One-cell Lithium-ion/Lithium-polymer battery protection IC with integrated MOS-FET

MC3651 Series

OUT LINE

MC3651 series are protection IC with integrated MOS-FET for protection of the rechargeable Lithium-ion or Lithium-polymer battery.The overcharge, overdischarge and discharging and charging overcurrent protection of the rechargeable one-cell Lithium-ion or Lithium-polymer battery can be detected.

FEATURES

（Unless otherwise specified, Ta=+25℃）

(1) Range and accuracy of detection/release voltage

・ Overcharge detection voltage	4.15V to 4.50V, 5mV step		Accuracy±20mV
			Accuracy±25mV （Ta=-5 to +60℃）
・ Overcharge release voltage	4.00V to 4.35V	*1	Accuracy±50mV
・ Overdischarge detection voltage	2.00V to 3.00V	*2	Accuracy±100mV
・ Overdischarge release voltage	2.00V to 3.00V	*2	Accuracy±100mV
・ Discharging overcurrent detection voltage (Discharging overcurrent detection current)	+20mV to +65mV, 1mV step (0.310A to 1.00A)		Accuracy±5mV
・ Charging overcurrent detection voltage (Charging overcurrent detection current)	-25mV to -65mV, 1mV step (0.385A to 1.00A)		Accuracy±5mV
・ Short detection voltage	Selection from 0.19V, 0.36V		Accuracy±50mV

*1 Hysteresis voltagebetween Overcharge detection and release voltage is selectable from 0.10V/0.15V/0.20V/0.25V.

*2 Please inquire to us about details of the setting of Overdischarge detection and release voltage.

(2) Range of detection delay time

・ Overcharge detection delay time	1.0s fixed
・ Overcharge release delay time	Selection from 6ms, 16ms
・ Overdischarge detection delay time	Selection from 100ms, 256ms
・ Overdischarge release delay time	0.5ms fixed
・ Discharging overcurrent detection delay time	Selection from 8ms, 12ms, 16ms, 20ms, 48ms, 224ms
・ Charging overcurrent detection delay time	Selection from 8.5ms, 16.5ms, 32.5ms
・ Short detection delay time	Selection from 0.50ms, 0.75ms
・ Chager connection detection delay time	Selection from 1.0ms, 8.0ms

(3) 0V battery charge function　　Selection from "Inhibition" or "Permission" *3

*3 In the case of "0V battery charge inhibition", the setting voltage is selectable from 0.65V or 0.90V.

(4) Low current consumption

・ Normal mode	Typ. 3.0μA, Max. 4.5μA
・ Stand-by mode	Max. 0.025μA (In case Overdischarge latch function "Enable")
	Max. 0.500μA (In case Overdischarge latch function "Disable")

(5) MOS-FET

・ Source to Source on state resistance　　Typ. 65.0mΩ (@VDD=3.5V)

(6) Absolute maximum ratings

・ VDD pin	-0.3V to +12V
・ V- pin	VDD-24V to VDD+0.3V
・ Drain-source voltage	Max. 24V
・ Drain current	Max. 1.2A
・ Total Power Dssipation	Max. 0.4W
・ Storage temperature	-40 to +125℃
・ Operation temperature	-40 to +85℃

(7) Package type

・ PLP-4E	1.25 × 2.85 × 0.50max [mm]

*4 Please inquire to us, if you need another specifications.

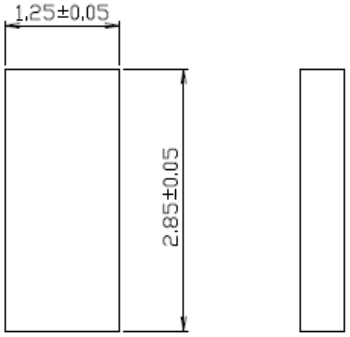
PIN CONFIGURATION

Package: PLP-4E	Pin No.	Symbol	Function
TOP View  1.25 × 2.85mm, t=0.50mm max.	1	S1	Negative power supply and source of discharge MOS-FET terminal. Connect to the negative terminal of the battery.
	2	VDD	Positive power supply voltage input terminal. Connect to the positive terminal of the battery through R1.
	3	V-	Charger negative voltage input terminal. Connect to S2 terminal through R2.
	4	S2	Source terminal of charge MOS-FET. Connect to a negative power supply terminal of charger.
	-	D	Drain terminal of discharge and charge MOS-FET. Drain terminal must be open electrically.

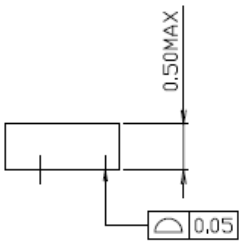
PACKAGE DIMENSION

UNIT: mm

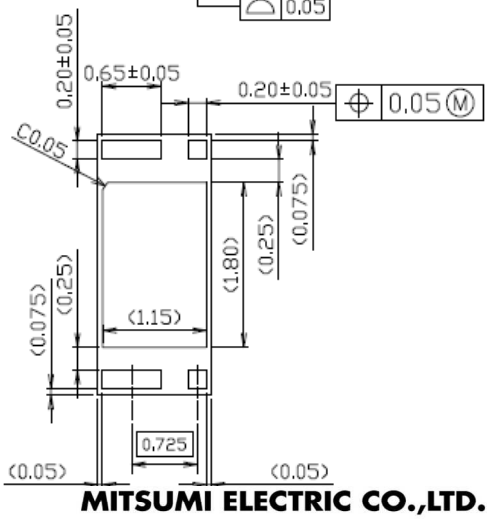
Top View



Side View



Bottom View



RECOMMEND OPERATION CONDITIONS

ITEM	SYMBOL	MIN.	MAX.	UNIT
Operating Ambient temperature	Topr	-40	85	℃
Operating voltage	Vop	1.5	5.5	V

ELECTRICAL CHARACTERISTICS（Main item）

Ta=25℃, S1=0V unless otherwise specified.

ITEM	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Discharge overcurrent release resistance	Rshort	VDD=3.6V, V-=3.6V	5.0	10.0	25.0	kΩ
VM terminal pull-up resistances	Rpu	VDD=2.0V, V-=0V	175.0	350.0	700.0	kΩ
Current consumption	Idd	VDD=3.6V, V-=0V	-	3.0	4.5	uA
Current consumption at stand-by	Istb	VDD=2.0V, V-=VDD *5	-	-	0.025	uA
		VDD=2.0V, V-=VDD *6	-	-	0.500	

Ta=25℃, S1=0V unless otherwise specified.

ITEM	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Overcharge detection voltage	Vdet1		Vdet1-0.02	Vdet1	Vdet1+0.02	V
Overcharge release voltage	Vrel1	Vdet1=Vrel1 *7	Vrel1-0.05	Vrel1	Vrel1+0.02	V
		Vdet1≠Vrel1 *8	Vrel1-0.05		Vrel1+0.05	
Overdischarge detection voltage	Vdet2		Vdet2-0.10	Vdet2	Vdet2+0.10	V
Overdischarge release voltage1	Vrel2	Vdet2=Vrel2 *5	Vrel2-0.10	Vrel2	Vrel2+0.10	V
Overdischarge release voltage2	Vrel2D	Vdet2≠Vrel2 *6	Vrel2D-0.10	Vrel2D	Vrel2D+0.10	
Discharging overcurrent detection voltage	Vdet3-1	VDD=4.5V, R2=2.7kΩ	Vdet3-8.0	Vdet3	Vdet3+8.0	mV
	Vdet3-3	VDD=3.5V, R2=2.7kΩ	Vdet3-5.0		Vdet3+5.0	
	Vdet3-3	VDD=2.5V, R2=2.7kΩ	Vdet3-8.0		Vdet3+8.0	
Charging overcurrent detection voltage	Vdet4	VDD=3.5V, R2=2.7kΩ	Vdet4-5.0	Vdet4	Vdet4+5.0	mV
Short detection voltage	Vshort	VDD=3.5V, R2=2.7kΩ	Vshort-0.05	Vshort	Vshort+0.05	V
0V battery charge inhibition battery voltage	Vst	Vst=VDD-VSS	0.40	0.65	1.10	V
		V-=VDD-4.2V *9	0.65	0.90	1.25	
0V battery charge permission charger voltage	Vst	Vst=VDD-V-, VDD=S1=0V S2=V-, Is=-1mA *10	-	-	1.60	V
Overcharge detection delay time	tVdet1	VDD=3.6V->4.6V,V-=0V	tVdet1*0.75	tVdet1	tVdet1*1.25	s
Overcharge release delay time	tVrel1	VDD=4.6V->3.6V,V-=0V	1.00	6.00	20.00	ms
			5.00	16.00	50.00	
Overdischarge detection delay time	tVdet2	VDD=3.6V->2.0V, V-=0V	tVdet2*0.75	tVdet2	tVdet2*1.25	ms
Overdischarge detection delay time	tVrel2	VDD=2.0V->3.6V, V-=0V	0.10	0.50	3.00	ms
Discharging overcurrent detection delay time	tVdet3	VDD=3.6V, V-=0V->0.1V	tVdet3*0.75	tVdet3	tVdet3*1.25	ms
Charging overcurrent detection delay time	tVdet4	VDD=3.6V, V-=0V->-0.3V	tVdet4*0.75	tVdet4	tVdet4*1.25	ms
Short detection delay time	tshort	VDD=3.6V,	0.36	0.50	0.84	ms
		V-=0V->3.6V	0.55	0.75	1.14	
Chager connection detection delay time	tVchg	VDD=3.6V	0.30	1.00	3.00	ms
		V-=3.6V->0.0V	3.00	8.00	16.00	

Ta=25℃, S1=0V unless otherwise specified.

ITEM	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Drain current of cut off	IDSS	VDS=24V	-	-	1.0	uA
Source to source on state resistance	RSS(on)45	VDD=4.5V , Is=1.0A	53.0	62.0	71.0	mΩ
	RSS(on)42	VDD=4.2V , Is=1.0A	53.5	62.5	71.5	mΩ
	RSS(on)39	VDD=3.9V , Is=1.0A	54.5	63.5	72.5	mΩ
	RSS(on)37	VDD=3.7V , Is=1.0A	55.0	64.0	73.0	mΩ
	RSS(on)35	VDD=3.5V , Is=1.0A	56.0	65.0	74.0	mΩ
	RSS(on)33	VDD=3.3V , Is=1.0A	56.5	66.0	76.5	mΩ
	RSS(on)30	VDD=3.0V , Is=1.0A	58.0	68.0	81.0	mΩ
	RSS(on)25	VDD=2.5V , Is=1.0A	59.0	74.0	91.0	mΩ
Body diode forward voltage	VSD	Is=1A	0.50	0.70	1.00	V

*5 In case Overdischarge latch function "Enable"

*6 In case Overdischarge latch function "Disable"

*7 In case Overcharge latch function "Enable"

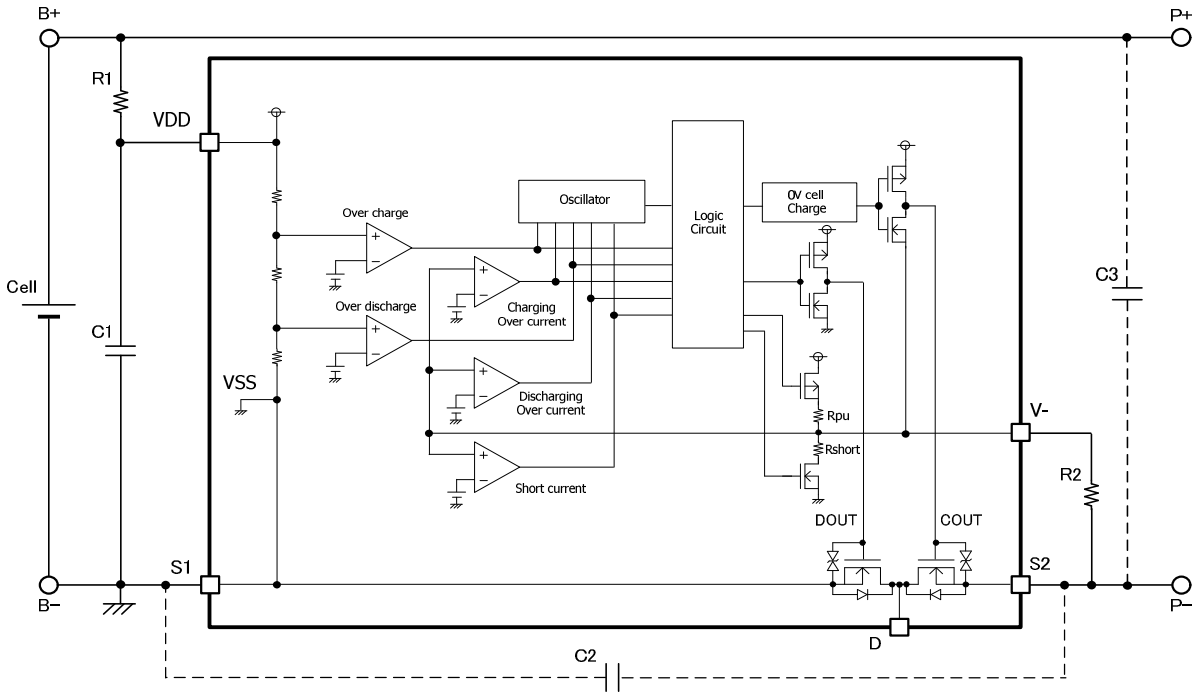
*8 In case Overcharge latch function "Disable"

*9 In case 0V battery charge inhibition, "Inhibition"

*10 In case 0V battery charge inhibition, "Permission"

*11 These range and accuracy are the one of the standard setting. It may differ each product.
Please refer to an individual specifications about detail parameters.

Typical application circuit



Symbol	Parts	Min.	Typ.	Max.	Purpose
R1	Resistor	-	330Ω	470Ω	For voltage fluctuation, For ESD
C1	Capacitor	-	0.1uF	-	For voltage fluctuation
R2	Resistor	-	2.7kΩ	-	Current limit for charger reverse connection
C2	Capacitor	-	0.1uF	-	For exogenous noise
C3	Capacitor	-	0.1uF	-	For exogenous noise

Application hints

The resistors that are inserted into each pin are to protect the IC. They help to remove ESD and latch-up damages. The capacitors help to reduce the effects of transient variations in voltage and electromagnetic waves,and to improve ESD tolerance of the IC.

Please use either C2 or C3, or both of them by request of your application.

These values in the above figure are for example. Please choose appropriate values.

PRODUCT LINEUP

Development state	Product name	Package	Model Code.	Optional function			Detection/Release voltage							Detection delay time					Overcurrent		MOS-FET
				0V battery charge function (inhibition battery voltage[V])	Overcharge detection Latch function	Overdischarge detection Latch function	Overcharge detection voltage	Overcharge release voltage	Overcharge release voltage	Overdischarge release voltage	Discharging overcurrent detection voltage	Charging overcurrent detection voltage	Short detection voltage	Overcharge detection delay time	Overdischarge detection delay time	Discharging overcurrent detection delay time	Charging overcurrent detection delay time	Short detection delay time	Discharge current limit (@VDD=3.5V)	Charge current limit (@VDD=3.5V)	Source to source on-state resistance (@VDD=3.5V)
							Vdet1	Vrel1	Vdet2	Vrel2	Vdet3	Vdet4	Vshort	tVdet1	tVdet2	tVdet3	tVdet4	tshort	Idischg	Icharge	Rss(on)
							V	V	V	V	mV	mV	V	s	ms	ms	ms	us	A	A	mΩ
MP	MC3651DF1AAM	PLP-4E	651DF1M	0.65	Disable	Enable	4.280	4.180	2.700	2.700	20.0	-25.0	0.190	1.0	100.0	20.0	8.5	750	0.315	0.390	65.0
MP	MC3651DF3AAM	PLP-4E	651DF3M	0.90	Disable	Enable	4.265	4.065	3.000	3.000	20.0	-25.0	0.190	1.0	100.0	20.0	8.5	500	0.315	0.390	65.0
MP	MC3651DF5AAM	PLP-4E	651DF5M	0.90	Disable	Enable	4.480	4.280	2.700	2.700	20.0	-25.0	0.190	1.0	100.0	12.0	8.5	500	0.315	0.390	65.0
ES	MC3651DF6AAM	PLP-4E	651DF6M	Permission	Disable	Enable	4.225	4.125	3.000	3.000	20.0	-25.0	0.190	1.0	100.0	12.0	8.5	500	0.315	0.390	65.0
MP	MC3651DF8AAM	PLP-4E	651DF8M	Permission	Disable	Enable	4.425	4.225	2.600	2.600	20.0	-54.0	0.190	1.0	100.0	12.0	8.5	500	0.315	0.845	65.0
MP	MC3651DF9AAM	PLP-4E	651DF9M	0.90	Disable	Enable	4.370	4.170	2.600	2.600	20.0	-30.0	0.190	1.0	100.0	12.0	8.5	500	0.315	0.470	65.0
MP	MC3651DFAAAM	PLP-4E	651DFAM	0.90	Disable	Enable	4.370	4.170	2.800	2.800	20.0	-30.0	0.190	1.0	100.0	12.0	8.5	500	0.315	0.470	65.0
ES	MC3651DFBAAM	PLP-4E	651DFBM	0.65	Disable	Enable	4.280	4.180	2.700	2.700	64.0	-32.0	0.190	1.0	100.0	20.0	8.5	500	1.000	0.500	65.0
ES	MC3651DC1AAM	PLP-4E	651DC1M	Permission	Disable	Enable	4.425	4.225	3.000	3.000	30.0	-30.0	0.190	1.0	100.0	12.0	8.5	500	0.470	0.470	65.0
ES	MC3651DC3AAM	PLP-4E	651DC3M	Permission	Disable	Enable	4.370	4.170	2.600	2.600	20.0	-54.0	0.190	1.0	100.0	12.0	8.5	500	0.315	0.845	65.0
MP	MC3651LC1AAM	PLP-4E	651LC1M	Permission	Enable	Enable	4.425	4.425	2.700	2.700	37.0	-25.0	0.190	1.0	100.0	12.0	8.5	500	0.580	0.390	65.0
ES	MC3651LC2AAM	PLP-4E	651LC2M	Permission	Enable	Enable	4.475	4.475	2.600	2.600	57.0	-46.0	0.190	1.0	100.0	20.0	32.5	500	0.890	0.720	65.0
MP	MC3651LC3AAM	PLP-4E	651LC3M	Permission	Enable	Enable	4.475	4.475	2.700	2.700	38.0	-37.0	0.190	1.0	100.0	224.0	8.5	500	0.595	0.580	65.0
ES	MC3651LF1AAM	PLP-4E	651LF1M	0.90	Enable	Enable	4.500	4.500	2.500	2.500	70.0	-70.0	0.190	1.0	100.0	48.0	32.5	500	1.095	1.095	65.0
MP	MC3651RF1AAM	PLP-4E	651RF1M	2.60	Disable	Enable	4.225	4.125	2.600	2.600	20.0	-25.0	0.190	1.0	100.0	12.0	8.5	500	0.315	0.390	65.0
MP	MC3651RF3AAM	PLP-4E	651RF3M	2.60	Disable	Enable	4.225	4.125	2.600	2.600	20.0	-34.0	0.190	1.0	100.0	12.0	8.5	500	0.315	0.530	65.0

Please inquire to us, if you request a rank other than the above.

NOTES

【Safety Precautions】

- Though Mitsumi Electric Co., Ltd. (hereinafter referred to as "Mitsumi") works continually to improve our product's quality and reliability, semiconductor products may generally malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of this product could cause loss of human life, bodily injury, or damage to property, including data loss or corruption. Before customers use this product, create designs including this product, or incorporate this product into their own applications, customers must also refer to and comply with (a) the latest versions or all of our relevant information, including without limitation, product specifications, data sheets and application notes for this product and (b) the user's manual, handling instructions or all relevant information for any products which is to be used, or combined with this products. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. Mitsumi assumes no liability for customers' product design or applications.

- This product is intended for applying to computers, OA units, communication units, instrumentation units, machine tools, industrial robots, AV units, household electrical appliances, and other general electronic units.

【Precautions for Product Liability Act】

- No responsibility is assumed by us for any consequence resulting from any wrong or improper use or operation, etc. of this product.

【ATTENTION】

- This product is designed and manufactured with the intention of normal use in general electronics. No special circumstance as described below is considered for the use of it when it is designed. With this reason, any use and storage under the circumstances below may affect the performance of this product. Prior confirmation of performance and reliability is requested to customers.
  Environment with strong static electricity or electromagnetic wave
  Environment with high temperature or high humidity where dew condensation may occur

- This product is not designed to withstand radioactivity, and must avoid using in a radioactive environment.

- This specification is written in Japanese and English. The English text is faithfully translated into the Japanese. However, if any question arises, Japanese text shall prevail.

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