1A Single-chip Li-ion Charger with OVP

General Description

The ET95152 is a cost-effective, fully integrated high input voltage single-cell Li-ion battery charger. The charger uses a CC/CV charge profile required by Li-ion battery. The charger accepts an input voltage up to 28V but is disabled when the input voltage exceeds the OVP threshold, typically 6.8V (ET95152A) or 10.5V (ET95152B), to prevent excessive power dissipation. The 28V rating eliminates the over-voltage protection circuit required in a low input voltage charger.

The charge current and the end-of-charge (EOC) current are programmable with external resistors. When the battery voltage is lower than typically 2.55V, the charger preconditions the battery with typically 18% of the programmed charge current. When the charge current reduces to the programmable EOC current level during the CV charge phase, an EOC indication is provided by the $\overline{CHG}$ pin, which is an open-drain output. An internal thermal foldback function protects the charger from any thermal failure.

Two indication pin $\overline{CHG}$ allow simple interface to a microprocessor or LEDs. When no adapter is attached or when disabled, the charger draws less than 1μA leakage current from the battery.

The ET95152 is available in DFN10(3×3) and rated over the -40°C to +85°C temperature range.

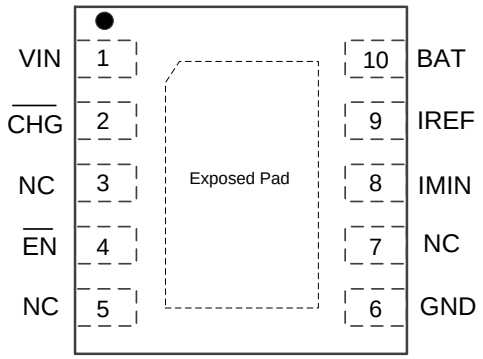
Features

- Complete Charger for Single-Cell Li-ion or Polymer Batteries
- Integrated Pass Element and Current Sensor
- No External Blocking Diode Required
- Low Component Count and Cost
- Programmable Charge Current up to 1.1A
- Programmable End-of-Charge Current
- Charge Current Thermal Foldback for Thermal Protection
- 2.55V Trickle Charge Threshold
- 6.8V Input Over-Voltage Protection for ET95152A
- 10.5V Input Over-Voltage Protection for ET95152B
- 28V Maximum Voltage for the Power Input
- Power Presence and Charge Indications
- 1μA Leakage Current off the Battery When No Input Power Attached or Charger Disabled
- DFN10 (3×3) Package

Applications

- Blue-Tooth Devices
- Stand-Alone Chargers
- Other Handheld Devices

Pin Configuration



DFN10

TOP VIEW

Pin Function

Pin No.	Name	Function
1	VIN	Power Supply Input.
2	$\overline{CHG}$	Indicator Output for Power Status.
3,5,7	NC	None connect.
4	$\overline{EN}$	Enable Input. Drive to high to disable the charger. Driven to low or left floating, the charger is enabled. This pin has an internal pull-down resistor.
6	GND	Exposed Thermal Pad. Must be electrically connected to the GND.
8	IMIN	End-of-Charge (EOC) Current Programming Pin. Connect a resistor between this pin and the GND pin to set the EOC current. The EOC current IMIN can be programmed by the following equation: $I_{MIN} = 9700/R_{IMIN}$ (mA) Where R_{IMIN} is in KΩ.
9	IREF	Charge-Current Programming and Monitoring Pin. Connect a resistor between this pin and the GND pin to set the charge current limit determined by the following equation: $I_{REF} = 12150/R_{IREF}$ (mA) Where R_{IREF} is in KΩ.
10	BATT	Charger Output Pin.
	Exposed PAD	Exposed PAD. Connect to GND

Product Information

Part	VBAT (V)	VOVP (V)	PRODUCT NAME
ET95152	4.2V	6.8V	ET95152AL
		10.5V	ET95152BL
	4.35V	6.8V	ET95152AH
		10.5V	ET95152BH

Functional Description

The ET95152 charges a Li-ion battery using a CC/CV profile. The constant current IREF is set with the external resistor R_{IREF} (see Figure 1) and the constant voltage is fixed at 4.2V. If the battery voltage is below a typical 2.55V trickle charge threshold, the ET95152 charges the battery with a trickle current of 18% of IREF until the battery voltage rises above the trickle charge threshold. Fast charge CC mode is maintained at the rate determined by programming IREF until the cell voltage rises to 4.2V. When the battery voltage reaches 4.2V, the charger enters a CV mode and regulates the battery voltage at 4.2V to fully charge the battery without the risk of over charge. Upon reaching an end-of-charge (EOC) current, the charger indicates the charge completion with the $\overline{CHG}$ pin, but the charger continues to output the 4.2V voltage. Figure 1 shows the typical charge waveforms after the power is on.

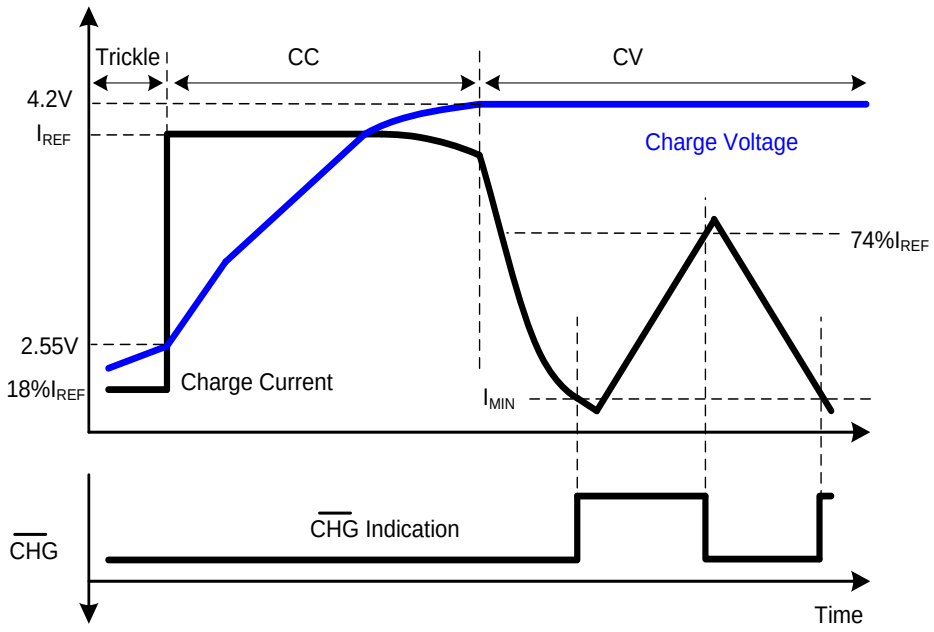


Figure1. Typical Charge Profile

End of Charge Current

The EOC current level I_{MIN} is programmable with the external resistor R_{IMIN}. The $\overline{CHG}$ pin turns to low when the trickle charge starts and rises to high impedance at the EOC. After the EOC is reached, the charge current has to rise to typically 74% IREF for the $\overline{CHG}$ pin to turn on again, as shown in Figure 1. The current surge after EOC can be caused by a load connected to the battery.

The EOC current I_{MIN} can be programmed by the following equation:

$$I_{MIN} = 9700 / R_{IMIN} (mA)$$

Where R_{IMIN} is in kΩ.

Thermal Foldback

A thermal foldback function reduces the charge current anytime when the die temperature reaches typically 115°C. This function guarantees safe operation when the printed circuit board (PCB) is not capable of dissipating the heat generated by the linear charger.

OVP

The ET95152 accepts an input voltage up to 28V but disables charging when the input voltage exceeds the OVP threshold, typically 6.8V for ET95152A and 10.5V for ET95152B, to protect against unqualified or faulty AC adapters.

$\overline{CHG}$ Indication

The $\overline{CHG}$ is an open-drain output capable of sinking at least 15mA current when the charger starts to charge, and turns off when the EOC current is reached. The $\overline{CHG}$ signal is interfaced either with a microprocessor GPIO or an LED for indication.

$\overline{EN}$ Input

$\overline{EN}$ is an active-low logic input to enable the charger. Drive the $\overline{EN}$ pin to low or leave it floating to enable the charger. This pin has a 200kΩ internal pull-down resistor so when left floating, the input is equivalent to logic low. Drive this pin to high to disable the charger. The threshold for high is given in the Electrical Characteristics table.

IREF Pin

The IREF pin has the two functions as described in the Pin Description section. When setting the fast charge current, the charge current is guaranteed to have 12% accuracy with the charge current set at 500mA. When monitoring the charge current, the accuracy of the IREF pin voltage vs. the actual charge current has the same accuracy as the gain from the IREF pin current to the actual charge current.

The charge current IREF can be programmed by the following equation:

$$I_{REF} = 12150 / R_{IREF} (mA)$$

Where R_{IREF} is in kΩ.

Absolute Maximum Ratings

Parameter	Rating	Unit
VIN to GND	-0.3 to 30	V
$\overline{CHG}$, $\overline{EN}$, IMIN, IREF, BAT to GND.	-0.3 to 6	V
Storage Temperature Range	-65 to 150	°C
DFN10(3×3), θ_{JA}	84	°C/W
DFN10(3×3), P_D	1.1	W
Junction Temperature	150	°C
Operating Temperature Range	-40 to 85	°C
Lead Temperature (Soldering 10 sec)	260	°C

Electrical Characteristics

(V_{IN} = 5V, R_{IMIN} = 243kΩ, T_A = 25°C, unless otherwise noted.)

Parameter		Symbol	Conditions	Min	Typ	Max	Units
Recommended Operating Conditions							
Maximum Supply Voltage				--	--	28	V
Operating Supply Voltage	ET95152A			4.55	--	6.10	V
	ET95152B			4.55	--	9.35	
Programmed Charge Current				100	--	1100	mA
Power-On Reset							
Rising POR Threshold		V_{POR}	V_{BAT} = 3.0V, R_{IREF} = 120kΩ	3.21	3.95	4.55	V
Falling POR Threshold		V_{POR}		2.86	3.60	4.35	V
Over-Voltage Protection							
Over-Voltage Protection Threshold	ET95152A	V_{OVP}	V_{BAT} = 4.3V, R_{IREF} = 120kΩ	6.10	6.80	7.26	V
	ET95152B			9.35	10.5	11.15	
OVP Threshold Hysteresis	ET95152A	V_{OVPHYS}		140	220	300	mV
	ET95152B			245	340	430	
Standby Current							
BAT Pin Sink Current		$I_{STANDBY}$	The input is floating, V_{BAT} = 4V	--	1	5	μA
VIN Pin Supply Current		I_{VIN}	V_{BAT} = 4.5V, R_{IREF} = 24.3kΩ, charger disabled	--	200	275	μA
VIN Pin Supply Current		I_{VIN}	V_{BAT} = 4.5V, R_{IREF} = 24.3kΩ, charger enabled	--	270	320	μA

Electrical Characteristics(Continued)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Voltage Regulation						
Output Voltage	V_{CH}	R_{IREF} = 24.3kΩ, 4.55V < V_{IN}< 6.10V,	4.152	4.2	4.248	V
		R_{IREF} = 24.3kΩ, 4.55V < V_{IN}< 6.10V,	4.305	4.35	4.395	
PMOS On Resistance	$R_{DS\ (ON)}$	V_{BAT} = 3.8V, charge current = 500mA, R_{IREF} = 10kΩ	--	0.5	--	Ω
Charge Current						
IREF Pin Output Voltage	V_{IREF}	V_{BAT} = 3.8V, R_{IREF} = 120kΩ	--	1.215	--	V
Constant Charge Current	I_{REF}	R_{IREF} = 24.3kΩ, V_{BAT} = 2.8V to 3.8V	440	500	560	mA
Trickle Charge Current	I_{TRK}	R_{IREF} = 24.3kΩ, V_{BAT} = 2.4V	55	90	135	mA
End-of-Charge Current (1)	I_{MIN}	R_{IREF} = 24.3kΩ	20	40	75	mA
EOC Rising Threshold		R_{IREF} = 24.3kΩ	315	370	435	mA
Preconditioning Charge Threshold						
Preconditioning Charge Threshold Voltage	V_{MIN}	R_{IREF} = 120kΩ	2.40	2.55	2.70	V
Preconditioning Voltage Hysteresis	V_{MINHYS}	R_{IREF} = 120kΩ	20	100	190	mV
Internal Temperature Monitoring						
Charge Current Foldback Threshold(1)	T_{FOLD}		--	115	--	°C
Logic Input and Outputs						
$\overline{EN}$ Pin Logic Input High			1.5	--	--	V
$\overline{EN}$ Pin Logic Input Low			--	--	0.4	V
$\overline{EN}$ Pin Internal Pull Down Resistance			--	200	--	kΩ
$\overline{CHG}$ Sink Current when LOW		Pin Voltage = 1V	15	24	--	mA
$\overline{CHG}$ Leakage Current when High Impedance		V_{CHG}= 5.5V	--	--	20	μA

Note 1. Guaranteed by design and characterization. not a FT item.

Application Circuits

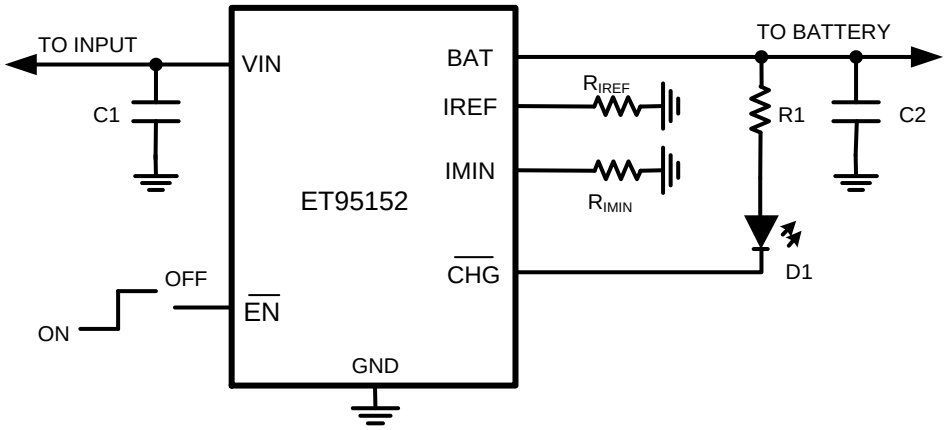


Figure 2. Application Circuit Interfacing to Indication LEDs

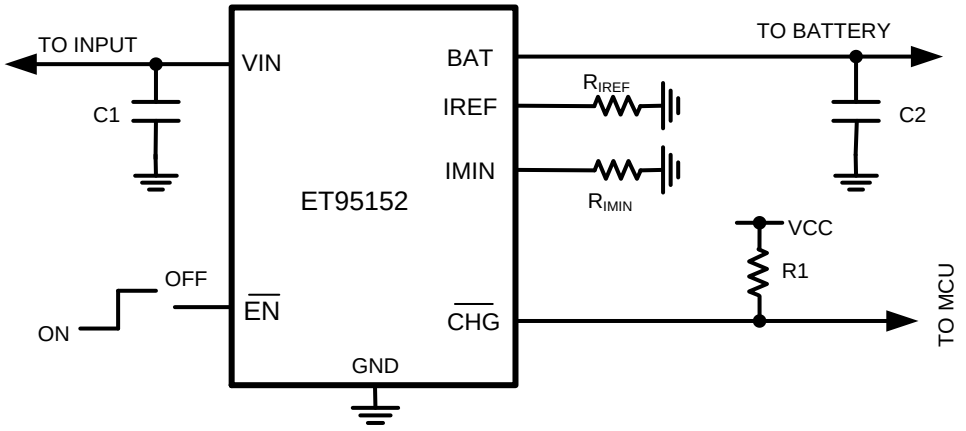
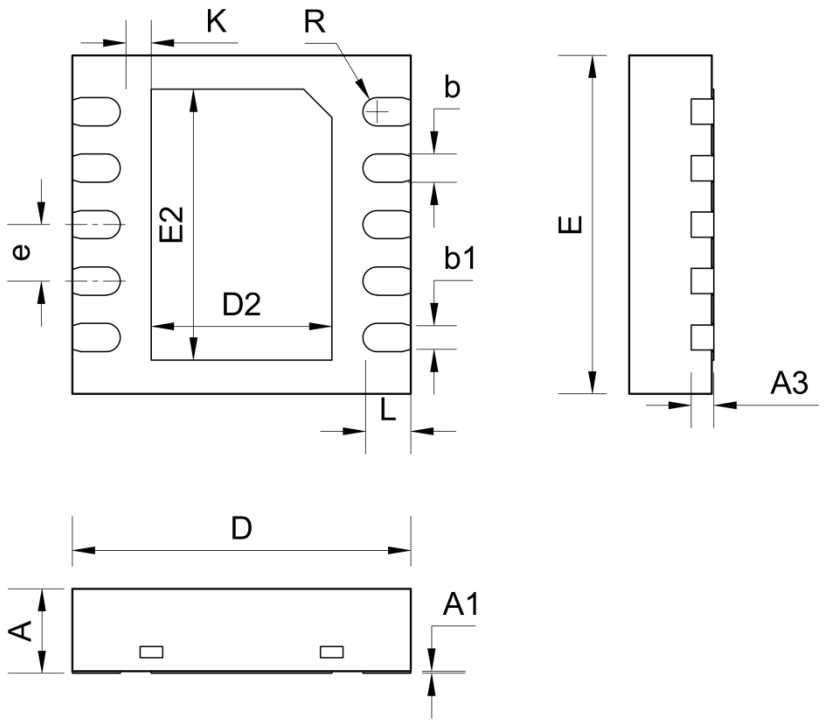


Figure 3. Application Circuit with the Indication Signals Interfacing to an MCU

Package Dimension

DFN10



COMMON DIMENSION
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3		0.20 REF	
b	0.20	0.25	0.30
b1		0.20 REF	
D	2.90	3.0	3.10
E	2.90	3.0	3.10
D2	1.50	1.60	1.70
E2	2.40	2.50	2.60
e	0.40	0.50	0.60
K	0.20	-	-
L	0.30	0.40	0.50
R	0.13	-	-

Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
1.0	2020-05-11	Initial version	Xiayj	Xiayj	Zhujl
1.1	2023-08-30	Update Typeset	Qinpl	Xiayj	Liujy