FORTUNE' Properties For Reference Only

Datasheet

FS325

One Cell Lithium-ion/Polymer Battery Protection IC

Fortune SEMICONDUCTOR CORPORATION

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Properties
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1. General Description

FS325 is a series of lithium-ion and lithium-polymer rechargeable battery protection ICs with high accurate voltage detection and delay circuits.

These ICs are suitable for protection of single cell lithium-ion or lithium polymer battery packs from over charge, over discharge and over current.

2. Features

- **Low supply current**
  Normal Operation : 2.5 μA typ. @VDD=3.9V
  Power-down mode : 0.05 μA typ. @VDD=2.0V
  Auto recovery function : 1.8 μA typ. @VDD=2.0V
- **Overcharge detection voltage〔VOCU〕**
  4.25V~4.31V, Accuracy of ±25mV
- **Overcharge release voltage〔VOCR〕**
  4.05V~4.11V, Accuracy of ±50mV
- **Overdischarge detection voltage〔VODL〕**
  2.30V~2.40V, Accuracy of ±100mV
- **Overdischarge release voltage〔VODR〕**
  2.30V~2.90V, Accuracy of ±100mV
- **Over current detection voltage〔VOI1〕**
  0.10V~0.13V, Accuracy of ±10mV
- **Short circuit detection voltage〔VOI2〕**
  0.7V~0.9V, Accuracy of ±10mV
- **Charger over current detection voltage〔VCH〕-0.09V~0.10V, Accuracy of ±20mV**
- **Delay times are generated by an internal circuit. (External capacitors are unnecessary.)**
- **Reset resistance for Over current protection >150k□**
- **Wide supply voltage range 1.5 ~ 5.5V**
- **Small package SOT-23-5、SSON-6**
- **0V-Battery charging function**

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3. Ordering Information

FS325 **x - x**

- **x**: Serial code from A to D *
- **x**: N6A、N6C Package code

(N6A：1.8*2.0mm SSON-6 Green-Package)

(N6C：1.6*1.6mm SSON-6 Green-Package)

*: Refer to the product name list on next page.

4. Applications

- **Protection IC for One-Cell Lithium-Ion / Lithium-Polymer Battery Pack**

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5. Product Name List

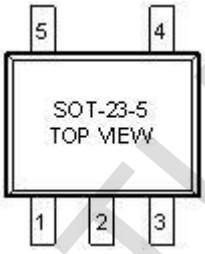
Model	Package	Overcharge detection voltage [VOCU] (V)	Overcharge release voltage [VOCR] (V)	Overdischarge detection voltage [VODL] (V)	Overdischarge release voltage [VODR] (V)	Overcurrent detection voltage [VOI1] (V)	Charger over current detection voltage [VCH] (V)	0V change function	Standby function release
FS325A	SOT-23-5	4.310±25mV	4.110±50mV	2.300±77mV	2.300±77mV	0.130±10mV	-0.090±20mV	YES	Connection of charger
FS325B	SOT-23-5	4.250±25mV	4.050±50mV	2.400±100mV	2.900±100mV	0.100±10mV	-	YES	AUTO recovery
FS325C	SOT-23-5	4.275±25mV	Note: 1	2.300±100mV	2.300±100mV	0.100±10mV	-0.100±20mV	YES	Connection of charger
FS325D	SOT-23-5	4.280±25mV	4.080±50mV	2.300±100mV	2.300±100mV	0.130±10mV	-0.100±20mV	0.65V	Connection of charger
FS325D-N6A	SSON-6 (1.8×2.0)	4.280±25mV	4.080±50mV	2.300±100mV	2.300±100mV	0.130±10mV	-0.100±20mV	0.65V	Connection of charger
FS325D-N6C	SSON-6 (1.6×1.6)	4.280±25mV	4.080±50mV	2.300±100mV	2.300±100mV	0.130±10mV	-0.100±20mV	0.65V	Connection of charger

Note: 1. FS325C VOCR release conditions : VDD<VOCU & VCSI>VOI1 (100mV)
2. FS325D series 0V charging prohibit range: 0.4V～1.1V (typ=0.65V)
3. FS325D-N6C SSON-6 similar to Seiko SNT-6A Package

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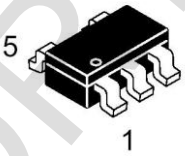
6. Pin Configuration and Package Marking Information

Pin No.	Symbol	Description
1	CSI	Input pin for current sense, charger detect
2	VDD	Positive power input pin
3	VSS	Negative power input pin
4	OD	FET gate connection pin for discharge control
5	OC	FET gate connection pin for charge control





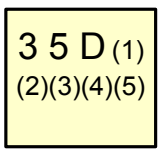
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Bottom Point：Year
w : week, A~Z & A ~ Z



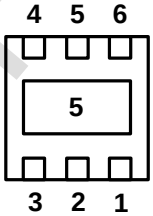
Pin No.	Symbol	Description
1	NC	NC
2	OC	FET gate connection pin for charge control
3	OD	FET gate connection pin for discharge control
4	VSS	Negative power input pin
5	VDD	Positive power input pin
6	CSI	Input pin for current sense, charger detect

Top View





Bottom View



(1)：Year Code, 0~9
(2)(3)：Week Code, 01~54
(4)(5)：Serial Code, 01~99

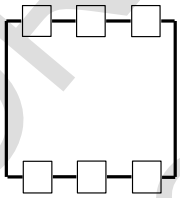
FORTUNE Properties For Reference Only

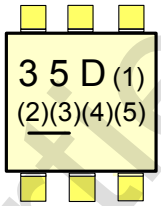
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Top View



Bottom View

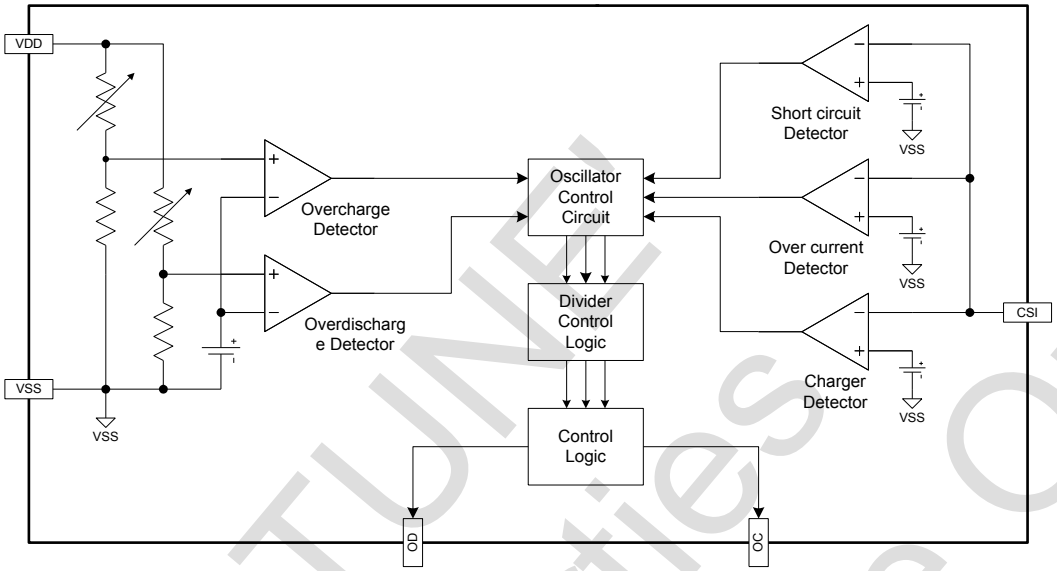




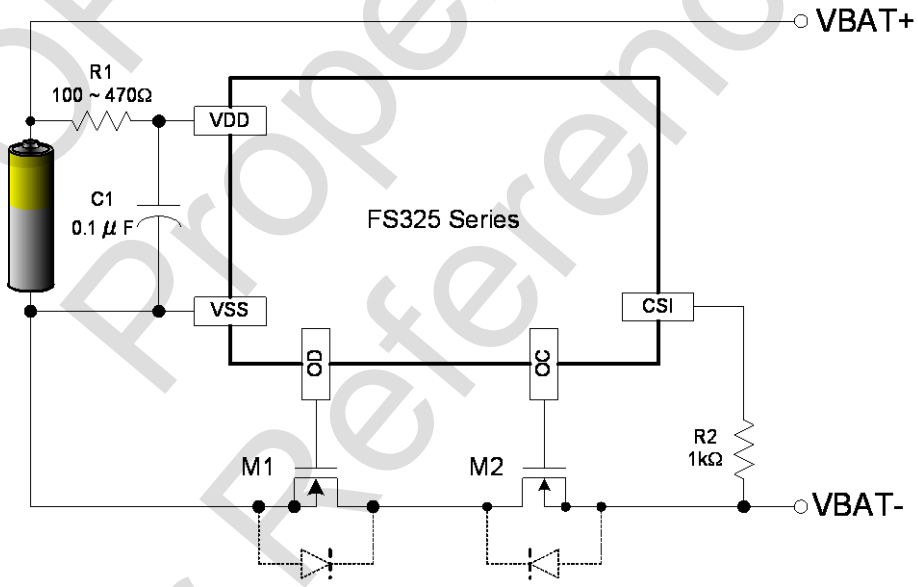
(1)：Year Code, 0~9
(2)(3)：Week Code, 01~54
(4)(5)：Serial Code, 01~99
__：Pin1 mark

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7. Functional Block Diagram



8. Typical Application Circuit



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9. Absolute Maximum Ratings

(VSS=0V, Ta=25°C unless otherwise specified)

Item	Symbol	Rating	Unit
Input voltage between VDD and VSS *	VDD	VSS-0.3 to VSS+12	V
OC output pin voltage	VOC	VDD-26 to VDD+0.3	V
OD output pin voltage	VOD	VSS-0.3 to VDD+0.3	V
CSI input pin voltage	VCSI	VDD-26 to VDD+0.3	V
Operating Temperature Range	TOP	-40 to +85	°C
Storage Temperature Range	TST	-40 to +125	°C

Note: FS325 contains a circuit that will protect it from static discharge; but please take special care that no excessive static electricity or voltage which exceeds the limit of the protection circuit will be applied to it.

* Pulse (μ sec) noise exceeding the above input voltage (VSS+12V) may cause damage to the IC.

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10. Electrical Characteristics

FS325A(VSS=0V, Ta=25°C unless otherwise specified)

PARAMETER	CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
CURRENT CONSUMPTION						
Supply Current	VDD=3.9V	IDD		2.5	5.2	μA
Power-Down Current	VDD=2.0V	IPD		0.05	1.0	μA
OPERATING VOLTAGE						
Operating input voltage1	VDD-VSS	VDS1	1.5		5.5	V
Operating input voltage2	VDD-CSI	VDS2	1.5			V
DETECTION VOLTAGE						
Overcharge detection voltage		VOCU	4.285	4.310	4.335	V
Overcharge release voltage		VOCR	4.060	4.110	4.160	V
Overdischarge detection voltage		VODL	2.223	2.300	2.377	V
Overdischarge release voltage		VODR	2.223	2.300	2.377	V
Over current detection voltage		VOI1	0.120	0.130	0.140	V
Short circuit detection voltage	VDD=3.6V	VOI2	0.80	0.90	1.00	V
Charger over current detection voltage	VDD=3.6V	VCH	-0.11	-0.09	-0.07	V
Release pull up resistor	VDD=2.0V,CS=VDD-1.0V	Rdown	75	150	300	kohm
Release pull down resistor	VDD=3.6V,CS=VDD	Rshort	15	30	150	kohm
Faulty charger detect voltage		Vdet	5.5	8.0	10.5	V
Faulty charger recovery voltage		Vrec	5.3	7.3	9.3	V
0V charging prohibit		VST	0	0	0	V
Power-Down detect voltage		Vstd	0.3VCC	0.5VCC	0.7VCC	V
DELAY TIME						
Overcharge detection delay time	VDD=4.0V to 4.4V	TOC	4	6.25	8.5	s
Overdischarge detection delay time	VDD=3.0V to 2.0V	TOD	65	100	135	ms
Over current detection delay time	VDD=3.6V	TOI1	7.365	11.0	14.25	ms
Short circuit detection delay time	VDD=3.6V	TOI2	0.45	0.750	1.4	ms
Charger over current delay time	VDD=3.6V	Tdet	16.25	32.5	48.75	ms
Overcharge timer reset delay time		Td1	5.0	16	50.0	ms
Charge release delay time		Td2	5.0	16	50.0	ms
Charge connection detection delay		Tdr1	0.3	1	3.0	ms
OTHER						
Output high level voltage	VDD=3.6V, Ioh=-20μA, CSI=0V OC,OD	VOH	3.1			V
Output low level voltage	VDD=3.6V, Ioh=+20μA, CSI=0V OC,OD	VOL			0.5	V

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FS325A(VSS=0V, Ta=-5 to +55°C unless otherwise specified)

PARAMETER	CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
CURRENT CONSUMPTION						
Supply Current	VDD=3.9V	IDD		2.5	5.5	μA
Power-Down Current	VDD=2.0V	IPD		0.05	1.0	μA
OPERATING VOLTAGE						
Operating input voltage1	VDD-VSS	VDS1	1.5		5.5	V
Operating input voltage2	VDD-CSI	VDS2	1.5			V
DETECTION VOLTAGE						
Overcharge detection voltage		VOCU	4.280	4.310	4.340	V
Overcharge release voltage		VOCR	4.060	4.110	4.160	V
Overdischarge detection voltage		VODL	2.223	2.300	2.377	V
Overdischarge release voltage		VODR	2.223	2.300	2.377	V
Over current detection voltage		VOI1	0.120	0.130	0.140	V
Short circuit detection voltage	VDD=3.6V	VOI2	0.80	0.90	1.00	V
Charger over current detection voltage	VDD=3.6V	VCH	-0.11	-0.09	-0.07	V
Release pull up resistor	VDD=2.0V,CS=VDD-1.0V	Rdown	75	150	300	kohm
Release pull down resistor	VDD=3.6V,CS=VDD	Rshort	15	30	150	kohm
Faulty charger detect voltage		Vdet	6.0	8.0	10.0	V
Faulty charger recovery voltage		Vrec	5.8	7.3	8.8	V
0V charging prohibit		VST	0	0	0	V
Power-Down detect voltage		Vstd	0.3VCC	0.5VCC	0.7VCC	V
DELAY TIME						
Overcharge detection delay time	VDD=4.0V to 4.4V	TOC	3.125	6.25	9.375	s
Overdischarge detection delay time	VDD=3.0V to 2.0V	TOD	50	100	150	ms
Over current detection delay time	VDD=3.6V	TOI1	5.5	11.0	16.85	ms
Short circuit detection delay time	VDD=3.6V	TOI2	0.37	0.75	1.48	ms
Charger over current delay time	VDD=3.6V	Tdet	13	32.5	76.5	ms
Overcharge timer reset delay time		Td1	5.0	16	50.0	ms
Charge release delay time		Td2	5.0	16	50.0	ms
Charge connection detection delay		Tdr1	0.3	1	3.0	ms
OTHER						
Output high level voltage	VDD=3.6V, Ioh=-20μA, CSI=0V OC,OD	VOH	3.1			V
Output low level voltage	VDD=3.6V, Ioh=+20μA, CSI=0V OC,OD	VOL			0.5	V

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FS325A(VSS=0V, Ta=-30 to +70°C unless otherwise specified)

PARAMETER	CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
CURRENT CONSUMPTION						
Supply Current	VDD=3.9V	IDD		2.5	6	μA
Power-Down Current	VDD=2.0V	IPD		0.05	1.0	μA
OPERATING VOLTAGE						
Operating input voltage1	VDD-VSS	VDS1	1.5		5.5	V
Operating input voltage2	VDD-CSI	VDS2	1.7			V
DETECTION VOLTAGE						
Overcharge detection voltage		VOCU	4.245	4.310	4.345	V
Overcharge release voltage		VOCR	4.025	4.110	4.165	V
Overdischarge detection voltage		VODL	2.223	2.300	2.377	V
Overdischarge release voltage		VODR	2.223	2.300	2.377	V
Over current detection voltage		VOI1	0.115	0.130	0.145	V
Short circuit detection voltage	VDD=3.6V	VOI2	0.80	0.90	1.00	V
Charger over current detection voltage	VDD=3.6V	VCH	-0.115	-0.09	-0.065	V
Release pull up resistor	VDD=2.0V,CS=VDD-1.0V	Rdown	75	150	300	kohm
Release pull down resistor	VDD=3.6V,CS=VDD	Rshort	15	30	150	kohm
Faulty charger detect voltage		Vdet	5.5	8.0	10.5	V
Faulty charger recovery voltage		Vrec	5.3	7.3	9.3	V
0V charging prohibit		VST	0	0	0	V
Power-Down detect voltage		Vstd	0.3VCC	0.5VCC	0.7VCC	V
DELAY TIME						
Overcharge detection delay time	VDD=4.0V to 4.4V	TOC	2.50	6.25	10.60	s
Overdischarge detection delay time	VDD=3.0V to 2.0V	TOD	40	100	170	ms
Over current detection delay time	VDD=3.6V	TOI1	5.0	11.0	20.0	ms
Short circuit detection delay time	VDD=3.6V	TOI2	0.225	0.75	2.000	ms
Charger over current delay time	VDD=3.6V	Tdet	13.0	32.5	76.5	ms
Overcharge timer reset delay time		Td1	5.0	16	50.0	ms
Charge release delay time		Td2	5.0	16	50.0	ms
Charge connection detection delay		Tdr1	0.3	1	3.0	ms
OTHER						
Output high level voltage	VDD=3.6V, Ioh=-20μA, CSI=0V OC,OD	VOH	3.1			V
Output low level voltage	VDD=3.6V, Ioh=+20μA, CSI=0V OC,OD	VOL			0.5	V

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FS325B(VSS=0V, Ta=25°C unless otherwise specified)

PARAMETER	CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
CURRENT CONSUMPTION						
Supply Current	VDD=3.9V	IDD		2.5	5.5	μA
Overdischarge Current	VDD=2.0V	IOD		1.8	4.5	μA
OPERATING VOLTAGE						
Operating input voltage1	VDD-VSS	VDS1	1.5		5.5	V
Operating input voltage2	VDD-CSI	VDS2	1.5			V
DETECTION VOLTAGE						
Overcharge detection voltage		VOCU	4.225	4.250	4.275	V
Overcharge release voltage		VOCR	4.000	4.050	4.100	V
Overdischarge detection voltage		VODL	2.300	2.400	2.500	V
Overdischarge release voltage		VODR	2.800	2.900	3.000	V
Over current detection voltage		VOI1	0.090	0.100	0.110	V
Short circuit detection voltage	VDD=3.6V	VOI2	0.80	0.90	1.00	V
Charger over current detection voltage	VDD=3.6V	VCH		NO		V
Release pull up resistor	VDD=2.0V,CS=VDD-1.0V	Rdown	75	150	300	Kohm
Release pull down resistor	VDD=3.6V,CS=VDD	Rshort	15	30	150	Kohm
Faulty charger detect voltage		Vdet	6.0	8.0	10.0	V
Faulty charger recovery voltage		Vrec	5.8	7.3	10.0	V
0V charging prohibit		VST	0	0	0	V
Power-Down detect voltage		Vstd		NO		V
DELAY TIME						
Overcharge detection delay time	VDD=4.0V to 4.4V	TOC	0.6	1.00	1.35	s
Overdischarge detection delay time	VDD=3.0V to 2.0V	TOD	65	100	140	ms
Over current detection delay time	VDD=3.6V	TOI1	8.37	12.5	17.13	ms
Short circuit detection delay time	VDD=3.6V	TOI2	0.275	0.50	1.30	ms
Charger over current delay time	VDD=3.6V	Tdet		NO		ms
Overcharge timer reset delay time		Td1	1	6	20	ms
Charge release delay time		Td2	1	6	20	ms
Charge connection detection delay		Tdr1	--	--	--	ms
OTHER						
Output high level voltage	VDD=3.6V, Ioh=-20μA, CSI=0V OC,OD	VOH	3.1			V
Output low level voltage	VDD=3.6V, Ioh=+20μA, CSI=0V OC,OD	VOL			0.5	V

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FS325B(VSS=0V, Ta=-5 to +55°C unless otherwise specified)

PARAMETER	CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
CURRENT CONSUMPTION						
Supply Current	VDD=3.9V	IDD		2.5	5.5	μA
Overdischarge Current	VDD=2.0V	IOD		1.8	4.5	μA
OPERATING VOLTAGE						
Operating input voltage1	VDD-VSS	VDS1	1.5		5.5	V
Operating input voltage2	VDD-CSI	VDS2	1.5			V
DETECTION VOLTAGE						
Overcharge detection voltage		VOCU	4.220	4.250	4.280	V
Overcharge release voltage		VOCR	4.000	4.050	4.100	V
Overdischarge detection voltage		VODL	2.300	2.400	2.500	V
Overdischarge release voltage		VODR	2.800	2.900	3.000	V
Over current detection voltage		VOI1	0.090	0.100	0.110	V
Short circuit detection voltage	VDD=3.6V	VOI2	0.80	0.90	1.00	V
Charger over current detection voltage	VDD=3.6V	VCH		NO		V
Release pull up resistor	VDD=2.0V,CS=VDD-1.0V	Rdown	75	150	300	Kohm
Release pull down resistor	VDD=3.6V,CS=VDD	Rshort	15	30	150	Kohm
Faulty charger detect voltage		Vdet	6.0	8.0	10.0	V
Faulty charger recovery voltage		Vrec	5.8	7.3	10.0	V
0V charging prohibit		VST	0	0	0	V
Power-Down detect voltage		Vstd		NO		V
DELAY TIME						
Overcharge detection delay time	VDD=4.0V to 4.4V	TOC	0.5	1.00	1.5	s
Overdischarge detection delay time	VDD=3.0V to 2.0V	TOD	50	100	150	ms
Over current detection delay time	VDD=3.6V	TOI1	6.25	12.5	19.1	ms
Short circuit detection delay time	VDD=3.6V	TOI2	0.25	0.50	1.50	ms
Charger over current delay time	VDD=3.6V	Tdet		NO		ms
Overcharge timer reset delay time		Td1	1	6	20	ms
Charge release delay time		Td2	1	6	20	ms
Charge connection detection delay		Tdr1	--	--	--	ms
OTHER						
Output high level voltage	VDD=3.6V, Ioh=-20μA, CSI=0V OC,OD	VOH	3.1			V
Output low level voltage	VDD=3.6V, Ioh=+20μA, CSI=0V OC,OD	VOL			0.5	V

PORTING Properties Only For Reference

FS325B(VSS=0V, Ta=-30 to +70°C unless otherwise specified)

PARAMETER	CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
CURRENT CONSUMPTION						
Supply Current	VDD=3.9V	IDD		2.5	6	μA
Overdischarge Current	VDD=2.0V	IOD		1.8	5	μA
OPERATING VOLTAGE						
Operating input voltage1	VDD-VSS	VDS1	1.5		5.5	V
Operating input voltage2	VDD-CSI	VDS2	1.5			V
DETECTION VOLTAGE						
Overcharge detection voltage		VOCU	4.185	4.250	4.285	V
Overcharge release voltage		VOCR	3.965	4.050	4.105	V
Overdischarge detection voltage		VODL	2.300	2.400	2.500	V
Overdischarge release voltage		VODR	2.800	2.900	3.000	V
Over current detection voltage		VOI1	0.085	0.100	0.115	V
Short circuit detection voltage	VDD=3.6V	VOI2	0.80	0.90	1.00	V
Charger over current detection voltage	VDD=3.6V	VCH		NO		V
Release pull up resistor	VDD=2.0V,CS=VDD-1.0V	Rdown	75	150	300	Kohm
Release pull down resistor	VDD=3.6V,CS=VDD	Rshort	15	30	150	Kohm
Faulty charger detect voltage		Vdet	5.5	8.0	10.5	V
Faulty charger recovery voltage		Vrec	5.3	7.3	9.3	V
0V charging prohibit		VST	0	0	0	V
Power-Down detect voltage		Vstd		NO		V
DELAY TIME						
Overcharge detection delay time	VDD=4.0V to 4.4V	TOC	0.4	1.00	1.7	s
Overdischarge detection delay time	VDD=3.0V to 2.0V	TOD	40	100	170	ms
Over current detection delay time	VDD=3.6V	TOI1	5.00	12.5	21.6	ms
Short circuit detection delay time	VDD=3.6V	TOI2	0.2	0.50	1.80	ms
Charger over current delay time	VDD=3.6V	Tdet		NO		ms
Overcharge timer reset delay time		Td1	1	6	20	ms
Charge release delay time		Td2	1	6	20	ms
Charge connection detection delay		Tdr1	--	--	--	ms
OTHER						
Output high level voltage	VDD=3.6V, Ioh=-20μA, CSI=0V OC,OD	VOH	3.1			V
Output low level voltage	VDD=3.6V, Ioh=+20μA, CSI=0V OC,OD	VOL			0.5	V

PORTING Properties Only For Reference

FS325C(VSS=0V, Ta=25°C unless otherwise specified)

PARAMETER	CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
CURRENT CONSUMPTION						
Supply Current	VDD=3.9V	IDD		2.5	5.5	μA
Power-Down Current	VDD=2.0V	IPD		0.05	1.0	μA
OPERATING VOLTAGE						
Operating input voltage1	VDD-VSS	VDS1	1.5		5.5	V
Operating input voltage2	VDD-CSI	VDS2	1.5			V
DETECTION VOLTAGE						
Overcharge detection voltage		VOCU	4.250	4.275	4.300	V
Overcharge release voltage		VOCR	VDD<VOCU & VCSI>VOI1			V
Overdischarge detection voltage		VODL	2.200	2.300	2.400	V
Overdischarge release voltage		VODR	2.200	2.300	2.400	V
Over current detection voltage		VOI1	0.090	0.100	0.110	V
Short circuit detection voltage	VDD=3.6V	VOI2	0.80	0.90	1.00	V
Charger over current detection voltage	VDD=3.6V	VCH	-0.12	-0.10	-0.08	V
Release pull up resistor	VDD=2.0V,CS=VDD-1.0V	Rdown	75	150	300	Kohm
Release pull down resistor	VDD=3.6V,CS=VDD	Rshort	15	30	150	Kohm
Faulty charger detect voltage		Vdet	6.0	8.0	10.0	V
Faulty charger recovery voltage		Vrec	5.8	7.3	8.8	V
0V charging prohibit		VST	0	0	0	V
Power-Down detect voltage		Vstd	0.3VCC	0.5VCC	0.7VCC	V
DELAY TIME						
Overcharge detection delay time	VDD=4.0V to 4.4V	TOC	0.6	1	1.35	s
Overdischarge detection delay time	VDD=3.0V to 2.0V	TOD	65	100	140	ms
Over current detection delay time	VDD=3.6V	TOI1	10.8	16.5	21.6	ms
Short circuit detection delay time	VDD=3.6V	TOI2	0.3	0.50	1.3	ms
Charger over current delay time	VDD=3.6V	Tdet	12.5	25.0	37.5	ms
Overcharge timer reset delay time		Td1	5.0	16.0	50.0	ms
Charge release delay time		Td2	5.0	16.0	50.0	ms
Charge connection detection delay		Tdr1	3.0	8.0	16.0	ms
OTHER						
Output high level voltage	VDD=3.6V, Ioh=-20μA, CSI=0V OC,OD	VOH	3.1			V
Output low level voltage	VDD=3.6V, Ioh=+20μA, CSI=0V OC,OD	VOL			0.5	V

FORTUNE Preliminary For Reference Only

FS325C(VSS=0V, Ta=-5 to +55°C unless otherwise specified)

PARAMETER	CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
CURRENT CONSUMPTION						
Supply Current	VDD=3.9V	IDD		2.5	5.5	μA
Power-Down Current	VDD=2.0V	IPD		0.05	1.0	μA
OPERATING VOLTAGE						
Operating input voltage1	VDD-VSS	VDS1	1.5		5.5	V
Operating input voltage2	VDD-CSI	VDS2	1.5			V
DETECTION VOLTAGE						
Overcharge detection voltage		VOCU	4.245	4.275	4.305	V
Overcharge release voltage		VOCR	VDD<VOCU & VCSI>VOI1			V
Overdischarge detection voltage		VODL	2.200	2.300	2.400	V
Overdischarge release voltage		VODR	2.200	2.300	2.400	V
Over current detection voltage		VOI1	0.090	0.100	0.110	V
Short circuit detection voltage	VDD=3.6V	VOI2	0.80	0.90	1.00	V
Charger over current detection voltage	VDD=3.6V	VCH	-0.12	-0.10	-0.08	V
Release pull up resistor	VDD=2.0V,CS=VDD-1.0V	Rdown	75	150	300	Kohm
Release pull down resistor	VDD=3.6V,CS=VDD	Rshort	15	30	150	Kohm
Faulty charger detect voltage		Vdet	6.0	8.0	10.0	V
Faulty charger recovery voltage		Vrec	5.8	7.3	8.8	V
0V charging prohibit		VST	0	0	0	V
Power-Down detect voltage		Vstd	0.3VCC	0.5VCC	0.7VCC	V
DELAY TIME						
Overcharge detection delay time	VDD=4.0V to 4.4V	TOC	0.5	1	1.5	s
Overdischarge detection delay time	VDD=3.0V to 2.0V	TOD	50	100	150	ms
Over current detection delay time	VDD=3.6V	TOI1	8.0	16.5	25.0	ms
Short circuit detection delay time	VDD=3.6V	TOI2	0.25	0.50	1.5	ms
Charger over current delay time	VDD=3.6V	Tdet	5.0	25.0	37.5	ms
Overcharge timer reset delay time		Td1	5.0	16.0	50.0	ms
Charge release delay time		Td2	5.0	16.0	50.0	ms
Charge connection detection delay		Tdr1	3.0	8.0	16.0	ms
OTHER						
Output high level voltage	VDD=3.6V, Ioh=-20μA, CSI=0V OC,OD	VOH	3.1			V
Output low level voltage	VDD=3.6V, Ioh=+20μA, CSI=0V OC,OD	VOL			0.5	V

FORTUNE Proprietary For Reference Only

FS325C(VSS=0V, Ta=-30 to 70°C unless otherwise specified)

PARAMETER	CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
CURRENT CONSUMPTION						
Supply Current	VDD=3.9V	IDD		2.5	6	μA
Power-Down Current	VDD=2.0V	IPD		0.05	1.0	μA
OPERATING VOLTAGE						
Operating input voltage1	VDD-VSS	VDS1	1.5		5.5	V
Operating input voltage2	VDD-CSI	VDS2	1.5			V
DETECTION VOLTAGE						
Overcharge detection voltage		VOCU	4.240	4.275	4.320	V
Overcharge release voltage		VOCR	VDD<VOCU & VCSI>VOI1			V
Overdischarge detection voltage		VODL	2.200	2.300	2.400	V
Overdischarge release voltage		VODR	2.200	2.300	2.400	V
Over current detection voltage		VOI1	0.085	0.100	0.125	V
Short circuit detection voltage	VDD=3.6V	VOI2	0.80	0.90	1.00	V
Charger over current detection voltage	VDD=3.6V	VCH	-0.125	-0.10	-0.075	V
Release pull up resistor	VDD=2.0V,CS=VDD-1.0V	Rdown	75	150	300	Kohm
Release pull down resistor	VDD=3.6V,CS=VDD	Rshort	15	30	150	Kohm
Faulty charger detect voltage		Vdet	5.5	8.0	10.5	V
Faulty charger recovery voltage		Vrec	5.3	7.3	9.3	V
0V charging prohibit		VST	0	0	0	V
Power-Down detect voltage		Vstd	0.3VCC	0.5VCC	0.7VCC	V
DELAY TIME						
Overcharge detection delay time	VDD=4.0V to 4.4V	TOC	0.4	1	1.7	s
Overdischarge detection delay time	VDD=3.0V to 2.0V	TOD	40	100	170	ms
Over current detection delay time	VDD=3.6V	TOI1	2.5	14.5	28.9	ms
Short circuit detection delay time	VDD=3.6V	TOI2	0.25	0.50	1.75	ms
Charger over current delay time	VDD=3.6V	Tdet	5.5	25.0	69.0	ms
Overcharge timer reset delay time		Td1	5.0	16.0	50.0	ms
Charge release delay time		Td2	5.0	16.0	50.0	ms
Charge connection detection delay		Tdr1	3.0	8.0	16.0	ms
OTHER						
Output high level voltage	VDD=3.6V, Ioh=-20μA, CSI=0V OC,OD	VOH	3.1			V
Output low level voltage	VDD=3.6V, Ioh=+20μA, CSI=0V OC,OD	VOL			0.5	V

FORTUNE Preliminary For Reference Only

FS325D、FS325D-N6A、FS325D-N6C
(VSS=0V, Ta=25°C unless otherwise specified)

PARAMETER	CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
CURRENT CONSUMPTION						
Supply Current	VDD=3.9V	IDD		2.5	5.5	μA
Power-Down Current	VDD=2.0V	IPD		0.05	1.0	μA
OPERATING VOLTAGE						
Operating input voltage1	VDD-VSS	VDS1	1.5		5.5	V
Operating input voltage2	VDD-CSI	VDS2	1.5			V
DETECTION VOLTAGE						
Overcharge detection voltage		VOCU	4.255	4.280	4.305	V
Overcharge release voltage		VOCR	4.030	4.080	4.130	V
Overdischarge detection voltage		VODL	2.200	2.300	2.400	V
Overdischarge release voltage		VODR	2.200	2.300	2.400	V
Over current detection voltage		VOI1	0.120	0.130	0.140	V
Short circuit detection voltage	VDD=3.6V	VOI2	0.60	0.70	0.80	V
Charger over current detection voltage	VDD=3.6V	VCH	-0.120	-0.100	-0.080	V
Release pull up resistor	VDD=2.0V,CS=VDD-1.0V	Rdown	75	150	300	Kohm
Release pull down resistor	VDD=3.6V,CS=VDD	Rshort	15	30	150	Kohm
Faulty charger detect voltage		Vdet	6.0	8.0	10.0	V
Faulty charger recovery voltage		Vrec	5.8	7.3	8.8	V
0V charging prohibit		VST	0.40	0.65	1.10	V
Power-Down detect voltage		Vstd	0.3VCC	0.5VCC	0.7VCC	V
DELAY TIME						
Overcharge detection delay time	VDD=4.0V to 4.4V	TOC	0.6	1	1.35	s
Overdischarge detection delay time	VDD=3.0V to 2.0V	TOD	65	100	140	ms
Over current detection delay time	VDD=3.6V	TOI1	13.3	20.0	26.5	ms
Short circuit detection delay time	VDD=3.6V	TOI2	0.60	1.0	1.80	ms
Charger over current delay time	VDD=3.6V	Tdet	-	-	-	ms
Overcharge timer reset delay time		Td1	5.0	16.0	50.0	ms
Charge release delay time		Td2	5.0	16.0	50.0	ms
Charge connection detection delay		Tdr1	0.5	1.0	2.0	ms
OTHER						
Output high level voltage	VDD=3.6V, Ioh=-20μA, CSI=0V OC,OD	VOH	3.1			V
Output low level voltage	VDD=3.6V, Ioh=+20μA, CSI=0V OC,OD	VOL			0.5	V

FORTUNE Properties For Reference only

FS325D、FS325D-N6A、FS325D-N6C
(VSS=0V, Ta=-5 to +55°C unless otherwise specified)

PARAMETER	CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
CURRENT CONSUMPTION						
Supply Current	VDD=3.9V	IDD		2.5	5.5	μA
Power-Down Current	VDD=2.0V	IPD		0.05	1.0	μA
OPERATING VOLTAGE						
Operating input voltage1	VDD-VSS	VDS1	1.5		5.5	V
Operating input voltage2	VDD-CSI	VDS2	1.5			V
DETECTION VOLTAGE						
Overcharge detection voltage		VOCU	4.250	4.280	4.310	V
Overcharge release voltage		VOCR	4.030	4.080	4.130	V
Overdischarge detection voltage		VODL	2.200	2.300	2.400	V
Overdischarge release voltage		VODR	2.200	2.300	2.400	V
Over current detection voltage		VOI1	0.120	0.130	0.140	V
Short circuit detection voltage	VDD=3.6V	VOI2	0.60	0.70	0.80	V
Charger over current detection voltage	VDD=3.6V	VCH	-0.120	-0.100	-0.080	V
Release pull up resistor	VDD=2.0V,CS=VDD-1.0V	Rdown	75	150	300	Kohm
Release pull down resistor	VDD=3.6V,CS=VDD	Rshort	15	30	150	Kohm
Faulty charger detect voltage		Vdet	6.0	8.0	10.0	V
Faulty charger recovery voltage		Vrec	5.8	7.3	8.8	V
0V charging prohibit		VST	0.40	0.65	1.10	V
Power-Down detect voltage		Vstd	0.3VCC	0.5VCC	0.7VCC	V
DELAY TIME						
Overcharge detection delay time	VDD=4.0V to 4.4V	TOC	0.5	1	1.5	s
Overdischarge detection delay time	VDD=3.0V to 2.0V	TOD	50	100	150	ms
Over current detection delay time	VDD=3.6V	TOI1	10.0	20.0	30.0	ms
Short circuit detection delay time	VDD=3.6V	TOI2	0.55	1.0	1.85	ms
Charger over current delay time	VDD=3.6V	Tdet	-	-	-	ms
Overcharge timer reset delay time		Td1	5.0	16.0	50.0	ms
Charge release delay time		Td2	5.0	16.0	50.0	ms
Charge connection detection delay		Tdr1	0.5	1.0	2.0	ms
OTHER						
Output high level voltage	VDD=3.6V, Ioh=-20μA, CSI=0V OC,OD	VOH	3.1			V
Output low level voltage	VDD=3.6V, Ioh=+20μA, CSI=0V OC,OD	VOL			0.5	V

FORTUNE Properties For Reference Only

FS325D、FS325D-N6A、FS325D-N6C
(VSS=0V, Ta=-30 to +70°C unless otherwise specified)

PARAMETER	CONDITIONS	SYMBOL	Min	Typ	Max	UNIT
CURRENT CONSUMPTION						
Supply Current	VDD=3.9V	IDD		2.5	6	μA
Power-Down Current	VDD=2.0V	IPD		0.05	1.0	μA
OPERATING VOLTAGE						
Operating input voltage1	VDD-VSS	VDS1	1.5		5.5	V
Operating input voltage2	VDD-CSI	VDS2	1.5			V
DETECTION VOLTAGE						
Overcharge detection voltage		VOCU	4.215	4.280	4.315	V
Overcharge release voltage		VOCR	3.995	4.080	4.135	V
Overdischarge detection voltage		VODL	2.200	2.300	2.400	V
Overdischarge release voltage		VODR	2.200	2.300	2.400	V
Over current detection voltage		VOI1	0.115	0.130	0.145	V
Short circuit detection voltage	VDD=3.6V	VOI2	0.60	0.70	0.80	V
Charger over current detection voltage	VDD=3.6V	VCH	-0.125	-0.100	-0.075	V
Release pull up resistor	VDD=2.0V,CS=VDD-1.0V	Rdown	75	150	300	Kohm
Release pull down resistor	VDD=3.6V,CS=VDD	Rshort	15	30	150	Kohm
Faulty charger detect voltage		Vdet	5.5	8.0	10.5	V
Faulty charger recovery voltage		Vrec	5.3	7.3	9.3	V
0V charging prohibit		VST	0.40	0.65	1.10	V
Power-Down detect voltage		Vstd	0.3VCC	0.5VCC	0.7VCC	V
DELAY TIME						
Overcharge detection delay time	VDD=4.0V to 4.4V	TOC	0.4	1	1.7	s
Overdischarge detection delay time	VDD=3.0V to 2.0V	TOD	40	100	170	ms
Over current detection delay time	VDD=3.6V	TOI1	8.0	20.0	34.4	ms
Short circuit detection delay time	VDD=3.6V	TOI2	0.40	1.0	2.50	ms
Charger over current delay time	VDD=3.6V	Tdet	-	-	-	ms
Overcharge timer reset delay time		Td1	5.0	16.0	50.0	ms
Charge release delay time		Td2	5.0	16.0	50.0	ms
Charge connection detection delay		Tdr1	0.5	1.0	2.0	ms
OTHER						
Output high level voltage	VDD=3.6V, Ioh=-20μA, CSI=0V OC,OD	VOH	3.1			V
Output low level voltage	VDD=3.6V, Ioh=+20μA, CSI=0V OC,OD	VOL			0.5	V

FORTUNE Properties For Reference Only

11. Description of Operation

Normal Condition

If VODP<VCC<VOCP and VST<VCS<VOI1, M1 and M2 are both turned on. The charging and discharging processes can be operated normally.

Overcharge Protection

When the voltage of the battery cell exceeds the overcharge protection voltage (VOCP) beyond the overcharge delay time (TOC) period, charging is inhibited by turning off of the charge control MOSFET. The overcharge condition is released in two cases:

The voltage of the battery cell becomes lower than the overcharge release voltage (VOCR) through self-discharge.

The voltage of the battery cell falls below the overcharge protection voltage (VOCP) and a load is connected.
When the battery voltage is above VOCP, the overcharge condition will not release even a load is connected to the pack.

Overdischarge Protection

When the voltage of the battery cell goes below the overdischarge protection voltage (VODP) beyond the overdischarge delay time (TOD) period, discharging is inhibited by turning off the discharge control MOSFET.

The default of overdischarge delay time is 100ms. Inhibition of discharging is immediately released when the voltage of the battery cell becomes higher than overdischarge release voltage (VODR) through charging.

Overcurrent Protection

In normal mode, the FS325 continuously monitors the discharge current by sensing the voltage of CS pin. If the voltage of CS pin exceeds the overcurrent protection voltage (VOIP) beyond the overcurrent delay time (TOI1) period, the overcurrent protection circuit operates and discharging is inhibited by turning off the discharge control MOSFET. The overcurrent condition returns to the normal mode when the load is released or the impedance between BATT+ and BATT- is larger than 150kΩ. The FS325 provides two overcurrent detection levels (0.13V and 0.9V) with two overcurrent delay time (TOI1 and TOI2) corresponding to each overcurrent detection level.

Charge Detection after Overdischarge

When overdischarge occurs, the discharge control MOSFET turns off and discharging is inhibited. However, charging is still permitted through the parasitic diode of MOSFET. Once the charger is connected to the battery pack, the FS325 immediately turns on all the timing generation and detection circuitry. Charging progress is sensed if the voltage between CS and GND is below charge detection threshold voltage (VST).

Power Down after Overdischarge

When overdischarge occurs, the FS325 will enter into power-down mode, turning off all the timing generation and detection circuitry to reduce the quiescent current to 0.05μ A (VCC=2.0V). At the same time, the CS pin is pull-up to VCC through an internal resistor.

Auto Power Down recovery

The IC continues to operate even after the overdischarge state has been entered. The battery voltage rising to the overdischarge release voltage(VODR) or higher is the only required condition for the IC to return to the normal state.

Supervising charger voltage

By supervising the charge voltage, charging can be prohibited instantly when a charger with overvoltage is connevted. The charger voltage detection circuit supervises the voltage between the VDD and CSI pins. When this voltage exceeds Vdet(Vdet < (VDD – VCSI)),regardless of the battery voltage,the charge FET control pin output alow level(CSI level)signal and the charge FET is turned off. When the charger voltage drops to Vrec or lower, the charger FET control output level is dependent on battery voltage.

Note: When a battery is connected to FS325 for the first time, it may not enter the normal condition (dischargeable may not be enabled). In this case, short the CS and VSS pins or connect to a charger to restore to the normal condition.

FORTUNE Properties For Reference Only

12. Design Guide

Selection of External Control MOSFET

Because the overcurrent protection voltage is preset, the threshold current for overcurrent detection is determined by the turn-on resistance of the charge and discharge control MOSFETs. The turn-on resistance of the external control MOSFETs can be determined by the equation: RON=VOIP/ (2 x IT) (IT is the overcurrent threshold current). For example, if the overcurrent threshold current IT is designed to be 3A, the turn-on resistance of the external control MOSFET must be 25mΩ. Be aware that turn-on resistance of the MOSFET changes with temperature variation due to heat dissipation. It changes with the voltage between gate and source as well. (Turn-on resistance of MOSFET increases as the voltage between gate and source decreases). As the turn-on resistance of the external MOSFET changes, the design of the overcurrent threshold current changes accordingly.

Suppressing the Ripple and Disturbance from Charger

To suppress the ripple and disturbance from charger, connecting R1 and C1 to VCC is recommended.

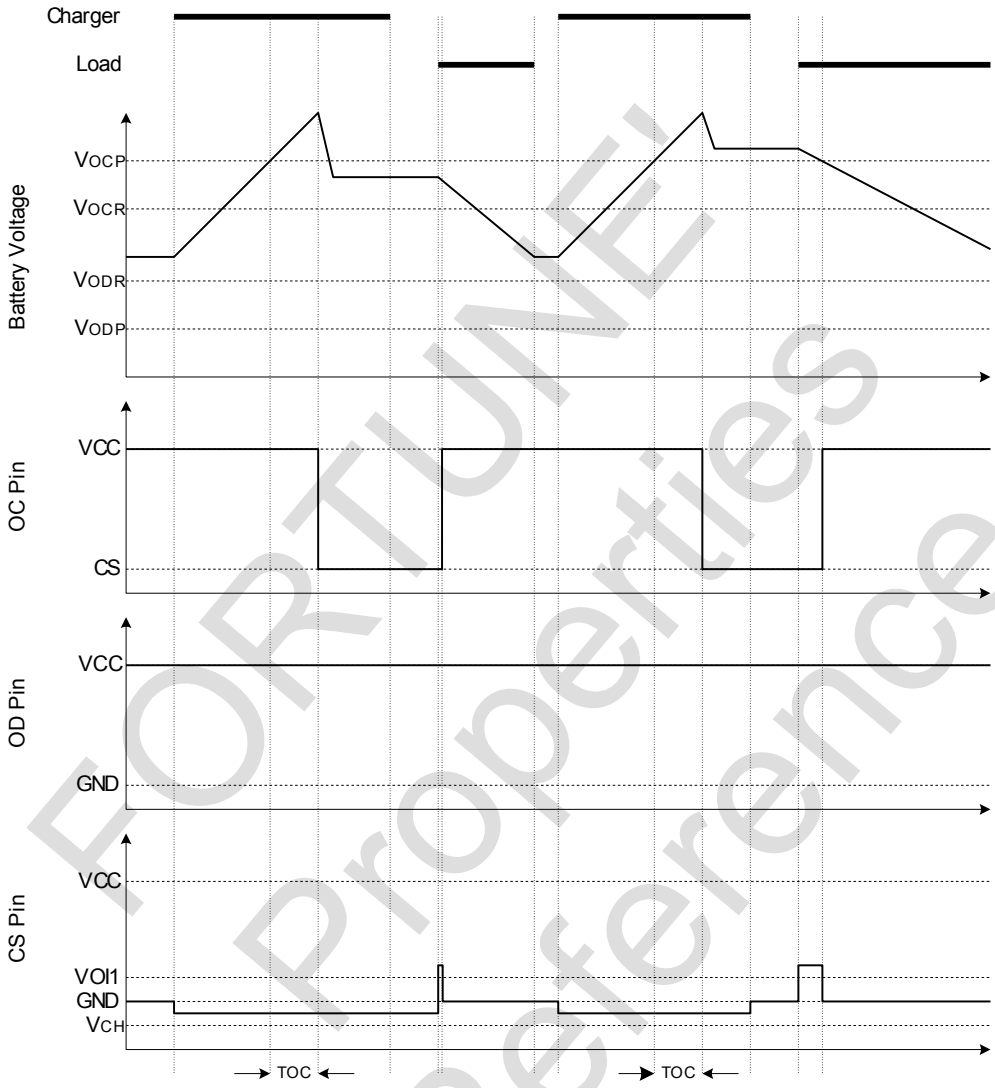
Protection the CS pin

R2 is used for latch-up protection when charger is connected under overdischarge condition and overstress protection at reverse connecting of a charger.

FORTUNE Properties For Reference Only

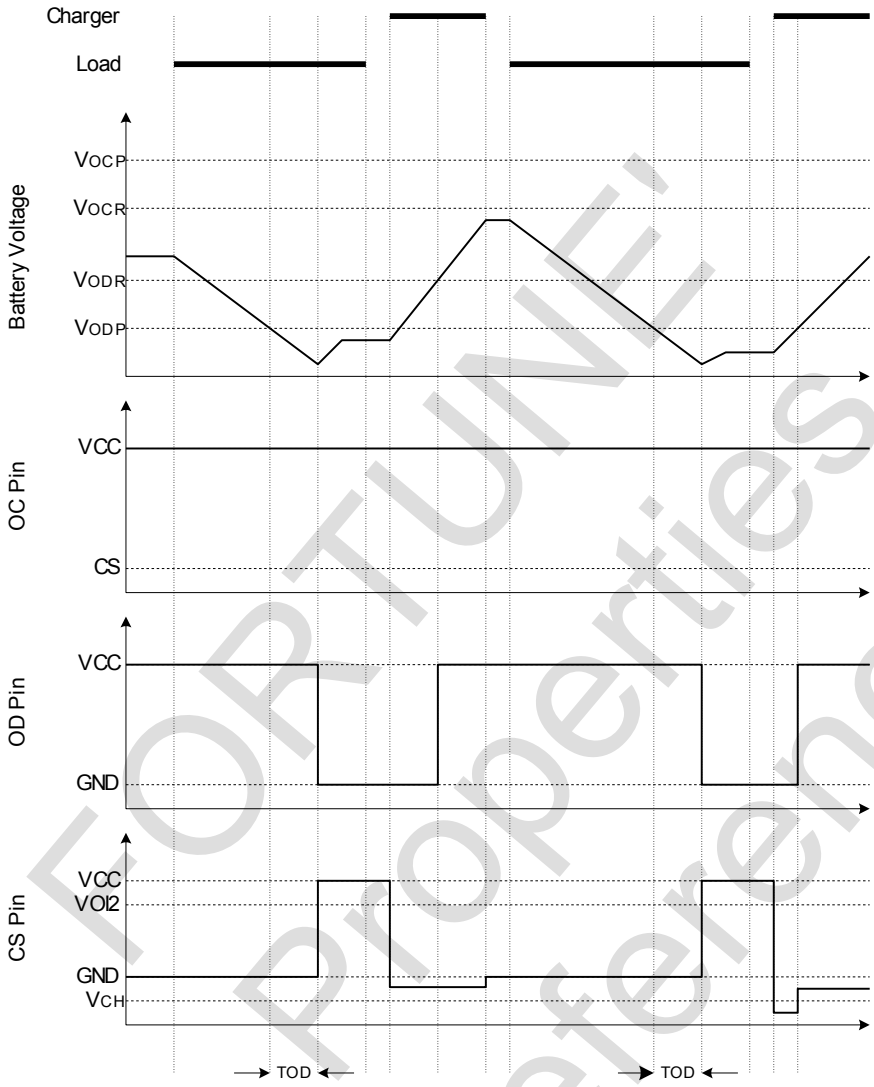
13. Timing Diagram

Overcharge Condition →Load Discharging → Normal Condition



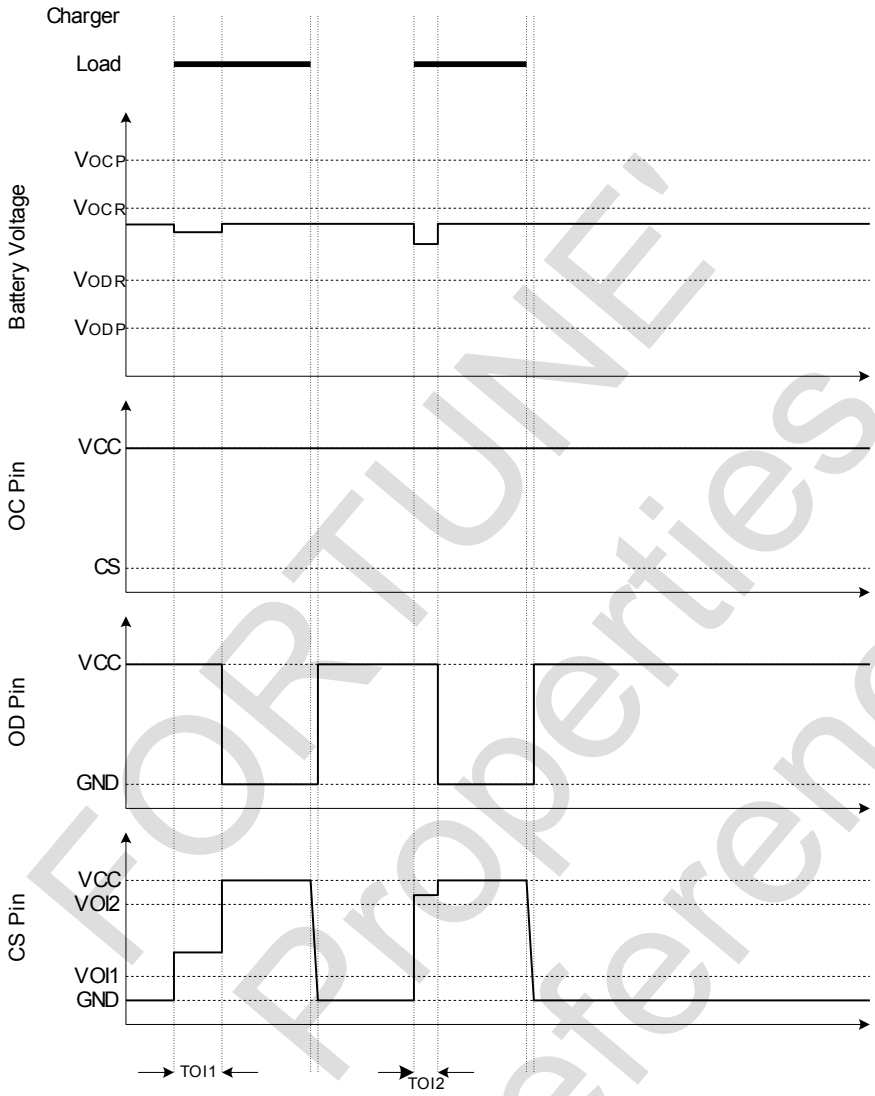
FORTUNE Properties For Reference Only

Overdischarge Condition → Charging by a Charger →Normal Condition



FORTUNE Properties For Reference Only

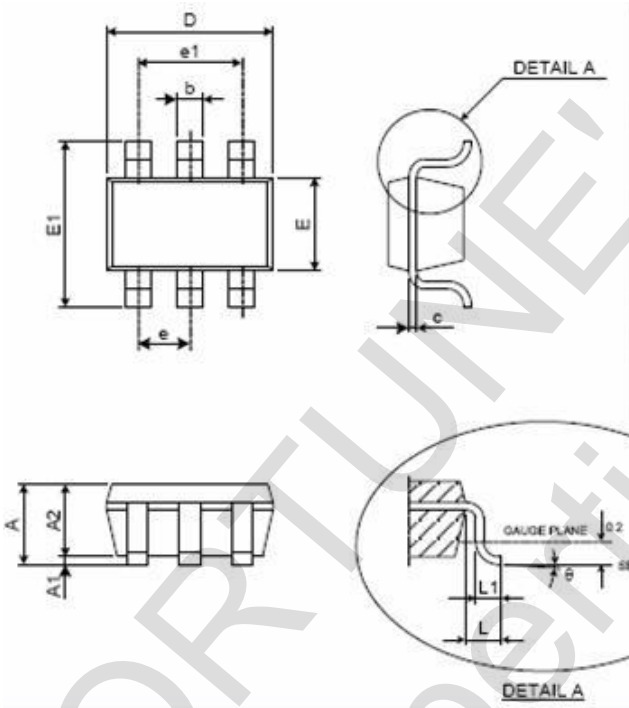
Over Current Condition → Normal Condition



FORTUNE Properties For Reference Only

14. Package Outline

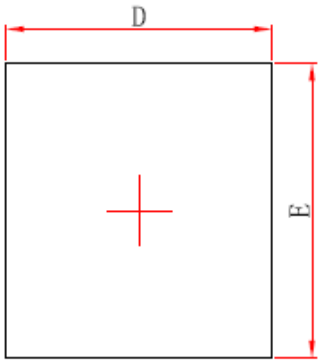
Dimension (SOT-23-5)



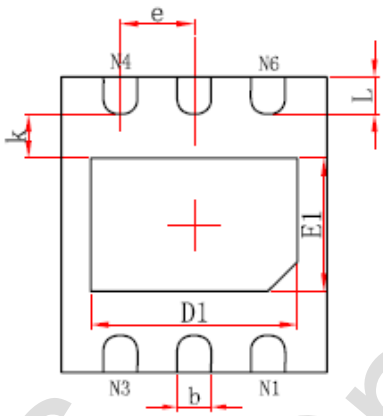
	Min.	TYP.	Max.
A	-	-	1.45
A1	0	-	0.15
A2	0.90	1.15	1.30
b	0.30	-	0.50
c	0.08	-	0.22
D	2.75	2.90	3.05
E	1.45	1.60	1.75
E1	2.60	2.80	3.00
e	0.95 BSC		
e1	1.90 BSC		
L	0.60 REF		
L1	0.30	0.45	0.60
Theta	0	4	8

FORTUNE Properties For Reference Only

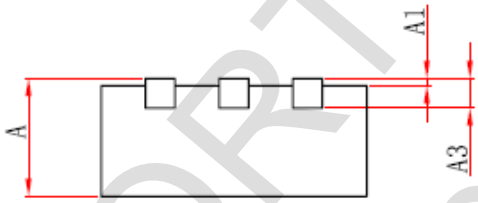
Dimension (SSON-6_N6A)



Top View



Bottom View

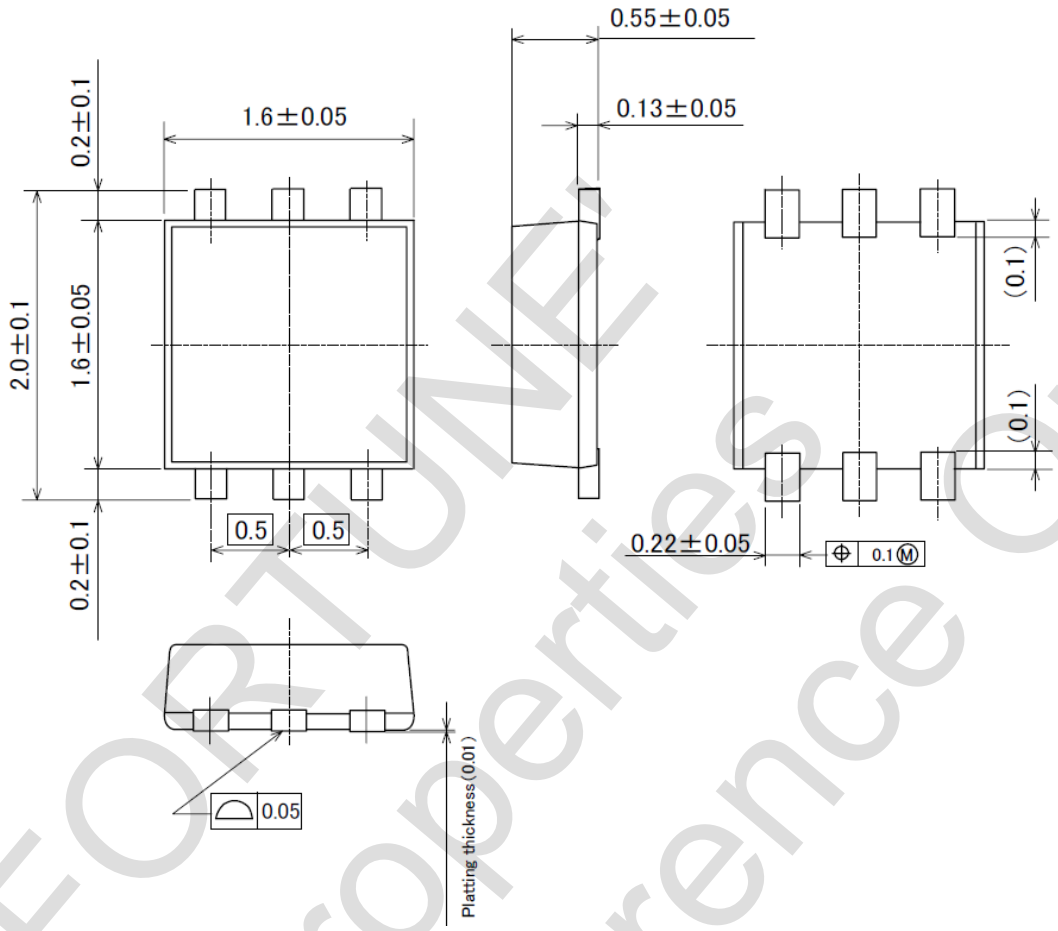


Side View

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.450/0.550	0.550/0.650	0.018/0.022	0.022/0.026
A1	0.000	0.050	0.000	0.002
A3	0.150REF.		0.006REF.	
D	1.724	1.876	0.068	0.074
E	1.924	2.076	0.076	0.082
D1	1.300	1.500	0.051	0.059
E1	0.800	1.000	0.031	0.039
k	0.200MIN.		0.008MIN.	
b	0.180	0.280	0.007	0.011
e	0.500TYP.		0.020TYP.	
L	0.174	0.326	0.007	0.013

FORTUNE Properties For Reference Only

Dimension (SSON-6_N6C)



FORTUNE Properties For Reference Only

15. Revision History

Version	Date	Page	Description
1.0	2010/06/02	ALL	New release
1.1	2011/07/08	4	Revise Product name list package SOT-23-5
1.2	2011/09/08	24	Revise Package Outline
1.3	2012/04/17	4,13,14,15	FS325C(VOCR)、FS325D(0V charging prohibit) function explain
1.4	2012/10/08	16,17,18	Revise FS325D VCH、Tdet Specified
1.5	2012/10/16	3,4,5,17,18,19	Add SSON-6 Package Information
		26	Add SSON-6 Package Information
1.6	2013/11/26	3,4,6,18,19,20	Add FS325D-N6C SSON-6 Package Information
		28	Add FS325D-N6C SSON-6 Package Information
		4,5,27	Revise FS325D-N6A SSON-6 Package Information
1.7	2013/12/25	4	Revise VOI1 Specified Unit
		28	Revise SSON-6_N6C Package Outline
1.8	2014/05/22	2	Revised company address
1.9	2015/06/08	3,4,18,19,20	Add Charger Over Current Detection Voltage Specified