

## 3A Bus Termination Regulator

### Features

- Provide Bi-direction Current
  - Sourcing or Sinking Current up to 3A
- 1.25V/0.9V Output for DDR I/II Applications
- Fast Transient Response
- High Output Accuracy
  - $\pm 20\text{mV}$  over Load, VOUT Offset and Temperature
- Adjustable Output Voltage by External Resistors
- Current-Limit Protection
- On-Chip Thermal Shutdown
- Shutdown for Standby or Suspend Mode
- Simple SOP-8, SOP-8-P with thermal pad, TO-252- 5 and TO-263-5 Packages

### Applications

- DDR I/II SDRAM Termination
- SSTL-2/3 Termination Voltage
- Applications Requiring the Regulator with Bi-direction 3A Current Capability

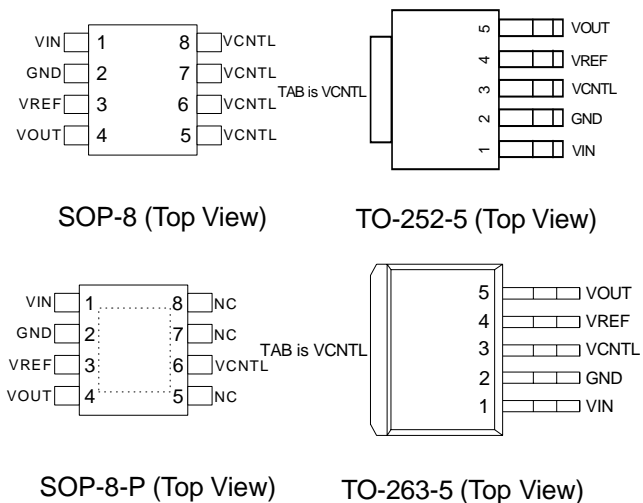
### General Description

The HPL5331 linear regulator is designed to provide a regulated voltage with bi-directional output current for DDR-SDRAM termination. The HPL5331 integrates two power transistors to source or sink current up to 3A. It also incorporate current-limit, thermal shutdown and shutdown control functions into a single chip. Current-limit circuit limits the short-circuit current.

### General Description (Cont.)

On-chip thermal shutdown provides protection against any combination of overload that would create excessive junction temperature. The output voltage of HPL5331 track the voltage at VREF pin. A resistor divider connected to VIN, GND and VREF pins is used to provide a half voltage of VIN to VREF pin. In addition, an external ceramic capacitor and an open-drain transistor connected to VREF pin provides soft-start and shutdown control respectively. Pulling and holding the VREF to GND shuts off the output. The output of HPL5331 will be high impedance after being shut down by VREF or thermal shutdown function.

### Pin Configuration



NC = No internal connection

= Thermal Pad (connected to GND plane for better heat dissipation)

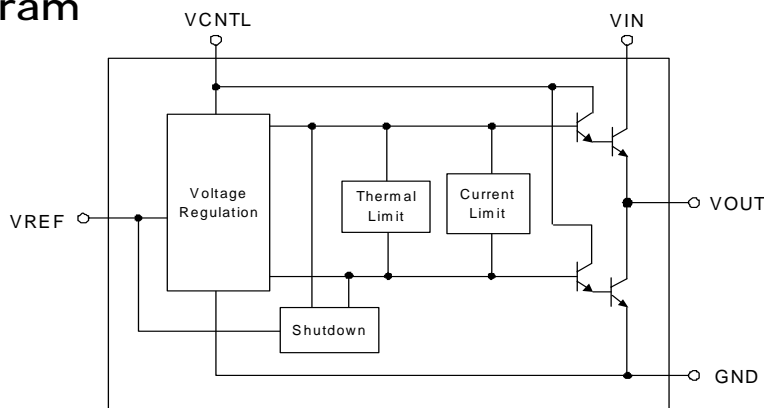
## Ordering and Marking Information

<p>HPL5331 □□□-□□□</p> <p> <span style="margin-left: 100px;">└─</span> Lead Free Code  <span style="margin-left: 80px;">└─</span> Handling Code  <span style="margin-left: 60px;">└─</span> Temp. Range  <span style="margin-left: 40px;">└─</span> Package Code         </p>	<p>Package Code</p> <p>K : SOP-8      KA : SOP-8-P</p> <p>U5 : TO-252-5      G5 : TO-263-5</p> <p>Temp. Range</p> <p>C : 0 to 70 °C</p> <p>Handling Code</p> <p>TR : Tape &amp; Reel</p> <p>Lead Free Code</p> <p>L : Lead Free Device    Blank : Original Device</p>
<p>HPL5331KC-TR :    <span style="border: 1px solid black; padding: 2px;">HPL5331</span></p> <p>HPL5331KAC-TR :    <span style="border: 1px solid black; padding: 2px;">XXXXX</span></p>	<p>XXXXX - Date Code</p>
<p>HPL5331U5C-TR :    <span style="border: 1px solid black; padding: 2px;">HPL5331</span></p> <p>HPL5331G5C-TR :    <span style="border: 1px solid black; padding: 2px;">XXXXX</span></p>	<p>XXXXX - Date Code</p>

## Pin Description

PIN NAME	I/O	DESCRIPTION
VIN	I	Main power input pin. Connect this pin to a voltage source and an input capacitor. The HPL5331 sources current to VOUT pin by controlling the upper NPN pass transistor, providing a current path from VIN pin.
GND	O	Power and signal ground. Connect this pin to system ground plane with shortest traces. The HPL5331 sinks current from VOUT pin by controlling the lower NPN pass transistor, providing a current path to GND pin. This pin is also the ground path for internal control circuitry.
VCNTL	I	Power input pin for internal control circuitry. Connect this pin to a voltage source, providing a bias for the internal control circuitry. A bypass capacitor is usually connected near this pin.
VREF	I	Reference voltage input and active-low shutdown control pin. Apply a voltage to this pin as a reference voltage for the HPL5331. Connect this pin to a resistor divider, between VIN and GND, and a capacitor for soft-start and filtering noise purposes. Applying and holding this pin low by an open-drain transistor to shut down the output.
VOUT	O	Output pin of the regulator. Connect this pin to load. Output capacitors connected this pin improves stability and transient response. The output voltage tracks the reference voltage and is capable of sourcing or sinking current up to 3A.

## Block Diagram



## Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
V <sub>CNTL</sub>	VCNTL Supply Voltage, VCNTL to GND	-0.2 ~ 7	V
V <sub>IN</sub>	VIN Supply Voltage, VIN to GND	-0.2 ~ 3.9	V
P <sub>D</sub>	Power Dissipation	Internally Limited	W
T <sub>J</sub>	Junction Temperature	150	°C
T <sub>STG</sub>	Storage Temperature	-65 ~ 150	°C
T <sub>SDR</sub>	Soldering Temperature, 10 Seconds	300	°C
V <sub>ESD</sub>	Minimum ESD Rating (Human Body Mode)	±3	kV

## Thermal Characteristics

Symbol	Parameter	Rating	Unit
θ <sub>JA</sub>	Thermal Resistance in Free Air		°C/W
	SOP-8	160	
	SOP-8-P	80	
	TO-252-5	80	
	TO-263-5	50	

## Recommended Operating Conditions

Symbol	Parameter	Range	Unit
V <sub>CNTL</sub>	VCNTL Supply Voltage	3.1 ~ 6V	V
V <sub>IN</sub>	VIN Supply Voltage	1.6 ~ 3.5	V
V <sub>REF</sub>	VREF Input Voltage	0.8 ~ 1.75	V
I <sub>OUT</sub>	VOUT Output Current (Note1, 2)	-3 ~ +3	A
T <sub>J</sub>	Junction Temperature	0 ~ 125	°C

Note1 : The symbol "+" means the VOUT sources current to load; the symbol "-" means the VOUT sinks current to GND.

Note2 : The max. I<sub>OUT</sub> varies with the T<sub>J</sub>. Please refer to the typical characteristics.

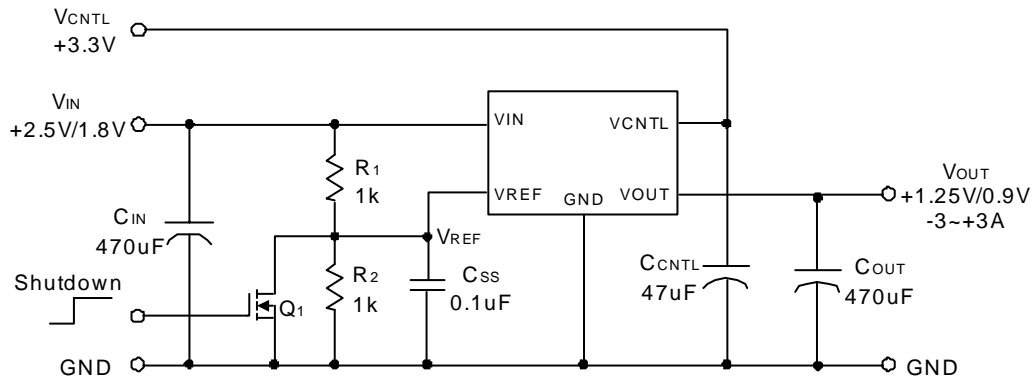
## Electrical Characteristics

Refer to the typical application circuit. These specifications apply over,  $V_{CNTL}=3.3V$ ,  $V_{IN}=2.5V/1.8V$ ,  $V_{REF}=0.5V_{IN}$  and  $T_J=0$  to  $125^{\circ}C$ , unless otherwise specified. Typical values refer to  $T_J=25^{\circ}C$ .

Symbol	Parameter	Test Conditions	HPL5331			Unit	
			Min	Typ	Max		
<b>Output Voltage</b>							
$V_{OUT}$	$V_{OUT}$ Output Voltage	$I_{OUT}=0A$		$V_{REF}$		V	
	System Accuracy	Over temperature, $V_{OUT}$ offset, and load regulation	-20		20	mV	
$V_{OS}$	$V_{OUT}$ Offset Voltage ( $V_{OUT}-V_{REF}$ )	$I_{OUT}=+10mA$	-14	-9		mV	
		$I_{OUT}=-10mA$		2	8		
	Load Regulation	$I_{OUT}=+10mA$ to $+3A$	-6	-3		mV	
		$I_{OUT} = -10mA$ to $-3A$		7	12		
<b>Protection</b>							
$I_{LIM}$	Current Limit	Sourcing Current ( $V_{IN}=2.5V$ )	$T_J=25^{\circ}C$	+3.3	+3.6	A	
			$T_J=125^{\circ}C$		+3.1		
		Sinking Current ( $V_{IN}=2.5V$ )	$T_J=25^{\circ}C$	-3.3	-3.6		
			$T_J=125^{\circ}C$		-3.1		
	Thermal Shutdown Temperature	Rising $T_J$		150		$^{\circ}C$	
				40		$^{\circ}C$	
<b>Input Current</b>							
$I_{CNTL}$	$V_{CNTL}$ Supply Current	$I_{OUT}=0A$		2	4.5	6	mA
		$I_{OUT}=\pm 3A$ (Normal Operation), $V_{CNTL}=5V$			50	110	
		$V_{REF}=GND$ (Shutdown)			2.6		
$I_{VREF}$	$V_{REF}$ Bias Current (The current flows out of $V_{REF}$ )	$V_{REF}=1.25V/0.9V$ (Normal Operation)			150	500	nA
		$V_{REF}=GND$ (Shutdown)			20	40	$\mu A$
<b>Shutdown Control</b>							
	Shutdown Threshold Voltage		0.2	0.35	0.65	V	

## Typical Application Circuit

### 1. $V_{OUT}=1.25V/0.9V$ Application



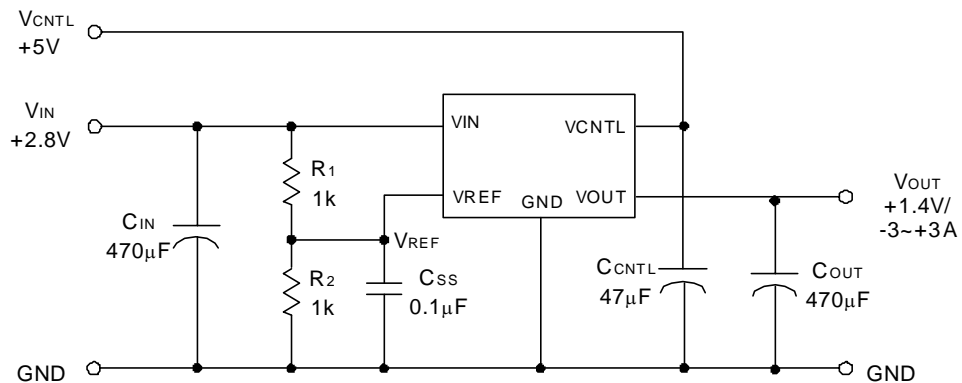
$C_{OUT} : 470\mu F, ESR=25m\Omega$

$R_1, R_2 : 1k\Omega, 1\%$

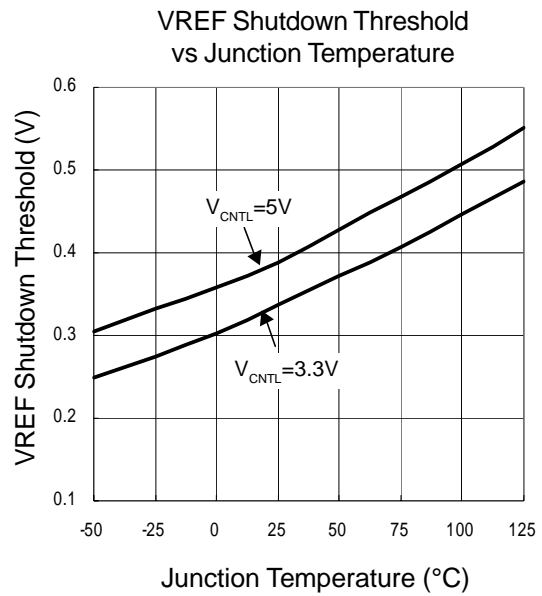
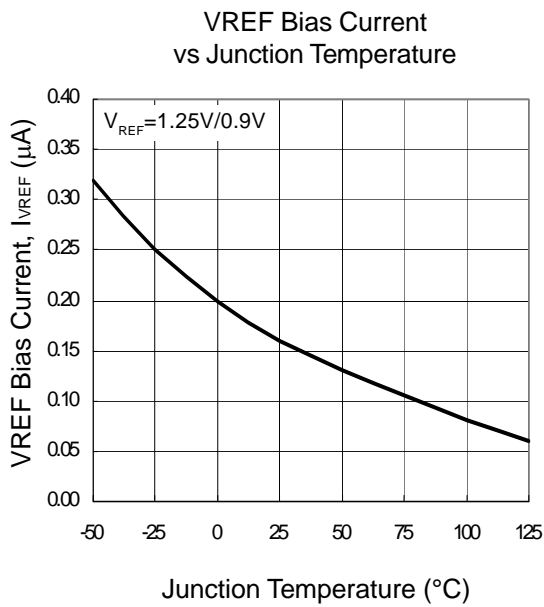
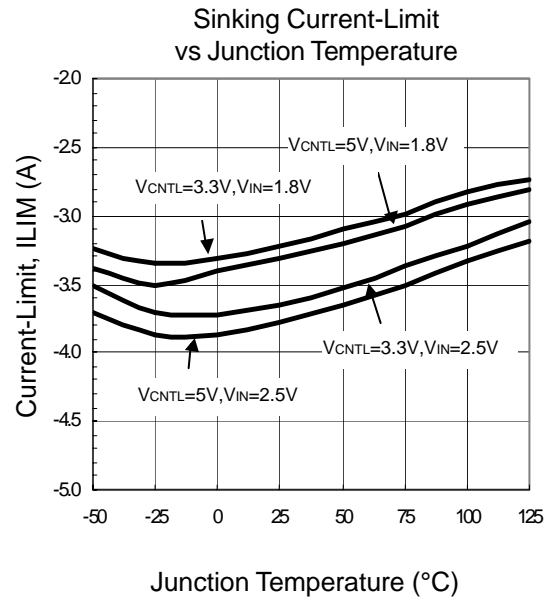
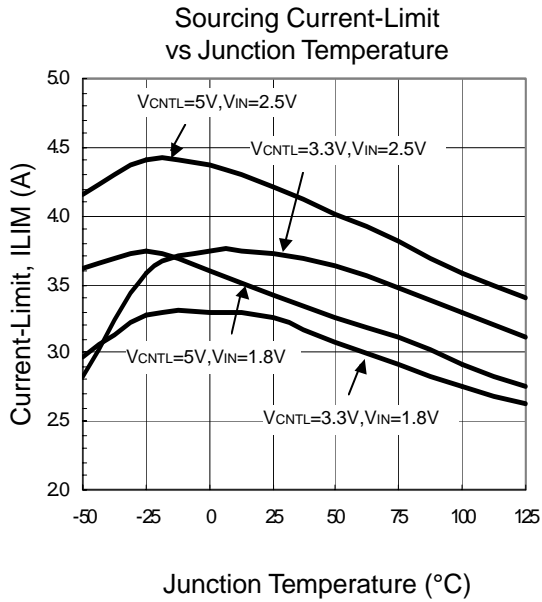
$Q_1 : HPM2300 AC$

Note : Since  $R_1$  and  $R_2$  are very small, the voltage offset caused by the bias current of  $V_{REF}$  can be ignore.

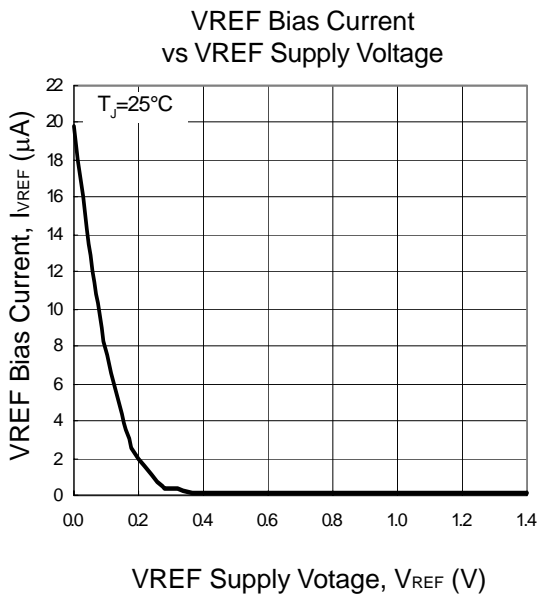
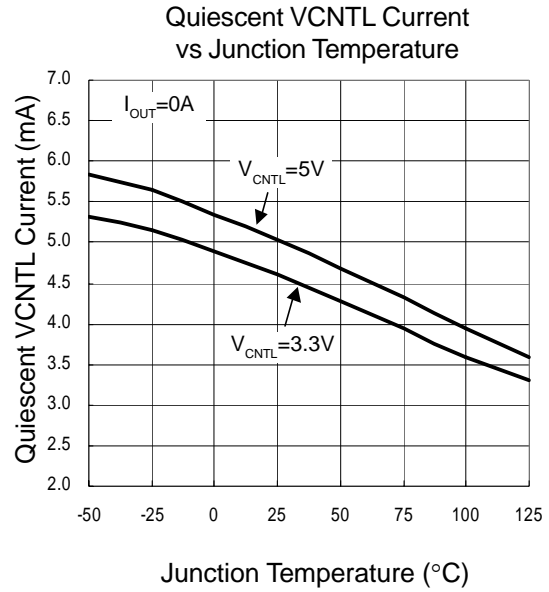
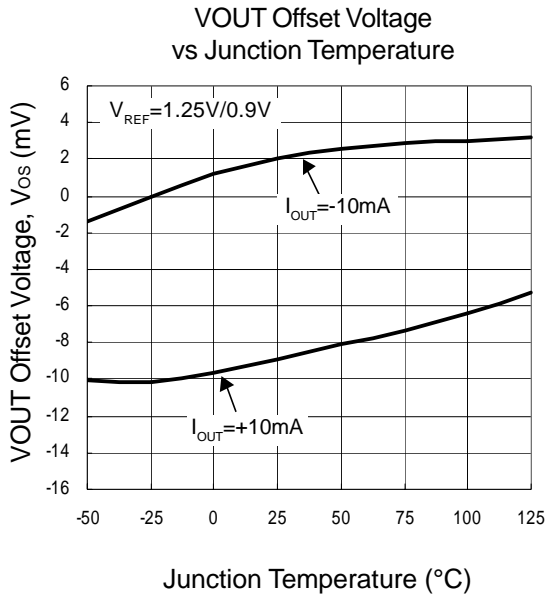
### 2. $V_{OUT}=1.4V$ Application



## Typical Characteristics



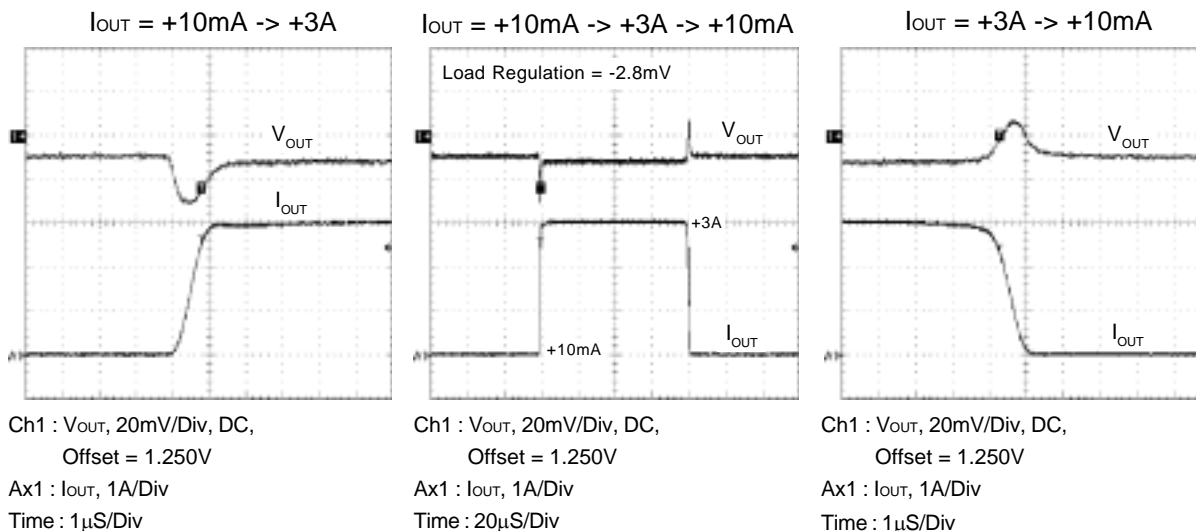
Typical Characteristics (Cont.)



## Operating Waveforms

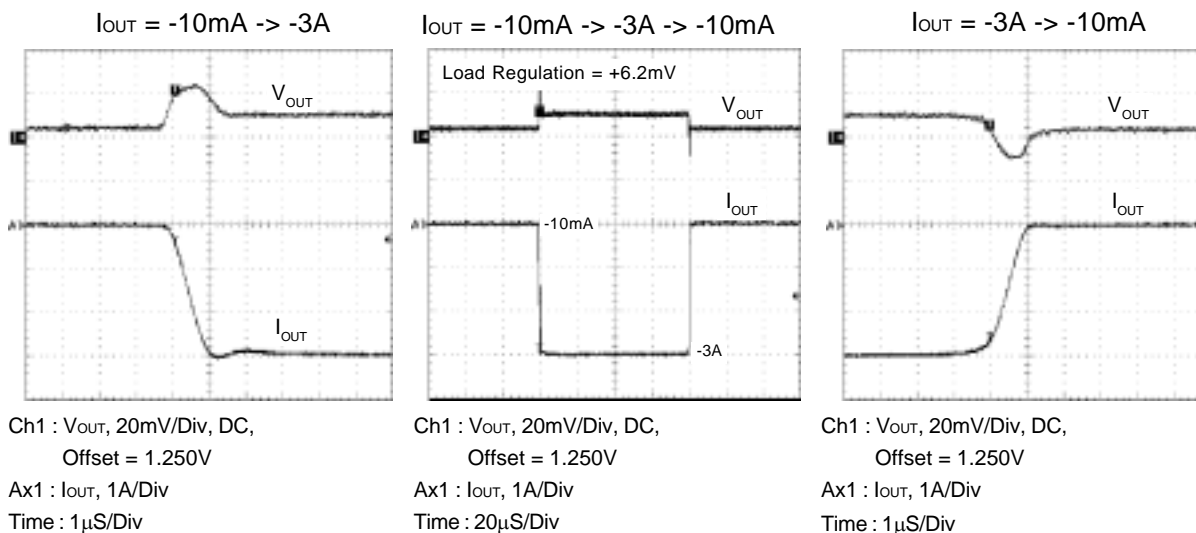
### 1. Load Transient Response : $I_{OUT} = +10mA \rightarrow +3A \rightarrow +10mA$

- $V_{IN} = 2.5V$ ,  $V_{CNTL} = 3.3V$
- $V_{REF}$  is 1.250V supplied by a regulator
- $C_{OUT} = 470\mu F/10V$ ,  $ESR = 30m\Omega$
- $I_{OUT}$  slew rate =  $\pm 3A/\mu S$



### 2. Load Transient Response : $I_{OUT} = -10mA \rightarrow -3A \rightarrow -10mA$

- $V_{IN} = 2.5V$ ,  $V_{CNTL} = 3.3V$
- $V_{REF}$  is 1.250V supplied by a regulator
- $C_{OUT} = 470\mu F/10V$ ,  $ESR = 30m\Omega$
- $I_{OUT}$  slew rate =  $\pm 3A/\mu S$

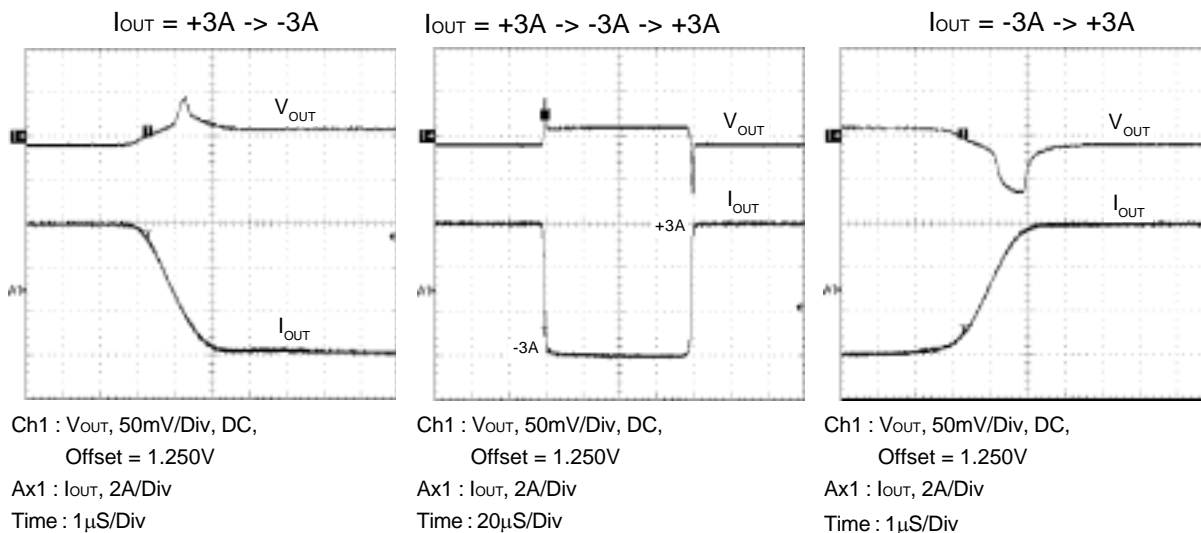




## Operating Waveforms (Cont.)

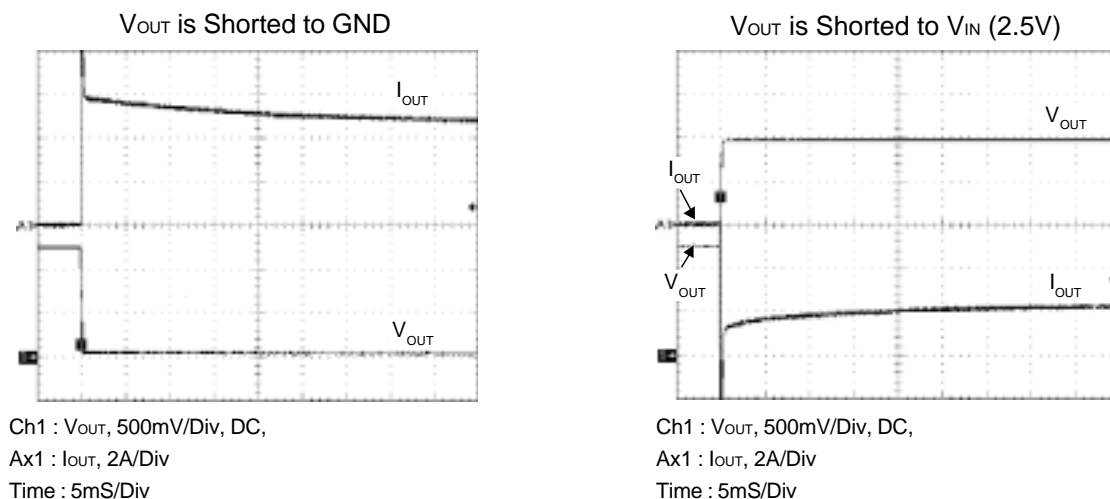
### 3. Load Transient Response : $I_{OUT} = +3A \rightarrow -3A \rightarrow +3A$

- $V_{IN} = 2.5V$ ,  $V_{CNTL} = 3.3V$
- $V_{REF}$  is 1.250V supplied by a regulator
- $C_{OUT} = 470\mu F/10V$ ,  $ESR = 30m\Omega$
- $I_{OUT}$  slew rate =  $\pm 3A/\mu S$



### 4. Short-Circuit Test

- $V_{IN} = 2.5V$ ,  $V_{CNTL} = 3.3V$



## Application Information

### General

The HPL5331 is a linear regulator and is capable of sourcing or sinking current up to 3A. The HPL5331 has fast transient response, accurate output voltage (small voltage offset, load regulation), active-low shutdown control and fault protections (current-limit, thermal shutdown). The HPL5331 is available in several packages to meet different of power dissipation in requirement various applications.

### Output Voltage Regulation

The output voltage at VOUT pin tracks the reference voltage applied at VREF pin. Two internal NPN pass transistors controlled by separate high bandwidth error amplifiers regulate the output voltage by sourcing current from VIN pin or sinking current to GND pin. The base currents of the pass transistors are provided by VCNTL pin. An internal kelvin sensing scheme use at the VOUT pin for perfect load regulation at various load current. To prevent the two pass transistors from shoot-through, a small voltage offset is created between the positive inputs of the two error amplifiers. This results in higher output voltage while the regulator sinks light or heavy load current. Since the HPL5331 exhibits very fast load transient response, lesser amount of capacitors can be use. In addition, capacitors with high ESR can also be use.

### Current Limit

The HPL5331 monitors sourcing and sinking current, and limits the maximum output current to prevent damages during overload or short-circuit, To increase the input voltage of VIN or VCNTL will get higher current-limit points.

### Shutdown and Soft-Start

The VREF pin is a dual-function input pin, acting as reference input and shutdown control input. Applying and holding a voltage below 0.35V(typ.) to VREF pin shuts down the output of the regulator. An NPN transistor or N-channel MOSFET is used to pull down the VREF while applying a “high” signal to turn on the transistor. When shutdown function is active, the two pass transistors are turned off and the impedance of the VOUT is about 10M $\Omega$  (typ.), sourcing or sinking no current. When release the VREF pin, the current through the resistor divider charges the soft-start capacitor to initiate a soft-start cycle. The output voltage tracks the rising VREF. The soft start process limits the input surge current.

### Thermal Shutdown

An thermal shutdown circuit limits the junction temperature of the HPL5331. When the junction temperature exceeds  $T_{J} = +150^{\circ}\text{C}$ , a thermal sensor turns off both pass transistors, allowing the device to cool down. The regulator starts to regulate again after the junction temperature reduces by  $40^{\circ}\text{C}$ , resulting in a pulsed output during continuous thermal overload conditions. The thermal limit designed with a  $40^{\circ}\text{C}$  hysteresis lowers the average  $T_{J}$  during continuous thermal overload conditions, extend life time of HPL5331.

## Application Information

### Power Inputs

Input power sequence are not required for VIN and VCNTL. However, do not apply a voltage to VOUT when there is not voltage VCNTL. This is due to the internal parasitic diodes between VOUT to VIN and VOUT to VCNTL which will be forward bias. The HPL5331 can source few current or sinks current up to 3A for load when the input Voltage at VIN is not present.

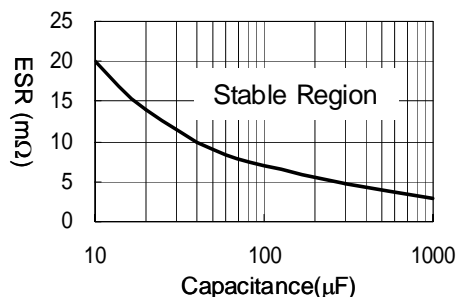
### Reference Voltage

A reference voltage is applied at the VREF pin by a resistor divider between VIN and GND pins. Normally the bias current of the VREF pin flows out of the IC and is about 150nA(typ.), creating voltage offset at the resistor divider and affecting the output voltage accuracy. The recommended resistor is  $<5k\Omega$  to maintain the accuracy of the output voltage. An external bypass capacitor is also connected to VREF. The capacitor and the resistor divider form a low-pass filter to reduce the inherent reference noise from VIN. A ceramic capacitor can be use and is selected to be greater than  $0.1\mu\text{F}$ . Connected the capacitor as close to VREF as possible for optimal effect. More capacitance and large resistor divider will increase the soft-start interval. Do not place any additional loading on this reference input pin.

### Output Capacitor

The HPL5331 requires a proper output capacitor to maintain stability over full temperature and current ranges, and improve transient response. The output capacitor selection is dependent upon the ESR (equivalent series resistance) and capacitance of the output capacitor over full temperature range. The following chart shows the stable region of the output capacitor for HPL5331. The stable region is above the curve, indicating minimum required ESR and capacitance to maintain stability. However, the out

put capacitor should have an ESR less than  $1\Omega$ .



Ultra-low-ESR capacitors, such as ceramic chip capacitors, may promote under-damped transient response, but proper ceramic chip capacitors placed near loads can be used as decoupling capacitors. A low-ESR solid tantalum and aluminum electrolytic capacitor ( $\text{ESR} < 1\Omega$ ) works extremely well and provides good transient response and stability over temperature.

The output capacitors are also used to reduce the slew rate of load current and help the HPL5331 to minimize variations of the output voltage, improving transient response. For this purpose, the low-ESR capacitors are recommended and depend on the stepping and slew rate of load current.

### Input Capacitor

The input capacitors of VCNTL and VIN pins are not required for stability but for supplying surge currents during large load transients, This will prevent the input rail from drooping and improve the performance of the HPL5331. Because of parasitic inductors from voltage sources or other bulk capacitors to the VCNTL and VIN pins will limit the slew rate of the surge currents during large load transients, resulting in voltage drop at VIN and VCNTL pins.

A capacitor of 1 $\mu$ F (ceramic chip capacitor) or greater (aluminum electrolytic capacitor) is recommended to connect near VCNTL pin. For VIN pin, an aluminum electrolytic capacitor (>50 $\mu$ F) is recommended. It is not necessary to use low-ESR capacitors.

### Layout and Thermal Consideration

The input capacitors for VIN and VCNTL pins are normally placed near each pin for good performances. Ceramic decoupling capacitors at output must be placed as close to the load to reduce the parasitic inductors of traces. It is also recommended that the HPL5331 and output capacitors are placed near the load for good load regulation and load transient response. The negative pins of the input and output capacitors and the GND pin of the HPL5331 should connect to analog ground plane of the load.

See figure 1. The SOP-8-P utilizes a bottom thermal pad to minimize the thermal resistance of the package, making the package suitable for high current applications. The thermal pad is soldered to the top ground pad and is connected to the internal or bottom ground plane by several vias. The printed circuit board (PCB) forms a heat sink and dissipates most of the heat into ambient air. The vias are recommended to have proper size to retain solder, helping heat conduction.

Thermal resistance consists of two main elements,  $\theta_{JC}$  (junction-to-case thermal resistance) and  $\theta_{CA}$  (case-to-ambient thermal resistance).  $\theta_{JC}$  is specified from the IC junction to the bottom of the thermal pad directly below the die.  $\theta_{CA}$  is the resistance from the bottom of thermal pad to the ambient air and it includes  $\theta_{CS}$  (case-to-sink thermal resistance) and  $\theta_{SA}$  (sink-to-ambient thermal resistance). The specified path for heat flow is the lowest resistance path and it dissipates majority of the heat to the ambient air. Typically,  $\theta_{CA}$  is the dominant thermal resistance. Therefore, enlarging the internal or bottom ground

plane reduces the resistance  $\theta_{CA}$ . The relationship between power dissipation and temperatures is the following equation :

$$P_D = (T_J - T_A) / \leq \theta_{JA}$$

where,

$P_D$  : Power dissipation

$T_J$  : Junction Temperature

$T_A$  : Ambient Temperature

$\theta_{JA}$ : Junction-to-Ambient Thermal Resistance

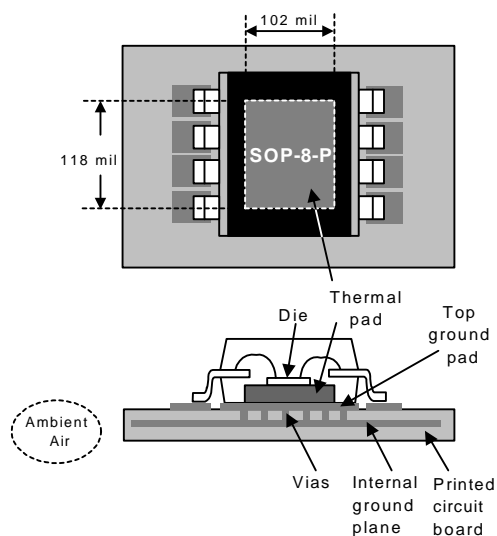


Figure 1 Package Top and side view

Figure 2 shows a board layout using the SOP-8-P package. The demo board is made of FR-4 material and is a two-layer PCB. The size and thickness are 65mm\* 65mm and 1.6mm. An area of 140mil\*105mil on the top layer is use as a thermal pad for the HPL5331 and this is connected to the bottom layer by vias. The bottom layer using 2 oz. copper acts as the ground plane for the system. The PCB and all components on the board form a heat sink. The  $\theta_{JA}$  of the HPL5331 (SOP-8-P) mounted on this demo board is about 37 $^{\circ}$ C/W in free air. Assuming the  $T_A=25^{\circ}$ C and the maximum  $T_J=150^{\circ}$ C (typical thermal limit temperature), the maximum power dissipation is calculated as :

$$P_D(\text{max}) = (150 - 25) / 37$$

$$= 3.38\text{W}$$

If the  $T_J$  is designed to be below 125°C, the calculated power dissipation should be less than :

$$P_D = (125 - 25) / 37$$

$$= 2.70\text{W}$$

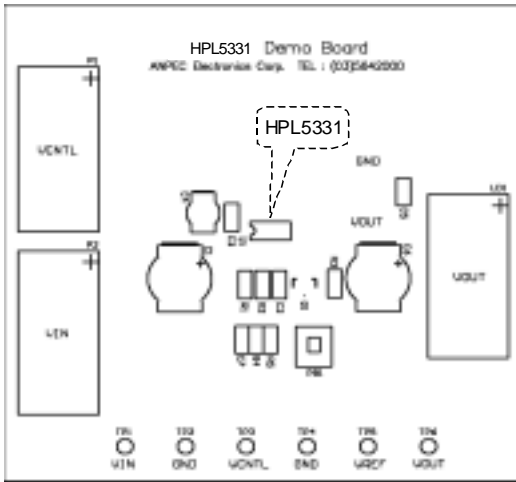


Figure 2(a) TopOver layer

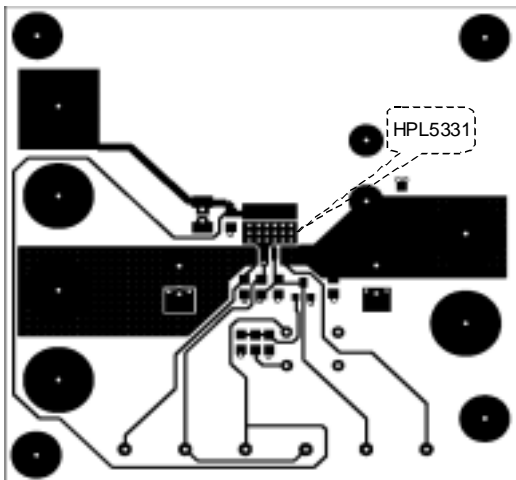


Figure 2(b) Top layer

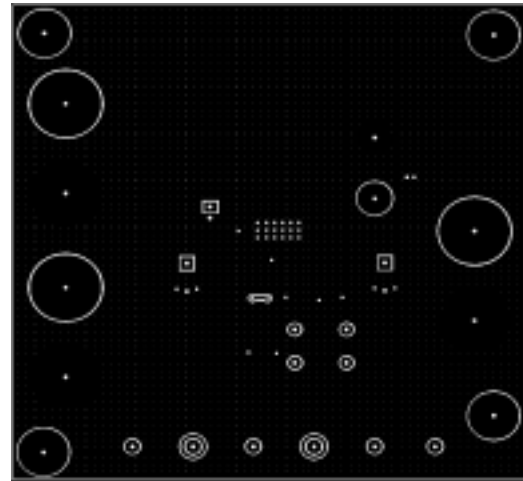
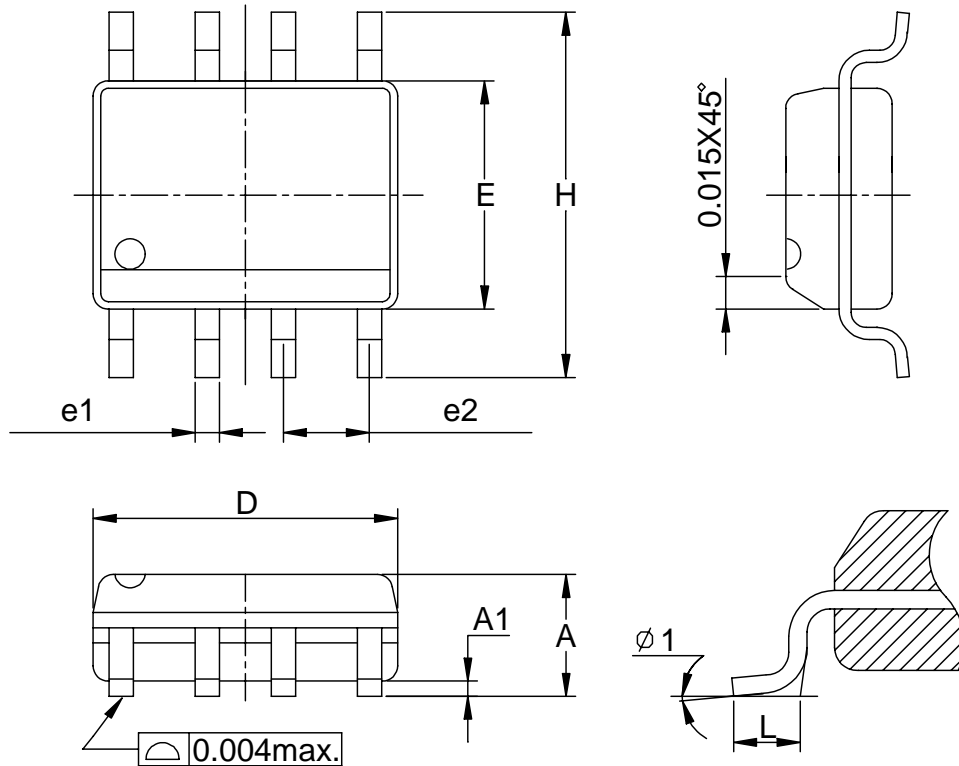


Figure 2(c) Bottom layer

## Packaging Information

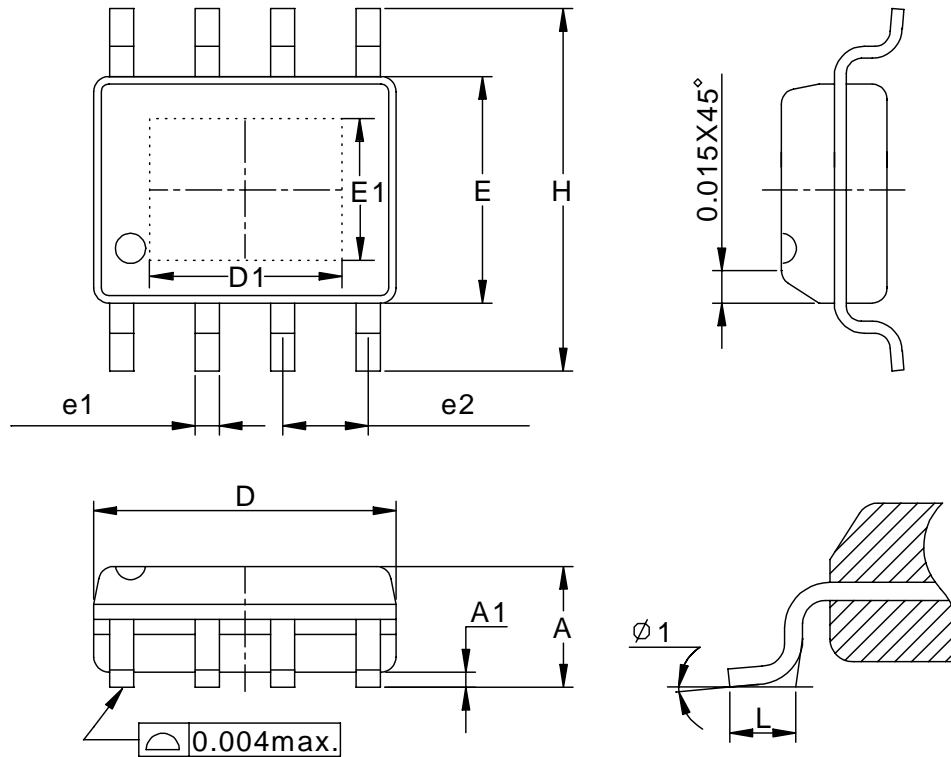
SOP-8 pin ( Reference JEDEC Registration MS-012)



Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
D	4.80	5.00	0.189	0.197
E	3.80	4.00	0.150	0.157
H	5.80	6.20	0.228	0.244
L	0.40	1.27	0.016	0.050
e1	0.33	0.51	0.013	0.020
e2	1.27BSC		0.50BSC	
φ 1	8°		8°	

## Packaging Information

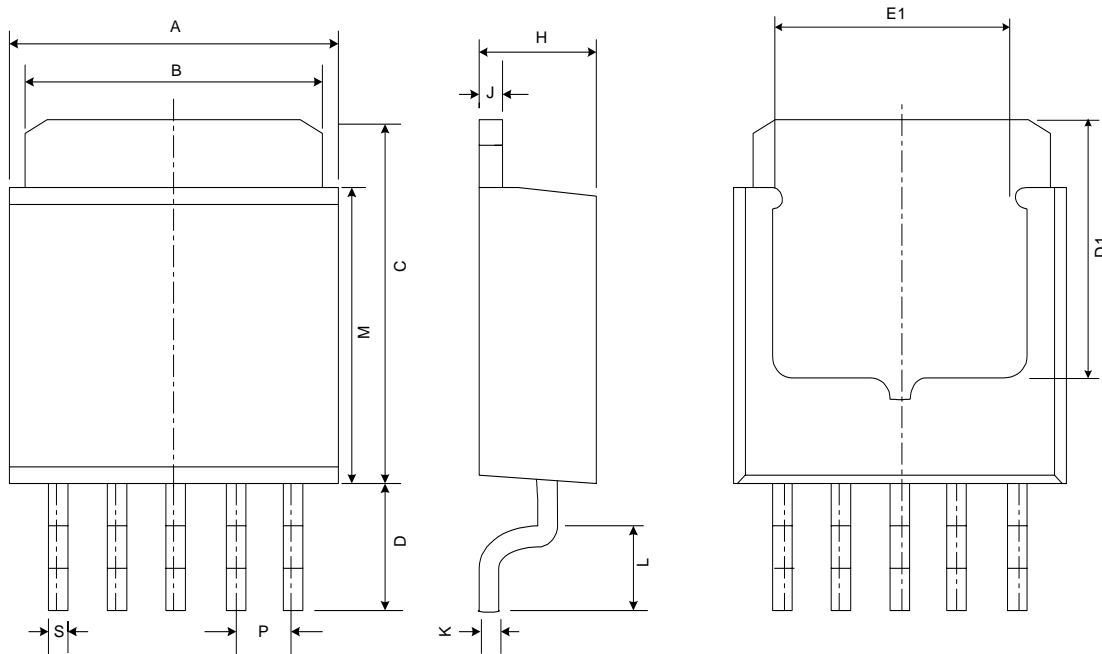
SOP-8-P pin ( Reference JEDEC Registration MS-012)



Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
D	4.80	5.00	0.189	0.197
D1	3.00REF		0.118REF	
E	3.80	4.00	0.150	0.157
E1	2.60REF		0.102REF	
H	5.80	6.20	0.228	0.244
L	0.40	1.27	0.016	0.050
e1	0.33	0.51	0.013	0.020
e2	1.27BSC		0.50BSC	
φ 1	8°		8°	

Packaging Information

TO-252-5

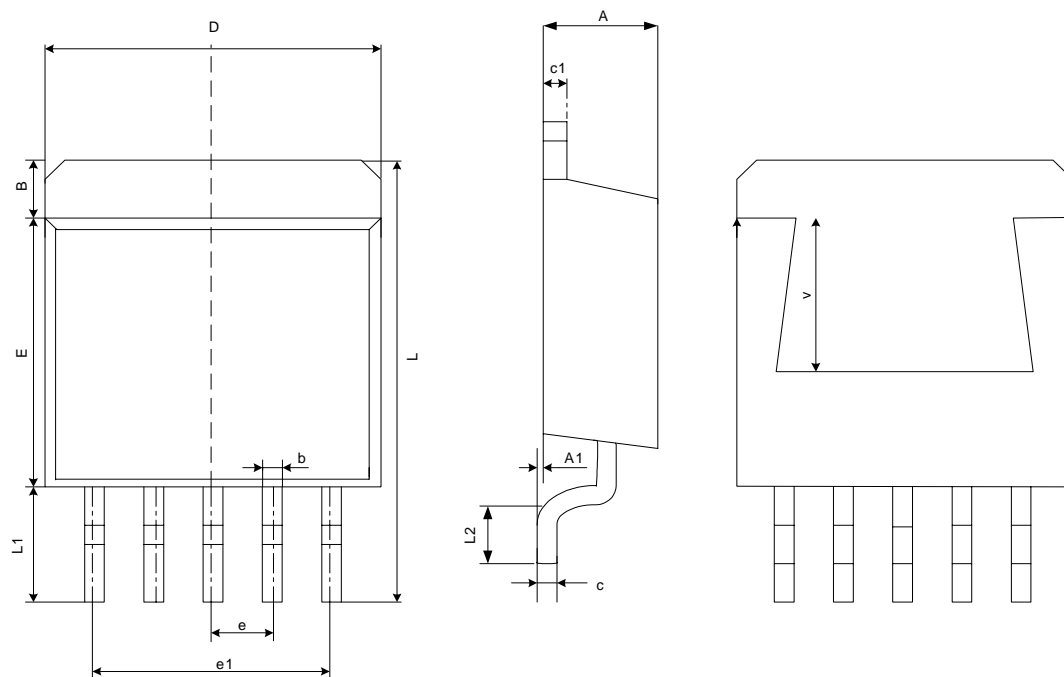


Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	6.40	6.80	0.25	0.26
B	5.20	5.50	0.20	0.21
C	6.80	7.20	0.26	0.27
D	2.20	2.80	0.08	0.11
D1	5.2REF		0.205REF	
E1	5.3REF		0.209REF	
P	1.27REF		0.05REF	
S	0.50	0.80	0.02	0.03
H	2.20	2.40	0.08	0.09
J	0.45	0.55	0.01	0.02
K	0.45	0.60	0.018	0.024
L	0.90	1.50	0.03	0.06
M	5.40	5.80	0.21	0.22



Packaging Information

TO-263-5

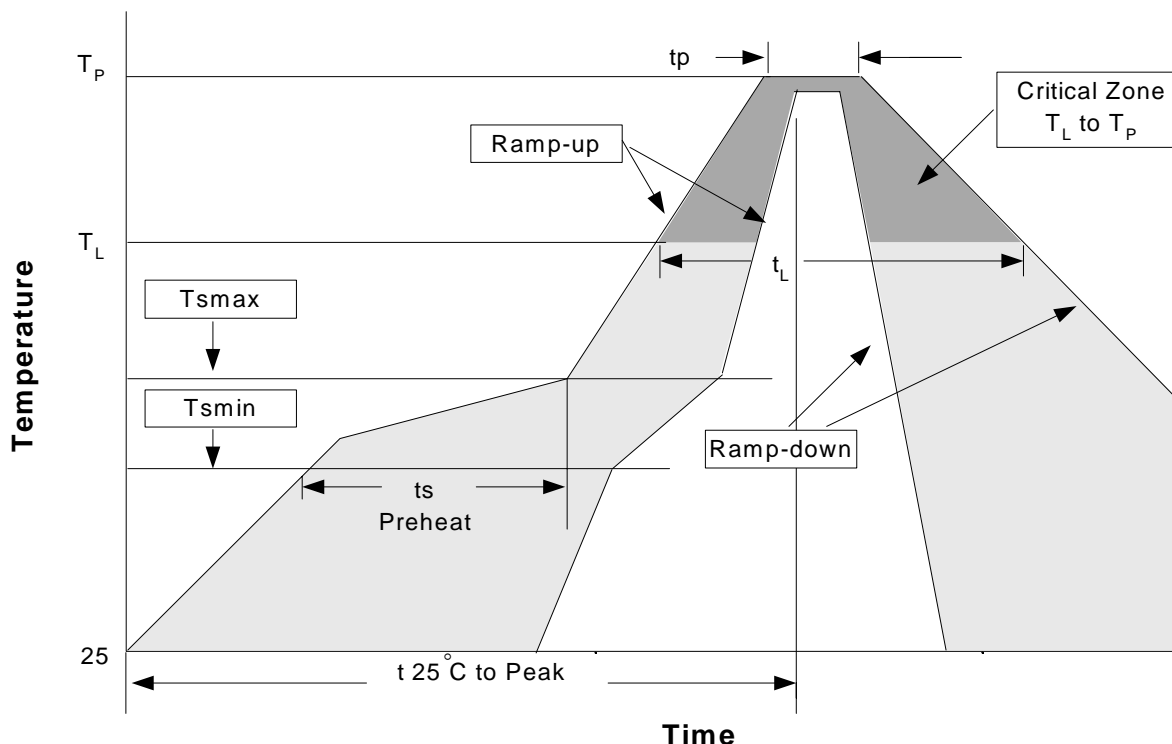


Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	4.06	4.83	0.160	0.190
b	0.50	0.99	0.020	0.039
b1	1.52	1.83	0.060	0.072
c	0.457	0.736	0.018	0.029
c1	1.14	1.40	0.045	0.055
D	8.25	9.66	0.325	0.380
E	9.65	10.29	0.380	0.405
L	14.60	15.88	0.575	0.625
L1	2.28	2.80	0.090	0.110
L2		1.40		0.055

## Physical Specifications

Terminal Material	Solder-Plated Copper (Solder Material : 90/10 or 63/37 SnPb), 100%Sn
Lead Solderability	Meets EIA Specification RS186-91, ANSI/J-STD-002 Category 3.

### Reflow Condition (IR/Convection or VPR Reflow)



### Classification Reflow Profiles

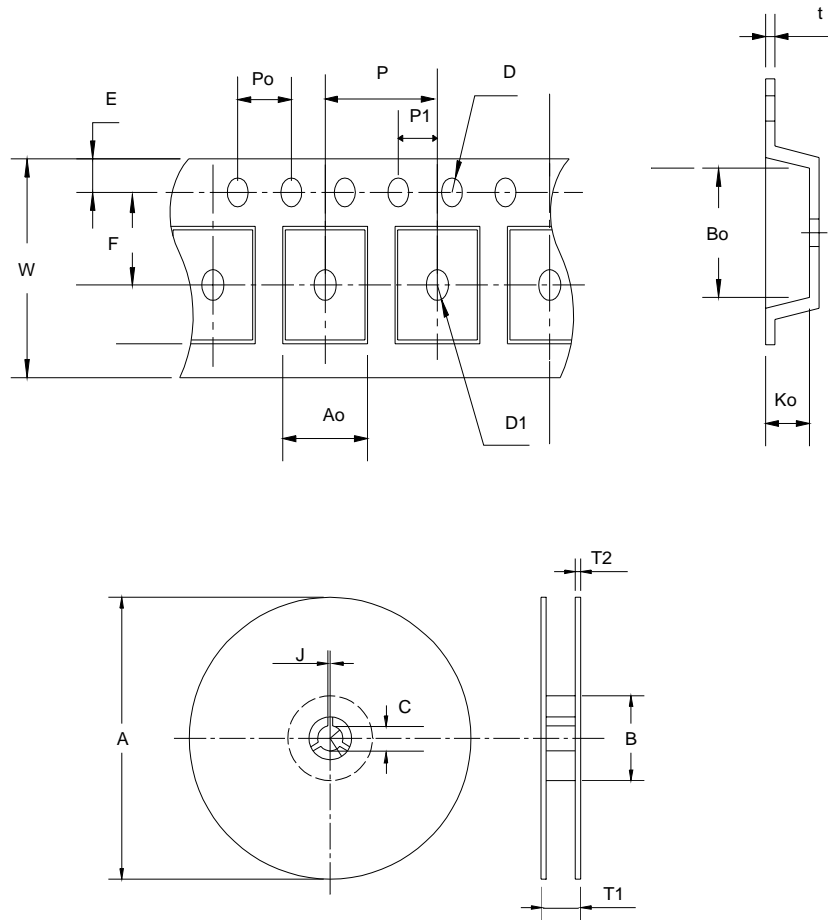
Profile Feature	Sn-Pb Eutectic Assembly		Pb-Free Assembly	
	Large Body	Small Body	Large Body	Small Body
Average ramp-up rate ( $T_L$ to $T_P$ )	3°C/second max.		3°C/second max.	
Preheat				
- Temperature Min ( $T_{smin}$ )	100°C		150°C	
- Temperature Mix ( $T_{smax}$ )	150°C		200°C	
- Time (min to max)( $t_s$ )	60-120 seconds		60-180 seconds	
$T_{smax}$ to $T_L$				
- Ramp-up Rate			3°C/second max	
$T_{smax}$ to $T_L$				
- Temperature( $T_L$ )	183°C		217°C	
- Time ( $t_L$ )	60-150 seconds		60-150 seconds	
Peak Temperature( $T_p$ )	225 +0/-5°C	240 +0/-5°C	245 +0/-5°C	250 +0/-5°C
Time within 5°C of actual Peak Temperature( $t_p$ )	10-30 seconds	10-30 seconds	10-30 seconds	20-40 seconds
Ramp-down Rate	6°C/second max.		6°C/second max.	
Time 25°C to Peak Temperature	6 minutes max.		8 minutes max.	

Note: All temperatures refer to topside of the package. Measured on the body surface.

## Reliability Test Program

Test item	Method	Description
SOLDERABILITY	MIL-STD-883D-2003	245°C, 5 SEC
HOLT	MIL-STD-883D-1005.7	1000 Hrs Bias @ 125°C
PCT	JESD-22-B,A102	168 Hrs, 100%RH, 121°C
TST	MIL-STD-883D-1011.9	-65°C~150°C, 200 Cycles
ESD	MIL-STD-883D-3015.7	VHBM > 2KV, VMM > 200V
Latch-Up	JESD 78	10ms, $1_{tr} > 100mA$

## Carrier Tape



## Carrier Tape

Application	A	B	C	J	T1	T2	W	P	E
SOP- 8 SOP-8-P	330 ± 1	62 +1.5	12.75+ 0.15	2 ± 0.5	12.4 ± 0.2	2 ± 0.2	12 ± 0.3	8 ± 0.1	1.75 ± 0.1
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	5.5 ± 1	1.55 +0.1	1.55+ 0.25	4.0 ± 0.1	2.0 ± 0.1	6.4 ± 0.1	5.2 ± 0.1	2.1 ± 0.1	0.3 ± 0.013
Application	A	B	C	J	T1	T2	W	P	E
TO-252	330 ± 3	100 ± 2	13 ± 0.5	2 ± 0.5	16.4 + 0.3 -0.2	2.5 ± 0.5	16 + 0.3 -0.1	8 ± 0.1	1.75 ± 0.1
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	7.5 ± 0.1	1.5 + 0.1	1.5 ± 0.25	4.0 ± 0.1	2.0 ± 0.1	6.8 ± 0.1	10.4 ± 0.1	2.5 ± 0.1	0.3 ± 0.05
Application	A	B	C	J	T1	T2	W	P	E
TO-263	380 ± 3	80 ± 2	13 ± 0.5	2 ± 0.5	24 ± 4	2 ± 0.3	24 + 0.3 -0.1	16 ± 0.1	1.75 ± 0.1
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	11.5 ± 0.1	1.5 + 0.1	1.5 ± 0.25	4.0 ± 0.1	2.0 ± 0.1	10.8 ± 0.1	16.1 ± 0.1	5.2 ± 0.1	0.35 ± 0.013

(mm)

## Cover Tape Dimensions

Application	Carrier Width	Cover Tape Width	Devices Per Reel
SOP- 8 / SOP-8-P	12	9.3	2500
TO- 252	16	13.3	2500
TO- 263	24	21.3	1000

## CONTACT

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