AS1360

Data Sheet

1.5µA Low-Power, Positive Voltage Regulator

1 General Description

The AS1360 low-power, positive voltage regulator was designed to deliver up to 250mA while consuming only 1.5µA of quiescent current. The device is available in fixed output voltages of 1.8, 2.1, 2.5, 3.0, 3.3, and 5.0V.

The device features integrated short-circuit and overcurrent protection.

The wide input voltage range, low-dropout voltage, and high-accuracy output voltage makes the device perfectly suited for 2- and 3-cell battery-powered and portable applications.

The low dropout voltage (650mV) prolongs battery life and allows high current in small applications when operated with minimum input-to-output voltage differentials.

The device features very stable output voltage (using only 1µF tantalum or aluminum-electrolytic capacitors), strict output voltage regulation tolerances (±0.5%), and excellent line-regulation.

The AS1360 is available in a 3-pin SOT23 package.

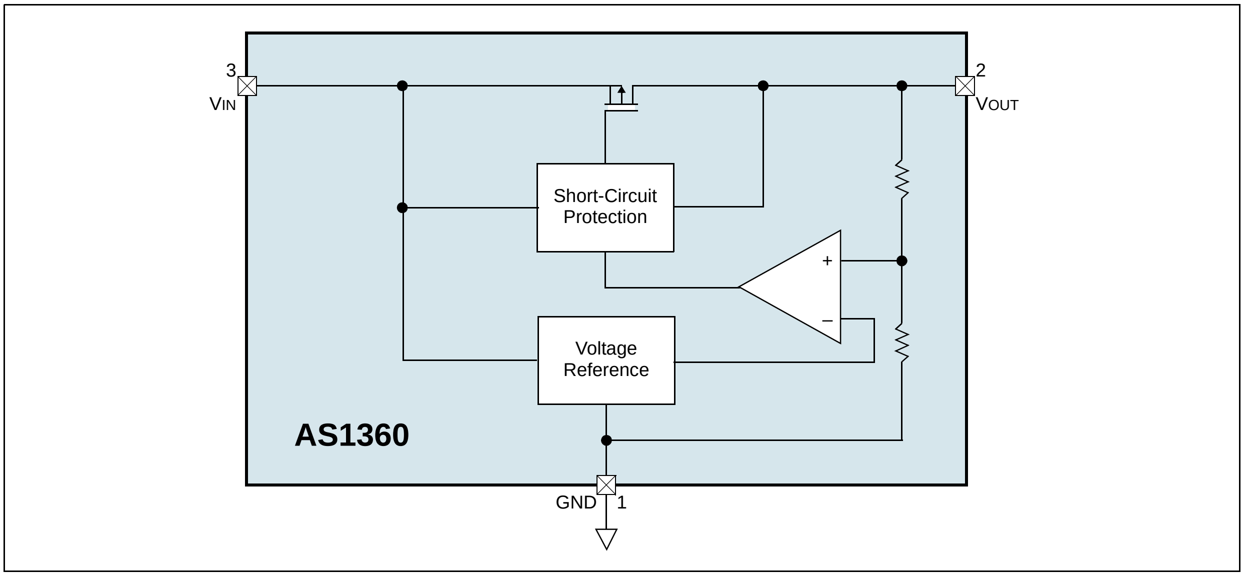
2 Key Features

- Low Quiescent Current: 1.5µA
- Input Voltage Range: Up to 20V
- Low Dropout Voltage
  - 250mV @ 100mA
  - 400mV @ 200mA
- Fixed Output Voltages: 1.8, 2.1, 2.5, 3.0, 3.3, 5.0V
- High Output Current: 250mA (V_{OUT} = 5.0V)
- High-Accuracy Output Voltage: ±1.5%
- Exceptional Line Regulation: 0.1%/V
- Low Temperature Drift: ±100ppm/ºC
- Integrated Short-Circuit and Overcurrent Protection
- 3-pin SOT23 Package

3 Applications

The device is ideal for mobile phones, PDAs, digital cameras, smart battery packs, battery-powered alarms, solar-powered instruments, intelligent instruments, CO2 and smoke detectors, CPU power supplies, and any battery-powered application.

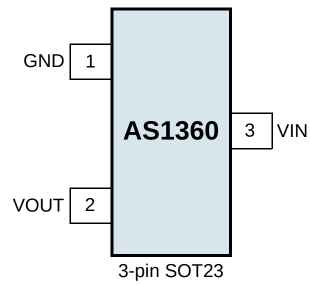
Figure 1. Block Diagram



4 Pinout and Packaging

Pin Assignments

Figure 2. Pin Assignments (Top View)



Pin Descriptions

Table 1. Pin Descriptions

Pin Number	Pin Name	Description
1	GND	**Ground**. This pin should be connected to the negative side of the output and the negative terminal of the input capacitor. No high-current flows out of this pin, only bias current (1.5µA, typ). **Note:** Voltage drops between this pin and the negative side of the load should be minimized.
2	VOUT	**Regulated Output Voltage**. This pin should be connected to the positive side of the load and the positive terminal of the output capacitor. Current flowing out of this pin is equivalent DC load current. **Note:** The positive side of the output capacitor should be mounted as close as is practical to this pin.
3	VIN	**Unregulated Input Voltage**. This pin should be connected to the positive terminal of the input capacitor. **Note:** The input capacitor should be mounted as close as is practical to this pin.

5 Absolute Maximum Ratings

Stresses beyond those listed in Table 2 may 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 in Section 6 Electrical Characteristics on page 4 is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 2. Absolute Maximum Ratings

Parameter	Min	Max	Units	Comments
Input Voltage		+30	V	
Continuous Output Current		PD/ (V_{IN} - V_{OUT})	mA	
Peak Output Current		500	mA	
Output Voltage	- 0.3V	V_{IN} + 0.3V or +7V	V	Minimum of the two values
Thermal Resistance Θ_{JA}		230	ºC/W	Typical FR4, 4-layer application
Operating Temperature Range	-40	+85	ºC	
Storage Temperature Range	-40	+125	ºC	
Electrostatic Discharge (ESD) Protection Level	1		kV	*HBM - Norm: MIL 883 E methode 3015*
Package Body Temperature		+260	ºC	The reflow peak soldering temperature (body temperature) specified is in compliance with *IPC/JEDEC J-STD-020C "Moisture/ Reflow Sensitivity Classification for Non-Hermetic Solid State Surface Mount Devices"*.

6 Electrical Characteristics

T_{AMB} = +25ºC (unless otherwise specified).

Table 3. Electrical Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_{IN}	Input Voltage				20	V
V_{OUT}	Output Voltage	I_{OUT} = 40mA[1], I_{OUT} = 15mA if V_{OUT} = 1.8V	V_{OUTNOM} - 1.5%	V_{OUTNOM} ± 0.5%	V_{OUTNOM} + 1.5%	V
$I_{OUT(MAX)}$	Maximum Output Current	V_{OUT} = 5.0V (V_{IN} = V_{OUTNOM} + 1.0V)	250			mA
		V_{OUT} = 3.3V	150			
		V_{OUT} = 3.0V	150			
		V_{OUT} = 2.5V	125			
		V_{OUT} = 2.1V	115			
		V_{OUT} = 1.8V	110			
$\Delta V_{OUT}/V_{OUT}$	Load Regulation [2]	V_{OUT} = 5.0V, 1mA ≤ I_{OUT} ≤ 100mA	-1.60	±0.8	+1.60	%
		V_{OUT} = 3.3V, 1mA ≤ I_{OUT} ≤ 80mA	-2.72	±1.3	+2.72	
		V_{OUT} = 3.0V, 1mA ≤ I_{OUT} ≤ 80mA	-3.00	±1.5	+3.00	
		V_{OUT} = 2.5V, 1mA ≤ I_{OUT} ≤ 60mA	-3.60	±1.8	+3.60	
		V_{OUT} = 2.1V, 1mA ≤ I_{OUT} ≤ 40mA	-2.60	±1.6	+2.60	
		V_{OUT} = 1.8V, 1mA ≤ I_{OUT} ≤ 30mA	-1.60	±0.8	+1.60	
ΔV_{OUT} x 100/ ΔV_{IN} x V_{OUT}	Line Regulation	I_{OUT} = 40mA, (V_{OUTNOM} +1.0) ≤ V_{IN} ≤ 10.0V		0.1	0.25	%/V
V_{IN} - V_{OUT}	Dropout Voltage	I_{OUT} = 200mA, V_{OUTNOM} = 5.0V		400	630	mV
		I_{OUT} = 160mA, V_{OUTNOM} = 3.3V		400	700	
		I_{OUT} = 160mA, V_{OUTNOM} = 3.0V		400	700	
		I_{OUT} = 120mA, V_{OUTNOM} = 2.5V		400	700	
		I_{OUT} = 60mA, V_{OUTNOM} = 2.1V		200	500	
		I_{OUT} = 20mA, V_{OUTNOM} = 1.8V		180	300	
I_Q	Input Quiescent Current	V_{IN} = V_{OUTNOM} +1.0V		1.5	3.0	µA
TCV_{OUT}	Temperature Coefficient of V_{OUT} [3]	I_{OUT} = 40mA, -40ºC ≤ T_{AMB} ≤ +85ºC		±100		ppm/ºC
t_R	Output Rise Time	10% V_{OUTNOM} to 90% V_{OUTNOM}, V_{IN} = 0V to V_{OUTNOM} + 1V, R_{LOAD} = 25Ω resistive		150		µs

1. V_{OUTNOM} is the nominal device output voltage.
2. Measured at a constant junction temperature using low duty cycle pulse testing.
3. TCV_{OUT} = (V_{OH} - V_{OL}) x 10^6/(V_{OUTNOM} x Temperature).
   Where:
   V_{OH} is the highest voltage measured over the device temperature range.
   V_{OL} is the lowest voltage over the device temperature range.

7 Typical Operating Characteristics

V_{OUT} = 3.3V, I_{LOAD} = 100µA, V_{IN} = 4.3V, C_{IN} 1µF (tantalum), C_{OUT} = 1µF (tantalum), T_{AMB} = +25ºC (unless otherwise specified).

Figure 3. Supply Current vs. Input Voltage;

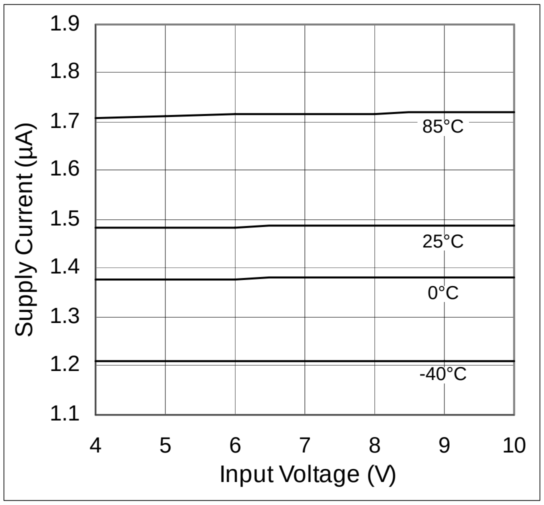


Figure 4. Supply Current vs. Load Current;

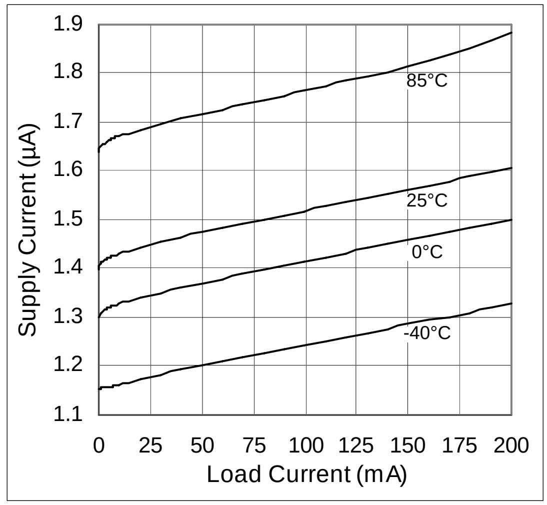


Figure 5. Supply Current vs. Temperature;

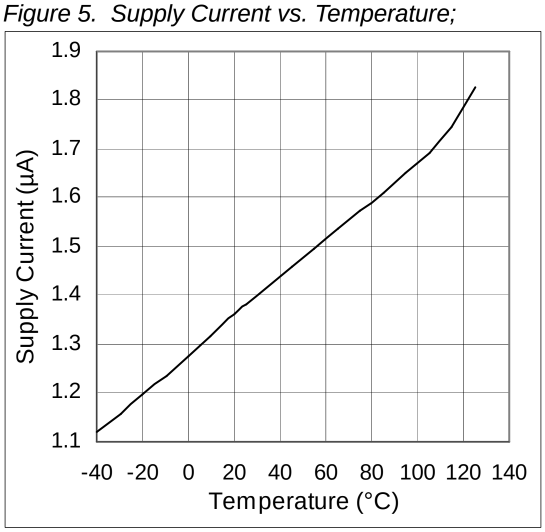


Figure 6. Output Voltage vs. Input Voltage;

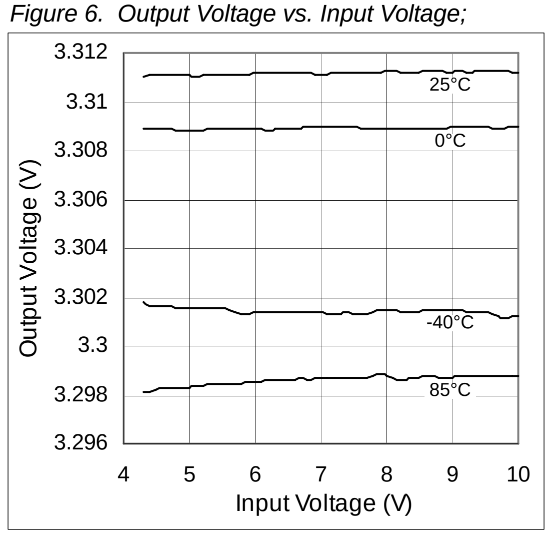


Figure 7. Output Voltage vs. Load Current,

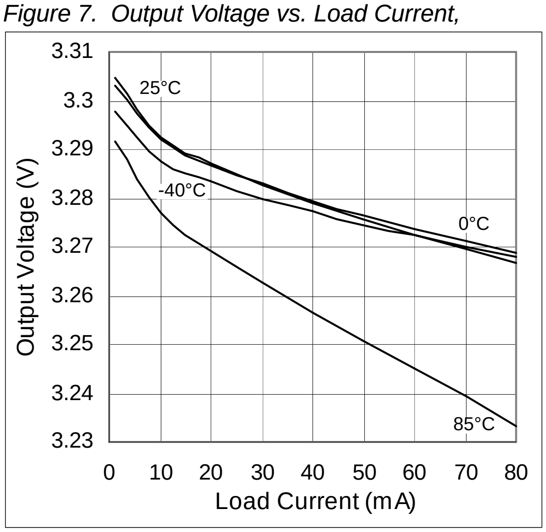


Figure 8. Dropout Voltage vs. Load Current;

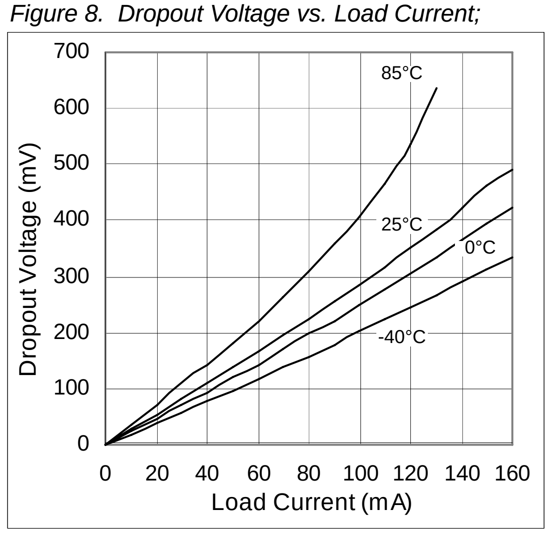


Figure 9. Load Regulation vs. Temperature,

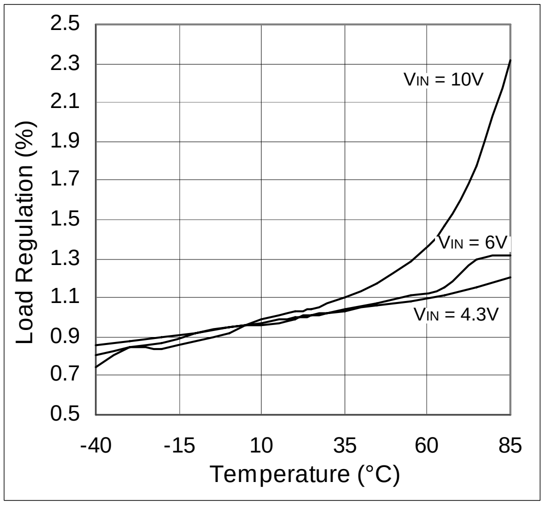


Figure 10. Line Regulation vs. Temperature;

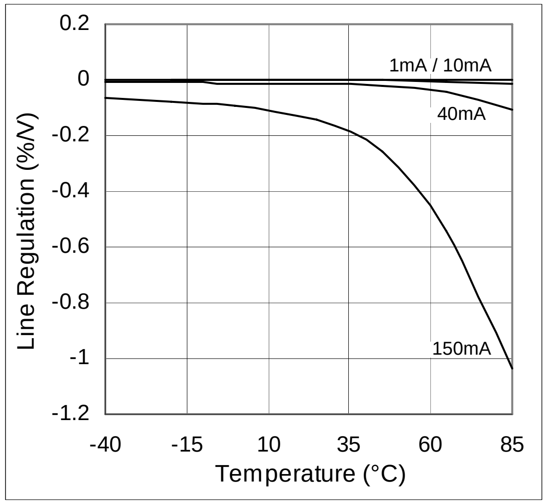


Figure 11. Startup Rise Time;

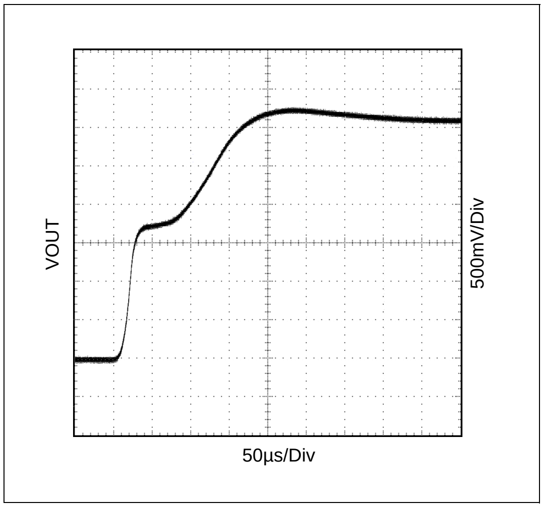
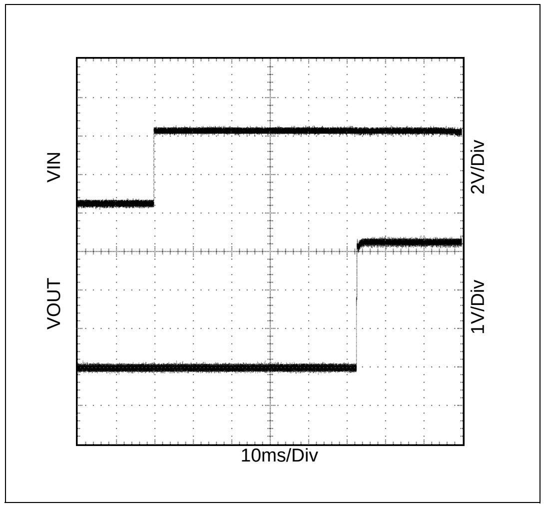


Figure 12. Startup Delay;



Note: All graphs where measured without additional heat sinks, with the SOT23 package mounted on a 4-layer PCB. Adding additional heat sinks will improve performance in high temperature enviroment.

8 Detailed Description

The AS1360 is a low-power, positive voltage regulator designed in such a way that the supply current is independent from the load current. The device regulates the output by comparing the output voltage to an internally generated reference voltage.

The device is available in fixed output voltages of 1.8, 2.5, 3.0, 3.3, and 5.0V. Fixed output voltages are generated using the internal resistor divider network (see Figure 1 on page 1).

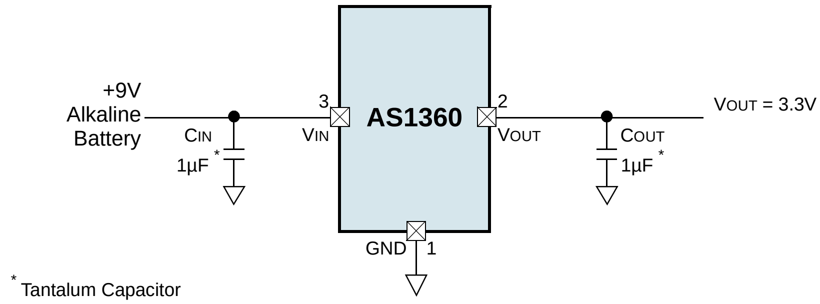
Short Circuit/Overcurrent Protection

The AS1360 monitors current flow through the p-channel MOSFET. In short-circuit or overcurrent conditions, the integrated short-circuit protection circuitry will limit output current.

Note: Thermal Dissipation according to Absolute Maximum Ratings on page 3 must be considered.

9 Application Information

Figure 13. Typical Application Diagram



Power Dissipation

Power dissipation (PD) of the AS1360 is the sum of the power dissipated by the p-channel MOSFET and the quiescent current required to bias the internal voltage reference and the internal power amplifier, and is calculated as:

$$PD\ (P\text{-}Channel\ MOSFET) = (V_{IN} - V_{OUT})I_{OUT} \quad \text{(EQ 1)}$$

Internal power dissipation as a result of the bias current for the internal voltage reference and the error amplifier is calculated as:

$$PD\ (Bias) = V_{IN}I_{GND} \quad \text{(EQ 2)}$$

Total AS1360 power dissipation is calculated as:

$$PD(Total) = PD\ (P\text{-}Channel\ MOSFET) + PD\ (Bias) \quad \text{(EQ 3)}$$

The internal quiescent bias current (2µA, typ) is such that the PD(Bias) term of (EQ 3) can be disregarded and the maximum power dissipation can be estimated using $V_{IN(MAX)}$ and $V_{OUT(MIN)}$ to obtain a maximum voltage differential between V_{IN} and V_{OUT}, and multiplying the maximum voltage differential by the maximum output current:

$$PD = (V_{IN(MAX)}V_{OUT(MIN)})I_{OUT(MAX)} \quad \text{(EQ 4)}$$

Where:

V_{IN} = 3.3 to 4.1V
V_{OUT} = 3.0V ±2%
I_{OUT} = 1 to 100mA
$T_{AMB(MAX)}$ = 55ºC
P_{MAX} = (4.1V - (3.0V x 0.98)) x 100mA = 116.0mW

Junction Temperature

The AS1360 junction temperature (T_J) can be determined by first calculating the thermal resistance from junction temperature-to-ambient temperature.

Note: Thermal resistance is estimated to be the junction temperature-to-air temperature $R_{\Phi JA}$, and is approximately 230°C/W or 335ºC/W (when mounted on 1 square inch of copper). $R_{\Phi JA}$ will vary depending on PCB layout, air-flow and application specific conditions.

The AS1360 junction temperature is determined by calculating the rise in T_J above T_{AMB}, and then adding the increase of T_{AMB}:

$$T_J = P_{D(MAX)} \times R_{\Phi JA} + T_{AMB} \quad \text{(EQ 5)}$$

From (EQ 5), the value of T_J can be calculated as:

$$T_J = 116.0mW \times 230ºC/W + 55ºC$$

Therefore:

$$T_J = 81.68ºC$$

External Component Selection

Input Capacitor

In applications where input impedance is approximately 10Ω, a 1µF capacitor is sufficient for C_{IN} (see Figure 13 on page 8).

In cases where the AS1360 is operated from a battery, or when there is significant distance between the input source to the AS1360, larger values for C_{IN} may be required for output stability.

Note: For values of C_{OUT} > 1µF, the value of C_{IN} should be increased to prevent high source-impedance oscillations.

Output Capacitor

In most applications for the AS1360, a 1µF capacitor (ESR > 0.1Ω/< 5Ω, f_{RES} > 1MHz) is sufficient for C_{OUT} (see Figure 13 on page 8).

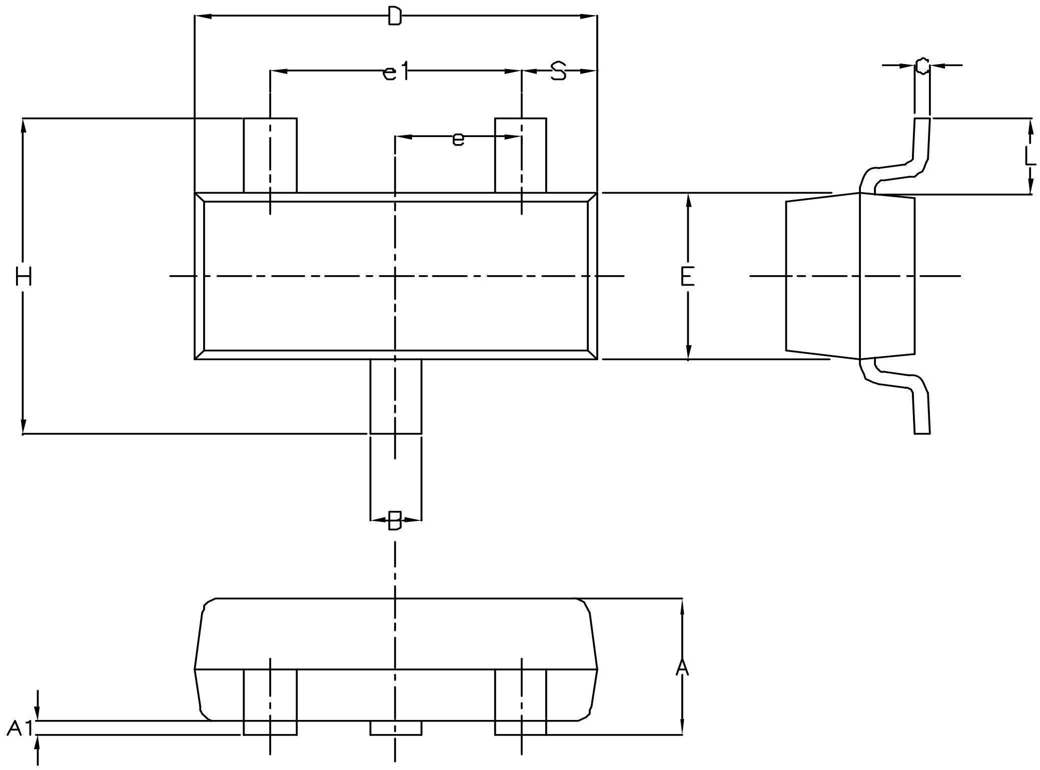
For improved power supply noise rejection and device transient response, larger values can be used for C_{OUT}.

Note: For values of C_{OUT} > 1µF, the input impedance must not be so large that it causes high-input impedance oscillations.

10 Package Drawings and Markings

The device is available in an 3-pin SOT23 package.

Figure 14. 3-pin SOT23 Package



Notes:

1. Lead coplanarity should be 0 to 0.10mm (.004”) max.
2. Package surfacing:
   a. Top: matte (charmilles #18- 30).
   b. All sides: matte (charmilles #18- 30).
   c. Bottom: smooth or matte (charmilles #18- 30).
3. All dimensions excluding mold flashes and end flash from the package body shall not exceed 0.25mm (.010”) per side (D).
4. Details of pin #1 identifier are optional but must be located within the zone indicated.
5. Dimensions are in millimeters.

Symbol	Min	Max
A	0.89	1.12
A1	0.013	0.100
B	0.37	0.51
C	0.085	0.18
D	2.80	3.04
E	1.20	1.40
e	0.89	1.03
e1	1.78	2.05
H	2.10	2.64
L	0.55ref	
A	0.89	1.12
S	0.45	0.60

11 Ordering Information

The device is available as the standard products shown in Table 4.

Table 4. Ordering Information

Model	Marking	Description	Delivery Form	Package
AS1360-18-T	ASKD	HV low-quiescent current LDO, 1.8V	Tape and Reel	3-pin SOT23
AS1360-21-T	ASRO	HV low-quiescent current LDO, 2.1V	Tape and Reel	3-pin SOT23
AS1360-25-T	ASKE	HV low-quiescent current LDO, 2.5V	Tape and Reel	3-pin SOT23
AS1360-30-T	ASKF	HV low-quiescent current LDO, 3.0V	Tape and Reel	3-pin SOT23
AS1360-33-T	ASKG	HV low-quiescent current LDO, 3.3V	Tape and Reel	3-pin SOT23
AS1360-50-T	ASKH	HV low-quiescent current LDO, 5.0V	Tape and Reel	3-pin SOT23

All devices are RoHS compliant and free of halogene substances.

Copyrights

Disclaimer

Devices sold by austriamicrosystems AG are covered by the warranty and patent indemnification provisions appearing in its Term of Sale. austriamicrosystems AG makes no warranty, express, statutory, implied, or by description regarding the information set forth herein or regarding the freedom of the described devices from patent infringement. austriamicrosystems AG reserves the right to change specifications and prices at any time and without notice. Therefore, prior to designing this product into a system, it is necessary to check with austriamicrosystems AG for current information. This product is intended for use in normal commercial applications. Applications requiring extended temperature range, unusual environmental requirements, or high reliability applications, such as military, medical life-support or life-sustaining equipment are specifically not recommended without additional processing by austriamicrosystems AG for each application. For shipments of less than 100 parts the manufacturing flow might show deviations from the standard production flow, such as test flow or test location.

The information furnished here by austriamicrosystems AG is believed to be correct and accurate. However, austriamicrosystems AG shall not be liable to recipient or any third party for any damages, including but not limited to personal injury, property damage, loss of profits, loss of use, interruption of business or indirect, special, incidental or consequential damages, of any kind, in connection with or arising out of the furnishing, performance or use of the technical data herein. No obligation or liability to recipient or any third party shall arise or flow out of austriamicrosystems AG rendering of technical or other services.

Contact Information

Headquarters
austriamicrosystems AG
A-8141 Schloss Premstaetten, Austria

Tel: +43 (0) 3136 500 0
Fax: +43 (0) 3136 525 01

For Sales Offices, Distributors and Representatives, please visit:

http://www.austriamicrosystems.com/contact-us