16V/120mA, 1mA Termination Current Linear Charger

DESCRIPTION

ETA4116 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 ETA4116 ideal for portable applications. No external sense resistor or blocking diode is necessary for the ETA4116. Build-in thermal feedback mechanism regulates the charge current to control the die temperature during high power operation or at elevated ambient temperature. The ETA4116 has a pre-charge function for trickle charging deeply discharged batteries. 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 1/10th of the programmed value. The ETA4116 keeps monitoring the battery voltage and enables a new charge cycle once the voltage drops by 120mV below the CV value. ETA4116 is in a DFN2x2-8 package.

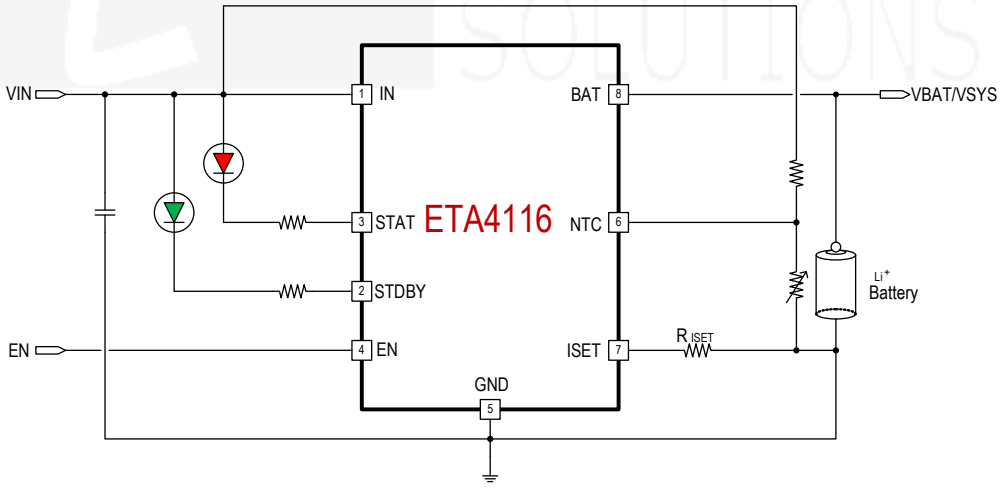
FEATURES

- 16V input standoff voltage
- 4.35V charge termination voltage
- 1mA termination current
- 2.9V trickle charge threshold
- Charge current programmable, up to 120mA
- 250nA BAT current when no charging
- Soft-start limits in-rush current
- DFN2x2-8
- RoHS Compliant

APPLICATIONS

- E-cigarette
- Toys
- Bluetooth applications
- Li-ion battery powered devices

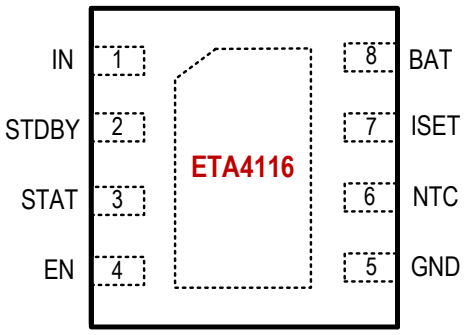
TYPICAL APPLICATION



ORDERING INFORMATION

PART No.	PACKAGE	TOP MARK	Pcs/Reel
ETA4116D2I	DFN2x2-8	N6YW	3000

PIN CONFIGURATION



DFN2x2-8

ABSOLUTE MAXIMUM RATINGS

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

IN Voltage .....–0.3V to 20V
ISET Voltage .....–0.3V to 6V
All other pin 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}
DFN2x2-8	20	100 °C/W

Lead Temperature (Soldering, 10sec) .....260°C
ESD HBM (Human Body Mode) 2KV

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		16			V
Input Over-Voltage Protection Voltage	V_{IN} rising, hys=0.3V	6.5	7	7.4	V
Input Voltage Range for Charging			5		V
Input Supply Current	Charge Mode		300		μA
	Standby Mode (Charge Terminated)		65	100	μA
	Shutdown Mode (ISET Not Connected, EN=0, V_{IN}<V_{BAT}, or V_{IN}<V_{ULO})		25	50	μA
Regulated Output (Float) Voltage	R_{ISET} = 1K, I_{BAT} = 40mA	4.306	4.35	4.394	V
BAT Pin Current	R_{ISET} = 2K, Current Mode	40	50	60	mA
	Standby Mode, V_{BAT} = 4.35V		2	3	μA
	Shutdown Mode, ISET Not Connected	0	0.25	0.35	μA
	Sleep Mode, V_{IN} = 0V	0	0.25	0.35	μA
Trickle Charge Current	V_{BAT} < V_{TRIKL}, R_{ISET} = 2K		5		mA
Trickle Charge Threshold Voltage	V_{BAT} Rising	2.75	2.93	3.1	V
Trickle Charge Hysteresis Voltage		100	130	165	mV
V_{IN} Under-voltage Lockout Threshold	From V_{IN} Low to High	3.05	3.35	3.6	V
V_{IN} Under-voltage Lockout Hysteresis		0.4	0.55	0.65	V
EN Pull-Up Current		0.5	1		μA
Enable Charger	EN Pin Rising	1.6			V
Disable Charger	EN Pin Falling			0.6	V

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}–V_{BAT} Lockout Threshold Voltage	V_{IN} from Low to High		100		mV
	V_{IN} from High to Low		30		mV
Termination Current Threshold			10		%ICHG
ISET Pin Voltage	Current Mode, V_{BAT}=4V		1		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		0.35	0.6	V
Recharge BAT Threshold Voltage	V_{VCV} - V_{RECHRG}	90	120	150	mV
Junction Temperature in Constant Temperature Mode			120		°C
Power FET “ON” Resistance (Between VIN and BAT PIN)			0.5		ohm
Soft-Start Time	I_{BAT} =0 to I_{BAT} =1000V/R_{ISET}		100		μs
Recharge Comparator Filter Time	V_{BAT} High to Low	400	1000	2500	μs
Termination Comparator Filter Time	I_{BAT} Falling Below I_{CHG}/10	400	1000	2500	μs
ISET Pin Pull-Up Current			1		μA
NTC Threshold, Cold	Charger Suspended		80	83	% V_{IN}
NTC Threshold, Hot	Charger Suspended	42	45		% V_{IN}
NTC Threshold Hysteresis			2		% V_{IN}
NTC Disable Threshold	Tie NTC to GND				
NTC Input Leakage			0	1	μA

PIN DESCRIPTION

PIN#	NAME	DESCRIPTION
6	NTC	Battery Temperature Monitoring input pin. It sets the valid temperature operating range for both battery charging and discharging.
7	ISET	Program, Monitor the charge current and Shutdown. This pin set to 1V in constant-current mode. The charge current is programmed by connecting a 1% resistor (R_{ISET}), between ISET, to GND pin. The charge current can be calculated using the following formula: $$I_{BAT}=\frac{1}{R_{ISET}}\times 100-\left(\frac{1}{3.6}\times\frac{1}{R_{ISET}}\times 100\right)^2$$ The ISET pin can also be used to switch the charger to shutdown mode by disconnecting the program resistor from ground.
5	GND	Ground.
1	IN	Positive Input Supply. Needs to be bypassed with at least a 4.7μF capacitor.
8	BAT	Charge Current Output. This pin provides charge current to the battery and regulates the final float voltage to 4.35V which is set by an internal precision resistor divider.
2	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.
3	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.
4	EN	Enable the IC charger or not. Drive this pin high or floating to enable charger, low to disable.

FUNCTIONAL DECRIPTIONS

The ETA4116 is a single cell, fully integrated constant current (CC)/constant voltage (CV) Li-ion battery charger. It can deliver up to 120mA of charge current with a final float voltage accuracy of 1%. The ETA4116 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 ETA4116 is also capable of operating from a USB power source.

Normal Charge Cycle

The ETA4116 initiates a charge cycle once the voltage at the IN 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 2.9V, 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 2.9V, the charge current is thus resumed to full programmed value. When the final float voltage (4.35V) is reached, the ETA4116 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 100 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:

$$I_{BAT}=\frac{1}{R_{ISET}}\times 100-\left(\frac{1}{3.6}\times\frac{1}{R_{ISET}}\times 100\right)^2$$

Charge Termination

The ETA4116 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 100mV for longer than t_{TERM} (typically 1ms), charging is terminated. The charge current is latched off and the ETA4116 enters standby mode, where the input supply current drops to 200μA. (Note: C/10 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 100mV 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 ETA4116 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 ETA4116 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 is the pin to pull low during IN CHARGING status and become high impedance in CHARGING FINISHED status. And 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 125°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 V_{IN} 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 V_{IN} falls to within 30mV of the battery voltage. If the UVLO comparator is tripped, the charger will not come out of shutdown mode until V_{IN} rises 100mV above the battery voltage.

Manual Shutdown

There are two methods can disable the IC charger:
1. Driver the EN pin to low.
2. Floating the ISET pin by removing the resistor from ISET pin to ground.
Once one of above conditions happen can put the device in shutdown mode. The battery drain current is thus reduced to 250nA and the supply current to <50μA. Reconnecting the resistor back or drivering EN pin high will restart a new charge cycle.

Automatic Recharge

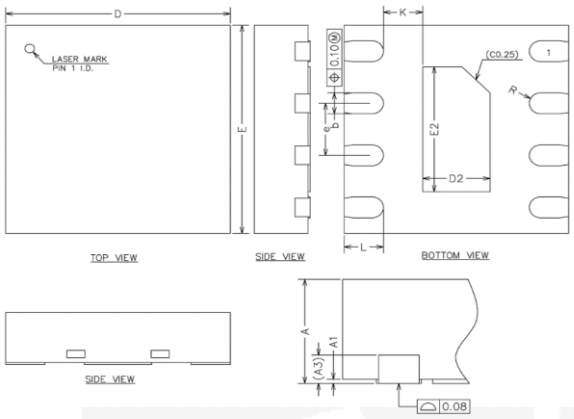
After the termination of the charge cycle, the ETA4116 constantly monitors the BAT pin voltage and starts a new charge cycle when the battery voltage falls below 4.23V, keeping the battery at fully charged condition. ISET pin output enters a strong pull-down state during recharge cycles.

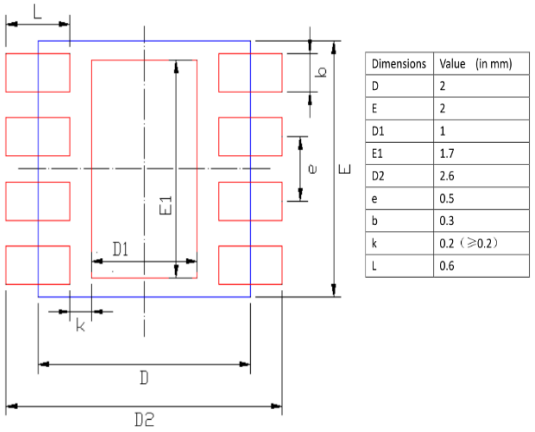
Battery Temperature Monitoring

ETA4116 continuously monitors temperature by measuring the voltage of NTC pin. A negative or positive temperature coefficient thermistor and an external voltage divider typically develop this voltage. ETA4116 compares this voltage against its internal 80%V_{IN} and 45%V_{IN} thresholds to determine if charging is allowed. The temperature sensing circuit is immune to any fluctuation in V_{IN}, since both the external voltage divider and the internal thresholds 80%V_{IN} and 45%V_{IN} are referenced to V_{IN}. If the NTC pin is connected to GND will disable the temperature-sensing feature.

PACKAGE OUTLINE

Package: DFN2x2-8





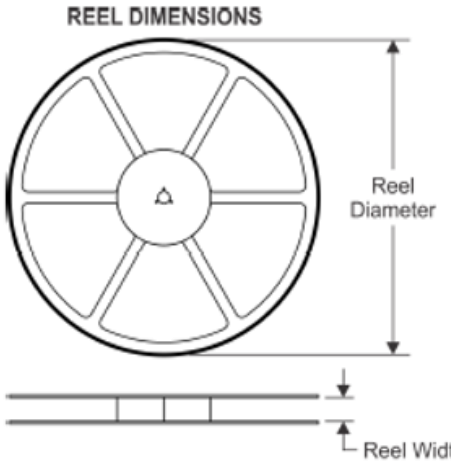
Dimensions	Value (in mm)
D	2
E	2
D1	1
E1	1.7
D2	2.6
e	0.5
b	0.3
k	0.2 (≥0.2)
L	0.6

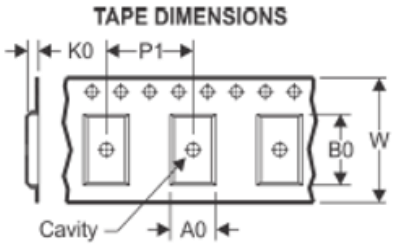
RECOMMENDED LAND PATTERN

COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

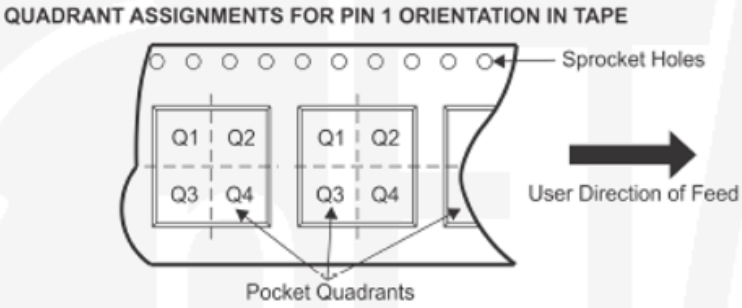
SYMBOL	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0	0.02	0.05
A3		0.20REF	
b	0.15	0.20	0.25
D	1.90	2.00	2.10
E	1.90	2.00	2.10
D2	0.50	0.60	0.70
E2	1.10	1.20	1.30
e	0.40	0.50	0.60
K	0.20	–	–
L	0.30	0.35	0.40
R	0.09	–	–

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
ETA4116D2I	DFN2x2-8	8	3000	180	9.5	2.3	2.3	1.1	4	8	Q1