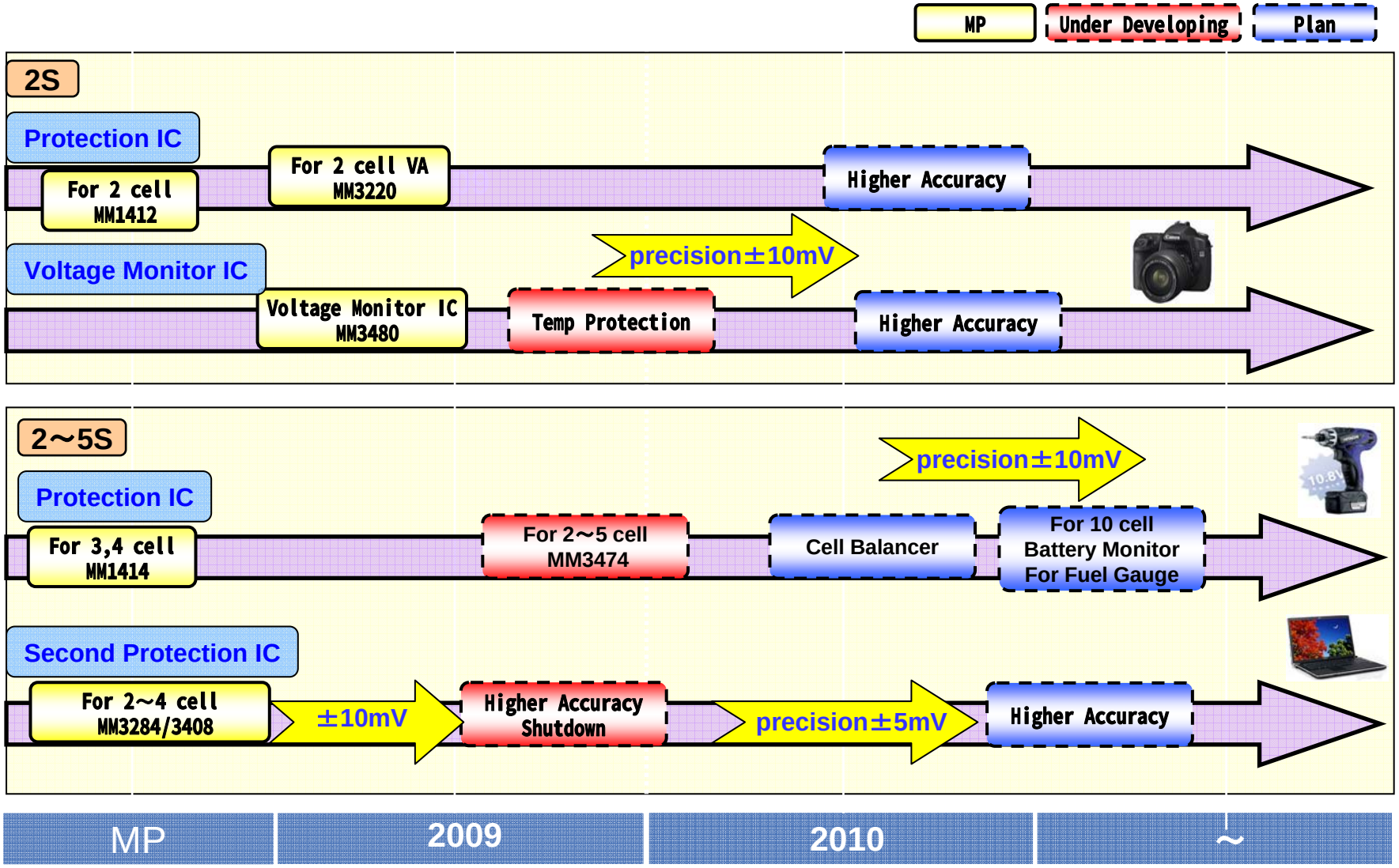
Li-ion Battery
Multi Serial Cell Protection IC

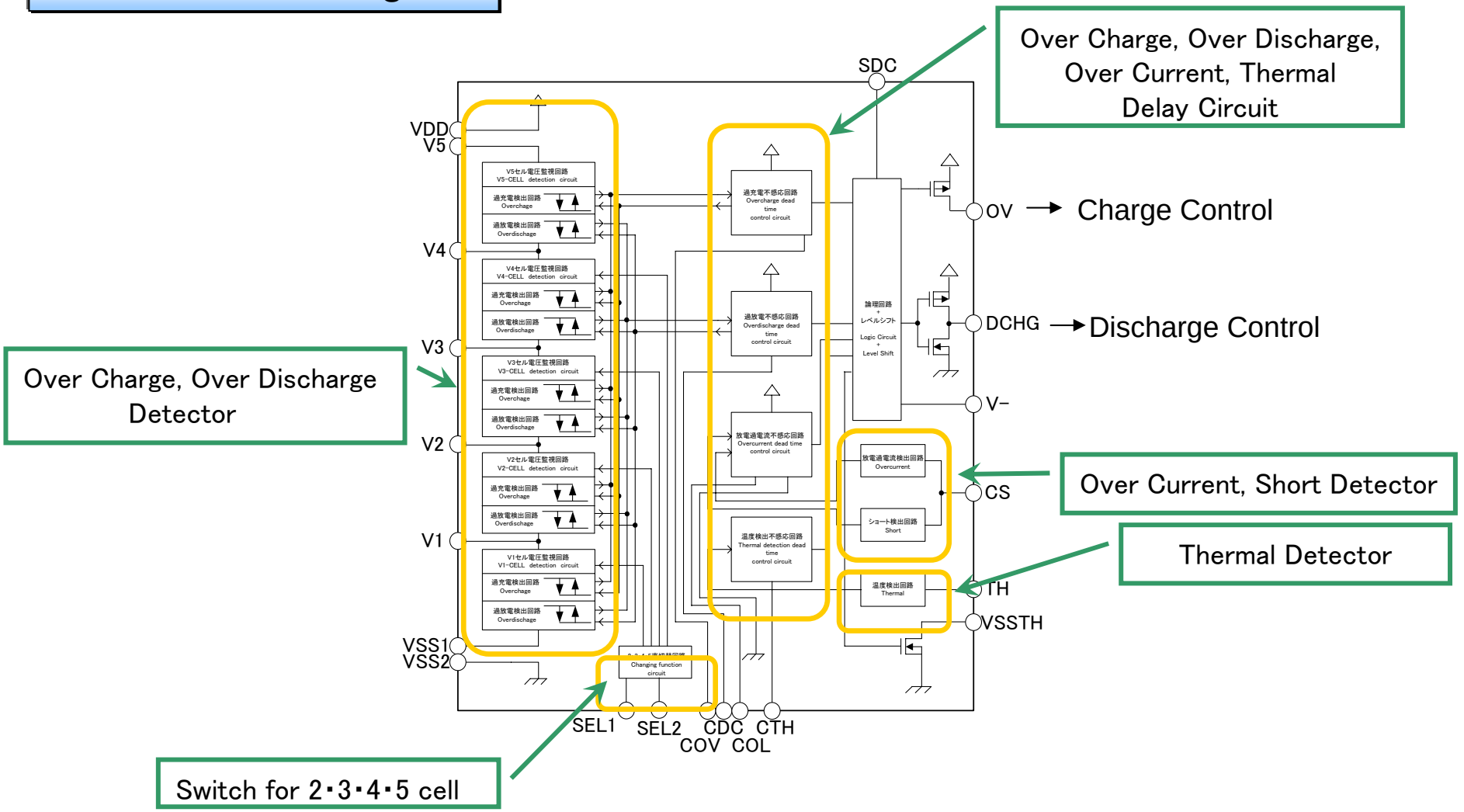
Battery Protection IC Roadmap



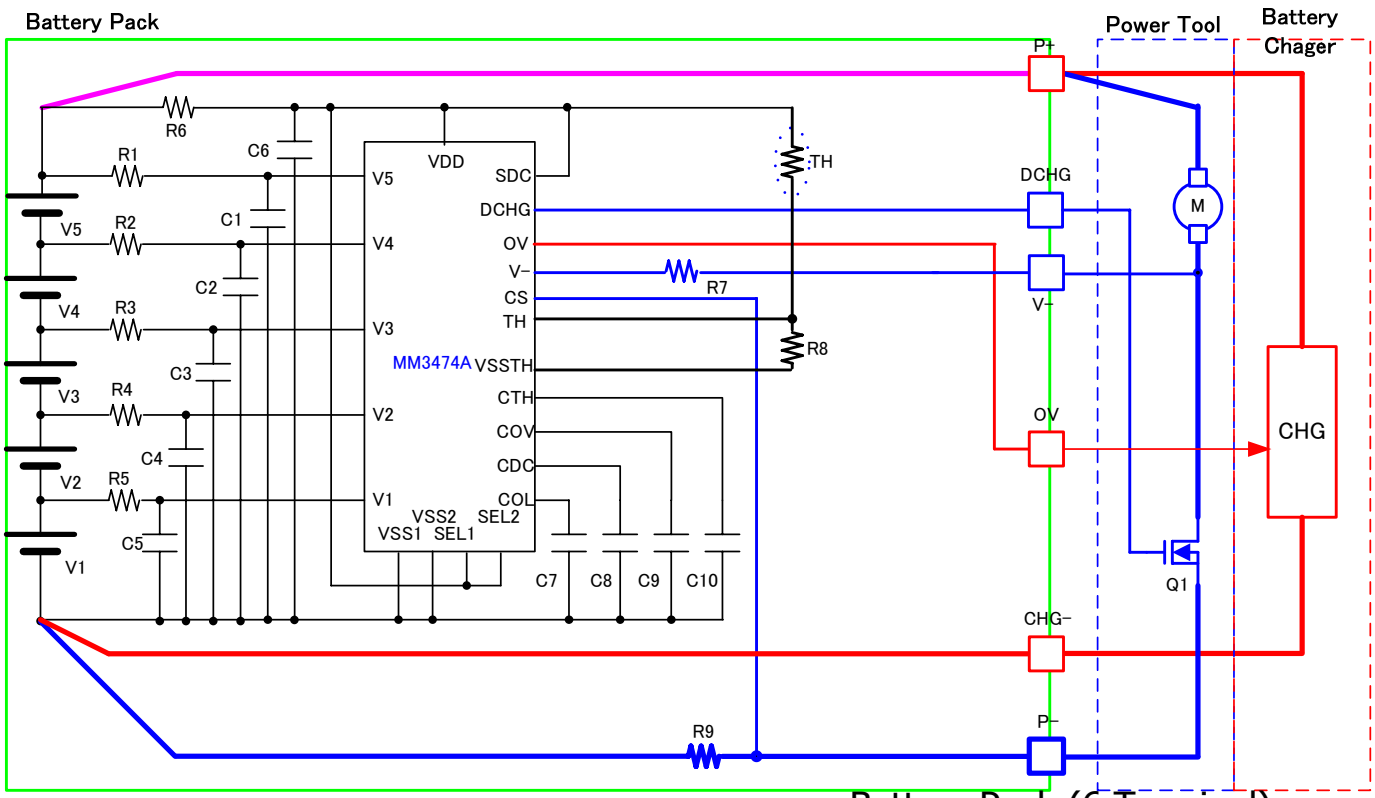
Li-ion Battery
2～5 Cell Protection IC

2～5 Cell Battery Protection IC　MM3474（Under Developing）

MM3474 Block Diagram



5-cell Application for Electrical Power Tools



Charge,Discharge route

Charge route

Discharge route

・All Cell Voltage Detector
・Over Discharge Current
・Battery Temperature

↓

Higher level of safety

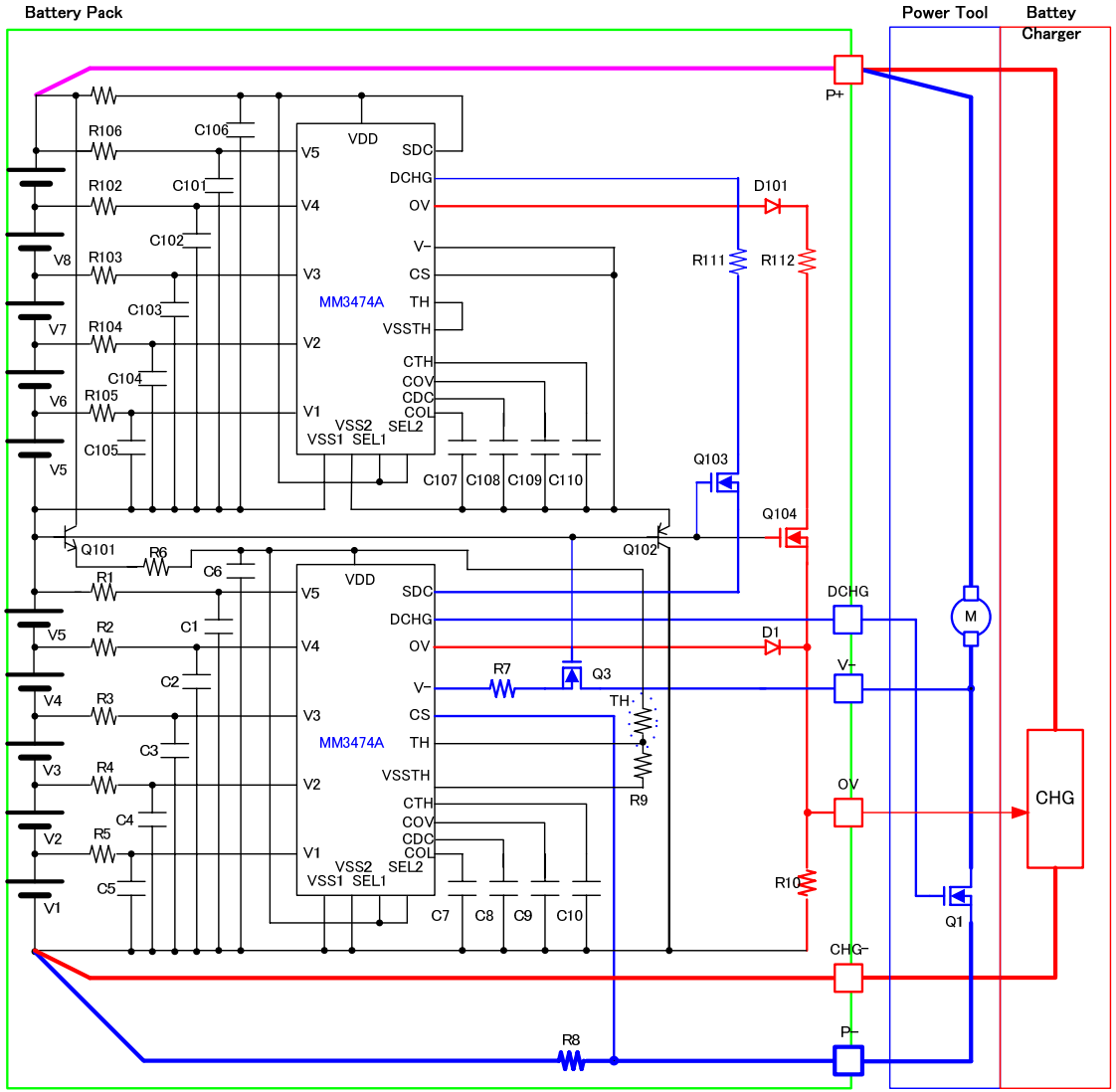
Battery Protection Functions

- Over Charge
- Over Discharge
- Over Discharge Current
- Thermal Protect
  (Forbid Charge, Discharge)

Battery Pack (6 Terminal)

- P+ : Battery + terminal
- DCHG : Over Discharge, Over Current Detection Output
- V- : Load Detect Terminal for Over Current
- OV : Over Charge Detection Output
- CHG- : For Charger
- P- : Battery – Terminal

10-cell Application for Electrical Power Tools



It is possible to correspond to the multi cell battery more than 2 cells by the combination.

Multi-cell Battery Protection IC: MM3474

Model Name		SII	MITUMI	
		S8204	MM3474	
		B	A	H
Overcharge Detection Accuracy		±25mV	±25mV	±25mV
Overdischarge Detection Accuracy		±50mV	±100mV	±100mV
Overcurrent detection voltage range	Detection voltage 1	0.05～0.3V	0.05～0.3V	0.15V
	Detection voltage 2	0.5V	0.5V	–
	Detection voltage 3	1.0V	1.0V	1.0V
Overcurrent detection method		GND side Detection resistance voltage	GND side Detection resistance voltage	GND side Detection resistance voltage
Overcharge release delay time		External C	External C	External C
Overdischarge release delay time		External C	External C	External C
Discharge overcurrent release delay time		External C	External C	External C Detection and release are separated.
Temperature detection function		–	✓	–
External charge/discharge control pin	Discharge	✓	✓	✓
	Charge	✓	– *Note 1	–
Package		TSSOP-16	VSOP-20	VSOP-20
Maximum rating		24V	30V	30V
Supply current (MAX)		33μA	28μA	28μA
Standby mode (MAX)		0.1μA	3.0μA *Note 2	3.0μA *Note 2

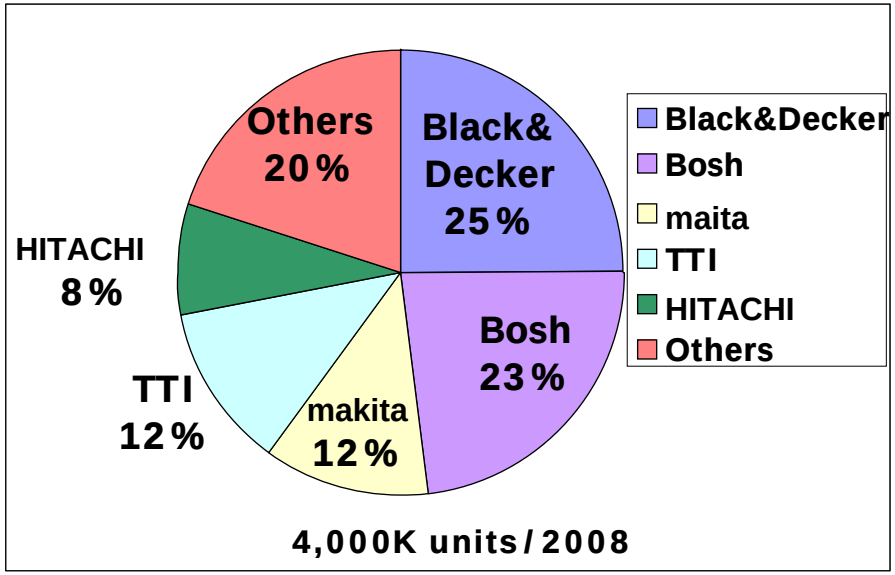
*Note 1: A temperature detecting pin can be used as a substitute.
*Note 2: Charger connection release with 0.1uA standby current is also acceptable.

3,4 Cell Battery Protection IC Line-up

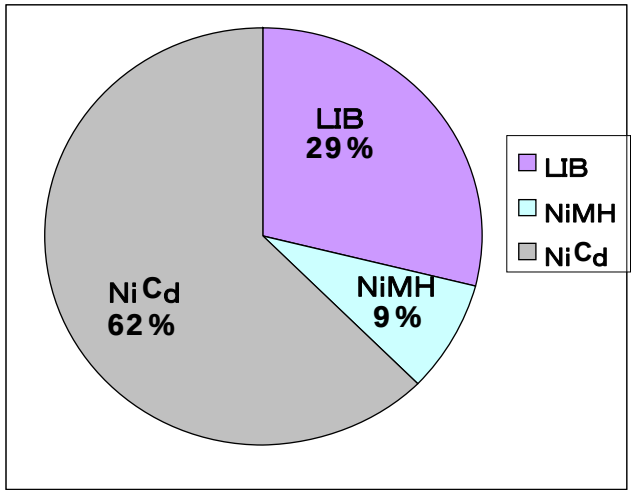
Model	Rank	Maximum Multiple cell	Package	Thermal Protect	Overcharge Detection voltage	Overcharge Hysterisis	Overcharge detection Delay-time	Overdischarge Detction voltage	Overdischarge Release voltage	Overdischarge detection Delay-time	Overcurrent Detection voltage	Overcurrent Detection Delay-time	Overcurrent Detection Release Delay-time	Overcurrent Dead-time	Sample Available
					V	mV	S	V	V	S	mV	S	S	mS	
MM1414	AV	4	TSOP-20		4.350±0.025	200±60		2.00±0.1	3.00±0.15	min. 0.5S	150±15			min. 5mS	MP
MM1414	CV	4	TSOP-20		4.350±0.025	200±60	typ. 1.0S	2.30±0.1	3.00±0.15	typ. 1.0S	150±15			typ. 10mS	MP
MM1414	DV	4	TSOP-20		4.250±0.025	200±60	COV=0.1μF	2.30±0.1	3.00±0.15	max. 1.5S	150±15			max. 15mS	MP
MM1414	FV	4	TSOP-20		4.325±0.025	200±60		2.30±0.1	3.00±0.15	CDC=0.1μF	100±15			COL=0.001μF	MP
MM1414	GV	4	TSOP-20		4.295±0.025	8mV		2.30±0.1	3.00±0.15		150±15				MP
MM1414	HV	4	TSOP-20		4.250±0.025	8mV		2.00±0.1	2.80±0.15		150±15				MP
MM3474	A	5	TSOP-20	✔	4.225±0.025	200±60	typ. 1.0S	2.00±0.1	3.00±0.15	typ. 1.0S	150±15	typ. 10.0S	typ. 1.0S		-
MM3474	H	5	TSOP-20		4.225±0.025	200±60	COV=0.1μF	2.00±0.1	3.00±0.15	COV=0.1μF	150±15	COV=0.001μF	COV=0.001μF		-

Electrical Power Tools Market

2008 Electrical Power Tools World Wide Market Share



2008 Electric Power Tool Battery Composition Ratio



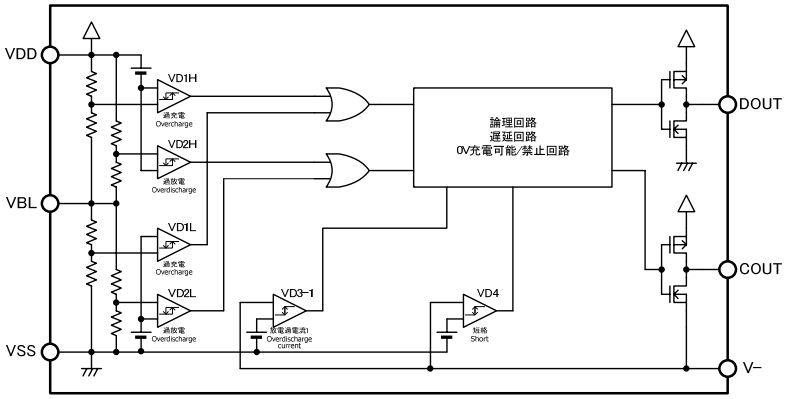
December 2008 IT総研

☐ It is expected that protection ICs for monitoring all cells designed for electrical power tools will grow in demand since electrical power tools must have battery packs with a protection function from 2010 in the Japanese domestic market.
☐ Lithium batteries (cells) are expected to surpass NiCd batteries in 2010.

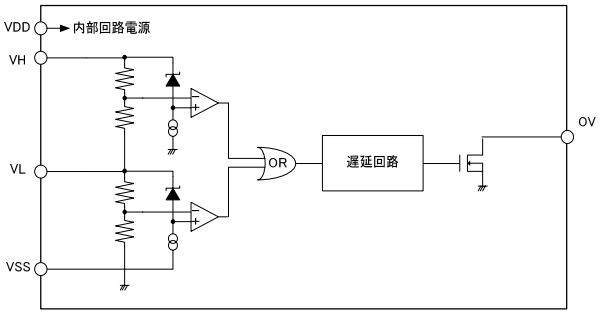
Li-ion Battery
2-cell Protection IC + Voltage Monitor IC

2-cell Protection IC + Voltage Monitor IC (Double Protection)

2-cell Battery Protection IC (MM3220)



Voltage Monitor IC (MM3480)



◇ Protected operation (Example)

Battery voltage increases.

↓

MM3480 detects overcharge and notifies the charger of the abnormality.

↓

Voltage increases even further due to defect in the charger.

↓

MM3220 detects overcharge and prohibits charging.

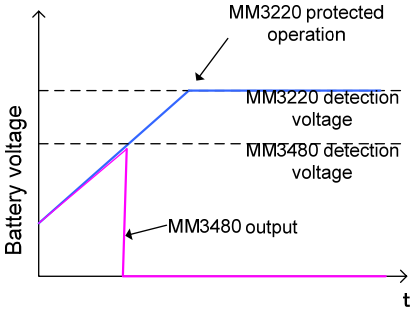
◇ Features

MM3220 (2-cell protection IC)

- Overdischarge/overcharge/ overcurrent detection
- Detection accuracy: ±25mV
- Shutdown in overdischarge mode 0.1uA (Normal: 4uA)

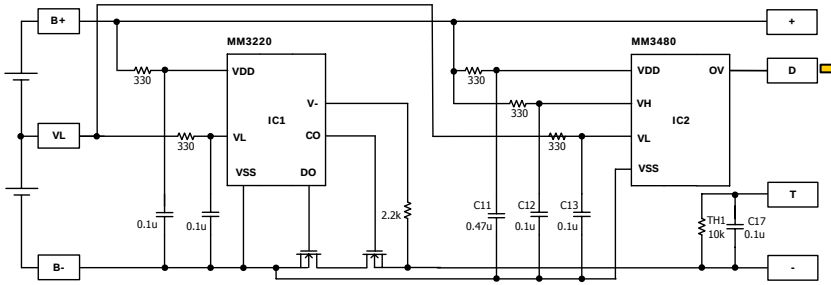
MM3480 (Voltage monitor)

- Overcharge detection
- Detection delay: 10ms
- Shutdown in overdischarge mode 0.1uA (Normal: 3uA)



COB modularization enables battery protection modules to be downsized and have a superior level of safety.

・Application



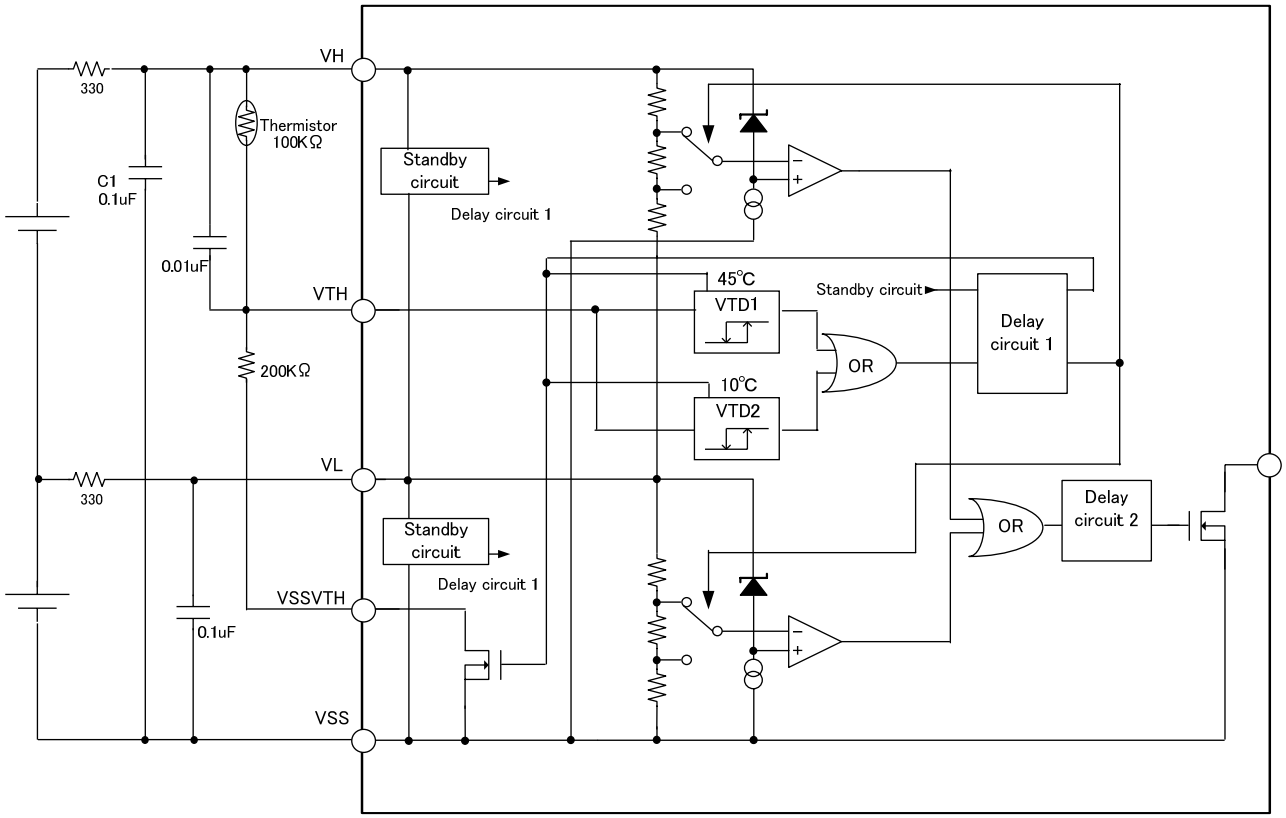
Charge Control

Adopted for digital single-lens reflex cameras

Introduction of 2s Protection IC: MM3220

Parameter		SEIKO	RICOH		MITSUMI		単位
		S-8242 Series	R5460x2xxAA (Cell voltage release)	R5460x2xxAB (Charger connection release)	MM3220 (Cell voltage release)	MM3220 (Charger connection release)	Unit
Current consumption	Operating	Typ 5.0 Max 10.0	Typ 4.0 Max 8.0	Typ 4.0 Max 8.0	Typ 4.0 Max 8.0	Typ 4.0 Max 8.0	uA
	Standby	Max 0.1	Max 2.0	Max 0.1	Max 2.0	Max 0.1	uA
Overcharge detection voltage (Accuracy		±25 ±50 (0～50℃)	±25 ±30 (-5～55℃)	±25 ±30 (-5～55℃)	±20 ±25 (0～50℃)	±20 ±25 (0～50℃)	mV
Overcharge release voltage (Accuracy)		±50	±50	±50	±50	±50	mV
Overcharge release method		VM ≦ Overcurrent detection voltage1 VDD ≦ Overcharge release voltage VM ≧ Overcurrent detection voltage1 VDD ≦ Overcharge detection voltage	V- ≦ Discharging overcurrent detection voltage VDD ≦ Overcharge release voltage V- ≧ Discharging overcurrent detection voltage VDD ≦ Overcharge detection voltage		V- ≦ Discharging overcurrent detection voltage VDD ≦ Overcharge release voltage V- ≧ Discharging overcurrent detection voltage VDD ≦ Overcharge detection voltage		-
Overdischarge detection voltage (Accuracy)		±50	±50～75 (±2.5%)	±50～75 (±2.5%)	±50	±50	mV
Overdischarge release voltage (Accuracy)		±100	±2.5%	-	±100	-	mV
Overdischarge release method		VM ≦ Charger detection voltage (typ. -0.7V) without overdischarge hysteresis VM ≧ Charger detection voltage (typ. -0.7V) with overdischarge hysteresis	Cell voltage release	Charger connection release	Cell voltage release	Charger connection release	-
Discharging overcurrent detection voltage (Accuracy)		±15	±15	±15	±10	±10	mV
Charging overcurrent detection voltage (Accuracy)		-	±40	±40	±20	±20	mV
Short detection voltage (Accuracy)		±300	±400	±400	±300	±300	mV
Absolute maximum rating		28	30	30	28	28	V
0V battery charge		Possible/Prohibited	Possible	Possible	Possible/Prohibited	Possible/Prohibited	
Package		6Pin SOT-23-6w VSS VDD VC 6 5 4 1 2 3 DO CO VM 2.8mm × 2.9mm × 1.1mm 8Pin SNT-8A VM NC VDD VC CO DO NC VSS 2.8mm × 2.9mm × 1.1mm	6Pin SNB(B) VDD VC VSS 6 5 4 1 2 3 VM CO DO 2.0mm × 1.8mm × 0.8mm 8Pin TSSOP VM NC VDD VC CO DO NC VSS 2.0mm × 1.8mm × 0.8mm	6Pin SOT23-6 VSS VDD VC DO CO V- 2.8mm × 2.9mm × 1.1mm	6Pin PLP1820-6 VC VDD VSS CO V- DO 2.0mm × 1.8mm × 0.6mm(max)	SOT-26A VSS VDD DOUT COUT V- 2.8mm × 2.9mm × 1.15mm	SSON-6A VDD VBL V- COUT DOUT 2.0mm × 1.8mm × 0.75mm	

Battery Monitor (Under Developing)



ES '10.1

◇MM3481

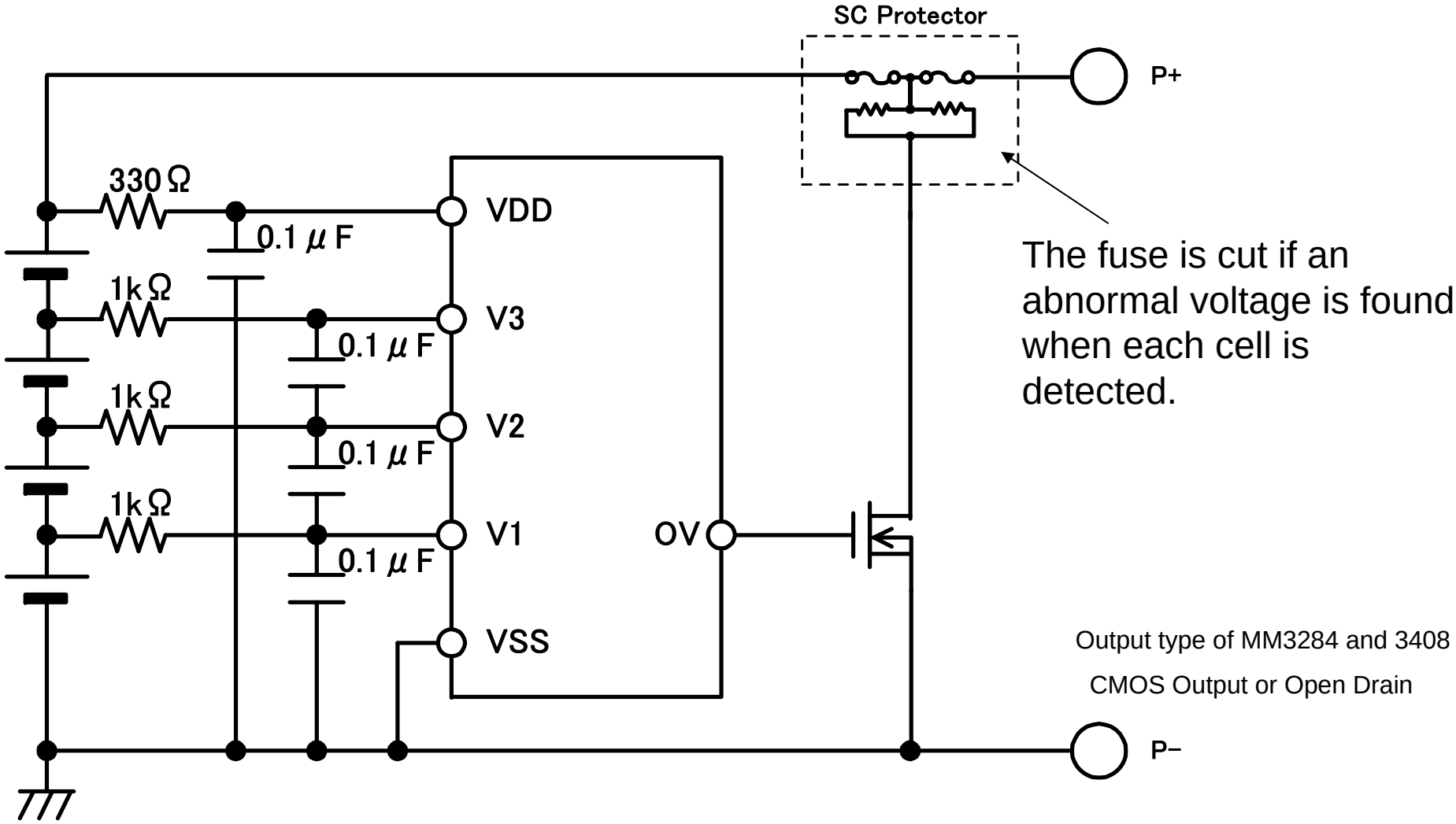
- Temp detect by the thermistor (3-level Over Charge Detection)
- The thermistor Current Reducer (ON：200ms/OFF： 20s)
- Shutdown for Over Discharge Quiescent Current 0.1uA(Vdd=2.3V) (Active: 5uA)
- Voltage Detect Precision ±25mV（0～60℃)

2-cell Battery Protection IC Line-up

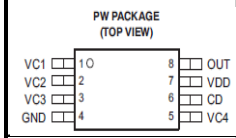
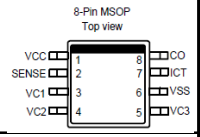
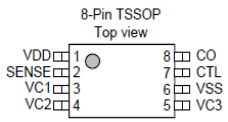
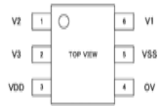
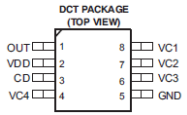
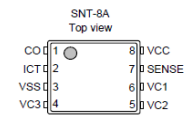
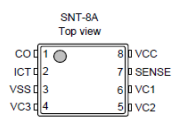
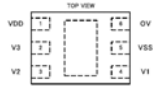
Model	Rank	Package	0V Charging Function (O:Available, X:Disabled)	Charge FET gate control (OV pin)	Discharge FET gate control (DCHG pin)	Overcurrent Detection method	Overcharge Detection voltage V	Overcharge Hysterisis mV	Overcharge detection Delay-time S	Overdischarge Detction voltage V	Overdischarge Release voltage V	Overdischarge detection Delay-time mS	Overcurrent Detection voltage mV	Overcurrent Dead-time mS	Short mode V	Condition for releasing	Sample Available
MM1412	AW	VSOP-8A	O	Open-Collecter Active-low	Push-Pull Active-High	FET ON resitor	4.350±0.025	220±50	CTD=0.18μF	2.3±0.1	3.5±0.2	typ. 13ms	150±15	typ. 12ms	0.45	More than 5MΩ	MP
MM1412	CW	VSOP-8A	O	Open-Collecter Active-low	Push-Pull Active-High	FET ON resitor	4.295±0.025	0		2.3±0.1	3.5±0.2		150±15		0.45	More than 5MΩ	ES
MM1412	EW	VSOP-8A	O	Open-Collecter Active-low	Push-Pull Active-High	FET ON resitor	4.250±0.025	300±50		2.3±0.1	3.5±0.2		150±15		0.45	More than 5MΩ	MP
MM1412	GW	VSOP-8A	O	Open-Collecter Active-low	Push-Pull Active-High	FET ON resitor	4.300±0.025	220±50		2.0±0.1	3.1±0.2		140±15		0.45	More than 5MΩ	MP
MM1412	HW	VSOP-8A	O	Open-Collecter Active-low	Push-Pull Active-High	FET ON resitor	4.225±0.025	0		2.3±0.1	3.5±0.2		150±15		0.45	More than 5MΩ	MP
MM1412	KW	VSOP-8A	O	Open-Collecter Active-low	Push-Pull Active-High	FET ON resitor	4.350±0.025	220±50		2.3±0.1	3.5±0.2		100±15		0.45	More than 5MΩ	ES
MM1412	NW	VSOP-8A	O	Open-Collecter Active-low	Push-Pull Active-High	FET ON resitor	4.190±0.025	0		2.0±0.1	3.1±0.2		100±15		0.45	More than 5MΩ	MP
MM1412	PW	VSOP-8A	O	Open-Collecter Active-low	Push-Pull Active-High	FET ON resitor	4.300±0.025	220±50		2.0±0.1	3.1±0.2		75±15		0.45	More than 5MΩ	MP
MM1412	SW	VSOP-8A	O	Open-Collecter Active-low	Push-Pull Active-High	FET ON resitor	4.300±0.025	220±50		2.0±0.1	2.0±0.1		100±15		0.45	More than 5MΩ	MP
MM1412	TW	VSOP-8A	O	Open-Collecter Active-low	Push-Pull Active-High	FET ON resitor	4.350±0.025	220±50		2.7±0.1	3.5±0.2		150±15		0.45	More than 5MΩ	MP
MM1412	VW	VSOP-8A	O	Open-Collecter Active-low	Push-Pull Active-High	FET ON resitor	4.350±0.025	220±50		2.95±0.1	3.5±0.2		150±15		0.45	More than 5MΩ	ES
MM1412	WW	VSOP-8A	O	Open-Collecter Active-low	Push-Pull Active-High	FET ON resitor	4.300±0.025	220±50		2.7±0.1	3.5±0.2		150±15		0.45	More than 5MΩ	ES
MM1412	ZW	VSOP-8A	O	Open-Collecter Active-low	Push-Pull Active-High	FET ON resitor	4.280±0.025	220±50		2.3±0.1	3.1±0.2		100±15		0.45	More than 5MΩ	MP
MM3220	B	COB	O	Push-Pull Active-High	Push-Pull Active-High	-	4.300±0.02	200±30	typ. 1.0s	2.000±0.03	-	typ.12ms	220±10	typ. 12ms	0.9	More than 5MΩ	MP
MM3220	C	SOT-26	O	Push-Pull Active-High	Push-Pull Active-High	-	4.300±0.02	200±30	typ. 1.15s	2.000±0.03	-	typ.14ms	85±10	typ. 10.8ms	0.45	More than 5MΩ	ES
MM3220	D	SOT-26	O	Push-Pull Active-High	Push-Pull Active-High	-	4.250±0.02	150±30	typ. 1.15s	3.000±0.03	-	typ.144ms	200±10	typ. 12ms	0.9	More than 5MΩ	Now Preparing

Li-ion Battery
Second Protection IC

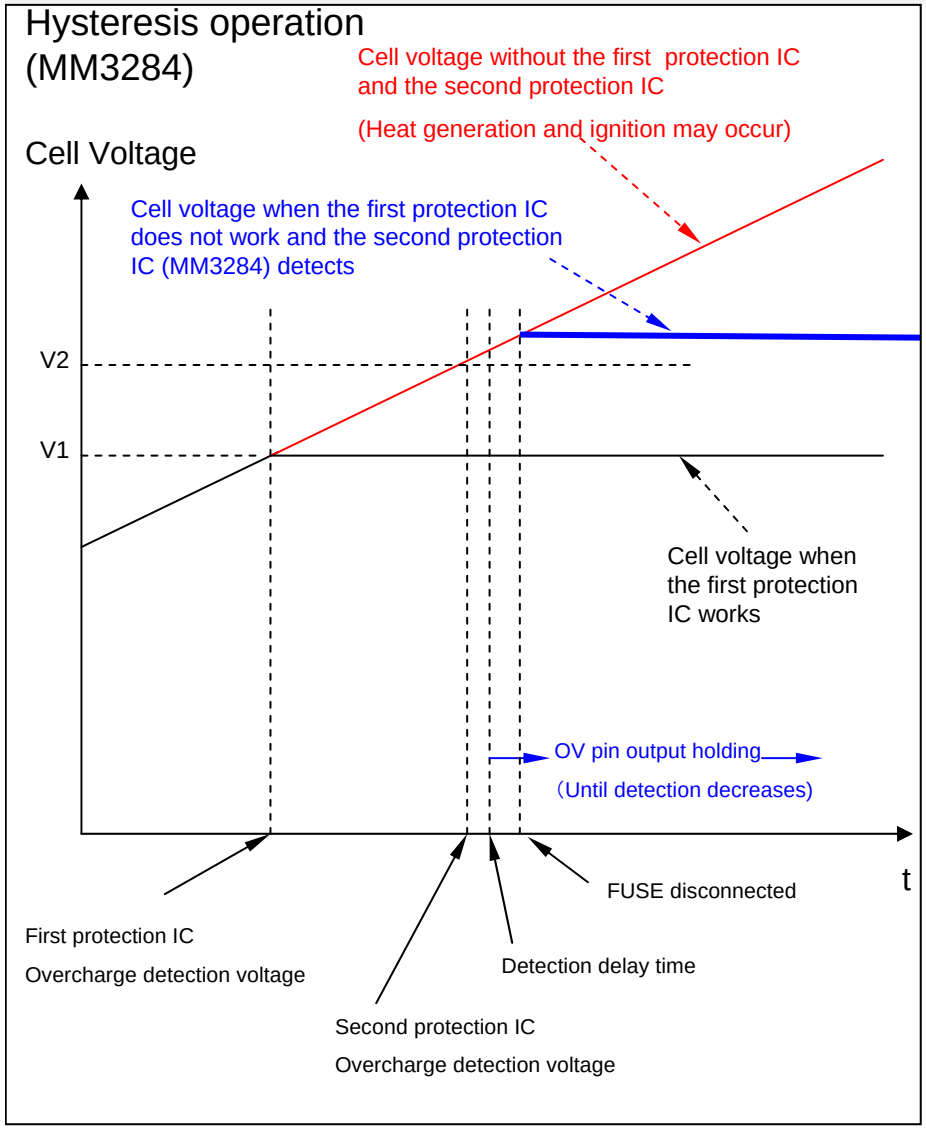
Second Protection Basic Circuit



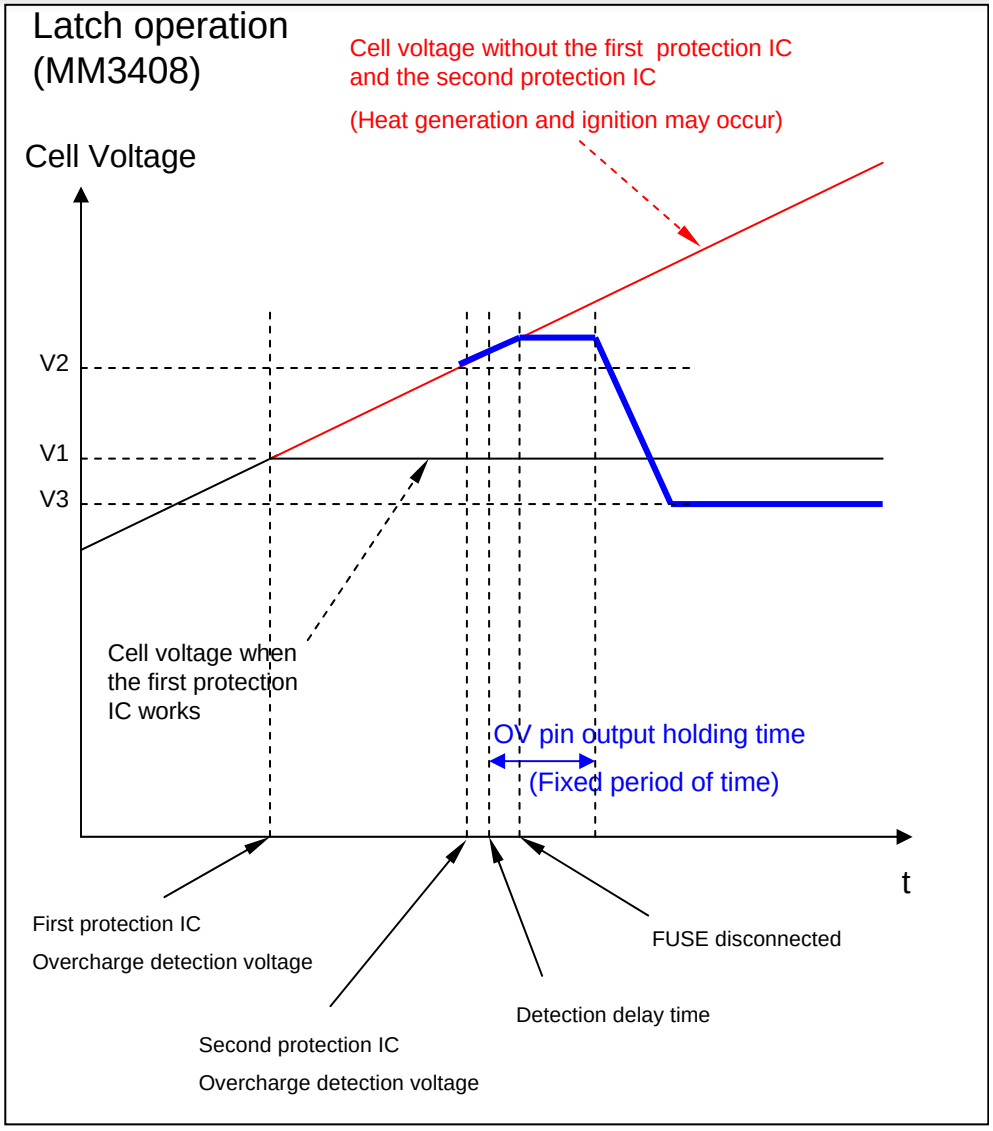
Second Protection IC Line-up

Item		bq2941x	S8244	S8264A/B	MM3284	MM3408	MM3xxx (Underdevelopment)
Withstanding voltage		28V	26V	26V	28V	28V	28V
Supply current	Vcell=3.5V	2μA	1.5μA	2.5μA	2.5μA	3.5μA	3.0μA
	Vcell=2.3V	1.5μA	1.2μA	2μA	2.0μA	3.0μA	0.2μA
Detection accuracy	25℃	±35mV	±25mV	±25mV	±25mV	±25mV	±10mV
	-0～50℃	-	-	-	±30mV	±30mV	±20mV
	-5～55℃	-	-	±30mV	-	-	-
	-20～85℃	±50mV	-	-	-	-	-
	-40～85℃	-	±50mV	-	±50mV	±50mV	±30mV
Hysteresis		0.32V	0～0.38V	0～0.52V	0.2～1.0V	0.5V (Forcing Vdd pull-down release)	0.5V (Forcing Vdd pull-down release)
Sink current		1mA	0.01mA	0.4mA	0.02mA	0.02mA	0.02mA
Source current		0.005mA	0.01mA	0.02mA	0.02mA	0.02mA	0.02mA
Delay circuit		External capacity	External capacity	Built-in	Built-in	Built-in	Built-in
Delay time		1.5s at 0.22uF	1.5s at 0.1uF	2～4s	1.2～10s	4.1s	4.1s
External control pin				✔	(Enabled in external circuit)	(Enabled in external circuit)	(Enabled in external circuit)
Output latch function				✔(B)		✔	✔
Output latch time out						✔(94s)	✔(94s)
Forcing Vdd internal pull-down						✔(60kΩ)	✔(60kΩ)
Overdischarge shutdown							✔
Package (Pin configuration)		MSOP 3.0×6.0×1.2mm 	MSOP8 2.95×4.0×1.1mm 	TSSOP8 3.0×6.4×1.1mm 	SOT-26A 2.9×2.8×1.15mm 		
		SSOP 3.0×4.0×1.3mm 	SNT-8A 1.97×2.46×0.48mm 	SNT-8A 1.97×2.46×0.48mm 	SSON-6A 1.8×2.0×0.75mm 		

Second Protection IC Function



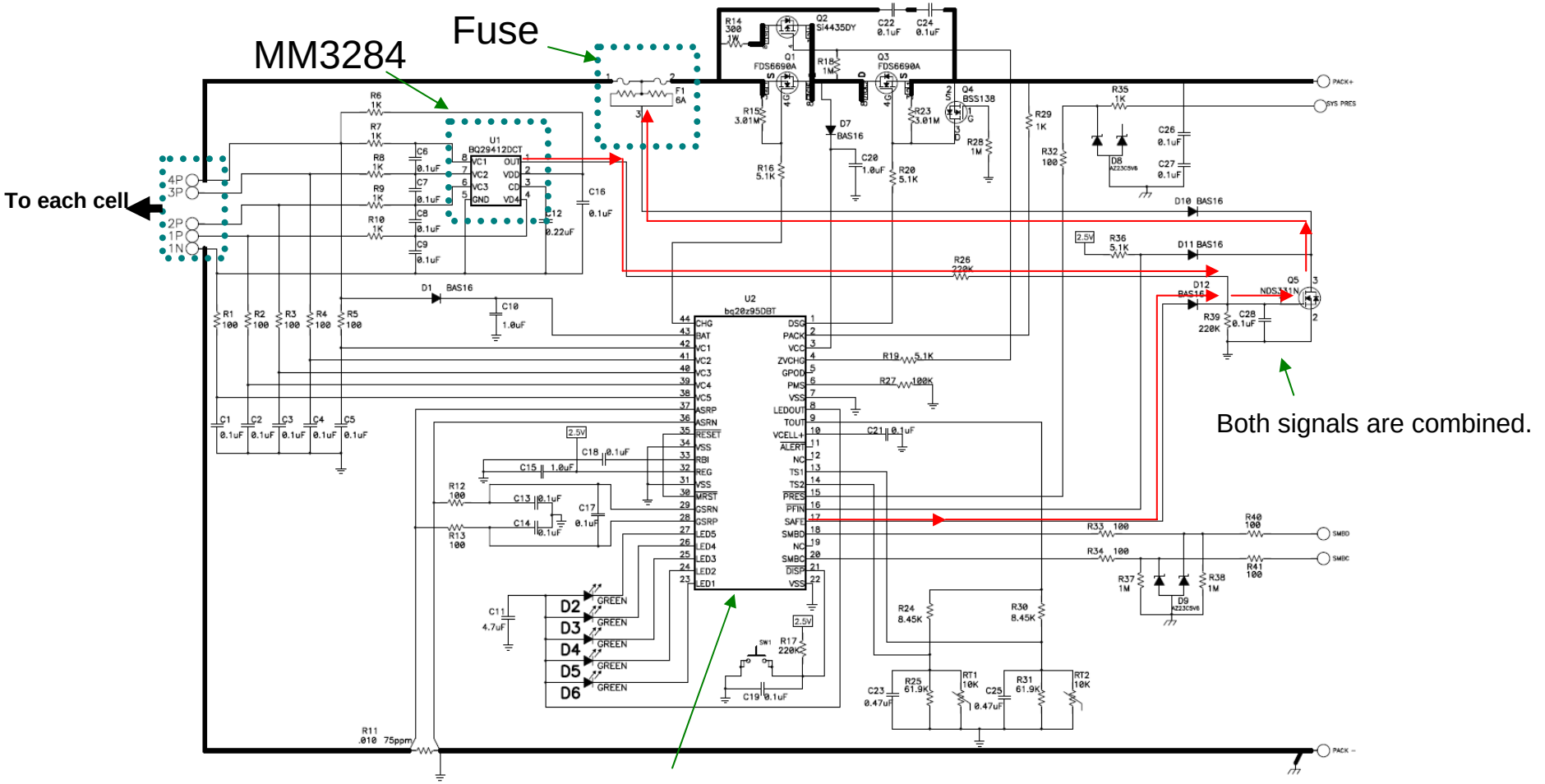
MM3284 Overcharge detection timing chart



MM3408 Overcharge detection timing chart

Second Protection Application

MM3284 with a fuel gauge IC (bq20z95)



4-cell Second Protection IC Line-up

MM3284

Model	Rank	Package	0V Charging Function (O:Available, X:Disabled)	Charge FET gate control (OV pin)	Standby Function (O:Available, X:Disabled)	Overcharge Detection voltage	Overcharge Hysterisis	VDD pin pull-down release voltage	Overcharge detection Delay-time	Vdd Internal pull-down (after Latch)	Overcharge detection Latch timeout	sample Available
						V	mV	V	S	S	S	
MM3284	CR	SSON-6A	○	Push-Pull Active-High	×	4.350±0.03	1000±200	-	typ.10.0s	-	-	MP
MM3284	EN	SOT-26A	○	Push-Pull Active-High	×	4.450±0.03	200±60	-	typ.1.2s	-	-	MP
MM3284	FN	SOT-26A	○	Push-Pull Active-High	×	4.350±0.03	V4:680±100 V3:340±100	-	typ.1.2s	-	-	MP
MM3284	FN	SOT-26A	○	Push-Pull Active-High	×	4.350±0.03	V4:680±100 V3:340±100	-	typ.1.2s	-	-	MP
MM3284	IN	SOT-26A	○	Push-Pull Active-High	×	4.450±0.03	1000±200	-	typ.5.0s	-	-	MP
MM3284	MR	SSON-6A	○	Push-Pull Active-High	×	4.280±0.030	1000±200	-	typ.4.1s	-	-	MP
MM3284	NN	SOT-26A	○	Push-Pull Active-High	×	4.450±0.03	200±60	-	typ.4.1s	-	-	MP
MM3284	PN	SOT-26A	○	Push-Pull Active-High	×	4.300±0.03	V4:620±100 V3:270±100	-	typ.2.0s	-	-	MP
MM3284	PN	SOT-26A	○	Push-Pull Active-High	×	4.300±0.03	V4:620±100 V3:270±100	-	typ.2.0s	-	-	MP
MM3284	RN	SOT-26A	○	Push-Pull Active-High	×	4.450±0.03	V4:750±100 V3:420±100	-	typ.2.0s	-	-	MP

4-cell Second Protection IC Line-up

MM3408

Model	Rank	Package	0V Charging Function (O:Available, X:Disabled)	Charge FET gate control (OV pin)	Standby Function (O:Available, X:Disabled)	Overcharge Detection voltage	Overcharge Hysterisis	VDD pin pull-down release voltage	Overcharge detection Delay-time	Vdd Internal pull-down (after Latch)	Overcharge detection Latch timeout	Sample Available
						V	mV	V	S	S	S	
MM3408	AR	SSON-6A	○	Push-Pull Active-High	×	4.280±0.03	-	0.5±0.1	typ.4.1s	typ.60kΩ	typ.94.3	MP
MM3408	CR	SSON-6A	○	Push-Pull Active-High	×	4.350±0.03	-	0.5±0.1	typ.4.1s	typ.60kΩ	typ.94.3	MP
MM3408	GR	SSON-6A	○	Push-Pull Active-High	×	4.220±0.03	-	0.5±0.1	typ.4.1s	typ.60kΩ	typ.94.3	ES

Introduction of
Li-ion Battery Related Products

Introduction of Li-ion Battery Related Products

Mobil device

AC-Adapter

Charge Controller IC
・MM3358・・・Built-in Power-Tr
Built-in Timer
Temp Control

Battery pack

AC-Adapter Controller IC
・MM1558・・・Secondary control
CC, CV
(Standby mode electricity 5mW)

AC-Charger Controller IC

・MM3324・・・Secondary control CC, CV, timer, temperature control

Protection module
COB・・・High reliability
Small board size
MIM・・・Quick Delivery

Protection IC
・MM3280・・・Small PKG
High Accuracy

AC-Charger