ITE4035A
500mA Li-ion Battery Linear Charger

Description

The ITE4035A is a constant current/constant voltage linear charger for single-cell Li-ion batteries with excellent performance. ITE4035A adopts SOT23-5L package with less peripheral components, making it very suitable for portable products, and suitable for USB power supply and adapter power supply.

Based on the special internal MOSFET structure and anti-reverse charging circuit, the ITE4035A does not require external sense resistors and blocking diodes. When the external ambient temperature is too high or in high-power applications, thermal feedback can adjust the charging current to reduce the chip temperature. The charge voltage is fixed at 4.35V, while the charge current can be set externally with a resistor. When the charge current drops to 1/10 of the set value after reaching the final float voltage, the chip will terminate the charge cycle.

When the input voltage is disconnected, the ITE4035A goes to sleep and the battery leakage current will drop below 1uA. ITE4035A can also be set in shutdown mode, at this time the chip quiescent current is reduced to 25uA.

ITE4035A also includes other features: under voltage lockout, automatic recharge and charge status flag.

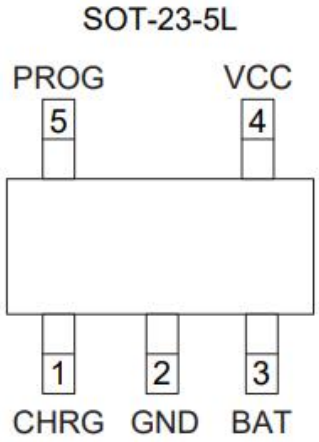
Features

- Programmable charge current up to 500mA
- No MOSFETs, sense resistors and blocking diodes required
- Small size enables fully linear charge management for Li-ion batteries
- Constant current/constant voltage operation and thermal regulation for maximum battery management without risk of overheating
- Manage Monolithic Li-Ion Batteries from USB Interface
- 4.35V Preset Charge Voltage with ±1% Accuracy
- Charge current output monitoring
- Charging status indicator
- 1/10 Charge Current Termination
- 2.9V Trickle Charge Threshold Voltage
- Soft Start Limits Inrush Current
- Battery reverse connection protection
- Battery under-voltage protection activates charging

App lications

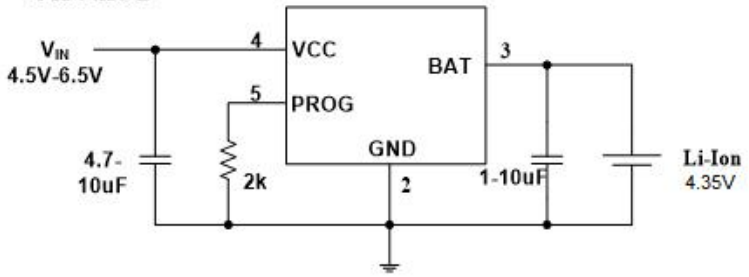
- Mobile Phone、PDA、MP3
- Bluetooth
- Single cell charger

Package Type : SOT-23-5L

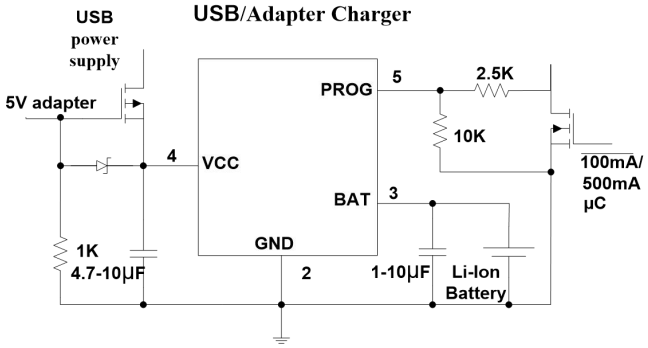


Typical Application Circuit

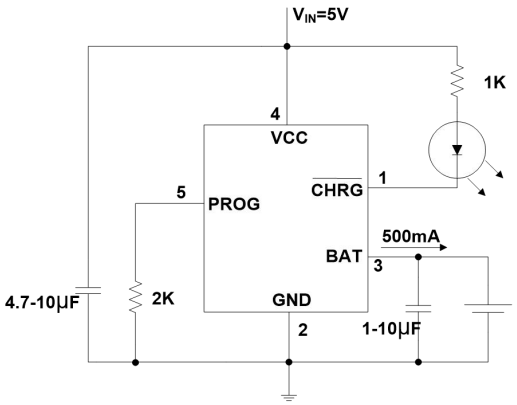
Typical Circuit 1



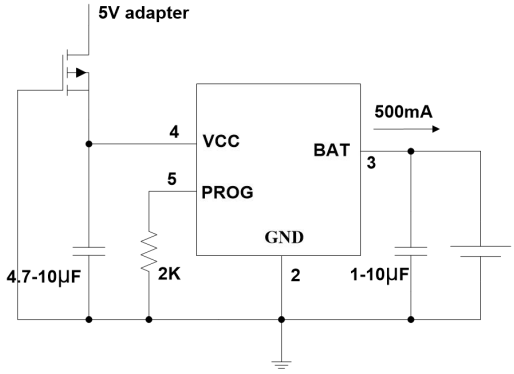
Typical Circuit 2



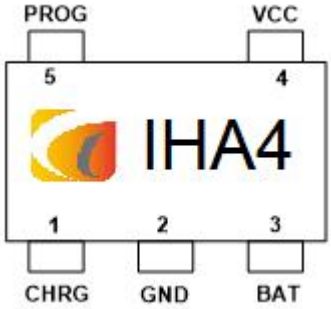
Single Cell Charger



Reverse Protection Charger



Pin Assignment



No.	Name	Description
1	CHRG	Charge state indicator
2	GND	Ground
3	BAT	Battery Voltage
4	VCC	Supply Voltage
5	PROG	CC charge current setting & monitor

Pin Function

CHRG （pin 1）：Open-Drain Charge Status Output. When charging, the CHRG port is driven low by a built-in N-channel MOSFET. When charging is complete, CHRG assumes a high impedance state. When the ITE4035A detects a low power lock condition, CHRG assumes a high impedance state. When a 1μF capacitor is connected between the BAT pin and the ground, the indication of whether the battery is connected can be completed. When there is no battery, the LED light will flash quickly.

GND（pin 2）：Ground.

BAT （pin 3）：Charge current output. Provides charging current to the battery and controls the float voltage to eventually reach 4.35V. When the battery is reversely connected, the internal protection circuit protects the ESD diode of VBAT from being burned out, and a current of about 0.7mA is formed between GND and BAT.

VCC （pin 4）：Provides a positive voltage input. Power the charger. VCC can be 4.25V to 6.5V and must have a bypass capacitor of at least 1μF. If the voltage difference between the BAT pin and VCC drops to less than 30mV, the ITE4035A enters the shutdown state and reduces the BAT current to less than 2μA.

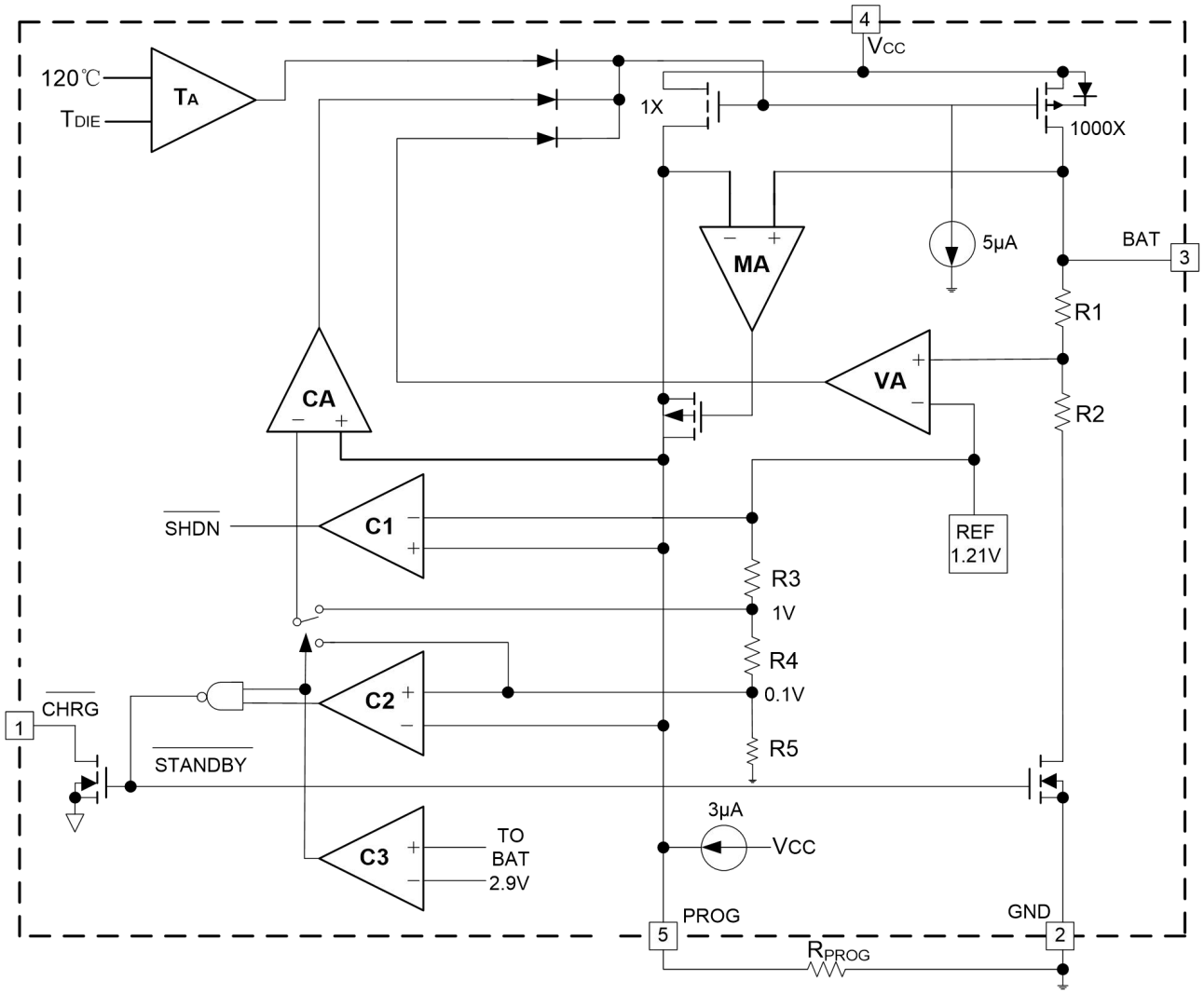
PROG（pin 5）:Charge current programming, charge current monitoring and shutdown terminals. The charge current is controlled by a 1% accurate resistor to ground on the PROG pin. In the constant charge current state, this port supplies 1V. In all states, this port voltage can be used to measure the charging current with the following formula: IBAT = (VPROG/RPROG)×1000. The PROG port can also be used to turn off the charger. Separating the programming resistor from the ground terminal can pull up the PROG port voltage through a pull-up 2μA current source. When the limit shutdown voltage value of 1.21V is reached, the acting device enters the shutdown state, the charging ends, and the input current drops to 25μA. This port pinch-off voltage is about 2.4V. Supplying this port with a voltage in excess of the pinch-off voltage will result in a high current of 1.5 mA. Combining PROG with ground will bring the charger back to normal.

Absolute Maximum Ratings (note 1)

Symbol	Parameter	Rating	Unit
V_{CC}	Input Voltage	Vss-0.3~Vss+7	V
V_{PROG}	PROG Pin Voltage	Vss-0.3~Vss+0.3	V
V_{BAT}	BAT Pin Voltage	Vss-0.3~7	V
V_{CHRG}	CHRG Pin Voltage	Vss-0.3~Vss+10	V
P_{DMAX}	Maximum Power Dissipation	250	mW
I_{BAT}	BAT Pin Current	500	mA
I_{PROG}	PROG Pin Current	800	μA
V_{ESD}	HBM ESD	4	kV
Latch-Up	Latch-up Capability	400	mA
T_{OPA}	Operating Temperature Range	-40~+85	℃
T_{STR}	Storage Temperature Range	-65~+125	℃

Note 1: Exceeding the maximum range may damage the device. The device will operate within the recommended operating range, but its characteristics are not guaranteed. The DC and AC characteristics indicated by the electrical characteristics are measured under specific conditions and their characteristics are guaranteed. This feature assumes that the device is operating within the recommended operating range. Features not shown do not guarantee performance. Typical values are best performance points.

Block Diagramb



Electrical Characteristics

Test Condition : 25℃

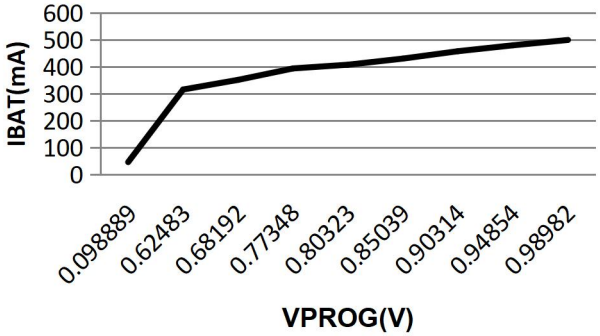
Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
V_{CC}	Input Voltage		4.2		6.5	V
I_{CC}	Input	Charge（R_{PROG}=10KΩ）（1）		240	500	μA
		Stand-by		45	90	μA
		Shunt-down（R_{PROG} not connect，V_{CC}<V_{BAT} or V_{CC}<V_{UV}）		25	50	μA
V_{FLOAT}	CV output(float) Voltage	0℃<Ta<85℃	4.3	4.35	4.393	V
I_{BAT}	BAT pin current	R_{PROG}=10K	93	100	107	mA
		R_{PROG}=2K	465	500	535	mA
		V_{BAT}=4.24V，Stand-by	0	-2.5	-6	μA
		Shunt-down		1	2	μA
		V_{BAT}= - 4V，Battery reverse		0.7		mA
		V_{CC}=0V，Sleep		0	1	μA
I_{TRIKL}	Trickle charge current	V_{BAT}<V_{TRIKL}，R_{PROG}=2K	40	50	60	mA
V_{TRIKL}	Trickle charge threshold voltage	R_{PROG}=10K，V_{BAT} rising	2.7	2.9	3.1	V
V_{TRHYS}	Trickle charge hysteresis voltage	R_{PROG}=10K	60	80	110	mV
V_{UV}	Vcc under voltage lockout threshold	V_{CC} rising	3.6	3.8	4.0	V
V_{UVHYS}	Vcc under voltage lockout threshold hysteresis		150	200	300	mV
V_{MSD}	PROG pin voltage	PROG pin rising	1.15	1.21	1.30	V
		PROG pin falling	0.9	1.0	1.1	V
V_{ASD}	V_{CC}-V_{BAT} lockout threshold	V_{CC} rising	70	100	140	mV
		V_{CC} falling	5	30	50	mV
I_{TERM}	C/10 termination current threshold	R_{PROG}=10K	0.085	0.10	0.115	mA/mA
		R_{PROG}=2K	0.085	0.10	0.115	
V_{PROG}	PROG pin voltage	R_{PROG}=10K，current mode	0.93	1.0	1.07	V
V_{CHRG}	CHRG pin output low voltage	I_{CHRG}=5mA		0.35	0.6	V
ΔV_{RECG}	Battery recharge threshold voltage	V_{FLOAT}-V_{RECHRG}		50	100	mV
t_{RECHG}	Recharge comparator filter time	V_{BAT} hige to low	0.8	1.8	4	mS
t_{TERM}	C/10 termination comparator filter time	I_{BAT} falling below I_{TERM}	0.63	1.4	3	mS
I_{PROG}	PROG pin pull-up current			2.0		μA

Notes（1）：At this time it is charging，ICC=IVCC-IBAT

（2）：C/10 termination current threshold refers to the ratio of termination current to constant current charging current

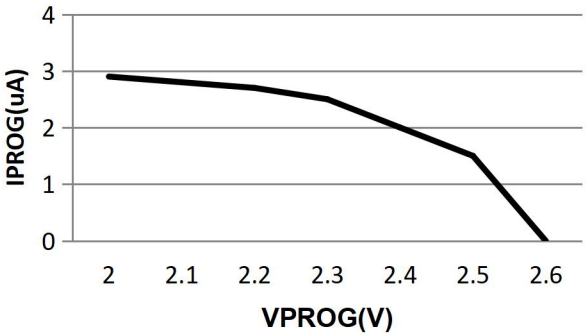
Typical Operating Characteristics

Charge Current Vsprog Pin Voltage



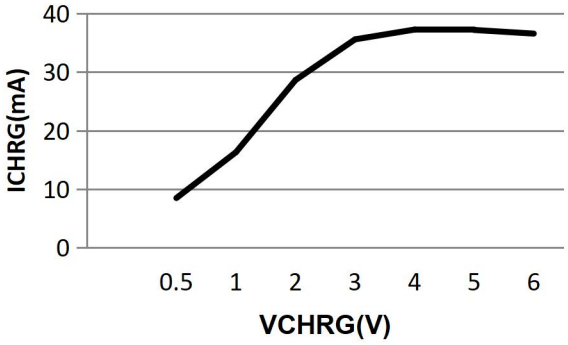
IBAT VS VPROG

PROG Pin Current VS PROG Pin Voltage(Pull-Up Current)

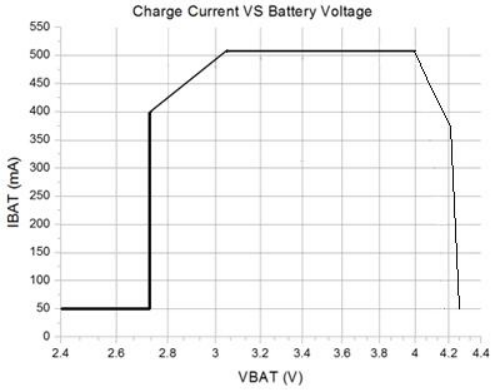


IPROG VS VPROG

CHRG Pin I-V Curve (Strong Pull-Down State)

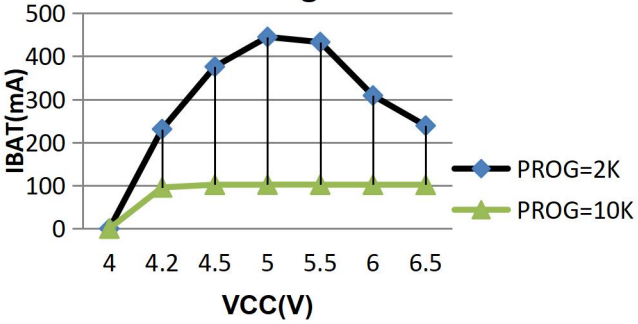


I-V Curve



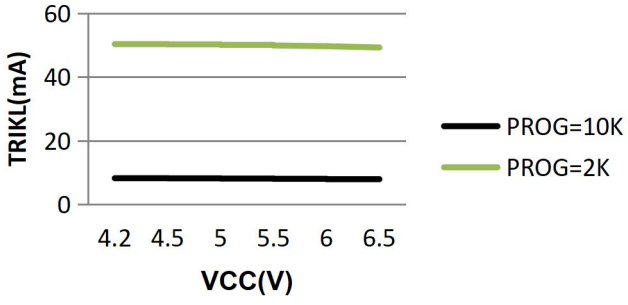
IBAT VS VBAT

Charge Current VS Supply Voltage



IBAT VS VCC

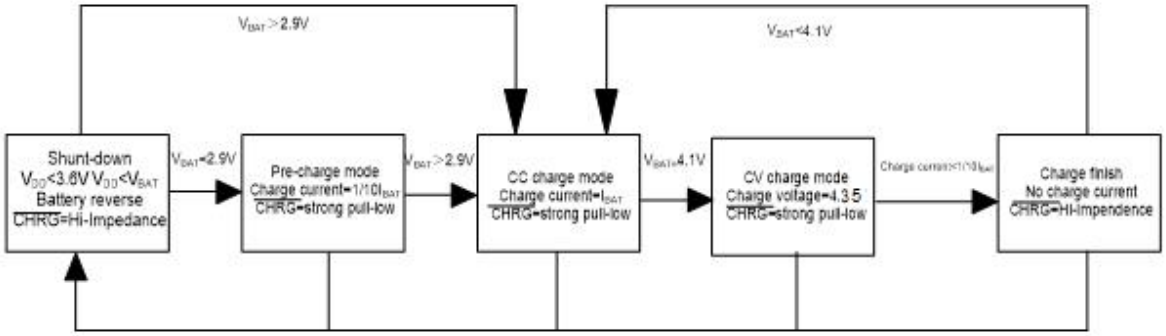
Trickle Charge Current VS Supply Voltage



TRICKLE CURRENT VS VCC

Function Description

The ITE4035A is a single-cell Li-Ion battery charger with constant current/constant voltage algorithm. It is capable of supplying a maximum charge current of around 500mA (with a good thermal design PCB layout) and an internal P-channel power MOSFET and thermal regulation circuitry. No blocking diodes or external current sense resistors are required.



Normal charge cycle

A charge cycle begins when the Vcc pin voltage rises above the UVLO threshold level and a 1% accurate set resistor is connected between the PROG pin and ground or when a battery is connected to the charger output . If the BAT pin level is lower than 2.9V, the charger enters trickle charge mode. In this mode, the ITE4035A provides about 1/10 of the set charge current in order to boost the current to a safe level for full current charging. When the BAT pin voltage rises above 2.9V, the charger enters the constant current mode, which provides a constant charging current to the battery at this time. When the BAT pin voltage reaches the final float voltage (4.35V), the constant voltage mode is entered and the charging current begins to decrease. The charging cycle ends when the charging current drops to 1/10 of the set value.

Setting of charging current

The charge current is set with a resistor connected from the PROG pin to ground. The current charging current is 1000 times the output current of the PROG pin. The setting resistor and charging current are calculated using the following equations:

$$R_{PROG} = \frac{1000V}{I_{CHG}}, I_{CHG} = \frac{1000V}{R_{PROG}}$$

The charging current output from the BAT pin can be determined at any time by monitoring the PROG pin voltage with the following formula:

$$I_{BAT} = \frac{V_{PROG}}{R_{PROG}} \bullet 1000$$

The relationship between RPROG and charging current can be determined by referring to the following table:

R_{PROG}(K)	I_{BAT}(mA)
1.4	600
2	500
2.2	400
3	300
5	200
10	100

Battery reverse polarity protection

ITE4035A has the lithium battery reverse connection protection function. The positive and negative poles of the lithium battery are reversely connected to the ITE4035A current output pin. The ITE4035A will stop and display the fault status without charging current. In the case of reverse connection, the power supply voltage should be around the standard voltage of 5V and should not exceed 8V. If the power supply voltage is too high, the voltage difference of the chip will exceed 10V when the battery voltage is reversely connected, so the power supply voltage should not be too high in the case of reverse connection.

Charge status indicator（CHRG ）

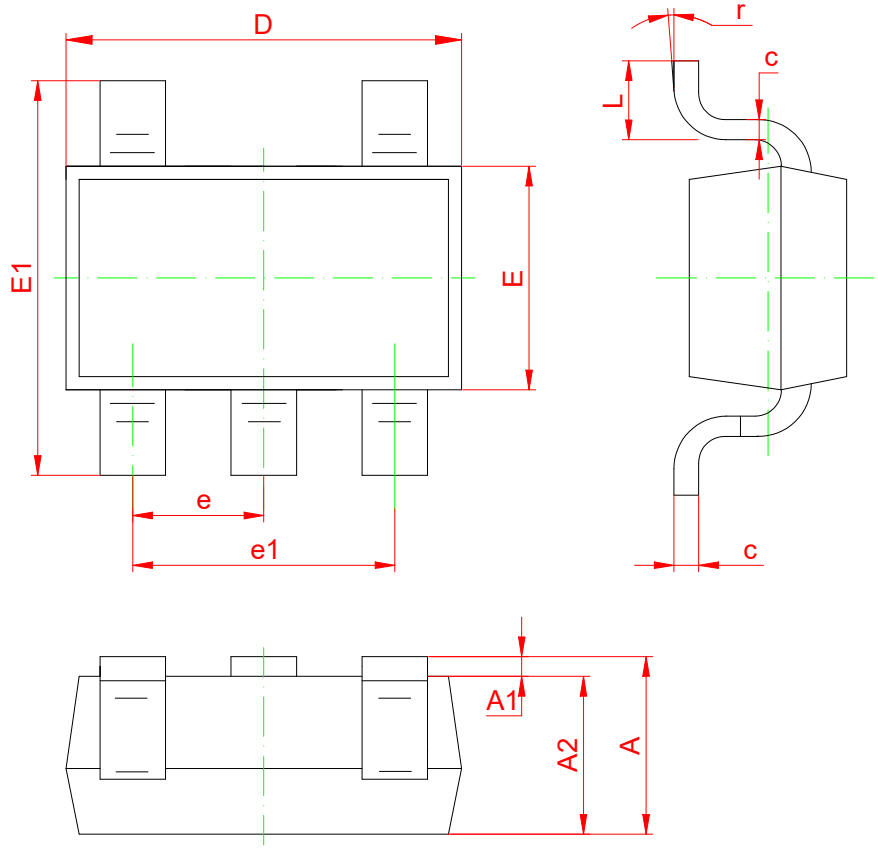
The ITE4035A has an open-drain status indication output "CHRG". When the charger is in the charging state, CHRG is pulled low, in other states, CHRG is in a high-impedance state. When the battery is not connected to the charger, the CHRG output pulse signal indicates that the battery is not installed. When the external capacitance of the BAT pin at the battery connection end is 10uF, the CHRG flashing period is about 0.5-2 seconds. When the status indication function is not used, connect the unused status indication output to ground.

With battery charge indicator status	CHRG
Normal state of charge	On
Battery fully charged	Off
The battery is reversely connected, the power supply is under voltage	Off
Power up without battery	Flicker

Thermal limitation

An internal thermal feedback loop will reduce the set charge current if the die temperature attempts to rise above a preset value of about 120° C. This feature prevents the ITE4035A from overheating and allows the user to increase the upper limit of the power handling capability of a given board without risking damage to the ITE4035A. The charging current can be set based on typical (rather than worst-case) ambient temperature, with the assurance that the charger will automatically reduce the current under worst-case conditions. Power considerations for the SOT-23-5L are discussed further in the Thermal Considerations section

Package Outline： SOT-23-5L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 (BSC)		0.037 (BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
r	0°	8°	0°	8°

- The information described herein is subject to change without notice.
- CHIPLINK Technology is not responsible for any problems caused by circuits or diagrams described hereinwhose related industrial properties, patents, or other rights belong to third parties. The application circuit examples explain typical applications of the products, and do not guarantee the success of any specific mass-production design.
- When the products described herein are regulated products subject to the Wassenaar Arrangement or other agreements, they may not be exported without authorization from the appropriate governmental authority.
- Use of the information described herein for other purposes and/or reproduction or copying without the express permission of CHIPLINK Technology is strictly prohibited.
- The products described herein cannot be used as part of any device or equipment affecting the human body, such as exercise equipment, medical equipment, security systems, gas equipment, or any apparatus installed in airplanes and other vehicles, without prior written permission of CHIPLINK Technology
- Although CHIPLINK Technology exerts the greatest possible effort to ensure high quality and reliability, the failure or malfunction of semiconductor products may occur. The user of these products should therefore give thorough consideration to safety design, including redundancy, fire-prevention measures, and malfunction prevention, to prevent any accidents, fires, or community damage that may ensue.