High charging current accuracy, low charging current chip

General Description

ME4052 is a complete constant-current/constant voltage linear charger for single cell lithium-ion batteries. With a thermally enhanced ESOP8 package on the bottom and low external component count make the ME4052 ideally suited for portable applications. Furthermore the ME4052 is specifically designed to work within USB power specifications.

ME4052 can achieve high precision charging current by detecting resistance with external current. The internal thermal feedback circuit can control the chip temperature during the charging process. The charge voltage is fixed at 8.4V, and the charge current can be programmed externally with a single resistor. The ME4052 automatically terminates the charge cycle when the charge current drops to 1.5/10th the programmed value after the final float voltage is reached.

When the input supply (wall adapter or USB supply) is removed the ME4052 automatically enters a low current state dropping the battery drain current to less than 5μA.

Other features include Battery temperature monitor, under-voltage lockout, automatic recharge and two status pins to indicate charge and charge termination.

Features

- Input voltage range：8.9~15V
- Input maximum voltage:18V
- Preset 8.4V charge voltage with ±1% accuracy
- Charge termination current detection
- Charging current accuracy：±10%
- Input removed, BAT current:< 5uA
- Automatic Recharge
- When the power supply is disconnected, it automatically goes into sleep mode
- When the battery is low, it automatically enters the trickle-flow charging mode
- Battery temperature detection
- Charging status indicator function

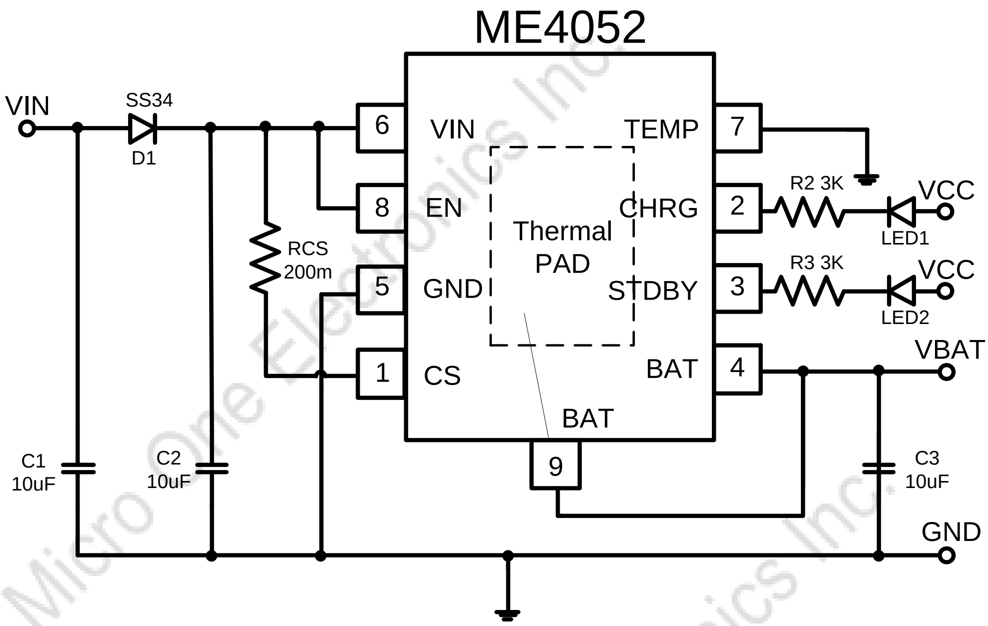
Applications

- Portable charging equipment
- Mobile power supply
- Hand-held electronic device

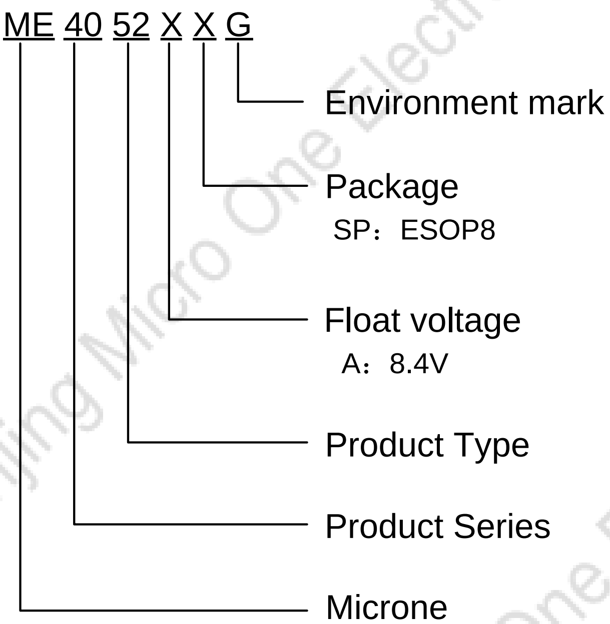
Package

- 8-pin ESOP8

Typical Application circuit



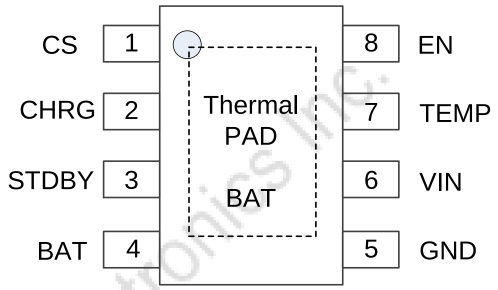
Selection Guide



product series	product description
ME4052ASPG	V_{FLOAT} =8.4V；Package：ESOP8

NOTE: If you need other voltage and package, please contact our sales staff。

Pin Configuration

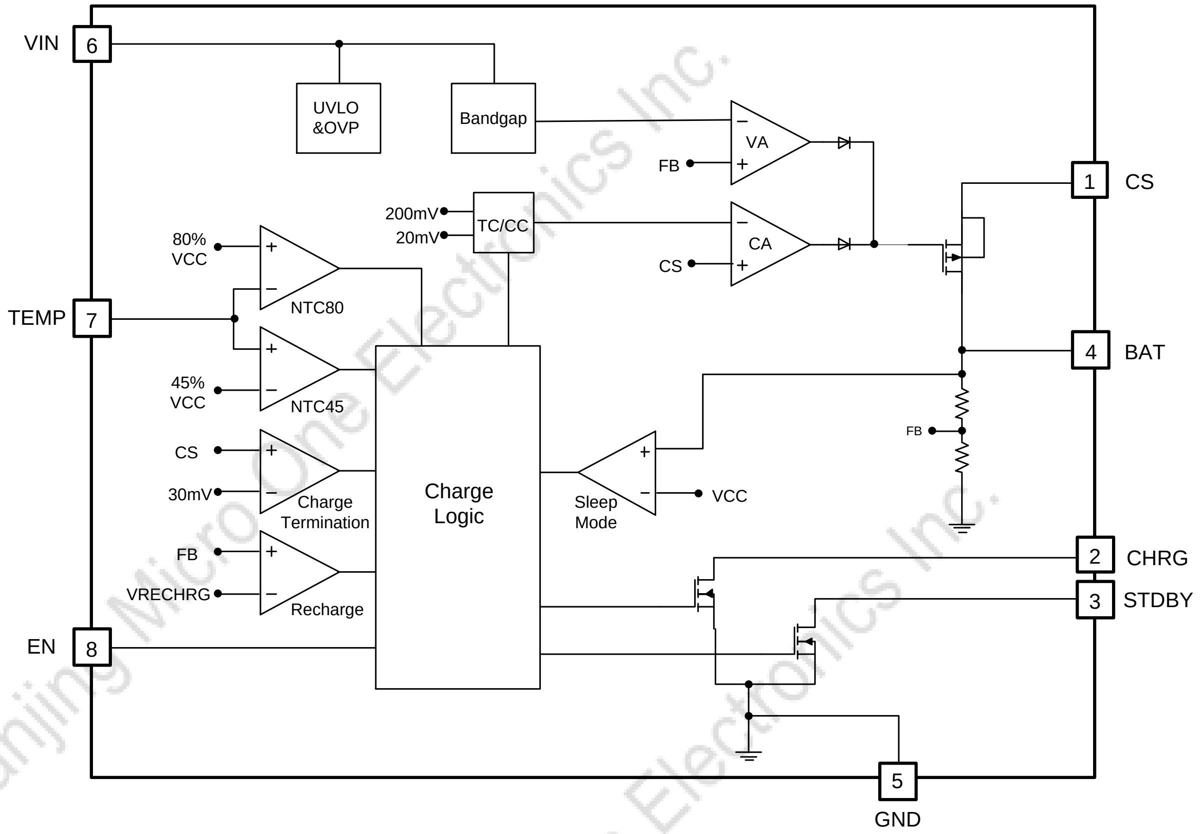


ESOP8

Pin Assignment

Pin Num.	Symbol	Function
1	CS	**Charge Current Monitor Pin** Set the charging current through the external resistance
2	CHRG	Connect the LED indicator to realize charging state output. When charging, the LED light will be on and the fully charged LED light will be off.Open drain output
3	STDBY	Connect the LED indicator to realize charging state output. When charging, the LED light is off and the fully charged LED light is on.Open drain output
4	BAT	**Battery connection Pin** BAT pin provides charge current to the battery and provides regulation voltage of 8.4V .
5	GND	**Ground**
6	VIN	**Positive input supply voltage**
7	TEMP	**Battery temperature detection** Access thermistor to realize the battery temperature detection. When this function is not used, it needs to be directly connected to GND
8	EN	**Enable pin** Connect to GND, chip off; Connect high, chip on
	Thermal PAD	**Chip cooling pad, please connect to BAT.**

Block Diagram



Absolute Maximum Ratings

Parameter	Rating	Unit
Input supply voltage : V_{CC}	-0.3～18	V
PROG pin voltage	-0.3～VCC+0.3	V
BAT pin voltage	-0.3～18	V
STDBY pin voltage	-0.3～18	V
CHRG pin voltage	-0.3～18	V
BAT pin current	1000	mA
Maximum junction temperature	-40～145	℃
Operating ambient temperature :T_{opa}	-40～85	℃
Storage temperature :T_{str}	-55～150	℃
Soldering temperature and time	+260（Recommended 10S）	℃
Package thermal impedance: θ_{JA}	63	℃/W
Maximum Power Dissipation: Pd	1.98	W

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

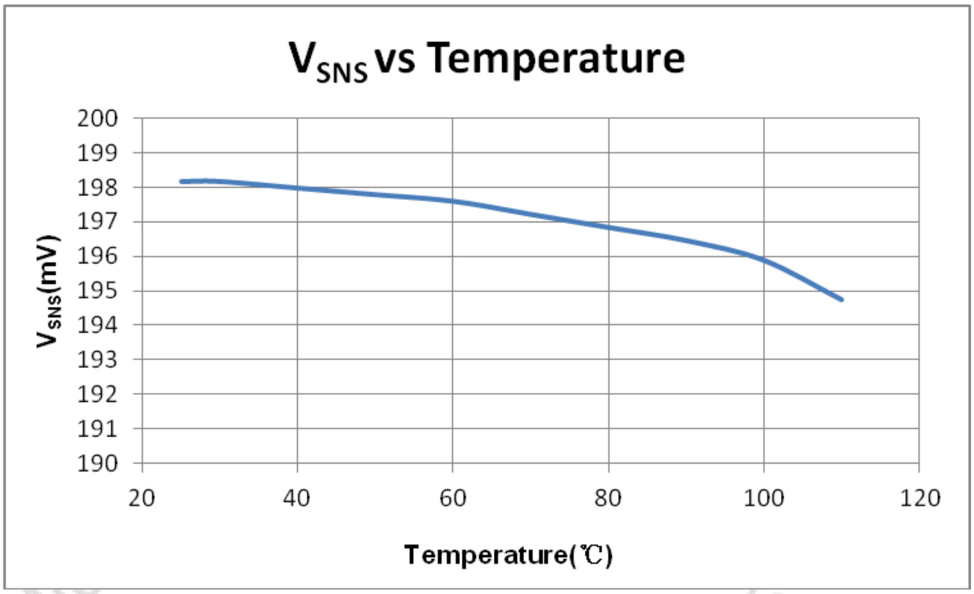
Electrical Characteristics

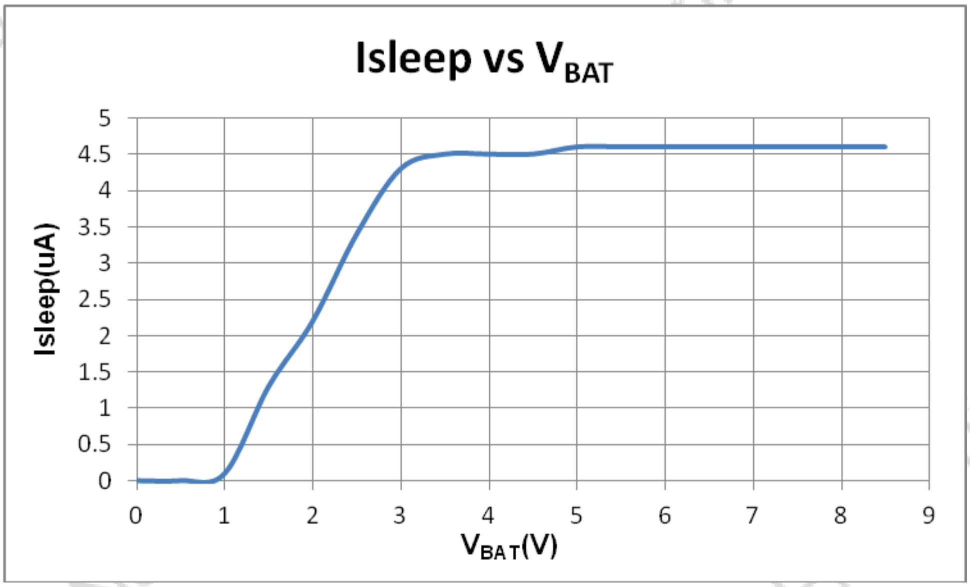
(Note: unless otherwise specified, Rprog = 4K Ω by default)

Symbol	Parameter	Condition	Min	Typ.	Max	Unit
V_{IN}	Input supply voltage	●	8.9	9	15	V
I_{IN}		●Standby mode(charge end)	-	200	-	μA
		●Shutdown mode（EN=0）	-	20	-	μA
V_{FLOAL}	Regulated output voltage	0℃≤T_A≤85℃	8.317	8.4	8.484	V
I_{BAT}	BAT pin current	Sleep mode, V_{IN}=0V	-	5	-	μA
V_{TRIKL}	Trickle charge threshold voltage	V_{BAT} rising	-	6	-	V
V_{TRHYS}	Trickle voltage hysteresis voltage		-	300	-	mV
V_{SNSC}	Constant current sampling voltage	R_{CS}=300mΩ	180	195	215	mV
V_{SNST}	Trickle sampling voltage	VBAT=5V，R_{CS}=300mΩ	8	19	30	mV
V_{TEMI}	Charging cutoff sampling voltage		20	30	40	mV
V_{UV}	V_{CC} under voltage lockout threshold	● V_{CC} from high to low	-	3.6	-	V
V_{UVHYS}	V_{CC} under voltage lockout hysteresis	●	-	100	-	mV
V_{OV}	VIN Overvoltage lock	VIN from low to high	-	15	-	V
V_{OVHYS}	VIN Over-voltage locking hysteresis		-	1.2	-	V
V_{ASD}	V_{CC}-V_{BAT} lockout threshold voltage	V_{CC} from low to high	-	150	-	mV
		V_{CC} from high to low	-	30	-	mV
V_{ENON}	EN Open voltage	EN rising	2	-	-	V
V_{ENOFF}	EN Off voltage	EN falling	-	-	0.4	V
V_{CHRG}	CHRGPin output low voltage	I_{CHRG} =5mA	-	0.3	0.6	V
V_{STDBY}	STDBYPin output low voltage	I_{STDBY}=5mA	-	0.3	0.6	V
V_{TEMP-H}	Temperature rise detection threshold	VTEMP rising	-	80	83	$\%V_{IN}$
V_{TEMP-L}	Temperature reduction detection threshold	VTEMP falling	42	45	-	$\%V_{IN}$
ΔV_{RECHRG}	Recharge battery threshold voltage	V_{FLOAT} -V_{RECHRG}	170	270	370	mV
$t_{RECHARGE}$	Recharge comparator filter time	V_{BAT} from low to high	-	1.4	-	mS
t_{TERM}	Termination comparator filter time	I_{BAT} below I_{CHG}/10	-	1.4	-	mS

Note: The ● denotes specifications which apply over the full operating temperature rang, otherwise specifications are at T_A=25℃，V_{CC}=5V，unless otherwise specified.

Typical performance characteristics





Description of the Principle

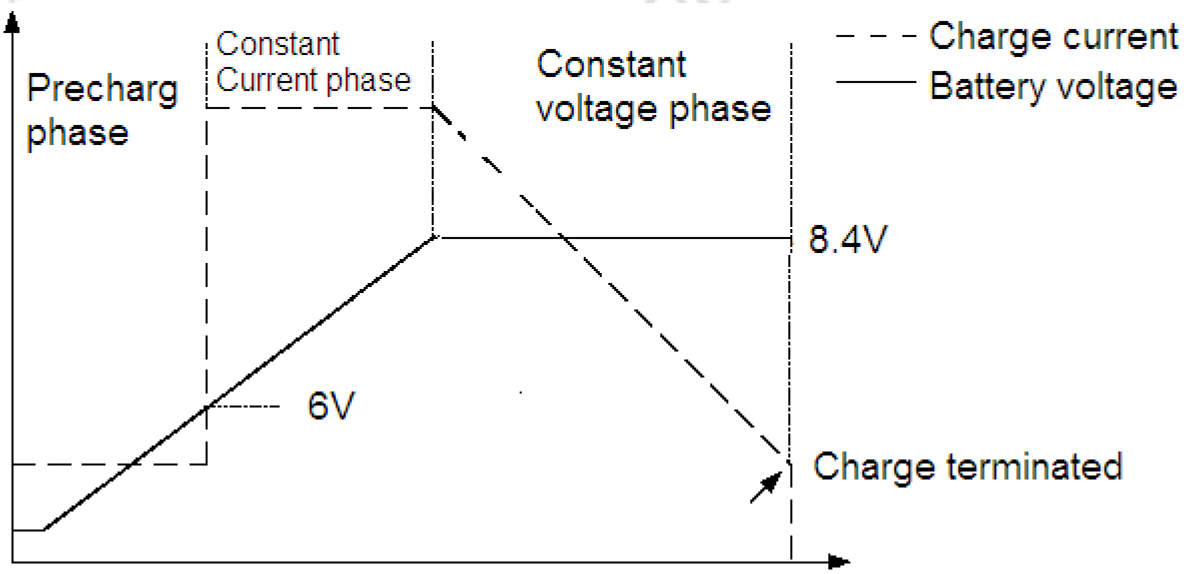
The ME4052 is a dual lithium battery charging management chip with constant voltage and current charging characteristics. Charge current range：100~1000mA . ME4052 include two Open-Drain charge status Pins: Charge status indicator CHRG and battery failure status output STDBY.

The internal thermal regulation circuit reduces the programmed charge current if the die temperature attempts to rise above a preset value of approximately 110℃. This feature protects the ME4052 from excessive temperature, and allows the user to push the limits of the power handling capability of a given circuit board without risk of damaging the ME4052 or the external components.

When the input voltage exceeds the voltage undervoltage protection threshold and enables terminals to be connected to high power, ME4052 starts to charge the battery. CHRG pin outputs a low level, indicating that charging is in progress. If the battery voltage is lower than 5.6V, the charger precharges the battery with a small current.When the battery voltage exceeds 6V, switch to the constant current mode to charge the battery. The charging current is determined by the resistance between CS pin and GND.When the battery voltage is close to 8.4V, the charging current gradually decreases.When the current decreases to the charging end threshold (1.5/10 of the constant current current), the charging cycle ends, the CHRG terminal outputs a high resistance state, and STDBY outputs a low potential.

When the battery voltage drops below the recharging threshold, a new charging cycle is automatically started.The high precision voltage reference source, error amplifier and resistance voltage divider network inside the chip ensure the voltage precision of the battery terminal modulation is within 1%.Meet the requirements of lithium ion battery and lithium polymer battery.When the input voltage drops or falls below the battery voltage, the charger goes into sleep mode.The leakage current at the battery end is as low as 5uA, thus increasing standby time.If the enable terminal is low, the chip will stop charging.

The charging profile is shown in the following figure:



Programming charge current

The charging current is set using a resistor connected to the CS pin and the VIN.The formula for setting the resistor and charging current is as follows

$$I_{BAT}=195mV/R_{CS}$$

Charge termination

A charge cycle is terminated when the charge current falls to 1.5/10th the programmed value after the final float voltage is reached. This condition is detected by using an internal filtered comparator to monitor the CS pin. When the CS pin voltage falls below 30mV for longer than t_{TEMP} (typically 1.4ms), Charging is terminated. The charge current is latched off and the ME4052 enters standby mode, where the input supply current drops to 180μA (Note:C/10 termination is disabled in trickle charging and thermal limiting modes).

In standby mode, ME4052 continuously monitors the voltage of BAT pins. If the pin voltage drops below the recharging threshold of 8.13V, another charging cycle begins to supply current to the battery again.

Charge status indicator

The ME4052 has two leaky open-circuit status indicating the output, CHRG and STDBY. When the charger is charging, CHRG is pulled to a low level, and in other states the CHRG is in a high resistance state. When the battery temperature is outside the temperature range, both CHRG and STDBY pins output high resistance states. When TEMP pins are in use, when TEMP approaches the flip threshold of COLD(80%VIN) or HOT(45%VIN), the charging current switch decreases and the charging indicator gradually changes from on to off.

When the typical TEMP connection is not available and the battery is not charged, the fault state is indicated: CHRG and STDBY pins both output high resistance states. When TEMP is grounded, the battery temperature detection does not work. When the battery is not connected to the charger, CHRG outputs a pulse signal, indicating that the battery is not installed. When the external capacitor of battery connected BAT pin is 10uF, the CHRG flashing frequency is about 1~4 seconds. When the state indicator function is not used, the input end of the state indicator is connected to the ground.

charger's status	Red led CHRG	Green led STDBY
Charging	light	dark
Battery in full state	dark	light
Under pressure, over pressure, etc	dark	dark
BAT pin is connected to 10μF capacitor， No battery mode (TEMP=GND)	Green LED bright, Red LED flicker （At this time, reverse-battery, the light does not shine, this phenomenon is normal. Such a case, after the battery is properly connected to the indicator light back to light and flicker.）	

Thermal limiting

An internal thermal feedback loop reduces the programmed charge current if the die temperature attempts to rise above a preset value of approximately 110℃. The feature protects the ME4052 from excessive temperature and allows the user to push the limits of the power handling capability of a given circuit board without risk of damaging the ME4052. The charge current can be set according to typical (not worst-case) ambient temperature with the assurance that the charger will automatically reduce the current in worst-case conditions.

Under Voltage lockout (UVLO)

An internal under voltage lockout circuit monitors the input voltage and keeps the charger in shutdown mode until VCC rises above the under voltage lockout threshold . If the UVLO comparator is tripped, the charger will not come out of shutdown mode until VCC rises 120mV above the battery voltage.

Manual terminate

The ME4052 can be stopped at any time during the charging cycle by setting EN pin to low level.This makes the battery leakage current below 5uA and the power current below 20uA.Reset the EN pin to high level to start a new charging cycle.

If the ME4052 is in undervoltage locked mode, the CHRG and STDBY pins are in a high impedance state.

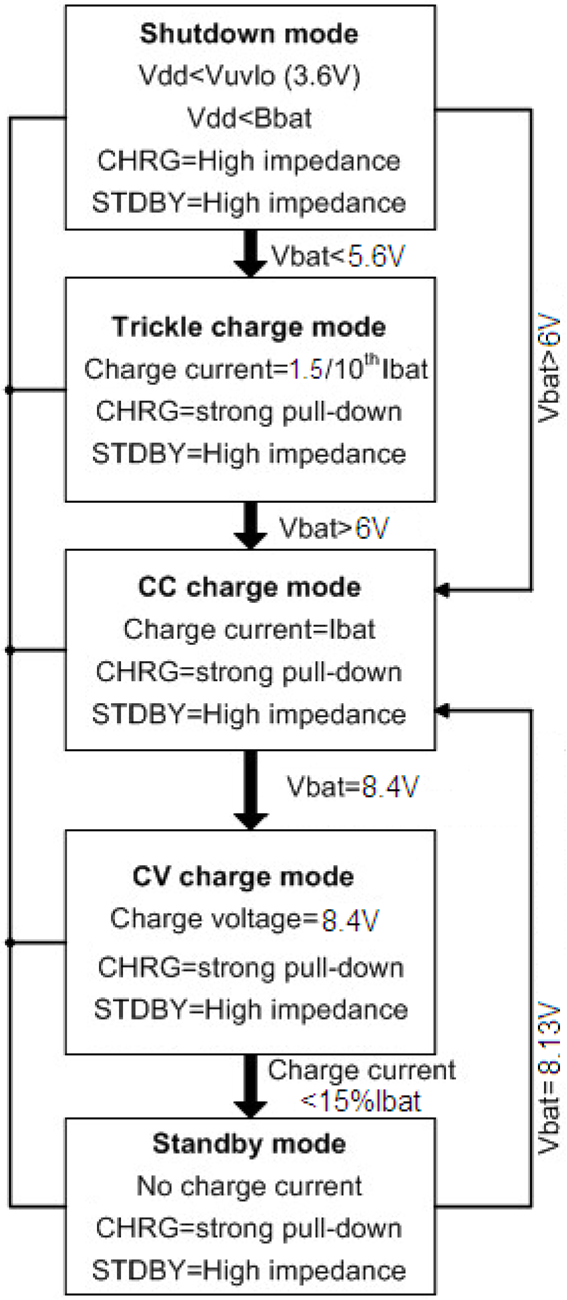


Fig.1 State diagram of a typical charge cycle

Auto restart

Once charge is been terminated, ME4052 immediately use a 1.4ms filter time（ $t_{RECHARGE}$ ）on the termination comparator to constant monitor the voltage on BAT pin. If this voltage drops below the 8.13V recharge threshold (about between 80% and 90% of VCC), another charge cycle begins. This ensured the battery maintained (or approach) to a charge full status and avoid the requirement of restarting the periodic charging cycle. In the recharge cycle, CHRG pin enters a pulled down status.

Power dissipation

The conditions that cause the ME4052 to reduce charge current through thermal feedback can be approximated by considering the power dissipated in the IC. Nearly all of this power dissipation is generated by the internal MOSFET-this is calculated to be approximately:

$$P_D = \left(V_{CC} - V_{BAT}\right) \times I_{BAT}$$

PD is the dissipated power, VIN is the input power voltage, VBAT is the battery voltage, and IBAT is the charging current. When the thermal feedback reduces the charging current, the voltage on the CS pin will decrease proportionately. Remember not to consider the worst thermal conditions in the DESIGN of the ME4052 application, as the chip will automatically reduce power consumption when TJ reaches 110℃.

V_{IN} bypass capacitor

Many types of capacitors can be used for input bypassing, however, caution must be exercised when using multilayer ceramic capacitors. Because of the self-resonant and high Q characteristics of some types of ceramic capacitors, high voltage transients can be generated under some start-up conditions, such as connecting the charger input to a live power source. Adding a 1.5Ω resistor in series with a ceramic capacitor will minimize start-up voltage transients.

Charging Current Soft Start

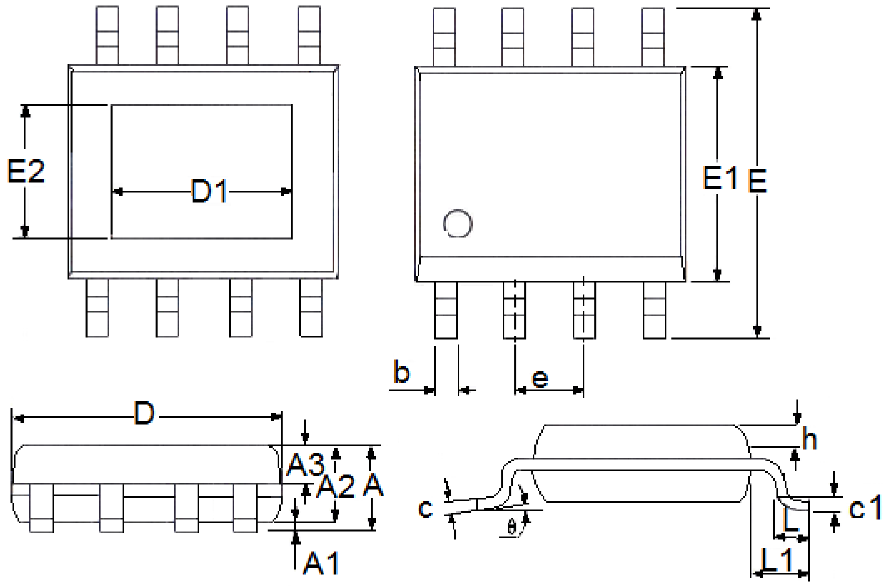
ME4052 includes a soft start circuit which used to maximize to reduce the surge current in the begging of charge cycle. When restart a new charge cycle, the charging current ramps up from 0 to the full charging current within 20μs. In the start process it can maximize to reduce the action which caused by surge current load.

Board Layout Considerations

- R_{PROG} at PROG pin should be as close to ME4052 as possible, also the parasitic capacitance at PROG pin should be kept as small as possible.
- The capacitance at V_{CC} pin and BAT pin should be as close to ME4052 as possible.
- During charging, ME4052's temperature may be high, the NTC thermistor should be placed far enough to ME4052 so that the thermistor can reflect the battery's temperature correctly.
- It is very important to use a good thermal PC board layout to maximize charging current. The thermal path for the heat generated by the IC is from the die to the copper lead frame through the package lead (especially the ground lead) to the PC board copper, the PC board copper is the heat sink. The footprint copper pads should be as wide as possible and expand out to larger copper areas to spread and dissipate the heat to the surrounding ambient. Feed through vias to inner or backside copper layers are also useful in improving the overall thermal performance of the charger. Other heat sources on the board, not related to the charger, must also be considered when designing a PC board layout because they will affect overall temperature rise and the maximum charge current.
- The ability to deliver maximum charge current under all conditions require that the exposed metal pad on the back side of the ME4052 package be soldered to the PC board ground. Failure to make the thermal contact between the exposed pad on the backside of the package and the copper board will result in larger thermal resistance.

Packaging Information

- **Packaging Type: ESOP8**



DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	1.3	1.75	0.0512	0.0689
A1	0	0.2	0.0000	0.0079
A2	1.25	1.65	0.0492	0.0650
A3	0.5	0.7	0.0197	0.0276
b	0.33	0.51	0.0130	0.0201
c	0.17	0.25	0.0067	0.0098
D	4.7	5.1	0.1850	0.2008
E	5.8	6.2	0.2283	0.2441
E1	3.8	4	0.1496	0.1575
e	1.27(TYP)		0.05(TYP)	
h	0.25	0.5	0.0098	0.0197
L	0.4	1.27	0.0157	0.0500
L1	1.04(TYP)		0.0409(TYP)	
θ	0	8°	0.0000	8°
c1	0.25(TYP)		0.0098(TYP)	
D1	3.1(TYP)		0.122(TYP)	
E2	2.21(TYP)		0.087(TYP)	