30V Input Standoff, 1A Fully Integrated Linear Charger for 1 Cell Li-ion Battery

DESCRIPTION

ETA4048 is a single cell, fully integrated constant current (CC)/constant voltage (CV) Li-ion battery charger. Its compact package with minimum external components requirement makes the ETA4048 ideal for portable applications. No external sense resistor or blocking diode is necessary for the ETA4048. Build-in thermal feedback mechanism regulates the charge current to control the die temperature during high power operation or at elevated ambient temperature. The ETA4048 has the function of pre-charge, which can charge the deeply discharged batteries by trickle. The fast charge current can be programmed by an external resistor. CV regulation mode is automatically enabled once the battery's charging curve reaches the constant voltage portion. The output current then decays and is finally terminated once the charge current drops to 1/10 of the programmed value. The ETA4048 keeps monitoring the battery voltage and enables a new charge cycle once the voltage drops by 135mV below the CV value. ETA4048 is in a DFN3x3-10 package.

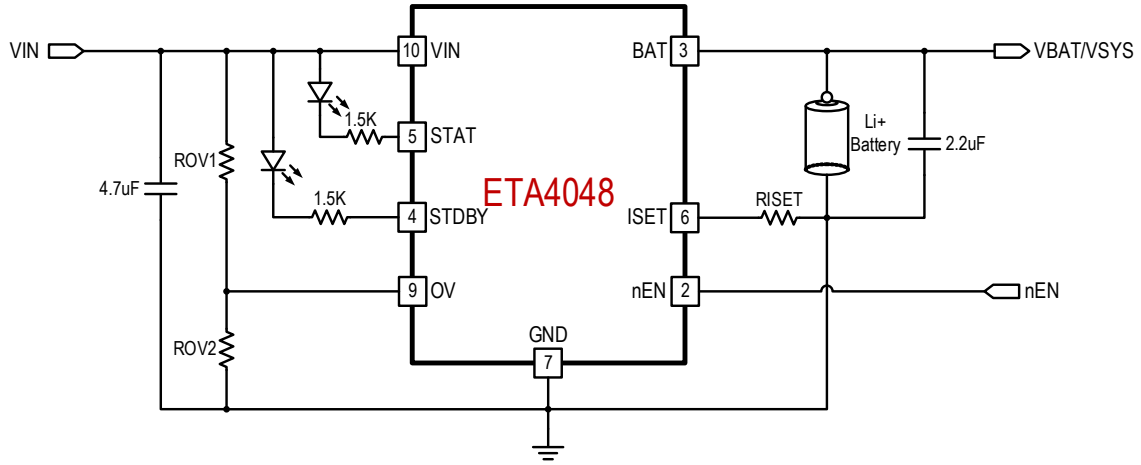
FEATURES

- 30V Input Standoff Voltage
- 4.2V Charge Termination Voltage
- 2.6V Trickle Charge Threshold
- Input Over Voltage Protection
- Charge Current Programmable, up to 1A
- 400nA BAT Current when No Charging
- Soft-start Limits in-rush Current
- DFN3x3-10 Package

APPLICATIONS

- E-cigarette
- Toys
- Bluetooth Applications
- Li-ion Battery Powered Devices

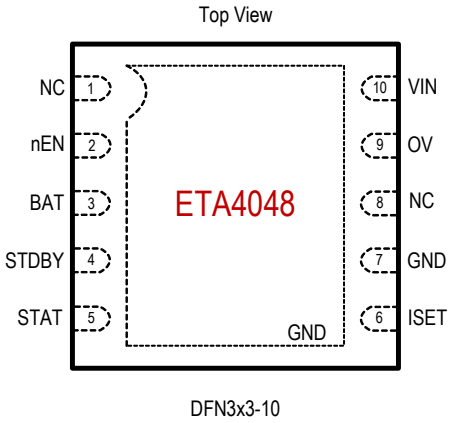
TYPICAL APPLICATION



ORDERING INFORMATION

PART No.	PACKAGE	TOP MARK	Pcs/Reel
ETA4048D3K	DFN3x3-10	ETA4048 YWW2L	5000

PIN CONFIGURATION



DFN3x3-10

ABSOLUTE MAXIMUM RATINGS

(Note: Exceeding these limits may damage the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

VIN, OV Voltage .....–0.3V to 30V
ISET Voltage .....–0.3V to 6V
All other pins Voltage..... –0.3V to 16V
Operating Temperature Range.....–40°C to 85°C
Storage Temperature Range .....–55°C to 150°C

Thermal Resistance	Θ_{JC}	Θ_{JA}	
DFN3x3-10	12	50	°C/W

Lead Temperature (Soldering, 10sec) .....260°C
ESD HBM (Human Body Mode)……..……....2KV
ESD CDM (Charged Device Mode)……1KV

ELECTRICAL CHARACTERISTICS

(V_{IN} = 5V, unless otherwise specified. Typical values are at T_A = 25°C.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Standoff Voltage		30			V
Input Over-Voltage Protection Voltage	VIN Rising, Hys=0.4V, OV pin Floating	5.7	6.1	6.5	V
Input Voltage Range for Charging		4.25		6	V
Input Supply Current	Charge Mode		800	2000	μA
	Standby Mode (Charge Terminated)		180	360	μA
	Shutdown Mode (ISET not Connected, VIN<VBAT, or VIN<VULO)		45	90	μA
Regulated Output (Float) Voltage	Rset = 10K, IBAT = 40mA	4.16	4.2	4.24	V
BAT Pin Current	Rset = 2K, Current Mode, VBAT=3.8V	450	500	550	mA
	Rset = 1.6K to 8K, Current Mode	90	100	110	%ICHRG
	Standby Mode, VBAT = 4.2V		6	8	μA
	Shutdown Mode, ISET not Connected	0	0.4	0.7	μA
	Sleep Mode, VIN = 0V	0	0.4	0.7	μA
Trickle Charge Current	VBAT < VTRICKLE	8	10	12	%ICHRG
Trickle Charge Threshold Voltage	VBAT Rising	2.45	2.60	2.75	V
Trickle Charge Hysteresis Voltage			100		mV
VIN Under-voltage Lockout Threshold	From VIN Low to High	3.3	3.6	3.9	V
VIN Under-voltage Lockout Hysteresis		0.4	0.55	0.65	V

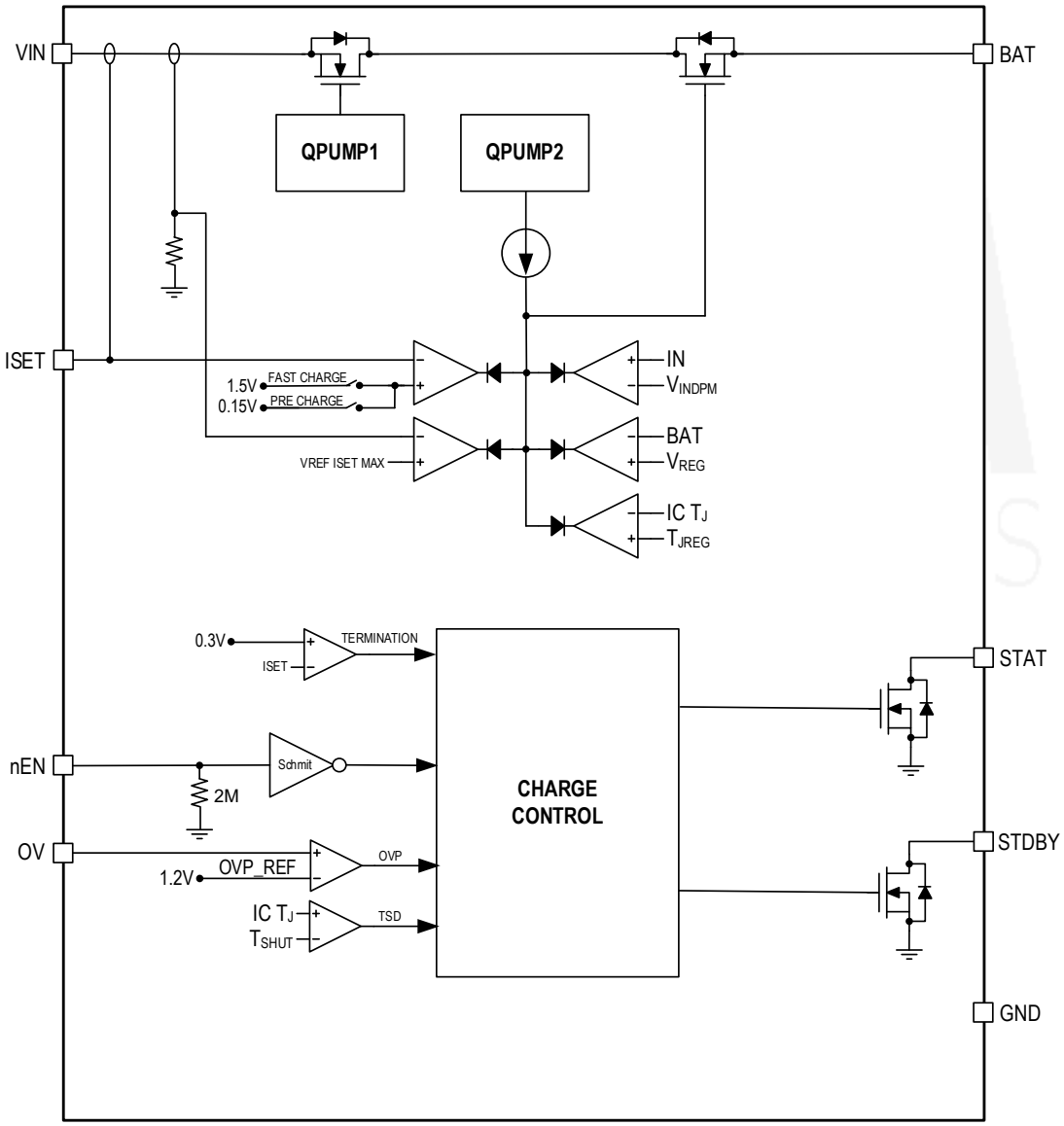
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
VIN–VBAT Lockout Threshold Voltage	VIN from Low to High	70	150	230	mV
	VIN from High to Low	20	70	130	
Termination Current Threshold		5	10	15	%ICHRG
ISET Pin Voltage	Current Mode, VBAT=4V	1.35	1.5	1.65	V
STAT/STDBY Pin Weak Pull-Down Current	V_STAT = 5V		0.1		μA
STAT/STDBY Pin Output Low Voltage	I_STAT or I_STDBY= 5mA		0.7	1.4	V
Recharge BAT Threshold Voltage	VBAT Falling	70	135	200	mV
Junction Temperature in Constant Temperature Mode			110		°C
Power FET "ON" Resistance (Between VIN and BAT)			0.6		Ω
Soft-Start Time			40		ms
ISET Pin Pull-Up Current			1		μA
Enable Charger	nEN Pin Falling			0.6	V
Disable Charger	nEN Pin Rising	1.6			V

PIN DESCRIPTION

PIN#	NAME	DESCRIPTION
1,8	NC	None connection.
2	nEN	Enable the IC charger or not. Drive this pin low or floating to enable charger, high to disable.
3	BAT	Charge current output. This pin provides charge current to the battery and regulates the final float voltage to 4.2V which is set by an internal precision resistor divider.
4	STDBY	Open-Drain output for charge finished flag. The STDBY pin outputs low when the battery is finished charging. When in the status of charging, it becomes high-impendence.
5	STAT	Open-Drain output for in charging flag. The STAT pin outputs low when the battery is in charging. Upon the completion of the charge cycle, it becomes high-impendence.
6	ISET	Charge current setting. Program, Monitor the charge current and Shutdown. This pin set to 1.5V in constant-current mode. The charge current can be calculated using the following formula: $$I_{BAT}(mA)=\frac{1}{R_{set}(k\Omega)}\times 1000$$ The ISET pin can also be used to switch the charger to shutdown mode by disconnecting the program resistor from ground.

PIN#	NAME	DESCRIPTION
7/ Exposed Pad	GND	Ground.
9	OV	Input over voltage protection setting. The OVP voltage can be calculated by using the following formula: $\mathrm{VIN_{OVP}} = 1.2 \times (\mathrm{ROV1} + \mathrm{ROV2})/\mathrm{ROV2}$ If OV pin is floating, the OVP voltage will be equal to 6.1V.
10	VIN	Positive input supply. Needs to be bypassed with at least a 4.7μF capacitor.

FUNCTION BLOCK DIAGRAM



FUNCTIONAL DESCRIPTIONS

The ETA4048 is a single cell, fully integrated constant current (CC)/constant voltage (CV) Li-ion battery charger. It can deliver up to 1000mA of charge current with a final float voltage accuracy of 1%. The ETA4048 has a build-in thermal regulation circuitry that ensures its safe operation. No blocking diode or external current sense resistor is required; hence reduce the external components for a basic charger circuit to two. The ETA4048 is also capable of operating from a USB power source.

Normal Charge Cycle

The ETA4048 initiates a charge cycle once the voltage at the VIN pin rises above the UVLO threshold level. A 1% precision resistor needs to be connected from the ISET pin to ground. If the voltage at the BAT pin is less than 2.6V, the charger enters trickle charge mode. In this mode, the charge current is reduced to nearly 1/10 the programmed value until the battery voltage is raised to a safe level for full current charging.

The charger switches to constant-current mode as the BAT pin voltage rises above 2.6V, the charge current is thus resumed to full programmed value. When the final float voltage (4.2V) is reached, the ETA4048 enters constant-voltage mode and the charge current begins to decrease until it drops to 1/10 of the preset value and ends the charge cycle.

Programming Charge Current

The charge current is programmable by setting the value of a precision resistor connected from the ISET pin to ground. The charge current is 1000 times of the current out of the ISET pin. The charge current out of the BAT pin can be determined at any time by monitoring the ISET pin voltage using the following equation:

$$I_{BAT}(mA) = \frac{1}{R_{set}(k\Omega)} \times 1000$$

Charge Termination

The ETA4048 keeps monitoring the ISET pin during the charging process. It terminates the charge cycle when the charge current falls to 1/10 the programmed value after the final float voltage is reached. When the ISET pin voltage falls below 135mV for longer than tTERM (typically 1ms), charging is terminated. The charge current is latched off and the ETA4048 enters standby mode, where the input supply current drops to 180μA. (Note: termination is disabled in trickle charging and thermal limiting modes).

During charging, the transient response of the circuit can cause the ISET pin to fall below 135mV temporarily before the battery is fully charged, thus can cause a premature termination of the charge cycle. A 1ms filter time on the termination comparator can prevent this from happening. Once the average charge current drops below 1/10 the programmed value, the ETA4048 terminates the charge cycle and ceases to provide any current through the BAT pin. In this state, all loads on the BAT pin must be supplied by the battery.

The ETA4048 constantly monitors the BAT pin voltage in standby mode and resume another charge cycle if this voltage drops below the recharge threshold. User can also manually restart a charge cycle in standby mode either by removing and then reapplied the input voltage or restart the charger using the ISET pin.

Charge Status Indicator (STAT and STDBY pin)

There are 2 different states of the charge status, one is IN CHRGING, and the other is CHARGING FINISHED. STAT pin is to pull low during IN CHARGING status and become high impedance in CHARGING FINISHED status. STDBY pin just works the opposite way, pulling low after charge finished, and high impedance when in charging.

High Temperature Fold-back

Build-in feedback circuitry mechanism can reduce the value of the programmed charge current once the die temperature tends to rise above 50°C, hence prevents the temperature from further increase and ensure device safe operation.

Under-voltage Lockout (UVLO)

Build-in under-voltage lockout circuit monitors the input voltage and keeps the charger in shutdown mode until VIN rises above the under-voltage lockout threshold. The UVLO circuit has a built-in hysteresis of 500mV. Furthermore, to protect against reverse current in the power MOSFET, the UVLO circuit keeps the charger in shutdown mode if VIN falls to within 70mV of the battery voltage. If the UVLO comparator is tripped, the charger will not come out of shutdown mode until VIN rises 150mV above the battery voltage.

Manual Shutdown

There are two methods can disable the IC charger:

1. Drive the EN pin to high.
2. Floating the ISET pin by removing the resistor from ISET pin to ground can put the device in shutdown mode. The battery drain current is thus reduced to <5μA and the supply current to <50μA. Reconnecting the resistor back will restart a new charge cycle.

Automatic Recharge

After the termination of the charge cycle, the ETA4048 constantly monitors the BAT pin voltage and starts a new charge cycle when the battery voltage falls below 4.06V, keeping the battery at fully charged condition. ISET pin output enters a strong pull-down state during recharge cycles.

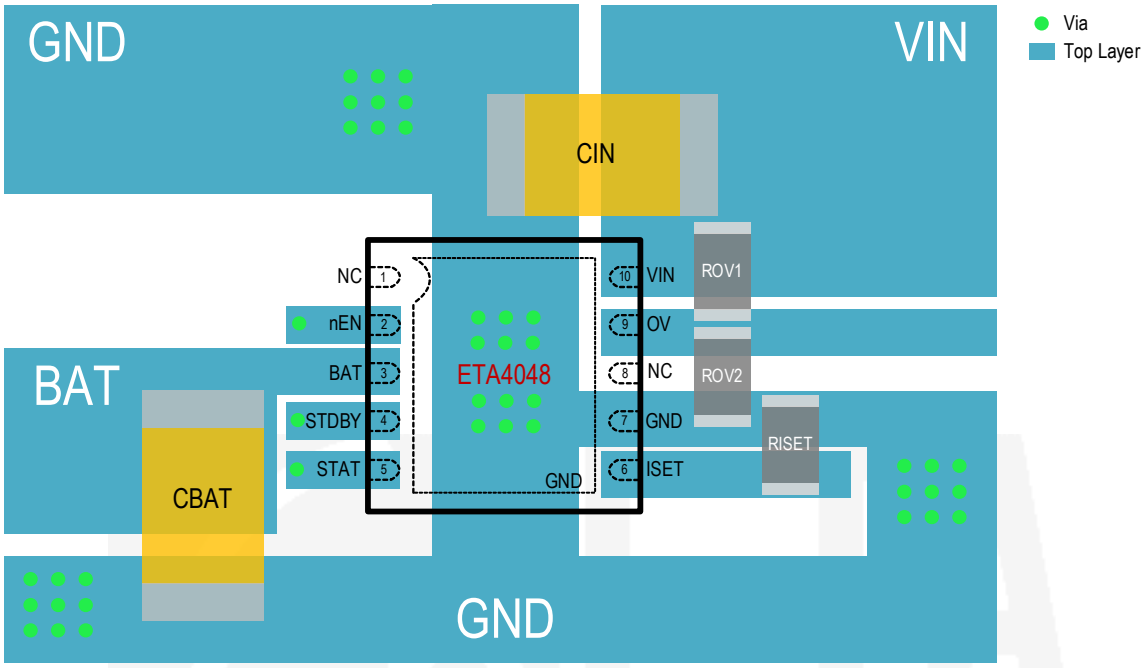
Over Voltage Protection Setting

ETA4048 provides OVP setting function by using two external resistors at OV pin. The OVP voltage can be set by the following equation:

$$\mathrm{VIN_{OVP}} = 1.2 \times (\mathrm{ROV1} + \mathrm{ROV2})/\mathrm{ROV2}$$

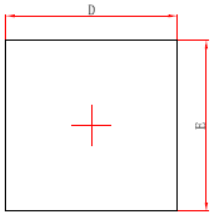
If OV pin is floating, the OVP voltage will be equal to 6.1V.

PCB GUIDELINES

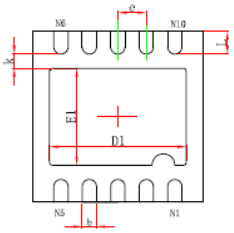


PACKAGE OUTLINE

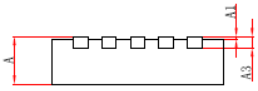
Package: DFN3x3-10



Top View



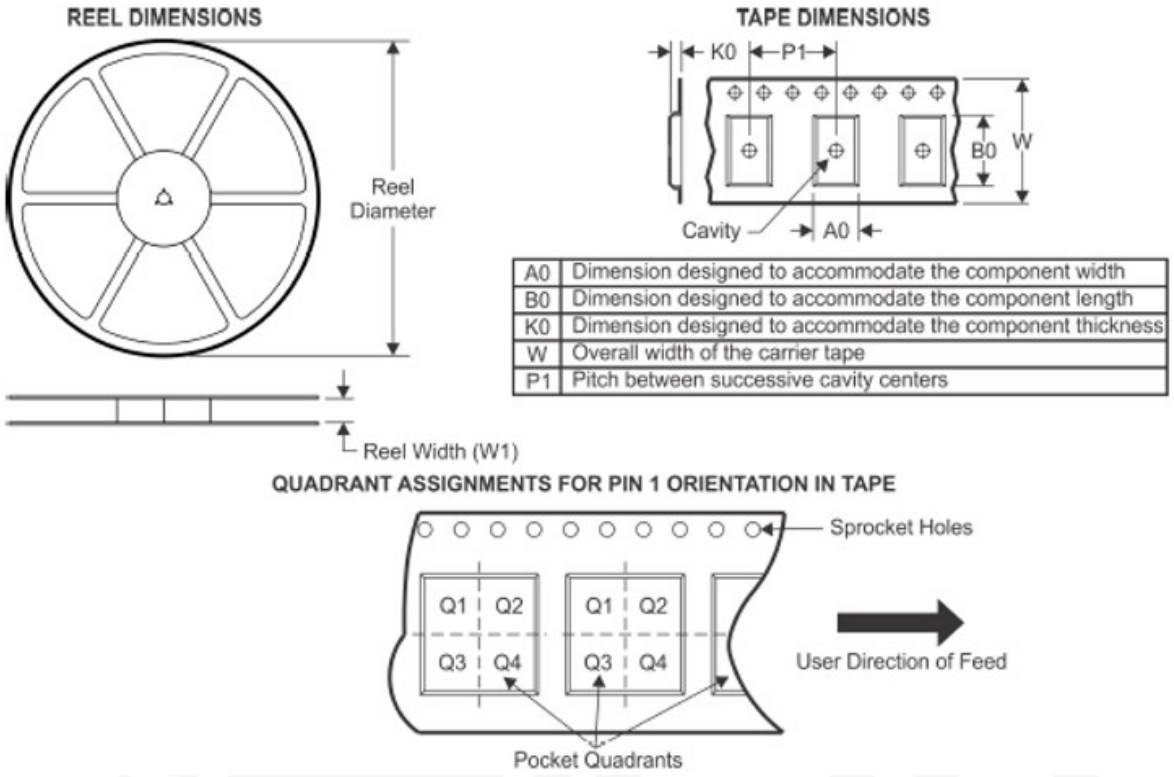
Bottom View



Side View

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	2.924	3.076	0.115	0.121
E	2.924	3.076	0.115	0.121
D1	2.300	2.500	0.091	0.098
E1	1.600	1.800	0.063	0.071
k	0.200MIN.		0.008MIN.	
b	0.200	0.300	0.008	0.012
e	0.500TYP.		0.020TYP.	
L	0.324	0.476	0.013	0.019

TAPE AND REEL INFORMATION



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

Device	Package Type	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
ETA4048D3K	DFN3x3-10	10	5000	330	12.4	3.35	3.35	1.13	8	12	Q1