KP3111

High Performance Low Cost Off-line PWM Power Switch

FEATURES

- **High Precision 5V Default Output**
- **Integrated with 500V MOSFET and High Voltage Startup Circuit**
- **Ultra Low System BOM Cost**
- **Support Buck and Buck/Boost Topology**
- **On/OFF Peak Current Mode Control**
- **Less than 50mW Standby Power**
- **Built-in 31kHz Oscillator with Frequency Shuffling**
- **Built-in Soft Start**
- **Very Low VDD Operation Current**
- **Build in Protections:**
  - **Over Load Protection (OLP)**
  - **On-Chip Thermal Shutdown (OTP)**
  - **Cycle-by-Cycle Current Limiting (OCP)**
  - **Leading Edge Blanking (LEB)**
  - **VDD UVLO**
- **SOP-8, TO-92 and SOT23-3 Package Available**

APPLICATIONS

- **Small Home Appliance**
- **Linear Regulator/RCC Replacement**

GENERAL DESCRIPTION

KP3111 is a low cost, highly integrated PWM power switch for non-isolated buck and buck-boost applications.

KP3111 combines a 500V power MOSFET with the ON/OFF PWM controller in one chip. The IC can achieve high precision 5V default Output at universal AC input. In KP3111, PWM switching frequency with shuffling is fixed to 31kHz. The IC has built-in green mode control for light and zero loadings, which can achieve less than 50mW standby power.
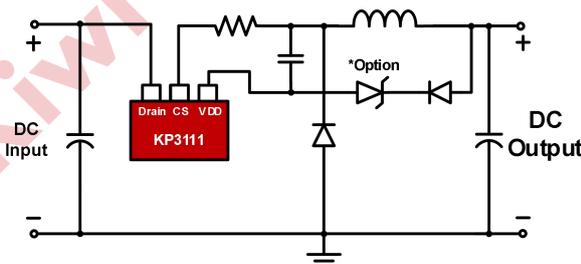
KP3111 integrates functions and protections of Under Voltage Lockout (UVLO), Cycle-by-cycle Current Limiting (OCP), On-chip Thermal Shutdown (OTP), Over Load Protection (OLP) Short Load Protection (SLP), etc.
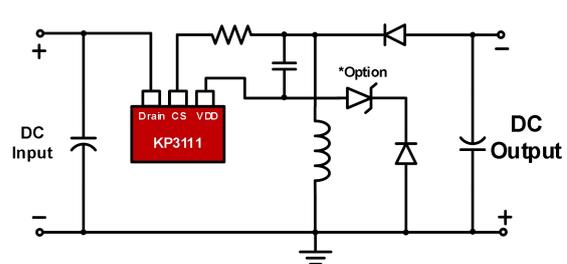
TYPICAL APPLICATION CIRCUIT

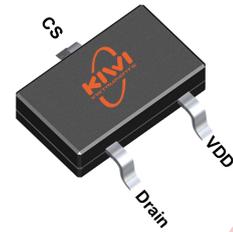**Buck Converter**

Buck/Boost Converter
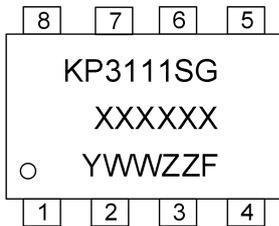
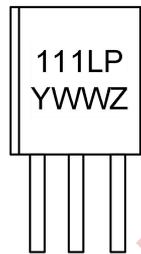## Pin Configuration
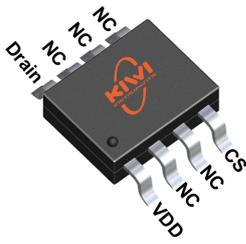
SOP-8

TO-92

SOT23-3

Marking Information

XXXXXX: Wafer lot code
Y: Year code
WW: Week code, 01-52
ZZ: Serial number, 01-99 or A0-ZZ
F: Control Number, 1-9 or A-Z, a-z

8	7	6	5

KP3111SG

XXXXXX

○ YWWZZF

1	2	3	4

SOP-8

Y:Year Code
WW: Week Code, 01-52
Z: Serial Number, 1-9 or A-Z

111LP
YWWZ

TO-92

Y: Year Code
WW: Week Code,01-52
Z: Serial Number, 1-9 or A-Z

3

GAVYWWZ

1		2

SOT23-3

Typical Output Power Table[1]

Product	Package	Maximum Load Current@85-265Vac[2]
KP3111	SOP-8	220mA
KP3111	TO-92	220mA
KP3111	SOT23-3	200mA

(1) Default 5V Buck output

(2) The practical output power is determined by the output voltage and thermal condition

Pin Description

SOP-8	TO-92	SOT23-3	Pin Name	I/O	Description
1	3	2	VDD	P	Power Supply Pin of the Chip
2,3,5,6,7	-	-	NC		Non-Function Pin, Left Open
4	2	3	CS	P	The Ground of the IC. This pin is also used for peak current control
8	1	1	Drain	P	Internal Power MOSFET Drain

(3) P - Power

Ordering Information[4]

Part Number	Description
KP3111SGA	SOP-8, Halogen Free in T&R, 4000Pcs / Reel
KP3111LPA	TO-92, Pb Free in Tape, 2000Pcs / Box
KP3111LGA	SOT23-3, Halogen free in T&R, 3000Pcs / Reel

(4) Suffix "A" - Tape&Reel

Block Diagram
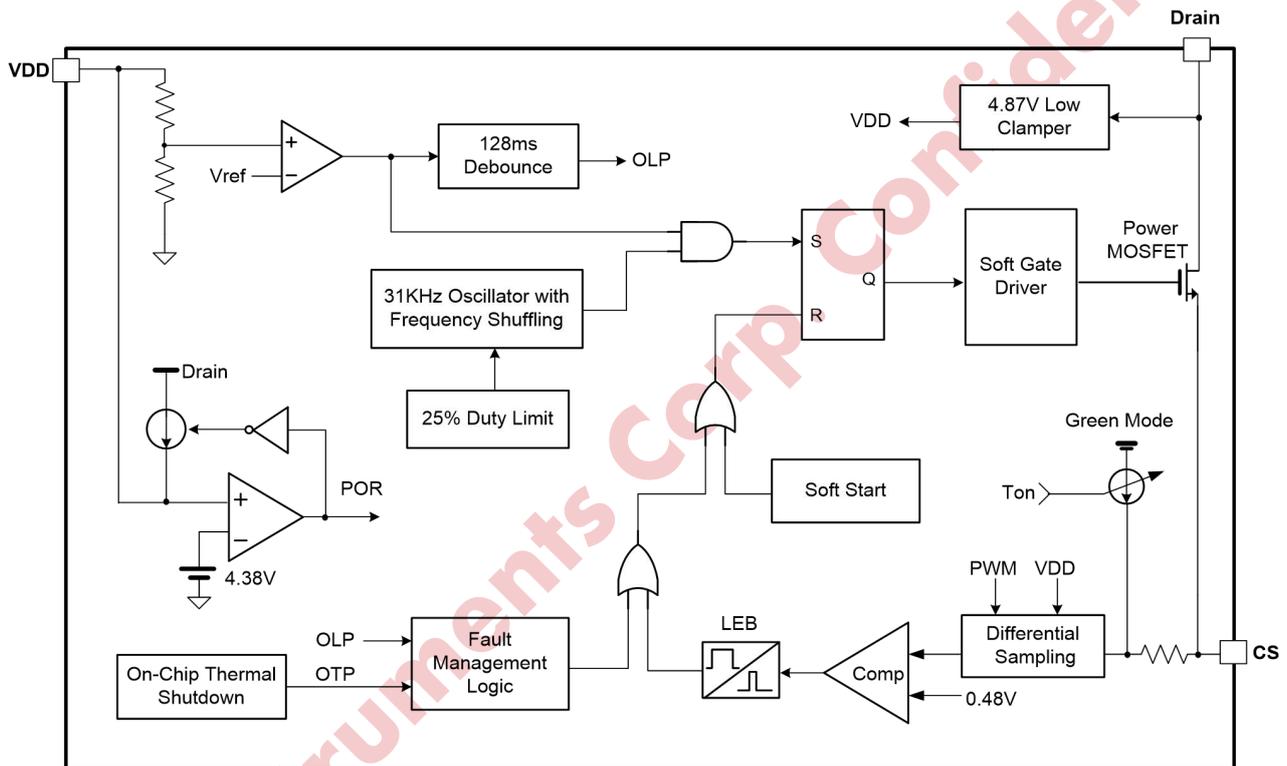
Absolute Maximum Ratings[5]

Parameter	Value	Unit
VDD DC Supply Voltage	-0.3 to 8.5	V
Drain pin	-0.3 to 500	V
Package Thermal Resistance ---Junction to Ambient (SOP-8)	165	℃/W
Package Thermal Resistance---Junction to Ambient (TO-92)	170	℃/W
Package Thermal Resistance---Junction to Ambient (SOT23-3)	260	℃/W
Maximum Junction Temperature	160	℃
Storage Temperature Range	-65 to 150	℃
Lead Temperature (Soldering, 10sec.)	260	℃
ESD Capability, HBM (Human Body Model)	3	kV

Recommended Operation Conditions

Parameter	Value	Unit
Operating Junction Temperature	-40 to 125	℃

Electrical Characteristics (Ta = 25℃, if not otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage Section (VDD Pin)						
$I_{VDD\_standby}$	Standby Operation Current	VDD=6V		150	300	µA
V_{DD_Op}	VDD Operation Voltage	@ Full Load	5.32	5.45	5.58	V
V_{DD_OFF}	VDD Under Voltage Lockout Enter			4.38		V
V_{DD_ON}	VDD Under Voltage Lockout Exit			4.87		V
Oscillator Section						
F_{OSC}	Oscillator Frequency	VDD=5.46V	28.5	31	35.5	kHz
$\Delta F_{(shuffle)}/F_{OSC}$	Frequency Shuffling Range			±5		%
$T_{(shuffle)}$	Frequency Shuffling Period			32		ms
D_{MAX}	Maximum PWM Switching Duty Cycle[6]		21	25	29	%
T_{D_OLP}	Over Loading Debounce Time	VDD=5.46V		128		ms

Current Sense Input Section (CS Pin)							
T_{LEB}	CS Input Leading Edge Blanking Time				300		ns
$V_{cs(max)}$	Current limiting threshold			440	480	520	mV
T_{D_OCP}	Over Current Detection and Control Delay				100		ns
Over Temperature Protection							
T_{SD}	Thermal Shutdown Trigger Point[6]				155		°C
Power MOSFET Section (Drain Pin)							
V_{BR}	Power MOSFET Drain Source Breakdown Voltage			500			V
R_{dson}	Static Drain-Source On Resistance	I(Drain)=50mA			13		Ω
$I_{Drain\_to\_VDD}$	High Voltage VDD Charging Current Source	Drain=40V, VDD=4V			1	3	mA
$I_{Drain\_leakage}$	Drain Leakage Current	HV=500V, VDD=6V				50	μA

(5) Stresses listed as the above "Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to maximum rating conditions for extended periods may remain possibility to affect device reliability.
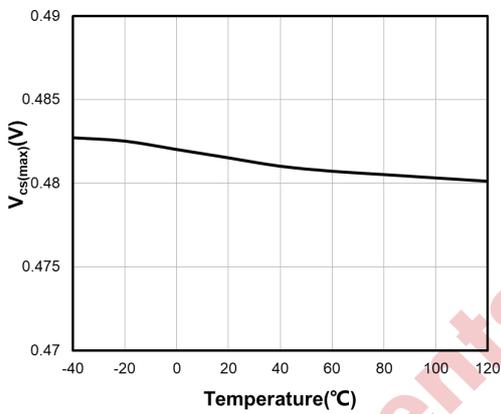
(6) Guaranteed by design.
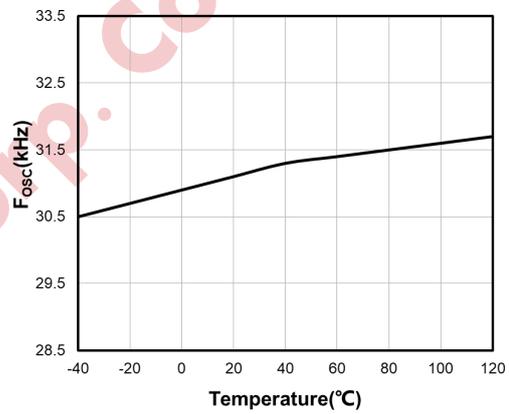
Typical Characteristic
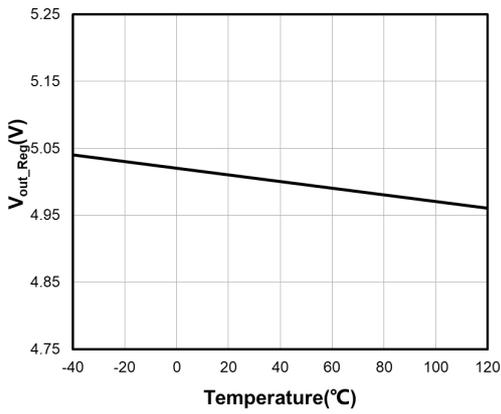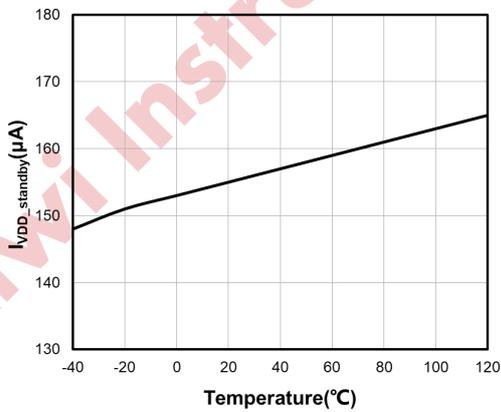
V_{out_Reg} vs Temperature
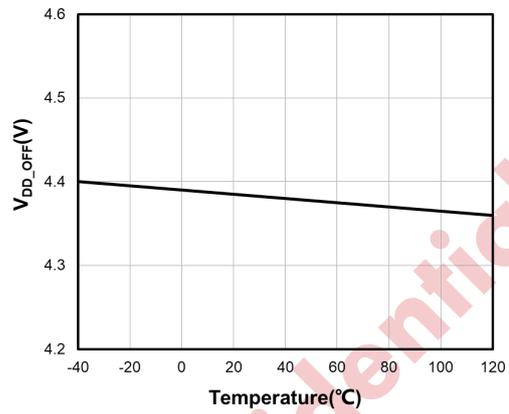
V_{DD_OFF} vs Temperature

$V_{cs(max)}$ vs Temperature

F_{OSC} vs Temperature

$I_{VDD\_standby}$ vs Temperature

Operation Description

KP3111 combines a high voltage power MOSFET switch with power controller in one chip. It is optimized for off-line non-isolated buck or buck-boost applications for small home appliances and linear regulator replacement. The IC utilizes the ON/OFF current mode PWM control to regulate a 5V default output with high precision and lowest components count.

● Very Low Operation Current

The standby operating current in KP3111 is as small as 150µA (typical). The small operating current results in higher efficiency and reduces the VDD hold-up capacitance requirement. Normally 0.1-1µF ceramic capacitor is recommended.

● Oscillator with Frequency Shuffling

PWM switching frequency in KP3111 is fixed to 31kHz. To improve system EMI performance, KP3111 operates the system with +-5% frequency shuffling around setting frequency. The practical system switching frequency is determined by the load condition and the comparison of VDD voltage over output reference, which cause system works in the pulse-skipping mode.

● Current Limit and Leading Edge Blanking

The current limit circuit samples the differential voltage between VDD and CS, as shown in "Block Diagram". When the sampled differential voltage exceeds the internal threshold, the power MOSFET is turned off for the remainder of that cycle. An internal leading edge blanking circuit is built in. During this blanking period (300ns, typical), the cycle-by-cycle current limiting comparator is disabled and cannot switch off the GATE driver.

● Green Mode Operation

In light/zero load condition, the system usually works in DCM mode. Therefore, the main power dissipation is proportional to the square of peak current limit. In KP3111, the IC can automatically reduce the peak current limit under such load conditions, thus less than 50mW standby power can be achieved.

● Soft Start

KP3111 features an internal 4ms (typical) soft start that slowly increases the threshold of cycle-by-cycle current limiting comparator during startup sequence. Every restart attempt is followed by the soft start activation.

● Over Load Protection (OLP) / Short Load Protection (SLP)

If over load or short load occurs, a fault is detected. If this fault is present for more than 128ms (typical), the protection will be triggered, the IC will experience an auto-restart mode protection as mentioned below.

● On Chip Thermal Shutdown (OTP)

KP3111 integrates thermal shutdown function. When the IC temperature is over 155 ℃, the IC shuts down and enters into auto-restart mode as mentioned below.

### ● Protections with Auto-Restart

In the event of OTP or OLP, the IC enters into auto-restart and VDD oscillation mode begins, wherein the power MOSFET is disabled. In VDD oscillation mode, the VDD hold-up capacitor voltage will periodically ramp up and down between 4.87V and 4.38V with a digital counter counting the oscillation cycle. When 511 cycles had been counted, the IC will reset and start up the system again. However, if the fault still exists, the system will experience the above mentioned process.

● **Soft Totem-Pole Gate Driver**

KP3111 has a soft totem-pole gate driver with optimized EMI performance.

Package Dimension

SOP-8
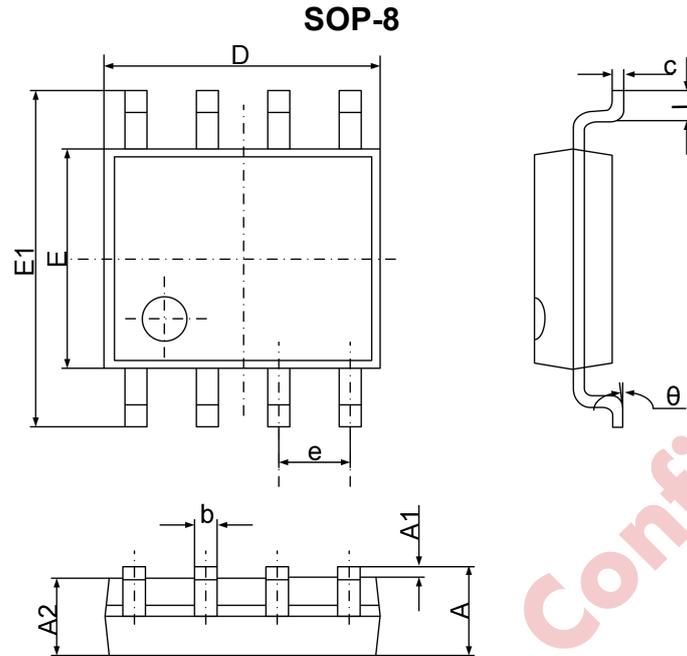
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min.	**Max.**	**Min.**	**Max.**
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.300	1.500	0.051	0.059
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Package Dimension (Continued)

TO-92
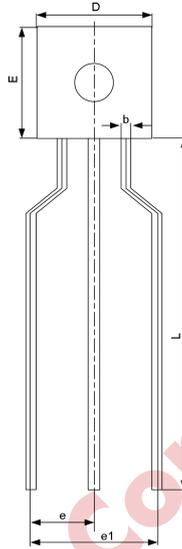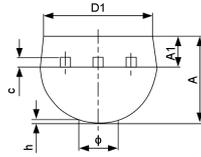
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min.	**Max.**	**Min.**	**Max.**
A	3.300	3.700	0.130	0.146
A1	1.100	1.400	0.043	0.055
b	0.380	0.560	0.015	0.022
c	0.360	0.510	0.014	0.020
D	4.300	4.700	0.169	0.185
D1	3.430	4.300	0.135	0.169
E	4.300	4.700	0.169	0.185
e	2.500 (TYP)		0.098 (TYP)	
e1	4.700	5.300	0.185	0.209
L	11.000	15.000	0.433	0.591
φ	-	1.600	-	0.063
h	0.000	0.380	0.000	0.015

Package Dimension (Continued)

SOT23-3
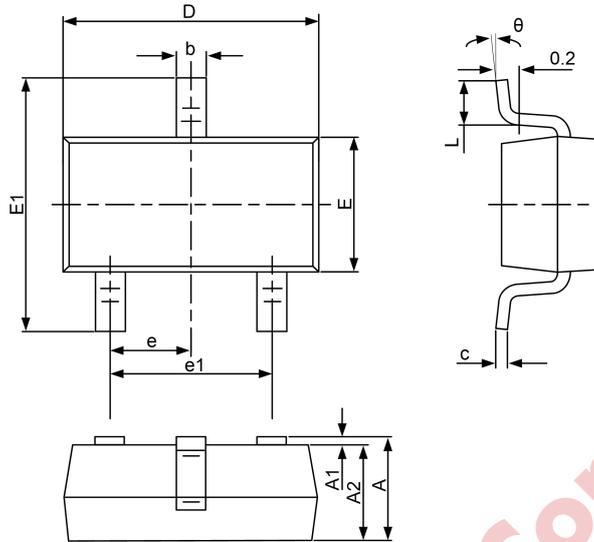
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min.	Max.	Min.	Max.
A	-	1.350	-	0.053
A1	0.000	0.150	0.000	0.006
A2	1.000	1.200	0.039	0.047
b	0.300	0.500	0.012	0.020
c	0.100	0.220	0.004	0.009
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.600	3.000	0.102	0.118
e	0.950 (BSC)		0.037 (BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

Tape and Reel Information

SOP-8
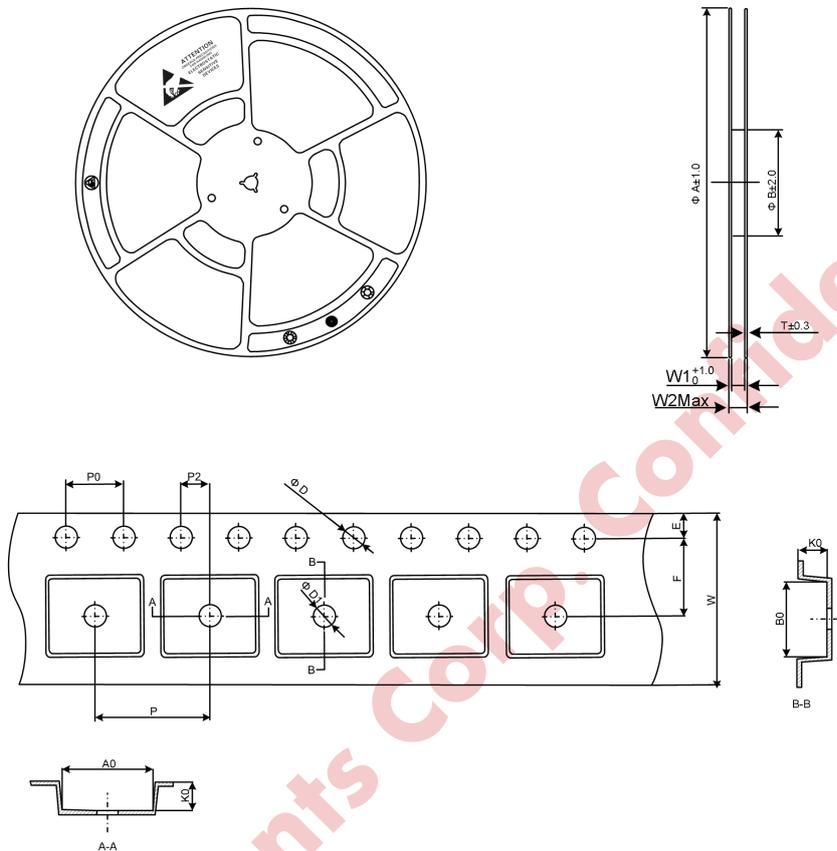
Reel Dimensions (mm)				
A	**B (Inner Diameter)**	**W1**	**W2 Max**	**T**
330	100	12.4	18.4	1.5

Tape Dimensions			
Symbol	**Dimensions (mm)**	**Symbol**	**Dimensions (mm)**
E	1.75±0.10	W	12.00±0.10
F	5.50±0.10	P	8.00±0.10
P2	2.00±0.10	A0	6.60±0.10
D	$1.50^{+0.1}_{-0}$	B0	5.30±0.10
D1	1.55±0.05	K0	1.90±0.10
P0	4.00±0.10		

Tape and Reel Information (Continued)

TO-92
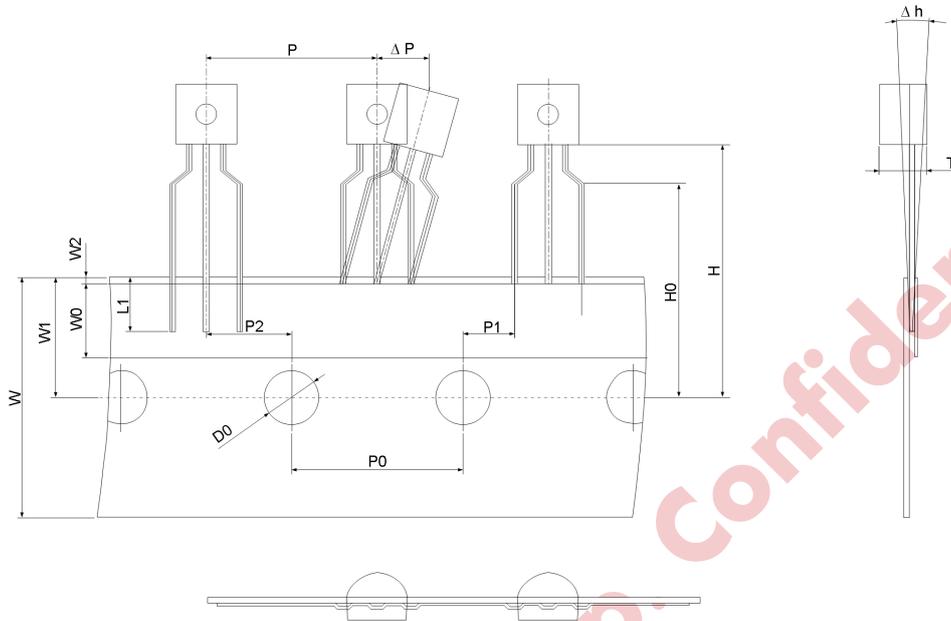
Tape Dimensions			
Symbol	Dimensions (mm)	Symbol	Dimensions (mm)
T	3.5±0.1	W2	1.0 MAX
P	12.7±0.3	H	$19.0^{+2.0}_{-1.0}$
P0	12.7±0.2	H0	16.0±0.5
P2	6.35±0.3	L1	2.5 MIN
Δh	0±1.0	D0	4.0±0.2
W	$18.0^{+1.0}_{-0.5}$	P1	3.85±0.3
W0	6.0±0.5	ΔP	0±1.0
W1	9.0±0.5		

Tape and Reel Information (Continued)

SOT23-3
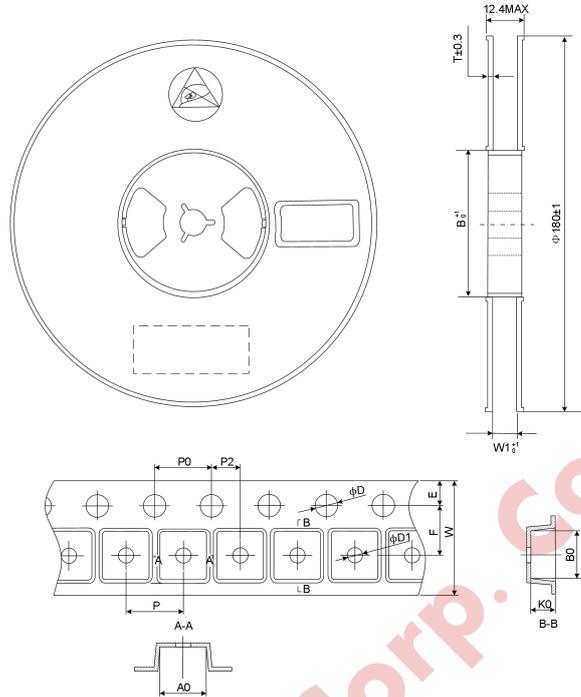
Reel Dimensions (mm)

B	W1	T
54.4	8.6	1.5

Tape Dimensions

Symbol	Dimensions (mm)	Symbol	Dimensions (mm)
E	1.75 ± 0.10	W	8.00 ± 0.10
F	3.50 ± 0.05	P	4.00 ± 0.10
P2	2.00 ± 0.05	A0	3.26 ± 0.10
D	$1.50^{+0.10}_{-0}$	B0	3.30 ± 0.10
D1	1.05 ± 0.05	K0	1.40 ± 0.10
P0	4.00 ± 0.10		

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