



AP7366

600mA, LOW QUIESCENT CURRENT FAST TRANSIENT LOW DROPOUT LINEAR REGULATOR

Description

The DIODES[™] AP7366 is a 600mA, adjustable and fixed output voltage, low-dropout linear regulator. This device includes pass element, error amplifier, band-gap, current limit and thermal-shutdown circuitry. The device is turned on when EN pin is set to logic-high level.

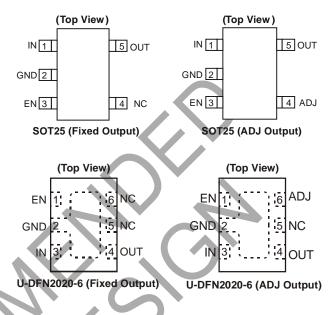
The characteristics of low-dropout voltage and low quiescent current make it suitable for low-power applications such as battery-powered devices. The typical quiescent current is approximately 60 μ A. Built-in current-limit and thermal-shutdown functions prevent IC from damage in fault conditions.

This device is available with adjustable output from 0.8V to 5.0V, and fixed version with 1.0V, 1.2V, 1.5V, 1.8V, 2.0V, 2.5V, 2.8V, 3.0V, 3.3V, 3.6V and 3.9V outputs. Please contact your local sales office for other voltage options.

The AP7366 is available in SOT25 and U-DFN2020-6 packages.

Features

- 600mA Low-Dropout Regulator with EN
- Low I_Q: 60μA
- Wide Input Voltage Range: 2.2V to 6V
- Wide Adjustable Output: 0.8V to 5.0V
- Fixed Output Options: 1.0V, 1.2V, 1.5V, 1.8V, 2.0V, 2.5V, 2.8V, 3.0V, 3.3V, 3.6V, 3.9V
- High PSRR: 75dB at 1kHz
- Fast Start-Up Time: 150µs
- Stable with Low ESR, 1µF Ceramic Output Capacitor
- Excellent Load/Line Transient Response
- Low Dropout: 300mV at 600mA
- Current-Limit and Short-Circuit Protection
- Thermal-Shutdown Protection
- Ambient Temperature Range: -40°C to +85°C
- Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)
- Halogen and Antimony Free. "Green" Device (Note 3)
- For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please <u>contact us</u> or your local Diodes representative. <u>https://www.diodes.com/guality/product-definitions/</u>
- Notes:
- No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
 See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and
- See https://www.d Lead-free.
- 3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

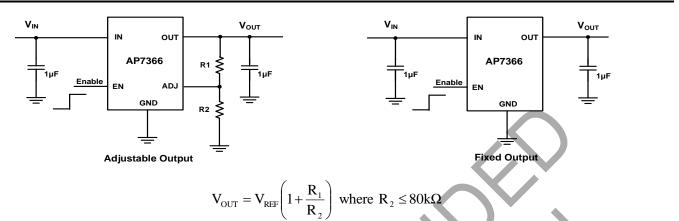


Applications

- Servers and notebook computers
- Low and medium power applications
- FPGA and DSP core or I/O power
- Consumer electronics



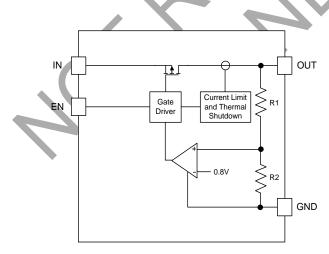
Typical Applications Circuit



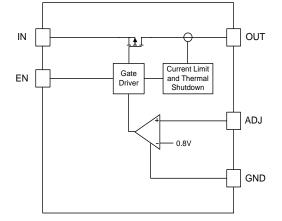
Pin Descriptions

	Pin Number						
Pin Name	SOT25 (Fixed Output)	SOT25 (ADJ Output)	U-DFN2020-6 (Fixed Output)	U-DFN2020-6 (ADJ Output)	Functions		
IN	1	1	3	3	Voltage Input Pin. Bypass to ground through at least $1\mu F$ MLCC capacitor		
GND	2	2	2	2	Ground		
EN	3	3	1	1	Enable Input, Active High		
ADJ		4	- (6	Output Feedback Pin		
NC	4	—	5, 6	5	No Connection		
OUT	5	5	4	4	Voltage Output Pin. Bypass to ground through 1µF MLCC capacitor		

Functional Block Diagram



Fixed Output



Adjustable Output



Absolute Maximum Ratings (@TA = +25°C, unless otherwise specified.)

Symbol	Parameter	Ratings	Unit
ESD HBM	Human Body Model ESD Protection	2000	V
ESD CDM	Charged Device Model	±1000	V
Vin	Input Voltage	6.5	V
—	OUT, EN Voltage	V _{IN} +0.3	V
T _{ST}	Storage Temperature Range	-65 to +150	°C
TJ	Maximum Junction Temperature	+150	°C

Recommended Operating Conditions (@TA = +25°C, unless otherwise specified.)

Symbol	Parameter	Min	Max	Unit
Vin	Input Voltage	2.2	6	V
Vout	Output Voltage	0.8	5	V
Ιουτ	Output Current (Note 4)	0	600	mA
TA	Operating Ambient Temperature	-40	+85	°C

Note: 4. The device maintains a stable, regulated output voltage without a load current.



Symbol	Parameter	Test Conditions		Min	Тур	Max	Unit	
V _{REF}	ADJ Reference Voltage (Adjustable Version)	I _{OUT} = 10mA		0.788	0.8	0.812	V	
I _{ADJ}	ADJ Leakage (Adjustable Version)			_	0.1	0.5	μA	
lq	Input Quiescent Current	Ven = Vin, Iout =	0mA	_	60	80	μA	
			$1.0V \leq V_{OUT} < 1.5V$	Vouт - 0.015	V _{OUT}	Vout + 0.015	V	
Vout	Output Voltage Accuracy	I _{OUT} = 10mA	$1.5V \leqq V_{OUT} \leqq 3.9V$	Vоuт * 0.99	Vout	Vоuт * 1.01	%	
ISHDN	Input Shutdown Current	Ven = 0V, Iout =	0mA	-1.0	0.05	1.0	μA	
ΔVουτ			$V_{IN} = (V_{OUT} + 1V) T_A = +25^{\circ}C$		0.01	0.1		
/ΔVIN/Vout	Line Regulation	to 5.5V, I _{OUT} = 10mA	$\text{-40°C} \leq \text{T}_{\text{A}} \leq \text{+85°C}$		—	0.2	%/V	
ΔVουτ/Vout	Load Regulation	I _{OUT} = 1mA to 600mA	1.2V < Vout ≦ 3.9V	-1.0	_	+1.0	%	
			$1.0V \leq VOUT \leq 1.2V$	-1.5		+1.5		
		Vout = 1.0V, lou		_	650	900		
		Vout = 1.2V, Iou		-	480	700		
		Vout = 1.5V, lou			200	340		
		V _{OUT} = 1.8V, I _{OU}			160	250		
			Vout = 2.0V, lout = 300mA Vout = 2.5V, lout = 300mA Vout = 2.8V, lout = 300mA		140	200	mV	
Vdropout	Dropout Voltage (Note 5)				125	190		
					115	180		
		Vout = 3.0V, lou		—	110	170	-	
		Vouτ = 3.3V, lou		—	105	160		
		Vout = 3.6V, Iou		—	105	160		
		Vout = 3.9V, lou		—	100	150		
		Vout = 1.0V, lou		—	850	1200	mV	
		Vout = 1.2V, Iou		—	800	1000		
		Vout = 1.5V, lou		—	450	700		
		Vout = 1.8V, lou		—	320	420		
		Vout = 2.0V, Iou		—	285	400		
Vdropout	Dropout Voltage (Note 5)	$V_{OUT} = 2.5V, I_{OU}$		—	250	380		
		Vout = 2.8V, Iou	T = 600mA	—	230	350		
	$ \land \land$	Vout = 3.0V, Iou	⊤ = 600mA	—	220	330		
		$V_{OUT} = 3.3V, I_{OUT}$	T = 600mA	—	210	320		
		Vout = 3.6V, Iou	T = 600mA	—	210	320		
		Vout = 3.9V, Iou	т = 600mA	—	190	290		
PSRR	PSRR (Note 6)	f = 1kHz, lout = 1	100mA	—	75	—	dB	
		f = 10kHz, Iout =	100mA	—	55	—	dB	
ISHORT	Short-Circuit Current	V _{IN} = V _{OUT} + 1V, Output Voltage <		—	250	—	mA	
ts⊤	Start-Up Time	$V_{OUT} = 0V \text{ to } 3.0^{\circ}$ $R_L = 30\Omega$		_	150	_	μs	
ILIMIT	Current Limit	$V_{\rm IN} = V_{\rm OUT} + 1V$		0.66	1.0		A	
VIL	EN Input Logic-Low Voltage	$V_{IN} = V_{IN-Min}$ to V	IN-Max			0.3	V	
VIL	EN Input Logic-High Voltage	$V_{IN} = V_{IN-Min}$ to V $V_{IN} = V_{IN-Min}$ to V		1.0		V _{IN}	V	
	EN Input Leakage Current	$V_{\rm IN} = V_{\rm IN-Min} \ 10 \ v$ $V_{\rm IN} = 5.5 V \ or \ V_{\rm EN}$		-0.1		+0.1	μA	
	Thermal Shutdown Threshold		- UV	-0.1	+150	ru. 1	µA °C	
TSHDN							°C	
THYS	Thermal Shutdown Hysteresis	_		—	+20			

Electrical Characteristics (@T_A = +25°C, V_{IN} = V_{OUT} +1V, C_{OUT} = 1µF, C_{IN} = 1µF, V_{EN} = V_{IN}, unless otherwise specified.)

Notes: 5. 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 input voltages above minimum $V_{IN} = 2.0V$.

6. At V_{IN} < 2.3V, the PSRR performance may be reduced.

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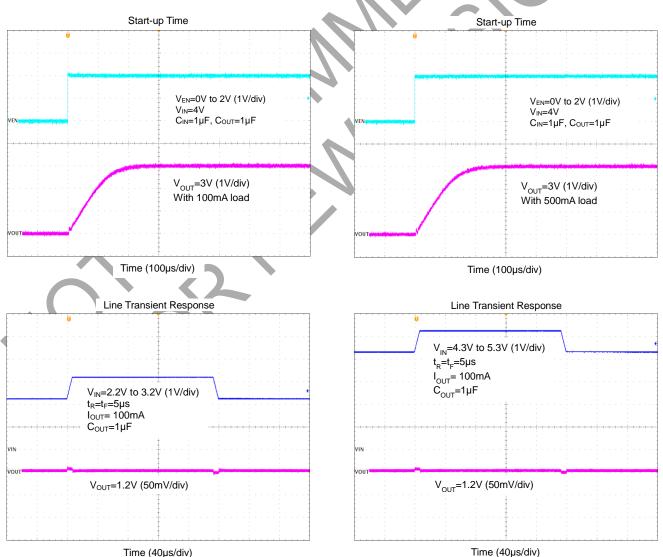
Electrical Characteristics (continued) ($@T_A = +25^{\circ}C$, $V_{IN} = V_{OUT} + 1V$, $C_{OUT} = 1\mu$ F, $C_{IN} = 1\mu$ F, $V_{EN} = V_{IN}$, unless otherwise specified.)

Symbol	Parameter	Test Conditions	Min	Тур	Max	Unit	
Renpd	EN Pulldown Resistor	—	—	3	_	MΩ	
Rpd	Output Discharge Resistor	Vol = 1V	_	100	_	Ω	
ΔVout /ΔTa/Vout	Output Voltage Temperature Coefficient	Iou⊤ = 100mA, -40°C ≤ T _A ≤ +85°C	—	±100		ppm/°C	
θյΑ	Thermal Resistance Junction-to-Ambient	SOT25 (Note 7)	_	169			
	Thermal Resistance Junction-to-Ampleht	U-DFN2020-6 (Note 7)		132			
θJC	Thermal Resistance Junction-to-Case	SOT25 (Note 7)	X	31	_		
	Thermal Resistance Junction-to-Case	U-DFN2020-6 (Note 7)		48	_	°C/W	

Note:

7. Test condition for all packages: Device mounted on FR-4 substrate PC board, 1oz copper, with minimum recommended pad layout.

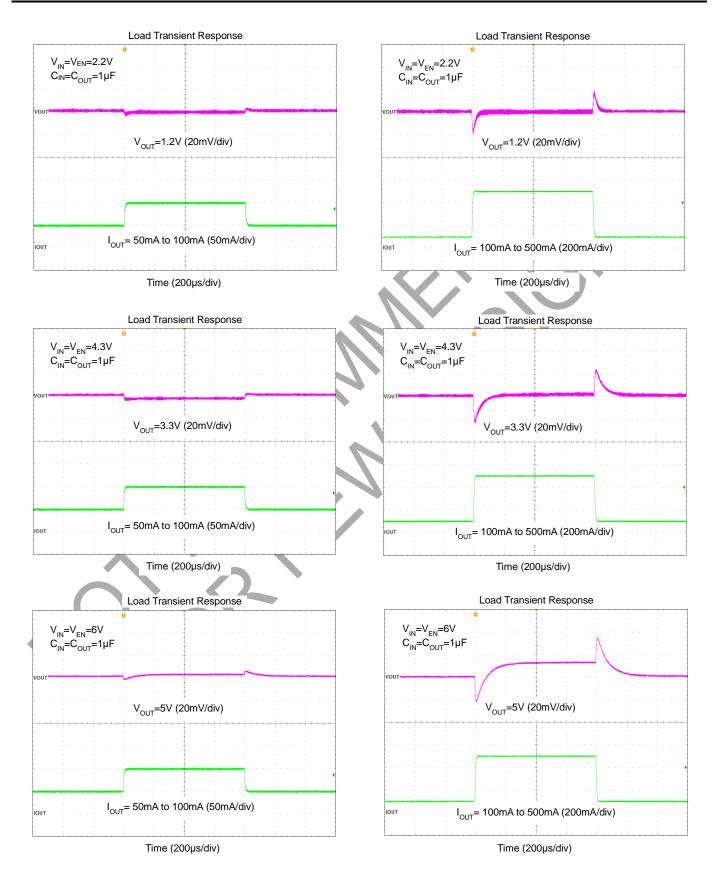
Typical Performance Characteristics



Time (40µs/div)

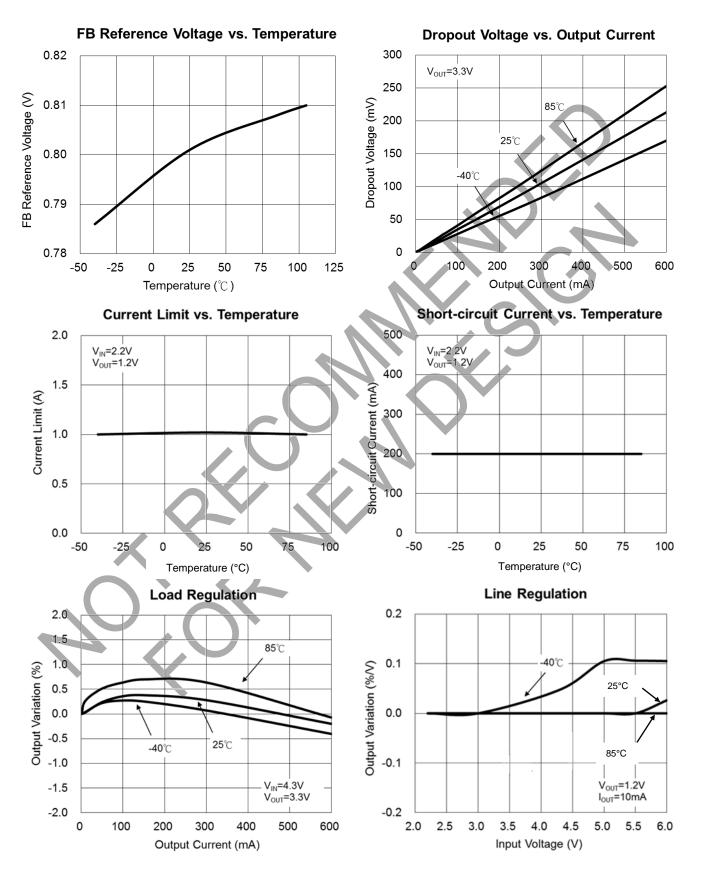


Typical Performance Characteristics (continued)



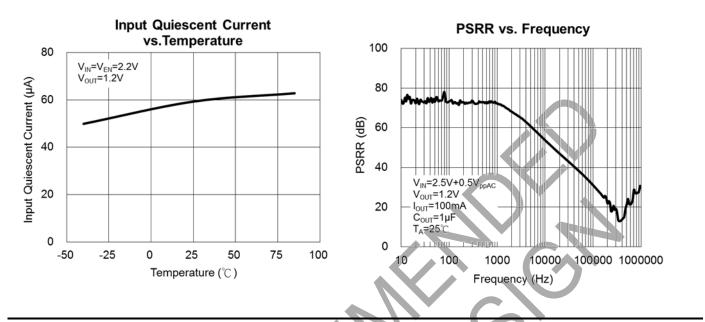


Typical Performance Characteristics (continued)





Typical Performance Characteristics (continued)



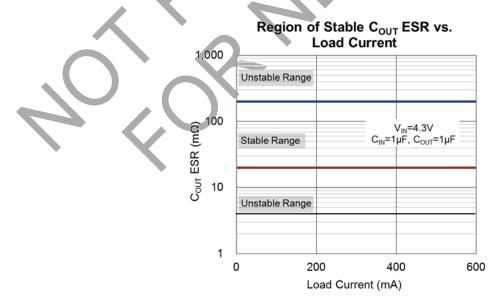
Application Information

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 AP7366 is stable with very small ceramic output capacitors. Using a ceramic capacitor value that is at least 2.2 μ F with $10m\Omega \le ESR \le 300m\Omega$ 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.

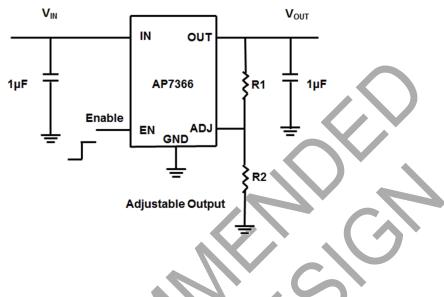




Application Information (continued)

Adjustable Operation

The AP7366 provides output voltage from 0.8V to 5.0V through external resistor divider as shown below.



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, R2 needs 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 AP7366 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} .

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 overcurrent 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 250mA. Full current is restored when the output voltage exceeds 15% of V_{OUT}. This feature protects the regulator from overcurrent 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.



Application Information (continued)

Ultra Fast Start-Up

After enabled, the AP7366 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 AP7366, consuming only around 60µA 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:

$$\mathbf{P}_{D} = (V_{IN} - V_{OUT}) \times I_{OUT}$$

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:

$$P_D(\max@T_A) = \frac{(+150^{\circ}C - T_A)}{R_{\theta IA}}$$

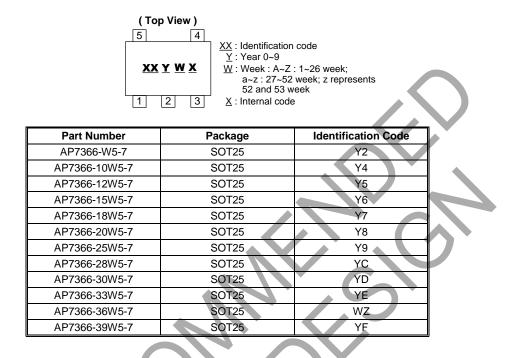
Ordering Information

Ordering inform	lation							
Output Package Packing Blank : ADJ W5 : SOT25 7 : 7" Tape & Reel 10 : 1.0V SN : U-DFN2020-6 7 : 7" Tape & Reel 15 : 1.5V 15 : 1.5V 15 : 1.5V 18 : 1.8V 20 : 2.0V 25 : 2.5V 28 : 2.8V 30 : 3.0V 30 : 3.0V 39 : 3.9V								
Part Number	Package Code	Package	Pack	_				
	- achage code	_	Qty.	Carrier				
AP7366-W5-7	W5	SOT25	3,000	7" Tape & Reel				
AP7366-XXW5-7	W5	SOT25	3,000	7" Tape & Reel				
AP7366-SN-7	SN	U-DFN2020-6	3,000	7" Tape & Reel				
AP7366-XXSN-7	SN	U-DFN2020-6	3,000	7" Tape & Reel				

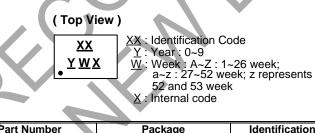


Marking Information

(1) SOT25



(2) U-DFN2020-6





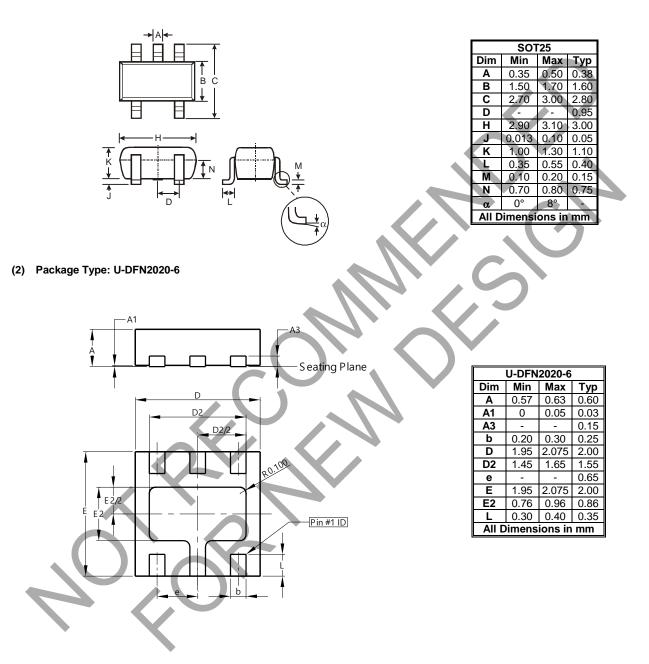
Part Number	Package	Identification Code
AP7366-SN-7	U-DFN2020-6	Y2
AP7366-10SN-7	U-DFN2020-6	Y4
AP7366-12SN-7	U-DFN2020-6	Y5
AP7366-15SN-7	U-DFN2020-6	Y6
AP7366-18SN-7	U-DFN2020-6	Y7
AP7366-20SN-7	U-DFN2020-6	Y8
AP7366-25SN-7	U-DFN2020-6	Y9
AP7366-28SN-7	U-DFN2020-6	YC
AP7366-30SN-7	U-DFN2020-6	YD
AP7366-33SN-7	U-DFN2020-6	YE
AP7366-36SN-7	U-DFN2020-6	WZ
AP7366-39SN-7	U-DFN2020-6	YF



Package Outline Dimensions

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

(1) Package Type: SOT25





Dimensions

Z G

Х

Y

C1

C2

Value 3.20

1.60

0.55

0.80

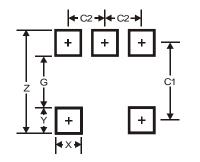
2.40

0.95

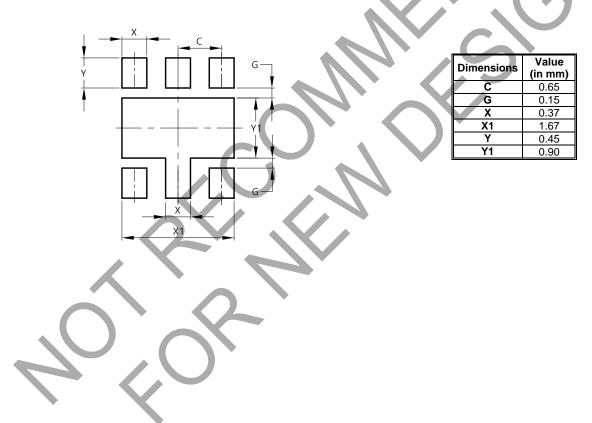
Suggested Pad Layout

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

(1) Package Type: SOT25



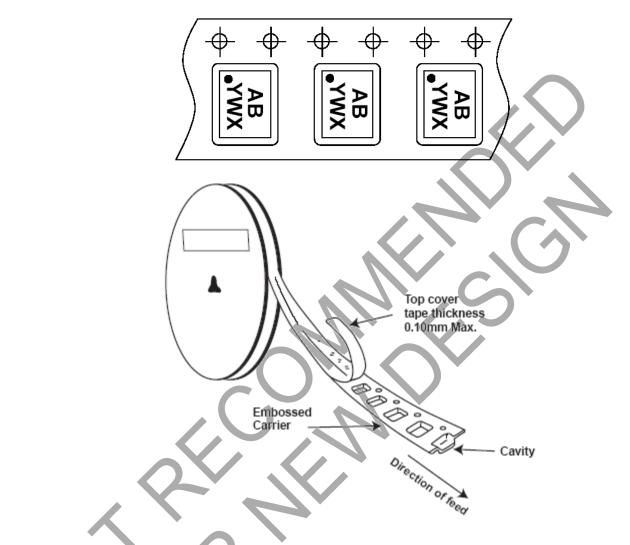
(2) Package Type: U-DFN2020-6





Tape Orientation (Note 8)

For U-DFN2020-6



Note: 8. The taping orientation of the other package type can be found on our website at http://www.diodes.com/package-outlines.html.



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