Dual or three-cell Li-Ion Switch Mode Battery Charger ME4078

General Description

The ME4078 is a complete battery charger controller for two (8.4V)or three(12.6V) cell lithium-ion battery. The ME4078 provides a small, simple and efficient solution to fast charge Li-ion battery. The ME4078 built in anti current backward function, so the application does not need the blocking diode. An external sense resistor sets the charge current with high accuracy. An internal resistor divider and precision reference set the final float voltage to two (8.4V)or three(12.6V) cell with ±1% accuracy. When the input supply is removed, the ME4078 automatically enters a low current sleep mode, dropping the battery drain current to 8μA.After the charge cycle ends, If the battery voltage drops below two (8.2V)or three(12.2V) cell, a new charge cycle will automatically begin. ME4078 has the function of charging timing protection, which automatically turns off after 6 hours of charging.

Features

- Input Supply Range:
  Dual-cell：10V~16V
  three-cell：13.5V~16V
- Maximum charge current：
  Dual-cell：2A
  three-cell：1.5A
- Built in anti current backward function
- High Efficiency Current Mode PWM Controller
- Built-in input adaptive function
- Constant Switching Frequency for Minimum Noise
- ±1% charge voltage accuracy
- Automatic Recharge
- Automatic Shutdown When Input Supply is Removed
- 6 hour charging timing protection
- Automatic Trickle Charging of Low Voltage
- Stable with Ceramic Output Capacitor
- Battery Temperature Sensing

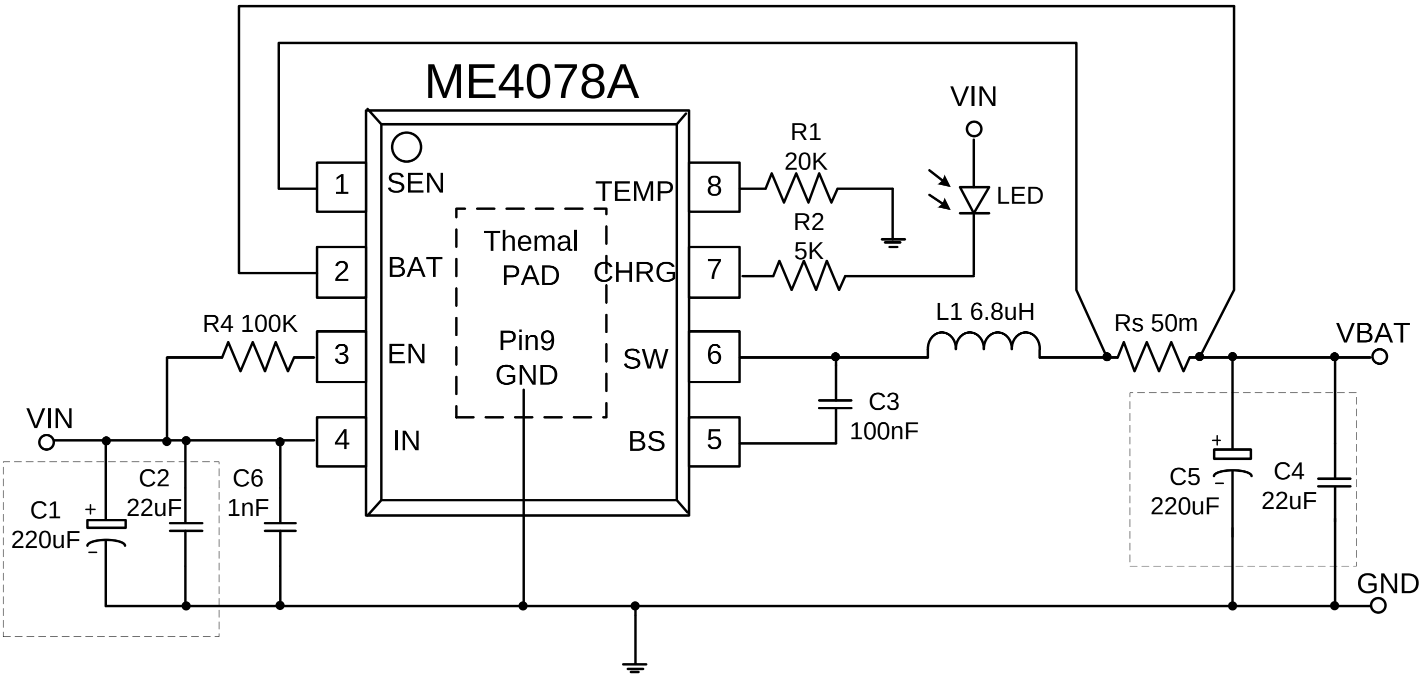
Typical Applications

- Charging Docks
- Handheld InstrumenTEMP
- Portable Computers

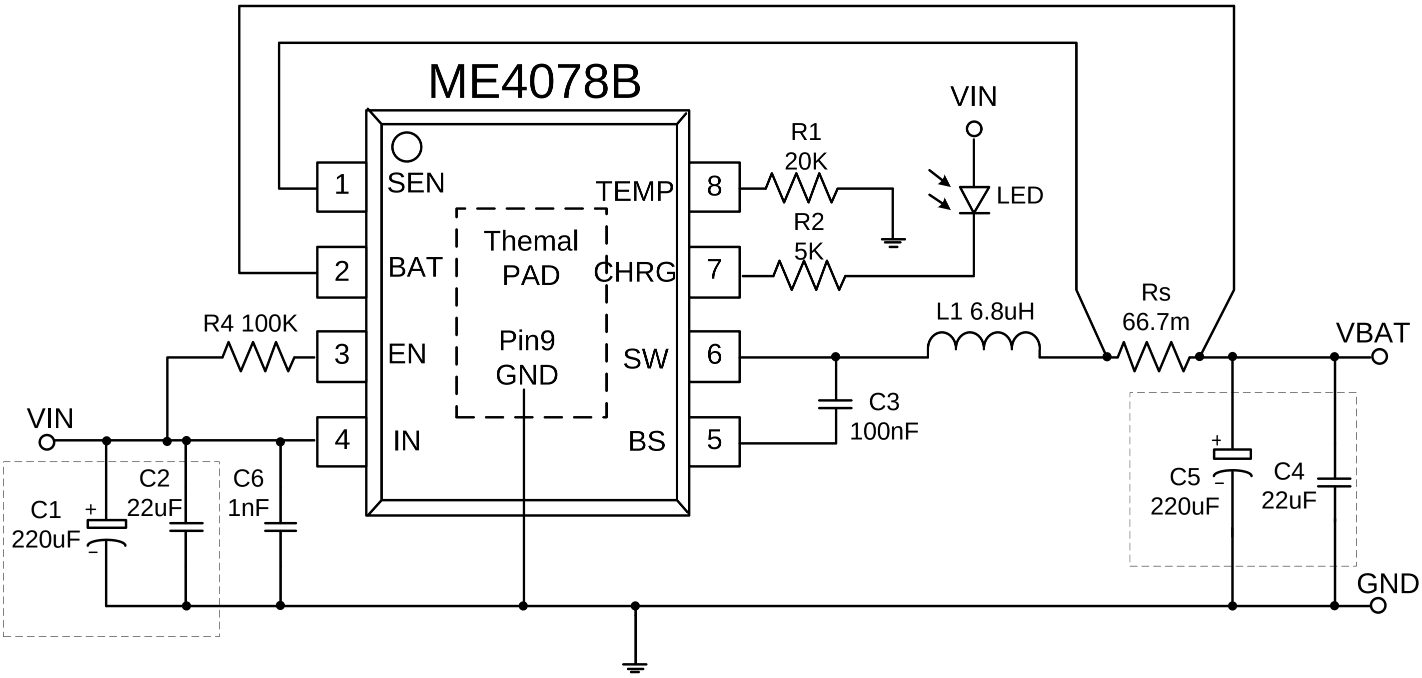
Package

- 8-pin ESOP8

Typical Application Circuit



ME4078A application circuit



ME4078B application circuit

NOTE:

1. The input capacitor is in the dotted line box. The input requires 220uF or more electrolytic capacitor. The larger the charging power, the larger the capacity of the electrolytic capacitor.

2, for the hot-swappable application at the BAT end, it is also necessary to add electrolytic capacitors, it is recommended to be 220uF or more.

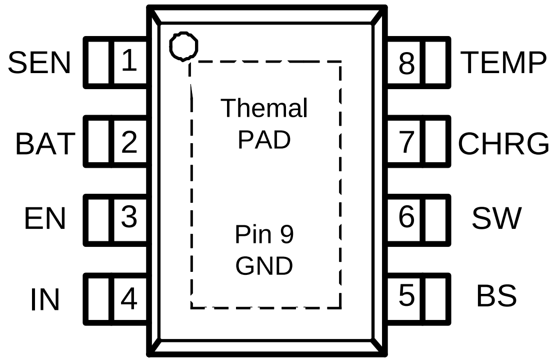
Selection Guide

ME 40 78 X X G

- G — Environment mark
- X — Package
  SP:ESOP8
- X — Float Volate
  A：8.4V
  B：12.6V
- 78 — Product Type
- 40 — Product Series
- ME — Microne

product series	product description
ME4078ASPG	V_{FLOAT} =8.4V
ME4078BSPG	V_{FLOAT} =12.6V

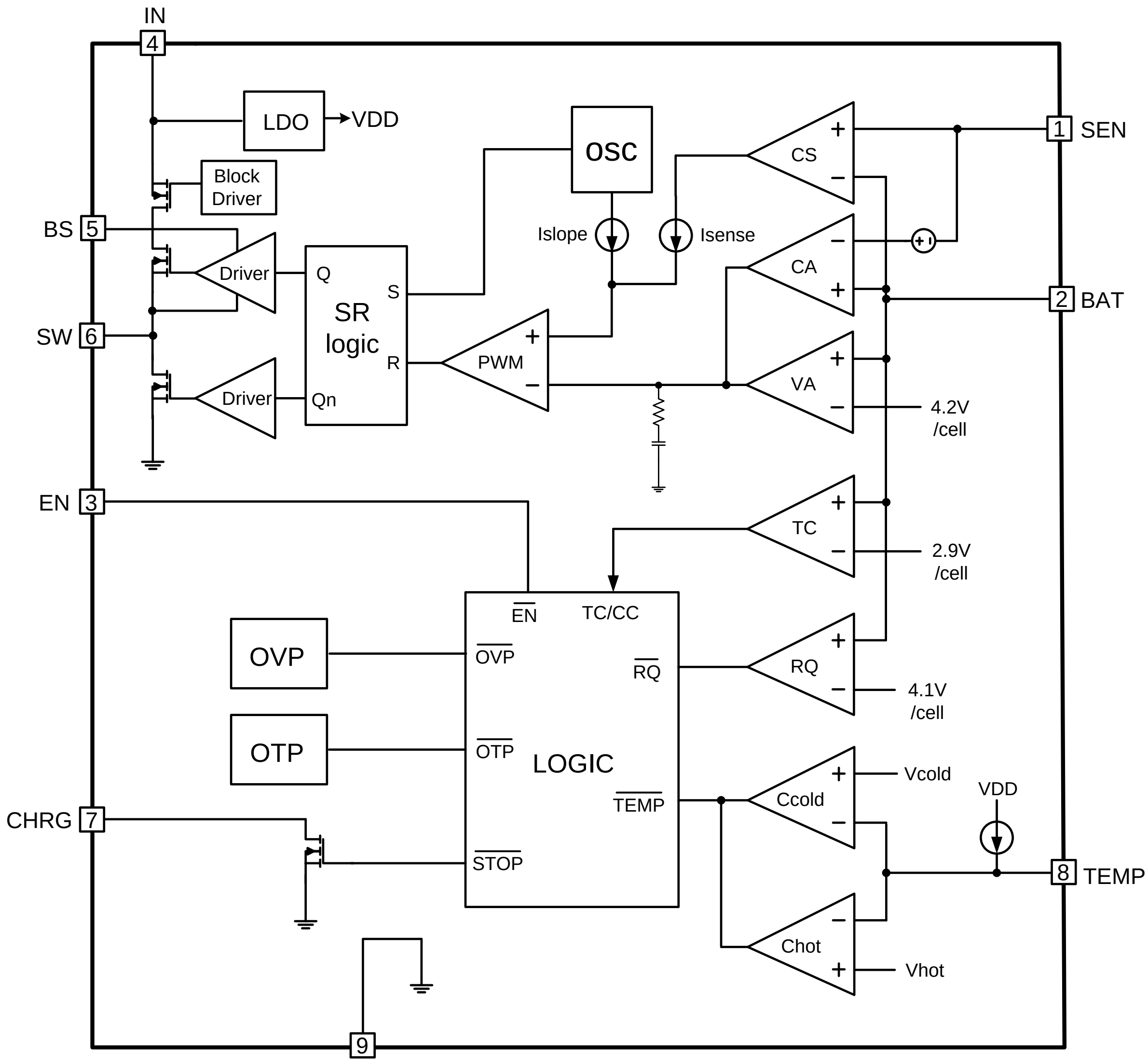
Pin Configuration



Pin Assignment

Pin Num.	Symbol	Function
1	SEN	Charge Current program. The output current is set by an external resistor according to the following formula: I_{OUT}= 100mV/Rs.
2	BAT	Feedback Pin. Receives the feedback voltage from an external resistor across the output
3	EN	ON/OFF Control
4	IN	Positive Supply Voltage Input. VIN can range from 10V to 16V. A 10μF low ESR capacitor is required near the chip.
5	BS	The driver of upper MOSFET
6	SW	Switching
7	CHRG	Open drain,When the charge current drops below the End-of-Charge threshold, the N-channel MOSFET turns off. When the input supply is removed, CHRG pin becomes high impedance.
8	TEMP	Temperature sense. TEMP Thermistor Input.a negative temperature coefficient thermistor to ground, this pin senses the temperature of the battery pack and stops the charger To disable the temperature qualification function,put a 20KΩ resisitor to ground.
9	Themal PAD	The themal PAD is the Ground of the chip.

Block Diagram



Absolute Maximum Ratings

Parameter	Rating	Unit
VIN, CHRG, SW，BS, SEN EN Voltage	-0.3~18	V
TEMP	-0.3~5	V
SW Pin Current	3.8	A
Thermal resistance (Junction to air) θ_{JA}	63	℃/W
Internal Power Dissipation	1.98	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.

Electrical Characteristics

ME4078ASPG

Operating Conditions：TA=25℃,VIN=12V, Rs =0.05Ω,unless otherwise specified

Parameter	Symbol	Condition		Min	Typ	Max	Unit
VIN	Input Voltage			10	12	16	V
IIN	Input Current	BATfloat		-	2	-	mA
		EN=0V，VIN=12V		-	10	-	uA
ISLEEP		No input，BATCurrent，VBAT=8.4V		-	4	-	uA
VFLOAT	Float Voltage	IBAT=2A	ME4078A	8.316	8.4	8.484	V
VSNSC	CC mode	VBAT=7.5V		90	100	110	mV
VSNST	TC mode	VBAT=5V		-	10	-	mV
VTEMI	Charge Teminal Voltage			-	10	-	mV
VRECH	Recharge Voltage			8.06	8.2	8.31	V
△VRE	Recharge battery threshold voltage	VFLOAT -VRECH		100	-	310	mV
VTRCL	TC CC switch Voltage	VBAT rise		-	5.6	-	V
VINUV	VIN under voltage protection	VIN fall		-	3.9	-	V
	Under Voltage Hysteresis			-	300	-	mV
VINOV	VIN over voltage protection	VIN rise		-	18	-	V
	Over voltage Hysteresis			-	800	-	mV
VASD	Auto shutdown	VIN-VBAT		-	100	-	mV
VENON	EN On Voltage	EN rise		-	1.55	-	V
VENOFF	EN Off Voltage	EN fall		-	1.5	-	V
OTP	Over temperature protection				160	-	℃
OTP_hys	The Hysteresis of OTP			-	30	-	℃
ITEMP	TEMP Source Current	VTEMP=1V		-	78	-	uA
VTHOT	Hot Voltage	VTEMP fall		-	0.52	-	V
VTCOLD	Cold Voltage	VTEMP rise		-	2.26	-	V
FOSC	Frequency			430	530	630	kHz
DC	Max Duty			-	95	-	%
VCHRG	CHRG Voltage	ICHRG=5mA		-	0.4	0.6	V

ME4078BSPG

Operating Conditions：TA=25℃,VIN=15V, Rs =0.0667Ω,unless otherwise specified

Parameter	Symbol	Condition		Min	Typ	Max	Unit
VIN	Input Voltage			14	15	16	V
IIN	Input Current	BATfloat		-	2	-	mA
		EN=0V，VIN=15V		-	15	-	uA
ISLEEP		No input，BAT Current，VBAT=12.6V		-	8	-	uA
VFLOAT	Float Voltage	IBAT=2A	ME4078B	12.474	12.6	12.726	V
VSNSC	CC mode	VBAT=10V		90	100	110	mV
VSNST	TC mode	VBAT=7.5V		-	10	-	mV
VTEMI	Charge Teminal Voltage			-	10	-	mV
VRECH	Recharge Voltage			12.09	12.2	12.5	V
△VRE	Recharge battery threshold voltage	VFLOAT -VRECH		150	-	450	mV
VTRCL	TC CC switch Voltage	VBAT rise		-	8.4	-	V
VINUV	VIN under voltage protection	VIN fall		-	3.9	-	V
	Under Voltage Hysteresis			-	300	-	mV
VINOV	VIN over voltage protection	VIN rise		-	18	-	V
	Over voltage Hysteresis			-	800	-	mV
VASD	Auto shutdown	VIN-VBAT		-	100	-	mV
VENON	EN On Voltage	EN rise		-	1.55	-	V
VENOFF	EN Off Voltage	EN fall		-	1.5	-	V
OTP	Over temperature protection				160	-	℃
OTP_hys	The Hysteresis of OTP			-	30	-	℃
ITEMP	TEMP Source Current	VTEMP=1V		-	78	-	uA
VTHOT	Hot Voltage	VTEMP fall		-	0.52	-	V
VTCOLD	Cold Voltage	VTEMP rise		-	2.26	-	V
FOSC	Frequency			430	530	630	kHz
DC	Max Duty			-	95	-	%
VCHRG	CHRG Voltage	ICHRG=5mA		-	0.4	0.6	V

Description of the Principle

The ME4078 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 (Rs) across the SEN and BAT pins. The final battery float voltage is internally set to two cells 8.4V or three cells 12.6V. 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 Rs and an internal 100mV reference; IOUT= 100mV/Rs：

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 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 TEMP (negative temperature coefficient) thermistor can be connected from the TEMP pin to ground for battery temperature qualification .To disable the temperature qualification function,put a 20KΩ resisitor to ground.

Functional Description

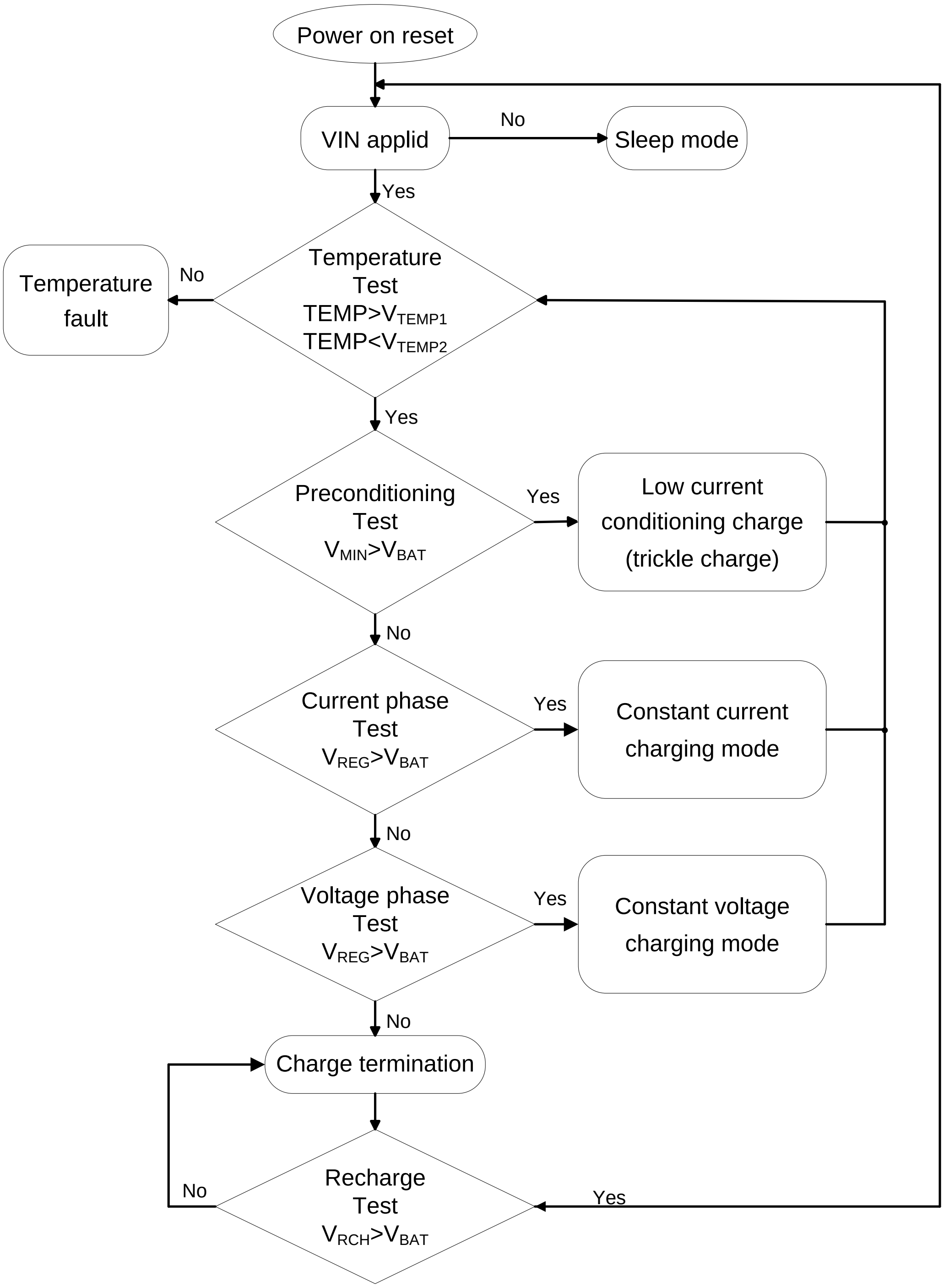


Fig. 1: Operation Flow Chart

Qualification and Precharge

The ME4078 suspends charge if the battery temperature is outside the VTEMP1 to VTEMP2 range and suspends charge until the battery temperature is within the allowed range. The ME4078 also checks the battery voltage. If the battery voltage is below the precharge threshold V(min) , the ME4078 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.

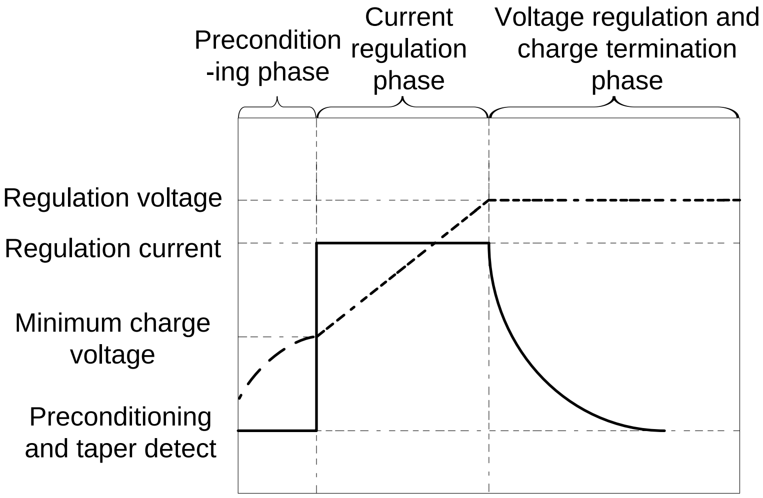


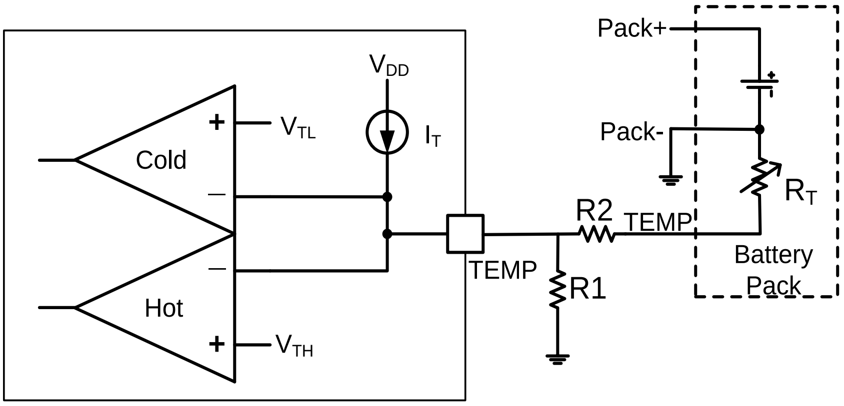
Fig. 2: Typical Charge Profile

Charge Termination Recharge

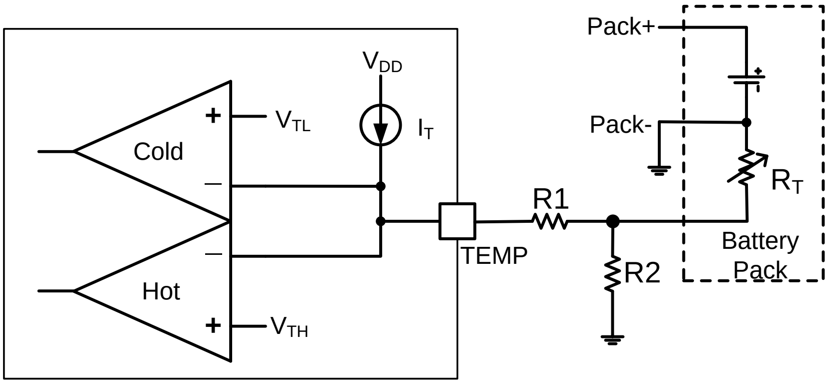
The ME4078 monitors the charging current during the voltage-regulation phase. The ME4078 declares a done condition and terminates charge when the current drops to the charge termination threshold A new charge cycle begins when the battery voltage falls below 8.2V(8.4Vproduct) /12.2V（12.6Vproduct）.

Battery Temperature Monitoring

A negative temperature coefficient (NTC) thermistor 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 thermistor from the TEMP pin to ground. The formulas for calculating resistance selection are as follows.



（a）



（b）

Fig 3: Thermistor Selection of Corresponding Circuits

The relationship of R1，R2 and RTH，RTL as follows:

(a) $\frac{1}{RTH+R2}+\frac{1}{R1}=\frac{IT}{VTH}$ $\frac{1}{RTL+R2}+\frac{1}{R1}=\frac{IT}{VTL}$

(b) $R1+\frac{R2\times RTH}{R2+RTH}=\frac{VTH}{IT}$ $R1+\frac{R2\times RTL}{R2+RTL}=\frac{VTL}{IT}$

RTH and RTL are the resistance values of thermistors at high and low temperatures respectively. The corresponding resistance values can be found according to the required temperature. VTH, VTL, IT are the design values, where VTH=0.52V，VTL=2.26V，IT=78uA. The resistance values corresponding to R1 and R2 can be calculated by bringing these values into the calculation formula above. To disable the temperature qualification function,put a 20KΩ resisitor to ground.

Charge Status Indication

Table 1

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

The ME4078 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.

Automatic Shutdown Voltage (VASD) and Charging timing protection

When the difference between input voltage and battery voltage VBAT is less than 100 mV, IC will enter automatic shutdown mode.

To prevent the battery charging function abnormal due to unexpected situation in the charging process, the chip has the function of charging timing protection. When charging starts, the chip starts timing. After 6 hours, the chip automatically shuts off charging. At this time, only removing input to start next charging cycle.

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 ME4078 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 15μA.

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. The electrolytic capacitor should be added to absorb the peak voltage. The larger the charging power is, the larger the electrolytic capacitor capacity will be. Normally, the electrolytic capacitor should be larger than 220uF.Selecting the highest possible voltage rating on the capacitor will minimize problems. Consult with the manufacturer before use.

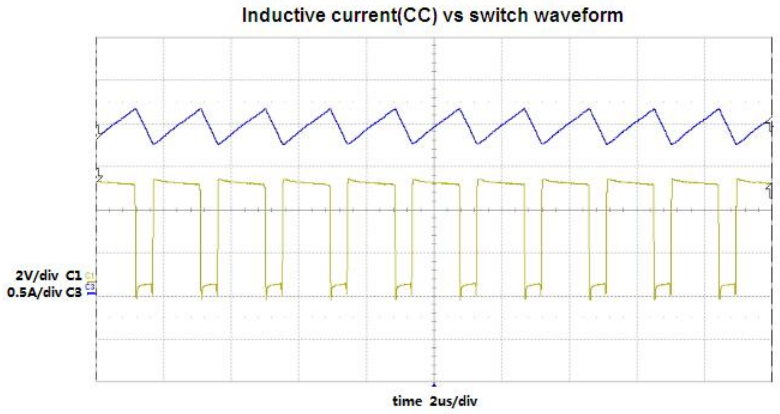
The selection of output capacitor COUT is primarily determined by the ESR required to minimize ripple voltage and load step transients. The output ripple ΔVOUT is approximately bounded by:

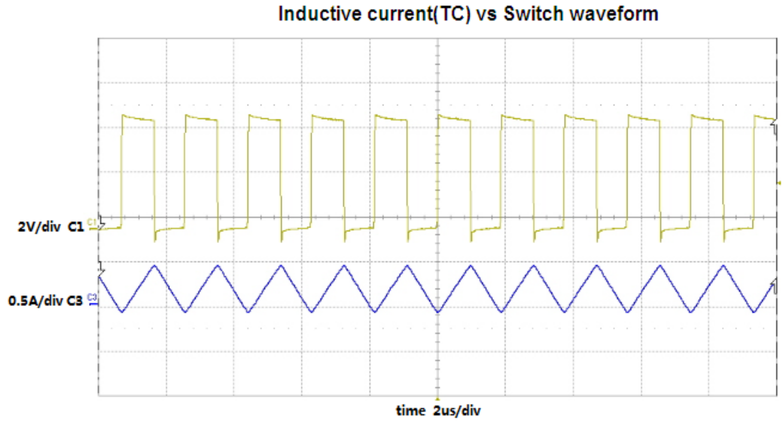
$$\Delta V_{OUT} \leqq \Delta I_L \left(ESR + \frac{1}{8 f_{OSC} C_{OUT}}\right)$$

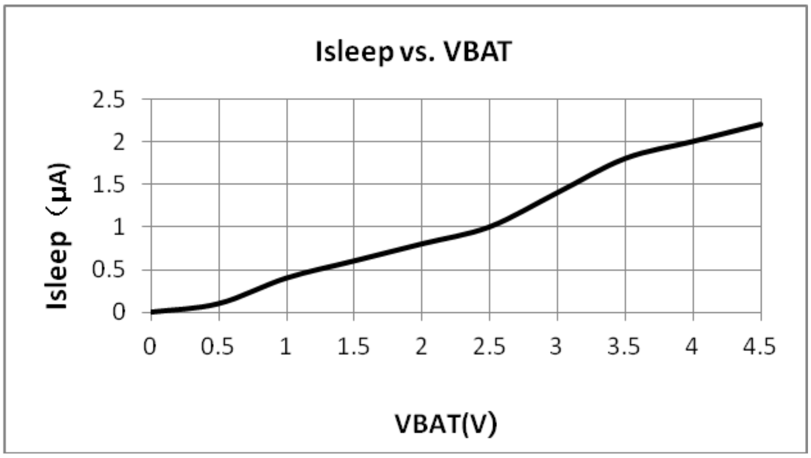
Since ΔIL increases with input voltage, the output ripple is highest at maximum input voltage. Typically, once the ESR requirement is satisfied, the capacitance is adequate for filtering and has the necessary RMS current rating. Switching ripple current splits between the battery and the output capacitor 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.

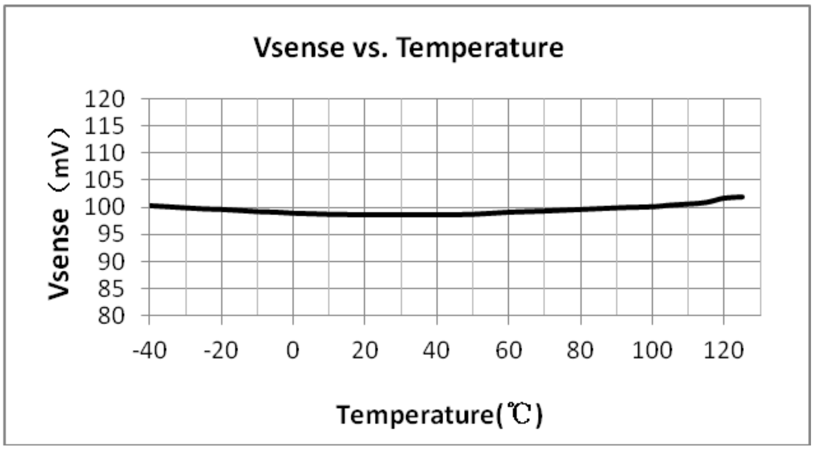
For applications with hot-swap at the BAT end, the BAT terminal needs to be equipped with an electrolytic capacitor, which is recommended to be 220uF or more.

Typical Performance Characteristics



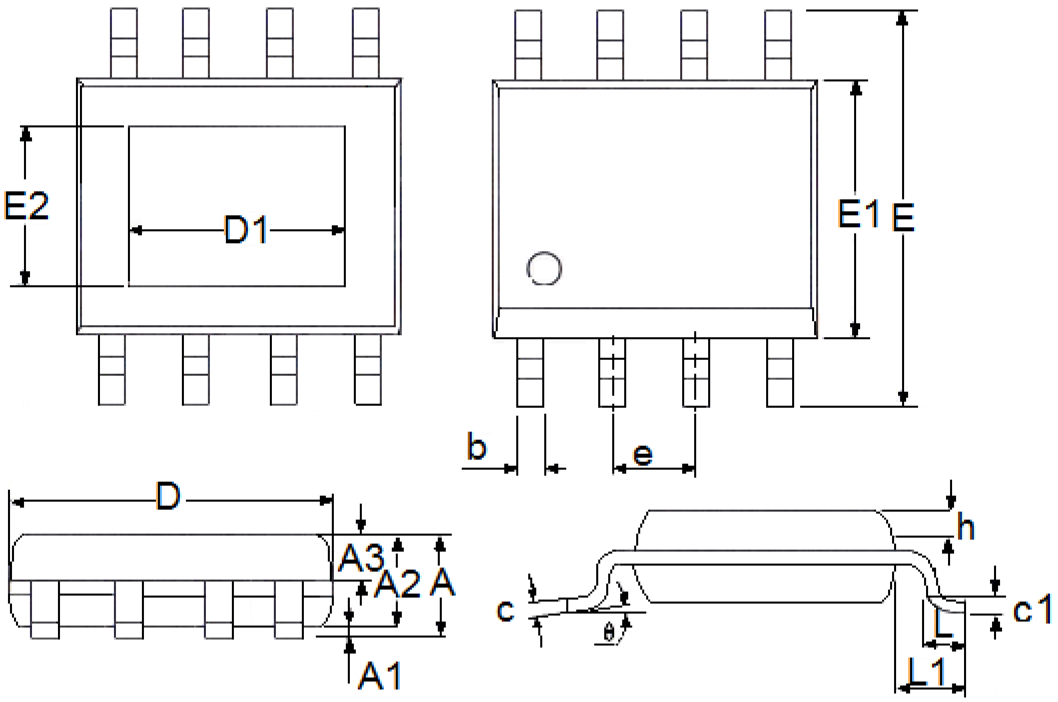






Packaging Information:

- **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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