

# 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  $\pm 25\text{mV/cell}$
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

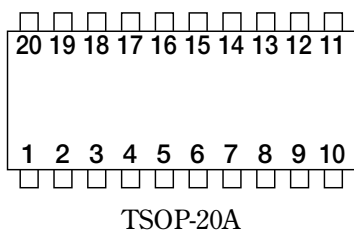
## Package

TSOP-20A

## Applications

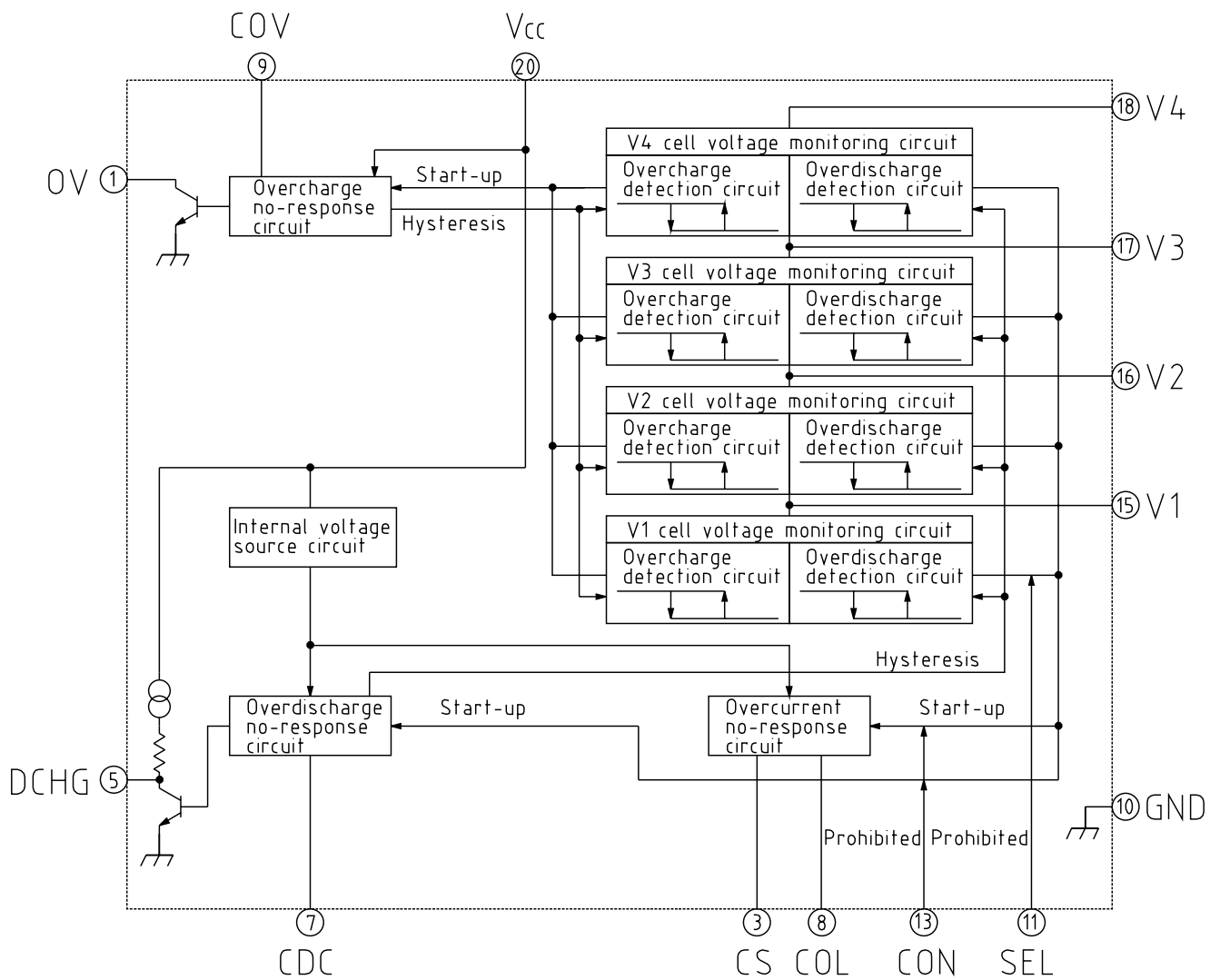
IC for protection of lithium-ion batteries consisting of three or four cells

## 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

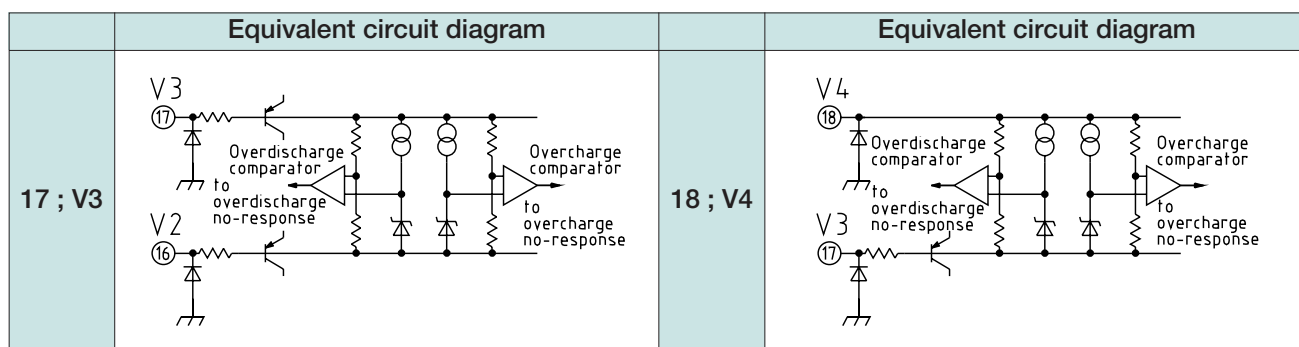


## Pin Description

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

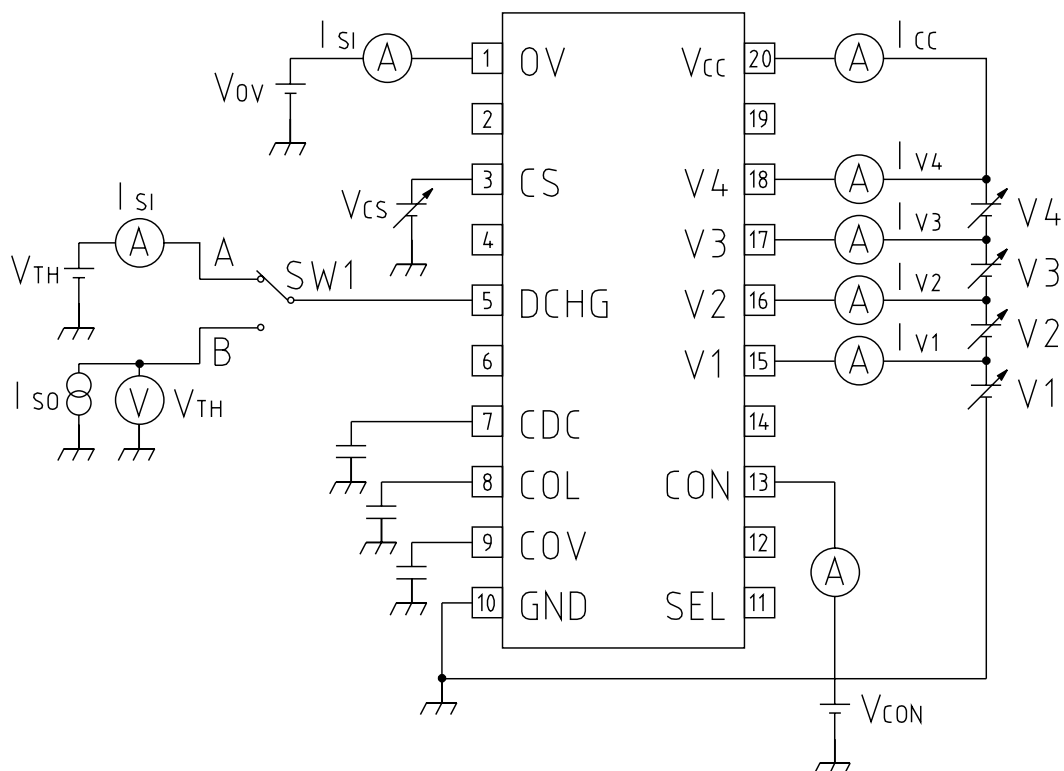
## Recommended Operating Conditions

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, V<sub>CC</sub>=V<sub>4</sub>+V<sub>3</sub>+V<sub>2</sub>+V<sub>1</sub>, V<sub>CELL</sub>=3.5V, CON=0V, SEL=0V)

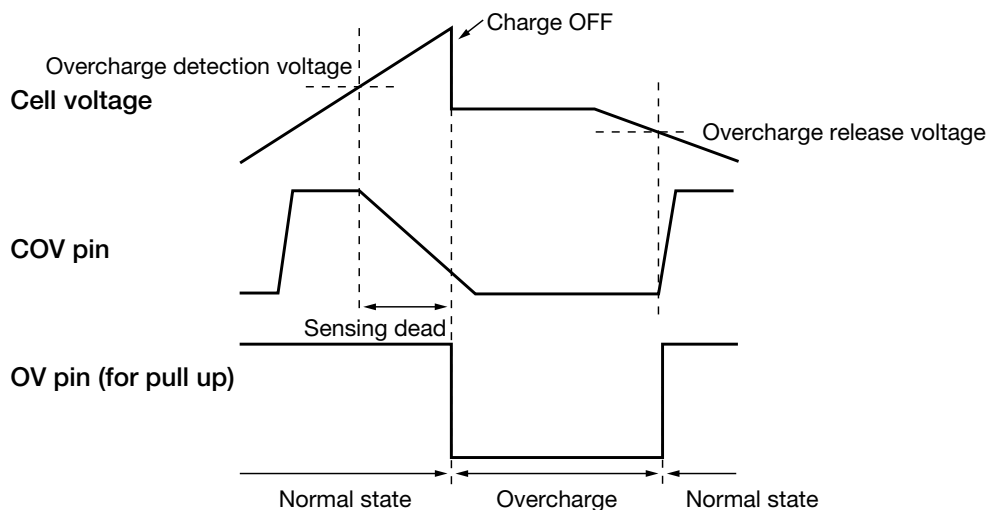
Item	Symbol	Measurement conditions		Min.	Typ.	Max.	Unit
Consumption current (V <sub>CC</sub> pin) 1	I <sub>CC1</sub>	V <sub>CELL</sub> =4.4V, CON=0V			55	110	μA
Consumption current (V <sub>CC</sub> pin) 2	I <sub>CC2</sub>	V <sub>CELL</sub> =3.5V, CON=0V			27	50	μA
Consumption current (V <sub>CC</sub> pin) 3	I <sub>CC3</sub>	V <sub>CELL</sub> =1.8V, CON=0V			2	4	μA
Consumption current (V <sub>CC</sub> pin) 4	I <sub>CC4</sub>	V <sub>CELL</sub> =3.5V, CON=V <sub>CC</sub>			12	20	μA
Consumption current (V <sub>CC</sub> pin) 5	I <sub>CC5</sub>	V <sub>CELL</sub> =1.8V, CON=V <sub>CC</sub>			1	2	μA
Consumption current (V4 pin) 1	I1V4	V <sub>CELL</sub> =4.4V			10	20	μA
Consumption current (V4 pin) 2	I2V4	V <sub>CELL</sub> =3.5V			8	15	μA
Consumption current (V4 pin) 3	I3V4	V <sub>CELL</sub> =1.8V			2.5	5.0	μA
V3 pin input current	IV3	V <sub>CELL</sub> =3.5V				±300	nA
V2 pin input current	IV2	V <sub>CELL</sub> =3.5V				±300	nA
V1 pin input current	IV1	V <sub>CELL</sub> =3.5V				±300	nA
Overcharge detection voltage	V <sub>CELLU</sub>	V <sub>CELL</sub> : 4.2V→4.4V	A, C	4.325	4.350	4.375	V
			B, D	4.225	4.250	4.275	
Overcharge hysteresis voltage	ΔV <sub>U</sub>	V <sub>CELL</sub> : 4.2V→4.4V→3.9V		140	200	260	mV
Overcharge sensing dead time	t <sub>OV</sub>	COV=0.1μF		0.5	1.0	1.5	S
Overdischarge detection voltage	V <sub>CELLS</sub>	V <sub>CELL</sub> : 3.5V→1.8V	A, B	1.90	2.00	2.10	V
			C, D	2.20	2.30	2.40	
Discharge resume voltage	V <sub>CELLD</sub>	V <sub>CELL</sub> : 1.8V→3.5V		2.85	3.00	3.15	V
Overdischarge hysteresis voltage	ΔV <sub>DS</sub>	V <sub>CELLD</sub> -V <sub>CELLS</sub>	A, B	0.75	1.00	1.25	V
			C, D	0.45	0.70	0.95	
Overdischarge sensing dead time	t <sub>CDC</sub>	CDC=0.1μF		0.5	1.0	1.5	S
Overcurrent detection voltage	V <sub>OC</sub>	V <sub>CC</sub> -V <sub>CS</sub> , DCHG		135	150	165	mV
Overcurrent hysteresis voltage	ΔV <sub>OC</sub>				20	40	mV
Overcurrent sensing dead time 1	t <sub>COL1</sub>	COL=0.001μF		5	10	15	mS
Overcurrent sensing dead time 2	t <sub>COL2</sub>	COL=0.001μF, V <sub>CC</sub> -CS>1.0V			1.5	3.0	mS
Overcurrent sensing dead time 3	t <sub>COL3</sub>	COL=0.001μF		5	10	15	mS
Overcurrent reset conditions		Load release conditions 500kΩ					
DCHG pin source current	I <sub>SO</sub> D <sub>CH</sub>	V <sub>CELL</sub> =1.8V, SW1 : A VDCHG=V <sub>CC</sub> -0.8V		20			μA
DCHG pin sink current	I <sub>SI</sub> D <sub>CH</sub>	V <sub>CELL</sub> =3.5V, SW1 : A VDCHG=0.8V		20			μA
DCHG pin output voltage H	V <sub>TH</sub> D <sub>cH</sub>	V <sub>CC</sub> -VDCHG, I <sub>SO</sub> =20μA, SW1 : B				0.8	V
DCHG pin output voltage L	V <sub>TH</sub> D <sub>cL</sub>	VDCHG-GND, I <sub>SI</sub> =-20μA, SW1 : B				0.8	V
OV pin sink current	I <sub>SI</sub> OV	VOV=0.4V, Ta=-20~+70°C		100			μA
OV pin leak current	I <sub>LK</sub> OV	VOV=24V				0.1	μA
CON pin L voltage		DCHG= "High"				0.4	V
CON pin H voltage		DCHG= "Low"		V <sub>CC</sub> -0.4			V
CON pin current		V <sub>CELL</sub> =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		V <sub>CC</sub> -0.4			V
SEL pin current		V <sub>CELL</sub> =3.5V, SEL=0.4V			1	2	μA

## Measuring Circuit

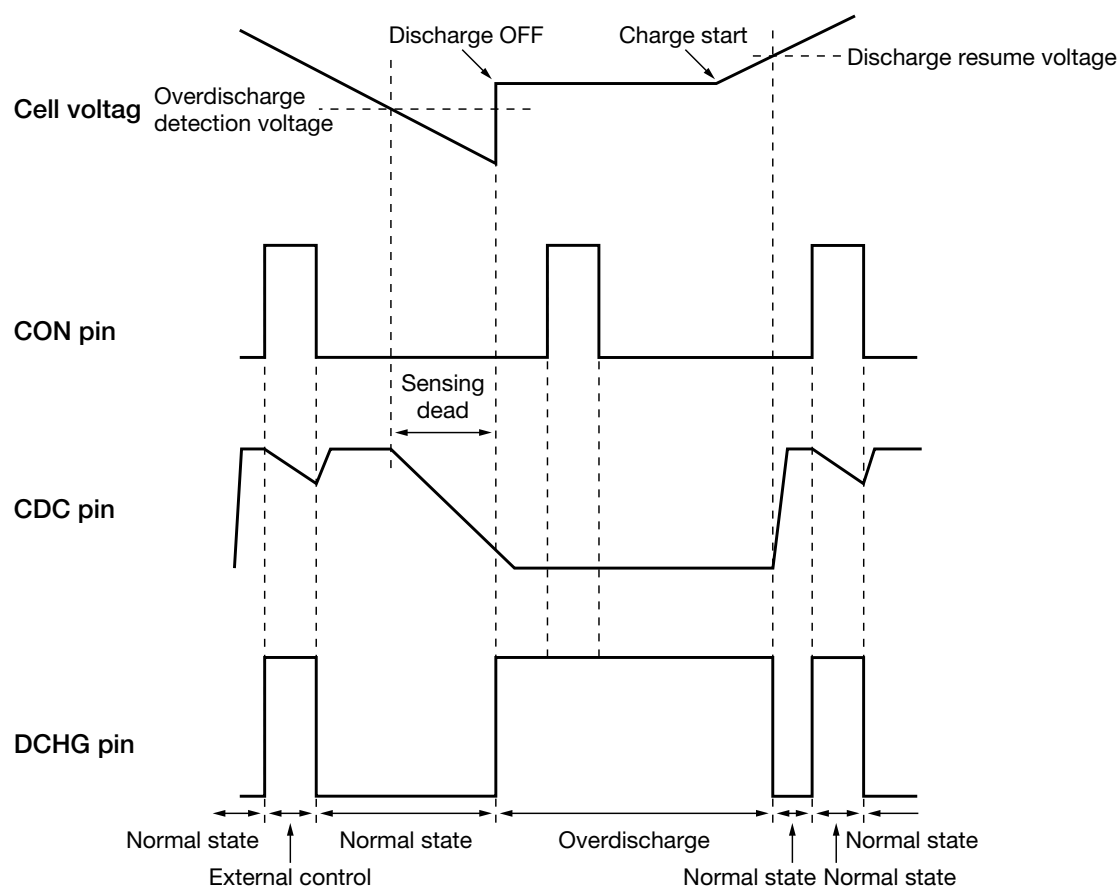


## Timing Chart

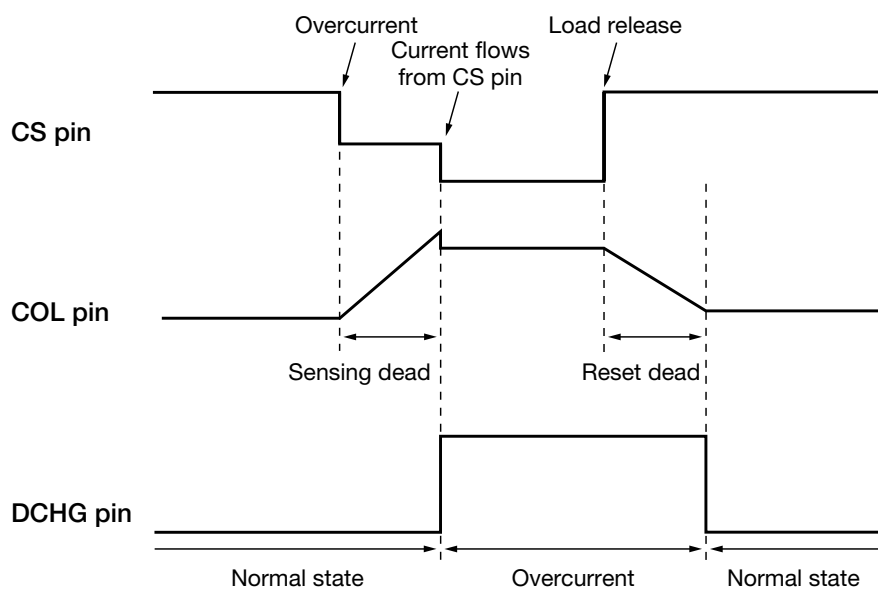
### ■ For overcharge



■ For overdischarge

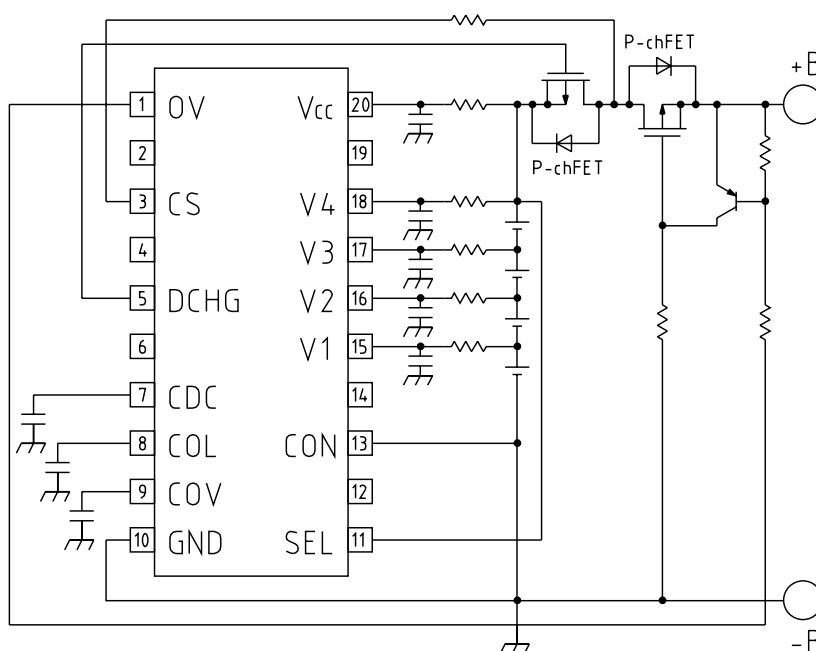


■ For overcurrent



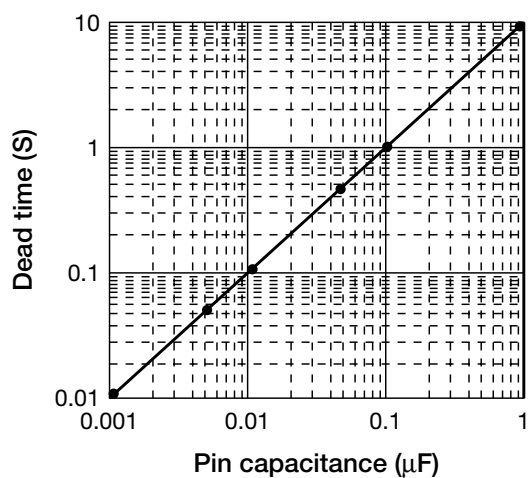


## Application Circuit

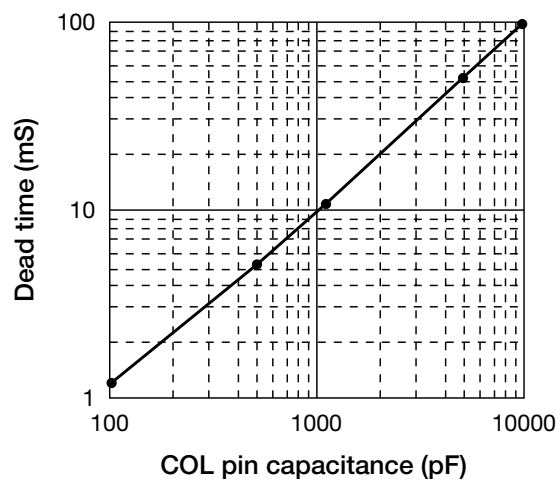


## Characteristics

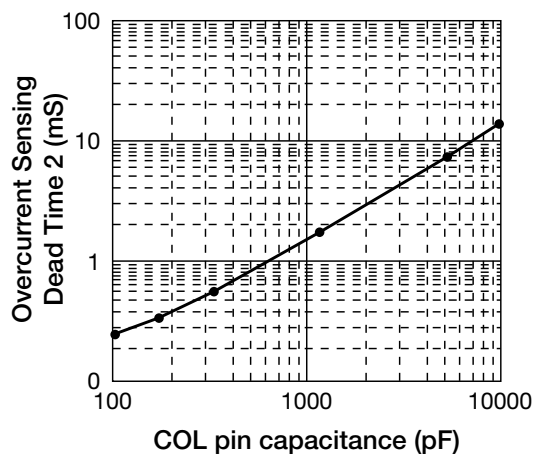
### Overcharge & Overdischarge Sensing Dead Times



### 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.