

# Protection of Lithium Ion Batteries (three four cells in series) Monolithic IC MM1414

April 14, 1999

## Outline

This IC protects lithium ion batteries in the event of overcharge, overdischarge and overcurrent. It has the following two functions: an overcurrent detection function that turns the external FET-SW off when a problem occurs during charging, etc. and excess voltage is impressed on each battery for longer than a certain time, and an overdischarge detection function that turns the external FET-SW off when battery voltage drops below a certain voltage during discharge, in order to prevent battery overdischarge. When these functions operate, the IC is put into low consumption current mode. It also has an overcurrent detection function that turns the FET-SW off when excess current flows due to a short or the like.

## Series Table

Temperature conditions A:  $T_a = -25 \sim 75^\circ\text{C}$ , B:  $T_a = -20 \sim 70^\circ\text{C}$ , C:  $T_a = 0 \sim 50^\circ\text{C}$ ,  
D:  $T_a = 0 \sim 40^\circ\text{C}$ , E:  $T_a = -20 \sim 25^\circ\text{C}$

Model	Package	Overcharge detection voltage (V)	Overcharge detection voltage temperature conditions	Overcharge detection hysteresis voltage (V)	Overdischarge detection voltage (V)	Overdischarge resumption voltage (V)	Overcurrent detection voltage (mV)
	TSOP-20A						
MM1414	AV	4.350±0.025	C	200±60	2.00±0.10	3.00±0.15	150±15
	CV	4.350±0.025	C	200±60	2.30±0.10	3.00±0.15	150±15
	DV	4.250±0.025	C	200±60	2.30±0.10	3.00±0.15	150±15
	FV	4.325±0.025	C	200±60	2.30±0.10	3.00±0.15	100±15
	GV	4.295±0.025	C	8±8	2.30±0.10	3.00±0.15	150±15

## Features

1. Consumption current (during overcharge)  $V_{\text{CELL}} = 4.4$  CON = 0V 55µA typ.
2. Consumption current (normal)  $V_{\text{CELL}} = 3.5\text{V}$  CON = 0V 15µA typ.
3. Consumption current (during overdischarge)  $V_{\text{CELL}} = 1.9\text{V}$  CON = 0V 0.5µA typ.
4. Consumption current (during overdischarge)  $V_{\text{CELL}} = 1.0\text{V}$  CON =  $V_{\text{CC}}$  0.1µA max.
5. Overcharge detection voltage ( $T_a = 0^\circ\text{C} \sim 50^\circ\text{C}$ )  
A, C, D, G; Load open 500kΩ or more  
F; Load open 1MEGΩ or more

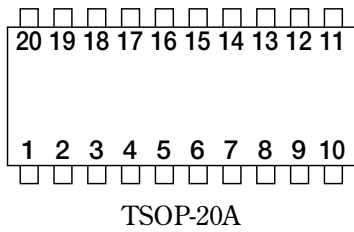
## Package

TSOP-20A

## Applications

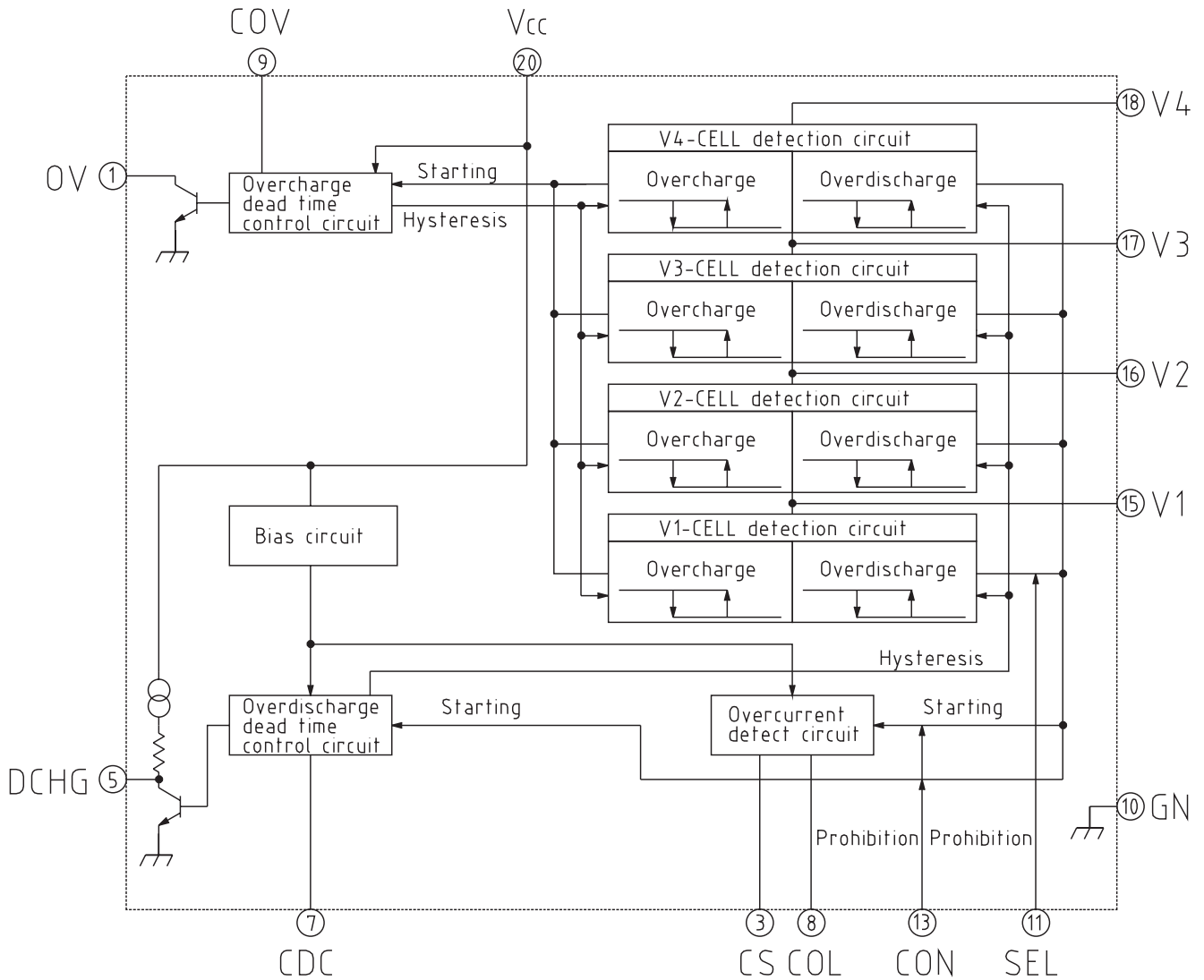
IC for protection of lithium-ion batteries consisting of three or four cells  
Notebook PC lithium - ion battery packs

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

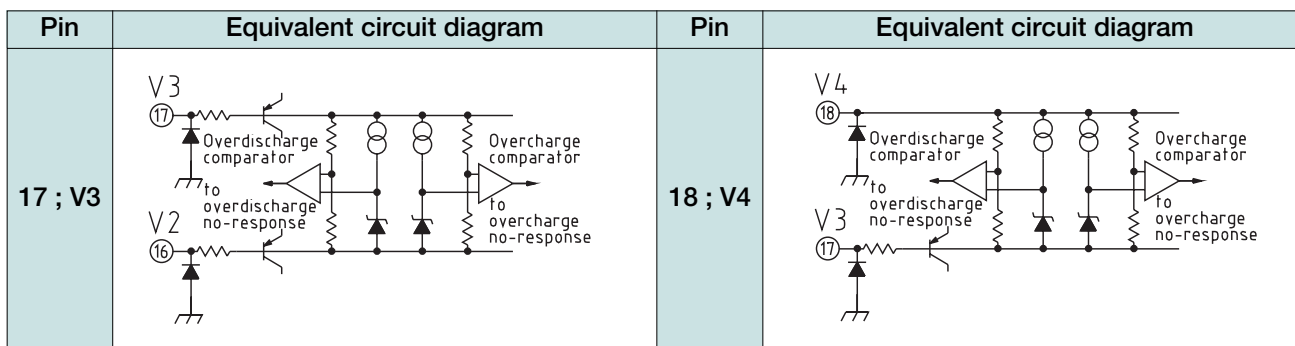


**Pin Description**

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		
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 overdischarge mode.
4	N.C		
5	DCHG	Output	Discharge control FET (P-ch) drive pin Normal: Low Overdischarge: High
6	N.C		
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	GND pin
11	SEL	Input	3 cell switch pin   SEL pin = GND: 3 cell (Connect V1 to GND) SEL pin = V <sub>cc</sub> : 4 cell
12	N.C		
13	CON	Input	Discharge FET ON/OFF pin CON pin low; DCHG pin low (Normal mode) CON pin high; DCHG pin high (Discharging prohibited)
14	N.C		
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		
20	V <sub>cc</sub>	Input	Power supply input pin

Pin Description

Pin	Equivalent circuit diagram	Pin	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

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	$P_d$	300	mW

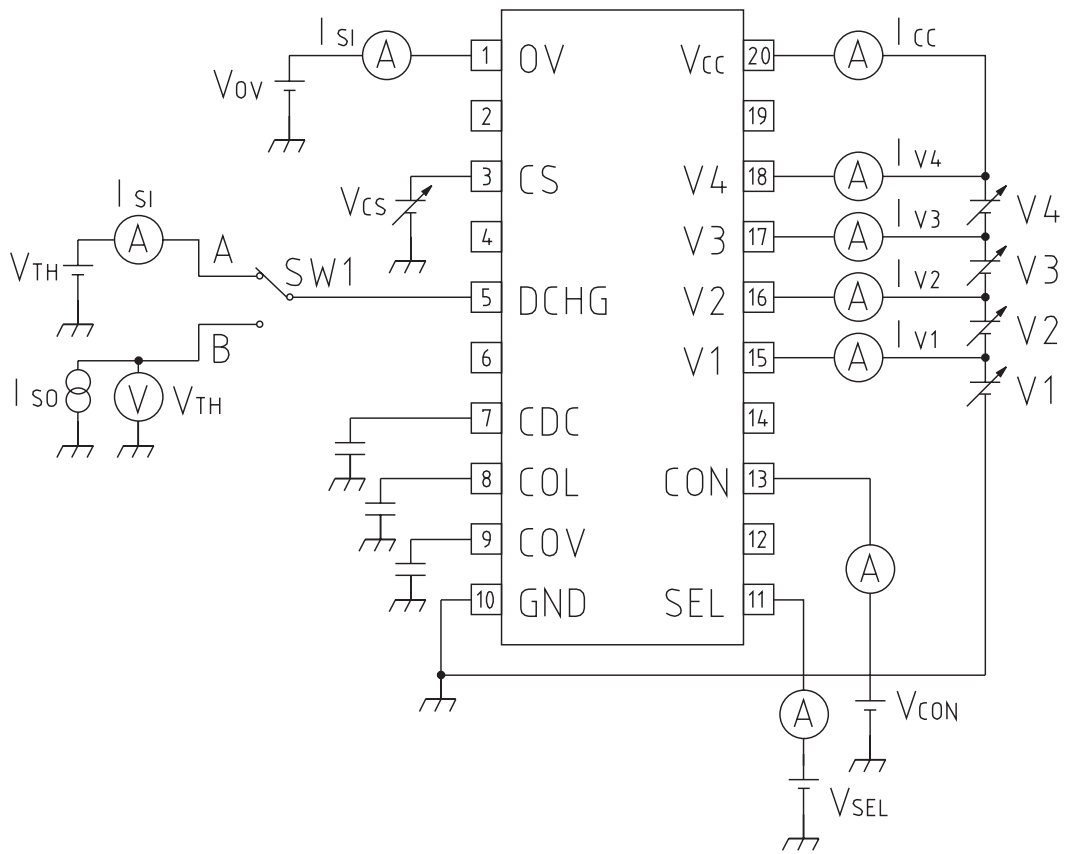
### Recommended Operating Conditions

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, VCELL=3.5V, CON=GND, SEL=Vcc) Models listed MM1414G

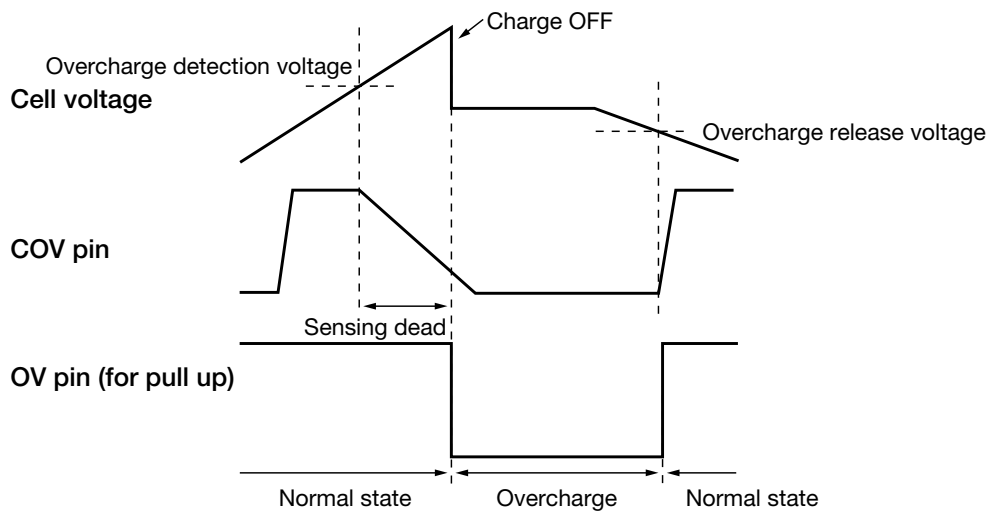
Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Unit
Consumption current (Vcc pin) 1	Icc1	VCELL=4.4V, CON=0V		55	110	μA
Consumption current (Vcc pin) 2	Icc2	VCELL=3.5V, CON=0V		27	50	μA
Consumption current (Vcc pin) 3	Icc3	VCELL=1.8V, CON=0V		2	4	μA
Consumption current (Vcc pin) 4	Icc4	VCELL=3.5V, 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	0	+300	nA
V2 pin input current	IV2	VCELL=3.5V	-300	0	+300	nA
V1 pin input current	IV1	VCELL=3.5V	-300	0	+300	nA
Overcharge detection voltage	VCELLU	VCELL : 4.2V→4.4V, Ta=0~50°C	4.270	4.295	4.320	V
Overcharge hysteresis voltage	ΔVU	VCELL : 4.2V→4.4V→3.9V		8	16	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	2.20	2.30	2.40	V
Discharge resume voltage	VCELLD	VCELL : 1.8V→3.5V	2.85	3.00	3.15	V
Overdischarge hysteresis voltage	ΔVDS	VCELLD-VCELLS	0.45	0.70	0.95	V
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

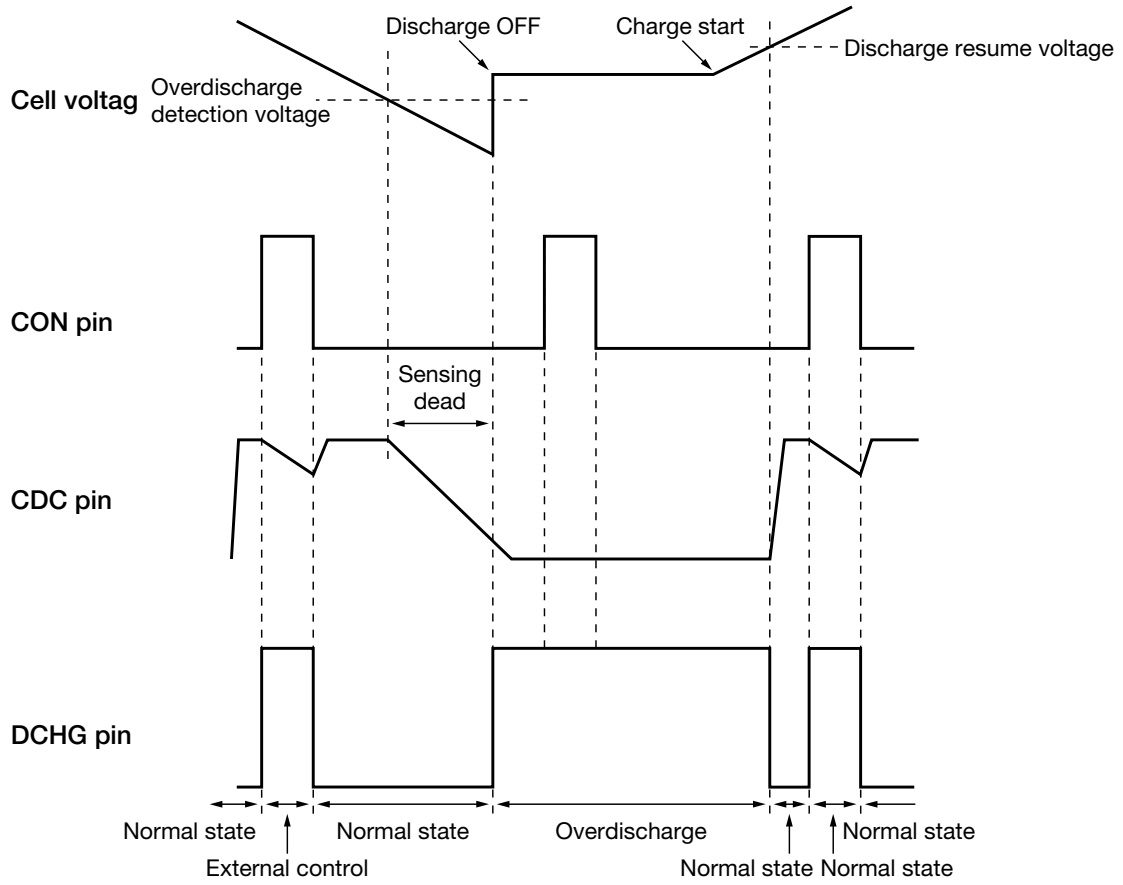


Timing Chart

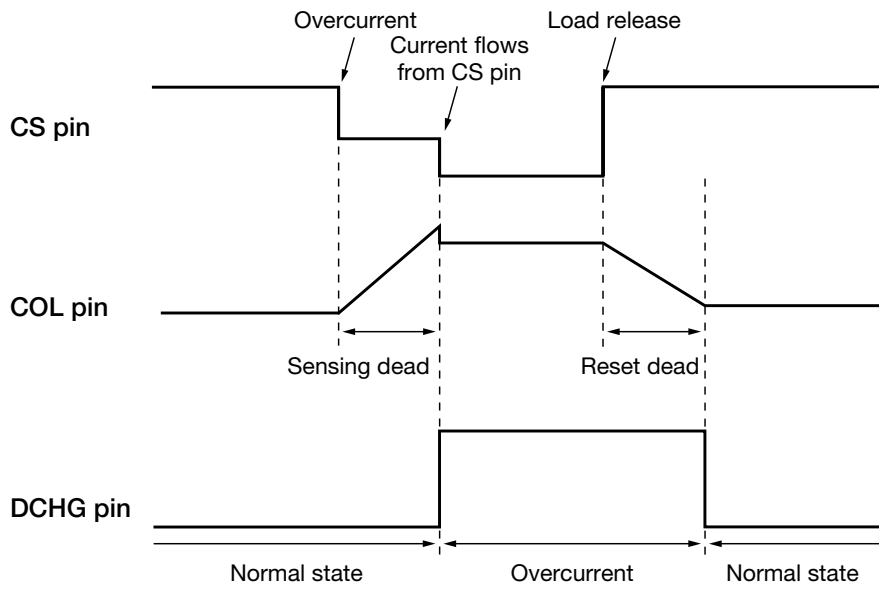
■ For overcharge



■ For overdischarge

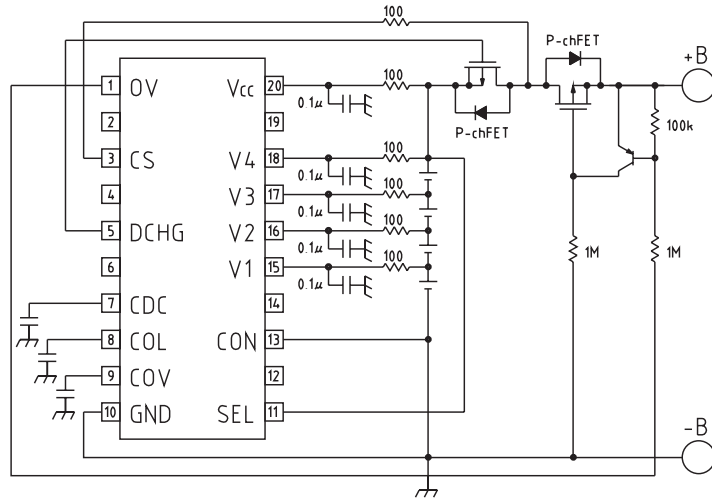


■ For overcurrent





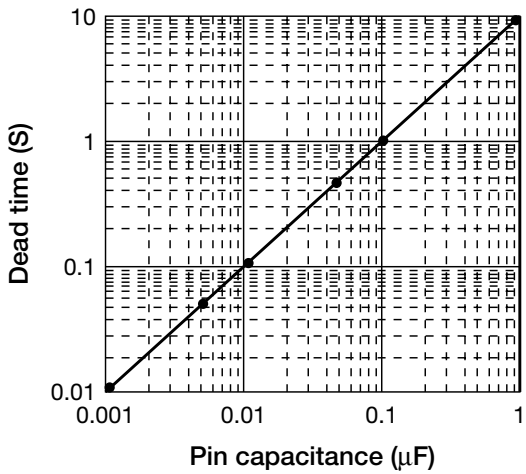
Application Circuit



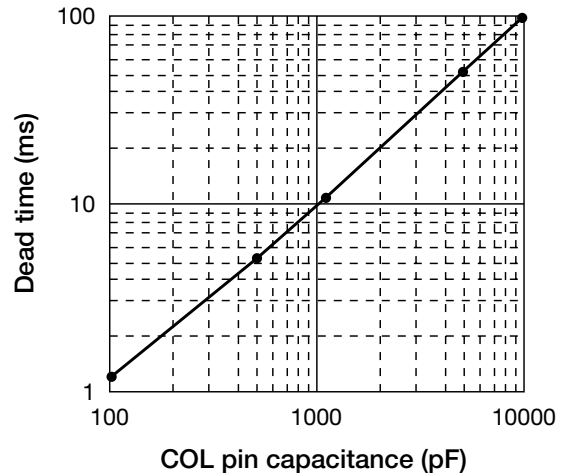
Note: Applicable circuits shown are typical examples provided for reference purposes. Mitsumi cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party patent and other right due to same.

Characteristics

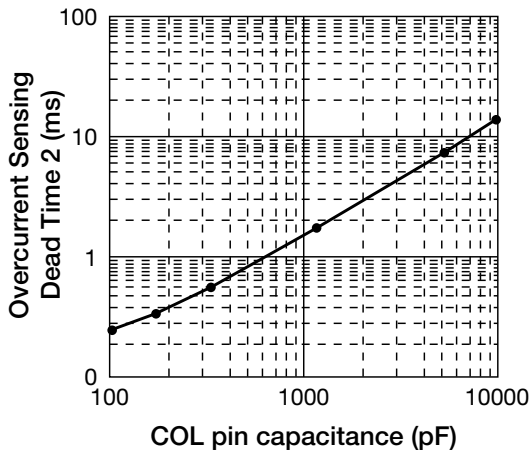
Overcharge & Overdischarge Sensing Dead Times



Overcurrent Sensing Dead Time 1, Overcurrent Reset Dead Time 3



Overcurrent Sensing Dead Time 2



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