

**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

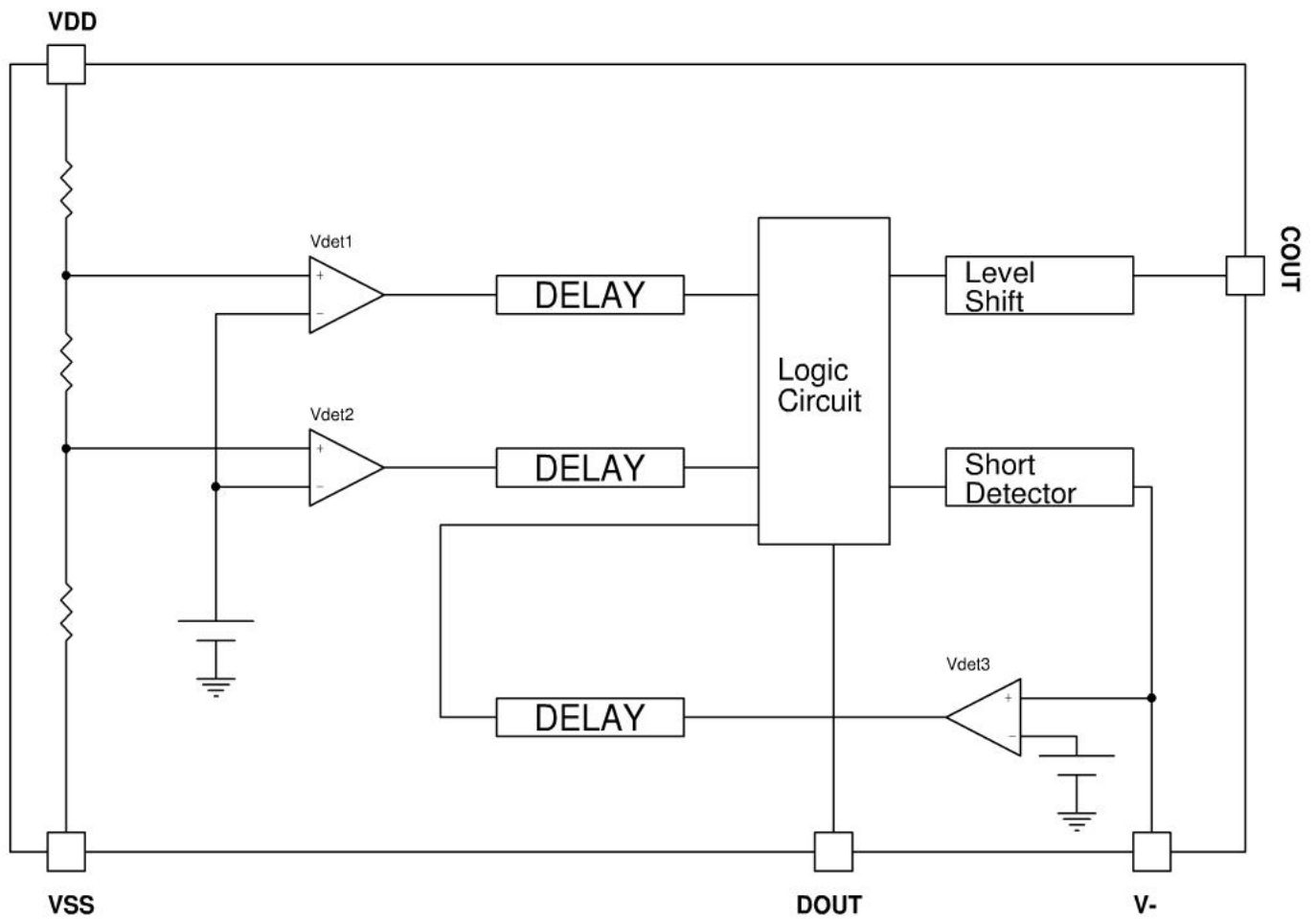
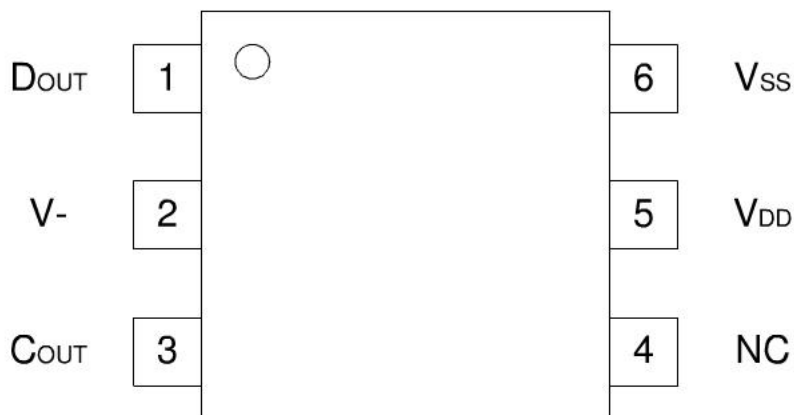
- (1) High withstand voltage CMOS process used Charger connection absolute maximum rating 28V(VDD-V-)
- (2) Low current consumption TYP. 3.0 μ A
- (3) Low current consumption at Standby(after detecting overdischarge) TYP. 0.3 μ A
- (4) Detection voltage precision
 - Overcharge detection precision ± 40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

Package

SOT-26

Application

- (1) Lithium-ion rechargeable battery packs
 - (2) Lithium-ion polymer battery packs
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**Block diagram****Pin Assignment**

1	D _{OUT}
2	V ₋
3	C _{OUT}
4	NC
5	V _{DD}
6	V _{SS}

**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 V _{ss}
3	C _{OUT}	Overcharge detection Output.
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,

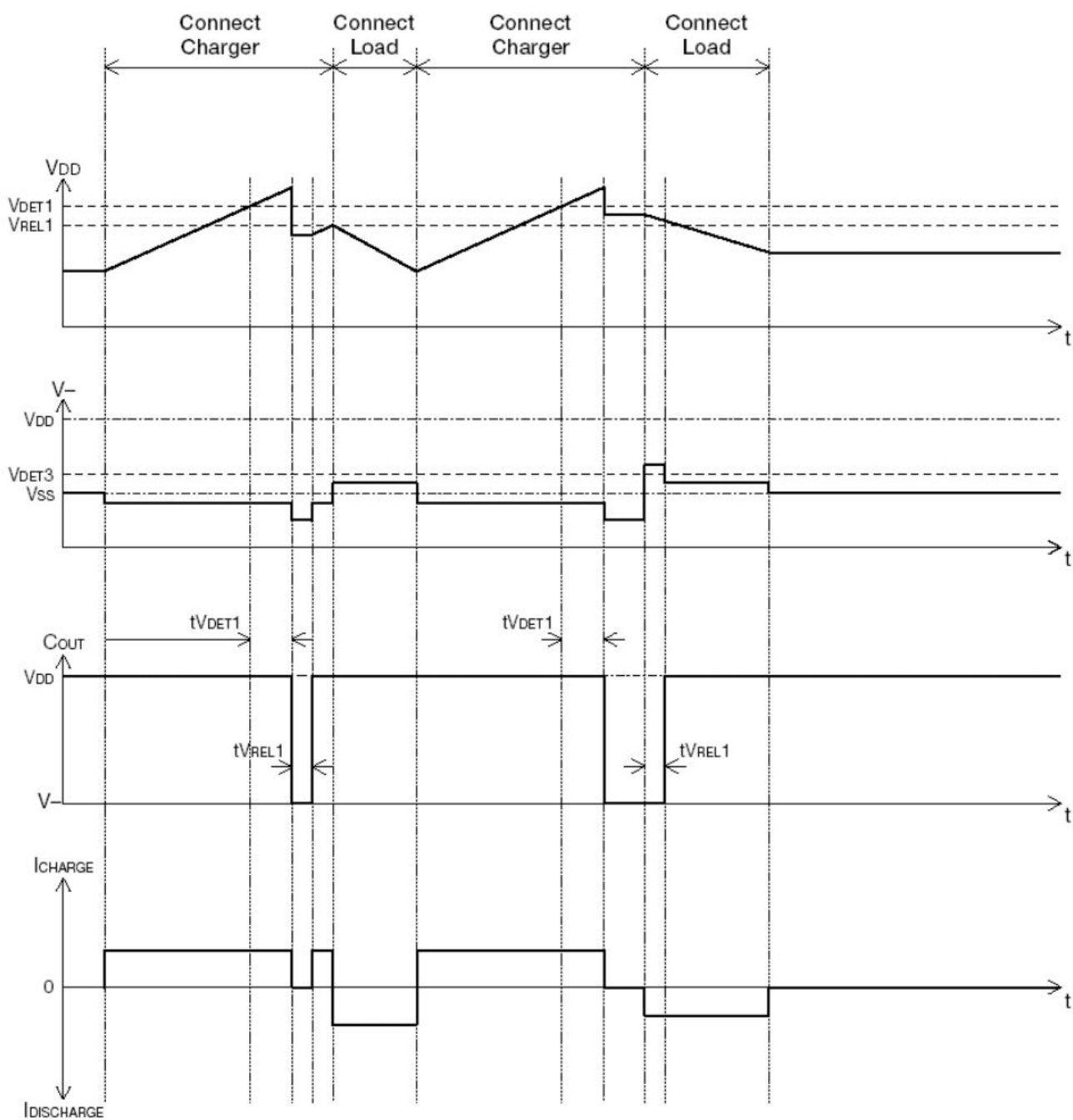
FORTUNE DW-01, DW-02.

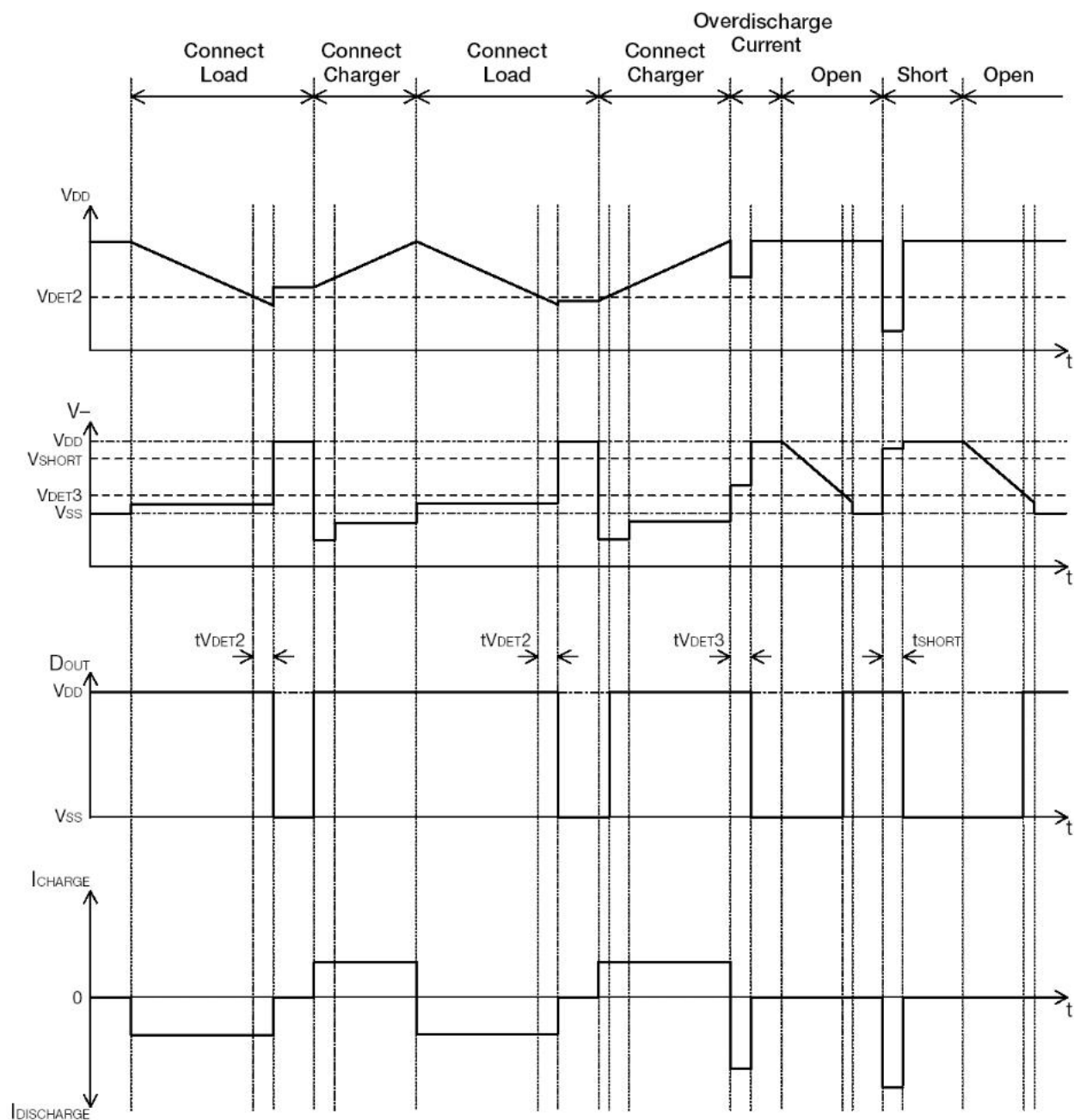
**Absolute Maximum Ratings**

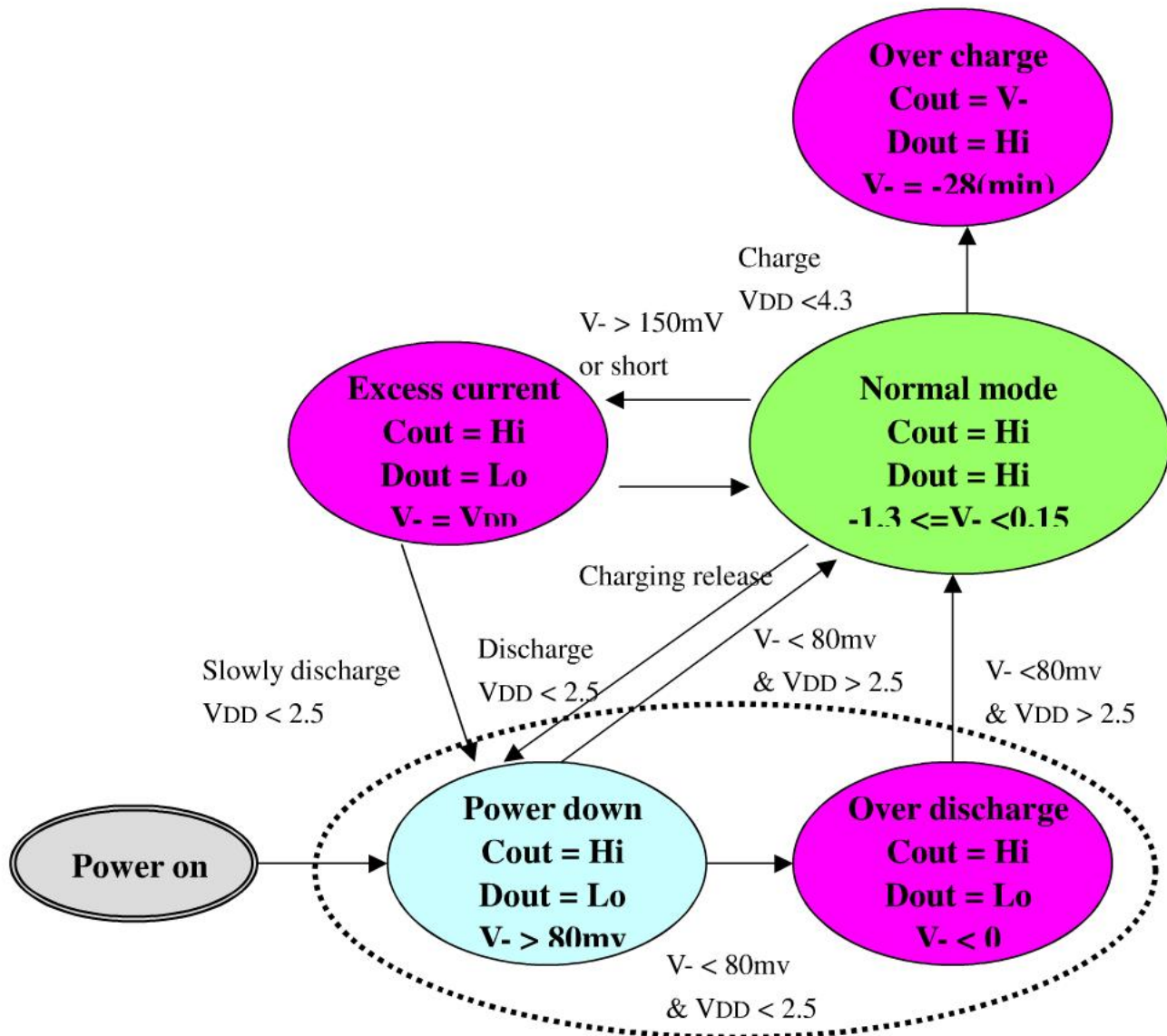
Item	Symbol	Rating	Unit
Supply voltage	V _{DD}	-0.3 ~ 12	V
Charge minus pin input voltage	V ₋	V _{DD} -28 ~ V _{DD} +0.3	V
C _{OUT} pin input voltage	V _{COUT}	V _{DD} -28 ~ V _{DD} +0.3	V
D _{OUT} pin input voltage	V _{DOUT}	V _{DD} -28 ~ V _{DD} +0.3	V
Operating temperature	T _{OPT}	-40 ~ +80	°C
Storage temperature	T _{STG}	-55 ~ +125	°C

Electrical CharacteristicsT_{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	t _{VDET1}	V _{DD} =3.6V→4.4V	50		270	ms
Overcharge release voltage	V _{REL1}		4.060	4.100	4.140	V
Overdischarge detection voltage	V _{DET2}	Detect falling edge of supply voltage	2.4	2.5	2.6	V
Overdischarge detection delay time	t _{VDET2}	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	t _{VDET3}	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	t _{VSHORT}	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 V_{DD} 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 $V_{DD}=2.0V$ 0.6 μA 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 ($V_{DD}-0.5V$ 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**