南京拓品微电子有限公司

Nan Jing Top Power ASIC Corp.

DATASHEET

TP4056H

1A Linear Lithium-Ion Battery Charger with 30V Input & OVP Function

Description

The TP4056H is a 1A linear charger for single-cell lithium-ion batteries, featuring 30V input voltage tolerance, power supply OVP, and battery reverse-polarity protection.

It offers three selectable full-charge voltages: 4.35V, 4.2V and 3.7V. The charging current can be externally set by a resistor. The TP4056H automatically terminates the charging cycle when the charging current drops to 1/10 of the preset value after reaching the final float voltage.

When the input voltage (AC adapter, USB supply or solar panel) is removed, the device automatically enters a low-current state, reducing battery leakage current to below 1μA. The TP4056H can also enter shutdown mode while connected to a power source, reducing supply current to 85μA.

Other features include power supply adaptation, battery temperature detection, under-voltage lockout and automatic recharge.

Features

- Input supply port withstands voltage up to 30V (Typical Application)
- OVP activates at input supply voltage of 6.3V
- Li-ion battery reverse-polarity protection
- Power supply adaptation
- Programmable charging current up to 1000mA
- Constant-current / constant-voltage operation with thermal regulation for maximum charging rate
- Preset charging voltage with ±1% accuracy
- Charging current monitor output for battery capacity detection
- Automatic recharge
- Dual charge status outputs; no-battery & fault status indication
- C/10 charge termination
- Trickle current: C/5
- Battery leakage current < 1μA without power input
- Soft-start limits inrush current
- Battery temperature monitoring
- Available in 8-pin ESOP / DFN2×2 package

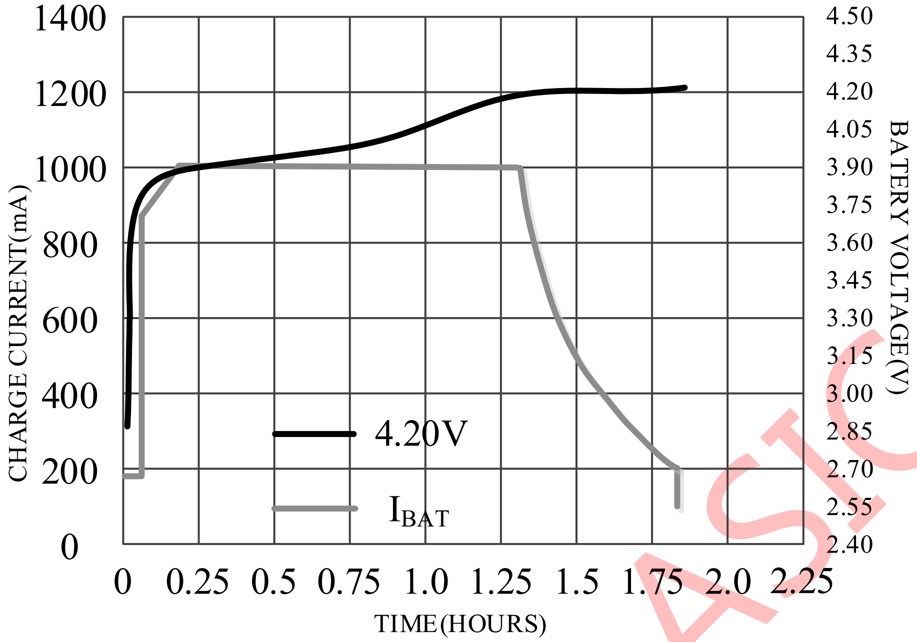
Applications

- Energy storage and fast-charging equipment
- Aesthetic and medical devices
- Mobile payment terminals
- Chargers for smart wearables, solar products, etc.

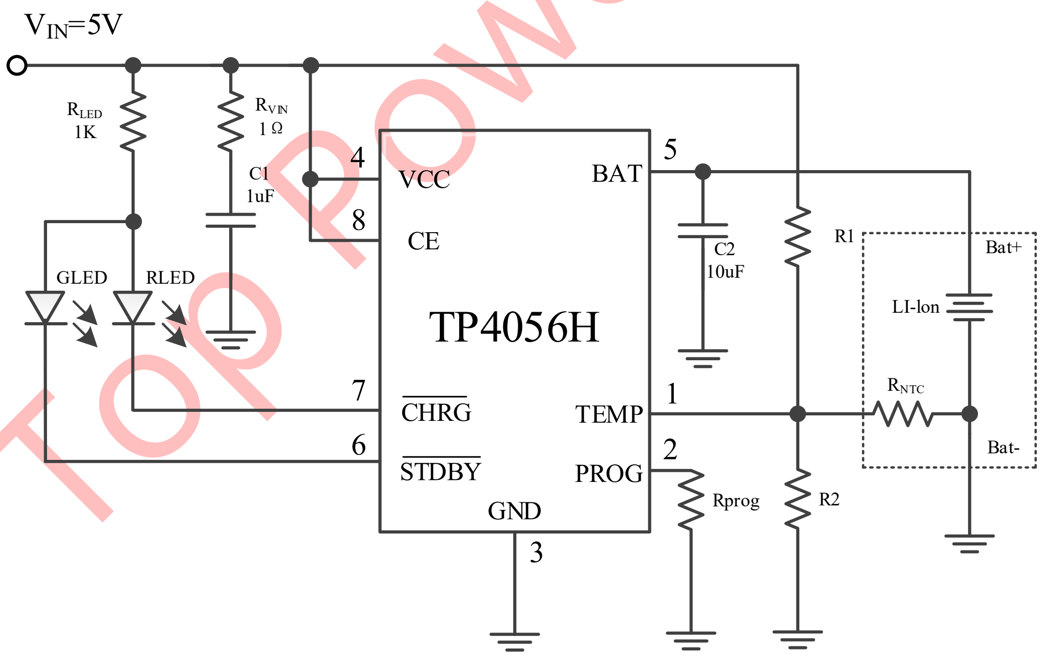
Absolute Maximum Ratings

- Input Supply Voltage (VCC): -0.3V to 35V
- PROG: -0.3V to 6V
- BAT: -4.35V to 10V
- $\overline{CHRG}$: -0.3V to 30V
- $\overline{STDBY}$: -0.3V to 30V
- TEMP: -0.3V to 30V (Typical Application)
- CE: -0.3V to 30V
- BAT Short-circuit Duration: Continuous
- BAT Pin Current: 1100mA
- PROG Pin Current: 1.1mA
- Maximum Junction Temperature: 145℃
- Operating Ambient Temperature Range: -20℃ to 85℃
- Storage Temperature Range: -65℃ to 125℃
- Pin Temperature (soldering time: 10 s): 260℃

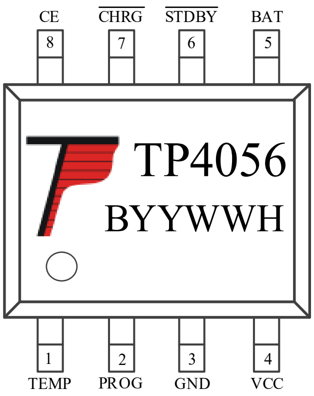
Complete Charging Cycle (1500mAh battery, typical application circuit)

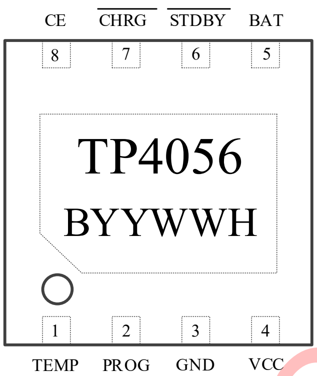


Typical Application



Package & Ordering Information

Package	Ordering Part Number
 ESOP8	TP4056H-4.35V-ESOP8 TP4056H-4.2V-ESOP8 TP4056H-3.7V-ESOP8
	AYYWWH→4.35V **BYYWWH**→4.2V **CYYWWH**→3.7V
	BYYWWH (B: preset voltage code; YYWW: production week/year; H: fixed)

Package	Ordering Part Number
 DFN2*2-8	TP4056H-4.35V-DFN228 TP4056H-4.2V-DFN228 TP4056H-3.7V-DFN228
	AYYWWH→4.35V **BYYWWH**→4.2V **CYYWWH**→3.7V
	BYYWWH (B: preset voltage code; YYWW: production week/year; H: fixed)

Pin Function (ESOP8/DFN2×2-8)

Pin No.	Pin Name	Pin Function
1	TEMP	Battery temperature monitoring input
2	PROG	CC charge current setting & monitoring
3	GND	Ground
4	VCC	Positive input supply voltage
5	BAT	Battery connection
6	$\overline{STDBY}$	Charge complete indicator (open-drain)
7	$\overline{CHRG}$	Charge status indicator (open-drain)
8	CE	Chip enable input
9	PAD	Ground

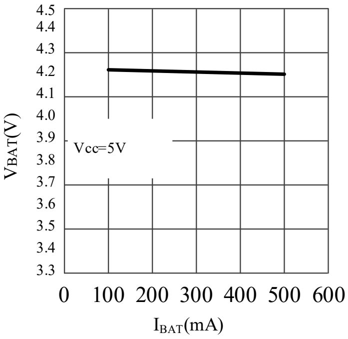
Electrical Characteristics

Specified over full operating temperature range; else TA=25°C, VCC=5V unless noted

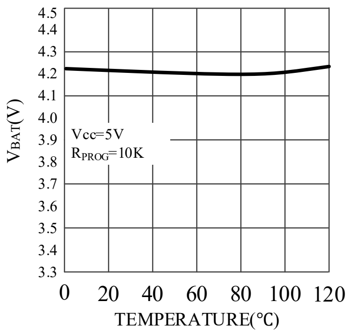
Symbol	Parameter	Condition		MIN	TYP	MAX	Unit
V_{CC}	Input Operating Supply Voltage			4.5	5	6	V
V_{CC}	Input Supply Voltage		●			30	V
V_{OVP}	Over Voltage Protection Threshold		●	6.0	6.3	6.6	V
I_{CC}	Input Supply Current	Charge mode, R_{PROG}=1KΩ	●	60	120	200	μA
		Standby mode (charge terminated)	●	60	85	150	μA
		Shutdown mode (R_{PROG} open, VCC<VBAT or VCC<VUV)	●		85	150	μA
V_{FLOAT}	Float Voltage	0°C≤T_A≤85°C		4.306	4.35	4.394	V
				4.158	4.2	4.242	V
				3.663	3.7	3.737	V
I_{BAT}	Battery Pin Current (Test: VBAT=4.0V)	R_{PROG}=2.05K	●	450	500	550	mA
		R_{PROG}=1.05K	●	0.9	1	1.1	A
		Standby mode, VBAT=4.2V	●	0	-2	-6	μA
		Shutdown mode			±1	±2	μA
		Sleep mode, V_{CC}=0V			-1	-2	μA
I_{TRIKL}	Trickle Charge Current	V_{BAT}<V_{TRIKL}，R_{PROG}=1K	●	100	200	300	mA
V_{TRIKL}	4.35V/4.2V	R_{PROG}=1K，V_{BAT} rising		2.8	2.9	3.0	V
	3.7V	R_{PROG}=1K，V_{BAT} rising		2.4	2.54	2.68	V
V_{UV}	UVLO Threshold (VCC rising)		●	3.85	4.0	4.15	V
V_{ASD}	VCC-VBAT Lockout Threshold	V_{CC} rising		80	100	120	mV
		V_{CC} falling		30	50	70	mV
I_{TERM}	Termination Current Threshold	R_{PROG}=1K	●	50	100	200	mA
V_{PROG}	PROG Pin Voltage	R_{PROG}=1K	●	0.9	1.0	1.1	V
V_{CHRG}	$\overline{CHRG}$ Output Voltage	I_{CHRG}=5mA			0.3	0.6	V
V_{STDBY}	$\overline{STDBY}$ Output Voltage	I_{STDBY}=5mA			0.3	0.6	V
V_{TEMP-H}	TEMP High Trip Voltage				80		%V_{CC}
V_{TEMP-L}	TEMP Low Trip Voltage				45		%V_{CC}
ΔV_{RECHRG}	4.35V/4.2V	V_{FLOAT}-V_{RECHRG}		90	120	150	mV
	3.7V	V_{FLOAT}-V_{RECHRG}		320	360	400	mV
T_{LIM}	Thermal Regulation Junction Temp				140		℃
$t_{RECHARGE}$	Recharge Comparator Filter Time				1.5		ms
t_{TERM}	Termination Comparator Filter Time				1.5		ms
V_{ADPT}	V_{CC} Adaptive Start Voltage	R_{PROG}=1kΩ, V_{CC} falling		4.1	4.35	4.6	V
I_{BAT}	Battery Reverse Leakage Current	Battery reverse, VIN=5V			20	35	mA
V_{CE_ON}	CE Enable Voltage	VIN=5V，CE rising		0.7	0.73	0.76	V

Typical Performance Characteristics

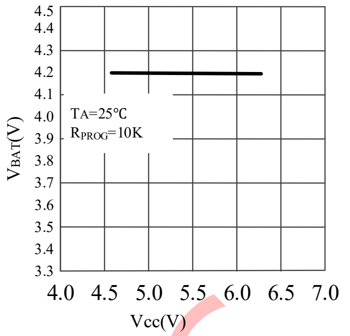
Float Voltage vs. Charge Current



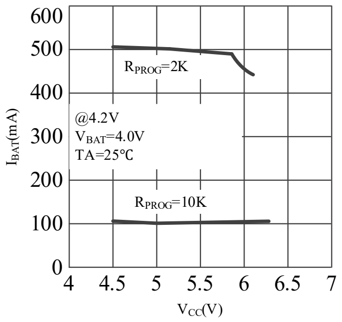
Float Voltage vs. Temperature



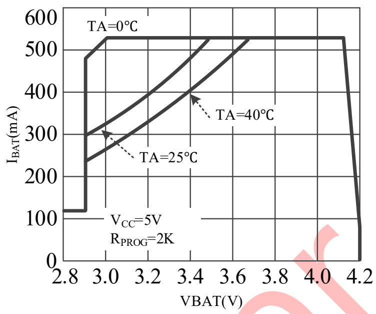
Float Voltage vs. Supply Voltage



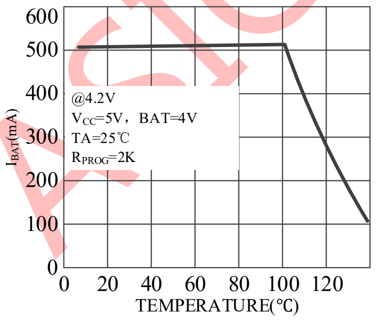
Charge Current vs. Supply Voltage



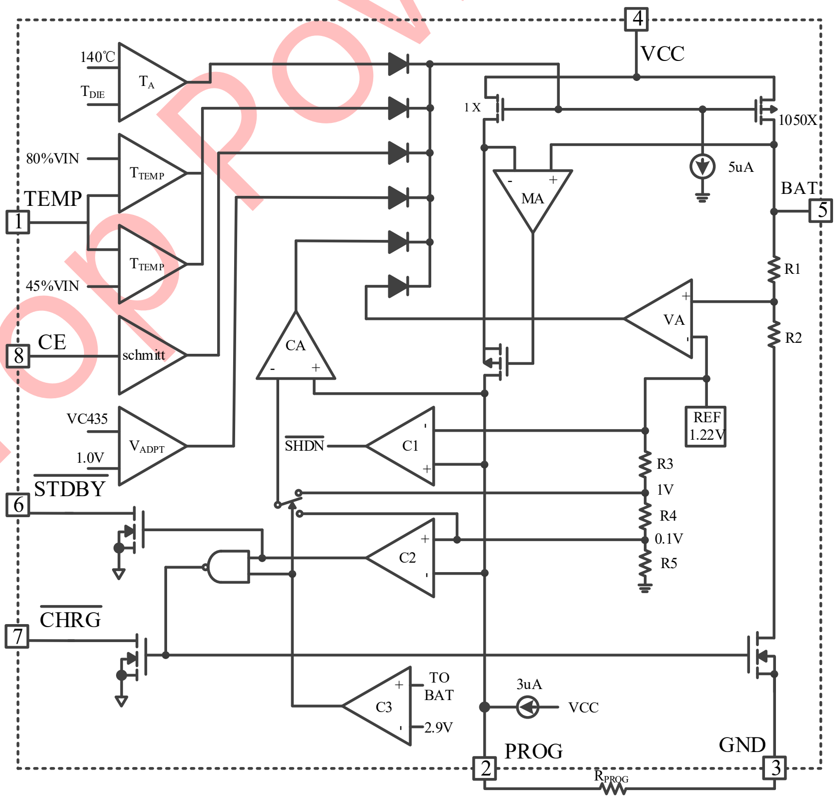
Charge Current vs. Battery Voltage



Charge Current vs. Chip Temperature



Block Diagram



Operation Principle (4.2V Version as Example)

TP4056H is a linear charger IC designed for single-cell lithium-ion/lithium-polymer batteries. It charges the battery in constant-current (CC) and constant-voltage (CV) modes via an internal power transistor. The charge current is programmable by an external resistor, with a maximum continuous charge current of 1A.

The IC integrates two open-drain status indicators: $\overline{CHRG}$ (charge status) and $\overline{STDBY}$ (fault/standby status). A thermal management loop reduces the charge current automatically when the junction temperature exceeds 140°C, maximizing power handling without overheating damage.

When the input voltage exceeds the power supply undervoltage detection threshold and the chip enable input (CE) is pulled high, the TP4056H starts charging the battery, and the $\overline{CHRG}$ pin outputs a low level to indicate that charging is in progress. If the battery voltage is below 2.9V, the TP4056H precharges the battery with trickle current. When the battery voltage exceeds 2.9V, the charger charges the battery in constant-current mode, and the charging current is determined by the resistor RPROG between the PROG pin and GND. As the battery voltage approaches 4.2V, the charging current gradually decreases, and the TP4056H enters constant-voltage charging mode. When the charging current drops to the charge termination threshold, the charging cycle ends; the $\overline{CHRG}$ pin switches to a high-impedance state, and the $\overline{STDBY}$ pin outputs a low level.

The charge termination threshold is 10% of the constant-current charging current. A new charging cycle starts automatically when the battery voltage falls below the recharge threshold. The high-precision internal voltage reference, error amplifier and resistive divider network ensure that the regulated voltage at the battery terminal is accurate within 1%, meeting the requirements of lithium-ion and lithium-polymer batteries. When the input voltage is powered off or lower than the battery voltage, the charger enters a low-power sleep mode, with the current consumption at the battery terminal being less than 1μA, thus extending the standby time. Driving the enable input (CE) low stops the charger from charging.

Charge Current Setting

Charge current is set by a resistor (R_{PROG}) between PROG and GND, calculated by:

$$R_{PROG} = \frac{1050}{I_{BAT}}$$

The appropriate R_{PROG} can be selected based on application requirements.
Refer to the table below for the relationship between R_{PROG} and the charging current.

R_{PROG} (KΩ)	I_{BAT} (mA)
10	98
5.1	188
2	526
1.8	584
1.6	660
1.5	704
1.3	824
1.2	900
1.1	972
1	1070

Charge Termination

The charging cycle terminates when the charging current drops to 1/10 of the set value after reaching the final float voltage. This condition is detected by monitoring the PROG pin with an internal filtered comparator. Charging is terminated when the PROG pin voltage falls below 100mV for longer than t_{TERM} (typically 1.5ms). The charging current is shut off, and the TP4056H enters standby mode, at which point the input supply current drops to 85μA.

Note: C/10 termination is disabled in trickle charge and thermal regulation modes.

During charging, transient loads on the BAT pin may cause the PROG pin voltage to briefly drop below 100mV before the DC charging current falls to 1/10 of the set value. The 1.5ms filter time (t_{TERM}) of the termination comparator prevents such transient loads from triggering premature termination of the charging cycle. Once the average charging current drops below 1/10 of the set value, the TP4056H terminates the charging cycle and stops supplying any current through the BAT pin. In this state, all loads on the BAT pin must be powered by the battery.

In standby mode, the TP4056H continuously monitors the voltage at the BAT pin. If this voltage drops below the recharge threshold (V_{RECHRG}), a new charging cycle starts and current is supplied to the battery again.

Charge Status Indicator

To disable indicators, tie unused pins to GND.

Two open-drain outputs drive LED indicators:

Charge Status	$\overline{CHRG}$	$\overline{STDBY}$
Charging	ON	OFF
Charge Complete	OFF	ON
Fault (OVP/UVLO/Temp out of range)/No battery (TEMP enabled)	OFF	OFF
Battery Reverse Connection	ON	ON
No battery, BAT with 10μF cap (TEMP=GND)	Blinks (1-4s)	ON

Thermal Regulation

When junction temperature rises above ~140°C, the internal thermal loop reduces the charge current; current drops to 0 above 145°C. This protects the IC and allows setting charge current for typical ambient conditions.

Battery Temperature Monitoring

The IC monitors battery temperature via the TEMP pin, using an internal NTC/PTC divider network.

TEMP voltage thresholds: 45%VCC (low) / 80%VCC (high)

Charging pauses if V_{TEMP} < 45%VCC or >80%VCC.

Tie TEMP to GND to disable temperature monitoring.

Selecting R1 and R2

The values of R1 and R2 in the application circuit can be determined according to the assumed temperature monitor range and thermistor's values. See following example as a reference:

Assume temperature monitor range is T_L～T_H，(TL＜TH)； the thermistor in battery has negative temperature coefficient (NTC). R_{TL} is thermistor's resistance at T_L, R_{TH} is the resistance at TH，so R_{TL}＞R_{TH}.

Then at temperature T_L, the voltage at TEMP pin is:

$$V_{TEMPL} = \frac{R2 \| R_{TL}}{R1 + R2 \| R_{TL}} \times VIN$$

At temperature TH, the voltage at TEMP pin is:

$$V_{TEMPH} = \frac{R2 \| R_{TH}}{R1 + R2 \| R_{TH}} \times VIN$$

We know $V_{TEMPL} = V_{HIGH} = K2 \times Vcc$ (K2=0.8)；$V_{TEMPH} = V_{LOW} = K1 \times Vcc$ (K1=0.45)

Then we can have:

$$R1 = \frac{R_{TL} R_{TH} (K_2 - K_1)}{(R_{TL} - R_{TH}) K_1 K_2}$$

$$R2 = \frac{R_{TL} R_{TH} (K_2 - K_1)}{R_{TL}(K_1 - K_1 K_2) - R_{TH}(K_2 - K_1 K_2)}$$

Likewise, for positive temperature coefficient thermistor in battery, we have R_{TH}＞R_{TL} and we can calculate:

$$R1 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{(R_{TH} - R_{TL})K_1K_2}$$

$$R2 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{R_{TH}(K_1 - K_1K_2) - R_{TL}(K_2 - K_1K_2)}$$

We can conclude that temperature monitor range is independent of power supply voltage V_{CC} and it only depends on R1, R2, R_{TL} and R_{TH}. The values of R_{TH} and R_{TL} can be found in the related battery handbook or deduced from testing data. In actual application, if considering only one terminal temperature (normally protecting from overheating), there is no need to use R2.

Input Over Voltage Protection (OVP)

OVP triggers at VIN=6.3V, stopping charging. Charging resumes when VIN drops to ~6.0V.

Under Voltage Lockout (UVLO)

UVLO holds the charger in shutdown until VCC exceeds the UVLO threshold. The charger exits shutdown only when VCC is 100mV higher than VBAT.

Manual Shutdown

Drive CE low or disconnect R_{PROG} to enter shutdown mode:

Battery leakage current <1µA

Supply current <85µA

Set CE high or reconnect R_{PROG} to restart charging.

Auto-Recharge

After termination, the IC monitors VBAT with a 1.5ms filter. Charging restarts when VBAT drops below 4.08V (4.2V version), keeping the battery near full charge.

Thermal Considerations

The bottom thermal pad must be soldered well to the PCB with large copper area and thermal vias for heat dissipation.
Poor thermal design triggers thermal regulation, reducing charge current.
Isolate the charger from other heat sources on the PCB.

VCC Bypass Capacitor

Use an RC series filter for VCC input. Select high-quality capacitors with appropriate voltage rating.

Charge Current Soft-Start

A built-in soft-start circuit ramps charge current from 0 to full scale in ~20µs, minimizing inrush current.

Power Supply Adaptation

When V_{CC} drops to V_{ADPT}, the adaptive circuit reduces charge current to stabilize V_{CC}, supporting USB, low-power adapters, and solar power sources.

Battery Reverse Connection Protection

Reverse battery connection triggers fault mode with 0 charging current.
Reverse leakage current <20mA; both indicators turn ON.
Correct the battery connection to resume charging automatically.
Note: Keep VIN≈5V (max 5.5V) during reverse connection to avoid overstress.

TP4056H Usage Precautions

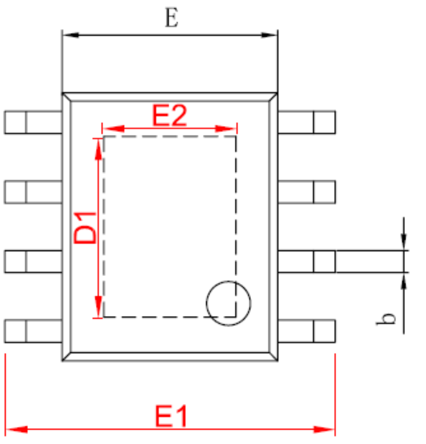
1. The TP4056H is packaged in ESOP8/DFN2×2-8. During operation, the thermal pad at the bottom must be soldered well to the PCB. Vias should be added to the bottom heat dissipation area, and large-area copper foil is preferred for better heat dissipation. Sufficient vias on a multi-layer PCB help improve heat dissipation significantly. Poor heat dissipation may cause the charging current to drop due to thermal protection. Adding proper vias to the back thermal pad of the ESOP8/DFN2×2-8 package also facilitates manual soldering (solder can be filled through the back vias to achieve a reliable thermal pad connection).

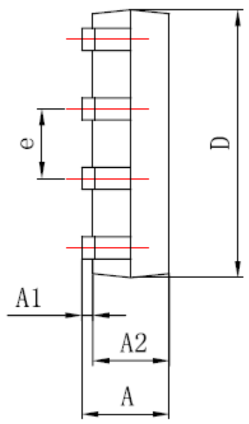
2. In TP4056H applications, the 1μF~10μF capacitor at the BAT pin and the RC filter capacitor at the VCC pin must be placed close to the chip pins, not far away. High-quality ceramic capacitors with standard 0603, 0806 or 1206 packages are recommended (poor-quality capacitors may easily damage the chip). The ground of the capacitors and the ground of the TP4056H should be connected at a single point.

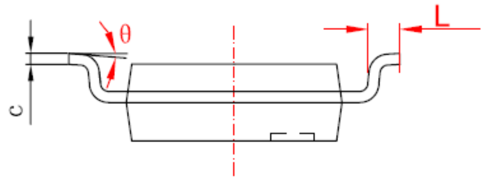
3. When testing the TP4056H, the BAT pin should be connected directly to the battery without an ammeter in series. An ammeter can be connected to the VCC pin.

Package Description

8-pin ESOP (dimension: mm)

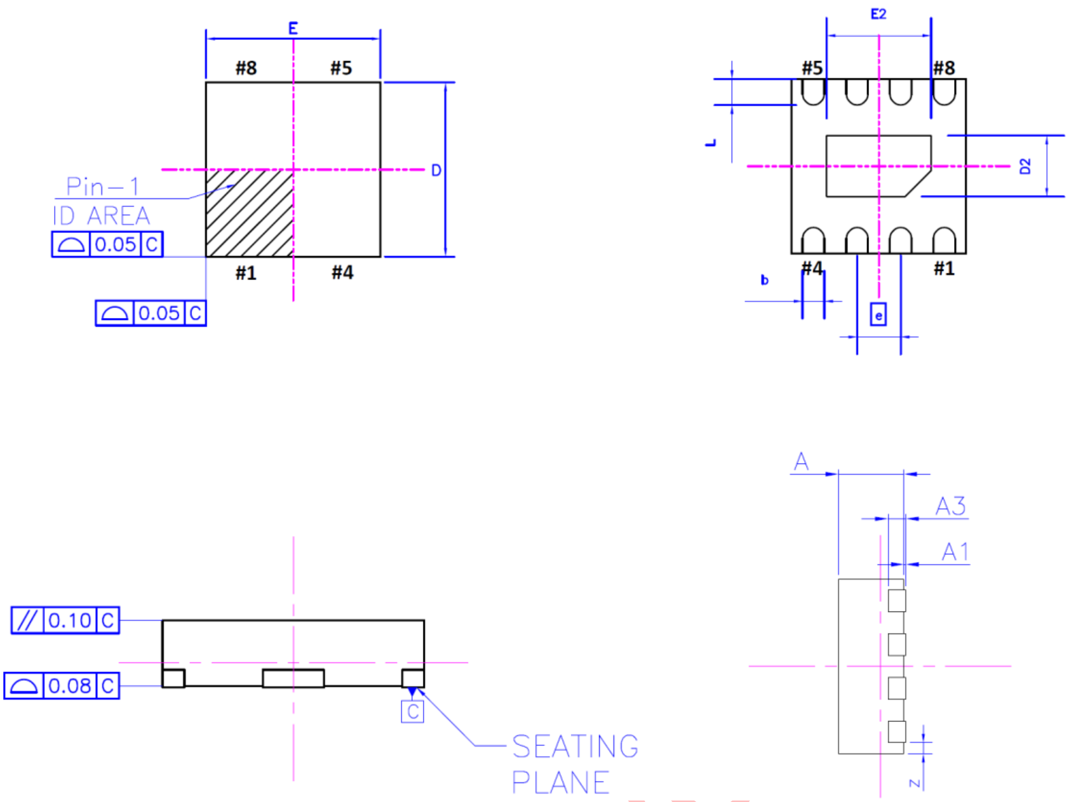






字符	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1. 350	1. 750	0. 053	0. 069
A1	0. 050	0. 150	0. 004	0. 010
A2	1. 350	1. 550	0. 053	0. 061
b	0. 330	0. 510	0. 013	0. 020
c	0. 170	0. 250	0. 006	0. 010
D	4. 700	5. 100	0. 185	0. 200
D1	3. 202	3. 402	0. 126	0. 134
E	3. 800	4. 000	0. 150	0. 157
E1	5. 800	6. 200	0. 228	0. 244
E2	2. 313	2. 513	0. 091	0. 099
e	1. 270 (BSC)		0. 050 (BSC)	
L	0. 400	1. 270	0. 016	0. 050
θ	0°	8°	0°	8°

8-pin DFN2×2 thin package with thermal pad (dimension: mm)



Dimensions

Unit	D	E	D2	E2	A	A1	A3	b	e	h	L	y	z
mm	2.10 (2.00) 1.90	2.10 (2.00) 1.90	0.80 (0.70) 0.60	1.30 (1.20) 1.10	0.80 (0.75) 0.70	0.05 (0.02) 0.00	0.203 REF	0.30 (0.25) 0.20	0.50 BSC	-	0.400 (0.300) 0.200	-	0.125 REF

Revision History

Date	Revision Description	Version
2026.03.01	First Release	REV_1.0
2026.06.10	Fine adjustment of absolute maximum ratings and revision of package types	REV_1.1