Outline

This protection IC was developed for use with lithium-ion/lithium polymer 1-cell serial batteries.
It detects overcharge, overdischarge, discharge overcurrent and other abnormalities, and functions to protect the battery by turning off the external FET-SW.
The IC also has a built-in timer circuit (for detection delay times), so fewer external parts can be used in protection circuit configuration.

Features

(1) High withstand voltage CMOS process used Charger connection absolute maximum rating 28V(VDD-V-)
(2) Low current consumption TYP. 3.0μA
(3) Low current consumption at Standby(after detecting overdischarge) TYP. 0.3μA
(4) Detection voltage precision Overcharge detection precision ±40mV
Overdischarge detection precision ±100mV
Discharge overcurrent detection precision ±20mV
(5) Built-in detection delay time (timer circuit)

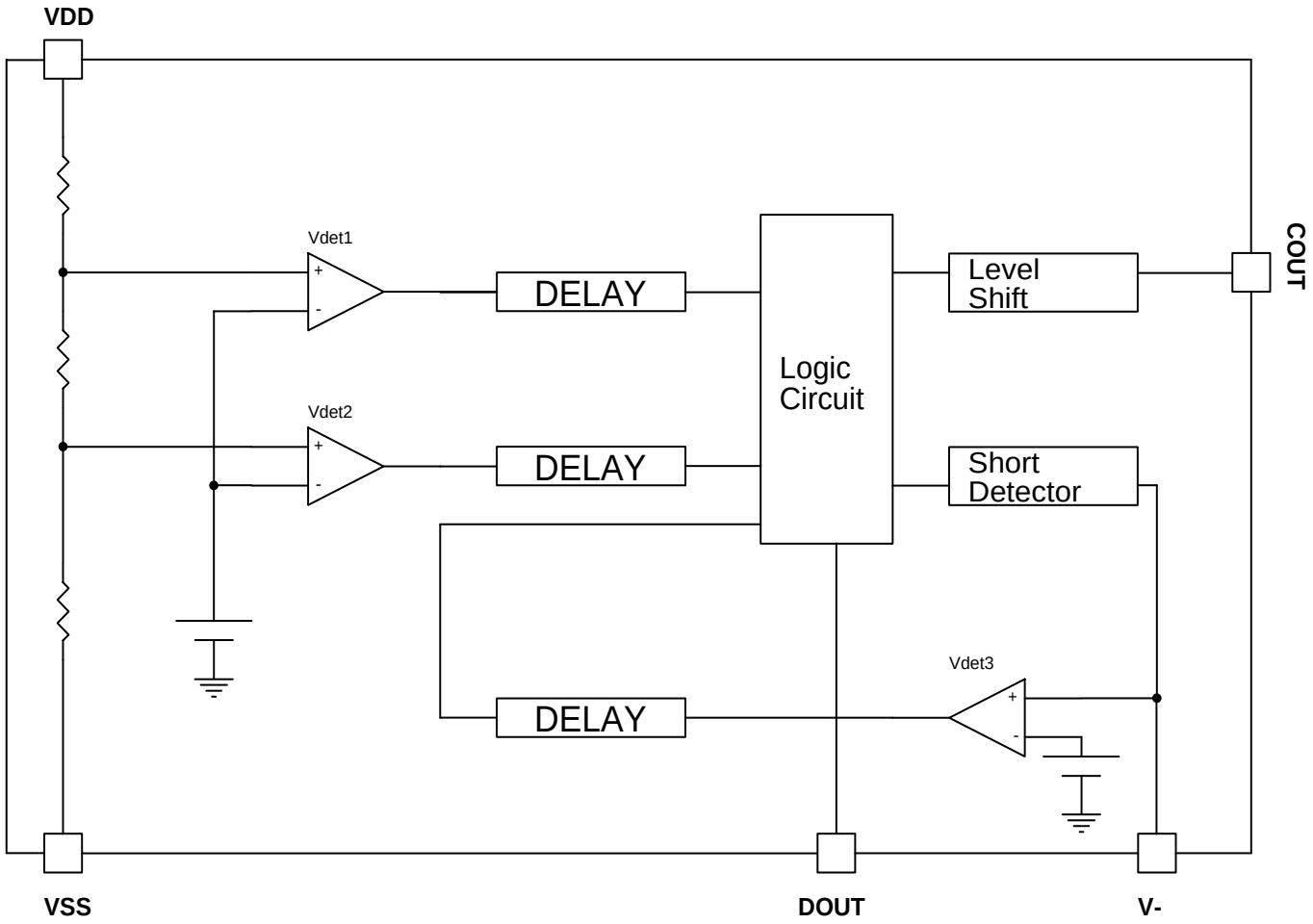
Package

SOT-26

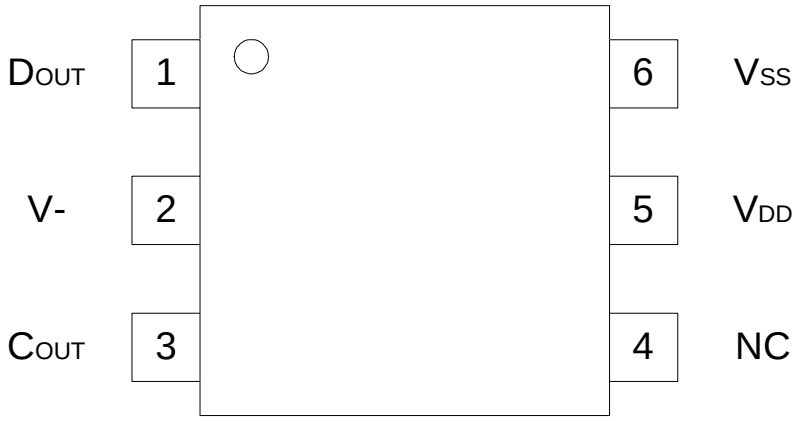
Application

(1) Lithium-ion rechargeable battery packs
(2) Lithium-ion polymer battery packs

Block diagram



Pin Assignment



1	DOUT
2	V-
3	COUT
4	NC
5	VDD
6	VSS

Pin Description

Pin No.	Pin Name	Function
1	D_{OUT}	Overdischarge detection Output. Output type is CMOS.
2	V-	Voltage detection pin between V- and Vss
3	C_{OUT}	Overcharge detection Output. Output type is CMOS.
4	NC	No connection
5	V_{DD}	Positive power input pin
6	V_{SS}	Negative power input pin

Pin assignment compatible with

RICOH R542X,

SEIKO S-8261,

RICHTEK RT9541CER,

FORTUNE DW-01, DW-02.

Absolute Maximum Ratings

ITEM	Symbol	Rating	Unit
Supply Voltage	V_{DD}	-0.3~12	V
Charge Minus Pin Input Voltage	V-	V_{DD}-28~V_{DD}+0.3	V
C_{OUT} Pin Input Voltage	VC_{OUT}	V_{DD}-28~V_{DD}+0.3	V
D_{OUT} Pin Input Voltage	VD_{OUT}	V_{SS}-0.3~V_{DD}+0.3	V
Power Dissipation	P_D	150	mW
Operating Temperature range	T_{OPT}	-40~+80	℃
Storage Temperature Range	T_{STG}	-55~+125	℃

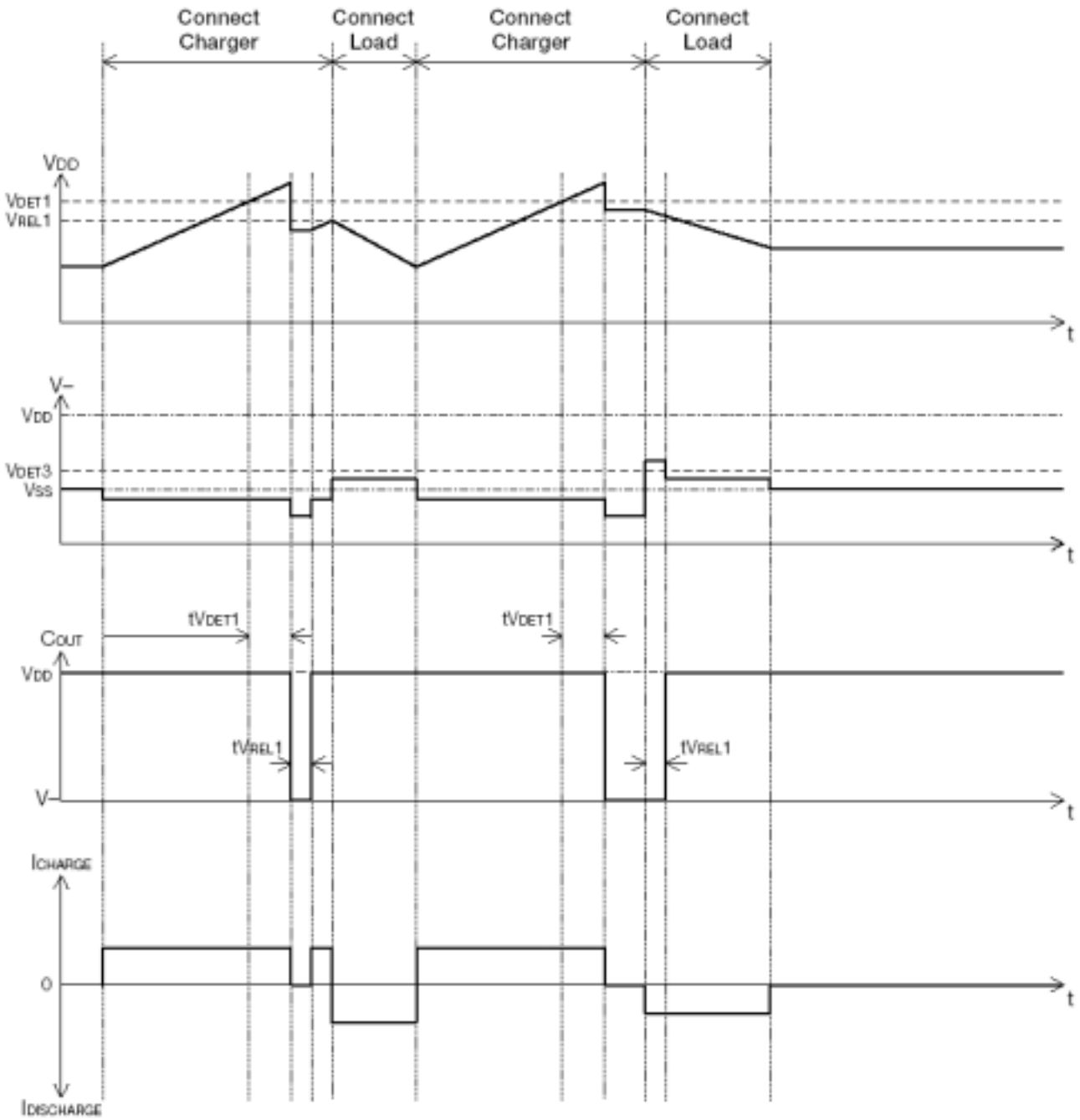
Electrical Characteristics

T_{OPT}=25°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operating Input Voltage	V_{DD1}	V_{DD}-V_{SS}	1.5		10	V
Minimum Operating Voltage for 0V Charging	V_{ST}	V_{DD}-V-,V_{DD}-V_{SS}=0V			1.2	V
Overcharge Detection Voltage	V_{DET1}	Detect Rising Edge of Supply Voltage	4.260	4.300	4.340	V
Overcharge Detection Delay Time	tV_{DET1}	V_{DD}=3.6V→4.4V	50	150	270	mS
Overcharge Release Voltage	V_{REL1}		4.060	4.100	4.160	V
Overdischarge Detection Voltage	V_{DET2}	Detect Falling Edge of Supply Voltage	2.4	2.5	2.6	V
Overdischarge Detection Delay Time	tV_{DET2}	V_{DD}=3.6V→2.2V	5	15	25	mS
Overdischarge Current Detection Voltage	V_{DET3}	Detect Rising Edge of "V-" Pin Voltage	0.13	0.15	0.17	V
Overdischarge Current Detection Delay Time	tV_{DET3}	V_{DD}=3.0V	5	13	26	mS
Short Detection Voltage	V_{SHORT}	V_{DD}=3.0V	V_{DD}-1.0	V_{DD}-0.5	V_{DD}	V
Short Detection Delay Time	tV_{SHORT}	V_{DD}=3.0V			50	uS
Current Consumption	I_{DD}	V_{DD}=3.9V,V-=0V		3.0	6.0	uA
Current Consumption at Standby	$I_{STANDBY}$	V_{DD}=2.0V		0.3	0.6	uA

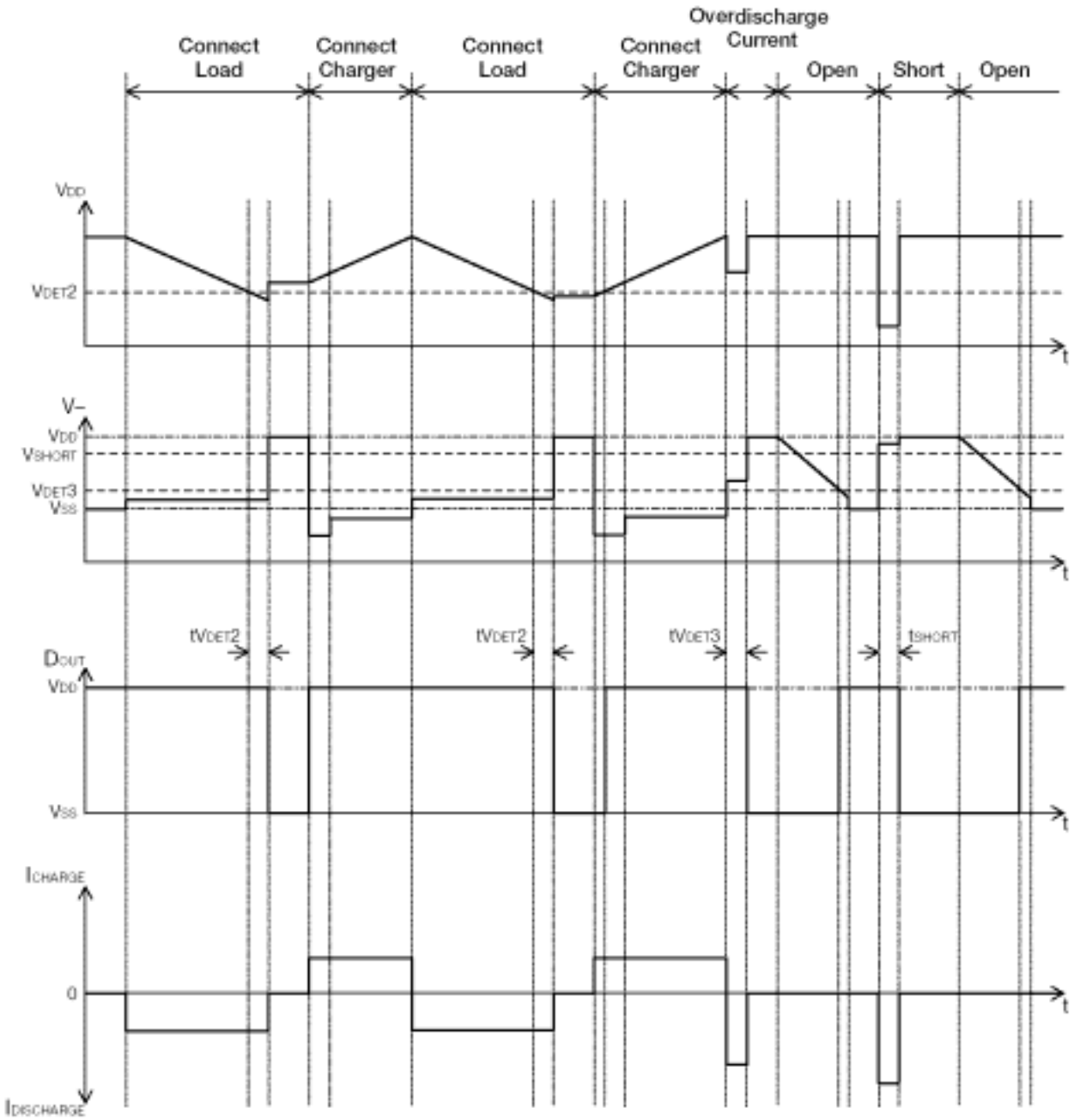
Timing chart

1. Overcharge operations

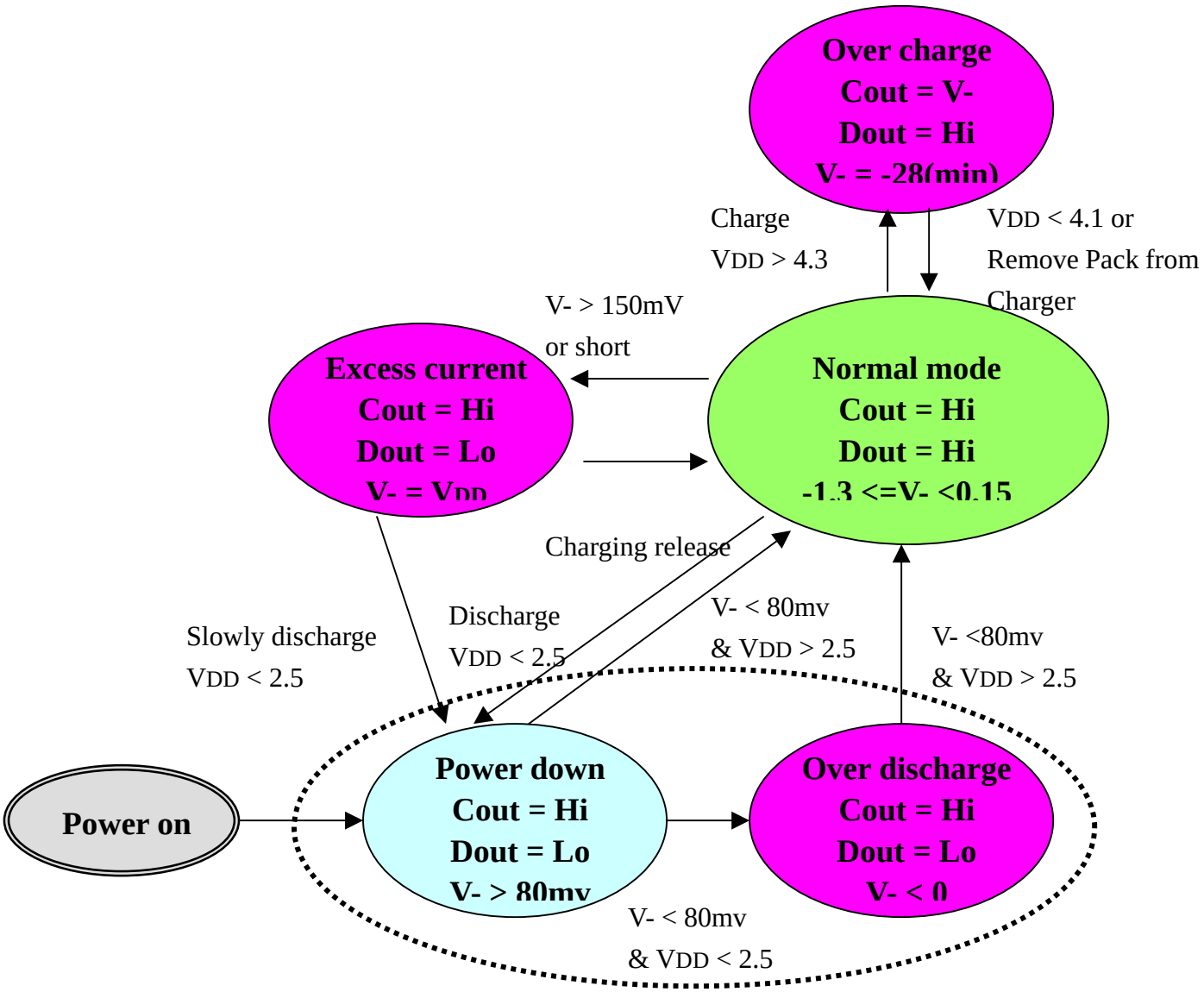


Timing chart cont.

2. Overdischarge, Overdischarge current, Short operations



State machine Diagram



Description

1. Over charge detection circuit (V_{DET1})

This IC monitors V_{DD} pin voltage, when the voltage of V_{DD} crosses overcharge detection voltage (4.30V typ.) from a low value higher than the overcharge detection voltage, the IC sense an overcharging and external charging control Nch MOS FET turns to OFF with C_{OUT} pin being low level.

After detecting overcharge when in the V_{DD} pin voltage is coming down to a level than overcharge release voltage (4.10 typ.) external charging control Nch MOS FET turns to ON with C_{OUT} pin being high level.

After detecting overcharge with the V_{DD} voltage, connecting system load to the battery pack makes load current allowable through parasitic diode of external charge control Nch-MOS FET. The C_{OUT} would be “H” when the V_{DD} level is coming down to a level below the overcharge detection voltage by continuous sending a load current.

2. Over discharge detection circuit (V_{DET2})

This IC monitors V_{DD} pin voltage, when the voltage of V_{DD} crosses overdischarge detection voltage (2.50V typ.) from a high value lower than the overdischarge detection voltage, the IC sense an overdischarging and external charging control Nch MOS FET turns to OFF with D_{OUT} pin being low level.

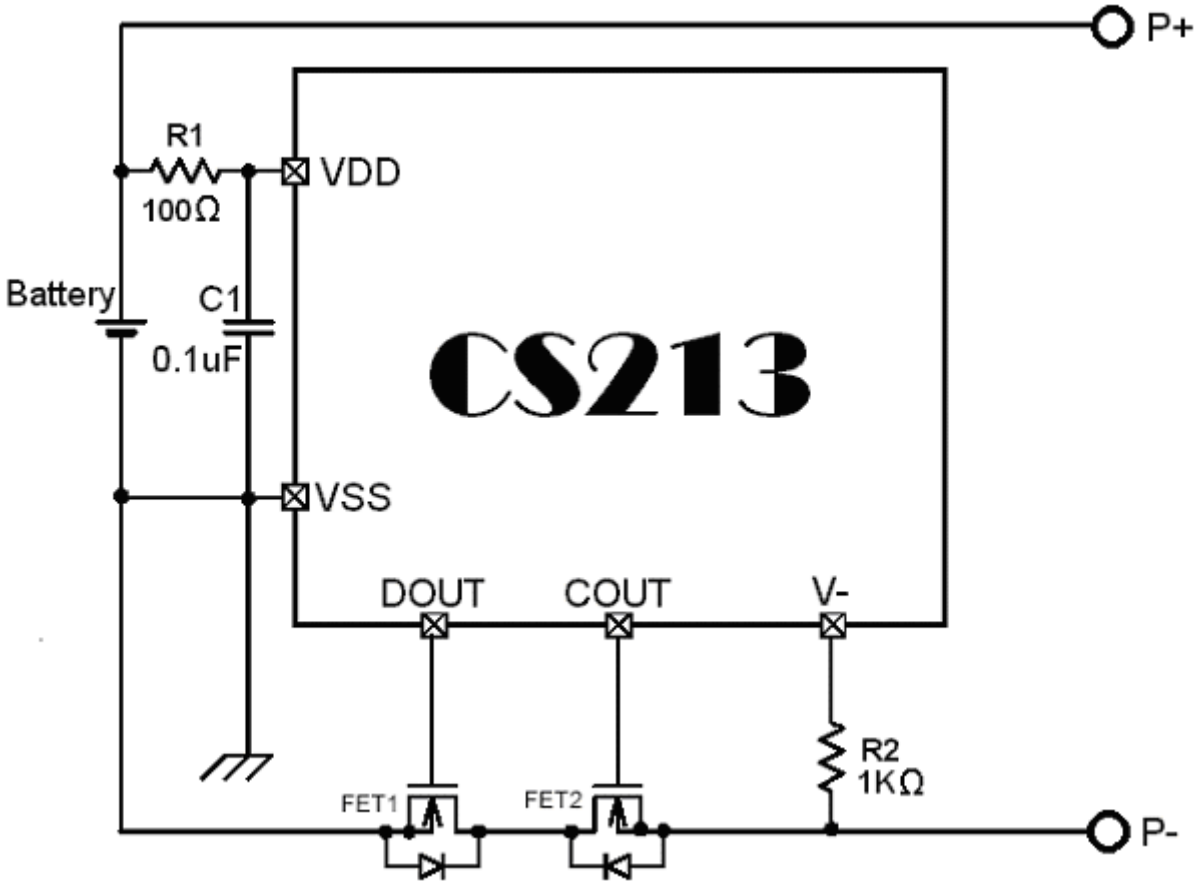
Only connecting the charger does the release from the overdischarge. Charging current is supplied through a parasitic diode of Nch MOS FET when the VDD pin voltage is below the overdischarge detection voltage to the connection of the charge, and the D_{OUT} pin enters the state which can be discharged by becoming high level, and turning on Nch MOS FET when the V_{DD} pin voltage rise more than the overdischarge detection voltage.

After the overdischarge is detected, all the circuits are stopped. It is assumed the state of standby, and decreases the current (standby current), which IC consumes as much as possible (The VDD=2.0V 0.6uA max).

3. Discharging over current detector & Short Circuit protector (V_{DET3},V_{SHORT})

When the V- pin voltage is going up to a value during the short detector voltage (VDD-0.5V typ.) and overdischarge current detection voltage (0.150V typ.) is overdischarge current detection mode, when the V- pin voltage higher than short detection voltage makes the short detection mode, This leads the external discharge control Nch MOS FET turns to OFF with the D_{OUT} pin being at low level.

Application Circuit



** Add a capacitor(0.1uF) between V- and Vss will get more stable for big current load**