# 36V/0.8A Standalone Single-Cell Linear Charger

## General Description

The ET95128 is a highly advanced linear charger for single-cell Li-Ion and Li-Polymer batteries. The device is ideally suited for portable applications due to the small package and low number of external components required.

The device employs a full charge algorithm with trickle current, constant current (CC), constant voltage (CV) modes, charge termination and automatic recharge. The device supports charge current up to 0.8A, programmed by an external resistor. The device can withstand an input voltage up to 36V, which can protect the charger from the accidental insertion of a high voltage supply or a hot insertion. The device can withstand a BAT voltage up to 14V, which is suited for power battery applications. Without an input supply, the battery leakage current is only 5nA typical.

The device provides various safety features for battery charging, including input under voltage lockout (UVLO), input over-voltage protection (OVP), battery reverse connection protection, and thermal regulation protection that is implemented by reducing the charge current when the junction temperature reaches 140°C.

## Features

- Easy-to-use Standalone Single-Cell Charger
- High Input Voltage Linear Charger
  - Support Up to 7V Operating Input Voltage with 36V Absolute Maximum Input Rating
  - Maximum BAT Withstand Voltage Up to 14V
  - Programmable Up to 0.8A Fast Charge Current
  - -0.5%/+1% Regulated Output Voltage Accuracy
  - Trickle Current 10% of Fast Charge Current
  - Termination Current 10% of Fast Charge Current
- High Integration
  - Integrated Reverse Blocking MOSFET
  - Built-in Charge Current Sensing
  - Internal Loop Compensation
  - Integrated Charge Status Indication
- Support Full Charge Cycle of Trickle Current Mode, Constant Current (CC) Mode, Constant Voltage (CV) Mode, Charge Termination and Automatic Recharge
- BAT Leakage Current 5nA Typical

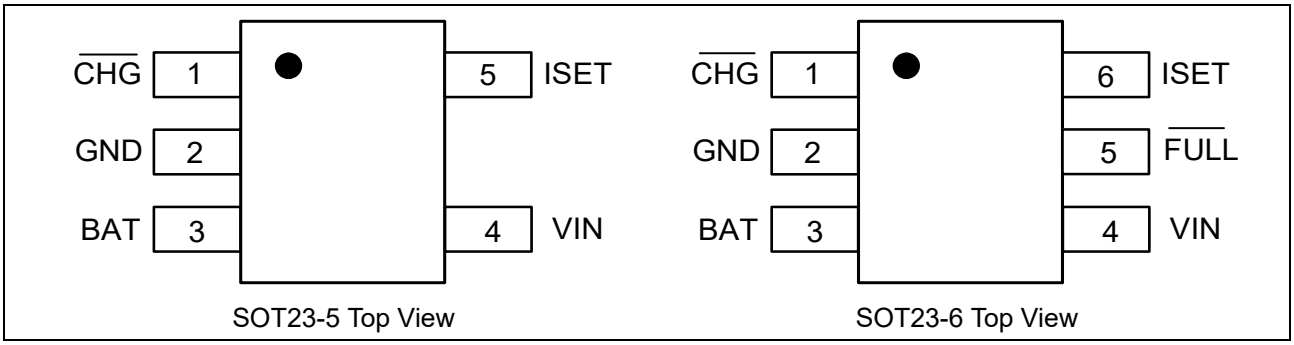
- Protection Features
  - Input Under-voltage Lockout (UVLO)
  - Input Over-voltage Protection (OVP)
  - Battery Reverse Connection Protection
  - Thermal Regulation
- RoHS Compliant and 100% Lead (Pb)-Free
- Package Information：

| Part No. | $V_{FLOAT}$ | Package | Reel | MSL |
|---|---|---|---|---|
| ET95128T | 4.2V | SOT23-5(2.92*2.8mm) | 3k/Reel | Level 3 |
| ET95128HT | 4.35V | SOT23-5(2.92*2.8mm) | 3k/Reel | Level 3 |
| ET95128T1 | 4.2V | SOT23-6(2.92*2.8mm) | 3k/Reel | Level 3 |
| ET95128HT1 | 4.35V | SOT23-6(2.92*2.8mm) | 3k/Reel | Level 3 |

## Application

- Wireless Speaker
- Cordless Power Tools
- Gaming Devices
- Portable Media Players
- Handheld Battery-Powered Devices
- Charging Docks and Cradles
- Power Bank
- E-Cigarettes

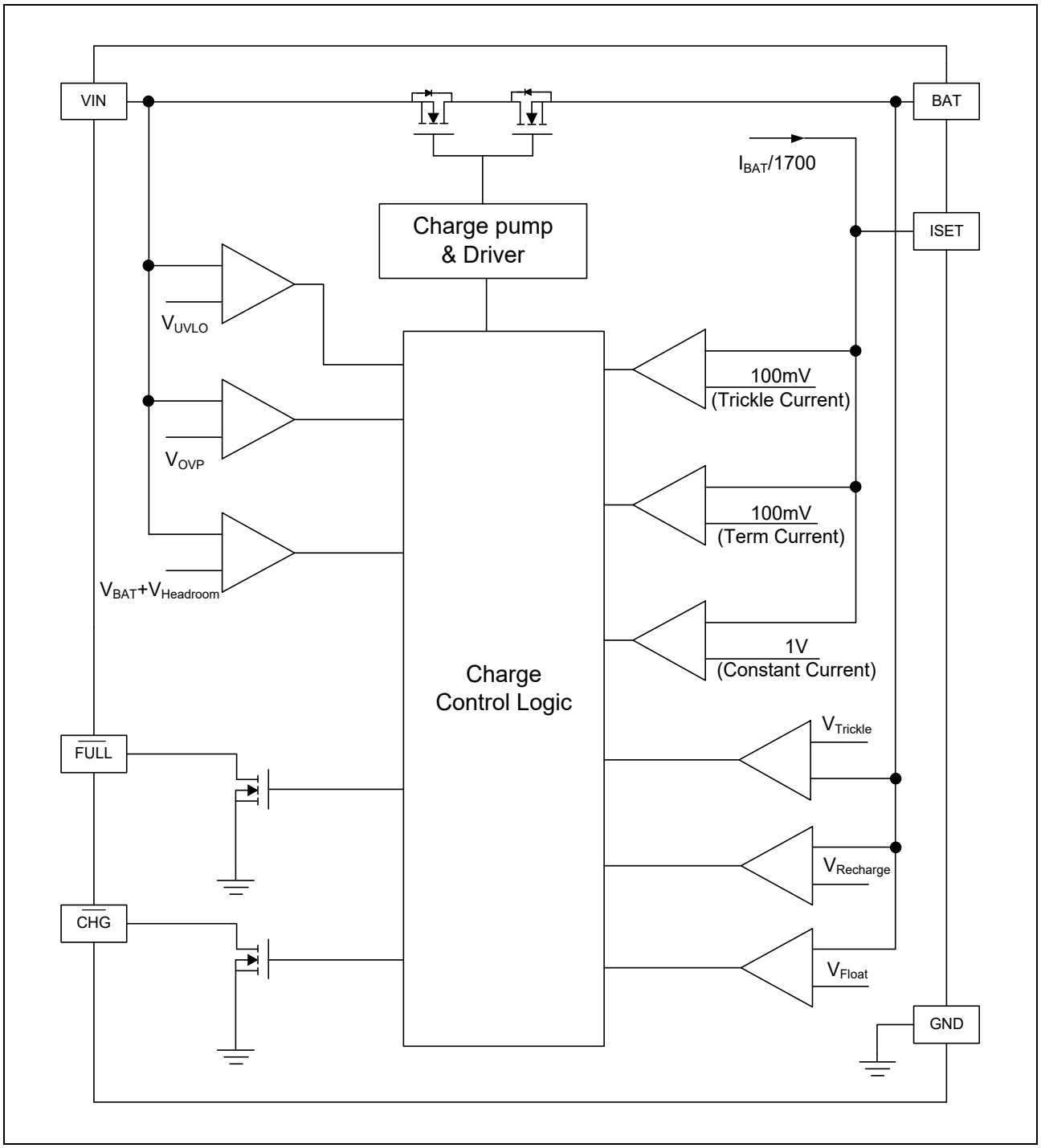
## Pin Configuration




## Pin Function

| Pin No. | | Pin Name | Description |
|---|---|---|---|
| SOT23-5 | SOT23-6 | | |
| 1 | 1 | $\overline{CHG}$ | Open-Drain Charge Status Output. When the device is in charging state, the $\overline{CHG}$ pin is pulled low by an internal NMOS. When the charge cycle is completed, the internal NMOS turned-off, the pin could be pulled high by an external pull-up resistor. |
| 2 | 2 | GND | GND. Connect to the system ground. |
| 3 | 3 | BAT | Battery Pin. Connect to the battery, A 1-10μF capacitor is needed typically. |
| 4 | 4 | VIN | Positive Supply Voltage Input. Place a 4.7Ω resistor and a 1~10μF ceramic capacitor in series from VIN to GND, and place the components as close as possible to IC. |
| | 5 | $\overline{FULL}$ | Open-Drain Status Output. When the device is in charging state, the $\overline{FULL}$ pin is pulled high by an external pull-up resistor. When the charge cycle is completed, the pin is pulled low by an internal NMOS. |
| 5 | 6 | ISET | Fast Charge Current Program Pin. Connect this pin with an external resistor $R_{ISET}$ to GND to program the fast charge current. |

## Block Diagram



## Absolute Maximum Ratings

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{IN}$ | VIN to GND | -0.3 to +36 | V |
| | $\overline{CHG}$ , $\overline{FULL}$ to GND | -0.3 to +28 | V |
| $V_{BAT}$ | BAT to GND | -5 to +14 | V |
| | ISET Pin to GND | -0.3 to +6.5 | V |
| $T_{STG}$ | Storage Temperature Range | -55 to 150 | °C |
| $T_J$ | Maximum Junction Temperature | 150 | °C |
| ESD | Human Body Model (1) | ±2000 | V |
| | Charged Device Model (1) | ±500 | |
| $T_{SOLD}$ | Maximum Soldering Temperature (at leads, 10 sec) | 260 | °C |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

***Note1:*** This device series incorporates ESD protection and is tested by the following methods:

ESD Human Body Model tested per ESDA/JEDEC JS-001-2017.

ESD Charged Device Model tested per ESD22-C101.

## Recommended Operating Conditions

| Symbol | Characteristic | Min | Max | Unit |
|---|---|---|---|---|
| $V_{IN}$ | Input Voltage | 4.5 | 6 | V |
| $I_{CHG}$ | Maximum Charge Current | - | 0.8 | A |
| $T_J$ | Operating Junction Temperature Range | -20 | 140 | °C |
| $T_A$ | Operating Ambient Temperature Range | -20 | +85 | °C |

## Electrical Characteristics

$V_{IN}$=5V, $T_A$=25°C for typical values (unless otherwise noted).

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **INPUT VOLTAGE AND CURRENT** | | | | | | |
| $V_{IN}$ | Input Voltage Range | | 4.5 | 5 | 6 | V |
| $I_{Standby}$ | Input Standby Current | Standby mode (Charge terminated) | | 100 | | uA |
| $V_{UVLO}$ | Under Voltage Lockout of $V_{IN}$ | $V_{IN}$ Rising | 3.3 | 3.5 | 3.7 | V |
| $V_{UVLO_HYS}$ | $V_{UVLO}$ Hysteresis | $V_{IN}$ Falling | | 200 | | mV |
| $V_{OVP}$ | Over-Voltage Protection Threshold Voltage | $V_{IN}$ Rising | 6.7 | 7 | 7.3 | V |
| $V_{OVP_HYS}$ | OVP Hysteresis | $V_{IN}$ Falling | | 250 | | mV |
| **BAT LEAKAGE CURRENT** | | | | | | |
| $I_{BAT_Leakage}$ | Battery Leakage Current | $V_{IN}$ Floating,$V_{BAT}$=4.2V | | 5 | | nA |
| **BATTTERY CHARGER** | | | | | | |
| $V_{FLOAT}$ | Regulated Output Voltage | ET95128T/ET95128T1 | 4.179 | 4.2 | 4.242 | V |
| | | ET95128HT/ET95128HT1 | 4.328 | 4.35 | 4.394 | V |
| $I_{CHG}$ | Fast Charge Current | $R_{ISET}$=3.4kΩ, Constant Current Mode | 460 | 500 | 540 | mA |
| | | $R_{ISET}$=17kΩ, Constant Current Mode | 90 | 100 | 110 | mA |
| $I_{EOC}$ | End of Charge Current | $R_{ISET}$=3.4kΩ, Constant Voltage Mode | | 10% | | $I_{CC}$ |
| $I_{TC}$ | Trickle Charge Current | $V_{BAT}$<$V_{PRE}$, $R_{ISET}$=3.4kΩ | | 10% | | $I_{CC}$ |
| $V_{PRE}$ | Trickle Charge Threshold Voltage | $V_{BAT}$ Rising | 2.75 | 2.9 | 3.05 | V |
| $V_{PRE_HYS}$ | Trickle Charge Hysteresis Voltage | $V_{BAT}$ Falling | | 200 | | mV |
| $V_{RECHG}$ | Battery Recharge Voltage Difference Threshold ($V_{FLOAT}$ -$V_{RECHRG}$) | $V_{BAT}$ Falling | 100 | 150 | 200 | mV |
| $V_{Headroom}$ | $V_{IN}$-$V_{BAT}$ threshold Voltage | $V_{BAT}$=3.7V, $V_{IN}$ Rising | 80 | 130 | 180 | mV |
| $V_{Headroom_HYS}$ | $V_{IN}$-$V_{BAT}$ threshold Voltage Hysteresis | $V_{BAT}$=3.7V, $V_{IN}$ Falling | | 60 | | mV |
| $T_{FOLD}$ | Junction Temperature Limit | Thermal Foldback Protection State | | 140 | | °C |
| $R_{DS}$ | VIN-BAT MOSFET on-resistance | Charge Current=500mA | | 760 | | mΩ |

## Electrical Characteristics (Continued)

$V_{IN}$=5V, $T_A$=25°C for typical values (unless otherwise noted).

| **ISET/ $\overline{\text{CHG}}$ / $\overline{\text{FULL}}$ PINs** | | | | | | |
|---|---|---|---|---|---|---|
| $V_{ISET_CC}$ | ISET Pin Voltage | Constant Current Mode | | 1 | | V |
| $V_{ISET_TC}$ | | Trickle Current Mode | | 0.1 | | V |
| $V_{STAT}$ | $\overline{\text{CHG}}$ / $\overline{\text{FULL}}$ Pin Output Low Voltage | $I_{STAT}$=5mA | | | 0.5 | V |
| $I_{STAT}$ | $\overline{\text{CHG}}$ / $\overline{\text{FULL}}$ Pin Sink Current | | | | 5 | mA |

## Detailed Description

### Overview

The ET95128 is a highly advanced linear charger with up to 0.8A maximum charge current for single cell Li-Ion and Li-Polymer batteries. The device charges the battery with full charge cycle: trickle current mode, constant current mode (CC), constant voltage mode (CV), charge termination and recharge. The typical charge profile can be showed as the figure below.

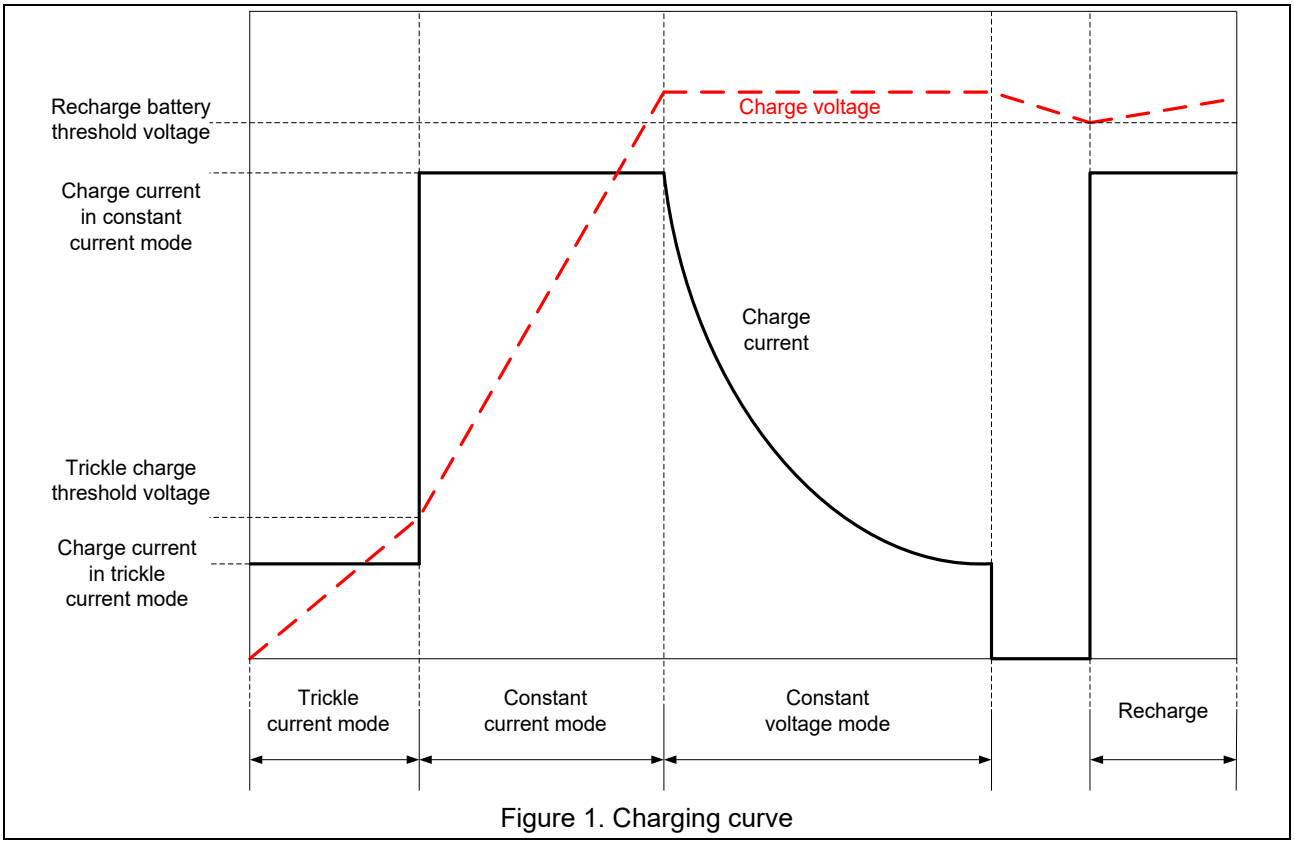



Figure 1. Charging curve

When the battery voltage is lower than Trickle Charge Threshold Voltage ($V_{PRE}$, 2.9V typical), the device charges in the trickle current mode, the charge current will be set to Trickle Charge Current ($I_{TC}$), which is approximately 10% of the ISET programmed Fast Charge Current ($I_{CHG}$) to bring the battery voltage up to a safe level for full current charging. When the battery voltage rises to $V_{PRE}$, the device enters the constant current mode, where the charge current is 100%$I_{CHG}$. When the battery voltage approaches the Regulated Output Voltage ($V_{FLOAT}$), the device goes to constant voltage mode, the charge current starts to decrease. When the charge current is lower than the Termination Current threshold ($I_{EOC}$), which is 10%$I_{CHG}$, the device will terminate the charging.

The device will automatically recharge the battery while the battery voltage drops $\Delta V_{RECHRG}$ (150mV, typical) from the Regulated Output Voltage ($V_{FLOAT}$)

**ISET Programming Fast Charge Current**

The Fast Charge Current ($I_{CHG}$) is set by a resistor ($R_{ISET}$) connecting from the ISET pin to GND. The relationship between $I_{CHG}$ and the programming resistance is established by the following formula:

$$I_{CHG} = \frac{V_{ISET} \times 1700}{R_{ISET}} \quad (1)$$

Where $V_{ISET}$=1V typical.

**Charge Termination and Automatic Recharge**

A charge cycle will be terminated when the charge current falls to $I_{EOC}$ (10%$I_{CHG}$, typical), as the battery voltage reached $V_{FLOAT}$. The function is implemented by monitoring the ISET pin voltage and comparing to a 100mV threshold voltage. When the ISET pin voltage falls below 100mV for longer than 1ms typically, the charging will be terminated.

Once the charge cycle is terminated, the ET95128 continuously monitors the voltage on the BAT pin by a comparator. A new charge cycle starts when the battery voltage drops by a voltage difference $\Delta V_{RECHRG}$ (150mV, typical) from $V_{FLOAT}$, which means the battery level drops to approximately 80% to 90% capacity. This ensures that the battery always keeps at or near a fully charged condition.

**Under-Voltage Lockout (UVLO) and Minimum Headroom Voltage**

An internal UVLO circuit monitors the input voltage and keeps the device in Shutdown mode until the input supply rises above the UVLO threshold. The UVLO circuitry has a built-in hysteresis of 200 mV. The UVLO circuit always be active.

Again, the input supply must be $V_{Headroom}$ (130mV, typical) higher than the battery voltage before the ET95128 become operational. Whenever the input supply is below the UVLO threshold or lower than a voltage of $V_{Headroom}$ above the BAT pin, the ET95128 is in Shutdown mode.

**Charge Status Indicator ($\overline{CHG}$ & $\overline{FULL}$)**

When the input voltage is above the $V_{UVLO}$ and above the voltage of $V_{BAT}$+$V_{Headroom}$, but lower than $V_{OVP}$ ($V_{IN}$<$V_{OVP}$), $\overline{CHG}$ and $\overline{FULL}$ pins have two different states: strong pull-down (~5mA) and high impedance. The strong pull-down state of CHG implemented by an internal NMOS indicates that the ET95128 is in a charge cycle. After the charge current decreased to $I_{EOC}$ in CV mode and then charging terminated, the $\overline{CHG}$ pin will become high impedance, the $\overline{FULL}$ pin will become pull-down state.

| Function | $\overline{CHG}$ | $\overline{FULL}$ |
|---|---|---|
| Charging | Low | Hi-Z |
| Charge Terminated | Hi-Z | Low |

### Thermal Regulation Foldback

An internal thermal regulation foldback loop reduces charge current if the junction temperature reaches a preset value of approximately 140°C to prevent further temperature rise. This function protects the device from excessive temperature and allows the user to get the limits of the power handling capability of a given circuit board without the risk of damaging the device. The charge current can be set according to typical ambient temperature with the assurance that the charger will automatically reduce the current in worst-case conditions.

Charge termination function will not be active when thermal foldback regulation protection is happening.

## Application Information

### External Capacitors

In order to maintain good stability in the whole charge cycle, a capacitance of 1-10μF is recommended to bypass the BAT pin to GND. In addition, the battery and interconnections appear inductive at high frequencies. These elements are in the control feedback loop during constant voltage mode. Therefore, the bypass capacitance may be necessary to compensate for the inductive nature of thew battery pack.

### ISET Resistor

In order to assure the accuracy of the charge current, better than 1% precision resistance is recommended.

### Layout Consideration

For optimum voltage regulation, place the battery pack as close as possible to the device's BAT and GND pins. This is recommended to minimize voltage drops along the high current-carrying PCB traces. If the PCB layout is used as a heat sink, adding many vias in the heat sink pad can help conduct more heat to the PCB backplane, thus reducing the maximum junction temperature. It is also recommended to place the capacitor $C_{IN}$ and $C_{OUT}$ as close as possible to the corresponding pins and the GND pin.

## Application Circuit

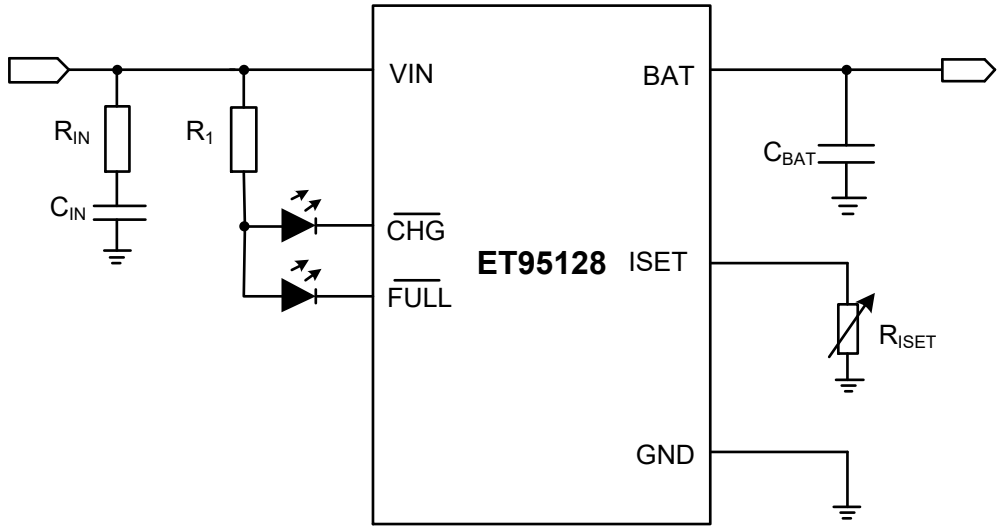
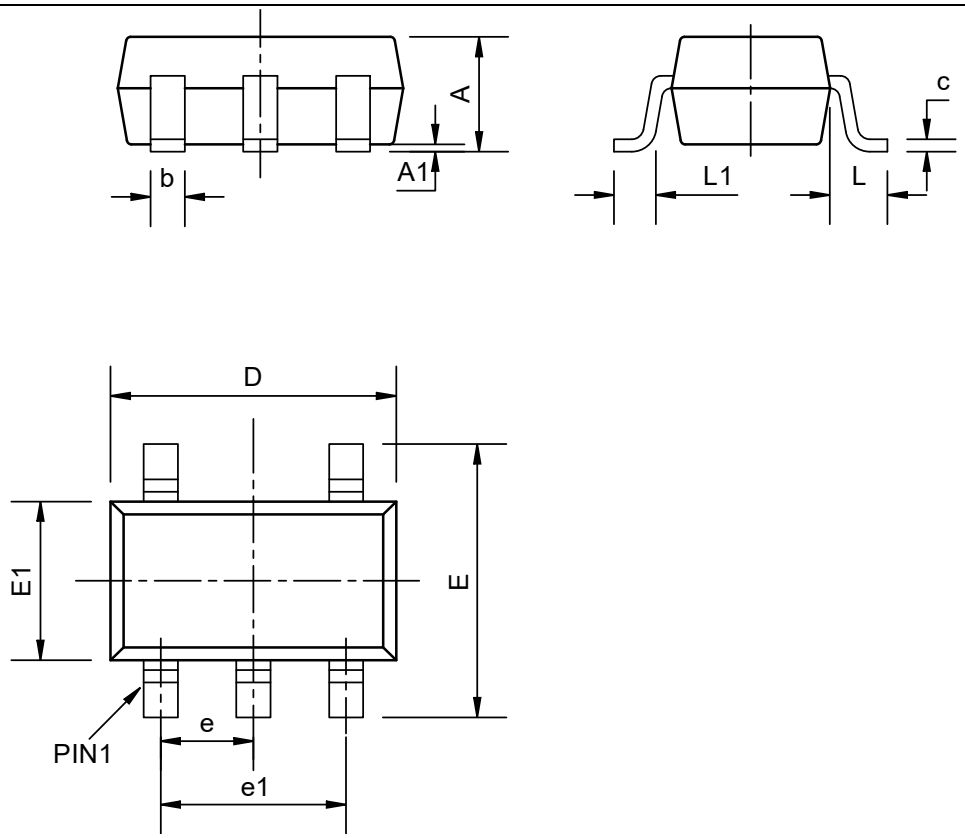



Figure 2. Typical Application Circuit

***Note2.*** This application circuit is used for ET95128T1 or ET95128HT1.

## Package Dimension

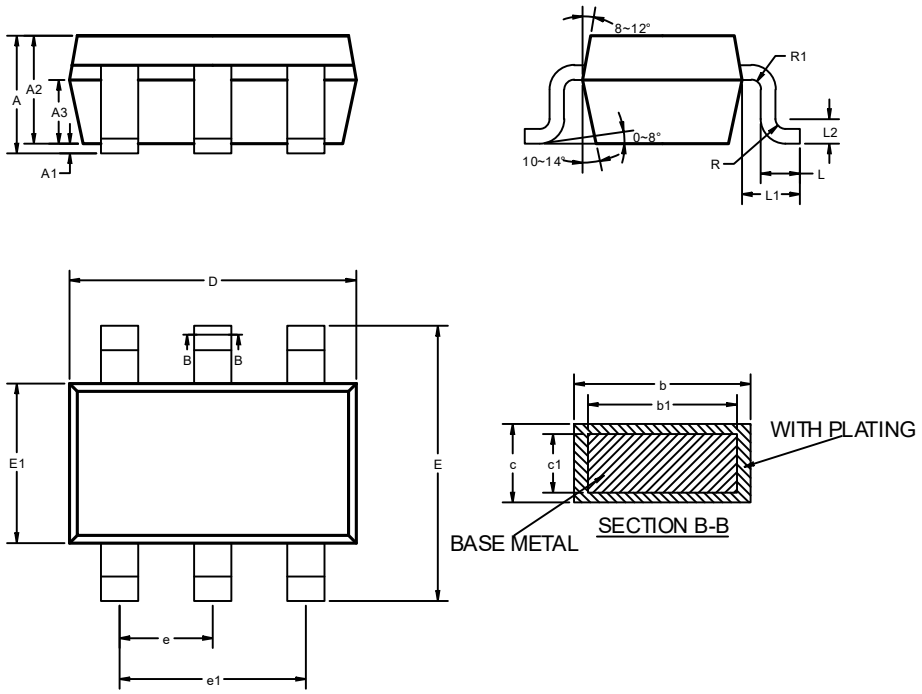
SOT23-5(2.92*2.8mm)




**Dimensions Table (Units:mm)**

| Symbol | Min | NOM | Max |
|---|---|---|---|
| A | 1.050 | 1.150 | 1.250 |
| A1 | 0.000 | — | 0.100 |
| b | 0.300 | 0.350 | 0.400 |
| c | 0.100 | — | 0.200 |
| D | 2.820 | 2.920 | 3.020 |
| E | 2.650 | 2.800 | 2.950 |
| E1 | 1.500 | 1.600 | 1.700 |
| e | 0.950 BSC | | |
| e1 | 1.800 | 1.900 | 2.000 |
| L | 0.700 BSC | | |
| L1 | 0.300 | 0.450 | 0.600 |

SOT23-6(2.92*2.8mm)

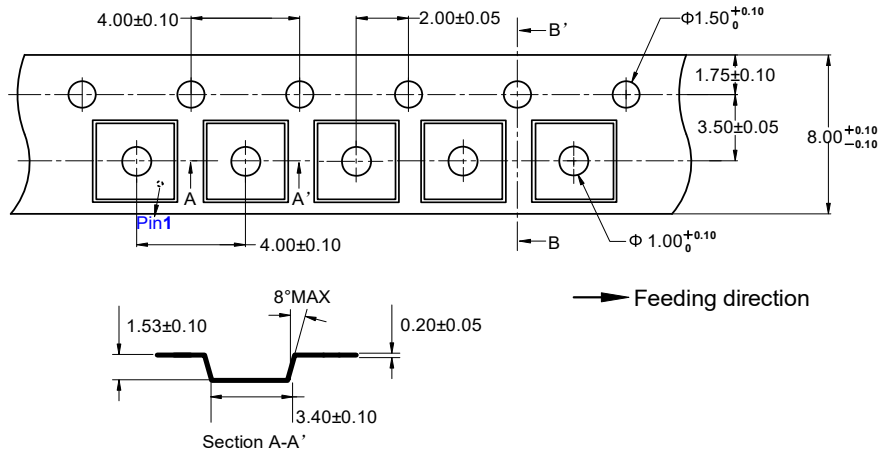


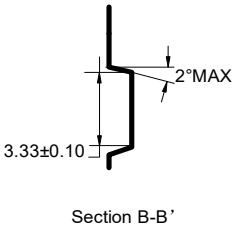

COMMON DIMENSIONS

(UNITS OF MEASURE=MILLIMETER)

| SYMBOL | MIN | NOM | MAX |
|---|---|---|---|
| A | — | — | 1.250 |
| A1 | 0 | — | 0.150 |
| A2 | 0.750 | — | 1.200 |
| A3 | 0.350 | 0.650 | 0.700 |
| b | 0.360 | — | 0.460 |
| b1 | 0.350 | 0.380 | 0.430 |
| c | 0.130 | — | 0.200 |
| c1 | 0.120 | 0.150 | 0.160 |
| D | 2.820 | 2.920 | 3.020 |
| E | 2.600 | 2.800 | 3.000 |
| E1 | 1.500 | 1.626 | 1.726 |
| e | 0.900 | 0.950 | 1.000 |
| e1 | 1.800 | 1.900 | 2.000 |
| L | 0.300 | 0.400 | 0.500 |
| L1 | 0.590REF | | |
| L2 | 0.250BSC | | |
| R | 0.050 | — | 0.200 |
| R1 | 0.050 | — | 0.200 |

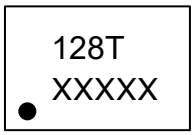
## Tape Information




Unit : mm

## Marking Information




***Note***：X (Tracking Number) is variable, according to the wafer lot number.

## Revision History and Checking Table

| Version | Date | Revision Item | Modifier | Function & Spec Checking | Package & Tape Checking |
|---|---|---|---|---|---|
| 1.0 | 2025-12-11 | Official Version | Licx | Zhujy | Liujy |
| 1.0.a | 2026-1-19 | Add overlines to CHG and FULL | Licx | Zhujy | Liujy |
| 1.0.b | 2026-2-5 | Update description | Licx | Zhujy | Liujy |