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AS1360

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, 4.0, 4.5 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.

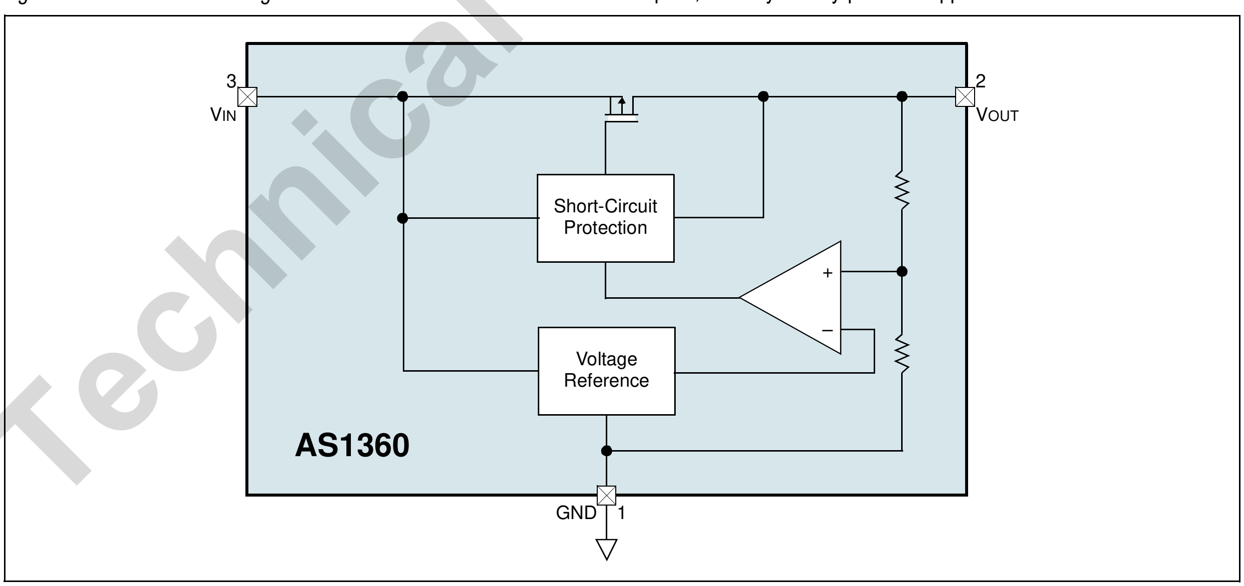
2 Key Features

- 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, 4.0, 4.5, 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.

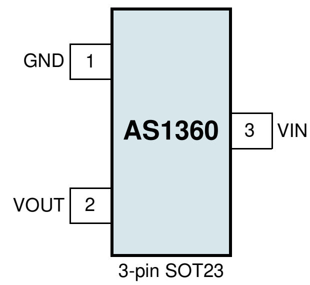
Figure 1. AS1360 - Block Diagram



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
Electrical Parameters				
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
Electrostatic Discharge				
Electrostatic Discharge HBM	+/- 1		kV	Norm: MIL 883 E method 3015
Thermal Information				
Thermal Resistance Θ_{JA}		230	ºC/W	Typical FR4, 4-layer application
Temperature Ranges and Storage Conditions				
Storage Temperature Range	-40	+125	ºC	
Package Body Temperature		+260	ºC	The reflow peak soldering temperature (body temperature) specified is in compliance with *IPC/ JEDEC J-STD-020 "Moisture/ Reflow Sensitivity Classification for Non-Hermetic Solid State Surface Mount Devices"*.
Humidity non-condensing	5	85	%	
Moisture Sensitive Level	1			Represents a max. floor life time of unlimited

6 Electrical Characteristics

Typical values are at T_{AMB} = +25°C, V_{DD} = 3.3V (unless otherwise specified). All limits are guaranteed. The parameters with min and max values are guaranteed with production tests or SQC (Statistical Quality Control) methods.

Table 3. Electrical Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
T_{AMB}	Operating Temperature Range		-40		+85	°C
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} = 4.0V	200			
		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} = 4.0V, 1mA ≤ I_{OUT} ≤ 100mA	-2.25	±1.1	+2.25	
		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} = 200mA, V_{OUTNOM} = 4.0V		400	700	
		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

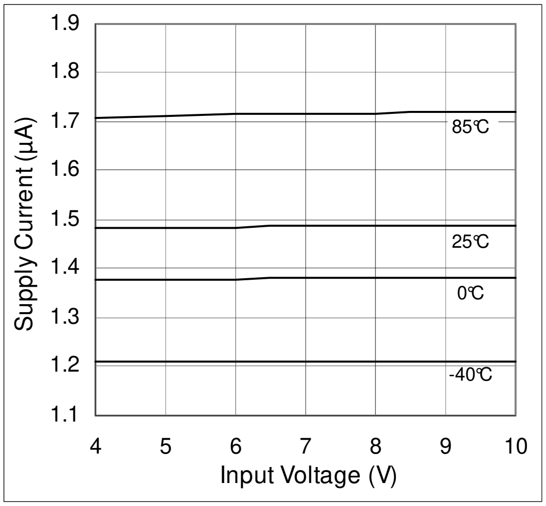


Figure 4. Supply Current vs. Load Current

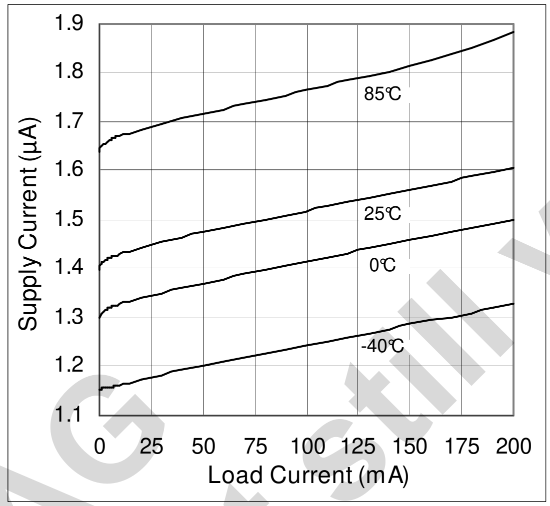


Figure 5. Supply Current vs. Temperature

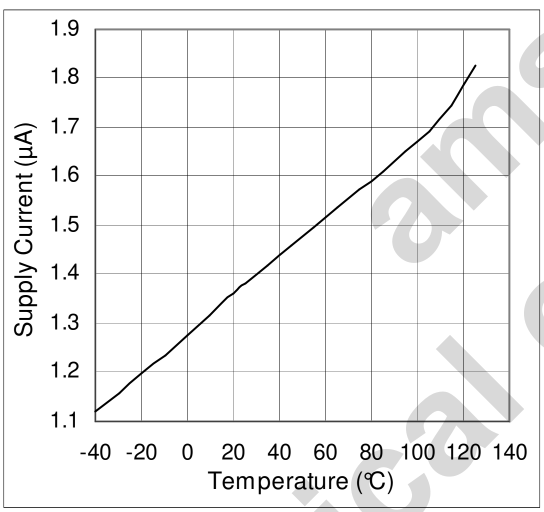


Figure 6. Output Voltage vs. Input Voltage

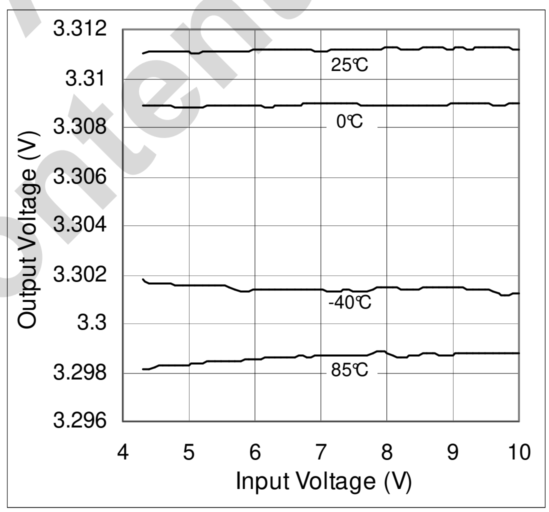


Figure 7. Output Voltage vs. Load Current

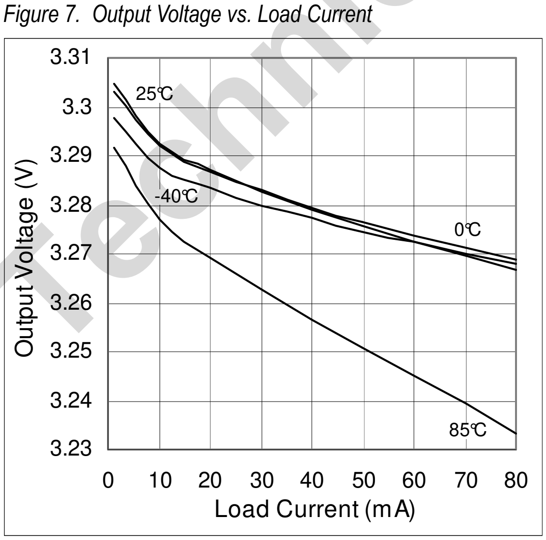


Figure 8. Dropout Voltage vs. Load Current

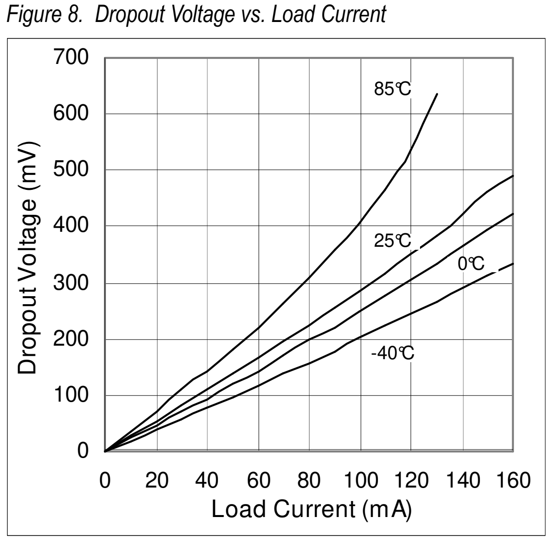


Figure 9. Load Regulation vs. Temperature

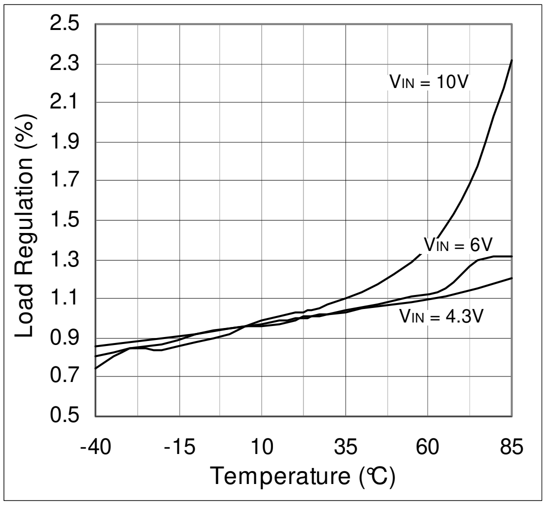


Figure 10. Line Regulation vs. Temperature

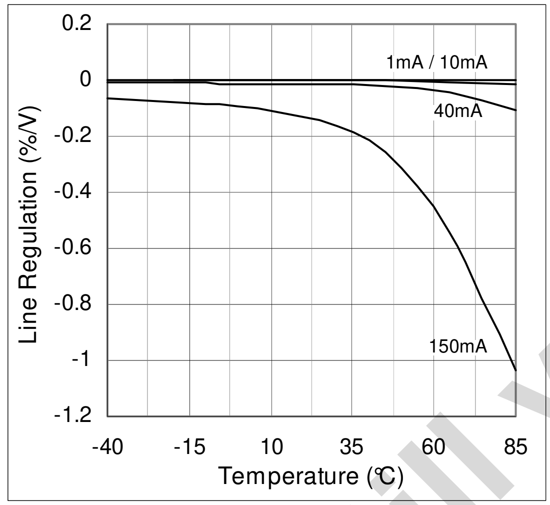


Figure 11. Output Voltage vs. Input Voltage; Dropout

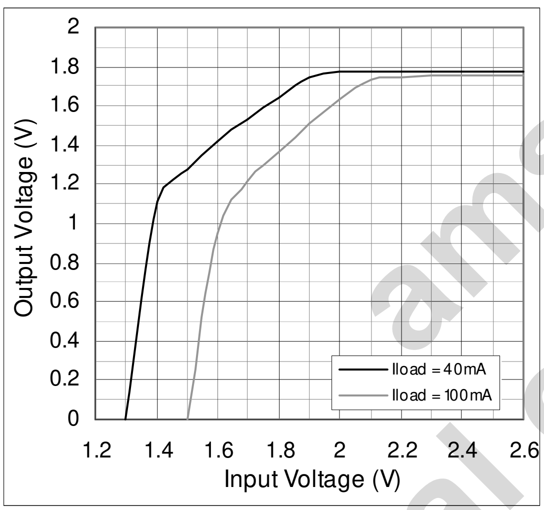


Figure 12. Startup Rise Time

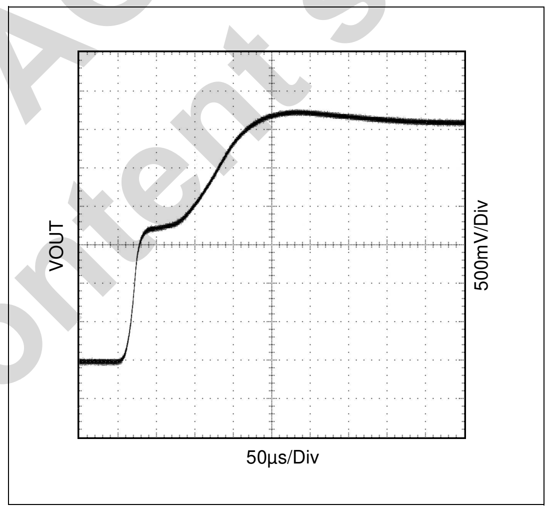
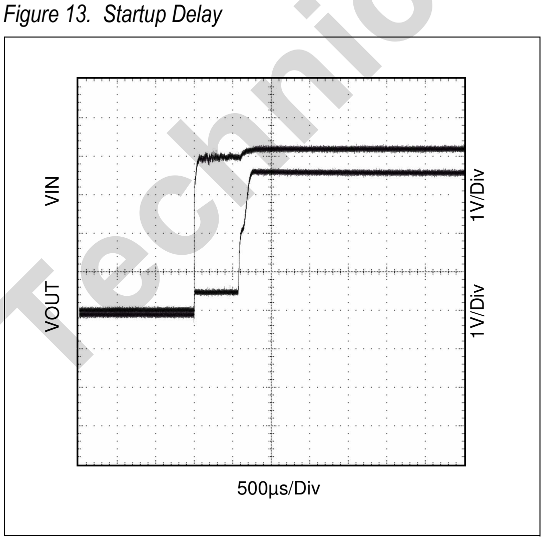


Figure 13. Startup Delay



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).

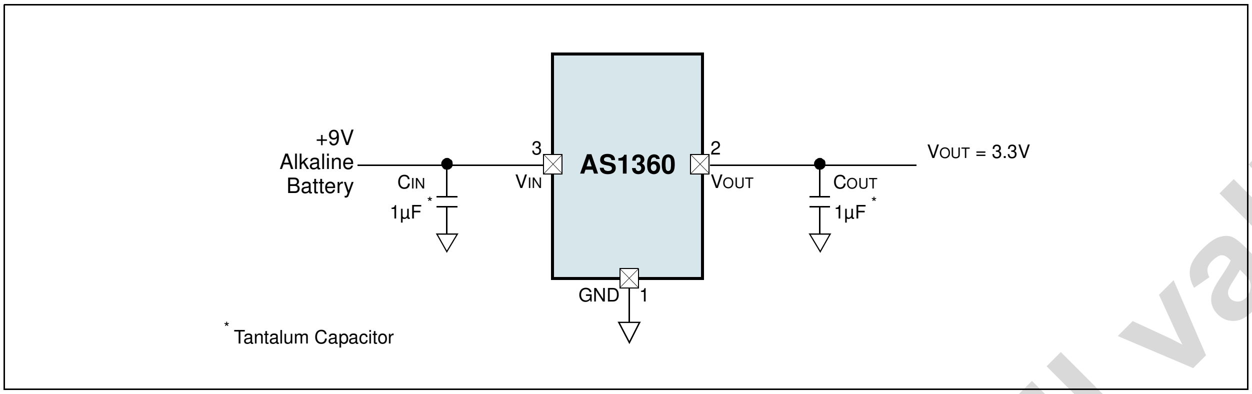
Short Circuit/Overcurrent Protection

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 14. AS1360 - 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:

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

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

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

Total AS1360 power dissipation is calculated as:

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

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:

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

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}:

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

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 14 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 14 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

Figure 15. 3-pin SOT23 Marking

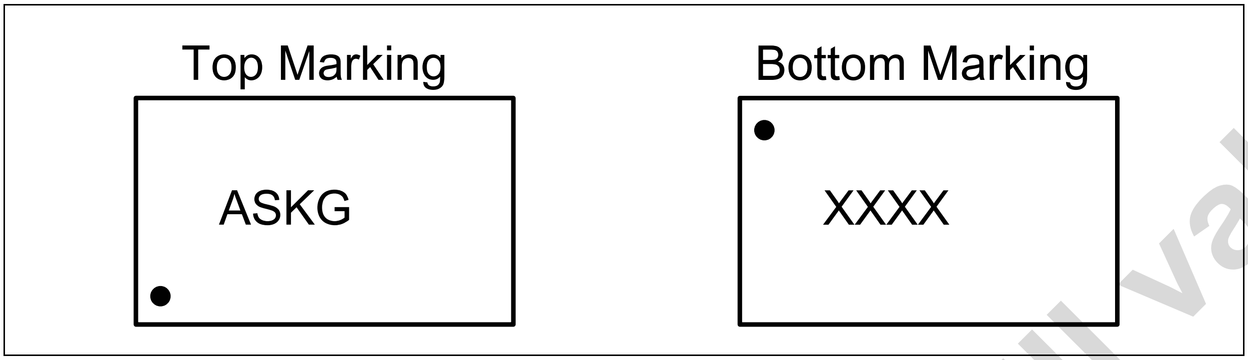
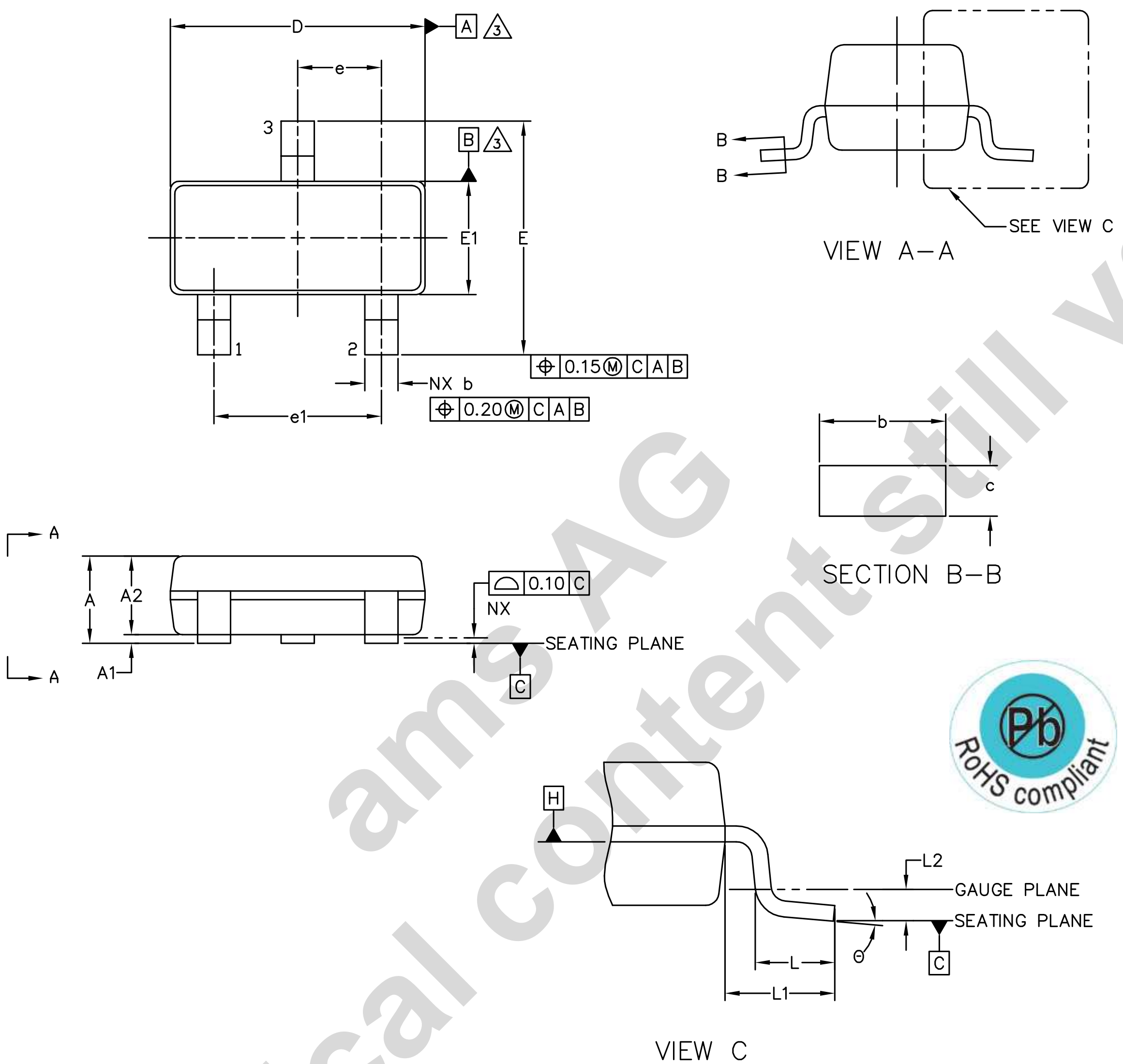


Table 4. Packaging Code xxxx

xxxx
encoded Datecode

Figure 16. 3-pin SOT23 Package



REF.	MIN	NOM	MAX
A	0.89	–	1.12
A1	0.01	–	0.10
A2	0.88	0.95	1.02
b	0.30	–	0.50
c	0.08	–	0.20
D	2.80	2.90	3.04
E	2.10	–	2.64
E1	1.20	1.30	1.40
e		0.95 BSC	
e1		1.90 BSC	
L	0.40	0.50	0.60
L1		0.54 REF	
L2		0.25 BSC	
Θ	0°	–	8°
N		3	

NOTE:

1. DIMENSIONS & TOLERANCEING CONFIRM TO ASME Y14.5M–1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS. ANGELS ARE IN DEGREES.

3 DATUMS A AND B TO BE DETERMINED AT DATUM PLANE H.

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ASSEMBLY ENGINEERING

DRAWN RH8	DATE 2010.12.22	REV. N/C	TITLE SOT23, 3 LEAD	REFERENCE DOCUMENT JEDEC TO – 236 LATEST REVISION
CHECKED GBO	DATE 2010.12.22		DRAWING NO. JAZ	UNIT
APPROVED MKR	DATE 2010.12.22	SHEET 1 OF 1	DIMENSION AND TOLERANCE	SCALE NOT IN SCALE

11 Ordering Information

The device is available as the standard products shown in Table 5.

Table 5. Ordering Information

Ordering Code	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
AS1360-40-T	ASQV	HV low-quiescent current LDO, 4.0V	Tape and Reel	3-pin SOT23
AS1360-45-T	ASTQ	HV low-quiescent current LDO, 4.5V	Tape and Reel	3-pin SOT23
AS1360-50-T	ASKH	HV low-quiescent current LDO, 5.0V	Tape and Reel	3-pin SOT23

Note: All products are RoHS compliant.
Buy our products or get free samples online at ICdirect: http://www.austriamicrosystems.com/ICdirect

Technical Support is found at http://www.austriamicrosystems.com/Technical-Support

For further information and requests, please contact us mailto:sales@austriamicrosystems.com
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