MAX6190–MAX6195/MAX6198

Precision, Micropower, Low-Dropout Voltage References

General Description

The MAX6190–MAX6195/MAX6198 precision, micropower, low-dropout voltage references offer high initial accuracy and very low temperature coefficient through a proprietary curvature-correction circuit and laser-trimmed precision thin-film resistors.

These series-mode bandgap references draw a maximum of only 35µA quiescent supply current, making them ideal for battery-powered instruments. They offer a supply current that is virtually immune to input voltage variations. Load-regulation specifications are guaranteed for source and sink currents up to 500µA. These devices are internally compensated, making them ideal for applications that require fast settling, and are stable with capacitive loads up to 2.2nF.

Selector Guide

PART	OUTPUT VOLTAGE (V)	INITIAL ACCURACY (mV)	TEMPERATURE COEFFICIENT (ppm/°C)
MAX6190A	1.250	±2	<5
MAX6190B	1.250	±4	<10
MAX6190C	1.250	±6	<25
MAX6191A	2.048	±2	<5
MAX6191B	2.048	±5	<10
MAX6191C	2.048	±10	<25
MAX6192A	2.500	±2	<5
MAX6192B	2.500	±5	<10
MAX6192C	2.500	±10	<25
MAX6193A	3.000	±2	<5
MAX6193B	3.000	±5	<10
MAX6193C	3.000	±10	<25
MAX6198A	4.096	±2	<5
MAX6198B	4.096	±5	<10
MAX6198C	4.096	±10	<25
MAX6194A	4.500	±2	<5
MAX6194B	4.500	±5	<10
MAX6194C	4.500	±10	<25
MAX6195A	5.000	±2	<5
MAX6195B	5.000	±5	<10
MAX6195C	5.000	±10	<25

Typical Operating Circuit appears at end of data sheet.

Features

- ±2mV (max) Initial Accuracy
- 5ppm/°C (max) Temperature Coefficient
- 35µA (max) Supply Current
- 100mV Dropout at 500µA Load Current
- 0.12µV/µA Load Regulation
- 8µV/V Line Regulation

Applications

Hand-Held Instruments

Analog-to-Digital and Digital-to-Analog Converters

Industrial Process Control

Precision 3V/5V Systems

Hard-Disk Drives

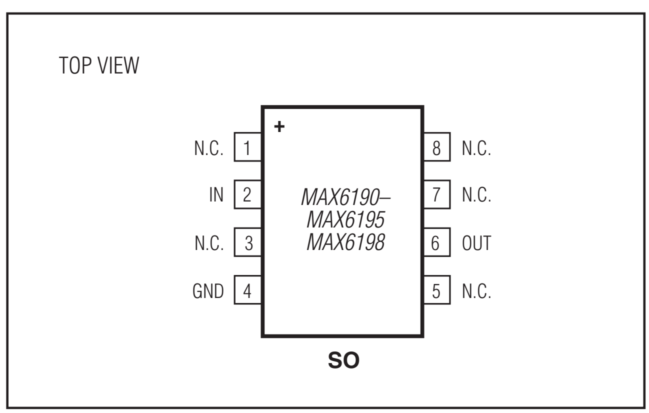
Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX6190AESA+	-40°C to +85°C	8 SO
MAX6190BESA+	-40°C to +85°C	8 SO
MAX6190CESA+	-40°C to +85°C	8 SO
MAX6191AESA+	-40°C to +85°C	8 SO
MAX6191BESA+	-40°C to +85°C	8 SO
MAX6191CESA+	-40°C to +85°C	8 SO
MAX6192AESA+	-40°C to +85°C	8 SO
MAX6192BESA+	-40°C to +85°C	8 SO
MAX6192CESA+	-40°C to +85°C	8 SO

Ordering Information continued at end of data sheet.

+Denotes a lead(Pb)-free /RoHS-compliant package.

Pin Configuration



ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to GND
IN ....-0.3V to +13.5V
OUT ....-0.3V to (V_{IN} + 0.3V)
Output Short Circuit to GND or IN (V_{IN} < 6V) ....Continuous
Output Short Circuit 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
Junction Temperature ....+150°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10s) ....+300°C
Soldering Temperature (reflow) ....+260°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—MAX6190

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

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
OUTPUT							
Output Voltage	V_{OUT}	T_A = +25°C	MAX6190A	1.248	1.250	1.252	V
			MAX6190B	1.246	1.250	1.254	
			MAX6190C	1.244	1.250	1.256	
Output-Voltage Temperature Coefficient (Note 1)	TCV_{OUT}	MAX6190A			2	5	ppm/°C
		MAX6190B			4	10	
		MAX6190C			8	25	
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	2.5V ≤ V_{IN} ≤ 12.6V			8	80	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 ≤ I_{OUT} ≤ 500µA			0.12	0.5	µV/µA
		Sinking: -500µA ≤ I_{OUT} ≤ 0			0.15	0.6	
Short-Circuit Current	I_{SC}	Short to GND			4		mA
		Short to IN			4		
Temperature Hysteresis (Note 2)	ΔV_{OUT}/cycle				75		ppm
Long-Term Stability	ΔV_{OUT}/time	1000hrs at +25°C			50		ppm/1000hrs
DYNAMIC							
Noise Voltage	e_{OUT}	0.1Hz to 10Hz			25		$µV_{P-P}$
		10Hz to 10kHz			65		$µV_{RMS}$
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5V ±100mV, f = 120Hz			86		dB
Turn-On Settling Time	t_R	To 0.1%, C_{OUT} = 50pF			30		µs
Capacitive-Load Stability Range	C_{OUT}	(Note 3)		0		2.2	nF
INPUT							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		2.5		12.6	V
Quiescent Supply Current	I_{IN}				27	35	µA
Change in Supply Current	I_{IN}/V_{IN}	2.5V ≤ V_{IN} ≤ 12.6V			0.8	2	µA/V

ELECTRICAL CHARACTERISTICS—MAX6191

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

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
OUTPUT							
Output Voltage	V_{OUT}	T_A = +25°C	MAX6191A	2.046	2.048	2.050	V
			MAX6191B	2.043	2.048	2.053	
			MAX6191C	2.038	2.048	2.058	
Output-Voltage Temperature Coefficient (Note 1)	TCV_{OUT}	MAX6191A			2	5	ppm/°C
		MAX6191B			4	10	
		MAX6191C			8	25	
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	2.5V ≤ V_{IN} ≤ 12.6V			10	100	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 ≤ I_{OUT} ≤ 500µA			0.12	0.55	µV/µA
		Sinking: -500µA ≤ I_{OUT} ≤ 0			0.18	0.70	
Short-Circuit Current	I_{SC}	Short to GND			4		mA
		Short to IN			4		
Temperature Hysteresis (Note 2)	ΔV_{OUT}/cycle				75		ppm
Long-Term Stability	ΔV_{OUT}/time	1000hrs at +25°C			50		ppm/1000hrs
DYNAMIC							
Noise Voltage	e_{OUT}	0.1Hz to 10Hz			40		$µV_{P-P}$
		10Hz to 10kHz			105		$µV_{RMS}$
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5V ±100mV, f = 120Hz			84		dB
Turn-On Settling Time	t_R	To 0.1%, C_{OUT} = 50pF			30		µs
Capacitive-Load Stability Range	C_{OUT}	(Note 3)		0		2.2	nF
INPUT							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		2.5		12.6	V
Quiescent Supply Current	I_{IN}				27	35	µA
Change in Supply Current	I_{IN}/V_{IN}	2.5V ≤ V_{IN} ≤ 12.6V			0.8	2	µA/V

ELECTRICAL CHARACTERISTICS—MAX6192

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

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
OUTPUT							
Output Voltage	V_{OUT}	T_A = +25°C	MAX6192A	2.498	2.500	2.502	V
			MAX6192B	2.495	2.500	2.505	
			MAX6192C	2.490	2.500	2.510	
Output-Voltage Temperature Coefficient (Note 1)	TCV_{OUT}	MAX6192A			2	5	ppm/°C
		MAX6192B			4	10	
		MAX6192C			8	25	
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	(V_{OUT} + 0.2V) ≤ V_{IN} ≤ 12.6V			15	140	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 ≤ I_{OUT} ≤ 500µA			0.14	0.60	µV/µA
		Sinking: -500µA ≤ I_{OUT} ≤ 0			0.18	0.80	
Dropout Voltage (Note 4)	V_{IN} - V_{OUT}	ΔV_{OUT} ≤ 0.2%, I_{OUT} = 500µA			100	200	mV
Short-Circuit Current	I_{SC}	Short to GND			4		mA
		Short to IN			4		
Temperature Hysteresis (Note 2)	ΔV_{OUT}/cycle				75		ppm
Long-Term Stability	ΔV_{OUT}/time	1000hrs at +25°C			50		ppm/1000hrs
DYNAMIC							
Noise Voltage	e_{OUT}	0.1Hz to 10Hz			60		$µV_{P-P}$
		10Hz to 10kHz			125		$µV_{RMS}$
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5V ±100mV, f = 120Hz			82		dB
Turn-On Settling Time	t_R	To 0.1%, C_{OUT} = 50pF			85		µs
Capacitive-Load Stability Range	C_{OUT}	(Note 3)		0		2.2	nF
INPUT							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		V_{OUT} + 0.2		12.6	V
Quiescent Supply Current	I_{IN}				27	35	µA
Change in Supply Current	I_{IN}/V_{IN}	(V_{OUT} + 0.2V) ≤ V_{IN} ≤ 12.6V			0.8	2	µA/V

ELECTRICAL CHARACTERISTICS—MAX6193

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

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
OUTPUT							
Output Voltage	V_{OUT}	T_A = +25°C	MAX6193A	2.998	3.000	3.002	V
			MAX6193B	2.995	3.000	3.005	
			MAX6193C	2.990	3.000	3.010	
Output-Voltage Temperature Coefficient (Note 1)	TCV_{OUT}	MAX6193A			2	5	ppm/°C
		MAX6193B			4	10	
		MAX6193C			8	25	
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	2.5V ≤ V_{IN} ≤ 12.6V			20	150	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 ≤ I_{OUT} ≤ 500µA			0.14	0.60	µV/µA
		Sinking: -500µA ≤ I_{OUT} ≤ 0			0.18	0.80	
Dropout Voltage (Note 4)	V_{IN} - V_{OUT}	I_{OUT} = 500µA			100	200	mV
Short-Circuit Current	I_{SC}	Short to GND			4		mA
		Short to IN			4		
Temperature Hysteresis (Note 2)	ΔV_{OUT}/cycle				75		ppm
Long-Term Stability	ΔV_{OUT}/time	1000hrs at +25°C			50		ppm/1000hrs
DYNAMIC							
Noise Voltage	e_{OUT}	0.1Hz to 10Hz			75		μV_{P-P}
		10Hz to 10kHz			150		μV_{RMS}
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5V ±100mV, f = 120Hz			80		dB
Turn-On Settling Time	t_R	To 0.1%, C_{OUT} = 50pF			100		µs
Capacitive-Load Stability Range	C_{OUT}	(Note 3)		0		2.2	nF
INPUT							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		V_{OUT} + 0.2		12.6	V
Quiescent Supply Current	I_{IN}				27	35	µA
Change in Supply Current	I_{IN}/V_{IN}	(V_{OUT} + 0.2V) ≤ V_{IN} ≤ 12.6V			0.8	2	µA/V

ELECTRICAL CHARACTERISTICS—MAX6194

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

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
INPUT							
Output Voltage	V_{OUT}	T_A = +25°C	MAX6194A	4.498	4.500	4.502	V
			MAX6194B	4.495	4.500	4.505	
			MAX6194C	4.490	4.500	4.510	
Output-Voltage Temperature Coefficient (Note 1)	TCV_{OUT}	MAX6194A			2	5	ppm/°C
		MAX6194B			4	10	
		MAX6194C			8	25	
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	(V_{OUT} + 0.2V) ≤ V_{IN} ≤ 12.6V			25	160	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 ≤ I_{OUT} ≤ 500µA			0.16	0.80	µV/µA
		Sinking: -500µA ≤ I_{OUT} ≤ 0			0.22	1.00	
Dropout Voltage (Note 4)	V_{IN} - V_{OUT}	ΔV_{OUT} ≤ 0.2%, I_{OUT} = 500µA			100	200	mV
Short-Circuit Current	I_{SC}	Short to GND			4		mA
		Short to IN			4		
Temperature Hysteresis (Note 2)	ΔV_{OUT}/cycle				75		ppm
Long-Term Stability	ΔV_{OUT}/time	1000hrs at +25°C			50		ppm/1000hrs
DYNAMIC							
Noise Voltage	e_{OUT}	0.1Hz to 10Hz			110		$µV_{P-P}$
		10Hz to 10kHz			215		$µV_{RMS}$
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5V ±100mV, f = 120Hz			76		dB
Turn-On Settling Time	t_R	To 0.1%, C_{OUT} = 50pF			180		µs
Capacitive-Load Stability Range	C_{OUT}	(Note 3)		0		2.2	nF
OUTPUT							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		V_{OUT} + 0.2		12.6	V
Quiescent Supply Current	I_{IN}				27	35	µA
Change in Supply Current	I_{IN}/V_{IN}	(V_{OUT} + 0.2V) ≤ V_{IN} ≤ 12.6V			0.8	2	µA/V

ELECTRICAL CHARACTERISTICS—MAX6195

(V_{IN} = 5.5V, I_{OUT} = 0nA, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
INPUT							
Output Voltage	V_{OUT}	T_A = +25°C	MAX6195A	4.998	5.000	5.002	V
			MAX6195B	4.995	5.000	5.005	
			MAX6195C	4.990	5.000	5.010	
Output-Voltage Temperature Coefficient (Note 1)	TCV_{OUT}	MAX6195A			2	5	ppm/°C
		MAX6195B			4	10	
		MAX6195C			8	25	
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	(V_{OUT} + 0.2V) ≤ V_{IN} ≤ 12.6V			25	160	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 ≤ I_{OUT} ≤ 500µA			0.17	0.85	µV/µA
		Sinking: -500µA ≤ I_{OUT} ≤ 0			0.24	1.10	
Dropout Voltage (Note 4)	V_{IN} - V_{OUT}	ΔV_{OUT} ≤ 0.2%, I_{OUT} = 500µA			100	200	mA
Short-Circuit Current	I_{SC}	Short to GND			4		mA
		Short to IN			4		
Temperature Hysteresis (Note 2)	ΔV_{OUT}/cycle				75		ppm
Long-Term Stability	ΔV_{OUT}/time	1000hrs at +25°C			50		ppm/1000hrs
DYNAMIC							
Noise Voltage	e_{OUT}	0.1Hz to 10Hz			120		μV_{P-P}
		10Hz to 10kHz			240		μV_{RMS}
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5.5V ±100mV, f = 120Hz			72		dB
Turn-On Settling Time	t_R	To 0.1%, C_{OUT} = 50pF			220		µs
Capacitive-Load Stability Range	C_{OUT}	(Note 3)		0		2.2	nF
OUTPUT							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		V_{OUT} + 0.2		12.6	V
Quiescent Supply Current	I_{IN}				27	35	µA
Change in Supply Current	I_{IN}/V_{IN}	(V_{OUT} + 0.2V) ≤ V_{IN} ≤ 12.6V			0.8	2	µA/V

ELECTRICAL CHARACTERISTICS—MAX6198

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

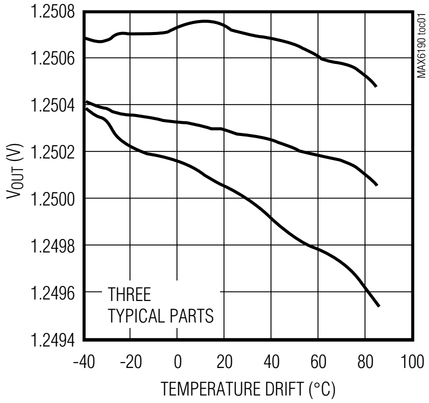
PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
OUTPUT							
Output Voltage	V_{OUT}	T_A = +25°C	MAX6198A	4.094	4.096	4.098	V
			MAX6198B	4.091	4.096	4.101	
			MAX6198C	4.086	4.096	4.106	
Output-Voltage Temperature Coefficient (Note 1)	TCV_{OUT}	MAX6198A			2	5	ppm/°C
		MAX6198B			4	10	
		MAX6198C			8	25	
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	(V_{OUT} + 0.2V) ≤ V_{IN} ≤ 12.6V			25	160	µV/V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	Sourcing: 0 ≤ I_{OUT} ≤ 500µA			0.15	0.70	µV/µA
		Sinking: -500µA ≤ I_{OUT} ≤ 0			0.20	0.90	
Dropout Voltage (Note 4)	V_{IN} - V_{OUT}	ΔV_{OUT} ≤ 0.2%, I_{OUT} = 500µA			100	200	mV
Short-Circuit Current	I_{SC}	Short to GND			4		mA
		Short to IN			4		
Temperature Hysteresis (Note 2)	ΔV_{OUT}/cycle				75		ppm
Long-Term Stability	ΔV_{OUT}/time	1000hrs at +25°C			50		ppm/1000hrs
DYNAMIC							
Noise Voltage	e_{OUT}	0.1Hz to 10Hz			100		$µV_{P-P}$
		10Hz to 10kHz			200		$µV_{RMS}$
Ripple Rejection	V_{OUT}/V_{IN}	V_{IN} = 5V ±100mV, f = 120Hz			77		dB
Turn-On Settling Time	t_R	To 0.1%, C_{OUT} = 50pF			160		µs
Capacitive-Load Stability Range	C_{OUT}	(Note 3)		0		2.2	nF
INPUT							
Supply Voltage Range	V_{IN}	Guaranteed by line-regulation test		V_{OUT} + 0.2		12.6	V
Quiescent Supply Current	I_{IN}				27	35	µA
Change in Supply Current	I_{IN}/V_{IN}	(V_{OUT} + 0.2V) ≤ V_{IN} ≤ 12.6V			0.8	2	µA/V

Note 1: Temperature Coefficient is measured 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 +25°C output voltage before and after cycling the device from T_{MIN} to T_{MAX}.
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 MAX6195).

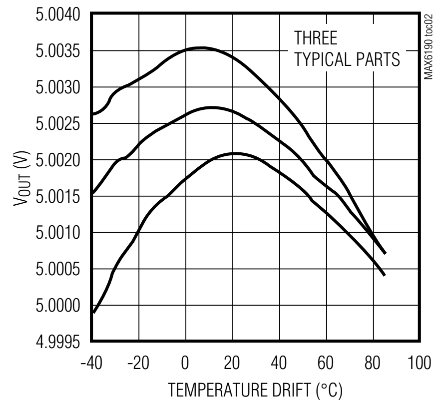
Typical Operating Characteristics

(V_{IN} = 5V for MAX6190/1/2/3/4/8, V_{IN} = 5.5V for MAX6195; I_{OUT} = 0nA; T_A = +25°C; unless otherwise noted.) (Note 5)

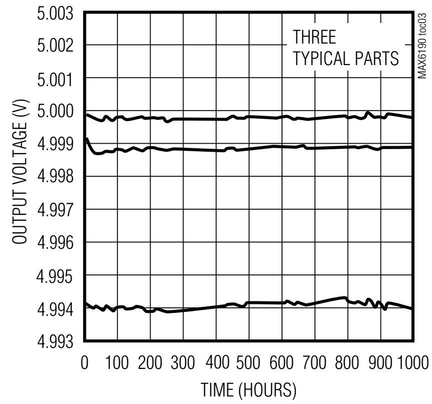
MAX6190 OUTPUT VOLTAGE TEMPERATURE DRIFT



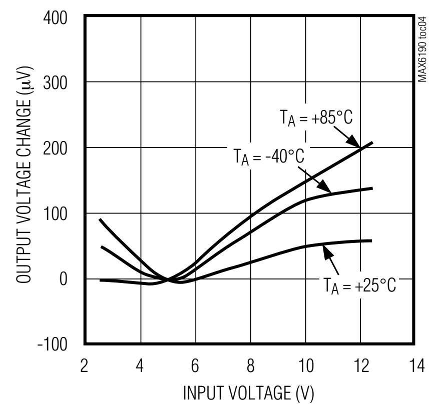
MAX6195 OUTPUT VOLTAGE TEMPERATURE DRIFT



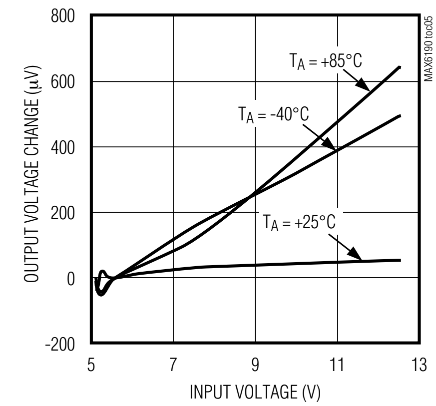
MAX6195 LONG-TERM DRIFT



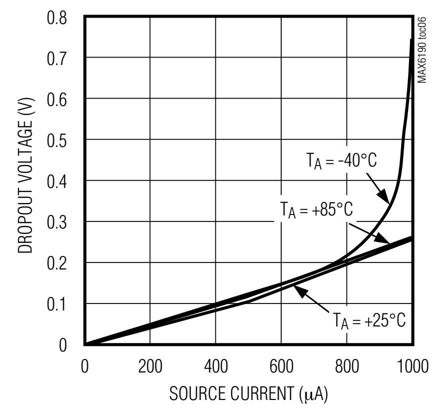
MAX6190 LINE REGULATION



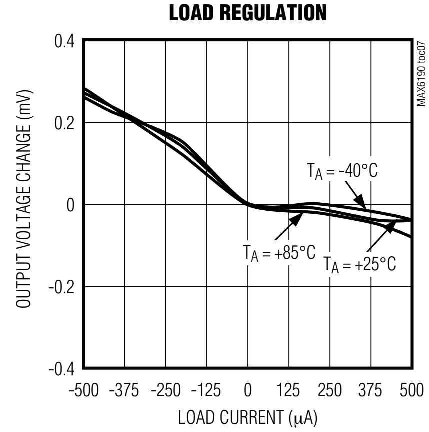
MAX6195 LINE REGULATION



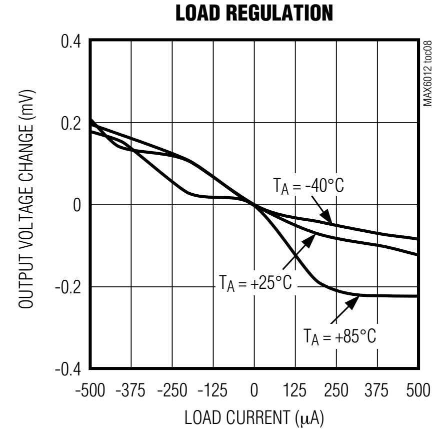
MAX6192/MAX6193 DROPOUT VOLTAGE vs. SOURCE CURRENT



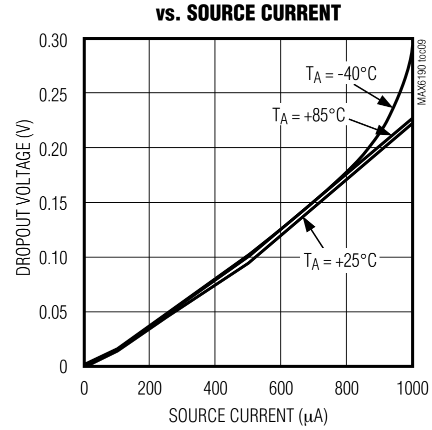
MAX6190 LOAD REGULATION



MAX6195 LOAD REGULATION



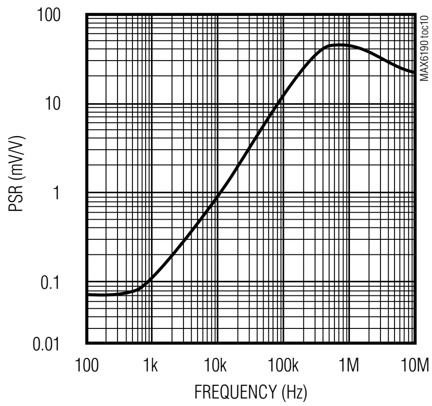
MAX6194/MAX6195/MAX6198 DROPOUT VOLTAGE vs. SOURCE CURRENT



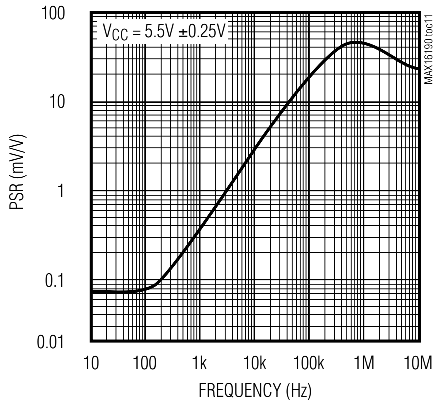
Typical Operating Characteristics (continued)

(V_{IN} = 5V for MAX6190/1/2/3/4/8, V_{IN} = 5.5V for MAX6195; I_{OUT} = 0nA; T_A = +25°C; unless otherwise noted.) (Note 5)

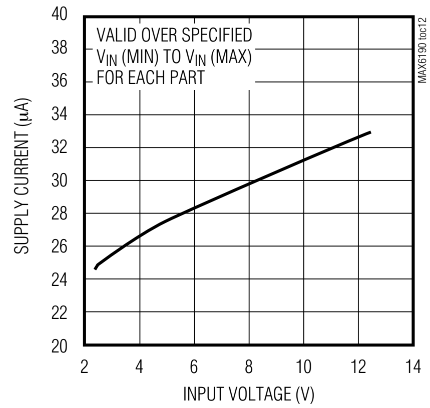
MAX6190 POWER-SUPPLY REJECTION vs. FREQUENCY



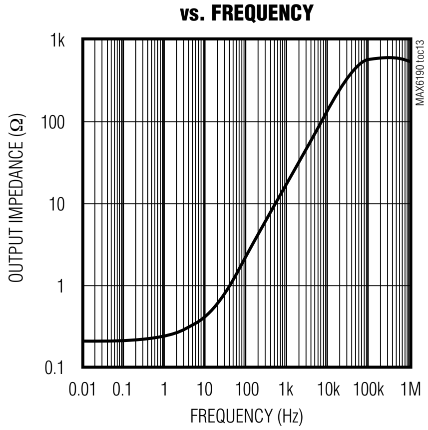
MAX6195 POWER-SUPPLY REJECTION vs. FREQUENCY



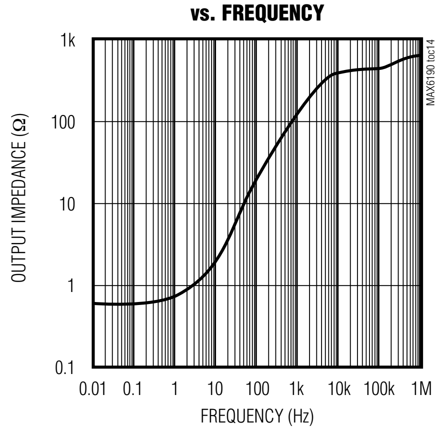
SUPPLY CURRENT vs. INPUT VOLTAGE



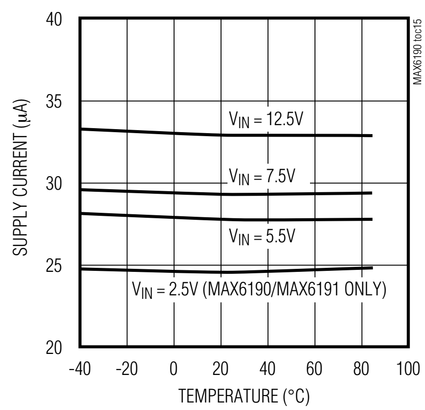
MAX6190 OUTPUT IMPEDANCE vs. FREQUENCY



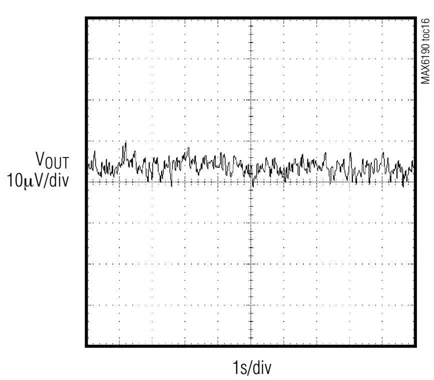
MAX6195 OUTPUT IMPEDANCE vs. FREQUENCY



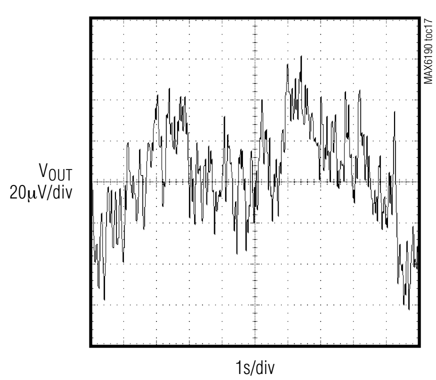
SUPPLY CURRENT vs. TEMPERATURE



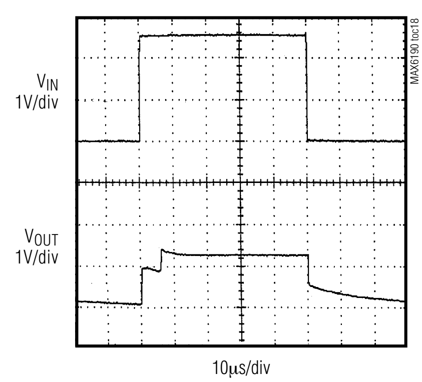
MAX6190 0.1Hz TO 10Hz OUTPUT NOISE



MAX6195 0.1Hz TO 10Hz OUTPUT NOISE



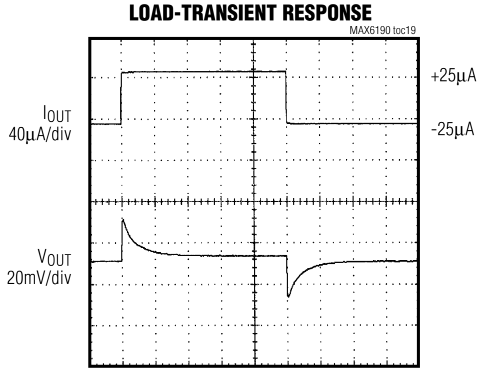
MAX6190 TURN-ON TRANSIENT



Typical Operating Characteristics (continued)

(V_{IN} = 5V for MAX6190/1/2/3/4/8, V_{IN} = 5.5V for MAX6195; I_{OUT} = 0nA; T_A = +25°C; unless otherwise noted.) (Note 5)

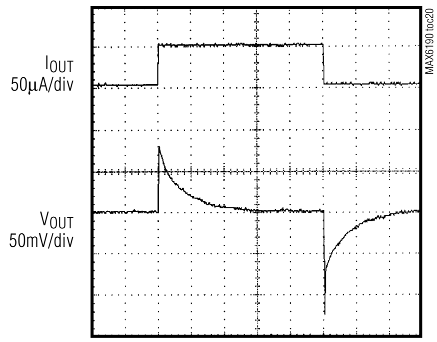
MAX6190 LOAD-TRANSIENT RESPONSE



10µs/div

I_{OUT} = ±25µA, AC-COUPLED

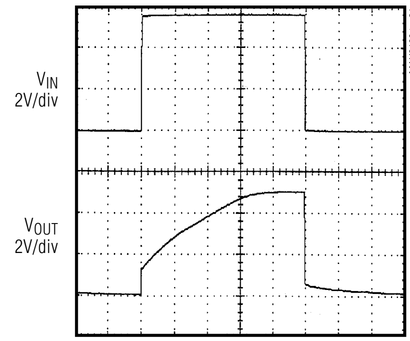
MAX6195 LOAD-TRANSIENT RESPONSE



20µs/div

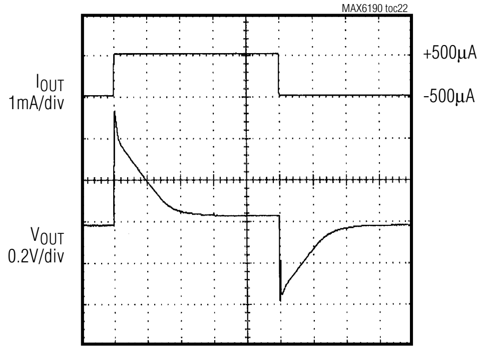
V_{IN} = 5.5V, I_{OUT} = ±25µA, AC-COUPLED

MAX6195 TURN-ON TRANSIENT



10µs/div

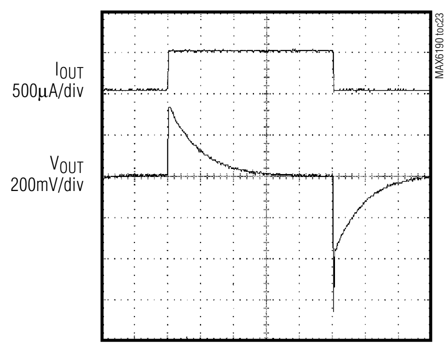
MAX6190 LOAD-TRANSIENT RESPONSE



10µs/div

I_{OUT} = ±500µA, AC-COUPLED

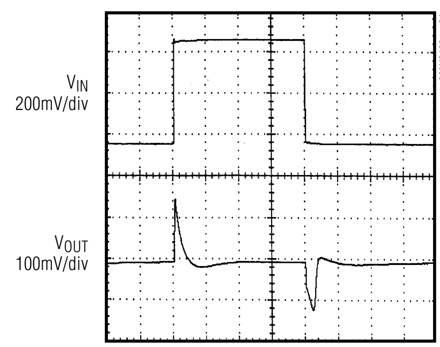
MAX6195 LOAD-TRANSIENT RESPONSE



20µs/div

V_{IN} = 5.5V, I_{OUT} = ±500µA, AC-COUPLED

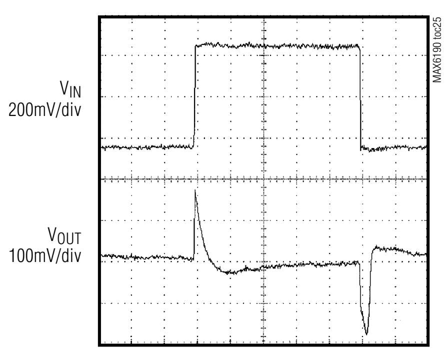
MAX6190 LINE-TRANSIENT RESPONSE



2.5µs/div

V_{IN} = 5V ±0.25V, AC-COUPLED

MAX6195 LINE-TRANSIENT RESPONSE



2µs/div

V_{IN} = 5.5V ±0.25V, AC-COUPLED

Note 5: Many of the *Typical Operating Characteristics* of the MAX6190 family are extremely similar. The extremes of these characteristics are found in the MAX6190 (1.2V output) and the MAX6195 (5.0V output) devices. The *Typical Operating Characteristics* of the remainder of the MAX6190 family typically lie between these two extremes and can be estimated based on their output voltage.

Precision, Micropower, Low-Dropout Voltage References

Pin Description

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

Detailed Description

The MAX6190–MAX6195/MAX6198 precision bandgap references use a proprietary curvature-correction circuit and laser-trimmed thin-film resistors, resulting in a low temperature coefficient of <5ppm/°C and initial accuracy of better than 0.1%. These devices can sink and source up to 500µA with <200mV of dropout voltage, making them attractive for use in low-voltage applications.

Applications Information

Output/Load Capacitance

Devices in this family do not require an output capacitance for frequency stability. They are stable for capacitive loads from 0 to 2.2nF. However, in applications where the load or the supply can experience step changes, an output capacitor will reduce the amount of overshoot (or undershoot) and assist the circuit's transient response. Many applications do not need an external capacitor, and this family can offer a significant advantage in these applications when board space is critical.

Supply Current

The quiescent supply current of these series-mode references is a maximum of 35µA and is virtually independent of the supply voltage, with only a 0.8µA/V 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 all the time. In the series-mode MAX6190 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 can help reduce power dissipation and extend battery life.

When the supply voltage is below the minimum specified input voltage (as during turn-on), the devices can draw up to 200µA 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 output 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 75ppm.

Turn-On Time

These devices typically turn on and settle to within 0.1% of their final value in 30µs to 220µs, depending on the device. 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.

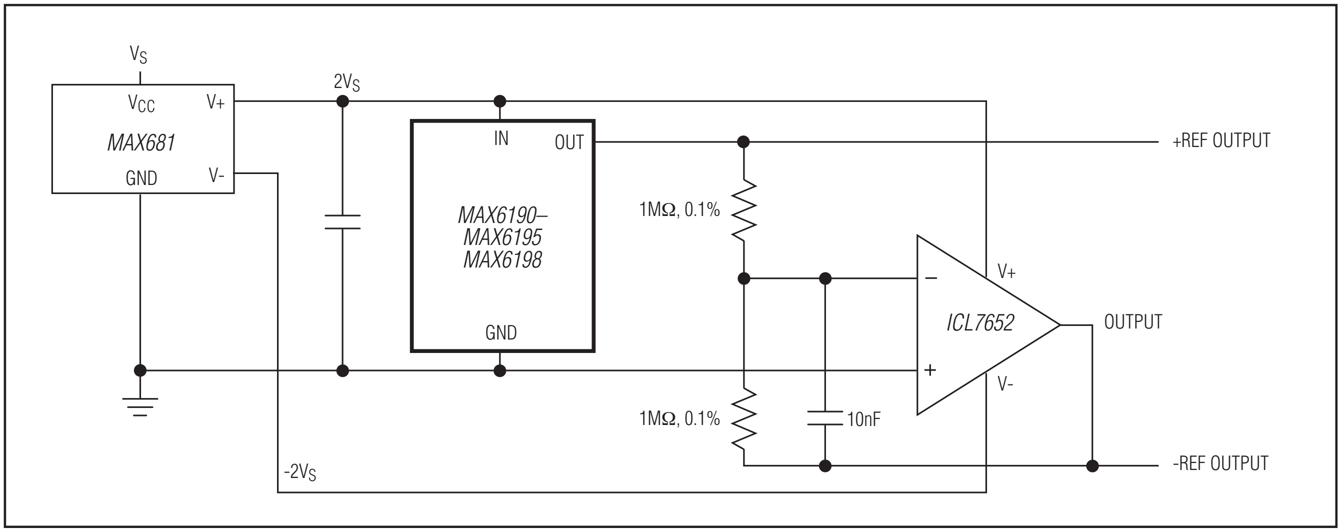


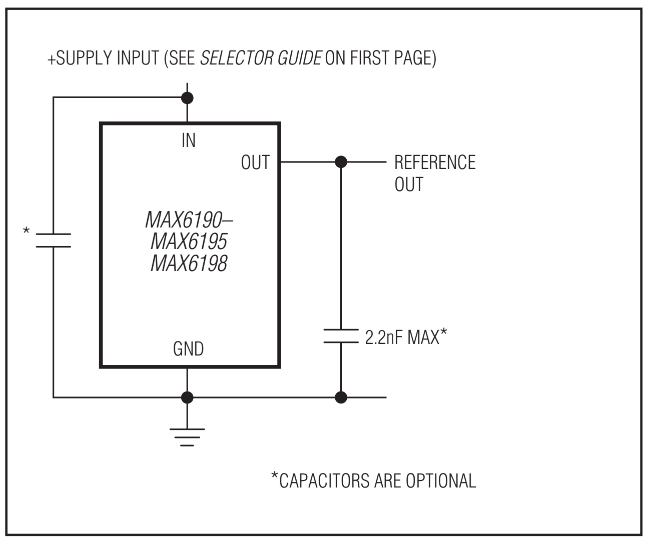
Figure 1. Positive and Negative References from Single 3V or 5V Supply

Ordering Information (continued)

PART	TEMP RANGE	PIN-PACKAGE
MAX6193AESA+	-40°C to +85°C	8 SO
MAX6193BESA+	-40°C to +85°C	8 SO
MAX6193CESA+	-40°C to +85°C	8 SO
MAX6194AESA+	-40°C to +85°C	8 SO
MAX6194BESA+	-40°C to +85°C	8 SO
MAX6194CESA+	-40°C to +85°C	8 SO
MAX6195AESA+	-40°C to +85°C	8 SO
MAX6195BESA+	-40°C to +85°C	8 SO
MAX6195CESA+	-40°C to +85°C	8 SO
MAX6198AESA+	-40°C to +85°C	8 SO
MAX6198BESA+	-40°C to +85°C	8 SO
MAX6198CESA+	-40°C to +85°C	8 SO
MAX6198AESA/V+	-40°C to +85°C	8 SO

+Denotes a lead(Pb)-free /RoHS-compliant package.
/V denotes an automotive qualified part.

Typical Operating Circuit



Chip Information

PROCESS: BiCMOS

Package Information

For the latest package outline information and land patterns (footprints), go to **www.maximintegrated.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	OUTLINE NO.	LAND PATTERN NO.
8 SO	S8+2	**21-0041**	**90-0096**

MAX6190–MAX6195/MAX6198

Precision, Micropower, Low-Dropout Voltage References

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
3	4/10	Added automotive grade part, added lead-free information, and made style changes	1–14

Maxim Integrated 160 Rio Robles, San Jose, CA 95134 USA 1-408-601-1000