30V Input Standoff, 1A Fully Integrated Linear Charger for 1 Cell Li-ion Battery

DESCRIPTION

ETA4085 is a single cell, fully integrated constant current (CC)/constant voltage (CV) Li-ion battery charger. Its compact package with minimum external components requirement makes the ETA4085 ideal for portable applications. No external sense resistor or blocking diode is necessary for the ETA4085. Build-in thermal feedback mechanism regulates the charge current to control the die temperature during high power operation or at elevated ambient temperature. ETA4085 has the function of pre-charge, which can charge the deeply discharged batteries by trickle. The fast charge current can be programmed by an external resistor. CV regulation mode is automatically enabled once the battery's charging curve reaches the constant voltage portion. The output current then decays and is finally terminated once the charge current drops to 1/10 of the programmed value. ETA4085 keeps monitoring the battery voltage and enables a new charge cycle once the voltage drops 100mV below the CV value.
ETA4085 is in a DFN3x3-10L package.

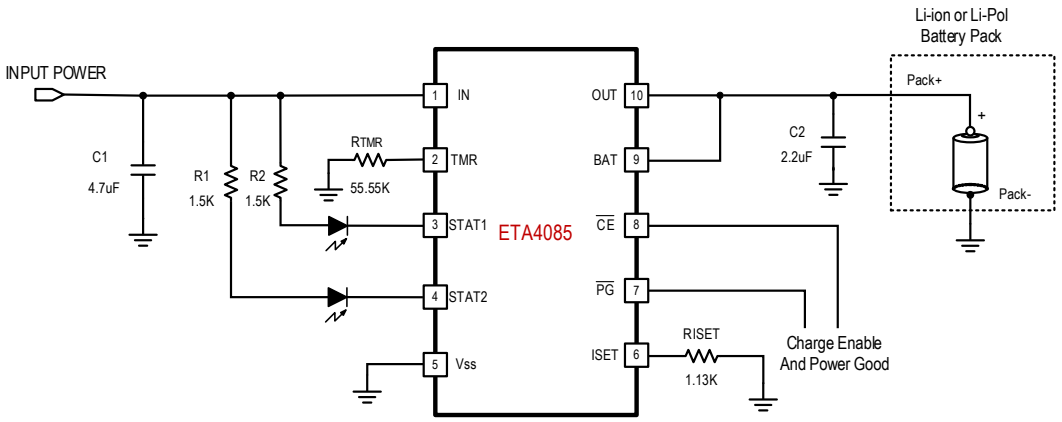
FEATURES

- 30V Input Standoff Voltage
- 4.2V Charge Termination Voltage
- 2.95V Trickle Charge Threshold
- Input Over Voltage Protection
- Charge Current Programmable, up to 1A
- 400nA BAT Current when No Charging
- Charge Conditioning with Safety Timer
- Status Output for LED
- Soft-start Limits in-rush Current
- DFN3x3-10L Package
- RoHS Compliant

APPLICATIONS

- E-cigarette
- Toys
- Bluetooth Applications
- Li-ion Battery Powered Devices

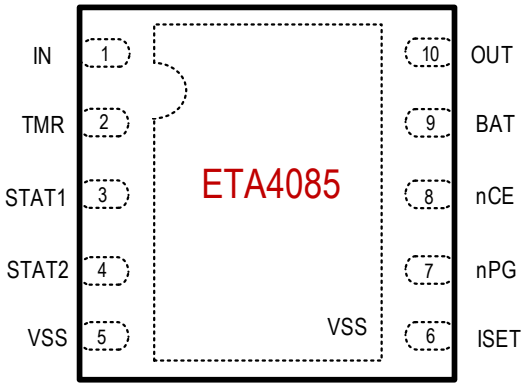
TYPICAL APPLICATION



ORDERING INFORMATION

PART No.	PACKAGE	TOP MARK	Pcs/Reel
ETA4085D3K	DFN3x3-10	ETA4085 YWW2L	5000

PIN CONFIGURATION



DFN3x3-10L

ABSOLUTE MAXIMUM 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 30V
BAT, OUT Voltage .....–0.3V to 16V
STAT1, STAT2, nPG, nCE Voltage .....–0.3V to 16V
All other pins Voltage..... –0.3V to 6V
Operating Temperature Range.....–40°C to 85°C
Storage Temperature Range .....–55°C to 150°C
Thermal Resistance Θ_{JC} Θ_{JA}
DFN3x3-10L .....12.....50..... °C/W
Lead Temperature (Soldering 10secs) .....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°C.)

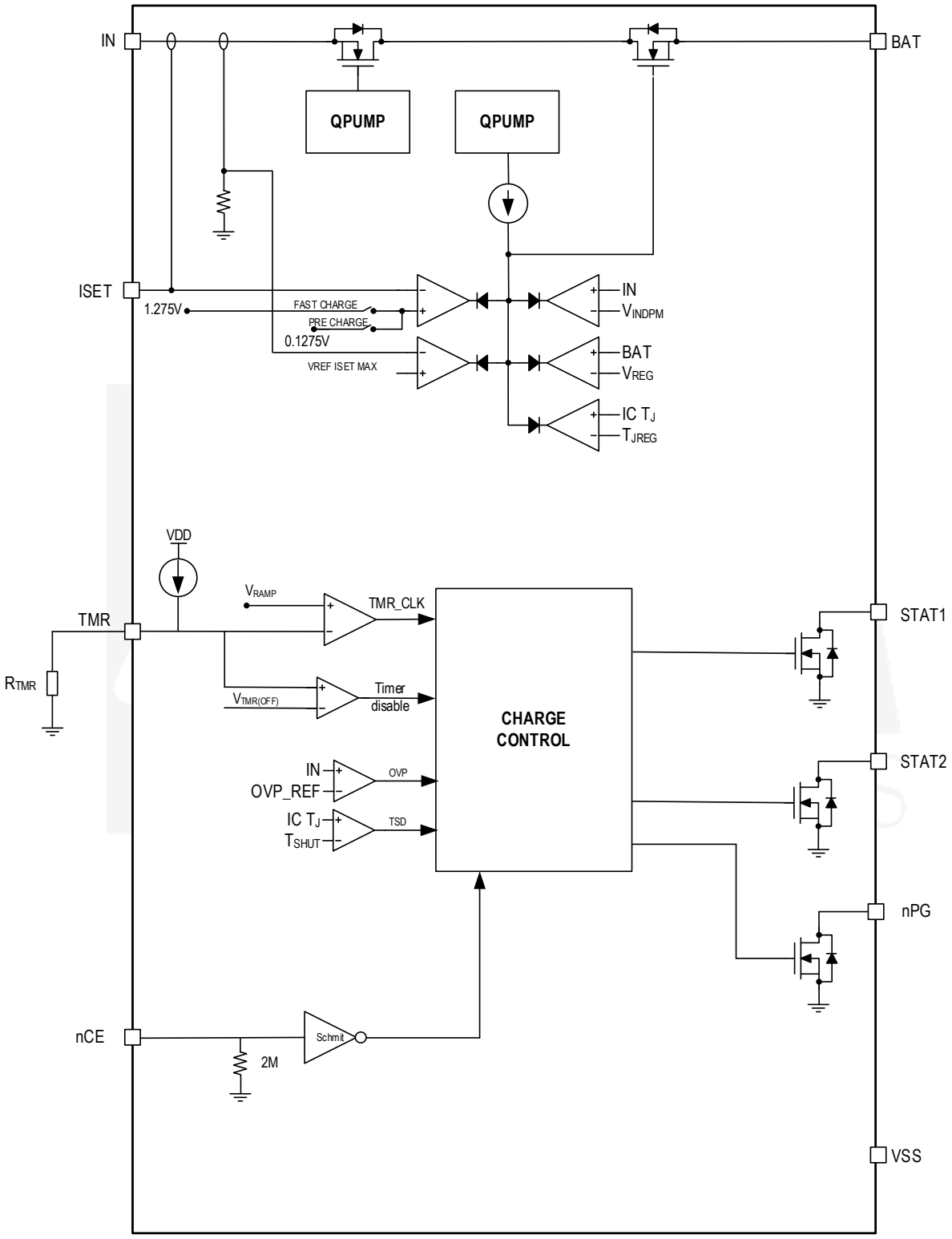
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Standoff Voltage		30			V
Input Over-Voltage Protection Voltage	V_{IN} Rising, Hys=0.4V	6.4	6.65	6.9	V
Input Voltage Range for Charging		4.35		6.5	V
Input Supply Current	Charge Mode		800	2000	μA
	Standby Mode (Charge Terminated)		180	360	μA
	Shutdown Mode (ISET not Connected, or V_{IN}<V_{BAT}, or V_{IN}<V_{UVLO})		45	90	μA
Regulated Output (Float) Voltage	R_{ISET} = 5K, I_{BAT} = 40mA	4.16	4.2	4.24	V
BAT Pin Current	R_{ISET} = 0.5K, CC Mode, V_{BAT}=3.8V	840	920	1000	mA
	R_{ISET} = 0.45K to 8K, CC Mode	90	100	110	%ICHRG
	Standby Mode, V_{BAT} = 4.2V		6	8	μA
	Shutdown Mode, ISET not Connected	0	0.4	0.7	μA
	Sleep Mode, VIN = 0V	0	0.4	0.7	μA
Trickle Charge Current	V_{BAT} < $V_{TRICKLE}$	8	10	12	%ICHRG
Trickle Charge Threshold Voltage	V_{BAT} Rising	2.75	2.95	3.15	V
Trickle Charge Hysteresis Voltage			110		mV
VIN Under-Voltage Lockout Threshold	V_{IN} From Low to High	3.1	3.3	3.5	V
VIN Under-Voltage Lockout Hysteresis			200		mV

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
VIN–VBAT Lockout Threshold Voltage	V_{IN} from Low to High	70	150	230	mV
	V_{IN} from High to Low	20	70	130	
Termination Current Threshold			10		%ICHRG
ISET Pin Voltage	CC Mode, V_{BAT}=4V	1	1.275	1.45	V
STAT1/STAT2 Pin Weak Pull-Down Current	V_STAT1 = 5V		0.1		μA
STAT1/STAT2 Pin Output Low Voltage	I_STAT1 or I_STAT2= 5mA		0.7	1.4	V
Recharge BAT Threshold Voltage	V_{BAT} Falling	60	100	160	mV
Junction Temperature in Constant Temperature Mode			110		°C
Power FET “ON” Resistance (Between VIN and BAT)			0.6		Ω
Soft-Start Time	I_{BAT} = 0 to I_{BAT} = 90% Full Current		40		ms
ISET Pin Pull-Up Current			1		μA
nCE Pull-down Resistance			2		MΩ
Enable Charger	nCE Pin Falling			0.6	V
Disable Charger	nCE Pin Rising	1.6			V
TMR safe timer	R_{TMR}=55.55k, V_{IN}=5V, V_{BAT}=3.8V		5		hr

PIN DESCRIPTION

PIN#	NAME	DESCRIPTION
1	IN	Positive Input Supply. Needs bypass with at least a 4.7μF capacitor.
2	TMR	Safety Timer Program Input, timer disabled if floating. Connect a resistor to VSS pin to program safety timer timeout value
3	STAT1	Open-Drain Output for In Charging flag. The STAT pin outputs low when the battery is in charging. Upon the completion of the charge cycle, it becomes high-impendence.
4	STAT2	Open-Drain Output for Charge Finished flag. The STDBY pin outputs low when the battery is finished charging. When in the status of charging, it becomes high-impendence.
5	VSS	Ground
6	ISET	Charge Current Setting. Program, Monitor the charge current and Shutdown. This pin set to 1.275V in constant-current mode. The charge current can be calculated using the following formula: $I_{BAT}(mA)=\frac{1}{R_{ISET}(k\Omega)}\times 460$ The ISET pin can also be used to switch the charger to shutdown mode by disconnecting the program resistor from ground.
7	nPG	Low (FET on) indicates that the input voltage is above UVLO and the battery voltage.
8	nCE	Enable the IC charger or not. Drive this pin low or floating to enable charger, high to disable.
9	BAT	Charge Current Output. This pin provides charge current to the battery and regulates the final float voltage to 4.2V which is set by an internal precision resistor divider.
10	OUT	Output Pin. This needs to be connected to BAT.

FUNCTION BLOCK DIAGRAM



FUNCTIONAL DECRIPTIONS

The ETA4085 is a single cell, fully integrated constant current (CC)/constant voltage (CV) Li-ion battery charger. It can deliver up to 1000mA of charge current with a final float voltage accuracy of 1%. The ETA4085 has a build-in thermal regulation circuitry that ensures its safe operation. No blocking diode or external current sense resistor is required; hence reduce the external components for a basic charger circuit to two. The ETA4085 is also capable of operating from a USB power source.

Normal Charge Cycle

The ETA4085 initiates a charge cycle once the voltage at the VIN pin rises above the UVLO threshold level. A 1% precision resistor needs to be connected from the ISET pin to ground. If the voltage at the BAT pin is less than 2.95V, the charger enters trickle charge mode. In this mode, the charge current is reduced to nearly 1/10 the programmed value until the battery voltage is raised to a safe level for full current charging.

The charger switches to constant-current mode as the BAT pin voltage rises above 2.95V, the charge current is thus resumed to full programmed value. When the final float voltage (4.2V) is reached, the ETA4085 enters constant-voltage mode and the charge current begins to decrease until it drops to 1/10 of the preset value and ends the charge cycle1.

Programming Charge Current

The charge current is programmable by setting the value of a precision resistor connected from the ISET pin to ground. The charge current is 460 times of the current out of the ISET pin. The charge current out of the BAT pin can be determined at any time by monitoring the ISET pin voltage using the following equation:

$$I_{BAT}(mA)=\frac{1}{R_{ISET}(k\Omega)}\times 460$$

Charge Termination

The ETA4085 keeps monitoring the ISET pin during the charging process. It terminates the charge cycle when the charge current falls to 1/10 the programmed value after the final float voltage is reached. When the ISET pin voltage falls below 100mV for longer than t_{TERM} (typically 1ms), charging is terminated. The charge current is latched off and the ETA4085 enters standby mode, where the input supply current drops to 100μA.

During charging, the transient response of the circuit can cause the ISET pin to fall below 100mV temporarily before the battery is fully charged, thus can cause a premature termination of the charge cycle. A 1ms filter time on the termination comparator can prevent this from happening. Once the average charge current drops below 1/10 the programmed value, the ETA4085 terminates the charge cycle and ceases to provide any current through the BAT pin. In this state, all loads on the BAT pin must be supplied by the battery.

Charge Status Indicator (STAT1 and STAT2 pin)

STAT1 and STAT2 are 2 different states of the charge status, one is IN CHRGING, and the other is CHARGING FINISHED. STAT1 is the pin to pull low during IN CHARGING status and become high impedance in CHARGING FINISHED status. And STAT2 pin just works the opposite way, pulling low after charge finished, and high impedance when in charging.

Power good Indication (nPG)

After application of a 5V source, the input voltage rises above the UVLO and sleep thresholds (V_{IN}>V_{BAT}+V_{SLEEP}), but is less than OVP (V_{IN}<V_{OVP}), and nCE low, then the nPG FET turns on and provides a low impedance path to ground

High Temperature Fold-back

Build-in feedback circuitry mechanism can reduce the value of the programmed charge current once the die temperature tends to rise above 110°C, hence prevents the temperature from further increase and ensure device safe operation.

Under-voltage Lockout (UVLO)

Build-in under-voltage lockout circuit monitors the input voltage and keeps the charger in shutdown mode until V_{IN} rises above the under-voltage lockout threshold. The UVLO circuit has a built-in hysteresis of 200mV. Furthermore, to protect against reverse current in the power MOSFET, the UVLO circuit keeps the charger in shutdown mode if V_{IN} falls to within 70mV of the battery voltage. If the UVLO comparator is tripped, the charger will not come out of shutdown mode until V_{IN} rises 150mV above the battery voltage.

Manual Shutdown

There are two methods can disable the IC charger:
1. Driver the nCE pin to high.
2. Floating the ISET pin by removing the resistor from ISET pin to ground.

Once one of above conditions happen, it can put the device in shutdown mode. The battery drain current is thus reduced to 400nA and the supply current to 50μA. Reconnecting the resistor back will restart a new charge cycle. Once manually shutdown, the ISET pin is in a high impedance state.

Automatic Recharge

After the termination of the charge cycle, the ETA4085 constantly monitors the BAT pin voltage and starts a new charge cycle when the battery voltage falls below 4.1V, keeping the battery at fully charged condition. ISET pin output enters a strong pull-down state during recharge cycles.

Charge safety timer

The ETA4085 activate an internal safety timer during the battery pre-condition phase. As a safety mechanism, the

ETA4085 has a user-programmable timer that monitors the total fast charge time. This timer (charge safety timer) is started at the beginning of the fast charge period. The charge safety timer time-out value is set by the external resistor connected to TMR pin, R_{TMR} and the timeout constants K_{TMR}:

$$K_{TMR} = 0.09hr/k\Omega$$

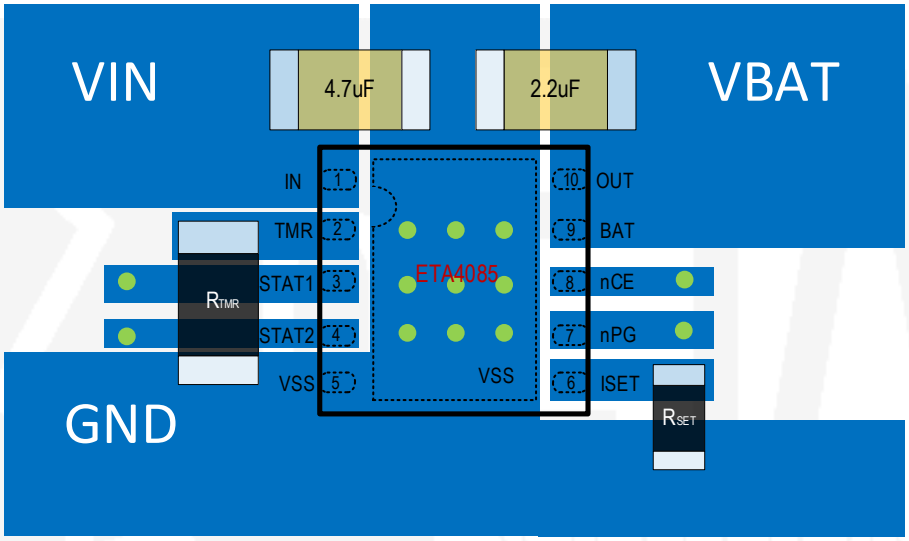
The charge safety timer time-out value is calculated as follows:

$$T_{CHG}(hr) = R_{TMR}(k\Omega) \times K_{TMR}(hr/k\Omega)$$

$$T_{PRE\_CHG}(hr) = R_{TMR}(k\Omega) \times \frac{K_{TMR}(hr/k\Omega)}{10}$$

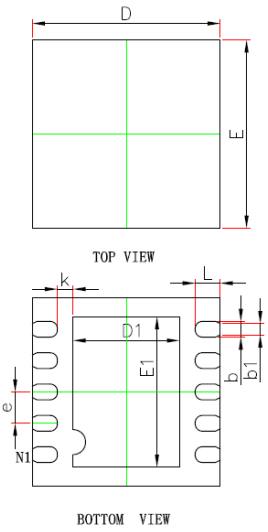
If pin TMR is left open (floating) disables the charging termination circuit and holds the safety timer clock in reset. This is often used for operation without a battery or in production testing.

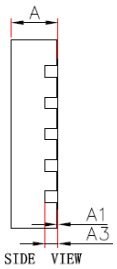
PCB GUIDELINES



PACKAGE OUTLINE

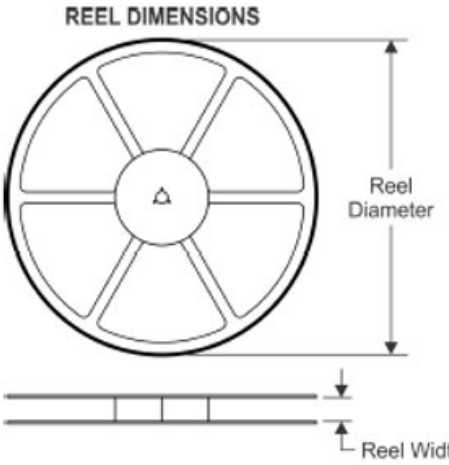
Package: DFN3x3-10

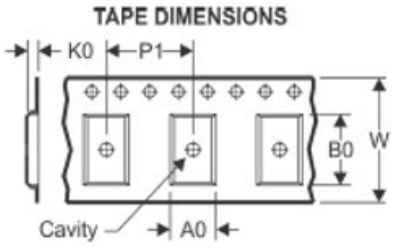




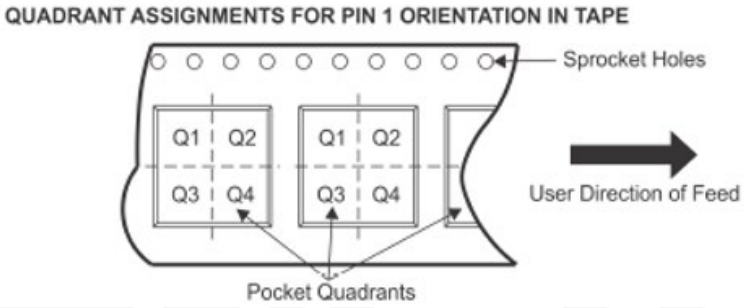
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN.	MAX.	MIN.	MAX.
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	2.924	3.076	0.115	0.121
E	2.924	3.076	0.115	0.121
D1	1.600	1.800	0.063	0.071
E1	2.300	2.500	0.091	0.098
b	0.200	0.300	0.008	0.012
b1	0.180REF		0.007REF	
e	0.500BSC.		0.020BSC.	
k	0.250REF		0.010REF	
L	0.324	0.476	0.013	0.019

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
ETA4085D3K	DFN3x3-10	10	5000	330	12.4	3.35	3.35	1.13	8	12	Q1