300mA, LOW QUIESCENT CURRENT, FAST TRANSIENT LOW DROPOUT LINEAR REGULATOR

Description

The AP7335A is a 300mA, fixed output voltage, low-dropout linear regulator with ±1% output voltage accuracy. The 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.

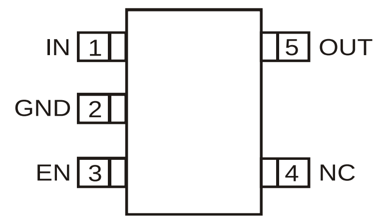
The characteristics of low-dropout voltage and low-quiescent current make it suitable for low-power applications, for example, battery powered devices. The typical quiescent current is 35µA. Built-in, current-limit and thermal-shutdown functions prevent IC from damage in fault conditions.

This device is only available as a 3.3V fixed version now. Please contact your local sales office for any other voltage options.

The AP7335A is packaged in SOT25 and U-DFN2020-6.

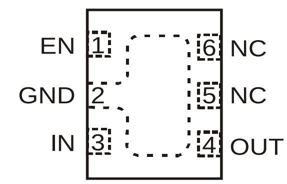
Pin Assignments

(Top View)



SOT25
(Fixed Output)

(Top View)



U-DFN2020-6
(Fixed Output)

Applications

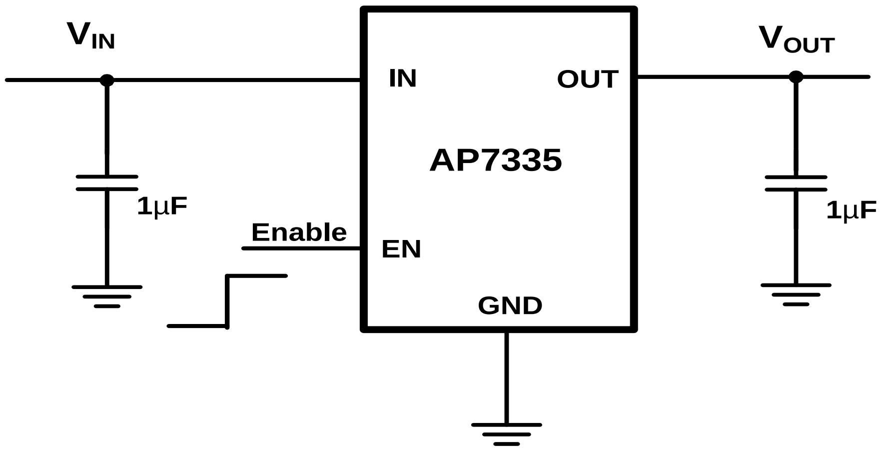
- 300mA Low Dropout Regulator with EN
- Very Low I_Q 35µA
- Fixed Output at 3.3V
  - $V_{IN(MIN)}$ 4.3V
- High PSRR: 65dB at 1kHz
- Fast Start-up Time 220µs
- Stable with Low ESR, 1µF Ceramic Output Capacitor
- Excellent Load/Line Transient Response
- Low Dropout 150mV at 300mA
- Current Limit and Short Circuit Protection
- Thermal Shutdown Protection
- Ambient Temperature Range -40ºC to +85°C
- SOT25, and U-DFN2020-6 Available in “Green” Molding Compound (No Br, Sb)
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. “Green” Device (Note 3)**

Features

- Smart Phones
- MP3/MP4s
- Battery-Powered Devices
- Bluetooth Headsets
- Battery Chargers
- LCD TVs
- Multifunction Monitors

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated’s definitions of Halogen- and Antimony-free, "Green" and 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.

Typical Applications Circuit

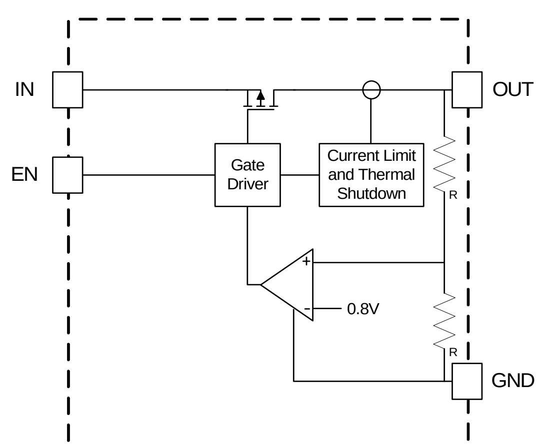


Fixed Output

Pin Descriptions

Pin Number	Package Name		Function
	SOT25 (Fixed)	U-DFN2020-6 (Fixed)	
IN	1	3	Voltage input pin. Bypass to ground through at least 1μF MLCC capacitor
GND	2	2	Ground
EN	3	1	Enable input, active high
NC	4	5, 6	No connection
OUT	5	4	Voltage output pin. Bypass to ground through 1μF MLCC capacitor

Functional Block Diagram



Fixed Version

Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified.)(Note 4)

Symbol	Parameter	Ratings	Unit
V_{IN}	Input Voltage	6.5	V
V_{OUT}, V_{EN}	OUT, EN Voltage	V_{IN} + 0.3	V
I_{LIMIT}	Continuous Load Current per Channel	Internal Limited	mA
T_{ST}	Storage Temperature Range	-65 to +150	°C
ESD HBM	Human Body Model ESD Protection	2,000	V
ESD MM	Machine Model ESD Protection	200	V

Notes: 4. Stresses greater than the 'Absolute Maximum Ratings' specified above, may cause permanent damage to the device. These are stress ratings only; functional operation of the device at these or any other conditions exceeding those indicated in this specification is not implied. Device reliability may be affected by exposure to absolute maximum rating conditions for extended periods of time.

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

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input voltage (Note 6)	4.3 (Note 6)	6	V
I_{OUT}	Output Current (Note 5)	0	300	mA
T_A	Operating Ambient Temperature	-40	+85	°C

Notes: 5. The device maintains a stable, regulated output voltage without a load current.
6. $V_{IN(MIN)}$ = 4.3V for 3.3V, V_{OUT} at 300mA I_{OUT}.

Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

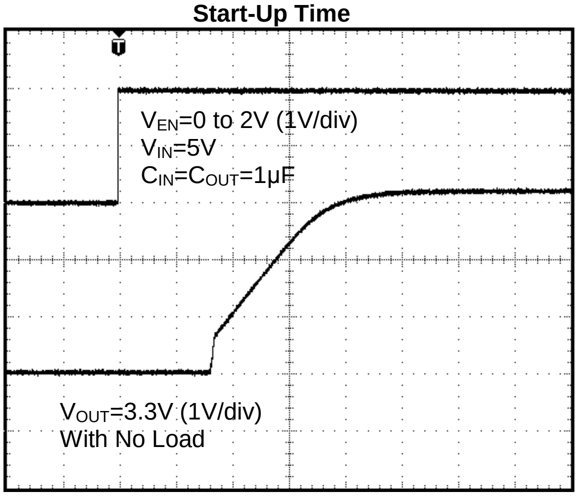
(T_A = +25°C, V_{IN} = V_{OUT}+1V, C_{IN} = 1µF, C_{OUT} = 1µF, V_{EN} = 2V, unless otherwise stated.)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
V_{OUT}	Output Voltage Accuracy	T_A = -40°C to +85°C, I_{OUT} = 10% of $I_{OUT\text{-}Max}$	-1	-	1	%
$\Delta V_{OUT}/\Delta V_{IN}/V_{OUT}$	Line Regulation	V_{IN} = (V_{OUT} + 1V) to $V_{IN\text{-}Max}$ V_{EN} = V_{IN}, I_{OUT} = 1mA	-	0.02	0.20	%/V
$\Delta V_{OUT}/V_{OUT}$	Load Regulation	V_{IN} = (V_{OUT} + 1V) to $V_{IN\text{-}Max}$ I_{OUT} = 1mA to 300mA	-0.6	-	0.6	%
$V_{DROPOUT}$	Dropout Voltage (Note 7)	I_{OUT} = 300mA	-	150	200	mV
I_Q	Input Quiescent Current	V_{EN} = V_{IN}, I_{OUT} = 0mA	-	35	80	µA
I_{SHDN}	Input Shutdown Current	V_{EN} = 0V, I_{OUT} = 0mA	-	0.1	1	µA
I_{LEAK}	Input Leakage Current	V_{EN} = 0V, OUT grounded	-	0.1	1	µA
T_{ST}	Start-up Time	V_{EN} = 0V to 2.0V in 1µs, I_{OUT} = 300mA	-	220	-	µs
PSRR	PSRR	V_{IN} = (V_{OUT} + 1V)V_{DC} + 0.5V_{PPAC}, f = 1kHz, I_{OUT} = 50mA	-	65	-	dB
I_{SHORT}	Short-circuit Current	V_{IN} = $V_{IN\text{-}Min}$ to $V_{IN\text{-}Max}$, V_{OUT} < 0.2V (Fixed)	-	160	-	mA
I_{LIMIT}	Current limit	V_{IN} = $V_{IN\text{-}Min}$ to $V_{IN\text{-}Max}$, V_{OUT}/R_{OUT} = 1.2A	400	650	-	mA
V_{IL}	EN Input Logic Low Voltage	V_{IN} = $V_{IN\text{-}Min}$ to $V_{IN\text{-}Max}$	-	-	0.4	V
V_{IH}	EN Input Logic High Voltage	V_{IN} = $V_{IN\text{-}Min}$ to $V_{IN\text{-}Max}$	1.4	-		V
I_{EN}	EN Input Current	V_{IN} = 0V or $V_{IN\text{-}Max}$	-1	-	1	µA
T_{SHDN}	Thermal Shutdown Threshold	-	-	+145	-	°C
T_{HYS}	Thermal Shutdown Hysteresis	-	-	+15	-	°C
θ_{JA}	Thermal Resistance Junction-to-Ambient	SOT25 (Note 8)	-	187	-	°C/W
		U-DFN2020-6 (Note 8)	-	251	-	

Notes: 7. Dropout voltage is the voltage difference between the input and the output at which the output voltage drops 2% below its nominal value.
8. Test condition for all packages: Device mounted on FR-4 substrate PC board, 1oz copper, with minimum recommended pad layout.

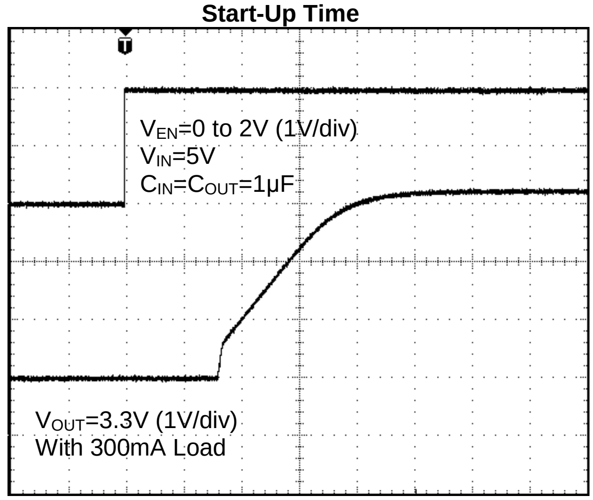
Performance Characteristics

Start-Up Time



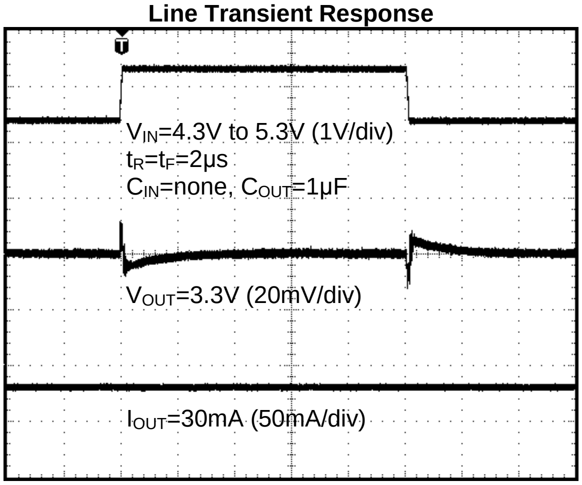
Time (40µs/div)

Start-Up Time



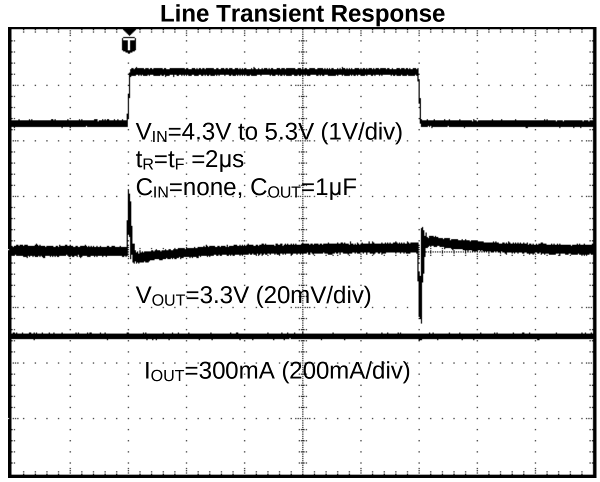
Time (40µs/div)

Line Transient Response



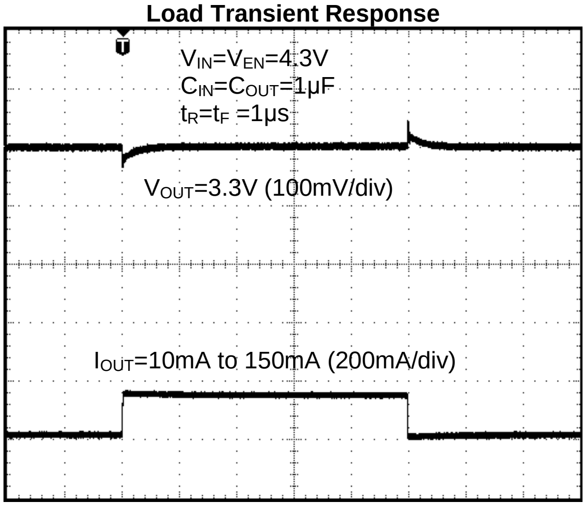
Time (40µs/div)

Line Transient Response



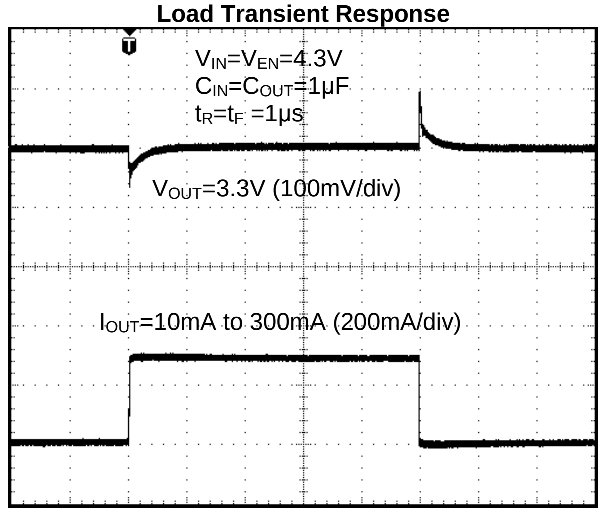
Time (40µs/div)

Load Transient Response



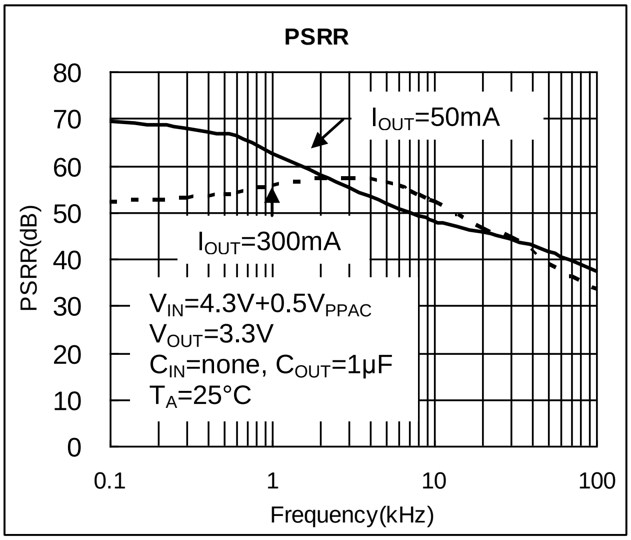
Time (100µs/div)

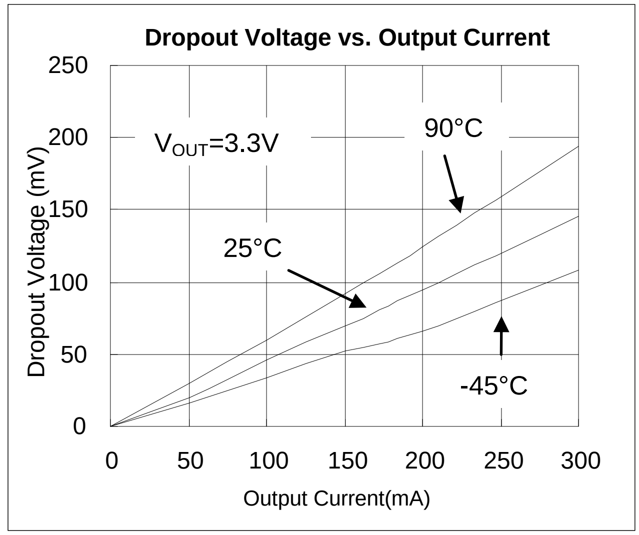
Load Transient Response

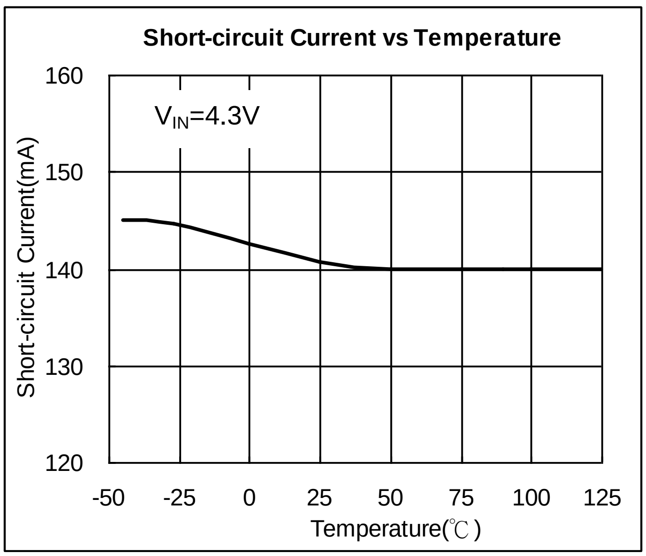


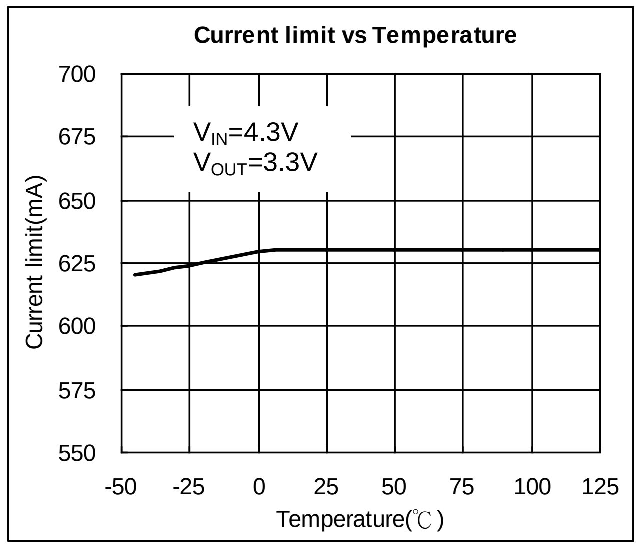
Time (100µs/div)

Performance Characteristics (Cont.)









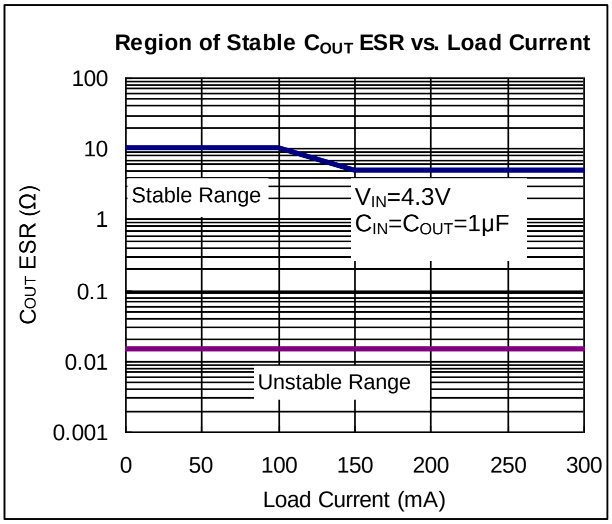
Application Note

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 AP7335A is stable with very small ceramic output capacitors. Using a ceramic capacitor value that is at least 1µF with ESR > 15mΩ 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.



No Load Stability

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 AP7335A 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 approximately 650mA 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 160mA. 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 +145°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 AP7335A is able to provide full power in as little as tens of microseconds, typically 220µs, 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.

Application Note

Fast Transient Response

Fast transient response LDO can extend battery life. TDMA-based cell phone protocols such as Global System for Mobile Communications (GSM) have a transmit/receive duty factor of only 12.5 percent, enabling power savings by putting much of the baseband circuitry into standby mode in between transmit cycles. In baseband circuits, the load often transitions virtually instantaneously from 100µA to 100mA. To meet this load requirement, the LDO must react very quickly without a large voltage drop or overshoot — a requirement that cannot be met with conventional, general-purpose LDO.

The AP7335A's fast transient response from 0 to 300mA provides stable voltage supply for fast DSP and GSM chipset with fast changing load.

Low Quiescent Current

The AP7335A, consuming only around 35µA for all input range, provides great power saving in portable and low power applications.

Power Dissipation

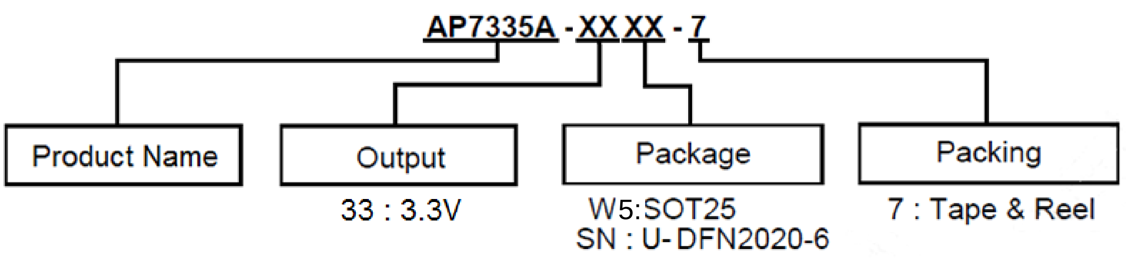
The device power dissipation and proper sizing of the thermal plane that is connected to the thermal pad is critical to avoid thermal shutdown and ensure reliable operation. Power dissipation of the device depends on input voltage and load conditions and can be calculated by:

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

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 following equation:

$$P_D(max@T_A) = \frac{(+145°C - T_A)}{R_{\theta JA}}$$

Ordering Information



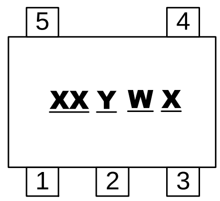
Part Number	Package Code	Packaging (Note 9)	7" Tape and Reel	
			Quantity	Part Number Suffix
AP7335A-XXW5-7	W5	SOT25	3,000/Tape & Reel	-7
AP7335A-XXSN-7	SN	U-DFN2020-6	3,000/Tape & Reel	-7

Note: 9. Pad layout as shown on Diodes Inc. suggested pad layout document, which can be found on our website at http://www.diodes.com/package-outlines.html.

Marking Information

(1) SOT25

(Top View)

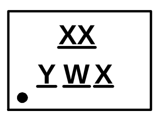


XX : Identification code
Y : Year 0~9
W : Week : A~Z : 1~26 week;
a~z : 27~52 week; z represents
52 and 53 week
X : A~Z : G = Green

Part Number	Package	Identification Code
AP7335A-33W5-7	SOT25	TN

(2) U-DFN2020-6

(Top View)



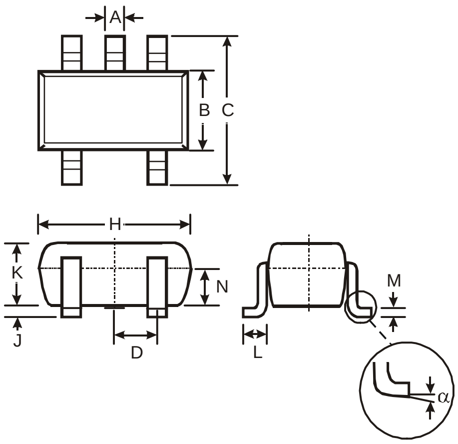
XX : Identification Code
Y : Year : 0~9
W : Week : A~Z : 1~26 week;
a~z : 27~52 week; z represents
52 and 53 week
X : A~Z : G = Green

Part Number	Package	Identification Code
AP7335A-33SN-7	U-DFN2020-6	TN

Package Outline Dimensions (All dimensions in mm.)

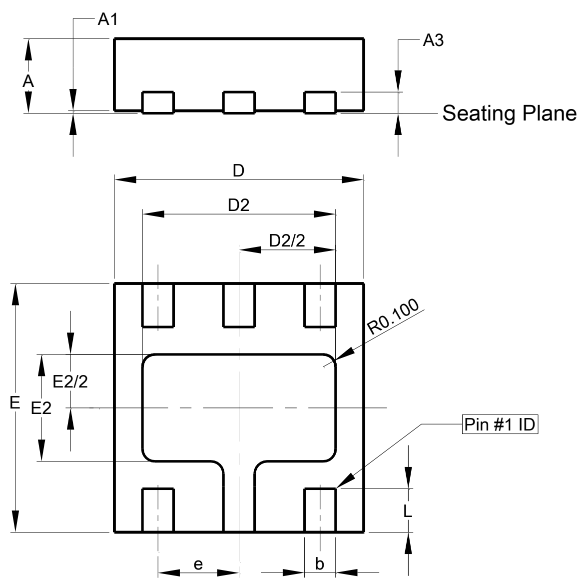
Please see http://www.diodes.com/package-outlines.html for the latest version.

(1) Package Type: 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			

(2) Package Type: U-DFN2020-6

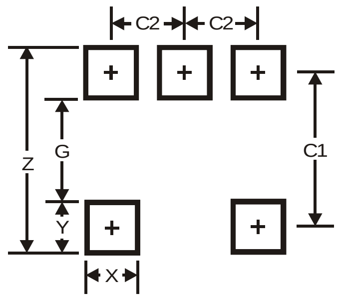


U-DFN2020-6			
Dim	Min	Max	Typ
A	0.57	0.63	0.60
A1	0	0.05	0.03
A3	-	-	0.15
b	0.20	0.30	0.25
D	1.95	2.075	2.00
D2	1.45	1.65	1.55
e	-	-	0.65
E	1.95	2.075	2.00
E2	0.76	0.96	0.86
L	0.30	0.40	0.35
All Dimensions in mm			

Suggested Pad Layout

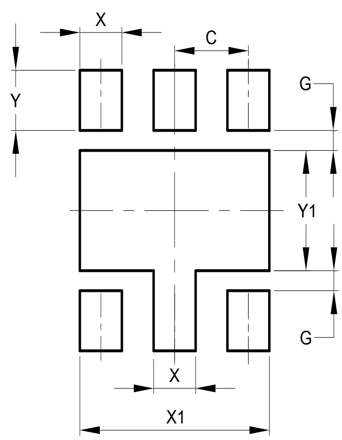
Please see http://www.diodes.com/package-outlines.html for the latest version.

Package Type: SOT25



Dimensions	Value (in mm)
Z	3.20
G	1.60
X	0.55
Y	0.80
C1	2.40
C2	0.95

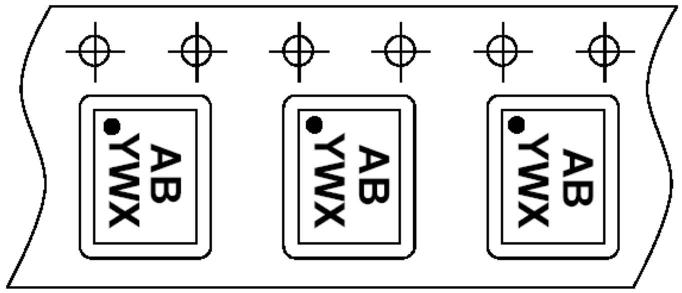
Package Type: U-DFN2020-6

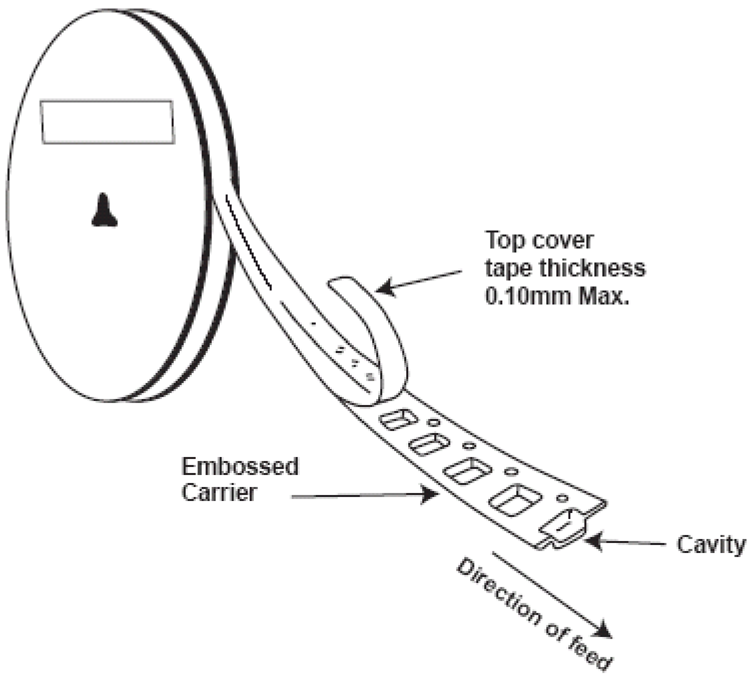


Dimensions	Value (in mm)
C	0.65
G	0.15
X	0.37
X1	1.67
Y	0.45
Y1	0.90

Taping Orientation (Note 10)

For U-DFN2020-6





Note: 10. 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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1. are intended to implant into the body, or
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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