

## Description

The AP7330 is a low dropout regulator with high output voltage accuracy, low  $R_{DS(ON)}$ , high PSRR, low output noise and low quiescent current. This regulator is based on a CMOS process.

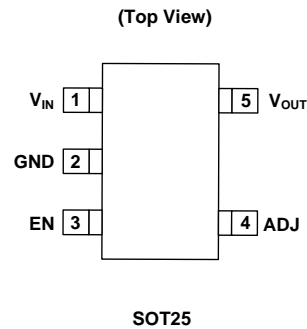
The AP7330 includes a voltage reference, error amplifier, current limit circuit and an enable input to turn it on and off. With its low power consumption and line and load transient response, the AP7330 is well suited for low power handheld communication equipment.

The AP7330 is packaged in SOT25 package, allows for smallest footprint and dense PCB layout.

## Features

- Low  $V_{IN}$  and Wide  $V_{IN}$  Range: 1.8V to 5.5V
- Wide  $V_{OUT}$  Range: 1.0V to 4.5V
- Guarantee Output Current: 300mA
- $V_{OUT}$  Accuracy  $\pm 1\%$
- Ripple Rejection 80dB at 1kHz
- Low Output Noise, 60 $\mu$ Vrms from 10Hz to 100kHz
- Quiescent Current as Low as 45 $\mu$ A
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

## Pin Assignments

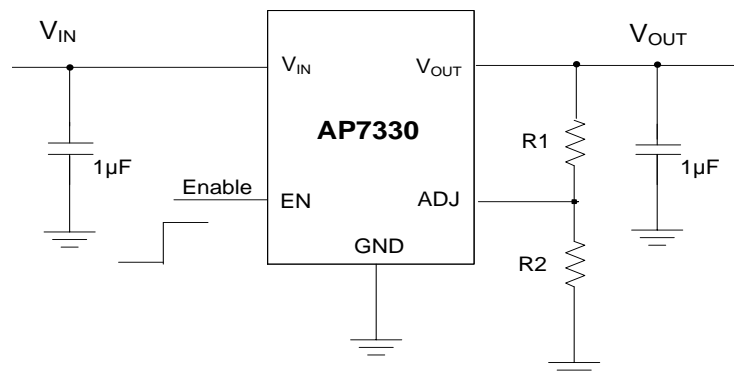


## Applications

- Smart Phone/Tablet
- RF Supply
- Cameras
- Portable Video
- Portable Media Player
- Wireless Adapter
- Wireless Communication

- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
  2. See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
  3. Halogen, Antimony and Beryllium-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl), <1000ppm antimony compounds and <1000ppm Beryllium.

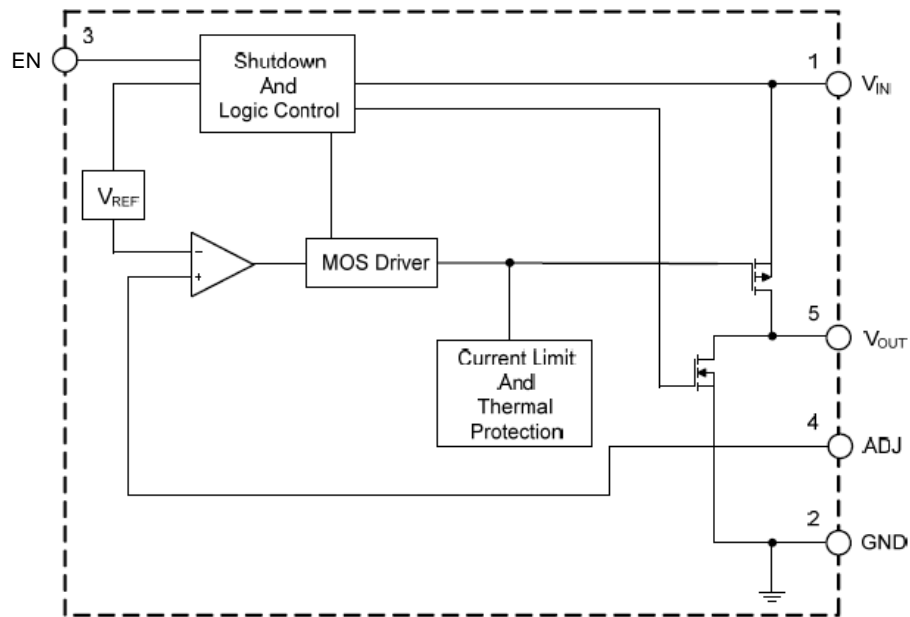
## Typical Applications Circuit



## Pin Descriptions

Pin Number	Pin Name	Function
1	V <sub>IN</sub>	Power Input Pin
2	GND	Ground
3	EN	Enable Pin This pin should be driven either high or low and must not be floating. Driving this pin high enables the regulator, while pulling it low puts the regulator into shutdown mode
4	ADJ	Output Feedback Pin
5	V <sub>OUT</sub>	Power Output Pin

## Functional Block Diagram



## Absolute Maximum Ratings (Note 4) (@T<sub>A</sub> = +25°C, unless otherwise specified.)

Symbol	Parameter	Ratings	Unit
ESD HBM	Human Body Mode ESD Protection	> 2	kV
ESD MM	Machine Mode ESD Protection	> 200	V
V <sub>IN</sub>	Input Voltage	6.0	V
V <sub>EN</sub>	Input Voltage for EN Pin	6.0	V
V <sub>OUT</sub>	Output Voltage	-0.3 to V <sub>IN</sub> + 0.3	V
I <sub>OUT</sub>	Output Current	300	mA
P <sub>D</sub>	Power Dissipation	300	mW
T <sub>A</sub>	Operating Ambient Temperature	-40 to +85	°C
T <sub>STG</sub>	Storage Temperature	-55 to +125	°C

Note: 4. a). Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these conditions is not implied. Exposure to absolute-maximum-rated conditions for extended period may affect device reliability.  
 b). Ratings apply to ambient temperature at +25°C. The JEDEC High-K board design used to derive this data was a 2 inch x 2 inch multilayer board with 1oz. internal power and ground planes and 2oz. copper traces on the top and bottom of the board.

**Recommended Operating Conditions** (@ $T_A = +25^\circ\text{C}$ , unless otherwise specified.)

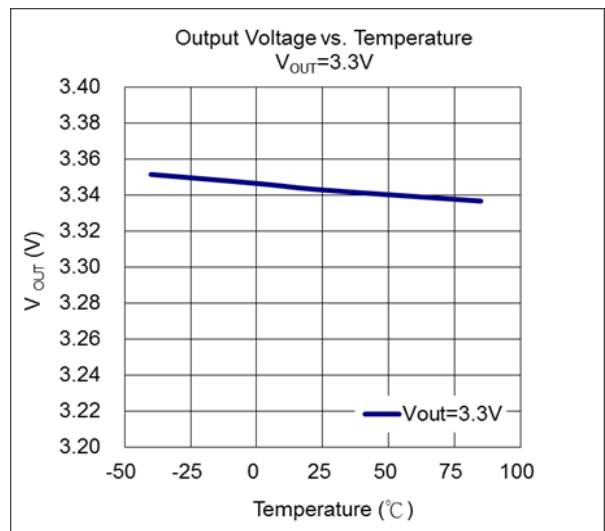
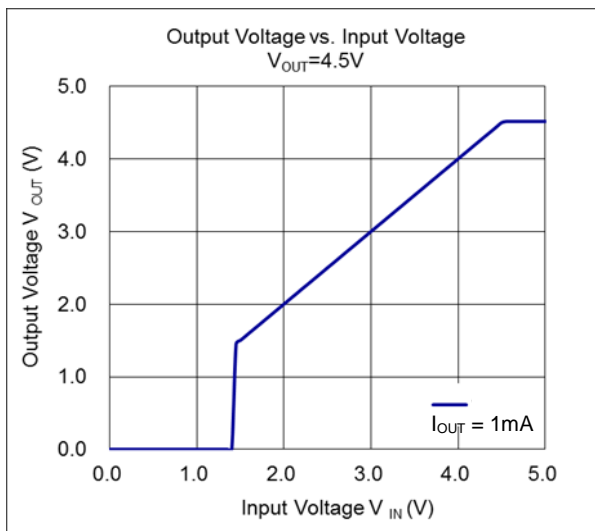
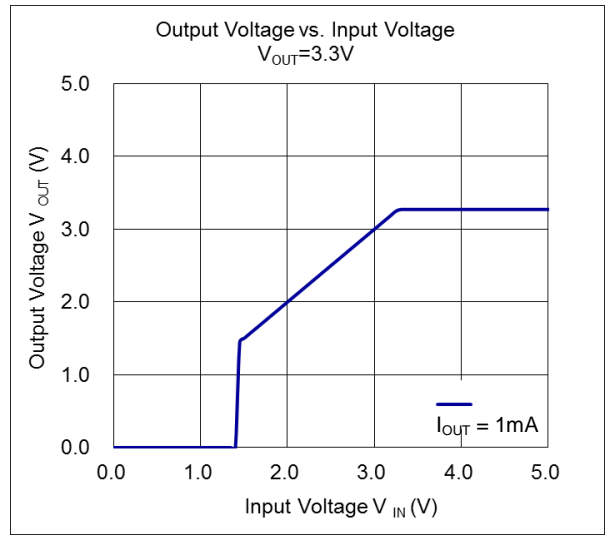
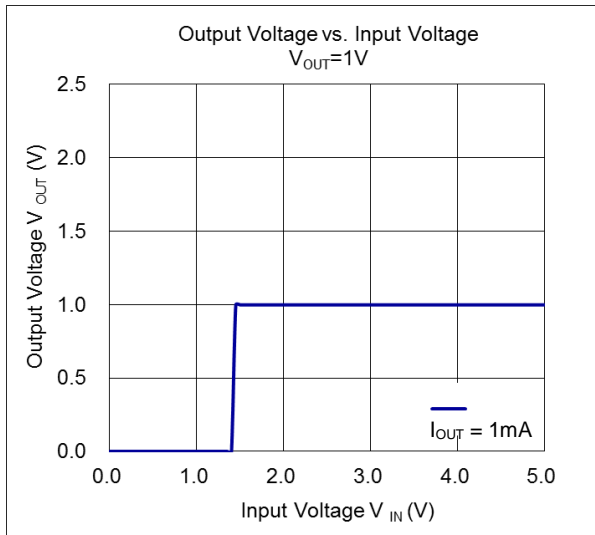
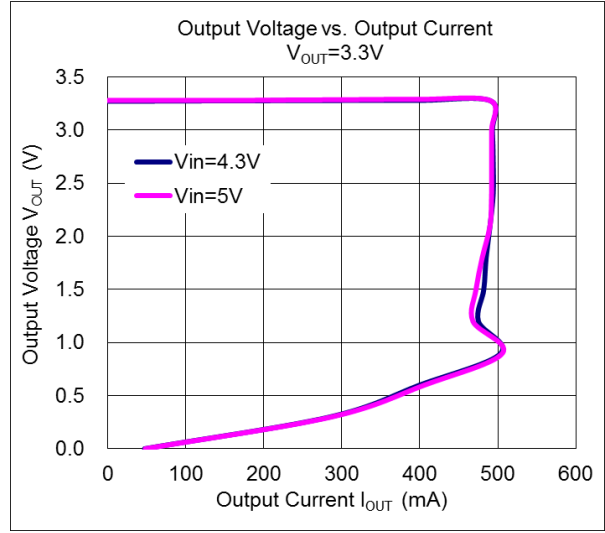
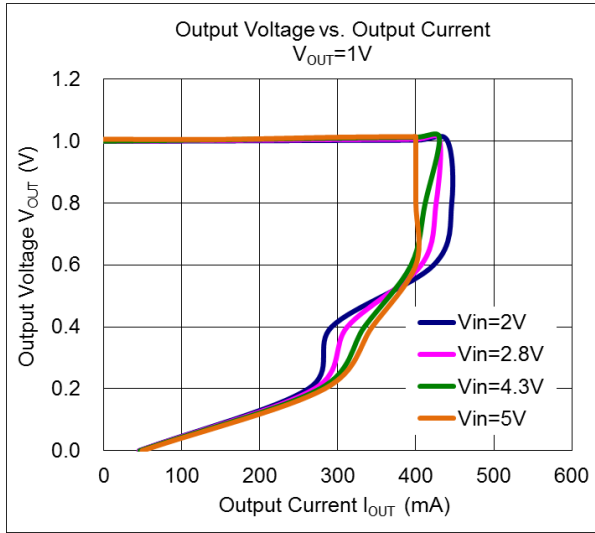
Symbol	Parameter	Min	Max	Unit
$V_{IN}$	Input Voltage	1.8	5.5	V
$V_{OUT}$	Output Voltage	1.0	4.5	V
$I_{OUT}$	Output Current	0	300	mA
$T_A$	Operating Ambient Temperature	-40	+85	$^\circ\text{C}$

**Electrical Characteristics** (@ $T_A = +25^\circ\text{C}$ ,  $V_{IN} = V_{OUT} + 1.0\text{V}$ ,  $C_{IN} = C_{OUT} = 1.0\mu\text{F}$ ,  $I_{OUT} = 1.0\text{mA}$ , unless otherwise specified.)

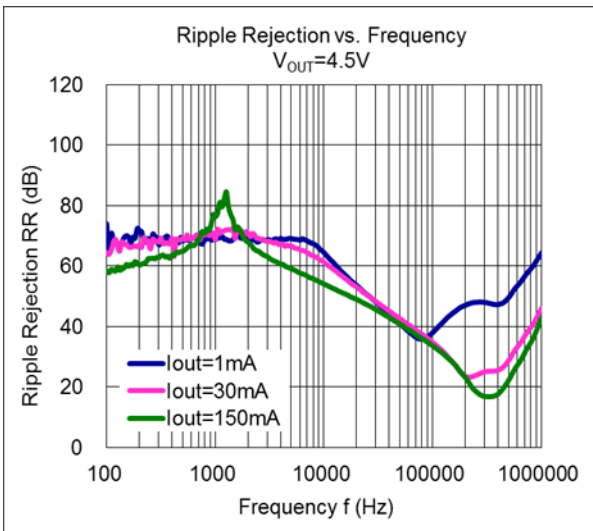
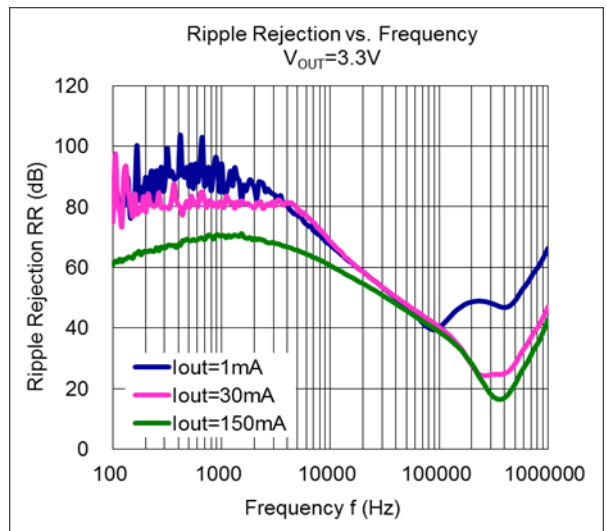
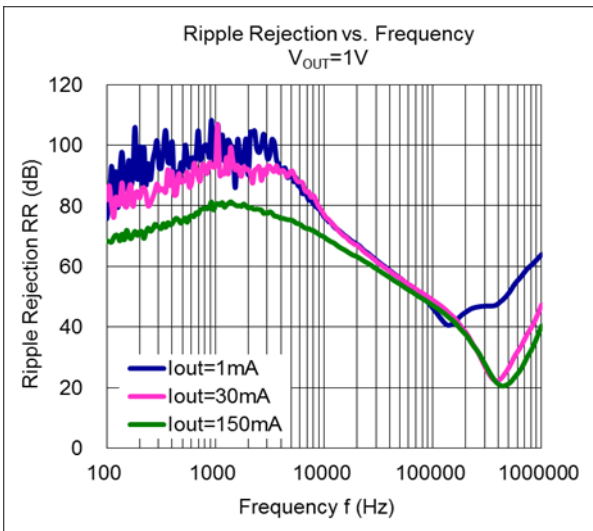
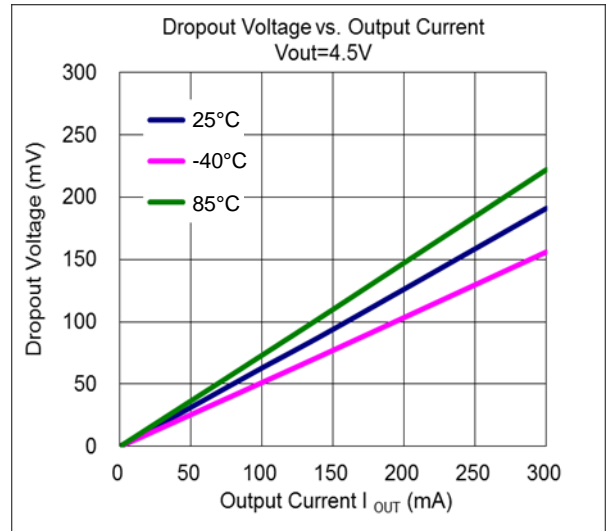
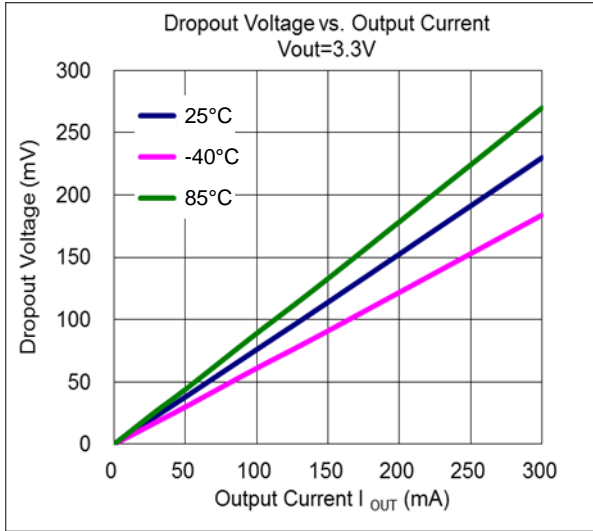
Parameter	Condition	Min	Typ	Max	Unit	
Input Voltage	$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$	1.8	—	5.5	V	
Output Voltage Accuracy (Note 11)	$V_{IN} = V_{OUT(T)} + 1\text{V}$ , $T_A = +25^\circ\text{C}$	$V_{OUT(T)}^* \cdot 0.99$	$V_{OUT(T)}$	$V_{OUT(T)}^* \cdot 1.01$	V	
ADJ Leakage Current	—	—	0.1	1	$\mu\text{A}$	
$V_{ADJ}$	Reference Voltage $V_{IN} = V_{OUT} + 1\text{V}$ $1\text{mA} \leq I_{OUT} \leq 300\text{mA}$	0.792	0.8	0.808	V	
Line Regulation ( $dV_{OUT}/dV_{IN}/V_{OUT}$ )	$V_{IN} = (V_{OUT - Nom} + 1.0\text{V})$ to $5.5\text{V}$ , $I_{OUT} = 1.0\text{mA}$	—	0.02	0.1	%/V	
Load Regulation	$V_{IN} = V_{OUT - Nom} + 1.0\text{V}$ , $I_{OUT} = 1\text{mA}$ to $300\text{mA}$	—	15	30	mV	
Quiescent Current (Note 6)	$I_{OUT} = 0\text{mA}$	—	45	78	$\mu\text{A}$	
$I_{STANDBY}$	$V_{EN} = 0\text{V}$ (Disabled)	—	0.01	1.0	$\mu\text{A}$	
Output Current	—	300	—	—	mA	
Fold-back Short Current (Note 7)	$V_{OUT}$ Short to Ground	—	55	—	mA	
PSRR (Note 8)	$V_{IN} = V_{OUT} + 1\text{V}$ , Ripple $0.2\text{Vp-pAC}$ , $V_{OUT} = 1.0\text{V}$ to $4.5\text{V}$ , $I_{OUT} = 30\text{mA}$ , $f = 1\text{kHz}$	—	80	—	dB	
Output Noise Voltage (Note 8) (Note 9)	$\text{BW} = 10\text{Hz}$ to $100\text{kHz}$ , $V_{OUT} = 1.0\text{V}$ , $I_{OUT} = 30\text{mA}$	—	60	—	$\mu\text{Vrms}$	
Dropout Voltage (Note 5)	$I_{OUT} = 300\text{mA}$ (SOT25)	$1.0\text{V} \leq V_{OUT} \leq 1.2\text{V}$	—	0.67	0.89	V
		$1.2\text{V} < V_{OUT} \leq 1.4\text{V}$	—	0.57	0.70	
		$1.4\text{V} < V_{OUT} \leq 1.7\text{V}$	—	0.50	0.63	
		$1.7\text{V} < V_{OUT} \leq 2.1\text{V}$	—	0.37	0.50	
		$2.1\text{V} < V_{OUT} \leq 2.5\text{V}$	—	0.32	0.45	
		$2.5\text{V} < V_{OUT} \leq 3.0\text{V}$	—	0.29	0.40	
		$3.0\text{V} < V_{OUT} \leq 3.6\text{V}$	—	0.24	0.33	
		$3.6\text{V} < V_{OUT} \leq 4.5\text{V}$	—	0.22	0.31	
Output Voltage Temperature Coefficient	$I_{OUT} = 30\text{mA}$ , $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$	—	$\pm 80$	—	ppm/ $^\circ\text{C}$	
Thermal Shutdown Threshold (TSHDN)	—	—	+150	—	$^\circ\text{C}$	
Thermal Shutdown Hysteresis (THYS)	—	—	+20	—	$^\circ\text{C}$	
EN Input Low Voltage	—	0	—	0.5	V	
EN Input High Voltage	—	1.4	—	5.5	V	
EN Input Leakage	$V_{EN} = 0$ , $V_{IN} = 5.0\text{V}$ or $V_{EN} = 5.0\text{V}$ , $V_{IN} = 0\text{V}$	-1.0	—	+1.0	$\mu\text{A}$	
On Resistance of N-Channel for Auto-Discharge (Note 10)	$V_{IN} = 4.0\text{V}$ , $V_{EN} = 0\text{V}$ (Disabled)	—	40	—	$\Omega$	
Thermal Resistance Junction to Ambient ( $\theta_{JA}$ )	SOT25	—	179	—	$^\circ\text{C/W}$	
Thermal Resistance Junction to Case ( $\theta_{JC}$ )	SOT25	—	52	—		

- Notes:
- Dropout voltage is the voltage difference between the input and the output at which the output voltage drops 2% below its nominal value.
  - Quiescent current is defined here is the difference in current between the input and the output.
  - Short circuit current is measured with  $V_{OUT}$  pulled to GND.
  - This specification is guaranteed by design.
  - To make sure lowest environment noise minimizes the influence on noise measurement.
  - AP7330 has 2 options for output, built-in discharge and non-discharge.
  - Potential multiple grades based on following output voltage accuracy.

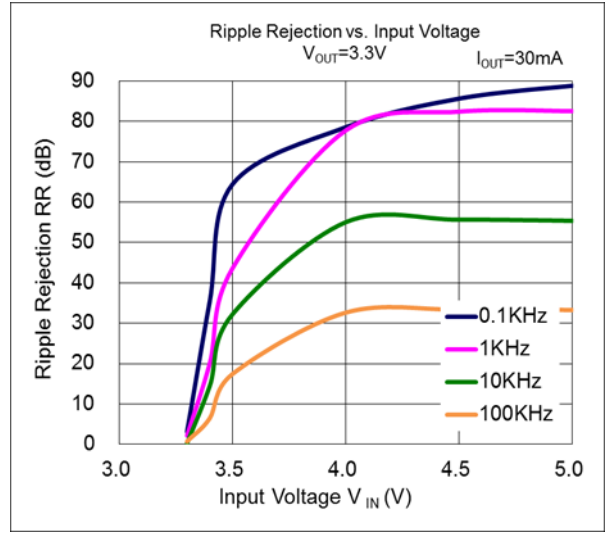
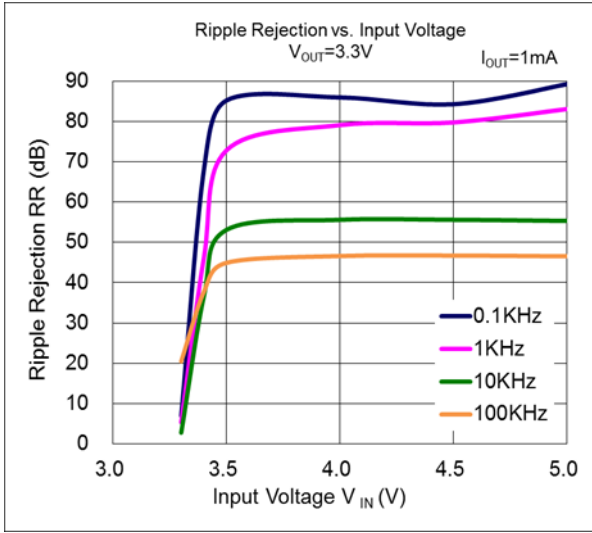
**Typical Characteristics**



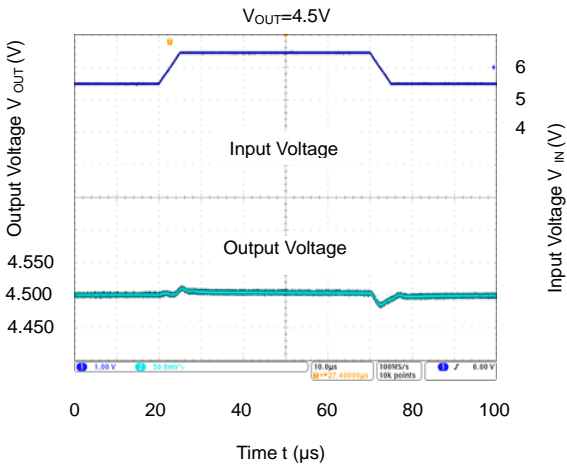
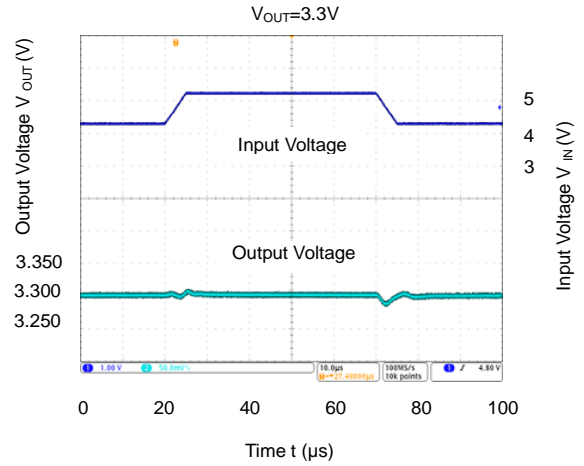
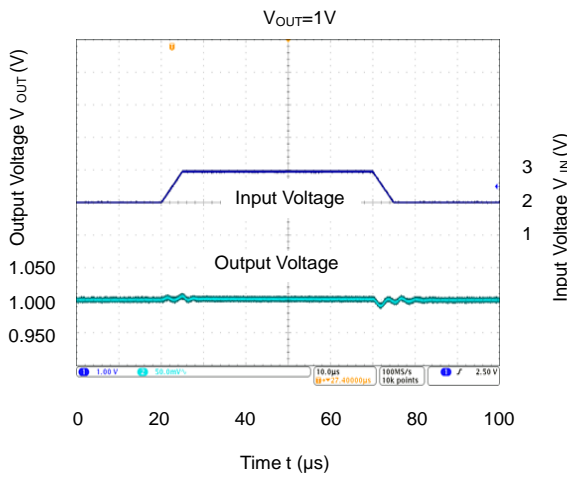
**Typical Characteristics (Cont.)**



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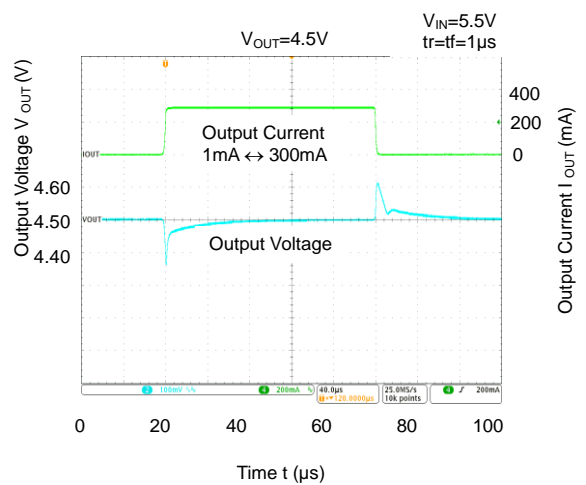
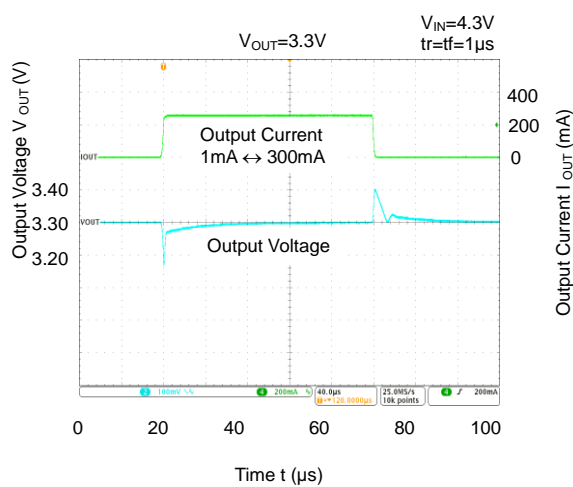
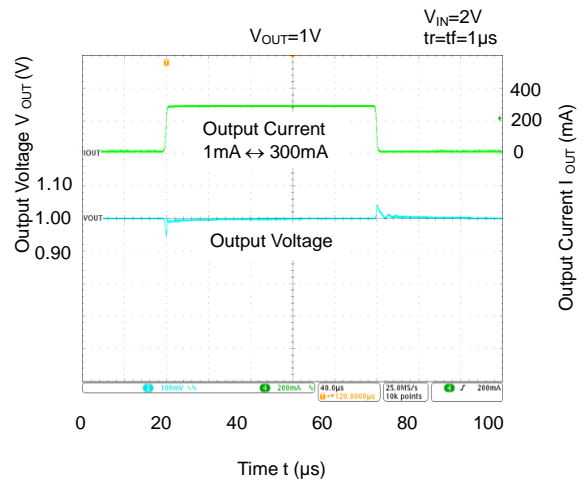
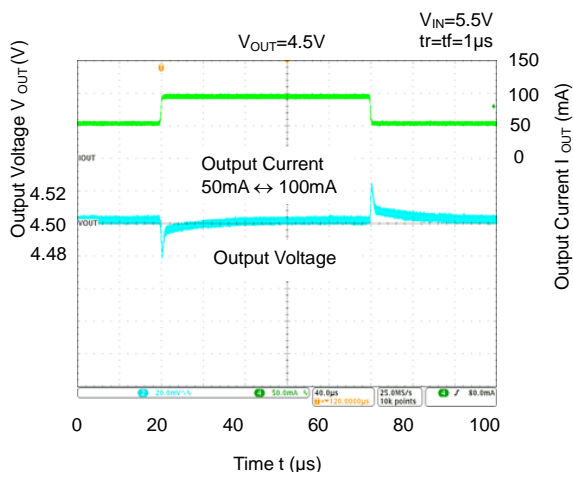
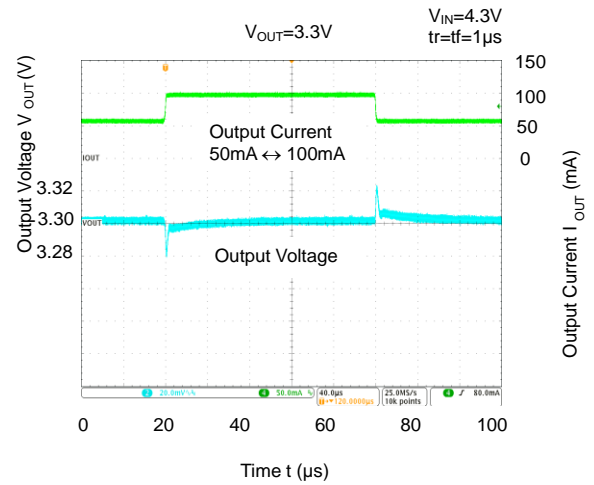
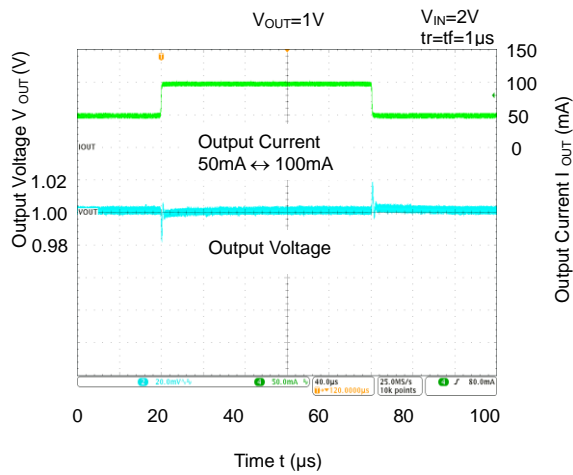


Line Transient Response Waveforms ( $I_{OUT} = 30mA$ ,  $t_R = t_F = 5\mu s$ ,  $C_{IN} = \text{None}$ ,  $C_{OUT} = 1\mu F$ ,  $T_A = +25^\circ C$ )



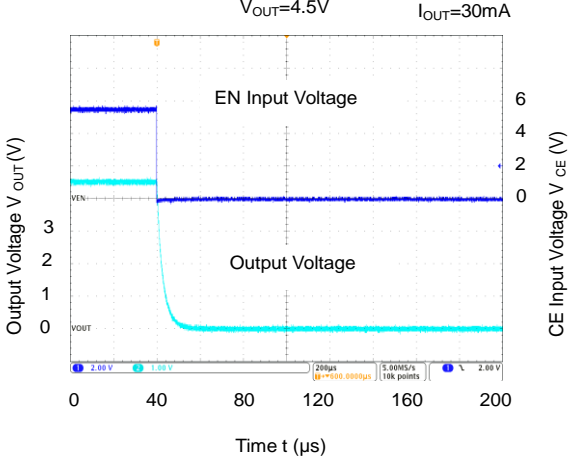
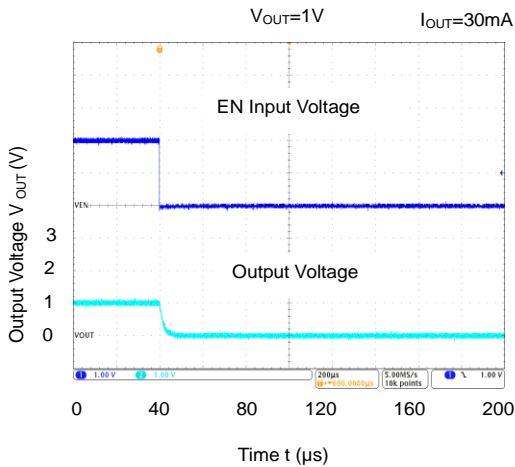
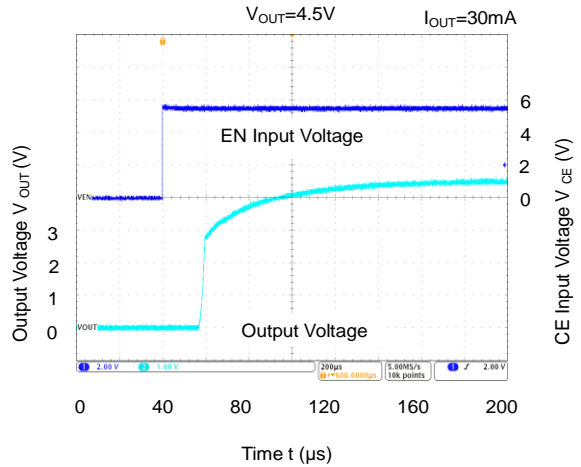
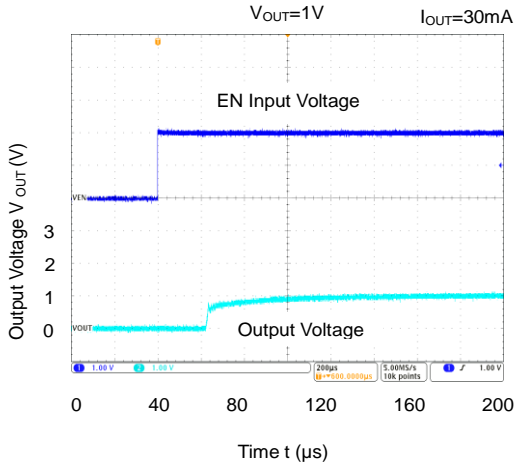
**Typical Characteristics (Cont.)**

Load Transient Response Waveforms ( $V_{IN} = V_{OUT} + 1V$ ,  $C_{IN} = C_{OUT} = 1\mu F$ ,  $T_A = +25^\circ C$ )



**Typical Characteristics (Cont.)**

Turn On & Off Waveforms ( $V_{IN} = V_{OUT}+1V$ ,  $C_{IN} = 1\mu F$ ,  $C_{OUT} = 1\mu F$ ,  $T_A = +25^\circ C$ )





## Application Information

### Output Capacitor

An output capacitor ( $C_{OUT}$ ) is needed to improve transient response and maintain stability. The AP7330 is stable with very small ceramic output capacitors. The ESR (equivalent series resistance) and capacitance drives the selection. If the application has large load variations, it is recommended to utilize low-ESR bulk capacitors. It is recommended to place ceramic capacitors as close as possible to the load and the ground pin and care should be taken to reduce the impedance in the layout.

### Input Capacitor

To prevent the input voltage from dropping during load steps, it is recommended to utilize an input capacitor ( $C_{IN}$ ). A minimum  $0.47\mu\text{F}$  ceramic capacitor is recommended between  $V_{IN}$  and GND pins to decouple input power supply glitch. This input capacitor must be located as close as possible to the device to assure input stability and reduce noise. For PCB layout, a wide copper trace is required for both  $V_{IN}$  and GND pins.

### Enable Control

The AP7330 is turned on by setting the EN pin high, and is turned off by pulling it low. If this feature is not used, the EN pin should be tied to  $V_{IN}$  pin to keep the regulator output on at all times. To ensure proper operation, the signal source used to drive the EN pin must be able to swing above and below the specified turn-on/off voltage thresholds listed in the Electrical Characteristics section.

### Short Circuit Protection

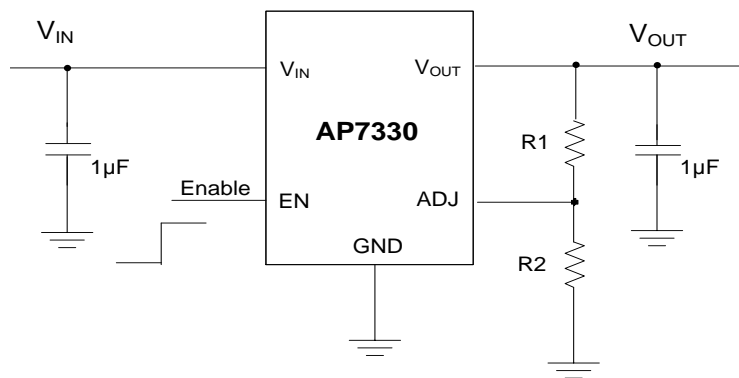
When  $V_{OUT}$  pin is short-circuit to GND, short circuit protection will be triggered and clamp the output current to approximately 60mA. This feature protects the regulator from overcurrent and damage due to overheating.

### Layout Considerations

For good ground loop and stability, the input and output capacitors should be located close to the input, output, and ground pins of the device. The regulator ground pin should be connected to the external circuit ground to reduce voltage drop caused by trace impedance. Ground plane is generally used to reduce trace impedance. Wide trace should be used for large current paths from  $V_{IN}$  to  $V_{OUT}$ , and load circuit.

### Adjustable Operation

The AP7330 provides output voltage from 1V to 4.5V through external resistor divider as shown below.



The output voltage is calculated by:

$$V_{OUT} = V_{REF} \left( 1 + \frac{R1}{R2} \right)$$

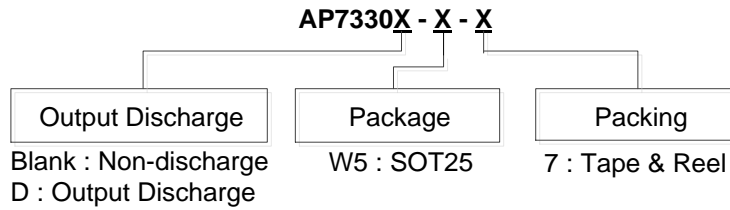
Where  $V_{REF} = 0.8\text{V}$  (the internal reference voltage)

Rearranging the equation will give the following that is used for adjusting the output to a particular voltage:

$$R1 = R2 \left( \frac{V_{OUT}}{V_{REF}} - 1 \right)$$

To maintain the stability of the internal reference voltage,  $R2$  need to be kept smaller than 10k.

**Ordering Information** (Note 12)

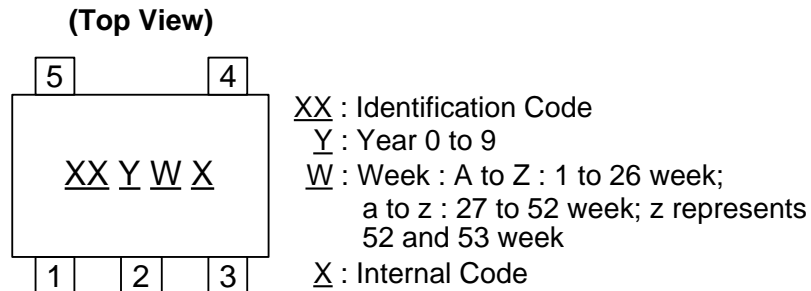


Part Number	Package Code	Packaging	7" Tape and Reel	
			Quantity	Part Number Suffix
AP7330-W5-7	W5	SOT25	3,000/Tape & Reel	-7
AP7330D-W5-7	W5	SOT25	3,000/Tape & Reel	-7

Note: 12. For packaging details, go to our website at <https://www.diodes.com/design/support/packaging/diodes-packaging/>.

**Marking Information**

(1) SOT25

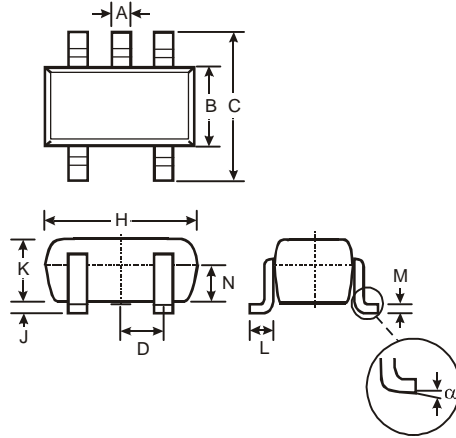


Part Number	Package Type	Identification Code
AP7330-W5-7	SOT25	YH
AP7330D-W5-7	SOT25	YJ

**Package Outline Dimensions**

Please see <http://www.diodes.com/package-outlines.html> for the latest version.

(1) SOT25

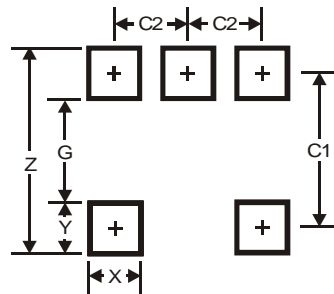


SOT25			
Dim	Min	Max	Typ
A	0.35	0.50	0.38
B	1.50	1.70	1.60
C	2.70	3.00	2.80
D	-	-	0.95
H	2.90	3.10	3.00
J	0.013	0.10	0.05
K	1.00	1.30	1.10
L	0.35	0.55	0.40
M	0.10	0.20	0.15
N	0.70	0.80	0.75
α	0°	8°	-
All Dimensions in mm			

**Suggested Pad Layout**

Please see <http://www.diodes.com/package-outlines.html> for the latest version.

(1) SOT25

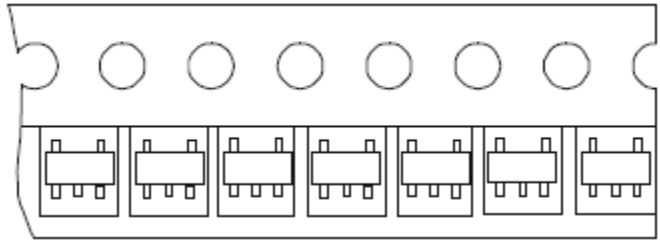


Dimensions	Value
Z	3.20
G	1.60
X	0.55
Y	0.80
C1	2.40
C2	0.95

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## Tape Orientation

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Note: 13. The taping orientation of the other package type can be found on our website at <http://www.diodes.com/datasheets/ap02007.pdf>.

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