1A LOW DROPOUT ADJUSTABLE AND FIXED-MODE REGULATOR WITH ENABLE

NEW PRODUCT

Description

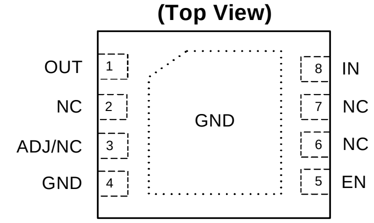
The AP7361 is a 1A, adjustable and fixed output voltage, ultra-low dropout linear regulator with enable. The device includes pass element, error amplifier, band-gap reference, current limit and thermal shutdown circuitry. The device is turned on when EN pin is set to logic high level.

The characteristics of the low dropout voltage and low quiescent current make it suitable for low to medium power applications, for example, laptop computers, audio and video applications, and battery powered devices. The typical quiescent current is approximately 70µA. Built-in current-limit and thermal-shutdown functions prevent IC from damage in fault conditions.

The AP7361 is available in DFN3030E-8 package.

Pin Assignments

(Top View)



DFN3030E-8

Applications

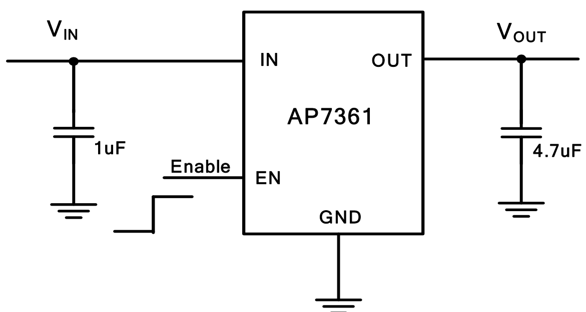
- Servers and laptops
- FPGA and DSP core or I/O power
- TV, and home electrical appliances
- Battery-powered devices

Note: 1. EU Directive 2002/95/EC (RoHS). All applicable RoHS exemptions applied. Please visit our website at http://www.diodes.com/products/lead_free.html

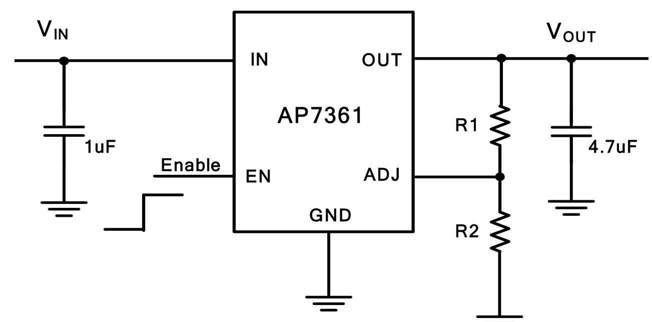
Features

- Wide input voltage range: 2.2V – 6V
- 150mV very low dropout at 300mA load
- 500mV very low dropout at 1A load
- Low quiescent current (I_Q): 70µA typical
- Adjustable output voltage range: 1V to 5.0V
- Fixed output options: 1V to 3.3V
- Very fast transient response
- High PSRR
- Accurate voltage regulation
- Current limiting and short circuit protection
- Thermal shutdown protection
- Stable with ceramic output capacitor ≥ 2.2µF
- Ambient temperature range -40ºC to 85 ºC
- DFN3030E-8: Available in “Green” Molding Compound (No Br, Sb)
- Lead Free Finish/ RoHS Compliant (Note 1)

Typical Application Circuit



Fixed Output

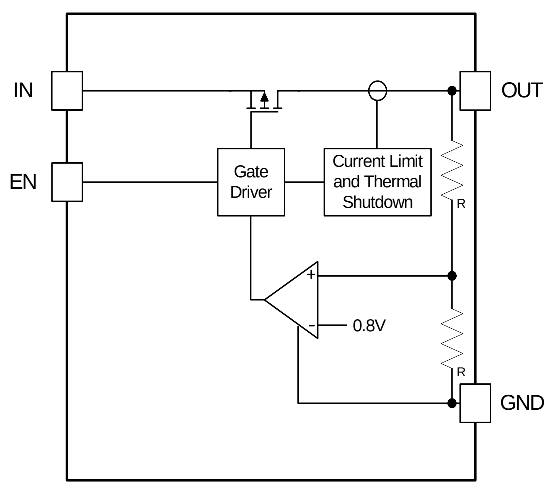


Adjustable Output

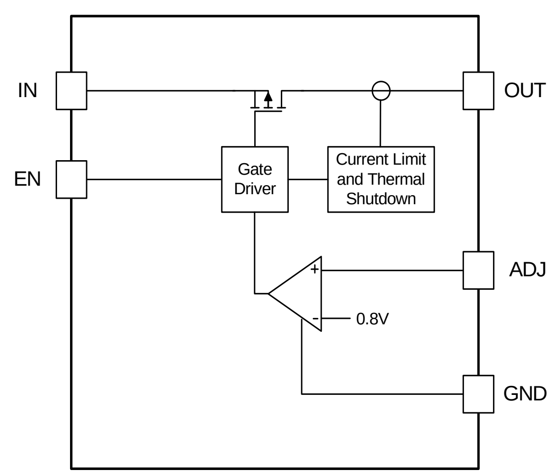
Pin Descriptions

Pin Name	Pin Number DFN3030E-8	Description
IN	8	The input of the regulator. Bypass to ground through at least 1µF ceramic capacitor.
OUT	1	The output of the regulator. Bypass to ground through at least 2.2µF ceramic capacitor. For improved ac load response a larger capacitor is recommended.
GND	4	Ground.
ADJ	3	Adjustable voltage version only – a resistor divider from this pin to the OUT pin and ground sets the output voltage.
EN	5	Enable input, active high.
NC	2, 6, 7	No connection.

Functional Block Diagram



Fixed Version



Adjustable Version

Absolute Maximum Ratings

Symbol	Parameter		Ratings	Unit
ESD HBM	Human Body Model ESD Protection		> 2	KV
ESD MM	Machine Model ESD Protection		> 200	V
V_{IN}	Input Voltage		6.5	V
	OUT, ADJ, EN Voltage		V_{IN} + 0.3	V
T_J	Operating Junction Temperature Range		-40 ~ 150	°C
T_{ST}	Storage Temperature Range		-65 ~150	°C
P_D	Power Dissipation (Note 2)		Internally limited by maximum junction temperature of 150°C	
P_D	Power Dissipation (Note 2)	DFN3030E-8	1700	mW

Note: 2. Ratings apply to ambient temperature at 25°C

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Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input voltage	2.2	6.0	V
I_{OUT}	Output Current (Note 3)	0	1.0	A
T_A	Operating Ambient Temperature	-40	85	°C

Note: 3. The device maintains a stable, regulated output voltage without a load current. When the output current is large, attention should be given to the limitation of the package power dissipation.

Electrical Characteristics

($T_A = 25^oC$, $V_{IN} = V_{OUT}$ +1V, C_{IN} = 1µF, C_{OUT} = 4.7µF, $V_{EN} = V_{IN}$, unless otherwise stated)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
V_{REF}	FB reference voltage	I_{OUT} = 10mA, T_A = 25°C		0.8		V
I_{ADJ}	ADJ pin leakage			0.1	0.5	µA
I_Q	Input Quiescent Current	Enabled, I_{OUT} = 0A		70	90	µA
I_{SHDN}	Input Shutdown Current	V_{EN} = 0V, I_{OUT} = 0A	-1	0.05	1	µA
V_{OUT}	Output Voltage Accuracy	I_{OUT} = 100mA, T_A = 25°C	-1		1	%
		I_{OUT} = 100mA, -40°C ≤ T_A ≤ 85°C	-2		2	
		Over V_{IN}, I_{OUT}, and T_A	-3	±0.5	3	
$\frac{\Delta VOUT}{\Delta VIN \times V_{OUT}}$	Line Regulation	V_{IN} = V_{OUT} +1V to 6V, I_{OUT} = 100mA; T_A = 25°C		0.01	0.1	%/V
		V_{IN} = V_{OUT} +1V to 6V, I_{OUT} = 100mA; -40°C ≤ T_A ≤ 85°C			0.2	
ΔV_{OUT} / V_{OUT}	Load Regulation	I_{OUT} from 1mA to 300mA	-1.0	0.5	1.0	%
		I_{OUT} from 1mA to 1A	-1.0	0.5	1.0	%
$V_{Dropout}$	Dropout Voltage (Note 4)	I_{OUT} = 300mA		150	200	mV
		I_{OUT} = 500mA		250	350	
		I_{OUT} = 1A		500	700	
V_{IL}	EN Input Logic Low Voltage		0		0.3	V
V_{IH}	EN Input Logic High Voltage		1.0		V_{IN}	V
I_{EN}	EN Input leakage	V_{IN} = 6V, V_{EN} = 0V or 6V	-0.1	0.01	0.1	µA
I_{LIMIT}	Current limit	V_{IN} = V_{OUT} +1V	1.1	1.5		A
I_{SHORT}	Short-circuit Current	V_{IN} = V_{OUT} +1V, Output Voltage < 25% Vout		200		mA
PSRR	Power Supply Rejection Ratio (Note 5)	f = 1KHz, I_{OUT} = 100mA	60	65		dB
		f = 10KHz, I_{OUT} = 100mA		45		
t_{ST}	Start-up Time	V_{OUT} = 3V, C_{OUT} = 1µF, R_L = 30Ω		200		µs
$\frac{\Delta VOUT}{\Delta T_A \times VOUT}$	Output voltage temperature coefficient	I_{OUT} = 100mA, -40°C ≤ T_A ≤ 85°C		±130		ppm/°C
T_{SHDN}	Thermal shutdown threshold			150		°C
T_{HYS}	Thermal shutdown hysteresis			20		°C
θ_{JA}	Thermal Resistance Junction-to-Ambient	DFN3030E-8 (Note 6)		70		°C/W

Notes: 4. Dropout voltage is the voltage difference between the input and the output at which the output voltage drops 2% below its nominal value. This parameter only applies to output voltages above 1.5V since minimum V_{IN} = 2.2V.
5. For V_{IN} ≥ 2.5V and V_{IN} = V_{OUT} + 1V. For V_{IN} < 2.5V, the PSRR performance may be reduced.
6. Test condition for DFN3030E-8: Device mounted on 2"x2", FR-4 substrate PCB, with minimum recommended pad on top layer and thermal vias to bottom layer ground plane.

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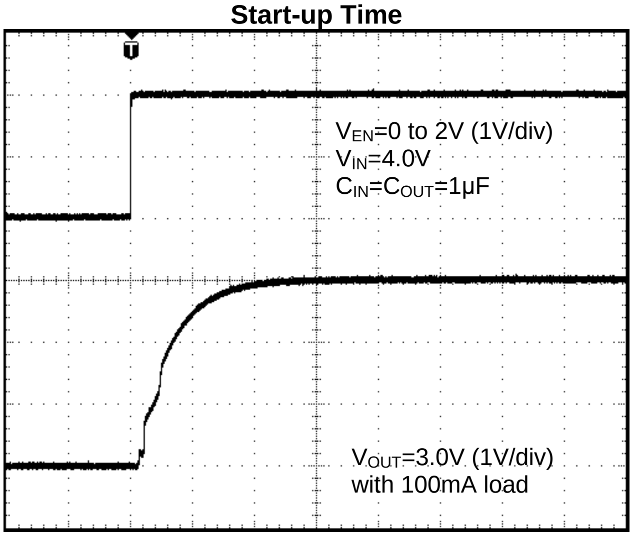
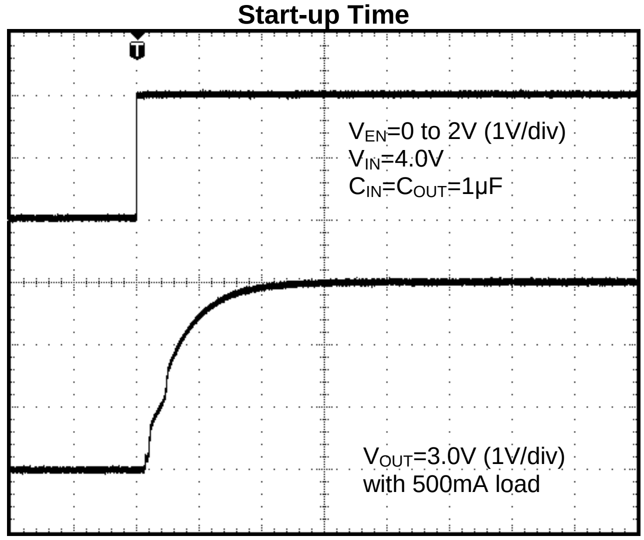
Typical Performance Characteristics

Start-up Time



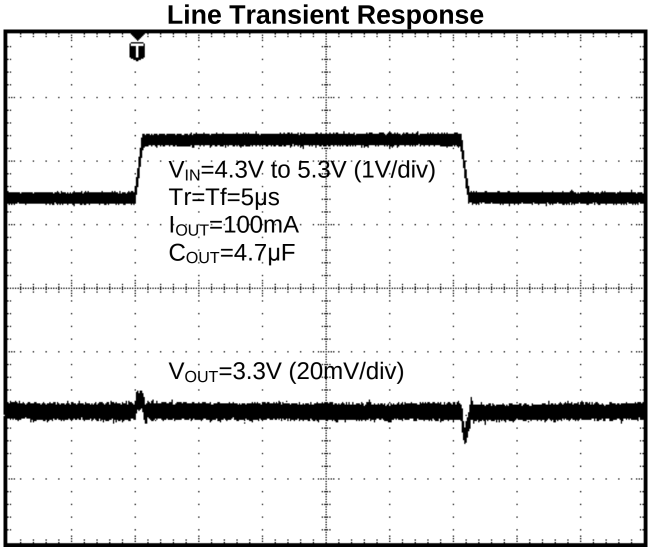
Time (100μs/div)

Start-up Time



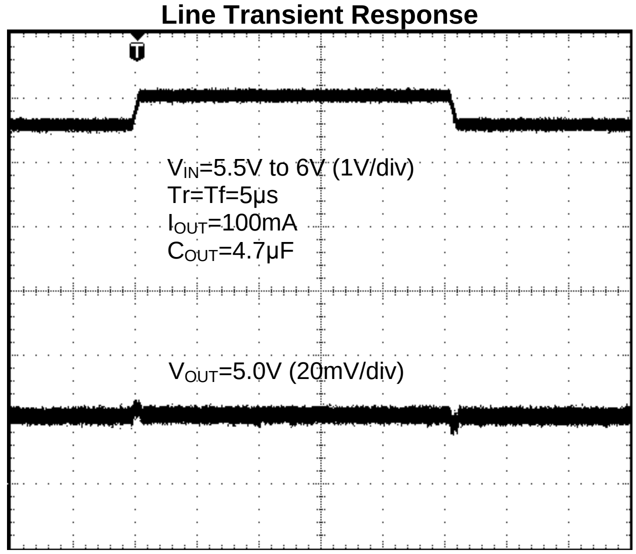
Time (100μs/div)

Line Transient Response



Time (40μs/div)

Line Transient Response



Time (40μs/div)

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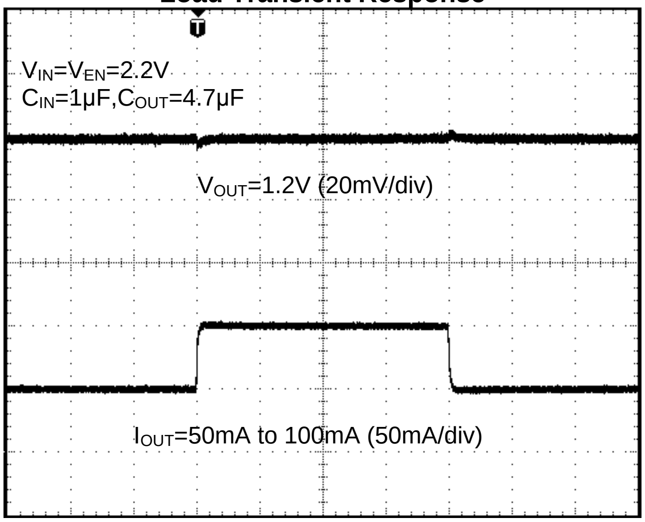
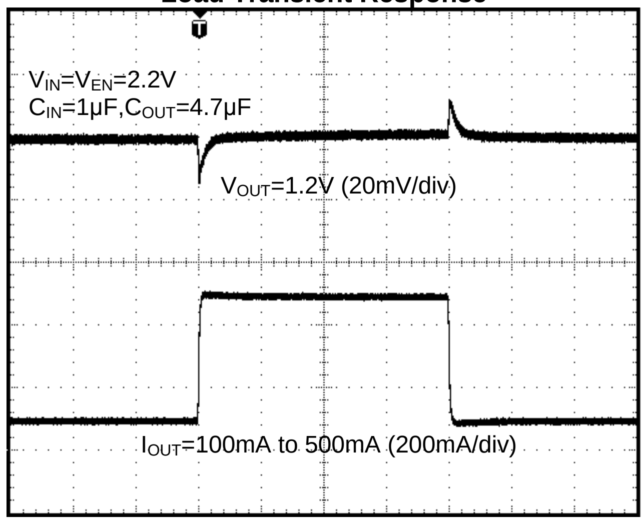
Typical Performance Characteristics (Continued)

Load Transient Response



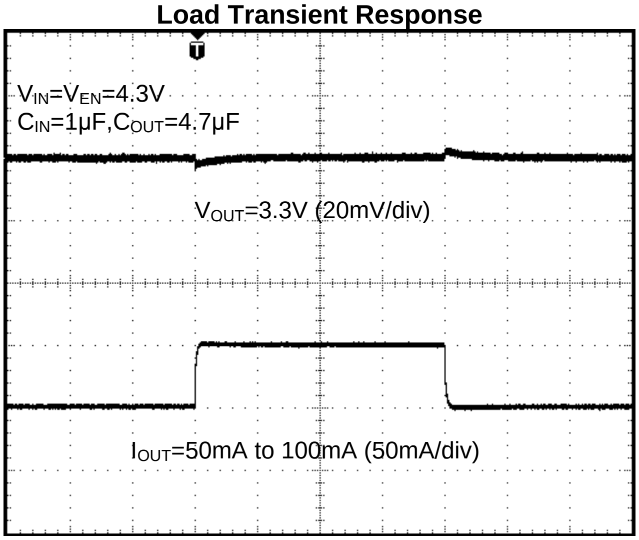
Time (200µs/div)

Load Transient Response



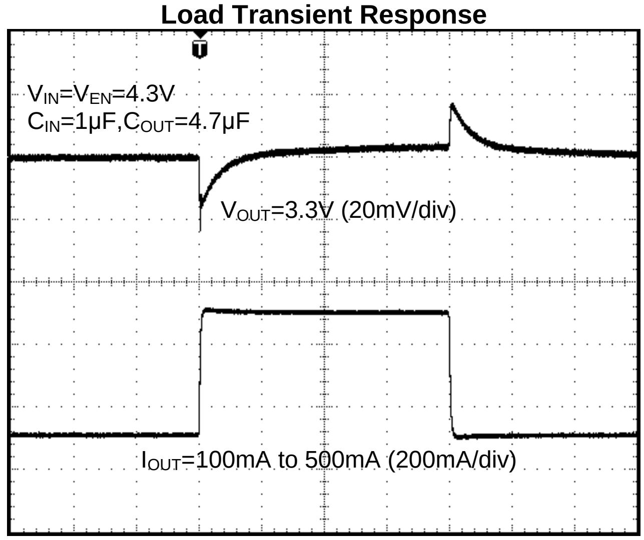
Time (200µs/div)

Load Transient Response



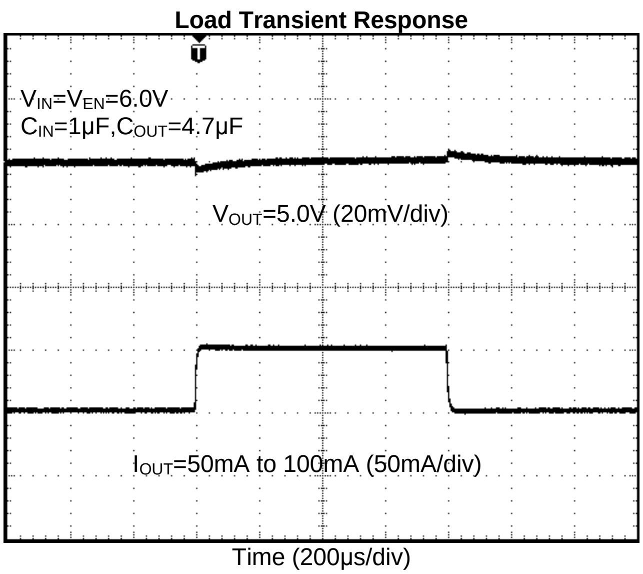
Time (200µs/div)

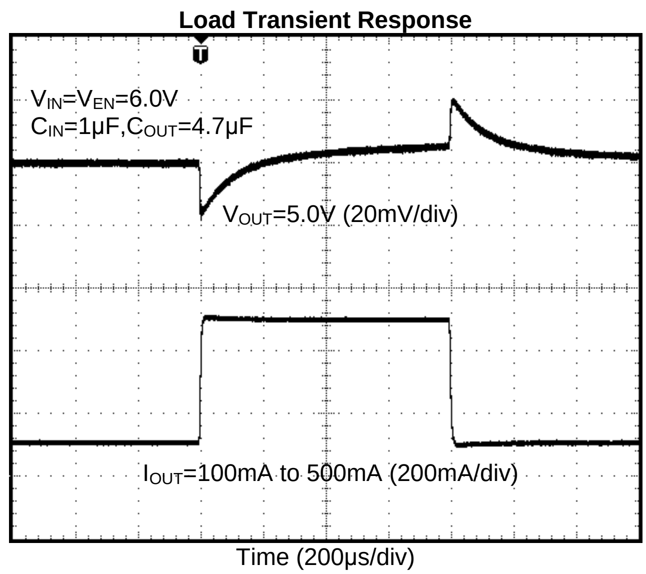
Load Transient Response

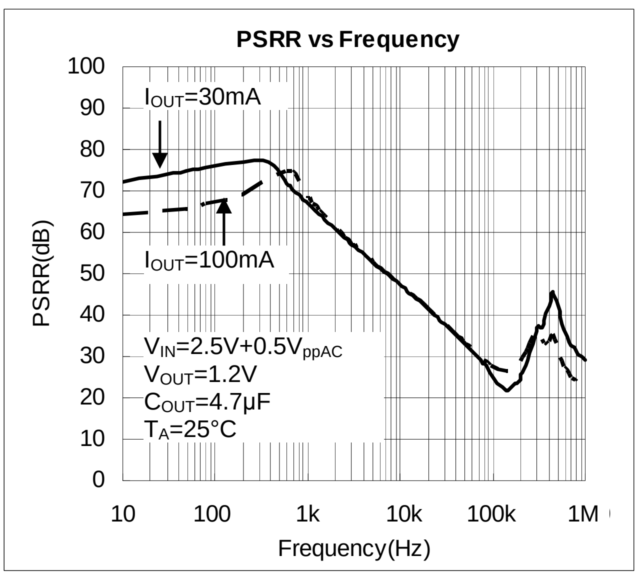


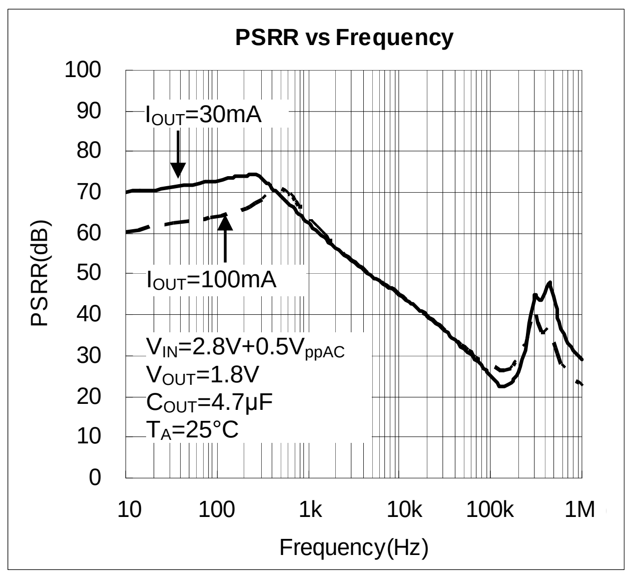
Time (200µs/div)

Typical Performance Characteristics (Continued)

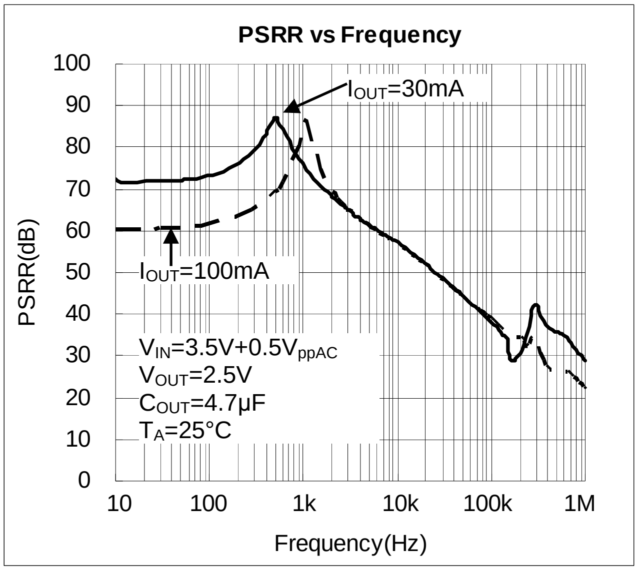


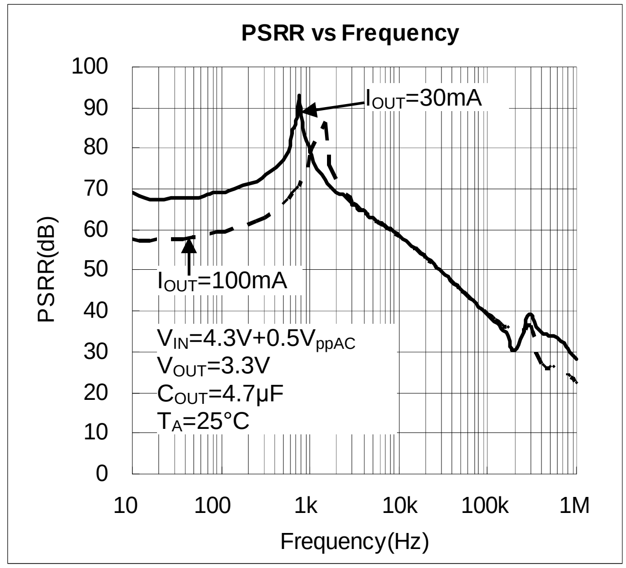


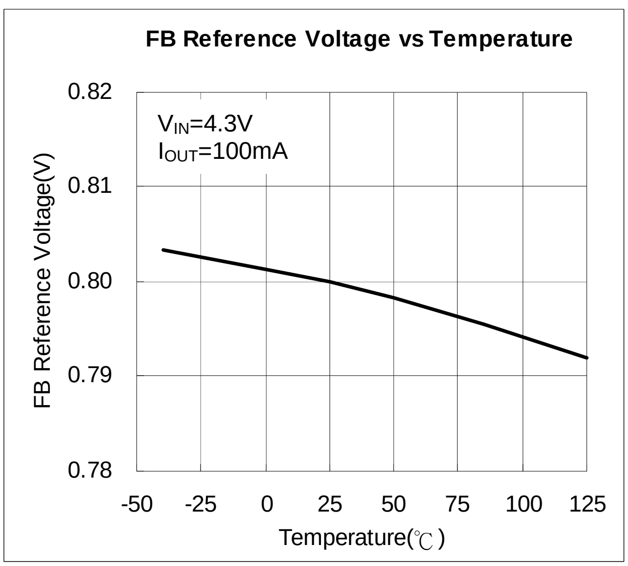


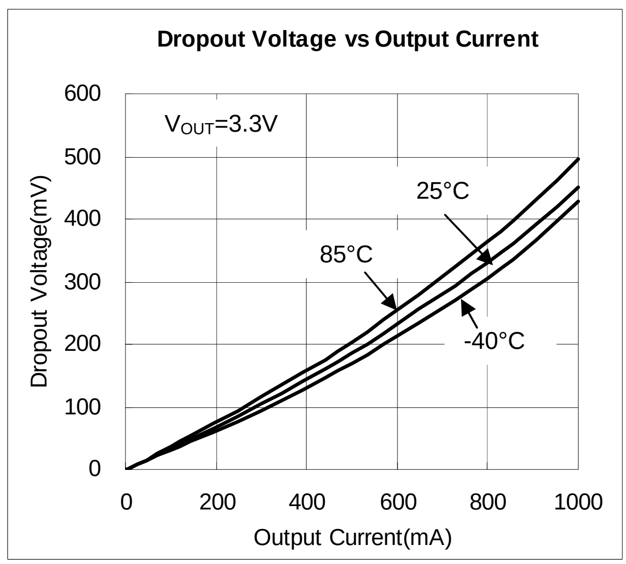


Typical Performance Characteristics (Continued)

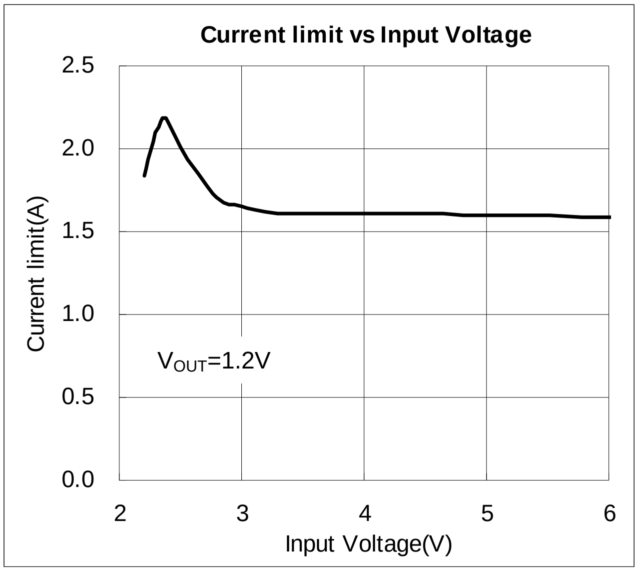


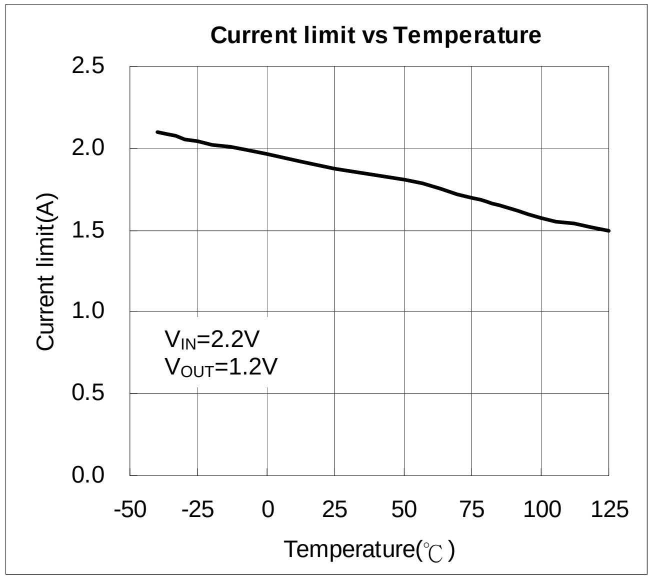


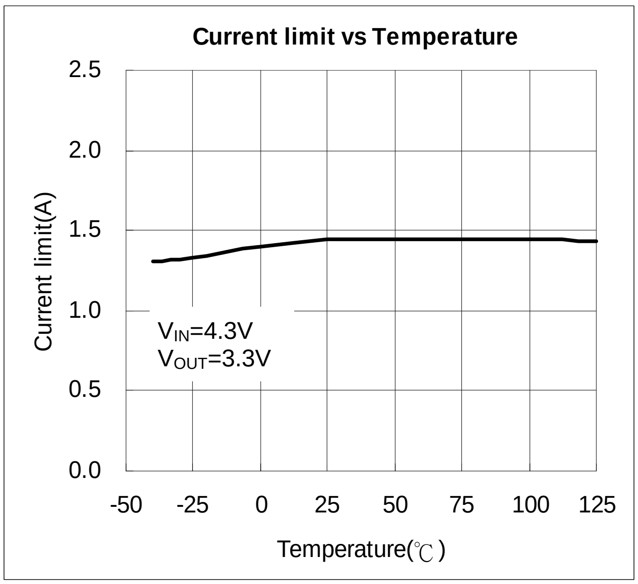


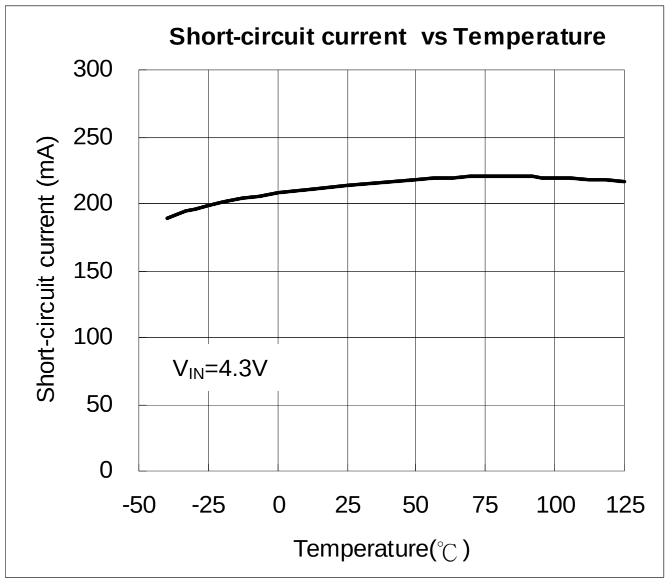


Typical Performance Characteristics (Continued)

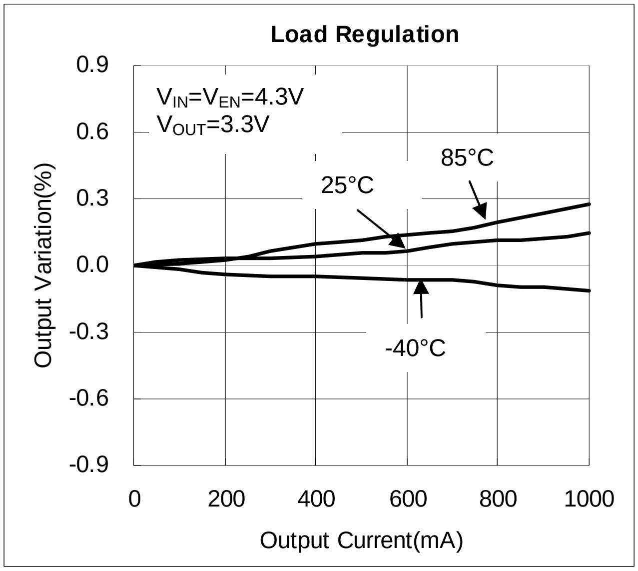


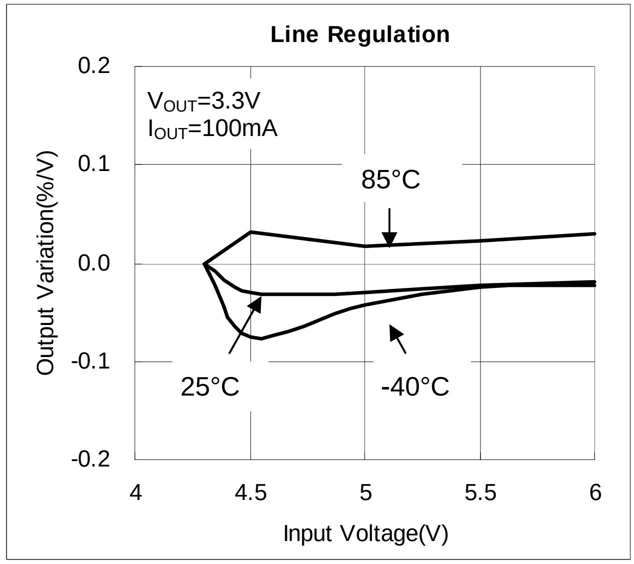


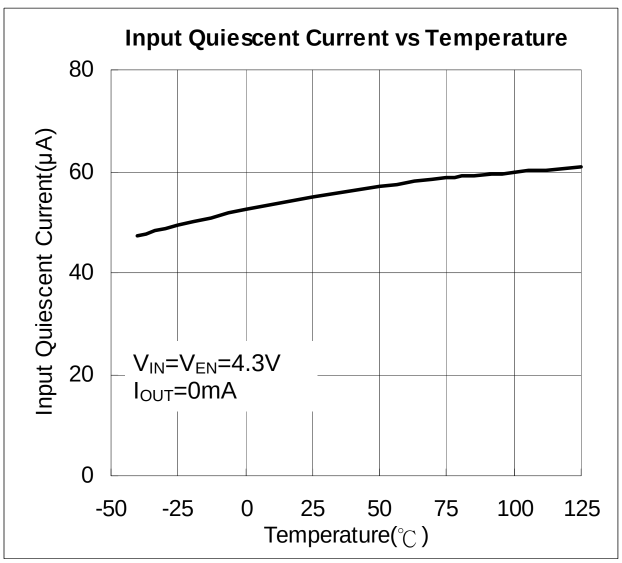


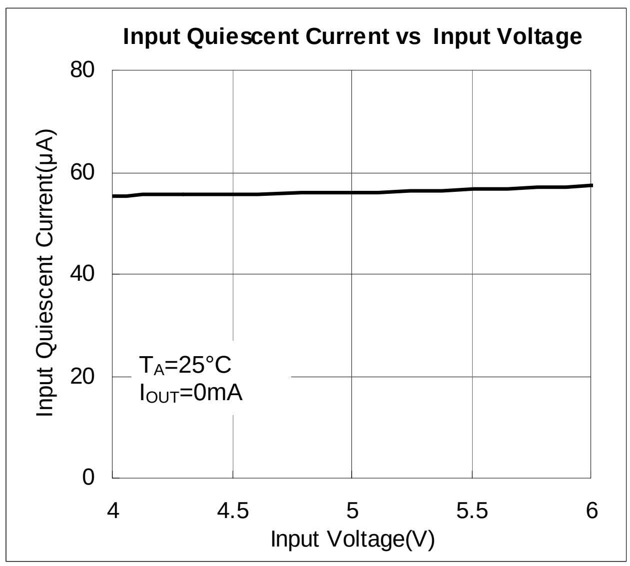


Typical Performance Characteristics (Continued)









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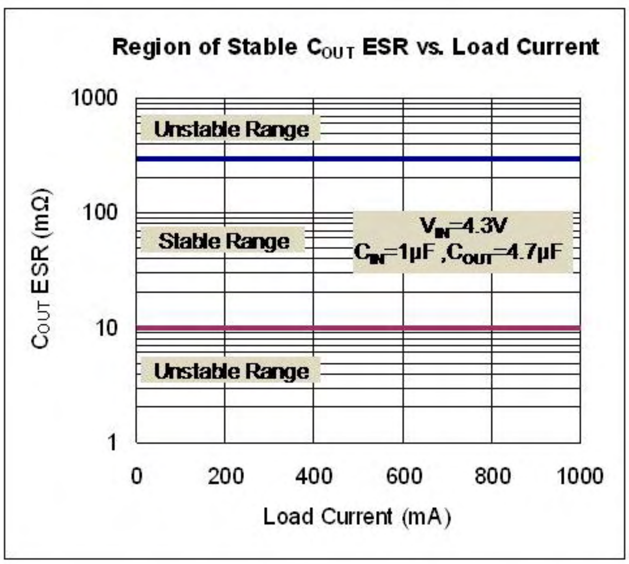
Application Information

Input Capacitor

A 1μF ceramic capacitor is recommended between IN and GND pins to decouple input power supply glitch and noise. The amount of the capacitance may be increased without limit. 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 IN and GND pins. A lower ESR capacitor type allows the use of less capacitance, while higher ESR type requires more capacitance.

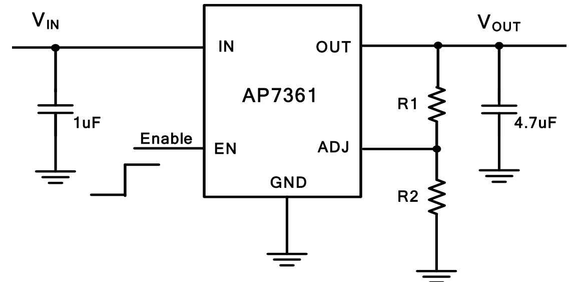
Output Capacitor

The output capacitor is required to stabilize and improve the transient response of the LDO. The AP7361 is stable with very small ceramic output capacitors. Using a ceramic capacitor value that is at least 2.2μF with 10mΩ ≦ ESR ≦ 300mΩ on the output ensures stability. Higher capacitance values help to improve line and load transient response. The output capacitance may be increased to keep low undershoot and overshoot. Output capacitor must be placed as close as possible to OUT and GND pins.



Adjustable Operation

The AP7361 provides output voltage from 0.8V to 5.0V through external resistor divider as shown below.



Adjustable Output

The output voltage is calculated by:

$$V_{OUT} = V_{REF}\left(1+\frac{R_1}{R_2}\right)$$

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

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

$$R_1 = R_2\left(\frac{V_{OUT}}{V_{REF}} - 1\right)$$

To maintain the stability of the internal reference voltage, R_2 need to be kept smaller than 80kΩ.

No Load Stability

Other than external resistor divider, no minimum load is required to keep the device stable. The device will remain stable and regulated in no load condition.

ON/OFF Input Operation

The AP7361 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 IN pin to keep the regulator output on at all time. 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 under V_{IL} and V_{IH}.

NEW PRODUCT

Application Information (Continued)

Current Limit Protection

When output current at OUT pin is higher than current limit threshold, the current limit protection will be triggered and clamp the output current to prevent over-current and to protect the regulator from damage due to overheating.

Short Circuit Protection

When OUT pin is short-circuit to GND, short circuit protection will be triggered and clamp the output current to approximately 200mA. Full current is restored when the output voltage exceeds 25% of Vout. This feature protects the regulator from over-current and damage due to overheating.

Thermal Shutdown Protection

Thermal protection disables the output when the junction temperature rises to approximately +150°C, allowing the device to cool down. When the junction temperature reduces to approximately +130°C the output circuitry is enabled again. Depending on power dissipation, thermal resistance, and ambient temperature, the thermal protection circuit may cycle on and off. This cycling limits the heat dissipation of the regulator, protecting it from damage due to overheating.

Ultra Fast Start-up

After enabled, the AP7361 is able to provide full power in as little as tens of microseconds, typically 200µs, without sacrificing low ground current. This feature will help load circuitry move in and out of standby mode in real time, eventually extend battery life for mobile phones and other portable devices.

Low Quiescent Current

The AP7361, consuming only around 70µA for all input range, provides great power saving in portable and low power applications.

Power Dissipation

The device power dissipation and proper sizing of the thermal plane that is connected to the thermal pad is critical to avoid thermal shutdown and ensure reliable operation. Power dissipation of the device depends on input voltage and load conditions and can be calculated by:

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT}$$

The maximum power dissipation, handled by the device, depends on the maximum junction to ambient thermal resistance, maximum ambient temperature, and maximum device junction temperature, which can be calculated by the equation in the following:

$$P_D(max@T_A) = \frac{(+150°C - T_A)}{R_{\theta JA}}$$

NEW PRODUCT

Ordering Information

AP7361 - XX XXX - X

Output	Package	Packing
Blank : ADJ	FGE : DFN3030E-8	7 : Tape & Reel
10 : 1.0V		
12 : 1.2V		
15 : 1.5V		
18 : 1.8V		
25 : 2.5V		
28 : 2.8V		
33 : 3.3V		

Device	Package Code	Packaging (Note 7)	7"/13" Tape and Reel	
			Quantity	Part Number Suffix
AP7361-XXFGE-7	FGE	DFN3030E-8	3000/Tape & Reel	-7

Note: 7. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at http://www.diodes.com/datasheets/ap02001.pdf.

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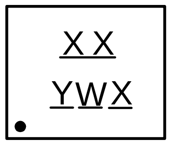
Marking Information

(1) DFN3030E-8

(Top View)

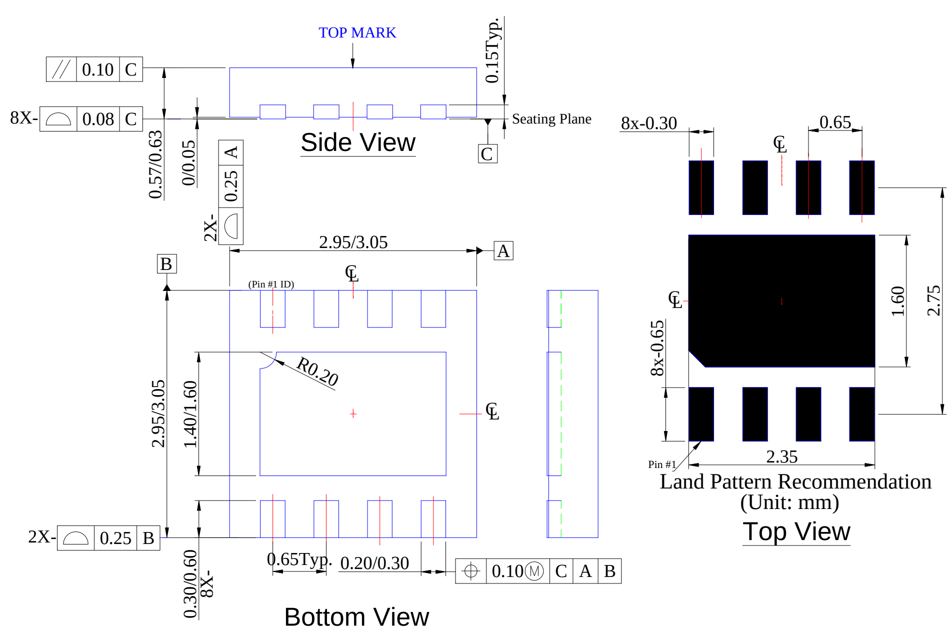


XX : Identification Code
Y : Year : 0~9
W : Week : A~Z : 1~26 week; a~z : 27~52 week; z represents 52 and 53 week
X : A~Z : Internal code

Device	Package	Identification Code
AP7361ADJ	DFN3030E-8	PA
AP7361-10	DFN3030E-8	PB
AP7361-12	DFN3030E-8	PC
AP7361-15	DFN3030E-8	PD
AP7361-18	DFN3030E-8	PE
AP7361-25	DFN3030E-8	PF
AP7361-28	DFN3030E-8	PG
AP7361-33	DFN3030E-8	PH

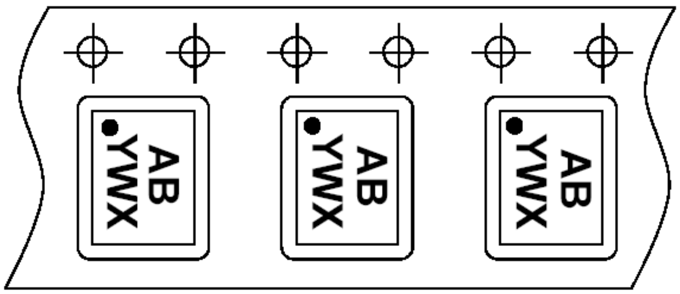
Package Outline Dimensions

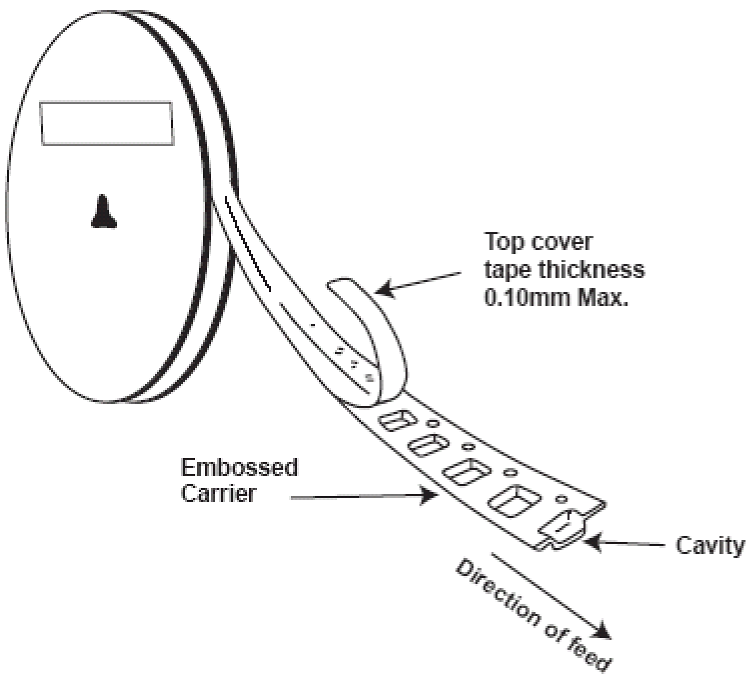
(1) Package Type: DFN3030E-8



Taping Orientation (Note 9)

For DFN3030E-8





Note: 9. 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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2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

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