Battery Protection IC with Internal MOSFET for Single-Cell Pack

Features

- Low supply current
  Normal operation: 3.5uA typ. @VCC = 3.5V
  Power-down mode: 0.1uA max. @VCC = 2.0V
- Internal Dual N-Channel MOSFET
  $R_{DS(ON)}$ = 19mΩ (Typ.)X2 @V_{GS} = 4.0V
- Over-charge detection voltage (V_{CU})
  4.1V ~ 4.4V, accuracy: ±25mV
- Over-charge release voltage (V_{CU} -V_{HC})
  0.0V ~ 0.4V, accuracy: ±25mV
- Over-discharge detection voltage (V_{DL})
  2.2V ~ 2.5V, accuracy: ±50mV
- Over-discharge release voltage (V_{DL} +V_{HD})
  0.0V ~ 0.7V, accuracy: ±50mV
- Over-current detection voltage (V_{IOV1})
  0.0V ~ 0.15V, accuracy: ±15mV
- Short circuit detection voltage (V_{SHORT})
  0.5V, accuracy: ±100mV
- Reset resistance for over current protection
  > 500KΩ
- Delay time clock is generated with internal circuit
- TSSOP-8/MSOP-8 Package

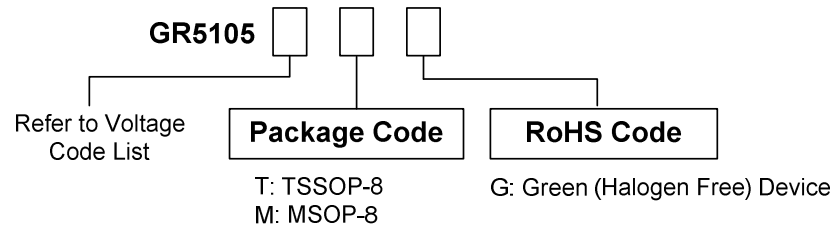
Applications

- Bluetooth earphone
- Lithium-ion/Lithium polymer protector of over-charge, over-discharge, excess-current for battery pack
- High precision protector for cell-phone and any other gadgets using on board Lithium-ion/Lithium polymer battery
- Battery packs occupy tiny space

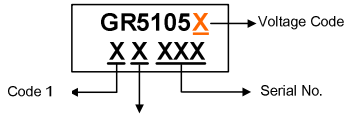
Description

The GR5105 series are protection ICs for over-charge/discharge of rechargeable one-cell Lithium-ion/Lithium polymer excess load current, further include a short circuit protector for preventing large external short circuit and excess charge/discharge-current. The GR5105 includes dual NMOSFETs and affects the smaller PCB size. NMOSFETs ESD Rating: 2KV.

Ordering and Marking Information



TSSOP-8/MSOP-8



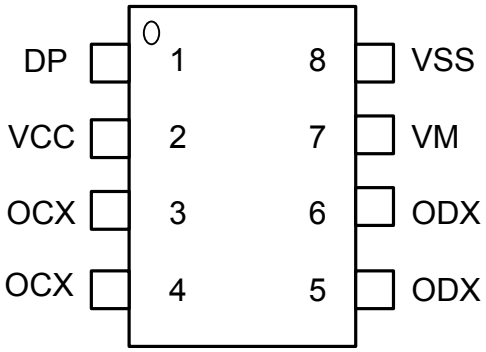
Code 1	8	9	A	B		G	H	I	J
Year	2008	2009	2010	2011	• • •	2016	2017	2018	2019
Code 2	1	2	3	4		9	A	B	C
Month	Jan.	Feb.	Mar.	Apr.		Sep.	Oct.	Nov.	Dec.

Voltage Code List

Product Name	Package	Over-charge detection voltage V_{CU}(V)	Over-charge release voltage V_{HC}(V)	Over-discharge detection voltage V_{DL}(V)	Over-discharge release voltage V_{HD}(V)	Over-current detection voltage V_{IOV1}(mV)	Delay Time Combination
GR5105A	TSSOP-8	4.300±0.025	4.075±0.025	2.45±0.05	2.95±0.05	150±15	(I)
GR5105B	TSSOP-8	4.280±0.025	4.130±0.025	2.6±0.05	3.1±0.05	120±15	(II)
GR5105C	TSSOP-8	4.280±0.025	4.080±0.025	2.3±0.05	2.3±0.05	105±15	(II)
GR5105D	TSSOP-8	4.280±0.025	4.280±0.025	2.8±0.05	2.8±0.05	50±15	(I)
GR5105E	MSOP-8	4.240±0.025	4.02±0.025	2.42±0.05	2.91±0.05	150±15	(I)

Pin Configuration

TSSOP-8/MSOP-8 (TOP VIEW)



Pin Description

Pin No.	Symbol	Description
1	DP	Test pin for delay time measurement
2	VCC	Power supply pin, the substrate voltage level of the IC
3, 4	OCX	The source terminal of over-charge protection MOSFET
5, 6	ODX	The source terminal of over-discharge protection MOSFET
7	VM	Voltage detection pin between VM and VSS
8	VSS	Ground pin for the IC

Absolute Maximum Ratings

Input voltage between VCC and VSS ---------- VSS-0.3 ~ VSS+12V

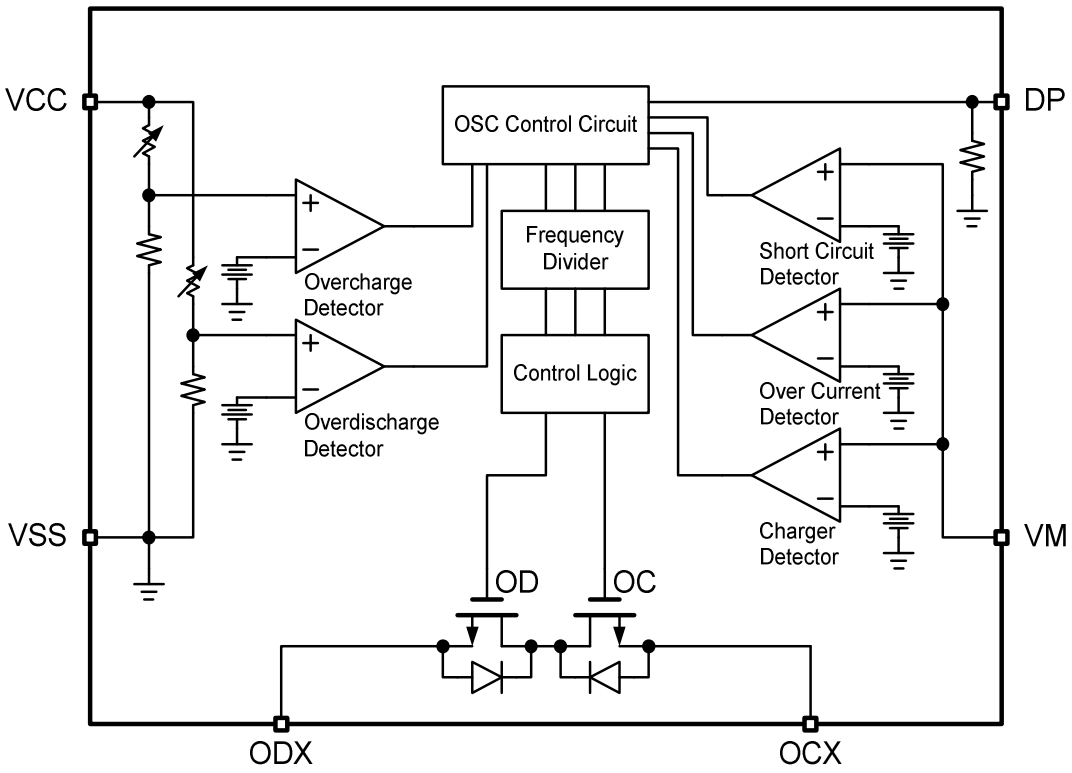
VM input pin voltage ---------- VCC-20 ~ VCC+0.3V

DP input pin voltage ---------- VSS-0.3 ~ VCC+0.3V

Operating temperature range ---------- −40 ~ 85 °C

Storage temperature range ---------- −40 ~ 125 °C

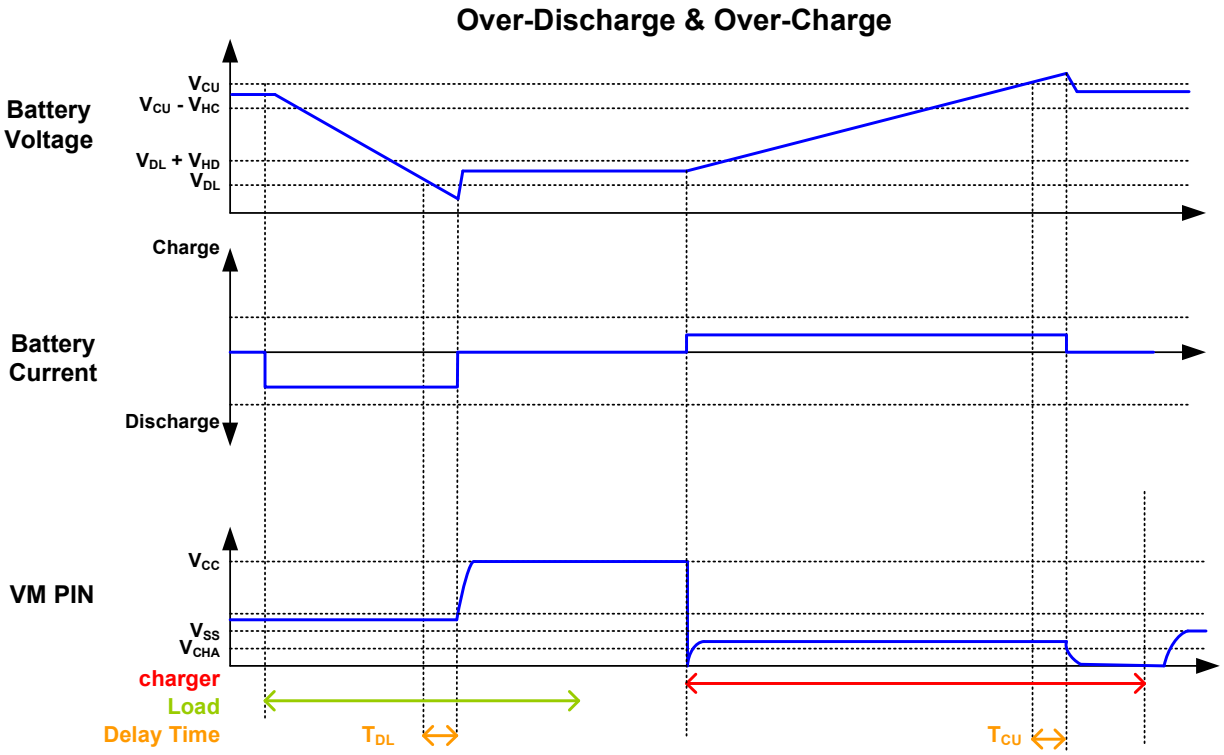
Block Diagram

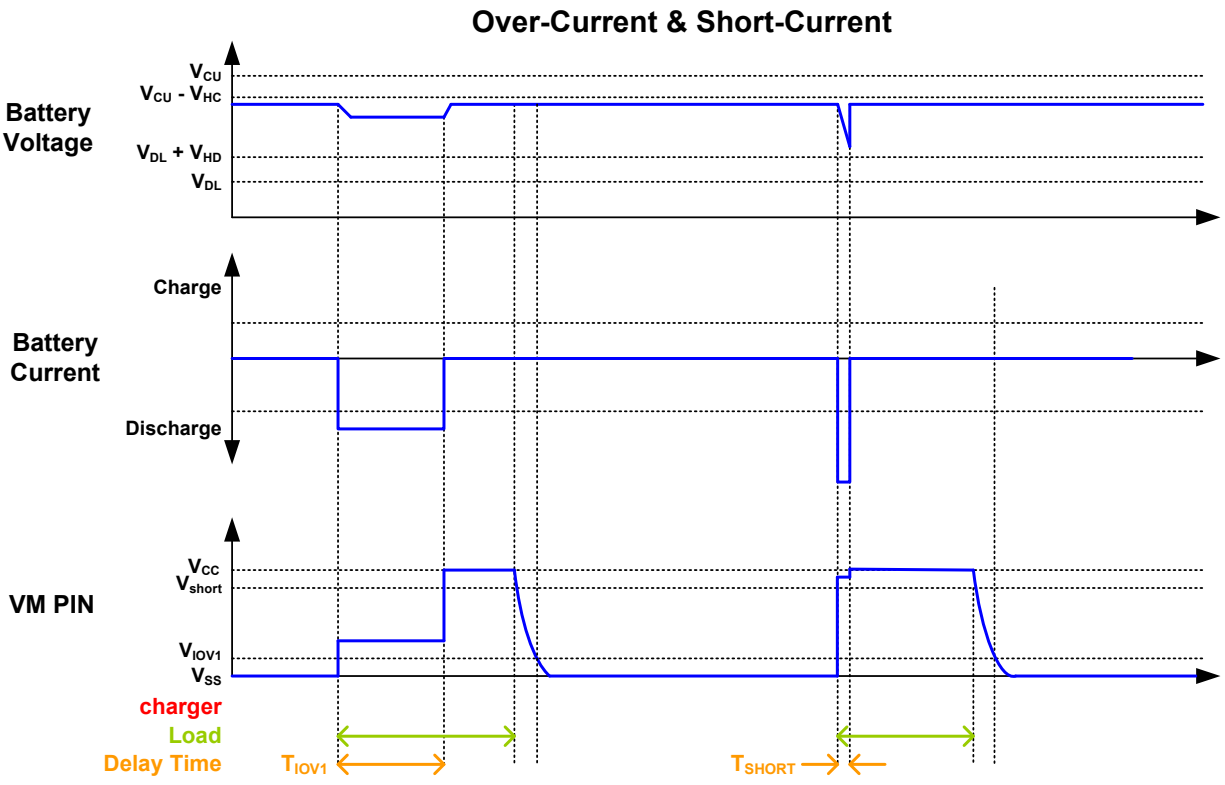


Electrical Characteristics (T_A = 25℃)

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
CURRENT CONSUMPTION						
Supply current	VCC = 3.5V	I_{OPE}	1.0	3.5	7.0	μA
Power-down current	VCC = 2.0V	I_{PDN}			0.1	μA
OPERATING VOLTAGE						
Operating input voltage	VCC-VSS	V_{DSOP}	1.8		8.0	V
DETECTION VOLTAGE						
Overcharge detection voltage		V_{CU}	V_{CU} -0.025	V_{CU}	V_{CU} +0.025	V
Overcharge hysteresis voltage		V_{HC}	V_{HC} -0.025	V_{HC}	V_{HC} +0.025	V
Over discharge detection voltage		V_{DL}	V_{DL} -0.050	V_{DL}	V_{DL} +0.050	V
Over discharge hysteresis voltage		V_{HD}	V_{HD} -0.050	V_{HD}	V_{HD} +0.050	V
Over current detection voltage		V_{IOV1}	V_{IOV1} -0.015	V_{IOV1}	V_{IOV1} +0.015	V
Short current detection voltage	VCC = 3.5V	V_{SHORT}	0.4	0.5	0.6	V
Charger detection voltage		V_{CHA}	-1.0	-0.7	-0.2	V
DELAY TIME (I)						
Overcharge detection delay time	VCC = 4.3V	T_{CU}	64	80	96	mS
Over discharge detection delay time	VCC = 2.4V	T_{DL}	32	40	48	mS
Over current detection delay time	VCC = 3.5V	T_{IOV1}	5	10	15	mS
Short current detection delay time	VCC = 3.5V	T_{SHORT}	60		200	μS
DELAY TIME (II)						
Overcharge detection delay time	VCC = 4.3V	T_{CU}	0.9	1.2	1.5	S
Over discharge detection delay time	VCC = 2.4V	T_{DL}	100	150	190	mS
Over current detection delay time	VCC = 3.5V	T_{IOV1}	7	10	13	mS
Short current detection delay time	VCC = 3.5V	T_{SHORT}	250	350	450	μS
MOSFET						
Drain-source breakdown voltage	V_{GS} = 0V	BV_{DSS}	20	-	-	V
Gate threshold voltage	V_{DS} = V_{GS}	$V_{GS(TH)}$	0.5	0.7	1	V
Drain-source on-state resistance	V_{GS} = 4.0V	$R_{DS(ON)}$		19	25	mΩ
Diode forward voltage	I_S = 1.5A	V_{SD}		0.7	1.3	V
Continue drain current	V_{GS} = 3.5V	I_D			6	A
Diode continuous forward current		I_S			1.5	A

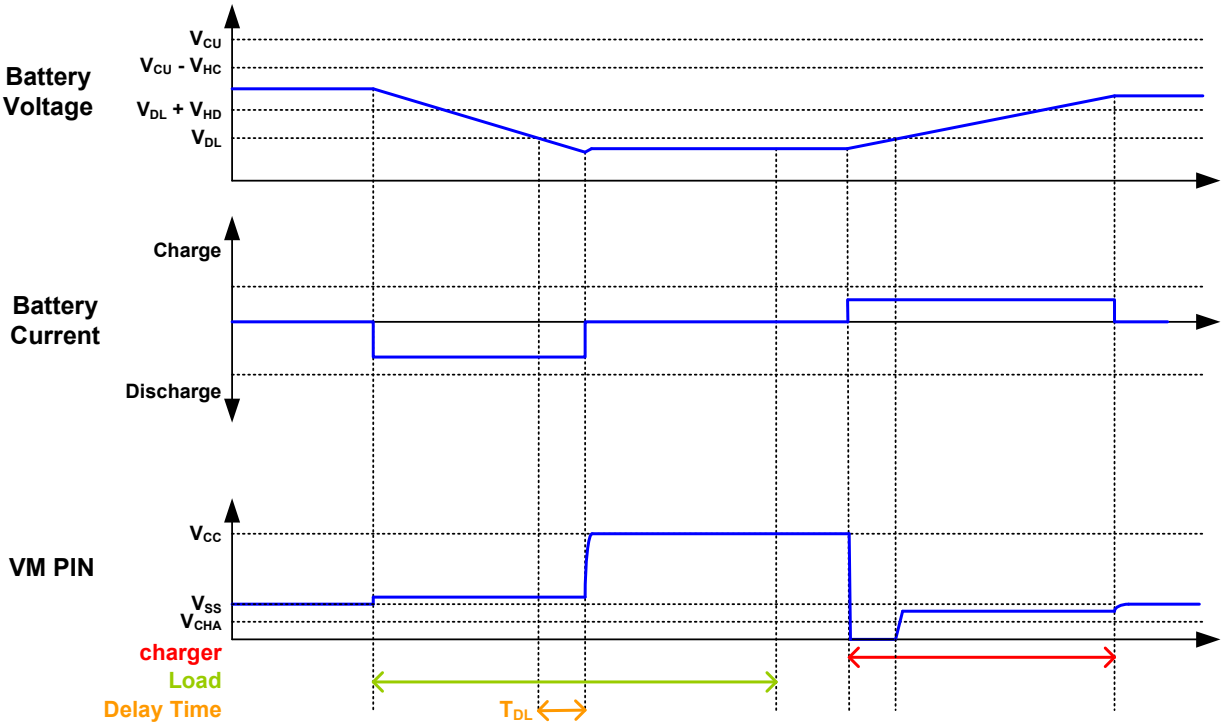
Timing Chart



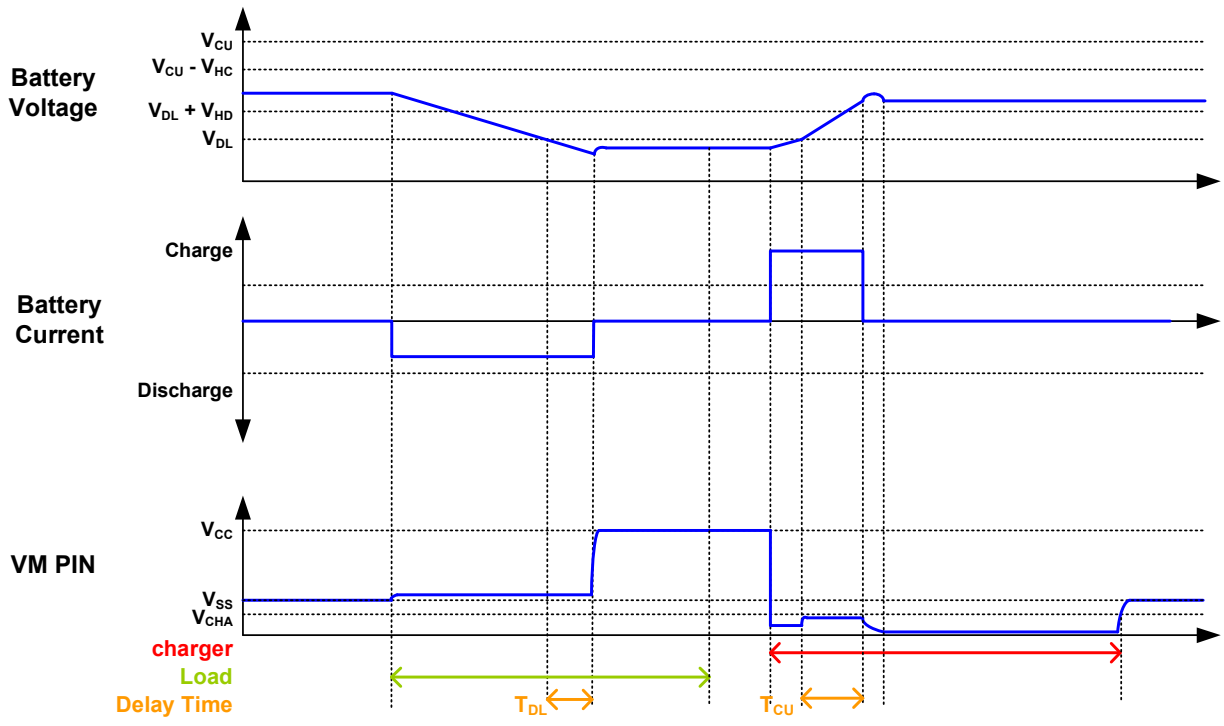


Timing Chart (Cont.)

Charger Detection



Abnormal Charge Current Detection



Description of Operation

Normal Status

This IC monitors the voltage of the battery connected between the VCC pin and VSS pin and the voltage difference between the VM pin and VSS pin to control charging and discharging. When the battery voltage is in the range from over discharge detection voltage (V_{DL}) to overcharge detection voltage (V_{CU}), and the VM pin voltage is not more than the discharge over current detection voltage (V_{IOV1}), the IC turns both the charging and discharging control FETs on. This condition is called the normal status, and in this condition charging and discharging can be carried out freely. The resistance (R_{VMD}) between the VM pin and VCC pin, and the resistance (R_{VMS}) between the VM pin and VSS pin are not connected in the normal status. Caution when the battery is connected for the first time, discharging pin may not be enabled. Please short the VM pin and VSS pin or connect the charger to restore the normal status.

Over-charge Status

When the battery voltage becomes higher than overcharge detection voltage (V_{CU}) during charging in the normal status and detection continues for the overcharge detection delay time (T_{CU}) or longer, the GR5105 Series turns the charging control FET off to stop charging. This condition is called the overcharge status. The resistance (R_{VMD}) between the VM pin and VCC pin, and the resistance (R_{VMS}) between the VM pin and VSS pin are not connected in the overcharge status. The overcharge status is released in the following two cases:

(1) In the case that the VM pin voltage is higher than or equal to charger detection voltage (V_{CHA}), and is lower than the discharge over current detection voltage (V_{IOV1}), GR5105 Series releases the overcharge status when the battery voltage falls below the overcharge release voltage (V_{CU} -V_{HC}).

(2) In the case that the VM pin voltage is higher than or equal to the discharge over current detection voltage (V_{IOV1}), GR5105 Series releases the overcharge status when the battery voltage falls below the overcharge detection voltage (V_{CU}). When the discharge is started by connecting a load after the overcharge detection, the VM pin voltage rises more than the voltage at VSS pin due to the voltage of the parasitic diode. This is because the discharge current flows through the parasitic diode in the charging control FET. If this VM pin voltage is higher than or equal to the discharge over current detection voltage (V_{IOV1}), GR5105 Series releases the overcharge status when the battery voltage is lower than or equal to the overcharge detection voltage (V_{CU}).

Over-discharge Status

When the battery voltage falls below over discharge detection voltage (V_{DL}) during discharging in the normal status and the detection continues for the over discharge detection delay time (T_{DL}) or longer, the GR5105 Series turns the discharging control FET off to stop discharging. This condition is called the over-discharge status. Under the over discharge status, the VM pin voltage is pulled up by the resistor between the VM pin and VCC pin in the IC (R_{VMD}). When voltage difference between the VM pin and VSS pin then is 0.5 V (Typ.) or higher, the current consumption is reduced to the power-down current consumption (I_{PDN}). This condition is called the power-down status. The resistance (R_{VMS}) between the VM pin and VSS pin is not connected in the power-down status and the over discharge status. The power-down status is released when a charger is connected and the voltage difference between the VM pin and GND pin becomes 0.5 V (typ.) or lower. When a battery in the over discharge

status is connected to a charger and provided that the VM pin voltage is lower than charger detection voltage (V_{CHA}), the GR5105 Series releases the over discharge status and turns the discharging FET on when the battery voltage reaches over discharge detection voltage (V_{DL}) or higher. When a battery in the over discharge status is connected to a charger and provided that the VM pin voltage is not lower than charger detection voltage (V_{CHA}), the GR5105 Series releases the over discharge status when the battery voltage reaches over discharge release voltage (V_{DL} +V_{HD}) or higher.

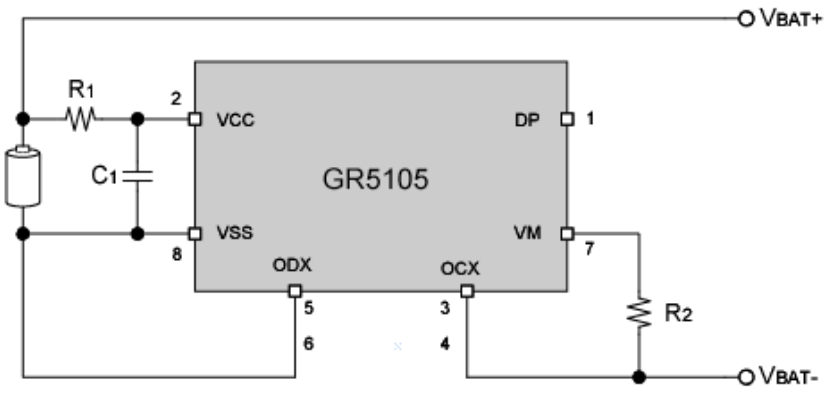
Discharge Over-current Status (Discharge Over current or Short-circuiting)

When a battery is in the normal status and the voltage of the VM pin is equal to or higher than the discharge over current detection voltage because the discharge current is higher than the specified value and the status lasts for the discharge over current detection delay time, the discharge control FET is turned off and discharging is stopped. This status is called the discharge over current status. In the discharge over current status, the VM pin and VSS pin are shorted by the resistor between VM pin and VSS pin (R_{VMS}) in the IC. However, the voltage of the VM pin is at the VCC potential due to the load as long as the load is connected. When the load is disconnected, the VM pin returns to the VSS potential. This IC detects the status when the impedance between the Bat+ pin and Bat- pin increases and is equal to the impedance that enables automatic restoration and the voltage at the VM pin returns to discharge over current detection voltage (V_{IOV1}) or lower, the discharge over current status is restored to the normal status. Even if the connected impedance is smaller than automatic restoration level, the GR5105 Series will be restored to the normal status from discharge over current detection status when the voltage at the VM pin becomes the discharge over current detection voltage (V_{IOV1}) or lower by connecting the charger. The resistance (R_{VMD}) between the VM pin and VCC pin is not connected in the discharge over current detection status.

Detection for abnormal charging current

During charging a battery which is in the normal status, if the VM pin voltage becomes lower than the charger detection voltage (V_{CHA}) and this status is held longer than the overcharge detection delay time (T_{CU}), GR5105 turns off the charge-control FET to stop charging. This is detection for abnormal charging current. If the abnormal charger current flows in the battery in the over discharge status, and the battery voltage becomes higher than the over discharge detection voltage, after the overcharge detection delay time (T_{CU}), GR5105 turns off the charge-control FET to stop charging. The status irregular charging current detection is released by the lower potential difference between the VM and VSS pin than the charger detection voltage (V_{CHA}).

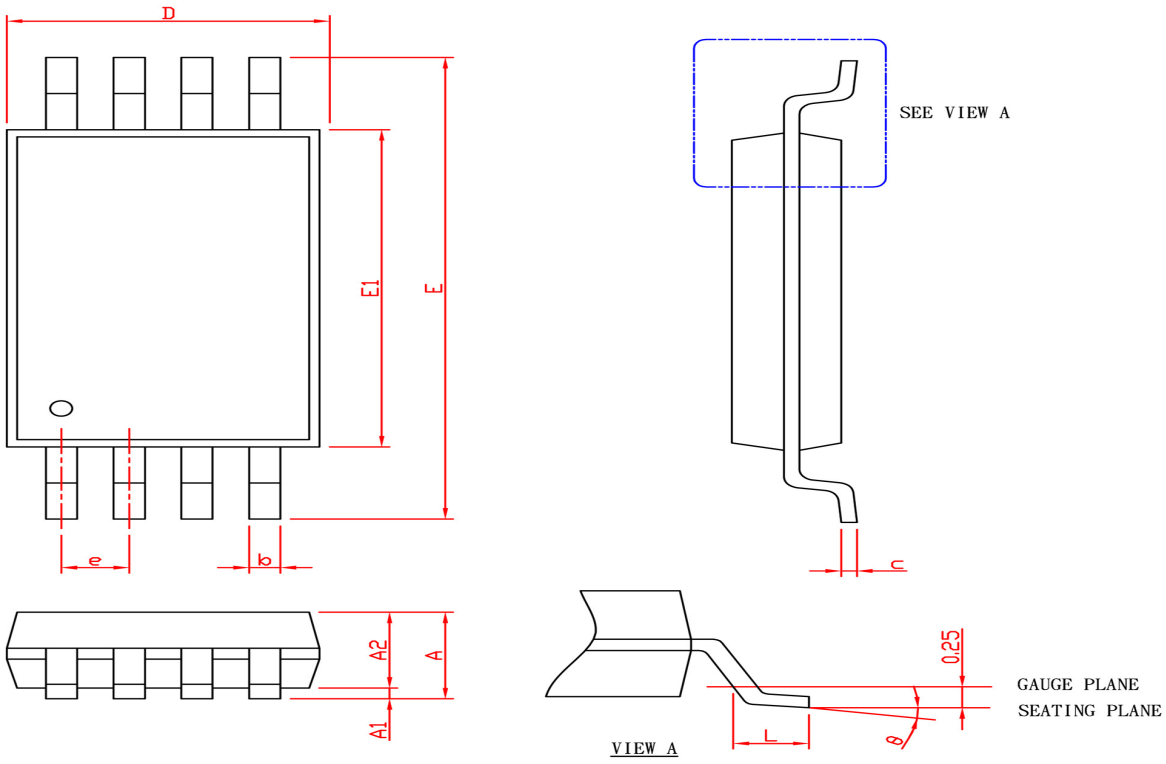
Typical Application Circuit



Constant for External Components

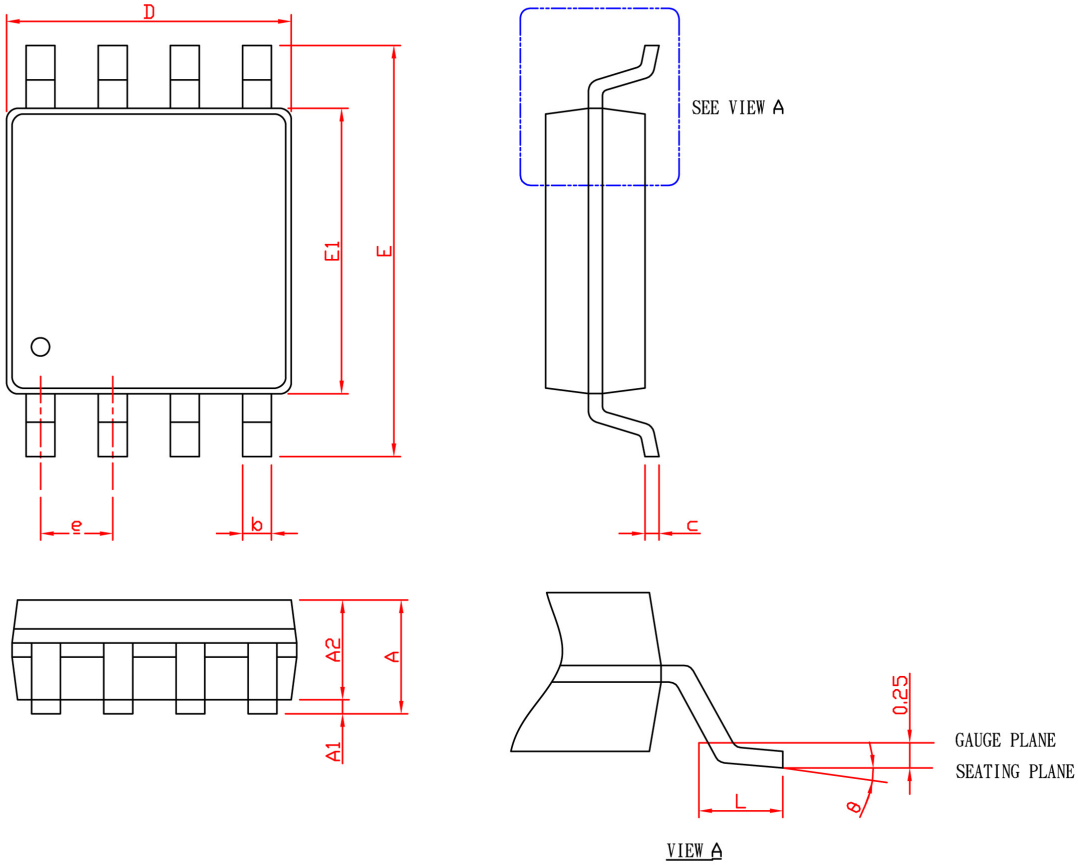
Symbol	Part	Purpose	Min.	Typ.	Max.	Remarks
R1	Resistor	ESD protection, for power fluctuation	100Ω	100Ω	1KΩ	Resistance should be as small as possible to avoid lowering of the overcharge detection accuracy caused by VCC pin current
R2	Resistor	Protection for reverse connection of a charger	300Ω	1KΩ	4KΩ	Select a resistance as large as possible to prevent large current when a charger is connected in reverse
C1	Capacitor	For power fluctuation	0.022uF	0.1uF	1.0uF	Install a capacitor of 0.022uF or higher between VCC and VSS

Package Information



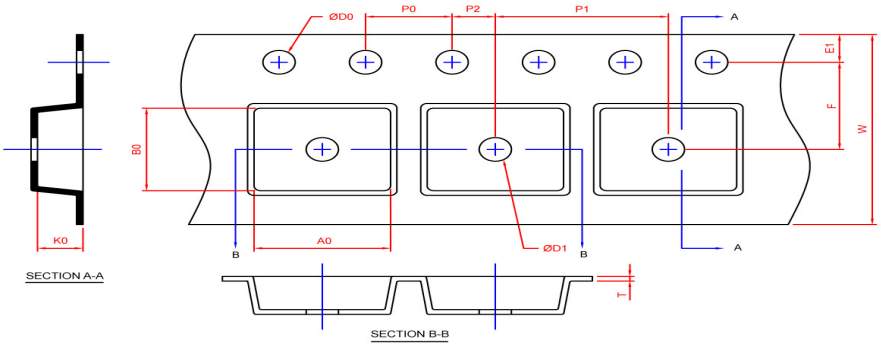
SYMBOL	TSSOP-8			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.20		0.047
A1	0.05	0.15	0.002	0.006
A2	0.80	1.05	0.031	0.041
b	0.19	0.30	0.007	0.012
c	0.09	0.20	0.004	0.008
D	2.90	3.10	0.114	0.122
E	6.20	6.60	0.244	0.260
E1	4.30	4.50	0.169	0.177
e	0.65 BSC		0.026 BSC	
L	0.45	0.75	0.018	0.030
θ	0^o	8^o	0^o	8^o

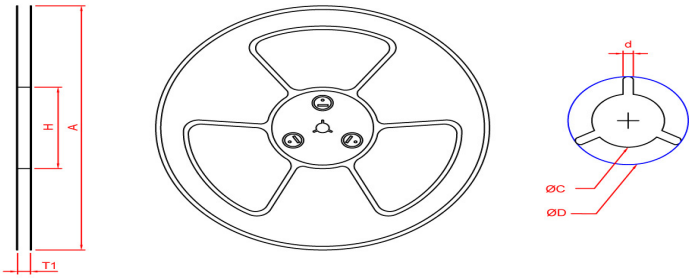
Package Information



SYMBOL	MSOP-8			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.10		0.043
A1	0.00	0.15	0.000	0.006
A2	0.75	0.95	0.030	0.037
b	0.22	0.38	0.009	0.015
c	0.08	0.23	0.003	0.009
D	2.90	3.10	0.114	0.122
E	4.70	5.10	0.185	0.201
E1	2.90	3.10	0.114	0.122
e	0.65 BSC		0.026 BSC	
L	0.40	0.80	0.016	0.031
θ	0^o	8^o	0^o	8^o

Carrier Tape & Reel Dimensions





Application	A	H	T1	C	d	D	W	E1	F
TSSOP-8	330.0± 2.00	50 MIN.	12.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	12.0±0.30	1.75±0.10	5.5±0.10
	P0	**P1**	**P2**	**D0**	**D1**	**T**	**A0**	**B0**	**K0**
	4.00±0.10	8.00±0.10	2.00±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	6.90±0.20	3.40±0.20	1.60±0.20

(mm)

Application	A	H	T1	C	d	D	W	E1	F
MSOP-8	330.0± 2.00	50 MIN.	12.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	12.0±0.30	1.75±0.10	5.5±0.05
	P0	**P1**	**P2**	**D0**	**D1**	**T**	**A0**	**B0**	**K0**
	4.00±0.10	8.00±0.10	2.00±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	5.30±0.20	3.30±0.20	1.40±0.20

(mm)

Application	Carrier Width	Cover Tape Width	Devices Per Reel
TSSOP-8	12	-	2500
MSOP-8	12	-	3000