

# Protection of Lithium Ion Batteries

## Monolithic IC MM1414

### Outline

This IC is used 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                       $\pm 25\text{mV/cell}$
2. Consumption current ( $V_{\text{cell}}=4.4\text{V}$ )                               $50\mu\text{A typ.}$
3. Consumption current ( $V_{\text{cell}}=3.5\text{V}$ )                               $23\mu\text{A typ.}$
4. Consumption current ( $V_{\text{cell}}=1.8\text{V}$ )                               $2\mu\text{A typ.}$
5. Overcharge sensing dead time: can be set externally
6. PF detection: warning signal when cell voltage falls

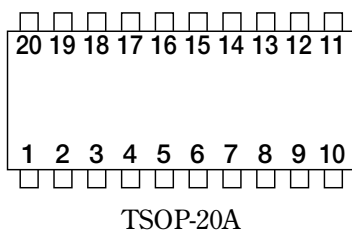
### Package

TSOP-20A

### Applications

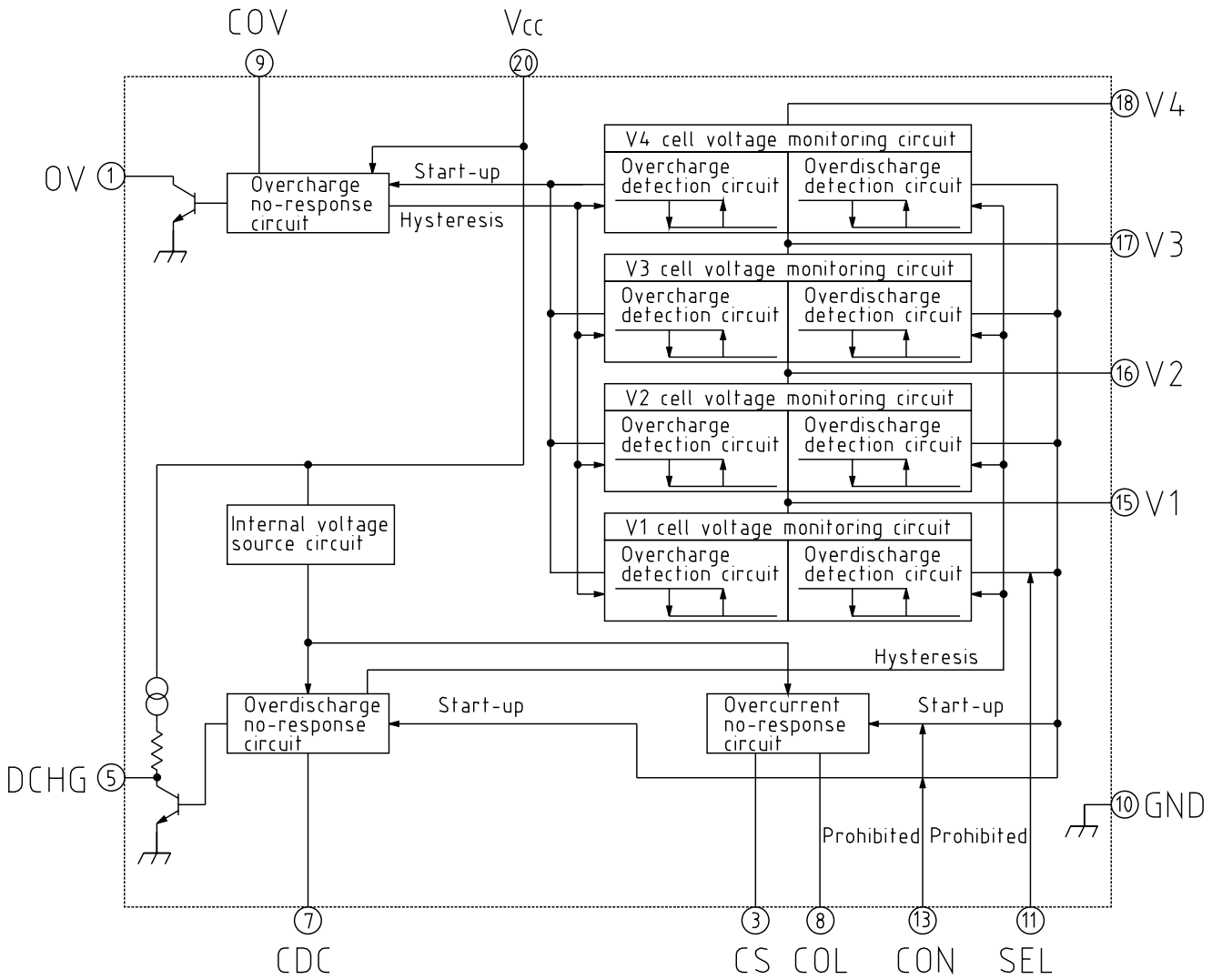
IC for protection of lithium-ion batteries consisting of three or four cells

### Pin Assignment



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	V <sub>CC</sub>

Block Diagram

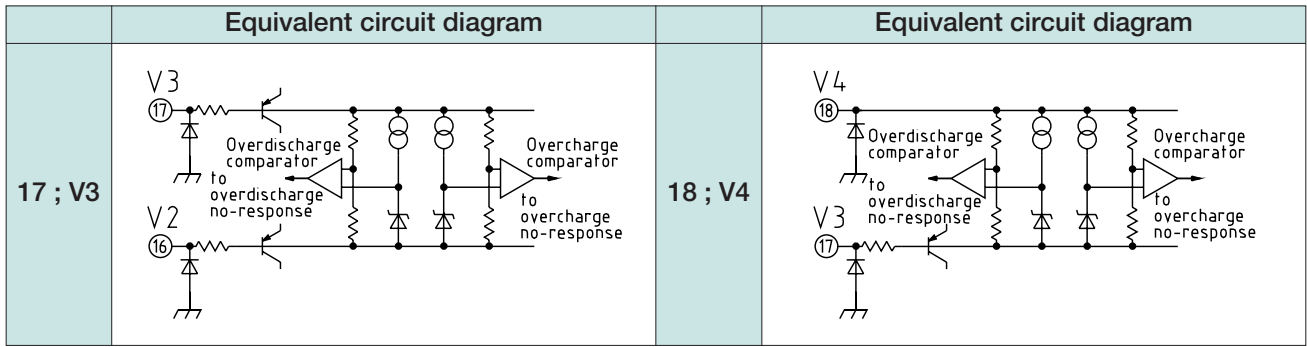


## Pin Description

Pin No.	Pin name	I/O	Functions
1	OV	Output	Overcharge detection output pin NPNT <sub>r</sub> 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 <sub>cc</sub> : 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 <sub>cc</sub>	Input	Power supply input pin

Pin Description

	Equivalent circuit diagram		Equivalent circuit diagram
1 ; OV		9 ; COV	
3 ; CS		11 ; SEL	
5 ; DCHG		13 ; CON	
7 ; CDC		15 ; V1	
8 ; COL		16 ; V2	



**Absolute Maximum Ratings** (Ta=5°C)

Item	Symbol	Ratings	Unit
Storage temperature	T <sub>STG</sub>	-40~+125	°C
Operating temperature	T <sub>OPR</sub>	-20~+70	°C
Power supply voltage	V <sub>CC</sub> max.	-0.3~24	V
OV pin impressed voltage	V <sub>OV</sub> max.	-0.3~24	V
SEL pin impressed voltage	V <sub>SEL</sub> max.	-0.3~24	V
CON pin impressed voltage	V <sub>CON</sub> max.	-0.3~24	V
Allowable loss	P <sub>d</sub>	300	mW

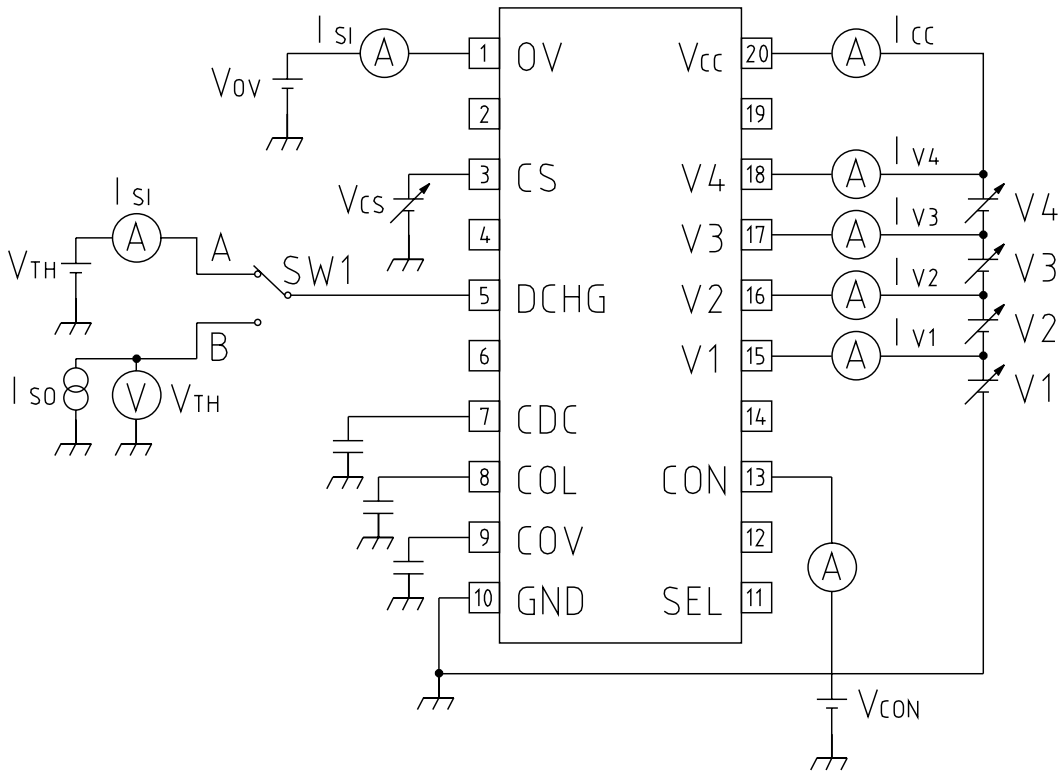
**Recommended Operating Conditions**

Item	Symbol	Ratings	Unit
Operating temperature	T <sub>OPR</sub>	-20~+70	°C
Operating voltage	V <sub>OPR</sub>	+1.8~+24	V

**Electrical Characteristics** (Except where noted otherwise, Ta=25°C, Vcc=V4+V3+V2+V1, Vcell=3.5V, CON=0V, SEL=0V)

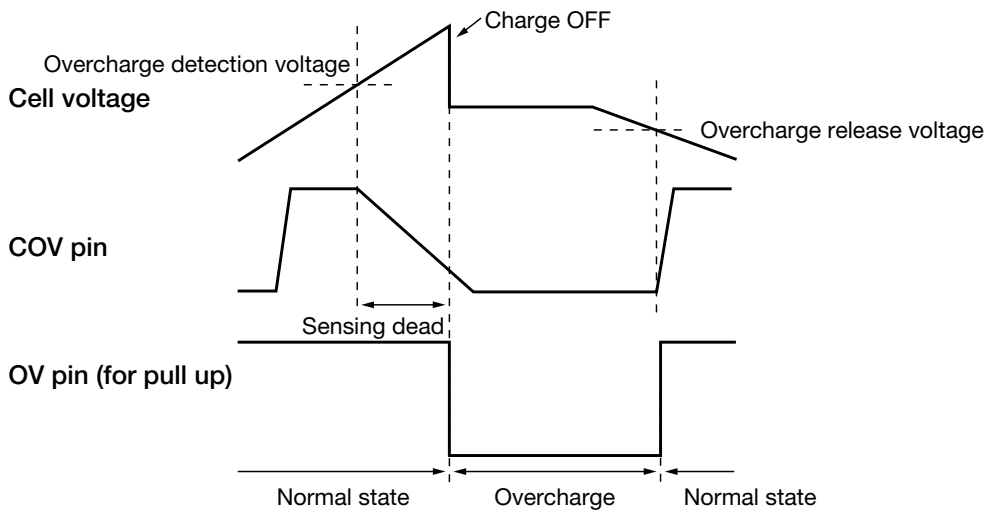
Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Unit	
Consumption current (Vcc pin) 1	Icc1	VCELL=4.4V, CON=0V		55	110	μA	
Consumption current (Vcc pin) 2	Icc2	VCELL=3.5V, CON=0V		27	50	μA	
Consumption current (Vcc pin) 3	Icc3	VCELL=1.8V, CON=0V		2	4	μA	
Consumption current (Vcc pin) 4	Icc4	VCELL=3.5V, 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	ΔVU	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	ΔVDS	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	ΔVOC			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	ILROV	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

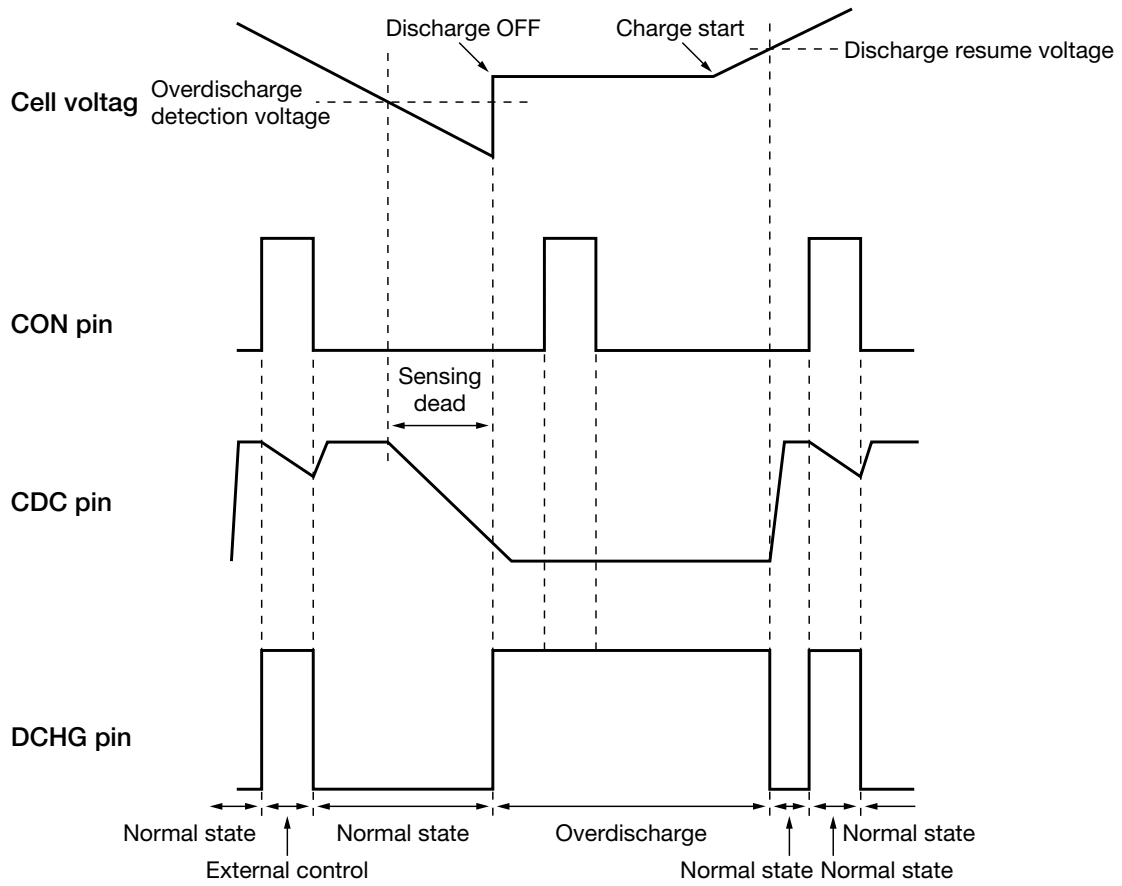


Timing Chart

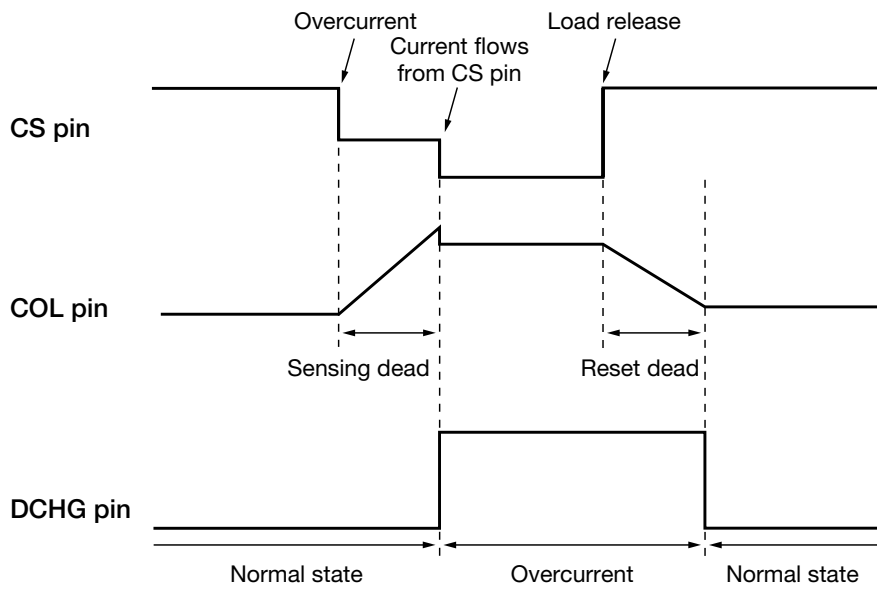
■ For overcharge



■ For overdischarge

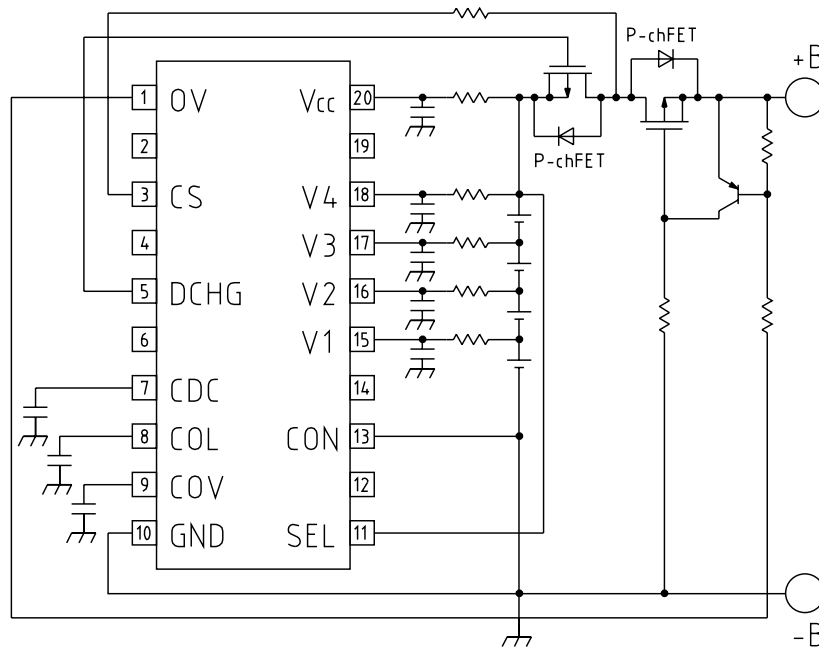


■ For overcurrent



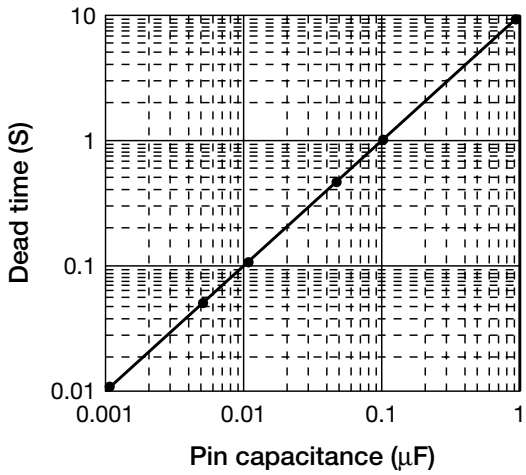


Application Circuit

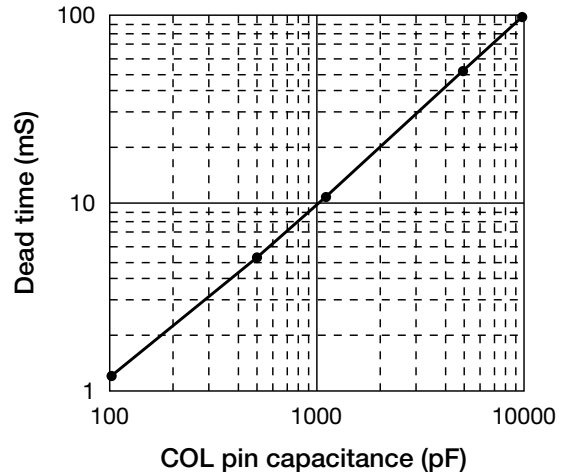


Characteristics

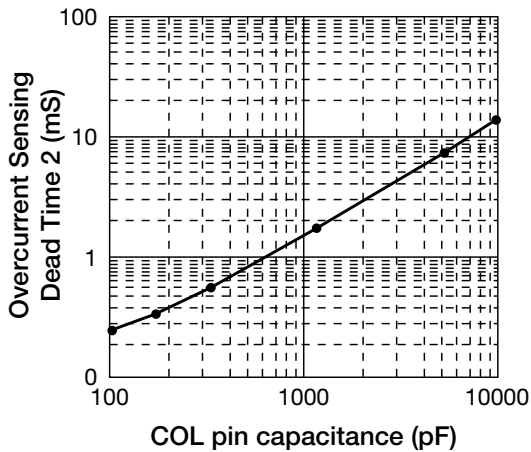
Overcharge & Overdischarge Sensing Dead Times



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.