Protection of Lithium Ion Batteries
Monolithic IC MM1414

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: Ta=−25 ~ 75°C, B: Ta=-20 ~ 70°C, C: Ta=0 ~ 50°C, D: Ta=0 ~ 40°C, E: Ta=−20 ~ 25°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_{CELL} = 4.4 CON = 0V	55μA typ.
2. Consumption current (normal)	V_{CELL} = 3.5V CON = 0V	15μA typ.
3. Consumption current (during overdischarge)	V_{CELL} = 1.9V CON = 0V	0.5μA typ.
4. Consumption current (during overdischarge)	V_{CELL} = 1.0V CON = V_{CC}	0.1μA max.
5. Overcharge detection voltage (Ta = 0°C ~ 50°C)		A, C, D, G; Load open 500kΩ or hight F; Load open 1MEGΩ or hight

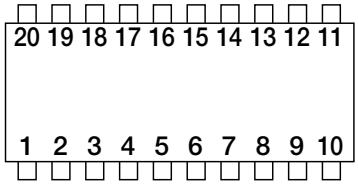
Package

TSOP-20A

Applications

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

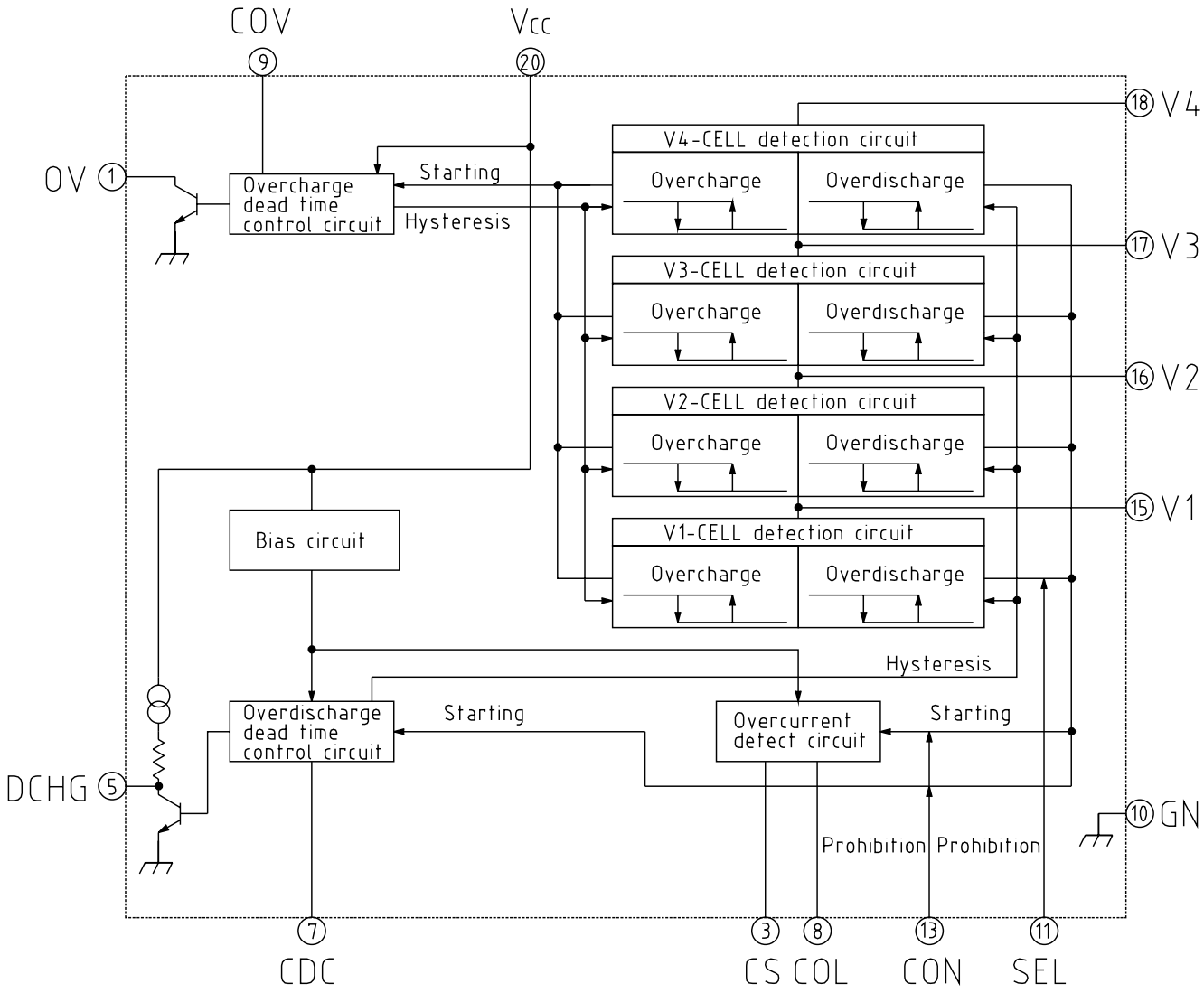
Pin Assignment



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

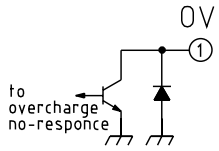
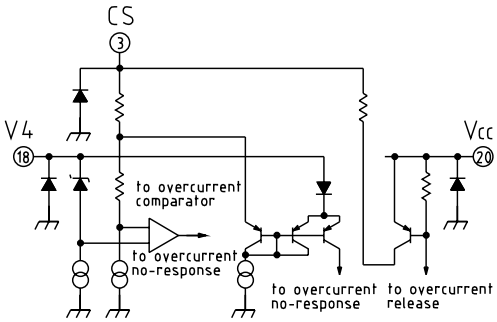
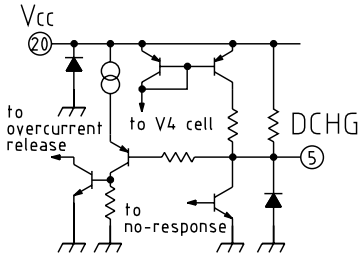
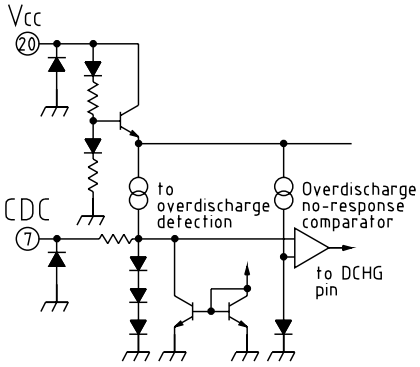
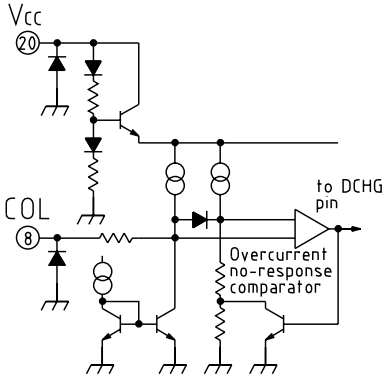
Block Diagram

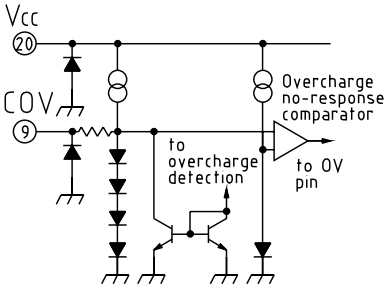
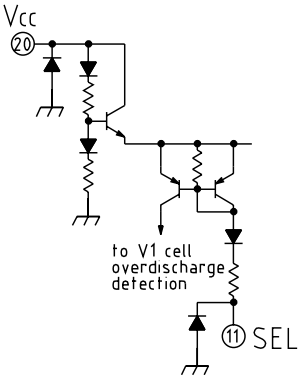
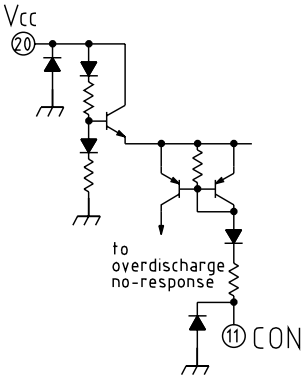
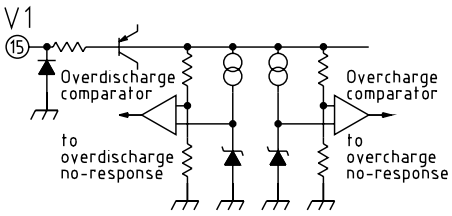
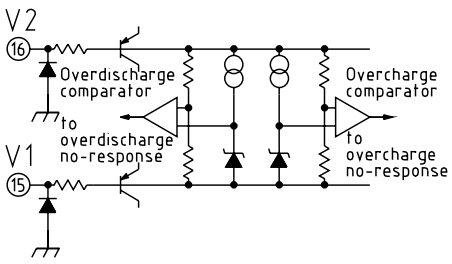


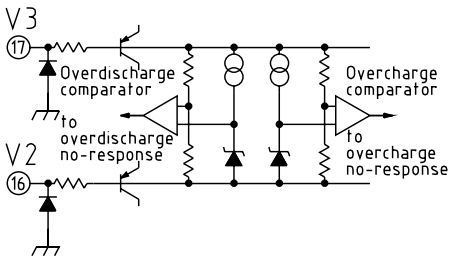
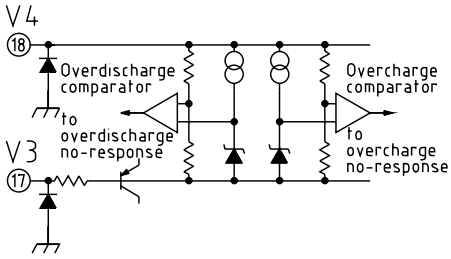
Pin Description

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 overdischarge 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 (Connect V1 to GND) SEL pin = Vcc: 4 cell
12	N.C		Not connected
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		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	Vcc	Input	Power supply input pin

Pin Description

Pin	Equivalent circuit diagram
1 ; OV	
3 ; CS	
5 ; DCHG	
7 ; CDC	
8 ; COL	

Pin	Equivalent circuit diagram
9 ; COV	
11 ; SEL	
13 ; CON	
15 ; V1	
16 ; V2	

Pin	Equivalent circuit diagram	Pin	Equivalent circuit diagram
17 ; V3		18 ; V4	

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	Pd	300	mW

Recommended Operating Conditions

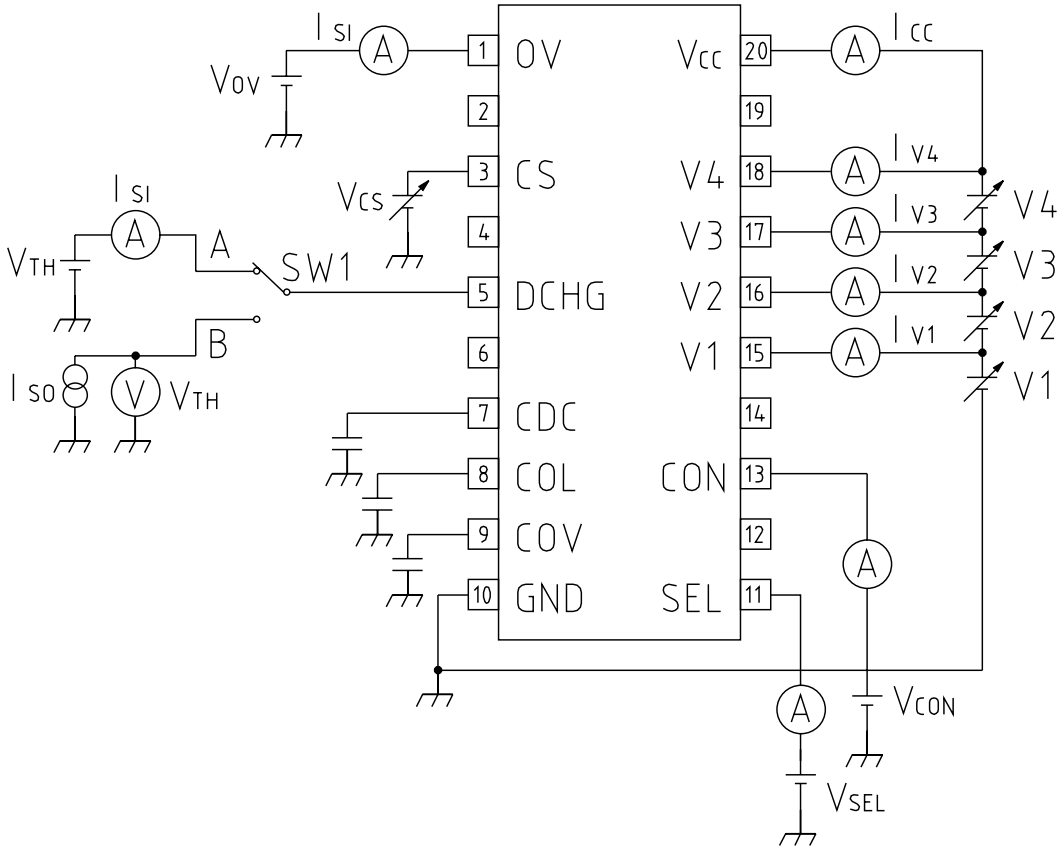
Item	Symbol	Ratings	Unit
Operating temperature	T_{OPR}	–20~+70	°C
Operating voltage	V_{OPR}	+1.8~+24	V

Electrical Characteristics

(Except where noted otherwise, Ta=25°C, V_{CC}=V4+V3+V2+V1, V_{CEL}=3.5V, CON=GND, SEL=V_{CC}) Models listed MM1414G

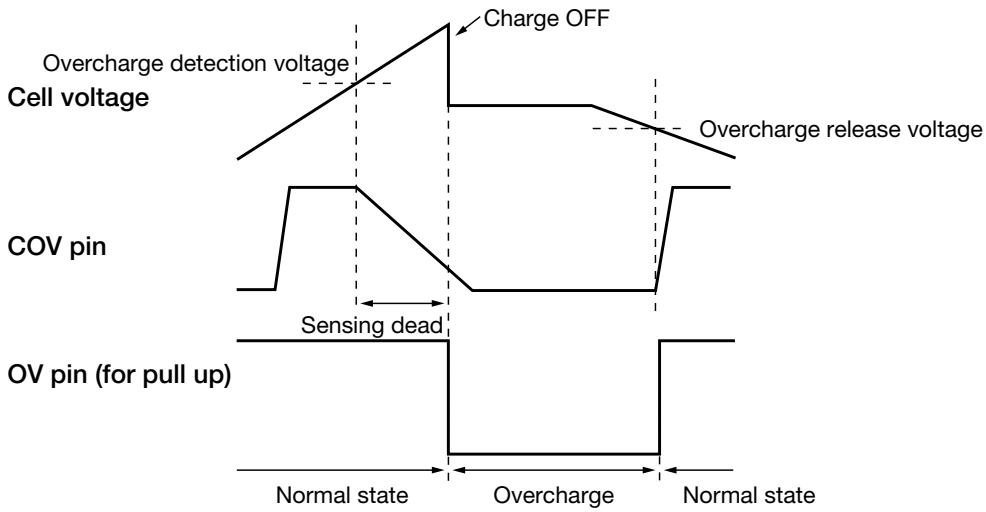
Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Unit
Consumption current (V_{CC} pin) 1	$I_{CC}1$	V_{CELL}=4.4V, CON=0V		55	110	µA
Consumption current (V_{CC} pin) 2	$I_{CC}2$	V_{CELL}=3.5V, CON=0V		27	50	µA
Consumption current (V_{CC} pin) 3	$I_{CC}3$	V_{CELL}=1.8V, CON=0V		2	4	µA
Consumption current (V_{CC} pin) 4	$I_{CC}4$	V_{CELL}=3.5V, CON=V_{CC}		12	20	µA
Consumption current (V_{CC} pin) 5	$I_{CC}5$	V_{CELL}=1.8V, CON=V_{CC}		1	2	µA
Consumption current (V4 pin) 1	I1V4	V_{CELL}=4.4V		10	20	µA
Consumption current (V4 pin) 2	I2V4	V_{CELL}=3.5V		8	15	µA
Consumption current (V4 pin) 3	I3V4	V_{CELL}=1.8V		2.5	5.0	µA
V3 pin input current	IV3	V_{CELL}=3.5V	–300	0	+300	nA
V2 pin input current	IV2	V_{CELL}=3.5V	–300	0	+300	nA
V1 pin input current	IV1	V_{CELL}=3.5V	–300	0	+300	nA
Overcharge detection voltage	$V_{CELL}U$	V_{CELL} : 4.2V→4.4V, Ta=0~50°C	4.270	4.295	4.320	V
Overcharge hysteresis voltage	⊿VU	V_{CELL} : 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	$V_{CELL}S$	V_{CELL} : 3.5V→1.8V	2.20	2.30	2.40	V
Discharge resume voltage	$V_{CELL}D$	V_{CELL} : 1.8V→3.5V	2.85	3.00	3.15	V
Overdischarge hysteresis voltage	⊿VDS	$V_{CELL}D$–$V_{CELL}S$	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	V_{CC}–V_{CS}, 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, V_{CC}–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	$I_{SO}D_{CH}$	V_{CELL}=1.8V, SW1 : A VDCHG=V_{CC}–0.8V	20			µA
DCHG pin sink current	$I_{SI}D_{CH}$	V_{CELL}=3.5V, SW1 : A VDCHG=0.8V	20			µA
DCHG pin output voltage H	$V_{TH}D_{CH}$	V_{CC}–VDCHG, I_{SO}=20µA, SW1 : B			0.8	V
DCHG pin output voltage L	$V_{TH}D_{CL}$	VDCHG–GND, I_{SI}=–20µA, SW1 : B			0.8	V
OV pin sink current	$I_{SI}OV$	VOV=0.4V, Ta=–20~+70°C	100			µA
OV pin leak current	$I_{LK}OV$	VOV=24V			0.1	µA
CON pin L voltage		DCHG= "High"			0.4	V
CON pin H voltage		DCHG= "Low"	V_{CC}-0.4			V
CON pin current		V_{CELL}=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_{CC}-0.4			V
SEL pin current		V_{CELL}=3.5V, SEL=0.4V		1	2	µA

Measuring Circuit

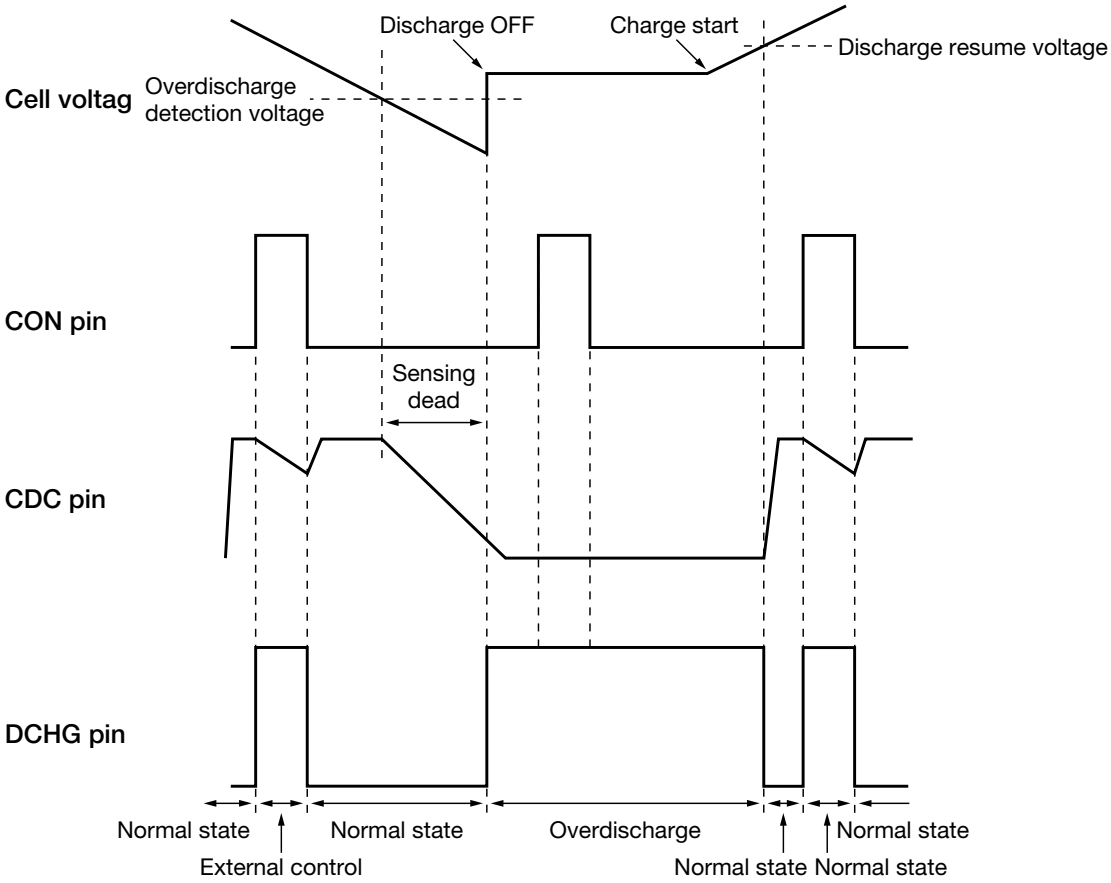


Timing Chart

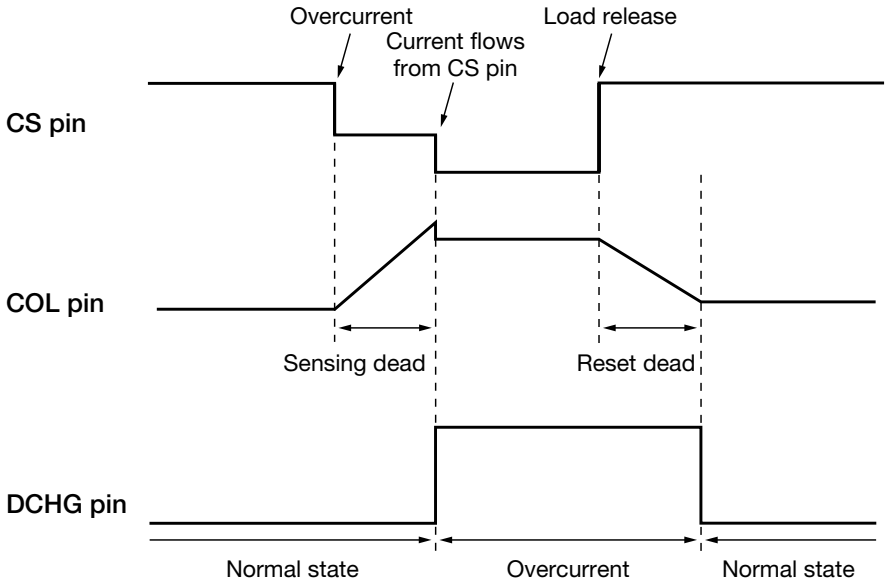
For overcharge



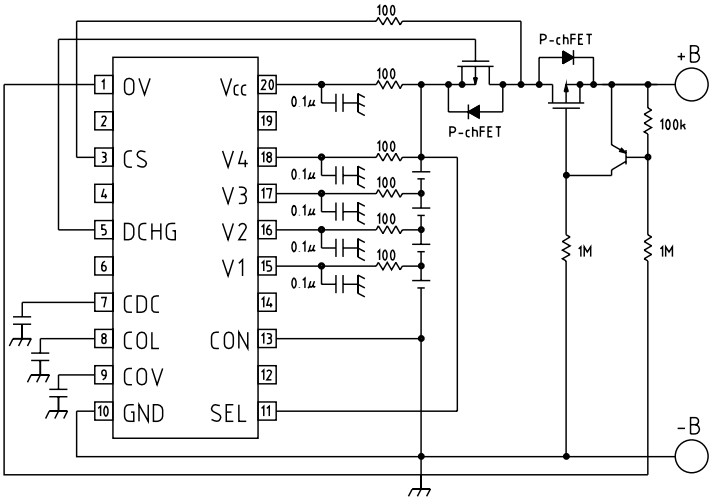
For overdischarge



For overcurrent



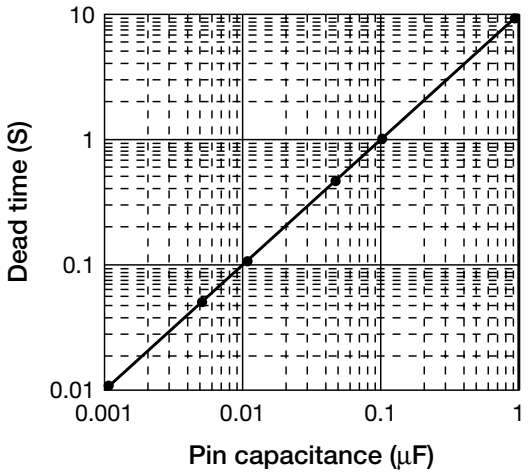
Application Circuit



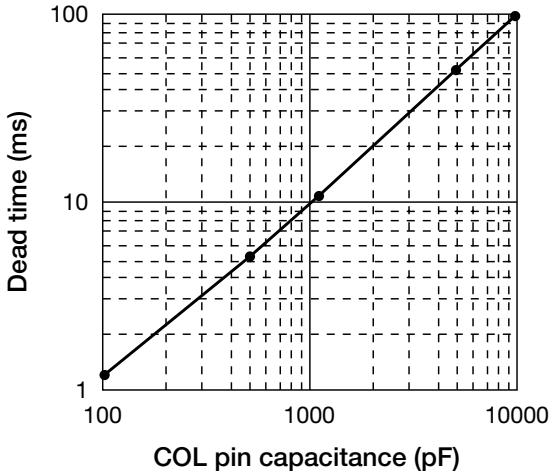
Note: Applicable circuits shown are typical examples provided for reference purposes. Mitsumi cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party patent and other right due to same.

Characteristics

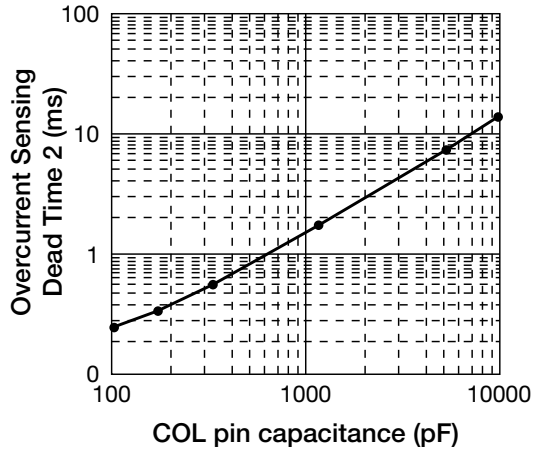
Overcharge & Overdischarge Sensing Dead Times



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.