AUTOMOTIVE COMPLIANT WIDE INPUT VOLTAGE RANGE 150mA ULDO REGULATOR

Description

The DIODES™ AP7387Q series is a wide input voltage range (60V), low quiescent current, high PSRR linear regulator able to driver 150mA output current.

The AP7387Q features a very fast line/load transient response against the rapid input voltage and load current changes. The IC consists of a voltage reference, an error amplifier, a resistor network for setting output voltage, a current limit circuit for current protection, short-circuit and thermal shutdown protection.

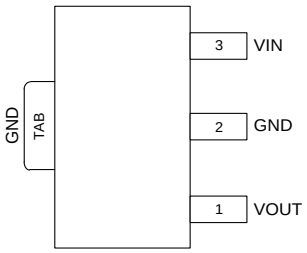
The AP7387Q has 3.0V, 3.3V, 3.6V, and 5V fixed output voltage versions, and is available in the SOT89 and U-DFN2020-6 (SWP) (Type UXC) packages.

Features

- Wide Input Voltage Range: 5V to 60V
- Maximum Output Current: 150mA
- Dropout Voltage:
  V_{DROP} = 700mV @I_{OUT} = 100mA (Typ.)
  V_{DROP} = 1100mV @I_{OUT} = 150mA (Typ.)
- Low Quiescent Current: 2μA (Typ.)
- High Output Voltage Accuracy: ±2%
- High PSRR: 70dB @1kHz
- Excellent Line/Load Regulation
- Thermal Shutdown Function
- Short Current Protection Function
- Output Current Limit
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen- and Antimony-Free. "Green" Device (Note 3)**
- **The AP7387Q is suitable for automotive applications requiring specific change control; this part is AEC-Q100 qualified, PPAP capable, and manufactured in IATF 16949 certified facilities.**
  https://www.diodes.com/quality/product-definitions/

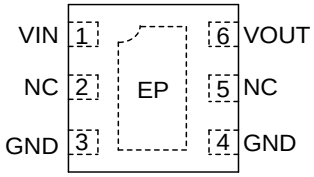
Pin Assignments

(Top View)



SOT89

(Top View)



U-DFN2020-6 (SWP) (Type UXC)

Future Product

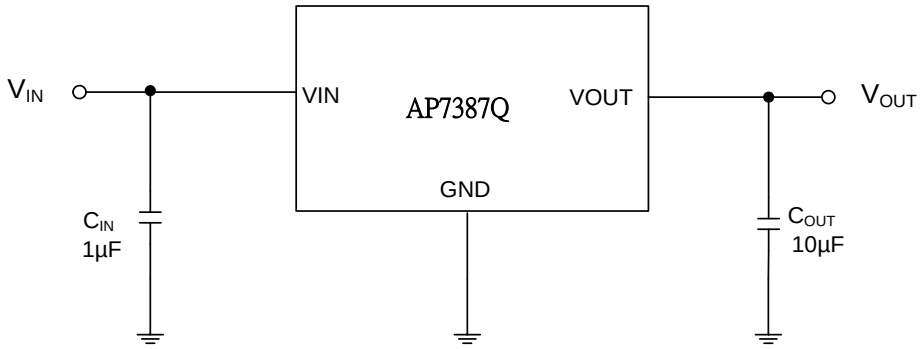
Applications

- Powering MCUs and CAN/LIN transceivers
- Automotive head units
- EV and HEV battery management systems
- Body control modules
- Transmission control units (TCUs)

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- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

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Typical Applications Circuit

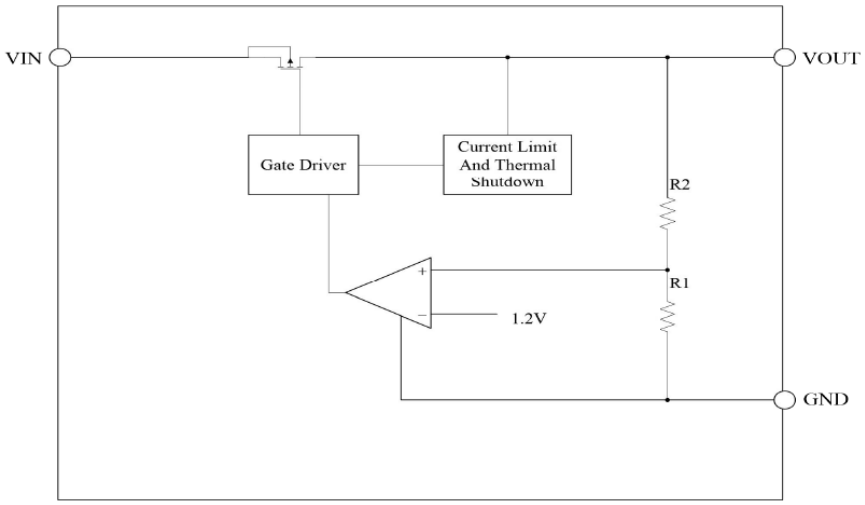


Pin Descriptions

Pin Number		Pin Name	Function
SOT89	U-DFN2020-6 (SWP) (Type UXC)		
3	1	VIN	Input voltage
2, TAB	3, 4	GND	Ground
—	2, 5	NC	Not connected internally, recommend connection to GND to maximize PCB copper for thermal dissipation.
1	6	VOUT	Regulated output voltage
—	EP	Exposed Pad	In PCB layout, prefer to use large copper area to cover this pad for better thermal dissipation, then connect this area to GND or leave it open. However, do not use it as GND electrode function alone.

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Functional Block Diagram



Absolute Maximum Ratings (Note 4) (@T_A = -40°C to +125°C, unless otherwise specified.)

Symbol	Parameter	Rating		Unit
V_{IN}	Supply Input Voltage	-0.3 to 80		V
V_{OUT}	Regulated Output Voltage	-0.3 to 6		V
V_{OUT}_V_{IN}	V_{OUT} to V_{IN}	-35 to 0.3		V
I_{OUT}	Output Current	Internally Limited		mA
T_{LEAD}	Lead Temperature (Soldering, 10sec)	+260		°C
T_J	Operating Junction Temperature	+150		°C
T_A	Operating Ambient Temperature	-40 to +125		°C
θ_{JA}	Thermal Resistance Junction to Ambient (θ_{JA})	SOT89	78.6	°C/W
		U-DFN2020-6 (SWP) (Type UXC)	47.9	
T_{STG}	Storage Temperature Range	-40 to +150		°C
CDM	ESD (Change Device Model)	1.5		kV
HBM	ESD (Human Body Model)	4		kV

Note: 4. a). Stresses greater than those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to *Absolute Maximum Ratings* for extended periods can affect device reliability.

b). Ratings apply to ambient temperature at +25°C. The JEDEC STD.51 High-K board design used to derive this data was a 3 inch x 3 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

Symbol	Parameter	Min	Typ	Max	Unit
V_{IN}	Supply Input Voltage	5.0	—	60	V
V_{OUT}	Supply Output Voltage	3.0	—	5	V
T_J	Operating Junction Temperature	-40	—	+125	°C
C_{IN}	Input Capacitor	—	1	—	µF
C_{OUT}	Output Capacitor	1	10	—	µF

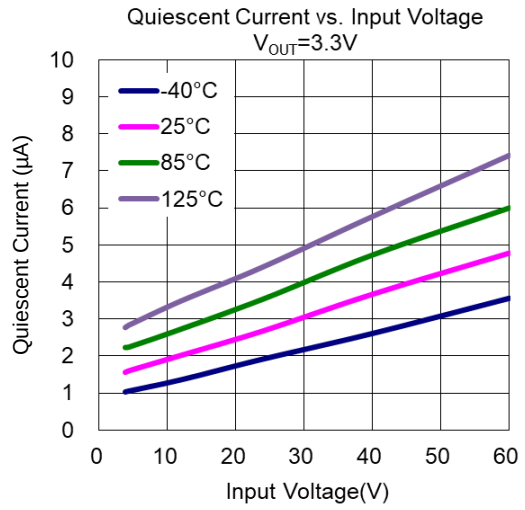
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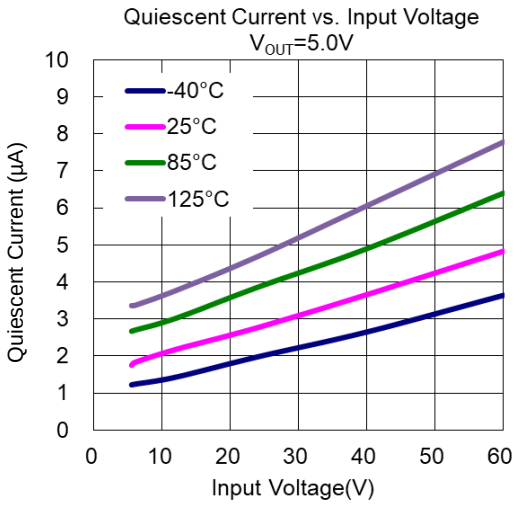
Electrical Characteristics (T_A = -40°C to +125°C, I_{OUT} = 1mA, C_{IN} =1µF, C_{OUT} = 10µF ceramic capacitor, V_{IN} = V_{OUTNOM} +2.0V)

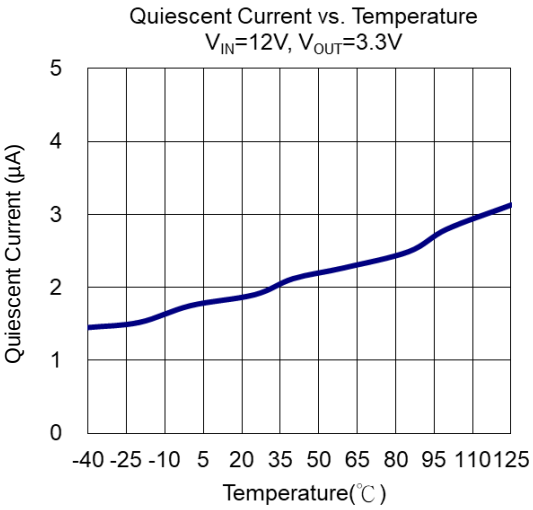
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage	—	5.0	—	60	V
I_{GND}	Quiescent Current	V_{IN} = 12V, No Load	—	2	5	µA
V_{OUT}	Output Voltage	V_{IN} = 12V, I_{OUT} = 10mA	V_{OUT}x98%	—	V_{OUT}x102%	V
I_{OUT_MAX}	—	—	—	150	—	mA
V_{DROP}	Dropout Voltage	I_{OUT} = 50mA, V_{OUT} = V_{OUTNOM} – 0.1V	—	350	500	mV
		I_{OUT} = 100mA, V_{OUT} = V_{OUTNOM} – 0.1V	—	700	1000	mV
		I_{OUT} = 150mA, V_{OUT} = V_{OUTNOM} – 0.1V	—	1100	1600	mV
$\triangle V_{OUT}(\triangle I_{OUT})$	Load Regulation	V_{IN} = 12V, 1mA ≤ I_{OUT} ≤ 150mA	—	0.02	0.03	%/mA
$\triangle V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{OUTNOM} + 0.5V ≤ V_{IN} ≤ 60V I_{OUT} = 1mA	—	0.01	0.02	%/V
I_{LIMIT}	Current Limit	—	—	250	—	mA
T_{OTSD}	Thermal Shutdown Temperature	—	—	+150	—	°C
T_{HYOTSD}	Thermal Shutdown Hysteresis	—	—	+30	—	°C
PSRR	Power Supply Rejection Ratio	V_{IN} = 12V, I_{OUT} = 1mA V_{OUT} = 3.3V @1kHz	—	70	—	dB
θ_{JC}	Thermal Resistance Junction to Case (θ_{JC})	SOT89	—	25.1	—	°C/W
		U-DFN2020-6 (SWP) (Type UXC)	—	15.5	—	

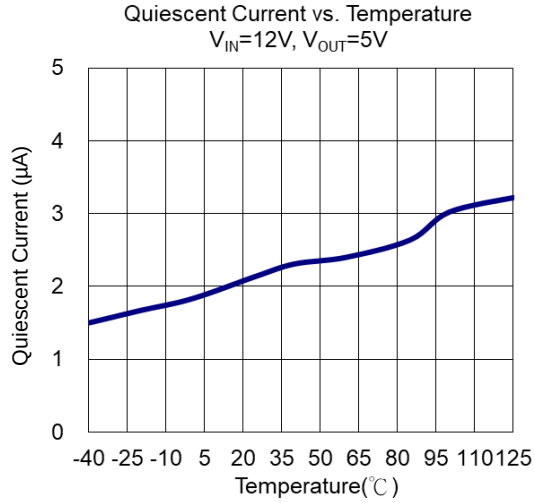
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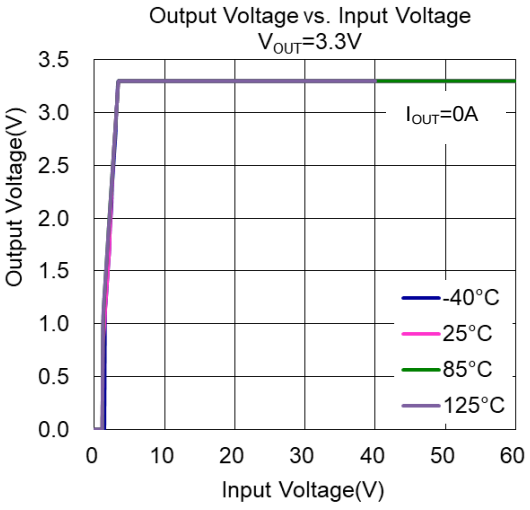
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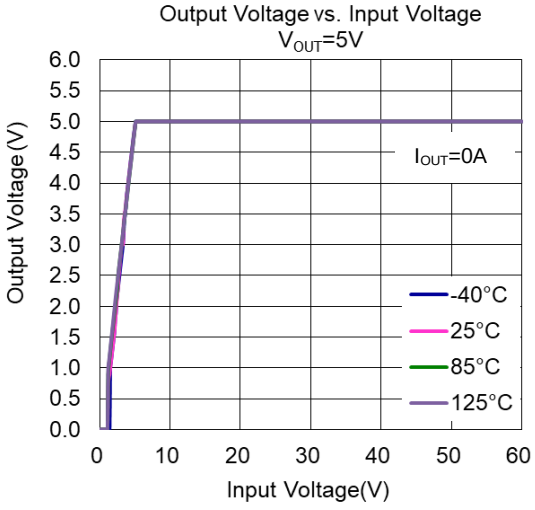






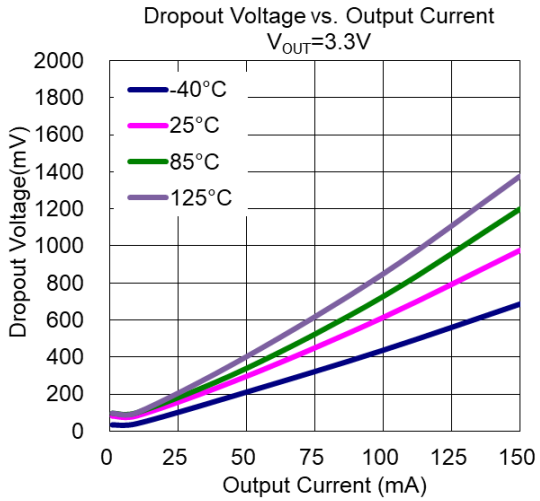


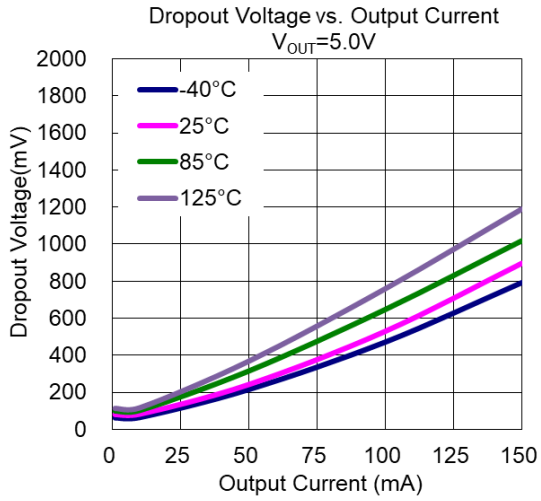


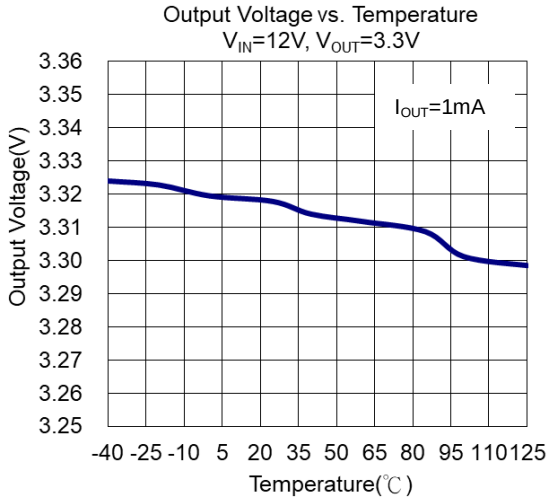


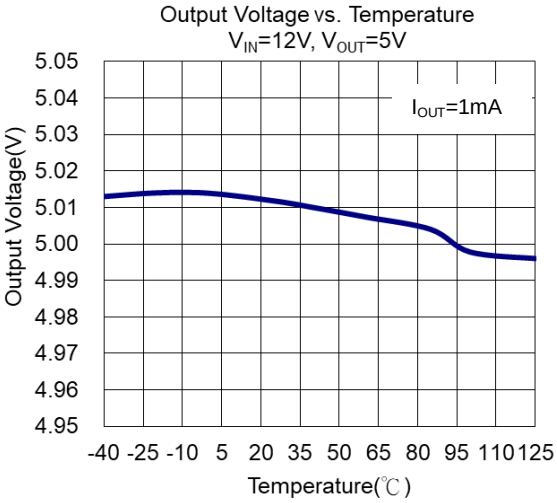
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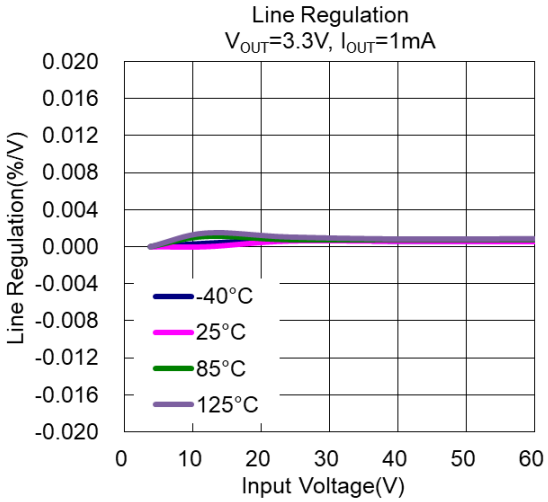
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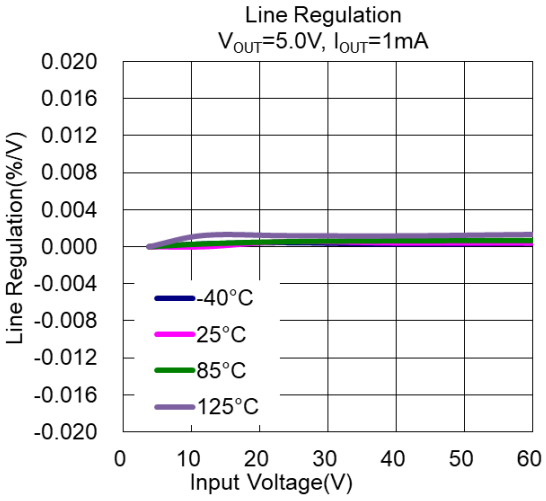






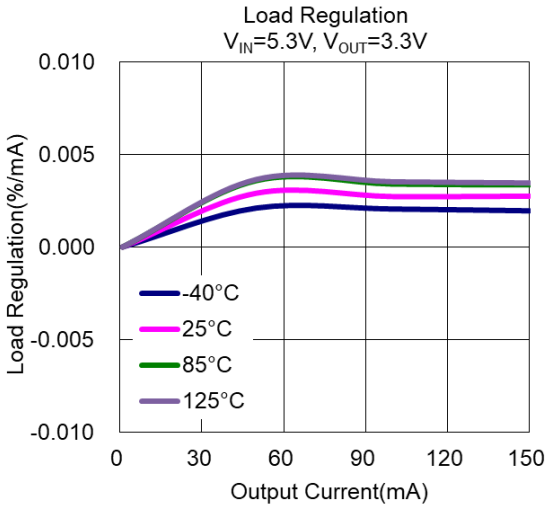


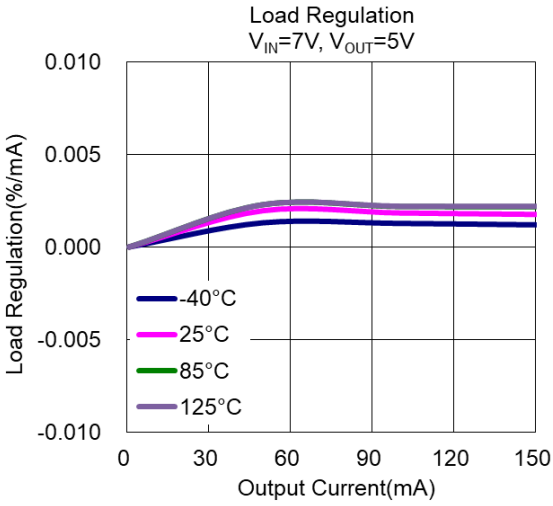


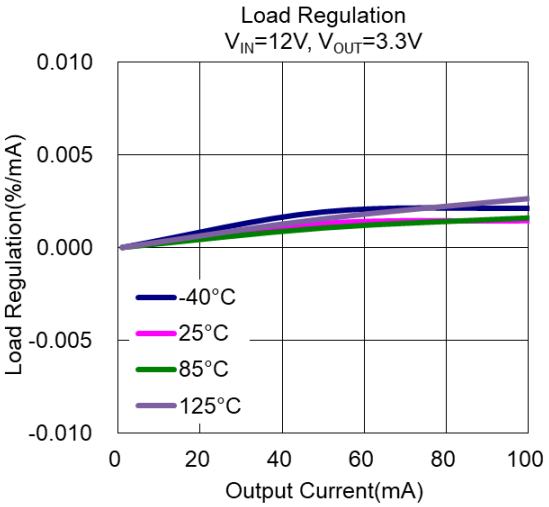


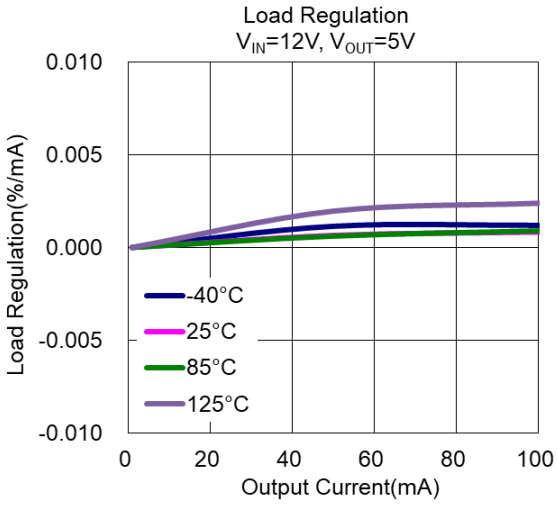
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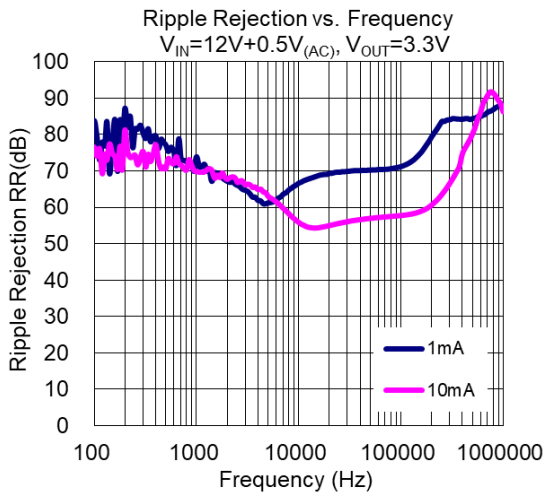
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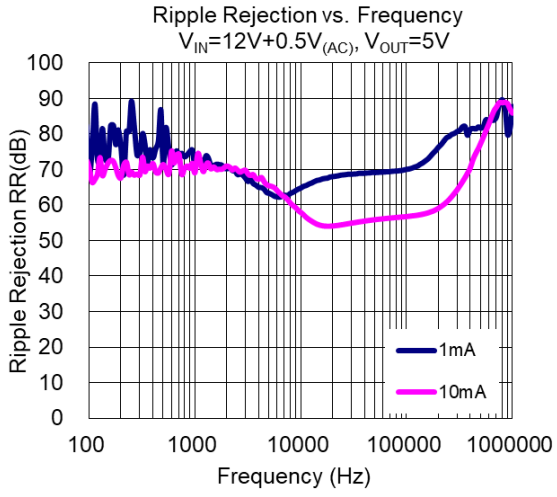






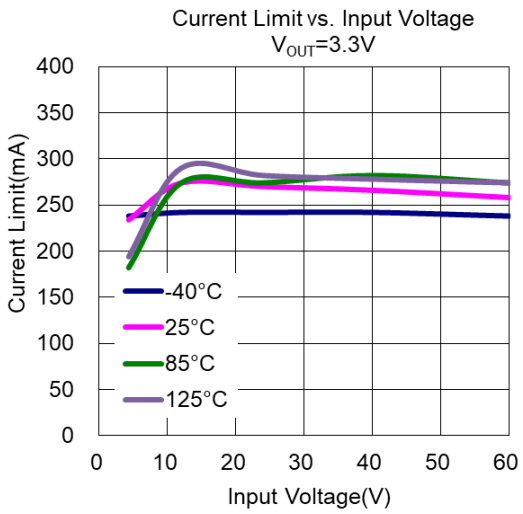


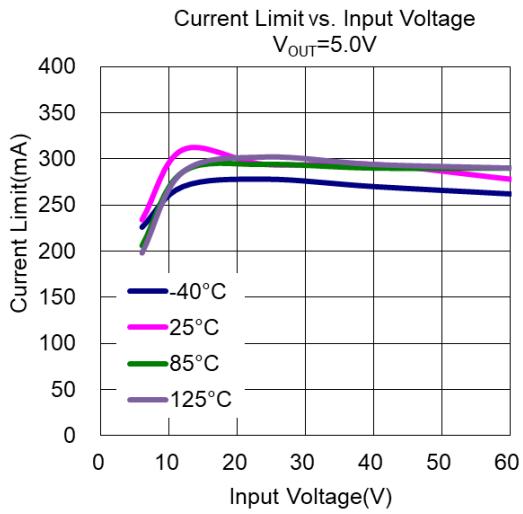


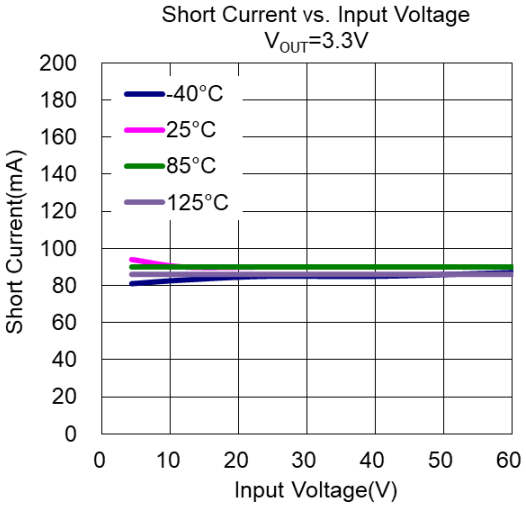


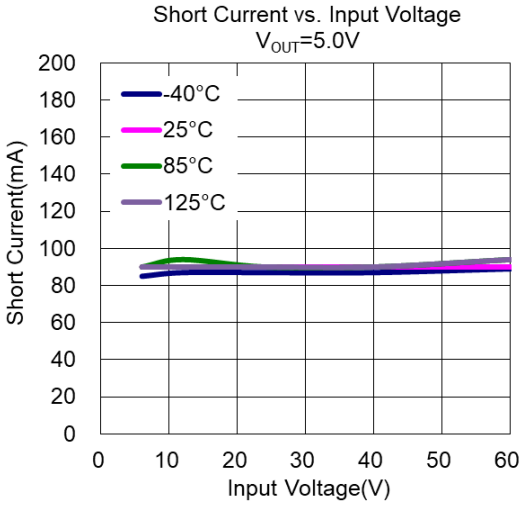
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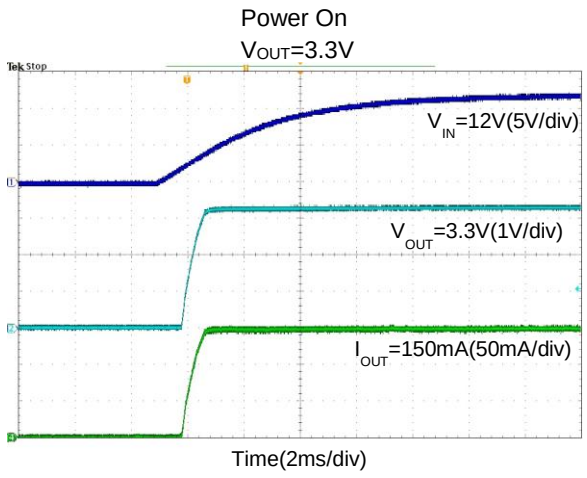
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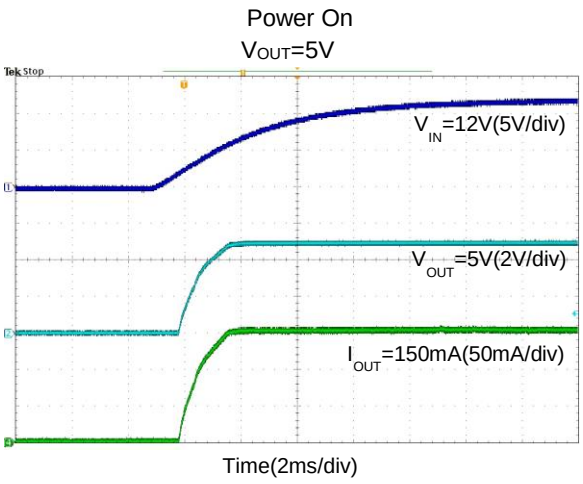








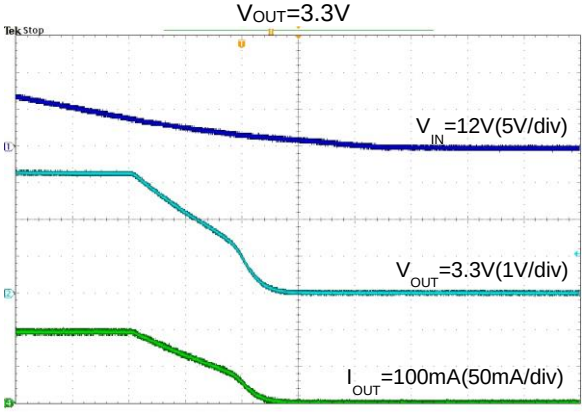




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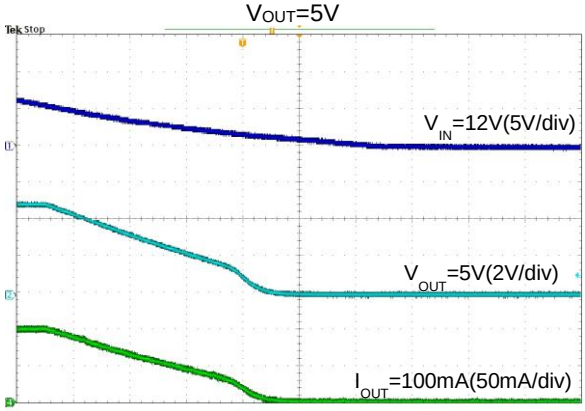
Typical Characteristics (continued)

Power Off
V_{OUT}=3.3V



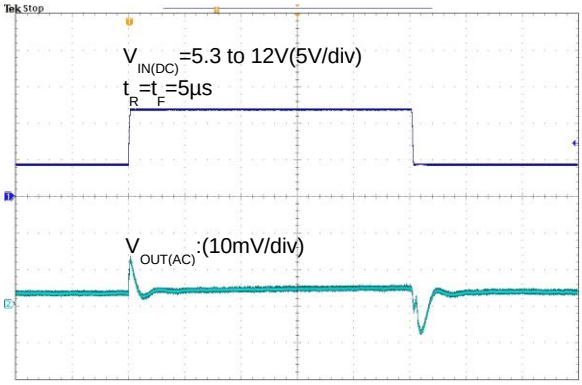
Time(4ms/div)

Power Off
V_{OUT}=5V



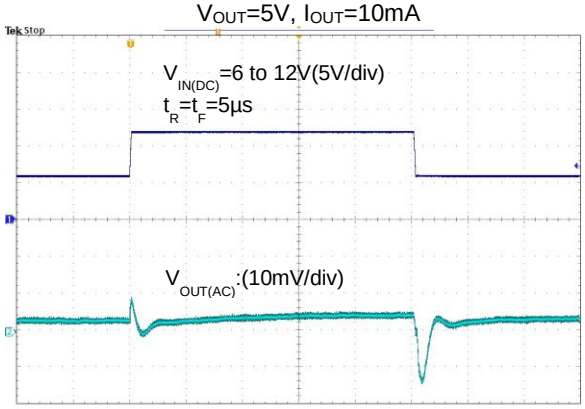
Time(4ms/div)

Line Transient Response
V_{OUT}=3.3V, I_{OUT}=10mA



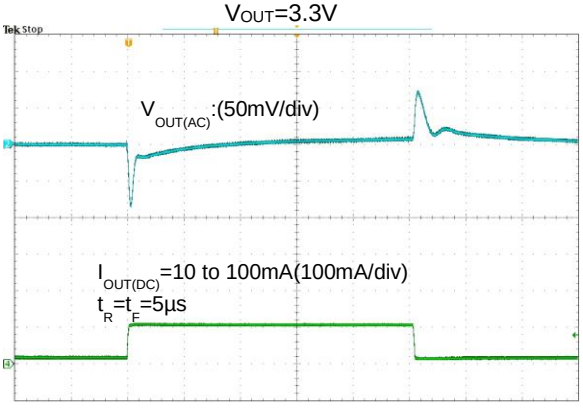
Time:200µs/div

Line Transient Response
V_{OUT}=5V, I_{OUT}=10mA



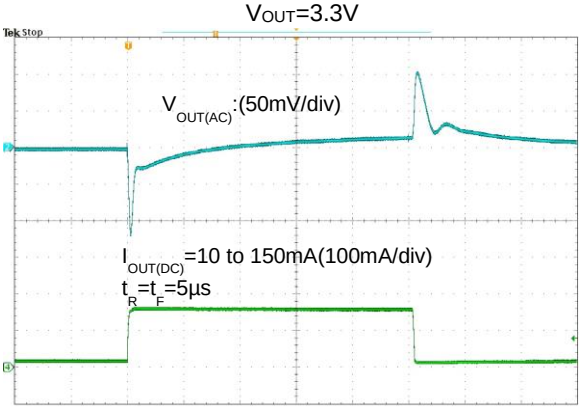
Time:200µs/div

Load Transient Response
V_{OUT}=3.3V



Time:200µs/div

Load Transient Response
V_{OUT}=3.3V



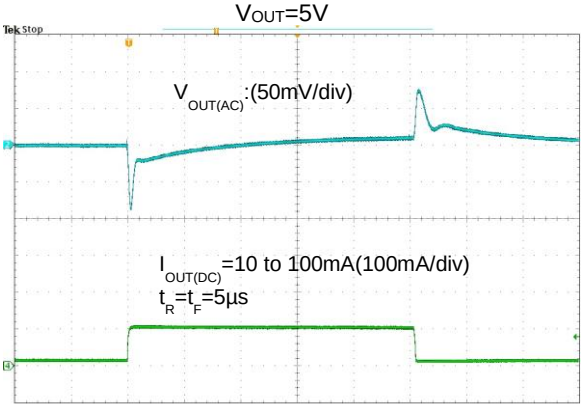
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Typical Characteristics (continued)

Load Transient Response

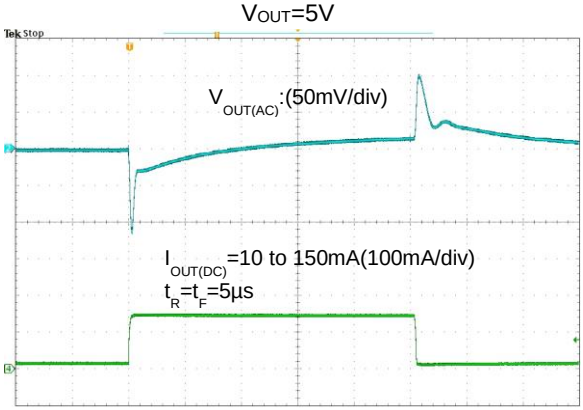
V_{OUT}=5V



Time:200µs/div

Load Transient Response

V_{OUT}=5V



Time:200µs/div

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Application Information

Output Capacitor

An output capacitor is required for the stability of the LDO. The recommended minimum output capacitance is 1μF. A ceramic capacitor is recommended with the temperature characteristics of X7R or X5R. Higher capacitance values help to improve load/line transient response. The output capacitance may be increased to keep low undershoot/overshoot. Place the output capacitor as close as possible to VOUT and GND pins.

Input Capacitor

A 1μF ceramic capacitor is recommended to connect between VIN 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 ensure input stability and less noise. For PCB layout, a wide copper trace is required for both VIN and GND.

Current-Limit and Short-Circuit Protection

When the output current at VOUT pin is higher than the current-limit threshold or the VOUT pin is directly shorted to GND, current-limit protection will be triggered and clamp the output current at a pre-designed level to prevent overcurrent and thermal damage.

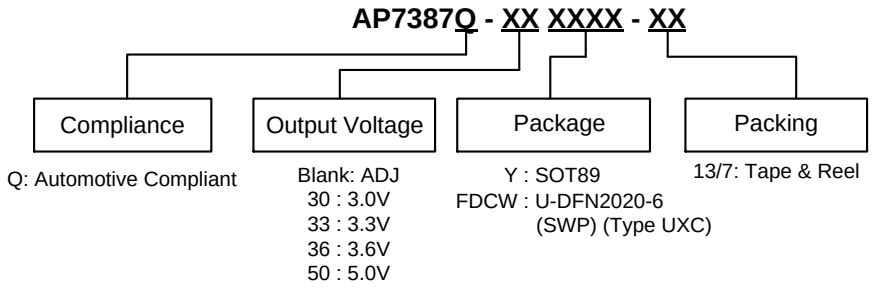
Thermal Protection

The AP7387 has internal thermal sense and protection circuits. When excessive power dissipation happens on the device, such as short circuit at the output pin or very heavy load current with a large voltage drop across the device, the internal thermal protection circuit will be triggered, and it will shut down the power MOSFET to prevent the LDO from damage. As soon as the excessive thermal condition is removed and the temperature of the device drops down, the thermal protection circuit will release the control of the power MOSFET and the LDO device will return to normal operation.

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.

Ordering Information



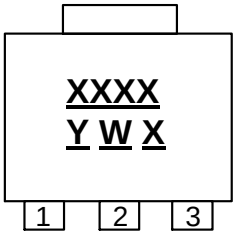
Part Number	Part Number Suffix	Package	Package Code	Packing	
				Qty.	Carrier
AP7387Q-XXY-13	-13	SOT89	Y	2,500	13” Tape & Reel
AP7387Q-XXFDCW-7	-7	U-DFN2020-6 (SWP) (Type UXC)	FDCW	3,000	7” Tape & Reel

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Marking Information

(1) SOT89

(Top View)

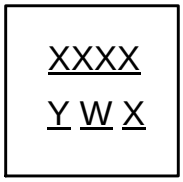


XXXX : Identification Code
Y : Year : 0 to 9 (ex: 2 = 2022)
W : Week : A to Z : week 1 to 26;
a to z : week 27 to 52;
z represents week 52 and 53
X : Internal Code

Part Number	Package	Identification Code
AP7387Q-30Y-13	SOT89	H7AQ
AP7387Q-33Y-13	SOT89	H7BQ
AP7387Q-36Y-13	SOT89	H7CQ
AP7387Q-50Y-13	SOT89	H7DQ

(2) U-DFN2020-6 (SWP) (Type UXC)

(Top View)



XXXX : Identification Code
Y : Year : 0 to 9 (ex: 2 = 2022)
W : Week : A to Z : week 1 to 26;
a to z : week 27 to 52; z represents
week 52 and 53
X : Internal Code

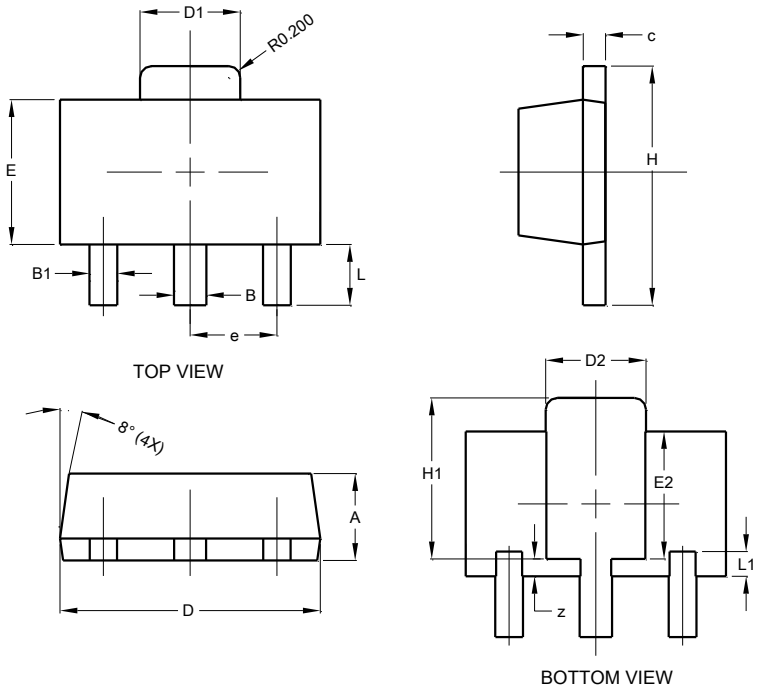
Part Number	Package	Identification Code
AP7387Q-30FDCW-7	U-DFN2020-6 (SWP) (Type UXC)	H7AQ
AP7387Q-33FDCW-7	U-DFN2020-6 (SWP) (Type UXC)	H7BQ
AP7387Q-36FDCW-7	U-DFN2020-6 (SWP) (Type UXC)	H7CQ
AP7387Q-50FDCW-7	U-DFN2020-6 (SWP) (Type UXC)	H7DQ

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Package Outline Dimensions

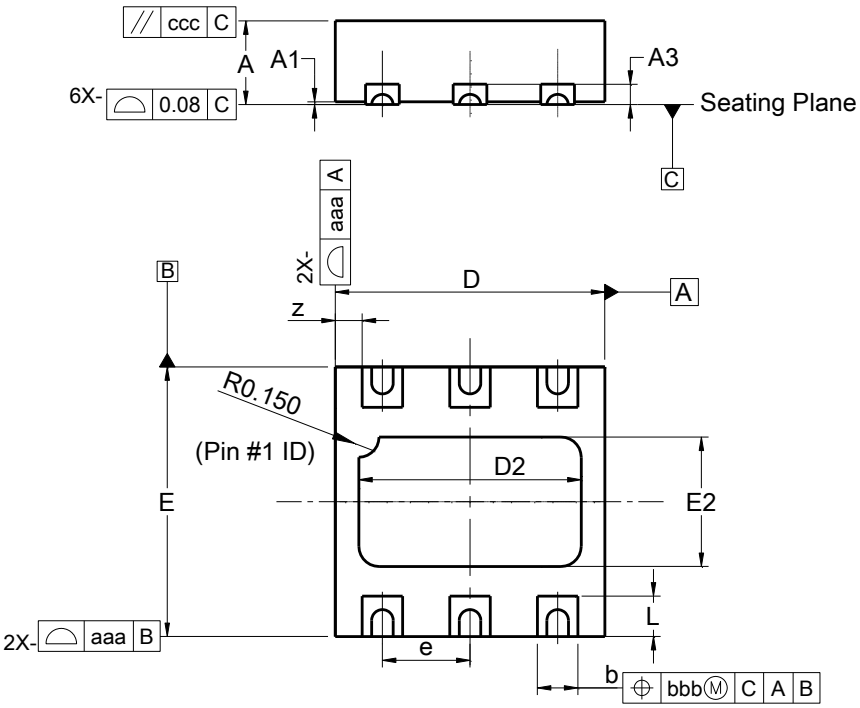
Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT89



SOT89			
Dim	**Min**	**Max**	**Typ**
A	1.40	1.60	1.50
B	0.50	0.62	0.56
B1	0.42	0.54	0.48
c	0.35	0.43	0.38
D	4.40	4.60	4.50
D1	1.62	1.83	1.733
D2	1.61	1.81	1.71
E	2.40	2.60	2.50
E2	2.05	2.35	2.20
e	-	-	1.50
H	3.95	4.25	4.10
H1	2.63	2.93	2.78
L	0.90	1.20	1.05
L1	0.327	0.527	0.427
z	0.20	0.40	0.30
All Dimensions in mm			

U-DFN2020-6 (SWP) (Type UXC)



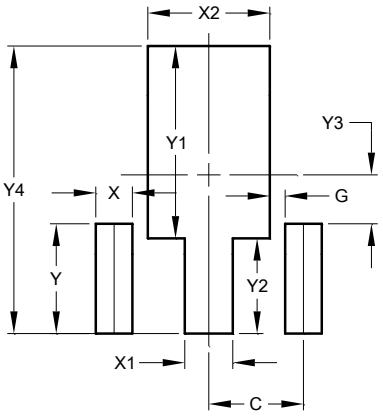
U-DFN2020-6 (SWP) (Type UXC)			
Dim	**Min**	**Max**	**Typ**
A	0.57	0.63	0.60
A1	0.00	0.05	0.02
A3	—	—	0.13
b	0.25	0.35	0.30
D	1.95	2.075	2.00
D2	1.55	1.75	1.65
E	1.95	2.075	2.00
E2	0.86	1.06	0.96
e	—	—	0.65
L	0.25	0.35	0.30
z	—	—	0.20
aaa	0.25		
bbb	0.10		
ccc	0.10		
All Dimensions in mm			

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Suggested Pad Layout

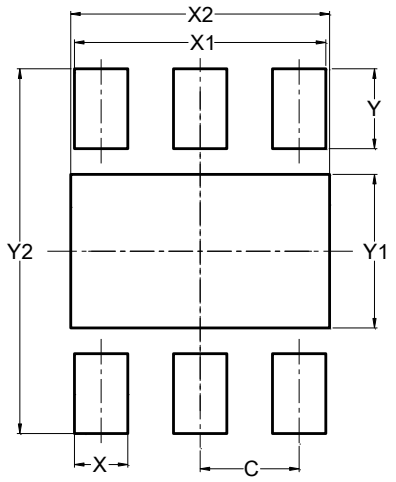
Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT89



Dimensions	Value (in mm)
C	1.500
G	0.244
X	0.580
X1	0.760
X2	1.933
Y	1.730
Y1	3.030
Y2	1.500
Y3	0.770
Y4	4.530

U-DFN2020-6 (SWP) (Type UXC)



Dimensions	Value (in mm)
C	0.650
X	0.350
X1	1.650
X2	1.700
Y	0.525
Y1	1.010
Y2	2.400

Mechanical Data

- Moisture Sensitivity: Level 1 Per J-STD-020
- Terminals:
  - SOT89: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 e3
  - U-DFN2020-6 (SWP) (Type UXC): Finish – NiPdAu over Copper Leads, Solderable per MIL-STD-202, Method 208 e4
- Weight:
  - SOT89: 0.056 grams (Approximate)
  - U-DFN2020-6 (SWP) (Type UXC): 0.007 grams (Approximate)

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