Ultra-Low 1uA Quiescent Current at BAT, 2.5A Switch Mode Battery Charger

DESCRIPTION

ETA6097 is a switching Li-Ion battery charger capable of delivering up to 2.5A of charging current to the battery with high efficiency. 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. ETA6097 is an ideal all-in-one solution for battery charging application, such as power banks, smart phones, and tablets with only one USB port that can be used for charging battery function.

ETA6097 is suitable for charging a 4.2V Li-ion battery. And ETA6097 is in DFN2x3-8 package.

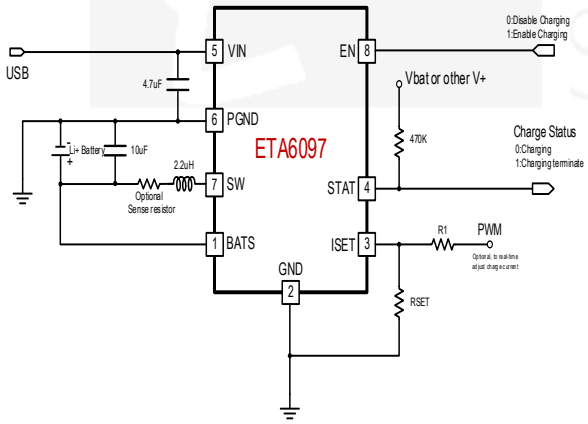
FEATURES

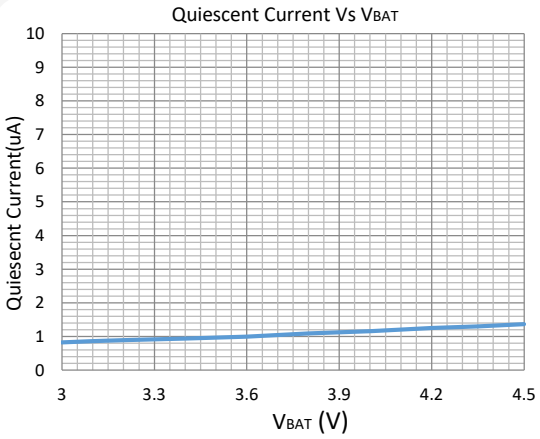
- Directional Power conversion with Single Inductor
- Switching Charger
- Up to 95% Efficiency
- Up to 2.5A Max charging current
- Ultra-Low 1uA Quiescent Current at BAT
- No-Battery detection
- No External Sense resistor
- DFN2x3-8 Package
- RoHS Compliant

APPLICATIONS

- Tablet, MID
- Smart Phone
- Power Bank

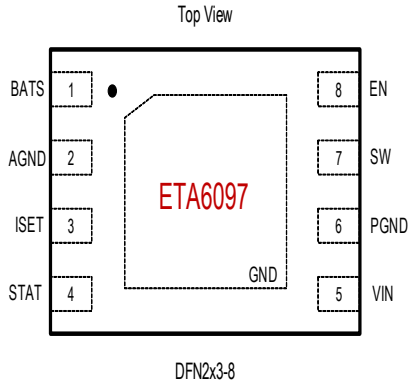
TYPICAL APPLICATION





ORDERING INFORMATION	PART No.	PACKAGE	TOP MARK	Pcs/Reel
	ETA6097D6I	DFN2x3-8	SNYW	3000

PIN CONFIGURATION



ABSOLUTEMAXIMUM RATINGS

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

VIN Voltage .....-0.3V to 6V

All Other Pin Voltage .....V_{IN}-0.3V to V_{IN}+0.3V

SW, VIN 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

ELECTRICAL CHARACTERISTICS

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

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
VIN Range		4.5		5.5	V
VIN UVLO Voltage	Rising, Hys=500mV		4.5		V
VIN OVP Voltage	Rising, Hys=320mV	5.89	6.08	6.27	V
VIN Operating Current	Switcher Enable, Switching		5		mA
	Switcher Enable, No Switching		800		μA
BATTERY CHARGER					
Battery CV Voltage	I_{BAT} =0mA, default	4.16	4.2	4.24	V
Charger Restart Threshold	From DONE to Fast Charge		160		mV
Battery Pre-Condition Voltage	V_{BAT} Falling Hys=250mV		2.9		V
Quiescent Current at Battery	VBAT=3.6V,No Adapter or EN=GND		1		uA
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
Maximum Duty Cycle			90		%
Highside Pmos Rdson	I_{SW} =500mA		120		mΩ
Lowside Nmos Rdson	I_{SW} =500mA		100		mΩ
ISET					
ISET Voltage	Normal Charging		0.8		V
ISET Voltage	Stop Charging	1			V

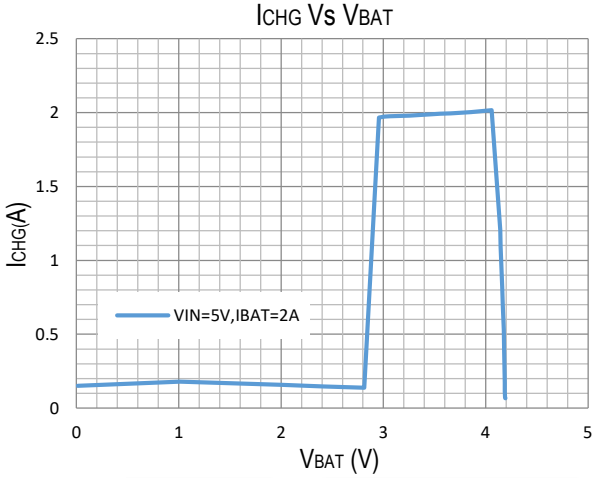
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
LOGIC EN					
Logic Input High		1.2			V
Logic Input Low				0.6	V
THERMAL PROTECTION					
Charging Thermal Regulation threshold			85		°C
Thermal Shutdown	Rising, Hys=20°C		150		°C

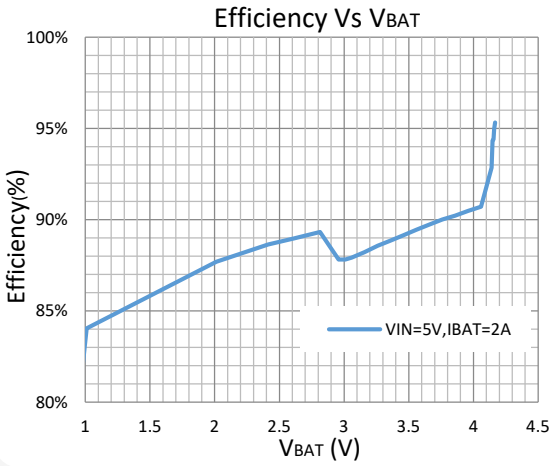
PIN DESCRIPTION

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 VIN Cap separately
3	ISET	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	VIN	Adaptive input pin. This is a power pin, by pass with 4.7uF ceramic cap 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	EN	Charging function Enable pin. When EN=0, Charge function will disable. Otherwise, Charging function will enable

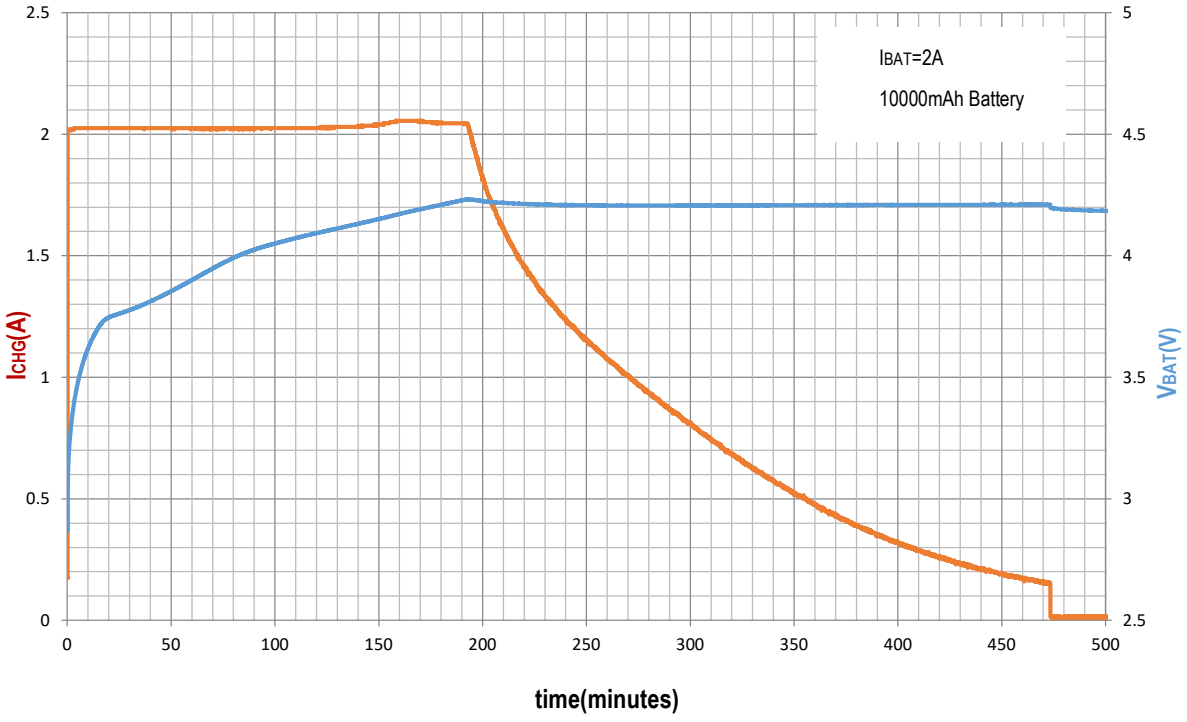
TYPICAL CHARACTERISTICS

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





Complete charging cycle of a 10000mAH battery at 2A charge current



FUNTIONAL DESCRITION

ETA6097 is currently the most compact 2.5A switching charger, It has only 8 pins, with an input EN pin to set ETA6097 in charge mode when EN pin is set “1” or Stop Charging when EN pin is set “0”. Charge current can be set by an external resistor connecting to ISET pin, and charge status is output by STAT pin.

Switching Battery Charger

ETA6097 is configured in charge mode when Vin is valid and EN pin is set to “1”. 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 ETA6097, 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 it 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 ETA6097 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 82K. During a normal charge cycle, fast charge continues in CC mode until Vbat reaches the charge termination voltage, at which point the ETA6097 enters into top off state.

Top off

With the battery voltage approaches the end of charge (EOC) voltage (4.2V, 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.

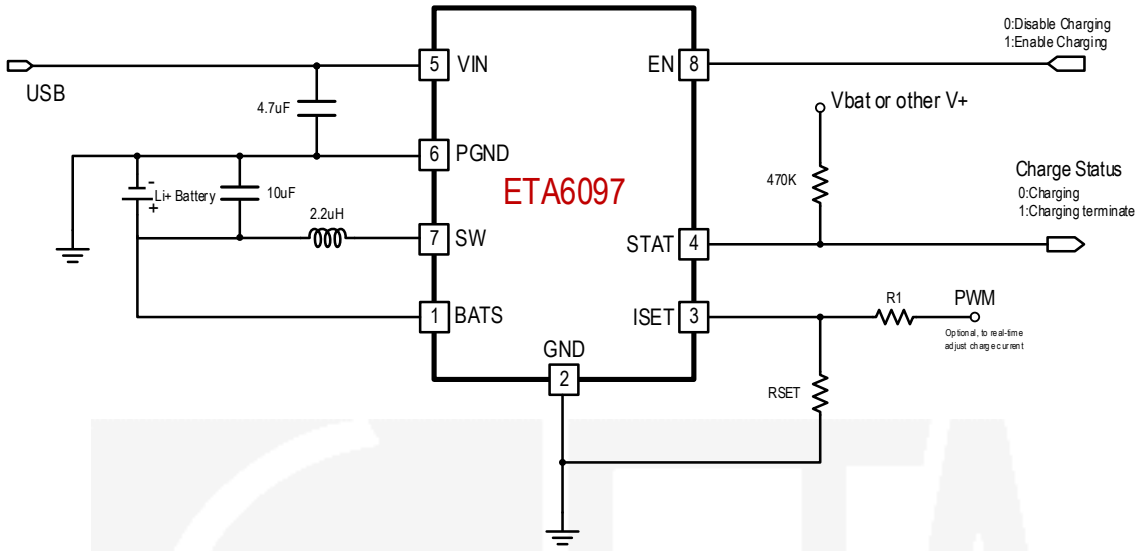
Recharge

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.

Sense resistor in serial with battery

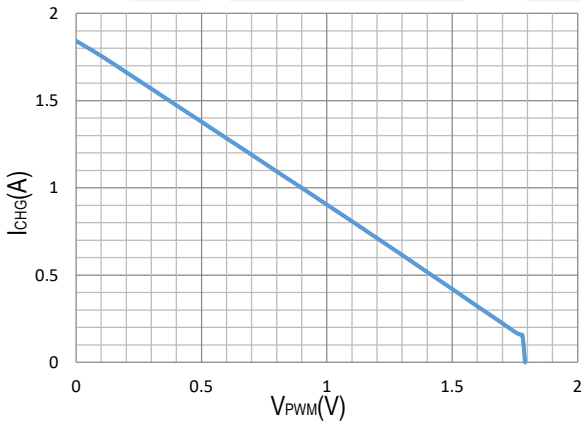
One can connect a serial current sense resistor to battery to sense the charge, as illustrated in the typical application circuit shown on page 1. The sense resistor is not a must for ETA6097 charge loop control or constant current control. In other words, ETA6097 does not rely on this resistor to control the charge current. So please use it only charge current need to be measured for gas gauge purpose.

ADJUSTING CHARGE CURRENT by PWM VOLTAGE

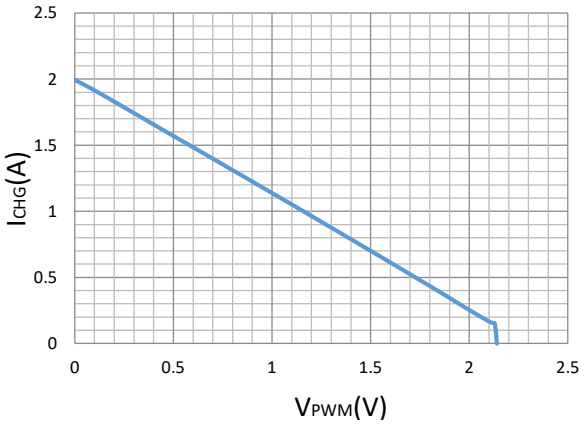


As given by above application circuit, one can real-time adjust the charge current by a PWM signal with different duty-cycle. The Vpwm is the RC filtered voltage of the PWM signal, and it will change linearly with the duty-cycle of the PWM signal. Followings are 2 examples of charge current's relationship to Vpwm. Please contact ETA engineers if one wants to have specific real-time charge current setting, the choosing of R1 and Rset value will be provided quickly.

Charge Current Vs. Vpwm at R1=200K, Rset=160K

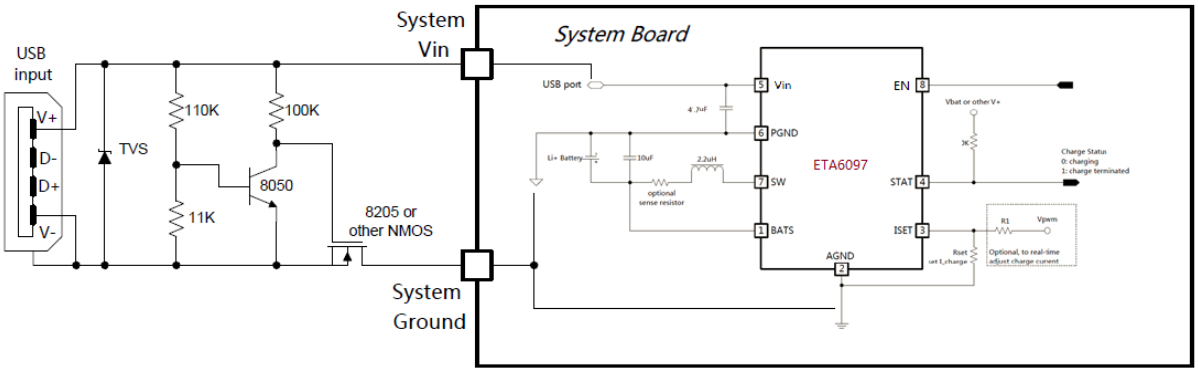


Charge Current Vs. Vpwm at R1=220K, Rset=130K

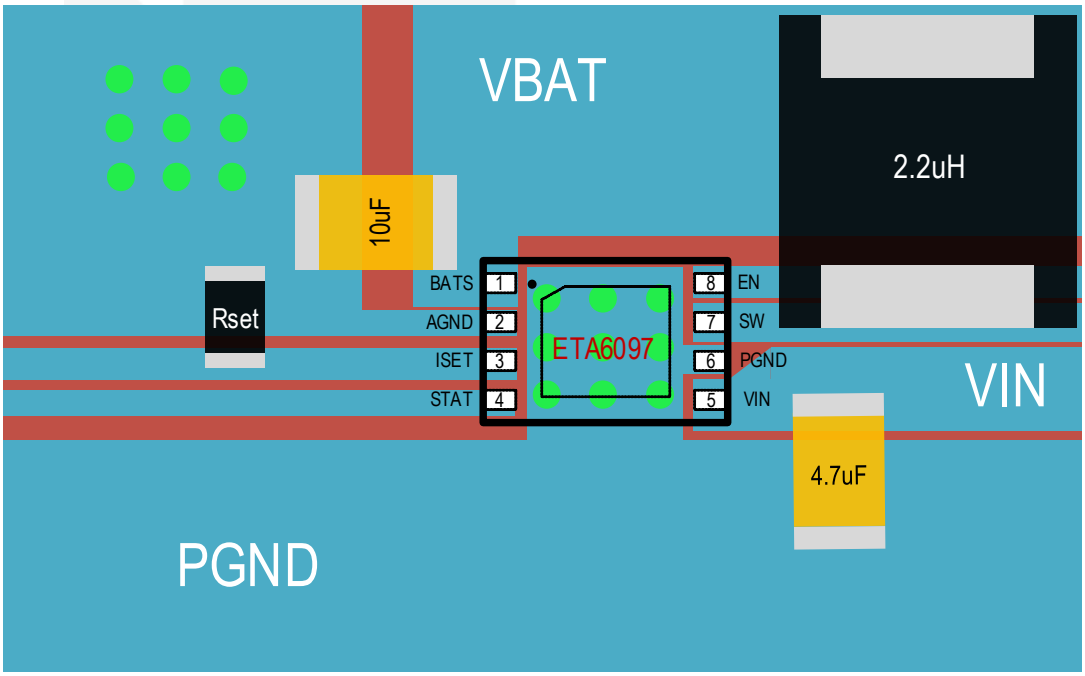


OVER VOLTAGE PROTECTION

As such ETA6097 is always connected directly to the USB input interface, which occasionally suffers from high 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.

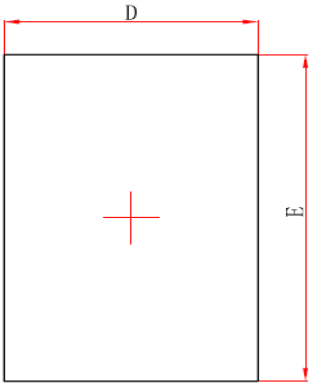


PCB GUIDES

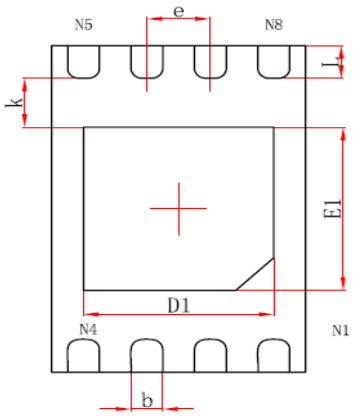


PACKAGE OUTLINE

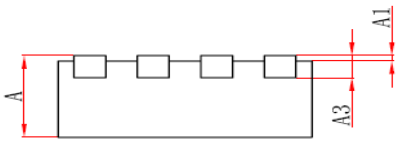
DFN2x3-8



Top View



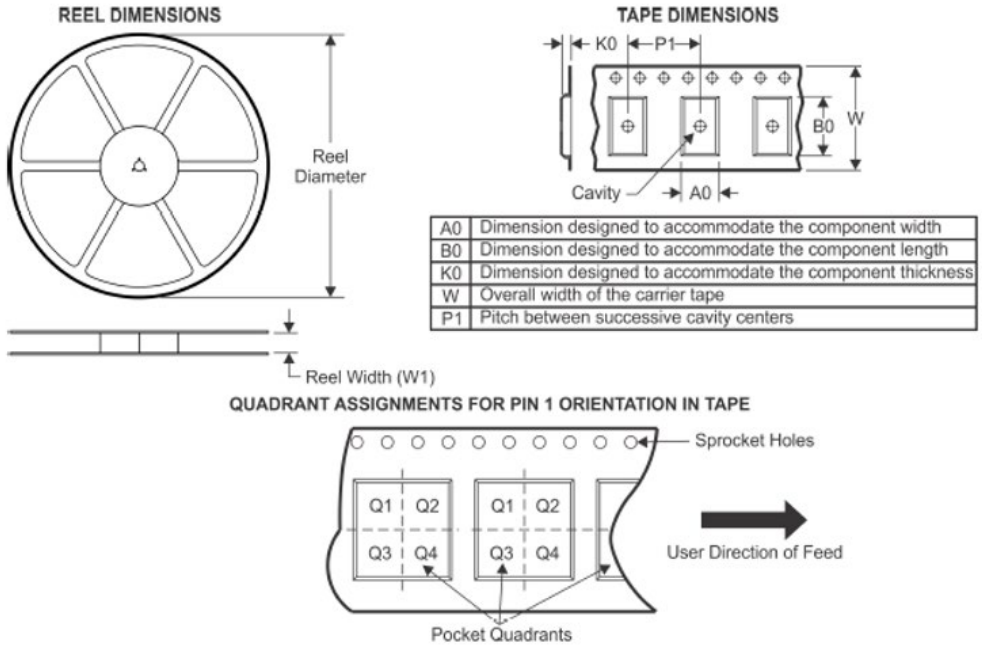
Bottom View



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

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
ETA6097D6I	DFN2x3-8	8	3000	180	9.5	3.3	2.3	1.1	4	8	Q1