



TC4056A (File No: S & CIC1103)

1A Linear lithium ion battery charger

First, the product description

TC4056A It is a complete single lithium-ion battery with a constant current / constant-voltage linear charger. Bottom finned ESOP8 / DIP8 With fewer number of external elements such that the package TC4056A Ideal for portable applications. TC4056A You can fit USB Power adapter and power supply.

As a result of internal PMOSFET Architecture, coupled with anti-down charge circuit, so that no external blocking diode. Thermal feedback to automatically adjust the charging current to limit the die temperature during high power operation or high ambient temperature conditions. The charge voltage is fixed at 4.2V , The charge current can be set by an external resistor. When the charge current drops to the final value after reaching float voltage 1/10 Time, TC4056A The charge cycle is automatically terminated.

When the input voltage (AC adapter or USB Power) is removed when, TC4056A Automatically enters a low current state, the drain current to the battery 2uA the following. TC4056A When a power supply may be placed in shutdown mode, reducing the supply current is reduced to 55uA . TC4056A Other features include a battery temperature detection, undervoltage lockout, automatic recharge and two for indicating the charging end led State pin.

Second, characteristics

- Up 1000mA Programmable charge current
- No need MOSFET , Sense resistor or blocking diode
- A single lithium-ion batteries, using SOP Complete Linear charger package
- Constant-current / constant-voltage operation, and having a charge rate can be achieved without risk maximize overheating thermal regulation
- Accuracy $\pm 1.5\%$ of 4.2V Predetermined charge voltage
- Current monitor for detecting the output of battery
- Automatic recharge
- Dual output state of charge, and fault-free battery status display
- C / 10 Charge termination
- Current supply in the standby mode 55uA
- 2.9V Trickle Charge version
- Soft-start limits inrush current
- Battery temperature monitoring function
- use 8 Pin package (ESOP-8 , DIP-8)

Third, the product application

- mobile phone, PDA
- MP3 , MP4 player
- Digital cameras
- E-dictionary
- GPS
- Portable equipment, various chargers

Fourth, the absolute maximum ratings

- 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
- BAT Short circuit duration: Continuous
- BAT Pin Current: 1200mA
- PROG Pin Current: 1200uA
- The maximum junction temperature: 145 °C
- Operating temperature range: - 40 °C ~ 85 °C
- Storage temperature range: - 65 °C ~ 125 °C
- Lead Temperature (Soldering 10 second): 260 °C



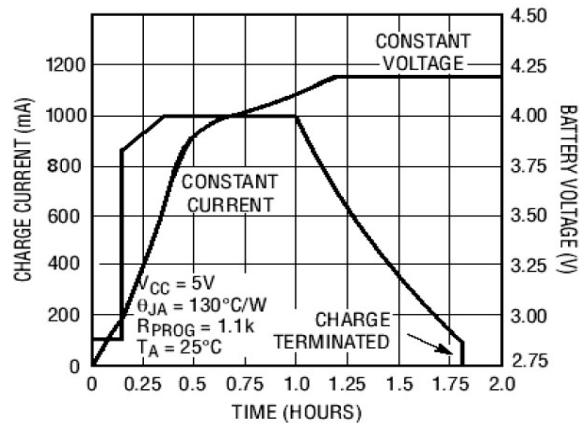
Shenzhen Fu Man Electronics Group Co., Ltd.

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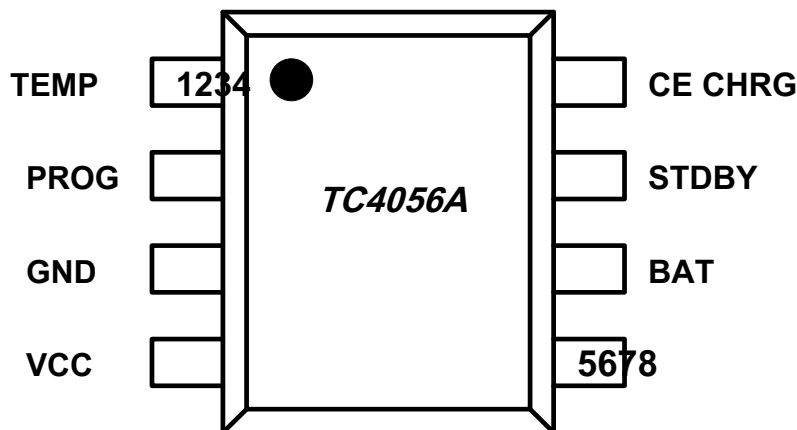
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Five complete charging cycle (1000mAh battery)



VI Package / ordering information and functions



- **TEMP (Pins 1):** Battery temperature detection input terminal. will TEMP Pin to current NTC The output of the sensor. in case TEMP Pin voltage less than the input voltage 45% Or greater than the input voltage 80% It means that the battery temperature is too low or too high, the charging is suspended. in case TEMP Direct access GND Battery temperature detection function is canceled, another charging function properly.
- **PROG (Pins 2):** Constant charge current and a charge current monitoring terminal is provided. From PROG Pin is connected to the ground terminal of an external resistor can be programmed charging current. In the precharge phase, the voltage at this pin is modulated 0.1V ; Constant-current charging phase, the voltage at this pin is fixed 1V . In all modes, the state of charge, measuring the voltage at pin charging current can be estimated according to the following formula:

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

- **GND (Pins 3):** Power ground.
- **VCC (Pins 4):** Input voltage at the positive input terminal. This voltage is the power supply pin of the internal circuit. when Vcc versus BAT is smaller than the voltage difference between pins 30 m V Time, TC4056A Enters low power shutdown modes, then BAT Pin current is less than 2uA .
- **BAT (Pins 5):** A battery connection terminal. The positive terminal of the battery is connected to this pin. In the chip disable mode or in sleep mode, BAT Pin leakage current is less than 2uA . BAT Pin provides charge current to the battery, and 4.2V Limit voltage.

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- STDBY (Pins 6): Indicating completion of charging the battery terminal. When the current charging is completed STDBY Internal switch is pulled low to indicate the completion of charging. In addition, STDBY The pin is in high impedance state.
- CHRG (Pins 7) The state of charge indication open-drain output terminal. When the battery is being charged, CHRG Internal switch pin is pulled low, indicating the charging progress; otherwise CHRG Pin is high impedance.
- CE (Pins 8) Chips before they can input. High input level will TC4056A In normal working condition; low input level so TC4056A It is prohibited in the state of charge. CE Pin can be TTL Level or CMOS Level driver.

Seven, the electrical characteristics

Where Table Notes • It denotes specifications which apply over the full operating temperature range, otherwise specifications TA = 25 °C, Vcc = 5V Unless

otherwise noted.	symbol	parameter	condition		Min	Typ	Max	Units
VCC		Input supply voltage		•	4.0	5	8.0	V
ICC		Input supply current	Charging mode, RPROG = 1.2K	•		150	555	500
			Standby mode (charge termination) Stop mode (RPROG = 1.2K)	•			100	μA
			not connected,	•			100	μA
			VCC < VBAT , or VCC < VUV)	•			100	μA
VFLOAT	Stable	output (floating) voltage	0 °C ≤ TA ≤ 85 °C,		4.16	4.2	4.24	V
IBAT		BAT Pin Current: (Current mode test conditions VBAT = 4.0V)	RPROG = 2.4K The current mode	•		500	550	1050
			RPROG = 1.2K The current standby	•		1000		mA
			mode, VBAT = 4.2V	•	450	950	0	μA
			Shutdown Mode (RPROG Unconnected) sleep mode, VCC = 0V			± 1	± 2	μA
ITRIKL		Trickle charge current	VBAT < VTRIKL RPROG = 1.2K • 120			130	140	mA
VTRIKL		Trickle charge threshold voltage	RPROG = 1.2K , VBAT rise		2.8	2.9	3.0	V
VTRHYS		Trickle charge voltage hysteresis	RPROG = 1.2K		60	80	100	mV
VUV		VCC Undervoltage lockout threshold from	VCC Low to High	•	3.5	3.7	3.9	V
VUVHYS		VCC Undervoltage lockout hysteresis		•	150	200	300	mV
V _{ASD}		VCC-VBAT Lockout threshold voltage	VCC From low to high		605	10030	10030	mV
			VCC High to Low					mV
IT _{TERM}		C / 10 Termination current threshold	RPROG = 2.4K	•		70	130	80
			RPROG = 1.2K	•	60	120		mA
V _{PROG}		PROG Pin voltage	RPROG = 1.2K The current mode	•	0.9	1.0	1.1	V
V _{CHRG}		CHRG Low voltage output pin	I CHRG = 5mA			0.3	0.6	V
V _{STDBY}		STDBY Pin output low	I STDBY = 5mA			0.3	0.6	V
V _{TEMP-H}		TEMP High voltage pin Flip				80	82	% Vcc
V _{TEMP-L}		TEMP Pin voltage low-end flip			43	45		% Vcc
ΔV _{RECHRG}		Threshold voltage of the rechargeable battery	VFLOAT-VRECHRG		100	150	200	mV



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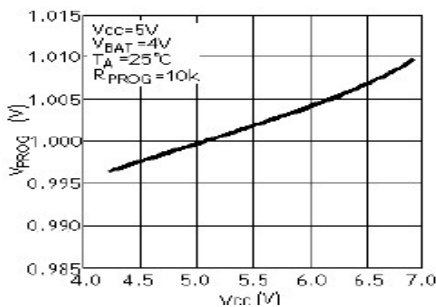
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T _{LIM}	Defining a temperature model of the junction temperature				145		°C
R _{ON}	power FET " Conduction " Resistance (in VCC versus BAT between)				650		mΩ
t _{ss}	Soft start time	IBAT = 0 to IBAT = 1200V / RPROG			20	4	μs
t _{RECHARGE}	Comparator Filter recharging between	VBAT High to Low		0.8	1.8 4		ms
t _{TERM}	Termination Comparator Filter Time IBAT Drops ICHG / 10 the following			0.8	1.8		ms
I _{PROG}	PROG Pin pull-up current				2.0		μA

Eight typical performance characteristics

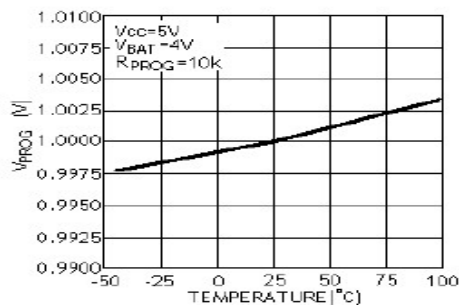
Constant current mode PROG Pin

The voltage versus supply voltage



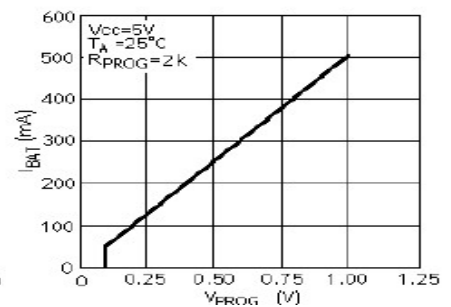
PROG Pin voltage and temperature

Relationship lines



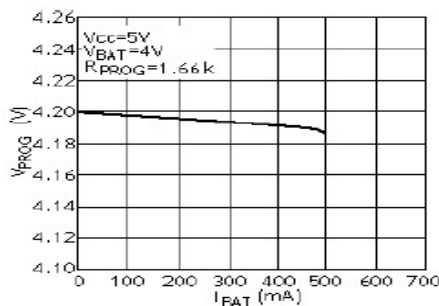
And a charging current PROG Pin

Pressure curve



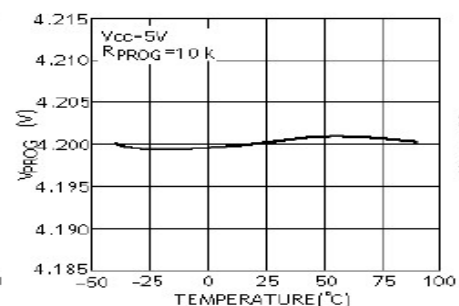
Stable output (float) and the charging voltage

Electric current curve



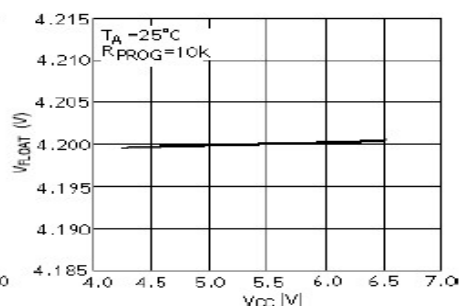
Stable output (Float) Voltage Temperature

The degree of curve



Stable output (float) the voltage indicating

Pressure curve

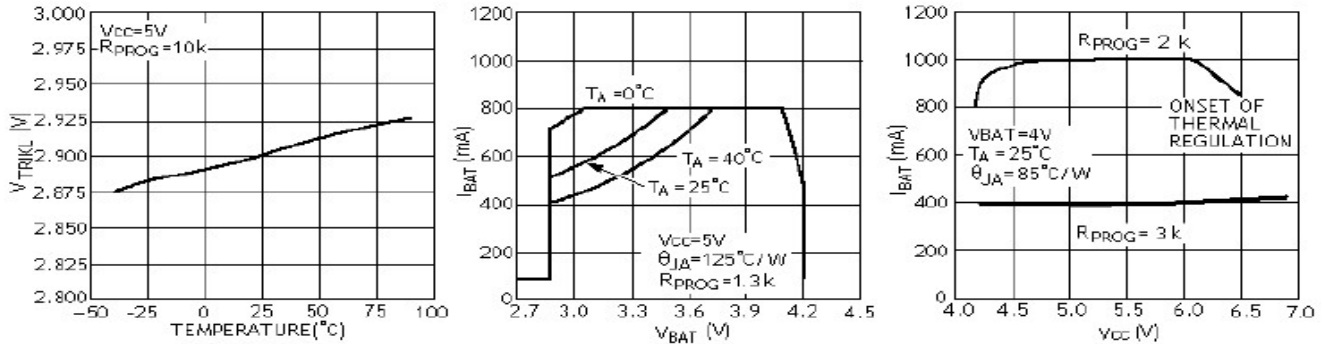




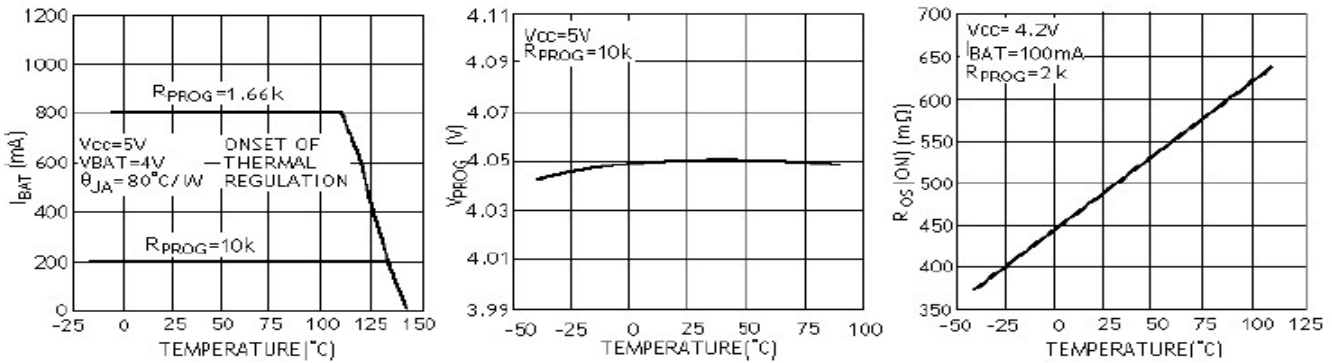
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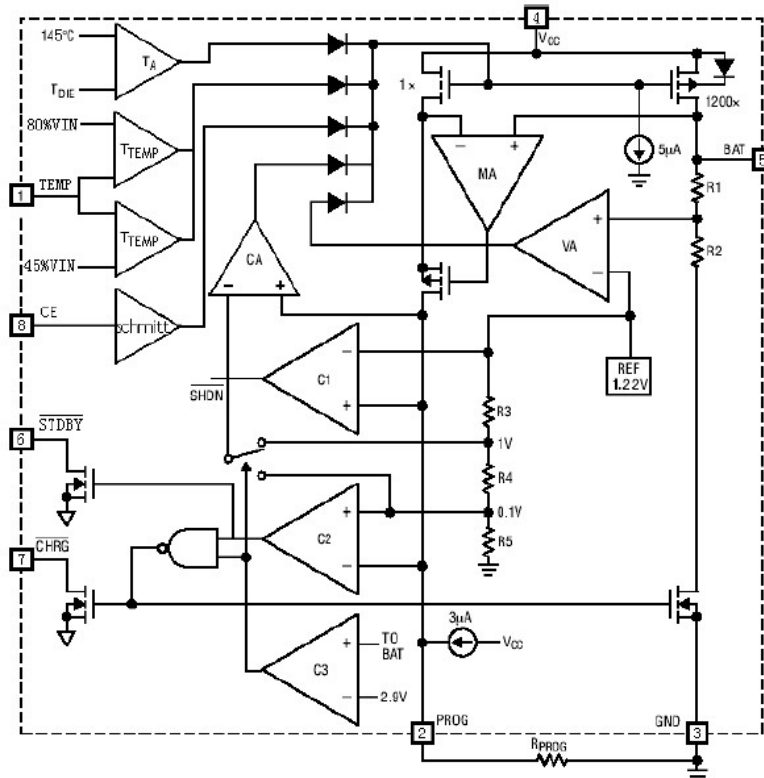
Trickle charging relation of the charging curve and the temperature curve threshold current and the battery charging current and voltage curve of the supply voltage



Power versus ambient temperature, charging current and the charging voltage curve and then the temperature threshold FET "Conduction" Resistance versus temperature



Nine, block diagram and working principle





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TC4056A Linear charger circuit is designed for a lithium ion or lithium polymer battery is designed, using a chip inside the power transistor for a constant current and constant voltage battery charge. The charging current can be programmed with an external resistor, the charging current up to the maximum continuous 1A No blocking diode and current sense resistor. TC4056A Contains two open-drain output state indication output terminal, the charging indicator status CHRG Fault Status and output terminal STDBY . Power management circuitry inside the chip junction temperature of the chip exceeds 145 Automatically reduces the charge current °C, this feature allows the user to use the maximum power handling capability of the chip, do not worry about damaging the chip or the chip overheating external components. Thus, when the charge current user may not consider the worst case, but only according to typical case can be, as in the worst case, TC4056A It will automatically reduce the charging current.

When the input voltage is greater than the supply voltage detection threshold and the low chip enable input pull high, TC4056A Start charging the battery, CHRG Output pin low to indicate that charging is in progress. If the battery voltage is below 3V , The battery charger is precharged with a small current. When the battery voltage exceeds 3V , The battery charger uses a constant current mode, the charging current from the PROG Pin and GND Resistance between R_{PROG} determine. When the battery voltage is close to 4.2V Voltage, the charging current decreases, TC4056A Constant voltage charging mode. When the charge current is reduced to a charge termination threshold, of a charge cycle, CHRG End a high impedance state, STDBY The low potential side.

Charge end threshold is a constant charge current 10% . When the battery voltage falls below the recharge threshold, a new charge cycle starts automatically. Precision voltage reference source within the chip, the error amplifier and the resistor divider network to ensure the accuracy of the battery voltage in the modulator 1.5% Or less, meet the requirements of a lithium ion battery and lithium polymer batteries. When the power-down the input voltage or the input voltage is lower than the battery voltage, the charger enters a low power sleep mode, the current consumption of the battery is less than the end 3uA From an increase of standby time. If you enable input CE Then low, the charger to stop charging.

- The charging current is set

A charging current is connected to the color PROG A resistor between the pin and ground to set. And a charging current setting resistor is calculated using the following equation: to determine the resistance of the charging current according to the resistance required

$$R_{PROG} = \frac{1200}{I_{BAT}} \quad (\text{误差} \pm 10\%)$$

Client applications can be selected according to the needs of the appropriate size R_{PROG} , R_{PROG} Determining the relationship between the charging current is shown in the table:

$R_{PROG} (K)$	$I_{BAT} (M A)$
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 termination

When the current reaches the final float charging voltage drops below a set value 1/10 When the charge cycle is terminated. This condition is achieved by using an internal filtered comparator PROG Temporary control pins to detect. when PROG Pin voltage falls 100 m V For longer than t_{TERM} (Usually 1.8ms), The charge is terminated. The charging current is latched off, TC4056A Enters standby mode, the input supply current is reduced to 55UA . (Note: C / 10



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Failure to terminate and thermal limit trickle charge mode).

Charging, BAT Transient loads can cause the pin PROG Pin voltage DC Value of the charge current drops 1/10 Briefly fell between 100mV the following. Termination of the comparator 1.8ms Filter time (T_{TERM}) To ensure that transient loads of this nature do not lead to premature termination of the charging cycle. Once the average value of the charge current drops 1/10 the following, TC4056A That terminates the charge cycle and stopped by BAT Pin any current. In this state, BAT All the load on the pins must be powered by a battery. In standby mode, TC4056A Correct BAT Pin voltage is continuously monitored. If this voltage drops 4.05V Recharging limit switches ($RECHRG$) Hereinafter, another charge cycle begins again and the current supplied to the battery.

Map 1 It shows a typical charge cycle state of FIG.

• Charging status indicator

TC4056A Two open-drain status output terminal, CHRG with STDBY . When the charger is in the charging state, CHRG It is pulled low, in other states, CHRG In a high impedance state. When the outside temperature of the battery is in a normal temperature range, CHRG with STDBY Pins are high impedance. when TEMP When using typical connection end, When the battery charger is not received, it indicates a fault condition: Red and green are lit in TEMP Termination GND When the battery temperature detection does not work when there is no battery to the charger, CHRG Output pulse signal indicate that the battery. When the battery connecting terminal BAT Pin external capacitance 10uF Time CHRG Flashing frequency of about 1-4 Second indication state when not, will not have the status outputs to ground.

charging	red light CHRG	Green STDBY
Charging status	bright	Destroy
Full voltage state	Destroy	bright
Voltage, battery temperature is too high, too low a fault condition, the battery without intervention or (TEMP use)	Destroy	Destroy
BAT Termination 10u Capacitors, battery-free (TEMP = GND)	Green light, red light flashes T = 1-4S	

Various state of charge indicating Refer TC4056A Cautions and DEMO Plate specification.

• Thermal limitations

If the chip temperature is raised to about 140 °C than a preset value, then a thermal feedback loop reduces the internal charge current until 150 Reducing the current to the above °C 0 . This feature prevents TC4056A Overheated, and allows the user given increasing the maximum power handling capability of the circuit board without damage TC4056A risks of. In ensuring the charger will automatically reduce the current in the worst case conditions of the premise, according to a typical (but not the worst case) the ambient temperature is set to the charging current.

• Battery temperature monitoring

In order to prevent the temperature is too high or too low for damage caused by the battery, TC4056A Battery temperature monitoring within the integrated circuit. It was monitored by measuring the battery temperature TEMP Voltage pin to achieve, TEMP Voltage pin is inside the cell NTC A thermistor and a resistor divider network of FIG.

1 Fig.

TC4056A will TEMP Internal chip pin with two voltage thresholds V_{LOW} with V_{HIGH} Compared to confirm that the temperature of the battery exceeds a normal range. in TC4056A internal, V_{LOW} Is fixed $45\% \times V_{CC}$, V_{HIGH} Is fixed $80\% \times V_{CC}$. in case TEMP Voltage pin $V_{TEMP} < V_{LOW}$ or

$V_{TEMP} > V_{HIGH}$, It indicates that the battery temperature is too high or too low, the charging process is suspended; if TEMP Voltage pin V_{TEMP} in V_{LOW} with V_{HIGH}

Among the charge cycle continues.



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If the TEMP Pin to ground, the battery temperature monitoring function is disabled .

- **determine R1 with R2 The value**

R1 with R2 Values to be determined according to the resistance value of the thermistor temperature monitoring range and a battery, are illustrated as follows: Assume the battery temperature range $T_L \sim T_H$, (among them $T_L < T_H$; Battery using a negative temperature coefficient thermistor (NTC), R_{TL} In its temperature T_L When the resistance, R_{TH} In its temperature T_H When the resistance of the thermistor R_T $> R_{TH}$ Then, the temperature T_L When the first pin TEMP Voltage terminal is:

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

In the temperature T_H When the first pin TEMP Voltage terminal is:

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

Then, by the $V_{TEMPL} = V_{HIGH} = k_2 \times V_{CC}$ ($k_2 = 0.8$) $V_{TEMPH} = V_{LOW}$

$= k_1 \times V_{CC}$ ($k_1 = 0.45$)

We can solve for:

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

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

Similarly, if the internal battery is a positive temperature coefficient (PTC) Thermistor, is $>$, 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, to be set in a temperature range supply voltage V_{CC} It is irrelevant, and only $R1$, $R2$, R_{TH} , R_{TL} About; which,

R_{TH} , R_{TL} Can be found in related battery handbook or deduced from testing. In practice, if only one side of the temperature characteristic of interest, such as thermal protection, the $R2$ Can not, but only $R1$ It can be. $R1$ Derivation becomes simple, not discussed here.

- **Undervoltage lockout**

An internal undervoltage lockout circuit monitors the input voltage, and V_{CC} It rises above the undervoltage lockout threshold before the charger in shutdown mode.

UVLO Charger circuit will remain in shutdown mode. in case UVLO The comparator transition occurs at V_{CC} Raised higher than the battery voltage 100mV Before charger will not exit the shutdown mode.



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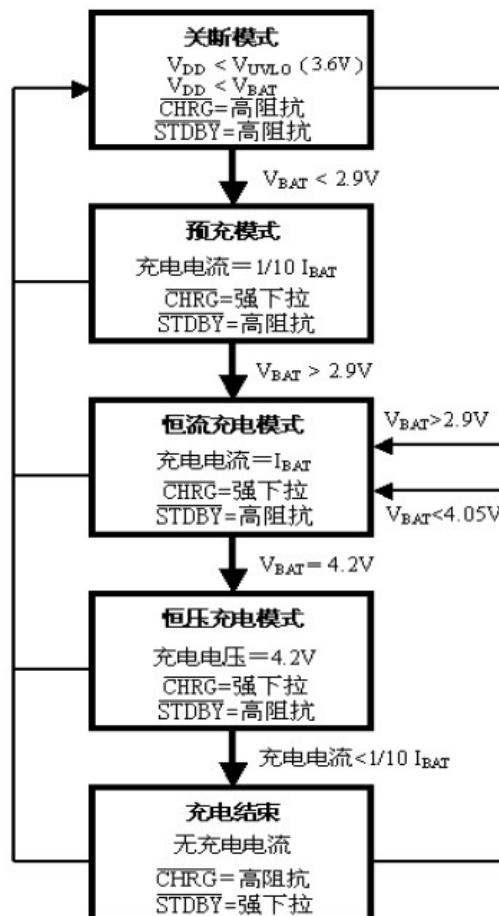
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• Manual Shutdown

Any point in the charge cycle can be set by CE A low potential side or removed R_{PROG} (So that PROG Pin floating) to the TC4056A Put into shutdown mode. This reduces the battery drain current to $2\mu\text{A}$ Or less, and the supply current drops $55\mu\text{A}$ the following. Re CE Opposite end connected to a high potential or a resistor may be set to start a new charging cycle. in case TC4056A It is in undervoltage lockout mode, CHRG And pins are high impedance state: either V_{CC} Higher BAT Pin voltage is less than the magnitude 100mV Or applied in V_{CC} Insufficient voltage on the pin.

• Automatic restart

Once the charge cycle is terminated, TC4056A Now has adopted a 1.8ms Filter time (RECHARGE t) Of the comparators BAT Continuously monitoring the voltage on the pin. When the battery voltage drops 4.05V (Substantially corresponding to the battery capacity 80% to 90%) Or less, the charge cycle begins again. This ensures that the battery needs to be maintained at (or near) a fully charged state, and eliminates the periodic charge cycle starts. In the recharge cycle, CHRG Output pin enters a strong pull-down state.



Map 1 : A typical charge cycle state of FIG.

• Stability considerations

In the constant current mode, it is located in the feedback loop PROG Pins, instead of the battery. Stability constant current mode by PROG The effects of pin impedance. when PROG No additional capacitance will reduce the maximum allowable setting resistor the resistance of the pin. PROG Pole frequency should be kept on the pin

C_{PROG} , Can be calculated using the formula R_{PROG} The maximum resistance value:

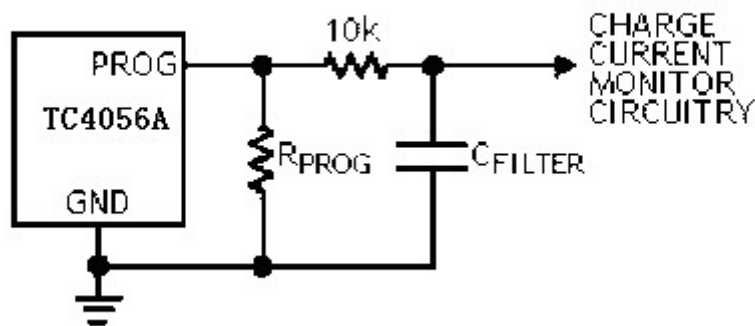


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$$R_{PROG} \leq \frac{1}{2\pi \cdot 10^5 \cdot C_{PROG}}$$

For users, they are more likely to be interested in the charging current, rather than the transient current. For example, if a run at low current mode switching power supply in parallel with the battery, from BAT The average current out of the pin is usually more important than the transient current pulses. In this case, it can be PROG Using a simple pin RC Filter to measure the average battery current (FIG. 2 Shown). in PROG The addition of a capacitor between the pin and the filter 10k Resistor to ensure stability.



Map 2 :isolation PROG Capacitive load on the pin and the filter circuit

• Power loss

TC4056A Conditions for the sake of thermal feedback charging current is reduced by IC The estimated power loss. Nearly all of this power loss by the internal MOSFET produced - This approximation is obtained by the following formula:

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

Formula P_D For the dissipation of power, V_{CC} Input power source voltage, V_{BAT} Battery voltage, I_{BAT} Charging current. When the thermal feedback begins IC Providing protection, the ambient temperature is approximately:

$$T_A = 145^\circ C - P_D \theta_{JA}$$

$$T_A = 145^\circ C - (V_{CC} - V_{BAT}) \cdot I_{BAT} \cdot \theta_{JA}$$

Example: by programming from a 5V Power supply to get work TC4056A To have a 3.75V Discharge voltage lithium-ion battery to provide 800mA

Full magnitude of the current. Hypothesis θ_{JA} for 150 °C / W (See board layout considerations), when TC4056A When the charging current begins to decrease, the ambient temperature is approximately:

$$T_A = 145^\circ C - (5V - 3.75V) \cdot (800mA) \cdot 150^\circ C / W$$

$$T_A = 145^\circ C - 0.5W \cdot 150^\circ C / W = 145^\circ C - 75^\circ C$$

$$T_A = 65^\circ C$$

TC4056A Can 65 Using at least °C ambient temperature conditions will be reduced but the charge current 800mA the following. For a given ambient temperature, the charging current may have determined the approximate formula:



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$$I_{BAT} = \frac{145^{\circ}C - T_A}{(V_{CC} - V_{BAT}) \cdot \theta_{JA}}$$

As part of the operation principle discussed above, when the thermal feedback reduces the charge current, the PROG The voltage on the pin is also reduced proportionally. Remember do not need TC4056A

The worst heat conditions considered in the design application, which is very important, because the IC Will reach the junction temperature 145 Automatically reduces power consumption

approximately deg.] C.

- **Thermal Considerations**

due to SOP8 / MSOP8 The small form factor package, therefore, a need for using sophisticated thermal design PC Plate layout to maximize the available charge current may be used, it is very important. For dissipate IC Cooling path of the generated heat from the chip to the lead frame, and through the heat sink reaches a bottom

PC Board copper. PC Board copper heat sink. Copper area connected to the heat sink should be as wide, and extends outwardly to a large copper area to spread the heat to the surroundings. Back to the inside or through-holes in the copper layers to improve the overall thermal performance of the charger are also quite useful. When performing PC

Board layout design, other heat sources related to the charger board also must be considered, because they will affect overall temperature rise and the maximum charge current has been affected.

- **Increased thermal regulation current**

Reduce the internal MOSFET The voltage drop across can be significantly reduced IC In power consumption. During thermal conditioning, which has an increased current supply to the battery effect.

One countermeasure is through an external element (e.g. a resistor or a diode) will be part of the power dissipated. Example: by programming from a 5V AC power adapter to get work TC4056A To

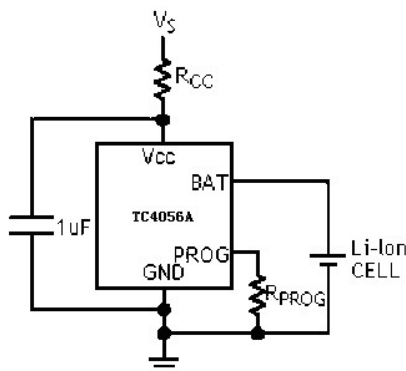
have a 3.75V Voltage of the lithium ion battery to discharge

800mA The full-scale charge current. Hypothesis θ_{JA} for 125 °C / W , Then 25 °C ambient temperature conditions, the charging current is approximately:

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

And by reducing a 5V Voltage of the resistor connected in series across the AC adapter (FIG. 3 Shown), the on-chip power consumption can be reduced, thereby increasing the thermal regulation of the charging current:

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





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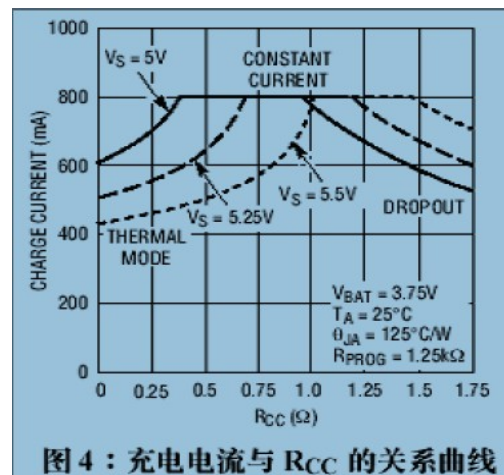
Map 3 : One kind of the thermal conditioning circuit pattern maximize the charge current section

Can be obtained using the quadratic equation₂

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

take $R_{CC} = 0.25\Omega$, $V_S = 5V$, $V_{BAT} = 3.75V$, $T_A = 25^\circ C$ and $125^\circ C / W_{JA}$, We can calculate the thermal regulation of the charging current: I_{BAT}

= 948mA, The results described structure may be output at higher ambient temperatures 800mA Full-scale charge. Although this application may be delivered in thermal mode and more energy to the battery charging time is shortened, but in the voltage mode, if V_{CC} Becomes sufficiently low so that TC4056A State at a low pressure drop, it may actually lengthen the charging time. Map 4 It shows how this circuit with R_{CC} Increases caused by voltage drop. When the element size in order to maintain a small pressure drop and to avoid the R_{CC} Value is minimized, the best technology can play a role. Remember select a resistor having a sufficient power handling capability.



• VCC Bypass capacitor

Various types can be input bypass capacitor. However, care must be taken when using multilayer ceramic capacitors. Because some types of ceramic capacitors having a high self-resonant Q Characteristic values, therefore, under certain start conditions (such as the battery charger is connected to the power supply input and a work) may produce a high voltage transients. And increase a X5R Ceramic capacitors in series 1.5Ω Resistor will minimize start-up voltage transients.

• Charging current soft start

TC4056A Comprising a charging cycle for the start soft-start circuit to minimize the inrush current. When a charge cycle is initiated, the charging current 20μs Around time from 0 Up to full-scale full-scale value. During startup, it can play a role in minimizing the transient current load on the power supply.

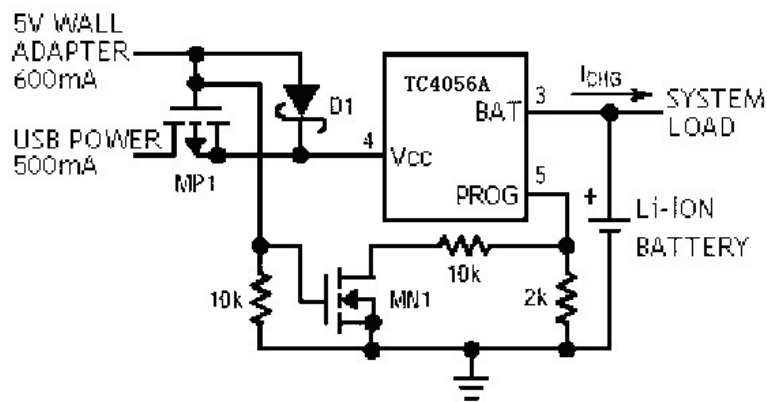
Map 5: Low-loss input reverse polarity protection USB And AC power adapter

TC4056A Allowing an AC adapter or from a USB Port for charging. Map 6 Shows how the AC adapter and USB One example of the power input to be combined. One P Channel MOSFET (MP1) When the AC adapter is used to prevent back conducting into the USB Port, and a Schottky diode (D1) Were used to prevent USB After power 1K Loss occurs when the pull-down resistor. Generally, the ratio of the AC adapter can be provided as a current limit 500mA of USB Much of the current port. Thus, when the AC adapter is the access, can be a N Channel MOSFET (MN1) And an additional 10K Setting resistor to increase the charge current to 600mA .



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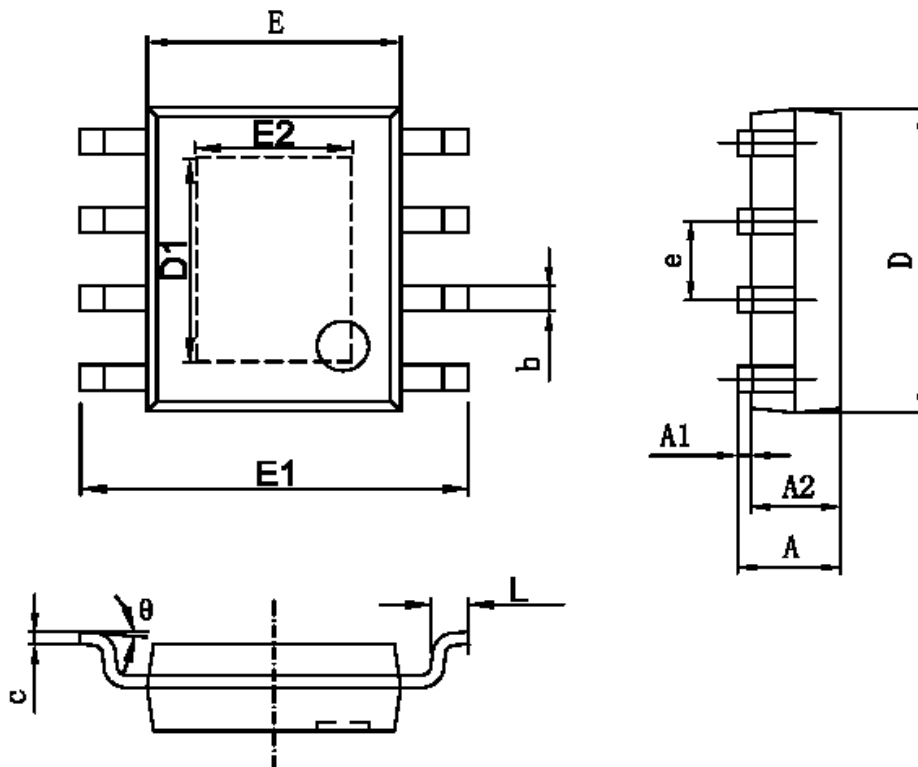
1A Linear lithium ion battery charger



Map 6 : AC adapter USB The combined power supply

X. Package Description

8 Pin ESOP-8 Package (Unit mm)





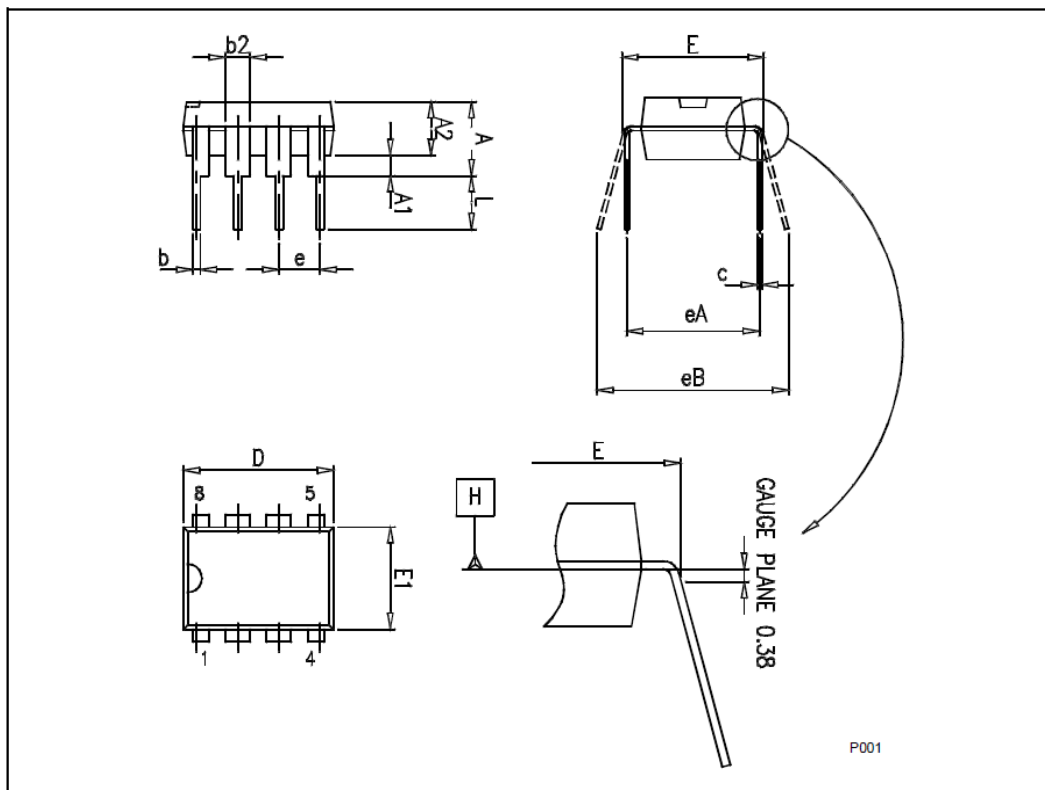
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字符	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.150	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
D1	3.202	3.402	0.126	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°	

8 Pin package (Unit mm)

DIP-8



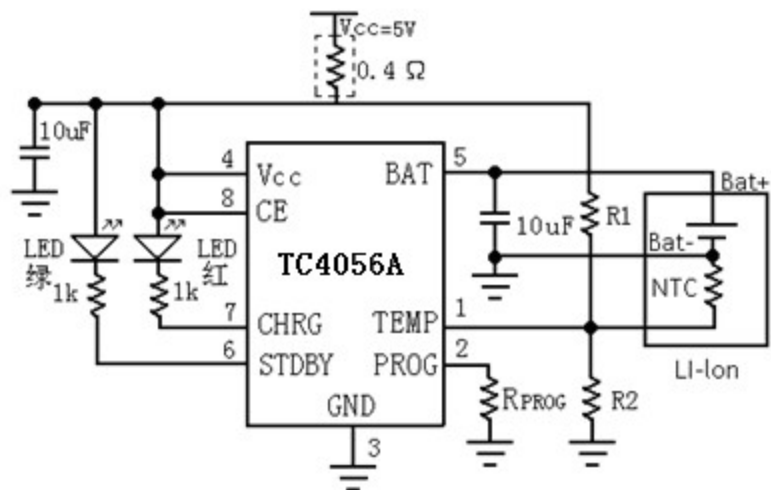


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symbol	Millimeter		
	Least	typical	maximum
A			5.33
A1	0.38		
A2	2.92	3.30	4.95
b	0.36	0.46	0.56
b2	1.14	1.52	1.78
c	0.20	0.25	0.36
D	9.02	9.27	10.16
E	7.62	7.87	8.26
E1	6.10	6.35	7.11
e		2.54	
eA		7.62	
eB			10.92
L	2.92	3.30	3.81

XI, typical applications



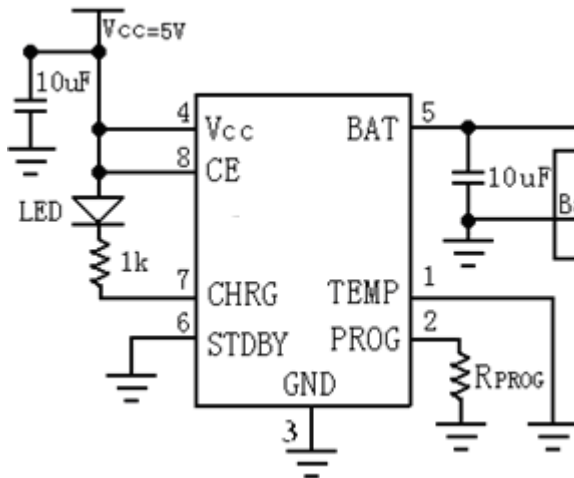
Need for battery temperature detection, battery temperature abnormality is indicated

And charging status indication application



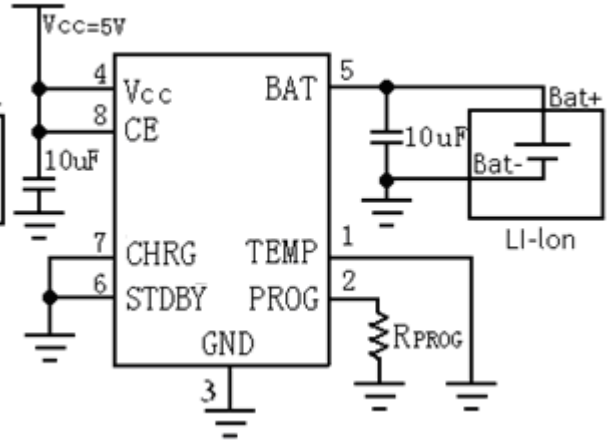
TC4056A (File No: S & CIC1103)

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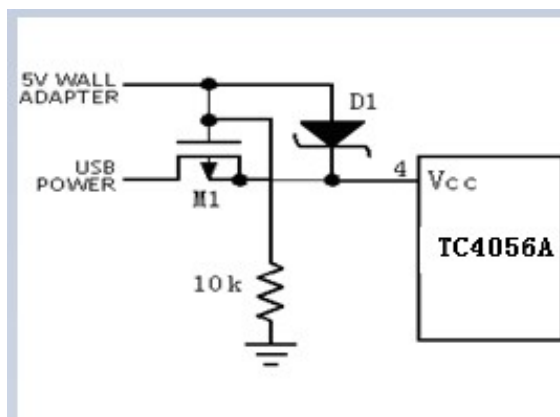
Required for status indication, and does not require

Application of battery temperature monitoring function

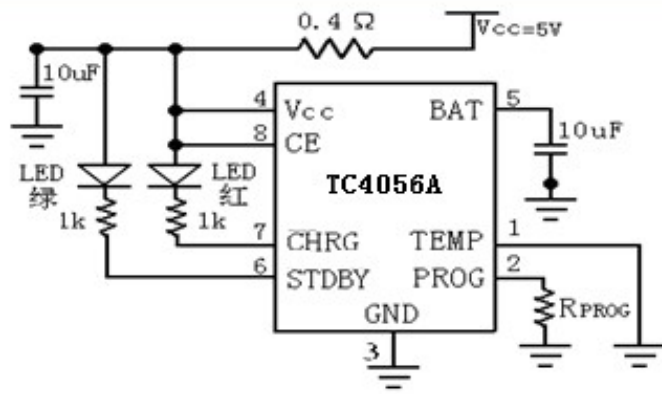


Suitable neither status indication, and does not require

Application of battery temperature monitoring function



For simultaneous application USB And charging interfaces wall adapter



Red state of charge led Indication, the state of the charge completion

green led It indicates, increasing the dissipation power of resistance

TC4056A Cautions and DEMO Specification plate

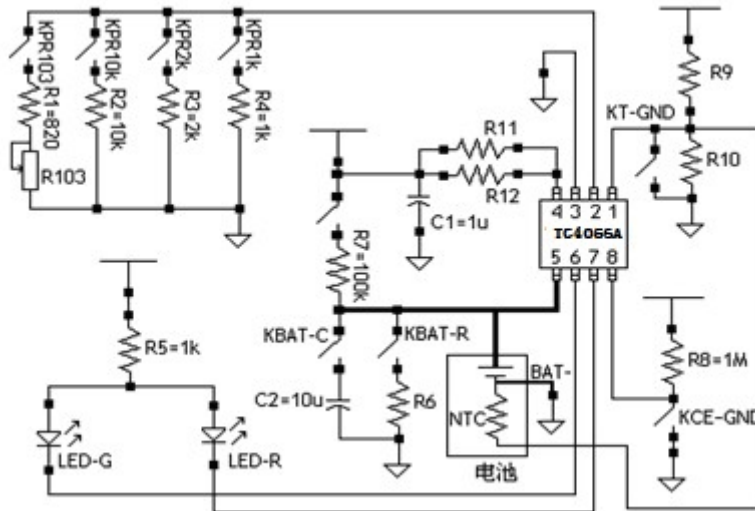
One, TC4056A Caution:

- 1, TC4056A use SOP8 / ESOP8-PP Packaging, the need to use the bottom of the heat sink and PCB Well plate welding, the bottom area need to increase the heat dissipation through holes, And a large area of the copper foil excellent heat. Multilayer PCB Plus vias sufficiently good cooling effect, the cooling effect may cause poor charging current is reduced by the temperature protection. in SOP8 / ESOP8 The back surface of the heat radiating portion with appropriate vias, also to facilitate the manual welding, (from the back through hole filling solder, reliable weld heat dissipating surface).
- 2, TC4056A Application of large current charging (700mA Above), in order to shorten the charging time, the need to increase the heat dissipation resistor (as in FIG. R11 , R12), Resistance Range 0.2 ~ 0.5Ω . Customers select the appropriate size of the resistance based on usage.
- 3 , TC4056A Applications BAT End of 10u Position close to the chip capacitor BAT End is preferred, should not be too far.
- 4 , TC4056A testing, BAT End should be connected directly to the battery, not in series ammeter, the ammeter can be connected Vcc end.
- 5 To ensure the reliable use of various circumstances, prevent chip damage due to voltage spikes and glitches, it is recommended BAT And each terminal connected to a power input terminal 0.1u Ceramic capacitors, and very close in the wiring TC4056A chip.

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two, TC4056A DEMO Board circuit diagram



Third, the functional demonstration shows :(work environment: power supply voltage 5V , Ambient temperature 25 °C.)

1, Charge current. (The user may select the charge current setting potentiometer desired) closed KPR1k,

RPROG = 1k 1300mA

closure KPR1.2k, RPROG = 1.2k 1000mA

closure KPR2k, RPROG = 2k 600mA

closure KPR10k, RPROG = 10k 130mA

closure KPR103, RPROG = 0.82k - 10.5k 120mA - 1300mA 2 , Set up lights, red and

green dual-lamp indication:

charging	LED status
Charging status	Red light, green light off
Battery is fully charged state	Red light off, green light
Voltage, battery temperature is too high, too low, no battery Fault status (TEMP End of the normal connection)	Red light off, green light off
BAT Termination 10u Capacitor, no battery (TEMP end Ground)	Green light, red light flashes

3 Simulated state of charge

closure KPR10k, KBAT-C, KBAT-R , KT-GND BAT A capacitor connected to an end C2 And a resistor R6 Instead of lithium batteries, charging state analog:

red light, green light off. Description: This state only the analog supply voltage less 5V ,more than the 5V Please use lithium batteries when the actual test.

closure KPR10k, KBAT-C , KT-GND BAT A capacitor connected to an end C2 Instead of lithium batteries, the charging completion state analog: green light,

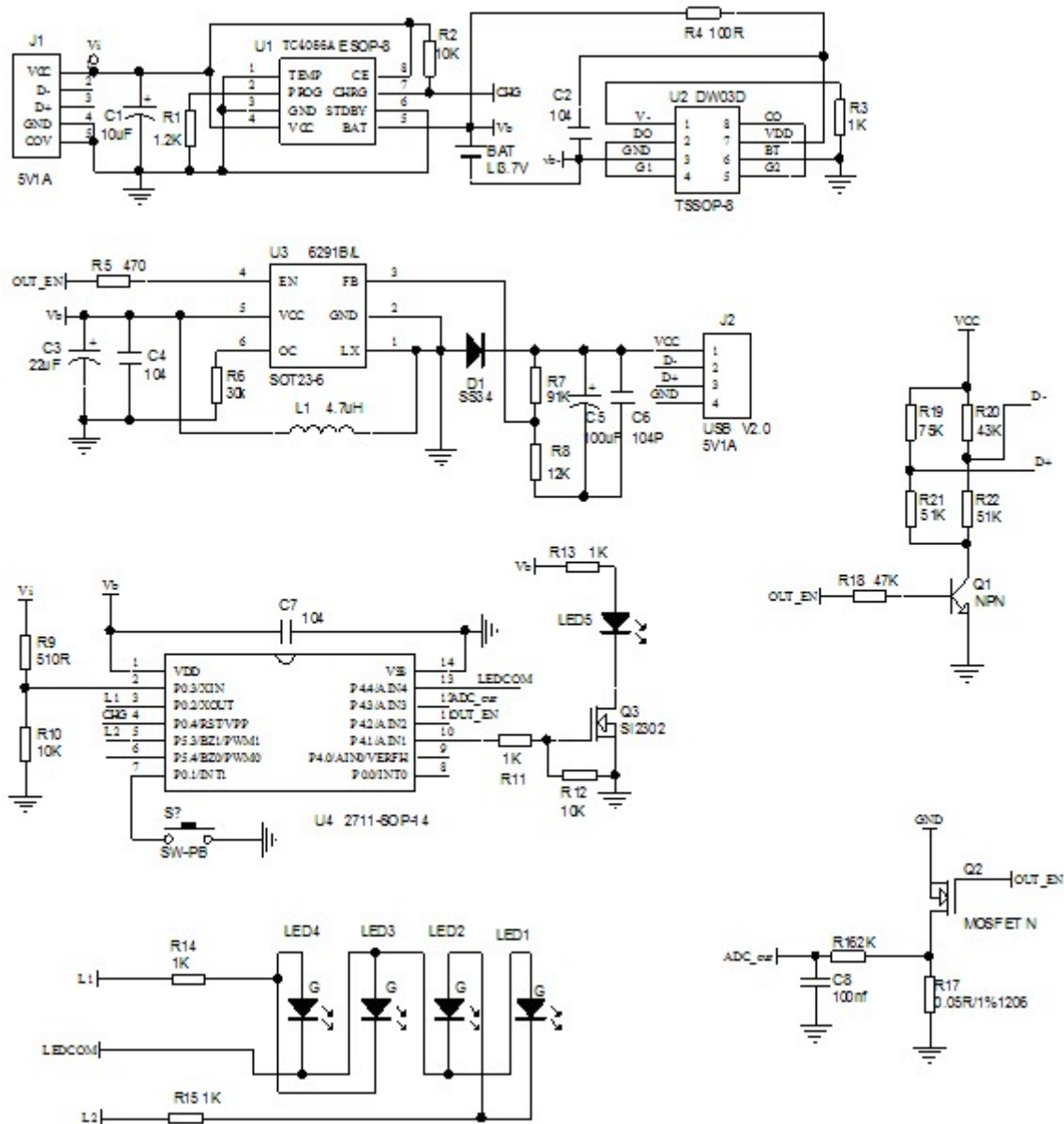
red light flashes. Note: Due to the use of 10uF Capacitance C2 Instead of a full state lithium analog, the capacitor discharges slowly filled up when the capacitor voltage becomes a threshold voltage recharging 4.05V When automatically recharged, periodically flashes the red light can be seen.

4 Analog charging end BAT Closing the terminal voltage KPR10k, KBAT-C, KBAT-R , KT-GND measuring BAT Voltage. It is the end of the charging voltage

 $4.2V \pm 1.5 \%$



1A Linear lithium ion battery charger





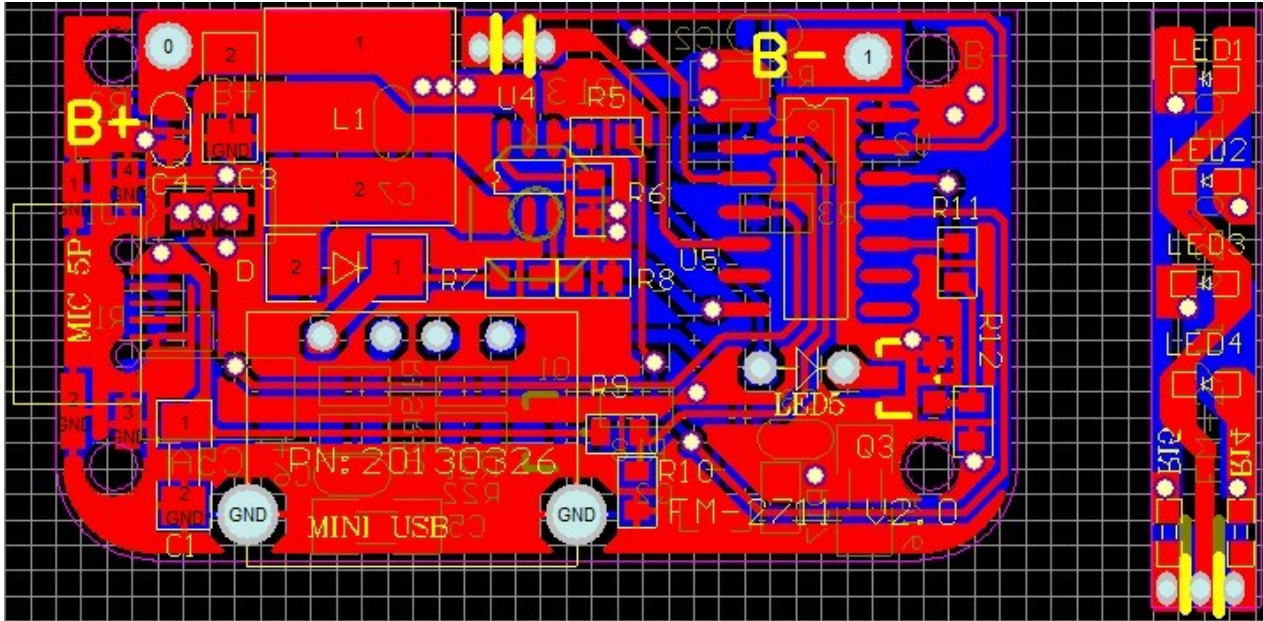
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2 , PCB Map



3 , BOM table

No.	Name element	Model & Specifications		Unit dosage		position	Remark
1	PCB	FM-2711B Vv2.0 Fiberglass panels PCS			1	21.6 * 37.7mm	
2	Chip Resistor	1.2k	5% 0603	PCS	1	R1	
3	Chip Resistor	10K	5% 0603	PCS	3	R2 / R10 / R12	
4	Chip Resistor	1K	5% 0603	PCS	5	R3 / R14 / R15 / R11 / R13	
5	Chip Resistor	100R	5% 0603	PCS	1	R4	
6	Chip Resistor	470R	5% 0603	PCS	1	R5	
7	Chip Resistor	30K	5% 0603	PCS	1	R6	
8	Chip Resistor	91K	1% 0805	PCS	2	R7	
9	Chip Resistor	12K	1% 0603	PCS	1	R8	
10	Chip Resistor	510R	5% 0603	PCS	1	R9	
11	Chip Resistor	2K	5% 0603	PCS	1	R16	
12	Chip Resistor	50mR	5% 1206	PCS	1	R17	Milliohms
13	Chip Resistor	47K	5% 0603	PCS	1	R18	
14	Chip Resistor	43K	5% 0603	PCS	1	R19	
15	Chip Resistor	75K	5% 0603	PCS	1	R20	
16	Chip Resistor	51K	5% 0603	PCS	2	R22 / R21	
17	Chip capacitors	22uF / 10V	1206 10%	PCS	3	C1 / C3 / C5	
18	Chip capacitors	104	0603 10%	PCS	5	C2 / C4C6 / C7 / C8	
19	Chip capacitors	100uF 10V 10%		PCS	1	C5A	
20	SMD LED SS34	DO-214AC		PCS	1	D1	
twenty one	SMD transistor SS8050	SOT-23		PCS	1	Q1	
twenty two	Patch IC	TC4056A	SOP-8	PCS	1	U1	



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twenty three	Patch IC	DW03D	TSSOP-8 PCS		1	U2	
twenty four	Patch IC	TC6291	SOT23-6	PCS	1	U4	
25	Patch MCU	2711B V2.0 SOP-14		PCS	1	U5	IC Confess
26	Patch N-MOS	2302	SOT-23	PCS	2	Q2 / Q3	
27	Chip inductors	3.3uH	6D38-100M PCS		1	L1	Electric current 3A
28	SMD LEDs Hair blue		0603	PCS	4	LED1-LED4	
29	led		φ 5mm White hair Baigao Liang	PCS	1	LED5	
30	SMD button switch		5.2 * 5.2 * 1.5 Touch switch	PCS	1	K	
31	Pin		3P0.7 spacing	PCS	1	led	with FM-V3
32	USB Female		Mic usb 10MM Short body	PCS	1	USB	
33	Mike female patch	patch 5P, Pin to be lengthened	PCS		1	MIC 5P	Full cover
34	Electronic wire	φ 1.5 * 40mm	red PCS		1	B +	
35	Electronic wire	φ 1.5 * 40mm	black PCS		1	B-	