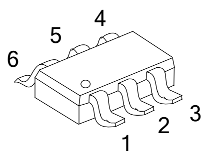
1-CELL LITHIUM-ION/POLYMER BATTERY PROTECTION IC



SOT-26

■ DESCRIPTION

The UTC **UB227** is a series of lithium-ion/lithium-polymer rechargeable battery protection ICs incorporating high accuracy voltage detection circuits and delay circuits.

The UTC **UB227** is suitable for protection of single cell lithium-ion / lithium polymer battery packs from overcharge, over discharge and over current.

The ultra-small package and less required external components make it ideal to integrate the UTC **UB227** into the limited space of battery pack.

■ FEATURES

* Wide Supply Voltage Range: V_{DD}=1.5V~8.0V
* Ultra-Low Quiescent Current: I_{OPE}=3.0μA (V_{DD}=3.9V)
* Ultra-Low Power-Down Current: I_{PDN}=0.1μA (V_{DD}=2.0V)
* Overcharge Detection Voltage: V_{CU}=3.9V~4.4V
* Overcharge Release Voltage: V_{CL}=3.8V~4.4V
* Over Discharge Release Voltage: V_{DL}=2.0V~3.0V
* Over Discharge Release Voltage: V_{DU}=2.0V~3.4V
* Discharge Over Current Detection Voltage: V_{DIOV}=0.05V~0.30V
* Charge Over Current Voltage: V_{CIOV}=-0.115V (Fixed)
* Charger Detection Voltage: V_{CHA}=-0.7V (Fixed)
* Delay Times are Generated by an Internal Circuit.
  (External Capacitors are Unnecessary.)

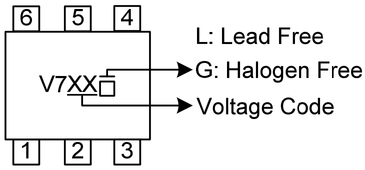
■ ORDERING INFORMATION

Ordering Number		Package	Packing
Lead Free	Halogen Free		
UB227L-xx-AG6-R	UB227G-xx-AG6-R	SOT-26	Tape Reel

Note: xx: Output Voltage, refer to Marking Information.

UB227G-xx-AG6-R	
(1) Packing Type	(1) R: Tape Reel
(2) Package Type	(2) AG6: SOT-26
(3) Output Voltage Code	(3) xx: Refer to Marking Information
(4) Green Package	(4) G: Halogen Free and Lead Free, L: Lead Free

■ MARKING INFORMATION

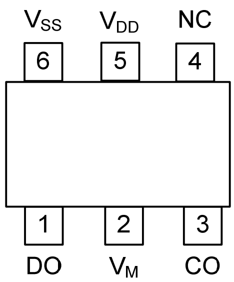
PACKAGE	VOLTAGE CODE	MARKING
SOT-26	XX	

Note: XX : Refer to Serial Code List.

■ SERIAL CODE LIST

Model	Code	Overcharge Detection Voltage [V_{CU}](V)	Overcharge Release Voltage [V_{CL}](V)	Over discharge Detection Voltage [V_{DL}](V)	Over discharge Release Voltage [V_{DU}](V)	Over Current Detection Voltage [V_{DIOV}](V)
UB227	AA	4.325	4.075	2.50	2.90	0.150
	AB	4.325	4.075	2.50	2.90	0.100
	AC	4.300	4.200	2.40	3.00	0.200
	AD	4.280	4.180	2.50	3.00	0.150
	AE	4.280	4.080	2.30	2.40	0.100
	AF	4.275	4.075	2.50	2.90	0.150
	AG	4.250	4.150	2.40	3.00	0.100
	AH	4.200	4.100	2.80	2.90	0.150
	AI	4.100	3.850	2.50	2.90	0.150
	AJ	4.265	4.100	2.30	2.90	0.115

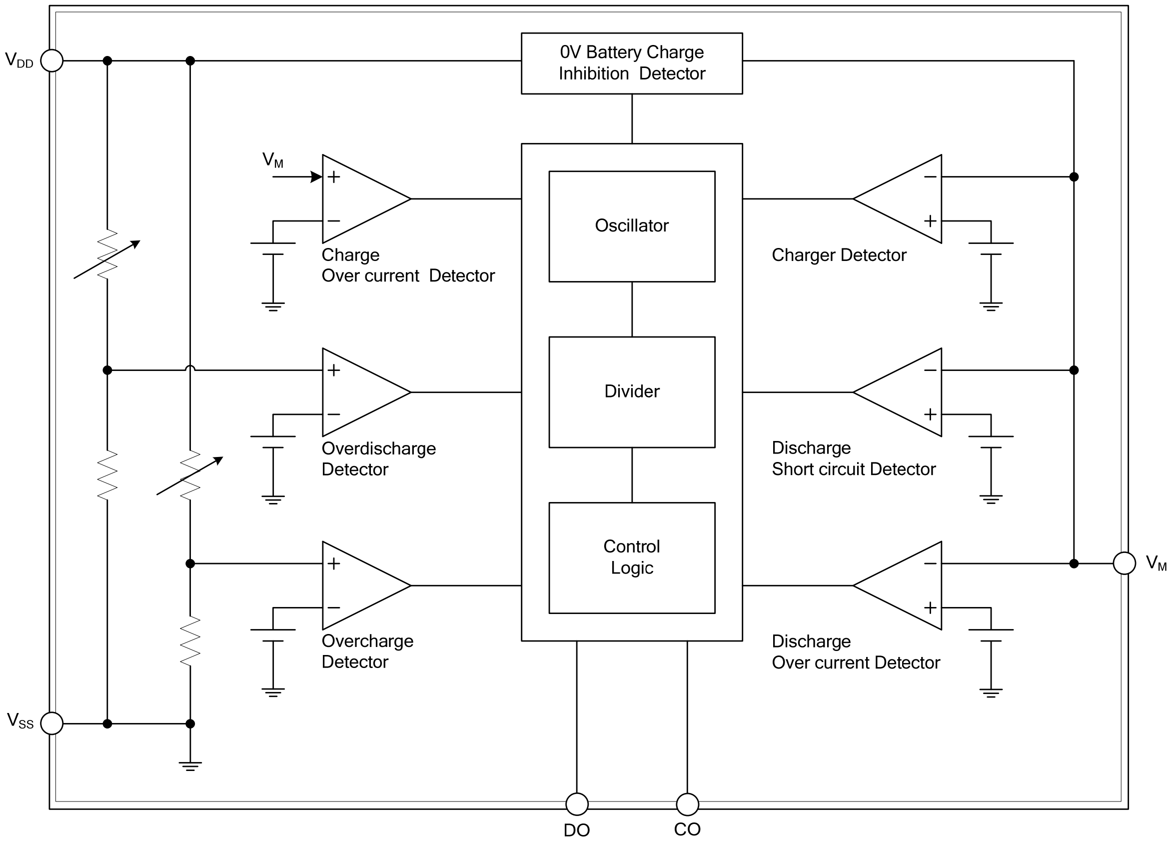
■ PIN CONFIGURATION



■ PIN DESCRIPTION

PIN NO.	PIN NAME	DESCRIPTION
1	DO	For discharge control: FET gate connection pin
2	V_M	For current sense and charger detection input pin
3	CO	For charge control: FET gate connection pin
4	NC	No connection
5	V_{DD}	Positive power input
6	V_{SS}	Negative power input

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATING (V_{SS}=0V, T_A=25°C unless otherwise specified)

PARAMETER	SYMBOL	RATINGS	UNIT
Input Voltage Between V_{DD} and V_{SS} (Note 2)	V_{DD}	V_{SS}-0.3 ~ V_{SS}+12	V
CO Output Pin Voltage	V_{CO}	V_{DD}-20 ~ V_{DD}+0.3	V
DO Output Pin Voltage	V_{DO}	V_{SS}-0.3 ~ V_{DD}+0.3	V
V_M Input Pin Voltage	V_M	V_{DD}-20 ~ V_{DD}+0.3	V
Ambient Operating Temperature	T_{OPR}	-40 ~ +85	°C
Storage Temperature	T_{STG}	-55 ~ +125	°C

Notes: 1. Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.
2. Pulse (μsec) noise exceeding the above input voltage (V_{SS}+12V) may cause damage to the IC.

■ ELECTRICAL CHARACTERISTICS (V_{SS}=0V, T_A=25°C unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
CURRENT CONSUMPTION						
Supply Current	I_{OPE}	V_{DD}=3.9V, V_M=0V		3.0	6.0	μA
Power-Down Current	I_{PDN}	V_{DD}=V_M=2.0V			0.1	μA
OPERATING VOLTAGE						
Operating Voltage Between V_{DD}-pin and V_{SS}-pin	V_{DS1}		1.5		8	V
Operating Voltage Between V_{DD}-pin and V_M-pin	V_{DS2}		1.5		20	V
DETECTION VOLTAGE						
Overcharge Detection Voltage	V_{CU}		V_{CU}-0.050	V_{CU}	V_{CU}+0.050	V
Overcharge Release Voltage	V_{CL}		V_{CL}-0.050	V_{CL}	V_{CL}+0.050	V
Overdischarge Detection Voltage	V_{DL}		V_{DL}-0.100	V_{DL}	V_{DL}+0.100	V
Overdischarge Release Voltage	V_{DU}		V_{DU}-0.100	V_{DU}	V_{DU}+0.100	V
Discharge Over Current Detection Voltage	V_{DIOV}	V_{DD}=3.6V	V_{DIOV}-0.03	V_{DIOV}	V_{DIOV}+0.03	V
Discharge Short Circuit Detection Voltage	V_{SHORT}	V_{DD}=3.0V	0.50	0.85	1.20	V
Charge Over Current Detection Voltage	V_{CIOV}		-0.145	-0.115	-0.085	V
Charger Detection Voltage	V_{CHA}	V_{DU}≠V_{DL}	-1.6	-0.7	-0.2	V
0V BATTERY CHARGE VOLTAGE						
0V Battery Charge Starting Charger Voltage	V_{0CHA}		1.2			V
CONTROL OUTPUT VOLTAGE(DO&CO)						
CO Pin Output "H" Voltage	V_{COH}		V_{DD}-0.1	V_{DD}-0.02		V
CO Pin Output "L" Voltage	V_{COL}			0.1	0.5	V
DO Pin Output "H" Voltage	V_{DOH}		V_{DD}-0.1	V_{DD}-0.02		V
DO Pin Output "L" Voltage	V_{DOL}			0.1	0.5	V
DELAY TIME						
Overcharge Detection Delay Time	t_{CU}			1.0		s
Overdischarge Detection Delay Time	t_{DL}			125		ms
Discharge Over Current Detection Delay Time	t_{DIOV}	V_{DD}=3.6V		12		ms
Discharge Short Circuit Detection Delay Time	t_{SHORT}	V_{DD}=3.0V		500		μs
Charge Over Current Detection Delay Time	t_{CIOV}			16		ms

OPERATION

1. Normal Condition

The **UTC UB227** series monitors the voltage of the battery connected between V_{DD} pin and V_{SS} pin and the voltage difference between V_M pin and V_{SS} pin to control charging and discharging. When the battery voltage is in the range from the overdischarge detection voltage (V_{DL}) to the overcharge detection voltage (V_{CU}), and the V_M pin voltage is in the range from the charge overcurrent detection voltage (V_{CIOV}) to discharge overcurrent detection voltage (V_{DIOV}), 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, discharging may not be enabled. In this case, short the V_M pin and V_{SS} pin or connect the charger to restore the normal condition.

2. Overcharge Condition

When the battery voltage becomes higher than the overcharge detection voltage (V_{CU}) during charging under the normal condition and the detection continues for the overcharge detection delay time (t_{CU}), the **UTC UB227** series 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) When the V_M pin voltage is higher than or equal to the charge overcurrent detection voltage (V_{CIOV}), and is lower than the discharge overcurrent detection voltage (V_{DIOV}), the **UTC UB227** Series releases the overcharge status when the battery voltage falls below the overcharge release voltage (V_{CL}).

(2) When the V_M pin voltage is higher than or equal to the discharge overcurrent detection voltage (V_{DIOV}), the **UTC UB227** Series releases the overcharge condition when the battery voltage falls below the overcharge detection voltage (V_{CU}).

Note 1: If the battery is charged to a voltage higher than overcharge detection voltage (V_{CU}) and the battery voltage does not fall below overcharge detection voltage (V_{CU}) even when a heavy load is connected, discharge overcurrent detection and load short-circuiting detection do not function until the battery voltage falls below overcharge detection voltage (V_{CU}). Since an actual battery has an internal impedance of tens of mΩ, the battery voltage drops immediately after a heavy load that causes overcurrent is connected, and discharge overcurrent detection and load short-circuiting detection function.

Note 2: When a charger is connected after overcharge detection, the overcharge status is not released even if the battery voltage is below overcharge release voltage (V_{CL}). The overcharge status is released when the VM pin voltage goes over the charge overcurrent detection voltage (V_{CIOV}) by removing the charger.

3. Overdischarge Condition

When the battery voltage falls below the overdischarge detection voltage (V_{DL}) during discharging under the normal condition and the detection continues for the overdischarge detection delay time (t_{DL}), the **UTC UB227** series turns the discharging control FET off to stop discharging. This condition is called the overdischarge condition. When the discharging control FET is turned off, the V_M pin voltage is pulled up by the resistor between V_M and V_{DD} in the IC (R_{VMD}). When the voltage difference between the V_M and V_{DD} then is 1.2V (typ.) or lower, the current consumption is reduced to the power-down current consumption (I_{PDN}). This condition is called the power-down condition.

The power-down condition is released when a charger is connected and the voltage difference between the V_M and V_{DD} becomes 1.2V (typ.) or higher. Moreover when the battery voltage becomes the overdischarge detection voltage (V_{DL}) or higher, the **UTC UB227** series turns the discharging FET on and returns to the normal condition.

4. Discharge Overcurrent Condition

Under normal condition, the **UTC UB227** continuously monitors the discharge current by sensing the voltage of V_M pin.

If the voltage of V_M pin exceeds the overcurrent detection voltage (V_{DIOV}) and the condition lasts beyond the overcurrent delay time (t_{DIOV}), discharging will be suspended by turning off the discharge control MOSFET (DO pin). This condition is called the discharge overcurrent status.

If the voltage of V_M pin exceeds the short circuit detection voltage (V_{SHORT}) and the condition lasts beyond the short circuit delay time (t_{SHORT}), discharging will be suspended by turning off the discharge control MOSFET (DO pin). This condition is called the short circuit status.

When the impedance between EB+ and EB- is larger than "automatic restoration impedance" and the voltage at the V_M pin is lower than overcurrent detection voltage (V_{DIOV}), the discharge overcurrent condition will be released.

■ OPERATION (Cont.)

5. Charger Detection

When the charger is connected to the overdischarge battery, if the voltage of V_M pin is lower than charger detection voltage (V_{CHA}), based on the charger detection function, as long as the battery voltage is higher than overdischarge voltage(V_{DL}), the discharge status will be released and discharging control MOSFET (DO pin) will be turned on. This process is called the “charger detection status”.

Conversely, if V_M pin’s voltage is not lower than charger detection voltage (V_{CHA}), the battery voltage has to reach the overdischarge release voltage (V_{DU}) to relieve the overdischarge status as usual.

6. Charge Overcurrent Condition

When a battery in the normal status is in the status where the voltage of the V_M pin is lower than the charge overcurrent detection voltage (V_{CIOV}) because the charge current is higher than the specified value and the status lasts for the charge overcurrent detection delay time (t_{CIOV}), the charge control FET is turned off and charging is stopped. This status is called the charge overcurrent status.

This IC will be restored to the normal status from the charge overcurrent status when, the voltage at the V_M pin returns to charge overcurrent detection voltage (V_{CIOV}) or higher by removing the charger.

The charge overcurrent detection function does not work in the overdischarge status.

7. Delay Circuits

The discharge overcurrent detection delay time (t_{DIOV}) and the load short-circuiting detection delay time (t_{SHORT}) start when the discharge overcurrent detection voltage (V_{DIOV}) is detected. When the load short-circuiting detection voltage (V_{SHORT}) is detected over the load short-circuiting detection delay time (t_{SHORT}) after the detection of discharge overcurrent detection voltage (V_{DIOV}), the **UTC UB227** turns the discharging control FET off within t_{SHORT} from the time of detecting V_{SHORT}.

When any overcurrent is detected and the overcurrent continues for longer than the overdischarge detection delay time (t_{DL}) without the load being released, the status changes to the power-down status at the point where the battery voltage falls below overdischarge detection voltage (V_{DL}).

When the battery voltage falls below overdischarge detection voltage (V_{DL}) due to overcurrent, the **UTC UB227** Series turns the discharging control FET off via overcurrent detection. In this case, if the recovery of the battery voltage is so slow that the battery voltage after the overdischarge detection delay time is still lower than the overdischarge detection voltage, the **UTC UB227** Series shifts to the power-down status.

8. 0V Battery Charging Function “Unavailable”

This function is used to recharge a connected battery which voltage is 0V due to self-discharge. When the 0V battery charge starting charger voltage (V_{0CHA}) or a higher voltage is applied between EB+ and EB- pins by connecting a charger, the charging control MOSFET gate is fixed to the V_{DD} pin voltage.

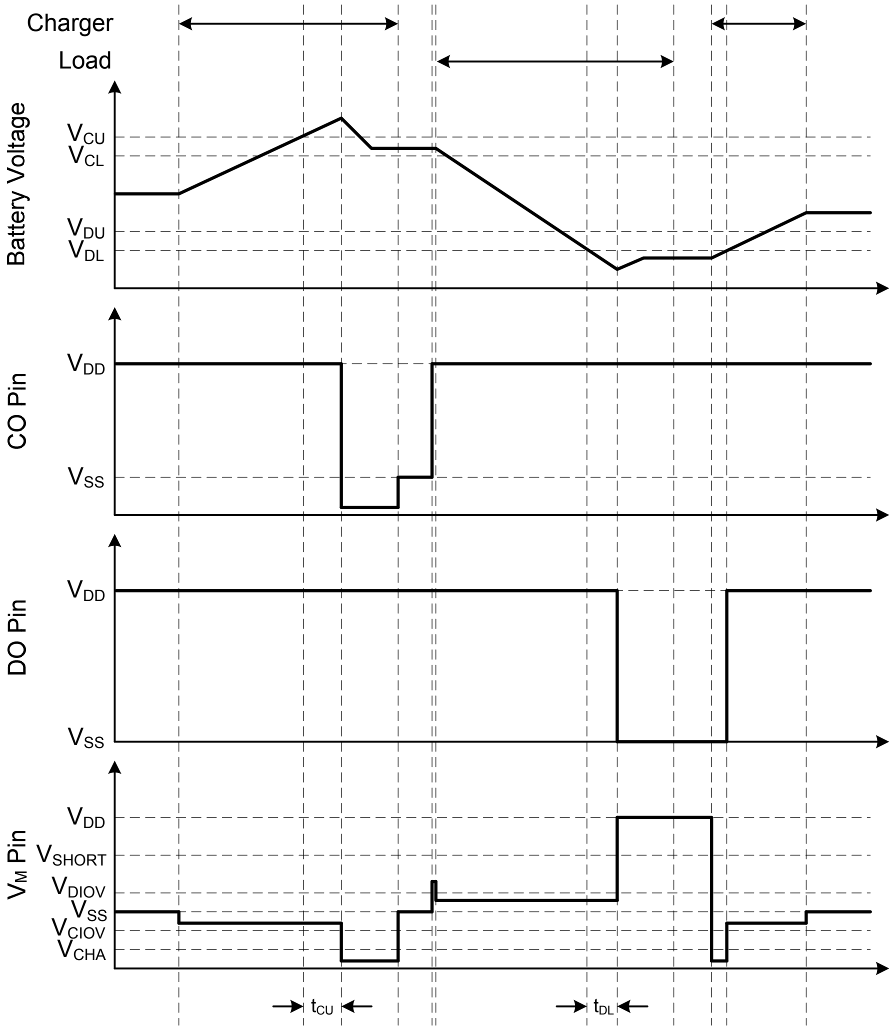
When the voltage between the gate and the source of the charging control MOSFET becomes equal to or higher than the turn on voltage due to the charger voltage, the charging control MOSFET is turned on to initiate charging. At this time, the discharging control MOSFET is off and the charging current flows through the internal parasitic diode in the discharging control MOSFET. When the battery voltage becomes equal to or higher than overdischarge voltage (V_{DL}), the **UTC UB227** series will enter into the normal status.

Note 1: Some battery providers do not recommend charging for a completely self-discharged battery. Please ask the battery provider to determine whether to enable or prohibit the 0V battery charging function.

Note 2: The 0V battery charge function has higher priority than the charger current detection function. Consequently, a product in which use of the 0V battery charging function is enabled charges a battery forcibly and the charge overcurrent cannot be detected when the battery voltage is lower than overdischarge detection voltage (V_{DL}).

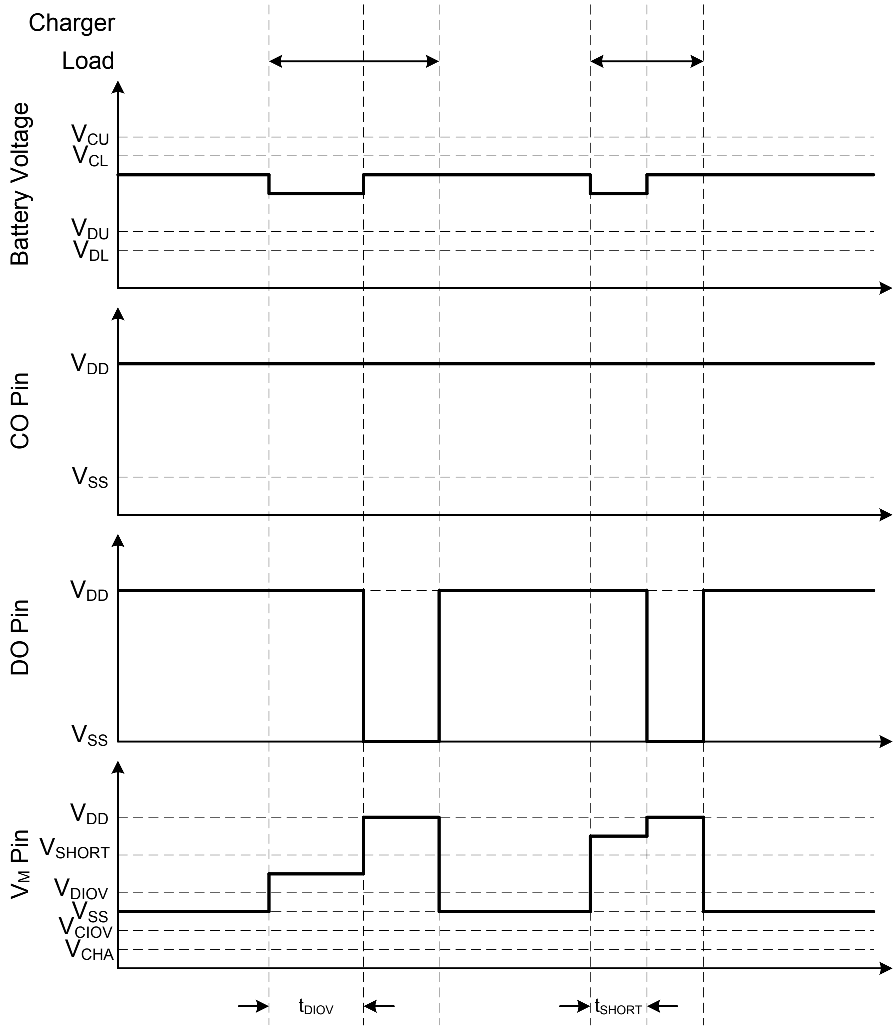
■ TIMING CHART

(1) Overcharge Detection, Overdischarge Detection



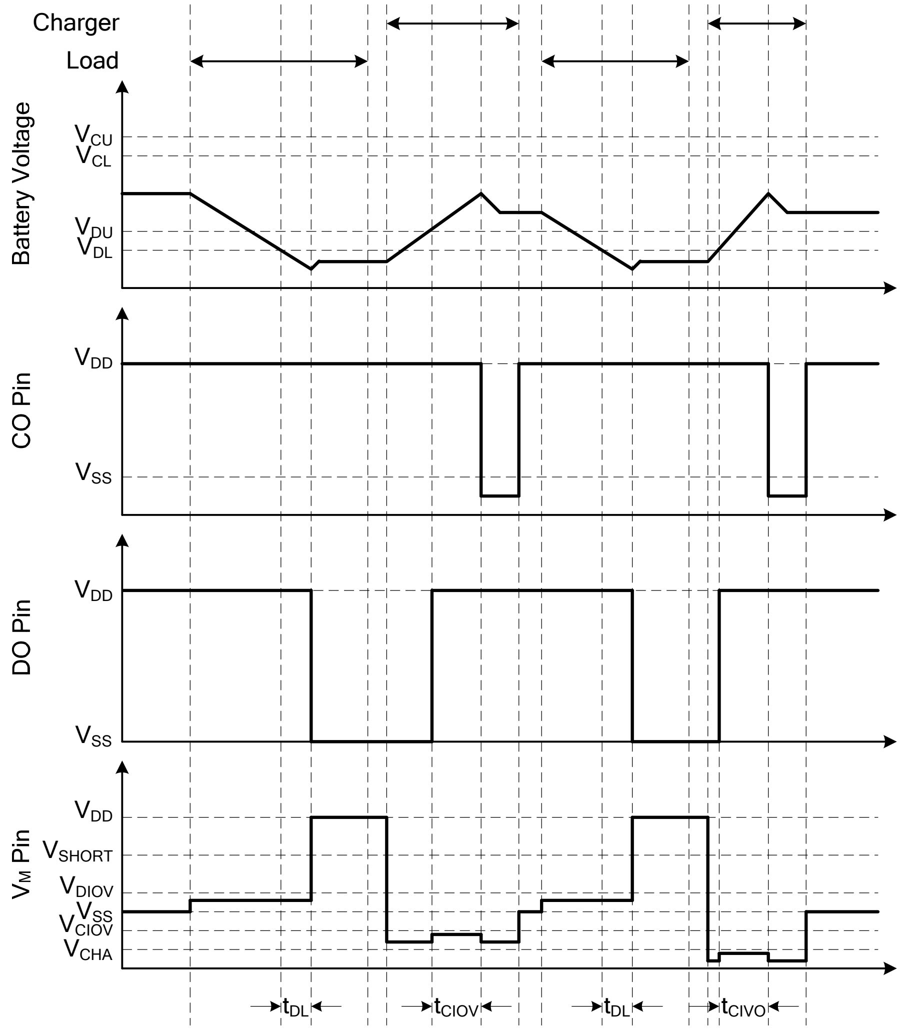
■ TIMING CHART (Cont.)

(2) Discharge Overcurrent Detection

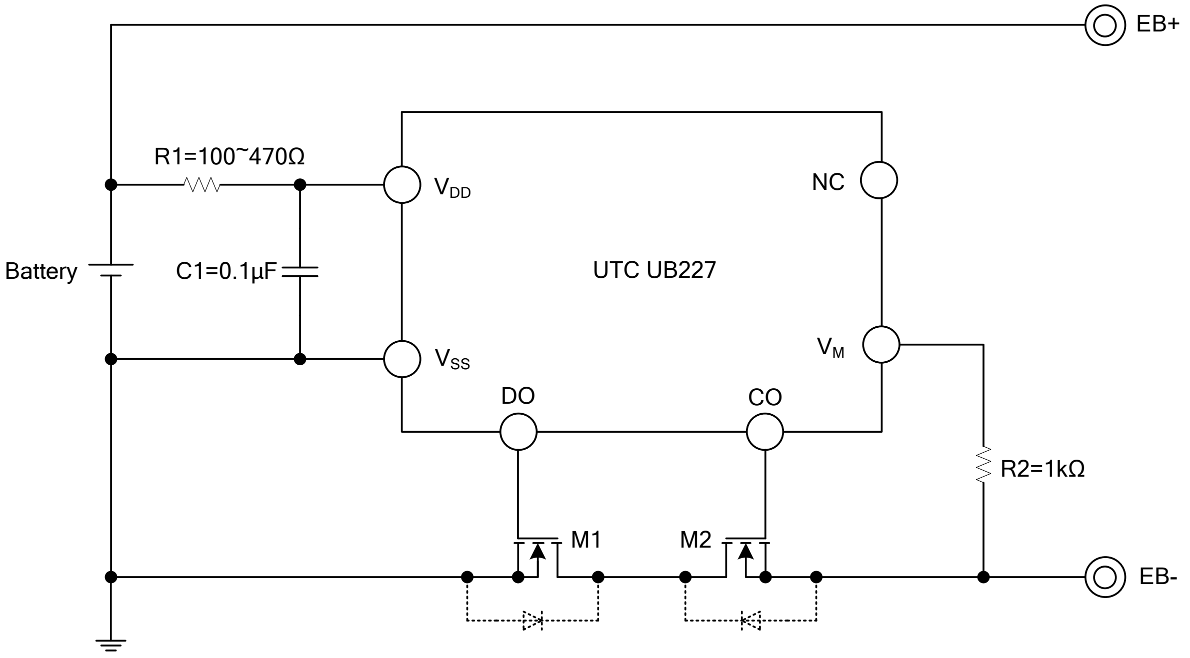


■ TIMING CHART (Cont.)

(3) Charge Overcurrent Detection



■ TYPICAL APPLICATION CIRCUIT



Notes: 1. Overdischarge detection voltage must be higher than the threshold voltage of M1 and M2, if not, the M1 may not cut the charging current. If the threshold voltage of M1 equal to or higher than the overdischarge detection voltage is used, discharging may be stopped before overdischarge is detected.

2. Charger voltage must be higher than the withstanding voltage between the gate and source of M1 and M2, if not, M1 and M2 may be destroyed.

3. Resistance of R1 can't be high, the value is about from 100Ω to 470Ω, If R1 has a high resistance, the voltage between V_{DD} pin and V_{SS} pin may exceed the absolute maximum rating when a charger is connected in reverse since the current flows from the charger to the IC. Insert a resistor of 100Ω or higher as R1 for ESD protection.

4. The capacitance of C1 must not be less than 0.022μF, if not, DO pin may oscillate when load short-circuiting is detected. Be sure to connect a capacitor of 0.022μF or higher to C1, the typical value is about 0.1μF.

5. The resistance of R2 can not be higher than 2kΩ, if not, the charging current may not be cut when a high-voltage charger is connected.