

## T63H0008A

Li-Ion/Polymer Battery for  
one-cell Protector**Features**

- **High voltage device is used for charger connection pins V- and COUT pins: Maximum 30V**
- **Internal high accuracy voltage detection circuit**
  1. Overcharge detection voltage 3.9V to 4.4V (applicable in 5mV step)  
Accuracy :  $\pm 25\text{mV}$  ( $+25^\circ\text{C}$ ) and  $\pm 30\text{mV}$  ( $-5^\circ\text{C}$  to  $+55^\circ\text{C}$ )
  2. Overcharge hysteresis voltage 0.0V to 0.4V .....Accuracy :  $\pm 25\text{mV}$   
The overcharge hysteresis voltage can be selected from the range 0.0V to 0.4V in 50mV step.
  3. Over-discharge detection voltage 2.0V to 3.0 V (10mV step) .....Accuracy :  $\pm 50\text{mV}$ .
  4. Over-discharge hysteresis voltage 0.0V to 0.7 V (\*2) .....Accuracy :  $\pm 50\text{mV}$   
The over-discharge hysteresis voltage can be selected from the range 0.0V to 0.7V in 100mV step.
  5. Overcurrent 1 detection voltage 0.05V to 0.3V (10mV step).....Accuracy :  $\pm 15\text{mV}$
  6. Overcurrent 2 detection voltage 0.5V (fixed) .....Accuracy :  $\pm 100\text{mV}$

\*1: Overcharge release voltage = Overcharge detection voltage - Overcharge hysteresis voltage  
(where overcharge release voltage < 3.8V is prohibited.)

\*2: Over-discharge release voltage = Over-discharge detection voltage + Over-discharge hysteresis voltage  
(where over-discharge release voltage > 3.4V is prohibited.)
- **Delay times** (overcharge: tVDET1, over-discharge: tVDET2, over-current 1: tVDET3, over-current 2: tVDET4) are generated by an internal circuit. No external capacitor is necessary. ....Accuracy:  $\pm 20\%$
- **Three-step over-current detection circuit is included** (over-current 1, over-current 2, and load short-circuiting).
- **Either charge function or charge inhibition function for 0V battery can be selected.**
- **Charger detection function and abnormal charge current detection function**
  1. The over-discharge hysteresis is released by detecting negative voltage at the V- pin ( $-0.7\text{V}$  typ.).  
(Charger detection function)
  2. When the output voltage of the DOUT pin is high and the voltage at the V- pin is equal to or lower than the charger detection voltage ( $-0.7\text{V}$  typ.), the output voltage of the COUT pin goes low.  
(Abnormal charge current detection function)
- **Low current consumption .**
  1. Operation 3.0uA typ. 7.0uA max. (IDD).
  2. Power-down 0.1 uA max. (ISB).
- **Wide operating temperature range:  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$**
- **Ultra Small package .....SOT-23-6 (6 PIN),SNB(B)(6PIN).**  
(SNB Type please contact Sales).

**Part Number Examples** (\*Note 1)

Part No.	Over-Charge detection voltage	Over-charge Hysteresis voltage	Over-discharge detection voltage	Over-discharge Hysteresis voltage	Over-Current 1 detection voltage	0V battery charge function	marking
T63H0008A -AX	4.28V	0.2V	2.3V	0V	0.13V	None	008A
T63H0008A -BX	4.30V	0.1V	2.3V	0V	0.08V	None	008B
T63H0008A -CX	4.325V	0.25V	2.5V	0.4V	0.15V	None	008C
T63H0008A -DX	4.35V	0.2V	2.5V	0.2V	0.15V	None	008D
...*Note2	....		....		....	....	....

**Note 1:**This table is for SOT-23-6 pin Package, SNB Type please contact Sales.

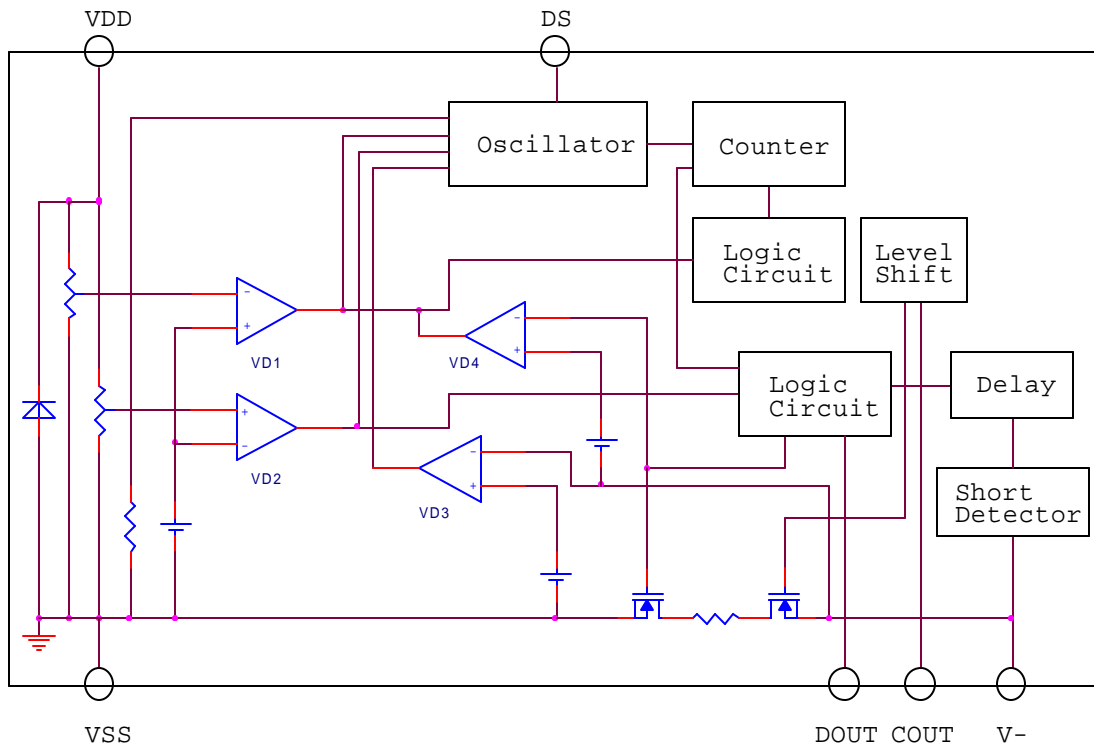
**Note 2:**New model version and specific characteristics may be order by customer.

**General Description**

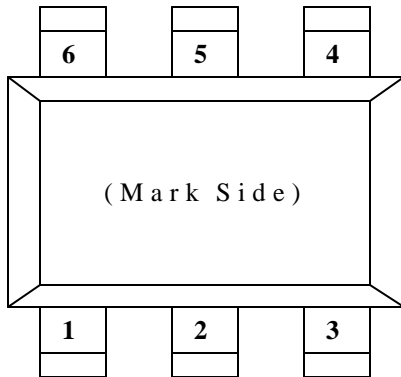
The T63H0008A series are lithium-ion/lithium polymer rechargeable battery protection ICs incorporating high-accuracy voltage detection circuit and delay circuit.

The T63H0008A series are suitable for protection of single-cell lithium ion/lithium polymer battery packs from overcharge, over-discharge and over-current and 0V battery charge function.

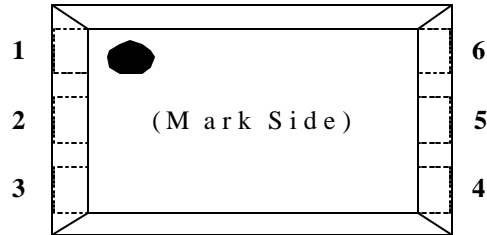
**BLOCK DIAGRAM**



**Pin Configurations**



**SOT-23-6 TOP VIEW**



**SNB(A & B) - 6 PIN TOP VIEW**

**PIN DESCRIPTION**

SOT-23-6	SNB(A)	SNB(B)	Symbol	Pin description
1	1	3	Dout	Output of over-discharge detection, CMOS output
2	6	2	V-	Pin for charge negative input
3	5	1	Cout	Output of over-charge detection, CMOS output
4	4	5	Ds	Test Pin for delay time measurement
5	2	6	VDD	Power supply
6	3	4	Vss	Ground

**ABSOLUTE MAXIMUM RATINGS**

(Temp=25°C)

Symbol	Item	Ratings	Unit
VDD	Supply voltage	-0.3 to 9	V
V- Vct	Input voltage	V <sub>DD</sub> -30 to V <sub>DD</sub> +0.3 V <sub>SS</sub> -0.3 to V <sub>DD</sub> +0.3	V V
	V- pin Ct pin		
Vcout Vdout	Output voltage	V <sub>DD</sub> -30 to V <sub>DD</sub> +0.3 V <sub>SS</sub> -0.3 to V <sub>DD</sub> +0.3	V V
	Cout pin Dout pin		
PD	Power dissipation	250	mW
Topt	Operating temperature range	-40 to 85	°C
Tstg	Storage temperature range	-55 to 125	°C

Absolute Maximum ratings are threshold limit values that must not be exceeded even for an instant under any conditions. Moreover, such values for any two items must not be reached simultaneously. Operation above these absolute maximum ratings may cause degradation or permanent damage to the device. These are stress ratings only and do not necessarily imply functional operation below these limits.

**ELECTRICAL CHARACTERISTIC1**

(Temp=25°C)

Symbol	Parameter	Conditions	MIN.	TYP.	MAX.	Unit	
<b>INPUT VOLTAGE / OPERATION VOLTAGE</b>							
VDD1	Operating input voltage	Voltage defined as VDD to VSS	1.5	-	8	V	
VDD2	Operating input voltage	Voltage defined as VDD to V-	1.5	-	30	V	
<b>CURRENT CONSUMPTION</b>							
IDD	Normal operation current	VDD=3.5V, V=0V	1.0	3.0	7.0	µA	
ISB	Standby current	VDD=V-=1.5V	-	--	0.1	µA	
<b>OUTPUT RESISTANCE</b>							
RCOUTH	COUT pin H resistance	VCOUT=3.0V,VDD=3.5V,V=0V	2.5	5	10	Kohm	
RCOUTL	COUT pin L resistance	VCOUT=0.5,VDD=4.5V,V=0V	2.5	5	10	Kohm	
RDOUTH	DOUT pin H resistance	VDOUT=3.0V,VDD=3.5V,V=0V	2.5	5	10	Kohm	
RDOUTL	DOUT pin L resistance	VDOUT=0.5V,VDD=V=1.8V	2.5	5	10	Kohm	
<b>V- INTERNAL RESISTANCE</b>							
RV-D	Internal resistance between V- and VDD	VDD=1.8V,V=0V	100	300	900	Kohm	
RV-S	Internal resistance between V- and VSS	VDD=3.5V,V=1.0V	10	20	40	Kohm	
<b>DETECTION VOLTAGE</b>							
VDET1	Over-charge detection voltage VDET1=3.9V to 4.4V 5mV Step	-	AX	4.255	4.280	4.305	V
			BX	4.275	4.300	4.325	V
			CX	4.300	4.325	4.350	V
			DX	4.325	4.350	4.375	V
VHCT1	Over-charge hysteresis voltage VHCT1=0.0V to 0.4V 50mV Step	-	-	VHCT1 -0.025	VHCT1	VHCT1 +0.025	V
tVDET1	Output delay of over charge	-	0.96	1.2	1.4	S	
VDET2	Over-discharge detection voltage VDET2=2.0V to 3.0V 10mV Step	-	AX /BX	2.25	2.30	2.35	V
			CX	2.45	2.50	2.55	V
			DX	2.45	2.50	2.55	V
VHDT2	Over-discharge hysteresis voltage VHDT2=0.0V to 0.7V 100mV Step	-	-	VHDT2 -0.050	VHDT2	VHDT2 +0.050	V
tVDET2	Output delay of over-discharge	-	115	144	173	ms	
VDET3	Over-current 1 detection voltage VDET3=0.05V to 0.3V 10mV Step	Detect rising edge of "V-" pin voltage	VDET3 -0.015	VDET3	VDET3 +0.015	V	
tVDET3	Over-current 1 detection delay time	-	7.2	9	11	ms	
VDET4	Over-current 2 detection voltage	-	0.4	0.5	0.6	V	
tVDET4	Over-current 2 detection delay time	-	1.8	2.24	2.7	ms	
VDET5	Charger detection voltage	Detect falling edge of "V-" pin voltage	-1.0	-0.7	-0.4	V	
VSHORT	Load short-circuiting detection voltage	-	0.9	1.2	1.5	V	
tSHORT	Load short-circuiting detection delay time	-	220	320	380	µs	
<b>0V BATTERY CHARGING FUNCTION</b>							
V0cha	0V Battery charge starting charge voltage	Applied for 0V battery charge function	-	-	1.5	V	
V0inh	0V Battery charge inhibition charge voltage	Applied for 0V battery charge inhibition function	0.6	1.0	1.4	V	

**Note:** Since products are not screened at low/high temperature, the specification for this range is guaranteed by design, not tested in production.

**ELECTRICAL CHARACTERISTIC2 \*note 1**

(Temp=-40 to 85°C)

Symbol	Parameter	Conditions	MIN.	TYP.	MAX.	Unit	
<b>INPUT VOLTAGE / OPERATION VOLTAGE</b>							
VDD1	Operating input voltage	Voltage defined as VDD to VSS	1.5	-	8	V	
VDD2	Operating input voltage	Voltage defined as VDD to V-	1.5	-	30	V	
<b>CURRENT CONSUMPTION</b>							
IDD	Normal operation current	VDD=3.5V, V=0V	0.7	3.0	8.0	µA	
ISB	Standby current	VDD=V-=1.5V		--	0.1	µA	
<b>OUTPUT RESISTANCE</b>							
RCOUTH	COUT pin H resistance	VCOUT=3.0V,VDD=3.5V,V=0V	1.2	5	15	Kohm	
RCOUTL	COUT pin L resistance	VCOUT=0.5,VDD=4.5V,V=0V	1.2	5	15	Kohm	
RDOUTH	DOUT pin H resistance	VDOUT=3.0V,VDD=3.5V,V=0V	1.2	5	15	Kohm	
RDOUTL	DOUT pin L resistance	VDOUT=0.5V,VDD=V=1.8V	1.2	5	15	Kohm	
<b>V- INTERNAL RESISTANCE</b>							
RV-D	Internal resistance between V- and VDD	VDD=1.8V,V=0V	78	300	1310	Kohm	
RV-S	Internal resistance between V- and VSS	VDD=3.5V,V=1.0V	7.2	20	44	Kohm	
<b>DETECTION VOLTAGE</b>							
VDET1	Over-charge detection voltage VDET1=3.9V to 4.4V 5mV Step	-	AX	4.225	4.280	4.320	V
			BX	4.260	4.300	4.340	V
			CX	4.270	4.325	4.365	V
			DX	4.320	4.350	4.380	V
VHCT1	Over-charge hysteresis voltage VHCT1=0.0V to 0.4V 50mV Step	-	-	VHCT 1 -0.025	VHCT 1	VHCT 1 +0.025	V
tVDET1	Output delay of over charge	-	-	0.7	1.2	2.0	S
VDET2	Over-discharge detection voltage VDET2=2.0 to 3.0V 10mV Step	-	AX /BX	2.22	2.30	2.38	V
			CX	2.42	2.50	2.58	V
			DX	2.42	2.50	2.58	V
VHDT2	Over-discharge hysteresis voltage VHDT2=0.0V to 0.7V 100mV Step	-	-	VHDT2 -0.050	VHDT2	VHDT2 +0.050	V
tVDET2	Output delay of over-discharge	-	-	80	144	245	ms
VDET3	Over-current 1 detection voltage VDET3=0.05V to 0.3V 10mV Step	Detect rising edge of "V-" pin voltage	VDET 3 -0.015	VDET3	VDET3 +0.015	V	
tVDET3	Over-current 1 detection delay time	-	5	9	15	ms	
VDET4	Over-current 2 detection voltage	-	0.37	0.5	0.63	V	
tVDET 4	Over-current 2 detection delay time	-	1.2	2.24	3.8	ms	
VDET5	Charger detection voltage	Detect falling edge of "V-" pin voltage	-1.0	-0.7	-0.4	V	
VSHORT	Load short-circuiting detection voltage	-	0.7	1.2	1.7	V	
tSHORT	Load short-circuiting detection delay time	-	150	320	540	µs	
<b>0V BATTERY CHARGING FUNCTION</b>							
V0cha	0V Battery charge starting charge voltage	Applied for 0V battery charge function	-	-	1.7	V	
V0inh	0V Battery charge inhibition charge voltage	Applied for 0V battery charge inhibition function	0.4	1.0	1.6	V	

**Note 1:** Since products are not screened at low/high temperature, the specification for this range is guaranteed by design, not tested in production.

## MEASUREMENT CIRCUITS

Unless otherwise specified, the output voltage levels “H” and “L” at COUT and DOUT pins are judged by the threshold voltage (1.0V) of the N channel FET. Judge the COUT pin level with respect to V- and the DOUT pin level with respect to VSS.

### (1) Measurement Condition 1, Measurement Circuit 1

(Overcharge detection voltage, Overcharge hysteresis voltage).

The overcharge detection voltage (VDET1) is defined by the voltage between VDD and VSS at which VCO goes “L” from “H” when the voltage V1 is gradually increased from the starting condition V1=3.5V and V2=0V. The overcharge hysteresis voltage (VHCT1) is then defined by the difference between the overcharge detection voltage (VDD) and the voltage between VDD and VSS at which VCO goes “H” from “L” when the voltage V1 is gradually decreased.

### (2) Measurement Condition 2, Measurement Circuit 2

(Over-discharge detection voltage, Over-discharge hysteresis voltage)

The over-discharge detection voltage (VDET2) is defined by the voltage between VDD and VSS at which VDO goes “L” from “H” when the voltage V1 is gradually decreased from the starting condition V1=3.5V and V2=0V. The over-discharge hysteresis voltage (VHDT2) is then defined by the difference between the over-discharge detection voltage (VDET2) and the voltage between VDD and VSS at which VDO goes “H” from “L” when the voltage V1 is gradually increased.

### (3) Measurement Condition 3, Measurement Circuit 2

(Over-current 1 detection voltage, Over-current 2 detection voltage, Load short-circuiting detection voltage)

The over-current 1 detection voltage is defined by the voltage between V- and VSS whose delay time for changing VDO from “H” to “L” lies between the minimum and the maximum value of the over-current 1 detection delay time when the voltage V2 is increased rapidly within 10 $\mu$ s from the starting condition V1=3.5V and V2=0V.

The over-current 2 detection voltage is defined by the voltage between V- and VSS whose delay time for changing VDO from “H” to “L” lies between the minimum and the maximum value of the over-current 2 detection delay time when the voltage V2 is increased rapidly within 10 $\mu$ s from the starting condition V1=3.5V and V2=0V.

The load short-circuiting detection voltage is defined by the voltage between V- and VSS whose delay time for changing VDO from “H” to “L” lies between the minimum and the maximum value of the load short-circuiting detection delay time when the voltage V2 is increased rapidly within 10 $\mu$ s from the starting condition V1=3.5V and V2=0V.

**(4) Measurement Condition 4, Measurement Circuit 2**

(Charger detection voltage, abnormal charge current detection voltage)

Set V1=1.8V and V2=0V. Increase V1 gradually until  $V1=V_{DET2}+(V_{HDT2}/2)$ , then decrease V2 from 0 V gradually. The voltage between V- and VSS when VDO goes "H" from "L" is the charger detection voltage (VDET5). Charger detection voltage can be measured only in the product whose over-discharge hysteresis VHDT2  $\neq$  0.

Set V1=3.5V and V2=0V, Decrease V2 from 0 V gradually. The voltage between V- and VSS when VCO goes "L" from "H" is the abnormal charge current detection voltage. The abnormal charge current detection voltage has the same value as the charger detection voltage (VDET 5).

**(5) Measurement Condition 5, Measurement Circuit 2**

(Normal operation current consumption, Power-down current consumption)

Set V1=3.5V and V2=0V under normal condition. The current IDD flowing through VDD pin is the normal operation consumption current (IDD).

Set V1=V2=1.5V under over-discharge condition. The current IDD flowing through VDD pin is the power-down current consumption (ISB).

**(6) Measurement Condition 6, Measurement Circuit 3**

(Internal resistance between V- and VDD, Internal resistance between V- and VSS)

Set V1=1.8V and V2=0V. The resistance between V- and VDD is the internal resistance (RV-D) between V- and VDD. Set V1=3.5V and V2=1.0V. The resistance between V- and VSS is the internal resistance (RV-S) between V- and VSS.

**(7) Measurement Condition 7, Measurement Circuit 4**

(COUT pin H resistance, COUT pin L resistance)

Set V1=3.5V, V2=0V and V3=3.0V. COUT pin resistance is the COUT pin H resistance (RCOUTH).

Set V1=4.5V, V2=0V and V3=0.5V. COUT pin resistance is the COUT pin L resistance (RCOUTL)

**(8) Measurement Condition 8, Measurement Circuit 4**

(DOUT pin H resistance, DOUT pin L resistance)

Set V1=3.5V, V2=0V and V4=3.0V. DOUT pin resistance is the DOUT pin H resistance (RDOOUTH).

Set V1=1.8V, V2=0V and V4=0.5V. DOUT pin resistance is the DOUT pin L resistance (RDOUTL).

**(9) Measurement Condition 9, Measurement Circuit 5**

(Overcharge detection delay time, Over-discharge detection delay time)

The overcharge detection delay time (tVDET1) is the time needed for VCO to change from "H" to "L" just after the V1 rapid increase within 10 $\mu$ s from the overcharge detection voltage (VDET1) - 0.2V to the

overcharge detection voltage (VDET1) + 0.2V in the condition V2=0V.

The over-discharge detection delay time (tVDET2) is the time needed for VDO to change from "H" to "L" just after the V1 rapid decrease within 10us from the over-discharge detection voltage (VDET2) + 0.2V to the over-discharge detection voltage (VDET2) - 0.2V in the condition V2=0V.

#### (10) Measurement Condition 10, Measurement Circuit 5

(Over-current 1 detection delay time, Over-current 2 detection delay time, Load short-circuiting detection delay time, Abnormal charge current detection delay time )

Set V1=3.5V and V2=0V. Increase V2 from 0 V to 0.35 V momentarily (within 10 us) The time needed for VDO to go "L" is over-current 1 detection delay time (tVDET3).

Set V1=3.5V and V2=0V. Increase V2 from 0 V to 0.7 V momentarily (within 10us) The time needed for VDO to go "L" is over-current 2 detection delay time (tVDET4).

Set V1=3.5V and V2=0V. Increase V2 from 0 V to 1.6 V momentarily (within 10 us) The time needed for VDO to go "L" is the load short-circuiting detection delay time (tSHORT ).

Set V1=3.5V and V2=0V. Decrease V2 from 0 V to -1.1 V momentarily (within 10 us) The time needed for VCO to go "L" is the abnormal charge current detection delay time. The abnormal charge current detection delay time has the same value as the overcharge detection delay time.

#### (11) Measurement Condition 11, Measurement Circuit 2 (Product with 0V battery charge function)

(0V battery charge starting charger voltage )

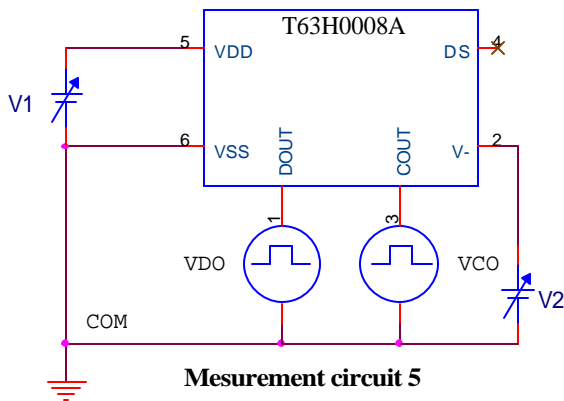
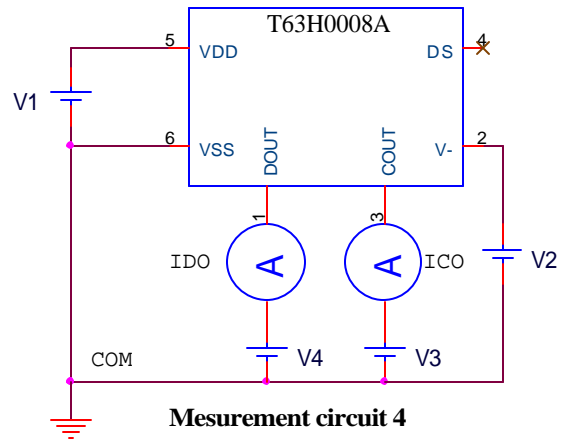
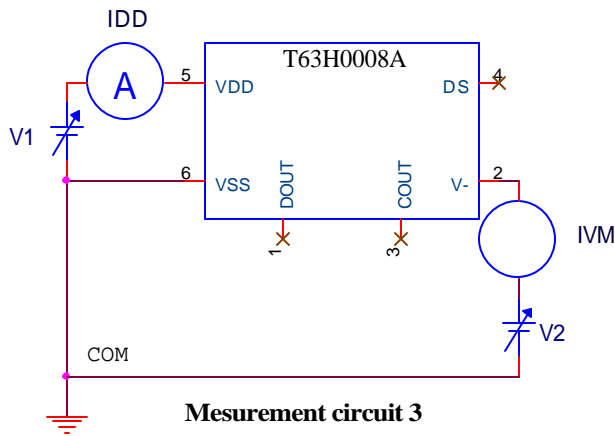
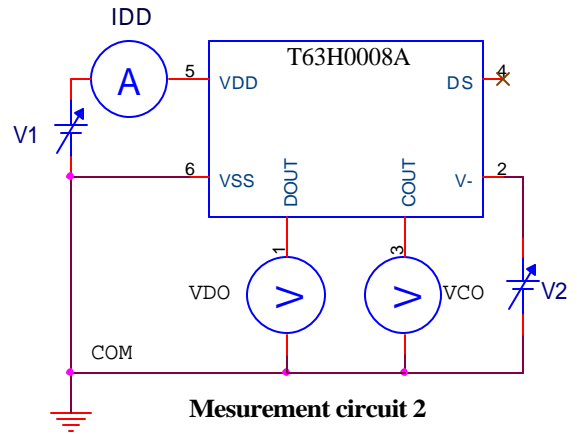
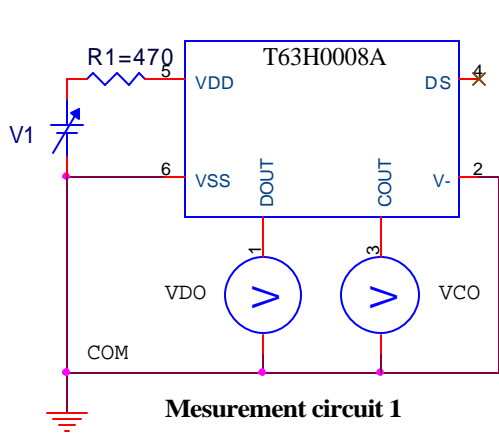
Set V1=V2=0V and decrease V2 gradually. The voltage between VDD and V- when VCO goes "H" (V- + 0.1 V or higher) is the 0V battery charge starting charger voltage (V0CHA ).

#### (12) Measurement Condition 12, Measurement Circuit 2 (Product with 0V battery charge inhibition function)

(0V battery charge inhibition battery voltage)

Set V1=0V and V2=-4V. Increase V1 gradually. The voltage between VDD and VSS when VCO goes "H"(V- + 0.1 V or higher) is the 0V battery charge inhibition battery voltage (V0INH ).





## Description of Operation

### Normal condition

The T63H0008A monitors the voltage of the battery connected between VDD and VSS pin and the voltage difference between V- and VSS pin to control charging and discharging. When the battery voltage is in the range from the over-discharge detection voltage (VDET2) to the overcharge detection voltage (VDET1), and the V- pin voltage is in the range from the charger detection voltage (VDET5) to the over-current 1 detection voltage (VDET3), the IC turns both the charging and discharging control FETs on. This condition is called the normal condition, and in this condition charging and discharging can be carried out freely.

**Note:** When a battery is connected to the IC for the first time, the battery may not enter dischargeable state. In this case, set the V- pin voltage equal to the VSS voltage or connect a charger to enter the normal condition.

### Over-current condition (Detection of Over-current 1, Over-current 2, and Load short-circuiting)

When the condition in which V- pin voltage is equal to or higher than the over-current detection voltage, condition which caused by the excess of discharging current over a specified value, continues longer than the overcharge detection delay time in a battery under the normal condition, the T63H0008A turns the discharging control FET off to stop discharging. This condition is called the over-current condition.

Though the V- and VSS pins are shorted by the RV-S resistor in the IC under the over-current condition, the V- pin voltage is pulled to the VDD level by the load as long as the load is connected.

The V- pin voltage returns to VSS level when the load is released. The over-current condition returns to the normal condition when the impedance between the EB+ and EB- pin becomes higher than the automatic recoverable load resistance (see the equation [1] below), and the IC detects that the V- pin potential is lower than the over-current 1 detection voltage (VDET3).

**Note:** The automatic recoverable load resistance changes depending on the battery voltage and over-current 1 detection voltage settings.

### Overcharge condition

When the battery voltage becomes higher than the overcharge detection voltage (VDD) during charging under the normal condition and the detection continues for the overcharge detection delay time (tVDET1) or longer, the T63H0008A turns the charging control FET off to stop charging. This condition is called the overcharge condition. The overcharge condition is released by the following

two cases ((1) and (2)):

- (1) When the battery voltage falls below the voltage difference, the overcharge detection voltage (VDET1) - overcharge detection hysteresis voltage (VHCT1), the T63H0008A turns the charging control FET on and turns to the normal condition.
- (2) When a load is connected and discharging starts, the T63H0008A turns the charging control FET on and returns to the normal condition. The mechanism is : just after the load is connected and discharging starts, the discharging current flows through the parasitic diode in the charging control FET. At this moment V- pin potential increases momentarily voltage of the parasitic diode from the VSS level. When the V- pin voltage goes higher than the over-current 1 detection voltage, and provided that the battery voltage goes

under the overcharge detection voltage by the internal impedance, the T63H0008A release the overcharge condition.

**Note:(1).**If the battery is charged to a voltage higher than the overcharge detection voltage (VDET1) and the battery voltage does not fall below the overcharge detection voltage (VDET1) even when a heavy load is connected, the detection of over-current 1, over-current 2 and load short-circuiting does not work. Since an actual battery has the internal impedance of several dozens of mW, the battery voltage drops immediately after a heavy load which causes over-current is connected, and the detection of over-current 1, over-current 2 and load short-circuiting then works..

(2).When a charger is connected after the overcharge detection, the overcharge condition is not released even if the battery voltage is below the overcharge detection voltage VDET1. The overcharge condition is released when the V- pin voltage goes over the charger detection voltage VDET 5 by removing the charger.

## Over-discharge condition

When the battery voltage falls below the over-discharge detection voltage (VDET2) during discharging under the normal condition and the detection continues for the over-discharge detection delay time (tVDET2) or longer, the T63H0008A turns the discharging control FET off to stop discharging. This condition is called the over-discharge condition. When the discharging control FET turns off, the V- pin voltage is pulled up by the RV-D resistor between V- and VDD in the IC. The voltage difference between V- and VDD then falls below 1.3V (typ.), the current consumption is reduced to the power-down current consumption (ISB). This condition is called the power-down condition. The power-down condition is released when a charger is connected and the voltage difference between V- and VDD becomes 1.3 V (typ.) or higher. Moreover when the battery voltage becomes the over-discharge detection voltage or higher, the T63H0008A turns the discharging FET on and returns to the normal condition.

## Charger detection

When a battery in the over-discharge condition is connected to a charger and provided that the V- pin voltage is lower than the charger detection voltage (VDET 5), the T63H0008A releases the over-discharge condition and turns the discharging control FET on as the battery voltage becomes equal to or higher than the over-discharge detection voltage (VDET2) since the charger detection function works. This action is called charger detection.

When a battery in the over-discharge condition is connected to a charger and provided that the V- pin voltage is not lower than the charger detection voltage (VDET5), the T63H0008A releases the over-discharge condition when the battery voltage reaches the over-discharge detection voltage (VDET2) + over-discharge hysteresis (VHDT2) or higher.

## Abnormal charge current detection

If the V- pin voltage falls below the charger detection voltage (VDET 5) during charging under normal condition and it continues for the overcharge detection delay time (t VDET1) or longer, the charging control FET turns off and charging stops. This action is called the abnormal charge current detection. Abnormal charge current detection works when the DOUT pin voltage is "H" and the V- pin voltage falls below the charger detection voltage (VDET 5). Consequently, if an abnormal charge current flows to an over-discharged battery, the T63H0008A turns the charging control FET off and stops charging after the battery voltage becomes higher than the over-discharge detection voltage which make the DOUT pin

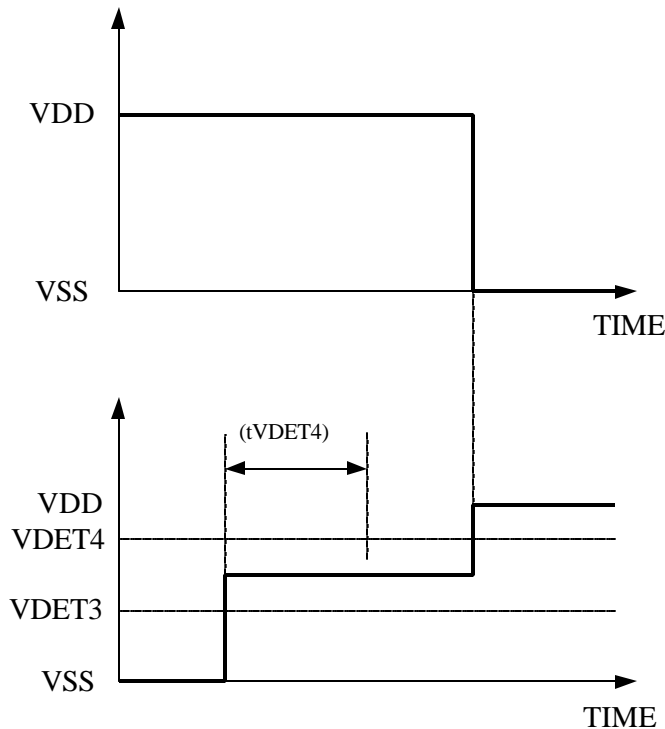
voltage “H”, and still after the overcharge detection delay time ( $t_{VDET1}$ ) elapses.

Abnormal charge current detection is released when the voltage difference between V- pin and VSS pin becomes less than charger detection voltage  $V_{DET5}$ .

**Delay circuits**

The detection delay times are generated by dividing the approximate 7 kHz clock with a counter.

**Note.** The detection delay time for over-current 2 and load and short-circuiting start when the over-current 1 is detected. As soon as the over-current 2 or load short-circuiting is detected over the detection delay time for over-current 2 or load short-circuiting after the detection of over-current 1, the T63H0008A turns the discharging control FET off.



**Over-current 2 detection delay time**

When the over-current is detected and it continues for longer than the over-discharge detection delay time without releasing the load, the condition changes to the power-down condition when the battery voltage falls below the over-discharge detection voltage.

When the battery voltage falls below the over-discharge detection voltage due to the over-current, the T63H0008A turns the discharging control FET off by the over-current detection. And in this case the recovery of the battery voltage is so slow that the battery voltage after the over-discharge detection delay time is still lower than the over-discharge detection voltage, the T63H0008A transits to the power-down condition.

**DS pin**

The DS pin is a test pin for delay time measurement and it should be open in the actual application. If a capacitor whose capacitance is larger than 100pF or a resistor whose resistance is larger than 100kΩ is connected to this pin, error may occur in the delay time.

**0V battery charge function (\*1) (\*2)**

This function is used to recharge the connected battery whose voltage is 0V due to the self-discharge. When the 0V battery charge starting charger voltage (V0CHA) or higher is applied between EB+ and EB- pins by connecting a charger, the charging control FET gate is fixed to VDD pin voltage. When the voltage between the gate and source of the charging control FET becomes equal to or higher than the turn-on voltage by the charger voltage, the charging control FET turns on to start charging. At this time, the discharging control FET is off and the charging current flows through the internal parasitic diode in the discharging control FET. When the battery voltage becomes equal to or higher than the over-discharge release voltage, the T63H0008A enters the normal condition.

**0V battery charge inhibition function (\*1)**

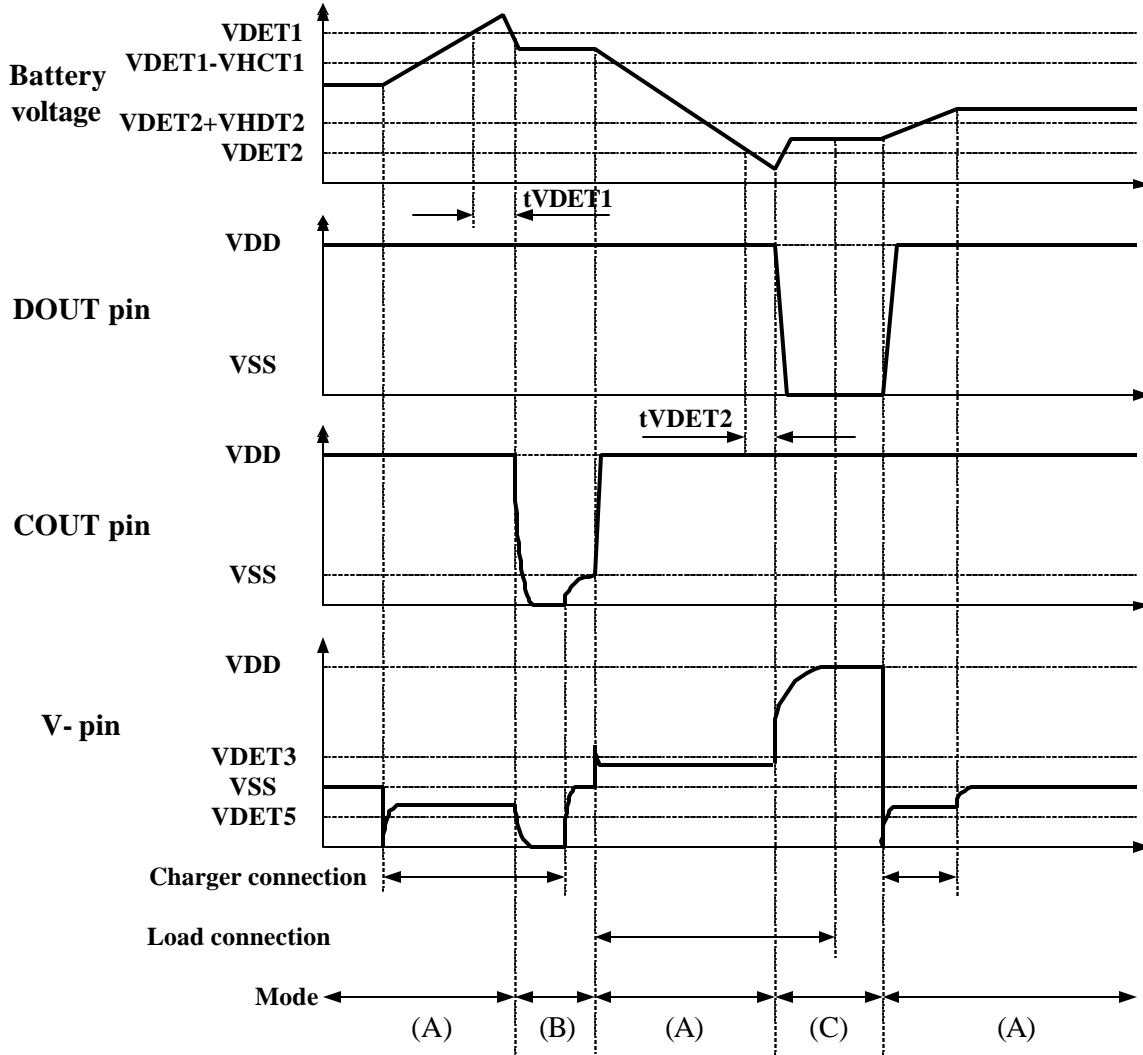
This function inhibits the recharging when a battery which is short-circuited (0V) internally is connected. When the battery voltage is 1.0 V (typ.) or lower, the charging control FET gate is fixed to EB- pin voltage to inhibit charging. When the battery voltage is the 0V battery charge inhibition battery voltage (V0INH) or higher, charging can be performed.

(\*1) Some battery providers do not recommend charging for completely self-discharged battery. Please ask battery providers before determining the 0V battery charge function.

(\*2) The 0V battery charge function has higher priority than the abnormal charge current detection function. Consequently, a product with the 0V battery charge function charges a battery forcedly and abnormal charge current cannot be detected when the battery voltage is low.

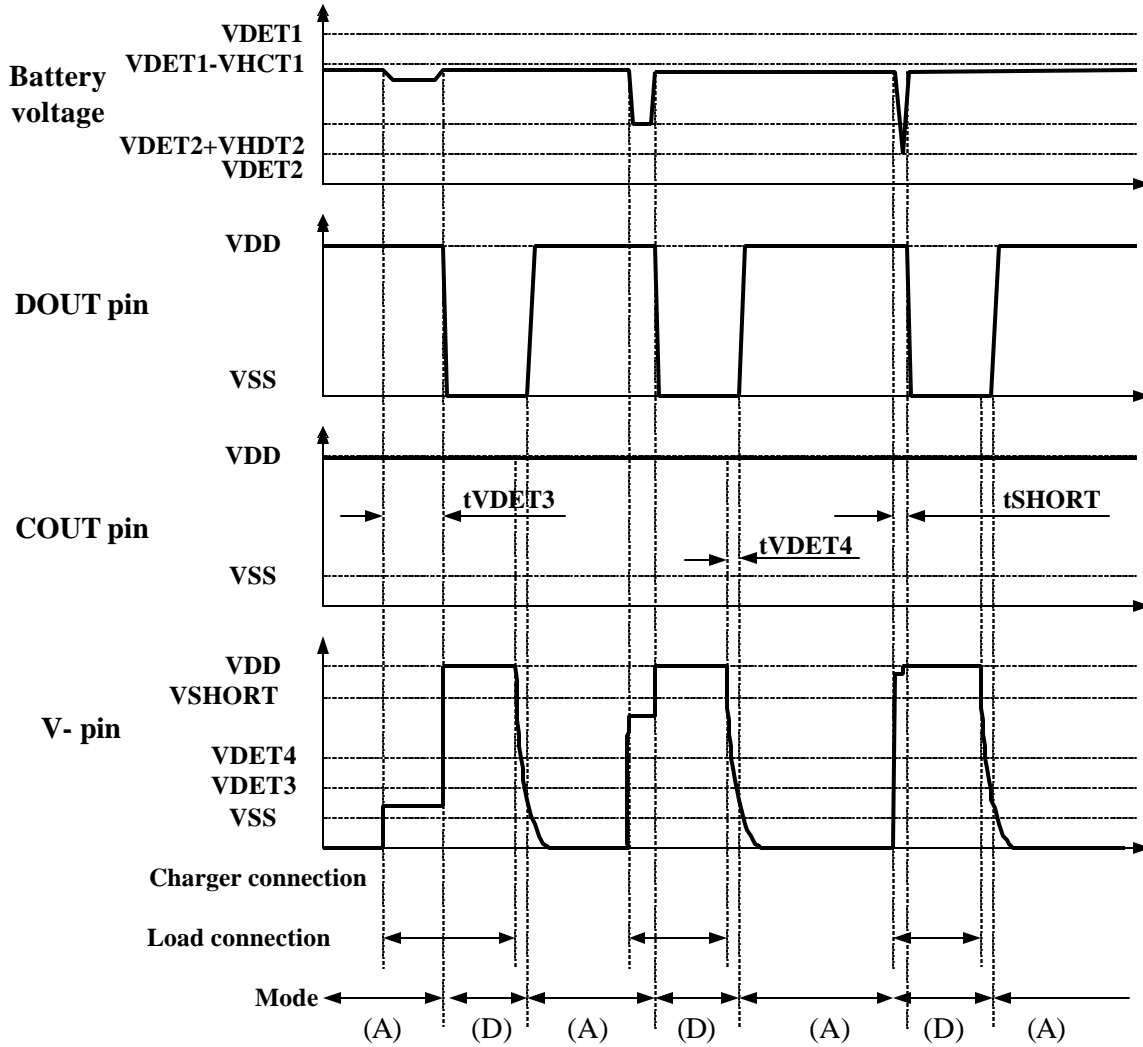
**Operation Timing Chart**

**1.Operation Timing Chart**



Note:(A):Normal condition, (B):Overcharge conditing, (C):Overdischarge condition,  
 (D):Overcurrent condition  
 The charge is supposed to charge with constant current.

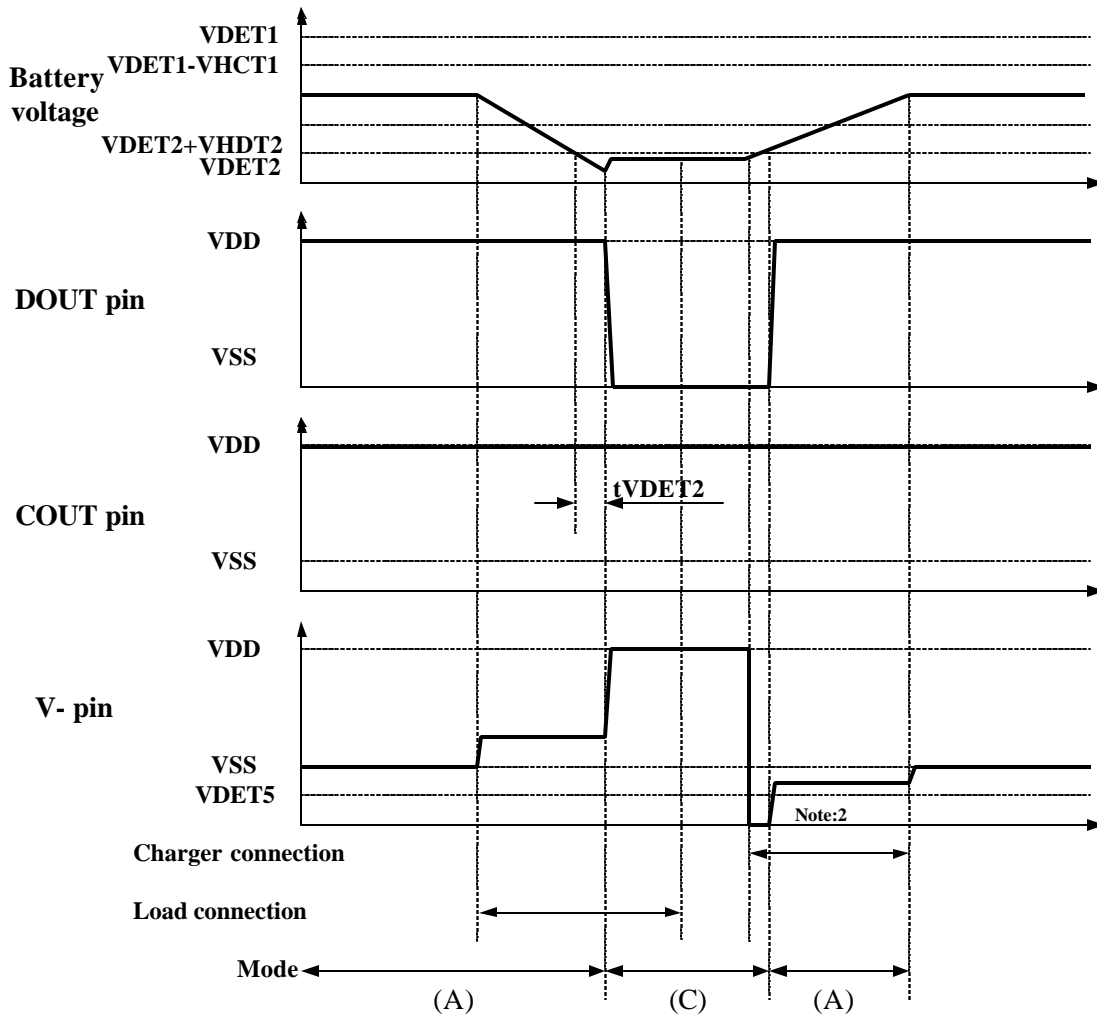
**2. Over-current detection**



Note:(A):Normal condition, (B):Overcharge conditing, (C):Overdischarge condition,  
(D):Overcurrent condition

The charge is supposed to charge with constant current.

**3.Charger detection**



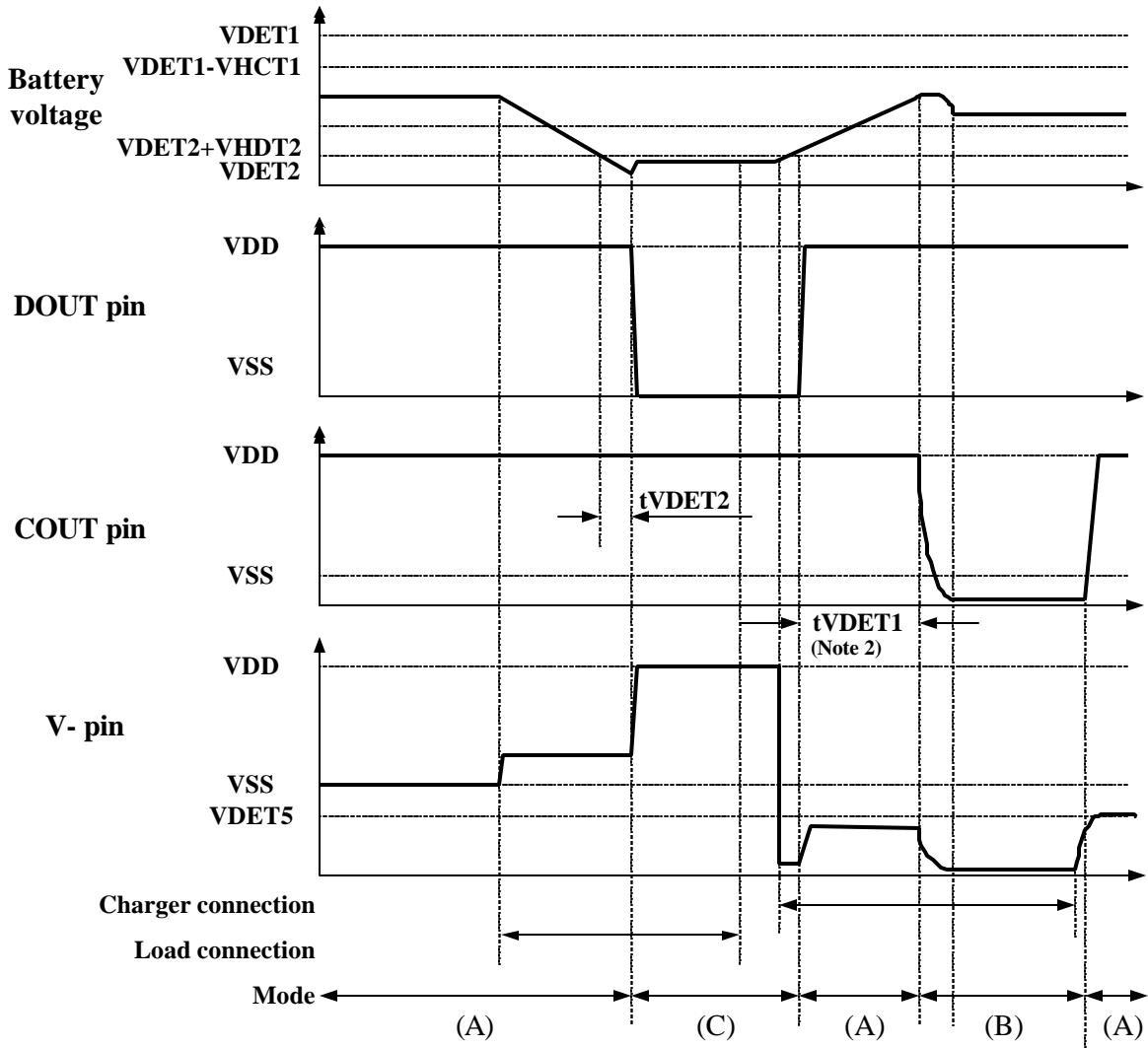
Note:(A):Normal condition, (B):Overcharge conditing, (C):Overdischarge condition, (D):Overcurrent condition

The charge is supposed to charge with constant current.

Note2:In case V- pin voltage <  $V_{DET5}$  Over-discharge is released at the overdischarge detection voltage( $V_{DET2}$ )



4.Abnormal charge current detection

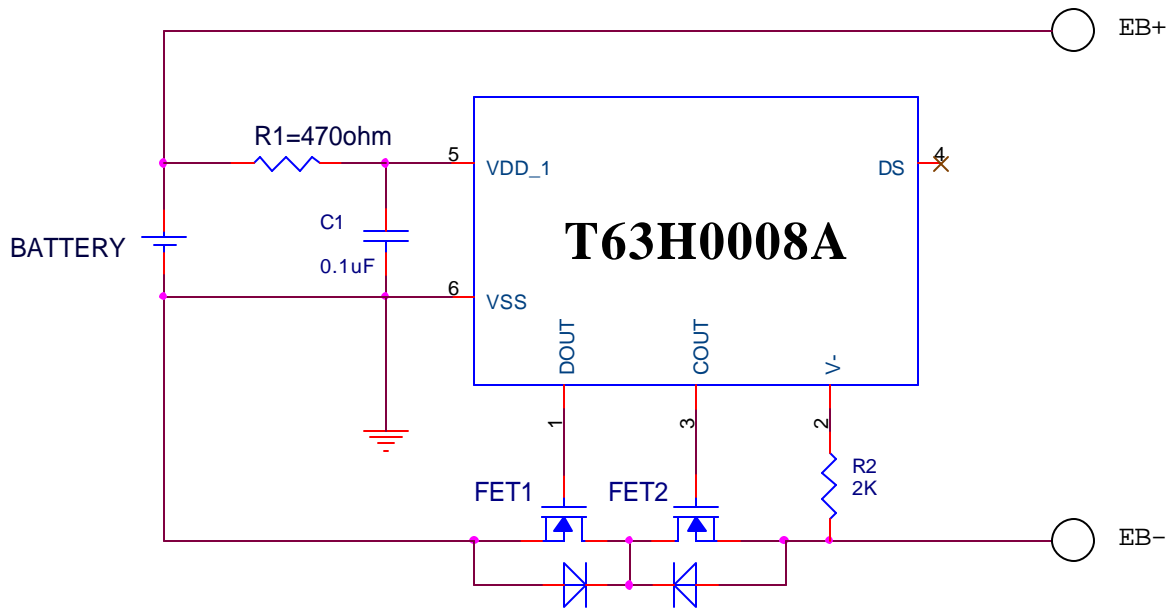


Note:(A):Normal condition, (B):Overcharge conditing, (C):Overdischarge condition, (D):Overcurrent condition

The charge is supposed to charge with constant current.

Note2:Abnormal charge current detection delay time  
 (=Overcharge detection delay time( $t_{VDET1}$ ))

**Application Circuits**



**Table Constant for external components**

Symbol	Parts	Purpose	Recommend	min.	max.	Remarks
FET1	N channel MOSFET	Charge control	---	---	---	*1) 0.4 V = Threshold voltage = over-discharge detection voltage, Gate to source withstand voltage = Charger voltage.
FET2	N channel MOSFET	Discharge control	---	---	---	*1) 0.4 V = Threshold voltage = over-discharge detection voltage, Gate to source withstand voltage = Charger voltage.
R1	Resistor	ESD protection For Power fluctuation	470ohm	300ohm	1k ohm	*2) Set resistance so that 2 x R1 = R2
C1	Capacitor	For Power fluctuation	0.1uF	0.022 uF	1.0uF	*3) Install a capacitor of 0.022uF of higher between VDD and VSS.
R2	Resistor	Protection for reverse connection of a charger	2kohm	300ohm	4k ohm	*4) To prevent current when a charger is reversely connected. Select a larger resistance within the range from 300ohm to 4kohm.

\*1) If an FET with a threshold voltage of 0.4 V or lower is used, the FET may not cut the charging current.  
 If an FET with a threshold voltage equal to or higher than the over-discharge detection voltage is used, discharging may be stopped before over-discharge is detected.  
 If the withstand voltage between the gate and source is lower than the charger voltage, the FET may destroy.

\*2) If R1 has a high resistance, the voltage between VDD and VSS may exceed the absolute maximum rating

when a charger is connected reversely since the current flows from the charger to the IC.

Insert a resistor of 300W or higher as R1 for ESD protection.

If R1 has a high resistance, the overcharge detection voltage increases by IC current consumption.

\*3) If a capacitor of less than 0.022uF is installed as C1, DOUT may oscillate when load short-circuiting is detected.

Be sure to install a capacitor of 0.022uF or higher as C1.

\*4) If R2 has a resistance higher than 4kW, the charging current may not be cut when a high-voltage charger is connected.

**Note:** (1).The D Spin should be open.

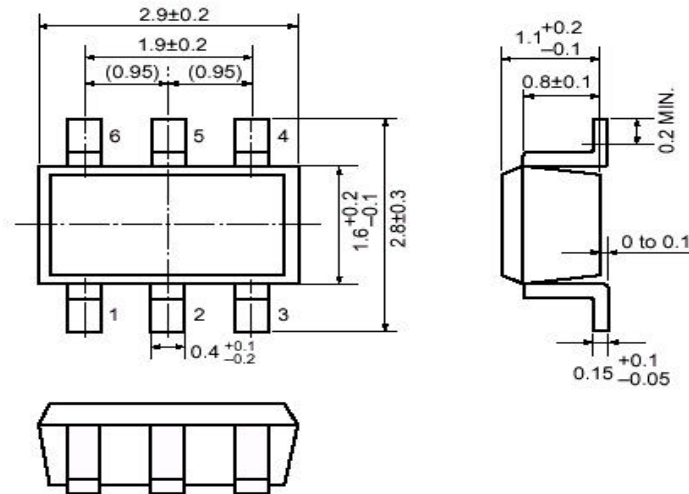
(2).The above connection diagram and constants do not guarantee proper operation. Evaluate upon actual application and determine constants properly.

## Precautions

Pay attention to the operating conditions for input/output voltage and load current so that the loss in the IC does not exceed the permissible loss (power dissipation) of the package.

**Package Dimension (Unit: mm)**

**SOT-23-6**



**Taping Specification (Unit: mm)**

**SOT-23-6**

