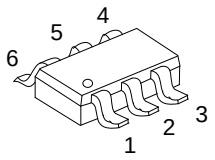
1-CELL LITHIUM-ION/POLYMER BATTERY PROTECTION IC



SOT-26

■ DESCRIPTION

The UTC **UB3421** is a series of lithium-ion/lithium-polymer rechargeable battery protection ICs incorporating high accuracy voltage detection circuits and delay circuits.

The UTC **UB3421** 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 **UB3421** into the limited space of battery pack.

■ FEATURES

* Wide Supply Voltage Range: V_{DD}=1.8V~6.5V
* Ultra-Low Quiescent Current: I_{OPE}=3.0μA (V_{DD}=3.5V)
* Ultra-Low Power-Down Current: I_{PDN}=0.2μA (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
* Over Current 1 Detection Voltage: V_{IOV1}=0.10V~0.20V
* Over Current 2 Detection Voltage: V_{IOV2}=0.5V (Fixed)
* Short Circuit Detection Voltage: V_{SHORT}=1.2V (Fixed)
* Charge overcurrent detection voltage: V_{CIP}=-0.2V (Fixed)
* Delay Times are Generated by an Internal Circuit. (External Capacitors are Unnecessary.)

■ ORDERING INFORMATION

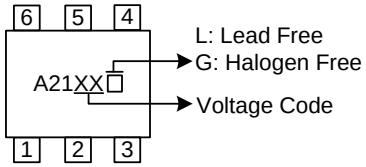
Ordering Number		Package	Packing
Lead Free	Halogen Free		
UB3421L-xx-AG6-R	UB3421G-xx-AG6-R	SOT-26	Tape Reel

Note: xx: Output Voltage, refer SERIAL CODE LIST.

UB3421G-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

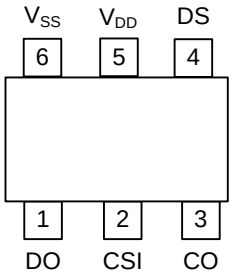
PACKAGE	VOLTAGE CODE (Note)	MARKING
SOT-26	XX	

Note: 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_{IOV1}](V)
UB3421	AA	4.380±0.050	4.280±0.050	2.600±0.100	2.800±0.100	0.150±0.050

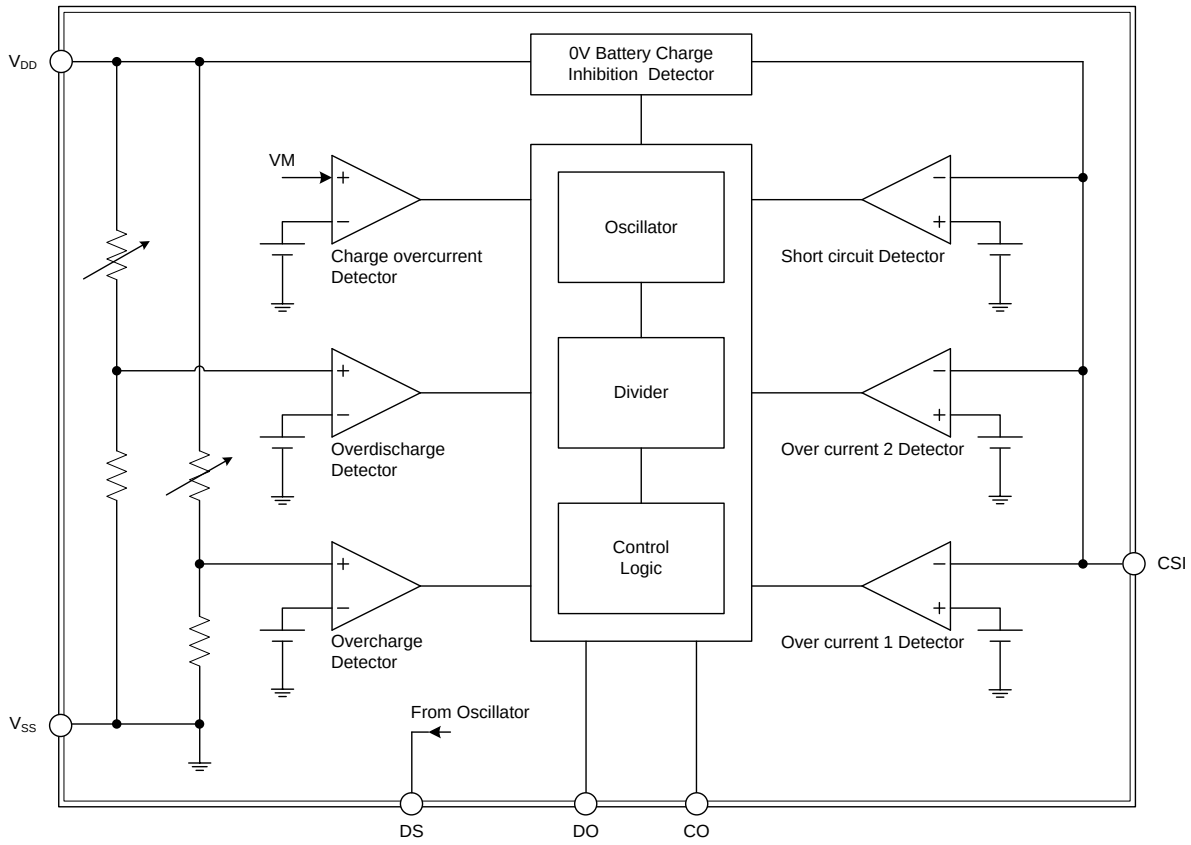
■ PIN CONFIGURATION



■ PIN DESCRIPTION

PIN NO.	PIN NAME	DESCRIPTION
1	DO	For discharge control: FET gate connection pin
2	CSI	For current sense and charger detection input pin
3	CO	For charge control: FET gate connection pin
4	DS	Test pin for delay time measurement
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}+10	V
CO Output Pin Voltage	V_{CO}	V_{DD}-24 ~ V_{DD}+0.3	V
DO Output Pin Voltage	V_{DO}	V_{SS}-0.3 ~ V_{DD}+0.3	V
CSI Input Pin Voltage	V_{CSI}	V_{DD}-24 ~ 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}+10V) 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}=3.5V, V_{CSI}=0V		3.0	8.0	μA
Power-Down Current		I_{PDN}	V_{DD}=V_{CSI}=2.0V		0.2	0.5	μA
OPERATING VOLTAGE							
Operating Voltage Between V_{DD}-pin and V_{SS}-pin		V_{DS1}		1.8		6.5	V
Operating Voltage Between V_{DD}-pin and CSI-pin		V_{DS2}		1.8		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
Over Current 1 Detection Voltage		V_{IOV1}	V_{DD}=3.5V	V_{IOV1}-0.050	V_{IOV1}	V_{IOV1}+0.050	V
Over Current 2 Detection Voltage		V_{IOV2}	V_{DD}=3.5V	0.35	0.50	0.65	V
Load Short Circuit Detection Voltage		V_{SHORT}	V_{DD}=3.5V	0.5	1.2	1.7	V
Charge overcurrent detection voltage		V_{CIP}	V_{DD}=3.5V	-300	-200	-100	mV
DELAY TIME							
Overcharge Detection Delay Time		t_{CU}		0.9	1.2	1.5	s
Overdischarge Detection Delay Time		t_{DL}		100	150	200	ms
Over Current 1 Detection Delay Time		t_{IOV1}	V_{DD}=3.5V	5	10	20	ms
Over Current 2 Detection Delay Time		t_{IOV2}	V_{DD}=3.5V	1.0	2.5	4.0	ms
Charge overcurrent Delay Time		t_{CIP}	V_{DD}=3.5V	5	7.5	10	ms
OUTPUT VOLTAGE							
OC Pin Output Voltage	High	V_{OH1}	V_{DD}=3.5V, I_{OH}=-50μA	V_{DD}-0.2	V_{DD}-0.1		V
	Low	V_{OL1}	V_{DD}=4.5V, V_{CSI}=0V		0.1	0.5	V
OD Pin Output Voltage	High	V_{OH2}	V_{DD}=3.5V, I_{OH}=-50μA	V_{DD}-0.2	V_{DD}-0.1		V
	Low	V_{OL2}	V_{DD}=2.0V, I_{OL}=50μA		0.1	0.5	V

■ OPERATION

1. Normal Condition

The UTC **UB3421** series monitors the voltage of the battery connected between V_{DD} pin and V_{SS} pin and the voltage difference between CSI 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 CSI pin voltage is in the range from charge overcurrent detection voltage (V_{CIP}) to the overcurrent 1 detection voltage (V_{IOV1}), 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 CSI pin and V_{SS} pin or connect the charger to restore the normal condition.

2. Overcurrent Condition

When a battery in the normal status is in the status where the voltage of the CSI pin is equal to or higher than the overcurrent detection voltage because the discharge current is higher than the specified value and the status lasts for the overcurrent detection delay time, the discharge control FET is turned off and discharging is stopped. This status is called the overcurrent status. In the overcurrent status, the CSI and V_{SS} pins are shorted by the resistor between CSI and V_{SS} (R_{CSIS}) in the IC. However, the voltage of the CSI pin is at the V_{DD} potential due to the load as long as the load is connected. When the load is disconnected, the CSI pin returns to the V_{SS} potential. This IC detects the status when the impedance between the EB+ pin and EB- pin (Refer to the typical application circuit) increases and is equal to the impedance that enables automatic restoration and the voltage at the CSI pin returns to overcurrent detection voltage 1 (V_{IOV1}) or lower and the overcurrent status is restored to the normal status.

Note: The impedance that enables automatic restoration varies depending on the battery voltage and the set value of overcurrent 1 detection voltage.

3. 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 **UB3421** 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 battery voltage falls below the overcharge release voltage (V_{CL}), the UTC **UB3421** series turns the charging control FET on and turns to the normal condition.

(2) When a load is connected and discharging starts, the UTC **UB3421** series turns the charging control FET on and returns to the normal condition. 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 the CSI pin potential becomes Vf, the voltage for the parasitic diode, higher than V_{SS} level. When the battery voltage goes under the overcharge detection voltage (V_{CU}) and provided that the CSI pin voltage is higher than the overcurrent 1 detection voltage, the UTC **UB3421** series releases the overcharge condition.

Note 1: If the battery is charged to a voltage higher than the overcharge detection voltage (V_{CU}) and the battery voltage does not fall below the overcharge detection voltage (V_{CU}) even when a heavy load is connected, the detection of overcurrent 1, overcurrent 2 and load shortcircuiting do not function until the battery voltage falls below over charge detection voltage (V_{CU}). Since an actual battery has an internal impedance of several dozens of mΩ, the battery voltage drops immediately after a heavy load that causes overcurrent is connected, and the detection of overcurrent 1, overcurrent 2 and load short-circuiting function.

Note 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 release voltage (V_{CL}). The overcharge condition is released when the CSI pin voltage goes over charge overcurrent detection voltage (V_{CIP}) by removing the charger.

■ OPERATION(Cont.)

4. 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 **UB3421** 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 CSI pin voltage is pulled up by the resistor between CSI and V_{DD} in the IC (R_{CSID}). When the voltage difference between the CSI 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 CSI 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 **UB3421** series turns the discharging FET on and returns to the normal condition.

5. Charge overcurrent Detection

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

The UTC **UB3421** Series releases the charge overcurrent status when the voltage at the CSI pin returns to V_{CIP} or higher by removing the charger.

6. Delay Circuits

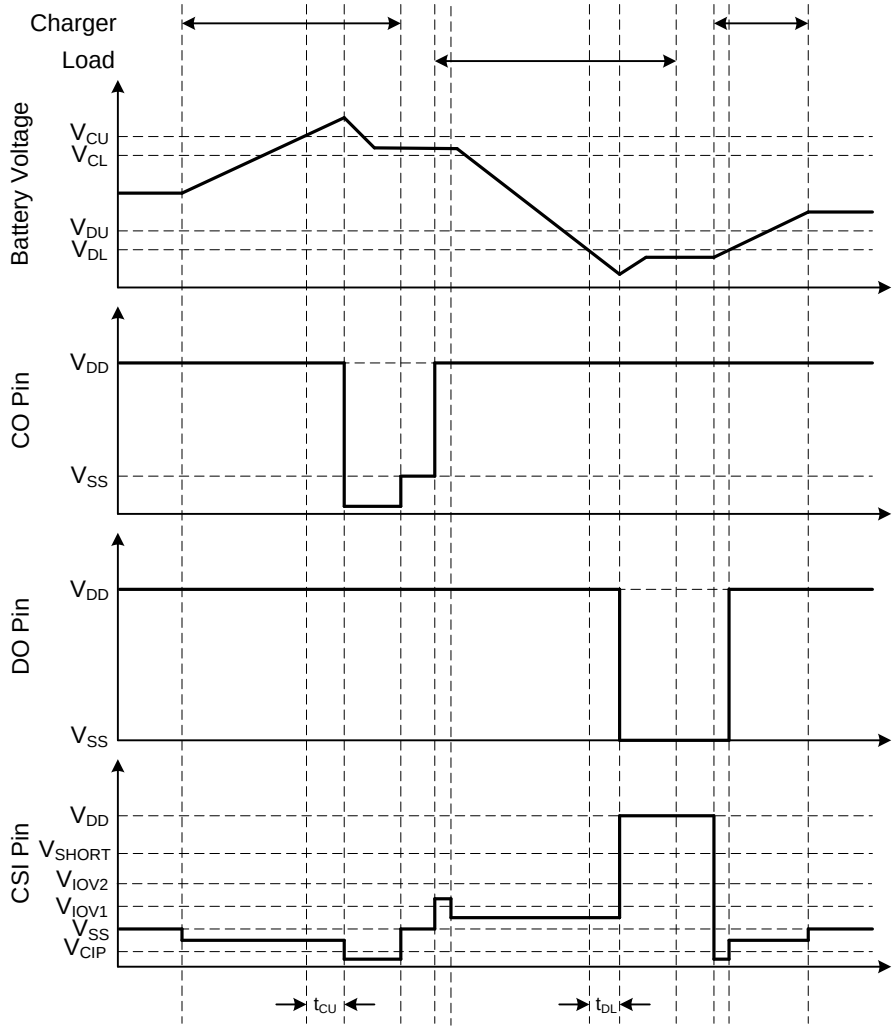
The detection delay times are determined by dividing a clock of the approximately 3.5kHz with the counter.

Note 1: The detection delay time for overcurrent 2 (t_{IOV2}) and load short-circuiting (t_{SHORT}) start when the overcurrent 1 (V_{IOV1}) is detected. When the overcurrent 2 (V_{IOV2}) or load short-circuiting (V_{SHORT}) is detected over the detection delay time for each of them (= t_{IOV2} or t_{SHORT}) after the detection of overcurrent 1 (V_{IOV1}), the UTC **UB3421** series turns the FET off within t_{IOV2} or t_{SHORT} of each detection.

Note 2: When the overcurrent is detected and continues for longer than the overdischarge detection delay time (t_{DL}) without releasing the load, the condition changes to the power-down condition when the battery voltage falls below the overdischarge detection voltage (V_{DL}). When the battery voltage falls below the overdischarge detection voltage (V_{DL}) due to the overcurrent, the UTC **UB3421** series turns the discharging control FET off by the overcurrent detection. In this case the recovery of the battery voltage is so slow that if the battery voltage after the overdischarge detection delay time (t_{DL}) is still lower than the over discharge detection voltage (V_{DL}), the UTC **UB3421** series shifts to the power-down condition.

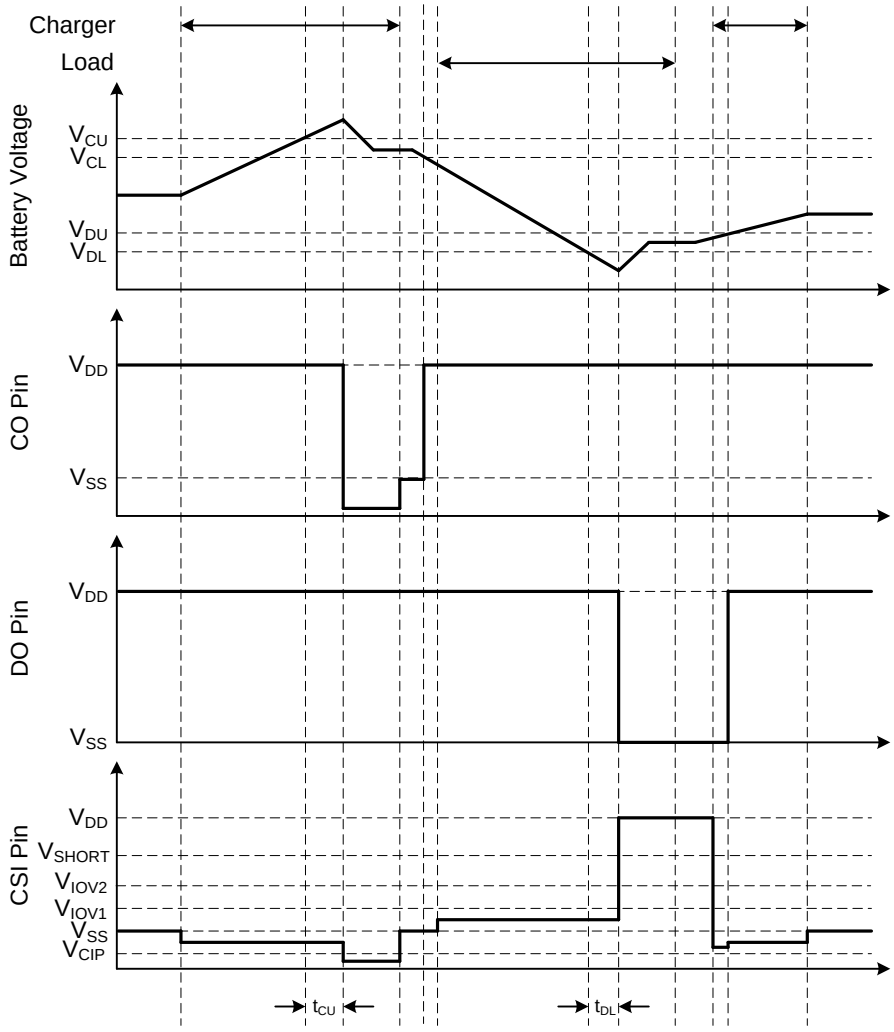
■ TIMING CHART

(1) Overcharge Detection, Overdischarge Detection



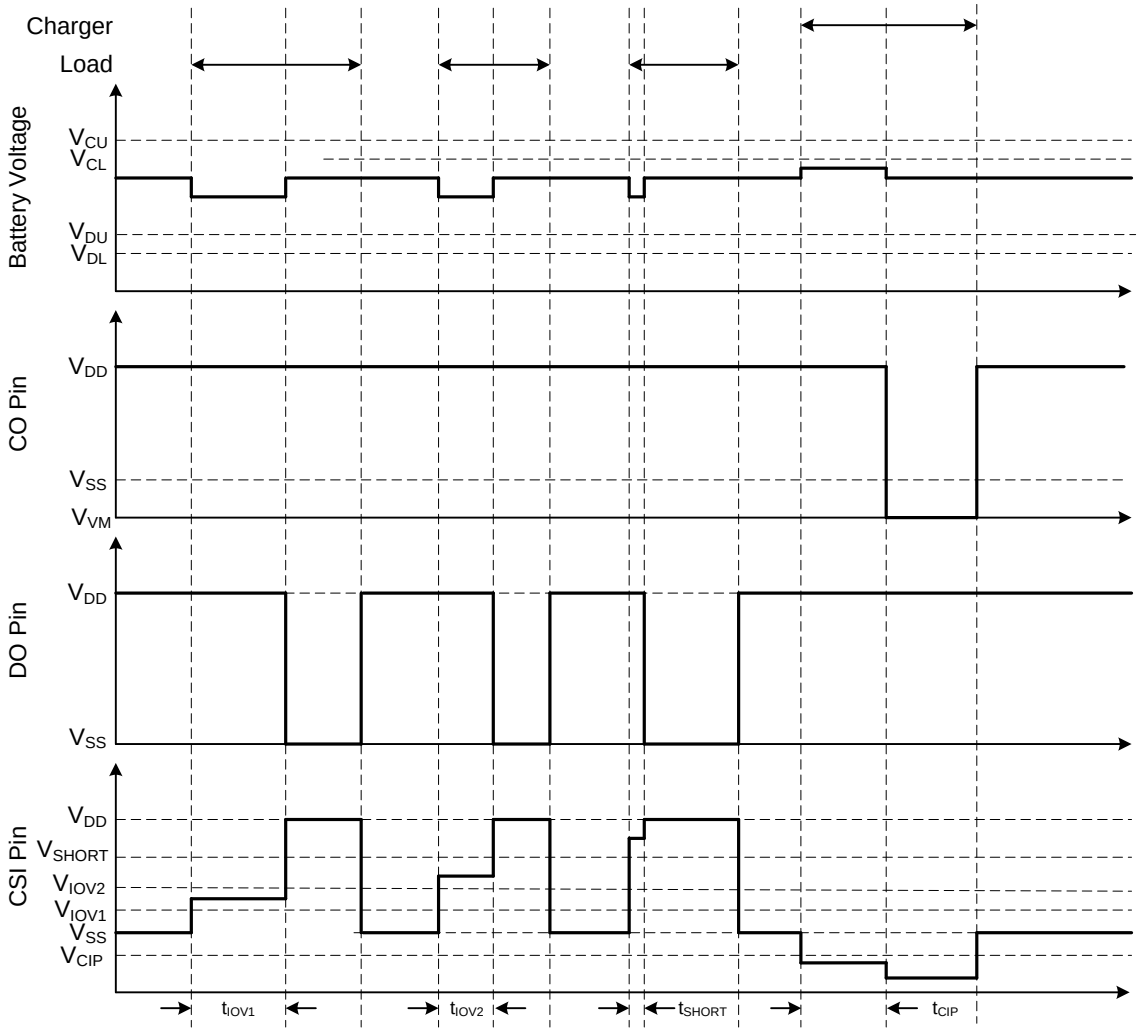
■ TIMING CHART (Cont.)

(2) Overcharge Detection, Overdischarge Detection

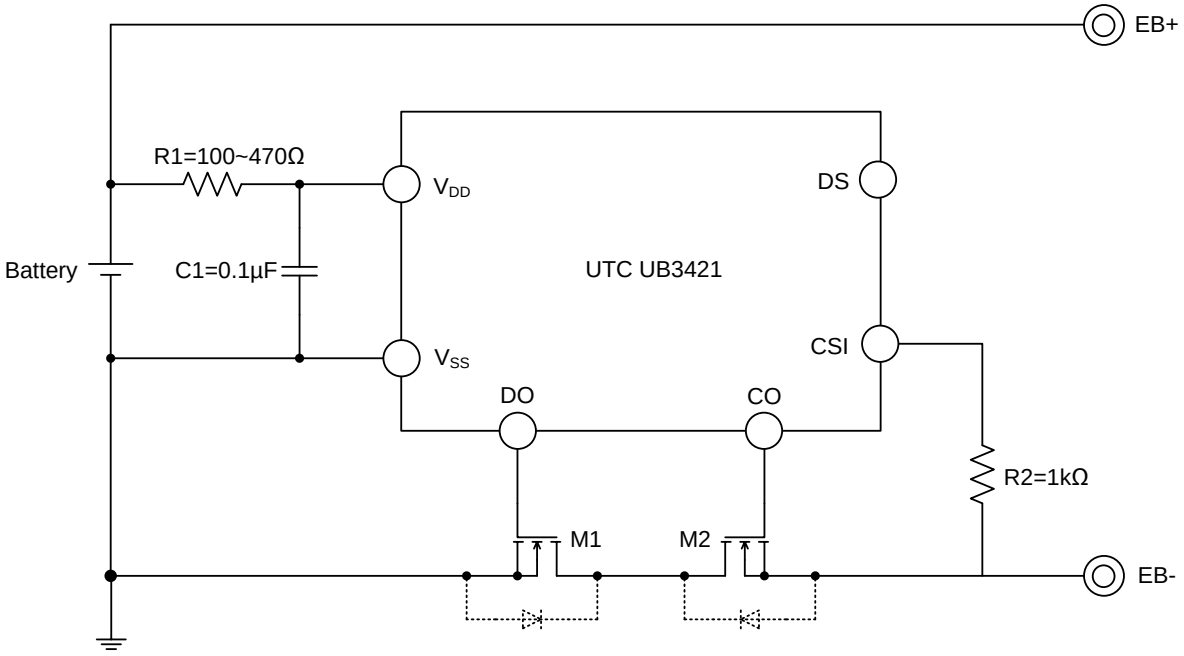


■ TIMING CHART (Cont.)

(3) Discharge Overcurrent Detection, 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.