300mA, Low Noise, Ultra-Fast CMOS LDO Regulator

General Description

The AC3198 is designed for portable RF and wireless applications with demanding performance and space requirements. The AC3198 performance is optimized for battery-powered systems to deliver ultra low noise and low quiescent current. Regulator ground current increases only slightly in dropout, further prolonging the battery life. The AC3198 also works with low-ESR ceramic capacitors, reducing the amount of board space necessary for power applications, critical in hand-held wireless devices. The AC3198 consumes less than 0.01μA in shutdown mode and has fast turn-on time less than 50μs. The other features include ultra low dropout voltage, high output accuracy, current limiting protection, and high ripple rejection ratio. Available in the SOT-23-3, SOT-23-5 and SC-70-5 packages, the AC3198 also offers a range of 1.5V to 3.5V with 0.1V per step.

Features

- **Low-Noise for RF Application**
- **Fast Response in Line/Load Transient**
- **Quick Start-Up (Typically 50μs)**
- **< 0.01μA Standby Current When Shutdown**
- **Low Dropout : 220mV @ 300mA**
- **Wide Operating Voltage Ranges : 2.5V to 5.5V**
- **TTL-Logic-Controlled Shutdown Input**
- **Low Temperature Coefficient**
- **Current Limiting Protection**
- **Thermal Shutdown Protection**
- **Only 1μF Output Capacitor Required for Stability**
- **High Power Supply Rejection Ratio**
- **Custom Voltage Available**
- **RoHS Compliant and 100% Lead (Pb)-Free**

Ordering Information

AC3198 -□□□□□

Package Type
U5 : SC-70-5
U5R : SC-70-5 (R-Type)
V : SOT-23-3
B : SOT- 23-5
BR : SOT- 23-5 (R-Type)

Operating Temperature Range
C : Commercial Standard
P : Pb Free with Commercial Standard

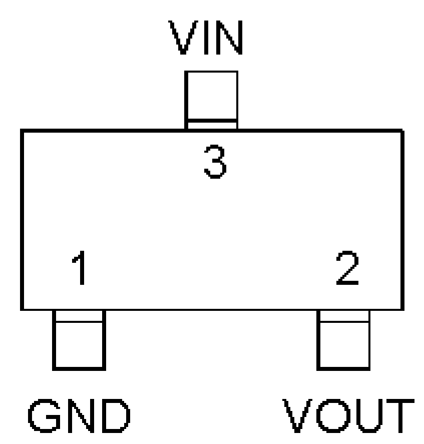
Output Voltage
15 : 1.5V
16 : 1.6V
:
34 : 3.4V
35 : 3.5V

Applications

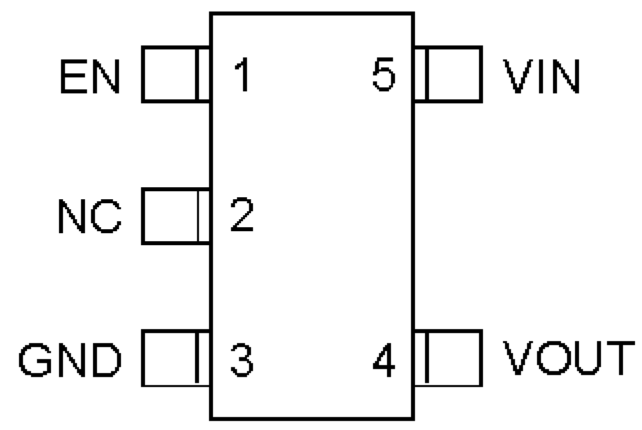
- CDMA/GSM Cellular Handsets
- Battery-Powered Equipment
- Laptop, Palmtops, Notebook Computers
- Hand-Held Instruments
- PCMCIA Cards
- Portable Information Appliances

Pin Configurations

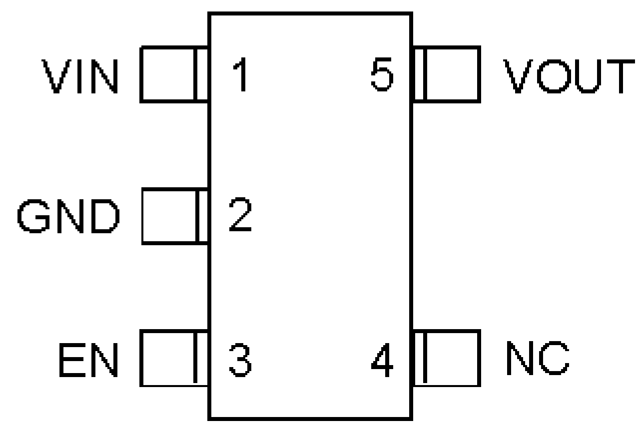
(TOP VIEW)



SOT-23-3

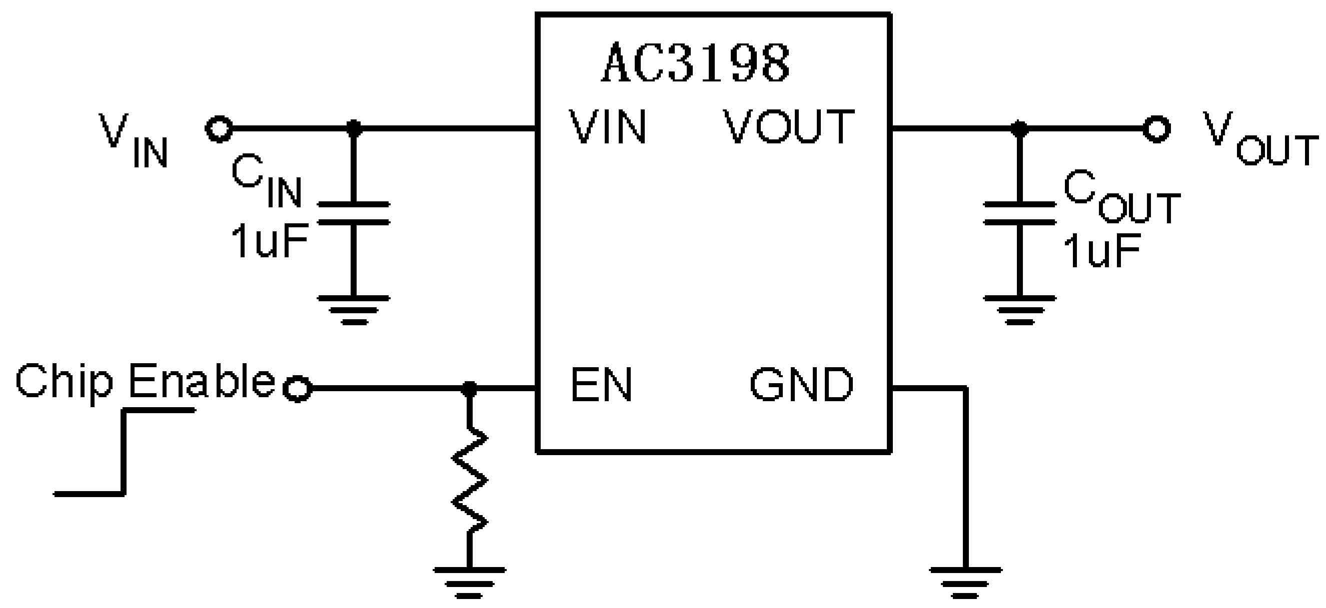


SOT-23-5/SC-70-5



SOT-23-5/SC-70-5 (R-Type)

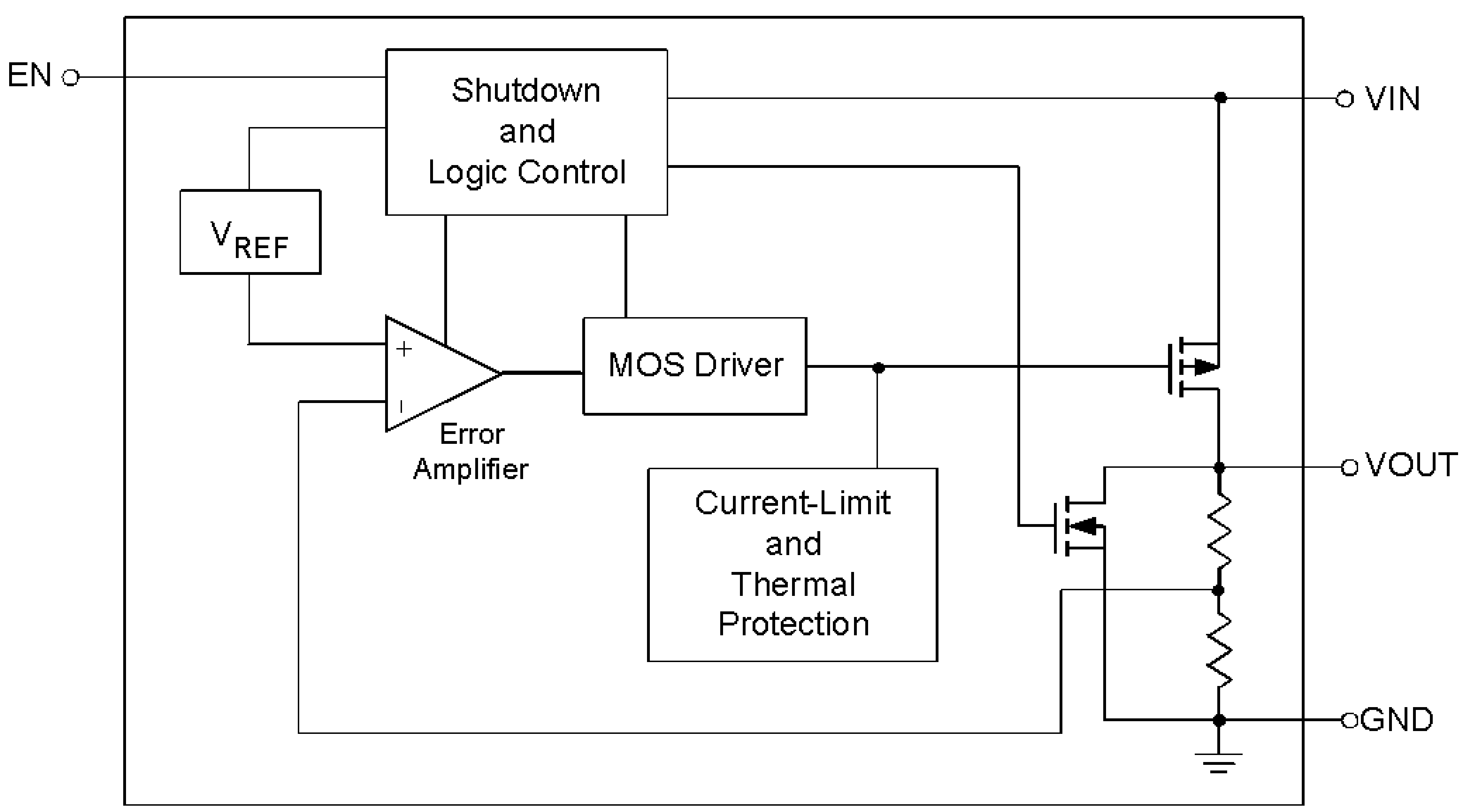
Typical Application Circuit



Functional Pin Description

Pin Name	Pin Function
EN	Chip Enable (Active High). Note that this pin is high impedance. There should be a pull low 100kΩ resistor connected to GND when the control signal is floating.
NC	No Connection
GND	Ground
VOUT	Output Voltage
VIN	Input Voltage

Function Block Diagram



Absolute Maximum Ratings (Note 1)

- Supply Input Voltage ---------- 6V
- Power Dissipation, P_D @ T_A = 25°C
  SOT-23-3 ---------- 0.4W
  SOT-23-5 ---------- 0.4W
  SC-70-5 ---------- 0.3W
- Package Thermal Resistance (Note 5)
  SOT-23-3, θ_{JA} ---------- 250°C/W
  SOT-23-5, θ_{JA} ---------- 250°C/W
  SC-70-5, θ_{JA} ---------- 333°C/W
- Junction Temperature ---------- 150°C
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Storage Temperature Range ---------- −65°C to 150°C
- ESD Susceptibility (Note 2)
  HBM (Human Body Mode) ---------- 2kV
  MM (Machine Mode) ---------- 200V

Recommended Operating Conditions (Note 3)

- Supply Input Voltage ---------- 2.5V to 5.5V
- EN Input Voltage ---------- 0V to 5.5V
- Operation Junction Temperature Range ---------- −40°C to 125°C
- Operation Ambient Temperature Range ---------- −40°C to 85°C

Electrical Characteristics

($V_{IN} = V_{OUT} + 1V$, $C_{IN} = C_{OUT} = 1\mu F$, T_A = 25°C, unless otherwise specified)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Units
Output Voltage Accuracy		ΔV_{OUT}	I_{OUT} = 1mA	−2	--	+2	%
Current Limit		I_{LIM}	$R_{LOAD} = 1\Omega$	360	400	--	mA
Quiescent Current		I_Q	V_{EN} >= 1.2V, I_{OUT} = 0mA	--	90	130	μA
Dropout Voltage (Note 4)		V_{DROP}	I_{OUT} = 200mA	--	170	200	mV
			I_{OUT} = 300mA	--	220	330	
Line Regulation		ΔV_{LINE}	$V_{IN} = (V_{OUT} + 1V)$ to 5.5V, I_{OUT} = 1mA	--	--	0.3	%
Load Regulation		ΔV_{LOAD}	1mA < I_{OUT} < 300mA	--	--	0.6	%
Standby Current		I_{STBY}	V_{EN} = GND, Shutdown	--	0.01	1	μA
EN Input Bias Current		I_{IBSD}	V_{EN} = GND or VIN	--	0	100	nA
EN Threshold	Logic-Low Voltage	V_{IL}	V_{IN} = 3V to 5.5V, Shutdown	--	--	0.4	V
	Logic-High Voltage	V_{IH}	V_{IN} = 3V to 5.5V, Start-Up	1.2	--	--	
Power Supply Rejection Rate	f = 100Hz	PSRR	$C_{OUT} = 1\mu F$, I_{OUT} = 100mA	--	−70	--	dB
	f = 10kHz			--	−60	--	
Thermal Shutdown Temperature		T_{SD}		--	165	--	°C
Thermal Shutdown Temperature Hysteresis		ΔT_{SD}		--	30	--	°C

Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

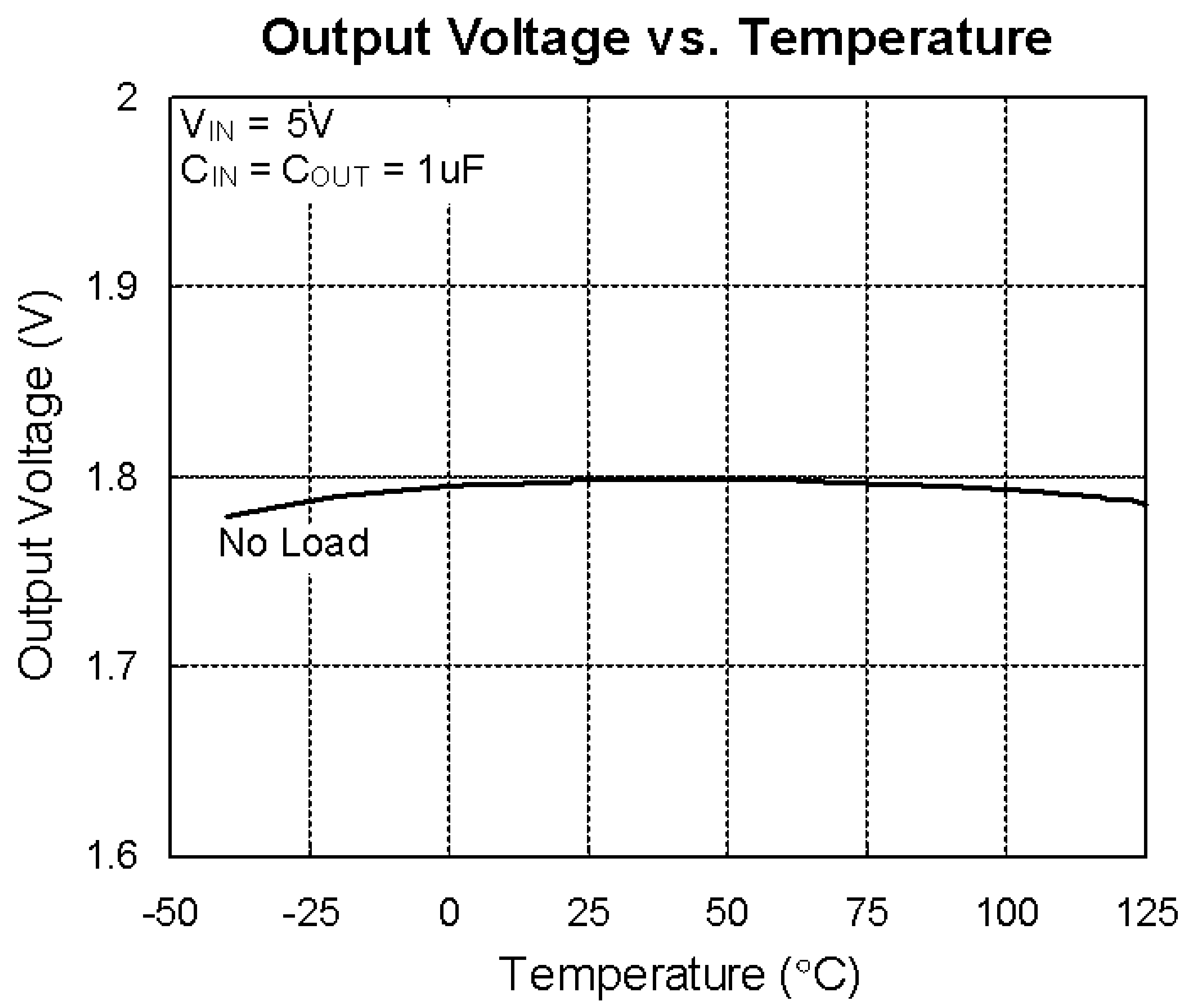
Note 2. Devices are ESD sensitive. Handling precaution recommended.

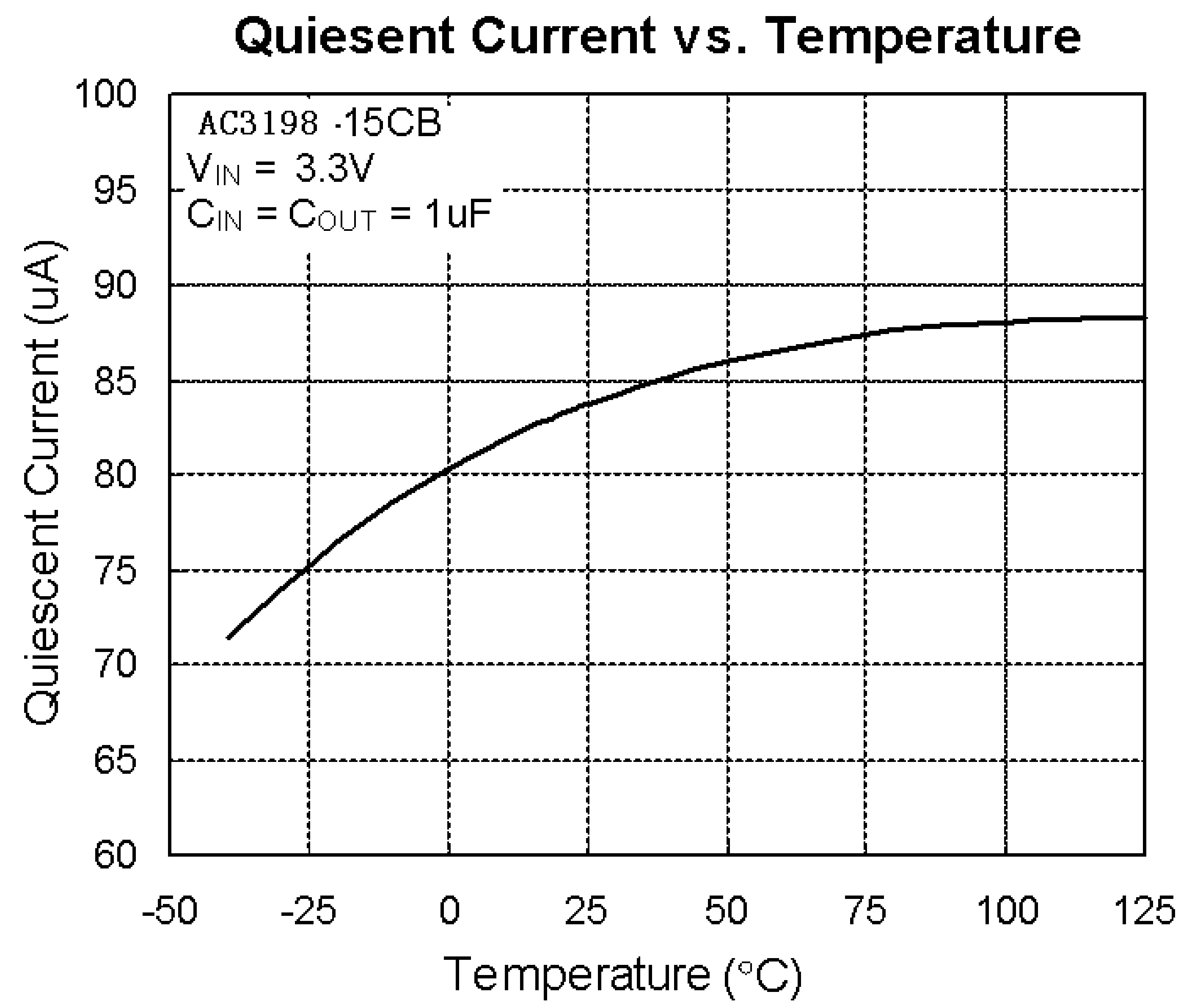
Note 3. The device is not guaranteed to function outside its operating conditions.

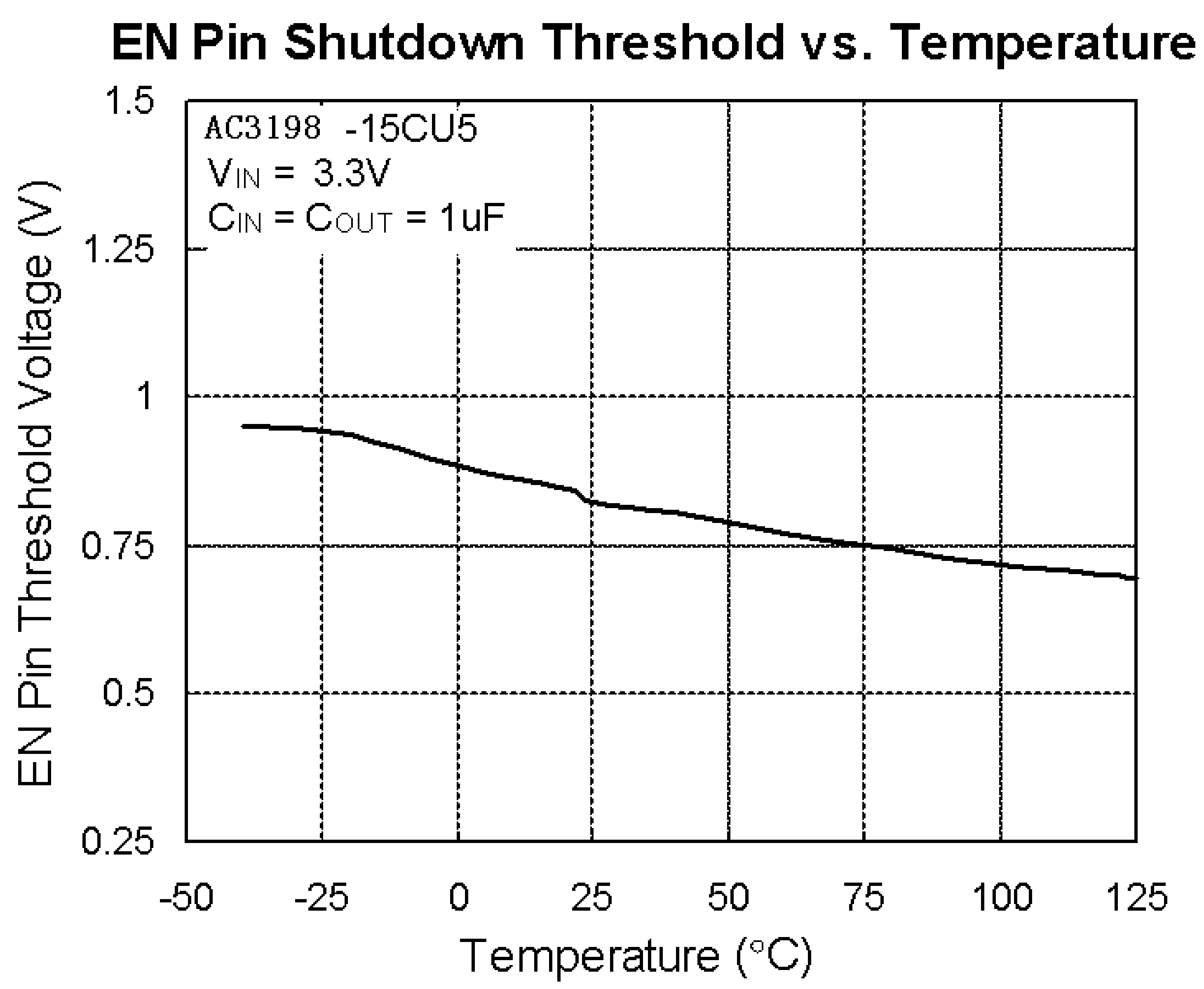
Note 4. The dropout voltage is defined as V_{IN} -V_{OUT}, which is measured when V_{OUT} is $V_{OUT(NORMAL)}$ – 100mV.

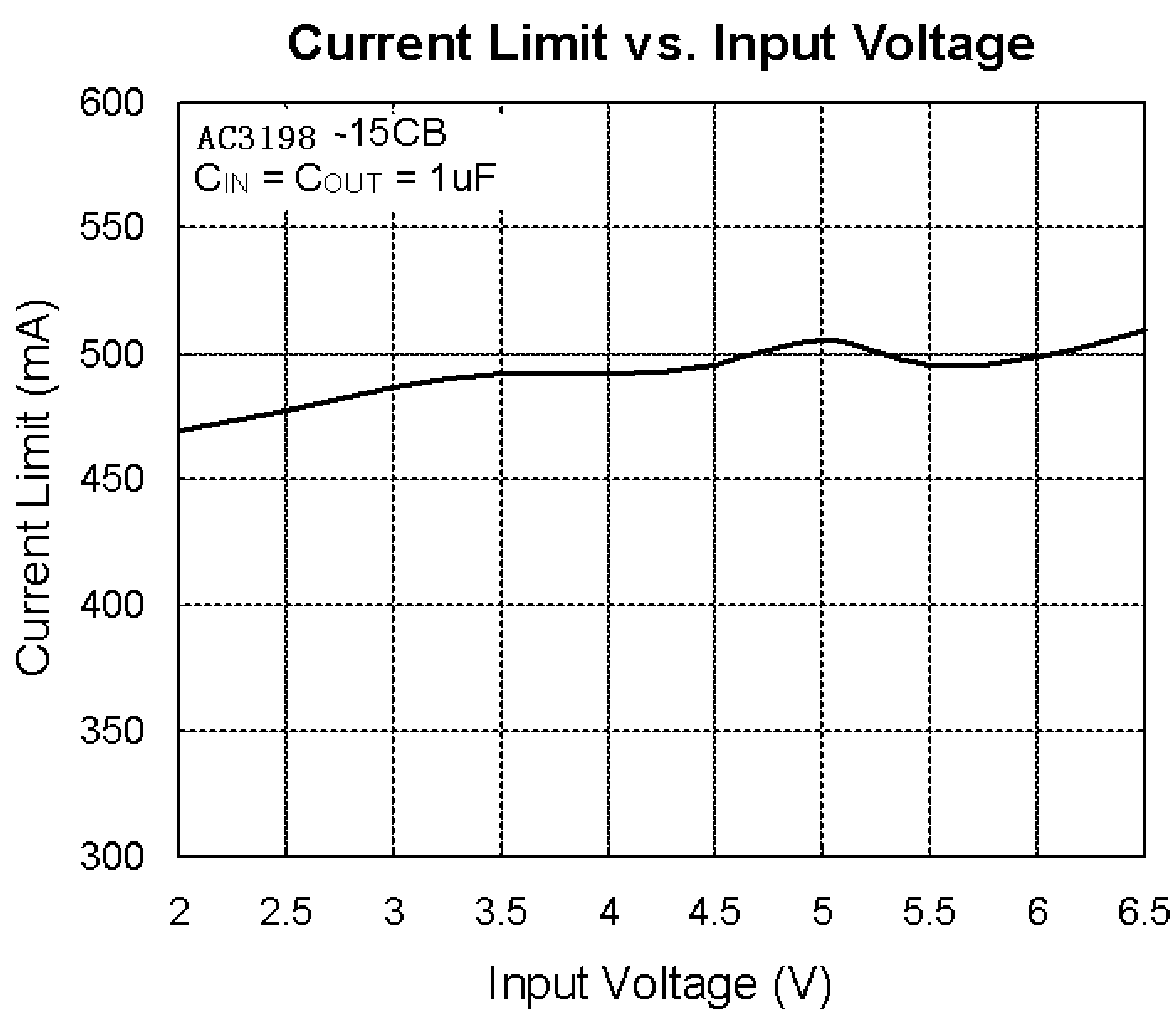
Note 5. θ_{JA} is measured in the natural convection at T_A = 25°C on a low effective thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

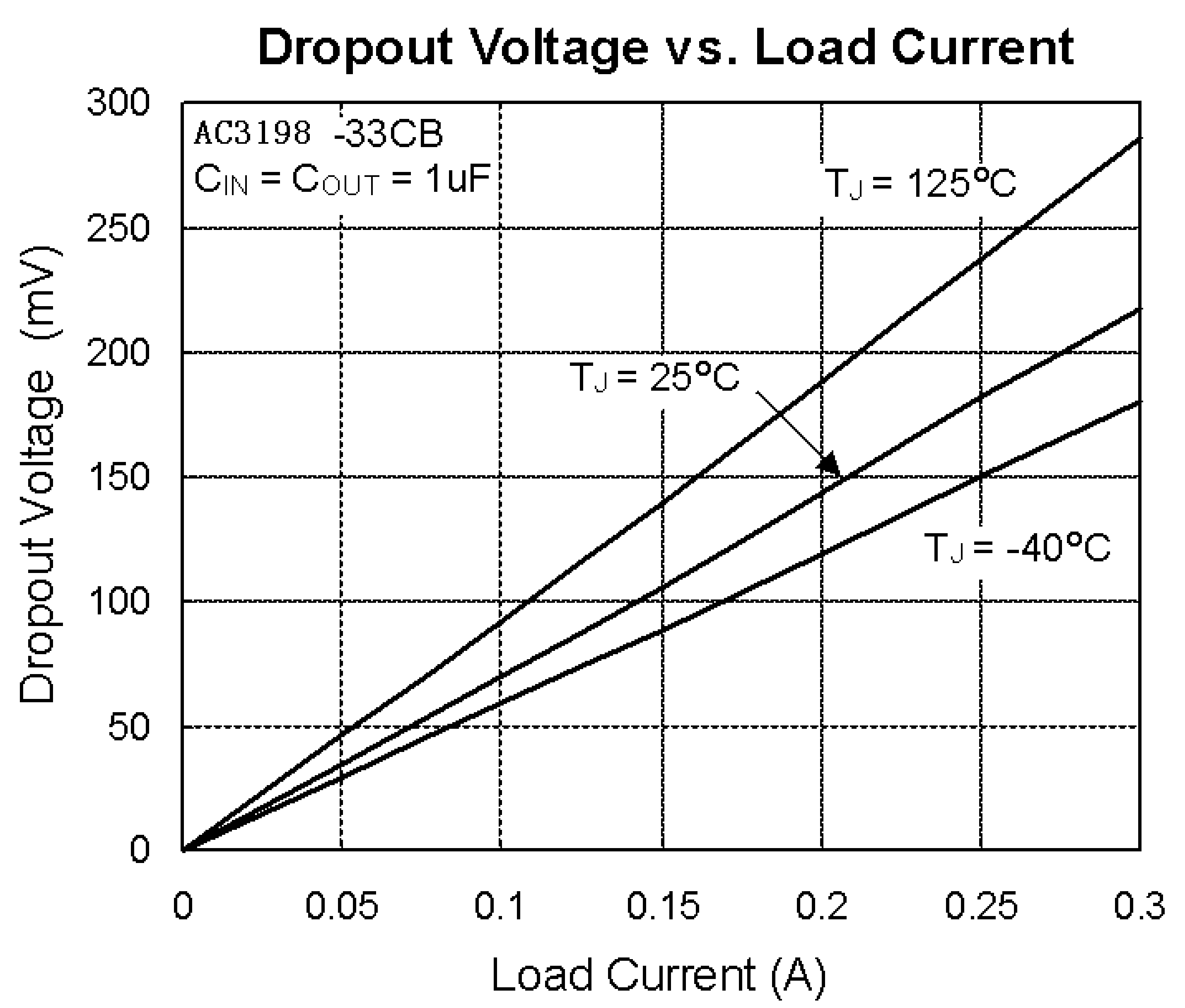
Typical Operating Characteristics



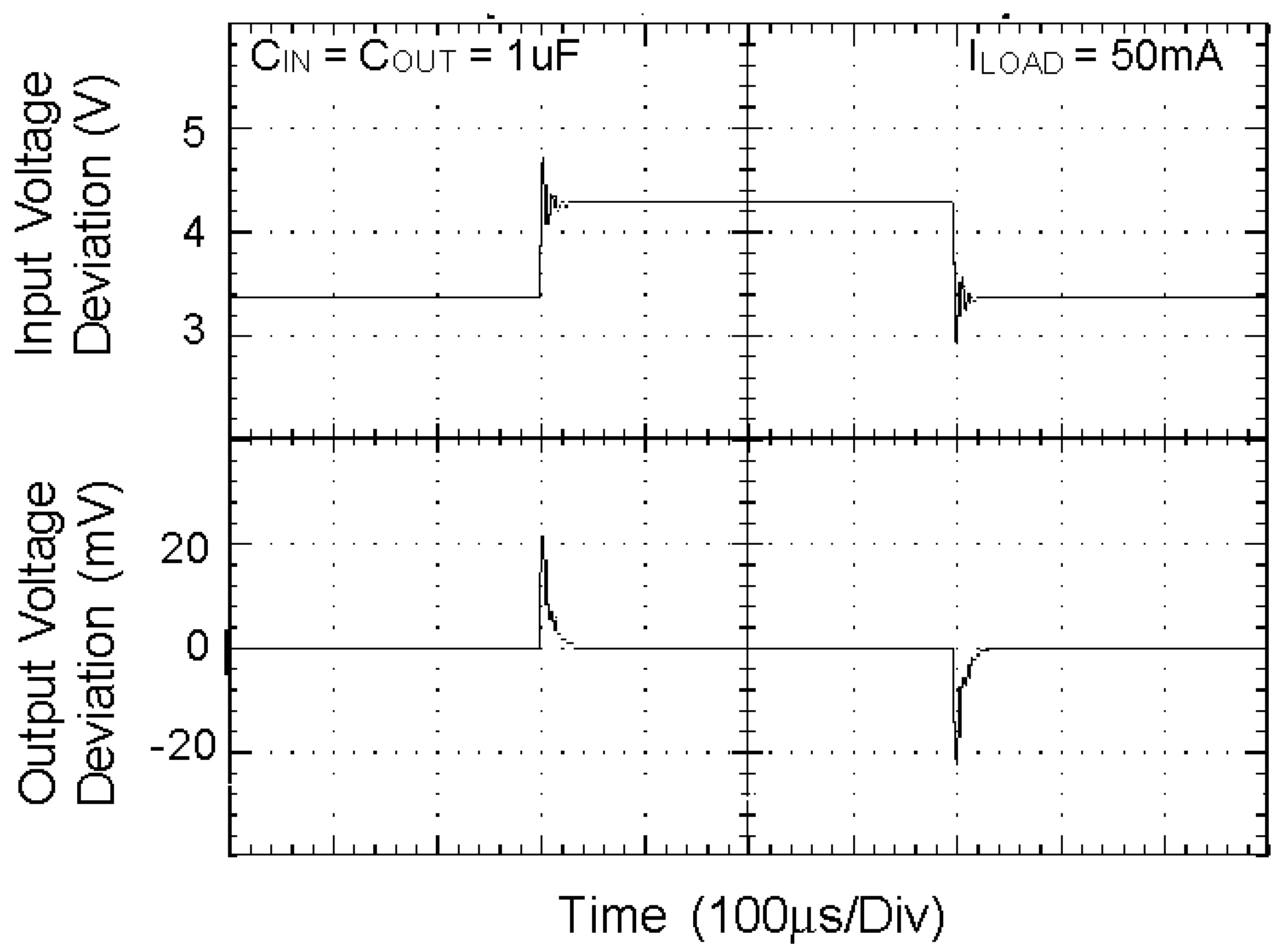




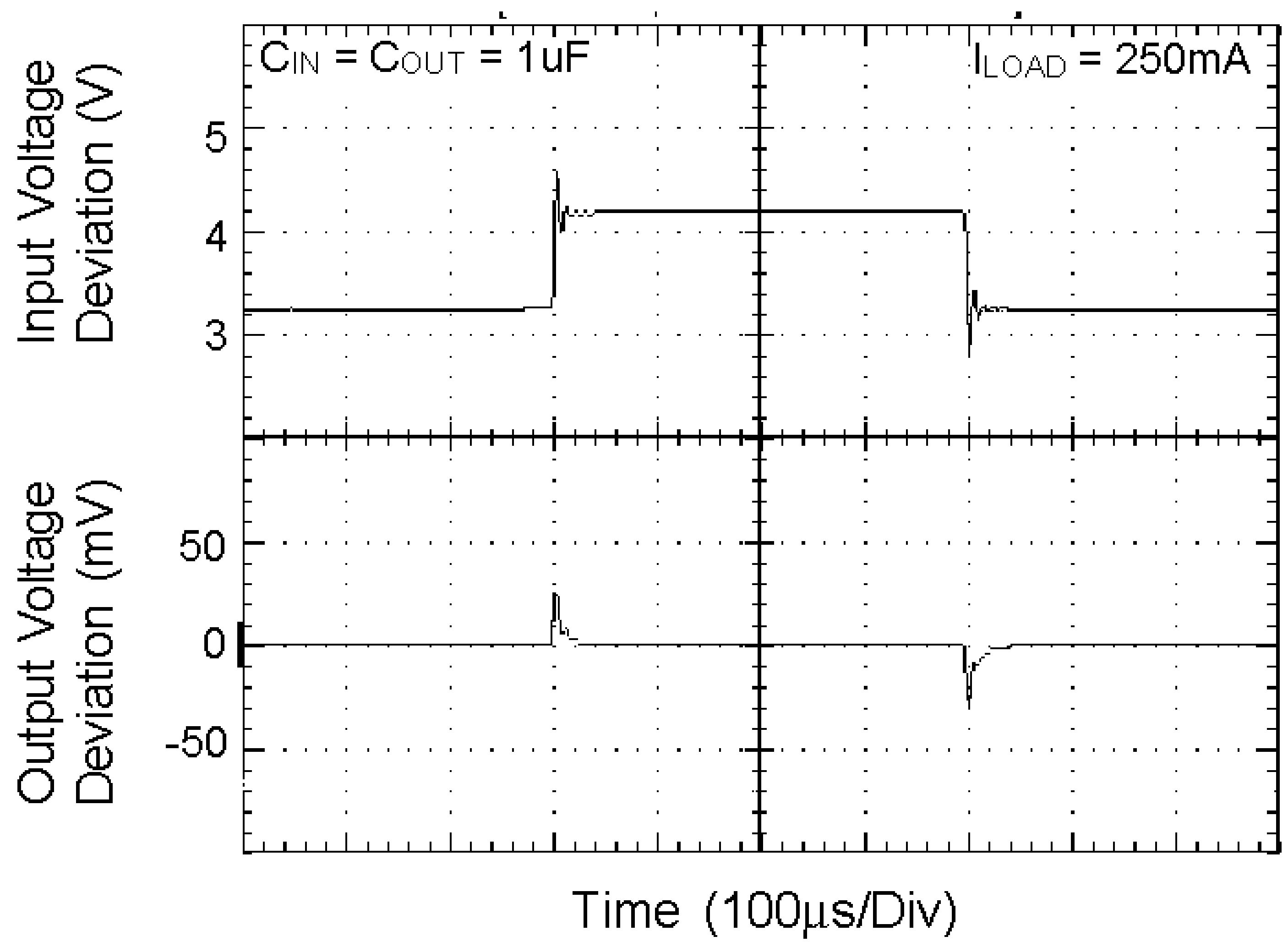




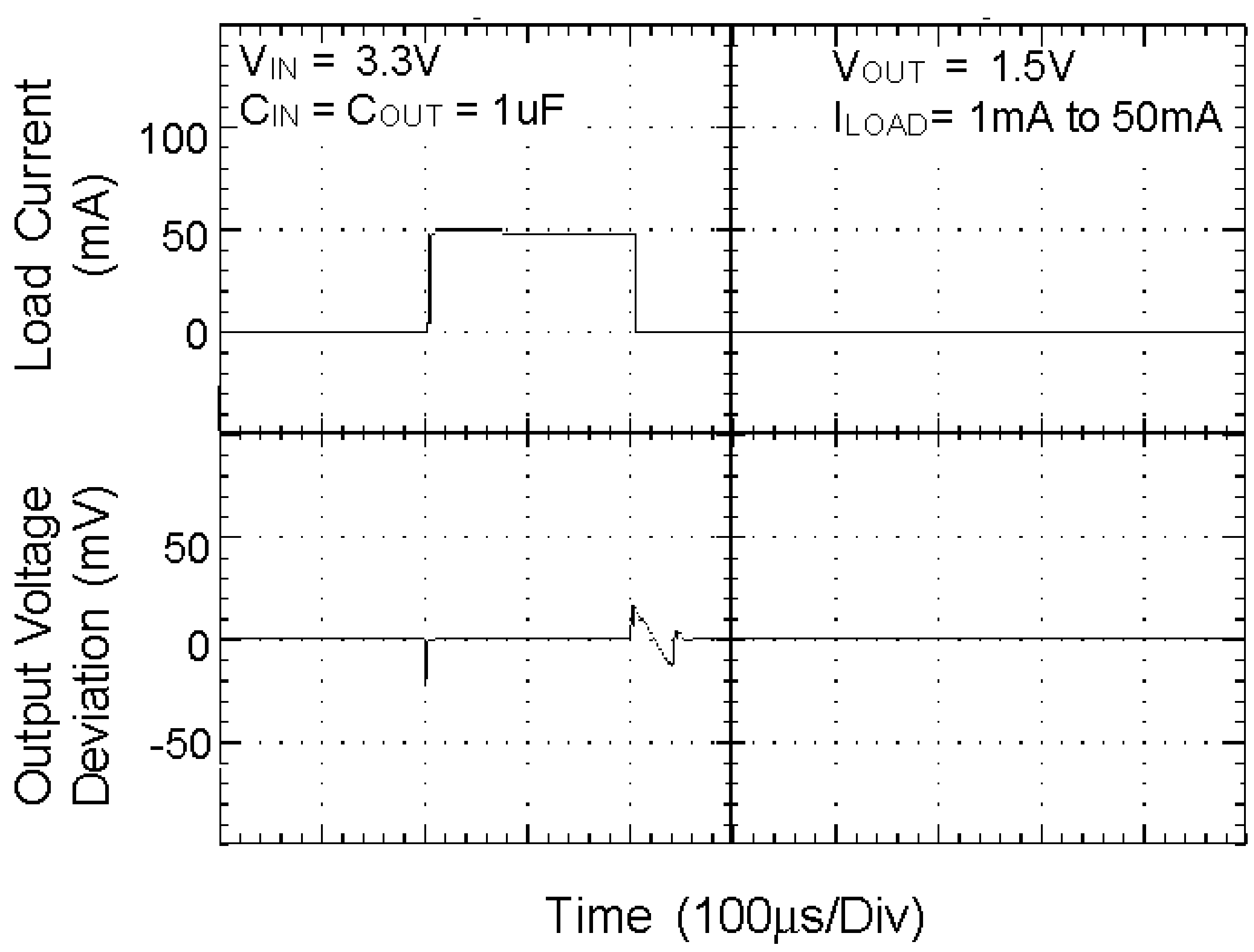
Line Transient Response



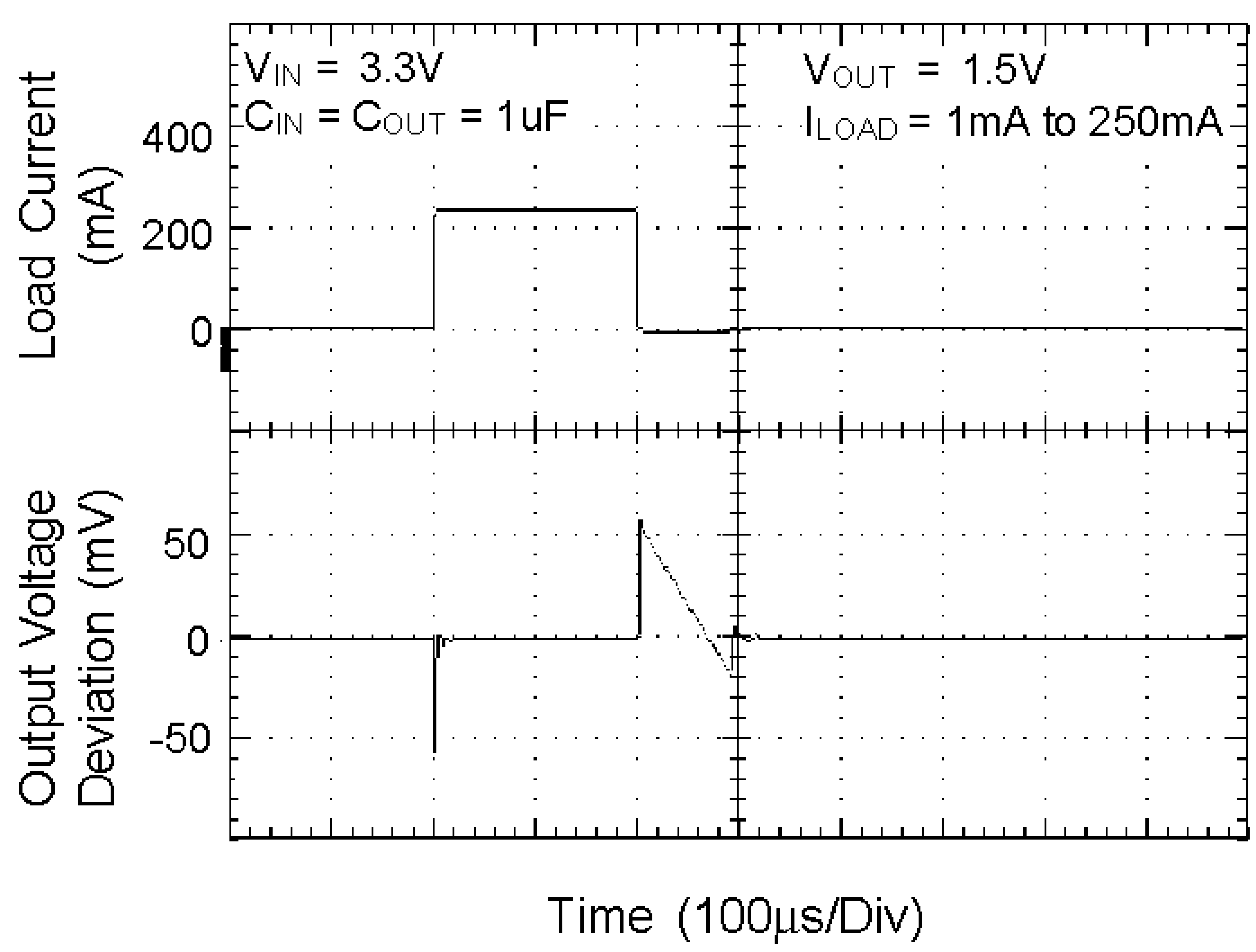
Line Transient Response



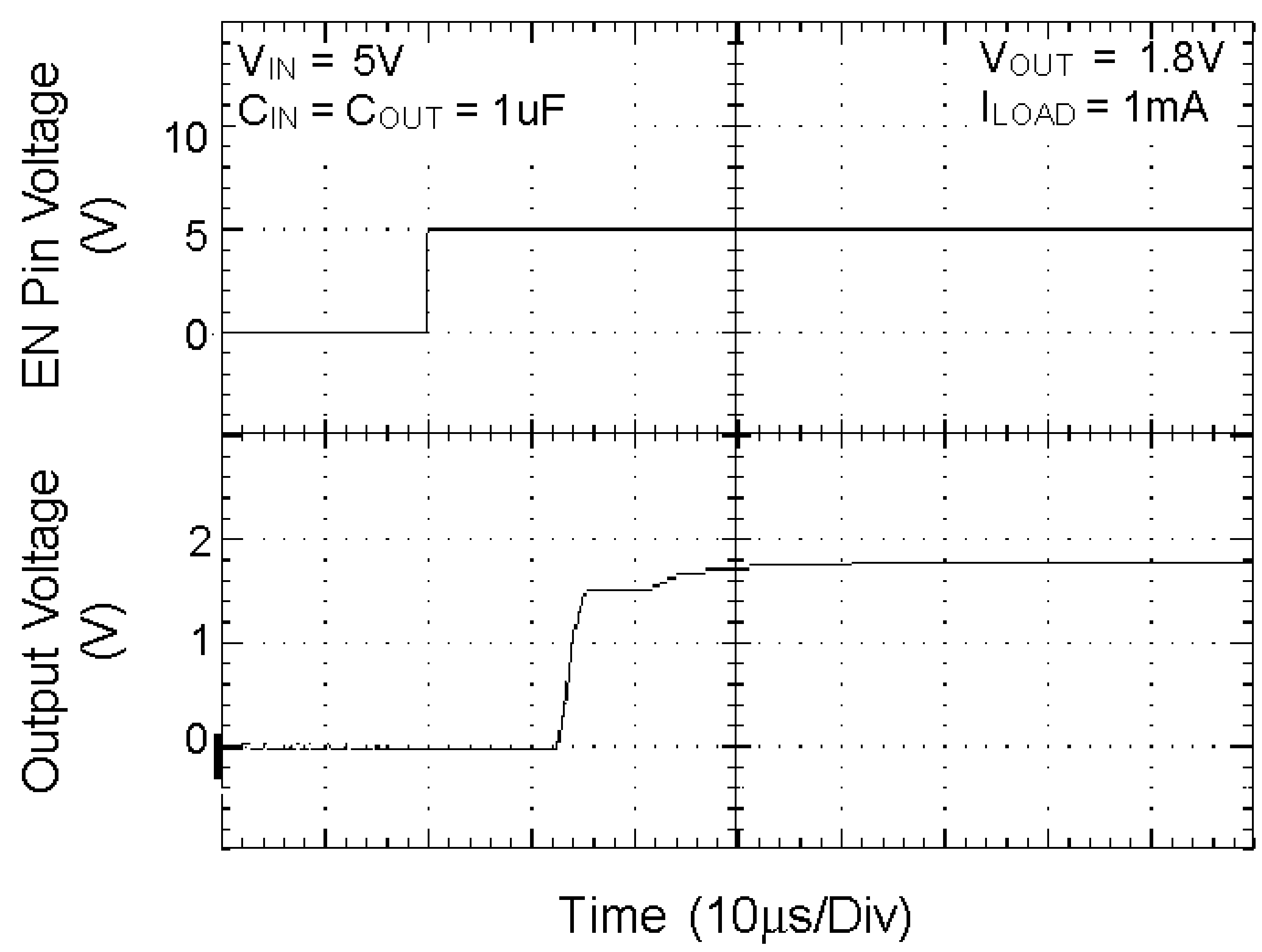
Load Transient Response



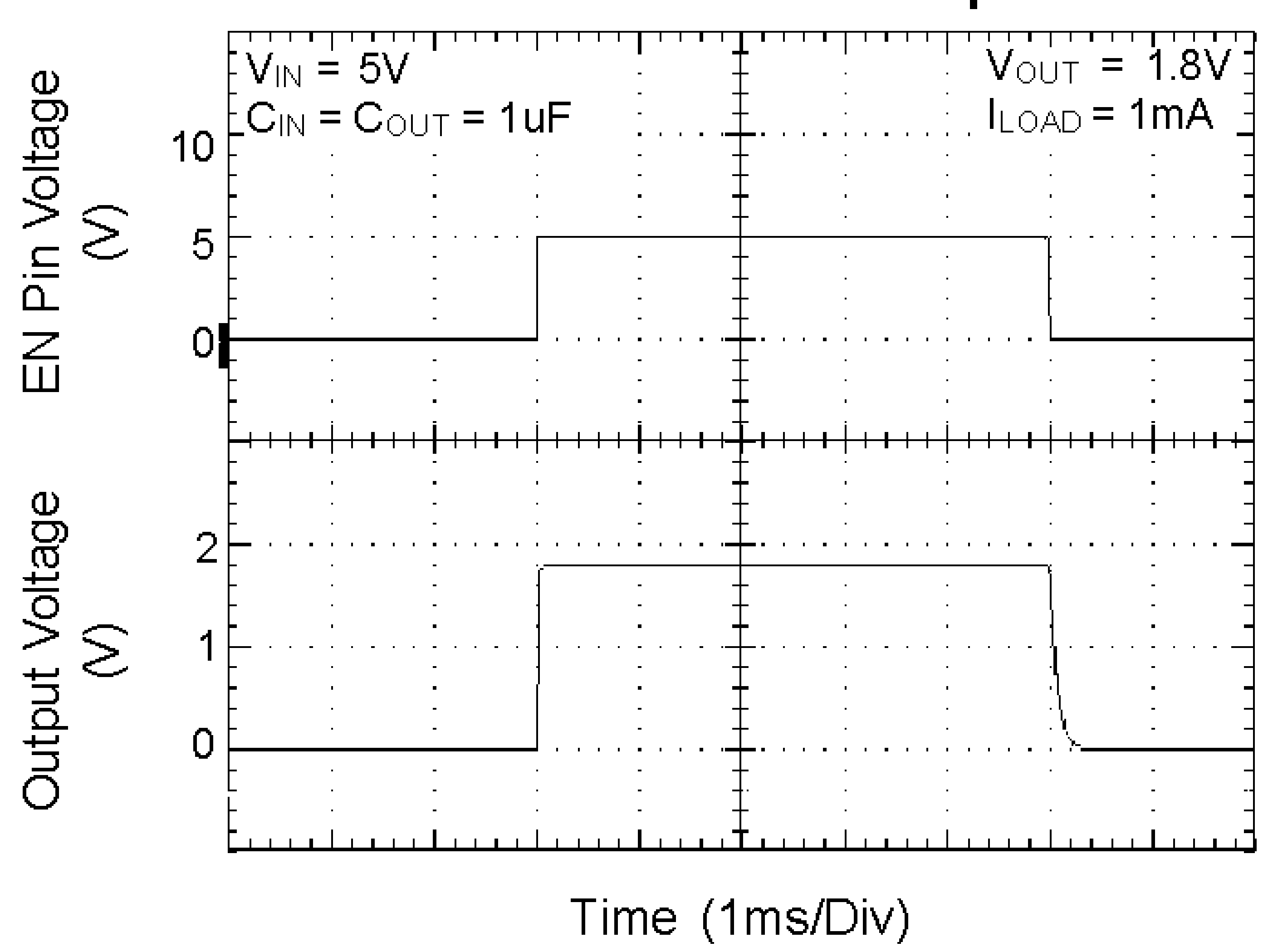
Load Transient Response



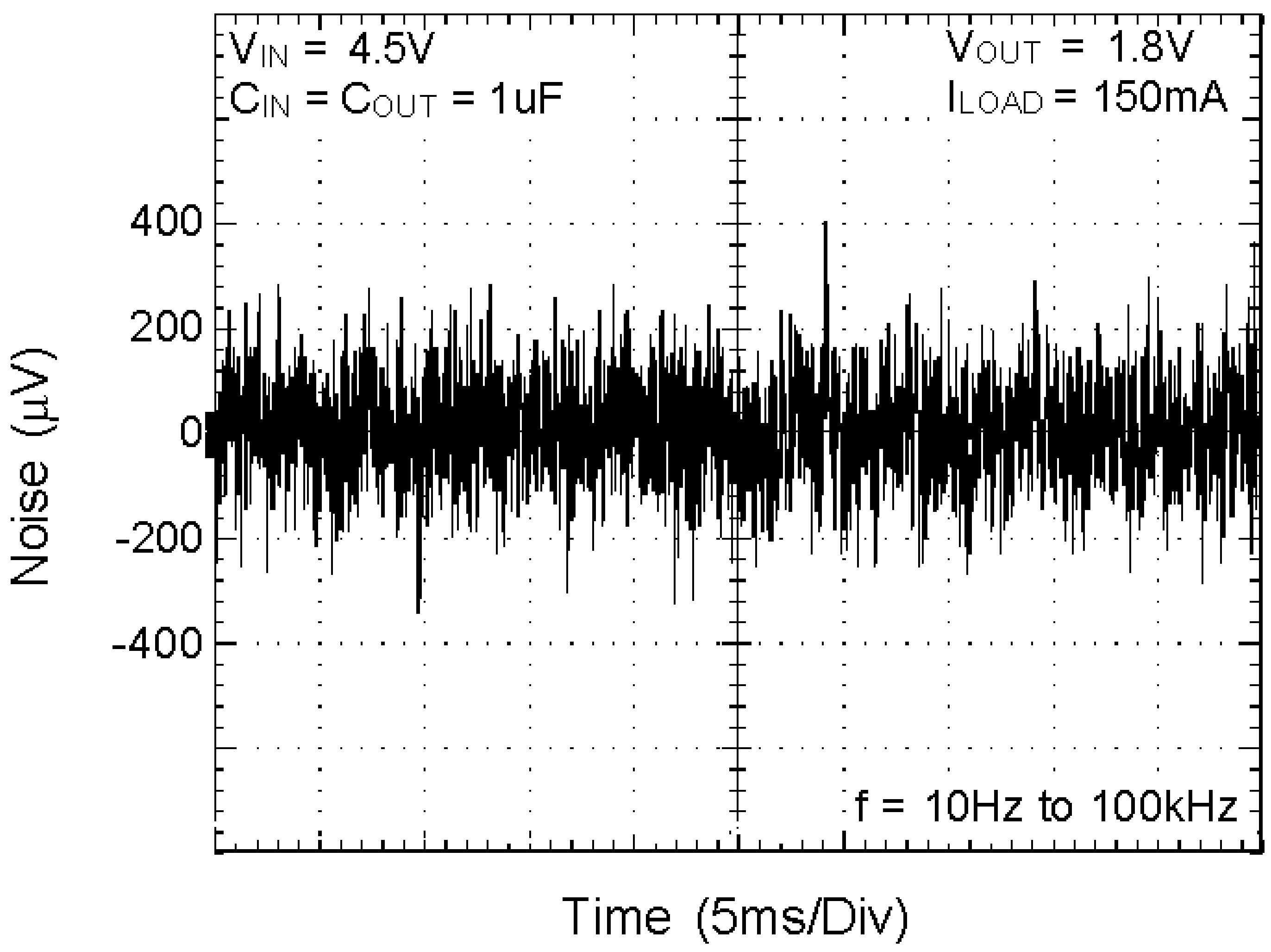
Start Up



EN Pin Shutdown Response

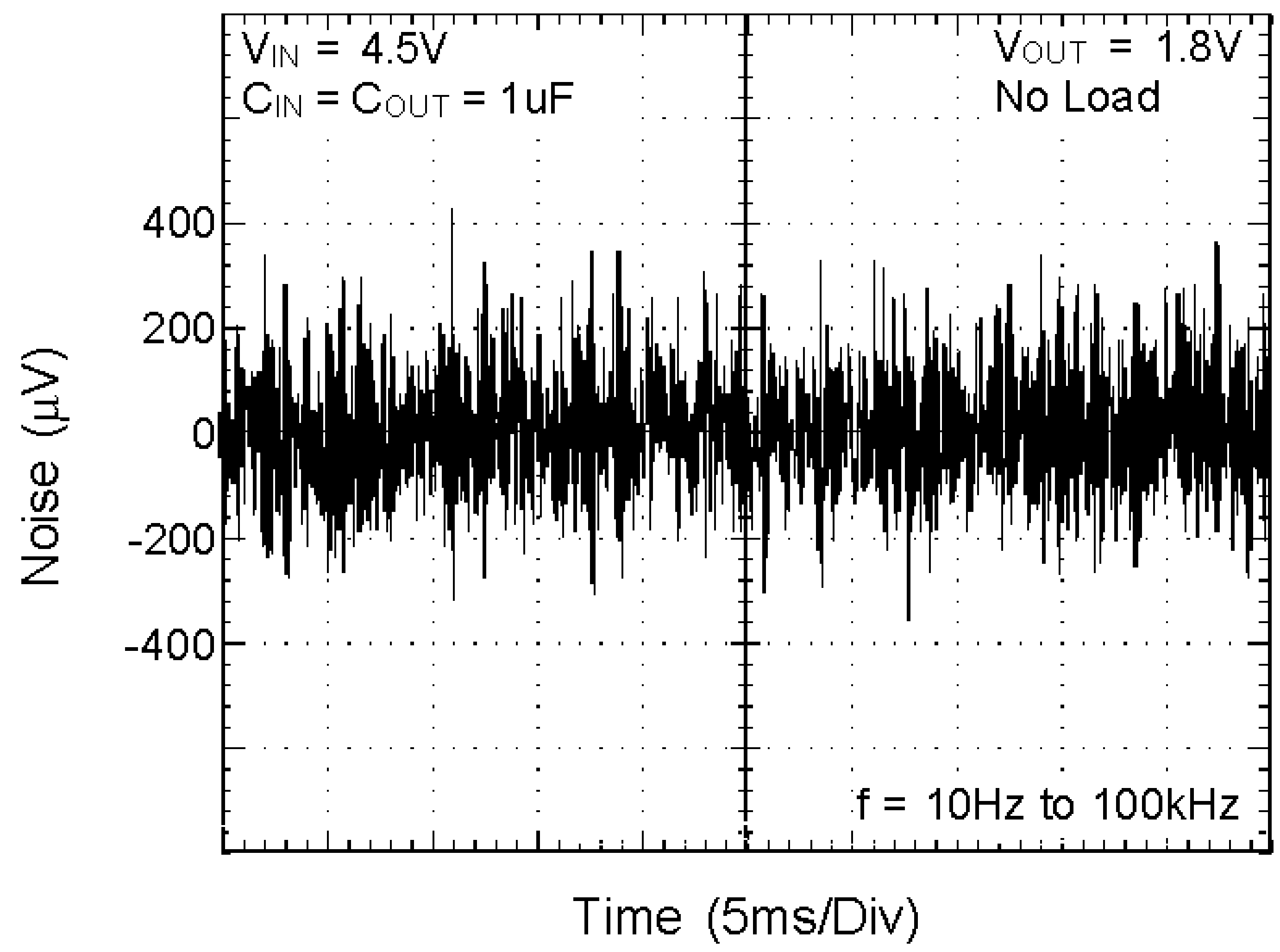


Noise



V_IN = 4.5V
C_IN = C_OUT = 1uF
V_OUT = 1.8V
I_LOAD = 150mA
400
200
0
-200
-400
Noise (µV)
f = 10Hz to 100kHz
Time (5ms/Div)

Noise



V_IN = 4.5V
C_IN = C_OUT = 1uF
V_OUT = 1.8V
No Load
400
200
0
-200
-400
Noise (µV)
f = 10Hz to 100kHz
Time (5ms/Div)

Applications Information

Like any low-dropout regulator, the external capacitors used with the AC3198 must be carefully selected for regulator stability and performance. Using a capacitor whose value is > 1µF on the AC3198 input and the amount of capacitance can be increased without limit. The input capacitor must be located a distance of not more than 0.5 inch from the input pin of the IC and returned to a clean analog ground. Any good quality ceramic or tantalum can be used for this capacitor. The capacitor with larger value and lower ESR (equivalent series resistance) provides better PSRR and line-transient response.

The output capacitor must meet both requirements for minimum amount of capacitance and ESR in all LDOs application. The AC3198 is designed specifically to work with low ESR ceramic output capacitor in space-saving and performance consideration. Using a ceramic capacitor whose value is at least 1µF with ESR is > 20mΩ on the AC3198 output ensures stability. The AC3198 still works well with output capacitor of other types due to the wide stable ESR range. Figure 1. shows the curves of allowable ESR range as a function of load current for various output capacitor values. Output capacitor of larger capacitance can reduce noise and improve load transient response, stability, and PSRR. The output capacitor should be located not more than 0.5 inch from the V_{OUT} pin of the AC3198 and returned to a clean analog ground.

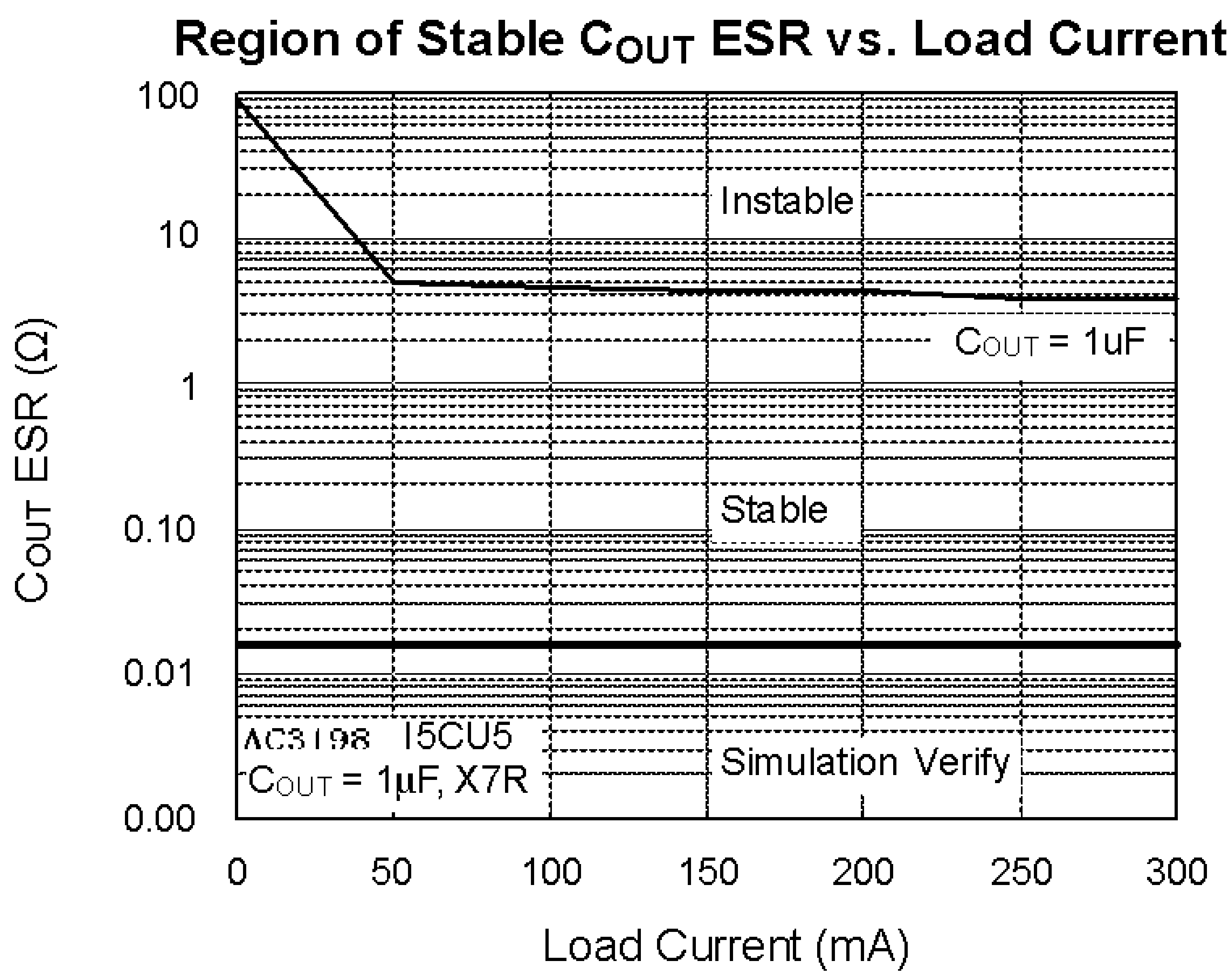


Figure 1

Enable Function

The AC3198 features an LDO regulator enable/disable function. To assure the LDO regulator will switch on, the EN turn on control level must be greater than 1.2 volts. The LDO regulator will go into the shutdown mode when the voltage on the EN pin falls below 0.4 volts. For to protecting the system, the AC3198 have a quick-discharge function. If the enable function is not needed in a specific application, it may be tied to V_{IN} to keep the LDO regulator in a continuously on state.

Thermal Considerations

Thermal protection limits power dissipation in AC3198 . When the operation junction temperature exceeds 165°C, the OTP circuit starts the thermal shutdown function and turns the pass element off. The pass element turn on again after the junction temperature cools by 30°C.

For continuous operation, do not exceed absolute maximum operation junction temperature 125°C. The power dissipation definition in device is :

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

The maximum power dissipation depends on the thermal resistance of IC package, PCB layout, the rate of surroundings airflow and temperature difference between junction to ambient. The maximum power dissipation can be calculated by following formula :

$$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$$

Where $T_{J(MAX)}$ is the maximum operation junction temperature 125°C, T_A is the ambient temperature and the θ_{JA} is the junction to ambient thermal resistance.

For recommended operating conditions specification of AC3198 , where $T_{J(MAX)}$ is the maximum junction temperature of the die (125°C) and T_A is the maximum ambient temperature. The junction to ambient thermal resistance (θ_{JA} is layout dependent) for SC-70 package is 333°C/W, 250°C/W is for SOT-23-3 and SOT-23-5 package on standard JEDEC 51-3 thermal test board. The maximum power dissipation at T_A = 25°C can be calculated by following formula:

$P_{D(MAX)}$ = (125°C–25°C)/250 = 400 mW (SOT-23-3/ SOT-23-5)

$P_{D(MAX)}$ = (125°C–25°C)/333 = 300 mW (SC-70-5)

The maximum power dissipation depends on operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance θ_{JA}. For AC3198 packages, the Figure 2. of derating curves allows the designer to see the effect of rising ambient temperature on the maximum power allowed.

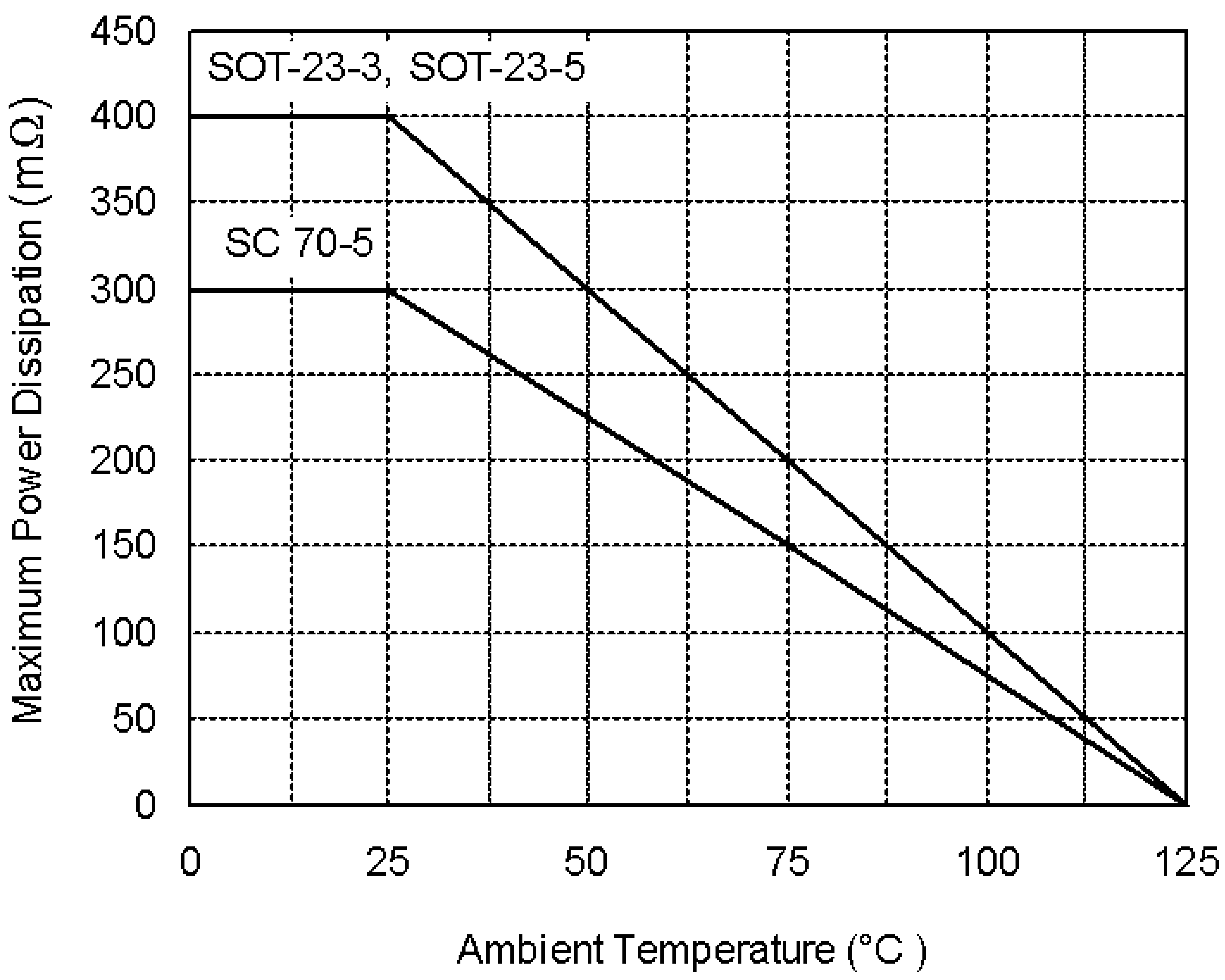
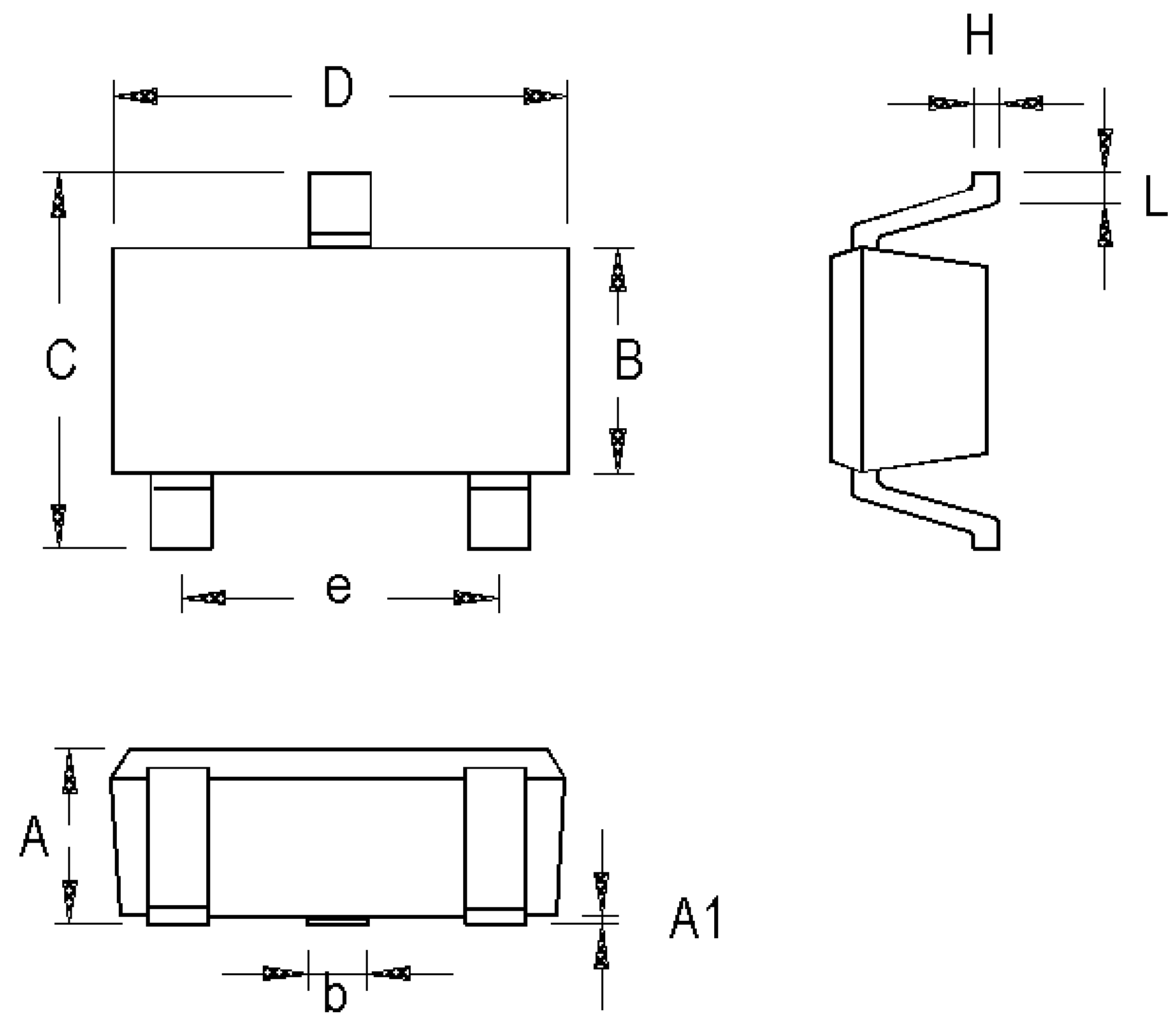


Figure 2. Derating Curve for Packages

Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.889	1.295	0.035	0.051
A1	0.000	0.152	0.000	0.006
B	1.397	1.803	0.055	0.071
b	0.356	0.508	0.014	0.020
C	2.591	2.997	0.102	0.118
D	2.692	3.099	0.106	0.122
e	1.803	2.007	0.071	0.079
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

SOT-23-3 Surface Mount Package