Aimtron
圓創科技股份有限公司

AT1457

Preliminary Product Information
1-Cell Lithium-Ion And Lithium-Polymer Charge Management IC

Features

- Ideal for Single-Cell (4.1 V or 4.2 V) and Li-Ion or Li-Pol Packs
- Better Than ±1% Voltage Regulation Accuracy With Preset Voltages
- Optional Cell-Temperature Monitoring Before and During Charge
- Integrated Voltage and Current Regulation With Programmable Charge-Current and High or Low-Side Current Sensing
- Charge Status Output for Single or Dual Led or Host Processor Interface
- Automatic Battery-Recharge Feature
- Charge Termination by Minimum Current
- Automatic Low-Power Sleep Mode When VCC is Removed
- Requires Small Number of External Components
- Packaging: 8-Pin MSOP

Applications

- 1-Cell Lithium-Ion And Lithium-Polymer Charger
- DSC

General Description

The AT1457 series Lithium-Ion (Li-Ion) and Lithium-Polymer (Li-Pol) linear charge ICs are designed for cost-sensitive and compact portable electronics. They combine high-accuracy current and voltage regulation, battery conditioning, temperature monitoring, charge termination, and charge-status indication in a single 8-pin IC. MSOP package options are offered to fit a wide range of end applications.

The AT1457 continuously measures battery temperature using an external thermistor. For safety, the AT1457 inhibits charge until the battery temperature is within user-defined thresholds.

The AT1457 then charges the battery in three phases: conditioning, constant current, and constant voltage. If the battery voltage is below the low-voltage threshold, V(min), the AT1457 precharges using a low current to condition the battery. The conditioning charge rate is approximately 10% of the regulation current. After conditioning, the AT1457 applies a constant current to the battery. An external sense-resistor sets the current. The sense-resistor can be on either the high or low side of the battery without additional components. The constant-current phase continues until the battery reaches the charge-regulation voltage. The AT1457 then begins the constant-voltage phase. The accuracy of the voltage regulation is better than ±1% over the operating- temperature and supply-voltage ranges.
For single cells, the AT1457 is offered in two fixed-voltage versions: 4.1 V, and 4.2 V. Charge stops when the current tapers to the charge termination threshold, $I_{(TERM)}$. The AT1457 automatically restarts the charge if the battery voltage falls below the $V_{(RCH)}$ threshold.

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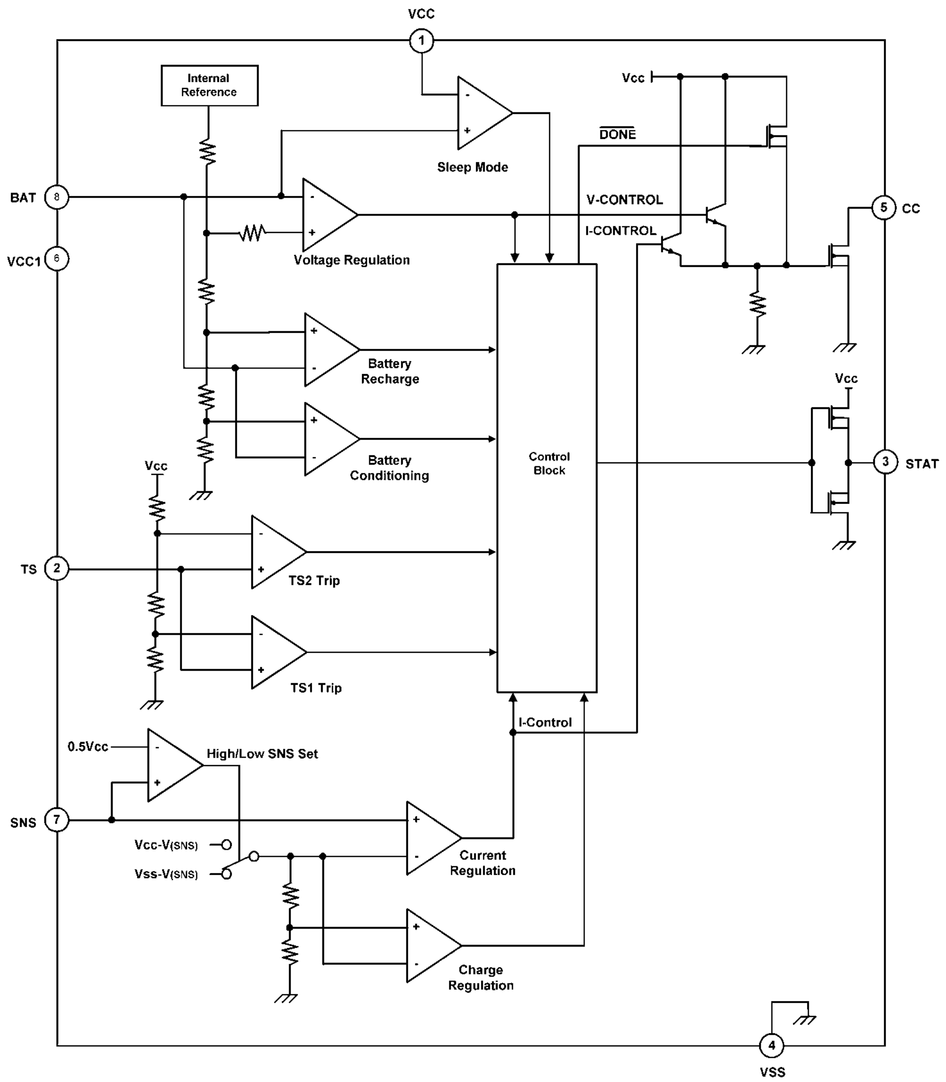
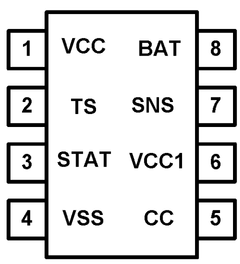
Block Diagram



Pin Configuration



AT1457

Ordering Information

Part number	Package	Marking
AT1457M	MSOP8(4.2V version)	1457
AT1457M_GRE	MSOP8(4.2V version),Green	1457, date code with one bottom line
AT1457AM	MSOP8(4.1V version)	1457A
AT1457AM_GRE	MSOP8(4.1V version),Green	1457A, date code with one bottom line

Pin Description

Pin No.	Symbol	I/O	Description
1	VCC	I	Supply voltage
2	TS	I	Temperature sense input
3	STAT	O	Charge status output
4	VSS	—	Ground
5	CC	O	Charge control output
6	VCC1	I	Supply voltage
7	SNS	I	Current sense input
8	BAT	I	Voltage sense input

Absolute Maximum Ratings

Parameter	Symbol	Condition	Rated Value		Unit
			Min.	Max.	
Power supply voltage	V_{CC}	—	-0.3	+8	V
Input voltage	$V_{(BAT)}$	—	-0.3	V_{CC}+0.3	V
	$V_{(SNS)}$	—	-0.3	V_{CC}+0.3	V
	$V_{(TS)}$	—	-0.3	V_{CC}+0.3	V
Sink current (STAT pin)	I_{OL}	not to exceed P_D	—	20	mA
Source current (STAT pin)	I_{OH}	not to exceed P_D	—	10	mA
Output current (CC pin)	$I_{O(CC)}$	not to exceed P_D	—	40	mA
Total power dissipation	P_D	at 25℃	—	300	mW
Operating free-air temperature range	T_A	–	-20	+85	℃
Storage temperature range	Tstg	–	-40	+125	℃
Lead temperature	T_L	soldering, 10 s	–	300	℃

Recommended Operating Conditions

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Power supply voltage	V_{CC}	4.5	–	7	V
Operating free-air temperature range	T_A	-20	–	+85	°C

Electrical Characteristics

(VIN=4.5V to 7V, T_A=-20°C to +85°C unless otherwise noted. Typical value are at T_A=+25°C)

Parameter		Symbol	Condition	Values Min.	Values Typ.	Values Max.	Unit
Entire device	V_{CC} Current	$I_{(VCC)}$	$V_{CC} > V_{CC(min)}$, Excluding external loads	--	2	4	mA
	V_{CC} Sleep current	$I_{(VCCS)}$	$V_{(BAT)} \geq V_{(min)}$, $V_{(BAT)} - V_{CC} \geq 0.8V$	--	3	6	μA
	Input bias current on BAT pin	$I_{IB(BAT)}$	$V_{(BAT)} = V_{(REG)}$	--	--	1	μA
	Input bias current on SNS pin	$I_{IB(SNS)}$	$V_{(SNS)} = 5$ V	--	--	5	μA
	Input bias current on TS pin	$I_{IB(TS)}$	$V_{(TS)} = 5$ V	--	--	5	μA
Battery Voltage Regulation	Output voltage	$V_{O(REG)}$	--	4.059	4.10	4.141	V
				4.158	4.20	4.242	V
Current Regulation	Current regulation threshold	$V_{(SNS)}$	High-side current sensing configuration	95.4	105	115.5	mV
			Low-side current sensing configuration	100	110	121	mV
Charge Termination Detection	Charge termination current detect threshold	$V_{(TERM)}$	Voltage at pin SNS, relative to V_{CC} for high-side sensing, and to Vss for low-side sensing, 0℃≤T_A≤50℃	4	14	24	mV
Temperature Comparator	Lower temperature threshold	$V_{(TS1)}$	TS pin voltage	29.1	30	30.9	%Vcc
	Upper temperature threshold	$V_{(TS2)}$		58.3	60	61.8	%Vcc
Precharge Comparator	Precharge threshold	$V_{(min)}$	--	2.94	3	3.06	V
				3.04	3.1	3.16	V
Precharge current regulation	Precharge current regulation	$V_{(PRECHG)}$	Voltage at pin SNS, relative to V_{CC} for high-side sensing, and to V_{SS} for low-side sensing, 0℃≤T_A≤50℃	--	13	--	mV
			Voltage at pin SNS, relative to V_{CC} for high-side sensing, 0℃≤T_A≤50℃, V_{CC}=5V	3	13	22	mV
V_{RCH} Comparator (Battery Recharge Threshold)	Recharge threshold	$V_{(RCH)}$	--	$V_{O(REG)}$ -98mV	$V_{O(REG)}$ - 100mV	$V_{O(REG)}$ - 102mV	V
STAT PIN	Output (low) voltage	$V_{OL(STAT)}$	I_{OL} = 10 mA	--	--	0.7	V
	Output (high) voltage	$V_{OH(STAT)}$	I_{OH} = 5 mA	V_{CC}-0.5	--	--	V

CC PIN	Output low voltage	$V_{OL(CC)}$	$I_{O(CC)}$ = 5 mA (sink)	--	--	1.5	V
	Sink current	$I_{O(CC)}$	Not to exceed power rating specification (P_D)	5	--	40	mA

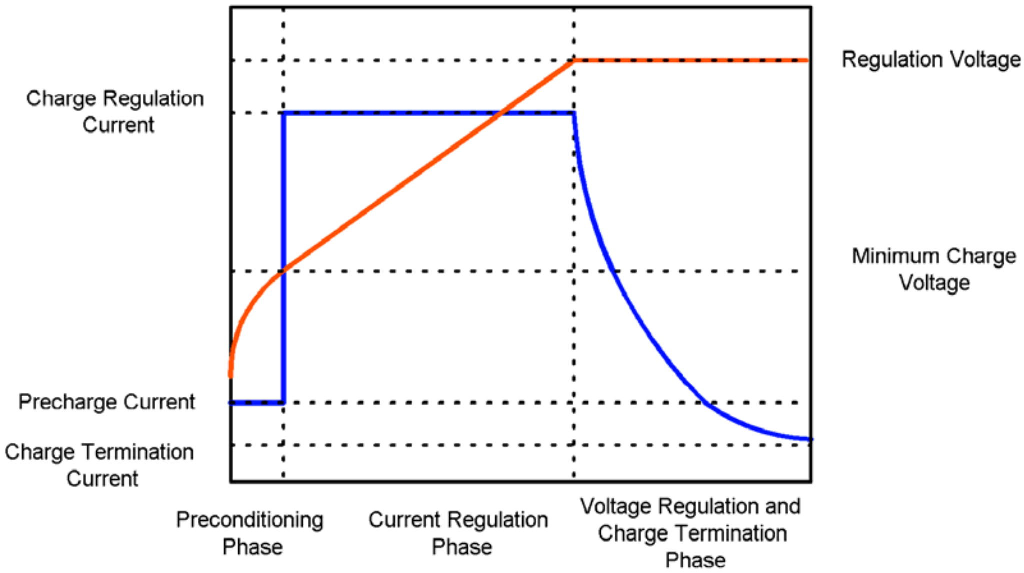


Figure 1: Typical Charge Profile

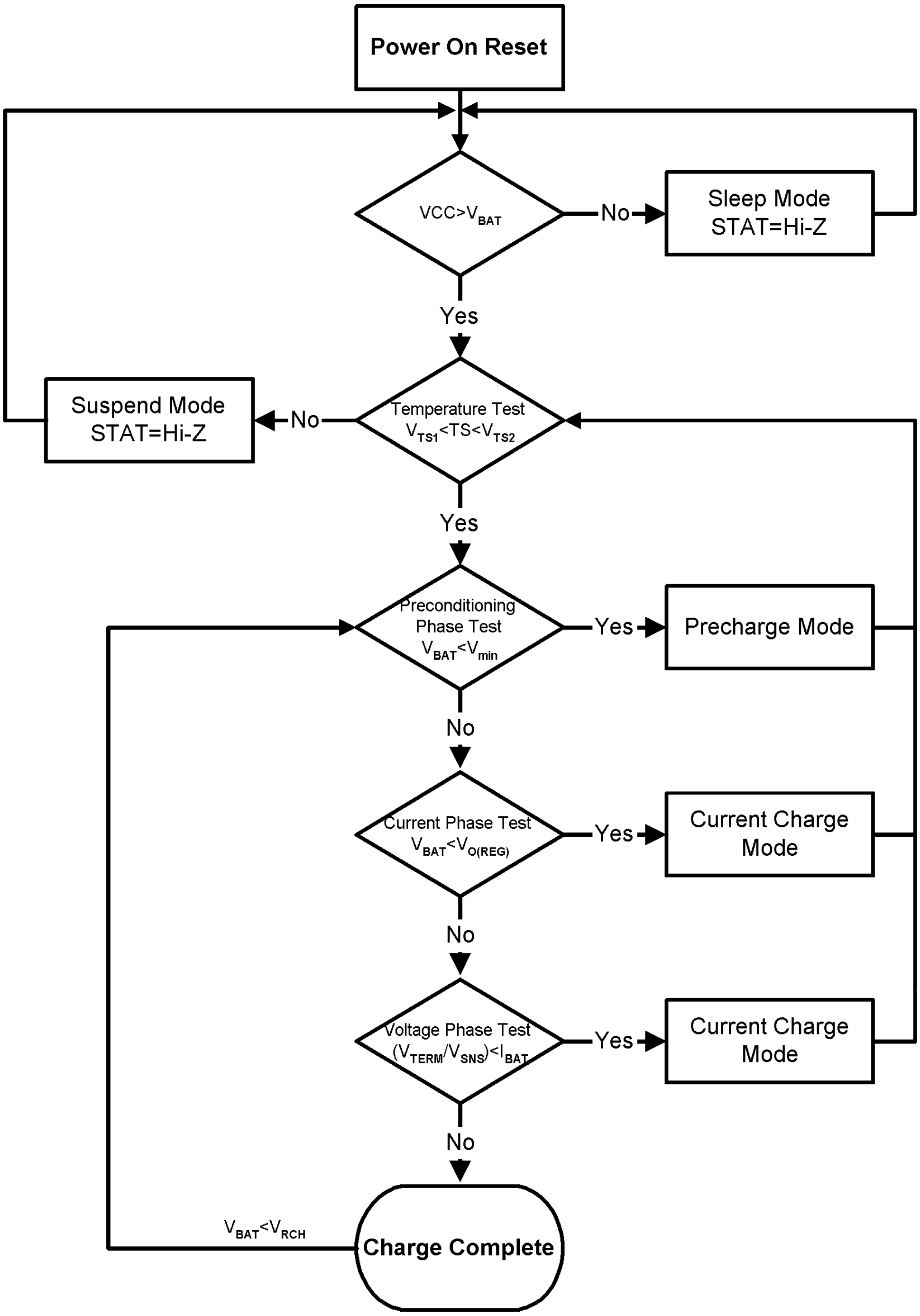


Figure 2: AT1457 Operational Flow Chart

Typical Application Circuit

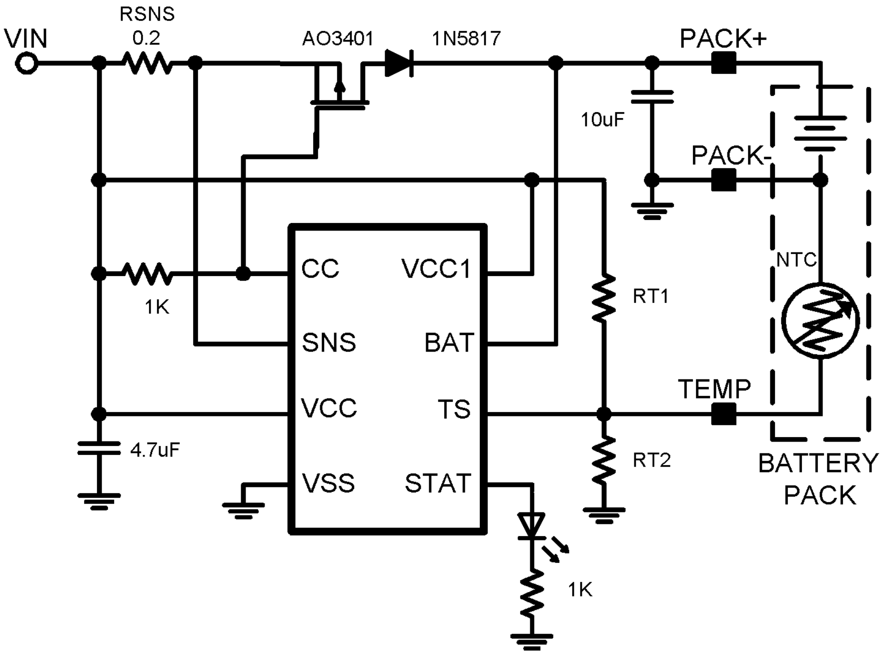


Figure 3: 0.5A Charger Using P-Channel MOSFET

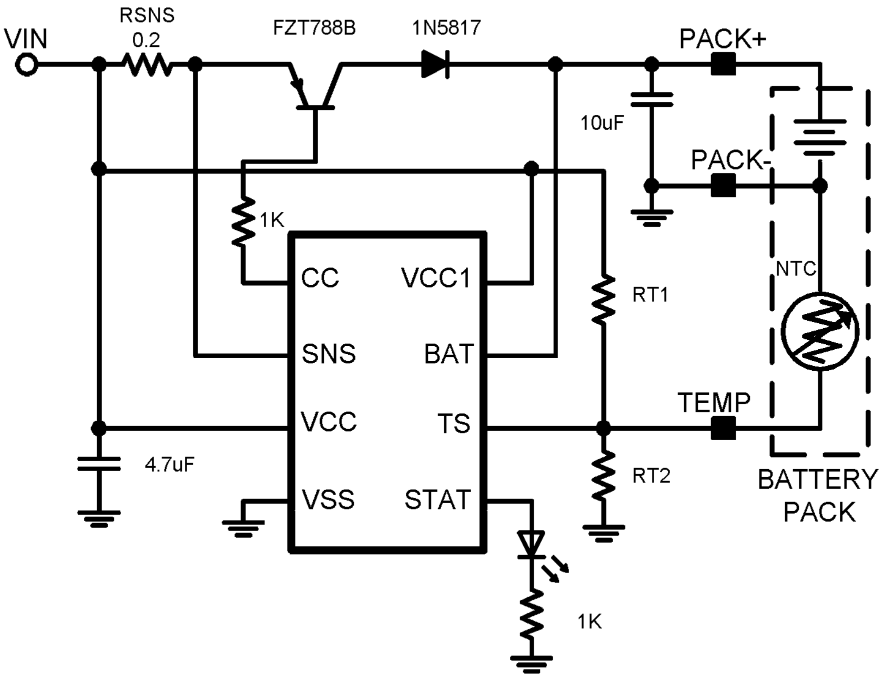


Figure 4: 0.5A Charger Using PNP Transistor

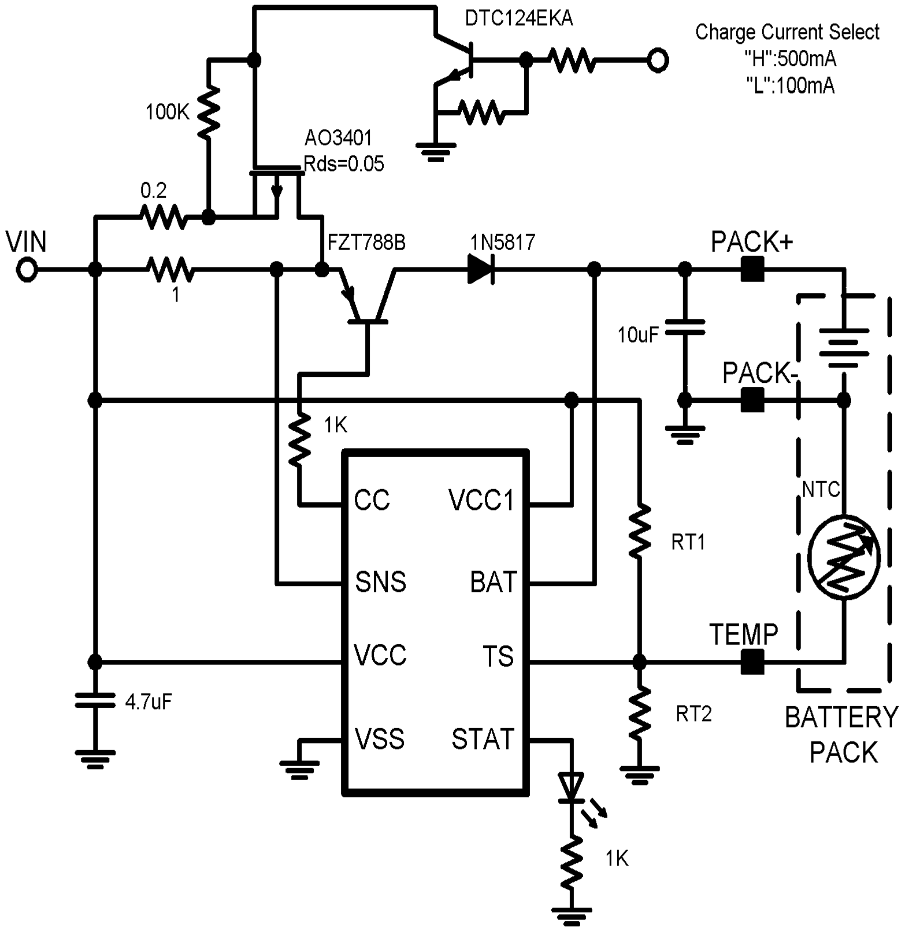


Figure 5: 0.5A/0.1A Charger Using P-Channel MOSFET Switching

Application Information

1. Charge Current Formula:

Precharge Current:

$$I_{PRECHG} = \frac{V_{PRECHG}}{R_{SNS}}$$

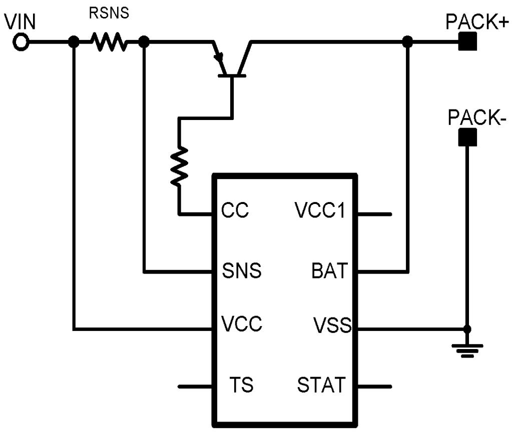
Current Regulation Charging :

$$I_{CHG} = \frac{V_{SNS}}{R_{SNS}}$$

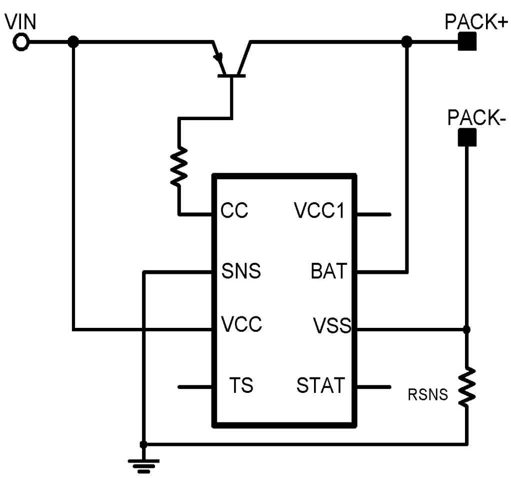
Charge Termination Current:

$$I_T = \frac{V_{TERM}}{R_{SNS}}$$

2. High-Side And Low-Side Current Sensing



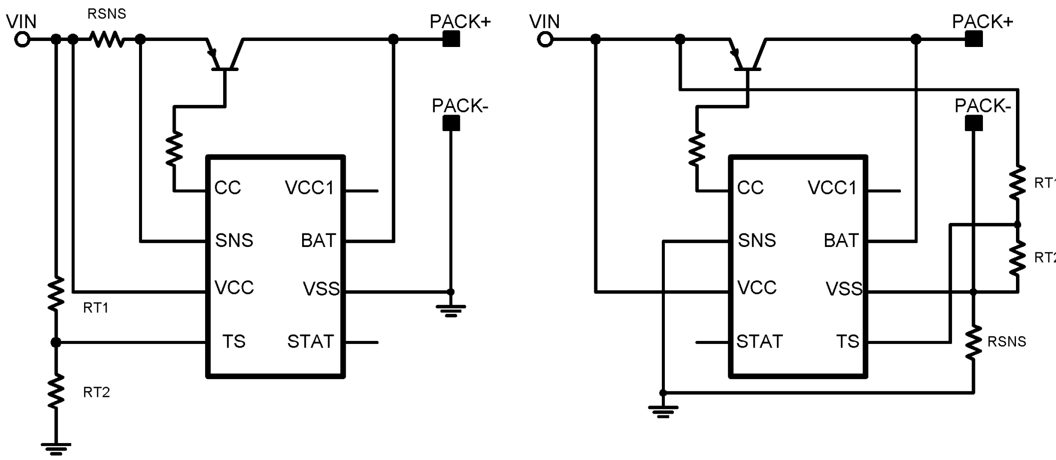
High-Side Current Sensing



Low-Side Current Sensing

3. Battery Temperature Monitor

The AT1457 continuously monitors temperature by measuring the voltage between the TS and VSS pins. A negative or a positive temperature coefficient thermistor (NTC or PTC) and external voltage divider typically develop this voltage. The AT1457 compares this voltage against its internal V_{TS1} and V_{TS2} threshold to determine if charging is allowed.



The resistor value of RT1 and RT2 ars calculated by the following equations:

For NTC Thermistor

$$R_{T1} = \frac{5 \times R_{TH} \times R_{TC}}{3 \times (R_{TC} - R_{TH})}$$

$$R_{T2} = \frac{5 \times R_{TH} \times R_{TC}}{[(2 \times R_{TC}) - (7 \times R_{TH})]}$$

For PTC Thermistor

$$R_{T1} = \frac{5 \times R_{TH} \times R_{TC}}{3 \times (R_{TH} - R_{TC})}$$

$$R_{T2} = \frac{5 \times R_{TH} \times R_{TC}}{[(2 \times R_{TH}) - (7 \times R_{TC})]}$$

R_{TC} is the cold temperature resistance and R_{TH} is the hot temperature resistance of thermistor.

4.Reverse Current Blocking Diode

(A) Transistor Circuit Application

When using the AT1457 with a PNP Transistor, a reverse-blocking diode is not required because there is no current path from BAT to VIN. However, it is advisable to still place a diode to the circuit. In the event where the input supply is interrupted or removed during the constant current or constant voltage phases, the battery under charge will discharge through the circuit pass transistor rendering it impossible to turn off. If the circuit is unable to turn off, the reverse leakage will discharge the battery. A Blocking diode will prevent this undesirable effect.

(B) MOSFET Circuit Application

An reverse blocking diode is required for the circuit show in Figure 3. The blocking diode gives the system protection from a shorted input. It also prevent the leakage current of battery when the input power is interrupted or removed.

5.Input Capacitor

It is good design practice to place a decoupling capacitor between VCC and VSS pins. An input capacitor in the range of 0.1μF to 10μF is recommended. A larger input capacitor in application will minimize switching or power bounce effects when the power supply is "hot plugged" in.

6.Input Capacitor

The AT1457 does not need an output capacitor for stability of the device itself, However, a capacitor connected between BAT and VSS will control the output voltage when the AT1457 is powered up when no battery is connected. If a high impedance load is placed across the BAT pin to VSS, the AT1457 can become unstable. Such a case is possible with aging Li-Ion battery cells. As cells age through repeated charge and discharge cycles, the internal impedance can rise over time. A 10μF or larger output capacitor will compensate for the adverse effects of a high impedance load and assure device stability over all operating conditions.

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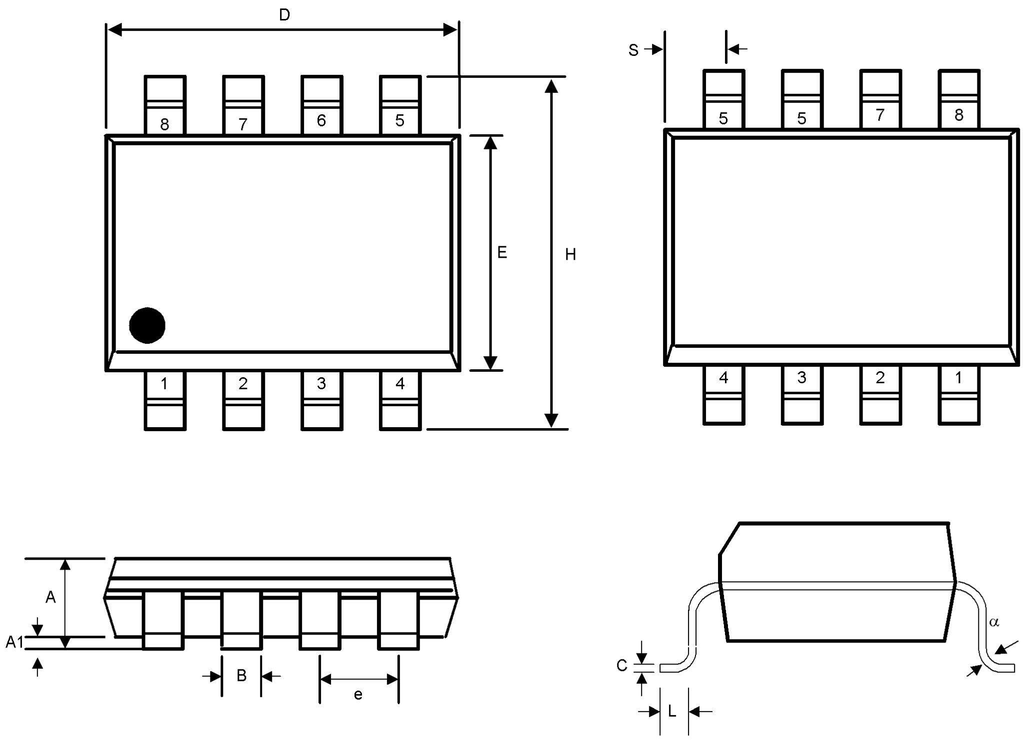
Package Outlines (units:mm): MSOP-8



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.037	0.043	0.94	1.10	-
A1	0.002	0.006	0.05	0.15	-
B	0.010	0.014	0.25	0.36	-
C	0.005	0.007	0.13	0.18	-
D	0.116	0.120	2.95	3.05	-
e	0.0256 BSC		0.65 BSC		-
E	0.116	0.120	2.95	3.05	-
H	0.188	0.198	4.78	5.03	
L	0.016	0.026	0.41	0.66	-
α	0°	6°	0°	6°	
S	0.207 BSC		0.525 BSC		-