19-2211; Rev 2; 12/02

Precision, Micropower, 1.8V Supply, Low-Dropout, SOT23 Voltage Reference

MAX6018

General Description

The MAX6018 is a precision, low-voltage, low-dropout, micropower voltage reference in a SOT23 package. This three-terminal reference operates with an input voltage from (V_{OUT} + 200mV) to 5.5V, and is available with output voltage options of 1.2V, 1.6V, 1.8V, and 2.048V

The MAX6018 voltage reference consumes less than 5µA (max) of supply current and can source and sink up to 1mA of load current. Unlike conventional shunt-mode (two-terminal) references that waste supply current and require an external resistor, devices in the MAX6018 family offer a supply current that is virtually independent of supply voltage (with only 0.1µA/V variation with supply voltage) and do not require an external resistor. The MAX6018 has initial accuracies of 0.2% (A grade) and 0.4% (B grade) and temperature drift of 50ppm/°C (max). The low-dropout voltage and the ultra-low, supply voltage-independent supply current make this device ideal for two-cell alkaline, end-of-life, battery-monitoring systems. The MAX6018 is available in a tiny 3-pin SOT23 package.

Applications

Two-Cell, Battery-Operated Systems

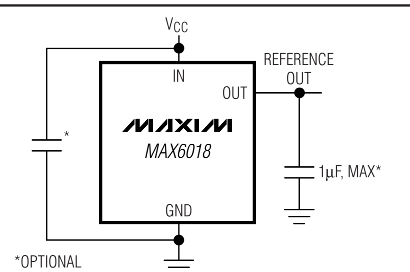
Battery-Operated Equipment

Hand-Held Equipment

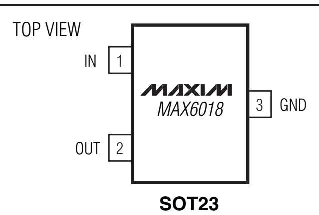
Data-Acquisition Systems

Industrial and Process-Control Systems

Typical Application Circuit



Pin Configuration



Features

- ♦ **Ultra-Low Supply Current: 5µA (max)**
- ♦ **1.6V Output from 1.8V Input**
- ♦ **Ultra-Small, 3-Pin SOT23 Package**
- ♦ **Initial Accuracy: ±0.2% (max)**
- ♦ **Low Temperature Drift: 50ppm/°C (max)**
- ♦ **200mV Dropout Voltage**
- ♦ **Load Regulation (1mA Source): 700µV/mA (max)**
- ♦ **Line Regulation (V_{OUT} + 200mV) to 5.5V: 250µV/V (max)**
- ♦ **Four Output Voltage Options: 1.2V, 1.6V, 1.8V, 2.048V**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	TOP MARK
MAX6018AEUR12-T	-40°C to +85°C	3 SOT23-3	FZJH
MAX6018BEUR12-T	-40°C to +85°C	3 SOT23-3	FZJI
MAX6018AEUR16-T	-40°C to +85°C	3 SOT23-3	FZJJ
MAX6018BEUR16-T	-40°C to +85°C	3 SOT23-3	FZJK
MAX6018AEUR18-T	-40°C to +85°C	3 SOT23-3	FZJL
MAX6018BEUR18-T	-40°C to +85°C	3 SOT23-3	FZJM
MAX6018AEUR21-T	-40°C to +85°C	3 SOT23-3	FZJN
MAX6018BEUR21-T	-40°C to +85°C	3 SOT23-3	FZJO

Selector Guide

PART	OUTPUT VOLTAGE (V)	INITIAL ACCURACY (%)
MAX6018AEUR12	1.263	±0.2
MAX6018BEUR12	1.263	±0.4
MAX6018AEUR16	1.600	±0.2
MAX6018BEUR16	1.600	±0.4
MAX6018AEUR18	1.800	±0.2
MAX6018BEUR18	1.800	±0.4
MAX6018AEUR21	2.048	±0.2
MAX6018BEUR21	2.048	±0.4

Precision, Micropower, 1.8V Supply, Low-Dropout, SOT23 Voltage Reference

ABSOLUTE MAXIMUM RATINGS

(Voltages Referenced to GND)
V_{IN} ....-0.3V to +6V
Output Short-Circuit Duration to GND or V_{IN} ....Continuous
Continuous Power Dissipation (T_A = +70°C)
3-Pin SOT23 (derate 4.0mW/°C above +70°C)............320mW
Operating Temperature Range ....-40°C to +85°C
Junction Temperature...+150°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10s) ....+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" 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 the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS (MAX6018_12–1.263V)

(V_{IN} = 1.8V; C_{OUT} = 47nF, I_{OUT} = 0; T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
OUTPUT						
Output Voltage	V_{OUT}	MAX6018A_12 (0.2%)	1.2605	1.2630	1.2655	V
		MAX6018B_12 (0.4%)	1.2580	1.2630	1.2681	
Output Voltage Temperature Drift	TCV_{OUT}	(Note 2)		16	50	ppm/°C
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	1.8V ≤ V_{IN} ≤ 5.5V		50	400	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	0 ≤ I_{OUT} ≤ 1mA		90	700	µV/mA
		-100µA ≤ I_{OUT} ≤ 0		2	9	µV/µA
Short-Circuit Current	I_{SC}	Sourcing to GND		3		mA
		Sinking from V_{IN}		6		
Long-Term Stability	ΔV_{OUT}/Time	1000hrs at T_A = +25°C		100		ppm
Thermal Hysteresis		(Note 4)		130		ppm
DYNAMIC CHARACTERISTICS						
Noise Voltage	e_{OUT}	0.1Hz to 10Hz		45		µVp-p
		10Hz to 10kHz		100		$µV_{RMS}$
Ripple Rejection		V_{IN} = 1.8V ±100mV (f = 120Hz)		85		dB
Turn-On Settling Time	t_R	Settling to 0.1%; C_{OUT} = 5nF		200		µs
Capacitive-Load Stability Range	C_{OUT}	(Note 2)	47		1000	nF
INPUT						
Supply Voltage Range	V_{IN}	Guaranteed by Line Regulation Test	1.8		5.5	V
Quiescent Supply Current	I_{IN}	T_A = +25°C		3	5	µA
		T_A = T_{MIN} to T_{MAX}		3	6	
Change in Quiescent Supply Current vs. Input Voltage	$\Delta I_{IN}/\Delta V_{IN}$	1.8V ≤ V_{IN} ≤ 5.5V		0.1	0.5	µA/V

ELECTRICAL CHARACTERISTICS (MAX6018_16–1.600V)

(V_{IN} = 1.8V; C_{OUT} = 47nF, I_{OUT} = 0; T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
OUTPUT							
Output Voltage	V_{OUT}	MAX6018A_16 (0.2%)	T_A = +25°C	1.5968	1.6000	1.6032	V
		MAX6018B_16 (0.4%)	T_A = +25°C	1.5936	1.6000	1.6064	
Output Voltage Temperature Drift	TCV_{OUT}	(Note 2)			16	50	ppm/°C
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	1.8V ≤ V_{IN} ≤ 5.5V			40	250	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	0 ≤ I_{OUT} ≤ 1mA			90	700	µV/mA
		-750µA ≤ I_{OUT} ≤ 0			0.6	50	µV/µA
Dropout Voltage (Note 3)	V_{IN} - V_{OUT}	I_{OUT} = 1mA			100	200	mV
Short-Circuit Current	I_{SC}	Sourcing to GND			6		mA
		Sinking from V_{IN}			2		
Long-Term Stability	ΔV_{OUT}/ Time	1000hrs at T_A = +25°C			100		ppm
Thermal Hysteresis		(Note 4)			130		ppm
DYNAMIC CHARACTERISTICS							
Noise Voltage	e_{OUT}	0.1Hz to 10Hz			40		µVp-p
		10Hz to 10kHz			150		$µV_{RMS}$
Ripple Rejection		V_{IN} = 1.8V ±100mV (f = 120Hz)			85		dB
Turn-On Settling Time	t_R	Settling to 0.1%; C_{OUT} = 5nF			200		µs
Capacitive-Load Stability Range	C_{OUT}	(Note 2)		0.1		1000	nF
INPUT							
Supply Voltage Range	V_{IN}	Guaranteed by Line Regulation Test		1.8		5.5	V
Quiescent Supply Current	I_{IN}	T_A = +25°C			3	5	µA
		T_A = T_{MIN} to T_{MAX}			3	6	
Change in Quiescent Supply Current vs. Input Voltage	$\Delta I_{IN}/\Delta V_{IN}$	1.8V ≤ V_{IN} ≤ 5.5V			0.1	0.5	µA/V

Precision, Micropower, 1.8V Supply, Low-Dropout, SOT23 Voltage Reference

ELECTRICAL CHARACTERISTICS (MAX6018_18–1.800V)

(V_{IN} = 2.0V; C_{OUT} = 47nF, I_{OUT} = 0; T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
OUTPUT							
Output Voltage	V_{OUT}	MAX6018A_18 (0.2%)	T_A = +25°C	1.7964	1.8000	1.8036	V
		MAX6018B_18 (0.4%)	T_A = +25°C	1.7928	1.8000	1.8072	
Output Voltage Temperature Drift	TCV_{OUT}	(Note 2)			16	50	ppm/°C
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	2.0V ≤ V_{IN} ≤ 5.5V			40	275	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	0 ≤ I_{OUT} ≤ 1mA			90	800	µV/mA
		-1mA ≤ I_{OUT} ≤ 0			0.4	50	µV/µA
Dropout Voltage (Note 3)	V_{IN} - V_{OUT}	I_{OUT} = 1mA			100	200	mV
Short-Circuit Current	I_{SC}	Sourcing to GND			7.5		mA
		Sinking from V_{IN}			3		
Long-Term Stability	ΔV_{OUT}/Time	1000hrs at T_A = +25°C			100		ppm
Thermal Hysteresis		(Note 4)			130		ppm
DYNAMIC CHARACTERISTICS							
Noise Voltage	e_{OUT}	0.1Hz to 10Hz			45		µVp-p
		10Hz to 10kHz			160		μV_{RMS}
Ripple Rejection		V_{IN} = 2.0V ±100mV (f = 120Hz)			85		dB
Turn-On Settling Time	t_R	Settling to 0.1%; C_{OUT} = 5nF			200		µs
Capacitive-Load Stability Range	C_{OUT}	(Note 2)		0.1		1000	nF
INPUT							
Supply Voltage Range	V_{IN}	Guaranteed by Line Regulation Test		2.0		5.5	V
Quiescent Supply Current	I_{IN}	T_A = +25°C			3	5	µA
		T_A = T_{MIN} to T_{MAX}			3	6	
Change in Quiescent Supply Current vs. Input Voltage	$\Delta I_{IN}/\Delta V_{IN}$	2V ≤ V_{IN} ≤ 5.5V			0.1	0.5	µA/V

ELECTRICAL CHARACTERISTICS (MAX6018_21–2.048V)

(V_{IN} = 2.25V; C_{OUT} = 47nF, I_{OUT} = 0; T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
OUTPUT							
Output Voltage	V_{OUT}	MAX6018A_21 (0.2%)	T_A = +25°C	2.0439	2.0480	2.0521	V
		MAX6018B_21 (0.4%)	T_A = +25°C	2.0398	2.0480	2.0562	
Output Voltage Temperature Drift	TCV_{OUT}	(Note 2)			16	50	ppm/°C
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	2.25V ≤ V_{IN} ≤ 5.5V			45	330	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	0 ≤ I_{OUT} ≤ 1mA			90	1000	µV/mA
		-1mA ≤ I_{OUT} ≤ 0			0.3	50	µV/µA
Dropout Voltage (Note 3)	V_{IN} - V_{OUT}	I_{OUT} = 1mA			100	200	mV
Short-Circuit Current	I_{SC}	Sourcing to GND			10		mA
		Sinking from V_{IN}			4		
Long-Term Stability	ΔV_{OUT}/Time	1000hrs at T_A = +25°C			100		ppm
Thermal Hysteresis		(Note 4)			130		ppm
DYNAMIC CHARACTERISTICS							
Noise Voltage	e_{OUT}	0.1Hz to 10Hz			50		µVp-p
		10Hz to 10kHz			175		$µV_{RMS}$
Ripple Rejection		V_{IN} = 2.25V ±100mV (f = 120Hz)			85		dB
Turn-On Settling Time	t_R	Settling to 0.1%; C_{OUT} = 5nF			200		µs
Capacitive-Load Stability Range	C_{OUT}	(Note 2)		0.1		1000	nF
INPUT							
Supply Voltage Range	V_{IN}	Guaranteed by Line Regulation Test		2.25		5.5	V
Quiescent Supply Current	I_{IN}	T_A = +25°C			3	5	µA
		T_A = T_{MIN} to T_{MAX}			3	6	
Change in Quiescent Supply Current vs. Input Voltage	$\Delta I_{IN}/\Delta V_{IN}$	2.25V ≤ V_{IN} ≤ 5.5V			0.1	0.5	µA/V

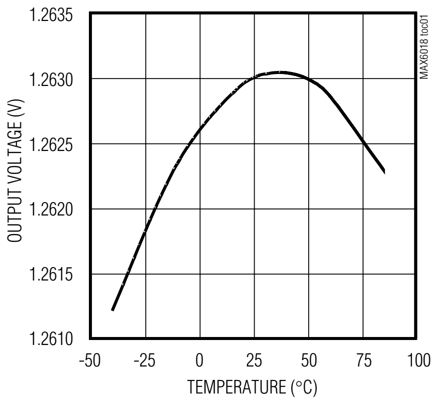
Note 1: Devices are 100% production tested at T_A = +25°C and are guaranteed by design from T_A = T_{MIN} to T_{MAX}.
Note 2: Not production tested. Guaranteed by design.
Note 3: Dropout voltage is the minimum input voltage at which V_{OUT} changes ≤ 0.2% from V_{OUT} at rated V_{IN} and is guaranteed by Load Regulation Test.
Note 4: Thermal hysteresis is defined as the change in T_A = +25°C output voltage before and after temperature cycling of the device (from T_A = T_{MIN} to T_{MAX}). Initial measurement at T_A = +25°C is followed by temperature cycling the device to T_A = +85°C then to T_A = -40°C and another measurement at T_A = +25°C is compared to the original measurement at T_A = +25°C.

Precision, Micropower, 1.8V Supply, Low-Dropout, SOT23 Voltage Reference

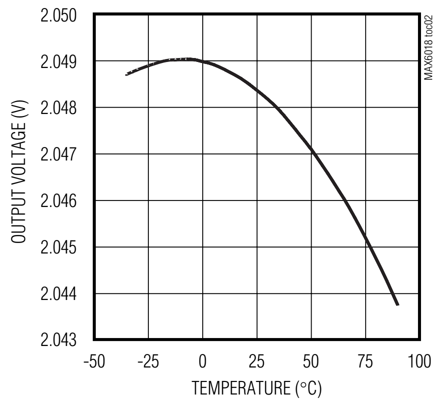
Typical Operating Characteristics

(T_A = +25°C, unless otherwise noted.)

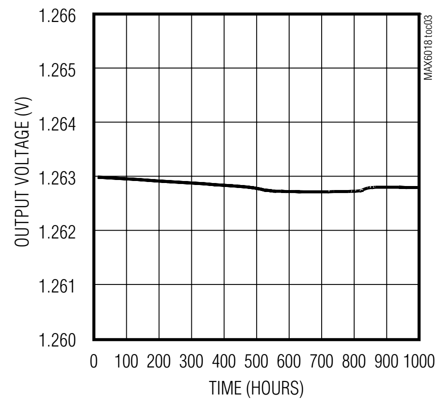
MAX6018_12
OUTPUT VOLTAGE DRIFT vs. TEMPERATURE



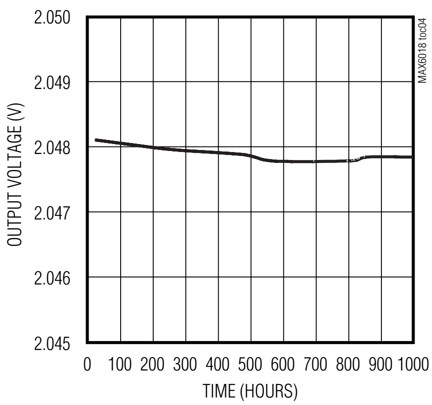
MAX6018_21
OUTPUT VOLTAGE DRIFT vs. TEMPERATURE



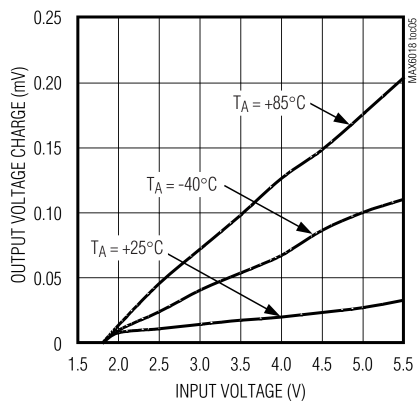
MAX6018_12
LONG-TERM DRIFT



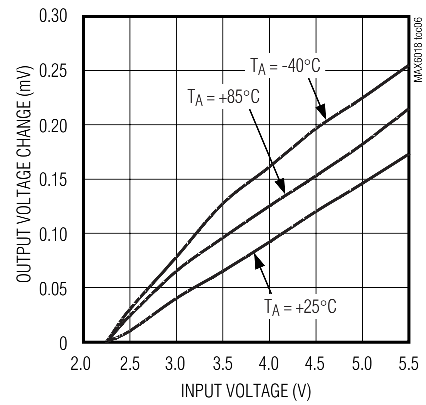
MAX6018_21
LONG-TERM DRIFT



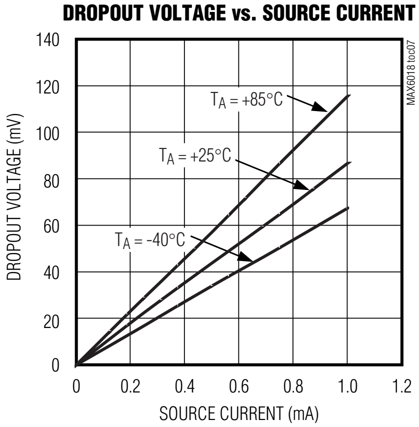
MAX6018_12
LINE REGULATION



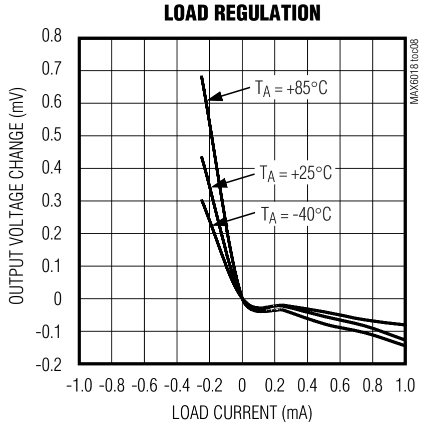
MAX6018_21
LINE REGULATION



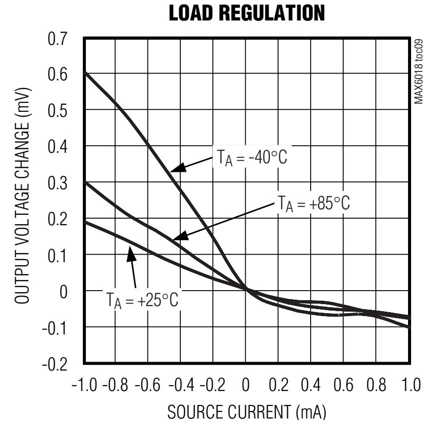
MAX6018_21
DROPOUT VOLTAGE vs. SOURCE CURRENT



MAX6018_12
LOAD REGULATION



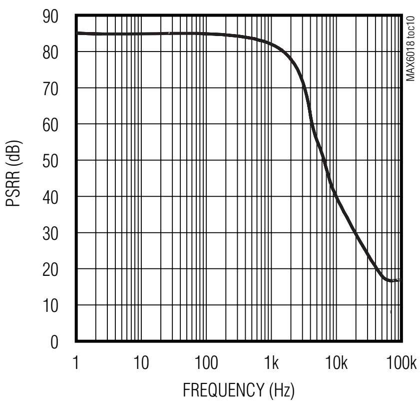
MAX6018_21
LOAD REGULATION



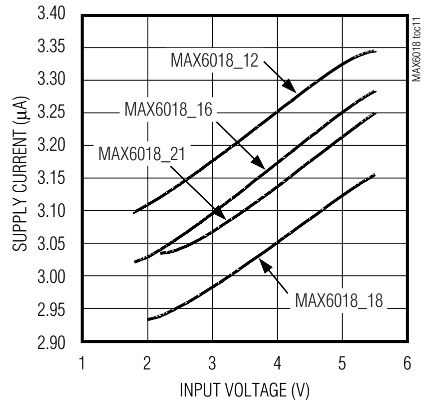
Typical Operating Characteristics (continued)

(T_A = +25°C, unless otherwise noted.)

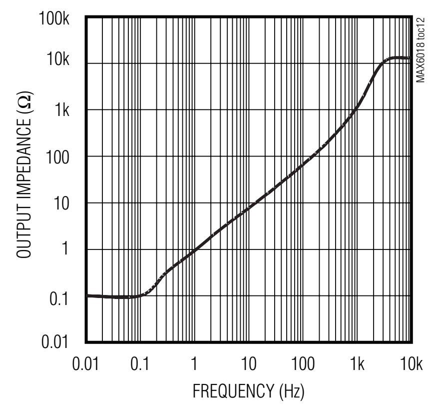
POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



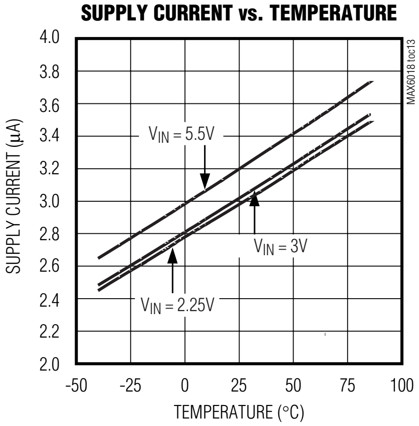
SUPPLY CURRENT vs. INPUT VOLTAGE



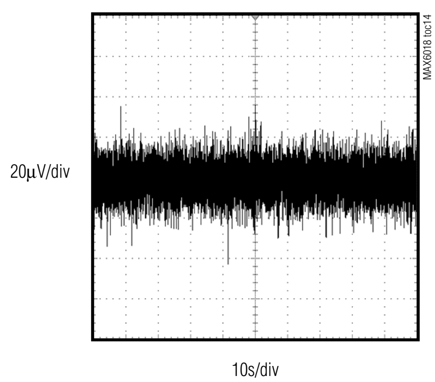
OUTPUT IMPEDANCE vs. FREQUENCY



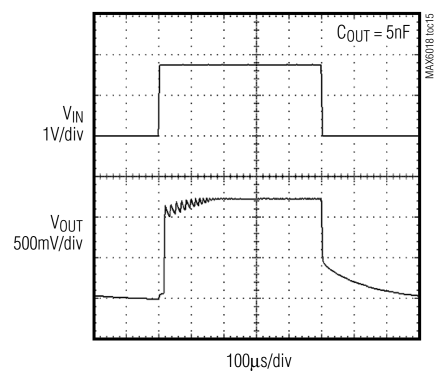
SUPPLY CURRENT vs. TEMPERATURE



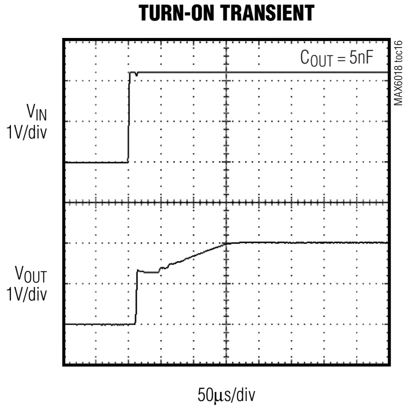
MAX6018_21
0.1Hz TO 10Hz OUTPUT NOISE



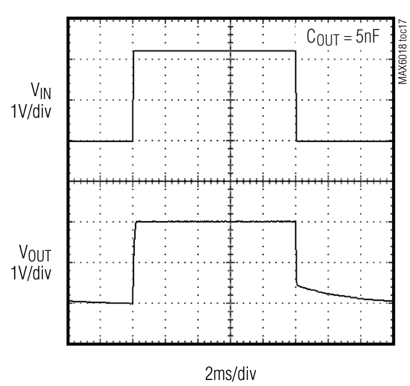
MAX6018_12
TURN-ON TRANSIENT



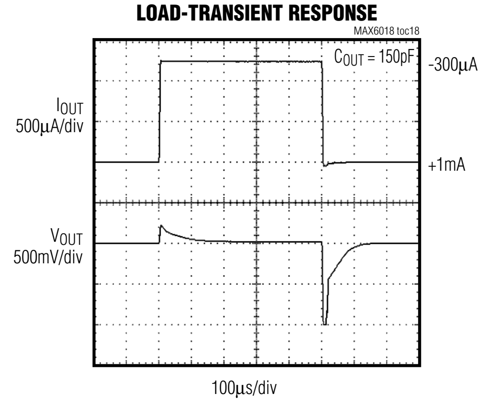
MAX6018_21
TURN-ON TRANSIENT



MAX6018_21
TURN-OFF TRANSIENT



MAX6018_12
LOAD-TRANSIENT RESPONSE

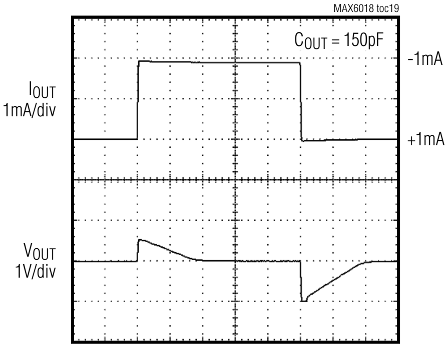


Precision, Micropower, 1.8V Supply, Low-Dropout, SOT23 Voltage Reference

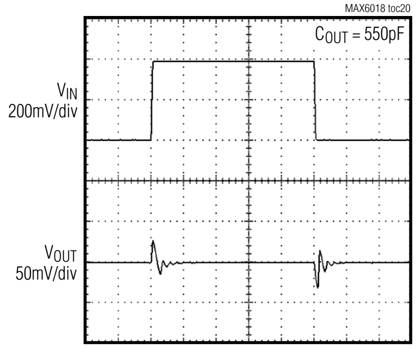
Typical Operating Characteristics (continued)

(T_A = +25°C, unless otherwise noted.)

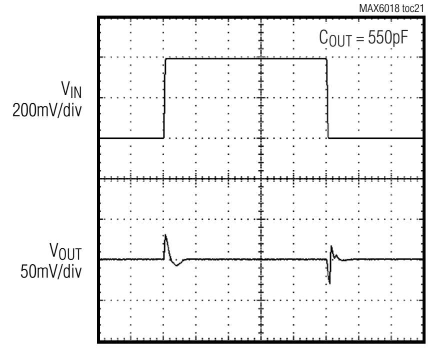
MAX6018_21
LOAD-TRANSIENT RESPONSE



MAX6018_12
LINE-TRANSIENT RESPONSE



MAX6018_21
LINE-TRANSIENT RESPONSE



Detailed Description

The MAX6018 is a precision, low-voltage, low-dropout, micropower, bandgap voltage reference in a SOT23 package. This three-terminal reference operates with an input voltage from (V_{OUT} + 200mV) to 5.5V, and is available with output voltage options of 1.2V, 1.6V, 1.8V, and 2.048V. These devices can source up to 1mA with <200mV of dropout voltage, making them attractive for use in low-voltage applications.

Applications Information

Output/Load Capacitance

These devices require a minimum of 100pF load to maintain output stability.

They remain stable for capacitive loads as high as 1µF. In applications where the load or the supply can experience step changes, a larger output capacitor reduces the amount of overshoot (or undershoot) and assists the circuit's transient response. Otherwise, applications may not need more than 100pF.

Supply Current

The 5µA maximum supply current varies only 0.1µA/V with the supply voltage.

When the supply voltage is below the minimum-specified input voltage (as during turn-on), the devices can draw up to 20µA beyond the nominal supply current. The input voltage source must be capable of providing this current to ensure reliable turn-on.

Pin Description

PIN	NAME	FUNCTION
1	IN	Supply Voltage Input. Bypass with a 0.1µF capacitor to ground.
2	OUT	Reference Voltage Output. Bypass with at least 100pF to ground. (See *Output/Load Capacitance* section).
3	GND	Ground

Turn-On Time

These devices typically turn on and settle to within 0.1% of their final value in 200µs. The turn-on time can increase up to 1ms with the device operating at the minimum dropout voltage and the maximum load.

Chip Information

TRANSISTOR COUNT: 87

PROCESS: BiCMOS

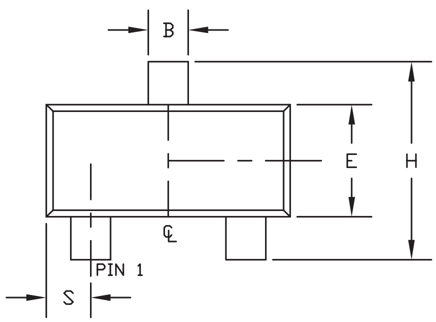
Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

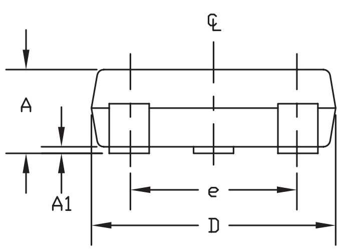
SOT23 L.EPS

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. REFERENCE JEDEC TO236.
5. LEADS TO BE COPLANAR WITHIN 0.10mm.

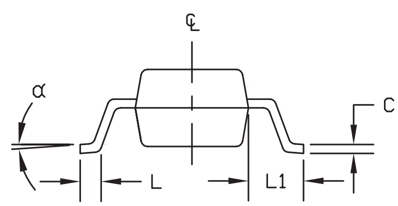
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.035	0.044	0.890	1.120
A1	0.001	0.004	0.013	0.100
B	0.015	0.020	0.370	0.510
C	0.003	0.071	0.085	0.180
D	0.110	0.120	2.800	3.040
E	0.047	0.055	1.200	1.400
e	0.070	0.081	1.780	2.050
H	0.083	0.104	2.100	2.640
L	0.008	0.017	0.210	0.420
L1	0.021 REF		0.54 REF	
S	0.018	0.024	0.45	0.60
α	0°	8°	0°	8°



TOP VIEW



FRONT VIEW



SIDE VIEW

DALLAS SEMICONDUCTOR MAXIM

PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, 3L SOT-23

APPROVAL	DOCUMENT CONTROL NO.	REV.	
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