Standalone 1.8A Li-Lon Switch Mode Battery Charger ME4069

ME4069 General Description

The ME4069 is a complete battery charger controller for one (4.2V) cell lithium-ion battery. The ME4069 provides a small, simple and efficient solution to fast charge Li-ion battery. An external sense resistor sets the charge current with high accuracy. An internal resistor divider and precision reference set the final float voltage to 4.2V per cell with ±1% accuracy. When the input supply is removed, the ME4069 automatically enters a low current sleep mode, dropping the battery drain current to 1μA.After the charge cycle ends, If the battery voltage drops below 4.1V per cell, a new charge cycle will automatically begin.

ME4069 Features

- Input Supply Range: 4.7V~5.5V
- High Efficiency Current Mode PWM Controller
- End Charge Current Detection Output
- Constant Switching Frequency for Minimum Noise
- Preset 4.2V charge voltage with ±1% accuracy
- Automatic Recharge
- Automatic Shutdown When Input Supply is Removed
- Automatic Trickle Charging of Low Voltage
- Stable with Ceramic Output Capacitor
- Battery Temperature Sensing

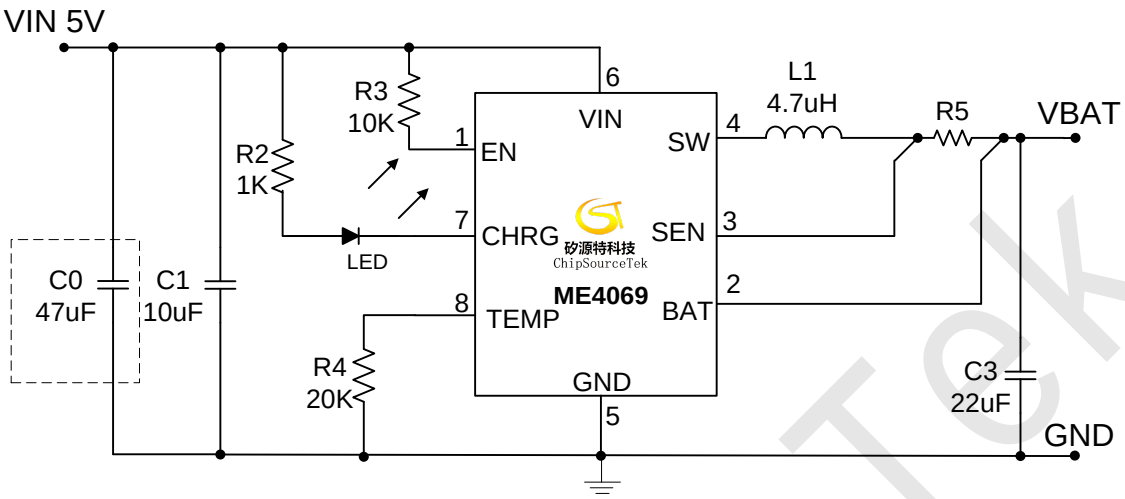
ME4069 Typical Applications

- Charging Docks
- Handheld InstrumenTEMP
- Portable Computers

ME4069 Package

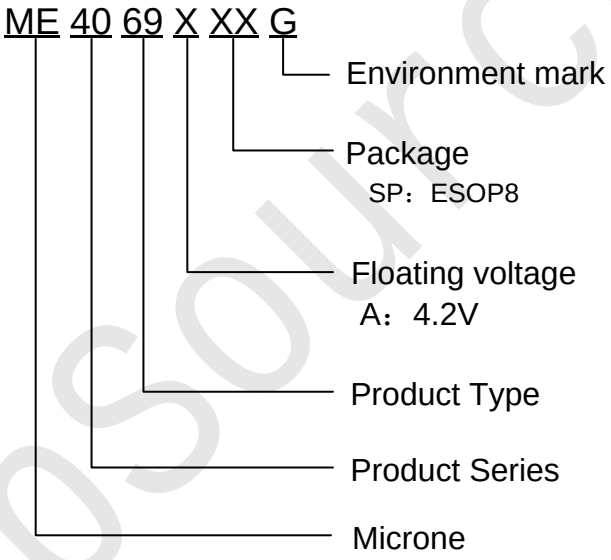
- 8-pin ESOP8

ME4069 Typical Application Circuit



Note: C0 in the dotted box is the electrolytic capacitor, which needs to be added in the input hot plug application.

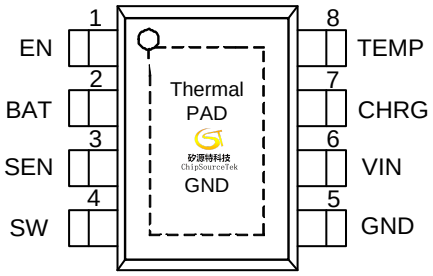
ME4069 Selection Guide



product series	product description
ME4069ASPG	V_{FLOAT} =4.2V；Package type：ESOP8

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

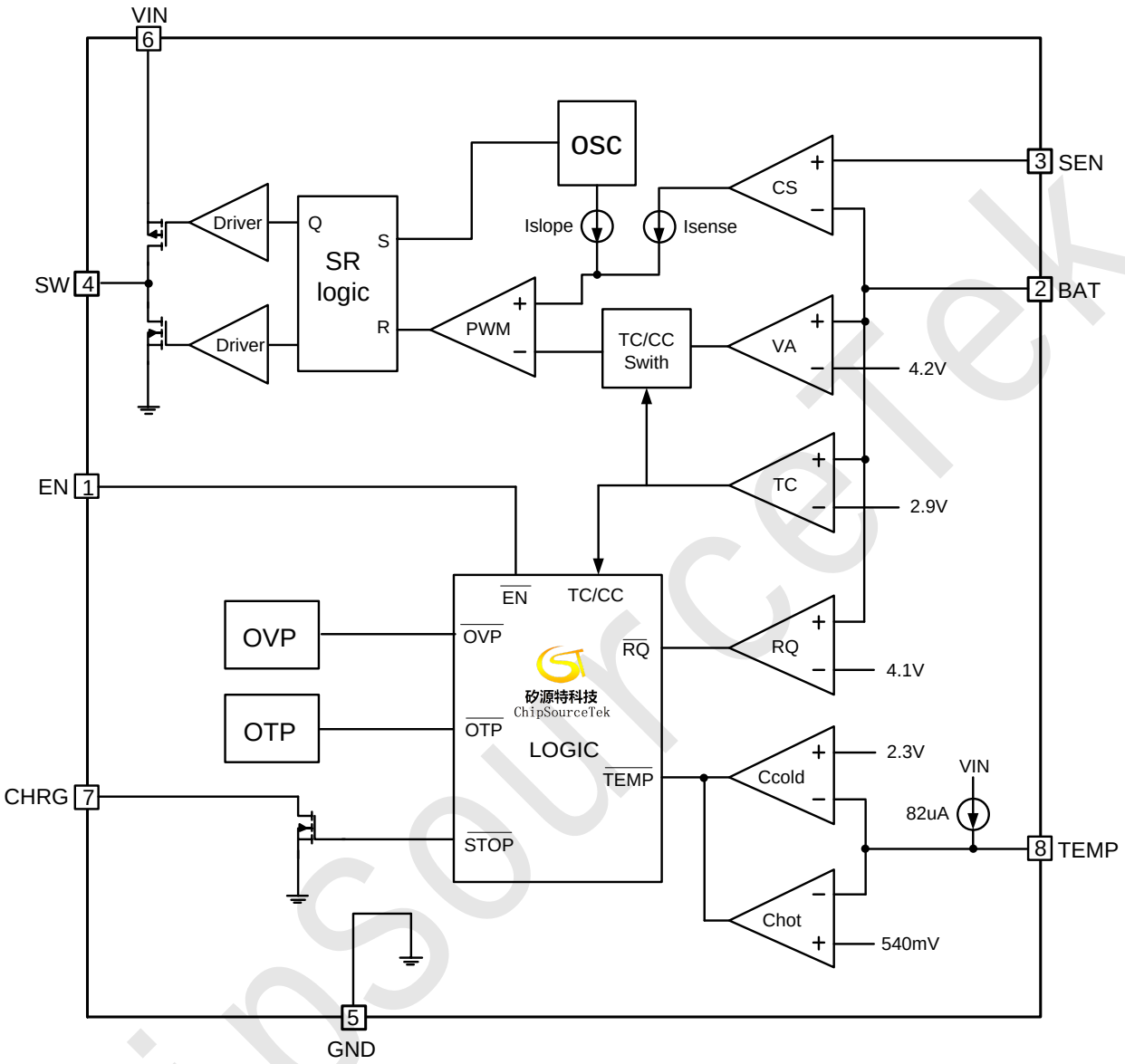
ME4069 Pin Configuration



ME4069 Pin Assignment

Pin Num.	Symbol	Function
1	EN	ON/OFF Control
2	BAT	Feedback Pin. Receives the feedback voltage from an external resistor across the output.
3	SEN	Charge Current program. The output current is set by an external resistor according to the following formula: I_{OUT}= 100mV/R5.
4	SW	Charge Current Output.
5、Thermal PAD	GND	Ground
6	VIN	Positive Supply Voltage Input. VIN can range from 4.7V to 5.5V. A 10μF low ESR capacitor is required at the source pins of the power P-channel MOSFET.
7	CHRG	When the charge current drops below the End-of-Charge threshold for more than 120μs, the N-channel MOSFET turns off and a weak current source is connected from the CHRG pin to GND. When the input supply is removed, the weak current source is turned off and the CHRG pin becomes high impedance.
8	TEMP	Temperature sense. TEMP Thermistor Input. With an external 20KΩ, negative temperature coefficient thermistor to ground, this pin senses the temperature of the battery pack and stops the charger when the temperature is out of range. When the voltage at this pin drops below 540mV at hot temperature or rises above 2.3V at cold temperature, charging is suspended and the internal timer stops. The CHRG pin output is not affected during this hold state. To disable the temperature qualification function, ground the TEMP pin.

ME4069 Block Diagram



ME4069 Absolute Maximum Ratings

Parameter	Rating	Unit
VIN, CHRG, SW, SEN Voltage	-0.3～6	V
SW Pin Current	3.8	A
Thermal resistance(Junction to air)	60	ºC /W
Continuous Total Power Dissipation	2.0	W
Operating Ambient Temperature Range	-40～85	℃
Maximum junction temperature	-40～150	℃
Storage temperature :range	-55～150	℃
Soldering temperature and time	+300（Recommended 10S）	℃

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.

ME4069 Electrical Characteristics

Operating Conditions: TA=25℃,VIN=5V, R5 = 0.1Ω,unless otherwise specified

Symbol	Parameter	Condition	Min	Typ.	Max	Unit
VIN	Input supply voltage		4.7	5.0	5.5	V
I_{IN}	static current		-	350	-	μA
I_{BAT}	BAT pin current	Sleep mode	-	0	1	μA
V_{FLOAT}	Battery Regulated Float voltage	0℃≤T_A≤85℃, I_{OUT}=1.5A	4.158	4.20	4.242	V
$V_{SNS(CHR)}$	Constant Current Sense Voltage	3V≤V_{BAT}≤4V	90	100	110	mV
$V_{SNS(TRKL)}$	Trickle Current Sense Voltage	V_{BAT}=2.7V	-	10	-	mV
V_{CHTM}	Charging cut-off sampling voltage		5	-	20	mV
V_{TRKL}	Trickle Charge Threshold voltage	V_{BAT} Rising	-	2.9	-	V
V_{ASD}	Automatic Shutdown Threshold voltage	VIN-V_{BAT}	-	100	-	mV
I_{TEMP}	TEMP Pin Output Current	V_{TEMP}=0.85V	-	82	-	μA
V_{TH-HOT}	TEMP Pin Threshold Voltage (Hot)	V_{TEMP} Falling	-	0.52	-	V
$V_{TH-COLD}$	TEMP Pin Threshold Voltage (Cold)	V_{NTC} Rising	-	2.3	-	V
OVP	Over voltage protection	VIN Rising	-	6.0	-	V
OVPhys	Overvoltage protection voltage hysteresis	VIN Falling	-	150	-	mV
ΔV_{RECHRG}	Recharge battery voltage Offset from Full Charged Battery Voltage	V_{FLOAT} -V_{RECHRG}, V_{BAT} Falling	50	-	200	mV
f_{OSC}	Switching Frequency		650	750	850	KHz
Dutymax	Maximum Duty Cycle		-	-	100	%
Tsd	Thermal Shutdown			150	-	°C
Tsd_hys	Thermal Shutdown hysteresis		-	30	-	°C

ME4069 Description of the Principle

The ME4069 is a constant current, constant voltage Li-Ion battery charger controller that uses a current mode PWM step-down (buck) switching architecture. The charge current is set by an external sense resistor (R5) across the SEN and BAT pins. The final battery float voltage is internally set to 4.20V. For batteries like lithium-ion that require accurate final float voltage, the internal reference, voltage amplifier and the resistor divider provide regulation with high accuracy.

A charge cycle begins when the voltage at the VIN pin is greater than the battery voltage 100mV. At the beginning of the charge cycle, if the battery voltage is less than the trickle charge threshold, the charger goes into trickle charge mode. The trickle charge current is internally set to 10% of the full-scale current. When the battery voltage exceeds the trickle charge threshold, the charger goes into the full-scale constant current charge mode. In constant current mode, the charge current is set by the external sense resistor R5 and an internal 100mV reference; I_{OUT}= 100mV/R5.

When the battery voltage approaches the programmed float voltage, the charge current will start to decrease. When the current drops to 10% of the full-scale charge current, an internal comparator turns off the internal pull-down N-channel MOSFET at the CHRG pin, and connects a weak current source to ground to indicate a end-of-charge condition and then the charge cycle is terminated and the CHRG pin is forced high impedance. To restart the charge cycle, remove and reapply the input voltage or momentarily shut the charger down. Also, a new charge cycle will begin if the battery voltage drops below the recharge threshold voltage. When the input voltage is present, the charger can be shut down. When the input voltage is not present, the charger goes into sleep mode. This will greatly reduce the current drain on the battery and increase the standby time.

A 20KΩ TEMP (negative temperature coefficient) thermostat can be connected from the TEMP pin to ground for battery temperature qualification.

ME4069 Functional Description

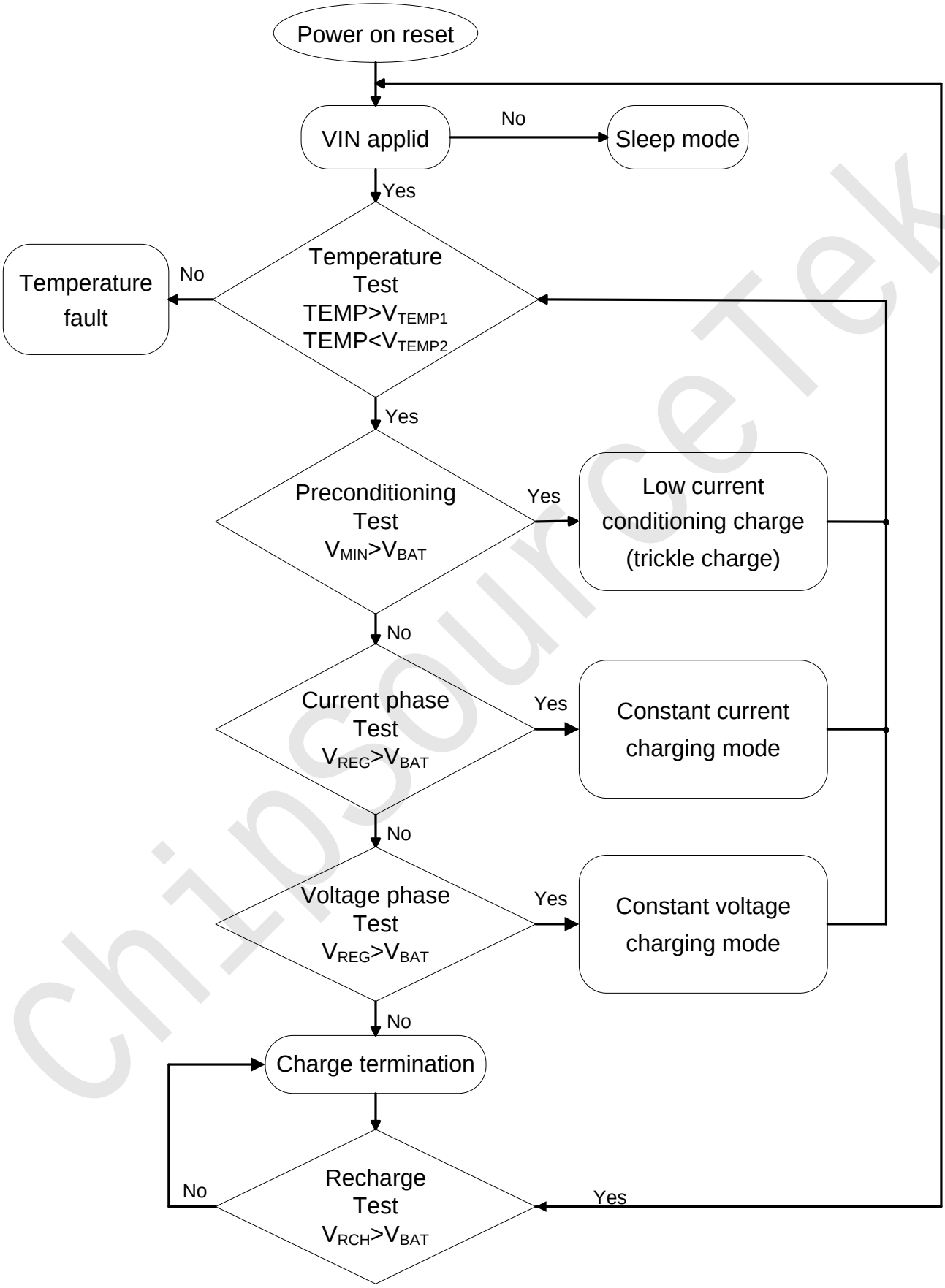


Fig. 1: Operation Flow Chart

Qualification and Precharge

The ME4069 suspends charge if the battery temperature is outside the V_{TEMP1} to V_{TEMP2} range and suspends charge until the battery temperature is within the allowed range. The ME4069 also checks the battery voltage. If the battery voltage is below the precharge threshold V(min) , the ME4069 uses precharge to condition the battery. The conditioning charge rate $I_{(PRECHG)}$ is set at approximately 10% of the regulation current. See Fig.2 for a typical charge-profile.

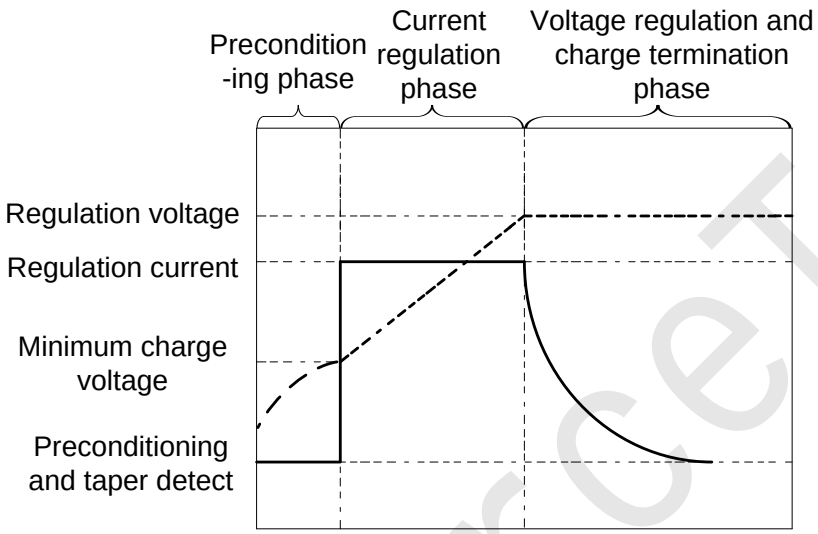


Fig. 2: Typical Charge Profile

Charge Termination Recharge

The ME4069 monitors the charging current during the voltage-regulation phase. The ME4069 declares a done condition and terminates charge when the current drops to the charge termination threshold A new charge cycle begins when the battery voltage falls below 4.1V(4.2Vproduct).

Battery Temperature Monitoring

A negative temperature coefficient (NTC) thermostat located close to the battery pack can be used to monitor battery temperature and will not allow charging unless the battery temperature is within an acceptable range. Connect a 20KΩ thermostat from the TEMP pin to ground. With the 82μA pull-up current source, the Hot temperature voltage threshold is 540mV. For Cold temperature, the voltage threshold is set at 2.3V with 82μA of pull-up current. The charge cycle begins or resumes once the temperature is within the acceptable range.

Charge Status Indication

The ME4069 reports the status of the charge on the CHRG pin. The following Table 1 summarized the operation of the CHRG pin. The CHRG pin can be used to drive a chip LED.

Table 1

Condition	CHRG pin
Battery conditioning and charging	Low
Charge complete(done)	Hi-Z
Temperature fault or sleep mode	Hi-Z

Automatic Shutdown Voltage (VASD)

Differential input voltage and VBAT is less than 100 mV, IC will enter shutdown mode.

Trickle Charge

At the beginning of a charge cycle, if the battery voltage is below the trickle charge threshold, the charger goes into trickle charge mode with the charge current reduced to 10% of the full-scale current.

Shutdown

The ME4069 can be shut down by pulling the EN pin to ground. In shutdown, the output of the CHRG pin is high impedance and the quiescent current remains at 18μA.

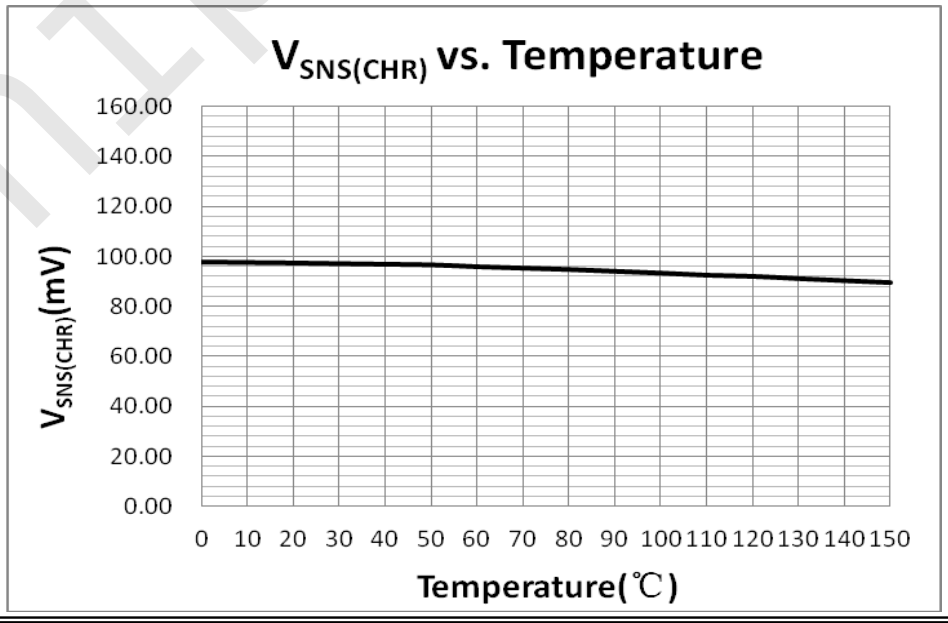
Input and Output Capacitors

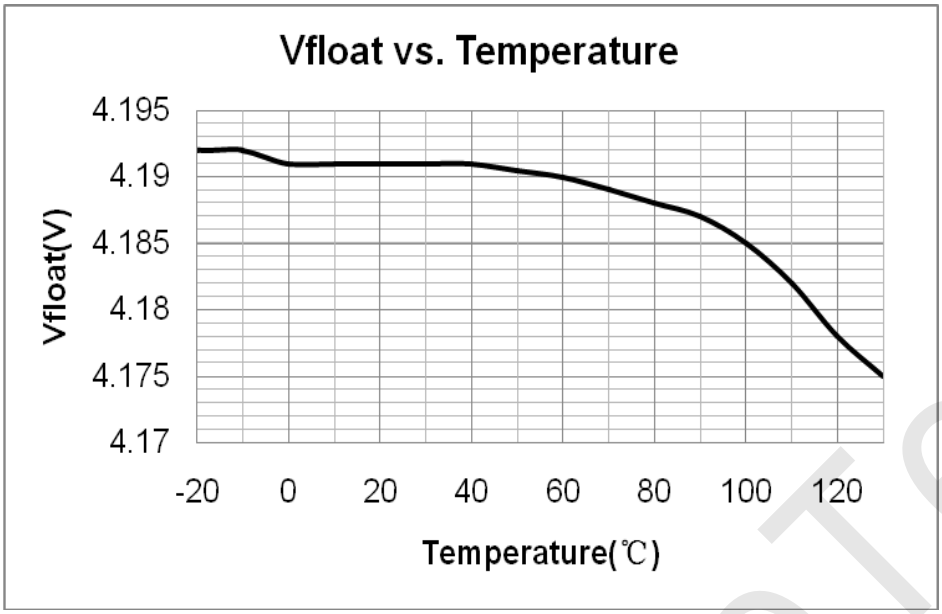
Since the input capacitor is assumed to absorb all input switching ripple current in the converter, it must have an adequate ripple current rating. Worst-case RMS ripple current is approximately one-half of output charge current. Actual capacitance value is not critical. Solid tantalum capacitors have a high ripple current rating in a relatively small surface mount package, but caution must be used when tantalum capacitors are used for input bypass. High input surge currents can be created when the adapter is hot-plugged to the charger and solid tantalum capacitors have a known failure mechanism when subjected to very high turn-on surge currents. Selecting the highest possible voltage rating on the capacitor will minimize problems. Consult with the manufacturer before use. The selection of output capacitor COUT is primarily determined by the ESR required to minimize ripple voltage and load step transients. The output ripple ΔVOUT is approximately bounded by:

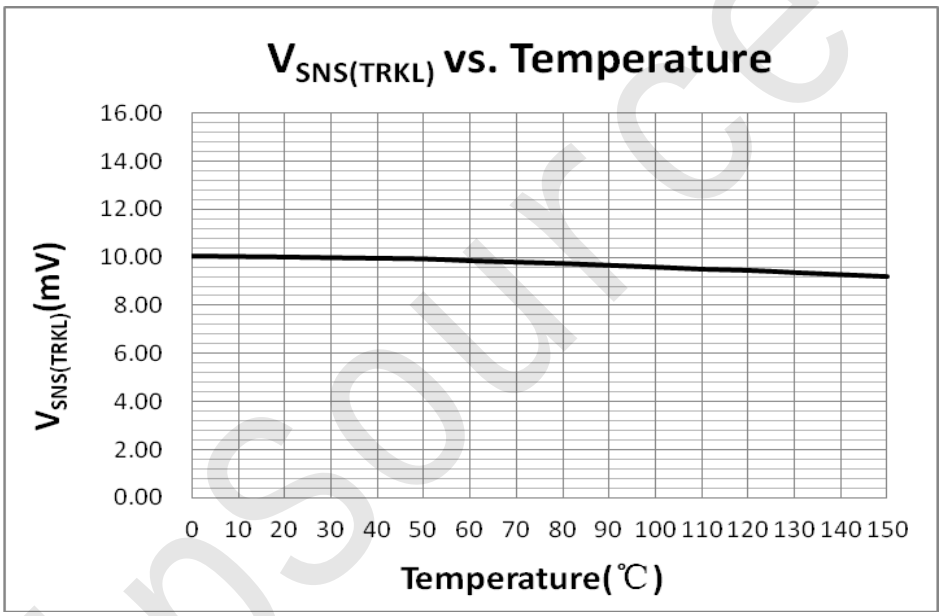
$$\Delta V_{OUT} \leqq \Delta I_L \left(ESR + \frac{1}{8 f_{OSC} C_{OUT}}\right)$$

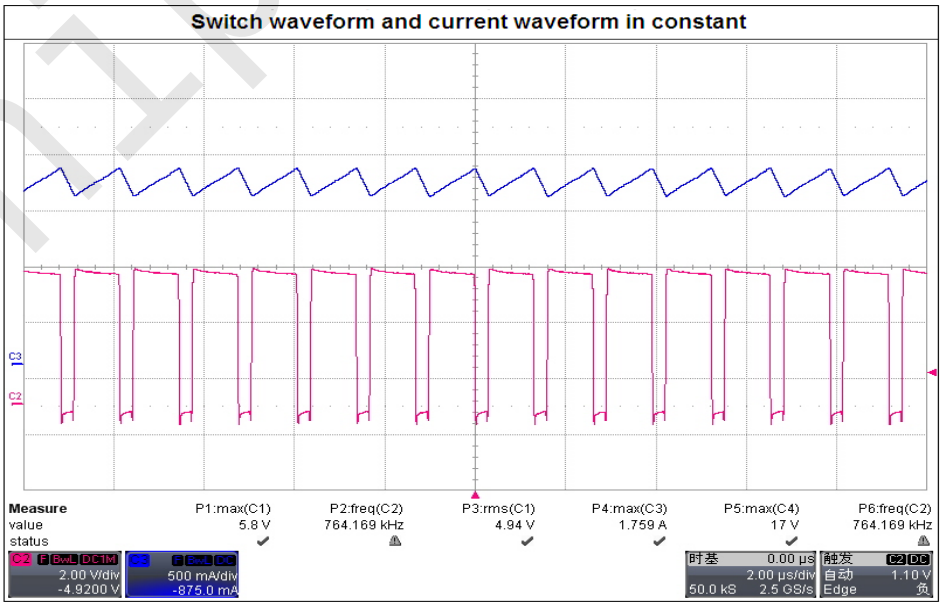
Since ΔIL increases with input voltage, the output ripple is highest at maximum input voltage. Typically, once the ESR requirement is satisfied, the capacitance is adequate for filtering and has the necessary RMS current rating. Switching ripple current splits between the battery and the output capacitor depending on the ESR of the output capacitor and the battery impedance. EMI considerations usually make it desirable to minimize ripple current in the battery leads. Ferrite beads or an inductor may be added to increase battery impedance at the 1.1MHz switching frequency. If the ESR of the output capacitor is 0.2Ω and the battery impedance is raised to 4Ω with a bead or inductor, only 5% of the current ripple will flow in the battery.

ME4069 Typical Performance Characteristics



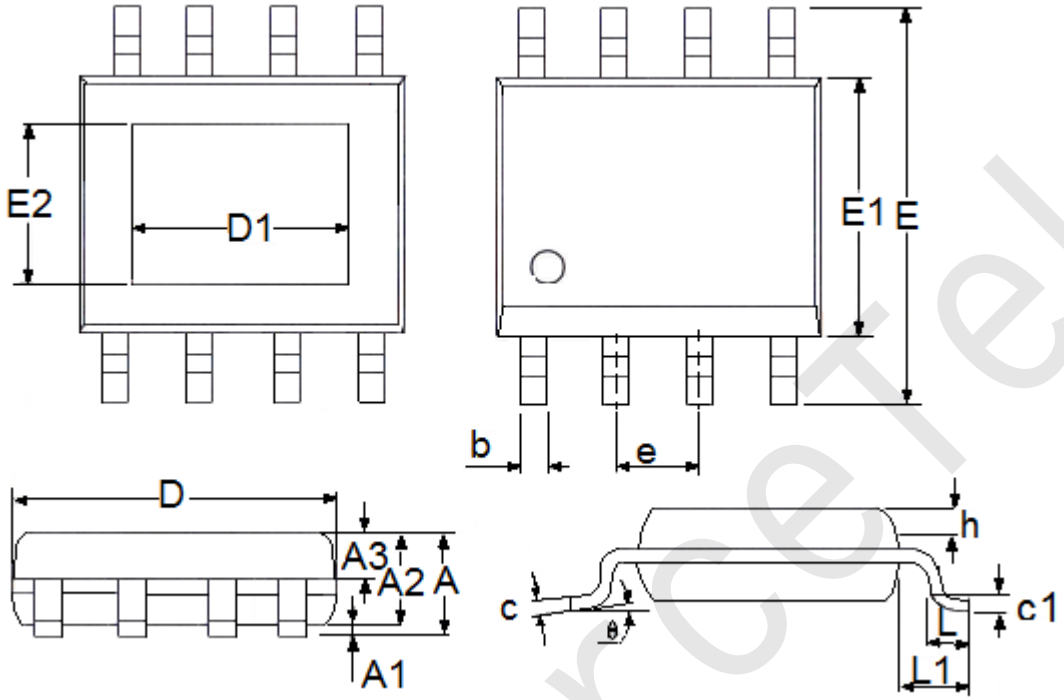






ME4069 Packaging Information

- **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)	

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