Protection Integrated Circuit for 3S/4S-Cell Li-Ion and Li-Polymer Batteries

1. Description

IP3254 provides multi-protection with high precision for battery, such as overcharge protection (OVP), over-discharge protection (UVP) and over current protection (OCC&ODC).

By switching the SEL pin,IP3254 can provide protection for 3-serial or 4-serial cell pack.

2. Features

- **Detect Voltage with A High Degree of Accuracy**
  - ➢ Overcharge Protection (OVP) Detection voltage
    3.500V ~ 4.100V, step 50mV
    4.100V ~ 4.575V, step 25mV
    Accuracy ±25mV
  - ➢ OVP Release Detection voltage
    3.450V ~ 4.050V, step 100mV
    4.050V ~ 4.400V, step 50mV
    Accuracy ±50mV
  - ➢ Over-discharge Protection(UVP) Detection voltage
    1.800V ~ 2.100V, step 50mV
    2.100V ~ 3.000V, step 100mV
    Accuracy ±80mV
  - ➢ UVP release Detection voltage
    2.000V ~ 3.1000V, step 100mV
    Accuracy ±100mV
- **Detect Current with A High Degree of Accuracy**
  - ➢ Discharge Over-Current protection 1
    0.03V ~ 0.34V, step 10mV
    Accuracy ±25mV
  - ➢ Charge Over-Current protection
    0.03V ~ 0.34V, step 10mV
    Accuracy ±25mV
  - ➢ Discharge Over-Current protection 2
    0.35V ~ 0.70V, step 50mV
    Accuracy ±50mV
  - ➢ Short-circuit detection voltage：
    V_{VC1}-1.20V
    Accuracy ±0.3V
- Delay times for overcharge detection, overdischarge detection and overcurrent detection 1 can be set by external capacitors (delay times for overcurrent detection 2 and 3 are fixed internally).
- **IP3254 can charge 0V-battery**
- **IP3254 will shut down MOS when battery line is open circuited**
- Low current consumption
  - ➢ During operation： 35 μA max
  - ➢ During power-down：3.5 μA max
- **Package：TSSOP16**

3. Applications

- Li-ion rechargeable battery packs
- Li-polymer rechargeable battery packs

4. Pin Configuration and Functions

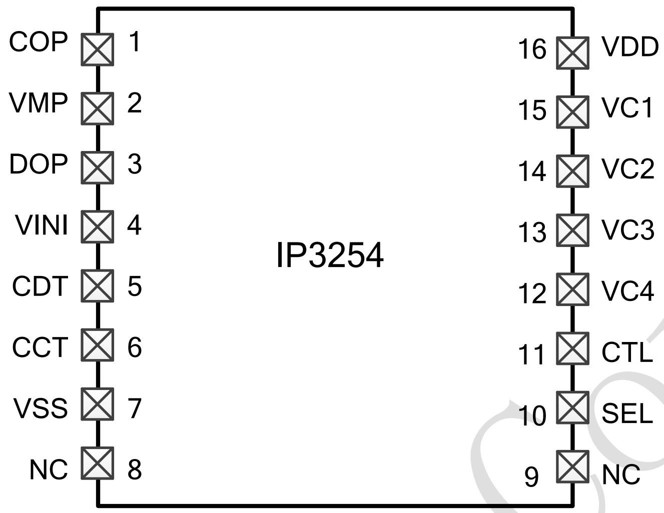


Figure 1. PIN Configuration

Table 1. 16-Lead Pin Functions

Pin	Name	Description
1	COP	FET gate connection pin for charge control (open drain output)
2	VMP	Pin for voltage detection between VC1 and VMP (Pin for SC detection)
3	DOP	FET gate connection pin for discharge control FET (CMOS output)）
4	VINI	Pin for voltage detection between VSS and VINI (Pin for overcurrent detection)
5	CDT	Capacitor connection pin for delay for overdischarge detection, delay for overcurrent detection 1
6	CCT	Capacitor connection pin for delay for overcharge current
7	VSS	Input pin for negative power supply, Connection pin for battery 4's negative voltage
8&9	NC	floating
10	SEL	Pin for switching 3-series or 4-series cell VSS level: 3-series cell, VDD level : 4-series cell
11	CTL	Control of charge FET and discharge FET
12	VC4	Connection pin for battery 3's negative voltage, Connection pin for battery 4's positive voltage
13	VC3	Connection pin for battery 2's negative voltage, Connection pin for battery 3's positive voltage
14	VC2	Connection pin for battery 1's negative voltage, Connection pin for battery 2's positive voltage
15	VC1	Connection pin for battery 1's positive voltage
16	VDD	Input pin for positive power supply, Connection pin for battery 1's positive voltage

Table 2. Product Name List

Product	OVP	OVP release	UVP	UVP release	ODC1	ODC2	OCC	Balancing
IP3254AAA	4.350±0.025V	4.150±0.05V	2.00±0.08V	2.70±0.10V	0.30±0.025V	0.35±0.050V	-	N
IP3254AAB	4.250±0.025V	4.250±0.05V	2.00±0.08V	2.70±0.10V	0.30±0.025V	0.35±0.050V	-	N
IP3254AAE	4.350±0.025V	4.150±0.05V	2.00±0.08V	2.70±0.10V	0.20±0.025V	0.35±0.050V	-	N
IP3254AAF	4.350±0.025V	4.150±0.05V	2.40±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	-	N
IP3254AAG	4.275±0.025V	4.100±0.05V	2.30±0.08V	2.70±0.10V	0.13±0.025V	0.35±0.050V	-	N
IP3254AAH	4.350±0.025V	4.150±0.05V	2.40±0.08V	2.70±0.10V	0.10±0.025V	0.35±0.050V	-	N
IP3254AAI	4.350±0.025V	4.150±0.05V	2.40±0.08V	3.00±0.10V	0.30±0.025V	0.35±0.050V	-	N
IP3254AAK	4.350±0.025V	4.150±0.05V	2.70±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	-	N
IP3254AAL	4.300±0.025V	4.150±0.05V	2.40±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	-	N
IP3254AAM	4.200±0.025V	4.100±0.05V	2.50±0.08V	2.70±0.10V	0.30±0.025V	0.35±0.050V	-	N
IP3254AAN	4.250±0.025V	4.150±0.05V	2.50±0.08V	3.00±0.10V	0.10±0.025V	0.35±0.050V	-	N
IP3254AAQ	3.900±0.025V	3.800±0.05V	2.30±0.08V	2.70±0.10V	0.30±0.025V	0.35±0.050V	0.30±0.025V	N
IP3254AAR	4.275±0.025V	4.150±0.05V	2.70±0.08V	3.00±0.10V	0.10±0.025V	0.35±0.050V	-	N
IP3254AAS	3.650±0.025V	3.500±0.05V	2.30±0.08V	2.70±0.10V	0.30±0.025V	0.35±0.050V	0.30±0.025V	N
IP3254AAT	4.220±0.025V	4.100±0.05V	2.50±0.08V	3.00±0.10V	0.10±0.025V	0.35±0.050V	0.10±0.025V	N
IP3254AAV	4.250±0.025V	4.100±0.05V	2.70±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	-	N
IP3254AAW	4.250±0.025V	4.100±0.05V	3.00±0.08V	3.10±0.10V	0.10±0.025V	0.35±0.050V	-	N
IP3254AAZ	3.650±0.025V	3.400±0.05V	2.50±0.08V	2.80±0.10V	0.20±0.025V	0.35±0.050V	-	N
IP3254ABA	3.900±0.025V	3.800±0.05V	2.00±0.08V	2.50±0.10V	0.15±0.025V	0.35±0.050V	-	N
IP3254ABC	4.175±0.025V	3.975±0.05V	2.70±0.08V	3.00±0.10V	0.10±0.025V	0.35±0.050V	-	N
IP3254ABD	4.450±0.025V	4.250±0.05V	2.70±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	-	N
IP3254ABF	4.200±0.025V	4.100±0.05V	2.00±0.08V	2.70±0.10V	0.30±0.025V	0.35±0.050V	-	N
IP3254ABM	4.200±0.025V	4.100±0.05V	2.50±0.08V	2.70±0.10V	0.10±0.025V	0.35±0.050V	-	N
IP3254ABN	4.425±0.025V	4.250±0.05V	2.50±0.08V	2.90±0.10V	0.15±0.025V	0.50±0.050V	0.10±0.025V	N
IP3254ABP	4.425±0.025V	4.250±0.05V	2.50±0.08V	2.90±0.10V	0.15±0.025V	0.50±0.050V	0.15±0.025V	N
IP3254ABQ	4.375±0.025V	4.20±0.05V	2.50±0.08V	2.90±0.10V	0.15±0.025V	0.50±0.050V	0.10±0.025V	N
IP3254ABR	4.475±0.025V	4.30±0.05V	2.70±0.08V	3.00±0.10V	0.08±0.025V	0.35±0.050V	0.05±0.025V	N
IP3254ACA	4.200±0.025V	4.100±0.05V	2.80±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	0.20±0.025V	N
IP3254ACB	4.350±0.025V	4.150±0.05V	2.00±0.08V	2.70±0.10V	0.30±0.025V	0.35±0.050V	0.30±0.025V	N
IP3254ACC	4.175±0.025V	3.975±0.05V	2.75±0.08V	3.00±0.10V	0.10±0.025V	0.35±0.050V	0.10±0.025V	N

IP3254ACD	4.450±0.025V	4.250±0.05V	2.70±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	0.20±0.025V	N
IP3254ACE	4.350±0.025V	4.150±0.05V	2.00±0.08V	2.70±0.10V	0.20±0.025V	0.35±0.050V	0.20±0.025V	N
IP3254ACF	4.350±0.025V	4.150±0.05V	2.40±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	0.20±0.025V	N
IP3254ACG	4.275±0.025V	4.100±0.05V	2.30±0.08V	2.70±0.10V	0.13±0.025V	0.35±0.050V	0.13±0.025V	N
IP3254ACH	4.350±0.025V	4.150±0.05V	2.40±0.08V	2.70±0.10V	0.10±0.025V	0.35±0.050V	0.10±0.025V	N
IP3254ACI	4.350±0.025V	4.150±0.05V	2.40±0.08V	3.00±0.10V	0.30±0.025V	0.35±0.050V	0.30±0.025V	N
IP3254ACJ	3.900±0.025V	3.800±0.05V	2.00±0.08V	2.50±0.10V	0.15±0.025V	0.35±0.050V	0.15±0.025V	N
IP3254ACK	4.350±0.025V	4.150±0.05V	2.40±0.08V	2.70±0.10V	0.20±0.025V	0.35±0.050V	0.20±0.025V	N
IP3254ACL	4.300±0.025V	4.150±0.05V	2.40±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	0.20±0.025V	N
IP3254ACM	4.200±0.025V	4.100±0.05V	2.50±0.08V	2.70±0.10V	0.30±0.025V	0.35±0.050V	0.30±0.025V	N
IP3254ACN	4.250±0.025V	4.150±0.05V	2.50±0.08V	3.00±0.10V	0.10±0.025V	0.35±0.050V	-	N
IP3254ACP	3.650±0.025V	3.550±0.05V	2.50±0.08V	2.80±0.10V	0.15±0.025V	0.35±0.050V	0.15±0.025V	N
IP3254ACQ	3.900±0.025V	3.800±0.05V	2.30±0.08V	2.70±0.10V	0.30±0.025V	0.35±0.050V	0.30±0.025V	N
IP3254ACR	3.750±0.025V	3.600±0.05V	2.10±0.08V	2.50±0.10V	0.15±0.025V	0.35±0.050V	0.15±0.025V	N
IP3254ACS	4.275±0.025V	4.100±0.05V	2.90±0.08V	2.90±0.10V	0.15±0.025V	0.35±0.050V	0.15±0.025V	N
IP3254ACV	4.250±0.025V	4.150±0.05V	2.70±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	0.20±0.025V	N
IP3254ACW	4.300±0.025V	4.100±0.05V	2.50±0.08V	3.00±0.10V	0.10±0.025V	0.35±0.050V	0.10±0.025V	Y
IP3254ACZ	4.250±0.025V	4.150±0.05V	3.00±0.08V	3.10±0.10V	0.20±0.025V	0.35±0.050V	0.20±0.025V	Y
IP3254AEA	4.275±0.025V	4.150±0.05V	2.40±0.08V	2.70±0.10V	0.50±0.025V	0.35±0.050V	0.10±0.025V	Y
IP3254AEB	4.375±0.025V	4.150±0.05V	2.40±0.08V	2.70±0.10V	0.50±0.025V	0.35±0.050V	0.10±0.025V	Y
IP3254AEM	4.400±0.025V	4.350±0.05V	2.80±0.08V	3.00±0.10V	0.17±0.025V	0.50±0.050V	0.10±0.025V	Y
IP3254AER	4.400±0.025V	4.200±0.05V	2.80±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	0.10±0.025V	Y
IP3254AEV	4.250±0.025V	4.150±0.05V	2.70±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	0.10±0.025V	Y
IP3254BAA	4.350±0.025V	4.150±0.05V	2.00±0.08V	2.70±0.10V	0.30±0.025V	0.35±0.050V	-	3.800±0.030V
IP3254BAE	4.350±0.025V	4.150±0.05V	2.00±0.08V	2.70±0.10V	0.20±0.025V	0.35±0.050V	-	Y
IP3254BAF	4.350±0.025V	4.150±0.05V	2.40±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	-	Y
IP3254BAG	4.275±0.025V	4.100±0.05V	2.30±0.08V	2.70±0.10V	0.13±0.025V	0.35±0.050V	-	4.150±0.030V
IP3254BAH	4.350±0.025V	4.150±0.05V	2.40±0.08V	2.70±0.10V	0.10±0.025V	0.35±0.050V	-	4.150±0.030V
IP3254BAI	4.350±0.025V	4.150±0.05V	2.40±0.08V	3.00±0.10V	0.30±0.025V	0.35±0.050V	-	4.100±0.030V
IP3254BAK	4.350±0.025V	4.150±0.05V	2.70±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	-	Y
IP3254BAL	4.300±0.025V	4.150±0.05V	2.40±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	-	Y
IP3254BAM	4.200±0.025V	4.100±0.05V	2.50±0.08V	2.70±0.10V	0.30±0.025V	0.35±0.050V	-	Y

IP3254BAN	4.250±0.025V	4.150±0.05V	2.50±0.08V	3.00±0.10V	0.10±0.025V	0.35±0.050V	-	Y
IP3254BAQ	3.900±0.025V	3.800±0.05V	2.30±0.08V	2.70±0.10V	0.30±0.025V	0.35±0.050V	-	Y
IP3254BAR	4.275±0.025V	4.150±0.05V	2.70±0.08V	3.00±0.10V	0.10±0.025V	0.35±0.050V	-	4.100±0.030V
IP3254BAT	4.220±0.025V	4.100±0.05V	2.50±0.08V	3.00±0.10V	0.10±0.025V	0.35±0.050V	-	3.800±0.030V
IP3254BAV	4.250±0.025V	4.100±0.05V	2.70±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	-	Y
IP3254BBA	3.900±0.025V	3.800±0.05V	2.00±0.08V	2.50±0.10V	0.15±0.025V	0.35±0.050V	-	Y
IP3254BBC	4.175±0.025V	3.950±0.05V	2.70±0.08V	3.00±0.10V	0.10±0.025V	0.35±0.050V	0.10±0.025V	4.050±0.030V
IP3254BBD	4.450±0.025V	4.250±0.05V	2.70±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	-	Y
IP3254BBE	4.400±0.025V	4.200±0.05V	2.40±0.08V	3.00±0.10V	0.17±0.025V	0.50±0.050V	-	Y
IP3254BBF	4.475±0.025V	4.300±0.05V	2.70±0.08V	3.00±0.10V	0.08±0.025V	0.35±0.050V	0.05±0.025V	4.400±0.030V
IP3254BBG	4.275±0.025V	4.100±0.05V	2.30±0.08V	2.70±0.10V	0.13±0.025V	0.35±0.050V	-	4.100±0.030V
IP3254BCD	4.450±0.025V	4.250±0.05V	2.70±0.08V	3.00±0.10V	0.20±0.025V	0.35±0.050V	0.20±0.025V	Y
IP3254BCE	4.225±0.025V	4.100±0.05V	2.50±0.08V	3.00±0.10V	0.11±0.025V	0.35±0.050V	0.11±0.025V	4.150±0.030V
IP3254BCN	4.250±0.025V	4.150±0.05V	2.50±0.08V	3.00±0.10V	0.10±0.025V	0.50±0.050V	0.10±0.025V	Y
IP3254BCP	3.650±0.025V	3.50±0.05V	2.50±0.08V	2.80±0.10V	0.15±0.025V	0.35±0.050V	0.15±0.025V	3.650±0.030V

Note: 1.Unless otherwise specified, the balancing voltage is 0.1V lower than the overvoltage value.

2.Products with cell balancing, the internal default maximum value of cell balancing current is 192mA, and the current is limited by external resistance.

3.For products with other parameters, please contact our company's business department.

5. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
INPUT VOLTAGE	VMP 、V_{DD}	V_{SS} - 0.3 ~ V_{SS} + 30	V
	VC1、VC2、VC3、VC4、CTL、SEL、DOP、COP	V_{SS} - 0.3 ~ V_{DD} + 0.3	V
	VINI、CCT、CDT	V_{SS} - 0.3 ~ V_{SS} + 12	V
Max operating temperature	T_{opr}	-40 ~ +85	℃
Storage temperature	T_{stg}	-40 ~ +125	℃
Thermal resistance junction-ambient	θ_{JA}	50	℃/W
Electrostatic Discharge（HBM）	ESD	2	kV

*Stresses beyond those listed under Absolute Maximum Ratings can cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods can affect device reliability.

6. Electrical Characteristics

Typical Values stated where T_A = 25 ℃

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Voltage						
OVP	V_{CU}	3.5 ~ 4.575V	V_{CU}-0.025	V_{CU}	V_{CU}+0.025	V
OVP release	V_{CL}	3.4 ~ 4.5V	V_{CL}-0.05	V_{CL}	V_{CL}+0.05	V
UVP	V_{DL}	1.8 ~ 3.0V	V_{DL}-0.08	V_{DL}	V_{DL}+0.08	V
UVP release	V_{DR}	2.0 ~ 3.1V	V_{DR}-0.1	V_{DR}	V_{DR}+0.1	V
ODC1	V_{IOV1}	0.03 ~ 0.34V	V_{IOV1}-0.025	V_{IOV1}	V_{IOV1}+0.025	V
ODC2	V_{IOV2}	0.35 ~ 0.70V	V_{IOV2}-0.05	V_{IOV2}	V_{IOV2}+0.05	V
SC	V_{IOV3}	—	V_{vc1}-1.5	V_{vc1}-1.2	V_{vc1}-0.9	V
OCC	V_{CIOV}	0.03 ~ 0.34V	V_{CIOV}-0.025	V_{CIOV}	V_{CIOV}+0.025	V
Balancing threshold	V_{CBON}	—	V_{CBON}-0.03	V_{CBON}	V_{CBON}+0.03	V
Delay Time						
Delay for OVP	t_{CU}	CCT 0.1 μF	0.5	1.0	1.5	s
Delay for UVP	t_{DL}	CDT 0.1 μF	50	100	150	ms
Delay for OCC	t_{CIOV}	-	5	10	15	ms
Delay for ODC1	t_{IOV1}	CDT 0.1 μF	5	10	15	ms
Delay for ODC2	t_{IOV2}	-	0.5	1.0	1.5	ms
Delay for SC	t_{IOV3}	-	100	200	300	μs
Power Consumption						
Current consumption in NORMAL mode	I_{OPE}	V1=V2=V3=V4=3.5	15	20	30	μA
Current consumption in power down mode	I_{PDN}	V1=V2=V3=V4=1.5	2.0	3.0	4.0	μA
Controller						
VMP to VDD pull-up resistor	R_{VMD}		0.5	1	1.5	MΩ
VMP to GND pull-down resistor	R_{VMS}		450	900	1800	kΩ

7. Functional Block Diagram

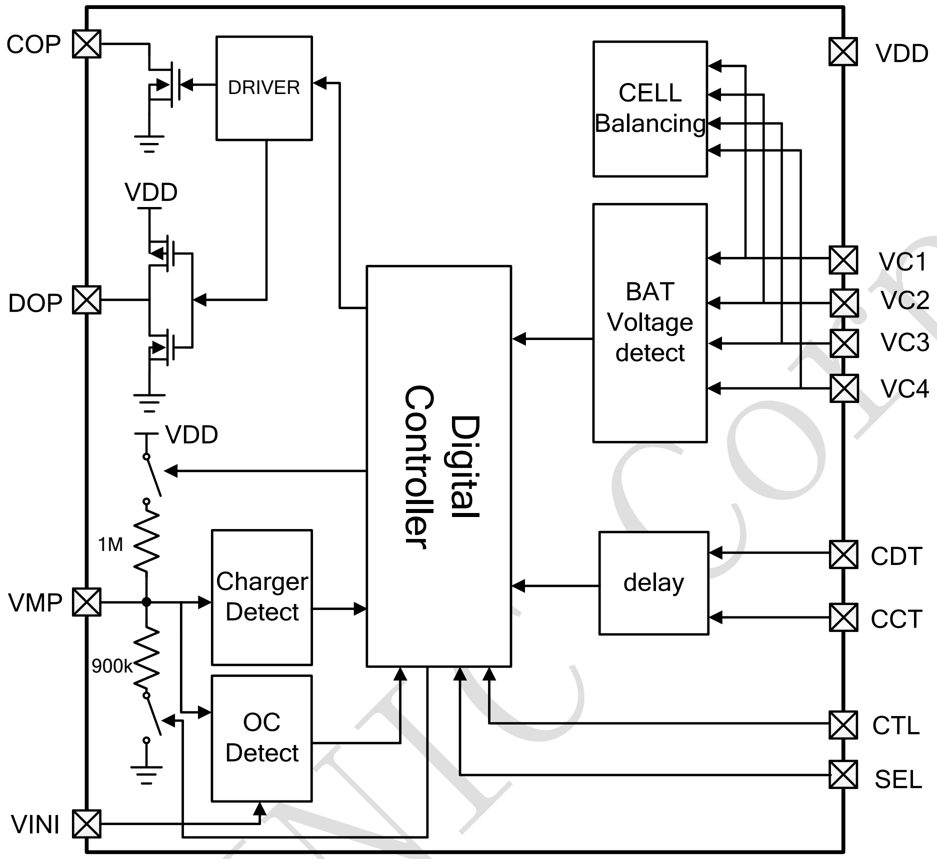


Figure 2. IP3254 Function Diagram

8. Function Description

8.1. Normal Status

When the voltage of all cells is between V_{DL} and V_{CU}, and the discharge current is lower than the over-current value(the voltage at the VINI terminal is lower than V_{IOV1} and V_{IOV2}), and the voltage at the VMP terminal is higher than V_{IOV3}, the COP and DOP are pulled down, the charging and discharging MOSFETs are connected, and IP3254 is in normal status.

8.2. Overcharge Protection

Once VBATn > V_{CU} and t > t_{CU} , the overcharge protection is triggered. The logic circuit in IP3254 will shut down the charge FET to prevent charging.

OVP will be release when one of the following two conditions is met:

(1) All VBATn < V_{CL}

(2) All VBATn < V_{CU} , and VMP < 39/40 ×VDD

8.3. Over-discharge Protection

Once VBATn < V_{DL} and t < t_{DL} , the over-discharge protection is triggered. The logic circuit in IP3254 will shut down the discharge FET to prevent discharging.

UVP will be release when one of the following two conditions is met:

(1) All VBATn > V_{DR}, and VDD-1.5V < VMP < VDD

(2) All VBATn > V_{DL}, and VMP>VDD+10mV

8.4. Discharge Over-current Protection

The discharge current detection principle of IP3254 series is that when the current flows through the current detection resistor and MOS, it will be converted into a voltage signal and captured by the IC. When the voltage exceeds the set threshold, the IC will conduct discharge overcurrent protection detection.

When a battery is in normal operation, once the voltage of VINI to VSS is higher than V_{IOV} and t> t_{IOV}, the logic circuit in IP3254 will shut down the discharge FET and charge FET. And then IP3254 goes into ODC status. In this status, the VM is connected to VDD with a internal resistor R_{VMS}.

After entering the discharge overcurrent status, when the voltage at the VMP terminal is higher than VDD-V_{IOV3}, the IC will exit the discharge overcurrent status. The following two conditions can be met:

(1) Connect charger.

(2) Load current is less than 10 μA.

8.5. Charge Over-current Protection

Some IP3254 models have charging overcurrent detection function. IP3254 charging overcurrent detection principle is similar to discharge over current. When the charging current flows through the current detection resistor, it will be converted into a voltage signal and captured by the VINI pin. At this time, the VINI voltage is lower than VSS.

When the voltage of VSS to VINI is higher than V_{CIOV} and t> t_{CIOV}, the logic circuit in IP3254 will shut down the charge FET. And then IP3254 goes into OCC status.

IP3254 returns to normal operation only when charger is disconnected.

8.6. Delay Time Setting

Overcharge detection delay time (t_{CU}) can be set by external capacitor connected to CCT terminal. The over discharge detection delay time (t_{DL}) and the overcurrent detection delay time 1 (t_{IOV1}) can be set by the external capacitor connected to the CDT terminal. Each delay time is calculated by the following formula. Overcurrent detection delay times 2 and 3 (t_{IOV2}, t_{IOV3}) are fixed internally by the IC.

$$t_{CU}(s) = 10 * C_{CCT}\ (\mu F)$$

$$t_{DL}(s) = 1 * C_{CDT}\ (\mu F)$$

$$t_{IOV1}(s) = 0.1 * C_{CDT}\ (\mu F)$$

8.7. CTL & SEL

CTL is the control pin of DOP and COP. SEL is used for select number of battery. The specific settings are shown in Table 3 and Table 4.

Table 3. CTL setting

CTL	COP	DOP
High	High-Z	VDD
Open	High-Z	VDD
Low	Normal	Normal

Table 4. SEL seting

SEL	number of battery.
High	4
Open	NA
Low	3

*Note: When selecting three batteries, the VC4 pin of the IC needs to be connected to VSS.

8.8. Cell Balancing

The IP3254 supports the cell balancing function (the model is IP3254-B**, read the product name list for details). IP3254 has built-in balancing MOSFETs, which can realize the cell balancing function without any external components. At the same time, the balancing current can be increased by expanding the MOSFETs. As shown in Figure 3, the dotted line box is an expanded MOSFETs balancing circuit.

When it is detected that any cell voltage is higher than the balancing voltage V_{CBON}, the IC turns on the internal balancing MOSFETs to discharge the corresponding cell. IP3254 adopts parity balance strategy, which means two adjacent cells do not turn on balancing MOSFETs to discharge them at the same time, but discharge them alternately, as shown in Figure 4.When it is detected that the cell voltage is higher than the balancing voltage V_{CBON}, the IC turns on the balancing MOSFETs corresponding to the odd number of cells to be balanced.The cell discharges through two R_{VCn} and internal MOSFETs (as shown by the red dotted line in Figure 3). After 100ms, the IC closes the balancing MOSFETs, delays for 20ms to detect the cell voltage, and then opens the balancing MOSFETs corresponding to the even number of cells to be balanced, discharges the corresponding cell for 100ms, and keeps cycling like this. When using the integrated MOSFETs for cell balancing, the cell monitor filter resistance R_{VCn} controls the amount of cell balancing current the device can supply to the cells. The cell balancing currents of Internal cell balancing is: $I_{CBn} = 0.417 * V_{BATn} / (R_{VCn} + R_{VCn+1})$.

When it is necessary to expand the MOSFETs to increase the balancing current, the typical value of 1kΩ can be taken for R_{VCn} to reduce the value of the filter capacitor C_{VCn} (see the fourth typical application schematic diagram for details).At this time, the balancing current flowing through the internal MOSFETs is very low, about 2mA.When the internal balancing MOSFET is turned on, the VGS of the external balancing PMOS is equal to -VBATn/2, and the PMOS transistor is turned on. The corresponding cell discharges through the external PMOS and R_{CBn} (as shown by the green dotted line in Figure 3), and the equivalent balancing current is : $I_{CBn} = 0.417 * V_{BATn} / R_{CBn}$.

External MOSFETs have to be used if higher cell balancing currents are required. In the case of external balancing, the balancing current is controlled by the resistor R_{CBn} in series with the external MOSFET. The cell balancing currents of external cell balancing is: $I_{CBn} = 0.417 * V_{BATn} / R_{CBn}$. It should be noted that the external PMOS threshold voltage VGSth should be lower than 1.6V, and the selection of R_{CBn} resistance power is determined by the current flowing.

The cell balancing will be turned off when:

(1) All the cell voltage are higher or lower than the balancing threshold voltages(V_{CBON}).

(2) Any abnormal situation occurs, such as open circuit, UVP, OC, OT and so on.

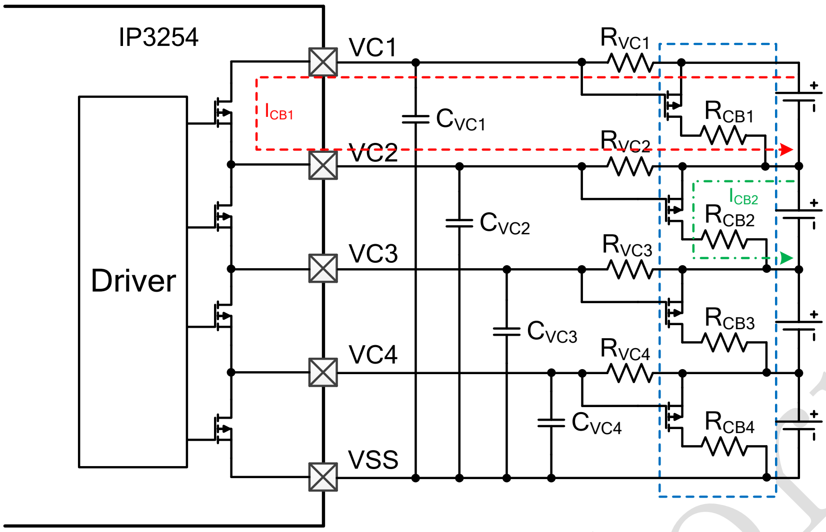


Figure 3. Cell Balancing

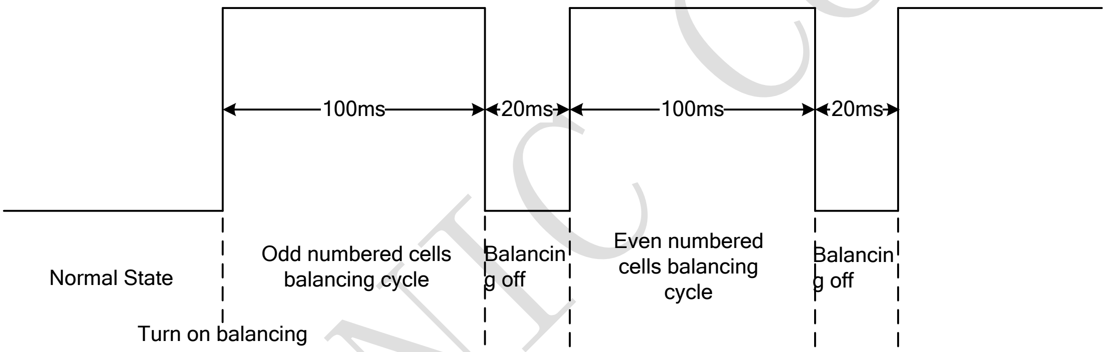


Figure 4. Cell Balancing Algorithm

Note: When a cell is balancing, the maximum overcharge detection delay will increase by 120ms.

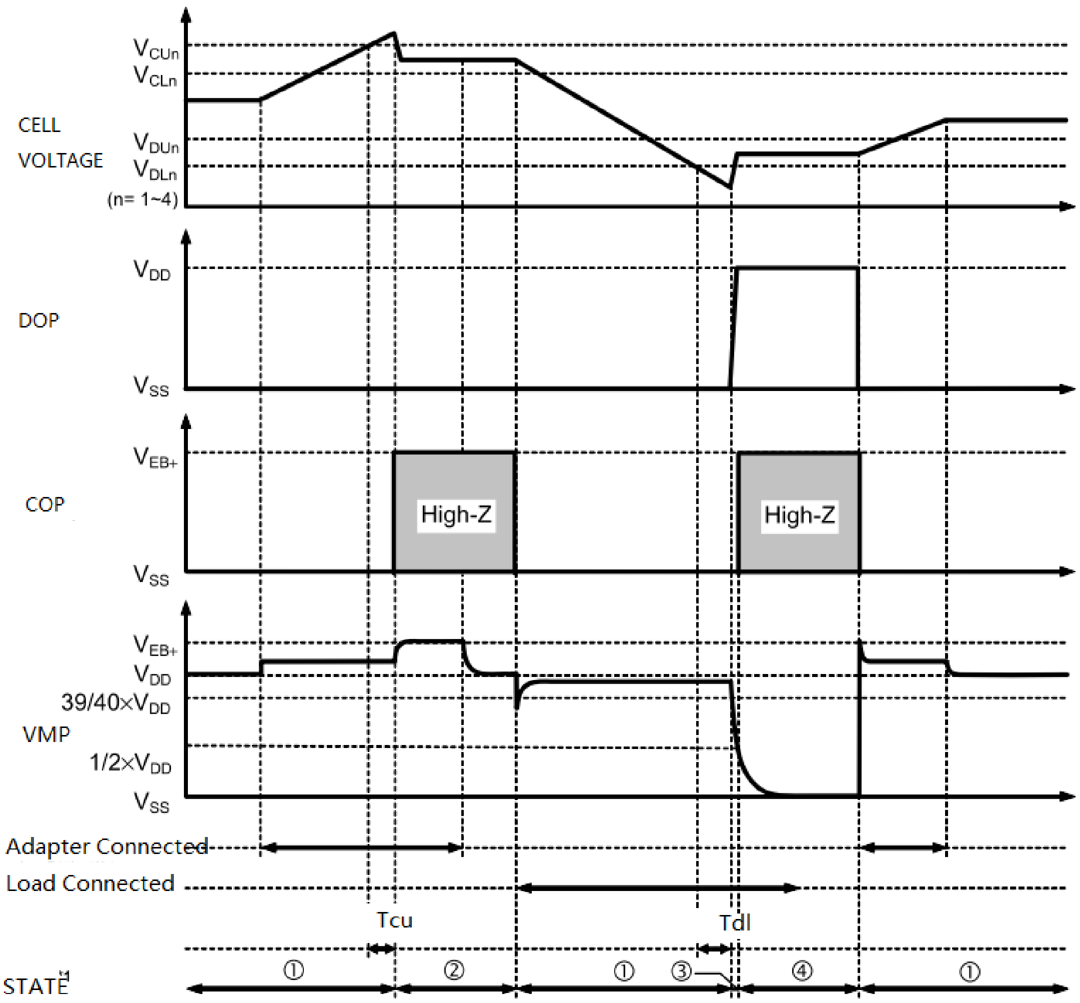
8.9. 0V Battery Charge Enable

IP3254 supports 0V battery charging. When the battery voltage drops to 0V due to self discharge, it can still be charged. If a charger with 0V charging function is connected to P+ and P- terminals, IP3254 internal logic control charging MOSFET is forced to open to start charging. At the same time, the discharge MOSFET is turned off, and the charging current charges the battery through the internal parasitic diode. When the battery voltage is greater than the over discharge voltage V_{DL}, the chip will enter the normal status.

Note: Please consult the battery supplier if the battery used by the customer supports 0V charging.

9. Timing Charts

9.1. OVP & UVP Detection and Release

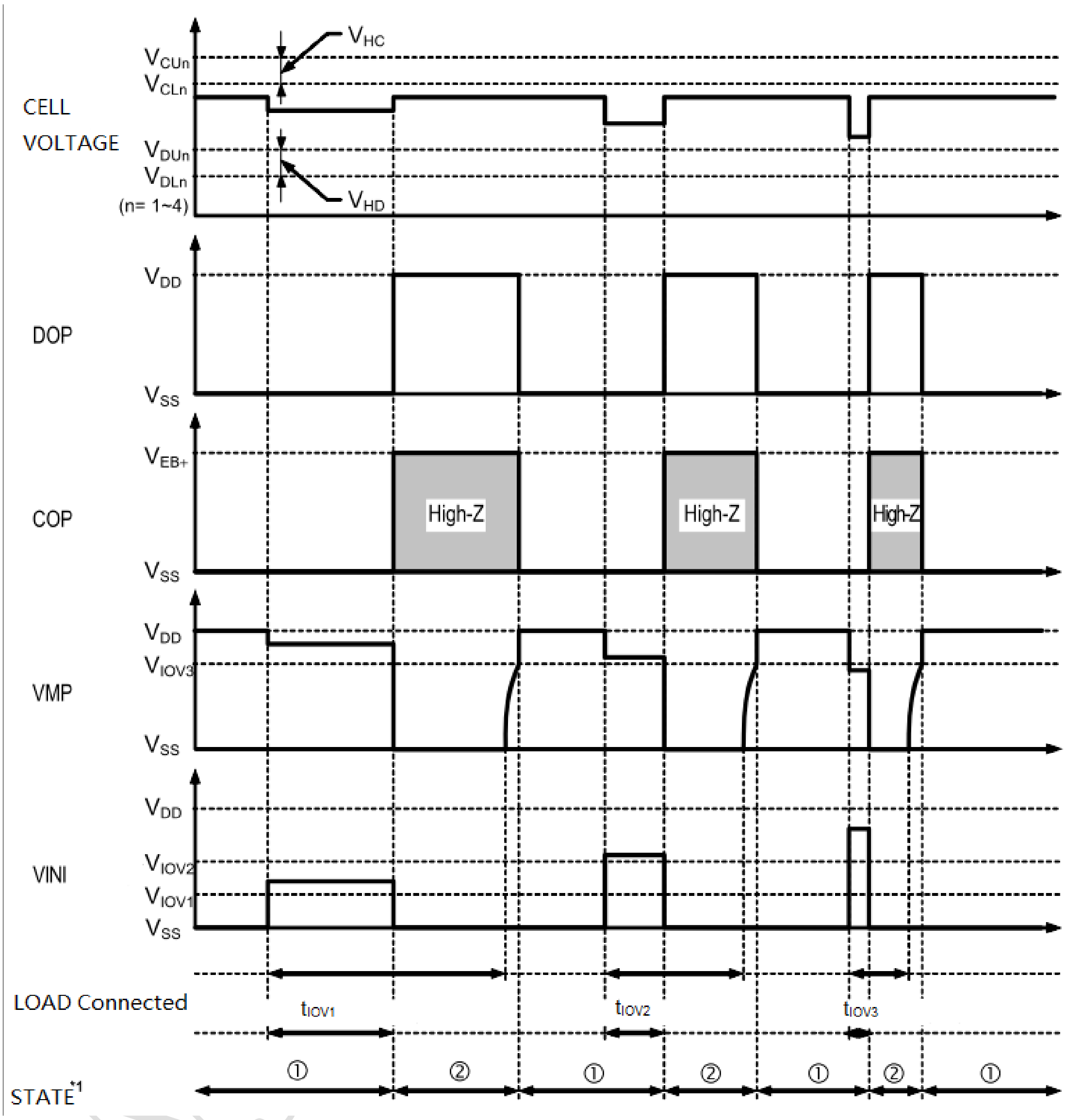


*1 ①： normal

②： OVP

③： UVP

9.2. OC and Short Circuit Detection

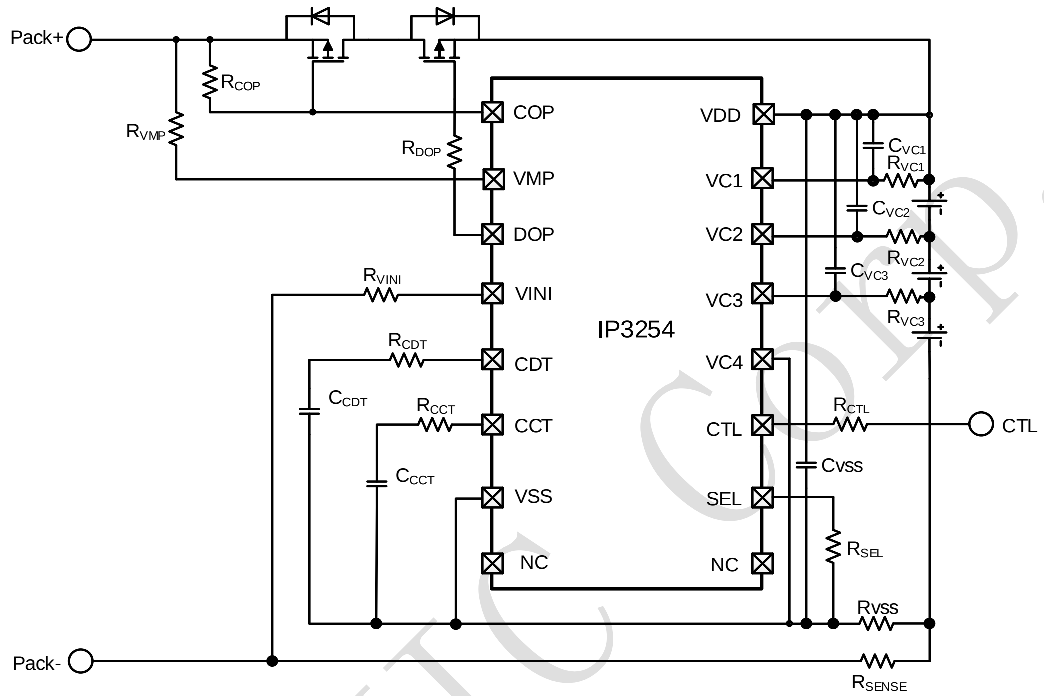


*1 ①： normal

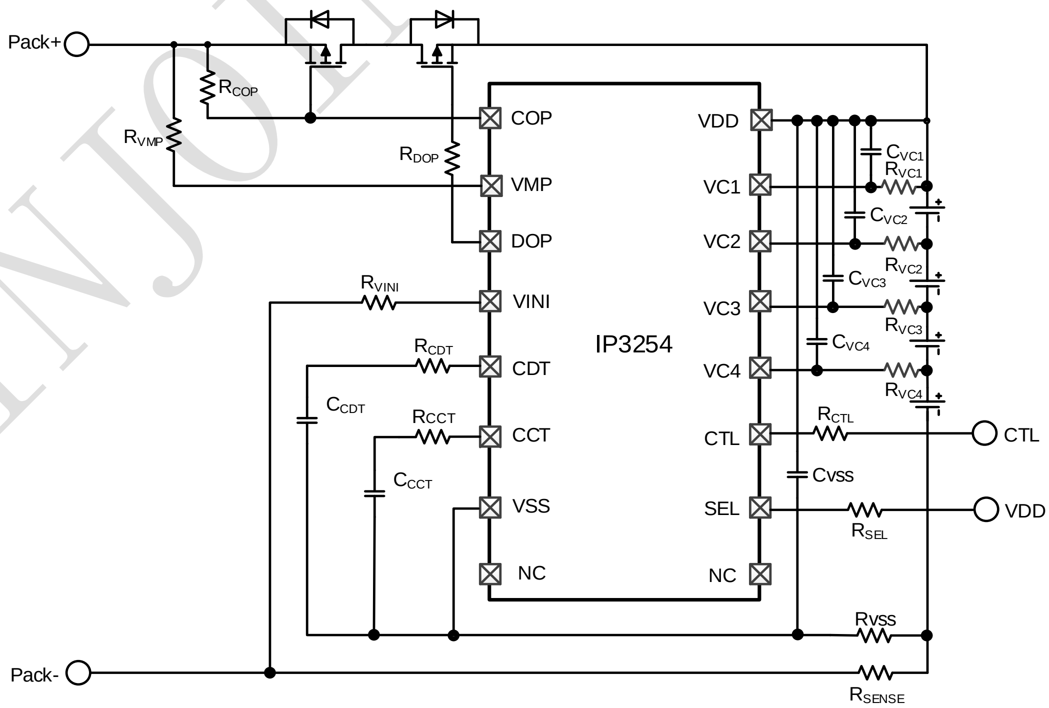
②： OC and short circuit detection

10. Typical Application

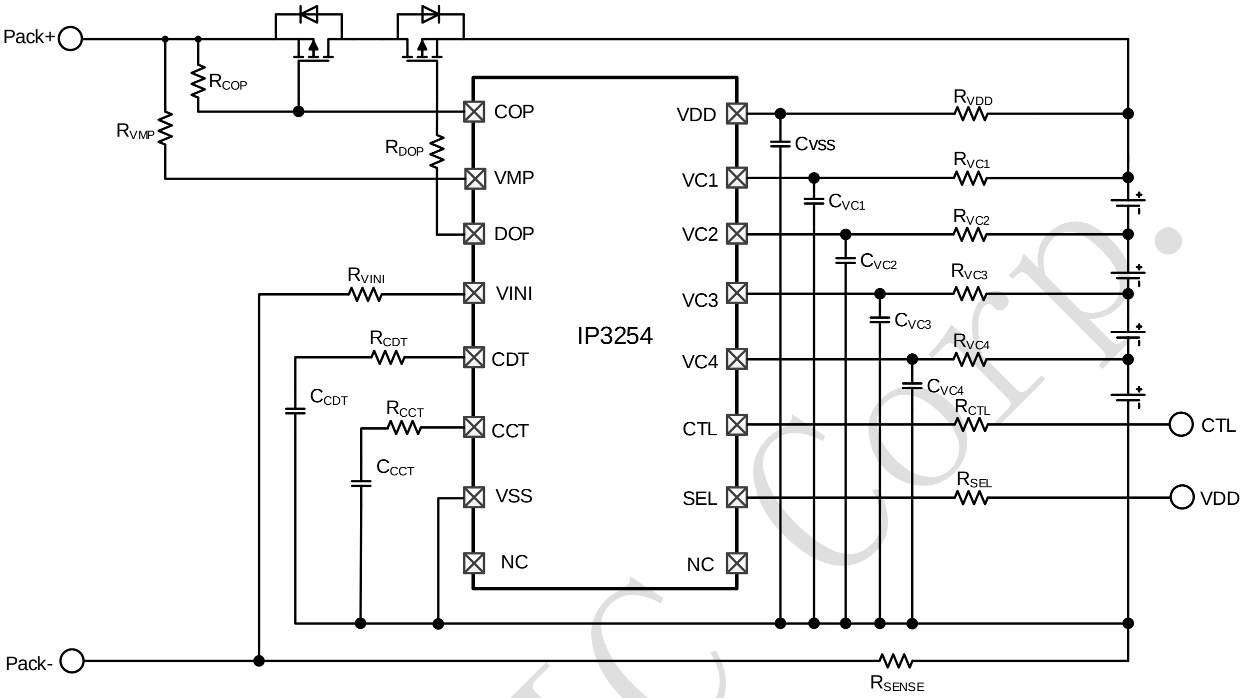
1. 3-serial cell, refer to Table 5 for specific peripheral component parameters



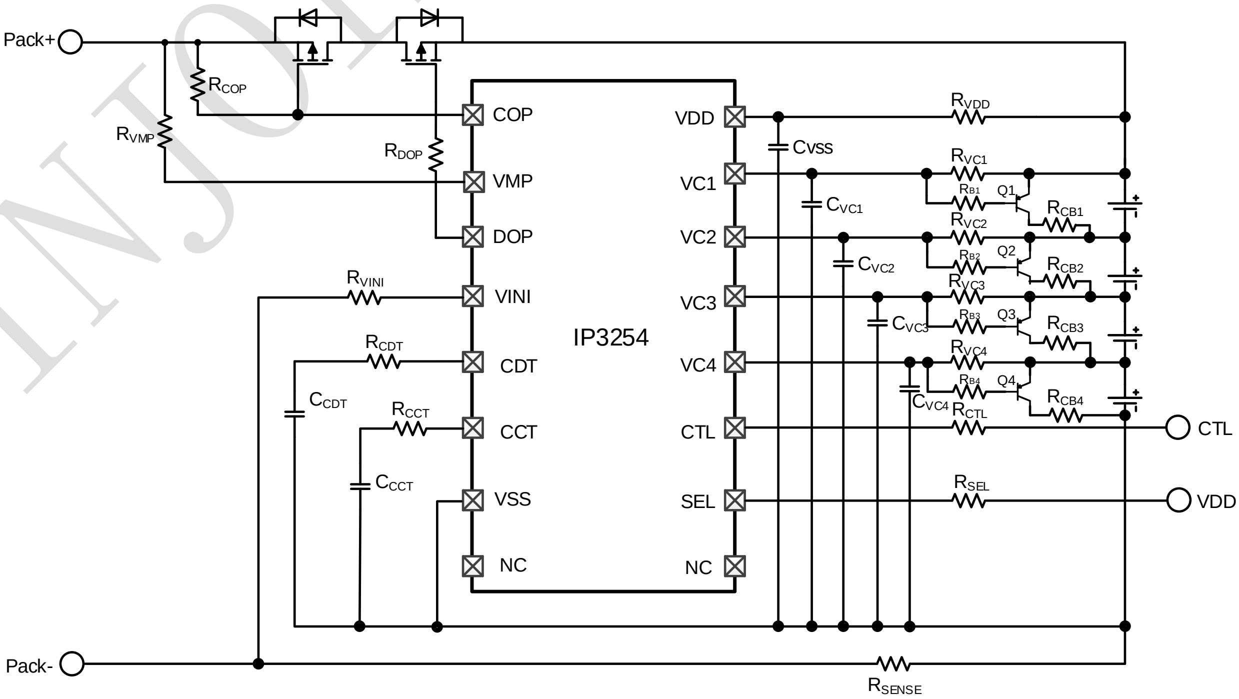
2. 4-serial cell, refer to Table 5 for specific peripheral component parameters



3. 4-serial cell with 10mA balancing current, R_{VCn}=100Ω,C_{VCn}=1μF, refer to Table 5 for specific peripheral component parameters



4. 4-serial cell with 50mA balancing current through external triode, R_{CBn}=43Ω, R_{Bn}=510Ω, refer to Table 5 for specific peripheral component parameters



5. 4-serial cell with 50mA balancing current through externa MOSFETs, R_{CBn}=43Ω, V_{GSth} of balancing MOSFETs is lower than 1.6V, refer to Table 5 for specific peripheral component parameters

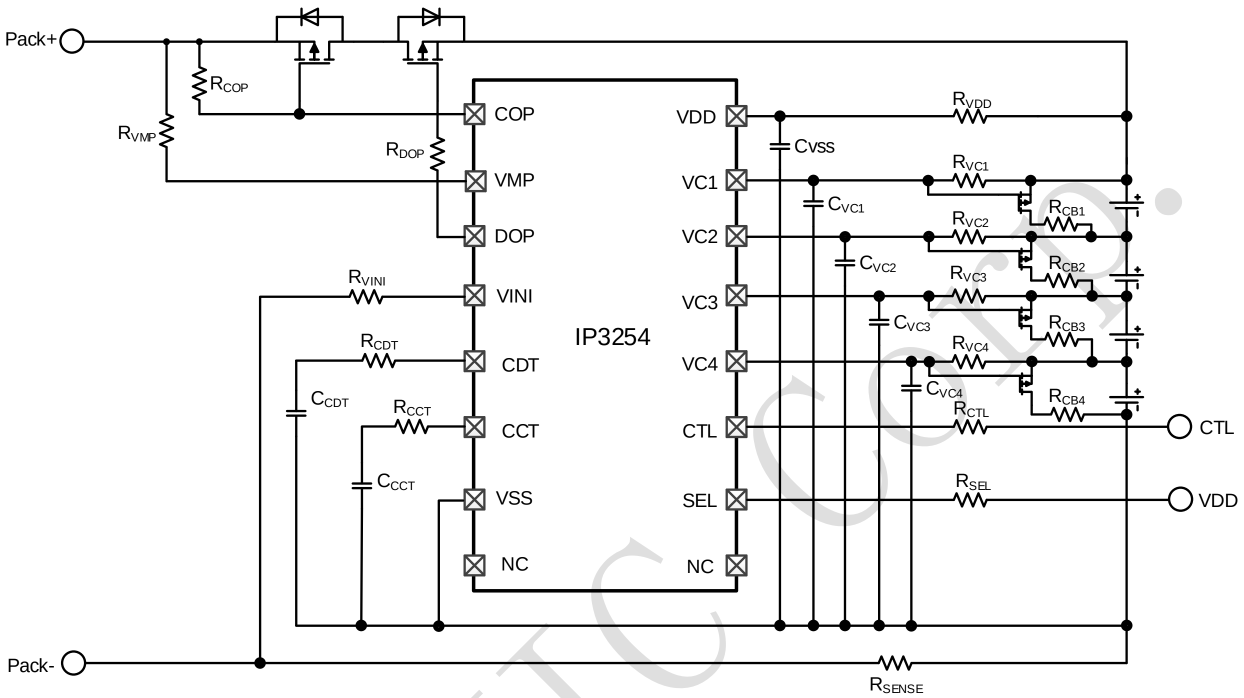


Table 5. BOM

Position	Min	Typ	Max	Unit
R_{VC1}、R_{VC2}、R_{VC3}、R_{VC4}	0	1	1	kΩ
*[1]R_{CB1}、R_{CB2}、R_{CB3}、R_{CB4}	--	100	--	Ω
R_{B1}、R_{B2}、R_{B3}、R_{B4}	--	510	--	Ω
*[2]R_{CCT}、R_{CDT}	1	1	5	kΩ
R_{DOP}	2	5.1	10	kΩ
R_{COP}	0.1	3	3	MΩ
R_{VMP}	1	5.1	10	kΩ
R_{CTL}	1	1	100	kΩ
R_{SEL}	1	1	100	kΩ
R_{VINI}	1	1	100	kΩ
R_{SENSE}	0	—	—	mΩ
R_{VSS}	20	47	51	Ω
R_{VDD}	51	100	510	Ω
C_{VC1}、C_{VC2}、C_{VC3}、C_{VC4}	0	0.1	2.2	μF

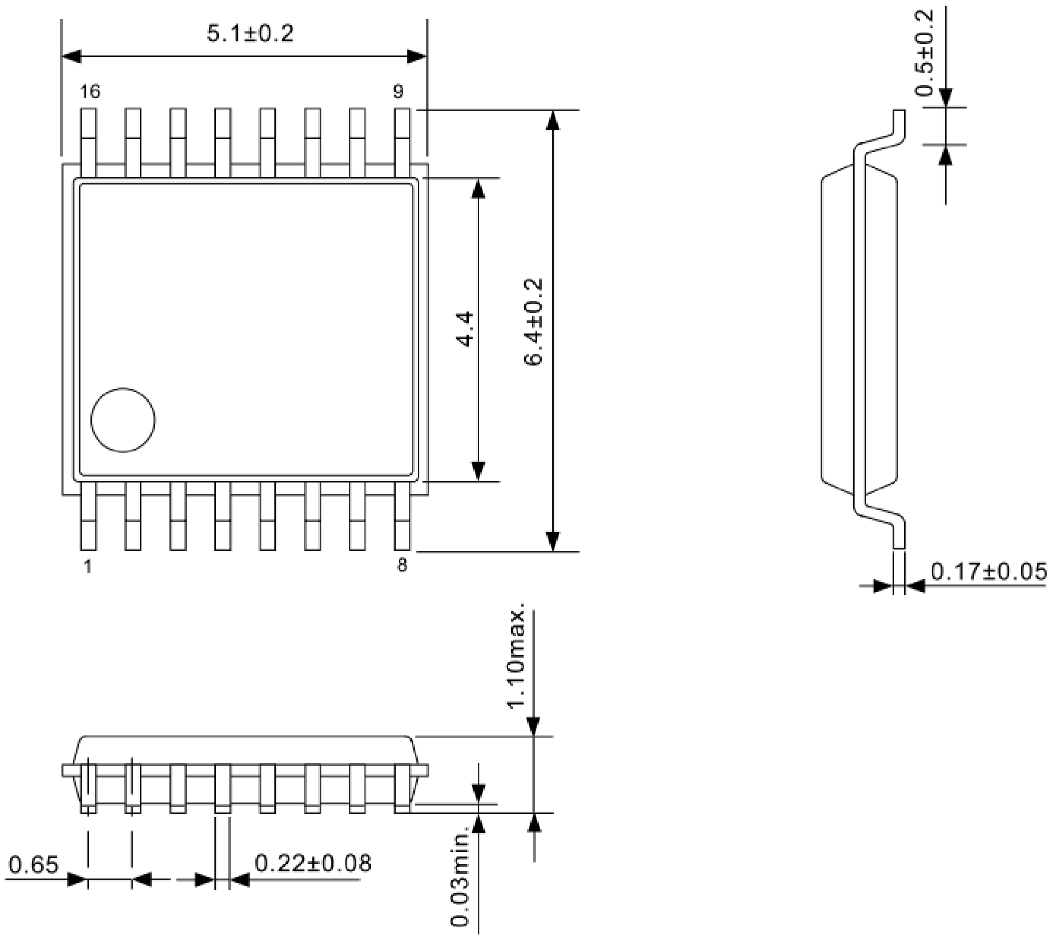
C_{CCT}	0.01	0.1	—	μF
C_{CDT}	0.07	0.1	—	μF
C_{VSS}	2.2	4.7	10	μF
Q1、Q2、Q3、Q4	-	MMBT5401	-	-

*[1]： R_{CBn} recommends using 1206 package.

*[2]： R_{CDT} and R_{CCT} are used to enhance overall protection circuit.

11. Package

TSSOP-16 as follows
unit：mm



12. Silk Screen Printing Explanation

Expiain:

1、 ——INJOINIC Mark
2、IP3254 ——Product modle
3、XXXXXXXX——Batch number
4、 ○ ——Pin1 Mark

13. Important Notice

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