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### Datasheet

### AS1375 1µA Quiescent Current, 200mA LDO

### **1** General Description

The AS1375 low-power, positive voltage regulator is designed to deliver up to 200mA, while consuming only 1 $\mu$ A (typ.) of quiescent current. The device is available in fixed output voltages between 1.2V and 5.0V (programmable in 50mV steps). The input voltage ranges from 2V to 5.5V. Operation with large input to output differential voltages is limited by the maximum power dissipation available from package and environment.

The very-low dropout voltage 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, strict output voltage regulation tolerances ( $\pm$ 1%), and excellent line-and load-regulation.

The device features integrated short-circuit and over current protection. Under-Voltage lockout prevents erratic operation when the input voltage is slowly decaying. Thermal Protection shuts down the device when die temperature reaches 160°C. This is a useful protection when the device is under sustained short circuit conditions.

The AS1375 is available in an 6-pin TDFN 2x2mm package and is qualified for -40 $^{\circ}$  to +85 $^{\circ}$  operation.

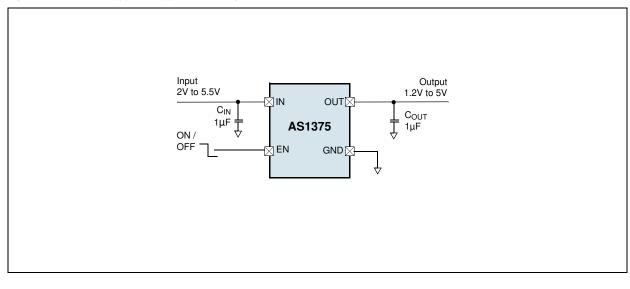
### 2 Key Features

- Input Voltage: 2V to 5.5V
- Low Dropout Voltage: 120mV @ 200mA load
- Output Voltage Range: 1.2V to 5.0V (50mV steps)
- Max. Output Current: 200mA
- Very Low Quiescent Current: 1µA
- Output Voltage Accuracy: ±1%
- Low Shutdown Current: 10nA (typ.)
- Integrated Overtemperature/Overcurrent Protection
- Under-Voltage Lockout Feature
- Enable Input
- Minimal External Components Required
- Operating Temperature Range: -40℃ to +85℃
- 6-pin TDFN 2x2mm Package

### **3** Applications

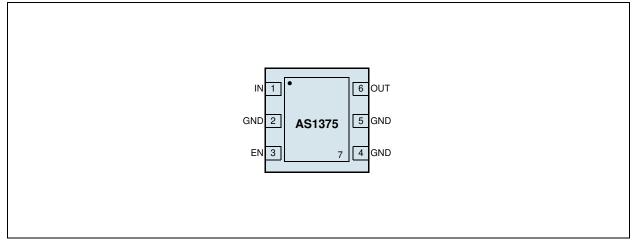
The device is perfectly suited for wireless handsets, smartphones, PDAs, MP3 players, and other batteryoperated handheld devices, where the regulators have to be always on.

Figure 1. AS1375 - Typical Application Diagram



### **4 Pin Assignments**

Figure 2. Pin Assignments (Top View)



#### **Pin Descriptions**

Table 1. Pin Descriptions

Pin Name	Pin Number	Description
IN	1	Input Supply
EN	3	<b>Enable Input.</b> A logic low disables the regulator. Connect to pin IN for normal operation.
GND	2, 4, 5	Ground
OUT	6	<b>Regulated Output Voltage</b> . Current flowing out of this pin is equivalent DC load current.
Exposed Pad	7	<b>Ground.</b> This pin also functions as a heat sink. Solder to a large pad or the circuit-board ground plane to maximize power dissipation.



### **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
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Parameter	Min	Max	Units	Notes
Input Voltage		+7	V	
Output Short-Circuit Duration	Indefinite		V	
Electrostatic Discharge	2		kV	HBM MIL-Std. 883E 3015.7 methods
Latch-Up	100		mA	@85°C, JEDEC 78
Thermal Resistance $\theta_{JA}$	+140		ºC/W	
Junction Temperature	+150		°C	Internally limited
Operating Temperature Range	-40 +85		°C	
Storage Temperature Range	-65	+150	°C	
Package Body Temperature	+260		°C	The reflow peak soldering temperature (body temperature) specified is in accordance with <i>IPC/JEDEC J-STD-</i> 020D "Moisture/Reflow Sensitivity Classification for Non-Hermetic Solid State Surface Mount Devices". The lead finish for Pb-free leaded packages is matte tin (100% Sn).

### **6 Electrical Characteristics**

 $V_{IN} = V_{OUT} + 500 \text{mV} \text{ or } V_{IN} = +2V$  (whichever is greater),  $C_{IN} = C_{OUT} = 1\mu\text{F}$ , EN = IN,  $T_{AMB} = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  (unless otherwise specified). Typical values are at  $T_{AMB} = +25^{\circ}\text{C}$ .

Parameter	Condition	Min	Тур	Max	Unit		
Input Voltage		2		5.5	V		
	IOUT = 10mA	-1		+1	%		
Output Voltage Accuracy	IOUT = 1 to 200mA, VOUT > $1.5V^{1}$	-1.5		+1.5	%		
	IOUT = 1 to 200mA, VOUT $\leq 1.5$ V <sup>1</sup>			+2	%		
Output Voltage Range		1.2		5.0	V		
Guaranteed Output Current (RMS)		200			mA		
Short-Circuit Current Limit	Vout = 0	250	330	450	mA		
In-Regulation Current Limit	VOUT > 96% of nominal value		330		mA		
	IOUT = 0		1.2	2	μΑ		
Ground-Pin Current	Ιουτ = 100μΑ		1				
-	IOUT = 200mA		1.7				
2	Iout = 200mA, Vout $\ge$ 2.8V		120	200			
Dropout Voltage	IOUT = 200mA, 2V < VOUT < 2.8V		170	350	mV		
Line Regulation	VIN from (Vout + 500mV) to 5.5V, ILOAD = 10mA	-0.125		+0.125	%/V		
Load Regulation	IOUT = 1mA to 200mA		0.003		%/mA		
1							
Shutdown Supply Current	EN = GND		10	100	nA		
EN Input Threehold	2V < VIN < 5.5V	1.2			V		
	2V < VIN < 5.5V			0.4	V		
EN Input Bias Current	EN = IN or GND		1	40 <sup>3</sup>	nA		
Startup Time	from EN to 90% of VOUT(NOM)		750				
Shutdown Time	from EN to 10% of VOUT(NOM)		500		μs		
Protection							
Thermal Shutdown Temperature			160		°C		
Thermal Shutdown Hysteresis			20		°C		
	Output Voltage Accuracy   Output Voltage Range   Guaranteed Output Current   Gharanteed Output Current   Short-Circuit Current Limit   In-Regulation Current Limit   Ground-Pin Current   Dropout Voltage <sup>2</sup> Line Regulation   Load Regulation   Shutdown Supply Current   EN Input Threshold   EN Input Bias Current   Startup Time   Shutdown Time   Thermal Shutdown   Thermal Shutdown	IOUT = 10mAOutput Voltage AccuracyIOUT = 1 to 200mA, VOUT > $1.5V^{1}$ IOUT = 1 to 200mA, VOUT $\leq 1.5V^{1}$ IOUT = 1 to 200mA, VOUT $\leq 1.5V^{1}$ Output Voltage RangeGuaranteed Output Current (RMS)Short-Circuit Current LimitVOUT > 96% of nominal valueIn-Regulation Current LimitVOUT > 96% of nominal valueIoUT = 0IOUT = 0Ground-Pin CurrentIOUT = 100 $\mu$ AIoUT = 200mAIOUT = 200mADropout Voltage2IOUT = 200mA, VOUT $\geq 2.8V$ IoUT = 200mA, VOUT $\geq 2.8V$ IOUT = 200mA, VOUT $\geq 2.8V$ Line RegulationIOUT = 200mA, VOUT $\geq 2.8V$ Line RegulationIOUT = 100 $\mu$ ALoad RegulationIOUT = 100 $\mu$ AShutdown Supply CurrentEN = GNDEN Input Threshold $2V < VIN < 5.5V$ EN Input ThresholdEN = IN or GNDStartup Timefrom EN to 90% of VOUT(NOM)Shutdown Timefrom EN to 10% of VOUT(NOM)Thermal Shutdown TemperatureInternal Shutdown	IOUT = 10mA-1Output Voltage AccuracyIOUT = 1 to 200mA, VouT > 1.5V 1-1.5IOUT = 1 to 200mA, VouT $\leq 1.5V 1$ -2Output Voltage Range1.2Guaranteed Output Current (RMS)200Short-Circuit Current LimitVOUT = 0250In-Regulation Current LimitVOUT > 96% of nominal value-1Iout = 100µAIout = 010Ground-Pin CurrentIout = 200mA-1Dropout Voltage2Iout = 200mA, Vout $\geq 2.8V$ -0.125Iout = 200mA, Vout $\geq 2.8V$ Iout = 200mA, Vout $\geq 2.8V$ -0.125Line RegulationIout = 200mA, 2V < Vout $< 2.8V$ -0.125Load RegulationIout = 1mA to 200mA-0.125Shutdown Supply CurrentEN = GND-0.125EN Input Threshold $2V < VIN < 5.5V$ 1.2Shutdown Timefrom EN to 90% of VOUT(NOM)-0.125Shutdown Timefrom EN to 90% of VOUT(NOM)-0.125Thermal Shutdown Temperaturefrom EN to 10% of VOUT(NOM)-0.125	Iout = 10mA-1Output Voltage AccuracyIout = 1 to 200mA, Vout > 1.5V 1-1.5Iout = 1 to 200mA, Vout $\leq 1.5V^1$ -2Output Voltage Range1.2Guaranteed Output Current (RMS)200Short-Circuit Current LimitVout > 0250In-Regulation Current LimitVout > 96% of nominal value330In-Regulation Current LimitVout > 96% of nominal value1Iout = 01.21Ground-Pin CurrentIout = 100µA1Iout = 200mA, Vout $\geq 2.8V$ 120Dropout Voltage2Iout = 200mA, Vout $\geq 2.8V$ 120Iout = 200mA, Vout $\geq 2.8V$ 120Iout = 200mA, Vout $\geq 2.8V$ 170Line RegulationIout = 200mA, 2V < Vout $< 2.8V$ 170Line RegulationIout = 100µA1Load RegulationIout = 1mA to 200mA0.003EN Input Threshold2V < VIN < 5.5V	Iour   Iour   10ur   -1   +1     Output Voltage Accuracy   Iour = 1 to 200mA, Vour > 1.5V <sup>1</sup> -1.5   +1.5     Iour = 1 to 200mA, Vour $\leq 1.5V^1$ -2   +2     Output Voltage Range   1.2   5.0     Guaranteed Output Current (RMS)   200   200   200     Short-Circuit Current Limit   Vour = 0   250   330   450     In-Regulation Current Limit   Vour > 96% of nominal value   330   200   1.2   2     Ground-Pin Current   Iour = 100µA   1   1   1   1   1     Dropout Voltage <sup>2</sup> Iour = 200mA, Vour > 2.8V   120   200   100   200   1.7   350     Line Regulation   ViN from (Vour + 500mV) to 5.5V, ILOAD = 10mA   0.125   +0.125   +0.125     Load Regulation   Iour = 1mA to 200mA   0.003   100   100   100     EN Input Threshold   EN = GND   10   100   100   10   100     EN Input Bias Current   EN = IN or GND   1   40 <sup>3</sup>		

Table 3. Electrical Characteristics

1. Guaranteed by production test of load regulation.

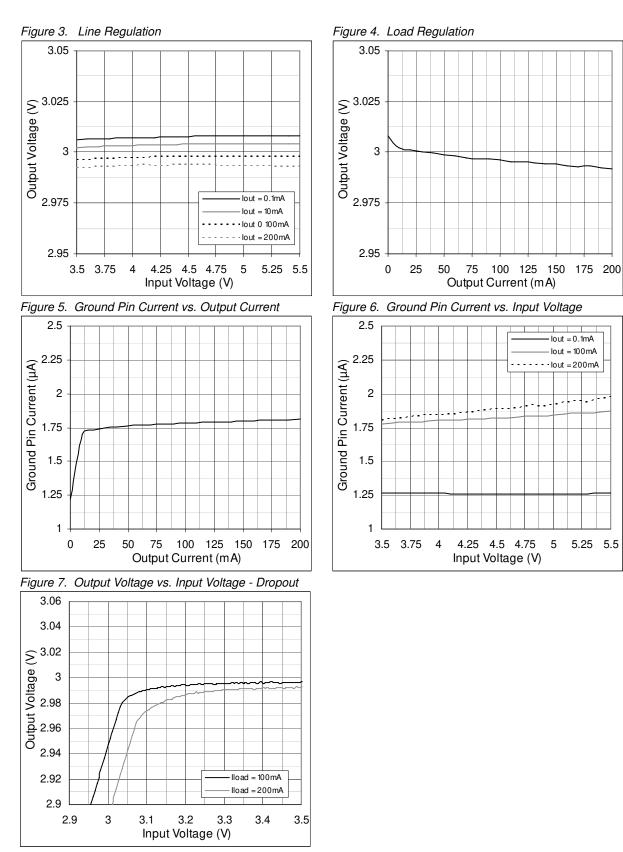
2. Dropout voltage is defined as VIN - VOUT, when VOUT is 100mV below the value of VOUT measured for VIN = (VOUT(NOM) + 500mV). Since the minimum input voltage is 2V, this specification is only valid when VOUT(NOM) > 2V.

3. Guaranteed by design.

**Note:** All limits are guaranteed. The parameters with min and max values are guaranteed with production tests or SQC (Statistical Quality Control) methods.

### **7** Typical Operating Characteristics

VIN = 3.5V, VOUT = 3.0V, TAMB = +25°C (unless otherwise specified).



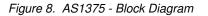
### 8 Detailed Description

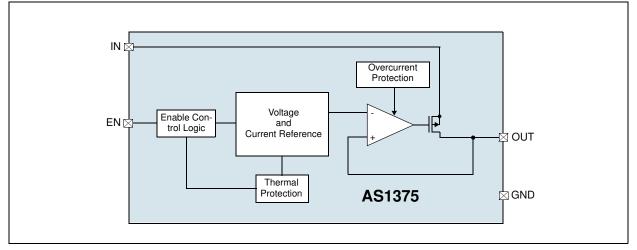
The AS1375 is an low-power and low-quiescent current linear-regulator specifically designed for space-limited applications. These device can supply loads up to 200mA. As shown in Figure 8, the AS1375 consist of an integrated voltage reference, error amplifier, P-channel MOSFET pass transistor.

Additional blocks include a current limiter, thermal sensor, and enable logic.

#### Internal Voltage Reference

The bandgap reference is connected to the error amplifier's inverting input. The error amplifier compares this reference with the feedback voltage and amplifies the difference. If the feedback voltage is lower than the reference voltage, the pass-transistor gate is pulled low. This allows more current to pass to the output and increases the output voltage. If the feedback voltage is too high, the pass transistor gate is pulled high, allowing less current to pass to the output.





#### **Current Limit**

The AS1375 include a current limiting circuitry to monitor and control the P-channel MOSFET pass transistor's gate voltage, thus limiting the device output current to 300mA.

**Note:** See Table 3 on page 4 for the min and max current limits. The output can be shorted to ground indefinitely without causing damage to the device.

#### **Thermal Protection**

Integrated thermal protection circuitry limits total power dissipation in the AS1375. When the junction temperature (TJ) exceeds +160°C, the thermal sensor signals the shutdown logic, turning off the P-channel MOSFET pass transistor and allowing the device to cool down. The thermal sensor turns the pass transistor on again after the device's junction temperature drops by 20°C, resulting in a pulsed output during continuous thermal-overload conditions.

**Note:** Thermal protection is designed to protect the devices in the event of fault conditions. For continuous operation, do not exceed the absolute maximum junction temperature rating of +150°C.

### **9** Application Information

#### **Capacitor Selection and Regulator Stability**

For normal operation, use a 1µF capacitor at pin IN and a 1µF capacitor at pin OUT. Larger input capacitor values and lower ESR provide better noise rejection and line-transient response. Reduce output noise and improve load-transient response, stability, and power-supply rejection by using large output capacitors.

**Note:** Some ceramic dielectrics exhibit large capacitance and ESR variation with temperature. With dielectrics such as Z5U and Y5V, it may be necessary to use a 2.2μF or larger output capacitor to ensure stability at temperatures below -10°C. With X7R or X5R dielectrics, 1μF is sufficient at all operating temperatures.

#### Noise, PSRR, and Transient Response

The AS1375 is designed to deliver low dropout and low quiescent currents in battery-powered systems. The powersupply rejection is 85dB at 1kHz and 50dB at 100kHz.

When operating from sources other than batteries, improved supply-noise rejection and transient response can be achieved by increasing the values of the input and output capacitors, and through passive filtering techniques.

#### **Dropout Voltage**

The AS1375 minimum dropout voltage determines the lowest usable supply voltage. In battery-powered systems, this determines the useful end-of-life battery voltage.

Since the AS1375 use a P-channel MOSFET pass transistor, the dropout voltage is a function of drain-to-source on-resistance (RDS(ON)) multiplied by ILOAD.

### **10 Package Drawings and Markings**

The device is available in a 6-pin TDFN 2x2mm package.

Figure 9. 6-pin TDFN 2x2mm Package Diagram

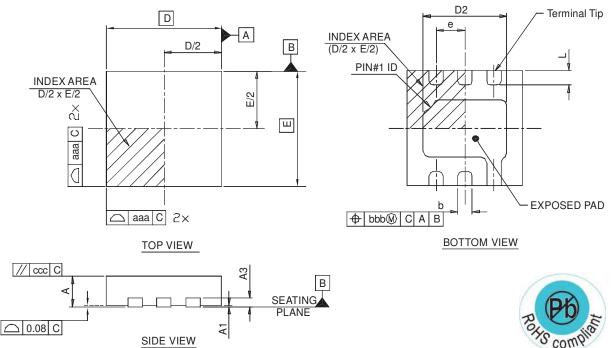


Table 4. 4-bumps WL-CSP package Dimensions

Symbol	Min	Тур	Max	Symbol	Min	Тур	Max
A	0.51	0.55	0.60	D BSC	1.95	2.00	2.05
A1	0.00	0.02	0.05	E BSC	1.95	2.00	2.05
A3		0.15 REF			1.30	1.45	1.55
b	0.20	0.25	0.32	E2	0.85	1.00	1.10
е		0.50		L	0.15	0.25	0.35
aaa		0.15		k	0.20		
bbb		0.10		ND		3	
CCC		0.10		N		6	

#### Note:

- 1. All dimensions are in millimeters, angle is in degrees (9.
- 2. N is the total number of terminals.
- 3. The location of the terminal #1 identifier and terminal numbering convention conforms to JEDEC publication 95 SPP-002.
- 4. ND and NE refer to the number of terminals on each D and E side respectively.
- 5. NJR refer to non jedec registered.
- 6. Dimension b applies to metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip. If the terminal has the optional radius on the other end of the terminal, the dimension B should not be measured in that radius area.
- 7. Coplanarity applies to the terminals and all other bottom surface metallization.

### **11 Ordering Information**

The devices are available as the standard products shown in Table 5.

Ordering Code	Marking	Output	Description	Delivery Form	Package
AS1375-BTDT-12	ABD	1.2V	1µA Quiescent Current, 200mA LDO	Tape and Reel	6-pin TDFN 2x2mm
AS1375-BTDT-18	ABE	1.8V	1µA Quiescent Current, 200mA LDO	Tape and Reel	6-pin TDFN 2x2mm
AS1375-BTDT-25	ABF	2.5V	1µA Quiescent Current, 200mA LDO	Tape and Reel	6-pin TDFN 2x2mm
AS1375-BTDT-30	ABG	3.0V	1µA Quiescent Current, 200mA LDO	Tape and Reel	6-pin TDFN 2x2mm
AS1375-BTDT-33	ABH	3.3V	1µA Quiescent Current, 200mA LDO	Tape and Reel	6-pin TDFN 2x2mm

Non-standard devices from 1.2V to 5.0V are available in 50mV steps. For more information and inquiries contact http://www.austriamicrosystems.com/contact

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

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