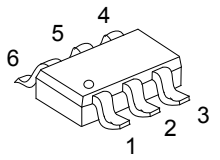
1-CELL LITHIUM-ION/POLYMER BATTERY PROTECTION IC



SOT-26

■ DESCRIPTION

The UTC **UB291** is a series of lithium-ion/lithium-polymer rechargeable battery protection ICs incorporating high accuracy voltage detection circuits and delay circuits.

The UTC **UB291** 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 **UB291** into the limited space of battery pack.

■ FEATURES

* Wide Supply Voltage Range: V_{DD}=1.5V~10V
* Ultra-Low Quiescent Current: I_{OPE}=3.0μA (V_{DD}=3.9V)
* Ultra-Low Power-Down Current: I_{PDN}=0.2μA (V_{DD}=2.0V)
* Overcharge Detection Voltage: V_{DET1}=4.05V~4.35V
* Overcharge Release Voltage: V_{REL1}=3.8V~4.25V
* Over Discharge Detection Voltage: V_{DET2}=2.2V~3.1V
* Over Discharge Release Voltage: V_{REL2}=2.3V~3.3V
* Discharge Over Current Detection Voltage: V_{DET3}=0.07V~0.23V
* Discharge Short Circuit Detection Voltage: V_{SHORT}=0.5V
* Charge Over Current Voltage: V_{DET4}=-0.1V
* Charger Detection Voltage: V_{CHA}=-0.7V
* Delay Times are Generated by an Internal Circuit. (External Capacitors are Unnecessary.)

■ ORDERING INFORMATION

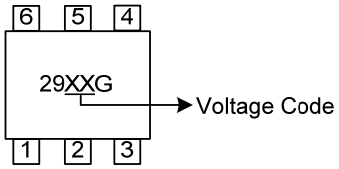
Ordering Number	Package	Packing
UB291G-xx-AG6-R	SOT-26	Tape Reel

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

UB291G-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

■ MARKING INFORMATION

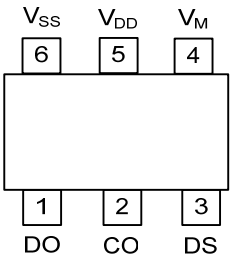
PACKAGE	VOLTAGE CODE (Note)	MARKING
SOT-26	XX	

Note: Refer to Serial Code List

■ SERIAL CODE LIST

Model	Code	Overcharge Detection Voltage [V_{DET1}](V)	Overcharge Release Voltage [V_{REL1}](V)	Over discharge Detection Voltage [V_{DET2}](V)	Over discharge Release Voltage [V_{REL2}](V)	Over Current Detection Voltage [V_{DET3}](V)
UB291	AA	4.275	4.175	3.00	3.20	0.150
	AB	4.280	4.100	2.30	2.50	0.150
	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	4.280	4.150	2.80	3.10	0.150

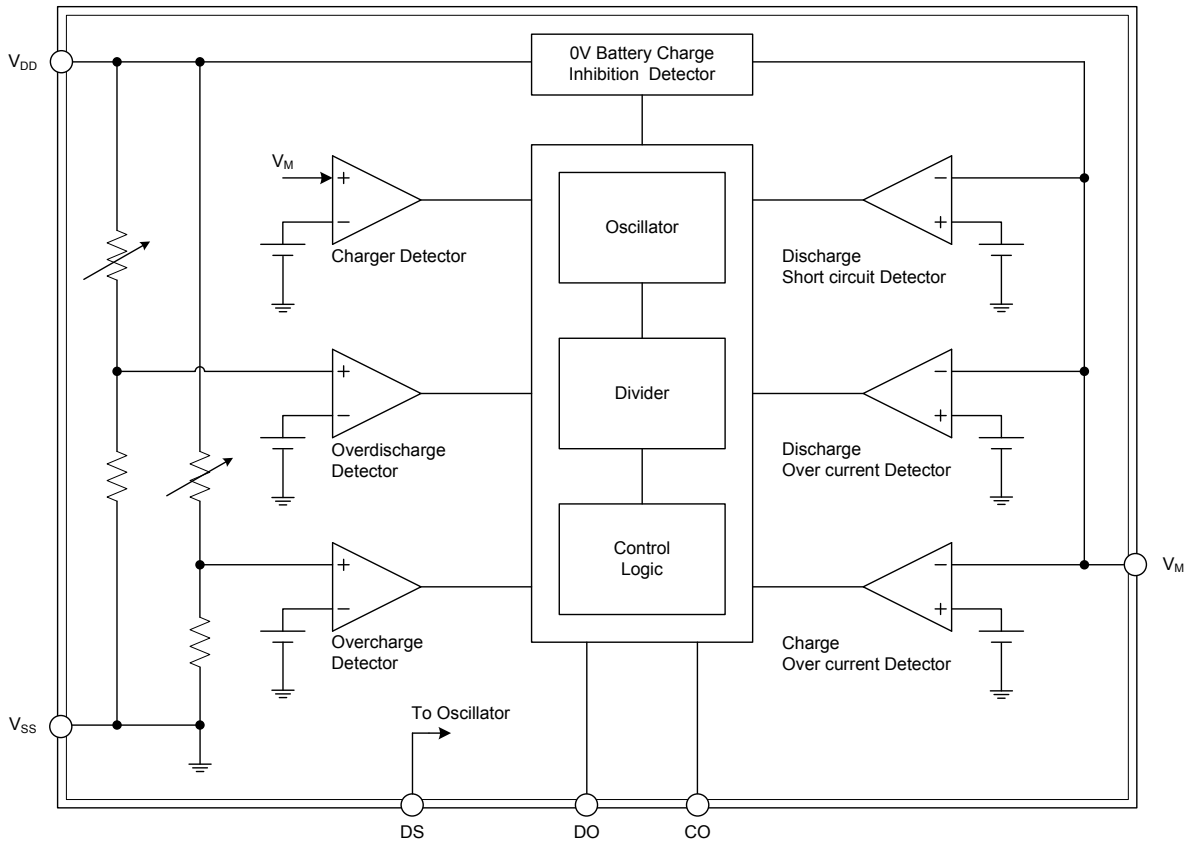
■ PIN CONFIGURATION



■ PIN DESCRIPTION

PIN NO.	PIN NAME	DESCRIPTION
1	DO	For discharge control: FET gate connection pin
2	CO	For charge control: FET gate connection pin
3	DS	For reduce delay time: test pin
4	V_M	For current sense and charger detection input pin
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 1)	V_{DD}	V_{SS}-0.3 ~ V_{SS}+12	V
CO Output Pin Voltage	V_{CO}	V_{DD}-28 ~ 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}-28 ~ V_{DD}+0.3	V
DS Input Pin Voltage	V_{DS}	V_{SS}-0.3 ~ 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	8.0	μA
Power-Down Current	I_{PDN}	V_{DD}=V_M=2.0V		0.2	0.5	μA
OPERATING VOLTAGE						
Operating Voltage Between V_{DD}-pin and V_{SS}-pin	V_{DS1}		1.5		12	V
Operating Voltage Between V_{DD}-pin and V_M-pin	V_{DS2}		1.5		26	V
DETECTION VOLTAGE						
Overcharge Detection Voltage	V_{DET1}		V_{DET1}-0.05	V_{DET1}	V_{DET1}+0.05	V
Overcharge Release Voltage	V_{REL1}		V_{REL1}-0.05	V_{REL1}	V_{REL1}+0.05	V
Overdischarge Detection Voltage	V_{DET2}		V_{DET2}-0.10	V_{DET2}	V_{DET2}+0.10	V
Overdischarge Release Voltage	V_{REL2}		V_{REL2}-0.10	V_{REL2}	V_{REL2}+0.10	V
Discharge Over Current Detection Voltage	V_{DET3}	V_{DD}=3.0V	V_{DET3}-0.03	V_{DET3}	V_{DET3}+0.03	V
Discharge Short Circuit Detection Voltage	V_{SHORT}	V_{DD}=3.0V	0.35	0.50	0.65	V
Charge Over Current Detection Voltage	V_{DET4}	V_{DD}=3.0V	-0.120	-0.100	-0.080	V
Charger Detection Voltage	V_{CHA}	V_{REL2}≠V_{DET2}	-1.6	-0.7	-0.2	V
0V BATTERY CHARGE VOLTAGE						
0V Battery Charge Inhibition Battery Voltage	V_{0INH}			0.9	1.8	V
CONTROL OUTPUT VOLTAGE(CO&DO)						
CO Pin Output “H” Voltage	V_{COH}	V_{DD}=3.9V, I_{CO}=-30μA	3.4	3.7		V
CO Pin Output “L” Voltage	V_{COL}	V_{DD}=4.5V, I_{CO}=30μA		0.4	0.5	V
DO Pin Output “H” Voltage	V_{DOH}	V_{DD}=3.9V, I_{DO}=-30μA	3.4	3.7		V
DO Pin Output “L” Voltage	V_{DOL}	V_{DD}=2.0V, I_{DO}=30μA		0.2	0.5	V
DELAY TIME						
Overcharge Detection Delay Time	t_{DET1}	V_{DD}=3.6V to 4.6V		1.00		s
Overcharge Release Delay Time	t_{REL1}	V_{DD}=4.6V to 3.6V		16		ms
Overdischarge Detection Delay Time	t_{DET2}	V_{DD}=3.6V to 2.0V		125		ms
Overdischarge Release Delay Time	t_{REL2}	V_{DD}=2.0V to 3.6V		1.0		ms
Discharge Over Current Detection Delay Time	t_{DET3}	V_{DD}=3.0V, V_M=0V to 0.3V		8.0		ms
Discharge Over Current Release Delay Time	t_{REL3}	V_{DD}=3.0V, V_M=0.3V to 0V		1.0		ms
Charge Over Current Detection Delay Time	t_{DET4}	V_{DD}=3.0V, V_M=0V to -1V		8.0		ms
Charge Over Current Release Delay Time	t_{REL4}	V_{DD}=3.0V, V_M=-1V to 0V		1.0		ms
Discharge Short Circuit Detection Delay Time	t_{SHORT}	V_{DD}=3.0V, V_M=0V to 3V		500		μs

■ OPERATION

1. Over charge detector

In the state of charging the battery, it will detect the overcharge state of the battery if the V_{DD} terminal voltage becomes higher than the overcharge detection voltage (V_{DET1}). And then the CO terminal turns to low level, so the external charging control Nch MOSFET turns OFF and it forbids to charge the battery.

After detecting overcharge, it will release the overcharge state if the V_{DD} terminal voltage becomes lower than the overcharge release voltage (V_{REL1}). And then the CO terminal turns to high level, so the external charging control Nch MOS FET turns ON, and it accepts to charge the battery.

When the V_{DD} terminal voltage is higher than the overcharge detection voltage, to disconnect the charger and connect the load, leave the CO terminal low level, but it accepts to conduct load current via the paracitical body diode of the external Nch MOSFET. And then if the V_{DD} terminal voltage becomes lower than the overcharge detection voltage, the CO terminal turns to high level, so the external Nch MOSFET turn ON, and it accepts to charge the battery.

The overcharge detection and release have delay time decided internally. When the V_{DD} terminal voltage becomes higher than the overcharge detection voltage, it will not detect overcharge, if the V_{DD} terminal voltage becomes lower than the overcharge detection voltage again within the overcharge detection delay time (Typ.1.00s). And in the state of overcharge, when the V_{DD} terminal voltage becomes lower than the overcharge release voltage, it will not release overcharge, if the V_{DD} terminal voltage backs higher than the overcharge release voltage again within the overcharge release delay time (Typ.16ms).

The output driver stage of the CO terminal includes a level shifter, so it will output the V_M terminal voltage as low level. The output type of the CO terminal is CMOS output between V_{DD} and V_M terminal voltage.

2. Over discharge detector

In the state of discharging the battery, it will detect the overdischarge state of the battery If the V_{DD} terminal becomes lower than the overdischarge detection voltage (V_{DET2}). And then the DO terminal turns to low level, so the external discharging control Nch MOSFET turn OFF and it forbids to discharge the battery.

The release from the overdischarge state is done by the overdischarge release voltage (V_{REL2}) or connecting the charger. If the charger is connected and the V_{DD} terminal voltage is lower than the overdischarge detection voltage, it accepts to conduct charge current via the paracitical body diode of the external Nch MOSFET. And then if the V_{DD} terminal voltage becomes higher than the overdischarge detection voltage, the DO terminal turns to high level, so the external Nch MOSFET turns ON, and it accepts to discharge the battery. If the charger is connected and the V_{DD} terminal voltage is higher than the overdiscahrge detection voltage, the DO terminal will turn to high level with the delay time.

Charging current cannot be supplied to the battery that is discharged to lower than the maximum forbidden voltage for 0V charging .

The overdischarge detection have delay time decided internally. When the V_{DD} terminal voltage becomes lower than the overdischarge detection voltage, it will not detect overdischarge, if the V_{DD} terminal voltage becomes higher than the overdischarge detection voltage again within the overdischarge detection delay time (Typ.125ms). Moreover, the overdischarge release delay time (Typ.1ms) exists, too.

All the circuits are stopped, and after the overdischarge is detected, it is assumed the state of the standby, and decreases the current (standby current) which IC consumes as much as possible (When V_{DD}=2V, Max.0.5uA).

The output type of the DO terminal is CMOS output between V_{DD} and V_{SS} terminal voltage.

■ OPERATION (Cont.)

3. Discharging overcurrent detector, Short detector

In the state of chargable and dischargabe, if the V_M terminal voltage becomes higher than the discharging overcurrent detection voltage (V_{DET3}) by short of loads, etc., it will detect discharging overcurrent state. If the V_M terminal voltage becomes higher than short detection voltage (Typ.0.5V), it will detect discharging overcurrent state, too. And then the DO terminal outputs low level, so the external discharging control Nch MOSFET turns OFF, and it protects from large current discharging.

The discharging overcurrent detection has delay time decided internally. When the V_M terminal voltage becomes higher than the discharging overcurrent detection voltage, it will not detect discharging overcurrent, if the V_M terminal voltage becomes lower than the discharging overcurrent detection voltage within the discharging overcurrent detection delay time (Typ.8ms). Moreover, the discharging overcurrent release delay time (Typ.1ms) exists, too.

The short detection delay time (Typ.500us) decided internally exists, too.

The discharging overcurrent release resistance (Typ.50kohm) is built into between V_M terminal and V_{SS} terminal. In the state of discharging overcurrent or short, if the load is opened, V_M terminal is pulled down to the V_{SS} via the discharging overcurrent release resistance. And when the V_M terminal voltage becomes lower than the discharging overcurrent detection voltage, it will automatically release discharging overcurrent or short state. The discharging overcurrent release resistance turns ON, if discharging overcurrent or short is detected. On the normal state (chargable and dischargable state), the discharging overcurrent release resistance is OFFed.

4. Charging overcurrent detector

In the state of chargable and dischargable, if the V_M terminal voltage becomes lower than charging overcurrent detection voltage (Typ.-0.100V) by abnormal voltage or current charger, etc., it will detect charging overcurrent state. And then the CO terminal outputs low level, so the external charging control Nch MOSFET turn OFF, and it protects from large current charging.

It release charging overcurrent state, if the abnormal charger is disconnected, and the load is connected.

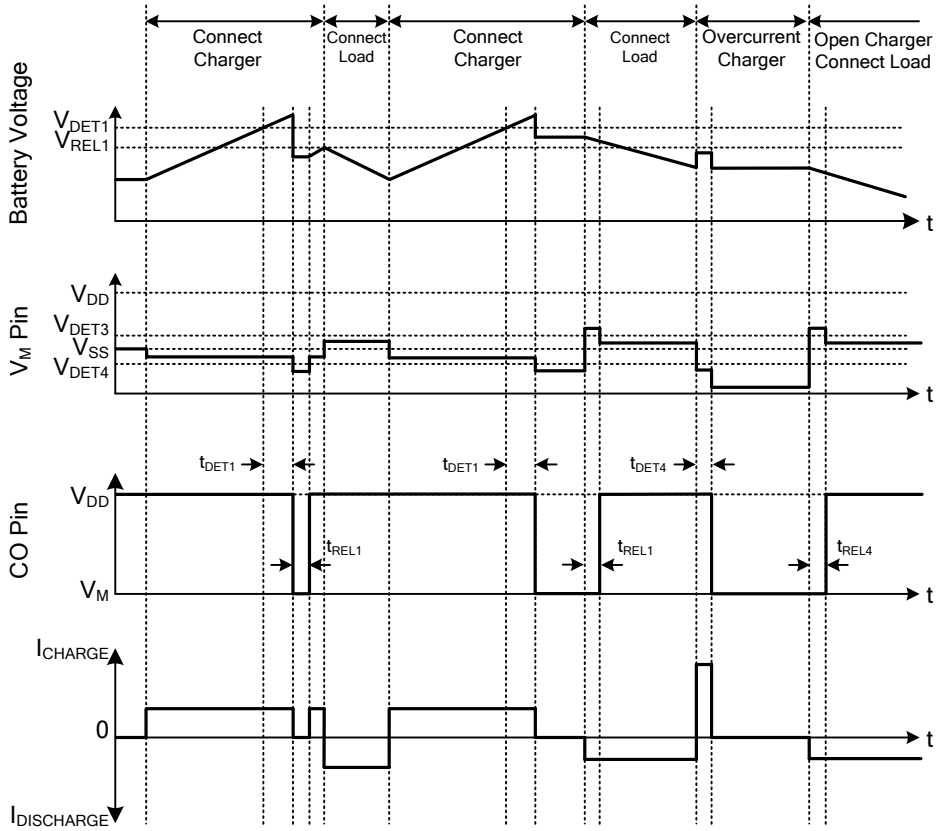
The charging overcurrent detection has delay time decided internally. When the V_M terminal voltage becomes lower than the charging overcurrent detection voltage, it will not detect charging overcurrent, if the V_M terminal voltage becomes higher than the charging overcurrent detection voltage within the charging overcurrent detection delay time (Typ.8ms). Moreover, the charging overcurrent release delay time (Typ.1ms) exists, too.

5. DS (Delay Shortening) function

The delay time of overcharge detection and overdischarge detection can be shortened by making the DS pin to V_{DD} level voltage. In the DS pin, the pull-down resistance of 15kohm is connected between V_{SS}. Please open the DS pin when using usually.

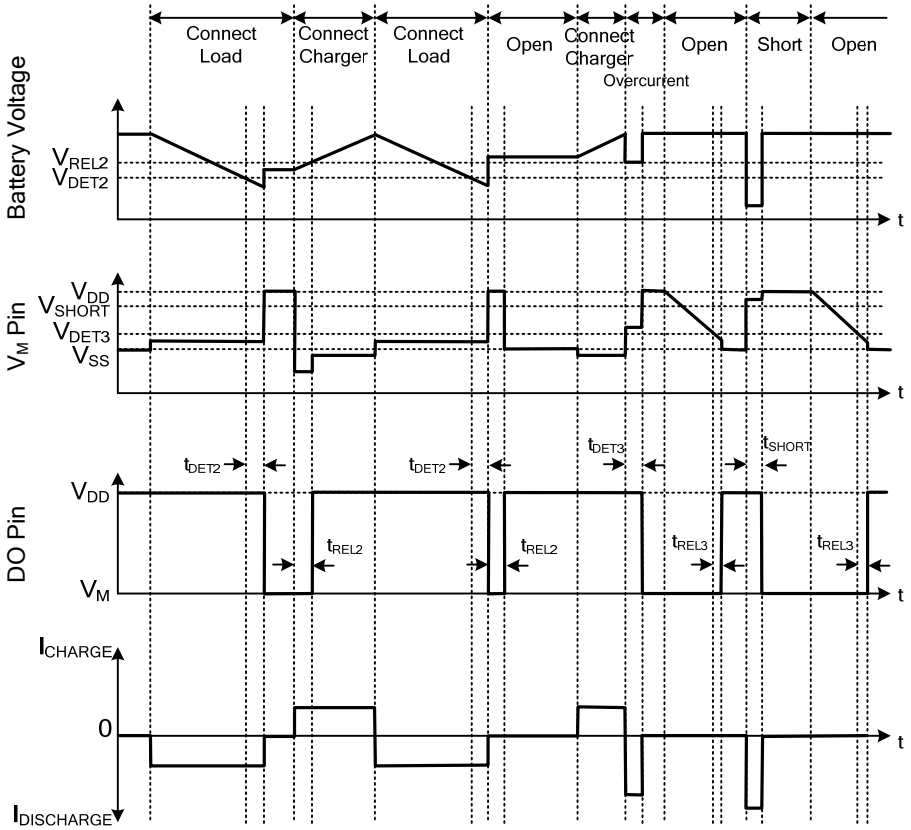
■ TIMING CHART

(1) Overcharge, Charging Overcurrent Operations

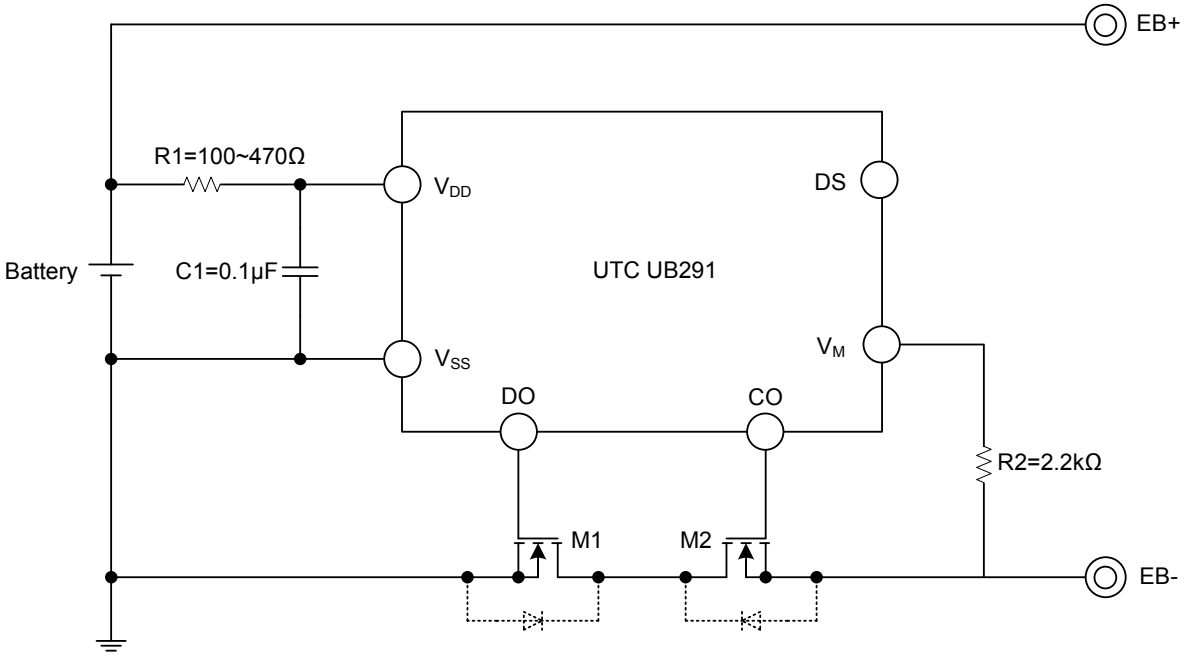


■ TIMING CHART (Cont.)

(2) Overdischarge, Discharging Overcurrent, and Short Operations



■ TYPICAL APPLICATION CIRCUIT



Notes: 1. R1 and C1 stabilize a supply voltage ripple. However, the detection voltage rises by the current of penetration in IC of the voltage detection when R1 is enlarged, and the value of R1 is adjusted to 1kohm or less. Moreover, adjust the value of C1 to 0.01uF or more to do the stability operation, please.

2. R1 and R2 resistors are current limit resistance if a charger is connected reversibly or a high voltage charger that exceeds the absolute maximum rating is connected. R1 and R2 may cause a power consumption will be over rating of power dissipation, therefore the 'R1+R2' should be more than 1kohm. Moreover, if R2 is too enlarged, the charger connection release cannot be occasionally done after the overdischarge is detected, so adjust the value of R2 to 10kohm or less, please.
3. C2 and C3 capacitors have effect that the system stability about voltage ripple or imported noise. After check characteristics, decide that these capacitors should be inserted or not, where should be inserted, and capacitance value, please.