcurrent detection
  Discharge/charge overcurrent detection accuracy
  :±10mV/ ±10mV(25℃)
- Short current detection function
- Temperature detection function
- Cell voltage monitoring function
- External charge/discharge FET control : NMOS FET driver built-in, discharge inhibition input available.
- FET overheat protection function: stop large charge/discharge current through FET body diode
- Number of connected cells, each detection voltage, each detection delay time is selected (mask-option).
- Low power consumption
  Normal state : 25 μA (typ.) , 60μA(max)
  Power down state : 0.1 μA (typ.), 1μA(max)
- Supply voltage : +7V to +80V
- Operating temperature : -40℃ to +85℃
- Package : 30pin SSOP

Applications

- Electric Bicycle
- Electric Cart

■Battery Pack system example with the ML5245



Upgraded from ML5235

∗: selected by mask option
For other parameter setting range, please refer to datasheet.

4-12. ML5238 : LIB Monitoring AFE

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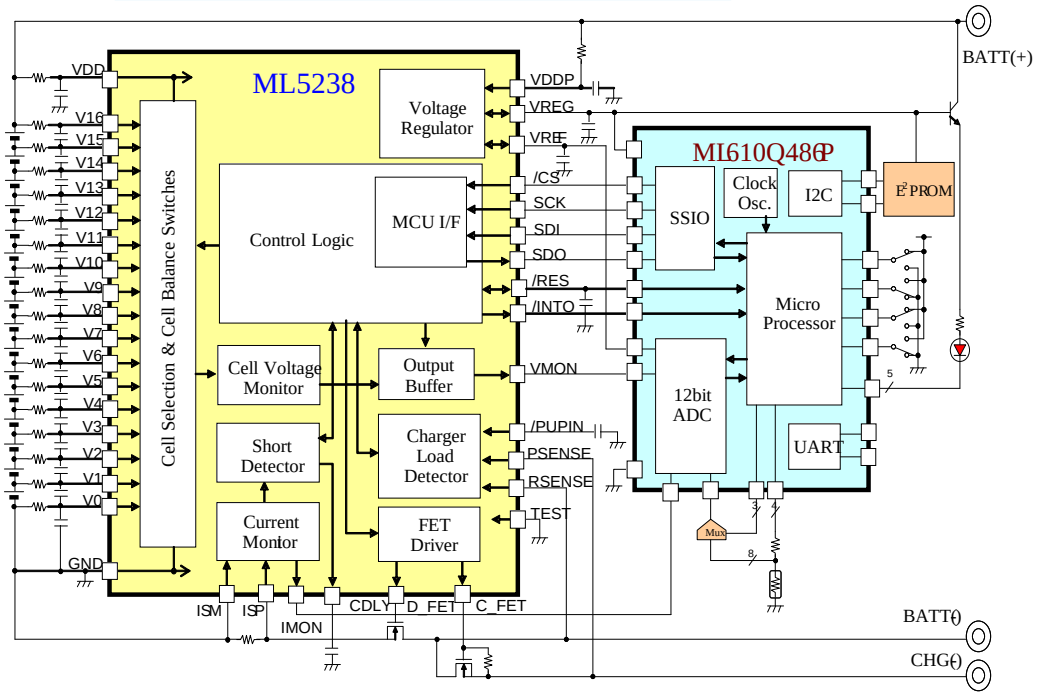
16-cell, cell voltage/current monitoring, cell balancing built-in and short detection

Features

- 16 cell high accuracy cell voltage monitoring: VMON pin output cell voltage
- Cell balancing switch built-in for each cell
- Charge /discharge current monitoring: select voltage gain of ISP-ISM and output from IMON pin. voltage gain selection is x10/x50
- Short current detection: detecting threshold voltage selectable, 0.1V/0.2V/0.3V/0.4V(typ).
- NMOS-FET driver built-in
- MCU interface: SPI serial interface(mode0)
- 3.3V regulator for external MCU built-in: output current is 10mA(max)
- Reference voltage regulator for external ADC: 3.3V(typ)
- Low current consumption
  - Normal : 50μA(typ)
  - Power-save : 25μA(typ)
  - Power-down : 0.1μA(typ)
- Supply voltage : +7V to +80V
- Operating temperature: -40℃ to +85℃
- package: 44pinQFP(QFP44-P-910-0.80-2K)

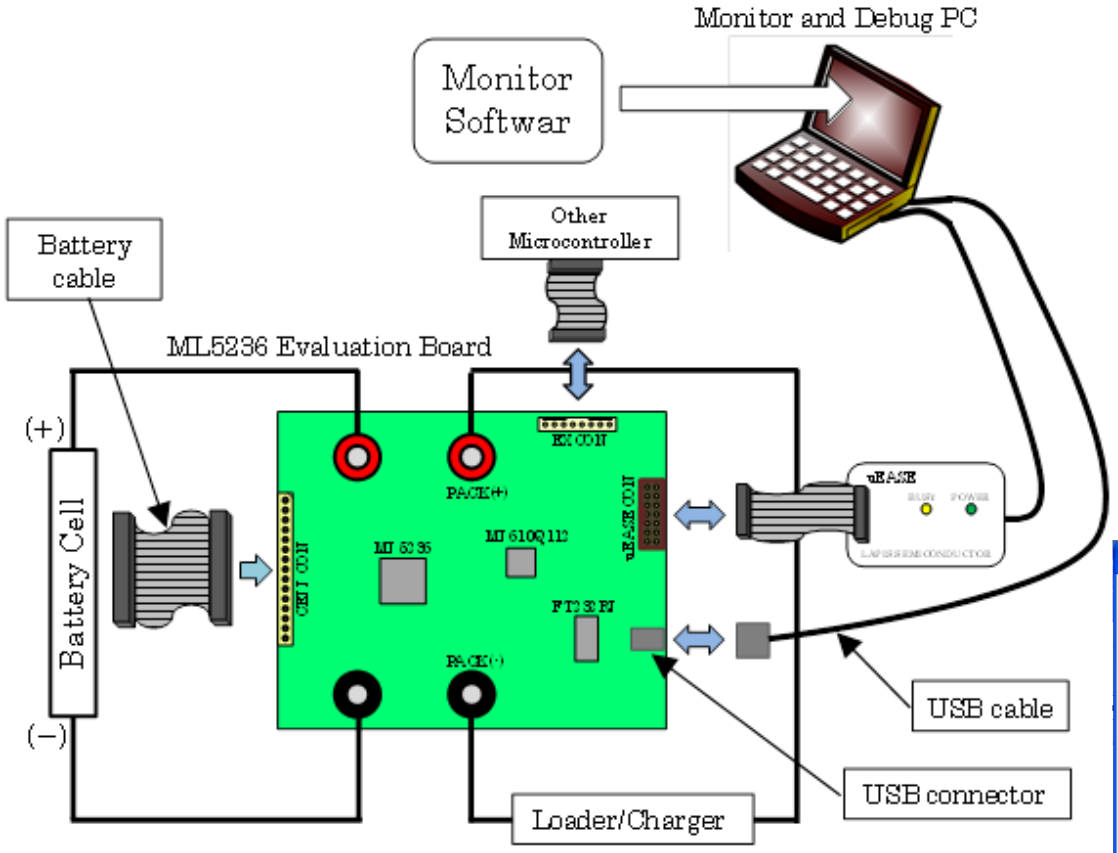
Applications

- Electric bicycle
- Electric storage system for home
- UPS

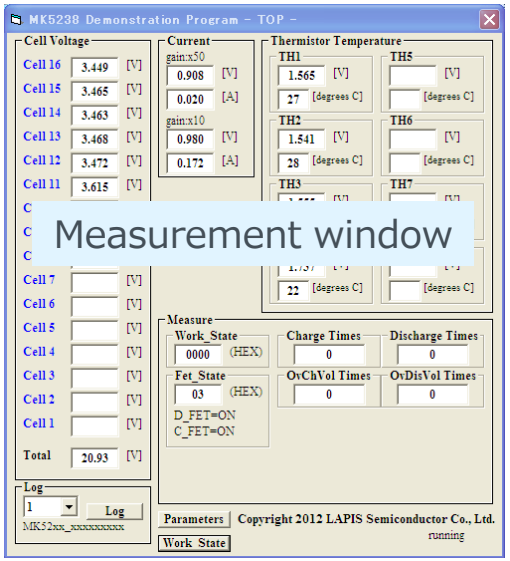


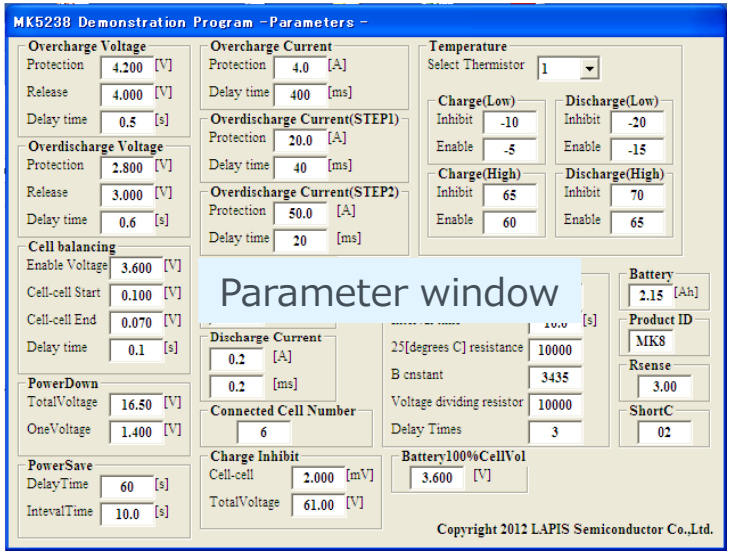
5. Evaluation Kits

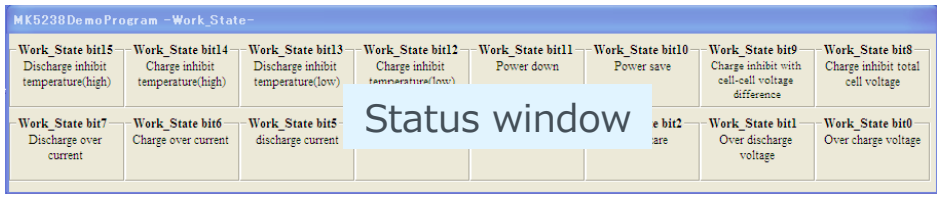
ML5236 Evaluation System



ML5236 evaluation software







6 . Customer Support Website

LAPIS Semiconductor provides the latest product information on our customer support website.
Registered users receive the following benefits:

- Downloadable latest data sheets/user manuals including preliminary versions.
- Downloadable latest software tools.

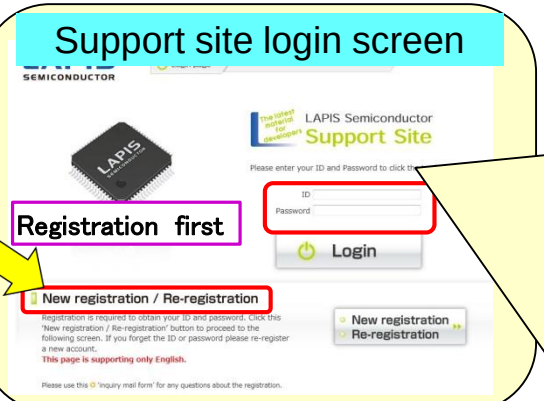
The contents will be updated on regular basis.

LAPIS Semiconductor's web site
http://www.lapis-semi.com/en/

To Support site's login screen

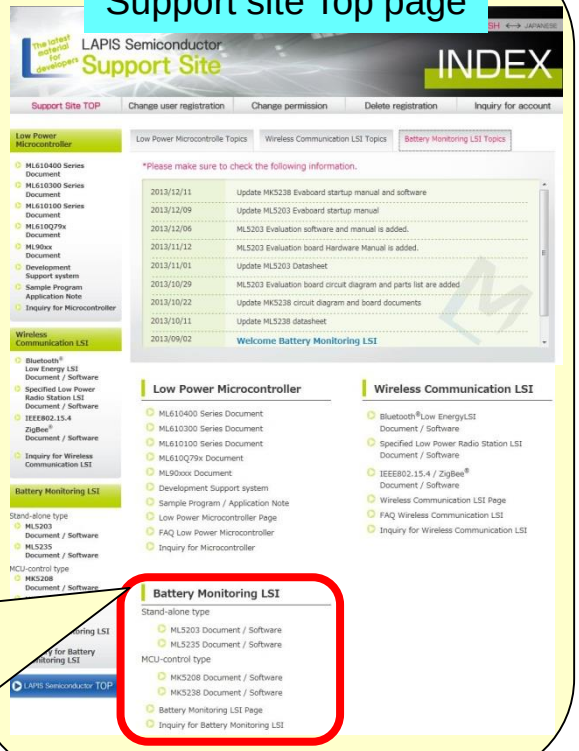
To Battery Monitoring LSI site

Support site login screen



Support site Example: ML5203

Support site Top page



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