

## 32V Input Standoff Voltage, 2.5A Switching Mode Battery Charger

### Ultra-Low 1uA Quiescent Current at BAT

#### DESCRIPTION

ETA6098 is a high efficiency, switching Li-Ion battery charger capable of delivering up to 2.5A of charging current to the battery. 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.

An OVP function protects the IC itself and its downstream system against input voltage surges. With this OVP function, the IC can stand off input voltage as high as 32V, making it an ideal solution for industrial applications.

ETA6098 is suitable for charging a 4.2V Li-ion battery. And ETA6098 is in DFN3x3-10 package.

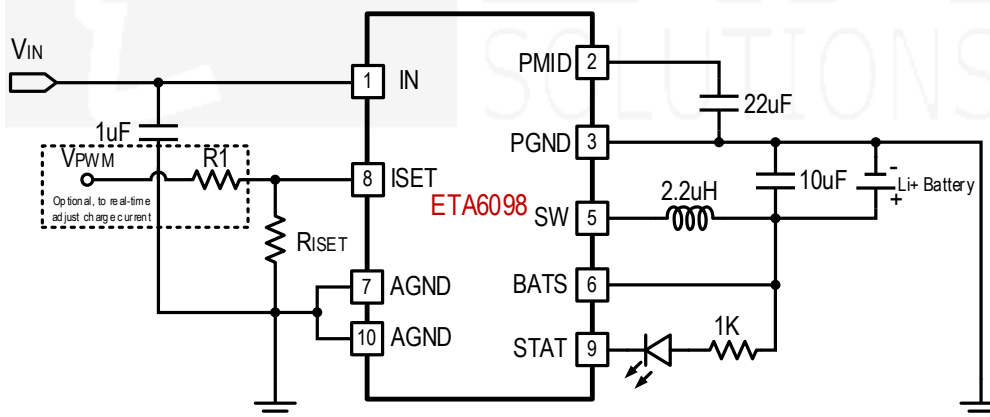
#### FEATURES

- ◆ Ultra-Low 1uA Quiescent Current at BAT
- ◆ 32V Input Standoff Voltage
- ◆ Input Over Voltage Protection
- ◆ 60ns Fast OVP Transient Response
- ◆ Up to 94% Efficiency
- ◆ Up to 2.5A Max Charging Current
- ◆ No-Battery detection
- ◆ No External Sense Resistor
- ◆ DFN3x3-10 Package
- ◆ RoHS Compliant

#### APPLICATIONS

- ◆ Tablet, MID
- ◆ Smart Phone

#### TYPICAL APPLICATION

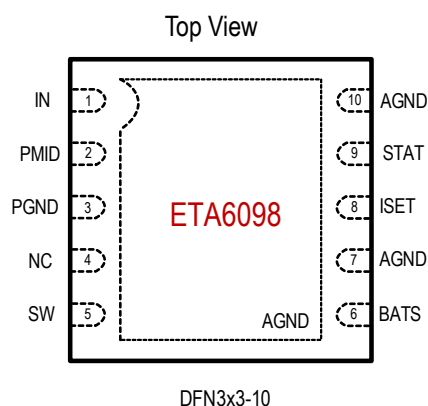


#### ORDERING

#### INFORMATION

PART No.	PACKAGE	TOP MARK	Pcs/Reel
ETA6098D3K	DFN3x3-10	ETA6098 YWW2L	5000

## PIN CONFIGURATION



## 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 Pin Voltage .....	-0.3V to 32V
All Other Pin Voltage .....	-0.3V to 6V
SW, PMID to ground current.....	Internally limited
Operating Temperature Range .....	-40°C to 85°C
Storage Temperature Range .....	-55°C to 150°C
Thermal Resistance $\theta_{JC}$ $\theta_{JA}$	
DFN3x3-10.....	12 50 °C/W
Lead Temperature (Soldering, 10sec) .....	260°C
ESD HBM (Human Body Mode) .....	2KV
ESD CDM (Charged Device Mode) .....	1KV

## ELECTRICAL CHARACTERISTICS

( $V_{IN} = 5V$ , unless otherwise specified. Typical values are at  $T_A = 25^\circ C$ .)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>INPUT</b>					
Input Standoff Voltage		32			V
Input Range		4.5		5.5	V
Input UVLO Voltage	Rising, Hys=500mV		4.5		V
Input OVP Voltage	Rising, Hys=320mV	5.89	6.08	6.27	V
$V_{PMID}(V_{HOLD})$	$V_{HOLD}=4.4V$		4.4		V
Input Operation Current	Switching		5		mA
	No Switching		900		uA
<b>OVP</b>					
Switch $R_{DS(on)}$	$V_{IN}=5V, I_{OUT}=1A, 25^\circ C$		45	50	m $\Omega$
Discharge Resistance			197		$\Omega$
Tpower-on	Power ON delay		20		ms
<b>BATTERY CHARGER</b>					
Battery CV Voltage	$I_{BAT} = 0mA$ , default	4.16	4.2	4.24	V
Charger Restart Threshold	From Charge Done to Fast Charge		160		mV
Battery Pre-Condition Voltage	$V_{BAT}$ Falling, Hys=250mV		2.9		V
Pre-Condition Charge Current			200		mA
Quiescent Current at BAT	$V_{BAT}=3.6V$		1		uA
Fast Charge Current	$R_{ISET} = 82K\Omega$		2		A
	$R_{ISET} = 150K\Omega$		1.2		A
Charge Termination Current			130		mA
Charge Termination Blanking time			16		S

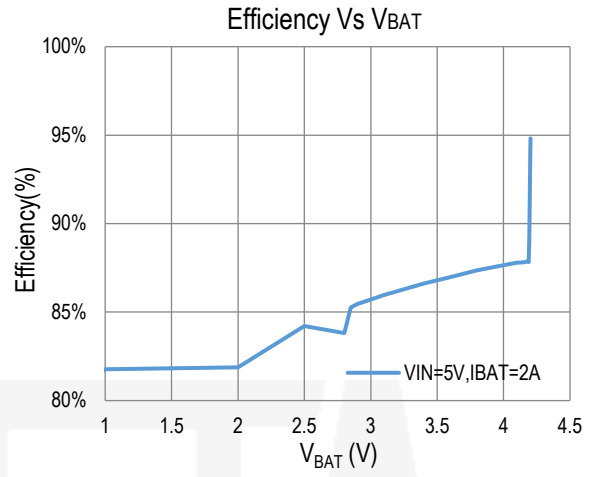
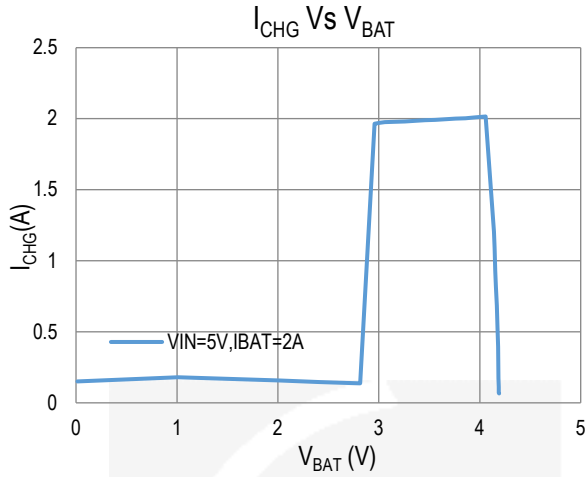
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Highside Pmos Rdson	I <sub>sw</sub> =500mA		120		mΩ
Lowside Nmos Rdson	I <sub>sw</sub> =500mA		100		mΩ
<b>ISET</b>					
ISET Voltage	Normal Charging		0.8		V
ISET Voltage	Stop Charging	1			V
<b>THERMAL PROTECTION</b>					
Charging Thermal Regulation threshold			85		°C
Thermal Shutdown	Rising, Hys=20°C		150		°C

## PIN DESCRIPTION

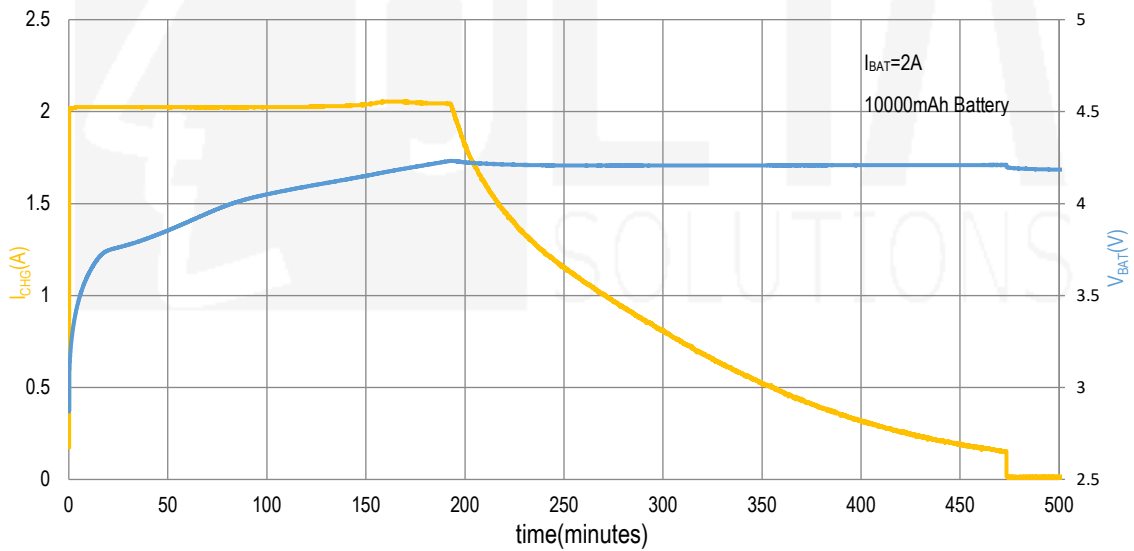
PIN #	NAME	DESCRIPTION
1	IN	Input pin. Bypass with a 1uF capacitor to GND.
2	PMID	Connection point between internal OVP and charger. Bypass with a 22uF ceramic capacitor from PMID to GND. This capacitor should be close to the PMID pin.
3	PGND	Power Ground pin
4	NC	No Connection
5	SW	Switching Pin. Connect with an inductor between this pin and positive terminal of battery
6	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
8	ISET	Charging Current setting pin. Connect a resistor between this pin and analog ground to set the current level.
9	STAT	Charge status indication pin. When in charging, STAT is pulled low. And STAT become high-impedance when charging is completed.
7,10/ Exposed pad	AGND	Analog Ground.

## TYPICAL CHARACTERISTICS

( $V_{IN}=5V$ ,  $T_A=25^{\circ}C$ , unless otherwise specified)



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



## FUNTIONAL DESCRIPTION

ETA6098 is a switching Li-Ion battery charger capable of delivering up to 2.5A of charging current to the battery. With OVP function, the IC can stand off input voltage as high as 32V, making it an ideal solution for industrial applications. It features pre-charging, fast charging(CC) and constant voltage(CV) charging, end-of charging termination, and auto-recharge. Charge current can be set by an external resistor connecting to ISET pin, and charge status is output by STAT pin.

### CC/CV Regulation Loop

There are CC/CV regulation loops built in ETA6098, 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 to 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  $V_{BAT}$  exceeds the precondition threshold voltage. When operating in precondition state, the cell is charged at 200mA. Once  $V_{BAT}$  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 charges battery with constant current. In fast charge state, the ETA6098 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  $V_{BAT}$  reaches the charge termination voltage, at which point the ETA6098 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.

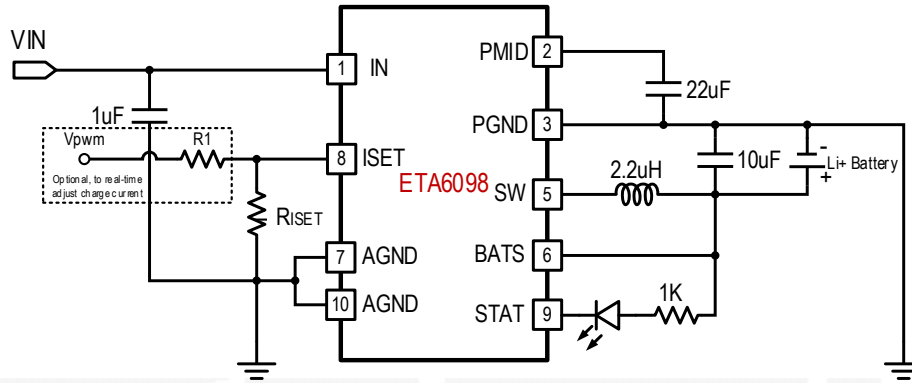
### End of charge

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

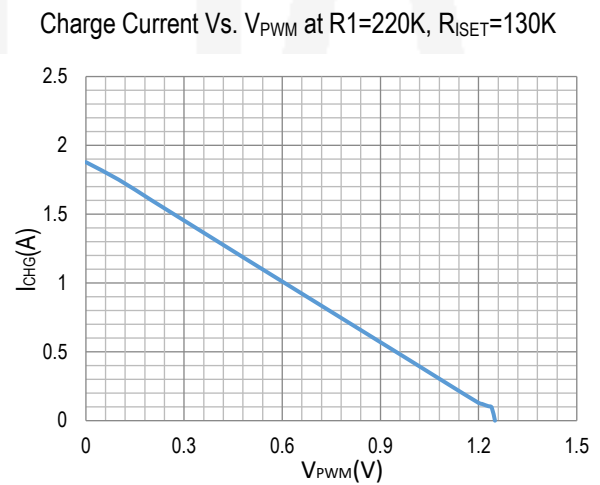
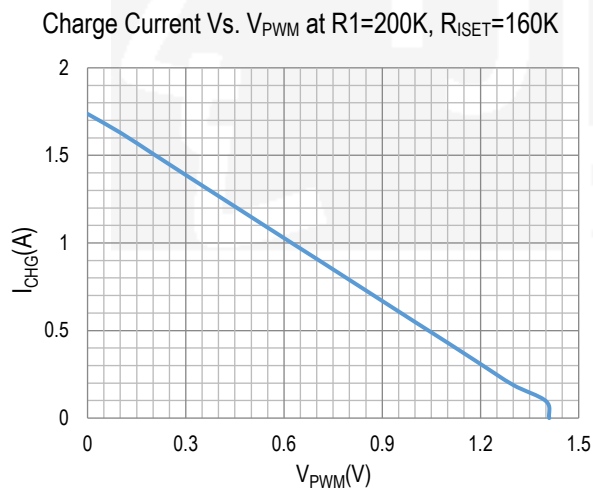
### Recharge

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.

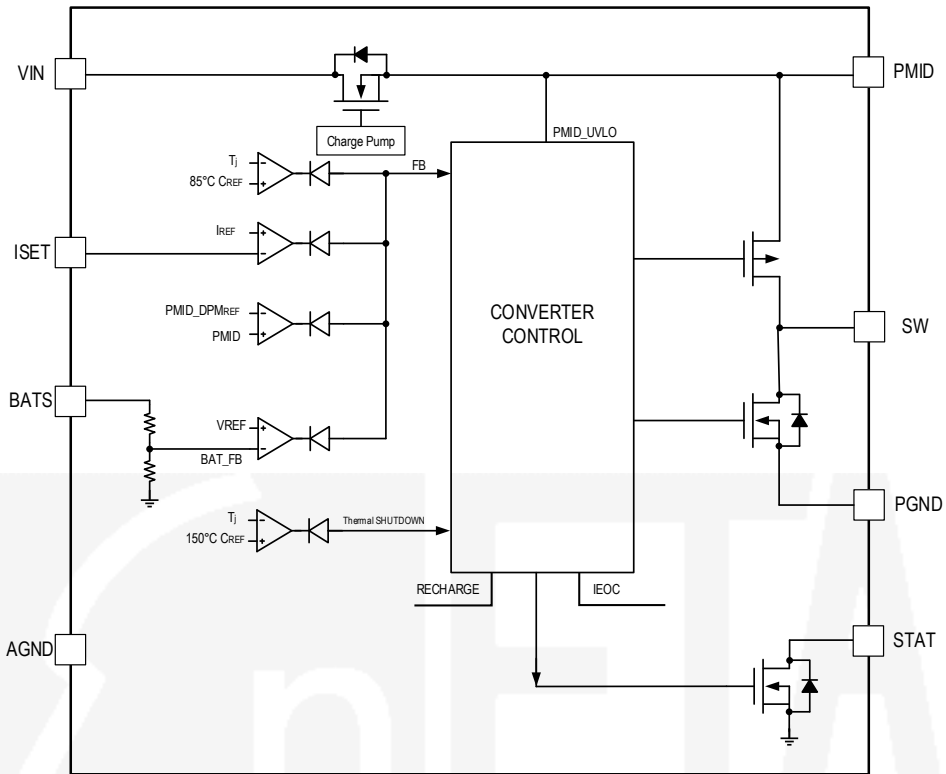
## ADJUSTING CHARGE CURRENT by PWM VOLTAGE



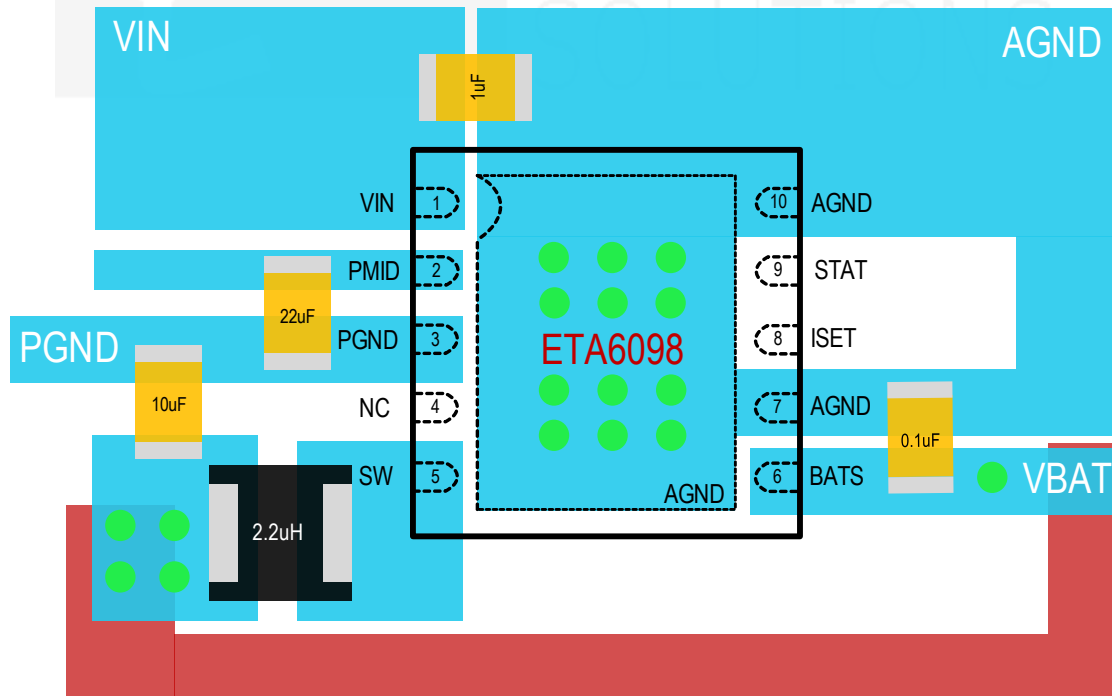
As given by above application circuit, one can real-time adjust the charge current by a PWM signal with different duty-cycle. The  $V_{pwm}$  is the RC filtered voltage of the PWM signal, and it will change linearly with the duty-cycle of the PWM signal. Followings are 2 examples of charge current's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



## FUNCTION BLOCK DIAGRAM

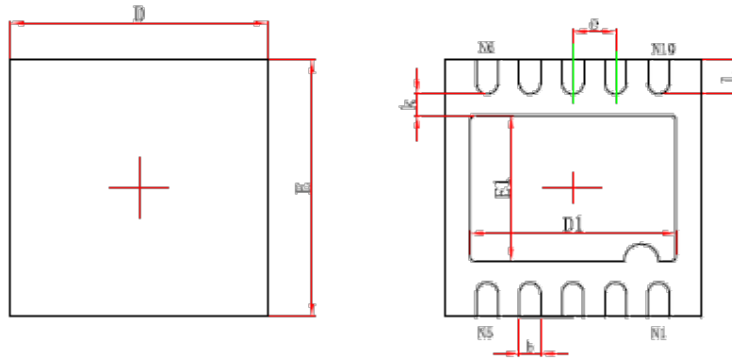


## PCB GUIDELINES



## PACKAGE OUTLINE

Package: DFN3x3-10



Top View

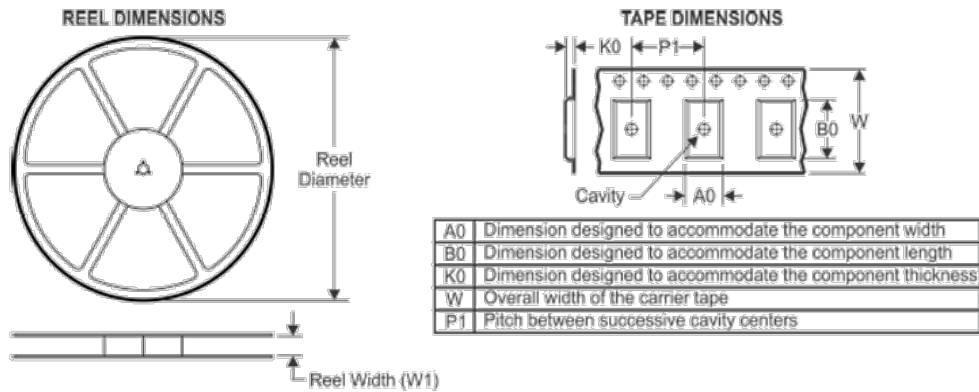
Bottom View

Side View

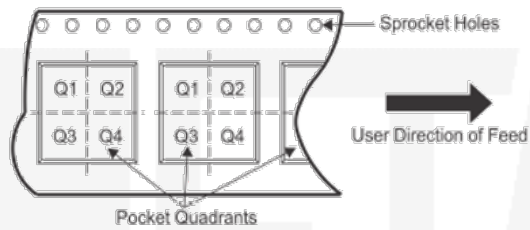
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	2.924	3.076	0.115	0.121
E	2.924	3.076	0.115	0.121
D1	2.300	2.500	0.091	0.098
E1	1.600	1.800	0.063	0.071
k	0.200MIN.		0.008MIN.	
b	0.200	0.300	0.008	0.012
e	0.500TYP.		0.020TYP.	
L	0.324	0.476	0.013	0.019



## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



Device	Package Type	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
ETA6098D3K	DFN3x3-10	10	5000	330	12.4	3.35	3.35	1.13	8	12	Q1