19-1650; Rev 0; 7/00

Precision, Micropower, Low-Dropout, High-Output-Current, SO-8 Voltage References

General Description

The MAX6161–MAX6167 are precision, low-dropout, micropower voltage references. These three-terminal devices operate with an input voltage range from (V_{OUT} + 200mV) to 12.6V and are available with output voltage options of 1.25V, 2.048V, 2.5V, 3V, 4.096V, 4.5V, and 5V. They feature a proprietary curvature-correction circuit and laser-trimmed thin-film resistors that result in a very low temperature coefficient of 5ppm/°C (max) and an initial accuracy of ±2mV (max). Specifications apply to the extended temperature range (-40°C to +85°C).

The MAX6161–MAX6167 typically draw only 90µA of supply current and can source 5mA (4mA for MAX6161) or sink 2mA of load current. Unlike conventional shunt-mode (two-terminal) references that waste supply current and require an external resistor, these devices offer a supply current that is virtually independent of the supply voltage (8µA/V variation) and do not require an external resistor. Additionally, the internally compensated devices do not require an external compensation capacitor and are stable with up to 1µF of load capacitance. Eliminating the external compensation capacitor saves valuable board area in space-critical applications. Low dropout voltage and supply independent, ultra-low supply current make these devices ideal for battery-operated, high-performance, low-voltage systems.

The MAX6161–MAX6167 are available in 8-pin SO packages.

Applications

Analog-to-Digital Converters (ADCs)

Portable Battery-Powered Systems

Notebook Computers

PDAs, GPS, DMMs

Cellular Phones

Precision 3V/5V Systems

Typical Operating Circuit and Selector Guide appear at end of data sheet.

Features

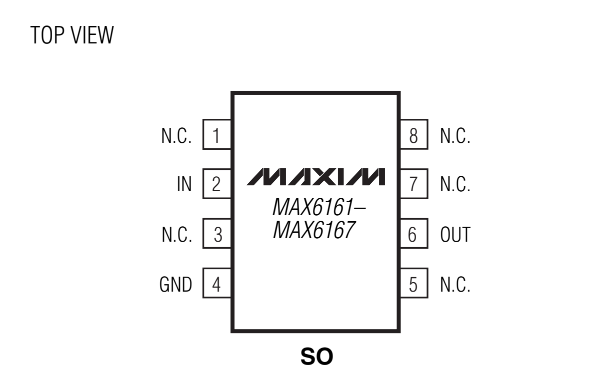
- ♦ ±2mV max Initial Accuracy
- ♦ 5ppm/°C max Temperature Coefficient
- ♦ 5mA Source Current at 0.9mV/mA
- ♦ 2mA Sink Current at 2.5mV/mA
- ♦ Stable with C_{LOAD} = 0 to 1µF
- ♦ 90µA typ Quiescent Supply Current
- ♦ 200mV max Dropout at 1mA Load Current
- ♦ 60µV/V Line Regulation
- ♦ Output Voltage Options: 1.25V, 2.048V, 2.5V, 3V, 4.096V, 4.5V, 5V

Ordering Information

PART*	TEMP. RANGE	PIN-PACKAGE	OUTPUT VOLTAGE (V)
MAX6161_ESA	-40°C to +85°C	8 SO	1.250
MAX6162_ESA	-40°C to +85°C	8 SO	2.048
MAX6163_ESA	-40°C to +85°C	8 SO	3.000
MAX6164_ESA	-40°C to +85°C	8 SO	4.096
MAX6165_ESA	-40°C to +85°C	8 SO	5.000
MAX6166_ESA	-40°C to +85°C	8 SO	2.500
MAX6167_ESA	-40°C to +85°C	8 SO	4.500

**Insert the code for the desired initial accuracy and temperature coefficient (from the Selector Guide) in the blank to complete the part number.*

Pin Configuration



Precision, Micropower, Low-Dropout, High-Output-Current, SO-8 Voltage References

ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to GND
IN ....-0.3 to +13.5V
OUT...-0.3V to (V_{IN} + 0.3V)
Output Short-Circuit Duration to GND or IN (V_{IN} ≤ 6V) ...Continuous
Output Short-Circuit Duration to GND or IN (V_{IN} > 6V)..............60s

Continuous Power Dissipation (T_A = +70°C)
8-Pin SO (derate 5.88mW/°C above +70°C)...............471mW
Operating Temperature Range ....-40°C to +85°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—MAX6161 (V_{OUT} = 1.25V)

(V_{IN} = 5V, I_{OUT} = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}	T_A = +25°C	MAX6161A	1.248	1.250	1.252	V
			MAX6161B	1.246	1.250	1.254	
Output Voltage Temperature Coefficient (Note 1)	TCV_{OUT}		MAX6161A		2	5	ppm/°C
			MAX6161B		4	10	
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	2.5V ≤ V_{IN} ≤ 12.6V			6	60	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 ≤ I_{OUT} ≤ 4mA			0.5	0.9	mV/mA
		Sinking: -2mA ≤ I_{OUT} ≤ 0			1.3	2.5	
OUT Short-Circuit Current	I_{SC}	Short to GND			25		mA
		Short to IN			25		
Long-Term Stability	ΔV_{OUT}/time	1000hr at +25°C			80		ppm/1000hr
Output Voltage Hysteresis (Note 2)	ΔV_{OUT}/cycle				80		ppm
DYNAMIC CHARACTERISTICS							
Noise Voltage	e_{OUT}	f = 0.1Hz to 10Hz			20		µVp-p
		f = 10Hz to 10kHz			15		μV_{RMS}
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5V ±100mV, f = 120Hz			80		dB
Turn-On Settling Time	t_R	V_{OUT} to 0.1% of final value, C_{OUT} = 50pF			50		µs
Capacitive-Load Stability Range (Note 3)	C_{OUT}			0		1.0	µF
INPUT CHARACTERISTICS							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		V_{OUT} + 0.2		12.6	V
Quiescent Supply Current	I_{IN}				90	120	µA
Change in Supply Current	$\Delta I_{IN}/\Delta V_{IN}$	2.5V ≤ V_{IN} ≤ 12.6V			3.2	8.0	µA/V

Precision, Micropower, Low-Dropout, High-Output-Current, SO-8 Voltage References

ELECTRICAL CHARACTERISTICS—MAX6162 (V_{OUT} = 2.048V)

(V_{IN} = 5V, I_{OUT} = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}	T_A = +25°C	MAX6162A	2.046	2.048	2.050	V
			MAX6162B	2.043	2.048	2.053	
Output Voltage Temperature Coefficient (Note 1)	TCV_{OUT}		MAX6162A		2	5	ppm/°C
			MAX6162B		4	10	
Line Regulation	$\Delta V_{OUT}/$	2.5V $\leq V_{IN} \leq$ 12.6V			42	130	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 $\leq I_{OUT} \leq$ 5mA			0.5	0.9	mV/mA
		Sinking: -2mA $\leq I_{OUT} \leq$ 0			1.5	4	
OUT Short-Circuit Current	I_{SC}	Short to GND			25		mA
		Short to IN			25		
Long-Term Stability	$\Delta V_{OUT}/$ time	1000hr at +25°C			80		ppm/ 1000hr
Output Voltage Hysteresis (Note 2)	$\Delta V_{OUT}/$ cycle				80		ppm
DYNAMIC CHARACTERISTICS							
Noise Voltage	e_{OUT}	f = 0.1Hz to 10Hz			22		µVp-p
		f = 10Hz to 10kHz			22		μV_{RMS}
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5V ±100mV, f = 120Hz			78		dB
Turn-On Settling Time	t_R	V_{OUT} to 0.1% of final value, C_{OUT} = 50pF			100		µs
Capacitive-Load Stability Range (Note 3)	C_{OUT}			0		1.0	µF
INPUT CHARACTERISTICS							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		V_{OUT} + 0.2		12.6	V
Quiescent Supply Current	I_{IN}				90	120	µA
Change in Supply Current	$\Delta I_{IN}/\Delta V_{IN}$	2.5V $\leq V_{IN} \leq$ 12.6V			3.4	8.0	µA/V

Precision, Micropower, Low-Dropout, High-Output-Current, SO-8 Voltage References

ELECTRICAL CHARACTERISTICS—MAX6166 (V_{OUT} = 2.500V)

(V_{IN} = 5V, I_{OUT} = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}	T_A = +25°C	MAX6166A	2.498	2.500	2.502	V
			MAX6166B	2.495	2.500	2.505	
Output Voltage Temperature Coefficient (Note 1)	TCV_{OUT}		MAX6166A		2	5	ppm/°C
			MAX6166B		4	10	
Dropout Voltage (Note 4)	V_{IN} - V_{OUT}	I_{OUT} = 1mA			50	200	mV
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	V_{OUT} + 0.2V ≤ V_{IN} ≤ 12.6V			60	220	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 ≤ I_{OUT} ≤ 5mA			0.5	0.9	mV/mA
		Sinking: -2mA ≤ I_{OUT} ≤ 0			1.6	5	
OUT Short-Circuit Current	I_{SC}	Short to GND			25		mA
		Short to IN			25		
Long-Term Stability	ΔV_{OUT}/time	1000hr at +25°C			80		ppm/1000hr
Output Voltage Hysteresis (Note 2)	ΔV_{OUT}/cycle				80		ppm
DYNAMIC CHARACTERISTICS							
Noise Voltage	e_{OUT}	f = 0.1Hz to 10Hz			27		µVp-p
		f = 10Hz to 10kHz			30		μV_{RMS}
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5V ±100mV, f = 120Hz			76		dB
Turn-On Settling Time	t_R	V_{OUT} to 0.1% of final value, C_{OUT} = 50pF			115		µs
Capacitive-Load Stability Range (Note 3)	C_{OUT}			0		1.0	µF
INPUT CHARACTERISTICS							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		V_{OUT} + 0.2		12.6	V
Quiescent Supply Current	I_{IN}				90	120	µA
Change in Supply Current	$\Delta I_{IN}/\Delta V_{IN}$	V_{OUT} + 0.2V ≤ V_{IN} ≤ 12.6V			3.2	8.0	µA/V

ELECTRICAL CHARACTERISTICS—MAX6163 (V_{OUT} = 3.000V)

(V_{IN} = 5V, I_{OUT} = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}	T_A = +25°C	MAX6163A	2.998	3.000	3.002	V
			MAX6163B	2.995	3.000	3.005	
Output Voltage Temperature Coefficient (Note 1)	TCV_{OUT}	-40°C to +85°C	MAX6163A		2	5	ppm/°C
			MAX6163B		4	10	
Dropout Voltage (Note 4)	V_{IN} - V_{OUT}	I_{OUT} = 1mA			50	200	mV
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	V_{OUT} + 0.2V ≤ V_{IN} ≤ 12.6V			83	300	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 ≤ I_{OUT} ≤ 5mA			0.5	0.9	mV/mA
		Sinking: -2mA ≤ I_{OUT} ≤ 0			1.8	5	
OUT Short-Circuit Current	I_{SC}	Short to GND			25		mA
		Short to IN			25		
Long-Term Stability	ΔV_{OUT}/time	1000hr at +25°C			80		ppm/1000hr
Output Voltage Hysteresis (Note 2)	ΔV_{OUT}/cycle				80		ppm
DYNAMIC CHARACTERISTICS							
Noise Voltage	e_{OUT}	f = 0.1Hz to 10Hz			35		µVp-p
		f = 10Hz to 10kHz			40		μV_{RMS}
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5V ±100mV, f = 120Hz			76		dB
Turn-On Settling Time	t_R	V_{OUT} to 0.1% of final value, C_{OUT} = 50pF			115		µs
Capacitive-Load Stability Range (Note 3)	C_{OUT}			0		1.0	µF
INPUT CHARACTERISTICS							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		V_{OUT} + 0.2		12.6	V
Quiescent Supply Current	I_{IN}				90	120	µA
Change in Supply Current	$\Delta I_{IN}/\Delta V_{IN}$	V_{OUT} + 0.2V ≤ V_{IN} ≤ 12.6V			3.2	8.0	µA/V

ELECTRICAL CHARACTERISTICS—MAX6164 (V_{OUT} = 4.096V)

(V_{IN} = 5V, I_{OUT} = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}	T_A = +25°C	MAX6164A	4.094	4.096	4.098	V
			MAX6164B	4.091	4.096	4.101	
Output Voltage Temperature Coefficient (Note 1)	TCV_{OUT}		MAX6164A		2	5	ppm/°C
			MAX6164B		4	10	
Dropout Voltage (Note 4)	V_{IN} - V_{OUT}	I_{OUT} = 1mA			50	200	mV
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	V_{OUT} + 0.2V ≤ V_{IN} ≤ 12.6V			140	300	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 ≤ I_{OUT} ≤ 5mA			0.6	0.9	mV/mA
		Sinking: -2mA ≤ I_{OUT} ≤ 0			2.0	7.0	
OUT Short-Circuit Current	I_{SC}	Short to GND			25		mA
		Short to IN			25		
Long-Term Stability	ΔV_{OUT}/time	1000hr at +25°C			80		ppm/1000hr
Output Voltage Hysteresis (Note 2)	ΔV_{OUT}/cycle				80		ppm
DYNAMIC CHARACTERISTICS							
Noise Voltage	e_{OUT}	f = 0.1Hz to 10Hz			50		µVp-p
		f = 10Hz to 10kHz			50		μV_{RMS}
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5V ±100mV, f = 120Hz			72		dB
Turn-On Settling Time	t_R	V_{OUT} to 0.1% of final value, C_{OUT} = 50pF			190		µs
Capacitive-Load Stability Range (Note 3)	C_{OUT}			0		1.0	µF
INPUT CHARACTERISTICS							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		V_{OUT} + 0.2		12.6	V
Quiescent Supply Current	I_{IN}				90	120	µA
Change in Supply Current	$\Delta I_{IN}/\Delta V_{IN}$	V_{OUT} + 0.2V ≤ V_{IN} ≤ 12.6V			3.2	8.0	µA/V

ELECTRICAL CHARACTERISTICS—MAX6167 (V_{OUT} = 4.500V)

(V_{IN} = 5V, I_{OUT} = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}	T_A = +25°C	MAX6167A	4.498	4.500	4.502	V
			MAX6167B	4.495	4.500	4.505	
Output Voltage Temperature Coefficient (Note 1)	TCV_{OUT}		MAX6167A		2	5	ppm/°C
			MAX6167B		4	10	
Dropout Voltage (Note 4)	V_{IN} - V_{OUT}	I_{OUT} = 1mA			50	200	mV
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	V_{OUT} + 0.2V ≤ V_{IN} ≤ 12.6V			160	450	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 ≤ I_{OUT} ≤ 5mA			0.6	0.9	mV/mA
		Sinking: -2mA ≤ I_{OUT} ≤ 0			2.3	8.0	
OUT Short-Circuit Current	I_{SC}	Short to GND			25		mA
		Short to IN			25		
Long-Term Stability	ΔV_{OUT}/time	1000hr at +25°C			80		ppm/1000hr
Output Voltage Hysteresis (Note 2)	ΔV_{OUT}/cycle				80		ppm
DYNAMIC CHARACTERISTICS							
Noise Voltage	e_{OUT}	f = 0.1Hz to 10Hz			55		µVp-p
		f = 10Hz to 10kHz			55		μV_{RMS}
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5V ±100mV, f = 120Hz			70		dB
Turn-On Settling Time	t_R	V_{OUT} to 0.1% of final value, C_{OUT} = 50pF			230		µs
Capacitive-Load Stability Range (Note 3)	C_{OUT}			0		1.0	µF
INPUT CHARACTERISTICS							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		V_{OUT} + 0.2		12.6	V
Quiescent Supply Current	I_{IN}				90	120	µA
Change in Supply Current	$\Delta I_{IN}/\Delta V_{IN}$	V_{OUT} + 0.2V ≤ V_{IN} ≤ 12.6V			3.1	8.0	µA/V

ELECTRICAL CHARACTERISTICS—MAX6165 (V_{OUT} = 5.000V)

(V_{IN} = 5V, I_{OUT} = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Output Voltage	V_{OUT}	T_A = +25°C	MAX6165A	4.998	5.000	5.002	V
			MAX6165B	4.995	5.000	5.005	
Output Voltage Temperature Coefficient (Note 1)	TCV_{OUT}		MAX6165A		2	5	ppm/°C
			MAX6165B		4	10	
Dropout Voltage (Note 4)	V_{IN} - V_{OUT}	I_{OUT} = 1mA			50	200	mV
Line Regulation	$\Delta V_{OUT}/$	V_{OUT} + 0.2V ≤ V_{IN} ≤ 12.6V			180	400	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 ≤ I_{OUT} ≤ 5mA			0.6	0.9	mV/mA
		Sinking: -2mA ≤ I_{OUT} ≤ 0			2.4	8.0	
OUT Short-Circuit Current	I_{SC}	Short to GND			25		mA
		Short to IN			25		
Long-Term Stability	$\Delta V_{OUT}/$ time	1000hr at +25°C			80		ppm/ 1000hr
Output Voltage Hysteresis (Note 2)	$\Delta V_{OUT}/$ cycle				80		ppm
DYNAMIC CHARACTERISTICS							
Noise Voltage	e_{OUT}	f = 0.1Hz to 10Hz			60		µVp-p
		f = 10Hz to 10kHz			60		μV_{RMS}
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5V ± 100mV, f = 120Hz			65		dB
Turn-On Settling Time	t_R	V_{OUT} to 0.1% of final value, C_{OUT} = 50pF			300		µs
Capacitive-Load Stability Range (Note 3)	C_{OUT}			0		1.0	µF
INPUT CHARACTERISTICS							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		V_{OUT} + 0.2		12.6	V
Quiescent Supply Current	I_{IN}				90	120	µA
Change in Supply Current	$\Delta I_{IN}/\Delta V_{IN}$	V_{OUT} + 0.2V ≤ V_{IN} ≤ 12.6V			3.1	8.0	µA/V

Note 1: Temperature Coefficient is specified by the "box" method; i.e., the maximum ΔV_{OUT} is divided by the maximum ΔT.

Note 2: 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.

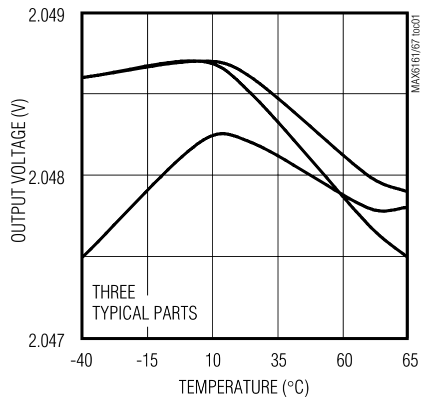
Note 3: Not production tested. Guaranteed by design.

Note 4: Dropout voltage is the minimum input voltage at which V_{OUT} changes ≤ 0.2% from V_{OUT} at V_{IN} = 5.0V (V_{IN} = 5.5V for MAX6165).

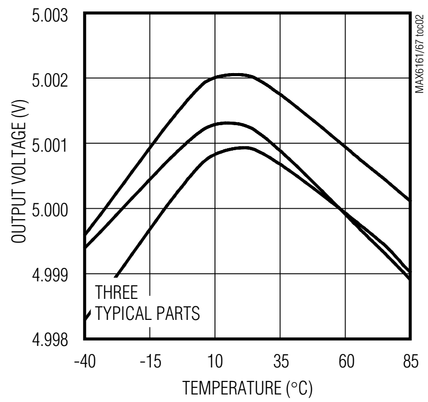
Typical Operating Characteristics

(V_{IN} = +5V for MAX6161/2/3/4/6/7, V_{IN} = +5.5V for MAX6165, I_{OUT} = 0, T_A = +25°C, unless otherwise noted.) (Note 5)

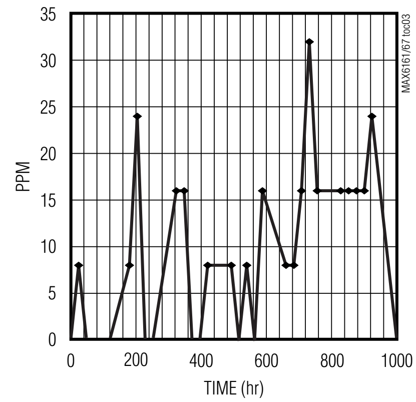
MAX6162
OUTPUT VOLTAGE TEMPERATURE DRIFT



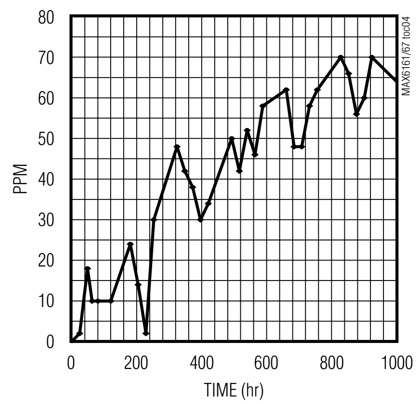
MAX6165
OUTPUT VOLTAGE TEMPERATURE DRIFT



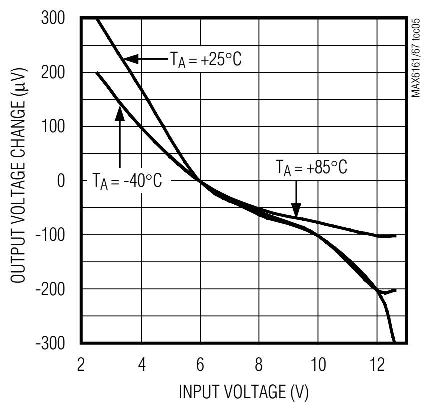
MAX6161
PPM vs. TIME



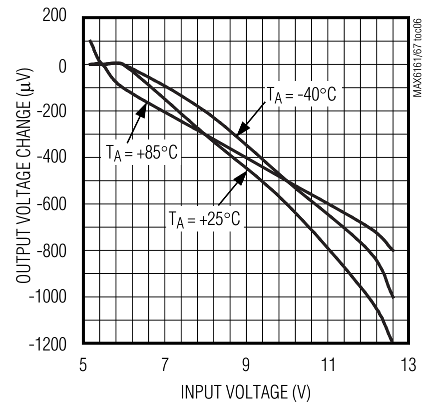
MAX6165
PPM vs. TIME



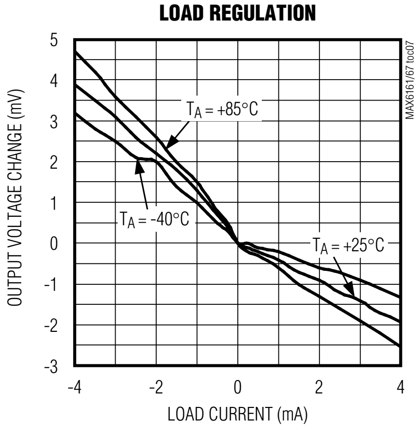
MAX6161
LINE REGULATION



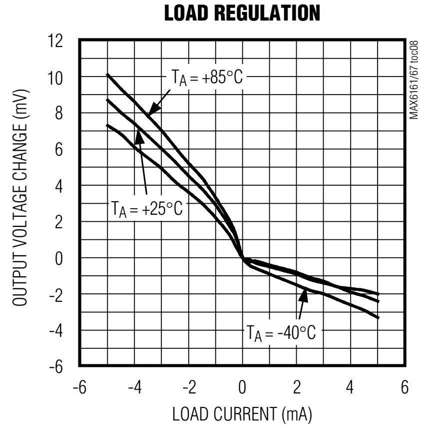
MAX6165
LINE REGULATION



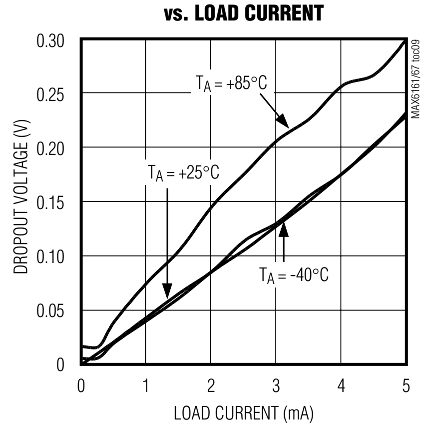
MAX6161
LOAD REGULATION



MAX6165
LOAD REGULATION



MAX6166
DROPOUT VOLTAGE
vs. LOAD CURRENT

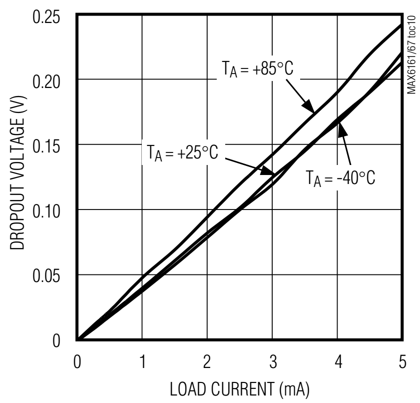


Precision, Micropower, Low-Dropout, High-Output-Current, SO-8 Voltage References

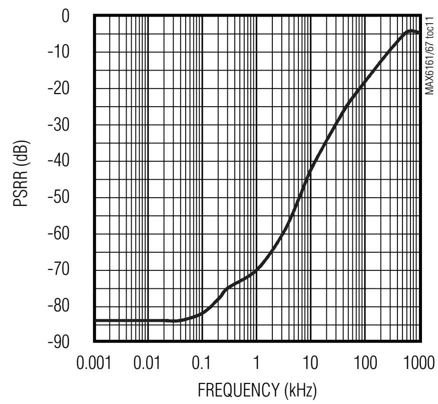
Typical Operating Characteristics (continued)

(V_{IN} = +5V for MAX6161/2/3/4/6/7, V_{IN} = +5.5V for MAX6165, I_{OUT} = 0, T_A = +25°C, unless otherwise noted.) (Note 5)

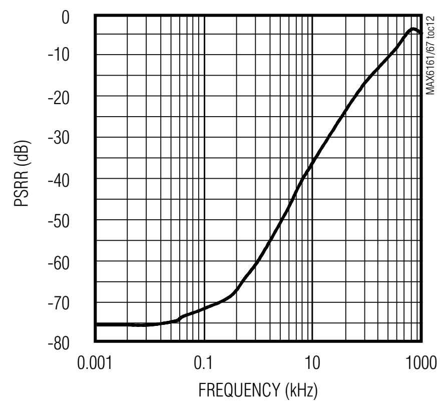
MAX6165 DROPOUT VOLTAGE vs. LOAD CURRENT



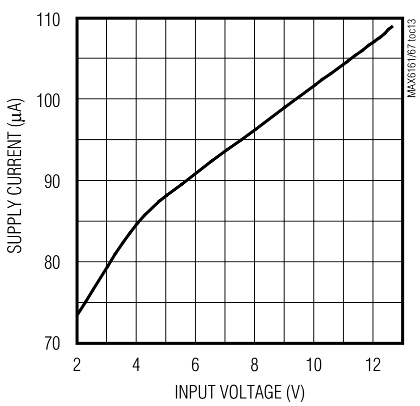
MAX6161 POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



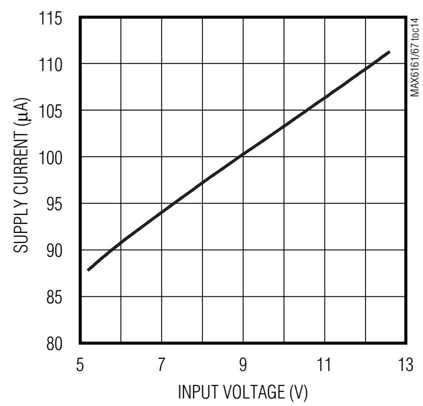
MAX6165 POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



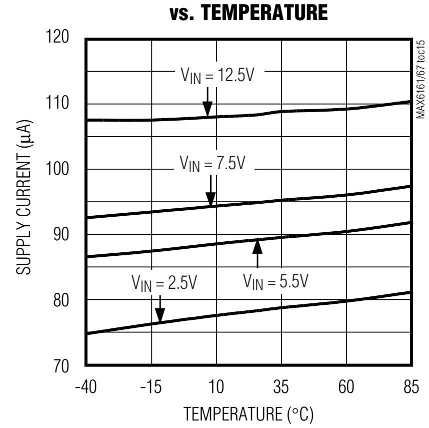
MAX6161 SUPPLY CURRENT vs. INPUT VOLTAGE



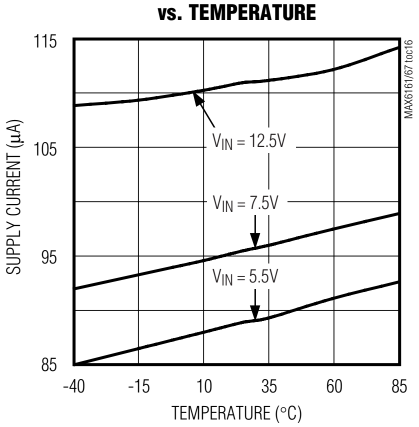
MAX6165 SUPPLY CURRENT vs. INPUT VOLTAGE



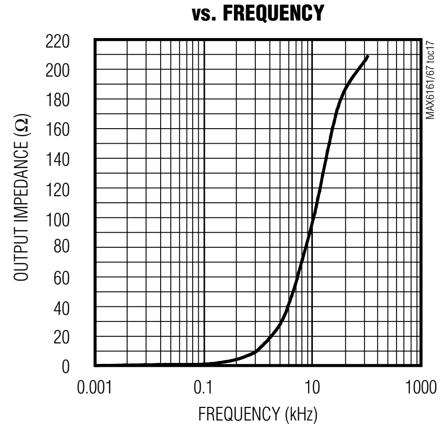
MAX6161 SUPPLY CURRENT vs. TEMPERATURE



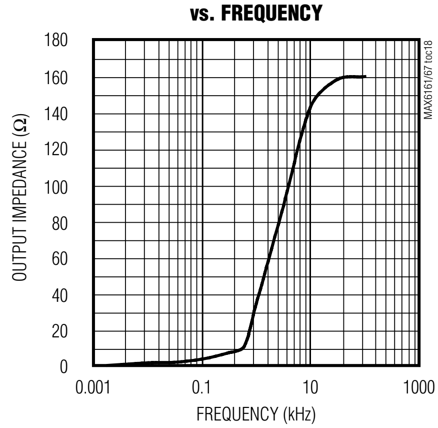
MAX6165 SUPPLY CURRENT vs. TEMPERATURE



MAX6161 OUTPUT IMPEDANCE vs. FREQUENCY



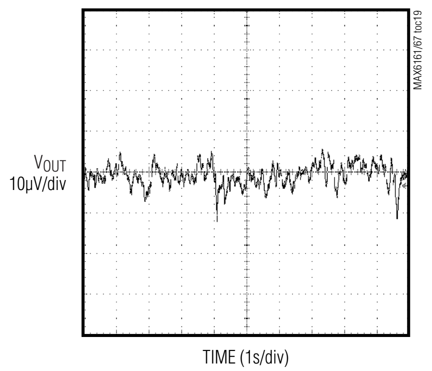
MAX6165 OUTPUT IMPEDANCE vs. FREQUENCY



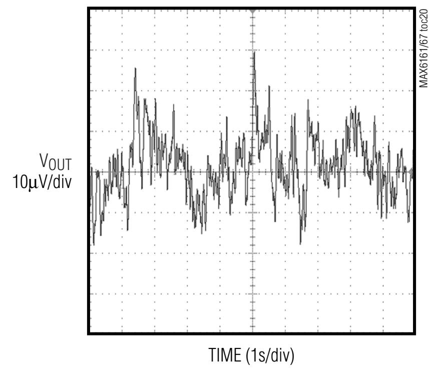
Typical Operating Characteristics (continued)

(V_{IN} = +5V for MAX6161/2/3/4/6/7, V_{IN} = +5.5V for MAX6165, I_{OUT} = 0, T_A = +25°C, unless otherwise noted.) (Note 5)

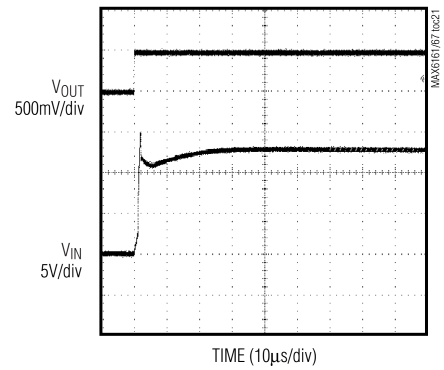
MAX6161
0.1Hz TO 10Hz OUTPUT NOISE



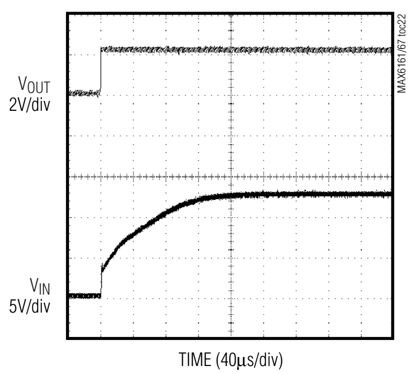
MAX6165
NOISE



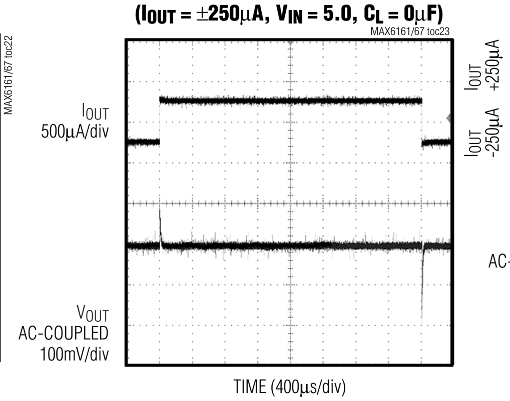
MAX6161
TURN-ON TRANSIENT
(C_L = 50pF)



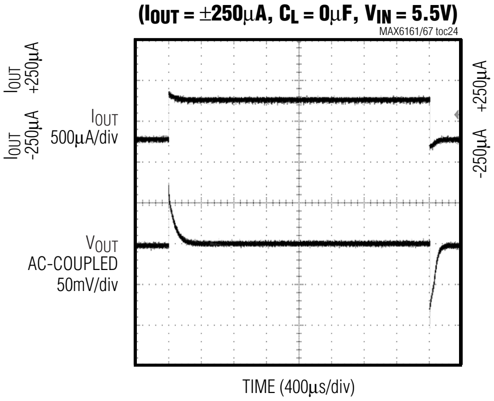
MAX6165
TURN-ON TRANSIENT
(C_L = 50pF)



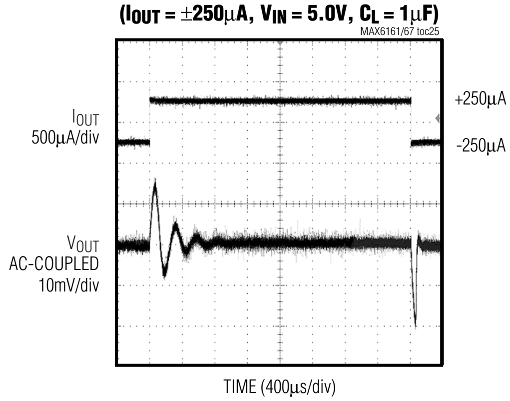
MAX6161
LOAD TRANSIENT
(I_{OUT} = ±250µA, V_{IN} = 5.0, C_L = 0µF)



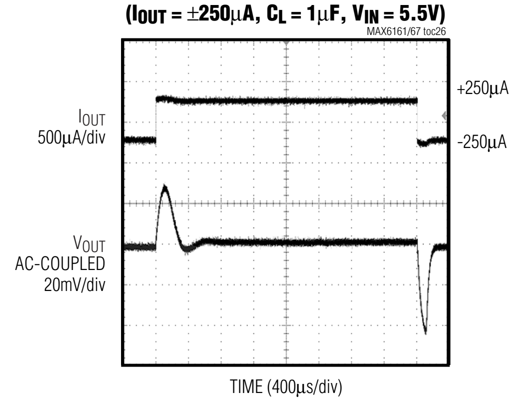
MAX6165
LOAD TRANSIENT
(I_{OUT} = ±250µA, C_L = 0µF, V_{IN} = 5.5V)



MAX6161
LOAD TRANSIENT
(I_{OUT} = ±250µA, V_{IN} = 5.0V, C_L = 1µF)



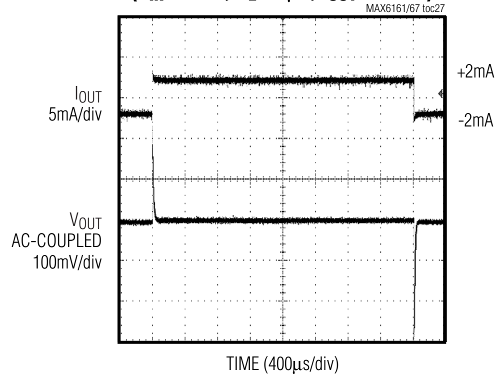
MAX6165
LOAD TRANSIENT
(I_{OUT} = ±250µA, C_L = 1µF, V_{IN} = 5.5V)



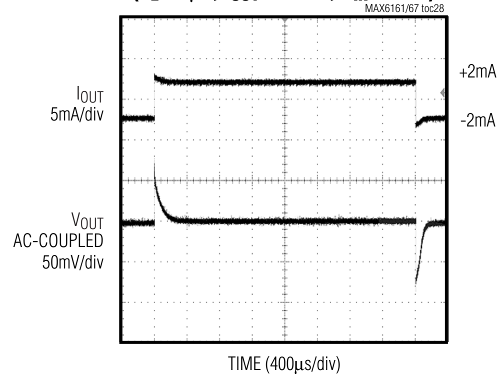
Typical Operating Characteristics (continued)

(V_{IN} = +5V for MAX6161/2/3/4/6/7, V_{IN} = +5.5V for MAX6165, I_{OUT} = 0, T_A = +25°C, unless otherwise noted.) (Note 5)

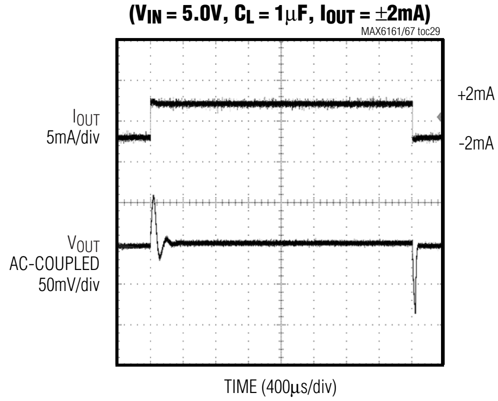
MAX6161 LOAD TRANSIENT (V_{IN} = 5.0V, C_L = 0µF, I_{OUT} = ±2mA)



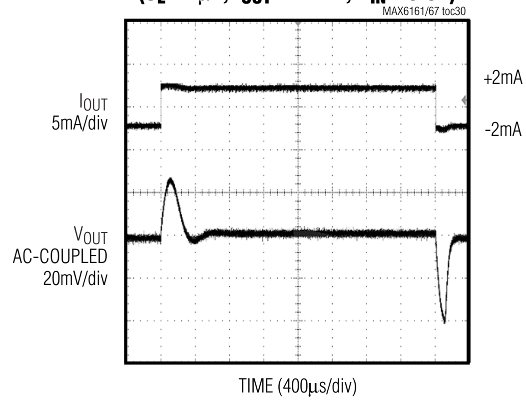
MAX6165 LOAD TRANSIENT (C_L = 0µF, I_{OUT} = ±2mA, V_{IN} = 5.5V)



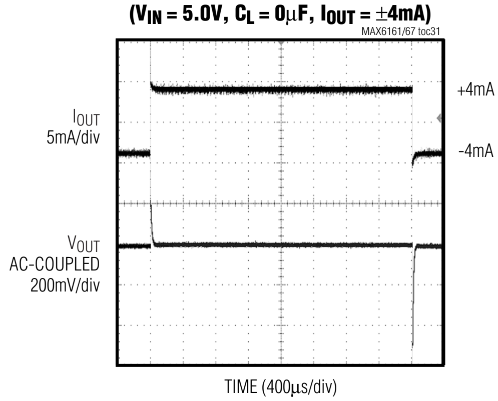
MAX6161 LOAD TRANSIENT (V_{IN} = 5.0V, C_L = 1µF, I_{OUT} = ±2mA)



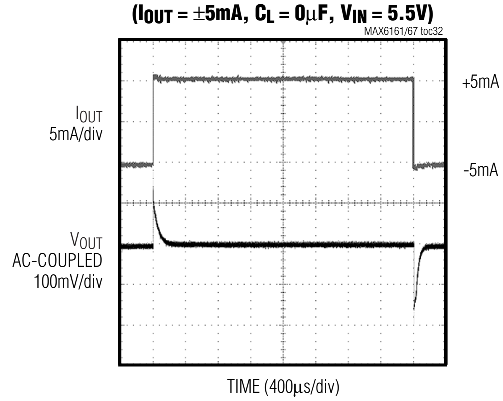
MAX6165 LOAD TRANSIENT (C_L = 1µF, I_{OUT} = ±2mA, V_{IN} = 5.5V)



MAX6161 LOAD TRANSIENT (V_{IN} = 5.0V, C_L = 0µF, I_{OUT} = ±4mA)



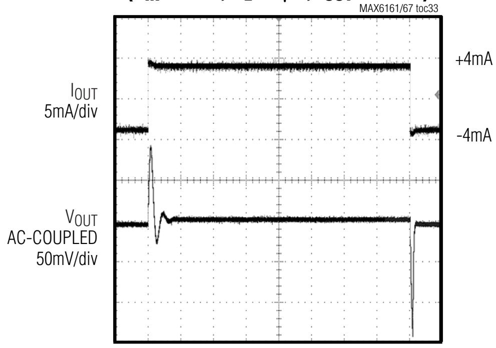
MAX6165 LOAD TRANSIENT (I_{OUT} = ±5mA, C_L = 0µF, V_{IN} = 5.5V)



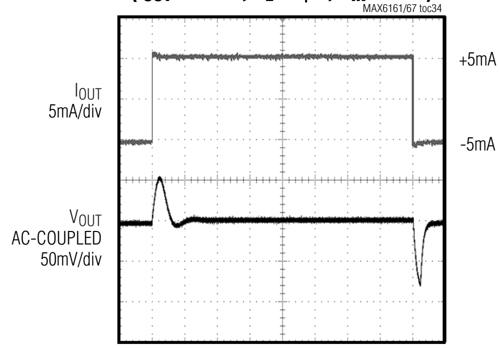
Typical Operating Characteristics (continued)

(V_{IN} = +5V for MAX6161/2/3/4/6/7, V_{IN} = +5.5V for MAX6165, I_{OUT} = 0, T_A = +25°C, unless otherwise noted.) (Note 5)

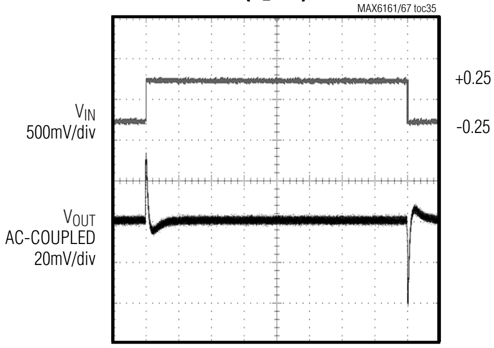
MAX6161 LOAD TRANSIENT (V_{IN} = 5.0V, C_L = 1µF, I_{OUT} = ±4mA)



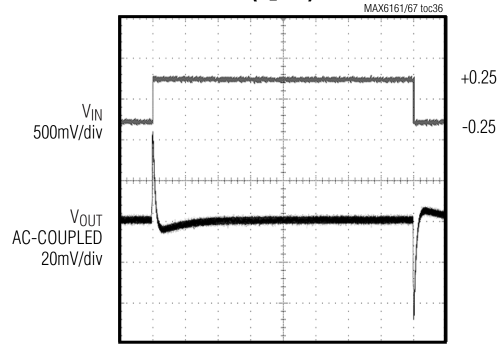
MAX6165 LOAD TRANSIENT (I_{OUT} = ±5mA, C_L = 1µF, V_{IN} = 5.5V)



MAX6161 LINE TRANSIENT (C_L = 0)



MAX6165 LINE TRANSIENT (C_L = 0)



Note 5: Many of the MAX6161 family *Typical Operating Characteristics* are extremely similar. The extremes of these characteristics are found in the MAX6161 (1.25V output) and the MAX6165 (5.0V output). The *Typical Operating Characteristics* of the remainder of the MAX6161 family typically lie between these two extremes and can be estimated based on their output voltages.

Pin Description

PIN MAX617_	NAME	FUNCTION
1, 3, 5, 7, 8	N.C.	No Connection. Not internally connected.
2	IN	Input Voltage
6	OUT	Reference Output
4	GND	Ground

Applications Information

Input Bypassing

For the best line-transient performance, decouple the input with a 0.1µF ceramic capacitor as shown in the *Typical Operating Circuit*. Locate the capacitor as close to IN as possible. When transient performance is less important, no capacitor is necessary.

Output/Load Capacitance

Devices in the MAX6161 family do not require an output capacitor for frequency stability. They are stable for capacitive loads from 0 to 1µF. However, in applications where the load or the supply can experience step changes, an output capacitor will reduce the amount of overshoot (undershoot) and improve the circuit's transient response. Many applications do not require an external capacitor, and the MAX6161 family can offer a significant advantage in applications when board space is critical.

Supply Current

The quiescent supply current of the series-mode MAX6161 family is typically 90µA and is virtually independent of the supply voltage, with only a 8µA/V (max) variation with supply voltage. Unlike series references, shunt-mode references operate with a series resistor connected to the power supply. The quiescent current of a shunt-mode reference is thus a function of the input voltage. Additionally, shunt-mode references have to be biased at the maximum expected load current, even if the load current is not present at the time. In the MAX6161 family, the load current is drawn from the input voltage only when required, so supply current is not wasted and efficiency is maximized at all input voltages. This improved efficiency reduces power dissipation and extends battery life.

When the supply voltage is below the minimum specified input voltage (as during turn-on), the devices can draw up to 400µA beyond the nominal supply current. The input voltage source must be capable of providing this current to ensure reliable turn-on.

Output Voltage Hysteresis

Output voltage hysteresis is the change in the input voltage at T_A = +25°C before and after the device is cycled over its entire operating temperature range. Hysteresis is caused by differential package stress appearing across the bandgap core transistors. The typical temperature hysteresis value is 80ppm.

Turn-On Time

These devices typically turn on and settle to within 0.1% of their final value in 50µs to 300µs, depending on the output voltage (see electrical table of part used). The turn-on time can increase up to 1.5ms with the device operating at the minimum dropout voltage and the maximum load.

Positive and Negative Low-Power Voltage Reference

Figure 1 shows a typical method for developing a bipolar reference. The circuit uses a MAX681 voltage doubler/inverter charge-pump converter to power an ICL7652, thus creating a positive as well as a negative reference voltage.

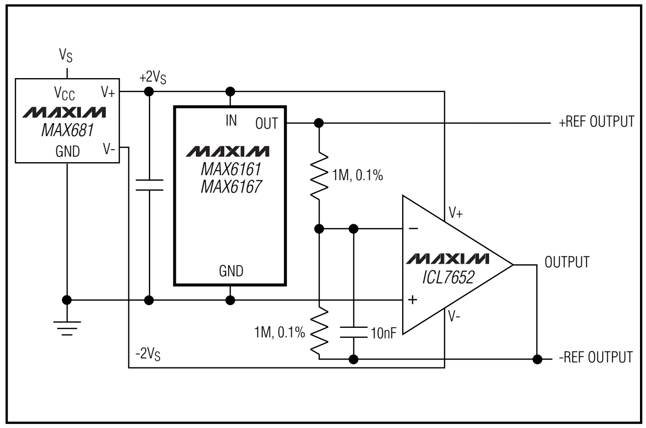
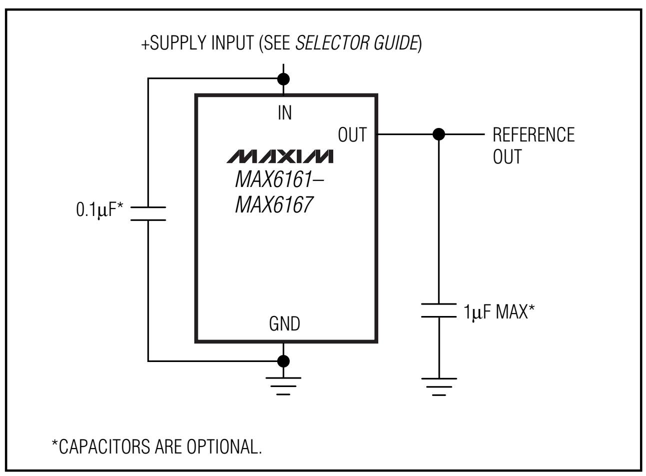


Figure 1. Positive and Negative References from Single +3V or +5V Supply

Typical Operating Circuit



Chip Topography

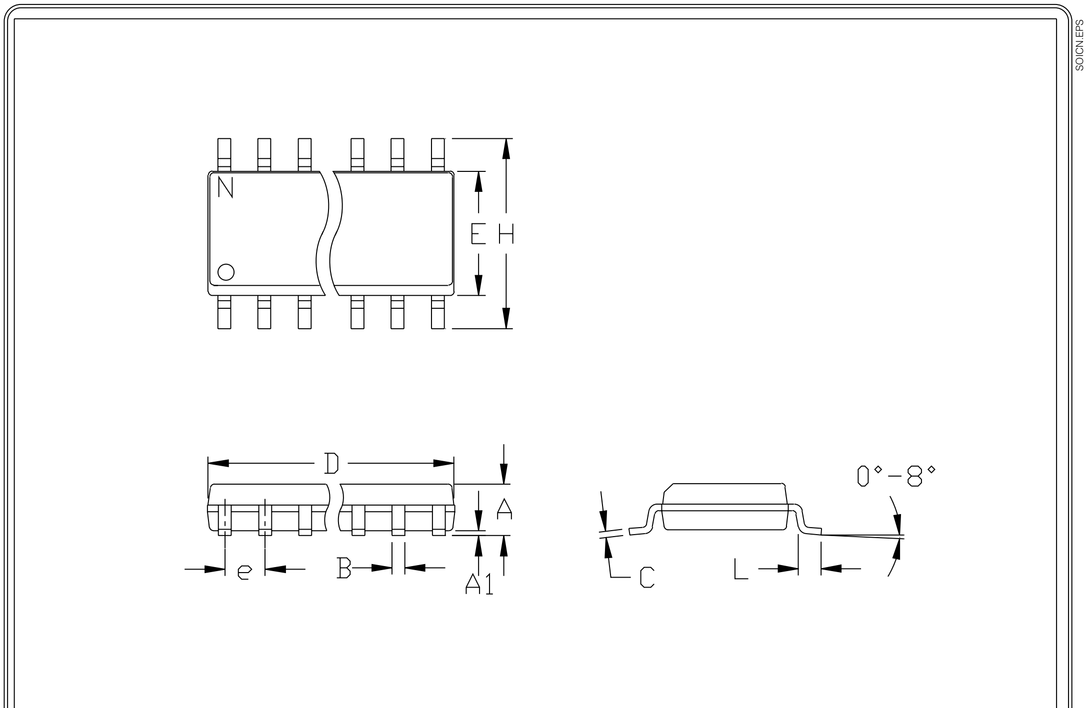
TRANSISTOR COUNT:117

PROCESS: BiCMOS

Selector Guide

PART	OUTPUT VOLTAGE (V)	INITIAL ACCURACY (mV)	TEMPERATURE COEFFICIENT (ppm/°C)
MAX6161A	1.250	±2	5
MAX6161B	1.250	±4	10
MAX6162A	2.048	±2	5
MAX6162B	2.048	±5	10
MAX6166A	2.500	±2	5
MAX6166B	2.500	±5	10
MAX6163A	3.000	±2	5
MAX6163B	3.000	±5	10
MAX6164A	4.096	±2	5
MAX6164B	4.096	±5	10
MAX6167A	4.500	±2	5
MAX6167B	4.500	±5	10
MAX6165A	5.000	±2	5
MAX6165B	5.000	±5	10

Package Information



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
e	0.050		1.27	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
h	0.010	0.020	0.25	0.50
L	0.016	0.050	0.40	1.27

	INCHES		MILLIMETERS			
	MIN	MAX	MIN	MAX	N	MS012
D	0.189	0.197	4.80	5.00	8	A
D	0.337	0.344	8.55	8.75	14	B
D	0.386	0.394	9.80	10.00	16	C

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. LEADS TO BE COPLANAR WITHIN .102mm (.004")
4. CONTROLLING DIMENSION: MILLIMETER
5. MEETS JEDEC MS012-XX AS SHOWN IN ABOVE TABLE
6. N = NUMBER OF PINS

MAXIM 120 SAN GABRIEL DR SUNNYVALE CA 94086 FAX (408) 737 7194 PROPRIETARY INFORMATION | TITLE: PACKAGE FAMILY OUTLINE: SOIC .150" | 1/1 | DOCUMENT CONTROL NUMBER: 21-0041 REV: A