TC4056A(File No:S&CIC1103) 1ALinear Li-Ion Battery Charger

1. Product description

TC4056Ais a complete single-cell Li-Ion battery using a constant current/constant voltage linear charger. with heat sink on the bottom ESOP8/ DIP8package with less external component count enablesTC4056AIdeal for portable applications.TC4056Acan fitUSBPower supply and adapter power supply work.

Due to the internalPMOSFETarchitecture, plus an anti-reverse charging circuit, so no external blocking diodes are required. Thermal feedback automatically adjusts the charge current to limit the die temperature during high power operation or high ambient temperature conditions. The charging voltage is fixed at4.2V, while the charge current can be set externally with a resistor. When the charging current drops to the set value after reaching the final float voltage1/10hour,TC4056AThe charging cycle will be automatically terminated.

When the input voltage (AC adapter orUSBpower) is removed,TC4056Aautomatically enters a low current state, reducing battery drain current to 2uA the following.TC4056ACan also be placed in shutdown mode when power is present to reduce supply current to55uA.TC4056AOther features include battery temperature detection, undervoltage lockout, automatic recharge and twoledstatus pin.

2. Features

- Gundam1000mAProgrammable charge current of
- no needMOSFET, sense resistor or blocking diode
- For single-cell Li-ion batteries, usingSOPComplete Linear Charger in Package
- Constant current/constant voltage operation with charge rates that can be achieved without risk of overheating Maximized thermal regulation
- Accuracy reaches±1.5%of4.2VPreset charging voltage
- Charge current monitor output for battery charge detection
- automatic recharge
- Charge status dual output, no battery and fault status display
- C/10Charge terminated
- The supply current in standby mode is55uA
- 2.9VTrickle Charge Device Versions
- Soft-Start Limits Inrush Current
- Battery temperature monitoring function
- use8pin package (ESOP-8,DIP-8)

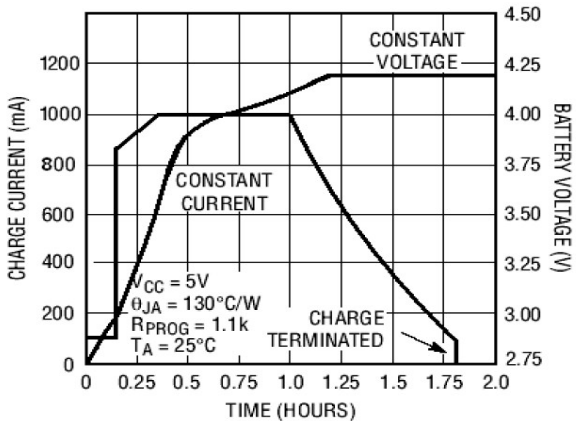
3. Product application

- mobile phone,PDA
- MP3,MP4player
- digital camera
- E-dictionary
- GPS
- Portable devices, various chargers

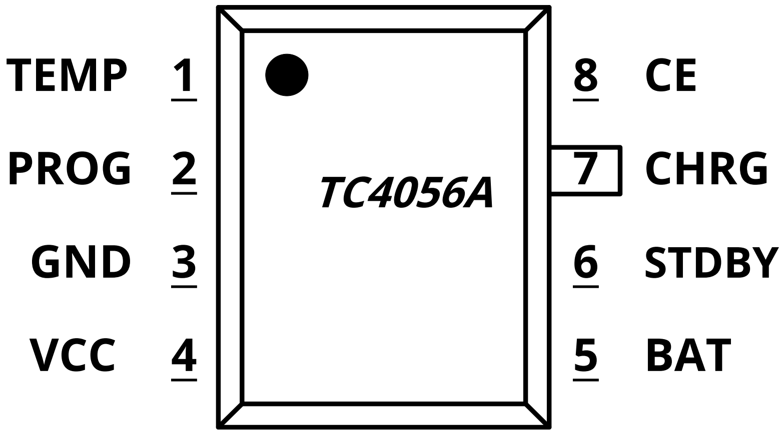
4. Absolute maximum rating

- Input supply voltage (Vcc):-0.3V~8V
- PROG:-0.3V~ Vcc +0.3V
- BAT :-0.3V~7V
- GHRG :-0.3V~10V
- STDBY:-0.3V~7V
- TEMP:-0.3V~7V
- CE:-0.3V~7V
- BATShort Circuit Duration: Continuous
- BATPin current:1200mA
- PROGPin current:1200uA
- Maximum Junction Temperature:145°C
- Operating ambient temperature range:-40°C~85°C
- Storage temperature range:-65°C~125°C
- Pin temperature (soldering time10second)260°C

Five, complete charging cycle (1000mAhBattery)



6. Packaging/ordering information and functions



- TEMP(pin1) : Battery temperature detection input terminal. WillTEMPpin receives currentNTCsensor output. ifTEMPpin voltage is less than the input voltage45%or greater than the input voltage80%, meaning the battery temperature is too low or too high, charging is suspended. ifTEMPdirectlyGND, the battery temperature detection function is canceled, and other charging functions are normal.
- PROG(pin2) : Constant current charging current setting and charging current monitoring terminal. fromPROGThe charge current can be programmed by connecting the pin to an external resistor to ground. During the precharge phase, the voltage of this pin is modulated at0.1V; During the constant current charging phase, the voltage of this pin is fixed at1V. In all modes of charging state, measuring the voltage of this pin can estimate the charging current according to the following formula:

$$I_{BAT} = \frac{V_{PROG}}{R_{PROG}} \times 1200$$

- GND(pin3): power ground.
- VCC(pin4): Input voltage positive input terminal. The voltage of this pin is the working power of the internal circuit. whenVccandBATThe voltage difference between the pins is less than 30mVhour,TC4056Awill enter a low-power shutdown mode, whenBATpin current is less than2uA.
- BAT(pin5): battery connection terminal. Connect the positive terminal of the battery to this pin. When the chip is disabled from working or in sleep mode,BATThe leakage current of the pin is less than2uA.BATpin provides charging current to the battery and4.2Vlimit voltage.

- STDBY(pin6): indicating terminal of battery charging completion. When current charging is completeSTDBYPulled to low level by the internal switch, indicating that charging is complete. besides,STDBYThe pins will be in a high impedance state.
- GHRG(pin7) charge status indication terminal of open-drain output. When the charger charges the battery,CHRGThe pin is pulled low by the internal switch, indicating that charging is in progress; otherwiseCHRGThe pin is in a high impedance state.
- CE(pin8) chip can only be input. A high input level will enableTC4056Ain normal operation; low input levels enableTC4056AIn a state where charging is prohibited.CEpins can beTTLlevel orCMOSlevel driven.

Seven, electrical characteristics

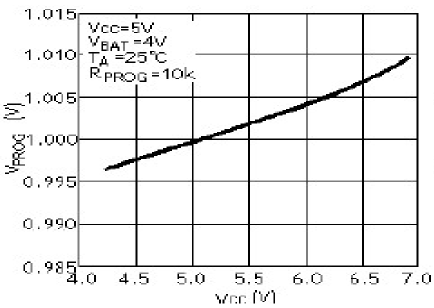
Where table note●Indicates that the indicator is suitable for the entire operating temperature range, otherwise only refers toTA=25°C,Vcc=5V, unless otherwise noted.

symbol	parameter	condition		small value	Typical value	Large value	unit
VCC	Input supply voltage		●	4.0	5	8.0	V
ICC	Input supply current	charging mode,RPROG=1.2K Standby Mode (Charge Termination) stop mode (RPROGnot connected, VCC<VBAT,orVCC<VUV)	● ● ●		150 55 55 55	500 100 100 100	μA μA μA
VFLOAL	Stable output (float) voltage	0°C≤TA≤85°C,		4.16	4.2	4.24	V
IBAT	BATPin current: (Current mode test conditions are VBAT=4.0V)	RPROG=2.4K, current mode RPROG=1.2K, current mode standby mode,VBAT=4.2V stop mode (RPROGnot connected) sleep mode,VCC=0V	● ● ●	450 950 0	500 1000 - 2.5 ±1 - 1	550 1050 - 6 ±2 - 2	mA mA μA μA μA
ITRIKL	Trickle Charge Current	VBAT<VTRIKLRPROG=1.2K	●	120	130	140	mA
VTRIKL	Trickle Charge Threshold Voltage	RPROG=1.2K,VBATrise		2.8	2.9	3.0	V
VTRHYS	Trickle Charge Hysteresis Voltage	RPROG=1.2K		60	80	100	mV
VUV	VCCUndervoltage Lockout Threshold	fromVCClow to high	●	3.5	3.7	3.9	V
VUVHYS	VCCUndervoltage Lockout Hysteresis		●	150	200	300	mV
VASD	VCC-VBATblocking threshold Voltage	VCClow to high VCCfrom high to low		60 5	100 30	100 30	mV mV
ITERM	C/10Termination Current Threshold	RPROG=2.4K RPROG=1.2K	● ●	60 120	70 130	80 140	mA mA
VPROG	PROGpin voltage	RPROG=1.2K, current mode	●	0.9	1.0	1.1	V
VCHRG	CHRGpin output low power pressure	I CHRG = 5mA			0.3	0.6	V
VSTDBY	STDBYpin output low power flat	I STDBY = 5mA			0.3	0.6	V
VTEMP-H	TEMPPin high side flip Voltage				80	82	%Vcc
VTEMP-L	TEMPPin low side flip Voltage			43	45		%Vcc
ΔVRECHRG	Rechargeable battery threshold voltage	VFLOAT-VRECHRG		100	150	200	mV

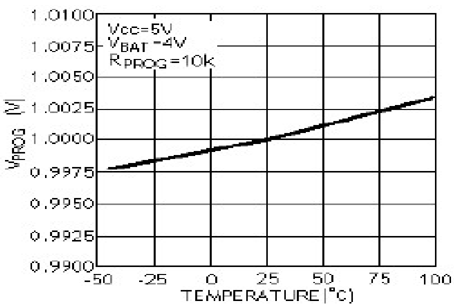
T_{LIM}	Junction in limited temperature mode temperature				145		°C
R_{ON}	powerFET""on" resistance (existVCCandBATbetween)				650		mΩ
t_{SS}	Soft start time	IBAT=0 to IBAT=1200V/RPROG			20	4	μs
$t_{RECHARGE}$	When the recharge comparator filters between	VBAThigh to low		0.8	1.8	4	ms
t_{TERM}	Terminate Comparator Filter Time	IBATdown toICHG/10the following		0.8	1.8		ms
I_{PROG}	PROGpin pull-up current				2.0		μA

Eight, typical performance characteristics

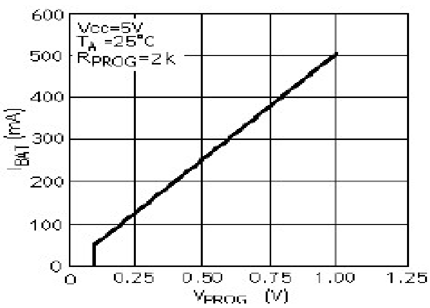
in constant current modePROGpin
The relationship between voltage and supply voltage



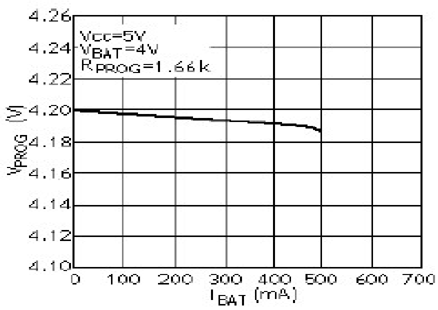
PROGpin voltage vs. temperature
Relationship lines



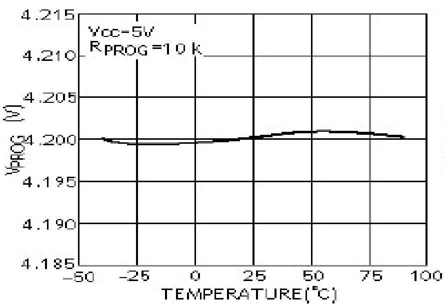
charging current withPROGpin power
pressure curve



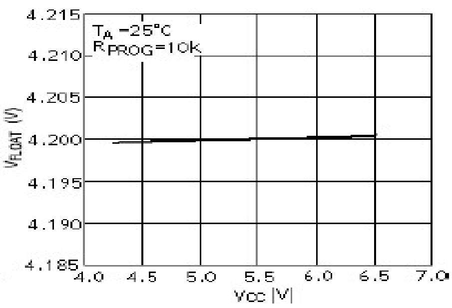
Stable output (float) voltage and charge
Electric current relationship curve



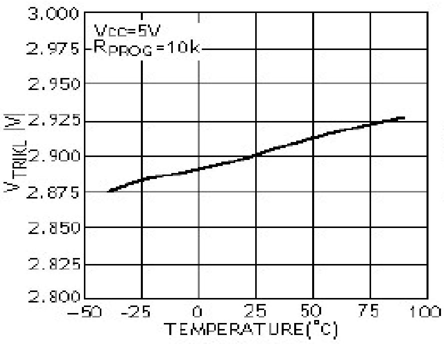
Stable output (float) voltage vs. temperature
degree curve



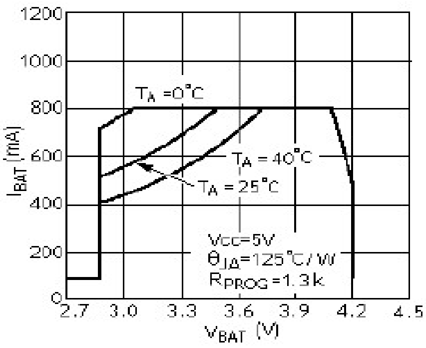
Stable output (float) voltage and power
pressure curve



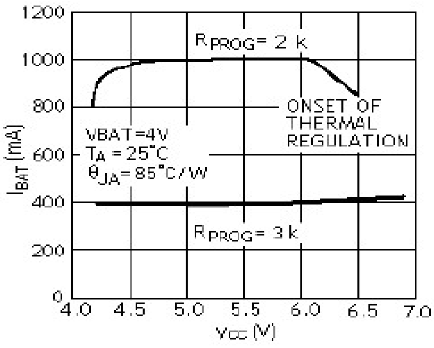
Trickle Charge Threshold vs Temperature



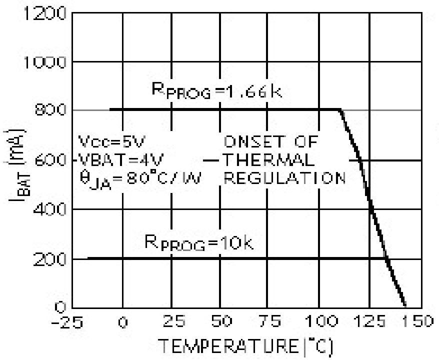
The relationship between charging current and battery voltage



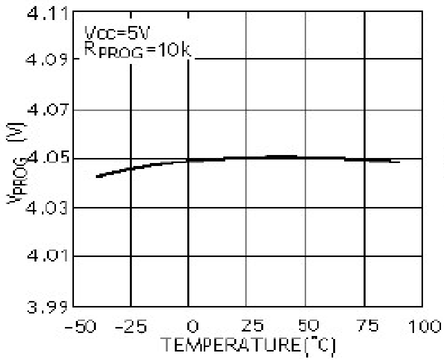
The relationship between charging current and supply voltage



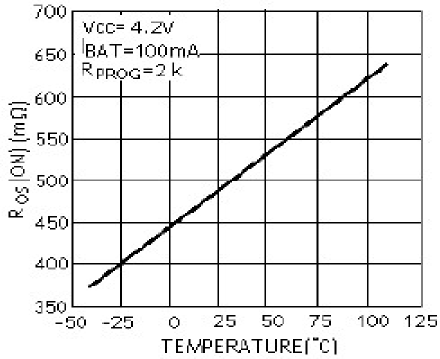
Relationship between charging current and ambient temperature



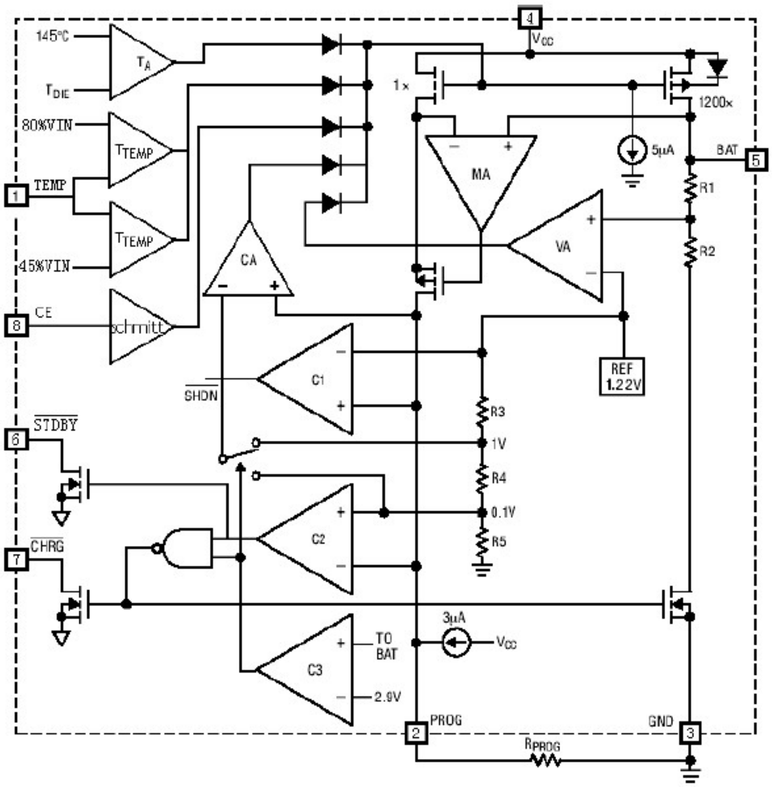
Recharge Voltage Threshold vs. Temperature



powerFET""On" Resistance vs. Temperature



9. Block diagram and working principle



TC4056AIt is a linear charger circuit specially designed for a lithium ion or lithium polymer battery. It uses the power transistor inside the chip to charge the battery with constant current and constant voltage. The charging current can be programmed with an external resistor, and the maximum continuous charging current can reach1A, no additional blocking diodes and current sense resistors are required.TC4056AStatus indication output including two open-drain outputs, charging status indicationCHRGand battery fault status indication outputSTDBY. The power management circuit inside the chip exceeds the junction temperature of the chip145When the temperature is ℃, the charging current is automatically reduced. This function allows users to maximize the power processing capability of the chip without worrying about the chip overheating and damaging the chip or external components. In this way, when designing the charging current, the user can not consider the bad situation, but only design according to the typical situation, because in the bad situation,TC4056AThe charging current is automatically reduced.

When the input voltage is greater than the power supply low voltage detection threshold and the chip enable input is pulled high,TC4056Astart charging the battery,CHRGThe pin outputs a low level, indicating that charging is in progress. If the battery voltage is lower than3V, the charger precharges the battery with a small current. When the battery voltage exceeds3V , the charger uses the constant current mode to charge the battery, and the charging current is determined byPROGpins andGNDresistance betweenR_{PROG}Sure. When the battery voltage is close to 4.2Vvoltage, the charging current gradually decreases,TC4056AEnter constant voltage charging mode. When the charging current decreases to the end-of-charge threshold, the charging cycle ends, CHRGThe output is in a high-impedance state,STDBYterminal output low potential.

The end-of-charge threshold is a constant-current charge current10%. When the battery voltage falls below the recharge threshold, a new charge cycle begins automatically. The high-precision voltage reference source, error amplifier and resistor divider network inside the chip ensure the accuracy of the modulation voltage at the battery terminal1.5%It meets the requirements of lithium-ion batteries and lithium-polymer batteries. When the input voltage is powered off or the input voltage is lower than the battery voltage, the charger enters a low-power sleep mode, and the current consumed by the battery is less than3uA, from increased standby time. If the input will be enabledCEConnected to low level, the charger stops charging.

-**Setting of charging current**

The charging current is the color one connected at thePROGset by a resistor between the pin and ground. The setting resistor and charging current are calculated using the following formula: Determine the resistance value of the resistor according to the required charging current

$$R_{PROG} = \frac{1200}{I_{BAT}} \quad （误差\pm10\%）$$

In customer applications, the appropriate size can be selected according to the needsR_{PROG},R_{PROG}The relationship with the charging current can be determined by referring to the following table:

R_{PROG}(K)	I_{BAT}(mA)
30	50
20	70
10	130
5	250
4	300
3	400
2	580
1.66	690
1.5	780
1.33	900
1.2	1000

-**Charge terminated**

When the charging current drops to the set value after reaching the final float voltage1/10, the charge cycle is terminated. This condition is achieved by using an internal filtered comparator toPROGThe pin is detected by the temporary control. whenPROGpin voltage drops to100mVThe following time exceeds t_{TERM}(usually 1.8ms), charging is terminated. The charging current is latched off,TC4056Aenters standby mode, at which point the input supply current drops to55UA. (Note:C/10 termination is disabled in trickle charge and thermal limit modes).

When charging,BATTransient loads on the pins will causePROGpin voltage atDCThe charging current drops to the set value of1/10briefly dropped to 100mVthe following. Terminate the comparator on1.8msfilter time (t_{TERM}) to ensure that transient loads of this nature do not cause premature termination of the charge cycle. Once the average charge current falls to the set value1/10the following,TC4056Ai.e. terminate the charge cycle and stop passingBATpin to supply any current. In this state,BATAll loads on the pins must be powered by batteries. In standby mode,TC4056ArightBATThe pin voltage is continuously monitored. If this pin voltage drops to4.05VThe recharge threshold of (V_{RECHRG})Following, another charge cycle begins and current is supplied to the battery again.

picture1A state diagram for a typical charge cycle is shown.

-charge status indicator

TC4056AThere are two open-drain status indication outputs,CHRGandSTDBY. When the charger is charging,CHRGis pulled low, in other states,CHRGin a high impedance state. When the temperature of the battery is outside the normal temperature range,CHRGandSTDBYThe pins are all output in a high-impedance state. whenTEMPWhen the terminal is used in a typical connection method, when the battery is not connected to the charger, it indicates a fault state: both the red and green lights are not on

existTEMPterminationGNDWhen the battery temperature detection does not work, when the battery is not connected to the charger,CHRGThe output pulse signal indicates that no battery is installed. When the battery connectionBATThe external capacitance of the pin is10uFTimeCHRGFlashing frequency approx.1-4second

When the status indication function is not used, connect the unused status indication output to ground.

charging	red lightCHRG	green lightSTDBY
charging status	Bright	extinguish
full voltage	extinguish	Bright
Undervoltage, battery temperature is too high, too low and other fault conditions, or no battery intervention (TEMPuse)	extinguish	extinguish
BATtermination10uCapacitor, no battery (TEMP=GND)	Green light on, red light flashing T=1-4S	

Please refer to the various charging indication statesTC4056AUse precautions andDEMOboard manual.

-thermal limitation

If the chip temperature rises to about140℃ above the preset value, an internal thermal feedback loop will reduce the set charge current until150℃ above reduce the current to0. This feature preventsTC4056Aoverheating, and allows the user to increase the upper limit of the power handling capability of a given board without damageTC4056Arisks of. The charging current can be set based on typical (rather than bad-case) ambient temperature, provided that the charger will automatically reduce the current under bad-case conditions.

-Battery temperature monitoring

In order to prevent damage to the battery caused by high or low temperature,TC4056AA battery temperature monitoring circuit is integrated inside. Battery temperature monitoring is done by measuringTEMPpin voltage achieved,TEMPpin voltage is determined by the batteryNTCThermistor and a resistor divider network are implemented as shown in 1shown.

TC4056AWillTEMPThe voltage of the pin is the same as the two thresholds inside the chipV_{LOW}andV_{HIGH}Compare to confirm whether the temperature of the battery exceeds the normal range. existTC4056Ainternal,V_{LOW}fixed in45%×Vcc,V_{HIGH}fixed in80%×Vcc. ifTEMPpin voltage$V_{TEMP}<V_{LOW}$ or

$V_{TEMP}>V_{HIGH}$, it means that the temperature of the battery is too high or too low, the charging process will be suspended; ifTEMPpin voltageV_{TEMP}existV_{LOW}andV_{HIGH}

In between, the charging cycle continues.

if theTEMPIf the pin is connected to ground, the battery temperature monitoring function will be disabled.

-SureR1andR2the value of

R1andR2The value of is determined according to the temperature monitoring range of the battery and the resistance value of the thermistor. Now an example is given as follows: Suppose the set battery temperature range isT_L~T_H,(inT_L<T_H); a negative temperature coefficient thermistor is used in the battery (NTC),$R_{TL}$for its temperature$T_L$resistance value whenR_{TH} for its temperature$T_H$resistance value whenR_{TL}>R_{TH}, then, at temperatureT_L, the first pinTEMPThe voltage at the terminal is:

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

in temperatureT_H, the first pinTEMPThe voltage at the terminal is:

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

Then, byV_{TEMPL}=V_{HIGH}=k_2×Vcc (k_2=0.8) V_{TEMPH}=V_{LOW}=k_1×Vcc (k_1=0.45) can be solved:

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

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

Similarly, if the battery has a positive temperature coefficient (PTC) of the thermistor, then >, we can calculate:

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

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

As can be seen from the above derivation, the temperature range to be set is related to the supply voltageVccis irrelevant, only withR1,R2,R_{TH},R_{TL}relating to; of which, R_{TH},R_{TL}It can be obtained by consulting the relevant battery manual or through experimental tests. In practical applications, if you only pay attention to the temperature characteristics of one end, such as overheating protection, thenR2can not be used, but only useR1That's it.R1The derivation is also simplified, and will not be repeated here.

-undervoltage lockout

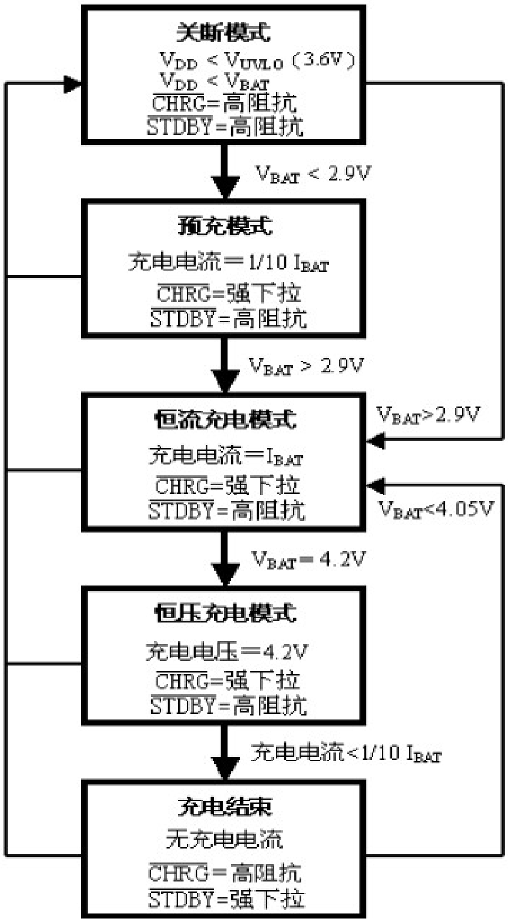
An internal undervoltage lockout circuit monitors the input voltage andVccKeeps the charger in shutdown until it rises above the undervoltage lockout threshold. UVLOThe circuit will keep the charger in shutdown mode. ifUVLOComparator transitions, theVccrises higher than the battery voltage100mVThe charger will not exit shutdown mode before.

-**Manual shutdown**

at any point during the charge cycle by setting theCEterminal is low or removedR_{PROG}(So thatPROGpin floating) to putTC4056Aput in stop mode. This reduces the battery leakage current to2μAbelow, and the supply current drops to55μAthe following. resetCETerminating high or connecting a set resistor initiates a new charge cycle. ifTC4056Ais in undervoltage lockout mode, theCHRGand the pin is in a high impedance state: orVcchigher thanBATInsufficient magnitude of pin voltage100mV, either imposed onVccInsufficient voltage on the pin.

-automatic restart

Once the charge cycle is terminated,TC4056Aimmediately adopt a1.8msfilter time (RECHARGE t) of the comparator toBATThe voltage on the pin is continuously monitored. When the battery voltage drops to4.05V(approximately corresponding to the battery capacity of80%to90%), the charge cycle restarts. This ensures that the battery is maintained at (or close to) a fully charged state and eliminates the need for periodic charge cycle initiations. During the recharge cycle,CHRG The pin output goes into a strong pull-down state.



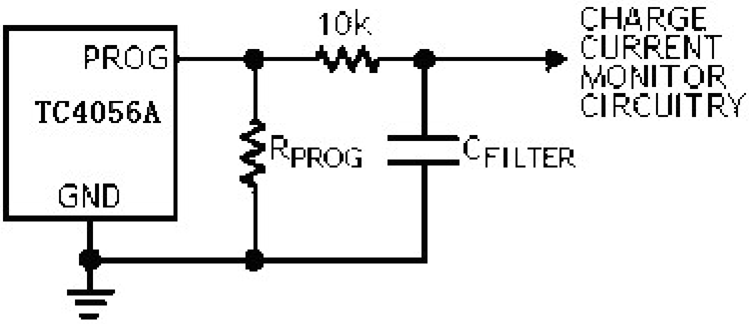
picture1: State diagram of a typical charge cycle

-**Stability Considerations**

In constant current mode, in the feedback loop isPROGpins, not the battery. The stability of the constant current mode is subject toPROGThe effect of pin impedance. whenPROGNo additional capacitance on the pin reduces the maximum allowable resistance of the set resistor.PROGThe pole frequency on the pin should be kept at C_{PROG}, the following formula can be used to calculateR_{PROG}The large resistance value of:

$$R_{PROG} \leq \frac{1}{2\pi \bullet 10^5 \bullet C_{PROG}}$$

For users, they may be more interested in charging current than transient current. For example, if a switching power supply operating in low current mode is connected in parallel with the battery, theBATThe average current flowing out of the pin is usually more important than the transient current pulse. In this case, thePROG pins using a simpleRCfilter to measure the average battery current (as shown in2shown). existPROGbetween the pin and the filter capacitor is added10k resistor to ensure stability.



picture2:isolationPROGCapacitive loads and filter circuits on pins

-Power loss

TC4056AConditions that reduce the charge current due to thermal feedback can be achieved byICto estimate the power loss. Almost all of this power loss is caused by internalMOSFETproduced——This can be approximated by:

$$P_D = (V_{CC} - V_{BAT}) \bullet I_{BAT}$$

in the formula$P_D$is the power dissipated,$V_{CC}$is the input supply voltage,$V_{BAT}$is the battery voltage,$I_{BAT}$is the charging current. When thermal feedback begins toICWhen providing protection, the ambient temperature is approximately:

$$T_A = 145°C - P_D\theta_{JA}$$
$$T_A = 145°C - (V_{CC} - V_{BAT}) \bullet I_{BAT} \bullet \theta_{JA}$$

Example: Programmatically make a slave5VThe power supply obtains the working powerTC4056Ato a3.75VThe voltage of the discharge Li-ion battery provides800mA full-scale current. Assumptionθ_{JA}for150°C/W(see Board Layout Considerations), whenTC4056AWhen starting to reduce the charge current, the ambient temperature is approximately:

$$T_A = 145°C - (5V - 3.75V) \bullet (800mA) \bullet 150°C / W$$
$$T_A = 145°C - 0.5W \bullet 150°C / W = 145°C - 75°C$$
$$T_A = 65°C$$

TC4056AAvailable at65℃ above ambient temperature conditions, but the charge current will be reduced to800mAthe following. For a given ambient temperature, the charging current can be approximated by the following equation:

$$I_{BAT} = \frac{145°C - T_A}{(V_{CC} - V_{BAT}) \bullet \theta_{JA}}$$

As discussed in the Principles of Operation section, when thermal feedback reduces the charge current,PROGThe voltage on the pin will also decrease proportionally. Remember you don't need toTC4056AIt is important to consider bad thermal conditions in the application design because theICwill reach the junction temperature145The power consumption is automatically reduced when the temperature is about ℃.

-**thermal consideration**

becauseSOP8/MSOP8The package size is small, therefore, a thermally well-designedPCIt is important to layout the board to greatly increase the available charge current. for dissipation ICThe heat dissipation path for the generated heat is from the die to the lead frame and through the bottom heat sink to PCPlate copper surface.PCThe copper surface of the board is the heat sink. The copper area where the heat sink is attached should be as wide as possible and extend out to the larger copper area to dissipate the heat to the surrounding environment. Vias to inner or back copper circuit layers are also useful in improving the overall thermal performance of the charger. when carried outPC Other heat sources on the board that are not related to the charger must also be considered when designing the board layout, as they will have an effect on the overall temperature rise and high charging current.

-**Increase thermal regulation current**

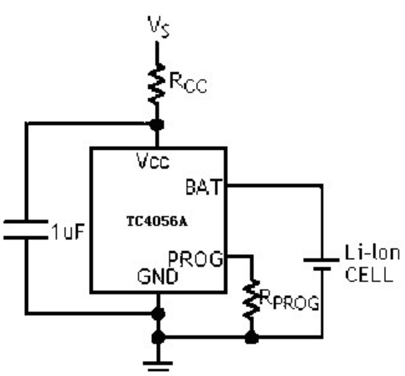
lower interiorMOSFETThe pressure drop across the two ends can be significantly reducedICpower consumption in . This has the effect of increasing the current delivered to the cell during thermal conditioning. One countermeasure is to dissipate some of the power through an external component such as a resistor or diode.

Example: Programmatically make a slave5VAC adapter to obtain working powerTC4056Ato a3.75VThe voltage of the discharged Li-Ion battery is set to 800mAfull-scale charge current. Assumptionθ_{JA}for125°C/W, then in25Under the ambient temperature condition of ℃, the charging current is approximately:

$$I_{BAT} = \frac{145°C - 25°C}{(5V - 3.75V) \bullet 125°C / W} = 768mA$$

by lowering one with5VThe voltage across the resistor in series with the AC adapter (Fig.3shown), which reduces on-chip power dissipation and thus increases thermally regulated charge current:

$$I_{BAT} = \frac{145°C - 25°C}{(V_S - I_{BAT}R_{CC} - V_{BAT}) \bullet \theta_{JA}}$$



picture3: A circuit that maximizes the thermal regulation mode charging current

Using the quadratic equation to find2

$$I_{BAT} = \frac{(V_S - V_{BAT}) - \sqrt{(V_S - V_{BAT})^2 - \frac{4R_{CC}(145°C - T_A)}{\theta_{JA}}}}{2R_{CC}}$$

PickR_{CC}=0.25Ω,V_S=5V,V_{BAT}=3.75V,T_A=25℃ and125°C/W$_{JA}$$q$, we can calculate the thermally adjusted charge current:I_{BAT} =948mA,The results show that the structure can output at higher ambient temperature800MAFull charge. While this application can deliver more energy to the battery and reduce charge time in thermal regulation mode, in voltage mode, ifV_{CC}becomes low enough thatTC4056Ain a low dropout state, it actually has the potential to extend the charging time. picture4shows how this circuit works withR_{CC}increases, resulting in a voltage drop. When used to keep component size small and avoid pressure dropR_{CC} This technique works best when the value is minimized. Remember to choose a resistor with sufficient power handling capability.

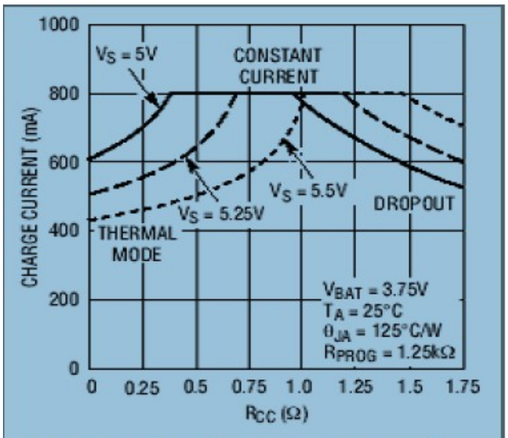


图 4：充电电流与 RCC 的关系曲线

-VCCBypass capacitor

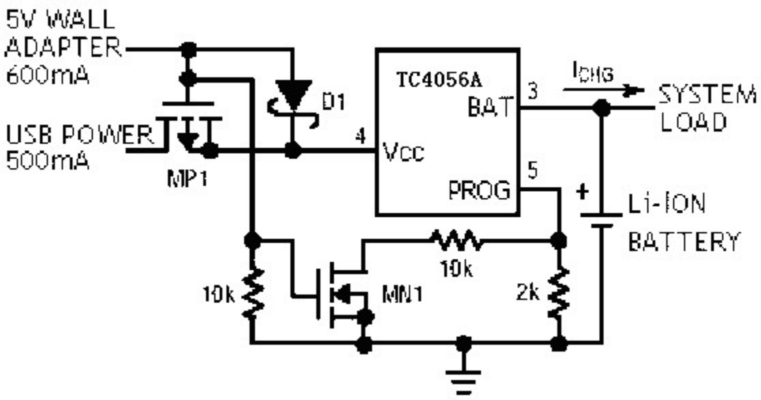
Input bypassing can use many types of capacitors. However, care must be taken when using multilayer ceramic capacitors. Since some types of ceramic capacitors have self-resonance and highQTherefore, high voltage transients may be generated under certain start-up conditions (such as connecting the charger input to a working power supply). add one withX5RCeramic capacitors connected in series1.5ΩThe resistors will minimize startup voltage transients.

-Charge current soft start

TC4056AIncludes a soft-start circuit to minimize inrush current at the beginning of a charge cycle. When a charge cycle is initiated, the charge current will be20μsaround the time from0Rise to full scale value. This acts to minimize transient current loads on the power supply during startup.

picture5:Low loss input reverse polarity protectionUSBand AC adapter power

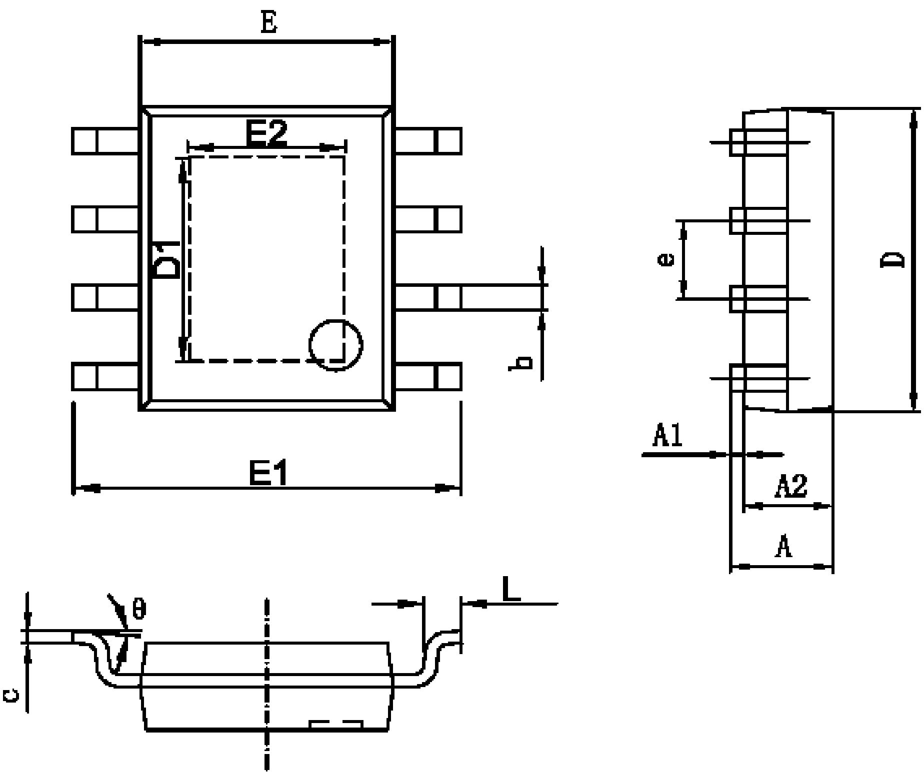
TC4056Aallows from an AC adapter or aUSBport for charging. picture6shows how to connect the AC adapter withUSBAn example of a combination of power inputs. OnePchannelMOSFET(MP1) is used to prevent reverse incoming signal when the AC adapter is connectedUSBport, while a Schottky diode (D1) is used to preventUSBpower is passing through1KLosses occur when pulling down the resistor. Generally speaking, the AC adapter can provide a specific current limit of500mAofUSBport much larger current. Therefore, when the AC adapter is plugged in, aNchannelMOSFET(MN1) and an additional10Kset the resistor to increase the charge current to600mA.



picture6: AC adapter withUSBCombination of power

10. Package description

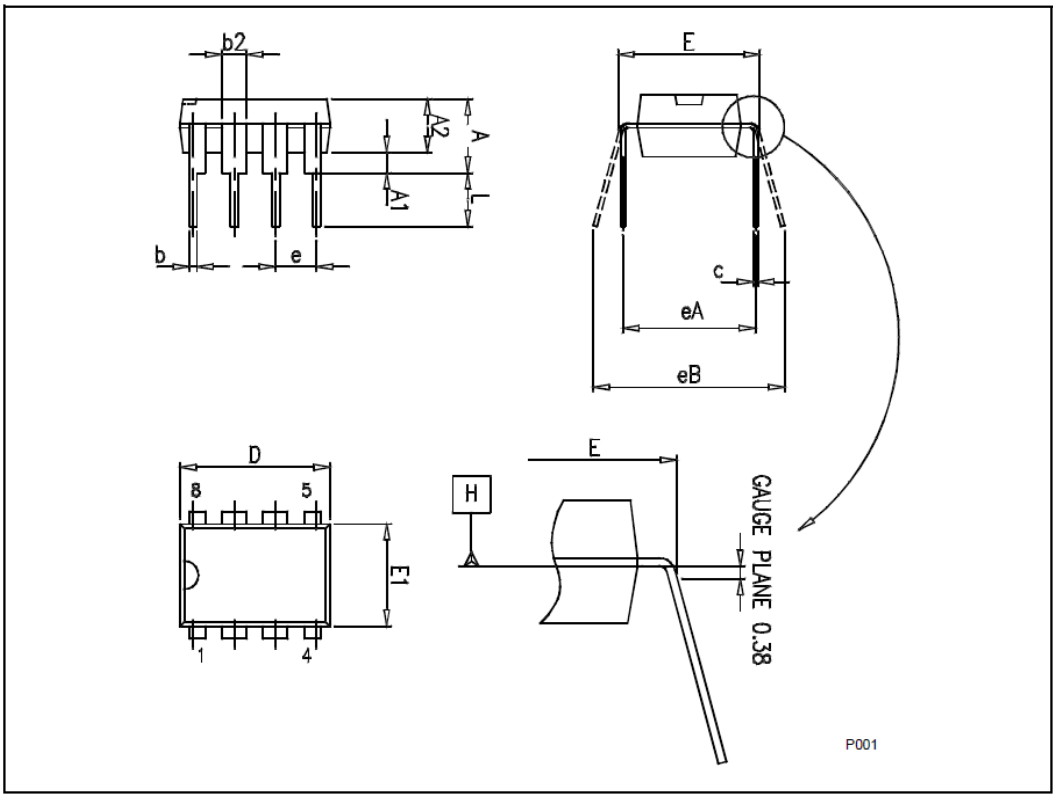
8pinESOP-8package (unitmm)



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°

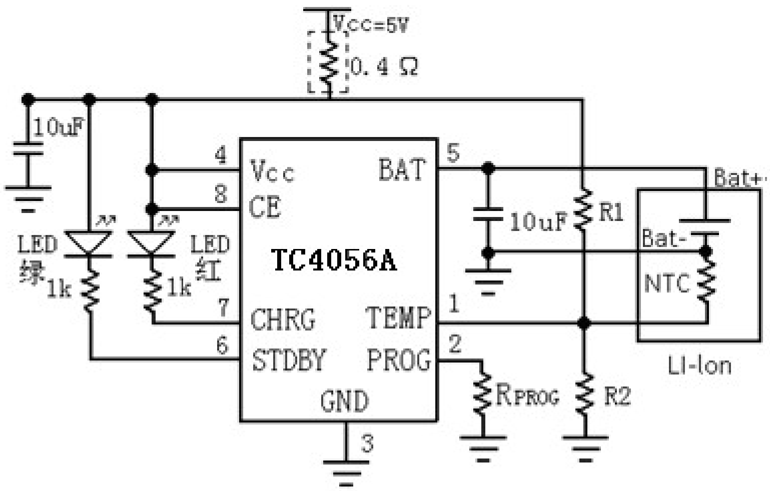
8Pin Package (Unitmm)

DIP-8



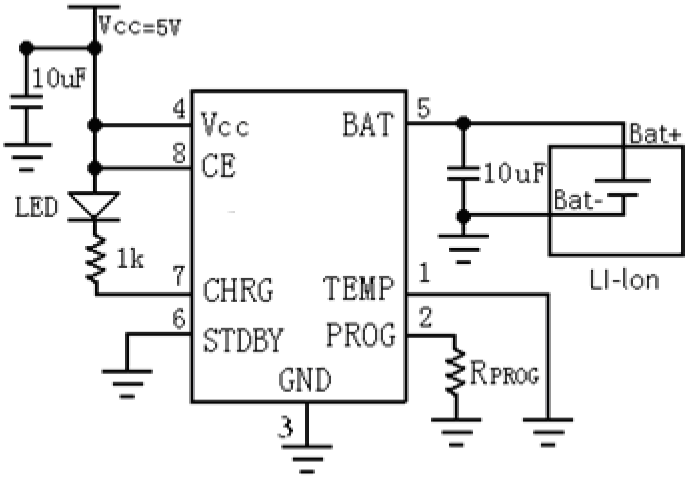
symbol	mm		
	Small	typical	Big
A			5.33
A1	0.38		
A2	2.92	3.30	4.95
b	0.36	0.46	0.56
b2	1.14	1.52	1.78
c	0.20	0.25	0.36
D	9.02	9.27	10.16
E	7.62	7.87	8.26
E1	6.10	6.35	7.11
e		2.54	
eA		7.62	
eB			10.92
L	2.92	3.30	3.81

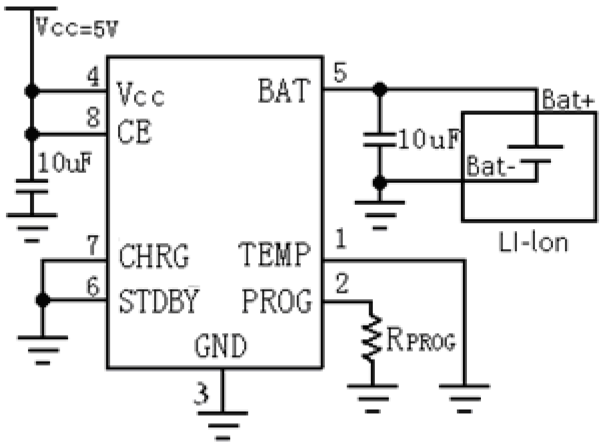
11. Typical applications



Suitable for battery temperature detection function, abnormal battery temperature indication

and charging status indication applications



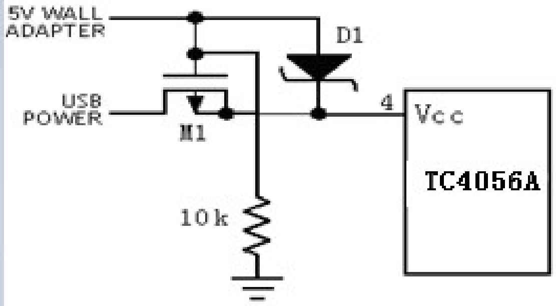


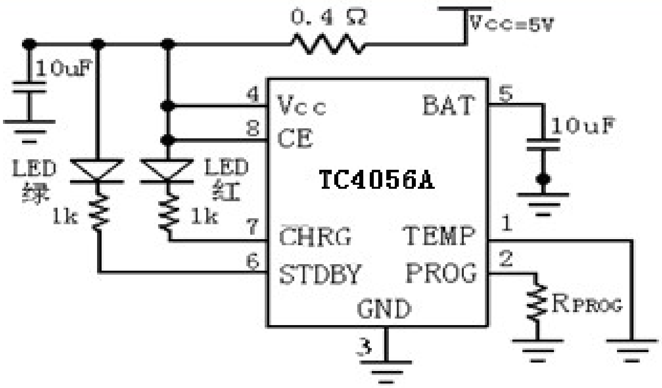
Suitable for charging status indication, not required

Application of battery temperature monitoring function

Suitable for neither charging status indication nor

Application of battery temperature monitoring function





Suitable for simultaneous applicationUSBInterface and wall adapter charging

red for charging statusledIndication, charging end status

with greenledindication, increase the heat dissipation power resistor

TC4056AUse precautions andDEMOBoard Instructions

one,TC4056APrecautions for use:

1,TC4056AuseSOP8/ESOP8-PPpackage, the bottom heat sink should be connected to thePCBThe board is well soldered, and the bottom heat dissipation area needs to add through holes,

And it is better to have a large area of copper foil for heat dissipation. multilayerPCBAdding sufficient vias has a good effect on heat dissipation. Poor heat dissipation may cause the charging current to be reduced by temperature protection. existSOP8/ESOP8Appropriate vias are added to the heat dissipation part on the back, which also facilitates manual soldering (you can fill solder from the back vias to reliably solder the heat dissipation surface).

2,TC4056Aapplied in high current charging (700mAabove), in order to shorten the charging time, it is necessary to increase the heat dissipation resistance (as shown in the figure below)R11,R12),

Resistance range0.2~0.5Ω. The customer selects the appropriate resistor size according to the usage.

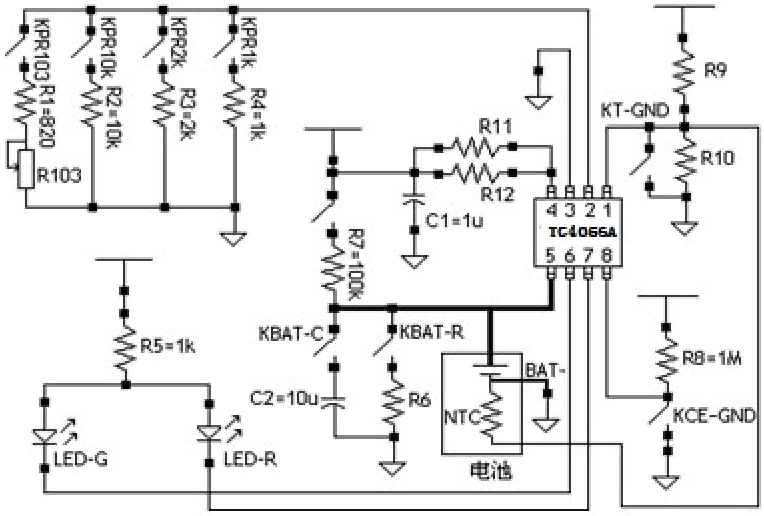
3,TC4056Ain applicationBATend10ucapacitor location to be close to the chipBATThe end is the best, not too far.

4,TC4056Atesting,BATThe terminal should be directly connected to the battery, and the ammeter cannot be connected in series. The ammeter can be connected toVccend.

5. In order to ensure reliable use in various situations and prevent chip damage caused by spikes and glitches, it is recommended to useBATOne terminal and one power input terminal0.1u

ceramic capacitors, and routed very close toTC4056Achip.

two,TC4056A DEMOboard circuit diagram



3. Function demonstration description: (Working environment: power supply voltage5V, the ambient temperature25°C.)

1, Set the charging current. (Users can adjust the potentiometer to select the required charging current) CloseKPR1k, RPROG=1k 1300mA closureKPR1.2k, RPROG=1.2k 1000mA

closureKPR2k, RPROG=2k 600mA

closureKPR10k, RPROG=10k 130mA

closureKPR103, RPROG=0.82k-10.5k 2, setting 120mA-1300mA

indicator, red and green double indicator light:

charging	light status
charging status	Red light on, green light off
battery fully charged	Red light off, green light on
Undervoltage, battery temperature too high, too low, no battery Waiting for failure status (TEMPnormal connection)	Red light off, green light off
BATtermination10uCapacitor, no battery (TEMPend ground)	Green light on, red light flashing

3, Simulate the state of charge

closureKPR10k, KBAT-C, KBAT-R,KT-GND

BATconnected to a capacitorC2and a resistorR6Instead of a lithium battery, simulate a charging state: red light on, green light off. Description: This state simulation is limited to the power supply voltage less than or equal to5V,more than the5VPlease use lithium battery for actual test.

closureKPR10k, KBAT-C,KT-GND

BATconnected to a capacitorC2Instead of lithium battery, simulate charging completion status: green light is on, red light is flashing. Description: Due to the use of10uFthe capacitanceC2Instead of a lithium battery to simulate a full state, the capacitor discharges slowly after it is fully charged. When the capacitor voltage drops to the recharge threshold voltage4.05VWhen it is automatically recharged, you can see the red light flashes periodically.

4, analog charging terminalBATterminal voltage closedKPR10k, KBAT-C, KBAT-R,KT-GNDMeasurementBATterminal voltage. is the voltage at the end of charging 4.2V ±1.5%.

5, If the customer needs to monitor the battery temperature, disconnect theKT-GND,connectTC4056AofTEMPend(1pin, the connection hole has been reserved) to the temperature monitoring terminal of the lithium battery, the customer can customize it according to the actual situationR9,R10size and install. If this function is not required, closeKT-GNDThat's it.

6,CEBeginning. close switchKCE-GND,CEThe terminal is pulled down to a low level, the chip stops charging; openKCE-GND, the chip is charging normally. 7, some customers are in the applicationBATWhen there is no lithium battery at the end, you don't want the red indicator to flash, close itKBATUP,WillBATend use100kresistor connected toVdd,

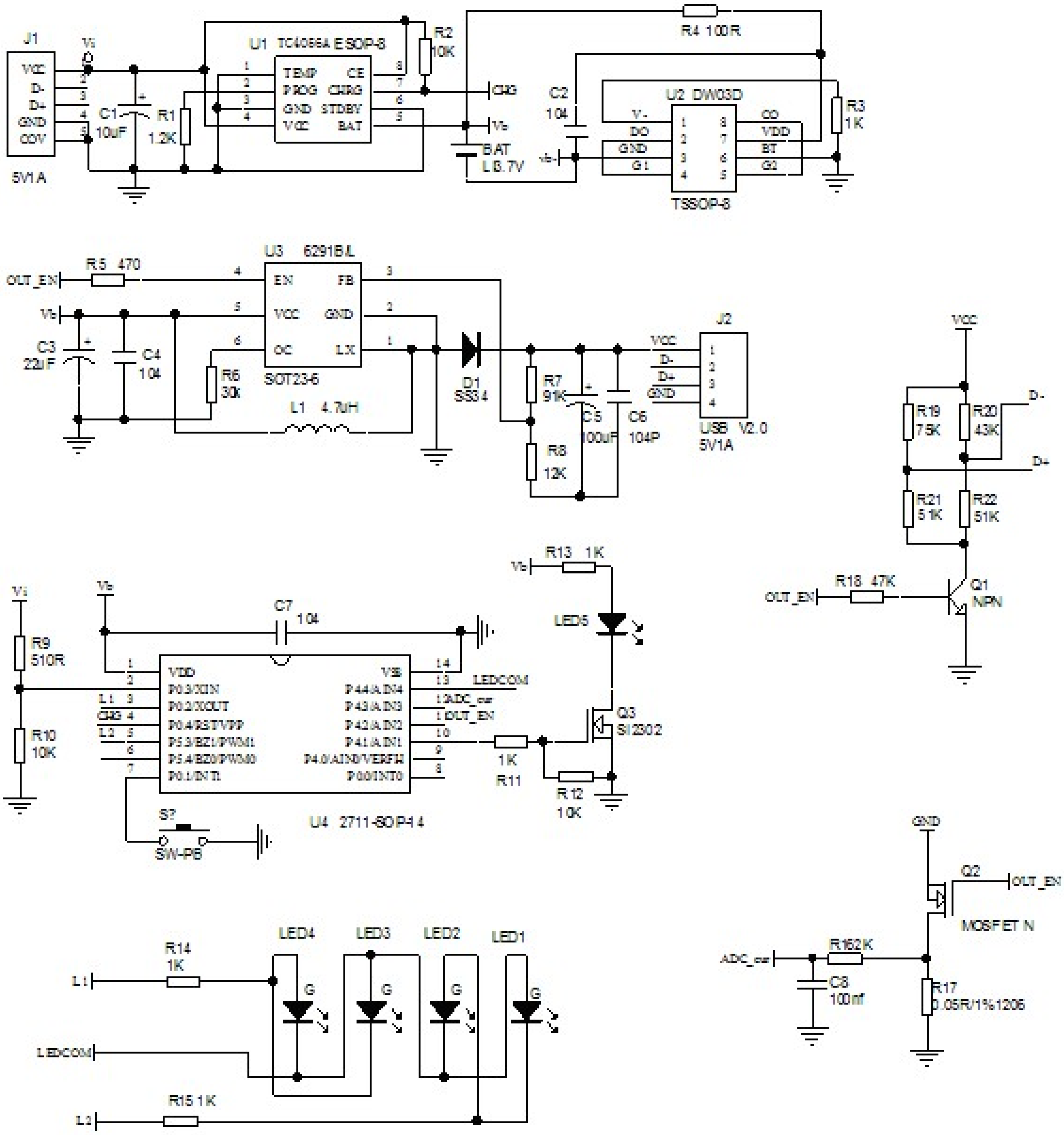
The green light is on, which can be used to indicate the standby state and does not affect normal charging.

8, Lithium battery charging

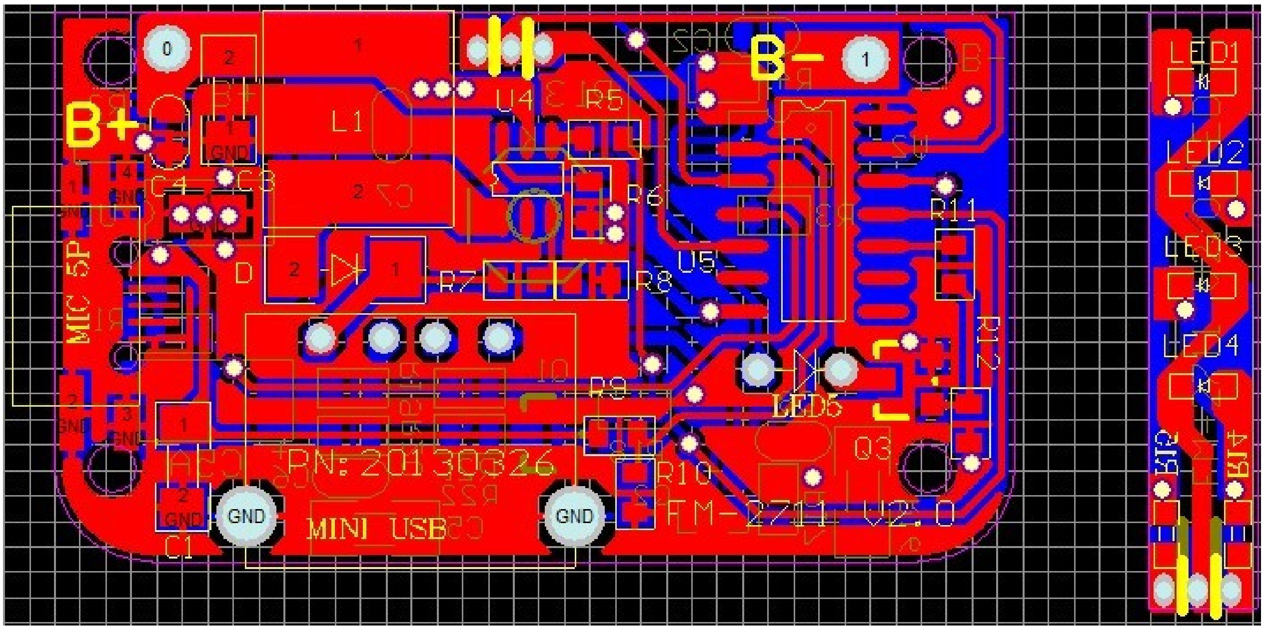
Connect the positive pole of the lithium battery to the chipBATterminal, the negative pole is grounded. If you need temperature monitoring function, please connectTEMPend(1foot), otherwise closedKT-GND. Set the required charging current and indicator light, disconnectKBATR,KCE-GNDto start charging.

Mobile power solution(software5V/1A)

1, circuit diagram



2,PCBpicture



3,BOMsurface

serial number	Component name	Models & Specifications	unit	Dosage	Location	Remark
1	printed board	FM-2711B Vv2.0Fiberglass panels	PCS	1	21.6*37.7mm	
2	Chip resistors	1.2k 5% 0603	PCS	1	R1	
3	Chip resistors	10K 5% 0603	PCS	3	R2/R10/R12	
4	Chip resistors	1K 5% 0603	PCS	5	R3/R14/R15/R11/R13	
5	Chip resistors	100R 5% 0603	PCS	1	R4	
6	Chip resistors	470R 5% 0603	PCS	1	R5	
7	Chip resistors	30K 5% 0603	PCS	1	R6	
8	Chip resistors	91K 1% 0805	PCS	2	R7	
9	Chip resistors	12K 1% 0603	PCS	1	R8	
10	Chip resistors	510R 5% 0603	PCS	1	R9	
11	Chip resistors	2K 5% 0603	PCS	1	R16	
12	Chip resistors	50mR 5% 1206	PCS	1	R17	milliohms
13	Chip resistors	47K 5% 0603	PCS	1	R18	
14	Chip resistors	43K 5% 0603	PCS	1	R19	
15	Chip resistors	75K 5% 0603	PCS	1	R20	
16	Chip resistors	51K 5% 0603	PCS	2	R22/R21	
17	Chip capacitors	22uF/10V 10% 1206	PCS	3	C1/C3/C5	
18	Chip capacitors	104 10% 0603	PCS	5	C2/C4C6/C7/C8	
19	Chip capacitors	100uF 10V 10%	PCS	1	C5A	
20	SMD diode	SS34 DO-214AC	PCS	1	D1	
twenty one	SMD transistor	SS8050 SOT-23	PCS	1	Q1	
twenty two	patchIC	TC4056A SOP-8	PCS	1	U1	

twenty three	patchIC	DW03D TSSOP-8	PCS	1	U2	
twenty four	patchIC	TC6291 SOT23-6	PCS	1	U4	
25	patchMCU	2711B V2.0 SOP-14	PCS	1	U5	ICself-supply
26	patchN-MOS	2302 SOT-23	PCS	2	Q2/Q3	
27	SMD inductor	3.3uH 6D38-100M	PCS	1	L1	current3A
28	SMD LED	white hair blue 0603	PCS	4	LED1-LED4	
29	led	¢5mmwhite hair white highlight	PCS	1	LED5	
30	SMD button switch	5.2*5.2*1.5tact switch	PCS	1	K	
31	pin	3P0.7spacing	PCS	1	led	sameFM-V3
32	USBfemale seat	Mic usb 10MMshort body	PCS	1	USB	
33	SMD female seat	SMD Mike5P,The pins need to be lengthened	PCS	1	MIC 5P	full post
34	electronic wire	¢1.5*40mm red	PCS	1	B+	
35	electronic wire	¢1.5*40mm black	PCS	1	B-	