Protection of Lithium Ion Batteries
Monolithic IC MM1414

Outline

This IC is use to protect lithium-ion batteries consisting of three or four cells. It adopts a compact package and has the functions of previous models, with functions for overcharge detection, overdischarge detection and overcurrent detection. A dead time can be set externally.

Features

1. Overcharge detection voltage accuracy ±25mV/cell
2. Consumption current (Vcell=4.4V) 50µA typ.
3. Consumption current (Vcell=3.5V) 23µA typ.
4. Consumption current (Vcell=1.8V) 2µA typ.
5. Overcharge sensing dead time: can be set externally
6. PF detection: warning signal when cell voltage falls

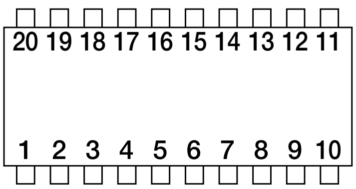
Package

TSOP-20A

Applications

IC for protection of lithium-ion batteries consisting of three or four cells

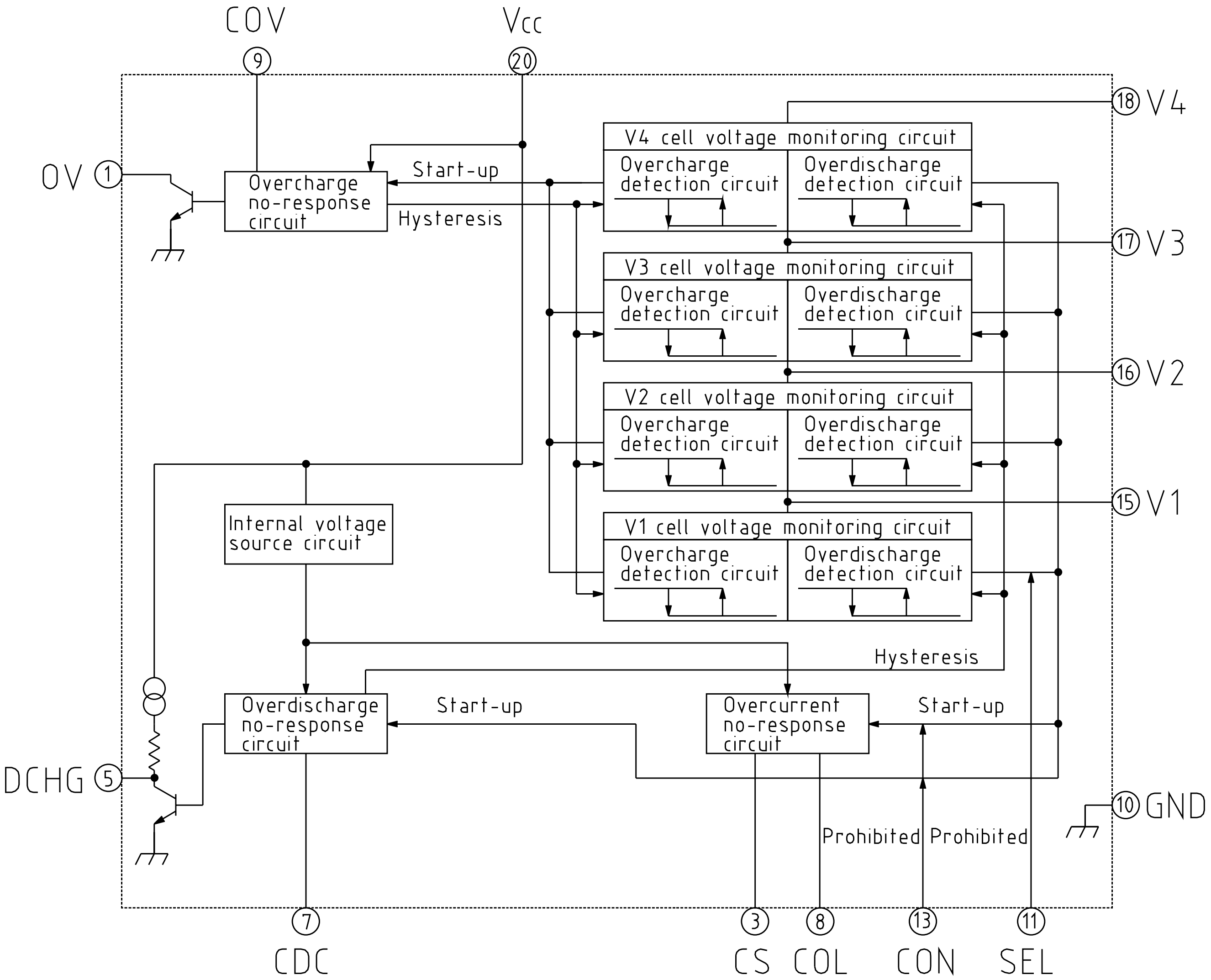
Pin Assignment



TSOP-20A

1	OV	11	SEL
2	N.C	12	N.C
3	CS	13	CON
4	N.C	14	N.C
5	DCHG	15	V1
6	N.C	16	V2
7	CDC	17	V3
8	COL	18	V4
9	COV	19	N.C
10	GND	20	Vcc

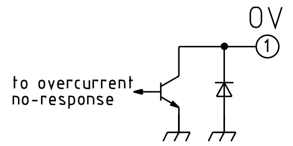
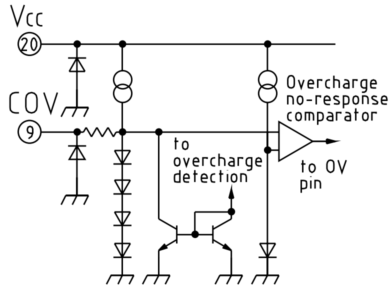
Block Diagram



Pin Description

Pin No.	Pin name	I/O	Functions
1	OV	Output	Overcharge detection output pin NPNTr open collector output Normal: high impedance Overcharge: Low
2	N.C		Not connected
3	CS	Input	Overcurrent detection pin Monitors load current equivalently by the voltage drop between discharge control FET source and drain, and makes DCHG pin high when the voltage goes below overcurrent detection voltage, turning off discharge control FET. After overcurrent detection, current flows from this pin and when there is a light load, overcurrent mode is released. This function does not operate in discharge mode.
4	N.C		Not connected
5	DCHG	Output	Discharge control FET (P-ch) drive pin Normal: Low Overdischarge: High
6	N.C		Not connected
7	CDC	Input	Overdischarge detection dead time setting pin Dead time can be set by connecting a capacitor between CDC pin and ground.
8	COL	Input	Overcurrent detection dead time setting pin Dead time can be set by connecting a capacitor between COL pin and ground.
9	COV	Input	Overcharge detection dead time setting pin Dead time can be set by connecting a capacitor between COV pin and ground.
10	GND	Input	Ground pin
11	SEL	Input	3 cell switch pin SEL pin = GND: 3 cell (no V1 cell detection) SEL pin = V_{CC}: 4 cell
12	N.C		Not connected
13	CON	Input	Discharge FET ON/OFF pin CON pin low; DCHG pin low CON pin high; DCHG pin high
14	N.C		Not connected
15	V1	Input	V1 cell high side voltage input pin
16	V2	Input	V2 cell high side voltage and V3 cell low side voltage input pin
17	V3	Input	V3 cell high side voltage and V4 cell low side voltage input pin
18	V4	Input	V4 cell high side voltage input pin
19	N.C		Not connected
20	V_{CC}	Input	Power supply input pin

Pin Description

<table>
<tr><th></th><th>Equivalent circuit diagram</th><th></th><th>Equivalent circuit diagram</th></tr>
<tr><td>1 ; OV</td><td>
</td><td>9 ; COV</td><td>
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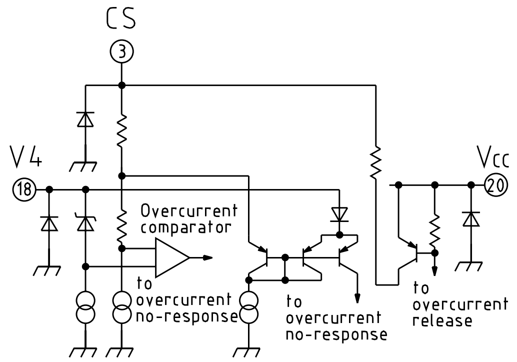
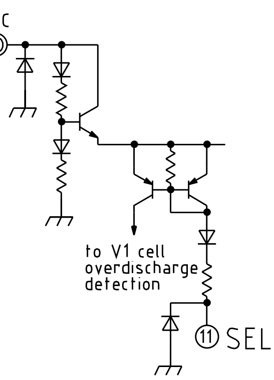
<tr><td>3 ; CS</td><td>
</td><td>11 ; SEL</td><td>
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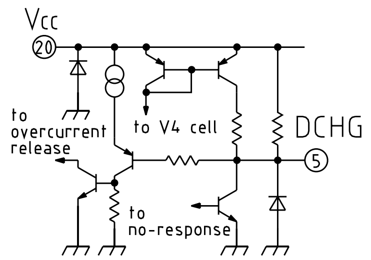
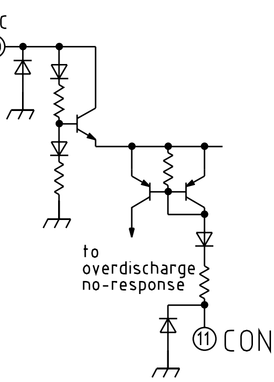
<tr><td>5 ; DCHG</td><td>
</td><td>13 ; CON</td><td>
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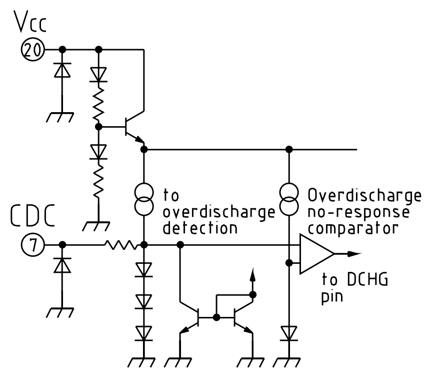
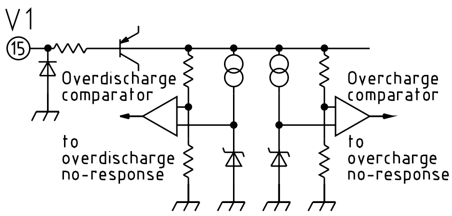
<tr><td>7 ; CDC</td><td>
</td><td>15 ; V1</td><td>
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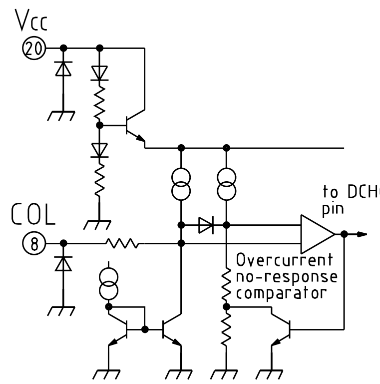
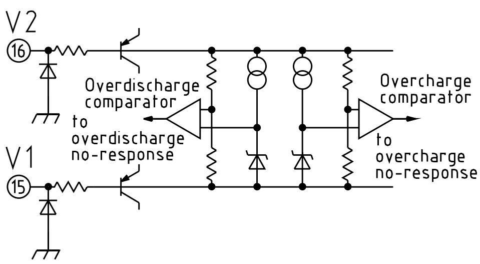
<tr><td>8 ; COL</td><td>
</td><td>16 ; V2</td><td>
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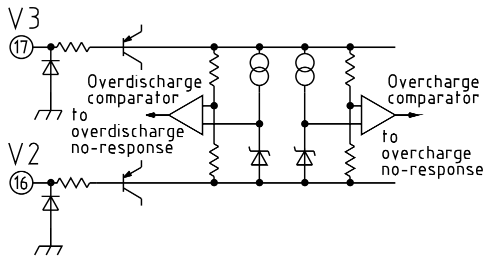
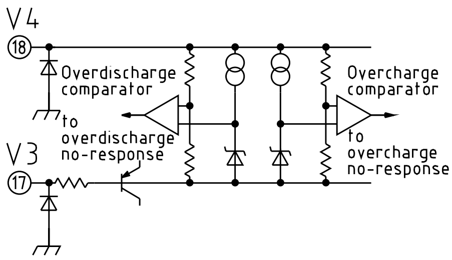
	Equivalent circuit diagram		Equivalent circuit diagram
17 ; V3		18 ; V4	

Absolute Maximum Ratings (Ta=5°C)

Item	Symbol	Ratings	Unit
Storage temperature	T_{STG}	–40~+125	°C
Operating temperature	T_{OPR}	–20~+70	°C
Power supply voltage	V_{CC} max.	–0.3~24	V
OV pin impressed voltage	V_{OV} max.	–0.3~24	V
SEL pin impressed voltage	V_{SEL} max.	–0.3~24	V
CON pin impressed voltage	V_{CON} max.	–0.3~24	V
Allowable loss	Pd	300	mW

Recommended Operating Conditions

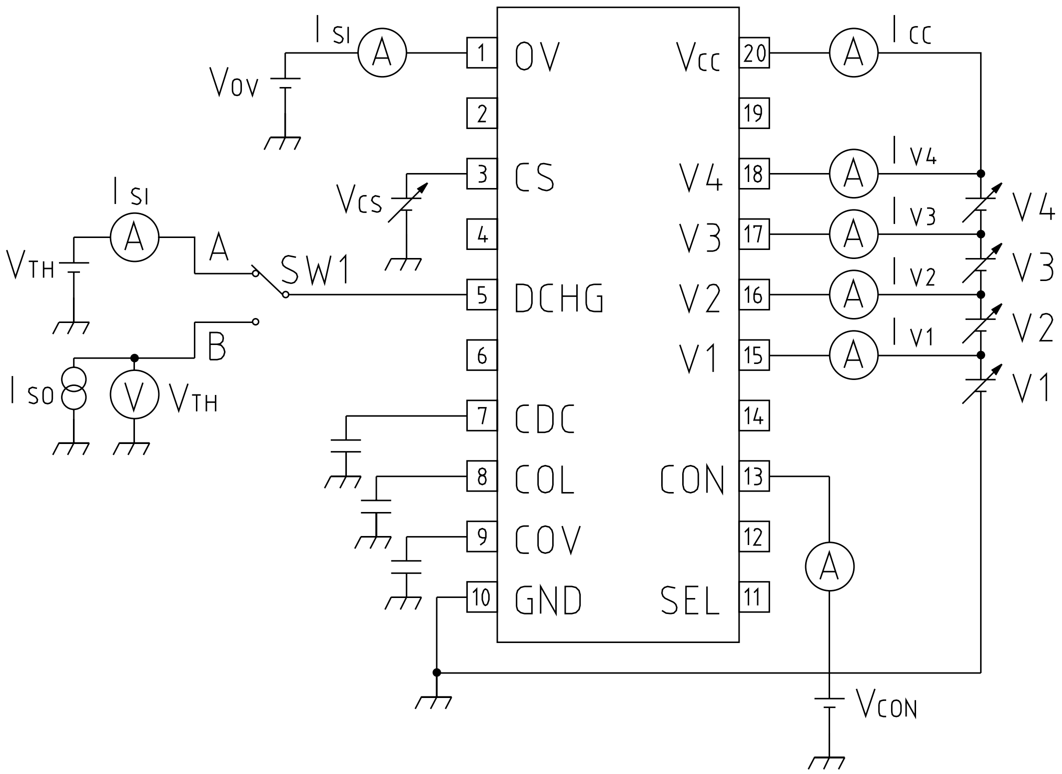
Item	Symbol	Ratings	Unit
Operating temperature	T_{OPR}	–20~+70	°C
Operating voltage	V_{OPR}	+1.8~+24	V

Electrical Characteristics

(Except where noted otherwise, Ta=25°C, VCC=V4+V3+V2+V1, VCEL=3.5V, CON=0V, SEL=0V)

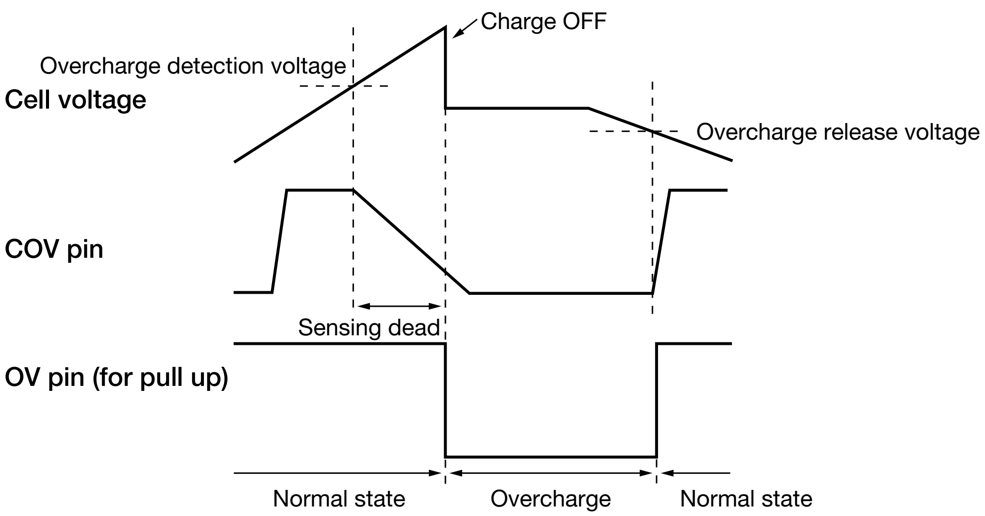
Item	Symbol	Measurement conditions		Min.	Typ.	Max.	Unit
Consumption current (VCC pin) 1	ICC1	VCELL=4.4V, CON=0V			55	110	μA
Consumption current (VCC pin) 2	ICC2	VCELL=3.5V, CON=0V			27	50	μA
Consumption current (VCC pin) 3	ICC3	VCELL=1.8V, CON=0V			2	4	μA
Consumption current (VCC pin) 4	ICC4	VCELL=3.5V, CON=VCC			12	20	μA
Consumption current (VCC pin) 5	ICC5	VCELL=1.8V, CON=VCC			1	2	μA
Consumption current (V4 pin) 1	I1V4	VCELL=4.4V			10	20	μA
Consumption current (V4 pin) 2	I2V4	VCELL=3.5V			8	15	μA
Consumption current (V4 pin) 3	I3V4	VCELL=1.8V			2.5	5.0	μA
V3 pin input current	IV3	VCELL=3.5V				±300	nA
V2 pin input current	IV2	VCELL=3.5V				±300	nA
V1 pin input current	IV1	VCELL=3.5V				±300	nA
Overcharge detection voltage	VCELLU	VCELL : 4.2V→4.4V	A, C	4.325	4.350	4.375	V
			B, D	4.225	4.250	4.275	
Overcharge hysteresis voltage	⊿VU	VCELL : 4.2V→4.4V→3.9V		140	200	260	mV
Overcharge sensing dead time	tOV	COV=0.1μF		0.5	1.0	1.5	S
Overdischarge detection voltage	VCELLS	VCELL : 3.5V→1.8V	A, B	1.90	2.00	2.10	V
			C, D	2.20	2.30	2.40	
Discharge resume voltage	VCELLD	VCELL : 1.8V→3.5V		2.85	3.00	3.15	V
Overdischarge hysteresis voltage	⊿VDS	VCELLD–VCELLS	A, B	0.75	1.00	1.25	V
			C, D	0.45	0.70	0.95	
Overdischarge sensing dead time	tCDC	CDC=0.1μF		0.5	1.0	1.5	S
Overcurrent detection voltage	VOC	VCC–VCS, DCHG		135	150	165	mV
Overcurrent hysteresis voltage	⊿VOC				20	40	mV
Overcurrent sensing dead time 1	tCOL1	COL=0.001μF		5	10	15	mS
Overcurrent sensing dead time 2	tCOL2	COL=0.001μF, VCC–CS>1.0V			1.5	3.0	mS
Overcurrent sensing dead time 3	tCOL3	COL=0.001μF		5	10	15	mS
Overcurrent reset conditions				Load release conditions 500kΩ			
DCHG pin source current	ISODCH	VCELL=1.8V, SW1 : A VDCHG=VCC–0.8V		20			μA
DCHG pin sink current	ISIDCH	VCELL=3.5V, SW1 : A VDCHG=0.8V		20			μA
DCHG pin output voltage H	VTHDCH	VCC–VDCHG, ISO=20μA, SW1 : B				0.8	V
DCHG pin output voltage L	VTHDCL	VDCHG–GND, ISI=–20μA, SW1 : B				0.8	V
OV pin sink current	ISIOV	VOV=0.4V, Ta=–20~+70°C		100			μA
OV pin leak current	ILKOV	VOV=24V				0.1	μA
CON pin L voltage		DCHG= "High"				0.4	V
CON pin H voltage		DCHG= "Low"		VCC-0.4			V
CON pin current		VCELL=3.5V, CON=0.4V			1	2	μA
SEL pin L voltage		for 3 cell				0.4	V
SEL pin H voltage		for 4 cell		VCC-0.4			V
SEL pin current		VCELL=3.5V, SEL=0.4V			1	2	μA

Measuring Circuit

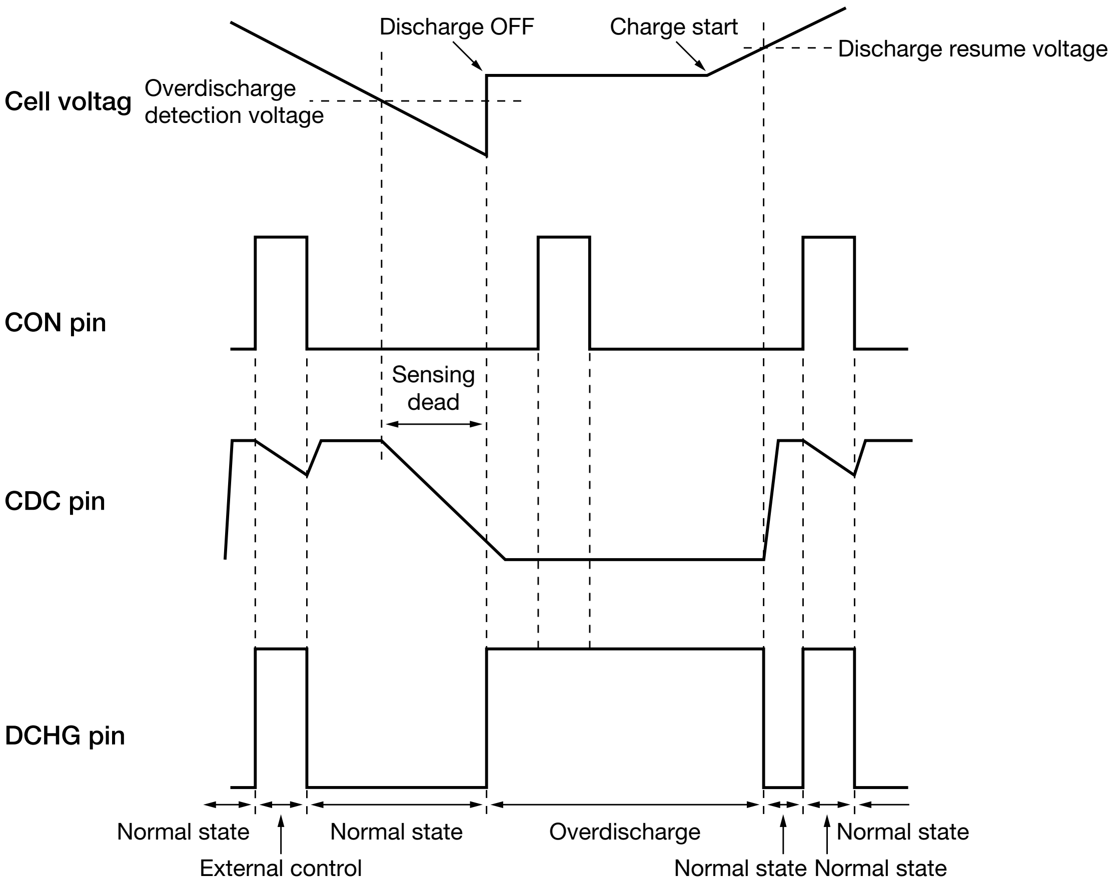


Timing Chart

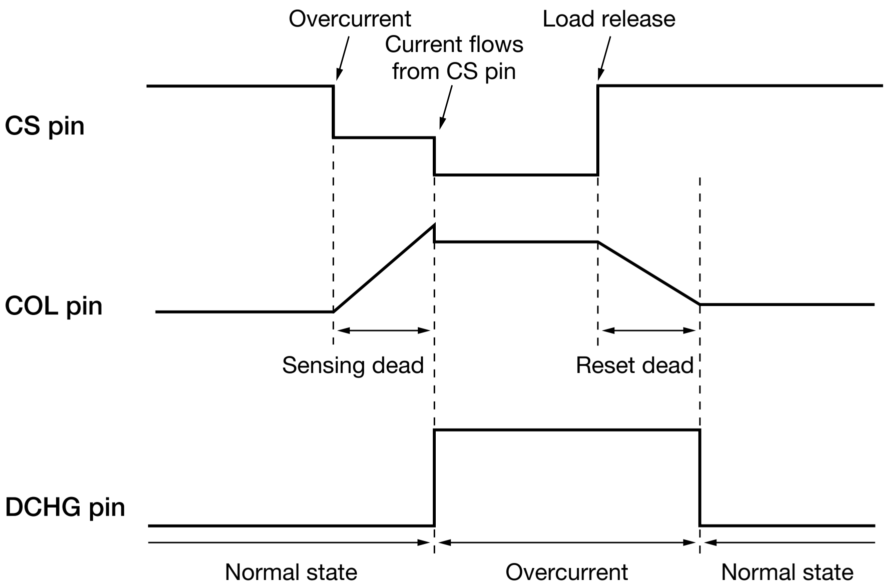
For overcharge



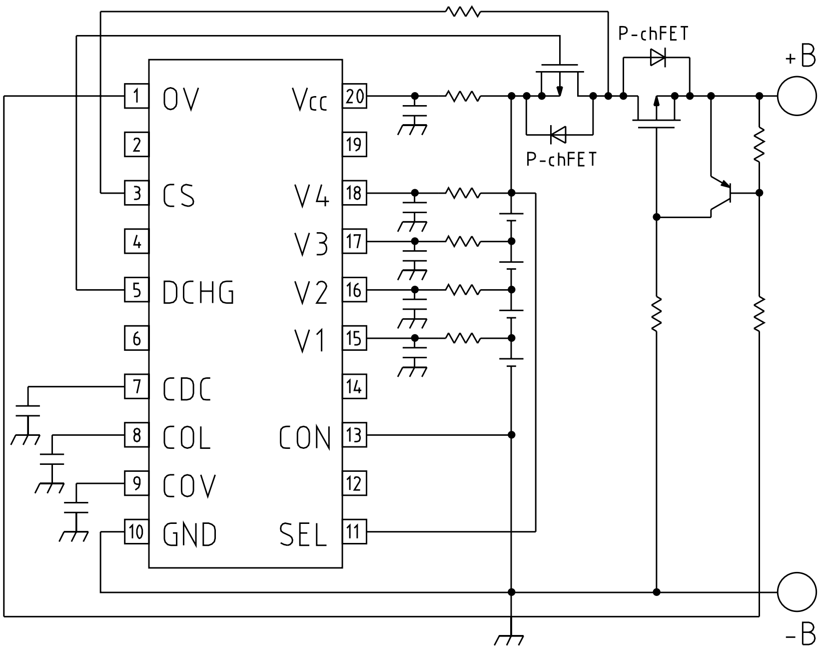
For overdischarge



For overcurrent

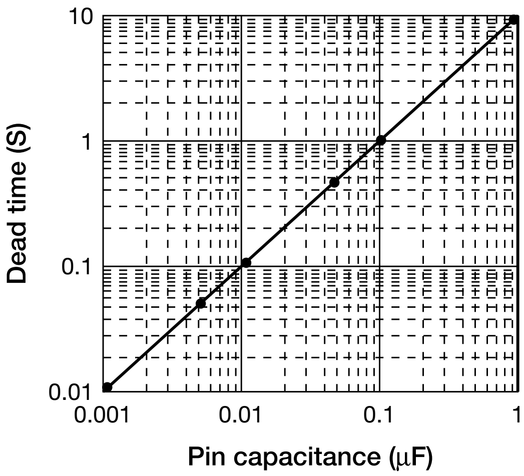


Application Circuit

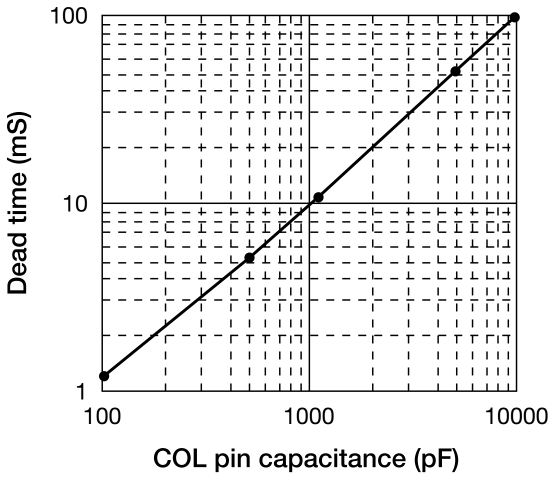


Characteristics

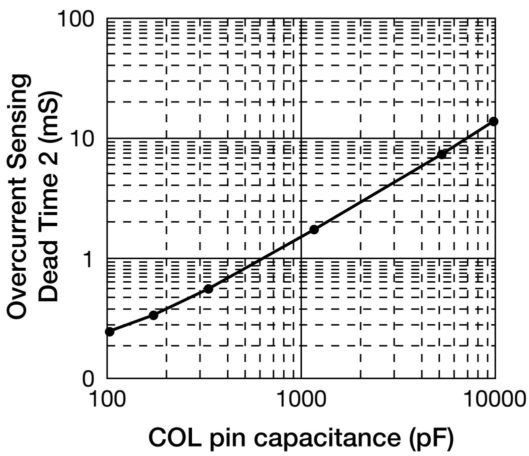
■ Overcharge & Overdischarge Sensing Dead Times



■ Overcurrent Sensing Dead Time 1, Overcurrent Reset Dead Time



■ Overcurrent Sensing Dead Time 2



Note: The above characteristics are representative values only, and are not guaranteed.