Single Inductor, 2.5A Switch Mode Battery Charger with 1.5A USB OTG

DESCRIPTION

ETA6195 is a switching Li-Ion battery charger capable of delivering up to 2.5A of charging current to the battery and also capable of delivering up to 1.5A in boost OTG operation, with high efficiency in both charging mode and OTG mode. For charging, it uses a proprietary control scheme that eliminates the current sense resistor for conventional constant current control, maximizing efficiency, reducing charging time and reducing costs. It can also output a 5V voltage in the reversed direction by boosting from the battery. It only needs a single inductor to provide power bi-directionally. ETA6195 is an ideal all-in-one solution for battery charging and discharge applications, such as power banks, smart phones, and tablets with only one USB port that can be used for both charging battery and USB OTG function.

ETA6195 is suitable for charging a 4.35V Li-ion battery. And ETA6195 is in DFN2x3-8 package.

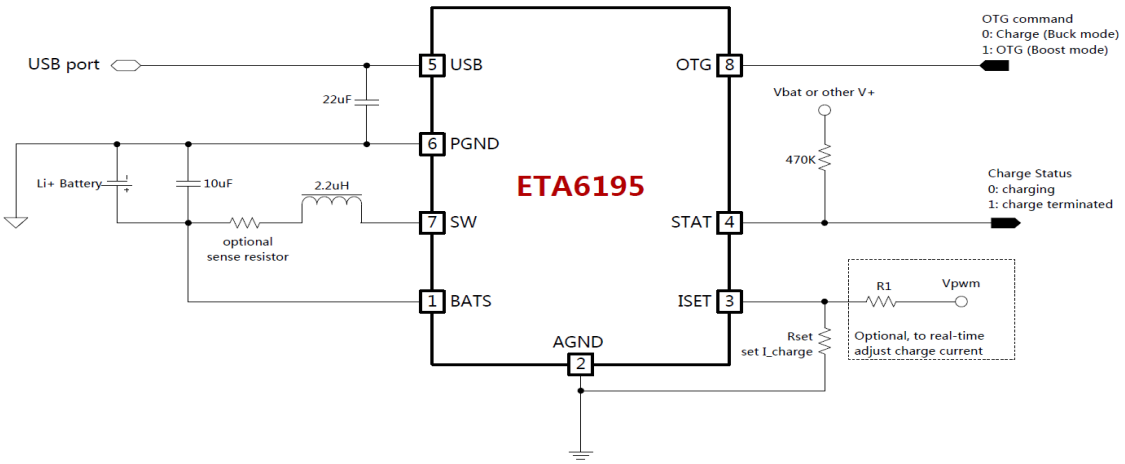
FEATURES

- Bi-Directional Power conversion with Single Inductor
- Switching Charger
- 5V Synchronous Boost
- Up to 95% Efficiency
- Up to 2.5A Max charging current and 1.5A discharging
- No-Battery detection
- No External Sense resistor

APPLICATIONS

- Tablet, MID
- Smart Phone
- Power Bank

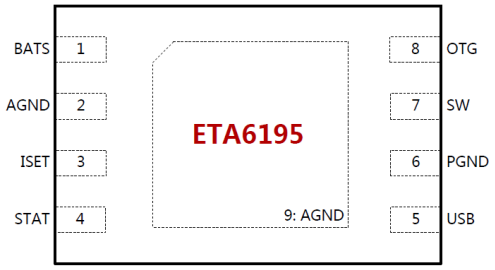
TYPICAL APPLICATION



ORDERING INFORMATION

PART No.	PACKAGE	TOP MARK	Pcs/Reel
ETA6195DGI	DFN2x3-8	JkYW	3000

PIN CONFIGURATION



DFN2x3-8

ABSOLUTEMAXIMUM RATINGS

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

USB Voltage .....–0.3V to 6V
All Other Pin Voltage ....V_{USB}–0.3V to V_{USB}+0.3
SW,USB to ground current.....Internally limited
Operating Temperature Range .....–40°C to 85°C
Storage Temperature Range .....–55°C to 150°C

Thermal Resistance	θ_{JC}	θ_{JA}
DFN2X3-8	20	70 ..... °C/W

Lead Temperature (Soldering, 10sec) .....260°C
ESD HBM (Human Body Mode) 2KV
ESD MM (Machine Mode) 200V

ELECTRICAL CHACRACTERISTICS

(V_{IN} = 5V, unless otherwise specified. Typical values are at TA = 25oC.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
BUCK MODE					
USB Range		4.5		5.5	V
USB UVLO Voltage	Rising, Hys=500mV		4.5		V
USB OVP Voltage	Rising, Hys=320mV	5.89	6.08	6.27	V
USB Operating Current as BUCK	Switcher Enable, Switching		5		mA
	Switcher Enable, No Switching		800		μA
BATTERY CHARGER					
Battery CV Voltage	I_{BAT} =0mA, default	4.306	4.35	4.394	V
Charger Restart Threshold	From DONE to Fast Charge		160		mV
Battery Pre-Condition Voltage	V_{BAT} Falling Hys=250mV		2.9		V
Pre-Condition Charge Current			200		mA
Fast Charge Current	R_{ISET} =82KΩ		2		A
	R_{ISET} =150KΩ		1.2		A
Charge Termination Current			130		mA
Charge Termination Blanking time			16		S
BOOST MODE					
BATT Ok Threshold	Rising, HYS=0.6 V		3.1		V
Output Voltage Range	Iout=100mA	5.0	5.1	5.2	V
Quiescent Current At BATT	Vbat=3.6V		80		μA
Switching Frequency	VIN<4.3V	0.9	1.2	1.5	MHz
Inductor Current Limit			2.4		A
Maximum Duty Cycle			90		%

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Highside Pmos Rdson	I_{SW} =500mA		120		mΩ
Lowside Nmos Rdson	I_{SW} =500mA		100		mΩ
Short Circuit Hiccup Current			1.8		A
Short Circuit Hiccup Timer	On Time		62.5		ms
	Off Time		2000		
ISET					
ISET Voltage			0.8		V
LOGIC INPUT OTG					
Logic Input High		1.2			V
Logic Input Low				0.6	V
THERMAL PROTECTION					
Charging Thermal Regulation threshold			85		°C
Thermal Shutdown	Rising, Hys=20°C		150		°C

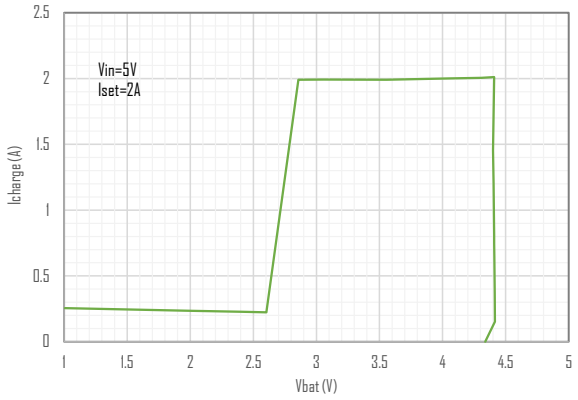
PIN DESCRIPTION

PIN #	NAME	DESCRIPTION
1	BATS	Battery Voltage sense pin. Connect to the battery positive terminal with a separate sensing wire to avoid voltage drop to achieve accurate battery CV charging
2	AGND	Analog Ground. Connect to USB Cap separately
3	ISET	Buck Charging current setting pin. Connect a resistor between this pin and analog ground to set the current level.
4	STAT	Charge status indication pin. When in charging, STAT is pulled low. And STAT become high-impedance when charging is completed.
5	USB	USB 5V output during boost and Adaptive input current limited pin during charging. This is a power pin, by pass with 2x22uF ceramic caps closed to the pin and PGND.
6	PGND	Power Ground pin
7	SW	Switching Pin. Connect with an inductor between this pin and positive terminal of battery
8	OTG	Manual Force Boost operation pin. OTG=1, force Boost Operation. When OTG=0, force Buck Operation

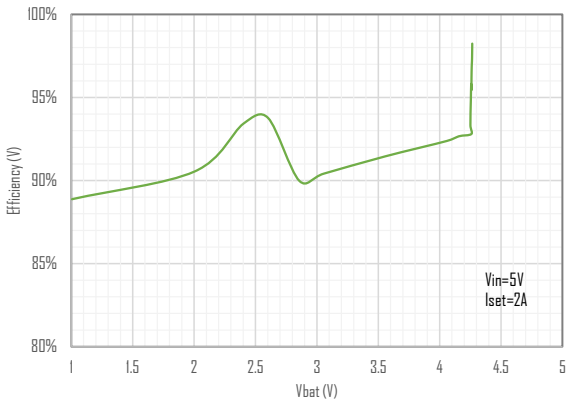
TYPICAL CHARACTERISTICS

(Vin=5V, T_A=25^{0}C, unless otherwise specified)

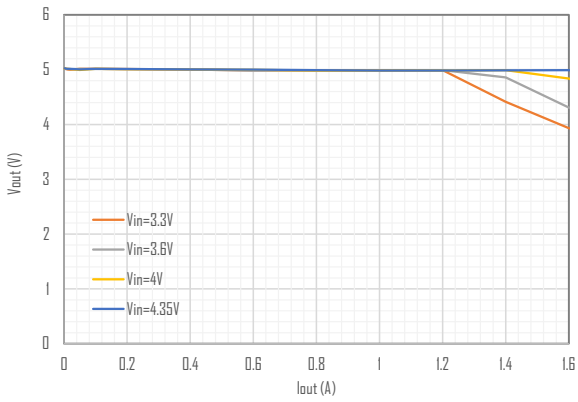
Charge Current Vs. Battery Voltage



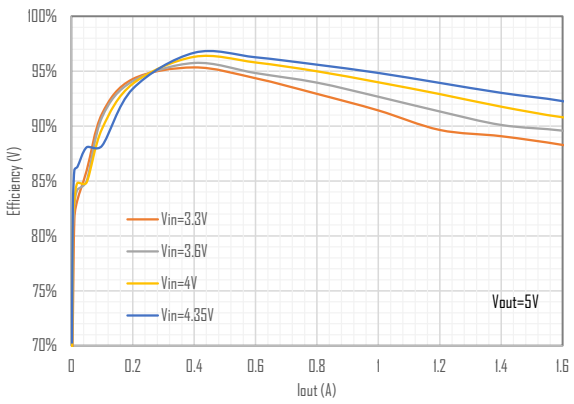
Charging Efficiency Vs. Battery Voltage



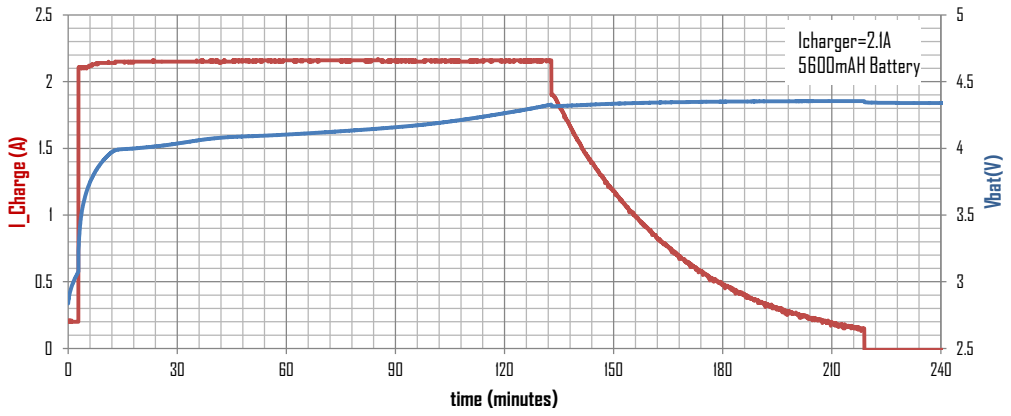
Boost Output Voltage Vs. Output Current



Boost Efficiency Vs. Output Current



Complete charging cycle of a 5600mAH battery at 2.15A charge current



FUNTIONAL DESCRITION

ETA6195 is currently the most compact 2.5A switching charger together with 1.5A OTG current, It has only 8 pins, with an input OTG pin to set ETA6195 in charge mode (Buck conversion) when OTG pin is set "0" or OTG mode (Boost conversion) when OTG pin is set "1". Charge current can be set by an external resistor connecting to ISET pin, and charge status is output by STAT pin.

Switching Battery Charger

ETA6195 is configured in charge mode (Buck conversion) when Vin is valid and OTG pin is set to "0". In this mode, a battery is charged with preconditioning, fast charge, top-off and end of charge (EOC).

CC/CV Regulation Loop

There are CC/CV regulation loops built in ETA6195, with regulates either current or voltage as necessary to ensure fast and safe charging of the battery. In a normal charge cycle, this loop regulates the current to the value set by the external resistor at the ISET pin. Charging continues at this current until the battery cell voltage reaches the termination voltage. At this point, the CV loop takes over, and charge current is allowed ti decrease as necessary to maintain charging at the termination voltage.

Precondition Charge

A new charging cycle begins with the precondition state, and operation continues in this state until Vbat exceeds the precondition threshold voltage. When operating in precondition state, the cell is charged at 200mA. Once Vbat reaches the precondition threshold voltage, the state machine jumps to the fast charge state.

Fast Charge

If battery voltage is above preconditioning threshold, buck converter chargers battery with constant current. In fast charge state, the ETA6195 charges at the current set by external resistor connected at ISET pin. For example, a 2A fast charge current can be achieved by setting the resistor to be 91K. During a normal charge cycle, fast charge continues in CC mode until Vbat reaches the charge termination voltage, at which point the ETA6195 enters into top off state.

Top off

With the battery voltage approaches the end of charge (EOC) voltage (4.35V, preset internally), charge current decreases as charging continues. In the top off state, the cell is charged in constant voltage (CV) mode. During a normal charging cycle, charging proceeds until the charge current decreases below 130mA, the EOC threshold. And then, the state machine terminates the charge cycle and jumps to the EOC state.

End of charge

When charge current decreases to 130mA, the buck converter ceases and keep monitoring the battery voltage.

Recharge

When battery voltage drops by 160mV below the EOC voltage, the Buck converter is turned on again, and re-start the constant current charge cycle.

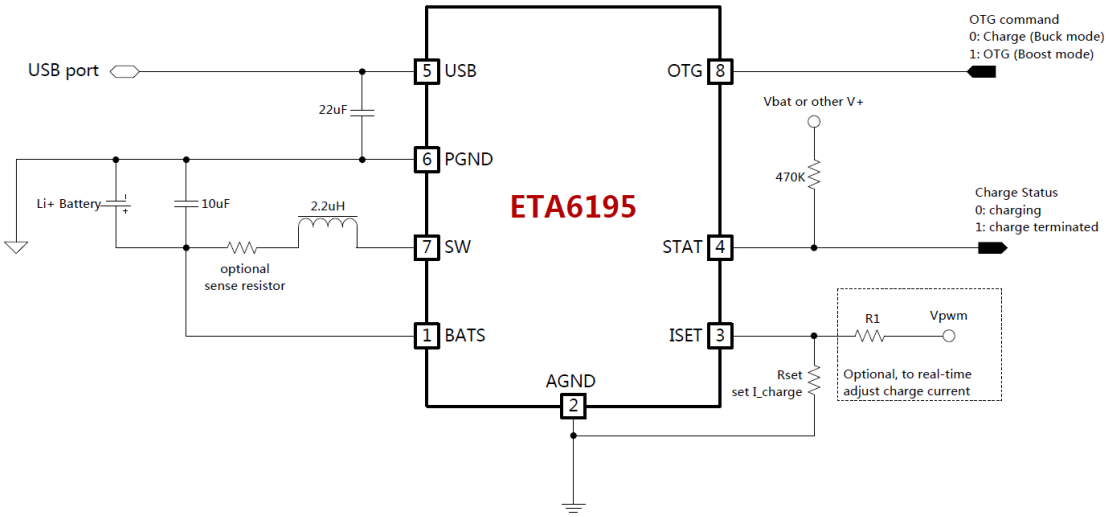
OTG mode – Synchronous Boost Converter

When OTG pin is set to "1", ETA6195 work as a synchronous boost converter, delivery 5V voltage to the USB pin with as much as 1.5A current. In this mode, the battery becomes the power input and USB as an output, current flows just the opposite way compared to the charge mode.

Sense resistor in serial with battery

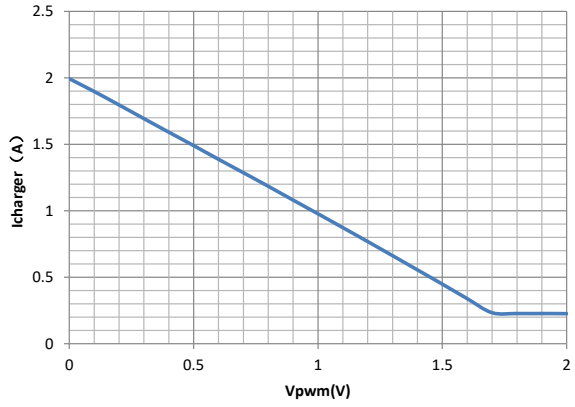
One can connect a serial current sense resistor to battery to sense the charge and discharge current through the battery, as illustrated in the typical application circuit shown on page 1. The sense resistor is not a must for ETA6195 charge loop control or constant current control. In other words, ETA6195 does not rely on this resistor to control the charge current. So please use it only when charge and discharge current need to be measured for gas gauge purpose.

ADJUSTING CHARGE CURRENT by PWM VOLTAGE

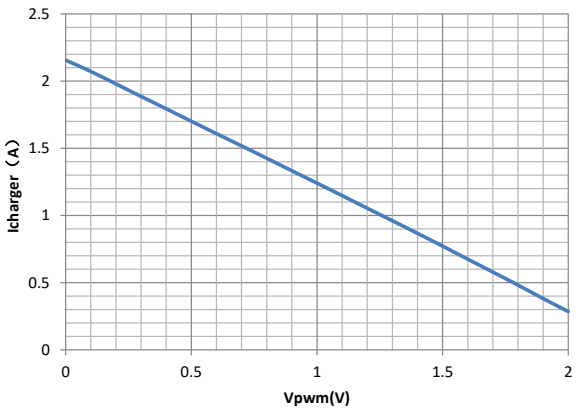


As given by above application circuit, one can real-time adjust the charge current by a PWM signal with different duty-cycle. The Vpwm is the RC filtered voltage of the PWM signal, and it will change linearly with the duty-cycle of the PWM signal. Followings are 2 examples of charge current's relationship to Vpwm. Please contact ETA engineers if one wants to have specific real-time charge current setting, the choosing of RI and Rset value will be provided quickly.

Charge Current Vs. Vpwm at RI=200K, Rset=160K

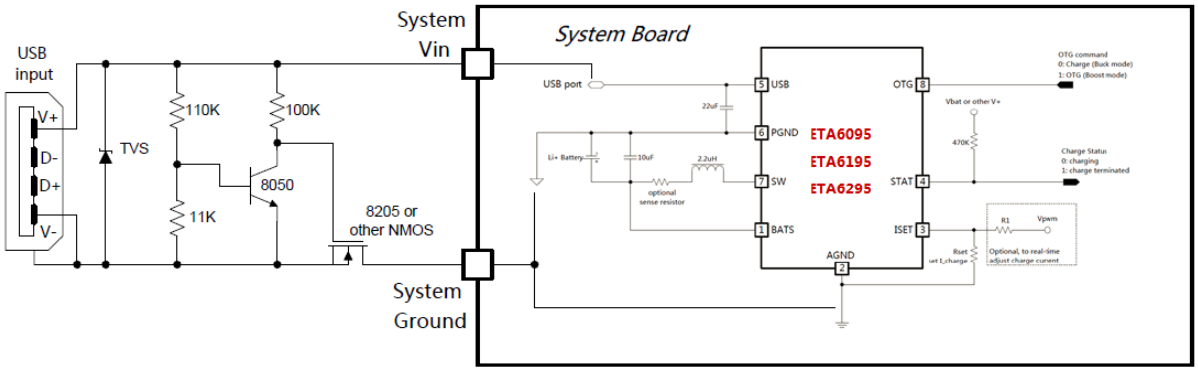


Charge Current Vs. Vpwm at RI=220K, Rset=130K



OVER VOLTAGE PROTECTION

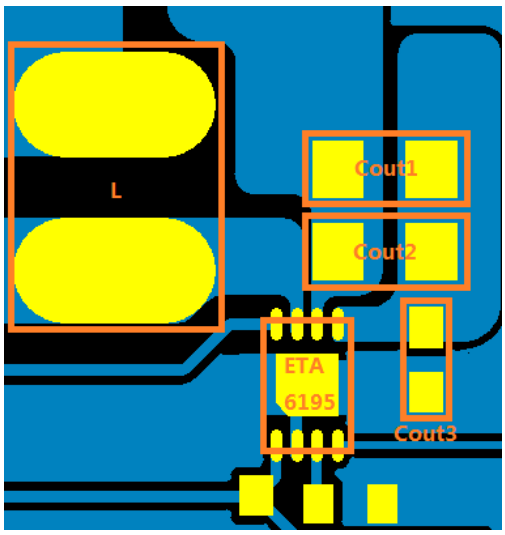
As such ETA6195 is always connected directly to the USB input interface, which occasionally suffers from hihg voltage spike cuased by adapter's plugging in. A simple and cost-effective over-voltage circuit is proposed, please refere to the circuit on the next page. The NPN (8050) will turn on when input voltage is larger than 6.6V, and will switch off the NMOS (8205) very quickly, so that a very fast and effective over-voltage-protection (OVP) of the whole system board is achieved. As such protection is inserted at the Ground side, so please make sure there is **no other bypassing ground path** connected to USB V- without going through this OVP circuit.



PCB GUIDES

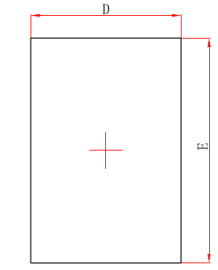
A Simple ETA6195 PCB illustration is shown below, Please place the output capacitor Cout1, Cout2 and Cout3 as close as possible to the ETA6195 pins. A good practice is just follow what is drawn below, with Cout1 and Cout2 connecting the ETA6195 USB and PGND pins and Cout3 connecting USB and AGND thru bottom head disspation pad.

Please always place these 3 output capcitors as the first step, and all other peripheral devices are less crucial than these output capacitors.

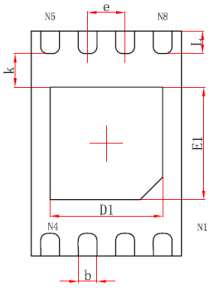


PACKAGE OUTLINE

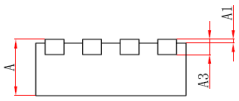
DFN2x3-8



Top View



Bottom View



Side View

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	1.924	2.076	0.076	0.082
E	2.924	3.076	0.115	0.121
D1	1.400	1.600	0.055	0.063
E1	1.400	1.600	0.055	0.063
k	0.200MIN.		0.008MIN.	
b	0.200	0.300	0.008	0.012
e	0.500TYP.		0.020TYP.	
L	0.224	0.376	0.009	0.015